Pedro Waloschek

Death-Rays as Life-Savers in the Third Reich

This is a draft English version of the report:
“Todesstrahlen als Lebensretter - Tatsachenberichte aus dem dritten Reich”
published (in German) in 2004.

To all my friends

Pedro Waloschek

Death-Rays as Life-Savers in the Third Reich

Contents

Foreword

Today we know that the ‘death rays’ made famous through science fiction literature and cinema were never actually deployed, and certainly not during World War II. The extensive literature on secret weapons provides us with very few mentions of ‘death rays’, and most of these refer to desperate publicity stunts by the German leadership towards the end of the war (see i.e. [Fo92] [Ir64] [Jo78a] [Jo78b]). However, several proposals were made, which led to the establishment of real research and development projects that aimed (or hoped) to achieve the development of ‘death rays’, or at least to gather some of the knowledge considered indispensable for the realisation of such weaponry. This does not belong to the world of conjecture; there is real evidence of activity, which can be reconstructed thanks to archive documents and witness statements.

Towards the end of the war, scientists in Germany tried to make use of what funds were still available for research work. Some of these projects were sensible, others less so. They also used such projects as pretexts to save their employees from war services (see Schiebold) or from deportation in concentration camps (see Schmellenmeier). Most of them were already thinking in terms of post-war scientific or commercial applications. So they were supported and encouraged by industrial firms like Brown Boveri (BBC), Philips and Siemens, which expected a future market for X-ray-producing machines for hospitals. And they were in strong competition with US-firms like General Electric.

However, in order to obtain the materials, financial support and services required for a project, several scientists found it expedient to declare that their work was of vital importance to the war effort. Their chances of success fared even better if they could assert that their developments were indispensable for producing a specific weapon, which could prove decisive for a conclusive (and somewhat miraculous) victory. Sometimes these proposals were explicit, and

unambiguous (albeit secret) reports were submitted to the authorities in writing. But in other cases suggestions were raised only orally, and the paperwork that was presented merely served to hide the military purpose of these projects behind a smokescreen of civilian intent. To some extent the scientists were able to play this game thanks to the Nazi leadership's lack of technical and scientific understanding. Furthermore, it was unlikely that experts with opposing viewpoints would raise any objections to a project considered essential to the war effort since this would have been considered in general as rank defeatism.

Nevertheless the world was afraid of Hitler's miracle weapons and particularly his death rays. What was the truth behind these death rays? And how had the German Luftwaffe and other authorities been convinced of the case for making substantial research and development efforts to produce such death rays? This is the area under discussion.

The subject began to fascinate me in my youth. My aim is to present the collection of data I have accumulated over many years, and make it accessible to others in a way that I hope will be interesting and easy to understand.

I have been particularly interested in the lives and problems of the people involved in the 'death ray' projects, and I hope that the information I present will contribute to the elimination of some of the myths and prejudices that arose after the war, mainly as a result of the (sometime justified) silence of the participants. This particularly affected the excellent scientists Ernst Schiebold and Rolf Wideröe. I have tried to fill some of the gaps in their curriculum vitae with factual and objective information.

I have generally limited myself to presenting verifiable data on devices which were actually built. Some of the proposals that have come to my attention over the years were quite serious but never rose above the level projects or were immediately rejected and I do not describe them here. I have reduced technical details to a minimum, although I have provided references whereby the interested reader can obtain additional information. Some drawings with short explanations should help understanding the texts.

As is naturally the case for any type of historic research, the work can continue ad infinitum; some questions will always remain unanswered and some new ones might come up. In this respect I would like to remark that access to documents and information about the time of World War II has improved in recent years and that new sources are therefore available.

It would be a great pleasure to me if the information I have presented here also serves as basis or encouragement for further investigation. For this reason I have mentioned as accurately as possible all references used and the names and facts contained in my documentation. And I welcome any comments and suggestions.

Pedro Waloschek
Hamburg, August 2004

Note on the English version.

After the publication of the last German version of the present report [Wa04a] I had to translate several parts of it into English and Spanish for particularly interested readers and friends. So it became soon clear that a complete translation would be quite useful and work was started by my daughter Karen, a professional translator in GB, in her spear time. She had already successfully translated my book on Wideröe´s autobiography [Wa93].

Up to now Karen was able to provide English versions of the texts of the first four (of seven) chapters. The remaining parts are now available in my so called “brenglish”, that is, the “broken English” often used by physicists in their publications. It is a not very elegant but understandable language. I hope that one day an improved version will be available and in the meantime the status of the present version can be consulted and downloaded as a compact (screen version) pdf-file from the DESY-Library (www-library.desy.de/elbook.html) and from my homepage (www.waloschek.de). And I welcome any corrections, comments and suggestions which can be sent to me through the “Kontakt” facility of my homepage.

Recently some new and interesting data became available. Accordingly I have tried to include them into the English version. Important contributions came particularly from Luisa Bonolis (Rome) who is working on the biography of Bruno Touschek together with Giulia Pancheri [Bo11]. So they found out, that the famous and important article on betatrons by Rolf Wideröe of 1942 [Wi43] had never been printed or published. In addition, Luisa and Giulia were able to reconstruct the chronology of the last months of the 15-MeV betatron in Hamburg based on over 100 letters Bruno Touschek did send to his parents in Vienna. They have been conserved by his widow Elsbeth Younge Touschek and had never been inspected before.

Pedro Waloschek
Hamburg, February, 2012

1 Some Personal Memories of 1943

In March 1943 I had just passed the entrance examination to the state grammar school, 'Colegio Nacional de San Isidro' and found myself in a class of 27 privileged young people. In accordance with Argentinean regulations, in five years time we would obtain free of any charges our 'bachillerato' (A-levels) needed to have access to universities. Nationality, religion and race were immaterial to this system, and most of my schoolfellows came from middle class backgrounds. Among them was Germán Armando Plett, a tall, blond boy whose father ran a glazing company and whose ancestry lay in Germany. Germán was a bit of a know-all, especially as regards the war that was raging at the time. His opposite number was Guillermo Isaac Mintz, the son of a well-to-do Jewish businessman. Flat feet and a plump and crooked nose augmented his overall chubbiness, and he frequently found himself at the receiving end of Plett's spite and ridicule.
In the schoolyard, Plett would share with us his opinions and boundless knowledge. He did so at a volume that was loud enough for everyone to hear, whether they wanted to or not. In this way we learnt that German scientists had succeeded in developing a range of amazing miracle weapons, which would help 'us' to a quick and conclusive Second World War victory. Naturally he assumed that 'we' were all on his and his pal Hitler's side – except, perhaps, for Guillermo Isaac Mintz and Pablo Vicente Lloyd. Pablo, whom we preferred to call by his English name Paul, was a placid boy with a British businessman father and a charming Danish mother. Guillermo and Paul were my best friends.

Germán Armando Plett's knowledge was scraped together from the 'Deutsche La Plata Zeitung' (German La Plata Newspaper) and the nightly German radio broadcasts he was devoted to. He would rhapsodise about the German army's triumph as it embarked on a strategic retreat from the occupied regions of the Soviet Union. Ecstatically he recounted the heroic deeds accomplished by the

German troops in Stalingrad, who could only have been betrayed into a hasty surrender to the Russians in January and February 1943. Time and again he recounted the glorious achievements in Africa of General Field Marshall Erwin Rommel, even though he was actually on his way out by then. Rommel was recalled from Africa on 9th March 1943, but Plett did not know this until two months later. Although Plett kept meticulous lists of all the allied ships that were sunk, he was blissfully unaware of any German U-boat losses. He considered the reality that bombs were now being dropped on German cities as just a temporary blip. The fact that Bolshevik troops were receiving support from the (Jewish-dominated) USA in the form of modern war materials confirmed Plett's opinion that Bolsheviks and Jews could not be permitted to exist in the thousand-year Reich. They, so he liked to tell us, would be exterminated. Just like vermin.

And so in 1943 total victory was going to be achieved with the help of top secret 'miracle weapons' since conventional means did not seem to be doing the job quite as swiftly as was hoped. This is when I first came across the concept of 'death rays', weapons that could bring down aircraft and destroy entire companies in one fell swoop. More on these in later chapters. I vaguely remember that Plett's strident orations, or perhaps the discussions that ensued as a result of his proclamations, also included unmanned aircraft and long-range missiles. Plett definitely claimed that a bombardment of New York would soon be possible.

When I came home my father would silently place a newspaper on the table for me to read, which provided me with an entirely different set of news. Father generally brought from his office in town the 'Argentinisches Tageblatt' (Argentinean Daily Newspaper). The Swiss immigrant Johann Alemann and his son Moritz had founded this liberal and democratically aligned newspaper in Buenos Aires in 1878. Although the newspaper was entirely opposed to the Nazis, it also featured reports about German secret weapons. There had been claims that these would turn things around for Germany. Although the reports were taken fairly seriously, few doubted the Allies would eventually win once the Americans had entered the war in December 1941. By 1943

only the most blinkered fanatic (i.e. Germán Armando Plett) had any faith in a German victory.

At home in Buenos Aires we had pinned a large map of Europe on a board. This map had been produced and distributed by the 'German La Plata Newspaper' at the beginning of the war in anticipation of a predicted conquest of the Ukraine (Europe's corn basket). Like so many others I used to pin little coloured flags on the map to record the progress of the front lines. Even to a fourteen year old as me the war situation was crystal clear.

My parents chose their words with great care and discretion when they spoke about the war and about politics. They had endured years in fear that Hitler may win. The general mood in Argentina tended to be pro-Germany and, for a variety of reasons, the Germans were held in high regard.

Back in 1933, following several interrogations by the armed Nazi party police (SA and SS), after all his files and documents had been seized, and his projects cancelled (he had been a successful architect in Dresden until that time), my father managed to escape Germany narrowly avoiding arrest. For him the possibility of a German victory must have been an utter nightmare, yet he never spoke about it. On the contrary he stubbornly declared that his leaving Germany in 1933 and then Vienna in 1936 had been voluntary and that his emigration had been in search of work. His earlier political activity as a committed Social Democrat and his father-in-law's Jewishness were facts he either decided to ignore or repress. His policy of silence was so rigorous that my sister Jutta and I were not entirely sure for a while whether 'we' (i.e. our family) were supposed to be for the Germans or the Allies. It came as quite a shock when my sister did eventually discover that she had a Jewish grandfather.

My father's family in Vienna was not having an easy time of it either. His mother had always been an advocate of the annexation of Austria's to the much-admired German Reich. When this finally happened in 1938 most Austrians cheered. My father's sister Emmy (my aunt) wrote us long letters (which I still have [Wa00]) expressing at length her veneration of the Führer and his achievements, and her hatred for Jews and trade unions. In these letters she also reproached

my father for deserting the 'Reich' in its hour of need when his skills as an architect were so urgently required. She signed off each letter with a great big „Heil Hitler!" Emmy was very proud of her husband who became a Luftwaffe (German air force) mechanic and, thanks to her political views; she was able to cultivate profitable relationships with the inhabitants of a military barracks in the forest to the west of Vienna, which she frequently visited. On her return she would usually bring back cigarettes or chocolate. To boot, she and her brother (my uncle Willi) each lived in one half of a pair of semi-detached houses. His wife had Jewish origins and conflict was inevitable. Many years later their neighbours still remembered their forceful disagreements.

However, by 1943 things had already changed quite a lot. Apart perhaps of my aunt Emmy and some of her friends most Austrians had put aside their enthusiasm for the Führer, and mainly they yearned for an end of the war. Yet Argentina was a long way away, and Germán Armando Plett was still bellowing out his poison and threatening Guillermo Isaac Mintz with imminent extermination. Other than that, by then only few could still have believed in Germany's ultimate victory.

Let me add some very personal remembrances. In the spring of 1943, while I was studying at my Buenos Aires grammar school, playing tennis with Paul at the 'Club Atlético San Isidro' in the afternoons, and sticking little flags in the map of Europe in the evenings, my maternal grandfather Karl Stark spent his time in a shed in Essling on the outskirts of Vienna. There he sat at a small table, where he used blue ink to write into an exercise book that had been roughly bound with a skimpy thread. He was copying from another exercise book, which he had previously copied from an even older one. Perhaps this is how the scribes in the synagogues used to deal with the pages of the Talmud. His father, and his grandfather before him may have done the same, although it is unlikely that his father Emanuel wrote a great deal since he was a kosher butcher by profession. Karl and his father had moved to Vienna from Trenzin, which at that time was part of Hungary. Karl was only 14 when his father died and he took over at the family's helm. Henceforth he was best known by the Hungarian soubriquet of 'Patschi' or 'Stark-Patschi'. But he was not a good 'Patschi'. He left

home before his two sisters were married, had a catholic girlfriend and declared himself a free-thinking atheist. All these were against the strict rules of his Jewish family and he was casted out. He had to hide to visit secretly his sisters. Later on he took me and my sister several times with him, as we still remember.

Karl became a typesetter, which is probably how he developed such a deep fondness for the written word; words, which he carefully inscribed into his booklet. Like Holy Scripture, he hoped that these few written words would remain in some way after his death. He hid the exercise books in various places, and a few pages have indeed served the purpose for which they were intended. My sister Jutta discovered them by chance in 2001 in the box room of her flat in Vienna. Grandfather Karl and his wife Antonia had moved into the very same flat back in 1923. However, after the outbreak of war (1939) he spent most of his time on the allotment in Essling where he could grew some vegetables, an essential task during that period.

When visiting his wife Antonia in his own home in Vienna's sixth district, Karl had to wear his grey coat with the palm-sized yellow Star of David, which Antonia had sown on for him - as required by law after the 19th of September 1941. Yet he never stayed long. From the window of her second floor flat Antonia had observed the trucks that occasionally came to collect the Jews who lived in her street. These people were never heard of again. And most neighbours claimed afterwards, that they had not seen anything. However, the trucks came and went in a rush and only ever took those Jews who were at home when the soldiers called. Karl Stark was not usually at home.

Antonia herself had little to fear since she was in possession of various documents with which she could prove her Aryan credentials, including an impeccable 'Certificate of Aryan Descent' in the form of a bright red booklet (which I keep in a safe place) with an Eagle and a swastika on the front. The documents described all of her ancestors as 'Roman Catholic', which, although it makes little sense from a purely biological point of view, is the only workable definition of the 'Aryan race' that could be applied. This definition continues to be used in certain circles. The way I understand it applicants to the Nazi-SS-troops had to prove three generations of pure Aryan (i.e. non-Jewish)

ancestry in order to qualify for service, whereas ordinary citizens had to prove only two for their blood to be considered pure or sufficiently Germano-Nordic.

Antonia's Certificate of Aryan Descent did have one flaw. The entry for her husband's religion read, „Hebrew". However, since he was never at home, she could (and did) tell the authorities that she had no idea where he was.

Furthermore, on the 26th of June 1939 my grandfather was forced to add 'Israel' to his name and so became 'Karl Israel Stark'. According to regulations they were also ordered to share their home with another 'non-Aryan' family but - probably thanks to Vienna's legendary sloppiness - this never happened.

Grandfather Karl was not afraid. He sent letters and postcards to Argentina in which he wrote about his life. He always wrote out his name and address in full. However, the post was heavily censored at the time, and any lines deemed unacceptable by the authorities were carefully cut out. The last letter we received from grandfather during the war was dated 25th September 1941, and we got no more post until late in 1946. My mother kept and filed each and every scrap of correspondence.

But let's return to the hand-written pages from Karl Stark's exercise book. Some of the pages seem to have been used to record addresses, and some names had a familiar ring to them. There are references to family birthdays, in some cases the dates on which relatives died, and occasionally he noted the date on which people had left Vienna:

„Hans Waloschek, left on 17th September 1936" (my father)

„Grete, Peter and Jutta, left on 28th March 1937" (my mother, I and my sister)

„Eduard Stark, left on 19th February 1939" (Karl's eldest son, an active Social Democrat)

„The Bibers, left on 25th July 1939" (Antonia's sister and her family)

There are also entries about his two sisters:

„Mathilde Stark, born on 6th November 1875. Taken away on 5th January 1942"

„Helene Grau, nee Stark, born on 11th January 1879. Taken away on 5th January 1942".

Although strictly speaking they were our great aunts, we called them Auntie Minna and Auntie Leni. They were 'taken away' after denunciation by a racially 'blameless' Aryan, who coveted their well-situated apartment in Vienna. It was as simple as that. I was told subsequently that they did not suffer long. Too old to work, they were 'selected' for the gas chambers as soon as they arrived in the camp.

Another note referred to my uncle Felix, Karl Stark's younger son:

„Dr. Felix Stark, Ried am Riederberg – Physicist at Lorenz, Berlin".

Much later, Uncle Felix recounted that he and his entire family and household goods were forced to move from Vienna to Berlin so that he could work on a top secret project related to the notorious rocket propelled V2 bombs. He had to promise formally, never to speak about it. He was treated extremely well, and not a single piece of his valuable china was broken in transport, not even when they were all moved back to Austria before the end of the war.

Already on the 10th of June 1938 Uncle Felix had written to us in Argentina:

„A decision has finally been made about what is to become of me. According to a law passed on 5th June, I cannot remain at my post; firstly because I am of mixed race and secondly, because my wife is of mixed race."

Until that point in time he had been a grammar school physics teacher and held a post in Vienna's schools inspectorate. He received a small settlement and, at the age of 32, was forced into retirement. He sought work in industry and eventually trained as an electrician. By this route he did eventually find employment and was subsequently moved to Berlin where, according to Karl Stark's booklet, he worked for Lorenz. No one in the company was greatly bothered by his non-Aryan origins; after all, he was working for victory. This is probably where he was in the spring of 1943, by which time his brother Eduard, the active Social Democrat, had become a detainee in a British internment camp.

I am quite certain that my family, with its conflicts, contradictions and separations, was not exceptional in Vienna. In fact I would even go so

far as to claim that it was typical, one of many similar fates during the Third Reich period.

———

2 Science Fiction and Reality

My friend Paul, Pablo Vicente Lloyd that is, asked his father about the German secret weapons we had discussed at school. His father was not surprised. The British newspapers and journals he subscribed to in Argentina mentioned death rays quite often. A famous and rather eccentric Welsh inventor died in September 1941. He had been known as 'Mister Death Rays' although his real name was Harry Grindell-Matthews. There were many press reports about this apparently brilliant man who during World War One had come up with some remarkable inventions, many of which were military in character. His biography was published in 1943 in London, although I have never seen a copy of it myself [Ba43].

Back in 1924 Harry Grindell-Matthews had publicly presented a device capable of producing invisible rays that could kill mice, light gun powder and even stop a small petrol engine by upsetting its ignition, all from a distance of only a few metres. His small set-up and the principle he had invented allowed him to make conjectures about the possibility of bringing down aeroplanes and destroying armies. His real hope however, was that this invention would make future wars an impossibility. The interest of Parliament and the British Ministry of Aviation was awakened, but when a representative of the Ministry exposed himself to the 'beam' from a distance of just a few metres distance and consequently suffered no damage whatsoever, the enthusiasm cooled. After all, the inventor had stated that his beam should have the capacity of killing people at a few miles distance.

Nevertheless, the Ministry of Aviation did make Grindell-Matthews a modest offer. They would provide him with a bigger petrol engine for further tests. He refused and moved to the USA where, as he later declared, he sold his invention.

This is what I remember Paul's father telling us about Grindell-Matthews. I could confirm some of it with the help of the Internet but this cannot be in all cases considered a reliable source.

With the hindsight afforded by the knowledge we have today one could hazard a guess that Grindell-Matthews' invisible rays may have been the intensive gamma-rays of a radioactive substance, or perhaps hard X-rays produced with the help of tubes that were already commercially available at the time. Naturally, this would presuppose that his shows were more than just highly sophisticated magic tricks. Other types of radiation, such as a beam of sufficiently fast electrons, would have produced visible tracking in the air. Furthermore, in order to accelerate the electrons Grindell-Matthews would have required a bulky high voltage generator, which he does not seem to have used in any of his shows.

However, there are other explanations for Grindell-Matthews' rays, for example, those put forward by the President of 'HSV Technologies Inc.' in San Diego, California, Peter Anthony Schlesinger and his collaborators. These explanations appeared on the Internet in 1999/2000 [SP99], and were formulated in a fairly reasonable way. The claim was that Grindell-Matthews used deep-ultraviolet radiation to prepare a thin electrically conducting channel by ionising air molecules, that is by separating electrons from their molecules. Similar experiments were described already prior to 1900. From reports in newspapers and the biography of Grindell-Matthews Schlesinger reconstructed that in 1924 Grindell-Matthews must have used adequate ultraviolet radiation produced by 'multiple electric arcs'. Such devices were used as searchlights during World War II. As soon as the conducting path in air was available, it can be used to transmit and guide very intensive electric currents to a target. Electromechanical devices could be destroyed from a distance of half a mile.

Schlesinger also reported that special lasers can now be efficiently used to produce very intense and well collimated ultraviolet radiation beams. This type of radiation can ionise air in a narrow channel, so allowing it to conduct short pulses of high frequency alternate electrical current. This is the basic idea behind HSV Technologies Inc.'s proposals, (i) to destroy the electronic components of motor vehicles using a method they dubbed the 'Vehicle Disabling Weapon' or VDW, and (ii) to temporarily immobilise living organisms. The estimated, theoretical range for operational devices is two kilometres. According to

Schlesinger, successful tests with smaller installations have already been performed at the University of California in San Diego and three patents submitted. One of the interesting applications mentioned by Schlesinger is the pursuit and apprehension by the police of fugitive vehicle driver. However, since Schlesinger's last Internet announcement in February 2000 I have been unable to find any further reports on practical results or successes regarding the VDW.

Around 1930 Grindell-Matthews' name hit the headlines again, after he produced some astonishing light effects in the cloudy skies of New York and London. Four years later he formulated some adventurous proposals for defending London against air attack by using a variety of means including balloons, cables and nets.

By 1935 the British realised that Hitler was building up a powerful air force. In response to this a serious proposal was made for the use of 'death rays', consisting of strongly focussed electromagnetic waves, as a defence against possible German air attack. It is unlikely that this had any connection with Grindell-Matthews' ideas. The physicist Reginald Victor Jones (1911-1997) worked for British Intelligence during the war, and he makes a brief mention of this proposal in his book 'Most Secret War' [Jo78a]. The British abandoned these plans once they realised that the technology available to them at the time was simply not advanced enough. In the end, therefore, not one of the 'death ray' proposals, including those of Grindell-Matthews, was ever realised or taken seriously. By the time Grindell-Matthews died in 1941, London had already been subject to repeated bomb attacks by German aircraft.

However, there had been other, earlier death ray inventions. Whereas Grindell-Matthews remained relatively unknown, the life and ideas of the brilliant Croatian-American physicist and inventor Nicola Tesla (1856-1943) have been accessible to the public thanks to a great many articles and books [Te02].

Nicola Tesla was born on July 9, 1856 in Croatia, studied physics in Graz (Austria) and followed courses on philosophy in Prague. He immigrated to the USA in 1884. Tesla made several important contributions to the field of electrical engineering and developed many other applications of electromagnetism. The induction motor (without

contact brushes) is one of his most famous inventions, and was a major factor in the introduction of alternate current (AC) as an expedient substitute for direct current (DC), which Tesla's famous rival Thomas Alva Edison (1847-1931) was championing at the time.

Tesla also developed a double coil, named after him the 'Tesla transformer'. It allows the production of alternate currents of high frequency ('Tesla currents') which can cause extremely high voltage discharges. The Tesla transformer subsequently found many useful applications.

The internationally used unit for 'magnetic induction' (which is one of the parameters that define the strength of a magnetic field) has been officially called 'Tesla' in honour of the great inventor. This should partially compensate the fact that Tesla was never awarded the Nobel Prize. The latter was deeply regretted by his many admirers. However this omission was probably based on understandable reasons, and I would like to stay with Nicola Tesla for a little longer since his name is directly linked to the ideas put forward for death rays.

Tesla's knowledge and his brilliant ideas were based on 'classic electromagnetism', a well defined branch of physics in which practically all observations related to electricity, magnetism, optic and electromagnetic waves known up to about 1900 are correctly described. A comprehensive theory, which included all this knowledge, was elegantly formulated in 1861 by the British physicist James Clerk Maxwell (1831-1879). His theory also predicted some phenomena, which were as yet unknown at the time of its formulation. Confirmation of one of these predictions was provided in 1886 by the German physicist Heinrich Rudolf Hertz (1857-1894) when he succeeded in transmitting electromagnetic signals (waves) between two adequate antennas. Hertz's experiment is considered to have provided the basis of wireless telegraphy and later radio and television transmission techniques. The vast field of electrical engineering as we know it today has as its theoretical background classical electromagnetism and Maxwell's theory.

The classical theory of electromagnetism and its multiple experimental confirmations were published as scientific papers and therefore available to all, free of charge. These papers also provided the

basis for Tesla's original inventions, ideas and predictions. For many he claimed priority rights for future development and application by registering them in the form of patents numbering 600 or so, most of which were lodged in the USA, where regulations are less stringent than in other countries. For researchers who, like Tesla, work in industry patents are actually more important than scientific papers. Tesla's ongoing work only concerned a few of his many ideas. In general he concentrated on extremely high electrical voltages and high frequencies, but he also conducted a few somewhat curious experiments which could never be repeated afterwards.

Tesla was not a good businessman and suffered several serious financial problems during his lifetime. In 1906 he fell seriously ill. It is thought that he may have had a nervous break down, probably as a result of his many problems and exceptionally ascetic lifestyle. We may assume that he was in no condition to follow the important developments of physics that came about at the beginning of the 20th Century. As a consequence he did not accept relativity and quantum mechanics, even though he should have known that both were theories deduced from concrete experimental observations. Perhaps Tesla's refusal was due to the fact that the new theories appeared counter-intuitive if one tried to describe their results using models based on classical physics.

Tesla also insisted in believing in the existence of an 'ether' which filled all space. Such an 'ether' was never detected in experiments, and in any case, the new theories no longer needed one. Tesla's special 'ether' had to have very extraordinary properties indeed in order to evade its experimental observation.

Tesla's rejection of new theories and even parts of classic scientific knowledge went still further. He postulated special forms of energy, some very curious particles and extremely high velocities, which have never been observed in nature and do not make an appearance in conventional physics.

Tesla presented his later ideas and the predictions he deduced from them at many conferences, in newspaper articles and press interviews, but he did not ever publish them as scientific papers. His somewhat original ideas attracted countless devotees and admirers who obviously

recognised the value of his early work, but also considered his later prophetic predictions as ‘truths’ that had to be taken very seriously. As proof of the correctness of his proposals and predictions, Tesla often mentioned some vaguely specified experiments (which he claimed to have conducted many years in the past), a number of his very old patents and even the successful construction of a power plant. He assumed that his readers and audience would be very familiar with all of his early work.

Tesla’s prophetic texts and many and varied commentaries thereupon are now accessible to the interested reader in published books, articles in journals and on the Internet [Te02]. However, anyone with a modicum of knowledge about modern physics and the current technology that arises from it will be faced with serious problems. I was very disappointed to find many vague or even erroneous formulations.

Over the years a ‘Tesla faith community’ has grown to quite a respectable size. This generally includes people who, like Tesla himself, are unable to deal with the findings of modern physics. There is also a tendency to search for esoteric solutions to problems of the future. Several ‘Tesla Societies’ [Te03] have been established all over the world, and there is a central Tesla Museum in Belgrade where 150,000 objects and documents pertaining to Tesla’s life are conserved.

In addition to many publications on Tesla, it is possible to purchase a broad range of very peculiar products, which have proven good money-spinners for manufacturers, distributors and salesmen. Among the items for sale one may find devices for obtaining ‘free’ or ‘ether’ energy, i.e. for the purpose of domestic heating or to improve the efficiency of engines, as well as ‘Tesla plates’ which increase or provide shields against ‘Tesla energy’ [Te03a]. There is no law against believing in something, spending money on it, or even against making a pretty penny from it although perhaps, this may be regarded as ‘fraud’, which is against the law. Since there are no visible or repeatable experiments or objective tests that prove the effects of any of these products, buyers must simply have faith in the suppliers’ promises.

Several ideas for ‘death rays’ and ‘long range weapons’ proposed by Tesla appear in the literature. Also mentioned is the use of different systems for transporting huge amounts of energy over long distances

without any of the losses that are incurred using conventional techniques. Tesla assumed that it was possible to produce extremely thin 'ionised channels' similar to those mentioned by Grindell-Matthews and Peter Schlesinger. Tesla believed his 'channels' would be able to transfer energy not only through the atmosphere, but also through solid materials as it would be the case under the surface of the earth.

Tesla was a committed pacifist and generally concentrated his efforts on useful civilian applications. However, he does in several instances mention the destruction of machinery and human life. His 'death rays' ideas earned him headlines in the American press in 1934, by which time he was already 78 years old. At the time he claimed that he had developed and tested his 'death rays' prior to 1900. He supposed them to be sufficiently powerful to destroy aeroplanes from a distance of 400 kilometres by interrupting the aircrafts' 'magnetic ignition', which was an idea that had also been proposed by other people. Later on Tesla offered his ideas to the governments of several countries.

No really detailed technical documents on Nicola Tesla's death ray ideas are preserved. It is therefore possible to speculate only on the basis of vague descriptions, some of which he gave at press conferences while others are contained in a few notes and drawings found after his death. Most of the drawings were not produced by Tesla who was not a good draughtsman; they were drawn following his instructions, or on the basis of his written descriptions by graphic designers.

For the production and transmission of Tesla's energy loaded beams a very strong repulsive force was required. Such force was not known at the time, nor has it ever been observed. The beams themselves had to be very thin, with a cross sectional diameter measuring less than 1/10,000 of a millimetre. Beams of such thinness would ensure that 'ionised' (electrically charged) air molecules would be repulsed, that is, kept away, thereby providing a practically empty channel. Within this channel the beam would be kept collimated, again thanks to the repulsive force of the surrounding air ions. In this way the propagation of electric currents would be secured without losses. A very interesting idea perhaps, but far removed from reality.

Tesla claimed that his 'beam' would have an 'electromagnetic

nature', although this is not specified in any detail. It would consist of very small 'bullets of matter' with an extremely high electric charge. He computed this 'electric charge' with a very questionable method, using relations only valid for much bigger objects. The assertion was that these little bullets would be faster than light. This claim stood in direct contradiction to the theory of relativity which had already become well established by then, but Tesla did not allow this fact to worry him. He stated that his 'matter bullets' would be „much smaller than molecules" (800 times smaller is sometimes mentioned [Te02]), although he did not make clear what that could possibly mean. They would, he argued, be accelerated inside an electrically charged sphere of several metres diameter and reach outer space through a specially designed valve that would act as a kind of 'gun'.

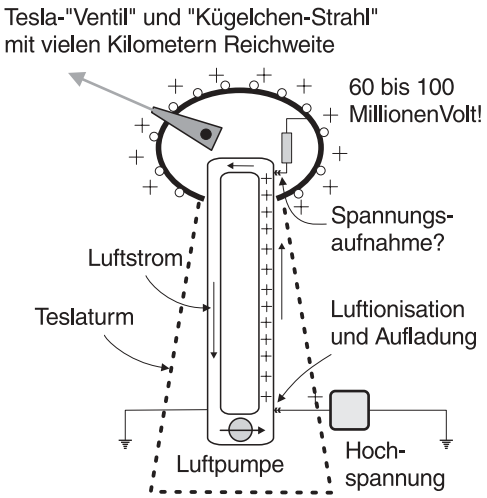
There are publications in which a drawing of this valve is depicted and described as highly original. However, the valve turns out to be a simple device, unmistakably based on the well-known principle of the water jet pump. Sending an extremely intense gas stream through the external structure of the 'valve' may make it possible to keep a modest vacuum inside the electrically charged sphere, but it would not do much to accelerate Tesla's electrically charged bullets of matter.

Some drawings show a high voltage generator attributed to Tesla, which corresponds in principle to a device built and successfully operated in 1931 by Robert Jemison Van de Graaff (1901-1967). The Van de Graaff generator continues to be used in many laboratories. The only difference between this and Tesla's design is that Tesla substituted the rubber band of Van de Graaff's design (which transports electric charges to a large sphere on top of the device) with a stream of ionised air, a principle that (to my knowledge) has never worked (see Boxes 1 and 3). Furthermore, it would be extremely difficult to maintain an electric potential of 17 million Volt, which is stipulated for Tesla's generator (60 million Volt are even mentioned [Te02]), in a reasonably sized experimental hall without having spark discharges to the walls. Tesla's early experiments in the field should have made him perfectly aware of this fact.

On his HSV Internet page, Peter A. Schlesinger also proposes an explanation for Tesla's energy transporting beams, which is based on

Box 1

Tesla´s High Energy Gun



Principle of Tesla´s modified Van-de-Graaff high-voltage generator (s. Box 3), which however was never realized. The electrostatically loaded rubber band is substituted by a flux of ionized air which loads a big sphere on top.

With the help of some protuberances Tesla expects non-realistic voltages on the surface of the sphere. Exptremely small matter bullets with enormous electric charges would be accelerated in a special valve and emmited with several times the velocity of light.

In fact Tesla had a 60 m high tower for such experiments built on Long Island, including a top sphere of 10 m diametre.

Tesla´s ideas for beam weapons (and similar ones by inventor Harry Grindell-Matthews) are quite similar to several proposals which were made at the end of WW II to the German leaders.

ultraviolet radiation. He remarks that transmitting electric currents through ionised air channels was one of Tesla's main interests. However, it would not be possible to realise the ideas Schlesinger put forward in 1999/2000 without the special ultraviolet laser beams that did not become available until many years after Tesla had put forward his proposals.

Tesla could not foresee the existence of laser beams or similar techniques, since these are all based on quantum theory. However, he did have a robust intuition and it just may be possible that he produced a primitive laser beam before 1900 by trial and error, without any knowledge of the physical background. In fact he enclosed crystals (which he called 'buttons') of diamond, ruby or other materials in a reflecting sphere to which he applied a high frequency voltage. On several occasions he observed an extremely intense flash of light, while at the same time the crystal exploded or melted.

The extensive literature that exists on Tesla's strange ideas avails itself of a range of terminology that the authors do not define with any precision. Hence the concept of 'tachyons' (particles that fly faster than light) which originally arises from abstract relativistic theory is introduced with quite a different meaning. The authors claim that these tachyons should be able to carry 'tachyon energy' from outer space (Tesla's ether?) to earth, despite the fact that none of these claims could be checked or verified scientifically and that there had never been any observations of energy obtained from outer space.

Tesla died a poor man on January 7, 1943 in a hotel in New York, and I imagine that on this occasion his many achievements and futuristic ideas were again publicised in the world's media. However, the day after he died, all his documents in the hotel vanished mysteriously.

Tesla's death rays and those of Grindell-Matthews have several things in common. Firstly, no original documents with accurate technical details are available for either, although occasionally one comes across speculation that the Soviet Union's government or secret service seized all the paperwork. Another shared aspect is that both their proposals are consistently rejected or even ignored by conventional academic scientists, except perhaps in a few institutions that are devoted to para-scientific matters (see i.e. [GW01]) particularly in Russia. Finally, both

proposals and predictions have been used extensively to inspire numerous science fiction stories and films.

The Tesla devotees who refused to accept relativity and quantum theory, and maintained their faith in the existence of an 'ether' were not alone with their ideas. Two eminent German physicists and Nobel Prize winners arrived at similar conclusions, although they used completely different arguments. These scientists were among the first to embrace National Socialism. They believed that the new findings and theories of physics were 'Jewish', i.e. 'non-Aryan', and therefore condemnable and clearly wrong. After all, the ideology that coloured their scientific spectacles maintained that only Aryans were capable of investigating nature and recognising the truth.

One of these two scientists was Professor Philipp Lenard (1862-1947). Fired by the dogma of the time he wrote a physics textbook in four volumes entitled 'German Physics' (Deutsche Physik) several editions of which were published from 1936 onwards (even after the end of the Second World War) [Le36]. Lenard, who was awarded the Nobel Prize in 1905, had already before come into conflict with British scientists with regard to the priority of the discoveries of the electron and the atomic nucleus. He had in fact conducted fundamental experiments on both of these subjects ahead of the British, but had been unable to provide a sufficiently intelligible interpretation. He had also clashed with Albert Einstein and later became a particularly fanatic anti-Semite. He especially advocated National Socialism in student circles.

Lenard's fellow traveller was the talented experimentalist Professor Johannes Stark (1874-1957) who discovered a phenomenon of atomic physics which was named after him, the 'Stark effect'. This discovery earned him the Nobel Prize in 1919. Under Hitler's rule Stark occupied leading positions in German organisations. From 1933 until 1939 he was the president of the 'Physikalisch-Technische Reichsanstalt' PTR in Berlin, a world leading institution for the control of standards and units; and from 1934 to 1936 president of 'Notgemeinschaft der Deutschen Wissenschaft', an organisation that dealt with research funding during the war. In July 1937 Stark approved an anti-Semitic article in 'Das schwarze Korps' ('The Black Corps'), the journal of the SS. This

article, to which he added his own comment, discredited Werner Heisenberg and several of his colleagues and, among other 'offences', accused them of being 'white Jews' (whatever that may mean) [St37]. Heisenberg reacted with a protest to Himmler and threatened to retire if the government agreed with Stark's statements. It took Himmler a year to respond, but he assured Heisenberg that such attacks would not be repeated [Hi38]. Although this meant Heisenberg was exonerated from the charges levelled against him by Stark, the surreal 'German Physics' continued to be propagated, even though most German physicists believed it to be wrong.

It is difficult for people who are not themselves involved in the natural sciences to make any kind of assessment of modern theories of physics, and they cannot be blamed for expressing misgivings concerning the validity of such theories. It is not surprising therefore to encounter occasional scepticism with regard to relativity and quantum theory. Speculation about Tesla's 'ether' has not disappeared, and there are some who still believe that the discovery of new form of energy ('free energy', 'tachyon energy' etc.) based on the 'ether' is entirely within the realms of possibility.

Even the transmission of energy through ionised air channels could be regarded as a realistic option for producing 'death rays'. It would have been feasible for the adherents of 'Aryan physics' during Hitler's rule to have considered Tesla's predictions and proposals realistic, but I have not found any explicit references that would substantiate such a link. One may also suppose that members of the Tesla faith community would not be keen on being linked to the anti-Semitic ideas of Lenard and Stark.

In 1943 laser beams were as yet unknown. Explicit references to Tesla or Grindell-Matthews' ideas would certainly have been inadequate for the purposes of submitting official research proposals in Germany. Nevertheless, it was possible to present the prospects offered by electrically conducting ionised air channels and invisible high energy X-rays as a concrete basis for manufacturing death rays. In fact, and as I will show in subsequent chapters, such developments were taken very seriously in the Third Reich.

The idea of using death rays to defend national air space had its most modern incarnation in 1993, by which time suitable lasers had been sufficiently well developed. This was the ‘Strategic Defence Initiative’ (SDI) begun by president Ronald Reagan to shoot down enemy rockets. Prior to this, Nikita Khrushchev (1894-1971) had been vociferous in his announcement that the Soviet Union had already developed such systems. Neither of these initiatives seem to have borne any fruit, and it appears that they were abandoned, unless they progressed in conditions of the deepest secrecy. In 2002 a project for a strategic system with similar goals was started in the USA and could be considered another step in this direction.

———

3 Richard Gans and Heinz Schmellenmeier's 'Rheotron'

It was March in 1943 when the well-known university professor Richard Gans was sent to work on the site of a company called 'R. Waelisch', in Berlin-Plötzensee. His allotted task, ordered by the 'Department for the Deployment of Jews', was to clear up after one of the allied air raids, which by that time had already become increasingly frequent. But Gans was 63 years old, had never done any physical work before, and was too weak to shift rubble. For this reason he was in imminent danger of being deported to a concentration camp. Perhaps it was only a figure of speech when I was told many years later that Richard Gans was already standing in line for transportation to Theresienstadt when he was saved in the nick of time. Whatever the truth of it, he had been clearing away rubble for over two months when on the 28th of May 1943 a telex from the pertinent SS authority arrived with orders that he be taken away from the building site. On the following day he was enlisted by the labour exchange as an unskilled worker for the privately run 'Entwicklungslaboratorium Dr. Schmellenmeier' ('Developmental Laboratory Dr. Schmellenmeier') in Berlin-Lankwitz, Leonorenstraße 47. In this position Gans survived the war.

More information about this and about Richard Gans' eventful life are available in the beautiful and well-researched biography by Edgar Swinne ('Richard Gans - Hochschullehrer in Deutschland und Argentinien' ('Richard Gans – A University Teacher in Germany and Argentina') [Sw92]). This book includes a contribution by Dr. Heinz Schmellenmeier himself, in which he describes how Richard Gans was saved ('Die Affaire Prof. Dr. Richard Gans', pp. 111-131). With the permission of Edgar Swinne I would now like to summarise, and comment on, some of the information contained in his book as well as the additional data with which he kindly provided me [Sw93]. For this

reason this chapter will only feature source references if the information has *not* come from Edgar Swinne's book. For instance, I must thank my dear friend Prof. Klaus Gottstein (born 1924) in Munich for providing me with much supplementary data, several important corrections and valuable advice [Go02]. When Klaus Gottstein was a young man he worked for Heinz Schmellenmeier.

Richard Gans in 1948, From [Sw92], p. 6.

Richard Gans was born in Hamburg on 7th March 1880, the son of a wealthy merchant. Although his family was of Jewish origin the young Richard described himself as "not belonging to any church or religion". In 1898 Gans left Hamburg for Hanover where he embarked on a course in electrical engineering, but by 1899 he had moved again, this time to Strasbourg where he studied physics and mathematics. Shortly before gaining his doctorate (with 'summa cum laude') he became an assistant to Professor Georg Hermann Quincke (1834-1924) in Heidelberg. In 1901 Richard Gans began work as an assistant to Professor Friedrich Paschen (1865-1947) in Tübingen where on 6th July 1903 he became a lecturer at that university despite the fact that (as Prof. Paschen critically noted in a letter) "ancient tradition forbids the inclusion of Jews among the teaching staff". On 30th December 1908 Gans was even bestowed with the title and rank of 'extraordinary professor'. By then he had already published 33 scientific papers and was a committed and successful teacher. In 1905 Gans published 'Einführung in die Vektoranalysis' ('Introduction to Vector Analysis') [Ga05], the sixth edition of which was issued in 1929 and is considered a classic textbook on the subject. His

'Einführung in die Theorie des Magnetismus' ('Introduction to the Theory of Magnetism') [Ga08] was also a great success. In addition to theoretical physics and experimental exercises Gans had also specialised in the field of magnetism.

Among the students who attended Gans' Tübingen lectures in the winter semester of 1909/10 was the talented Walther Gerlach (1889-1979). Not long after that Gerlach became an assistant to Paschen at the Institute of Physics while also continuing with his studies. Gans and Gerlach became good friends during that time and remained so until the end of their lives, even during difficult times. The extensive correspondence between Gans and Gerlach, much of which can be found in the archives of the Deutsches Museum in Munich, provides many interesting biographical details of these two physicists [Fu98].

Walther Gerlach played a major, sometimes pivotal, part in the various projects I shall describe below. He gained his doctorate in 1912 and qualified as a university lecturer ('Habilitation') in 1916. After active service during the Great War he went to work in a paint factory in Berlin until 1921 when he moved to Frankfurt University where he and Otto Stern (1888-1969) conducted a very important experiment on the 'directional quantisation of atoms'. Between 1921 and 1929 he taught at Tübingen and from then on at Munich Universities. I shall make frequent reference to his various posts and positions during the Second World War. He seemingly held the full confidence of the rulers of the day.

In 1911 Gans left Paschen and spent the winter semester of 1911/12 lecturing as an honorary professor ('Titularprofessor' and 'Privatdozent') in Strasbourg. In March 1912 he was contacted by the Argentinean University of La Plata, south of Buenos Aires. Gans paid La Plata city and university a visit before taking over as head of its well-equipped Institute of Physics. He was preceded by the German Professor Emil Hermann Bose (1874-1911) who during his tenure had raised the Institute's standard to a European level. Richard Gans successfully continued this aspect of Bose's work. In the end he

stayed in La Plata for 13 years during which time he made a major contribution to the development of teaching and research in Argentina. Gans was a patriot and he supported Germany from afar during the Great War. He also helped many German physicists find professorships or other employment in Argentina. According to Swinne, none of these were Jews.

However, Gans was having personal problems (his wife was ill) in Argentina and, above all, he was finding it difficult to organise his research work, due to the unreliable and cumbersome Argentine bureaucracy. So he renewed his many contacts in Germany. As a result there arose the possibility of a position in Königsberg (Kaliningrad), the historical capital of East Prussia. He visited Königsberg and in 1925 he took over the position of Professor of Theoretical Physics and the direction of the Second Institute of Physics of the University of Königsberg. Here too he seems to have been successful, although the Institute's destruction during the Second World War means that there is little documentary evidence of this.

On 7th April 1933 the Third Reich government passed the 'Law for the Restoration of the Professional Civil Service' ('Gesetz zur Wiederherstellung des Berufsbeamtentums'), which provided a legal basis for purging the civil service (including the universities) of all "non-Aryans" and of persons which, due to her previous activity, could be considered as politically unreliable. This caused Gans a number of extreme difficulties in Königsberg. First he was excluded from the examinations, then, on 14th October 1935 he was 'given leave of absence', and finally was forced to retire. He was forbidden to enter the Institute and the Library. What seems to have irked him most was that he could no longer view his vast collection of scientific reprints. However, the Dean appears to have given him for a short time access to the Library.

In a letter written much later, Schmellenmeier states ([Sw92], p. 185) that Gans was then classified as a 'privileged non-Aryan'. This was possible, given that his wife was Aryan and his two sons (who

were classified as 'first-degree half-Jews') were *not* brought up in the Jewish faith (by the way: they were Argentine citizens). As a result, Gans was allowed to seek work in private industry after he was forced to resign from the University, and by 1st April 1936 he had found work as an 'Advisor for Theoretical Physics' at the well known 'AEG Research Institute' in Berlin, directed by Professor Carl Ramsauer (1879-1955), at the time also Chairman of the German Physical Association. Ramsauer was one of the German physicists opposing openly to the 'Aryian Physics' propagated by Philipp Lenard. At AEG Gans met among others, one of his pupils and assistants from Königsberg, Bernhard Mrowka (1907-1973), who had problems to teach at Leipzig university just by not joining the official Nazi organizations.

In 1937 Gans fell seriously ill, which was probably related to his unpleasant position. He had a perforated stomach ulcer, which required urgent medical attention. Fortunately the eminent surgeon Professor Ernst F. Sauerbruch (1875-1951) was able to provide him with the operation he required in good time. Gans remained in contact with Sauerbruch and especially with his senior surgeon at the Chirurgical Clinic of the famous "Charité"-hospital in Berlin, Dr. Woitek**.** This later proved very useful.

Once war broke out in September 1939 AEG could no longer keep Gans. For a while he worked at Telefunken where he and the well known specialist in electro-magnetic matters Kurt Fränz (born 1912) developed aerials for radio waves [Fr92]. Amongst Kurt Fränz's achievements are the first radio-astronomical observations made in Germany. Years later, Gans and Fränz met in several occations.

Gans subsequently worked for the famous GEMA company (a pioneer in developing radar devices) and other industries. In his book, 'Friedrich Paschen als Hochschullehrer' ('Friedrich Paschen the University Lecturer') [Sw89] Swinne mentions that Gans' employments allegedly concerned "theoretical work regarding military

technology". This probably was related to radar technique and antennas, a subject on which Gans remained interested for the rest of his life. At that time GEMA, AEG, Telefunken and Siemens collaborated in the development and mass production of German radar devices.

Schmellenmeier remarks that Gans was afterwards employed in the private laboratory run by the famous scientist Manfred von Ardenne (1907-1997). However, by early 1943 also von Ardenne had to drop Gans, who then was sent by the 'Department for the Deployment of Jews' to work clearing bombsites. And, as already mentioned above, on 28th May 1943 Gans was assigned to Dr, Schmellenmeier's developmental laboratory.

According to Klaus Gottstein who worked for Schmellemeier from 1943 until 1945, Gans was at that time simply described as 'Non-Aryan' (not 'priviledged'), because his wife had already died in 1932. Gottstein also remembers that this brought in its wake numerous attempts to have him deported to a concentration camp [Go02], although Schmellenmeier succeeded in preventing this. However, Gottstein can not remember Gans wearing the yellow Star of David obligatory for Jews after 1941, which means that Gans had some kind of special status. The regulations regarding the treatment of Jews were changed several times during the Nazi regime and some exceptions were possible.

Heinz Paul Schmellenmeier (1909-1994) was born into a family of lower middle class civil servants whose traditional political views tended to the left of centre. After leaving school in 1927 he studied German and history, and then physics and chemistry. In 1932 he was given a student placement at one of Osram's production plants, and during his year there he took part in various conferences and discussions during which he forged a friendship with the physicist Dr. Friedrich Georg Houtermans (1903-1966), at the time one of Gustav Hertz' (1887-1975)

senior assistants at the Institute of Physics of the Technical University at Berlin-Charlottenburg.

Houtermans was an extraordinary man. I had the good fortune to work in his Institute in Bern for six months in 1957, and spent several pleasant and stimulating evenings in his company. One of his favourite mottos was, "Even in physics you have to be able to fool around". He was renowned for his huge collection of witty jokes, which were even reproduced and distributed. Most people called him Fritz, and to his friends and family he was known as Fissl. Much of his extremely adventurous life is described in Thomas Powers' book, 'Heisenbergs Krieg' (Heisenberg's War) [Po93]. Also, Iosiv B. Khriplovich's article, 'The Eventful Life of Fritz Houtermans' [Kh92] is very impressive. The Russian historian Viktor J. Frenzel worked on a biography of Houterman's, but was unable to complete it fully before his death in 1997. However it was published posthumously [Fr97]. The eminent Italian physicist Prof. Edoardo Amaldi also left a manuscript on Houtermans' life [Am78], and Dr. Jürgen W. Weil (Vienna) has collated the existing biographies in one volume (in German) [We03].

By the late 1920s Houtermans and Robert Atkinson (1898-1982) succeeded in explaining in principle the basic process by which energy is produced in the centre of the sun, which is by the fusion of hydrogen atomic nuclei into helium nuclei [At29]. Houtermans was always very proud of this achievement. Later on, Bethe and Weizsäcker provided a more detailed description of the processes in form of a 'cycle' subsequently named after them.

Houtermans and Schmellenmeier were both full of admiration for the October Revolution that had taken place in Russia, despite the fact that Houtermans was the son of a wealthy Dutch banker who had generously supported him for a period of time. To some extent Fritz Houtermans' political views may have arisen out of a sense of antagonism towards his father's luxurious lifestyle. However, he was

brought up in Vienna by his half Jewish mother. Later he studied at the university in Göttingen where he struck up many important acquaintances including Werner Heisenberg, Wolfgang Pauli, Viktor Weisskopf, Enrico Fermi, Gian Carlo Wick and Robert Oppenheimer. Houtermans and Oppenheimer both gained their doctorates in 1927, after which Houtermans went to work as assistant of the famous Professor Gustav Hertz in Berlin. In 1933 he moved to the United Kingdom and in 1935, filled with idealism and illusions, he went to live in the Soviet Union.

Towards the end of 1937 Houtermans' enthusiasm for the Soviet system had waned and he was about to leave when he was arrested as a suspect foreigner during one of Stalin's purges (see [Am78]). It was not until April 1940, after months of abuse, that the Soviet authorities handed him over to the Gestapo (probably in the course of an exchange of prisoners) who held him in the prison complex at Alexanderplatz in Berlin until late July 1940 when he was released thanks to the intervention of the prominent physicist Max von Laue (1879-1960). Von Laue was also able to obtain work for Houtermans in the private laboratory of the well known scientist Manfred von Ardenne (1907-1997), as he could not get a position in any state organisation, for racial and political reasons. At that time the 'Uranium Association' ('Uranverein'), involving most of the nuclear physicists still remaining in Germany, was up and running, investigating nuclear energy applications, especially with regard to the construction of a nuclear power plant.

One of the things Houtermans achieved while he was working for von Ardenne was to calculate that it was possible for an, at that time still unknown, chemical element to be produced during the operation of a uranium nuclear reactor. This chemical element could be easily separated by chemical means (i.e. without having to resort to the complexities of isotope separation as would be necessary for uranium), and could then be used to make atomic bombs. The element

Heinz Schmellenmeier in May 1944 [Go03].

was later given the name 'plutonium'. Houtermans became well known in the field thanks to this work. The original paper was kept secret for a few weeks in a save of von Ardenne, but soon afterwards distributed to several German scientists including some of the 'Uranium Association'. Klaus Gottstein [Go03] remarked to me, that independently the physicist Carl Friedrich von Weizsäcker had the same idea, and that Heisenberg had recognized that this was a possible way to built an atomic bomb. But he considered it as a much too lengthy and therefore not practicable procedure. This was one of the reasons which induced Heisenberg to his famous visit to Niels Bohr in Kopehaguen in 1941.

Let us return to Schmellenmeier. Friendship with other like-minded people led Schmellenmeier to join Germany's Communist Party (KPD) in 1932 and the underground movement whose aim it was to defeat the National Socialists. In March 1936 he was arrested, but released after five months because the Gestapo were unable to make a concrete case against him. Schmellenmeier probably remained faithful to the original Communist ideals for the rest of his life, although, as Klaus Gottstein [Go02] has reported, he did never reveal this during the war.

By the middle of 1935 Schmellenmeier had gained his doctorate and eventually joined the company C. Lorentz AG in Berlin-Tempelhof. However, on 1st April 1941 he set up his own company, the previously mentioned 'Entwicklungslaboratorium Dr. Schmellenmeier' ('Development Laboratory Dr. Schmellenmeier') and, as he himself has stated, he did this in order to avoid military service. Establishing the company was made possible by a contract

with the Army Ordnance Office ('Heereswaffenamt'). Other contracts followed and within a year the company already consisted of a staff of four.

Edgar Swinne learnt from a historian based in East Berlin [Sw93] that the authorities of the German Democratic Republic (GDR) did not believe Schmellenmeier's description of how Gans was saved. They probably assumed (or were justified in assuming) that he was simply trying to put himself in a good light as the saviour of a highly respected Jew. Apparently Schmellenmeier was nont pleased about this. Klaus Gottstein, however, has a very different opinion on this subject; but more on this later.

Judging by Edgar Swinne's in-depth research, as well as the documentary evidence found so far and statements made by other people there is little reason to doubt Schmellenmeier's account of Gans' rescue, and I shall attempt a short description and discussion in the following.

It was around 11 pm on a late March Friday in 1943 when Heinz Schmellenmeier received an agitated telephone call from his friend Fritz Houtermans who later that night even came to call on him. This, however was not unusual for Houtermans temperamental style of life. He had just heard that Richard Gans had been set to work clearing bomb sites and was insistent that something had to be done immediately. Houtermans proposed that Schmellenmeier requests that Gans be transferred to his company as his contribution to an important project being conducted there was indispensable.

At first Schmellenmeier was not particularly keen on the idea. Young Klaus Gottstein, who was classified as a 'half-Jew', already formed part of his workforce, and Schmellenmeier's own past and arrest as a communist could also be used to incriminate him in the eyes of the authorities. Nevertheless, he paid Gans a visit on the very next day and assured him that he would do everything in his power to get him out of his predicament.

The matter was discussed with a few trustworthy friends and acquaintances. During one such conversation, it was between Schmellenmeier, Prof. Hans Daniel Jensen (1907-1973) and Fritz Houtermans, the idea of proposing the construction of a relatively small electron accelerator, a 'Rheotron' (later named bBetatron) was born. The reason for Jensen's presence at this discussion can probably be explained by his political beliefs, which were probably quite similar to those held by Schmellenmeier and Houtermans. Although Jensen described himself as a socialist, his friend Professor Otto Haxel (1909-1998) mentioned in a later interview with the author Thomas Powers ([Po93] p. 221) that, *"he was actually a communist"*. This may have had a part to play in the beginning, but much more important to this small circle of friends was the solidarity that existed between scientists who held certain convictions at the time.

According to Schmellenmeier several well-known academics were asked to provide advice and support for the Rheotron proposal, and these included the Professors Max von Laue (1879-1960), Walter Friedrich (1883-1968), Richard Becker (1887-1955), Werner Heisenberg (1901-1976) and, as Schmellenmeier stated, only some time later also Walther Gerlach. All this was going on within a rigorously lawful framework and *'in the interest of Führer and Reich'*, although everyone concerned knew or guessed what the real point of the exercise was. There was also some correspondence (some of which has survived), the contents of which, according to Schmellenmeier, had been agreed in advance.

In the report, which Schmellenmeier still wrote in the GDR time, he did not particularly emphasise Gerlach's role in this episode, even though he was acutely aware that Gerlach's support was vital for the plan's success, especially once Gerlach was appointed by Göring to be the Commissioner for Nuclear Physics in the Reich's Research Council ('Reichsforschungsrat'). According to Gottstein, Gerlach was jokingly known at the time as the 'Marshall of the Reich for Nuclear Physics' [Go02]. Edgar Swinne's writings go into great detail about

how closely Gans and Gerlach were befriended and how frequently they used to meet or speak on the telephone during that period. Gans' home in Berlin was never without a telephone connection during the war, even when he had to move after his building was destroyed in a bombing raid.

At any rate, many highly regarded scientists expressed positive opinions about the Rheotron plan, and finally Schmellenmeier first took on the task of drafting a proposal and then agreed to work on its realisation in his laboratory, should a contract be forthcoming.

Rheotrons were not unknown in Germany at the time. They were even thought of as a German invention, and had been patented under the name 'Elektronenschleuder' ('electron catapults') in 1933 and 1935 by the physicist Max Steenbeck (1904-1981), who was employed by Siemens-Schuckert in Berlin-Siemensstadt [Ru33] [St35]. However, the electron beam produced by the experimental apparatus that Steenbeck developed in strict secrecy was so weak that Siemens decided to stop the project.

The crucial factor that was to arose such a high degree of interest in the Rheotron and the 'electron catapult' was an article written in 1941 and published in the last issue of 'Physical Review' to be distributed in Germany during the Third Reich. In this article the American physicist Donald William Kerst (1911-1993) [Ke41b] described a relatively small piece of apparatus in which electrons coursed around a circle with a diameter of only 15 centimetres. The energy achieved by the electrons was the same as that, which would result from accelerating them with an electric potential of 2.3 million Volts. The equipment, including the required magnet, measured less than 50 centimetres in width and could easily be placed on a laboratory table. The astonishing thing was the intensity of the X-rays which resulted from the electron beams hitting a suitable material, and which Donald Kerst was able to measure. In the first apparatus this was more or less equivalent to the radiation produced by a tenth of a gram of radium, and in a second device this rose to the radiation produced by an entire

gram – and equally dangerous! At the time a gram of radium was prohibitively expensive (people worked with micrograms) and a high voltage generator that could produce a similar electron beam (and X-rays) was not much cheaper. Kerst called his early apparatus an 'Induction Accelerator', but within a year he had constructed a larger piece of equipment that he named 'Betatron', by which name it continues to be known to this day.

Hence people were aware that it should be possible to accelerate electrons just as if high electric potentials of several million Volts, or even 100 or 200 million Volts were available, using relatively simple devices as the Betatron/Rheotron. It was anyway impossible to achieve or maintain more than a few million Volts with ordinary high voltage generators in reasonably sized experimental halls, since there would be discharges to the walls similar to lightning. The acceleration in the new types of apparatus was therefore produced by a completely different principle.

There were obvious uses for the~~i~~se devices in medicine, nuclear physics and engineering. Many institutes, companies and hospitals would in future be able to afford such relatively small and inexpensive devices, and there seemed to be in principle no obstacles in the way of constructing much larger Rheotrons. Naturally, this aroused immediate interest among those manufacturing companies that had the wherewithal to build and distribute this kind of equipment. As I shall describe later on how, by December 1942, Siemens had once again picked up on Steenbeck's idea and decided to continue to work on it.

In a Rheotron/Betatron electrons turn around in a circular ('torus' shaped), evacuated tube made of glass or porcelain, bedded into a large iron magnet. In principle this magnet is not unlike the kind found in ordinary current transformers, although it has to be very precise in meeting particular conditions in the vacuum tube area. Calculating the electrons' orbits and the complicated magnetic field were tasks that could only be entrusted to an experienced theoretical physicist. Richard Gans was not only a theoretician, he was also one of

Germany's few specialists in the field of magnetism, and so it was clear that he was the right man for the job of developing a Rheotron. In May 1943, however, he was still heaving rubble about.

Schmellenmeier found out (or perhaps intended) that other than Gans there was only one other expert in the field that could be considered for the apparatus' calculations, and this was Richard Becker, a Professor at Göttingen University at the time. However, as Schmellenmeier noted in a letter, Becker was unable to take on the work due to other commitments. Becker was a party to the Gans affair, and allegedly his time was fully taken up with 'projects essential to the war effort'. Klaus Gottstein remembers that in conversation with Schmellenmeier it was not Becker but Gerlach who was mentioned as the alternative to Gans. Nevertheless, Gerlach was just as busy with 'tasks essential to the war effort' as Becker was, and this in the end is what was important.

The development and manufacture of Rheotrons/Betatrons was an impeccable project from the points of view of science and economics. However, the authorities in charge of this sort of projects were somewhat preoccupied with other affaires in the spring of 1943. But Schmellenmeier needed financial support for his project. So he made up a case and claimed that, *"the expected radiation could be of great significance to the conduct of the war"*.

Schmellenmeier drafted an exposé in which he argued that, *"the bundled, highly penetrant radiation could be used to pre-ionise the engines of aircraft, which would cause the ignition to cease functioning, the machines would be unable to continue their flight and would therefore come into the flak area"*. This claim was not new. The British inventor Harry Grindell-Matthews, for instance, had already formulated something similar in 1934 and had even demonstrated examples with a somewhat questionable 'beam'. Nicola Tesla had also suggested that aircraft could be shot down by stopping their engine's ignition. For these kind of effects, a relatively small amount of radiation was required.

Schmellenmeier explained the reason for concentrating on shooting down aircraft, rather than knocking out the engines of tanks or trucks, in a letter to Professor Jensen written in April 1943 ([Sw92], p. 183):

"One of the Departments of the RLM (Reichsluftfahrtministeriums – Reich's Air Ministry) has approached me with an enquiry as to whether it would be possible to prepare in my laboratory the construction of a Rheotron by conducting model measurements and theoretical calculations, especially with regard to the questions of stability and intensity".

We do not know whether this letter forms part of the 'pre-arranged' correspondence, although inventing such an approach by the Air Ministry would have been dangerous since this was an easy matter to check. However, there is no disputing that the Air Ministry's was interested at the time, given that every effort was being made to prevent the intrusion of American and British aircraft into German airspace.

Straight away Richard Gans made an important contribution to Schmellenmeier's proposal, which Schmellenmeier mentions in an appendix of Swinne's Book. Gans probably did not know about the future use of his work and calculated the spatial distribution (angular distribution) of the X-ray radiation that would be produced by an electron beam, which had been accelerated by a potential of 100 million Volts (the energy of these electrons would then be 100 MeV or Megaelectronvolts). Electrons in ordinary X-ray tubes are accelerated with tensions of only a few tens of thousands of Volts (in some special tubes this can rise to a few hundreds of thousands of Volts). They are directed towards a piece of metal (the anticathode) in which they are slowed down producing X-rays (very short electromagnetic waves). At the time, electrons of 100 MeV which Gans was postulating, were only known to exist in cosmic radiation.

Gans came to the conclusion that X-rays produced by 100 MeV electrons in the anticathode were intensely bundled in the direction of the incident electrons. This was completely different from the situation

at much lower electron energies, where the produced X-rays are distributed more or less evenly in all directions, across the entire space. The more energy there is, the narrower becomes the cone in which the X-rays are produced. This kind of intense bundling is of major importance when the aim is to direct the produced radiationto a target.

Another important aspect is the range of the radiation when it penetrates matter. I shall go into this subject in more detail later on. This concerns on one side the range in air, i.e. ensuring that sufficient radiation reaches its target, but on the other side the radiation should also be able to penetrate relatively thick walls or shields made from solid materials. In both cases the calculations are the same in principle. Based on density it is possible to predict that the range in solid materials will be roughly a factor thousand smaller than in gasses under atmospheric pressure, which includes air. In the latter case it is necessary to calculate the distance at which a device may still be able to irradiate an object with sufficient intensity to cause some defined damage or, in extreme cases, the death of the irradiated human being. Naturally, this was what the military were hoping to achieve. By then medicine had already provided some data on the radiation dose required to damage or kill cells (such as cancer cells) or an entire living creature. Schmellenmeier assumed that he would never be able to achieve such a high level of intensity.

The penetration of solid materials is interesting for quite different reasons. It was already known that ‘harder’ X-rays, i.e. produced by electrons of higher energy, could penetrate thicker layers of matter. Materials research experts could only dream of 20 to 100 MeV X-rays that would enable them to X-ray thick work pieces. But that kind of Voltage (to which the electrons would first have to be accelerated) was not available in those days.

Relatively little was known at the time about the range in air of high-energy X-rays. To meet military requirements the range needed to be at least one, although preferably several kilometres in order to

deal with aircraft approaching from high altitudes. Heinz Schmellenmeier's estimates must have come within these parameters. Furthermore, the radiation needed to be fairly 'hard' in order to penetrate through several centimetres of metal and other solid materials to reach the engines' interior. Schmellenmeier also supposed that the X-rays by Rheotrons could not cause serious biological damage at distances of several kilometres, and were therefore unsuitable for the purpose of killing human beings. He used the argument of 'engine pre-ionisation' to substantiate his project's usefulness to the war effort, even in the case that only very low radiation intensity could be achieved.

Klaus Gottstein 1942, Foto see [Go03].

It seems that potential backers did not respond with particular interest to Schmellenmeier's arguments and calculations regarding range and bundling of the eventually produced radiation. However, even he by himself was not convinced at all. Many years later (around 1985) he expressed this in his report to Edgar Swinne: *"I state here emphatically that I was fully aware at the time that the process was impossible"*.

Schmellenmeier was by no means alone in this later assessment. Klaus Gottstein wrote to Edgar Swinne ([Sw92], p. 200): *"Incidentally, I once detected a similar sense of embarrassment in Heisenberg when on some occasion or other I asked Heisenberg, who had been the director of my Institute for 20 years, about the Gans case and the Rheotron's deployment to bring down enemy aircraft. He knew about it but showed no hint of amusement, saying instead with some irritation that of course all that had been complete nonsense. Then he quickly changed the subject. Clearly he did not like the thought that the fact he had covered up bad physics, however humanitarian the reason may have been,*

may come out. After all, some brainless historian or malicious colleague may get the idea that those who were in on the project had themselves believed in it …"

I also spoke about this to Wolfgang Paul (1913-1993) who was a Professor in Bonn and the Director of the DESY research centre where I worked at the time. Wolfgang Paul was very familiar with the German Betatron projects and even described them shortly after the end of the war [Pa47]. I asked him about the reasoning by which constructing such equipment would be 'essential to the war effort', particularly for combating aircraft. He too maintained that these ideas had been complete twaddle, but was unwilling to talk about it in detail.

On the one hand Schmellenmeier probably had justifiable doubts that pre-ionisation (i.e. the separation of electrons from the gas mixture's molecules by means of radiation) could impede the ignition of engines in any way. He could hardly refer to the eccentric inventor Grindell-Matthews' presentations using unknown beams. On the other hand he knew that the calculation he made at the time for the range of the radiation and its intensity over long distances in air was problematic. Schmellenmeier's attitude is typified in the following remark: *"Gans said to me, 'Yes, you've forgotten the Compton Effect!' To which I replied, 'Mr Gans, now that the glorious Third Reich is on the verge of collapse, do you want to produce good physics, or would you rather survive?'"*

As Schmellenmeier declared explicitly, he was counting that his proposal would not be examined by an expert, since this would have caused him to *"be left looking like a charlatan"*. In fact, ambitious bureaucrats duly recommended his proposal for approval, evidently without any technical advice.

However, there was barely an expert in Germany at the time who could have claimed (or wanted to claim) that Schmellenmeier's proposals and calculations were fundamentally wrong. There were only a few physicists in the world who were sufficiently familiar with quantum theory to be able to execute these kinds of calculations. Had

any experts been asked, therefore, their response would have been to suggest that first of all suitable equipment had to be built to investigate the phenomena that occur at such high energies in more detail and to confirm the corresponding theories. Only then would it be possible to make any concrete statements about applications that could be 'essential to the war effort'. For military purposes and for the allocation of fundings, it was therefore of primary importance to construct Rheotrons or similar apparatus, quite independently of the reasons put forwards at the time.

Richard Gans' remark about the forgotten Compton Effect demonstrates that he was among those who had a good understanding of the 'Quantum Theory of Radiation' of the time. The famous theoretician Walter Heitler (1904-1981) had lectured on this subject at Göttingen University as early as 1932/33. In1936, after his not exactly voluntary emigration, Heitler published in Bristol a book on the subject [He36] in which he provides a fairly accurate account of the basis for calculating the passage of electromagnetic radiation through matter (which includes air and solid materials). We can assume that Gans was familiar with this important book or its contents, and therefore knew that calculating the range and the somewhat unusual spread of high-energy radiation (and the 'particle avalanches' that accompany it) was fairly difficult. However, he may well have left that to Schmellenmeier who would definitely have used the rough approximations that were customary at the time rather than the more precise Quantum Theory. It was only the bundling of the produced X-rays which Gans calculated quite accurately at the time. If he did make more precise estimates using Quantum Theory, his results concerning the distance at which the radiation continues to have an effect would not have been very different to Schmellenmeier's estimations and even to better computations which can be made today. However, Gans would have noticed that the spread of the beams was not at all as envisaged by Schmellenmeier and probably all the other experts of the period.

We cannot verify today the estimates for the range of radiation submitted by Schmellenmeier to the authorities. He does not provide values or details of his calculations and the expected effects. In this respect he refers to a 'Bericht über die Arbeiten des Entwicklungslaboratorium Dr. Schmellenmeier' (Report on the Work Conducted by Dr. Schmellenmeier's Developmental Laboratory') that, as far as I know (and according to Edgar Swinne's book) was never published or made accessible to others.

After an initial approach to an office of the army (which was rejected) Schmellenemeier submitted on 1st May 1943 a proposal to construct a Rheotron for test puposes to the Reich's Air Ministry (Reichsluftfahrtministerium, RLM). This plan foresaw that the electrons should only reach 1.5 MeV and that costs should be limited to 8,000 RM (Reichsmark) to begin with. Captain Thurn (Department GL/C-E 4/IB of the RLM) *"declared himself willing to place an order for the development of a Rheotron, a simple piece of equipment for the production of very hard X-rays"*.

Schmellenmeier further remarks: *"The selection of this project, which was made in joint agreement with many physicists – and especially F. G. Houtermans – was not an easy task. The project to be ordered had to meet several conditions; firstly it had to be of sufficient importance to the war effort to persuade the relevant authorities that the outcome of the war was under threat if the Jew Gans did not work on it; it had to be specialised enough to mean that there was no other expert to do it, yet not secret enough to prevent a Jew being allowed to join the team. In the Third Reich all these points of view had to be taken into consideration."*

Here I would add that, given the circumstances, the idea of proposing a very small Rheotron was rather clever. The construction of such an apparatus could realistically be ordered at a relatively modest research laboratory as Schmellenmeier's was. This small

Rheotron could never have had the capacity for war use as envisaged by the Death Rays; at most it could be used as a portable X-ray machine in the field. Nevertheless, in principle the machine contained the same components as a larger machine that could achieve 100 MeV or even more. At the time there was no better alternative for producing X-rays of such high energy. For a variety of reasons the cyclotrons that had been developed in the 1930's were not at all suitable for this purpose.

Despite several recommendations and interventions, the much-heralded commission of the Air Ministry never materialised. The Luftwaffe offices dealing with these kind of affaires were probably busy with other proposals for wonder weapons. Nevertheless on 28th May 1943 Gans was, as previously mentioned, relieved from clearance duty and the employment office designated him an 'unskilled worker' and sent him to do compulsory work at Schmellenmeier's laboratory – where Schmellenmeier promptly changed his job description to *'scientific labourer'*, and secretly increased his pay from the 300 RM limit permitted by the authorities to 600 RM.

In the meantime, Professor Walter Friedrich, who directed the Institute for Radiation Research at Berlin University, and Professor Max von Laue had approached the Department of Medicine at the Reich's Research Council ('Reichsforschungsrat') to back the construction of a Rheotron as an important medical instrument. The Head of this Department was the same Professor Ernst Sauerbruch who had operated Gans in 1937 and was also a close acquaintance of Walther Gerlach.

Schmellenmeier made another proposal on 26th July 1943, but this time he submitted it to the Reich's Research Council and his budget was 9,000 RM. On 5th August 1943 he was officially issued an order to develope a small Rheotron "for medical purposes".

I do not know whether "applications essential to the war effort" were mentioned in this order, but it is very likely they were. It was obvious (and has been mentioned in the literature) that these pieces of

equipment were highly suitable for use as relatively low-cost X-ray machines, especially in field hospitals.

According to Edgar Swinne, contact between Schmellenmeier and one of the pioneers of Rheotron construction, Dr. Max Steenbeck (1904-1981) of Siemens (where the apparatus was known as the 'electron catapult') already began to be established in September 1943, and there ensued discussions on the acquisition of patents and rights (by Siemens) concerning the construction of Rheotron/ Betatrons. It seems therefore that Schmellenmeier had every confidence in his and Richard Gans' abilities and in the originality of their contributions. Indeed, by January 1944 he had already submitted three patents, although I am not in possession of any details. Nevertheless this does demonstrate that Schmellenmeier was aware of similar developments having already been begun at Siemens and that this was something of interest to industry. Everyone agreed that in the future there would be many applications for betatrons in medicine and materials testing. And this would certainly create a big demand for such devices.

However, Schmellenmeier encountered many problems running the project with Gans in the team. There were attempts to declare it as 'top secret', and he had to prevent this since it would have prohibited him from employing any Jew, including Gans.

The authorities' desire for secrecy was probably in order to keep the Allies in the dark about the Germans' plans and preliminary works on electron accelerators. Secrecy was pointless from a scientific point of view because an apparatus similar to a Rheotron (with 2.3 MeV) had already been successfully put into operation in the USA in 1941. Practically all the information needed to buid it had (as previously mentioned) been published by Donald Kerst [Ke41b] in the periodical 'Physical Review'. He and R. Serber [Ke41c] outlined the theory behind it in a second article in the same publication. Furthermore, press reports in 1943 publicised the fact that a larger Betatron (for 100 MeV) was under construction in the USA. Awareness of the

work being done in America must also have provided a major impetus for driving forward similar work in Germany, since the heads of the military probably assumed that the Americans also intended to use this for making weapons.

Gans was particularly well versed in the construction of magnets. One of his earliest practical contributions in Schmellenmeier's company was to design the iron structure for a very low energy (1.5 MeV) Rheotron. The form of this type of iron yoke is similar to a largish transformer. Klaus Gottstein, who worked for Schmellenmeier until November 1944 when he was conscripted to the 'Organisation Todt', remembers that some iron plates (transformer plates) were made for the magnet. The shape of the pole pieces determines the magnetic field on the electron beam, which is vital for stabilising the orbits of the electrons (which form something akin to the transformer's secondary winding).

Naturally, the 9,000 Reichsmarks originally earmarked for the 'Rheotron Project for Medical Applications' were soon spent. Edgar Swinne checked documents in the archives of the 'Berlin Document Center' (BDC) and the German Federal Archive in Coblenz and discovered that a further sum of 24,000 RM was approved for the Rheotron project on 20th October 1944, as well as a research grant of 600 RM per month to be paid during the period 1st October 1944 to 31st March 1945 ([Sw92] p.196). The corresponding extension of the project is also recorded. An interesting file note mentions that Walter Gerlach recommended the project to be continued and stated that he wanted to participate.

According to Klaus Gottstein's diaries, Gerlach did occasionally visit Schmellenmeier's laboratory, but he never worked there. At the time, of course, Gerlach had to travel between his important responsibilities in Berlin and his university work in Munich and so had many other things to worry about. From the summer of 1944 until the end of the war Gerlach had at his disposal (and responsibility) around 500,000 RM per month for nuclear research work ([Sw92] p.196).

There were others who intervened on Gans' behalf at the time, including Göbbels' trustee General Wilhelm von Faupel (1873-1945) who ran the Ibero-American Institute in Berlin from 1934 onwards. This he did entirely in the spirit of the powers that were, providing active support to German right-wing organisations all over South America, but particularly in Chile and Argentina. In 1936 Faupel was also Hitler's special envoy to Franco's regime in Spain. He spent some time in Buenos Aires during the First World War where he knew Gans as a German nationalist. Faupel and his wife committed suicide at the close of the Second World War.

Several attempts were made to send Gans to a concentration camp, but each time Schmellenmeier successfully used his contacts to prevent this happening. Klaus Gottstein expressly confirmed this to me. Gans was even arrested in June 1944, probably as part of the last phase of the 'final solution' of the 'Jewish problem', and was sent to a transit camp in Große-Hamburger-Strasse. With a great deal of effort and the assistance of a member of the SS Schmellenmeier managed to secure his release. The SS man was the chief aide-de-camp of Ernst Kaltenbrunner (1903-1946), the man appointed by Himmler in January 1943 to head the 'Reichssicherheitshauptamt', or 'Reich Central Security Office', which was entrusted with executing the 'Ffinal Ssolution'. Schmellenmeier concluded subsequently that this aide-de-camp could claim later on, that he helped to save the life of a prominent Jew, *"as a protection for himself once the brown (Nazi) horror was over"*. (This may have been SS Major Dr. Hans-Achim Ploetz [Sw93]). As recalled by Klaus Gottstein, Schmellenmeier frequently mentioned his successful visits to Kaltenbrunner's bureau and to his aide-de-camp. However, Kaltenbrunner refused to talk personally with Schmellenmeier about the case of the 'Jew Gans'. After the war Kaltenbrunner was sentenced to death by hanging as a major war criminal.

In the autumn of 1944 Schmellenmeier succeeded in loading the laboratory and his staff, including Gottstein and Gans (the latter with a

special permission by the Gestapo), and even some of their household furnishings, onto three goods wagons and to carry the lot away from the dangers of Berlin to Oberoderwitz in Upper Lusatia near the Czech border. When it became clear that Soviet troops were fast approaching Oberoderwitz, Schmellenmeier (again with the help of an SS man) used a Luftwaffe truck to transport the most important documents and equipment to Burggrub (between Bamberg and Bayreuth), where the Americans were expected to arrive first. Despite his (hidden) enthusiasm for communism, he must have dreaded falling into the hands of the Russians; after all, it would have been difficult to conceal his splendid relations to the SS and other Nazi authorities! On 28th March 1945, so Schmellenmeier, the trucks drove past Dresden, which was still in flames.

The Rheotron laboratory, or rather what remained of it, was taken over by the Americans on 14th April 1945, and Richard Gans was released. At this point we lose the Rheotron's tracks. It had served its purpose. The beams the Rheotron was meant to produce and which were supposed to be of such importance to the war effort, could not really be described as death rays, and they always stood in the background of this project, as a pretext for obtaining concessions and privileges.

It appears that Gans was not really alert to the real danger he was exposed to during the entire time he spent in the Third Reich. He seems to have looked at it as if from outside, and considered himself safe thanks to his scientific qualifications and large circle of friends and acquaintances. As he once wrote in a letter to Gerlach, he believed that he would anyway survive *"this Reich"*. His subsequently expressed gratitude to Schmellenmeier was delivered in a rather matter-of-fact way, and Schmellenmeier was naturally somewhat disappointed by this.

Gans did take it for granted that he would be saved. However, there was a misunderstanding in all of this. Schmellenmeier complained that Gans did not say good-bye before leaving for Argentina. He did

not know that Gans left Germany illegally and without taking leave of anyone.

In Swinne's book, Schmellenmeier also reports briefly on his life after the war; *"By the beginning of 1946 I had made it back to Berlin; I worked for what was then the Central Authority for National Education in the Soviet occupied zone, and also spent a few weeks in the employ of the newly founded DEFA, but nowhere had funds to pay me a salary. I lived from my savings. At the end of 1946 I came to Berlin University."* In one of his letters to me Klaus Gottstein wrote that Schmellenmeier subsequently found a fair amount of success in the GDR [Go02]:

"In 1950 he founded and built up the Institute for Experimental Physics at the Brandenburg Regional University (later to become the College for Education) in Potsdam. In 1958 he became the director of the Technical University for Chemistry in Leuna-Merseburg, later on he ran one of the GDR's Institutes of the Academy of Sciences and held a secondary office as a scientific director of the Berliner Light Bulb Factory (formerly Osram). He was also a leading personality in the GDR's Cultural Association.

After the war Schmellenmeier and I corresponded at length, although with major interruptions. He came to visit me in Göttingen once, and after he retired I went to see him twice in Berlin where he led the comfortable life of a formerly important functionary with his wife. In his home he kept six freezers, which he was very proud of because particularly high value foods were not easy to get hold of in the GDR and had to be bought whenever they happened to be available. So he had stores of all the foods he and his wife were particularly fond of. Nevertheless, in honour of my visit – there were three of us including his wife – he had ordered an opulent cold buffet from a special GDR caterer for foreign visitors, which could have fed ten people. Naturally

we were only able to eat a fraction of the food, and I guess the left-overs went back into the freezers.

Incidentally, I doubt that the GDR authorities did not believe Schmellenmeier's story about how Gans was saved and that he was disappointed about that. Rather, I believe that he himself kept the story from the GDR authorities because his close working relationship with Kaltenbrunner and other nazi authorities and his 'armament projects' could have been misunderstood. He could even have been thought of as a nazi collaborator. In addition, by saving Gans he had not rescued a communist but someone who was probably an anti-communist, German nationalist. Hence Schmellenmeier requested that I refrain from publicising the personal notes he had given me to read for as long as the GDR was still in existence. On a personal level Schmellenmeier was a likeable, energetic and agreeable man. When the house in Dahlem that I shared with my mother and siblings was damaged in an air attack, my boss Schmellenmeier turned up to help clear up."

Nonetheless, in his article for Edgar Swinne, Schmellenmeier described his later dealings with Gottstein in a more negative light. About his visit to Göttingen he even wrote, "*We seemed to have drifted apart in conversation*". As Klaus Gottstein explicitly clarified to me [Go30], this only regarded their different political opinions, and had nothing to do with their always excellent personal relation. The fact that Schmellenmeier did not emphasize his friendship to Gottstein probably reflects the fact that the text was drafted and published in the GDR a long time before German reunification. His text also contains relatively little on the important part Gerlach had played, and includes the kind of overt left-wing political phrases usual in most publications in the GDR.

Schmellenmeier died on 31st August 1994 aged 85.

After regaining his freedom Richard Gans continued to work on the theory of Betatrons, which seems to have been of greater interest to him than his personal fate. He has stated that his work at the time involved improving the Betatron-theory put forward by Kerst and Serber. He also went on discussing with Schmellenmeier the possibility of continuing their work on Rheotrons, although that was not realistic at the time.

Late in 1945 Gans was offered the Sommerfeld chair at Munich University on a temporary basis, and he accepted. However, he and Sommerfeld agreed that this post should only be regarded as a transitional solution. Gans' intention was to join his two sons whose unpleasant experiences in Europe had given them cause to settle in Argentina. Mainly for this reason, but also because he was not entirely happy in Munich Gans resigned from this post on 24th December 1946.

The move to Argentina was not as simple as Gans would have liked. The American occupying powers refused his application to leave Germany. Albert Einstein had written to him saying that he could get a teaching post at Tucumán University in northern Argentina, so he secretly travelled to Paris without taking leave of anyone in Germany. From Paris he tried to organise his entry to Argentina. Finally, a long-standing acquaintance in Argentina (and also his student), the physics professor Dr. Enrique Gaviola, managed to obtain a visa for him and Gans arrived in Argentina on 19th May 1947. Although the Tucumán post was no longer available, Gans was made 'interim' research director of his old institute in La Plata.

Gans lived in a beautiful house with a garden in a town called City Bell, between Buenos Aires and La Plata. In 1949 he wrote to Gerlach (see [Sw92], p. 147) that he received many guests at his home, including the German meteorologist Professor Walther Georgii (1888-1968) and Kurt Fränz (formerly at Telefunken Berlin) whom he had known well during his time in Germany.

Walther Georgii became a professor at Darmstadt University in 1926, and between 1926 and 1945 he was the Director of the German Research Institute for Glider Flying ('Deutsche Forschungsanstalt für Segelflug'). During the war he was on the Research Management

Board of the Reich's Air Travel Ministry (RLM), and it was here that he became involved in some of the other projects that I intend to discuss here. After the War he first settled in France and then in Argentina where he became the head of a research department at Cuyo University (in the Andean province of Mendoza) for a while. Early in 1951 I spent three months as a student trainee in his department, working on the construction of a cosmic ray observatory in the mountains called 'Estación de alturas Juan Perón'. Georgii was 63 years old by then, but appeared much older. Even though he knew very little Spanish he obstinately refused to speak German, either with me or other German speakers, and so it was not surprising that it was impossible to have a normal conversation with him. Georgii died in Munich in 1968.

Gans celebrated his 70th birthday in City Bell on 7th March 1950. He received many messages of congratulation whereby a very kind letter sent by Max von Laue stands out (see [Sw92], pp. 142-143). A special edition of the periodical 'Rev. Unión Mat. Argentina' was issued by the 'Asociación Física Argentina' (AFA) to commemorate the occasion, and included contributions by many well-known scientists [Ga50].

After this, Gans' situation in La Plata deteriorated. The dictator Juan Perón's fascist-leaning government installed a sympathising rector whose appointment of new staff members practically paralysed all scientific activity. Gans' life was also blighted by right-wing student organisations, and in 1951 he was more or less forced to give up his post at La Plata following a clash with the principal. Thanks to the intervention of the famous Argentinean mathematician Professor Alberto Gonzalez Dominguez he was then awarded a two-year contract at Buenos Aires University's Institute for Radio Engineers [Fr92] where Kurt Fränz also taught.

At this point I would like to insert a few personal comments. As a student of physics in 1953/54 I could not understand why we had to analyse the stability of electron orbits in a 'Betatron' and the shape of some radar antenna, just as practical exercise that formed part of an ordinary course on electricity and magnetism. I was interested in a

whole range of things in physics, but I was not particularly fired up by electrons whizzing around and being accelerated in this kind of apparatus or in radar technology. This was in Argentina at Buenos Aires University. The assistant who set us these tasks was a student and admirer of Professor Richard Gans who by then had returned to teaching at La Plata (50 km south of Buenos Aires). I had met Gans there once and had been fascinated by a lecture he gave on the origin of the blue of the sky. A group of us physics students at Buenos Aires University had travelled to La Plata to meet Gans and visit his Institute, and this is when he gave us the sky blue lecture. I remember well his strong lisp, which we would occasionally mimic - although this always happened in the spirit of respect and admiration.

After Richard Gans' brilliant lecture (in Argentina he was known as Ricardo Gans and naturally spoke to us in Spanish) I finally understood why so many students and assistants were impressed by him and enthusiastically accepted his advice and guidance. However, I did not have a clue what had led him to work on Betatrons and electron orbits, or why he encouraged others to get involved in this subject. His reasons did not become apparent to me until much later.

As a physics student preparing my doctorate in March 1952 I got a job at the Argentine Atomic Energy Commission in Buenos Aires where I helped to set up a research laboratory in a newly established institute. The Perón dictatorship's aim in starting this project was to make up for the humiliation it had been caused by the fantasist Ronald Richter and his nuclear fusion plans and promises. Incidentally, to a major extent it was Gans and his Argentinian students whom we have to thank for exposing Richter.

One of the first to help us at the planning stage of the new laboratory was Professor Karl Wirtz, and he continued to provide active support from his base in the Max Planck Intitute in Göttingen. Later on other European scientists joined us, including the already mentioned Kurt Fränz and radiochemist Walter Seelmann-Eggebert, both of whom settled in Argentina for several years.

Karl Wirtz used to talk to us about the time he spent in British internment, and it was interesting to find his words confirmed in the now published Farm Hall Transcripts [Ho93]. Walter Seelmann-Eggebert

liked to regale us with tales about his uranium splitting work with Otto Hahn and the astonishingly simple measuring methods they used. However, he would also tell us about the problems he experienced in the Third Reich as a result of his aversion to the Nazis.

It was through our German advisers that I had first indications about how much Richard Gans had had to endure during his lifetime. As far as I can remember there was some vaguely evasive talk that it was "probably Heisenberg" who had hidden Gans as an "unskilled worker" in a secret laboratory during the War. I believed this account until 1993 when I discovered a more accurate description in Edgar Swinne's book, although I had made no further inquiries in the interim, not even during my two years at Göttingen (working in Heisenberg's Institute under Klaus Gottstein's direction) nor in my six months with Houtermans in Bern. There were so many questions about the war period that one did not ask in those days, or about which one did not speak unless the persons concerned raised the subject themselves. Consequently I was amazed when in reading Swinne's book I came across Houtermans, Schmellenmeier and Gottstein, as well as the way in which they had succeeded in saving the life of Gans the Jew during the War. Perhaps the discretion apportioned to all of this after the War may have arisen because nobody wished to incriminate Schmellenmeier through his links

Tombstone of Richard Gans in Buenos Aires
Foto Pedro Waloschek, Febr. 2000.

with SS functionaries. He was living in the GDR and the saving of Gans would not have been helpful to him.

When Richard Gans' contract with Buenos Aires University was not renewed in 1953, he was offered a post as scientific adviser to the Argentine Atomic Energy Commission where Kurt Fränz and Walter Seelmann-Eggebert were also employed as advisers, and where I too had a job. Sadly Gans could not take up this position. He died in City Bell on 27th June 1954. I was among his many colleagues and fellow students who attended his funeral at the German cemetery in Buenos Aires – a separate area of the large and atmospheric 'Cementerio del Oeste', also known as 'Chacarita'. I went to visit his grave in February 2000 [Ga00]. A small and simple stone at the head of the grave, which is lovingly cared for by his descendants, reads, "Prof. Dr. / Richard Gans / 1880-1954".

As is mentioned in Edgar Swinne's biography of Friedrich Paschen [Sw89], the memory of Richard Gans has been kept alive in Argentina with the support of the Gans family through the establishment of a 'Prof. Dr. Richard Gans Prize' in the form of a gold medal, which is usually awarded every year for excellent and topical work in physics.

I was deeply moved by the mementos to Richard Gans that I was shown at the Physical Institute of La Plata University. The lecture hall that Gans had equipped with German technology during his first period in Argentina (1912-1924) and where he gave us the blue-sky lecture, was still in use during my visit in February 2000 and many of the instruments he purchased are exhibited in a physics museum. Although some people were aware that Gans' life was saved by a Betatron project, the 'vital to the war effort' reasoning that was used repeatedly to keep him out of harm's way and Hans Schmellenmeier's risky rescue operations seem to have remained hidden from most.

44 Ernst Schiebold and his ‘X-Ray Guns’

On 5th April 1943 a quite unusual document was delivered to the Berlin office of General Field Marshal Erhard Milch (1892-1972), at that time ‘Director of Air Armament’ (*Generalluftzeugmeister*) and ‘Air Inspector General’ (*Generalinspekteur*) of the Luftwaffe, that is, one of the most powerful man under Hermann Goering (1893-1946) in the Third Reich.

Although I have not been able to discover a signed and dated copy of this interesting document, there are copies of ten typed pages in the Archives of the State of Saxony in Leipzig (SSL) and of the Leipzig University [SE43a] which very probably match up with the original document or may represent a draft version. Unfortunately pictures, tables and Greek letters in formulas are missing. After reading of three signed and dated addendums that were presented in the days that followed, as well as other related documents, I concluded that the original version of the document very probably differed little from the text I was able to unearth. SSL has kindly permitted me to reproduce here some of the texts. The first page starts as follows:

P r o p o s a l

For an additional defensive weapon to combat and annihilatethe crews of enemy aircraft and ground troops by means of X-rays and electron beams

By Prof. Dr. Ernst Schiebold Leipzig C1 Talstrasse 38

The undersigned takes the liberty of presenting below several proposals for the defence of the country in the Total War, which in his opinion as an experienced specialist on X-rays and electron beams may represent a new means to fight the enemy.

The author, Prof. Dr. Ernst Schiebold, was in fact well known internationally as a specialist in the mentioned fields, as well as in their application. However, the style of the overblown title and almost pathetic opening sentences of this text is quite unlike the austere tone one would usually expect to find in a scientific report. Perhaps the unusual formulation was intentional, a device to spell out its political rather than scientific character, and to indicate that it was aimed at less technically accomplished administrative officers or civil servants.

Schiebold begins by making a general comparison of conventional weapons and the possible use of various types of radiation or particle beams for war purposes. He includes some detailed numerical data, taking into account a range of economic and physical criteria. The text appears formally correct, but to my mind it is somewhat contrived, although one has to bear in mind that he was addressing military experts and not physicists.

In the following, Schiebold shows that some heavier particles like atomic nuclei (which could be accelerated with 'cyclotrons' already developed in the 30th) were not suitable for use as long ranging 'beams'. Here I should mention that cyclotrons had been built for the acceleration of atomic nuclei, such as those of hydrogen (protons), deuterium (deuterons) and helium (alpha particles) up to energies ranging between 20 and 100 MeV. All these particles would come to a halt in air after travelling no more than a few metres or even centimetres. Heavier nuclei would have an even smaller range. And it was also well known at the time that physical reasons prevented conventional cyclotrons to achieve much higher energies. They were more suitable for other applications, e.g. in nuclear physics and to produce artificial isotopes, in particular for medical purposes. Several German institutes had already begun to conduct research in this direction. Correctly, Schiebold also stated that neutrons (the neutral components of atomic nuclei) although having in principle a much longer range in air, did not provide suitable beams for military purposes. Furthermore, producing intense neutron beams would have been a hugely complicated undertaking.

With regard to the electrons that Schiebold mentioned in his

proposal's title, he again came to the conclusion that their range in air was insufficient for military purposes. However he only considered the highest energy that could be achieved at the time (for electrons), which was about 1.5 MeV. This could be reached accelerating electrons with several types of high voltage generators providing the corresponding electric potentials of up to 1.5 million Volt. The possible use of other kinds of accelerators (such as the already known 'betatron'), which could reach much higher electron energies was not mentioned in Schiebold's first proposal.

According to Schiebold, the situation is very different for X-rays with very short wave lengths also known as gamma rays. They would provide the best option for a successful weapons' application and in his opinion technology was sufficiently advanced for such a use to be possible. He also mentions the biological effects of X-rays, which were fairly familiar at the time thanks to their medical applications, in particular the fight against cancer.

Schiebold considered two possibilities:

(a) Radiation concentrated on a relatively small target.

(b) Radiation spread out over a wide cone in space.

Whilst 'concentrated radiation' (a) could be directed at low-flying aeroplanes or ground troops in the open-air, 'spatial radiation' (b) would be preferable as a defensive weapon for the protection of entire regions or towns from aerial attack by constructing something akin to a radiation belt.

Schiebold believed that obtaining the required harmful effects over distances of several kilometres was technically feasible if *"radiation of sufficient penetration power and intensity is used"*. Penetration power and intensity, Schiebold explained, depend on the available primary energy to run the device and on the electric tension applied in the X-ray tube to accelerate the electrons, which should be at least 500,000 Volt. Schiebold mentions *"several million Volts"* as desirable, probably because at the time no generator could achieve higher voltages than that with sufficient beam intensity.

Schiebold's ambitious goals for the harmful effect of X-rays were formulated very clearly: the aim was to kill or incapacitate human

beings from a distance of several kilometres. The radiation dose required to achieve these effects was well known.

To improve the effects on a small target located at a certain distance the X-ray beam must be concentrated on it, that is 'focussed' in some way. In spotlights and searchlights light is focussed with conveniently shaped mirrors and lenses. As this is not possible with X-rays. Schiebold proposes that the radiation should be already focussed (on the target) at production, that is, in the X-ray source. This would concentrate as much as possible of the X-ray energy provided by the X-ray tube onto the target.

On the other hand, if the radiation is spread over a wide cone, only a much smaller part of the X-ray energy provided by the tube would reach a relatively small target at higher distance and one would therefore necessitate tubes with a much higher output.

To protect a region from air attacks would require a row of wide cone X-ray generators to be placed one to two kilometres apart, pointing upwards. The result would be that aircraft passing overhead at speeds of up to 400 km an hour would spend around thirty seconds within the 'radiation belt'. Several hundred X-ray generators would be sufficient to protect larger cities, but many thousands would be required to encircle all of Germany. It is also possible to imagine such X-ray generators being mounted on appropriate vehicles from which, placed on hill-top positions, they could spend hours irradiating enemy troop encampments without making a noise or producing any immediate, visible effects. However, Schiebold's writings never included any such details. He was always insistent that it was necessary first of all to solve the basic problems involved in his proposals.

A crucial item in this respect is the required primary energy. Schiebold estimated that obtaining a favourable, but otherwise unspecified, collimated X-ray beam, would require an X-ray tube that could handle and withstand at least 10, but preferably up to 1,000 Megawatts of power over short periods. He also claimed that it would be possible to obtain more than about 10 Megawatt from ordinary urban power plants over short periods, although this may necessitate the civilian consumption of electric energy to be cut back for a while. Schiebold stated that even higher power pulses could be obtained by

storing energy in adequate capacitor batteries, although he conceded that obtaining the power requirements of 1,000 Megawatts would certainly have posed a serious problem.

With regard to the technical construction problems involved in producing an X-ray tube that could handle such large amounts of power, Schiebold made reference to devices that already existed or were in development at the time. Although these could achieve very high levels of power, they were still insufficient for his purposes. The main reason for this is the small focal spot on the 'anticathode' (part of the X-ray tube's electrically positive anode) on which the accelerated electrons producing X-rays were concentrated. In conventional X-ray tubes this focal spot needs to be as small as possible to obtain sharp X-ray pictures. However, in a tube with higher power it is not possible to cool sufficiently the small focal spot, and the anticathod run the risk of being damaged or even melt.

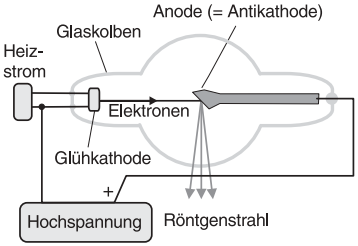
Schiebold's proposed solution to this problem was to enlarge the focal spot, i.e. the area on the anticathode on which X-rays were produced. He began by looking at areas with a radius of 10 cm, but eventually his later proposals foresaw huge anticathodes of up to 2 metres in diameter, which represents a one million times bigger surface than a spot with only 2 Millimetres diameter. This he thought would allow for much improved cooling, especially if the tubes were only used for short pulses. Tubes with this kind of extended focal region and run at a very high voltage of several million Volts, would be the hearts of what Schiebold sometimes referred to as 'X-ray guns'.

Attached to the 9 numbered text pages of this first proposal there is a loose sheet, in which Schiebold recommends some "immediate action" to be taken. This included the participation of five specialists: a high voltage engineer, a design engineer, an X-ray engineer, a thermodynamics engineer and a gun construction specialist. He even made a list of possible candidates:

1. *R. Seifert Owner of an X-ray apparatus factory, Hamburg; Chairman of the Radiology and Electrical Industry Association*
2. *Prof. Schardin, Luftwaffe Test Laboratory at Gatow*

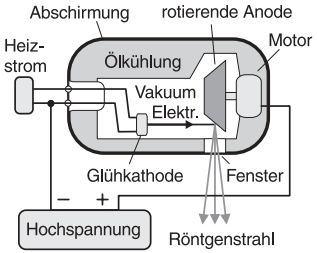
Box 2

X-Ray Tubes

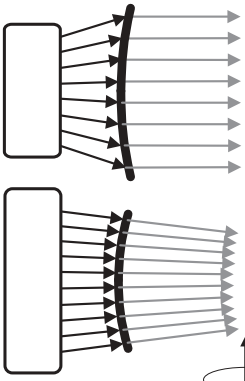


Einfache Röntgeröhre mit Glühkathode

Schematic sketch of the principle of normal X-ray-tubes with a small „burning point“ (X-ray source) which needs cooling (it heats up).



Röntgenröhre mit rotierender Anode

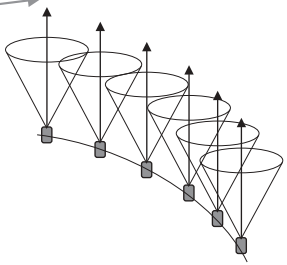


Elektronen-
quellen

Big surface anodes for better cooling and eventual focusing effects

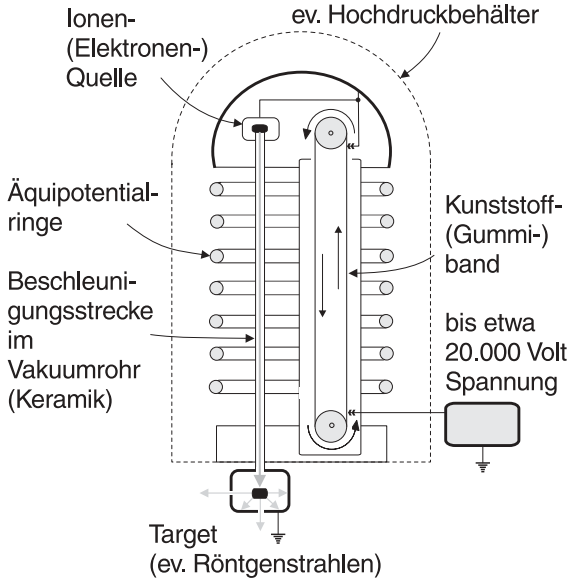
.

Below: Vertical X-ray tubes to built a protecting ring against enemy air-crafts.



Box 3

The Van-de-Graaff-Generator



Principle of the high voltage generator developed in 1931 by Robert J. Van de Graaff (1901-1967) in the USA, shown here with an acclerator tube. It was succesfully built in many laboratories and in industry [Gr31]. Electric charges are mechanically transported to an upper sphere by means of a rubber band. At normal atmospheric pressure a metallic sphere can reach 1 to 2 megavolt in a sufficiently big hall. Compact versions in a high pressure tank of 2 to 3 metres length can reach up to 5 million Volt. Such a device was proposed by Otto Hahn in 1941 for the Kaiser-Wilhelm-Institut (Berlin-Dahlen) [We94]. This was probably known by Schiebold. About 1932 Cockcroft-Walton devices were developed, which Schiebold mentions explicitly (see Box4).

3. *High voltage installations: Valves AEG Berlin Dr. Herz or Dr. Steenbeck*
4. *Koch & Sterziel A.G. Dresden (Dr. Fischer)*
5. *X-ray medicine: Prof.Dr. Baensch, Chairman of the Medical X-Ray Society*
6. *Thermodynamics: Dr.Ing. W. Schultes, Director of German Technical Survey Society.*

Schiebold added that none of these people had been invited to participate at the time of writing and that he would be willing to take on the task of informing the consultants himself.

Furthermore, he suggested that orders should be placed for the design and construction of a 'wide cone beamer' and a 'directional beamer', and he stated that the realisation of the project would primarily depend on the degree of urgency it was assigned.

Following his written proposal of 5th April 1943, Schiebold was officially authorised by Colonel Pasewald (from the Luftwaffe's Research Department) to discuss this highly classified undertaking with his friend and adviser Richard Seifert who owned 'R. Seifert & Co', a renowned X-ray equipment factory in Hamburg, and who also lead an official working group on electro-medical applications. These discussions were to take place in the presence of the engineer and Luftwaffe Captain Fennel.

The first of these officially sanctioned meetings took place in Hamburg on 17th of April 1943 and the minutes of this discussion are expansive as regards Richard Seifert's opinions on Schiebold's proposals [SE43b].

First of all Seifert agreed in principle that, given the technology available at the time, it should be possible within 1 or 2 years to *"solve the problems related to the use of X-rays and electron beams for war purposes"*.

However, in his next statement Seifert clearly expressed his doubts that it was feasible within the same period to prepare equipment and facilities, which, *"produce at distances of up to two kilometres the radiation dose of 600 roentgen units per second required for permanent biological damage"*.

It is important to remember at this point that in 1943 research and development projects for which tangible results were not expected in less than a year were in general not approved by the German authorities. Seifert's statement therefore posed a serious limitation to the goals originally envisaged by Schiebold.

On the other hand Seifert immediately added that a solution to this timing problem was found during the course of the discussion. It would, he stated, be easier to produce X-rays with a much lower intensity, but sufficient to produce some "*ionisation effects*", and mentions several not easy to understand alternatives for applications in this direction:

a) 'overloading' the ionised beam with high voltage, thereby immediately eliminating an enemy;

b) the effects of highly ionised air to block ignition engines should be investigated;

c) also the enhancement effects of blowing specific, more easily ionised gases into the beam should be studied. At the same time the influence of 'potential gradients' in the atmosphere and the 'ionic wind' must be investigated.

Seifert was aware that the time factor was crucial to gaining approval for the project, and therefore proposed that initial experiments should be conducted using an existing X-ray generator that had been built and factory tested by the AEG company. This modern piece of equipment had been delivered to a Hamburg hospital, but the onset of war had prevented its installation. It was able to achieve a voltage of one million volt and a current of 10 milliampere. The intensity of the produced X-rays, measured at a distance of one metre, was equivalent to the radiation provided by 840 grams of radium, which already constitutes a rather dangerous amount. This powerful X-ray generator would enable them to conduct the following tests:

a) Study the range in air of high energy X-rays and their dose-effects;

b) test a model of a Schiebold-type X-ray tube;

c) study the effects of introducing X-ray ionised air into ignition engines.

The minutes of the meeting held on 17th April also outline the organisation, timing and many practical details for the immediate start

of the project, provided it is approved. Schiebold would then be nominated scientific director, and Seifert would had the technical resposibility. Administrative tasks would be taken on by a university, either Dresden or Leipzig. Finally, they proposed *'X-ray Inspection of Armour Plates'* as a codename to camouflage the project. The copy on hand [SE43b] ends with a statement that the original document had been signed by Seifert, Fennel and Schiebold.

Schiebold was very active during this period. Already on 19th April 1943 he presented a 5 pages long first addendum [SE43c] to his original proposal. Most of it was probably written before the meeting of 17th April. In this addendum he expanded his comparison with conventional weapons. Schiebold also remarked that large, high voltage generators for X-ray production were already in construction in other countries, particularly in the USA.

The addendum includes a few rough calculations of the attenuation of a parallel beam of X-rays in matter and, more particularly, in air. In these estimations Schiebold takes into account absorption, scattering (Compton effect) and electron-positron pair production, although the latter process only happens at energies above 1.2 Megavolt. Schiebold considers the ideal case of a parallel beam, as it is treated in textbooks. But this approximation can only be used for relatively short distances. For longer distances other effects must be taken into account, including the unavoidable divergence of real beams, which Schiebold wanted to try to minimise using his special X-ray tubes. Since this was one of the aims of his proposed development work, he was not able to provide greater details on this subject.

As soon as the distance between source and target becomes much larger than the source dimension (that is in our case, the size of the focal spot of the X-ray tube), the intensity normally decreases with the inverse square of the distance, a well known general law. However, Schiebold applied this law only on the case of radiation that is distributed over a large cone.

After some quite general considerations, Schiebold also provides in this first addendum the official definition of the 'roentgen' (r), a unit which was in use for X-ray doses at the time. He also explains that

irradiation above about 600 roentgen per second (r/s) will cause substantial biological damage, as it was already quoted by Seifert [SE43b].

It is at this point that Schiebold introduces an extrapolation that can only be described as risky. The conventional X-ray tubes in use at the time consumed about 1 kilowatt (kW) and produced a radiation dose of 0.8 r/s at a distance of 1 metre. If, so the extrapolation goes, it were possible to construct a tube that was able to consume and withstand about 100,000 kW, it would be possible to produce a dose of something like 80,000 r/s at small distances. Schiebold now calculates that at 1350 metres the intensity of a parallel beam (with no divergence) would be attenuated by absorption in air to about 1% of it initial value. This would still provide a dose of ca. 800 r/s, which clearly has a very harmful effect. At 2000 metres still 1/1000 of the original intensity would be available.

Schiebold added that the calculated intensities would be about one million times smaller if the divergence law was taken into account. Even so, this would be more than sufficient to cause ‘ionisation effects’ like those that Seifert had mentioned at the meeting of 17th April. Schiebold describes some of these effects in the last section of this first addendum. He includes the possibility of obtaining with X-rays an ionised channel in air, which would conduct electricity, like it happens in a wire. A high voltage discharge could be send through such a channel. This would correspond to the early ideas of Grindell-Matthews and Nicola Tesla, which however Schiebold never mentions. He further suggests that it may be possible to utilise the ionisation caused by strong X-rays to condensate clouds or mistiness. This could be used to improve the visibility at airports.

Obviously Schiebold (and his advisers) searched for effects that would be obtained with much lower X-ray intensities. They would not kill human beings, but reach some practical results for war purposes. Regarding the energy requirements and the focussing of the beams, some fundamental problems remained to be solved, but Schiebold was still very optimistic on this respect.

The day after issuing the first addendum to his original proposal, i.e. on 20th April 1943, Schiebold was given the opportunity of presenting his ideas in person to the office of General Field Marshal Milch, although the Field Marshal did not himself attend (see i.e. [SE44c]). Instead General Vorwald, head of a Division of the Ministry of Aviation (*Reichsluftfahrtministerium RLM*) called 'GL/C' and Colonel Pasewald, head of the 'GL/C-E' Division of the RLM were present at the meeting. Schiebold had also requested that Captain Dipl.Ing. Fennel and Mr Theodor Hollnack, both men of confidence of the RLM, be invited to attend. Schiebold knew Hollnack from earlier research contracts he had with the RLM. In a later statement Schiebold explicitly mentions (for unknown reasons) that Colonel Diesing, head of the 'Technical Air-Force Armaments of the RLM' Division, was not present.

At this important meeting, the 'GL/C' Division issued an

'Order for Research Work - Urgency Class DE 6224/0109/43',
(Forschungsauftrag der Dringlichkeitsstufe DE 6224/0109/43)

regarding Schiebold's proposal. At the same time, a declaration of full power of attorney for the realisation of the project was issued personally by General Field Marshal Milch for Fennel, Hollnack, Schiebold and Seifert. Schiebold had nominated the latter to act as technical adviser to the project [SE44c].

The following day, that is, on 21st April 1943, Schiebold issued a second addendum which provides more details about the conclusions of the Schiebold-Seifert-Fennel meeting of 17th April [SE43d], particularly as regards the ionisation effects of X-ray beams. On 5th May 1943 Schiebold submitted a third addendum [SE43e] which essentially provides a detailed description of a high voltage 'cascade generator' (or 'Cockcroft-Walton' accelerator) for X-ray production. This type of generator had already been built by then, and examples were operating successfully in several laboratories. However, for his purposes Schiebold needed a much more powerful version than the generators that had already been developed or were being planned.

This was the situation of Schiebold's proposals one month after commencement. As he clearly pointed out several times, many problems needed to be overcome, particularly with regard to energy requirements and the method for concentrating the beams onto a target. Schiebold's ideas were the source of heated discussions, but he remained optimistic.

The 'Research Order' issued by the Luftwaffe on 20th April meant that work could now begin and would be organised by an Institute of the University of Leipzig with a very particular status: It was authorised to enter into commercial research and development contracts (on a private basis) with both state organisations and industrial companies, although any profits the Institute made had to be returned to the University. Schiebold was the founder and director of this fairly well known institute called 'Institute for X-Ray Materials Research' (*Institut für röntgenologische Roh- und Werkstofforschung*).

The leadership of the top-secret X-ray gun project was officially organised as follows:
Ernst Schiebold - scientific director,
Richard Seifert - technical adviser,
Theodor Hollnack - administrator.
The fourth member of the team was Captain Fennel. He appears to have been present at many meetings, but I was not able to determine what role he played.

As one can deduce from later documents, the project was under the command of a Department known as 'Research Command of the Air Force Minister and Commander in Chief of the Luftwaffe' (*Forschungsführung des Reichsministers der Luftfahrt und Oberbefehlshaber der Luftwaffe RdL. und ObdL.*), which was run by the meteorologist Prof. Walther Georgii (1888-1962) as managing Director. The Department's other scientific directors in 1943 were, Ludwig Prandl, Adolf Baeumker and Friedrich Seewald (Chairman). At the same time Georgii held the Director's post at the 'German Research Institute for Glider Aircraft' (*Deutsche Forschungsanstalt für Segelflug,* DFS).

Everyone I have mentioned so far had to have already been in receipt of confidential information regarding Ernst Schiebold's top-secret proposals. Arnold Sommerfeld and Werner Heisenberg had been introduced before by direct consultations of Schiebold.

However, minutes of a meeting between Hollnack and Dr Eisl of the AEG Valves Factory in Berlin-Oberschöneweise held on 3rd June 1943 [Ho43] demonstrate that these were not the only ones in the know.

Counsellor of State Prof. Dr. Abraham Esau (1884-1955) had asked Dr. Eisl for his opinion on Schiebold's proposals. At the time Esau presided over the eminent German institution that controlled standards and units, the *'Physikalisch-Technische Reichsanstalt' (PTR),* having succeeded Prof. Johannes Stark in 1939.

On 31st May 1943 Dr. Eisl presented Prof. Esau with an exposé which expressed his views on Schiebold's project in very general terms. Hollnack had his own doubts, and was curious to find out what Dr. Eisl's thoughts were on the matter. Eisl' response was cautious and expressed that Schiebold's ideas for X-ray tubes with enlarged focal regions and the methods he had proposed for collimating beams, were *"quite new"*. However, Eisl also reported that the concept for a larger focal spot was not original, and had already been discussed in American and Swiss publications. Furthermore, several years previously, Dr. Graf, an assistant of Prof. Glockner at Stuttgart Technical University had already proposed the construction of an X-ray tube with a large anticathode surface. The project had not been considered feasible from a technical point of view, and AEG refused to go ahead with it.

This did not satisfy Hollnack, and he insisted that Eisl should provide him with a detailed expert opinion. Eisl prudently refused to provide a more concrete answer, and stated that any assessment in addition to his exposé to Esau would be possible only when he was in possession of more detailed information regarding Schiebold's plans, although he did recognise that it was possible they could indicate *"new pathways for exploration"*. There is in existence a written report on the meeting between Hollnack and Eisl [Ho43], but it does not include Eisl's exposé to Esau.

We may assume that Schiebold began work on his project soon after he and his 'Institute' was issued with the official 'order'. Most of the work was done in Leipzig, but some of it was also conducted at the Luftwaffe's 'Grossostheim Research Station ' (*Forschungsstelle Groß Ostheim*) that had been installed adjacent to the 'Grossostheim' military airport near to the city of Aschaffenburg. This research station and its military chief officer were also under the command of the above mentioned Luftwaffe Research Department with Seewald as Chairman and Georgii as managing Director.

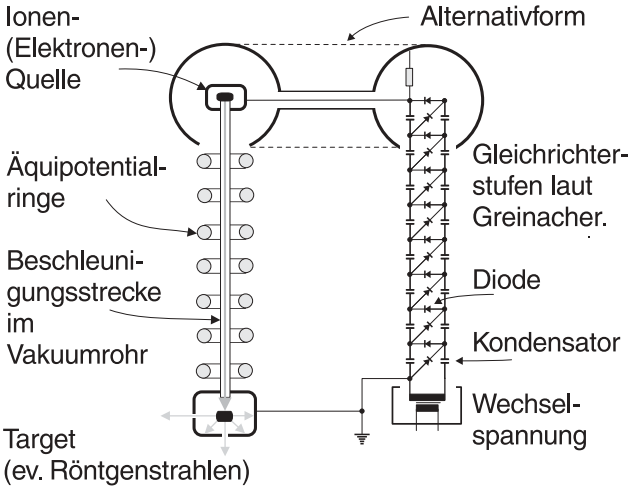
A big hall was required to place the high voltage generator proposed by Seifert and later on even generators of higher voltage. An adequate hall was designed by Prof. F. Tamms and architect Sander with the help of members of the pertinent Air Force District (*Luftgau*) XII. To avoid spark discharges to the walls the hall had to be 12.3 metres high and had a base surface of 15.7 by 24 metres. Construction at Grossostheim started in the second half of 1943. Under and on one side of the hall, concrete shielded shelter rooms for instruments and personnel were placed. The walls of the hall instead had a wooden structure. Several draft drawings of this building are conserved [Ta43]. In one of them a high voltage device is sketched. It is 4 metres tall and has on top a sphere of 1.4 metres diameter. The electron beam should be directed downwards, to a target (anticathode) in the bunker and an even deeper hole to dump the beam.

Schiebold described the progress made on his X-ray gun project during 1943 in a letter he wrote to Georgii [SE44c]. The following actions had been taken by December of that year:

1. *Acquisition of the 1.2 million Volt X-ray generator from the city of Hamburg for the sum of 135,000,- RM.*
2. *Construction of a large hall in Grossostheim (under Wiesbaden Air Command District) with special facilities for the installation of an X-ray generator. Completion of civil engineering works expected within 4 to 6 weeks.*
3. *An order placed with the C.H.F. Müller company for a spare X-ray generator tube , with which it was hoped 1.5 million Volt would be achieved.*

Box 4

The Cascade-Generator



Sketch of the principle of the cascade generator with attached accelerating tube, as it was originally developed by the british physicists John Douglas Cockcroft (1979-1967) and Ernest Thomas Sinton Walton (1903-1995). With such a device they were able to observe for the first time nuclear reactions produced by artificially accelerated particles in 1932.

The cascade circuit used had been already developed in 1914 by the Swiss physicist Heinrich Greinacher (1880-1974) [Gr21].

Cockcroft-Walton-generators are still used today (as well as Van-de-Graaff-Generators see box 3) for physics experiments and also as preaccelerators.

Such a device was had been forseen for a hospital in Barmbek (Hamburg) and Richard Seifert proposed to use it for Schiebold´s tests. The ineresting history of this accelerator is describeb by Burkhard Weiss [We00].

4. *An order worth 150,000 RM placed with the C.H.F. Müller company for the development and construction of a 15 megavolt ray transformer of the 'Wideröe type'. Delivery expected in mid-1944.*

This is the first time that the words *ray transformer of the 'Wideröe type'* (under item 4) make an appearance in Schiebold's writings. It is the name of an electron accelerator (later called betatron) which had to be built in Hamburg. This forms the subject of the next chapter.

It might be of interest to remark that between late 1942 and the end of 1943 Schiebold had at least three more research contracts with the Luftwaffe (RLM), worth about 270,000 Reichsmark (RM) in total. These contracts were completely unrelated to his X-ray gun projects [SJ94a], although some of the work for them was also conducted at the Grossostheim Research Station. In one of these three contracts the well known laboratory of Prof. Manfred von Ardenne in Berlin Lichterfelde was also involved.

A comparison of the costs quoted above and some other Air Force Ministry's expenses provides food for thought. A famous encyclopaedic work on World War II ([Be93], p 577) informs us that, in the period January 1944 to April 1945, a total of 5,940 V2-rockets were delivered to the Luftwaffe at a unit cost of 119,600 RM each (not including war heads), being built in underground factories in the Harz mountains by cheap, forced labour and concentration camps inmates. So it is evident that the cost of Schiebold's research and development projects were not considered particularly important at the time.

Before I continue reporting on the development of Ernst Schiebold's proposals and related subjects, I would like to digress a little and convey something of his personality and life prior to 1943 and about the possible reasons which induced him to make his X-ray gun proposals.

In this respect Schiebold's son Joachim was extremely helpful in providing me with major items of information and many important documents during the course of several meetings and extensive correspondence since we first had contact in 1993. Joachim was very

keen that I write a biography of his highly esteemed father, but sadly, he died before we were able to realise this project.

Besides Joachim's valuable help I also had other sources of information about Ernst Schiebolds life.

On 9th June 1994 the Otto-von-Guericke University in Magdeburg hosted a celebration to commemorate Schiebold's 100th birthday, which took the form of a one day colloquium at the 'Institute for Materials Technology and Test' (*Institut für Werkstofftechnik und Werkstoffprüfung*), an institution which Ernst Schiebold had founded in 1954. The guests included many of his pupils, assistants and collaborators, and they supplied me with a great deal of additional information on Schiebold's life.

The first talk at the meeting was delivered by Fritz Günther, a retired professor currently living in Freiberg, who recalled fond memories of his much-admired teacher Ernst Schiebold. A man of advanced years, he was the only one present who had actually worked with Ernst Schiebold as far back as 1943.

Prof. Egon Becker (Magdeburg) gave a very interesting laudation and recounted many details of Ernst Schiebold's life. Prof. Becker kindly sent me an article on Schiebold that he had written in 1983 [Be83], as well as some other documents.

The Magdeburg celebration, particularly the post-colloquium dinner, also gave me the opportunity to meet other people who had worked with Schiebold, and who were able to provide me with interesting information.

Ernst Schiebold was born on 9th June 1894 in Leipzig, the son of a police detective. Still in Leipzig, Schiebold passed his school-leaving examinations and studied at the University where he obtained his doctorate under the direction of Professor Friedrich Rinne (1863-1933). The subject of his thesis was a quantitative analysis of the 'Laue diagrams' that were employed to study the structure of crystals using X-rays.

Whilst a student Ernst Schiebold became acquainted with Richard Seifert (1890-1969) and his younger brother Hermann, who was also studying at Leipzig. Their father was the founder and owner of 'Rich.

Seifert & Co', a company that had begun building X-ray devices as early as 1899. Both the Seifert brothers volunteered for active service in World War I, and in 1915, Hermann was killed in battle in France.

Not long after Roentgen had made his historic discovery, Richard Seifert sen. (1862-1929) made his first X-ray experiments. Based in Hamburg he started constructing X-ray devices and developed a successful industrial enterprise. Richard Seifert jun. was already the junior manager of the factory when his father died, and he subsequently took on the role of Director. Ernst Schiebold and Richard Seifert Jun.'s shared interest in X-ray devices and their application certainly provided a major foundation of their cordial relationship

In 1920 Ernst Schiebold passed the examination for 'high-school teaching' (*Staatsexamen für das höhere Lehrfach*) and worked as Prof. Friedrich Rinne's assistant until 1922. During this time he married Charlotte Hauer. He had the good fortune to find in his wife a woman who agreed with his deep commitment to work. They had for sons; Wolfgang (b. 1927), Joachim (1931-2002), Helmuth (b. 1936) and Karlheinz (b. 1939).

In 1922, Ernst Schiebold started working for the 'Kaiser-Wilhelm Institute for Metal Research' (*Kaiser-Wilhelm Institut für Metallforschung*), Neubabelsberg in Berlin, where he took over the organisation and direction of a new X-ray laboratory. At the same time he was the director of the Institute's Division of Applied Physics.

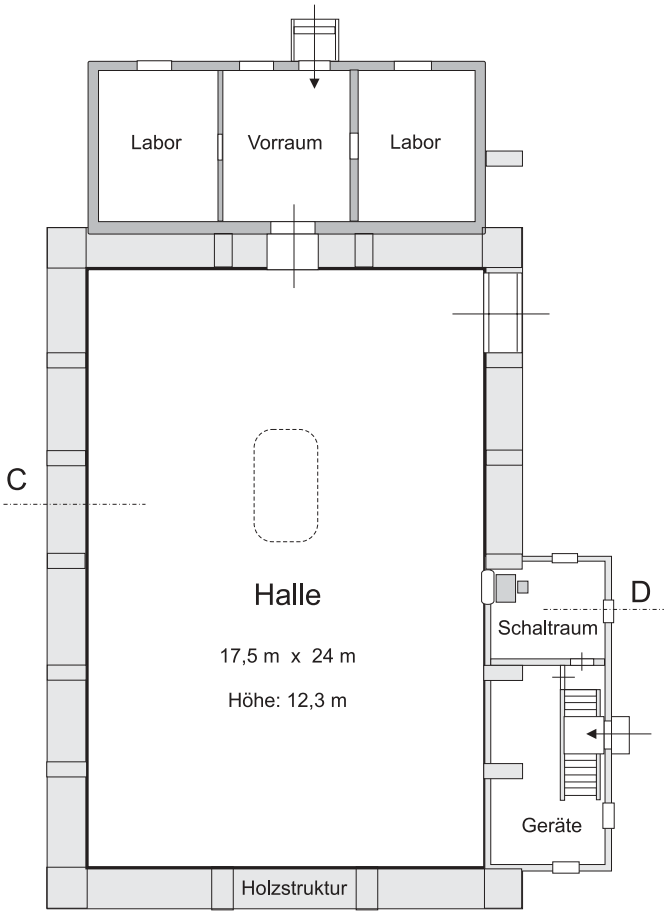
In 1926 the University of Leipzig offered Schiebold the chair for 'Physicochemical Mineralogy, Petrography and Fine Structure Analysis' (*Professur für physikalisch-chemische Mineralogie, Petrographie und Feinstrukturlehre*). This came as a complete surprise to him since he was very young to be offered such a position. Nevertheless, he accepted gladly, and took his new responsibilities, with regard to both teaching and research, very seriously. He was always available to his assistants and students, and was known for working at the Institute until late in the evenings.

In 1928 Schiebold also took over the direction of the University of Leipzig's Mineralogical Institute. In this position he was able to forge valuable links with industry. In 1929 he was among a group of people who suggested that a course on 'X-ray Technology for Materials

Box 5a

Hall and Bunker for Accelerator Experiments in Groß Ostheim

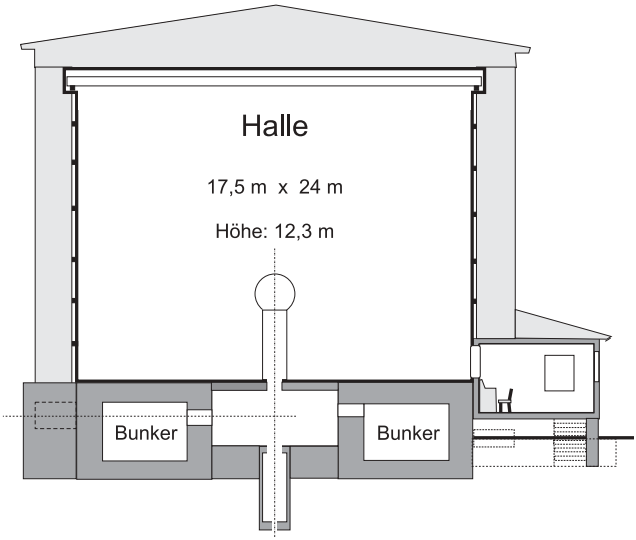
A: Ground Plan



Box 5b

Hall and Bunker for Accelerator Experiments in Groß Ostheim

B: cut C - D (see ground plan)



Original drawins by Prof. E. Tamms
Sept. 5, 1943

The here shown new drawings were made by Pedro Waloschek exactly following the originals in the Sächsisches Landesarchiv Leipzig.
The bunker is today used as museum, see „Comments“ on „References“ and internet: under Peter Hepp and Klaus Sauerwein.

The „Tatzelwurm“ [SE40].

Testing’ (*Röntgentechnik in der Materialprüfung*) should be established at the Technical University of Berlin.

In Saxony and surroundings, and even as far as in Hamburg, Ernst Schiebold was better known to the general public for his so called ‘Tatzelwurm’ (Bavarian name for a ‘Winged Dragon’). This was a large Skoda bus earlier used by the Royal Austro-Hungarian Post Administration, that Schiebold purchased for 5,700 RM, and in which he had installed (with the help of industrial firms) a complete X-ray laboratory for structure analysis, including a dark room for processing X-ray films and plates. This mobile facility enabled him to conduct X-ray investigations on objects that could not easily, if at all, be transported to a laboratory, such as pipelines and the welding seams of bridges, and it made it possible to see and analyse the results immediately. The ‘Tatzelwurm’ was also deployed as a mobile teaching station. A publicity leaflet, A4 in size and featuring a photograph [SE40], has survived the ravages of time, and is entitled:

‘Mobile X-Ray Station for Materials Testing of the Research Society for Materials Development. Office: Leipzig C1 Bitterfelder Straße 3.’
(Röntgen-Kraftwagenstation für Werkstoffprüfung der Studiengesellschaft für Werkstoffentwicklung. Geschäftsstelle: Leipzig C1 Bitterfelder Straße 3.)

In 1929 Ernst Schiebold and the renowned scientist John Emil Max Eggert (1891-1973) founded the ‘German Society for Technical X-Ray Investigations’ (*Deutsche Gesellschaft für technische Röntgenkunde*) . From 1930 onwards this became known as the ‘Committee 60’ of the ‘German Federation for Materials Testing in the Technical Domain’ (*Deutscher Verband für die Materialprüfung der Technik*). Between 1930 and 1938 Eggert and Schiebold edited the reports on the Committee’s meetings in six volumes entitled ‘Results of the Technical X-Ray Investigations’ (*Ergebnisse der technischen Röntgenkunde*).

From 1924 until 1937 John Eggert worked as an extraordinary professor at the Technical University of Berlin. He also founded and directed the ‘Central Scientific Laboratories’ of the ‘AGFA Filmfabriken’ in Wolfen.

In 1932 Ernst Schiebold became an associate member of the ‘Kaiser-Wilhelm Institute for Metal Research’. In 1935 the ‘Reich’s X-Ray Office’ (*Reichsröntgenstelle*) commissioned him to conduct a number of investigations for manufacturing companies in the eastern and central regions of Germany. His son Joachim has a vague recollection that this also included having to use X-rays to check an oil or gas supply line to a luxury mountain chalet that belonged to a major Nazi functionary.

An important step in Schiebold’s life was his nomination to the post of Ordinary Professor for ‘X-ray Physics and Non-Destructive Materials Testing’ (*Röntgenphysik und zerstörungsfreie Werkstoffprüfung*) at the Technical University (TH) of Dresden. He also took over the direction of the Division for ‘Non-Destructive Materials Testing’ at the Materials Testing Office of the TH Dresden.

On top of all this Schiebold collaborated with industry to run the above mentioned semiprivate ‘Institute for X-Ray Materials Research’

which held a special status at the University of Leipzig. Industrial firms provided the Institute with interesting instruments, some of them on a permanent loan basis. The provision of X-ray equipment and measuring instruments by 'Rich. Seifert & Co' Hamburg was particularly valuable .

Schiebold's essentially private Institute was able to survive the Nazi period, war and the GDR regime thanks to a large number of orders, most of which came from state owned industries, although some work was also commissioned by private companies. Later on, when Schiebold left Leipzig, his son Joachim took over the Institute, but after the reunification of Germany most client companies ceased to exist and the Institute gradually reduced its activities until it finally went out of business.

Joachim Schiebold told me in one of our meetings that his father enjoyed the acquaintance of Theodor Hollnack, whom I have already mentioned above. According to Joachim, Hollnack was an extremely accurate and reliable man. His father had complete confidence in him and frequently asked him for advice. Hollnack was in charge of an Air Force Ministry (RLM) office or department in Berlin W8, Leipzigerstrasse 7. He had the trust of the Luftwaffe and, as mentioned above, his direct superior was General Field Marshal Milch. Hollnack also owned a commercial firm in Essen that traded in light metal alloys mainly for the use of the aircraft industry. Joachim Schiebold found out the address: Essen-Bredeney, Alfredstrasse 383 [SJ94d].

Ernst Schiebold [SE59].

Joachim was convinced that Hollnack occasionally required his products to be examined using X-rays and that this task was entrusted to his father, often with instruments provided by Rich. Seifert & Co. The latter had, as one of their successful specialities during World War II, just the supply of

instruments needed by the aircraft industry.

According to Joachim Schiebold [SJ94b] in 1942 his father embarked on a politically dangerous course of action. He was part of a group of people who took responsibility (in the form of an unspecified 'guarantee') for the physicist Dr. Margarethe Eggert-Ettisch, the Jewish wife of his colleague John Eggert, in order to prevent her internment in a concentration camp. This caused Ernst Schiebold a certain amount of trouble with the Nazi authorities.

Nevertheless, and as Joachim later told me, his father also exploited his relationship with General Field Marshal Milch to ensure that John Eggert would be permitted to continue in his leading position at AGFA. As the husband of a Jew the Nazi racial purity laws stipulated that Eggert should have lost his job. This had already been the reason why he was dismissed from his professorship in Berlin in 1937, and had even been denied the use of the title of 'Professor'. Eventually his dismissal from AGFA was prevented thanks to the efforts of a number of people, chief among them Dr. Fritz Gajewski, a director of the AGFA company. Eggert remained in his post until the end of the war. Milch's assistance in this and similar situations is probably attributable to Milch's father's Jewish origins, a fact he had been unaware of until he had already achieved a high-ranking position in the Third Reich. Attacked by his Nazi colleagues, he was defended by Göring with the famous words, "It is up to me to decide who is a Jew" (*Wer Jude ist bestimme ich!*) [Be93].

Ernst Schiebold developed a reputation for doing all he could to help his colleagues and students, particularly with regard to ensuring their exemption from active military service wherever possible. Naturally, he needed them to help him in his work, but his prime motivation appears to have stemmed from the paternal feelings he harboured for them all. Ernst Schiebold himself had no need to fear a call-up as a deformed foot made him unfit for service.

By 1943 Ernst Schiebold had provided the scientific world with around 72 publications, according to a list made by his son [SJ94c]. It is also certain that he submitted many patents, but of these I have no list. Some are mentioned in his proposals, particularly those for X-ray tubes with large surface focal regions.

To my knowledge in the spring of 1943 Ernst Schiebold was still teaching at the TH Dresden, as well as directing the 'Non Destructive Materials Testing' Division, the Leipzig branch office of Dresden Technical University, and his semi-private 'Institute' in Leipzig. The mobile 'Tatzelwurm' laboratory was definitely still in use at that time.

Hence Schiebold was a distinguished, busy, committed and enthusiastic scientist when, in April 1943, he presented to the Luftwaffe his somewhat peculiar proposal for the development of X-ray guns. There is ample justification for asking why he embarked on such an uncertain task.

Schiebold's son Joachim provided a possible answer to this question in a 3-page long memorandum he sent to me in 1994 [SJ94b]. In Joachim's opinion the nomination of his father as Director of Dresden Technical University's Leipzig branch office in 1942 was in reality a disciplinary 'transfer' ordered by the Ministry in question as a punishment for his intervention on behalf of John Eggert's Jewish wife. As a reaction, the X-ray gun proposals were intended to demonstrate his father's patriotism and loyalty in the 'Total War'. However, as Joachim also points out, his father was politically quite naive, and others who worked with him later on have confirmed to me the son's opinion in this regard.

Another possible reason for the presentation of Schiebold's proposals could be his scientific engagement. Ernst Schiebold certainly had an interest in having his ideas about new types of X-ray tubes investigated. This can be considered as legitimate research curiosity. And Ernst Schiebold was certainly a convinced and sincere research worker.

However, there may be a third reason, namely that the proposal was a well-prepared and professional stratagem with the aim of obtaining the kind of privileges that would make it possible to exempt some of his colleagues from active military service .

At the dinner held after the Magdeburg celebration on 9th June 1994 this topic was the subject of lively discussion. In the opinion of Prof. Horst Blumenauer [Bl94] the last two would seem to be the most probable reasons behind the risky proposal submitted by Schiebold, whom he greatly admired as a teacher and adviser.

Prof. Fritz Günther made some interesting remarks (which he confirmed in a later letter to myself [Gu94]) on the actual events that led Schiebold to present his proposals.

In 1942 Ernst Schiebold had asked the Air Force Ministry (RLM) to finance a research project on materials testing that he had proposed in collaboration with a foundry specialist called Lehmann. It was during these discussions that Schiebold became acquainted with Theodor Hollnack, who was (as Günther points out) neither a physicist nor an engineer, but a businessman and administrator. And it was here that Schiebold mentioned the idea of developing powerful radiation sources for use as 'miracle weapons'. The spontaneously expressed idea was considered acceptable, and Schiebold inspired to prepare a research project.

Schiebold began by making calculations for the construction of such a high intensity source of radiation. As Prof. Günther reports, these calculations were all Schiebold's own work, which he performed without any contact with his university colleagues in Leipzig. He could certainly have had technical discussion with specialists in Leipzig, especially on the theoretical aspects of his work, but he did not. However, this does not mean that Schiebold did not ask people outside Leipzig for their opinion. Indeed, he did consult Prof. Friedrich Seewald (the Luftwaffe's Director of Research) and Prof. Werner Heisenberg who taught at Leipzig until 1942. A later document reveals that Schiebold believed that both Seewald and Heisenberg formed positive opinions of his written proposal and verbal presentation [SE44j].

After completing the manuscript Schiebold sent it to Prof. Arnold Sommerfeld in Munich, whose appraisal turned out to be rather negative, mainly due to his political and ethical views as regards that particular type of research.

Prof. Günther also read the manuscript, but he did not keep a copy and was not aware whether a copy had been preserved in Schiebold's later archives, since he left Schiebold's Institute already in 1945. However he did remember that Schiebold had been in close contact with Richard Seifert with regard to the project's realisation. He also mentions that besides their professional relationship the families of the two men had been close acquaintances of many years' standing.

As Joachim explained to me, it is not surprising that Schiebold's closest collaborators in Leipzig were not initially informed of the project he was preparing. He knew his father as a very precise, but extremely reserved and diffident person. He would never allow anyone to look into his affairs.

In his Leipzig office (and perhaps in all his places of work) Ernst Schiebold had a Leica camera mounted on his desk so that he could make copies of important documents for himself. Joachim had kept some of his father's films and during one of our meetings he handed them to me in the hope that they might prove useful should I ever wish to write something about the father he so much admired. However, with some exceptions, the films only contain documents that can now be seen at the Leipzig Archives.

As for Ernst Schiebold's ideas, although presented in a somewhat vague form, they did have some plausible scientific foundations, even if several of his applications of physical laws are open to question. It is clear that he knew and used the knowledge available at the time on X-ray production and that he was informed about the latest developments of quantum theory. Yet he remained fixed on the idea of using X-rays that were obtained in the traditional way, and he tried to extrapolate this to much higher energies, which, as we now know, is not correct. I will explain this in more detail in later chapters. In 1943 though the theoretical principles required to understand the physical phenomena were already available (see i.e. [He36]), nobody had made (or could make) sufficiently precise calculations for practical applications.

All the information so far available indicates that we can assume that Ernst Schiebold made in April 1943 a personal decision to take on the full responsibility and all the risks involved in making an official presentation of his ideas to the Luftwaffe. And, as I have already shown, with the assistance of Richard Seifert's practical ideas the project was in pretty good shape by the end of 1943.

———

Much shorter than German version (?)

5. Rolf Wideröe's "Beam-Transformer"

It was sometime in the spring or summer 1943 in Oslo. The weather was good and the electrical engineer Rolf Wideröe was trying to repair his bike, which he used to go to work every day. Suddenly two uniformed officers of the German Luftwaffe stand behind him. Could be they were three, he could not remember exactly later on. All these happened in the yard of the NEBB-Company, a Norwegian daughter enterprise of the Swiss Brown Bovery & Cie (BBC) in Basel (CH). Wideröe had a leading position at NEBB, in the section in which power plants were planned and constructed. Wideröe was not particularly surprised about his visitors. In three years of German occupation Norvegians were quite used to the presence of uniformed Germans. The officers were very polite and asked him, if he could come with them to the Grand Hotel to discuss some important matter. He answered, that he would like to come, but before he had to finish mending his bike.

They finally spent two or three days discussing at the Grand Hotel. They had some proposals related to the construction of a new type of electron accelerator. And they also hinted that it could eventually be of interest for his brother. His brother Viggo had been condemned to 10 years jail, after helping Norwegian underground partisans to flee to England, probably with some aircraft from his (at the time forbidden) "Wideröe Air Line". Viggo was in a prison in Germany and was not healthy at the time. As Wideröe described it later on, it was even mentioned that perhaps they could get Viggo free. Wideröe found it interesting and the officers asked him if he could accompany them to Berlin.

So Wideröe was flown to Berlin, in an aircraft of the Luftwaffe. Wideröe knew Berlin quite well. He worked there from 1928 to the end of 1932 developing special relays for high power current lines at the AEG Company. He had in Berlin an old friend from the time they were

both students in Aachen: Dipl.Ing.Dr. Ernst Sommerfeld (1899-1976), son of the famous physicist Arnold Sommerfeld (1868-1951). Ernst had become a lawyer specialised on patent matters and had as such an excellent reputation. He was working among others for Telefunken Company. And he had also made already many patent applications for his friend Rolf Wideröe.

In Berlin the discussions were more concrete. Officials of the Luftwaffe asked Wideröe if he would be willing to direct the construction of one or several of his "Ray Transformers" in Germany. This was the name, Wideröe gave to the type of electron accelerators which in Germany was also known as "Rheotrons" and for which the name "Betatron" was later on generally accepted. The name Betatron was proposed by the American physicist Donald William Kerst (1911-1993) in his publications.

Wideröe was probably not surprised by the German proposal, since a year before (in September 1992) he had submitted a detailed report on the theory and construction of "Ray Transformers" to the German journal "Archiv für Elektrotechnik". The article was already composed for printing (including page numbers) [Wi42] and was distributed as such to a selected number of persons including the young physics student Bruno Touschek, who at the time helped the editor of the journal, Dr. K.A. Egerer correcting papers before publication.

It was only in 2011 that the Italian physicist Luisa Bonolis researching on the life of Bruno Touschek, discovered that Wideröe´s article was in fact not contained in the volumes of the "Archiv für Elektrotechnik" stored in a München library [Bo11b]. It had been carefully substituted in the printed and distributed journal by another contribution with exactly the same length and page numbers. This fact was checked and confirmed to me by DESY-librarian Outi Wulf [Wu11]. Even Wideröe did not know this and distributed reprints of his article assuming that it was really published.

But with this paper Wideröe demonstrated to the few informed experts to be one of the few European specialists on this field. He had been working in Oslo on these ideas after he knew in 1941 about Kerst´s successful betatron-work in the USA, and even proposed to

BBC (CH) the construction of betatrons, as is demonstrated in several preserved letters [Br98].

After clearing some practical issues and formalities Wiedröe agreed to the German proposals and was officially “appointed for service” (“dienstverpflichtet”) for a special commission in Germany. Wideröe was at that time not informed about the reasons why just the Air Force (the “Luftwaffe”) was interested in his work and as a “foreign worker” he should not even know about it. Obviously later on he ended up knowing the real reasons behind it.

In 1943 Wideröe certainly new about the development of betatrons in Germany. Siemens company made no secret about their activity in this field, mainly for medical applications. The best known expert was Max Steenbeck who had already registered for Siemens several patents regarding betatrons. In December 1941 Siemens still agreed with General Electric (USA) on the use of Steenbeck´s patents, just before Pearl Harbour. Following a suggestion of Steenbeck, Ing. Konrad Gund had started the design of a 6-MeV-betatron at Siemens (Erlangen) already in 1941. Other activities on betatrons were supported officially as I show in chapter 3 and in the appendix of the present report.

The fact that just the Luftwaffe became interested in building a betatron can be understood in connection to the military death-ray-project proposed in April 1943 by Professor Schiebold (Leipzig) which was described in the last chapter. As mentioned there Generalfeldmarschal Milch ordered personally to start this top secret project under the direction and responsibility of Schiebold (as scientific leader), Seifert (as expert in industrial X-ray-devices), Hollnack (as trusted administrator) and Fennel (probably representing the Luftwaffe).

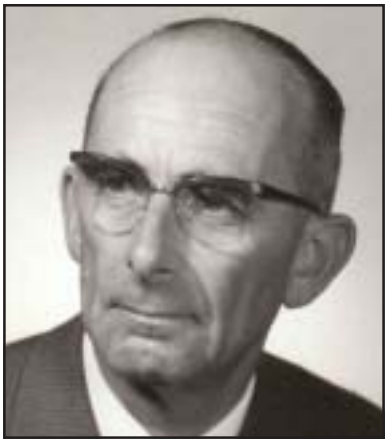
The project required the use of electrons accelerated to high energies, that is, with high voltages. Initially Schiebold only considered high voltage devices known at the time (namely cascade and van de Graaf generators), which were limited to about 1 to 2 Million Volts (MeV).

It was only several months later that the eventual use of betatrons as sources of electrons of much higher energy was added to Schiebold´s project including the idea of calling Wideröe to Germany to construct

such devices. All this was apparently suggested to the Luftwaffe by two well informed persons. One was the editor of the journal "Archiv für Elektrotechnik" Dr. K.A. Egerer, who claims (in a later letter to Ernst Schiebold [Eg45]) that it was him to suggest to Generalfeldmarschall Erhard Milch to include Wideröe´s ideas in Schiebold´s adventurous project. Egerer was an adviser of Milch at the time. The other person involved in calling Wideröe to Germany was Richard Seifert, the owner of a well known factory for X-ray equipment in Hamburg. This was reported to me by Mr Willi Markert [Ma94], who in 1943 was the commercial director of Seifert´s factory. I consulted him following a suggestion of Seifert´s daughter Elisabeth Samusch [Sa94].

The people involved with the Luftwaffe-death-ray project could certainly have asked Siemens to built a betatron for them. I assume that Seifert had no interest in doing this as he produced in his factory X-ray devices which were in competition with Siemens. And as he demonstrated later on, he was very interested in keeping the betatron construction under his control.

Most big companies producing X-ray devices were already speculating on the after-the-war market and on innovations like betatrons. And Wideröe was working for the Norwegian branch of the BBC-Group (Baden and Mannheim) which was certainly interested in a future production of betatrons. This is confirmed by a correspondence with Wideröe. C.H.F. Müller Co., where the Luftwaffe´s betatron was finally built in Hamburg, was part of the Philips group, who was also interested in getting some knowledge on betatron-construction. All partners probably agreed to develop a project *independent of Siemens*.



Rolf Wideröe, 1960 [Wa93]

Wideröe had at the time practical no contacts with other researchers working on the field of particle accelerators (and with physicists in general). His article for the "Archiv

für Elektrotechnik" and all the patents related to betatrons he submitted were kept strictly as secrets of war. He was therefore a kind of ideal partner for the Luftwaffe project and probably also for Richard Seifert´s future plans.

Rolf Wideröe made during his life several very interesting proposals for the construction of particle accelerators and that was why I became interested in his life story. Encouraged and supported by Björn Wiik (a Norwegian), at the time director of the research centre DESY in Hamburg (where I was one of the senior scientists) I got in touch with Rolf Wideröe who was living near Baden (CH). He agreed to help in writing his biography.

The result was an autobiographic report, published as a book in German, English and Russian. It can also be consulted in the Internet [Wa93]. However, I soon found out that Rolf Wideröe‘s activity during the war was sometimes interpreted as a kind of collaboration with the Germans. No specialist on the subject was willing to write a review on our book in the journal CERN-Courier (of which I was at the time correspondent at DESY). Although no physicists had concrete objections to Wideröe´s activity, the matter was controversial, especially in Norway. This problem increased my curiosity on the subject and I continued collecting data on war-time activity on betatrons. My results are presented in the present report.

Most documents on Rolf Wideröe´s life and work are conserved in the archives of the Scientific Historic Collections ("Wissen-schafts-historischen Sammlungen") of the Library of the "Eidgenössischen Tech-nischen Hochschule" ETH in Zürich [Wi80]. It was on this famous university, where Wideröe lectured as a "Titular Professor" from 1962 to 1972.

Some important documents about the controversial events on Wideröe's life after the War are stored in the National Archives in Oslo. They were seen (with permission of Wideröe‘s family) by the oncologist Prof. Dr. Tor Brustard (of the Radium Hospital Oslo) who wrote in 1998 an article defending Wideröe [Br98]. I will refer several times to this text. Tor Brustard also organized a Minimuseum-Wideröe at the

Radium Hospital in Oslo. I add here a short version of Wideröe‘s biography.

Rolf Wideröe was born on July 11, 1902 in Oslo where he also went to school. His father was a well situated importer of wine, cognac and oils. His mother was of German origin. After getting his A-levels (“Abitur”) in 1920 he started studying electrical engineering at the Technical University in Karlsruhe. Already as a student he had quite original ideas, like i.e. a device which could accelerate electrons to very high energies. Such electrons could be used to investigate the structure of atoms (he admired Lord Rutherford´s discoveries). His accelerator should work on the principle of the well known electric current transformer. The secondary windings of the transformer would be substituted with an electron beam turning around in an evacuated tube [Wi23]. So he called his accelerator “beam transformer” or “ray transformer” (“Strahlentransformator”).

After finishing his studies as an electrical engineer (“Diplom Ingenieur”) he had some practical experience in Norway and accomplished his military service there. Back in Karlsruhe he proposed to construct a “beam-transformer” as thesis-work to obtain the degree of “Dr.-Ing.”. He presented his ideas to the theoretician Prof. Schleiermacher who liked them. However, the famous physicist and vacuum-expert Prof. Wolfgang Gaede (1878-1945) considered Wideröe´s proposals as non-realistic. He argued, that the vacuum one could at the time reach would not be good enough. The electrons would be scattered by the residual gas molecules and thrown out of their orbits.

Wideröe did not give up. He made new calculations based on accurate measurements published by Nobel-laureate Prof. Philipp Lenard (later on author of the “Aryan-Physics” ideas) and concluded that his beam-transformer could very well work. But he did not like to go back to Gaede and contacted Prof. Walter Rogowski (1881-1947) of the Aachen Technical University (the “Rheinisch-Westfälische Technische Hochschule” in Aachen, RWTH). Rogowski found Wideröe’s ideas quite reasonable. So Wideröe moved to the RWTH and

got a small room in the seller of the Physics Institute and the necessary support to construct a first version of his accelerator.

In Aachen Wideröe had a very interesting time. He found many new contacts and had encouraging discussions with colleagues, naturally also with Rogowski and with his first assistants Dr. Eugen Flegler. At the time they were both developing high performance cathode-ray-oscilloscopes.

By the way: Walter Rogo-wski and the later Nobel-laureate for chemistry Peter Debye (1884-1966) were the first students of Arnold Sommerfeld, who was professor at the RWTH from 1900 to 1906.

But Wideröe´s beam-transformer did not work. Later on he understood why. Therefore he could not use it for his doctoral thesis. So he built another particle accelerator, this time with positive result. He applied an idea of the Swedish physicist Gustav Ising [Is24] which consisted in using an available high voltage several times to accelerate the same particles.

With 25.000 Volt available he was able to accelerate particles as if he would have 50.000 Volts! This device was worldwide the first successfully running “linear accelerator” and is considered as an important pioneer achievement in the field.

Wideröe´s report on his results was accepted as doctoral thesis and published in a well known journal edited by Rogowski, the “Archiv für Elektrotechnik” [Wi28]. As an appendix he added his ideas about a beam-transformer and described an important condition which the used magnet should satisfy. This was later on known as the “Wideröe 2 to 1” condition.

The American physicist Ernest Orlando Lawrence (1901-1958) saw Wideröe´s publication in the Library of his Institute, could not understand much of the German texts, but very well the included illustrations. This inspired him to an interesting idea. The principle of the linear accelerator could be used several times on the same particles, if their orbit would be would up with the help of a magnetic field. This was the starting idea for the famous “cyclotron”, which in the following years became one of the most important instruments for nuclear physics research. For the development of the cyclotron Lawrence was awarded in 1939 the Nobel Prize in physics. He always acknowledged thankfully Wideröe´s

initial suggestion [La31]. A curiosity: The cyclotron-principle was at about the same time also presented in their institutes by two German physicists, Eugen Flegler and Max Steenbeck. To my knowledge Flegler never published his ideas and Steenbeck did so, but much too late.

After his promotion in 1929, Wideröe was no longer active in particle accelerators but followed the pertinent developments. Recommended by his mentor Rogowski, he got a good position in a factory for transformers at AEG in Berlin-Oberschöneweide. Here he was in charge of developing very fast relays, which were used (a) to quickly interrupt the electrical current when short circuits happened along over-land power lines and (b) to determine the distance at which the short circuit had happened.

Wideröe had a very interesting time in Berlin, met several famous personalities, did listen to lectures by Einstein and Eddington and registered in total 42 patents on relays in Germany and two in the USA. Towards the end of 1932 Wideröe was worried about the political situation in Germany and went back to Norway, where he continued developing and installing relays for similar purposes. At this time he made acquaintance with his future wife Ragnhilde. They married on November 14, 1934 and later on had three children, Unn (1936), Arild (1938) und Rolf (1941).

In September 1939, at the beginning of World War II, Wideröe was offered a very promising position at the "Norsk Elektrisk og Brown Boveri" (NEBB). As already mentioned, he was in charge of planning and constructing electrical power plants.

In the autumn of 1941 Wideröe had the opportunity to listen to a seminar organised by a "Physics Association" of the University of Oslo. The lecturer was Roald Tangen (1912-1997), a physicist from Trondheim, and he reported on latest developments in the field of particle accelerators. Part of the presented information was very surprising for Wideröe and caused a drastic change in his life. Tangen reported among others issues on an article by physicist Donald William Kerst published in the journal "Physical Review" [Ke41b]. Here Kerst described the successful operation of an accelerator which worked on the basic principle of Wideröe´s "beam-transformer". Fascinated by this information Wideröe immediately started to work on the subject again.

Kerst had also elaborated with his colleague Robert Serber (1909-1997) a quite useful theory for his accelerator [Ke41c], which Wideröe studied accurately and later on even improved in some aspects. He considered himself as the author or original inventor of the principle used for the machine.

Wideröe started planning realistic projects for bigger "beam-transformers". They would accelerate electrons as if 100 and even 1000 (!) million Volts (MeV) were available. He even estimated the size, the required materials and the costs for such big machines. Kerst´s accelerator just reached modest 2.3 million Volt equivalent. But he was already building a 20-MeV-machine at General Electric Company in the USA and a 100-MeV one was also in preparation.

In 1942 Wideröe started writing down his improved theory of the ray-transformer and his ideas for bigger accelerators. As it was already mentioned, he submitted this report on September 15, 1942 to the journal "Archiv für Elektrotechnik", where he had already published his doctoral thesis in 1928. It was finally never published. But the chief-editor of the journal Dr. Karl A. Egerer gave it to read and check (among others) to the talented young Austrian physics student Bruno Touschek, who at the time was helping him editing the journal. The latter discovered that Wideröe had not taken into account correctly some relativistic effects which were important for the high energies reached by the electrons in the accelerator. He contacted Wideröe and convinced him to correct his report. This seems to have been their first contact and the beginnon of a very intens collaboration.

While working on his report on beam-transformers, Wideröe had contacts with BBC in Baden (CH), as reported by Tor Brustard [Br98]. Wideröe proposed in letters to BBC the construction of ray-transformers. In an answering letter BBC-directors asked Wideröe not to forget to apply for patents for his ideas in Germany and, if possible, also in the USA and in England. For these tasks he could count with the support of BBC.

Already on July 12, 1943 Wideröe submitted a second Article to the "Archiv für Elektrotechnik" in which, according to his memories, he presented quite accurate computations and construction details for a 15 MeV and for a 200 MeV ray-transformer. According to Wideröe these

manuscript was also declared a secret of war from the beginning and therefore never published. Only selected trustees received copies. Wideröe did not keep a copy and it seems that no copies have been preserved.

A few days later, on July 15, 1943 Wideröe applied in Berlin for a first patent on an injection system for electrons into a beam-transformer. This obviously reinforced his position in the negotiations with the German authorities. But, as already mentioned, this patent and all the following ones were declared secret of war and not published for discussion, as is otherwise usual for normal patent-submissions.

In the middle of 1943 Wideröe was "appointed for service" in Germany with his more or less voluntary or free consensus. His commitment consisted in building beam-transformers "for the German Luftwaffe". His Norwegian employer NEBB accepted this agreement - or was forced to do so. But as became clear later on, also the Swiss BBC was interested in the construction of beam-transformers or betatrons. One can assume that Wideröe had from the beginning the full consensus of the Norwegian NEBB while spending a lot of time already working on his accelerator ideas in Oslo.

Anyway Wideröe´s wife received his full Norwegian salary from NEBB during all the time he worked in Germany. Wideröe was still considered as employee of NEBB. He was allowed to visit his family in Oslo whenever he wanted and also to work there for his reports. He was anyway free to decide about his own official or private journeys. Wideröe was obviously considered a very important person. As he commented, he obtained (or negotiated) quite convenient working conditions and a good salary for his time in Germany. Apparently the involved German authorities had no objections to his still good relations with NEBB and in particular with BBC. This could have been related to the fact that the largest BBC-factory was placed in the German city of Mannheim - and not in Switzerland.

Regarding personal contacts in Germany, Wideröe tells that he did not have an explicit superior for his activity. He had some contact with a colonel of the Luftwaffe called Friedrich Geist. He payed him several short visits in his office in Berlin and had the impression that it was a quite reasonable and sympathetic person.

Friedrich Geist was at the time directing the Department of Technical Developments (or Research) in Speer´s Ministry for Armaments and War-Production ("Reichministerium für Rüstung und Kriegsproduktion"). According to a comment by Werner Heisenberg in the "Farm-Hall-Protocols" (s. [Ho93]), Geist was even "the right hand" of Speer. Later on Speer was the successor of Generalfeldmarschall Milch in directing all competences regarding the Luftwaffe.

Wideröe considered Geist as officially responsible for his activity in Germany. But he should apparently not know exactly for which organisation he was in reality working. Many questions about Wideröe's activity in the summer of 1943 remain open. He could not even remember all details on the many meetings and discussions which must have taken place at the time.

Instead Wideröe very often mentioned in our meetings, that he appreciated very much factory owner Richard Seifert, who did help him a lot from the beginning in Hamburg. Wideröe and Seifert (and their families) remained in friendly contact even after the war. Anyway, Wideröe came to know through Seifert, several persons which were quite important for his work. One of them was the already mentioned Theodor Hollnack, who became responsible for all administrative tasks (including money payments, mostly in cash) for Wideröe´s (and also Schiebold´s) projects. But, as Wideröe mentioned, money was no problem at the time, and he never had difficulties with the always very accurate Mr Hollnack. Wideröe reports that Hollnack often referred to Nietsche, whom he seemed to admire very much. But he never expressed any opinion or comment on Hitler or on actual political events. He always remained for Wideröe a quite strange and overexcited person, he could never understand well.

Wideröe vaguely remembered in his autobiography, that it was at Hollnack´s place, where he came to know personally both, Prof. Ernst Schiebold and the editor of the journal „Archiv für Elektrotechnik", Dr. K.A. Egerer. But with Egerer he probably had contacts before, during the editing work of his first contribution on the "Strahlentransformator". Bruno Touschek mentions in a letter a meeting for the correction of Wideröe´s paper, which took place on June 17, 1943 in Berlin [Bo11a].

Regarding Schiebold, the situation was quite unusual. Officially

Wideröe (as a foreigner) should not know about Schiebold's top secret projects. On the other side he could not ignore the existence of the new facilities available, like the research-centre (and big hall) in Groß Ostheim and the semiprivate "Institute" Schiebold directed in Leipzig.

Anyway Wideröe was informed in some way about Schiebold's proposals. Schiebold was still trying to convince colleagues and authorities on the utility of his X-ray-guns. Wideröe and most physicists informed about these plans considered them as not realistic and even wrong. But most people did not dare to make any comment since they were all scared to be considered as defeatists.

From July 25 until August 4 1943 the "Operation Gomorrah" took place. A big part of Hamburg was destroyed by allied bombs. This had consequence for the activity of Wideröe. As he commented, shortly after it was decided to construct a beam-transformer just in Hamburg. The argument was simple: it was certainly not worth repeating such intensive bombings, which therefore were not expected anymore. Furthermore, the large factory for X-ray-tubes and equipment "C.H.F. Mül-ler" in Hamburg-Fuhlsbüttel (usually called "Röntgenmüller", see [Fe81]), which belonged to the Dutch Philips-Group, had remained practically intact. And this was a place where a beam-transformer could be conveniently built.

Anyway, an order was issued by a trustee of the Luftwaffe (it was probably Seifert, who had commercial relations with C.H.F-Müller already before) for the construction of a beam-transformer of 15 MeV under the direction of Wideröe. It should cost 150.000 RM. However, in later documents it is mentioned, that the main components should already be made for two such machines.

Still in August 1943 Wideröe rented a room in Hamburg and got an adequate working place at Röntgenmüller in a division directed by the competent engineer Albert Kuntke, who helped him a lot. The working atmosphere was excellent, as Wideröe recounted later on, and he especially remembered Dr. Werner Fehr, Ing. Gert Krohn and Ing. Friedrich Reiniger.

Wideröe also had a lot to do with the leader of the department of developments at C.H.F. Müller. It was at the time the physicist Dr. Walther M. Müller (1905-1979), who had no familiar relations with the

owners of the factory. It was the “Müller” who had developed in 1928, with his Professor in Kiel Hans Geiger (1882-1945), the famous “Geiger-Müller-Counter”.

Walther Müller also participated personally in the developments for beam-transformers, as can be concluded by the fact that he submitted seven patents [Ka47] on this subject and wrote a long report on the injection of electrons into beam-transformers, which can be consulted at the ETH-Archives [Mu43] in Zürich. According to a report on German X-ray industry [Ca45] Walther Müller had even built and tested in 1945 at C.H.F. Müller a very small 2-MeV betatron which had never been mentioned in any other documents.

All colleagues were very careful when talking with this Müller, as he was an engaged national-socialist, a fact he loudly propagated. (Occasionally this Müller is confused with the famous physicist Erwin Wilhelm Müller (1911-1977), who made important contributions to the development of field-electron-microscopes.) When the British troupes approached Hamburg in 1945, Walther Müller volunteered to be included in the body-guard of the mayor of Hamburg. After the war he was soon dismissed following instructions from Philips Eindhoven. He emigrated to Australia and later on lived in Canada where he died.

Several physicists were engaged to work in Wideröe´s group: Dr. Rudolf Kollath, Dr. Gerhard Schumann and also the talented student Bruno Touschek (as theoretician). Very probably they all received their salaries or payments from the Luftwaffe, which means, by Hollnack.

Rudolf Kollath (1900-1978) came from Danzig and worked first at the AEG in Berlin, in a department directed by Carl Ramsauer, in which also Richard Gans was allowed to work for some time. Afterwards Kollath moved to Norway, where he worked in an aluminium-factory at Sauda, near to Stavanger. Wideröe suspected that at that time Kollath came to know Hollnack, who traded (privately) with aluminium alloys for aircraft construction, besides belonging officially to the Luftwaffe. Kollath had problems in the Third Reich. His wife was of Jewish origin. So he was not allowed to apply for any position at a university or state organisation. He had to find a position in a private enterprise or to work for a project “important for war”, as Wideröe´s one.

I do not know much about Gerhard Schumann. He was born in

Dresden in 1911 and studied at Leipzig University. Under the direction of Adolf Smekal (1895-1959) he investigated mechanical properties of glasses. After the war he moved to Heidelberg, where he worked with Professor Otto Haxel (1909-1998). Later on he dedicated to the study of "fall-out" problems and exchange processes in the atmosphere [Am81].

Instead I knew quite well the temperamental and sympathetic Bruno Touschek (1921-1978) and therefore I would like to report a bit more about him. We met several times in physics conferences and summer-schools. Being both originally from Vienna we used to have longish evening chats (in our dialect) in general with some good food.

It was in 1959, in a restaurant at the Lake Como, when Touschek told me about a strange Norwegian engineer who wanted to publish a scientific report on an idea which he (Touschek) considered as absolutely obvious and which could be concluded from data you find in any normal physics school-book. The engineer was not happy and decided to apply for a patent on his idea [Wi43a]. Touschek was very disappointed but he could not avoid it.

As Touschek told me in our meeting, the "strange engineer" was Rolf Wideröe and the discussion took place in Hamburg during World War II. Touschek was working for Wideröe as a theoretician. And the patent in question is considered today as the invention of the "storage rings with colliding beams". They became later on very important tools for research work in high energy particle physics. And one of the first such rings was proposed and built in 1961 by Touschek himself, when he was a professor in Rome.

The well known physicist Edoardo Amaldi (1908-1989) wrote a very interesting and detailed report on the sometimes adventurous life of Bruno Touschek. It was distributed as CERN-Yellow Report [Am81] and was the basis of the summary I present here. Pupils of Touschek are working at present (2011) on several projects about Touschek´s work and life [Bo11a] [Bo11b].

Bruno Touschek was born in Vienna on February 3, 1921. His father was an officer of the Austrian Army and his mother was of Jewish origin. The latter fact caused that Bruno had to leave his grammar

school (Piaristen Gymnasium) after Austria had been “annexed” to Nazi-ruled Germany in March 1938. As “private student” he finally succeeds in graduating (“Abitur”) at the “Schottengymnasium” to access University. After this he started studies of engineering in Rome and tried to continue this in Manchester, with no success.

So he came back to Vienna and tried to listen secretly to lectures on physics and mathematics at the University. He soon became the best under his colleagues. However, in June 1940, being recognised as “half-Jewish” he had to leave the University. It was even forbidden to him to use the library of the Physics Institute. Physicists in SS-uniform had taken over the control of the Institute, a dark chapter in the history of the Institute, which some people try to ignore. However, Professor Paul Urban (1905-1995), who was teaching in Vienna when all this happened (later on he moved to Graz) accurately reported to me (in 1962) about these unpleasant facts. He did take care of Touschek and of many other “racially handicapped” students.

Urban had soon recognized Touschek´s extraordinary capabilities and recommended him to Professor Arnold Sommerfeld in München. Here Touschek had the interesting task of correcting the first two volumes of Sommerfeld´s famous work on atomic structure and spectral lines (“Atombau und Spektrallinien”). Touschek finished this successfully and Sommerfeld recommended him to Professor Paul Harteck (1902-1985) in Hamburg, where nobody knew about his racial problems. Here the professors Wilhelm Lenz (1888-1957) and Hans (Johannes) Daniel Jensen (1907-1973) allowed Touschek to listen to their lectures, even not being officially registered as a student of the University. Touschek moved to Hambug in March 1942.

To earn some money to survive, Touschek accepted smaller jobs, several at the same time, some of them in Berlin. He often changed his residence in order not to be easily found. His longest job was at the “Studiengesellschaft für Elektronengeräte” in Hamburg, an enterprise created 1939 by the Dutch Philips to develop special drift-tubes, the predecessors of the later “klystrons”. Touschek´s work consisted mainly in theoretical calculations which he could in part do and write down on the train, in libraries or at home. In Hamburg he had good contacts with Professor Hans Eduard Suess (1909-1993), who also came from

Vienna. For longer periods he lived with Professor Lenz. This was not easy, as Lenz was terribly scared during the frequent aerial attacks. Touschek had to carry him down to the seller of the house.

In one of his trips to Berlin Touschek came to know in the train a young lady, employee of "Opta AG", a well known company mainly producing special radio-valves. Since 1941 they produced and developed devices exclusively for war purposes. Opta AG also had a central leading function on all the German production of such valves (also made by other enterprises) on behalf of the Luftwaffe. Opta AG was a group of enterprises that had been taken over by the Nazi-authorities from its Jewish owners, the brothers Sigmund and David Loewe. Being a private enterprise officially *working for war purposes*, they were very tolerant and did not object to the eventual racial origin of their collaborators.

The lady in the train was also "half-Jewish", as was Touschek, and this probably induced her to introduce him to her bosses at Opta AG. In November 1942 Touschek got there a job in a section developing cathode ray tubes. The leader of this section was Dr. Karl E. Egerer, who at the same time was editor in chief of the journal "Archiv für Elektrotechnik". So Touschek also started (on a voluntary basis) helping Egerer in correcting and editing contributions for the journal.

And so it happened that Touschek came to read the article on beam-transformers submitted by Rolf Wideröe in September 1942. As already mentioned Touschek found some mistakes in the relativistic computations of particle orbits. Wideröe was very impressed and as soon it became clear that he would in fact construct a beam-transformer, he wrote to Touschek inviting him to collaborate with him. This was accepted by Touschek.

Here I would like to observe, that the activity of K.E. Egerer at Qpta AG certainly involved frequent contacts with responsibles of the Luftwaffe and in particular with Generalfedmarschall Milch. This could explain why he was considered as an expert adviser of Milch and also his relation to Hollnack.

Wideröe vaguely remembered that, when he moved to Hamburg, in the Summer of 1943, he came to know Touschek personally at the home of Professor Lenz. But this is probably wrong. They met before in

Berlin. And it was in August 1943 when Touschek had the controversy with Wideröe about the storage rings with colliding beams. Probably it was at Lenz´s place where Wideröe met Jensen and Suess. As Wideröe told me, he liked very much to talk in full confidence with Suess, who did not make any secret about his aversion to the Hitler-regime.

Wideröe had in Hamburg with Touschek, Kollath and Schumann a very efficient team of physicists and the full support of the staff of an experienced company. So he had enough time to prepare in September of 1943 other five patents which he submitted in Berlin with the help of his friend Ernst Sommerfeld. The controversial one on storage-rings was included. As already reported , they were all immediately classified as “secrets of war” and therefore not made public. Up to 1945 Wideröe had submitted 12 patent applications related to betatrons in Germany.

Still in the same month Wideröe wrote in Oslo a report in which he summarised the available knowledge on the subject (including his original ideas of 1922 and many other references) and specified the most important preparations to be done for the development of his beam-transformer [Wi43b].

During his first months in Hamburg, Wideröe apparently had negotiations with Hollnack, Seifert and Schiebold, the members of the “Institute” nominated to work on Schiebold´s proposals. Wideröe never mentioned these facts to me and did not include them in his biography. But in Schiebold´s documents, archived at the University of Leipzig, the drafts for a contract (dated October 19, 1943) were found, which were written by lower Schilling (from Essen) following Schiebold´s instructions [SE43f]. Here the duties and wrights of Wideröe during his “service work” in Germany were quite exactly specified. By the way, in this contract it is stated that this service (“Dienstverpflichtung”) was “ordered by the Reichskommissar for the occupied Norwegian regions” without mentioning his name. Obviously Wideröe had to accept some compromises, still trying to do something for his brother Viggo.

In the draft of the contract Wideröe states that in an appendix a complete list of the six patents on beam-transformers he had already submitted in Germany is included. The appendix is missing in the available copy. An important paragraph of the proposed contract states that Wideröe was obliged to leave to Schiebold´s “Institute” all the

already submitted and all further patents and developments he would make for at least the following three years.

So Schiebold, but probably also Seifert and Hollnack, were well informed about the patents Wideröe had already submitted and still would like to submit in Berlin. But Wideröe did not inform the staff of C.H.F. Müller company about his patents.

As already mentioned, Wideröe never referred to this contract or to similar negotiations. But the proposed contract describes exactly the conditions under which Wideröe in fact worked in Germany. So i.e. it is made clear, that he was free to travel whenever and where he wanted. The page specifying his earnings or payments is missing in the conserved copy, but Wideröe never complained about that.

I could not find any proof on the existence of a contract like the one described here. But there seems to have been some agreement about the property of the patents. This is supported by a curious meeting described by Wideröe. It was after the war, in 1947, with the always very correct Mr Hollnack, who by then had changed his name. They met on a meadow in Waldshut, near the Swiss-German border, after a telephone call by Hollnack. He wanted to speak personally with Wideröe. Hollnack meant, that he had some rights or participation on Wideröe´s patents, probably based on some agreement made with Schiebold´s "Institute". The patents already had a considerable value. But he had no clear proofs for his claims. So Wideröe had to tell him, that all the 16 patents submitted between 1943 and 1945 were by then property of BBC-Basel, the company for which he was working. Hollnack did not want to start arguing with BBC and left (according to Wideröe) quite unhappy.

In fact there are 12 patents officially registered at the German Patent-Office under the name "Rolf Wideröe of BBC-Basel". These patents had been confiscated after the war by the Allies, then given back to Germany, retroactively recognised (after 1950) and later on published. Information on these patents could perhaps be found in the correspondence of Ernst Sommerfeld (who submitted the patents) which is now stored (and will be catalogued) at the Deutsches Museum in München [So02]. So it could perhaps be cleared up if the patents

were from the beginning registered for BBC or if Wideröe sold them to BBC after the war. He remembered only vaguely such a deal.

In one of his frequent visits to Oslo, Wideröe wrote a 4-pages long report dated November 6, 1943 with the title:

"Recommendations to plan, construct and assemble
the beam-transformer as fast as possible"

A copy of this report is stored at the archives of the ETH-Zürich [Wi43c] (later on Wideröe could not remember its existence). He divided the work to be done in three groups:

a) Preliminary tests and afterwards construction of the 15-MeV beam-transformer.

b) Preliminary tests and afterwards construction of the 200-MeV beam-transformer.

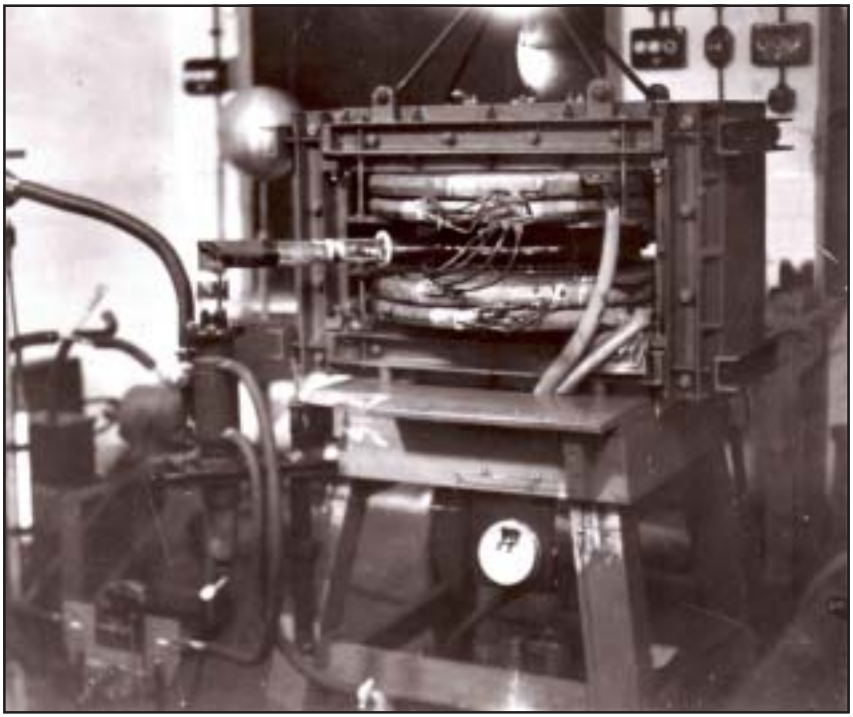
c) Planning and installation of the test-station Gross-Ostheim.

In this report Wideröe remarks that work mentioned under a) had already been started at C.H.E. Müller. Then he specifies with some more details the manpower and work required for each of the three mentioned items.

Regarding the construction of the 200-MeV beam-transformer Wideröe remarks that the problems involved can in general be easily solved with the standard methods used in the construction of electrical machines. He adds that the problems have certain similarities with those appearing in the construction of cyclotrons. Therefore it seems to him convenient to have the iron joke of the transformer made by ELIN-company in Vienna (which still existed in 1994). He remarks that he had long lasting relations with the directors of this factory.

Regarding the developments required to construct the accelerating tube and the electron source Wideröe remarks shortly that these could be done i.e. at C.H.F. Müller or at Opta-Radio AG during the same time the iron-core of the transformer is built.

Wideröe states in the report that the 200-MeV apparatus should be ready in 10 to 12 months. During this time the required preparatory work and the building of the hall at Gross-Ostheim should be finished, so that work with the 200-MeV device could start in 12 months. Wideröe seemed to take into account the conditions under which orders were



The 15-MeV Beam transformer in Hamburg (Foto ETH, *Hs 906*: 612).

delivered to industry, knowing very well that his proposed time-schedule could hardly be realized.

In this report Wideröe do not mention at all Schiebold or Schiebold´s ideas. In principle he should not know about them, as it would mean that he was informed about the war-relevant background of his activity. Also in his autobiography and in the many conversations with me, he mentioned Schiebold´s proposals only marginally. He disapproved them, as did most of the experts involved at the time. Instead he was allowed to know about the research centre in Gross-Ostheim and could include it in his plans.

When I reminded Wideröe about his report of November 6, 1943, he accepted that it could be included in his autobiography but asked me to add, that except for item a) all the rest were obviously illusions. So I did,

The 15-MeV-Beam-Transformer

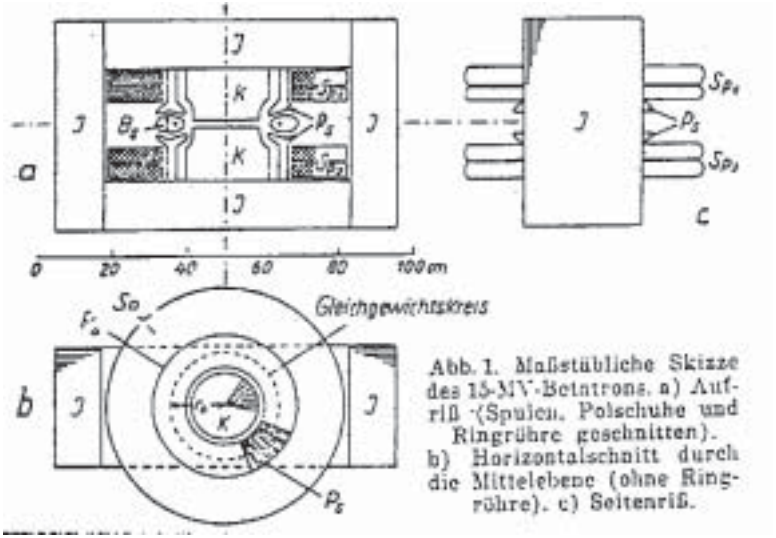
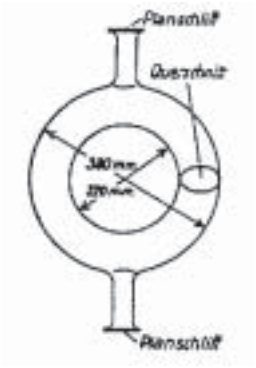


Abb. 1. Maßstäbliche Skizze des 15-MV-Betatrons. a) Aufriß (Spulen, Polschuhe und Ringröhre geschnitten). b) Horizontalschnitt durch die Mittelebene (ohne Ringröhre). c) Seitenriß.



Vacuum-chamber

Drawings by R. Kollath and G. Schumann [Ko47], showing the principle of the beam-transformer. The electron beam in the vacuum-tube represents the secondary windings of the transformer The magnetic field in the tube is determined by the exact shape of the pole pieces.
The apparatus war built at C.H.F. Müller & Co in Hamburg under the direction of Rolf Wideröe.
The iron yoke was 92 by 56 (wide) cm big and had a weight of 1,2 t.

.

but it was clear to me, that he must have invested quite a lot of time in the 200-MeV project. Later on he never mentioned this machine, as well as the test-centre Groß Ostheim and refused reluctantly to answer questions about them. But it is clear that the 200-MeV beam-transformer was one of his predilected projects or just one of his illusions.

Work on the 15-MeV beam-transformer was progressing very well thanks to the efficient collaboration between Wideröe´s direct collaborators and the specialists of C.H.F. Muller, a fact that Wideröe emphasized several times.

I could obtain some interesting information about these activities in a meeting kindly organised on by the PR-department of the company „Philips Medizin Systeme", the successor of C.H.F- Müller, which also incorporated the still existing buildings and laboratories in Hamburg-Fuhlsbüttel where the beam-transformer was assembled. The meeting took place on April 28, 1994 and besides me, there were present Dr. Werner Fehr, Dr. Jenss Schmith-May, Ing. Heinz Bergmüller and Ing. Friedrich Reiniger [Wa94].

Fehr, Bergmüller and Reiniger were active at C.H.F. Müller during Wideröe´s time and knew him quite well. I kept in contact with them and later on they provided me with useful additional information.

In the meeting, it was first explained to me, that the two companies C.H.F. Müller and Rich. Seifert & Co had from the beginning quite good contacts. The founders and owners of both had from the beginning personal relations. Carl Heinrich Florenz Müller (1845-1912) and Richard Seifert Sen. were among the first repeating in Hamburg the famous experiments performed in Würzburg by Wilhelm Konrad Röntgen (1845-1923). Seifert started producing equipment for X-ray application and C.H.F Müller provided him initially with the required X-ray tubes. Later on Seifert started to order the tubes at AEG-Berlin, which C.H.F. Müller did not like much. However, this did not disturb much their further commercial relations.

Regarding the activity of Rolf Wideröe it was emphasized, that his direct collaborators and the specialists of C.H.F. Müller performed most of the required work quite independently. Wideröe travelled a lot, also to

see his family and write reports in Oslo. Essentially he fixed the frame conditions for his project and gave instructions of general character. His main contribution to the practical realisation consisted in the design and construction of the magnet-yoke. This was due to his experience in building electrical transformers.

But the extremely important exact determination of the magnetic field produced by the yoke had to be done by Albert Kuntke, who used a special method to do it. Normally this would have required a theoretician specialised in such problems. But Kuntke solved the problem successfully with a so called “electrolytic tough” (in German: “elektrolytischer Trog”).

Regarding Albert Kuntke, the excellent work he did was emphasized several times. He had started as apprentice at Rich. Seifert & Co. Soon afterwards he started working for C.H.F. Müller where he was helped in continuing his education until he obtained the title of “Ing.” He spent then several years in Eindhoven working in close collaboration with Dr. A. Bowers in the X-ray and high-voltage laboratory of Philips Company. Also there he was very successful, as Werner Fehr reported [Fe81]. After his return to Hamburg Kuntke became division leader at C.H.F. Müller. He and his group made substantial contributions to the successful construction of the beam-transformer.

As physicists, Kollath und Schumann had the main responsibility on the scientific aspects involved with the 15-MeV beam-transformer. A main task consisted in preparing the measurement to be done after the machine was put into operation. They did this successfully, mostly when Wideröe was already leaving the laboratory or had finally left completely. When they had difficult theoretical problems to solve, they consulted the ingenious Bruno Touschek who had the required mathematical background. Several of Touschek´s reports written on his portable typewriter, are stored in the archives of the ETH-Zürich [To45]. Others are mentioned in some documents, including reports by Schiebold regarding his X-ray gun projects. So it seems that also Schiebold consulted Bruno Touschek.

If I remember well, Dr. Werner Fehr was at the time, as an X-ray-specialist, assistant and representative of the director of C.H.F. Müller Company, Dr. Heinz Ritz. Fehr was also signing clerk (“Prokurist”) of

the company. As it was reported, this was necessary because Ritz was an expert on a completely different subject, namely on “instrument transformers” (“Messwandler”) and had little experience with X-ray tubes production. He had been ordered to Hamburg in 1940 mainly for political reasons. At the time all Philips owned companies and other foreign organisations were under obligatory war administration. Ritz came originally from AEG-Berlin. He had good relations with Schiebold and initially supported his ideas on X-ray-guns. After the war Ritz founded in Hamburg a very successful and rapidly expanding enterprise for instrument transformers (the “Ritz Messwandler GmbH & Co. KG.”) which still exists today.

In the meeting it was also reported that the Dutch Philips Company did help many colleagues working at C.H.F. Müller to move in time to positions in Holland, if they were (or could be) persecuted by the Nazis for political or racial reasons.

Fehr, Bergmüller und Reiniger assessed that from the beginning they did not consider Schiebold´s plans on X-ray-guns as realistic. In their minds Schiebold was a quite extravagant and perhaps original personality, who sometimes was exaggerating too much. Schiebold was interesting for them as they could eventually obtain due to his influence orders with high priority for war-purposes. On another subject they all three agreed: They did not like the mysterious Mister Hollnack, for reasons which will become clear in the next chapters.

The “Trio”, as they called Hollnack, Schiebold and Seifert, came occasionally to visit the laboratory in Hamburg, but only Hollnack and particularly Seifert were seriously interested in the progress of the beam-transformer. Schiebold seemed to have different problems and had soon disappeared.

During the meeting we also discussed the patents registered at the time. I was very surprised, that none of the present hat ever heard anything about the 12 patents on beam-transformers submitted by Rolf Wideröe in Berlin between 1943 and the beginning of 1945, probably encouraged by BBC. It seems that C.H.F. Müller Company should not know about them.

But none of the presents new anything about the seven patent applications which at the same time were submitted by their own

colleague and director of research, the already mentioned Dr. Walther M. Müller. These patents were mentioned in the report published shortly after the war by the American expert Herman F. Kaiser [Ka47]. I have asked Wideröe about Müller´s patents and he did not know about them either.

It seems that there was at the time a lot of activity kept secret or hidden by some reasons. But it is possible, that the participants to the meeting I am reporting were not interested in these matters and therefore could not remember much about them. A certain roll did probably play the competition of industrial companies which were already thinking on the market for X-ray installations of high energy after the war

The completion of the 15-MeV beam-transformer in Hamburg during the first half of 1944 did not present any major problems, except for some interruptions caused by bombing alarms. They had to stop working and had some relax-time in the bunkers. Vibrations due to bombs falling nearby were quite dangerous to the delicate apparatus, but no serious damage was registered.

Many items were ordered at external enterprises. The iron-sheets for the magnet were ordered at Rich. Seifert & Co. The toroidal glass tubes for the electron beam and their conducting connections were made in Silesia by Weißwasser, a company probably owned by Philips or by C.H.F. Müller and specialised on glass glass-blowing, a tradition in Bohemia and Silesia. Ing. Bergmüller remembers that five such tubes were made and the remaining ones were thrown away in 1947. The cathode used as source and injector for electrons was made by specialist Boersch.

A hardly readable copy of a life size drawing of the machine is preserved in the archives of the ETH in Zürich. It is signed “Rei.”, the symbol used by Ing. Friedrich Reiniger [Re44]. The iron joke was made of iron sheets (as used for transformers) 0.25 mm thick. It had a width of 92 cm, a height of 56 cm and weighted 1.2 tons. Electrons were accelerated 50 times per second. More details can be found in reports by Rudolf Kollath [Ko45] [Ko47], Wolfgang Paul [Pa 47] and Herman F. Kaiser [Ka47].

Wideröe has always proudly remarked that in summer 1944 weak electron beams in a 15-MeV beam-transformer were observed in Hamburg and that this was the “first European beam-transformer of 15-Mev energy”. In many later reports the indication of the energy was dropped. Only reluctantly he accepted, that already in April of the same year, X-ray-specialist Konrad Gund (1907-1953) at Siemens Company in Erlangen did run successfully a 6-MeV machine of the same type. He went to see this machine only in November 1944 and concluded that for several reasons it would never function well. I present some details on Gund´s quite successful project in the Appendix.

Occasionally the radiation level in Wideröe´s laboratory was quite high, but they were very far from a continuous routine running. Some details on the quite adventurous and interesting further destiny of this machine will be described in chapter 7. But before I will report on the problems which Schiebold had in 1944.

End of Ch 5

6 The End of the X-Ray-Guns

On December 4, 1943 the Mineralogical Institute of the University of Leipzig was to a great deal destroyed during Anglo-American bomb-attacks, including Schiebold´s half private "Institute" and his private apartment. Practically all of Schiebold´s numerous scientific instruments, his mineralogical collections and models, his library and most of his manuscripts were destroyed. Probably most documents and records regarding his proposals for X-ray-guns were also lost, as well as his correspondence with Seifert, Hollnack and Wideröe. It was a big shock for Schiebold and the beginning of quite a hard time.

But Schiebold and his collaborators immediately started organizing a new laboratory, using the few saved instruments or remaining parts of them. The activities were provisionally started in some free rooms in Leipzig and in part in Groß Ostheim. Since from the beginning of 1944 the neighbouring aircraft-basis of the Luftwaffe was no longer used, no allied bombings were expected. This changed later on, in September 1944, when a squadron of night fighters was again based at Groß Ostheim.

Construction of the big hall in Groß Ostheim was finished in January/ February 1944. It was dimensioned so to house a 1.2 Megavolt high-voltage device which was confiscated by the Luftwaffe in Hamburg, before being installed in a hospital for X-ray treatment. Schiebold wanted to use it for his tests regarding the range and collimation of the produced high-energy X-rays. He had prepared an extensive scientific programme to be performed there [SE44d] [SE44e]. Naturally it included tests with big-sized anodes (anti-cathodes). In addition Schiebold mentions that by the middle of 1944, the 15-MeV beam-transformer under construction at C.H.F. Müller "model Wideröe" could be installed in the hall.

At this point Schiebold had a first quite unpleasent surprise. On February 15, 1944 the military commander of the "Luftwaffe Research

Centre Groß Ostheim", as it was called (the name of the commander is not mentioned in the files), received a letter from his immediate superior, Prof. Dr. Walther Georgii, in which he was instructed that the semiprivate "Institute" of Prof. Schiebold was only temporarily allowed to stay at Groß Ostheim and that this permission expired on April 1, 1944. The commander handed over a copy of this letter to Schiebold, apparently on a meeting which took place at the Research Centre on February 18, 1944 [SE44a] [SE44b]. Schiebold reacted with a long letter to Georgii in which he explained his plans and his situation, and kindly asked him to revise his decision. It is quite remarkable, that Georgii did not address Schiebold at the same time or even before on this delicate matter. At this moment Schiebold should have noticed, that at least part of his colleagues and even some of his supporters at the Luftwaffe were no longer approving his activity.

Anyway it seems that Georgii did change his opinion. Schiebold continued to work in Groß Ostheim with his semiprivate "Institut für röntgenologische Roh- und Werkstofforschung", as it was officially called, even after April 1, 1944. On May 4, 1944 he still wrote a report on the work of his Institute regarding X-ray-guns [SE44d]. In this report he again mentions the construction of the 15-MeV beam-transformer at C.H.F. Müller in Hamburg and also some theoretical computations done for him by a "Dr. Touschek" who at the time was still a student [To44].

With the same date Schiebold presented a ten-pages-long proposal with a scientific program for the Research Centre Groß Ostheim [SE44e] in which he explains the preliminary work necessary for his future technical developments and the possible applications of very penetrating corpuscular beams and X-rays.

In the meantime some developments happed which Schiebold could (and should) not know and on which I could not find any written evidence either. But I could find a testimony who told me something about that time. It was Prof. Dr. M. Scheer. I knew him well. We had been running night-shifts together for an experiment at the research centre DESY. He could tell me some interesting datails about the year 1943 in which he was working on his thesis in Jena.

Scheer did tell me (and confirmed it in a letter later on [SM94]) that his thesis-supervisor in Jena Prof. Helmuth Kulenkampff (1895-1971)

was occasionally visited during the war by his friend Prof. Walther Gerlach who frequently had to travel through Jena when moving between his activities in Berlin and his teaching in München. Scheer remembers well that time. In one of his visits Gerlach carried to Jena 100 cubic centimetres of water strongly enriched with “heavy water” (a quite rear substance at the time) which Scheer did use later on for his doctoral thesis.

In one of his visits Gerlach arrived very excited and wanted to discuss with Kulenkampff on an extremely secret project, he was really not allowed to talk about, but in some way he had arrived to know about. He even carried with him some relevant documents. In the project a very questionable method for the production of a particular kind of X-rays was proposed. And Kulenkampff was an expert just on this subject.

So it happened, that Gerlach told his colleague Kulenkampff about Schiebold´s proposals to use X-rays as weapons against enemy aeroplanes or troupes. He also did show to Kulenkampff Schiebold´s written proposals. Kulenkampff soon found out that Schiebold applied two well known relations in a range in which they were no longer valid.

A first point was that Schiebold assumed that the efficiency in transforming energy of fast electrons into X-rays should grow at higher energies according to the Bethe-Heitler-theory used at lower energies (this theory was among others explained in Heitler´s book „Quan-tum Theory of Radiation” published in 1936 [He36]). Schiebold’s assumption was wrong, according to Kulenkampff.

The second critic of Kulenkampff referred to the range of X-rays produced by anticathods of big dimensions (2 metres diameter were proposed). The relation used by Schiebold to compute this range can eventually be used for relatively small distances (compared to the size of the anticathode) but can not be applied at all for distances of several kilometres, as Schiebold did in his proposal.

Kulenkampff´s strong objections confirmed suspects which Gerlach had from the beginning. Kulenkampff declared to be ready to write down his opinions in an expertise, even not having been officially asked to do so. Encouraged by Gerlach Kulenkampff finally wrote an explanatory letter to Generalfeldmarschall Milch, a letter which had

been probably (according to Scheer) announced to Milch by Gerlach. It was a quite courageous action. It made clear that Gerlach violated his duty to keep Schiebold´s project strictly secret. Soon afterwards Kuhlenkampff received a very personal letter from Milch (which he showed to Scheer) in whitch Milch thanked him for his courage and for his clearly expressed critics.

From later documents it becomes evident that already much before, it must have been arround February 1944, a “Board of Trustees for the Luftwaffe-Research-Centre Großostheim” (“Kuratorium der Forschungsstelle der Luftwaffe Großostheim”) was created. The members of the Board were: Egerer, Esau, Fennel, Geist, Gerlach, Georgii, Heisenberg, Heuser, Hollnack, v. Loßberg, Seifert und Tamms [Ge44].

Schiebold, as director of the Research Centre, was not a member of the Board of Trustees. Obviously the board was created to judge and controll Schiebold´s activity. But also Kuhlenkampff and Wideröe were not members. They could only be invited as guests to the meetings of the board.

Already on February 22, 1944 Kulenkampff had send to all members of the Board of Trustees an expertise in which he explains his critics to Schiebold´s proposals with more details [Ku44a]. Up to now I could not find copies of this expertise and none of the original letter to Milch. It seems that Kulenkampff burned all his archived documents while still alive. No copies were either found in the archives of the “Deutsches Museum” in München, where about 40.000 documents regarding Gerlach are carefully conserved. Most items from the years 1940 to 1945 are missing ([Fu98], see Part I, p. 12).

However, a few documents are still available, which allow to reconstruct part of the events happening at the time. A set of documents is conserved in the archives of the State of Saxony (“Sächsisches Staatsarchiv”) and (in part copies of the same) at the Leipzig University (“Universitätsarchiv in Leipzig”). Some others were in possession of Schiebold´s son Joachim who kindly allowed me to inspect them. From this information it follows that on May 6, 1944 there was a meeting of the Board of Trustees in Berlin. Besides the members of the Board there were invited as guests: Kulenkampff, Schiebold, Schuman,

Spengler, Rößler und Wideröe. They seem to have been all present, as they were explicitly welcomed by Gerlach, the chairmen of the meeting, as he stated in a kind of "proceeding" he wrote down later on.

Schiebold´s already mentioned report [SE44d] and the programme for scientific work [SE44e] from May 4, 1944 were obviously prepared for the meeting which happened two days later.

And it was at this meeting, when Schiebold was for the first time confronted with the critics of Kulenkampff and with the fact that the members of the "Board of Trastees" had already received a copy of Kulenkampff expertise of February 22, 1944, which he did not know either.

Schiebold was not prepared for this. He was not informed before about the schedule of the meeting and had only prepared arguments of general character, easy to understand, without any technical details based on physical principles or more accurate computations.

Walter Gerlach, the chairman of the Board of Trustees, did write down much later, on August 25, 1944, a kind of "proceeding" of the meeting of May 6, 1944 in Berlin. Here he included a report on another meeting of a subcommittee of the Board which took place in Airing on August 15, 1944. Ernst Schiebold made microfilms of the six pages of this important document with the Leica-apparatus he always had mounted on his desk [Ge44]. His son Joachim found the negatives and gave them to me. And this was all I could find out about meetings of the Board of Trustees.

It must be emphasized that Gerlach´s report of August 25, 1944 has not to be considered as an exact proceeding of the two described meetings. It expresses Gerlach´s personal conclusions (or decisions?) as responsible chairman of the Board of Trustees. But according to the national-socialist rules valid at the time, the "leader-principle" (the "Führerprinzip") [Bp03], Gerlach´s conclusions had to be accepted as decisions of the entire Board of Trustees.

Regarding Gerlach´s report on the meeting of Mai 6, 1944 in Berlin I have tryed to interpret correctly the meening in a free translation.

1. The discussion of the proposal of Prof. Schiebold did not lead to a final conclusion. Schiebold had proposed to construct special X-ray-

tubes with big sized anodes which should be able to produce at distances of about 10 kilometres a radiation of 100 or more Röntgen per second. And this was one of the main goals of the Research Centre of the Luftwaffe in Großostheim.

Prof. Kulenkampff from Jena presented instead a report in which he estimated that the radiation produced by X-rays of 10 to 100 million Volts could reach at 1 to 2 kilometres a value of just 10 Röntgen per second. Such X-ray tubes would reqire a power of 105 to 107 Kilowatts. All this could not be technically realized for a long time. Kulenkampff also argues that in Schiebold´s proposal all background information for the production of the high voltage, for the required power and for the needed X-ray-tubes is missing.

Kulenkampff´s computations are in strong contradiction with the results presented by Prof. Schiebold. Since it was impossible to clarify the matter during the meeting, it was decided that Kulenkampff and Schiebold should exchange their opinions in written form. If they do not come to an agreement, the chairman would ask them both, together with a few members of the Board of Trustees, to a new discussion meeting. This should happen in about three weeks time.

2. The 1200-KV-facility will not be installed at Großostheim, since no new fundamental knowledge in this range of high voltage is expected. It is proposed that this equipment should be offered to other researchers, i.e. Prof. Gehrsten, to perform investigations in atomic physics.

3. The hall built at Großostheim for the 1200 KV-device could also house the 2000 KV-generator which at present is stored in Hamburg. The latter should now be installed in Großostheim and used for the production of neutrons and radioactive indicators which are urgently needed in Germany for important technical and medical investigations..

To the last paragraph it must be remarked that a 2000 KV-device had been ordered at C.H.F. Müller in Hamburg. To my knowledge this equipment was never finished or put into operation. Another high

voltage generator which Gerlach perhaps meant had been ordered in Berlin. It was a cascade generator of the Cockroft-Walton type.

After the meeting of May 6, 1944 there are no indications or documents available in which a positive opinion on Schiebolds original proposals could be found. Evidently Kulenkampff´s critical presentations had impressed his audience, including in particular Richard Seifert and Theodor Hollnack, who still a year before did support Schiebold´s ideas and accepted to participate actively in their realisation. There are even indications [Eg45] that both now disagreed completely with Schiebold´s original ideas (in particular regarding war-relevant X-ray guns). But with the agreement of the Luftwaffe they kept the issued research-order, including in particular the development of beam-transformers.

Schiebold was not able to finish his report within the requested three weeks. He sent a detailed exposé (41 narrow written pages with many formulas and tables) to Kulenkampff on July 12, 1944 [SE44g].

Kulenkampff again disagreed with Schiebold´s calculations and within five days (on July 17, 1944) wrote a critical answer [Ku44b].

On July 29, 1944 Schiebold sent an eight-pages long "contradiction" to Kulenkampff [SE44h] who did answer on August 4, 1944 [Ku44c].

But in some way they also found out, that the results of their respective calculations for high-energy electrons and big-sized anodes were not too far away from each other and that taking into account the big involved uncertainties they could even be compatible with each other. But the uncertainties could be interpreted in very different ways, which then carried to quite different conclusions.

Kulenkampff and Schiebold were both specialists in the fields of production and applications of X-rays in the energy range far under 2 million Volts. They were now trying to apply their knowledge and their methods to obtain conclusion for X-ray-tubes of much higher energy. Seen from a present point of view it appears quite clear whay these ideas would carry to very different and in general useless results. While Kulenkampff and Schie-bold new in principle which phenomena had to be taken into account at higher energies (like i.e. the production of electron-positron-pairs), they were not able to perform useful calculations taking them into account. All this was only developed much

later and carried to methods which I will try to explain here for interested readers in a simplified way.

When electrons with high energy traverse matter they occasionally pass near atomic nuclei and are deviated by their electric field. In this process they can emit a “photon”, as it happens in the anode (anticathode) of any X-ray tube. The emitted photon can occasionally take over a great deal of the energy of the incident electron and in the field of other nuclei transform into an “electron-positron pair” (pair-production). These newly produced particles can obviously produce further photons, when passing near other atomic nuclei. If sufficient energy is available a kind of avalanche process takes place which is called a “shower” (see i.e. [Wa98]). The newly created particles and photons will naturally have decreasing energy and at a certain point will no longer be able to produce electron-positron pairs. Low energy electrons and positron will then lose part of their remaining energy colliding with atoms (processes like “ionisation” or “excitation” take place). Slow positrons can in addition be annihilated with electrons of the atoms, a process in which they transform in photons. At that point the shower is practically finished. It has more or less the shape of an inverted crashing blow. At higher energies the width of the cone containing the shower decreases, it becomes “narrower”.

When high energy photons traverse matter they will first produce an electron-positron pair which will start developing a “shower” which has practically the same shape as if it would have been created by an incident electron. Therefore the shape of a shower will essentially depend on the traversed material structure and on the energy of the incident electron, positron or photon.

For the length and width of a shower a very practical parameter has been introduced. It is called “radiation length” (see [Wa98]). In air at normal atmospheric pressure the radiation length amounts to about 300 metres, in copper-metal it is 1.4 cm, for shielding concrete 11 cm and for lead 5.6 mm.

For showers of energy of about 1000-MeV one can roughly estimate that all its parts (electrons, positrons and photons) would be practically absorbed after 10 radiation lengths. And this is quite independent of the

traversed material. After 2 radiation lengths a 1000-MeV-shower will reach its highest number of components. This corresponds in air to about 600 metres. The width of a shower depends on the available energy. For 1000-MeV showers it is of the order of one radiation length.

Following the basic ideas just roughly sketched, sophisticated computer programmes were developed to calculate with high accuracy the development of showers in any given configuration of materials. They simulate the real processes using the so called Monte-Carlo-method (s. [Ge02]). Such programmes, which were initially developed for high energy physics experiments, are now also very useful to determine i.e. the amount of radiation reaching the parts of a patient's body to be irradiated. The programmes include the calculation of the energy deposited in the material which is directly related to the radiation doses.

Today Schiebold´s proposals would just be fed into one of the standard computer programms to determine with an accuracy of a few percent the radiation dosis to be expected in any place of a given distribution of materials and for any available energy.

But without any calculations one can already state that at higher energies the transformation of an electron-beam into X-rays in a thick and big anticathode (as proposed by Schiebold) would be extremely energy-wasting and only make sense in some very special cases. An efficient anticathode made of 3 cm thick cupper i.e. would just reduce the range of the finally produced showers by two radiation lengths, which means for the produced "beam", a reduction of 600 metres range in air, without providing any advantage. It would make more sense to direct the accelerated electrons (to an enemy?) through a thin window to oblain the maximum range of the showers in air. The practically unsolved problems regarding the cooling of the anticathode and the discussion about its size and form would be meaningless.

The range of high energy showers in air, their lateral extension (or natural "bundeling") and the multiplication of particles taking place (according to the actual knowledge) could perhaps be of some military interest, but the intesities of available electron beams would have never been sufficient. In addition an accelerator for i.e. 200 MeV electrons (a beam-transformer) would have a weight of 40 to 100 tons. Not a very

handy device for military applications. In no case a few hundred or even thousends of them could have been built and run.

Another problem for eventual military applications would be the fact that a high energy shower produces in air even by day a clearly visible track. This is caused by low energy photons (visible light) which are emitted laterally. This fact is obviously independent of how the shower was produced. The "beam" would be clearly visible, which certainly do not correspond to the military concept of "invisible death-rays".

In his original proposals Schiebold mainly referred to X-ray production at less then 1.2 MeV. At such low energies no electron-positron pair-production is possible (for energetic reasons) and therefore only rudimentary showers with relatively short range can develop. The number of scattered electrons in the shower, which is responsible for the (wanted) radiation doses, is also limited. A few millimetres of lead are enough to absorb most of the beam. This corresponds in the best case to a range of a few hundred metres in air.

Scientists who at that time followed the latest publications on high energy cosmic rays knew already about the existence of "showers" in air and in solid materials. There were also attempts to understand and explain their production and development, as it is mentioned in Heitler´s book of 1936 [He36]. Among those best informed on these matters were obviously Werner Heisenberg, Walther Gerlach and Arnold Sommerfeld. But also the theoreticians Richard Gans und Bruno Touschek had good knowledge of these facts.

Let us return now to the unpleasant Kulenkampff/Schiebold exchange of letters. Since they did not reach to an agreement Gerlach invited to a meeting which took place on August 15, 1944 in Ainring (Upper Bavaria, near the border to Austria.) at the "German Research Institute for Glider Flight" ("Deutschen Forschungsanstalt für Segelflug") which at the time was directed by Professor Georgii. To the meeting were invited Georgii, Geist, Hei-senberg, Kulenkampff, v. Loßberg, Schiebold und Seifert. Major Geist did send as his representative Mr Schumann and Prof. Heisenberg could not come. Dr Spengler was present as guest.

In this "proceedings" (of August 25, 1944 [Ge44]) Gerlach reported

also on the Airing meeting. He started with a hard critic of the delay caused by Schiebold. Then described the highlights of the discussion including many technical details which I will not reproduce here. At the end he makes the following concluding remarks:

1.) A correct discussion of compatible results of Schiebold and Kulenkampff demonstrated that there is no physical effect in view which could change the order of magnitude of the final conclusions.

2.) There is no chance to use Schiebold´s ideas for military applications of the Luftwaffe.

3.) For military application at shorter distances (about several100 metres) equipment is required for which no technical specification is available at present.

Schiebold interpreted Gerlach´s concluding report as an accurate proceeding of the two meetings and answered with a 15 pages long quite furious "statement" on September 20, 1944 [SE44i]. He contradicts practically all affirmations, recommendations and conclusions made by Gerlach. He refers several times to the original instructions or orders given to him by Generalfeldmarschall Milch. But all these could no longer change the situation. Schiebold distributed 13 copies of his letter, in which he also mentions a paper (which he included as an appendix "Anlage 037077/448") of a "Dr. Touschek" who calculated the range of the radiation produced by an anticathode of 2 metres diameter [To44].

Kulenkampff naturally disagreed with Schiebold´s "statement" and answered with a 5-pages long letter [Ku44d].

In his "statement" Schiebold mentions a "very important letter" which he received the same day he was writing his report, that is, on September 20, 1944. I could not find any information about the contents of this mysterious letter, but in fact after that day the name Schiebold do not appear anymore in relation to the order originally issued by the Luftwaffe.

It was of no help for Schiebold that already on June 21, 1944 Generalfeldmarschall Milch had to pass his competences as "Master of Acquisitions of the Air Force" ("Generalluftzeugmeister") to the powerful ministry lead by Albert Speer. Milch´s best time in the Reich

was over and in January 1945 he also lost his position as “Inspector General” of the Luftwaffe (see i.e. [Be93], p. 380).

There is some information from another source, namely from the somewhat vague memories of Rolf Wideröe. He remembers a meeting which could have happened in the autumn of 1944, but it is quite possible that in reality he meant the meeting of the Board of Trustees of May 6, 1944 (see [Wa93], p. 88). Wideröe was over 90 years old when he dictated to me the following text:

“At that time I was invited to a meeting which took place at the Kaiser-Wilhelm-Institute in Berlin. I remember a very beautiful garden. I think that Heisenberg had invited, but it could also have been Gerlach. It was a purely scientific conference. Everybody was free to speak and could express whatever he meant. Nobody from the Gestapo was present and nothing was kept secret. And everybody agreed that Schiebold´s fantastic projects should be stopped. They could not be realized. Instead it was agreed that the betatron was a very interesting developement, especially for medicin and for future nuclear physics. The hopeless project to shoot down aeroplanes using X-rays produced by betatrons was at that point (or already before) completely abandoned. Instead the developement of betatrons should be continued. The initial argument, that this was important for medical applications, could be officially kept.”

But Wideröe also told me, that he was only allowed to participte in some special parts of the discussions and spent the rest of the time wolking through the garden.

After his last “statement” of September 2, 1944 evidently Schiebold retired completely (freely or forced) from the X-ray-guns project. He had enough other worries and even some interesting research projects. And perhaps he had recognized by himself that his proposals could not be practically realized.

Therefore after the autumn 1944 the „Research Centre Groß Ostheim”, its Scientific Director and the corresponding “Board of Trustees” did not exist anymore.

Regarding the big hall for high voltage experiments built in Groß Ostheim it is not known to me if a high voltage generator has been ever installed, but the probability for this is very low. In September 1944 a

night-flight squadron of the Luftwaffe was based in the neighbouring air field which was also used by transport aircrafts. All this was easily found out by the allies, as is reported by Dr. Hans Dietrich Nikolaisen in a war-chronic he published in 1993 [Ni93]. On September 29 and November 9, 1944 the basis was bombed and on December 24, 1944 50 American Liberators throw three “carpets” of bombs on the runway which was left practically “ploughed”. A last attack happened on February 21, 1945 and on Monday before Easter the Luftwaffe abandoned the place. Dr. Nikolaisen still reports that in 1993 the underground bunker of the research centre was used as a deposit for a factory of toys. It can be assumed that the huge hall, which was made of wood, would not withstand the bombing. But the history of all this is being investigated at present.

The last sign of life I had from Schiebold´s son Joachim consisted in a postcard with a footnote stating that an old document came up which rehabilitates his father.

I assume that the document which Joachim refers to (which I will try to summarize in the following) is part of several copies of documents which appeared in the Archives of the State of Saxony and in those of the University of Leipzig without any indication of their origin. They can be consulted there [Eg45].

The document I mean is a long letter sent by Dr. K.A. Egerer (Address: Berlin Schöneberg, Berchtesgadenerstr. 14) to Ernst Schiebold (Leipzig S3, Dankwarthstr.1) on January 2, 1945. It was formulated in a quite complicated (personal?) style. Egerer was probably still the editor in chief of the journal “Archiv für Elektrotechnik” and before he had been a member of the no longer existing Board of Trustees of Luftwaffe´s Research Centre Groß Ostheim.

The main goal of Egerer´s letter is quite clear: He tries to rehabilitate Schiebold as much as possible from the many incriminations in which he was made responsible for the failure of his death-ray projects and of the Research Centre Groß Ostheim.

Egerer explains first that he did not participate in the initial steps of the “Ostheim Complex” (as he called it) in its original form. Later on in

his letter he even claims that the planning of the "Research Centre Ostheim" had been a mistake and that he welcomed the fact that it did no longer exists.

Here I would like to remind the reader that according to Gerlach, the main duty of the Research Centre consisted in the development and test of the X-ray-tubes with big anodes proposed by Schiebold.

Regarding Schiebold´s activity, Egerer states that according to his knowledge the negative comments on his activity were based on completely false assumptions and, what is more important, they did not take into account the effective distribution of responsibilities.

Egerer states that it should be made clear that the proposals personally presented by Schiebold by no means represented "a well defined programme for the development of a new weapon within a well determined time limit". His proposals had in any case the merit of promoting new developments for the production of highest voltages which he needed for his projects.

Regarding the participation of others, Egerer remarks that Schiebold had presented his ideas for a discussion of their feasibility to the specialists he knew, as i.e. the "director of developments" (no name is mentioned) and the future "technical director of his project" (here he probably meant Seifert). Both did not have particular objections, had a clearly positive influence on the continuation of his work and finally organized the necessary connections for the presentation of Schiebold´s proposals to the GM ("Generalfeldmarschall Milch"). This might contradict in part a later statement of Schiebold in which he claims that he was allowed to speak officially with the "technical director" (Seifert) only after the Luftwaffe-order had been issued.

Egerer also claims that anyway Schiebold could not be made responsible for the possible execution of a project and for its unwanted future developments, as he had his original ideas checked by specialists he knew. As a university teacher Schiebold could anyway not take over such responsibilities alone and later on one could not blame him for this.

Since I could not find much information on Egerer´s life, it is interesting to deduce from his letter to Schiebold that he evidently was one of the consultants and trustees of Generalfeldmarschall Milch

Egerer also mentions that he suggested to Milch to include Wideröe´s ideas into the research order which had already been issued.

When Schiebold received the letter of Egerer in January 1945 he had probably already resigned regarding the lucrative order of the Luftwaffe and the closing of the Research Centre Groß Ostheim. He continued running his semiprivate "Institute" which was kept alive by other orders for research and development.

I include here only a short summary of Schiebold´s later life, as it is not directly related to the subject of the present report. More information on Schiebold´s life can be found in the already mentioned article by Burkhard Weiss [We03].

Among the numerous resumees and lists which Jouchim Schiebold made in 1994 there was an interesting, three pages long report with the title "Happenings after 1945" ("Vorgänge nach 1945") [SJ94b]. I would like to reproduce some of the contained information, which was confirmed later on by others and in particular by the already mentioned careful investigations of Burkhard Weiss.

In his report Joachim describes first the situation after the American Army had occupied Saxony in April 1945. End of May 1945 it was made public that the Americans would leave the occupation of Leipzig to the Russians. Before this happened it was offered to the professors of the University of Leipzig to move with the Americans to the west and many of them accepted. But Ernst Schiebold was not included in this offer because at the time he was not on the list of teachers of the University of Leipzig. He had been officially "transferred" for political reasons to Dresden, while continuing to work in Leipzig.

In the history of the Leipzig Institute for Mineralogy [UL03] it is documented that Professor Schumann, at the time Director of the Institute, did accept the offer of the Americans. He carried to Bonn several collections of minerals and precious stones which had survived the bombings in the seller of the institute.

On November 30, 1945 Schiebold was dismissed with immediate effect of all his functions as a civil servant. This had been ordered by the Soviet Military Administration and was based on the political functions he had during the Third Reich [We03].

Later on it was attempted several times to convince Ernst Schiebold

to move to the West. According to his son Joachim, he refused all these offers and claimed to have had bad experiences with western enterprises at the commercialization of his numerous patents.

As Joachim reports [SJ94a], already in August 1945 a representative of the Soviet Army, colonel Arbusov, came to see his father and offered him the possibility to collaborate in research projects of the Ministry for Building in Moscow. They did know about him because one of his books (on crystallographic problems) was published in Moscow translated into Russian language in 1924.

This collaboration took place and lasted until 1948, when the coordinating office of the "Soviet Military Administration" SMA was moved from Berlin to the Soviet Union. As Egon Becker reported, Ernst Schiebold was at this time in Leipzig the main referent of the scientific-technical section of the Ministry for Building Materials of the Soviet Union.

Joachim writes that after this his father had serious problems with the authorities of the DDR. In February 1949 the Criminal Investigation Police arrested him, due to a political denunciation. He was treated as a "prisoner on trial" and kept in a cell with other 10 to 14 suspected persons, including the children's doctor Gründer who still had a private praxis. To pass their time Schiebold gave some lectures to the other prisoners and they thanked with parts of their food rations. After about three weeks his father was released, due to an intervention of the Soviet Occupation Autorities. But in March 1949 the German Criminal Investigation Police confiscated most of the instruments stored in Schiebold´s private appartement and carried it all to the University.

More accurate information is reported by the historian Burkhard Weiss. He shows that the problems which Schiebold had were related to a pretended denunciation of the director of the Institute (an enemy of Schiebold) during the Nazi-time which finally resulted to be false.

Back to Joachim´s report. By intervention (or instruction) of the "German Commission for Economic Matters" ("Deutsche Wirtschaftskommission" DWK) in Berlin his father got a position at a research institute in Henningsdorf near Berlin where he remained from August 1949 till July 1951. There he organized and directed a new section dedicated to non-destructive tests of materials. Due to an

expertise on the scandalous hygienic conditions in an iron and steel factory, which he wrote together with Dr. med. Hoffmann, the latter was sacked from his position and Schiebold was sent back to his semiprivate "Institute" in Leipzig.

There Schiebold took over officially the direction of the research section for "non-destructive tests of materials" of the "German Office for Materials and Goods Tests" DAMW ("Deutsches Amt für Material- und Warenprüfung"), as was reported by Egon Becker and Burkhard Weiss.

One year later, in October 1952, according to Joachim, the political director of the research section of the DAMW prohibited to Schiebold´s "Institute" any research activity.

But in January 1953, following orders of the Soviet Military Administration, the confiscation of Schiebold´s materials and instruments was revoked and the "Institute" could start again with its regular activity. Evidently the authorities of the DDR had finally accepted that Ernst Schiebold was a valuable scientist, who deserved to be supported.

In our discussions Joachim Schiebold insisted several times on the fact that the change of opinion of the authorities of the DDR was a consequence of the pressure exercised by the Soviet Military Administration. The latter were very pleased with the work Schiebold had done for them. The fact that his father did not abandon the DDR (even having the possibility to do so) might also have been a positive factor.

Anyway this change marked an important highlight in Schiebold´s career, as it was described in an interesting article written by his pupil and collaborator Egon Becker in 1983 [Be83].

Becker reports that the culmination in Schiebold's life was certainly his appointmewnt as Ordinary Professor (with his own chair) and at the same time his nomination as Director of the "Institute for Research and Test of Materials" within the newly created "Highschool for the Construction of Heavy-Machines" ("Hochschule für Schwermaschinenbau" at present called University) in Magdeburg in 1954. Becker remembers that according to Schiebold this corresponded to the creation of an institute particularly concentrated on the test of materials based on physical principles with special emphasis on non-

destructive testing and that such an institute was in its character unique in the DDR.

In his report Egon Becker devoted only a few lines to the time between 1946 and 1953. This is well understandable as he wrote the article when the DDR was still existing. Schiebold´s proposals for X-ray weapons during the war and the Research Centre Groß Ostheim are not mentioned at all.

Ernst Schiebold´s time after 1954 can be considered as a continuous sequence of successes, for which he worked hard and with great enthusiasm. But he also had problems, as his son Joachim reported to me. He was always carefully "observed" by the DDR-authorities. It should also be taken into account that Schiebold was already sixty years old in 1954.

Becker starts his report stating that Ernst Schiebold was one of the outstanding scientists in the fields of crystallography, physics of metals and test of materials. He directed the already mentioned institute in Magdeburg from 1954 to 1961. During this time he took over for two periods the duty as dean of his faculty. In 1962 he retired and became "professor emeritus" but continued belonging to the High Council of the Highschool as "senator honoris causa". Besides his teaching duties Schiebold worked in the voluntary team of the "Chamber of Technique" KDT ("Kammer der Technik", DDR) and was chairman of several committees of specialists. He was always ready to support cultural activities and was one of the founding members and first chairman of the later on well known "Otto von Guericke Club".

Becker still reports that the authorities of the DDR honoured Ernst Schiebold in 1958 with the National Prize for Science and Technique, 2nd Class. The Chamber of Technique KDT thanked him for his exemplary work with the nomination as Honorary Member and with the Golden Medall of Honour. He was also honoured with the Johannes-R.-Becher-Medal from the DDR Cultural Union ("Kulturbund").

I can still add that between 1956 and 1963 Ernst Schiebold was the chairman of the "Central Committee for Materials Testing" of the KDT. To celebrate his 65th birthday a festschrift in his honour was published in 1959. It included 39 contributions written by his former pupils, friends and collaborators [SE59]. During the last years of his life Schiebold

concentrated on the biography of several important scientists and inventors. Remarkable was his unfinished work on Otto von Guericke.

Ernst Schiebold died on June 4, 1963 in Magdeburg.

On June 9, 1994 Ernst Schiebold would have been 100 years old. This gave the opportunity to organize the already mentioned scientific colloquium in Magdeburg. Written versions of the contributions presented at the meeting were published by the University [Ka94]. The building, in which the colloquium took place, was still the same in which Schiebold originally started working, in the Große Steinernetischstrasse Number 5. Since 1999 it is called Ernst-Schiebold-Building. A relieve image of Schiebold decorates the entrance (see Box 7).

Since 1997 a "Memorial-Coin Ernst Schiebold" (including then 8000 DM) is awarded for special achievements to junior scientists. It was donated by the "German Association for Non-Destructive Testing" DGZfP ("Deutsche Gesellschaft für Zerstörungsfreie Prüfung e.V.") an association created already in 1933.

In 1983 a chair was created at the University of Marburg which later on was transformed into a 6-months guest-professorship of highest rank (C4) ("Ernst-Schie-bold-Gastprofessur") [SE95].

My summary on Schiebold´s life and honorifications is certainly not complete and should just encourage further investigations.

Let us return now to the plans of the Luftwaffe in 1944. The fact that Schiebold´s strange X-ray-tubes with enormous anticathodes were declared as not feasible and even as totally wrong projects did not mean that the Luftwaffe had abandoned its interest on the production of high energy beams. Betatrons or beam-transformers were well indicated for this purpose and remained in the programmes of the Luftwaffe.

Gerlach did mention these facts with just one sentence in his report of August 25, 1944. Here he claims that the developments of betatrons would be useful to verify the physical lows used by Kulenkampf in his computations.

But his positive opinion on these developments was quite clear. Already on March 28, 1944 he had expressed his support for the contribution of his friend Richard Gans to Schmellenmeier´s

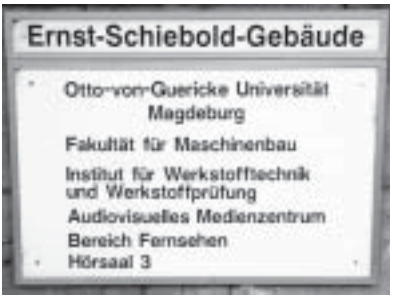
Box 7

The Ernst-Schiebold-Building

The building of the „Institut für Werkstofftechnik und Werkstoffprüfung der Otto-von-Guericke Universität“ in October 2003.

Commemoratve tablet at the entrance
Foto P. Waloschek

.Official name of the building:



Photos Mark Landau (Magdeburg).

"Rheotron"-project and even offered his personal active participation. He also favoured the construction of "electron-catapults" (as betatrons were called) at Siemens Company.

All this should now take place in the frame of the expected new applications for medicine and for nuclear physics research. And with this motivation in mind Gerlach evidently did not object to the Luftwaffe still supporting Wideröe´s construction of his beam-transformer in Hamburg. Anyway several members of the no longer existing Board of Trustees of Groß Ostheim belonged to the Ministry of Aviation (RLM) and evidently agreed with Gerlach´s ideas.

This is why Seifert and Hollnack could continue with Wideröe´s project (without Schiebold) following the instructions or commands originally given by the Luftwaffe. They had ordered the main components for two 15-MeV beam-transformers at C.H.F. Müller in Hamburg. The first one should be used to investigate the properties of the machine and with the second one practical applications in medicine and technique should be performed. However, the second one was never assembled.

As a second step Wideröe had already proposed i.e. in the "working programme" of November 6, 1943 [Wi43c] the construction of a 200-MeV beam-transformer. He even mentioned the firms which could undertake the construction of different parts of the accelerator. Evidently the preliminary discussions on this project reached to a different conclusion. Director Mayer-Delius from BBC-Mannheim reports about decisions which had already been taken in a meeting on April 29, 1944 [Me44] after several days of detailed discussions.

As Mayer-Delius reports Director Seifert had issued in the name of the RLM (Ministry of Aviation) a provisional order to BBC-Mannheim for the design-work of the bigger beam-transformer and nominated Dr. Wideröe as consultant for this work. He also reports that Seifert did ask BBC-Mannheim to take over the full project (the construction of the machine), because it could not be done at BBC-Oslo, as it was originally planned.

Mayer-Delius added that BBC had only accepted to perform the mentioned design work under the condition that the two requested constructors (engineers) should be "declared free" for this work by the

RLM, but that under the present conditions they refuse to build the apparatus. The fabrication of the device could only be taken into consideration if additional working power would be “made free” by the RLM.

This text makes clear how much the realisation of a project depended on the availability of specialists which should then be freed from their military service.

After a few instructions of technical character Meyer-Delius remarks finally that Dr. Wideröe called the attention on the fact that all this matter should be considered as strictly secret and that the number of informed participants should be kept as small as possible.

It is perhaps remarkable that in Meyer-Delius´s list of participants to the meeting on April 29 Wideröe was mentioned as representing a “Research-Place of the Luftwaffe” (“Forschungsstelle der Luftwaffe”). The fact that he was still a member of the Norwegian branch of BBC Oslo was not mentioned at all.

Wideröe did also write down a quite detailed report on his visit to BBC which started already on April 27 and finished with the already mentioned meeting on April 29, 1944 [Wi44].

At first a mainly technical discussion took place in Weinheim regarding the provisional project presented by Wideröe. Chief Ing. Weiss, Dr. Schwab and Chief Electrician Dr. Kade were present. Here Dr. Meyer-Delius told Wideröe that the BBC-specialist on high voltage technique Dr. Böcker would take care of the project as main responsible. Ing. Weiss mentioned that a provisional estimation of the required special transformer-iron-sheets of 0.35 mm thickness resulted in an amount of 40 to 50 tons. Dr. Böcker expressed very positive comments on the project.

Wideröe also mentions the meeting of April 29 in Heidelberg. As he told me later on, this meeting took place in the private residence of Meyer-Delius, but that in Heidelberg no BBC factories or representatives were located, as is misleadingly mentioned in the Kaiser-Report [Ka47]. Under the “big facilities”, in which the machine would be built, the factories of BBC in Mannheim were certainly meant.

During these meetings Wideröe was informed by Dr. Meyer-Delius about other existing projects for beam-transformers. Professors Bothe

and Gentner were both working on such plans. Bothe had already started in 1941 with the design for a 10-MeV betatron with Prof. Dänzer and had also contacts with Gentner.

Wideröe was also informed by news arriving through Sweden that in the USA at a high energy betatron the electron beam was successfully extracted from the machine.

It is remarkable, that the projects going on at Siemens (see Appendix) were not mentioned at all.

It is not known to me if finally BBC-company did later on accept Schiebold´s proposal to construct (not only to design) the 200-MeV beam-transformer, but it seems to me not very realistic. In January 1945 BBC stopped working on the detailed design of the 200-MeV-machine. The factory in Mannheim was nearly destroyed by allied bomb attacks, as Wideröe remarks in his biography. And in March 1945 Wideröe had already left Germany.

It is certainly not probable that the Luftwaffe had at that time much interest in long lasting basic research projects for future nuclear physics or for the improvement of medical X-ray equipment to be used for diagnostics or for treatment of cancer. In addition it had been decided anyway to support only projects for which useful applications could be expected within less than one year. This could eventually be the case for Wideröe´s 15-MeV machine. The produced X-rays could have been used to inspect materials used in the construction of aeroplanes.

There must have been same special reason to make an exception regarding Seifert´s order for a bigger ray-transformer at BBC, which was known as a long lasting and complicated enterprise. I could not find up to now any concrete answer to this question.

It is possible that someone (it could have been Gerlach) had recognised that without the questionable and energy wasting transformation into X-rays in the big anticathodes of Schiebold, the accelerated electrons could be extracted from the machine and directed to an enemy target. Schiebold did mention this possibility only in his first proposal but immediately dismissed it. It could be that later on this possibility gave to the experts of the Luftwaffe a good reason to construct bigger betatrons, as it is also suspected by Burghard Weiss in

his considerations regarding this matter (see [We03a] p. 217). In press reports reaching Germany through Finland and Sweden it was informed that in the USA (as already mentioned) a big betatron was successfully run and the electron beam could be extracted. The luminous track of the produced shower could be observed in air over several hundred metres. This news could perhaps awake new hopes (also at the Luftwaffe) even if they were no longer the "invisible death-rays" but a kind of fire-gun.

However, I would consider it as very probable that at the time the authority of Gerlach was so dominating that those responsible for political or military matters (including Speer, Milch, Georgii und Geist) would follow his opinions or decisions without asking many questions. And Gerlach had anyway full power over all nuclear physics activities and on the adjudicated research funds.

The 200-MeV beam transformer, which Wideröe later on called an illusion, was in reality a very remarkable project in which also he and his team (that is Kollath, Schumann and Touschek) had invested a lot of time and energy. But it remained an illusion, which he did not want to be specially mentioned in his biography. One can imagine his disappointment, after such intensive planning and designing work, when at the end of the war he had to abandon the project.

In addition, Wideröe had soon recognized afterwards that a 200-MeV machine did not represent the optimum for applications in medicin or technique (X-raying of big pieces of material). Beam-transformers under 50 Mev were quite sufficient for these applications and obviously much cheaper and smaller. A 200-Mev machine could just be used for research in atomic or nuclear physics, but in this energy range other accelerators like cyclotrons ans synchrotrons soon started to be more convenient. A military use of the 200-MeV machine was never mentioned, even beeing officially still financed by the Luftwaffe (the RLM).

In any case, the 200-MeV project was a demonstration of the high standard of the developments in this field in Germany. Physicist Herman F. Kaiser, a specialist of the U.S. Naval Research Laboratory in Washington D.C., studied the situation soon after the war and published

his results in an 18 pages long quite accurate report with the title "European Electron Induction Accelerators" [Ka47].

This report contains a lot of information about the 200-MeV project which Kaiser considered as the most important betatron-project in Europe. He mentions as "authors" the group around Wideröe (he meant Kollath, Schuhmann and Touschek) which he called MVA, the "Megavolt-Versuchanstalt". This name (and the used method) is called in several other documents as the "Megavolt procedure" ("MV-Verfahren") of "Wideröe´s type" ("nach Wideröes Art").

Already in 1942, in his first report on beam-transformers, Wideröe had included data for accelerators with 100 to 1000 MeV energy. From his second report (from July 1943) we only know that besides a 15 MeV accelerator it was mainly devoted to the project of a 200-MeV machine. Probably this was the starting point for additional planning of a machine of this energy. There was afterwards a preliminary proposal for a 100-MeV machine which was soon abandoned in favour of the 200-MeV one.

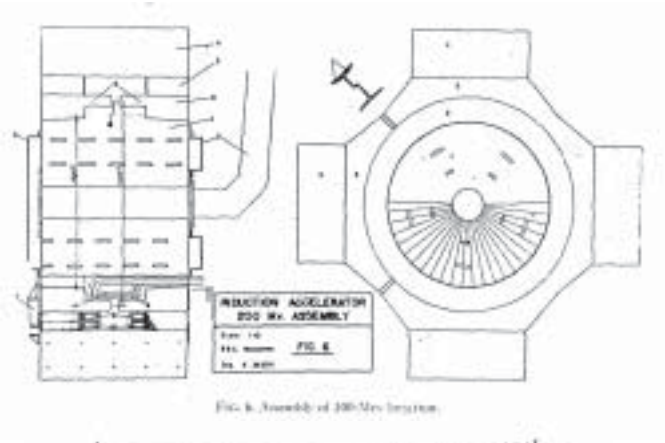
I would like to emphasize that according to the available documents Ernst Schiebold did not participate at all on the planning or design of the 200-MeV machine. In his first proposals he did not mention such apparatus. Only later on, when he knew more about them, he included beam-tarnsformers in his plans. He even gave a concrete example for the use of 200-MeV beam transformer for an X-ray gun with a non realistic anticathod of 2 metres diameter. According to Schiebold it would provide an "X-ray-beam" of only about 500 metres range [SE44g]. He even asked Bruno Touschek to perform some computations in this direction [To44] which he then used in a questionable way.

This demonstrates that Bruno Touschek knew very well about Schiebold´s intentions. Touschek never considered the many computations he did at the time as scientific or technical reports and do not mention them even in his CV.

In the first calculations made by Wideröe on the size of the 200-MeV beam-transformer for BBC he obtained a magnet core of 5 metres diameter and 2 metres height. It would weigh 160 tons and the cost was estimated in 1.12 million Reichsmark.

Box 8

The 200-MeV-BBC-Betatron



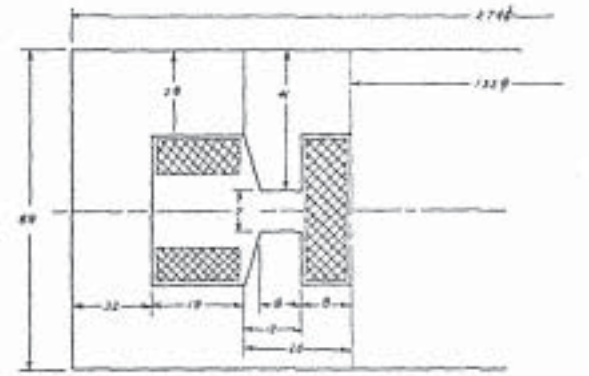


FIG. 5. Schematic construction of 200-Mev betatron (Wideroe).

Precise construction drawings for this accelerator were made at BBC (Mannheim) under the direction of Rolf Wideröe following an order issued by the Luftwaffe. According to H. F. Kaiser the device should have a diametre of 274 cm and 89 cm high. The iron yoke would weigh 26 t. Drawings from [Ka47].

During the detailed design work Wideröe could make use of his experience as electro-engineer and obtained a considerable saving of iron. In the final design the total weight was reduced to 40 tons. Kaiser compared this with the 100-MeV machine built by Kerst at General Electric which required 130 tons of iron. According to Kaiser the German 200-MeV design contained many other extremely interesting technical details.

——————————— End of chapter 6

7 The Luftwaffe´s Last ‘Betatron’

It happened at the beginning of December 1944 in the waiting hall of a hospital in Marburg. A good looking young man was there for the final checks before being released. He was 17 years old and had just been cured from a quite common sexual decease in the dermatological clinic. He was approached by a middle aged man coming from the internal deceases department who asked him about his name, his provenance and his activity. The young man answered that he was the Dutch river-sailor Jan Gerrit Overbeek, hired on the cargo-barge ‘Matthias Stinnes 18’ based in Duisburg, but that he did not want to go back there. They continued chatting and it came out that the young man did like to read. So the older one offered him a book from Nietzsche he would bring to him next day. In the book he would find a note with his address. He should come along as soon as he is released. Then he would see what he could do for him.

The young sailor Overbeek became later on the talented writer Jakov Lind, who described the above mentioned middle aged man with some more details in one of his very interesting autobiographic books [Li97]. *“He had short cut hair and a quite sympathetic face, brown eyes and a shortish and a bit bent-up nose”*. They separated that day with a strong hand-shake.

The middle-aged man did in fact return the next day, as Jakov Lind reports. He was dressed like a real boss and gave him the book ‘Also sprach Zarathustra’. He was wearing a dark-blue dress, white shirt and a black tie. He wished him fast recovery, put down the book and left. The hand written note in the book had the size of a postcard:

Theodor Hollnack
Baracke Mittelfeld, Dillenburg/Dill.

I must clarify that in his book Jakov Lind did hide the real name *“Theodor Hollnack”* and changed it into *“T. Kolberg”*. In a later

letter to me [Li94] and in a telephone call he explicitly attested that the person he meant and described was Theodor Hollnack. So it also came out that the Dutch sailor Overbeek, alias Lind was in reality the Jew Heinz Landwirth, born in Vienna on February 10, 1927. His parents did send him to Holland with the help of an organisation for refugees when they were able to emigrate to Israel (see [Li11]). The young boy Landwirth and later on Jakov Lind succeeded in obtaining false personal documents and could submerge in an adventurous way as sailor Overbeek. The doctors in the dermatological station in Marburg obviously noticed that he was circumcised but he told them that he was not responsible for that, it was not his fault and they let him go.

A few days later sailor Overbeek reached Dillenburg by bus and with the help of several passers-by finally found the “Baracke Mittelfeld”, half way in the direction to a castle situated on a nearby hill. Hollnack was not there but had left precise instructions, if Overbeek should arrive. Even adequate logging had been reserved for him. He should keep ready and if Hollnack needs him, he would let him know. That was all he had to do for the moment, for a monthly salary of 400 Reichsmark (RM). His colleagues in the Barack were all very helpful and polite. They did not know for what kind of important task he had been contracted by Hollnack.

The “Baracke Mittelfeld” included four or five bigger rooms and several smaller ones. Four or five men were actually working there, a personnel manager, two typists and the secretary of the boss, Miss Blohm. It was in fact a department of the Ministry of Aviation of the Reich (RLM) which had been moved out from Berlin. On the letter-heads it was called „Metallurgical Research Institute of the Ministry of Aviation” (“Metallurgisches Forschungsinstitut des Reichsluftfahrtministeriums”) and on Holl-nack´s letters he was called “The Trustee of the Metallurgical Research Institute of the Reich´s Ministry of Aviation” (“Der Treuhänder des Metallurgischen Forschungsinstitutes des Reichsluftfahrtministeriums”). Ex-sailor Overbeek had not to care at all about the research or other activities of the department. And Hollnack had strictly prohibited him to have any personal contacts within or outside the department, in particular with girls, an instruction which Overbeek could not always follow.

Overbeek spent Xmas 1944 still in Dillenburg. But he frequently drove with his boss to Berlin, where he had a modest office on the third floor of a building in the Friedrichstrasse. Overbeek´s job consisted essentially in carrying around messages or documents between different official agencies.

Hollnack drove a big Opel-Kapitän car and during the trips with Overbeek they had time for longer conversations. So Overbeek came to know that Hollnack belonged to a Prussian family of officers from Halle an der Saale. He was originally a flight-teacher and his immediate superior was at present Generalfeldmarschall Milch, whatever that meant at the end of 1944.

Early in January 1945 Hollnack provided his messenger Overbeek with passepartout documents ("Marschpapiere") in which *"all offices of the police and SS in the Reich were asked to help in any possible way Jan Gerrit Overbeek who was travelling on behalf of the Ministry of Aviation (RLM)"*. With these documents Overbeek could freely travel all around through Germany, on trains even in first class.

Overbeek had in fact to travel a lot through all Germany, with brown files, envelopes and packets which he had to carry up and down between Hamburg, Berlin, Dillenburg, Dresden, Mannheim and other cities. He did spend a lot of time in trains and found this very relaxing, as nobody could localize or find him there. When staying in Hamburg he lodged in the luxurious hotel 'Vier Jahreszeiten' next to the Alster, which was frozen at that time. He had very critical remarks on the extravagant style of life of the hotel guests.

In Hamburg Overbeek came to know about the extremely secret project on which his boss was involved, namely the construction and operation of a very special apparatus which he erroneously called in his autobiography a 'cyclotron' and which was built under the direction of a Norwegian engineer called Wideröe.

The 'extremely secret' machine was in fact the 15-MeV beam-transformer (now often called 'betatron') which, as already described in chapter 4, had been successfully assembled and put into operation in summer 1944 in the laboratories of C.H.F. Müller Company in Hamburg, in close collaboration between experienced staff members of

the company with Wideröe´s team: Kollath and Schumann, and with the assistance of Touschek as talented theoretical. Experimental physicists Kollath and Schuman had already started to investigate the properties of the machine. The original intention was to built two such betatrons of 15-MeV and the corresponding orders had been issued by Seifert (for the Luftwaffe). The first one should serve to study the properties of the machine and the second one (which was never assembled) should then be used for practical applications in medicine, materials testing or nuclear physics.

But not everything went on as smooth in Hamburg as it was during the construction of the machine. Wideröe devoted increasingly more time on the project for the future 200-MeV machine, which should have been built at BBC in Mannheim, and not in Hamburg. He was also submitting betatron-patents in Berlin, with the help of his friend Ernst Sommerfeld, without reporting it to C.H.F. Müller (he was still an employee of NEBB Oslo). It is probable that he occasionally used the services of Hollnack´s messenger Overbeek, but he could not remember it later on.

As Touschek commented later on he was by no means careful in Hamburg and went frequently to the Chamber of Commerce to read foreign newspapers and journals which still were available for visitors there. Also at the University, where he was listening lectures as illegal student, he was quite extravagant. He several times inverted Hitler-portraits so that the Fuehrer was hanging on the wall head down. But it seems that nobody took care of denouncing these activities.

At the end of 1944 or somewhat later it was decided to move the operational 15-MeV device to a ‘save place’ in the surroundings of Hamburg. According to Wideröe this instruction came from the Ministry of Aviation RLM, that is, from the Luftwaffe. To my knowledge it has never been cleared up who really issued this order. Generalfeldmarschall Milch had already lost his position as “Luftzeugmeister” in June 1944 and from January 1945 he was no longer “Generalinspecteur der Luftwaffe”. It is hard to imagine that Colonel Geist in Berlin would care about this. Gerlach could certainly have made this suggestion. But it is clear that Richard Seifert would have had anyway full power to take this decision (in the name of the

Luftwaffe) with the obvious agreement of Seifert and Hollnack. And Wideröe seemed to have nothing against it. His main interests at that time were in Mannheim and Berlin. Seifert had already stored parts of the second betatron (to be built) in his dependences and probably considered himself as responsible for the whole project.

Anyway, in March 1945 Kollath, Schumann and Touschek with the help of Seifert and assisted by staff members of C.H.F. Müller Company transported the complete set-up to a plain shed (which had an adequate big entrance door) in a small village called Wrist (near Kellinghusen, about 50 km north of Hamburg). The building was part of a dairy, property of Seifert´s family. The re-assembled apparatus worked from the beginning without particular problems. It is there were Overbeek sow it once and commented it as a big grey monster well camouflaged in a shed.

In our meetings preparing Wideröe´s autobiography I asked him several times about the work done at Wrist. He insisted that he had never been in Wrist and therefore had not seen the betatron in its new location. Work there was done by Kollath, Schumann and Touschek without his intervention.

The now available information contained in the letters of Bruno Touschek to his parents did allow to reconstruct (or correct) some details of the events happening in 1945. Two of the letters are reproduced (in English) in the interesting Touschek-biography by Luisa Bonolis and Giulia Pancheri [Bo11a]. With the kind permission of the authors I reproduce here several parts of the letters.

On November 17, 1945 Touschek wrote from Kellinghusen to his parents in Vienna:

"... I would like to tell you what happened starting from the beginning of March. More or less in that period, I do not remember very well, … Relationships with Berlin were not the best: disapproval for my collaboration at the betatron, many telephone conversations with Wideröe,(...) In Hamburg Wideröe told me that C.H.F. Müller, where the betatron was built, had become unbearable and that he had the intention of moving immediately (from Hamburg) *to Kellinghusen."*

On March 15 Wideröe made this reality and went with Touschek to

Kellinghusen. Touschek had also there a quite nice room, as he mentions in his letter (up to then he was normally living in Hamburg). On March 16 in the morning Wideröe and Touschek still sat on the veranda and discussed on a paper of two Russian authors on “radiation dumping” which appeared in the Physical Review.

Wideröe´s tens relation with C.H.F. Müller at this point is also documented by a letter send on March 13, 1945 by C.H.F. Müller (illegible signature, could be Fehr or Kuntke) to the “Working Group Dillenburg, personally to Dr. Wideröe, (24) Wrist/Holstein” in which they asked Wideröe to take care that the Folder “Konstruktionsmappe LMV” (which had been taken away by a Mr Flegel without informing the laboratory-staff) should be returned into the property of the C.H.F Müller Company **[Ku45]**. They obviously knew that Kollath and Schumann did continue performing measurements on the beam-transformer at Wrist in the frame of Hollnack´s “Working Group Dillenburg” and that Wideröe was with them.

In the evening of March 16 Touschek returned from Kellinghusen to Hamburg on a truck with a quite inexperienced driver. They had several accidents and there was a bombing alarm. He finally reached his home at midnight, had still a telephone call and then slept up to 7:30 in the morning, when he was woken up by two gentlemen which declared to be of the Gestapo (“Secret State Police”). Touschek comments tis in one of his letters:

“They were very kind. It took them an hour to search through the mess that my desk was, to search for hidden firearms and to put everything in my bag. The bag, which was very heavy, I had to bring myself to the Gestapo (15 minutes from Dammtor). They interrogated me for an hour, to tell me in the end that they did not know why they had to arrest me, the order had come from Berlin. I asked them to inform Seifert and the ‘assistant’, whose name was Kneesch, called him. After Kneesch told me I should not get angry if the tone downstairs was ‘rude but sincere’, I was then brought in a basement. We sat on a bench, the face towards the wall. The window in the courtyard was open and it was very cold. My neighbour was not ‘‘waterproof’’ and was dripping from above and below. After an hour we were brought by tram to Fuhlsbüttel. There the various rites of

cleaning and lice searching. I was then brought to the cell where the Jews were and where there was a lot of good company. With a certain Waiblinger, who now studies, I am still friends. The only unreasonable thing was that there was no space to sleep, the toilet stank and obviously the people were not in good health. Apart from this, there was practically nothing to eat. The following day was Sunday. The next Monday I was again brought to the Gestapo in a overfull tram wagon, better not discuss the treatment during these transportations. At the Gestapo Seifert, Dr. Wideröe and Dr. Kollath were waiting for me."

According to Touschek´s letter they explained to the Gestapo people that *„the future of the Reich, for better or worse, depended from a research on the influence of the radiation-damping just started by Mr. Touschek. Mr. Touschek should have the right to smoke, read and receive visits. The first week nothing came from these concessions. I was confined without a pencil. Wideröe had put a couple of cigarettes in my pockets, but I had no matches. On Friday I wanted to hang myself, and on Saturday, Wideröe came. From then on the situation got better. I had a 'decent' cell on the first floor and Wideröe brought me Heitler's Quantum Theory of Radiation and I started research on radiation-damping. W. never forgot to bring me a pack of cigarettes with written on it the important sign 'Propellent for you'. Apart from the terrible nutrition, the worse thing was to be forced to sit or stand up alternatively all day long. Furthermore, it was horribly cold. After a lot of coming and going which procured some free cigarettes to the SS on guard, I managed to obtain the permission to lay down in my cell, so I stayed horizontal for a whole week with Heitler and Joos under my arm and, in my mouth, a quote from Goethe's "Götz". I was treated relatively well, because the frequent visits by important people gave me a certain respect (…). One Wednesday, about April 10th, W. visited me and told me the courier with my pardon papers was coming from Berlin. The day after, despite my protesting, I was woken up at five o' clock."*

A personal comment: In one of our happy evening meals Touschek told me that Wideröe provided him in prison, besides some food, his beloved books and the required cigaretts, also with some schnaps, which

he also needed to work. Touschek did not mention the schnaps in the letters to his parents. It was also ommitted in Amaldi´s biography of Touschek [Am81].

When the British Army was approaching Hamburg, it was decided to transfer the inmates of Fuhlsbüttel jail to an other concentration camp near Kiel. This happened the day after Wideröe´s visit, that is, on April 11 or 12, 1945. Several slightly different versions of these dramatic events are known, but Touschek´s own description is now available **:**

"At dawn we met in the corridors. At the beginning, the fact that we should march towards Kiel was only a rumour, but at 10 o'clock it was a fact. I tried to protest again with the SS, especially since I was waiting for my release. I had suffered the whole week of diarrhoea, the worst thing that can happen to a prisoner. I was not able to stand. In all 200 of us were deported. We all received a big sack to carry. They were (my one was?) *extremely heavy, loaded with books. The people were divided in groups of twos. The whole affair was very discomforting. I definitely broke down in Langenhorn* (North limit of Hamburg). *They made me roll down the trench near the street and then they shot me, one bullet pierced through the padding of my coat, the other one went very near my ear. I waited for the guards to go away. In the meanwhile some people had assembled to see if I was dead or not. I wanted to find the way to phone Seifert and ask him for a car. In the meanwhile my head was hurting me terribly and I managed to go to the hospital of Langenhorn, I needed help. Thanks to Wideröe's message I had no worries about it. But they would have been justified. They brought me to all kinds of prisons for other three weeks (…). From there, Hollnack came to pick me up on the 30th of April. He then explained to me - after having done nothing for three weeks - that without him I would have definitely been shot."*

In some way Touschek succeeded in reaching Seifert´s home (probably with the help of Hollnack) and stood on the front door of the house still in prisoner's dress, as Richard Seifert´s daughter, Mrs. Elisabeth Samusch, reported later on in a letter to me [Sa94]. They were very surprised, as they had all assumed that he was shot.

Elisabeth Samusch was during the War a young girl. Later on she

had taken over (she was a lawyer) the direction of the company "Rich. Seifert & Co" which then was part of the AGFA-Gevaert Group. She did send me the mentioned letter in 1994 [Sa94]. She also described her night trips by car between Hamburg and Wrist. In the back were sitting Kollath and Hollnack and she had to sit with chauffeur Otto Trautmann in the front. Every now and then she had to leave the car to find the way as the headlines were covered except for very small slips to avoid being seen by attacking allied aircrafts.

Touschek soon returned to Kellinghusen to continue working on the 15-MeV betatron. Here he wrote several interesting reports [To45b].

On April 11 or 12, 1945 Wideröe was still in Hamburg and had visited Touschek in prison. So it probably was after this day that Hollnack gave to Wideröe a "special payment for his services" (according to Wideröe) consisting in 38.000 Reichsmark and 150.000 Norwegian Crowns (according to another source there were only 38.000 Crowns [Wa93]). Considering the situation it was anyway a small fortune. In a later document [Wi46a] Wideröe explained that this was considered as payment for the use of his patents. With this money Wideröe disappeared silently following an advice of Hollnack. He left by train and, with some interruptions due to sabotage and a stop in Copenhagen (for document regulations) he reached his native town Oslo, which was still occupied by German troupes. And here he was still employed by NEBB, the daughter of the Swiss BBC.

On April 30, 1945, as already mentioned, Hollnack had succeeded in getting Touschek out of prison, probably in an illegal way. Exactly on this day Hitler committed suicide in the Führerbunker in Berlin and three days later Britisch troups occupied Hamburg.

A few days after the news of Hitler's death reached Kellinghusen Overbeek revealed to his boss Hollnack that in reality he was a Viennese Jew and not the Dutch Jan Overbeek [Li97]. Hollnack took this as a Prussian officer should do, that is without the slightest visible reaction. After a while he said *"Ah"* and after a pause: *"Mrs Bohm is half-Jewish, Overbeek"*. Now it would have been Overbeek´s turn to say *"Ah"* but he was not very impressed. So Hollnack added: *"I have done valuable work for the Allies"*.

Overbeek could at first not imagine what Hollnack meant with his

last sentence. He thought on metal alloys for aeroplanes and then on the hidden grey "cyclotron"-monster he had once seen in Wrist. So he asked Hollnack what he meant. Hollnack answered: *"Stay here, Overbeek, until die British arrive and you will then see what happens. Today or tomorrow they must arrive. You did help me to help the Allies and this will be appreciated."* After that he offered to get for him a scholarship to study in England or America. Overbeek was just 18 years old and had not learned any profession. He refused it all but still stayed a few days in Kellinghusen. The idea that he could be used by Hollnack as a show-off-Jew, together with Half-Jewish Mrs Blohm, with the Jewish wife of Kollath and the Half-Jew Touschek did not particularly attract him. He wanted first of all to go back to Amsterdam, to his friends and his former girl friend.

On May 3, 1945 the British forces occupied Hamburg. There was no fight because Hamburg had been declared 'open city'. Dr. Walther M. Müller, the director of developments of C.H.F. Müller, did not need to risk his life as voluntary bodyguard of Hamburg´s mayor. A few days later the British troupes reached Kellinghusen, as Jakov Lind observed and described in his autobiography [Li97]. He sow British tanks rolling into Kellinghusen. It was the Eighth Army and they distributed suits and Player-cigarettes, but not to everyone. Only to girls and children. Also the inn (where he lived) was occupied and a shield was mounted on the entrance:

"Eighth Army, T-Force, Keep Out".

But Overbeek was allowed to enter.

As it soon became clear, Theodor Hollnack was not only the trusted confident of the Luftwaffe, but also of the arriving British troupes. He immediately took contact with a special unit of the British Army and as a first action guided them to the site of the C.H.F. Müller Company. He showed them the laboratories and offices in which the object now called "betatron" was developed. All still available documents were immediately confiscated and taken away. The Company was for the moment forbidden any activity, which made the staff very unhappy, as it was also reported to me at the already mentioned meeting on April 28, 1994 [Wa94]. They knew that their mother-house Philips in Eindhoven was very interested in the further development of betatrons on which

they had already invested a lot of work. And they could not understand at all why they should not work for a while.

But Hollnack´s organizing talent went much further on. He obviously had convinced the British authorities (probably already before their arrival) to allow Kollath, Schumann and Touschek to continue peacefully their work on the betatron in Seifert´s hidden dairy in Wrist, an activity which now was considered strictly as a "secret of state" by the British authorities. Therefore it was not allowed to Touschek to use data of the betatron for a thesis he wanted to present first in Oslo (Wideröe had contacted Professor Hylleraas) and later on at Göttingen University. He felt like a prisoner at Kellinghusen.

Material support for the activity in Wrist was probably provided by Seifert, including transport facilities. Not much could be expected from the Ministry of Aviation RLM in Berlin after the unconditioned surrender of Germany on May 7, 1945. Touschek mentions in one of his letters that Hollnack still had 200.000 (RM?) *"war money"* left over in Kellinghusen. In March 1945 Hollnack had already lodged Kollath, Schuman, Touschek, Overbeek and (after March 15) also Wideröe in Kellinghusen and several other *"not very nice people... from various posts of special services"*, as Touschek mentions. Also Wideröe´s friend Ernst Sommerfeld was living in Kellinghusen. Overbeek was lodged in a "inn", that is, a pension with attached bar. Touschek mentions that Hollnack was then called by the guards "Kellinghusen´s Mussolini", probably due to his behaviour as a boss.

Anyway Kollath, Schumann and Touschek were able to continue working in Wrist on the 15-MeV machine now called 'betatron' until December 1945. On December 11, 1945 Kollath wrote a five pages long report on their results [Ko45] and together with Schumann a more detailed paper which was published only two years later [Ko47]. In a footnote on the first page of this report they mention: *"We thank the staff of C.H.F. Müller Company for their continuous and active support and for their interest on the progress of the work done."* Dr. Fehr clarified to me that the active participation could only refer to the contributions during the transfer to Wrist, since after the arrival of the British troupes any activity was forbidden to the staff of C.H.F. Müller and so they were not able to make any contributions to the work

at Wrist. In another footnote Kollath and Schumann mention that they like to thank *"factory-owner Richard Seifert, Hamburg, who always and willingly put at their disposition any necessary help"*. The original financial contributions from the Luftwaffe and the permission or even support by the British are not mentioned at all.

It is interesting to remark that at Wrist only the properties of the 15-MeV betatron were investigated. It was designed for this purpose and many parameters and settings could be easily modified to gain experience for the next machine of which parts had already been delivered to Seifert. But according to Kollath even this tasks could not be finished within December 1945. They were not allowed to have any contact with other researchers at universities which eventually could make some practical use of the very intense radiation produced by the machine.. This was in part a consequence of the strict military secrecy imposed first by the Luftwaffe and later on by the British authorities.

At the turn of the years 1945/46 the 15-MeV betatron was transported to England as booty of war. It was installed in the 'Woolwich Arsenal' in the surroundings of London. There it was used for at least one year for X-ray-inspections of thick steel-plates (for armoured cars), which finally corresponded to a more or less military application. Rudolf Kollath had been contracted first for six months to help with the running of the machine in England. His contract was prolonged for other six months. After this time the track of the machine is lost. Probably it was dismantled and scrapped. Years later Kollath and Wideröe tried without any success to find the rests of the machine, to be exposed in a museum. It was the first betatron reaching 15-MeV in Europe and probably the only one which was officially ordered and completed for the German Luftwaffe.

Here I would like to mention that the well known accelerator physicist D.E. Barnes was at the time working at the Woolwich Arsenal in London and that he was probably involved in the actual application of the already running 15-MeV betatron.

In August 1946 Barnes with his colleague F.K. Goward (then at the "Telecommu-nications Research Establishment" Malvern, Worcs.) succeeded in transforming a 4-MeV betatron (probably built in the USA by Kerst) into an 8-MeV "Synchrotron" which they could successfully

run [Go46]. This was the first experimental confirmation of the correctness of the 'synchrotron-principle' which had been independently proposed in 1945 by Edwin M. Mc-Millan [Mc45] in USA and Vladimir Veksler [Ve45] in the Sowjet-Union. Also Wideröe had worked out this important principle [Wi46] and submitted his ideas as a patent.

So it is clear why at the beginning of 1946 there was a serious interest on a well running betatron at the Wool-wich Arsenal, and this not only for its application as an X-ray source. It is possible that some components of the 15-MeV betatron could have been used for other accelerator developments in the United Kingdom but there is no evidence for this.

Rudolf Kollath finally remained nearly a year in England. Later on he became Professor at the Johannes Gutenberg University in Mainz and wrote a well known textbook on particle accelerators [Ko55] which appeared in several editions, even in the DDR. Rudolf Kollath died in 1978 at the age of 78.

I do not have any information about the further activity or life of the multi-talented Theodor Hollnack, except his already mentioned meeting with Wideröe in 1947 in Waldshut near the Swiss-German border, when he tried to obtain some benefit from Wideröe´s original patents. According to Wideröe at that time he had already changed his name.

But I would like to add here a comment on Hollnack written by Jakov Lind in his already mentioned letter to me [Li94]: *"Who this man was or what exactly he did was always a little nebulous, but at no time (remember we are talking about the end of the war) did I have the impression I am dealing here with a man who believes in the Fuehrer or the Nazi philosophy. He might have done so at some previous period, after all millions of Germans did, but this was certainly not my impression. Could well be he was a greater believer when Wideröe met him first. That he thought I was the Dutch young man I claimed to be there is no doubt. That he would enrol a Dutchman, certainly not known for their love to the Third Reich, told me he didn´t care much for the same Reich either. But I repeat: At the end of the war there was hardly a Nazi to be found in Germany. I think there are more of them now in Germany among*

young and old than were at the end of 1944 and the beginning of 1945."

Instead some additional information is available on the further life of Jan Overbeek/Jakov Lind, Rolf Wideröe, Richard Seifert and Bruno Touschek. For the interested reader I report here shortly about them.

Jan Overbeek was again offered by Hollnack to stay with him. Overbeek refused and wrote as Jakov Lind some details about their separation [Li97]: *"Following good Prussian bureaucratic traditions Hollnack provided me with a note certifying that I was provisionally on leave but still in the service of the Ministry, which at the moment was perhaps still existing, but probably not".*

In some way Overbeek/Lind did not feel well any-more as *'assisting spy'* (as he called it). In his letter to me [Li94] he insisted that it was Hollnack himself who made him think that they were working as spies for the Allies. The brown envelopes which he carried around probably also contained technical information on the secrete betatron at Wrist and could have been perhaps first carried to BBC in Switzerland in the frame of Hollnack´s spy-work for the Allies.

As already mentioned, the rest of the life of Overbeek/Lind is described in a fascinating way in his autobiographic books and articles [Li97]. I summarize here only a few details.

After separating from Hollnack, Overbeek tried first to find a way to reach Holland or even Palestine to meet his parents. But emigration to Palestine was strictly limited by quotas. At the registration by the British military authorities he declared to be the Palestinian Jakov Chaklan, born in Haifa on February 10, 1927. The second name was a more or less Hebrew translation of his original name Landwirth he had invented.

He was then flown to Brussels and reached Amsterdam, where he found out that his former girl friend had already a relation with an English soldier. In some obscure way he succeeded in getting as illegal passenger on a ship leaving from Marseilles to Haifa where he arrived on July 25, 1945. He found his father and his sister in a kibbutz. His mother had died already in 1941. Initially he had no money and no job, and he had not learned any profession. After several attempts and jobs he finally decided to become a writer and perhaps even an actor.

But after some time Lind did not feel well in Israel any-more and he moved to Vienna, where among other activities he participated in the well-known Max-Reinhard-Seminar for actors. After several round trips through Europe he finally settled in London where he wrote in English several quite successful novels, theatre plays and productions for television. Very often his central argument was fascist terror and holocaust.

In 1994 I was in London and had a longish telephone call with Jakov Lind in which I was able to clarify and verify some details of his descriptions. A planned meeting could unfortunately not be realized. After 2003 Jakov Lind lived alternately in New York, London and Mallorca, was very active, occasionally visited Vienna where several of his books were reprinted by Picus-Publishers in the frame of the Austrian Exile-Library under the direction of Dr. Ursula Seeber. He also started painting, in particular aquarelles and had several exhibitions of his works. Jakov Lind died in London on February 17, 2007.

Richard Seifert´s well known company for X-ray apparatus and installations did not lose anything of its excellent national and international prestige during the war and afterwards could continue expanding and exporting all around the world. This was mainly based on Seifert´s excellent department of development which allowed him to present continuously new and innovative products on the market. Richard Seifert Junior continued successfully the pioneer work on applications of X-rays in medicine, analysis of structures and non-destructive analysis of materials started by his father.

Due to military service and to his engagements in the family owned enterprise, Richard Seifert Junior could not finish his studies at the University. In 1926 he became Junior-boss of the company and his father died already in 1929. So it came that after the war he was honoured with the title of Doctor Honoris Causa in natural sciences by the University of Hamburg and the same in engineering sciences by the University of Hanover. Already in 1947 he became a member of the Science Council of the Free and Hanseatic City of Hamburg. From 1958 to 1960 he was the president of this Council.

Among the many honours which Richard Seifert received I would

like to mention only a few. In 1960 he was awarded with the prestigious Roentgen Medal by the German Roentgen Museum in Reimscheid. By the way: With this badge were also honoured Helmuth Kulenkampff in 1965 and Rolf Wideröe in 1969. Seifert was a member of the "Society of Friends and Benefactors of the Roentgen Museum" and for one period its chairman. He became Senator Honoris Causa of the Technical University of Stuttgart and the first not-American member of the "Non Destructive Testing Society" NDT in the USA. On October 12, 1966 he was honoured with the "Medal for Art and Science" of the City of Hamburg.

Different parts of Richard Seifert´s Company were inconveniently dispersed around Hamburg. In 1966 Seifert decided to concentrate them all in a single new building in Ahrensburg near to the Hamburg border. Only the administration remained in Hamburg. At this time he had already the active assistance of his daughter Elisabeth, who, as already said, had studies law. She afterwards took over the direction of the enterprise and became President of "Rich. Seifert & Co", then in the frame of the AGFA-Gevaert Group, which in 2004 became part of "GE Measurement & Control Solutions". Richard Seifert Junior died in 1969.

Bruno Touschek, after his liberation by Hollnack who probably took him to Seifert´s home still in his jail dress, did also move to Kellinghusen. A curiosity: During his absence "in jail" his room in Kellinghusen was occupied by Wideröe´s friend Ernst Sommerfeld. In one of his letters Touschek mentions that he was very disappointed when Ernst decided to return to Berlin, with the last available transport (probably just before the arrival of the Sowjet troupes). In Kellinghusen Touschek received an offer to work as interpreter for the British troops, as Edoardo Amaldi reports [Am81]. He refused. It seemed to him much too dangerous, since at the time there were still some nonsense killings between the occupation troops and some fanatic country population.

After the 15-MeV betatron had been transferred from Wrist to England in 1945/46, Bruno Touschek in some way reached Goettingen. He had already been there in August 1944 and he knew that there another betatron had to be installed. This happened to be the 6-MeV betatron built by Konrad Gund at Siemens-Reiniger Company in

Erlangen. Senior physicist Hans Kopfermann (1895-1963) and (at the time) physics lecturer Wolfgang Paul (1913-1993) succeeded in having this interesting machine transferred from Erlangen to Goettingen, as I will still describe with some more details in the appendix.

Besides Kopfermann and Paul, Touschek came to know in Goettingen several other prominent physicists, like i.e. Richard Becket, Otto Haxel, Werner Heisenberg, Fritz Hou-termans, Ludwig Prandtl and Carl Friedrich von Weizsäcker

Under the direction of Richard Becker and Hans Kopfermann Bruno Touschek continued at Goettingen working on the theory of betatrons and wrote on this subject a Thesis to obtain the title of "Diplom Physiker". After this he got a position as Scientific Assistant at the Max-Planck-Institute in Goettingen, where he elaborated under the direction of Werner Heisenberg two theoretical subjects. The results were afterwards published ([To48] [To49], s. also [Am81]).

In February 1947 Touschek moved to Glasgow, where he had obtained a scholarship to study at the University. As a first step he worked for his degree of PhD under the direction of John Currie Gunn (1916-2002) and Rudolf Peierls (1907-1995). After this was successfully finished he was nominated "Offi-cial Lecturer in Natural Philosophy" at the University of Glasgow, a position he did hold until 1952. Working in Glasgow Touschek published results of several interesting investigations on theoretical quantum-physics and some on another field, the just appearing "synchrotrons" (a type of particle accelerators), with his friend Philip Ivor Dee (1909-1983). He also worked with the Viennese Prof. Walter Thirring (born 1927), who in 1950 was "Nuffield Fellow" in Glasgow.

In December 1952 Touschek moved to Rome attracted by a very active young group of theoreticians and by the personality of Professor Bruno Ferretti (1913-2010). In addition, in Rome was living his quite wealthy aunt Ada Vannini, who enjoyed spoiling him. Touschek soon was offered a good position at the „Istituto Nazionale di Fisica Nucleare" INFN directed at the time by Professor Edoardo Amaldi. In 1955 he returned to Glasgow to marry Elspeth Yonge [Am81]. They had two sons. Elspeth has carefully conserved over hundred letters of Touschek which now helped to clarify many aspects of Bruno´s life.

Touschek was very successful in Rome. He could publish many scientific papers and was allowed to teach at the University. His originality, enthusiasm and his extroverted character made him very popular. And many of his suggestions demonstrated later on to be quite brilliant ideas. End of the 50th I met Touschek several times. I was also working for the INFN. As already mentioned we also discussed with him about his activity in Hamburg and his conflict on patents with Wideröe (1943).

On March 7, 1960 Bruno Touschek gave a brilliant seminar talk at the "Laboratori Na-zionali di Frascati" (south of Rome) which made him very famous later on [To60]. He first showed which important results could be obtained investigating collisions of electrons with their antiparticles, the positrons. Since the two particles can annihilate each other in the collision, it remains a final state which is extremely interesting for further research work. Positrons can be produced by electrons of sufficient energy hitting a metal block (shower).

Now Touschek added in his talk a very risky proposal. Electron-positron-collisions could be practically realized in a single accelerator ring, in which bunches of electrons turn in one sense and bunches of positrons in the opposite, on exactly the same orbits. The accelerator-ring would be a special construction of the already known "synchrotron" which then would be called a "storage ring".

In this device electrons and positrons would have exactly the same energy and in their frontal collisions reach the maximum possible "reaction-energy", which is exactly what is required for further investigations, like the creation of new and unknown particles. From a theoretical point of view all this sounds quite realistic. And it corresponded exactly to the basic ideas which Rolf Wideröe had patented in Germany in 1943, against the explicit opinion of Bruno Touschek. Just that at that time the technique and the known accelerators would by far not be adequate.

The brilliant proposal of Bruno Touschek was the basic idea for many so called "electron-positron-colliders" which were built in the following decades and conducted to important discoveries in particular regarding the quark-structure of matter.

Already in 1956 there were in the USA projects to produce frontal

collisions of electrons with electrons circulating in two accelerator-rings mounted side by side, so to have the beams intersecting in one point [Ke56]. In principle exactly these devices were proposed in Wideröe´s patent. But Touschek´s idea of a single ring for electrons and positrons was by far more successful. By the way; Wideröe´s patent was completely ignored in all these proposals and only much later recognised as a predecessor. Patents are officially not accepted as scientific publications.

Bruno Touschek´s colleagues and his directors in Frascati were so enthusiastic with his idea that they immediately started to construct such a machine. It was called AdA for "anello di accumulazione" or perhaps following the first name of his preferred aunt. It was the first successfully operated apparatus of its kind. And Touschek had the pleasure to observe the visible light produced by circulating electrons stored in AdA.

Afterwards Touschek worked successfully on several subjects of theoretical physics and again contributed with particularly original ideas. He always remained enthusiastic with his communicative character. He did also spent some time at the European research centre CERN in Geneva.

Bruno Touschek was particularly active and creative under the influence of alcohol. On the long run his liver was not able to withstand this lifestyle and on May 25, 1978 Touschek died in Innsbruck.

Rolf Wideröe´s life after the War was rather complicated. As already mentioned he arrived back to Oslo probably in April 1945. In May of that year the German troupes retired from Norway. On May 9 the leading collaborator Vikun Quisling surrendered to the Norwegian police. One day later Wideröe was anonymously denounced to the police. He allegedly should have participated in Germany on the development of the V2-rockets, which meant that he had worked "for the enemy". As a consequence he was arrested on May, 23. As it was soon clear, the allegations were false, but Wideröe was kept in jail until July 9, 1945. He used this time to write a report on the betatron. However, under these circumstances he was dismissed by his employer NEBB and remained for a longer period unemployed. At home he

developed the theory of a new type of accelerator which, as already mentioned, corresponded exactly to the "synchrotron" which was proposed at the same time in USA and in the Soviet Union. But Wideröe submitted his ideas as a patent in Norway (in January 1946), a fact which was for a long time ignored in the scientific world.

Following a suggestion by his former director at NEBB, Wideröe contacted again the mother house BBC in Switzerland and offered to continue there his work on the construction of betatrons. His proposal was also supported Paul Scherrer (1890-1969), Professor at the Swiss Federal Institute of Technology ("Eidgenossische technische Hochschule") ETH in Zürich, who was a good friend of Walter E. Boveri, the last one carrying the name of one of the founders of the enterprise BBC in 1891, which were Charles E. L. Brown and Walter Boveri.

But building betatrons with Wideröe was anyway quite obvious to BBC since he had a leading roll on the proposal for a 100-MeV betatron and later on for the design-work of a 200-MeV betatron which had been assigned to BBC-Mannheim by Richard Seifert on behalf of the Luftwaffe. We can also assume that the folder with documents on the 15-MeV-betatron which disappeared at C.H.F. Müller ended up at BBC. Hollnack, his working-group "Dillenburg" and Richard Seifert were obviously in close contact with BBC-Mannheim. The fact that the American expert Herman Kaiser of the US Naval Research Laboratory was allowed immediately after the war to see all documents and design drawing for betatrons at BBC-Mannheim can suggest that Hollnack contacted the Allies through BBC-Germany and perhaps also BBC-Switzerland.

It was only in the spring of 1946 that Wideröe was allowed to travel to Switzerland to BBC for a few weeks. Here he immediately started working on the design of a betatron for medical and technical applications. The experience gained with the 15-MeV and later on with the 100 and 200- MeV projects did show that a 31-MeV betatron would represent an optimal choice for the envisaged purposes, taking into account performance, size and costs of the machine. Wideröe had already worked out with the engineers of BBC in Mannheim, a particularly economic design for a betatron-magnet which had first four

and finally six return yokes, instead of only two as it was on the original Hamburg machine.

Drawings for the construction of a 31-MeV betatron were already completed when Wideröe started in his new leading position at BBC-Baden on August 1, 1946. He was completely free in his decision regarding the development of the 31-MeV betatron. His family could soon follow him to Switzerland.

In October 1946 Wideröe was asked to return to Oslo to clear up his position in a judicial hearing. There were at the time a lot of fanatic resentments in Norway as a natural consequence of the atrocities committed during the German occupation. So it also happened that several extremely patriotic Norwegians tried to find out and collect new arguments against Wideröe.

Already a year before, in November 1945, an experts committee had been nominated in Oslo to judge Wideröe´s activity during the War. Chairman was the well known theoretician of the University of Oslo Prof. Egil A. Hyl-leraas (1898-1967), famous for his extension of quantum theory to helium atoms. The other members of the committee were: Gunnar Randers (1914 –1992), Roald Tangen (1912-1997) and Harald Wergeland (1912-1987).

In 1993 the only survivor of the four was Roald Tangen and I had with him an interesting exchange of letters [Ta93]. By the way, Tangen was the same who gave the seminar in 1941 which induced Wideröe to start again working on betatrons. Tangen assured me several times that the first concern of the committee consisted in demonstrating with their exposé that Wideröe had nothing to do with the development of the V2, as it was initially assumed. And this was successfully shown. On the other side the Committee made very negative, partially wrong and quite unfair statements about the scientific work of Wideröe. This was critically discussed by Prof. Tor Brustard in 1997 [Br97]. Anyway this exposé was not taken into account by the judging authorities later on. A copy of the exposé signed by the authors is conserved at the Norwegian National Archives (“Riksarkivet”) in Oslo [Hy46].

After the V2-question was cleared up, there still remained three smaller points for an accusation against Wideröe which were specified

in a “proposal” (a “Forelegg”) presented to Wideröe by the police authorities:

(a) In April 1941 Wideröe published an article in a journal in which he objected to the bombing of German cities by the Allies.

(b) In May 1942 Wideröe made a donation of 80 Norwegian Crowns to a pro-German organisation

(c) From October 1943 until April 1945 Wideröe worked as engineer for Germany, including the permission to use his patents for the construction of a beam-transformer for which he received an equivalent of 140.000 Norwegian Crowns.

In the same “Forelegg” the police authorities proposed to Wideröe to pay a fine of 5.000 Norwegian Crowns to the State Administration. In this sum it was already taken into account that he had been in jail for 47 days. In addition he was asked to recognise the following:

1. He lost the right to vote in all public matters.
2. He lost the right to serve in the Norwegian Army.
3. He would pay back the “illegally” earned patent-rights of 120.000 Norwegian Crowns.

Wideröe was under time pressure. He wanted to return as soon as possible to his working place in Switzerland. On the other side he also had to take into account that in a full legal proceeding the result could be even much worth than the agreement offered in the “Forelegg”. After consulting with his lower he decided to agree to the “Forelegg” and signed it on November 2, 1946. This original document is conserved in the Norwegian National Archives. The ink had gone through the paper making it difficult to read. Archivist Mr Ole Kolsrud did kindly send me a copy [Wi46a] and explained to me in an attached letter (in German) the legal situation:

“Hereby it is to remark that the money-fine which Rolf Wideröe accepted on November 2, 1946 was the result of a legal process, which means, a judgement. This judicial decision is based on the three points mentioned in page one.

Instead of an official judicial procedure which would end with a judgement, in the Norwegian judicial praxis a fine which the accusing

authority proposes, is accepted as such if the case is not particularly serious and the accused agrees to it."

After this Wideröe was a "free men", a fact which he often exaggeratedly enhanced as "fully absolved" ("Freigesprochen" in German). But in reality the situation should be interpreted as Archivist Ole Kolsrud made it clear to me. I would like to add that Wideröe´s wife Ranghild, listening to Rolf´s autobiographic descriptions, had also called my attention on his misinterpretation of the situation.

Anyway Wideröe´s activity in Germany was judged in the "Forelegg" very carefully as "illegal" and not as "treason to his country", which would have been possible.

Wideröe was always proud of being a Norwegian citizen, I would even say that he was a patriot and perhaps even a nationalist. The fact that he liked Germany and the Germans is certainly also true. But he accepted in 1943 to come to Germany, eventually to help his brother Viggo and to build a betatron, a device for which he did never see any military application, even being financed by the Luftwaffe. He never was enthusiastic for Hitler and for the Nazi-regime. This was why he left Germany in 1932.

The proposed "judgement" accepted by Wideröe a bit in a hurry had never been revoked or revised, according to my knowledge. This fact was much regretted by several of Wideröe´s admirers, like i.e. Dr. Olav Aspelund of the University of Oslo. They tried to obtain a reopening of the judicial case [As93], without any success.

But Wideröe did not have only friends. As he assumed by himself, these took care among other things, that he had never been proposed for the Nobel Prize. There were not only political arguments against him, but also scientific, as it was already noticed (in an exaggerated way) by the experts committee in Oslo in 1946. An inspection of the list of more than 100 allegedly "scientific publications" presented by Wideröe in 1994 [Wi94] shows that only a few of them would be considered as such in the usual sense, that means, that they would have been accepted for publication by a specialised journal after careful inspection by competent experts. Many of the publications of his list are just written versions of his talks, printed under his own responsibility.

Wideröe´s geniality and his original achievements are located mainly

in the domain of technology and inventions, which is best expressed by his more than 200 patent registrations. However, patents cannot substitute scientific publications and in general are not accepted as such. In this sense the exaggerated negative judgement of the Norwegian experts committee of 1946 must be interpreted. On the other side, it must also be taken into account that developments made in the locations of industrial enterprises are first of all registered as patents. As scientific publications they would be available free of charge to their competitors.

Many other well known physicists, as i.e. the Norwegian Björn Wiik, later on director of the Research Centre DESY in Hamburg, often remarked their disappointment regarding the fact that Wideröe never got the Nobel Prize, which he would (in their opinion) have certainly deserved. As already mentioned Prof. Tor Brustard of the Radium Hospital Oslo published a very positive judgement of Wideröe´s activity in the journal "Acta Oncologica" [Br97]. Per Dahl, the sun of Wideröe´s friend Odd Dahl also published a very prising article on Wideröe [Da92]. And there are many other scientists which highly appreciated Wideröe and made him famous worldwide as the grandfather of particle accelerators. Wideröe became also famous for his contributions to medicine. There is no doubt that it was an extraordinary and genial person on which Norwegians should certainly be very proud.

Finally Wideröe was allowed to return permanently to BBC in Switzerland in November of 1946, where he successfully directed the construction of a series of 31-MeV betatrons, mainly for use in hospitals but some for materials testing in industry. Later on he also built a 45-MeV betatron. Under Wideröe´s direction about 86 betatrons built at BBC were installed worldwide. They can be in principle considered as improved successors of the original design of a 200-MeV machine which had been commissioned at BBC-Mannheim by Seifert on behalf of the Luftwaffe. Later on Wideröe collaborated with physicist of the University of Torino in the development and construction of a combined beta-synchrotron which was successfully operated at 105 MeV in 1959 [Go64].

According to Wideröe more than 200 betatrons were built worldwide. After 1970 smaller and cheaper linear accelerators (also

called “linacs”) came up and dominated the market. Wideröe, who did successfully run the first linear accelerator in 1928, could not follow these developments at BBC. However, several letters with Ernst and Arnold Sommerfeld demonstrate that he had been seriously thinking in this direction [Wi48].

As a comparison: Until 1993 there were already 3.500 handy linacs installed worldwide, half of them in the USA. They have the form of a tube and need no iron yoke. With a length of less than one metre they provide electrons with up to 20 MeV. They are mainly used for medical applications where higher energies are in general not required.

Linear accelerators for electrons have been developed for much higher energies. The “Stanford Linear Accelerator” in the USA reached an energy of 5.000 MeV or 50 GeV (Gigaelectronvolt). There are projects for machines with a length of 15 to 30 km length which can reach 200 to 500 GeV. They are designed for basic research. Other developments are used for practical applications. More information can be obtained from DESY [TE00].

From December 1953 on Wideröe lectured at the famous Swiss Federal Institute of Technology ETH in Zürich. In 1962 he was nominated “Titularprofessor”, a position he kept until 1972. For several important accelerator projects at CERN and DESY Wideröe was called in as adviser. His contacts within medical circles carried him to investigate processes related to radiation therapy. He developed a remarkable “two components theory” for the effects of radiation on living cells (see i.e. [Wi90]). For his activity in medical applications he obtained in 1964 the title of “Dr.med”. Honoris Causa” of the University of Zürich. Already in 1962 he had been promoted as “Dr. Honoris Causa” by the RWTH Aachen University. Besides many other distinctions he got two Roentgen-Medals in 1969 in Remscheid and was honoured with the Roentgen Prize in Würzburg in 1971. In 973 he finally was also accepted in Norway and became a member of the Norwegian Academy of Sciences.

Rolf Wideröe died on October 11, 1996 in Nussbaumen (near Baden, CH).

At this point I finish my report on betatron developments known to me, which were started during the Third Reich and officially justified as

‘important for war applications’. For completeness I still add in an appendix a short description of the betatron developments for medical applications performed at Siemens Company which to my knowledge did not have any direct relation to war applications.

——— End of chapter 7 ———————————

Appendix:

Max Steenbeck and Konrad Gund´s 'Electron-Catapults'

In 1944 Walter Gerlach became the successor of Abraham Esau as "Commissioner for Nuclear Physics Research" within the "Research Council of the Reich" ("Reichsforschungsrat"). In summer 1944 the direction of this institution issued (under the responsibility of Gerlach and among many others) three quite particular orders (with very high priority) to Dr. Max Anderlohr, director of the Siemens-Reiniger-Werke in Erlangen, as it was reported by Maria Osietzki in a very interesting and accurate research on the developments of the first particle accelerators done at Siemens 1935-1945 [Os88].

Gerlach´s three orders for Siemens were:

1. *Construction of an electron-catapult* (betatron) *for 5 million Volt.*
2. Research and development for the construction and delvery of an electron-catapult for 20 to 25 million Volt.
3. Planning and peliminary design work for an electron-catapult for 100 million Volt.

This was confirmed to me by Edgar Swinne based on his extesive archives [Sw93]. He had already reported to me about Gerlach´s interest on the work of Schmellenmeier and Gans, as it was described in chapter 3. Swinne called my attention on Gerlach´s budget for nuclear research for the administrative year 1944/45 (!) which consisted in more than 3 million Reichsmark and was explicitly authorized and signed by Göring. Money obviously was no problem.

With the three mentioned orders Gerlach probably wanted to

encourage Siemens in their developments of betatrons. Siemens had already started work in this direction under their own responsibility (and financiation) in 1941, only a few months after the publication of Kerst´s reports on his first successful betatrons [Ke41b] in the USA. And a betatron for 6 MeV built by Gund in Erlangen had just started operation in April 1944. Siemens considered it interesting for future applications in medicine.

With these investments and many other developments financed at the time by Gerlach´s organisation he obviously had already in view the time after the war. He did not believe at all in war applications like the death-rays or similar proposals which anyway could not change the course of the war anymore.

As already mentioned, Siemens company had already started much earlier activities on the field of betatron-developement which they called "electron-catapults" or "electron-centrifuges" ("Elektronenschleuder"). They considered them as a German invention, since physicist Dr. Max Steenbeck (working for the Siemens-Schuckert-Werke in Berlin Siemensstadt) in collaboration with his senior chef Dr.-Ing. Dr.-Ing. hon. causa Reinhold Rüdenberg (1883-1961) had already submitted a patent on the subject on March 1, 1933 [Ru33].

Physicist Rüdenberg was well known in the thirties as one of the pioneers of the development of electron microscopes [Ru94]. Already before he was considered an authority in the field of electrical high-current technology. I came to know about these during my talks with Rolf Wideröe, who showed me a book on protection-relays published by Rüdenberg in 1929 [Ru29]. Wideröe was working for AEG on such relays while Rüdenberg was at Siemens. So Wideröe never came to know Rüdenberg personally, but appreciated very much his work and his ideas.

Rüdenberg descended from a Jewish family and his son Gunter Rüdenberg kindly send me a letter from the USA explaining the fate of his father during the Nazi-time [Ru95]:

"My father left Siemens in 1936. As he registered in his calendar he left Berlin on April 2, 1936 and renounced to his position at Siemens in a letter sent only a few weeks later from

London. As it was done for many others, Siemens did send him (to England) *in a normal travelling commission and so he could cross the German border controls without problems."*

This is the reason why in the German patent with Steenbeck, which was published on February 4, 1939, Rüdenberg is mentioned with his address in England.

Rüdenberg did not participate in further patents submissions on betatrons for Siemens. Without him Steenbeck submitted already in March 1935 patents in Germany and also in Austria [St35], and in March 1936 in the USA [St36].

More details about all these were reported by Max Steenbeck in an interesting autobiographic book [St77], which however was politically and philosophically strongly influenced by the fact that it was written and published in the German Democratic Republic (GDR). Therefore some of his comments (in particular regarding Siemens Company) appear quite negativ.

Max Steenbeck was born on March 21, 1904 in Kiel where he studied physics. From 1927 on and up to the end of the War he worked in the research department of the already mentioned Siemens-Schuckert-Werke in Berlin-Siemensstadt. Here he was also allowed to finish his PhD-thesis.

Already in 1927/28 Steenbeck had developed the basic ideas for an accelerator which corresponded exactly to the "Cyclotron" proposed in 1931 by Lawrence. And he also sketched the first ideas for a later on called "Synchrocyclotron". Encouraged by his colleagues at Siemens he wrote all this down in a report which he wanted to publish in the journal "Naturwissenschaften". Due to a misunderstanding with his boss Rüdeneberg (who had asked him for a discussion of his ideas) the paper was never published.

In 1934 Steenbeck had already seen the PhD-thesis published in 1928 by Wideröe and included in his patents the conclusions to which Wideröe had arrived. Wideröe had also tried to submit his ideas as patents in 1929 but did not care about it in the following years, as he was working on a completely different subject (relays).

In his patents Steenbeck included the most important condition which the magnetic field of the accelerator must fulfil in order to stabilize the

electrons on their circular orbits. He deduced himself this stability condition and it is frequently mentioned in combination with his name. Wideröe did not mention this condition in his published thesis and therefore (and for several other reasons) the "betatron" he tried to built in Aachen would have never worked. But already in 1925, in his notebooks, Wideröe mentioned a useful stability condition, which (strangely enough) he did not take into account in the appendix to his thesis.

As Steenbeck realized much later, this important stability condition for betatrons had been already deduced (in an even more general form) by the British physicist Ernest T. S. Walton (1903-1995) in 1929 and published in a quite complicated mathematical form [Wa29] which was not easy to understand. By the way, the suggestion to work in this direction came from Lord Ernest Rutherford (1871-1936). Walton also started some experimental work on betatrons which however was not successful.

According to Steenbeck, the interest of the Siemens directors on his patents consisted mainly in the possible writes which they could ask for their use in form of licenses. At the beginning they were not willing to start complicated and expensive experimental developments by themselves. They would rather prefer that others start such experiments and they would need in any case to pay for the licence to use Steenbeck´s patents.

However, finally Steenbeck got a rather modest order (or permission?) to develop a test-model of an "electron-catapult" for 6 MeV with the restriction to keep it absolutely secret. He was only allowed to speak about it with selected Siemens staff members. It was obviously forbidden to him to publish any of his results or to present them in talks, seminars or physics meetings. These restrictions made his work quite difficult. Since he was a perfectionist (his words) his apparatus resulted somewhat too complicated. He could accelerate electrons up to 1.8 MeV, but with very low intensity.

In the course of German rearmament Steenbeck had to dedicate increasingly more time to research work for military purposes and when the War started in 1939 the Siemens management decided to stop

completely all activities for the electron-catapult. Steenbeck obviously was not at all happy with this decision.

One year later Donald Kerst performed his first successful betatron experiments at the University of Illinois. He described shortly some of his results in November 1940 as a letter to the editor of the Physial Review [Ke40a] and as a comunication to a conference [Ke41a]. These publications seem to have been practically ignored in Germany. The General-Electric Group had already substantially supported Kerst´s work at the University and so Kerst submitted on Nov. 13, 1940 a patent in the USA for General Electric [Ke40b] which was astonishly similar to Steenbeck´s ones. In 1941 Kerst started a sabbatical year at the University and used it to work for General Electric. There he built with W.E. Westendorp a 22-MeV betatron [Ke42].

At that time the USA were not yet in war with Germany and they kept some commercial relations. Evidently General Electric had already realized that betatrons could be used for practical applications (particularly in medicine) and wanted to avoid any problems with Siemens. As Hermann F. Kaiser reports (without mentioning any source [Ka47], p. 2), General Electric (USA) had already asked in 1941 for a licence to use Steenbeck´s patents and that Siemens agreed to this just before the USA declared war to Germany.

A different version is given by Max Steenbeck in an article published in 1964 [St64]. There he claims that the licence was given to Westinghouse in 1941 and that Kerst, knowing the patent, reached his goal with a less “perfectionistic” but essentially better apparatus. In his autobiographic book ([St77], p. 118) Steenbeck mentions the license without specifying the USA company. But he remarks that the licence was given the day before the Japanese attack of Pearl Harbour, which was on Dec. 7, 1941.

Anyway, this licence agreement did not have any practical consequences since immediately after the War all German patents were temporarily confiscated by the Allies. When later on they were given back to Germany, many of them had already expired (after 20 years). In this context Wideröe reports that on November 18, 1954 he was present at a judicial case in Mannheim and Karlsruhe in which BBC-Baden (CH) was condemned to pay to Siemens about 100.000

Marks for the use of their still valid patents ([Wa93], p. 167). This was possible because Siemens had registered several additional patents up to the end of the War, which were still valid. They were considered as "very interesting" in Kaiser´s report ([Ka47], p. 15-16). He mentions that they contained 14 important technical ideas which were explicitly patented.

In the course of the year 1941 the results on Kerst´s successfully run betatrons in the USA [Ke41b] were known in Germany. The possible applications of such a small, handy and relatively cheap machine (to produce very high energy electrons) could be easily recognized. This time Siemens did not hesitate. After solving some internal problems (see [Os88]) and following a suggestion of Max Steenbeck, the X-ray specialist Ing. Konrad Gund (1907-1953), who was working in the laboratories for electro medical applications of the Siemens-Reiniger-Werke in Erlangen, elaborated a proposal for a 6-MeV betatron [Ka47]. He could obviously take into account the known results of Kerst and was soon put in charge of developing and constructing such a machine. Siemens had abandoned all kinds of secrecy and Steenbeck was allowed in March 1943 to report about this activity, including his results of 1935, in the journal "Naturwissenschaften" [St43].

Konrad Gund came from Vienna, where he had studied electrical engineering ("Diplom Engineer") at the Technical University. He started working in a section for medical applications of the "Siemens Werke" in Vienna and in 1936 moved to the Siemens-Reiniger laboratories in Erlangen. *"There the extraordinary ability of Gund, in particular for theoretical design tasks, was soon recognized and in 1942 he was put in charge of developing the electron-catapult for medical applications"*, as Hans Kopfermann (1895-1963), professor at Göttingen, wrote about Gund whom he new very well.

Gund´s "electron-catapult" was planed with completely different requirement than the "beam-transformer" of Wideröe. While Wideröe, perhaps influenced by the intentions of Schiebold, Seifert and Hollnack, designed his betatron mainly for the production of very high energy ("hard") X-rays (for materials testing and perhaps utopic war-applications), Gund was completly concentrated on medical applications,

as it was planned by the Siemens manegement. And here, besides the use of hard X-rays, the use of external electron beams was essential.

Wolfgang Paul described accuratelly the requirements for the design of the Siemens "electron-catapult" in a report published in 1947 (see [Pa47], p. 51):

The following criteria were relevant for he construction:

1) The electrons should be able to leave the vacuum vessel after the end of their acceleration. This requires that the electron source must be located inside the nominal circular orbit of the electrons.

2) It should be possible to select arbitrarily the final energy of the electrons up to their higest value.

3) To allow for easy variations of all parameters during the tests, the vacuum vessel, ncluding the injector and the anticathode, shold all be easily accessible

I discussed the matter with Wolfagang Paul (at the time chairmen of the DESY-directorate) and he did send me later on a letter [Pa93] with some additional information about the electron-catapult of Gund (see original German text in [Pa79], p.191/192):

"... The 5-MeV accelerator was constructed by Konrad Gund at Siemens in Erlangen. Gund was electrical engineer and had very little experience with physical experiments. My teacher Hans Kopfermann and I, we were working on problems of optical hyperfine structure to measure nuclear momenta, spins and magnetic moments. We also tryed to obtain information about the charge distribution inside the nucleous from the isotopic displacement.

Towards the end of 1942, when we read about Don Kerst´s results on the Rheotron (Betatron) in one of the last issues of the "Physical Review" arriving from the USA to Germany, it immediately became clear to us, that we could reach our goals much better scattering free electrons of high-energy on nuclei. So we planed to construct such an accelerator as soon as the war or the political situation would allow to do so.

When we heard that Siemens was already building an "electron catapult" for medical applications, we offered our help to test the new

machine. I started learning the required impulse-electronic and some nuclear physics and we mounted the required apparatus in Goettingen. During the summer of 1944 I started first measurements in Erlangen: The time structure of the X-rays produced in an internal target, the angular distribution and the energy of the electrons, both from their range and using photo-effect on beryllium and deuterium.

With the arrival of the US-troupes in 1945 the apparatus was confiscated and should have been destroyed. Kopfermann and I, we ware able to avoid this with the help of he British military administration. The controlling officer was Roland Fraser, an senior physicist specialized molecular beams who had studied with Otto Stern in Hamburg. In 1947 the betatron was finally transported to Goettingen.

We obtained a work-permission under the condition to perform essentially research on radio-biology and radiation-therapy. Nuclear physics was forbidden. So I started collaborating with H. Schubert from the hospital for women. Schubert had worked with Rajewski in Berlin and during the war at the cyclotron in Paris. Later on he was lecturer at the women's hospital in Hamburg. During our time we made about 10 investigations on biologic subjects and several on therapy of skin-tumours. In addition we investigated the energy-loss of electrons, systematic measurements of multiple and single scattering of electrons and also on the splitting of deuterons by electrons."

These words of Paul demonstrate that Gund´s betatron was not only the first operational one in Germany but also the first one which was used to perform scientific research wok. The initial goal to extract electrons from the machine was realized in1947 [Gu49]. But the machine did run astonishingly stable and reliable, a fact which was explicitly confirmed by Kaiser in his report [Ka47].

Research activity on Gund´s betatron in Goetting ended in 1952, when Pual left to become Professor and Director of the Physics-Institute at Bonn University. Paul still reports that after 1960 the betatron was exposed in the Smithsonian Museum in Washington. Today it can be admired at the Deutsches Museum in Bonn [DM02] as a loan of the Siemens-Museum in München.

Regarding the technique, Gund´s betatron included many very

original details. The vacuum tube could be easily opened. It was made of several parts of hard ceramics (Kaiser mentioned “Kallait”) which were pressed together with adequate rubber seals. The operating frequency was 500 Herz (Kaiser reports 550 Herz). The whole apparatus had a weight of only 700 kilogram, had a width of 65 cm and was 50 cm high. Additional details can be found in the reports of Wolfgang Paul [Pa47] and Herman F. Kaiser [Ka47]. As originally specified, the electron source was placed inside the ring, to make the extraction of the electron beam easier. As already reported, this was realized only a few years later [Gu49] [Gu50].

In November 1944 Rolf Wideröe visited the laboratory of Konrad Gund in Erlangen. As he told me for his biography in 1993, he was still convinced that Gund´s machine would never work properly for several reasons. So i.e. he considered the vacuum-chamber as not reliable enough and the used frequency of 550 Herz as too high. He preferred lower frequencies (50 Herz) and it seems that he convinced the Erlanger specialists on the advantages of lower frequencies. The next 5-MeV betatron of Siemens (probably it was the one ordered by Gerlach) was designed for a frequency of 50 Herz.

Bruno Touschek did not take Wideröe´s critical remarks very seriously and at the beginning of 1946 (after the 15-MeV betatron had been transported from Wrist to England) he moved to Göttingen, where he was able (as already mentioned) to continue working with the 6-MeV betatron built by Gund and write his thesis for he qualification as “Diplom Physiker”.

After the War Max Steenbeck moved in a very adventurous way to Moscow where he was “engaged” for 11 years, mainly to work on the separation of uranium isotopes. He returned to Germany (GDR) as a convinced communist. As such he judged (in his autobiographic book [St77]) his pre-War activity at Siemens Company in a very critical way. he was nominated Professor at Jena and was successfully active in several fields like cosmic magnetic fields, plasma physics, solid state physics but mainly on nuclear physics arguments. He had in the GDR a good reputation as scientist and a good position, was a member of the Academy of Sciences of the GDR, of the Research Council of the

Box 9

The 6-MeV-Betatron of Gund

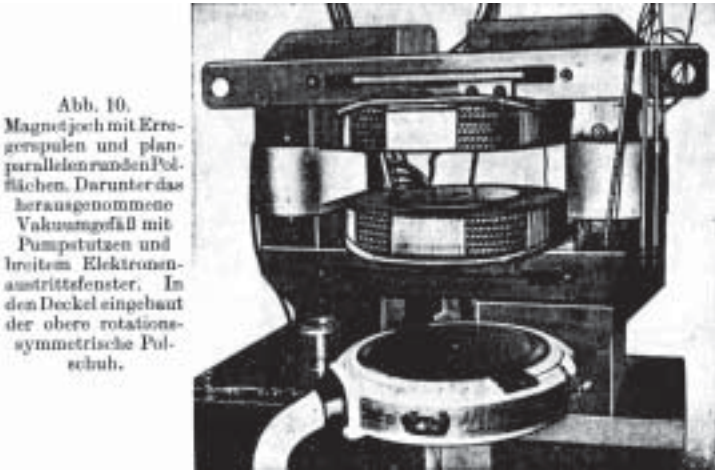


Abb. 10. Magnetjoch mit Erregerspulen und planparallelen runden Polflächen. Darunter das herausgenommene Vakuumgefäß mit Pumpstutzen und breitem Elektronenaustrittfenster. In den Deckel eingebaut der obere rotationssymmetrische Polschuh.

The iron yoke has a width of 65 cm, is 50 cm high and has a wiegth of 272 kg. On top an illustration from W. Paul und H. Dänzer [Pa47]. Bellow the 6-MeV-Betatron as exposed in the Deutsches Museum Bonn, loan from the Siemens-Museums München.

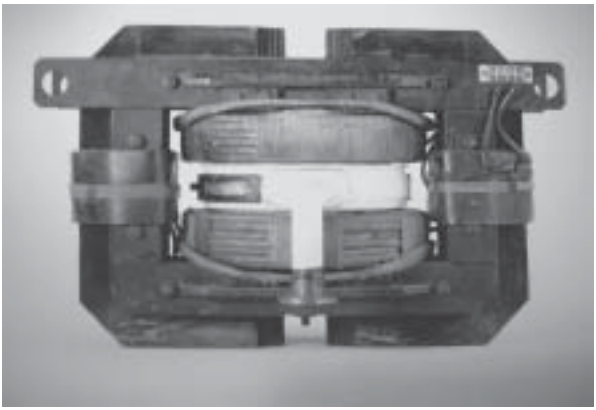


Foto Hans-Joachim Becker, Deutsches Museum.

GDR and of the Committee for European Security and Collaboration of the GDR. In 1979 his 75th birthday was celebrated with a Scientific Colloquium [Ro79]. Max Steenbeck died 1981 in Berlin (East).

After the War Konrad Gund continued to work for Siemens-Reiniger in Erlangen and colaborated in many investigations done with the 6-MeV betatron [Gu50]. As Wolfgang Paul reported, Gund was also able to fulfil one of his youth dreams and obtained in 1946 at the University of Gottingen his doctor-degree [Gu46]

In 1949 Gund took over the direction of the design office of the Siemens-Reiniger factories in Erlangen. He continued bilding betatrons, the last one for Kopfermann, which went successfully in operation afteros Gund´s geath. Gund suffered from deep depressions which he survived thanks to the care of his wife. In one of these attacs in 1953 he finally suicided. His wife followed him. Gund´s life and merits were described in in a detailed obituary by Hans Kopfermenn [Ko53].

Gund´s 6-MeV betatron and Wideröe´s 15-MeV one were the only two accelerators of this type which were successfully put into operation before the end of the War in Germany. Of the small 1.5-MeV Rheotron of Schmellenmeier apparently only a few sample components of the magnet were made. Of the 200-MeV betatron to be built at BBC Mannheim under the direction of Wideröe only intersting design drawings were completed.

However, as Wolfgang Paur reports [Pa47], after 1941 there were also plans to construct a 10-MeV betatron proposed by Walter Bothe (1891-1957), professor in Heidelberg and Hermann Dänzer (1904-1987) professor in Frankfurt. In the second part of the already mentioned report published by Paul [Pa47], Dänzer included an accurate treatment of the theory of the betatron.

—— End of Appendix

Chronology

Some historic events are included as interesting references and there is no claim for completeness.
Additional chronological data related to Rolf Wideröe´s life can be found in his autobiography [Wa07].

Year-Month-Day	
1895-11-08	***Röntgen*** discovers X-rays.
1896…	Seifert ***and*** C.H.F. Müller ***(independently) start producing X-ray devices in Hamburg***
1901-1904	***Tesla*** builds in Long Island a 60 metres high tower to test his utopic ideas on energy transmission.
1908-12-30	***Gans*** is nominated Extraordinary Professor at the University of Tübingen.
1909	***Gerlach*** is a student of ***Gans*** in Tübingen and soon becomes an assistant of *Paschen*. *Gans* and *Gerlach* became good friends.
1912-03	***Gans*** is nominated Professor and Director of the Physics-Institute in La Plata (Argentina)
1919-06-27	***Schiebold*** graduates at Leipzig-University (thesis on crystallography) [SE19].
1922-04-01	***Slepian*** (Westinghouse) submits a patent in the USA on an “X-Ray Tube” [Sl22]. First known proposal for a rudimental betatron principle. Published on Oct. 11, 1927.
1923	OPTA-Radio history: *Siegmund Loewe* and his brother *David Ludwig* start a successful industrial group, later known under different names: Loewo/Löwe/OPTA (radio valves, television etc).
1923-03-15	*Wideröe´s* first (preserved) notes in a copy-book including a sketch for a betatron [Wi23]. Several copy-books followed with additional details [Wi23].
1924	***Grindell-Matthews*** presents his “death-rays” in England.

1924-03-12	*Ising:* First known proposal for the acceleration of particles using a sequence of drift-tubes [Is24].
1925-01	*Gans* returns from Argentina and is nominated Professor and Director of the Physics-Institute at the University of Königsberg.
1925-Autumn	Wideröe *proposes a thesis to obtain the "Dr.-Ing." degree. Subject: the "beam-transformer". It is rejected by vacuum specialist Prof.* Gaede *(Karlsruhe).*
1926-04-01	Schiebold *is nominated Extraordinary Professor at the University of Leipzig.*
1926-05	*Rogowski* accepts *Wideröe´s* proposal for a "Dr.-Ing." diploma thesis. He is allowed to construct a beam-transformer at the Aachen University (RWTH) which however did not work.
1927-10-11	Slepian´s *US-Patent "X-Ray Tube" is accepted and published.*
1927-Autumn	*Wideröe* changes over to building a small linear accelerator following the ideas of *Ising*. He succeeds in accelerating ions to 50.000 Volts, having only 25.000 volts at his disposal. It was the first drift-tube linear accelerator (linac) ever operated successfully.
1927-11-28	*Wideröe* obtains his "Dr.-Ing."-diploma at the RWTH Aachen. Main subject is the linear accelerator. But he includes a description of the betatron-principle including the important "2 to 1 relation" which later on is associated with his name [Wi28].
1927	*Breit* and *Tuve* (Carnegie Institution USA) perform interesting tests with a simple betatron [Br27]. Their efforts are not successful, but very promising.
1928	*Wideröe´s* Dr.Ing.-thesis is published [Wi28], English version in [Li66].
1928-03	*Wideröe* develops long-distance relays at AEG-Berlin. Until the end of 1932 he submits 42 patents in Germany and 2 in the USA.
1929	Schiebold *and* Eggert *start the "German Union for Materials Testing in Technology" ("Deutscher Verband für Materialprüfung der Technik"). Until*

1938 six volumes with reports of meeting are published.

1929 *Gerlach* is nominated Professor in München, following a suggestion of *Arnold Sommerfeld*.

1929-06-17 *Walton* (Dublin) publishes theoretical computations on the stability of orbits of electrons in induction accelerators [Wa29]. Very accurate, but difficult to understand. Experiments at Cambridge with a simple betatron and a linac are not successful.

1930 *Breit, Tuve, Hafstad and Dahl* (Carnegie Institution, Washington) construct interesting high-voltage devices based on the principle of Tesla-coils.

1931-01 Lawrence´s *short communication to the US-Physical Society about the successful operation of his 13 cm Cyclotron (80 keV). He was inspired by Wideröe´s PhD-thesis.*

1931 Lawrence and Sloan *built a linac following* Wideröe´*s example, but with 15 drift-tubes. He reaches 1.26 MV.*

1931 Van de Graaff *presents to the US-Physical Society his first electrostatic Voltage generator using a silk-band [Gr31]. He reaches 1.5 MV. Similar apparatus were soon built.*

1932 Cockcroft and Walton *succeed in obtaining first nuclear disintegrations using artificially accelerated particles. They used a 400-kV cascade generator (later on called* "Cockcroft-Walton"*).*

1932 *A few months later* Lawrence *succeeds the same using his 1.2-MeV cyclotron.*

1932-12 The 69-cm-cyclotron of *Lawrence* goes into operation (4.8 MeV).

1932-12 *Wideröe* moves from Berlin to Norway.

1933-01-30 *Hindenburg* nominates *Hitler* "Reichskanzler".

1933 *OPTA-Radio history:* David Ludwig Loewe *must leave Nazi-Germany f****or racial reasons. His brother*** Sigmund ***still stays until 1938.***

1933-03-01 Rüdenberg and Steenbeck ***(Siemens-Schuckert-***

	Werke, Ber-lin) submit a first patent regarding betatrons. They define a stability condition [Ru33].
1933-04-01...	*Wideröe* constructs relays for the protection of power lines at N. Jacobsen Company in Oslo. Until 1937 he registers 10 Norwegian patents.
1933-04-07	*German law excluding Jews from state-positions.*
1933-05-01	*Schiebold* becomes a member of the NSDAP (Nazi-party) and later on, also of the Nazi´s-Teachers Union ("NS-Lehrerbund").
1934	*Tesla* presents his "death-rays" to the press in the USA.
1935	*A proposal is discussed in England to investigate the possibility of using strongly focussed electromagnetic radiation against attacking enemy aeroplanes. The idea is soon rejected as non realistic [Jo78a].*
1935-03-07	*Steenbeck* (Siemens) submits a second patent in Germany and Austria on betatrons [St35]. These patents include the 2:1-stability condition already proposed by *Wideröe*.
1935-03-01	*Schiebold* founds a half-private company called "Institute for X-ray-Testing of Raw and Elaborated Materials" ("Institut für röntgenologische Roh- und Werkstoffprüfung") located in buildings of the Mineralogical Institute of the University of Leipzig.
1935-10-14	*Gans* is forced to take first a "vacation" and then to retire from the University of Königsberg.
1936-03-06	*Steenbeck* (Siemens) submits a patent on the betatron in the USA [St36].
1936-04-01	*Gans* obtains a job as "theoretical physics adviser" ("theoretisch physikalischer Berater") at the Research Centre of the AEG (Berlin), under the direction of *Ramsauer.*
1936-09-03	Jassinski *(Moscow) publishes a very interesting theory of the betatron [Ja36].*
1938-??	OPTA-Radio history: *Siegmund Loewe´s* radio factories are "Aryanized" (racially "cleaned"). He must emigrate tu the USA.

1938-02-04 *Rüdenberg and Steenbeck´s* German patent on betatrons is accepted [Ru33]. At that time *Rüdenberg* had already emigrated (with the help of Siemens) to England for racial reasons.

1938-03-12 *German troupes occupy Austria ("Anschluss").*

1938-Fall *Touschek* (as "half-Jew") is not allowed to continue attending classes in the "Piaristen Gymnasium" in Vienna. As private student he graduates at the "Schottengymnasium" to access University. He started studying engineering in Rome, wanted to continue at Manchester but finally returned to Vienna.

1938-10-24 *Milch* is nominated "Inspector General of the German Luftwaffe".

1938-11-09 *Pogrom in Germany and occupied regions ("Kristallnacht").*

1938-12-28 *Steenbeck´s* US-patent on betatrons is accepted and published.

1939 OPTA-Radio, the former *Loewe/Löwe/Opta* factories change production to war-relevant items.

1939... *Touschek* tryes to attend (unobserved) lectures on physics and mathematics at Vienna University. He is soon one of the best students.

1939-09-01 *German troupes invade Poland.*

1939-09-03 *Great Britain and France declare war to Germany.*

1939-09 *Gans* is dismissed from AEG, works for some time for Telefunken and afterwards at GEMA on Radar-technology.

1939-10 *Wideröe* starts working for "Norsk elektrisk og Brown Boveri" (NEBB) in Oslo. He directs the planning and construction of power plants.

1939-10 *Lawrence´s* 150-cm cyclotron starts operation accelerating deuteron-nuclei to 19 MeV.

1939-11 Nobel Prize for *Lawrence* for the development of the cyclotron.

1940-04-09… *German troupes occupy Norway.*

1940-05 *Touschek* is not allowed to continue studying at the

University of Vienna as “Non-Aryan”. He is not allowed even to use the institute´s library.

1940-1941 ***Urban*** helps ***Touschek*** to study secretly in Vienna and contacts *Arnold Sommerfeld* (München) to help him to continue studying in Germany. *Sommerfeld* recommends going to Hamburg.

1940-10-15 *Kerst* (Univ. Illinois) announces the first successful tests of a 2 MeV betatron [Ke40a]; he mentions *Wideröe* und *Walton*, but not *Steenbeck´s* Patent.

1940-11-13 *Kerst* (now at General Electric) submits a US-Patent on the betatron [Ke40b].

1940-11-14 *Coventry 80% destroyed by 500 German bombing aircrafts.*

1940-11-22 Kerst *first report on tests of a 2.3-MeV betatron at General Electric [Ke41a].*

1941 *Schiebold* is forced to accept a Professorship at the Technical University of Dresden.

1941? General Electric (GE) asks for a licence to use *Steenbeck´s* patent(s) [Ka47].

1941-04-18 *Kerst* (General Electric) submits to Phys.Rev. a report on the operation of the 2.3-MeV betatron [Ke41b]. He measured an equivalent of the radiation of about 1 gram Radium. *Kerst and Serber* add a corresponding theory [Ke41c]. It was one of the last issues of the Phys.Rev. which arrived to Germany and Norway.

1941-09 *Harry Grindell-Matthews*, called “Mister Death-Rays” dies. Big resonance in the English press.

1941-09 *Heisenberg´s visit to Bohr in (German occupied) Copenhagen.*

1941-09-19 *Jews must show a big sized David-star on their coats or wests.*

1941-10 Wideröe *attends to a seminar by* Tangen *in Oslo in which he mentioned the successful results on betatrons published by* Kerst *(USA). He immediately starts working again on the subject.*

1941-11-17 *Udet* commits suicide; *Milch* takes over his function as “Generalluftzeugmeister”.

1941-12-06 Siemens and General Electric agree on a licence for the use of *Steenbeck´s* patents [St77].

1941-12-07 *Japanese surprise attack on Pearl Harbour. USA declares war!*

1941-12 End *Disaster of German troupes before Moscow, retirement!*

1941 End Following a suggestion by *Steenbeck*, *Gund* starts designing a 6 MeV betatron for medical applications in the laboratories of Siemens-Reiniger in Erlangen.

1942 *OPTA-Radio: New "Aryan" name for the Loewe group. Still 100% war-relevant production.*

1942-02 *Steenbeck´s* short report on his betatron-tests of 1935/1936 [St42].

1942-?? *Wideröe´s* brother *Viggo* (a pioneer of air transports in Norway) is condemned to 10 years prison for his activity helping underground resistance.

1942-04 *Touschek* moves to Hamburg, is able to attend university lectures by *Harteck, Jensen, Lenz* and *Möller* [Bo11a]. He also obtains a position at the "Studiengesellschaft für Elektro-nen-geräte" (a Philips company). Lives part time in *Lenz´s* apartment. Needs to accept odd jobs to survive, some in Berlin. Travels a lot up and down.

1942-07 According to *Kaiser* [Ka47] several more patents on betatrons were submitted by Siemens.

1942 *The "Research Centre of the Luftwaffe Groß Ostheim" ("Forschungsstelle der Luftwaffe Groß Ostheim") is created.*

1942 *Kerst* publishes data on his 20-MeV betatron and introduces the denomination "betatron" [Ke42].

1942-09-15 *Wideröe* submits a detailed paper on betatrons ("Der Strahlentransformator") to the journal "Archiv für Elektrotechnik" [Wi43b]. It is typesetted and corrected but replaced in the last moment by another paper, therefore never published [Bo11b].

1942-09-29 *Kerst´s* (General Electric) betatron-patent is accepted in the US-Patent [Ke40].

1942-11… Touschek *starts working for "OPTA Radio AG" in Berlin under* Egerer *(Braun-tubes production) who*

	*is also editor of the jou**rnal "Archiv für Elektrotechnik" and adviser of*** Milch ***(OPTA works for the Luftwaffe). Correcting*** Wide-röe´s ***betatron*** *paper* Touschek *finds errors and contacts* Wideröe *[Am81].*
1942-12-15	Steenbeck*: Meeting at Siemens on specifications for a betatron. New proposal of* Gund *following computations made by* Jassinski *[Ka47].*
1943	OPTA-Radio becomes responsible for the production and acquisition of all types of radio-valves for the Luftwaffe (also made by other enterprises).
1943-?	*Gerlach* is nominated Director of the Physics Section in the "Central Research Council of the Reich".
1943-01-07	*Tesla* dies in New York. Big press resonance.
1943-01	*Gans* (of Jewish origin) is forced to perform clear up work in Berlin.
1943-01-31	*Capitulation of German troupes in Stalingrad.*
1943-02	*Touschek* studies relativistic effects on cyclotron projects, submits related patents with *Egerer.* They have an agreement on that (*Touschek*-letter from Berlin [Bo11b]).
1943-03-20	*Steenbeck* publishes results he already obtained in 1935/1936 operating a 1.8-MeV betatron and explains the patents he submitted [St43].
1943-03-Ende	*Schmellenmeier and Houtermans* discuss with several scientists on possible means to save *Gans.*
1943-04-05	Schiebold´s *proposal to the Luftwaffe (*Milch*) for additional means to combat the enemy [SE43a]. Main components would be X-ray tubes with very big anodes.*
1943-04-17	Fennel, Schiebold and Seifert *meet to discuss the eventual use of X-ray-tubes with lower power consumption [SE43b].*
1943-04-19	Schiebold´s *addendum nr. 1 to his proposal of April 5, 1943 [SE43c].*
1943-04-20	Schiebold´s *personal presentation of his ideas in the office of* Milch *(Luftwaffe RLM). He obtains an*

official research commission, responsible: Fennel, Hollnack, Schiebold *and* Seifert.

1943-04-21 Schiebold´s *addendum nr. 2 to his proposal of April 5, 1943 [SE43d].*

1943-05-05 Schiebold´s *addendum nr. 3 to his proposal of April 5, 1943 [SE43e].*

1943-05-01 *Schmellenmeier* discusses with *Jensen* (in agreement with *Hou-termans*) a project to construct a 1,5-MeV betatron (here called "Rhe-otron"). A proposal submitted to the Aviation Ministry RLM (estimated costs: 8000 RM) is rejected after several interventions.

1943-05-28 *Gans* is freed from his cleaning duties and assigned to the "Entwicklungslaboratorium Dr. *Schmellenmeier*".

1943-06-03 Meeting of *Hollnack and Eisl* to discuss *Schiebold´s* Proposals.

1943-06? *Wideröe* is approached in Oslo by officers of the Luftwaffe. A few days later he was flown to Berlin and after long negotiations accepts to construct a betatron for the Aviation Ministry ("Reichsluftfahrt-mini-sterium", RLM).

1943-06-27 In a meeting at RLM in Berlin *Touschek* convinces *Wideröe* about relativistic effects for his betatron orbit-computations. *Wideröe´s* paper [Wi43b] is accordingly corrected [To43]. Widerö e´s contacts with RLM probably through *Egerer* and *Hollnack* (RLM-office?)

1943-07-12 *Wideröe* submits a second article to the "Archiv für Elektrotechnik" with details for a 15- and a 200-MeV betatron. Considered as secret of war it was never published. No copy available.

1943-07-15 *Wideröe* submits his first patent on betatron details in Germany [Wi94].

1943-07-25… *Fife nights heavy bombing of Hamburg.*

1943-07-26 *Schmellenmeier* submits to the "Central Research Council of the Reich" (directed by *Gerlach*) a proposal to construct a "Rheotron" now estimated to cost 9000 RM [Sw92].

1943-08-05 *Schmellenmeier* is commissioned by the "Central

Research Council of the Reich" to construct a "Rheotron" for medical applications.

1943-08 *Wideröe* starts his activity at C.H.F. Müller in Hamburg. His family remains in Oslo and continues receiving his NEBB-salary. According to *Wideröe´s* rough memories he had first personal contacts in Hamburg with *Hollnack, Seifert, Kollath, Schumann and Lenz*. Probably he met at least *Touschek* and *Egerer* before in Berlin.

1943-09 Wideröe *meets* Egerer *and* Schiebold *at* Hollnack´s *(in Berlin or Hamburg?).*

1943-09-02... Wideröe *submits 5 more patents in Germany (up to October 1943) with ideas and proposals for betatrons [Wi94].*

1943-09-08 *Drawings for a big hall for high-voltage experiments to be built in Groß Ostheim, signed by* Tamms *with Architect* Sander *and the administration of the "Luftgau XII". Construction is started.*

1943-10-19 *Interesting draft for a contract between* Wideröe *and* Schie-bold´s *"Institute" in which* Wideröe´s *working conditions in Germany are exactly specified including rights on eventual patents. It was probably never signed but the "working conditions" corresponded exactly to the real ones.*

1944 Wideröe *submits fife more patents in Germany on details for betatron construction [Wi94].*

1944-01 Gerlach *becomes fully responsible for nuclear physics activities in Germany including the secret project on reactors ("Deutsches Uranprojekt").*

1944-02-? *Nomination of a committee ("Kuratoriums der Forschungsstelle der Luftwaffe Großostheim"), which should judge and supervise* Schiebold´s *activity. Chairmen* Gerlach, *members are:* Egerer, Esau, Fennel, Geist, Georgii, Heisenberg, Heuser, Hollnack, v.Loßberg, Seifert and Tamms.

1944-02... Big hall for *Schiebold´s* high voltage experiments finished at "Fliegerhorst" Groß Ostheim.

1944-02-18 *Schiebold* has problems with *Georgii* (Research Director in the Aviation Ministry RLM) regarding his

activities in Groß Ostheim. *Schie-bold* tries to explain his situation in a letter dated 1944-02-29.

1944-02-22 *Kulenkampff* (Jena) distributes a very negative report on *Schiebold´s* proposal to the members of the "Kuratorium" (no copy to *Schiebold*).

1944-04 *Gund´s* 5-MeV betatron starts operation in Erlangen. Measurements and first experiments are performed there by *Kopfermann and Paul* (both from Göttingen).

1944-04-27... Three-days visit of *Wideröe* at BBC in Weinheim and Heidelberg [Wi44].

1944-04-29 During the meeting of *Wideröe* at BBC in Heidelberg. Director *Meyer-Delius* reports that *Seifert* issued a provisional order to BBC for the design work of the 200-MeV betatron. The final construction of the machine was however refused by BBC [Me44].

1944-05-01 *Wideröe* reports about the three days visit to BBC on April 4, 1944 [Wi44].

1944-05-04 *Schiebold´s* report [SE44d] and a programme for the activity of the "Forschungsstelle Groß Ostheim" [SE44e].

1944-05-06t *Meeting of the "Kuratorium Groß Ostheim" in Berlin following an invitation of* Gerlach. Schiebold´s *projects are declared as not feasible and rejected. However, the development of betatrons should be continued (see* Gerlach´s *"Niederschrift" [Ge44]).*

1944-06-13 *FirstV1-bomb reaches London.*

1944-06-21 Milch *is no longer "Staatssekretär" and his functions as "Luftzeugmeister" are taken over by the Ministry of* Speer.

1944-07-01... The Research Council of the Reich issues orders (until Sept. 30 1944) to Siemens-Reiniger, Erlangen (signed by *Gerlach*): a) to construct a 5 MeV betatron and b) for the design of a 20 to 25 MeV betatron and a 100 MeV one [Os88].

1944-07-12 *Schiebold´s* 41-pages long answer to *Kulen-kampff´s* critics [SE44g].

1944-07-17 *Kulenkampff´s* answer to *Schiebold* [Ku44]

1944-07-29 *Schiebold´s* contradiction to *Kulenkampff* [SE44h].

1944-08-04	*Kulenkampff´s* answer to *Schiebold* [Ku44b].
1944-Sommer	*Wideröe´s* 15-MeV betatron starts operation in Hamburg.
1944-08-15	Meeting of a subcommittee of the "Kuratorium Großostheim" in Airing. *Schiebold´s* proposals were definitely declared as useless for war purposes [Ge44].
1944-08-25	*Gerlach´s* report ("Niederschrift") on the two meetings of the "Kuratorium" on May 6 and August 15, 1944 [Ge44].
1944-09-06	*First V2-rocket over London.*
1944-09-20	Schiebold´s *final objections to* Gerlach´s *"Niederschrift" [SE44j] including a remark on a "very important letter" he received the same day from the "Research Direction". The content of this letter is not known but after this day* Schiebold *is not mentioned anymore in any document related to the original project of the Luftwaffe (and the Grossostheim laboratory). However, work on betatrons for the Luftwaffe is continued under the direction of* Seifert *and* Hollnack.
1944-10	Meeting at BBC in Heidelberg. *Wideröe* und *Kollath* representing the "Megavolt-Versuchs-anstalt". Progress of *Gund´s* and *Wideröe´s* projects are discussed [Ka47].
1944-10-25	More remarks of *Kulenkampff* to *Schiebold* [Ku44c].
1944-11	*Wideröe* visits the laboratories of Siemens-Reiniger in Erlangen and makes very critical remarks on *Gund´s* betatron.
1944-Herbst	Transfer of *Schmellenmeier´s* Rheotron-Laboratory from Ber-lin to Oberoderwitz in Oberlausitz (near the Czech border).
1944-12	*Hollnack* meets sailor *Overbeek* (a. *Jakov Lind*) in a Marburg hospital and engages him a few days later as his personal courier [Li97].
1945-01-02	Long letter of *Egerer* to *Schiebold* trying to justify *Schie-bold´s* activity during the war [Eg45].
1945-01	*Milch* looses his position as "Generalinspekteur der Luftwaffe".

1945-01 Design-work for *Wideröe´s* 200-MeV-betatron at BBC-Mannheim is stopped [Ka47].

1945-02-13 *Allied intense bombing of Dresden.*

1945-02-17 Wideröe *submits a betatron patent in Germany [Wi94].*

1945-02-19 *Wideröe* submits another betatron patent in Germany [Wi94].

1945-03? *Viggo Wideröe* is freed by US-troupes in Darmstadt.

1945-03... *Kollath, Schumann and Touschek*, with the help of *Seifert* and staff members of C.H.F. Müller transport the betatron from Hamburg to Wrist (near Kellinghusen) and immediately are able to continue test runs there.

1945-03... *Hollnack* lodges *Kollath, Schumann, Touschek, Overbeek* and several of his "friends" (including *Ernst Sommerfeld*) in Kellinghusen. According to *Touschek Hollnack* has still "War money" (100.000 RM) and is called "Mussolini of Kellinghusen" due to his behaviour.

1945-03-16 Wideröe *moves to Kellinghusen. Meets* Touschek, *who returns to Hamburg in the evening.*

1945-03-17 *Touschek* is arrested in Hamburg suspected of spy-work and is interned in the concentration camp (KZ) in Fuhlsbüttel [Bo11a]. After a few difficult days he is allowed to continue working for *Wideröe* who brings him (into his cell!) his books, food, cigarettes and drinks.

1945-03-27 *Last of 2.800 V2 fired.*

1945-03-28 Schmellenmeier´s *Rheotron-Laboratory it transported in two SS-lories to a small village (Burggrub) in Oberfranken ([Sw92] S. 122).*

1945-03-29 *Last of 10.500 V1 fired.*

1945-04-11 *Touschek* should be transferred to a concentration camp in Kiel. On the way he fells, is shot by SS-guards and left, supposed dead. After cured in a hospital he is again imprisoned and ended up in a jail in Altona [Am81] [Bo11a].

1945-04-11... *Hollnack´s* final payment of 28.000 RM und 150.000 (?) Norwegian Crowns to *Wideröe*. Following an

advice of Hollnack *Wideröe* returns by train to Oslo as soon as possible.

1945-04-14 US-Troupes free *Gans* and take over in Burggrub *Schmellenmeier´s* Rhe-otron-Laboratory.

1945-04-24 *Berlin enclosed by Sowjet Troupes.*

1945-04-30 Hitler *commits suicide.*

1945-04-30 *Touschek* set free in Hamburg with the (probably illegal) help of *Hollnack*. He reaches *Seifert´s* home and returns to Kellinghusen to continue working on the 15-MeV betatron. Here he writes several reports [To45].

1945-05 *Overbeek* explains to *Hollnack* his real identity [Li97]. *Hollnack* is not surprised.

1945-05 Gerlach *is interned with a group of prominent physicists at Farm-Hall (near Cambridge, GB). Until January 1946 they are interrogated and closely observed.*

1945-05 *German troupes retire from Norway.*

1945-05-03 *British troupes occupy Hamburg.*

1945-05-03... *Hollnack* had "best relations" to the arriving Allies. He immediately guided a special unit of the British Army to the laboratories of C.H.F. Müller. All still available documents on the betatron were confiscated. But *Kollath, Schumann* and *Touschek* are allowed to continue their work on the 15-MeV betatron at Wrist. This is now considered as a strictly secret matter by the British authorities, until the future of the betatron should be clarified.

1945-05-07 *End of the War – Germany´s unconditional surrender.*

1945-05-09 *Quisling* surrenders to Norwegian Police.

1945 *Steenbeck* reaches Moscow after an extremely adventurous journey and works there for 10 years as nuclear physicist (isotopes-separation). Later on he is nominated professor at Jena [St67].

1945-05-23 *Wideröe* is arrested in Norway (Oslo jail Ilebu) suspected of having worked for the development of

V2-rockets in Germany. In jail he writes a detailed report on betatrons.

1945-06 *Wideröe* is formally dismissed by NEBB (Oslo) but remains in contact with BBC-Baden [Br97].

1945-07-09 *Randers* visits *Wideröe* in jail to clear up the accusations against him.

1945-07-09 *Wideröe* is left free by intervention of *Odd Dahl* and other friends [Da81]. He has no job, very little money and no passport.

1945-07... *Wideröe* develops a theory of what later on was called a "synchrotron" and submitted it as a Norwegian and later as German patents [Wi46].

1945-07-25 *Overbeek* (now called *Jakov Chaklan*) arrives to Haifa as illegal passenger by ship.

1945-08-06 *Atomic bomb on Hiroshima.*

1945-09-05 McMillan *(USA) submits his theory of the synchrotron to the Phys.Rev. [Mc45] and during the same year* Veksler *publishes independently a similar report in the UdSSR [Ve45].*

1945-11 *A "Committee of Experts" is created in Oslo to judge* Wideröe´s *activity in Germany. Chairman is* Hyl-leraas, *the other members are:* Randers, Tangen and Wergeland.

1945-11-30 *Schiebold* is dismissed from all his official positions due to the political functions he had during the Third Reich. He first worked for the Soviet authorities and is later declared free of having been a Nazi. ("entnazifiziert").

1945-12-11 *Kollath´s* short report on the work done at Wrist with the 15-MeV betatron [Ko45].

1945-12 *End of the tests of the 15-MeV betatron at Wrist. The 15-MeV betatron is transported as booty of war to the Woolwich Arsenal, near to London.*

1946 *Gund* gets his PhD in Göttingen [Gu46].

1946-01-31 Wideröe *submits his patent on the theory of the synchrotron in Norway (Nr. 76.696).*

1946-01 Kollath *goes for a year to England to help reinstalling the 15-MeV betatron. The intense X-**rays produced are used for materials testing. Afterwards the betatron is probably scrapped.***

1946-02-14	Negative and in part quite unfair judgment (with some wrong statements) of the "Committee of Experts" on *Wideröe´s* activity during the war in Germany [Hy46]. But it is made clear that *Wideröe* did not participate in any V2-developements.
1946	*Touschek* moves to Göttingen and starts his "Di-ploma-Thesis" based on *Gund´s* 6-MeV betatron. He also works on some interesting theoretical investigations.
1946-Frühling	*Wideröe* obtains a provisional passport to spend about two weeks in Baden where he makes first designs for a betatron to be constructed at BBC-Baden (CH). His engagement at BBC is strongly supported by Prof. *Scherrer* (ETH Zürich).
1946 Summer	*Touschek* obtains his Diploma in Physics in Göttingen with a thesis on the theory of betatrons under the direction of *Becker* and *Kopfer-mann* [Am81].
1946-08-01	*Wideröe* obtains a leading position at BBC-Baden (CH).
1946-10	*Wideröe* is called back to Norway for a judicial hearing.
1946-11-02	*Wideröe* accepts and signs a proposal ("Forelegg") of the police authorities in Oslo in which it is established that: a) he looses the right to vote in Norway, b) he is not allowed to serve in the Norwegian Army and c) he should pay back the illegal writes for patents he received in Germany [Wi46a]. After this, the matter is considered as closed by the Norwegian justice and Wideröe is allowed to return to Switzerland "as a free man" (his words).
1946...	*Wideröe* directs at BBC the construction of betatrons (31 to 45 MeV), mainly for medical applications but several also for materials testing. Until 1986 about 78 betatrons were installed by BBC.
1947-01	*Kaiser,* from the US Naval Research Lab. (Washington DC) publishes a detailed report on the European developments concerning "induction accelerators" (betatrons) [Ka47].
1947-05-22	*Kollath and Schumann* publish a detailed report on their work with the 15-MeV betatron [Ko47].
1947-08	Gund's *5-MeV betatron (built at Siemens-Erlangen)*

is transported to Göt-tingen. There the electron beam could be extracted [Gu49].

1948-11-09 *Wideröe* submits his patent on the theory of the synchrotron in Germany (Nr. 847,318). It is accepted and published on June 26, 1952 [Wi46].

1949 *OPTA-Radio: The enterprise-group is completely returned to the Loewe family.*

1949 *Gund* is nominated Director in chief of the Design-Department of Siemens-Reiniger-Werke in Erlangen.

1952 End of operation of *Gund´s* betatron in Göttingen. The main components were first exposed at the Smithsonian Museum in Washington and are now at the Bonn branch of the Deutsches Museum.

1953-12-12 *Wideröe* is Professor at the ETH-Zürich and teaches until 1972.

1954 *Schiebold* is nominated Professor and Director of a new "Institute for Materials Testing" at Magdeburg University. He received many honours from the DDR-authorities.

1954-10-18 BBC is condemned by German Federal Tribunals (in Mannheim and Karlsruhe) to pay about 100.000 DM to Siemens for using *Steenbeck´s* patents regarding betatrons. *Wideröe* was called in as testimony.

1960-03-07 In a seminar talk in Frascati *Touschek* explains the scientific interest and the practical possibility to obtain electron-positron collisions in a single storage-ring. Construction of the worldwide first such machine was immediately started in Frascati and called AdA [Am81].

1961-02-27 *The storage-ring AdA is successfully operated for the first time.*

1994-04-28 *Meeting with* Fehr, Bergmüller and Reiniger *(ex C.H.F. Müller) organized by* Schmdth-May *at* ***"Philips Medizin Systeme" in Fuhlsbüttel to discuss details of*** Wideröe´s ***time.***

———————

References

Comments:

Accurate sources and more references regarding the life of Richard Gans can be found in the biography of Gans by Edgar Swinne [Sw92] und on the life of Rolf Wideröe in his autobiography [Wa93].

Practically the full scientific and technical inheritance of Rolf Wideröe and most documents regarding his life has been carefully collected in the “Wissenschaftshistorischen Sammlungen” of the library of the “Eidgenossische technische Hochschule Zürich” (ETH) under the Ref. „Hs 903". Documents of this archives are mentioned here as „ETH Hs 903: nn” where nn is the official identifying number in the archives.

Documents on Ernst Sommerfeld´s life, including his correspondence with Rolf Wideröe has been stored in the “Deutsches Museum München”.

A smaller collection of documents on Rolf Wideröe is conserved in a “Minimuseum Wideröe” in the Radiumhospital in Oslo organized by Prof. Tor Brustard (contact: Aashild Sörheim). Some important documents on Wideröe´s life are preserved in the Norwegian Nationalarchiv (Oslo).

A series of about 100 numbered pages (copies) from the inheritance of Ernst Schiebold (NES) regarding his X-ray-war-projects are stored in the “Sächsisches Staatsarchiv” Leipzig (SächsStAL) and identical copies at (see [Ba02]) the Universitätsarchiv Leipzig and are referred here as „NES: #” with # as the page number. Another set of numbered pages collected by Pedro Waloschek (mentioned as “PPW”) were deposited as copies in both mentioned Leipzig Archives. as „PPW: A-#” (# is the page number, if available)

At the “Universitätsarchiv Leipzig” there are more documents on Schiebold´s life in Leipzig including 2000 of his slides. Also at the archives of the “Max-Planck-Gesellschaft” in Berlin some rests of

Ernst-Schiebold´s inheritance are collected [Ha02].[Ka02] [SG03]. Further references on Schiebold´s life can be found in the accurate report of Burghard Weiss [We03].

On Schiebold´s later activity in Marburg, the “Institut für Werkstoffprüfung der Otto-von Guerricke UniversItät” should be consulted.

Interesting results of research on the Luftwaffe Basis in Großostheim during WW II were presented in the Internet during the last years including a television spot (Bavarian-TV) and a book by Peter Hepp and Klaus Sauerwein (“Großostheim in den Kriegsjahren 1939-1945”, BoD, 2005, no longer available). In the bunker under the big (no longer existing) test-hall a conmemoration-museum for the “Fliegerhorst” has been installed. An interview with Schiebold´s secretary confirmed the chronology and information I present here, including Schiebold´s presence in Großostheim. According to all data available to me, no accelerator or high voltage device was ever installed in Großostheim. This fact was sometimes ignored or presented in a missunderstanding way.

Historic data were checked i.e. with [Be93], [Ha82] and [Pi85].

[Am78] **Amaldi, E.(?):** ***"The adventurous life of Friedrich Georg Houtermans, physicist", typed manuscript probably never published, 76 pages (p. 44-45 missing), including a report by F.G. Houtermans "Chro-nological Report on my life in Rus-sian Prisons" of May 1945. (PPW-Ha-01).***

[Am81] **Amaldi, E.:** ***"The Bruno Touschek Legacy", CERN-Report Nr. 81-19, 83 p. (1981).***

[Ar42] **Ardenne, M. von, Günther, F., Schiebold, E.:** ***"Feinstrahl-Elektronenbeugung im Universal-Elektronenmikroskop. Arbeitsweise und Ergebnisse", Z. Phys. 119 (1942), p. 352-356.***

[As93] **Aspelund, O.:** ***Letter to P. Waloschek, Sept. 27, 1993.***

[At29] **Atkinson, R. and Houtermans, F.:** ***"Über die Ener-gie-erzeugung im Zentrum der Sonne" (About energy production in the centre of the sun), Z.f.Ph., Vol. 54, p. 656 (1929).***

[Ba02] **Bähr, Marion** ***(Sächsisches Staatsarchiv Leipzig): Letter to P. Wa-loschek, Aug. 26, 2002.***

[Ba43] **Barwell, E.G.H.:** ***"The Death Ray Man - The Biography of Grindell-Matthews, Inventor and Pioneer", Hatchinson & Co, London 1943.***

[Be83] **Becker, E.:** ***"Ernst Schiebold", Scientific Journal of the University of Mag-deburg, Vol. 27 (1983) Issue Nr 3, p. 43 to 48 (6 p.).***

[Be93] **Bedürftig, F. und Zentner, Ch.:** ***"Das große Lexikon des Zweiten Weltkrieges" (The big dictionary about the second World War), Südwest Verlag 1993, 656 pages.***

[Be94] **Becker, E.:** ***"Der Beitrag von Ernst Schiebold zur Entwicklung der zerstörungsfreien Werkstoffprüfung" (The contribution of Ernst Schiebold to the non destructive materials testing), in [Ka94], p. 45-50.***

[Bl03] **Blecher, Jens** ***(Universitätsarchiv Leipzig): E-Mails***

and tel. call to P. Waloschek on Febr. 7 and Sept. 16, 2003 (PPW A-121).

[Bl94] **Blumenauer, H.:** *Letter to P. Waloschek, Nov. 9. 1994 (PPW A-102).*

[Bo05] *L. Bonolis, "Bruno Touschek vs Machine Builders. AdA, the first matter-antimatter collider", in La Rivista del Nuovo Cimento, 28 (11) (2005) 1-60.(ref. in [Bo11a])*

[Bo11a] **Bonolis, L. and Pancheri, G.,** *"Bruno Touschek: particle physicist and father of the e+e–collider", European Physics Journal H 36 (1) (2011), 1-61.*

[Bo11b] **Bonolis, L.,** *private communication to P. Waloschek, confirmed by the DESY library [Wu11].*

[Br27] **Breit, G. and Tuve, M.A.:** *Report on betatron-tests in the Carnegie Institution Year Book 27,* **209** *(1927/28).*

[Br97] **Brustard, Tor:** *"Rolf Wideröe – Why is the Originator of The Science of Particle Accelerators so Neglected, Particularly in his Home Coun-try", Original Article, Scandina-vian Uni-versity Press 1998 (PPW), abriged version in Acta Oncologica 1998; 37.*

[Da92] **Dahl, P.F.:** *"Rolf Wideröe: Progenitor of Particle Accelerators", SSC-Report, SSCL-SR-1186, 10 p., (1992).*

[DM02] **Deutsches Museum Bonn,** *"The 6-MeV-Betatron" Inventory # 1994 – L 37.000. Loan from the Siemens-Museum München*

.[Eg30] **Eggert, J. und Schiebold, E.:** *"Ergebnisse der technischen Röntgenkunde" (Results from technical X-ray research), 6 Volumes (1930-1938), Akademische Verlagsgesellschaft M.B.H., Leipzig.*

[Eg45] **Egerer, K. A.:** *Letter to Ernst Schiebold, Jan.2, 1945, 5 p. (NES: #134...).*

[Fe45] **Fehr, Werner:** *Letter to* **Wideröe** *regarding LMV-folder, from* **E. Swinne** *archives.*

[Fe81] **Fehr, Werner:** *"C.H.F. Müller ...mit Röntgen begann die Zukunft" (C.H.F. Müller ... starting into the future with Roentgen), published by Philips*

GmbH, Ham-burg, 87 p. (1981). Copy (with original photographs) at the Library of the German Röntgen Museum in Remscheid-Lennep.

[Fo92] **Ford, Brian:** *„Die deutschen Geheimwaffen" (The German secret waepons), Moe-wig Verlag Rastatt (1992).*

[Fo93] **Ford, John:** *„Little Linacs Fight Cancer", Beam Line (SLAC),* **23,** *Nr. 1, p. 6 13 (1993).*

[Fr92] **Fränz, Kurt:** *Letter to Edgar Swinne, March 9, 1992, E. Swinne-archives.*

[Fr97] **Frenkel, V.J.:** *"Professor Friedrich Houtermans – Work, Life, Destiny", published by PIJaF of the Russ. Academy of Sciences in 1997, 199 p. (in Russian) ISBN 5-8673-110-9. Reviewed by Dr. Horst Kant (History of Science Institute of the MPI, Berlin) in Physikal. Blätter, Vol. 55 (1999), Nr.9, p. 80.*

[Fu98] **Füßl, Wilhelm:** *lists of scientific documents and letters regarding Gerlach ("Der wissenschaftliche Nachlaß von Wal-ther Gerlach"), conserved in the Archives of the Deutschen Museum, two volumes, ISBN 3-924183-48-1 (1998) in total 1091 pages.*

[Ga00] **Gans, R.:** *His tombstone at the German Cementry ("Cemen-terio Ale-mán") in Buenos Aires, Argent., Av.Elcano 4530, position: Fracc: UA, Fila 12, N# 189. Photographed by P. Waloschek, Febr. 2000 (PPW).*

[Ga05] **Gans, R.:** *"Einführung in die Vektoranalysis mit Anwendungen auf die mathematische Physik" (Textbook on vector-analysis and applications in mathematical physics), first published by B.G. Teubner, Leipzig in 1905, 7. edition (1950), 120 p. English versions were published in several editions.*

[Ga08] **Gans, R.:** *„Einführung in die Theorie des Magnetismus", (Introduction into the theory of magnetism), Teubner Editors Leipzig (1908), 110 p.*

[Ga50] **Gans, R.:** *Special issue of the journal „Rev. Unión Mat. Argentina", Vol. 14, Nr. 3, (1950) with contributions by Max von Laue, Walther Gerlach*

with J. Kranz, K. Fränz, Hector Isnardi, José Würsch-midt, J.A. Balseiro, W. Seelmann-Eggebert, A.E. Rodriguez and Ricardo Platzeck.

[Ge02] **GEANT 4:** *A toolkit for the simulation of the passage of particles through matter. It is being improved in international collaboration since 1970, see Internet: http://geant4.web.cern.ch/geant4/*

[Ge44] **Gerlach, W.:** *Minutes ("Niederschrift") dated Aug. 25, 1944, regarding (a) the session of the "Kuratorium Großostheim" on May 6, 1944 in Berlin and (b) the meeting of a sub-commity on Aug. 15, 1944 in Ainring. In total 6 p., distributed to: 1) Milch, 2) all members of the "Kuratorium", 3) Diesing, 4) Mentzel, 5) Georgii, 6) Schiebold. Copy conserved by Joachim Schiebold (PPW A-17...).*

[Go02] **Gottstein, K.:** *Letters to P. Waloschek, Sept. 1 and 3, and Nov. 10, 2002 (PPW).*

[Go03] **Gottstein, K.:** *E-mail to P. Waloschek, Aug. 11, 2003 (PPW).*

[Go46] **Goward, F.K. and Barnes, D.E.:** *„Experimental 8 MeV Synchrotron for Electron Acceleration", Nature, Letter to the Editor, Sept. 21, 1946, p. 413.*

[Go64] **Gonella, L Nabholz, H and Wideröe:** *"The Turin 100-MeV Electron Synchrotron" Nuclear Instr. & Methods, Vol. 27, p. 141-155 (1964).*

[Gu46] **Gund, K.:** *PhD-tesis, Göttingen 1947 (unpublished).*

[Gu49] **Gund, K. und Reich, H.:** *Z. Physik* **126,** *383 (1949), about the extraction of electrons from the 5-MeV betatron.*

[Gu50] **Gund, K. und Paul, W.:** *„Experiments with a 6-MeV-Betatron", Nu-cleonics, 7, 37 (July, 1950).*

[Gu94a] **Günther, F.:** *"Erinnerungen an Ernst Schiebold" (Remembering Ernst Schiebold), in [Ka94], p. 17-19.*

[Gu94b] **Günther, F.:** *Letter to P. Waloschek of Nov. 18, 1994 (PPW: A-103...).*

[GW01] **GWUP,** *Society for the scientific investigation of parasciences ("Gesellschaft zur wissenschaftlichen*

Untersuchung von Parawissenschaften e.V.", Darmstadt). See internet: "www.gwup.org" Similar organisations exist in the USA and in GB, as well as a publication called "skeptiler".

[Ha02] **Hayes, Katherine A.** *(Niels Bohr Library, American Institute of Phy-sics), E-mail to P.Waloschek, Aug. 15, 2002 (PPW: A-117).*

[Ha82] **Harenberg, Bodo:** *„Chronik des Zwanzigsten Jahrhunderts", Westermann Verlag (1982), 1216 Seiten.*

[He36] **Heitler, Walter:** *„Quantum Theory of Radiation", Oxford at Clarendon Press (1936), 252 S.*

[Ho43] **Hollnack, Theodor.:** *Minutes of the meeting Eisl-Hollnack on June 3, 1943, 3 p., distributed to Dr. Eisl, to the Ministry of Ammonition ("Munitionsmi-nisterium"), to the RLM Gl/C, to Prof. Dr. Esau PTR, to Prof. Dr. Schiebold and to Mr Hollnack. (NES: #82x2 und 83)*

[Ho93] **Hoffmann, Dieter:** *„Operation Epsilon – Die Farm-Hall-Protokolle oder die Angst der Alliierten vor der deutschen Atombombe" (Operation Epsolon – The Farm-Hall protocols or the fear of the Allies , Ro-wohlt-Berlin (1993), 381 pages.*

[Hy46] **Hylleraas, E.A., Randers, G., Tangen, R. and Wergeland, H.:** *Critical report on Wideröe´s activity in Germany, written on request of the Oslo-Police authorities. 15 typed pages in Norwegian dated Feb. 14, 1946, National Archives, Oslo.*

[Ir64] **Irving, David:** *„Die Geheimwaffen des Dritten Reichs" (The secret weapons of the Third Reich), Sigbert Mohn Verlag Gütersloh (1965), 370 p. German version of "The Mare's Nest" (1964).*

[Is24] **Ising, G.:** *„Prinzip einer Methode zur Herstellung von Kanalstrahlen hoher Voltzahl", (A principle for a method to make canal rays of high voltage) Arkiv för matematik o. fysik, Vol. 18, Nr. 30, 1-4 (1924).*

[Ja36] **Jassinski, W.W. (Moskau):** *„Beschleunigung der Elektronen im elektromagnetischen Wechselstromfeld" (Acceleration of electrons in an*

alternating electromagnetic field), Arch. f. Elektrot. **30**, *590 (1936).*

[Jo78a] **Jones, R.V.:** *„Most Secret War", Hamish Hamilton Ltd. (1978), Co-ronet Edition (1979), 702 Seiten.*

[Jo78b] **Johnson, Brian:** *„Streng geheim - Wissenschaft und Technik im Zweiten Weltkrieg" (Strictly secret – Science and technique in WW II), Weltbild Verlag Augsburg (1978), 374 S. German version of „The Secret War" (1978).*

[Ka02] **Kazemi, Marion** *(Archiv-Berlin der MPG): Letter to P. Walo-schek, Aug. 20, 2002 (PPW: A-118).*

[Ka47] **Kaiser, H.F.:** *"European Electron Induction Acce-lerators", J. of Appl. Phys.* **18**, *1-17 (1947). Review report with many details on the work of Gund and Wideröe and on the 200-MeV betatron designed at BBC in 1944.*

[Ka94] **Kärfenstein, P. and Blumenauer, H.:** *„Wissenschaftliches Kolloquium zum Gedenken an Prof. Dr. phil. Ernst Schiebold – aus Anlass des 100. Geburtstages" (Scientific coloqium in memoriam Prof.Dr. Ernst Schiebold in occasion of the 100. aniversary of his birth), Preprint Nr. 3 (1994), Fakultät für Maschinenbau, Universität Magdeburg.*

[Ke40a] **Kerst, D.W.:** *„Acceleration of Electrons by Magnetic Induction", Letter to the Editor (15. Okt.1940), Phys.Rev.,* **58**, *841 (1940).*

[Ke40b] **Kerst, D.W.:** *"Magnetic Induction Accelerator" US-Patent (General Electric) 2 297 305, submitted on Nov. 13, 1940, published on Sept. 29, 1942.*

[Ke41a] **Kerst, D.W.:** *"Induction Electron Accelerator", Comm. to the Am. Phys. Soc., Nov. 22-23, 1940, Phys.Rev.* **59**, *110 (1941).*

[Ke41b] **Kerst, D.W.:** *"The Acceleration of Electrons by Magnetic Induction", Phys.Rev.* **60**, *47-53 (1941), also published in [Li66] p. 188.*

[Ke41c] **Kerst, D.W. and Serber, R.:** *"Electronic Orbits in the Induc-tion Acce-lerator", Phys. Rev.* **60**, *53 (1941), reproduced in [Li66] p. 194.*

[Ke42] **Kerst, D.W.:** ***"20 MeV Betatron or Induction Accelerator", Jour. Sci. Instr.*** **13,** ***387-394 (1942).***

[Ke56] **Kerst, D.W., Cole, F.T., Crane, H.R., Jones, L.W., Laslett, L.J., Ohkawa, T., Sessler, A.M., Symon, K.R., Terwilliger, K.W. and Nilsen, N.V.:** ***"Attain-ment of Very High Energy by Means of Intersecting Beams of Particles", Phys. Rev.(Letter) 102, 590-591 (1956).***

[Kh92] **Khriplovich, Iosiv B.:** ***"The Eventful Life of Fritz Hou-termans", Physics Today, 1992, S. 29 bis 37.***

[Ko45] **Kollath, R.:** ***Betatron-Report of Dec. 11, 1945, ETH,*** **Hs 903***: 29 (5 p.).*

[Ko47] **Kollath, R. and Schumann, G.:** ***"Untersuchungen an einem 15-MeV-Betatron" (Test results of a 15-MeV betatron), Z. Naturforschg.*** **2a,** ***634-642 (1947).***

[Ko55] **Kollath, R.:** ***"Teilchenbeschleuniger" (Textbook on particle accelerators), Vieweg Editors Braunschweig, 1. Edition 1955 (222 pages), improved edition 1962, with several other authors (335 pages). Other editions followed.***

[Ko53] **Kopfermann, Hans:** ***"Konrad Gund Nachruf" (Obituary on Konrad Gund), Phys. Bl.*** **9,** ***4126 (1953).***

[Ko93] **Kolsrud, Ole:** ***Letter to P. Waloschek, Nov. 18, 1993 (PPW).***

[Kr00] **Kroge, Harry von:** ***GEMA: "Birthplace of German Radar and Sonar", IoP Institute of Physics (2000) 250 pages, extended version of a German book of he same author (1998). (GEMA: „Gesellschaft für elektroakustische und mechanische Apparate").***

[Ku44a] **Kulenkampff, H.:** ***Accurate critical judgement of Schiebold´s X-ray-proposals directed to the „Kuratorium Großostheim". dated Febr. 22. 1944 (no copy available!).***

[Ku44b] **Kulenkampff, H.:** ***Answer of July 17, 1944 on Schie-bold´s report of July 12, 1944 (5 p.), NES, #105-109.***

[Ku44c] **Kulenkampff, H.:** ***Letter of Aug. 4, 1944 to***

Schiebold (2 p.). Joachim Schiebold´s Microfilm (PPW: A-15).

[Ku44d] **Kulenkampff, H.:** ***"Remarks" of Okt. 25, 1944 on Schiebold's „Stellungnahme" of Sept. 20, 1944, (5 p.). Microfilm from Joachim Schiebold (PPW: A-23).***

[Ku45] **Kuntke, A.:** ***Letter („Kt/Lts/338") to R. Wideröe, March 13, 1945 (PPW).***

[La31] **Lawrence, E.O.:** ***First cyclotron in operation, 80 keV, 13 cm Diametre, Comunication to the Am. Phys. Soc., Jan. 1931.***

[Le36] **Lenard, Philipp:** ***German (Aryian) physics textbooks ("Deutsche Physik"), i.e. 3rd Edition J.F. Leh-manns Editors (1943).***

[Li11] **Lind, Jakov:** ***See his homepage, www.jakovlind.com and wikipedia.***

[Li66] **Livingston, M.S. (Editor):** ***„The Development of High-Energy-Acce-lerators" (Reproductions of important original publications), Dover Publish. Inc. N.Y. (1966).***

[Li70] **Lind, Jakov:** ***„Selbstporträt", S. Fischer Verlag, 1970. Ich verdanke Herrn Rüdiger Giel vom Ge-schichts-verein Dillenburg den Hinweis auf dieses Buch. Titel der englischen Originalausgabe: „Counting My Steps", The Macmillan Company (1969).***

[Li94] **Lind, Jakov:** ***Letter to Pedro Waloschek dated Oct. 31, 1994 (PPW).***

[Li97] **Lind, Jakov:** ***"Selbstporträt" (Self portrait), Picus Verlag Wien, 1997. New edition, revised by the author of the book [Li70]. The same editor published two more books of Jakov Lind "Nahaufnahme" and "Im Gegenwind". All three form an impressive autobiographic trilogy.***

[Ma94] **Markert, Willi:** ***Telephone call of March 13, 1994 and letter to P. Wa-loschek dated April 9, 1994 (PPW).***

[Mc45] **McMillan, E.M.:** ***„The Synchrotron – A Proposed High Energy Particle Accelerator", Phys. Rev.* 68,**

143-144 (1945) (Issue Nr. 5 and 6, Sept. 1 and 15 1945), submitted on Sept. 5, 1945; see also [Li66], p. 211.

[Me44] **Meyer-Delius, Dr.:** *„Niederschrift über die Besprechung mit Herrn Dr. Wideröe über Strahlentransformatoren (MV-verfahren), am 29. Apr. 1944 in Heidelberg" (Minutes of the meeting with Dr. Wideröe on beam transformers on April 29, 1944 in Heidelberg.), dated May 2, 1944, ETH,* **Hs 903***: 63.*

[Mu43] **Müller, W.M.:** *„Über die Elektronenerzeugung im Strah-lentrans-for-mator" (About electron production in the beam-transformrr) Typed report with drawings, ETH,* **Hs 903***: 47.*

[Mu45] **Müller, C.H.F. & Co.:** *Interal report directed to Dr. Ritz (PPW).*

[Ni93] **Nikolaisen, Hans Dietrich:** *"Gruppenfeuer und Salventakt"(Group-fire and ...), 1993, Teil I, p.388/ 389. see also [St83]. Information kindly sent to me by Klaus Seib [SK95].*

[Os88] **Osietzki, Maria:** *"Zur Entwicklung der ersten deutschen Teilchenbeschleuniger bei Siemens 1935-45" (The developement of particle accelerators at Siemens 1935-45) in "Technikgeschichte", VDI-Editors,* **55***, p. 25-46 (1988).*

[Pa47] **Paul, W. und Dänzer, H.:** *"Betatrons" (Betatrons), Chapter 5.5 in "Naturforschung und Medizin in Deutschland 1939-1946", Vol.* **14***, Part II, p. 49-80, Verlag Chemie, Weinheim (1947), in German.*

[Pa79] **Paul, W.:** *"Early Days In The Developmen Of Accelerators" in "Aesthetics and science", proceedings of the international symposium in honor of Robert R. Wilson, April 27, 1979, Batavia, Ill. : Fermi National Accelerator Laboratory, 109 p.*

[Pa93] **Paul, W.:** *Letter to P. Waloschek, Jan. 14., 1993 (PPW).*

[Pi85] **Piekalkiewicz, J.:** *"Der Zweite Weltkrieg" (The second World-War), Econ (1985), 1119 p.*

[Po93] **Powers, Thomas:** ***"Heisenbergs Krieg" (Heisenbergs War), Hoffmann und Campe (1993), 767 p.***

[Re44] **Reiniger, F.:** ***full-size drawings of the 15-MeV btatron, dated March 11, 1944, ETH,*** **Hs 903*: 35-40*.**

[Ro03] **Roederer, G:** ***"Early Cosmic-Ray Research in Argentina", Physics Today, Vol. 56, p. 32, Jan. 2003*.**

[Ro79] **Rompe, R. et al:** ***"Max Steenbeck zum 75. Geburtstag", Colloquium on June 28, 1979, in "Sitzungsberichte der Akademie der Wissenschaften der DDR", 1980, Nr. 6/N, Akademie Verlag Berlin (1980).***

[Ru29] **Rüdenberg, R. (Hrsg.):** ***"Relais und Schutzschaltungen in elektrischen Kraftwerken und Netzen" (Relalys and protection circuits in power plants and networks), Julius Springer Berlin 1929, 284 p.***

[Ru33] **Rüdenberg, R. und Steenbeck, M.:** ***German-Patent (Siemens) 656 378, submitted on March 1, 1933, published on Febr. 4, 1938.***

[Ru94] **Rudenberg, H.G. and Rudenberg, F.H.:** ***"Reinhold Rüdenberg as a Physicist – His Contributions and Patents on the Electron Microscope, Traced Back to the 'Göttingen Electron Group'", Bull. of the Mi-croscopy Society of America (MSA), Vol. 24, Nr. 4, p. 572-580 (1994).***

[Ru95] **Rudenberg, H.G.:** ***Letter to P. Waloschek, April 27, 1995 (PPW).***

[Sa94] **Samusch, Elisabeth:** ***Letter to P. Waloschek, March 3, 1994 (PPW).***

[SE19] **Schiebold, E.:** ***PhD-Thesis: "Die Verwendung der Lauediagramme zur Bestimmung der Struktur des Kalkspates", in: "Mitteilung aus dem Institut für Mineralogie und Petrographie der Universität Leipzig", published in "Abhandl. d. S. Akademie d. Wissensch.", math.-phys. Kl. XXXVI, No. II, B. G. Teubner, Leipizg (1919) 213 p., 46 Illustrations.***

[SE40] **Schiebold, E.:** ***Prospectus on his mobile X-ray station ("Röntgen-Kraftwagenstation") with a photograph. Received from J. Schiebold, one page, A4-size, (PPW: A-1).***

[SE43a] **Schiebold, E.:** ***"Vorschlag eines zusätzlichen Kampfmittels ...", draft of the proposal to use X-rays for war-purposes. April 5, 1943, 9 + 1 pages, NES: #01-10.***

[SE43b] **Schiebold, E.:** ***"Niederschrift über die Besprechung Seifert-Fennel-Schiebold vom 17. April 1943" in Hamburg, NES: #75 to 77.***

[SE43c] **Schiebold, E.:** ***1. Addendum of April 19, 1943 to the proposal [SE43a], NES: #11-15.***

[SE43d] **Schiebold, E.:** ***2. Addendum of April 21, 1943 to the proposal [SE43a], NES: #16-17.***

[SE43e] **Schiebold, E.:** ***3. Addendum of May 5, 1943 to the proposal [SE43a], NES: #78 bis 81.***

[SE43f] **Schiebold, E.:** ***Draft for a contract between Schie-bold´s "Institut" (Leipzig) and Wideröe dated Oct. 19, 1943, written by Dr. Jur. Schilling, Essen, NES: #84 bis 88.***

[SE44a] **Schiebold, E.:** ***List of tasks assigned to the research department Gr.O." ("Aufgaben der Forschungsstelle Gr.-O.") 8 items, dated Febr. 18, 1944, NES: #91.***

[SE44b] **Schiebold, E.:** ***Letter dated Febr. 24, 1944 to the "Commandant of Gr.-O." about the discussion meeting of Febr. 18, 1944, NES: #90.***

[SE44c] **Schiebold, E.:** ***Letter dated Febr. 29, 1944 to Georgii, protesting to "clarify the situation", NES: #92x2-93.***

[SE44d] **Schiebold, E.:** ***Short report (1 p.) of May 5, 1944 related to the commission of Apr. 20, 1943. with 17 items. Item #13 refers to an order to C.H.F. Müller HH for the design of a 15-MeV beam-transformer following Wideröe´s ideas, NES: #94.***

[SE44e] **Schiebold, E.:** ***scientific programm proposed on May 4, 1944 for the research laboratory Gross Ostheim. It includes: a) 1,2 MV DC-installation, b)***

15-MeV betatron, c) 2,2 MV DC-installation (at Müller HH) and a 200-MeV Betatron (in preparation), NES: #95-104.

[SE44g] **Schiebold, E.:** ***„Ausarbeitung" (Long elaboration) dated July 12, 1944, to Kulenkampff as answer on his critics of Febr. 22, 1944. 41 p. (!), page 1 missing, NES: #18 bis 57.***

[SE44h] **Schiebold, E.:** ***"Entgegnung" (Reply) to Kuhlenkampff´s report of July 17, 1944, NES: #110-117.***

[SE44i] **Schiebold, E:** ***Letter to Gerlach dated Aug. 3, 1944 accepting invitation of July 29 (PPW: A-14).***

[SE44j] **Schiebold, E.:** ***Critical comments of Sept. 20, 1944 to Gerlach´s "Minutes" ("Niederschrift") of Aug. 25, 1944, distributed to Milch, Gerlach, Diesing, Mentzel, Georgii, Geist, G1C/E-Chef(RLM), Esau, Hei-senberg, Tamms, Egerer(VDE), Seifert, z.d.A. (13 copies). NES: #119 bis 133.***

[SE59] **Schiebold, E.:** ***"Festschrift zu seinem 65. Geburtstag" (Publication in honour of his 65th birthday) published as "Freiberger Forschungsheft" B37 & B38, Akademie Verlag Berlin, Part I (1959), 162 p., Part II (1960), 350 p.***

[SE75] **Schiebold, E.:** ***Chronology of life data and list of scientific publications, probably from an anual report, 6 p., first page: "A. 52 - E. Schiebold X/ 1975" (PPW: A-28...).***

[SE94] **Schiebold, E.:** ***Scientific Colloquium on his 100th birthday on June 9, 1994, in Magdeburg, Talks [Ka94] and Notes, several parts (PPW).***

[SE95] **Schiebold-Guest-Lectures** ***at the Univ. Magdeburg, announcing leaflet of Febr 1, 1995.***

[SJ94a] **Schiebold, Joachim:** ***Letter to P. Waloschek dated Apr. 20, 1994 (PPW: A-43-44) with details on three commisions of the RLM (Luftwaffe) to E. Schiebold.***

[SJ94b] **Schiebold, Joachim:** ***"Vorgänge nach 1945" (Happenings after 1945), to P. Waloschek, 3 p., Nov. 1994 (PPW: A-97...), text based on the documenation of Ernst Schiebold.***

[SJ94c] **Schiebold, Joachim:** ***Several lists on the life of Ernst Schie-bold, based on existing documentsto P. Waloschek, 27 S. (PPW: A-54 to A-80).***

[SJ94d] **Schiebold, Joachim:** ***Letter to P. Waloschek, Apr. 29, 1994 (PPW: A-47) with some additional data from the extensive estate ("Nachlass") of Ernst Schiebold.***

[SJ94e] **Schiebold, Joachim:** ***Notes on a meeting with P. Waloschek on Apr. 15, 1994.***

[SJ98] **Schiebold, Joachim:** ***Last postcard to P. Waloschek, Dez. 24, 1998 (PPW: A-116).***

[SG03] **Schiebold, Gerda:** ***E-mails to P. Waloschek dated Febr. 3, 2003 and Dec. 4, 2003 regarding documents of the estate ("Nachlass") of Ernst Schiebold.***

[So02] **Sommerfeld, Ernst:** ***Documents regarding patents of Wideröe, 2007 new at Deutsches Museum München.***

[SK95] **Seib, Klaus:** ***Letter of March 9, 1995 to P. Waloschek (PPW: A-109...), see also [Ni93].***

[Sl22]? **Slepian, J.:** ***"X-Ray Tube", US-Patent 698,867, submitted on March 3, 1936, published Dec. 28, 1937.***

[SM94] **Scheer, M.:** ***Letter to P. Waloschek, Nov. 7, 1994 (PPW: A-100).***

[SP99] **Schlesinger, Peter A.:** ***Internet-page, interesting, questionalble ("www.HSVT.org"), not updated after 1999.***

[SR67] **Seifert, R.:** ***"75 Jahre Rich. Seifert und Co." (Disk recording a radio transmission on 75 years of Rich. Seifert´s company called "Das Porträt"), Dez. 1967.***

[St35] **Steenbeck, M.:** ***German Patents (Siemens) 656 378 und 698 867 (the last one submitted on March 7, 1935, accepted on Dec. 6,1940), submitted also as Austrian. Patent Nr. 153 324.***

[St36] **Steenbeck, M.:** ***US-Pat. (Siemens) 2 103 303, submitted on March 6, 1936, issued on Dec. 28, 1937.***

[St37] **Stark, Johannes:** ***Contribution to the article "Weiße Juden in der Wissenschaft" (White yews in science) in the review of the SS "Das Schwarze Korps" of July 15, 1937. See i.e. Universitätsarchiv Leipzig, Exhibition on the 100th birthday of Werner Heisenbergs.***

[St42] **Steenbeck, M.:** ***Short report on his betatron-experiments in the review "Elec-tronics", Febr. 1942, p.22-23.***

[St43] **Steenbeck, M.:** ***"Beschleunigung von Elektronen durch elektrische Wirbelfelder" (Accleration of electrons in electrical vortex fields) in "Naturwissenschaften", (short news) on March 20, 1943, Issue 19/20, Vol. 31, p. 234-235 (1943).***

[St64] **Steenbeck, M.:** ***„Persönliche Erinnerungen aus der Betatron Entwicklung" (Personal remembrances from the betatron development), in "Wiss. Zeitschr. der Friedrich-Schiller-Universität Jena", 13th year, Issue 4, Series: Mathem.-Naturwiss., p. 437-438 (1964).***

[St77] **Steenbeck, M.:** ***„Impulse und Wirkungen – Schritte auf meinem Lebensweg" (Impulses and effects, steps in my life, autobiography), published by "Verlag der Nation", Berlin, DDR (1977), 447 pages.***

[St83] **Stadtmüller, Alois:** ***„Mein Gebiet und Spessart im Zweiten Weltkrieg" (My region and Spessart in WW II) A publication of the "Geschichts- und Kunstvereins Aschaffenburg", 1983, Stadt- und Stiftsarchiv Schönborner Hof.***

[St94] **Stüben, Alfred:** ***Personal communication to P. Waloschek on the history of Rich. Seifert & Co, with the help of [SR67].***

[Sw89] **Swinne, E.:** ***„Friedrich Paschen als Hochschullehrer" (Friedrich Paschen as university teacher), book published by "Berliner Beiträge zur Geschichte der Naturwissenschaften und der Technik, D.A.V.I.D." editors in Berlin (1989), 166 pages.***

[Sw92] **Swinne, E.:** ***„Richard Gans – Hochschullehrer in Deutschland und Argentinien", (Richatd Gans - University teacher in Germany and Argentina) published in "Berliner Beiträge zur Geschichte der Naturwissenschaften und der Technik", ERS-Editors, Berlin (1992), 212 pages.***

[Sw93] **Swinne, E.:** ***Private communitions to Pedro Waloschek (letters and telephone calls 1993, PPW-SW) with results from his accurate research activity including documents of the 'Berlin Document Center' (BDC) and the 'German Federal Archives' in Coblenz,***

[Ta43] **Tamms, F.:** ***Drawings ofthe bunkers und der hall of the reasearch centre of the Luftwaffe in Groß Ostheim dated Sept. 8, 1943, NES, not numbered pages. New drawing by P. Walo-schek (PPW: A-2 und A-3).***

[Ta93] **Tangen, R.:** ***Letters to Pedro Waloschek of May 9 and July 22, 1993.***

[TE00] **TESLA:** ***Name of a proposed "TeV-Energy Superconducting Linear Accelerator" at DESY.***

[Te02] **Tesla, N.:** ***Many publications on Tesla available, so i.e. the 6 volumes edited by Ulrich Heerd, German version by Franz Ferzak, published as "Edition Tesla" (1997) and "Tesla Life and Legacy" in the internet: (www.pbs.org/tesla/) of the USA TV PBS.***

[Te03] **Tesla, N.:** ***Several Tesla-societies, i.e.: „Tesla Memorial Society in New York" Ridgewood, New York; „Australian Nikola Tesla Society", Melbourne, Victoria, Australia; „San Francisco Tesla Society", San Francisco, USA; „International Tesla Institute", Colorado Springs, USA.;. „The Tesla Memorial Society", New Jersey USA.***

[Te03a] **Tesla-Platten:** ***Tesla "plates" with special properties. See i.e. Philip Stul, Basel, Internet pages (i.e. www.teslaplatten.ch.).***

[To43] **Touschek, B.:** ***Letters to his parents from Berlin dated Febr. 15, and June 17, 1943. See [Bo11a].***

[To44] **Touschek, B.:** ***"Berechnung für großflächige***

Anode" (computations for big-sized anodes), AZ: „037077/448", NES: #70-71 and microfilm from Joachim Schiebold (PPW).

[To45a] **Touschek, B.:** ***Letters to his parents from Kellinghusen dated June, 22 and Nov. 17, 1945. English translations in [Bo11a].***

[To45b] **Touschek, B.:** ***Typed reports about betatrons, ETH,* Hs 903*: 29, 30, 33, 73, 74. Titles of seven such reports are mentioned in [Hy46].***

[To48] **Touschek, B.:** ***"Zur Theorie des doppelten Betazerfalls" (On the theory of the double beta decay), Z. Phys. 125, 108 (1948).***

[To49] **Touschek, B.:** ***"Zum analytischen Verhalten Schrö-din-ger'scher Wellenfunktionen" (on the analytical behaviour of Schrödinger´s wave function), Z.Phys. 125, 293 (1949).***

[To60] **Touschek, B.:** ***First proposal for an electron-positron storage ring. Seminar in Frascati, on March 7, 1960 (s. i.e. [Am81]).***

[Ve45] **Veksler, V.:** ***"A New Method of Acceleration of Relativistic Particles", Journal of Physics UdSSR,* 9*, 153-158 (1945), English translation in [Li66], p. 202.***

[UL03] **University of Leipzig:** ***„Geschichte der mineralogisch-petro-graphischen Sammlung vor dem 2. Weltkrieg" (History of the mineralogical and petrographical collection before WW I), www.uni-leipzig.de (2003) (see also PPW: A-122).***

[Wa00] **Waloschek, P.:** ***Archives of family Waloschek in Hamburg, more then 2400 letters and about 400 documents.***

[Wa04] **Waloschek; P.:** ***"Todesstrahlen als Lebensretter", BoD, 240 S. (2004) ISBN 978-3-8334-1616-3.***

[Wa07] **Waloschek; P. (ed.):** ***"Rolf Wideröe (1902-1996). A Pioner of Particle Accelerators and Radiation Therapy", revised edition of [Wa93], BoD (2007), 208 p., 48 ill., ISBN 978-3-8370-0557-8.***

[Wa29] **Walton, E.T.S.:** ***„The Production of High Speed Electrons by Indirect Means", Proc. Cambr. Phil.***

Soc. **25**, *469-481 (1929). Submitted by E. Rutherford on June 17, 1929.*

[Wa93] **Waloschek, P. (ed.):** *„Als die Teilchen laufen lernten – Leben und Werk des Rolf Wideröe", Vieweg (1993) and „The Infancy of Particle Accelerators – Life and Work of Rolf Wideröe", Vieweg (1994) and DESY-R eport 94-039, March 1994. A Russian translation was published in 1998. All three edions are out of print, pdf-versions are available in the Internet under "Monographies" at the DESY-Library and under www.waloschek.de . Revised versions were published 2004 in German: "Rolf Wideröe über sich selbst", ISBN 978-3-8334-0804-5 and 2007 in English, "Rolf Wideröe", ISBN 978-3-8370-0557-8.*

[Wa04a] **Waloschek, P.:** *"Todesstrahlen als Lebensretter – Tatsachenberichte aus dem Dritten Reich", BoD (2004), 240 pages, 20 illustrations, ISBN 978-3-8334-1616-3.*

[Wa94b] **Waloschek, P.:** *Notes on a meeting at C.H.F. Müller on Apr. 28, 1994 (PPW-A-130).*

[Wa98] **Waloschek, P.:** *"Wörterbuch Physik" (Physics Dictionary), Deutscher Taschenbuch Verlag (dtv) 1998, 596 pages. Corrected 2nd edition by Tosa editors, Vienna 2006.*

[We94] **Weiss, B.:** *"The 'Minerva' Project", p. 271 to 405 in „Sci-ence, Tech-nology and Nacional Socialism" edited by M. Renneberg and M. Walker, Cambridge Uni-ver-sity Press, 1994.*

[We00] **Weiss, B.:** *"Die Megavolt-Röntgenanlage des Allgemeinen Krankenhauses Hamburg-Barmbek (1938-1945): Vom Therapiegerät zur Strah-lenwaffe" (The MVolt-X-ray installation at the Barmbek hospital (1938-1945): From therapy to waepons), in Med. hist. J. 35 (2000) 55-84.*

[We03] **Weil, J.W.:** *"Friedrich Georg Houtermans - Ein abenteuerliches Leben für die Kernphysik" (Friedrich Georg Houtermans - an adventurous life for nuclear physcs), book presented on 25.03.2003*

in the Austrian Academy of Sciences (Vienna), "to be published soon".

[We03a] **Weiss, B.:** ***"Ein Forscher ohne Labor ist wie ein Soldat ohne Waffe – Ernst Schiebold und die zerstörungsfreie Materialforschung und -prüfung in Deutschland" (A scientist without a laboratory is like a soldier without weapons –– Ernst Schiebold and the non destructive materials testing in Germany), p. 209 to 220 in "Physik im Nach-kriegs-deutsch-land", edited by Dieter Hoffmann, published by Harri Deutsch (2003).***

[Wi23] **Wideröe, R.:** ***Original copy books from 1923 to 1928 with sketches and computations on the ray-transformer, ETH Library Zürich, Archiv: Hs 903: 624-632 (633-638?).***

[Wi28] **Wideröe, R.:** ***"Über ein neues Prinzip zur Herstellung hoher Spannungen" (On a new principle to obtain high voltages), Arch. f. Elektrot. Vol. 21, 387 (1928), 27 pages, PhD-thesis at the TH-Aachen. English version in [Li66], p. 92.***

[Wi42] **Wideröe, R.:** ***"Der Strahlentransformator" (The ray-transformer), Arch. f. Elek-trot., Vol. 37, 542-555 (1943), submitted on Sept. 15, 1942, typesetted (composed with page numbers) and corrected. It was probably considered as a secret of war and in the last moment substituted in the printed version of the journal by another contribution, of exactly the same length and page numbers [Bo11b] [Wu11].***

[Wi43a] **Wideröe, R.:** ***"Speicherringe mit kollidierenden Strah-len" (Subject: storage rings with colliding beams) German Pat. Nr. 876279, Klasse 21g, Gruppe 36, submitted on Sept. 8, 1943, published on May 11, 1953 (for BBC). Up to 1945 Wideröe had submitted in total 12 patents on betatrons which were all kept secret.***

[Wi43b] **Wideröe, R.:** ***"Bericht über Theorie des Betatrons" (Report on the theory of the betatron), Oslo, Sept. 1943, ETH,* Hs 903: *41, 44, 45.***

[Wi43c] **Wideröe, R.:** ***"Vorschläge über eine möglichst***

rasche Durchführung von Konstruktion, Bau und Aufstellung des Strahlentransformators" (Proposals for a fast construction and installation of the beam-transformer), Oslo, Nv. 6,1943, 4 S., ETH, **Hs 903***: 48.*

[Wi44] **Wideröe, R.:** ***Report on the visits to BBC in Weinheim (27 to 29, April 1944), wrtitten on May 1, 1944, ETH,*** **Hs 903***: 62, 63.*

[Wi46] **Wideröe, R.:** ***"Anordnung zur Beschleunigung von elektrisch geladenen Teilchen" (A set up to accelerate charged particles, thoery of the synchrotron!) Norw. Patent Nr. 76 696 submited Jan. 31, 1946; submtted inGermany on Nov. 9, 1948, Nr. 847 318, published on June 26, 1952.***

[Wi46a] **Wideröe, R.:** ***"Forelegg", Important "proposal" of the Oslo Police Authorities accepted and signed by Rolf Wideröe on Nov. 2, 1946. Original at the Norwegian Na-tional Archives in Oslo.***

[Wi48] **Wideröe, R.:** ***Exchange of letters with Ernst Sommerfeld with questions to his father Arnold regarding linear accelerators and travelling waves, June 1948. Copies kindly provided by Frau Monika Baier (München). Copies at PPW.***

[Wi80] **Wideröe, R.:** ***Most extensive collection of documents, data and the estate of R. Wideröer in the archives of the Libratry of theer Eidgenössische Technische Hochschule in Zürich, ETH,*** **Hs 903.**

[Wi90] **Wideröe, R.:** ***"Zweikomponententheorie und Strahlentherapie" (The two components theory and radiation therapy), Lecture at Paul-Scherrer-Inst., Villigen, 1988, Strahlenther. Onkoll*** **166,** ***311-316 (1990).***

[Wi94] **Wideröe, R.:** ***Several lists about: (a) Publications, (b) Patents and (c) Journays (PPW).***

[Wu11] **Wulff, Outi.:** ***Communication to P. Waloschek, e-mails of June 6, 2011.***