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Computer Graphics at DESY

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by

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Abstract:

A survey of the history, development, and status of graphics at DESY is given; hardware and software components of our system are presented as well as future plans.

Introduction

The history of graphics at DESY begins in '69, when first planning of a true graphic facility started out. At that time huge piles of crude histograms and scatterplots -mainly of bubble chamber experiments- were produced as line printer output of batch jobs. Most of them went into the waste-basket because of wrong binning and/or event selection; after time and paper consuming re-runs the "good" pictures had to be redrawn by draftsmen for publication. So the idea was to get a hardcopy device fast and accurate enough to produce high quality pictures ready for publication (especially scatterplots with tenthousands of points), a graphic display terminal capable of showing large collections of points and vectors free of flicker, and a program system for interactively presenting and selecting data from large data bases. The natural choice was to build a system consisting of an electro-static plotter and storage tube display terminals with keyboard and graphic input device connected to the IBM/360 of the DESY computing center.

Since we planned for a large number of terminals and money was scarce, it was decided to purchase only components like display monitors, keyboards, plotter, mini computers, etc, from the manufactures, and develop and build everything else in our group R2, including a low cost data transmission system.

Development of the graphic system IPS at DESY

The first electro-static plotter -a VARIAN STATOS V- was purchased in '70; it went into operation in '71 connected to a 2701 parallel data adapter unit of the IBM host via a home grown interface. The device was operated from the main console of the IBM(!); the first application was to simulate a "universal printing chain" in software for neat printed output (TEXT360).

The development of the main hardware components started in '71: a general data transmission system -called "dataline", a display controller, and various interfaces. At the same time the software for the graphics system and basic applications was being developed on the IBM.

In '72 the prototype of our graphic system IPS -"Interactive Plotting System"- was ready for production work: It consisted of one graphic display terminal (Tektronix 611 storage tube monitor with keyboard), one display controller, one electro-static plotter (VARIAN STATOS V), and a controller (Data General NOVA 1200 mini computer), and was linked to a 2701 on the IBM/360-65 via our "dataline" datatransmission system.

In '73 the important step from one to more than one (namely 2) terminals was done. We built a control program on the IBM with a TSO-like multitasking structure using TCAM as a message switching facility. While the main application was the presentation of experimental data in the form of histograms, scatterplots, and graphs, the DESY group F33 came up with the idea of using our system for interactively scanning events from the PLUTO-detector. So we added two more terminals to the system on a second NOVA 1200, and from '74 on there were 4 public 611-Terminals in operation. At that time the DESY computing center was running 2 IBM/360-168 machines, and TSO was being introduced on the site.

Since there was a strong need for more graphic terminals plans were discussed to take a big step forward by using a new concept: to connect graphic terminals via a general computer net (DESYNET) hooked to the host computer via a programmable channel interface and make them look like "ordinary" TSO-Terminals with graphic capabilities.

The main advantages of the new concepture are:

- utilization of standard software on the IBM
- limitation of the number of graphic terminals only by TSO
- availability of standard TSO facilities at the graphic terminals
- mutual independence of graphic user sessions on the host

While the four 611-terminals of the "old" IPS were still heavily used, we started to bring up "TSO-IPS": In '76 we ordered the first NOVA3 with 4025 programmable interface to connect our system to the IBM channel. In '77 we were able to prove the correctness of the new concept by running a second electro-static plotter (GOULD 5200) via the new link and having the first TSO-session at a graphic terminal. At the same time the basic software for the general computer net DESYNET was being developed.

The major breakthrough came in '78, when due to the upcoming new PETRA experiments a "spontaneous" need and engagement of the local physicists for graphics occurred. To cope with the new main application we ordered ten Tektronix 619-monitors with larger screens; to make the system more flexible a second NOVA3-4025 was purchased to access the second IBM machine simultaneously.

By the end of '78 six graphic terminals (4 x 611 + 2 x 619) were running successfully under TSO and the "old" IPS was discontinued. In spring '79 TSO-IPS reached its so far larges extension with 13 public terminals (3 x 611 + 10 x 619), as shown in figure 1.

TSO-IPS is now running under MVS on the new IBM/370-3033 computer, which was added to the DESY computing center in May '79.

Hardware components of IPS

The following components are used in IPS as manufacturer supplied hardware:

1.) Display monitors: Tektronix 611 and 619 storage tubes with "write through", 4096 x 4096 addressable points, HP 1300 refresh CRT
PLATO IV plasma panel, 512 x 512 addressable points

2.) Plotters: GOULD 5200 electro-static plotter, 200 dots/inch, 2112 dots/line.

3.) Terminal controllers: Data General NOVA 1200 and NOVA 3, up to 32 K 16 bit words of memory

4.) alphanumeric and graphic input: keyboards and joysticks

Everything else has been developed and built in our group:

1. a general data transmission system: "dataline", 7 Mbit/sec serially full duplex on 50Ω koax transmission lines, 2 modules (transmitter / receiver, microprogrammed supervisor),
32 bit blocks transmission (16 bit data, 16 bit address + control).

2. a general purpose display controller with "dataline" and analog output, 11 bit 2's-complement relative point, vector and increment mode, character generator.

3. various interface moduls, mostly in microprogrammed technique.

Software Components of IPS

There are two software systems involved when running a graphic session under TSO:

The first one is the DESYNET and terminal controller software which is used to connect a terminal to the IBM. It is written in PASCAL and Assembler language and allows the user to build a "virtual link" to the host, run his session, and ultimately delete the link again. There is a very simple command language to serve this purpose.

The second system resides on the IBM: A new TSO command processor IPS was written, which allows to activate any general (R2 supplied) or user written graphic application module. A subroutine package was supplied to manage terminal I/O of graphic data and to allow for dynamic allocation of data sets at run time.

The transmission of graphic data to the terminal turned out to be the main problem, since graphic data is of binary nature in principle (x,y-coordinates) and TSO/TCAM does only let pass "valid" EBCDIC characters. Our first approach was to use the "TCS character string" format, which turned out to be too slow, because we had to simulate standard Tektronix 40xx terminal on the mini computer side. So we invented a "trick" to circumvent this problem and gained a factor of more than 10 in speed. The methode involves a fast packing/unpacking algorithm of binary graphic data.

As a basic graphic subroutine package we currently use the Tektronix PLOT 10 software (TCS and AG II). There was one major modification done to TCS to have a hardcopy facility on the IBM, i.e. the addition of a "graphic transaction" file, which at any time contains the graphic elements of the current presentation on the terminal screen. By subroutine call a copy of this file may be sent to a special SYSOUT queue, which is served asynchronously by an "External writer" under JES3.

Concluding remarks

The graphic system IPS under TSO has proven to be a very efficient tool, which is heavily used at DESY. Especially the speed of graphic presentation on the screen compares favourably with the speed found at other labs.

One main application is the presentation of experimental data as histograms, scatterplots, hidden line plots, and other graphs, as well as printing of reports with upper and lower case letters and special characters. For these tasks there are a number of ready to use public modules available in the system.

The second main application is interactive scanning of events from the physical experiments at DESY. There are special user written modules for each experiment in production.

Typical examples of pictures generated with IPS are shown in Figures 2 to 19; for explanation see figure captions.

Some aspects of future development of our system are the following:

- taking graphics to the experiment locations: We are in the process of building terminal pools in the experimental halls; TASSO and PLUTO have already their private installations.
- improving and augmenting the hardware by use of special micro-programmed processors to replace the NOVA minis and to add more refresh capability to the storage tube terminals
- adding more and possibly wider electro-static plotters to the system
- implementation of more ready to use graphic software systems
- extensive work on more efficient data formats and command languages.

Figure captions:

Fig. 1 : R2-dataline-network DESYNET
Fig. 2 : scatterplot
Fig. 3 : histogram with fitted curves
Fig. 4 : graph generated by application module IPSAT
Fig. 5 : graph generated by using Tektronix AGII package
Fig. 6 and 7 : 2 examples of application module WAMQ
Fig. 8 and 9 : 2 examples from experimental group JADE
Fig. 10 and 11 : 2 examples from experimental group MARK J
Fig. 12 and 13 : 2 examples from experimental group PLUTO
Fig. 14 and 15 : 2 examples from experimental group TASSO
Fig. 16 : plot generated on TR86 graphic system
Fig. 17 : example of output from application module PRINTER
Fig. 18 : HERSHEY's occidental fonts
Fig. 19 : HERSHEY's far east fonts

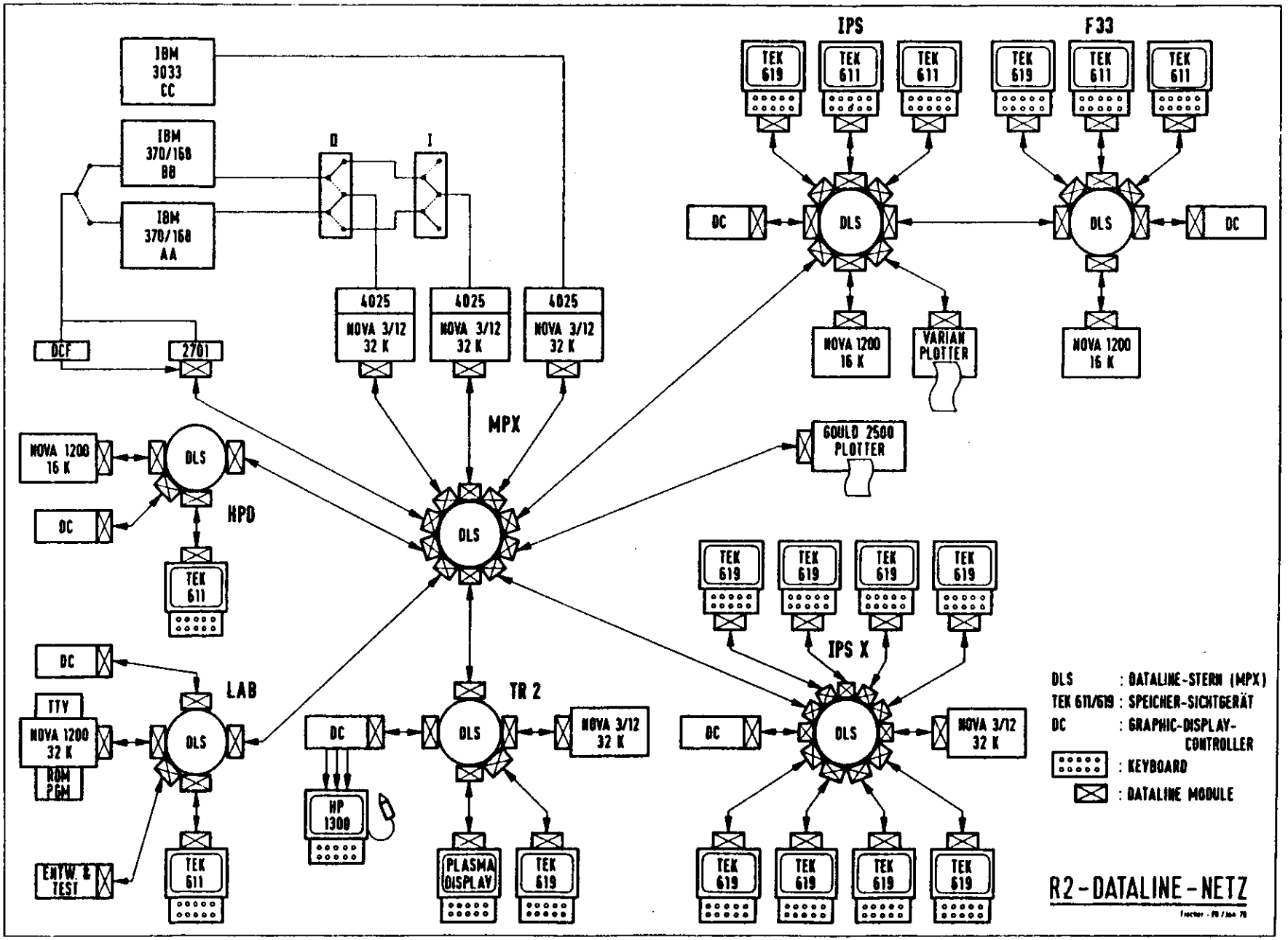
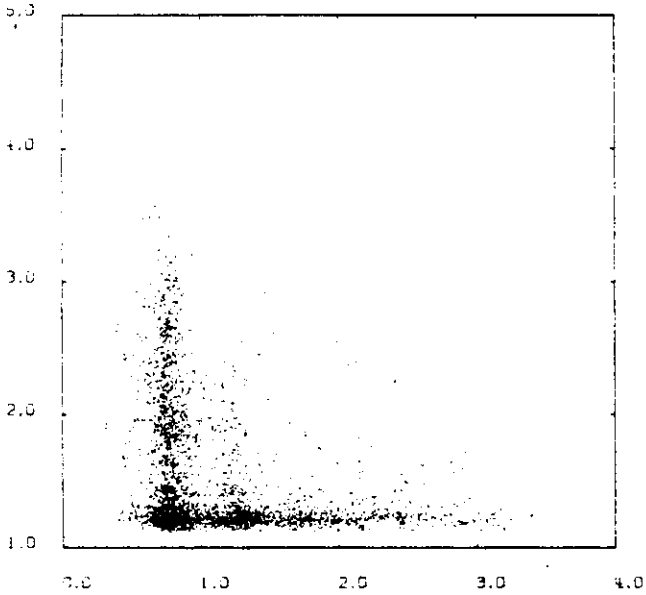


Fig. 1 : R2-dataline-network DESYNET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4.0
3.0
2.0
1.0
0.0
1.0
2.0
3.0
4.0

Fig. 2

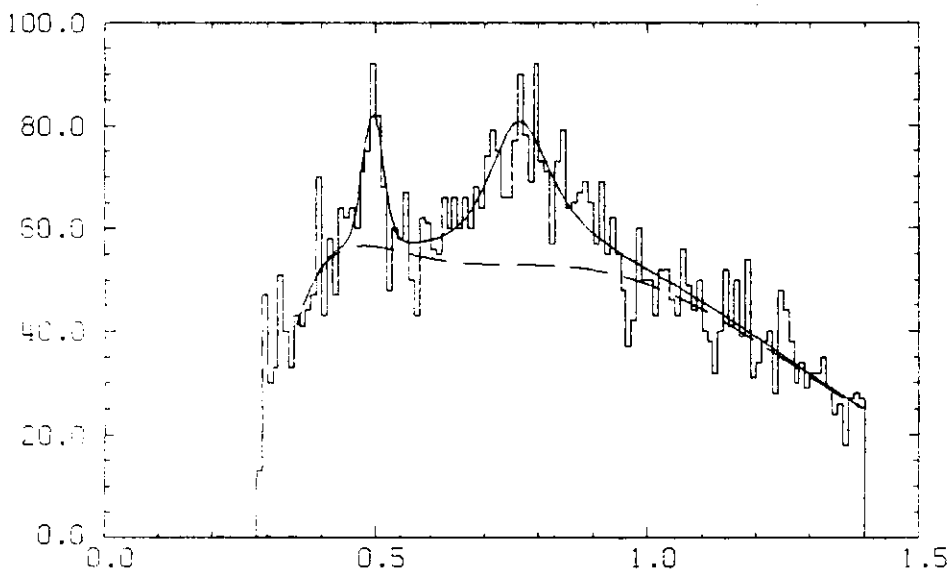

100.0
80.0
60.0
40.0
20.0
0.0
0.0
0.5
1.0
1.5
PI PI

Fig. 3

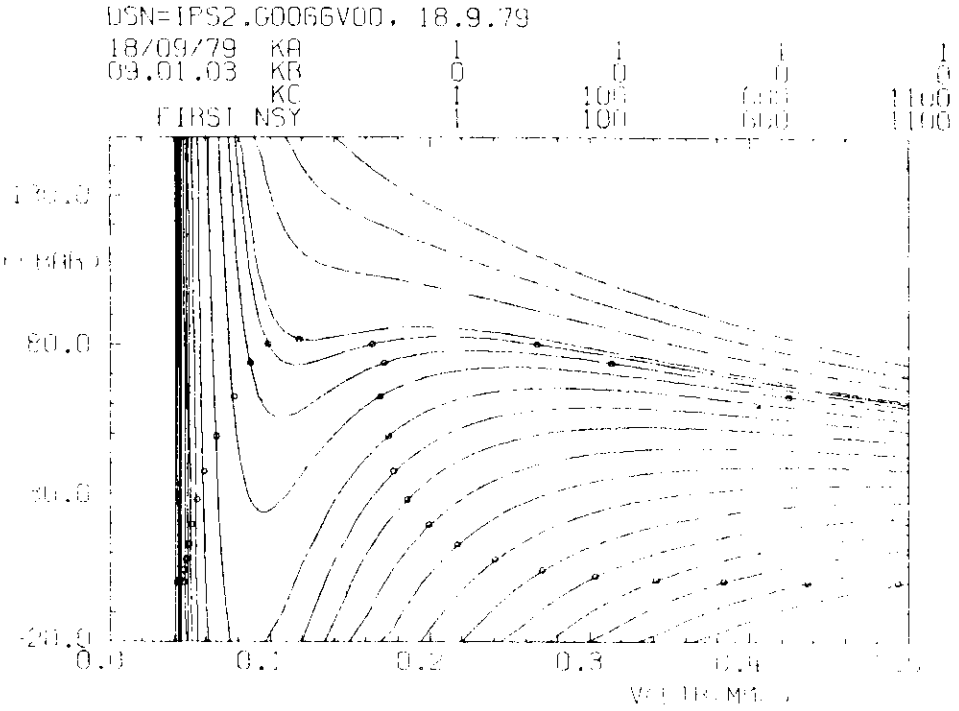
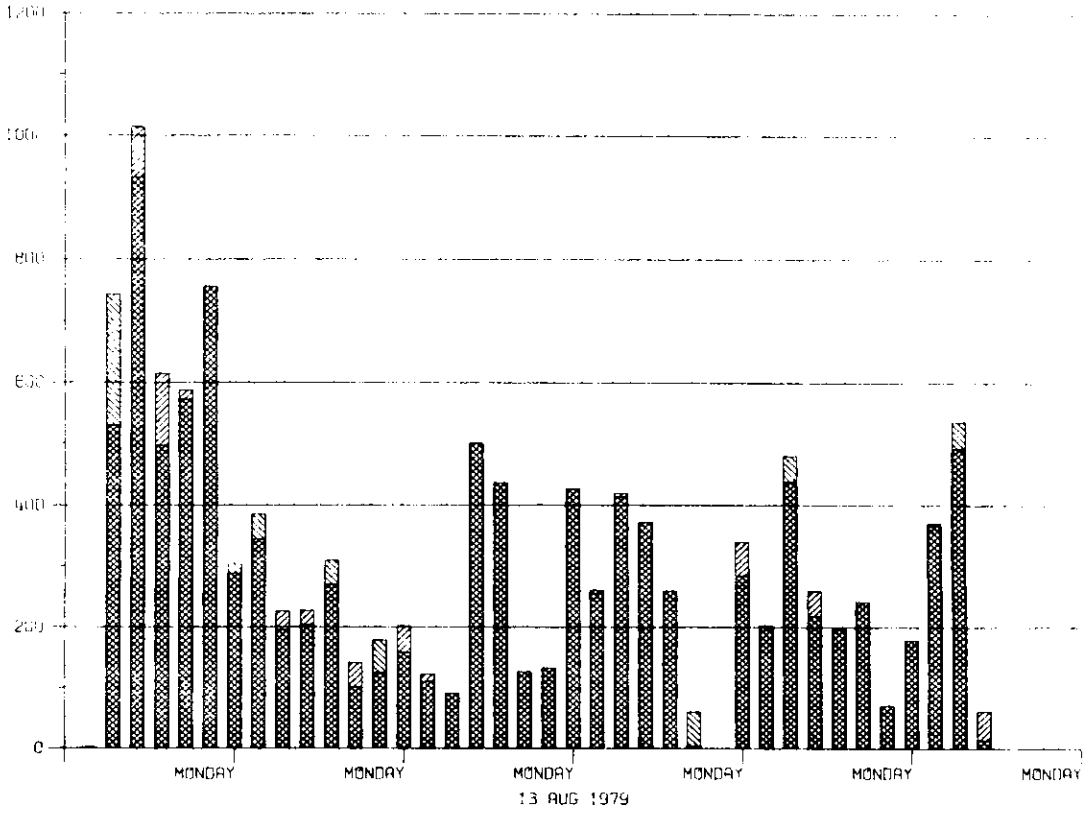


Fig. 4



NUMBER OF PLOTS QUEUED AND PLOTTED PER DAY.
TOTAL NUMBER OF DAYS= 38. TOTAL NUMBER OF PLOTS= 11320
MEANS VALUES - NPLOTS= 3371. NVCT= 2720. NPNT= 643. NTXT= 0.

Fig. 5

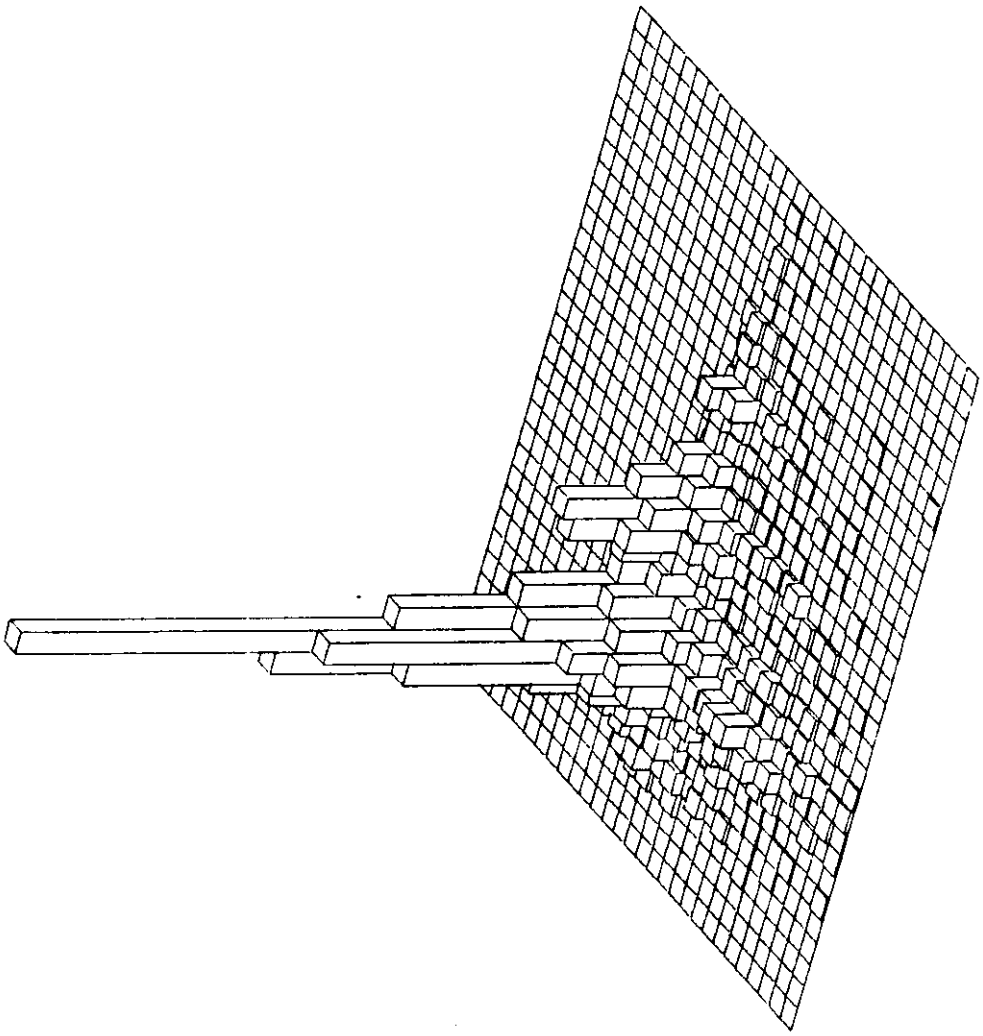


Fig. 6

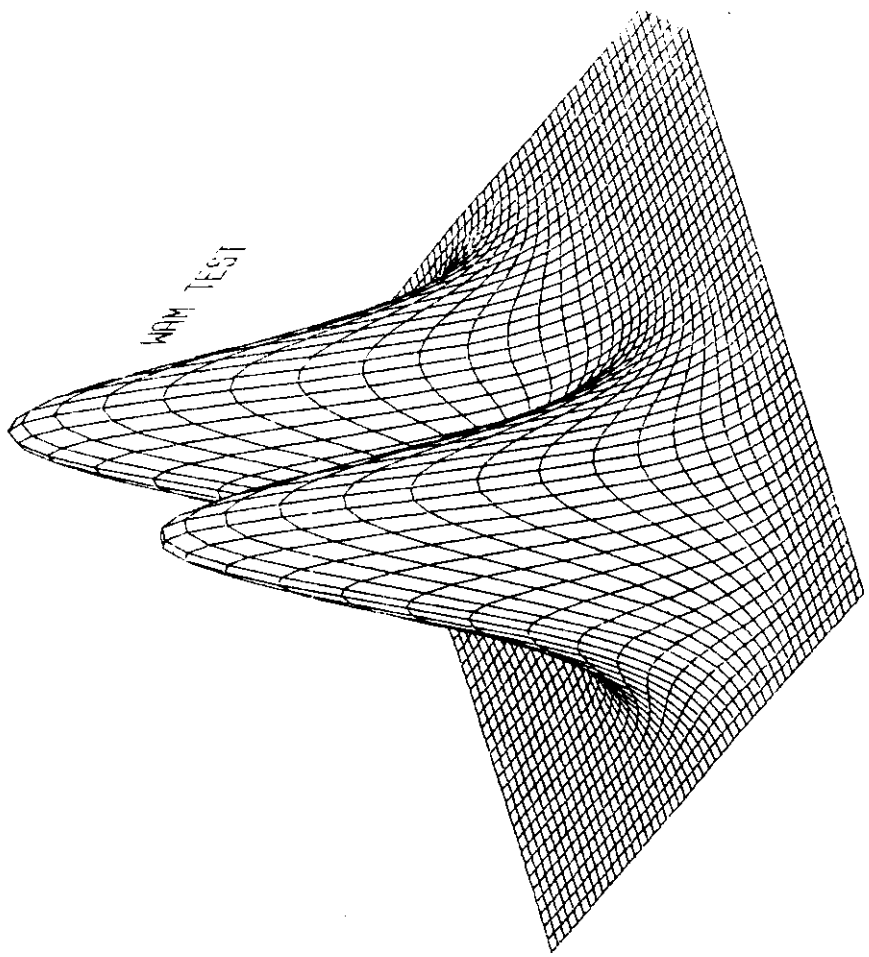
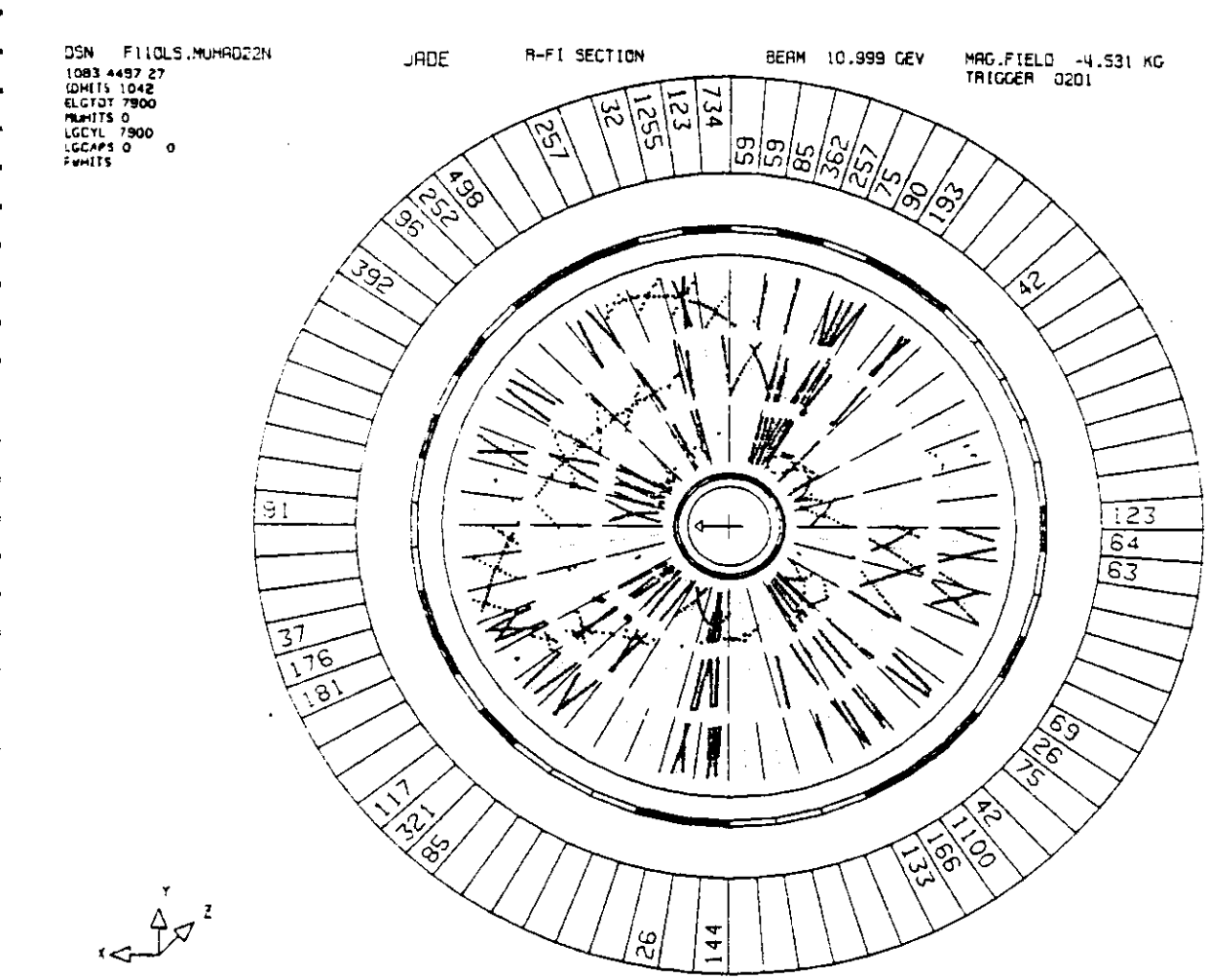


Fig. 7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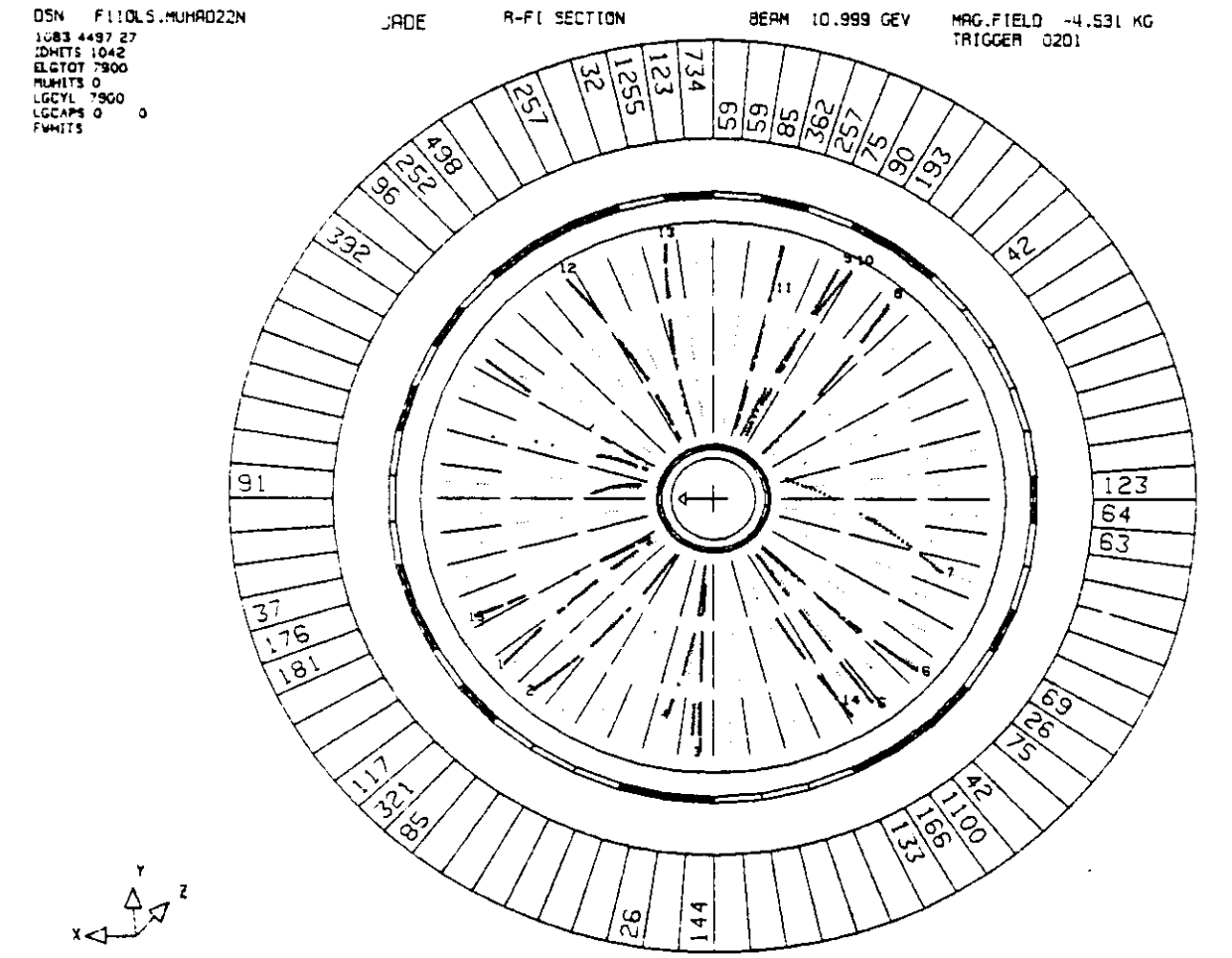
1083 4497 27
IDHITS 1042
ELGTOT 7900
MUHITS 0
LGCYL 7900
LGCAPS 0 0
FWHITS
JADE
R-FI SECTION
BEAM 10.999 GEV
MAG.FIELD -4.531 KG
TRIGGER 0201
DATE 20/09/79
TIME 16.03.41
734 123 1255 32 257 498 252 96 392 91 37 176 181 117 321 85 26 144 26 92 133 166 1100 42 75 26 69 63 64 123 193 90 75 257 362 85 59 59

Fig. 8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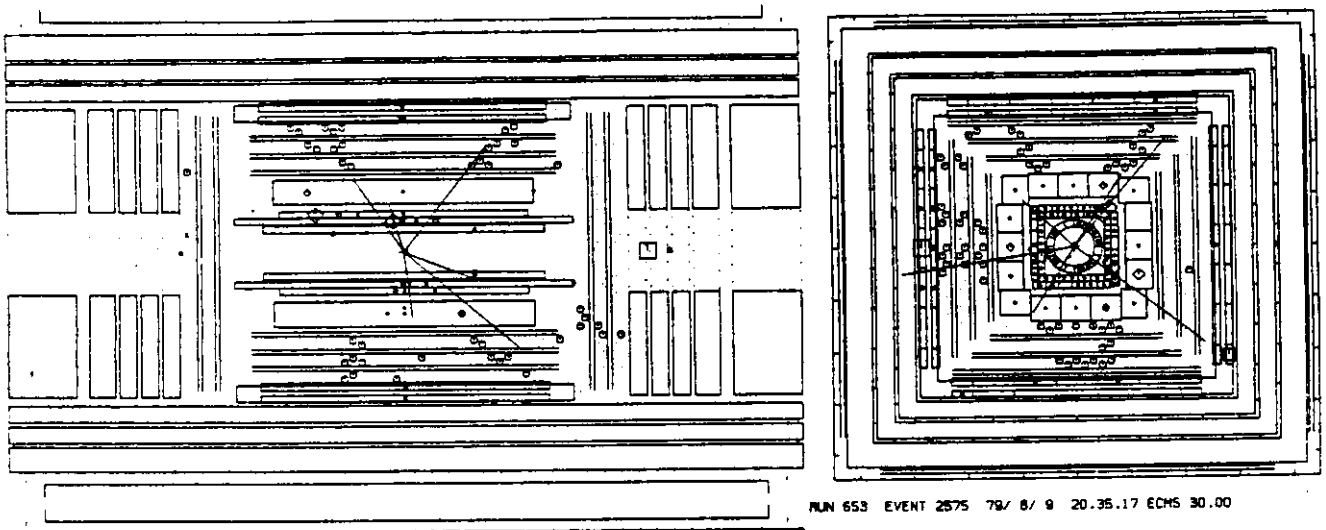
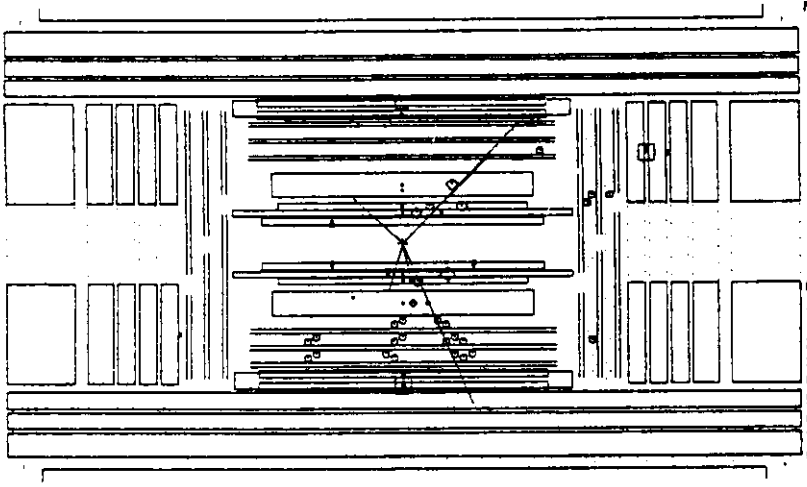
ELGTOT 7900
MUHITS 0
LGCYL 7900
LGCAPS 0 0
FWHITS
JADE
R-FI SECTION
BEAM 10.999 GEV
MAG.FIELD -4.531 KG
TRIGGER 0201
DATE 20/09/79
TIME 16.02.50
734 123 1255 32 257 498 252 96 392 91 37 176 181 117 321 85 26 144 26 92 133 166 1100 42 75 26 69 63 64 123 193 90 75 257 362 85 59 59

Fig. 9



RUN 653 EVENT 2575 79/ 8/ 9 20.35.17 ECMS 30.00

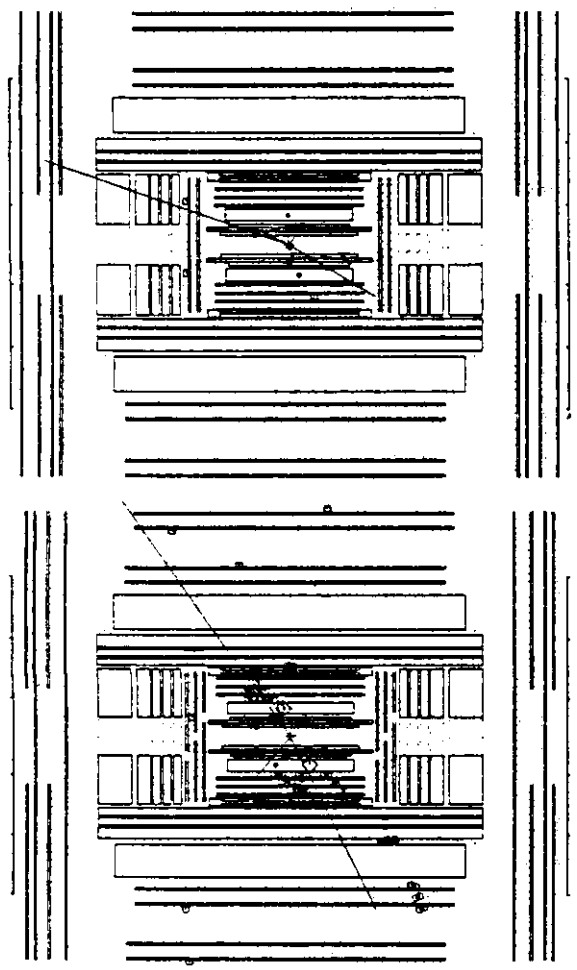
Fig. 10

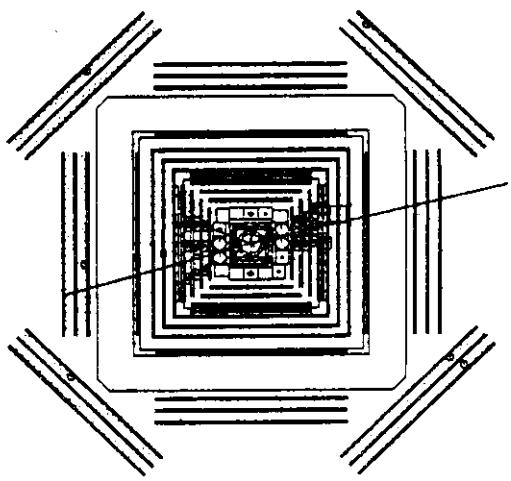


NJ 8 ETOT 32.10 EKO 8.28 PXYZ 0.21 1.88 8.47

J	EJ	EKO	THE	PHI	NC
1	6.94	0.38	59.8	51.1	4
2	3.99	0.0	118.7	57.3	5
3	2.83	1.85	101.5	136.4	8
4	7.37	2.52	88.2	189.2	10
5	3.13	0.11	84.4	238.3	7
6	7.87	1.47	54.8	322.2	9
7	0.21	0.0	35.3	115.1	1
8	0.15	0.15	121.4	0.0	1

EMIN= 0.10 ESCALE= 10.0





RUN 523 EVENT 3617 79/ 7/15 12.25.31 ECMS 0.55

Fig. 11

NJ 9 ETOT 30.30 EKO 12.74 PXYZ 5.73 2.04 -7.94

J	EJ	EKO	THE	PHI	NC
1	17.73	9.52	122.6	13.3	18
2	2.26	1.46	128.2	158.1	8
3	8.36	1.38	66.3	196.0	11
4	0.11	0.0	92.0	303.8	1
5	0.49	0.0	98.7	90.0	1
7	0.83	0.0	74.4	270.0	1
8	0.25	0.0	124.3	313.9	1
9	0.38	0.38	57.4	85.0	1

EMIN= 0.10 ESCALE= 10.0

RUN 20743

EVENT 4405

TR	1	-1.	320.	1.104
TR	2	-1.	309.	0.790
TR	3	-1.	291.	2.090
TR	4	1.	283.	4.386
TR	5	-1.	275.	0.449
TR	6	1.	268.	0.825
TR	7	1.	255.	0.749
TR	8	1.	246.	0.458
TR	9	1.	127.	0.287
TR	10	-1.	115.	31.474
TR	11	-1.	94.	0.245
TR	12	-1.	67.	0.729
TR	13	1.	47.	0.487
TR	14	1.	35.	0.277
TR	15	1.	29.	0.446
TR	16	1.	122.	0.080
BA	1	9.	124.	0.930
BA	2	12.	68.	0.211
BA	3	11.	100.	0.085
BA	4	10.	115.	0.573
BA	5	15.	29.	1.005
BA	6	7.	254.	0.140
BA	7	4.	285.	2.026
BA	8	0.	244.	0.491
BA	9	11.	104.	0.229
BA	10	0.	276.	0.160

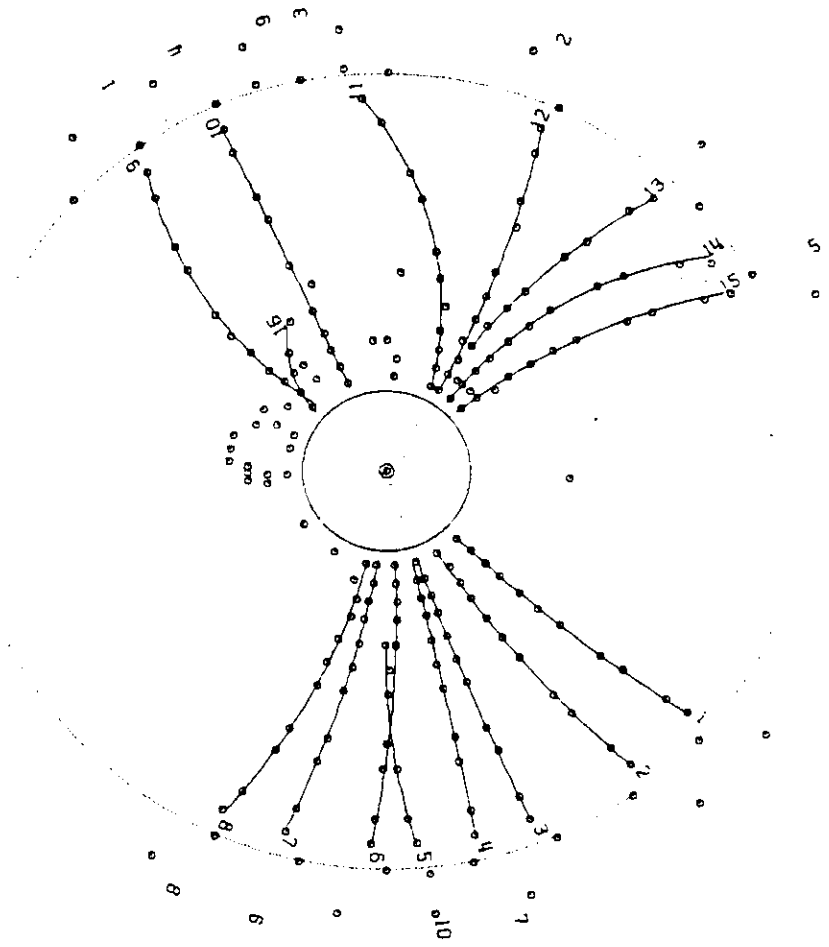


Fig. 12

RUN 20743
EVENT 4403
SHOWER ADCS.SUM
CUTS= 1.30000
MYNAM LAGE UNDEF
61 351 X
139 25

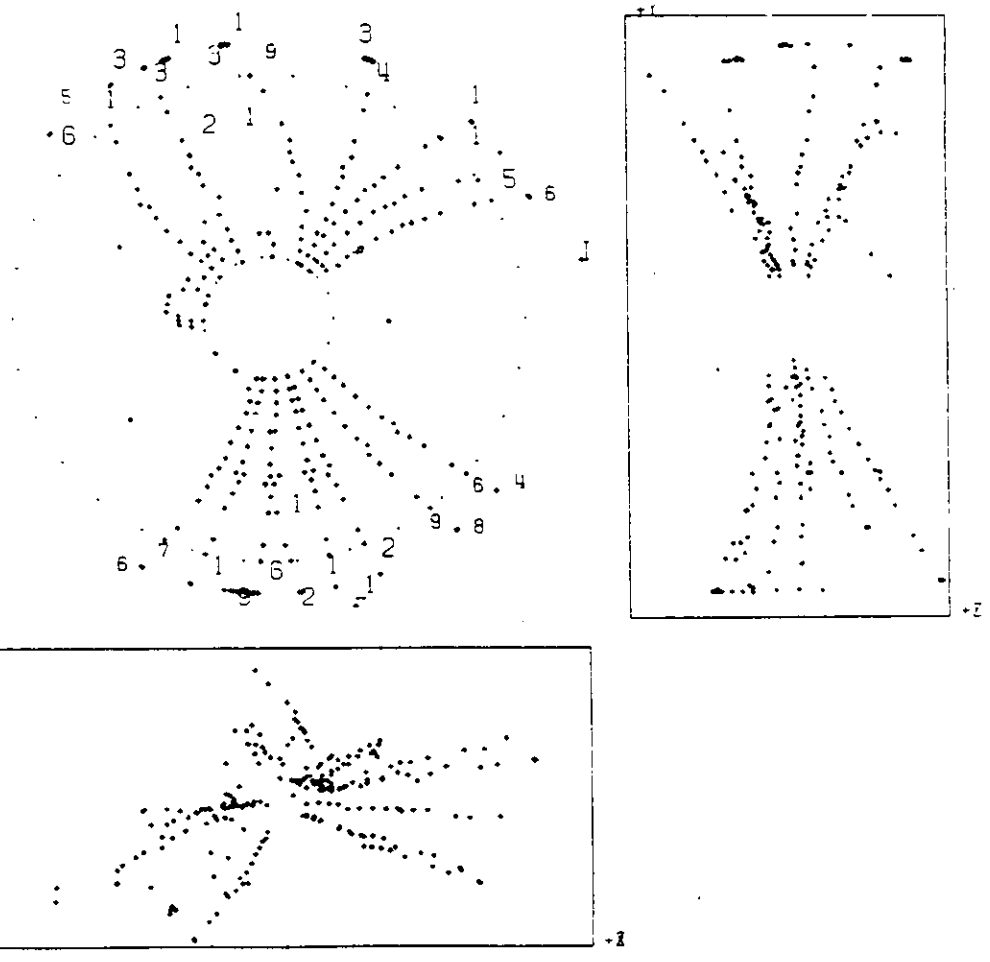
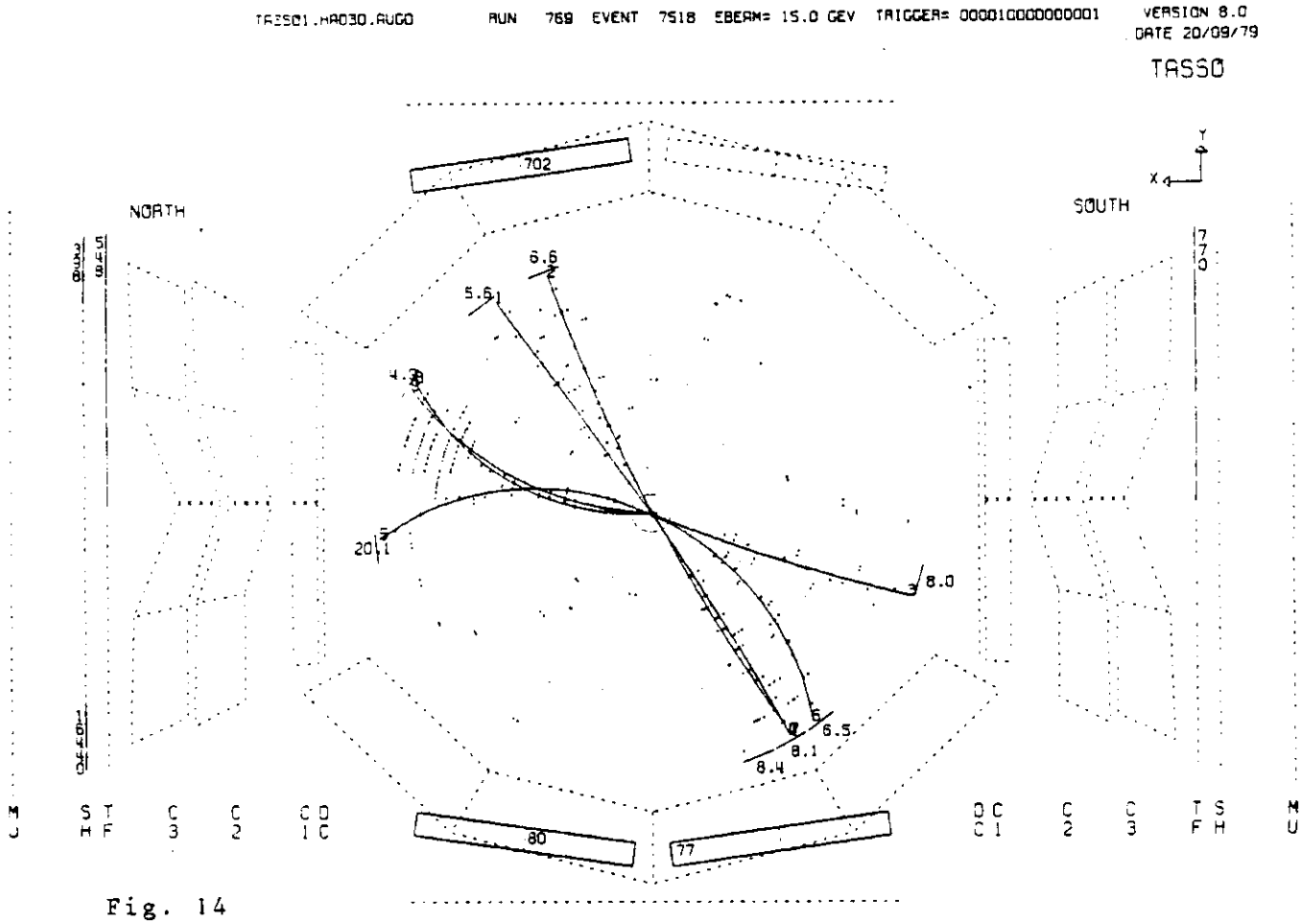


Fig. 13


TASS01.HA030.AUGO RUN 769 EVENT 7518 EBEAM= 15.0 GEV TRIGGER= 0000100000000001
VERSION 8.0
DATE 20/09/79
TASSO
NORTH
SOUTH
Y
X
702
80
77
6.6
5.6
4.8
20.1
8.0
6.5
8.1
8.4
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D C C 1
C 2
C 3
T S F H
M U

Fig. 14

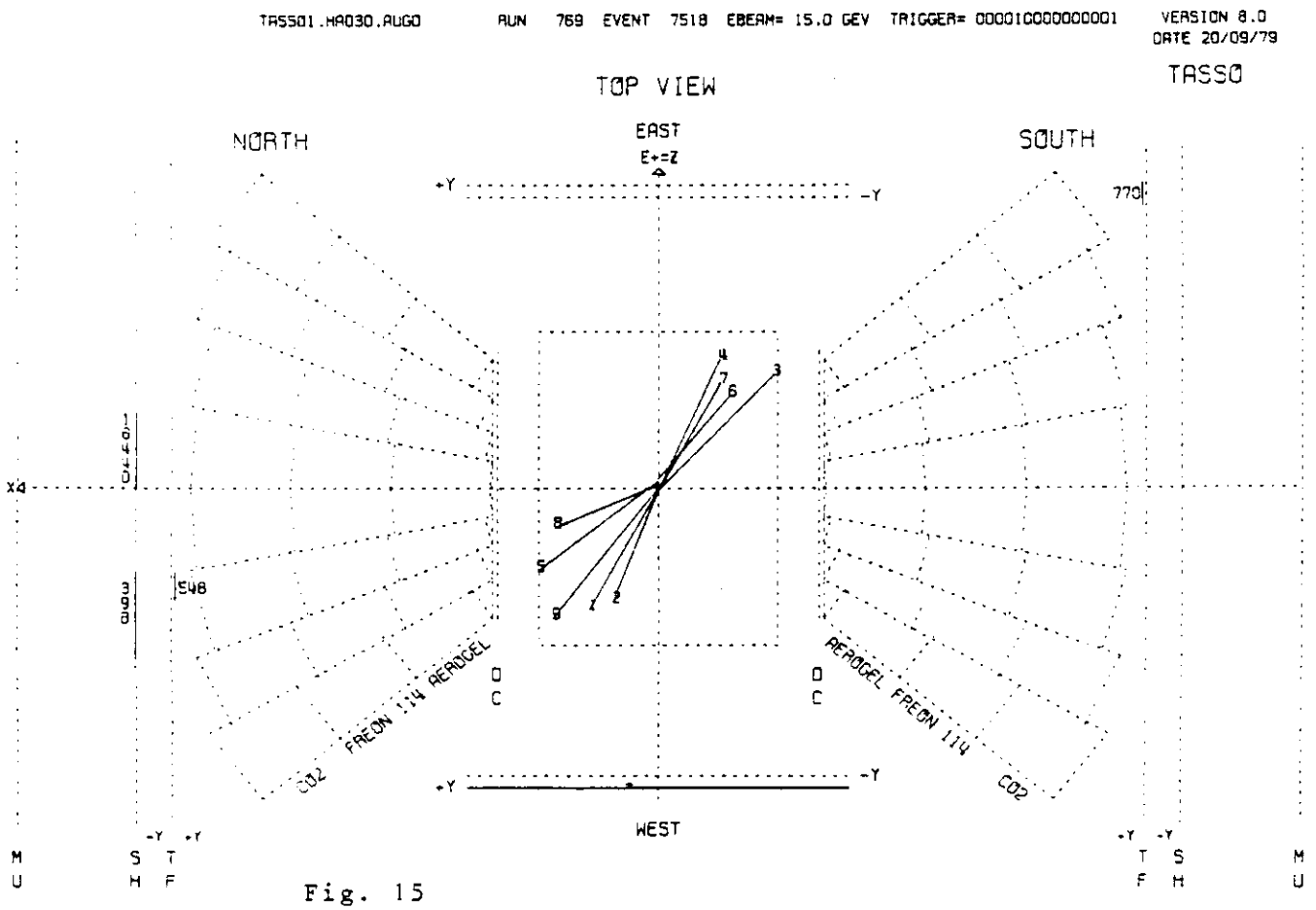
TASS01.HA030.AUGO RUN 769 EVENT 7518 EBEAM= 15.0 GEV TRIGGER= 0000100000000001
VERSION 8.0
DATE 20/09/79
TASSO
TOP VIEW
NORTH
EAST
E+=Z
SOUTH
+Y
-Y
548
FREON 114 AEROGEL
CO2
AEROGEL FREON 114
CO2
WEST
M U
S T H F
T S F H
M U

Fig. 15

USERID=SYSSCH PLOTID=NORMPLOT PLOTNR=0012
PLOT QUEUED AT 175218 ON 780119
PLOT STARTED AT 175310 ON 780119
PLOT RECEIVED FROM SYSSCH:ARGUPLOT MODULE ON SYSTEM B

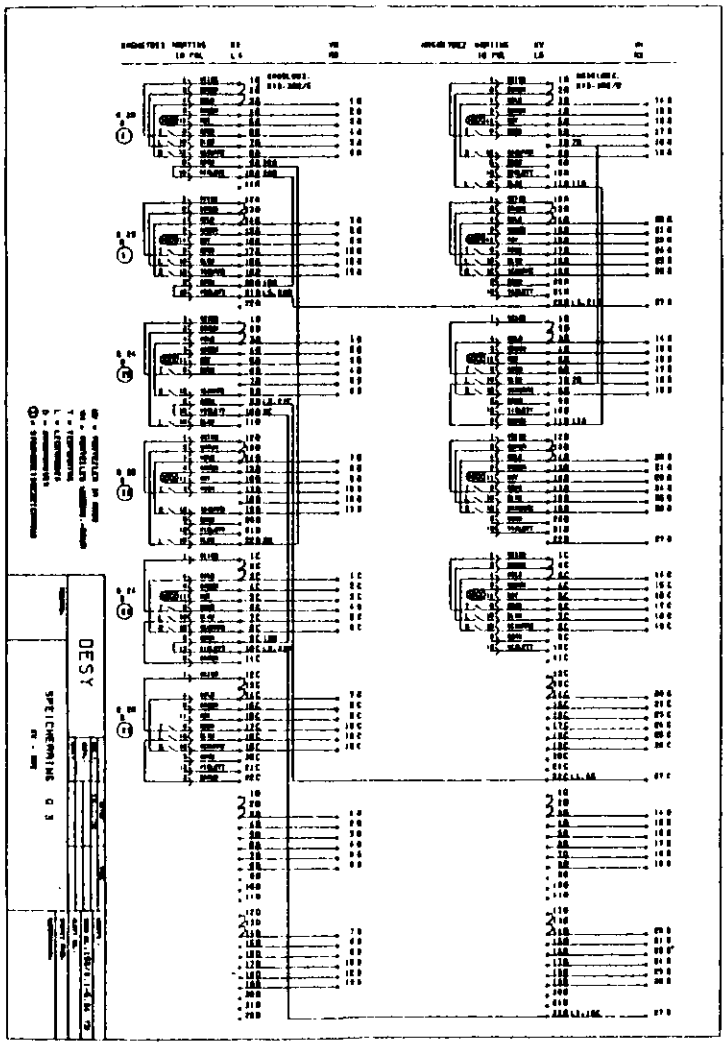

Fig. 16

Fig. 17

USERID=SYSSCH PLOTID=NORMPLOT PLOTNR=0012
PLOT ENDED AT 175501 ON 780119
PLOT RECEIVED FROM SYSSCH:ARGUPLOT MODULE ON SYSTEM B

1. INTRODUCTION

IPS is a multi-terminal system, which is on-line to the IBM/370 computer.

The terminals of the system are controlled on the IBM-side by a multitasking program system. Basically it consists of a master task (task supervisor) and a message switching program, which allow user tasks to be initiated and run by commands given at the terminals. At any time it is possible to communicate via the keyboard with the master task by master commands (starting with the two characters ||) and with the user task by user commands (no || at the beginning).

Internally each group of terminals is controlled by a NOVA minicomputer.

The most important application of the system is to run the user subtask with the name IPS (Interactive Plotting System), which allows the user to manipulate and edit statistical data in terms of graphic displays and hardcopies on a plotter.

2. HOW TO OPERATE THE SYSTEM

2.1. How to use a terminal

Select a terminal and switch power on at the Tektronix-611-screen (switch located behind the front cover). After a few seconds the screen becomes bright, then push the "ERASE"-key at the screen. Now a cursor (small horizontal line) should be visible at the bottom line on the screen; if not, refer to the paper "IPS-System initialization procedures".

Now you can start your terminal session. After the end of your session, push the "ERASE"-key, then switch power off.

2.2. How to give commands

Commands are entered via the keyboard and edited under NOVA control. The current character string representing the command is held in a buffer, which is displayed in refresh mode at the bottom line of the screen. A cursor is shown to aid editing.

You can edit the current character string by the following key strokes ("+" means simultaneous hitting of the specified keys):

DEL	:	The character to the left of the cursor is deleted
CTRL+A	:	Cursor is moved 1 position to the left
CTRL+S	:	Cursor is moved 1 position to the right
CTRL+W	:	Cursor is moved to the beginning of the string
CRTL+Z	:	Cursor is moved to the end of the string
CTRL+SHIFT+K	:	Buffer is cleared, cursor is moved to beginning of line

You send a command to the IPS-system by hitting CTRL+EOT at the same time. After successful transmission the buffer is cleared and the cursor positioned to the beginning of the line.

Note: If keyboard seems to be "locked", try "CTRL+E" to escape from this situation!

Fig. 18

一万三下五天不可平正百両再亜函画昼歪夏悪中内甲本出向曲果表永氷半為単
九及千午少弗未年系束卵来垂東乗重島乙七事二元六市主交京夜変率商人化今
他仕代合全位伸体低作余何価例供係値側偏傾像億先入八分公共典並其前円同
周次冷刀切割力加動北十古直南真幹準上点反圧原又双口右号吸味品哲嗅器四
因回図固国圏土去在地均型基塔場塩境増士冬処各夕外多名大太女如始子存学
宇字宙定実室家密寒導小光当常尺尾屈居層山炭嵐川工左項巻布帆幅干幾応底
度庭座式弓引弧弦強弾帰形役径彼後従徒術御微衝衡心性恒惑想感態慣戈成或
戸扇手折押持指挺振捩接摘支故教散数文対斜新方於放日早易昔明昨星春時晶
暑量晴最暗曇題月木析林枝松柳柱相核桜根械森植極楕楽構標横橋機欠止此雌
整列死母毎比毛氏気水沢汽決波河油法海涌酒流液渦湿測温減滝源溶潮火灯炉
然焼無熱燐燃愛父状片牙牛物特犬王玉珪球理現瓜瓦甘生用田男界思異病発白
的皮皿目具矛矢知短石研硫硝硼磁示利私和秒科秋秤称程稲種積穴究空窒立竹
第等筆算管籠米料粒粘糸級純紙素組終細経絵絶結絹続総緯線締縦置羊美差着
羽翠翼老考者耳取書肉有胞期朝臣自至舌乱辞舟般船良色花若草茶荷菊葉蒸薬
虚虫血行衣装複西要見角解言計記証話語読誰論谷豆象貝負質赤走超足距路身
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銅銀鋼長門問閉間開関聞限除降陸陰陽雄難離雨雪雲零雷電震霊青静非翡面革
音類風飛食首香馬験骨高鬼魚鳥鹿麦麻黄黒墨鼓鼻歯竜亀あいうえおかきくけ
こさしすせそたちつてとなにぬねのはひふへほまみむめもやいゆえよらりる
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ヤイユエヨラリルレロワヰウヱヲンガギグゲゴザジズゼゾダヂヅデドバビブ
ベボパピプペポ．，ー

Fig. 19