MEMORANDUM

31 August 1987.

CERN/SPSC 87-46
SPSC/M436

From: C.R. Gruhn, NA 36 spokesman.

To: L. Foa, SPSC chairman.

Refno: NA 36/i14/SPSC/87-46

Subject: NA 36 status, schedule impact and beam requirements.

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1. INTRODUCTION.

The purpose of this memo is to address questions of the NA 36 status relative to being prepared to take data in the forthcoming ion run, NA 36 beam requirements and the impact of different possible schedules on NA 36.

The aim of NA 36 is to measure strange baryon production cross-sections correlated to global event parameters: E_t, $dE_t/d\eta$ and projectile fragments using the sulfur ion beam at the CERN SPS. An experimental layout is shown in figure 1.

BT	Beam Tag	IGD	Intermediate Gamma Detector
U3,W2	MWPCs	INC	Intermediate Neutral Calorimeter
D1-D6	Drift Chambers	FC	Forward Cerenkov
H1,H2	Hodoscopes	FGD	Forward Gamma Detector
M1,M2	Magnets	FNC	Forward Neutral Calorimeter

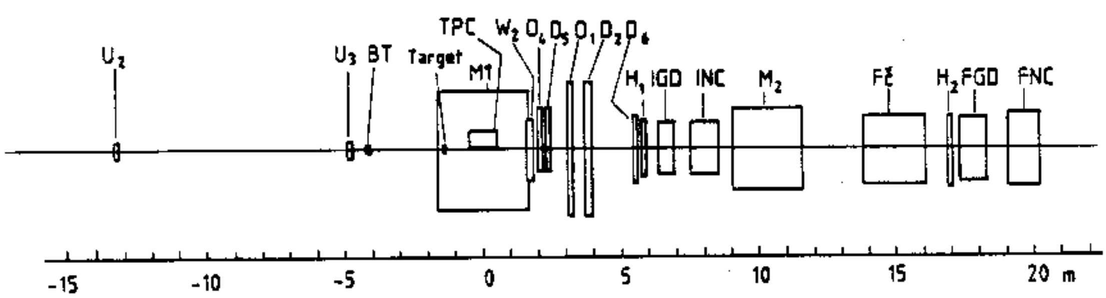

Figure 1: NA 36 experimental layout.

In the experimental layout there are several important features. A TPC is used to visualize the strange baryon decays. A high magnetic field (2.7 Tesla) is used to sweep away low rapidity pions while passing the more massive strange baryons on to the TPC. The external tracking chambers provide additional leverage in the momentum measurements of the strange baryon decay products. A Cerenkov detector is used to measure the charge of the non-paticipating projectile fragments. The calorimetry covers the forward hemisphere of the interactions and allows a fine grained E_t measurement. In addition the energy of the non-participating projectile fragments is measured. Provisions for both an active target and a passive target have been made. The data acquisition system is based upon Fastbus.

All the detectors and the readout electronics are complete and operational, detector calibrations are in progress. To illustrate this status, a few selected "on-line" views of raw data will be presented here.

The NA 36 beam requirements for the September ion run and the schedule impact are discussed.

2. STATUS OF THE NA 36 ELEMENTS.

A brief status of each of the NA 36 experimental elements is presented.

2.1 TPC

The TPC operational parameters are presented in table 1. The TPC is small in volume (0.25 m^3) and operates in a very high magnetic field (2.7 Tesla).

Table 1: TPC operational parameters.

Magnetic field	2.7 Tesla
Drift field	110 V/cm
Drift distance	50 cm
Gas	91 % Ar + 9 % CH_4
Volume	0.25 m^3
Anode wires	7680
length	1 cm
pitch along rows	2.54 mm
40 rows, row pitch	2.4 cm
Cathode to anode wire distance	2 mm
Anode wire to wire cathode distance	3 mm
Gain	10^4

The TPC has been designed for this experiment. Several important features of the design are listed in table 2. The aim has been to avoid, as much as possible, design problems that go beyond present TPC experience and yet accommodate relative high track densities.

Table 2: TPC special design features.

no dE/dx
no ions from beam or target
magnetic sweeping limits tracks in TPC

two track resolution:
- drift direction, dz, 1 cm
- bend direction, dy, 5.4 mm
- beam direction, dx, 5.6 cm

single track sense volume, 10 x 2.5 x 10 mm^3
total volume elements, 384,000
total frontal elements, 9,600

The electronics chain is simple. Current sensing preamplifiers (LeCroy TRA 402) are mounted on the end cap connected to each sense wire. A differential signal is transmitted through 18 meters of twisted pair cable to the electronics hut. A low noise level has been achieved in the preamplifier design ($\sigma \sim 60$ nA). The signal at the electronics is received differentially at a passive filter and then viewed at the differential input of a comparator (LeCroy MVL 407) which produces a time over threshold signal. The original goal was to be able to operate with a 0.5 μA threshold. In fact it has been possible to operate as low as 0.1 μA threshold with little problem (this is to be compared with the 10 μA threshold of the last ion run). The differential time over threshold signal is sent to a TDC (LeCroy 1879) where the times are measured relative to a common stop signal.

All channels of the electronics chain have been completed. The electronics has been installed and is operational allowing the TPC to be calibrated.

In fact, proton-nucleus data has been taken successfully as a first step in achieving the needed comparisons for the ion beam running.

In figures 2 and 3 an on-line monitor view is shown of an event in the TPC. The x direction is along the beam, the y direction is perpendicular to the beam and the magnetic field. The z direction is along the magnetic field and is measured by drift time. This figures shows how the TPC is able to view a secondary vertex in the presence of background tracks.

Additional on-line views of events are presented in appendix A.

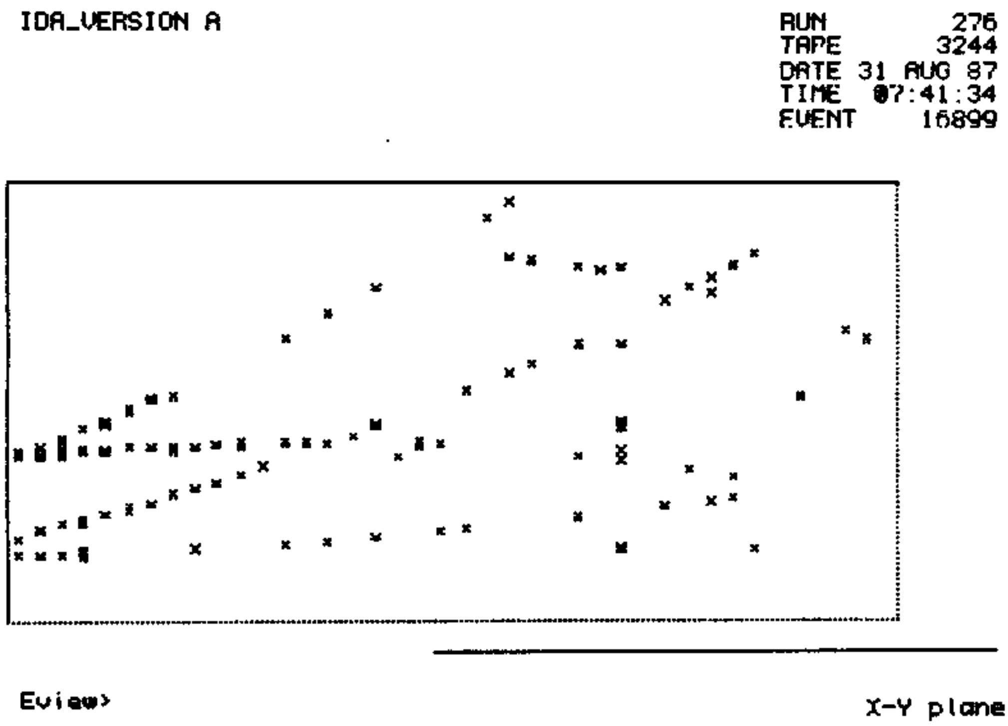

Figure 2: Event no. 16899 in the TPC, side view.

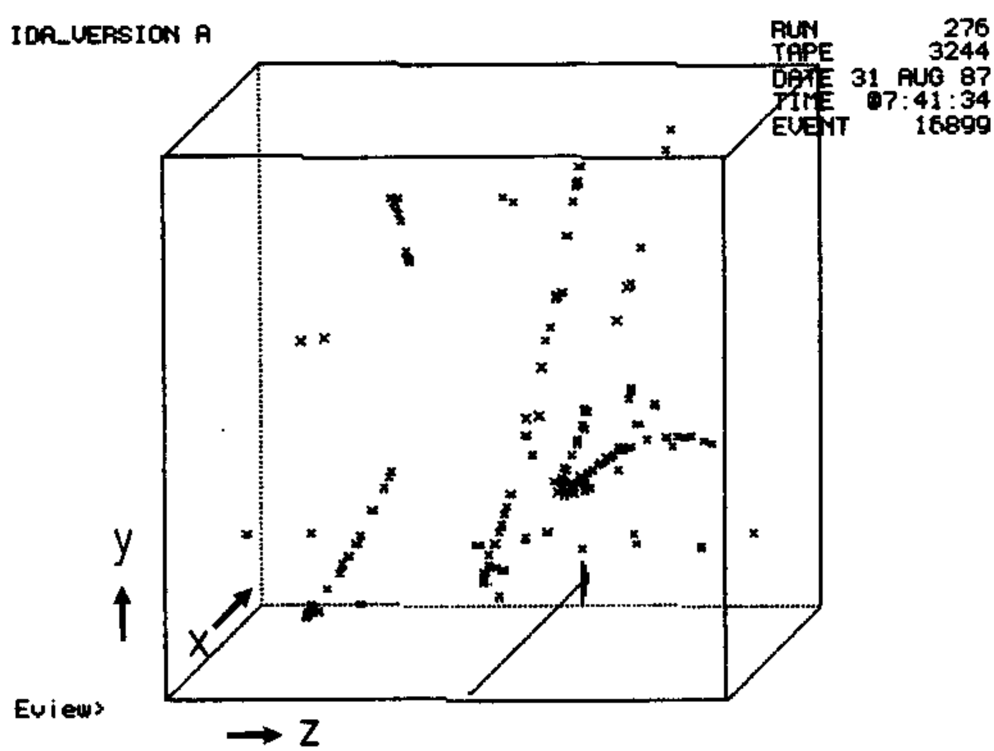

Figure 3: Event no. 16899 in the TPC, 3-dimensional view.

2.2 Wire chambers.

The upstream chambers U1, U2 and U3 were installed again and are fully operational. One plane of the 7 plane proportional wire chamber W2 has been repaired (broken wire). All planes are fully operational. The drift chambers D1, D2, D4, D5 and D6 have been modified such that the central wires can be operated with a lower proportional voltage in order to reduce the degradation of the counter gas and the space charge effects where the ^{32}S beam traverses the chambers. The whole HV distribution and monitoring system has been upgraded and improved. For both readout systems (RMH and DTRC) FASTBUS interfaces have been developed and integrated into the FASTBUS system. The gain in readout speed is about a factor of 15. All 42 planes of the wire chamber system have been operating successfully.

2.3 Calorimeters.

The NA36 calorimetry is made up by four detectors, initially designed for the EHS facility: two electromagnetic and two hadronic calorimeters. The reshuffling of the set-up, according to the heavy ion physics program requirements, has been completed in 1987 by achieving the two following tasks:

1. The whole data acquisition has been switched from CAMAC to FASTBUS; the 1592 channels are now read out through 17 LeCroy 1882 and 1885 ADC modules.

2. Lead glass blocks from the central part of the FGD have been removed in order to be able to make a clean central collision trigger based on the four central blocks of FNC. Indeed the transverse size of these last blocks (15x15 cm^2) is such that more than 80 % of the hadronic showers can be contained in a group of four cells. The fast dynode outputs, inverted and added lineary give a signal on which a threshold cut allows a clean selection of the forward energy. The peripheral collisions can thus be rejected.

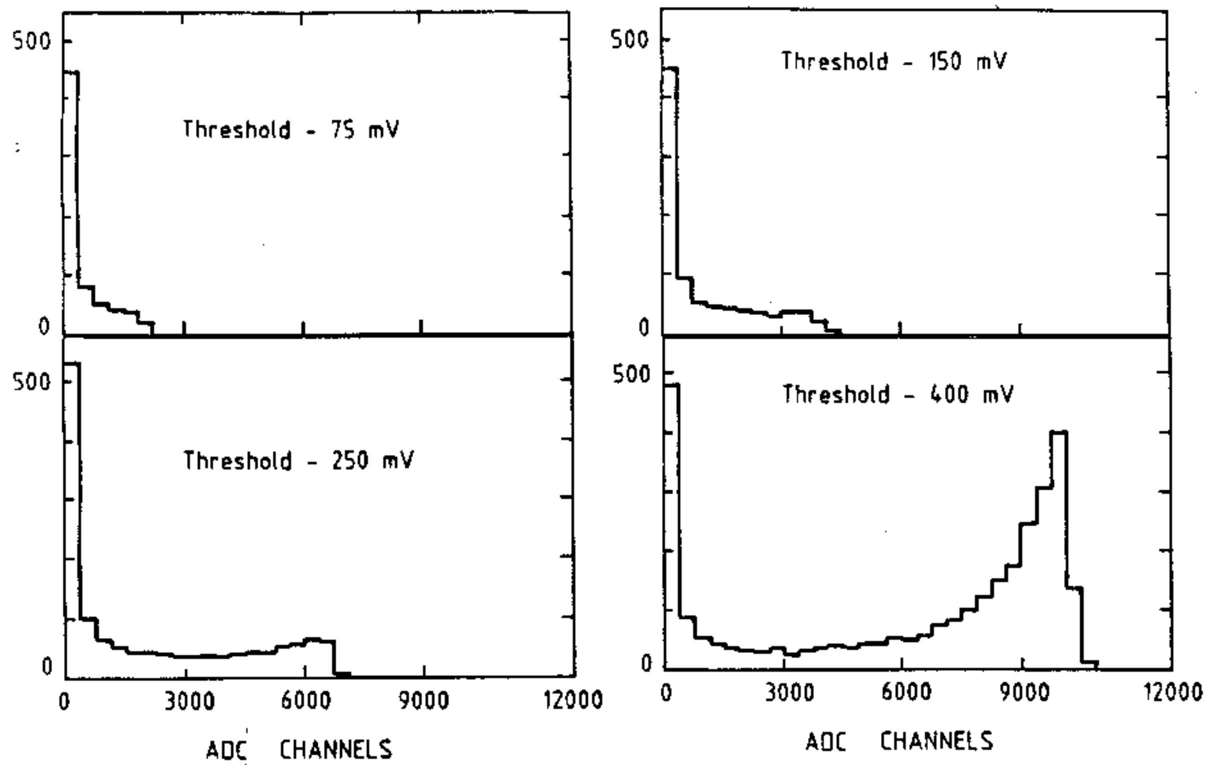

Figure 6: Threshold cut with the FNC signal.

As shown on the distributions in fig. 6, this trigger should give a good selection of the energy accepted.

The NA36 calorimetry is fully operational but will suffer from a limited calibration due to the amount of beam time allocated during the proton periods for setting up the experiment as well as to the very small fraction of the ion time which can reasonably be devoted to calibrations.

2.4 Projectile fragment Cerenkov status.

The projectile fragment Cerenkov detector is a shortened (1.4 m) version of the forward Cerenkov used in the EHS facility. It has been adapted to measure the z^2 of projectile fragments of the ion beam interactions. It is installed and presently being calibrated. It has operated successfully in the last years ^{16}O ion beam run.

2.5 Active target.

The active target has been installed one meter in front of the TPC and is in the process of being tested and calibrated. Early tests at Berkeley with argon beam showed it to be operational. Because of poor experience by other experiments with active targets, NA 36 has studied the question of a 3-target system with identification of the interaction point being determinated by tracking in following tracking chambers. This latter idea is considered as a back-up to the active target solution. Both systems have been tested in this weeks proton run.

2.6 On-line hardware.

The NA36 data acquisition system consists of 6 FASTBUS crates. Readout and control is performed via interfaces to a microVAX, a VAX 750 and a VME crate. The VAX 750 functions as the primary readout machine. Data are written to standard high density tape (6250 bpi).

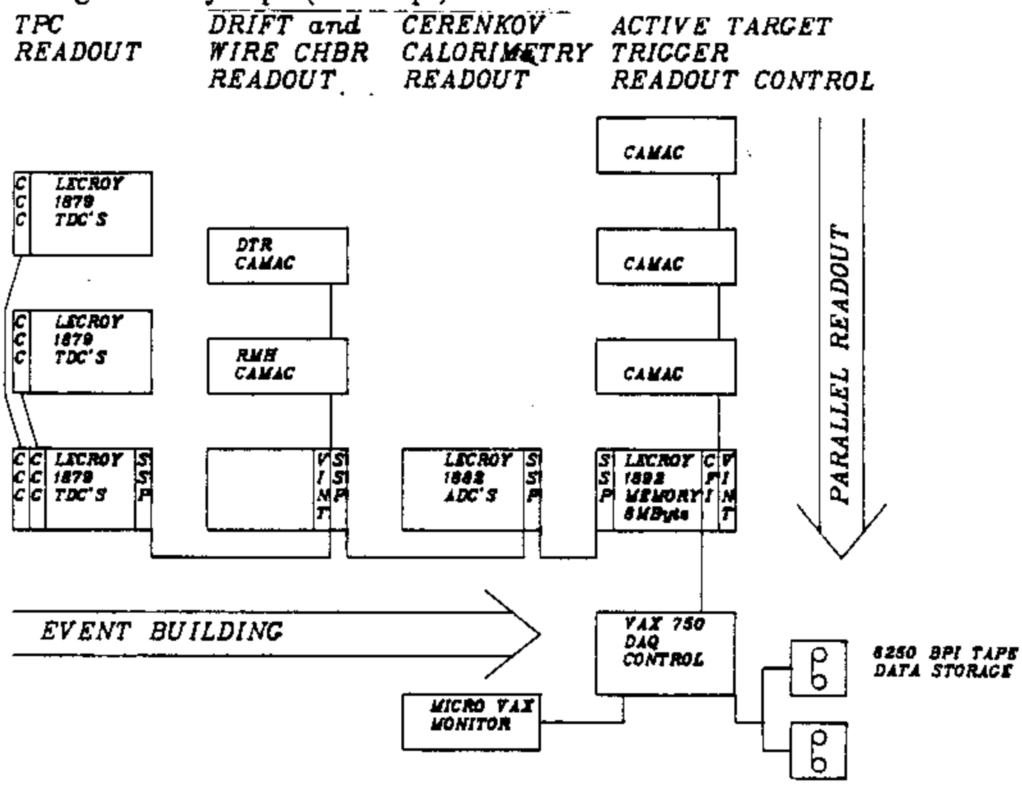

Figure 7: NA 36 data acquisition system.

The crate containing the calorimeter ADCs is interfaced and controlled by a SLAC scanner processor (SSP). The front panel of the SSP allows data transfer between the FASTBUS crates via a 30 m long cable segment. This crate also has access to a CAMAC branch for monitoring and control functions. The readout speed (<2 ms) is limited by the ADC conversion time.

The TPC readout requires 3 FASTBUS crates located nearer the TPC. These remote crates sit in a water cooled rack and contain all of the TDCs for the TPC. The readout in each crate is controlled by an SSP. Readout time is less than 1.5 ms for minimum bias events with a proton beam.

A fifth crate holds the SSP which does the event building. The crate also contains a large FASTBUS buffer memory (4 Mbytes), an interface to the CAMAC crates used for trigger control and the beam detectors, interfaces to the drift chamber readout (DTR) and wire chamber readout (RMH), as well as an interface to the VAX 750. The readout time for this crate is less than 2 ms for minimum bias events with a proton beam.

Data are readout and stored in the buffer memory after each event. The time required for event building and software resets is about 6 ms. Between spills events are extracted from FASTBUS by the VAX 750 and written to tape. This can be done at speeds of up to 400 kB/sec. Additional tape streams will be added if the data rate requires. The data rate is typically > 200 events per spill (2.8 second flat top).

The final FASTBUS crate is allocated to test and development work. It is controlled by means of an interface to VMEbus. A NORD 100 computer can also be used for testing via a shared interface to CAMAC.

2.7 Triggers.

The general scheme of the trigger hardware and software to provide the whole system with the signals needed when running physics and special calibration triggers is the same as for the ^{16}O run in 1986. The trigger hardware is operational.

2.7.1 Hardware.

The remote control system for the Beam geometry counters has been improved for better steering on the active target. The whole electronics chain including the signal distribution for gating and aborting has been retimed. The layout of the Camac and TV scalers is updated for easier monitoring of the beam and trigger rates.

2.7.2 Trigger software.

The programs to prepare and to download the trigger files to programmable logic units have been installed on the VAX 750 and are successfully implemented in the data acquisition.

2.8 Software.

2.8.1 Data acquisition software.

The data acquisition software has been expanded and improved in a number of areas since the November/December ion run. The principal aim of these changes has been to increase the volume of data that can be collected from Fastbus and written to tape. An improvement of nearly an order of magnitude has been achieved.

This has been done by modifying and extending the computer code for the SLAC Scanning Processors that are used as event builders in Fastbus, to support the new Event Data Format that was defined to allow data to be efficiently compressed. Thus, without altering the overall data transfer rate between Fastbus and the VAX 750, an improvement in the event rate of almost a factor of 2 has been obtained. The new Data Format also incorporates data tables concerning the location of individual modules in the Fastbus/CAMAC system. These are used to assist the monitoring software in the MicroVax to select particular modules from a complete event for high speed monitoring. In addition, more streamlined methods have been devised to readout Fastbus modules thus further contributing to data collection rates.

Substantial changes have been made to the code in the VAX 750 which communicates with the SLAC Scanning Processors (SSP) via a CFI interface. These changes reflect the need to improve overall data logging and conversations with users, but more importantly to improve the rate at which data are collected. These changes go hand in hand with the new code in the the SSP's. An improvement of between four and five times in the data rate to tape has been achieved and it is now possible to dump four Megabytes of data to tape in the gap between spills.

2.8.2 Monitoring.

NA36 software consists of the interactive monitoring system running on a microvax sampling data written to tape and a library of off-line programs.

At present the system performs on-line monitoring of all detectors with specialized programs written for each detector. Interactive access to data is provided in a multi-user system. Interactive graphics packages are used for event and histogram display.

Data from all the detectors is unpacked on-line and analized. The present status of on-line analysis is as follows:

1. TPC - unpacking, reconstruction of space points, basic corrections, basic pattern recognition and tracking

2. Wire chambers - unpacking, space points, beam tracking

3. Drift chambers - unpacking, storing lines corresponding to hits, (software following tracks from TPC through the chambers is ready and can be used on-line when alignment parameters are ready)

4. Calorimeters, Cerenkov, beam counters etc - unpacking, calculating energies.

The off-line program runs on VM and is ready to perform basic analysis of existing data. The pattern recognition algorithm chosen will deal with high multiplicity events but requires extensive tuning with real data before it can be applied successfully.

3. RUNNING STATUS OF NA 36.

All components of the NA 36 experiment have been operated collectively in data taking mode. Calibration, minimum bias and central collision triggers have been used to accumulate more than 100,000 events for each trigger type. This data collection is on tape and is presently being analyzed. In figure 8 an on-line display is shown of hits in all tracking elements for the same event. This is the same event viewed with more detail in the TPC in figures 2 and 3.

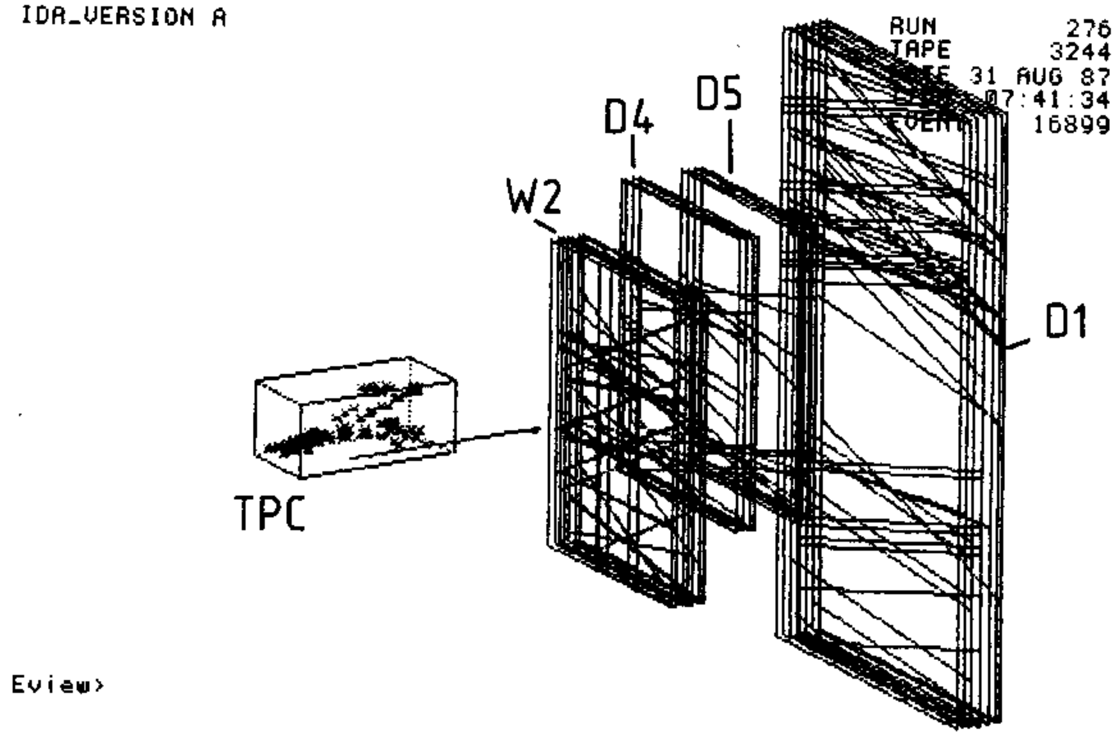

Figure 8: Event no. 16899 in the NA 36 detector system, 3-dimensional.

4. NA 36 BEAM REQUIREMENTS AND SCHEDULE IMPACT.

A total of 18 days for ion beam running has been foreseen. This is very little time by any standard and NA 36 needs the maximum available time to achieve its physics goals.

As it now is seen, 7 days are needed for check-out and tuning of the equipment for the new physics, this is minimal. Assuming one energy (200 GeV/A) this leaves 10 days to absorb machine inefficiencies and data taking.

The data will be taken with two polarities of the magnetic field. A zero field comparison is anticipated. Mixed triggers will be used (~ 50 % min. bias, ~ 45 % central collisions and ~ 5 % for beam and calibration). Assuming a good machine,

10^8 kBytes of data are expected, 2.4 x 10^6 events total. Since the aim is to probe the more massive strange baryon production, the experiment is limited by statistics. Any cut in time hurts. NA 36 needs NA 35 transparent as promised by the SPSC.

The desire of NA 35 to want a information about the energy going down the beam pipe is understood. Therefore it is suggested that NA 35 considers using a signal for their trigger from the NA 36 calorimetry which sees a large fraction of this energy. They could also get a handle on this energy by using a Cerenkov and a thin dE/dx measurement.

5. SUMMARY.

The NA 36 experiment is operational and ready to take data in the coming ion run. Because of the electronic nature of the experiment, the achievement of relatively high statistics in the measurement of strange baryon production can be expected. This is needed because of the aim to look at the more massive strange baryons.

APPENDIX A

SELECTED EVENTS FROM ON-LINE DISPLAY.

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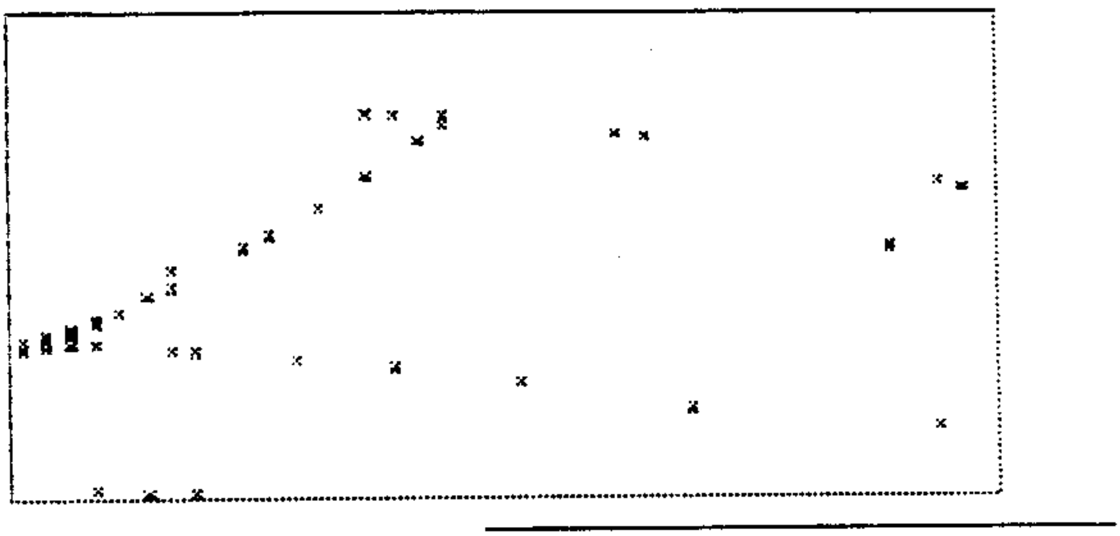
EVENT 64



Eview> X-Y plane

IDA_VERSION C

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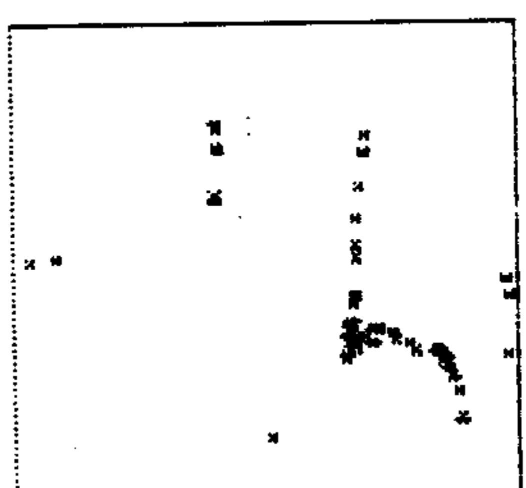
EVENT 64



IDA_VERSION C

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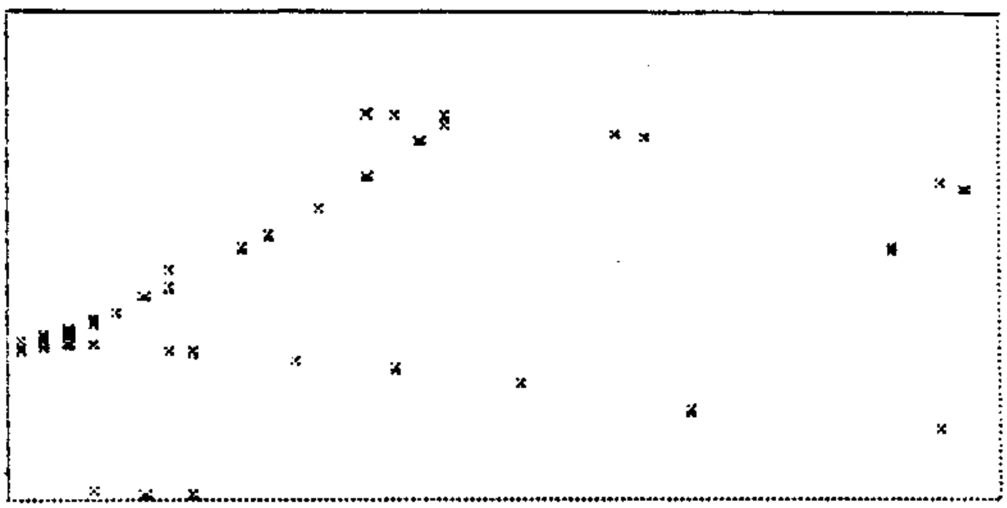

Eview>

X-Y plane

IDA_VERSION C

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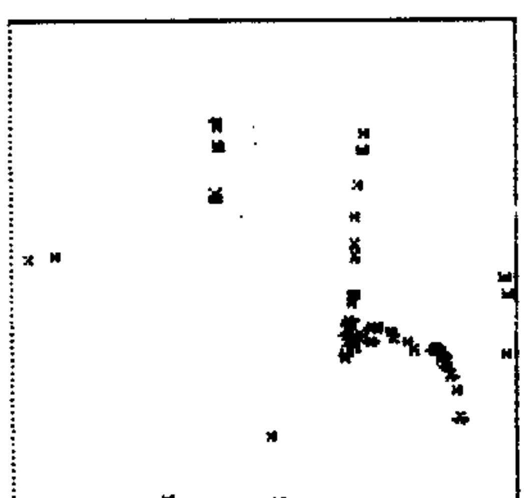

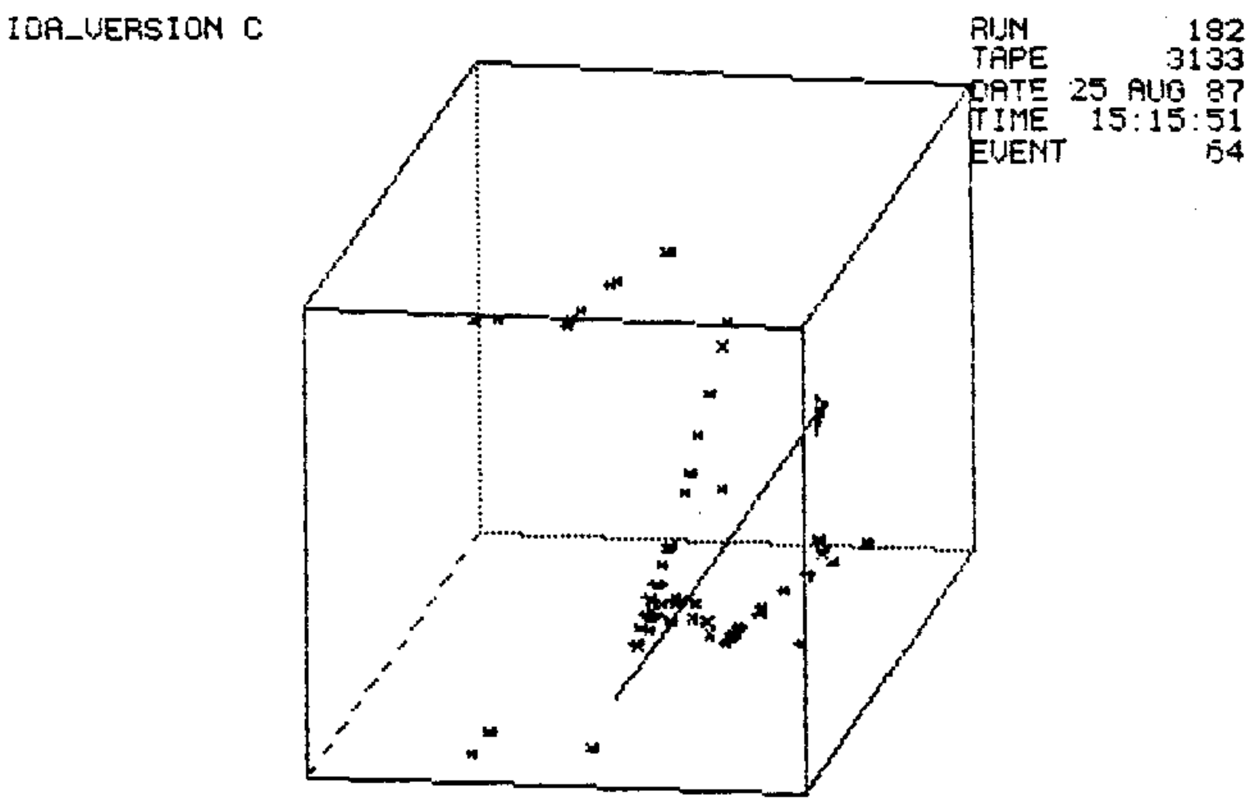
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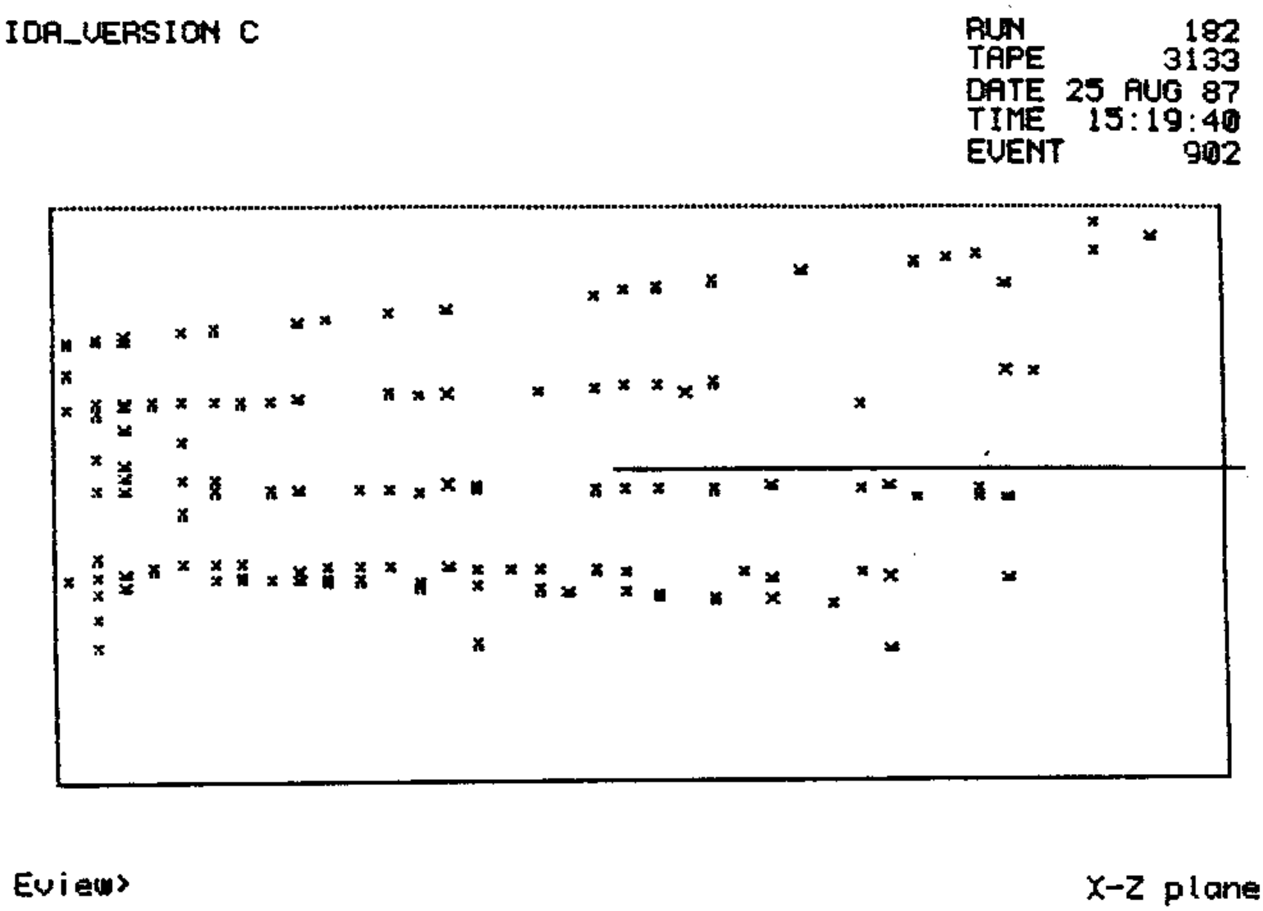
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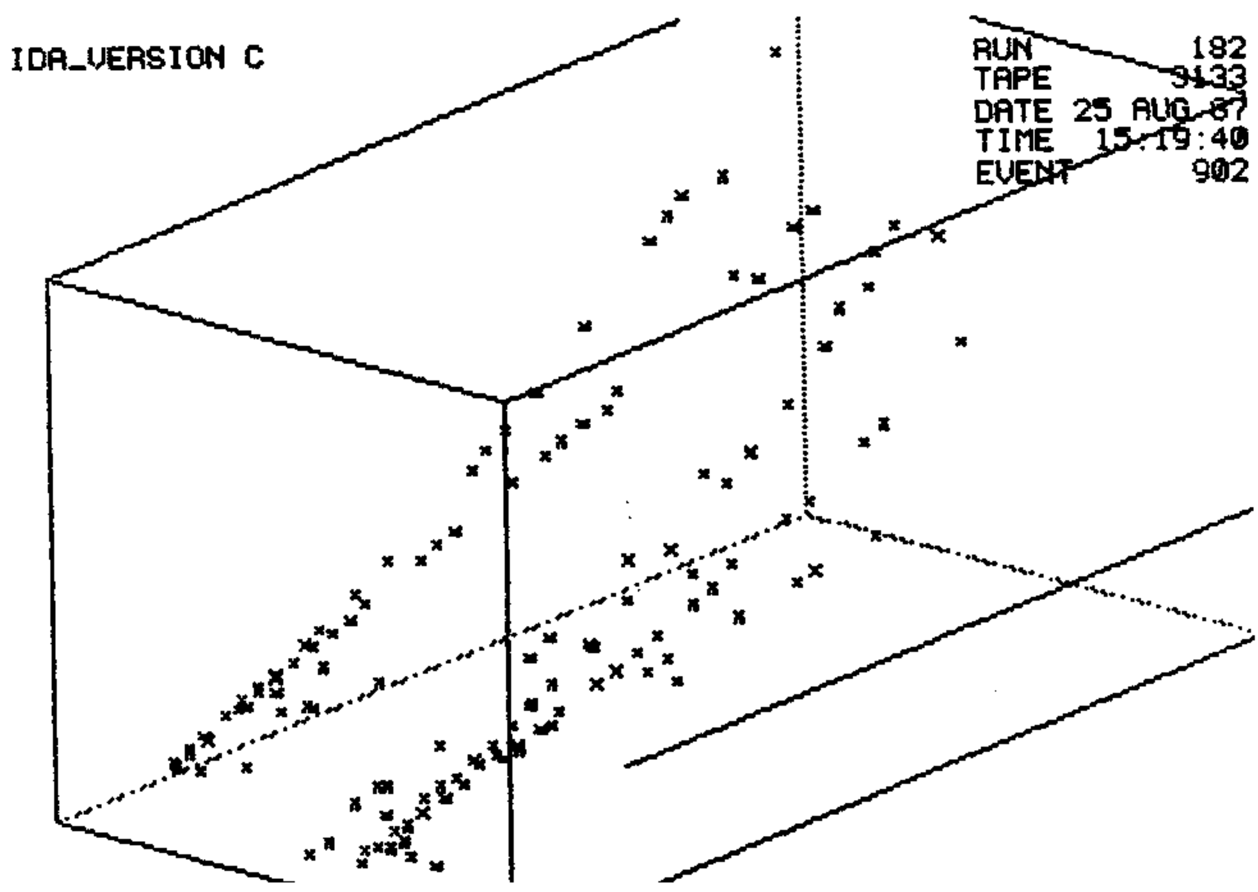
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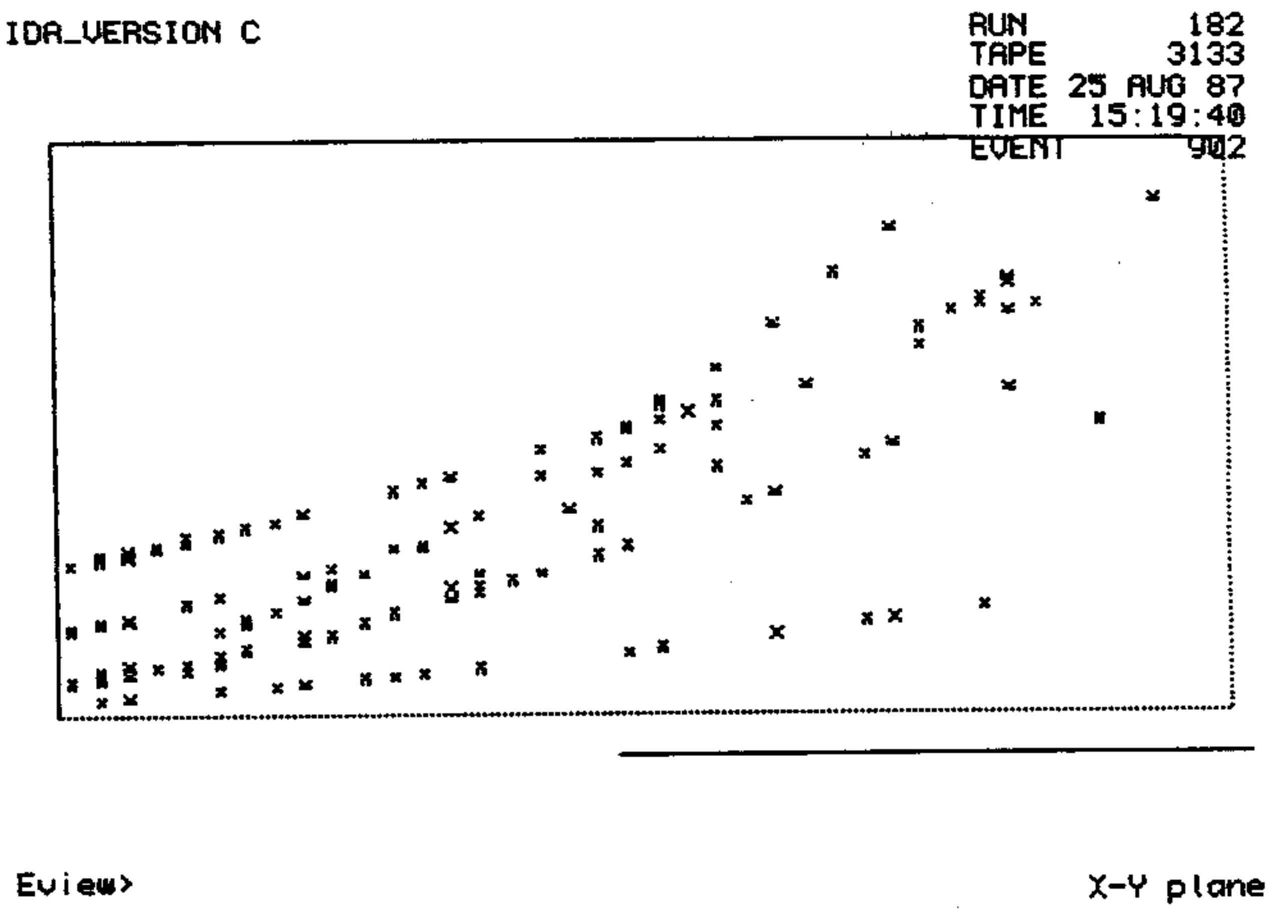
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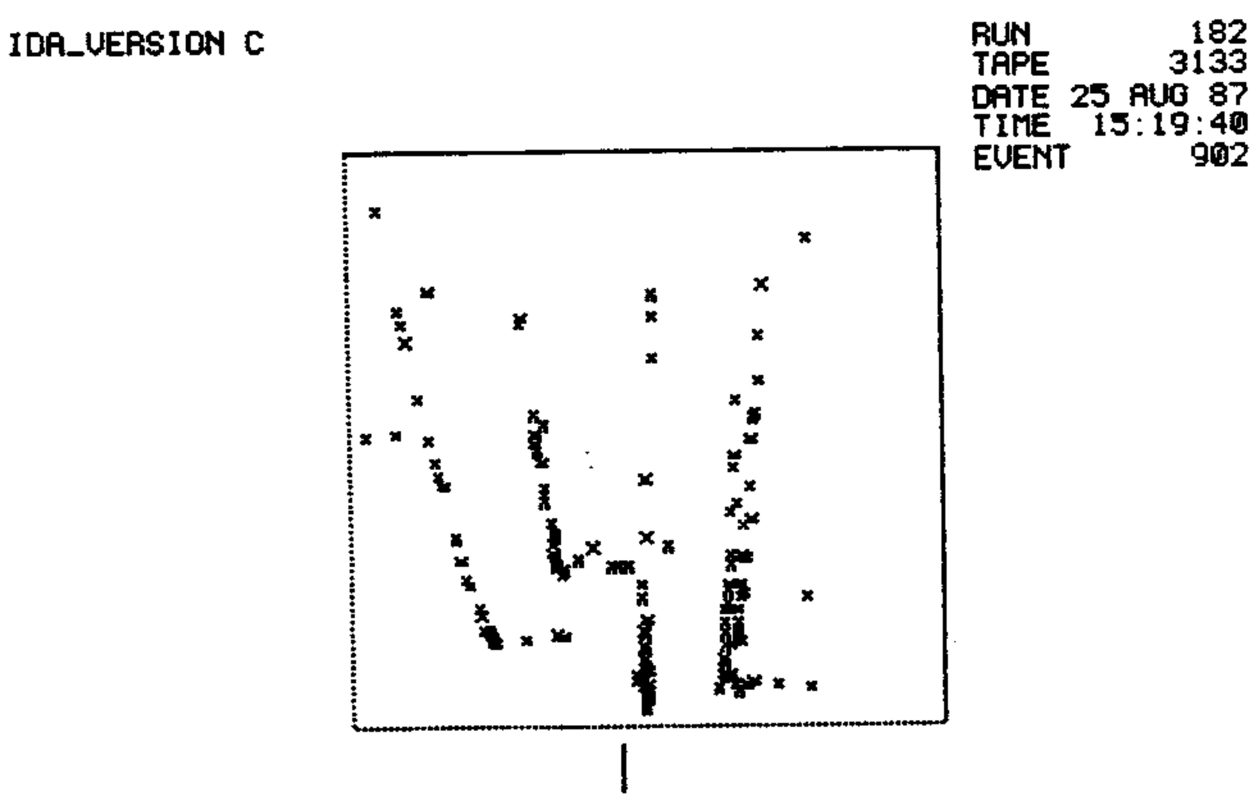
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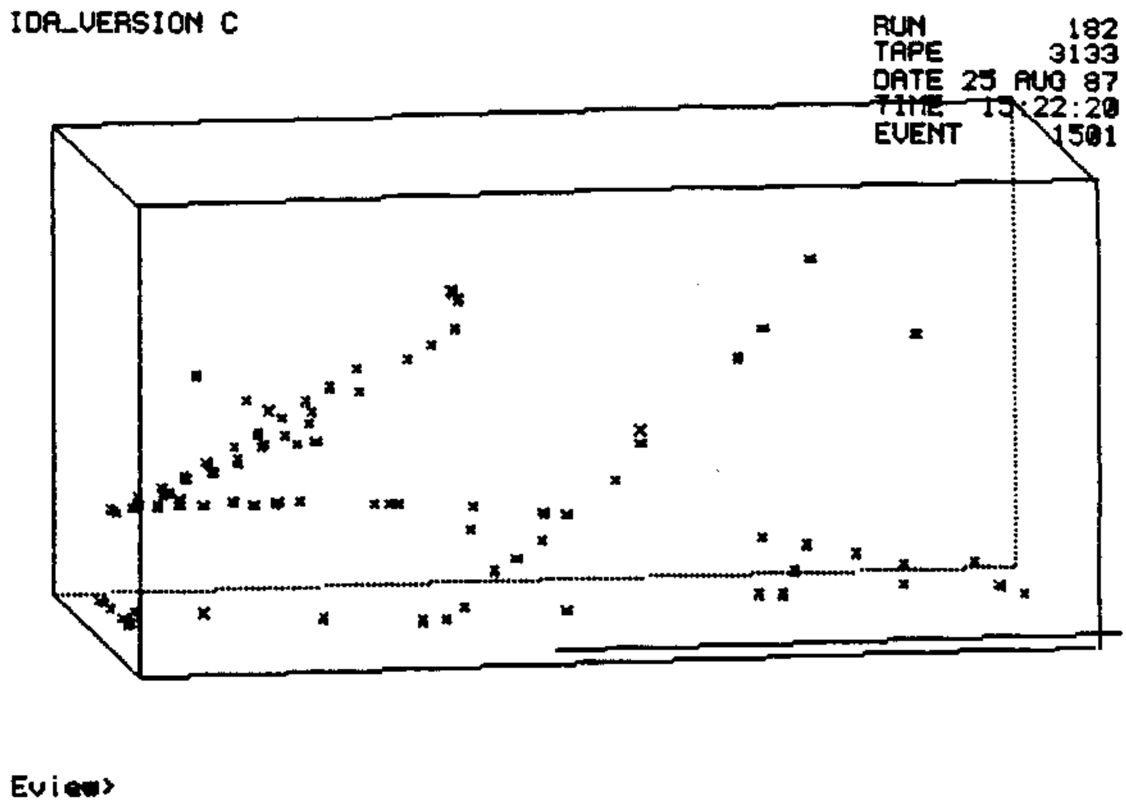
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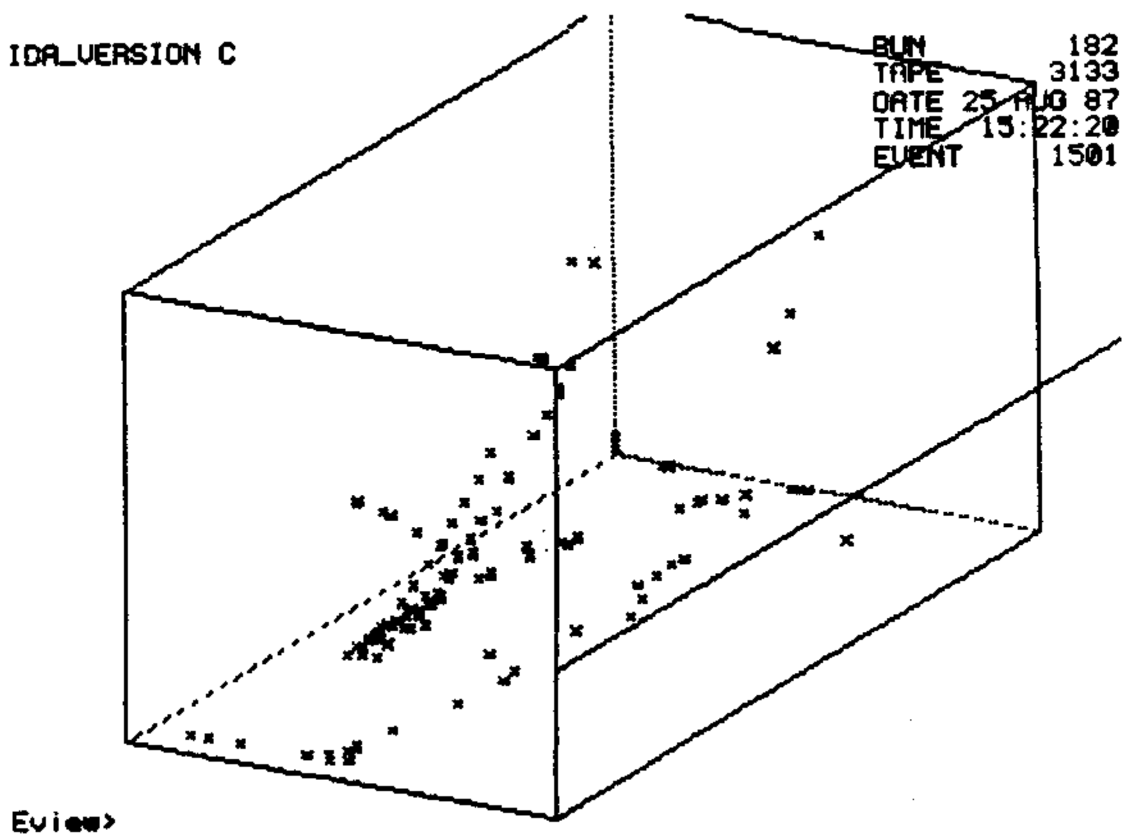
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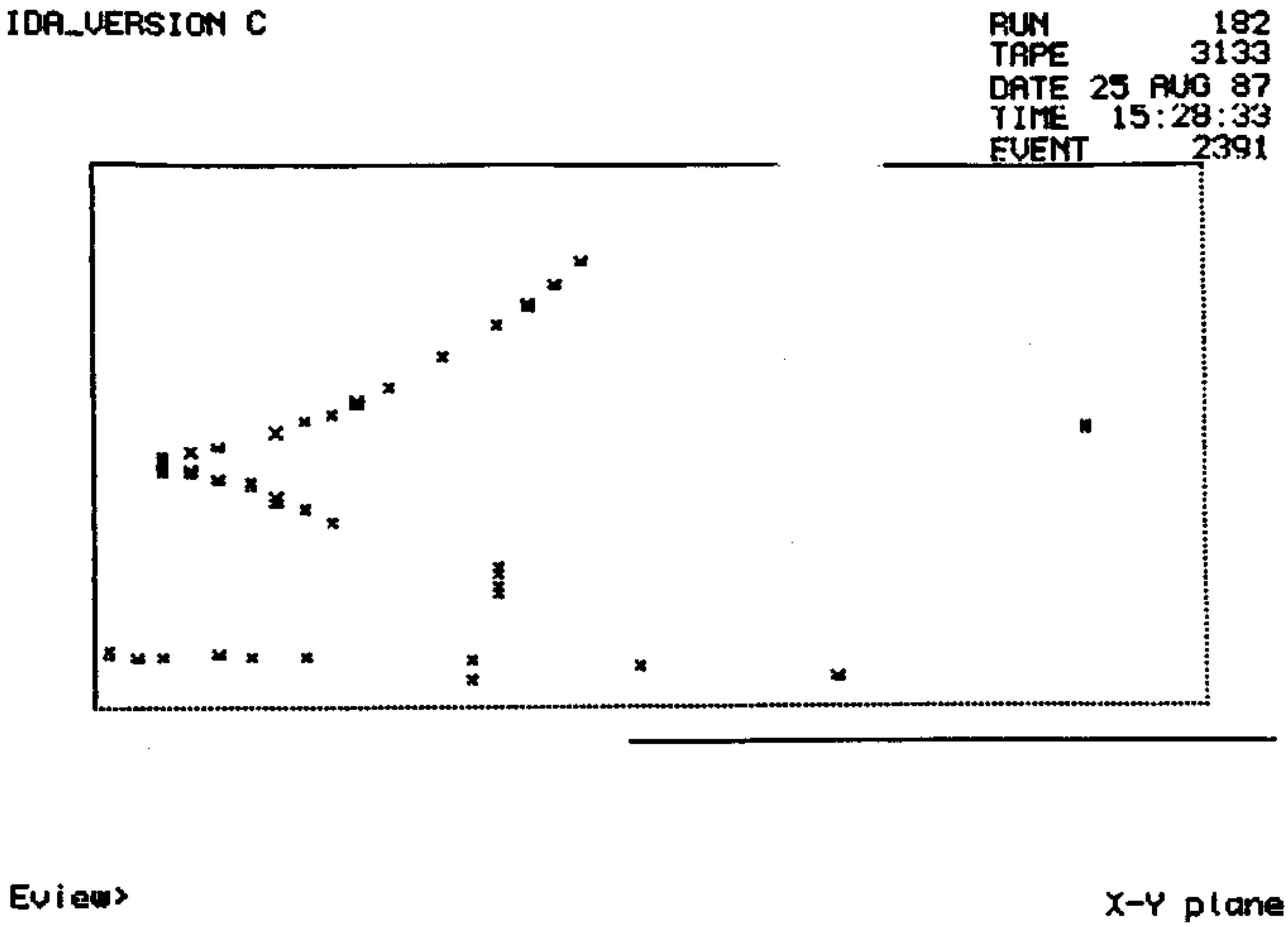
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Eview>
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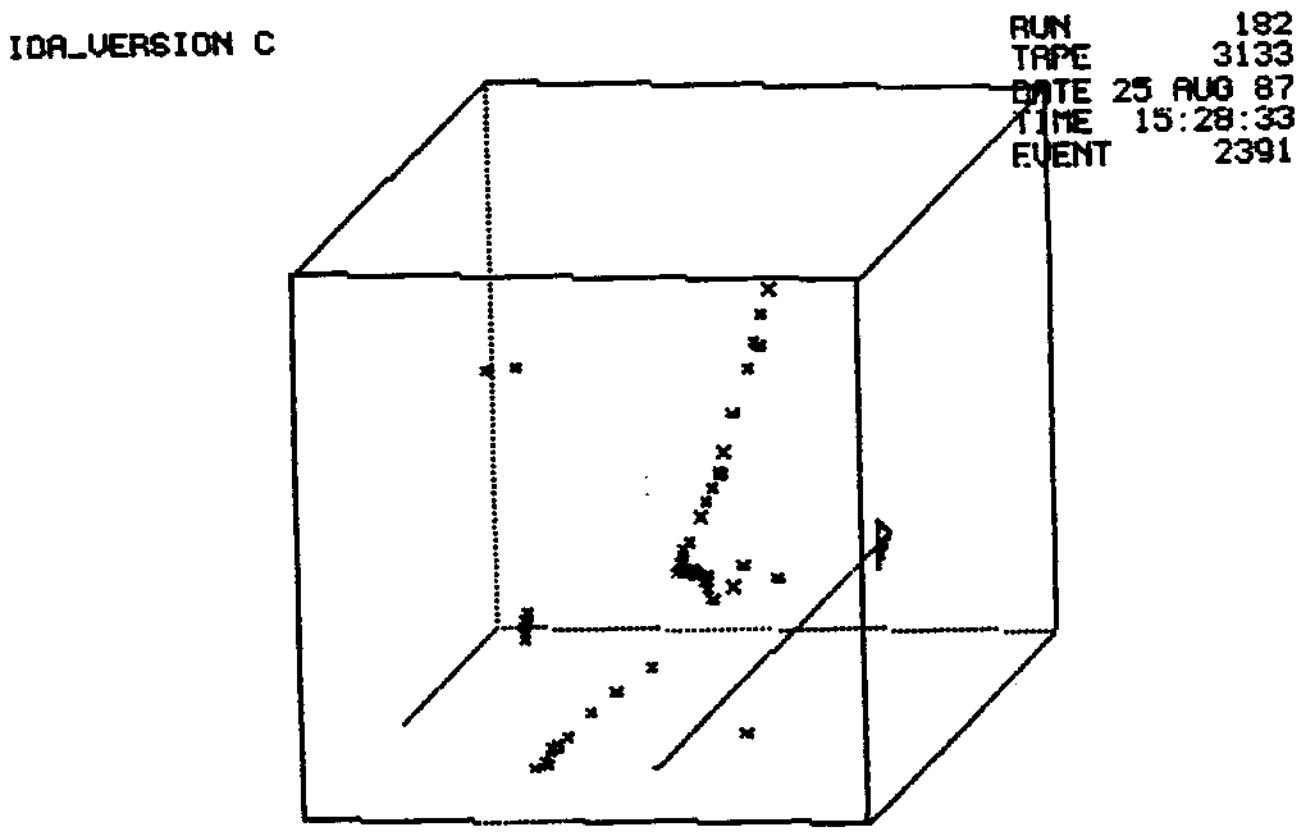
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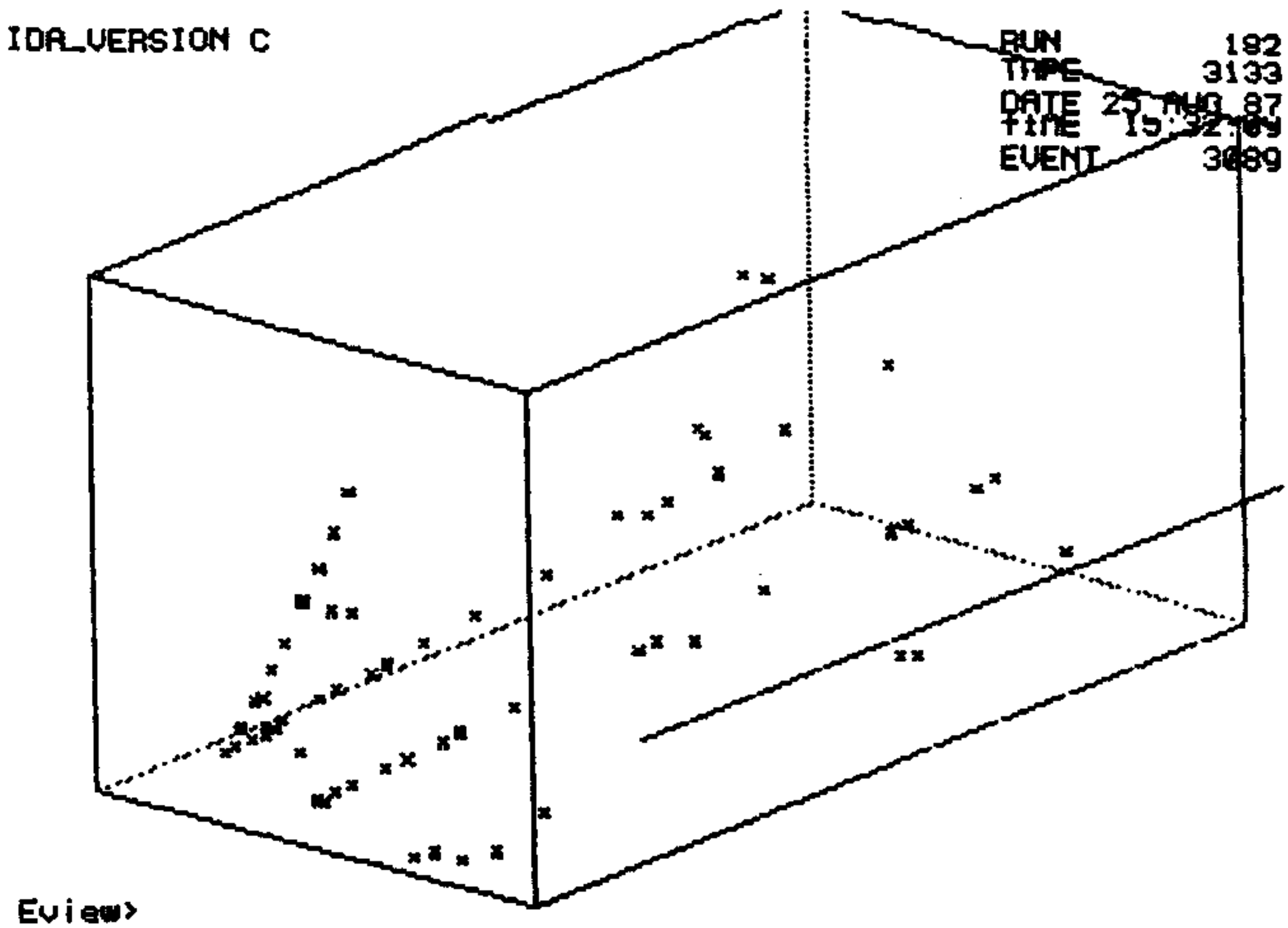
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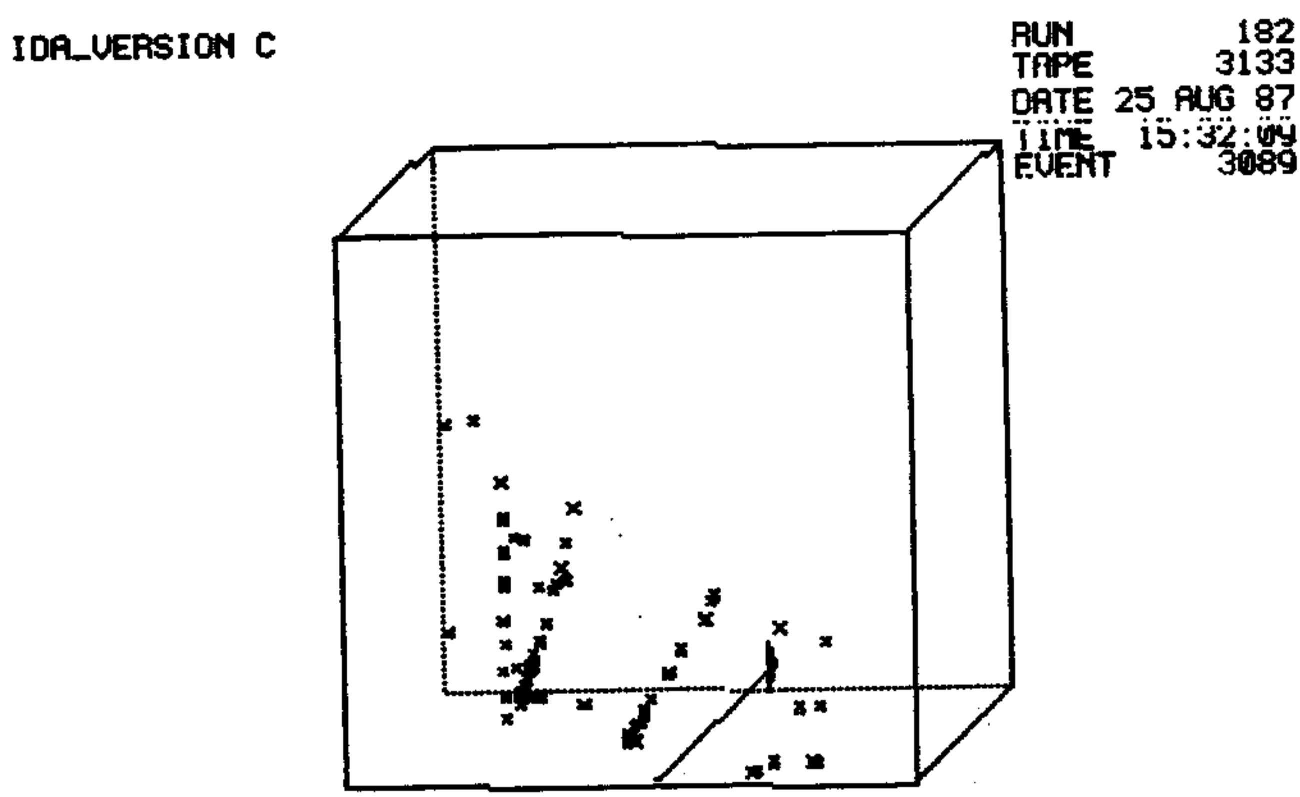
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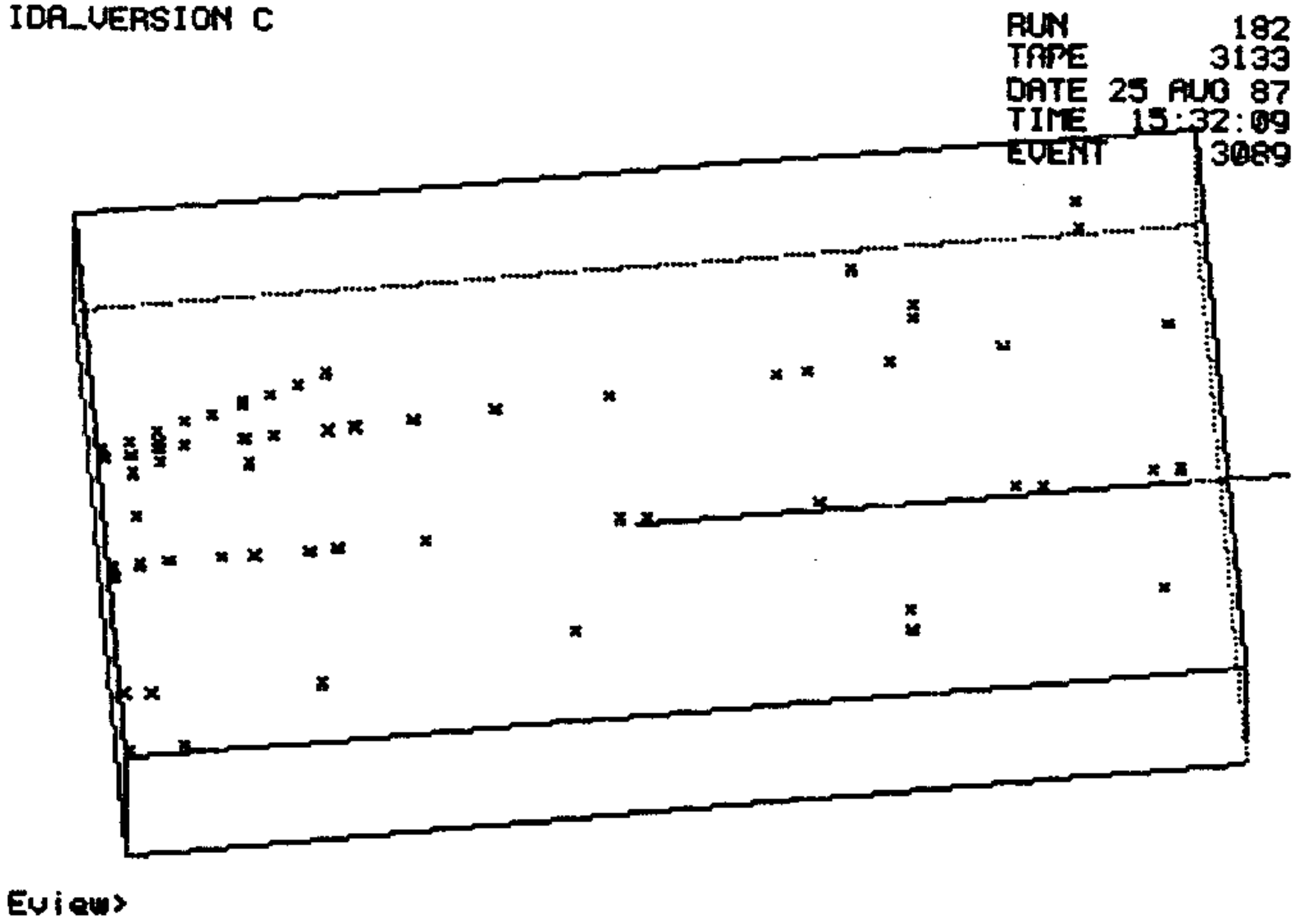
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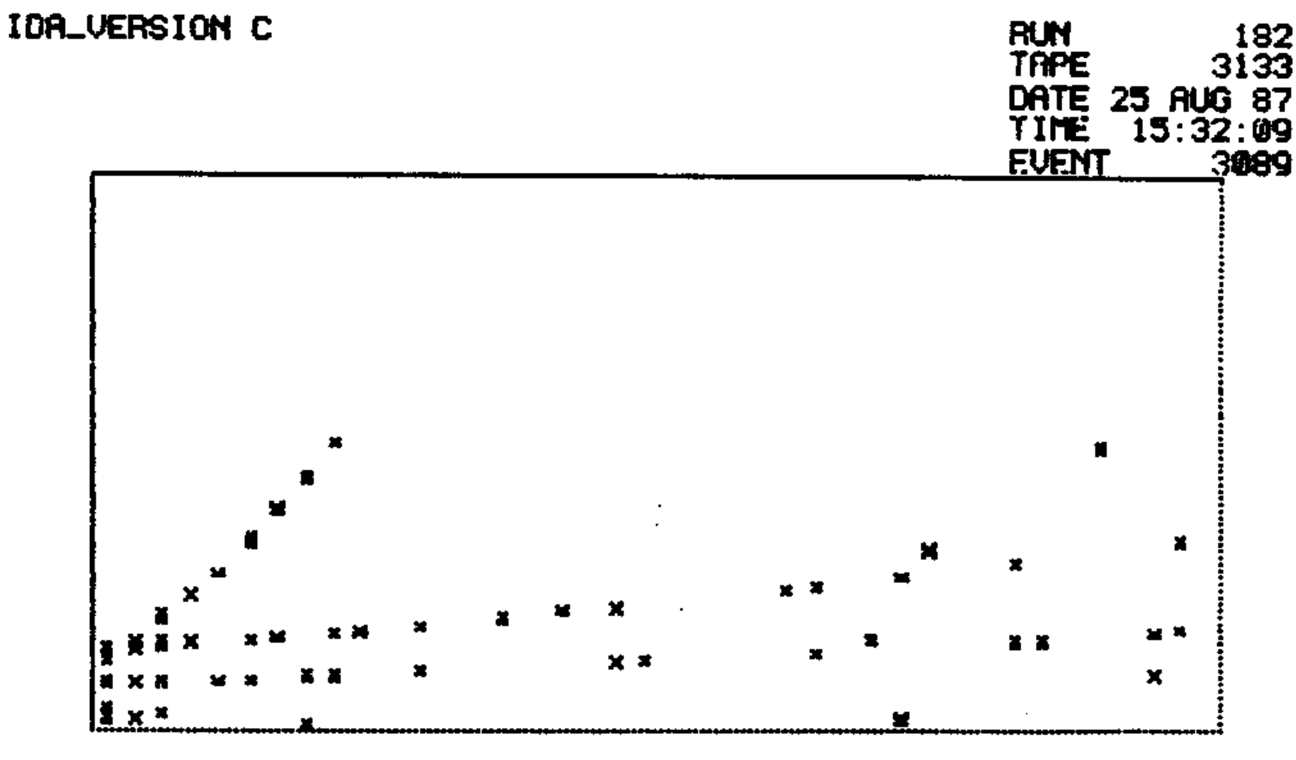
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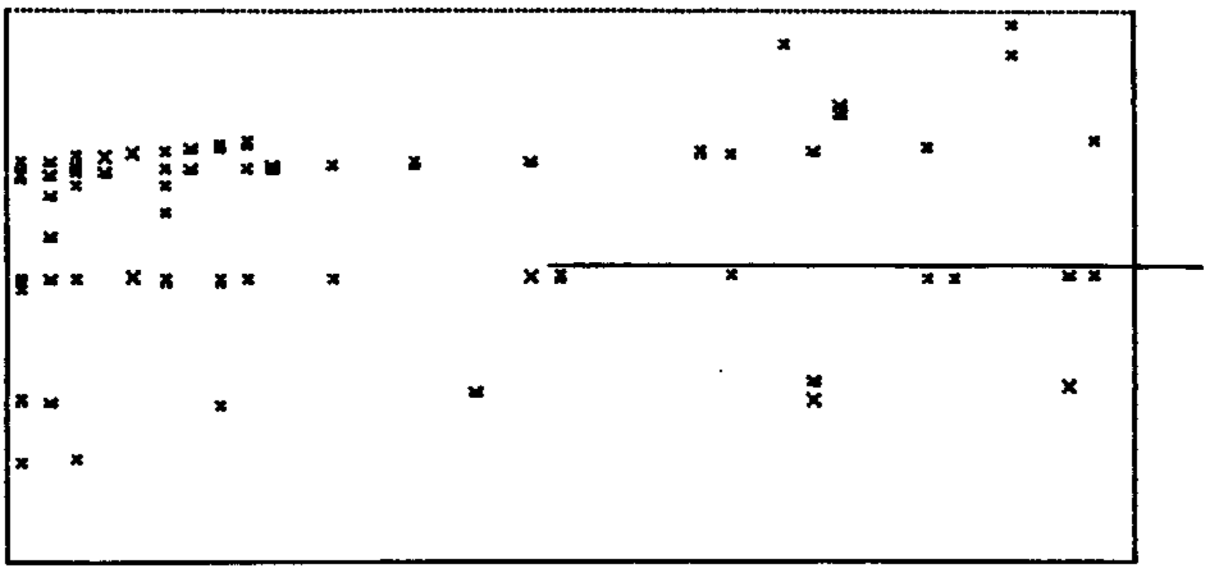

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X-Z plane

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