INTER-UNIVERSITY INSTITUTE

FOR

HIGH ENERGIES

ULB-VUB, BRUSSELS

ANNUAL REPORT 1989.

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J. LEMONNE and J. SACTON
January 1990.

I. INTRODUCTION.

The physicists, engineers and computer scientists whose names are listed below have contributed to the different activities of the Institute during the year 1989.

U.L.B.

F. Alexandre (chercheur)
M. Barth (maître de recherche FNRS)
D. Bertrand (chercheur qualifié FNRS)
G. Bertrand-Coremans (chef de travaux associé)
A. Cohen (assistante)
C. Hanon (assistant de recherche)
P. Huet (aspirant FNRS)
P. Malisse (chercheur)
P. Marage (1er assistant ULB)
T. Massart (assistant de recherche)
O. Paridaens (chercheur)
J. Sacton (professeur associé)
B. Sales (assistant until September and then chercheur sous contrat)
F. Stichelbaut (boursier IRSIA until October 1989 and then collaborateur scientifique FNRS)
P. Van Binst (chargé de cours associé)
C. Vander Velde (chef de travaux associé)
P. Vilain (chercheur qualifié FNRS)
J. Wickens (chercheur IISN)
G. Wilquet (chercheur qualifié FNRS)
S. Willocq (doctorant) has spent the whole year at Tufts University - Boston in support of the E632 experiment
As "Boursier-correspondant", D. Bertrand has spent three months at CERN in the framework of the DELPHI Collaboration.

V.U.B.

P. Bruyndonckx (vorser IIKW since November 1989)
F. Cao (VUBAROS fellow)
H. Cobbaert (part time assistent Vesalius College until May 1989)
C. De Clercq (logistiek medewerker IIKW)
K. De Winter (assistent VUB until July 1989)

E. Evrard (vorser IIKW)
D. Geiregat (vorser IIKW)
B. Guerard (EC grant since March 1989)
D. Johnson (vorser IIKW until September 1989; and then professor Vesalius College)
P. Kluit (vorser IIKW)
J. Lemonne (gewoon hoogleraar)
N. Meulemans (vorser IIKW until July 1989 and then vorser op extern kontrakt)
J. Moreels (assistent VUB)
R. Roosen (gevoegdverklaard navorser NFWO)
S. Tavernier (onderzoeksleider NFWO)
R. Vandenbroucke-Tassin (eerst aanwezend informaticus IIKW)
W. Van Doninck (bevoegdverklaard navorser NFWO)
L. Van hamme (aspirant NFWO until September 1989)
S. Zhang (VUBAROS fellow since Septembre 1989).

F. Verbeure, J. Buytaert, H. De Boeck, A. De Roeck, A. De Roeck-Michalowska E. De Wolf, and L. Verluyten from the Universitaire Instelling Antwerpen have been working in close collaboration with the Institute.

II. RESEARCH ACTIVITIES.

II.1. Neutrino physics.

II.1.1. Neutrino and antineutrino interactions in BEBC filled with an heavy H_2/Ne mixture.

(**P. Marage and J. Sacton; WA59 Collaboration** : Athens, Bari, Birmingham, Brussels, CERN, Cracow, Ecole Polytechnique - Palaiseau, I.C. London, U.C. London, Munich, Oxford, Rutherford, Saclay, Stockholm).

The results obtained this year from the on-going analysis of a sample of 16500 ν_μ and 10000 $\bar{\nu}_\mu$ charged current interactions are summarized below :

. From a study of $\rho^{+,-,o}$ (770), η (550), ω (783) and f_2 (1270) produced by both ν_μ and $\bar{\nu}_\mu$ it was shown that, except for the f_2, the main features of meson resonance production are reasonably well described by the Lund model, although the average resonance multiplici-

ties are overestimated by the model by (67 ± 30) %. These multiplicities (including the f_2) are well reproduced however by a semi empirical model with parameters determined from hadron interaction data.

. The coherent π^+ meson production by ν_μ interactions on neon was found to agree satisfactorily with predictions based on the PCAC hypothesis and the Meson Dominance Model. This confirms our previous result on coherent production of π^- mesons by antineutrinos.

. Backward proton and pion production, as a tool to investigate nuclear structure, has been studied in both ν_μ and $\bar{\nu}_\mu$ interactions. The proton data are compatible with protons being produced by reinteractions in the neon nuclei. However for events with one proton only, muon kinematic variables appear to be correlated to those of the backward proton, as expected by the two-nucleon correlation model.

. ν_μ interactions producing protons with momenta below 600 MeV/c were found to have softer x distributions than interactions without such protons. The softening is however less pronounced than in deuterium and even less than in hydrogen. This observation precludes interpreting the softness of x distributions of interactions with slow protons in neon (and freon) as being due to nuclear effects, at variance with previous claims by other authors.

. Comparing the kinematical distributions of events obtained on neon and deuterium targets in similar conditions has revealed a reduction of the neutrino and antineutrino charged current cross section per nucleon in neon at low Q^2. The effect, interpreted as due to geometric shadowing of the weak propagator in interactions of neutrinos and antineutrinos with nuclei, agress with predictions derived from PCAC.

Combining data from the WA59 Collaboration with those, obtained under similar conditions at Fermilab by the E180 Collobration, evidence was found for the production of vector charmed D_s^{*-} mesons in a sample of 22700 $\bar{\nu}_\mu$ interactions in the energy range

10-200 GeV. To isolate the radiative $D_s^{*-} \rightarrow \gamma\ D_s^-$ channel a semi inclusive approach embracing all the $\phi\pi^-x$ decays of the D_s^- meson was used. Relative to all charged current events, the D_s^{*-} production rate times the $D_s^- \rightarrow \phi\pi^-x$ branching ratio was found to be $(4.3 \pm 1.2) \times 10^{-3}$.

II.1.2. Neutrino and antineutrino interactions in the 15' bubble chamber filled with an heavy H_2/Ne mixture and exposed to the Tevatron high energy neutrino beam.

(M. Barth, E. De Wolf, P. Marage, J. Moreels, J. Sacton, L. Verluyten; E632 Collaboration : Berkeley, Birmingham, Brussels, CERN, Chandigarh, Fermilab, Hawaii, Illinois Institute of Technology, Jammu, I.C. London (Part I only), Munich, Oxford (Part I only), Rutgers, Rutherford (Part I only), Saclay (Part I only), Stevens Institute of Technology, Tufts.

The Collaboration was joined in October 1989 by three russian laboratories : ITEP-Moscow, IHEP-Protvino and Moscow State University-Moscow.

. Data from the 1985 run.

During this run the chamber was filled with a 25/75 mol % H_2/Ne mixture. About 150000 pictures were taken, corresponding to 15000 charged current ν_μ and $\bar{\nu}_\mu$ induced events. All two and four-prong events were completely measured and used to study single π^+ and π^- coherent production on neon nuclei in the energy range of 40-300 GeV. The measured cross section - $(315 \pm 120) \times 10^{-40}$ cm^2 per neon nucleus - and the kinematical distributions are in agreement with predictions based on PCAC and the Meson Dominance Model.

All leaving tracks from an unbiased sample of events were measured and extrapolated to the External Muon Identifier to select di-muon condidates. All corrections and signal losses being included, the measured opposite sign dimuon rates - (0.64 ± 0.14) % for ν_μ and (0.47 ± 0.25) % for $\bar{\nu}_\mu$ induced events - and the kinematical distributions were found to agree with predictions from the standard charm production models. The like sign dimuon candidates are compatible with backgrounds, both for rate and production characteristics.

A study of the production of neutral strange particles and of short lived particles (lifetime ~ 10^{-13} s) is still in progress. In the latter case, use is made of one high resolution (~ 200 μm) camera complementing the information from three conventional cameras (400-500 μm resolution).

. Data from the 1987-1988 run.

In this case, the chamber contained a lighter mixture of 37/63 mol % H_2/Ne. Some 300000 conventional pictures, corresponding to about 20000 charged current ν_μ and $\bar{\nu}_\mu$ induced interactions, together with 220000 holograms (of which about one half useful for physics analysis) were taken.

The measurements of two, three (for background estimates) and four-prong events is in progress for the study of coherent π, ρ and a_1 meson production. This analysis will triple the statistics from the 1985 run.

Short-lived particles are being searched for in parallel in holograms, high resolution film and conventional pictures; the analysis of the holograms is currently done on three replay machines located at RAL (HOLRED), Fermilab and the University of Hawaii. An example of an hologram showing the neutrino production and subsequent decay of such a particle is given in figure 1.

II.1.3. Neutrino and antineutrino scattering on electrons.

(K. De Winter, D. Geiregat, P. Vilain, G. Wilquet; CHARM II or WA79 Collaboration : Brussels, CERN, Hamburg, Louvain-La-Neuve, Moscow ITEP, Munich, Naples, Rome).

The WA79 experiment.

The CHARM II detector - a 550 tons fiducial calorimeter followed by a muon spectrometer - has been described in previous reports. In this apparatus, exposed at the CERN SPS wide band neutrino beam, a total of 762 $\nu_\mu e$ and 1017 $\bar{\nu}_\mu e$ interactions have been collec-

ted during the data taking runs of 1987 and 1988 corresponding to a total of 9×10^{18} protons on target. The distributions of the neutrino (and antineutrino) electron scattering events as a function of $E\Theta^2$, after background subtraction, are shown in figure 2. From the ratio of $\nu_\mu e$ and $\bar{\nu}_\mu e$ scattering cross sections a new determination of the electroweak mixing angle was made :

$$\mathrm{Sin}^2\Theta_W = 0.233 \pm 0.012 \ (\mathrm{stat}) \pm 0.008 \ (\mathrm{syst})$$

without radiative corrections. Taking $m_t = m_H = 100$ GeV for the top quark and Higgs particle masses, a value of $\sin^2\Theta_W = 0.232 \pm 0.012 \pm 0.008$ is found after radiative corrections.

During the second half of this year a total of $6.8\ 10^{18}$ protons on target will be accumulated, and we hope for a similar number of protons during the first half of 1990. The statistical error on $\mathrm{Sin}^2\Theta_W$ should then drop to $\pm$ 0.007. An improved determination of the electron shower direction will lead to a better estimation of the signal to background ratio and hence reduce the systematic error to $\pm$ 0.005. A better understanding of the neutrino flux normalization, the beam composition and the background sources may further reduce the systematic error down to $\pm$ 0.004. The precision of the experiment would then be limited by statistics. The calibration run of the detector, performed in October 1989 with a wide range of pion and electron beam energies will help greatly in achieving this goal; the analysis of the large amount of data collected during the 1989 run has just started.

In parallel, detailed studies of the coherent π° production by neutral current interactions, of the inverse μ decay and of opposite sign dimuon events are being performed.

Future projects on neutrino physics.

A first option consists in a search for ν_μ-ν_τ oscillations in the unexplored domain of the mixing parameter $|U_{\mu\tau}|^2 > 2\ 10^{-4}$ and of $\Delta m^2 > 10\ \mathrm{eV}^2$ using the CERN SPS Wide-band neutrino beam.

The envisaged detector consists of emulsion stacks totaling 800 kg in mass, and scintillating fibre arrays totaling 400 kg. The fibre detector serves both as a high resolution active target and a precise tracking medium for track extrapolation in the emulsion. Additional tracking is provided by a set of interleaved drift chambers. This set-up is then placed into a 1 T spectrometer surrounded by a muon identifier and a calorimeter.

For this project, the CHARM II Collaboration has been enlarged to the Universities of Ferrara and Nagoya and to the IHEP, Berlin-Zeuthen. Monte-Carlo studies of the physics processes, signal and background, and of the detector response - principally the optional fibres active target - are being made. A systematic study of optical fibre performances is in progress. A first test set-up will be exposed to a hadron beam during summer 1990 with the aim of introducing a proposal to the CERN SPSC if the results are judged satisfactory. The aim would be to take data in 1992 and 1993.

The second option consists in a search for ν_μ-ν_x (disappearance) and ν_μ-ν_e (appearance) oscillations in the CERN PS Wide-band neutrino beam over a long distance of ~ 4 km in the unexplored domain of $\Delta m^2 > 0.03$ eV^2. In this case, the largest part (500 tons) of the CHARM II detector would be moved in a new site at 4500 m from its present location to measure the ν_μ flux relative to the flux observed in the remaining part (170 tons) of the detector left in its present position. A major difficulty of the experiment is the redesign and rebuilding of the PS ejection beam line and the PS neutrino beam. Cost and time estimates are in progress. The aim would be to run in 1992 and 1993.

Finally, a letter of intent has been introduced and positively received by the Experiment Committee of the future 3 TeV UNK accelerator currently built at Serpukhov, in Soviet Union. The physics goal of the proposed experiment is to detect the ν_τ neutrino from the identification of the decay of its charged partner, the τ lepton. This beam dump experiment would use a large array of scintillating optical fibres as a massive high resolution active target. The future of this project relies both on the demonstration of the

feasibility of the technique - probed at the SPS, would our first project come to a realisation - and on the time schedule for the construction and the running of the UNK accelerator and the beam lines. 1995 appears to be the earliest date for data taking.

II.2. Hadron physics.

The research programme on hadron physics has come to an end this year. Various papers presenting the last results of this programme which had been described in details in previous reports appear in the list of publications (see section IX).

II.3. Study of e^+e^- annihilations at LEP.

(D. Bertrand, C. Bricman, J. Buytaert, F. Cao, H. De Boeck, C. De Clercq, P. Kluit, J. Lemonne, F. Stichelbaut, S. Tavernier, C. Vander Velde, W. Van Doninck, F. Verbeure, J. Wickens; DELPHI Collaboration : Ames-Iowa, Athens, Athens-NTU, Belgium, Bergen, CERN, Collège de France, Copenhagen, Dubna, Ecole Polytechnique - Palaiseau, Helsinki, INFN-Bologna, INFN-Genova, INFN-Milano, INFN-Padua, INFN-Roma, INFN-Trieste, INFN-Torino, Karlsruhe, Krakow, LAL-Orsay, LIP-Lisboa, Liverpool, Lund, NIKHEF-Amsterdam, Oslo, Oxford, Paris-LPNHE, Rutherford, Saclay, Santander, Serpukhov, Stockholm, Strasbourg, Uppsala, Valencia, Vienna, Warsaw, Wuppertal).

The collaboration between Belgium (IIHE/ULB-VUB, Mons UIA) and the laboratories of Oxford and Rutherford is responsible for the muon part of the DELPHI detector.

The Belgian groups have constructed the forward muon identifier consisting of 16 detector modules called "quadrants". Each of them covers a sensitive area of about 4.4 x 4.4 m^2 and is made of two orthogonally crossed layers of 22 drift chambers. Four such quadrants assembled into a square of approximately 9 x 9 m^2 provide one detection plane of the forward muon identifier. Two such detection planes are installed in both end caps of DELPHI, the outer plane being situated at the outer edge of the forward part of the magnet yoke, just behind the forward scintillator layer which was built by Serpukhov (USSR) with the help of the Belgian groups. The inner de-

tection plane is imbedded in the iron yoke itself separated from the outer plane by 30 cm of which 20 cm are steel.

The basic detector cell consists of a drift chamber with a sensitive volume : 4354 mm long, 188 mm wide ans 20 mm thick. The chamber body is an extruded aluminium tube equipped with PVC profiles into which copper strip electrodes have been coextruded to provide the drift field of about 700 V/cm. A 100 micron diameter stainless steel anode wire is strung along the chamber axis. One of the cathodes facing the anode wire consists of a flat solenoïdal delay line with an inverse velocity of about 600 ns/m. The drift chambers are operated in the limited streamer mode using a gas mixture of 68 % CO_2, 15 % Ar, 15 % C_4H_{10} and 2 % of alcohol vapour at an anode voltage of about 5000 V.

The coordinates of a hit are determined from three time measurements; the drift time (ta) and the arrival times of the induced pulse at both ends of the delay line (t1 and t2). The left-right ambiguity, inherent to drift chambers with a central anode wire, is resolved using the delay line of the crossed layer. The efficiency, resolution and calibration of the quadrants have been determined in cosmic hodoscopes. The precision on the drift distance was found to be better than 1 mm, whereas the resolution on coordinates measured by the delay lines is about 3 mm.

The first half of 1989 has essentially been devoted to the completion of these calibration measurements at CERN and to the subsequent installation of the quadrants into the DELPHI detector (see figure 3). Moreover, the various read-out (fastbus), high tension and control crates needed to operate the quadrants have been installed in two control rooms situated near each end-cap.

Further contributions have been made to the completion of the software needed for the analysis of muon data as well as to the general purpose software of the DELPHI detector, including graphical event representation.

The data taking with LEP started in August and continued with short interruptions until the end of December. During this period, the forward muon chamber system was operated with less than 1 % of bad channels. Some 100.000 Z° events were recorded by all four LEP experiments of which 15.000 by DELPHI which suffered from running in problems with its data acquisition system. Preliminary results from DELPHI based on 1066 events have already been published, in particular on the Z°-line shape (see figure 4) and the number N_ν of light neutrino species :

$$M_{Z^\circ} = (91.06 \pm 0.09 \text{ (stat)} \pm 0.045 \text{ (syst)}) \text{ GeV}/c^2$$

$$\Gamma_{Z^\circ} = (2.42 \pm 0.21 \text{ (stat)}) \text{ GeV}$$

$$N_\nu = 2.4 \pm 0.4 \text{ (stat)} \pm 0.5 \text{ (syst)}$$

II.4. Study of e-p collisions at HERA.

(M. Barth, G. Bertrand-Coremans, A. De Roeck, E. De Wolf, E. Evrard, D. Johnson, P. Huet, P. Marage, J. Moreels, R. Roosen, J. Sacton; H1 Collaboration : RWTH-Aachen (I and III), Antwerp and Brussels, Cracow, Davis, DESY, Dormund, Ecole Polytechnique - Palaiseau, Glasgow, Hamburg (I and II), Kosice, Lancaster, Liverpool, Manchester, Moscow (ITEP & Lebedew), München, Orsay, Paris (P. & M. Curie), Prague, Rome, Rutherford, Saclay, Wuppertal, Zeuthen and Zurich.

The e-p collider HERA is expected to come into operation at the end of 1990. The H1 detector, which is to be installed in one of the interaction regions of the machine, is in an advanced construction stage. Of the five tracking chambers of this detector, one is being built at the IIHE; this chamber - called COP (Central Outer Proportional Chamber) - is expected to arrive at DESY in May 1990 to be installed into the central tracking detector unit.

The COP detector consists of two coaxial cylindrical chambers of 2.2 m length and with diameter of about 1 m. Each of the chambers contains 1600 wires (2 mm pitch) and has a cathode readout; the two chambers are made out of three sandwich cylinders with an extremely light core material.

The construction of these chambers which has been described in last year report requires the mastering of various techniques such as the controlled depositing of graphite layers on kapton, transfer of 20 micron wires from prewired frames to the chamber body etc. That these techniques are at present fairly well controlled has been shown by the results obtained with a full size prototype chamber under tests during the last three months. Measurements made with a source have shown that the results are conform to those previously obtained with a flat prototype chamber. This flat prototype chamber (being a reduced version of the final chamber) has been used to investigate the electronic read-out of the final COP in particular, the influence of the transmission line and the pad capacities on the read-out electronics, as well as the influence of the chamber gas on the signal formation. The results have shown that the set of parameters chosen are adequate to make the data from the COP useful as input for the first trigger level in H1.

At present one of the three cylinders that constitute the COP is finalised and the two others are in a fairly advanced stage and are expected to be fully finished in the beginning of next year. The finalised cylinder has been used in a full size prototype chamber (figure 5) and has been exposed to an electron beam in DESY in December. The data taken are in the process of analysis.

A second responsability of the IIHE group within the H1 collaboration is the design and construction of the front-end data acquisition system of all the proportional chambers of the H1 detector i.e. 5 chambers, of 2 to 3 planes each, with around 4500 electronic channels.

All the front-end elèctronics are based on a simple backplane called "Easybus", split into 4 subbranches for which there are 280 receiver cards distributed between 16 crates. Each receiver card consists of a discriminator which feeds a pipeline, keeping synchronisation with the collider 10 MHz clock. Controller Cards (CC) interface these crates with the central DAQ system via VME Branch Driver Cards (BDCs) (figure 6a), each equipped with a DMA controller and on-board FIFO.

The receiver cards have not been designed at the IIHE but will be realized here (component mounting, wave soldering); the production is to start soon. Concerning the interface modules (CC and BDC), a prototype of both is actually available and being tested in a reduced size setup simulating the trigger electronics. With the very positive results obtained so far it is expected that the series production can start early next year.

The whole of this MWPC read-out system is under software control and run on a VME based 68020 CPU connected with the central data acquisition via an optical fibre crate interconnect. Major part of the on-line routines, controlling the front-end data transfer into the MWPC multi-event buffer, has been written, purely in assembler, and debugged. Furthermore, in the first weeks of December the software has been inbedded in the overal H1 central DAQ software at DESY and one can state that this part is operational.

A monitoring software, running on a MacII computer, is also under development. This program can "steal" events from the VME MWPC buffer, reconstruct the hits in the various detectors and perform histogram analysis. For this purpose, graphic libraries using MacGKS, have been developed to implement the CERN HBOOK & HPLOT routines and to draw 3D objects (figures 6b and c).

III. TEACHING ACTIVITIES AND SEMINARS.

III.1. Teaching activities.

. **J. Lemonne** : "Elementaire Deeltjes" (45 h + 35 h of pratical work - 1ste and 2de licentie natuurkunde - VUB)

"Statistieke Analyse van Experimentele Gegevens" (15 h + 15 h of practical work - 2de licentie natuurkunde - VUB)

"Algemene Natuurkunde" (60 h + 60 h of practical work - 2de kandidatuur Natuurkunde, Scheikunde, Geologie - VUB).

. **J. Sacton** : "Physique des Particules Elémentaires" (30 h - 1ère licence en sciences physiques - ULB).

. **M. Barth, D. Bertrand, G. Bertrand-Coremans, P. Huet, F. Stichelbaut, P. Vilain and G. Wilquet** have contributed to the practical work for students attending the lectures of J. Sacton on "Physique des Particules Elémentaires" and organized specific practical work for students of the 3rd year in physics at the ULB.

. **D. Bertrand** : "Computer Principles" (26 h + 13 h of practical work - 1st year University Studies in Sciences - ULB).

. **G. Bertrand-Coremans** : "Questions Approfondies de Physique des Particules" (part time 30 h + 45 h of practical work - 2ème licence en sciences physiques - ULB).

. **K. De Winter** has contributed to the "Practica van de kandidaturen Natuurkunde" (180 h Natuurkunde; 120 h Elektronika).

. **D. Geiregat and R. Roosen** have contributed to the practical work for students attending the lectures of J. Lemonne on "Elementaire Deeltjes".

. **D. Johnson** : "Introduction to Physics II - Physics 103" (45 h - Vesalius College - VUB)
"Introduction to Modern Physics - Physics 105" (45 h - Vesalius College - VUB)
"Introduction to Physics I - Physics 101" (45 h - Vesalius College - VUB)
"Solid State Physics - Physics 104" (45 h - Vesalius College - VUB).
All these lectures are accompanied by student consultation and regular interval student exercices.
D. Johnson also assisted in the teaching and laboratory planning for the course "Physics Laboratory I - Physics 102" (Vesalius College - VUB).

. **P. Marage** : "Introduction à la Physique Générale : mécanique - électricité" (20 h "enseignement de propédeutique" organized jointly by ULB and Chambre de Commerce)

"Physique" (120 h of practical work - 1ère candidature Ecole de Commerce Solvay).

. **J. Moreels** : "Algemene Natuurkunde" (60 h practical work - 2de kandidatuur Natuurkunde - VUB)

"Algemene Natuurkunde" (240 h practical work - 1ste kandidatuur Geneeskunde, polyvalente Wetenschappen, Diergeneeskunde, Tandheelkunde, Wiskunde, Natuurkunde - VUB).

. **S. Tavernier** : "Detectie van Ioniseerde Stralingen" (15 h + 15 h of practical work - 2de licentie Natuurkunde and bijzondere licentie medische fysica - VUB).

. **P. Van Binst** : "Introduction à l'Informatique" (30 h + 30 h of practical work - Section Informatique et Sciences Humaines; Faculté des Sciences Sociales, Politiques et Economiques - ULB)

"Informatique (pratique)" (60 h + 30 h of practical work - Section Informatique et Sciences Humaines; Faculté des Sciences Sociales, Politiques et Economiques - ULB)

"Télématique" (30 h - Section Informatique et Sciences Humaines; Faculté des Sciences Sociales, Politiques et Economiques - ULB and licence spéciale en Sciences de l'Information et de la Documentation - Faculté de Philosophie et Lettres - ULB).
In collaboration with Professor L. Wilkin, P. Van Binst has contributed to the creation of a one-year postgraduate curriculum entitled : "Licence Spéciale en Télématique et Organisation" - Faculté des Sciences & Faculté des Sciences Sociales, Politiques et Economiques - ULB. He is coordinator of this Licence and chairman of its Jury.

. **C. Vander Velde** : "Mechanics II" (26 h + 13 h of practical work) - 1st year University Studies in Sciences - ULB)

"Introduction à la Physique Générale : mécanique" (22 h - "enseignement de propédeutique" organized jointly by ULB and Chambre de Commerce)

"Physique" (135 h of practical work - 1ère candidature Ecole de Commerce Solvay).

. **W. Van Doninck** : "Statistiche Analyse van Experimentele Gegevens" (15 h practical work - 2de licentie Natuurkunde - VUB).

. **P. Vilain** : "Questions Approfondies de Physique des Particules" (part time 30 h + 45 h of practical work - 2ème licence en sciences Physiques - ULB)

"Precision Determination of $\sin^2\Theta_W$ (Joint Belgian Deutch German (Aachen) Summer School on Elementary Particle Physics - Chevetogne).

. **A. Cohen** (50 % of her time) has contributed to the practical work for the students of the "Section Informatique et Sciences Humaines" (Faculté des Sciences Sociales, Politiques et Economiques - ULB).

. **C. Hanon, T. Massart** (30 % of their time) and **B. Sales** (50 % of his time) have contributed to the practical work for the students of the "Section Informatique" (Faculté des Sciences - ULB).

Three PhD theses were completed during this year :

. **H. Cobbaert** (VUB) : "Contribution to the Study of the A-Dependence of Charm Production in Hadronic Interactions".

. **L. Van hamme** (VUB) : "Study of Strangeness Production in $p\bar{p}$ Interactions at c.m. Energies between 200 and 900 GeV at the CERN SPS Collider".

. **B. Vonck** (VUB) : "Contribution to the Study of Production Characteristics of Charmed Particles in Hadronic Interactions".

The following "Mémoires" and "Licentiaatsverhandelingen" have been made at the IIHE/ULB-VUB :

. **P. Bruyndonckx** (VUB, supervisor : S. Tavernier) : "Evaluatie van een PET-camera gebaseerd op Ba F_2 en foto-gevoelige dradenkamers aan de hand van een Monte Carlo simulatie".

. **H. Deceuninck** (VUB, supervisor : W. Van Doninck) : "Bijdrage tot de ijking van de voorwaartse muon detektor van het DELPHI experiment".

. **M. Steenhoudt** (VUB, supervisor : J. Moreels) : "Studie van coherente π^+ produktie in ν_μ Ne geladen stroomprocessen".

. **Y. Adam** (ULB, supervisor : T. Massart) : "Conception d'un synthétiseur automatique de spécifications de protocoles à partir de spécifications de service en LOTOS".

. **M. Christiaens** (ULB, supervisor : B. Sales) : "Protocoles OSI de couches 2 et 3 pour réseaux locaux : analyse et possibilités d'implantation".

. **P. Paridans** (ULB, supervisors : F. Alexandre and C. Hanon) : "Etude des couches OSI 6 et 7 en vue de la réalisation d'un UA à distance".

. **J. Massaut** (ULB, supervisor : P. Van Binst) : "Système informatisé de mapping pour la chirurgie des troubles du rythme cardiaque".

III.2. Seminars.

The following seminars were given by members of the IIHE :

. **J. Lemonne** : "Fysica van de Elementaire Deeltjes" (in the lecture series "Navorming leraren" - VUB).

. **P. Marage** : "La fusion froide : pathologie de la science ?" (Colloquium "le Vrai et le Faux" organized by the Groupe Interdisciplinaire en Sciences Humaines - Brussels).

. **J. Sacton** : "New Results Presented at the SLAC Lepton-Photon Symposium and at the Madrid EPS HEP Conference" (Joint Belgian, Dutch and German (Aachen) Summer School on Elementary Particle Physics - Chevetogne).

. **S. Tavernier** : "Preliminary Results on the Photosensitive Wire Chamber Approach" (meeting of the EC exploratory group on PET technology - Paris-France)

"Ontwikkeling van medische instrumentatie (in the lecture series "Navorming leraren" - VUB).

. **C. Vander Velde** : "Le LEP, nouvel accélérateur du CERN - Qu'y cherche-t-on ?" (Faculté des Sciences - ULB).

. **W. Van Doninck** : "De LEP versneller van het CERN : Nieuwe horizonten in de Natuurkunde" (Departement Natuurkunde - VUB).

. **G. Wilquet** : "Ces neutrinos qui peuplent notre univers" (seminar to the students of the 1st year in Physics - ULB).

. **P. Van Binst** : "Les PC's en entreprise, dans la perspective d'un environnement LAN et WAN en mutation" (ASAB-VEBI - Brussels)

"Usage of OSI Standards and Profiles : Where Do We Stand Today ?" (IIHE - Brussels)

"Les techniques de réseau et leur évolution" (Ecole Supérieure d'Informatique, Brussels)

"Les télécommunications et la télématique dans le monde" (Ecole Supérieure d'Informatique - Brussels)

"Les perspectives belges et européennes en matière de télécommunications" (Ministère de la Fonction Publique - Rendeux-Haut)

"Transmission des données et télématique" (Université de Liège - LENTIC)

"De Guttenberg à la publication assistée par ordinateur" (Extension de l'ULB - Braine-le-Comte).

. **F. Alexandre** : "Tests de conformité OSI : de la théorie à la pratique dans le cadre du RTS" (Laboratoire d'Informatique Théorique - ULB).

. **A. Cohen** : "Procédures de transmission et problèmes d'interconnexion des réseaux dans un environnement satellite" (Laboratoire d'Informatique Théorique - ULB).

. **T. Massart** : "Etude d'un protocole de liaison de données pour liaison satellite" (Laboratoire d'Informatique Théorique - ULB).

. **O. Paridaens** : "Tests de conformité OSI : description des normes" (Laboratoire d'Informatique Théorique - ULB).

. **B. Salès** : "Interfonctionnement LAN/WAN dans le contexte du projet HELIOS B " (Laboratoire d'Informatique Théorique - ULB).

In the framework of the Seminars on Elementary Particles Physics organized at the IIHE by G. Wilquet, the following talks were given :

. **Dr R. Raupach** (I Phys. Inst. RWTH - Aachen) : "Measurements of Nuclear Stability with Underground Detectors".

. **Dr W. Schmidt-Parzefall** (DESY) : "$B^{\circ}\bar{B}^{\circ}$ Mixing".

. **Dr R. Windmolders** (Mons - CERN) : "Nucleon Spin and Nucleon Constituants : the EMC Results and Prospects for New Experiments".

. **Dr M. Arnould** (ULB) : "Dark Matter in the Universe'".

. **Dr L. Van hamme** (VUB) : "LATEX : a Demystification".

. **Dr G. Snow** (Michigan) : "Direct Photon Production from Experiment UA6 at CERN".

. **Dr J. Engel** (World Teleport Association - Europe) : "Teleports in Europe".

IV. COMPUTER MATTERS.

IV.1. Computing and networking.

The persons involved in the activities described in this section are : management : **P. Van Binst** and **R. Vandenbroucke-Tassin**, scientifics (HELIOS-B Group) : **F. Alexandre, A. Cohen-Melard, C. Hanon, P. Malisse, T. Massart, N. Meulemans, O. Paridaens** and **B. Salès**, logistics : **G. Depiesse, J. Liesen** (part-time), **D. Pauwels-Pirnay** (half-time), **G. Rousseau, A. Van Cauwenberge-De Coster** (part-time) and **W. Van Droogenbroeck**.

No significant change was made to the data processing facilities of the IIHE in 1989, but various improvements were made to the computing and networking environments :

- acquisition of two DEC VAXstations 3100, both equipped with 8 Mb of central memory, 200 Mb of disk and a 19" screen; one has colour facilities and is being used for graphics applications, the other one is black and white and is being used as a general batch machine, as well as for system and performance monitoring;
- acquisition of a small number of PC's and MacSE's;
- acquisition of three DEC Terminal Servers (8 lines each);
- acquisition of a number of FALCO and DEC terminals;
- installation of a new Ethernet infrastructure on IIHE premises in the VUB and ULB buildings; bridging of these Ethernets with the VUB ones (VUBNET) and also with a new Ethernet segment installed in the ULB NO building, by making use of ILAN intelligent routing bridges; use of an optical fibre between the two campusses. These developments were realized under a research contract with the Belgian company COMTECH.

A number of other developments took place in the scope of the activities of the HELIOS-B Group, which are reported elsewhere.

Besides these internal developments, the IIHE has also started making use of the facilities of the CRAY X/MP-14 supercomputer installed at the ULB-VUB Computer Centre, with its new SUN 4 front-end.

Full connectivity, using a variety of communication protocols, is available between all IIHE computers, including VAXes running VMS, UNIX machines and PC's, and the CRAY, CDC, PRIME, IBM and SUN machines at the Computer Centre, as with any other networked machine in the world. Heavy use is being made of the RTT DCS public network, at 9.6 Kbps, particularly for accessing CERN computers, for interactive, batch, file transfer and mail applications. Use is also being made of the EARN, EUNET and RARE MHS services.

By the end of the year, the IIHE was getting ready to participate in the pilot usage of the new RARE/COSINE IXI network, which will provide international X.25 connectivity at 64 Kbps to academic networks and research centres in Europe, including CERN.

IV.2. Graphics development.

(D. Bertrand - L. Van hamme).

A working version of the 3D graphics interactive analysis program has been settled for the first LEP DELPHI data taking process which took place in August 1989. The system allowed to visualize the events almost immediately after their detection by the DELPHI detector. As foreseen, it helped a lot in understanding the detector geometry defects and misalignements as well as the effects of the adjustment of the calibration constants. The development work done during the last year using Monte-Carlo events looked to be quite fruitful and well adapted to the delicate task of interpreting events reconstructed by complex pattern recognition programs. Only minor adaptation had to be done in order to handle events but further developments are pursued in order to follow closely the physics analysis needs, more particularly in the search of rare particles. A copy of drawings produced by the program are shown in figure 7. The portability of the program has been increased by producing a GKS (graphics kernel system) version working in the same way as the specialized versions running on Apollo and Megatek stations. The program is now working on all workstations supporting GKS in a multi-windowing environment.

Presently most of the 15.000 events registered in 1989 by DELPHI were scanned by the different laboratories of the collaboration using this program mostly developed by the IIHE staff.

V. TECHNOLOGICAL R & D.

V.1. Technology transfer from basic research to applications.

(P. Bruyndonckx, B. Guerard, S. Tavernier and S. Zhang).

The photosensitive wire chamber technology was developed over the last decade in a number of High Energy Physics research institutes. It allowes to detect and localise very weak light signals over large areas. It is now used in a number of instruments like the DELPHI Ring Image Cherenkov detector. The aim of the present project is to use this technology to build a Positron Emission Tomograph camera with improved performances compared to present commercial systems.

The project is a collaboration between Brussels, Brunel University (UK), CERN, Ecole Polytechnique (F) and LAL/Orsay (F). It is supported by the EC under the program SCIENCE. After a slow start the project has now gained momentum, and the team in Brussels has been reinforced during 89 by 3 young researchers.

Measurements with two small technical prototypes equipped with BaF_2 crystals measuring 5 x 5 x 50 mm^3 have allowed to measure the following performances for the detection of gamma rays of 511 keV :
- time resolution 10ns
- detection efficiency 60 %
- almost no energy resolution.

With the help of an elaborate Monte Carlo calculation we have evaluated what would be the imaging performance of a PET camera based on this gamma detection technique. It is found that it would give a spatial resolution in the image of 4.2 mm in all 3 space directions and a considerable increase in the sensitivity of the instrument

compared to current commercial systems. It was also shown that a better time and energy resolution would significantly improve the performance. For this reason we now propose a modified design where the BaF_2 crystals are read-out on one side with a photomultiplier, which provides time and energy resolution, and on the other side with a wire chamber to identify the crystal which was hit.

With these modifications the Monte Carlo calculation predicts the following performances for the PET camera :

- spatial resolution : 4.2 mm in all 3 space directions
- sensitivity : 660 kHz/μCi/cm^3
- random fraction at 100 kHz : 5 %
- scatter fraction 17,5 % for a cylinder with 20 cm diameter.

We have now built a technical prototype in which this double sided read-out can be tested, and expect results from it soon.

V.2. Scintillating optical fibres technique.

(L. Van hamme and G. Wilquet).

Further work on the use of a scintillating optical fibre array as high resolution active target has been pursued within the CHARM II Collaboration (see section II.1.3) and the WA84 Collaboration. The latter aims to detect and reconstruct a large sample of events which include the creation in hadronic interactions and subsequent decay of B mesons. The WA84 target has been exposed to a high energy hadron beam in normal running conditions with the Omega spectrometer. The purpose was to perform ultimate measurements before a data taking run for understanding in details the potentialities and the limitations of the technique. Signal and noise contributions to the events image originating from both the target and the opto-electronic read-out chain are being carefully studied, as well as their impact on the track and vertex resolutions. A simulation chain has been developed to understand in all details the test results observed in the WA84 target. It has been adapted to help designing the experimental set-up forseen by CHARM II to detect τ

lepton decays in a massive detector made of emulsion and scintillating fibres layers. Work is in progress.

VI. TECHNICAL AND ADMINISTRATIVE WORK.

The members of the workshop staff were : **J. De Bruyne, J.P. Dewulf, L. Etienne, R. Gindroz, R. Goorens, E. Lievens, R. Ruidant, H. Turtelboom, G. Van Beek, J. Vanbegin, R. Vanderhaegen, L. Van Lancker, J. Van Vaerenbergh, G. Vincent** and **C. Wastiels.**

P. Marage was in charge of the general coordination; **L. Etienne** and **L. Van Lancker** organised the work of the electronics and mechanics workshops respectively.

The 17 modules of the DELPHI end-cap detectors, delivered at CERN in 1989, where further tested, calibrated and installed as part of the DELPHI detector, with contribution of **L. Etienne, R. Goorens, E. Lievens, H. Turtelboom, L. Van Lancker** and **J. Van Vaerenbergh.**

For the H1 experiment, the members of the mechanical workshop have constructed several additional infrastructure pieces and tools for the making of the COP chamber and the installation of the testing set-up. Those who contributed to the construction of the COP itself (see section II.4) were **J. De Bruyne, J.P. Dewulf, R. Gindroz, R. Ruidant, G. Van Beek, J. Van Vaerenbergh** and **G. Vincent** with the help of **J. Gevers-De Schutter, D. Luypaert-Peymans, M. Pins, R. Pins** and **A. Van Cauwenberge-De Coster,** from our bubble chamber scanning and measuring teams. The fixation system of the chambers for their transportation and installation at DESY was designed by **L. Van Lancker** with the help of **R. Gindroz, E. Lievens, R. Ruidant** and **J. Van Vaerenbergh. J.P. Dewulf, L. Etienne, R. Vanderhaegen** and **C. Wastiels** have contributed to parts of the electronics of the data acquisition system and to the installation

of the read-out electronics for the prototype set-up and for the COP.

J. De Bruyne was mostly engaged in the PET camera project to which **L. Van Lancker** and other members of the mechanical workshop also occasionally contributed.

J.P. Dewulf and **H. Turtelboom**, with the help of **M. Delasorte, M.P. Kips-Galloy, D. Legrand-Mahaux, D. Luypaert-Peymans, A. Pels-Vermijlen, A. Van Cauwenberge-De Coster** and **L. Vermeersch-Polderman** produced additional electronics cards (wave soldering method) for the CHARM II experiment.

R. Gindroz, R. Ruidant, L. Van Lancker, G. Vincent and **C. Wastiels** were in charge of the maintenance of the bubble chamber film measuring machines. The personnel of both workshops, helped by **J. Gevers-De Schutter, M.L. Ronsmans** and **J. Vanbegin** contributed to the general maintenance in the laboratory.

In performing the neutrino bubble chamber experiments which were presented in section II.1, the physicists have benefited from the efficient work of the scanning and measuring teams of the laboratory : **C. Carlier, M. Delasorte, M. De Schutter, Ch. Garnier-Stoffen, M.P. Kips-Galloy, D. Legrand-Mahaux, D. Luypaert-Peymans, A. Pels-Vermijlen** and **L. Vermeersch-Polderman.**

The secretarial work was accomplished by **R. Lecluse-Alluyn** and **M. Van Doninck-Garnier** - assisted by **M. Goeman** and **J. Liesen** - and by **J. Castera** for the HELIOS-B program. **M. Pins** has contributed to the realization of a film illustrating the construction of the muon chambers for the DELPHI detector. **Cl. Vorstermans-Hennebert** took care of the library; since December this task has been taken over by **M. Delasorte** and **A. Van Cauwenberge.**

VII. REPRESENTATION IN COUNCILS AND COMMITTEES.

J. Lemonne has been the Belgian scientific representative in the CERN Council; he was elected as representative of the academic personnel of the Faculty of Science in the Council of the VUB.

J. Lemonne and J. Sacton were members of the Organizing Committee of the 1990 CERN School for Computing.

J. Lemonne, J. Sacton and F. Verbeure have organized the First Joint Belgian, Dutch and German (Aachen) Summer School on Elementary Particle Physics at Chevetogne (Belgium).

J. Lemonne, J. Sacton and F. Verbeure were members of the Scientific Committee "High Energies" of the IIKW-IISN and of the Belgian Selection Committee of CERN fellows.

J. Sacton acted as Vice-Chairman of the Faculté of Sciences of the ULB, as advisor of the Rector of the ULB for all matters dealing with computing; he has deputized the Rector as Chairman of the Conseil de l'Informatique and acted as Vice-Chairman of the Conseil de Gestion du Centre de Calcul ULB-VUB. He was member of the Steering Committee for Computing at CERN in the 1990's; this Committee concluded its work by producing a New CERN Green Book summarizing its recommendations to the CERN Management.
J. Sacton was also member of the Working Group "Supercomputers" of the Belgian Academy Council of Applied Sciences and deputy member of the Comité d'accompagnement du programme d'impulsion en technologie de l'information (Service de Programmation de la Politique Scientifique).

F. Verbeure has acted as Belgian representative at RECFA.

P. Marage has acted at the ULB as member of its Council, of the Council of the Institut de Sociologie, the Council of the Faculty of Sciences, the Commission des Finances, the Commission de la Programmation et des Investissements.

S. Tavernier was member of the "Bureau van de Onderzoeksraad" of the VUB, of the Committee of the EC Exploratory Group on PET Technology and of the Council of the Belgian Physical Society.

C. Vander Velde has acted as secretary of the "Conseil du Département de Physique" at the Faculty of Sciences of the ULB.

The following responsabilities were taken in the organisation of the DELPHI experiment :

. **D. Bertrand** : member of the Software Coordination Panel (SCOOP).

. **J. Lemonne** : Vice-Chairman of the Collaboration Board and representative of "Belgium", representative of the IIKW-IISN in the DELPHI Finance Committee.

. **C. Vander Velde** : responsible for the muon subtrigger

. **J. Wickens** : member of SCOOP and PAP (Physics Analysis Panel).

The following responsabilities were taken in the organisation of the H1 experiment :

. **R. Roosen** : representative of "Belgium" in the Collaboration Board.

. **J. Sacton** : representative of the IISN-IIKW in the H1 Finance Committee.

P. Van Binst was member of : EWOS Technical Assembly, ETSI (representing RARE), COSINE Policy Group, RARE Council of Administration, RARE WG4 on Lower Layers Management, ECTUA, HEPNET Requirements Committee (Deputy member), DECUS European Council (Chairman of DECUS At-Large Chapter), the Board of DECUS BELUX, Commission Informatique of FNRS/NFWO, Comité Informatique of IBN/BIN.
He also acted as deputy chairman of RARE WG6 on High Speed Services and ISDN and as expert to the Commission of the European Communities.

R. Vandenbroucke-Tassin was member of the DECUS Europe SIG Advisory Committee. She acted as chairperson of DECUS Belux Networks SIG, and of DECUS Europe Networks SIG. She represented DECUS Europe

in EWOS, Belgium in the IXI Coordination Committee and the Belgian HEP Community in the HEPNET Requirements Committee.

C. Hanon was a member of the EWOS Expert Group on Message Handling Systems.

O. Paridaens was member of the EWOS Expert Group on Conformance Testing.

B. Sales was a member of the EWOS Expert Group on Lower Layers, of the RARE Working Group 4 of IBN/BIN SCCI/4A. Within EWOS, he was Editor of the "EWOS Technical Guide - Lower Layers Relays".

VIII. ATTENDANCE TO CONFERENCES, WORKSHOPS AND SCHOOLS.

VIII.1. Conferences and Workshops.

- International Europhysics Conference on High Energy Physics (Madrid - Spain)
A. De Roeck, P. Marage, J. Sacton and W. Van Doninck.

- XIV International Symposium on Lepton and Photon Interactions (Stanford - USA)
G. Bertrand-Coremans and P. Vilain.

- Physics in Collision (Jerusalem - Israël)
E. De Wolf.

- Conference on Supercollider Physics and Experiments (Dallas - USA)
J. Sacton.

- Workshop on Multiparticle Dynamics (La Thuile - Italie)
F. Verbeure.

- Workshop on Physics at UNK (Moscow - USSR)
P. Vilain and G. Wilquet.
G. Wilquet has participated to two meetings at Zeuthen (GDR) and Moscow (USSR) in preparation of this Workshop.

- ECFA Study Week on Instrumentation Technology for High Luminosity Hadron Colliders (Barcelona - Spain)
G. Wilquet.

- First Workshop on Accuracy Determination in Positron Emission Tomography (Pisa - Italia)
S. Tavernier.

- Digital Living Laboratories Symposium (Boston - USA)
D. Bertrand.

- Colloque pour une télématique de service public, Fondation Roi Baudouin (Brussels)
P. Van Binst.

- CENELEC Workshop on the European Standardization of the Home Electronic System (Brussels)
P. Van Binst.

- For an European Telecommunications Strategy Matching Users Needs, ECTUA (Brussels)
P. Van Binst.

- 5th International Conference on the Application of Standards for Open Systems (Tokyo - Japan)
P. Van Binst.

- Olympus Utilization Conference, ESA (Vienna - Austria)
P. Van Binst.

- ISDN in Europe (The Hague - Netherlands)
P. Van Binst.

- Jornadas Technicas IRIS 89 (Santander - Spain)
P. Van Binst.

- International Symposium on Information Technology Standardization (Braunschweig - Federal Republic of Germany)
P. Van Binst.

- IBM Europe Institute (Garmish-Partenkirschen - Germany)
P. Van Binst.

- IFIP World Computer Congress (San Fransisco - USA)
P. Van Binst.

- ESPRIT Conference (Brussels)
P. Van Binst.

- DECUS Europe Symposium (The Hague - Netherlands)
F. Alexandre, P. Van Binst, R. Vandenbroucke-Tassin.

- EUUG Spring' 89 Conference (Brussels)
F. Alexandre, P. Malisse, O. Paridaens.

- Eighth International Conference on Digital Satellite Communications (Pointe-à-Pitre - Guadeloupe)
A. Cohen, T. Massart.

- Journées Scientifiques du SITEB (Casablanca - Maroc)
A. Cohen.

- ACM Sig Comm' 89 Symposium on Communication Architecture and Protocols (Austin - USA)
P. Malisse, O. Paridaens.

- Second International Conference on Formal Description Techniques (Vancouver - Canada)
T. Massart.

- International Symposium on Protocol Specification, Testing and Verification (Twente - Netherlands)
T. Massart.

- DECUS Belux Symposium (Gent - Belgium)
R. Vandenbroucke.

- DECUS US Symposium (Atlanta - USA)
R. Vandenbroucke.

VIII.2. Schools.

- Joint Belgian-Dutch-German (Aachen) Summer School on Elementary Particle Physics (Chevetogne - Belgique)
F. Cao, H. De Boeck, E. Evrard, P. Huet, F. Stichelbaut, L. Verluyten.

- CERN School of Computing (Bad Herrenalb - Federal Republic of Germany
B. Evrard.

- 1989 CERN Summer Student Program
H. De Boeck.

IX. LIST OF PUBLICATIONS, REPORTS AND CONTRIBUTIONS TO CONFERENCES.

IX.1. Publications.

. Neutrino Physics.

1. "Coherent Production of π^+ Mesons in ν-Neon Interactions"
P. Marage, ..., J. Sacton, et al.
Z. Physik C, Particles and Fields C43, 523, 1989.

2. "Backward Particle Production in Neutrino Neon Interactions"
E. Matsinos, ..., P. Marage, ..., J. Sacton, et al.
Z. Physik C, Particles and Fields C44, 79, 1989.

3. "Neutrino Interactions, Proton Production and a Nuclear Effect"
J. Guy, ..., P. Marage, ..., J. Sacton, et al.
Physics Letters 229B, 421, 1989.

4. "Production of $\rho^{+,-,o}(770)$, $\eta(550)$, $\omega(783)$ and $f_2(1270)$ Mesons in $\bar{\nu}$ Neon and ν Neon Charged Current Interactions"
W. Wittek, ..., P. Marage, S. Willocq, et al.
Z. Physik C, Particles and Fields C44, 175, 1989.

5. "Observation of Shadowing of Neutrino and Antineutrino Interactions and Comparison with PCAC Predictions"
P.P. Allport, ..., P. Marage, et al.
Physics Letters 232B, 417, 1989.

6. "Coherent Production of π^+ and π^- Mesons by Charged Current Interactions of Neutrinos and Antineutrinos on Neon Nuclei at the Fermilab Tevatron"
M. Aderholz, ..., M. Barth, E. De Wolf, P. Marage, J. Moreels, J. Sacton, L. Verluyten, S. Willocq, et al.
Physical Review Letters 63, 2349,; 1989.

7. "A New Determination of the Electroweak Mixing Angle from Muon-Electron Scattering"
D. Geiregat, P. Vilain, G. Wilquet, et al.
Physics Letters 232B, 539, 1989.

. Hadron Physics.

8. Comparative Properties of 400 GeV/c Proton-Proton Interactions with and without Charm Production"
M. Aguilar-Benitez, ..., P. Vilain, B. Vonck, et al.
Z. Physik C, Particles and Fields C41, 191, 1988 (not included in the 1988 report).

9. "Charged Particle Multiplicity at 200 and 900 GeV c.m. Energy"
R.E. Ansorge, ..., J. Gaudaen, L. Van hamme, G. Wilquet, et al.
Z. Physik C, Particles and Fields C43, 357, 1989.

10. "Hyperon Production at 200 and 900 GeV c.m. Energy"
R.E. Ansorge, ..., J. Gaudaen, L. Van hamme, G. Wilquet, et al.
Nuclear Physics B328, 36, 1989.

11. "Photon-Production at 200 and 900 GeV"
R.E. Ansorge, ..., G. Gaudaens, ..., L. Van hamme, G. Wilquet
Z. Physik C, Particles and Fields C43, 75, 1989.

12. "Inclusive Meson Resonance Production in π^+p Interactions at 250 GeV/c"
N.M. Agababyan, ..., A. De Roeck, E. De Wolf, ..., A. Michalowska, ..., F. Verbeure, et al.
Z. Physik C, Particles and Fields C41, 539, 1989.

13. "Multiplicity Distribution in K^+ A1 and K^+ Au Collisions at 250 GeV/c and a Test of the Multiple Collision Model"
I.V. Ajinenko, ..., A. De Roeck, E.A. De Wolf, ..., B. Michalowska, ..., F. Verbeure, et al.
Z. Physik C, Particles and Fields C42, 377, 1989.

14. "Forward-Backward Multiplicity Correlation in π^+p, K^+p and pp Collisions at 250 GeV/c"
V.V. Aivazyan, ..., A. De Roeck, E.A. De Wolf, ..., B. Michalowska, ..., F. Verbeure, et al.
Z. Physik C, Particles and Fields C42, 533, 1989.

15. "Intermittency Patterns in π^+p and K^+p Collisions at 250 GeV/c"
I.V. Ajinenko, ..., A. De Roeck, E.A. De Wolf, ..., B. Michalowska, ..., F. Verbeure, et al.
Physics Letters 222B, 306, 1989.

16. "A Study of Four- and Six-Body Reactions in π^+p and K^+p Interactions at 250 GeV/c"
I.V. Ajinenko, ..., A. De Roeck, E.A. De Wolf, ..., B. Michalowska, ..., F. Verbeure, et al.
Z. Physik C, Particles and Fields C43, 15, 1989, also Bulletin of the IIHE-ULB/VUB 89.01.

17. "Charge and Energy Flow in π^+p, K^+p and pp Interactions at 250 GeV/c"
I.V. Ajinenko, ..., A. De Roeck, E.A. De Wolf, ..., B. Michalowska, ..., F. Verbeure, et al.
Z. Physik C, Particles and Fields C43, 37, 1989.

18. "Study of ρ° anf f_2-Meson Production in π^-p Interactions at 360 GeV/c"
F. Verbeure, A. De Roeck, et al.
Soviet Journal of Nuclear Physics 49, 631, 1989.

19. "Vector Meson Production in π^-p Interactions at 360 GeV/c"
M. Aguilar-Benitez, ..., A. De Roeck, ..., F. Verbeure, et al.
Z. Physik C, Particles and Fields C44, 531 1989.

20. "Strange and Non-Strange Baryon Production in π^+p and K^+p Interactions at 250 GeV/c"
I.V. Ajinenko, ..., A. De Roeck, E.A. De Wolf, ..., B. Michalowska, ..., F. Verbeure, et al.
Z. Physik C, Particles and Fields C44, 573, 1989, also Bulletin of the IIHE-ULB/VUB 89.02.

21. "Minijets and the Rise of the Total Cross Section"
P. Kluit
Physics Letters 222B, 155, 1989.

. e^+e^- Physics.

22. "Measurement of the Mass and Width of the Z° Particle from Multihadronic Final States Produced in e^+e^- Annihilations"
P. Aaruio, ..., D. Bertrand, C. Bricman, J. Buytaert, C. De Clercq, M. De Jode, P. Kluit, J. Lemonne, F. Stichelbaut, S. Tavernier, W. Van Doninck, C. Vander Velde, F. Verbeure, J. Wickens, et al.
Physics Letters 231B, 539, 1989.

. Experimental Techniques.

23. "Holography in the 15 Foot Bubble Chamber"
G. Harigel, ..., M. Barth, E. De Wolf, P. Marage, J. Moreels, J. Sacton, L. Verluyten, S. Willocq, et al.
Nuclear Instruments and Methods 279A, 249, 1989.

24. "Holred - A Machine for the Replay of Holograms Mode in a Large Bubble Chamber"
M. Aderholz, ..., J. Moreels, L. Verluyten, et al.
Nuclear Instruments and Methods 284A, 311, 1989.

25. "Tests Results and Conditioning Procedure of a Limited Streamer Tube Calorimeter"
J.P. Dewulf, ..., P. Vilain, G. Wilquet, et al.
Nuclear Instruments and Methods 263A, 109, 1988 (not included in the 1988 report).

26. "A Detector for the Study of Neutrino-Electron Scattering"
K. De Winter, J.P. Dewulf, D. Geiregat, P. Vilain, G. Wilquet, et al.
Nuclear Instruments and Methods 278A, 670, 1989.

27. "Experimental Results Obtained from a Low Z, Fine-Grained Electromagnetic Calorimeter"
K. De Winter, D. Geiregat, P. Vilain, G. Wilquet, et al.
Nuclear Instruments and Methods 277A, 83, 1989.

28. "An Electron-Hadron Separator for Digital Sampling Calorimeters"
K. De Winter, D. Geiregat, P. Vilain, G. Wilquet, et al.
Nuclear Instruments and Methods 277A, 170, 1989.

29. "A Hybrid Experiment to Search for Beauty Particles"
S. Aoki, ..., M. Barth, D. Bertrand, G. Bertrand-Coremans, R. Roosen, et al.
Nuclear Instruments and Methods 274A, 64, 1989.

30. "Performance of the Delay Lines of the DELPHI Forward Muon Chambers"
F. Stichelbaut, C. Bricman, J. Buytaert, C. De Clercq, L. Etienne, B. Goorens, J. Lemonne, S. Tavernier, C. Vander Velde, W. Van Doninck, J. Wickens, et al.
Nuclear Instruments and Methods 283A, 792, 1989, also Bulletin of the IIHE-ULB/VUB 89.04.

31. "Left-Right Ambiguity Resolution in a Drift Chamber Working in the Self-Quenching Streamer Mode"
L. Etienne, P. Jadot, S.P.K. Tavernier and C. Vander Velde
Nuclear Instruments and Methods 284A, 439, 1989, also Bulletin of the IIHE-ULB/VUB 89.05.

32. "A New Approach to Positron Emission Tomography"
G. Charpak, ..., S. Tavernier, et al.
European Journal of Nuclear Medicine 15, 690, 1989.

. Computing.

33. "Computing at CERN in the 1990's"
R. Billinge, ..., J. Sacton, et al.
New CERN Green Book, July 1989.

34. "Computing for Experiments - Part of Computing at CERN in the 1990's"
R. Böck, ..., D. Bertrand, et al.
New CERN Green Book, July 1989.

35. "Quelques considérations techniques sur des tendances récentes ou LAN, MAN, WAN : même combat ?"
ULB, Télex, September 1989.

IX.2. Reports.

1. "Evidence for Antineutrino Production of D_s^* Mesons"
A. Asratyan, ..., P. Marage, J. Sacton, et al.

2. "Negative Binomials and Multiplicity Distributions in 250 GeV/c K^+ and π^+ Interactions on Al and An Nuclei"
I.V. Ajinenko, ..., A. De Roeck, E.A. De Wolf, A.B. Michalowska, F. Verbeure, et al.
Bulletin of the IIHE-ULB/VUB 89.03.

3. "Inclusive Production of Vector Mesons in π^+p Interactions at 250 GeV/c"
N.M. Agababyan, ..., A. De Roeck, E.A. De Wolf, A.B.Michalowska, F. Verbeure, et al.
Bulletin of the IIHE-ULB/VUB 89.07.

4. "Multiplexing for the End-Cap μ-Chambers"
J. Buytaert and C. Vander Velde
DELPHI 88/19 TRACK 46 (not included in the 1988 report).

5. "Detector Dependent Graphics Implementation Guide Lines"
D. Bertrand, ..., M. De Jode, et al.
DELPHI 89/9 PROG 128.

6. "A Model for DELPHI Data Processing"
E. Dahl-Jensen, ..., J.H. Wickens
DELPHI 88/65 PROG 116 (not included in the 1988 report).

7. "Fastbus Read-Out Systems for the DELPHI Muon Chambers, Time of Flight Counters and End-Cap Scintillator Counters"
J. Buytaert, C. De Clercq, C. Vander Velde, et al.
DELPHI 88/92 DAS 90 (not included in the 1988 report).

8. Event Viewing Software - Installation Procedure and User Manual"
P. Abreu, D. Bertrand, ..., M. De Jode, et al.
DELPHI 89/6 PROG 126.

9. "DELSIM - DELPHI Event Generation and Detector Simulation"
A. de Angelis, ..., D. Bertrand, M. De Jode, et al.
DELPHI 89/15 PROG 130.

10. "Experimentele Fysica van de Elementaire Deeltjes aan het IIHE-ULB/VUB"
J. Lemonne
VUB Magazine nr 16 - 1989.

11. "Bref historique des tests de messagerie électronique à l'IIHE"
F. Alexandre, C. Hanon, B. Salès, P. Van Binst, R. Vandenbroucke
IIHE Helios-B Report 89-107.

12. "Report on some Experiments with NCR-X.400 Release 1.0"
F. Alexandre, G. Hanon, P. Paridaens
IIHE Helios-B Report 89-109.

13. "Construction of an RTS Conformance Tester. The ASP Constraint Part"
P. Alexandre
IIHE Helios-B Report 89-113.

14. "Construction of an RTS Conformance Tester. The Dynamic Behaviour Part"
P. Alexandre, O. Paridaens
IIHE Helios-B Report 89-114.

15. "An ASN.1 PDU Decoder for Conformance Testing"
C. Hanon, O. Paridaens
IIHE Helios-B Report 89-112.

16. "Introduction to the ISO Development Environment - ISODE"
P. Malisse
IIHE Helios-B Report 89-127.

17. "Installation of Internetworking Bridges at the IIHE/ULB-VUB"
P. Malisse
IIHE Helios-B Report 89-131.

18. "Definition of a Protocol Synthesizer for LOTOS Service Specification"
T. Massart
IIHE Helios-B Report 89-101.

19. "A Collision Problem in OSI Standard Formal Specifications"
T. Massart
IIHE Helios-B Report 89-100.

20. "An Object Oriented Environment for Conformance Testing"
N. Meulemans
IIHE Helios-B Report 89-103.

21. "An Introduction to Conformance Testing"
O. Paridaens
IIHE Helios-B Report 89-104.

22. "Construction of an RTS Conformance Tester. The PDU Constraint Part.
O. Paridaens
IIHE Helios-B Report 89-110.

23. "Contribution of IIHE to the UNISYS Open Forum"
O. Paridaens
IHE Helios-B Report 89-134.

24. "Some Experience with a U6050"
O. Paridaens
IIHE Helios-B Report 89-138.

25. "IIHE Comments on Proposal on Relay Profile Tree in M-IT-02 (issue 4)
B. Salès
IIHE Helios-B Report 89-121.

26. "About the Service Provided by the OSI Data Link Layer"
B. Salès
IIHE Helios-B Report 89-123.

27. "Belgian Contribution to Physical Service Definition (ISO/DIS 10022)"
B. Salès
IIHE Helios-B Report 89-124.

IX.3. Contributions to Conferences.

a. Presented by members of the IIHE.

1. "Particle Production in Meson-Proton and Meson-Nucleus Interactions at 250 GeV/c"
Talk presented by A. De Roeck at the International Europhysics Conference on High Energies (Madrid - Spain)
Bulletin of the IIHE-ULB/VUB 89.08.

2. "Multiplicity Distributions in Meson Interactions on Al and Au"
Talk presented by F. Verbeure at the Workshop on Multiparticle Dynamics (La Thuile - Italy).

3. "Cluster Analysis in K^+p Interactions at 250 GeV/c"
Talk presented by E. De Wolf at Physics in Collisions (Jerusalem - Israël).

4. "Minijets and the Rise of the Total Cross Section"
Talk presented by P. Kluit at the Third Conference on Elastic and Diffractive Scattering (Chicago - USA).

5. "Producing Physics at LEP in the Nineties"
Talk presented by D. Bertrand at the Digital Living Laboratories Symposium (Boston - USA).

6. "Performance of the Delay Lines of the DELPHI Forward Muon Chambers"
F. Stichelbaut, C. Bricman, J. Buytaert, C. De Clercq, L. Etienne, B. Goorens, J. Lemonne, S. Tavernier, C. Vander Velde, W. Van Doninck, J. Wickens, et al.
Talk presented by F. Stichelbaut at the Wire Chamber Conference (Vienna - Austria) - see publication list.

7. "The DELPHI Forward Muon Chambers"
Talk presented by F. Stichelbaut at the Annual Meeting of the Belgian Physical Society - Brussels.

8. "Construction of the Cylindrical MWPC for the Central Tracking Detector of H1"
G. Bertrand-Coremans, A.De Roeck, J.P. Dewulf, E. Evrard, P. Huet, D. Johnson, P. Marage, J. Moreels, R. Roosen and G. Van Beek
Talk presented by P. Marge at the International Europhysics Conference on High Energy Physics (Madrid - Spain).

9. "A New Approach to Positron Emission Tomography"
Talk presented by S. Tavernier at the First Workshop on Accuracy Determination in Positron Emission Tomography (Pisa - Italy).

10. "Use of Holographic Optics to Obtain High Resolution over a Large Volume to Search for Short-Lived Particles"
Talk presented by L. Verluyten at the Annual Meeting of the Belgian Physical Society - Brussels.

11. "Local Networks and Fast Networks"
P. Van Binst
Invited paper at the IFIP WG 5.4/IFAC/EWICS Working Conference, Warsaw, 1988. In Hardware and Software Real Time Process Control, ed. by J. Zalewski and W. Ehrenberger, North-Holland, 1989, p. 453.

12. "How to Transfer Files through TELECOM 1 while Following the OSI Model ?
A. Cohen, T. Massart, B. Salès, P. Van Binst
Paper presented by A. Cohen,
Proceedings of the 8th International Conference on Digital Satellite Communication, Pointe-à-Pitre, April 1989, p. 199.

13. "X.25 Networks, Present and Future : Some Elements of Assessment"
P. Van Binst
Invited paper at the X.25 Seminar, Ericsson, Brussels, February 1989.

14. "Testing MRX400 in a "Multivendor OSI Shop""
F. Alexandre, O. Paridaens, P. Van Binst, R. Vandenbroucke
Paper presented by F. Alexandre
Proceedings of the 1989 DECUS Europe Symposium, The Hague, p. 209
also IIHE Helios-B Report 89-125.

15. "The "Multivendor OSI Shop" : an Environment for Conformance and Interoperability Testing in Belgium"
P. Van Binst, R. Vandenbroucke
Paper presented by P. Van Binst at the International Symposium on Information Technology Standardization, Braunschweig, July 1989.

16. "OSI Standards and Research Networks in Europe"
P. Van Binst
Invited Communication at the Jornadas Tecnicas IRIS 89, Santander, June 1989.

17. "Automatic Execution of Standardized Test Cases for MHS"
F. Alexandre, C. Hanon, P. Paridaens
Paper presented by O. Paridaens at the International Symposium on Information Technology Standardization, Braunschweig, July 1989
also IIHE Helios-B Report 89-126.

18. "Interconnexion d'équipements hétérogènes au travers de réseaux locaux et d'une liaison satellite"
A. Cohen et P. Van Binst
Paper presented by A. Cohen
Comptes-rendus des Journées Scientifiques du SITEB (Casablanca - Maroc).

b. Others.

1. "A New Determination of the Electroweak Mixing Angle from Muon Neutrino-Electron Scattering"
K. De Winter, D. Geiregat, P. Vilain, G. Wilquet, et al.
XIV International Symposium on Lepton and Photon Interactions (Stanford - USA)
and International Europhysics Conference on High Energy Physics (Madrid - Spain).

2. "Supercollider Scintillating Fibre Trackers"
C. d'Ambrosio, ..., L. Van hamme and G. Wilquet
Workshop on Scintillating Fibre Developments for the SSC (Fermilab - USA).

3. "Sources of Noise in High Resolution Tracking with Scintillating Fibres"
C. Angelini, ..., G. Wilquet
4th Pisa Meeting on Advanced Detectors - Frontier Detectors for Frontier Physics - (Isola d'Elba - Italy).

4. "Optoelectronic Delay for the Read-Out of Particle Tracks from Scintillating Fibres"
T. Gijs, ..., L. Van hamme, et al.
Proceedings of the ECFA Study Week on Instrumentation Technology for High Luminosity Hadron Collider - Barcelona - CERN 89/10; ECFA 89/124 - Vol. I p. 255, 1989.

5. "Informatics and Human Sciences : a Working Synergy"
P. Van Binst, L. Wilkin
Information Processing 89, Proceedings of the 11th IFIP World Computer Congress, San Francisco, ed. by G.X. Ritter, North-Holland, p. 415.

We would like to thank all those who contributed to the preparation of this report.

FIGURE CAPTIONS.

Figure 1 : Hologram showing the neutrino production and subsequent decay of a short-lived particle (E632 Collaboration).

Figure 2 : Distribution of neutrino (and antineutrino) electron scattering events as a function of $E\Theta^2$ (WA79 Collaboration).

Figure 3 : Four quadrants of muon chambers installed in the DELPHI detector (DELPHI Collaboration).

Figure 4 : The Z° peak as measured by DELPHI; the curve illustrates a three parameter fit to the data points performed by leaving free an overall normalisation factor in addition to the mass and the width of the Z° (DELPHI Collaboration).

Figure 5 : The full size COP prototype (with one finalized cylinder) being packed for its transportation for testing at DESY (H1 Collaboration).

Figure 6 : Contributions to the front-end electronics of the MWPC of the H1 detector.
a. The VME Branch Driven Card.
b. and c. Examples of the use of the HPLOT libraries on Mac II.

Figure 7 : A Z° hadronic decay as seen by the DELPHI Interactive Analysis program : a. cross sectional view and
b. spatial view.

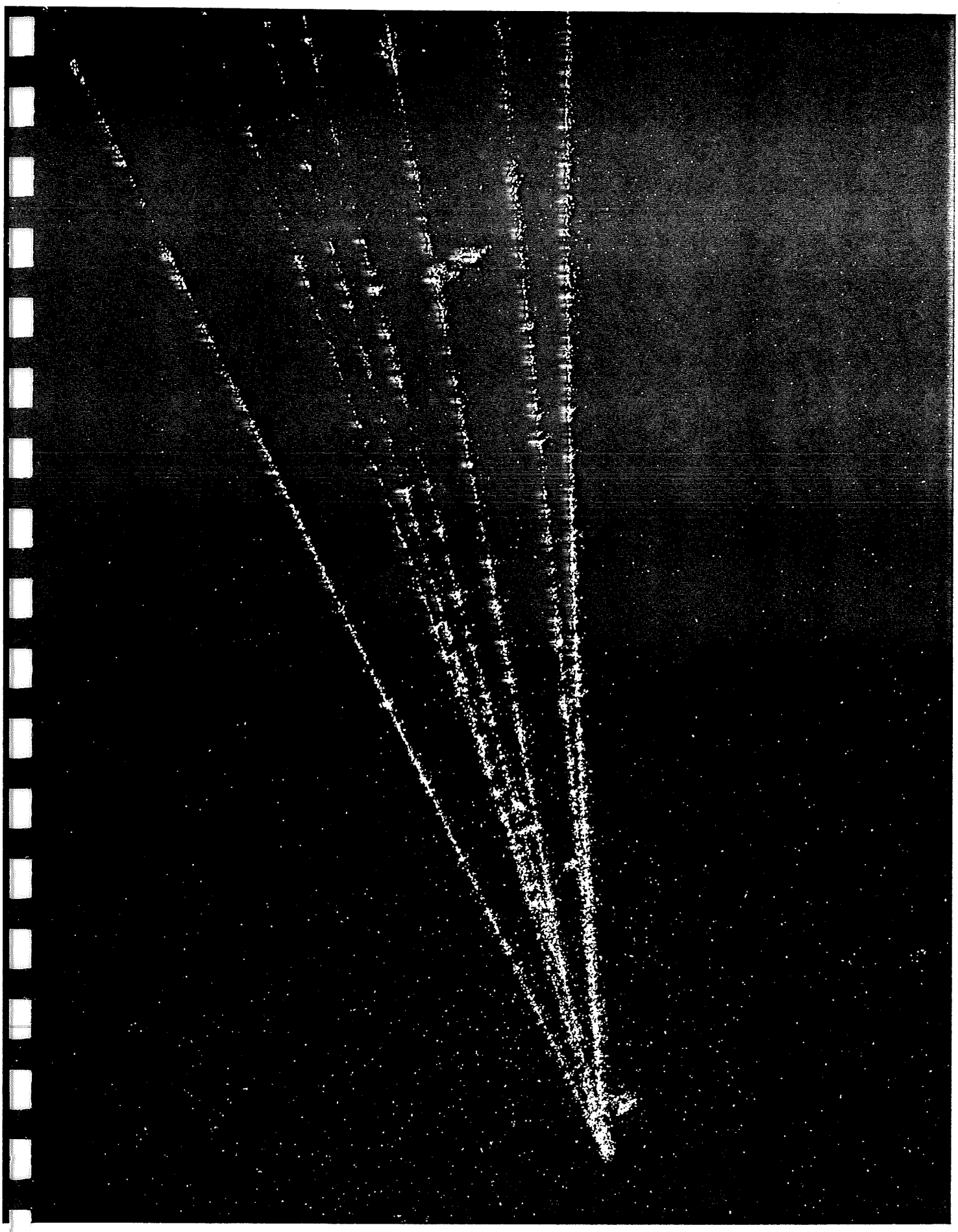


FIG. 1.

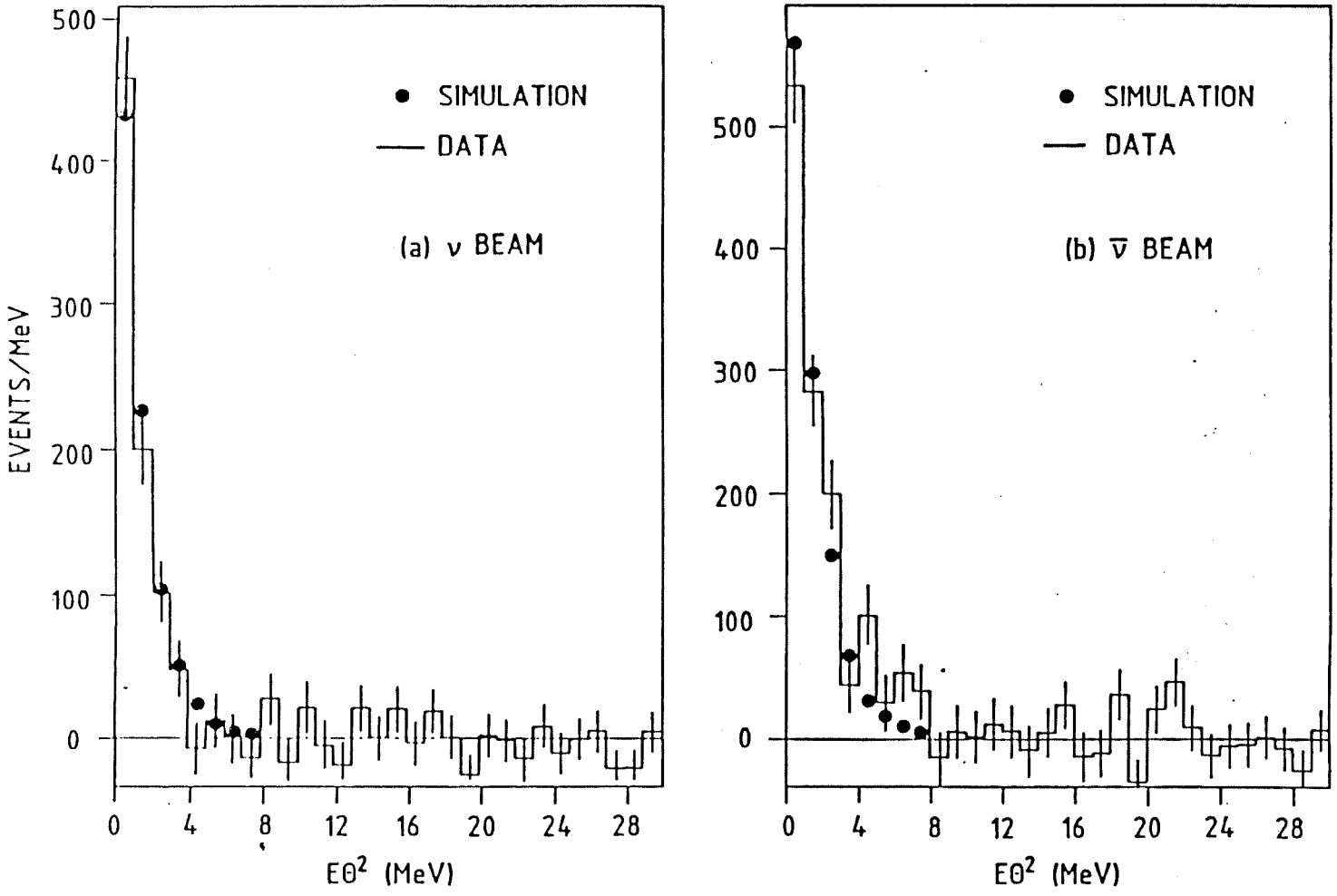

500
400
300
200
100
0
EVENTS/MeV
SIMULATION
DATA
(a) ν BEAM
0
4
8
12
16
20
24
28
Eθ² (MeV)
SIMULATION
DATA
(b) ν̄ BEAM
Eθ² (MeV)

FIG. 2

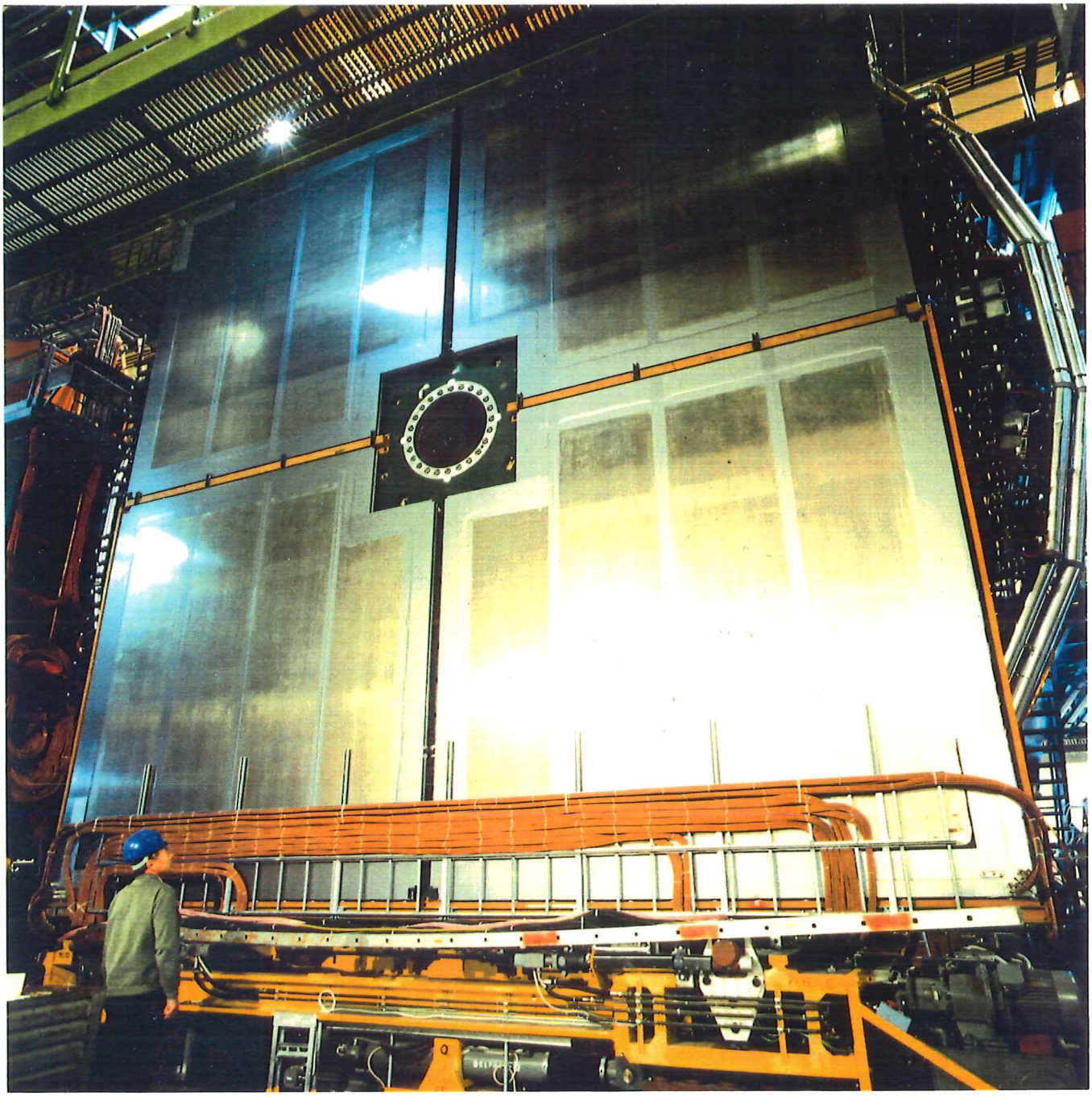


FIG. 3

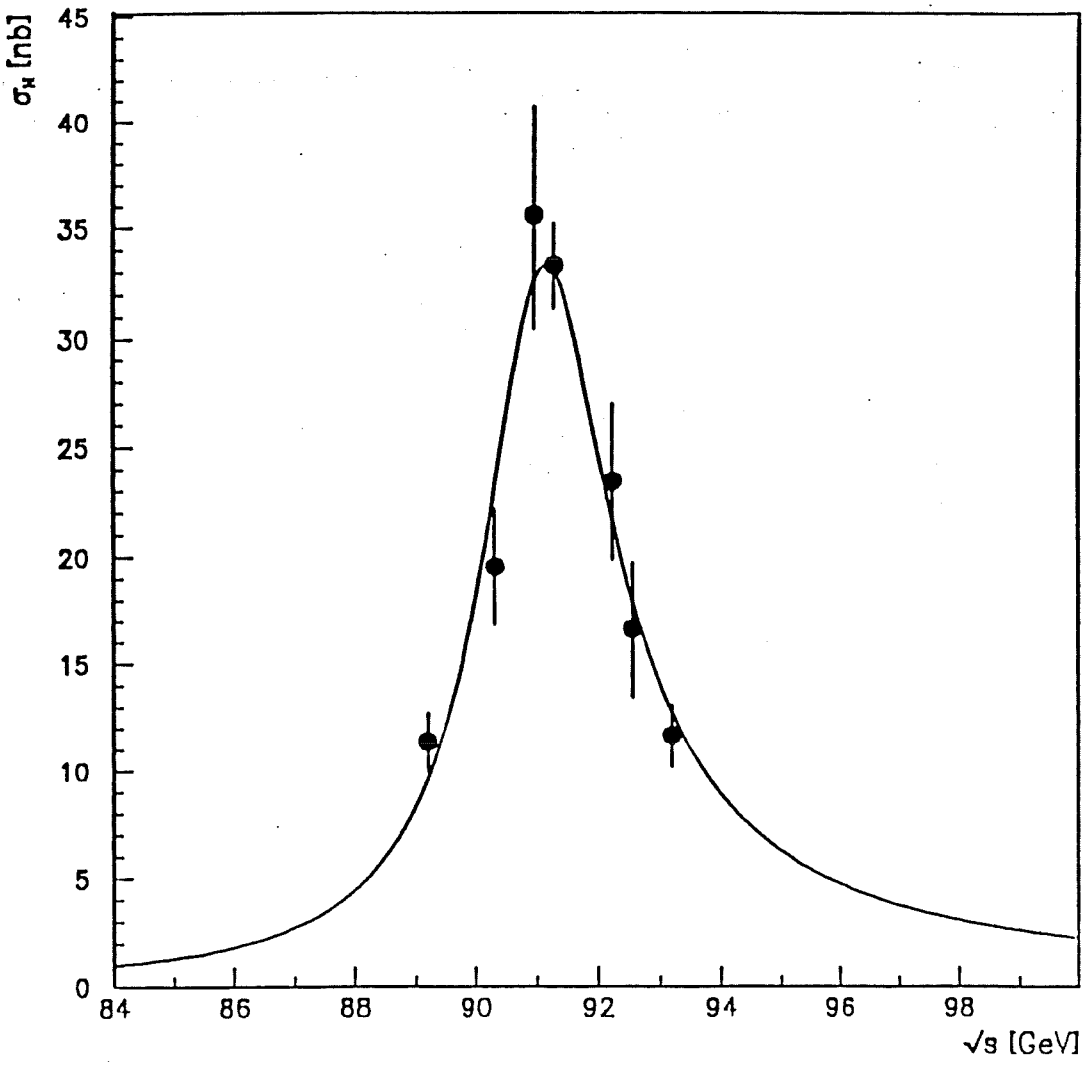


FIG. 4

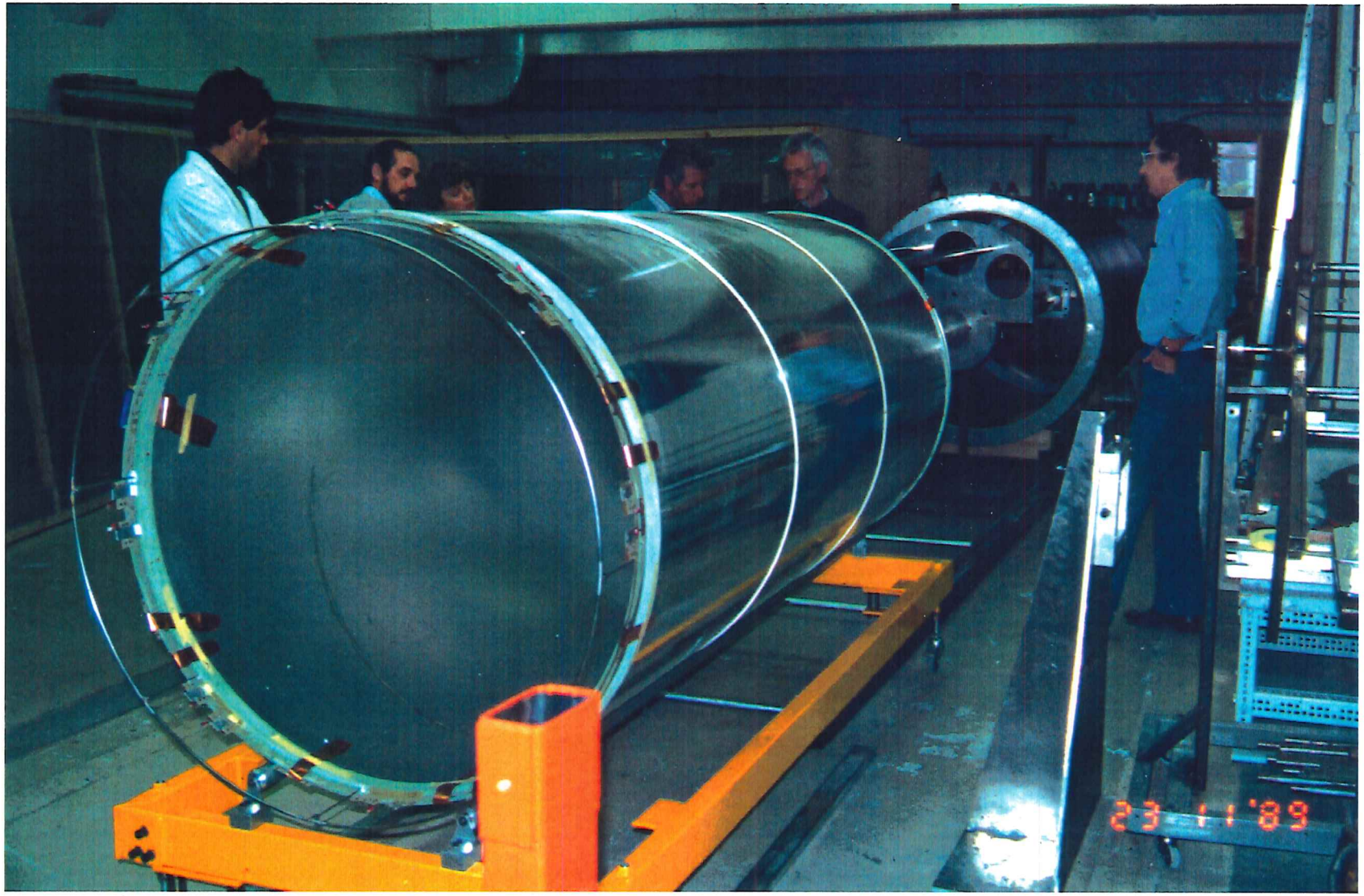
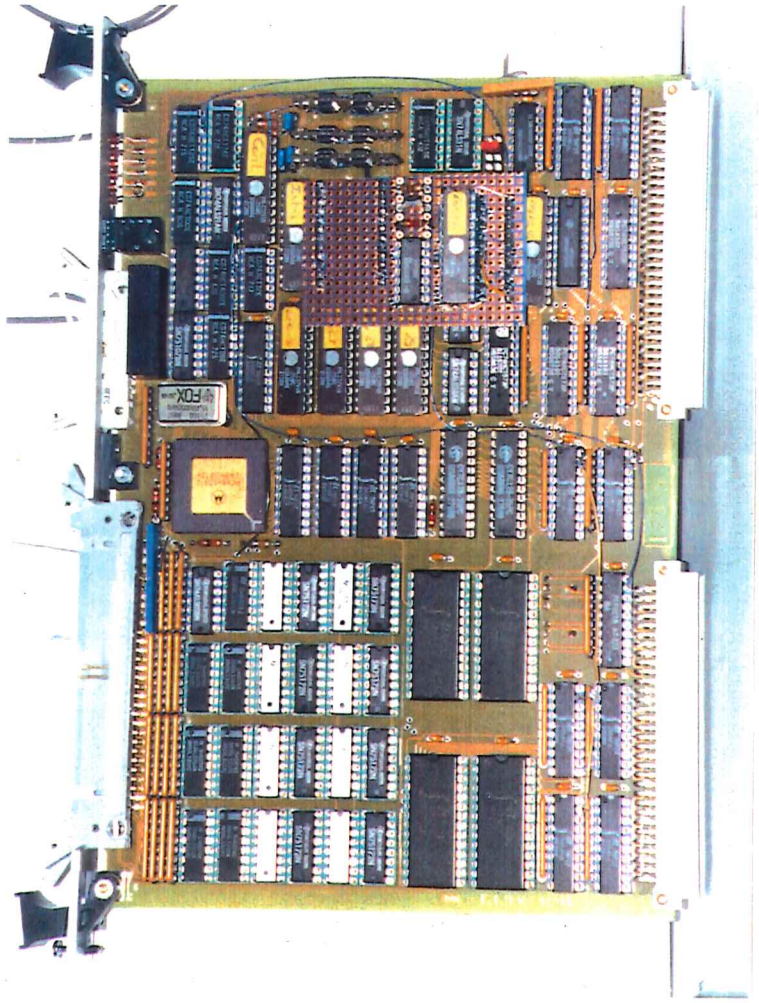
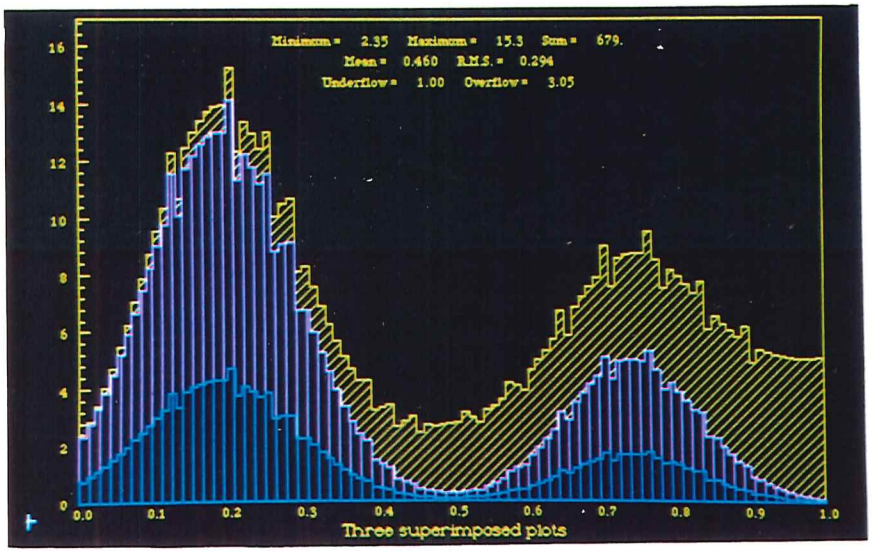


FIG. 5

a)



b)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Mean = 0.460 R.M.S. = 0.294
Underflow = 1.00 Overflow = 3.05
16
14
12
10
8
6
4
2
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Three superimposed plots

c)

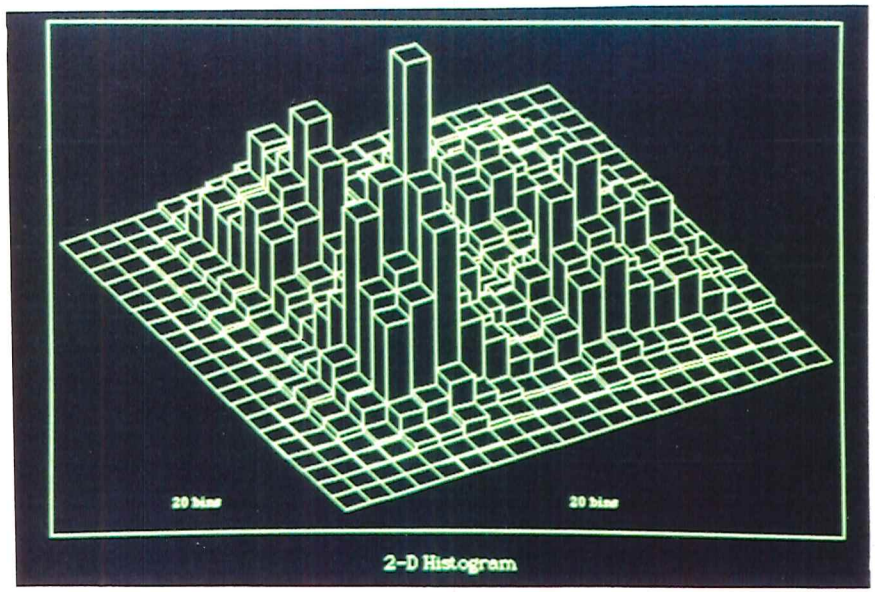
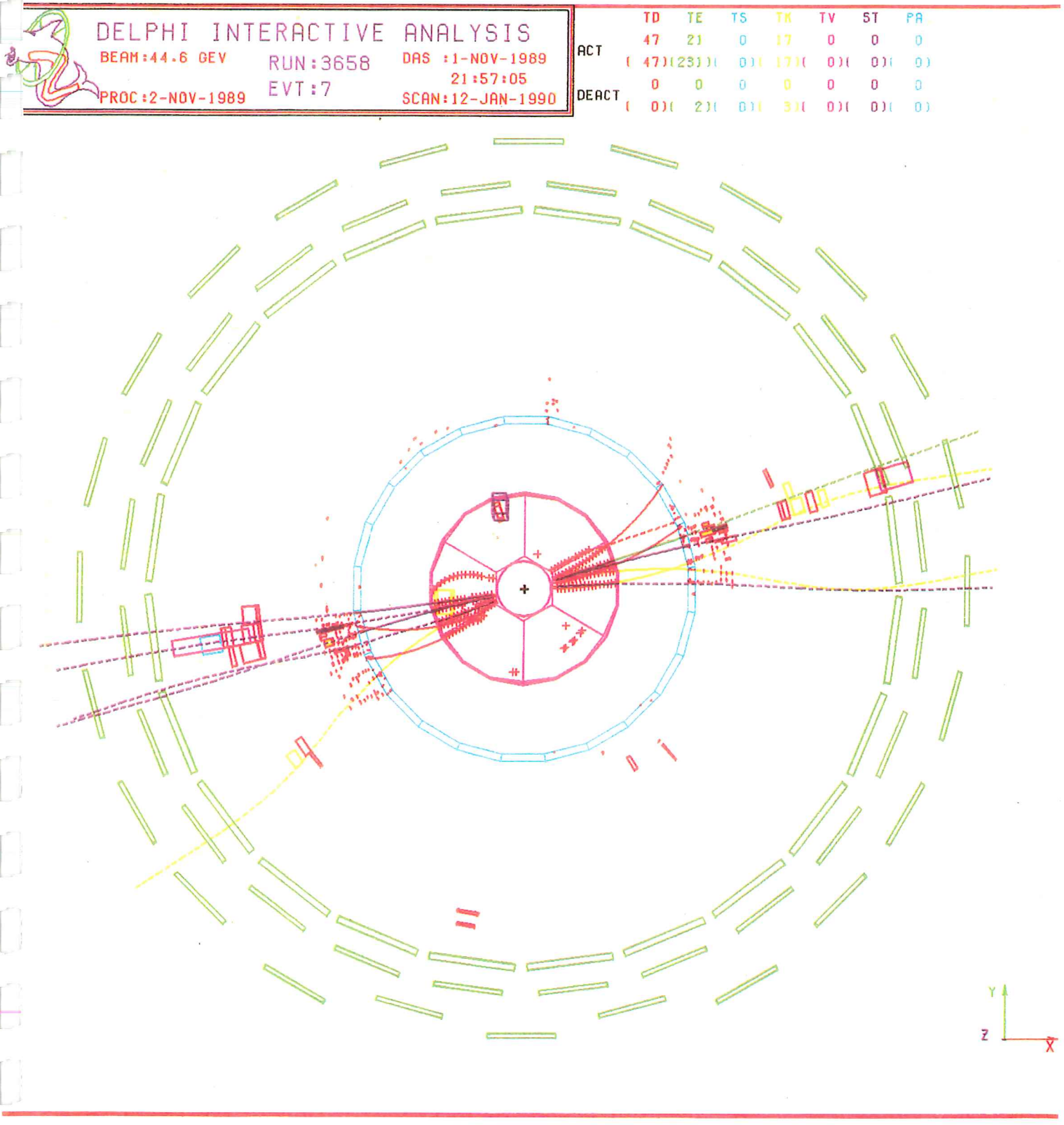

20 bins
20 bins
2-D Histogram

FIG. 6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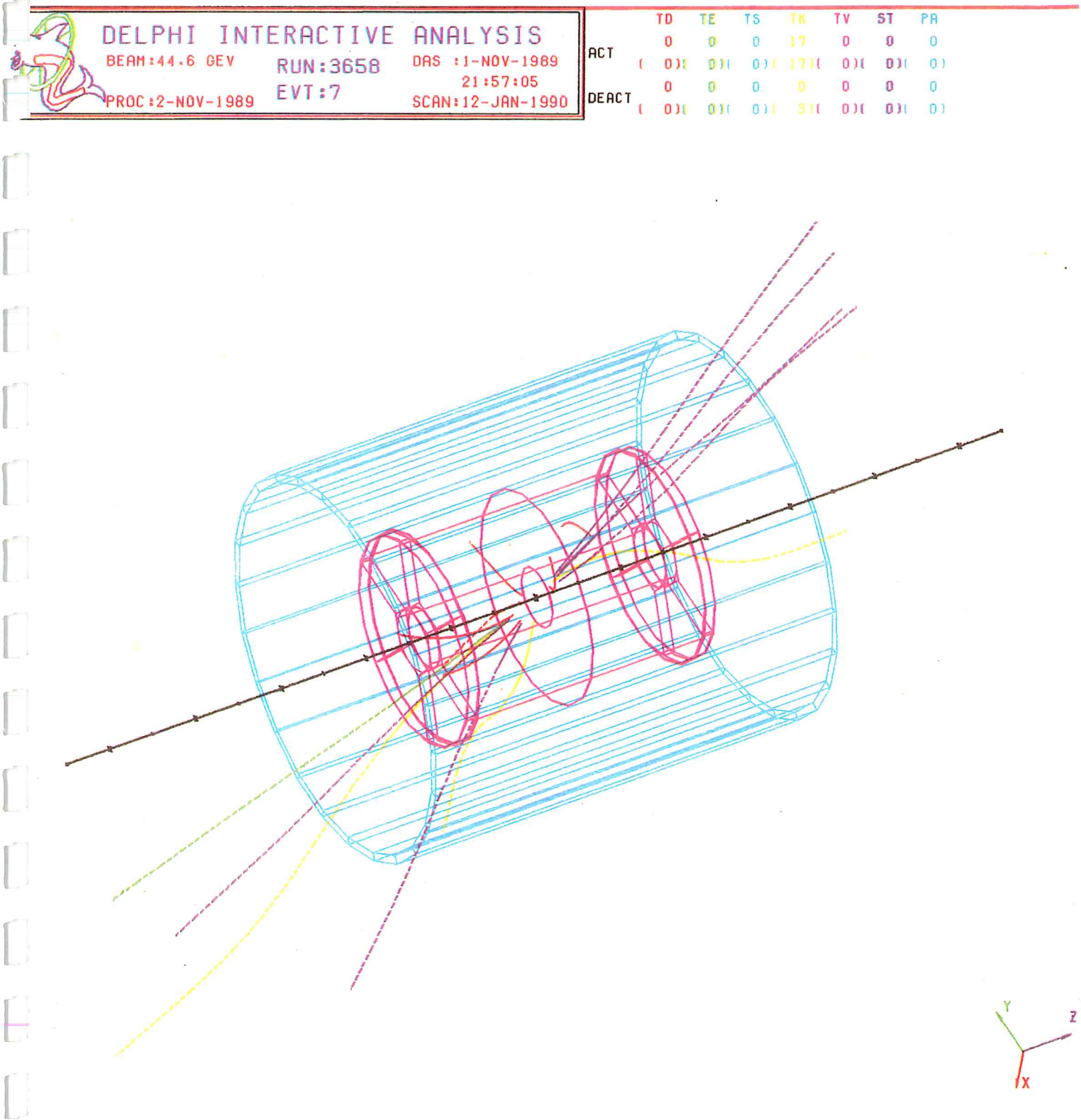
21:57:05
EVT:7
PROC:2-NOV-1989
SCAN:12-JAN-1990
TD TE TS TK TV ST PA
ACT 47 21 0 17 0 0 0
(47)(23))(0)(17)(0)(0)(0)
DEACT 0 0 0 0 0 0 0
(0)(2)(0)(3)(0)(0)(0)
Y
Z
X

FIG. 7a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PROC:2-NOV-1989
SCAN:12-JAN-1990
TD TE TS TK TV ST PA
ACT
DEACT
Y
Z
X

FIG. 7b