

S.L.

# INTER-UNIVERSITY INSTITUTE FOR HIGH ENERGIES

ULB-VUB, BRUSSELS - ANNUAL REPORT 1988

---

J. LEMONNE and J. SACTON

January 1989

## INTER-UNIVERSITY INSTITUTE FOR HIGH ENERGIES

### ULB-VUB, BRUSSELS - ANNUAL REPORT 1988.

J. LEMONNE and J. SACTON  
January 1989.

#### I. INTRODUCTION.

The physicists and computer scientists whose names are listed below have contributed to the different activities of the laboratory during the year 1988.

##### 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)  
M. De Jode (boursier IRSIA until october 1988)  
M. Dimou (doctorant)  
C. Hanon (assistant de recherche)  
P. Huet (boursier IRSIA until october 1988 and then aspirant FNRS)  
P. Marage (1er assistant ULB)  
T. Massart (assistant de recherche)  
J. Sacton (professeur associé)  
B. Sales (assistant)  
F. Stichelbaut (boursier IRSIA)  
P. Van Binst (chargé de cours associé)  
C. Vander Velde (chef de travaux associé)  
P. Vilain (chercheur qualifié FNRS)  
A. Walraevens (chercheur; july - november 1988)  
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

##### V.U.B.

H. Cobbaert (vorser IIKW until 30.06.1988 - part time assistant Vesalius College)  
C. De Clercq (logistiek medewerker IIKW)  
E. Evrard (vorser IIKW since 1.07.1988)  
K. De Winter (assistent)  
D. Geiregat (vorser IIKW)  
D. Johnson (vorser IIKW - adjunct professor Vesalius College)  
J. Lemonne (gewoon hoogleraar)  
N. Meulemans (vorser IIKW)  
J. Moreels (assistent VUB)  
R. Roosen (bevoegdverklaard navorser NFWO)  
S. Tavernier (onderzoeksleider NFWO)

R. Vandenbroucke-Tassin (eerst aanwezig informaticus IIKW)  
 W. Van Doninck (bevoegdverklaard navorser NFWO)  
 L. Van hamme (aspirant NFWO)  
 B. Vonck (vorser IIKW)

F. Verbeure, J. Buytaert, A. De Roeck, E. DE Wolf, A. Michalowska and L. Verluyten from the UIA are 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 are based on the analysis of 16500  $\nu_\mu$  and 10000  $\bar{\nu}_\mu$  charged current interactions. The topics under study were :

- (i) production rates and characteristics of charged hadrons of  $\pi^0$ ,  $\rho^0$ ,  $\omega$  and  $f$  mesons and of neutral strange particles;
- (ii) Nuclear effects : observation of shadowing; emission of backward protons; coherent production of  $\pi^+$  mesons in neutrino scattering and of  $a_1^-$  mesons in antineutrino scattering;
- iii) QCD effects on the transverse momentum distribution of single particles in the hadron shower

A collaboration agreement has been settled with the Russian groups (IHEP Moscou and ITEP Serpukhov) from the E180 experiment at Fermilab. Putting in common the WA59 and E180 data, obtained in similar conditions, this collaboration will provide increased statistics (~ 10 000 additional  $\bar{\nu}$  charged current events) and useful scientific interactions.

### II.1.1. 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), Tufts).

This experiment used the 15' bubble chamber filled with an hydrogen neon mixture, exposed to the Tevatron Quadrupole Triplet Beam; the chamber was equipped with 3 conventional cameras, a high resolution ( $\sim 150 \mu m$ ) and a holographic camera.

About 150000 pictures were taken in 1985 (part I), corresponding to 15000 charged current interactions. The 2- and 4-prong events were fully measured for coherent interaction studies; the leaving tracks were measured in the relevant subsample of events, for dimuon studies; about 10% of all events were also completely measured. Two analyses are in progress :

(i) dimuon production : the opposite sign sample is in agreement with the standard models for charm production and semi-leptonic decay; the like sign sample is compatible with background, both for rate and production characteristics.

(ii) the single  $\pi^+$  and  $\pi^-$  coherent production conforms, in this high energy range, the predictions based on PCAC and the Meson Dominance Model.

An additional 300 000 pictures were taken in 1987 (part II), corresponding to  $\sim 20$  000 charged current interactions;  $\sim 200$  000 holograms were also taken, in which about 2500 good events vertices are expected.

The first priority is given to a search for events containing, close to the primary vertex, indications of a secondary vertex due to the decay of short-lived particles; this search is made in parallel on the conventional pictures, on the high resolution camera pictures and on the holograms. The 2-prong events will be measured for coherent studies. A complete sample of unbiased events will progressively be measured in view of studies of neutral current interactions and of details of the hadron shower in this higher energy domain (fragmentation functions, neutral strange particle production, etc.)

### 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).

About 110 days of beam time were allocated this year to

WA79. The detector has been running very smoothly lower than expected, data corresponding to  $7.10^{18}$  protons on target have been recorded. This amount represents about 40 million events, 1280

tapes and an estimate of 1350 events in the  $(\bar{\nu}_{\mu}) e^{-}$  channel. The

1986 and 1987 running periods lead to about 900 of these events; and that the total sample required to meet the proposed accuracy of 0.005 on the value of  $\sin^2 \theta_w$  amounts to about 4000 events. At least another year of data taking will thus be necessary.

The first step of the data analysis is called filtering. It serves different purposes :

- to recognize parasitic cosmic muon events
- to reject bursts with incomplete or erroneous data
- to apply conservative cuts on event topology (minimum number of hits, fiducial volume, presence of a muon, ...)
- to distribute the events into different output streams according to their trigger types and topology ( $\nu_{\mu} e^{-}$  candidates, charged current, dimuons, etc...)

Out of about  $13 \cdot 10^6$  "electron" triggers (for the 1988 data), 388 000 (~ 3%) were selected by this procedure. The efficiency of this separation of true electron showers (as obtained in calibration beams) is larger than 99%.

In the next step, still in progress, each filtered event is analyzed in more details to define the angle  $\theta$  and energy  $E$  of the electron shower. By applying stricter cuts (the efficiency of which is found to be 80%), a clear signal due to  $\nu_{\mu} e^{-}$  scattering is observed for values of  $E\theta^2$  below 2 MeV. The signal over background ratio is of the order of 1., but depends on the choice of the cuts.

Much progress has been made in the simulation of the experiment and calculation of the relevant background sources. The statistical error on the result is, however, still too large due to computer time limitations.

Another important quantity to be measured is the flux factor, which is defined as the energy weighted ratio of the  $\nu_{\mu}$  fluxes in  $\nu$  and  $\bar{\nu}$  beams. Various methods are being used to determine this number :

- measure the relative rate of events in channels of constant cross-sections (quasi-elastic and single pion channels)
- measure the rate of inclusive (charged + neutral)  $\nu$  interactions on nucleons, for which the cross-sections are well known
- deduce it from the muon fluxes in the shielding (through a reliable simulation of the beam)

The present results are in good agreement with each others, with statistical errors of about 3% and systematic errors of 5%. These studies will still be improved in the next months, aiming at a combined precision of 3%.

## II.2 Hadron Physics

### II.2.1. Hadron interactions in EHS with $K^+$ and $\pi^+$ meson beams of 250 GeV/c.

(A. De Roeck, E. De Wolf, A.B. Michalowska and F. Verbeure: NA22 Collaboration : Aachen, Antwerp-Brussels, Berlin, Helsinki, Krakow, Moscow State University, Nijmegen, Rio de Janeiro, Serpukhov, Warsaw, Yerevan).

At the IIHE, all measurements for this experiment are finished and a data sample of 45000  $K^+p$ , 90000  $\pi^+p$ , 6000  $pp$  and 11000  $\bar{p}$  interactions on Al and Au nuclei is available. Results on the following items were obtained :

- 1) Phase space dependence of multiplicity distributions and interpretations in terms of negative binomials.
- 2) First results on  $K^+$  Al and  $K^+$  Au interactions and interpretation in terms of multiple collision models
- 3) Charged particle and resonance production in  $K^+$  interactions.

### II.2.1.b. Low- $P_T$ study of $\pi^-p$ interactions at 360 GeV/c and $pp$ interactions at 400 GeV/c with EHS.

(A. De Roeck, F. Verbeure; NA27 Collaboration - NOBC experiment : Aachen, Bombay, Brussels, CERN, Duke, Genova, Japan, Liverpool, Madrid, Mons, Oxford, Padova, Paris Collège de France, Rome, Rutgers, Rutherford, Serpukhov, Stockholm, Strasbourg, Tennessee, Torino, Trieste, Vienna, Zeuthen).

The idea is to use the very large amount of interactions recorded during both runs of NA27, the  $\pi^-$  and the proton runs, without measurements of the bubble chamber pictures. Thus only the scanning information and the electronics data were used to reconstruct tracks in the EHS spectrometer. The  $0.5 \times 10^6$   $pp$  events are being used for high statistics low  $p_T$  studies such as single particle distributions, resonance production, Bose-Einstein effects, ...

### II.2.3. Study of $p\bar{p}$ interactions at the CERN SppS collider.

(L. Van hamme, G. Wilquet; UA5 Collaboration : Bonn, Brussels, Cambridge, CERN, Stockholm).

All analyses performed by the UA5 collaboration have been finalized, and the following results have been published :

- 1) Charged particle pseudorapidity and multiplicity correlations and forward-backward charged particle multiplicity correlations are well interpreted by a cluster model requiring on average two charged particles per cluster, their pseudorapidity decay width being approximately constant with multiplicity and  $\sqrt{s}$ .

2) Kaon production exhibits a considerable increase in mean transverse momentum ( $0.62 \pm 0.08$  GeV/c at  $\sqrt{s} = 900$  GeV) with respect to the data at energies below 60 GeV. The kaon production cross-section, the  $K/\pi$  production ratio and the central production density are also increasing with energy. A clear correlation is established between the charged particle and the kaon multiplicities. Studies on photon multiplicity distributions, and hyperon production are in progress. The main results are :

i) The full phase space multiplicity distribution of 900 GeV departs from the negative binomial parameterization, well suited to describe the data up to 546 GeV, as well as the 900 GeV distribution in limited regions of pseudorapidity. The Dual Parton, Pythia and Fritiof model predictions are in broad agreement with the data, but exhibit discrepancies when looked at in detail.

ii) The photon production rate is observed to increase with energy. There is a positive correlation between the production of photons and charged particles, the correlation slope being  $1.09 \pm 0.09 \pm 0.13$  at 900 GeV. These correlations are of a short range nature. The correlation data can be interpreted successfully in terms of a cluster model.

iii) The production rate of  $\Lambda$  hyperons is seen to increase with collision energy. The average transverse momentum of  $\Lambda$  particles is  $0.82^{+0.20}_{-0.14}$  GeV/c at 200 GeV and  $0.76^{+0.10}_{-0.09}$  GeV/c at 900 GeV. For  $\Xi$  baryons, the mean transverse momentum is  $0.8^{+0.4}_{-0.2}$  GeV/c and  $0.7^{+0.2}_{-0.1}$  GeV/c at 200 and 900 GeV respectively. The ratio of  $\Xi$  to  $\Lambda$  production at 900 GeV is found to be  $0.09^{+0.12}_{-0.04}$  in contradiction with the higher value of 0.6 which was measured at 546 GeV.

#### II.2.4. Charm production in pp interactions at 800 GeV.

(J. Lemonne and B. Vonck; E743 Collaboration : Aachen, Berlin, Brussels, CERN, Duke, Fermilab, Kansas, Michigan (Ann Arbor), MSU, Mons, Notre Dame, Bombay, Vanderbilt, Vienna).

This experiment were designed to measure the total charm production cross-section in pp interactions at 800 GeV/c. Data were taken at the Fermilab Tevatron. The high resolution bubble chamber LEBC was used as target in front of the Multi Particle Spectrometer. Using a minimum bias interaction trigger about 500000 hydrogen events were recorded on film. They have all been double scanned for secondary activities. Events containing decays into 3 or more charged tracks, unclear topologies or more than one low charged multiplicity ( $n_{ch} < 2$ ) decay were measured on the ERASME facility at CERN or on the ADAM & EVE device at Mons.

The total inclusive D-meson production cross-section at

$\sqrt{s} = 38.8$  GeV has been calculated on the basis of the bubble chamber picture measurements only (without using the spectrometer information), using 60 % of the statistics. The results based on 84 selected events are :

$$\sigma(D^0/\bar{D}^0) = (22_{-17}^{+19}) \text{ } \mu\text{b}, \quad \sigma(D^\pm) = (26 \pm 4) \text{ } \mu\text{b}$$

and, 
$$\sigma(D/\bar{D}) = (48_{-8}^{+10}) \text{ } \mu\text{b}$$

The spectrometer data are being analyzed in order to extract inclusive differential cross-sections for the D-mesons.

Using only events with acceptable kinematical fits, the experimental Feynman  $x_F$  and transverse momentum  $p_T$  distributions have been fitted to an expression of the form

$$(1 - |x_F|)^n \cdot \exp(-ap_T^2)$$

The results :  $n = 8.6 \pm 2.0$

and  $a = .8 \pm .2 \text{ (GeV/c)}^{-2}$

are in good agreement with the expectations of a QCD fusion model.

#### II.2.5. Study of the production of beauty particles using a muon spectrometer and a hadron calorimeter.

(H. Cobbaert and R. Roosen; CERN WA78 Collaboration : Bari, Brussels, CERN, U.C. London, Rome and Turin).

The WA78 collaboration has measured the  $B\bar{B}$  hadronic production cross section in  $\pi U$  interactions at 320 GeV/c. The production of the beauty particles was deduced from the yield of like sign dimuons and trimuons. The cross section was derived from 13 trimuon events (background 2) and 29  $\mu^+\mu^+$  events (background 6) and 35  $\mu^-\mu^-$  events (background 14). The muon acceptance was evaluated using a  $B\bar{B}$  production based on QCD predictions, which accounted for correlations between both heavy quarks. After including 20% of  $B^0\bar{B}^0$  mixing good agreement between the data and the Monte Carlo predictions is found within the statistical significance of the data. The cross section was found to be

$$\sigma(\pi N) = (2.0 \pm .3 \pm .9) \text{ nb/nucleon}$$

assuming a linear A-dependence of the  $B\bar{B}$  cross section. Present work on the  $B\bar{B}$  data concentrates on estimating the cross section



of 4 charm p-production, associated production of  $D\bar{D}$  and  $J/\Psi$ , double  $J/\Psi$  production. These three processes together with the  $\bar{B}B$  production will be fitted in a general maximum likelihood fit, to obtain estimates for the cross section of each process.

The other aim of this collaboration was the study of nuclear effects on charm production. The dump calorimeter was special in the sense that it was expandable, and the dense absorbers could be replaced by others. This allowed a measurement of the A-dependence of the charm cross section in the single muon channel. Data have been taken with a proton beam (300 GeV) and a pion beam (320 GeV). The nuclear targets were Al, Fe and U. The largest background due to pion and kaon decays is determined by the  $1/\rho$  extrapolation technique. The other type of background are muons created in electromagnetic processes and is estimated using Monte Carlo techniques.

It is common to parameterise the A-dependence of the charm charm production as :

$$\sigma(hA \rightarrow C\bar{C}) = \sigma_0 A^\alpha$$

where  $\alpha$  and  $\alpha_0$  are the parameters to be determined. The new values found for  $\alpha$  are :

$$\text{p-data } \alpha^+ = .82 \pm .11 \quad + .07 \\ \phantom{\text{p-data } } \phantom{\alpha^+} \phantom{=} - .09$$

$$\alpha^- = .79 \pm .12 \quad + .07 \\ \phantom{\alpha^-} \phantom{=} \phantom{=} - .10$$

$$\pi\text{-data } \alpha^+ = .97 \pm .08 \pm .05$$

$$\alpha^- = .90 \pm .06 \pm .06$$

The small increase ( $\sim .05$ ) of these values as compared to the previously published results is due to a better understanding of the model dependence of these results. On the other hand, the new value of  $\alpha^+$  in the  $\pi$ -data, is higher by  $\sim 2$  standard deviations, due to systematic effects which were previously not taken into account.

### II.3. Study of $e^+ e^-$ annihilation at LEP.

(D. Bertrand, J. Buytaert, C. De Clercq, M. De Jode, 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, Cracow, Dubna, Ecole Polytechnique-Palaiseau, Helsinki,

INFN-Bologna, INFN-Genova, INFN-Milano, INFN-Padua, INFN-Roma, INFN-Trieste, INFN-Torino, Karlsruhe, LAL-Orsay, Liverpool, Lund, NIKHEF-Amsterdam, Orsay, 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 DELPHI muon chamber system is designed to identify muons by recording two spatial points on the tracks of those charged particles which penetrate the iron of the hadron calorimeter over its full depth. Coordinates are measured by drift chambers, a first layer of which is inserted in the iron at a depth of approximately 0,2 m, a second layer being fixed on the outer surface of the calorimeter.

The barrel chambers will be operated in the proportional mode and constructed by Oxford and R.A.L. The endcap chambers will be operated in the limited streamer mode and constructed by the Belgian teams. The drift fields are sufficiently uniform to achieve 1 mm accuracy in the direction perpendicular to the anode wire. Measurement of coordinates along the anode wire are performed with wound solenoidal type delay lines which also function as central field shaping electrodes. The high pulses recorded in the limited streamer mode have allowed the design of very slow (inverse velocity  $\sim 580$  ns/m) and accurate spatial resolution ( $\sim 3$  mm) lines for the endcap chambers. In the barrel of DELPHI, the chambers are arranged in two staggered double layers, with 4 points measured for each track. The delay-lines provide z-measurements with  $\sim 1$  cm accuracy in this case.

The endcap chambers are assembled into 4 x 4 quadrants; each quadrant being square (4.6 m x 4.6 m) and containing 22 + 22 drift tubes crossed at right angles so that time measurements in both directions provide 1 mm accuracy. In this case, the delay-line will often mainly be used to resolve left-right ambiguities.

The construction of the endcap quadrants has been completed in Belgium in the spring of 1988. During their construction phase, it was checked that the chambers were operating according to their design properties. Anode and delay line efficiencies of almost 100% were reached in a gas mixture consisting of 15% Ar, 15% iso - C<sub>4</sub>H<sub>10</sub> and 70% CO<sub>2</sub> (including a few percent of alcohol). Since their transportations to CERN in June 1988 the 17 quadrants constructed (16 + 1 spare) are submitted to a second series of tests in a special set-up which also allows the calibration of the propagation velocity of signals, in particular those along the delay-lines. Moreover, the test set-up at CERN makes use of all essential components of the final read-out electronics of the data as well as of the slow-controls. The installation of the quadrants in the DELPHI pit should take place in April 1989.

#### II.4. Study of ep collisions at HERA.

(M. Barth, G. Coremans, A. De Roeck, E. De Wolf, E. Evrard, D. Johnson, Ph. Huet, P. Marage, J. Moreels, R. Roosen, J. Sacton; H1 Collaboration : RWTH-Aachen (I and III), Antwerp and Brussels, Cracow, Davis, DESY, Dortmund, E.P.-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.

HERA, the first electron (30 GeV)-proton (820 GeV) collider, is expected to come in operation at DESY-Hamburg in 1990. Two 4 $\pi$ -multi purpose detectors, H1 and ZEUS, are being constructed to be installed in two of the four interaction regions of the machine. In February 1987 the IIHE and the UIA joined the H1-Collaboration. Our primary responsibility is the construction of the Central Outer Proportional chambers (C.O.P.) being part of the central tracking detector. Furthermore we are involved in the conception, construction and read-out of the frontend electronics of all MWPC of the H1 detector. The COP consists in a set of two coaxial central proportional chambers of 2.2 m length and with diameter of 1.01 m and 1.037 m respectively. The radial annular space that these chambers occupy is 33 mm. Both chambers contain about 1500 wires, the wire pitch being 2 mm and the gapsize being 4 mm. None of the wires are read-out. In contrast, one of the cathodes of each chamber is segmented<sub>2</sub> in z and phi constituting 2 x 304 pads of dimensions 190 x 117 mm<sup>2</sup> that are read. The chamber walls are of sandwich type with Rohacell as basic material faced on either side with Al (or Kapton) foils 25 micron thick. This sandwich structure, necessary to give the cylinder the required stability, also allows a means of transporting the signals to one of the chamber ends.

The signals of the COP and CIP (a detector similar to the COP but with smaller radius) are combined into the first level trigger.

At present most of the mechanical structures required to construct the sandwich cylinders are available. The furnace to form the Rohacell is working well; two of the steel mandrills are available on site and were found to have the requested tolerances; all the mechanical structures to support or handle these 1.5 ton mandrills are constructed.

A complete set of G10 flanges for all three chambers that will reinforce the chamber edges and also serve as support structure are now machined. Several sandwich cylinders have been build to master the difficult operations involved in the constructions. One innermost cylinder has been constructed with flanges mounted on together with the PCB prints. This cylinder was partly equipped with anode wires. At the same time a cylinder containing the read-out structure has been started. It is expected that a first chamber can be mounted and tested in March 89. Due to delays in other detector area the COP has to be in DESY only in beginning 1990. A complete set of two chambers is expected to be ready in fall 1989.

In parallel a prototype chamber has been build to check and optimize the chamber parameters. The chamber signals are read using a CAMAC read-out controlled by a MacIntosh. Systematic study has shown that the charge collection is somewhat less than expected and the signal risetime is on the critical edge. A new cathode is being build to investigate the influence of different parameters on the signal risetime.

The complete read-out for MWPC chambers in H1 have to been build in Brussels. At present most of the equipment to test the read-out scheme by means of 68020 in a VME environment in conjunction with a MacII is available. Mechanisms to download code to be run on the 68020 from the MacII have successfully been installed. Software to monitor the chambers and to test the electronics is well under way.

From the electronics point of view basically two cards have to be developed and build. They form the hart of the read-out system as they control the data transfer from the frontend crates to the event memory buffer. The design is well advanced and a first test is being expected by the middle of 1989.

### III. TEACHING ACTIVITIES AND SEMINARS

- J. Lemonne assured the lectures on "Elementaire Deeltjes" (45h + 35h pract.) (1ste and 2de Licentie Natuurkunde) and on "Statistische analyse van experimentele gegevens" (15h + 15h pract. - 2de Licentie Natuurkunde during the academic year 1987-1988.
- J. Sacton has assured the lectures (30h) on "Physique des Particules" (1re Licence en Sciences Physiques)
- S. Tavenier has deputized J. Lemonne for his lectures (15h) on "Detektie van ionizerende stralingen" (2de Licentie Natuurkunde) and related practical work (15h).
- P. Van Binst has given the following lectures :
  - . "Introduction à l'informatique" (30h - Licence en Informatique et Sciences Humaines - Faculté des Sciences Sociales, Politiques et Economiques)
  - . "Télématique" (30h - Licence en Informatique et Sciences Humaines - SOCO et Licence Spéciale en Sciences de l'Inforamtion et de la Documentation - Faculté Philo et Lettres).
  - . "Informatique" (60h - Licence en Informatique et Sciences Humaines - SOCO)
- At Vesalius College, D.P. Johnson gave introductory physics courses entitles "Physics 101" (45h), "Physics 103" (90h) and "Physics 104 (Solid state Physics)" (180h)
- G. Bertrand and P. Vilain gave a cours (part-time) on "Questions approfondies de physique des particules" (30h) and organized the

associated practical work (45h - 2ème Licence en Sciences Physiques).

- In the framework of "enseignement de propédeutique" organized by the ULB and la Chambre de Commerce, C. Vander Velde contributed to an introductory course on "Physique Générale" (24h)
- C. Vander Velde and P. Marage have given practical work (135h and 120h respectively) for the lecture (Physique Générale" (1ère candidature Institut Solvay)
- F. Verbeure gave the following lectures at the UIA :
  - . "Numeriek rekenen" (60h + 60h oefeningen, 1e Licentie Nat.)
  - . "Kernfysika en elementaire deeltjes" (60h, 1e Licentie Nat.)
  - . "Gevorderde Elementaire Deeltjes" (60h, 2de Licentie Nat.)
  - . "Radioaktiviteit" (15h, 2de Licentie Nat.)
  - . "Meten en simuleren" (30h, 2e Licentie Nat.)
- E. De Wolf gave a course on "Fundamentele wisselwerkingen tussen Elementaire Deeltjes" (30h - UIA; 2de Licentie Natuurkunde).
- J. Moreels guided practical work in physics for students of "1ste kandidatuur Scheikunde, Landbouwingenieur, Geneeskunde en Farmacie" en "2de kandidatuur Scheikunde en Geologie".
- K. De Winter has contributed to the "Practica van de kandidaturen Natuurkunde" (180h Natuurkunde; 120h Elektronika).
- W. Van Doninck provided the exercises of the course "Statistische analyse van experimentele gegevens" (15h - 2de Licentie Nat.)
- M. Barth, D. Bertrand, G. Bertrand-Coremans, M. De Jode, P. Marage and J. Wickens have contributed to the practical work for students attending the lectures on particle physics of J. Sacton (1ère Licence en Sciences Physique).
- M. Barth, G. Bertrand-Coremans, P. Huet and P. Vilain have contributed to the organization of the practical work for students of the 3rd year in physics of the ULB.
- C. De Clercq, D. Geiregat, L. Van hamme, W. Van Doninck, B. Vonck and S. Tavernier contributed to the practical work for students attending the lectures of J. Lemonne on particles physics (1ste Licentie Natuurkunde).
- 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).
- In the framework of the Vesalius College H. Cobbaert acted as teaching assistant for "An introduction to Physics Lab" and "Physics I with Lab"
- C. Hanon, T. Massart (30% of their time) and B. Salès (50% of his time) have contributed to the practical work organized for students in computing science.

The following "Mémoires", "Licentiaatsverhandelingen" and "Travaux de fin d'études" have been made at the IIHE :

- . P. Neirinckx (VUB, supervisor P. Vilain) : "Bijdrage tot de studie van di-muon gebeurtenissen in neutrino wisselwerkingen"
- . P. Goedtkindt (VUB, supervisor W. Van Doninck) : "Bijdrage tot de automatische monitoring van de elektron driftsnelheid in de driftkamers van de voorwaartse muon detektor van het DELPHI experiment"
- . M. Speltens (ULB, supervisor R. Vandenbroucke) : "Des outils de gestion pour un système de passerelles entre protocoles de transfert de fichiers"
- . O. Paridaens (ULB, supervisor P. Van Binst) : "Conception d'un testeur de conformité dans un environnement X.400".

The following seminars have been presented by members of the IIHE:

- D. Johnson : "Beam gas Monte Carlo at HERA"; Berlin-Zeuthen (DDR)
- J. Lemonne : "Het wetenschappelijk onderzoek aan de VUB in het gebied van de Elementaire Deeltjes"; ontmoetingsdag onderwijzend personeel VUB
- J. Lemonne : "Elementaire Deeltjes : hoe elementair?"; uitstraling Permanente Vorming, VUB
- E. De Wolf : "What do we know about Quark Fragmentation in Soft Hadron Collision"; Warsaw (Poland)
- P. Vilain : "Qu'y a-t'il dans le proton?"; seminar to the students of 1re cand. physique ULB
- R. Roosen : "States of the H1-experiment"; presentation to the Physics Research Committee of DESY (Hamburg)
- F. Alexandre : "Expérience de l'utilisation de logiciels DEC OSI à l'IIHE", Decus Belux Networks Sig Meeting, Brussels
- C. Hanon : "Normes et profils X.400", Laboratoire d'informatique théorique, ULB
- T. Massart : "Spécification d'un protocole de niveau 2 pour liaison satellite", Laboratoire d'informatique théorique, ULB
- N. Meulemans : "Directory Services", Commission of the European Communities, Luxembourg
- B. Salès : "Taxonomie des normes OSI de couches 2 à 4", Laboratoire d'informatique théorique, ULB
- P. Van Binst : "Normes et profils OSI : la situation Européenne", Laboratoire d'informatique théorique, ULB
- P. Van Binst : "Multiprocessors and Distributed Computing Systems", Computing Center for Geology, Bucarest
- P. Van Binst : "The evolution of ISDN and B-ISDN in Europe and Worldwide", IIHE-Brussels

At the occasion of the meeting of the Restricted European Committee for Future Accelerators held in Brussels in April 1988 the following reports were presented by members of the IIHE :

- J. Lemonne : "Belgian contribution to DELPHI"
- J. Sacton : "High Energy Physics in Belgium"
- R. Roosen : "Belgian Contribution to HERA"
- E. De Wolf : "The Belgian Fixed Target Program"

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

- Dr. R. Wigmans (from CERN-LAA)  
"High Resolution Hadron Calorimetry"
- Dr. E.H.M. Heijnen (from CERN-EF)  
"Microelectronics Technology applied to Particle Detection"
- A. Deroeck (from UIA, Antwerp)  
"Results from the NA22 experiment"
- Dr. S. Tavernier (from IIHE-Brussels)  
"A new approach to positron emission tomography"
- Dr. S. Hellman (from CERN-EP)  
"The UA2 experiment at Acol"
- Prof. A. Wroblewski (from Univ. of Warsaw)  
"Fits and Misfits in Physics"
- Dr. W. Willis (from CERN-EP)  
"Studies of high energy density from sulfur beams at the SPS"
- Dr. R. Zitoun (from LPNHE-Paris)  
"Structure functions applied to the radiative  $\mu^+\mu^-$  production at LEP-SLC energies"
- Dr. L. Gatignon (from CERN-EP)  
"First evidence for direct CP violation and other recent results from the NA31 experiment"
- Dr. P. Schotanus (from Univ. Delft))  
"Results on the use of  $\text{BaF}_2$  and photosensitive wire chambers in positron emission tomography"
- Dr. P.M. Kluit (NIKHEF-Amsterdam)  
"The rise of the proton - (anti)proton total cross section at Tevatron energies and beyond"
- Dr. J. Feltesse (from CEN-Saclay)  
"HERA : what could be really measured?"

#### IV. COMPUTER MATTERS

##### IV.1. Computing and communications

The persons involved in the various activities described here under are the following :

- Management : P. Van Binst, R. Vandenbroucke
- Logistics, support, administration : A. De Coster, G. Depiesse, D. Pirnay, G. Rousseau, W. Van Droogenbroeck
- Scientific (HELIOS-B group) : F. Alexandre, A. Cohen, C. Hanon, T. Massart, N. Meulemans, B. Salès, A. Walraevens

The IIHE computing equipment was augmented in 1988 by the following :

- a VAXstation 2000 running the VMS operating system, equipped with a 19" high resolution black and white screen;
- a VAXstation 2000 running the ULTRIX operating system, used as a gateway between the DECnet and TCP-IP networking environments;
- a DEC LNO3R Postscript compatible laser printer, which is able to print files produced on various computers, including MacIntoshes;
- an NCR Tower 32/600 minicomputer running the UNIX operating system, used essentially by the HELIOS-B Group.

The networking facilities were upgraded as follows :

- the new computers were integrated in the Ethernet architecture;
- the DECsystem10 Ethernet integration was completed;
- a third DCS connection was installed;
- new Ethernet cables were installed on the IIHE premises, both in the VUB and ULB buildings (Ethernet bridges will be installed between these various segments, under a contract with COMTECH);
- full connectivity has been achieved between all VMS/DECnet computers and UNIX/TCP-IP computers, within the IIHE as well as outside (VUBNET, ULB-VUB Computer Centre);
- all VAX VMS computers have been integrated in a Local Area VAX Cluster, which allows the sharing and optimization of resources;
- UUCP mail is available between UNIX computers inside and outside the IIHE;
- X.400 mail is in a preliminary operational phase on the VAX 8200 and the NCR Tower, national and international relations are being established.

All the national and international activities, particularly in the fields of HEP and OSI networking (ECFA and RARE associations), were pursued, as well as the involvement in DECUS. An important study on international public X.25 networks performance was awarded by RARE to the IIHE, in the frame of the EUREKA COSINE project. A contract was finalized, for the IIHE to take part in the Conformance Testing Services project of the Commission of the European Communities (DG XIII). A new consultancy contract was obtained with SOBEMAP. A major new contract on R&D in OSI networking was concluded with UNISYS, taking effect on January 1, 1989.

Members of the HELIOS-B group took part in RARE and EWOS (European Workshop on Open Systems) working groups; one of them was invited to the first meeting of a USA-Europe-Japan group of experts on FTAM; another one was invited by AFNOR to take part in



the edition of European standardized profiles for X.400.

Study of high speed data communication through the TELECOM 1 satellite continued, particularly in the field of layer 2, 3 and 4 protocols; data transmissions between Brussels and Paris were realized at 256 Kbps; tests were conducted in Brussels between two Bull computers by making use of a satellite simulator lent by France Câbles et Radio. Papers on some of these detailed topics were submitted as Belgian contributions to ISO; general papers were invited or accepted in many international conferences, including the worldwide, high level, International Conference on Computer Communications.

#### IV.2. High performance graphics interactive analysis

D. Bertrand and M. De Jode were involved in this program. The central body of the interactive graphics analysis program was achieved this year. In view of portability in the various types of workstations of the DELPHI collaboration the program was completely rewritten following the GKS standard. Furthermore GKS interfaces were developed in the laboratory both on the MEGATEK Whizzard 3375 and on the Digital VS8000. These two stations are amongst the most powerful 3D graphics engines presently available on the market.

The Megatek has a resolution of 1024 pixels on 1024 raster lines, 4 color planes and is able to transform 400000 vectors per second.

The VS8000 has an intrinsic resolution of 1024 pixels on 864 raster lines but due to the antialiasing method this reduction is multiplied by 8. Twenty four color planes are available and the transformation capacity is of the order of 200000 short vectors per second.

The next step of the software implementation is the incorporation of the detector dependent graphics algorithm. This program was supported financially by ULB ARC contract.

### V. TECHNOLOGICAL R&D

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

(S. Tavernier)

The aim of the project is to build a PET camera based on photosensitive wire chambers and UV scintillators. This technique was recently developed at CERN for electromagnetic calorimetry. Preliminary tests in CERN in 1987 have demonstrated that the principle works. During 1988 we have build two prototype detectors in Brussels. These prototypes will be used to perform a careful

study of the relevant parameters for such a system, and to study and compare different technical variants. The detection efficiency for gammas of 511 keV was carefully measured and found to be 70% with a 50mm thick  $\text{BaF}_2$  crystal. This is slightly lower than the anticipated 81% for a reason which is still being studied. This slightly lower detection efficiency is not a problem for the application considered.

The geometry which represents the best compromise between efficiency, time resolution and position resolution will be sought in a series of tests which have just started. In parallel a program is being written to simulate the performance of such a PET scanner.

## V.2. R&D project on the use of scintillating fibers in particle detectors

(G. Wilquet, L. Van hamme)

The research program on scintillating optical fibres and their use for building fast high resolution active targets, tracking devices or compensating calorimeters for the future high energy accelerators of the new generations has been pursued in the following directions :

- In collaboration with the CERN LAA group, a simulation program has been set up to understand the light emission and transmission phenomena in fibers, with the aim of locating the key parameters to be improved for further developments.
- In collaboration with the Service des Milieux Continus of the ULB, an optical bench has been built and tested for the measurement of the differential light yield transmission through fibres.
- Calculations have been completed that allow the feasibility study of an image buffering tube, made of several modules with varying fields. This tube aims to bunch as many as a hundred of electronic event images during periods of time as long as 1  $\mu\text{s}$ , a typical first level trigger delay.
- In collaboration with a CHARM-II working group, a letter of intent has been prepared for presentation to the selection panel of the future UNK accelerator in USSR. The experiment consists in the direct observation of  $\tau$ -lepton tracks produced in the interactions of high energy neutrinos in a large active scintillating fibre target.
- In collaboration with a CHARM-II working group, the design study of a 4 $\pi$  fully hermetic and compensating calorimeter using the so-called "spaghetti" technique has been started.

## VI. TECHNICAL AND ADMINISTRATIVE WORK

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

J. Wickens until summer, and then P. Marage were in charge of the general coordination; L. Etienne and L. Van Lancker organised the work of the electronics and mechanics workshops respectively.

The series production of the end cap muon detector units for the DELPHI experiment was completed. The 17 modules were delivered at CERN in June 1988 where they were submitted to further test and calibration procedures. Moreover, their final installation as part of the DELPHI detector, foreseen in April 1989, has been prepared.

For the H1 experiment, the mechanical workshop has contributed a large amount of infrastructure pieces and tools : room equipment, installation of a 3m long lathe, building of the 10m<sup>3</sup> pulsed-air oven, handling and stockage tools for the steel mandrills and for the chamber bodies, etc; the body of the flat prototype was machined in the workshop. The workshop staff directly contributed to the making of the first chamber bodies. The electronics workshop has contributed to the prototype installation and to the preparation of the electronics for the chambers.

Both workshops have also been in charge of the maintenance of the bubble chamber picture measuring machines and of the general maintenance in the laboratory.

In performing the bubble experiments which are summarized in the present report, the physicists have benefited from the efficient work of the scanning and measuring teams of the laboratory which consisted of : C. Carlier, A. De Coster-Van Cauwenberge, M. Delasorte, J. De Schutter-Gevers, M. De Schutter, M.P. Galloy-Kips, Ch. Garnier-Stoffen, M. Goeman, D. Legrand-Mahaux, J. Liesen, D. Peymans-Luybaert, M. Pins, R. Pins, D. Pirnay-Pauwels, M.L. Ronsmans, L. Vermeersch-Polderman, A. Vermijlen-Pels. It should be mentioned that many of these persons have contributed also to the production of the DELPHI muon chambers and to the construction of the HERA proportional chambers.

The secretarial work was accomplished by R. Alluyn-Lecluse and M. Garnier-Van Doninck and by J. Castera for the HELIOS-B programme. Cl. Vorstermans-Hennebert took care of the library.

## VII. REPRESENTATION IN COUNCILS AND COMMITTEES

J. Lemonne has been the Belgian scientific representative in the CERN Council. 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 has been elected as Vice-Chairman of the Faculty of Science of the ULB; he has acted 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 chairman of the Conseil de Gestion du Centre de Calcul ULB-VUB.

J. Sacton was member of the International Advisory Committee for the 1989 Europhysics Conference on High Energy Physics to be held in Madrid.

J. Sacton was member of the Steering Committee for Computing at CERN in the 1990's.

F. Verbeure has acted as Belgian representative at RECFA.

D.P. Johnson was member of the Engineering Committee of Vesalius College for Curriculum Development (VUB).

P. Marage acted as :

- substitute of the representative of the Scientific Personnel of the Faculty of Sciences at the Council of the ULB
- member of the "Bureau" of the Faculty of Sciences, of the ULB Committees for Social Affairs, Scientific Research and Finances (as substitute)
- representative of the Scientific Personnel of the Physics Department at the Council of the Faculty of Sciences

S. Tavernier acted as : representative of the Scientific Personnel of the Faculty of Sciences (VUB) at the "Faculteitsbestuur en Faculteitsraad" of this Faculty.

B. Vonck was a member of the redaction committee of "PHYSICALIA MAGAZINE".

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

- D. Bertrand and J. Wickens : members of SCOOP
- J. Lemonne : representative of "Belgium" in the Board and representative of the IIKW-IISN in the DELPHI Finance Committee
- J. Wickens : member of the Executive Committee
- C. Vander Velde : responsible for the muon subtrigger

F. Alexandre was a member of the RARE Working Group 1 on Electronic Mail

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

N. Meulemans was a member of EWOS Expert Group on File Transfer, Access and Management, RARE Working Group 2 on File

Transfer, Access and Management and of Working Group 3 on Directory Services.

B. Salès was a member of EWOS Expert Group on Lower Layers.

P. Van Binst was a member of :

- EWOS Technical Assembly
- COSINE Policy Group
- RARE Council of Administration
- RARE Working Group 4 and Lower Layers Management
- ECTUA
- ECFA Subgroup 5 on Links and Networks
- DECUS European Council, Board of DECUS BELUX
- Scientific Committee of IFIP/IFAC Conference on Hardware and Software for Real Time Process Control
- Organizing Committee of IEEE Compeuro Conference
- Commission Informatique of FNRS/NFWO
- Comité Informatique of IBN/BIN

P. Van Binst was Chairman of DECUS At-Large Chapter and of the RARE Club of ABUT/BVT, Deputy Chairman of RARE Working Group 6 on High Speed Services and ISDN, Expert to the Commission of the European Communities.

R. Vandenbroucke was a member of the RARE/WG2 (workgroup on FTAM), GIFT project.

R. Vandenbroucke was chairperson of the DECUS BELUX Networks Special Interest Group and of the DECUS Europe Networks Special Interest Group.

R. Vandenbroucke was a participant to the "Belgische Vereniging voor Telecommunicatie/DCS"

#### VIII. ATTENDANCE TO CONFERENCES, SCHOOL AND WORKSHOP

- European Particle Accelerator Conference (Rome, Italy)  
J. SACTON, D. JOHNSON
- DEC High Energy Physics (Vevey, France)  
J. SACTON
- XXIV International Conference on High Energy Physics (Munich, DDR)  
J. LEMONNE
- XIIIth International Conference on Neutrino Physics and Astrophysics (Boston, USA)  
J. MOREELS, G. WILQUET
- General meeting of the American Physical Society (Baltimore - USA)  
L. VERLUYTEN

- Novel features of High Energy Collisions in the 1-100 TeV Region (Erice - Sicilia)  
H. COBBAERT
- IXth European Symposium on Proton-Antiproton Interactions and Fundamental Symmetries (Mainz, DDR)  
L. VAN HAMME
- Quark Lepton Physics in Collisions VIII (Capri, Italy)  
D. GEIREGAT, S. TAVERNIER, P. VILAIN,
- Rencontres de Moriond (Les Arcs, France)  
A. DE ROECK
- DESY Theory Workshop (Hamburg, DDR)  
A. DE ROECK
- International Symposium on Multiparticle Dynamics (Arles, France)  
A. DE ROECK, F. VERBEURE
- DECUS meeting (Cannes, France)  
D. BERTRAND, P. VAN BINST, R. VANDENBROUCKE, W. VAN DROOGENBROECK
- The 1988 CERN School of Physics (Lefkada, Greece)  
E. EVRARD, Ph. HUET
- VME Bus in Research, ESONE Conference (Zurich, Switzerland)  
PH. HUET
- CERN Computing School (Oxford, England)  
A. WALRAEVENS
- IEEE INFOCOM'88 (New Orleans, USA)  
F. ALEXANDRE
- IFIP WG 6.5 Message Handling Systems (Los Angeles, USA)  
F. ALEXANDRE, C. HANON
- ACM SIGCOMM'88 : Communications Architectures and Protocols (San Fransisco, USA)  
A. COHEN
- International Conference on Computer Communications (Tel Aviv, Israel)  
A. COHEN, T. MASSART, P. VAN BINST
- International Symposium on Protocol Specification, Testing and Verification (Atlantic City, USA)  
T. MASSART
- French Symposium on Protocol Engineering (Bordeaux, France)  
T. MASSART

- International Workshop on Protocol Test Systems (Vancouver, Canada)  
N. MEULEMANS
- International Workshop on Telematics (Caen, France)  
B. SALES
- University Computing in Europe, UNISYS (St. Paul-de-Vence, France)  
P. VAN BINST
- COMPAT 88, Computer Aided Trade (The Hague, Netherlands)  
P. VAN BINST
- EUTECO 88, European Teleinformatics Conference (Vienna, Austria)  
P. VAN BINST
- RARE European Networkshop (Les Diablerets, France)  
P. VAN BINST
- IFIP/IFAC Conference on Hardware and Software for Real Time Process Control (Warsaw, Poland)  
P. VAN BINST
- EUROCON'88, European Conference on Electrotechnics (Stockholm, Sweden)  
P. VAN BINST
- International Symposium on Subscriber Loops and Services (Boston, USA)  
P. VAN BINST
- Domestic and Regional Satellite Communication Systems (Paris, France)  
P. VAN BINST
- Eurosite'88, Telematica Symposium (Genk)  
P. VAN BINST
- International Chair in Computer Science (Brussels)  
P. VAN BINST
- DECUS US Spring Symposium (Cincinnati, USA)  
R. VANDENBROUCKE

## IX. LIST OF PUBLICATIONS AND CONTRIBUTIONS TO CONFERENCES

### IX.1. Publications

Production of  $\pi^0$  mesons and charged hadrons in  $\bar{\nu}$  neon and  $\nu$  neon charged current interactions  
W. WITTEK, ..., P. MARAGE, ...  
Z. Phys. C, Particles and Fields

Experimental study of  $B\bar{B}$ -production in  $\pi^-U$  interactions at 320 GeV/c  
M.G. Catanesi, ..., H. COBBAERT, R. ROOSEN, ...  
Phys. Lett. B202 (1988) 453

A-dependence of the charm production cross section in 300 GeV/c proton interactions  
H. COBBAERT, R. ROOSEN, ...  
Phys. Lett. B206 (1988) 546

A-dependence of low-mass-muon pair production in 300 GeV/c p and 320 GeV/c  $\pi^-$  interactions  
H. COBBAERT, R. ROOSEN, ...  
Phys. Lett. B213 (1988) 395

D-meson production from 400 GeV/c pp interactions; evidence for leading diquarks?  
M. AGUILAR-BENITEZ, ..., P. VILAIN, B. VONCK, ...  
Phys. Lett. 201B, 1 (1988) 176

Charm hadron properties in 400 GeV/c pp interactions  
M. AGUILAR-BENITEZ, ..., S. TAVERNIER, P. VILAIN, B. VONCK, ...  
Z. Physik C, Particles and Fields 40 (1988) 321

D-meson production in 800 GeV/c pp-interactions  
R. AMMAR, ..., J. LEMONNE, B. VONCK, ...  
Phys. Rev. Lett. 61 (1988) 2185

Charged particle correlations in pp collisions at c.m. energies of 200, 546 and 900 GeV  
R.E. ANSORGE, ..., D. JOHNSON, L. VAN HAMME, G. WILQUET, ...  
Z. Phys. C, Particles and Fields 37 (1988) 191

Kaon production at 200 and 900 GeV CM energy  
R.E. ANSORGE, ..., D. JOHNSON, L. VAN HAMME, G. WILQUET, ...  
Phys. Lett. B199, 2 (1988) 311

Kaon production in pp interactions at c.m. energies from 200 to 900 GeV  
R.E. ANSORGE, ..., D. JOHNSON, L. VAN HAMME, G. WILQUET, ...  
Z. Phys. C, Particles and Fields 41 (1988) 179

The transverse energy distribution in  $^{16}O$ -nucleus collisions at 60 and 200 GeV per nucleon  
T. AKESON, ..., R. ROOSEN, ...  
Z. Phys. C, Particles and Fields 38 (198) 383



Inclusive meson resonance production in  $K^+p$  interactions at 250 GeV/c

N.M. AGABABYAN, ..., E. DE WOLF, ..., A.B. MICHALOWSKA, ..., F. VERBEURE

Bulletin IIHE 88-11

Some properties of charmed particles produced in  $\pi^-$  nucleus interactions

S. AOKI, M. BARTH, ..., G. BERTRAND-COREMANS, ..., R. ROOSEN, ...  
Phys. Lett. 209B (1988) 113

Phase space dependence of the multiplicity distribution in  $\pi^+p$  and pp collisions at 250 GeV/c

M. ADAMUS, ..., A. DE ROECK, E.A. DE WOLF, B. MICHALOWSKA, F. VERBEURE, ...

Z. Phys. C, Particles and Fields 37 (1988) 215

Bose-Einstein correlations in  $K^+p$  and  $\pi^+p$  at 250 GeV/c

M. ADAMUS, ..., A. DE ROECK, E.A. DE WOLF, B. MICHALOWSKA, F. VERBEURE, ...

Phys. Lett. 205B (1988) 401

Single diffraction dissociation in  $\pi^+p$  and  $K^+p$  interactions at 250 GeV/c

M. ADAMUS, ..., A. DE ROECK, E.A. DE WOLF, B. MICHALOWSKA, F. VERBEURE, ...

Z. Phys. C, Particles and Fields 39 (1988) 301

Charged particle production in  $K^+p$ ,  $\pi^+p$  and pp interactions at 250 GeV/c

M. ADAMUS, ..., A. DE ROECK, E.A. DE WOLF, B. MICHALOWSKA, F. VERBEURE, ...

Z. Phys. C, Particles and Fields 39 (1988) 311

Multiplicity dependence of the average transverse momentum in  $\pi^+p$ ,  $K^+p$  and pp collisions at 250 GeV/c

V.V. AIVAZYAN, ..., A. DE ROECK, E.A. DE WOLF, B. MICHALOWSKA, F. VERBEURE, ...

Phys. Lett. 209B (1988) 103

A  $BaF_2$ -TMAE detector for positron emission tomography

P. MINE, ..., S. TAVERNIER, ...

Nucl. Instr. and Meth. A273 (1988) 881

Tests of a  $BaF_2$ -TMAE detector for positron-emission tomography

P. MINE, ..., S. TAVERNIER, ...

Nucl. Instr. and Meth. A269 (1988) 385

Computing in High Energy Physics

D. BERTRAND

Physicalia Magazine 10 (1988) 222

Computing in Physics - and what is so special about it?

P. VAN BINST

Physicalia Magazine 10 (1988) 177

Etude et description d'un protocole de Données pour liaison satellite

A. COHEN, T. MASSART, P. VAN BINST  
CFIP'88, Ingénierie des Protocoles, ed. R. Castanet et O. Rafiq,  
Eyrolles, 1988, 203

## IX.2. Contributions to Conferences

### IX.2.a. Presented by members of the IIHE

- "Tests of PCAC and coherent interactions on nuclei"  
P. MARAGE  
Review talk presented at the 13th International Conference on Neutrino Physics and Astrophysics (Boston, USA)
- "De ontwikkeling van een PET scanner gebaseerd op een totaal nieuw werkingsprincipe"  
S. TAVERNIER  
PRIMIS Workshop (Brussels)
- "Use of holographic optics to obtain high resolution over a large volume to search for short-lived particles"  
L. VERLUYTEN (E632 collaboration)  
General Meeting of APS - Baltimore  
Buletin IIHE 88-01
- "A-dependence of low-mass dimuon production in 320 GeV/c  $\pi^-$  interactions and 300 GeV/c p-interactions"  
H. COBBAERT  
Novel features of High Energy Collisions in the 1-100 TeV region (Erice, Sicily)
- "Progress report on the activities of the Inter-University Institute for High Energies (IIHE)"  
J. LEMONNE  
Annual Meeting of the BNV-SBP (Namur)
- "Charge and Energy Flow in  $\pi^+p$ ,  $K^+p$  and  $pp$  interactions at 250 GeV/c"  
A. DE ROECK  
Contributed talk at the Rencontre de Moriond (Les Arcs, France)
- "Fragmentation Models Confronted with Results on Inclusive Particle Production in  $K^+p$  and  $\pi^+p$  Interactions at 250 GeV/c"  
A. DE ROECK  
Contributed talk at the XIXth International Symposium on Multiparticle Dynamics (Arles, France)  
Bulletin IIHE 88-03
- "Pan-European High Speed Networking"  
P. VAN BINST  
Invited paper at the RARE European Networkshop, Les Diablerets Computer Networks and ISDN systems, North-Holland 16 (1988) 124  
Bulletin IIHE 88-02

- "Local Networks and Fast Networks"  
P. VAN BINST  
Invited paper at the IFIP WG 5.4/IFAC/EWICS Working Conference  
(Warsaw, Poland)  
In Hardware and Software for Real Time Process Control, ed. by  
J. Zalewski and W. Ehrenberger, North-Holland (1989) 453  
Bulletin IIHE 88-04
- "The HELIOS Project : OSI Conformant, High Speed Data  
Communication by Satellite in Europe"  
P. VAN BINST  
Proceedings of the IXth International Conference on Computer  
Communication (Tel Aviv, Israel)  
Bulletin IIHE 88-05
- "High Speed Data Communication by Satellite in Europe : the  
HELIOS Architecture"  
P. VAN BINST  
8th European Conference on Electrotechnics (Stockholm, Sweden)  
Proceedings on Area Communication, IEEE, 261
- "LAN, WAN, PABX : Derrière les sigles, quelles fonctionnalités?"  
P. VAN BINST  
Actes du Séminaire "Le Dirigeant et les choix informatique  
d'aujourd'hui" (ULB, Ferme de la Pitance)
- "An object oriented environment for conformance testing"  
N. MEULEMANS  
International Workshop on Protocol Test Systems (Vancouver,  
Canada)
- "Satellites"  
P. VAN BINST  
International Chair of Computer Science (Brussels)

#### IX.2.b. Others

- "Coherent Production of  $\pi^+$  and  $\pi^-$  mesons by charged current  
interactions of neutrinos and antineutrinos on neon nuclei at  
the Tevatron"  
N. ADERHOLZ, ..., M. BARTH, P. MARAGE, E. DE WOLF, J. MOREELS,  
J. SACTON, L. VERLUYTEN, ...  
Bulletin IIHE 88-08  
Contributed paper to the 13th International Conference on  
Neutrino Physics and Astrophysics (Boston, USA) and to the  
XXIVth International Conference on High Energy Physics (Munich,  
DDR)
- "Coherent production of  $a_1$  mesons by antineutrino scattering on  
neon"  
M. ADERHOLZ, ..., P. MARAGE, J. SACTON, ...  
Bulletin IIHE 88-07  
Contributed paper to the 13th International Conference on  
Neutrino Physics and Astrophysics (Boston, USA) and to the  
XXIVth International Conference on High Energy Physics (Munich)

- "Coherent production of  $\pi^+$  mesons in  $\nu$ -neon interactions"  
P.P. ALLPORT, ..., P. MARAGE, J. SACTON, ...  
Bulletin IIHE 88-06  
Contributed paper to the 13th International Conference on Neutrino Physics and Astrophysics (Boston, USA) and to the XXIVth International Conference on High Energy Physics (Munich)
- "Determination of the charged pion ratio in the current fragmentation region of neutrino and antineutrino neutral current interactions on a proton"  
..., J. MOREELS, W. VAN DONINCK, ....  
International Conference on Neutrino and Astrophysics (Boston, USA)
- "An Electron-Hadron Separator for Digital Sampling Calorimeters"  
..., D. GEIREGAT, P. VILAIN, G. WILQUET, K. DE WINTER, ...  
CERN EP/88-87  
3th Topical Seminar on Perspectives for Experimental Apparatus (San Miniato, Italy)
- "Experimental results obtained from a low-Z fine-grained electromagnetic calorimeter"  
..., D. GEIREGAT, P. VILAIN, G. WILQUET, K. DE WINTER, ...  
CERN EP/88-88  
3th Topical Seminar on perspectives for Experimental Apparatus (San Miniato, Italy)
- "The central tracking system of the H1 experiment"  
..., G. BERTRAND-COREMANS, E. EVRARD, D. JOHNSON, J. MOREELS, R. ROOSEN, ...  
Contributed paper to the XXIV Conference on High Energy Physics (Munich, DDR)