# INTER-UNIVERSITY INSTITUTE FOR HIGH ENERGIES

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J. LEMONNE and J. SACTON
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## I. INTRODUCTION.

The physicists and computer scientists whose names are listed below have contributed to the different activities of the laboratory during the year 1987.

U.L.B.
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)
M. Dimou (doctorant)
C. Hanon (assistant de recherche - since February 1987)
Ph. Huet (boursier IRSIA - since October 1987)
P. Marage (chercheur ARC - 1er assistant since October 1987)
T. Massart (assistant de recherche)
J. Sacton (professeur associé)
B. Sales (assistant - since September 1987)
F. Stichelbaut (boursier IRSIA)
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)
St. Willocq (doctorant) has spent the whole year at FNAL in support of the E632 experiment
Z. Xing Ciang (stagiaire - doctorant)

V.U.B.
H. Cobbaert (vorser IIKW)
C. De Clercq-Vincent (logistiek medewerker IIKW)
K. De Winter (assistent)
E. Evrard (doctorandus)
D. Geiregat (vorser IIKW)
D. Johnson (vorser IIKW - Docent Vesalius College)
J. Lemonne (gewoon hoogleraar)
N. Meulemans (vorser VUB)
J. Moreels (vorser IIKW)
R. Roosen (bevoegdverklaard navorser NFWO)
S. Tavernier (onderzoeksleider NFWO)
R. Vandenbroucke-Tassin (eerst aanwezend informaticus IIKW)
W. Van Doninck (bevoegdverklaard navorser NFWO)
L. Van hamme (aspirant NFWO)
B. Vonck (vorser IIKW)

F. Verbeure, J. Buytaert (since January 1987), A. De Roeck, E. De Wolf, A. Michalowska and L. Verluyten from the UIA are working in close collaboration with the Institute. L. Verluyten has spent the whole year at FNAL in support of the E632 experiment.

## II. RESEARCH ACTIVITIES.

### II.1. Neutrino physics.

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

(D. Bertrand, 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) measurement of the structure functions $F_2$ and $xF_3$, and comparison with QCD predictions, including kinematical and dynamical higher twist effects. This study was one of the major goals of the experiment; a low $\Lambda_{\overline{MS}}$ value, around 100 MeV, was measured, and the contribution of dynamical higher twist effects was found to be small and negative;

(ii) study of the EMC effect, using $\nu$ and $\bar{\nu}$ interactions in neon and deuterium (WA25 experiment); the data were compared with several theoretical predictions; models predicting a large increase of the sea in Neon nuclei are discarded.

(iii) coherent production of $\rho^-$ mesons by $\bar{\nu}$ interactions on neon nuclei; a signal is observed in agreement with VMD models.

(iv) spin alignment of $\rho^0$ mesons produced in $\bar{\nu}$ and $\nu$ charged current interactions; comparison is made with the scarse published data and model predictions are discussed.

#### 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 and St. Willocq; 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 heavy neon mixture, exposed to the Tevatron Quadrupole Triplet Beam; the chamber was equipped with 3 conventional cameras, a high resolution (~ 150 μm) and a holographic camera.

1985 run (Part I).

About 150000 pictures were taken in 1985, corresponding to 12000 charged current interactions. The measurements are finished in most of the laboratories. The 2- and 4-prong events were fully measured for coherent interaction studies; all leaving tracks were measured in a subsample of ~ 1,5 % of the events, selected using the vertex position and the EMI information, for dimuon studies; an unbiased sample of at least 150 events were measured in each laboratory for calibration purposes.

The main effort has been devoted in 1987 to the preparation of the 2- and 4-prong event analysis. A common chain of programs needed for the treatment of the data was made available from Brussels and Saclay to the whole collaboration; a careful check of the data quality was performed, in order to build up a high quality standardized data tape.

The analysis of dimuon production characteristics is under way.

1987 run (Part II).

A second run started in June 1987 and is still going on; some 200000 conventional pictures have been taken, as well as some 80000 good quality holograms. L. Verluyten and St. Willocq were partially in charge of the holographic data taking system during all the run.

The scanning of the conventional pictures has just started.

## 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).

After the first running in period of 1986, the work has, this year, been oriented in two directions : the data taking of 1987 and the preliminary analysis of last year data.

The main improvement to the detector was a strong reduction of the noise on the signals coming from the analog strips. This was achieved by a slight modification of each amplifier card and by careful cleaning of the electrical contacts. Another improvement consisted in a new and more reliable design of the electronic boards used for the trigger decisions. These boards were mounted and soldered at the IIHE. After this upgrading, the detector ran smoothly for the 90 days of data taking. Unfortunately, the SPS has not been fully efficient during this period and the accumulated data, corresponding to $3.25\ 10^{18}$ protons on target, represent only 70 % of what was expected and 25 % of the final statistics aimed for. Another 2 years will be necessary to complete the experiment.

Concerning the data analysis, the priority was given to the selection of the candidates for the reactions $\overset{(-)}{\nu}_\mu + e \rightarrow \overset{(-)}{\nu}_\mu + e^-$.

Briefly, the different steps of this selection procedure are :

- A quick filtering of the data was used to remove most of the cosmic background. The efficiency of this selection for neutrino events in the fiducial volume was shown to be better than 99.9 %.

- A study was performed of the characteristics (width, length, energy deposition, density of hits, ...) of the showers produced by $\pi^-$ mesons and $e^-$ of the calibration beams. This allowed to define criteria rejecting 95 % of the hadronic showers and only 1 % of the signal.

- Another order of magnitude in rejection power was gained by stronger cuts and more sophisticated analyses including all the detector informations (streamer tube hits, scintillators, analog strips). The IIHE group has developped a program for multivariate discriminant analysis which looks promising. The efficiency of these methods for genuine electron showers is about 85 %.

- Methods were derived from the calibration data to calculate the energy and angle of the electron showers and the associated errors. The distribution of the variable $E\Theta^2$ for the candidate $\nu$-e events exhibits, as expected, a peak at low values containing 110 and 135 events, respectively for $\nu$ and $\bar{\nu}$ data of 1986, over the background. The signal to noise ratio is about 1 in both cases.

- In order to extrapolate correctly the background under the peak, it is important to understand the composition of this background. At the IIHE, progress was made in that direction by different methods :
  - Separation of the showers due to single $e^-$ and to $e^+e^-$ pairs (coming from $\pi^0$ meson decays), using the energy deposition in the first active scintillator plane.
  - Monte Carlo simulation of the coherent production of $\pi^0$ mesons by neutral current.
  - Construction of background samples by cleaning out the signals due to the muon in charged current reactions.

This selection procedure is now being applied to the 1987 data.

Other important topics are studied in parallel, among which :
- Neutrino flux calculations.
- Selection of the quasi elastic charged current reactions which will be used for the relative flux normalisation of $\nu$ and $\bar{\nu}$ runs.
- Selection of dimuon events.
- Selection of the "inverse muon decay" reaction

$$\nu_\mu + e^- \rightarrow \mu^- + \nu_e$$

These problems rely heavily on the programs for muon track finding and fitting (both in the calorimeter and the spectrometer) which have been strongly improved during the last months; DST production will start soon.

## 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, Cracow, 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 $K^+p$, 70000 $\pi^+p$, 6000 pp and 10000 interactions on nuclei is available. Results on the following items were obtained :

1) From a study of $\rho^+$ production in $\pi^+$ interactions, it was found that the recombination of valence quarks is suppressed in $\pi^+$ fragmentation into a $\rho^+$ meson, thus confirming our earlier finding in $K^+$ interactions.

2) One event with unusually large density of particles in rapidity space was published. This publication stimulated a considerable amount of theoretical work on fluctuations, intermittency ...

3) An indication of the onset of hard-like effects in hadron-hadron interactions at our energy : a study of the "sea-gull" effect showed that the emission of rather hard gluons is to be included in any fragmentation model in order to describe the form and energy dependence of the average transverse momentum versus Feynman-x.

4) The determination of the $K^{*o}(890)$ and the $\Phi$ cross section in the kaon fragmentation region allowed to estimate the strangeness suppression factor. The value found in $K^+p$ interactions is almost energy independent between 32 and 250 GeV/c and equal to $0.17 \pm 0.02$.

5) The $\rho^o$, $\rho^+$ and $\omega$ cross sections are determined in the $K^+$ fragmentation region and found to be remarquably similar to muon-inelastic scattering at 290 GeV/c.

### II.2.2. 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, Antwerp-Brussels, CERN, Duke, Genova, Japan, Liverpool, Madrid, Mons, Oxford, Padova, Paris Collège de France, Rome, Rutgers, Rutherford, Serpukhov, Stockholm, Strasbourg, Tenessee, Torino, Trieste, Vienna, Zeuthen).

The idea is to use the very large amount of interactions recorded during both the $\pi^-$ and the proton runs of the NA27 experiment, without measurements of the bubble chamber pictures. Thus only the scanning information and the electronics data were

used to reconstruct the tracks in the EHS spectrometer. A total of 165000 $\pi^- p$ events and 500000 pp events was reconstructed in 7 laboratories of the NA27 collaboration. These samples are now available for physics analyses. First results based on the $\pi^- p$ sample are published, nl. inclusive charged pion, kaon and (anti-)proton production and production of $\rho^0$ and $f_2$.

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

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

The measurement of the film collected in 1982 and 1985 has been completed mid-1987. The following topics have been analyzed during this year :

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 ± 0.08 GeV 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.

3) The multiplicity distribution at 900 GeV appears to depart from the negative binomial parametrisation, well suited to describe the data at 200 and 543 GeV, as well as at lower energies. The final check of the data, search for systematics or for diffractive contamination, is in progress.

4) Photon production and photon-charged particle production correlation studies are in their final state.

5) Strange baryon ($\Lambda$, $\Xi$) production is still under study.

Two comprehensive summary reports have been published this year : A survey of the $\sqrt{s}$ = 546 GeV data in Physics Reports and a detailed description of the simulation program in Nuclear Physics.

## II.2.4. Charmed particle production by 360 GeV/c $\pi^-$ mesons and 400 GeV/c protons in a rapid cycling hydrogen bubble chamber.

(G. Bertrand-Coremans ($\pi^-$ part only), K. De Winter, J. Lemonne, P. Vilain, B. Vonck and J. Wickens; NA27 Collaboration : Aachen, Bombay, Brussels, CERN, Duke, Genova, Japan, Liverpool, Madrid, Mons, Oxford, Padova, Paris, Collège de France, Rome, Rutgers, Rutherford, Serpukhov, Stockholm, Strasbourg, Tenessee, Torino, Trieste, Vienna, Zeuthen).

The NA27 experiment was designed to study charm production and decay properties in $\pi^- p$ interactions at 360 GeV/c and pp interactions at 400 GeV/c.

The set up consisted of the high resolution bubble chamber LEBC combined with the European Hybrid Spectrometer, providing momentum measurement and particle identification.

Most of the results on the $\pi^-$ part of the experiment have by now been published.

The analysis of the proton data was performed on a sample of 557 charm decays, extracted from about $10^6$ bubble chamber pictures containing a primary pp interaction. The most important results are the following :

$\sigma(D^+/D^-) = (11.9 \pm 1.2)$ µb $\qquad \sigma(D^\circ/\bar{D}^\circ) = (18.3 \pm 1.9)$ µb

$\sigma(D^\circ) = (10.5 \pm 1.7)$ µb $\qquad \sigma(\bar{D}^\circ) = (7.9 \pm 1.5)$ µb

$\sigma(D^+) = (5.7 \pm 1.0)$ µb $\qquad \sigma(D^-) = (6.2 \pm 1.0)$ µb

$\sigma(D\bar{D}) = (14.6 \pm 1.3)$ µb

$\sigma(D^*/\bar{D}^*) = (15.0 \pm 3.4)$ µb

These results show that the $\Lambda_c \bar{D}/\bar{\Lambda}_c D$ associated production is small and that $D^*$ mesons are an important source of D mesons. The analysis of the differential cross-sections of D mesons shows that, in general, these mesons are produced rather centrally. However, the $D^+$ $X_f$ distribution is harder than the $D^\circ$ one.

Variables describing the correlations between charm-anticharm pairs, $X_f$, $p_t$, rapidity gap and invariant mass of the pair, and the angle between both charms in the transverse plane, have been studied. All distributions agree well with the predictions made on the basis of the QCD fusion model, except for the transverse momentum of the pair which is on average too large to be explained by the fusion model.

The lifetimes of the D mesons have been measured with greater accuracy, combining the $\pi^- p$ and pp data :

$$\tau(D^\circ) = (4.6^{+\ 0.6}_{-\ 0.5})\ 10^{-13}\ s$$

$$\tau(D^\pm) = (11.2^{+\ 1.4}_{-\ 1.1})\ 10^{-13}\ s$$

On the basis of 10 events the lifetime of the $\Lambda_c$ has been estimated to be :

$$\tau(\Lambda_c) = 1.2^{+\ 0.5}_{-\ 0.3}\ 10^{-\ 13}\ s$$

Some limits for the production cross section of $\Lambda_c$ could be derived :

$$1.4\ \mu b < \sigma(\Lambda_c/\bar{\Lambda}_c).BR(\Lambda_c \rightarrow 3prongs) < 6.1\ \mu b$$

$$\sigma(\Lambda_c\bar{D}/\bar{\Lambda}_c D) < 6.1\ \mu b,$$

as well as the cross-section of $\Lambda_c$ decaying to $pK\pi$ :

$$\sigma(\Lambda_c/\bar{\Lambda}_c).BR(pK\pi) = 1.2^{+\ 1.6}_{-\ 0.8}\ \mu b$$

The data also suggest that :

$$BR(\Lambda_c \rightarrow pK\pi) > 4.4\ \%$$

## II.2.5. Charm production in pp interactions at 800 GeV.

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

This experiment was 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 particles, 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 40 % of the statistics. These preliminary results are :

$$\sigma(D^0/\overline{D^0}) = (22^{+13}_{-10})\ \mu b, \qquad \sigma(D^{\pm}) = (29 \pm 10)\ \mu b$$

and, $$\sigma(D/\bar{D}) = (51^{+16}_{-14})\ \mu b$$

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

## II.2.6. Direct observation, in emulsion, of the decay of beauty particles selected by their muonic decay.

(M. Barth, G. Bertrand-Coremans, R. Roosen; WA75 Collaboration : Bari, Brussels, CERN, Dublin, Funabashi, Gifu, Kariya, U.C. London, Nagoya, Rome, Torino, Utsunomiya, Yokohama).

Taking into account the fraction (~ 80 %) of the material analysed so far and the single event of production of a pair of beauty particle $B^-$-$B^0$ observed in the early stage of the experiment, the production cross-section is in agreement with the new result of the WA78 experiment i.e. $\sigma = 2.0 \pm .3 \pm 0.9$ nb/N assuming a linear A dependence.

An analysis of the charm production and decay characteristics, based on about 90 charm-pairs and 80 single charm-events produced in the same experiment, is in progress.

## II.2.7. Study of the production of beauty particles using a muon spectrometer and a hadron calorimeter.

(H. Cobbaert and R. Roosen; 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 360 GeV/c. The experimental setup essentially consists of a muon spectrometer and a Uranium/scintillator sandwich calorimeter, equipped with an hardware processor. The trigger requested at least two muons in the final state and at most 280 GeV in the calorimeter. Off-line analysis of the 3-muon sample, introducing cuts on the missing energy ($E_{miss} > 50$ GeV) and on the $p_t$ of the muons ($\Sigma\ p_t > 3.2$ GeV/c), revealed an excess of 13 events with an estimated background of 2 events. This results in a cross section of

$$\sigma(\pi N) = 1.6 \pm 0.5\ (stat)\ nb$$

assuming a linear A-dependence. The present value is smaller than the one published previously (4.5 ± 1.5 ± 1.5 nb) owing to a

different production mechanism for computing the acceptance. It has been evaluated using a QCD prediction for BB production including a correlation between the two heavy quarks. The like-sign dimuon sample has been analysed in a similar way. Requiring $p_t^{tot} > 2.7$ GeV/c, $E_{miss} > 20$ GeV, $E_{lept} < 100$ GeV, 29 $\mu^\pm\mu^\pm$ and 35 $\mu^-\mu^-$ remain: the contribution from the background is estimated to be 6 $\mu^+\mu^+$ and 14 $\mu^-\mu^-$ respectively. After including 20 % of $B^oB^o$-mixing, we obtain good agreement, within the statistical significance of both samples, between Monte Carlo data and experimental data for all variables of interest. Combining both samples we end up with a cross section of

$$\sigma(\pi N) = (2.0 \pm 0.3 \pm 0.9)\ \text{nb}$$

The systematical error is mainly due to the uncertainty in the absolute normalisation and in the acceptance of the apparatus.

The dump calorimeter was special in the sense that it was expandable and the dense absorbers could easily be replaced by others. This allowed a measurement of the A-dependence of the charm production cross section in the single muon channel, since the largest background due to pion and kaon decays could be estimated by a $1/\rho$ analysis. Data have been taken both with incident $\pi^-$ mesons and incident protons. The materials used in the target section of the calorimeter were Al, Fe and U. It is common to express the A-dependence of the charm cross section as :

$$\sigma(hA) = \sigma_0\, A^\alpha$$

where $\alpha$ is the parameter to be determined. The analysis of the data lead to the following values of $\alpha$ :

for pions

$$\alpha(\mu^+) = 0.76 \pm 0.08 \quad \text{and} \quad \alpha(\mu^-) = 0.83 \pm 0.06$$

for protons

$$\alpha(\mu^+) = 0.78 \pm 0.10 \quad \text{and} \quad \alpha(\mu^-) = 0.76 \pm 0.10$$

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

(D. Bertrand, J. Buytaert, C. De Clercq, M. De Jode, J. Lemonne, J. Sacton, 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 field is 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 solenoïdal 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 ~ 580 ns/m) and accurate (spatial resolution ~ 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 ~ 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 only be used to resolve left-right ambiguities.

The design of the endcap detection system is essentially identical to the one described in previous report apart from the fact that a four-fold multiplexing of the delay line read-out has been decided.

The construction of these end-cap detectors is proceeding as scheduled. A total of 13 quadrants have been completed and successfully submitted to a series of acceptance tests regarding their high voltage behaviour and the anode and delay line signal quality and logic. The chambers were operated in a gas mixture consisting of approximately 15 % Ar, 15 % iso-$C_4H_{10}$ and 70 % $CO_2$ with a small (1 to 2 %) addition of alcohol vapour.

Average absolute anode efficiencies per quadrant of the order of 80 % were measured to be compared to an expected maximum value of 92 % for trigger acceptance and dead space. Delay line efficiencies are typically of the order of 99 %.

One quadrant has been submitted to more detailed tests regarding :

- the anode efficiency along a chamber and as a function of drift distance
- the linearity of the delay lines. For this purpose, the scintillator-test rig used for the ordinary test was complemented by a set of reference chambers providing impact predictions of cosmic ray particles.

Disregarding unavoidable edge effects, all distributions were found to be uniform with the exception of the delay line measurements which exhibit a systematic S-shaped deviation from linearity. Those deviations are however < 5 mm and can be corrected for after the delay line calibration. Such calibration procedures are presently under study.

Moreover, further studies are still pursued on :

- Gas purity requirements and pressure monitoring
- Detector response for particles incident at large angles
- Data acquisition and detector control
- A muon trigger utilising both the barrel and endcap muon chambers as well as the scintillator counters and the hadron calorimeter
- Event simulation and muon tracking algorithms
- Graphical event display and software procedures designed to unravel complicated track patterns expected from the DELPHI detector
- General purpose software for DELPHI.

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

(M. Barth, G. Bertrand-Coremans, 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 responsability 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 readout 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 half-gap size being 4 mm. None of the wires are readout. In contrast, one of the cathodes of each chamber is segmented in z and phi, constituting 2 x 304 pads of dimensions 190 x 117 $mm^2$ 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.

The construction of the COP as a sandwich structure is a rather complex operation. To give the Rohacell its dimensional stability and cylindrical form, the material has to be heated up to 180 degrees on a cylinder. The sandwich structure is made on high precision steel mandrils. First a 25 micron Al foil is rolled on the cylinder and kept in place by a vacuum inside the steel mandril. In a second operation the performed Rohacell is glued on the Al foil. The Rohacell surface is then machined to a 50 micron precision (necessary to garantee the chamber gap size). For this operation the steel mandril and Rohacell are mounted on a lathe. Finally a second Al (or kapton) foil is glued on the Rohacell, terminating the first sandwich cylinder. For the two chambers 3 sandwich cylinders have to be constructed requiring 3 steel mandrils. As these objects weight over 1.5 ton a special infrastructure has to be provided to manipulate them. Furthermore most of the basic materials are temperature and humidity sensitive and therefore must be handled in special conditioned rooms. At present, most of the infrastructure, including temperature control, humidity control and cranes, have been installed. Also the furnace to treat the Rohacell is well underway. So we expect to start a first chamber construction beginning next year.

As mentionned previously the transport of the chamber signals is rather special and needs testing. To test the readout a flat prototype chamber is under construction. First results are expected at the beginning of 1988.

In parallel a design for the VME readout scheme between the frontend electronics and the subdetector crate level has started. A first test of the global electronic readout scheme is expected in the second half of 1988. The chambers have to be ready at the beginning of 1989 and have to be shipped to DESY in June 1989.

## III. TEACHING ACTIVITIES AND SEMINARS.

- J. Lemonne assured the lectures (90 h) on "Algemene Natuurkunde" (1ste Kandidatuur Natuurkunde, Scheikunde, Wiskunde en Geologie) and on "Elementaire Deeltjes" (60 h) (1ste and 2de Licentie Natuurkunde) during the academic year 1986-87.

- G. Bertrand has deputized J. Sacton for his lectures (30 h) on "Introduction à la Physique des Particules Elémentaires" (1ère et 2ème licences en sciences physiques).

- S. Tavernier has deputized J. Lemonne for his lectures (15 h) on "Detektie van ionizerende stralingen" (2de licentie Natuurkunde) and related practical work (15 h).

- P. Van Binst has given the following lectures :
. "Introduction à l'informatique" (30 h - Licence en Informatique et Sciences Humaines - Faculté des Sciences Sociales, Politiques et Economiques)

. "Télématique" (30 h - Licence en Informatique et Sciences Humaines - SOCO et Licence Spéciale en Sciences de l'Information et de la Documentation - Faculté Philo et Lettres).
. "Informatique (pratique)" (60 h - Licence en Informatique et Sciences Humaines - SOCO).
. "Introduction à la télématique" (15 h, cours libre, Faculté des Sciences).
. "Informatique" (25 h, partim, Faculté des Sciences).

- At Vesalius College, D.P. Johnson gave an introductory physics course "Physics 101" (45 h) and contributed to student tutorials (75 h).

- G. Bertrand and P. Vilain (in collaboration with J.M. Frère) gave a course on "Questions approfondies de physique des particules" (30 h) and organized the associated practical work (45 h - 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" (22 h).

- C. Vander Velde and P. Marage have given practical work (135 h and 122 h respectively) for the lecture "Physique Générale",(1ère candidature Institut Solvay).

- F. Verbeure gave the following lectures at the UIA :
. "Numeriek rekenen" (60 h + 60 h oefeningen, 1e Lic. Natk.)
. "Kernfysika en elementaire deeltjes" (60 h, 1e Lic. Natk.)
. "Gevorderde Elementaires Deeltjes" (60 h, 2e Lic. Natk.)
. "Radioaktiviteit" (15 h, 2e Lic. Natk.)
. "Meten en simuleren" (30 h, 2e Lic. Wisk.).

- E. De Wolf gave a course on "Fundamentele wisselwerkingen tussen Elementaire Deeltjes" (30 h - UIA) (2de licentie Natuurkunde).

- K. De Winter has contributed to the "Practica van de kandidaturen Natuurkunde" (150 h Natuurkunde; 150 h Elektronika).

- M. Barth, D. Bertrand, G. Bertrand, M. De Jode, P. Marage and J. Wickens have contributed to the practical work for students (3 series of 30 h) attending the lectures on particle physics of J. Sacton (1ère et 2ème licences en sciences physiques).

- M. Barth, G. Bertrand and P. Vilain have organised (5 series of 35 h) the optional practical work for students of the 3rd year in physics.

- H. Cobbaert has organized 5 days of laboratory demonstrations concerning particle physics in the framework of the VUB "Zomerschool - Natuurkunde"; and C. De Clercq contributed to the practical work for students attending the lectures of J. Lemonne on particle 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).

- C. Hanon, T. Massart (30 % of their time) and B. Salès (50 % of its time) have contributed to the practical work organized for students in computing science.

The following "mémoires", "licentiaat verhandelingen" and "travaux de fin d'études" have been made at the IIHE :

- "Etude des couches OSI 5 à 7 dans le contexte de la messagerie électronique"
F. Alexandre (Sciences - LIT/IIHE) under the responsabililty of P. Van Binst.

- "Intelligence artificielle et systèmes experts dans un environnement bancaire"
B. Bovy (SOCO - SISH) under the leading of P. Van Binst.

- Le "Vidéotexlike" - Une application des principes du vidéotex interactif
J.P. Buisseret (SOCO - SISH) under the leading of P. Van Binst.

- "Contribution au système de déclenchement sélectif de l'expérience DELPHI"
Ph. Huet (Sciences Appliquées) under the leading of C. Vander Velde.

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

- C. De Clercq
"Hardware and Software aspects of the DELPHI FASTBUS readout system"
(RWTH - Aachen).

- J. Lemonne
"Fysica van de Elementaire Deeltjes aan het IIHE"
(VUB).

- C. Vander Velde
"The DELPHI endcap muon chambers"
(IIHE).

- A. Cohen and Th. Massart
"Protocoles pour une liaison satellite"
(CEN, Saclay).

- C.Hanon
"Introduction aux recommandations X.400"
(LIT, Brussels).

- N. Meulemans
"An Introduction to FTAM"
(IIHE)

"An Introduction to OSI Naming, Adressing and Directory Services"
(IIHE).

- P. Van Binst
"Evolution de l'informatique - Réseaux et télématique"
(GECHEM, Brussels)

"Presentation of the HELIOS project"
(ECMWF, Reading)

"Les transmissions de données à haute vitesse en Europe"
(LIT, Brussels)

"New Computer Architectures - Trends in Networking"
(University of Mining and Metallurgy, Cracow)

"Télématique (3 x 20 h)
(SIEMENS, Belgium).

- R. Vandenbroucke
"Burotica - Netwerken"
(BULL, Belgium).

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

- M. Arnould
(from ULB)
"Supernova and neutrino flux".

- M. Bourquin
(from Université de Genève)
"The narrow ($\Lambda p + \pi$'s) states at 3.1 GeV/$c^2$".

- L. Cifarelli
(from INFN, Bologna)
"New results on charm and beauty baryon production at the ISR".

- A. Diddens
(from NIKHEF, Amsterdam)
"Ring Imaging Cherenkov Counters".

- J.M. Frère
(from ULB)
"Can one disprove Supersymmetry ?".

- P. Marage
(from IIHE)
"Hadronic Component in Neutrino Interactions".

- Th. Müller
(from CERN - EP Division, Geneva)
"Highlights of physics with the UA1 detector".

- R. Reinfordt
(from Universität Frankfurt"
"The NA35 Experiment and Results from the First Heavy Ion Run at the CERN SPS".

- F. Sauli
(from CERN-EP Division, Geneva)
"Recent Developments with Gaseous Proportional Detectors".

- B.G. Taylor
(from CERN - EP Division, Geneva)
"The Apple Macintosh applied to CAMAC and VMEbus systems".

- R. Wigmans
(from CERN-LAA, Geneva)
"High Resolution Hadron Calorimetry".

The following seminar was also organized :
Dr W. BAUERFELD (from DSN, Germany) "OSI becomes reality".

## 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

- scientific : A. Cohen, M. Dimou, C. Hanon, T. Massart, N. Meulemans, B. Salès

- system, support and logistics : G. Depiesse, G. Rousseau, W. Van Droogenbroeck.

The computing architecture of the IIHE has seen in 1987 its major modification since the creation of the laboratory; indeed, instead of being organized around a mainframe type of computer (PDP-10, then DECsystem10 or 20) surrounded in a star-like fashion by minicomputers (two PDP-11) and microcomputers (Apple II, three MacIntosh, etc), computing at the IIHE is now more and more decentralized by means of an Ethernet local area network including a number of VAX computers of different sizes (VAX 8200 supermini and three MicroVAX II) as well as Bull (two SPS/7). Dozens of terminals may be connected to terminal servers or directly to computers. The DECsystem20 itself, and its associated network, is being integrated in the Ethernet network. A personal office computer acquired last year for the IIHE secretariat (DEC PRO 380) has also been integrated in the distributed architecture.

The VUB network being itself based on Ethernet, information can be exchanged between the IIHE and other VUB computers. On the other hand, the wide-area type of communications are possible via the public X.25 network (DCS), of which two connections are presently available in the laboratory; this is compatible with the ULB network to which the IIHE will soon be connected.

Such a change in architecture, including for the first time DEC as well as other manufacturers' products, and based on "open systems" concepts, represents an exceptional amount of work for which the personnel traditionnally in charge of computing and communications at the IIHE is now being supplemented by the added scientific personnel linked to the HELIOS-B project.

As computing and communications become ever more important in elementary particle physics, it is obvious that an institute like ours, on the international scale, needs more and more to look "outside" for collaborations, support and expert advice. In this context, our activities in international organizations are of great importance; let us mention ECFA, RARE, DECUS, CEN/CENELEC, HEPNET, the GIFT project. For the first time, the IIHE will be involved in a scientific programme of the Commission of the European Communities (Conformance Testing Services) as well as in

an EUREKA project (COSINE). Members of the laboratory are also involved in consultancy or research and development contracts where our own expertise can be matched with the one of other institutions; let us note DEC Belgium, RTT, SPAG Services, TRASYS (for the European Space Agency), Bull Belgium, NCR Belgium.

A separate report will cover the activities of the HELIOS-B group in more detail. It may be mentioned that file transfers via satellite between Saclay and Brussels, at 128 kbps, have been successfully realized (a first in Belgium), while the specifications of a new data communication protocol were completed. Expertise is gathered on new OSI protocols like X.400 and FTAM, as well as more traditional ones like TCP-IP, used at the IIHE and on VUBNET. An implementation of the X.400 message handling system is under test and the exchanges of messages on the public network (another Belgian first) have been realized in collaboration with Namur. Concerning our more traditional use of the Blue Book file transfer protocol over X.25 networks, extensive performance studies have been realized by the IIHE, in Europe and worldwide.

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

The persons involved in this programme are D. Bertrand and M. De Jode.

Complex software was developped on high performance graphics engines in order to build an interactive tool to perform the physics analysis of the DELPHI experiment.

As far as the hardware is concerned, a WHIZZARD 3375 Megatek station is used. This station has a resolution of 1024 pixels on 1024 lines in four raster planes and can transform up to 400000 short vectors per second. It is controlled by a μVAXII minicomputer. A medium performance station was developed in the laboratory with a resolution of 1280 pixels on 1024 lines in four raster planes and a transformation speed of the order of 20000 short vectors per second.

The software is intended to help in solving the difficult pattern recognition problems raised by the use of complex electronics detector as well as the physics interpretation of the events by a 3D visualisation of their kinematics. The operator interaction was privileged and a particular effort was made in order to have an "easy to learn" program.

The software which amounts for the time being to 50000 lines of code is almost half developped. A first working version is to be released during the second half of 1988.

This programme was supported financially by an ULB ARC contract.

## V. TECHNOLOGICAL R & D.

### V.1. Technology transfer from basic research to applications (S. Tavernier).

For the use of basic research in high energy a large number of remarkable technological developments have been made. Some of these new techniques can also be very useful in other fields.

In our laboratory there is a project to develop a medical scanner of the Positron Emission Tomograph (PET) type using wire chambers in combination with $BaF_2$ and TMAE. This project is supported by the EC under the Incentive Action program and is a collaboration involving VUB, CERN, Orsay and Brunel University, Brussels acting as a coordinator. Financial support was also given by the Nationale Loterij.

PET is a technique which allowes to determine the three dimensional distribution of a radioactively labeled substance in a living organism. It is mainly useful to study metabolic processes. In this technique a substance is labeled with a positron emitting isotope. In the organism the positron annihilates with an electron in two back to back gammas of 511 keV. A PET scanner is essentially a detector for this gamma radiation, coupled to a computer. The computer reconstructs the density of the positron emitters from the observed radiation.

In high energy physics gamma detectors based on wire chambers with TMAE (an organic vapour) and $BaF_2$ scintillator are being developed. It is the aim of our project to demonstrate the usefulness of this technique for PET with a very simple prototype.

We have used a small prototype detector built at CERN for high energy physics work do demonstrate that this device was able to detect gammas of 511 KeV with an efficiency near to 100 % and with good time and position resolutions. In Brussels we have built two small detectors with a sensitive area of 15 x 15 $cm^2$. These will be used later to make images of phantoms.

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

One of the major problems related to the use of the next generation of hadron colliders at very high energies (LHC, SSC, Eloïsatron) which are now being planned is the development of new concepts for the future detectors. These will have to stand very strong constraints, the most stringent ones being a radioactivity level of ~ 1Mrad and a collision cycle period of 6 to 25 ns. Furthermore, the tracking devices should achieve a spatial resolution of the order of 20 μm. The compacness of the device is an other essential element to be considered.

The detecting techniques based on scintillating optical fibers are among the most appealing ones both for calorimetry and tracking devices. If adequate fibers are already available for calorimetry, the situation is far from being so in the domain of tracking; no manufacturer is currently able to provide fibers, that fit the desired specifications. Glass fibers have attenuation lengths two orders of magnitude smaller than the typical detector

size; the smallest individual plastic fibers now available have sections of 100 x 100 $\mu m^2$. Moreover, the technique used to coat the fibers with the so-called extra mural absorber to prevent cross-talk is well suited for large fibers (1 $mm^2$), such as for the UA2 detector, but it is totally inadequate for tiny fibers of, say, 20 x 20 $\mu m^2$. Finally, reflectances of the order of 0.99999 on the core/clading interface have to be achieved in order to extract some signal over distances of a meter or so.

G. Wilquet is taking an active part in two R & D projects on the use of scintillating fibers. In the framework of the CERN LAA programme he is participating in a working group under the leading of J.P. Fabre, J. Kirkby and H. Leutz. Within the CHARM II experiment, in collaboration with W. Flegel and V. Zaceck, he is involved in a feasibility study of an experiment to detect $\nu_\tau$ interactions in a massive bundle of scintillating fibers used as an active target integrated into the present CHARM II set up. His contribution to these projects has mainly consisted in developing and running simulation programs on the light emission and transmission in the fibers, and on their coupling to the opto-electronical reading system.

## VI. TECHNICAL AND ADMINISTRATIVE WORK.

The members of the workshop staff were : M. Beck, J. De Bruyne, E. De Clerck, 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 was in charge of the general coordination and L. Etienne and L. Van Lancker organised the work of the electronics and mechanics workshops respectively.

During 1987, series production of the end cap muon detector units for the DELPHI experiment has continued. To date 13 modules, out of the total of 17 foreseen, have been completed. Workshop personnel have performed the following tasks throughout the year :

- preparation of components of the muon detector in house (winding of delay lines, cutting and cleaning of aluminium and PVC extrusions etc).

- cabling of the front end electronics for the modules.

- assembly and testing of the final modules.

Also within the DELPHI project, 1987 has seen the construction of specialised chambers for studying operation with differing gas mixtures and to act as prototypes of the monitoring chambers to be installed with the muon modules. A system of slow controls for the detector is under development, including the construction of electrometers and time-digital converters. The design of the support structures for the muon modules has been finalised and components ordered from industry.

This year has seen the start of a second major project requiring a large participation of the workshop personnel, namely construction of trigger chambers to be installed in the H1 experiment at the HERA e-p collider in Hambourg. To date the main activities have centred around :

- large scale transformations of rooms previously occupied by bubble chamber scanning tables to house equipment required to construct the chambers.

- construction of ovens for the pre-conditioning of material used to form the chamber body.

- design, manufacture and installation of infrastructure (wiring frame, supports for the large cylinders on which the chambers will be built and milled to size, work tables etc).

- prototype construction.

- design and test of PCB's for the readout system.

The above preliminary work should be completed early next year, to be followed by final tests and chamber construction.

All members of the workshop staff have been heavily involved in either the DELPHI or the H1 project. In addition, activities have included :

- maintenance of laboratory equipment (scanning tables, compressors, electronic systems etc).

- further development of graphic display controllers.

- production of a new series of PCB's for the WA79 (CHARM II) experiment.

- installation of the PCAD system for computer aided design of printed circuit boards, and investigation of the AUTOCAD system for computer aided design of mechanical components.

In performing the track chamber 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, C. Donis, C. Dumont, P.P. Galloy-Kips, Ch. Garnier-Stoffen, M. Goeman, D. Legrand-Mahaux, J. Liesen, D. Peymans-Luypaert, 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 chamber and of the CHARM II PCB's and to the construction of the prototype 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.

In his capacity of chairman of the European Committee for Future Accelerators, J. Sacton has organized and chaired the various meetings of the Committee during 87. He also attended :
- two ICFA meetings in Balatonaliga (Hungary) and at BNL (USA)
- the meetings of the CERN Scientific Policy Committee, Finance Committee, Committee of Council and Council
- two meetings of the Extended Scientific Committee at DESY
- four meetings of the Working Group on the Scientific & Technological Long Term Future of CERN, chaired by C. Rubbia
- three meetings of the European Computing Coordinating Committee at CERN
- three meetings of the Board of the HEPP Division of the EPS at Geneva.

J. Sacton was member of :
- the International Advisory Committee of the 1987 International Symposium on Lepton and Photon Interactions at High Energies in Hamburg
- the International Advisory Committee and Inter national Organizing Committee of the Europhysics Conference on High Energy Physics in Uppsala in 1987.

He also acted as external adviser on a Search Committee to consider candidates for indefinite appointment as research physicists in the EP Division at CERN and as member of the Visiting Committee of the Physics Department (Professor D. Imrie) of the BRUNEL University (U.K.).

J. Sacton has been nominated as "Advisor" of the Recteur of the ULB for all matters dealing with computing, he will deputize the Recteur as chairman of the Conseil de l'Informatique of the ULB. He has been elected as chairman of the Conseil de Gestion du Centre de Calcul ULB-VUB.

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, Finances and Teaching (as substitute)
- representative of the Scientific Personnel of the Physics Department at the Council of the Faculty of Sciences
- representative of the Faculty of Sciences at the User Committee of the Computing Center (ULB-VUB).

S. Tavernier acted as : representative of the Scientific personnel of the faculty of sciences at the "faculteitsbestuur en faculteitsraad" of this faculty.

C. Vander Velde has acted as representative of the Scientific Personnel at the Council of the Physics Department of the Faculty of Sciences (ULB).

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

C. Wastiels was the representative of the technical personnel in the Science Faculty of the VUB.

The following responsabilities 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
- W. Van Doninck : project leader of the muon detector
- J. Wickens : member of the Executive Committee.
- C. Vander Velde : responsible for the muon subtrigger.

P. Van Binst acted as :
- member of the RARE Council of Administration
- chairman of the ABUT/BVT RARE Club
- member of COSINE Policy Group
- member of various CEN/CENELEC Working Groups
- member of the Comité Informatique of IBN
- chairman of the DECUS Europe At-Large Chapter
- member of various committees of DECUS Europe and BELUX
- expert to the Commission of the European Communities
- member of the Commission Informatique of FNRS/NFWO
- observer representing RARE in ECTUA
- member of ECFA Subgroup 5, Links and Networks
- chairman of the Scientific Committee and member of the Organizing Committee of the International Conference on Communication and Data Communication, Nivelles, May 87
- member of the organizing Committee of :
  . the 7th School on Computing Techniques in Physics, Czechoslovakia
  . the 7th International Conference on Distributed Computing Systems, Berlin.

M. Dimou - has acted as Technical Officer for the RARE Secretariat.

C. Hanon was member of the CEN/CENELEC Working Group on PMHS.

N. Meulemans was member of the CEN/CENELEC Working Group on FTAM.

R. Vandenbroucke was elected :
- chairperson of the DECUS BELUX Symposium Planning Committee, of the DECUS BELUX Networks Group and of the DECUS Europe Netwoks Group.

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

- International Europhysics Conference on High Energy Physics
  (Uppsala - Sweden)
  G. BERTRAND, A. DE ROECK, J. SACTON, W. VAN DONINCK and P. VILAIN.

- 1987 International Symposium on Lepton and Photon Interactions at High Energies
  (Hamburg - Federal Republic of Germany)
  J. SACTON, S. TAVERNIER and C. VANDER VELDE.

- The Second International Conference on Hadron Spectroscopy
  (KEK - Japan)
  J. LEMONNE.

- PANIC 1987; XIth International Conference on Particles and Nuclei
  (Kyoto - Japan)
  J. LEMONNE.

- XVIIth International Symposium on Multiparticle Dynamics
  (Tashkent - USSR)
  F. VERBEURE.

- International Conference to Celebrate the 40th Anniversary of the Discovery of the $\pi$-Meson
  (Bristol - U.K.)
  J. SACTON.

- Present Trends, Concepts and Instruments of Particle Physics
  (Rome - Italy)
  J. SACTON.

- XXII Rencontre de Moriond : Quarks, Gluons and Hadrons
  (Les Arcs - France)
  L. VAN hAMME and B. VONCK.

- XVth Winter Meeting on Fundamental Physics
  (Sevilla - Spain)
  D.P. JOHNSON and P. MARAGE.

- Xth Warsaw Symposium on Elementary Particle Physics
  (Kazimierz - Poland)
  E. DE WOLF and G. WILQUET.

- Workshop on Physics at Future Accelerators
  (La Thuile - Italy and Geneva - Switzerland)
  J. SACTON.

- 1987 DESY Theory Workshop : "Physics at HERA"
  (Hamburg - Federal Republic of Germany)
  D.P. JOHNSON and P. MARAGE.

- Position Sensitive Detectors Conference
  (London - U.K.)
  L. ETIENNE, S. TAVERNIER and G. WILQUET.

- Computing in High Energy Physics
  (Asilomar - USA)
  D. BERTRAND and C. DE CLERCQ.

- Workshop on VME-Bus Applications
  (Antwerp - Belgium)
  C. DE CLERCQ.

- High Energy Physics Seminar - Digital Equipment.Corporation
  (Divonne-les-Bains - France)
  C. DE CLERCQ and J. SACTON.

- High Energy Physics Meeting - Digital Equipment Corporation
  (Geneva - Switzerland)
  J. SACTON.

- International Conference on Communication and Data Communication
  (Nivelles - Belgium)
  M. DIMOU, Th. MASSART, N. MEULEMANS, P. VAN BINST and
  R. VANDENBROUCKE.

- IFIP 6.5 Working Conference on Message Handling Systems
  (Münich - Federal Republic Germany)
  C. HANON and P. VAN BINST.

- IFIP 7.3 International Symposium on Computer Performance
  (Brussels - Belgium)
  C. HANON.

- CTS Technical Days 87
  (Brussels - Belgium)
  N. MEULEMANS.

- DFN Workshop on High Speed Data Communication
  (Berlin - Federal Republic Germany)
  P. VAN BINST.

- DECUS UK Symposium
  (York - U.K.)
  P. VAN BINST.

- ISDN Joint Meeting CEPT/CEC/European Industry
  (Brussels - Belgium)
  P. VAN BINST.

- RARE European Networkshop
  (Valencia - Spain)
  P. VAN BINST.

- TENCON 87, IEEE Region 10 Conference
  (Seoul - South Korea)
  P. VAN BINST.

- 4th ESPRIT Conference
  (Brussels - Belgium)
  P. VAN BINST.

- Symposium on Computer Networks in Belgium
  (Namur - Belgium)
  P. VAN BINST.

- COSINE Workshop
  (Brussels - Belgium)
  P. VAN BINST.

- 9ème Journées Francophones sur l'informatique
  (Liège, Belgium)
  T. MASSART.

- DECUS Europe Symposium
  (Rome, Italy)
  P. VAN BINST, R. VANDENBROUCKE.

- DECUS US Spring Symposium
  (Nashville, USA)
  R. VANDENBROUCKE.

- Frontiers in Computing Conference
  (Amsterdam - Netherlands)
  P. VAN BINST.

- CERN-JINR School of Physics
  (Varna - Bulgaria)
  K. DE WINTER and F. STICHELBAUT.

- Bull courses "Temps réel SPART" and "Système SPART"
  (Trappes - France)
  Th. MASSART.

- DEC courses "VAX/VMS Utilities and Commands" and "VAX System Use"
  (Brussels - Belgium)
  W. VAN DROOGENBROECK.

S. TAVERNIER, in collaboration with Professor F. DE CONINCK (VUB) has organized an International Symposium on Wire Chambers in Medical Imaging (Corsendonk - Belgium).

## IX. LIST OF PUBLICATIONS AND CONTRIBUTIONS TO CONFERENCES.

### IX.1. Publications.

1. "Spin Alignement of $\rho^0$ Mesons Produced in Antineutrino and Neutrino Neon Charged-Current Interactions"
W. WITTEK ... D. BERTRAND, P. MARAGE, J. SACTON ...
Physics Letters 187B - 179 - 1987.

2. "Coherent Production of $\rho^-$ Mesons in Charged Current antineutrino-Neon Interactions in BEBC"
P. MARAGE ... D. BERTRAND, J. SACTON ...
Z. Phys. C, Particles and Fields 35 - 275 - 1987.

3. "Measurement of the Structure Functions $F_2$ and $xF_3$ and Comparison with QCD Predictions Including Kinematical and Dynamical Higher Twist Effects"
K. VARVELL ... D. BERTRAND, P. MARAGE, J. SACTON ...
Z. Phys. C, Particles and Fields 36 - 1 - 1987.

4. "A Study of the EMC Effect Using Neutrino and Antineutrino Interactions in Neon and Deuterium"
J. GUY ... D. BERTRAND, P. MARAGE, J. SACTON ...
Z. Phys. C, Particles and Fields 36 - 337 - 1987.

5. "Suppression of Valence-Quark Recombination in $\pi^+$ Fragmentation in $\rho^+$"
M. ADAMUS ... A. DE ROECK, E.A. DE WOLF, B. MICHALOWSKA, F. VERBEURE ...
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- "Low $p_T$ Physics with EHS"
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- "Quark Fragmentation in Soft $K^+p$ Collisions at 250 GeV/C"
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