

INTER-UNIVERSITY INSTITUTE FOR HIGH ENERGIES

ULB-VUB, BRUSSELS - ANNUAL REPORT 1981.

J. Lemonne and J. Sacton,  
January 1982.

I. INTRODUCTION.

The physicists whose names are listed below have contributed to the different activities of the Laboratory during the year 1981.

U.L.B.

M. Barth (Maître de recherche FNRS)  
D. Bertrand (chercheur qualifié FNRS)  
G. Bertrand-Coremans (Chef de travaux associé)  
M. Dewit (chercheur agréé IISN up to October 1981)  
J.J. Dumont (chercheur agréé IISN)  
P. Marage (boursier IRSIA)  
H. Mulkens (chercheur agréé IISN - CERN fellow working on the UA5 experiment)  
J. Sacton (Professeur associé)  
P. Van Binst (chercheur IISN)  
P. Vilain (chercheur qualifié FNRS)  
J. Wickens (chercheur IISN)  
G. Wilquet (chercheur qualifié FNRS - at CERN for the UA5 experiment)  
C. Wilquet-Vander Velde (Chef de travaux associé - CERN fellow working on the R607 experiment).

V.U.B.

C. De Clercq-Vincent (vorser IIKW)  
M. Gysen (vorser IIKW - CERN fellow since August 1981)  
D. Johnson (vorser IIKW)

J. Lemonne (Gewoon hoogleraar)  
 J. Moreels (vorser IIKW)  
 P. Peeters (werkleider - on private leave since October 1981)  
 R. Roosen (bevoegdverklaard navorser NFWO)  
 S. Tavernier (bevoegdverklaard navorser NFWO)  
 P. Theocharopoulos (vorser IIKW since July 1981)  
 W. Van Doninck (bevoegdverklaard navorser NFWO)  
 G. Vanhomwegen (vorser IIKW).

F. Verbeure, E. De Wolf and M. Van Immerseel from the UIA are working in close collaboration with the Institute. J. Gaudaen (UIA) is working at CERN on the experiment UA5.

## II. RESEARCH.

### II.1. Neutrino Physics.

#### II.1.1. Gargamelle (WA15 experiment)

(D. Bertrand, G. Bertrand-Coremans, M. Dewit and P. Vilain - Aachen, Bergen, Brussels, CERN, Milano, Strasbourg, Univ. Coll. London Collaboration).

The  $Q^2$  dependence (measured in the range  $0.5 < Q^2 < 50 \text{ (GeV/c)}^2$ ) of the non-singlet part of the structure functions  $F_2(x)$  and  $x F_3(x)$  has been determined from the analysis of 3000  $\nu$  and 3800  $\bar{\nu}$  interactions; it is well described by QCD, in leading order using the Altarelli-Parisi equations and in next-to-leading order by applying methods of Bialas and Buras or Gonzales-Arroyo, Lopez and Yndurain. Contributions from operators with twist higher than two are not necessary but cannot be excluded. If target mass corrections are applied, the data are well described by pure scaling in the variable

$$\xi = \frac{2x}{1 + \sqrt{1 + 4 \frac{M^2 x^2}{Q^2}}}$$

This analysis will be discussed in details in the Ph D thesis of M. Dewit.

### II.1.2. $\nu$ and $\bar{\nu}$ interactions in BEBC equipped with an $H_2$ filled track sensitive target and an EMI (WA24 experiment)

(D. Bertrand, J. Moreels, J. Sacton, W. Van Doninck, G. Wilquet and C. Wilquet-Vander Velde - Bari, Birmingham, Brussels, CERN, Ec. Pol. -Palaiseau, Rutherford, Saclay and University College London Collaboration).

The ratio  $R^{\bar{\nu}}$  of the charged current interaction cross sections of antineutrinos on neutrons and protons has been measured using a flux independant method :  $R^{\bar{\nu}} = 0.74 \pm 0.14$ . The corresponding ratio for neutrinos had been measured previously in the same experiment to be  $1.98 \pm 0.19$ . The x dependence of  $R^{\nu}$  and  $R^{\bar{\nu}}$  has been studied. Distributions functions for valence and sea quarks will be deduced under various assumptions.

Different statistical methods have been used to select  $\nu$  and  $\bar{\nu}$  neutral current interactions occurring on hydrogen. As a result a preliminary value of  $0.53 \pm 0.05 \pm 0.03$  has been obtained for the ratio of the neutral to charged current interaction cross sections of neutrinos on protons.

### II.1.3. High statistics experiment to measure the nucleon structure functions using $\nu$ and $\bar{\nu}$ interactions in BEBC filled with heavy neon (WA59 experiment)

(D. Bertrand, G. Bertrand-Coremans, P. Marage, J. Sacton and W. Van Doninck - Athens, Bari, Birmingham, Brussels, CERN, Ec.

Pol.-Palaiseau, Imperial College London, University College London, Munich, Oxford, Rutherford, Saclay Collaboration).

Some 12000 antineutrino charged current interactions ( $p_{\mu^+} > 5 \text{ GeV}/c$ ;  $E_{\bar{\nu}} > 10 \text{ GeV}$ ) have been measured. The hadronic shower of these events is presently under study : charged particle multiplicities and related parameters, rapidity distributions, fragmentation functions and higher twist effects. The importance of reliable energy determination and particle identification in these studies has been stressed.

A first lot of some 4000 neutrino interactions will be available soon so that the structure functions studies, the main aim of the experiment, should start early in 82.

#### II.1.4. Neutrino oscillations

(G. Bertrand-Coremans, H. Mulkens, J. Sacton, C. Vander Velde-Wilquet and W. Van Doninck - Bari, Birmingham, Brussels, U.C. London, Ecole Polytechnique-Palaiseau, Rutherford, Saclay Collaboration).

A total of  $110 \pm 13$   $\nu_e$  events (corrected for losses and backgrounds) with energy greater than 10 GeV has been identified and measured in BEBC filled with a 74 mole %  $H_2/Ne$  mixture and exposed to the 350 GeV wide band neutrino beam of the SPS. The ratio of seen to expected (from flux) numbers of events is  $1.21 \pm 0.19$  consistent with the assumption of  $\mu$ -e universality. The kinematical distributions of the  $\nu_e$  events are well described by a Monte Carlo calculation using this assumption, the predicted  $\nu_e$  momentum distribution and the Field-Feynman parametrization of the nucleon structure functions. From these distributions and the observed rate of events improved limits have been set on  $\nu_e \rightarrow \nu_x$ ,  $\nu_\mu \rightarrow \nu_e$  and  $\nu_\mu \rightarrow \nu_\tau$  mixings.

#### II.2. Hadron Physics.

##### II.2.1. $K^+p$ and $\bar{p}p$ interactions at 32 GeV/c in Mirabelle

(M. Barth, E. De Wolf, J.J. Dumont, M. Gysen, M. Van Immerseel, F. Verbeure - Brussels, Mons, Serpukhov Collaboration).

The data analysis of the  $\bar{p}p$  experiment, which concerned only events with hadronic  $V^0$ 's, is finished since last year. The physics analysis has led to the publication of results on inclusive boson resonances and  $\gamma(\pi^0)$  production.

Scanning, measuring and data processing has continued for the extended  $K^+p$  experiment. The final sample of pictures (960K) was obtained during the last Mirabelle  $K^+$  exposure in April 1981. At the IIHE, the technical analysis will continue during the first half of 1982. Serpukhov will terminate its part

for the end of 1982. Together with the  $\sim 110.000$  measured events of all topologies, the final statistics will consist of about 30.000, 4.500 and 2.500 events with unambiguously identified  $K_S^0$ ,  $\Lambda$  and  $\bar{\Lambda}$ , respectively.

During 1981, results were published on the following subjects :

- inclusive  $\rho^0$  and  $\phi$  production
- inclusive  $K^{*+,0}(890)$  production
- a comparison of  $\Delta^{++}(1232)$  and  $\Sigma^+(1385)$  production mechanisms
- a systematic study of hadronic fragmentation processes in  $K^\pm p$  and  $p\bar{p}$  interactions at 32 GeV/c in the frame work of quark counting rules
- a study of two-particle fragmentation processes and their analysis in terms of quark-recombination models.

Several other papers were submitted to Conference and accepted for publication. They concern :

- a comparison of strange antibaryon and strange meson production ( $\bar{\Lambda}$ ,  $K_S^0$ ), ( $\bar{\Sigma}^*$ ,  $K_{890}^*$ ) testing hypotheses about  $\bar{s}$ -valence quark fragmentation/recombination processes
- a comparison study of the tensor and vector mesons  $K^{*+,0}(1430)$ ,  $f(1270)$  and  $K^{*+,0}(892)$ ,  $\rho^0$ .
- a detailed analysis of proton and  $K^+$  fragmentation into resonant and non-resonant particle systems
- production of resonances in association with a large  $|x|$  particle or resonance "trigger".

The last two subjects have, for the first time, provided clear, discriminating tests of the existing models. In particular, it appeared that the popular quark-recombination model is in strong disagreement with our data. If confirmed by other experiments at higher energies, this would imply that the mechanism initiating the (soft) interaction among hadrons is of the type suggested by dual-sheet or fragmentation models. These models then establish a connection between quark fragmentation processes in low  $p_T$  collisions and the hadronization of partons in deep-inelastic reactions initiated e.g. by leptons.

### II.2.2. The $K^+p$ experiment at 70 GeV/c (WA27 experiment)

(M. Barth, C. De Clercq, E. De Wolf, J.J. Dumont, M. Gysen, D.P. Johnson, J. Lemonne and P. Peeters - Brussels, CERN, Mons, Nijmegen and IHEP (USSR) Collaboration).

The technical work related to this experiment (scanning and measurement of  $\sim 80000$  events registered in  $\sim 160000$  frames) has been completed by the collaboration. New results have been published or presented at conferences concerning :

- (i) the inclusive and semi-inclusive production of  $\Lambda(\bar{\Lambda})$  particles, with a study of their polarization. Between 32 and 70 GeV/c, the production of  $\Lambda(\bar{\Lambda})$  particles is scale invariant in the fragmentation regions. However, the cross section for  $\Lambda\bar{\Lambda}$ -pair production increases significantly in this momentum interval
- (ii) the inclusive production of  $K_s^0$ -mesons.

The rapid increase with incident momentum observed for the cross section of  $K^0$ -particles is also due to multi-kaon reactions. The Feynman-x distribution of  $K^0$ 's has been studied in the framework of recombination and fragmentation models.

- (iii) the production of vector ( $K^{*}(892)$ ,  $(770)$ ) and tensor mesons.

Spin density matrix elements have been determined for  $K^{*+}$  and  $K^{*0}$ -production and the results have been interpreted in terms of the quark parton-dynamics.

- (iv) the "jet-like properties" of the many particle systems produced. A detailed comparison of jets produced in  $e^+e^-$  annihilations and in deep inelastic  $\nu$ -N interactions revealed the existence of several close analogies.

- (v) the forward distribution of identified charged particles and the net charge and strangeness rapidity distributions of beam fragments. For this purpose, the External Particle Identifier (EPI) was used to separate  $\pi^+$  and  $K^+$  mesons emitted in the forward region.

II.2.3. The study of prompt lepton production and ordinary hadronic interactions in antiproton-proton interactions at 70 GeV/c in BEBC equipped with a track sensitive target (WA31 experiment)

(J. Lemonne, G. Van Homwegen, F. Verbeure, J.H. Wickens - Brussels Helsinki, Liverpool, Mons and Stockholm Collaboration).

A search for directly produced electrons in 70 GeV/c  $\bar{p}p$  interactions has been performed using BEBC equipped with a hydrogen filled track sensitive target surrounded by a hydrogen/neon blanket. No candidates for single electron production with momentum  $p_e > 500$  MeV/c were found in a sample of 66.000 primary interactions. This result places an upper limit of 2.5  $\mu\text{b}$  on the cross section for single  $e^\pm$  production at the 90 % confidence level. The corresponding upper limit on the charmed particle production cross section is 14  $\mu\text{b}$ . From the observation of 7 events producing an  $e^+e^-$  pair with mass  $m_{e^+e^-} > m_0$  the  $e^\pm/\pi^\pm$  ratio from this source is estimated to be  $\frac{e^\pm}{\pi^\pm} (0.7 \pm 0.2) \times 10^{-4}$ .

The topological cross section for  $\bar{p}p$  interactions at 70 GeV/c were measured in the same film and the moments of the inelastic multiplicity distribution are  $\langle n_c \rangle = 6.16 \pm 0.09$ ,  $\langle n_c \rangle / D = 2.04 \pm 0.05$  and  $f_2^{cc} = 2.97 \pm 0.03$ . The average number of Dalitz pairs per inelastic event is  $(3.12 \pm 0.09) \times 10^{-2}$ . Assuming that these all arise from  $\pi^0$  decay the average  $\pi^0$  multiplicity is  $\langle n_{\pi^0} \rangle = 2.71 \pm 0.14$ . The  $\bar{p}p - pp$  cross section differences lead to an annihilation cross section  $\sigma_A = 4.42 \pm 0.41$  mb. An independent check of  $\sigma_A$  was made by investigating fast forward charged and neutral secondary interactions in the TST and in the surrounding neon-hydrogen mixture, and gives a value  $\sigma_A = 5.0 \pm 1.6$  mb. The ratio of fast  $\bar{n}$  to  $\bar{p}$  production in non-annihilation interactions at 70 GeV/c is found to be  $0.45 \pm 0.11$ .

Serpukhov has now joined the collaboration to study inclusive  $\Lambda^0$ ,  $K_S^0$  and  $\gamma(\pi^0)$  production.

#### II.2.4. Study of the hadronic production and of the decay of charmed particles (NA16 experiment)

(G. Bertrand-Coremans, J. Lemonne, S. Tavernier, M. Van Immerseel, P. Vilain, J.H. Wickens - Amsterdam, Brussels, CERN, Madrid, Mons, Nijmegen, Oxford, Padova, Paris VI, Rome, Rutherford, Serpukhov, Stockholm, Trieste and Vienna Collaboration).

This experiment has been performed in the mini-bubble chamber LEBC in combination with a preliminary version of the European Hybrid Spectrometer (EHS). The chamber was exposed to  $\pi^-$ -mesons ( $\sim 650.000$  frames) and protons ( $\sim 650.000$  frames) with a momentum of 360 GeV/c. The technical analysis (scanning and measurement) of the film attributed to the IIHE is completed. This will be the case for the entire collaboration in the spring of 1982. A study of the final event sample (corresponding to  $\sim 900.000$  useful frames) will then be performed. Preliminary results derived from the analysis of  $\sim 50\%$  of the  $\pi^-$  film and of  $\sim 15\%$  of the proton film have been reported in conferences. These initial studies are based on the analysis of 21 fully reconstructed decays of charmed mesons. The results are :

a) Lifetimes :

$$\tau(D^\pm) = (8.0^{+4.9}_{-2.4}) \times 10^{-13} \text{ s}$$

$$\tau(D^0) = (3.2^{+2.2}_{-1.0}) \times 10^{-13} \text{ s}$$

b) Production characteristics in  $\pi^-p$  interactions :

$$\frac{dN}{dx_F} \div (1 - |x_F|)^n \quad \text{with } n = 3.2 \pm 1.0 \text{ for } x_F > 0$$

$$\langle p_T \rangle = 780 \text{ MeV/c}$$

Average charm pair rapidity gap

$$\langle \Delta y \rangle = .4$$

c) Inclusive cross sections for  $\pi^-p$  at 360 GeV/c ( $x_F \geq 0$ )

$$\sigma(D^\pm) = 12.5 \pm 5. \text{ } \mu\text{b}$$



$$\sigma(D^0) \simeq \sigma(D^{\pm})$$

II.2.5. Study of the hadroproduction of charmed particles using the CERN holographic heavy liquid bubble chamber HOBC (NA25 experiment)

(M. Barth, R. Roosen and S. Tavernier - Bari, Brussels, CERN, U.C. London, Mons, Paris, Strasbourg, Vienna Collaboration).

Holography in bubble chambers is expected to provide spatial resolution of the order of  $10\text{ }\mu\text{m}$ , allowing the detection of particles with lifetimes down to  $10^{-13}\text{ s}$ . The pilot NA25 experiment aims to estimate the possibilities and limitations of holography in the study of charmed particle production in hadron interactions at high energies. To reduce the scanning effort a restrictive muon trigger should be applied, the chamber being placed in front of the muon filter used in the NA19 experiment.

In summer 1981 the CERN holographic heavy liquid bubble chamber HOBC was tested with a low intensity beam at the P.S. During these tests charged particle tracks were observed with  $10\text{ }\mu\text{m}$  diameter bubbles and with a density of 200 bubbles/cm. With such a low intensity - less than one track per expansion on average - a cycling rate of 10 Hz was seemingly possible. During these tests a modified in line holographic method using relay optics, which seems particularly appropriate to small bubble chambers, was successfully tried.

In September HOBC was installed at the SPS in the H2 beam. There, the chamber was tested in a high intensity beam equipped with a kicker magnet. In this run  $\sim 10.000$  interaction triggered holograms, and 1150 muon triggered holograms were recorded. These data should allow to prove that it is possible to produce and analyse holograms.

Considerable experience with hologram scanning has been gained. Among the  $\mu$ -triggered holograms some events with the correct topology for associated charm decays were found showing that it is possible to detect decays occurring at short distances and with small decay angles.

During these tests an effect was observed which seriously limited cycling rate if one wanted to maintain a 10  $\mu\text{m}$  resolution. The time needed to dissipate the heat produced by the recompression of the bubbles was found to be of the order of 1 sec. Before their disappearance, these local hot spots in the chamber produce turbulences which limit the data taking frequency to about 1 Hz.

From theoretical study of the operating conditions in bubble chambers it follows that the chamber should be operated at a temperature close to the critical one. Indeed, as at higher temperatures the speed of the bubble growth is smaller  $\lambda$ , out of time tracks will be less disturbing.

Further tests are expected for the beginning of 1982 and data taking could occur in the autumn.

#### II.2.6. Search for $B\bar{B}$ production in 370 GeV/c $\pi^-$ meson interactions in nuclear emulsion (NA19 experiment)

(M. Barth, D. Bertrand, G. Bertrand-Coremans, R. Roosen, J. Sacton and J.H. Wickens - Bari, Brussels, CERN, U.C. Dublin, U.C. London, Open University, Rome and Turin Collaboration).

Some  $10^9$   $\pi^-$  mesons of 370 GeV/c momentum were sent in 65 emulsion stacks ( $\sim 50$  l in total) located in front of a muon filter in an attempt to produce B particles which would be identified via the detection of their muonic decays into charmed particles which in turn decay semileptonically. Upstream of the emulsion, a set of centroid chambers was used to locate the incoming  $\pi^-$  meson within 100  $\mu\text{m}$ . A small vertex detector was placed between the emulsion stacks and the muon filter to help in the location of the muon triggered interactions. Some 150 candidates containing 3 muons have been selected of which about one half has been searched in the emulsion. No example of the associated production of B and  $\bar{B}$  particles has been observed yet. This result is not in contradiction with recent estimates for the  $B\bar{B}$  production cross sections, all below 50 nb.

### II.2.7. $\bar{p}p$ collisions at the ISR (R703T experiment) and the Collider (UA5 experiment)

(D. Bertrand, J. Gaudaen, M. Gysen, D. Johnson, H. Mulken, G. Wilquet - Bonn, Brussels, Cambridge, CERN, Stockholm Collaboration).

The UA5 experiment is devoted to an exploratory study of the first  $\bar{p}p$  collisions at very high energy ( $\sqrt{s} = 540$  GeV) observed at the CERN collider with low luminosity beams ( $\mathcal{L} \sim 10^{25} - 10^{26} \text{ cm}^{-2} \text{ s}^{-1}$ ).

The apparatus consists of two long streamer chambers, placed above and below the beam pipes. Both chambers are viewed by 3 cameras through image intensifiers, each producing a stereo pair. The chambers are equipped, both across the beam directions and side ways by lead glass plates to convert photons. The trigger system consists of six planes of scintillator hodoscopes : two along each of the beam directions and one on each side of the chambers.

The apparatus has first been installed for development and tests at the ISR where data from both  $pp$  and  $\bar{p}p$  collisions have been collected during Easter 1981 at  $\sqrt{s} = 53$  GeV with extremely low luminosities,  $\sim 2-8 \cdot 10^{24} \text{ cm}^{-2} \text{ s}^{-1}$  (experiment R703T).

A total of 3600  $pp$  and 4000  $\bar{p}p$  events have been measured. Although their analysis is not completely finalised, two main following conclusions may be drawn :

- the  $pp$  data agrees very well with the results of an earlier ISR experiment<sup>(2)</sup> after correction for trigger and software efficiencies and for apparatus acceptance,
- the comparison of their pseudorapidity and the multiplicity distributions indicates that  $\bar{p}p$  and  $pp$  interactions do not differ by more than  $\sim 2\%$ .

The UA5 equipment has been installed at the Collider during summer and pictures of about 16000  $\bar{p}p$  interactions have been taken during two test Collider periods in late October and November. First results based on 350 events involving about 17000 tracks have been obtained. They only concern non-

diffractive inelastic production, as diffractive and elastic interactions have an extremely low trigger efficiency. They show the main following features, based on a pseudorapidity range of  $|\eta| < 5$  :

- the average value of the central rapidity density is  $3.0 \pm 0.1$  while the FWHM of the  $\eta$  distribution has grown by 2 units from the ISR energy ( $\sqrt{s} = 53$  GeV) to the Collider energy ( $\sqrt{s} = 540$  GeV),
- a conventional cylindrical phase space model could accommodate the  $\eta$  distribution if the  $\langle p_t \rangle$  is increased from  $\sim 350$  to  $\sim 500$  MeV/c over the same energy range,
- the parametrization  $\langle n_{ch} \rangle = a + b \ln s + c \ln^2 s$ , when extrapolated from the ISR energies, predicts a mean charged multiplicity of  $\sim 25$ , in agreement with our observed value of  $27.4 \pm 2.0$ ,
- the charged multiplicity distribution is compatible with KNO scaling; more data are needed in the high multiplicity tail to definitely confirm this hypothesis or, conversely, observe new phenomena in particle production at very high energies.

### II.3. Participation to EHS.

A calibration system for the Silica Aerogel Detector (SAD) using muons from the  $h_2$  beam halo was built, tested and implemented. The software to control and calibrate the detector was rewritten to adapt it to the global EHS data acquisition system running on a Nord 100 computer.

The detector SAD is now completely finished and available to the EHS users. It was used for the first time in the experiment NA23.

### III. SEMINARS AND LECTURES.

- The practical work for students attending the lectures of J. Lemonne and J. Sacton (3rd and 4th year in physics) has been organized by the staff of the Institute as well as some optional practical work for students of the 3rd year in physics.

- P. Van Binst has given the following lectures at the ULB :  
 "Notions pratiques d'informatique" (Faculté des Sciences)  
 "Introduction à l'informatique" et "Informatique (pratique)"  
 (Licence en Informatique et Sciences Humaines, Centre Régionale Wallon, ULB, Nivelles).
- M. Gysen has obtained his PhD (Experimental aspects of  $K^+p$  interactions at an incident momentum of 32 GeV/c).
- G. Vanhomwegen has obtained his PhD (Contribution to the study of elastic and diffractive processes in  $K^-d$  and  $K^-n$  interactions at 4.5 GeV/c).
- C. De Clercq has obtained her PhD (A contribution to the study of inclusive and exclusive processes in  $K^-p$  interactions at 6.5 GeV/c).
- One student of the ULB has done her "mémoire" at the IIHE :  
 Jacqueline, Vu Ngoc Kim : "Contribution à l'étude de particules charmées produites par interactions hadroniques".
- J. Sacton has presented a paper at the Europhysics Study Conference on the Search for Charm, Beauty and Truth at High Energies, Erice : "Photographic emulsion versus bubble chambers in Charm and Beauty searches".
- D. Bertrand has presented a paper at the Tristan Physics Workshop, KEK : "Preliminary results from ISR  $\bar{p}p$  experiment".
- G. Vanhomwegen has presented a paper at the European Hybrid Spectrometer Workshop, Strasbourg : "Study of transverse and longitudinal spatial resolution in holography".
- J. Lemonne presented two papers at the XVth Rencontre de Moriond (March 21-27) entitled :  
 "A search for single  $e^\pm$  production in  $\bar{p}p$  interactions at 70 GeV/c"  
 "Observation of a fully reconstructed  $D^0\bar{D}^0$  pair with long lifetimes in a high resolution hydrogen bubble chamber at the European Hybrid Spectrometer".
- E. De Wolf presented a paper at the XIIth International Symposium on Multiparticle Dynamics, Notre Dame : "Multiparticle fragmentation in  $K^+p$  32 GeV/c interactions".

- E. De Wolf presented a paper at the Europhysics Study Conference on Soft interactions, Erice : "Comments on fragmentation models".
- E. De Wolf has given a talk in the CERN Particle Seminars, June 1981 : "Jets and quark parton models in soft hadron interactions".
- The following talks were presented at the Annual Scientific Meeting of the Belgian Physical Society, K.U. Leuven, June 81 :

M. Dewit : Measurement and analysis of the nucleon structure functions from  $\nu$  and  $\bar{\nu}$  interactions in the  $Q^2$  range 0.5 to 50 (GeV/c)<sup>2</sup>.

G. Vanhomwegen : A study of the reaction  $K^- d \rightarrow K^- \pi^+ \pi^- n$  ( $p_s$ ) at 4.5 GeV/c.

J. Moreels : Measurement of the ratio of the total and differential cross sections on n and p for charged current  $\nu$  and  $\bar{\nu}$  interactions.

W. Van Doninck : Limits on  $\nu$  oscillations from a study of  $\nu_e$  charged current interactions.

- In the framework of the Seminars on Elementary Particles at the IIHE :

J. Haissinski (Orsay) : Mise en oeuvre de Cello sur PETRA.

A. Bohm (Aachen) : Experimental tests of electro weak interactions at PETRA.

J. Sacton : Charm and Beauty : experimental review after the 1981 cycle of conferences.

D. Johnson : Preliminary results from the UA5 experiment at the ISR.

W. Van Doninck : Deep inelastic lepton-nucleon scattering (Summary of Bonn and Lisbon Conferences).

P. Vilain :  $e^+e^-$  interactions (Summary of Bonn and Lisbon Conferences).

K. Lubelsmeyer (Aachen) : Inclusive Hadron Production at TASSO.

E. De Wolf : Recent results in hadron collisions.

D.C. Colley (Birmingham) : Photoproduction of charmed particles at 20 GeV using the SLAC hybrid facility.

H. Mulkens (CERN) : First results of the UA5 experiment at the CERN  $p\bar{p}$  Collider.

A. Tenner (Amsterdam) : Study of neutrino interactions in BEBC filled with  $D_2$ .

#### IV. COMPUTERS AND DATA PROCESSING.

The data processing tasks are split between the IIHE computers and the ULB-VUB Computer Centre.

The IIHE computers are under the management of P. Van Binst, assisted by R. Vandenbroucke. The main event in 1981 was the installation of a new mainframe in the laboratory, namely a DEC system 2060, running the same operating system and software as the previous DEC system 10. This last one is still operating but its configuration has been very much reduced in order to support a limited number of applications, among which the control of the POLLY film reader. The new computer offers much increased power and reliability; its configuration includes 1600 bpi tape drives. The installation took place during the holiday period; all applications were quickly and easily transferred to the new system, including the support of the locally-developed link with the PDP-11 minicomputers.

The software relative to the SWEEPNIK film reader, running on one of the PDP-11's, has been extensively modified by R. Vandenbroucke to fit the requirements of the UA5 streamer chamber experiment. A colour graphic display has been included in this configuration; the associated executive and application softwares were developed and implemented successfully.

An old ENETRA measuring machine has been modified to direct its output, via a Zilog Z80 microprocessor, to the DEC system 10, instead of using paper tape. This microprocessor application was essentially under the responsibility of L. Etienne.

The electronics of a table for analysis of holographic films are based on a MIK-11 microcomputer, including a LSI-11 microprocessor, which is linked to the DEC system 20. These developments are by J.J. Dumont and R. Goorens.

All physicists, programmer and engineers constantly participate in the development and implementation of various application software.

The field of data communications and computer networks is being actively studied by P. Van Binst and R. Vandembroucke in order to provide the laboratory with such facilities in the years to come.

#### V. TECHNICAL AND ADMINISTRATION WORK.

- The following work has been accomplished by the technical staff of the workshop (J.F. De Wulf, L. Etienne, R. Gindroz, R. Goorens, E. Lievens, J. Muller, R. Ruidant, G. Van Beek, J. Van Begin, R. Vanderhaegen, L. Van Lancker, G. Vincent, Ch. Wastiels) :
  1. Maintenance of the scanning and measurement devices of the IIHE.
  2. Realisation of a scanning-measuring device for holographic film with a direct projection on a table and a TV image controlled by a microprocessor.
  3. Modification of an old ENETRA measuring machine, in order to perform measurements on a television screen under the on-line control of the DEC-10 computer.
  4. Realisation of a new optical projection for the Sweepnik device together with a superposition of a graphic to the TV image.
  5. Transfer of the Mangia Spago from a Gargamelle table to a Bessic table.
  6. Realisation of super fast routers for mini drift chambers to be used in the EHS facility at CERN.
  7. Calibration of the aerogel Cerenkov counters of the SAD-EHS device.



8. Final installation of the fast cycling cameras of CERN collider UA5 experiment.

9. Study of a semi-automatic device for track measuring in nuclear emulsion.

In performing the 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.

- The scanning and measurement team of the Institute consisted of: C. Carlier, J. De Bruyne, A. De Coster-Van Gauwenberge, L. De Langhe, M. Delasorte, J. De Schutter-Gevers, M. De Schutter, Cl. Donis, M. Dumont, J. Du Mortier-Liesen, M.P. Galloy-Kips, Ch. Garnier-Stoffen, M. Goeman, R. Kelders, D. Legrand-Mahaux, D. Luybaert-Peymans, M. Pins, R. Pins, D. Pirnay-Pauwels, M.L. Ronsmans, J. Thys-Raynaerd, M.L. Van Dale-Ollier, L. Martens, M. Van Mechelen-Paulus, L. Vermeersch-Polderman, A. Vermijlen-Pels, Cl. Vorstermans-Hennebert.
- The secretarial work was accomplished by R. Lecluse-Alluyn and M. Van Doninck-Garnier.

## VI. REPRESENTATION IN COUNCILS AND COMMITTEES.

J. Lemonne has been one of the Belgian representatives in the CERN Council. He was invited to attend the meetings of the CERN-Scienty Polity Committee as an observer. J. Sacton has acted as a member of the SPS Committee at CERN. 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. P. Van Binst is a member of the board of the Computational Physics Group of the European Physical Society and of ECFA Working Group on Data Processing Standards, Subgroup "Links and Networks".

# VII. ATTENDANCE TO CONFERENCES AND SCHOOLS.

- J. Sacton and G. Bertrand-Coremans have attended the XVIth Rencontre de Moriond on Perturbative QCD and Electroweak Interactions, March 81.
- J. Lemonne attended the XVIth Moriond meeting on "Low  $Q^2$ -Physics, March 81.
- J. Sacton has attended the International Conference on Neutrino Physics and Astrophysics-Neutrino 81, Hawaii, July 81.
- J. Sacton and W. Van Doninck have attended the 1981 International Symposium on Lepton and Photon Interactions at High Energies, Bonn, August 81.
- J. Sacton has attended the Workshop on Physics and Astrophysics with a multikiloton modular underground track detector, Rome, October 81.
- J. Sacton, G. Bertrand-Coremans and R. Roosen have attended the Europhysics Study Conference on the Search for Charm, Beauty and Truth at High Energies.
- J. Lemonne and J. Wickens have attended the General Meeting on LEP organized at Villars-sur-Ollon (June 81) by ECFA.
- P. Vilain, J.J. Dumont and M. Gysen have attended the International Conference on High Energy Physics at Lisbon, July 1981.
- D. Bertrand has attended the Tristan Physics Workshop at KEK-Japan, November 81.
- J. Lemonne, S. Tavernier and G. Vanhomwegen have attended the European Hybrid Spectrometer Workshop on Holography and High Resolution Techniques, Strasbourg, November 81.
- E. De Wolf, S. Tavernier and F. Verbeure attended the XIIth International Symposium on Multiparticle Dynamics, Notre Dame, June 81.
- P. Van Binst has attended :  
Decus Europe Symposium, Hambourg  
DECUS Holland Symposium, Utrecht, and various BENELUG meetings  
Europhysics Conference on Vector and Parallel Processors, Chester

EPS Computational Physics Group Board meetings, Delft and Chester

ECFA Working Group on Data Processing Standards, Subgroup "Links and Networks" meeting, CERN

Congrès International Informatique et Sciences Humaines, Liège

SWEEPNIK Users Group meeting, Paris

IEEE Benelux Section Symposium on Software Engineering, Liège

Congrès de l'Association Belge des Utilisateurs de Télécommunications, Bruxelles.

- P. Marage and J. Moreels have attended : La 13ème Ecole d'Eté de Physique des Particules, Gif s/Yvette, September 1981.

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

LISTE DES PUBLICATIONS.

- "Limits on Neutrino Oscillations from a Study of  $\nu_e$  Charged Current Interactions"  
O. ERRIQUEZ .... G. BERTRAND-COREMANS, H. MULKENS, J. SACTON,  
C. VANDER VELDE-WILQUET ...  
Physics Letters 102B - 73 - 1981.
- "Measurement of the Ratio of Total and Differential Cross Sections on Neutrons and Protons for Charged-Current Neutrino Events"  
N. ARMENISE ... J. SACTON, C. VANDER VELDE-WILQUET, G. WILQUET  
Physics Letters 102B - 374 - 1981.
- "Total Cross Sections and Nucleon Structure Functions in the Gargamelle SPS Neutrino/Antineutrino Experiment"  
J. MORFIN ... D. BERTRAND, G. BERTRAND-COREMANS, M. DEWIT, P. VILAIN  
Physics Letters 104B - 235 - 1981.
- "Inclusive Hadronic Fragmentation in  $K^+p$  Interactions at 32 GeV/c and Counting Rules"  
D. DENEGRÉ ... M. BARTH ...  
Physics Letters 98B - 127 - 1981.
- "Coherent Production of the  $K^-\pi^+\pi^-$  System in  $K^-d$  Interactions at 4.5 GeV/c"  
C. DE CLERCQ .... J. WICKENS ....  
Particles and Fields 7 1 - 1981.
- "Slow Proton and  $\Delta^{++}$  Production in  $K^+p$  Interactions at 70 GeV/c"  
M. BARTH, J.J. DUMONT ....  
Particles and Fields 7 - 89 - 1981.
- "Charged Pion Production in 70 GeV/c  $K^+p$  Interactions"  
M. BARTH, J.J. DUMONT ...  
Particles and Fields 7 - 187 - 1981.
- "Inclusive  $\gamma$  and  $\pi^0$  Production in  $\bar{p}p$  Interactions at 32 GeV/c"  
C. POIRET .... M. BARTH ...  
Particles and Fields 7 - 283 - 1981.

- "Observation of a Fully Reconstructed  $D^0\bar{D}^0$  Pair with Long Proper Lifetimes in a High Resolution Hydrogen Bubble Chamber and the European Hybrid Spectrometer"  
B. ADEVA ... G. BERTRAND-COREMANS, P. VILAIN, J. WICKENS ...  
Physics Letters 102B - 285 - 1981.
- "Exclusive Reactions in  $\bar{p}p$  Interactions at 32 GeV/c"  
M.A. JABIOL ... M. BARTH ...  
Nuclear Physics B183 - 330 - 1981.
- "Jet-Like Properties of Multiparticle Systems produced in  $K^+p$  Interactions at 70 GeV/c"  
M. BARTH, J.J. DUMONT ...  
Nuclear Physics B192 - 289 - 1981.
- "Systematics of Exclusive Diffractions Dissociations Modes in  $K^+p$  Interactions at 32 GeV/c"  
A. GIVERNAUD ... M. BARTH ...  
Particles and Fields 8 - 291 - 1981.
- "Two-Particle Production in  $K^+p$  Interactions at 32 GeV/c"  
E.A. DE WOLF, J.J. DUMONT ...  
Particles and Fields 8 - 189 - 1981.
- "Inclusive  $\Lambda$  and  $\bar{\Lambda}$  Production in  $K^+p$  Interactions at 70 GeV/c"  
M. BARTH, J.J. DUMONT ...  
Particles and Fields 10 - 205 - 1981.
- "High  $p_T$  Two-Body Correlations and Single\_particle Inclusive Hadron Spectra in 24 GeV Proton-Nucleus Collisions"  
A. BAMBERGER ... P. VILAIN  
Nuovo Cimento 62A - 327 - 1981.
- "Study of the Adn Final State from K-NN Interactions at rest in Liquid Helium"  
R. ROOSEN and J.H. WICKENS  
Nuovo Cimento 66A - 101 - 1981.
- "Inclusive Neutral Kaon Production in 70 GeV/c  $K^+p$  Interactions"  
M. BARTH, J.J. DUMONT ...  
Nuclear Physics B191 - 39 - 1981.

- "A Search for Direct Electron Production in  $\bar{p}p$  Interactions at 70 GeV/c"

J.J. DUMONT, J.H. WICKENS ...

Particles and Fields 11 - 95 - 1981.

- "Inclusive Production of Neutral Strange Particles in  $\bar{p}p$  Interactions at 32 GeV/c"

C. POIRET .... M. BARTH, J.J. DUMONT ...

Particles and Fields 11 - 1 - 1981.

- "Inclusive  $K^{*+}(1430)$ ,  $K^{*0}(1430)$  and  $f(1270)$  Production in  $K^+p$  Interactions at 32 GeV/c"

P.V. CHLIAPNIKOV ... J.J. DUMONT ...

Bulletin of the IIHE/ULB-VUB - 81-1 - 1981.

- "Comparison of Strange Antinbaryon and Strange Meson Production in  $K^+p$  Interactions at 32 GeV/c"

P.V. CHLIAPNIKOV ... M. BARTH ...

Bulletin of the IIHE/ULB-VUB - 81-2 - 1981.

- "A Study of Multiparticle Fragmentation in  $K^+p$  Interactions at 32 GeV/c"

E.A. DE WOLF, J.J. DUMONT ...

Bulletin of the IIHE/ULB-VUB - 81-3 - 1981.

- "Photographic Emulsion Versus Bubble Chambers in Charm and Beauty Searches"

J. SACTON

Bulletin of the IIHE/ULB-VUB - 81-4 - 1981.