

INTER-UNIVERSITY INSTITUTE FOR HIGH ENERGIES

ULB-VUB; Brussels - ANNUAL REPORT 1977.

J. LEMONNE and J. SACTON

(February 1978).

I. INTRODUCTION.

The physicists whose names are listed below have contributed to the different activities of the laboratory during the year 1977.

U.L.B.

D. Bertrand (chercheur IISN)

Gh. Bertrand-Coremans (Chef de travaux associé)

M. Csejthey-Barth (chercheur IISN-FNRS)

M. Dewit (boursier IRSIA)

J.J. Dumont (chercheur IISN)

H. Mulkens (chercheur IISN)

J. Sacton (Professeur associé)

P. Van Binst (chercheur IISN)

P. Vilain (chercheur IISN)

J. Wickens (chercheur IISN)

G. Wilquet (chercheur IISN)

C. Wilquet-Vander Velde (Assistant and 1er Assistant since October 1977)

Note : During the first months of 1977 D. Bertrand has been working at CERN (Boursier CERN) in the Gargamelle group on the EMI project.

V.U.B.

C. De Clercq (vorser IIKW)

M. Goossens (vorser IIKW)

M. Gysen (vorser IIKW)

D. Johnson (vorser IIKW)

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J. Lemonne (Gewoon Hoogleraar)
 P. Peeters (Werkleider)
 R. Roosen (Assistent, until October 1977)
 S. Tavernier (vorser IIKW)
 W. Van Doninck (vorser IIKW)
 G. Vanhomwegen (vorser IIKW)
 F. Verbeure, E. De Wolf and F. Van Den Bogaert (as well 3 students from UIA) are working in close collaboration with the Institute.

II. RESEARCH.

II.1. Neutrino Physics.

II.1.1. Gargamelle at the PS.

A. The analysis of the data taken in the ν and $\bar{\nu}$ CERN PS beams with Gargamelle filled with freon is coming to its end.

a. A series of results concerning strange particle production via neutral current processes has been obtained under the assumption that strange particles are produced in pairs ($\Delta S = 0$).

(i) the ratio ρ of the inclusive cross section for Λ^0 , Σ^0 , K^0 and \bar{K}^0 production to the inclusive cross section for all neutral current processes with hadron energy greater than 1 GeV is found to be :

$$\rho_{\nu} = 3.8^{+1.1}_{-1.0} \times 10^{-2}$$

$$\rho_{\bar{\nu}} = 1.4^{+1.2}_{-0.7} \times 10^{-2}$$

(ii) using the measured ratio of the $\bar{\nu}$ flux to the ν flux 1.19 ± 0.12 one gets

$$R = \frac{\sigma_{inel}^{\nu}(\Lambda^0, \Sigma^0, K^0, \bar{K}^0)}{\sigma_{inel}^{\bar{\nu}}(\Lambda^0, \Sigma^0, K^0, \bar{K}^0)} = 0.13^{+0.11}_{-0.07}$$

(iii) this last result analyzed in terms of the quark model and the GIM mechanism indicates that the production of strange particles is essentially due to the associated production of strange quarks from non strange quarks, the contribution of the strang

quarks present in the sea being small.

(iv) within the same frame work an upper limit of 4 % is obtained (90 % CL) for the momentum fraction of the nucleon carried by the strange quarks.

This analysis is based on respectively 81 and 12 V^0 particles observed in the ν and $\bar{\nu}$ film.

b. From the observation of one candidate for the reaction $\nu_\mu + e^- \rightarrow \nu_\mu + e^-$ an upper limit of $2 \times 10^{-42} \text{ E}_\nu \cdot \text{cm}^2$ per electron, at 90 % confidence level, has been obtained for the cross section of this process, interpreted in the usual V-A framework, for an electron recoil energy larger than 300 MeV.

c. A study has been made of inclusive ν_e and $\bar{\nu}_e$ interactions. Evidence for scaling has been found; the slopes of the cross sections are in good agreement with those obtained in similar conditions for ν_μ and $\bar{\nu}_\mu$ interactions. The rate of V^0 particle production in ν_e interactions is $(3.8 \pm 1.7) \%$. No evidence appears for oscillations of neutrinos or antineutrinos which would have induced an excess of electron or positron events. The data are in agreement with the additive law for the lepton number. From an analysis of isolated electron-positron pairs no evidence is found for the electromagnetic decay of neutrinos or antineutrinos. The 90 % confidence level limits on the lifetimes in the c.m. system are $7 \times 10^{-3} \text{ s.m.}_{\nu_\mu} \text{ (eV)}$ and $1.2 \times 10^{-2} \text{ s.m.}_{\bar{\nu}_\mu} \text{ (eV)}$.

d. The cross section ratio of the elastic neutral current reaction $\nu p \rightarrow \nu p$ to the quasi elastic charged current reaction $\nu n \rightarrow \mu^- p$ in the kinematical region $0.3 \leq q^2 \leq 1.0 \text{ (GeV/c)}^2$ has been found to be 0.17 ± 0.08 , in agreement with previous measurements made in different experimental conditions.

e. Semi-inclusive π^+ , π^- and π^0 production in neutrino and antineutrino interactions induced by the neutral current has been studied. The raw pion charge ratios have been corrected for detection and scanning efficiencies, π^+/p ambiguity, contaminations and nuclear effects. Using the complete neutral current sample, a χ^2 fit of the charge ratios to a pure isoscalar current hypothesis has a confidence level of less than 10^{-4} . Using a restricted pion sample, corresponding to current fragment pions, a χ^2 fit of the π^+/π^- ratios in ν and $\bar{\nu}$ to the predictions of an isovector current has a

confidence level of 0.02. The sign of the isovector-isoscalar interference term is found to be consistent with that predicted by the Weinberg-Salam model.

B. The first results of the neutrino experiment made in Gargamelle filled with propane are now available.

(i) a comprehensive study of all four neutral current induced single pion channels has been made in an attempt to investigate the isospin structure of the weak neutral current. After background subtraction and corrections for detection efficiencies and nuclear effects, the relative cross section (in arbitrary units) are as follows : $\nu\pi^0/\nu n\pi^+/\nu n\pi^0/\nu p\pi^- = 297 \pm 37, 180 \pm 31, 177 \pm 43, 237 \pm 59$ (for comparison, the relative cross section for the charged current channel $\mu^-p\pi^0$ is 526 ± 65). An isospin analysis is made in terms of a linear combination of an isovector and an isoscalar amplitude. The weak neutral current is not pure isoscalar; the data favour the hypothesis of an isovector (with $I = 3/2$ dominance) plus an admixture of an isoscalar. This conclusion is based on the observations of a non zero interference term and a clear $\Delta(1236)$ resonance production

(ii) a study of strange particle production by neutral current confirms, on smaller statistics, the results obtained in the freon experiment.

The physicists involved in these experiments are : G. Bertrand-Coremans, M. Dewit, H. Mulkens, J. Sacton, C. Vander Velde-Wilquet, W. Van Doninck and P. Vilain. The work is done in the framework of the Gargamelle Collaboration.

II.1.2. Gargamelle at the SPS.

Gargamelle equipped with its EMI and filled with a mixture of propane and freon (rad. length ~ 55 cm) has been exposed for a short period (technical difficulties with the beam and the chamber) to the antineutrino SPS wide-band beam. A few thousands of pictures only are available per laboratory. Although the average quality of the pictures is poor, they have been scanned and rescanned, yielding a few hundreds of $\bar{\nu}$ interactions. The best events will be

used for testing the reconstruction programs, the identification efficiency for electrons and other calibration purposes.

The physicists involved are D. Bertrand, G. Bertrand-Coremans, M. Dewit, J. Sacton and P. Vilain; the work is done in collaboration with Aachen, Bergen, Strasbourg and University College-London.

II.1.3. The emulsion-spark chamber experiment at FNAL.

This experiment which is now considered as being completed has yielded 36 candidates for ν interactions in a total volume of emulsion of 18 l. exposed to a wide band beam of high energy neutrinos ($\langle E_\nu \rangle \sim 30$ GeV). Among them one likely example of the production and subsequent decay of a charmed particle has been observed. Extensive ionisation and multiple scattering measurements have been performed to calibrate the few emulsion plates in which the decay products are contained. These measurements essentially confirm the results of the preliminary analysis of the event published last year in Physics Letters, leaving our conclusions unchanged. With the finding of more ν interactions (36 versus 16) the probability for the event to be due to the secondary interaction of a hadron emitted from the neutrino vertex is now estimated to be $\sim 3 \times 10^{-3}$. A paper is now being prepared to give a more complete account of the results with particular emphasis on the technical aspects of the experiment and its difficulties.

G. Bertrand-Coremans, J. Sacton and P. Vilain have been collaborating with colleagues from CERN, FNAL, Dublin, University College and Imperial College-London, Open University-Milton Keynes, Mulhouse, Rome and Strasbourg.

II.1.4. The emulsion-BEBC experiment.

This experiment is intended to be an extension of the search for short-lived ($10^{-12} - 10^{-14}$ s) particles in ν interactions we made recently at FNAL (see II.1.3.). Again it is based on the high spatial resolution power of the emulsion. Emulsion stacks, which constitute the target, are located in front of the BEBC window so that the products of the interaction which enter the chamber can be observed and measured. From these measurements the position of the ν vertex in the emulsion can be determined with an

accuracy which is expected to be better than in the FNAL experiment. Between the stacks and the BEBC window there is a multiwire proportional chamber and a scintillation counter covering the entire window surface, the purposes of which, are threefold (i) help in intercalibrating the emulsion and BEBC reference frames (ii) help in the selection of the events to be measured and (iii) help in the analysis of the EMI information.

Two runs were made in the ν SPS wide band beam : in August with ~ 13 l. of emulsion and in October-November with ~ 20 l. of emulsion. In total about 200.000 BEBC pictures were taken. It is expected to have slightly less than 1000 ν interactions in the emulsion. Extensive calibration tests using passing through muons have been made which allow to correlate the BEBC reference frame with the multiwire proportional chamber. The relative positions of the MWPC and the emulsion is said to be known to 0.1 to 0.2 mm. One unknown subsists : the influence of the BEBC magnetic field on the MWPC readings. This will be checked using pictures taken in December with muons and hadrons, with and without magnetic field. In the meantime the scanning and the measurements of a first lot of BEBC photos has been made allowing to make a few vertex predictions. Until now 4 events have been found in the emulsion.

The physicists involved in this experiment are G. Bertrand-Coremans, J. Sacton, P. Vilain, J. Wickens and G. Wilquet in the frame of a large European Collaboration.

II.1.5. ν and $\bar{\nu}$ interactions in BEBC filled with a H_2/Ne mixture.

During the first technical run of the ν , $\bar{\nu}$ wide band beams at the CERN SPS some 30.000 pictures were taken with BEBC filled with a 74 mole % $Ne-H_2$ mixture of radiation length ~ 40 cm. These pictures were scanned with particular emphasis on a search for electrons and positrons originating from the neutrino interaction vertices. As a result 22 events were found to contain a pair $\mu^- e^+$ ($E_e > 300$ MeV) with additional hadrons, in a sample of ~ 6000 charged current events. After background subtraction and different corrections for scan and detection efficiencies the rate of such events above 10 GeV is found to be ~ 0.5 % of CC events in agreement with previous studies. The rate of V^0 association to these

$\bar{\nu} e^+$ events is found to be intermediate between those obtained in two similar FNAL experiments.

An attempt is now being made for measuring the ν -nucleon total cross section in the energy range between 10 and 50 GeV.

Those who contribute to this work are G. Bertrand-Coremans, H. Mulkens, J. Sacton, C. Vander Velde-Wilquet and J. Wickens in collaboration with physicists from Bari, Birmingham, Ecole-Polytechnique, Rutherford, Saclay and University College-London.

II.2. Hadron Physics.

II.2.1. K^-d experiment at 4.6 GeV/c.

(C. De Clercq, D. Johnson, J. Lemonne, P. Peeters, P. Renton, P. Van Binst, G. Van Homwegen and J.H. Wickens).

A study of the reactions $K^-d \rightarrow K^-d$ and $K^-d \rightarrow K^-n (p_s)$ has been completed. The high energy Glauber formalism, in which the nucleon scattering amplitudes are parameterized, has been used in conjunction with an impulse approximation analysis of the K^-n differential scattering. A global fit has been made to the existing $K^\pm N$ two-body scattering data at 4.5 GeV/c incident momentum in order to determine the scattering amplitude. It was found that the K^-n and K^-p elastic amplitudes are dominantly imaginary with a relatively small contribution from spin-flip amplitudes.

At present, one is concentrating upon the final analysis of 4C-reactions of the type $K^-n \rightarrow K^-p \pi^-$ (~ 1500 events) and $K^-d \rightarrow K^-d \pi^+ \pi^-$ (~ 450 events).

II.2.2. K^-p experiment at 6.5 GeV/c.

(C. De Clercq, D. Johnson, J. Lemonne, P. Peeters, P. Renton and J.H. Wickens) - collaboration : Argonne National Laboratory, Brussels, University of Kansas, Michigan State University and Tuft University (U.S.A.).

The scanning and premeasurement of the 0 prong V, 4-prong and 4 prong-V event samples of this high statistics experiment (~ 70000 events in total), performed in the Argonne 12'-bubble chamber, is almost completed. Approximately half of these events have been automatically measured on Polly.

The study of inclusive V^0 -production has been pursued. The total cross sections for inclusive K^0 and Λ^0 production are respectively found to be $\sigma(K^0) = (7.98 \pm .49)$ mb and $\sigma(\Lambda^0) = 3.94 \pm .24$ mb. The corresponding differential topological cross sections have been determined as a function of the mass recoiling against the V^0 , the Feynman variable x , the transverse momentum squared of and the four momentum transfer to the V^0 . The average charged multiplicity $\langle n_c \rangle$, the ratio $\langle n_c \rangle / D$ and the correlation function f_2^{cc} have been studied as a function of the mass of the recoiling system. The results favor the universal aspects of multiparticle production derived from quark interaction models with indication of a dominant contribution of quark-exchange annihilation over that of gluon exchange, in particular for the $K^- \rightarrow \Lambda^0$ fragmentation processes.

A first analysis of ~ 2200 4C-events of the type $K^- p \rightarrow K^- p \pi^+ \pi^-$ (approximately 1/3 of the final statistics expected) has been undertaken with the object of estimating the importance of various subchannels such as : ϕ -production, simultaneous $K^* N^*$ (Δ^*) production, diffractive dissociation of the target nucleon into $p \pi^+ \pi^-$, etc. The methods used to isolate these final states are based upon a simultaneous multidimensional analysis of the channel parameters involved.

II.2.3. Study of $\bar{p}p$ interactions at 12 GeV/c.

(D. Bertrand, D. Johnson, J. Lemonne, P. Renton, F. Van Den Bogaert and J.H. Wickens); Brussels, CERN, I.C. London, Mons, Orsay collaboration.

The technical part of this study performed in the CERN-BEBC- H_2 bubble chamber has been completed. Evidence was found for the existence of a narrow ($\Gamma < 18$ MeV) resonance, named I, with a mass of 2.6 GeV, with a $I^\pm \rightarrow K_S^0 \pi^\pm \pi^+ \pi^-$ decay mode.

No additional evidence for the production of very narrow particle states was found. For instance, a search for charmed particles (D, D^* -meson and Λ_c -baryons), based on a study of 18000 events with a visible V^0 -decay was unsuccessful.

The same event sample was used to study the inclusive reactions $\bar{p}p \rightarrow K^0 X$, $\bar{p}p \rightarrow \Lambda X$ and $\bar{p}p \rightarrow \bar{\Lambda} X$. The cross sections have been studied as a function of the Feynman scaling variable x , the rapidity, the transverse momentum of the V^0 and the missing mass squared. The dependence of the Λ and $\bar{\Lambda}$ polarization on x has also been investigated. Finally, events with two detected V^0 's were analyzed in order to study correlations arising from the production of two strange neutral particles.

The inclusive production cross sections of $K^*(890)$, $\Sigma^\pm((\bar{\Sigma}^\pm)1385)$ and $S^*(993)$ resonances have also been determined as a function of p_T^2 and rapidity. The contribution of annihilation processes to K and K^* production has been investigated from a comparison with the corresponding pp data.

II.2.4. Mirabelle K^+p experiment at 32 GeV/c.

(M. Csejthey-Barth, E. De Wolf, J.J. Dumont, M. Gysen, S. Tavernier, F. Verbeure).

The present sample on DST is almost complete and contains approximately 150000 events. The following subjects were studied and are published or ready for publication :

- Energy dependence, total and differential inclusive cross sections of Λ and $\bar{\Lambda}$ production.

The total inclusive cross sections were found to be 0.78 ± 0.05 and 0.42 ± 0.04 mb respectively.

- Energy dependence, total and differential inclusive cross sections of K^0 and \bar{K}^0 production. The total inclusive cross section for neutral K production is 7.6 ± 0.2 mb.
- ~~4.6~~ body final states were studied in terms of principal axis variables. Contrary to certain claims these collective variables turn out to be rather insensitive to details of the reaction characteristics.
- Inclusive total and differential cross sections were determined for 11 resonances. Resonance production is generally believed to reflect better the underlying production mechanism than "stable" particle production, most of the "stable" particles being in fact decay products of resonances.

- Different methods to determine lower bounds on the impact parameter for a reaction are applied to our data and compared. These impact parameters can distinguish between different production mechanisms. An extension of the experiment to study neutral strange particles and six prong-events was decided. This experiment is done in close collaboration with the University of Mons in the frame of the USSR-France-CERN project.

II.2.5. Mirabelle $\bar{p}p$ experiment at 32 GeV/c.

(M. Csejthey-Barth, E. De Wolf, J.J. Dumont, M. Gysen, S. Tavernier and F. Verbeure).

A first bunch of about 10000 $\bar{p}p$ events, which had been processed in the same manner as the K^+p ones, was available on DST in the beginning of 77. They were analysed in order to get as much information as possible with such a limited statistics. This resulted in a paper which was published in Nuclear Physics, and where one can find :

- the topological cross sections
- cross sections and multiplicities for γ , K^0 and $\Lambda/\bar{\Lambda}$ production
- inclusive distributions for γ , K^0 and $\Lambda/\bar{\Lambda}$
- inclusive distributions for π^+ and π^- production
- total cross sections for exclusive reactions
- a preliminary analysis of the $\bar{p}p \rightarrow \bar{p}p \pi^+ \pi^-$ reaction

In the meantime, more pictures became available; 14 rolls containing about 600 events each were given to the Belgian part of the collaboration. The scanning of these rolls was nearly completed, but the measurement was not yet undertaken.

A extension of this experiment was decided, but restricted to the study of neutral strange particle production.

This experiment is performed in close collaboration with the University of Mons in the frame of the USSR-France-CERN collaboration.

II.2.6. K⁻p interactions at low energy.

(D. Bertrand, M. Goossens, G. Van Homwegen and G. Wilquet).

This experiment is performed in the Rutherford Laboratory chamber filled with a H₂/Ne mixture and equipped with a track sensitive target full of H₂. The final results concerning the interactions of K⁻ mesons at rest can be summarized as follows :

- (i) the ratio γ of the number of $\Sigma^- \pi^+$ final states to the number of $\Sigma^+ \pi^-$ final states is found to be 2.38 ± 0.04 , in agreement with a previous emulsion result but at variance with Kim's data.
 - (ii) the fraction R_c of charged final states is 0.664 ± 0.011
- These data also provide a new determination of the Σ^+ decay branching ratio

$$B = \frac{\Sigma^+ \rightarrow n + \pi^+}{\Sigma^+ \rightarrow \text{all modes}} = 0.488 \pm 0.008$$

A measurement of the cross sections for the $\Lambda\pi$, $\Sigma\pi$ and $\bar{K}N$ channels between 150 and 350 MeV/c is in progress.

These studies are made in collaboration with Durham, U.C. London and Warsaw.

II.3. IIHE participation to the EHS.

(Technical preparation : S. Tavernier and F. Van Den Bogaert).

We have designed and tested a full scale prototype module of a large, multi-cell Cerenkov detector using Silica aerogel as radiator material. The module has a sensitive area of $18 \times 52 \text{ cm}^2$ and is designed such that the elements can be assembled to produce a counter with a sensitive area of several square meters. Two possible designs were tried. One using a white diffusely reflecting coating to collect the light, the other using a spherical mirror. With 9 cm of aerogel we obtained 5.5 and 4.6 photoelectrons respectively. We have thus established for the first time the feasibility of large area Silica aerogel Cerenkovs.

A paper describing the result is submitted to Nuclear Instruments and Methods. We are presently building prototype modules which aim at testing several improvements on the light collecting system. At the same time we are studying the main technical problem

in this project : the shielding of the photomultipliers from the strong (several kilo gauss) stray field of the magnet. We use two approaches. On one hand we rely on numerical calculations to estimate the magnetic field to be expected and to evaluate the influence of large masses of iron on these fields. On the other hand we measure the shielding obtained with models and with similar fields in a wide gap magnet at CERN. We have not yet found a satisfactory solution but it is already clear that a massive iron plate of 22 tons in front of the detector would be extremely helpful as a general shielding. In addition each individual PM needs several layers of well chosen materials to reduce the field to below 1 gauss as is required for the photomultipliers.

New measurements on models are going to be performed in CERN soon. A complete and final design should be ready by next summer.

This work is performed in collaboration with the Universities of Mons and Stockholm and with the IISN Counter group of CERN.

III. SEMINARS AND LECTURES.

- The practical work for students attending the lectures of J. Lemonne and J. Sacton (3rd and 4th years 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.
- A series of lectures on neutrino physics have been given by G. Bertrand-Coremans, J. Sacton and W. Van Doninck in collaboration with Dr P. Castoldi from the ULB for the theoretical aspects.
- J. Sacton has been invited to give talks at the University of Warsaw (Multilepton Production in Neutrino Interactions) and at the Universitaire Instelling Antwerpen (New Particles : Experimental Results).
- G. Bertrand-Coremans has been invited to give a talk at the XI Rencontre de Moriond (Observation of a likely example of the decay of a charmed particle).
- P. Vilain has been invited to give a talk at the University of Warsaw (Single Pion Production by the Neutrino induced Neutral Current).
- P. Van Binst has given two seminars at the Laboratoire d'Informatique Théorique at the ULB (MINIBROL - Nouvelles applications en temps réel à l'IIHE, and un rapport partiel et des commentaires sur les congrès IFIP 77).

- J. Lemonne has been invited by the University of Warsaw to give a series of lectures on the following topics :

-K13 - decays

-Observation of new narrow state with a mass of 2.6 GeV/c in $\bar{p}p$ interaction at 12 GeV/c

- E. De Wolf gave a talk on "Hadron production" at the UIA.

- F. Verbeure gave a review talk on "Central production at the EHS" during the Workshop "Physics with EHS", at CERN.

- J. Lemonne has been invited to give a review talk on "New hadron spectroscopy" at the CERN-EHS-Workshop (4-7 April 1977).

- M. Goossens gave a talk at the University of Warsaw entitled "The Oades-Reshe Formalism applied to the K^-p interactions".

- F. Verbeure gave three invited talks at the First Highly specialized Workshop on Multiparticle Production, Erice (20 May-4 June).

- In the frame of a Seminar on Elementary Particles organized by the Institute, the following lectures were given

J.P. Stroot (belgian group at CERN) : The GAMS Project

J. Sacton : New Data in $e^+ e^-$ collisions and the Observation of the Upsilon (report on the Lepton-Photon Conference in Hambourg).

P. Vilain : New Data in ν interactions (report on the Lepton-Photon Conference in Hambourg).

J.P. Lagnaux (belgian group at CERN) : Collissions $e^+ e^-$ à très haute énergie - rapport sur la réunion d'Hambourg 1977.

C. Franzinetti (Universita di Torino) : Muon experiments at 400 GeV Machines.

J. Guy (Rutherford Laboratory) : Electron Production in 4 GeV π^+p interactions in a track sensitive target.

- Internal seminars (organized by M. Goossens) were given by :

J. Wickens : Search for new particles in 12 GeV/c $\bar{p}p$ interactions in BEBC.

M. Goossens : Coulomb corrections applied to low momentum K^-p interactions.

W. Van Doninck : A cinematographic study of high jumping.

R. Roosen : Charm Search in a Streamer Chamber.

G. Wilquet : Report on the European Conference on Particle Physics held at Budapest.

E. De Wolf : Hadron Physics with the TST.

IV. COMPUTERS AND SOFTWARE.

Two kinds of computers are being used by the IIHE : two large CDC machines at the Brussels Universities Computer Centre (one CDC 6600 and one 6500) and four DEC computers belonging to the laboratory itself : one DEC system 10, two PDP-11/40 and one PDP-8. Data is exchanged between these machines by using magnetic tapes, and specially developed reading routines allow the handling of the numerous recording formats (G. Rousseau, R. Tassin-Vandenbroecke). One data link is already operational between two of the IIHE computers, the DEC-10 and the PDP-8, and more are planned and being tested.

We briefly summarize hereafter the use of the various machines.

1. CDC computers.

The main use of those is for large production jobs, essentially based on the CERN HYDRA geometry and kinematics programs, as well as the making of DST's and various associated data handling tasks, for the following experiments : Rutherford Laboratory TST K^-p , Mirabelle K^+p and $\bar{p}p$, BEBC $\bar{p}p$, ANL 30" K^-d , ANL 12' K^-p .

A large number of hours have also been used for computations related to the IIHE participation in the CERN EHS project.

A total of about 440 hours of CDC 6400 equivalent time has been used by the IIHE during the year.

2. IIHE computers.

The management of these computers has been under P. Van Binst, assisted by J.J. Dumont and R. Tassin-Vandenbroeck.

2.1. DEC_system_10.

This computer provides on-line support for the POLLY automatic

film reader and for 4 SAAB tables equipped with manual digitizers. POLLY is measuring film from the ANL 12' and BEBC chambers and the SAAB tables have been used with film from the Gargamelle, Mirabelle and BEBC chambers. All five devices are driven by concurrent real-time tasks, backed by on-line geometrical reconstruction facilities.

The computer is also used, in batch and time-sharing mode, to process a significant amount of other tasks related to all the experiments in which the IIHE is involved. All the physicists and programmers are participating in this kind of software development. The availability of the DEC-10 has been extremely high throughout the year, with a mean of 96 % for 7 days/week, 24 hours/day. A total of about 2800 CPU hours have been used during the year.

2.2. PDP-11 "SWEEPNIK".

This computer is devoted to the support of the SWEEPNIK optical reader; an important software development has taken place during the year, including the realization of a real-time software module for the control of the measuring device and the implementation of the bubble chamber pictures measuring software, in collaboration with the University of Mons. Various calibration and test programs have also been written. Production measurements of Mirabelle film have started in fall, with an accuracy and rate comparable to previous SWEEPNIK performances (R. Tassin-Vandenbroeck, P. Van Binst).

2.3. PDP-11 "BEBC".

This computer will be used to support 3 tables for the analysis of BEBC film. The specifications of the interface have been designed (J.P. De Wulf, L. Etienne, H. Mulkens, G. Van Beek, P. Van Binst, G. Wilquet) and the software is presently under development (H. Mulkens, G. Rousseau, W. Van Doninck, G. Wilquet).

First tests of the feasibility of a data link between this computer and the DEC-10 are being conducted (G. Depiesse, P. Van Binst).

2.4. PDP-8.

This computer has been linked to the DEC-10 (G. Depiesse) and is being used to handle the data produced by the ENETRA measuring

machines on paper tape.

Development is taking place regarding the use of this computer to control a revised version of the PROSAM device, and to link it to the "BEBC" PDP-11 (G. Depiesse, P. Van Binst).

V. TECHNICAL WORK.

1. Adaptation of the hardware of the automatic machine Polly to the requirements specific to film from the CERN BEBC-bubble chamber (L. Van Lancker, B. Goorens).
2. Tuning of the Sweepnik semi-automatic measurement device (J.P. De Wulf, L. Etienne).
3. Rebuilding of the Prosam measurement machine into a high precision measurement device (R. Goorens, C. Nadin, G. Van Beek, L. Van Lancker).
4. Study of the output electronics and on-line connection to a PDP-11 of scanning and measurement apparatus for BEBC film (J.P. De Wulf, L. Etienne).
5. Building of a scanning device for Gargamelle film (J.P. De Wulf, G. Van Beek).
6. Processing at Cern of the emulsion for the experiment reported in section II.1.4. (C. Donis) and participation to the preparation of the experiment (R. Gindroz, E. Lievens).

VI. ATTENDANCE TO CONFERENCES AND SCHOOLS.

1. Conferences.

- 1977 International Symposium on Lepton and Photon Interactions at High Energies - Hamburg : J. Sacton and P. Vilain.
- VIII International Conference on Multiparticle Dynamics - Kayserberg : S. Tavernier, E. De Wolf.
- IFIP Congress 77 (International Federation for Information Processing), Toronto : P. Van Binst.

- European Conference on Particle Physics - Budapest : D. Johnson, G. Wilquet.
- Neutrino 77 - Elbrouz : H. Mulkens.
- GORDON Conferences on Elementary Particle Physics - Tilton, New Hampshire (U.S.A.) : J. Lemonne.
- First Highly specialized Workshop on Multiparticle Production - Erice (20 May-4 June) : F. Verbeure.

2. Schools.

- International School of Elementary Particle Physics - Kupari - Dubrovnik : C. De Clercq, M. Dewit.
- "Ettore Majorana" International School of Subnuclear Physics - Erice : G. Wilquet.
- CERN Summer School - Nafplion (Greece) : M. Gysen.

VII. LIST OF PUBLICATIONS.

- K^- Meson Absorptions at rest in Carbon Nuclei leading to Final States containing a Λ -Hyperon

C. VANDER VELDE-WILQUET, J. SACTON, J.H. WICKENS ...

Nuovo Cimento, 178, vol. 38A n° 2, 1977.

- Determination of the Branching Fractions for K^- Meson Absorptions at rest in Carbon Nuclei

C. VANDER VELDE-WILQUET, J. SACTON, J.H. WICKENS ...

Nuovo Cimento, 538, vol. 39A n° 4, 1977.

- Dilepton and Strange Particles Production by Neutrinos in Gargamelle

G. BERTRAND-COREMANS, H. MULKENS, J. SACTON, W. VAN DONINCK ...

Phys. Letters, 474, 67B, 1977.

- Search for Strangeness Changing Neutral Currents induced by Neutrinos in Gargamelle

G. BERTRAND-COREMANS, H. MULKENS, J. SACTON, W. VAN DONINCK ...

Phys. Letters, 231, 71B, 1977.

- Strange Particle Production by Neutrino-Induced Neutral Currents, in the CERN PS Neutrino Beam

G. BERTRAND-COREMANS, J. SACTON ...

Proceedings of the International Conference on Particle Physics, Budapest 1977.

- A Study of the Reactions $K^-d \rightarrow K^-d$ and $K^-d \rightarrow K^-n$ (p_s) at 4.5 GeV/c

C. DE CLERCQ, D. JOHNSON, J. LEMONNE, P. PEETERS, P. RENTON,

P. VAN BINST, G. VANHOMWEGEN, J. WICKENS

Nucl. Phys., 397, B126, 1977; also Bulletin of IIHE 77-01.

- Multidimensional Analysis of the $K^+p \rightarrow K^+p\pi^+\pi^-$ Reaction at 32 GeV/c

J.J. DUMONT

Réunion de la Société Belge de Physique-VUB Brussels, June 1977.

- Particle Multiplicities in K^+p Interactions at 32 GeV/c

J. LAURENT

Réunion de la Société Belge de Physique-VUB Brussels, June 1977.

- Determination of the Neutral to Charged Current Inclusive Cross-Section Ratio for ν and $\bar{\nu}$ Interactions in the "Gargamelle" Experiment

G. BERTRAND-COREMANS, M. DEWIT, H. MULKENS, J. SACTON,
W. VAN DONINCK

Nucl. Phys., 218, B118, 1977.

- A Comparison between K_S^0 Inclusive Production in $\bar{p}p$ and e^+e^- Interactions at 4.9 GeV Center of Mass Energy
Brussels, CERN, Imperial College, Mons, Orsay Collaboration
Proceedings of the International Conference on Particle Physics, Budapest 1977.

- Inclusive Production of $K^*(890)$ and $Y^*(1385)$ Resonances in $\bar{p}p$ Interactions at 12 GeV/c Incident Momentum
Brussels, CERN, Imperial College, Mons, Orsay Collaboration
Proceedings of the International Conference on Particle Physics, Budapest 1977.

- Single and Double Diffraction Dissociation in K^+p Interactions at 32 GeV/c
M. CSEJTHEY-BARTH, J.J. DUMONT, F. VERBEURE ...
Proceedings of the International Conference on Particle Physics, Budapest 1977.

- Λ and $\bar{\Lambda}$ Production in K^+p Interactions at 32 GeV/c
M. CSEJTHEY-BARTH, J.J. DUMONT, M. GYSEN ...
Proceedings of the International Conference on Particle Physics, Budapest 1977; Nucl. Phys., 93, B131, 1977 and IHEP 77-103.

- Impact Parameter Bounds for Multiparticle Exclusive K^+p Reactions at 32 GeV/c
E. DE WOLF, M. GYSEN, S. TAVERNIER, F. VERBEURE ...
Proceedings of the International Conference on Particle Physics, Budapest 1977.

- Inclusive Production Cross Sections of Resonances in 32 GeV/c K^+p Interactions
E. DE WOLF, S. TAVERNIER, F. VERBEURE ...
Proceedings of the International Conference on Particle Physics, Budapest 1977.

- General Features of $\bar{p}p$ Interactions at 32 GeV/c

E. DE WOLF, J.J. DUMONT, M. GYSEN ...

Nucl. Phys., 365, B127, 1977.

- An Analysis of the Gargamelle Freon Data Concerning Pion Production by the Weak Neutral Current

W. VAN DONINCK ...

Phys. Letters, 446, 71B, 1977.

- Inclusive V^0 Production in K^-p Interactions at 6.5 GeV/c

C. DE CLERCQ, D. JOHNSON, J. LEMONNE, P. PEETERS, P. RENTON and J. WICKENS ...

Réunion de la Société Belge de Physique-VUB Brussels, June 1977.

- Measurement of the $\Sigma^- \pi^+ / \Sigma^+ \pi^-$ Ratio in K^-p Interactions at rest and of the $p \pi^0 / n \pi^+$ Decay Ratio of the Σ^+ Hyperon

D. BERTRAND, M. GOOSSENS, G. VANHOMWEGEN, G. WILQUET

Réunion de la Société Belge de Physique-VUB Brussels, June 1977.

- Single Pion Production by the Weak Neutrino induced Neutral Current

C. VANDER VELDE-WILQUET ...

Réunion de la Société Belge de Physique-VUB Brussels, June 1977.

- Study of ν_e and $\bar{\nu}_e$ Interactions in Gargamelle

M. DEWIT ...

Réunion de la Société Belge de Physique-VUB Brussels, June 1977.

- Development of Two New On-Line Applications at the IIHE

J.P. DEWULF, L. ETIENNE, H. MULKENS, R. TASSIN-VANDENBROECKE, P. VAN BINST and G. WILQUET

Réunion de la Société Belge de Physique-VUB Brussels, June 1977.

- Inclusive V^0 Production in $\bar{p}p$ Interactions at 12 GeV/c

D. BERTRAND, D. JOHNSON, J. LEMONNE, P. RENTON, F. VAN DEN BOGAERT, J. WICKENS ...

Nucl. Phys., 365, B128, 1977.

- Analysis of a Foreground-Background System with Two Levels of Priority among Foreground Jobs

J.J. DUMONT and G. LATOUCHE

Proceedings of International Computing Symposium 1977, Ed.

E. Morlet and D. Ribbens.

- Study of Slow Inclusive Protons in K^+p Interactions at 16 GeV/c

E. DE WOLF, D. JOHNSON, F. VERBEURE ...

Nucl. Phys., 493, B123, 1977.

- Study of Exclusive one Pion Production in all Neutrino Induced Neutral Current Channels

Neutrino-Propane Gargamelle Collaboration : Aachen, Brussels, CERN, Ecole Polytechnique, Orsay, Padova

Proceedings of the International Conference on Particle Physics, Budapest 1977.

- Associated Multiplicities in the Reactions $K^+p \rightarrow K^0X$ and $K^+p \rightarrow \pi^-X$ at 32 GeV/c

F. VAN DEN BOGAERT, M. GYSEN, M. CSEJTHEY-BARTH ...

Sov. J. Nucl. Phys., 312, vol. 25 n° 3, 1977.

- Evidence for a Narrow Peak in $K_S^0 \pi^+ \pi^-$ at 2.6 GeV in 12 GeV/c $\bar{p}p$ Interactions

D. BERTRAND, J. LEMONNE, P. RENTON, J. WICKENS, F. VAN DEN BOGAERT, D. JOHNSON ...

Phys. Letters, 185, 66B, 1977.

- Evidence for a New and General Scaling Law in Strong Interactions

S. TAVERNIER and M. GYSEN

Proceedings of the VIII International Conference on Multiparticle Dynamics, Kayzersberg (France) 1977. (to be published).

- Observation of a Likely Example of the Decay of a Charmed Particle

G. BERTRAND

Proceedings of the XII Rencontre de Moriond, March 1977.

- Charged Σ -Hyperon Production by K^- Meson Interactions at rest

D. BERTRAND, M. GOOSSENS, G. VANHOMWEGEN, G. WILQUET

Bulletin of IIHE 77.02, 1-13, 1977.

- Further Results from the Gargamelle Experiment

H. MULKENS

Proceedings of the 'Neutrino 77' International Conference on Neutrino Physics and Neutrino Astrophysics, 16-24 June 1977.

- Two Pion Correlations in K^+p Interactions at 32 GeV/c

F. VERBEURE, M. GYSEN, M. CSEJTHEY-BARTH

Sov. J. Nucl. Phys., 802, vol. 26 n° 4, 1977.

- Production of Neutral Kaons in K^+p Interactions at 32 GeV/c

M. CSEJTHEY-BARTH, F. VERBEURE, E. DE WOLF

IHEP 77-102.

- Distribution with Respect to Transverse Momentum in the Inclusive Reaction $K^+p \rightarrow K^0 + X$ in the Primary Momentum Interval from 5 to 32 GeV/c and in the Reaction $K^+p \rightarrow \pi^- + X$ from 8.2 to 32 GeV/c

E. DE WOLF, J.J. DUMONT, S. TAVERNIER ...

Sov. J. Nucl. Phys., 191, vol. 25, 1977.

- Spin Parity Analysis of the $K^+ \pi^-$ System produced in $K^+n \rightarrow K^+ \pi^- p$ at 4.6, 8.25 and 12 GeV/c

S. TAVERNIER ...

Nuovo Cimento, 29, 41A, 1977.

- A Study of the Reactions $K^-d \rightarrow K^-d$ and $K^-d \rightarrow K^-n (p_s)$ at 4.5 GeV/c

C. DE CLERCQ, J. LEMONNE, P. PEETERS, P. RENTON, P. VAN BINST, G. VANHOMWEGEN, J. WICKENS

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- Strange Particle Production on Charmed Particle Search in the Gargamelle Neutrino Experiment

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Phys. Letters, 3, 58B, 1977.

- Charmed Particle Searches in Hadron-Hadron Collisions

J. LEMONNE

CERN/EP/HES/PM 774, 208, 1977.

- A Contribution to the Study of Inclusive and Semi-Inclusive Neutrino and Antineutrino Interactions in CF_3Br
Thesis VUB, Walter VAN DONINCK, 1977.

- A Contribution to the Study of K^- -Meson Absorption at rest in Liquid Helium

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