

INTER-UNIVERSITY INSTITUTE FOR HIGH ENERGIES

ULB-VUB, BRUSSELS - ANNUAL REPORT 1979.

J. LEMONNE and J. SACTON,  
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I. INTRODUCTION.

The physicists whose names are listed below have contributed to the different activities of the laboratory during the year 1979.

U.L.B.

M. Barth (Maître de recherche FNRS)  
D. Bertrand (chercheur qualifié FNRS)  
G. Bertrand-Coremans (Chef de travaux associé)  
M. Dewit (aspirant FNRS)  
J.J. Dumont (chercheur IISN; at SLAC since May 1979)  
H. Mulkens (chercheur IISN)  
J. Sacton (Professeur associé)  
P. Van Binst (chercheur IISN)  
P. Vilain (chercheur qualifié FNRS)  
J. Wickens (chercheur IISN)  
G. Wilquet (chercheur qualifié FNRS)  
C. Wilquet-Vander Velde (1er Assistant)

V.U.B.

C. De Clercq-Vincent (vorser IIKW)  
M. Goossens (vorser IIKW; at CERN since February 1979)  
M. Gysen (vorser IIKW)  
D. Johnson (vorser IIKW)  
J. Lemonne (Gewoon hoogleraar)  
J. Meijnaerts (vorser IIKW)  
J. Moreels (vorser IIKW since August 1979)  
P. Peeters (werkleider)

S. Tavernier (bevoegdverklaard navorser NFWO)

W. Van Doninck (bevoegdverklaard navorser NFWO)

G. Vanhomwegen (vorser IIKW)

F. Verbeure, E. De Wolf, F. Van Den Bogaert and M. Van Immerseel from UIA are working in close collaboration with the Institute.

Note : - Since October 1977 R. Roosen is working in the IISN Counter group at CERN.

- Since September 1979 J. Gaudaen (UIA) is working at CERN on the experiment UA5.

In performing the experiments which are summarized in the present report, the physicists have benefit of the efficient work of the scanning and measuring teams of the laboratory.

## II. RESEARCH.

### II.1. Neutrino physics.

#### II.1.1. Gargamelle at the PS.

The last results of the analysis of the data taken with Gargamelle filled with propane and exposed to the  $\nu$  CERN PS beam have been published :

- i) The value of the ratio  $\frac{\langle\sigma\rangle}{\langle E\rangle}$  measured at 2.87 and 9.05 GeV are  $0.69 \pm 0.05$  and  $0.61 \pm 0.06$  in units of  $10^{-38} \text{ cm}^2 \text{ GeV nucleon}$ .
- ii) From a comparison of single  $\pi^0$  production by  $\nu$  and  $\bar{\nu}$  neutral currents it is confirmed that the vector-axial vector interference contribution is different from zero by about 3 standard deviations.
- iii) The variation of the total cross section of the process  $\nu_{\mu} + n \rightarrow \mu^{-} + p$  as a function of the energy and the behaviour of its differential cross section  $\frac{d\sigma}{dq^2}$  as a function of  $q^2$  have been studied. Estimates of the axial mass  $M_A$  have been obtained :

from  $\sigma$  vs  $E$  :  $M_A = 0.87 \pm 0.05 (\pm 0.17 \text{ syst.})$

from  $\frac{d\sigma}{dq^2}$  vs  $q^2$  :  $M_A = 0.99 \pm 0.12$

The physicists involved in this work, in the frame of the Gargamelle Collaboration are M. Dewit, C. Wilquet-Vander Velde and

P. Vilain.

### II.1.2. Gargamelle at the SPS.

This research programme has been considerably amended as a result of the Gargamelle break-down. Indeed only 20 % of the requested film ( $\bar{\nu}$  wide-band beam from 330 GeV protons) to study rare processes associated with antineutrinos ( $\bar{\nu}_\mu e^-$  scattering; dilepton production and  $\bar{\nu}_e N$  interactions) has been taken. All the available good quality film has been scanned twice and all charged current neutrino induced interactions with a muon (EMI) of momentum greater than 5 GeV/c have been measured. Preliminary results, based on 550 charged-current events selected by use of the EMI, were presented at the Bergen Conference concerning the  $\bar{\nu}$  interaction cross section in the energy range from 10 to 90 GeV. In the near future some 3000 charged current  $\bar{\nu}$  interactions of energy greater than 10 GeV will have been measured. These data will be combined with similar neutrino statistics also obtained in Gargamelle in an attempt to estimate the nucleon structure functions, to check scale invariance and to perform a detailed comparison of the experimental data with QCD predictions.

In parallel, all available film has been scanned for  $\bar{\nu}_\mu + e^- \rightarrow \bar{\nu}_\mu + e^-$  candidates. None were found. This leads to an upper limit of the fully corrected cross section for this process of  $2.7 \times 10^{-42} E_\nu \text{ (GeV) cm}^2$  and an upper limit of 0.39 for  $\sin^2 \theta_W$ , both at 90 % C.L.

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

### II.1.3. $\nu$ and $\bar{\nu}$ interactions in BEBC equipped with an $H_2$ filled TST.

Respectively, 280.000 and 220.000 pictures were taken in the  $\nu$  and  $\bar{\nu}$  CERN SPS wide-band beam with BEBC filled with a 77 mole %  $H_2/Ne$  mixture and equipped with an  $H_2$  filled track sensitive target and an EMI. The average quality of the

film is quite poor, thus slowing down the analysis. At present some 1000 neutrino events occurring in the TST have been measured ( $\sim 2/3$  of the data) and the scanning of the  $\bar{\nu}$  pictures is nearly complete. First priority will be given to the analysis of those events containing strange particles in an attempt to identify charmed particles.

In the mean time the  $\bar{\nu}$  film has been selectively scanned for dimuon events occurring both in the  $H_2$  and in the  $H_2/Ne$  mixture using the EMI facilities. Respectively, thirty two and two opposite sign dimuons, with muon momentum greater than 3 GeV, were found in the neon and in the TST. The total background in the neon event sample is estimated empirically to be  $9.2 \pm 3.8$  events. Taking account of the EMI acceptance, the event selection criteria and the  $\nu$  induced event contamination, the rate for dimuon production in  $\bar{\nu}$  charged current interactions is  $0.3 \pm 0.1$  %. On average  $0.9 \pm 0.5$  neutral strange particles were found per dimuon event. These numbers and the  $x$  distribution of  $\mu^+ \mu^-$  events are in agreement with the G I M model predictions.

Using a method which is independent of both the neutrino flux and nuclear interaction corrections, the ratio  $R$  of the total charged-current interaction cross sections of neutrinos on neutrons and protons has been measured as

$$R = 1.97 \pm 0.38$$

from the simple counting of events occurring in the TST and in a Ne volume downstream the TST.

The laboratories participating in the experiment are Bari, Birmingham, Ecole Polytechnique, Rutherford, Saclay and University College London; the Brussels physicists are D. Bertrand, J. Moreels, J. Sacton, C. Wilquet-Vander Velde, W. Van Doninck and G. Wilquet.

#### II.1.4. Search for the charmed particles in an hybrid emulsion-bubble chamber-counter experiment.

At the end of 1977 a total of 28 litres of emulsion located in front of BEBC had been exposed to the SPS  $\nu$  wide-band

beam during two runs corresponding to a total of  $\sim 10^{18}$  protons on the target. The analysis of this experiment is now complete and has yielded 6 examples of the production and subsequent decay of charmed particles : 3 neutral and 3 of positive charge. The flight times are of the order of a few times  $10^{-13}$  s, in agreement with the most recent theoretical estimates; no significant difference is observed between charged and neutral charmed particles. One of the events is identified as a  $\Lambda_c^+$  baryon of mass  $2.295 \pm 0.015$  GeV/c<sup>2</sup> which undergoes the decay process  $\Lambda_c^+ \rightarrow p + K^- + \pi^+$  with a proper decay time  $(7.3 \pm 0.1) \times 10^{-13}$  s.

The experiment has been made by a collaboration grouping Ankara, CERN, Dublin, Open University-Milton Keynes, Pisa, Rome, Torino and U.C. London. The physicists of the IIHE involved in this work are G. Bertrand-Coremans, J. Sacton, P. Vilain, J. Wickens and G. Wilquet.

## II.2. Hadron physics.

### II.2.1. The $K^-p$ experiment at 6.5 GeV/c.

(C. De Clercq, D.P. Johnson, J. Lemonne, P. Peeters, J. Wickens-IIHE, Argonne, Kansas, Michigan SU and Tufts (Boston) Collaboration).

The scanning and measurement phase (over 50.000 - 3 and 4-prong events) of this experiment has been completed as well as the experimental analysis of the inclusive  $V^0$  ( $\Lambda^0$ ,  $K^0$ ) production. Part of the latter data has been published and compared to theoretical predictions in the fragmentation region (quark counting rules of Brodsky and Gunion and triple-Regge model). Complements of this study are double  $V^0$  and inclusive resonance production.

Preliminary results concerning the exclusive channel  $K^-p \rightarrow K^-p \pi^+ \pi^-$  have already been discussed at the last scientific meeting of the Belgian Physical Society. They comprise the analysis of :

- resonance production via multidimensional and fraction methods,
- two subchannels, namely :

$$\begin{aligned} K^-p &\rightarrow Q^-p \\ &\rightarrow \Lambda^{++} K^- \pi^- \quad (K^- \pi^- \text{ scattering}). \end{aligned}$$

### II.2.2. $K^+p$ and $\bar{p}p$ interactions at 32 GeV/c.

(M. Barth, E. De Wolf, J.J. Dumont, M. Gysen, S. Tavernier, M. Van Immerseel, F. Verbeure - Collaboration : IIHE, Mons, France, Soviet Union).

The analysis of the 130.000 events already collected on DST is continued or has been completed on the following subjects :

- inclusive  $p$ ,  $\gamma$ ,  $\pi^0$  and  $K^0$  production
- inclusive resonance production ( $K^*$ ,  $\rho$ ,  $\phi$ ,  $\Delta^{++}$ ,  $\Sigma^*$ )
- single and double diffraction dissociation
- impact parameter analysis of  $K^+p$  and  $K^-p$  elastic scattering
- quasi-two body reactions
- Bose-Einstein effects
- possible resonance effects in  $\bar{\Lambda} \pi^+$ ,  $\bar{\Lambda} K^+$  and  $\bar{\Lambda} p$  systems
- polarization of  $\Lambda$  and  $\bar{\Lambda}$  hyperons in  $K^+p$  and  $K^-p$  interactions
- inclusive production of charged pions
- two-body production and tests of quark models.

An additional 300.000 photos have been taken and 300.000 more should become available in 1980. The data of both experiments will be used to study new resonances of the  $\phi$  family or  $(\Lambda, \bar{\Lambda})$ -bound states; positive evidence for such effects has been found and will be published.

About 40.000  $\bar{p}p$  events are now available. Results have already been presented at the Geneva and Goa Conferences. The main subjects under study are :

- production of baryonic resonances
- inclusive production of charged pions,  $\pi^0$ 's and  $\gamma$ 's
- Kopylov and rapidity correlations.

### II.2.3. The $K^+p$ experiment at 70 GeV/c.

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

Results on the first part of this BEBC-experiment ( $\sim 40.000$  frames without EPI) have been published or released,

either in a final (cross sections and multiplicities) or preliminary (inclusive  $\pi^-$ ; slow proton and  $\Delta^{++}$  production) form.

A comparison of the data for slow proton production in the reaction  $K^+p \rightarrow p + \text{anything}$ , with a simplified triple-Regge parametrization of this reaction at 32 GeV/c, indicates the dominance of Pomeron exchange. Comparison of this reaction and  $K^+p \rightarrow \Delta^{++} + \text{anything}$ , with corresponding  $K^+p$  reactions at 32 GeV/c and pp reactions at 69 GeV/c shows evidence for factorization. Inclusive single particle distributions of negative secondaries in 70 GeV/c  $K^+p$  reactions are compared with data at lower energies and confirm "early" scaling in the fragmentation regions, whereas the cross section in the central region rises with energy. The invariant transverse momentum distribution in the central region shows thermodynamical behaviour when expressed in terms of transverse mass  $m_T = (p_T^2 + m^2)^{1/2}$ .

An additional amount of 120.000 frames with EPI was taken of which the scanning and measurement has been undertaken.

#### II.2.4. The study of prompt lepton production in antiproton-proton interactions at 70 GeV/c in BEBC equipped with a track sensitive target.

(J. Lemonne, G. Vanhomwegen, F. Verbeure, J. Wickens - IIHE, Helsinki, Liverpool, Mons, Stockholm Collaboration).

A total of  $\sim 85.000$  pictures, amounting to almost 50 % of all the available statistics, has now been scanned and partially rescanned (25 %). In this analysis,  $\sim 40.000$   $\bar{p}$  interactions in  $H_2$  have been recorded of which each track was followed over its entire length in all views, in a search for signatures characteristic of  $e^\pm$  tracks. Tracks considered to be produced by electrons (positrons) were measured and passed through a special version of the HYDRA geometrical reconstruction program. It appeared that the experimental method used only allows for a high electron detection and identification efficiency for those particles of sufficiently high momentum to penetrate the  $H_2/Ne$  mixture. Introducing a minimum momentum cut of 500 MeV/c to eliminate this difficulty, several single  $e^\pm$  candidates were detected in a subsample of  $\sim 20.000$   $\bar{p}$  interactions, in which detailed and repeated measurements were performed on

all single  $e^\pm$  and  $e^+ e^-$  candidates. Only those electrons (positrons) identified by signatures occurring in at least two different points of their track have been retained in order to minimize background. Studies of the electron identification efficiency and of the background problems are now being completed and it is expected that preliminary data on single  $e^\pm$  production and its bearing on the cross section for charm production will be released in 1980. Moreover, studies of high mass lepton pair production (both  $\mu^+ \mu^-$  and  $e^+ e^-$ ) are in progress.

#### II.2.5. Detection of short lived particles ( $\tau \sim 10^{-13}$ to $10^{-11}$ s) in $\pi^- p$ interactions at 370 GeV/c.

(J. Lemonne, J. Sacton, S. Tavernier, P. Vilain, J. Wickens - Collaboration : IIHE, CERN, Oxford, Padova, Rome, Rutherford, Trieste).

A small rapid cycling bubble chamber with a high spatial resolution ( $\sim 40 \mu\text{m}$ ) has been exposed at CERN to a  $\pi^-$  beam of 370 GeV/c. The aim of this experiment is the direct observation of the associated production of charmed particles.

Approximately 50.000  $\pi^- p$  interactions have been analysed as the result of the scanning of  $\sim 100.000$  frames. On the basis of "reasonable" criteria, of the order of 10 events can be considered as possible examples of associated production of charmed particles. This result, if not too strongly affected by the background problems still under study, indicates a plausible order of magnitude for the cross section for charmed particle production of a few tens of microbarn.

#### II.3. IIHE participation to EHS.

(S. Tavernier and F. Van Den Bogaert).

The study of a large Cerenkov detector with silica-aerogel as a radiator (SAD) has been completed in the course of 1979 and all ensuing important contracts with industry have been concluded. The main technical problems which had to be resolved are :



- a) The conception of a shielding of the photomultipliers operating in the high magnetic stray field of the bubble chamber nearby where SAD will be installed.
- b) The optimalization of the concentration of the Cerenkov light on the photomultipliers.

These problems have been satisfactorily resolved as described in the CERN reports CERN/EP/EHS/PH 79-4 and CERN/EP/EHS/PH 79-5.

Although the installation of SAD at CERN will start in 1980, tests of the apparatus as part of the complete EHS spectrometer will continue until 1981.

#### II.4. An investigation of $p\bar{p}$ events at 540 GeV C M energy with a streamer chamber detection system.

(D. Bertrand, J. Gaudaen, D. Johnson, H. Mulken, S. Tavernier and G. Wilquet; UA5 Collaboration : IIHE, Bonn, Cambridge, CERN and Stockholm).

In LSS4 of the CERN Collider, 2 streamer chambers of dimensions  $6 \times 1.25 \times 0.5 \text{ m}^3$  triggered by a system of counters, will be installed. Such a detector providing a good spatial resolution, a high detection efficiency and about  $4\pi$  solid angle covering is well adapted to the topological analysis (multiplicities and pseudo-rapidities) of the high multiplicity events to be expected at these energies (Centanro events). The streamer chambers will be equipped with metal plates allowing  $\pi^0$  detection. The experiment is presently in its early technical preparation phase. It is expected that the essential components of the apparatus will be ready in 1980 in order to be tested at the ISR. The exposure at the Collider should take place in 1981 in the early stage of the machine running. D. Johnson has devoted a large part of his time on this project at CERN. J. Gaudaen and G. Wilquet have joined him in the last months of the year.

### III. SEMINARS AND LECTURES.

- The practical work for students attending the lectures of J. Lemonne and J. Sacton (3rd and 4th years 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.
- During this year, three students have completed their "mémoire" or "proefschrifte" at the IIHE :  
 Johan Moreels : Bijdrage tot de studie van neutrino wisselwerkingen bij hoge energie in een bellenvat uitgerust met een spoorgevoelig doel.  
 Rosette Vandenbroucke : Développement d'un réseau local entre un ordinateur DEC system 10 et deux ordinateurs DEC PDP-11/40.  
 Philippe Vienne : Interactions de Neutrinos. Production de particules à vie courte.
- J. Lemonne was invited by the Physics Department of the University of Helsinki to give a talk on "Slow proton and  $\Delta^{++}$  production in  $K^+p$  interactions at 70 GeV/c".
- P. Van Binst has given a series of lectures entitled "Notions pratiques d'informatique" at the Faculty of Sciences of the ULB.
- P. Van Binst has given a talk at the "Convention Informatique" (Paris) : "Study of the replacement of the computers at the Brussels Universities Computer Center".
- P. Van Binst has given a talk at the REAL TIME DATA '79 Symposium in Berlin : BROLNET, Development of a small network for distributed realtime data processing.
- R. Roosen presented a talk at the "1979 International Conference on Hypernuclear and low energy kaon physics" (Jabona-Poland) on : Final states for multinucleonic  $K^-$  meson absorption at rest in liquid helium.
- J. Sacton has been invited to present a talk on "The present status of the searches, in emulsion, for charmed particles produced in Neutrino Interactions" at the XIVth Rencontre de Moriond - Les Arcs.

- F. Verbeure has given an invited talk on "Inclusive pion production in 32 GeV/c  $K^+p$  interactions" at the XIV Rencontre de Moriond - Les Arcs.
- In the framework of the Seminars on Elementary Particles organized by the Institute, the following lectures have been given :
  - . Prof. S. Barshay (Leuven) : How to study a gluon jet produced by  $\bar{p}p$  colliding beams.
  - . P. Vilain : Observation of charmed particles produced by neutrino interactions in nuclear emulsion.
  - . J. Sacton : Selected topics from the 1979 lepton photon symposium.
  - . J. Morfin (Aachen) : Comparison of neutrino results with QCD predictions.
  - . P. Vilain : Neutrino bubble chamber physics at Tevatron energies (summary of the Argonne Workshop).

#### IV. COMPUTERS AND DATA PROCESSING.

Two kinds of data processing tasks are handled at the IIHE. One is the on-line acquisition of data from manual or automatic measuring machines with associated guidance and, for some devices, on-line geometrical reconstruction; the other one is the batch or interactive processing of the large quantities of measured events through a chain of geometry, kinematics and data analysis programs.

The on-line tasks are run on four DEC computers installed at the IIHE : a DEC system 10, two PDP-11/40's and a PDP-8. The measuring machines are a POLLY film reader and four SAAB tables on the DEC-10, a SWEEPNIK reader on a PDP-11, five BEBC tables on the other PDP-11 as well as a PROSAM device, through the PDP-8. Work is in progress to link the PDP-11's to the DEC-10 in order to provide background computational power to the minicomputers.

The second category of tasks, which are essentially computer-bound or data manipulation jobs, are run on the DEC system 10 and on the CDC 6600 and 6500 computers of the ULB-VUB Computer Centre.

All the physicists of the lab are involved in the programming and data processing tasks, together with the programmers (G. Depiesse, G. Rousseau and R. Vandenbroucke) and some engineers and technical staff.

The IIHE computers are under the management of P. Van Binst. They are used in open shop, 24 hours a day and 7 days a week. Their mean overall availability is in excess of 96 % (unscheduled down-time is of the order of 2 %). Over the 168 hours week, the use of the DEC-10 CPU has been greater than 47 %.

Some configuration changes have been made on the DEC-10 (tape drive addition and line printer replacement) and the "BEBC" PDP-11 (central memory extension); more terminals have also been installed. Software has been installed or upgraded on the various computers, at the applications, utilities and system level (TOPS-10 6.03 with virtual memory option on the DEC-10 and RSX-11M 3.1 on the PDP-11's).

#### V. TECHNICAL WORK.

- M. Barth and G. Bertrand-Coremans have carried out technical tests of Kodak emulsion at Fermilab in preparation of an experiment to be performed with a neutrino beam in 1980.
- The following work has been accomplished by the technical staff of the workshop (J.P. Dewulf, L. Etienne, R. Gindroz, R. Goorens, E. Lievens, J. Muller, Ch. Nadin, R. Ruidant, G. Van Beek, L. Van Lancker, G. Vincent, Ch. Wastiels) :
  1. Maintenance of the scanning and measurement tables of the IIHE.
  2. Study and test of a new interface of the Polly automatic machine to introduce an infra red camera.
  3. Transformation of the Prosam measurement machine into a high precision BEBC equivalent measurement device.
  4. On-line connection to a PDP-11/40 of scanning and measurement apparatus for BEBC film.
  5. Study of the construction and realization of :
    - a) part of the BEBC measurement equipment (track ball + xy command)

- b) universal film drive as a basic component of film copying machine
- c) a scanning table for 50 mm non-perforated film (LEBC) with two magnifications (10 to 20 and 40 to 60).
- 6. Study of the mechanical support and magnetic shielding of the aerogel Cerenkov counter (EHS projet).
- 7. Study and construction of the reflectors for the aerogel counters.
- 8. Modification of the BEBC-prototype table (improvement of the optical projection).

#### VI. ATTENDANCE TO CONFERENCE AND SCHOOLS.

- J. Lemonne, E. De Wolf and F. Verbeure have attended the Xth International Symposium on Multiparticle Dynamics (Goa, India). At this occasion talks were given by J. Lemonne and F. Verbeure.
- S. Tavernier has attended the XVIII International Conference Universitatswochen fur Kernphysik (Schladming, Austria).
- M. Barth, C. Wilquet-Vander Velde and W. Van Doninck have attended the XXth International Conference on High Energy Physics at Geneva.
- G. Vanhomwegen and M. Van Immerseel have attended the 1979 JINR CERN School of Physics (Dobogoko, Hungary).
- R. Vandenbroucke and P. Van Binst have attended the Decus Europe Symposium (Monte-Carlo, Monaco).
- G. Bertrand-Coremans, J. Sacton and P. Vilain have attended the International Neutrino 79 Conference at Bergen.
- J. Sacton has attended the International Symposium on Lepton and Photon interactions at High Energies at Fermilab-Batavia.
- P. Vilain has attended the Workshop on Neutrino Bubble Chamber Physics at Tevatron Energies at Argonne. He participated to a sub-group on "high resolution optics".
- P. Vilain has attended the Workshop on the production of new particles in super high energy collisions  $\sqrt{s} = 10^2 - 10^5$  GeV at Madison.

- P. Van Binst has visited the following computer centres for the ULB-VUB Computer Centre study : RECKU (Copenhagen), Rieter (Wintertur), PTT Darmstadt, Technische Hochschule Aachen.
- P. Van Binst has attended the BENELUG (DEC system 10 and 20 local users group) meetings in Wageningen, Utrecht and Rotterdam.
- R. Vandenbroucke has attended the BENELUG meeting in Antwerpen.
- P. Van Binst has attended the UNIVAC Users Association Europe meeting in Paris.
- D. Bertrand has attended the 17th International School on Sub-nuclear Physics at Erice.

#### VII. LIST OF PUBLICATIONS.

- A study of the  $\Lambda \pi^- p d$  final state produced in  $K^-$  meson interactions at rest in helium  
R. ROOSEN, C. WILQUET-VANDER VELDE, J.H. WICKENS et al  
Nuovo Cimento 49A (1979) 217.
- Study of inclusive reactions  $K^- p \rightarrow \bar{K}^0 X$  and  $K^- p \rightarrow \Lambda X$  at 6.5 GeV/c  
C. DE CLERCQ, D.P. JOHNSON, J. LEMONNE, P. PEETERS, P. RENTON, J.H. WICKENS  
Physical Review D19 (1979) 3197.
- Cross sections and multiplicity distributions for  $K^+ p$  interactions at 70 GeV/c  
M. BARTH, C. DE CLERCQ, E. DE WOLF, J.J. DUMONT, M. GYSEN, D.P. JOHNSON, J. LEMONNE, P. PEETERS et al  
Z. Phys. C2 (1979) 285 and CERN/EP 79-58.
- Transverse momentum correlations and impact-parameter bounds for exclusive  $K^+ p$  reactions at 32 GeV/c  
E. DE WOLF, M. GYSEN, S. TAVERNIER, F. VERBEURE et al  
Phys. Rev. D19 (1979) 1336.

- A study of  $\bar{\Lambda} \pi^+$ ,  $\bar{\Lambda} K^+$ , and  $\bar{\Lambda} p$  production in 32 GeV/c  $K^+p$  interactions  
E. DE WOLF, J.J. DUMONT, M. GYSEN, F. VERBEURE et al  
Nucl. Phys. B158 (1979) 253.
- Implementation of a Sweepnik system and its performance in measuring Mirabelle pictures  
M. BARTH, J.P. DEWULF, J.J. DUMONT, M. GYSEN, P. VAN BINST, R. VANDENBROUCKE  
Bulletin of the IIHE-79.03.
- Upper limit to the cross section for  $\bar{\nu}_\mu + e^- \rightarrow \bar{\nu}_\mu + e^-$  at high energy  
D. BERTRAND, J. SACTON, C. WILQUET-VANDER VELDE, W. VAN DONINCK, G. WILQUET et al  
Phys. Lett. 81B (1979) 385.
- Observation of a second charmed particle produced by a high energy neutrino and decaying after a few times  $10^{-13}$  s  
G. BERTRAND-COREMANS, J. SACTON, P. VILAIN, J. WICKENS, G. WILQUET et al  
Phys. Lett. 80B (1979) 428.
- Present status of the searches, in emulsion, for charmed particles produced in neutrino interactions  
J. SACTON  
Bulletin of the IIHE-79.02 and  
XIVth Rencontre de Moriond Vol. II Current Hadron Interactions p. 371.
- On the lifetime of charged charmed particles. First direct observation of a charmed baryon decay  
G. BERTRAND-COREMANS, J. SACTON, P. VILAIN, J. WICKENS, G. WILQUET et al  
Phys. Lett. 84B (1979) 150.
- An upper limit to the cross section for the reaction  $\bar{\nu}_\mu e^- \rightarrow \bar{\nu}_\mu e^-$  at SPS energies  
D. BERTRAND, G. BERTRAND-COREMANS, M. DEWIT, J. SACTON, P. VILAIN et al  
Phys. Lett. 84B (1979) 354.

- Comparison of single  $\pi^0$  production by  $\nu$  and  $\bar{\nu}$  neutral currents  
C. WILQUET-VANDER VELDE, P. VILAIN et al  
Phys. Lett. 82B (1979) 461.
- Experimental study of single-pion production in charged current neutrino interactions  
M. DEWIT, C. WILQUET-VANDER VELDE, P. VILAIN et al  
Lett. al Nuovo Cimento 24 (1979) 540.
- Non-diffractive two-body channels in reactions  $K^+ p \rightarrow K^0 \pi^+ p$  and  $K^+ p \rightarrow K^+ \pi^- \pi^+ p$  at 32 GeV/c  
M. BARTH, J.J. DUMONT, F. VERBEURE et al  
Nucl. Phys. B153 (1979) 280.
- Total cross section for neutrino charged current interactions at 3 GeV and 9 GeV  
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