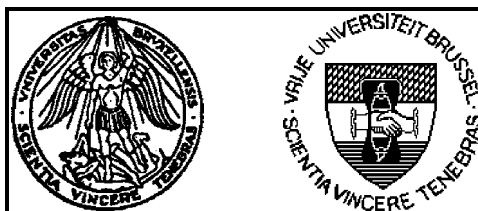


INTER-UNIVERSITY INSTITUTE FOR HIGH ENERGIES

ULB-VUB, BRUSSELS

ANNUAL REPORT 1996



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J. LEMONNE and J. SACTON,

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I. INTRODUCTION

The work presented in this report is supported by the **Université Libre de Bruxelles (ULB)**, the **Vrije Universiteit Brussel (VUB)**, the **Fonds National de la Recherche Scientifique (FNRS)**, the **Fonds voor Wetenschappelijk Onderzoek (FWO)**, the **Fonds pour la Formation à la Recherche dans l'Industrie et dans l'Agriculture (FRIA)** and the **Vlaams Instituut voor de bevordering van het wetenschappelijk-technologisch onderzoek in the industrie (IWT)**.

The physicists, engineers and computer scientists whose names are listed below have contributed to the different activities of the Institute during the year 1996.

U.L.B.

P. Annis (boursier, région Sardaigne)
M. Barth (maître de recherche FNRS - until August 96)
D. Bertrand (directeur de recherche FNRS; chargé de cours temps partiel)
G. Bertrand-Coremans (chef de travaux)
O. Bouhali (doctorant)
B. Clerbaux (boursière FRIA)
R. El Aidi (doctorant)
M. Elamiri (doctorant)
V. Lefébure (boursière FRIA)
P. Marage (agrégé de faculté; chargé de cours-temps partiel)
A. Panitch (boursier ULB)
J. Sacton (professeur ordinaire)
J. Stefanescu (boursière FRIA)
F. Tallouf (doctorant)
M. Vander Donckt (boursière FRIA)
C. Vander Velde (chargé de cours associé)
P. Vanlaer (boursier FRIA until October 96; then aspirant FNRS)
P. Vilain (chercheur qualifié FNRS; chargé de cours temps partiel)
J. Wickens (chercheur IISN)
G. Wilquet (chercheur qualifié FNRS; chargé de cours temps partiel)

L. Favart presently at LAL-Orsay is also "collaborateur scientifique" at the ULB

V.U.B.

P. Bruyndonckx (FWO post-doc until July 1996, IWT post-doc since August 1996)
Cao Fang (vrijwillig medewerker)
S. Claes (wetenschappelijk medewerker FWO until April 1996)
C. De Clercq (logistiek medewerker FWO)
A. Fremout (wetenschappelijk medewerker FWO since October 1996)
R. Heremans (wetenschappelijk medewerker FWO since October 1996)
D. Johnson (hoogleraar VESALIUS College)
J. Lemonne (gewoon hoogleraar)
X. Liu (VUBAROS beurs)
C. Mommaert (post-doc/FWO until June 96))
J. Nelissen (IWT-beurs until May 1996)
R. Roosen (onderzoeksleider FWO)
Ruru Chen (VUBAROS fellow since July 1996)
S. Tavernier (onderzoeksdirecteur FWO)
A. Tomaradze (wetenschappelijk medewerker from May to October 1996)
F. Udo (gastprofessor - deeltijds 20 %)
R. Vandenbroucke (logistiek medewerker FWO)
B. Van De Vyver (aspirant FWO since October 1996)
W. Van Doninck (onderzoeksdirecteur FWO)
P. Van Esch (wetenschappelijk medewerker FWO)

—

A. Van Lysebetten (wetenschappelijk medewerker FWO)

J. Wulleman (OZR-vorser)

Zhang Shuping (rectorale beurs until November 1996)

W. Beaumont (since April 96), T. Beckers, F. Botterweck (until July 96), S. De Brabandere, J. Detroy (since October 96), E. De Wolf, Ch. Ruru (until June 96), A. Tomaradze, P. Van Mechelen and F. Verbeure from the Universitaire Instelling Antwerpen have been working in close collaboration with the Institute.

Research in the field of telecommunications and data is conducted at IIHE/VUB by R. Vandenbroucke, Z. Cekro and N. Meulemans in collaboration with the members of the "Service Télématique et Communication" at the ULB : P. Van Binst, Y. Brants, J. Castera, A. Cohen, M. Colin, L. Franck, A. Guillen, Hyoung-Jun Kim, E. Mannie, N. Messori, R. Najmabadi Kia, O. Paridaens, N. Paroni, B. Sales, E. Tsigros and J.-M. Verbergt.

II. RESEARCH ACTIVITIES.

II.1. NEUTRINO PHYSICS.

II.1.1. Bubble chamber experiments.

(P. Marage).

The production of hadrons in charged current interactions has been studied with BEBC filled with a 75 mole % Ne-H₂ mixture or with H₂ and exposed to the CERN neutrino and antineutrino wide band beams. Smearing and systematic effects in the experimental data have been corrected for by using an unfolding procedure based on a detailed Monte Carlo simulation. Fast-hadron production in a neon target was found to be attenuated as compared to that in an hydrogen target. This feature was discussed within theoretical models based on the idea of a hadron formation length. The data were found to favour the "constituent" over the "yo-yo" length concept and suggest a quark cross section of the order of 3 mb.

II.1.2. The CHARM II experiment.

(P. Vilain and G. Wilquet - the WA79 Collaboration).

A leading order QCD analysis of the neutrino charm production has been performed using a sample of 4111 ν_μ and 871 $\bar{\nu}_\mu$ induced opposite-sign dimuon events. Two parameters of the standard model have been determined :

- the charm quark mass, $m_c = 1.79 \pm 0.38 \text{ GeV}/c^2$
- the Cabibbo-Kobayashi-Maskawa matrix element $|V_{cd}| = 0.209 \pm 0.016$, using an independent determination for the average semileptonic branching ratio of charm hadrons ($B_c = 10.15 \pm 1.25 \%$).

The strange quark content of the nucleon was found to be suppressed with respect to the non-strange sea quarks by a factor $x = 0.38 \pm 0.09$.

Another study about to be published concerns the so-called "trident" reaction, the neutrino induced production of muon pairs in the electromagnetic field of a nucleus. A cross section measurement of this process is interesting since it provides a direct test of the interference between the amplitudes of W and Z exchange as predicted by the standard model. The first significant observation of this reaction has been published in 1990, based on about 50 % of the final CHARM II data. In the present analysis, corresponding to a total integrated neutrino flux of $(2.01 \pm 0.12) \times 10^{12} \text{ cm}^{-2}$, a clear signal of 132 events above an estimated background of 55 events has been observed. The determination of the corresponding cross section and the analysis of the systematic errors are in progress.

II.1.3. The CHORUS experiment.

(P. Annis, R. El Aidi, C. Mommaert, M. Vander Donckt, B. Van De Vijver, P. Vilain and G. Wilquet - *the WA95 Collaboration*).

This experiment aims at finding evidence for ν_{μ} - ν_{τ} oscillations by detecting examples of the reaction $\nu_{\tau} + \text{nucleon} \rightarrow \tau^{-} + \text{hadrons}$ in a nuclear emulsion target exposed to the CERN SPS high energy neutrino beam. A tracking system made of scintillating fibers helps in finding the neutrino interactions in the emulsion; it is followed by a magnetic spectrometer, a calorimeter and a muon spectrometer.

During the first two years of operation (1994 and 1995) some 400.000 neutrino interactions were registered in the detector. The 1994 sample of events with a final state muon has been analyzed to select the events to be searched in the emulsion target. Up to now about 20.000 events have been located in the target and are being scrutinized for the presence of interesting topologies. This study should lead to a determination of the ν_{μ} - ν_{τ} oscillation probability at a sensitivity level corresponding to the present limits.

The second two-year analysis period has started early this year with 4 new emulsion stacks. The increased beam intensity and the excellent detector efficiency (95 %) have allowed to accumulate 300.000 additional neutrino interactions.

Various modifications to the detector had been made before the 1996 run, in particular :

- three planes of emulsion have been installed on each side of the magnet to improve the momentum measurement of the charged particles emitted from the neutrino interactions
- six streamer chambers located in front of the calorimeter have been replaced by 18 planes of "honeycomb" chambers of higher spatial resolution ($\sigma \sim 300 \mu\text{m}$ vs 3 mm) which should improve the track reconstruction downstream the magnet.

II.2. STUDY OF $e^{+}e^{-}$ ANNIHILATIONS AT LEP.

(D. Bertrand, F. Cao, S. De Brabandere, C. De Clercq, M. Elamiri, V. Lefébure, J. Lemonne, A. Tomaradze, C. Vander Velde, W. Van Doninck, A. Van Lysebetten, F. Verbeure, J. Wickens - *the DELPHI Collaboration*).

The collaboration between the Belgian groups (IIHE/ULB-VUB, Mons, UIA) and the laboratories of Oxford and Rutherford has been responsible for running the muon chambers of the DELPHI detector.

During 1996, LEP was operated at various energies : at the Z° peak, for calibration purposes, and successively at 130, 136 and 161 GeV to finally reach the record energy of 172 GeV.

In the following, the main results presented at conferences or published during the present year are summarized :

A. At the Z° peak.

a. Using a sample of 4 millions of events accumulated until the end of 1995, a new determination of the Z° resonance parameters and of the electroweak couplings has been made; allowing for lepton conservation, a fit to the hadronic and leptonic cross sections and asymmetries yields the following results :

$$\begin{aligned}
 M_Z &= 91.1859 \pm 0.0028 \text{ GeV} \\
 \Gamma_Z &= 2.4896 \pm 0.0042 \text{ GeV} \\
 \sigma_0^h &= 41.566 \pm 0.079 \text{ nb}
 \end{aligned}$$

-

$$R_l = \Gamma_h/\Gamma_l = 20.754 \pm 0.068 \quad \text{with } l = e, \mu \text{ or } \tau$$
$$A_{\text{FB}}^0(l) = 0.0175 \pm 0.0020$$

The asymmetry parameters $A_1 = \frac{2 g_{V1} g_{A1}}{g_{V1}^2 + g_{A1}^2}$ as measured from the longitudinal polarisation of τ -pairs are

:

$$A_\tau = .138 \pm .009 \pm .008 \quad \text{and} \quad A_e = .140 \pm .013 \pm .003,$$

in good agreement with lepton universality.

b. A first study of the interference between initial and final state radiation in the process $e^+ e^- \rightarrow \mu^+ \mu^-$ has been performed by measuring the forward-backward asymmetry as a function of the acoplanarity angle between the final state muons. This interference effect depends on the width Γ_Z which was derived to be : $\Gamma_Z = 2.50 \pm .21 \pm 0.06$ GeV, in good agreement with the results of direct Γ_Z measurements from the Z-line shape.

c. The tau lepton lifetime has been measured using different methods. The combination of two measurements of one-prong decays gave the result $\tau_\tau = (291.8 \pm 3.3 \pm 2.0)$ fs, while the decay length distribution of 3-prong decays gave $\tau_\tau = (286.7 \pm 4.9 \pm .3)$ fs. A combination of these values with previous DELPHI measurements yielded $\tau_\tau = (291.4 \pm .3)$ fs from which a ratio of τ - to μ - coupling constants to the W^\pm , $g_\tau/g_\mu = .990 \pm .009$ was derived.

d. The inclusive differential cross section as a function of the energy has been measured for π^0 -production in $q\bar{q}$ - and $f\bar{f}$ -events. The number of π^0 's per hadronic event was found to be $9.2 \pm .2 \pm 1.0$; for bb -events the corresponding number was $10.1 \pm .4 \pm 1.1$. The measured π^0 -cross sections were compared with the production of different parton shower models.

e. The inclusive production of the $f_2'(1525)$ resonance has been studied, in particular through its $K^+ K^-$ decay, using the RICH detector. Its average production rate per hadronic Z^0 -event ($\langle f_2' \rangle = .020 \pm .005 \pm .006$) and the f_2' momentum distribution have been measured. The results are consistent with the assumption that the $f_2'(1525)$ is an $s\bar{s}$ -tensor meson.

The inclusive production rates and differential cross sections of neutral vector mesons $K^{*0}(892)$ and $\phi(1020)$ as well as of the tensor meson $K_2^{*0}(1430)$ have also been measured and compared to QCD-based Monte Carlo models such as JETSET and HERWIG which generally provide a reasonable description of the data. However, a large discrepancy was observed in the case $K_2^{*0}(1430)$ production.

f. The first measurement of like-sign charged kaon correlations in the hadronic decays of Z^0 's has been performed. The charged kaons were identified by the ring imaging Cherenkov detectors. A significant enhancement of like sign kaon production was observed at small values of their four momentum difference. An update of the measurement of $K_S^0 K_S^0$ interference showed similar effects quantified by similar Bose-Einstein correlation parameters.

g. A study of the production of Σ^0 and Ω^- led to the following average production rates per event :

$$\langle \Sigma^0 + \bar{\Sigma}^0 \rangle = .070 \pm .010 \pm .010 \quad \text{and} \quad \langle \Omega^- + \bar{\Omega}^- \rangle = .0014 \pm .0002 \pm .0004$$

h. A search was made for the production of heavy quarkonium states J/Ψ , $\Psi(2s)$ and $\gamma(1s)$ $\gamma(2s)$ or $\gamma(3s)$ in a sample of over 3 million Z^0 -decays and upper limits ($< 10^{-4}$ and $< 10^{-3}$ at 90 % CL) were set on their production rates.

i. Three jet events were used to measure differences in quark and gluon fragmentation characteristics. The average value of the ratio of the mean charged multiplicities of gluon and quark jets was : $\langle r \rangle = 1.241 \pm .015 \pm .025$.

Using a correlation method based on the different particle multiplicity distributions of quark and gluon jets, a 95 % CL upper limit for the $Z^0 \rightarrow g g g$ branching ratio has been estimated at 1.6×10^{-2} [Jade jet finder] or 1.5×10^{-2} [DURHAM jet finder].

Photon plus n-jet events were used to measure the strong coupling constant : $\alpha_s(M_Z) = .116 \pm .003 \pm .009$.

j. A measurement of the photon structure function F_Z^γ was performed in a Q^2 -range from 4 to 30 GeV/c^2 down to x-values around .001 using events of the type $e^+e^- \rightarrow e^+e^- X$, where X- is a system of particles produced by a collision of two photons radiated from the beam particles. The measured Q^2 -evolution of F_Z^γ was derived and compared to QCD-calculations.

k. Three different measurements of the partial decay width $R_b^0 = \Gamma_{b\bar{b}} / \Gamma_h$ of the Z^0 into b-hadrons have been performed. The combined result can be expressed as

$$R_b^0 = .22194 \pm .0032 \pm .0022 \left(- .0049 \frac{R_c - .172}{.172} \right)$$

Assuming the standard model (SM) value $R_c = .172$, this result is 2.3 standard deviations higher than the SM prediction $R_b^{\text{SM}} = .2155 \pm .005$ (taking $m_t = 180 \pm 12 \text{ GeV}/c^2$).

l. An update of the mean lifetime of the B_b^0 -mesons gave the result : $\tau(B_b^0) = (1.67 \pm .14) \text{ ps}$

A determination of the average lifetime of b-baryons by different methods led to the combined result :

$$\tau(\text{b-baryon}) = (1.255 \pm .115 \pm .102) \text{ ps}$$

Finally, a measurement of the average lifetime of b-hadrons using inclusive reconstructed secondary vertices yielded the result : $\tau_B = (1.575 \pm .010 \pm .026) \text{ ps}$

m. From a sample of five fully reconstructed Λ_b^0 -decays found in 3 million Z-events, the mass of this baryon was measured to be $m_{\Lambda_b} = (5668 \pm 16 \pm 8) \text{ MeV}/c^2$.

n. A determination of $|V_{cb}|$ from the semileptonic decay $B^0 \rightarrow D^{*-} l^+ \nu_l$ led to the result :

$$|V_{cb}| = [38.9 \pm 2.0 \pm 2.6 \pm 1.7 (\text{theory})] \times 10^{-3}$$

Moreover, the branching ratio : $\text{BR}(B^0 \rightarrow D^{*-} l^+ \nu) = (5.52 \pm .17 \pm .68) \%$ was determined.

o. The time dependence of the $B_d^0 - \bar{B}_d^0$ oscillations has been used to extract the mass difference

$$\Delta m_d = \left(.531 \begin{smallmatrix} +.050 \\ -.046 \end{smallmatrix} \pm .078 \right) \text{ ps}^{-1} = \left(3.49 \begin{smallmatrix} +.33 \\ -.046 \end{smallmatrix} \pm .52 \right) 10^{-4} \text{ eV}/c^2 \text{ between the two physical } B_d^0 \text{-states.}$$

p. Rare decays of beauty particles were studied in several charmless modes. Evidence for charmless B-decays was found for two body decay modes with branching ratios :

$$\text{BR} \left(B_{d,s}^0 \rightarrow \pi^+ (\text{or } K^+) \pi^- \right) = \left(2.8^{+1.5}_{-1.0} \pm .2 \right) 10^{-5}$$

and

$$\text{BR} \left(B_u^0 \rightarrow \rho^0 (\text{or } K^{*0}) \pi^- \right) = \left(1.7^{+1.2}_{-.08} \pm .2 \right) 10^{-4}$$

q. A search for a high mass resonance decaying into $\gamma\gamma$ motivated by a previous study of $1^{+1} \gamma\gamma$ events by the L3 collaboration, yielded a negative result from a sample of 3.5 million Z^0 -decays. No evidence was found for events clustering in $\gamma\gamma$ -mass regions above $10 \text{ GeV}/c^2$ in any channel considered.

B. At $\sqrt{s} = 130 \text{ GeV}$ (and 136 GeV).

- a. The average charge multiplicity $\langle n_{\text{ch}} \rangle = 23.84 \pm .51 \pm .52$ measured at $\sqrt{s} = 130 \text{ GeV}$ is consistent with lower energy data for a Q^2 -evolution of α_s such that : $\alpha_s(130 \text{ GeV}) = .105 \pm .003 \pm .008$
- b. A measurement of the single photon production in the reaction : $e^+e^- \rightarrow \gamma + \text{invisible particles}$ was found to be compatible with the S.M. prediction for the reaction $e^+e^- \rightarrow \gamma \nu \bar{\nu}$ and corresponds to a number of neutrino families $N_\nu = 3.1 \pm .6$. Limits were also derived on anomalous gauge boson couplings and on compositeness.
- c. Radiative leptonic (e, μ, τ) events were studied and compared to the S.M. predictions. These data were used in a search for excited charged leptons decaying to their ordinary ground state by the emission of a photon. No significant signal was observed. From a search for pair produced excited leptons the following 95 % confidence limits were derived :

$$m_{e^*} > 62.5 \text{ GeV}/c^2; \quad m_{\mu^*} > 62.6 \text{ GeV}/c^2 \quad \text{and} \quad m_{\tau^*} > 62.2 \text{ GeV}/c^2.$$

- d. A search for the production of the lightest chargino particle was carried out in the framework of the Minimal Supersymmetric Standard Model. No evidence of a signal was found and lower mass limits ranging from $56.3 \text{ GeV}/c^2$ to the kinematic limit were derived for various scenarios.
- e. A search for neutralinos, scalar leptons and scalar quarks in events with jets or leptons produced in conjunction with missing momentum, also remained negative.
- f. No candidates were found in a search for pair production of heavy objects in 4-jet events (e.g. the production of Higgs particles in hA or H^+H^- -final states). No significant excess was found of 4-jet events with high multiplicity and high mass (as seen by ALEPH) although a slight excess is observed in the mass region around $105 \text{ GeV}/c^2$.

C. At 161 GeV .

The DELPHI collaboration has observed the first W-pair event.

In addition to the classical topics implying the study of $Z^0 \rightarrow \mu^+\mu^-$ and $Z^0 \rightarrow \tau^+\tau^-$ line shape and asymmetries, the interest of the DELPHI members of the IIHE/ULB-VUB was mainly oriented towards the following physics subjects :

- i) radiative $e^+e^- \rightarrow \mu^+\mu^- \gamma$ processes
- ii) τ -polarisation and decay properties
- iii) study of WW - pair production.

Initial state radiation has been isolated in the radiative processes $e^+e^- \rightarrow \mu^+\mu^- \gamma$ with the aim of improving the cross-section and asymmetry measurements in $e^+e^- \rightarrow \mu^+\mu^-$ interactions below the Z^0 -peak ($20 \leq \sqrt{s} \leq$

87 GeV). The analysis of the data collected until 1994 was optimised and preliminary results were contributed to conferences.

The decay channels of the τ lepton into 1 charged particle and any neutrals were used to determine the Lorentz structure of the weak charged current. A by-product of this analysis was the precise determination of the corresponding branching fractions taking into account a fully correlated efficiency matrix at the level of the particle identification. The analysis was performed on data collected from 1992 until 1995.

A study of WW - pair production was started at LEP200 with the aim to analyse the triple gauge boson coupling.

At the UIA, work was done on the determination of the decay branching ratios of the τ lepton in different multipion modes and on the τ polarization. Using WW events where, on one hand both W's decay hadronically and on the other hand one W decays leptonically, it was shown that, at the present level of statistics, there is no evidence for correlations between pions of different W's.

General hardware and software tasks were performed by the DELPHI members of the IIHE/ULB-VUB in order to ensure successful data taking runs.

II.3. STUDY OF $e^{\pm}p$ COLLISIONS AT HERA.

(M. Barth, G. Bertrand-Coremans, F. Botterweck, A. Buniatian, R. Chen, B. Clerbaux, E. De Wolf, Z. Garutchava, D. Johnson, P. Marage, A. Panitch, R. Roosen, P. Van Esch, P. Van Mechelen - the H1 Collaboration).

After a long shut down in winter 1995-1996, it was decided that the HERA runs in 1996 and 1997 would consist essentially in one long run over the two years, with only a short shut down from December 1996 to February 1997. In the first part of this run (June-November 1996), HERA has accumulated a total luminosity of 15 pb^{-1} , of which 8 are to be used for physics analysis.

Compared to the first 3 years of running (1992-1994), the data taking of H1 is characterised by the need to handle higher instantaneous luminosities and features induced by the installation of a new backward calorimeter, the SPACAL, during the 1994-95 shut down. Indeed, the installation of the SPACAL induces a much higher trigger rate for physics events (photoproduction and deep inelastic scattering) due to the extended angular acceptance and to lower energy thresholds required by progresses in the physics analysis. In addition, a very high trigger rate is due to the detection of parasitic energy deposition in restricted areas of the SPACAL ("hot spots"). A major effort in 1996 was thus devoted by the H1 Collaboration to the implementation of new triggers schemes ("level 2 triggers") and to the definition of an improved strategy for (on-line) event selection, in order to eliminate the effects of the "hot spots" and to decrease the amount of events written on tape for classes with very high cross section (e.g. low Q^2 events). These new schemes will be fully operational in 1997.

The general performance of the detector in 1996 was satisfactory, except for the "hot spots" and for the silicon vertex detector, which had to be switched off because unacceptable noise in the rest of the detector. A new forward neutron counter was installed, and worked properly.

The COP chambers, which are under the responsibility of the Belgian group, were functioning in a very stable way over the years. Apart for the 3 sectors (on a total of 32) which are down since 1992 because of a broken wire, the sector efficiencies ranged from 90 to 99 %.

The main physics results presented at conferences or published in 1996 are based on the data accumulated until the end of 1994; they can be summarized as follows :

A. Measurement and QCD analysis of the proton structure function $F_2(x, Q^2)$.

The $F_2(x, Q^2)$ measurement has been published for $1.5 < Q^2 < 5000 \text{ GeV}^2$ and $3 \cdot 10^{-5} < x < 0.32$. A significant extension of the accessible kinematic range, compared to the 1993 data, is due to a tenfold increase in statistics, and to the use of two dedicated data samples : events with a shifted vertex and events with initial state radiation. The structure function is found to increase significantly with decreasing x , even in the lowest accessible Q^2 region. The data are well described by a Next to Leading Order QCD fit, and the gluon density in the proton has been extracted.

The first determination of the longitudinal structure function $F_L(x, Q^2)$ has been presented at conferences. It is obtained from a high y measurement of the total ep cross section, under the assumption that the proton distribution obtained at lower y can be extrapolated in Q^2 according to the DGLAP evolution equations.

B. Diffractive interactions.

i. Diffractive structure function.

The structure function $F_{2D}^3(x, Q^2, \beta)$ was measured for events with a large rapidity gap, including shifted vertex data. When this structure function is expressed as the product of a diffractive exchange flux and of a structure function of the exchanged object, a "factorisation breaking" is observed, which is attributed to the contribution of both pomeron and reggeon exchanges (for $x/\beta < 0.05$).

The Q^2 and β dependences of the structure function indicate that the pomeron is a gluon dominated object. A QCD (DGLAP) evolution study suggests a leading, nearly singular, gluon distribution at the starting scale ($Q^2 = 2.5 \text{ GeV}^2$).

ii. Vector meson production.

The following topics were covered in 3 published papers : ρ^0 photoproduction ($Q^2 \sim 0$), J/ψ elastic and inelastic photoproduction, and ρ^0 and J/ψ electroproduction ($Q^2 > 8 \text{ GeV}^2$).

The elastic photoproduction of ρ^0 mesons presents features expected in a Regge-VDM framework, characteristic of "soft" diffraction, i.e. a hadron-like behaviour.

The elastic (and proton dissociation) photoproduction of J/ψ mesons presents, in contrast, a rapid rise of the cross section with the available energy as expected for "hard" diffraction in a perturbative QCD framework with two-gluon exchange, the hard scale being provided by the charm quark mass. The inelastic (photon dissociation) photoproduction of J/ψ mesons is (within large errors) in agreement with NLO QCD calculations in a colour singlet model.

The elastic electroproduction of ρ mesons presents an energy dependence intermediate between soft and hard diffraction. This channel thus may provide an insight in the onset of hard diffractive phenomena expected in QCD when a hard scale is present. The electroproduction of J/ψ mesons exhibits, as expected, a hard behaviour already observed in photoproduction. The $J/\psi / \rho$ cross section ratio increases by several orders of magnitude from $Q^2 \sim 0$ to $Q^2 > 8 \text{ GeV}^2$.

Results were also presented at conferences on ρ electroproduction with proton dissociation, and on the elastic electroproduction of ϕ and ρ' mesons.

iii. Final state studies.

Several studies of the hadronic final state in diffractive interactions were performed : jet production (photo- and electroproduction), energy flow, thrust analysis and open charm production (electroproduction). The results are compatible with a model of gluon-dominated pomeron, as obtained from the QCD analysis of the diffractive structure function.

—

C. Hadronic final state studies.

Studies of the hadronic final state included :

i. Jet and energy flow in photoproduction.

The γp events can be consistently described by QCD models including - in addition to the primary hard processes - interactions between the two beam remnants.

ii. Energy flow in deep inelastic scattering.

The final state in DIS exhibits features expected if the interaction is interpreted as the scattering of an electron off a current quark, with associated effects of perturbative QCD. In diffractive events, the measurements are well reproduced by a partonic model of the pomeron.

iii. D^{\pm} meson production.*

The photoproduction of $D^{*\pm}$ mesons is reasonably reproduced, both for the total and the differential cross sections, by a NLO QCD calculation.

iv. A detailed analysis of the multiplicity distribution in deep inelastic scattering, compared to several models, and a study of strange particle production, compared to a NLO QCD calculation, will be published soon.

D. Electroweak studies.

The Q^2 dependence of the charged and neutral current cross section for e^-p (1993 data) and e^+p scattering (1993 and 1994 data) was found to be in agreement with the electroweak theory predictions.

E. Search for new particles.

Three papers were published, giving null results concerning the production of leptoquarks, squarks of R_p-violating SUSY, selectrons and squarks. Similar studies for the 1995 data also gave no discovery results.

In 1996, all IIHE and UIA members of the H1 Collaboration have contributed to the general detector operation in Hamburg. R. Chen, B. Clerbaux and P. Van Esch acted as local coordinators for the H1 multiwire proportional chambers, in collaboration with the Orsay and Zurich groups. The COP efficiencies were studied in Brussels by M. Barth and G. Coremans.

Various H1 softwares were maintained in Brussels by G. Coremans. The UIA group contributed large samples of simulated events for general purpose.

The Belgian contributions to the physics analysis mainly concern three topics : measurements of the proton structure functions, studies of diffractive interactions and studies of the hadronic final state in deep inelastic scattering.

a. Proton structure functions.

A. Panitch performed the analysis of the $F_2(x, Q^2)$ structure function at low x using the "satellite bunch" events, and contributed to the measurements using data taken with a shifted vertex; these results are part of the published paper on $F_2(x, Q^2)$.

The possibility of measuring the longitudinal structure function F_L using radiative events was presented in a paper published by L. Favart, M. Gruwé, P. Marage and Z. Zhang (Orsay).

P. Marage acted as H1 internal referee for the paper on the F_L determination using the cross section measurement in an extended y range.

b. Diffractive interactions.

B. Clerbaux finalised the study of ρ meson elastic production with $Q^2 > 8 \text{ GeV}^2$ using the 1994 data (paper published in 1996), and contributed to the study of the ϕ meson electroproduction (paper in preparation).

R. Roosen and P. Van Esch contributed to semi-inclusive analyses of the hadronic final state in diffractive interactions.

E. De Wolf acted as H1 internal referee for the paper on inclusive features of diffractive scattering in photoproduction (submitted for publication) and P. Marage as convenor of the working group on diffractive interactions.

c. Hadronic final state.

F. Botterweck, E. De Wolf and P. Van Mechelen have performed the analysis of the multiplicity distributions in deep inelastic scattering (paper submitted for publication).

A. Buniatian has contributed to the analysis on jet production in photoproduction.

E. De Wolf acted as convenor of the working group on hadronic final state since September 1996.

II.4. STUDY OF pp COLLISIONS AT LHC.

(W. Beaumont, T. Beckers, O. Bouhali, J. Detroy, F. Udo, J. Stefanescu, S. Tavernier, W. Van Doninck, C. Vander Velde, P. Vanlaer, L. Van Lancker and J. Wulleman - the CMS Collaboration).

The CERN Council has approved the construction of the "Large Hadron Collider" in the 27 km long LEP tunnel. This superconducting hadron collider will allow proton-proton collisions at a centre of mass energy of 14 TeV and should be operational towards the year 2005. The CERN Research Board has recommended to construct two multipurpose detectors ATLAS and CMS to study these collisions.

The experimental research groups from the IIHE(ULB-VUB), UIA, UCL and UMH are participating in a common effort to the design and construction of the "Compact Muon Solenoid" detector. Their contribution concentrates on the forward part of the central tracker consisting of some 6000 "Micro Strip Gas Counters" (MSGC), an effort conducted in collaboration with the groups from RWTH Aachen, CRN Strasbourg, Budker Institute Novosibirsk and the universities of Karlsruhe and Lyon.

For the mechanical support structure and the servicing scheme (gas, high voltage, low voltage and cooling) the design developed at the IIHE has been chosen among various competing projects. A full size carbon fiber structure (2.4 m diameter) of one detector wheel has been manufactured in collaboration with Aachen and Karlsruhe and is ready for the testing of its stiffness, stability and vibration modes. A carbon fiber-honeycomb composite was also developed and tested in collaboration with the laboratory for Structural Analysis of Materials of the VUB (Professor P. Dewilde) for the manufacturing of the MSGC gas boxes. Several full size boxes have been produced in collaboration with CRN Strasbourg. These support structures will be used to manufacture a milestone prototype wheel equipped with about 50 operational MSGC counters of 512 read out channels each.

A test set-up has been constructed at the UIA for measurements on MSGC's and MGC's, to be excited by a laser beam and with VME read-out.

Concerning the detector cell itself, the MSGC, a series of prototypes have been built and tested in a cosmic hodoscope and in particle beams at CERN. They have led to a series of results that validate the concept of the design of the forward MSGC tracker for CMS.

- A side by side assembly of MSGC substrates (wall-less ϕ crack) was proven to maintain full detection efficiency across the boundary.
- The resolution in the crack region was measured to be around 65 μm to be compared to 42 μm elsewhere.
- Gain and efficiency have been measured in novel Ne-DME gas mixtures and were found to improve the chamber's performance w.r.t. conventional Ar-DME and CO₂-DME mixtures.

- Gain and efficiency have been measured along the strips of wedge shaped MSGC substrates (as required in the forward region) and full detection efficiency was demonstrated.
- A scheme of strip and amplifier input protection, with fuses integrated in the anode bonding pads, has been successfully tested.
- In collaboration with IMEC (Leuven) we have developed substrates of a slightly different concept; the "Micro Gap Counter" (MGC), where anode strips are insulated from the cathode plane by polyimide strips. Patterning of the cathode plane then allows the measurement of 2 coordinates with a single substrate. High voltage behaviour and operation characteristics are being investigated.

In the framework of a collaborative effort within CMS, parts of the general software for the tracker have been developed in Belgium and integrated in the CMSIM program. This concerns the clustering algorithm for MSGC and MGC counters, the detailed description of the forward MSGC tracker structure, and the investigation of $b\bar{b}$ final states.

III. TEACHING ACTIVITIES AND SEMINARS

III.1. TEACHING ACTIVITIES (academic year 1995-1996)

- **M. Barth, D. Bertrand, O. Bouhali, B. Clerbaux, G. Coremans-Bertrand, V. Lefébure, P. Marage, A. Panitch, J. Stefanescu, M. Vander Donckt, P. Vanlaer, P. Vilain, J. Wickens and G. Wilquet** have contributed to the practical work for students attending the lectures of J. Sacton on "Physique des Particules Élémentaires" and organized specific practical work for students of the 3rd year in physics at the ULB.
- **D. Bertrand**
 - "Computer Principles" (26 h + 13 h exercises - 1st year University Studies in Sciences - ULB)
 - "Prise, analyse et simulation de données expérimentales" (10 h - licence spéciale en physique théorique - 2^{ème} licence en physique - ULB)
 - He acted as "coordonnateur pédagogique en physique" at the Faculty of Sciences - ULB.
- **G. Bertrand-Coremans**
 - "Physique Expérimentale" (120 h of practical work - 1^{ère} candidature en sciences pharmaceutiques - ULB).
 - She acted as secretary of the "Commission de coordination pour la physique" at the Faculty of Sciences - ULB.
- **S. Claes and P. Van Esch**
 - "Algemene Natuurkunde" (30 h exercises - 2^{de} kandidatuur natuurkunde, scheikunde - 1^{ste} lic. geologie - Prof. J. Lemonne - VUB).
- **C. De Clercq, R. Roosen, W. Van Doninck, P. Van Esch and A. Van Lysebetten** have contributed to the practical work for students attending the lectures of J. Lemonne on "Elementaire Deeltjes" - lic. natuurkunde VUB.
- **E. De Wolf**
 - "Waarschijnlijkheidsrekening en statistiek (30 u - 2^{de} kandidatuur natuurkunde RUCA)
 - "Fundamentele wisselwerkingen tussen elementaire deeltjes" (30 u - 2^{de} licentie natuurkunde UIA).
- **D. Johnson**
 - "Introduction to Physics II - Physics 103" (45 h - Vesalius College - VUB)
 - "Introduction to Physics I - Physics 101" (45 h - Vesalius College - VUB)
 - "Engineering 231" (45 h - Vesalius College - VUB)

All these lectures are accompanied by student consultation and regular interval student exercises.

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D. Johnson also assisted in the teaching and laboratory planning for the course "Physics Laboratory I - Physics 102" (Vesalius College - VUB).

□ **J. Lemonne**

- "Elementaire Deeltjes" (60 h + 60 h of practical work - 1^{ste} and 2^{de} licentie natuurkunde - VUB)
- "Algemene Natuurkunde" (60 h + 60 h of practical work - 2^{de} kandidatuur natuurkunde en scheikunde VUB and 30 h + 30 h of practical work - 1st licentie geologie VUB)
- "Statistische Analyse van Experimentele Gegevens" (15 h + 15 h exercises - licentie natuurkunde - VUB).

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□ **P. Marage**

- "Histoire des sciences" (15 h - 2^{ème} licence en sciences physiques et sciences mathématiques - ULB)
- "Physique" (60 h of practical work - 1^{ère} candidature Ecole de Commerce Solvay - ULB)
- Animator of the "Atelier - Histoire des Sciences et pédagogie de la physique", for secondary school teachers.
- Organizer of a 4-day formation on "Introduction à la civilisation et aux sciences du Moyen Age islamique" for secondary school teachers.

□ **J. Sacton**

- "Physique des Particules Elémentaires" (30h - 1^{ère} licence en sciences physiques - ULB)
- Local coordinator of an ERASMUS student exchange programme at the level of the 3rd and 4th years in Physics.

□ **S. Tavernier**

- "Detectie van Ioniserende Stralingen" (15 h + 15 h of practical work - 2^{de} licentie natuurkunde and bijzondere licentie medische fysica - VUB)
- Practical work 2^{de} kandidatuur natuurkunde, VUB
- Local coordinator of an ERASMUS-TEMPUS exchange program : European Mobility scheme for Physics Students.

□ **C. Vander Velde**

- "Mechanics 2" (26 h + 13 h of exercises - 1st year University Studies in Sciences - ULB)
- "Laboratory" (20 h - 1st year University Studies in Sciences ULB)
- "Physique Générale" (60 h of practical work- 1^{ère} Cand. Polytechnique ULB).

□ **W. Van Doninck**

- "Statistische analyse van experimentele gegevens" (15 h exercises - licentie natuurkunde - VUB)
- "Introduction to particle physics" (2 h - 1st year polytechnics - VUB).

□ **F. Verbeure**

- "Introduction to elementary particle and nuclear physics"
- "Elementary particle physics"
- "Numerical analysis"
- "Radioactivity"
- "Simulations in physics".

□ **P. Vilain**

- "Questions Approfondies de Physique des Particules" (15 h + 45 h of practical work - 2^{ème} licence en physique - ULB).

□ **G. Wilquet**

- "Prise, analyse et simulation de données expérimentales" (20 h - Licence Spéciale en Physique Théorique - 2^{ème} licence en physique - ULB).

The yearly visit to CERN of the ULB students of the 3rd year in physics has been organized by P. Vilain and G. Wilquet.

III.2. Ph.D. THESES AND "LICENTIEVERHANDELINGEN" COMPLETED DURING 1996.

Ph D Theses.

- **Evrard, Erik** (VUB) "Measurement of the proton structure function $F_2(x, Q^2)$ and the gluon density of the proton at low x using deep inelastic ep scattering at the H1 detector". Promotor : J. Lemonne; begeleider : R. Roosen.

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- **Panitch, Arkadi** (ULB) "Measurement of the proton structure function $F_2(x, Q^2)$ with the H1 detector at HERA". Promotor : P. Marage.

- **Zhang, Shuping** (VUB) "Design , feasibility study and construction of an animal PET scanner using a multistep avalanche chamber and baryum fluoride scintillators". Promotor : S. Tavernier.

Master applied computer science.

- **Cao, Fang** (VUB) "Monte Carlo simulation for the design study of a pinhole collimator for single photon emission computed tomography (SPECT)". Promotors : M. Defrise and J. Tiberghien.

Licentiaatsverhandelingen.

- **R. Heremans** (VUB) "Bepaling van de voorwaarts-achterwaarts asymmetrie voor de reactie $e^+e^- \rightarrow \mu^+\mu^-$ by energieën beneden de Z^0 piek door en studie van radiatieve processen bij LEP". Promotor : J. Lemonne; begeleider : C. De Clercq.
- **B. Van de Vyver** (U. Gent) "Aandeel en herkomst van ν_τ in de ν_μ bundel voor het CHORUS experiment". Promotor : K. Keyde (U. Gent); co-promotor : J. Lemonne; begeleider : P. Vilain.
- **F. Nolette** (ISIB) "Comparaison des performances des MSGC pour différents mélanges gazeux". Promotor : C. Vander Velde; assistant : O. Bouhali.

III.3. SEMINARS.

The IIHE had the pleasure to welcome the following invited speakers :

- **F. Stichelbaut** (CERN) : "First results from LEP 1.5"
- **V. Novikov** (ITEP - Moscow) : "Bounds on extra quark-lepton generations".
- **G. Brooymans** (UCL) : "Alignment of large, high precision tracking detectors : Example of the CHORUS target trackers".
- **C. Racca** (CRN - Strasbourg) : "Search for quark gluon plasma at CERN - Results of NA38 and NA50 experiments".
- **A. Caner** (CERN) : "Top physics at CDF".
- **K. Hoepfner** (Technion Haifa) : "Development of high resolution detectors based on glass capillaries filled with liquid scintillator".
- **A. Sevrin** (VUB) : "String theory and duality for experimentalists".

R. Vandenbroucke has organized a one day seminar on Internet Firewalls.

The following seminars were given by members of the IIHE :

- **D. Bertrand** : - "Les réseaux neuronaux et leurs applications à la physique des hautes énergies" - 1st year students in physics - ULB
- "Neural networks" - service d'astrophysique théorique - ULB
- **C. De Clercq** : "Experimental physics at LEP 200" - lecture given at the VIIIth annual graduate school of particle physics; Rolduc - the Netherlands.
- **D. Johnson** : - "DESY - HERA - H1, a scenario for structure function analysis and much more" - DOE

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Washington DC - USA
- "Recent results from the H1 experiment at HERA, DESY" - Boston University - Boston
USA

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- **J. Lemonne** : "General organisation of HEP in Belgium" - Open ECFA meeting - Brussels - Belgium.
 - **P. Marage** : - "Galilée : réhabilitation ou amnistie ?" - Centre Universitaire du Film Scientifique - ULB
- "Diffractive interactions at HERA" - Max Planck Institute of Heidelberg - Heidelberg - Germany
- "Diffractive interactions at HERA" - Université de Liège - Liège - Belgium.
 - **R. Roosen** : "The H1 experiment" - Open ECFA meeting - Brussels - Belgium.
 - **S. Tavernier** : - "R & D on scintillators " - Open ECFA meeting - Brussels - Belgium
- "Het onderzoek naar de materie : de elementaire bouwstenen van de materie" - Brugs Universitair Centrum - Belgium.
 - **W. Van Doninck** : "The CMS experiment" - Open ECFA meeting - Brussels - Belgium.
 - **F. Verbeure** : "HEP and the Belgian universities" - Open ECFA meeting - Brussels - Belgium.
 - **P. Vilain** : "Le neutrino : tout ou rien ?" - 1st year students in physics - ULB.

III.4. ORAL PRESENTATIONS AT SCHOOLS AND COLLABORATION MEETINGS.

- **P. Annis** : "The tracking system of the CHORUS detector" - Student talk at the VIIIth annual graduate school of particle physics; Rolduc - the Netherlands.
- **O. Bouhali** : - "Results from the operation of MSGC's with Ar, He, Ne/DME and pure DME" - CMS week - CERN
- "Experimental study of the spatial resolution in between two side-by-side MSGC's substrates" - CMS week - CERN
- "Results from the operation of MSGC's with Ar, He and Ne/DME gas mixtures" - CMS forward meeting - Brussels
- "The microstrip gas counter and its application in the CMS forward tracker" - Student talk at the VIIIth annual graduate school of particle physics; Rolduc - the Netherlands
- "Results from the test of a trapezoidal chamber" - CMS week - CERN.
- **V. Lefebure** : - "Status of P_{τ} measurements" - General DELPHI meeting - CERN
- "Hadronic and topological branching ratios of the τ lepton" - General DELPHI meeting - Vienna- Austria.
- **P. Vanlaer** : - "Implementation of angular dependent errors in hit smearing and track fitting" - CMS tracker week
- "Tracker evaluation" - CMS-Belgium meeting.

III.5. ORGANISATION OF A VISIT OF THE MEMBERS OF RECFA.

P. Vilain, the Belgian representative at the **Restricted European Committee for Future Accelerators (RECFA)**, has organized a visit of this committee on the ULB-VUB campus on 19-20 April 1996.

At this occasion, RECFA held an open meeting with the members of the Belgian HEP community. During this meeting, after a welcome address by professor G. Huez, dean of the faculty of science of the ULB, J. Lemonne gave an overview of the organisation of HEP in Belgium. In a series of talks, the various facets of the Belgian particle physics programme were then presented by F. Binon (in a search for glueballs and exotics), D. Favart (neutrino physics), J.-M. Frère (theoretical physics), Ph. Herquet (the DELPHI experiment), D. Rijckbosch (the HERMES experiment), R. Roosen (the H1 experiment), N. Severyns (experiments at low energy), S. Tavernier

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(R & D on scintillators), W. Van Doninck (the CMS experiment), F. Verbeure (HEP education in Belgium) and R. Windmolders (the NMC & SMC experiments). The meeting was followed by a general discussion.

IV. COMPUTER MATTERS.

IV.1. COMPUTING AND NETWORKING.

Management : R. Vandenbroucke

Scientific staff : Z. Cekro, N. Meulemans

Logistic and technical staff : Y. Brants, G. Depiesse, D. Pirnay (part-time), G. Rousseau.

A. Management.

To facilitate the communication between the physicists and the computer team a committee has been set up including D. Bertrand, Y. Brants, C. De Clercq, J. Lemonne and R. Vandenbroucke. The results of the committee discussions are made available to the whole laboratory.

B. Operations.

Y. Brants, G. Depiesse and G. Rousseau are sharing the day-to-day logistic tasks necessary to be done in the IIHE computing environment; these tasks include backups, printers maintenance, management and redistribution of user equipment, following up of repairs. More specifically G. Depiesse takes care of the VMS cluster and G. Rousseau takes care of the network infrastructure. He also realised the cabling and network connections needed for the upgrade of the local area network and got familiar with optical fibre equipment. Y. Brants, already acquainted with the IIHE, joined the group in July; he is in charge of all UNIX flavoured machines and gives user support.

D. Pirnay is getting more and more familiar with PC and PC tools. She now masters the HTML language and creates WEB pages, also in the frame of DECUS BELUX, whose server is hosted at the IIHE.

C. Systems.

1996 saw no major change in computer equipment. More disk was bought to be able to cope with the increasing amount of data. More PC's have been acquired for the CAD work of the electrical and mechanical engineers; a colour printer was found necessary for the drawings produced by these design programs. Two Apple Macintoshes replaced the old Macintoshes of the secretaries.

However the computer power needed by the experiments and the amount of data to be treated is increasing sharply. The disparity in power between the workstations and the diskserver has become a problem, the latter being slower than the workstations acquired in 1995 and unable to serve these workstations fast enough; this situation creates delays in program execution and causes local network problems.

D. Networking.

The plans made in 1995 to upgrade the local area network have been partially realised. An Ethernet/FDDI switch has been acquired and part of the thinwire ethernet segments could be moved to that switch. A 100 Mbps FDDI backbone has been built and replaces partially the 10 Mbps ethernet backbone. In the future the whole ethernet backbone is expected to be replaced by the 100 Mbps FDDI.

Wide area networking has been a major problem during 1996. During the first half of the year the connection to CERN was acceptable but the connection to DESY was very bad. Mid July the computer connections outside of Belgium became almost impossible. This period lasted till the beginning of December when Belnet took two more 2 Mbps international lines into use. These poor computer connections restrain very much the work of the physicists as they have to contact machines in CERN and DESY for their day-to-day work. Belnet will try to avoid such situations by anticipating international network demand.

E. Computer and telematics related project.

The project EuroDemo in the frame of the CEC programme "Telematics for Research" started on 1st of July 1996. EuroDemo is aimed at providing a global network and computer infrastructure for demonstrating other projects of the Telematics Programme.

F. Scientific activities.

Nils Meulemans completed the LIRN project at the end of March. He did further research on directories and LDAP. In a contract with Belgacom he participated in an Eurescom Project "Piloting F510 Directory Services" in which he realised the DUA Specifications and Implementation.

Zlatica Cekro worked essentially on ATM. She especially focused on network management issues related to IP over ATM. She is group leader in the management workgroup for the TEN34-James tests in the frame of a TERENA taskforce on lower layers.

IV.2. INTERACTIVE GRAPHICS DEVELOPMENTS IN THE DELPHI EXPERIMENT.

(D. Bertrand).

The updating of the interactive graphics system was pursued in order to get a better detector representation. A full volume representation was added with hidden line removal and shading. The volume of the detector can be opened interactively in order to get a precise representation of the regions not covered by sensitive modules. This allows to check if these regions correspond to missing momentum in events with unbalanced energy. This new feature was heavily used for new particle searches in the e^+e^- interactions at 160 and 172 GeV.

V. TECHNOLOGICAL R & D.

V.I. TECHNOLOGICAL TRANSFER FROM BASIC RESEARCH TO APPLICATIONS.

(P. Bruyndonckx, A. Fremout, Liu Xuan, S. Rajeswaran, S. Tavernier and S. Zhang; Collaboration : Hammersmith hospital (London), Royal Marsden hospital (London), Deutsche Krebsforschungszentrum (Heidelberg), Ospedale San Raffaele (Milano), Ringshospitalet (Copenhagen)).

Positron Emission Tomography is a non-invasive, atraumatic method which allows the in vivo determination of the three-dimensional density distribution of a radioactively labelled substance; it makes use of positron emitting isotopes. The positron annihilates with an electron into two back-to-back gamma rays of 511 keV which can be detected.

A small diameter Positron Emission Tomograph (PET) dedicated to animal imaging, using BaF₂ crystals and photosensitive wire chambers with tetrakis-dimethylamine-ethylene (TMAE), has been designed and built. It consists of 17 cylindrical rings with a 200 mm inner diameter and without inter-ring septa, thus allowing for 3D data acquisition and reconstruction. The instrument contains 2958 BaF₂ crystals 3x3x20 mm each.

To avoid artifacts in the image due to dead zones in the sensitive area of the scanner, a rotating gantry was designed and put into place. In addition, by rotating the scanner back and forth over 360°, the normalisation of the scanner can be performed much more efficiently. Initially the performance of a rotating scanner was studied by scanning rotating objects in a stationary scanner. The resolution in the image at the center of the field of view (FOV) was measured to be 3.0 mm transaxially and 3.5 mm axially. Towards the edge of the FOV (4 cm off center), the transaxial resolution degrades to 5.3 mm for the radial component and to 4.3 mm for the tangential component. After

the implementation of the rotation system, new performance assessments were done. The obtained resolutions were in agreement with the previously found values.

To facilitate the operation of the scanner, a **Graphical User Interface (GUI)** was developed and installed. The same GUI is used to set all the necessary parameters for sinogram and image reconstructions. In addition, the software now foresees all sorts of correction processes for the raw data (random, scatter and deadtime corrections) and allows temporal binning of the events.

To improve the data acquisition speed, a new VME card was designed in collaboration with the University of Science and Technology in China. Once this card is finished and installed, the maximum readout speed will be 8 to 10 times higher than at present.

The scanner with a rotating gantry is now fully operational and will be moved to the Royal Marsden Hospital in January 1997. There it will be used in oncology studies with mice and rats.

V.2. R & D PROGRAMME ON HIGH RESOLUTION TRACKING DEVICES BASED ON CAPILLARIES FILLED WITH LIQUID SCINTILLATOR.

(P. Annis, C. Mommaert, P. Vilain and G. Wilquet - the RD46 Collaboration - CERN).

Two prototypes of active targets made of capillaries are presently being tested. In front of the first one (length : 180 cm; section : $2 \times 2 \text{ cm}^2$; 5×10^5 capillaries of $20 \text{ }\mu\text{m}$ diameter) an auxiliary lead target has been installed to check the vertex reconstruction efficiency for events outside the active volume. The second one (length : 100 cm; diameter : 50 mm; 1.5×10^6 fibers of $30 \text{ }\mu\text{m}$ diameter), characterised by a better fiber alignment and an increased sensitive surface, is equipped with an EBCCD image intensifier built by Geosphera which allows - without preamplifier - to detect single photoelectrons. Therefore, a low noise read-out electronics had to be developed. To sustain the high interaction rates ($10^7 - 10^8$ int. per sec) expected at the LHC, a VIP (Vacuum Image Pipe) image intensifier has been built and tested. It allows to stock successive images during $1.5 \text{ }\mu\text{s}$ with a time resolution of 20 ns and a spatial resolution of $25 \text{ }\mu\text{m}$. Using multiple reflexion of the photoelectrons between the intensifier extremities, the delay time could be increased up to 15 or 20 μs .

Recently, a prototype target made of 4 thin layers (2 mm) of capillaries has been built; such a set up is optimized for collider experiments such as LHCb.

V.3. R & D ON HEAVY SCINTILLATORS.

(Ruru Chen, F. Tallouf and S. Tavernier - Crystal Clear Collaboration - CERN, RD-18).

The most significant results obtained by the CRYSTAL CLEAR Collaboration (spokesman : S. Tavernier) were presented in last year report. During 1996, the CRYSTAL CLEAR Collaboration has mainly pursued its systematic investigation of the properties of Pb WO_4 scintillator and of Cerium doped rare earth oxides. Thanks to their work, the scintillation mechanism of Ce F_3 is now well understood and it is possible to predict which materials are likely to be fast, dense and luminous cerium based scintillators.

The most significant results have been published and/or presented at international conferences. This work was supported by an EU Human Capital & Mobility Network intitled "Search for new & better scintillators for radiation detection".

VI. TECHNICAL AND ADMINISTRATIVE WORK.

The members of the workshop staff were : J. De Bruyne, H. De Nil, J.-P. Dewulf, L. Etienne, R. Gindroz, R. Goorens, E. Lievens, E. Raspoet, G. Van Beek, J. Vanbegin, R. Vanderhaeghen, L. Van Lancker and C. Wastiels, helped by M. Pins and R. Pins.

W. Van Doninck was in charge of the general coordination; R. Goorens and G. Van Beek organised the tasks of the electronics and mechanics workshops respectively.

For the CHORUS experiment the mechanical workshop has contributed to the installation and testing of the "Rasnik" alignment system. This work was coordinated by G. Van Beek with help from R. Gindroz and E. Raspoet. The same team was also responsible for the installation of the Emulsion Trackers. G. Van Beek was responsible and has taken an important share in the maintenance of the opto-electronic read out system of the scintillating fibre trackers of CHORUS. Within an R&D programme (RD 46) concerning large capillary targets filled with liquid scintillator, G. Van Beek and E. Raspoet have contributed to the design and manufacturing of support structures. M. Pins and R. Pins have contributed to the pouring and processing of emulsion.

The DELPHI experiment has proceeded to the replacement of the "Trigger Decodes Box" by new hardware. The new design was achieved by J.-P. Dewulf and R. Goorens. They were also responsible for the installation and commissioning. For the mounting of the electronic boards they were assisted by C. Wastiels. New electronics cards to dispatch the clock signals to the Lep Time Digitisers (LTD) were designed, built and tested by J.-P. Dewulf and R. Goorens. They also participated to the installation of the new Pandora modules and were responsible for the testing and debugging of the trigger part. The maintenance of the electronics of the end cap muon systems, built in the IIHE, was under the responsibility of R. Goorens. He also produced spare Fastbus cards.

In the framework of the H1 experiment at the HERA collider in DESY, C. Wastiels was responsible for the maintenance and upgrade of the Central Outer Proportional Chambers, built at the IIHE. With the help of H. De Nil, he was responsible for the preparation and starting up of the H1 runs in 1996.

The IIHE has taken major responsibilities in the design of the forward MSGC tracking system of the CMS experiment at the CERN Large Hadron Collider. L. Van Lancker has designed (pro engineering) the mechanical support structures based on carbon fibre composite materials and evaluated the mechanical stability via finite element analysis (ANSYS). In collaboration with the laboratory of Structural Analysis of Materials of the VUB (Professor P. Dewilde) several stability tests have been performed. In collaboration with the universities of Karlsruhe and Aachen, a full size prototype support structure has been built. E. Lievens, R. Gindroz and E. Raspoet have built several carbon fibre gas boxes to house the MSGC prototypes under test at the IIHE. They have also built a high voltage test rig for MSGC's and modified an existing projection table to allow the visual inspection of detector substrates. H. De Nil has designed and built the electronics system to steer a precision x-y stage for substrate alignment. R. Vanderhaeghen has maintained and built a series of high voltage electrometers. L. Etienne has designed and tested a scheme of protection of MSGC substrates against shorts. It was shown that resistor fuses integrated in the anode bonding pads can be interrupted via a reverse polarity pulse. M. and R. Pins have produced MSGC substrates at SRON (Utrecht) for the milestone prototype. They produced 22 large detector substrates via photolithography on glass as well as 168 pitch adaptor circuits. Both technicians contributed to the ultrasonic wire bonding of MSGC substrates to the read out electronics.

For the Positron Emission Tomograph (PET), the testing and commissioning was performed by J. De Bruyne and L. Etienne. C. Wastiels produced the necessary cables and connectors. H. De Nil developed a power driving board for the stepping motors.

J.-P. Dewulf was responsible for the maintenance of the PCAD software package for electronic design.

C. Carlier contributed to logistic tasks for the DELPHI experiment.

The secretarial work was accomplished by R. Alluyn-Lecluse and M. Garnier-Van Doninck - assisted by M. De Schutter, M. Goeman, J. Liesen and D. Luybaert-Peymans. M. Pins has contributed to the maintenance of a documentation centre and has provided illustrations for several publications and lectures of members of the laboratory. A. De Coster-Van Cauwenberge and M. Delasorte took care of the library.

VII. REPRESENTATION IN COUNCILS AND COMMITTEES.

C. De Clercq was the Belgian representative at the HEPCCC Technical Advisory Subcommittee (HTASC).

D. Johnson was member of the Academic Standards Committee for Upperclassmen at the Vesalius College, VUB.

J. Lemonne has been the Belgian scientific representative in the CERN Council; he was a member of the EPS-HEP board and was a member of the Physics Research Training Grants Panel (TMR) of the EC. He was vice-dean of the Faculty of Sciences and president of the Department of Physics of the VUB. He was the representative of the Faculty of Sciences in the "Senate" of the VUB and chairman of the "Commissie Middelen en Personeel" of this Faculty. He was also a member of the "Commissie Begroting en Financiën" of the Vlaamse Raad voor Wetenschapsbeleid.

J. Lemonne, J. Sacton and F. Verbeure were members of the Scientific Commissions "Hautes et Basses Energies" of the IISN and "Hoge Energie" of the IKW and of the Belgian Selection Committee of CERN fellows.

P. Marage was vice-dean of the Faculty of Sciences of the ULB since 1st October 1996; was member of the "Commission d'évaluation scientifique pour les nominations au titre de premier assistant" and acted as expert at the "Commission des Finances" and at the "Commission du Patrimoine" of the ULB. He was associate member of the "Comité National de Logique, de Philosophie et d'Histoire des Sciences", member of the "Comité scientifique attaché au Musée des Sciences", of the Council of "Focus Research" and of Altaïr, an ASBL devoted to the history of science (ULB).

J. Sacton was vice-dean of the Faculty of Sciences of the ULB until 1st October 1996. He acted as chairman of the C11 Commission (Particles and Fields) of the International Union for Pure and Applied Physics (IUPAP) and as a member of the International Committee for Future Accelerators (ICFA). He was also a member of the "Commission de Physique" at the FNRS and of the "Commissie voor Fysica" at the FWO. He was vice-chairman of the "Comité Scientifique attaché au Musée des Sciences et Technologies" of the ULB at Parentville and also acted as member of the "Groupe de Pilotage" preparing the visit at the ULB of experts from the Commission of European Rectors. He acted as project co-ordinator of an INTAS program intitled "Development of substrates suitable for use in radiation hard microstrip gas counters".

S. Tavernier was member of the "Onderzoeksraad" of the VUB and chairman of the "Facultaire onderzoekscommissie Wetenschappen" van de Onderzoeksraad. He is spokesman of the "Crystal Clear Collaboration (CERN,, R & D18) and coordinator of the Human Capital and Mobility Network : "Search for new and better scintillating materials for basic research".

R. Vandembroucke acted as member of the board of DECUS BELUX, as representative of DECUS BELUX in the DECUS Europe Council, as Belgian representative in the Public Procurement Group of the European Commission. She was also delegate of the VUB at the Belgian ATM platform, member of the ATM platform symposium planning committee. At the VUB she was member of the ITI commission of the Faculteit Wetenschappen.

W. Van Doninck acted as a Belgian representative in plenary ECFA and as a member of the Board of directors of the Belgian Physical Society.

F. Verbeure acted as vice rector of the Universitaire Instelling Antwerpen.

P. Vilain was the Belgian representative at the Restricted European Committee for Future Accelerators (RECFA).

G. Wilquet was member of the SPS and LEAR Committee at CERN. He acted as Belgian representative on the Advisory Committee of CERN users and as project co-ordinator of an INTAS program intitled "A tracking detector board on capillaries filled with liquid scintillator using a read-out via electron bombarded charge coupled device for future experiments in elementary particle physics".

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The following responsibilities were taken in the organisation

1) of the *DELPHI experiment* :

- **D. Bertrand** : member of the editor committee.
- **C. De Clercq** : muon project leader.
- **J. Lemonne** : vice-chairman of the Collaboration Board and representative of "Belgium", representative of the IIKW-IISN in the Finance Committee.
- **C. Vander Velde** : contact person of the DELPHI Collaboration for the sub-group "New particles - generators" of the LEP 200 Workshop.
- **J. Wickens** : project leader of the off-line software, member of the physics steering panel, of the software steering panel and of the hardware panel.

2) of the *H1 experiment* :

- **P. Marage** : convener of the working group on diffraction.
- **R. Roosen** : representative of "Belgium" in the Collaboration Board.
- **J. Sacton** : representative of the IISN-IIKW in the Finance Committee.

3) of the *CMS experiment* :

- **W. Van Doninck** : member of the management board, of the collaboration board and of the Tracker Institution and Technical boards. He was deputy MSGC coordinator and, since November, chairman of the MSGC steering committee. He acted as internal reviewer for the CMS muon system
- **J. Lemonne** and **J. Sacton** : representatives of the IIKW and IISN, respectively, in the Finance Committee.
- **S. Tavernier** : member of the ECAL institution board.

4) of the *CHORUS experiment* :

- **P. Vilain** : representative of the IIHE at the Collaboration Board.

VIII. ATTENDANCE TO CONFERENCES, WORKSHOPS AND SCHOOLS.

VIII.1. CONFERENCES AND WORKSHOPS.

- XXVIIIth International Conference on High Energy Physics, Warsaw - Poland : *D. Bertrand, V. Lefébure, J. Lemonne and J. Sacton*
- XVIIth International Conference on neutrino physics and astrophysics; Helsinki - Finland : *M. Vander Donckt and G. Wilquet*
- VIIIth Rencontres de Blois - Neutrinos, Dark matter and the Universe; Blois - France : *J. Sacton and P. Vilain*
- Frontier objects in astrophysics and particle physics; Vulcano - Italy : *P. Vilain*
- IVth International Workshop on Tau Lepton Physics; Estes Park - USA : *D. Bertrand*
- International Workshop on Deep Inelastic Scattering and QCD; Rome - Italy : *B. Clerbaux and P. Marage*
- Topical Conference on hard diffractive processes; Eilat - Israël : *P. Marage, R. Roosen*
- International Workshop on low x - physics; Durham - UK : *P. Marage*
- Workshop on Future Physics at HERA; Hamburg - Germany : *B. Clerbaux*
- Vth ICFA Seminar on Future Perspectives in High Energy Physics; KEK - Japan : *J. Sacton*

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- Annual meeting of the International Committee for Future Accelerators; KEK - Japan : *J. Sacton*
- IUPAP - C11 Commission on particles and fields; Warsaw - Poland : *J. Sacton*
- Annual joint ICFA/Laboratory Directors meeting; CERN : *J. Sacton*
- XXXIth Rencontres de Moriond : Electroweak interactions and unified theories; Les Arcs - France : *P. Annis and V. Lefébure*
- XXXIth Rencontres de Moriond : QCD and high energy hadronic interactions; Les Arcs - France : *A. Panitch*
- Annual scientific meeting of the Belgian Physical Society; Bruxelles - Belgique : *G. Bertrand-Coremans, B. Clerbaux, C. De Clercq, J. Lemonne, A. Panitch*
- VIth topical seminar on experimental apparatus for particle physics and astrophysics; San Miniato - Italy : *M. Vander Donckt*
- Second Workshop on electronics for LHC experiments; Balatonfured - Hungary : *J.-P. Dewulf*
- First conference on new developments in photodetection; Beaune - France : *S. Tavernier*
- MSGC Workshop; Lyon - France : *J. Detroy*
- CADCOMP'96 - Computer Aided Design in Composite Material; Udine - Italy : *L. Van Lancker*
- IEEE - NSS conference; Anaheim CA - USA : *S. Tavernier*
- IVth International conference on position - sensitive detectors; Manchester - UK : *P. Bruyndonckx*
IEEE nuclear science symposium and medical imaging conference; Anaheim - USA : *P. Bruyndonckx*
- Rand-Axis user Pro-engineer group meeting; Genval - Belgium : *L. Van Lancker*
- ANSYS club des utilisateurs; Paris - France : *L. Van Lancker*
- DECUS BELUX Symposium; Laroche - Belgium : *Y. Brants and R. Vandenbroucke*
- DECUS BELUX Symposium; Barcelona - Spain : *Y. Brants and R. Vandenbroucke*
- Global Information Infrastructure Workshop; Geneva - Switzerland : *R. Vandenbroucke*
- GSM Conference; Cannes - France : *R. Vandenbroucke*
- TELEPORT worldwide conference; Tokyo - Japan : *R. Vandenbroucke*
- ATM conference; Paris - France : *R. Vandenbroucke*
- TINA'96 - The convergence of Telecommunications and Distributed Computing Technologies; Heidelberg - Germany : *R. Vandenbroucke*
- EDUCA conference; Berlin - Germany : *R. Vandenbroucke*
- ACE2000 Workshop and annual meeting; Madrid - Spain : *R. Vandenbroucke*
- VIIth Joint European Networking Conference : *N. Meulemans*

- IVth Name FLOW-PARADISE meeting; Brussels - Belgium : *N. Meulemans*
- Joint EWOS/EGDIR - ETSI TSC TE.6 - FDAS meeting; Brussels - Belgium : *N. Meulemans*
- EURESCOM P416 extension; Kick-off-meeting; Helsinki - Finland : *N. Meulemans*
- Name FLOW-PARADISE Indexing meeting; Brunel University, London - UK : *N. Meulemans*
- Joint EURESCOM P416 Extension - FDAS meeting; London - UK : *N. Meulemans*
- IVth International IFIP Workshop on quality of service IWQOS 96; Paris - France : *Z. Ceko*

VIII.2. SCHOOLS.

- Summer school on physics with neutrinos; Zuoz - Switzerland : *P. Annis*
- VIIIth Annual graduate school of particle physics (Aachen-Belgian-Dutch school); Rolduc - the Netherlands : *P. Annis, T. Beckers, O. Bouhali, M. Elamiri, J. Stefanescu and A. Van Lysebetten*
- Nordic School in High Energy Physics phenomenology; Solvalla - Esbo - Finland : *B. Clerbaux*
- 1996 European School of High Energy Physics; Carry-le-Rouet - France : *P. Vanlaer*

IX. LIST OF PUBLICATIONS, REPORTS AND CONTRIBUTIONS TO CONFERENCES.

IX.1. PUBLICATIONS.

Neutrino Physics

- Nuclear attenuation of fast hadrons produced in charged-current ν and ν_{bar} interactions in neon
W. Burkot et al.
Z. Phys. C70 (1996) 47-53

e^+e^- physics

- A measurement of the photon structure function F_2^γ at an average Q^2 of $12 \text{ GeV}^2/c^4$
P. Abreu et al.
Z. Phys. C69 (1996) 223-233
- A precise measurement of the tau lepton lifetime
P. Abreu et al.
Phys. Lett. B365 (1996) 448-460
- Measurement of inclusive π^0 production in hadronic Z^0 decays
W. Adam et al.

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Z. Phys. C69 (1996) 561-573

- Production of Σ^0 and Ω^- in Z decays

W. Adam et al.

Z. Phys. C70 (1996) 371-381

- Search for exclusive decays of the Λ_b baryon and measurement of its mass

P. Abreu et al.

Phys. Lett. B374 (1996) 351-361

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- Measurement of the partial decay width $R_b^0 = \Gamma_{b\bar{b}}/\Gamma_{\text{had}}$ of the Z with the DELPHI detector at LEP
P. Abreu et al.
Z. Phys. C70 (1996) 531-547
 - Study of radiative leptonic events with hard photons and search for excited charged leptons at $\sqrt{s} = 130-136$ GeV
P. Abreu et al.
Phys. Lett. B380 (1996) 480-490
 - Search for anomalous production of single photons at $\sqrt{s} = 130$ and 136 GeV
W. Adam et al.
Phys. Lett. B380 (1996) 471-479
 - First measurement of f_2^1 (1525) production in Z^0 hadronic decays
P. Abreu et al.
Phys. Lett. B379 (1996) 309-318
 - Search for the lightest chargino at $\sqrt{s} = 130$ and 136 GeV
P. Abreu et al.
Phys. Lett. B382 (1996) 323-336
 - Determination of the average lifetime of b-baryons
P. Abreu et al.
Z. Phys. C71 (1996) 199-210
 - Mean lifetime of the B_s^0 meson
P. Abreu et al.
Z. Phys. C71 (1996) 11-30
 - Determination of $|V_{cb}|$ from the semileptonic decay $B^0 \rightarrow D^{*+} l^+ \nu$
P. Abreu et al.
Z. Phys. C71 (1996) 539-553
 - Measurement of the B_d^0 oscillation frequency using kaons, leptons and jet charge
P. Abreu et al.
Z. Phys. C72 (1996) 17-30
 - First study of the interference between initial and final state radiation at the Z resonance
P. Abreu et al.
Z. Phys. C72 (1996) 31-38
 - Study of rare b decays with the DELPHI detector at LEP
W. Adam et al.
Z. Phys. C72 (1996) 207-220
 - Search for high mass $\gamma\gamma$ resonances in $e^+e^- \rightarrow l^+l^- \gamma\gamma$, $\nu\bar{\nu} \gamma\gamma$ and $q\bar{q} \gamma\gamma$ at LEP I
P. Abreu et al.
Z. Phys. C72 (1996) 179-190
 - Search for neutralinos, scalar leptons and scalar quarks in e^+e^- interactions at $\sqrt{s} = 130$ GeV and 136 GeV
P. Abreu et al.
Phys. Lett. B387 (1996) 651-666
 - Combining heavy flavour electroweak measurements at LEP
The LEP experiments : ALEPH, DELPHI, L3 and OPAL
Nucl. Instr. and Methods A378 (1996) 101-115

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- Kaon interference in the hadronic decays of the Z^0
P. Abreu et al.
Phys. Lett. B379 (1996) 330-340
 - Updated precision measurement of the average lifetime of B hadrons
P. Abreu et al.
Phys. Lett. B377 (1996) 195-204
 - Energy dependence of the differences between the quark and gluon jet fragmentation
P. Abreu et al.
Z. Phys. C70 (1996) 179-195
 - Charged particle multiplicity in e^+e^- interactions at $\sqrt{s} = 130$ GeV
P. Abreu et al.
Phys. Lett. B372 (1996) 172-180
 - Search for promptly produced heavy quarkonium states in hadronic Z decays
P. Abreu et al.
Z. Phys. C69 (1996) 575-583
 - An upper limit for $\text{Br}(Z^0 \rightarrow ggg)$ from symmetric 3-jet Z^0 hadronic decays
P. Abreu et al.
Phys. Lett. B389 (1996) 405-415
 - Search for pair production of heavy objects in 4-jet events at $\sqrt{s} = 130-136$ GeV
W. Adam et al.
Z. Phys. C73 (1996) 1-9
 - Tuning and test of fragmentation models based on identified particles and precision event shape data
P. Abreu et al.
Z. Phys. C73 (1996) 11-59
 - Measurement of inclusive $K^{*0}(892)$, $\phi(1020)$ and $K_2^{*0}(1430)$ production in hadronic Z decays
P. Abreu et al.
Z. Phys. C73 (1996) 61-72

ep physics

- Jets and energy flow in photon-proton collisions at HERA
S. Aid et al.
Z. Phys. C70 (1996) 17-30
- A search for leptoquarks at HERA
S. Aid et al.
Phys. Lett. B369 (1996) 173-185
- Energy flow in the hadronic final state of diffractive and non-diffractive deep-inelastic scattering at HERA
S. Aid et al.
Z. Phys. C70 (1996) 609-620
- A search for selectrons and squarks at HERA
S. Aid et al.
Phys. Lett. B380 (1996) 461-470
- Measurement of the Q^2 dependence of the charged and neutral current cross sections in $e^\pm p$ scattering at HERA
S. Aid et al.

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Phys. Lett. B379 (1996) 319-329

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- A search for squarks of Rp-violating SUSY at HERA
S. Aid et al.
Z. Phys. C71 (1996) 211-226
 - Photoproduction of $D^{*\pm}$ mesons in electron-proton collisions at HERA
S. Aid et al.
Nucl. Phys. B472 (1996) 32-51
 - Elastic and inelastic photoproduction of J/Ψ mesons at HERA
S. Aid et al.
Nucl. Phys. B472 (1996) 3-31
 - Elastic photoproduction of ρ^0 mesons at HERA
S. Aid et al.
Nucl. Phys. B463 (1996) 3-33
 - Elastic electroproduction of ρ and J/Ψ mesons at large Q^2 at HERA
S. Aid et al.
Nucl. Phys. B468 (1996) 3-33
 - A measurement and QCD analysis of the proton structure function $F^2(x, Q^2)$ at HERA
S. Aid et al.
Nucl. Phys. B470 (1996) 3-38
 - On the possibility of measuring $F_L(x, Q^2)$ at HERA using radiative events
L. Favart et al.
Z. Phys. C72 (1996) 425-428
 - Charged particle multiplicities in deep inelastic scattering at HERA
S. Aid et al.
Z. Phys. C72 (1996) 573-592
 - Inclusive D^0 and $D^{*\pm}$ production in neutral current deep inelastic ep scattering at HERA
C. Adloff et al.
Z. Phys. C72 (1996) 593-605
 - An observation on F_2 at low x
A. De Roeck and E.A. De Wolf
Phys. Lett. 388B (1996) 843-847
 - Strangeness production in deep-inelastic positron-proton scattering at HERA
S. Aid
Nucl. Phys. B480 (1996) 3-34

Hadron-hadron interactions

- Coherent inelastic interactions of π^+ and K^+ mesons on Al and Au nuclei at 250 GeV/c
N.M. Agababyan et al.
Z. Phys. C70 (1996) 233-238
- Two- and three-dimensional analysis of Bose-Einstein correlations in π^+/K^+p interactions at 250 GeV/c
N.M. Agababyan et al.
Z. Phys. C71 (1996) 405-414
- Nuclear-target diffraction dissociation in π^+ and K^+ collisions with Au and Al at 250 GeV/c

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- N.M. Agababyan et al.
Z. Phys. C72 (1996) 65-70
- Scaling laws for density correlations and fluctuations in multiparticle dynamics
E.A. De Wolf et al.
Phys. Reports 270 (1996) 1-141
 - Self-affine fractality in π^+p and K^+p collisions at 250 GeV/c
N.M. Agababyan et al.
Phys. Lett. 382B (1996) 305-311

Experimental techniques

- Study of the bunch crossing identification at LHC using microstrip gas chambers
F. Angelini et al.
Nucl. Instrs & Meth. A368 (1996) 345-352
- Operation of micro strip gas counters with Ne-DME gas mixtures
O. Bouhali et al.
Nucl. Instrs & Meth. A378 (1996) 432-438
- Performance of the DELPHI detector
P. Abreu et al.
Nucl. Instrs & Meth. A378 (1996) 57-100
- Performance of a cerium fluoride crystal matrix measured in high energy particle beams
E. Auffray et al.
Nucl. Instrs & Meth. A378 (1996) 171-178
- Cerium doped heavy metal fluoride glasses, a possible alternative for electromagnetic calorimetry
E. Auffray et al.
Nucl. Instrs & Meth. A380 (1996) 524-536
- Extensive studies on Ce F₃ crystals, a good candidate for electromagnetic calorimetry at future accelerators
E. Auffray et al.
Nucl. Instrs & Meth. A383 (1996) 367-390
- Design and physical characteristics of a small PET using Ba F₂ crystals and a photosensitive wire chambers
Liu Xuan et al.
Nucl. Instrs & Meth. A382 (1996) 589-600
- A current mode charge pulse amplifier in CMOS technology for use with particle detectors
J. Wulleman
IEE Electronics Letters 32 (1996) 515-516
- A 80 Msample/s low-powered high resolution comparator in radiation hard SOI-BiCMOS technology
J. Wulleman
IEE Electronics Letters 32 (1996) 649-651
- A low-powered high gain transresistance BiCMOS pulse amplifier
J. Wulleman
IEE Electronics Letters 32 (1996) 934-936
- $1/f$ noise suppression in front-end read-out pulse amplifiers
J. Wulleman
IEE Electronics Letters 32 (1996) 1089-1090

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- Super low gain band width and small area amplifier
J. Wulleman
IEE Electronics Letters 32 (1996) 1366-1367

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- Detector noise suppression by appropriate CR-(RC) shaping
J. Wulleman
IEE Electronics Letters 32 (1996) 1953-1954
 - Appropriate (CR)^m-(RC)ⁿ shaping for fast bipolar front-end read-out
J. Wulleman
IEE Electronics Letters 32 (1996) 1945-1947
 - A low-powered 2.1 5 sec binary delay line in radiation hard SOI-BiCMOS technology
J. Wulleman
IEE Electronics Letters 32 (1996) 2071-2072

Varia

- The proceedings of the International Europhysics Conference on High Energy Physics - Brussels 1995 were edited by J. Lemonne, C. Vander Velde and F. Verbeure and published by World Scientific.
- Evolution du doctorat
P. Marage
Cahiers Marxistes 202 (1996) 71-79
- Book account : "Particles and nuclei - an introduction to the physical concepts" by B. Povh et al.
P. Marage
Physicalia info 1996
- Book account : "Histoire de l'art romain" by L.M. Celnikier
P. Marage
Physicalia info 1996

IX.2. REPORTS.

- Studies of diffractive interactions using the H1 detector
P.R. Newman et al.
DESY 96-162
- Diffractive interactions
V. Del Duca, E. Gallo and P. Marage
DESY 96-179
- Hadronic and topological branching ratio of the τ lepton
V. Lefébure
IIHE note 96-02
- Experimental study of the spatial resolution in microstrip gas counters filled with a Ne/DME 50/50 % gas mixture
O. Bouhali et al.
IIHE note 96-03
- Evaluation of prototype detectors of the CMS tracker in a test beam
A. Peisert et al.
CMS TN/96-020
- A possible approach for the construction of the CMS forward-backward MSGC tracker
O. Bouhali et al.
Technical design report

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- The trigger decoder box
J.-P. Dewulf, R. Goorens and G. Valenti
DELPHI note 96-177 DAS183
- Efficiencies for muon tagging at the vertex
M. Vander Donckt
CHORUS note 96021
- Material evaluation for the mechanical structure of the CMS forward tracker
S. Claes, W. Van Doninck and L. Van Lancker
CMS TN 96/034
- EURESCOM P416, European Wide Directory Service
N. Meulemans
STC/96-4
- A Yellow pages service based on X.500
N. Meulemans
STC/96-5
- Report on the 7th Joint European Networking Conference
JENC7
N. Meulemans
STC/96-10
- Report on the 4th NameFLOW - PARADISE meeting
Brussels
N. Meulemans
STC/96-12
- Report on the joint EWOS/EGDIR - ETSI TSC TE.6 - FDAS meeting
Brussels
N. Meulemans
STC/96-15
- Report on the EURESCOM P416 Extension Kick-off meeting
Helsinki - Finland
N. Meulemans
STC/96-19
- Report on the name FLOW/Paradise Indexing meeting
Brunel University, London - UK
N. Meulemans
STC/96-20
- Report on the joint EURESCOM P416 Extension/FDAS meeting
London - UK
N. Meulemans
STC/96-24
- Belgian ATM Platform, Backup Application group : ULB/STC
Brussels
A. Guillen and Z. Cekro
STC/96-17
- Report of the Fourth International IFIP Workshop on Quality of Service IWQoS96
Paris - France
Z. Cekro
STC/96-21

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IX.3. CONTRIBUTIONS TO CONFERENCES.

- Neutrino oscillations from reactors and accelerators experiments
P. Vilain
Frontier Objects in astrophysics and particles physics; Vulcano - Italy
- Electroproduction of vector mesons at HERA
B. Clerbaux
Annual Scientific meeting of the Belgian Physical Society; Brussels
- Electroproduction of vector mesons at HERA
B. Clerbaux
Workshop on deep inelastic scattering and QCD
- Hadronic and topological branching ratio of the τ lepton
V. Lefébure
XXVIIIth International Conference on High Energy Physics; Warsaw - Poland
- Diffractive interactions : inclusive measurements
P. Marage
Summary report of the working group on diffractive interactions - International Workshop on Deep inelastic scattering; Rome - Italy
- On the possibility of measuring $F_2(x, Q^2)$ at HERA using radiative events
P. Marage
International Workshop on low x physics; Durham - UK
- Summary report of the session on diffraction
P. Marage
International Workshop on low x physics; Durham - UK
- F_2 structure function and x_G gluon density
A. Panitch
XXXIth Rencontre de Moriond; Les Arcs - France
- A measurement and QCD analysis of the proton structure function $F_2(x, Q^2)$ at HERA
A. Panitch
Annual scientific meeting of the Belgian Physical Society; Brussels
- Performances of the CHORUS scintillating fibre trackers
M. Vander Donckt
VIth Topical seminar on experimental apparatus for particle physics and astrophysics; San Miniato - Italy
- Applications of photodetectors in nuclear medicine
S. Tavernier
First conference on new development in photodetection; Beaune - France
- Performance of a photosensitive wire chamber in a high resolution PET scanner
S. Tavernier
First conference on new development in photodetection; Beaune - France
- Performance study of a 3D small animal PET scanner based on Ba F₂ crystals and a photosensitive wire chamber
P. Bruyndonckx
International conference on positron sensitive detectors; Manchester - UK