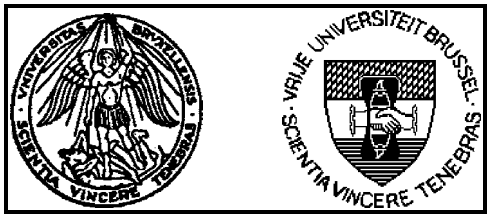
INTER-UNIVERSITY INSTITUTE FOR HIGH ENERGIES

ULB-VUB, BRUSSELS

ANNUAL REPORT 1999



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ANNUAL REPORT 1999

D. BERTRAND and J. LEMONNE

March 2000

CONTENTS

I. INTRODUCTION.

The work presented in this report is supported by the **U**niversité **L**ibre de **B**ruxelles (ULB), the **V**rije **U**niversiteit **B**russel (VUB), the **F**onds **N**ational de la **R**echerche **S**cientifique (FNRS), the **F**onds voor **W**etenschappelijk **O**nderzoek (FWO), the Fonds pour la **F**ormation à la **R**echerche dans l'**I**ndustrie et dans l'**A**griculture (FRIA) and the Vlaams Instituut voor de bevordering van het wetenschappelijk-technologisch onderzoek in de industrie (IWT). Various R & D activities are supported by the European Community.

The scientists whose names are listed below have contributed to the various activities of the Institute in 1999.

In October 1999, J. Sacton became Professor Emeritus of the ULB. From October 1999 his charge as co-director of the IIHE was taken over by D. Bertrand.

U.L.B.

P. Annis (doctorant)
L. Benussi (TMR fellow)
D. Bertrand (directeur de recherche FNRS; chargé de cours temps partiel)
G. Bertrand-Coremans (chef de travaux until April 1999, since then retired)
O. Bouhali (doctorant)
B. Clerbaux (assistant intérimaire until September 1999, since then collaborateur scientifique FNRS)
C. Collard (boursière FRIA)
G. De Lentdecker (boursier FRIA)
R. El Aidi (doctorant)
L. Favart (chargé de recherche FNRS until September 1999, since then chercheur qualifié FNRS)
X. Janssen (boursier FRIA)
P. Marage (chargé de cours)
J. Sacton (professeur ordinaire until September 1999; since then professeur émérite)
R. Stamen (doctorant)
J. Stefanescu (doctorant)
F. Tallouf (doctorant)
M. Vander Donckt (collaborateur scientifique IISN since October 1999)
C. Vander Velde (chargé de cours associé)
P. Vanlaer (chargé de recherche FNRS since October 1999)
P. Vilain (chercheur qualifié FNRS; chargé de cours temps partiel)
J. Wickens (chercheur IISN)
G. Wilquet (chercheur qualifié FNRS; chargé de cours temps partiel)

V. Lefébure (chargée de recherche FNRS is presently at CERN)

V.U.B.

P. Bruyndonckx (wetenschappelijk medewerker FWO)
R. Chen (VUBAROS fellow)
C. De Clercq (onderzoeksdirecteur FWO)
O. Devroede (wetenschappelijk medewerker FWO)
J. D'Hondt (overbrugginsbeurs VUB – October-December 1999)
A. Fremout (IWT scholarship)
R. Heremans (wetenschappelijk medewerker FWO)
F. Iacopi (wetenschappelijk medewerker FWO until August 1999)
D. Johnson (doctor assistent VUB)
J. Lemonne (gewoon hoogleraar)
C. Mommaert (E.U.)
R. Roosen (onderzoeksdirecteur FWO)
S. Tavernier (onderzoeksdirecteur FWO)
F. Udo (gastprofessor - deeltijds 20 %)
W. Van den Boeck (wetenschappelijk medewerker FWO)
R. Vandenbroucke (logistiek medewerker FWO)
B. Van De Vyver (aspirant FWO)
W. Van Doninck (onderzoeksdirecteur FWO)
A. Van Lysebetten (wetenschappelijk medewerker FWO)

B. Van De Vyver stayed at CERN in the framework of the CHORUS Collaboration
A. Van Lysebetten stayed at CERN from May to July as responsible person for the DELPHI forward muon chambers.

T. Anthonis (as from 1/10/99), W. Beaumont, T. Beckers, J. De Troy, E. De Wolf, Liu Hao, Ch. Van Dyck, P. Van Mechelen, F. Moortgat, N. Pukhaeva, N. Van Remortel, F. Verbeure and V. Zhukhov (until 30/9/99) from the Universitaire Instelling Antwerp (UIA) 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 M. Hensmans in collaboration with the members of the "Service Télématique et Communication" led by P. Van Binst at the ULB.

II. RESEARCH ACTIVITIES IN PARTICLE PHYSICS.

II.1. NEUTRINO PHYSICS.

A. The CHARM-II experiment.

(P. Vilain and G. Wilquet).

This experiment was completed long ago but a few analyses were still to be finalized. The study of charm production with dimuon events has now been published. The global analysis of the purely leptonic processes both in neutral and charged currents has provided further checks of the Standard Model parameters and a test of the separate conservation of the electronic and muonic lepton numbers. This analysis has been accepted for publication.

B. The CHORUS experiment.

(P. Annis, R. El Aidi, M. Vander Donckt, B. Van de Vyver, P. Vilain and G. Wilquet).

About 600 000 neutrino interactions have been reconstructed in the 4 emulsion targets which were exposed between 1994 and 97 to the CERN SPS Wide Band Neutrino Beam.

With highly automated microscopes, the region close to the interaction vertex is scrutinized to detect a possible decay topology, characteristic of the reaction

$$\nu_\tau + \text{nucleon} \rightarrow \tau^- + \text{hadrons}$$

followed by the one-prong decay of the τ lepton. A significant number of such events would demonstrate the existence of $\nu_\mu \rightarrow \nu_\tau$ oscillation and, thus, a non-vanishing neutrino mass. About 90% of the reconstructed interactions have now been analysed and only 1 event has been observed within the acceptance criteria. The estimated background from other sources is 0.9 event. The result can thus be expressed as a 90% confidence level upper limit on the ν_μ - ν_τ transition probability. Taking into account the efficiencies of each analysis step, the present limit is

$$P(\nu_\mu \rightarrow \nu_\tau) < 3.9\,10^{-4}$$

With the advent of microscopes equipped with faster processors and with improved reconstruction programs, less restrictive selection and scanning criteria can be adopted and a second phase of the data analysis is now starting. The aims are to obtain within one year :

- a sensitivity on P down to 1 or 2 10^{-4}
- an unbiased sample of more than 1000 charm decays, which would represent an order of magnitude improvement with respect to previous emulsion experiments.

In addition, the high statistics of events recorded in the CHORUS calorimeter and spectrometer is used for more “standard” studies of neutrino cross sections and nucleon structure functions. Several publications are in preparation on these subjects.

C. The AMANDA experiment.

(D. Bertrand, C. De Clercq, M. Vander Donckt and J.P. Dewulf)

This research project is pursued with two co-promoters at the FNRS level : J.M. Frère ("Professeur ordinaire" in theoretical physics at the ULB), F. Binon (Directeur de recherches FNRS at the ULB).

The AMANDA detector is made of optical modules (photomultipliers encapsulated into a glass sphere) aimed to detect the Cherenkov light produced by muons resulting from the interaction of neutrinos in the antarctic ice. A first part of the detector (13 strings of 40 modules) was deployed in 1996 and 1997. The telescope was completed during December 1999 and January 2000 by 6 strings of 40 modules. All these strings are deployed from 1000m to 2350m in the ice and are enclosed into a cylinder of 120m diameter. M. Vander Donckt and J.P. Dewulf took part in this installation as well as in the calibration of the detector. The laboratory was also involved in the development of the optical link communication between the modules buried in the ice and the control room located on the surface of the ice shell at the South Pole. In parallel, a test station was developed in the laboratory in order to measure the ageing of the optical modules in their extreme working conditions. These modules were put in a fridge working at –30°C and submitted to a blue led diode flashing at 10kHz. This test showed a gain loss of about 40% with a tendency to a stabilisation after 150 days (when working at a gain level of 10^9). Such a test corresponds to a working of 4 years of the detector in normal conditions. This test was designed in view of the extension of the detector in the framework of the ICE^3 project. In this context of the order of 4800 optical modules are to be deployed in 80 strings within of volume of 1 km^3. It was demonstrated that working with digital communication the gain can be limited to 10^8 reducing the failure rate to an acceptable level.

A simulation program is in preparation in order to determine the detector resolution of ν_τ's. It will be the starting point of a neutrino oscillation study based on emission of neutrinos by active galactic nuclei. These very energetic electron and muon neutrinos ($\geq$ 100 TeV) could oscillate to τ neutrinos and be detected as such with a good efficiency by the AMANDA detector. By comparing the number of neutrinos of each species various oscillation models can be tested and the oscillation amplitude measured with a good accuracy.

D. The future neutrino oscillation programme (OPERA and I216) .

D1. OPERA

(L. Benussi, G. Van Beek, P. Vilain and G. Wilquet)

The year 1999 has been devoted to the detailed design of the long baseline $\nu_\mu \leftrightarrow \nu_\tau$ oscillation experimental project OPERA. Our progress report CERN/SPSC 99-20 and its addendum CERN SPSC 99-38 have given enough confidence to CERN and INFN into OPERA to approve the construction of the new CNGS ν_μ beam line (see CERN 98-02 for a conceptual design) that will point towards the Gran Sasso underground laboratory at 730 km where the detector will be hosted. In the baseline configuration, the 2.5 kton target is built from walls of a total of 1000 000 bricks of lead/emulsion sandwiches arranged into 5 modules and complemented by trackers to identify the interaction vertex and by muon spectrometers. A highly efficient muon identification and charge measurement is mandatory to reduce the charm background. The momentum is used in the kinematic analysis of the τ^- decay candidates in the μ^- channel. For the other decay channels, the electron identification and energy estimation or the hadron momentum measurement by multiple scattering are performed in the emulsion sheets. At the central value of $\Delta m^2 = 3.5 \times 10^{-3} eV^2$ measured by SuperKamiokande, about 340 ν_τ interactions will occur in a sample of about 10 000 ν_μ CC events, and about 20 will be observed after 5 years of data taking. The expected background amounts to about 1 event while the ν_τ sample size varies like $(\Delta m^2)^2$, the measured mixing being compatible with maximum. On a daily base, the two handfuls of bricks containing the predicted interaction vertices will be removed and their emulsion sheets analysed within days. The beam is expected to be ready for physics in May 2005 and so must be the detector. Extensive tests of the performances of various brick assemblies in terms of events location, electron ID and momentum measurements have taken place in test beams, as well as tests of tracker prototypes made from scintillator strips read by WLS fibres.

D2. I216

(G. Van Beek, B. Van De Vyver, P. Vilain and G. Wilquet)

The I216 project aimed at the verification of the $\nu_\mu \leftrightarrow \nu_e$ oscillation signal found by LSND at large $\Delta m^2 \approx 1 eV^2$ and small mixing, and not by KARMEN-II. The search had to take place in the reshuffled low energy neutrino

beam at the CERN PS during years 2002-03. The project has been finalised in 1999 into an experiment proposal (CERN-SPSC 99-26) the scientific interest of which was recognised by the CERN SPSC and Research Board. The proposal was, however, turned down by CERN because of the tough competition with MiniBOONE at Fermilab and because of the worrying burden on laboratory resources and infrastructure.

II.2. STUDY OF e^+e^- ANNIHILATION AT LEP - THE DELPHI EXPERIMENT.

(D. Bertrand, C. De Clercq, J. D'Hondt, J. Lemonne, N. Pukhaeva, W. Van den Boeck, C. Vander Velde, W. Van Doninck, A. Van Lysebetten, N. Van Remortel, F. Verbeure and J. Wickens).

1. Performance of DELPHI and MUF

Since 1995-96, the energy of LEP has been gradually increased with the goal to reach 100 GeV per beam by 1999. By the end of the 1999 runs, the maximum centre-of-mass energy reached was 204 GeV and a record integrated luminosity of 232 pb^{-1} has been achieved during this year, of which 125 pb^{-1} have been accumulated above 200 GeV.

The forward muon chamber system MUF of DELPHI , which were built and are maintained by the Belgian groups, functioned efficiently without major problems.

2. Physics results

The main results published in 1999 can be summarized as follows :

i) Charm and beauty physics.

The following production and decay properties of hadrons carrying charm or beauty quantum numbers have been extracted from a total sample of □ 3.5 million hadronic Z° decays.

Measurements of the forward backward asymmetry in $e^+e^- \to c\bar{c}$ and $e^+e^- \to b\bar{b}$ at the Z° pole using reconstructed D-mesons yielded the results :

$$A_{FB}^{c\bar{c}}(89.434\,\mathrm{GeV}) = -0.0496 \pm 0.0368\,(\mathrm{stat}) \pm 0.0053\,(\mathrm{syst})$$

$$A_{FB}^{b\bar{b}}(89.434\,\mathrm{GeV}) = 0.0567 \pm 0.0756\,(\mathrm{stat}) \pm 0.0117\,(\mathrm{syst})$$

$$A_{FB}^{c\bar{c}}(91.235\,\mathrm{GeV}) = 0.0659 \pm 0.0094\,(\mathrm{stat}) \pm 0.0035\,(\mathrm{syst})$$

$$A_{FB}^{b\bar{b}}(91.235\ \mathrm{GeV}) = 0.0762 \pm 0.0194\,(\mathrm{stat}) \pm 0.0085\,(\mathrm{syst})$$

$$A_{FB}^{c\bar{c}}(92.990\,\mathrm{GeV}) = 0.1180 \pm 0.0318\,(\mathrm{stat}) \pm 0.0068\,(\mathrm{syst})$$

$$A_{FB}^{b\bar{b}}(92.990\,\mathrm{GeV}) = 0.0882 \pm 0.0633\,(\mathrm{stat}) \pm 0.0122\,(\mathrm{syst})$$

The combination of these results lead to an effective electroweak mixing angle

$$\sin^2\theta_{\mathrm{eff}} = 0.2332 \pm 0.0016$$

The forward-backward production asymmetries of b-quarks selected by using an impact parameter tag has been determined from a measurement of the average charge flow at three different energies with the result :

$$A_{FB}^{b\bar{b}}(89.55\,\mathrm{GeV}) = 0.068 \pm 0.018\,(\mathrm{stat}) \pm 0.0013\,(\mathrm{syst})$$

$$A_{FB}^{b\bar{b}}(91.26\,\mathrm{GeV}) = 0.0982 \pm 0.047\,(\mathrm{stat}) \pm 0.0016\,(\mathrm{syst})$$

$$A_{FB}^{b\bar{b}}(92.94\,GeV) = 0.123 \pm 0.016\,(stat) \pm 0.0027\,(syst)$$

The effective electroweak mixing angle deduced from these data is

$$\sin^2\theta_{eff} = 0.23186 \pm 0.0083$$

The average life-time of b-baryons was measured using three different samples, selected by the presence in the same jet of a high p_T-lepton and a fast Λ_c^+, proton or $\Lambda°$. These new measurements replace all previously published Delphi results on this subject except for the life-time analysis based on the impact parameter distribution of identified muons associated with a high momentum $\Lambda°$. Taking into account correlations, the combination of the four life-time determinations gave the result :

τ (b-baryon) = 1.14 ± .08 (stat) ± .04 (syst) ps

This result is in agreement with those of other LEP experiments and confirms the discrepancy between the measured and expected b-baryon lifetime.

A precise measurement of the partial decay width into $b\bar{b}$ yielded the result :

$$R_b^\circ = \frac{\Gamma(Z \to b\bar{b})}{\Gamma(Z \to hadron)} = 0.21634 \pm 0.00067\,(stat) \pm 0.00060\,(syst)$$

where the $c\bar{c}$ production fraction was fixed to its Standard Model (SM) value. This result is in good agreement with the SM-expectation of $R_b^0 = 0.21584 \mp 0.00018$, assuming a top quark mass m_t = 173.28 GeV/c^2.

The rate of $Z° \to b\bar{b}\,b\bar{b}$ was measured using a sample of approximately 2 million hadronic Z°-decays. This rate was found to be

$$R_{4b} = \frac{BR(Z° \to b\bar{b}\,b\bar{b})}{BR(Z \to hadrons)} = (6.0 \pm 1.9\,(stat) \pm 1.4\,(syst))x10^{-4}$$

From this result the probability of a secondary production of a $b\bar{b}$ pair from a gluon per hadronic Z-decay was estimated to be

$$g_{bb} = (3.4 \pm 1.0\,(stat) \pm 0.8\,(syst))x10^{-3}$$

ii) τ-lepton decay.

Z-decay data were also used to determine the leptonic branching fractions of τ-decays yielding the combined DELPHI result :

$$BR(\tau \to e\nu\bar{\nu}) = (17.877 \pm 0.109\,(stat) \pm 0.110\,(syst))\%$$

and $$BR(\tau \to \mu\nu\bar{\nu}) = (17.325 \pm 0.095\,(stat) \pm 0.077\,(syst))\%$$

in good agreement with e-μ universality in the weak charged current.

iii) Jet- and hadron multiplicity studies.

Data collected at the Z-resonance were used to determine the charged hadron multiplicity in gluon and quark jets as a function of a transverse momentum – like scale. The ratio of the variations of gluon and quark jet multiplicities with scale agrees with the QCD-expectation and directly reflects the higher colour charge of gluons compared to quarks. From the dependence of the charged hadron multiplicity on the opening angle in symmetric three-jet events the colour factor ratio is measured to be :

$$C_A / C_F = 2.246 \pm 0.62\,(\text{stat}) \pm .080\,(\text{syst}) \pm .095\,(\text{theo})$$

Experimental data on multiplicity fluctuations in one- and two – dimensional angular intervals in e^+e^- annihilations into hadrons at $\sqrt{s}$ = 91.1 GeV and □ 175 GeV have been compared with first order analytical calculations performed in the Double Log - (DLA) and Modified Leading Log Approximation (MLLA). Some general features of the calculations are confirmed by the data but at the quantitative level large deviations are observed which are probably mainly due to the high energy approximation inherent in the computations.

The transverse, longitudinal and asymmetric components of the fragmentation function have been measured from the inclusive charged particle production at the Z°-peak. The transverse σ_T and longitudinal σ_L components of the total hadronic cross section σ_{tot} have been evaluated as :

$$\sigma_T/\sigma_{tot} = .949 \pm .001\ (\text{stat}) \pm .007\ (\text{syst})$$

and $$\sigma_T/\sigma_{tot} = .051 \pm .001\ (\text{stat}) \pm .007\ (\text{syst})$$

The strong coupling constant has been derived from the latter value in next-to-leading order of perturbative QCD. The result, including non-perturbative power corrections, is :

$$\alpha_S\,(M_z) = 0.101 \pm .002\ (\text{stat}) \pm .013\ (\text{syst}) \pm .007\ (\text{scale})$$

From the energy dependence of the event shapes at five different center of mass energies between 130 and 183 GeV and results obtained at the Z°, the logarithmic energy slope of α_S was measured to be

$$\frac{\mathrm{d}\,\alpha_s^{-1}}{\mathrm{d}\log(E_{CM})} = 1.39 \pm 0.34\,(\text{stat}) \pm 0.17\,(\text{syst})$$

in good agreement with the QCD expectation of 1.27.

Finally, the “four jet anomaly” previously suggested by the results of the ALEPH experiment was not supported by an analysis of the DELPHI data at 130 and 136 GeV. In particular, no accumulation in the sum of the di-jet masses around 105 GeV/c^2 was found.

Measurements were also performed of the inclusive production of the neutral mesons, resulting in the following total production rates BR per hadronic Z°-decay :

$$\text{BR}\,(\rho^\circ) = 1.19 \pm 0.10$$

$$\text{BR}\,(f_0\,(980)) = 0.164 \pm .021$$

$$\text{BR}\,(f_2\,(1270)) = 0.214 \pm 0.038$$

$$\text{BR}\,(K^{*0}_2\,(1430)) = 0.073 \pm .023$$

and $$\text{BR}\,(f_2^{'}\,(1525)) = 0.012 \pm .006$$

The energy dependence of inclusive charged hadron distributions as a function of the rapidity, momentum and transverse momentum variables was studied at 130, 136, 161, 172 and 183 GeV. Fragmentation models tuned at the Z-resonance describe these higher energy data well. The energy evolution of rapidity distributions shows that the increase in multiplicity is to a large extent due to the growth in the plateau height.

iv) Fermion pair production at LEP energies above the Z°-peak.

The data collected with the DELPHI detector at energies between 130 and 172 GeV have been used to determine the hadronic and leptonic cross sections and leptonic forward backward asymmetries. No significant deviations from the Standard Model expectations were found. The results were interpreted by performing S-matrix fits to these data and those collected near the Z°-resonance peak.

v) W^+W^- production and decay.

The cross section for the double resonant process $\sigma(e^+e^- \rightarrow W^+W^-) = (15.86 \pm .69\ (stat) \pm 0.26\ (syst))pb$ has been measured at $\sqrt{s} = 183$ GeV and found to be in good agreement with the standard model expectation. The individual leptonic branching fractions were found to be in agreement with lepton universality and the hadronic branching fraction was measured to be

$$BR(W \rightarrow q\bar{q}) = 0.6771 \pm 0.0155\ (stat) \pm 0.0052\ (syst)$$

from which the CKM-matrix element value

$$|V_{cs}| = 0.985 \pm 0.69\ (stat) \pm 0.26\ (syst)$$

was derived.

The mass of the W-boson as determined from the dependence of the cross-section on the centre of mass energy has been measured to be

$$M_W = (80.49 \pm 0.43\ (stat) \pm .09\ (syst) \pm 0.03\ (LEP))\ GeV/c^2$$

From the direct reconstruction of $WW \rightarrow \ell\bar{\nu}q\bar{q}$ and $WW \rightarrow q\bar{q}\,q\bar{q}$ events, a W-mass value

$$M_W = (80.238 \pm 0.145\ (stat) \pm 0.035\ (syst) \pm 0.035\ (fsi) \pm 0.021\ (LEP))\ GeV/c^2$$

was obtained. Combined with the result of the direct measurement of the W-mass previously performed at 172 GeV and with the mass value derived from the energy dependence of the W^+W^- cross section one obtains the result :

$$M_W = (80.270 \pm 0.137\ (stat) \pm 0.031\ (syst) \pm 0.030\ (fsi) \pm 0.021\ (LEP))\ GeV/c^2$$

in good agreement with the Standard Model expectation. The width of the W-boson was also measured giving the value $\Gamma_W = (2.048 \pm 0.40\ (stat) \pm 0.10\ (syst))\ GeV/c^2$.

Measurements of the anomalous trilinear gauge couplings WWV with $V \equiv \gamma$ or Z have also been performed at $\sqrt{s} = 183$ GeV and the results $\Delta g_1^Z = -0.04^{+0.14}_{-0.12}$; $\Delta\kappa_\gamma = 0.19^{+0.32}_{-0.34}$ and $\lambda_\gamma = -.15^{+0.19}_{-0.15}$ have been considerably improved as compared to those obtained in previous DELPHI analyse s at $\sqrt{s} = 161$ and 172 GeV. They are still consistent with the Standard Model prediction $(\Delta g_1^z = \Delta\kappa_\gamma = \lambda_\gamma = 0)$.

vi) Higgs-boson searches.

Neutral Higgs bosons were searched for in the data collected by DELPHI at a centre-of-mass energy of 183 GeV. From a study of the production of the lightest neutral Higgs boson 95% C.L. lower limits were obtained of 85.7 GeV/c^2 for the Standard Model Higgs boson and 74.4 GeV/c^2 for the scalar and 75.3 GeV/c^2 for the pseudo-scalar Higss bosons as predicted by the minimal supersymmetric extension of the S.M. A search for $e^+e^- \rightarrow HZ$ production with $Z \rightarrow q\bar{q}$ or $\mu^+\mu^-$ and the Higgs boson decaying into stable non-interacting particles also lead to a negative result.

In addition, no evidence for the processes $e^+e^- \rightarrow H\gamma$ with $H \rightarrow b\bar{b}$ or $\gamma\gamma$ and $e^+e^- \rightarrow H\,q\bar{q}$ with $H \rightarrow \gamma\gamma$ was observed.

Finally, a search for pair produced charged Higgs bosons in the high energy data at $\sqrt{s} = 161$, 172 and 183 GeV led to a lower limit on the charged Higgs mass of 56.3 GeV/c^2 at the 95% confidence level.

vii) Particle searches beyond the Standard Model at LEP2 energies.

A search for unstable exotic and excited leptons and for excited quarks remained unsuccessful and led to a series of lower limits on their mass values. The production of single scalar and vector leptoquarks was also studied and 95% C.L. lower limits on leptoquark masses were set ranging from 134 GeV/c^2 to 171 GeV/c^2, assuming electromagnetic type couplings.

No evidence was found for the existence of supersymmetric particles. Different searches were made for

- heavy stable and long-lived squarks and sleptons
- scalar fermions and long-lived scalar leptons with the exclusion of stau masses below 55 GeV/C^2 (95% CL)
- lightest neutralino and stau pair production in light gravitino scenarios with stau NLSP in which the mass of the gaugino like neutralinos is found to be greater than 71.5 GeV/c^2. This search combined with the searches for stable heavy leptons and staus in the MSSM allowed to set a lower limit of 68.5 GeV/c^2 on the stau mass.
- pair produced neutralinos in events with photons and missing energy of the type $e+e^- \rightarrow YY$ with subsequent decay $Y \rightarrow XX\gamma$ where X is an undetectable neutral particle and Y a light neutralino.
- searches for charginos, neutralinos and gravitinos
- charginos nearly mass-degenerate with the ligthest neutralino.

The above studies allowed the exclusion of a large domain of SUSY parameters.

Most of these results were presented also at various international conferences and workshops.

3. Activities of the Brussels - Antwerp group

At the IIHE we concentrated our efforts on

- The study of $\tau^+\tau^-$ pairs.
  The polarisation of the τ lepton produced in e^+e^- interactions at a center of mass energy corresponding to the Z° mass was determined for the full sample of events recorded at LEP1 (from year 1990 to year 1995). A new measurement of the τ decay topological branching fractions was performed on the same sample.

- The determination of the W boson mass.
  The measurement of the W-boson mass was performed with a sample of fully hadronic WW final states taken at 189 GeV. An ideogram technique was used to extract the W-boson mass. The systematic error on this measurement is dominated by Final State Interactions (FSI), namely Bose-Einstein correlations between the two W bosons and colour reconnection effects. A technique was investigated to reduce this systematic error by appropriate cuts. The results are promising and the technique has now also been adopted by the other LEP experiments.

- The determination of the WW cross section.
  The WW cross section at 189 GeV was determined with a sample of fully hadronic WW final states. A Neural Network technique was used to select the events.

- The determination of the triple gauge bosons couplings (TGC)
  A measurement of the anomalous TGS couplings (γWW, ZWW) was performed with a sample of fully hadronic WW final states taken at 183 GeV. The method used was an extended maximum likelihood fit of the data to predictions of the Bilenky model, which gives a general description of anomalous couplings. A second study of the TGC parameters consisted of a model independent approach where spin density matrix elements were fitted to the data. The sample used consisted of semi-leptonic WW final states taken at 189 GeV. A Neural Network technique was used to select the events.

At the UIA major contributions were made to the

- Study of Final State Interactions in WW fully hadronic final states
  A study was made of Bose-Einstein correlations inside single W decays and between the two W bosons using a sample of fully hadronic WW final states taken at 189 GeV.

- Study of Bose-Einstein correlations in WW final states
  A study was made of Bose-Einstein correlations in WW events, both fully hadronic and mixed hadronic-leptonic final states. The parameters λ and r, characterising the correlation, were found to be compatible in fully hadronic events, in the mixed events and in Z-events, giving an indication that correlations exist between decay particles from different W's. In order to test the latter hypothesis, three different methods were developed : one based on the mixing of pairs of half-hadronic events, one based on a linear model of combinations of half-hadronic events and one based on the LUBOEI model. All three methods gave consistent results, favoring the hypothesis of Bose-Einstein correlations between pairs from different W-decays.

II.3. STUDY OF ep COLLISIONS AT HERA - THE H1 EXPERIMENT.

(B. Clerbaux, G. Coremans-Bertrand,, C.Collard, E. De Wolf, L. Favart, R. Heremans, X. Janssen, D. Johnson, P. Marage, R. Roosen and P. Van Mechelen).

1. Performances of HERA, H1 and COP.

After the 5 weeks winter shutdown of 1998-1999, a first HERA data taking period started in early January and ran up to late April during which 27.5 GeV electrons collided with 920 GeV protons resulting in a accumulated luminosity of about 14 pb^{-1}. With a second data taking period running from July until December in which the same conditions for the colliding beams were maintained, the H1 experiment collected a total integrated luminosity in 1999 close to 35 pb^{-1}.

The H1 detector has been working for most of the data taking period in optimal conditions. However, during the last months of 1999, a water leak occurred in the forward tracking detector. Shutdown of the cooling not only impaired seriously the efficiency of the forward tracking detectors, but also resulted in broken wires in the central tracking part (due to the high temperature), reducing the CJC1 and CJC2 track finding efficiency to 75 and 80% respectively.

The COP multiwire proportional chamber, which have been built and remain under the responsibility of the Brussels-Antwerp group, has been performing in 1999 as in 1998 with 2 inefficient sectors on a total of 32.

2. Physics analyses in H1.

The main results obtained in 1999 are summarised below :

a. Inclusive cross section at high Q^2

The double differential total cross section in Q^2 and Bjorken x has been measured for Q^2 values between 150 and 30 000 GeV^2 in e^+p collisions with a typical 4% precision. The Q^2 evolution of the extracted parton densities in the proton are in good agreement with the perturbative QCD prediction over four orders of magnitude in Q^2. The enhancement of the neutral current cross section relative to the expectation at $x = 0.4$ and $Q^2 > 15\,000$ GeV^2 reported before is less significant with the addition of the 1997 data. A fit to the Q^2 dependence of the charged current cross section gives a mass of $M_W = 80.9 \pm 3.7$ (exp) $\pm$ 3.7 (th) GeV/c^2. This value agrees well with the W boson mass in time-like processes, thereby confirming the electroweak sector of the Standard Model in space-like lepton nucleon scattering.

b. QCD studies

i) BFKL test with the forward π° cross section

The cross section measurement of large transverse momentum and small angle π° mesons with respect to the remnant proton has been performed. It corresponds to a kinematic region expected to be particularly sensitive to QCD effects. A strong rise with decreasing x of the π° cross section, similar to the inclusive cross section rise, is observed. Models using DGLAP QCD splitting functions cannot describe the differential cross section at low x, while a calculation based on BFKL formalism is in good agreement with the data.

ii) Precise QCD tests

In four publications, QCD predictions have been confronted to the data :
- measurement of D* meson cross sections
- measurement of internal jet structure in deep-inelastic
- measurements of transverse energy flow in deep-inelastic scattering

QCD predictions, including NLO, are giving a good, though not perfect, general description of the data. The gluon density extracted from the D* cross section is found to be in good agreement with the gluon density extracted from the F_2 structure function scaling violation.

c. Vector meson production in diffraction

In 1999, two measurements of exclusive diffractive vector meson production have been achieved : the first

quasi-elastic electroproduction of Ψ(2S) has been reported and the elastic electroproduction of ρ meson has been measured and studied in detail; including the determination of the full set of ρ spin density matrix elements. Evidence is found for a helicity flip amplitude. A QCD based prediction is in qualitative agreement with the measurement of the 15 matrix elements.

d. Virtual photon structure function

An effective leading order parton density for the virtual photon ($1.6 < Q^2 < 80$ GeV^2) has been extracted from the dijet cross section. The parton density as a function of the parton momentum fraction in the photon shows characteristic features of photon structure, and a suppression of this structure with increasing Q^2 is observed.

e. Heavy quarks

Three papers report heavy quark production :
- measurement of D* meson cross sections (see b.)
- charmonium production in deep inelastic scattering (also see c.)
- measurement of open beauty production

Charm production cross section measurements, inclusively, semi-inclusively through D* production and exclusively through J/Ψ tagging are well described by models based on QCD. No evidence is found for violation of the s-channel helicity conservation in the J/Ψ diffractive production. The shape of differential J/Ψ cross section is reasonably well described by the Soft Colour Interactions model, a non perturbative phenomenological approach, but the normalisations are not reproduced.

The first observation of open beauty production in ep collisions has been reported, both in electro- and photoproduction. The measured cross section are significantly higher than those predicted by QCD.

f. New phenomena

A search for leptoquark bosons, coupling lepton-quark pairs, and lepton flavour violation in e^+p collisions have been reported and exclusion domains have been derived. Scalar leptoquarks are excluded with masses up to 275 GeV/c² for an electromagnetic coupling strength $\lambda = 0.3$.

2. Activities of the members of the Brussels-Antwerp group.

a. Project of a new proton spectrometer

In 1999, the Belgian group has actively pursued preliminary studies concerning the construction and installation of a new proton spectrometer (PS) for diffraction studies.

Given the new beam line structure after the luminosity upgrade of HERA in the year 2000, numerous calculations were performed to estimate the resolution, the acceptance and the optimal location for installing the PS. The best choice for the detector location has been fount to be at 200 m downstream of the H1 interaction point, in the “cold” section of the beam line.

The design of a cold bypass for the helium lines was discussed in detail with the DESY cryogenics and vacuum group, and a pre-study was ordered to an engineering office. On the basis of this pre-study the DESY groups of the cryogenics, vacuum and accelerator evaluated the project favourably.

The fibre detectors identical to those which will be used for the PS have presently been installed into the HERA beam line in December 1999 and a first evaluation will be made in the next months. The same groups which have built the detectors and the electronics for the FPS, have offered their support for the new project and are prepared to modify the detector specification where needed and adjust the electronics to the new experimental conditions.

The possibilities to include the PS data either at level 1 or at level 2 of the H1 triggering system have been studied. The Lund group will contribute with technical support and manpower for the trigger and the DAS systems.

b. Physics analysis

The main activities in the Belgian group have been centered on the study of diffraction.

- ϕ meson electroproduction : a measurement based on 1995 low Q^2 data and 1996 data is well advanced and should be submitted for publication in the first semester of 2000.
- High Q^2 ρ and ϕ meson electroproduction : the data selection has been finalised for the 1997 data and the analysis is in progress; QED radiative corrections and tools for including a parametrisation of the polarisation states have been included in the DIFFVM Monte Carlo.
- ρ meson photo- and electroproduction at high t : spatial triggers have been implemented (level 1, level 2 neural network, level 4) for the 1999-2000 run (using the Electron Tagger, the VLQ and the SPACIAL detectors for different Q^2 ranges); a first selection has been performed of the data taken in 1997.
- ρ' meson production : the feasibility of a measurement of the Q^2 dependence of the ρ'/ρ cross section ratio with the 1997 data has been demonstrated.
- Deeply virtual Compton scattering (DVCS) : a signal has been found in the data of the unbiased run of 1997; the Bethe-Heitler background has been studied in detail, using the data and a Monte Carlo simulation; a DVCS Monte Carlo simulation program has been written; the signal of the full 1997 data taking period is under study.

Other activities have been pursued :

- Several contributions to the study of the characteristics of the hadronic final states have been provided in the framework of the corresponding H1 working group.
- The preliminary measurement of the proton structure function F_2 at low Q^2 and moderate x using radiative events has been cross checked, and a final analysis will be available in the first months of the year 2000.
- A first trial to measure the longitudinal ep cross section using radiative events.

II.4. STUDY OF pp COLLISIONS AT LHC - THE CMS EXPERIMENT.

(W. Beaumont, T. Beckers, O. Bouhali, G. De Lentdecker, O. Devroede, J. De Troy, F. Iacopi, Ph. Moortgat, F. Udo, J. Stefanescu, S. Tavernier, W. Van Doninck, C. Vander Velde, Ch. Van Dyck, P. Vanlaer, L. Van Lancker, F. Verbeure and V. Zhukov).

In December 1994, the CERN council decided the construction in the LEP tunnel of a "**L**arge **H**adron **C**ollider" (LHC) which is expected to be operational in 2005. This machine will allow the study of proton-proton interactions at a center-of-mass energy of 14 TeV with luminosities around 10^{34} cm^{-2} s^{-1}. Two multipurpose detectors, ATLAS and CMS, will be installed at LHC.

The **C**ompact **M**uon **S**olenoid (CMS) collaboration consists of more than 1700 physicists and engineers from 150 institutes over the world among which five Belgian research groups from the IIHE (ULB/VUB), UIA, UCL and UMH. The Belgian teams have chosen to participate to the design and construction of the tracker detector of CMS.

In October, November 99, a very decisive test of the counters envisaged to equip the FW wheels of the CMS tracker, took place. This milestone was done in collaboration with Aachen, Karlsruhe, Novosibirsk and Strasbourg/Mulhouse. Eighteen modules equipped with four MSGC + GEM counters each, were exposed during 360 hours to the high intensity pion beam at PSI, at the working point allowing 98 % detection efficiency for MIP's. The rate of electrodes damaged by sparks, induced by heavily ionizing particles, was observed to be $(0.12 \pm .03)\%$. Extrapolated to 10 years of operation at LHC this rate corresponds to less than 5 % of broken strip at the end of LHC, leading to a negligible inefficiency. Some counters were then pushed to higher voltages showing that the use of a GEM in conjunction with an MSGC insures a security margin of a factor 3 or 4 in signal-over-noise, even in the presence of heavily ionizing particles simulating the harsh LHC environment.

Several MSGC substrates produced at IMEC were used to mount MSGC and MSGC + GEM counters. Those prototypes were also tested in the high intensity pion beam at PSI. These tests showed that the procedure used at IMEC to produce the substrates leads to very robust strip that can undergo thousands of sparks without being damaged. However the quality of the lithography is not as good as for the ALENIA substrates. This leads to a higher spark rate and some of those sparks are able to kill the readout electronics in the absence of an appropriate input resistance.

A new micro-pattern strip detector, very cheap, the MICROMEGEM, has been developed at the IIHE. It consists in a GEM grid placed 50 to 100 μm above a simple printed circuit board with anode strips. Tests of this detector have been done in the laboratory and in the high intensity pion beam at PSI. High gains, up to 20000 can be

reached. The energy resolution is of the same order as for similar detectors : 20 % at a gain of 4000 and the counting rate can reach 10^5 photons/mm^{2}s. However, its performances degrade in the presence of heavily ionizing particles which prevents its use at LHC.

III. TECHNICAL R & D.

III.1. DEVELOPMENT OF INSTRUMENTATION FOR POSITRON EMISSION TOMOGRAPHY.

(P. Bruyndonckx, R. Chen, A. Fremout, S. Tavernier, in collaboration with the Royal Marsden Hospital - London and the Hopital Universitaire de Genève).

The small animal PET scanner based on BaF_2 scintillation crystals and photosensitive wire chambers filled with TMAE, designed and built at the IIHE, is presently at the Institute of cancer research at the Royal Marsden Hospital in London. It is used for the development of new PET radiotracers for monitoring tumour response to anticancer treatment. It is hoped that this will provide a much earlier indication of the efficacity of new anticancer drugs than current methods (X-ray CT, MRI) allow. Currently FDG is the only available tracer for doing this kind of study, and we know that it is not selective for tumour cells or anti-cancer drug targets. The studies performed in 1998 were used to look at the changes in FDG uptake kinetics of experimental rat mammary tumours as they responded to hormonal manipulation. This model system allows the intercomparison of FDG PET as it is commonly applied in the clinic, with alternative PET radiotracers under development. Our interest so far has focused on the development of $[I-124]$-IUdR as a probe for tumour cell proliferation. Fig. 7 shows a PET image and an autoradiographic image of a tumor with a necrotic area in the center.

A design study is being made for the construction of a high resolution **P**ositron **E**mission **T**omography (PET) system based on avalanche photodiodes to read out LSO, a new fast ($\tau \approx 40$ ns) scintillator with a high light-yield. A first step is to build a system with only two detector modules, mounted on a gantry, which allows them to rotate independently of each other. Thus, it will be possible to simulate a complete PET system. Each module consists of an APD array coupled to LSO. In order to understand more thoroughly how APD's work, some fundamental studies on the characteristics of APD's have been performed. Experimental results on gain, dark current, capacitance, excess noise factor and quantum efficiency were used to compare the theoretical noise formulae with the measured electronic noise. These studies were done with individual APD's of different sizes (3 mm diameter and 5 mm diameter) as well as with arrays (163 x 3 mm^2) APD's, all of which were supplied by Hamamatsu. The main conclusion from these studies is that APD's are a valid alternative for photomultiplier tubes in PET. Individual coupling between APD and crystal will yield a very good signal to noise ratio, while for block-detector systems, where light sharing occurs, the high light-yield of LSO is clearly a benefit. Several possible coupling schemes of APD's and crystals have to be considered. The 32-channel preamplifier-shaper circuit RD20 Preshape 32, which was developed at CERN, is implemented to read out all the channels of the APD array.

In parallel with the construction, Monte-Carlo simulations are developed for this system. After matching the simulations with the real performance, they will be used as a starting point to develop simulations for a complete PET scanner based on the same principles.

III.2. R & D ON HEAVY SCINTILLATORS.

(R. Chen, F. Tallouf and S. Tavernier - the Crystal Clear Collaboration).

The Crystal Clear Collaboration (RD-18) is an interdisciplinary network set up by CERN and involving solid state physicists with expertise in the study of scintillating phenomena, and instrument builders with expertise in several of the areas where scintillating materials are used, with the aim of finding new fast scintillators. In the beginning, the main aim of the project was to find a scintillating material which could be used at the new large hadron collider (LHC). The main materials studied were CeF3, PbWO4 and cerium doped hafnium glasses. On the basis of this study, the CERN management decided to equip the CMS experiment with a electromagnetic calorimeter using about 80 tons of PbWO4 scintillator.

In many other applications the scintillating materials are used to detect low energy gamma rays in the range

100 keV to 1 MeV. This is the case in gamma ray astrophysics, in nuclear medicine, and in most industrial uses of scintillators. Because of the low energy of the gamma rays, a high light yield scintillator is mandatory in such applications. There is also a need for faster scintillators. Traditional scintillators have a decay time of several 100 ns, which is slow compared to the possibilities of modern electronics. For example $Bi_4 (GeO_4)_3$ (BGO), which is one of the commonly used heavy scintillators today, has a decay time of 300 ns.

Partly as a result of our thorough study of CeF_3 scintillator as a candidate material for LHC, the scintillation properties of CeF_3 and of Ce^{3+} doped materials are now much better understood. We can predict that several heavy rare earth oxides doped with cerium or praseodymium are likely to be dense, fast and luminous scintillators. Indeed, excited Ce^{3+} ions exhibit a $4d \rightarrow 3f$ allowed transition which gives rise to a fast, near UV or blue luminescence with a decay time of a few 10 ns. The interaction of a high energy gamma ray in the scintillator will, after a complex cascade of interactions, give rise to the creation of a number of electron-hole pairs. This number of electron-hole pairs is equal to the energy lost by the ionizing particle divided by the factor $b.E_g$, where E_g is the bandgap energy. The factor b is typically in the range 2-3. The light yield of a scintillator will mainly depend on the efficiency with which the energy contained in these electron-hole pairs is transferred to the scintillating Ce^{3+} centres. This transfer mechanism is complex since it may involve excitonic effects, carrier capture, carrier and exciton self trapping etc., and it is difficult to predict reliably if it will be efficient. In the ground state, the "4f" level of the Ce^{3+} ion is occupied by one electron, and this level usually lies in the lower energy region of the forbidden band gap. The empty "4d" level is 3.4 eV above the "4f" level. In rare earth oxides the 4f level is often situated about one eV above the top of the valence band, making hole capture by this centre a likely process. The energy transfer from electron-hole pairs to Ce^{3+} ions can in this case be described as a hole capture by Ce^{3+}, followed by electron capture of the Ce^{4+} giving rise to an excited Ce^{3+} ion with one electron in the excited "4d" level. This electron will return to the ground state with emission of a scintillation photon.

One material belonging to this class is Cerium doped yttrium orthoaluminate, more commonly called yttrium aluminum perovskite or YAP. Since 1991, members of our network have been involved in developing this material together with the Czech company Preciosa. It has a moderate density (5.36 g/cc), but gives two times more light than BGO, with a broad emission band centred around 370 nm, and a decay time of 30 ns. It can now be considered an established scintillator material. It is used in electronic microscope screens and several other applications are under development, e.g. it is being used by a group in Rome in a mammography scanner.

Another interesting cerium activated oxide is cerium doped lutetium orthosilicate ($Lu_2 (SiO_4)O$ or LSO). It has a high density (7.41 g/cc), a decay time of 42 ns (but with some afterglow) and a light yield 5 times larger than BGO. It is difficult to produce material with constant properties, and the light is strongly non-linear below 100 keV. Both effects result in an energy resolution which is significantly worse than one would expect on the basis of the light yield.

The Crystal Clear Network is investigating a number of other dense rare earth perovskites, garnets and complex orthosilicates doped with cerium and praseodymium. One interesting material which is presently under study is $LuAlO_3$:Ce (LuAP). It is very dense (8.34 g/cc) and fast (17 ns decay time), but its light yield is, in our present samples, only comparable to BGO. We will have to see if this is an intrinsic property of the material, or simply due to defects in our present samples.

III.3. THE MICADO PROJECT.

(P. Bruyndonckx, C. Mommaert, S. Tavernier and F. Zanca).

In the frame of the "INNOVATION" programme of the European commission, a new project was launched under the name of MICADO, with the VUB as project-coordinator. The official starting date was August 1998 and a first term is set for 21 months.
The aim of the project is to validate the MicroGAp Chamber (MGC) technology for digital radiography, specifically mammography applications as a replacement for photographic films or phosphor screens. This new detector will allow for more efficient mammography with possible dose reduction, high throughput, high resolution, digital storage and on-line inspection abilities. It fits within the new approach of bringing medical files in a centralised hospital information system.

A demonstration radiographic imaging detector of 5x5 cm^2 will be built, with newly developed blue light photocathode for operation in gaseous environment of the MGC and with appropriate low noise readout electronics. The pre-production investigation for large area (commercialisable) systems will be executed as well. The development

is a join effort between IMEC, VUB, INFN Pisa AND THE Weizmann Institute of Science, with AGFA-Gevaert and Electron Tube limited as industrial collaborators. The specifications for the medical validation study are given by AGFA-Gevaert.

In addition we are studying the possibility to improve the image quality in digital radiography by increasing the detector Quantum Efficiency (QE) and the light Collection Efficiency (CE), in the current readout system of storage phosphor screens (SPS) produced and commercialised by AGFA-Gevaert.
In collaboration with AGFA we have evaluated the use of Avalanche Photodiodes (APD) (produced by Hamamatsu) as replacement for a photomultiplier tube (PM) and optical fibres. APD's were put forward as a solution for improved detection efficiency of fluorescent light because of their high quantum efficiency at the wavelength of interest (λ=390nm). The quantum efficiency QE of APD, at λ=390nm, is 70%, to be compared with a 28% in case of PM.
For the integration of the APD readout and the AGFA readout system a theoretical study for a special very low noise amplifier has been done. Actually we are trying to implement this integration, but the process is still underway and should be finalised soon.
For collecting the light emitted from the phosphor plate, a design study of an optical system using an elliptical mirror has been investigated, to increase the present light collection efficiency. Theoretical studies about that have also been done with the help of a ray-tracing program, Solstis. We could evaluate a light collection efficiency of about 70%, (considering the active surface area of the APD's we have now and the geometrical loss), to be compared with the present 25% in the system using optical fibre and PM. Moreover this 70% could be increased to 85% if we would use new APD's arrays proposed by Hamamatsu, with an average active area of 92% instead of the present 75%. Work is on progress to obtain images.
Our present study clearly demonstrates that it will be possible to obtain larger quantum efficiency and a better light collection efficiency using a readout scheme based on APD's.

III.4. R&D ON HIGH RESOLUTION TRACKING.

(L. Benussi, P. Vilain and G. Wilquet).

In the framework of an European contract TMR (Training and Mobility of Researchers), we continue to investigate possible applications of the scintillating fiber technology. Image intensifier tubes of the EBCCD type (Electron Bombarded CCD) seem to be an interesting option for the readout of the scintillators in the OPERA detector (see section 3). Successful tests were performed in a CERN test beam and simulation work is going on to evaluate the performance in the conditions of the OPERA experiment.

IV. COMPUTING AND NETWORKING.

Management : R. Vandenbroucke
Scientific staff : Z. Cekro, Manuel Hensmans
Logistic and technical staff : Y. Brants (halftime since April), G. Depiesse, D. Pirnay, G. Rousseau.

A. Management.

The management of the IIHE computer and network infrastructure and services is realised by R. Vandenbroucke. She coordinates the tasks of the technical staff and regularly meets with them to ensure the follow-up of all tasks. She is responsible for all maintenance contracts as well for the insurance of all computer-related equipment. She plans for system and network upgrades and holds contact with suppliers of IT equipment. Good communication between the computer group and the physicists is realised by the IIHE Computer Coordinating Committee.

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 and management of the redistribution of user equipment, follow-up of repairs… and the very important user support. More specifically G. Depiesse takes care of the VMS cluster. G. Rousseau takes care of the network infrastructure and realises all cabling and network connections needed for the maintenance and extension of the IIHE local area network. He gives a first level support for

Macs, PCs, VMS and Unix machines Y. Brants takes care of software installation for all UNIX flavoured machines (workstations and PCs) and gives high-level support for PCs and UNIX. Y. Brants, G. Rousseau and R. Vandenbroucke install Windows NT PCs and PC applications.
Next to administrative tasks, D. Pirnay creates web pages, as well those for the IIHE as those for DECUS BELUX. She contributes to the organisation of the DECUS BELUX Symposium and the Belgian ATM Platform Symposium and provides logistic support for the EuroDemo project.

C. Systems.

The trend to gradually replace with PCs the black/white X-Window terminals, which are not any longer adapted to the new network applications such as Netscape and mail with attached documents in PC formats, has been continued in 1999. In total 15 PCs running Windows NT or Linux have been installed. PCs are now also used for real-time measurements at some test equipment for the Amanda experiment.
The Digital Alpha diskserver has been extended with a second RAID controller and 3 diskshelves with a capacity of 21 disks. A total of 63 Gbyte (6 times 9 Gbyte), the use distributed over several experiments, has been added.

D. Networking.

Local area networking.

The Xylan 100 Mbps ethernet/FDDI switched has been extended with a 32 port ethernet module to support the new installed PCs at a speed of 100 Mbps.

Wide area networking.

During the whole of 1999 the connection to the outside world was very acceptable except during a small period in the summer months when networking upgrading was done as well at the university as at Belnet. During the second half of 1999 the connection to the USA via Belnet worked very well. The year 1999 was the best since a long time for outside connectivity with an acceptable performance.
Tests were done with the Belgacom ADSL connection and this proved to be a viable backup in case of a general breakdown of the VUB network or of Belnet.

F. Scientific activities.

Zlatica Cekro worked essentially on ATM. She especially focused on network management issues related to IP over ATM.

Manuel Hensmans worked on the project that defines and realises an extranet for the province Vlaams-Brabant.

V. TECHNICAL AND ADMINISTRATIVE WORK.

The members of the workshop staff in 1999 were : J. De Bruyne, H. De Nil, J.-P. Dewulf, L. Etienne, R. Gindroz, R. Goorens, E. Lievens, G. Van Beek, R. Vanderhaege, L. Van Lancker, Ch. Wastiels with the help of R. Pins.

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

For CMS an important milestone test of a large system of Micro Strip Gas Chambers (72 MSGC substrates) was run at the Paul Scherrer cyclotron facility during the fall of 1999. This major test was preceeded in June by an exposure of 2 detector modules assembled with MSGC substrates produced at IMEC. Rolande Pins participated at IMEC to the fabrication of several batches of MSGC substrates and to the control of their quality. Luc Van Lancker, Robert Gindroz and Etienne Lievens contributed to the preparation of these beam tests via the manufacturing of mechanical support elements. Luc Van Lancker also participated to the detector assembly performed at Strasbourg and Karlsruhe. Christian Wastiels carried the responsibility for the cabling of the modules produced for these beam tests. He also participated to the installation and testing of the detectors in the beam area.

Guy Van Beek was involved in the preparation of the OPERA experiment (ν oscillation detection at Gran Sasso). He took part in the design work of the emulsion-lead bricks of the detector as well as of the calorimeter.

J.P. Dewulf, L. Etienne and R. Goorens developped a test station to study the ageing of the optical modules of the AMANDA experiment (neutrino telescope in the Antarctic). This station is made of a complete DAQ system, a slow control system (voltage and temperature control) and of a diode driving system through optical fibers.

The DELPHI experiment at the LEP collider at CERN has benefited from the contribution of J.P. Dewulf and R. Goorens. J.P. Dewulf was responsible for the maintenance of the central trigger and of the MUF read-out and trigger hardware. R. Goorens ensured the maintenance of the front-end electronics, trigger and slow control hardware of the MUF.

In the framework of the spin-off activities related to detector developments for medical applications, J. De Bruyne was in charge of the technical support of the PET and of the MICADO project.

The secretarial work and the general administrative support of the experiments was accomplished by R. Alluyn-Lecluse and M. Garnier-Van Doninck assisted by M. De Schutter, M. Goeman, J. Liesen and D. Luypaert-Peymans. M. Pins has contributed to the maintenance of our documentation centre and has provided illustrations for several publications and lectures of members of the laboratory. A. De Coster-Vancauwenberg and M. De la Sorte took care of the library. Ch. Carlier took care of the DELPHI and CMS documentation and the running of the DELPHI data quality software.

VI. REPRESENTATION IN COUNCILS AND COMMITTEES.

D. Bertrand acted as chairman of the "Ecole Doctorale en Physique Microscopique et Astrophysique" (ULB); he was member of the “commission de classement du département de Physique (ULB) and chairman of the “commission de coordination pédagogique pour la physique” (ULB).

C. De Clercq was the Belgian representative in the HEPCCC Technical Advisory Subcommittee (HTASC) and in the European Particle Physics Outreach group depending from RECFA. She acted as member of the "Evaluatiecollege 42” - Kernfysica en Elementaire Deeltjes fysica of IWT for the selection of PhD students and as public relation for the Vakgroep Natuurkunde VUB. She was also the representative of the vakgroep Natuurkunde in the IDLO nascholingsgraad of the VUB.

E. De Wolf was member of the "Onderzoeksraad" U.I.A. and U.A.

E. De Wolf, C. Vander Velde and W. Van Doninck were members of the FWO-committee "Subatomaire fysica".

L. Favart acted as a convenor of the "Radiative Effects Working Group" at the Workshop : "Monte Carlo Generators for HERA Physics" (1998-1999).

X. Janssen was a representative of the “corps scientifique non définitif” in the council of the “Faculté des Sciences” and of the “Département de Physique” de l’ULB. He was also a member of the “commission de discipline pour étudiants” de l’ULB.

J. Lemonne has been the Belgian scientific representative in the CERN Council until March 1999; he was member of the EPS-HEP board and of the Physics Research Training Grants Panel (TMR) of the EC. He was dean of the Faculty of Sciences and member of the Council of the VUB. He was also member of the "Nationaal Comite voor Natuurkunde" of the Belgian Academy of Sciences and of the Council of the “Vlaams Interuniversitair Instituut voor Biotechnologie” (VIB).

J. Lemonne and G. Wilquet were members of the Scientific Commission "Hautes et Basses Energies" of the IISN.

J. Lemonne, J. Sacton and F. Verbeure were members of the Belgian Selection Committee of CERN fellows.

P. Marage was vice-dean of the Faculty of Sciences of the ULB until September 1999 and dean since the 1st of October 1999. He was associated member of the "Comité National de Logique, de Philosophie et d'Histoire des Sciences", vice chairman of the "Comité scientifique au Musée des Sciences et des Technologies". He acted as convenor of the session "7th International Workshop on Deep Inelastic Scattering and QCD" – DIS99 – Zeuthen (D - April 99" and was a member of the International Advisory Committee of the Workshop "Physics with HERA as eA collider" – Hamburg (D), May 1999.

R. Roosen acted convenor at the DESY Workshop on "Monte Carlo Generators for HERA physics" 1998-1999. He was a member of the Commissie Internationalisering en "Doctorale Opleiding" of the VUB, as well as the secretary of the Doctoral examination juries in Physics (VUB).

J. Sacton was member of the "Commission de Physique" at the FNRS. He was a member of the "Commission de recours contre les refus d'inscription d'étudiants" of the ULB and of the "Commission du Fonds Defay". He acted as a substitute of Prof. B. Leduc at the "Commission du personnel N° 1, as a member of a working group of the Faculty of Sciences" (ULB) in charge of preparing a report of "auto-evaluation" of the interfaculty department of agronomy. He participated to the preparation of a follow-up report of the Institutional Evaluation of the ULB for the Council of European Rectors.

S. Tavernier acted as chairman of the physics department of the VUB; he was member of the "Onderzoeksraad" and chairman of the "Facultaire onderzoekscommissie Wetenschappen" van de Onderzoeksraad. He is spokesman of the "Crystal Clear Collaboration" (CERN, R & D18). He acted as project co-ordinator of the EC/INNOVATION project MICADO. He was member of the scientific advisory committee of the 5th International Conference on positron sensitive detectors held in London – UK, of the Organizing committee of the IIE Conference Lyon France (2000) and a member of the International Scientific Committee SCINT 99 (Moskow).

G. Van Beek acted as a representative of PATG in the "Conseil de Physique" (ULB)

R. Vandenbroucke acted as member and communication coordinator of the board of DECUS BELUX, as delegate 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, and event manager of the ATM platform. At the VUB she was member of the ITI commission of the Faculteit Wetenschappen.

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

F. Verbeure acted as vice-rector of the UIA and ex-officio chairman or vice-chairman of a series of committees of that institution, among which the "Onderzoeksraad". As from December 1999, Belgian member of the CERN Council and Committee of Council and also of the Executive Council of ESF.

G. Wilquet was member of the PS and SPS Experiments Committee at CERN until January 1999 and he was the Belgian representative on the Advisory Committee of CERN users. He is the Belgian representative on the European Committee for Future Accelerators since September 1999. He was a member of the Board of the Belgian Physical Society.

The following responsibilities were taken in the organisation

1) of the *DELPHI experiment* :
- **D. Bertrand** : representative of "Belgium" in the collaboration board, member of the editor committee and of the committee in charge of selecting the conference speakers.
- **C. De Clercq** : project leader of the muon detector.
- **J. Lemonne** : representative of the FNRS-FWO in the Finance Committee.
- **A. Van Lysebetten** : Run coordinator of the DELPHI experiment in June 1999
- **J. Wickens** : member of the Executive Committee (until April 1999) of the physics steering panel and of the software steering panel.

2) of the *H1 experiment* :
- **E. De Wolf** : convenor of the working group on energy flow and final states.
- **L. Favart** : convenor of the radiation corrections working group.
- **R. Roosen** : representative of "Belgium" in the Collaboration Board.
- **J. Sacton** : representative of the IISN-IIKW in the Finance Committee.
- **P. Van Mechelen** : librarian of the H1 PHAN software package for physics analyses and convenor of the working group on diffraction since February 1999.

3) of the *CMS experiment* :
- **W. Van Doninck** : member of the management board, of the collaboration board, of the finance board and of the tracker steering committee. He was deputy MSGC coordinator and chairman of the MSGC steering committee.
- **J. Lemonne** and **J. Sacton** : acting as representatives of the FWO and FNRS, respectively, in the Resources Review Board.
- **C. Vander Velde** : representative of the belgian groups at the collaboration board and the tracker institution board.
- **P. Vanlaer** : coordinator of the CMS vertex reconstruction package.

4) of the *CHORUS experiment* :
- **B. Van De Vyver** : responsible for the CERN scanning laboratory
- **P. Vilain** : representative of the IIHE at the Collaboration Board and member up to March 1999 of the committee in charge of supervising the designation of the conference speakers and the edition of contributions.
- **G. Wilquet** : convenor of the committee "Detector and Emulsion".

5) of the *OPERA experiment* :
- **G. Wilquet** : member of the collaboration board, convenor of the working group on electronic detectors and member of the Physics coordination working group.

VII. TEACHING ACTIVITIES.

VII.1. TEACHING ACTIVITIES (academic year 1998-1999).

- ***D. Bertrand, O. Bouhali, B. Clerbaux, G. Collard, G. De Lentdecker, L. Favart, X. Janssen, P. Marage, J. Stefanescu, C. Vander Velde, P. Vanlaer, P. Vilain, J. Wickens and G. Wilquet*** (coordinator) have contributed to the practical work for students attending the lectures of J. Sacton on "Physique des Particules Elémentaires", of P. Vilain on "Questions approfondies de physique des particules", of D. Bertrand C. Vander Velde and G. Wilquet on "Simulation, prise et analyse de données" and of G. Wilquet on "Techniques de la physique expérimentale". They organized specific practical work for students of the 3rd year in physics at the ULB.

- ***D. Bertrand***
  - "Computer Principles" (39 h + 13 h exercises - First year University Studies in Sciences - ULB)
  - "Simulation, prise et analyse de données expérimentales" (partim for 10 h - DEA en physique théorique - 2ème licence en physique - ULB)
  - "Description des ordinateurs (aspects matériels et logiciels) : 45h + 15h exercises – Année préparatoire à la première licence en informatique (orientation gestion) UMH - Charleroi

- ***P. Bruyndonckx***
  - "Beeldvormingtechnieken (7 ½ h of practical work – 1st Licentie Natuurkunde VUB).

- ***P. Bruyndonckx, C. De Clercq, R. Roosen, B. Van De Vyver and W. Van Doninck*** have contributed to the practical work for students attending the lectures of J. Lemonne on "Elementaire Deeltjes" - 1ste licentie natuurkunde VUB.

- ***O. Devroede***
  - "Algemene natuurkunde" (30 h exercises - 1ste kandidatuur natuurkunde - VUB).

- ***E. De Wolf***
  - "Waarschijnlijkheidsrekening en statistiek" (30 h - 2de kandidatuur natuurkunde - RUCA)
  - "Fundamentele wisselwerkingen tussen elementaire deeltjes" (30 h - 2de licentie natuurkunde - UIA)
  - "Elementaire deeltjes fysika (30 h - 2de licentie natuurkunde - UIA).

- ***R. Goorens***
  - Bijstand practica (220u – 1st Kandidatuur GF)
  - Basiskennis informatica (80 h - analyst programmer A1 at the Industriele Hogeschool Anderlecht - Erasmus Hogeschool)
  - Bestandorganisatie en databanken (80 h - ibidem)
  - Data communicatie en netwerken (40 h - ibidem)

- Labo systeemontwikkeling en eindwerken (80 h - ibidem)

He took part in the examination board at KTA - Anderlecht and at the Erasmus Hogeschool - Anderlecht.

- ***R. Heremans***
  "Algemene Natuurkunde II met inbegrip van de kristallografie" (40 h exercises - 2de kandidatuur natuurkunde, scheikunde, geologie - VUB).

- ***D. Johnson***
  - Practica "Algemene en Proefondervindelijke Natuurkunde" (32h – 1ste kandidatuur met polyvalentie)
  - "Gevorderd practicum Natuurkunde" (20h – 2de kandidatuur natuurkunde)
  - "Practicum Algemene Natuurkunde" (20h – 2de kandidatuur natuurkunde)

- ***J. Lemonne***
  - "Algemene Natuurkunde" (90 h + 60 h practical work - 1ste kandidatuur wis- en natuurkunde - VUB).
  - "Algemene Natuurkunde II" (60 h + 60 h of practical work - 2de kandidatuur natuurkunde en scheikunde VUB and 30 h + 30 h of practical work - 2de kandidatuur geologie VUB)
  - "Elementaire Deeltjes" (30 h + 30 h of practical work - 1ste licentie natuurkunde - VUB)

- ***P. Marage***
  - "Histoire des sciences" (15 h - 2ème licence en sciences physiques et sciences mathématiques - ULB)
  - "Physique" (60 h of practical work - 1ère candidature Ecole de Commerce Solvay - ULB)
  - "Histoire des sciences en relation avec la pédagogie" (15 h - agrégation de l'enseignement secondaire supérieur - sciences physiques - ULB)
  - "Approches des pratiques scientifiques" (15 h - 1ère licence journalisme et communications - ULB).
  - "Laboratoire du cours de physique des particules Elémentaires" (J. Sacton) – (30h – 2ème licence en Sciences Physique)
  - "Laboratoire de physique générale" (R. Deltour) – (60h -1ère cand. Pharmacie)

- ***R. Roosen***
  - "Elementaire deeltjes II b - Electromagnetische and zwakke wisselwerkingen" (15 h - 2de licentie natuurkunde - VUB)
  - "Geschiedenis van de Natuurkunde – part 3 : Conceptual problems in physics, Philosophy" (10h – 2de licentie Natuurkunde VUB)

- ***J. Sacton***
  - "Physique des Particules Elémentaires" (30h - 1ère licence en sciences physiques - ULB)
  - Local coordinator of a SOCRATES student exchange programme at the level of the 3rd and 4th years in physics until October 1999.

- ***S. Tavernier***
  - "Detectie van Ioniserende Stralingen" (15 h + 15 h of practical work - 2de licentie natuurkunde and bijzondere licentie medische fysica - VUB)
  - "Transmission lines" (practical work - 2de kandidatuur natuurkunde - VUB).

- ***W. Van den Boeck***
  "Algemene Natuurkunde" (30h of practical work – 1ste kandidatuur natuurkunde - VU

- ***C. Vander Velde***
  - "Physique générale" (partim 60h + 44 h practical work - 1ère candidature en chimie, géologie, physique, mathématique et polyvalente - ULB)
  - "Physique générale" (électronique – 16h – 2ème candidature informatique - ULB)
  - "Technique de la physique expérimentale" (partim 15h – 1ère licence Sciences Physique – ULB)
  - "Simulation, prise et analyse de données expérimentales" (partim 10 h - DEA en physique théorique - 2ème licence en physique - ULB)
  - "Experimentarium" (8 h - 1ère candidature en chimie, géologie, physique, mathématique et polyvalente - ULB).

- ***W. Van Doninck***
  - "Elementaire deeltjes II a - Standard model van electrozwakke wisselwerkingen" (15 h - 2de licentie natuurkunde VUB)
  - "Elementaire deeltjes - Inleiding" (3 h; 1ste kandidatuur burgerlijk ingenieur VUB).

- ***A. Van Lysebetten***
  "Algemene Natuurkunde II" (30 h practical work - 1ste kandidatuur wiskunde and natuurkunde - VUB).

- ***F. Verbeure***
  - "Subatomaire fysica" (30 h - 1ste licentie natuurkunde - UIA)
  - "Numeriek rekenen" (15 h + 15 h of practical work - 1ste licentie natuurkunde - UIA)
  - "Radioactiviteit" (15 h - 2de licentie natuurkunde - UIA)
  - "Meten en simuleren" (15 h + 15 h of practical work - 2de licentie informatica - UIA)
  - "Detectoren voor deeltjesfysica" (15 h - 2de licentie natuurkunde - UIA).

- ***P. Vilain***
  - "Questions Approfondies de Physique des Particules" (partim for 15 h + 35 h of practical work - 2ème licence en physique - ULB)

- ***G. Wilquet***
  - " Simulation, prise et analyse de données expérimentales" (10 h - DEA en physique théorique - 2ème licence en physique - ULB)
  - "Technique de la physique expérimentale" (14 h + 30 h of practical work - 1ère licence en physique - ULB).
  - coordinator of the practical works at the Service de Physique des Particules Elémentaires

VII.2. PhD THESES, "MEMOIRES DE LICENCE" AND "LICENTIAATSVERHANDELINGEN" COMPLETED IN 1999.

*** Ph D Theses.**

- *Vander Donckt, Muriel* (ULB) : "Contribution to the $\nu_\mu \to \nu_\tau$ oscillation search in the CHORUS experiment". Promotor : P. Vilain.

- *Bouhali, Othmane* (ULB) : "Contribution to the study of the MSGC tracker of the CMS detector at the future proton collider LHC". Promotor : C. Vander Velde.

*** "Mémoires de licence" and "licentiaatverhandelingen".**

- *Deweze, Stéphanie* (ULB) : "Etude expérimentale d'un nouveau type de détecteur à gaz : le micromegem". Promotor : C. Vander Velde.

- *D'Hondt, Jorgen* (VUB) : "Bepaling van de W boson massa via $e^+e^- \to W^+W^- \to q\bar{q}'Q\bar{Q}'$ processen bij een massamiddelpuntsenergie van 189 GeV" - Promotor : C. De Clercq.

- *Robert, Caroline* (UIA) : "Studie van de MSGC in combinatie met een GEM" – promotor : F. Verbeure

- *Anthonis, Tine :* (UIA) : "Voorwaarts-achterwaarts correlaties in diep-inelastische ep botsingen bij HERA" - Promotor: E.A.De Wolf

VIII. SEMINARS AND ORAL PRESENTATIONS AT SCHOOLS AND COLLABORATION MEETINGS.

VIII.3. SEMINARS.

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

- ***D. Kielczewska*** (Warsaw and Irvine) **:** "Evidence for oscillation of atmospheric neutrinos by super-Kamiokande".

The following seminars were given by members of the IIHE :

- **J. D'Hondt :"** W-mass measurements and Outlook" – CERN – main auditorium

- **J. Lemonne :** "Elementaire Deeltjes – Hoe elementair ?" – Oudenaarde – UPV - VUB

- **P. Marage** :
  - "Introduction à la Civilisation et à la Science Arabo-Musulmane" (6h) – Lecture for secondary school teachers, ULB
  - "La mécanique quantique : une introduction historique" – Cycle de cours dans le cadre "Initiation à la Cosmologie" organisé par la Société Royale Belge d'Astronomie, de Météorologie et de Physique", CEPULB – ULB
  - "L'affaire Galilée et la liberté de recherche scientifique" – Conférence donnée à l'extension de l'ULB
  - "La Science "Pourquoi ? – Comment ?" – Conférence donnée pour l'ASBL "Progresser Ensemble" – Marchiennes.

- **R. Vandenbroucke** :
  - "LAN, WAW and TCP/IP" - Ministerie van Financiën
  - "Introduction to networking"- COLT, Brussel
  - "Understanding Networking Fundamentals, Global Knowledge" - Brussel

VIII.2. ORAL PRESENTATIONS AT SCHOOLS AND COLLABORATION MEETINGS.

- **P. Bruyndonckx** :
  "Image reconstruction for small animal PET – Crystal Clear Collaboration meeting

- **C. Collard** :
  - "Identifying rho mesons at large $|t|$" - Diffractive meeting - DESY (jan. 99)
  - "Trigger for studying rho mesons at large $|t|$" - Diffractive meeting and Trigger meeting - DESY (may 99)
  - "Report on new vector meson finders » – Data quality meeting - DESY (august 99)
  - "Triggering diffractive rho and phi vector mesons at large $|t|$ – present and future" – Trigger meeting – DESY (sept. 99)

- **C. De Clercq**
  "Physics with LEP2" (3h) – Course given at the 11th Belgian, Dutch, German (Aachen) graduate School on Particle Physics - Rolduc (Netherlands)

- **G. De Lentdecker**
  "The Micronegem Detector" – Student lecture given at the 11th Belgian-Dutch-German (Aachen) Graduate School on Particle Physics – Rolduc (Netherlands)

- **O. Devroede**
  - "Design of the MF2 mask" – talk given at the Forward MSGC meeting (Mulhouse, France)
  - "Testing of thick metal MSGC's in particle beams" – student talk given at the 11th Belgian-Dutch-German (Aachen) Graduate School on Particle Physics – Rolduc (Netherlands)

- **J. D'Hondt**
  - "Overview of the W mass analysis" – Delphi week (April 99)
  - "Bose-Einstein studies for the W-mass measurement" – ALEPH WW meeting (August 99)
  - "Observations on Bose-Einstein correlations" – ALEPH – WW meeting (September 99)
  - "Reducing a systematic error, example with Bose-Einstein effects on the W-mass" – student talk given at the 11th Belgian-Dutch-German (Aachen) Graduate School on Particle Physics – Rolduc (Netherlands)

- **R. Heremans**
  Series of talks given in the following topics – Diffractive workshop – DESY 1999
  - "Status of diffractive photoproduction analysis 97"
  - "Comparison of PHOJET-PYTHIA with minimum bias 97-data"

- "Extraction of the differential cross section $\frac{d\sigma}{dM_x^2}$"
- "Reweighting of PHOJET and PYTHIA cross sections for different diffractive processes"

- **X. Janssen**
  "The radial wave function of vector mesons" – H1 workshop – Seminar for H1 – PhD and Diploma students – DESY (Hamburg)

- **R. Roosen**
  "Summary report of the diffractive workgroup" given at the "Monte Carlo generators for HERA" - Physics Workshop – DESY (1998-99)

- **S. Tavernier**
  "General design consideration for an APD based small animal PET" – talk presented at the Crystal Clear Collaboration meeting in CERN (Geneva) – November 1999

- **G. Van Beek**
  "A horizontal solution for the positionning and exchangability of the emulsion lead bricks in vertical walls for the target tracker" – talk presented at the OPERA target workshop – CERN (1999)

- **W. Van Den Boeck**
  - "Preliminary result for the cross section of the reaction $e^+e^- \rightarrow W^+W^- \rightarrow q_1\,\bar{q}_2\,\bar{q}_3\,\bar{q}_4$ at 192 GeV by using a neural network" – Delphi meeting - CERN
  - "Determination of the cross section for the reaction $e^+e^- \rightarrow W^+W^- \rightarrow q_1\,\bar{q}_2\,\bar{q}_3\,\bar{q}_4$ at centre of mass energies of 189, 192 and 196 GeV at LEP" – student talk at the 11th Belgian, Dutch, German (Aachen) Graduate School on Particle Physics – Rolduc (Netherlands)

- **P. Vanlaer**
  "Results of the MF2 forward MSGC milestone at PSI" – CMS General Tracker meeting, CERN (dec. 99)

- **A. Van Lysebetten**
  "Review of the DELPHI running in June 99" – DELPHI forum – CERN (Geneva)

- **P. Vilain**
  "Neutrino oscillation "(4h) – Ecole doctorale en Physique Microscopique et Astrophysique (ULB)

- **G. Wilquet**
  - "Neutrino oscillations" (10h) – Cycle for post graduate students – University of Salerno (Italy)
  - "Neutrino oscillations" (3h) – Belgian, Dutch, German (Aachen) post graduate school of particle physics – Rolduc (Netherlands)
  - "Neutrino Physics" (3h) – Ecole Doctorale en Physique Microscopique et Astrophysique (ULB)

IX. ATTENDANCE TO CONFERENCES, WORKSHOPS AND SCHOOLS.

IX.1. CONFERENCES AND WORKSHOPS.

- EP-HEP 99, International Europhysics Conference on High Energy Physics - Tampere (Finland)
  J. Lemonne, P. Marage, P. Vilain, E. De Wolf, W. Van Doninck
  J. Lemonne was a member of the International Organizing Committee

- Lepton-Photon '99 : XIX International Symposium on lepton and photon interactions at High Energies - Stanford (USA)
  D. Johnson, C. Vander Velde, J. Wickens, G. Wilquet

- DIS99 – 7th International Workshop on DIS and CD – Zeuthen (Germany)
  P. Marage, E. De Wolf
  .
- Workshop on small x-physics at HERA – Tel Aviv (Israel)
  P. Marage, R. Roosen, E. De Wolf

- Moriond meeting on QCD –
  E. De Wolf

- WW '99 Workshop on WW physics at LEP 2000 – Kolymbari, Chania, Crete (Greece)
  C. De Clercq, A. Van Lysebetten, J. D'Hondt, W. Van den Boeck, N. Van Remortel, F. Verbeure

- ISMD99 – Providence (USA)
  E. De Wolf and F. Verbeure

- Fifth International Conference on Position Sensitive Detectors – University College London (U.K.)
  C. Vander Velde, S. Tavernier

- Colloquium in memory of B. Wiik – Hamburg (Germany)
  P. Vilain

- Workshop on neutrino telescopes – Venice (Italy)
  P. Vilain

- Mexican Workshop on Particles and Fields – Merida (Mexico)
  R. Stamen

- Symposium on frontiers in nuclear medicine technology – SCK Mol
  P. Bruyndonckx, R. Chen, A. Fremout, S. Tavernier

- Eight International Conference on Calorimetry in High Energy Physics – Lisbon (Portugal)
  S. Tavernier

- IEEE 1999 Nuclear Sympsosium – Seattle, Washington (USA)
  S. Tavernier

- IEEE World Engineering Congress, Part Telecommunications, Kuala Lumpur (Malasia)
  R. Vandenbroucke

- ITU99 World Conference – Geneve (Switzerland)
  R. Vandenbroucke

- Design for the Next Millenium – International design engineering technical conference & computer and information engeneering conference – ASME, Las Vegas (USA)
  G. Van Beek, L. Van Lancker

- 5th Workshop on Electronics for LHC experments – Snowmass (USA)
  R. Goorens

- DECUS, US Symposium – Las Vegas (USA)
  Y. Brants

- TERENA – Nordunet joint Conference – Lund (Sweden)
  R. Vandenbroucke

- XIVth Workshop on Quantum Field Theory in High Energy Physics – Moscow (Russia)
  A. Van Lysebetten

- General Scientific meeting of the Belgian Physical Society – VUB
  C. Collard, C. De Clercq, G. De Lentdecker, A. Fremout , R. Heremans, X. Janssen, J. Lemonne, W. Van den Boeck

- International Workshop on micro-pattern gas detectors – Orsay (France)
  O. Bouhali, W. Beaumont, P. Vanlaer

IX.2. SCHOOLS.

- Cargese 1999 Summer School : Particle Physics : Ideas and Recent Developments – Cargese (France)
  L. Favart
- 11th Annual Belgian, Dutch, German (Aachen) Graduate School of Particle Phycis – Rolduc (Netherlands)
  J. D'Hondt, G. De Lentdecker, C. Collard, O. Devroede, X. Janssen, W. Van den Boeck
- ICFA Instrumentation School – Univ. of Istanbul (Turkey)
  G. De Lentdecker
- Cross talk – The H1 Workshop – Seminar for H1 PhD and Diploma Students – DESY,Hamburg (Germany)
  C. Collard, X. Janssen
- CERN 99 Summerschool – CERN-Geneva (Switzerland)
  J. D'Hondt
- Ecole de Gif-sur-Yvette – Grenoble (France)
  R. El-Aidi
- College on Medical Physics - ICTP Gregnano, Trieste (Italy)
  F. Zanca

X. LIST OF PUBLICATIONS, REPORTS AND ORAL CONTRIBUTIONS TO CONFERENCES BY MEMBERS OF THE IIHE.

X.1. PUBLICATIONS.

Neutrino Physics

Neutral and charge-current neutrino-electron scattering
P. Vilain et al.
Accepted for publication in Eur. Phys. J. C

High resolution tracking using large capillary bundles filled with liquid scintillator
P. Annis et al.
CERN-EP-99-132
Accepted for publication in Nucl. Inst. & Meth. A

Leading-order QCD analysis of neutrino-induced dimuon events
P. Vilain et al.
Eur. Phys. J. C11 (1999) 19-34

e+e- physics

Measurement of the lifetime of b-baryons
P. Abreu et al.
Eur. Phys. J. C10 (1999) 185-199

Measurement of the leptonic branching fractions of the tau
P. Abreu et al.
Eur. Phys. J. C10 (1999) 201-218

Measurement of the forward backward asymmetry of c and b quarks at the Z pole using reconstructed D mesons
P. Abreu et al.
Eur. Phys. J. C10 (1999) 219-237

Search for neutral Higgs bosons in e+ e- collisions at $\sqrt{s}$ = 183 GeV
P. Abreu et al.
Eur. Phys. J. C10 (1999) 563-604

Measurement of the quark and gluon fragmentation functions in Z^0 hadronic decays
P. Abreu et al.
Eur. Phys. J. C6 (1999) 19-33

Search for pair-produced neutralinos in events with photons and missing energy from e^+e^- collisions at $\sqrt{s}$ = 130-183 GeV
P. Abreu et al.
Eur. Phys. J. C6 (1999) 371-384

Search for scalar fermions and long-lived scalar leptons at centre-of-mass energies of 130 GeV to 172 GeV
P. Abreu et al.
Eur. Phys. J. C6 (1999) 385-401

Search for lightest neutralino and stau pair production in light gravitino scenarios with stau NLSP
P. Abreu et al.
Eur. Phys. J. C7 (1999) 595-608

Search for composite and exotic fermions at LEP 2
P. Abreu et al.
Eur. Phys. J. C8 (1999) 41-58

Measurement of $A^{bb\text{-}bar}$ FB in hadronic Z decays using a jet charge technique
P. Abreu et al.
Eur. Phys. J. C9 (1999) 367-381

Search for Leptoquarks and FCNC in e+e- annihilations at $\sqrt{s}$ = 183 GeV
P. Abreu et al.
Phys. Lett. B446 (1999) 62-74

Search for charginos, neutralinos and gravitinos in e^+e^- interactions at $\sqrt{s}$ = 183 GeV
P. Abreu et al.
Phys. Lett. B446 (1999) 75-91
Erratum: Phys. Lett. B451 (1999) 447

Study of the four-jet anomaly observed at LEP centre-of-mass energies of 130 and 136 GeV
P. Abreu et al.
Phys. Lett. B448 (1999) 311-319

Measurement of inclusive ρ^0, $f_0(980)$, $f_2(1270)$, $K_2^{*0}(1430)$ and $F'_2(1525)$ production in Z^0 decays
P. Abreu et al.
Phys. Lett. B449 (1999) 364-382

The scale dependence of the hadron multiplicity in quark and gluon jets and a precise determination of C_A/C_F
P. Abreu et al.
Phys. Lett. B449 (1999) 383-400

W pair production cross-section and W branching fraction in e^+e^- interactions at 183 GeV
P. Abreu et al.
Phys. Lett. B456 (1999) 310-321

Energy dependence of event shapes and of α_s at LEP 2
P. Abreu et al.
Phys. Lett. B456 (1999) 332-340

Multiplicity fluctuations in one- and two- dimensional angular intervals compared with analytic QCD calculations
P. Abreu et al.
Phys. Lett. B457 (1999) 368-382

Search for the Higgs bosons in events with isolated photons at LEP 2
P. Abreu et al.
Phys. Lett. B458 (1999) 431-446

A search for invisible Higgs bosons produced in e^+e^- interactions at LEP 2 energies
P. Abreu et al.
Phys. Lett. B459 (1999) 367-381

Measurements of the trilinear gauge boson couplings WWV ($V \equiv \gamma, Z$) in e^+e^- collisions at 183 GeV
P. Abreu et al.
Phys. Lett. B459 (1999) 382-396

Energy dependence of inclusive spectra in e+ e- annihilation
P. Abreu et al.
Phys. Lett. B459 (1999) 397-411

Search for charged Higgs bosons at LEP 2
P. Abreu et al.
Phys. Lett. B460 (1999) 484-497

ep physics

Charged particle cross sections in photoproduction and extraction of the gluon density in the proton
C. Adloff et al.
Eur. Phys. J. C10 (1999) 363-372

Charmonium production in deep inelastic scattering at HERA
C. Adloff et al.
Eur. Phys. J. C10 (1999) 373-393

A search for leptoquark bosons and lepton flavor violation in e^+p collisions at HERA
C. Adloff et al.
Eur. Phys. J. C11 (1999) 447 - 471

Diffractive dijet production at HERA
C. Adloff et al.
Eur. Phys. J. C6 (1999) 421-436

Multijet event rates in deep inelastic scattering and determination of the strong coupling constant
C. Adloff et al.
Eur. Phys. J. C6 (1999) 575-585

Measurement of leading proton and neutron production in deep-inelastic scattering at HERA
C. Adloff et al.
Eur. Phys. J. C6 (1999) 587-602

Forward jet and particle production at HERA
C. Adloff et al.
Nucl. Phys. B538 (1999) 3-22

Measurement of D* meson cross sections at HERA and determination of the gluon density in the proton using NLO QCD
C. Adloff et al.
Nucl. Phys. B545 (1999) 21-44

Measurement of internal jet structure in dijet production in deep-inelastic scattering at HERA
C. Adloff et al.
Nucl. Phys. B545 (1999) 3-20

Forward π^0 Meson production at HERA
C. Adloff et al.
Phys. Lett. B462 (1999) 440-452

Measurement of open beauty production at HERA
C. Adloff et al.
Phys. Lett. B467 (1999) 156-164

Experimental techniques

High rate behaviour and discharge limits in micro-pattern detectors
A. Bressan et al.
Nucl. Inst. & Meth. A 424 (1999) 321-342
Also: Proceedings of the 8th Intern. Wire Chamber Conference - Vienna (98)

Large scale test of wedge shaped microstrip gas counter
M. Ackermann et al.
Nucl. Inst. & Meth. A436 (1999) 313-325

CP violation in CMS: expected performances
J. Stefanescu
Nucl. Phys. B (Proc. Suppl.) 75 (1999)

Operation of a microstrip gas counter equipped with a gas electron multiplier
W. Beaumont et al.
Nucl. Phys. B (Proc. Suppl.) 78 (1999) 395-400

Varia

A measurement of the holographic minimum-observable beam branching ratio in the FERMILAB 15-ft bubble chamber
M. Aderholz et al.
Nucl. Instr. & Meth. A421 (1999) 1-11
Also: CERN/PPE 97-01

IX.2. REPORTS.

- Lepton pair Monte Carlo generators for HERA physics
  D. Hoffmann, L. Favart
  Contribution to the HERA Monte Carlo Workshop
  IIHE report 99.01
  DEC-PROC-1999-02, 576-595

- A long baseline ν_τ appearance expeirment in the CNGS beam from CERN to Gran Sasso
  K. Kodama et al.
  CERN/SPSC 99-20, SPSC/M635, LNGS-LOIT 19/99

- Beam test results from MSGC's with thick metal strips
  W. Beaumont et al.
  CMS note 1999

- The DELPHI trigger system at LEP200
  V. Canale …, J.P. De Wulf, R. Goorens et al.
  DELPHI 99-7 DAS188

- Elastic production of vector mesons at HERA : study of the scale of the interaction and measurement of helicity amplitude
  B. Clerbaux
  IIHE report 99.02

X.3. CONTRIBUTIONS TO CONFERENCES.

Readout of scintillation light with gas gain devices
S. Tavernier
Talk presented at the VIIIth International Conference on Calorimetry in High Energy Physics – Lisbon, Portugal

Diffractive dissociation in photoproduction at HERA
R. Heremans
General meeting of the Belgian Physical Society – VUB

Der Topologische trigger des H1 experiments
R. Stamen
Früjahrstagung der DPG – Heidelberg, Germany

Results of the EISS project
R. Vandenbroucke
TERENA-Nordunet joint Conference – Lund, Sweden

Hadron structure, low x-physics and diffraction
P. Marage
Plenary talk at the EP-HEP'99 International Europhysics Conference on High Energy Physics – Tampere, Finland

The micromegem detector
G. De Lentdecker
General meeting of the Belgian Physical Society – Brussels

Study of the use of a PD's as an alternative to PM-tubes in Positron Emission Tomography
A. Fremout
General Scientific meeting of the Belgian Physical Society – Brussels and
Second Conference on new developments in photodetection (poster) – Beaune, France

The VUB-PET system : performance evaluation and applications for radiotracer validation and anticancer drug development
A. Fremout
Poster contribution to the workshop on High Resolution Imaging in small animals with PET, MR and other modalities – Amsterdam, Netherlands

Review of the VUB-PET system
P. Bruyndonckx
Poster presentation at the Symposium on the Frontiers in Nuclear Medicine Technology, SCK Mol, Belgium

A review of triple gauge boson couplings and W-mass measurements at LEP2
A. Van Lysebetten
Talk given at the 14^{th} Workshop on quantum field theory in high energy physics – Moscow, Russia

Minimizing the Bose-Einstein effect on the W-mass
J. D'Hondt
Presented at the WW '99 Workshop on WW Physics at LEP2000 – Kolymbari, Chania, Crete, Greece

Determination of the cross section for the reaction $e^+e^- \to W^+W^- \to q_1\,\bar{q}_2\,\bar{q}_3\,\bar{q}_4$ at a centre of mass energy of 189 GeV at LEP
W. Van den Boeck
General meeting of the Belgian Physical Society – VUB

Experimental and simulation studies of the uniformity in trapezoidal MSGC's
O. Bouhali
General Scientific meeting of the Belgian Physical Society - VUB

Hadronic Final States and QCD in DIS (H1/ZEUS)
E. De Wolf
Invited review talk at the Workshop on small x-physics at HERA – Tel-Aviv, Israel

New results on the hadronic final states in ep-collisions (H1/ZEUS)
E. De Wolf
Invited talk at the EP-HEP '99 International Europhysics Conference on High Energy Physics – Tampere, Finland

Tests of CMS-MSGC modules at PSI
W. Beaumont et al. – presented by **P. Vanlaer**
International Workshop on micro-pattern gas detectors – Orsay, France

XI. ILLUSTRATIONS.

Fig. 1 CHORUS event in emulsion

Fig. 2 Deployement of one optical module of the AMANDA detector at the south pole in December 1999.

Fig. 3 General view of the OPERA neutrino oscillation project.

Fig. 4 Event of the type $e^+e^- \rightarrow W^+W^- \rightarrow \mu\ \nu\ q\bar{q}$ taken by DELPHI on 28/6/99 at 196 GeV. The muon (red track) is detected in the endcap muon chambers while the two quarks are detected as jet of particles.

Fig. 5 Photoproduction of an ψ in an ep interaction in the H1 detector.
The subsequent decaying particles are also shown.

Fig. 6 CMS test set-up of the 18 MSGC+GEM modules together with 32 MSGC modules in the hight intensity pion beam at PSI.

Fig. 7 The right picture shows an autoradiographic image of a tumor with a central necrosis. The left picture shows A PET image of the same tumor.