INTER-UNIVERSITY INSTITUTE FOR HIGH ENERGIES

ULB -VUB BRUSSELS

ANNUAL REPORT 2006

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BRUXELLES BRUSSEL

UNIVERSITÉ LIBRE DE BRUXELLES,
UNIVERSITÉ D'EUROPE
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Vrije Universiteit Brussel

INTER-UNIVERSITY INSTITUTE FOR HIGH ENERGIES

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C. De Clercq - D. Bertrand

CONTENTS

I. INTRODUCTION

The work presented in this report is supported by the Université Libre de Bruxelles (ULB), the Vrije Universiteit Brussel (VUB), the Fonds National de la Recherche Scientifique (FNRS), the Fonds voor Wetenschappelijk Onderzoek-Vlaanderen (FWO), the Fonds pour la Formation à la Recherche dans l'Industrie et dans l'Agriculture (FRIA), the Instituut voor de aanmoediging van Innovatie door Wetenschap en Technologie in Vlaanderen (IWT), the Belgian Federal Science Policy Office and the European Union.

The scientists whose names are listed below have contributed to the various activities of the Institute in 2006.

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D. Hubert (IWT specialisatiebeurs)
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S. Tavernier (gewoon hoogleraar)
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P. Van Mulders (OZR-IWT overbruggingsbeurs since October 2006)
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T. Anthonis, W. Beaumont, M. Cardaci, A. De Roeck,L. Rurua, D. Sunar, T. Sykor, I. Tsurin, P. Van Mechelen, S. Zhokin and E. De Wolf from the Universiteit Antwerpen (UA) have been working in close collaboration with the Institute.

Research in the field of telecommunications and data communication is conducted at IIHE/VUB by O. Bouhali and R. Vandenbroucke 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

I.1. NEUTRINO PHYSICS

A. CHORUS EXPERIMENT (CERN WA95)

(P. Vilain, B. Van de Vijver, G. Wilquet)

Built in 1993, the CHORUS detector has been exposed between 1994 and 1997 to the CERN-SPS neutrino beam. About one million interactions were recorded in the 770 kg nuclear emulsion target and more than 10 millions were produced in the calorimeter and spectrometer material. Events of this latter type were also recorded in 1998, when the beam was mainly operated for the NOMAD experiment.

The main purpose of the experiment was the search for ν_μ-ν_τ oscillation through the observation for the reaction $\nu_\tau + N \rightarrow \tau^- +$ hadrons. The final exclusion plot will be published in 2007.

The analysis of the unprecedented large and unbiased sample of charmed particles production and decay events is still in progress and new results will be published in 2007 in addition to the about 15 papers already published earlier on this topic.

One paper has been published in 2006:

- Measurement of the nucleon structure functions in neutrinos scattering
  G. Önengüt et al.
  Phys. Let. B 642 (2006) 66-75

B. OPERA EXPERIMENT (CERN CNGS1).

(G. Van Beek, P. Vilain, G. Wilquet)

In 2000, the CERN Council approved the construction of the SPS CNGS neutrino beam, pointing towards Gran Sasso LNGS underground laboratory. The long baseline neutrino oscillation OPERA project, based on this beam, was approved in February 2001.

The motivation for this experiment resides in the now clear evidence, mainly from the Super Kamiokande experiment, of an energy and zenithal dependent deficit in the flux of atmospheric ν_μ's. The data are well fitted in terms of ν_μ-ν_τ oscillation for Δm^2 about 2.5 10^{-3} eV^2 and $\sin^2 2\theta > 0.9$ and compatible with full mixing. OPERA aims at covering this domain of the parameters space and demonstrate the ν_μ-ν_τ oscillation hypothesis through the direct observation of ν_τ interactions.

The detector design is based on two conflicting requirements: the τ detection calls for the spatial resolution of nuclear emulsion but the target mass must measure in kilotons in order to accumulate the required statistics of about 30 000 interactions. The solution consists in stacking 1 mm thick lead foils interleaved with 200 µm plastic sheets covered on both sides by 50 µm emulsion layers. Detailed simulations of this configuration have shown that high τ detection efficiency can be preserved while keeping the background at a tolerable level.

The modular detector structure is as follows:

- 56 foils of lead interleaved with emulsion sheets of about 120 cm^2 area stacked to form a 8.5 kg brick,
- 3264 bricks are assembled in a wall. Each wall, of about 40 m^2 area, is followed by a pair of orthogonal planes of plastic scintillator strips trackers constituting the target tracker and designed primarily to accurately predict the position of the events in the target,
- A super-module is made from 31 walls; it is followed by a muon spectrometer constituted of a dipole magnet instrumented with resistive plate chambers and equipped with high precision trackers made of drift tubes planes,
- Two identical super-modules compose the detector that reaches an effective target mass of 1800 tons.

Our group was more specifically involved in the conception, construction and installation of the target trackers together with two groups of IN2P3 (IReS, Strasbourg and LAPP, Orsay), the universities of Bern and Neuchâtel, and JINR, Dubna. A tracker plane consists of 4 modules, each composed of 64 7-m long scintillator strips equipped with wavelength shifting fibres. A tracker is made of two planes with orthogonal readings. The optical signals transmitted by the fibres are readout at both ends by 64-channel photomultipliers. The description of the target tracker is the object of a publication:

- The OPERA experiment target tracker
  T. Adam et al.

accepted for publication by Nucl. Instrum. Meth. A and arXiV:hep-ex/0701153

The commissioning of all the electronic detectors was completed during 2006 using cosmic muons, with the exception of some planes of drift tubes in the second muon spectrometer that are due to be ready before Easter 2007.

A sample of 319 neutrino interactions occurring in the electronic detectors and in the walls of the surrounding cavern have been recorded during a first period of commissioning of the CNGS beam in August 2006. It is statistically consistent with the beam integrated luminosity. The analysis of 9 tracks predicted to traverse emulsion sheets in a small number of bricks installed at that moment in the target has demonstrated the validity of the technique in which tracks reconstructed by the electronic detectors are extrapolated towards the emulsion sheet. This analysis is the topic of the first publication of the OPERA Collaboration as such:

- First events from the CNGS neutrino beam detected in the OPERA experiment R. Acquafredda et al.
- New Journal of Physics 8 (2006) 303 and arXiV:hep-ex/0611023
- The high speed filling of the target will start in March 2007 and must be completed with the resuming of the SPS activity in 2008.

The CNGS beam is due to operate at the end of the 2007 period of activity of the SPS. Given the expected integrated beam luminosity and the target mass available at that time, a total of 1000 events will be recorded in the target bricks and about three times as many in the cavern rock. This sample size is adequate to fine-tune the commissioning of the detector, to cross-check the CNGS beam, to tune the data analysis chain and test the event finding algorithms.

C. NEUTRINO ASTRONOMY WITH AMANDA AND ICECUBE

(B. Baret, P. Berghaus, D. Bertrand, C. De Clercq, D. Hubert, M. Labare, A. Rizzo and Q. Swillens)

This research project is pursued in collaboration with J.-M. Frère ("Professeur Ordinaire" in theoretical physics at the ULB), co-promotor at the FNRS level.

The AMANDA neutrino telescope is designed for the observation of high energy neutrinos from astrophysical sources in the northern hemisphere. The detector is located at the geographical South Pole and consists of 677 photo multiplier tubes (PMT) of a diameter of 8 inches deployed on a cylindrical array of a diameter of 200m and a height of 500m in the Antarctic ice at a depth of 1500m. A telescope of a second generation, IceCube, is presently under construction. A volume of 1 km^3 will be equipped with a total of 4800 PMT's of a diameter of 10 inches at depths between 1500 and 2300m completed by 160 surface stations made of 2m^3 ice tanks containing 2 PMT's each. The PMT's measure the Cherenkov light emitted in the ice by charged relativistic particles, like the muons produced in charged current muon-neutrino interactions below the detector or the light resulting from cascades produced by electron or tau-neutrinos in the detector. At the present time, 1320 IceCube PMT's are deployed on 22 strings in the ice and 52 tanks are installed on the surface. This represents about 25% of the the Icecube telescope, which will be completed in 2011. Calibrations are performed on the modules presently deployed, and the physics analysis has started on a combination of data sampled from the AMANDA and the partial IceCube telescope. In these analyses optimal use is made of the complementarity of AMANDA and IceCube. AMANDA with its denser instrumentation is more sensitive to low energy neutrinos, while IceCube with its larger surface has a better sensitivity for high energy neutrinos.

The main results published in 2006 by the IceCube collaboration are:

- **Flux limits on neutralino annihilations in the centre of the Earth and in the Sun.**

The data sampled by the AMANDA-B10 detector in 1997-99 (302 optical modules) were searched for nearly vertical upgoing neutrino-induced muons. No excess above the expected atmospheric neutrino background was observed. The data taken with AMANDA-II (677 optical modules) in 2001 were searched for an excess of muon-neutrinos from the direction of the Sun. Here also, no excess above the expected atmospheric neutrino background was observed. Upper limits at 90% confidence level were set on the annihilation rate of neutralinos, of masses in the range 50-5000 GeV/c^2, at the centre of the Earth and in the Sun, as well as on the muon flux at AMANDA induced by neutrinos created by the annihilation products. The Earth analysis was partly done at the IIHE.

- **Search for TeV neutrino sources from a stacking of potential sources**

This search was performed with the data taken with the full AMANDA-II detector in 2000 (677 optical modules). The sensitivity of the search for neutrinos from point sources was improved by grouping potential sources together into generic classes in a procedure known as source

stacking. Different classes of Active Galactic Nuclei (AGN) were established on the basis of their photon fluxes at different energies, assuming that the TeV neutrino flux is proportional to the corresponding photon flux. The analysis was performed on the data taken in 2000. For most sources the source stacking analysis is more sensitive than the point source analysis. No significant deviation from the background expectation was observed.

- **Limits on the high-energy gamma and neutrino fluxes from the SGR 1806-20 giant flare of December 27th, 2004**

On December 27th 2004 a giant γ flare from the Soft Gamma-ray Repeater 1806-20 saturated many satellite gamma-ray detectors. If the gamma emission extends up to TeV energies with a hard power law spectrum, photo-produced muons could be observed in surface and underground arrays. Moreover high-energy neutrinos could have been produced during the flare. Data taken with the full AMANDA-II detector was used to search for downgoing muons indicative of high-energy gammas and/or neutrinos. The data revealed no significant signal. The upper limit on the gamma-ray flux at 90% CL is

$$dN/dE < 0.05\ (0.5)\ TeV^{-1}\ m^{-2}\ s^{-1} \text{ for } \gamma=-1.47\ (-2.)$$

Activities of the IIHE group

The IIHE group took a large responsibility in the analysis of the data taken with AMANDA-B10 in 1997-99. This is a difficult task as the reconstruction and simulation programs had to be adapted to the varying detector configuration (10 strings in 98, 13 strings in 99). Two analyses were pursued with these data:

- study of WIMP (neutralino) annihilations in the centre of the earth
- search for high energy point like neutrino sources inside and outside our galaxy.

The results of the WIMP search in the 99 data have been published in 2007 (see above).
For the combined 97-99 point source search the main effort was the filtering and reconstruction of the data, and the production of samples of simulated data. Many difficulties were encountered linked to bugs in the new SIEGLINDE reconstruction software to which this sample of events was used as test bench. Presently the analysis is in its final stage and the unblinding process is ongoing.
The data taken with AMANDA II in 2000-03 are being analyzed with the aim of searching for WIMP annihilations in the sun. In 2006 the main effort was put on the selection procedure and on the simulations. The trigger conditions to accept data were also extended to include string triggered events with a large gain in statistics for the low energy events. The results from this analysis will be published at the end of this year. Since IceCube is now larger than AMANDA it was decided to use the full 2000-05 dataset in a search for WIMP's from the Sun. This analysis started in 2006 and is performed at the IIHE.
The IIHE is using the data taken in 2000-2004 to evaluate a new method, based on the control of the False Discovery Rate (FDR), for the search for high-energy neutrinos from point sources. In 2006 a study was made of the optimal pixelisation of the sky and the FDR method was tested with a large number of simulated experiments. The first results are promising showing that control of the FDR is possible independently of the background statistics and source luminosity, and with no loss of signal detection efficiency.

In the context of the preparation of the IceCube detector, the OM tests which were started in 2001 were pursued. Two IceCube DOMs were used to perform various sensitivity tests to led light. The TestDAQ software was run on a DomHub in order to develop a slow control monitoring program. A first version of this software is presently running and has been tested on the large test station of the PSL laboratory in Madison (Wisconsin).

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

(D. Bertrand, C. De Clercq, J. D'Hondt, J. Lemonne and J. Wickens)

During 12 years, between 1989 and 2000, the DELPHI experiment has taken about 4 million events at the Z^0 resonance (LEP I experiment), and about 10,000 W-pair events at energies between 161 and 209 GeV (LEP II experiment).

The analysis of the data is still pursued. In the following sections the main results published in 2006 are discussed with in addition special emphasis on the recent contributions from the physicists of the Brussels-Antwerp group.

1) Published DELPHI results:

- Soft photons inside hadronic jets produced by $Z^0 \to q\bar{q}$ final states were studied in the kinematical range .2< Eγ < 1GeV. A clear excess of photons in the experimental data as compared to the Monte Carlo predictions is observed. The ratio of the excess compared to the predicted inner bremsstrahlung rate is 3.4±.2±.8 and is similar in strength to the anomalous soft photon signal observed in fixed target experiments with hadronic beams.

- The exclusive decay branching ratios of τ leptons into final states containing up to five hadrons has been performed. Both sequential cuts -and neural network methods have been used in the selection of exclusive decay modes with different neutral pion multiplicity. The results obtained for 12 different decay channels have similar errors to the most precise single measurements performed in other analyses and are compatible with the current world averages.

- Production characteristics of D^{**} mesons in b-hadron semileptonic decays have been studied using exclusively reconstructed decay channels. Decay final states are dominated by the $D^{(*)}$ π channel and no evidence for a signal in a channel with two pions has been obtained. The dominating contribution is the broad D_1^* whose mass and total width have been measured to be:

$$m_{D_1^*} = 2445 \pm 34 \pm 10 MeV/c^2$$

$$\Gamma_{D_1^*} = 234 \pm 74 \pm 25 MeV/c^2$$

From a measurement of the moments of the hadronic mass distributions of the D^* states and of the corresponding lepton energy spectrum a series of parameters were extracted which enter into the determination of the Kobayashi-Maskawa $|V_{cb}|$ matrix element from the measurement of the inclusive b-hadron semileptonic decay width. Amongst these are the masses of the beauty and charm quarks:

m_b= (4.591±0.062±0.039±0.005) GeV/c^2

m_c= (1.170±0.093±0.055±0.005) GeV/c^2

Using these parameters and inclusive measurements of the b-hadron lifetime and semileptonic branching fraction at LEP, an accurate determination of the value of $|V_{cb}|$ has been obtained:

$$|V_{cb}| = 0.0421 \times (1 \pm 0.014_{meas.} \pm 0.014_{fit} \pm 0.015_{th.})$$

- The b- mass determined in the experiment described above is the so-called pole mass mb(mb) . A study of the normalised 3-jet rate of b-quark events with respect to light quark (u,d,s) events has allowed a determination of the running mass value of the b-quark at the Z0 pole with the result:

  mb(MZ) =2.85±.18(stat) ±.13(exp) ±.19(had) ±.12(theo) GeV/c2

  This value agrees with the prediction of quantum chromodynamics for the energy evolution of the running mass.

- The pseudoscalar meson ηb has been searched for through its decays to 4, 6 and 8 charged particles in two photon interactions at LEPII:

  $$e^+e^- \to e^+e^-\gamma^*\gamma^* \to e^+e^-\eta_b$$

  The data sample corresponds to 617 pb-1 collected at centre-of-mass energies between 161 to 209 GeV.
  Upper limits at a confidence level of 95% on the product $\Gamma_{\gamma\gamma}(\eta_b) \bullet BR(\eta_b)$ are 190, 470 and 660 eV/c2 for decays into 4 , 6 and 8 charged particles respectively.

- A study of double tagged $\gamma^*\gamma^*$ interactions within the energy range 189 to 209 GeV allowed a measurement of the cross sections of the processes:

  $$\sigma(e^+e^- \to e^+e^- + hadrons) = 2.09 \pm .09(stat) \pm .19(syst)\, pb$$
  $$\sigma(e^+e^- \to e^+e^- + \mu^+\mu^-) = 1.38 \pm .12(stat) \pm .06(syst)\, pb$$

  for photon virtualities Q2 between 10 and 200 GeV2 and final state invariant masses of the two photon interactions above 2 GeV/c2 . The latter result is in good agreement with the prediction of QED calculations.

- The DELPHI measurements of cross-sections, forward-backward asymmetries and angular distributions for the processes $e^+e^- \to f\bar{f}$ with $f = e, \mu, \tau, q$ at centre of-mass-energies ranging from 130 to 207 GeV are all in good agreement with the predictions of the standard model and no evidence was found for processes involving the exchange of Z' bosons, contact interactions between initial and final state fermions , the exchange of gravitons in large extra dimensions and the exchange of sneutrinos in R-parity violating supersymmetry. Additional searches for the production of excited leptons and for neutral MSSM Higgs bosons at LEPII also remained inconclusive.

- The cross-sections for single charged and neutral intermediate vector boson production in e+e- collisions have been measured at centre-of-mass energies between 183 and 209 GeV within limited kinematical regions. The results are in agreement with the predictions of the Standard Model.

2) Measurement of the W-boson polarisation and determination of anomalous Triple Gauge Boson couplings (TGC)

The single W Spin Density Matrix elements were measured by the Brussels group in the reaction:

$$e^+e^- \to W^+W^- \to l\nu q\bar{q}(l = e, \mu)$$

in the energy domain ranging from 189 GeV up to 209 GeV. Results on the W polarisation as a function of the W production angle and on anomalous CP-conserving and CP-violating TGC's have been derived from these data.
The results are ready for publication and can be summarised as follows:
i) for the average fraction of longitudinally polarized W's :

$$\sigma_L / \sigma_{tot} = 24.9 \pm 4.5(\text{stat}) \pm 2.2(\text{syst})\ \%$$

ii) for one parameter fits of the SDM elements to the full data sample with combined statistical and systematic errors one obtains:

$\Delta g_1^Z = .07 \pm^{.08}_{.12}$ $\lambda_\gamma = .16 \pm^{.12}_{.13}$ and $\Delta_{\kappa_\gamma} = -.32 \pm^{.17}_{.15}$ for the CP-conserving TGCs

and

$g_4^Z = -.39 \pm^{.19}_{.20}$ $\tilde{\kappa}_\gamma = -.09 \pm^{.08}_{.05}$ and $\tilde{\lambda}_Z = -.08 \pm .07$ for the CP-violating TGCs.

All these results, including those from 2- and 3-parameter fits, are in good agreement with the predictions of the standard Model.

3) Colour reconnection and W-boson mass

The IIHE has contributed significantly to the investigations of the Colour Reconnection effect in fully hadronical decaying WW events. They have proposed a new and better method to infer the parameters governing the effect. The SK-1 model of Colour Reconnection implemented in PYTHIA has one free parameter κ, being κ = 0 in the absence of the effect, and can be transformed into a Colour Reconnection probability P_{reco}. This parameter has been estimated via two orthogonal methods resulting in a value $\kappa = 2.2^{+2.5}_{-1.3}$ transformed in a 68 % confidence interval of 31 % $\leq P_{reco} \leq$ 68 %. Therefore it can be concluded that some indication for the presence of Colour Reconnection has been measured. The paper has been accepted for publication.

From the same events, the IIHE has estimated the mass and the width of the W boson. An advanced convolution technique was applied to extract the optimal information from the events. The dominating uncertainty was due to the possible Colour Reconnection effect mentioned above. People at the IIHE have proposed a method to reduce the total uncertainty in the LEP combined W boson mass measurement. This method has been implemented in each LEP experiment. Today the LEP combined measurement for the W boson mass is m_W = 80.376 ± 0.033 GeV/c^2. This result is final and has been presented for the first time by people of the IIHE at the ICHEP 2006 conference in Moscow.

II.3. STUDY OF EP COLLISIONS AT HERA – THE H1 EXPERIMENT

(A. Astvatsatourov, T. Anthonis, J. Delvax, E. De Wolf, L. Favart, T.Hreus, X. Janssen, D. Johnson, P. Marage, B. Roland, R. Roosen, D.Sunnar, T.Sykora, and P. Van Mechelen)

The HERA high luminosity phase continued during 2006, resulting in the accumulation of 70^{-1} e^-p collisions and 100 pb^{-1} e^+p collisions. During the 2005/2006 period, the collected data represent about 3 times those taken during the HERA I phase. The HERA data taking will terminate at the end of June 2007.

During the past year, the VFPS detectors, which are under the responsibility of the Belgian groups (IIHE-UIA), collected about 65 % of the data simultaneously recorded by H1, which is a good performance taken into account the moving in/out sequences of the Roman pots.

The main activities of the group are related to the VFPS project. During 2006 the VFPS has been continuously taking data in standard mode. To increase the detector acceptance, the proton beam was locally shifted from its nominal trajectory, resulting in a final orbit shift of 0.5 cm. Progress in understanding/correlating the VFPS data to the H1 event information has progressed on various points:

- integration of the beam position information in (x,y) into the VFPS analysis to get hold of the detector-beam distance;
- a full and relative(to H1) luminosity calculation for all VFPS data is available;
- implementation of a new diffractive jet trigger to enhance diffractive di-jet collection;
- a vast effort has been invested into the Monte Carlo beam simulation for the nominal and low energy (450 GeV) beam running. This beam simulation is of key importance in defining the proton momentum information to the VFPS data. This fine tuning of the Monte Carlo is presently finished;
- parametrization of the beam optics using a neural net has completed for Monte Carlo events;
- several analyses are cross-checking the H1 data with VFPS triggered events.

During 2006, H1 published a total of 12 articles in international journals. The most important results are:

- Polarization studies:
  Longitudinal polarization of the leptons during the HERA II phase, have permitted to measure the charged current cross section for longitudinal polarized positrons and this for the first time.
- QCD and hadronic structure:
  A large fraction of the H1 studies refer to the QCD analysis of the deep inelastic scattering process. Diffractive parton densities have been determined from a NLO DGLAB analysis and subsequently used in diffractive jet studies with charm or beauty particles in the final state leading to a good description of the data. Inclusive diffractive data have also been investigated using the forward proton spectromer (FPS) tending to support the Regge factorization hypothesis. QCD models have been further tested using exclusive final states such as the high -t rho production.
- Penta quarks:
  After the discovery of a narrow anti-charmed baryonic state in 2005, interpreted as a penta-quark i.e. matter constituted of 5 quarks, a search for penta-quarks containing a strange quark was conducted. Although seen in other experiments, in the H1 experiment no signal has been found.

Activities of the IIHE group

The physicists of the IIHE have been working in the field of diffraction:

- VFPS data analysis and momentum calibration (4 posdoc - UIA - VUB)
- Analysis of inclusive diffractive events using the VFPS (1 posdoc, 1 PhD - ULB)
- Analysis of diffractive events with 2 jets using the VFPS (1 PhD - ULB)
- Deeply Virtual Compton Scattering (1 PhD - ULB) ,

- Vector Meson production rho and phi (1 posdoc - ULB)
- Hadronic Final State (2 PhD- UIA).

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

(O. Bouhali, O. Charaf, B. Clerbaux, G. De Lentdecker, S. De Weirdt, J.P. Dewulf, J. D'Hondt, Sh. Elgammal, R. Goorens, G. Hammad, J. Heyninck, S. Lowette, J. Maes, T. Mahmoud, P. Marage, S. Tavernier, F. Udo, C. Vander Velde, W. Van Doninck, P. Vanlaer, L. Van Lancker, P. Van Mulders, I. Villela, J. Wickens).

During the year 2006, the Large Hadron Collider (LHC) entered its final construction phase. This machine, which will allow to study proton-proton interactions at a centre-of-mass energy of 14 TeV with luminosities around 10^{34} cm^{-2} s^{-1}, is expected to start at the end of 2007. Two multipurpose detectors, ATLAS and CMS, are presently being constructed and installed at the LHC.

A large research program will be performed at this collider. The machine and detectors have been optimised for the search for new physics at high energy, with particular focus on the discovery of the Higgs boson(s) over a very large mass range. It will discriminate between different theories to extend the Standard Model, with, for example, the observation of supersymmetric particles or with manifestation of extra spatial dimensions. Studies of the top quark properties will become possible due to the large top pair production rate.

The Compact Muon Solenoid (CMS) collaboration consists of more than 2000 physicists and engineers from 176 institutes all over the world among which five Belgian research groups from the IIHE (ULB-VUB), UA, UCL and UMH. The Belgian teams have chosen to participate to the design and construction of the Silicon tracker detector of CMS. The IIHE took the following responsibilities: coordination of the design and production of 17000 frame components to support the Silicon detector modules and 17000 pitch adapters, assembly of 7000 frames, assembly of around 1800 modules for the forward wheels of the tracker using a high precision positioning machine (gantry), mounting of modules on 32 support structures in the shape of a sector of a wheel (so called petals), and detailed long term tests of the modules and the petals.

All the IIHE commitments regarding the CMS tracker production have been successfully fulfilled in 2006. The last hundreds of pitch adapters and frames were delivered beginning of 2006. About 800 modules have been assembled in 2006 at a rate reaching up to 60 modules per week. Finally 20 petals have been produced and successfully tested. The last modules and petals were produced during the summer 2006.

In parallel, the CMS physicists of the IIHE continue to prepare the physics analyses. They contribute to the simulation studies of several physics channels of high relevance at the LHC. They participate to the development of the simulation and reconstruction programs which are required in order to perform the analyses. The two main physics topics are the search for high mass resonances decaying into electron or photon pairs and the study of the semi-leptonic decay of top-antitop quark pairs within the Standard Model.

Search for high mass resonances:

High mass resonances decaying into electron or photon pairs provide some of the most important discovery potentials beyond the Standard Model at the LHC. They are predicted in various models (gravitons and gauge bosons in extra dimension models, new Z bosons in supersymmetric and GUT models, etc.). The search for pairs of electrons and photons with high

transverse momentum is thus one of the hottest topics for CMS from the very beginning of the data taking at 14 TeV.

Since a couple of years the CMS physicists of the IIHE play a leading role in the preparation of the physics analyses for the search of heavy resonances decaying into electron pairs. In 2006, 5 CMS Notes have been published on this subject and this work provided a significant contribution to the CMS Physics Technical Design Report (PTDR volume II).

In addition to its implication in the fast discovery of high mass resonances the IIHE CMS group is involved in the study of the detector response to high electromagnetic objects, typically with a transverse momentum > 100 GeV/c, through the measurement of the total and differential cross-sections of the Drell-Yan process at invariant masses > 200 GeV/c^2.

Related to these physics topics, the CMS group also contributes to several specific software developments:

- reconstruction of very high energy electrons and photons, in particular the treatment of saturated cells of the CMS electromagnetic calorimeter.
- development of the online selection of events with high energetic electromagnetic objects.

In 2006, the CMS team of the IIHE initiated the creation of the HEEPP (High Energy Electron and Photon Pair) working group composed of physicists from Rutherford Appleton Laboratory (UK), University of Bristol (UK), Split (Croatia), Ecole Polytechnique (France), Caltech (US) and Universita La Sapienza (Italy). Several meetings have been organized at CERN in 2006. [https://twiki.cern.ch/twiki/bin/view/CMS/SUSYBSMHeep]

Finally, in December 2006, Pascal Vanlaer, member of the HEEPP group and expert in vertex reconstruction has been chosen by the CMS Collaboration to coordinate the group in charge of the reconstruction of the electrons and photons.

Study of the top quark:

The top quark is the heaviest particle within the Standard Model of particle physics. Due to its high mass it was only discovered in 1995 at the proton/anti-proton Tevatron collider (Chicago, U.S.). In the exploitation phase of the Large Hadron Collider millions of top quarks will be produced each year. These new data opens a new window to precision measurements of the properties of the top quark and their production mechanisms. With measurements of the cross-section, the mass and the angular distributions the Standard Model will be tested at its frontier.

The hypothesis of the Standard Model or theories beyond can be tested on the kinematics of the observed events. In this procedure signals of new physics could become visible. Top quark events are also used as a calibration sample for b-tagging algorithms and jet energy scales. The IIHE has contributed in the preparation of these measurements. The results are published in 8 public CMS notes.

An event selection was constructed to select the semi-leptonic decaying top quark pairs and reducing the main process background contributions. In this effort the b-tagging tools were studied extensively and also a data driven method was developed to extract the quantitative performance of these b-tag tools directly from data. The most relevant systematic uncertainties on a potential measurement of the cross section of the top quark pair production in proton collisions at 14 TeV were determined. It was shown that the knowledge of the b-tag performance is the dominating uncertainty.

An advanced event-by-event likelihood method was developed and implemented to extract the top quark mass from semi-leptonic decaying top quark pair events. The method is

based on the application of a least-square kinematic fit with mass constraints on the observed objects. The extensive study of the systematic uncertainties demonstrated that it should be possible with the CMS experiment to obtain a measurement of the top quark mass with a total uncertainty of 1 GeV/c2 or better. This potential measurement would be the most precise measurement of this Standard Model parameter. The dominating uncertainty comes from the uncertainty on the jet energy scale. Therefore a data driven method was developed to extract the jet energy scale of light and heavy quark jets using the mass constraints, W boson mass and top quark mass, in the top quark pair events. In the low energy range, transverse momentum below 150 GeV/c, this was proven to be the best technique currently available.

With the selected top quark pair events, studies were pursued to check what sensitivity the experiment potentially has beyond the Standard Model. Studies were made to observe the charged Higgs boson, Flavour Changing Neutral Currents (FCNC), mSUGRA like-sign lepton pairs and new resonances decaying in top quark pairs.

Finally, in December 2006, Jorgen D'Hondt, was elected by the CMS Collaboration to coordinate the group in charge of the physics analyses on the top quark.

Grid development:

The CMS team also contributes significantly to the deployment of the LHC Computing Grid (LCG). A cluster of 160 processors with 27 TB disk space has been installed at the IIHE, and has passed the certification tests of the European Grid Program EGEE in July 2005 (see the section on the Grid development at IIHE). This cluster is part of the Belgian "Tier-2" computing center for CMS.

This year, the CMS collaboration has organized a major computing challenge called "Computing, Software and Analysis Challenge 2006" (CSA06) in October and November. It consisted in a 2-month sustained running of the CMS computing grid at a level of 25% of the LHC data taking rate. It included the Tier-2 centers in production for the first time. For the first time also, it exercised data- and work-flow for physics analyses.

The IIHE contributed very successfully to both the computing and the analysis challenges. The commitments to the LCG Memorandum of Understanding (140 processors, 30 TB and 300 Mbit/s bandwidth) were met, except on the Wide-Area Network bandwidth requirement. The data transfer bandwidth was limited to 200 Mbit/s by the connection between the ULB-VUB computing center and the IIHE.

An analysis exercise was conducted in the framework of the HEEPP group, consisting in extracting the signal from a heavy Z resonance from a sample of 1 million events from different physics processes. That sample was simulated and made available on the Grid for the whole CMS collaboration. The experience gathered from this exercise was documented, and a tutorial on remote data analysis was made available for the Belgian Tier-2 users [http://mon.iihe.ac.be/trac/t2b/wiki].

Members of the IIHE also contributed actively to Grid meetings at the Belgian and LCG levels (see section "Computing at IIHE").

III. APPLIED R&D AND SPIN-OFF

DEVELOPMENT OF NEW SCINTILLATION MATERIALS AND OF RADIATION DETECTORS FOR BIOMEDICAL IMAGING APPLICATIONS – THE CRYSTAL CLEAR PROJECT.

(P. Bruyndonckx, Dang Jun, O. Devroede, M. Krieguer, C. Lemaître, Li Zhi, S. Tavernier, M. Wedrowski)

At the front line of organic research, molecular and cellular biologists engineer new molecular arrangements, including genes and proteins. Having produced these new strains, the next task is to investigate what happens when they are implanted in living tissue. The researchers want to know how the new genes "express" themselves. In a different area - pharmaceutical research - the effects of potential new drugs have to be established as quickly as possible. In the past, results have been established "in vitro", by either killing the samples or by taking biopsies. Until recently, there has been no other way of studying the effects of genetic manipulation or drug administration. Now researchers have found how imaging techniques used in medical diagnosis can be adapted for genetic or drug research, providing an immediate picture of how the modified tissue behaves "in vivo". One of these techniques is Positron Emission Tomography (PET).

Since a few years there has also been a steadily growing interest to use PET for mammography studies. Existing clinical PET systems are not optimized for this and the development of dedicated Positron Emission Mammography (PEM) scanners, which are specifically designed and optimized for the task at hand, is required.

From its inception, PET technology has continually benefited from new developments in radiation detection, first using sodium iodide crystals, then the improved performance from bismuth germinate (BGO), and more recently superior materials such as lutetium orthosilicate or aluminates, faster and more effective than BGO. The arrival of more advanced position sensitive PMTs (PS-PMTs) and Avalanche photo diodes (APDs) make it possible to read out matrices of small crystals individually without the introduction of excessive dead space.

In the framework of the Crystal Clear Collaboration (CCC), the medical instrumentation group of the IIHE, together with the UGent, CERN, the Université Claude Bernard (Lyon) and the Forschunszentrum Juelich has developed a new generation of high-resolution small animal PET scanners. The design of these small animal PET scanners is based on the use of position sensitive PMTs (PSPMT) and a phoswhich of LSO/LuAP scintillators to provide the depth of interaction information. The IIHE research group was responsible for the design and construction of the front-end detector modules for a number of small animal PET systems developed within the collaboration. These detector modules consist of a double layered 8x8 crystal matrix mounted on a position sensitive PMT. The upper layer contains 64 LSO crystals measuring 2x2x8 mm while the bottom layer consists of 64 LuYAP crystals measuring 2x2x8 mm. To check the quality of a fully assembled detector module, energy spectra and sensitivity of each pixel in the detector are measured in a dedicated evaluation set-up. We have also negotiated license contracts of our technology with major commercial companies.

In collaboration with other groups in the Crystal Clear Collaboration, the team at the VUB has also built a complete small animal PET system. The data acquisition software for this and parts of the electronics and mechanics were developed at the VUB. The system was moved to U-Gent where it is used in a number of biomedical research projects (Figure 1). A second and more sensitive version of the small animal PET system is now under construction and will replace the one at U-gent. The latter will return to the VUB where is can be used for future experiments or student experiments.

In addition, a project for a mammography PET camera (ClearPEM) has been set-up. This CCC project is in collaboration with a Portuguese consortium of scientific institutes led by LIP (Lisbon), which is also a member of the Crystal Clear Collaboration.

In preparation for the design and construction of a new generation BrainPET scanner, studies using Avalanche Photo diodes (APD) are performed. APDs are more compact, are more easily subdivided in small pixels, and are potentially lower in cost. In these prototype detector modules, very small individual crystals are replaced by a solid scintillator block to eliminate dead zones in- between the crystals. In addition, these scintillator blocks are much cheaper to produce and easier to mount. The position and depth of interaction is determined from the light distribution measured over the pixels in the APD array. The information is extracted from the light profile using neural networks, support vector machines or statistically based methods. The performance of these detector configurations for tomographic imaging can be evaluated on a hardware simulator. This device consists of two rotating platforms onto which two detector modules can be mounted. The two platforms can rotate over 360° and can also rotate relative to one another. This allows us to simulate a complete (or partial) detector ring of a PEM (or a next generation small animal PET) scanner and reconstruct tomographic images of an object. The resulting image showed the very encouraging resolution of 1.6 mm FWHM. To improve mechanical stability a new simulator set-up using a rotating phantom platform was designed and constructed.

The statistical learning algorithms used to find the photon incidence position need to be trained before they can be used. An in-situ position calibration procedure is being developed which allows a fully automatic collection of a training data sets for all detector modules in a fully assembled PET system.

The BrainPET project is a joined effort of de VUB team in collaboration with CIEMAT (Madrid, Spain) and Forschungzentrum Julich (FZJ, Germany). The monolithic scintillator block technology under development at the VUB will also be evaluated in a state-of-the art 9.4 T MRI/PET prototype machine which will be the result of a research effort between FZJ and Siemens Medical Solutions.

IV. COMPUTING AND NETWORKING

(*D. Bertrand, O. Bouhali, S. De Weirdt, G. Rousseau, S. Rugovac, S. Tavernier, E. Torisaen, P. Vanlaer, R. Vandenbroucke, D. Vijverman*)

The management of the IIHE computing team is under the responsibility of O. Bouhali. This covers the following tasks:

- Coordinating the work of the computing team;
- Follow-up of the maintenance and insurance contacts;
- Planning for hardware and software upgrade;
- Providing support for Linux users;
- Co-representing the IIHE in grid related projects;
- Organizing regular meetings with the users.

A. LOCAL CLUSTERS

The local computing facility has been reinforced with new hardware. It actually consists of:

- the condor based cluster composed of 46 CPU's (see figure 7). This gives a total processing power of more than 40 GFLOPS and a 50 GB total RAM. It is mainly used by the AMANDA/ICE^3 members for their analysis. Recently this cluster joined the ICE^3 worldwide MC production software. A first ICE^3 generation chain was successfully produced in the condor cluster.

- A PBS based cluster of 10 CPUs. A total processing power of 8 GFLOPS and 10 GB total RAM. This cluster is kept for specific CMS needs.

The local storage facility is composed of:
- A SAN of type MA8000 with a raw capacity of 3 TB (RAID5);
- A SAN of type MSA1500 with a raw capacity of 7.2 TB (RAID5);

B. GRID COMPUTING

Grid computing is the ultimate solution for the storage and the analysis of the enormous data that is (will be) produced by the different experiments. The IIHE computing groups is involved in several national and international grid projects.

BEGRID

The IIHE is participating to the BEgrid initiative since its beginning in 2003.
The BEGRID platform is composed of 443 CPUs and 3.5 TB of disk space, distributed over the participating institutes. The IIHE is participating with 114 CPUs and 1.8 TB of disk space.

CMS Tier-2

The Belgian institutes participating to the CMS experiment have the project to build a federated Belgian Tier-2 center. This latter will be physically located at two sites: ULB-VUB and UCL computing centers. The IIHE team is playing a key role in planning, testing and installing the necessary infrastructure for the foreseen Tier-2.

At the IIHE a first building block of the Tier-2 has been purchased and installed. It consists of 9 (dual processors, dual core) machines and 25 TB of disk space.

EGEE

The IIHE team is participating to two main EGEE activities: NA2 (dissemination and outreach), NA3 (Training) and SA3 (Integration, test and certification of the middleware).

Within the SA3 work package, our team is taking in charge the test of the Logging and Bookkeeping (LB) service of the middleware. The LB service tracks jobs and gathers events from the various Workload Management Systems (WMS) and processes them in order to give a higher level view of the job status. It also provides public interfaces for querying the job information as well as registering for notifications. The IIHE team has already accomplished two first test layers dedicated to this particular service.

Others

We are also involved in several grid related activities:
- Theses: three undergraduate theses have been successfully accomplished in 2006 thanks to the collaboration between our department, the Service of Distributed Systems of the Faculty of Sciences (ULB) and the service of Computer Networking and Engineering of the Faculty of Applied Sciences (ULB).
- We are collaborating with several institutions in Morocco in terms of grid computing. The first Moroccan site has joint the EumedGrid platform in June and the second one has joint in November.

C. OTHER SERVICES

In order to cope with the hardware increase, the cooling system has to be upgraded. Thus two cooling units (25 kW capacity each) has been installed in the IIHE computer room. One 48 GB/s ports switch has been purchased to reinforce the grid platform.

V. THE INTER-UNIVERSITY ATTRACTION POLE (IAP) IN FUNDAMENTAL INTERACTIONS

The IIHE (ULB-VUB) is part of the IAP 5/27 (www.f-i.be) in collaboration with the following groups: Theoretische Fysica (KUL), Elementaire Deeltjes Fysica (UA), Unité de Physique Théorique et de Physique Mathématique and Unité de Physique des Hautes Energies (UCL), Physique des Particules Elémentaires (UMH), Physique Mathématique des Interactions Fondamentales and Physique Théorique (ULB), Theoretische Natuurkunde (VUB).

The purpose of this IAP, extending over the years 2002 to 2006, is to improve our understanding of Fundamental Interactions through a closer collaboration between Belgian research teams engaged in theoretical or experimental investigations in the field.

An application to the next phase (IAP 6) was elaborated during 2006 and accepted at the end of the year. Two new groups, (Physique Théorique Fondamentale (ULg), Experimental Particle Physics (Ugent) joined the collaboration.

VI. TECHNICAL AND ADMINISTRATIVE WORK

The members of the workshop staff in 2006 were: J. De Bruyne, P. de Harenne, H. De Nil, J.-P. Dewulf, L. Etienne, R. Gindroz, R. Goorens, S. Hannaert, B. Meerschaut, G. Van Beek, R. Vanderhaeghen, L. Van Lancker and Ch. Wastiels, with the help of A. De Coster, M. Goeman, D. Pirnay and J. Liesen. D. Bertrand was in charge of the general coordination.

L. Van Lancker has the general responsibility of the design and of the assembly process of carbon fiber frames which will support the silicon detector of the forward CMS tracker. He is also responsible for the mechanics of the Gantry Robot used to glue silicon sensors and readout hybrids to the frames during module assembly. Mass production of the carbon fiber support frames for the silicon detector modules is ensured by A. De Coster with the help of J. Liesen, S. Hannaert and several job students. The Gantry electronics maintenance is the responsibility of Ch. Wastiels (who coordinated the production of the Gantry control electronics) and J.-P. Dewulf. Daily operation of the Gantry is performed by B. Meerschaut with the help of M. Goeman, D. Pirnay and G. Rousseau. The tests of the hybrids for module assembly were performed by H. De Nil. D. Pirnay was responsible for the inventory and the update of the CMS database and in charge of the practical organisation of the daily operation of the Gantry.

J.-P. Dewulf is responsible for the chain of readout electronics and safety controls used to test the Petals. He has been closely involved in the design of the readout chain used during these tests, and designed a test facility for the analog optical hybrids for CMS. R. Vanderhaeghen was involved in the installation of the readout system. Petal assembly is performed by P. de Harenne, L. Etienne, R. Goorens and Ch. Wastiels. P. de Harenne also participated to Petal assembly at CERN.

The quality of the pitch adapters, which will interface the modules to the amplification electronics, was checked during all the production on special machine at CERN. R. Goorens participated to these tests in 2006.

The logistics involved in the shipping of modules and parts between the IIHE and other laboratories of the CMS collaboration is taken care of by M. Goeman and D. Pirnay. R. Gindroz and S. Hannaert have acted as courier for several shipments to nearby Institutes.

G. Van Beek is responsible for the mechanics of the scintillator strips target tracker modules for OPERA. His contributions include R/D on tracker design. He is co-responsible for the trackers installation on the OPERA detector and has contributed to the conception of the procedure used for their survey. He is following-up the production by industry of the tracker end-caps and of the mechanical parts used in the tracker planes assembly. He has participated to the construction of the trackers in the LNGS cavern and to their insertion and survey in the OPERA target. P. de Harenne participated to the emulsion bricks assembly at the LNGS. R. Gindroz and S. Hannaert have contributed to OPERA through the fabrication of mechanical parts. They, together with R. Vanderhaeghen, have taken routinely charge of the transportation of the end-caps and other components to CERN and to IReS, Strasbourg.

L. Etienne is responsible of the installation of the test station for the DOM modules (Digital Optical Modules) of the IceCube experiment. He also maintained the test stations of the AMANDA modules which were used for practical works of undergraduate students in physics.

J.-P. Dewulf and L. Etienne were in charge of the design and the realisation of a new data acquisition system for a cosmic rays experiment to be implemented in secondary schools (OCRE). This system was considerably upgraded during 2006. L. Etienne was also in charge of the preparation of the scintillators used in the experiment. They also contributed to the installation of one detector at the "Einstein, l'autre regard" exhibition which took place from January until May 2006 at Brussels.

In the framework of the spin-off activities related to detector developments for medical applications, J. De Bruyne, H. De Nil, S. Hannaert and Ch. Wastiels were in charge of the technical support of the CRYSTAL CLEAR project.

The secretarial work and the general administrative support of the experiments were accomplished by R. Alluyn and D. Peymans. They were assisted by M. Goeman, J. Liesen and D. Pirnay. D. Peymans took part in the organisation of the ULB master classes. M. Goeman was in charge of the organisation of the Crystal Clear Collaboration meeting in Antwerp, was co-organiser of the 45th Crystal Clear Collaboration meeting at Cern and took part in the organisation of Euromedim 2006 in Marseille. Daisy Pirnay was responsible for the design and the update of the IAP website.

VII. REPRESENTATION IN ACADEMIC COUNCILS AND COMMITTEES

Daniel Bertrand

- Responsible for the ULB Physics Department Erasmus Students Exchange Program
- Member of the Doctoral and DEA Commission of the Physics Department
- Chairman of the Strategic Plan Commission of the Physics Department
- Belgian coordinator of the EGEE FP6 European project

Catherine De Clercq

- Member of the BaMa commissie faculteit Wetenschappen VUB

- Member of the Commissie PR faculteit Wetenschappen of VUB
- Secretary of the Examencommissie Bachelor Fysica
- Member of the Organisatiecomite Vlaamse Fysica Olympiades

Pierre Marage
- Président de la Commission scientifique Ecole doctorale de la Communauté française en Physique et Astrophysique
- Membre du Conseil d'Administration Institut national des Radioéléments, Fleurus
- Membre du Comité scientifique Expérimentarium de Physique de l'ULB
- Président du Comité scientifique Inforsciences, cellule de diffusion des sciences de la Faculté des Sciences de l'ULB
- Vice-président du Centre de Culture scientifique de l'ULB à Charleroi - Parentville
- Membre du CA Altair, asbl d'Histoire des Sciences attachée a l'ULB

Stefaan Tavernier
- Lid Bevorderingscommissie ZAP
- Lid lcommisie samenwerking VUB-China

Catherine Vander Velde
- Membre de la Commission de sélection des assistants du département de physique
- Membre de la Commission de classement du département de physique
- Chairperson de la Commission Bologne didactique de la Faculté des Sciences
- Membre de la Commission Bologne didactique de l'université
- Membre de la Commission scientifique de Michele Sferazza
- Membre de la Commission d'attribution des crédits pédagogiques du département de physique

Pascal Vanlaer
- Membre de la Commission Bologne "Programme Maîtrise" du Département de Physique de l'ULB

Pierre Vilain
- Vice President of the Council of the Physics Department

VIII. REPRESENTATION IN SCIENTIFIC COUNCILS AND COMMITTEES

Daniel Bertrand
- Member Representative of the ULB of the PAI governing board
- Member Representative of the FNRS of the Aspera Governing Board
- Member Representative of the FNRS of the ApPEC Steering Committee
- Member Representative of the FNRS of the DESY Experiments Finance Review Board
- Member Representative of the FNRS of the ILIAS Steering Committee
- Member Representative of the ULB of the Cern fellows Belgian selection committee

Othmane Bouhali
- Member de la Rencontre nationale sur la Recherche Scientifique, Morocco
- President of the Moroccan association of scientific and technological research

Peter Bruyndonckx
- Member of the Programme committee of the 2006 IEEE Nuclear science symposium
- Member of the Programme committee of the 2006 IEEE medical imaging conference
- Member of the Programme committee of the annual congress of the European Association of Nuclear Medicine

Catherine De Clercq
- Member representative of Belgium of the Plenary ECFA
- Member VRWB werkgroep voor Grote Internationale Onderzoeksinfrastructuren
- Member representative of the FWO of the ApPEC steering committee
- Member representative of VUB of the Vlaamse Raad Voor Wetenschapsbeleid - commissie CFIS,
- Member representative of FWO of the ASPERA Eranet board
- Member of the IISN commission des Hautes et Basses Energies
- Member of the Belgian selection committee of CERN fellows
- Member of the FWO commissie E5 Subatomaire Fysica
- Member of the NIKHEF Scientific Advisory Committee

Pierre Marage
- Member of the SPSC - CERN
- Member of the FWO - Commissie E5 (Subatomaire Fysica)
- Membre titulaire du Comité national de Logique, de Philosophie et d'Histoire des Sciences
- Coorganisateur des Séminaires Ilya Prigogine Penser la Science, ULB
- Membre du Comité scientifique international DIS06

Stefaan Tavernier
- Referee of the Nuclear Instrument Methods - EUROMEDIM2006

Catherine Vander Velde
- Member of the FWO - Subatomaire fysica
- Member of the Belgium Outreach Subcommittee of the European Linear Collider Steering Group
- Member of the CMS Thesis Award committee

Pierre Vilain
- Member of the Board of High Energy Physics section of European Physical Society

Gaston Wilquet
- Member personnel of the Commision Hautes et Basses Energies, IISN-FNRS
- Member FNRS of the Advisory Committee of CERN Users (ACCU)

IX. TEACHING ACTIVITIES

ACADEMIC YEAR 2005-2006

Daniel Bertrand
- PHYS-F-205 "Physique 2" (36/0/0/0) BA2 Biology/Geography/Geology Full time
- PHYS 105 "Stage de laboratoire" (0/0/75/0) 1ere licence en sciences physiques Full time
- INFO 162 "Description des Ordinateurs" (45/15/0/0) Annee preparatoire a la licence en informatique en horaire decale Full time

Peter Bruyndonckx
- "Aanvullend Practicum natuurkunde" (0/0/15/0) 1e lic. Full time
- "Inleiding tot Mathematica" (3/10/0/0) 1e Ba Full time
- "Recente ontwikkelingen in de medische fysica" (13/0/0/0) 2e GGS klinische en biologische ingenieurstechnieken Full time
- "Proefondervindelijke aspecten van de stralings- en kwantumfysica" (0/16/0/0) 2e Ba Full time,
- "Beeldvormingstechnieken" (0/0/15/0) 1e Lic. Full time

Catherine De Clercq
- WE-DNTK-1998 "Elementaire Deeltjesfysica I" (26/0/26/0) 3BA Fysica VUB Full time
- WE-DNTK-9246 "Meten en Experimenteren" (responsible - 0/0/65) 1BA Fysica VUB Full time
- WE-DNTK-11348 "IceCube: een ontmoeting tussen deeltjesfysica en astronomie op de Zuidpool - Seminarie actuele fysic" (2/0/0/0) 1BA Fysica VUB Part time

Daan Hubert
- WE-DNTK-5864 "Begeleiding licentiaatsverhandeling" () 2006-2007 Part time

Pierre Marage
- HIST-F-101 "Histoire des Sciences" (24/0/0/0) BA Full time
- PHYS-F-104 "Physique générale" (48/0/0/0) BA-1 Full time
- PHYS-F-310 "Stages" (0/0/20/0) BA-3 phys. Full time
- PHYS-F-312 "Laboratoires (physique des part. élém.)" (0/0/10/0) BA-3 phys. Full time
- PHYS096 "Histoire des sciences" (15/0/0/0) 2 lic. phys. etc. Full time
- METH083 "Histoire des sciences et épistemologie" (15/0/0/0) AESS Full time

Stefaan Tavernier
- BNEN "Radiation protection and nuclear measurement" (12+12) Interuniversitaire Masteropleiding in Nuclear Engineering Full time
- WE-DNTK-10163 "Detectie van ioniserende stralingen, klinische dosimetrie, wetgeving en kwaliteitsbewaking" (13/13) 2de Lic Full time
- WE-DNTK-2088 "Kernfysica en toepassingen" (13/13) 3de BA Full time

Catherine Vander Velde
- METH031 "Physique du secondaire et du supérieur" (30/0/110) Agrégation de physique Full time
- PHYS-F-103 "Physique" (36/0/0/20) BA1-Informatique Full time
- METH089 "Questions de pédagogie de la discipline" (0/10/0/0) Agrégation de physique Full time

Pascal Vanlaer
- PHYS-F-205: " Physique Générale II" (0/0/36/0) BA2-Biologie, Géographie, Géologie
- PHYS-F-104: "Physique Générale" (0/0/108/0 + 3 ECTS de coord. pédagogique) BA1-Biologie, Géographie, Géologie
- PHYS 105 "Stage de laboratoire" (0/0/75/0) 1ere licence en sciences physiques Full time
- Fourth year in Applied Sciences: 2 projects (Muon lifetime measurement)

Pierre Vilain
- PHYS115 "Questions approfondies de Physique des Particules" (16/0/35/0) 4th Full time
- PHYS109 "Introduction a la Physique des Particules" (26/0/70/0) 3rd Full time

Mateusz Wedrowski
- Practical workshops for lecture "Nuclear Physics and its Applications"
- Practical workshops for lecture "Detection of Ionising Detection"

Gaston Wilquet
- PHYS-F-312/313 "Coordination des travaux de laboratoires et stages" (0/90/0) PHYS - BAC3 Full time
- PHYS-F-301 "Techniques de la physique expérimentale" (14/90/0) PHYS - BAC3 Full time

X. PHD THESES, "LICENTIAATSVERHANDELINGEN" AND "MEMOIRES DE LICENCE" COMPLETED IN 2006

Othmane Bouhali:
- "Déploiement et configuration des intergiciels europééens de grille de calcul, ULB" August 2006 Promotor:O. Bouhali and J. Goossens
- "Etude comparative d'un gestionnaire de stockage pour la ferme de calcul du service de Physique des P" August 2006 Promotor:O. Bouhali and J. Goossens
- "Grid and Cluster Monitoring" August 2006 Promotor:O. Bouhali, J. Goossens, P. Vanlaer and E. Zimanyi

XI. SEMINARS AND ORAL PRESENTATIONS AT CONFERENCES, SCHOOLS AND COLLABORATION MEETINGS

XI.1. SEMINARS

Othmane Bouhali
- "gLite testing and certification activities" - Brussels, 27 October 2006

Peter Bruyndonckx
- "Status and results from the ClearPET project" - University of Science and Technology Hefei, China, 17 April 2006
- "Monolithic scintillator based detector design in PET" - University of Science and Technology Hefei, China, 17April 2006

Catherine De Clercq
- "Study of W boson polarisations and of Triple Gauge boson Couplings in the reaction $e^+e^- \rightarrow W^+W^-$ at energies between 189 and 209 GeV" DELPHI general meeting, - CERN, Switzerland, 24 October 2006

Gilles De Lentdecker
- " Recherche de bosons de gauge neutres de grande masse avec les detecteurs CMS et CDF" - CNRS, IRES, Strasbourg, France, 20 January 2006
- " Recherche de bosons de gauge neutres de grande masse avec les detecteurs CMS et CDF" (CNRS, IPNL, Lyon, Paris, 03 March 2006
- " Recherche de bosons de gauge neutres de grande masse avec les detecteurs CMS et CDF" - Ecole Polytechnique, LLR, Paris, France, 20 March 2006
- :" Recherche de bosons de gauge neutres de grande masse avec les detecteurs CMS et CDF" - CNRS, LPNHE, Paris, France, 21 April 2006
- " Recherche de bosons de gauge neutres de grande masse avec les detecteurs CMS et CDF" - CNRS, LAL, Orsay, France, 11 May 2006

Pierre Marage
- "Sciences, religions et laicite" - Formation sur la 'neutralité', Agrégation de l'Enseignement secondaire supérieur, ULB March 2006
- "Structure Function Parameterisations" - (post-graduate formation - IIHE (4 h.))30 October 2006
- "The Standard Model : General Reminder" (post-graduate formation - IIHE (4 h))9 October 2006
- "Du (bon ?) usage du relativisme" - Séminaire Ilya Progogine 'Penser la Science', ULB, 19 October 2006

- "Reflexions d'un physicien sur la biologie" - Séminaires de BA3 en biologie, Prof. B. André, ULB, 29 November 2006
- "Rapports entre sciences et religions"- Formation sur la 'neutralité', Agrégation de l'Enseignement secondaire supérieur, ULB, 13 November 2006
- "Les femmes face aux études et aux professions scientifiques" - Formation en cours de carrière des enseignants, Université de Liège) January 2006

XI. 2. ORAL PRESENTATIONS AT CONFERENCES, SCHOOLS AND COLLABORATION MEETINGS

Daniel Bertrand
- "The Underwater/ice Observatories of High Energy Neutrinos from the Universe" - Fysica 2006. Leiden (The Netherlands) 28 April 2006

Othmane Bouhali
- "Introduction à la grille de calcul" - Marakech, Morocco 4 December 2006
- "Status of the Logging and Bookkeeping test" - CERN, Geneva December 2006

Peter Bruyndonckx
- "Comparison of non-linear position estimators for scintillator blocks" - CERN, Geneva 12 October 2006
- "Towards a continuous crystal - APD based PET detector design" - Marseille, France. 10 May 2006

Olivier Devroede
- "Status ClearPET Rodent" - Antwerp - Belgium 01 March 2006
- "Status and results of the ClearPET rodent in Brussels" - CERN - Geneva - Switzerland 11 October 2006
- "Geometrical calibration of ClearPET" - CERN - Geneva - Switzerland 11 October 2006

Catherine De Clercq
- "Search for Dark Matter with AMANDA and IceCube" - SUSY06 conference, Irvine, CA, USA 12 June 2006

Tomas Hreus
- "Inclusive Diffraction with VFPS at HERA" - Joint Dutch Belgian German Graduate School 11 September 2006

Daan Hubert
- "Solar WIMPs, an update" - Icecube collaboration meeting, Southern University and A&M College, Baton Rouge, Louisiana, USA 12 April 2006
- "Towards L3 solar WIMPs" - Icecube collaboration meeting, DESY-Zeuthen, Berlin, Germany,06 October 2006
- "Neutralino searches with AMANDA/IceCube: past, present and future" - Workshop on Exotic Physics with Neutrino Telescopes (EPNT06), Uppsala University, Uppsala, Sweden, 20 September 2006
- "Neutralino dark matter searches with neutrino telescopes: AMANDA results and IceCube prospects" - 7th UCLA Symposium on Sources and Detection of Dark Matter and Dark Energy in the Universe (DM06), UCLA, Los Angeles, California, USA, 21 February 2006

Xavier Janssen
- "Prospects for Diffraction at HERA-II with the H1 detector" - H1 Convenors Meeting on Prospects for HERA II physics with H1, Goslar, Germany 18 February 2006

- "DVCS and exclusive vector meson production" - 2nd Workshop on the QCD Structure of the Nucleon, Frascati, Italy 12 June 2006
- "Inclusive processes in diffraction at HERA" - XXXVI International Symposium on Multiparticle Dynamics, Paraty, Brasil, 02 September 2006

Cedric Lemaître
- "Results block + APD detectors" - Antwerp 01 March 2006

Yves Pierseaux
- "La cinématique relativiste avec photons d'Einstein ou avec ondes électromagnétiques de Poincaré" - Université de Lille (Les Nouvelles d'Archimède) septembre 2006

Pascal Vanlaer
- "The GRID used at CERN in LHC experiments" – BELNET BEgrid meeting, Brussels, 27 October 2006
- "Vertex reconstruction in CMS" – CMS Tracker Software Workshop, FNAL (USA), 17-20 January 2006

Els Wieërs
- "Sensitivity of the ClearPET rodent, a comparison of the measurements and the simulation" - CERN, Geneva 11 October 2006

Gaston Wilquet
- "Probability and statistics for high energy physicists" - ULB/BUB PhD training programme 27/11/2006

XI.3. POSTER PRESENTATIONS AT CONFERENCES, WORKSHOPS AND SCHOOLS

Peter Bruyndonckx
- "Investigation of an In-situ position calibration method for continuous crystal based PET detectors" - Marseille, France. 10 May 2006
- "Comparison of Nonlinear Position Estimators for Continuous Scintillator Detectors in PET" - San Diego, USA 29October - 04 November 2006

Cedric Lemaître
- "Investigation of an In-situ position calibration method for continuous crystal based PET detectors" - Marseille, France. 8-12 May 2006
- "Automatic Calibration Method for Parallax Corrected Positioning Algorithms in Monolithic Scintillators" - San Diego - USA 29October - 04 November 2006

Yves Pierseaux
- "L'image par la transformation de Lorentz d'un front d'onde sphérique est-elle un front d'onde d'onde sphérique (Einstein, 1905)?" - question soumise aux CR de l'académie des sciences de Paris décembre 2005

XII. SCIENTIFIC VULGARISATION AND OUTREACH ACTIVITIES

Daniel Bertrand
- "Cosmic Rays Detection" - Practicals for College Pupils Whole scholar year

Othmane Bouhali
- "Introduction à la Physique des particules, Tétouan Morocco" - Oral presentation March 2006

Peter Bruyndonckx
- "Inside story: Fysica in de geneeskunde" - Master Class 25/03/2006
- "Further directions in PET imaging" - Article in European Musculoskeletal Review 2006, Touch Briefings, UK 2006

Catherine De Clercq
- "Vlaamse Wetenschapsweek" - workshop for high school students 19-20 October 2006
- "Het elementaire deeltje" - Interview in Academos, jaargang 9, nr 5 December 2006
- "IceCube: neutrino's vangen op Antarctica" - oral presentation at the 12de VlaamsCongres Leraars Wetenschappen, KULeuven 18 November 2006
- "Member of the Flemish Physics Olympiads Committee" - Physics Olympiads since 2005
- "visits of the IIHE for high school students" - laboratory visits 14 March, 25 April, 2 May 2006
- "organisation of visit of CERN for the VUB students in Science and applied science" - visit of CERN 2-5 November 2006
- "organisation of information afternoon for high school students" - information afternoon 24 May 2006
- "Donkere materie en IceCube" - interview in MIRA Ceti, jaargang 10, nr 3 september 2006
- "een nieuw venster op het universum" - interview in Academos jaargang 9, nr 4 October 2006
- "participation to the visit of CERN by the bureau of the FWO" - visit of CERN 31 August 2006
- "participation to the SIDIN information days for high schools" - information day for high school students 20 January, 11 March 2006

Daan Hubert
- "Meesterklassen Elementaire Deeltjes" - Master Class March 25, 2006
- "Een nieuw venster op het Universum" - Interview for Academos (VUB magazine) October 2006,
- "Donkere materie" - Interview for MIRA Ceti July 2006
- "Van de Big Bang tot nu en terug: een ontdekkingsreis naar de wereld van de elementaire deeltjes" - Wetenschapsweek VUB October 19-20, 2006

Pierre Marage
- "Towards an international network of university groups for scientific culture diffusion" - Communication Colloque Universita: ponte tra Scienza e Societa - univ. Turin 16 September 2006
- "Einstein, entre science et engagements" - Co-organisation de la soirée (ULB) 27 March 2006
- "Einstein et la Belgique : étapes heureuses, étapes tragiques" - Conférence, soirée 'Einstein, entre science et engagements', ULB 27 March 2006
- "Les Conseils Solvay" - Conférence Stage d'astronomie, Modave 06 May 2006
- "Aux origines de la science, ou Quelle science pour quelles origines ?" - Conférence, Avignon, Théatre des Doms 20 May 2006
- "Einstein et la Belgique : étapes heureuses, étapes tragiques" - Conférence Congrès des Sciences pour les professeurs de l'enseignement secondaire, UCL, 23 August 2006

Stefaan Tavernier
- "Further directions in PET imaging" - article in European Musculoskeletal Review 2006, Touch Briefings, UK, 2006

Catherine Vander Velde
- "Master classe de physique des particules" - Master classe 28/1/2006
- "Master classe de physique des particules" - Master classe 11/3/2006
- "Printemps des sciences" - Encadrement de laboratoires pour des élèves du secondaire 13 mars 2006

- "Erreurs de mesure et ressort" - Encadrement de laboratoire pour les lauréats des olympiades de physique 4 avril 2006

Pascal Vanlaer
- "La mesure en Physique des Particules" – Journée de remédiation pour les Professeurs du secondaire 24 janvier 2006
- "With students of 4th year in Applied Sciences, physics orientation" - visit of the Laboratory
- "Techniques de reconstruction de traces et de vertex dans l'expérience CMS" – Matinée Jeunes Chercheurs de la Faculté des Sciences Appliquées, ULB – 17 février 2006

Pierre Vilain
- "La Physique des Particules" - Master class oral presentation 28-1 and 11-3-2006
- "with students of 3rd year in Physics" - visit of Cern 26 and 27-1-2005

Gaston Wilquet
- "Lecture on 'Le modèle du Big-Bang'" - Master class 28/1/2006 - 11/3/2006

XIII. ATTENDANCE TO CONFERENCES, WORKSHOPS AND SCHOOLS

XIII.1. CONFERENCES AND WORKSHOPS

Daniel Bertrand
- "TeV Particle Astrophysics II Symposium", Madison (USA), 27-31August 2006
- "Open Symposium on Future Experiments in Particle Physics", LAL Orsay (France), 30-31 January 2006
- "ECRS 2006 Conference", LIP Lisbon (Portugal), 5-9 September 2006

Othmane Bouhali
- "EGEE06 Conference", Geneva, Switzerland, 26-29 September 2006
- "EGEE User Forum", CERN Geneva, 1-3 March 2006
- "EumedGrid Workshop", Marrakech, Morocco Oral presentation, 4-6 December 2006

Peter Bruyndonckx
- "IEEE Nuclear Science conference and medical imaging conference", San Diego, USA Poster, 29 October-4 November 2006
- "Symposium Van Eijk", Delft, 29 September 2006
- "EUROMEDIM - First European Conference on Molecular Imaging Technology", Marseille, France. Poster, 9-12 May 2006

Barbara Clerbaux
- "Flavour in the area of the LHC", CERN. Oral presentation, 11 October 2006

Olivier Devroede
- "Crystal Clear Collaboration meeting", Antwerp - Belgium Oral presentation, 1-2 March 2006
- "Crystal Clear Collaboration meeting", CERN - Geneva - Switzerland Oral presentation, from 11-12 October 2006

Catherine De Clercq
- "12de Vlaams Congres van Leraars Wetenschappen", KULeuven, Leuven, Belgium Oral presentation, 18 November 2006

- "Fysica 2006", Leiden University, The Netherlands Session organizer Session title: Astro-particle Physics and Cosmology, 28 April 2006
- "ASPERA kick off meeting", Paris, France, 20 July 2006
- "XXXIII International Conference on High Energy Physics ICHEP06", Moscow, Russian Federation from 26 July-2 August 2006
- "SUSY06", Irvine, California, USA Oral presentation, 12-17 June 2006
- "CERN Strategy Group Open Symposium", Orsay, France, 30 January-1 February 2006

Marleen Goeman
- "EUROMEDIM - First European Conference on Molecular Imaging Technology", Marseille, France. Conference organisation, 8-12 May 2006
- "45th Crystal Clear Collaboration Meeting", CERN, Geneva, 11- 12 October 2006
- "Steering Committee Crystal Clear Collaboration", CERN, Geneva, 13 October 2006
- "44th Crystal Clear Collaboration Meeting", Antwerp, 1-2 March 2006
- "Steering Committee Crystal Clear Collaboration", Antwerp, 3 March 2006

Daan Hubert
- "IceCube Collaboration meeting", Southern University and A&M College, Baton Rouge, Louisiana, USA Oral presentation, 9-14 April 2006
- "IceCube Collaboration meeting", DESY-Zeuthen, Berlin, Germany Oral presentation, 6-10 October 2006
- "7th UCLA Symposium on Sources and Detection of Dark Matter and Dark Energy in the Universe (DM06)", UCLA, Los Angeles, California, USA Oral presentation, 22-24 February 2006
- "Workshop on Exotic Physics with Neutrino Telescopes (EPNT06)", Uppsala University, Uppsala, Sweden Oral presentation, 20-22 September 2006

Xavier Janssen
- "H1 Convenors Meeting on Prospects for HERA II physics with H1", Goslar, Germany Oral presentation, 18-19 February 2006
- "2nd Workshop on the QCD Structure of the Nucleon", Frascati, Italy, Oral presentation, 12-16 June 2006
- "XXXVI International Symposium on Multiparticle Dynamics", Paraty, Brasil Oral presentation, 2-08 September 2006
- "International Linear Collider (ILC) Workshop", Valencia, Spain, 6-10 November 2006

Cedric Lemaître
- "44th General Meeting CCC", Antwerp Oral presentation, 1-2 March 2006
- "45th General Meeting CCC", CERN, Geneva, 11-12 October 2006
- "EUROMEDIM - First European Conference on Molecular Imaging Technology", Marseille, France. Poster, 9-12 May 2006
- "IEEE Nuclear Science conference and medical imaging conference", San Diego - USA Poster, 29 October 2006 to 4 November 2006
- "The Third workshop on the Nuclear Radiology of Breast Cancer", San Diego – USA, 4-5 November 2006

Pierre Marage
- "Intersections of Particle and Nuclear Physics CIPANP06", Puerto-Rico Oral presentation June 2006
- "DIS06", Tsukuba - Japon Conference organisation, May 2006

Benoit Roland
- "H1 Week, Diffractive meeting (24 January 2006)", Desy, Hamburg, Germany Oral presentation, 23-27 January 2006
- "H1 Week, Status Report (24 March 2006)", Desy, Hamburg, Germany Oral presentation, 20-24 March 2006

- "H1 Week, Diffractive meeting (4 April 2006)", Desy, Hamburg, Germany Oral presentation, 3-7 April 2006
- "H1 Week, Preliminary Report (7 April 2006)", Desy, Hamburg, Germany Oral presentation, 3-7 April 2006
- "H1 Week, Preliminary Report (13 April 2006)", Desy, Hamburg, Germany Oral presentation, 10-14 April 2006
- "14th International Workshop on Deep Inelastic Scattering (DIS 2006)", Tsukuba, Japan Oral presentation, 20-24 April 2006

Stefaan Tavernier
- "44th Crystal Clear Collaboration Meeting", Antwerp Session organizer Session title: CCC General Meeting Conference organisation Session chair-person, 1-2 March 2006
- "Steering Committee Crystal Clear Collaboration", CERN, Geneva Conference organisation Session chair-person; 13 October 2006
- "CERIMED executive and project committees", Marseille, 11-12 January 2006
- "Executive Committee Crystal Clear Collaboration", CERN, Geneva Conference organisation Session chair-person, 13 January 2006
- "EUROMEDIM - First European Conference on Molecular Imaging Technology", Marseille Oral presentation Poster Session organizer Session title: Conference organisation Session chair-person, 9-12 May 2006
- "45th Crystal Clear Collaboration Meeting", CERN, Geneva Session organizer Session title: CCC General meeting Conference organisation Session chair-person, 10-12 October 2006
- "CMS meeting", CERN, Geneva, 17-18 December 2006
- "CMS week", CERN, Geneva, 5-8 December 2006
- "CMS week", CERN, Geneva, 19-23 June 2006
- "CMS meeting", CERN, Geneva, 3-4 May 2006
- "CMS meeting", CERN, Geneva, 13-17 March 2006
- "CMS meeting", CERN, Geneva, 18-22 September 2006
- "Steering Committee Crystal Clear Collaboration", Antwerp Conference organisation Session chair-person, 3 March 2006
- "Haissinski Symposium", Orsay, 17 February 2006
- "2006 IEEE Nuclear science symposium and Medical imaging conference", San Diego – USA, 29 October-4 November 2006
- "The Third workshop on the Nuclear Radiology of Breast Cancer", San Diego – USA, 4-5 November 2006

Pascal Vanlaer
- "Workshop German Tier-1", Karlsruhe (Germany), 2-3 March 2006
- "Fourth Workshop on the LHC Luminosity Upgrade", Perugia (Italy), 2-5 April 2006

Luc Van Lancker
- "High Performance Structures and Materials", Oostende – Belgium, 3-5 May 2006
- "European Conference on Composite Materials", Biarritz – France, 28 August-01 September 2006

Pierre Vilain
- "Third International Workshop on Neutrino Oscillation", Venice (Italy) 7-10 February 2006

Mateusz Wedrowski
- "45th Crystal Clear Collaboration Meeting", CERN, Geneva, 11-12 October 2006

Els Wieërs
- "45th Crystal Clear Collaboration Meeting", CERN, Geneva Oral presentation 11-12 October 2006

Gaston Wilquet
- Session chair-person "IIIrd International Workshop on neutrino Oscillations", Venice (Italy) 6-10 February 2006

Li Zhi
- "45th Crystal Clear Collaboration Meeting", CERN, Geneva from 11-12 October 2006

XIII.2. SCHOOLS

Sherif Elgammal
- "Joint Dutch Belgian German Graduate School" Bad Honnef, Germany 1-13 September 2006

Tomas Hreus
- "Joint Dutch Belgian German Graduate School" Bad Honnef, Germany 1-13 September 2006

Mathieu Labare
- "Joint Dutch Belgian German Graduate School" Bad Honnef, Germany 1-13 September 2006

XIII.3. RESPONSIBILITIES IN EXPERIMENTS

Daniel Bertrand
- Member DELPHI Collaboration Board
- Member IceCube Collaboration Board

Peter Bruyndonckx
- Member Crystal Clear Collaboration Steering committee

Catherine De Clercq
- Principal Investigator for VUB IceCube Collaboration Board
- Member IceCube M&O scrutiny group

Laurent Favart
- Convenor H1 Working Group on Diffraction

Xavier Janssen
- Convenor H1 Working Group on Diffraction

Pierre Marage
- Member H1 Executive Committee

Stefaan Tavernier
- Member CMS CMS finance board
- Member CMS CMS institution board
- Member CMS CMS tracker institution board
- Member CERIMED CERIMED executive committee
- Spokesperson, Chairman Crystal Clear Collaboration board

Catherine Vander Velde
- Member CMS Collaboration Board
- Member CMS Tracker Institution Board
- Member CMS Finance Board

- Member CMS Tracker Finance Board

Pascal Vanlaer
- Coordinator of the workgroup "Electron and photon reconstruction" – CMS collaboration
- Coordinator of the workgroup "Vertex reconstruction" – CMS collaboration

Pierre Vilain
- Member OPERA editorial board

Gaston Wilquet
- Member OPERA Collaboration Board
- Member OPERA Editorial Board

XIII.4. MEMBERSCHIP IN ACADEMIC JURIES

Othmane Bouhali
- ULB "Déploiement et configuration des intergiciels européééen de grille de calcul, ULB" Promotor
- ULB "Grid and Cluster Monitoring" Promotor
- ULB "Etude comparative d'un gestionnaire de stockage pour la ferme de calcul du service de Physique des P" Promotor

Catherine De Clercq
- Ph thesis Vrije Universiteit Brussel "B-tagging as a tool for charged Higgs boson identification in CMS" President

Laurent Favart
- Mémoire ULB "Etude des interactions diffractives avec production de jets dans l'expérience H1". Promotor
- PhD (Rapporteur) Ecole Polytechnique - Paris /Orsay "Mesure de luminosité pour l'expérience H1 et étude de la diffusion Compton élastique". Member

Stefaan Tavernier
- Master thesis VUB "Observalility of narrow X-> t tbar resonances from theories beyond the Standard Model at LHC with CMS" Promotor
- Ph.D. Thesis VUB "B-tagging as a tool for charged Higgs Boson Identification in CMS" Promotor
- Ph.D. Thesis Ecole Polytechnique Fédérale de Lausanne "Developpement d'un module de detection Phoswich LSO/LuYAP pour le prototype de caméra a Positrons Cl" Member
- Ph.D. Thesis UCL "Radiation damage induced by neutrons in CMS silicon sensors" Member

XIV. LIST OF PUBLICATIONS, REPORTS AND CONTRIBUTIONS TO CONFERENCES

A. NEUTRINO PHYSICS : CHORUS

Measurements of Nucleon Structure Functions in Neutrino Scattering
G. Onengut et al.
Phys. Lett. B632 (2006) 65-75

First Events from the CNGS Neutrino Beam Detected in the OPERA Experiment
R. Acquafredda et al.
New Journal of Physics 8: Art. No. 303 DEC 5 2006

B. NEUTRINO PHYSICS : ICECUBE

The ICECUBE Prototype String in AMANDA
M. Ackermann et al.
Nucl.Inst.Meth.A556 (2006) 169-181

Optical Properties of Deep Glacial Ice at the South Pole
M. Ackermann et al.
Journal of Geophysical Research Vol.111,D13203 (2006) 1-26

Limits on the High-energy Gamma and Neutrino Fluxes from the SGR 1806-20 Giant Flare of December 27th, 2004 with the AMANDA-II Detector
A. Achterberg et al.
Physical Review Letters Vol.97 (2006)22110-

Limits to the Muon Flux from Annihilations in the Sun with the AMANDA Detector
M. Ackermann et al.
Astroparticle Physics 24 (2006) 459-466

Limits on the Muon Flux from Neutralino Annihilations at the Center of the Earth with AMANDA
A. Achterberg et al.
Astroparticle Physics 26 (2006) 129-139

First Year Performance of the IceCube Neutrino Telescope
M. Ackermann et al.
Astroparticle Physics 26 (2006) 155-173

C. ep PHYSICS : H1

Measurement of $F_2^{c[`(c)]}$ and $F_2^{b[`(b)]}$ at low Q^2 and x * using the H1 Vertex Detector at HERA
A. Aktas et al.
Eur. Phys. J. C 45 (2006) 23-33

Forward Jet Production in Deep Inelastic Scattering at HERA
A. Aktas et al.
Eur. Phys. J. C 46 (2006) 27-42

Measurement of Event Shape Variables in Deep-Inelastic Scattering at HERA
A. Aktas et al.
Eur. Phys. J. C 46 (2006) 343-356

Elastic J/ψ production at HERA
A. Aktas et al.
Eur. Phys. J. C 46 (2006) 585-603

Tau Lepton Production in ep Collisions at HERA
A. Aktas et al.
Eur.Phys.J. C 48 (2006) 699-714

Measurement of Charm and Beauty Dijet Cross Sections in Photoproduction at HERA using the H1 Vertex Detector
A. Aktas et al.
Eur. Phys. J. C 47 (2006) 597-610

Diffractive Deep-Inelastic Scattering with a Leading Proton at HERA
A. Aktas et al.
Eur. Phys. J.C 48 (2006) 749-766

Measurement and QCD Analysis of the Diffractive Deep-Inelastic Scattering Cross Section at HERA
A. Aktas et al.
Eur. Phys. J.C 48 (2006) 715-748

A Determination of Electroweak Parameters at HERA
A. Aktas et al.
Phys. Lett. B 632 (2006) 35-42

First Measurement of Charged Current Cross Sections at HERA with Longitudinally Polarised Positrons
A. Aktas et al.
Phys. Lett. B 634 (2006) 173-179

Diffractive Photoproduction of Rho Mesons with Large Momentum Transfer at HERA
A. Aktas et al.
Phys. Lett. B 638 (2006) 422-431

Search for Doubly-Charged Higgs Boson Production at HERA
A. Aktas et al.
Phys. Lett. B 638 (2006) 432-440

Photoproduction of Dijets with High Transverse Momenta at HERA
A. Aktas et al.
Phys. Lett. B 639 (2006) 21-31

Search for a Narrow Baryonic Resonance Decaying to $K^0_s p$ or $K^0_s \bar{p}$ in Deep Inelastic Scattering at HERA
A. Aktas et al.
Phys. Lett. B 639 (2006) 202-209

D. e+e- PHYSICS : DELPHI

Determination of Heavy Quark Non-perturbative Parameters from Spectral Moments in Semileptonic B Decays
J. Abdallah et al.
Eur.Phys.J.C45 (2006) 35-59

Single Intermediate Vector Boson Production in e^+e^- Collisions * at $\sqrt{s}$ =183-209 GeV
J. Abdallah et al.
Eur.Phys.J.C45 (2006) 273-289

Measurement and Interpretation of Fermion-pair Production at LEP Energies above the Z Resonance
J.Abdallah et al.
Eur.Phys.J.C45 (2006) 589-632

A Measurement of the tau hadronic branching ratios
J.Abdallah et al.
Eur.Phys.J.C46 (2006) 1-26

Search for Excited Leptons in e^+e^- Collisions at $\sqrt{s}$=189–209 GeV
J.Abdallah et al.
Eur.Phys.J.C46 (2006) 277-293

A Determination of the Centre-of-Mass Energy at LEP2 using Radiative 2-fermion Events
J.Abdallah et al.
Eur.Phys.J.C46 (2006) 295-305

Study of Double-Tagged γγ Events at LEPII
J.Abdallah et al.
Eur.Phys.J.C46 (2006) 559-568

Determination of the b Quark Mass at the M_Z Scale with the DELPHI Detector at LEP
J.Abdallah et al.
Eur.Phys.J.C46 (2006) 569-583

Evidence for an Excess of Soft Photons in Hadronic Decays of Z0
J.Abdallah et al.
Eur.Phys.J.C47 (2006) 273-294

Search for Neutral MSSM Higgs Bosons at LEP
S. Schael et al.
Eur.Phys.J.C47 (2006) 547-587

Search for ηb in Two-photon Collisions at LEP II with the DELPHI Detector
J.Abdallah et al.
Phys.Lett.B634 (2006) 340-346

E. p-p PHYSICS: CMS

The CMS High Level Trigger
Adam W. et al.
Eur.Phys.J. C46 (2006) 605-667

Production and the Quality Control for the CMS Endcap RPCs
Z. Aftab et al.
Nucl.Phys.Proc.Suppl.158 (2006) 16-20

Cosmic Ray Test Certification of the First 100 CMS Endcap RPCs and the Corresponding Construction Database
A. Ball et al.
Nucl.Phys.Proc.Suppl.158 (2006) 99-102

Assembly and Quality Certification for the First Station of CMS Endcap RPCs (RE1)
Z. Aftab et al.
Nucl.Phys.Proc.Suppl.158 (2006) 103-107

Charged MSSM Higgs boson observability in the $H^{+-} \rightarrow$ t b decay.
S. Lowette et al.
CERN-CMS-NOTE-2006-109, Jun 2006

Impact of CMS silicon tracker misalignment on track and vertex reconstruction.
P. Vanlaer et al.
CERN-CMS-NOTE-2006-029, Jan 2006

Offline calibration of b-jet identification efficiencies.
S. Lowette et al.
CERN-CMS-NOTE-2006-013, Jan 2006

Vertex fitting in the CMS tracker.
T. Speer et al.
CERN-CMS-NOTE-2006-032, Feb 2006

Measurement of the cross section of single leptonic t anti-t events.
J. D'Hondt et al.
CERN-CMS-NOTE-2006-065, May 2006

Top quark mass measurement in single leptonic t anti-t events.
J. Heyninck et al.
CERN-CMS-NOTE-2006-066, May 2006

Light quark jet energy scale calibration using the W mass constraint in single-leptonic t anti-t events.
S. Lowette et al.
CERN-CMS-NOTE-2006-025, Jan 2006

Electron and muon reconstruction in single leptonic t anti-t events.
J. D'Hondt et al.
CERN-CMS-NOTE-2006-024, Jan 2006

Fitting of event topologies with external kinematic constraints in CMS.
J. D'Hondt et al.
CERN-CMS-NOTE-2006-023, Jan 2006

F. APPLIED R&D AND SPINOFF

Using Cramer-Rao Theory combined with Monte Carlo Simulations for the Optimization of Monolithic Scintillator PET Detectors
D.J. van der Laan, P. Bruyndonckx, S. Léonard, M.C. Maas, D. Schaart and C. van Eijk,
IEEE Transanctions on Nuclear Science 53 (3): 1063-1070 Part 2, JUN 2006

Experimental Characterization of Monolithic-Crystal Small Animal PET Detectors Read Out by APD Arrays
M.C. Maas, D.J. van der Laan, D. Schaart, J. Huizenga, J.C. Brouwer, P. Bruyndonckx, S. Léonard, C. Lemaître and C. van Eijk,
IEEE Transactions on Nuclear Science 53 (3): 1071-1077 Part 2, Jun 2006

Development of an Optimised LSO/LuYAP Phoswhich Detector Head for the Lausanne ClearPET Demonstrator,
J.B. Mosset, O. Devroede, M. Krieguer, P. Bruyndonckx, S. Tavernier,et al.
Transactions on Nuclear Science, Vol 53, n°1 (2006), 25-29

Performance Study of a PET Detector Module Based on Continuous Scintillator
S. Léonard, P. Bruyndonckx, C. Lemaitre, S. Tavernier and Y. Wu
Transactions on Nuclear Science, Vol 53, n°5 (2006), 2536-2542

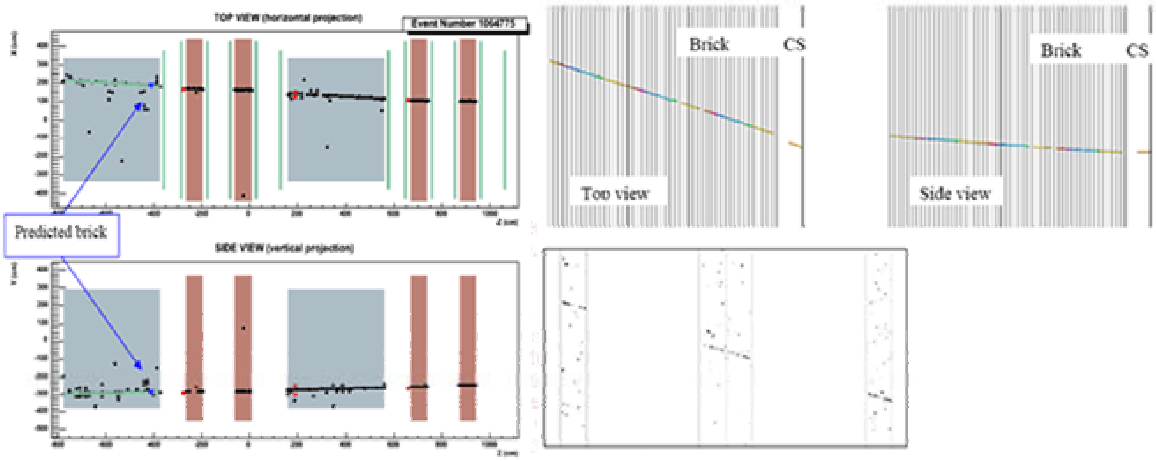
Initial Characterisation of a Non-Pixilated Scinitillator Detector in a PET Prototype Demonstrator
P. Bruyndonckx, C. Lemaitre, S. Leonard, D.R. Schaart, D.J. van der Laan, M.S. Maas, O. Devroede, Y, Wu, M. Krieguer, S. Tavernier
Transactions on Nuclear Science, Vol 53, n°5 (2006), 2543-2548

Image Reconstruction for the ClearPET Neuro
Simone Weber, Christian Morel, Luc Simon, Magalie Krieguer, Martin Rey, Brigitte Gundlich, Maryam Khodaverdi
NIM. A569 (2006) 381-385

XV. ILLUSTRATIONS

Track of a muon induced by the interaction of a CNGS beam neutrino in the rock of the LNGS underground cavern in front of the OPERA detector in November 2006.

Left : Top and side views of the muon track seen by the electronic detectors: the scintillator tracker instrumenting the targets (grey) and the RPC equipping the muon spectrometers dipole magnets (brown). The high precision drift tubes planes (green) surrounding the magnets were not yet operational. The front (left) target is only partially filled with bricks made of sandwiches of emulsion sheets and lead plates. The arrow points to the first brick into which the track penetrates.



Right top : Top and side views of the muon track seen by the emulsion sheets inside the target brick and in a doublet of emulsion sheets placed in front of the brick (CS) .
Right bottom : The muon track emerges from the grains reconstruction in the CS doublet. The structure of an emulsion sheet, two layers of emulsion on each side of a plastic base, is apparent.

Figure 1. One of the very first CNGS neutrino beam interactions observed in the emulsion sheets of the OPERA target

Figure 2. The new IceCube Control Station at the South Pole in March 2007. The outside temperature was -64°C

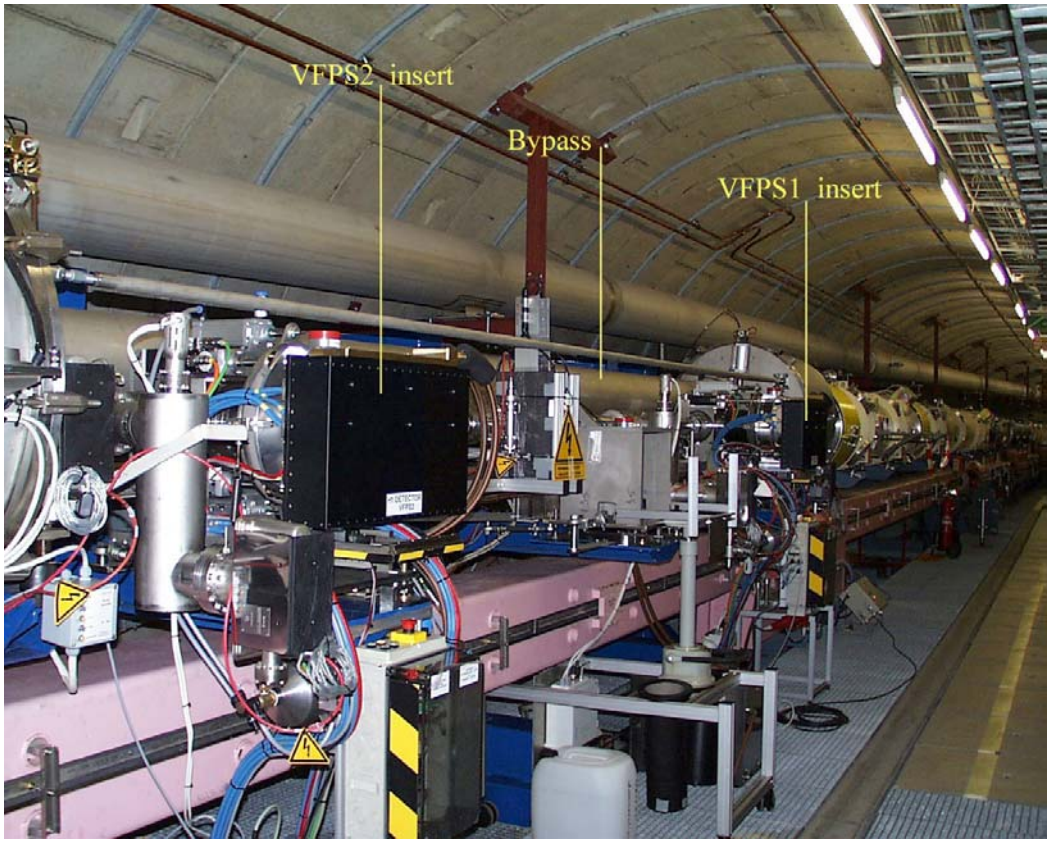


Figure 3. View on the VFPS Spectrometer in the HERA tunnel

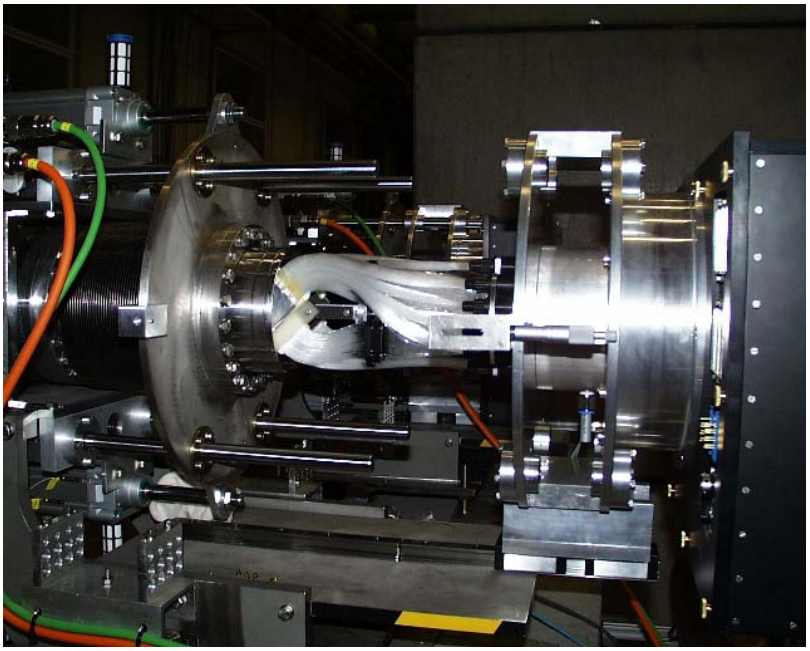


Figure 4. Insertion of optical fibre detector into the Roman pot structure. Visible are the detector and the optical light guides

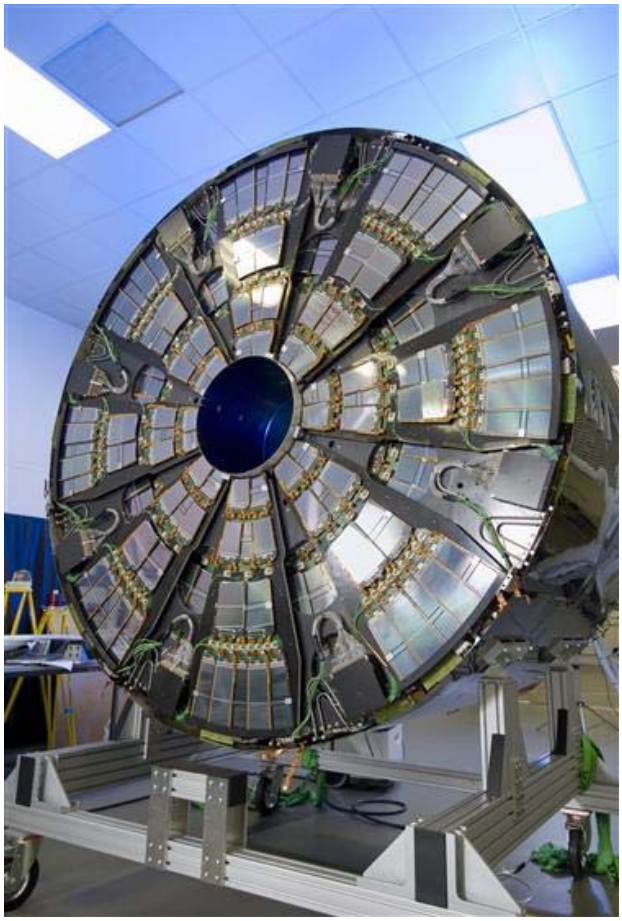


Figure 5. One of the two CMS tracker endcaps in the Tracker Integration Facility at CERN (TIF). Petals, sectors with silicone detectors, can be seen on the first of the 9 detection wheels

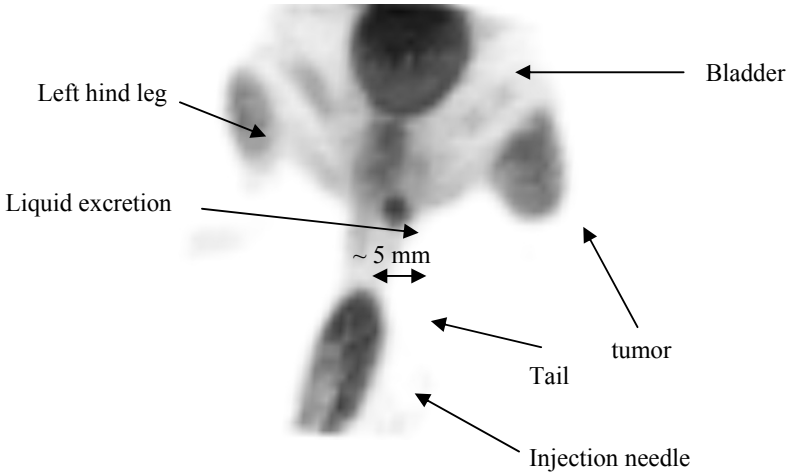


Figure 6. PET scan of a mouse injected with FDG. A tumor was implanted on the right hind leg

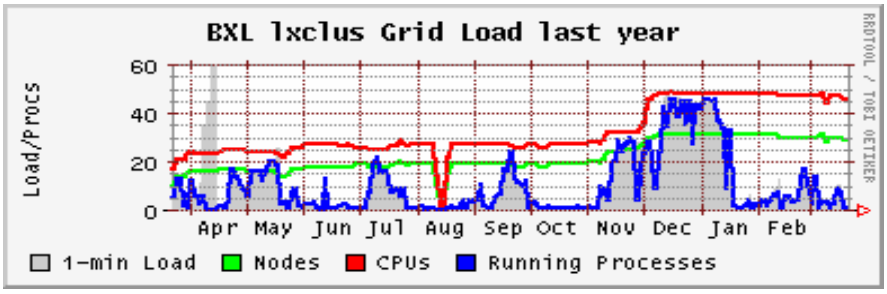


Figure 7. Load on the condor cluster for last year

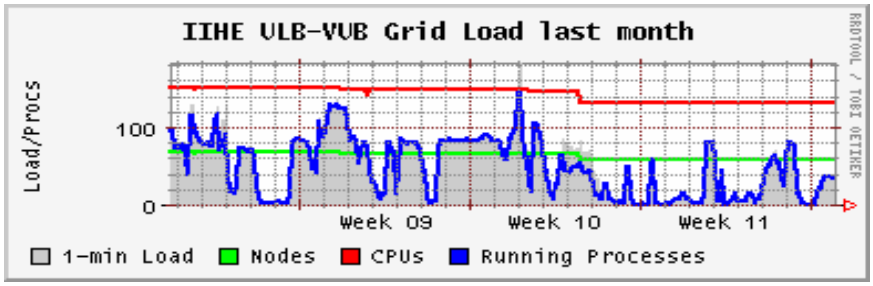


Figure 8. Load on the BEgrid platform