



# ANNUAL REPORT 2010

INTER-UNIVERSITY INSTITUTE  
FOR HIGH ENERGIES

UNIVERSITÉ LIBRE DE BRUXELLES,  
UNIVERSITÉ D'EUROPE

**ULB**



Vrije Universiteit Brussel



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# ANNUAL REPORT 2010

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C. De Clercq - P. Marage  
Directors

<http://w3.iihe.ac.be>

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On October 1st 2010 Daniel Bertrand retired after 11 years of co-directorship of the IIHE.

D. Bertrand became ULB director of the IIHE in October 1999. During the 11 years of his co-directorship, the IIHE evolved from a laboratory involved mainly in particle physics at accelerators to an institute with particle and astroparticle physics research. Daniel was a key player in this evolution. In 1998 he joined the AMANDA neutrino astronomy project at the South Pole with a handful of collaborators. Since then the group has grown considerably, the VUB group joined AMANDA and two senior researchers joined the IIHE. Now the group is one of the largest groups in IceCube, the cubic km neutrino observatory at the South Pole.

D. Bertrand can look back to 44 years of exciting research. This report is not the place to elaborate on his fruitful career, but it is the place where we would like to thank him for his investment in the Institute. We would like to acknowledge the diligent way in which he led the Institute during his mandate as director. It was a pleasure to work with him.

## I. INTRODUCTION

The work presented in this report is supported by the Université Libre de Bruxelles (ULB), the Vrije Universiteit Brussel (VUB), the Fonds de la Recherche Scientifique (F.R.S.-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.

Here follows the list of scientists, engineers, technical and logistic personnel who have contributed to the various activities of the Institute in 2010.

### I.1 U.L.B.

#### I.1.1 Academic and Scientific Personnel

S. Bechet (doctorant FRIA)  
 D. Bertrand (directeur de recherche F.R.S.-FNRS; chargé de cours à temps partiel)  
 E. Chabert (chercheur PAI till August 2010)  
 O. Charaf (doctorant IISN till September 2010)  
 B. Clerbaux (chercheur qualifié F.R.S.-FNRS ; chargé de cours à temps partiel)  
 G. De Lentdecker (chercheur qualifié F.R.S.-FNRS)  
 J. Delvax (boursière FNRS till September 2010 ; chercheur PAI since October 2010)  
 V. Dero (doctorant IISN)  
 M. Dierckxsens (chercheur BELSPO)  
 L. Favart (maître de recherche F.R.S.-FNRS ; chargé de cours à temps partiel)  
 A. Gay (chargé de Recherches F.R.S.-FNRS)  
 G. Hammad (boursier FRIA till December 2010)  
 K. Hanson (chargé de cours)  
 T. Hreus (chargé de Recherches F.R.S.-FNRS)  
 P. Marage (professeur ordinaire)  
 A. Marotta (chercheur PAI since October 2009)  
 Th. Meures (doctorant IISN since October 2010)  
 Y. Piersaux (collaborateur scientifique)  
 J. Sacton (professeur émérite)  
 L. Thomas (assistant)  
 R. Toncelli (doctorante)  
 C. Vander Velde (professeur)  
 P. Vanlaer (1<sup>er</sup> assistant)  
 E. Verhagen (doctorant ARC since September 2010)  
 P. Vilain (professeur de l'Université)  
 G. Wilquet (professeur de l'Université)

#### I.1.2 Master students

David Alaluf  
 Alexandre Leonard  
 Thierry Maerschalk  
 Laurent Thomas

### I.1.3 Engineers, Technical and Logistic Personnel

P. De Harenne (technicien)  
 L. Etienne (ingénieur)  
 M. Frère (informaticien)  
 S. Gérard (informaticien till October 2010)  
 F. Pero (secrétaire)  
 D. Peymans (secrétaire)  
 S. Rugovac (informaticien)  
 E. Torisaen (informaticien)  
 R. Vanderhaeghen (technicien)  
 Y. Yang (ingénieur, support logistique)

## I.2 V.U.B.

### I.2.1 Academic and Scientific Personnel

V. Adler (postdoctoraal onderzoeker FWO till July 2010 – vrijwillig wetenschappelijk medewerker till October 2010)  
 S. Beauceron (postdoctoraal onderzoeker FWO)  
 F. Blekman (onderzoeksprofessor from October 2010)  
 S. Blyweert (wetenschappelijk medewerker FWO)  
 D. Bose (postdoctoraal onderzoeker FWO)  
 P. Bruyndonckx (10% docent)  
 F. Ceccopieri (postdoctoraal onderzoeker IUAP till September 2010)  
 J. Dang (wetenschappelijk medewerker Bilateraal akkoord Vlaanderen-China)  
 C. De Clercq (hoofddocent)  
 O. Devroede (postdoctoraal onderzoeker FWO)  
 J. D'Hondt (docent)  
 R. Gonzalez Suarez (postdoctoraal onderzoeker FWO)  
 A. Kalogeropoulos (wetenschappelijk medewerker FWO)  
 M. Labare (postdoctoraal onderzoeker FWO from March 2010)  
 J. Maes (IWT specialisatiebeurs)  
 M. Maes (wetenschappelijk medewerker FWO)  
 K. Mawatari (postdoctoraal onderzoeker GOA, from 1st October 2010)  
 M. Mozer (postdoctoraal onderzoeker IUAP till February 2010)  
 B. Oexl (wetenschappelijk medewerker GOA, from 1 November 2010)  
 A. Rizzo (wetenschappelijk medewerker IUAP till June 2010 – FWO till November 2010)  
 R. Roosen (onderzoeksdirecteur FWO)  
 K. Singh (postdoctoraal onderzoeker FWO from April 2010 till December 2010)  
 E. Strahler (postdoctoraal onderzoeker IUAP)  
 S. Tavernier (emeritus gewoon hoogleraar)  
 W. Van Doninck (onderzoeksdirecteur FWO, on leave of absence at CERN)  
 N. Van Eijndhoven (gewoon hoogleraar)  
 P. Van Mulders (IWT specialisatiebeurs)  
 G. Van Onsem (wetenschappelijk medewerker VUB from October 2010)  
 I. Vilella (wetenschappelijk medewerker:– IUAP till October 2010- FWO till December 2010)  
 M. Wedrowski (wetenschappelijk medewerker Bilateraal akkoord Vlaanderen-Polen till September 2010)  
 L. Zhi (wetenschappelijk medewerker Bilateraal akkoord Vlaanderen-China till January 2010)



### I.2.2 Master Students

Dennis Diederix (Erasmus student)  
 Jan Kunnen  
 Annik Olbrechts  
 Irene Polderman (Erasmus student)  
 Gerrit Van Onsem  
 Robbe Vansintjan

### I.2.3 Engineers, Technical and Logistic Personnel

J. Debruyne (50% - technicus)  
 A. De Coster (technicus; till November 2010)  
 M. Goeman (technicus)  
 R. Goorens (50% - ingenieur)  
 S. Hannaert (technicus)  
 A. Ouchene (informaticus)  
 D. Pirnay (50% - technicus)  
 R. Vandenbroucke (informaticus)  
 L. Van Lancker (ingenieur)  
 C. Wastiels (50% - technicus)

The following members of the Particle Physics group of the Universiteit Antwerpen (UA) have been working in close collaboration with the Institute:

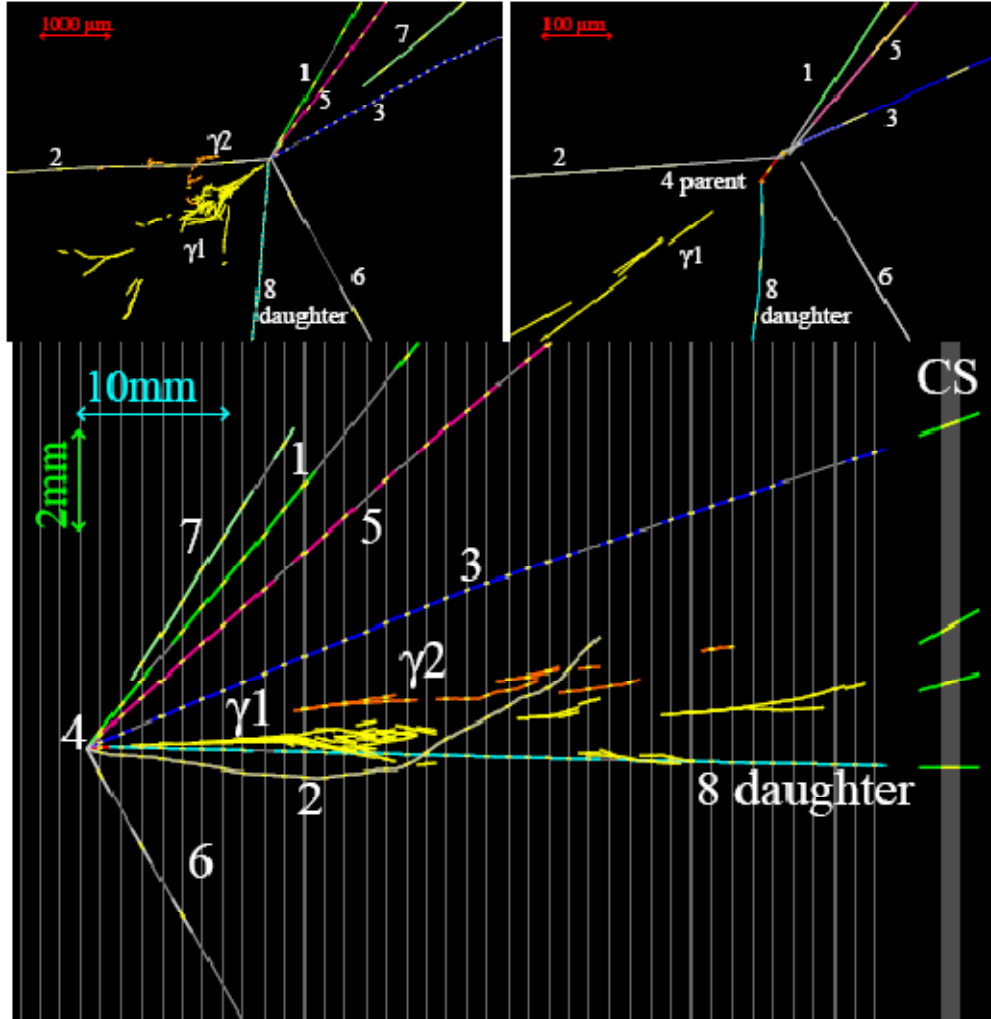
Prof. Em. Dr. Eddi De Wolf, Prof. Dr. Pierre Van Mechelen, Prof. Dr. Nick Van Remortel, Prof. Dr. Albert De Roeck, Prof. Dr. Hannes Jung, Dr. Leonardo Benucci, Dr. Igor Cherednikov (from 01/12/2010), Dr. Karel Cerny (until 01/10/2010), Dr. Xavier Janssen, Dr. Krzysztof Kutak (until 31/12/2010), Dr. Benoit Roland, Thomas Maes, Luca Mucibello, Silvia Ochesanu, Romain Rougny, Michele Selvaggi, Frederik Van Der Veken (from 01/10/2010), Hans Van Haevermaet, Ir. Wim Beaumont, Ir. Eric De Langhe and Ir. Dmitry Druzhkin.

## II. RESEARCH ACTIVITIES IN PARTICLE AND ASTROPARTICLE PHYSICS

### II.1 NEUTRINO PHYSICS

#### A. THE OPERA EXPERIMENT (CERN CNGS1).

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



**First  $\nu_\tau$  candidate event.** The interpretation of the event assumes that it is a CC  $\nu_\tau$  interaction.

**Bottom: longitudinal view of the event.** The incident  $\nu_\tau$  comes from the left. Tracks labelled 1 to 7 are emitted at the primary vertex. Track 4 (in red) of length is  $1335 \mu\text{m}$ , hardly visible on this view, is left by the  $\tau^-$  lepton, the mean lifetime of which is about  $0.3 \times 10^{-12} \text{ s}$ . Track 8 (in turquoise) is left by the charged decay product. The two electromagnetic showers labelled  $\gamma_1$  and  $\gamma_2$  point to the secondary vertex and their invariant mass is compatible with the  $\pi^0$  mass. The invariant mass of the charged decay product assumed to be a  $\pi^-$  and of the two  $\gamma$ -rays is compatible with that of the  $\rho^-$  meson. The most likely decay mode is therefore  $\tau^- \rightarrow \rho^- (\pi^- \pi^0) \nu_\tau$  with a  $B.R. \approx 25\%$ . The target elements are composed of 1-mm lead plates (schematised in black) interleaved with emulsion films (in white) in which the trajectories are registered. Top left: transverse view of the event. Top right: longitudinal view of the event zoomed on the vertices with the track of the  $\tau^-$  lepton (in red, labelled 4) clearly seen

The OPERA experiment aims at detecting for the first time the direct appearance of  $\nu_\tau$  in a  $\nu_\mu$  beam through the identification of the  $\tau^-$  lepton produced in their CC interactions in the oscillation parameters space indicated by the atmospheric neutrinos experiments. The detector is installed in the underground Gran Sasso Laboratory (LNGS) and exposed to the CNGS neutrino beam produced at CERN, 730 km away. The design of the detector takes into account two conflicting requirements: a large target mass to cope with the minute neutrino interaction cross-section and a micrometric resolution to allow the detection of the short-lived tau lepton. The target is made of 150000 basic units called bricks each consisting of 56 lead plates of 1 mm thickness interleaved with emulsion films, for a total weight of 1250 tons. Bricks are assembled in walls and the target is instrumented with the Target Tracker (TT): 62 pairs of planes of horizontal and vertical plastic scintillator strips having their signal collected by WLS fibres and read by multi-anode PM tubes. They are aimed to trigger the DAQ, measure the trajectories of charged particles through the target and locate bricks where neutrino interactions occurred. The instrumented target is divided into two identical super-modules. Downstream of each of these, a magnetic spectrometer identifies and measures the momentum and the charge of the penetrating muons. The dipole magnets are instrumented internally by planes of RPC and externally by stations of high precision streamer tubes to measure the bending of the tracks. A description of the OPERA detector is available in: The OPERA Collaboration, R. Acquafredda et al., JINST 4 (2009) P04018.

Our group was more specifically involved in the conception, construction and installation of the TT together with two groups of IN2P3 (IPHC, Strasbourg and LAPP, Orsay), the universities of Bern and Neuchâtel, and JINR, Dubna. The TT is described in: T. Adam et al., Nucl. Instrum. Methods A 577 (2007) 523-539. A study of its performances when exposed to the neutrino beam is ready for submission to publication: "Study of neutrino interactions with the electronic detectors of the OPERA experiment", The OPERA Collaboration, N. Agafonova et al., to be submitted to New J. Phys.

The first physics run took place in 2008 with a fully operational detector. Between 2008 and 2010, almost 10 000 neutrinos interactions have been registered in the target. The integrated neutrino beam flux that has been accumulated corresponds to 70% of the nominal flux. It however reached 90% in 2010 and would have reached 96% if the run would have lasted as long as expected. So far, about 1/3 of the registered interactions have been located into the target bricks and the search for signatures of short lived neutral and charged particles has been completed.

A first  $\nu_\tau$  candidate event (see figure) has been observed with the  $\tau^-$  decaying into one prong in a subsample of 1088 fully analysed interactions. The expected number of observed events at full  $\nu_\mu - \nu_\tau$  mixing and for  $\Delta m^2 = 2.5 \times 10^{-3} \text{ eV}^2$  is 0.5. The most probable decay mode is  $\tau^- \rightarrow \rho^- (\pi^- \pi^0) \nu_\tau$  where the two  $\gamma$  from the  $\pi^0$  decay are observed and their energies measured in the bricks. The main sources of background are charged charmed particle decays where the primary muon is unidentified and hadron re-interactions at short distance from the primary vertex. From MC estimations, they amount to  $0.018 \pm 0.007$  (syst.) events in the 1-prong hadron channel, the probability for the event to be due to a background fluctuation being of 1.8% and the statistical significance of the observation of a first  $\nu_\tau$  candidate event being of  $2.36 \sigma$ . The number of observed charm decays is 18 where  $15.5 \pm 2.8$  plus 1.7 background events are expected. This demonstrates that the  $\tau^-$  detection efficiency, similar to that of charmed particles and the charm background estimate are under control. Preliminary experimental results on hadron re-interactions, even if still based on small statistics, also fully support the MC background estimate. The event has been published in: The OPERA Collaboration, N. Agafonova et al., Phys. Lett. B 691 (2010) 138-145.

An update of the  $\nu_\tau$  production after completion of the 2008 and 2009 data analysis will be submitted to publication in spring 2011 while the 2010 data is analysed in parallel. Efforts are being deployed to improve the MC estimation of the charm background and to corroborate and ultimately replace the MC estimation of the hadron re-interactions background by experimental data.

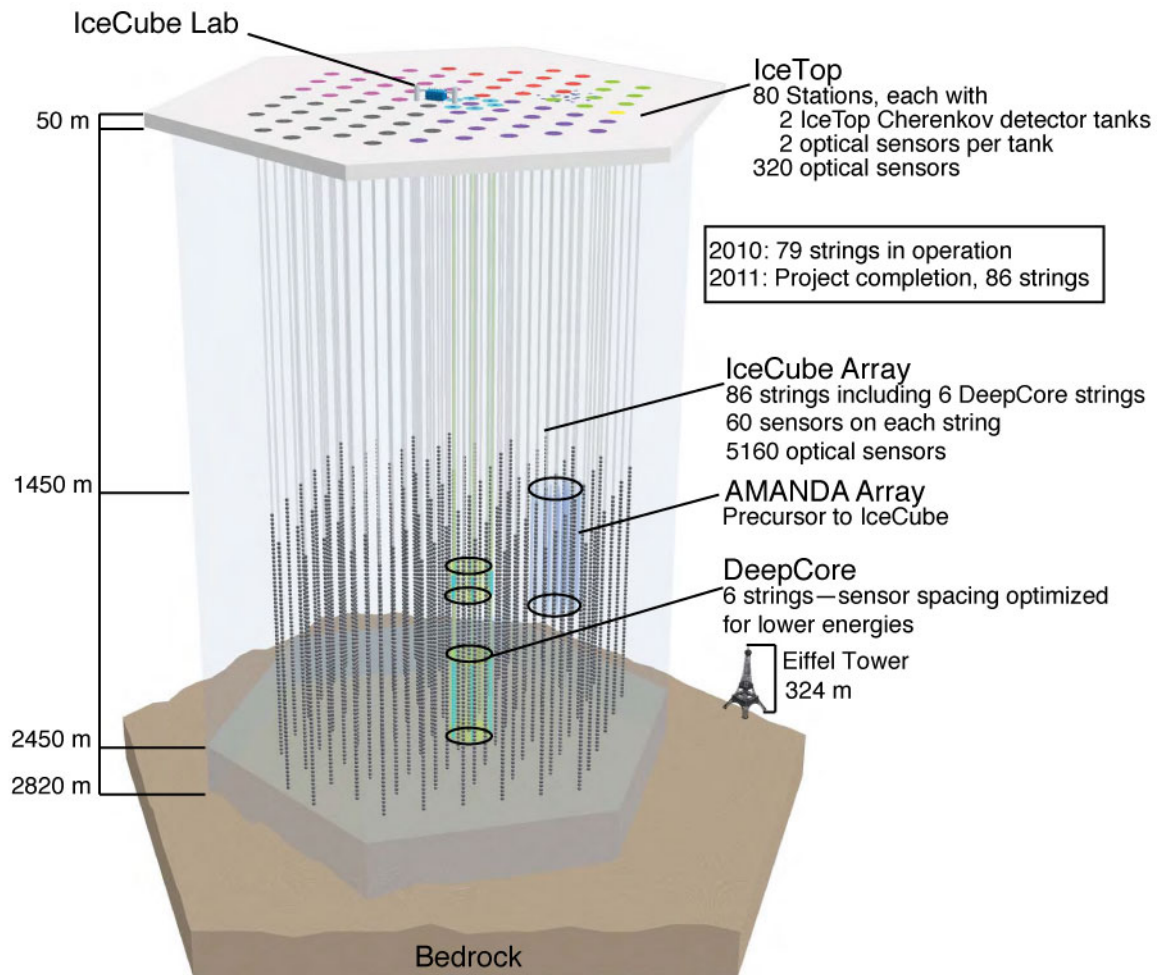
The study of high energy muons and neutrinos produced in cosmic ray interactions in the atmosphere is a very valuable by-product of this underground experiment. The flux ratio of positively to negatively charged muons has been measured with an unprecedented precision in the high energy region of 1.5 to 2 TeV. The results have been published in: The OPERA Collaboration, N. Agafonova et al., Eur. Phys. J. C 67 (2010) 25-37.

The experiment is scheduled to run until 2012. In 2011, six extra weeks of beam in dedicated mode have been attributed in the preliminary SPS schedule and, if everything else is as in 2010, the beam flux will correspond to 1.2 nominal years.

The OPERA Collaboration includes about 180 physicists from 33 institutions in 13 countries. One of us (G. W.) is Chair of the OPERA Collaboration Board since 2008 and until 2012.

## B. THE ICECUBE EXPERIMENT

(D. Bertrand, S. Bechet, D. Bose, C. De Clercq, D. Diederix, M. Dierckxsens, M. Frère, K. Hanson, J. Kunnen, M. Labare, A. Marotta, I. Polderman, A. Rizzo, K. Singh, E. Strahler, N. Van Eijndhoven and R. Vansintjan)



**The IceCube observatory**

Astroparticle Physics revolves around phenomena that involve (astro)physics under the most extreme conditions. Black holes with masses a billion times greater than the mass of the Sun, accelerate particles in jets to velocities close to the speed of light. The produced high-energy particles may be detected on Earth and as such provide us insight in the physical processes underlying these cataclysmic events.

Having no electrical charge and interacting only weakly with matter, neutrinos are special astronomical messengers. Only they can carry information from violent cosmological events at the edge of the observable universe directly towards the Earth. Furthermore, since they are hardly hindered by intervening matter, they are the only messengers that can provide information about the central cores of

cosmic accelerators like Gamma Ray Bursts and flares of Active Galactic Nuclei, which are believed to be the most violent cosmic events and the sources of the most energetic Cosmic Rays. Identification of related neutrino activity would unambiguously indicate hadronic activity and as such provide clues to unravel the nature of these mysterious phenomena.

Another mystery of the Universe is the illustrious Dark Matter, which has not yet been observed but which has to be present to explain various observed phenomena. According to some models, this dark matter may consist of Weakly Interacting Massive Particles (WIMPS) which can annihilate among themselves. In these annihilation processes some of the produced particles are high-energy neutrinos. Since these WIMPS are expected to get trapped in gravitational fields, there may be large concentrations of them at the center of massive objects like our Sun or the Galactic Center. Consequently, observation of high-energy neutrinos from these objects could provide indirect evidence for the existence of these dark matter particles.

At the Inter-university Institute for High Energies IIHE (ULB-VUB) in Brussels we are involved in a world wide effort to search for high-energy neutrinos originating from cosmic phenomena or from dark matter particles. For this we use the IceCube neutrino observatory at the South Pole, the world's largest neutrino telescope which is now completed and taking data.

## **The IceCube observatory**

IceCube (<http://www.icecube.wisc.edu>) is a neutrino telescope consisting of an array of optical sensors, located in the icecap of the South Pole at depths between 1450 and 2450 m.

The sensors are arrayed on vertical cables, called strings, each of which comprises 60 sensors spaced by 17 m. In the horizontal plane, the strings are arranged in a triangular pattern such that the distance between adjacent strings is always 125 m.

The overall configuration (see fig.) exhibits a hexagonal structure, which is the result of extensive optimisation procedures based on simulation studies.

At the end of 2010 the foreseen 86-string detector, including its DeepCore extension (see hereafter), has been completed and started to take data, representing an operational observatory with an instrumented volume of 1 km<sup>3</sup>.

Due to the geometrical configuration outlined above, the energy sensitivity for IceCube is ranging from a few hundred GeV up to several PeV. However, based on theoretical calculations the cosmic sources of interest are expected to yield an  $E^{-2}$  powerlaw energy spectrum for the produced neutrino flux, whereas most of the neutrinos originating from dark matter particles are also expected to have energies below the IceCube detection threshold. This implies that extending the sensitivity to lower energies will provide a significant increase in the neutrino detection potential.

Sensitivity to lower energies can be obtained by a smaller spacing between adjacent sensors and to achieve this, IceCube has been extended with a dense core located at the deepest parts of the detector. This so called Deep Core extension consists of 6 additional strings arranged around the central IceCube string such that the distance between adjacent strings will be 72 m as opposed to the 125 m standard IceCube string spacing.

Each Deep Core string has 50 sensors at 7 m spacing covering depths between 2100 and 2450 meter and 10 sensors at 10 m spacing between 1750 and 1860 m. With this Deep Core extension the lower energy threshold will be pushed down by an order of magnitude to about 20 GeV.

Furthermore, located at these large depths and completely surrounded by standard IceCube strings, an efficient trigger and veto system may be developed such that the Deep Core sensors provide sensitivity over the full  $4\pi$  solid angle. This will allow investigation of sources in the Southern hemisphere, including the Galactic center and the black hole within it.

## Research areas at the IIHE

At the IIHE we are involved in the following IceCube related (astro)physics topics:

- **Search for cosmic point sources**

This research comprises a full sky search for "hot spots" of neutrino production with a novel statistics method which has been developed at the IIHE. Identification of such "hot spots" on the neutrino sky would enable us to locate the sources of the most energetic cosmic ray particles.

- **Dark matter searches.**

In these studies the focus will be on neutrino signatures from WIMPs located in the center of the Sun or the (area around the) Galactic center. As mentioned before, this could lead to an indirect discovery of the predicted dark matter particles.

- **Detection of high-energy  $\tau$  neutrinos**

The production of high-energy  $\nu_\tau$  particles in astrophysical processes is negligible. However, due to neutrino oscillations a  $\nu_\tau$  component may be present in the neutrino flux. Identification of these  $\nu_\tau$  particles in the IceCube data would enable us to validate various neutrino oscillation scenarios.

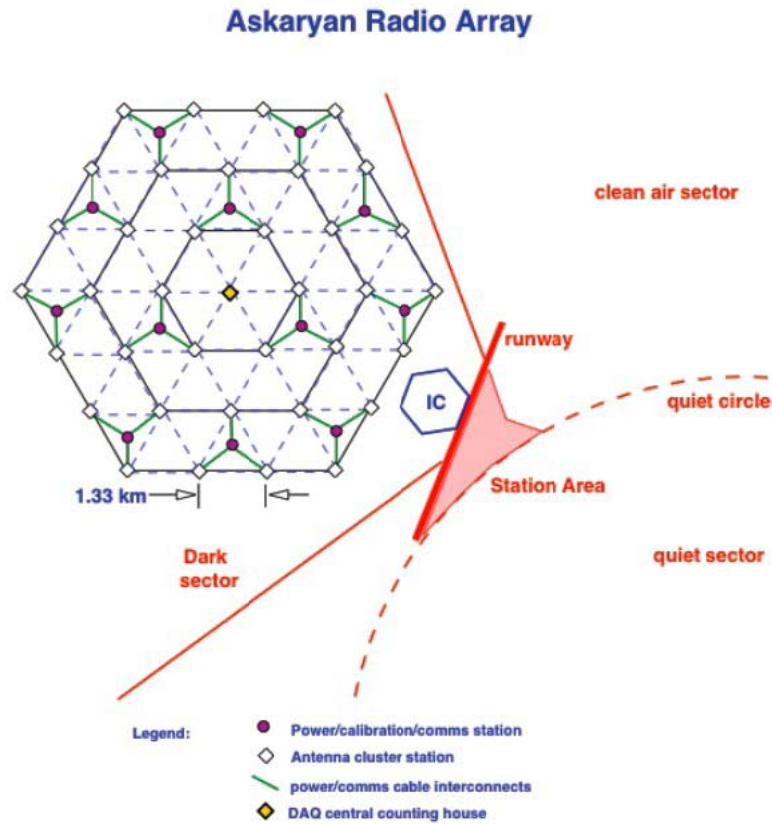
- **Search for high-energy neutrinos from transient events.**

This study is aimed at the identification of high-energy neutrino production in relation with Gamma Ray Bursts or flares of Active Galactic Nuclei. At the IIHE a special analysis method for the study of these phenomena has been developed and with the full IceCube observatory now operational we have the possibility of observing neutrinos from these processes for the first time in history with unprecedented sensitivity.



### C. THE ARA PROJECT

(D. Bertrand, K. Hanson, Th. Meures, Y. Yfan)



#### **Schematic overview of the location of the individual stations of the Askar'yan Radio Array at the South Pole.**

The ARA (Askar'yan Radio Array) experiment is a proposal to build 37 stations at the South Pole separated by 1.3km with a layout as shown in the figure. Each station will have a triad of 200m deep boreholes separated by 10-50m. An individual hole will contain two pairs of horizontally and vertically polarized antennas, also separated by 10-50m. Funding is secured to build and deploy 8 stations over the next few years, serving as a proof of concept for the second phase where the full array can be operational as early as 2016. The main goal of the project is to establish the existence of the GZK neutrinos expected at a rate of 5-10 events per year. These neutrinos result from the interaction of the most energetic cosmic ray particles with the Cosmic Microwave Background Radiation (CMBR) on their journey through the Universe. The aim of the experiment is to reach a sensitivity an order of magnitude better than current limits. The acquired experience will also be vital to the design of an array an order of magnitude larger.

The IIHE is more particularly involved in the development of the system that collects the signals from the individual stations and treats the data in the central system. Closely related is the choice for the technique of data transfer. Initially cables will be used but make the scaling of the experiment to a larger array difficult. Wireless communication between the stations is envisioned, but has

limitations due to bandwidth and power consumption, which will have to be taken into consideration during the development of the collection system, the data analysis and background studies.



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

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

Ten years after the end of the data taking, the analysis of the  $e^+e^-$  interactions at center of mass energies between 161 and 209 GeV (LEP II experiment) is reaching a completion.

These last years, the physicists of the laboratory were mainly involved in the analysis of the tau lepton production and decay properties, the study of the  $W$  polarisation and the estimation of the charged triple-gauge-boson couplings. Two papers were published in 2010 among which we can mention the following results:

Measurements of CP-conserving trilinear gauge boson couplings  $WWV$  ( $V=\gamma, Z$ ) in  $e^+e^-$  collisions at LEP II: In this study the data taken by DELPHI at center-of-mass energies between 189 and 209 GeV are used to place limits on the CP-conserving trilinear gauge couplings  $\Delta g_1^Z$ ,  $\lambda_\gamma$  and  $\Delta\kappa_\gamma$  associated to  $W^+W$  and single  $W$  production. Using data from the  $jj/\nu$ ,  $jjjj$ ,  $jjX$  and  $lX$  final states, where  $j$ ,  $l$  and  $X$  represent a jet, a lepton and missing four-momentum, respectively, the following limits are set on the couplings when one parameter is allowed to vary and the others are set to their Standard Model values of zero:

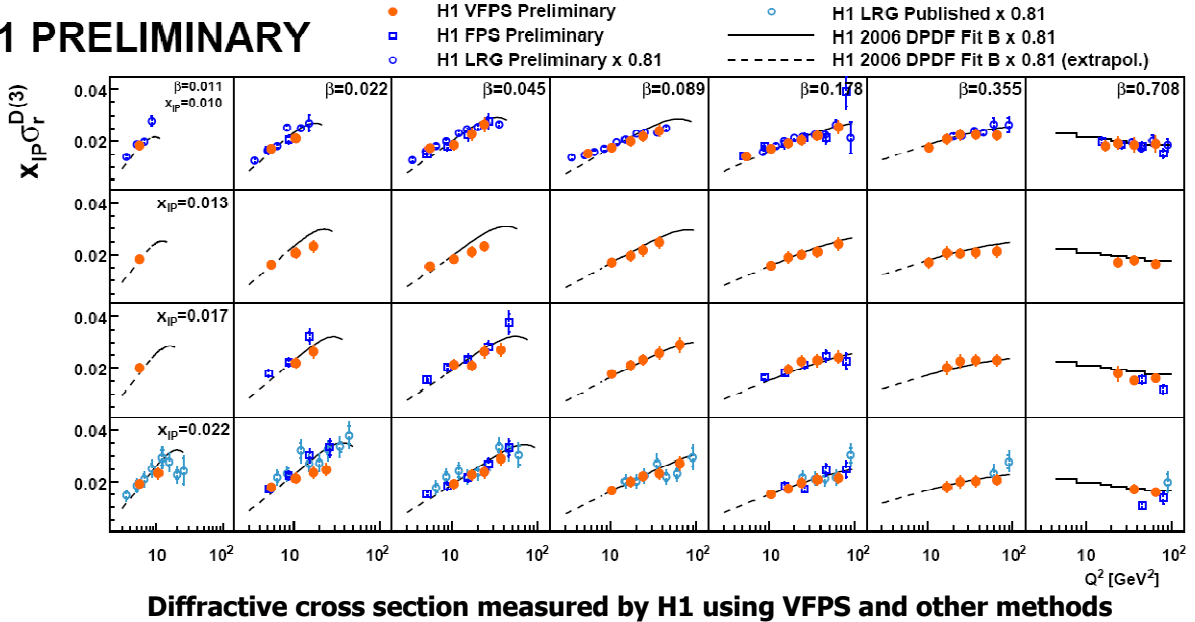
$$\begin{aligned}\Delta g_1^Z &= -0.025_{-0.030}^{+0.033} \\ \lambda_\gamma &= 0.002_{-0.035}^{+0.035} \quad \text{and} \\ \Delta\kappa_\gamma &= 0.024_{-0.081}^{+0.077} .\end{aligned}$$

Results are also presented when two of the three parameters are allowed to vary. All observations are consistent with the predictions of the Standard Model and supersede the previous results on these gauge coupling parameters published by the DELPHI collaboration.

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

(F. Ceccopieri, J. Delvax, E. De Wolf, L. Favart, T. Hreus, X. Janssen, P. Marage, R. Roosen, and P. Van Mechelen)

#### H1 PRELIMINARY



With the permanent closedown of the HERA accelerator in 2007 after 15 year of successful operation and the dismantling of the H1 detector completed, all effort is concentrated on the data analysis in which 80 FTE members were involved in 2010.

#### Activities of the IIHE group

As the VFPS was one of the last projects in the H1 experiment for which the IIHE group had full responsibility as well from the hardware as from the analysis point a view, the main activities of the group are hence linked to the VFPS data analysis:

- Improvement in the understanding of the proton-beam tilts has led to better description of the latter in the Monte Carlo and consequently has resulted in an improvement of the detector alignment from 10% to 2%.
- Full reconstruction of the proton momentum, not only in  $x_{pom}$  but also in  $t$ , the 4-momentum transfer, requires a complex minimization procedure which depends on stability of the beam condition and optimization of the sample selection to which the minimization is applied. Several Monte Carlo studies have shown satisfactory results and the procedure is now applied to the data samples.
- The first results on the diffractive structure function  $F_2^{D(3)}$  have been released and presented at DIS2010.
- Analysis of dijet events in diffractive deep inelastic scattering were the subject of J. Delvax's PHD (defended in Sept. 2010) and were presented internally in H1.

- Analysis of dijets in diffractive photo-production is still in progress. The measurement of the four momentum transfer,  $t$ , in both the photo-produced and DIS jets may shed further light on the subject of factorisation breaking in diffractive processes.
- F. Ceccopieri has been investigating diffractive parton density functions and their parameter dependence in QCD-fits obtained from large rapidity gap data and leading proton spectrometer data (FPS/VFPS). Results have been shown at several internal H1 meetings. He is also working on a NNLO implementation of the QCD evolution program to be used in the dijet analysis.
- Analysis of the rho and phi vector meson production covering the H1-data from 1996 to 2000 has been published. Rho data taken between 2005-2007, increasing the past statistics five-fold are presently under study as a subject to a master thesis.

During 2010, H1 published a total of 10 articles in international journals. An important effort was made by the 2 larger HERA collaborations, Zeus and H1, to combine their data in order and to publish global HERA results with a decrease in statistical and systematic errors. In 2010 two topics among several ongoing ones, were published:

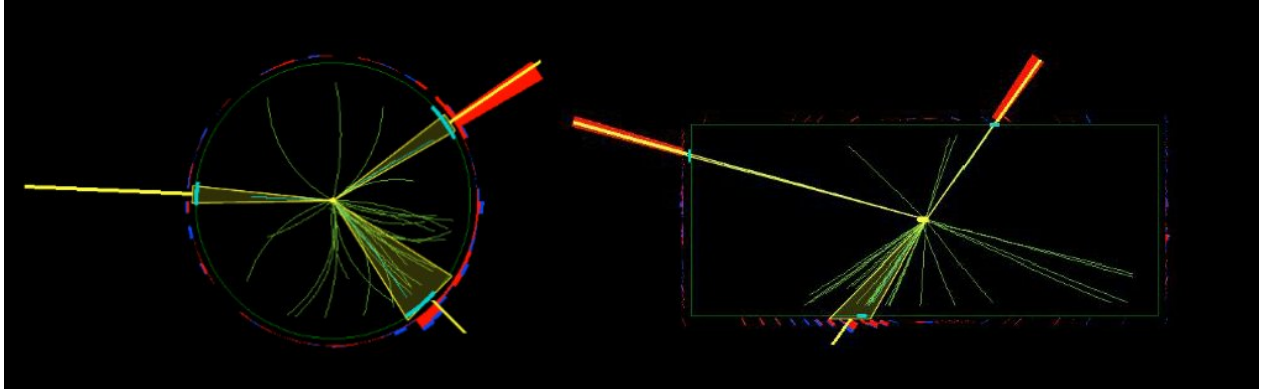
- "Events with an Isolated Lepton and Missing Transverse Momentum and Measurement of W Production at HERA". The data cover the years (1994-2007) and show that signal is in good agreement with the standard model predictions.
- Combined Measurement and QCD Analysis of the Inclusive  $e\pm p$  Scattering Cross Sections at HERA. The data span six orders of magnitude in  $Q^2$ , and in Bjorken  $x$ . A NLO QCD analysis has led to a new set of parton distributions where the total parameter uncertainties are only a few percent at low  $x$ .

Other results, the most important of which cover:

- Jet production (2-jets,3-jets) measurements at high  $Q^2$  using the H1 data (1999-2007) well described by NLO calculations have led to the determination of the strong coupling constant  $\alpha_s(Z) = 0.1168 \pm 0.0007(\text{exp}) - 0.003(\text{th}) \pm 0.0016(\text{PDF})$
- An extensive study on diffractive electroproduction of rho and phi mesons has been conducted including the measurement of the total, transverse and longitudinal cross sections as function of several parameters ( $Q^2, t, W$ ) as well as a determination of the spin density matrix elements. The results are extensively discussed in the QCD framework.

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

(S. Beauceron, W. Beaumont, L. Benucci, F. Blekman, S. Blyweert, E. Chabert, O. Charaf, K. Cerny, B. Clerbaux, E. De Langhe, G. De Lentdecker, V. Dero, A. Deroeck, O. Devroede, E. De Wolf, J.P. Dewulf, J. D'Hondt, D. Druzhkin, A. Gay, R. Gonzalez Suarez, R. Goorens, G. Hammad, X. Janssen, H. Jung, J. Maes, T. Maes, M. Maes, P. Marage, M. Mozer, L. Mucibello, S. Ochesanu, B. Roland, R. Rougny, M. Selvaggi, S. Tavernier, L. Thomas, C. Vander Velde, W. Van Doninck, H. Van Haevermaet, P. Vanlaer, Luc Van Lancker, P. Van Mechelen, P. Van Mulders, N. Van Remortel, I. Vilella and J. Wickens)



**Event display of the highest electron-positron mass event,  $M(ee)=419 \text{ GeV}/c^2$ , collected by CMS in year 2010 (data sample of  $35.5 \text{ pb}^{-1}$ ), with run=148822, event=263643676, lumi section=247. The transverse energy measurements for the electron and positron candidates are 125 and 84 GeV**

The Compact Muon Solenoid (CMS) experiment is one of the two general purpose experiments situated at the Large Hadron Collider (LHC) at CERN. The LHC has recorded the first proton-proton collisions in November 2009 at energy of 900 GeV in the center of mass and broke the energy world's record in December 2009 with runs at 2.36 TeV. The year 2010, has lead to great excitement as the first data were collected at high energy (7 TeV). The data taking started in March up to November, during which a total of  $35 \text{ pb}^{-1}$  integrated luminosities were collected. The machine and the detectors were running very smoothly and very high quality data were recorded, leading to impressive results already presented at the ICHEP conference in Paris in July 2010. The data taking at 7 TeV will continue in year 2011, with a target of few inverse femptobarn to be collected.

The CMS groups from ULB, VUB and UA have been during previous years involved in the preparation of the physics analyses, and have actively participated in 2010 to the data taking, the detector response control and the first physics results, in particular in the precise test of the Standard Model, and in the first searches for new physics beyond the Standard Model in different topologies. Only the most important of these analyses are briefly summarized below.

### Top Quark Physics

Although the top quark sector is accessible for dedicated research since its discovery in 1995, it remains a very rich and broad research domain with many unexplored aspects. Various event topologies of proton collisions in which top quarks appear are either described by the Standard Model or predicted in models beyond the Standard Model. The phenomenology of the top quark sector is strongly connected to the mechanism(s) of electroweak symmetry breaking and has in general an important interplay with supersymmetric models, models including a fourth chiral generation and models with extra spatial dimensions. The top quark sector therefore has a very rich and diverse phenomenology which opens a variety of experimental challenges to be studied with the CMS experiment at the LHC.

The richness of the research of the top quark sector is translated into a variety of topics studied by our team. The important ones are summarized below. Most of the analysis techniques we developed have been applied on the first proton collisions accumulated by the CMS experiment in 2010.

- **Top quark mass:**

The study of the measurement of the top quark mass, and the interplay with the data-driven jet energy scale calibration techniques. This was the main theme of the PhD thesis of P. Van Mulders defended in 2010. We have provided results based on the CMS 2010 data, resulting in 1% level precision for the jet energy calibration and 3% for the top quark mass. Now we develop a combined top quark mass and jet energy scale measurement. The verification of the equality between the top and anti-top quark masses predicted by the CPT symmetry is a key element in our Quantum Field Theoretical description of particle physics, and its measurement is being prepared.

- **Cross section and top quark event properties:**

The study of the measurement of the top quark pair production cross section, together with the interplay of data-driven techniques to estimate the b-tagging efficiency and of the different backgrounds. This was the main theme of the PhD thesis of J. Maes defended in 2010. The new method proposed was applied on the CMS 2010 data resulting in a first data-driven measurement of the b-tagging efficiency from top quark events although, for the moment, with a precision of about 30%. The data-driven estimation of the contribution of the main backgrounds to the top quark pair process is studied using a so-called ABCD method and the number of b-tagged jets per event. In 2010 J. D'Hondt was the editor of the first top quark physics publication at the LHC, namely the cross section measurement in the di-lepton channel. We were also a driving force in the measurement of the top quark pair cross section in the electron+jet channel using b-tagging methods. The measurement of the CKM element  $V_{tb}$  will be combined with these cross section studies.

- **Top quark couplings:**

The  $Wtb$  interaction vertex has a rich and mainly unexplored phenomenology to be observed in the V-A form of the top quark decay. This study may provide insights in the mechanism of electroweak symmetry breaking or indirect argument for physics beyond the Standard Model. Also the W helicity and the predicted spin correlations can be measured at the LHC. A new method to measure the spin correlations is being developed aiming for only a minor dependency on the hypotheses in the simulations. In parallel an analysis technique to measure the W helicity is being constructed.

- **The interplay of supersymmetry and top quarks:**

In the search for supersymmetric phenomena at the LHC, the Standard Model processes with top quarks are usually the dominating background. Also top quarks can appear in the cascade decays of supersymmetric particles. This motivates a dedicated study of supersymmetric phenomena in the top quark sector. A method, denoted S2-method, is developed to search for deviations of the kinematic observables in the top quark sector. This was applied as a goodness-of-fit test of the kinematics of the top quark pair events using the 2010 data. It has also been applied for the search for mSUGRA signals and the potential exclusion limits have been determined with dedicated simulations. A publication is soon expected.

In 2010 we have organized the 3<sup>rd</sup> International workshop on Top Quark Physics in Bruges (31 May – 4 June) with published proceedings. More information on this conference can be found at [www.top2010.be](http://www.top2010.be). The Workshop brought together about 130 experimentalists and theorists, to review the status and future prospects of top-quark physics. The program included reports on the first data taken at the LHC, measurements performed at the Tevatron, presentations of theoretical developments and discussions on the prospects for top physics at the LHC. The aim of the Workshop was to provide not only a state-of-the-art picture of top quark physics, but also a forum where experimentalist and theorists can discuss the future goals.

## Search for high mass resonances

High mass resonances decaying into electron pairs provide some of the most important discovery potentials beyond the Standard Model at the LHC. They are predicted in various models as for example massive gravitons or new massive gauge bosons in the framework of extra spatial dimension models, as well as new heavy Z bosons in Grand Unified Theories. A discovery in the electron pair channel is possible for certain models already after several months of LHC running at center-of-mass energy of 7 TeV (an integrated luminosity of few tens of  $\text{pb}^{-1}$ ).

Since a couple of years 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. They initiated the creation of the HEEP (High Energy Electron Pairs) working group, which has defined the strategy to adopt with the very first data (low luminosity and not well understood detector) to allow a fast discovery of high mass resonances in startup condition. The full analysis chain was designed and studied using MC simulation and lead to several publications.

In 2010, all the Brussels group activity went to the analysis and control of the first CMS data at 7 TeV. The group actively worked on trigger studies, data access and skimming, Data Quality Monitoring (DQM), as well as electron reconstruction and identification algorithms; these are very important tasks at start-up. The full analysis chain was run on data. The group was strongly involved in every step of the analysis, detailed here below:

### - Triggers and selection:

In order to select online high energy electrons, new trigger paths with different  $p_t$  thresholds have been designed and tested. The selection was designed to have high efficiency (due to small expected number of signal events) while rejecting the multijet background from QCD processes, mainly thanks to electron identification and electron isolation criteria. Improvement of the measurement of very high energy electrons by correcting for electronics saturation was studied and the same method is used to check the ECAL energy calibration at high energy.

### - Efficiency and backgrounds:

An important work of the Brussels HEEP group was to find procedures to estimate, from the data themselves, the selection efficiency and the remaining background in the final sample, in order to be as much as possible Monte-Carlo simulation independent. For this purpose, several complementary methods have been designed, tested on simulated samples, and successfully applied to the data. The main backgrounds come from top-antitop production and  $W$ +jet process where a jet is misidentified as an electron.

### - Drell-Yan cross section measurement:

Using the data driven methods described above to estimate the selection efficiency and the backgrounds, the Drell-Yan cross section was measured, both at the Z peak and at high mass ( $M > 120 \text{ GeV}/c^2$ ). This was the main subject of the thesis of O. Charaf, defended in October 2010.

### - Limit on new physics:

Important work was also performed to develop tools to estimate the CMS five-sigma discovery potential for heavy resonances as well as the 95% confidence limit on the resonance production cross section in case of the absence of signal, and also statistical tools for the combination of the electron and the muon decay channels.

The full 2010 dataset was analysed and the results were found to be in agreement with the Standard Model expectation. The dielectron and dimuon channel results were combined and limits were put on new physics models, some of them exceeding already the Tevatron ones.

The HEEP Brussels group has taken a leading role in the analysis and the publication procedures. B. Clerbaux was the editor of the first physics publication at the LHC on the search for new massive resonances in the di-electron channel.

## Study of strange particle production and of the underlying event

The production of soft hadrons accompanying the hard parton scattering in hadron collisions remains a topic that is poorly understood in QCD. This so-called underlying event is interesting to study in itself as it carries information about the particle production dynamics. It also constitutes a background to searches for new physics as it unavoidably accompanies each proton-proton collision.

IIHE members initiated a study of neutral strange particle ( $V_0$ s, i.e.  $K_0$ s,  $\Lambda$  and anti- $\Lambda$ ) production in the underlying event, in parallel with the study of charged hadron production in the underlying event. This study is expected to be competitive with other LHC experiments thanks to the remarkable low- $p_T$  charged particle tracking capability of the CMS tracker (down to  $\sim 100$  MeV/c).

The selection of  $K_0$ s,  $\Lambda$  and anti- $\Lambda$  relies on their long lifetime, known mass and two-prong decay topology. A kinematic fit is performed applying mass, secondary vertex and pointing constraints to the  $V_0$  candidates using a program specifically developed at IIHE. A background-free sample is achieved by selecting only those candidates that are consistent with these constraints.

## Tracker data quality monitoring and operations

The IIHE CMS team contributed significantly to the development of data quality monitoring programs for the CMS silicon strip tracker. A major development was the design and implementation of tests that reveal noisy or inefficient tracker modules. Since the module counting rate depends on the LHC beam conditions, that are quickly changing, such tests have been designed so as to be independent of the counting rate. They exploit the  $\phi$ -symmetry of the flux of particles produced. This development was done in collaboration with UMons. Another important development performed by IIHE members was the implementation of run validation scripts. A team of two people also contributed to the testing of tracker aspects relevant to the muon high-level trigger, and another team took in charge the documentation of the data quality monitoring programs. An IIHE member was also trained as an expert in tracker operations and will train new experts in 2011.

A fine monitoring of the track parameter measurement was also achieved by applying kinematic constraints on  $K_0$ s,  $\Lambda$  and anti- $\Lambda$  candidates (see section "Study of strange particle production"). The pulls of the constrained tracks from the decay pions or protons allowed a detailed monitoring of the tracker performance and revealed biases in particle momentum of the order of one per mil.

## Forward energy flow and jets with CASTOR

Members of the Antwerpen group have contributed to the construction, commissioning and operation of the forward CASTOR calorimeter of CMS. In 2010, data at various energies have been collected and a analysis of the energy flow at very forward rapidity ( $5.2 < \eta < 6.6$ ) was performed. Ratios of the energy flow in events with a central hard scale provide by a particle jet to the energy flow in minimum bias events were obtained and found to be very sensitive to the model parameters used to describe the underlying event. In parallel to the data analysis, members of the IIHE have been working on the validation of the CASTOR detector simulation with test beam and collision data and on the reconstruction algorithm for CASTOR towers and jets. In collaboration with researchers from UERJ (Brazil), members of the IIHE have been working on the construction and validation of a Shower Library for CASTOR, containing pre-simulated particle showers which are used to speed up the full CMS detector simulation.

## Search for exotica in events with a single jet and missing transverse energy.

An excess of events with a single jet and a large amount of missing transverse energy (so called monojet events) is predicted by models such as the ADD model of extra dimensions of the Unparticle model. Members of the IIHE have been using the full data sample collected in 2010 to select events with



the monojet signature and to study the event yield as function of the missing transverse energy. The main challenge is to suppress reducible backgrounds and to estimate the contribution of irreducible backgrounds such as events containing a jet and a Z boson decaying to neutrinos. The contribution of this last class of events has been estimated by measuring the yield of events containing a jet and W boson with the W decaying to a charged lepton and a neutrino. With the present data analysis CMS will be able to improve the limits set by previous experiments.

### **Study of Quantum Chromo Dynamics at small momentum transfers**

The majority of inelastic proton-proton collisions at the LHC can be considered as 'soft' processes that cannot be treated perturbatively within the framework of QCD. This is also the case for the treatment of beam remnants and soft radiation that is superimposed on every hard scatter occurring at large momentum transfers, the so-called underlying event. Both phenomena can be understood in terms of phenomenological models that rely on basic but fundamental quantum mechanical assumptions, such as unitarity, jet universality etc. During the past year, several studies were performed on the underlying event activity of collisions exhibiting a hard scale, characterized by the presence of a jet or a leading particle with a high transverse momentum, and on differential measurements of the multiplicity distributions in minimum-bias collisions. This resulted thus far in two publications on the topic where recent activities focus on the tuning of phenomenological parameters in order to describe as many inclusive spectra as possible.

### **Search for the Standard Model Higgs boson**

One of the golden signatures for the production and decay of the SM Higgs boson with an intermediate mass between 130 GeV and 300 GeV is the production via gluon fusion and its subsequent decay in a pair of leptonically decaying W bosons. The group has been actively participating in the optimization of selection criteria for the same flavor and mixed flavor leptonic final states, at several center-of-mass energies. Some of the important systematic uncertainties, mainly on the estimation of dominant background contributions, have been estimated by the group. This resulted in several public sensitivity reports that were presented at international conferences and a publication based on the first 3.5 fb<sup>-1</sup> of data collected at  $\sqrt{s} = 7$  TeV. Current activities are focused on the preparation of the coming 2-year run period in order to improve the exclusion limits set by the Tevatron experiments or find first hints of a Higgs boson in this decay channel.

### **Forward Muon Chambers**

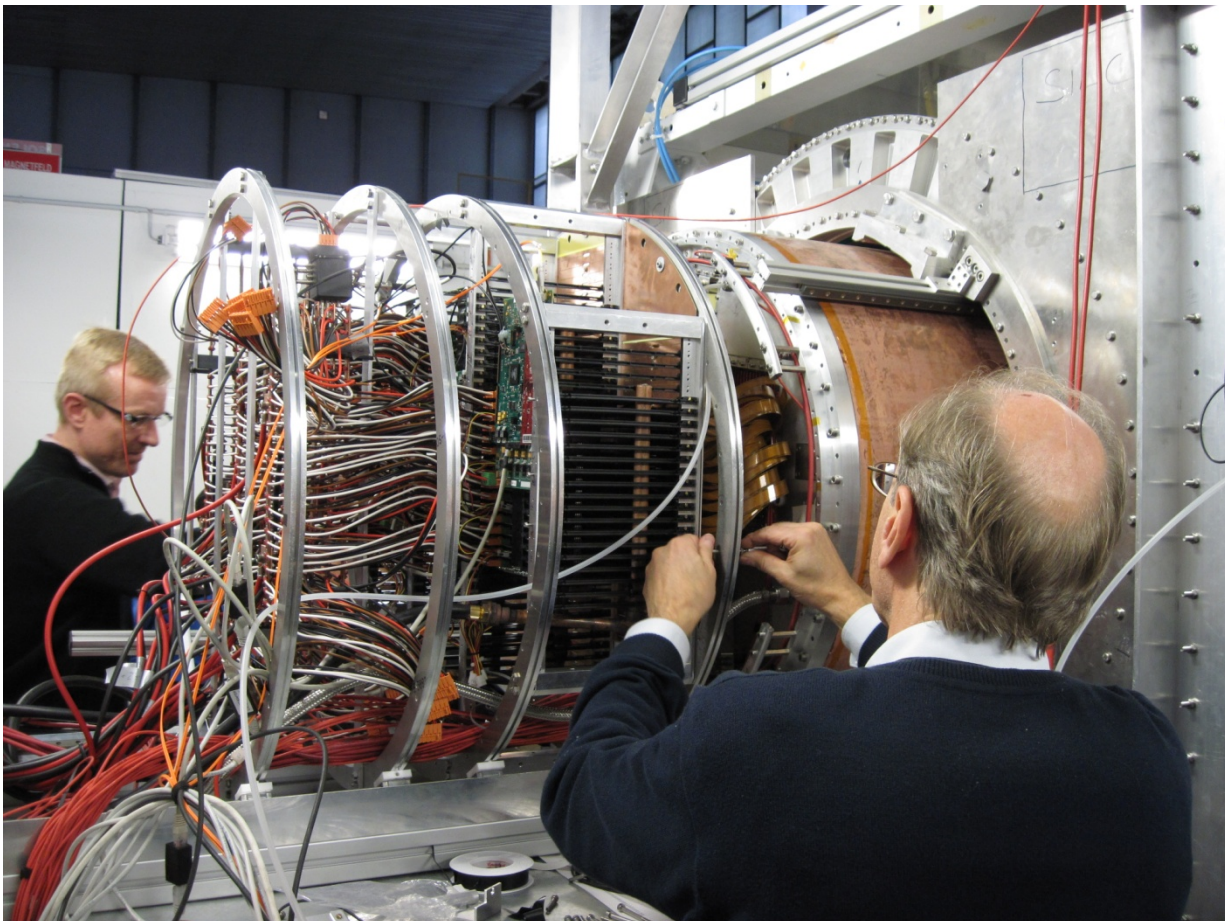
During 2010 the Forward RPC upgrade plan has been embedded into the Upgrade Technical Design Report of the CMS experiment. A fourth RPC station is to be designed, build and installed in the CMS end caps to be operational after the long shutdown presently scheduled in 2013. The Forward RPC collaboration has been enlarged for this purpose and now consists of groups from Belgium, CERN, China, India, Italy, Korea and Pakistan. A total of 200 chambers will be build and tested in India (Mumbai), Belgium (UGhent) and CERN. Two IIHE members (W. Van Doninck and L. Van Lancker) are responsible for the mechanical design of the chambers and their integration into the CMS end caps.



### III. APPLIED R&D AND SPIN-OFF

#### III.1 DATA ACQUISITION R&D PROJECT

*(D. Bertrand, G. De Lentdecker, K. Hanson, Th. Meures, E. Verhagen, Y. Yfan)*



**TPC equipped with its front-end electronics and with its cooling system, partly inserted into the 1 Tesla supra-conducting magnet at DESY, Hamburg**

Since 2007, the IIHE has started an R&D program in the field of data acquisition (DAQ) systems for future experiments in particle and astro-particle physics. Modern technologies allow to design a DAQ architecture independent of the detector technology to which the DAQ system will be connected, providing freedom to the choice of the future experiment. In addition the future particle and astro-particle experiments plan to use the most advanced technologies from the telecommunication and the digital programmable electronic industries: the Advanced Telecom Computing Architecture (ATCA) standard and Field Programmable Gate Arrays (FPGA). The choice of the IIHE to start such a R&D program has been driven by the fact that the laboratory has a large expertise in the development of DAQ systems for the major experiments in particle and astro-particle physics (DELPHI, H1, CMS, and IceCube).

To conduct these developments in a concrete case, the laboratory started a collaboration with the University of Lund (Sweden) and CERN to develop the DAQ system for a large prototype of Time Projection Chamber (TPC) that could be installed at a future linear electron-positron collider (ILC or CLIC), where the FPGAs and ATCA technologies will be largely used. Therefore the experience that the IIHE is gaining by developing DAQ systems in this framework will be a valuable asset for a probable participation of the lab in any future experiment in particle or astro-particle physics.

The first DAQ prototype for the TPC has been developed and extensively used since the end of 2008 with a large TPC prototype exposed to a 6 GeV electron beam at DESY (Hamburg). This DAQ system is based on the DAQ of the ALICE experiment at LHC but it had to be modified for the needs of the TPC. The modifications have been shared among the three institutes according to the expertise of each group. CERN developed a new front-end pre-amplifier and the University of Lund designed new front-end cards (FEC). The IIHE contributions in the project are numerous:

- development of a new electronic card equipped with FPGAs to distribute synchronization signals, to the FECs
- programming of the FPGAs located on the FEC that control the front-end pre-amplifiers
- in collaboration with the University of Lund and the University of Bonn, the development of the software to control and monitor the data acquisition

These developments have been performed within the EUDET project supported by the European Commission in the 6<sup>th</sup> Framework Program. EUDET has as objectives to create infrastructures to support the R&D programs for the future linear collider. In 2008, EUDET has identified the development of DAQ systems as a key component to setup these facilities, namely the design of a DAQ system common to various detectors that have to be tested together with beams. The design of a common DAQ system is now one of the targets of the new Advanced European Infrastructure for Detectors at Accelerators (AIDA) project (European Commission Framework Programme 7) starting on February 1<sup>st</sup> 2011, and to which the IIHE is collaborating.

In the framework of AIDA, the IIHE will improve the TPC DAQ prototype, including components of the new ATCA standard to make it more flexible and easily adaptable to other detector technologies and other experiments. This should be achieved by designing Advanced Mezzanine Cards (AMC) equipped with FPGAs with Giga-bit Ethernet and PCIexpress connections to the ATCA backplane. As an example, a specific issue of this kind of architecture, under study at the IIHE, is the remote programming of the FPGAs. These developments are performed with the support of the CMS DAQ working group for LHC upgrades.

Since 2010, DAQ developments have started at the IIHE in the framework of the Askaryan Radiotelescope Array (ARA) project, where the detectors will be spread over an area of several km<sup>2</sup>. One task of the IIHE in this project is to provide the communication system responsible for the data transfer from the detectors to the central station installed in the IceCube facilities. ATCA-based developments are also of interest for this project in which the detectors are spread over such a large area and cannot be easily accessed.

### III.2 DEVELOPMENT OF NEW SCINTILLATION MATERIALS AND OF RADIATION DETECTORS FOR BIOMEDICAL IMAGING APPLICATIONS – THE CRYSTAL CLEAR PROJECT

*(P. Bruyndonckx, Dang Jun, O. Devroede, Li Zhi, S. Tavernier and M. Wedrowski)*



**First prototype of multimodal dedicated PET/US scanner for mammography**

From its inception, PET technology has continually benefited from new developments in radiation detection for fundamental research in high energy physics, first using sodium iodide crystals, then using the improved performance from bismuth germinate (BGO), and more recently using superior materials such as lutetium orthosilicate or lutetium aluminates. These new scintillators are faster and produce more light than BGO. The arrival of more advanced position sensitive PMTs (PS-PMTs), Avalanche photo diodes (APDs) or Silicon PMTs 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, has been exploring several research lines that could, in the future, improve the performance of PET scanners. 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 solid scintillator blocks to eliminate dead zones in-between the crystals. In addition, these scintillator blocks are less expensive 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

the modules can also rotate relative to one another. This allows us to simulate a complete (or partial) detector ring and reconstruct tomographic images of an object. The resulting image shows the very encouraging resolution of 1.6 mm FWHM.

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 has been 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 Forschungszentrum Julich (FZJ, Germany). The basic detector modules will consist of a dual layer of trapezoidal LSO blocks. The complete system will consist of 4 detector rings, each with 52 detector modules. To determine the optimal design parameters of the detector modules, extensive simulations using GATE, were performed. This allowed us to estimate the impact of many parameters such as the crystal thicknesses, training data pattern to be recorded, electronic noise level and digitization accuracy, APD gain, position of the APDs on the LSO blocks, scattering in photo detectors and electronics very close to the scintillators, ...etc. The final parameters of the BrainPET system that will be developed by the collaboration were determined on the basis of this study.

One of the conclusions of our study was that the spatial resolution is mainly limited by the signal-to-noise ratio (SNR) of the APD signals. The SNR suffers from the low APD gain and high excess noise factor. The newly developed silicon PMTs allow a much larger gain and therefore could significantly improve the resolution that can be achieved with such a system.

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

Our research group is also actively involved in the development of a second generation of the ClearPEM prototypes. These are dedicated PET scanners for mammographic breast imaging. In this second generation, an ultra-sound (US) probe will be added to complement to mammographic PET studies with anatomical information. Our contribution will be the study of algorithms to fuse the PET and US images, overlaying the anatomical features with the corresponding molecular signatures of the cancer process. In order to develop and test appropriate algorithms, a suitable phantom has to be developed that can be used for both the PET and US imaging modality. In collaboration with the Laboratoire de mécanique et d'acoustique of the CNRS in Marseille, several material mixtures have been tested for their ultra-sonic properties (speed of sound, attenuation of sound waves, absence of shear waves,...) and compared with those found in real human breast tissue. With the help of this phantom strategies for image fusion of the PET an US image were studied, and a proposal on how this will be done as soon as the clinical images are available was worked out.



## IV. COMPUTING AND NETWORKING

*(D. Bertrand, F. Blekman, O. Bouhali, O. Devroede, M. Dierckxsens, M. Frère, J. D'Hondt, S. Gérard, K. Hanson, A. Marotta, A. Ouchene, S. Rugovac, S. Tavernier, E. Torisaen, P. Vanlaer, R. Vandenbroucke)*

### A. LOCAL COMPUTING RESOURCES

#### Computing

The local computing facility consists of a computing cluster containing 180 cores which uses the OpenPBS batch queuing system to handle job submission. To this number shall be added an additional 192 cores which were purchased by IceCube. In addition, Dr. M. Dierckxsens has purchased a specialized graphics processing (GPU) platform which contains the recent Tesla processing engine from NVIDIA. The scientific purpose of this novel hardware will be discussed below in the section on IceCube computing.

#### Storage

The storage server which was purchased in 2009 by the IceCube group was installed into the IIHE cluster in 2010 providing 63 TB of disk space for users. At the end of 2010 IceCube purchased another 96 TB J4500 storage array which was recently received and will be attached in the coming weeks. This storage will in large part be put to use to store IceCube experimental and simulated data: the level 2 reduced data set for the data runs of 2010 alone occupies over 50 TB.

#### Networking

In 2010, the IIHE computing support division began a program to install a wireless network infrastructure throughout the institute. This network will comprise 10 wireless access points distributed throughout the premises and each connected to a captive portal system for user authentication. This authentication is shared with the Unix account authentication both of which will be managed using LDAP. This has necessitated an upgrade of the older NIS framework to LDAP. This work was begun in 2010 and will be completed by Q2 of 2011.

#### Web

The IIHE web server will be replaced in early 2011 with a new host (E. Torisaen); this shall be soon thereafter accompanied by a redesign of the IIHE web site (F. Blekman, E. Torisaen, M. Frère).

### B. ICECUBE COMPUTING

The IceCube collaboration relies on its collaborating institutions to provide computing resources to generate simulated data sets. These data sets require vast amounts of CPU and in addition to the specialized nature of the simulation software, require compute hosts with at least 2 GB RAM per core. The IIHE cluster, described above, has been used by the IceCube Simulation Production group, under the local supervision of Dr. A. Marotta, to process more than 5000 simulation jobs for a total CPU time of over 3000 CPU-days for 2010. The IIHE CPU resource will continue to be partially allocated to the production of IceCube Monte Carlo data sets. In addition, Dr. Dierckxsens will research production of simulated data with the GPU-enabled systems by using the direction photon propagation method. This research is at the forefront of simulation and has only become possible with the massively parallel architectures found in modern GPU systems. On these hardware platforms, it is computationally feasible to track each of the  $O(10^{10})$  individual photons produced in the simulation of events. Heretofore, the simulation of photon propagation in the ice has been approximated by various tabulated photon density estimates. Due to the complex nature of the ice optics, this has resulted in sometimes large disagreements between simulation and real data. Early studies with the direct photon propagation indicate a much closer agreement between simulation and data.

### C. *LARGE-SCALE COMPUTING*

Distributed computing based on Grid technology is the solution chosen by CERN for the storage and the analysis of the large amount of data that is produced by the LHC experiments. The IIHE computing team is involved in several national and international Grid projects. In addition, members of the IIHE act as representatives of the ULB and the VUB in regional bodies promoting the deployment of large computing infrastructures in Belgium, the Consortium des Equipements de Calcul Intensif (CECI) in the French Community and the Vlaams Supercomputing Center (VSC) in Flanders.

#### **CMS Tier-2**

In 2010 the CMS "Tier-2" team counted three IT scientists (Shkelzen Rugovac, Olivier Devroede, Stéphane Gérard). The physicist in charge of the Belgian Tier-2 sites, and representative to the W-LCG and CMS computing boards, is Pascal Vanlaer, seconded by Giacomo Bruno (UCL). O. Devroede is the technical coordinator of the Belgian Tier-2 sites. The contract of S. Gérard ended in October 2010. S. Gérard has now obtained a position at the VUB to work on the VSC. Some of his activities will be taken over in 2011 by Joris Maes (UA), who will contribute to the operation of the "Tier-2" part time.

In 2010 the IIHE further deployed the "Tier-2" cluster integrated in the hierarchy of computing centers that process the data of the CMS experiment. The IIHE "Tier-2" is installed in the infrastructures of the ULB-VUB Computing Center and hosts the contributions of the U Antwerpen, U Gent, UMH, ULB and VUB funded by the F.R.S.-FNRS and by the FWO and Flemish region. It is connected to the Belgian research network BELNET through a 1.5 Gb/s connection. The "Tier-2" cluster contributes significantly to the computing resources of the CMS collaboration. The resource deployment schedule is bound by the memorandum of understanding of the Worldwide LHC Computing Grid (W-LCG) collaboration.

The "Tier-2" is supporting the analyses of the Belgian CMS physicists, ~65 people from both French-speaking and Flemish universities. The Brussels "Tier-2" cluster has been a crucial tool in 2010, that allowed Belgian physicists to contribute in an important way in the analyses of the LHC data, collected for the first time at 7 TeV proton-proton center-of-mass energy.

The equipment deployed in 2010 consisted in:

- processors of type Intel Xeon L5520, quad-core, to reach a total of 700 batch slots in 66 physical nodes, for an equivalent of 6000 HepSpec06 units of processing power;
- 200 TB of mass storage disks to reach 540 TB raw disk space in RAID6;
- a new file server that manages a file system of 65 TB disk space dedicated to analyses;
- additional 8-core machines dedicated to interactive analysis with ROOT;
- an additional rack to host future additional equipment.

In addition, a power failure protection system (UPS) common with the ULB-VUB computing center has been partially funded on the "Tier-2" budget. This allowed scale savings and the protection of both the "Tier-2" cluster and the ULB-VUB HPC cluster Hydra with better equipment.

Additional disk space and processing power will be bought in 2011 to meet the requirements of LHC data taking at high collision rate, and to replace obsolete equipment.

The IIHE CMS computing team (Stéphane Gérard) also contributed to the testing of new releases of the CMS Remote Analysis in Batch (CRAB) program, i.e. the interface to submit CMS analysis jobs on the grid.

The IIHE-T2 cluster extended with the equipment provided by a previous grid project with the Flemish government and very recently with equipment bought in the frame of the preparation of VSC forms the VUB-ULB gridcluster integrated into BEgrid. VUB researchers and researchers from other universities and research institutions can use these resources as agreed within BEgrid.

#### **BEgrid**

BEgrid is the Belgian computing/data grid for research. It is coordinated by BELNET, the Belgian research network. The BEgrid coordinator is Rosette Vandenbroucke. The IIHE is actively participating in

BEgrid: it makes resources available for BEgrid users and the grid team helps to prepare the Quattor middleware templates. On the other hand BEgrid/BELNET resources can be used to test new services.

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

The IIHE (ULB-VUB) is part of the IAP P6/11 "Fundamental Interactions: at the boundary of theory, phenomenology and experiment" ([www.f-i.be](http://www.f-i.be)) from 2007 until 2011. The members of the network are: Theoretische Fysica (KUL), Elementaire Deeltjes Fysica (UA), Centre de Physique des Particules et de Phénoménologie (CP3-UCL), Physique des Particules Élémentaires, Physique Mathématique des Interactions Fondamentales and Physique Théorique (ULB), Elementaire Deeltjesfysica and Theoretische Natuurkunde (VUB), Experimentele Deeltjesfysica (UGent), Physique Théorique Fondamentale (ULg). The purpose of this IAP 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.

In 2010 we had two general meetings, at ULB and UAntwerpen, where the activities of all the teams were presented. The physicists of the IIHE participated actively to these general meetings and to common seminars and journal clubs. They also contributed to the working group dedicated to the elaboration of future experiments. The contributions of the IIHE to the IAP research program are described in the Midterm Report, which was written for the ex-post evaluation which took place in 2010 (<http://www.f-i.be/EvaluationDocumentIAP-VI-11.pdf>).



## VI. PHENOMENOLOGY GROUP

*(B. Craps, C. De Clercq, J. D'Hondt, Ph. Grajek\*, A. Kalogeropoulos, F. Maltoni\*\*, A. Mariotti, K. Mawatari\*, B. Oexl\*, A. Sevrin)*

In the course of 2010 the theoretical physics (THEP) and (astro) particle physics (ELEM) groups of VUB obtained GOA (Geconcerteerde OnderzoeksActies) funding from the university to start a new research group. The promoters of the project are B. Craps (THEP), C. De Clercq (ELEM), J. D'Hondt (ELEM) and A. Sevrin (THEP). The leader of the group is K. Mawatari. This group has a close collaboration with F. Maltoni from UCL.

The main topic of research is Supersymmetric Models and their Signatures at the Large Hadron Collider (<http://we.vub.ac.be/dntk/onderzoek/GOAindex.htm>). The project will study the supersymmetry breaking mechanism on a formal theoretical level, explore the phenomenology of these sometimes novel models and provide methods to observe the signatures within particle collisions at the Large Hadron Collider.

The kick-off meeting of the new project took place at the IIHE on 20/01/10. The group formally started its activities in October and organised two meetings:

- MadGraph developers meeting, IIHE, 4-8/10/10
- Gauge Mediated SuperSymmetry Breaking Workshop, IIHE, 2-3/12/10

\* members hired on GOA project

\*\* Université Catholique de Louvain

## VII. TECHNICAL AND ADMINISTRATIVE WORK

The members of the workshop staff in 2010 were: J. De Bruyne, P. de Harenne, L. Etienne, R. Goorens, S. Hannaert, G. Van Beek, R. Vanderhaeghen, L. Van Lancker, Ch. Wastiels and Yang Yifan. D. Bertrand (till 30/09/10) and Gilles De Lentdecker (from 1/10/10) were in charge of the general coordination.

L. Van Lancker was responsible for the design of the additional RPC muon chambers which will be installed in the CMS detector during the next shutdown. He was also involved in the preparation of the installation procedure.

Yang Yifan was responsible for the development of a test DAQ system for a new TPC in the framework of the preparation of new detectors for future experiments. He was involved in the design of a FPGA based board. He also participated to the development of the readout of the Acoustic Radio Array (ARA) neutrino detector.

L. Etienne was responsible for the maintenance of the test station for the DOMs (Digital Optical Modules) of the IceCube experiment. He also maintained several didactic experiments which are used for the regular courses and was in charge of a cosmic ray experiment to be implemented in secondary schools (OCRE-KOSMIS).

J. De Bruyne, L. Etienne, S. Hannaert and G. Van Beek participated to the development of a new muon experiment, based on scintillating fibres and angular track information, to be used by students (ARCH).

In the framework of the spin-off activities related to detector developments for medical applications, J. De Bruyne and Ch. Wastiels were in charge of the technical support of the CRYSTAL CLEAR project. More particularly Ch. Wastiels maintained electronics control cards for the small PET camera.

The secretarial work and the general administrative and logistic support of the experiments were accomplished by M. Goeman and D. Peymans. They were working in collaboration with A. De Coster, F. Pero and D. Pirnay. F. Pero was more particularly in charge of the organisation of the travels of the members of the IIHE. A. De Coster was responsible of the library of the Institute. She also maintained the database of the physicists publications.

M. Goeman was in charge of the logistic support of the CRYSTAL CLEAR project. D. Pirnay maintained the IAP and Phenomenology Group websites. D. Peymans and R. Goorens took part in the organisation of the ULB master classes. M. Goeman was in charge of the organisation of the BND Summer School and participated to the organisation of the two meetings of the Phenomenology group. P. De Harenne, F. Pero and D. Peymans participated to the organisation of the CMS Exotica workshop. D. Pirnay, in collaboration with A. De Coster, was in charge of the organisation of the TOP2010 workshop. She was also in charge of the organisation of the e-IRG Workshop and participated to the organisation of the OGF30 – GRID2010 Conference. D. Peymans, in collaboration with P. De Harenne and F. Pero, was in charge of the organisation of the IceCube collaboration meeting.

## VIII. SPECIAL EVENTS

### VIII.1 IIHE ANNUAL MEETING



The annual meeting of the IIHE took place at Anhée on 29-30 October. The first day was devoted to a review of the activities in the different experiments and in computing and R&D for future detectors. The second day was devoted to team building activities. The organisation was in the hands of J. D'Hondt and P. Vanlaer, with support from M. Goeman.

The agenda of the meeting on 29/10/10 was

10 :15 Morning Sessions	Introduction of newly arrived people	
	IceCube general introduction, computing developments and analysis of transients	Nick van Eijndhoven
	IceCube WIMP analysis and DeepCore	Erik Strahler
	IceCube Tau analysis	Sabrina Bechet
	GZK neutrinos and the ARA project	Thomas Meures
	Opera	Pierre Vilain
12:30	Lunch	

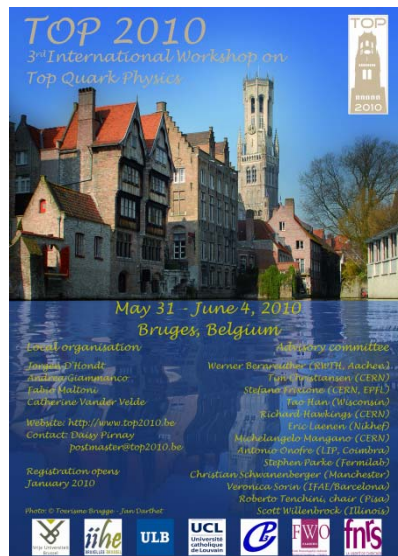
14:00 Afternoon Sessions 1	H1	Julie Delvax
	General news from the lab <ul style="list-style-type: none"> <li>o VUB</li> <li>o ULB</li> </ul>	Catherine De Clercq Pierre Marage
	General news from LHC/CMS	Catherine Vander Velde
15:30	Coffee	
16:00 Afternoon sessions 2	Physics with top topologies	Jorgen D'Hondt
	HEEP	Barbara Clerbaux
	Strange particle production and underlying event	Pascal Vanlaer
	T2 computing	Pascal Vanlaer.
	Generic DAQ developments	Gilles De Lentdecker
18:00	Drink	
19:00	Dinner	

## VIII.2 ORGANISATION OF CONFERENCES, WORKSHOPS, SCHOOLS AND SCIENTIFIC MEETINGS

### RECFA country visit

The Restricted ECFA (European Committee for Future Accelerators) visited Belgium on 5-6 March 2010 (<http://indico.cern.ch/conferenceDisplay.py?confId=85274>). C. De Clercq and C. Vander Velde participated to the local organisation.

### TOP2010 Workshop



The 2010 edition of the Top Conference took place in Brugge from 31 May to 4 June 2010 (<http://www.top2010.be>). The following members of the IiHE were part of the local organising committee: J. D'Hondt, C. Vander Velde and D. Pirnay.

### **BND summer school**

The 2010 edition of the Belgium-Nederland-Deutschland graduate school took place in Oostende, from 6 to 17 September 2010 (<http://bnd-graduateschool.org/main/>). The local organising committee was composed of: C. De Clercq (chair), J. D'Hondt, R. Roosen, N. Van Eijndhoven, M. Goeman (secretary).

### **CMS Exotica workshop**

On 14-15/10/10 the Exotica Group of the CMS experiment met in Brussels. The organisation was taken care of by B. Clerbaux, P. De Harenne and D. Peymans.

### **IceCube collaboration meeting**

The 2010 fall collaboration meeting took place in Brussels from 19 to 23 September 2010. The local organising committee was composed of D. Bertrand (chair), C. De Clercq, K. Hanson, N. Van Eijndhoven, D. Peymans and M. Frère.

### **MadGraph developers meeting**

The MadGraph 2010 fall meeting was held at the IIHE from 4 to 8 October 2010 (<http://cp3wks05.fynu.ucl.ac.be/twiki/bin/view/Main/MG2010BSM>). It was devoted to physics Beyond the Standard Model. This event was co-organised by K. Mawatari and Ph. Grajek from the phenomenology group of VUB and F. Maltoni of UCL.

### **GMSB phenomenology meeting**

On 2-3 December 2010 a workshop on Gauge Mediated Supersymmetry Breaking was organised at the IIHE (<http://w3.iihe.ac.be/indico/conferenceDisplay.py?confId=263>). It was attended mainly by theorists and was organised by A. Mariotti and K. Mawatari from the VUB phenomenology group.



## IX. REPRESENTATION IN ACADEMIC COUNCILS AND COMMITTEES

### ***Daniel Bertrand***

- Chairman "ULB Personnel C4 Commission"
- Responsible for the ULB Physics Department Erasmus Students Exchange Program

### ***Barbara Clerbaux***

- Member commission de classement - poste académique 2010
- Member commission de classement 1ere assistant
- Member bureau du conseil du département de physique

### ***Catherine De Clercq***

- Secretary Examencommissie Bachelor Fysica VUB
- President Examencommissie Master Fysica VUB
- Member Werkgroep samenwerking VUB-ULB Master Fysica
- Member Beroepscommissie AP VUB

### ***Olivier Devroede***

- Member PR "Commissie Wetenschappen"
- Member Vakgroepraad Fysica.

### ***Laurent Favart***

- Secrétaire Jury de Master en Physique de l'ULB
- Membre commission des doctorants

### ***Pierre Marage***

- Vice-president Centre de Culture scientifique de l'ULB à Charleroi - Parentville
- Membre du CA Altair, asbl d'Histoire des Sciences attachée à l'ULB
- Directeur de section Institut des Hautes Etudes de Belgique
- Membre du Conseil d'Administration Institut national des Radioelements, Fleurus

### ***Catherine Vander Velde***

- Chairperson Commission de selection des assistants du département de physique
- Representing the Dean of the Science Faculty Coordination des Actions Pédagogiques (CAP)
- Member Commission d'attribution des Crédits pédagogiques du Département de Physique

### ***Pascal Vanlaer***

- President ULB-VUB computing center user committee

### ***Pierre Van Mechelen***

- Member Bureau Onderwijscommissie Fysica
- Member Departementsraad Fysica
- Member Onderwijscommissie Fysica
- Member Onderwijscommissie Wiskunde
- Member Facultaire Selectiecommissie AAP

### ***Nick Van Remortel***

- Member Stuurgroep communicatie UA

## **X. REPRESENTATION IN SCIENTIFIC COUNCILS AND COMMITTEES**

### ***Daniel Bertrand***

- Member representative of the FNRS Aspera Steering Committee
- Member representative of the FNRS ApPEC Steering Committee
- Member of the C4 commission on Cosmic Rays of the International Union of Pure and Applied Physics (IUPAP)
- Member IIHE CERN fellows Belgian selection committee
- Member IIHE PAI governing board
- Member Belgium Astroparticle group of the OECD Global Science Forum
- Member Belgium SAC (Science Advisory Committee) of the Aspera Era-Net

### ***Barbara Clerbaux***

- Organisator Invited seminars at the IIHE

### ***Catherine De Clercq***

- Member FWO Expert Panel W&T2 Fysica
- Member IISN commission des Hautes et Basses Energies
- Member NIKHEF Scientific Advisory Committee
- Vice-president board of the IAP 6/11 Fundamental Interactions
- Representative of FWO in ASPERA Eranet Governing Board
- Member Belgian selection committee of CERN fellows
- Member organisation committee of the Belgian-Dutch-German summer school
- Representative of Belgium in Plenary ECFA
- Representative of the FWO in ApPEC steering committee
- Representative of VUB in Vlaamse Raad voor Wetenschapsbeleid- CFIS"

### ***Gilles De Lentdecker***

- Member ULB representative Belgian Physical Society

### ***Olivier Devroede***

- Member VSC technische werkgroep

### ***Laurent Favart***

- Member H1 executive committee
- Member SPS and PS experiments Committee

### ***Pierre Marage***

- Membre titulaire Comité national de Logique, de Philosophie et d
- Member FWO - Commissie E5 (Subatomaire Fysica)
- Co-organiser Ecole d'été Penser l'évolution, Penser la science, ULB

### ***Robert Roosen***

- Member Representative for Belgian groups H1 Collaboration board
- Member Belgian representative RecFa

### ***Pascal Vanlaer***

- Member ULB representative Consortium des équipements de calcul intensif

### ***Catherine Vander Velde***

- Member - FNRS - IISN - Hautes et basses énergies
- Member - Plenary European Committee of Future Accelerator (PECFA)
- Chairperson Belgium ACCU – CERN

**Walter Van Doninck**

- Member EPS HEPP Board
- Belgian Scientific Delegate CERN Council

**Nick Van Remortel**

- Member Interuniversity working group on future high energy experiments

## XI. TEACHING ACTIVITIES - ACADEMIC YEAR 2009-2010

**Daniel Bertrand**

- PHYS 105 "Stage de laboratoire" (0/0/75/0) 1ere licence en sciences physiques Full time
- PHYS-F-205 "Electromagnetisme" (36/0/0/12) BA2 Sciences biologiques/géologiques/géographiques Full time

**Peter Bruyndonckx**

- WE-DNTK-2118 "Medische Fysica" (13/13/0/0) 3BA Fysica VUB Full time

**Barbara Clerbaux**

- PHYS F416 "Interactions fondamentales et particules" (18/0/0/0) MA1 Full time
- PHYS-F-101 "Laboratoire du cours de Physique Générale" (0/30/0) BA1 Full time
- PHYS-F-436 "Stages de physique expérimentale des particules" (0/30/0) MA1 Full time

**Catherine De Clercq**

- WE-DNTK-9246 "Meten en Experimenteren" (responsable - 0/0/65) 1 BA Fysica VUB Full time,
- WE-DNTK-1998 "Elementaire Deeltjesfysica I" (26/0/26/0) 3 BA Fysica VUB Full time,
- WE-DNTK-12521 "Astroparticle physics" (13/13/0/0) Master fysica VUB Full time,
- WE-DNTK-13971 "Externe mobiliteit" (coordination) MA Physics Full time

**Gilles De Lentdecker**

- PHYS-F-314 "Electronics" (12/6/24/0) BA3 Part time
- PHYS-F-312 "Laboratoire de physique des particules" (0/0/60/0) BA3 Part time

**Olivier Devroede**

- "Informatica (modula 2)" (26) 1 BA Full time
- "Computervaardigheden" (60) 1 MA Full time
- "Mathematica" (12) 1 BA

**Laurent Favart**

- PHYS-F102 "Laboratoire de physique générale I et II" (0/0/24/0) BA1 Full time,
- PHYS-F477 "Physique auprès des collisionneurs hadroniques" (24/0/0/12) MA1-2 Full time.

**Kael Hanson**

- PHYS314 "Electronics for Physicists" (12 / 6 / 24 / 0) 2010 Full time,
- PHYS210 "Intermediate Laboratory" (0 / 0 / 48 / 0) 2010 Part time,
- PHYS101 "Intro Laboratory" (0 / 0 / 24) 2010 Part time,
- PHYS205 "Intro Laboratory" (0 / 0 / 24 / 0) 2010 Part time.

**Alexis Kalogeropoulos**

- BA3 "Statistical Physics" (0/24/24) Part time

**Pierre Marage**

- HIST-F-101 "Histoire des Sciences" (24/0/0/0) BA1 Full time
- PHYS-F-104 "Physique générale" (48/0/0/20) BA1 Full time



- HIST-F-500 "Histoire des Sciences et Epistémologie" (24/0/0/0) MA-didact., AESS Full time

## ***Benoît Roland***

- ROOT: an object-oriented HEP data analysis framework" (8) 2 Part time

## ***Robert Roosen***

- WE-DNTK-14315 "Subatomic Physics II" (15/0/0/15) 2010 Part time
- WE-DNTK-14538 "Elements of the History of Natural Sciences" (15/0/0/15) 2010 Part time
- WE-DNTK-1998 "Elementaire Deeltjesfysica I" (20) 3 BA Oefeningen

## ***Stefaan Tavernier***

- BNEN "Radiation protection and nuclear measurement" (12+12) Interuniversitaire Masteropleiding in Nuclear Engineering Full time
- WE-DNTK-2088 "Kernfysica en toepassingen" (13/13) 3BA Full time
- IR--12405 "Measurement techniques in nuclear and particle physics" (16/0/16/0) MA1 Biomedical engineering (UGent-VUB) Full time

## ***Laurent Thomas***

- PHYS-F-104 "Physique 1" (0/96/0/0) BA1 Full time

## ***Catherine Vander Velde***

- PHYS-F-510 "Didactique de la physique (du secondaire et du supérieur)" (36/0/0/12) AESS + MA1 physique Full time
- PHYS-F-443 "Travaux pratiques et stages" (0/0/12/36) AESS + MA1 physique Full time
- PHYS-F-511 "Travaux pratiques et stages" (0/0/0/36) AESS + MA2 physique Full time
- PHYS-F-103 "Physique" (36/0/0/20) BA1-Informatique Full time
- Coordinator "Objectif réussite - physique" (650) BA1-toutes sections Full time
- PHYS-F-305 "Introduction à la physique des particules - aspects expérimentaux" (24/0/12) BA3-physique Full time
- PHYS-F-101 "Physique générale I - Mécanique" (48/0/12) BA1-chimie, physique, mathématique et polyvalente en sciences Full time
- PHYS-F-420 "Méthodes expérimentales de la physique des particules" (12/0/0) MA2-physique Part time

## ***Walter Van Doninck***

- ELEM II "The Standard Model" (15 hours) 2008 Part time

## ***Nick Van Eijndhoven***

- Astroparticle Physics "Cosmic Rays and Gamma Ray Bursts" (8/8/0/0) 2010 Part time

## ***Pascal Vanlaer***

- PHYS-F104 "Physique générale - ondes et optique" (18/0/0/0) BA1 Full time
- PHYS-F205 "Physique générale 2 - électromagnétisme" (24/0/0/0) BA2 Full time
- PHYS-F102 "Laboratoires de physique générale" (0/0/36/0) BA1 Full time
- PHYS-FXXX "Laboratoires de physique générale - étudiants en chimie" (24/0/0/0) BA1 Full time
- PHYS-F420 "Détection de particules, acquisition et analyse de données, théorie, labos et exercices" (6/0/24/0) MA2 Full time

## ***Pierre Van Mechelen***

- 2BFYS-021 "Inleiding Relativiteitstheorie & Elementaire Deeltjes" (15/15/0/0) 2BA Full time
- 3BFYS-A-07 "Subatomaire fysica" (30/30/0/0) 3BA Full time
- MFYS1012 "Capita Selecta / Studentenseminarie" (30/0/0/0) Master Full time
- MFYS20241 "Accelerator physics" (30/0/0/30) Master Full time

**Petra Van Mulders**

- WE-DNTK-9246 "Meten en experimenteren" (0/0/40/40) 1BA Full time
- WE-DNTK-12058 "Statistiek voor fysici" (0/13/0/30) 1BA Full time

**Nick Van Remortel**

- 2BFYS-11 "Elektronica" (15/0/15/15) 2Bach Full time
- 1BFYS-101 "Inleiding tot programmeren" (30/0/30/15) 1Bach Full time
- GSNAFY01K00015 "Project computer simulation techniques" (5/0/40/25) Master Full time
- MFYS2012 "Computergestuurde Experimenten en Data Acquisitie" (10/0/20/10) Master Full time

**Mateusz Wedrowski**

- "Kernfysica en toepassingen" (0/13/0/0) 3BA Phys Full time

## XII. MASTER AND PHD THESES COMPLETED IN 2010

### XII.1 MASTER THESES

**David Alaluf**

- "Contribution à l'analyse des premières données de l'expérience CMS LHC" 18/05/2010 Promotor: Pascal Vanlaer

**Laurent Thomas**

- "Contribution à l'étude de la production de paires électron-positron à haute masse invariante au LHC " 25/05/2010 Promotor: Gilles De Lentdecker

**Gerrit Van Onsem**

- "Search for supersymmetric phenomena in the kinematics of top quark topologies at the LHC" 22/06/2010 Promotor: Jorgen D'Hondt

**Robbe Vansintjan**

- "Study of the sensitivity of the IceCube-40 neutrino detector for neutralino dark matter annihilations in the Sun" 22/06/2010 Promotor: Catherine De Clercq, co-promotor: Erik Strahler

### XII.2 PHD THESES

**Julie Delvax**

- "Etude de la production de jets en diffraction à HERA à l'aide du spectrometre à protons VFPS" 25/09/2010 Promotor: Laurent Favart

**Otman Charaf**

- "Study of the Drell-Yan production in the di-electron decay channel and search for new physics at the LHC.", 22/10/2010, Promotor: Barbara Clerbaux

**Mathieu Labare**

- "Search for cosmic sources of high energy neutrinos with the AMANDA-II detector", 26/01/2010, Promotor: Daniel Bertrand

**Joris Maes**

- "Estimation of the b-tag efficiency using top quarks at CMS", 04/11/2010, Promotor: Jorgen D'Hondt

**Alfio Rizzo**

- "Search for neutralino dark matter with 6 years of data of the AMANDA-II neutrino telescope", 21/12/2010, Promotor: Catherine De Clercq

**Rafaella Toncelli**

- "Le rôle des principes dans la construction des théories relativistes de Poincaré et Einstein." 23/12/2010, Promotor: P. Marage

**Petra Van Mulders**

- "Calibration of the jet energy scale using top quark events at the LHC", 28/06/2010, Promotors: Jorgen D'Hondt and Nick Van Remortel

**Mateusz Wedrowski**

- "Artificial neural network based position estimation in positron emission tomography", 16/12/2010, Promotors: Peter Bruyndonckx, Stefaan Tavernier

### XIII. SEMINARS AND ORAL PRESENTATIONS AT CONFERENCES, SCHOOLS AND COLLABORATION MEETINGS

#### XIII.1 SEMINARS AT THE IIHE (ORGANISED BY B. CLERBAUX)

- "Recent developments in laser wakefield acceleration", Arnd SPECKA, Laboratoire Leprince-Ringuet, Ecole Polytechnique CNRS/IN2P3,- Paris, France - 12/03/2010
- "Synchrotron light sources in Trieste and Data analysis in the Pierre Auger Observatory", Sophie FERRY, Sincrotrone - Trieste, Italy - 25/03/2010
- "High energy scattering at strong coupling from AdS/CFT: Progress and perils", Edmond IANCU, Service de Physique Théorique, CEA/DSM/Saclay - Paris, France - 29/04/2010
- "Decisive results of the BABAR experiment", Jacques Chauveau , LPNHE Université Pierre et Marie Curie - Paris-VI, France - 28/05/2010
- "The heavy ions program of the CMS experiment", Raphael Granier de Cassagnac, LLR - Ecole Polytechnique - Paris, France - 08/06/2010
- "Supernova Detection with the AMANDA/IceCube neutrino telescopes", Thomas Kowarik, Physics Institute- Mainz University, Germany - 18/06/2010
- "Solar neutrino spectroscopy results and cosmogenic backgrounds analysis with the Borexino detector", Davide D'Angelo, TUM, INFN-Milano, Italy - 22/10/2010
- "Hard diffractive scattering from soft color screening effect", Roman Pasechnik, Department of Physics and Astronomy - Uppsala, Sweden - 27/10/2010
- "Why are neutrinos different?", Jean-Marie Frère, ULB – Brussels - 01/12/2010
- "Dark matter in galaxies", Gianfranco Gentile,U Gent – Ghent - 06/12/2010
- "Observation of a first tau neutrino candidate event and current status of the OPERA neutrino oscillations experiment", Gaston Wilquet, ULB – Brussels - 14/12/2010

#### XIII.2 SEMINARS

**Freya Blekman**

- "Top quark physics at CMS", Split, Kroatia – 05/10/2010

**Kael Hanson**

- "Neutrino Astrophysics at the South Pole" Université Catholique de Louvain, Louvain-la-Neuve - 02/12/2010

## **Robert Roosen**

- "Geschiedenis van de Elementaire deeltjes" Ugent, Gent – 29/4/2010

## **Walter Van Doninck**

- "News from the Large Hadron Collider and the CMS experiment" IHEP, Beijing, China and Peking University, China - 5/2010

## **Nick Van Eijndhoven**

- "The Universe observed through a block of ice", Royal Flemish Academy of Belgium (KVAB), Brussel, Belgium - 09/06/2010
- "The Universe investigated in Detail", Vrije Universiteit Brussel, Brussel, Belgium - 02/3/2010
- "When Astrophysics, Particle Physics and Cosmology meet", Vrije Universiteit Brussel, Brussel, Belgium - 09/11/2010

## XIII.3 ORAL PRESENTATIONS AT CONFERENCES, SCHOOLS

### **Barbara Clerbaux**

- "Search for dark matter at CMS" - La Thuile, Italy 13-20/03/2010

### **Catherine De Clercq**

- "High Energy physics research in Belgium, from National Laboratory to IIHE", Universiteit Antwerpen, Antwerpen - 20/09/2010

### **Gilles De Lentdecker**

- "LCTPC DAQ status" - Paris, France 21/01/2010
- "Trigger and Data Acquisition at collider experiments" - Oostende, Belgium 14/09/2010
- "LCTPC DAQ status" - Hamburg, Germany 29/09/2010

### **Julie Delvax**

- "Diffraction with a Very Forward Proton Spectrometer at HERA" - IUAP-PAI Meeting, Anvers - 15/11/2010

### **Laurent Favart**

- "Deeply Virtual Compton Scattering and its Beam Charge Asymmetry in ep collisions at HERA" - DIS10 - Firenze - Italy - 20/04/2010
- "Physics at Accelerators" - RECFA Meeting - Brussels - 05/03/2010
- "Inclusive diffraction at HERA" - Diffraction 2010 - Otranto - Italy - 12/09/2010

### **Kael Hanson**

- "Radiofrequency Neutrino Detection and UHE Muons" - ARENA 2010, Nantes, France - 30/06/2010

### **Tomas Hreus**

- "Operation, performance of the VFPS at H1 and Measurement of inclusive diffractive deep inelastic scattering" - XVIII International Workshop on Deep-Inelastic Scattering and Related Subjects" Florence, Italy - 21/04/2010
- "Diffractive measurements in H1 using the VFPS", LOW X MEETING, Kavala, Greece - 24/06/2010

### **Xavier Janssens**

- "Diffractive Electroproduction of rho and phi Mesons at H1", DIS2010, Florence, Italy - 19/04/2010
- "Diffractive Physics at HERA", HCP2010, Toronto, Canada - 23/08/2010
- "Underlying event and jet reconstruction in CMS, for the CMS Collaboration", WISH2010, Catania, Sicily - 08/10/2010

- "Measurements of two-particle correlations in pp collisions with the CMS detector", ISMD2010, Antwerp, Belgium - 23/10/2010
- CMS results on long range correlations in high multiplicity events", MPI@LHC 2010, Glasgow, Scotland, UK - 30/11/2010

## **Joris Maes**

- "b-tag efficiency calibration with top quark events in CMS at LHC" - CERN, Geneva, Switzerland - 20/04/2010

## **Kentarou Mawatari**

- "Next-to-leading order SUSY pair productions in MadNLO/GOLEM" IIHE, Brussels - 07/10/2010
- "HELAS and MadGraph/MadEvent with gravitinos", ULB, Brussels - 05/11/2010
- "Gravitino phenomenology at the LHC" –UA, Antwerp - 15/11/2010
- "Gravitino phenomenology with MadGraph/MadEvent", IIHE, Brussels - 02/12/2010

## **Luca Mucibello**

- "The Underlying Event in pp Collisions at 900 GeV", QCD10, Montpellier, France - 28/06/2010
- "CMS results on underlying event structure", MPI@LHC 2010, Glasgow, Scotland, United Kingdom - 30/11/2010

## **Benoit Roland**

- "Observation of diffraction and Measurement of the transverse energy flow in a large eta range and forward jets with minimum bias triggers with CMS", PLHC2010, DESY, Hamburg, Germany - 11/06/2010
- "Forward physics at CMS", DIFF2010, Otranto, Italy - 2/09/2010

## **Romain Rougny**

- "Performance of CMS with first data", Madrid, Spain - 05/02/2010
- "Charged Hadron Spectra Measurement with the CMS detector in pp collisions at  $\sqrt{s} = 0.9, 2.36$  and 7 TeV", Montpellier, France - 28/06/2010

## **Shkelzen Rugovac**

- "Belgian High Energy Physics and the Grid", BEgrid Seminar, Brussels - 28/11/2010

## **Eric Strahler**

- "Searches for Signatures of Dark Matter with the IceCube Neutrino Telescope" - La Thuile, Italy 15/03/2010
- "Searches for Dark Matter in IceCube" - State College, PA, USA 01/07/2010
- "Searches for Dark Matter with the IceCube Neutrino Telescope" - Bonn, Germany 27/08/2010

## **Nick Van Eijndhoven**

- "IceCube : Catching Neutrinos at Antarctica" - Vrije Universiteit Brussel, Brussel, Belgium - 23/11/2010

## **Pierre Van Mechelen**

- "Forward QCD studies and prospects at the LHC", Seattle, US - 13/09/2010
- "Belgian activities in CMS", Brussels, Belgium - 05/03/2010

## **Petra Van Mulders**

- "JES calibration using ttbar events", CERN, Geneva, Switzerland - 02/03/2010

## **Nick Van Remortel**

- "CMS minimum bias results", WISH2010, Glasgow, Scotland, United Kingdom - 30/11/2010
- "Particle production in pp collisions at the LHC with CMS", MPI@LHC, Catania, Italy - 09/09/2010

### XIII.4 POSTER PRESENTATIONS AT CONFERENCES, WORKSHOPS AND SCHOOLS

***Yves Pierseaux***

- "From Special Relativity with Finite Interval to Steady State theory with Cosmological Constant", revue IIHE- 01/02/2010
- "From the Lorentz Transformation to the Hubble Law" - revue IIHE - 01/02/2010

***Romain Rougny***

- "Charged particle multiplicities in pp interactions at  $\sqrt{s} = 0.9, 2.36$  and  $7$  TeV" - Paris, France 22/07/2010

***Nick Van Remortel***

- "Charged particle multiplicities at  $\sqrt{s}=0.9, 2.36$  and  $7.0$  TeV with the CMS detector at LHC" , ICHEP2010, Paris, France - 21/07/2010

***Gaston Wilquet***

- "Lectures on Neutrino Physics: Neutrino Nature, Masses, Mixing and Oscillation" - Capita Selecta Series, VUB, Brussels, Belgium 06/04/2010

### XIII.5 PRESENTATIONS AT COLLABORATION MEETINGS

***Sabrina Bechet***

- "update for the tau to mu analysis" - Annapolis, USA 05/05/2011
- "update for the tau to mu analysis" - 21/09/2010

***Peter Bruyndonckx***

- "Nonlinear least squares modeling of the 3D interaction position in a monolithic scintillator block" - Crystal Clear Collaboration Meeting, CERN, 18/11/2010

***Barbara Clerbaux***

- "Z" searches in the di-electron and di-muon decay channels" - CERN 01/09/2010

***Julie Delvax***

- "Diffractive Dijets production using VFPS (status report)" - DESY, Hamburg 04/06/2010
- "Diffractive Dijets production using VFPS (status report)" - DESY, Hamburg 18/11/2010

***Marc Dierckxsens***

- "Outer Veto Reconstruction: Initial Thoughts" - Saclay, France 28/06/2010,
- "GENIE in IceSim" - Annapolis, Maryland, USA 04/05/2010,
- "GENIE in IceCube: Status Update" - Annapolis, Maryland, USA 06/05/2010,
- "GENIE Status Update" - Brussels, Belgium 21/09/2010, "Initial Look at Tau Analysis with IC59" - Brussels, Belgium 22/09/2010,
- "PID Working Group Status Update" - Nantes, France 25/11/2010.

***Kael Hanson***

- "ARA 2010-2011 Plans" - IceCube Collaboration Meeting, Brussels 21/09/2010
- "IceCube DAQ Status 2010" - IceCube Collaboration Meeting, Annapolis, MD USA 05/01/2010

***Mathieu Labare***

- "Time Stacking Method for the observation of GRB high energy neutrinos." - Brussels - 23/09/2010

***Joris Maes***

- "b-tag efficiency estimation with  $t\bar{t}$  events" - CERN, Geneva, Switzerland - 10/05/2010

## **Michael Maes**

- "Improved CRAB monitoring" - CMS Offline and Computing Workshop - 28/04/2010

## **Alfio Rizzo**

- "Search for neutralino dark matter with 6 years of data of AMANDA-II" – Annapolis, USA - 04/05/2010.

## **Robert Roosen**

- "VFPS: Calibration and t-measurement: Status report " - DESY-Hamburg, Germany - 19/10/2010

## **Eric Strahler**

- "New Solar WIMP Monte Carlo" - Brussels, Belgium 22/09/2010
- "IC59 Data Checks and Level 3 Preparation" - Annapolis, Maryland, USA 05/05/2010

## **Nick Van Eijndhoven**

- "Performance of the Direct Walk reconstruction" - Annapolis, Maryland, USA - 02/05/2010

## **Pascal Vanlaer**

- "K0 reconstruction study" - CERN, Geneva 10/12/2010

## **Pierre Van Mehelen**

- "The Castor detector: operations and first results" - Geneva, Switzerland - 17/11/2010

## **Mateusz Wedrowski**

- "New results in neural network based position determination" - Crystal Clear Collaboration Meeting, CERN 24/03/2010

## **XIV. SCIENTIFIC VULGARISATION AND OUTREACH ACTIVITIES**

### **Barbara Clerbaux**

- "Introduction to cosmology" - Oral presentation for undergraduate students at the masterclasses 30/01/2010
- "Introduction to cosmology" - Oral presentation for undergraduate students at the masterclasses 17/03/2010
- " CERN laboratory visit to MA1 ULB students 01-05/02/2010

### **Daniel Bertrand**

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

### **Freya Blekman**

- "Tour of ATLAS for school group from Amstelveen, The Netherlands" - CERN tour 07/12/010

### **Catherine De Clercq**

- "IceCube: neutrino's vangen op Antarctica" - workshop, Herfstkamp Wetenschappen 05/11/2010
- "IceCube en de zoektocht naar donkere materie" - Oral presentation MIRA sterrenwacht 23/01/2010
- "IceCube en de zoektocht naar donkere materie" - Oral presentation Vlaamse Vereniging voor Sterrenkunde 24/04/2010
- "Boodschappers uit de ruimte" - demo experiment Dag van de Wetenschap 21/11/2010

### **Gilles De Lentdecker**

- "Organizer" - Master Classes 31/01/2010
- "Organizer" - Master Classes 27/03/2010



**Kael Hanson**

- "Interview on glass engineering for IceCube experiment" - Journal Article - Interview : Journal Architectural Glass Concepts April 2010

**Thomas Hreus**

- "PC exercises supervision" - Master Class 15/02/2010

**Joris Maes**

- "The Large Hadron Collider" - VUB PhD Research day 28/05/2010

**Pierre Marage**

- "Les révolutions de la physique moderne" - Conférence, Mardis scientifiques, Aubagne (F) 19/05/2010

**Laurent Thomas**

- "Participation au Salon Service d'Information sur les Etudes et les Professions (Bruxelles)" - Lien avec l'enseignement secondaire 27/11/2010

**Catherine Vander Velde**

- "Master classe de physique des particules" - Master classe 23/02/2008
- "Erreurs de mesure et ressort" - Encadrement de laboratoire pour les lauréats des olympiades de physique 27/03/2010
- "<http://www.ulb.ac.be/actulb/podcast.php?pc=568>" - podcast de la recherche à l'ULB 01/04/010

**Walter Van Doninck**

- "Guide" - CMS Visits many

**Nick Van Eijndhoven**

- "Science in the focus" - Oral presentation 23/11/2010

**Pierre Van Mechelen**

- "Meesterklas Deeltjesfysica" - Masterclass 27/02/2010
- "Van quarks tot grote oerknal" - Science week 26/11/2010
- "Start to Know: Kosmologie" - Oral presentation at book fair Antwerpen 04/11/2010

**Petra Van Mulders**

- "Info verstrekken aan toekomstige studenten Natuurkunde" - Infodag VUB 04/09/2010

**Nick Van Remortel**

- "Oerknallers! Kinderuniversiteit UA" - Oral presentation, workshop 07/03/2010
- "Zoeken naar nieuwe fysica met de Large hadron Collider, Kekule XIII" - Oral presentation 09/03/2010
- "De fundamentele wetten van de fysica onderuit gehaald met de Large Hadron Collider, Vlaams Congres" - Oral presentation 20/11/2010
- "12 jaar onderzoek met de grootste deeltjesversnellers ter wereld, Alumni avond dept Fysica UA" - Oral presentation 09/12/2010

## **XV. ATTENDANCE TO CONFERENCES, WORKSHOPS AND SCHOOLS**

### **XV.1 CONFERENCES AND WORKSHOPS**

**Sabrina Bechet**

- "IceCube Collaboration Spring Meeting", Annapolis Oral presentation - 03-07/05/2010
- "IceCube Fall Collaboration Meeting", Brussels Oral presentation - 20-23/09/2010
- "IAP meeting", Anvers - 09/11/2010

## **Daniel Bertrand**

- "Science Advisory Committee ASPERA II", Berlin (Germany) - 22-23/11/2010
- "OECD Global Science Forum on Astroparticles", Mumbai (India) – 15-16/01/2010
- "Science Advisory Committee ASPERA II", Paris (France) – 12-13/04/2010
- "OECD Global Science Forum on Astroparticles", - 02-03/09/2010
- "Eurocosmics Workshop", CERN-Geneva (Switzerland) - 15/10/2010
- "IceCube Collaboration meeting", Baltimore (USA) – 03-07/05/2010
- "IceCube Collaboration meeting", Brussels (Belgium) Conference organisation Session chair-person - 20-23/09/2010

## **Freya Blekman**

- "CMS week", CERN - 29/11-10/12/010

## **Stijn Blyweert**

- "CMS Physics Days", CERN, Geneva, Switzerland – 22-26/02/2010
- "CMS Physics Week", CERN, Geneva – 17-20/05/2010
- "CMS Physics Days", CERN, Geneva - 18-21/10/2010
- "Top 2010", Bruges - 31/05-04/06/2010
- "CMS Week", CERN, Geneva, Switzerland 06-10/12/2010

## **Debanjan Bose**

- "IceCube Spring Collaboration Meeting", Annapolis, Maryland, United States of America – 02-08/05/2010

## **Barbara Clerbaux**

- "GDR - Terascale", ULB - Brussels Session organizer Session title: Alternative to SUSY Session chair-person – 03-05/11/2010
- "CMS exotica workshop", ULB - Brussels Conference organisation – 14-15/10/2010
- "The 45th rencontres de Moriond - cosmology session", La Thuile, Italy Oral presentation – 13-20/03/2010
- "CMS week", CERN – 07-09/12/2010
- "CMS Jamboree", CERN Oral presentation – 01-02/09/2010
- "PAI meeting", ULB - Brussels - 08/04/2010

## **Catherine De Clercq**

- "Colloquium Prof. Dr. Eddi De Wolf", Universiteit Antwerpen Oral presentation - 20/09/2010
- "Experimenteren in het onderwijs wetenschappen", Université Libre de Bruxelles - 03/02/2010

## **Gilles De Lentdecker**

- "IEEE Real Time Conference", Lisbon, Portugal - 24-28/05/2010
- "ILDWS Workshop 2010", Paris, France Oral presentation - 24-28/01/2010
- "Eudet Annual Meeting", Hamburg, Germany - Oral presentation - 29/09-01/10/2010

## **Julie Delvax**

- "DIS", Florence, Italie – 19-23/04/2010

## **Olivier Devroede**

- "HEPiX Spring 2010 Workshop", Lisbon, Portugal – 19-23/04/2010
- "CMS Offline and Computing Workshop", Geneva, Switzerland - 27-29/04/2010

## **Marc Dierckxsens**

- "Double Chooz Collaboration Meeting", Chooz, France - 10-12/02/2010
- "IceCube Collaboration Meeting", Annapolis, Maryland - Oral presentation - 03-07/05/2010

- "Double Chooz European Analysis Cluster Meeting", Saclay, France - Oral presentation - 28-29/06/2010
- "IceCube Collaboration Meeting", Brussels, Belgium - Oral presentation - 20-23/09/2010
- "IUAP Meeting - Fundamental Interactions", Antwerp, Belgium - Oral presentation - 15/11/2010
- "Double Chooz European Analysis Cluster Meeting", Nantes, France Oral presentation - 24-25/11/2010

## ***Laurent Favart***

- "XVIIIth International workshop on Deep-Inelastic Scattering (DIS 2010)", Firenze - Italy Oral presentation Session chair-person – 19-23/04/2010
- "Diffraction 2010", Otranto - Italy Oral presentation Session chair-person – 10-15/09/2010

## ***Rebeca Gonzalez Suarez***

- "II CPAN days", Valencia (Spain) Oral presentation – 29-30/11/2010

## ***Phillip Grajek***

- "Mad Graph 2010: BSM and more", IIHE – 04-08/10/2010

## ***Kael Hanson***

- "4th International Workshop on Acoustic and Radio EeV Neutrino Detection Activities (ARENA 2010)", Nantes, France Oral presentation - 29/06-02/07/2010

## ***Tomas Hreus***

- "XVIII International Workshop on Deep-Inelastic Scattering and Related Subjects", Convitto della Calza, Firenze, Italy Oral presentation – 19-23/04/2010
- "LOW X MEETING", KAVALA, GREECE Oral presentation - 23-27/06/2010
- "60th Meeting of Nobel Laureates", Lindau, Germany - 27/06-02/07/2010

## ***Xavier Janssens***

- "DIS10, XVIII International Workshop on Deep Inelastic Scattering and Related Subjects", Florence, Italy Oral presentation – 19-23/03/2010
- "Hadronic Collider Physics 2010", Toronto, Ontario, Canada Oral presentation – 23-27/08/2010
- "WISH 2010, International Workshop on Interplay between Soft and Hard interactions in particle product", Catania, Italy Oral presentation – 08-10/09/2010
- "40th edition of the International Symposium on Multiparticle Dynamics (ISMD 2010)", Antwerpen, Belgium Oral presentation Conference organisation Session chair-person – 21-25/09/2010
- "MPI@LHC 2010: 2nd International Workshop on Multiple Partonic Interactions at the LHC", Glasgow, Lanarkshire, United Kingdom Oral presentation - 29/11-03/12/2010
- "IUAP meeting", Brussels, Belgium Oral presentation - 08/04/2010
- "IUAP meeting", Antwerpen, Belgium Oral presentation - 15/11/2010

## ***Alexis Kalogeropoulos***

- "CMS Physics Days", CERN / Geneva – 22-26/03/2010
- "CMS Trigger Days", CERN / Geneva – 18-21/10/2010
- "CMS Week", CERN / Geneva – 02-12/12/2010
- "CMS Week", CERN / Geneva – 6- 9/12/2010

## ***Mathieu Labare***

- "IceCube Collaboration Meeting", Brussels Oral presentation – 20-24/09/2010
- "IceCube-Antares Collaboration Meeting", Paris, France – 24-25/09/2010
- "IceCube Collaboration Meeting", Annapolis, MD, USA – 03-07/05/2010

## ***Joris Maes***

- "Top Quark Meeting", CERN, Geneva, Switzerland Oral presentation - 20- 21/04/2010
- "b-tag POG meeting", CERN, Geneva, Switzerland Oral presentation – 10-1/05/2010

- "TOP 2010 - 3rd International Workshop on Top Quark Physics", Brugge, Belgium Oral presentation - 30/05-04/06/2010

## **Michael Maes**

- "CMS Physics days", CERN, Geneva, Switzerland - 22-26/2/2010
- "CMS Physics days", CERN, Geneva, Switzerland - 17- 20/05/2010
- "CMS Physics days", CERN, Geneva, Switzerland - 18-21/10/2010
- "3rd International Workshop on Top Quark Physics", Brugge - 31/05-04/06/2010
- "CMS December week", CERN, Geneva, Switzerland - 6-10/12/2010
- "Bezoek CERN met studenten", CERN, Geneva, Switzerland - 18-19/12/2010
- "CMS Physics week", CERN, Geneva, Switzerland - 07-11/02/2011

## **Pierre Marage**

- "18th International Workshop on Deep-Inelastic Scattering and QCD – DIS10", Firenze - Italy Conference organization, Session chair-person - 20-24/04/2010
- "XL Int. Symposium on Multiparticle Dynamics", Antwerp, Belgium Conference organisation Session chair-person - 21-25/09/2010

## **Kentarou Mawatari**

- "MadGraph 2010 : BSM and more", IIHE Oral presentation Conference organisation Session chair-person - 04-08/10/2010
- "GDR Terascale", ULB Oral presentation Session organizer Session title: Methods and Tools Session chair-person - 03-05/11/2010
- "IUAP meeting", Antwerp Oral presentation - 15/11/2010
- "Gauge mediated supersymmetry breaking workshop", IIHE Oral presentation Conference organisation - 02-03/12/2010

## **Luca Mucibello**

- "MPI@LHC 2010, 2nd International Workshop on Multiple Partonic Interactions at the LHC", Glasgow, Lanarkshire (United Kingdom) Oral presentation - 29/11-03/12/2010
- "QCD10, Quantum Chromo-Dynamics 2010", Montpellier, France Oral presentation - 28/06-03/07/2010

## **Bettina Oehl**

- "GDR Terascale", ULB - 03-05/11/2010
- "Gauge mediated supersymmetry breaking workshop", IIHE - 02/12/2010
- "IUAP meeting", Antwerp - 15/11/2010

## **Benoit Roland**

- "XVIII International Workshop on Deep-Inelastic Scattering and Related Subjects (DIS 2010)", Florence (Italy) - 19-3/04/2010
- "PLHC2010: Physics at the LHC 2010", DESY, Hamburg (Germany) Oral presentation - 07-12/06/2010
- "DIFF2010: International Workshop on Diffraction in High-Energy Physics", Otranto (Italy) Oral presentation - 10-15/09/2010

## **Romain Rougny**

- "SLHC-PP -2010", Madrid, Spain Oral presentation - 04-05/02/2010
- "CMS Week", CERN, Geneva Oral presentation - 14-19/03/2010
- "QCD10", Montpellier, France Oral presentation - 28/06-03/07/2010
- "ICHEP2010", Paris, France Poster - 21-28/07/2010
- "ISMD2010", Antwerpen, Belgium - 21-25/09/2010
- "Colloquium in honor of Prof. Eddi De Wolf", Antwerpen, Belgium - 20/09/2010
- "IUAP meeting", Antwerpen, Belgium - 25/11/2010

## ***Michele Selvaggi***

- "GDR Terascale@Brussels, 3-5 Nov 2010", Brussels, Belgium, Oral presentation – 03-05/11/2010

## ***Eric Strahler***

- "IceCube Fall Collaboration Meeting", Brussels, Belgium Oral presentation – 20-24/09/2010
- "IceCube Spring Collaboration Meeting", Annapolis, Maryland, USA Oral presentation – 03-07/05/2010
- "SUSY 10", Bonn, Germany Oral presentation – 23-28/08/2010
- "45th Rencontres de Moriond", La Thuile, Italy Oral presentation – 13-20/03/2010
- "Novel Searches for Dark Matter with Neutrino Telescopes", Columbus, OH, USA – 05-06/07/2010
- "2nd Workshop on 'Low Energy' Neutrino Physics and Astrophysics with IceCube's DeepCore Sub-Array", State College, PA, USA Oral presentation – 01-02/07/2010
- "Internal DeepCore Workshop 2010", State College, PA, USA Oral presentation – 29-30/06/2010

## ***Stefaan Tavernier***

- "ClearPEM Collaboration Meeting" Lisboa, Portugal – 28/1/2010
- "Crystal Clear Collaboration Meeting", CERN, Geneva, Switzerland - 25-26/3/2010
- "Crystal Clear Collaboration Workshop on future directions in crystal research". St Cyr sur Mer, France 23-24/9/2010
- "NSS/MIC IEEE Meeting", Knoxville, Tennessee, USA – 31/10-6/11/2010
- "Crystal Clear Collaboration Meeting", CERN, Geneva, Switzerland - 17-18/11/2010

## ***Laurent Thomas***

- "CMS week", CERN – 07-09/12/2010

## ***Edwin Torisaen***

- "Belnet - Security conference", Brussels Oral presentation Poster - 06/05/2010

## ***Frederik Van Der Veken***

- "IUAP on Fundamental Interactions", Antwerp - 15/11/2010.

## ***Catherine Vander Velde***

- "Top2010 - International Workshop on Top Quark Physics", Conference organization, Bruges - Belgium - 30/05-04/06/2010

## ***Nick Van Eijndhoven***

- "Annual meeting of the Belgian Physical Society", Utrecht, The Netherlands Oral presentation - 23/04/2010 to 23/04/2010,
- "IIHE annual meeting", Anhee, Belgium Oral presentation – 29-30/10/2010
- "IUAP annual meeting", Antwerp, Belgium Oral presentation - 15/11/2010
- "Night of the Researcher", Rotterdam, The Netherlands Oral presentation - 24/09/2010
- "BND Graduate school", Ravelingen, Belgium Conference organisation Session chair-person – 06-17/09/2010

## ***Pascal Vanlaer***

- "3rd International Workshop on Top Quark Physics", Bruges - 31/05-04/06/2010
- "International Symposium on Multiparticle Dynamics", Antwerpen – 21-25/09/2010

## ***Pierre Van Mechelen***

- "International Symposium on Multiparticle Dynamics", Antwerp, Belgium Oral presentation Conference organisation Session chair-person - 21-25/09/2010
- "INT Workshop on Perturbative and Non-Perturbative Aspects of QCD at Collider Energies", Seattle, US Oral presentation – 13-17/09/2010

## ***Petra Van Mulders***

- "Hadron Collider Physics Symposium", Toronto, Canada – 23-27/08/2010
- "ECFA meeting", Brussels, Belgium Oral presentation - 05/03/2010
- "VUB PhD Research Day", Brussels, Belgium Poster - 28/05/2010

## ***Ilaria Vilella***

- "TOP2010 3rd International Workshop on Top Quark Physics", Bruges, Belgium Poster - 31/05-04/06/2010

## ***Mateusz Wedrowski***

- "52nd Crystal Clear Collaboration Meeting", CERN, Geneva Oral presentation – 08-09/03/2010

## ***Gaston Wilquet***

- "XXIV International Conference on Neutrino Physics and Astrophysics", Athens, Greece - 14/06/2010

## **XV.2 SCHOOLS**

### ***Stijn Blyweert***

- "BND Summer School 2010" Oostende – 06-17/09/2010

### ***Kael Hanson***

- "Journées Jeunes Chercheurs 2010" Angers, France – 21-27/11/2010

### ***Alexis Kalogeropoulos***

- "BND Summer School 2010" Oostende – 06-17/09/2010

### ***Bettina Oexl***

- "Amsterdam-Brussel-Paris Doctoral School" ULB - 11-15/10/2010

### ***Romain Rougny***

- "BND Summer School" Oostende, Belgium – 06- 17/09/2010

### ***Michele Selvaggi***

- "MCNet-Cteq Summer School" Lauterbad , Germany - 24/07-04/08/2010

### ***Laurent Thomas***

- "BND Graduate School" Ravelingen – 06-17/09/2010

## **XVI. RESPONSIBILITIES IN EXPERIMENTS**

### ***Daniel Bertrand***

- Member IceCube Collaboration Board
- Member IceCube Executive committee

### ***Freya Blekman***

- Member CMS Collaboration board advisory group
- top group T2 data manager CMS top physics group

### ***Barbara Clerbaux***

- Chairperson CMS Exotica high pt electron group
- Responsible CMS CMS tracker geometry validation

## ***Catherine De Clercq***

- Principal Investigator for VUB IceCube Collaboration Board
- member IceCube Spokesperson Search Committee

## ***Gilles De Lentdecker***

- Monte Carlo production CMS DataOps
- Leader of the LCTPC DAQ Working Group

## ***Marc Dierckxsens***

- Co-leader Double Chooz Particle Identification Working Group

## ***Laurent Favart***

- Member of the H1 executive committee

## ***Kael Hanson***

- Data Acquisition Lead IceCube Data Acquisition Group
- Ex Officio Member IceCube TFT Board
- Member IceCube Supernova Working Group
- Member IceCube Detector Operations
- Member IceCube Resource Coordination Board
- Member IceCube Low Energy Working Group
- Lead ARA Computing

## ***Tomas Hreus***

- Member H1 Diffractive Working Group
- Member CMS Tracking Group

## ***Alexis Kalogeropoulos***

- Tracker Swifter CMS DQM SiStrip MuonHLT
- Member CMS Generators Group MadGraph Coordinator

## ***Pierre Marage***

- Member CMS Publication Committee + chair of internal referee committee (ARC) for 6 analyses

## ***Benoit Roland***

- MonteCarlo Generator contact person CMS Forward Physics Analysis Group
- member CMS Forward Physics Analysis Group
- Cascade Interface Responsible CMS Forward Physics Analysis Group

## ***Robert Roosen***

- Internal Referee H1 diffraction
- member H1 Collaboration Board

## ***Eric Strahler***

- Member IceCube WIMP working group
- Coordinator IceCube Offline Data Processing

## ***Stefaan Tavernier***

- spokesperson of the Crystal Clear collaboration ( till November)
- member of the finance board of CMS
- member of the tracker finance board in CMS
- member cerimed executive committee
- member IEEE nuclear science and medical imaging council



***Pascal Vanlaer***

- Tier-2 representative CMS Computing
- Tier-2 representative W-LCG W-LCG
- EWK W/Z cross-section analysis review committee CMS ARC
- Coordinator of tracker DQM developments for Belgium CMS Tracker operations

***Catherine Vander Velde***

- Member CMS Management Board
- Member CMS Collaboration Board
- Member CMS Finance Board
- Member CMS Tracker Institution Board
- Member CMS Tracker Finance Board
- Member CMS Analysis Review Committee (1 paper)

***Walter Van Doninck***

- coordinator CMS Muon FW RPC

***Nick Van Eijndhoven***

- Coordinator of first guess reconstruction algorithms IceCube Muon and DeepCore working group
- Member IceCube Muon working group
- Member IceCube Gamma Ray Burst working group
- Member IceCube Low Energy (DeepCore) working group
- Member IceCube Low level data quality check team
- Deputy member IceCube Collaboration board
- Member IceCube Point source working group
- Coordinator model-independent (time stacking) analyses IceCube Transient phenomena team

***Gaston Wilquet***

- Chairperson OPERA Collaboration Board
- Member OPERA Editorial Board
- Member OPERA Analysis Advisory Board

## XVII. MEMBERSHIP IN ACADEMIC JURY'S

***Daniel Bertrand***

- Doctorat ULB Mathieu Labare "Search for Cosmic sources of high energy neutrinos with the AMANDA-II detector"– Promotor, Member

***Freya Blekman***

- Ph.D. VUB Joris Maes "b-tag efficiency from top events" - Member

***Barbara Clerbaux***

- Ph. D. thesis jury ULB Otman Charaf "Study of the Drell-Yan production in the dielectron decay channel and search for new physics at the LHC" - Promotor

***Gilles De Lentdecker***

- Thesis Jury VUB Joris Maes "Estimation of the b-tag efficiency using top quarks at CMS" - Member

***Olivier Devroede***

- Master Thesis Vrije Universiteit Brussel Lynx Lean "Complex network dynamics of coupled nonlinear oscillators" - Member

## ***Kael Hanson***

- Ph.D. ULB Mathieu Labare "Search for cosmic source of high-energy neutrinos with the AMANDA-II detector" - Secretary
- Ph.D. Université de Mons Georges Kohnen "First Steps to Search for Extra Dimensions with IceCube" Member
- Ph.D. Université de Paris XI Selma Conforti di Lorenzo "Développement et caractérisation d'un ASIC de lecture de macrocellule de photo-détecteurs de grande" Member

## ***Alexis Kalogeropoulos***

- MSc VUB Gerrit Van Onsem "Search for supersymmetric phenomena in the kinematics of top quark topologies at the LHC" - Member

## ***Robert Roosen***

- PhD VUB/UA Petra Van Mulders "Calibration of the jet energy scale using top quark events at the LHC": - President
- PhD VUB/UG Frederik de Roo "Geometrical Resolution of Spacetime Singularities" Secretary
- PhD ULB Julie Delvax "Etude de la production de jet en diffraction a HERA, a l'aide du spectrometre VFPS"-: - Member
- PhD VUB Joris Maes "Estimation of the b-tag efficiency using top quarks at CMS" - President
- BPS UA Hans Van Haeve "Castor Ontwikkeling van reconstructie software ene/pi separatie analyse" - Member
- Master VUB Gerrit Van Onsem "Search for supersymmetric phenomena in the kinematics of top quark topologies at the LHC" - Member

## ***Eric Strahler***

- Master's Thesis Defense Vrije Universiteit Brussel Robbe Vansintjan "Study of the sensitivity of the IceCube-40 neutrino detector for neutralino dark matter annihilation" – Promotor, Member

## ***Catherine Vander Velde***

- PhD thesis ULB "Study of Drell-Yan production in the di-electron decay channel and search for new physics at LHC" - Member

## ***Nick Van Eijndhoven***

- PhD thesis VUB and UGent Frederix De Roo "Geometrical Resolution of Spacetime Singularities" - Member
- PhD thesis VUB Alfio Rizzo "Search for neutralino dark matter with 6 years of data of the AMANDA-II neutrino telescope" – Secretary, Member
- MSc thesis VUB Robbe Vansintjan "Study of the sensitivity of the IceCube-40 neutrino detector for neutralino dark matter annihilation" - Member
- MSc thesis Utrecht University Dennis Diederix "Model Independent Search for Neutrinos from Gamma Ray Bursts with the IceCube Detector"- Promotor, Member
- BSc thesis Utrecht University Irene Polderman "First Commissioning of a nearly completed IceCube Detector" – Promotor, Member

## ***Nick Van Remortel***

- Ph.D. Jury UCL Simon De Visscher "Observability of an unconventional two-Higgs doublet model at the LHC" - Member
- Ph.D. Jury VUB UA Petra Van Mulders "Calibratie van de jet energie met behulp van top quark gebeurtenissen aan de LHC" - Promotor
- Ph.D. Jury UCL Loïc Quertenmont "Search for Heavy Stable Charged Particles with the CMS detector at the LHC" - Member

**Gaston Wilquet**

- PhD thesis Université Libre de Bruxelles Mathieu Labare "Search for cosmic sources of high energy neutrinos with the AMANDA-II detector" - Member

## XVIII. LIST OF PUBLICATIONS, REPORTS AND CONTRIBUTIONS TO CONFERENCES

### XVIII.1 PUBLICATIONS

#### A. NEUTRINO PHYSICS: OPERA

Measurement of the atmospheric muon charge ratio with the OPERA detector

The OPERA Collaboration, N. Agafonova et al.

Eur. Phys. J. C 67 (2010) 25–37

Observation of a first  $\nu_\tau$  candidate event in the OPERA experiment in the CNGS beam

The OPERA Collaboration, N. Agafonova et al

Phys. Lett. B 691 (2010) 138-145

#### B. NEUTRINO PHYSICS : ICECUBE

Search for Muon Neutrinos from Gamma-Ray Bursts with the IceCube Neutrino Telescope.

R. Abbasi *et al.*, IceCube Collaboration

Astrophysical Journal **710** (2010) 346-359.

Time-Dependent Point Source Search Methods in High Energy Neutrino Astronomy.

J. Braun *et al.*, IceCube Collaboration

Astroparticle Physics **33** (2010) 175-181.

Search for a Lorentz-violating sidereal signal with atmospheric neutrinos in IceCube.

R. Abbasi *et al.*, IceCube Collaboration

Physical Review **D82** (2010) 112003.

The first search for extremely-high energy cosmogenic neutrinos with the IceCube Neutrino Observatory.

R. Abbasi *et al.*, IceCube Collaboration

Physical Review **D82** (2010) 072003.

Search for relativistic magnetic monopoles with the AMANDA-II neutrino telescope.

R. Abbasi *et al.*, IceCube Collaboration

European Physical Journal **C69** (2010) 361.

The IceCube neutrino observatory.

R. Abbasi *et al.*, IceCube Collaboration

International Journal of Modern Physics **D19** (2010) 1041.

Measurement of the Anisotropy of Cosmic Ray Arrival Directions with IceCube.

R. Abbasi *et al.*, IceCube Collaboration

Astrophysical Journal **718** (2010) L194.

The Energy Spectrum of Atmospheric Neutrinos between 2 and 200 TeV with the AMANDA-II Detector.

R. Abbasi *et al.*, IceCube Collaboration

Astroparticle Physics **34** (2010) 48.

Calibration and Characterization of the IceCube Photomultiplier Tube.

R. Abbasi *et al.*, IceCube Collaboration

Nuclear Instruments and Methods **A618** (2010) 139.

Limits on a Muon Flux from Kaluza-Klein Dark Matter Annihilations in the Sun from the IceCube 22-string Detector.

R. Abbasi *et al.*, IceCube Collaboration

Physical Review **D81** (2010) 057101.

Measurement of Sound Speed vs Depth in South Pole Ice for Neutrino Astronomy.

R. Abbasi *et al.*, IceCube Collaboration

Astroparticle Physics **33** (2010) 277.

### **C.      EP PHYSICS : H1**

Inelastic Production of J/psi Mesons in Photoproduction and Deep Inelastic Scattering at HERA

By H1 Collaboration (F.D. Aaron et al.) DESY-09-225

Eur.Phys.J. C68 (2010) 401 , 02/10

Measurement of Leading Neutron Production in Deep-Inelastic Scattering at HERA

By H1 Collaboration (F.D. Aaron et al.) DESY-09-185

Eur.Phys.J. C68 (2010) 381

Measurement of the D\* Meson Production Cross Section and F2CC, at High Q<sup>2</sup>, in ep Scattering at HERA  
DESY-09-165

Jet Production in ep Collisions at Low Q<sup>2</sup> and Determination of alpha<sub>s</sub>

By H1 Collaboration (F.D. Aaron et al.) DESY-09-162

Eur.Phys.J. C67 (2010) 1

Combined Measurement and QCD Analysis of the Inclusive ep Scattering Cross Sections at HERA

By H1 and ZEUS Collaboration (F.D. Aaron et al) DESY-09-158

JHEP01 (2010) 109

Events with an Isolated Lepton and Missing Transverse Momentum and Measurement of W Production at HERA

By H1 and ZEUS Collaboration (F.D. Aaron et al) DESY-09-140

JHEP03 (2010) 035

Prompt Photons in Photoproduction at HERA

By H1 Collaboration (F.D. Aaron et al.) DESY-09-135

Eur.Phys.J. C66 (2010) 17

Deeply Virtual Compton Scattering and its Beam Charge Asymmetry in e<sup>+</sup>p Collisions at HERA

By H1 Collaboration (F.D. Aaron et al.) DESY-09-109

Phys. Lett. B 681 (2009), pp. 391-399

Measurement of the Charm and Beauty Structure Functions using the H1 Vertex Detector at HERA

By H1 Collaboration (F.D. Aaron et al.) DESY-09-096

Eur.Phys.J. C65 (2010) 89

Diffraction Electroproduction of rho and phi Mesons at HERA  
By H1 Collaboration (F.D. Aaron et al.) DESY-09-093  
JHEP05 (2010) 032

Jet Production in ep Collisions at High  $Q^2$  and Determination of  $\alpha_s$   
By H1 Collaboration (F.D. Aaron et al.). DESY-09-032  
Eur.Phys.J.C65 (2010) 363

#### ***D.      E+ E- PHYSICS : DELPHI***

Measurements of CP-conserving trilinear gauge boson couplings  $WWV$  ( $V = \gamma, Z$ ) in  $e^+e^-$  collisions at LEP2.  
By DELPHI Collaboration (J. Abdallah et al.)  
Eur.Phys.J.C66:35-56,2010

Study of the dependence of direct soft photon production on the jet characteristics in hadronic  $Z^0$  decays.  
By DELPHI Collaboration (J. Abdallah et al.)  
Eur.Phys.J.C67:343-366,2010

#### ***E.      P-P PHYSICS : CMS***

Upsilon production cross section in pp collisions at  $\sqrt{s} = 7$  TeV  
By CMS Collaboration, arXiv:1012.5545 ; CERN-PH-EP-2010-055 ; CMS-BPH-10-003. - 2010. - 42 p., to be published

Search for Pair Production of Second-Generation Scalar Leptoquarks in pp Collisions at  $\sqrt{s} = 7$  TeV  
By CMS Collaboration, arXiv:1012.4033 ; CMS-EXO-10-007 ; CERN-PH-EP-2010-054. - 2010. - 24 p., to be published

Search for Pair Production of First-Generation Scalar Leptoquarks in pp Collisions at  $\sqrt{s} = 7$  TeV  
By CMS Collaboration", arXiv:1012.4031 ; CERN-PH-EP-2010-052 ; CMS-EXO-10-005. - 2010. - 24 p., to be published

Search for Microscopic Black Hole Signatures at the Large Hadron Collider  
By CMS Collaboration, arXiv:1012.3375 ; CMS-EXO-10-017 ; CERN-PH-EP-2010-073. - 2010. - 26 p., to be published

Measurement of the Isolated Prompt Photon Production Cross Section in pp Collisions at  $\sqrt{s} = 7$  TeV  
By CMS Collaboration, arXiv:1012.0799 ; CERN-PH-EP-2010-053 ; CMS-QCD-10-019. - 2010. - 26 p., to be published

Charged particle multiplicities in pp interactions at  $\sqrt{s} = 0.9, 2.36$ , and 7 TeV  
By CMS Collaboration, arXiv:1011.5531 ; CERN-PH-EP-2010-048 ; CMS-QCD-10-004. - 2010. - 36 p., to be published

Prompt and non-prompt J/psi production in pp collisions at  $\sqrt{s} = 7$  TeV  
By CMS Collaboration, arXiv:1011.4193 ; CERN-PH-EP-2010-046 ; CMS-BPH-10-002. - 2010. - 38 p., to be published

First Measurement of the Cross Section for Top-Quark Pair Production in Proton-Proton Collisions at  $\sqrt{s} = 7$  TeV  
By CMS Collaboration, arXiv:1010.5994; CERN-PH-EP-2010-039; CMS-TOP-10-001.- Geneva : CERN, 2010 - 26 p., to be published

Search for Quark Compositeness with the Dijet Centrality Ratio in pp Collisions at  $\sqrt{s} = 7$  TeV  
By CMS Collaboration, arXiv:1010.4439; CERN-PH-EP-2010-038; CMS-EXO-10-002.- 24 p., Phys. Rev. Lett. 105 (2010) 262001

Search for Dijet Resonances in 7 TeV pp Collisions at CMS  
By CMS Collaboration, arXiv:1010.0203; CERN-PH-EP-2010-035; CMS-EXO-10-010.- 26 p., Phys. Rev. Lett. 105 (2010) 211801

Observation of Long-Range, Near-Side Angular Correlations in Proton-Proton Collisions at the LHC  
By CMS Collaboration, arXiv:1009.4122; CERN-PH-EP-2010-031; CMS-QCD-10-002.- 36 p. J. High Energy Phys. 09 (2010) 091

CMS Tracking Performance Results from Early LHC Operation  
By CMS Collaboration, arXiv:1007.1988; CERN-PH-EP-2010-019; CMS-TRK-10-001.- 29 p. Eur. Phys. J. C 70 (2010) 1165

First Measurement of the Underlying Event Activity at the LHC with  $\sqrt{s} = 0.9$  TeV  
By CMS Collaboration, arXiv:1006.2083; CMS-QCD-10-001; CERN-PH-EP-2010-014.- 30 p. Eur. Phys. J. C 70 (2010) 555-572

Measurement of the charge ratio of atmospheric muons with the CMS detector  
By CMS Collaboration, arXiv:1005.5332; CMS-MUO-10-001; CERN-PH-EP-2010-011.- 32 p. Phys. Lett. B 692 (2010) 83-104

Transverse-momentum and pseudorapidity distributions of charged hadrons in pp collisions at  $\sqrt{s} = 7$  TeV  
By CMS Collaboration, arXiv:1005.3299; CMS-QCD-10-006; CERN-PH-EP-2010-009.- 26 p. Phys. Rev. Lett. : 105 (2010) 022002

First Measurement of Bose-Einstein Correlations in proton-proton Collisions at  $\sqrt{s} = 0.9$  and 2.36 TeV at the LHC  
By CMS Collaboration, arXiv:1005.3294; CMS-QCD-10-003; CERN-PH-EP-2010-010.- 24 p. Phys. Rev. Lett. 105 (2010) 032001

Transverse momentum and pseudorapidity distributions of charged hadrons in pp collisions at  $\sqrt{s} = 0.9$  and 2.36 TeV  
By CMS Collaboration, arXiv:1002.0621; CMS-QCD-09-010; CERN-PH-EP-2010-003.- 33 p., J. High Energy Phys. 02 (2010) 041

Commissioning and Performance of the CMS Pixel Tracker with Cosmic Ray Muons  
By CMS Collaboration, arXiv:0911.5434; CMS-CFT-09-001.- 37 p. J. Instrum. 5 (2010) T03007

Measurement of the Muon Stopping Power in Lead Tungstate  
By CMS Collaboration, arXiv:0911.5397; CMS-CFT-09-005.- 2010 - 31 p. J. Instrum. 5 (2010) P03007

Performance of the CMS Level-1 Trigger during Commissioning with Cosmic Ray Muons and LHC beams  
By CMS Collaboration, arXiv:0911.5422; CMS-CFT-09-013.- 2010 - 49 p. J. Instrum. 5 (2010) T03002

Performance of CMS Muon Reconstruction in Cosmic-Ray Events  
By CMS Collaboration, arXiv:0911.4994; CMS-CFT-09-014.- 2010 - 47 p. J. Instrum. 5 (2010) T03022

Commissioning and Performance of the CMS Silicon Strip Tracker with Cosmic Ray Muons  
By CMS Collaboration, arXiv:0911.4996; CMS-CFT-09-002.- 2010 - 45 p.  
J. Instrum. 5 (2010) T03008

Performance of the CMS Cathode Strip Chambers with Cosmic Rays  
By CMS Collaboration, arXiv:0911.4992; CMS-CFT-09-011.- 2010 - 39 p.  
J. Instrum. 5 (2010) T03018

Performance of the CMS Hadron Calorimeter with Cosmic Ray Muons and LHC Beam Data  
By CMS Collaboration, arXiv:0911.4991; CMS-CFT-09-009.- 2010 - 35 p.  
J. Instrum. 5 (2010) T03012

CMS Data Processing Workflows during an Extended Cosmic Ray Run  
By CMS Collaboration, arXiv:0911.4842; CMS-CFT-09-007.- 2010 - 43 p.  
J. Instrum. 5 (2010) T03006

Performance of the CMS Drift Tube Chambers with Cosmic Rays  
By CMS Collaboration, arXiv:0911.4855; CMS-CFT-09-012.- 2010 - 47 p.  
J. Instrum. 5 (2010) T03015

Calibration of the CMS Drift Tube Chambers and Measurement of the Drift Velocity with Cosmic Rays  
By CMS Collaboration, arXiv:0911.4895; CMS-CFT-09-023.- 2010 - 39 p.  
J. Instrum. 5 (2010) T03016

Commissioning of the CMS Experiment and the Cosmic Run at Four Tesla  
By CMS Collaboration, arXiv:0911.4845; CMS-CFT-09-008.- 2010 - 37 p.  
J. Instrum. 5 (2010) T03001

Identification and Filtering of Uncharacteristic Noise in the CMS Hadron Calorimeter  
By CMS Collaboration, arXiv:0911.4881; CMS-CFT-09-019.- 2010 - 31 p.  
J. Instrum. 5 (2010) T03014

Commissioning of the CMS High-Level Trigger with Cosmic Rays  
By CMS Collaboration, arXiv:0911.4889; CMS-CFT-09-020.- 2010 - 31 p.  
J. Instrum. 5 (2010) T03005

Aligning the CMS Muon Chambers with the Muon Alignment System during an Extended Cosmic Ray Run  
By CMS Collaboration, arXiv:0911.4770; CMS-CFT-09-017.- 2010 - 35 p., J. Instrum. 5 (2010) T03019

Performance of the CMS drift-tube chamber local trigger with cosmic rays  
By CMS Collaboration, arXiv:0911.4893; CMS-CFT-09-022.- 2010 - 33 p.  
J. Instrum. 5 (2010) T03003

Fine Synchronization of the CMS Muon Drift-Tube Local Trigger using Cosmic Rays  
By CMS Collaboration, arXiv:0911.4904; CMS-CFT-09-025.- 2010 - 33 p.  
J. Instrum. 5 (2010) T03004

Performance of CMS hadron calorimeter timing and synchronization using test beam, cosmic ray, and LHC beam data  
By CMS Collaboration, arXiv:0911.4877; CMS-CFT-09-018.- 2010 - 33 p.  
J. Instrum. 5 (2010) T03013



Alignment of the CMS Muon System with Cosmic-Ray and Beam-Halo Muons  
By CMS Collaboration, arXiv:0911.4022; CMS-CFT-09-016.- 2010 - 41 p., J. Instrum. 5 (2010) T03020

Performance Study of the CMS Barrel Resistive Plate Chambers with Cosmic Rays  
By CMS Collaboration, arXiv:0911.4045; CMS-CFT-09-010.- 2010 - 33 p.  
J. Instrum. 5 (2010) T03017

Time Reconstruction and Performance of the CMS Electromagnetic Calorimeter  
By CMS Collaboration, arXiv:0911.4044; CMS-CFT-09-006.- 2010 - 27 p.  
J. Instrum. 5 (2010) T03011

Precise Mapping of the Magnetic Field in the CMS Barrel Yoke using Cosmic Rays  
By CMS Collaboration, arXiv:0910.5530; CMS-CFT-09-015.- 2010 - 37 p.  
J. Instrum. 5 (2010) T03021

Performance and Operation of the CMS Electromagnetic Calorimeter  
By CMS Collaboration, arXiv:0910.3423; CMS-CFT-09-004.- 2010 - 39 p.  
J. Instrum. 5 (2010) T03010

Alignment of the CMS Silicon Tracker during Commissioning with Cosmic Rays  
By CMS Collaboration, arXiv:0910.2505; CMS-CFT-09-003.- 2010 - 41 p.  
J. Instrum. 5 (2010) T03009

#### ***F.      APPLIED R&D AND SPINOFF***

Development of an anthropomorphic breast phantom for combined PET, B-mode ultrasound and elastographic imaging, Jun Dang , Benjamin Frisch, Philippe Lasaygues, Dachun Zhang, Stefaan Tavernier, Nicolas Felix, Paul Lecoq, Etienne Auffray, Joao Varela, Serge Mensah, and Mingxi Wan, IEEE Trans Nucl Science. accepted on 5/1/2011

Nonlinear least-squares modeling of 3D interaction position in a monolithic scintillator block., Zhi LI, M. Wedrowski, P. Bruyndonckx, G. Vandersteen. Phys. Med Biol. (55(2010)6515-6532

Experimental techniques in nuclear and particle physics, Stefaan tavernier, Springer Verlag 2010

#### ***G.      PHENOMENOLOGY***

The Top Window for dark matter, K. Cheung, K. Mawatari, E. Senaha, P. Y. Tseng and T. C. Yuan, JHEP 1010, 081 (2010) arXiv:1009.0618 [hep-ph]

HELAS and MadGraph with spin-3/2 particles K. Hagiwara, K. Mawatari and Y. Takaesu  
arXiv:1010.4255 [hep-ph]

### **XVIII.2    CMS NOTES**

#### **CMS public PAS (Physics Analysis Summary)**

Search for Dielectron Resonances in the Dielectron Mass Distribution in pp Collisions at  $\sqrt{s} = 7$  TeV  
CMS Collaboration, CMS EXO-10-012

Selection of Top-Like Events in the Dilepton and Lepton-plus-Jets Channels in Early 7 TeV Data  
CMS Collaboration, PAS-TOP-10-004

Charged particle multiplicities at  $\sqrt{s}=0.9, 2.36$  and 7.0 TeV  
CMS Collaboration, PAS-QCD-10-004

Measurement of the Underlying Event Activity at the LHC with  $\sqrt{s} = 7$  TeV and Comparison with  $\sqrt{s} = 0.9$  TeV  
CMS Collaboration, PAS-QCD-10-010

## **CMS internal notes (CMS AN) and CMS Conference Reports (CR) :**

Search for Higgs Boson Decays to Two W Bosons in the Fully Leptonic Final State  $\sqrt{s} = 7$  TeV  
X. Janssen, N. Van Remortel, M. Selvaggi et.al., CMS AN-2010/411

Top Lepton Plus Jets: Electron and Muon Efficiency Measurements for 2010 Dataset  
F. Blekman, et al., CMS AN-2010-362

Optimization and Commissioning of Jet Substructure Algorithms  
E. Chabert, J. D'Hondt, G. Hammad, C. Vander Velde et al., CMS AN-2010/330

Search for High-Mass Resonances Decaying to Electron Pairs in the CMS Experiment  
O. Charaf, B. Clerbaux, V. Dero, A. Gay, G. De Lentdecker, Sh. Elgammal, A. Gay, P. Marage, L. Thomas, P. Vanlaer et al., CMS AN-2010/318

Statistical Analysis of a Resonant Signal search in Multiple Final State Modes  
B. Clerbaux, L. Thomas et al., CMS AN-2010/312

Selection of t-t Candidates in the Lepton+Jets Channels  
F. Blekman, et al., CMS AN-2010/297

Measurement of track charge deposits in the pixel detector using 2010 data  
A. Olbrechts, F. Blekman, J. d'Hondt, CMS AN-2010/294

A measurement of t bar cross section in early 7 TeV data using the semileptonic topology: electron plus jets with one or more b-tags, using 36 pb<sup>-1</sup> of CMS data  
F. Blekman, R. Gonzalez Suarez et al., CMS AN-2010/281

Measurement of the jet energy corrections using top quark events at  $\sqrt{s} = 7$  TeV  
S. Blyweert, J. D'Hondt, M. Maes, P. Van Mulders, CMS AN-2010/276

Charged particle multiplicities at  $\sqrt{s}=0.9, 2.36$  and 7.0 TeV with the CMS detector at LHC  
R. Rougny for the CMS Collaboration, CMS CR-2010/236

Particle production in pp collisions at the LHC as studied by CMS  
N. Van Remortel for the CMS Collaboration, CMS CR-2010/234

Forward physics at CMS  
R. Benoit for the CMS Collaboration, CMS CR-2010/214

Projections on new, exotic scenarios  
L. Benucci for the CMS Collaboration, CMS CR-2010/184

Single Particle Response in the CMS Calorimeters

S. Beauceron et al., CMS AN-2010/179

Selection of t-t Candidates in the Muon+Jets Channel

S. Beauceron, S. Blyweert, E. Chabert, J. D'Hondt, G. Hammad, M. Maes et al., CMS AN-2010/173

Charged Hadron Spectra Measurement with the CMS detector in pp collisions at  $\sqrt{s}$ = 0.9, 2.36, and 7 TeV

R. Rougny for the CMS Collaboration, CMS CR-2010/147

Search for Mono-Jet Final States at 10 TeV

L. Benucci for the CMS Collaboration, CMS CR-2010/138

Observation of diffraction and measurement of the forward energy flow with the CMS detector

R. Benoit for the CMS Collaboration, CMS CR-2010/134

The Underlying Event in pp Collisions at 900 GeV

L. Mucibello for the CMS Collaboration, CMS CR-2010/116

The underlying event in proton - proton collisions at 7 TeV

L. Mucibello et.al., CMS AN-2010/112

Expectation for the measurement of ttbar cross section in the lepton plus jets channel with the the first data in CMS at  $\sqrt{s}$  = 10 TeV

I. Vilella for the CMS Collaboration, CMS CR-2010/110

Leptons, b-tagging and MET reconstruction at CMS after the first data

J. Maes for the CMS Collaboration, CMS CR-2010/105

Charged particle multiplicities at  $\sqrt{s}$ =0.9, 2.36 and 7.0 TeV

E. De Wolf, X. Janssen, L.Mucibello, R. Rougny, N. Van Remortel et.al., CMS AN-2010/095

Studies of Top Tagging Algorithms

E. Chabert, J. D'Hondt, G. Hammad, C. Vander Velde et al., CMS AN-2010/080

Direct Search for Dark Matter at CMS

B. Clerbaux for the CMS Collaboration, CMS CR-2010/079

Data Flow for the CMS Exotica Group for Early

M. Mozer, P. Vanlaer et al., CMS AN-2010/071

Studies on Track Selection for the Underlying Event Analysis at  $\sqrt{s}$ =900~GeV

L. Mucibello et.al., CMS AN-2010/068

Electron and Photon High-Level Trigger in CMS

M. Mozer et al., CMS AN-2010/066

Statistical Analysis for Discovery and Limits of High Mass Resonances in Single Channels and Their Combination

M. Mozer, CMS AN-2010/047

Calibration of the jet energy scale using top quark events at the LHC

P. Van Mulders CMS TS-2010/028

The 2009 CMS Trigger Reviews

S. Beauceron, M. Mozer et al., CMS IN-2010/022

The underlying event in proton - proton collisions at 900 GeV

L. Mucibello et.al., CMS AN-2010/018

Underlying event and jet reconstruction in CMS

X. Janssen for the CMS Collaboration, CMS CR-2011/012

Measuring and Understanding Computing Resource Utilization in CMS

S. Blyweert, M. Maes et al., CMS CR-2011/010

Calorimetry Task Force Report

S. Beauceron et al., CMS NOTE-2010/007

Study of Various Photomultiplier Tubes with Muon Beams And Cerenkov Light Produced in Electron Showers

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