Romania at CERN

Research projects 2009-2011

Bucharest-Magurele, ROMANIA
2011

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Brief overview of the Romania-CERN cooperation

CERN, the European Organization for Nuclear Research, was founded in 1954. It has become a prime example of international collaboration, with currently 20 Member States. It is the biggest particle physics laboratory in the world, and sits astride the Franco-Swiss border near Geneva.

The experimental facilities of CERN comprise the particle accelerators and the detectors mounted around them. CERN presently has 3 main accelerators connected between them. Each of them was the most powerful in the world at the time it was started up: the Proton Synchrotron (PS), the Proton Super-Synchrotron (SPS), where the discoveries were awarded the Nobel Prize for Physics, and the Large Hadron Collider (LHC) proton crossed beam accelerating complex. The latter is the most powerful machine of this type in the world and it is expected that the experiments that are being completed there will lead to important discoveries.

CERN has established a reputation at the forefront of research, proven through its experiments, past and present. At CERN were discovered the field particles W and Z, confirming the electroweak theory of the Standard Model. It is also the place where new detector types were obtained and new principles of the particle beam acceleration were applied.

The research projects at CERN contributed also to the advancement of the frontiers of technology and engineering. The World Wide Web was invented at CERN to help particle physicists around the world to communicate; now CERN is leading work to create a "computing Grid" that will harness vast amounts of computer power through networks across the world. Engineering for CERN, especially in cryogenics, superconductivity, vacuum, microelectronics and civil engineering, provides a valuable expertise that can be applied elsewhere. Particle detectors invented at CERN are used in techniques for medical diagnosis.

CERN is a real global endeavour. Approximately 10 000 visiting scientists, half of the world's particle physicists, come to CERN for their research. They represent 608 universities and 113 nationalities.

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Romania has a long and valuable tradition in particle physics research. The activity in this field has practically started in 1949, in the Laboratory for Cosmic Rays (LRC) of the newly established Institute of Physics of the Academy. In 1956 the institute split into the Institute of Atomic Physics (IFA, including LRC) located at Magurele under the leadership of Horia Hulubei and the Bucharest Institute of Physics (IFB) directed by Eugen Badarau, member of the Romanian Academy and prominent specialist in plasma physics and electrical discharges in gases. The science performed at Magurele became widely acknowledged by the international scientific community, IFA setting a high standard for the Romanian scientific research. As the high energy accelerators started to develop, in 1962 a new laboratory was created in IFA: the Laboratory of High Energy Physics (LEN). In 1973 IFA was incorporated, along with other research and educational units throughout the country, into the Central Institute of Physics (ICEFIZ) belonging to the State Committee for Nuclear Energy (CSEN). In 1977 ICEFIZ was reorganized by setting up the main physics research institutes and technological units, specializing in fields of activity as follows: Magurele Physics Platform – nuclear physics and engineering (IFIN, including LEN), laser and plasma, materials, earth physics, space sciences (the former LRC), nuclear equipment; Cluj-Napoca – molecular and isotopic technologies; Iasi – technical physics; Ramnicu-Valcea – heavy water. In January 1990 IFA re-emerged as an institution with its own legal personality, in direct subordination to the Romanian Government, by taking over ICEFIZ research institutes following CSEN dissolution. In 1996, from IFA spun off the national research and development (R&D) institutes of today, five of which located at Magurele; since then, IFA has become a funding agency for national and international research programmes in the field.

The main activity in particle physics research is presently performed at the Horia Hulubei National R&D Institute for Physics and Nuclear Engineering (IFIN-HH) and, to a much lesser extent, at the Institute of Space Sciences (ISS) - a subsidiary of the National R&D Institute for Laser, Plasma and Radiation Physics. Three of IFIN-HH departments are directly involved in high-energy physics: Elementary Particles and Information Technologies, Hadron Physics and Theoretical Physics.

Although the Romanian participation in CERN before 1990 was mainly performed through the Joint Institute for Nuclear Research in Dubna, Russia, subsequently, the openness policy of CERN regarding the Eastern Europe countries made possible the direct access of the Romanian physicists to this prestigious research centre. The Agreement for Scientific and Technical Cooperation signed by the Government of Romania and CERN in 1991 and revised in 2002 marked an important progress in this relationship and provided the legal basis for its further development. Romania is presently a candidate to become a Member State of CERN. The agreement that formally recognizes this status of Romania was signed at CERN on February 11, 2010 and ratified by the Law no. 203/27.10.2010.

At present, Romania formally takes part in seven experiments unfolding at CERN's main facilities: ALICE, ATLAS, LHCb and WLCG at the Large Hadron Collider, DIRAC and n_TOF at the Proton

Romanian Minister of Education, Research, Youth and Sport, Daniel Petru Funeriu, and CERN Director General, Rolf-Dieter Heuer, immediately after the signing of the agreement that formally recognises Romania as a Candidate for Accession to membership of CERN. *(Geneva, February 11, 2010)*

Brief overview of the Romania-CERN cooperation

Synchrotron and ISOLDE. IFIN-HH, the largest and the most significant R&D institute from Romania, participates in all these experiments and coordinates seven domestic projects. Another domestic project, within the ALICE Collaboration, is coordinated by ISS. Two more national R&D institutes and two universities from Romania participate in CERN experiments. More than 100 Romanians, including not only particle physicists but also other scientists and engineers, are currently engaged in CERN activities (however, approximately half of them represent foreign institutions).

IFA, as a public institution subordinated to the National Authority for Scientific Research (ANCS) – Ministry of Education, Research, Youth and Sport, was assigned in 2010 to ensure the management of the Romanian participation in CERN's research programmes and projects. The evaluation and monitoring of the Romanian projects concluded with CERN is ensured by the International Scientific Advisory Board (ISAB), which also provides its support to IFA and ANCS in elaborating and implementing a strategy in the field of high energy physics and in the Romanian participation at CERN.

Aware of the importance and capacity of domestic basic research as well as of the CERN's role as a powerhouse of international science, the Romanian authorities follow with growing interest the development of this collaboration and encourage it to the extent of the country's financial possibilities.

Visit of the Romanian delegation at CERN laboratories. *(Geneva, February 11, 2010)*

Exotic states of matter, in-medium effects and dynamics at ALICE

Project Leader: Mihai PETROVICI
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ALICE Collaboration: *http://aliceinfo.cern.ch/*
Project web page: *http://niham.nipne.ro/cap_M3_alice.html*

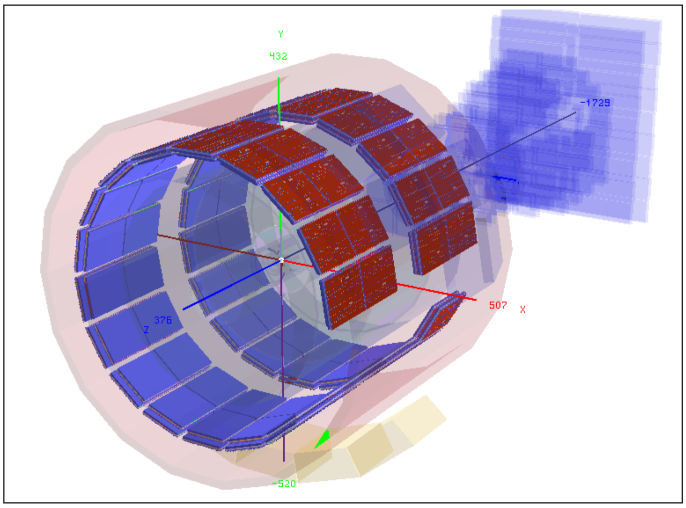
Quantum Chromodynamics (QCD) predicts that at extreme conditions of temperature and/or density a phase transition from normal nuclear matter into a new state of matter, formed by quarks and gluons, takes place. The ultra-relativistic heavy-ion collisions provide a unique opportunity to create and study the properties of matter in extreme conditions of temperature and/or density in terrestrial laboratories. The **L**arge **H**adron **C**ollider (LHC) at CERN is designed to accelerate protons and Pb ions and collide them up to 14 TeV and 5.5 Tev in the center of mass, respectively. The only dedicated experiment for heavy ion collisions at LHC energy is the ALICE Experiment, i.e., **A L**arge **I**on **C**ollider **E**xperiment. The main objective of ALICE experiment is to study nuclear matter in regime of temperature largely exceeding the critical temperature where a phase transition toward the deconfined phase takes place. As the energy density reached at LHC will, by far, outrun those attained at RHIC, this will allow to explore the properties of nuclear matter at extremely high energy density and to study in detail the properties and dynamics of the new state of matter. ALICE takes advantage of the proton beam at LHC to collect reference data in dedicated p–p and p–A scientific programs, complementary to the programs addressed by the ATLAS and CMS experiments.

The contribution of the Romanian specialists to the ALICE Collaboration consisted of:

- **TRD chambers construction and tests:** This started in early 2005 after we succeeded to organize in our Institute a Detector Laboratory at international standards, well known and appreciated at international level. According to the TRD-**T**echnical **D**esign **R**eport, the 18 Super Modules (SM) of the ALICE-TRD subdetector contain 540 TRD chambers. The TRD chambers construction task was initially equally shared between 5 institutes, i.e. Physics Institutes of Heidelberg and Frankfurt Universities, GSI - Darmstadt, JINR - Dubna and Hadron Physics Department of the National Institute of Physics and Nuclear Engineering – Bucharest. It is worth to underline that all the objectives initially foreseen (108 chambers from 540) were completely fulfilled. Finally we realized 130 chambers, i.e. 24% of ALICE-TRD.
- **Contribution to the TRD-FEE:** Members of our group had an essential contribution in designing the analog CHIP–PASA for the TRD Front End Electronics. In our group were designed and realized mechanical and electronic components required for the final tests of the TRD chambers constructed in our Laboratory. As a non profit organization, our Department obtained the CADENCE software package at modest price, it was implemented on the local machines and is currently used for designing FEE for the new detector prototypes developed by us.
- **A proper infrastrucure for a Data Centre was organized:** At present our NIHAM (Nuclear Interaction and Hadronic Matter) Data Centre is among the most efficient components of ALICE GRID, i.e. 8% of ALICE done jobs in the last three years, at an efficiency higher than 95 %. (*http://pcalimonitor.cern.ch:8889*)

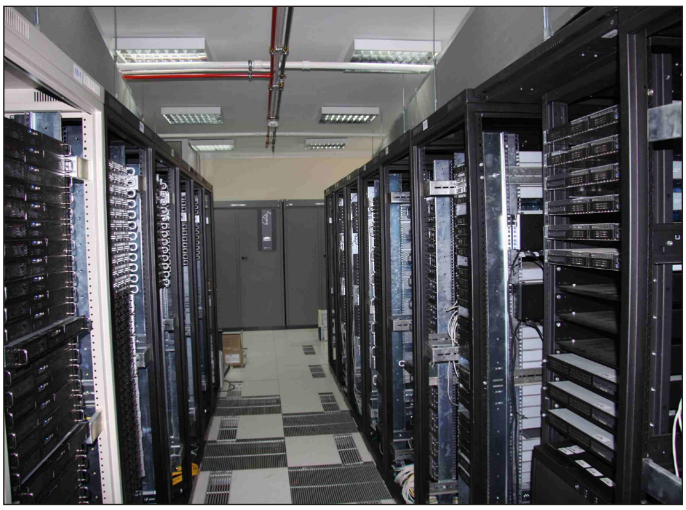
Detector Laboratory of Hadron Physics Department (IFIN-HH)

- **Participation to the installation of the TRD SM (Super Modules) in the experiment and their tests.**
- **Development of the tracking software package for TRD.**
- **Maintenance and operation of NIHAM, development of AliEn software packages for ALICE GRID monitoring.**
- **Experiments at LHC, experimental data and MC analysis for strongly interacting systems** This analysis for p + p collisions at 900 GeV and 7 TeV focused on p_T spectra for primary charged identified hadrons and event shape in order to study the possibility to evidence an axial isotropic flow in p+p collisions at 7 TeV. In parallel we are developing the necessary analysis environment for flow studies in central and mid-central Pb+Pb collisions measured at 2,76 TeV at LHC.
- **Organization of three successful International Workshops:** Cheile Gradistei, Romania, September 24-28(2005), Sinaia, Romania, October 13-18(2006) and Sibiu, Romania, August 20-24(2008) (*http://niham.nipne.ro/workshops.html*).
- **Prototype tests for the ALICE TRD** A. Andronic, H. Appelshauser, C. Blume, P. Braun-Munzinger, V. Catanescu, M. Ciobanu, H. Daues, A. Devismes, Ch.Fink, N. Herrmann, T. Lister, T. Mahmoud, T. Peitzmann, ***M. Petrovici***, K. Reygers, R. Santo, R. Schinker, S. Sedykh, R.S. Simon, J. Stachel, H. Stelzer, J. Wessels, A. Reishl, O. Wilkenmann, B. Wildenband, C. Xu – ALICE-TRD Collaboration IEEE Transaction on Nuclear Science, Volume 48, Issue 4, August 2001.
- **Studies of the collective expansion in ultra-relativistic heavy ion collisions based on hydrodynamical inspired models coupled with non-extensive statistical equilibrium** ***M. Petrovici*** and A. Pop AIP Conf. Proc. 972, p.98.
- **Contribution to the ALICE experimental set-up, ALICE-GRID, first experiments and first physics using p + p and Pb+Pb collisions** Eur. Phys. J C65(2010)111; Phys Rev Lett Vol.105, No.7, (2010);105(2010)252302; 105(2010)252301.

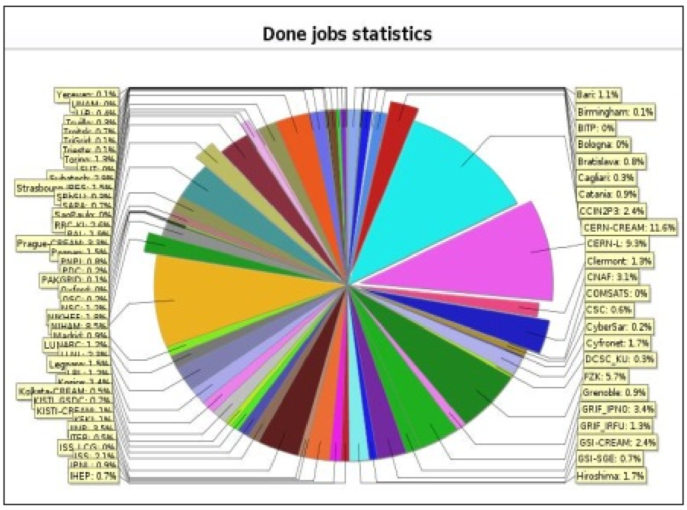


TRD chambers produced in Hadron Physics Department, IFIN-HH

Bonding and SMD Laboratory – HPD (IFIN-HH)



NIHAM Data Centre of DFH (IFIN-HH)



NIHAM Data Centre performance

Preparing simulation and preliminary analysis of data from ALICE experiment

Project Leader: Dumitru HASEGAN
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ALICE Collaboration: *http://aliceinfo.cern.ch/*
Project web page: *http://iss14.nipne.ro/projects/imotep/index_en.html*

Overall objectives: Making of detailed analyses regarding the jets phenomena in proton – proton collisions from ALICE experiment has been our main purpose pursued in this project. For reaching this goal we have used models of jet formation. Implementing analysis techniques of simulated data and also, the analysis of the first proton-proton experimental data, have been important stages for the project development. One of the major contributions of our group has consisted in making a geometric modeler for detection system representation.

Objectives – 2009: Evaluation, documentation and selection of practical methods which have been used for the purpose of obtaining the results and project completion:

1. Study of partonic energy loss in QCD medium, energy dependence; partonic dynamics and correlation with jet parameters; jet quenching.
2. Preparing of jet analysis software components; measurements of performances and optimization; implementation of automated submission methods of standard ALICE analysis.

Objectives – 2010: Development of analysis software for jet finding and profiling in proton – proton events. In the ALICE experiment, reconstruction of events recorded by detection systems are based on the same geometric modeler (made by ISS ALICE group) used for simulation. This model has been optimized for fast calculus of energy loss/multiple scattering corrections for the material in which particles are moving.

Objectives – 2011: Making a comparative study between various jet finder algorithms used by the ALICE collaboration on p-p data at $\sqrt{s} = 900$ GeV and 7 TeV and defining a preliminary study that involves HIJING simulations on jet production in Pb-Pb interactions at the ALICE experiment.

Main results: The results associated with the first phase (June 26, 2009) consisted in the realization of a long-term study on the partonic dynamics modelling. During the second stage of the project (December 10, 2009), one took into account both, the improvement of the working methods and the analysis of the data obtained with GRID technologies used by the ALICE experiment. The profiling analysis of the jets noticed in the ALICE experiment, i.e. of the total transverse energy spectra and of the radius spectra in the pseudorapidity and azimuthal angle space, was the obtained result during the third stage (June 10, 2010). The fourth phase of this project was finished by the end of 2010 by optimizing the geometrical model of the ALICE detectors, model used in the ALICE event reconstruction. Within the period of time dedicated to the fifth part of this project (December 5 – June 10, 2011), a number of essential jet distributions were made, like the average number of charged particles within the leading charged jet as a function of the transverse momentum of the leading charged jet (Fig. 1), the jet fragmentation function *F(z)*, and the average number of charged particles as a function of the relative azimuthal angle $\Delta\phi$ between the particle and the leading charged jet. The AOD files from the "analysis train" regarding proton-proton simulated and experimental data were analyzed with several specific ALICE jet finder algorithms (for e.g., see Fig. 2), including CDF jet cone algorithm, implemented by our team in AliROOT.

The impact on the education and research system: There has been a major scientific and didactic impact. The involvement of PhD students in this project has determined their qualification at the highest international level. The experience acquired will be used for the participation in other major experiments, such as: R3B and BECQUEREL and will contribute to the improvement of Romanian scientific human resource quality.

Perspectives for the future collaboration with CERN: The obtained results regarding the jet analysis in proton-proton collisions are very important for the subsequent studies of jet formation and development in hot and dense medium, because these data will be the reference point of nucleus – nucleus collision. The effort for the optimization of the geometrical modeler of detectors in the ALICE experiment will be continued as well.

Papers published or presented at international conferences:

1. **A. Gheata**, **M. Gheata**, C. Klein-Boesing, A.Morsch, "A collaborative analysis framework in use for ALICE experiment", 17th International Conference on Computing in High Energy and Nuclear Physics "CHEP'09";
2. ALICE Collaboration (K. Aamodt, ..., **A. Danu, D. Felea, A. Gheata, M. Gheata, M. Haiduc, D. Hasegan, C.M. Mitu, A. Sevcenco, I. Stan, I.S. Zgura** et al.), European Physical Journal C **vol. 65** (Nos. 1-2), 111-125 (2010);
3. O. Datskova, **A. Gheata**, I. Hřivnáčová, A. Morsch, E. Sicking, "The ALICE Geant4 Simulation", 18th International Conference on Computing in High Energy and Nuclear Physics "CHEP'10";
4. F. Antinori, F. Carminati, **A. Gheata**, **M. Gheata**, "A Trigger Simulation Framework for ALICE Experiment", 18th International Conference on Computing in High Energy and Nuclear Physics "CHEP'10";
5. A. Gheata, **M. Gheata**, "Making distributed ALICE analysis simple using the GRID plug-in", ACAT 2011, London, UK, 5-9 September 2011.

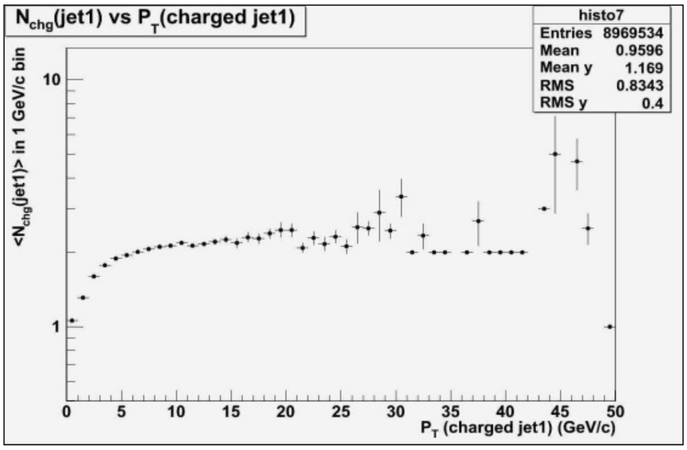


Figure 1

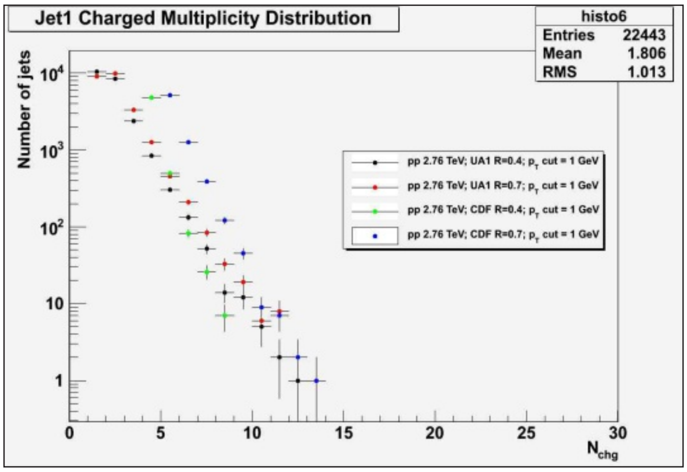


Figure 2

ATLAS Experiment at LHC: beginning of the data acquisition

Project Leader: Sanda DITA
Coordinator: Horia Hulubei National Institute of Physics and Nuclear Engineering
Partners: National Institute of Isotopic and Molecular Technologies Cluj-Napoca, University Politehnica Bucharest
ATLAS Collaboration: *http://atlas.web.cern.ch/Atlas/Collaboration*
Project web page: *http://www.nipne.ro/dpp/Collab/ATLAS/index.html*

The Romanian Atlas team includes experimental and theoretical particle physicists as well as electronic and mechanical engineers. During 2009-2011 years, the activities of the Romanian team were focused on six Work Packages (WP):

WP 1: ATLAS Tile Calorimeter (IFIN-HH+INCDTIM) - The Romanian team was involved in Tile Calorimeter (Tilecal) since the very beginning (R&D 34) with significant contributions to the construction, test beam and commissioning activities, followed by the participation to the operation and online Data Quality Monitoring, as well as Offline Data Quality Monitoring (106 shifts in Atlas Control Room -ACR- and 70 shifts as DQ data validators). A special device has been constructed at ITIM Cluj (Fig.1), to allow a better access to the drawers containing the Tilecal Front End electronics, a very useful device to be used for electronics repairs and Low Voltage Power Supply (LVPS) replacements. Teams from ITIM Cluj and IFIN are taking part permanently to maintenance activities during the LHC technical stops. The development of the Tilecal Detector Control System (DCS) was of most interest and a very detailed analysis of the DCS data has been done to monitor the behaviour of the Tilecal LVPS's. In the last two years, the involvement of the Romanian team in DCS activities includes also the participation to DCS expert on-call shifts (84 shifts). Several software tools have been developed to improve the monitoring of the Tilecal data quality in calibration and data taking runs. It can be mentioned the significant Romanian contribution in the test beam and the cosmic data analysis succeeded by publication of Tilecal performance papers [1].

WP 2: Online Software for ATLAS Data Acquisition System (DAQ) (IFIN-HH) - The Data Acquisition (DAQ) related activities included the development of Online Software components, the DAQ software releases management and testing, and the development of a set of tools to evaluate the DAQ efficiency. Online Software encompasses the software to configure, control and monitor the Trigger/DAQ system [2]. Our contribution was related mainly to two Online Software components, the Message Reportig System (MRS) and the Integrated Graphical User Interface (IGUI). MRS has been redesigned, the server functionality has been distributed over a publicly accessible MRS server process and a variable number of private MRS workers. For IGUI the panels information structure was optimized and new interfaces have been added (Expert System, Data Flow). Our contribution to the DAQ software releases was related to the development of the working model, of the policies and of the tools which are used by software developers and software librarians in order to develop, deploy and maintain the DAQ software. The Bucharest group contributed also to the release testing, as a remote test bed. To evaluate the DAQ efficiency during data-taking, a set of tools has been developed. The set includes applications to read

Fig.1

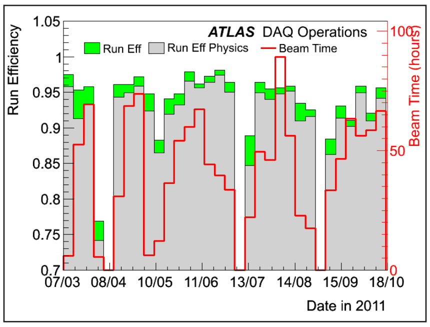


Fig.2

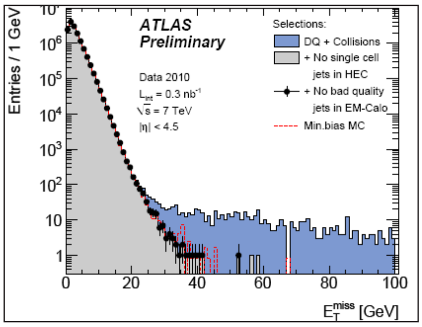


Fig.3

from online databases information about the stable beams intervals, active runs and dead time sources and software to display this information as plots and web pages (Fig. 2). The contribution to the ATLAS DAQ operation consisted of 159 ACR shifts (129 at Run Control desk and 30 at DAQ/HLT desk) and 160 expert on call shifts (109 as DAQ/HLT expert and 51 as Control & Configuration expert).

WP 3: ATLAS infrastructure management optimization solutions (UPB) - The research team was involved in the management of the ATLAS experiment infrastructure. Improvements have been made to the Trigger and DAQ network management: deployment and configuration of the Spectrum monitoring package (health monitoring and traffic statistics), development of software solutions for network topology autodiscovery and 3D network state visualization. Furthermore the researchers have enhanced the experiment's role based access control system by synchronizing the role related information between various user management systems (e.g. POSIX, CMF Active Directory).

WP 4: GRID activities and Computing (IFIN-HH + INCDTIM) - Two main directions of most importance: a) Maintenance and operation of the RO-02-NIPNE and RO-14-ITIM Cluj sites, according to ATLAS requirements b) Development, maintenance and operation of an ATLAS group analysis facility. The site performances: 350 (160) logical CPUs and 220 (100) TB Storage Capacity and 130 (120) jobs/ day for RO-02-NIPNE (RO-14-ITIM). A new data center infrastructure, housing the analysis facility, was developed in IFIN-HH, based on a 160kW UPS system and a chilled water topology cooling system. New network infrastructure was deployed based on an Unified Fabric Solution for data centers, handling LAN/SAN traffic of 10 Gigabit / 1 Gigabit Ethernet, iSCSI, Fibre Channel and Fibre Channel over Ethernet. The up-link connection was upgraded to 10 Gbit/s. The IFIN-HH local computing cluster used for simulations and PROOF analysis is composed of 44 cores, 1 GB/core RAM, with a storage area of 7 TB.

WP 5: Studies of Physics Processes (IFIN-HH) - The study of jet production, the dominant high transverse momentum process at LHC, is of most importance for Romanian team. The starting point was a comparative analysis of different jet identification algorithms using calorimeter clusters as input. Several values of the distance parameter (R=0.4, R=0.6) have been taken into account but also values near R=1 (allowing a possible study of the jet substructure). A detailed comparison of 2011 data and MC simulations has been done using some basic information related to jets: the number of jets per event, the distribution of jet transverse momentum, etc. Another study concerns the reconstruction and the calibration of the missing transverse energy, the Romanian contribution being related to the testing of the missing E_T performances using a sample of minimum bias events collected by ATLAS in 2010. In Fig. 3, the missing E_T distribution is presented, computed from topological clusters cleaned by rejecting the fake jets and the good agreement with simulations can be observed. These results have been presented on behalf of ATLAS Collaboration at ICEP 2010 Conference [3]. The study of ttbar pair production has been started focusing on a comparison of the selection criteria for one lepton and dilepton channels using simulations with different MC generators.

Phenomenological studies in perturbative QCD were performed. A new set of expansion functions were defined by analytic continuation in the Borel plane. The formalism was applied to the Adler function in massless QCD and allowed a precise determination of the strong coupling α_s from hadronic tau decays [4]. Work was also performed in order to improve the knowledge of the electromagnetic and weak form factors of interest in flavour physics. Using perturbative and nonperturbative QCD, stringent model independent constraints were derived on the shape of the semileptonic form factors, allowing in particular a precise determination of the element V_{ub} of the CKM matrix.

WP 6: ATLAS Tile Calorimeter Upgrade - Contributions to the evaluation of an alternative mini-drawer mechanical solutions. The main goals: an easier service, requiring a smaller detector opening, and accessibility of the electronics towards the patch panel. Preliminary tests of the proposed solution were performed at CERN confirming their working concept and feasibility.

[1] Testbeam studies of production modules of the ATLAS Tile Calorimeter, *NIM A 606 (2009) 362-394*

[2] Configuration and control of the ATLAS trigger and data acquisition, *NIM A 623 (2010) 549-551*

[3] Performance of the missing transverse energy energy reconstruction in first ATLAS data at a center-of-mass energy of 7 TeV, *CHEP 2010 Proceedings*

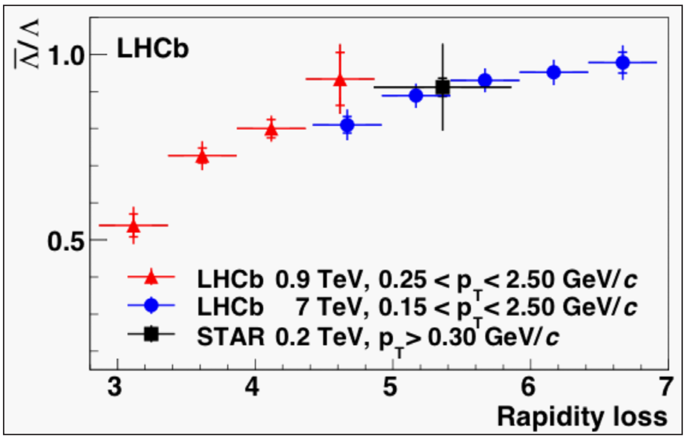
[4] Expansion functions in perturbative QCD and the determination of alphas (Mtau2), *Phys.Rev. D84, 054019 (2011).*

LHCb – from soft-QCD to b-physics results

Project Leader: Raluca Anca MURESAN
Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering
LHCb Collaboration: *http://lhcb.web.cern.ch/lhcb/*
Project web page: *http://www.nipne.ro/dpp/Collab/LHCb/*

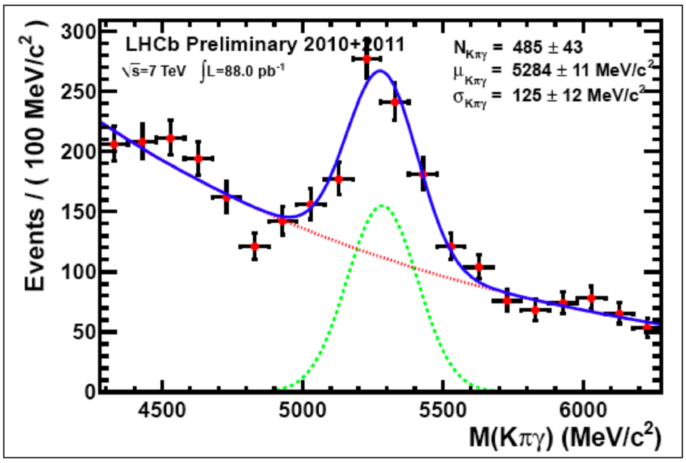
The LHCb experiment at LHC [1] is designed to look for New Physics (NP) through precise measurements of CP violation and rare decays in the beauty and charm sector. To exploit the large and kinematically correlated $b\bar{b}$ quark production in the forward region of pp interactions, the LHCb detector is built as a forward single arm spectrometer with a maximum angular coverage from 10 up to 300 mrad. Given the copious amount of the charm and beauty hadrons recorded by LHCb, studies of the production and the spectroscopy of the heavy quark hadrons are bound to provide interesting results. Taking advantage of the unique phase-space coverage among the LHC experiments, LHCb provides also an essential input for the light particle production models in a region of phase space where model predictions diverge as they are extrapolated not only in energy but also in (pseudo) rapidity. The Romanian participation in the LHCb started in 1996, our team, LHCb-Ro, being involved in: design, construction, commissioning, cosmic ray tests and calibration of the calorimeter modules; development of software for calorimeter, computing, and online projects; design and maintenance of the tool used for the shift organisation (ShiftDB); hardware and software upgrade and maintenance of the local GRID clusters; calibration of the RICH detector using data. We also worked on the validation of the Monte Carlo (MC) simulation in 2008-2009 and 2011. In 2008-2011 we participated in data taking as data managers, and in 2011 we also contributed to data quality and production shifts. It is worth noticing that the period from 2009-2011 was a difficult one for LHCb-Ro as the team structure and its programme undergone considerable changes due to the successive changes of the team leaders. From January 2011 the group started a new organization and programme.

Some of the physics studies pursued before 2011 followed two main directions: minimum bias physics (MB) that evolved from the studies for calibration of RICH sub-detector using $\Lambda \rightarrow \pi p$ and feasibility studies of algorithms for selecting various b-hadrons using kinematic and geometrical constraints. In year 2011, the physics effort of the group increased and a new physics program was initiated. We implemented PYTHIA 6 tunes, checked the implementation of PYTHIA 8, improved the interface to the HEPMC and worked on RIVET integration, in the LHCb simulation framework. Specific RIVET subroutines asociated to LHCb MB results were written. Based on the contribution from one of us to the V^0 ratio paper (first plot) [2] we are in the process of implementing selections for the multistrange baryons measurements. In the next years we will continue measuring the production cross-



The production ratio of $\bar{\Lambda}/\Lambda$ from LHCb at 0.9 TeV (triangles) and 7 TeV (discs) compared with the results published by STAR (squares) as a function of rapidity loss (LHCb official plot taken from [2])

sections of strange particles and their ratios. We are also committed to continue the tuning of the MC generators using the LHCb data, and to work on implementing and testing the new MC generators in the LHCb software framework. Work is going on to measure the Λ_b cross-section using the 2010 data. The study of the Λ_b differential cross-sections over the LHCb phase space will continue using the larger 2011 data sample and the data expected in 2012. Members of our group contributed to the LHCb preliminary result on the radiative decays of the B mesons (second plot) [3] and will follow this work until the publication. The way in which we can get involved in to the LHCb upgrade activities was investigated. The physics studies we contribute are particularly interesting. Studies of light particle production at LHCb provide a unique input to the hadronisation models. The interest for these results goes beyond the mere particle production. A thorough knowledge of the basic properties of inelastic pp-collisions is crucial to understand the background in all NP searches at LHC. The study of the b-baryon production and of their properties, is an almost virgin ground of the b-physics field of research and the radiative decays of the B mesons offers a unique opportunity for putting in evidence NP. Two Ph.D. theses will be completed in our group by the end of this year. Three members of our group participated to the organizing committee of "The European School of High-Energy Physics 2011", and two Ph.D. students attended the school, presenting one poster. Two students were hosted this Summer: a CERN student and a student in Bucharest. Bringing master and Ph.D. students into the group and participating as supervisors to the CERN Summer Students programme facilitate the education of a new generation of particle physicists, highly qualified and well integrated in the international environment. One of us was acting during 2011 as convener of the Hadronic Production and Spectroscopy working group of LHCb and represented LHCb in the LHC-Minimum Bias and Underlying Event working group. Well over ten talks were presented in the LHCb working groups in 2011. Two talks, a proceedings paper already published [4], and one poster, the associated paper being published in proceedings [5] were presented at conferences. Members of the LHCb-Ro team advertised in the University of Bucharest the student programs of CERN and our physics program. We presented a poster and provided guides to the CERN Romania exhibition in Bucharest in Summer 2011 and we participated to radio broadcasts. Our participation to conferences, schools, working group meetings and outreach activities increased the visibility of the Romanian particle physics community in CERN and in other research centers in Romania and abroad.



$B_d \to K^*\gamma$ invariant mass peak (LHCb preliminary result taken from [3,5])

From 2007 we are involved in the development and maintenance of a web-based application that manages the LHCb personnel participating in the data taking, ShiftDB. The first version was launched in the autumn of 2008, subsequent interactions with the users and the glitches discovered during the exploitation resulted in improvements during 2009. In 2009 we started the development of a new user-friendlier variant of the tool, with extended capabilities. Key parts of the project such as data redundancy, centralized mailing lists etc. were redesigned. The transition between the two variants of the tool took place gradually during 2011. Regular updates of middleware certificates, software updates and hardware upgrades of the GRID cluster nodes were made. Our involvement in the software tasks and the future involvement in the LHCb upgrade will result in transferable skills and advanced technological knowledge that can be applied not only in the particle physics experiments of the future but also in other areas of science and technology.

In conclusion, we shall continue working with the LHCb international collaboration at CERN, in order to guarantee a successful participation to data taking and a fruitful contribution to the physics analysis activities.

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National contribution to the development of the LCG computing grid for elementary particle physics

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LCG Collaboration: *http://lcg.nipne.ro/condegrid/*
Project web page: *http://lcg.web.cern.ch/lcg/*

The main objective of the CONDEGRID project is the development and exploitation of the national Grid system for the storage, processing, and analysis of the data for ALICE, ATLAS, and LHCb experiments, aiming at unifying all the existing national LCG resources in the Romanian Tier-2 federation RO-LCG.

Its main goals are the optimization of the existing RO-LCG infrastructure, the implementation of new technologies and new monitoring solutions which lead to the enhancement of the performance, reliability and quality of the Grid services provided at the national level, and the increased participation in the computational support of the LHC experiments within the Worldwide LHC Computing Grid (WLCG).

The specific objectives of the project, listed below, are strongly correlated to the requirements of the Memorandum of Understanding for Collaboration in the Deployment and Exploitation of the Worldwide LHC Computing Grid (MoU), which was concluded in March 2006 between CERN and the National Authority for Scientific Research.

- Fulfillment of the levels of hardware resources which are annually pledged, and the increase of the efficiency in using these resources
- Realization of the minimal levels of service availability which are specified by the MoU for the Tier-2 centres and federations of centres
- Development, implementation and operation of own software tools for monitoring and accounting of resources and services in RO-LCG
- Provision of support for the administration, operation, and maintenance of the grid centres
- Improvement of the RO-LCG management and of the communication within the consortium
- Access to and implementation of advanced technologies for improving the RO-LCG infrastructure
- Ensuring a better coordination between RO-LCG and the technical and organizational structures at the national and international level, and a greater visibility within the WLCG collaboration
- Dissemination of RO-LCG activities and of the results of the project.

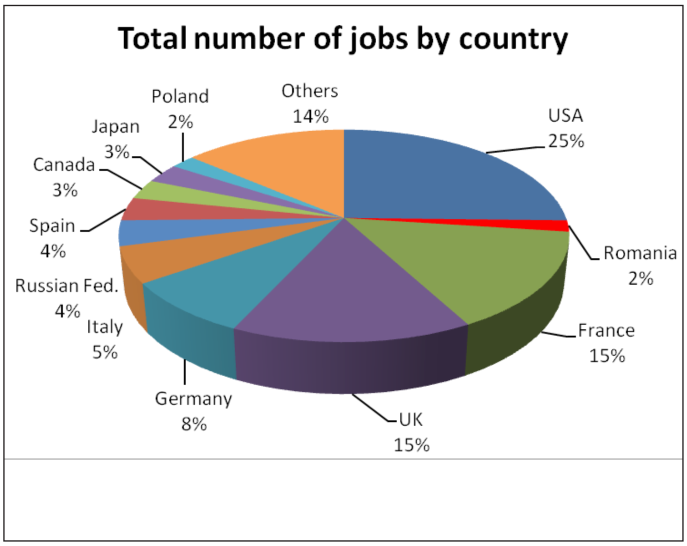

FIG. 1: The share in total number of Tier-2 jobs per contry processed between Nov. 2010 – Oct. 2011.

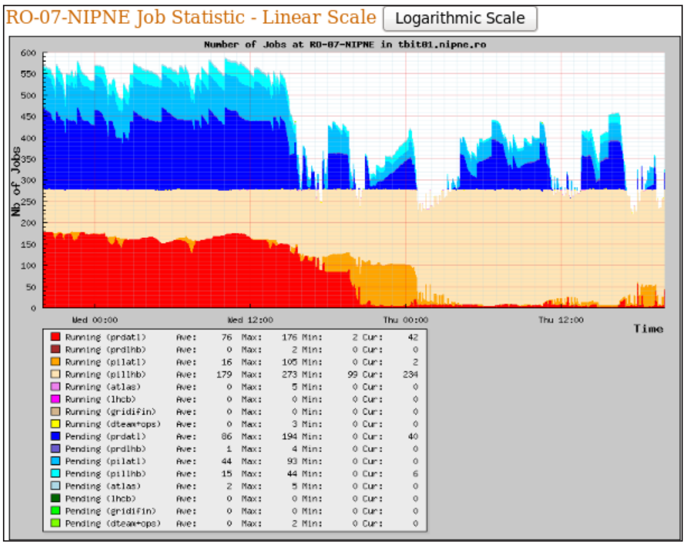

FIG. 2: Snapshot of the monitoring interface showing the various groups of jobs run in a 48 hours interval.

During the first stages of the project the distributed resource system of RO-LCG was implemented, the data communication infrastructure was modernized in order to support the traffic generated by the Grid production, and new LCG centres were developed in Cluj, Iasi and Bucharest. Annual upgrades of the computational capacity and of appropriate storage services for Monte Carlo event simulation and for end-user analysis were provided according to the experiments request and following the MoU specifications. Also, various technical solutions were implemented in order to improve the Grid availability of these resources.

Today, RO-LCG counts 9 grid sites, which are connected through the 10 Gbps backbone of the NREN RoEduNet to the European GEANT2 network. Together, these sites dedicate to the WLCG collaboration more than 2000 logical CPUs and 1,5 PetaBytes of storage space, providing 98% of the total Grid production of the country.

The growing of the RO-LCG performance as a consequence of the project is visible in the accounting data recorded by international databases. According to the data published by the EGI accounting portal (http://www3.egee.cesga.es/), during the last 12 months RO-LCG provided 1,72 % of the total number of jobs processed by all the Tier-2 centres worldwide, ranking 11th of 33 countries in the WLCG collaboration (Fig.1).

New monitoring and accounting solutions were recently developed at IFIN-HH and implemented in RO-LCG in order to enhance the performance, reliability and quality of the Grid service at the national level. The new software tools provide support for the global monitoring and accounting of the Grid infrastructure through the RO-LCG monitoring system, which parallels the central monitoring ensured by the National Grid Initiative, and significantly contributed to the improvement of the RO-LCG performances.

The project will be essential for the contribution that RO-LCG should provide to the computig support of the LHC experiments in the framework of the WLCG collaboration during 2012-2014. Its main goals are the further optimization of the existing RO-LCG infrastructure, the improvement of the quality of service, and the implementation of new technical solutions for the handling, processing and re-processing of the increasing amount of the analysis data which is generated during this period. Three annual stages are planned regarding a) the increase of the reliability of the Grid services provided by the RO-LCG federation (2012); b) the improvement of the Grid support for reprocessing and reanalysing of the LHC experimental data (2013); c) the adaptation of the RO-LCG Grid infrastructure to the new computing requirements of the experiments after the planned LHC break.

Preshower Detector for DIRAC Experiment at CERN

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Project web page: *http://tandem.nipne.ro/proj/psh/*

1. Introduction

In 1995 the DIRAC Collaboration at CERN [1], with IFIN-HH as founding member, has proposed an experiment to test some predictions of nonperturbative Quantum Chromodynamics (QCD) with hadronic atoms. According to the MEMORANDUM OF UNDERSTANDING, IFIN-HH group have to design, construct and operate a ***Preshower Detector*** (PSh) for pion and electron signal separation, respectively for real and background events. **In 2004** has been approved a new DIRAC Experiment to measure the lifetime of $\pi^+\pi^-$ and πK atoms. The new PSh was realized and installed at CERN (**Fig.1-2**), and now are taking experimental data for lifetime measurement of $\pi^+\pi^-$ and πK atoms.

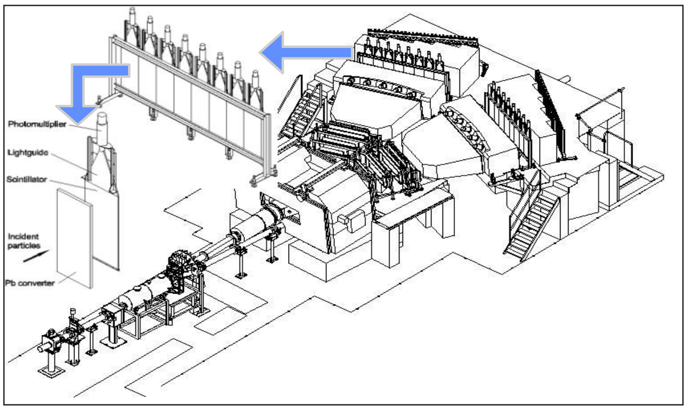

Figure 1. *The new DIRAC setup with Preshower Detector (pointed by blue arrows)*

Figure 2. *Mounting Preshower Detector at CERN – East Hall*

2. The project tasks

Quantum Chromodynamics (QCD) has successfully been tested only in the perturbative region of *high momentum transfer* (Q >1 GeV) or equally, at *short relative distance* $\Delta r \approx \hbar c/Q$ ($\Delta r \leq 0.2$ *fm*). In this region, the constituent quarks behave as weakly interacting (*asymptotic freedom*), nearly massless particles. As any gauge theory with massless fermions, QCD presents *chiral symmetry*.

In the nonperturbative region of low momentum transfer $Q < 100$ *MeV/c*, or at large distance $\Delta r > 2$ *fm*, *asymptotic freedom* is absent, and *quark confinement* with massive quarks takes place. Therefore, the *chiral symmetry* of QCD is *spontaneously broken*. Due to the fact that hadronic interactions at large distance ($\Delta r > 2$ *fm*) are described by pionic degrees of freedom, the Chiral Perturbation Theory (ChPT) [2] as the non-perturbative QCD theory, is replacing the QCD *quark degrees of freedom* (see **Fig. 3a)** by *pion degrees of freedom* (see **Fig. 3d)**. So we are studying the $\pi^+\pi^-$ and πK hadronic atoms, as objects with strong interaction structure. In the presence of *strong interaction*, the energy levels of the hadronic atoms will be shifted. The real part of the energy shift: $\mathrm{Re}(\Delta E_n)$ gives the energy level shift. The imaginary part of the energy shift: $-2\,\mathrm{Im}(\Delta E_n) = \Gamma_n$ gives the decay width ($\Gamma_n = 1/\tau_n$).There is a connection between $\pi^+\pi^-$ or πK bound states and their asymptotical counterpart of free particle scattering at zero energy [3]. The $\pi^+\pi^-$ or πK scattering are evaluated by *scattering amplitudes*, which at low energies are usually expressed in terms of *scattering lengths*. They are tested experimentally by measuring the lifetime (decay width) and energy level shifts for the $\pi^+\pi^-$ and πK hadronic atoms, directly connected with the s-wave scattering lengths [4].

3. The main responsibilities and results of the Romanian team

a) Study of shower development and particle discrimination for the DIRAC experiment.

b) Monte Carlo simulation of the new PSh Detector.
c) Design, construction and operation of the Preshower Detector along with DIRAC setup.
d) Determination of the PSh Detector characteristics and performances.
e) Design of experimental works with the PSh Detector in the DIRAC – CERN framework
f) Processing and analysis of the PSh signal distributions (electron and pion spectra).
g) Participation in acquisition, analysis and interpretation of the experimental data
h) Elaborate scientific papers on construction and use of PSh and on testing of nonperturbative QCD predictions.

4. The future challenges: Observation of the long-lived $\pi^+\pi^-$ atom and energy level shifts measurement.

In *p-Be* interaction $\pi^+\pi^-$ atoms in *ns* states are produced. Interacting with Be-atoms they will be excited (**Fig. 4**). The main 2*p*-state decay is a $2p \rightarrow 1s$ transition with a subsequent decay of 1*s*-state into $\pi^0\pi^0$. The lifetime of the $\pi^+\pi^-$ hadronic atom in the 2*p*-state is determined by its energy level. The $N^l_A(Be)$ excited $\pi^+\pi^-$ atoms will fly and breakup into the *Pt* foil (1-2μm), providing an additional number of atomic pairs n^l_A (see **Fig. 4**). The separation of atomic pairs produced in the *Be* target n^{Be}_A and in the *Pt* foil n^l_A is done by a magnetic field. The lifetime measurement of the excited $\pi^+\pi^-$ atom states is done similarly to that for the ground state.

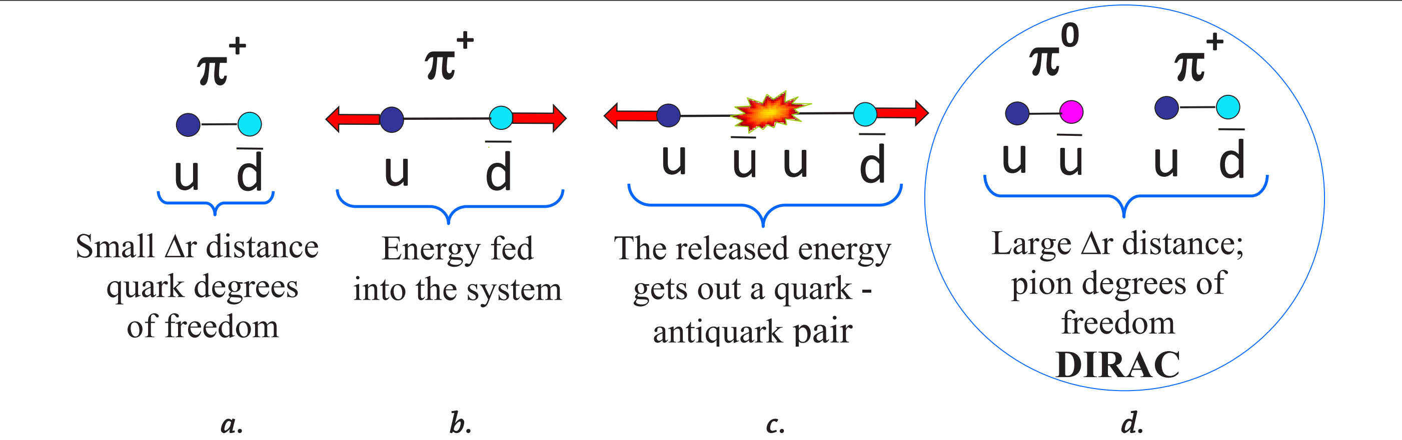

Figure 3. *Quark transition from perturbative (a) to nonperturbative (d) behavior*

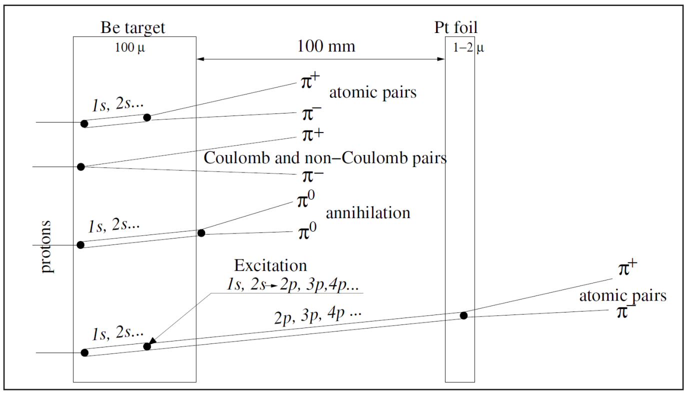

Figure 4. *Method for observing the long-lived (metastable) $\pi^+\pi^-$ atoms*

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Experimental and theoretical studies of exotic nuclei at ISOLDE

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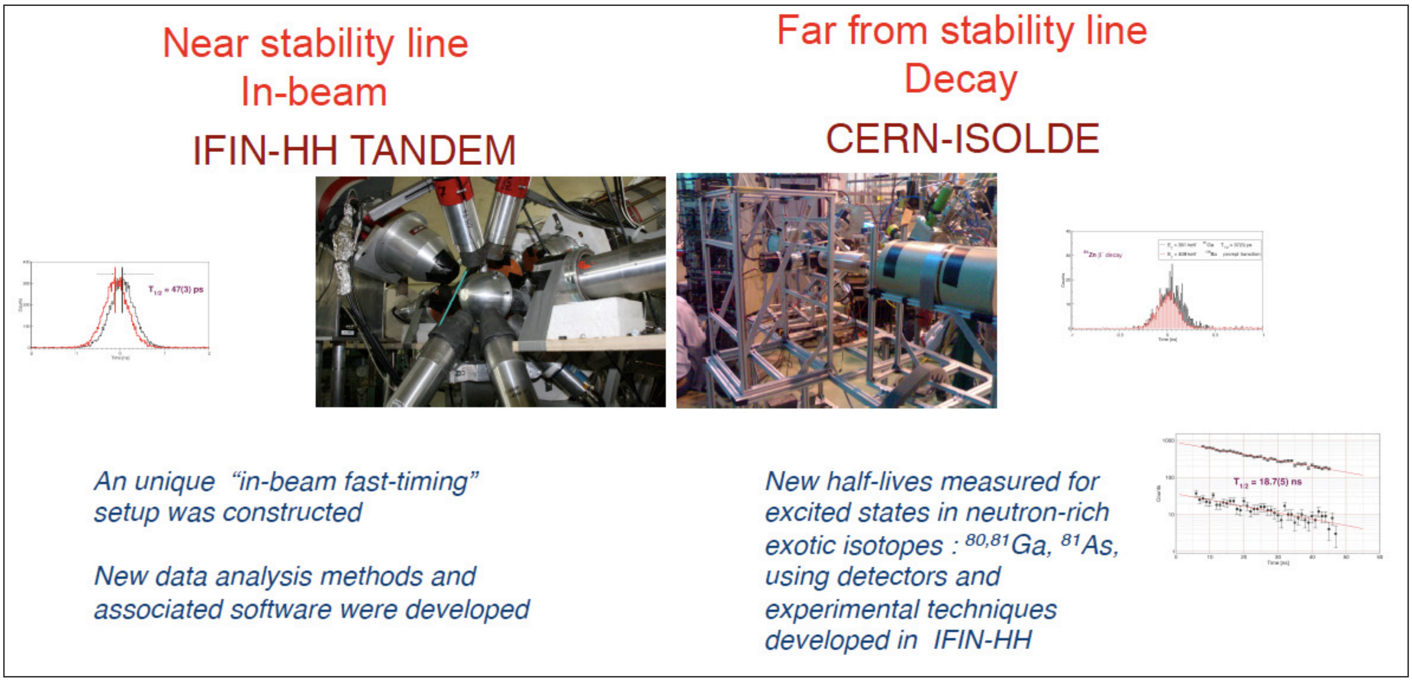
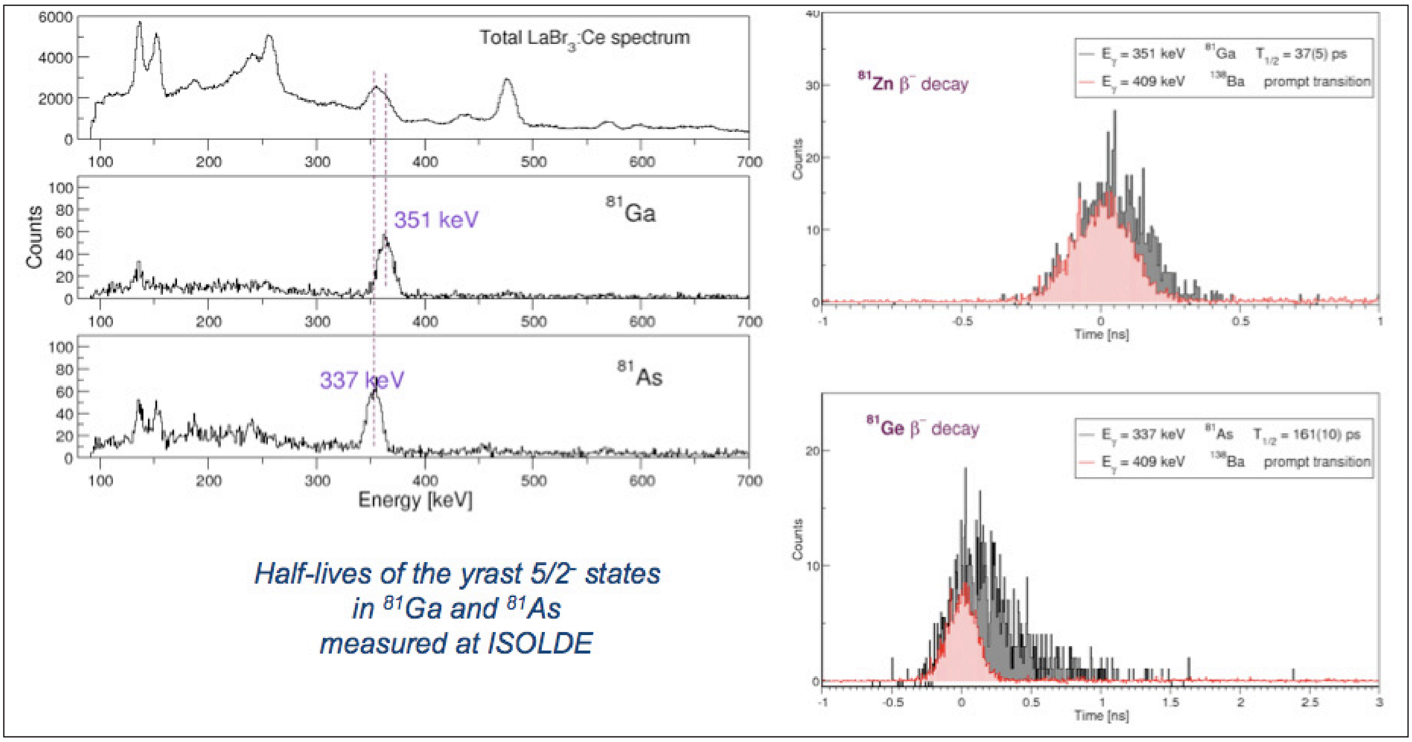
Project web page: *http://tandem.nipne.ro/proj/isolde*

The ISOLDE (*http://isolde.web.cern.ch/ISOLDE/*) experimental facility dedicated to the production of radioactive ion beams (RIB), located at CERN, is chronologically the first installation of this kind in the world, and has proven, along the years, to be one of the most prolific from the point of view of the scientific output. The present research programs cover a wide scientific spectrum, including nuclear physics (gamma spectroscopy, radioactive decay, precise nuclear mass measurements, etc), astrophysics, solid-state physics, bio-medical studies using radioisotopes for diagnostics and treatment. Presently ISOLDE offers a wide range of radioactive isotopes and the installation of a post-accelerator (REX-ISOLDE) has opened new RIB research fields especially in high-energy area.

The experimental possibilities existing at ISOLDE are ideally suited for studying the structure of atomic nuclei up to isotopes very far from the line of stability. This attracts the interest of many Romanian nuclear physicists having a long tradition and excellent results in studying the nuclear structure at low excitation energies, and it was a natural evolution the fact that Romania became member of ISOLDE collaboration in 2008.



Participating in large scientific collaborations always represent a motivation for development at national level, and this is the case also for the Romanian physicists collaborating at ISOLDE. During the last years the main highlight of the experimental activities of Romanian groups at this facility has been the measurements of lifetimes of excited states in atomic nuclei using the electronic "fast timing" technique. This experimental technique has become of very high interest in the last five years once the best inorganic scintillation material, $LaBr_3$(Ce), appeared on the market. Being one of the main promoters on the use of this new scintillation material in gamma spectroscopy, the Romanian physicists brought a significant added value to the European "fast timing" collaboration through significant investments in detectors and associated electronics. In the same time an unique setup with HPGe and $LaBr_3$(Ce) detectors for in-beam "fast timing" experiments was constructed at the TANDEM accelerator in Bucharest, providing the possibility to perform experiments that nicely complement the research carried on at ISOLDE. This approach of correlated development of the experimental infrastructure and data analysis techniques for complementary research at ISOLDE and at a national facility proved to be very successful, and this is demonstrated by the number of experiments performed in collaboration with international groups both at ISOLDE and at the TANDEM laboratory in Bucharest. Several very interesting physics results were obtained in the last two years using the "fast timing" technique by the Romanian group involved in the ISOLDE collaboration, good examples in this sense being the M2 matrix element coupling the normal and "intruder" configurations in the near-to-island-of-inversion nucleus ^{34}P in an experiment performed in Bucharest, and the determination of new level half-lives and isomeric states in very neutron-rich nuclei around ^{81}Ga at ISOLDE.



Half-lives of the yrast 5/2- states in ^{81}Ga and ^{81}As measured at ISOLDE

Another research topic in which the Romanian group was actively involved is the Coulomb excitation using the radioactive ion beams delivered by REX-ISOLDE. When dealing with very rare isotopes this type of experiments are often challenging, and this was the case for the successful studies performed in collaboration mainly with IKP Köln on the very neutron-rich $^{94,96}Kr$.

The experimental research pursued at ISOLDE and complementarily at Bucharest was continuously coupled with significant efforts along the line of theoretical understanding of the new physics results obtained at both facilities. In this respect, the most important results obtained within 2009-2011 concern (a) systematic derivation of effective nucleon-nucleon interactions and extrapolations to nuclei under extreme conditions, particularly in new regions of isospin, involving many-body microscopic models going beyond mean field approaches, (b) test of fundamental interactions and isospin symmetry breaking in medium mass nuclei describing self-consistently the mirror energy differences for mass numbers A= 66, 70, and 82, (c) Gamow-Teller strength distributions and accumulated strengths for the beta decay of the ground state and possible low-lying isomeric states of ^{68}Se, dominated by shape coexistence and mixing, relevant for the astrophysical rp-process and (d) self-consistent description of shape coexistence at low and intermediate spins for neutron-rich Zr nuclei in the A~100 mass region.

As a concluding remark one can say that the Romanian participation at ISOLDE has been beneficial because it triggered very significant experimental developments inside the collaboration and at the national TANDEM laboratory, contributed to maintain and increase the high scientific level of nuclear physics research of Romanian physicists and constitutes a continuous attraction for young Romanian students toward the field of nuclear physics.

Romanian Participation at CERN – n_TOF Collaboration

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Project web page: *http://proiecte.nipne.ro/pn2/135-proiecte.html*

Neutron cross-section measurements are important for several field of fundamental and applied Nuclear Physics. The most important ones have always been Nuclear Astrophysics and Nuclear Technology, but neutron data are also important in Nuclear Medicine, for material science, for Archeological and cultural studies, etc. In fundamental Nuclear Physics, neutrons have always been a precious probe to investigate the structure of nuclei, and the nature of fundamental forces. The neutron time-of-flight facility, n_TOF, is a neutron source that has been operating at CERN since 2001. It is a unique facility in which neutrons are produced in a wide range of energies and in very intense beams. This allows precise measurements of neutron related processes that are relevant for several fields. One example is nuclear astrophysics where data produced by n_TOF are used to study the ordinary stellar evolution as well as supernovae. Intense neutron beams are also critical in the studies of processes of incineration of radioactive nuclear waste and for a better understanding of the effects of radiation in the treatment of tumors with beams of hadrons (hadrono-therapy).

During 2009-2011, the Romanian n_TOF team was involved in activities concerning experimental and theoretical Basic Nuclear Physics.

Experimental activities. The main goal of the project is to produce, evaluate and disseminate high precision cross sections for the majority of the isotopes relevant to the waste incineration and the ADS design i.e. capture and fission cross sections for the minor actinides, capture cross sections for the main fission products and (n,xn). In this context we participated to the experimental activity dedicated to the determination of fission cross section for different isotopes of interest as Th-232, U-235, U-238, Np-237, U-234, U-236. The experimental set-up consists of nine target and the fission fragments are detected in coincidence in 2 parallel plate Avalanche Counters surrounding each target. To improve the efficiency, the targets are tilted with an angle with respect the neutron beam. This property, allows a full coverage of the angular distribution of the fragments. We participated also to measurement of neutron induced fission cross section by using a new fission tagging set up that combines a total absorption calorimeter with MicroMegas fission detectors.

Theoretical activities. For advanced systems involving the transmutation of nuclear wastes, it is necessary to improve the knowledge of fission cross-sections. The fission threshold and the sub-threshold resonance structure in some of the higher actinides allow for the studies of the fission barrier, as well as the structure (hyper-deformation) of the fission potential. Our group was focused on activities linked on new information on the basic mechanisms of nuclear fission. These can be obtained by mixing accurate experimental data with new theories that take into account the nuclear structure of the nuclear system during the whole disintegration process. For example, the new experimental values concerning the ^{234}U(n,f) cross-section, obtained in the n-TOF program, displayed a structure of supra-barrier resonances that are not of statistical nature. Phenomenological and statistical models based on the saddle density of state can not explain this rich resonant structure up to 20 MeV energies. New required methods were developed. Using di-nuclear mean field potentials of high complexity, the rearrangement of the intrinsic energy levels beginning from an initial just formed compound nucleus up to the asymptotic configuration of two separated fragments was obtained. The rearrangement of the nuclear levels in conjunction with constraints emerging from conservation of constant of motions is a cause for the existence of some microscopic effects. These dynamic effects manage the excitation of the nucleus. Each excitation gives rise to a specific fission barrier, and therefore to an associated resonance structure in the threshold fission cross section.

The Th anomaly could be explained in this context. Precise resonance spin and parities in the thermal region of the cross section could be obtained with our model, making possible comparisons with the fission fragment angular distributions measured in the framework of n_TOF-Ph2. Furthermore, the model allows also the determination of fission fragments yields. We expect that the experimental and theoretical coupling will lead finally to improved data evaluation. In this context, the first step is to determine theoretically the double humped fission barrier. For this purpose, the macroscopic-microscopic model was used. The macroscopic part is given by the Yukawa plus exponential model extended for binary systems with different charge densities. For the microscopic part, the shell and pairing effects are computed on the basis of the double center Woods-Saxon potential, The dynamic fission barriers were determined dynamically by taking into account the deformation energy landscape and the cranking inertia for systematics of nuclei of interest: U, Np and Th. For this purpose, the minimal action principle was used. By comparing our barrier heights with data obtained from experiment, a good agreement was obtained.

The results concerning the barriers lead us to analyze the excitation energy partition in fission fragments. Experimental direct indications about the excitation energies of the fragments are obtained by measuring their evaporated neutrons. Despite a similar temperature of the neutron velocity distributions, the experiment revealed that a larger excitation energy characterizes the light mass distribution in comparison with the heavy one. The shifting in the sawtoothlike behavior of the neutron multiplicity as a function of the parent excitation was attributed mainly to the deformation energy and not to the intrinsic heat. Motivated by these aspects, in our activities, the intrinsic excitation energy of the fragments are evaluated dynamically in terms of time-dependent pairing equations in the cold fission regime, The basic ingredients for the TDPE are the single-particle diagrams that must be computed from the initial state of the fissioning nucleus up the configuration given by two separated fragments. Using conditions that fix the number of particles in each fragment, it was possible to obtain for the first time the excitation energy of each nucleus issued in the fission process. A recent hypothesis that claims the excitation energy is not equilibrated between fragments was confirmed in the cold fission regime.

The IFIN-HH team joined the n_TOF collaboration last year, for the 2010 campaign. The results that have been obtained and published in the meantime are shown within the papers below.

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Evaluation of the ageing state and durability of CERN cable insulation materials

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The main objective is to set-up a method for monitoring the degradation state and evaluation the residual durability (residual life-time or residual supportable dose) of insulation cable materials in service in radiation environments in CERN accelerators.

The project development consisted in three stages:

I - exploratory: identification of the representative CERN cables, analyze of their structure and components (polymeric materials), comparative measurements by CL and DSC and correlations between the two techniques on different cable materials;

II - implementation of the procedure: establishing the adequate technique, calibration measurements, kinetic models of degradation, procedure;

III - procedure application and development: application of the procedure for characterization the ageing state and the residual durability of CERN aged materials (witness, real cables aged in service conditions, laboratory aged materials); extending the application field of the DSC procedure.

In the first step the concordance of CL and DSC measurements was experimentally proved on more than 20 different cable electroinsulation materials (Fig. 1) based on various polymers used in CERN cables structure - low density polyethylene (LDPE), high density polyethylene (HDPE), ethylene-vinyl acetate copolymers (EVA), ethylene-propylene copolymers (EPR) on initial and irradiated state (at different dose rates).

The comparison of both methods (CL and DSC) indicated that the results are equivalent, but the use of CL is not possible for very dark materials and for those degrading by different mechanisms than Bolland-Gee scheme. To continue this cooperation project (testing different materials, elaboration of residual durability evaluation procedure), at ICPE-CA was purchased a DSC Setaram 131 evo instrument and parallel measurements were performed at ICPE-CA an CERN in order to setting-up the procedures for cables testing and lifetime evaluations in the second step of the cooperation project.

Procedures based on international standards and own data were settled-up for oxidation induction time (OIT) in isothermal measurements as well as

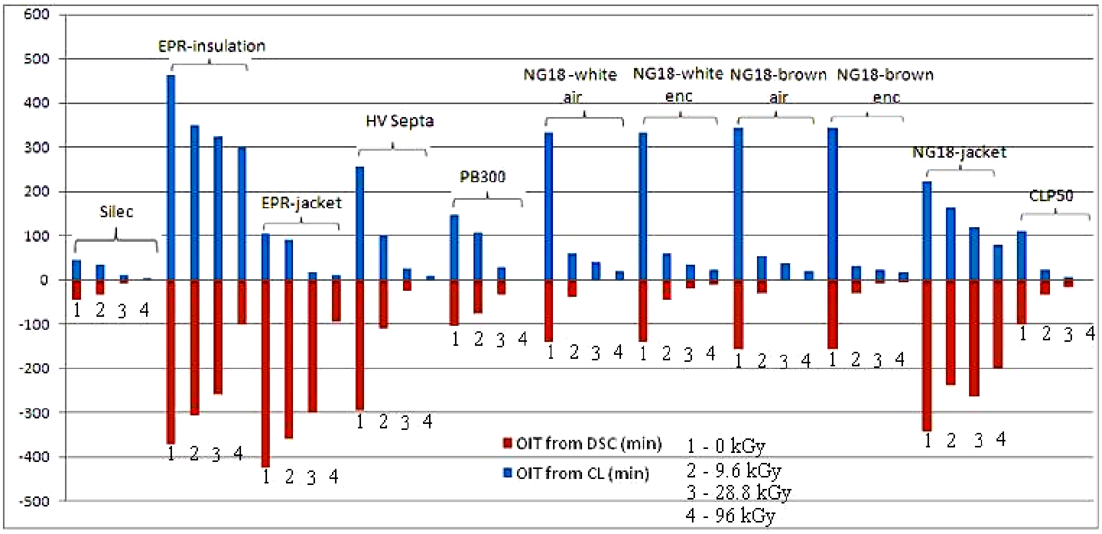

***Fig. 1** - Correlation between the OIT values from DSC (red) and CL (blue) for the insulation polymeric materials characterized at ICPE-CA (by isothermal CL) and respectively at CERN (by isothermal DSC)*

for oxidation induction temperature (OOT) and subsequent OIT calculation from non-isothermal data.

A first order kinetic of oxidation induction time (OIT) decrease with the irradiation dose or irradiation time was proved to occur in all cases of CERN representative cables (Fig. 2). This behavior enables to evaluate the residual lifetime or the maximum tolerable dose.

In the third step, cables and cable witness exposed in CERN in different critical points (i.e. SPS P4 (measured dose D = 105 kGy) and SPS point 5, D = 26 kGy, LSS-2 (unknown dose) etc. were measured in order to evaluate their residual lifetime and to decide about the replacement of these cables. Other cable witnesses placed in different points in LHC are going to be collected in CERN at the next stop of the machine.

Future cooperation will be focused on cables ageing monitoring, including the participation in CERN-RIAC-WG (Replacement Irradiated Aged Cables Working Group), investigation tools to improve the accuracy for the aged cables replacement, development of more accurate methods for diagnose the state of irradiated dielectric fluids.

The cooperation with CERN has benefic influence on the increasing of the cooperation capability of the Romanian research team in different national and international project as well as on increasing of their scientific and technical experience. The results of the experimental work of the Romanian team were disseminated by publication in academic journals and communication at key international conferences [1-5].

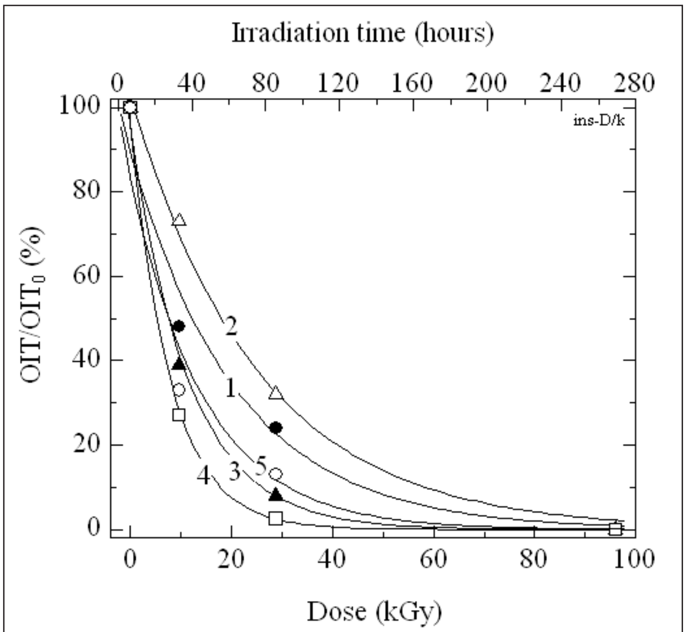

Fig. 2 *- The normalized OIT values decrease (OIT_D/ OIT_0; D = the radiation dose) vs. irradiation dose (γ ^{137}Cs, D_r = 0.4 kGy/h) for different LDPE insulation materials: 1(●) - cable Silec, strap; 2 (Δ) - cable PB-300, strap; 3 (▲) - cable HV Septa, strap; 4 (□) - cable NG-18, white insulation, bulk-enc. 5 (o) - cable NG-18, white insulation, bulk-air*

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CERN – European Organization for Nuclear Research
www.cern.ch

ANCS – Romanian Authority for Scientific Research
www.mct.ro

IFA – Institute of Atomic Physics
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