# Romanian research projects at CERN

## 2009 - 2015

Bucharest-Magurele, ROMANIA
2015

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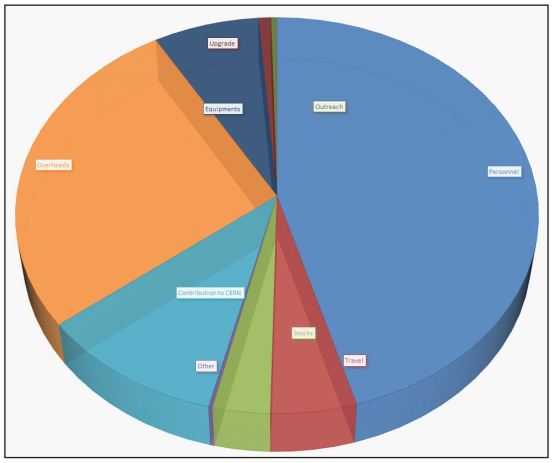
## RONIPALICE

The Romanian group is involved in the analysis of transverse momentum spectra of charged particles and identified charged hadrons as a function of charged particle multiplicity and event shape.

The NIHAM Group realized **130 ALICE-TRD chambers**, covering an area of **167m².**

The NIHAM GRID site has more than **2,000 cores and 1.8 PB storage capacity**. The site has delivered more then **75 Million normed CPU hours** over the last 6 years, representing **4%** of the total number of activities performed within ALICE collaboration.

Number of published papers: 255
Number of obtained patents: 2
Number of PhD theses: 2
Number of MSc theses: 2
Number of BSc theses: 2



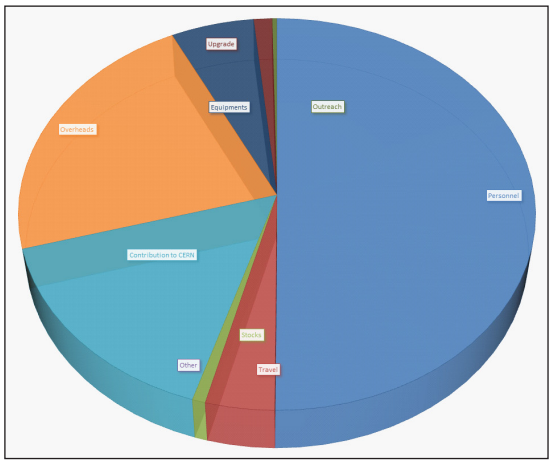

*Allocated budget **(13.656.917,42 lei)** and the distribution of costs between 2009 and 2015*

## JETALICE

The general objective of the group consists in the detailed analysis of the structure of leading jets in the event and the distribution in energy and hadronic content, collective phenomena in heavy ion collisions, Monte Carlo (MC) simulations and detector response, GRID.

ISS is involved in GRID activities related to CERN experiments since the beginning of the development of AliEn middleware (2001-2002), a pilot installation operating as early as July 2006. The GRID site have processed more than **3.382.000 jobs** (1% of total number of ALICE jobs) and transferred over **6.5 PB** of data.

Number of published papers: 95
Number of PhD theses: 4




*Allocated budget **(5.075.629,55 lei)** and the distribution of costs between 2009 and 2015*

## ATLAS

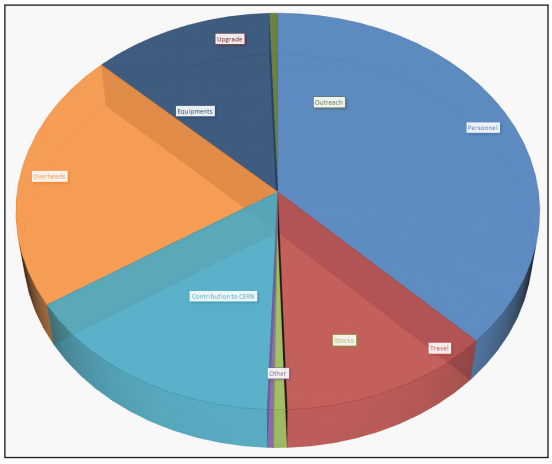
ATLAS will learn about the basic forces that have shaped our Universe since the beginning of time and that will determine its fate.

Trigger Companion Chip prototype was designed and produced. Detailed specification of the Trigger Processor Mezzanine was laid out and agreed with an external Romanian contractor that is specialized in **ATCA (Advanced Telecommunications Computing Architecture) technology.**

The **64-channel** data acquisition system has been designed and tested via simulations.

Two long baskets for **Tile super-drawers** extraction and insertion have been redesigned and delivered to CERN. Production of eight **Tile mechanical mini-drawers**; positive results from tests run at CERN.

Number of published papers: 375
Number of PhD theses: 8
Number of MSc theses: 3
Number of BSc theses: 4




*Allocated budget **(17.250.729,81 lei)** and the distribution of costs between 2009 and 2015*

# Short summaries

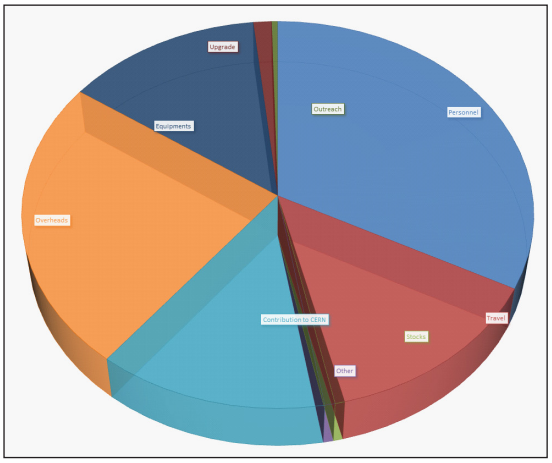
## LHCb

The scientific objectives of the LHCb collaboration involve Standard Model tests with high precision measurements, usually in systems composed of at least one beauty or charm quark.

The physics program of the Romanian group in LHCb involves the Minimum Bias studies of **light flavor particles** usually with a strange component.

Direct contributions to the LHCb program include the periodic shifts, data quality checks, **Monte Carlo simulations** and **developments of simulation software**, administrative software development and support, LHCb-dedicated **GRID Tier-2** sites provided to the LHCb Collaboration.

Number of published papers: 265
Number of PhD theses: 7
Number of MSc theses: 7
Number of BSc theses: 3




*Allocated budget **(6.934.542,09 lei)** and the distribution of costs between 2009 and 2015*

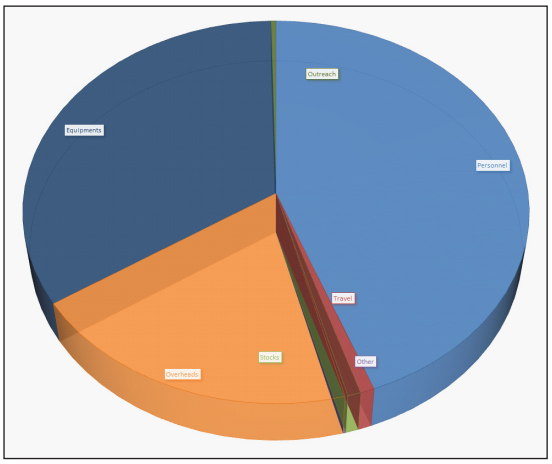
## CONDEGRID

The WLCG collaboration provides the computing support for the storage, processing, simulation and analysis of the data from the four major experiments at LHC.

The mission of the RO-LCG Federation is to provide offline computational support for ALICE, ATLAS and LHCb experiments, within the WLCG collaboration.

During 2009-2014 the computing capacity of the federation increased by four times, reaching **more than 7000 cores,** while the total disk storage doubled to **2.9 PB**. These resources have been highly available to the HEP community, which has run more than **157 Million normed CPU hours** and more than **330 million jobs** on the RO-LCG infrastructure. As a result, in the last couple of years RO-LCG ranked **12$^{th}$** among all the **36 Tier2** national centers, regarding the cumulated CPU hours.

Number of PhD theses: 11
Number of MSc theses: 4




*Allocated budget **(10.664.706,33 lei)** and the distribution of costs between 2009 and 2015*

## EXONTEX-ISOLDE

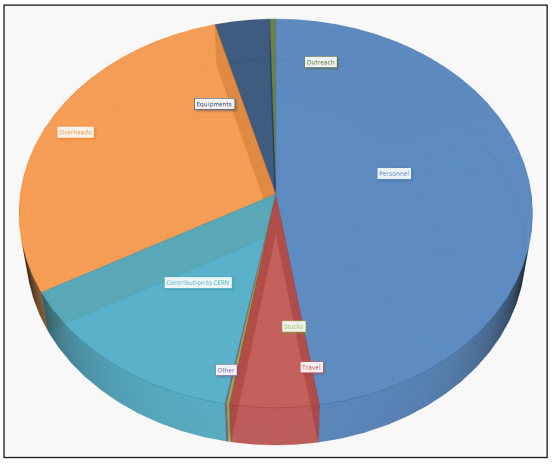
The ISOLDE experimental facility located at CERN is dedicated to the production of radioactive ion beams.

The main types of experiments performed by the Romanian researchers at ISOLDE are **decay spectroscopy of exotic nuclei, Coulomb excitation** and **lifetime measurements** using the fast-timing techniques.

The research activity of the Romanian team at ISOLDE evolved gradually, from collaborating at decay spectroscopy experiments with relatively simple detection systems to building complex setups for experiments based on ideas coming from Romanian physicists.

The ISOLDE collaboration had the role of a catalyst for developing experimental possibilities for **nuclear physics in Romania.**

Number of published papers: 21




*Allocated budget **(7.399.904,48 lei)** and the distribution of costs between 2009 and 2015*

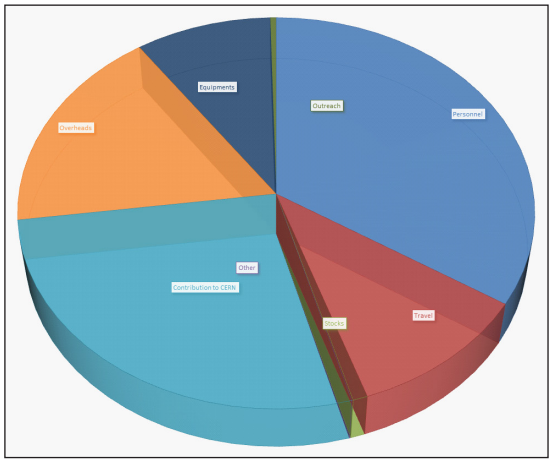
# Short summaries

## n_TOF

The main objectives of the n_TOF activities are: neutron cross section measurements for nuclear astrophysics, nuclear data measurements for advanced nuclear technologies and nuclear waste transmutation, as well as neutron cross section measurements for basic nuclear physics.

The activities carried out in the collaboration, addressed the resonant structure of the fission cross section and the dissipation produced in different fission channels. Using **time dependent equations of motion** that are similar to the time-dependent **Hartree-Fock-Bogoliubov** ones, we showed that the **dissipation is larger in symmetric fission channels** and **smaller in asymmetries.**

Number of published papers: 30




*Allocated budget* ***(843.798,51 lei)*** *and the distribution of costs between 2010 and 2015*

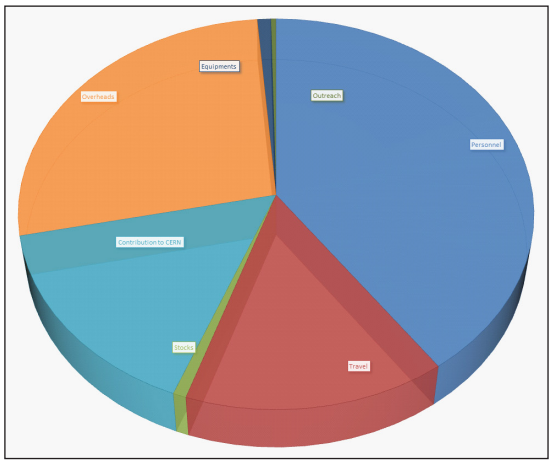
## DIRAC

The DIRAC experiment aims to test some predictions of the Chiral Perturbation Theory as the model of the nonperturbative Quantum Chromodynamics.

The design, construction and use of the Preshower Detector (PSh), which is the **first Romanian produced detector at CERN**. It is a large detector **(7m x 1.5m, weight ~ 1500kg)** used for the electron background rejection in hadronic atoms observation and their lifetime measurement.

The main responsabilities of the Romanian group were: designing, constructing and testing of the PSh detector; elaborating the PSh methodology; integrating and using PSh in the DIRAC data taking; performing the analysis, data processing and physical interpretation of the experimental results; writing scientific papers on PSh detector and on hadronic atoms detection and lifetime measurement.

Number of published papers: 5

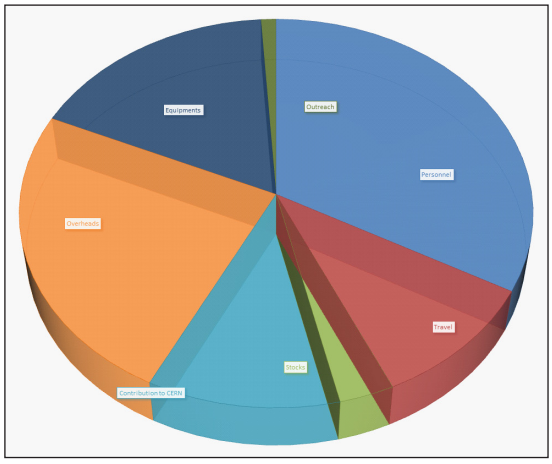



*Allocated budget* ***(3.678.064,92 lei)*** *and the distribution of costs between 2009 and 2015*

## NA62

The NA62 experiment aims to measure the very rare kaon decay $K^{+} \rightarrow \pi^{+} \nu \bar{\nu}$ at the CERN SPS, to make a decisive test of the Standard Model (SM) by extracting, through a 10% measurement, the Cabibbo–Kobayashi–Maskawa (CKM) parameter $|V_{td}|$.

Since 2014, IFIN-HH group is responsible for the NA62 Hadronic Sampling Calorimeter **(HASC) sub-detector**; the short term objectives are: Construction and commissioning of the **Read-Out system** of HASC; Development, implementation and deployment of **L1/L2 software trigger** for HASC; Maintenance, operation and performance analysis of the Hardware Sampling Calorimeter and LI/L2 software trigger; Participation in NA62 physics runs and data analysis.




*Allocated budget* ***(1.008.651,19 lei)*** *and the distribution of costs between 2014 and 2015*

# IFIN-HH Contribution to the ALICE Experiment at LHC (RONIPALICE)

**Project Leader:** Mihai PETROVICI
**Project Coordinator:** Horia Hulubei National Institute of Physics and Nuclear Engineering
**ALICE Collaboration**: *http://aliceinfo.cern.ch/*
**Project web page:** *http://niham.nipne.ro/cap_M3_alice.html*

**Main objectives of the CERN Experiment/ Collaboration:**

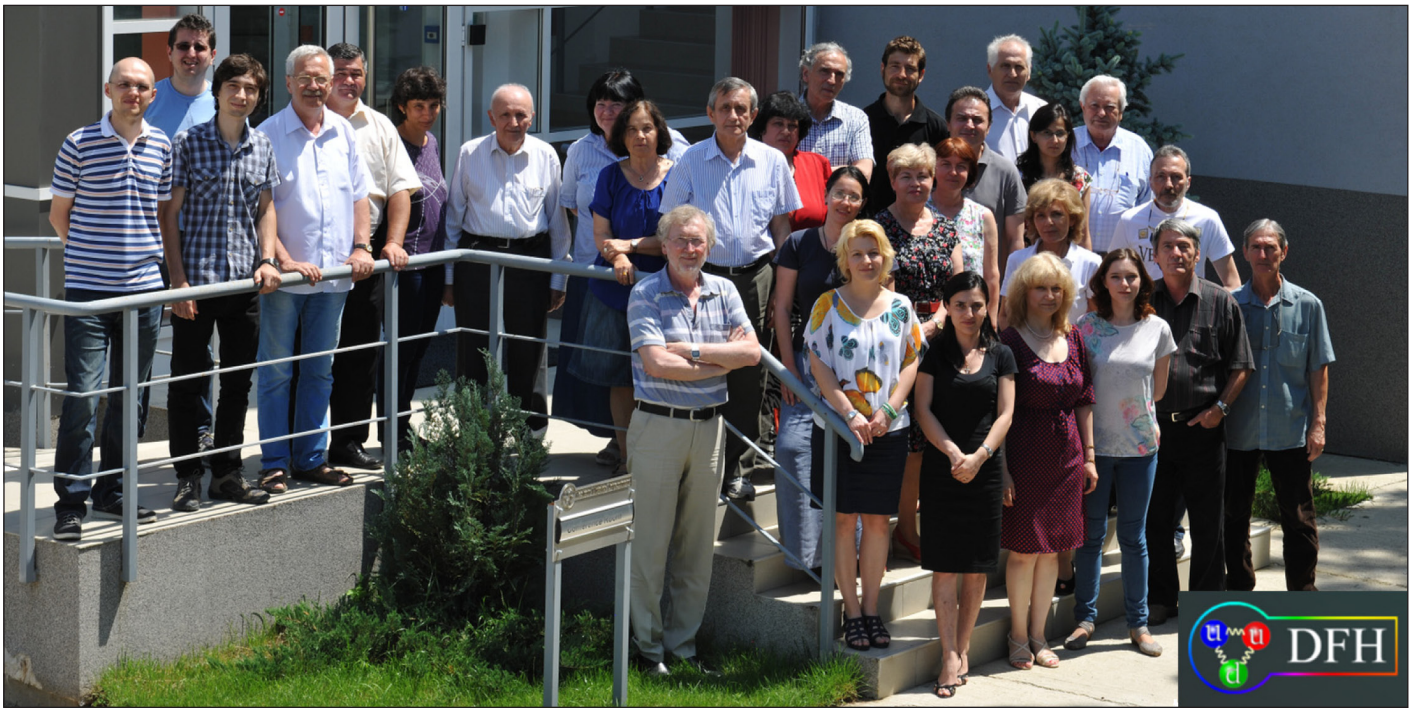
Since 1999, the Hadron Physics Department of the National Institute for Physics and Nuclear Engineering (IFIN-HH) is a member of the ALICE Collaboration. ALICE (A Large Ion Collider Experiment), an experiment carried out at the Large Hadron Collider at CERN-Geneva, optimised for the study of heavy ion collisions, and aims to study the properties of the hot deconfined matter formed in such collisions, its dynamical evolution, phenomena associated with the phase transition of re-hadronization and finally the evolution of the hadronic final state until kinetic freeze-out. To achieve this goal, ALICE is designed to measure a large set of observables over as much phase space as achievable.

**Main objectives of the Romanian participation in CERN Experiment/Collaboration:**

Our group is involved in the analysis of transverse momentum spectra of charged particles and identified charged hadrons as a function of charged particle multiplicity and event shape, a subject proposed by our team, aiming to put into evidence the production of deconfined matter and collective type phenomena in p+p collisions at LHC energies. Besides the fact that such phenomena are highlighted for the first time in hadron collisions, they will also have a strong impact in understanding the phenomena observed in Pb+Pb and p+Pb collisions, thus bringing an essential contribution to the main objectives of ALICE Experiment at LHC.

**Main achievements of the Romanian team during 2009 - 2015:**

Members of the group had significant contributions to the R&D activities related to the ALICE-TRD and the associated analogic front-end electronics. The first front-end electronics prototype realized with discrete components has been used for in-beam tests of the first TRD prototype. The final preamplifier/shaper chip was designed with the main contribution of our group. In our Department were realized 130 ALICE-TRD chambers, covering an area of 167 $m^2$ and having 253,000 read-out channels (24% of the ALICE-TRD). We actively participated in the installation of TRD supermodules



in the experimental set-up and since Autumn 2009 in running the experiment, calibration and tracking of TRD subdetector and data analysis. Being aware of the computational requirements for simulating, calibrating and analyzing the experimental information delivered by such a complex experimental device, GRID activities were initiated in our group since early 2000. By November 2002 together with the Computing Cluster of our Centre of Excellence NIHAM we realized the first international GRID application in Romania within ALICE GRID.

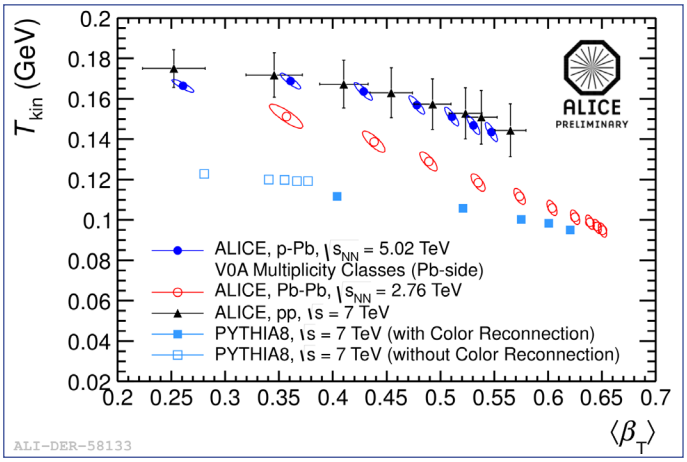
Presently the NIHAM GRID site, with more than 2,000 cores and 1.8 PB storage capacity is one of the most efficient ALICE GRID sites and has delivered more than 75 kSI2k Mhours over the last 6 years, representing 4% of the total number of activities performed within ALICE collaboration. The monitoring of these activities is done via the MonAlisa and is available online at: *http://pcalimonitor.cern.ch:8889/map.jsp*. Almost a similar computing capacity in terms of cores and storage is used as an analysis facility for internal needs of HPD for large scale model calculations, simulations, software development, calibration, tracking and fast analysis.

**Socio-economic impact of the Romanian participation:**

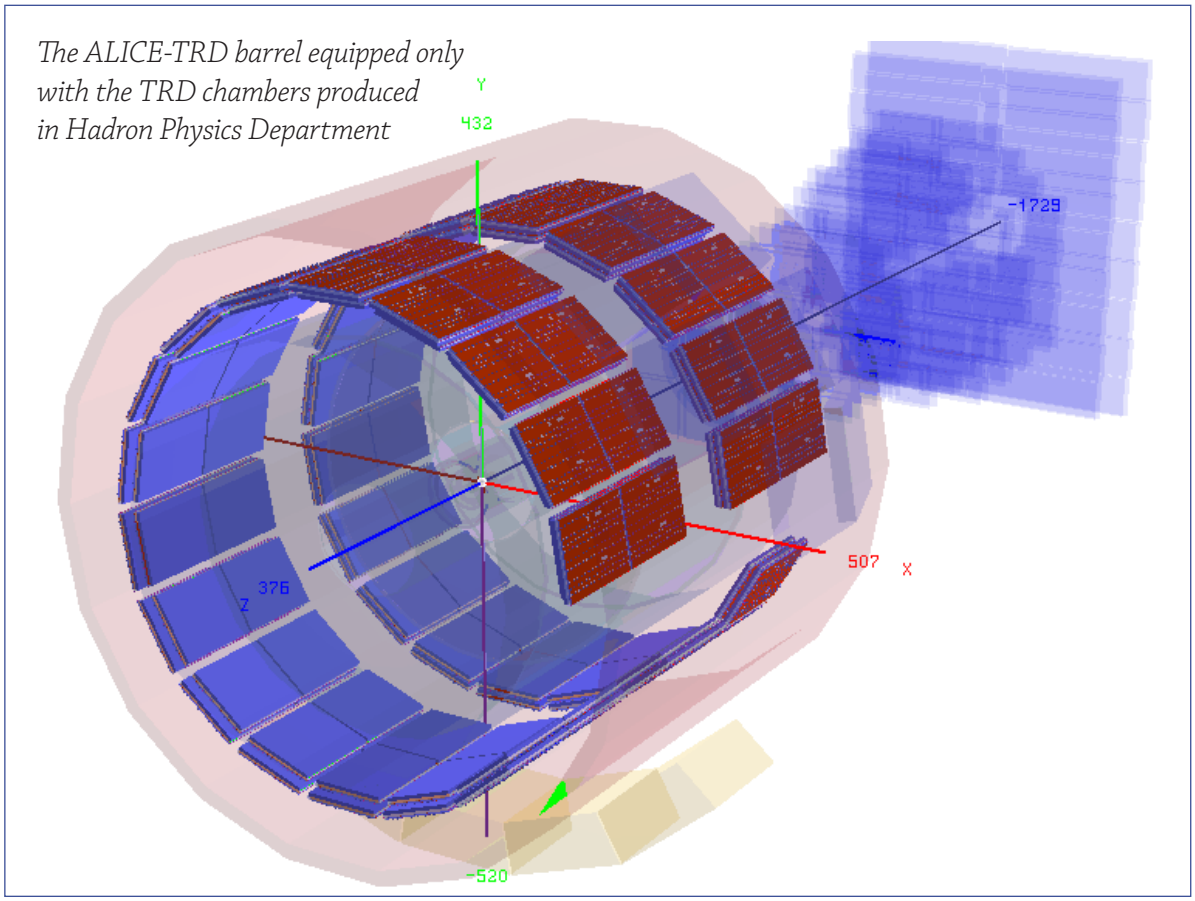
The first analog CHIPs designed in Romania were produced and are currently used in experiments. A new generation of gas detectors and their associated front-end electronics were designed, built and tested. HPD is organising Summer Student Programs, visits of students and coordinates diploma, master and PhD thesis.

**Perspectives of the Romanian participation in CERN Experiment/Collaboration:**

We are involved in the ALICE upgrade program; in HPD will be assembled and tested 50% of the outer read-out chambers (OROC) of the ALICE-TPC. The new type of detectors, front end electronics, the infrastructure and knowhow existing in HPD will guarantee a visible and competitive involvement of Romania in future projects at CERN as LHeC, ILC or SCC.




*Kinetic freeze-out temperature versus mean transverse expansion velocity.*




*The ALICE-TRD barrel equipped only with the TRD chambers produced in Hadron Physics Department*

# Detailed analysis of jets in p-p and Pb-Pb collisions at ALICE experiment (JETALICE)

**Project Leader:** Daniel FELEA
**Project Coordinator:** Institute of Space Sciences from Bucharest-Magurele
**ALICE Collaboration**: *http://aliceinfo.cern.ch/*
**Project web page:** *http://iss14.nipne.ro/projects/imotep/index_en.html*

**Main objectives of the CERN Experiment/ Collaboration:**

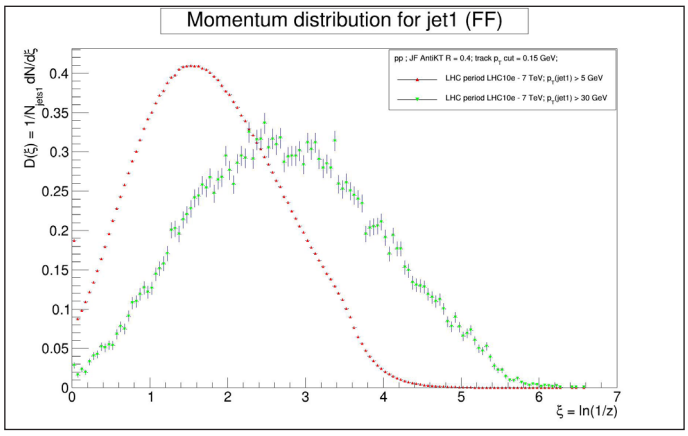
ALICE studies the role of chiral symmetry in the generation of hadronic mass using heavy-ion collisions to attain high-energy densities over large volumes and long timescales. ALICE investigates both, equilibrium as well as non-equilibrium physics of strongly interacting matter in the energy density regime above 1 GeV fm-3. The aim is to gain insight into the physics of parton densities close to phase-space saturation, and their collective dynamical evolution towards hadronization in a dense nuclear environment. Thus, one also expects to gain further insight into the structure of the QCD phase diagram and the properties of the QGP phase.

**Main objectives of the Romanian participation in CERN Experiment/Collaboration:**

The general objective of the group consists in the detailed analysis of the structure of leading jets in the event and the distribution in energy and hadronic content (particles - result of parton shower hadronization), collective phenomena in heavy ion collisions, MC simulations and detector response, GRID. The properties of jets (the parton showers that through hadronization are seen as particle jets) give information on both, fundamental phenomena of QCD physics and medium properties. The group is involved in the jet physics and is activating on full and charged jets analyses and QA in newer data and comparison with older data.

**Main achievements of the Romanian team during 2009 - 2015:**

***Physics:*** During the first three years (2009-2011) 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, the jet fragmentation function F(z), and the average number of charged particles as a function of the relative azimuthal angle, 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, including CDF jet cone algorithm, implemented by our team in AliROOT. Since 2012, proton-proton interactions at 2.76 and 7 TeV have been analyzed. A cvasi-linear dependence of the leading jet multiplicity with the leading jet pT (at small pT) was noticed. With the increasing incident energy, the multiplicity of the neutral hadronic content is decreasing. The same observations resulted from the study of particle multiplicities around the leading jet cone. In the multiplicity distribution, we observed




in the radius unit, a well-marked multiplicity maximum for 7 TeV data and an overestimation of 2.76 TeV Monte Carlo data. Instead, the experimental multiplicity distributions in the radius unit at 2.76 TeV showed significant contribution of the neutral content. The fragmentation function can offer a direct characterization of the partonic transport in the collision. The obtained difference between 2.76 and 7 TeV data provides information regarding a larger energy transfer capacity of the participant parton at 7 TeV than at 2.76 TeV incident energy. Also, during 2013, the ALIROOT framework of ALICE was adapted, to make use of 3.0.x version of FASTJET and the differences between the used versions were evaluated. In the last year we have done comparisons of leading jet shapes, jet observables and underlying event parameters between 2.76 and 7 TeV energies in pp collisions and also full versus charged jet

comparison analysis of leading jet shapes, leading jet and underlying event parameters for available datasets.

***Offline:*** An important activity has been related to the proper functionality of "Quality Assurance train", in order to ensure the central productions quality corresponding to the acquired data in 2011 and 2012. Another activity was integrated in the development of ALICE strategy, linked to data preservation and "open access" at the CERN level. The Online Event Display development and maintenance was yet another important activity performed at CERN. Starting with February 1st, 2014, an important percent of ALICE Monte Carlo Production service task has been covered. The service task includes, but is not limited to, support for MC productions requests - formatting and necessary parameters, configurations for both, AliEn and MonALISA, running and following-up the MC production. In this regard, a tutorial presentation was delivered at the ALICE Week Outside CERN (Primosten, September 2014).

***GRID:*** ISS is involved in GRID activities related to CERN experiments since the beginning of the development of AliEn middleware (2001-2002), a pilot installation operating as early as July 2006. This installation supported the AliEn GRID middleware of ALICE experiment (one of the first implementation of GRID in Romania) since the very beginning. Also, ISS has a certified EMI site that supports ALICE experiment. Since 2009 our GRID sites have processed more than 3,382,000 jobs (1% of total number of ALICE jobs) and transferred over 6.5 PB of data.

**Socio-economic impact of the Romanian participation:**

The aim of this project is fundamental research, with impact on medium and long-term. Through the accumulation of knowledge, the social impact is specific to fundamental science, improving working and living conditions and growing the opportunities for education. There is also a major scientific and didactic impact. The involvement of PhD students and MSc students in this project determines their qualification at the highest international level.

**Perspectives of the Romanian participation in CERN Experiment/Collaboration:**

The full jets spectra will be analyzed for p-p interaction at 2.76 TeV, using anti-kT algorithm for jet reconstruction. Full vs charged jets on newer datasets will be compared. We will study full jet fragmentation as function of the chosen particle type, for jets with pT > 25 GeV. The measurements regarding the dependence of the jet fragmentation with the particle type bring constraints on the fragmentation models. A study on the anisotropic flow at the newer energies will also be conducted.

# ATLAS Experiment at the LHC (ATLAS)

**Project Leader:** Calin ALEXA
**Project Coordinator:** Horia Hulubei National Institute of Physics and Nuclear Engineering
**Partners:** National Institute of Isotopic and Molecular Technologies Cluj-Napoca, University Politehnica Bucharest, Alexandru Ioan Cuza University of Iasi, West University, Timisoara; Transilvania University, Brasov
**ATLAS Collaboration:** *http://atlas.web.cern.ch/Atlas/Collaboration*
**Project web page:** *http://www.nipne.ro/dpp/Collab/ATLAS/index.html*

**Main objectives of the CERN Experiment/ Collaboration:**

ATLAS will learn about the basic forces that have shaped our Universe since the beginning of time and that will determine its fate. Among the possible unknowns are extra dimensions of space, unification of fundamental forces, and evidence of dark matter candidates in the Universe. Following the discovery of the Higgs boson, further data will allow in-depth investigation of the boson's properties and thereby of the origin of mass. What's even more exciting is the surprise coming from the discovery of completely new and unknown processes and particles that will change our understanding of energy and matter.

**Main objectives of the Romanian participation in CERN Experiment/Collaboration:**

***SUSY:*** multileptonic and leptons+jets+ETmiss channels; QCD background and PDF uncertainty; analysis software tools developments; prospect for Run 2; ***SM and BSM:*** ttH cross section measurements; general search; G(221); ***Detector***: Tilecal operation and maintenance; jet energy calibration; electron reconstruction efficiency; ***Computing and TDAQ***: parallel processing; MC on many-cores architecture; online computing farm; CCM of the DAQ system; HLT integration and standardization; data file formats and derivatives; ***Upgrade***: NSW - companion chip and trigger processor design and production; characterization of new detectors and electronics; Tilecal Upgrade Phase-II Project.

**Main achievements of the Romanian team during 2009 - 2015:**

Same-sign leptons final states: we mainly focused on preparing the SUSY analysis for the LHC run-II, and on prospect studies to extend our activities to the ttH cross-section measurement; for the latter, projected sensitivities have been obtained for center-of-mass energies of both 8 and 14 TeV; these results have been documented and are now being shared within ATLAS collaboration. Finalization of SUSY 1 lepton analysis with 2012 data. Improvements and extensions of several common analysis software tools. Paper is under submission.

Study of the ability of the upgraded ATLAS ITK detector to distinguish between similar final states produced by particles with different spins, in the context of charginos or sleptons pair production. Validation of the general search software setup using a benchmark defined by a specific cut flow used by the ATLAS general search group. Results were published in a conference note. To further extend and improve the analysis, tau leptons were implemented in the analysis package. G(221) model predictions for the $W' \rightarrow hH^{\pm}$ decay channel have been calculated. Results, including estimates of current experimental sensitivity, were published.

A software tool for the jet calibration study was implemented and used for the complete 2012 data analysis.

Concerning the tests for parallel data analysis performed with BAAF, preliminary results were presented at the 9th Workshop in Quantum Field Theory and Hamiltonian Systems. In the TDAQ area, several improvements of the core online software were made, and new components were developed.

Trigger Companion Chip prototype was designed and produced. Detailed specification of the Trigger Processor Mezzanine was laid out and agreed with an external Romanian contractor that is specialized in ATCA technology. Afterwards, Trigger Processor Mezzanine board, was sent to production. The low profile front-end board is currently under test. The 64-channel data acquisition system has been designed and tested via simulations.

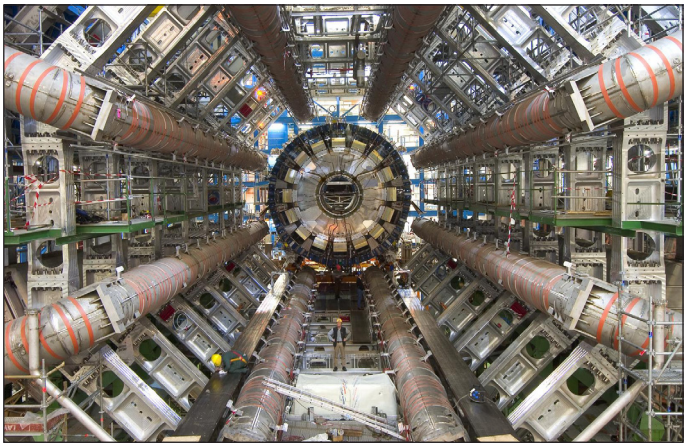
Two long baskets for Tile super-drawers extraction and insertion have been redesigned and delivered to CERN. Production of eight Tile mechanical mini-drawers; positive results from tests run at CERN.

**Socio-economic impact of the Romanian participation:**

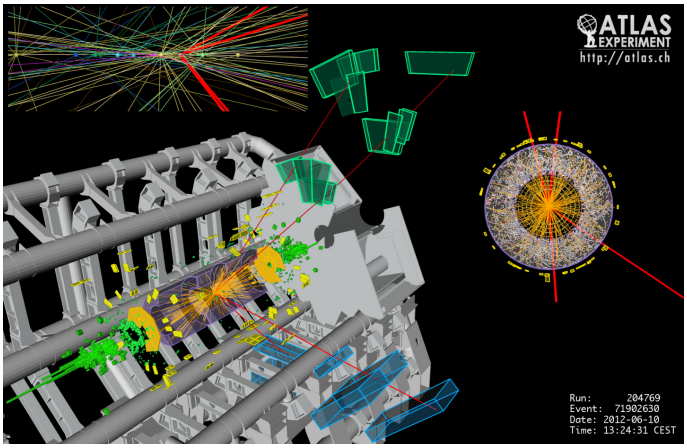
A large number of Outreach activities took place: International Masterclasses - Hands on Particle Physics held in Iasi, Bucharest and Timisoara, Mass Media shows - TV and radio, public screening of films dedicated to particle physics, 'CERN 60 - Glimpses from a Glorious History' film production, numerous visits to high schools in Iasi, Bucharest, Cluj-Napoca and Timisoara, etc. Between 2009 and 2015, 8 PhD theses, 3 Master Dissertations and 4 Licence Diploma have been finalised within our ATLAS cluster.

**Perspectives of the Romanian participation in CERN Experiment/Collaboration:**

Based on our experience accumulated in previous studies, our searches for new physics will benefit from both signal cross-sections increase at ECM=13TeV and the accumulation of a large integrated luminosity. In ATLAS Upgrade Phase I, our responsibility is for the NSW Frontend ASICs - design, prototyping, production of ART companion IC, readout module firmware and design, programmable delays, TTC. We are also contributing to the NSW MM Trigger processor WG and in the DAQ/HLT Configuration & Control software.



*ATLAS magnets*




*Higgs decay in 4 muons event*

# LHCb – from strangeness to b-physics and beyond (LHCb)

**Project Leader:** Florin MACIUC
**Project Coordinator:** Horia Hulubei National Institute of Physics and Nuclear Engineering
**Partners:** Suceava University „Stefan cel Mare"
**LHCb Collaboration:** *http://lhcb.web.cern.ch/lhcb/*
**Project web page:** *http://www.nipne.ro/dpp/Collab/LHCb/*

**Main objectives of the CERN Experiment/ Collaboration:**

The scientific objectives of the LHCb collaboration involve Standard Model tests with high precision measurements, usually in systems composed of at least one beauty or charm quark. The hope is to prove the existence of physics beyond the Standard Model of particle physics, i.e, the so-called New Physics. Some of the proposed probes in of this fundamental particle domain involve precise determination of the Cabibbo-Kobayashi-Maskawa matrix elements which govern the transition between some of the most elementary constituents of matter. In return, this would allow us to gain an understanding of matter and antimatter asymmetry in the universe.

**Main objectives of the Romanian participation in CERN Experiment/Collaboration:**

The physics program of the Romanian group in LHCb involves the Minimum Bias studies of light flavor particles usually with a strange component. In parallel, it contributes to studies of the decays and production of beauty and charm baryons and mesons. With the start of the LHCb Upgrade program the group became involved in the research and development tasks where the radiation hardness and characterization tests of the electronic devices took precedence. In addition to a strong flavor physics group, another objective is to form an electronics group capable to investigate the behavior of electronics in the special conditions specific to LHC.

**Main achievements of the Romanian team during 2009 - 2015:**

A Romanian group was involved from the beginning in the construction of the LHCb detector and has been involved in the several analyses of LHCb measurements. Direct contributions to the LHCb program include the periodic shifts, data quality checks, Monte Carlo simulations and developments of simulation software, administrative software development and support, LHCb-dedicated GRID Tier-2 sites provided to the LHCb Collaboration. Moreover, by bringing a contribution to the construction and operation of the detector, the recording of data, the internal review of several analyses, by undertaking and contributing to several analyses, the group was involved, directly as well as indirectly, in the release of more than 271 LHCb collaboration papers to date. Furthermore, the results obtained at LHCb were presented by members of the Romanian group at various international and local workshops and conferences. Also, in some cases, these events were followed by proceedings that were later published in international journals.

Two dedicated LHCb Tier-2 GRID sites were operated and maintained by our group, allowing the LHCb collaboration to performed tens of thousands of Monte Carlo simulations to emulate the physics signals in LHCb for hundreds of LHCb analyses. The group had a major contribution to the popularization of LHCb published results by making them available to the phenomenological and theoretical community through a dedicated interface, which allows the phenomenologists to directly implement the simulation of their signals in the LHCb context and to directly compare the results with the LHCb measurements and their uncertainties without experimental biases.

The LHCb analyses to which the group has made a major contribution are: the Minimum-Bias analyses where the production cross-sections of several physics signals have been investigated e.g. the production of strange and multistrange baryons and mesons, the production of a beauty-baryon, the rare radiative decays of the same baryon, correlation studies of strange particles, proton-lead interactions followed by the production of strange particles and more. The involvement in these analyses will continue with new results for the next set of 2015 data at higher collision energy for proton-proton interaction, proton-lead collisions, and eventually lead-lead case.

Due to the need of correlating the research and development activities with the LHCb-Upgrade program, a dedicated electronics laboratory was created at IFIN-

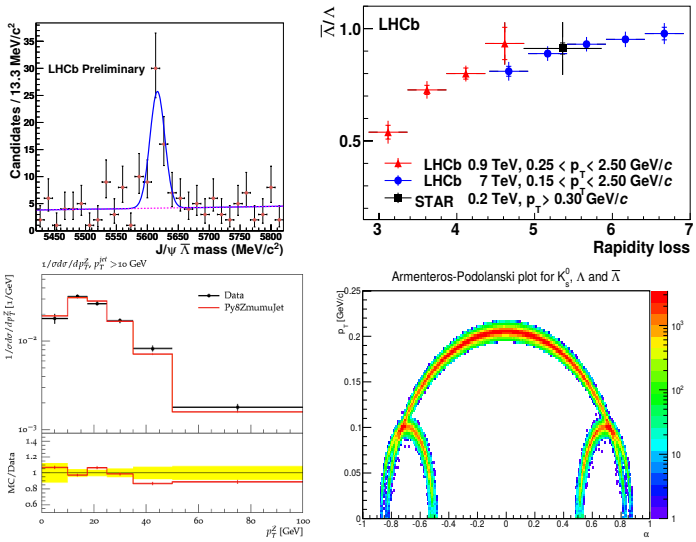
HH, and several tests of electronics devices, in conditions specific to LHC-environment of radiation and temperature, were already implemented with the first results about to be published. A second and a third set of tests of two other technologies dedicated simultaneously to LHCb Upgrade and space science are about to be performed abroad and at IFIN-HH, using various sources of radiation with distinct energies. The tested devices and their test setups were already assembled in the electronics laboratory. After making a few suggested optimizations the tests will be carried out. Our next aim is to extend the local Upgrade program to other activities such as: LHCb-Upgrade effective construction and testing with RICH digital boards assembly; LHCb site installation, with maintenance and operation of the Upgraded LHCb-RICH sub-detectors foreseen to be extended beyond 2019; technology and knowledge transfer to European space programs, which is a natural evolution, taking into account the multipurpose role or the electronic devices under tests, and the similitude between LHC environment and space environment.

**Socio-economic impact of the Romanian participation:**

The participation of Romanian groups in the highly competitive CERN collaborations, results in a new generation of scientists and engineers capable to respond to new challenges, and whose tasks are to integrate the Romanian academic and research community into the larger international /European context. Potential gains might greatly surpass even the previous concrete results, if the transfer of knowledge from CERN would result in a paradigm shift in the cultural/economical/social segments of the Romanian society.

**Perspectives of the Romanian participation in CERN Experiment/Collaboration:**

The Romanian group must be prepared for the next phase of the LHC data taking when the Upgraded LHCb will start recording data with unparalleled precision in a domain virtually inaccessible to other experiments like other LHC detectors and to future b-Factories. Therefore, it is essential to have a strong group with a thorough understanding of the Standard Model of physics, capable of analyzing the data and understanding the hardware/software limitation as well as the resulting measurement uncertainties.




*Left-up: Lambda_b mass spectrum in the combined mass of J/psi and Lambda daughter hadrons; left-down: RIVET display of LHCb and simulation data for Z boson production cross-section for Z+jet case; right-up: the baryon to anti-baryon ratio for strange baryon Lambda function of rapidity loss at 0.9 and 7 TeV proton-proton collision; right-down: the Armenteros-Podolanskiplot for K short and Lambda baryon and its antiparticle.*

# National Contribution to the Development of the LCG Computing Grid for Elementary Particle Physics (CONDEGRID)

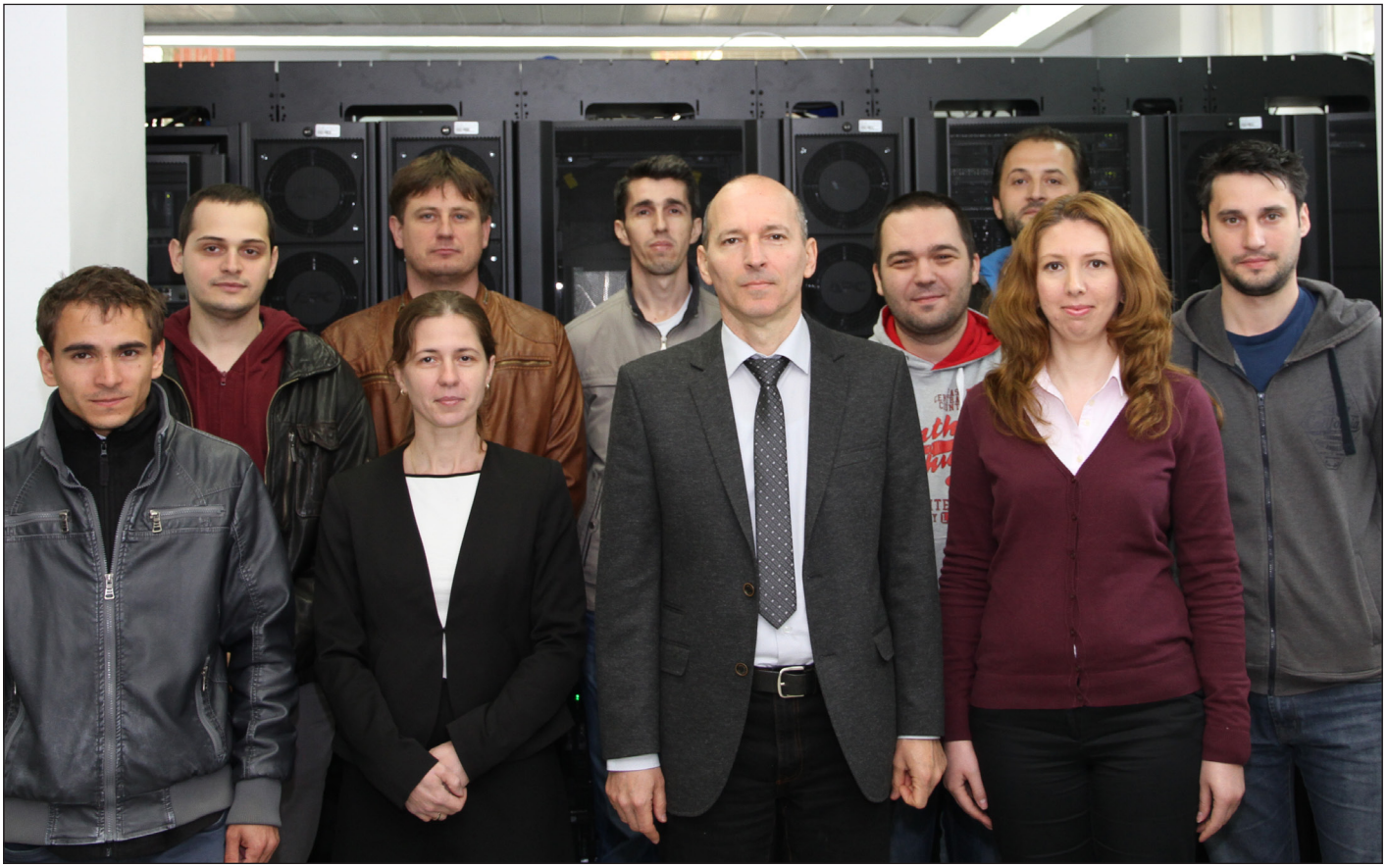
**Project Leader:** Mihnea DULEA
**Project Coordinator:** Horia Hulubei National Institute of Physics and Nuclear Engineering
**Partners:** Institute for Space Sciences, University Politehnica of Bucharest, National Institute of Isotopic and Molecular Technologies Cluj-Napoca, Alexandru Ioan Cuza University of Iasi.
**LCG Collaboration:** *http://lcg.nipne.ro/condegrid/*
**Project web page:** *http://lcg.web.cern.ch/lcg/*

**Main objectives of the CERN Experiment/ Collaboration:**

The WLCG collaboration provides the computing support for the storage, processing, simulation and analysis of the data from the four major experiments at LHC. It has developed and operates a wide distributed array of more than 170 resource centres interconnected through high-speed networks, whose goal is to provide high-quality grid services for the research performed by the worldwide HEP community. The computing services it offers must be permanently available, reliable and stable, and must closely follow the evolution of the LHC research program, increasing its processing and storage capacity according to the experiments' requests.

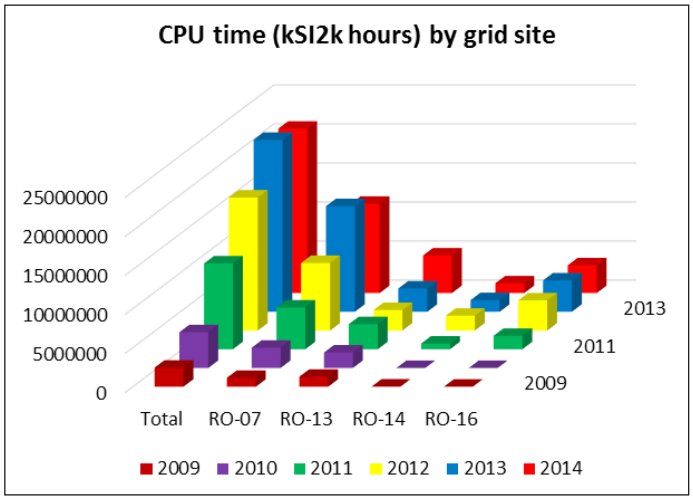
**Main objectives of the Romanian participation in CERN Experiment/Collaboration:**

The mission of the RO-LCG Federation is to provide offline computational support for ALICE, ATLAS and LHCb experiments, within the WLCG collaboration, through the deployment, operation, and coordination of a national grid system. This strategic goal is reached through the: delivery of computing resources and services at the levels stipulated by the WLCG Memorandum of Understanding; continuous support for the administration, operation and maintenance of the grid centres; development and operation of software tools for monitoring and accounting of the infrastructure; implementation of advanced technologies; enhancement of RO-LCG visibility.



**Main achievements of the Romanian team during 2009 - 2015:**

In his historic speech delivered at CERN on July 2012, Rolf Heuer highlighted the importance of WLCG for the HEP research, asserting that the discovery of the first evidence of the Higgs boson "has only been possible because of the extraordinary achievements of the experiments, infrastructure, and the grid computing". This statement acknowledges the performances of all the grid centres and federations of centres that contributed to the computational support of the LHC experiments, including the RO-LCG Federation - which has successfully fulfilled its tasks. RO-LCG's achievements since 2009 have closely been related to the evolution of WLCG's technical program, meeting the requirements of the experiments' research strategy with regard to their computational needs. The first priority has been the provision of managed computing and storage capacities with the highest quality of service, as required in the WLCG Memorandum of Understanding. The RO-LCG infrastructure was completed in 2010, when the grid centre of the "Alexandru Ioan Cuza" University was commissioned to support the ATLAS experiment. During 2009-2014 the computing capacity of the federation increased by four times, reaching more than 7000 cores, while the total disk storage doubled to 2.9 Petabytes. These resources have been highly available to the HEP community, which has run more than 157 mega kSI2k hours and more than 330 million jobs on the RO-LCG infrastructure. As a result, in the last couple of years RO-LCG ranked 12th among all the 36 Tier2 national centers, regarding the cumulated ALICE+ATLAS+LHCb CPU hours. Due to the increasing dependence of Tier2 sites performance on their network capabilities, special attention was paid to the increase of the bandwidth between the Magurele campus (where 80% of the grid resources are located) and RoEduNet centre at the "Politehnica" University Bucharest. This resulted in an upgrade of the network infrastructure that currently allows the increase of the bandwidth from 10 to 100 Gigabit/second. The improvement of the connection throughput and availability made possible the inclusion of RO-LCG centres in the LHCONE private network, which allows data transfers with multiple Tier1 centres. Also, a systematic study was performed on data transfer optimization between the storage servers and the worker nodes within the grid clusters, that led to significant improvement in the quality and reliability of the large file transfers. Solutions for improving the resource allocation and job scheduling on sites that support multiple experiments, RO-07-NIPNE, were designed and implemented, together with solutions for preserving the scalability of the grid cluster performance with respect to the upgrade of the resource capacity. The software infrastructure that provides the global monitoring of grid activity within RO-LCG was developed. Direct support was provided for experiments: the commissioning of RO-07-NIPNE as a Tier2 with Data site for the new computing model of LHCb, and its successful contribution to the ATLAS multicore migration, which was praised within the French Cloud. Also, RO-LCG participated in the French Cloud support team for ATLAS Distributed Computing Operations. Collaboration with the DIRAC 4 EGI project started for the purpose of integrating heterogeneous distributed systems of resources (Grid and HPC). The annual meeting of the RO-LCG federation has become a prestigious event, 3 workshops and 3 conferences with international participation have been organized by the RO-LCG partners in Bucharest, Cluj and Iasi.




**Socio-economic impact of the Romanian participation:**

The participation in WLCG was beneficial for increasing employment and education levels. The project contributed to the funding of 40 positions at national level. 11 members of the team have got their PhD degree and 4 master dissertations were delivered. The outreach activities attracted the interest on Grid computing of hundreds of high school students, increasing the opportunities of pursuing a career in IT. Many IT companies were guided towards the economic interaction with CERN and ELI-NP.

**Perspectives of the Romanian participation in CERN Experiment/Collaboration:**

The main focus of the participation of the RO-LCH team will be on providing high-quality computing support for the LHC Run 2. Resources will be further upgraded and service delivery optimized according to the new requirements, the sites will be qualified as directly connected Tier2s and new technologies will be implemented. Projects will be co-organized together with the Support for Distributed Computing group at CERN IT department, Romanian students being integrated in the CERN WLCG team.

# Experimental and theoretical studies of exotic nuclei at ISOLDE (EXONTEX-ISOLDE)

**Project Leader:** Nicolae MARGINEAN
**Project Coordinator:** Horia Hulubei National Institute of Physics and Nuclear Engineering
**ISOLDE Collaboration:** *http://isolde.web.cern.ch/ISOLDE/*
**Project web page:** *http://tandem.nipne.ro/proj/isolde*

**Main objectives of the CERN Experiment/ Collaboration:**

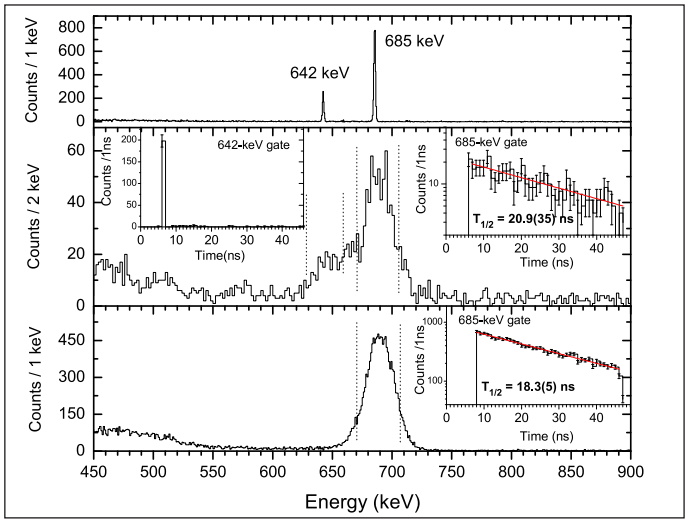
The ISOLDE experimental facility located at CERN is dedicated to the production of radioactive ion beams. From a chronological point of view, it is the first installation of this kind in the world, and, along the years, it has proven to be one of the most prolific facilities from the point of view of the scientific output. The present research programs cover a wide scientific spectrum, including nuclear physics, astrophysics, solid-state physics, bio-medical studies using radioisotopes for diagnostics and treatment. The installation of a new post-accelerator, HIE-ISOLDE, opens new possibilities for nuclear structure and reactions studies with radioactive ion beams.

**Main objectives of the Romanian participation in CERN Experiment/Collaboration:**

Romania joined the ISOLDE collaboration in 2008, with the principal aim to enhance its research activity in the field of nuclear structure with radioactive beams and complement the on-going development of research infrastructure in Bucharest. The main types of experiments performed by the Romanian researchers at ISOLDE are decay spectroscopy of exotic nuclei, Coulomb excitation and lifetime measurements using the fast-timing technique.

**Main achievements of the Romanian team during 2009 - 2015:**

The research activity of the Romanian team at ISOLDE evolved gradually, from collaborating at decay spectroscopy experiments with relatively simple detection systems to building complex setups for experiments based on ideas coming from Romanian physicists. An excellent example in this regard is the IS530 experiment that took place in September 2012. The scientific motivation was to study the beta-gamma spectroscopy of the 34Mg neutron-rich nucleus for the first time, in order to get a better understanding of the region of deformation and/or shape coexistence around N=20, the so called "Island of Inversion".




The detection array build for this experiment, using high-purity Germanium clovers, $LaBr_3$(Ce) scintillators, beta and neutron detectors, can be viewed as a prototype of the newest major detection setup installed at the facility: the ISOLDE Decay Station. Resulting from the coordinated effort of an international collaboration formed during 2013 with the purpose to build an array of various detectors centered on an implantation point served by a moving tape, the ISOLDE Decay Station (IDS) was commissioned in 2014, with a very consistent Romanian contribution in both equipment and manpower.

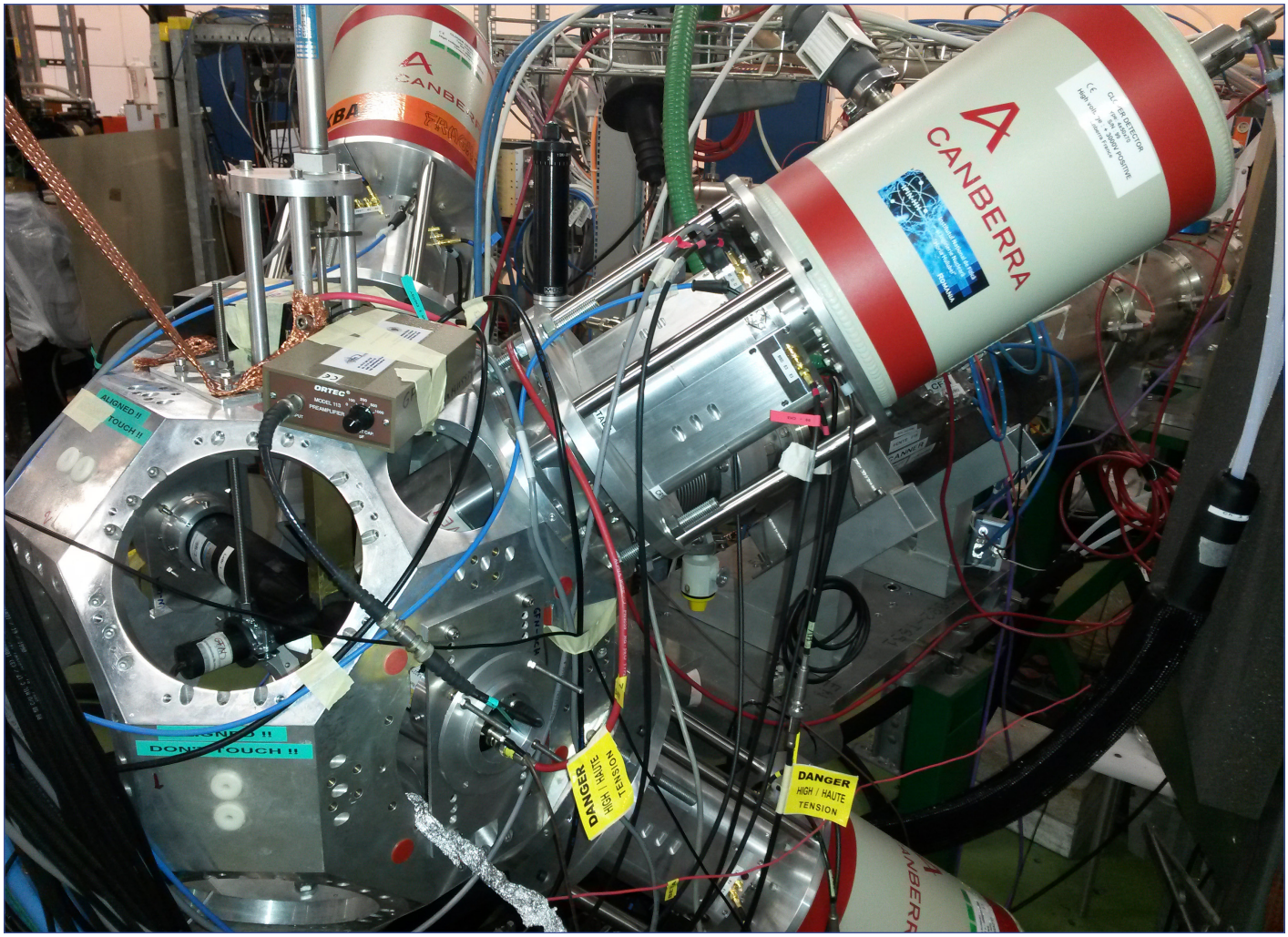
**Socio-economic impact of the Romanian participation:**

The ISOLDE collaboration had the role of a catalyst for developing experimental possibilities for nuclear physics in Romania. For instance, the idea to build the ROSPHERE array for in-beam fast timing experiments in Bucharest emerged as a natural extension of the fast timing studies carried out at ISOLDE. The fact that now the Tandem Laboratory in Bucharest has a well-established international user community could be considered, in a way, a consequence of the ISOLDE collaboration.

**Perspectives of the Romanian participation in CERN Experiment/Collaboration:**

Romanian involvement in ISOLDE will definitely be enhanced in the following years, since more and more young researchers are attracted by the experimental possibilities offered by the facility. Seen in a larger context, the complementarity of the research topics with the ELI-NP facility, now under construction in Bucharest, will additionally boost the Romanian scientists interest in performing experiments at ISOLDE.

*ISOLDE Decay Station in a configuration used in 2015*



# Romanian Participation at CERN – n_TOF Collaboration (n_TOF)

**Project Leader:** Tudor GLODARIU
**Project Coordinator:** Horia Hulubei National Institute of Physics and Nuclear Engineering
**n_TOF Collaboration:** *https://twiki.cern.ch/twiki/bin/view/NTOF*
**Project web page:** *http://proiecte.nipne.ro/pn2/135-proiecte.html*

**Main objectives of the CERN Experiment/ Collaboration:**

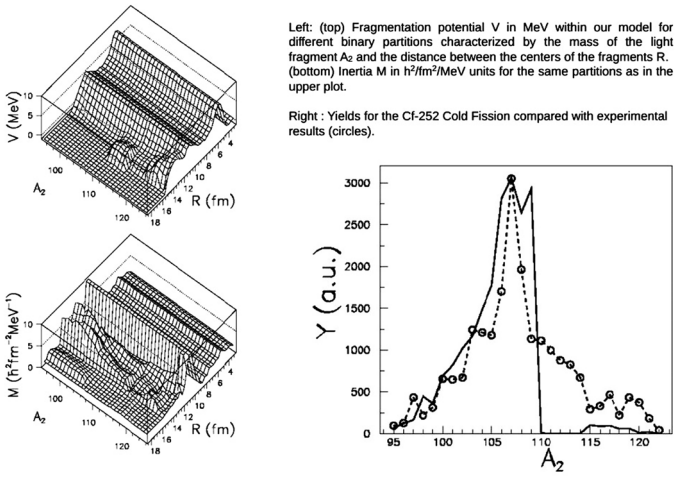
The main objectives of the n_TOF activities are: neutron cross section measurements for nuclear astrophysics, nuclear data measurements for advanced nuclear technologies and nuclear waste transmutation, as well as neutron cross section measurements for basic nuclear physics. The applicative goal of the project is to produce, evaluate and disseminate high precision cross sections for the majority of the isotopes relevant to the waste incineration and the accelerator driven system design, i.e., capture and fission cross sections for the minor actinides, capture cross sections for the main fission products and (n,xn) reactions for structural and coolant materials.

**Main objectives of the Romanian participation in CERN Experiment/Collaboration:**

One objective is to obtain new information on the basic mechanisms of nuclear fission by mixing accurate experimental data with new theories that take into account the nuclear structure of the nuclear system during the whole disintegration process. A second objective is the study of the neutron cross sections for nuclear astrophysics. This is a key point in obtaining accurate predictions for the reaction cross sections by using common model parameters for different mechanisms, consistent sets of input parameters determined from analyzing various independent experimental data, and a unitary account of a whole body of related data for isotope chains of elements.

**Main achievements of the Romanian team during 2009 - 2015:**

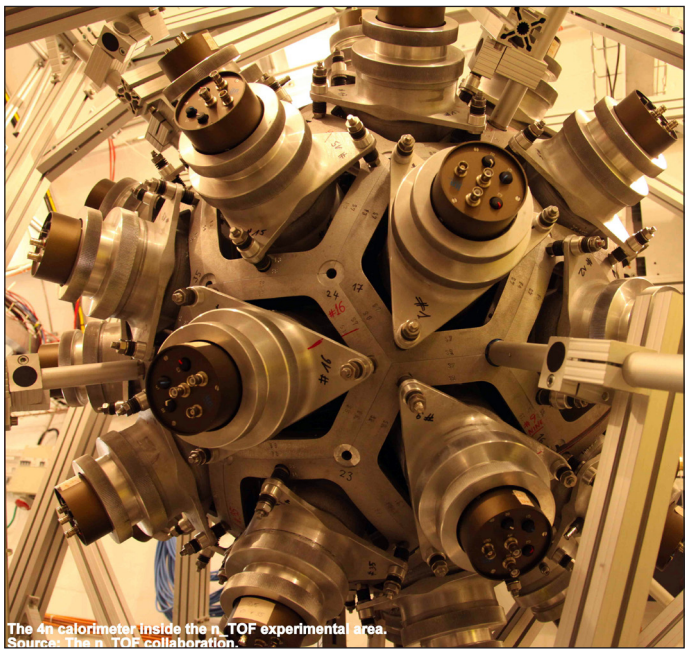
New theoretical tools are needed to understand the mechanism of nuclear fission and for evaluation purposes, given that improved nuclear theories are normally developed on the basis of experimental knowledge. New information on the basic mechanisms of nuclear fission can be obtained by mixing accurate experimental data with new theories that take into account the nuclear structure of the nuclear system during the whole disintegration process. The actual modality in which the evaluations of nuclear data are realized can be misleading in the case of fission. For example, the evaluated cross section fits the experimental data without taking into account the variation of the effective mass or the dissipated energy. So, the fission barriers are parametrized to reproduce the values of the cross sections for each nucleus in combination with level densities that contains correction factors. Two set of such ingredients could be compatible with the behavior of experimental fission cross section data. The inertia, as well as the height of the barriers, depends on the dissipated energy, more precisely on the excitation energy of the compound nucleus, and this dependence is completely neglected. The transitions states in the saddle configuration are obtained by fitting some resonances of the structure of the cross section, therefore the microscopic rearrangement of levels during the fission process is neglected. In conclusion, the evaluations being based on fits of experimental data are not able to make predictions for unknown reactions. Our treatment differs, being based on a dynamical full quantum mechanical de-




Left: (top) Fragmentation potential V in MeV within our model for different binary partitions characterized by the mass of the light fragment $A_2$ and the distance between the centers of the fragments R. (bottom) Inertia M in $h^2/fm^2/MeV$ units for the same partitions as in the upper plot.

Right : Yields for the Cf-252 Cold Fission compared with experimental results (circles).

scription that takes into account the nuclear structure during the disintegration. The activities carried out in the collaboration, addressed the resonant structure of the fission cross section and the dissipation produced in different fission channels. Using time dependent equations of motion that are similar to the time-dependent Hartree-Fock-Bogoliubov ones, we showed that the dissipation is larger in symmetric fission channels and smaller in asymmetries. By introducing conditions to dynamically fix the numbers of particles in the two fission fragments, the problem of energy sorting at scission was explained at the microscopic level. The partition of the excitation energy between the heavy and light fragment manages the neutron multiplicities, parameters that are of crucial importance in the design of nuclear reactors. Investigating the dynamical Landau-Zener effect during the deformation of a nuclear system in its way to scission, we explained the threshold resonant fine structure of the Thorium fission cross section. Apart from the common explanation for the fine structure, considered to be caused by the existence of a triple barrier, we showed that intrinsic excitations produced during the dynamical evolution of the nuclear system from ground state to scission describe this phenomenon. Another objective was to improve the description and to simulate better the cross sections. Therefore, a new Woods-Saxon two centre shell model was developed that supplies good values of the fission barrier heights. The heights of the barriers obtained by minimizing the least action within a cranking inertia for Uranium and Thorium were reproduced within an error less than 1 MeV. We expect to use this new formalism to theoretically simulate the fission cross section. So far, our models succeed to explain in a new way the resonant structure of the neutron induced fission cross section at low energy for Thorium isotopes.



The 4π calorimeter inside the n_TOF experimental area.
Source: The n_TOF collaboration.

**Socio-economic impact of the Romanian participation:**

The planned activities of the project have a great relevance for the nuclear waste transmutations and the design of accelerator driven systems. Both kinds of activity are important for the development of more sustainable sources of energy around the world, including Romania. From an educational point of view, young Romanian researchers have the opportunity to make contact with international research teams, to take part in them and to carry out the scientific research in one of the largest and most advanced laboratories in the world.

**Perspectives of the Romanian participation in CERN Experiment/Collaboration:**

Our main interest will be dedicated to perform measurements of (n,xn) reaction cross sections for heavy target nuclei for a neutron energy range extended up to 50 MeV. The motivation resides in two main topics regarding aspects related to nuclear technology and basics physics. The resulted data will contribute to the generation, maintenance and validation of nuclear data libraries relevant to ITER, IFMIF and DEMO nuclear engineering design demand, and also to the improvement of the dynamic nuclear models.

# Search for hadronic atoms at DIRAC-CERN (DIRAC)

**Project Leader:** Mircea PENTIA
**Project Coordinator:** Horia Hulubei National Institute of Physics and Nuclear Engineering
**DIRAC Collaboration:** *http://cern.ch/dirac*
**Project web page:** *http://tandem.nipne.ro/proj/psh/*

**Main objectives of the CERN Experiment/ Collaboration:**

The DIRAC experiment aims to test some predictions of the Chiral Perturbation Theory as the model of the nonperturbative Quantum Chromodynamics, in order to clarify the quark interactions at large relative distance $\Delta r > 2$ *fm*, where the asymptotic freedom is absent and where quark confinement with massive quarks takes place. Hadronic interactions are described here by pionic degrees of freedom. DIRAC searches the dimeson $\pi^+\pi^-$ and $\pi K$ hadronic atoms, as objects with strong interaction structure.

- the $\pi^+\pi^-$ and $\pi^\pm K^\mp$ atom lifetime and s-wave scattering lengths
- the long-lived $\pi^+\pi^-$ states and their lifetime
- the $K^+K^-$ and $\pi\mu$ atoms observation

**Main objectives of the Romanian participation in CERN Experiment/Collaboration:**

The Romanian group is involved in the design, construction, commissioning and use of the Preshower (PSh) detector for background particle rejection. It pursues the hadron/electron separation, with high electron rejection efficiency for the measurement of the $\pi^+\pi^-$ and $\pi K$ hadronic atoms lifetime. The main responsabilities of the Romanian group were: designing, constructing and testing of the PSh detector; elaborating the PSh methodology; integrating and using PSh in the DIRAC data taking; performing the analysis, data processing and physical interpretation of the experimental results; writing scientific papers on PSh detector and on hadronic atoms detection and lifetime measurement.

**Main achievements of the Romanian team during 2009 - 2015:**

The design, construction and use of the Preshower Detector, which is the first Romanian produced detector at CERN. It is a large detector (7m x 1.5m, weight ~ 1500kg) used for the electron background rejection in hadronic atoms observation and their lifetime measurement.

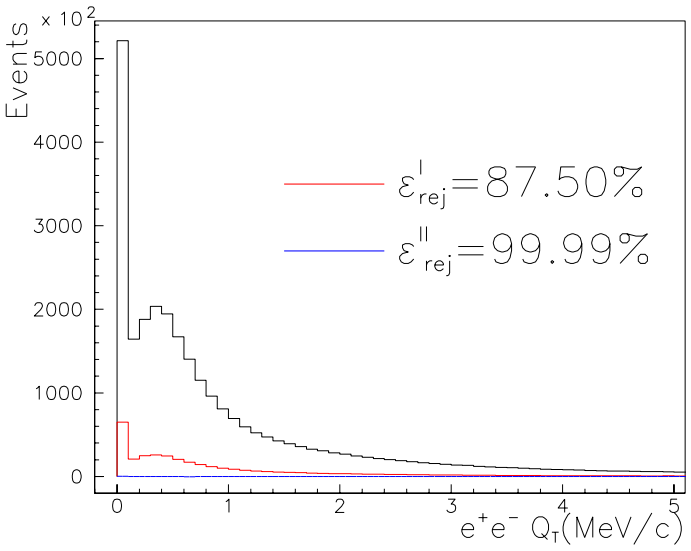
*2009 Study of the shower production and particle discrimination with the PSh Detector:* (1) Monte Carlo simulation of the new preshower detector: (a) electron rejection and pion loss evaluation; (b) light transmission effects in large scintillator slab; (2) Shower development and particle discrimination for the new DIRAC experiment.

*2010 The PSh detector configuration within DIRAC-II:* (3) Determination of the preshower detector characteristics and performances: (a) beam tests configuration; (b) amplitude signal distribution for pion/electron separation; (c) electron rejection and pion loss yield; (d) PSh track reconstruction efficiency with drift chamber data; (e) time signal distribution;

*2011 Dection and measurement of the particle shower with PSh detector:* (4) Analysis of the PSh amplitude signal distributions: ADC mean amplitude/slab dependence; Overall ADC mean amplitude/slab dependence; ADC/x and y dependence analysis; (5) Particle track reconstruction on PSh: x - hit coordinate/momentum dependence; Multiple scattering analysis with x and y hit distribution on PSh; x and y hit profile distributions on PSh;

*2012 Data acquisition and processing for* $\pi^+\pi^-$, $\pi^+K^-$ *and* $\pi^-K^+$ *hadronic atom measurements:* (6) Data acquisition: (a) Assembly of 40 separating diodes on the photo-

*IFIN-HH Team of the DIRAC Collaboration*
*Software team: Marius Gugiu, Dana Dumitriu, Daniela Fluerasu, Mircea Pentia, Soichiro Aogaki*

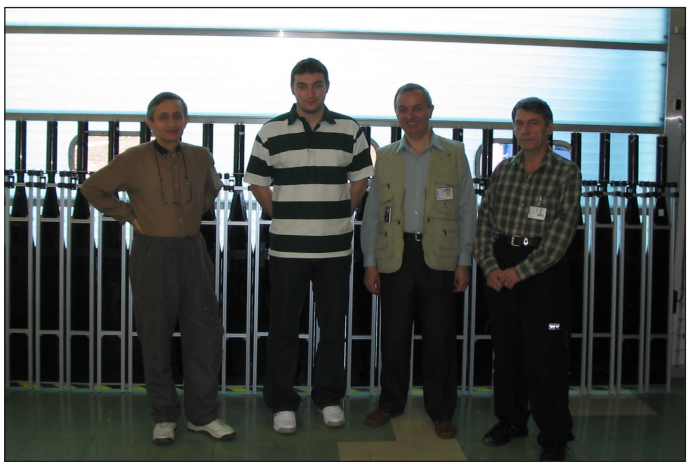



*Preshower electron rejection in the DIRAC Experiment at CERN. The figure presents $e^+e^-$ transversal relative momentum component QT distribution*

*before use of the PSh criteria*
*after the I-st step of the PSh cut criteria – electron rejection efficiency 87.50%*
*after the II-nd step of the PSh cut criteria – electron rejection efficiency 99.99%*

multiplier tube dividers of the PSh detector for inverse current protection of the HV power supplies; (b) Experimental data acquisition with different trigger configurations, for observing $\pi^+\pi^-$ metastable bound states; (7) Data processing for $\pi^+\pi^-$ and $K^+\pi^-$ hadronic atom observation: (a) Off-line data analysis and processing of the experimental 2008, 2009, 2010 and 2011 data for amplitude signal corrections of the PSh detector; (8) Preparation and design of the future experimental DIRAC works for $K^+\pi^-$ and $K^-\pi^+$ hadronic atoms study at Super-Proton Synchrotron (SPS). Monte-Carlo simulations of the inclusive Kaon production processes at the SPS energies.

*2013 Data analysis for $\pi^+\pi^-$ and $K^+\pi^-$ atom lifetime determination:* (9) The $\pi^+\pi^-$ and $K^+\pi^-$ lifetime measurement: (a) Events preselection for experimental 2008, 2009, 2010 and 2011 data; (b) Off-line analysis and ntuple production for separation of particle pairs ($e^+e^-$, $\pi^+\pi^-$, $K^+\pi^-$, $K^-\pi^+$); (10) Preselection and ntuple production of $\pi^+\mu^-$, $\pi^-\mu^+$ pairs for 2010 run, $e^+e^-$, $\pi^+\pi^-$ and Λ-antiΛ pairs for 2012 run; (11) Disassembly and conservation of the DIRAC detector components; (12) Preparation of the scientific paper First πK atom lifetime and πK scattering length measurements.



*IFIN-HH Team of the DIRAC Collaboration Hardware team: Gh. Caragheorgheopol, Cristian Ciocarlan, Mircea Pentia, Daniel Bartos (in background Preshower scintillation detector elements)*

*2014 Search for the $\pi^+\pi^-$ atom long-lived states (metastable atoms):* (13) Particle transport simulation within DIRAC setup for $\pi^+\pi^-$ atomic pairs from the breakup of metastable states; (14) The Qy distribution for $e^+e^-$ and $\pi^+\pi^-$ pairs produced in Be and Pt target for background reduction with magnetic field for long-lived $\pi^+\pi^-$ atom search; (15) Signal analysis for pπ identification and measurement of the Λ and anti-Λ hyperon effective mass; (16) Preparation of the scientific paper New Preshower detector for the DIRAC Experiment.

*2015 Data analysis and processing aiming to publish the scientific results:* (17) Preparation of the scientific paper Updated DIRAC spectrometer at CERN PS for investigating $\pi^+\pi^-$ and Kπ atoms.

**Socio-economic impact of the Romanian participation:**

Science, Technology & Innovation: New knowledge: Scientific papers; New methods and techniques: High electron background rejection; New instruments: Preshower Detector; Opportunities for spin-offs: Radiography method with Preshower Detector. Economic Impact: Increased economic activity: Industry orders; Highly-skilled workers for the labour market. Social Impact: Public awareness: More than 60 articles on Vox Publica; Knowledge transfer: 10 lessons on Youtube; Learning opportunities: 2 books.

**Perspectives of the Romanian participation in CERN Experiment/Collaboration:**

The DIRAC Collaboration is an ongoing experiment at CERN in the final stage of analysis, processing and interpretation of the last 7 years of the experimental data acquisition. The Romanian group is deeply involved in this endeavour. The future activities refer to the disclosure of the results and their publication in the scientific journals. With a minimal financial funding for the next years the ongoing works can be completed and the results published.

# Study of rare kaon decays at the CERN SPS (NA62)

**Project Leader:** Alexandru Mario BRAGADIREANU
**Project Coordinator:** Horia Hulubei National Institute of Physics and Nuclear Engineering
**NA62 Collaboration:** *http://na62.web.cern.ch/NA62/*
**Project web page:** *http://www.nipne.ro/dpp/Collab/NA62/*

**Main objectives of the CERN Experiment/ Collaboration:**

The NA62 experiment aims to measure the very rare kaon decay $K^+ \to \pi^+ \nu \bar{\nu}$ at the CERN SPS, to make a decisive test of the Standard Model (SM) by extracting, through a 10% measurement, the Cabibbo–Kobayashi–Maskawa (CKM) parameter $|V_{td}|$. In addition to the main objective, the NA62 experimental setup will offer the chance to perform many measurements on rare and medium-rare kaon decays.

**Main objectives of the Romanian participation in CERN Experiment/Collaboration:**

Since 2014, IFIN-HH group is responsible for the NA62 Hadronic Sampling Calorimeter (HASC) sub-detector; the short term objectives are:

- Construction and commissioning of the Read-Out system of HASC;
- Development, implementation and deployment of L1/L2 software trigger for HASC;
- Maintenance, operation and performance analysis of the Hardware Sampling Calorimeter and LI/L2 software trigger;
- Participation in NA62 physics runs and data analysis.

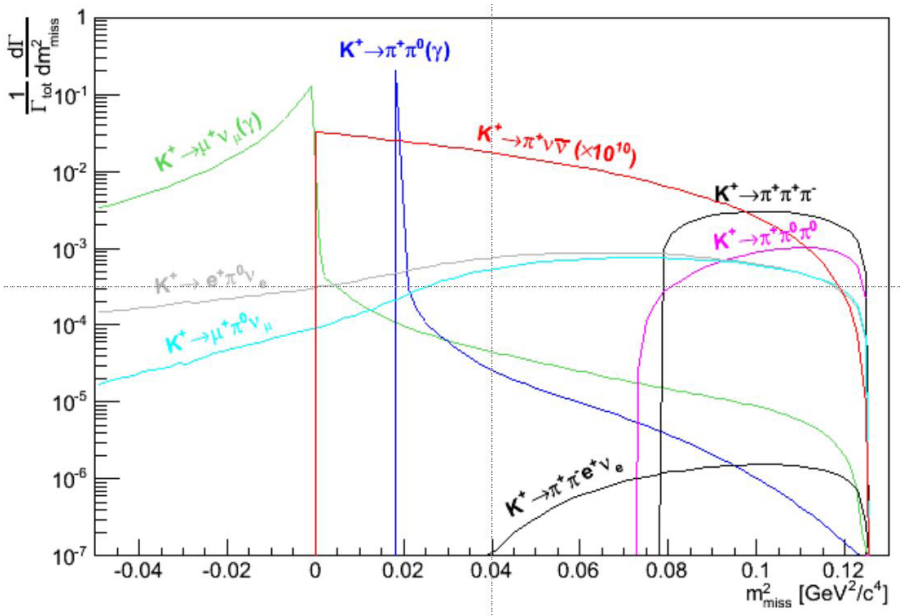
**Main achievements of the Romanian team during 2009 - 2015:**

In 2014 we succeeded to:

- define the HASC readout scheme, after a series of cosmic rays tests with one HASC module, with the possibility to insert the HASC in the NA62 L1/L2 trigger;
- build a Silicon Photomultiplier amplifier board with 3 gain choices; dynamic range evaluated with cosmic rays; final prototypes are prepared for beam test; ready for "mass-production".

For 2015 we are planning the:

- Production of Silicon Photomultiplier front-end electronics;
- Installation and commissioning of HASC Read-Out system in NA62 experimental area in ECN3;
- Start of HASC Read-Out integration in NA62 TDAQ system.



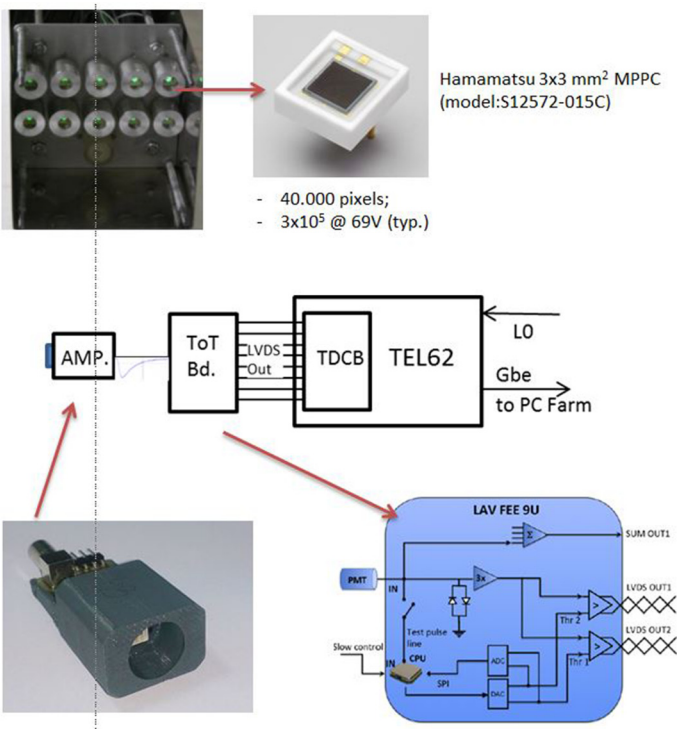

Simulated shape for the signal and background events under the hypothesis that the charged track is a pion.

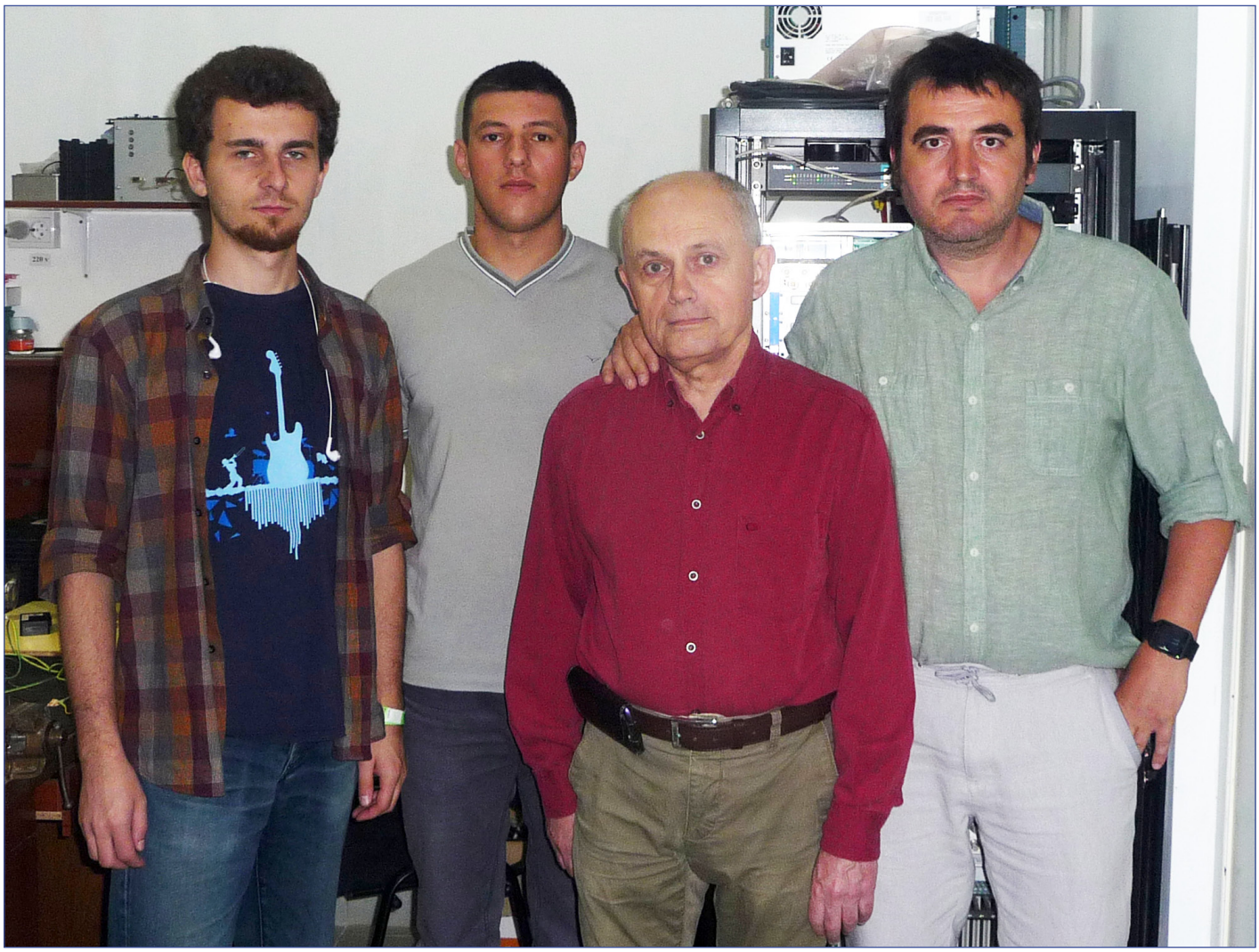
**Socio-economic impact of the Romanian participation:**

We expect several students to be trained in NA62. Taking into account the current standard in particle physics, the NA62 Collaboration encompasses about 200 members. This means that the students and the young physicists, in general, can count on the fact that their contribution will be well defined, visible and acknowledged.

**Perspectives of the Romanian participation in CERN Experiment/Collaboration:**

It is a unique opportunity to collaborate in a well defined physics programme at CERN. The availability of the super proton synchrotron (SPS) 400 GeV /c protons in the foreseeable future opens up the possibility of a well-planned and low risk rare kaon decay programme.



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

ANCSI – Romanian Authority for Scientific Research and Innovation
*www.mct.ro*

IFA – Institute of Atomic Physics
*Executive Agency for funding projects within the RO – CERN Programme*
*www.ifa-mg.ro*

***Participating institutions in the RO – CERN Programme 2009-2014***

Horia Hulubei National Institute of Physics & Nuclear Engineering
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Institute for Space Sciences
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National Institute for R&D of Isotopic & Molecular Technologies, Cluj-Napoca
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University Politehnica of Bucharest
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Alexandru Ioan Cuza University, Iasi
*www.uaic.ro*

Transilvania University, Brasov
*www.unitbv.ro*

West University, Timisoara
*www.uvt.ro*

Suceava University Stefan cel Mare (USV)
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