MINISTERUL CERCETĂRII ȘI INOVĂRII

HPD Courier

Number 1 | January 2019

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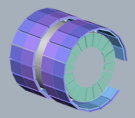
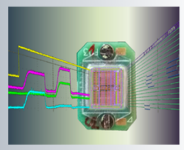
Assembled & Tested



130 TRD-MWPs (24%)
20 TPC OROCs (50%)
based on GEM technology

Designed

3rd version of FASP
(Fast Analog Signal Processor)
fully operational



Contents

Achievements

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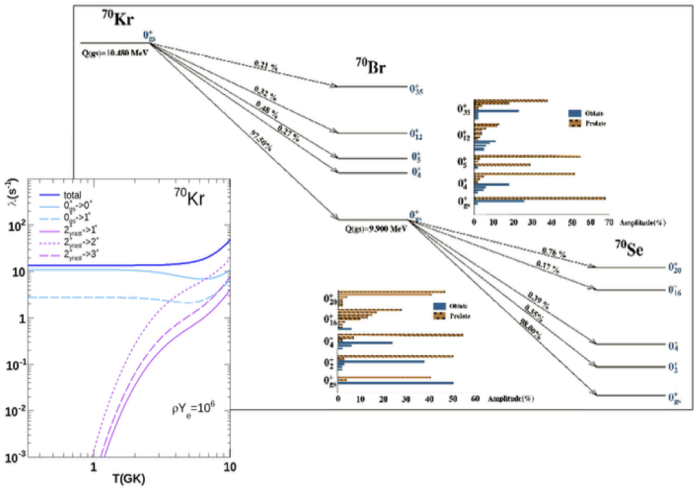
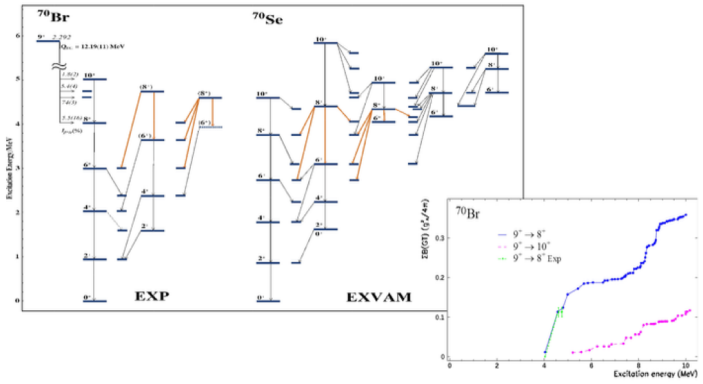
Achievements

Nuclear Structure and Dynamics

Comprehensive understanding of exotic structure and dynamics

Exotic phenomena in proton-rich nuclei in the $A = 70$ mass region bringing insights into fundamental symmetries and interactions require beyond-mean field models and realistic effective interactions in adequate model spaces. Our studies based on the complex Excited Vampir variational model using an effective interaction derived from G-matrix starting from Bonn CD potential revealed coexistence phenomena dominating the structure and dynamics of exotic nuclei. Tiny effects induced by isospin mixing have been self-consistently investigated. Influence of shape coexistence and mixing, isospin mixing, and n-p pairing correlations on structure properties as well as weak interaction processes have been comprehensively treated and robust predictions on characteristics relevant for the astrophysical scenarios on the rp-process path emerged. Within the same formalism we described simultaneously the $T = 1$ ($J = 0^+$) and $T = 0$ ($J = 9^+$) β decay of ^{70}Br to ^{70}Se.





For details

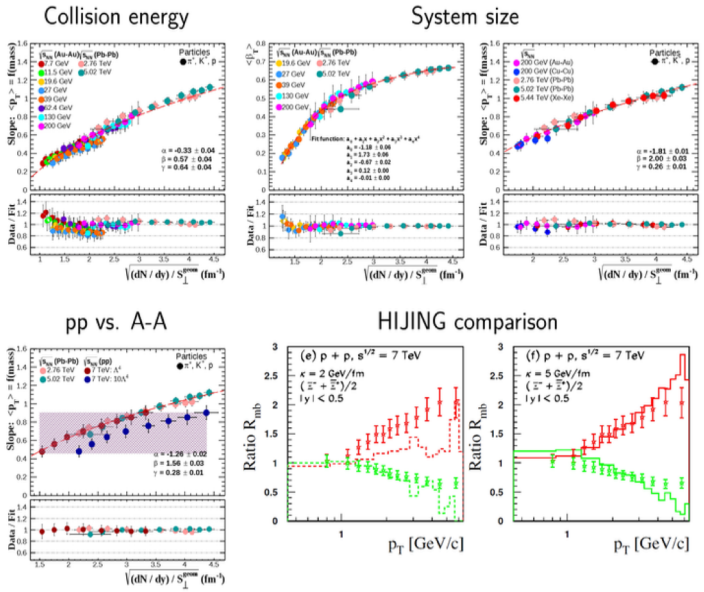
A. Petrovici, *Phys. Rev. C 97, 024313 (2018)*
A. Petrovici, O. Andrei, A. Chilug, *Phys. Scr. 93, 114001 (2018)*
A. Petrovici, O. Andrei, A. Mare, *AIP Conf. Proc.*, in print
A. Petrovici, invited talks: *Ganil, CSSP-2018 Sinaia, SSNET-2018 Paris, IMNA-2018, ECT-Trento*

Strongly Interacting Matter

Large values of gluon density and their occupation number for high multiplicity events in pp collisions at LHC energies seems to be the main contribution to the evidenced similarities of global properties relative to AA collisions. Detailed studies of the behavior of the slope of $\langle p_T \rangle$ dependence on the mass of identified light flavor charged hadrons and $\langle \beta_T \rangle$ fit parameter of their p_T spectra using Boltzmann-Gibbs Blast Wave (BGBW) expression as a function of $\sqrt{(dN/dy)/S_\perp}$, the relevant scale in a saturation gluon picture, evidenced a rather good scaling for all energies, starting from $\sqrt{s_{NN}} = 7.7$ GeV RHIC energy up to $\sqrt{s_{NN}} = 5.44$ TeV LHC energy for different mass of the symmetric colliding system and pp collisions at $\sqrt{s} = 7$ TeV at LHC. A summary of the results is presented in the plots from the next page, i.e. *upper row: left* the slope of $\langle p_T \rangle$ from BES energies and $\sqrt{s_{NN}} = 62.4$, 130, 200 GeV Au-Au collisions at RHIC and $\sqrt{s_{NN}} = 2.76$ and 5.02 TeV Pb-Pb collisions at LHC, *middle* the $\langle \beta_T \rangle$ values extracted from BGBW fits of the p_T spectra for the same energies and systems, *right* the slope of $\langle p_T \rangle$ as a function of mass for Cu-Cu, Au-Au at $\sqrt{s_{NN}} = 200$ GeV, Pb-Pb at $\sqrt{s_{NN}} = 2.76$ and 5.02 TeV and Xe-Xe at $\sqrt{s_{NN}} = 5.44$ TeV; *bottom row: left* the slope of $\langle p_T \rangle$ as a function of mass for Pb-Pb at $\sqrt{s_{NN}} = 2.76$ and 5.02 TeV compared with the

values obtained for pp collision at $\sqrt{s} = 7$ TeV for two values of the α parameter used to estimate the overlapping area of pp collision for a given hadron density per unit of rapidity, *middle and right* the ratio R of the p_T distribution of $(\Xi^- + \Xi^+)/2$ at a given charged particle multiplicity to the one corresponding to minimum bias (MB) for pp collisions at $\sqrt{s} = 7$ TeV for low and high multiplicity, respectively, estimated within HIJING/BB v2.0 model using a low and high string tension. It is evidenced that the experimental R at high multiplicity can be reproduced if a string tension similar with the value found for Pb-Pb collision is used. These scaling and similarities show that the global properties evidenced at LHC energies are governed by the properties of the flux tubes, the system size playing a minor role.

QCD inspired scaling



For details

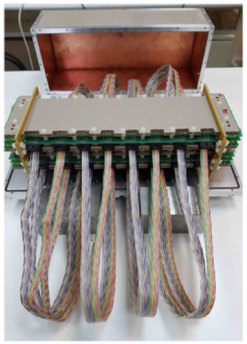
M. Petrovici, A. Lindner, A. Pop, M. Tarzila, I. Berceanu, *Phys. Rev. C98 (2018) 024904*
V. Topor-Pop, M. Petrovici, *Phys. Rev. C98 (2018) 064903*
M. Petrovici, A. Lindner, A. Pop, *AIP Conf. Proc.*, in print

R&D activities

High Counting Rate Timing RPC

High granularity, high counting rate RPC based on an architecture which gives the possibility to adjust the transmission line impedance to the front-end electronics value, developed in HPD, has shown high performance in terms of time and 2D position resolution in a series of cosmic rays or in-beam tests performed over the last period. Last year, two new prototypes which optimize the number of strips to the number of front-end board read-out channels and cluster size following the granularity requirements for the most inner zone of the CBM-ToF sub-detector, were designed and constructed (see *bottom left* photo). The two RPCs, stacking up of each other, housed in a special box with a negligible material budget and fully electromagnetically screened, were implemented in the cosmic rays set-up of the RPC TestLab (see *bottom right* photo).

RPC-2018 prototypes



Set-up ready for cosmic tests

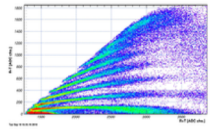
For details

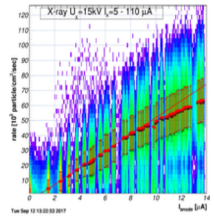
M. Petris et al., *ICHEP Conf. 2018*
L. Radulescu et al., *18th International Balkan Workshop on Applied Physics and Material Science*
M. Petris, D. Bartos, M. Petrovici, L. Radulescu, V. Simion et al., *J.Phys Conf.Series 1023 (2018), 012007*
D. Bartos, M. Petris, M. Petrovici, L. Radulescu, V. Simion, *Rom. Journ. Phys. 63, 901 (2018)*

High Counting Rate TRD

The new architecture of the TRD chambers developed in HPD for CBM at FAIR, shown an unprecedented performance in terms of 2D position resolution and energy resolution in high counting rate environment using a home developed front-end electronics operated in trigger or trigger-less mode. Detailed tests of the TRD prototypes based on cosmic rays, laser beam, high flux delivered by X-ray tubes and ^{55}Fe radioactive source using the latest version of FEE and continuous readout mode DAQ system developed in HPD are in progress (see *left* photo). They are planned to be finalized before the implementation of the 60×60 cm^2 prototype in the mCBM at GSI. The *top right* plot shows the position reconstruction along the pads by correlation of adjacent R (rectangular pairing) and T (tilted paring) signals which gives access to the anode wires visualization using a uniform illumination of the chamber by a ^{55}Fe X-ray source. The *bottom right* plot shows a linear behavior of the anode current as a function of counting rate up to 5×10^4 X-rays/$s \cdot cm^2$.

In-house high counting rate tests





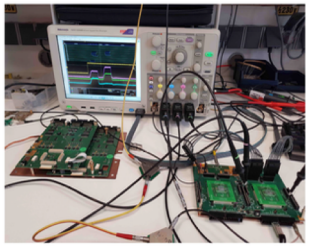
For details

A. Bercuci et al., *32nd CBM Collaboration Meeting*, https://indico.gsi.de/event/5863/session/25/contribution/28/material/slides/0.pdf
M. Petris, M. Petrovici, V. Catanescu et al., *Nucl. Instr. and Meth. A 732 (2013)375*
M. Petrovici, V. Simion, M. Petris et al., *Rom. Journ. Phys. 654,56(2011)*

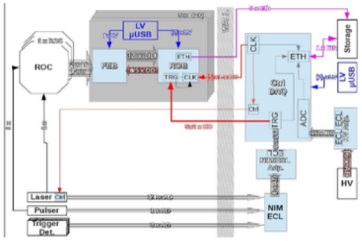
Front-End Electronics and Trigger-less Data Acquisition

FASP-0.3 ASIC microcircuit is an improved version of the previous FASP-0.2 ASIC. The dynamic input and output ranges, the output type shape signals (semi-Gaussian and flat top), the analogue channel gain and shaping time are identical for the two ASICs. The difference consist in the improvements on digital parts of the microcircuit implying system triggering: trigger of the own channel when the signal is above the threshold and forced trigger of the two neighboring channels. Such a triggering concept allows a better selection of the true useful signals in the neighboring channels associated to one in the central channel which will generates also a correct master trigger signal. FASP-0.3 ASIC was developed in four metals technology for a better grounding and shielding. The real FASP-0.3 ASICs in dice form, such they arrived from AMS foundry, were tested using pulse generators as well with signals delivered by TRD detectors. For these purposes a set of printed circuit test boards were designed in HPD department using CAD software, see *bottom left* photo. The performance of the free running mode DAQ developed by us, schematics can be followed in *bottom right* diagram, was successfully tested.

FASP-03 analog CHIP



Free running mode DAQ



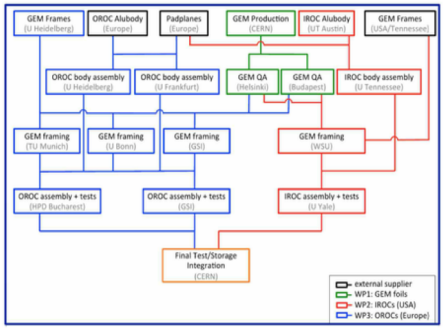
For details

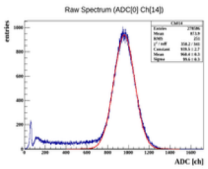
A. Bercuci et al., *CBM Progress Report 2016 ISBN 978-3-9815227-4-7, (2017) 114*

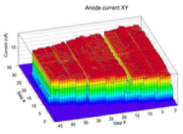
ALICE TPC Upgrade

The exploration of the new phenomena evidenced at LHC and understanding of the physics behind requires multi-differential analysis, therefore statistics well beyond the one accessed up to now. This goal can be achieved in the next LHC Runs using high luminosity (HL) of LHC starting from Run3. In order to make use of the collision rate accessible at HL-LHC, ALICE Collaboration embarked on an ambitious upgrade program. One component of this is the upgrade of the ALICE-TPC by replacing the present Read-Out Chambers (ROC) based on multi-wire proportional chambers by new ROCs using GEM technology. A diagram of the work-flow shared by many institutions from Europe and US is represented on the *next page, top left* figure, 50% of the large Outer ROCs (OROC) being assembled and tested in HPD. Snapshots of different activities taking place in the DetLabs of HPD can be viewed in the photos *below*. A sample of the test results are shown on the *next page, top right* plots in terms of energy resolution and 2D gain mapping.

ALICE TPC Upgrade - HPD activities







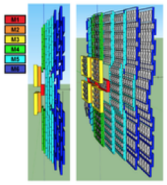
For details

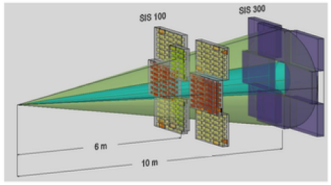
ALICE Collaboration, *Upgrade of the ALICE Time Projection Chamber, CERN-LHCC-2013-020; ALICE-TDR-016*

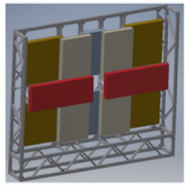
Status of HPD contribution to CBM

CBM Time of Flight (ToF)

As it is well known, CBM Experiment designed to be operated at SIS100-FAIR in Darmstadt, is dedicated to study the properties and dynamics of highly compressed baryonic matter looking for rare probes accessed in unprecedented high interaction rates. In conjunction with the STS sub-detector, CBM-ToF, will give access to charged particle identification. The most inner zone of the CBM-ToF will be exposed to the highest counting rate and track density, CBM being a fixed target experiment. The inner zone of CBM-ToF, marked on the *bottom left* figure by red, orange and yellow colors, is made of three types of RPC based on the architecture developed in HPD.







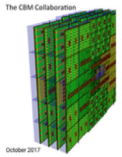
An exploded view of the inner zone architecture is represented in the *middle* plot. The mechanical support structure, *right* side, is designed such that the horizontal modules could slide in the horizontal plane in order to accommodate the hole for the beam pipe to a given beam type and collision energy.

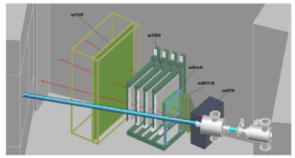
For details

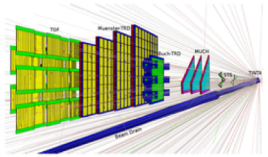
CBM Collaboration, *CBM-ToF TDR;* `http://repository.gsi.de/109024`

CBM Transition Radiation Detector (TRD)

The main activities of last year were focused on the implementation in the mini CBM (mCBM) of a real size TRD prototype based on the architecture developed in HPD, *bottom middle* plot, foreseen to be used for the most inner zones of the CBM-TRD sub-detector, *bottom left*. In order to study the physics performance of this architecture and associated FEE, the geometry and detector response were implemented in the CBM ROOT environment (see *bottom right* plot).







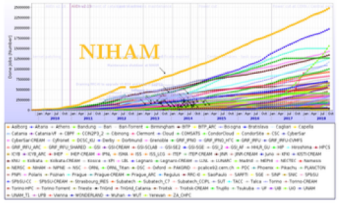
For details

A. Bercuci et al., *32nd CBM Collaboration Meeting*, `https://indico.gsi.de/event/5863/session/25/contribution/28/material/slides/0.pdf`

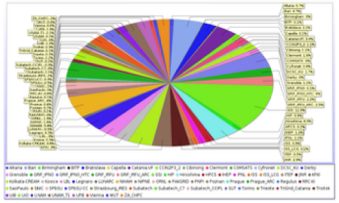
Computing

NIHAM stands for Nuclear Structure and Hadronic Matter, the name of our Center of Excellence, evaluated like that by the Romanian authorities in 2002. We continued to use this acronym for HPD Data Center, which in 2002 was used as the first GRID application in Romania within ALICE GRID. Starting from that period, the center was continuously developed in terms of infrastructure, computing and storage capacity, such that, based on the MonALISA monitoring of ALICE GRID activities, became one of the most efficient Tier2 centers in ALICE GRID, see the plots on the next page. By the end of January 2019, an extra storage capacity of ~ 4.5 PB will become operational.

Done jobs



Done jobs statistics

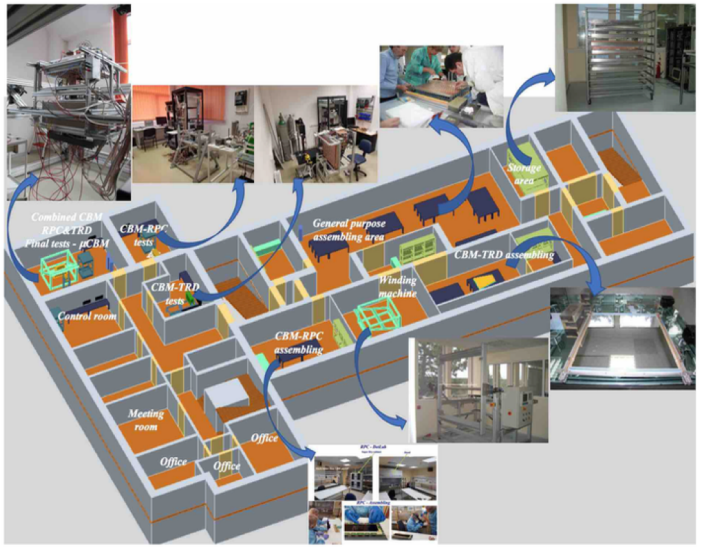


NIHAM, Tier2 component of ALICE GRID

Infrastructure

The Detector Laboratory of the initial NIHAM Center of Excellence, presently HPD, inaugurated in 2004, has been intensively used for our first contribution to the ALICE Experiment at LHC, i.e. the construction and tests of 130 TRD chambers, 24% of the full ALICE TRD Barrel. More or less in parallel, the

Laboratory housed the activities related to the R&D activities for developing a new generation of RPC and TRD detectors for high counting rate experiments, as CBM at FAIR. In the meantime, the infrastructure was supplemented by 3 test DetLabs, 1 general purpose Control Room, 2 Electronic Laboratories and one Bonding Laboratory. The outcome on terms of new type of detector prototypes, their associated FEE and DAQ systems were briefly summarized above. In the last 2 and a half years, the assembling area of the DetLab was refurnished and the area of clean rooms of ISO6 and ISO7 level was significantly increased. Based on these, i.e. skinless, experience and infrastructure, we embarked on the ALICE-TPC upgrade program with the commitment of assembling and testing 50% of the TPC OROCs based on GEM technology in HPD. The activity is close to be successfully finalized and we already started to reconfigure the infrastructure for assembling and test activities of important parts of the ToF and TRD sub-detectors of the CBM Experiment at FAIR. The activities flow and areas where they will take place is schematically presented in the *bottom* of the page. One of the Test DetLabs, i.e. *top left* picture, used for detailed tests of the OROCs, is foreseen to be used in the future for a joined test of the ToF inner zone modules and TRD chambers using cosmic rays. Such test configuration was already used for testing the corresponding detector prototypes before in-beam test at SPS-CERN.

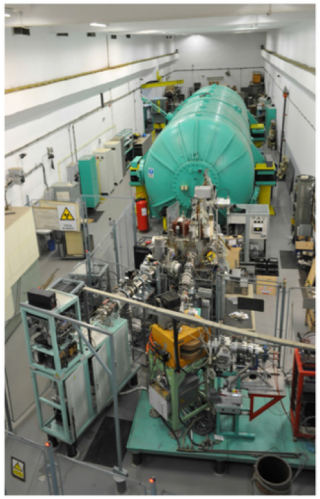


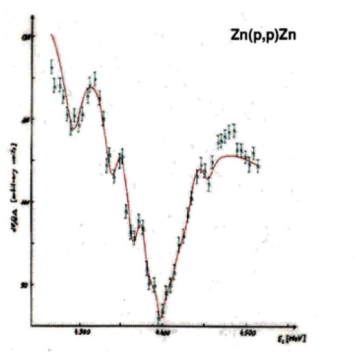
Events

2018 End of the Year Events

45 years from the first beam delivered by FN Tandem

In March 2019 were reached 45 years from the moment when the first proton beam of ~ 14 MeV was delivered by the IFIN-FN Tandem. The first experiment performed at the zero degree beam line by the group of Prof. Marius Petrascu focused on the excitation function for elastic and inelastic proton scattering on ^{66}Zn target aiming to evidence and study the nature of the intermediate structures within an isobaric analog resonance energy region in ^{67}Ga. Preliminary results were presented at the International Conference on Nuclear Physics from Munich, 1973.





$$\langle T\rangle_{\Delta E} = \frac{\langle \Psi_0^{(-)}|H_{Pd}|\Psi_d\rangle\langle\Psi_d|H_{dP}|\Psi_0^{(+)}\rangle}{E - E_d - \Delta_d^{\uparrow} - \Delta_d^{\downarrow NR} - \Delta_d^{\downarrow R} + \frac{i}{2}(\Gamma_d^{\uparrow} + \Gamma_d^{\downarrow NR} + \Gamma_d^{\downarrow R})}$$

$$\Delta_d^{\downarrow R} - i\frac{\Gamma_d^{\downarrow R}}{2} = \sum_h \frac{\Omega_{dh}}{E - E_h - \Delta_h^{\downarrow} + \frac{i}{2}\Gamma_h^{\downarrow}}$$

For details

C. Borcea, F. Carstoiu, G. Constantinescu, A. Isbasescu, I. Lazar, I. Mihai, M. Petrascu, M. Petrovici, V. Simion, *Proc. Int. Conf. on Nucl. Phys. Munich (1973)529*

40 Years of Heavy Ion Physics in Romania

http://niham.nipne.ro/Seminar_HPD.pdf

IFIN-HH Juniors Day

Three master students from our Department had excellent presentations to this annual event. Dana Avramescu, 1st year master student, received the Serban Titeica award, 3rd place.

Student	Title
Dana Avramescu	Towards Color Glass Condensate at LHC energies
Adrian Sorin Mare	Beyond-mean-field approach to rp-process waiting point nuclei and effects on X-ray burst models
Amelia Lindner	Dependence of different observables on the CGC inspired variable for light flavor hadrons in pp and A-A collisions at RHIC and LHC energies

For details

http://nipne.ro/indico/conferenceDisplay.py?confId=377

HPD Christmas Party

HPD End of The Year Seminar was followed by our traditional Christmas Party joined also by colleagues from Theory, Nuclear Physics and Nuclear Applied Physics Departments.

2019 Anniversaries

70th Anniversary of IFAR

Year	Institute
1949	Institute of Physics of Romanian Academy (IFAR) - precursor of present IFIN-HH
1956	IFAR becomes Institute for Atomic Physics (IFA)
1977	IFA becomes Central Institute of Physics (ICEFIZ)
	Institute for Physics and Nuclear Engineering (IFIN)
	Institute of Physics and Technology of Radiation Instruments (IFTAR)
	Institute of Physics and Material technology (IFTM)
	Institute for Gravitation and Space Science (IGSS)
	Institute of Nuclear Energy Reactors (IRNE)
1996	IFIN becomes IFIN-Horia Hulubei (IFIN-HH)

65th Anniversary of CERN

http://home.cern/news/news/cern/cern-open-days-explore-future-us

50th Anniversary of GSI

http://gsi.de/en/about_us/50_years_gsi.htm

15th Anniversary of the Detector Laboratory of HPD

http://niham.nipne.ro/trd_construction_L.html

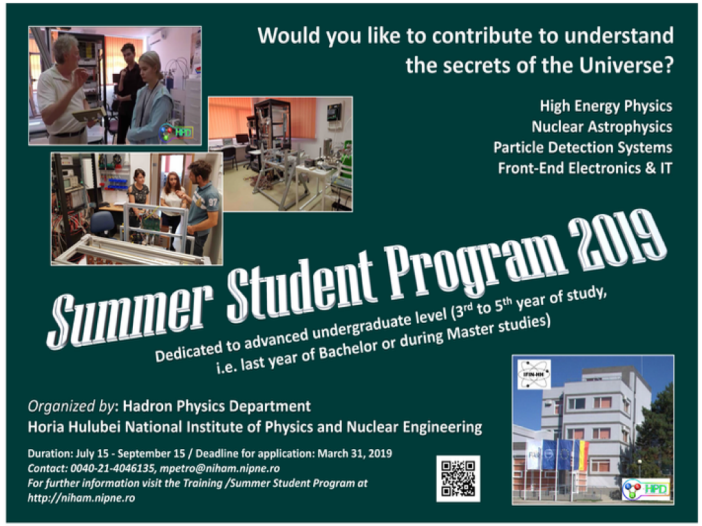
Summer Student Program

2018

Last year 3 students from Birmingham University, 1 student from Technical University of Bucharest and 1 from Sherbone High School, England were involved in the Summer Student Program organized by HPD. At the and of the program they presented an overview seminar, appreciated by HPD members. We are extremely pleased to hear the opinion of the former participants to this program on the impact of the experience they achieved attending this program on their performance in the places where they are, all over the world.

2019

We will organize such a program also in 2019. The poster will be distributed by the end of January 2019 and the whole information could be accessed on the web site of HPD: `http://niham.nipne.ro/conventie_studenti.html`.



2019 Main Events and Regular Meetings

Event/Meeting	Date
NUSTAR Annual Meeting	25 February-1 March
ALICE Weeks	25-29 March, 26-30 August, 25-29 September
ALICE Physics Week	15-19 July
ALICE-TPC Meeting	every Thursday at 14:30 CET
Spectra PAG Meeting	every Monday at 17:00 CET
CBM-TRD Retreat	27-29 March
CBM Meeting	1-5 April, 29 September-3 October
CBM-ToF Meeting	every Wednesday at 10:30 CET
CBM-TRD Meeting	every Wednesday at 14:00 CET
Strangeness in Quark Matter	10-15 June
Quark Matter	3-9 November

Job opportunities

Physicist

Physicist from master student to postdoc level, to be involved in Experimental Heavy Ion Nuclear Physics. The successful candidate will participate in research with members of the Hadron Physics Department from IFIN-HH, focusing on new generation of detectors construction, simulations, tests and their implementation in the CBM Experiment at FAIR. The candidate will also be involved in data analysis obtained in the test experiment at mCBM or in ALICE Experiment during Run3, starting from 2021.

Electronic Engineer

PhD or postdoc with some experience in CHIP design to be involved in development of analog and digital CHIPs for dedicated front-end electronics for the detectors developed in Hadron Physics Department for the present and future experimental devices. The successful candidate will participate also in the test activities of the present CHIPs designed in HPD and produced, associated mother boards and should have knowledge on FPGA programming. The activities will be related to the CBM Experiment at FAIR and later to the future Heavy Ion Experiment at LHC.

Technician

Technician with a post high school certificate. The successful candidate will be involved in preparation of detector components, detector construction, operation and tests, maintenance and operation of the DetLabs infrastructure.

Contact

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Selected candidates will have a temporary position for 1 year with the possibility to be extended to 2 years. In case of high performance and adequate involvement in the HPD activities, the position could become permanent once the successful candidates for Physicist and Electronic Engineer have a PhD degree.

Editors

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