ISAB FAIR-RO / 2017

Annual Summary Document

1. Cover Page

- Project Team:

- Prof. Dr. Mihai Petrovici (physicist) – team leader
- Scientific Researcher III Dr. Cristian Andrei (physicist)
- Senior researcher III Daniel Bartos (physicist)
- Senior researcher II Dr. Alexandru Bercuci (physicist)
- Senior researcher II Gheorghe Caragheorgheopol (electronics engineer)
- Senior researcher II Dr. Vasile Catanescu (electronics engineer)
- Senior researcher II Dr. Florin Constantin (physicist)
- Senior researcher II Viorel Duta (mechanical engineer)
- Scientific Researcher III Dr. Andrei Herghelegiu (physicist)
- Senior Engineer I Dr. Gheorghe Mateescu
- Senior researcher II Dr. Mariana Petris (physicist)
- Senior researcher I Dr. Amalia Pop (physicist)
- Senior engineer II Dr. Laura Radulescu (mechanical engineer)
- Senior researcher II Dr. Victor Simion (physicist)
- Computing coordinator Claudiu Schiaua (physicist)
- PhD student Madalina Tarzila (physicist)
- Technician Valerica Aprodu
- Technician Lucia Prodan
- Technician Andrei Radu
- Technician Constanta Dinca
- Turner Dima Gheorghe
- Financial coordinator Georgiana Toma (economist)

- Specific scientific focus of group

Contributions to the CBM TOF and CBM TRD R&D activities

- Highlights of accomplishments in the last year

- Data analysis of CERN-SPS in-beam tests campaign.
- Laser monitoring system.
- Construction and tests of the CBM compliant DAQ of TRD.
- Construction and tests of a new motherboard for electronic tests of FASP-0.2 ASIC.

- In beam tests of MSMGRPC prototypes with the granularity required by the inner zone of the CBM-TOF wall, using Pb beam of 30A· GeV at SPS-CERN.
- 6 contributions to CBM Progress Report/GSI Scientific Report
- 5 presentations to CBM Collaboration Meetings
- 2 presentations to the CBM TRD TDR Review
- 2 paper drafts, one sent to the review for publication, one is under internal reviewing
- A summer Student Program with 8 participants was successfully accomplished.

2. Scientific goals

- TRD - 2D position reconstruction in high counting rate and high multiplicity environment. Space resolution.
- TRD performance tests based on laser beam.
- Free running DAQ system prototype;
- ROC/FEE tests.
- MSMGRPC efficiency, system time resolution and cluster size in high counting rate and high multiplicity environment, close to the one of the CBM experiment.

3. **Scientific achievements in the last year corresponding to the actual program funding:**

CBM-TRD R&D

The testing of our TRD/FEE was performed for both ionizing particles and X-rays in conditions of high counting rates (HCR). The in-beam tests were performed at CERN-SPS beam facility while the X-ray tube, ^{55}Fe X ray source, laser and pulser were done in-house using the specially built test bench for X-rays irradiation and laser monitoring. For the SPS campaign 3 TRD prototypes were used operated by 3 DAQ systems based on FASP ASIC as FEE. The HCR laboratory tests were done using an optimized prototype operated with the CBM type free-running DAQ, FASPRO, based on Zinq-7000 technology. For all data taking campaigns event reconstruction was performed as detailed in the previous report. For the CERN-SPS setup only moderate rates were obtained due to limitations on the radiation dose imposed by CERN safety regulations. Therefore only maximum rates of $11x10^3$ particles/cm^2/s for several hundreds of seconds were obtained. Nevertheless parameters of cluster reconstruction were deduced from such data which are compatible with older results for which position resolutions on the level of under 200 x 1,000 μm^2 for the 2D position resolutions were estimated.

In order to test the performance required for the inner zone of the CBM experiment, i.e. average rates of 10^5 particle/cm^2/s, a laboratory setup was built based on X-rays tube producing the HCR environment and a laser beam used to test the gas detector performance during irradiation. With this device average rates of $0.7x10^5$ particles/cm^2/s were produced with maximum above $1.5x10^5$ particles/cm^2/s. Due to data back pressure of the present DAQ, continuous data taking was limited to tens of μs. Such particle rates are compatible with data rates per channel corresponding to the theoretical limit of FASP of 10^6 hit/ch. Laser beam was continuously monitored during and in between X-rays irradiation periods and deviation in in the detector response in terms of mean energy and detection efficiency was observed. Studies of the correlations with other reference signals in the system, such as radioactive source ^{55}Fe and monitoring pulser, are in progress in order to estimate if such systematic effects can be corrected such to recover the position and energy resolutions close to the values reached at lower rates. An upgrade of our free-running system with higher data throughput is ready for tests. This will allow a more precise estimate of the detector performance in HCR and high multiplicity environments.

The new motherboard designed for electronic tests of FASP-0.2 ASIC can be used for testing simultaneously two FASP-02 chips. It contains power supply circuits (+3V3A and 3V3D(PWR), reference circuits (COM., THR., BL), clock generation circuits, manual reset logic signal circuits, test points for all analog and digital signals with local grounding. It is made in 4 layers PCB technology with outer dimensions of 164 mm x 120 mm. The top layer contains components and tracks, the first inner layer the ground plane, the second one the power supply plane and the bottom one the radiators for power supply sources. Calibration measurements for FASP-0.2 selectable threshold (THR) voltages, were performed. They allow a precise setting of the THR value through the rotary switch position with a linear dependence of the setting value.

CBM-TOF R&D

In the trigger-less read-out mode in which CBM experiment is designed to be operated, all signals passing the electronic threshold are processed. In order to minimize the processing of a possible large number of fake signals resulted from reflections, a perfect matching of the signal transmission line to the value of the input impedance of the front-end electronics is required for the MSMGRPC counters of the CBM-TOF wall.

A MSMGRPC prototype with double – sided (DS) structure, which fulfills simultaneously the granularity and impedance matching requirements, was designed, built and tested. Its design exploits the advantage of the architecture of our prototypes which have a strip geometry for both, readout and high voltage electrodes, matching the characteristic impedance of the transmission line corresponding

to a single strip of MSMGRPC to the value of the input impedance of the front-end electronics (FEE), independent on the granularity adjustments. In the same time, an other MSMGRPC prototype with a single sided configuration was developed. Both of them have 100 Ohm signal transmission line impedance, matched to the corresponding value of the used FEE.

The original method was described in a draft of a paper which was uploaded on arxiv and sent for publication.

The two prototypes together with the prototype of a basic architecture of a module for the inner zone of the CBM-TOF wall and a narrow strip pitch MGMSRPC prototype were tested in-beam at the CERN-SPS accelerator. In the in-beam test the counters are exposed to the reaction products from collision of a 30·A GeV Pb beam on a Pb target, rather similar with the expected conditions at SIS100/FAIR. A number of 504 signals delivered by the descibed MSMGRPCs were fed to PADI fast amplifiers and digitized by 32-channel FPGA-TDCs. The readout was based on triggered TRB3 data hubs. The unpacking, calibration and analysis of the experimental data have been performed. The obtained results demonstrated the performance in terms of efficiency (97%) and system time resolution (~66 ps) for the prototypes developed by us. The value obtained for the cluster size of 2.4 strips is still under investigation. The long term operation studies demonstrated that the counter performance does not change in time after almost two weeks of exposure to the reaction products. The results have been presented to the CBM Collaboration Meetings and included in a proposal of a paper draft.

4. Group members:

Nr. Crt.	Name	Position within project
1	Prof. Dr. Mihai PETROVICI	Project director
2	Dr. Cristian ANDREI	Team member/ Specialist
3	Daniel BARTOS	Team member/ Specialist
4	Dr. Alexandru BERCUCI	Team member/ Specialist
5	Gheorghe CARAGHEORGHEOPOL	Team member/ Specialist
6	Dr. Vasile CATANESCU	Team member/ Specialist
7	Dr. Florin CONSTANTIN	Team member/ Specialist
8	Viorel DUTA	Team member/ Specialist
9	Gheorghe GIOLU	Team member/ Specialist
10	Dr. Andrei HERGHELEGIU	Team member/ Specialist

11	Dr. Gheorghe MATEESCU	Team member/ Specialist
12	Dr. Mariana PETRIS	Team member/ Specialist
13	Dr. Amalia POP	Team member/ Specialist
14	Dr. Laura RADULESCU	Team member/ Specialist
15	Claudiu SCHIAUA	Team member/ Specialist
16	Dr. Victor SIMION	Team member/ Specialist
17	Madalina TARZILA	Team member/ PhD student
18	Valerica APRODU	Team member/Technician
19	Lucia PRODAN	Team memberTechnician
20	Andrei RADU	Team memberTechnician
21	Constanta DINCA	Team member/Technician
22	Georgiana ROSU	Financial responsible
23	Gheorghe DIMA	Team member/Turner

Conferences and Meetings:

A. Bercuci, G.Caragheorgheopol, V.Catanescu, M. Petris, M. Petrovici, C. Schiaua
"Alternative Readout ASIC Test Beam Results"
CBM TRD TDR Review 14 – 15 March 2017
https://indico.gsi.de/conferenceDisplay.py?confId=5654

M.Petris et al.,
"Alternative Chamber Design"
CBM TRD TDR Review, 14 – 15 March 2017, GSI Darmstadt
https://indico.gsi.de/conferenceDisplay.py?confId=5654

A. Bercuci, G. Caragheorgheopol, V. Catanescu, C. Schiaua
"The free-running system developed for FASP-02"
29th CBM Collaboration Meeting GSI-Germany 20-24 March 2017.
https://indico.gsi.de/event/4759/session/16/contribution/95

A. Bercuci, V. Aprodu, D. Bartos, G. Caragheorgheopol, V. Catanescu, F. Constantin,M. Petris, M. Petrovici, L. Prodan, A. Radu, and C. Schiaua
"HCR measurements at SPS and X-ray tube in free-running mode"
29th CBM Collaboration Meeting GSI-Germany 20-24 March 2017
https://indico.gsi.de/event/4759/session/16/contribution/96

M. Petris et al.
"In-beam test performance of Bucharest – MGMSRPC prototypes"
CBM Collaboration Meeting, 20 – 24 March 2017, GSI Darmstadt

https://indico.gsi.de/event/4759/session/9/contribution/124

L.Radulescu, M. Petris, M. Petrovici, V. Simion
" CBM-TOF inner wall design for SIS100 "
The 17th International Balkan Workshop on Applied Physics, 11-14 July, 2017, Constanta, Romania
http://ibwap.univ-ovidius.ro/2017/articles/program

Mariana Petris
" Performance of the strip readout MRPC prototypes for the inner zone of CBM-TOF wall"
XXII International School on Nuclear Physics, Neutron Physics and Applications, 10-16 September, 2017, Varna, Bulgaria
http://www.inrne.bas.bg/international-school-varna/index.php/upcoming-school-2017/list-of-registered-participants

A. Bercuci, G.Caragheorgheopol, V.Catanescu, M. Petris, M. Petrovici, C. Schiaua
"The performance of the Bucharest TRD prototype up to 105 particles/cm2/sec rate and beyond …"
30th CBM Collaboration Meeting Wuhan-China 22-29 September 2017
https://indico.gsi.de/event/4760/session/6/contribution/58

M. Petris et al.
"Performance of the Bucharest MSMGRPC prototypes in a trigger-less mode operation"
30th CBM Collaboration Meeting, 24-28 September, Wuhan, China
https://indico.gsi.de/event/4760/session/5/contribution/85

Laura Radulescu et al.,
"Mechanical solutions for the inner zone of the CBM-TOF"
30th CBM Collaboration Meeting, 24-28 September, Wuhan, China
https://indico.gsi.de/event/4760/session/5/contribution/101

D. Bartos et al.,
"A method to adjust the impedance of the transmission line in a Multi-Strip Multi-Gap Resistive Plate Counter"
arxiv[physics.ins-det] 1708.02707

Contributions to CBM Progress Report 2016 (2017)/GSI Scientific Report 2016 (2017)

M. Petris et al.,
"CERN-SPS in-beam performance test of the new strip readout MRPC prototypes for the inner zone of the CBM-TOF wall"
CBM Progress Report 2016 (2017), 129/ GSI Scientific Report 2016 (2017), RESEARCH-NQM-CBM-6

M. Petris et al.,
"CERN-SPS in-beam performance test of the new strip readout MRPC prototypes for the inner zone of the CBM-TOF wall"
CBM Progress Report 2016 (2017), 131/GSI Scientific Report 2016 (2017), RESEARCH-NQM-CBM-

A. Bercuci, G. Caragheorgheopol, V. Catanescu, M. Petris, and M. Petrovici
“Laboratory tests of the Bucharest TRD prototype performance in High Counting Rate environment”
CBM Progress Report 2016 (2017) 122.

A. Bercuci, D. Bartos, G. Caragheorgheopol, V. Catanescu, M. Petris, and M. Petrovici
“Tracking with the Bucharest TRDs at the CERN-SPS test beam in 2015”
CBM Progress Report 2016 (2017) 121.

A. Bercuci, V. Aprodu, D. Bartos, G. Caragheorgheopol, V. Catanescu, F. Constantin, M. Petris, M. Petrovici, L. Prodan, A. Radu, and C. Schiaua
“Bucharest RPC and TRD prototypes at CERN-SPS test beam in 2016”
CBM Progress Report 2016 (2017) 118.

A. Bercuci, G. Caragheorgheopol, V. Catanescu, M. Petris, M. Petrovici, and C. Schiaua
“Tests of the FASPRO Free-Running DAQ for the Bucharest TRD prototypes at the CERN-SPS test beam in 2016”
CBM Progress Report 2016 (2017) 114.

Summer Student Program:
Quite successful, i.e. 8 participants: 2 students from Birmingham University, 2 from Oxford University, 2 from “Babes-Bolyai” University - Cluj - Romania, 1 from Bucharest Technical University and 1 from Physics Faculty of Bucharest University were involved in our activities in this summer. They participated in physics analysis for heavy-ion collisions at ultrarelativistic energies (2), TRD and RPC for CBM (3) CBM experiment design (1) TRD front-end electronics (1), nuclear structure and dynamics (1). Their activity was finalized with presentations. A booklet and a poster will be issued. Lectures concerning the detection and identification methods in nuclear and particle physics, data analysis using ALICE, introduction to heavy ion physics, two-particle correlations in pp collisions at 7 TeV, RPC for CBM were given by members of our group .

Outreach:

- Numerous visits of Romanian and foreign delegations, Romanian pupils winners of International Competitions in Physics, students of the Romanian Physics Faculties - Pentagon – network
- Interview for TVR International
- Visit of the Nuclear Physics Department Board of the European Physical Society
- Posters at the Researcher's Night, Bucharest, 2017