ISAB FAIR-RO / 5-6 Nov. 2015

Annual Summary Document

- **Group list** (physicists, staff, postdocs, students);

*- Prof. Dr. **Mihai Petrovici** (physicist) – **team leader***
*- 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)*
*- Senior researcher II **Gheorghe Giolu** (mechanical engineer)*
*- Senior researcher II Dr. **Mariana Petris** (physicist)*
*- Prof. Dr. **Alexandrina Petrovici** (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)*
*- Scientific Researcher Dr. **Cristian Andrei**(physicist)*
*- Scientific Researcher Dr. **Andrei Herghelegiu** (physicist)*
*- PhD student **Madalina Tarzila**(physicist)*
*- Technician **Valerica Aprodu***
*- Technician **Lucia Prodan***
*- Technician **Andrei Radu***
*- Technician **Constanta Dinca***
*- Financial coordinator **Georgiana Toma** (economist)*
- Student ***Cristina Dragoman***

- **Specific scientific focus of group**

Stage II

Objective IIa:

- Real size TRD tests using radioactive sources, cosmic rays and in-beam.

- Optimization of CBM-TRD architecture such to reduce as much as possible the dead zones of the whole set-up

Activity IIa.1:
- Design, manufacturing and assembly of the experimental set-ups for in-house tests using

radioactive sources and cosmic rays and for in-beam tests at CERN-PS and SPS

Activity IIa.2
- Data taking and on-line monitoring

Activity IIa.3
- Data calibration and analysis

Activity IIa.4
- Optimization of the CBM-TRD layers design

Objective IIb:

- Design and manufacturing of the mother board for electronic tests of the new FASP_02
CHIP

Activity IIb.1
- Development of the basic scheme to be designed

Activity IIb.2
- Motherboard design using ORCAD software

Activitate IIb.3
- Manufacturing and electronic tests of the motherboard

- Summary of accomplishments from the last reporting.

- All activities are within the proposed schedule and the expected results and performances were reached

2. Scientific accomplishments - Results obtained from the last reporting.

Based on the previous experience and especially on the recent results obtained at RHIC in the BES campaigns with the goal to find signatures of critical point existence, it is rather clear that the understanding of the phase diagram of strongly interacting matter and experimental support for phase transitions and critical points requires multidimensional analysis and rare probes, both of these being affordable once orders of magnitude better statistics than the one accessible in the present running experiments will be accessed. The beam intensities expected to be available at FAIR and CBM designed to cope with unprecedented counting rates will create premises for accessing such information. This was the main motivation for starting an ambitious R&D program within CBM Collaboration to develop a new generation of detectors with at least the same performance of those used in the present running experiments but in two orders of magnitude higher counting rate. Our group embarked on this ambitious project from the moment when CBM Collaboration was initiated.

After more than 10 years of intensive R&D activities we are reaching the target. The data collected in the in-beam test performed last November at PS at CERN using a combined beam of electrons and pions of 2-10 GeV/c and the experimental set-up shown in Fig.1 were calibrated and analyzed. The pion misidentification performance obtained in the previous measurements, see Fig.2, was confirmed. The main focus this time was on the two-dimensional position information resolution using the special pad geometry developed within our group.

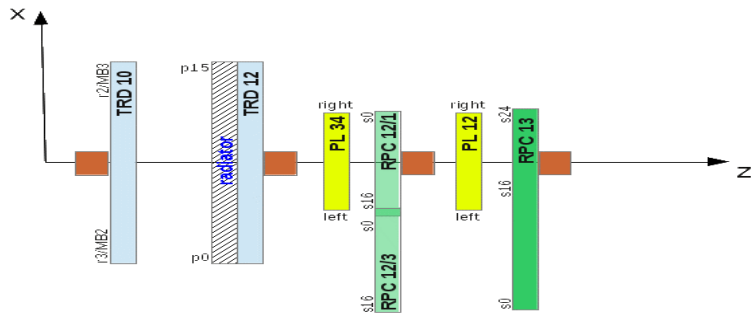


Fig.1 In-beam test configuration - PS – CERN

February this year we made an in-beam test at SPS using 19 A•GeV Ar beam on thick Pb target and the set-up sketched in Fig.3.

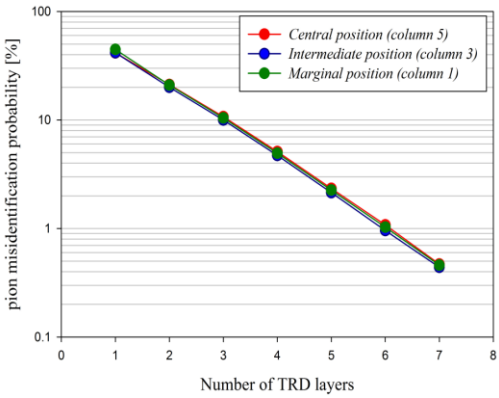


Fig.2 π missidentification probability as a function of number of TRD layers
for 3 positions on the TRD efficient area

Using three identical architecture TRDs, 2 small size (TRD2010) and one close to a real size TRD (TRD2012) and a configuration of 4 strip structure RPCs properly staggered (RPC2012) developed also in our group, it was possible to obtained detailed information on position resolution, tracking performance and behavior of the detectors in multi-hit environment.

RPC2012 TRD2010 TRD2010 TRD2012

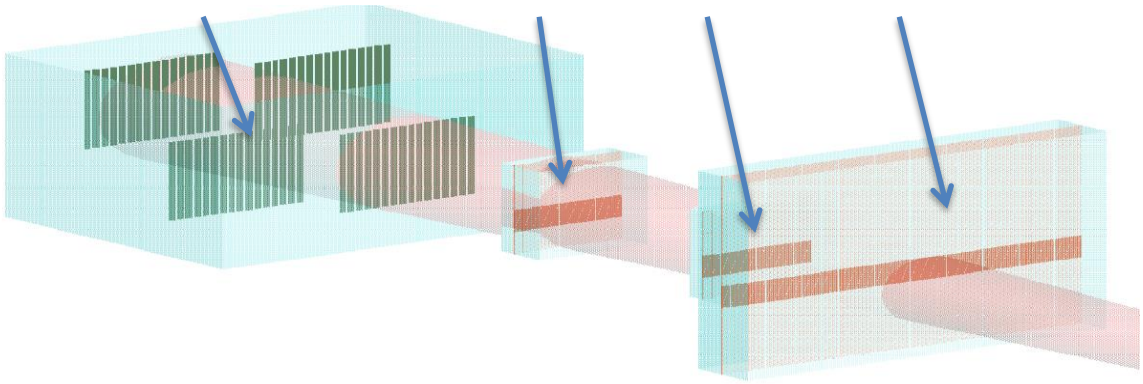


Fig.3 In-beam test configuration – SPS – CERN

An example of position reconstruction can be followed in Fig.4. One could clearly observe the position of the anode wires of 20 μm and 3 mm pitch, were the avalanches produced by single hits take place.

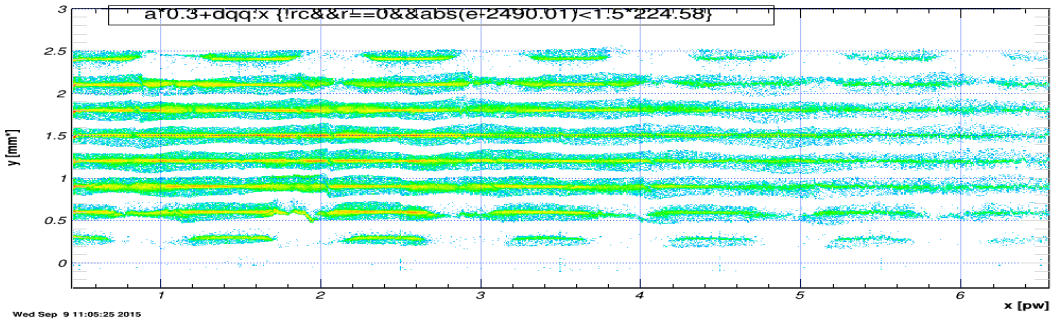


Fig.4 Position reconstruction based on the special pad geometry of the read-out electrode. Anode wire positions along the pads are clearly evidenced, the anode wires pitch being of 3 mm.

The information obtained in the two in-beam campaigns was completed by detailed ^{55}Fe X rays source and cosmic rays measurements done in our test laboratory using a rather similar experimental arrangement which can be followed in Fig.5.

Fig.5 Mechanical structure for detailed in-house tests

An example of a reconstructed track produced by cosmic rays using the information from the three TRDs, across (x) and along (y) the pads is presented in Fig.6.

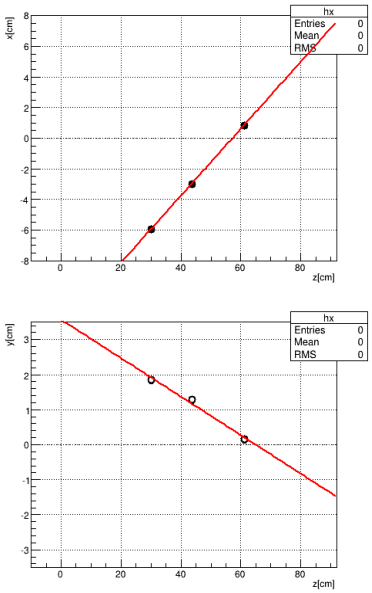


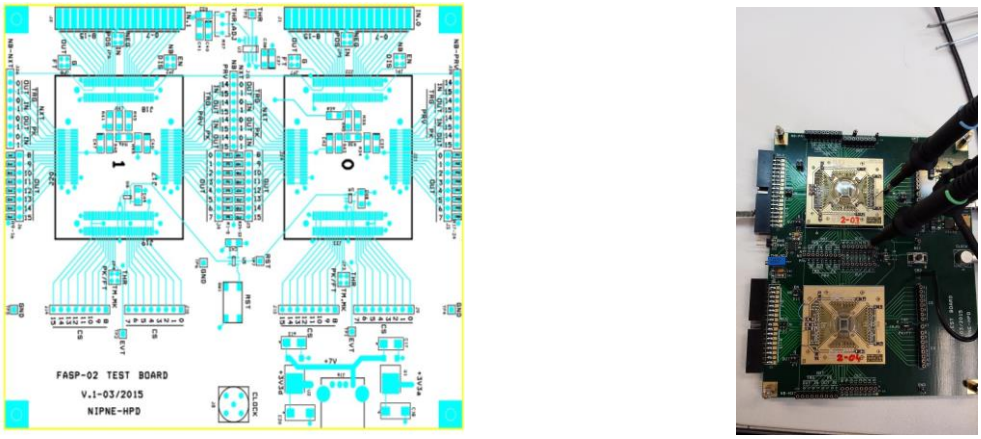
Fig.6 Cosmic rays reconstructed track across (x) and along (y) pads.

The obtained position resolution across the pads is of ~130 μm to which one has to add systematic errors which depend on the hit position within the pad, on the anode wire along the pad and the track inclination relative to the read-out electrode, σ(x, φ, anode wire…).

The position resolution along pads is ~700 μm and, as it is expected seeing the performance from Fig.4, it depends on the anode wires pitch. A 2 mm pitch could bring this value at ~ 500 μm.

Such a performance strongly recommends these type of TRD as solution for CBM especially for SIS100 where the TRD subdetector role is to enhance the PID performance of RICH and TOF subdetectors.

As it well known, our group proposed and designed a CHIP for a flat top amplifier as a dedicated FEE for the TRDs developed by us for CBM application. The main advantage of such a solution is that it keeps the TRD performance (the above results were obtained using the first version of this CHIP – FASP_01) reducing at minimum the information needed to be processed.



a) b)

Fig.7 a) the design of the mother board for FASP_02 electronic tests
b) a photo of the mother board with the two mini-boards and bonded FASP_02 CHIPs on

Based on the experience gained in testing the TRD prototypes and FASP_01 and on the obtained performance came the idea of the hardware pairing of the signals delivered by the triangular pads and triggering also the neighboring pads with signals below the threshold relative to the pad with signal

above the threshold, such to deliver the flat top information also for them. The number of channels of the new CHIP is 16 and it has also many other extra features relative to its previous version. For the electronic tests of these new CHIPs it was designed and produced a new motherboard of which drawing and photo are presented in Fig. 7.

The mother board was tested, it fulfills the specifications and detailed electronic tests of FASP_02 are in progress.

3. Group members:

- List each member, his/her role in project and the Full Time Equivalent (FTE) % time in project. FTE

*- Prof. Dr. **Mihai Petrovici** (physicist) – **team leader*** *- 0.3*
*- Senior researcher III **Daniel Bartos** (physicist)* *- 0.7*
- APLAC simulations, design of detectors' electric components, design of motherboards, electronic tests, in-house and in-beam tests
*- Senior researcher II Dr. **Alexandru Bercuci** (physicist)* *- 0.4*
- in-house and in-beam tests, calibration, analysis, MC simulations
*- Senior researcher II **Gheorghe Caragheorgheopol** (electronics engineer)* *- 0.7*
- design of motherboards, electronic tests, in-house and in-beam tests
*- Senior researcher II Dr. **Vasile Catanescu** (electronics engineer)* *- 0.8*
- ASIC design based on CADENCE
*- Senior researcher II Dr. **Florin Constantin** (physicist)* *- 0.5*
- DAQ design, operation, in-house and in-beam tests
*- Senior researcher II **Viorel Duta** (mechanical engineer)* *- 0.3*
- mechanical design, manufacturing, assembling, infrastructure
*- Senior researcher II **Gheorghe Giolu** (mechanical engineer)* *- 0.3*
- mechanical design, manufacturing, assembling, infrastructure
*- Senior researcher II Dr. **Mariana Petris** (physicist)* *- 0.7*
- in-house and in-beam tests, calibration, analysis
*- Prof. Dr. **Alexandrina Petrovici** (physicist)* *- 0.1*
- management
*- Senior researcher I Dr**. Amalia Pop** (physicist)* *- 0.2*
- physics @ CBM
*- Senior engineer II Dr. **Laura Radulescu** (mechanical engineer)* *- 0.7*
- detector and experiment design
*- Senior researcher II Dr. **Victor Simion** (physicist)* *- 0.7*
- detector design, assembling, tests
*- Computing coordinator **Claudiu Schiaua** (physicist)* *- 0.2*
- Computing Cetre coordinator
*- Scientific Researcher Dr. **Cristian Andrei**(physicist)* *- 0.2*

- physics @ CBM

*- Scientific Researcher Dr. **Andrei Herghelegiu** (physicist)* *- 0.2*

- physics @ CBM

*- Technician **Valerica Aprodu*** *- 0.5*

- prototype and final detectors assembling and tests

*- Technician **Lucia Prodan*** *- 0.5*

- prototype and final detectors assembling and tests

*- Technician **Andrei Radu*** *- 0.5*

- prototype and final detectors assembling and tests

*- Technician **Constanta Dinca*** *- 0.3*

- prototype and final detectors assembling and tests, procurement

*- Financial coordinator **Georgiana Toma** (economist)* *- 0.4*

- List PhD/Master students and current position/job in the institution.

*- PhD student **Madalina Tarzila** (physicist)* *- 0.2*

- in-house and in-beam tests, calibration, analysis

*- Student **Cristina Dragoman***

- electronic tests

4. Deliverables in the last year related to the project:

- List of papers (journal or conference proceeding);

- *Development of a Two Dimensional Position Sensitive Transition Radiation Detector for High Counting Rate Experiments*
  M. Petris, M. Petrovici, V. Catanescu
  Nuclear Theory, Vol. 33 (2014), p.152, ISSN 1313-2822 (Proceedings of the 33-rd International Workshop on Nuclear Theory (IWNT-33), Rila Mountains 2014)

- *Multi-Strip RPC for high counting rate experiment*
  M. Petris and M. Petrovici
  Journal of Physics: Conference Series, Volume 533, 012009, 2014

- *The CBM Time-of-Flight wall — a conceptual design*
  I. Deppner, N Herrmann, A Akindinov, D Bartos, A Balaceanu, S Belogurov, P Cao, G. Caragheorgheopol, H Chen, J Cheng, M Ciobanu, F Constantin, Z Deng, H Deppe, V Duta, H Fan, H Flemming, J Frühauf, J Gebelein, K Heidel, K Hildenbrand, U Kebschull, M Kiš, S Kiselev, K Koch, P Koczon, R Kotte, A Laso Garcia, J Lehrbach, C Li, Y Li, P A Loizeau, D Malkevich, S Manz, L Naumann, A Nedosekin, W Niebur, A Oancea, M Petris, M Petrovici, V Plotnikov, M Prokudi, L Radulescu, M Shao, V Simion, C Simon, R Sultanov, Y Sun, Z Tang, Y Wang, J Wüstenfeld, C Xiang, N Xu, Y Zhang, D Zhou and X Zhu
  2014 JINST 9 C10014

- List of talks of group members (title, conference or meeting, date);

- *Optimization of the geometrical detection efficiency of the CBM-TRD stations*
  L. Radulescu, M. Petris, M. Petrovici, V. Simion
  14th International Balkan Workshop on Applied Physics, IBWAP 2014, Constanta, 2-4 July, 2014

- *Present status of RPC R&D activities in Bucharest*
  V. Aprodu, A. Balaceanu, D. Bartos, A. Bercuci, V. Catanescu, F. Constantin, G. Caragheorgheopol, M. Petris, M. Petrovici, L. Prodan, A. Radu, L. Radulescu, V. Simion, P. Zaharia
  23rd CBM Collaboration Meeting, GSI Darmstadt, Germany, April 7-11, 2014

- *Present status of TRD R&D activities in Bucharest*
  A. Bercuci, V. Catanescu ,V. Aprodu, D. Bartos, F. Constantin, G. Caragheorgheopol, M. Petris, M. Petrovici, L. Prodan, A. Radu, L. Radulescu, V. Simion, M. Tarzila, P. Zaharia
  24th CBM Collaboration Meeting, Krakow, Poland, September 8-12, 2014

- *Present status of TRD R&D activities in Bucharest*
  A. Bercuci, V. Aprodu, D. Bartos, V. Catanescu ,F. Constantin, G. Caragheorgheopol, M. Petris, M. Petrovici, L. Prodan, A. Radu, L. Radulescu, V. Simion, M. Tarzila, P. Zaharia
  23rd CBM Collaboration Meeting, GSI Darmstadt, Germany, April 7-11, 2014

- *Status of RPC activities in Bucharest*
  M. Petris, V. Aprodu, D. Bartos, A. Balaceanu, A. Bercuci, G. Caragheorgheopol, F. Constantin, V. Duta, M. Petrovici, L. Prodan, A. Radu, L. Radulescu, V. Simion, M. Kis, I. Deppner, N. Herrmann, P-A. Loizeau, C. Simon
  24th CBM Collaboration Meeting, Krakow, Poland, September 8-12, 2014

- Other deliverables (patents, books etc.).

  - TDR (Technical Design Report) of CBM-RPC was finalized

  Contributions to CBM Progress Report 2014:

- *Common CBM beam test of the RICH, TRD and TOF subsystems at the CERN PS T9 beam line in 2014*

  C. Bergmann, D. Emschermann, W. Amend, A. Bercuci, R. Berendes, C. Blume, P. Dillenseger, C. Garcia,S. Glaßel, N. Heine, D. Hutter, B. Kardan, M. Kohn, M. Krieger, T. Morhardt, C. Pauly, M. Petris, M. Petrovici, F. Roether, M. Tanha, W. Verhoeven, J.P. Wessels

- *Two-dimensional MWPC prototype for CBM-TRD*

  A. Bercuci, D. Bartos¸ G. Caragheorgheopol, V. Catanescu, F. Constantin, M. Petris¸ M. Petrovici

- *Fast Analog Signal Processor FASP-02*

  V. Catanescu

- *Free-running acquisition system for Transition Radiation Detectors - in beam tests*

  F. Constantin, D. Bartos ¸, A. Bercuci, G. Caraghergheopol, V. Catanescu, M. Petris ¸, M. Petcu, an M. Petrovici

- *Cosmic-ray and in-beam tests of 100 Ohm transmission line MGMSRPC prototype developed for the inner zone of CBM-TOF*

  M. Petris ¸, V. Aprodu, D. Bartos ¸, A. Bercuci, G. Caragheorgheopol, F. Constantin, V. Duta, M. Petrovici, L. Prodan, A. Radu, L. Radulescu, and V. Simion

5. Further group activities:

- Collaborations, education, outreach:

  - Our Department will be involved in the construction and tests of 50% of OROCs for ALICE-TPC-upgrade based on GEM technology. Over the last 10 years there was quite a bit of synergy between our activities related to ALICE and CBM

  - *How to attack cutting edge research in a coherent manner based on local infrastructure ?*
    M. Petrovici - plenary session
    Annual Scientific Meting – Faculty of Physics, Bucharest University, 19.06.2015

  - *How to attack cutting edge research in a coherent manner based on local infrastructure ?*
    M. Petrovici – invited talk – West University Timisoara, 31.08.2015

  - numerous visits of high school pupils

  - visit of the students participating to the Pentagon of Romanian Universities

  - many visits of foreign delegations

  - visit of the Romanian President

  - Summer Student Program

  - 1 master thesis

  - Outreach material: movie, booklet, magic cube

6. Research plan and goals for the next year

- Two more RPC prototypes are on the way to be finalized and tested
- Finalizing the architecture of the inner-zone of CBM-TOF
- Finalizing the in-kind contract for production and tests of the inner-zone CBM-TOF RPCs
- Finalizing the proper infrastructure for RPC assembling and tests
- Starting the RPC production and tests for CBM-TOF
- One more TRD prototype on the way to be finalized and tested
- Calibration and analysis of data collected using radioactive sources, cosmic rays and in-beam tests
- Detailed tests of the FASP_02
- Submission of FASP_02-Version2
- Finalizing the architecture of the inner zones of the CBM-TRD layers
- Finalizing the CBM-TRD TDR
- Preparation of the in-kind contract for production and tests of CBM-TRD chambers
- Finalizing the proper infrastructure for production and tests of CBM-TRD chambers

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