R-I. “Lendület” innovative particle detector development

“Momentum” research team

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The objectives of the project ran along two directions: first is the completion of the strategic infrastructure development, the other concerns research related to detector physics and specific project activities, including commitments to CERN experiments and other international communities. Considerable success was achieved to participate in H2020 projects.

The infrastructure developments led to a consolidated, flexible laboratory, which in the national “NEKIFUT” register reached the Strategic Research Infrastructure status. A key addition is a new clean room related to the re-building the Time Projection Chamber (TPC) of the ALICE detector at the Large Hadron Collider of CERN.

The single photon scanner, nicknamed “Leopard” has taken the task 13.4.4 within the AIDA-2020 project, and thus received a 45kEUR grant at a total budget of 90kEUR. This means that the “Leopard” project sustains its own financing.

Considerable results have been reached in the field of cosmic ray detection. Publications present surface and underground measurements. Two tracking detectors have been purchased abroad, which initiated research collaboration with the involved institutes (HZDR Dresden; KACST Riyadh). We have been invited to the Muographers-2015 symposium in Tokyo, where besides talks by group members, the keynote plenary talk was presented by prof. Péter Lévai, the DG of the Wigner RCP. A research collaboration agreement has been formally signed by Wigner RCP and the Earthquake Research Institute of The University of Tokyo. The main aim of the collaborative effort is to develop detectors for volcano imaging and possible eruption prediction. Muon radiography is complicated in practice: Figure 1 shows a visualization by a small size tracking system.

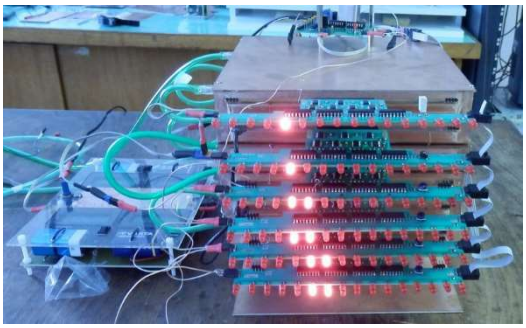

Figure 1. *Cosmic muon track visualized by an LED array, a model for the stand-alone tracking system developed by the group*

The participation of our research group has been approved in the TPC Upgrade project, which will concern the Quality Assurance of the GEM foils which will be built in. This officially means that Hungary will participate in the re-building of the ALICE TPC. The work will be performed in a newly built clean room, including optical scanning using a system developed by the Helsinki University, as well as our own system to directly measure the GEM gain map. Figure 2 shows

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the comparison of an optical (high resolution microscope) image of the hole sizes, with the measured amplification of the GEM layer.

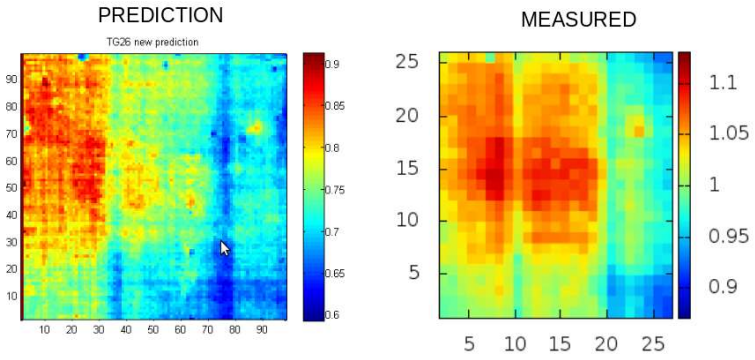

Figure 2. *Taking a GEM layer, 10 cm by 10 cm in size, the hole size distribution (left, measured at Helsinky University) correlates well with the measured amplification gain (right, our own result). The measurements are relevant to qualify GEM layers for construction in the upgraded ALICE TPC.*

The group has joined the BrightnESS project, a H2020-financed undertaking, with our aim in neutron detector development for the ESS facility in Lund. The detector concept, the so called "Multi Blade Detector", shown in Figure 3, developed by F. Piscitelli then at ILL, is based on an inclined boron layer which emits decay fragments, once it is irradiated by neutrons. Wigner RCP will contribute to construction, beam tests, simulations and electronics development.

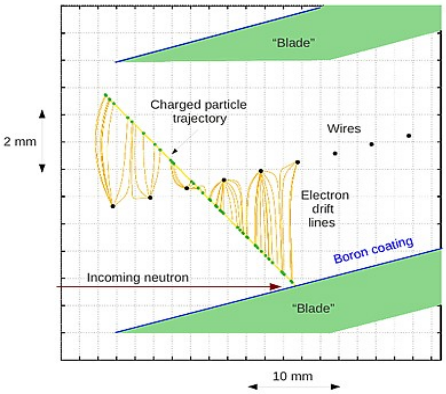

Figure 3. *The concept of a Multi-Blade neutron detector. The incident horizontal neutron arrives at grazing angle to be converted on the boron layer. The emitted charged fragment enters the sensitive volume and creates a measurable signal.*

The additional projects and assignments will progress in conjunction of availability of resources. One of the key participation is the Forward TPC construction for the NA61 Collaboration at the Super Proton Synchrotron of CERN. Along these lines, the outline for the NA61 data acquisition system has been published, led by group member András László.

Projects involving secondary school students continued with the leadership of Éva Oláh, who is a practicing teacher, and at the same time a PhD student at the Eötvös University. With the help of a successful EMET funding application, students were motivated for quality research, leading to competition results such as I. and III. Prizes at the national Innovation Competition.

Last year was particularly fruitful in defended Bachelor's and Master's theses, 4 in total, as well as presentations of TDK (undergraduate research project) activities. Notably, Gábor Galgóczi has won a I. prize at the prestigious National Scientific Students' Associations Conference competition.

Grants

"Momentum" Program of the HAS (D. Varga, 2013-2018)

AIDA-2020 (Advanced European Infrastructures for Detectors at Accelerators, WP13), H2020 (D. Varga, 2015-2018)

BrightnESS (Research Infrastructure for ESS), H2020 (D. Varga)

International cooperation

CERN NA61 Collaboration (A. Laszlo and K. Marton), CERN RD51 Collaboration (Gy. Bencze, G. Hamar and D. Varga), CERN ALICE Collaboration (G. Hamar, Gy. Bencédi and D. Varga)

Earthquake Research Institute, Tokyo University (Tokyo, Japan), Muography for Volcano Monitoring (L. Oláh, D. Varga)

Publications

Articles

1. Bencédi G, Barnaföldi GG, Molnár L: Monte Carlo Studies of Identified Two-particle Correlations in p-p and Pb-Pb Collisions. ***J PHYS CONF SER*** 589:(1) Paper 012001. (2015)

2. Carena F, Carena W, Barroso VC, Costa F, Chapeland S, Delort C, Dénes E, Divià R, Fuchs U, Grigore A, Ionita C, Kiss T, Simonetti G, Soós C, Telesca A, Vyvre PV, Haller BV DDL, the ALICE data transmission protocol and its evolution from 2 to 6 Gb/s ***J INSTRUM*** 10:(4) Paper C04008. 6 p. (2015)

3. László A, Dénes E, Fodor Z, Kiss T, Kleinfelder S, Soós Cs, Tefelski D, Tölyhi T, Vesztergombi Gy, Wyszyński O: Design and Performance of the Data Acquisition System for the NA61/SHINE Experiment at CERN. ***NUCL INSTRUM METH A*** 798: pp. 1-11. (2015)

4. Oláh L, Barnaföldi GG, Hamar G, Melegh HG, Surányi G, Varga D: Close Cathode Chamber technology for cosmic particle tracking. ***J PHYS CONF SER*** 632:(1) Paper 012020. 8 p. (2015)

5. Varga D, Gál Z, Hamar G, Molnár JS, Oláh É, Pázmándi P: Cosmic muon detector using proportional chambers. ***EUR J PHYS*** 36:(6) Paper 065006. 11 p. (2015)

Conference proceedings

7. Bencédi Gy, Barnaföldi GG, Molnár L: Identified Two-particle Correlations and Quantum Number Conservations in p-p and Pb-Pb Collisions at LHC Energies. In: *10^{th} International Workshop on High-p_T Physics in the RHIC/LHC era . Nantes, France, 09.09.2014 – 09.12.2014* Paper B2. 11 p.

8. László A: A natural extension of the conformal Lorentz group in a field theory context. In: *Proc. Gribov-85 Memorial Workshop (2015): Theoretical Physics of XXI Century. Chernogolovka, Russia, 17.06.2015 – 20.06.2015*. Paper LaszloGR. 12 p.

See also: R-B.23, R-B. ALICE Collaboration, R-H. CMS Collaboration, R-H. NA49 Collaboration, R-J.16.