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Technical design of the RPC-based ToF wall (iTOF) for the R3B experiment at FAIR

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Part of the experimental programs proposed for the R3B setup at the FAIR facility, requires a time-of-flight (ToF) measurement for the mass identification of ions in the large range of charges Z=1 to 92, at energies of several hundreds of MeV/u.

For flight paths about 15 m, the ToF measurement require resolutions well below 100 ps, and a detection surface of the order of 2x1 squared meters. Also the tracking and the granularity to resolve multiplicities impose requirements to the setup. Our group proposed the use of timing-RPCs made of strips for this detector [1]. An active R-and-D program was dedicated to define the RPC design, materials, and front-end electronics, adequate to measure heavy ions with the detector efficiency, timing and rate capabilities according to the R3B purposes.

The results obtained so far [2-4] allowed to pass from the conceptual design of the iToF detector [5], to a technical and construction phase. We have developed a RPC design based on self-supported modules, made of soda-lime glass sheets of 1 mm thickness, gas gaps of 0.3 mm, and 15 copper strips of 2 cm x 100 cm each. A group of modules can complete a detection plane of the required size for R3B. Several of such planes can achieve a time resolution low enough as to identify any ion of interest, overcoming the resolution limit of the RPC itself.

Summary

Our first goal after R-and-D was to build a set of modules (active area of 100 cm x 30 cm, each) that complete a detection plane (2 m x 1 m) of the iToF detector. The modularity of our design allows for the application to setups of large detection surface, but also for a multiple measurement of time in successive planes of reduced surface. The modules will be used immediately in scheduled experiments, being at the same time a test bench for the more demanding detector capabilities required in future R3B activities.

We have done the technical design to proceed to the construction of the modules. In this paper we detail the design and materials chosen to work with heavy ions, the procedure for the construction of the RPC modules, the gas control and distribution system, and the bias distribution. The mechanical mounting to allow for a robust and easy handling of the modules, an asset of iToF, is presented. We also describe in detail the front-end solution we have developed, and its performance. The characteristics of the first constructed modules are presented.

[1] H. Alvarez et al., Nuc. Phys. B 158 (2006) 186-189 .
[2] Y. Ayad et al., NIM A, doi:10.1016/j.nima.2010.08.079 .
[3] E. Casarejos et al., submitted to NIM A.
[4] C. Paradela et al., at this conference.
[5] E. Casarejos et al., NIM A, doi:10.1016/j.nima.2010.09.069 .

Primary author: Dr CASAREJOS, Enrique (University of Vigo, Spain)

Co-authors: Dr SEGADE, A. (University of Vigo, Spain); Dr PARADELA, C. (University of Santiago de Compostela, Spain); Dr DURAN, I. (University of Santiago de Compostela, Spain); Dr BENLLIURE, J. (University of Santiago de Compostela, Spain); Dr VILAN, J.A. (University of Vigo, Spain); PEREIRA, J.R. (University of Santiago de Compostela, Spain); Dr LOPEZ, M. (University of Vigo, Spain); MONTES, N. (University of Santiago de Compostela, Spain); AYYAD, Y. (University of Santiago de Compostela, Spain)

Presenter: Dr CASAREJOS, Enrique (University of Vigo, Spain)

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