



Contribution ID: 81

Type: Oral

Design of the new RPCs and Front End electronics for the ATLAS High Luminosity LHC program

Thursday, 29 September 2022 09:00 (20 minutes)

The present ATLAS RPC system is a 3D+time tracking detector providing the first level trigger in the ATLAS barrel. It is constituted by 6 concentric cylindrical layers providing independent space-time measurements along the track, with 1ns x 1cm resolution. This system will undergo a major upgrade for the HL-LHC program, consisting in inserting in the Inner Barrel region, three additional full coverage layers of new generation RPCs.

The new system will extend from about 70% to about 96% the trigger acceptance; add redundancy to the legacy RPC; increase the trigger selectivity and bring the resolution on the particle velocity to up 0.5%, thanks to the increased time resolution and lever arm.

The most innovative feature of this project, inheriting most of the other features from the BIS78 pilot, is a novel Front-End electronics (FE), and its integration in the RPC Farady cage. This FE features 1 fC sensitivity of preamplifier and fast discriminator and 70 ps resolution Time-To-Digital converter in SiGe BiCMOS technology, enabling the readout of the azimuthal coordinate from the time difference at opposite edges of the detector. A new RPC gas gap 1 mm thick, coupled with this novel front-end electronics represents a new generation of large area timing detectors, granting all the features above and a record time resolution of 350ps as well.

In this presentation, we will report the design progress, reaching the final prototype maturity, with a particular focus on the FE, our main challenge.

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Session Classification: Detector electronics and simulation