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Electronics and Trigger developments for the Diffractive Physics Proposal at 220m from LHC-ATLAS

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The instrumentation consists of two sets of Roman Pots installed respectively at 216 and 224m on both sides from the ATLAS IP to measure with precision the position (<10 micrometers) and the timing (< 5 picoseconds) of the two back to back diffracted protons tracks.
Each Roman Pot is equipped with several plans of edgeless silicon strip detectors read-out by a new version of the ATLAS SCT ABC chip with a longer latency (6.4 microseconds) and fast OR outputs defining a track segment.
These inputs are to be combined in time with the ATLASLVL1 trigger ACCEPT signal. In addition these tracks are time filtered with a very fast timing detector (MCP-PMT) allowing to constraint further at LVL2 the position of the IP within one millimeter precision. The description of the electronics and trigger system as well as the various technical issues associated with such challenging experiment (clocks, cabling, cooling, time monitoring) will be presented. Preliminary test results of the position and timing devices will be given.

Summary

This should be done within the L1 CTP latency of about 2 microseconds leaving around 500 nanoseconds for the full digital logic, taking into account the particles flight path and transit cables from the roman pots stations. These information will be combined with two jets with a large Pt >20 Gev/c to make the L1 diffractive trigger. The implementation of the various electronics functional blocks and cables as well as the associated timing and data flow will be presented. At LEVEL 2, the full digitized information of all the silicon strips planes will allow a precise reconstruction of each track hits with a precision of 5 micrometers. In addition the timing information can be then fully used in order to insulate the relevant vertex with a precision of the millimeter or better.
We propose to measure also very precisely the time of flight of diffracted protons produced at the collision IP in specific devices placed in each roman pot. using these new micro-channel-plate photomultipliers in which the particles product Cherenkov light while traversing the window of one element in an array of area (e.g. 2,5 cm x 2,5 cm) .Recently, there has been a substantial improvement in the time resolution of MCP's, which have now achieved a 10 picoseconds transit-time spread (FWHM) for a single photon and 6 picoseconds for multiple photoelectrons. The basic principle of such detector is the following. A relativistic particle produces Cherenkov radiation in a crystal placed in front of the window of a PMT-MCP. This radiation is converted into electronsby a photocathode. The electrons produce a shower in the micro- channel plates, and the shower is collected by the anodes. After transmission through an impedance matched segment, the signal is detected from a central collector, and conveyed to an on-board chip in where it is digitized. The Cherenkov emission light has been simulated as well as the MCP response spectra for several commercially available MCP's, showing that a TOF resolution on the order of 1 picosecond should be attainable. This would allow separation of the different vertices with a resolution of less than one millimeter. It may also be possible to associate a photon with its production vertex by conversion directly in front of the MCP. The system we are considering requires a custom large-area MCP design with an anode consisting of impedance-matched segments, directly coupled to a circuit capable of psec resolution. This anode is made in a multipads structure of 4 by 4 elements with equal time transmission lines to connect to a common collection point input of the on-detector readout ASIC. A description of the readout electronics chain and its preliminary implementation will be given.
A full description of all technical system issues associated with such particular implementation will be presented including the radiation level and shielding, cooling, clocks distribution and timing stability monitoring, data flow and wiring.

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