Diamond Pad Detector Telescope for Beam Conditions and Luminosity Monitoring in ATLAS (oral presentation)

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Beam conditions and the potential detector damage resulting from an anomalous event such as a full LHC bunch blasting into the collimators have provoked LHC experiments to plan their own monitoring devices in addition to those provided by the machine. ATLAS decided to build a telescope with two stations of four diamond pad detectors each. Equipped with fast electronics with shaping time of 1 ns it allows time-of-flight separation of events of beam anomalies from normally occurring p-p interactions. Placed symmetrically about the interaction point at z=+/-183.8 cm and r~55 mm (η~4.2) it will provide also a coarse measurement of the ATLAS LHC luminosity.

The stringent timing requirement to resolve signals half a bunch crossing apart, coupled with the radiation field of $\sim 10^{15}$ π/cm^2, prompted the usage of 500 μm thick pCVD diamond pad detectors of 1x1 cm^2, operated at an unconventionally high electric field of 2 V/μm. Two diamonds are glued back to back and tilted at 45° to the tracks to enhance the signal. Two stage high-bandwidth low-noise pre-amplifier composed of discrete components provides signal amplification of ~ 40 dB, with signal rise time of 1 ns, pulse width of 3 ns and base-line restoration in 10 ns. Low-loss coaxial cables are used to lead the signals ~14 m outwards, where they are processed in the NINO time-over-threshold timing amplifier-discriminator ASIC, thus preserving timing and amplitude information. Further processing of the optically transmitted signals, including timing coincidence and amplitude analysis, and event history tracing that could eventually lead to a beam abort request, is foreseen by an FPGA based system in the ATLAS service cavern.

Ten detector modules have been assembled and subjected to tests, from characterization of bare diamonds to source and beam tests. The latter were performed last December at KEK, and a decisive qualification test is taking place this summer in the CERN PS beam. Two periods are foreseen using a silicon telescope for efficiency evaluation across the detectors. Operating the modules in 2 T magnetic field is part of the test beam programme. Final electronics and services will be used. Based on performance, eight of the modules will be selected for installation on the pixel support structure. Details on the integration and first ideas on beam anomalies recognition algorithms will be given.