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The Diamond Beam Monitor for Luminosity Upgrade of ATLAS

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Luminosity monitors, beam monitors and tracking detectors of the experiments at the Large Hadron Collider and their upgrades must be able to operate in radiation environments several orders of magnitude harsher than those of any current detector. We have observed in ATLAS that as the environment becomes harsher detectors not segmented, either spatially or in time, have difficulty handling the separation of signal from background. Once the charged particle multiplicity reaches the point where all segments of these detectors have a high probability of having a hit in every bunch crossing their sensitivity quickly vanishes. This is already happening in ATLAS to the MBTS luminosity counters that will be removed in the 2011 year-end shutdown and LUCID luminosity counters. Chemical Vapour Deposition (CVD) diamond has a number of properties that make it an attractive alternative for high energy physics detector applications. Its large band-gap (5.5 eV) and large displacement energy (42 eV/atom) make it a material that is inherently radiation tolerant with very low leakage currents and high thermal conductivity. CVD diamond is being investigated by the RD42 Collaboration for use very close to LHC interaction regions, where the most extreme radiation conditions are found. The ATLAS Diamond Beam Monitor project (DBM) is a highly spatially segmented diamond-based luminosity monitor to measure bunch-by-bunch luminosity in ATLAS. The DBM will complement the highly time-segmented ATLAS BCM so that when the other ATLAS luminosity monitors (MTBS and LUCID) have difficulty functioning the ATLAS luminosity measurement which is a key to most precision measurement is not compromised. The DBM will provide three orders of magnitude higher spatial segmentation (relative to the single BCM pads) at the expense of lower (25 ns vs 2 ns) time resolution. However these two systems will complement one another in our characterisation of the beam backgrounds. The BCM will still use its exquisite timing resolution to localise beam background sources up (or down) stream of ATLAS, while the DBM will provide additional spatial information about the source(s) of background. To accomplish these goals, the DBM architecture is four 3-layer telescopes on each side of the interaction point with each layer having the size of one FE-I4 module, namely 20mm x 16.8mm active area. The first and last layers of the telescope are offset so that particles from both the ATLAS interaction point and beam halo background can be tracked. The results from protoype detectors and status of the project will be presented.

Presenter: GORISEK, Andrej (Jozef Stefan Institute (SI))

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