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Comparative study of proton induced radiation damage in plastic scintillators for the Tile Calorimeter of ATLAS

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Abstract content
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The Tile Calorimeter of the ATLAS detector, is a hadronic calorimeter responsible for detecting hadrons as well as accommodating for the missing transverse energy that result from the p-p collisions within the LHC. Plastic scintillators form an integral component of this calorimeter due to their ability to undergo prompt fluorescence when exposed to ionising particles. The scintillators employed are specifically chosen for their properties of high optical transmission and fast rise and decay times which enable efficient data capture since fast signal pulses can be generated.

The main draw-back of plastic scintillators however is their susceptibility to radiation damage. The damage caused by radiation exposure reduces the scintillation light yield and introduces an error into the time-of flight data acquired. During Run 1 of the LHC data taking period, cryostat scintillators in the GAP region of the Tile Calorimeter were exposed to a radiation environment of up to 10 kGy/year. With operational beam energy and luminosity set to increase in successive data taking periods to come, these scintillators will be exposed to a much harsher radiation environment. Hence these scintillators will be replaced during the 2018 detector upgrade.

A comparative study was therefore conducted into the radiation hardness of several PVT and PS based plastic scintillators available on the market. In this talk, we present an analysis of the damage undergone after subjecting 350 μm thick samples to 6 MeV proton irradiation using the tandem accelerator of iThemba LABS, Gauteng. The degradation in scintillation light yield and light transmission is assessed for doses ranging between 800 kGy to 80 MGy, and a Raman characterisation of the change to bonding structure is presented. The effect of irradiation dose rate to damage is also presented.

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