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Radiation hardness of plastic scintillators for the Tile Calorimeter of the ATLAS detector

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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 time which enables 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, plastic scintillators employed within the GAP region between the Tile Calorimeter's central and extended barrels sustained a significant amount of damage. With operational beam energy set to increase in successive data taking periods to come, these scintillators will be exposed to a much harsher radiation environment.
In lieu of the 2018 planned upgrade when the gap scintillators will be replaced, a comparative study was conducted into the radiation hardness of several grades of plastic scintillators available on the market. In this talk, I present an analysis on the damage undergone by several polyvinyl toluene and polystyrene based scintillators which have been subjected to 6 MeV proton irradiation using the tandem accelerator of iThemba LABS, Gauteng. The degradation in scintillation light yield as well as 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.

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