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A study of radiation damage in plastic scintillators using magnetic resonance techniques for the upgrade of the ATLAS detector

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Abstract content
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During the phase two upgrade of the Large Hadron Collider (LHC), various components of the accelerator and ATLAS detector are due to be replaced or upgraded to withstand the increase in instantaneous luminosity. The minimum bias trigger scintillator (MBTS) plastics located at 2.09 ≤|η|≤3.84 on the EndCaps of the Tile Calorimeter (TileCal) in the ATLAS detector were subjected to ionizing radiation that allows them to track the trajectories and measure the energies of energetic particles. However, it is this interaction that causes structural damage within the polystyrene based MBTS plastics. The 6 MeV proton tandem accelerator at iThemba LABS, Gauteng is used to replicate the damage that the MBTS plastics are subjected to in the ATLAS detector in order to find a plastic scintillator type that could replace the one currently used. In order to understand structural damage, electron paramagnetic resonance (EPR) and nuclear magnetic resonance (NMR) are employed to detect structural defects in two grades of polystyrene based plastic scintillators and three grades of polyvinyl based plastic scintillators. A replication of the spectra seen by both magnetic resonance techniques will be attempted using a computational ab-intio approach. This should offer insight into the electronic structure of the plastic scintillators and how ionizing radiation causes structural damage to them.

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