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Understanding radiation damage of the MBTS detector at ATLAS using Raman scattering

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Abstract content
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Ukrainian Polystyrene-based plastic scintillator (UP923A) samples manufactured by the Institute of Scintillating materials in Ukraine were investigated using Raman scattering techniques. Three irradiated samples of the same type (UP923A) from the Minimum Bias Trigger scintillator (MBTS) taken from three different positions: Top (T1), Bottom 1 (B1) and Bottom 2 (B2) in the ATLAS detector were investigated. And compared to an un-irradiated sample (D1) of the same type and a 40 MegaGray UP923A irradiated sample. The aim of this investigative project was to understand how the molecular structures of plastic scintillators are damaged due to high energy collisions at LHC using Raman scattering techniques. It was also to observe if there are any variations in molecular damage of the plastic at different positions in the MBTS. It was found that the Raman spectra of the irradiated samples at three different positions in MBTS are similar in shape and have similar peaks, thus the extent of the molecular damage at this positions is not easily distinguishable between the samples. It was also observed that the intensities of the Raman spectra peaks of irradiated samples are smaller in magnitude than the intensities of the peaks in the un-irradiated sample, thus bond breaking occurred during radiation interactions to decrease the amount of specific species in the molecular structure of the plastic. The 40 MegaGray irradiated sample Raman spectrum shows extensive molecular damage. Using Raman scattering analysis, it was observed that the benzene rings in UP923A molecular structure was damaged due to radiation. This study was done with collaboration between the ATLAS team at Wits University and iThemba labs in Gauteng, South Africa.

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