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Thermal simulations of temperature excursions on the Athena X-IFU detector wafer from impacts by cosmic rays

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We present the design and implementation of a thermal model, developed in COMSOL, of the Athena X-IFU detector wafer, aiming to probe the wafer-scale thermal response arising from realistic impact rates and energies of cosmic rays at L2. The COMSOL simulation is a four-layer 2D model, where 2 layers represent the constituent materials (Si bulk and Si3N4 membrane), and 2 layers represent the Au metallisation layer's phonon and electron temperatures. We base the simulation geometry on the current specifications for the X-IFU detector wafer, and simulate cosmic ray impacts using a simple power injection into the Si bulk (where the majority of minimally-ionising proton energy is deposited). We measure the temperature at the central-most point in the wafer –the point of the most central pixel, as would be seen by the instrument's TES detectors. By probing the response of the system and pulse characteristics as a function of the thermal input energy and location, we reconstruct cosmic ray pulses in Python. By utilising this Python code, and coupling it with the results of the GEANT4 simulations produced for Athena X-IFU of energy depositions in the wafer, we reconstruct realistic timelines of the temperature excursions seen by the central pixel, thus probing the wafer-scale thermal background. We use these timelines to simulate the degradation of the energy resolution of the instrument arising from this thermal background. By modifying wafer parameters and comparing the timelines, this study is a valuable tool for probing design changes on the thermal background seen by the detectors.

Less than 5 years of experience since completion of Ph.D

Y

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