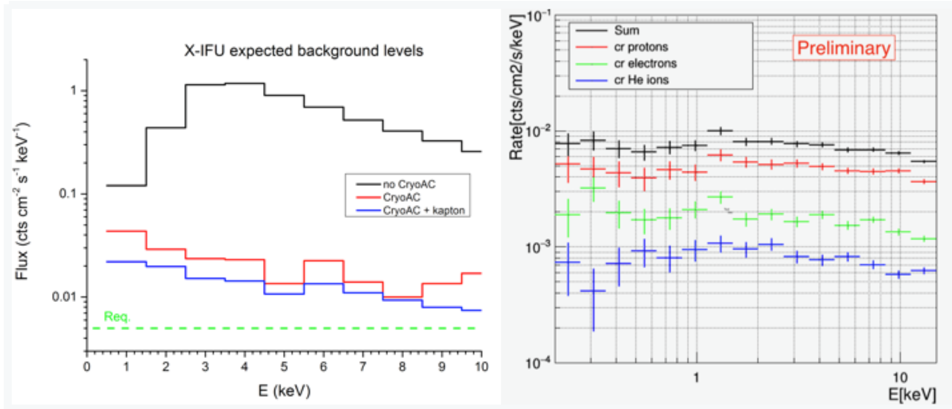
Athena Instrument Background

by Simone Lotti (INAF/IAPS, Rome) and Silvano Molendi (INAF/IASF, Milan)

Observations of faint X-ray sources are traditionally limited by instrumental background. The largest contributions to the background arise from Cosmic Rays (CRs) that possess enough energy to cross the spacecraft and reach the instruments from any direction and from Soft Protons (SPs) concentrated by the optics. Here we focus on the CR-induced component (see the AREMBES news, included in Newsletter#3, for a discussion on SPs). CRs create showers of secondaries, e.g., electrons, protons, along their path, which in turn induce further background on the detectors.

The standard approach is to exploit Monte Carlo simulations to predict and analyze the background components. This requires the construction of a representative mass model of the instruments and an adequate understanding of the radiative environment. In turn, these simulations allow to characterize not only the background level, but also its spectrum, origin and composition. All this information can be used to plan for solutions aimed to reduce specific background components, and/or suppress the generation of secondaries from specific elements of the mass model.



Preliminary spectra of the background in the Athena Instruments. Left - X-IFU background for different configurations of the FPA. Right - WFI background showing contributions from different particle populations (plot courtesy of A. von Kienlin and the WFI team). Optimizations are ongoing for both instruments.

In the case of the X-ray Integral Field Unit (X-IFU) Geant4 simulations indicated that the CR induced background on the instrument without any precaution would be >100 times above the level set by the scientific requirement and it was induced mostly by MIPs (Minimum Ionizing Particles). To reduce this component, it is foreseen to include a Cryogenic Anticoincidence detector (CryoAC) capable of intercepting ~ 98% of the MIPs.

Once MIPs are removed the residual background is still a factor >3 above the requirement. This time the culprit are low energy secondaries that deposit all of their energy inside the detector or scatter on its surface, not reaching the CryoAC. To reduce their flux a low-Z passive shielding (kapton) has been inserted in the FPA (Focal Plane Assembly), producing a background closer to the requirement. Possibilities under study to further reduce the background involve optimization of the passive shielding and possibly the use of a lateral CryoAC surrounding the detector on its sides, although their feasibility is yet to be studied by the instrument team.

The Wide Field Imager (WFI) background is mitigated in different ways. Due to the thickness of the detector, MIPs deposit a large amount of energy and can be discarded during event processing. Secondary particles (i.e. electrons, fluorescence photons) will also contribute strongly. Secondary electrons can be reduced through optimization of the detector coating, while to reduce the impact of fluorescence photons a graded-Z shield, i.e. a multi-layer coating with decreasing atomic number from outside inwards, will be implemented.

Further reductions in background can be achieved by a form of self-anticoincidence where the data from an entire quadrant of the WFI Large Detector Array hit by a particle can be rejected. These and other issues are being addressed within the WFI team to ensure compliance with the background requirements.