Protecting the Athena/WFI from UV and visible light

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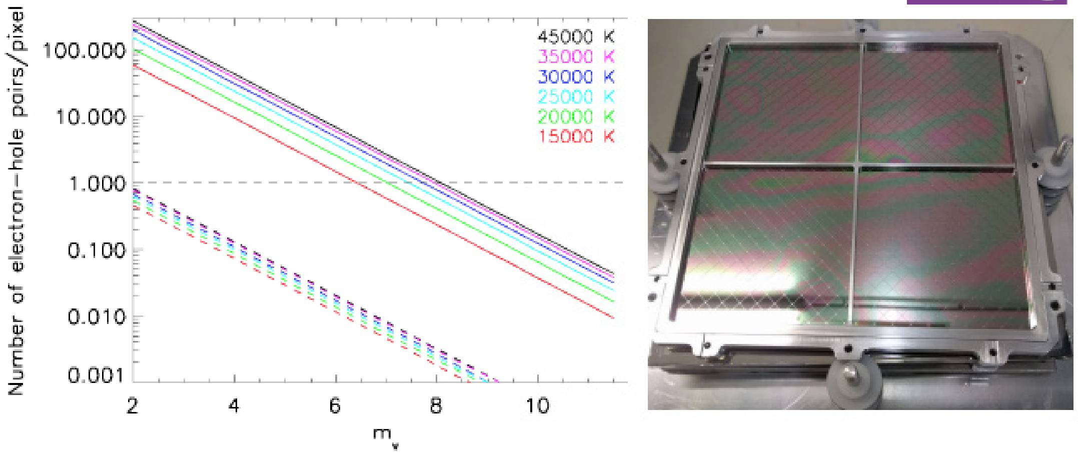
The DEPFET detectors foreseen for the Wide Field Imager (WFI) on board *Athena* are not only sensitive to X-ray photons, but also to UV and visible light with energies larger that the Si band gap (~1.1 eV). The effect of such photon hits is twofold: a degradation of the spectral resolution and a shift of the energy scale by on average 3.7 eV for each optically or UV light generated electron-hole pair. The astrophysical sources planned for observation with the WFI can be very bright in the optical/UV light, therefore, in order to study the X-ray component of their spectra with the WFI, UV/Vis photons need to be blocked.

In the current camera design, an optical blocking filter (OBF), consisting of 90 nm of Al, 30 nm of Si_3N_4 and 20 nm of SiO_2, will be deposited directly on the DEPFET sensors providing an attenuation of nearly 10^{-5} in the UV/Vis with a reduction of the transmission at 0.5 keV and 1 keV of ~30% and 10%, respectively. Such attenuation is, however, insufficient to, e.g., perform studies of X-ray variability in O-B stars (as bright as $m_v = 2$) to probe the dynamics of stellar winds, and to study stellar clusters which contain early-type stars as bright as $m_v = 4$. For this reason, an additional OBF will be mounted on a filter wheel (FW), leaving the possibility to use an open position for special cases where the X-ray sensitivity shall be increased and the sources are not optically bright.



Left Panel – predicted number of electron-hole pairs per pixel per read-out time of the WFI generated by UV/Vis photons from early-type stars without (solid lines) and with (dashed line) the FW OBF. Colors represent different stellar effective temperatures. *Right Panel* - FW OBF sample of the WFI imaging detector successfully tested under vibration and acoustic loads. Credit: Marco Barbera

The currently investigated FW OBF design consists of a thin film of polyimide 150 nm thick coated with 30 nm of aluminum. The combination of such filter and the on-chip OBF allows to obtain nearly 10^{-7} attenuation in the UV/Vis, sufficient to observe hot stars as bright as $m_v = 2$ (left panel in Figure), with a total loss in X-ray sensitivity of ~ 20% at 1 keV and ~ 50% at 0.5 keV.

The major challenge for the development of the FW OBF is the large size (~140x140 mm^2) of the WFI Large Detector Array. This requires the FW OBF to measure about 170 mm on each side. To protect the thin filter against the severe acoustic and vibration loads during the launch of *Athena*, a reinforcing mesh and a cross shaped structure is foreseen as mechanical support (right panel in Figure). A second OBF with similar characteristics and size of ~ 35 x 35 mm^2 will be mounted on the FW to protect the smaller WFI Fast Detector. Here, both the self-standing or mesh supported options are being investigated.

The currently investigated mesh is AISI 304 SS (pitch = 6 mm, wires thickness = 200 µm, wire width = 100 µm) plated with 5 µm of gold to absorb Fe fluorescence lines induced by particles which would contribute to the instrument background. The total mesh blocking factor is of ~ 4 %. The shadow due to the cross shaped supporting structure partially overlaps with the gap between the four detector quadrants resulting in a blocking factor for diffuse sources of the order of 2.5% averaged over the full detector under the hypothesis that a dithering algorithm is applied to smear out the blind detector gaps.

In order to demonstrate the capability of such filter to withstand the launch stresses, a few samples partially representative of the current design have been procured. Such samples have undergone vibration tests at the Centre Spatial de Liege (BE) and the Max-Planck-Institut für extraterrestrische Physik in Garching (DE) and acoustic tests at the AGH University in Krakow (PO). All tested samples have survived launch vibration and acoustic loads higher than the Ariane 5 launcher specifications. Structural analysis and new dynamic and static load tests will be performed to optimize the mesh and supporting structure design to reduce the overall blocking factor. Verification tests (acoustic and vibration) of fully representative filter samples are planned in Q3 2018.