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Investigation on the status of the XMM-Newton EPIC T and M filters after more than 10 years of operation

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Abstract. After more than ten years of operation of the EPIC camera on board XMM-Newton, we have started an investigation to review the status of the thin and medium filters by performing laboratory measurements on back-up filters, and on-board calibration measurements. The laboratory measurements will consist of: UV/VIS/IR transmission measurements, X-ray transmission measurements, and microscopic investigations. The on board calibration measurements will include: X-ray transmission measurements, measurement of optical loading, and measurement of the spatial homogeneity. We present the plan of the activities and preliminary results.

Key words. X-Rays: XMM-Newton – X-Rays: instrumentation – X-Rays: filters

1. Introduction

After more than 10 years of operation, possible performances degradation of the EPIC filters may have occurred due to oxidation, contamination, irradiation, fractures/holes, etc. Such degradation might affect: 1) Optical/UV rejection; 2) X-ray transmissivity; 3) Spatial homogeneity. No degradation of the in-flight EPIC filters has been reported to date, however, no specific tests have been recently performed. **On-ground filter tests**: UV/Vis transmission measurements were performed in Palermo on back-up filters between May 1997 and July 2002 (Barbera et al, 2003, Proc. SPIE, 4851, 264). Such measurements have shown an increase in transmission in the first year of the monitoring, followed by a stabilization. The monitored filters have been stored in dry Nitrogen between April 1997 and December 1999, and in vacuum after the launch of Newton XMM, between January 2000 and July 2002. **In-orbit filter tests**: Ground and space environments are very different (vacuum, irradiation, mechanical stresses, contamination), for this reason in-orbit aging tests are needed. Early in the mission some dedicated observations were done, and have been reported in calibration technical reports, e.g.: the supersoft

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source CAL83 observed in **rev63** with all the filters to check relative X-ray transmission; the stellar association AB Dor (V = 7) observed in **rev. 709** in Diagnostic mode to check the optical loading; the globular cluster Omega Cen observed in **rev35** in MOS diagnostics/PN offset mode to check spatial homogeneity.

2. On ground test plan

We have initially identified all back-up Thin (T) and Medium (M) EPIC filters still available in the laboratories of the EPIC consortium, have collected the documentation of the manufacturer MOXTEX, and have visually inspected their integrity. Five filters have been identified: Filter 4 (M), 7 (T), 15 (M), 23 (T), 69 (M). We decided to start the verification study on the two filters 69 (M) and 23 (T). The two filters are stored since March 2011 in vacuum inside a small chamber properly setup at the XACT facility of INAF-OAPA. The following measurement program is ongoing or planned on these filters.

UV/VIS transmission measurements are performed every three months since March 2011. The first measurement session was carried out on filters previously stored inside the containers provided by MOXTEX. The second measurement session was conducted after the filters have been maintained under vacuum for about a month. The measured transmission curves are in good agreement with the measured curves of similar filters, namely G12 and T4, performed in the second phase of the previous monitoring program. Some discrepancies are observed at short wavelengths which will be further investigated.

X-Ray transmission measurements will be performed to determine the mass areal density of the filter material. For this measurement we will use an electron impact X-ray source coupled with a transmission grating monochromator. We also plan to perform an X-ray shadowgraph of some area of the filters using a MCP detector to investigate spatial uniformity and check for pinholes.

IR spectroscopy will be conducted both in transmission and in scattering, with the micro-Raman technique. Such measurements, which unfortunately have not been conducted before and thus lack of a reference, may complement the other investigation techniques to give some information on the oxidation state of the aluminum layer deposited on the Polyimide carrier.

Atomic Force Microscopy will be used to investigate small samples of the filters G12 and T4, to obtain information on the surface roughness of both Aluminum and Polyimide on the 1-100 nanometer scale.

3. In orbit test plan

Possible tests and suitable targets include:

1. **X-ray transmission:** PKS 2155-304 with different filters (60 ks/yr available; less variable than CAL83);
2. **Optical loading:** MOS diagnostics/PN offsets on AB Dor with different filters (RGS target, 10 ks thick+40 ks cal closed every year);
3. **Spatial homogeneity:** MOS diagnostics/PN offsets on optical extended object (e.g. Omega Cen).

4. Summary and perspectives

We have briefly described an on-going investigation on the status of the XMM-Newton EPIC thin and medium filters. Archival data will be analyzed and complemented by new observations to address the performance of the flight filters. Laboratory investigations will be conducted to obtain some additional information on the aging of such filter material, stored in semi-controlled environments, over timescale of more than 10 years.

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