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On-ground and in-orbit filter aging tests

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Are the filters stable with time?

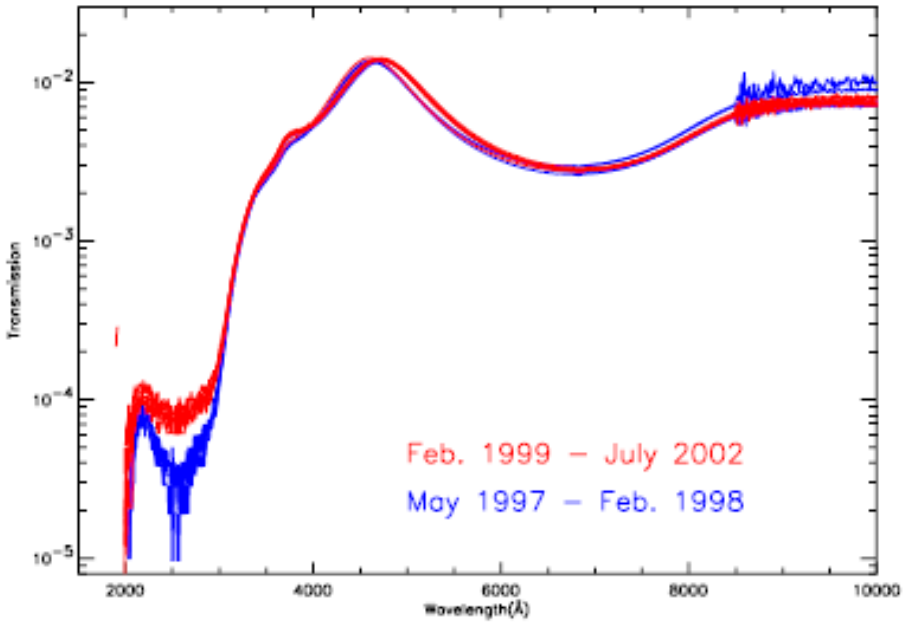
After >10 years, possible **performances degradation** (due to, e.g., oxidation, contamination, irradiation, fractures/holes):

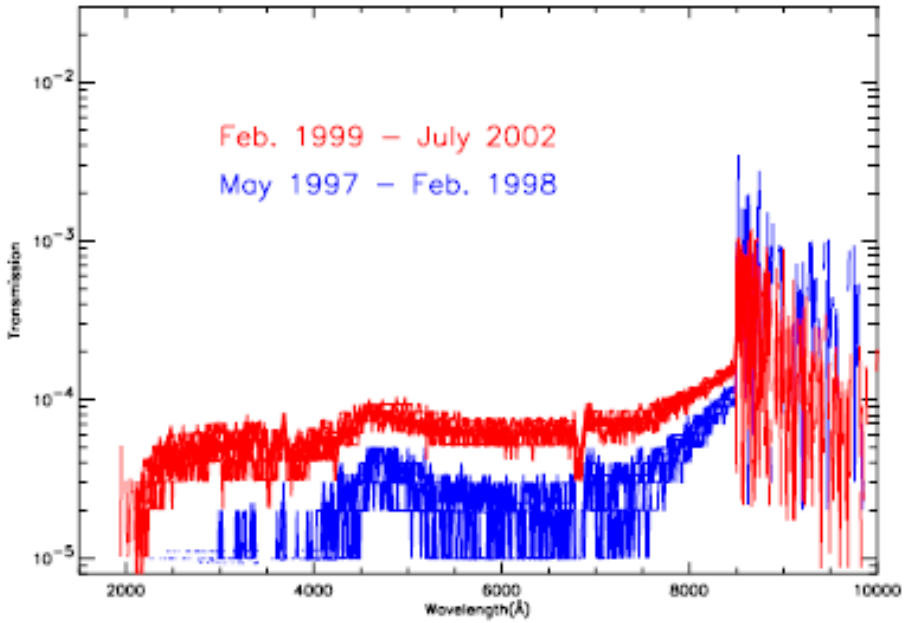
- **Optical/UV transmission**: strong impact on sources with bright optical/UV counterpart
- **X-ray transmission**: strong impact at low X-ray energies
- **Loss of spatial homogeneity**: strong impact on extended or off-axis sources (mainly at the lowest energies and if bright in optical/UV)

No degradation of the in-flight EPIC filters has been reported to date, but no specific tests have been recently performed

On-ground filter tests: past

UV/Vis/IR transmission measurements were done in **Palermo** on the spare copies of 1 thin and 1 medium filter between May 1997 and July 2002 ***(Barbera et al. 2003, Proc. SPIE 4851, 264)***

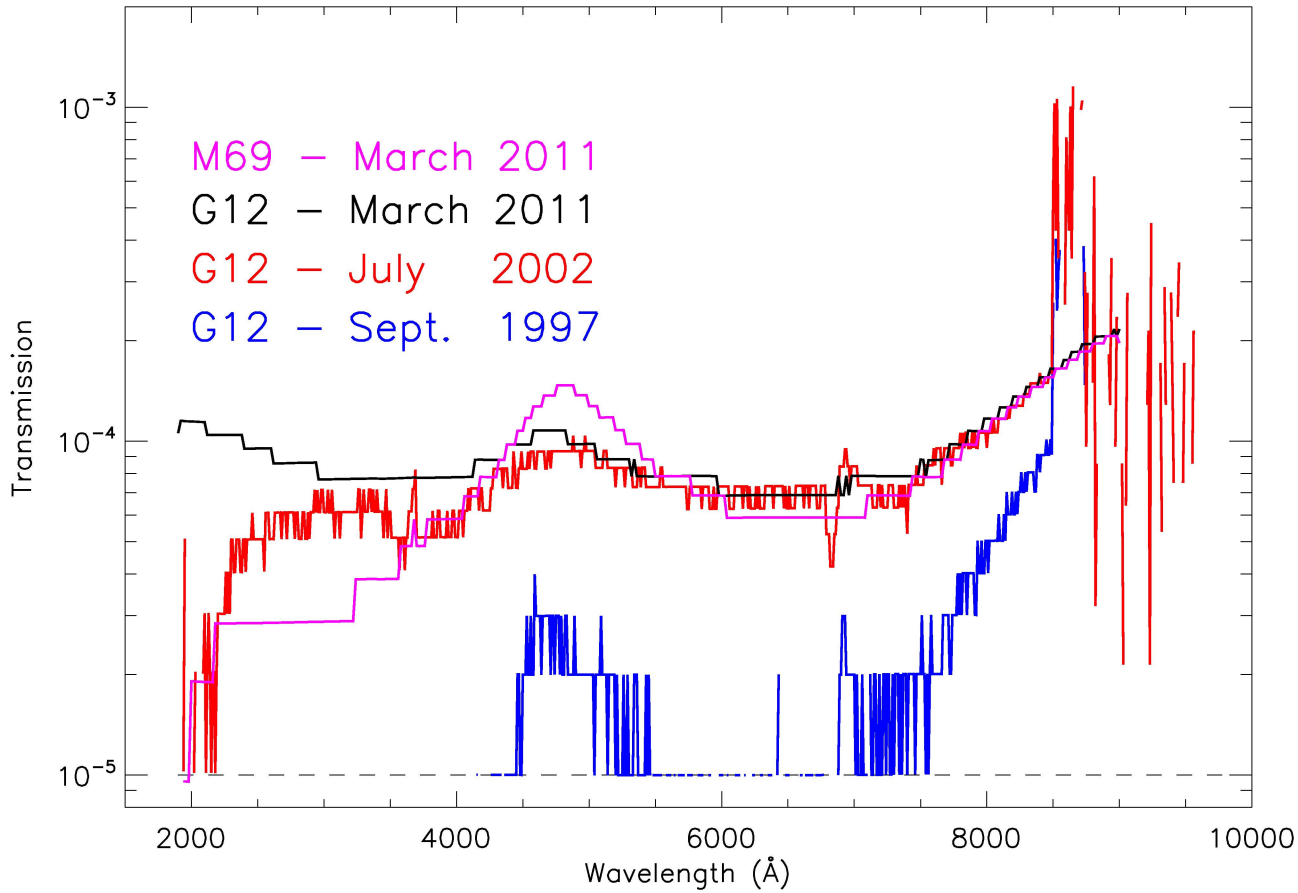




Feb98-Feb99 (no tests in between): **degradation** for unknown reasons. Not related to storage conditions (Apr97-Dec99: dry Nitrogen box; Jan00-Jul02: in vacuum; in air when tested)

On-ground filter tests: present

New UV/Vis/IR transmission measurement performed in Palermo on 1 **thin** filter (**M69**; never tested before) and portion of 1 damaged **medium** filter (**G12**, *Barbera et al. 2003*)



On-ground filter tests: future

Filter copies (thin and medium) are stored in Palermo and Milano (thick filters in Munich: *are they still there?*)

Schedule of on-ground test in **Palermo** (*in priority order*):

1. Vis/UV transmission (first measure already done, analysis in progress; ~4 measures/year)

2. Visual inspection with electronic microscope to check filter integrity (1 measure/year)

3. X-ray transmission (1 measure/year)

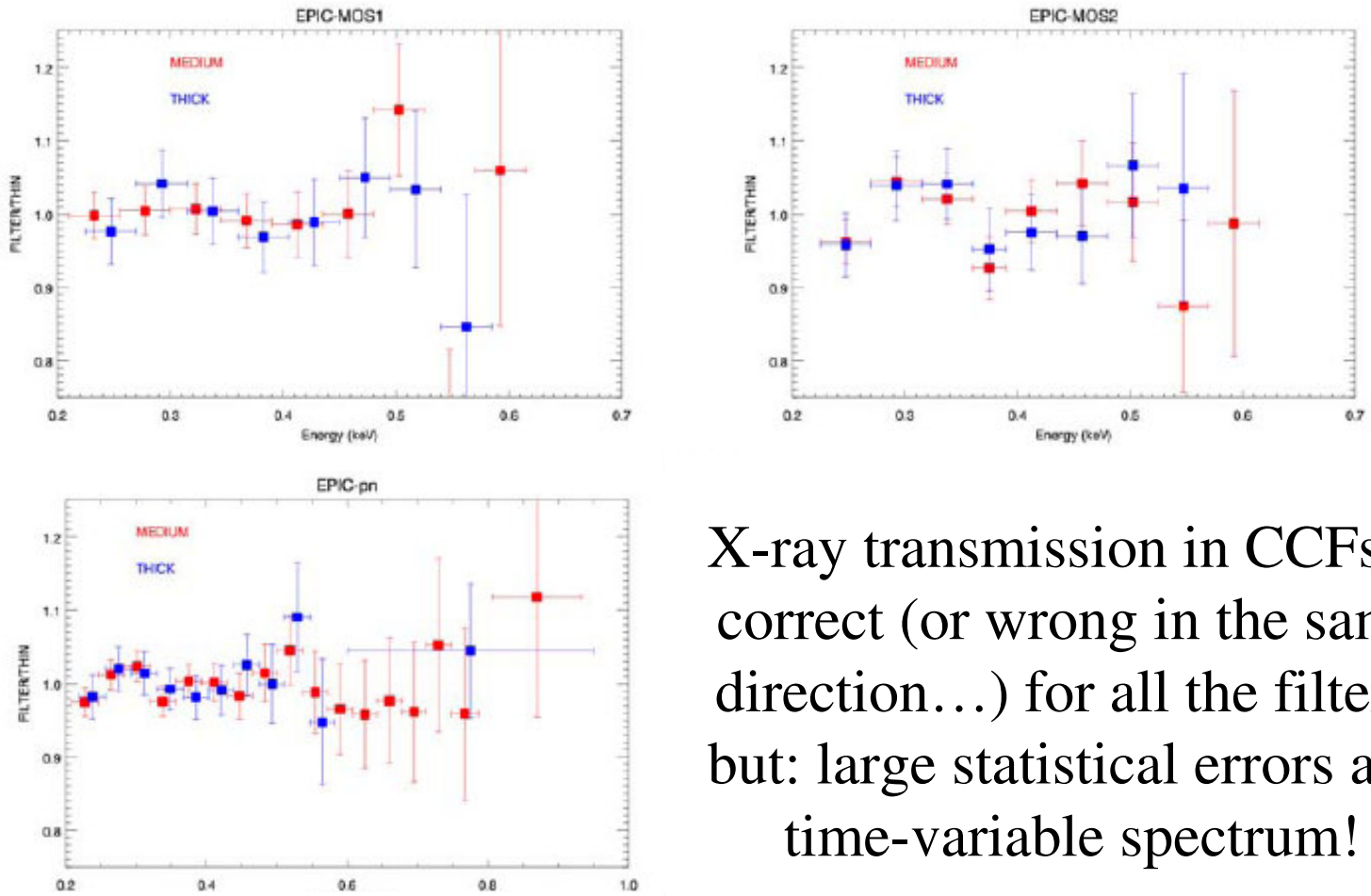
In-orbit filter tests: past

Ground and space **environments are very different** (air/vacuum; irradiation; different mechanical stresses) ⇒ **in-orbit** aging tests are needed

Early in the mission some **dedicated observations** were done to check the integrity and performances of all the filters:

• **rev63**: ***CAL83*** (supersoft source), observed with all the filters to check relative **X-ray transmission**. Results in EPIC calibration status document (Guainazzi et al., XMM-SOC-CAL-TN-0018)

In-orbit filter tests: past



X-ray transmission in CCFs is correct (or wrong in the same direction…) for all the filters, but: large statistical errors and time-variable spectrum!

Figure 1-7: Data/model ratios against a double blackbody model in the XMM-Newton observations of Cal83 normalized to the ratio obtained in the exposures taken with the THIN filter. *Red:* MEDIUM; *blue:* THICK filter. In *clock-wise order* from *top left:* EPIC-MOS1, EPIC-MOS2, EPIC-pn.

In-orbit filter tests: past

•**rev709**: MOS diagnostics on AB Dor (V=7 mag) with Thin filter. Analysis by B. Altieri (XMM-SOC-CAL-TN-0043)

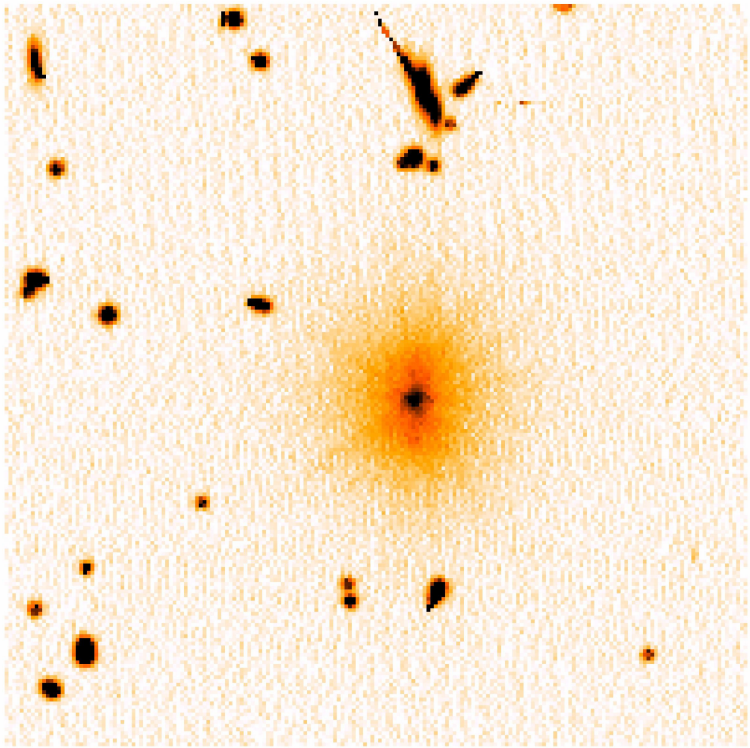
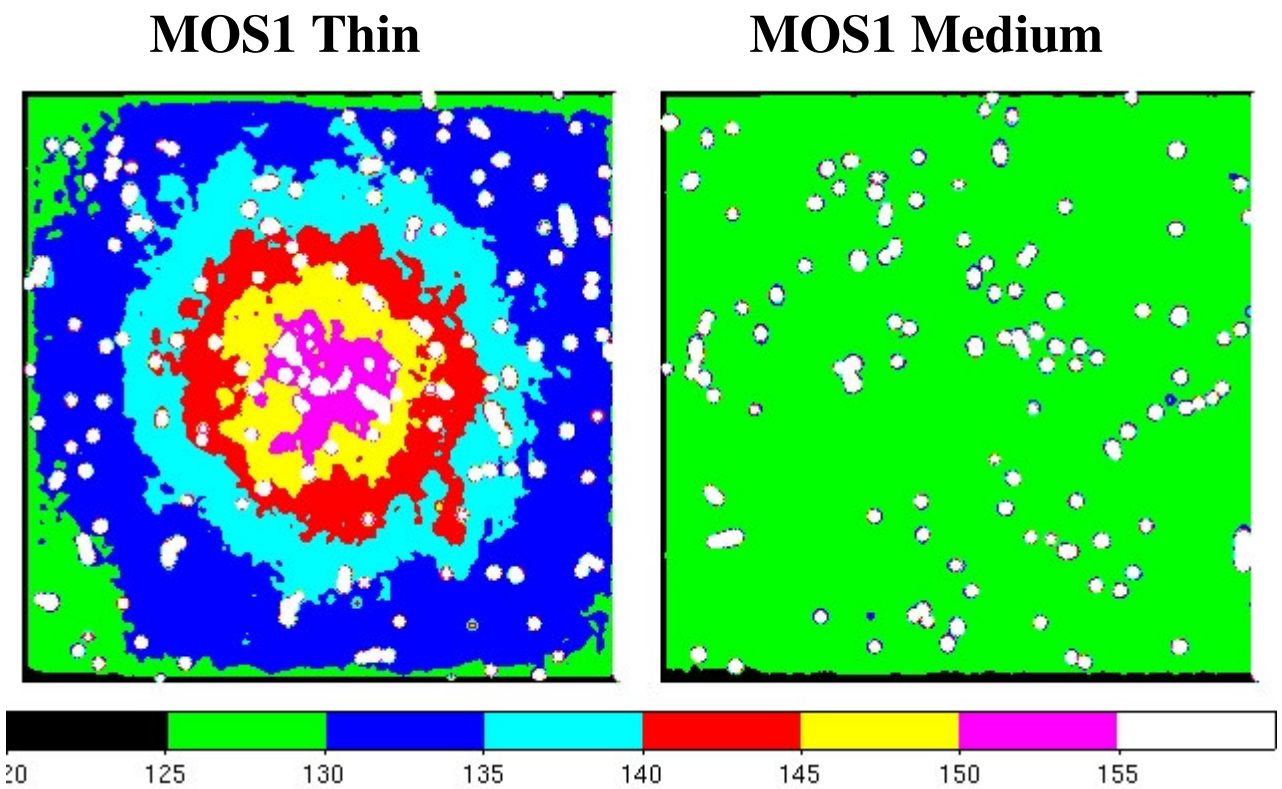


Figure 1: MOS1 optical PSF : AB Dor through THIN filter

In-orbit filter tests: past

•**rev35**: MOS diagnostics/ PN offsets with different filters on Omega Cen to check spatial homogeneity. No published results



In-orbit filter tests: future

Possible tests and suitable targets (priority order):

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 calclosed every year). *Alternative:* bkg maps from MOS imaging data.

3. **Spatial homogeneity**: MOS diagnostics/PN offsets on optical extended object (***Omega Cen***?)

Zeta Puppis (V=2.2 mag) is observed every year with thick filter (60 ks): usable for X-ray filter transmission? Diagnostics/offsets (or MOS bkg maps) to test optical loading with thick filter (AB Dor is too faint)?

Conclusions

Some degradation observed in filters on ground

- What is the reason? *Work in progress in Palermo…*
- Suggestions on the test schedule (priorities, frequency, how many filters)?

Some filter aging tests should be done also in-orbit

- Are dedicated calibration observations urgently needed?
- Suggestions on observation planning and data analysis (targets, operating modes, frequency)?