Optical contamination in TM6 (J. Schmitt, HS)

To investigate optical contamination of TM6 I analyzed the survey data which coincidentally contained Jupiter. The data sets analyzed were the files

e_6_43230_000_p001.fits
e_6_43231_000_p001.fits
e_6_43232_000_p001.fits
e_6_43234_000_p001.fits
e_6_43235_000_p001.fits
e_6_43236_000_p001.fits

In all event files Jupiter appears as a very strong source. To give an impression I include the photon image of one scan (that of e_6_43234_000_p001.fits) in the following figure:

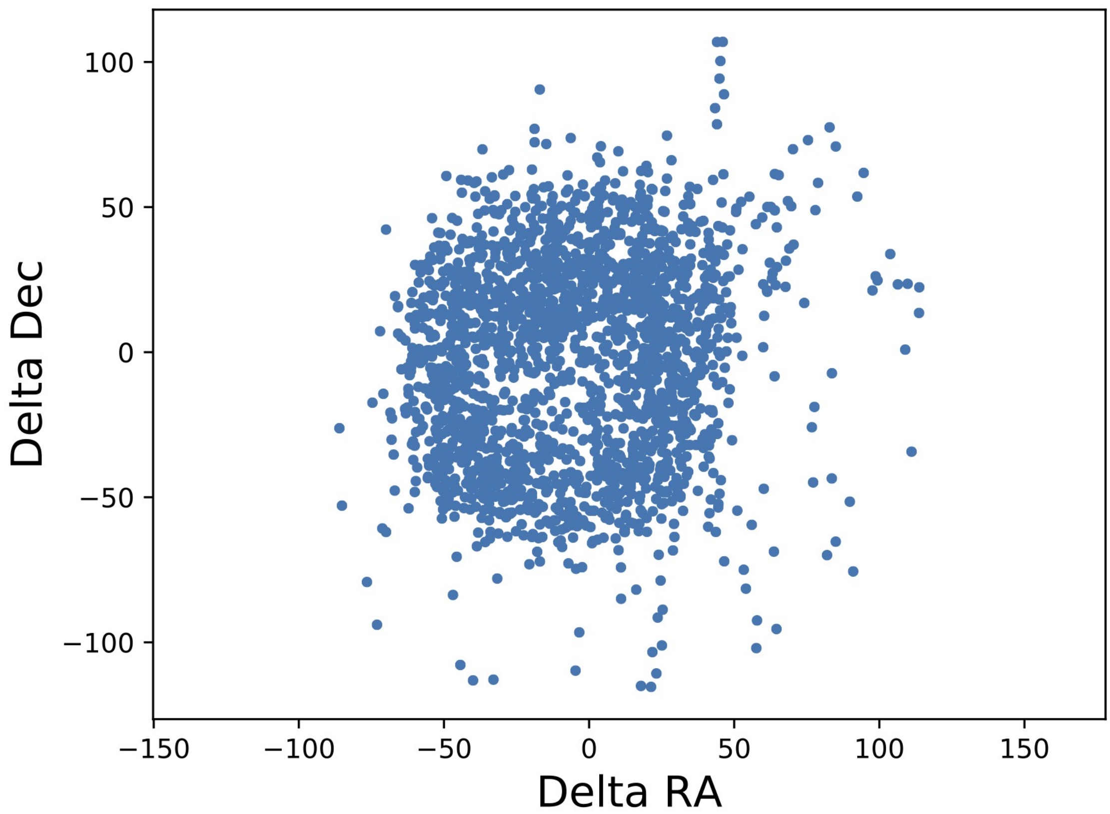

Fig.1: Photon distribution (in arcsec) in the Jupiter image of the scan e_6_43234_000_p001.fits

It is a characteristic feature of many images that appears to be some deficiency of photons in the center of the photon distribution; also the streak of events at RA about 30 is somewhat odd.

X-ray emission from Jupiter is well known since the days of the Einstein Observatory. I estimate (very roughly) that the number of X-ray photons from Jupiter in one eROSITA TM6 scan is well below 10, in other words, (almost) all events seen in Fig. 1 are due to optical contamination. This is also clear from inspecting the energy distribution of the recorded events shown in Fig. 2. The spectrum is extremely soft, but extends to energies above 2 keV.

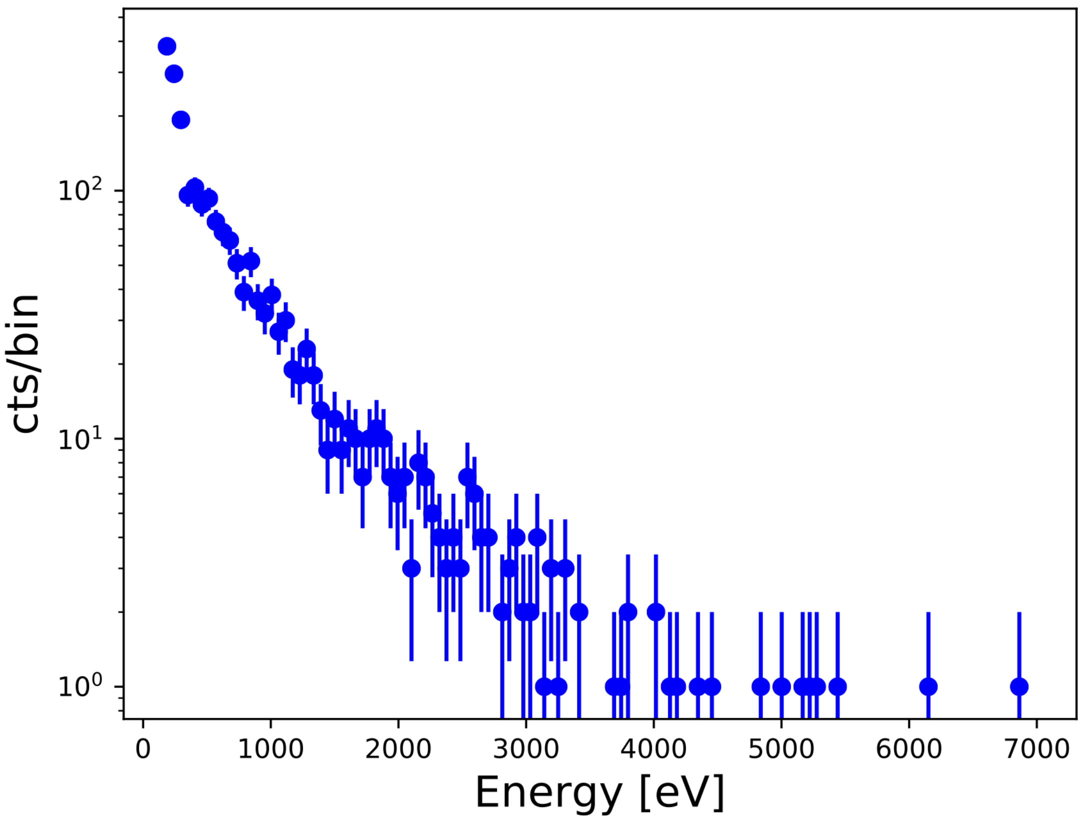

Fig. 2: Energy distribution of the photon events displayed in Fig.1

To obtain quantitative results, photons were extracted in a circle with a radius of 120" around the centroid position. In the following table the results are given for all recorded events and those with nominal energies above 2keV:

Filename:	Exposure (sec)	Counts (all)	Counts (> 2keV)	Countrate total	Countrate (> 2keV)
e_6_43230_001_p001.fits	28,587	1609	64	56,28	2,24
e_6_43231_001_p001.fits	44,052	2487	142	56,46	3,22
e_6_43232_001_p001.fits	46,398	2591	174	55,84	3,75
e_6_43234_001_p001.fits	37,937	2065	113	54,43	2,98
e_6_43235_001_p001.fits	24,926	1254	40	50,31	1,60

As is clear from this compilation (and from Fig.2) , the observed count rates are huge, and even above 2 keV, the apparent count rate is a few counts per second.

Assuming an ECF of 3 e^{-12} (in cgs units) for TM6 (which is a little educated guess at the moment), a count rate of 55 cts/sec would correspond to a „fiducial" X-ray flux $f_{X,Jup}$ of about 6 e^{-11} erg/cm^2/sec.

Jupiter's visual magnitude at the time of the eROSITA observations was around -2, which corresponds to a visual flux about $f_{opt} \sim 1.5$ e^{-5} erg/cm^2/sec; all these numbers are fraught with uncertainties of some factors (probably of around two or so). The (decadal) logarithmic ratio of these two fluxes is -5.5, with the consequence that any object with $\log(f_X/f_{opt}) = -5.5$ yields an equal amount of (true) X-ray to fiducial (i.e. optically contaminated) X-ray flux. The Sun at solar maximum has $\log(f_X/f_{opt}) = -6.3$, i.e., if we were looking at the Sun as a star, the TM6 signal would be by far dominated by optical contamination, rather than the Sun's true X-ray flux. As a consequence we would not be able to study the X-ray emission of solar-like stars with eROSITA.

Furthermore, assuming a soft eRASS1 limiting sensitivity of 5 e^{-14} erg/cm^2/sec and given Jupiter's „fiducial" X-ray flux of 6 e^{-11} erg/cm^2/sec, one expects to see optical emission down to a magnitude limit of $m_V = 5.7$, independent of any X-ray emission of the underlying sources. This estimate assumes that all telescope modules are identical to TM6, which is of course not the case. There are about 3600 stars brighter than $m_V = 5.7$. For the final eRASS8 with an assumed limiting sensitivity of 3 e^{-15} erg/cm^2/sec the corresponding magnitude limit turns out to $m_V = 8.75$; there are a few ten thousand stars brighter than this.