

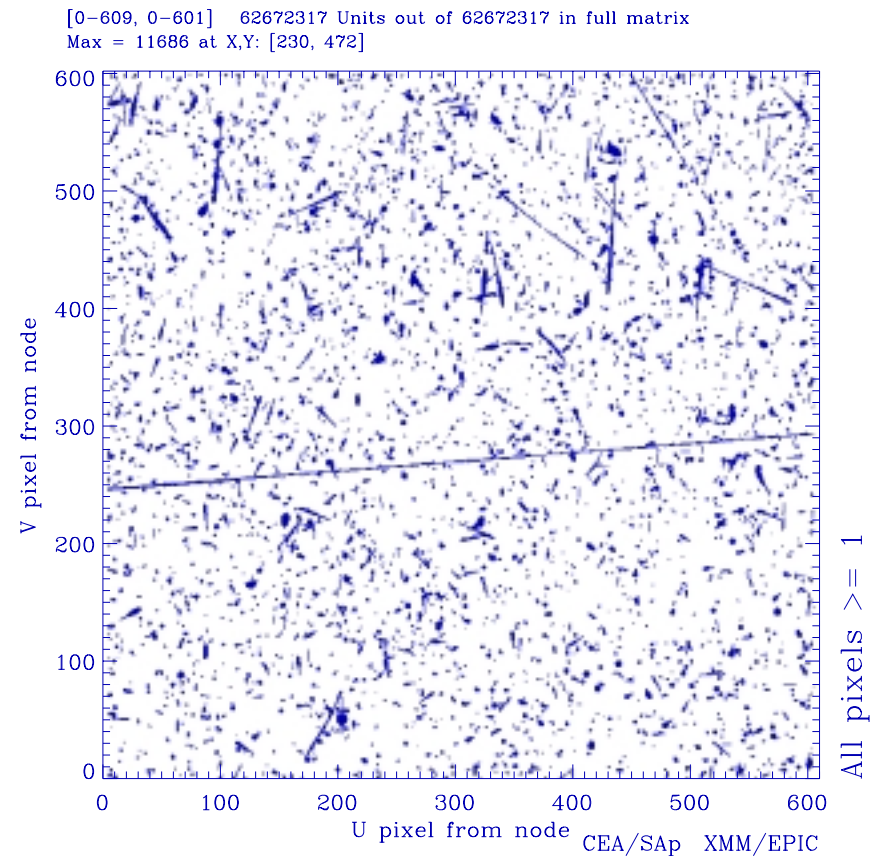
EPIC/MOS Diagnostic images analysis

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MOS 2 – CCD 5

100 frames accumulated (260 sec)

- The figure shows 100 frames of data taken in threshold mode (threshold at ~ 1.5 keV). Cosmic-ray tracks are clearly visible.
- Numerous diagnostic images taken in the commissioning phase (in closed, closed cal and on the sky). Data up to orbit 64 have been analysed.
- Diagnostic are the only data showing the full information on the cosmic-rays impacts (more than in threshold mode, for which the telemetry limit imposes a very high threshold).
- Images in closed or closed cal were eye selected (no HK easily available at the time of work) and kept for analysis by a specially developed software. On each image the number of tracks and their characteristics were determined.



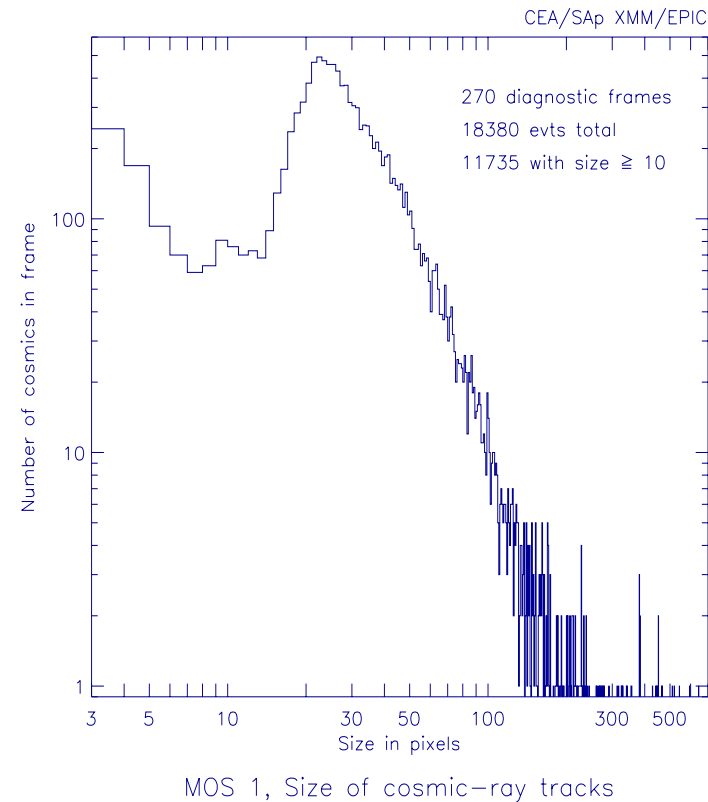
Flux and characteristics of tracks (I)

Flux (averaged on orbits 14 to 64)

- 0 Statistics : 15.0 cosmic-ray tracks per second for CCD 1 on average.
 - 0 Detection surface for CCD 1 : 5.76 cm^2 (imaging section) + $1/2 \times 1.9 \text{ cm}^2$ (store section, the 1/2 is for exposure efficiency in the store section)
- ⇒ Averaged flux : $\sim 2.2 \text{ particles / cm}^2.\text{s}$
- 0 Flux has been slightly decreasing with time for these orbits.

Track size distribution

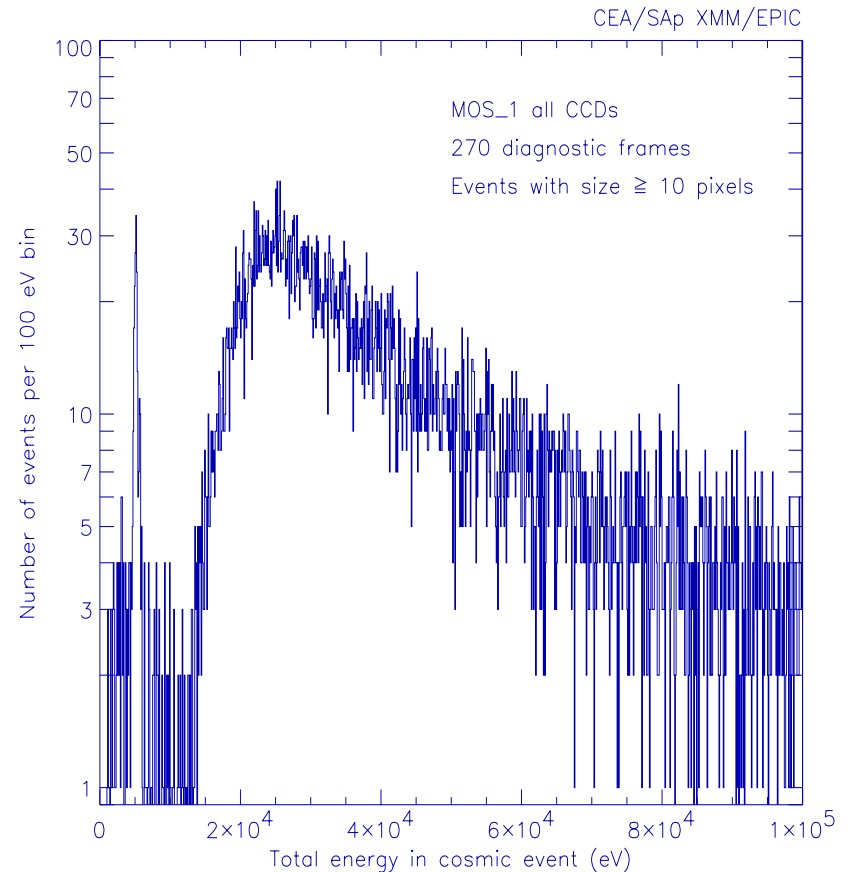
- Peaks at about 25 pixels / track
- Average size : 39 pixels / track



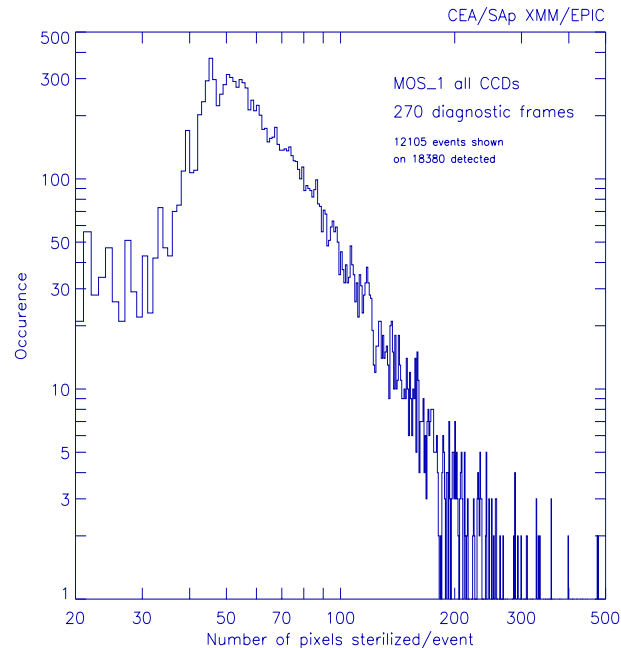
Flux and characteristics of tracks (II)

Deposited spectrum

- By adding all the amplitudes of pixels in a track, a lower limit of the energy measured per track is obtained. This is the right plot.
- Energies of more than 100 keV are measured
- The peak of the distribution is at ~ 25 keV
- The average energy is 74 keV/track
- There is a sharp rise at ~ 15 keV, which is about the MIP energy deposition in $30\text{ }\mu\text{m}$ of silicon.
- The line at lower energies comes from frames with the calibration source on.

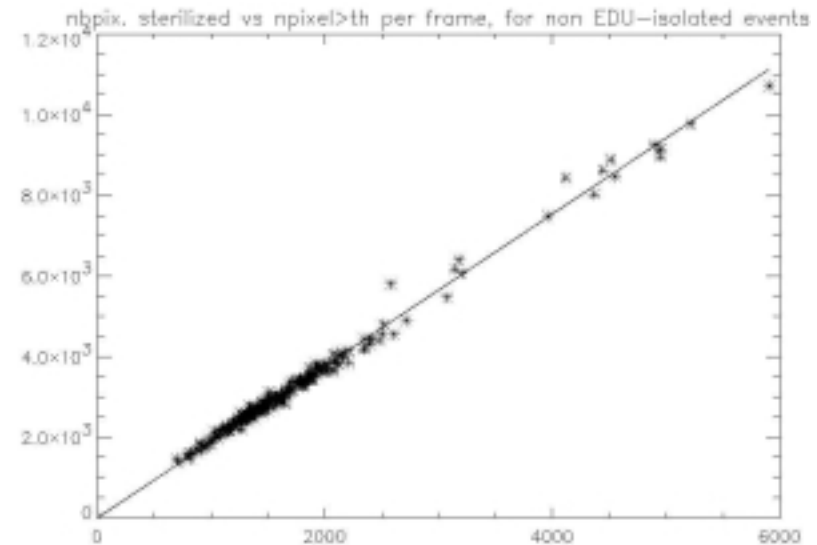


Sterilized pixels due to cosmic-rays tracks



In a frame, in addition to the pixels belonging to a cosmic-ray track, the pixels touching this track are also “sterilized” for X-rays detection in this frame.

The figure shows the distribution of the number of sterilized pixels per cosmic-ray track. The peak is at ~ 50 sterilized pixels / track. The average is 73 sterilized pixels / track.



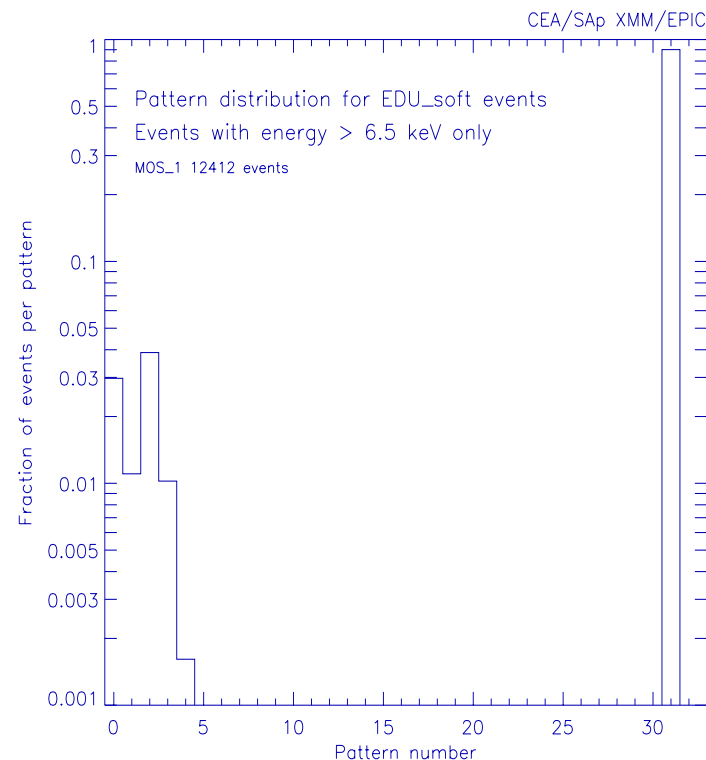
For each frame, the number of pixels above threshold is counted and downlinked. The above figure shows the number of pixels sterilized per frame (counted from tracks not selected as X-ray events onboard) as a function of the number of pixels above threshold for this frame. The correlation is excellent ; the fit results in $Y = 1.874 \times X + 22$.

This allows to correct each frame for the loss of X-ray detection surface due to the presence of cosmic-ray tracks.

Corresponding X-ray events

Images were processed by a software simulating the actual on board processing (“soft-EDU”). This generates events data for each frame (“EDU events”).

- There is on average one and only one EDU-event per track. In particular, a track does not give rise to several events with pattern 31. This is due to the demanding condition that the center pixel, even for this pattern, must have the largest signal in the 3×3 matrix.
- About 10 % of the events have an “X-ray pattern” as shown in the distribution on the right (built from events with energy $E1+E2 \geq 2000$ channels, i.e. ~ 6.5 keV, to reject calibration source events).
- Most (96 %) of the pattern 31 events have an energy $E1+E2$ larger than the upper EMDH threshold (4095 channels), and are thus not transmitted to the ground.



P.S. : this study will be redone from closed positions only, now that the House-Keeping information is more easily available. However, no dramatic change in the results is expected, since the above high energy cut efficiently rejects frames taken in closed-cal position.