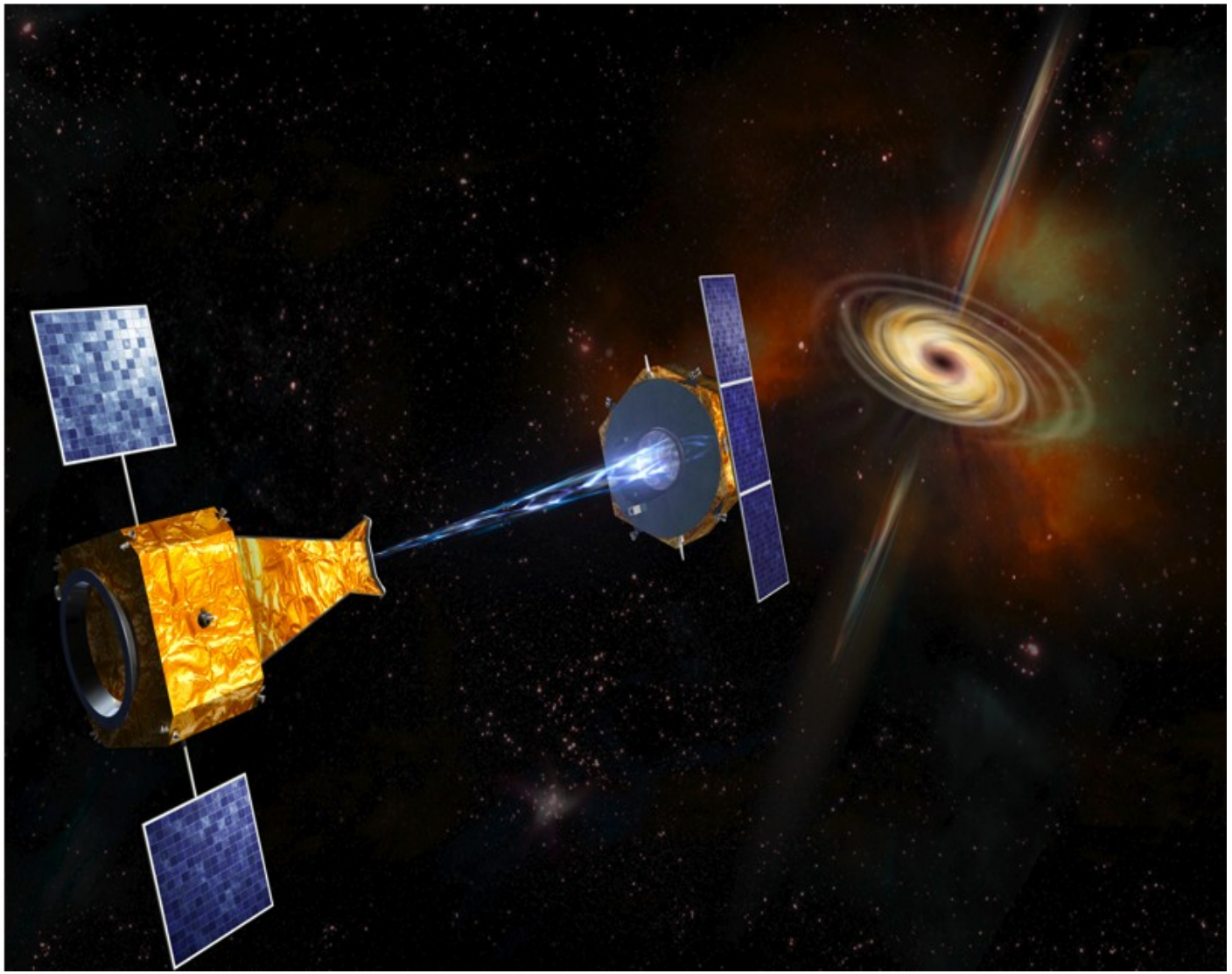
Simbol-X: an Overview



History and current context of the project

• Since 2001, discussions between French and Italian X-ray astronomers about a new X-ray mission in the 0.1–80 keV range.

• Programmatic contacts have been initiated between CNES and ASI.

• ASI and CNES agree to perform a joint feasibility study (phase A) on a X-ray mission called Simbol–X.

• MPE and IAATübingen were invited to contribute to Simbol–X
Contribution: Low Energy Detector (LED)

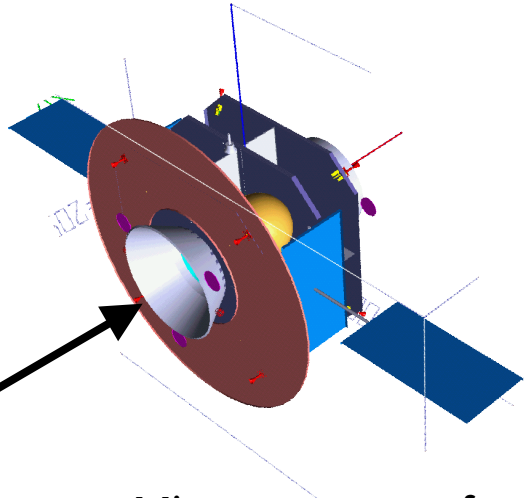
• Large French and Italien Consortium, including:
CEA/Saclay, APC/Paris, CESR/Toulouse, and
INAF-OAB/Milano, INAF/Bologna, INAF/Roma, INAF/Palermo

• **Simbol–X will offer an improvement of over two orders of magnitude in sensitivity and a much better angular resolution compared to the instruments currently operating above 10 keV**.

Summary of Simbol-X top-level scientific requirements

Parameter	Requirement
Energy band:	0.5 – ≥ 80 keV
Field of view (at 30 keV):	≥ 12' (diameter)
On-axis effective area:	≥ 100 cm^2 at 0.5 keV ≥ 1000 cm^2 at 2 keV ≥ 600 cm^2 at 8 keV ≥ 300 cm^2 at 30 keV ≥ 100 cm^2 at 70 keV ≥ 50 cm^2 at 80 keV (goal)
Detectors background	< 2×10^{-4} cts $s^{-1}cm^{-2}keV^{-1}$ HED < 3×10^{-4} cts $s^{-1}cm^{-2}keV^{-1}$ LED
On-axis sensitivity	≤ 10^{-14} c.g.s.(~0.5 μCrab), 10-40 keV band, 3σ, 1Ms, power law spectrum with Γ=1.6
Line sensitivity at 68 keV	< 3 **$\times10^{-7}$ ph cm^{-2} s^{-1}, 3σ,1Ms (2 $\times10^{-7}$goal)**
Angular resolution	≤ 20"*(HPD)*, E < 30 keV ≤ 40"*(HPD)* @ E = 60 keV (goal)
Spectral resolution	E/ΔE = 40-50 at 6-10 keV E/ΔE = 50 at 68 keV (goal)
Absolute timing accuracy	100 μs (50 μs goal)
Time resolution	50 μs
Absolute pointing reconstruction	~ 3" (radius, 90%) (2" goal)
Mission duration	3 years including commissioning and calibrations (2 years of scientific program) + provision for a possible 2 year extension
Total number of pointings	> 1000 (first 3 years, nominal mission) 500 (during the possible 2 year mission extension)

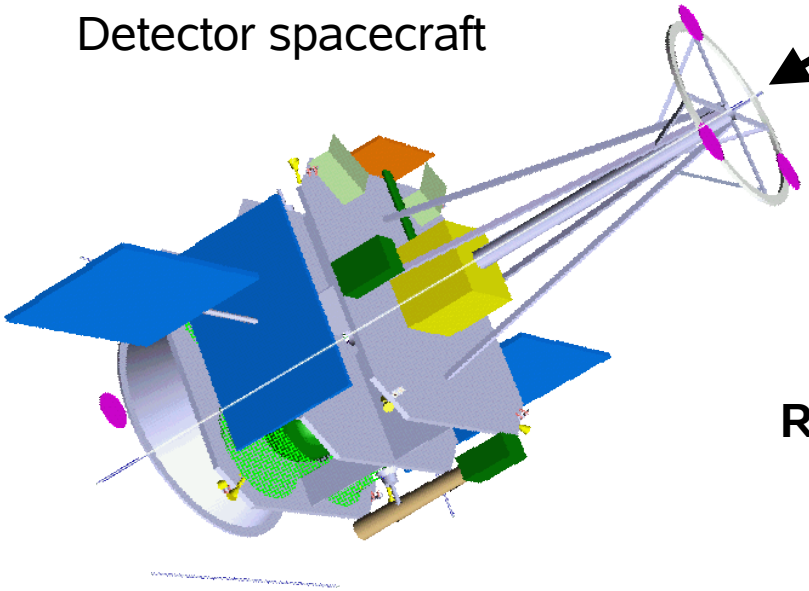
The way to go: focus radiation with long focal length X-ray optics in one satellite and X-ray detectors in a second satellite, flying in formation



~ 20 m

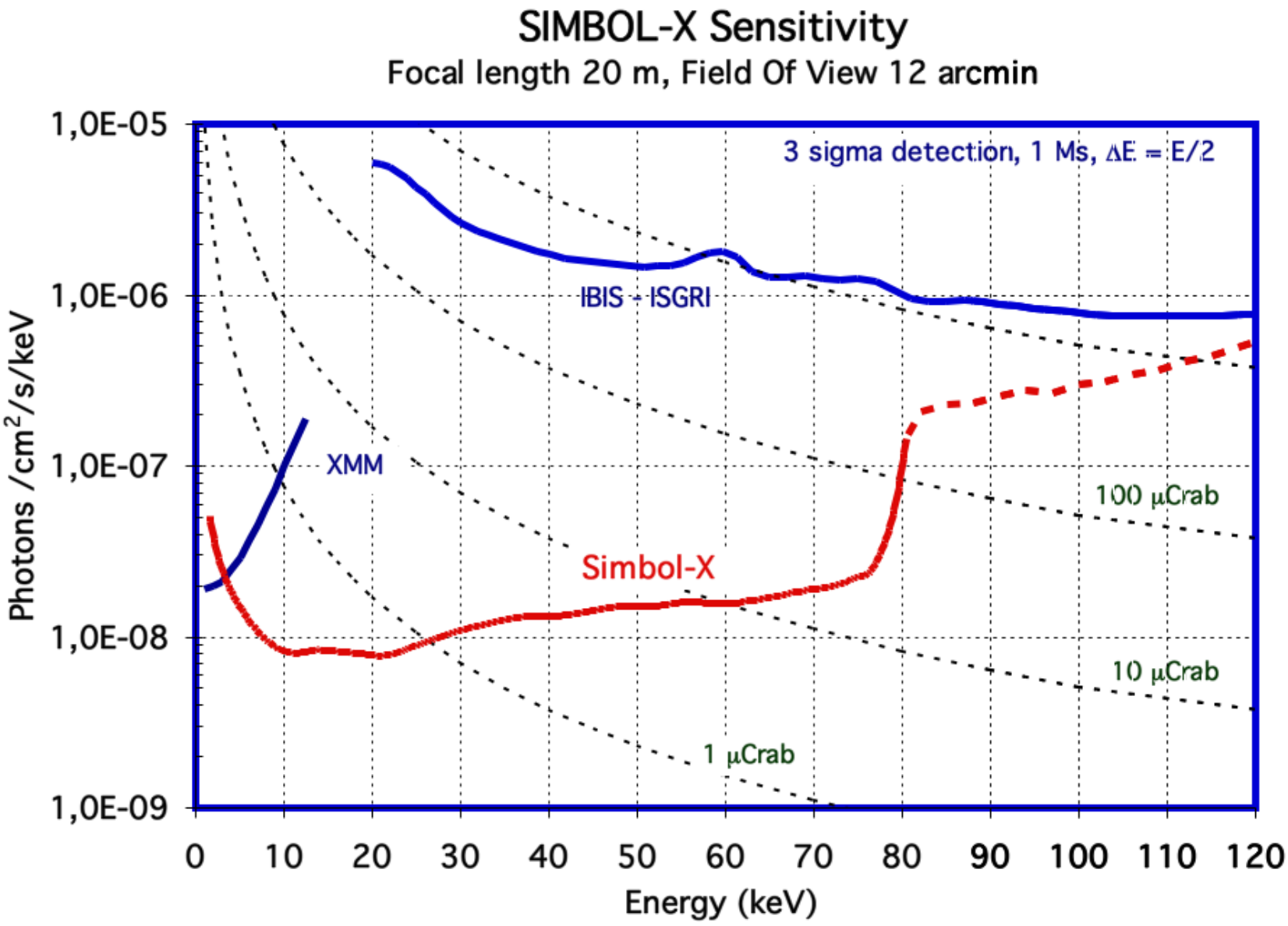
Mirror spacecraft

Detector spacecraft



Requirements on formation keeping:

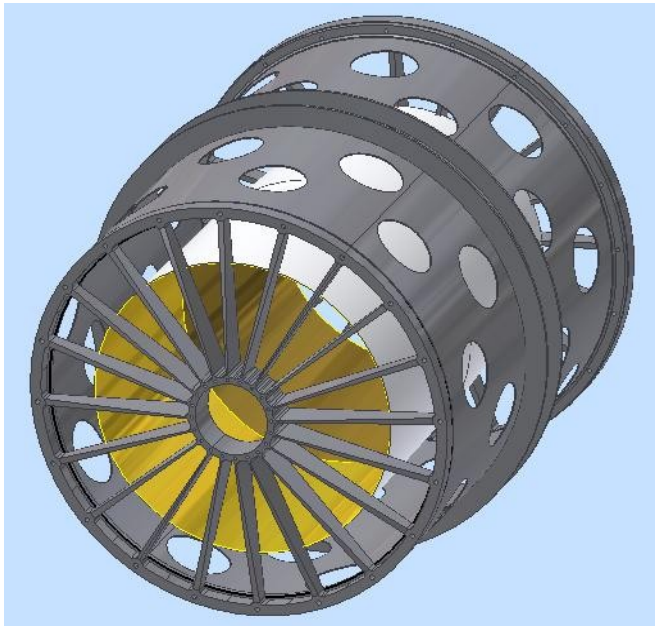
Position control within 1 cm^3

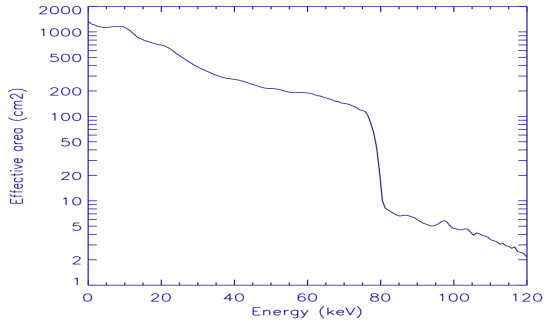

SIMBOL-X Sensitivity
Focal length 20 m, Field Of View 12 arcmin
3 sigma detection, 1 Ms, ΔE = E/2
IBIS - ISGRI
XMM
Simbol-X
100 μCrab
10 μCrab
1 μCrab
Photons /cm²/s/keV
1,0E-05
1,0E-06
1,0E-07
1,0E-08
1,0E-09
0
10
20
30
40
50
60
70
80
90
100
110
120
Energy (keV)

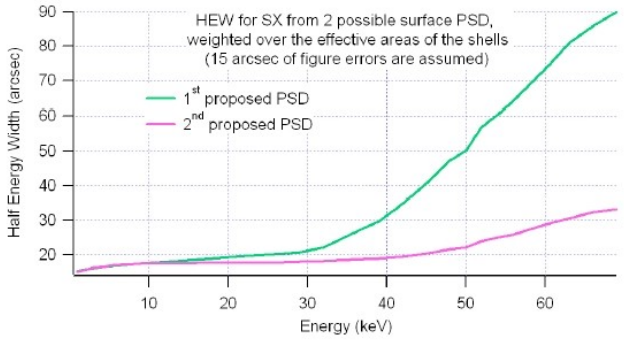
Optics (OAB / Media Lario)
G. Pareschi et al.

Parameters

- 100 shells (Ni, replicated from mandrels, XMM)
- focal length : 20 m
- max diameter : 70 cm
- shell thickness ~ 2-3 times less than XMM
- Pt/C multilayer (sputtering inside mirror shells)





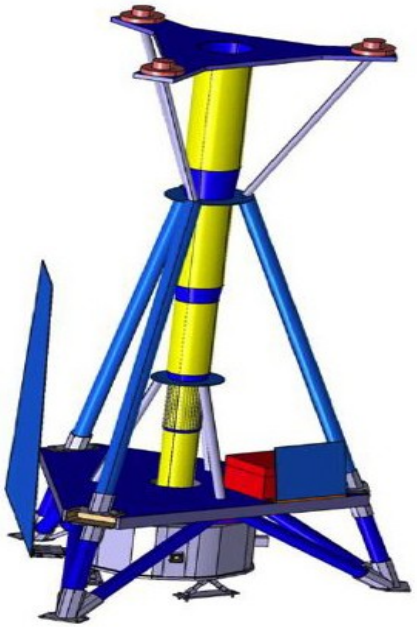


Mirror Tests and Calibration in Neuried at the Panter Facility

Modification of the Facility necessary

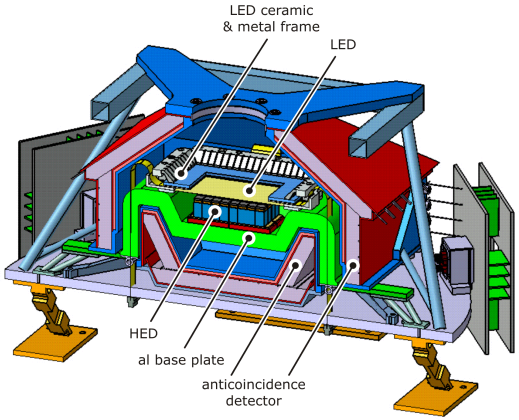
Detector payload

Designed to ensure low internal background and rejection of the cosmic diffuse background, with good spectro-imaging capabilities.



Background shielding

- Graded shield collimator, to block diffuse background (together with sky-shield on mirror spacecraft)
- Active anticoincidence shield, surrounding imaging detectors



Imaging detectors

- Two « sandwiched » systems, with a transition energy at 17 keV
- Both detectors are covering 8×8 cm² with 625 μm pixels
- Flexible read-out
- operating at moderately low temperature (~ –40°C)

Low Energy Detector (LED)

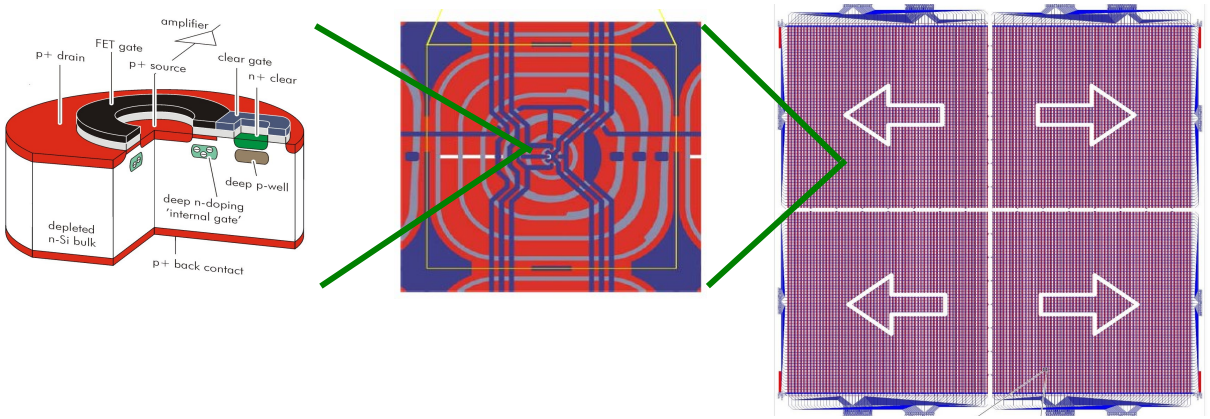
Peter Lechner, et. al

HLL(PNsensor)/IAAT/MPE/TUD/FAU

- Detector: Silicon Drift Detector with DEPFET readout
  128 x 128 pixel, pixel size 625 µm
  divided into 4 independent quadrants
  readout time 128 µs/frame in Fullframe mode
  (50 µs in Window mode)
  spectral resolution: < 150 eV at 6 keV

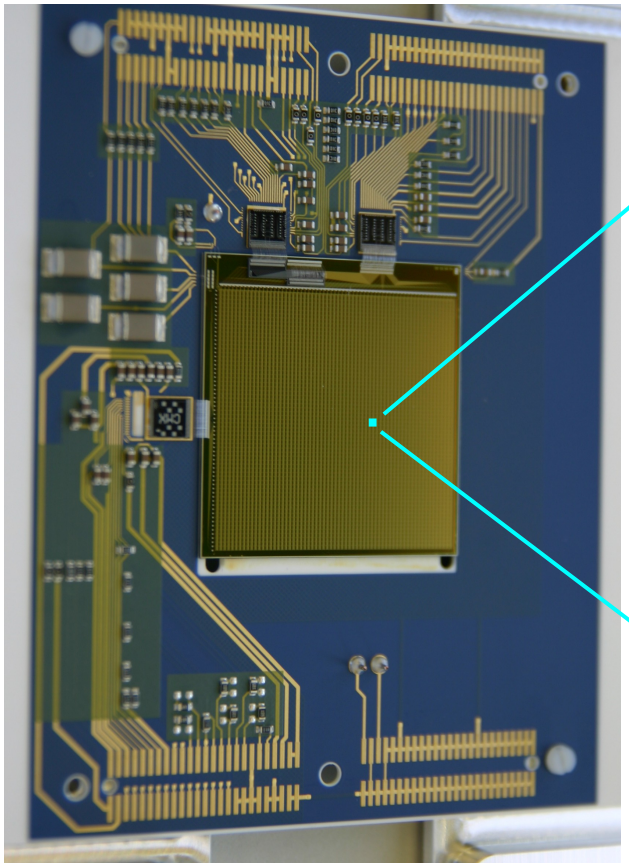
- Event Pre-Processor: One unit per quadrant

- One single cold redundant Interface Controller

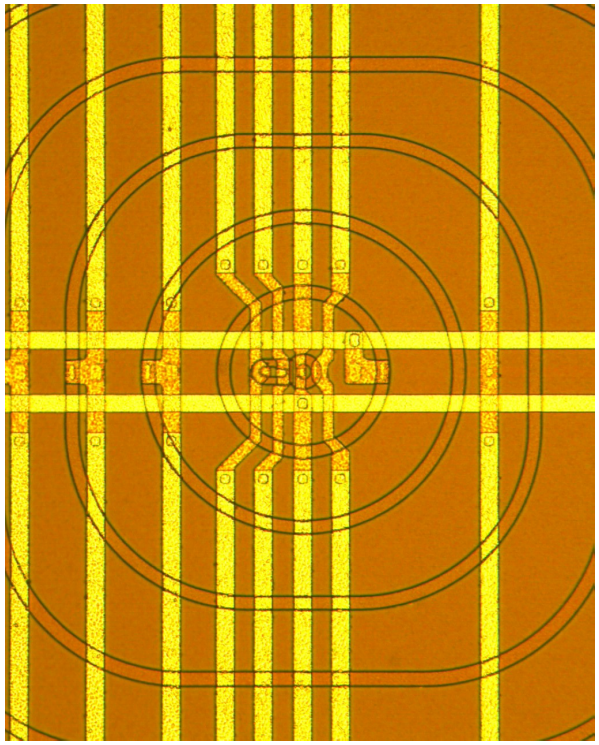


LED quadrant test

- SX-LED quadrant hybrid



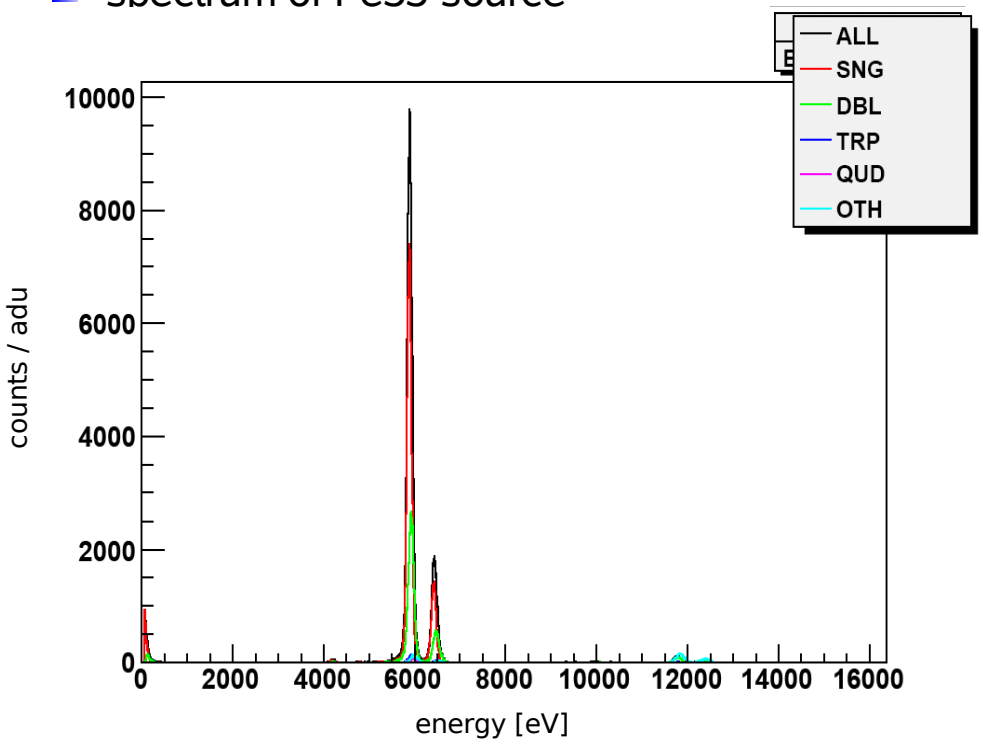
- SX-LED pixel 500 x 500 µm²



- sensitive area > 10 cm²
- largest device since XMM-pnCCD

LED quadrant test

- spectrum of Fe55 source



- voltages/currents

  moderate values

  - back -80 V
  - drift ring -40 V
  - drain 20 µA/pix

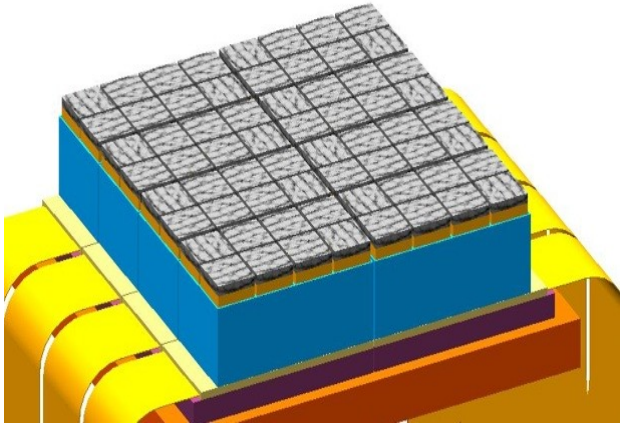
energy spectrum from flat-field illumination

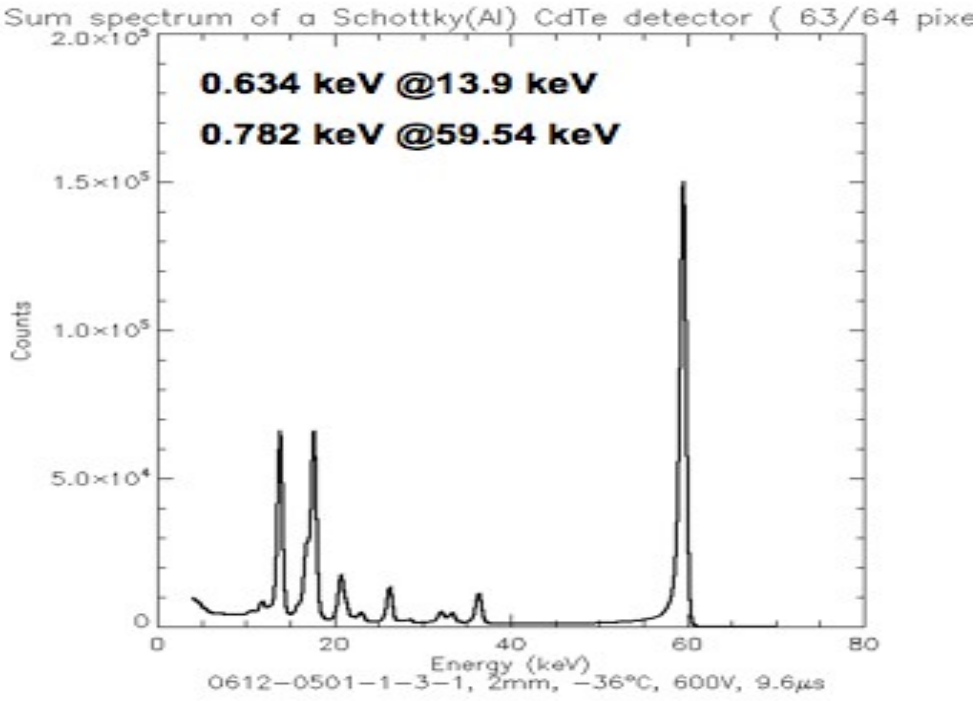
- 127 eV FWHM @ 5.9 keV (single pixel events)
- peak/background ratio 3.000:1

High Energy Detector (HED)

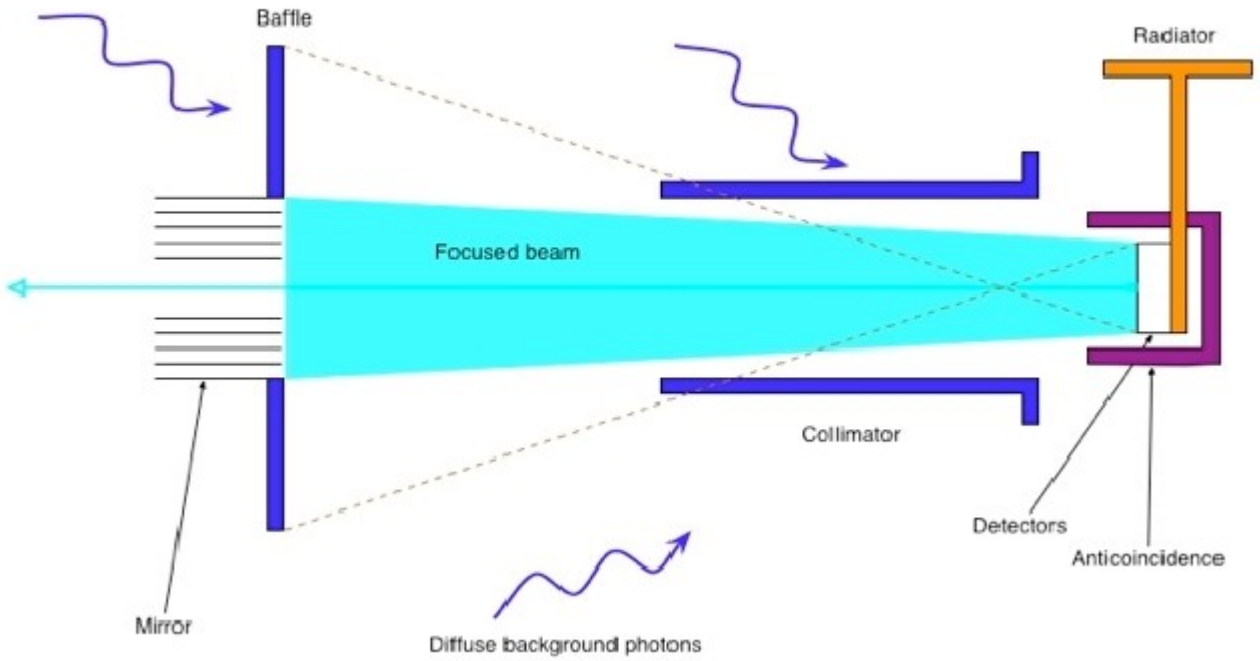
(O. Limousin, P. Ferrando, et al., CEA Saclay)

- array of 64 pixellated Cd(Zn)Te modules of 256 pixels each, 2 mm thick,
- each module ~ 1 cm² total area, four side buttable
- with integrated front-end ASICs.
- self trigger read-out.
- spectral resolution: ~ 1 keV at 60 keV





Schematic view of the two satellites with baffle, collimator and anti-coincidence counter (AC)

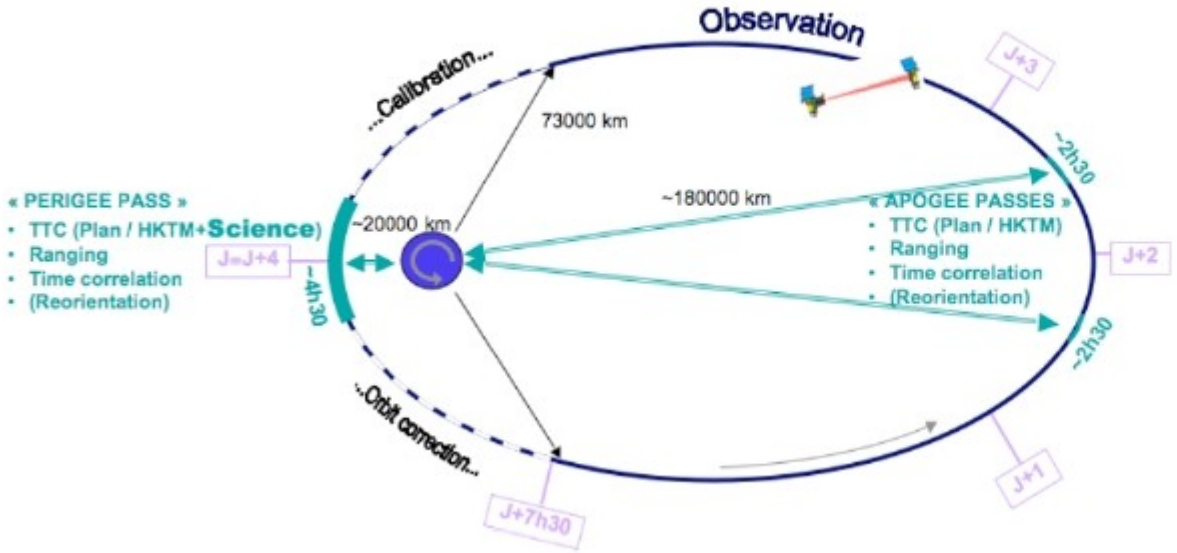


Detailed model of baffle, collimator, detectors and AC was basis for extensive Monte Carlo simulations of the background, using GEANT4

• done by R. Chipaux (CEA), **C. Tenzer (IAAT)** and M. Kuster (TUD)

Mission Implementation

- Launch date: in the middle of 2014
- Mission parameters are :
  - single launch, by Soyuz from Kourou
  - high elliptical 4 day orbit (~ 20,000 – 180,000 km)
  - mission duration: 3 years with provision for a 2 years extension



Perigee :	20,000 km
Apogee :	180,000 km
Period :	4 days
Cycling ratio :	83 %
Time > 73,000 km :	~ 290 ks

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