The IXO High Time Resolution Spectrometer

Didier Barret, Carine Amoros, Karine Lacombe, Pierre Mandrou,
Jacques Landé, Damien Rambaud, Pascale Ramon, Roger Pons
CESR Toulouse

Lothar Struder and Peter Lechner
MPE-MPI Munich

Joern Wilms
University of Erlangen-Nuremberg

Eckhard Kendziorra & Michael Martin
University of Tübingen

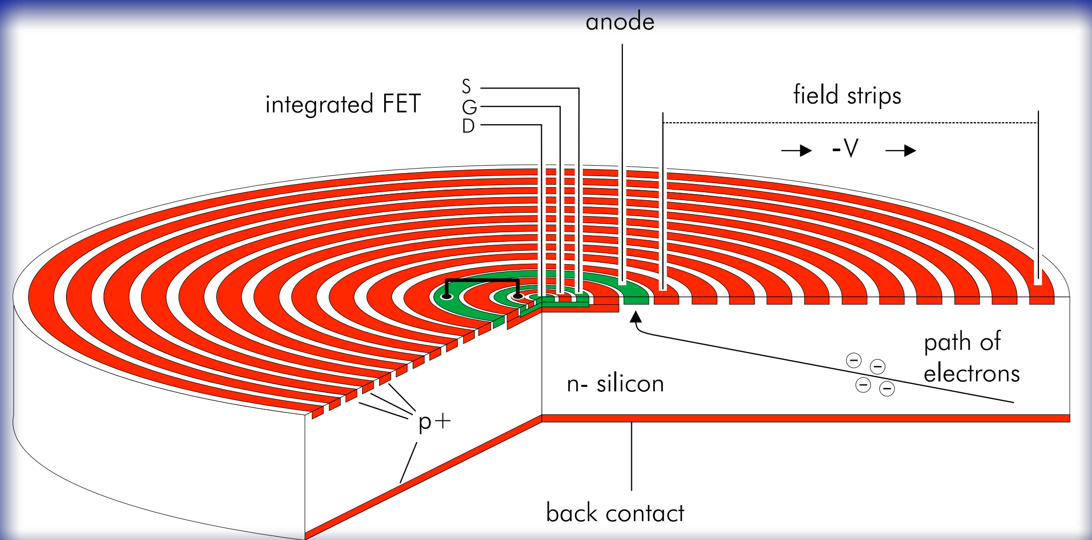
*With support from the HTRS science working group: DB, Shunji Kitamoto, Mariano Mendez ,
Jon Miller, Frits Paerels, Tod Strohmayer, Phil Uttley, Joern Wilms
And a larger group of 60 scientists in Europe, Japan and United States*

The HTRS for IXO

- ✓ The HTRS will provide IXO with the capability to observe bright X-ray sources (Crab or above):
  - ✓ black hole spins, type I X-ray bursters, magnetars, accretion disk physics
    - ➡ "Matter under extreme conditions" science goal of IXO
- ✓ The HtRS matches the top-level mission requirement of :
  - ✓ handling a 1 Crab source, with >90% throughput, microsecond time resolution, and better than 200 eV resolution

Detector principle

- ✓ Based on an array of Silicon Drift Detectors:
  - ✓ Fully depleted high resistivity Silicon
  - ✓ Increasingly biased rings drive the electrons towards a very small size, small capacitance anode. The first stage of the amplifying electronics is integrated onto the chip
    - ➡ Provides the capability to handle high count rates, with relatively good energy resolution
    - ➡ Used in synchrotron facilities, electro imaging, X-ray holography (up to Mcts/s rates)

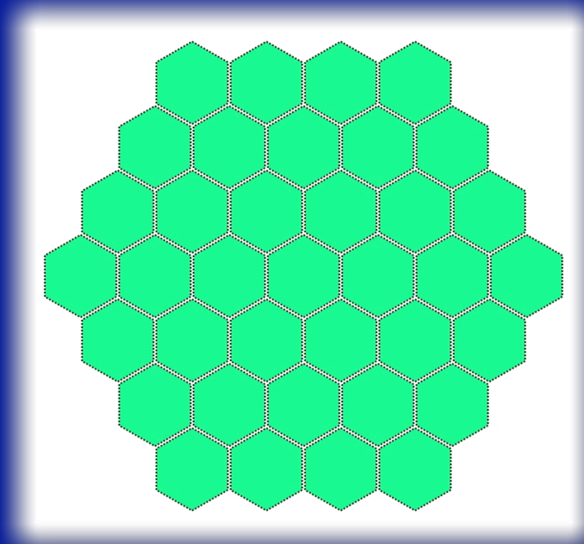


Cylindrical SDD

Implementation

- ✓ The detector is an array of 37 hexagonal SDDs placed out of focus, so that:
  - ✓ 100 % of the focal beam is intercepted by the array and counts are spread as uniformly as possible on the array
    - ➡ 12 cm out of focus distance for 2.3 mm hexagons
    - ➡ The brightest SDD get 3.5% of the counts or ~7000 counts/s @ 1 Crab
- ✓ The shaping time constant is set to a minimum of 50 ns, equivalent to a 300 ns deadtime per event

The SDD array



3 cm

Count rate capability

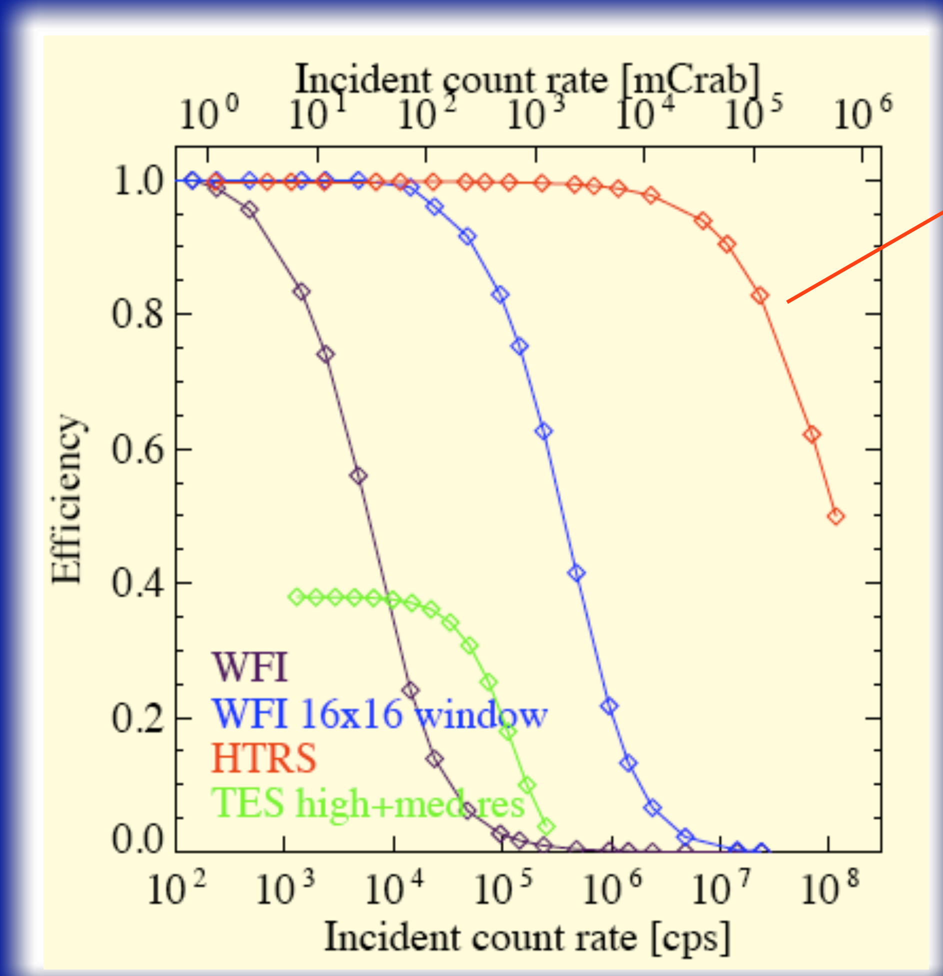
1 Crab

HTRS

100%

Efficiency

0%



Input count rate

HTRS performance

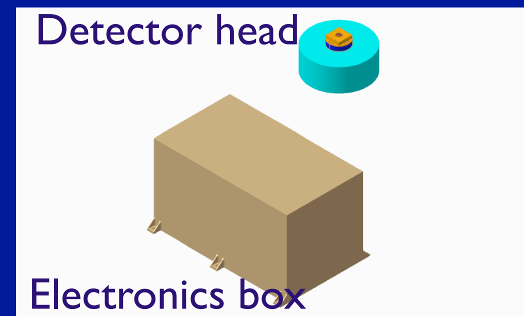
Energy range	~0.3 to 15 keV
Time resolution	10 µs
Energy resolution	~150 eV @ 6 keV
1 crab count rate	~200 000 counts/s
Throughput[1] @ 1 Crab	> 99 %
Throughput @ 10 Crab	~97 %
Data rate max @ 1 Crab	~6.6 Mbits/s[2]

[1] estimated through extensive Monte Carlo simulations

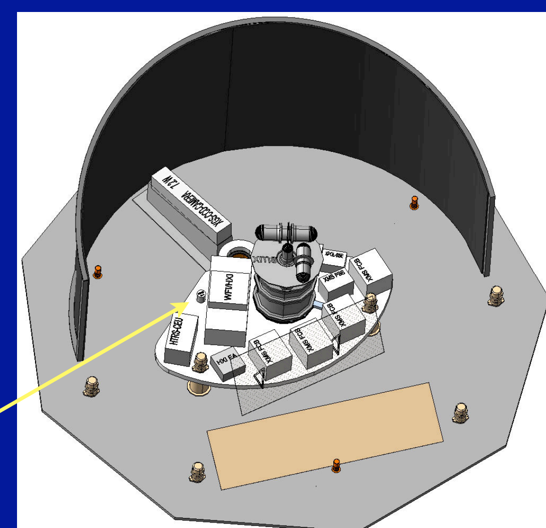
[2] binned spectral mode, 1/4096 seconds, 512 channels (without compression)

HTRS resources

Total SDD area	~3x3=9 cm^2
Detector head	h=8, d=7 cm
Control electronics	30x20x20 cm
Remperature	-20 C
Cooler	Radiator
Bias voltage	150 V
Mass	25 kg
Power (at peak)	<100 W



Courtesy of Jean Grady (NASA)



HTRS detector head

Conclusions

- ✓ A dedicated high count instrument as the HTRS is needed for IXO
  - ✓ The HTRS will uniquely contribute to the core of the IXO science case "Matter under extreme conditions"
  - ✓ The HTRS is the only instrument, which matches the high count rate requirement (the throughput at 30 Crab is ~90%)
- ✓ The HTRS is modest in size and mass
  - ✓ ESA and NASA studies have shown that it can be accommodated and is not driving the mission at system level
- ✓ Its development study is currently being funded by the French Space Agency and by DLR/MPE