FOXSI: the new generation solar X-ray telescope

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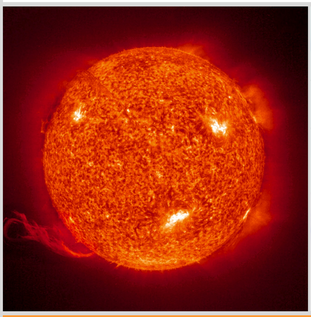
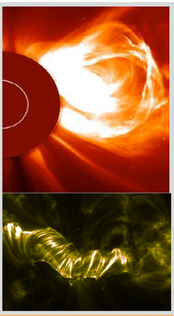
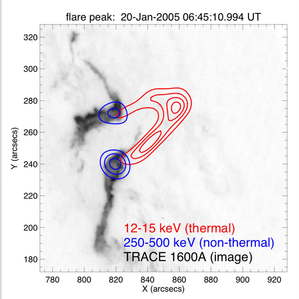
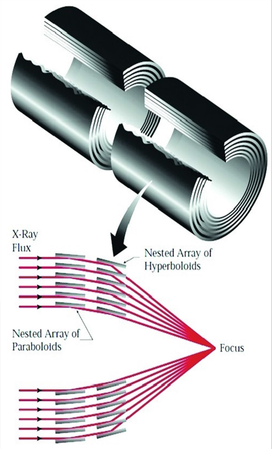
FOXSI (Focusing Optics X-ray Solar Imager) is a NASA Small Explorer (SMEX) mission concept currently being studied by the Goddard Space Flight Center whose science objective is to observe accelerated electrons and hot (T>10 million Kelvin) plasma directly in large solar flares and the solar corona. FOXSI will apply, for the first time on a satellite platform, grazing-incidence optics and pixelated solid-state detectors to hard X-ray observations (E>3 keV) of the Sun. FOXSI will provide unprecedented sensitivity (>10 × past observations) and dynamic range to systematically study t he acceleration and heating of high energy electrons in the solar corona.

The Wrocław group has been invited to design an X-ray flux monitor for this mission. The monitor will increase the science capabilities of FOXSI by allowing high cadence and high spectral resolution X-ray flux measurements of active sites on the solar disk. We will briefly present the science objectives and construction of FOXSI and present the design and capabilities of this X-ray flux sensor in support of the scientific success of the FOXSI mission. This mission will be proposed to NASA this Autumn.









A major goal of solar physics is to understand energy release/particle acceleration on the Sun, Solar flares in Particular

Unanswered questions:

- How/where do flares release energy?
- What is the source of the corona's high temperature?
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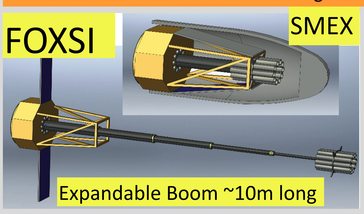
Currently we image HXRs ***indirectly*** (e.g. RHESSI, Yohkoh), dynamic range is limited by the entire field of view, effective area is limited by the size of the detector and non-solar background is large due to large detectors

FOXSI



Parameter	Value
Focal length	10 m
Energy Range	1-80 keV
Energy resolution	~1 keV
Spatial resolution	7 arcsec
Dynamic Range	Up to 100 x RHESSI
Sensitivity	100 x RHESSI
Cost	SMEX-like

This mission concept is based on **existing** technology.

The future may bring better spatial resolution, lighter optics, etc.

FOXSI will observe electrons as they are being accelerated in the corona, along which field line they travel away from the acceleration site, where they are stopped, and how some electrons escape to be detected as SEPs at Earth.

Grazing incidence HXR focusing optics combined with position sensitive solid detectors give:

- ***10 × better*** ratio of mass to effective area. For metal optics 2-4 kg/cm2 (e.g. 50 kg of optic => 125-200 cm2)
- ***10 × lower*** non-solar background due to smaller detectors

= IOO × better sensitivity

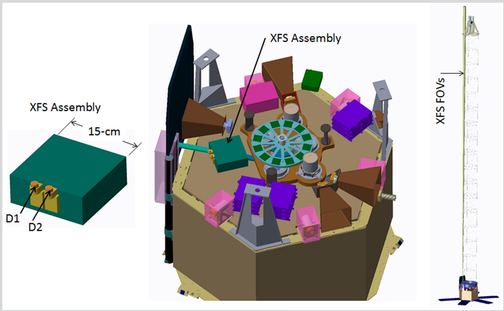
Solar X-ray Flux Sensor (XFS-Wrocław)

- Amptek XR100-FastSDD X-ray detector (includes TEC)
- Custom pre-amp and processing electronics
  - Can be designed with rad tolerance/hardness, unlike COTS X123
  - Count rate, resolution depending on electronics design
  - Small Mass, power (within requirements)
  - Data / Power interfaces with IDPU defined

XFS has **five** separate components:

X-ray SDD detectors

1. Two detectors with different apertures & filters to provide increased dynamic range and redundant operation
2. Front End Electronics & ADCs
3. Data Processing Unit (DPU)
4. Housing



Parameter	Value	Comment
FOV D1 D2	10 × 10 arcmin	or 10 × 10 arcmin - FOXSI FOV
Energy resolution	~200 eV	With active cooling
Energy range	~1 – 15 keV	
Cadence	1 s	
Power consumption	2,5 W	3 W upper limit
X-ray flux measurement accuracy	10% -20%	

- **Left**: Cad drawing of XFS assembly.
- **Middle**: Location of XSF on FOXSI Detector Board.
- **Right**: XFS field of view.

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