The Spectrometer Telescope for Imaging X-rays (STIX) on-board Solar Orbiter

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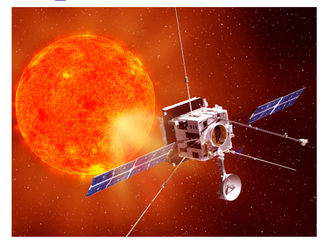
— for the STIX collaboration —



Solar Orbiter is a proposed sun-observing mission within ESA's Cosmic Visions program, addressing the man science question "**How does the Sun create and control the heliosphere?**". The **STIX** instrument that will image the sun in the X-ray range from **4 to 150 keV**. It will study thermal and non-thermal (bremsstrahlung) emission of electrons and so help in understanding the **acceleration of electrons** at the Sun and their **transport into interplanetary space**.

Solar Orbiter

Addresses
- sun and heliosphere interaction
- solar wind accelerating mechanisms
- energetic solar phenomena

Main questions
- How and where do the solar wind plasma and magnetic field originate in the corona?
- How do solar transients drive heliospheric variability?
- How do solar eruptions produce energetic particle radiation that fills the heliosphere?
- How does the solar dynamo work and drive connections between Sun and heliosphere?

Remote-sensing instruments

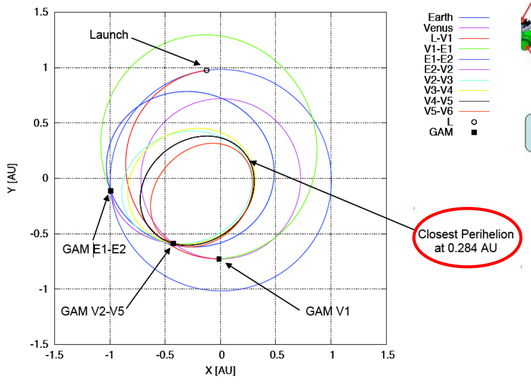
Polarimetric and Helioseismic Imager
EUV full-Sun and high-resolution Imager
EUV spectral Imager
X-ray spectrometer/telescope
Chronograph
Heliospheric Imager

In-situ instruments

Solar Wind Analyzer
Energetic Particle Detector
Magnetometer
Radio and Plasma Wave Analyzer

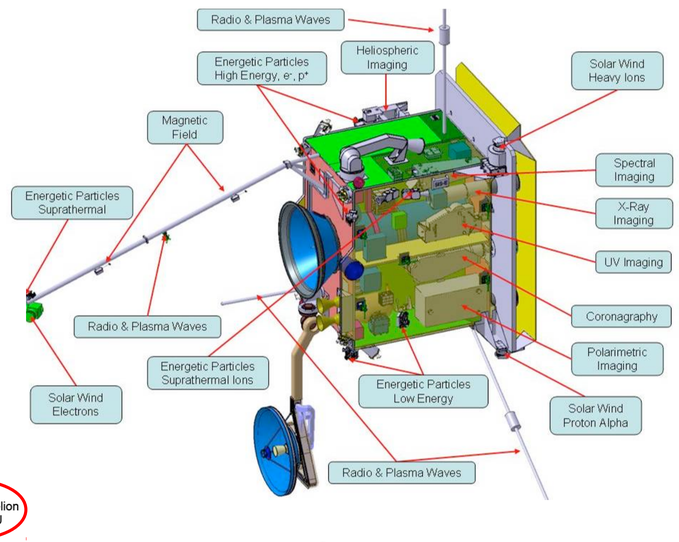
Orbit

4 gravity-assists (GAM) during cruise phase (3 years)



Resonance orbit with Venus
(increases inclination with GAMs to 34°)

Nominal mission duration 4 years
Extended mission 3 years



Spacecraft

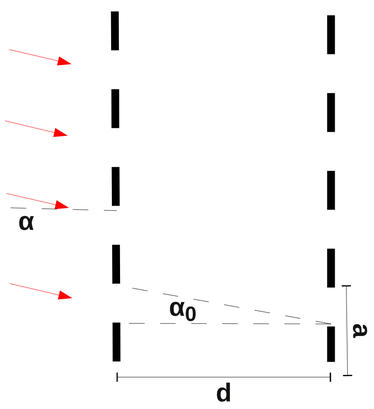
Sun-pointing, three axis stabilized
Telemetry at 1 AU distance **150 kbps**
Mass 1800 kg (**payload 180 kg**)

Schedule

Final down selection **October 2011**
Launch January 2017 (Atlas V401)
(March 2017/September 2018 back-up)

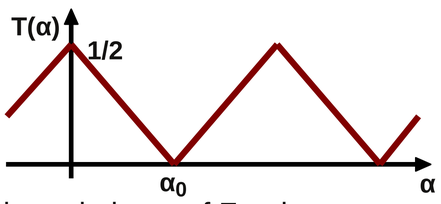
STIX Measurement Technique

Indirect Fourier imaging similar to HXT (Yohkoh) and RHESSI



Consider two equal grids with opaque slats separated by distance *d (d>>a, $\alpha_0 \approx a/2d$)*

Transmission for point source (at large distance)

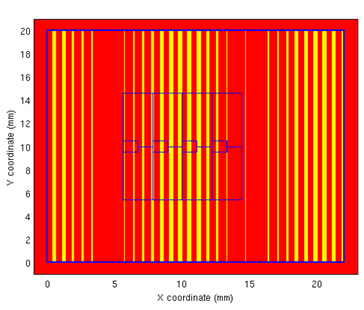


Amplitude and phase of Fourier components measurable by, for example, rotating grids

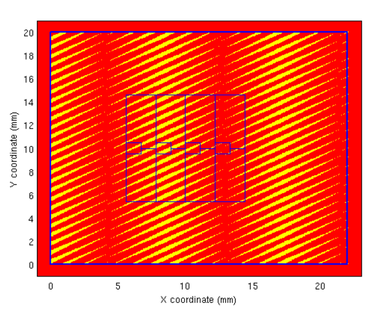
Rotation not possible for STIX
→ Different pitch and rotation for grids → Moire pattern in transmission

Pixelated detector samples Fourier component encoded in large scale Moire pattern

Pitches 666/714 µm
Both grids at 0°



Pitch 666/690 µm
Grids at 60° and 64°



Overlaid: size of grids and pixel structure of detector

Large scale Moire pattern

- Period 10 mm
  Detector samples one period
- Horizontal
  Detector orientation decoupled from Fourier imaging axis

Fine structure not seen by coarse pixels

STIX

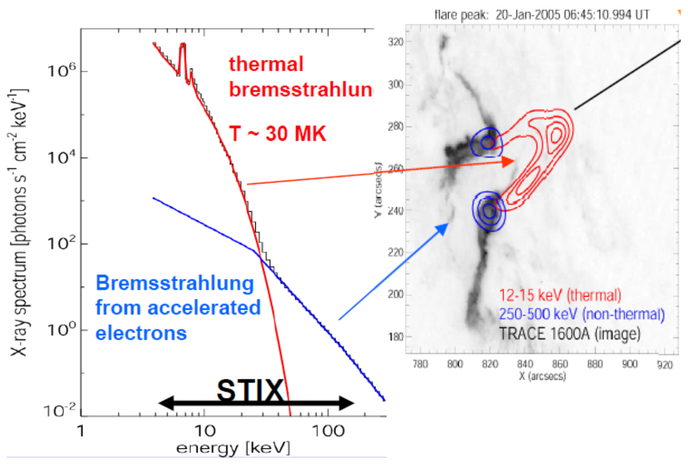
STIX determines by detecting **4-150 keV X-rays**

● **intensity** ● **spectrum** ● **timing** ● **location**

of **accelerated electrons** near the Sun.

Helps to understand
- the acceleration mechanism of electrons at the Sun,
- their transport into interplanetary space.

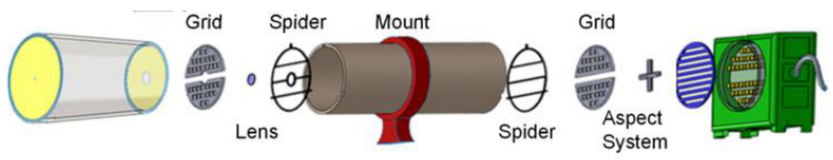
STIX links in-situ measurements with source regions.



Main parameters

Energy range	4-150 keV
Energy resolution	1-15 keV
	energy dependent
Effective area	6 cm^2
Angular resolution	7 arcsec
Pointing accuracy	4 arcsec
Field of view	2°
Time resolution	0.1 s
	statistics limited

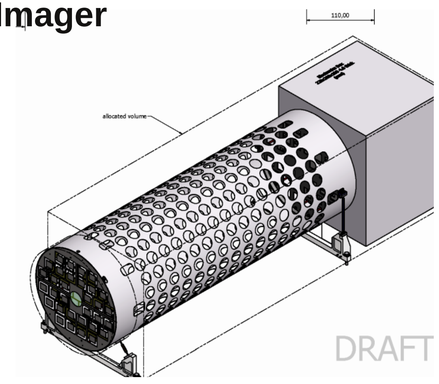
Heat shield **Imager** **Detector Electronics Module**



Beryllium Heat shield

Reduces thermal load from solar radiation (5 kW/m^2 at 0.28 AU)
Attenuation of high low energy X-ray flux

Imager

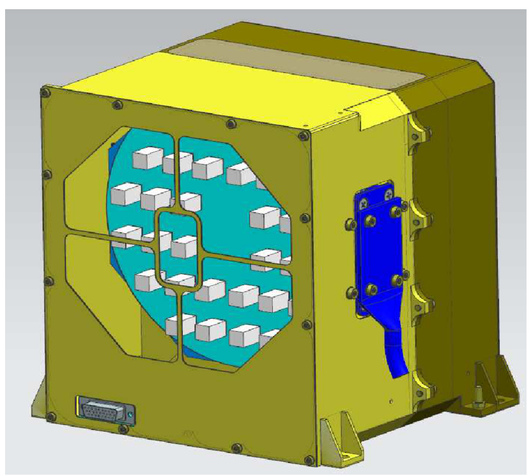


Supports grids at 55 cm distance
Ensures **relative** twist **below** 2 arcmin
(influence on Moire pattern)

Weight 1.3 kg, dimension 550 mm x 185 mm

Pointing determined by **aspect system**
Lens images sun onto pinholes, photo diodes detect crossing of solar lib over pin hole
→ relative alignment between spacecraft aspect and STIX established intermittently

Detector electronics module (DEM)



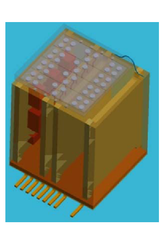
Mechanical flux **attenuator**
32 CdTe sensors on **Caliste-SO** hybrids
Analog-to-digital converters
Data processing unit (IDPU)
Low-voltage/sensor bias **power supplies**

Data rate to spacecraft ~200 bits/sec

Weight 3.5 kg
Dimension 180 mm x 200 mm x 220 mm
Electrical power ~4 W

N**ear real-time flare trigger** by IDPU
SpaceWire bus

CdTe operate below -20°C (using spacecraft provided cold finger)
→ low leakage current and high energy resolution



Caliste-SO hybrid

- CdTe sensor with bias voltage connection on top
- ASIC and passive components inside

Data availability

Level	Data Products	Time Lag from downlink
L-0	Time-ordered raw telemetry	≤24 hours
L-1	Quick-look light curves, images, and spectra Preliminary flare list and observing summary	~ one week
L-2	Fully calibrated light curves, images and spectra in physical units.	Four weeks
L-3	Other data, such as publications, descriptions, procedures, figures, etc. Final calibration data and flare list released after	As they become available

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