The Science and Capability of the Solar-B / X-Ray Telescope

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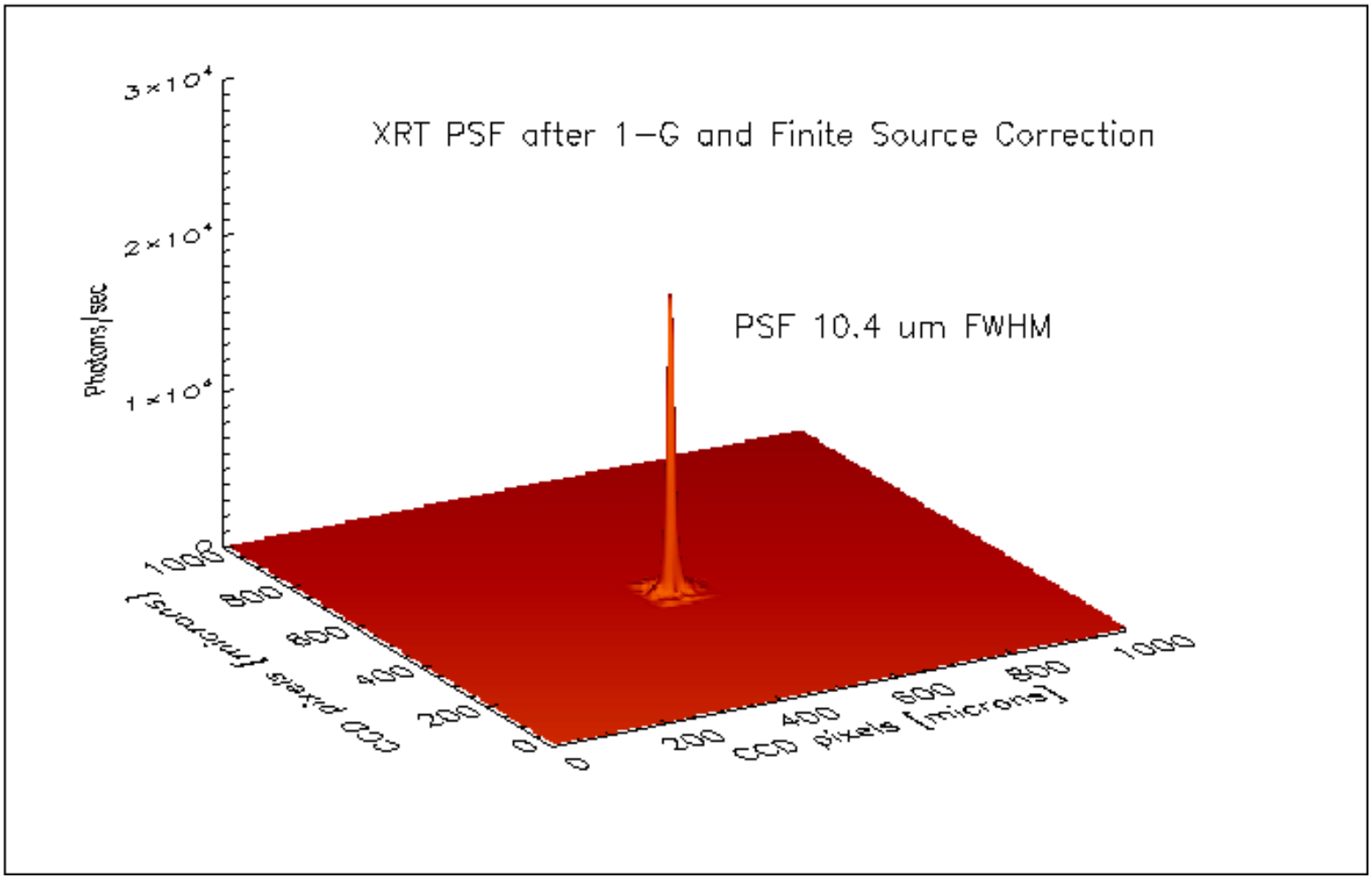
for the International XRT Team

XRT Performance Requirements

Verification #	Source	XRT Performance Requirement	Approach	Result
3	CEI	X-ray performance bandwidth 0.2 to 1.2keV	T	0.2 to 2.0keV
4	CEI	Image performance: 50% encircled energy with in 1" radius from an on-axis source at 1keV	T	52%
7	CEI	Effective area > 1.0cm^2 at 0.5keV	T	> 2.0 cm^2
13	CEI	Confocality X-ray and Visible light image +/- 150micorns	T	VLI depth of focus ~700microns
17	CEI	XRT filter shall provide a temperature resolution of 0.2(logT) over the range 6.1 < log(T) < 7.5	A	0.1 (logT) resolution
25	CEI	X-ray and VLI shall be coalligned to within 1'	T	17+/-5" separation

PSF after corrections for 1-G and finite source distance.



New XRT Instrumental Capabilities

1. Unprecedented combination of spatial resolution, field of view, and image cadence.
2. Broadest temperature coverage of any coronal imager to date.
3. High data rate for observing rapid changes in topology and temperature structure.
4. Extremely large dynamic range to detect entire corona, from coronal holes to X-flares.
5. Flare buffer, large onboard storage, and high downlink rate provide unique observing capability.

Anticipated XRT Science "Firsts"

- *Flares & Coronal Mass Ejections.*
  - How are they triggered, and what is their relation to the numerous small eruptions of active region loops?
  - What is the relationship between large-scale instabilities and the dynamics of the small-scale magnetic field?
  - XRT will determine the topology, physical parameters (T, n_e), and interrelatedness of the inner coronal regions integral to flare/CME formation.

- *Coronal heating mechanisms.*
  - How do coronal loops brighten? TRACE has observed loop oscillations associated with flares (Nakariakov et al. 1999). Are other wave motions visible? Are they correlated with heating?
  - Do loops heat from their footpoints upward, or from a thin heating thread outward? Do loop-loop interactions contribute to the heating?
  - XRT will exhibit the evolution and activity of both active and quiet inner coronal structures on MHD (seconds) to surface **B** diffusion (days) timescales.

Anticipated XRT Science "Firsts"

- *Solar flare energetics.*
  - Although Solar-B will launch well before the next solar maximum, there will still be many flare events seen. The XRT is designed so that it can test the reconnection hypothesis that has emerged from the *Yohkoh* data analysis.
  - XRT will extend the sample of observed flares by orders of magnitude in combined sensitivity, spatial, and temporal resolution, allowing stringent tests of flare theories.
- *Reconnection & Coronal Dynamics.*
  - *Yohkoh* observations of giant arches, jets, kinked and twisted flux tubes, and microflares imply that reconnection plays a significant role in coronal dynamics. With higher spatial resolution and with improved temperature response, the XRT will help clarify the role of reconnection in the corona.
  - XRT will determine importance of flows, B-field–plasma interactions, relevance of null points, reconnection sites, and separatrix (or QSL) surfaces.
- *Photosphere/corona coupling.*
  - Can a direct connection be established between events in the photosphere and a coronal response?
  - To what extent is coronal fine structure determined at the photosphere?

XRT Science Goals 1

- Coronal Mass Ejections
  - How are they triggered?
    - High time resolution
  - What is their relation to the magnetic structures?
    - High spatial resolution
  - What is the relation between large scale instabilities and the dynamics of small structures?
    - **Large FOV**
    - Broad temperature coverage

CME Movie

QuickTime™ and a
Cinepak decompressor
are needed to see this picture.

XRT Science Goals 2

- Coronal Heating
  - How do coronal structures brighten?
    - High time resolution
  - What are the wave contributions?
    - **High Spatial Resolution**
  - Do loop-loop interactions cause heating?
    - Large FOV
    - Broad temperature coverage

Coronal Heating: Sample Observation

QuickTime™ and a
Cinepak decompressor
are needed to see this picture.

What needs to be explained:

- Outflows
- Motions along field
- Separatrices and QSLs
- Intermingled hot and cool plasma

XRT Science Goals 3

- **Reconnection and Jets**
  - Where and how does reconnection occur? Is it related to slow CMEs?
    - High time resolution
    - Large FOV
  - What are the relations to the local magnetic field?
    - High spatial resolution
    - Broad temperature coverage
    - Coordinated observing with EIS/SOT

Reconnection and Jets

QuickTime™ and a
Cinepak decompressor
are needed to see this picture.

XRT Science Goals 4

- Flare Energetics
  - Where and how do flares occur?
    - **High time resolution**
  - What are the relations to the local magnetic field?
    - High spatial resolution
    - Large FOV
    - Broad temperature coverage
    - **High temperature response**
    - **Large dynamic range**

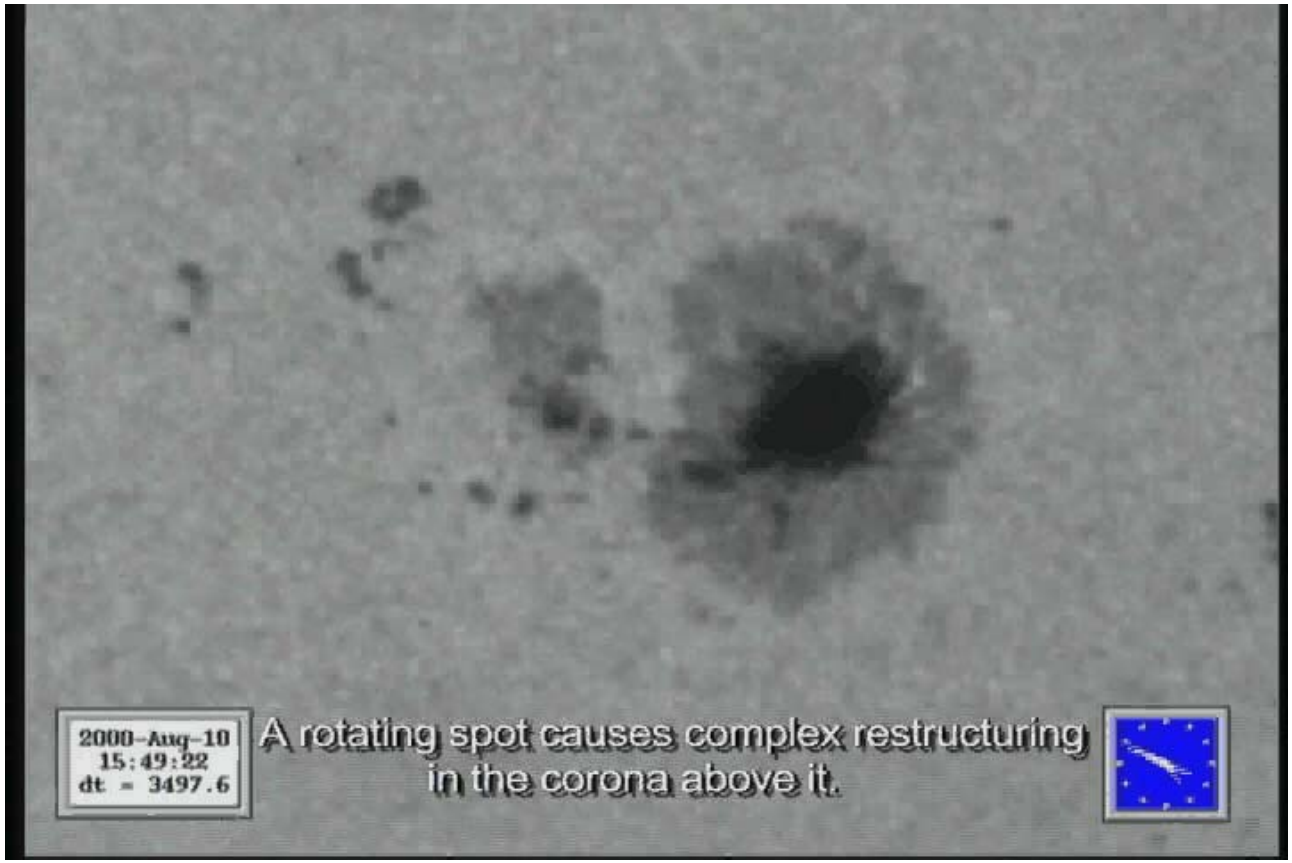
Flare Energetics - Example

QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

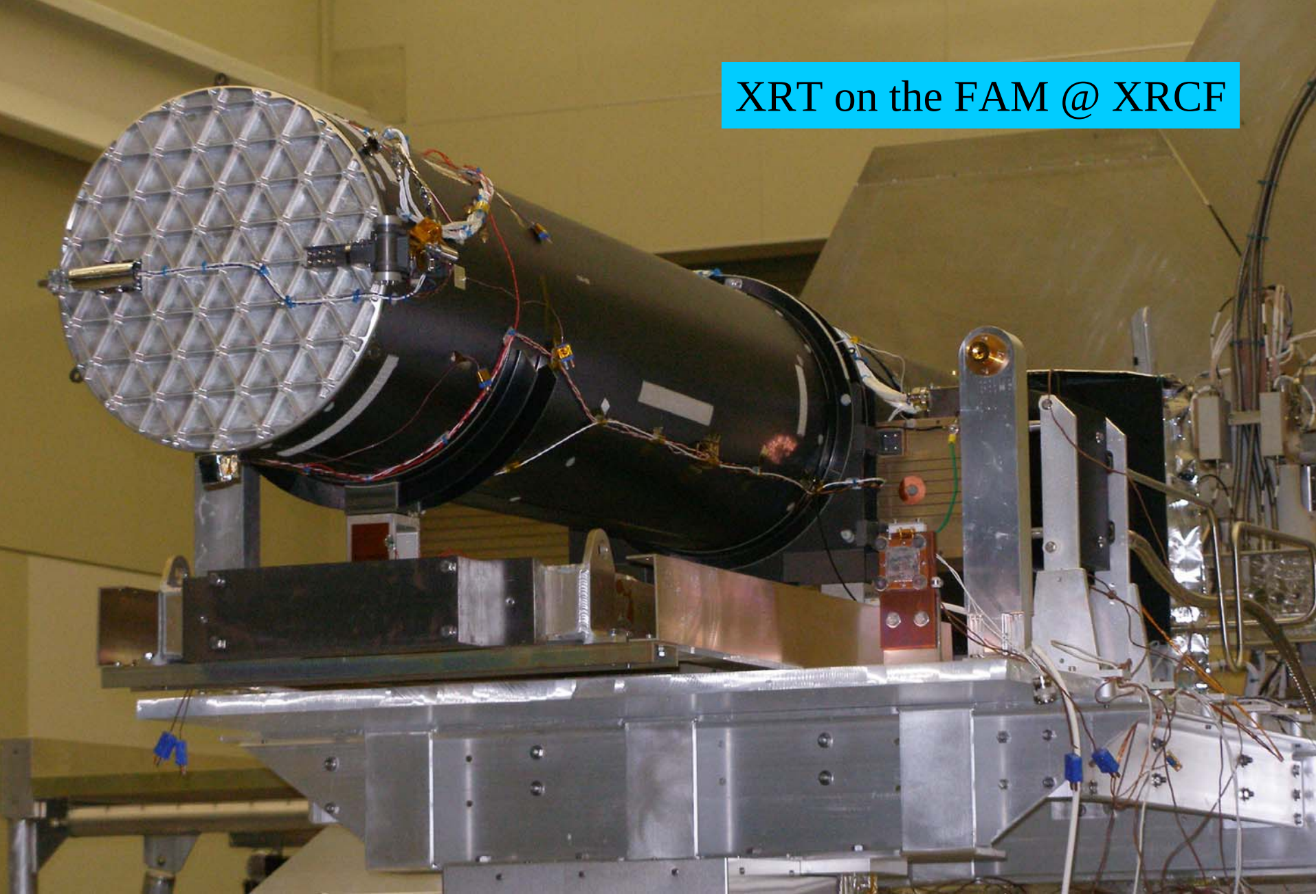
SXT Science Goals 5

- Photospheric-Coronal Coupling
  - **Can a direct connection between coronal and photospheric events be established?**
    - High time resolution
    - High spatial resolution
  - **How is energy transferred to the corona?**
    - Large FOV
  - **Does the photosphere determine coronal fine structure?**
    - Broad temperature coverage
    - **Coordinated observing with SOT-FPP/EIS**

Photospheric-Coronal Coupling



Courtesy A. Title


XRT on the FAM @ XRCF