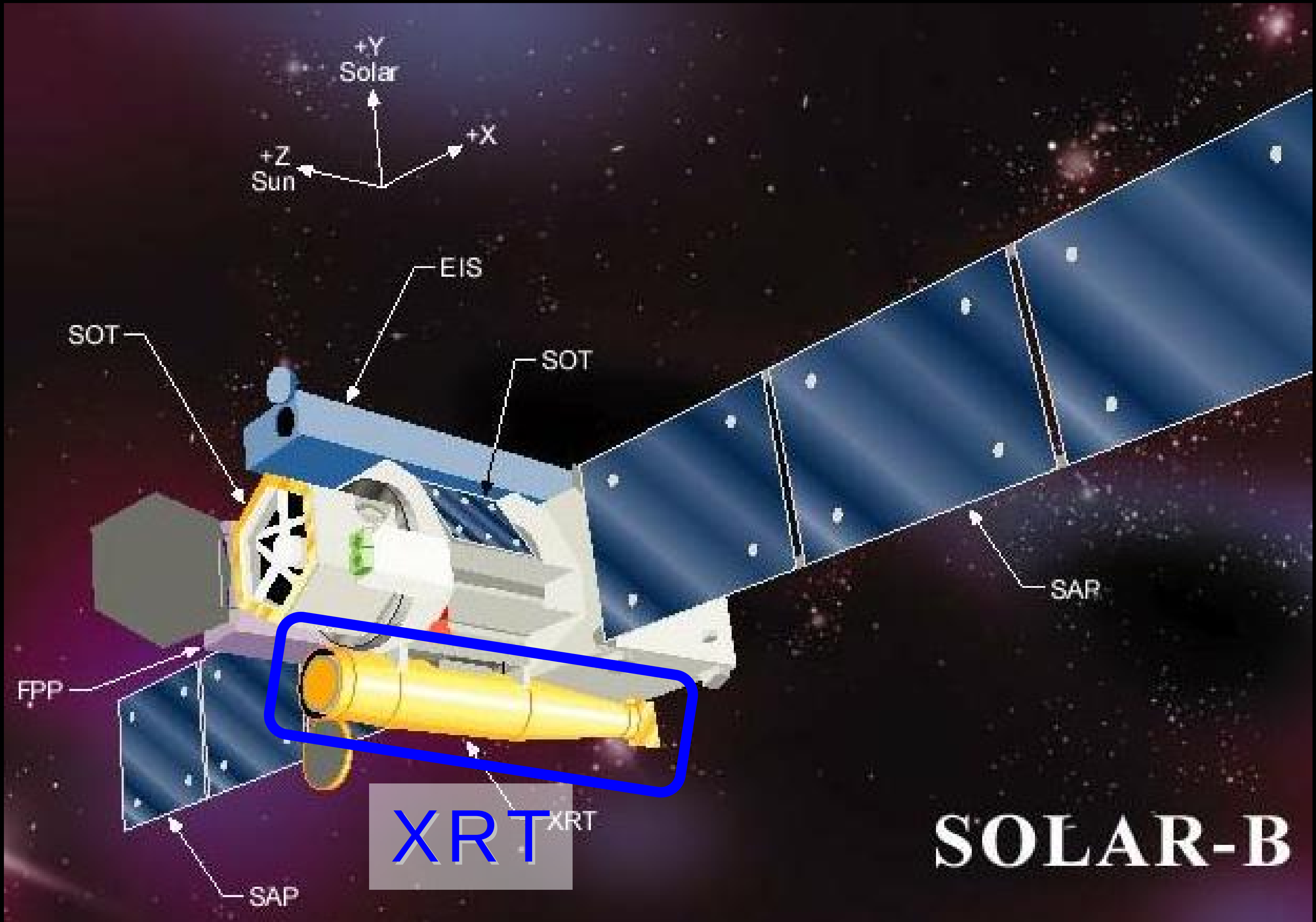
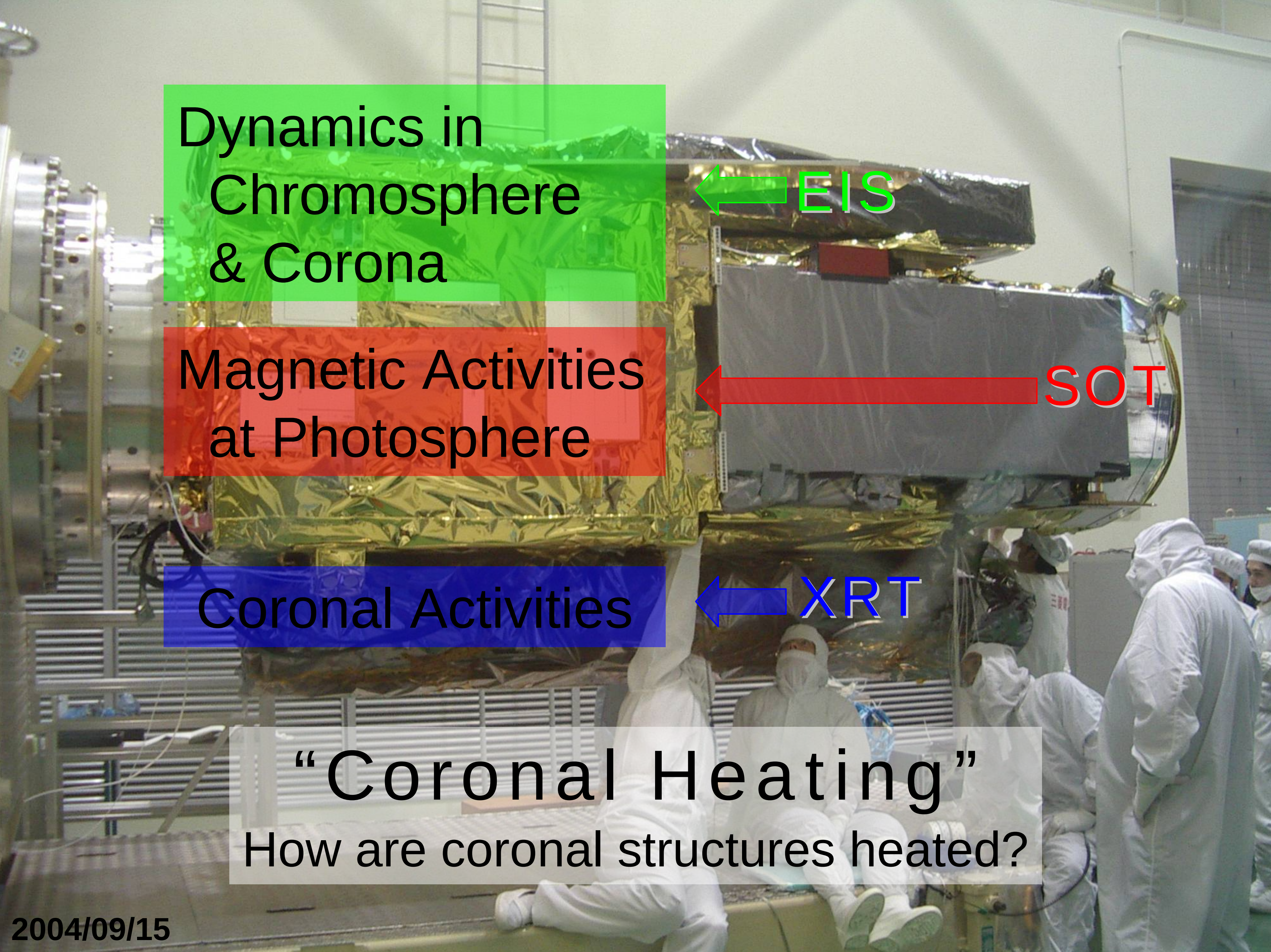
Solar-B X-ray Telescope (XRT)

R. Kano (NAOJ) and XRT Team





Dynamics in Chromosphere & Corona

EIS

Magnetic Activities at Photosphere

SOT

Coronal Activities

XRT

"Coronal Heating"

How are coronal structures heated?

2004/09/15

Targets of XRT Observations

Coronal Loop Structures

&

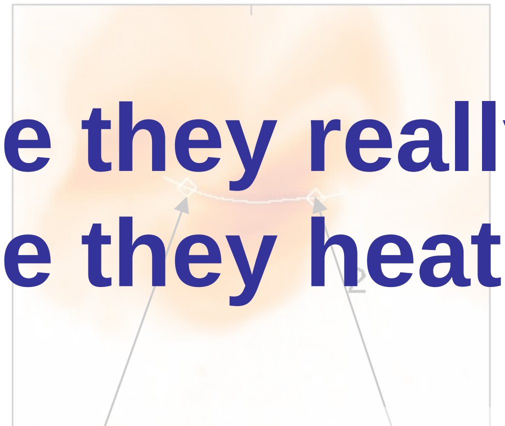
Coronal Loop Heating

- **Photosphere/Corona Coupling**
  - Can a direct connection be established between coronal and photospheric events?
- **Coronal Heating**
  - How do coronal structures brighten?
- **Flare Energetics**
  - What are the relations to the photospheric magnetic fields?
- **CMEs, Jets and other coronal dynamical events**

SXT Loops vs. EIT/TRACE Loops

SXT loops in active regions

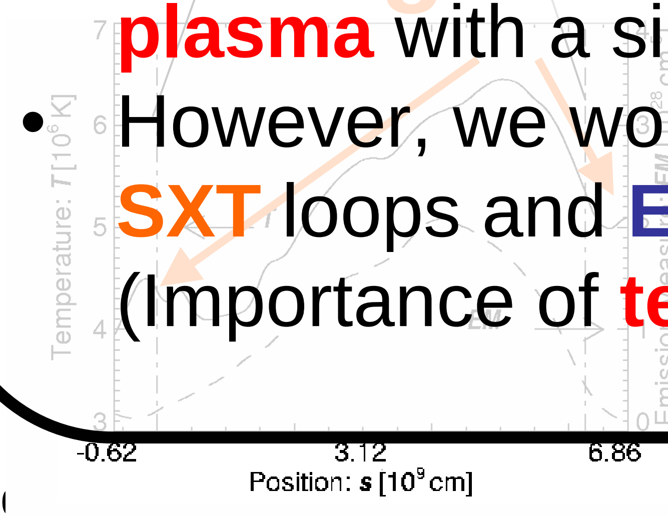
EIT Image

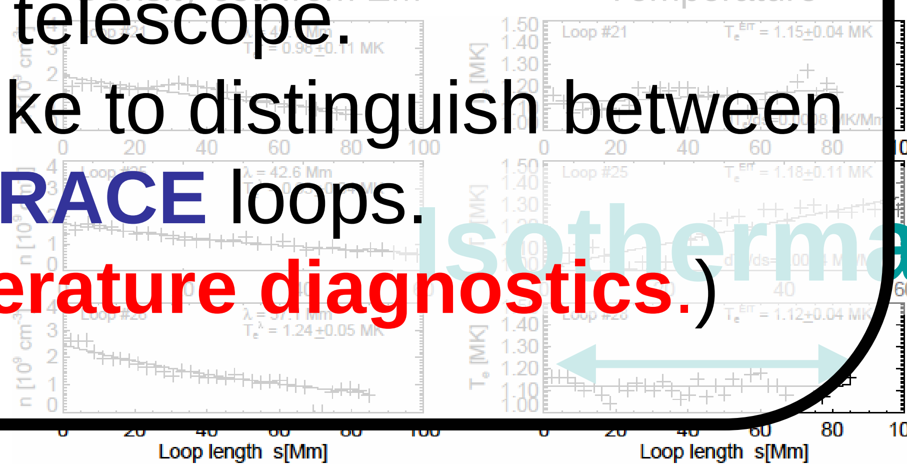


Are they really different?

Are they heated in a different way?

- We would like to observe **all of the coronal plasma** with a single telescope.
- However, we would like to distinguish between SXT loops and **EIT/TRACE** loops. (Importance of **temperature diagnostics**.)





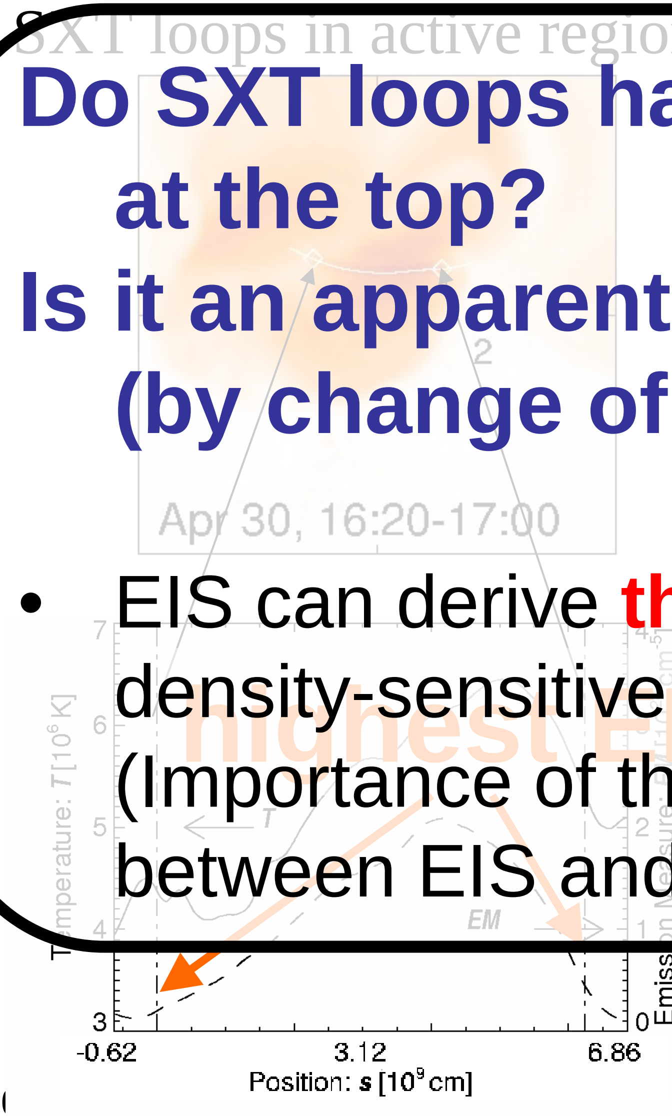
Kano & Tsuneta (1996, PASJ)

Aschwanden et al. (1999 &2000, ApJ)

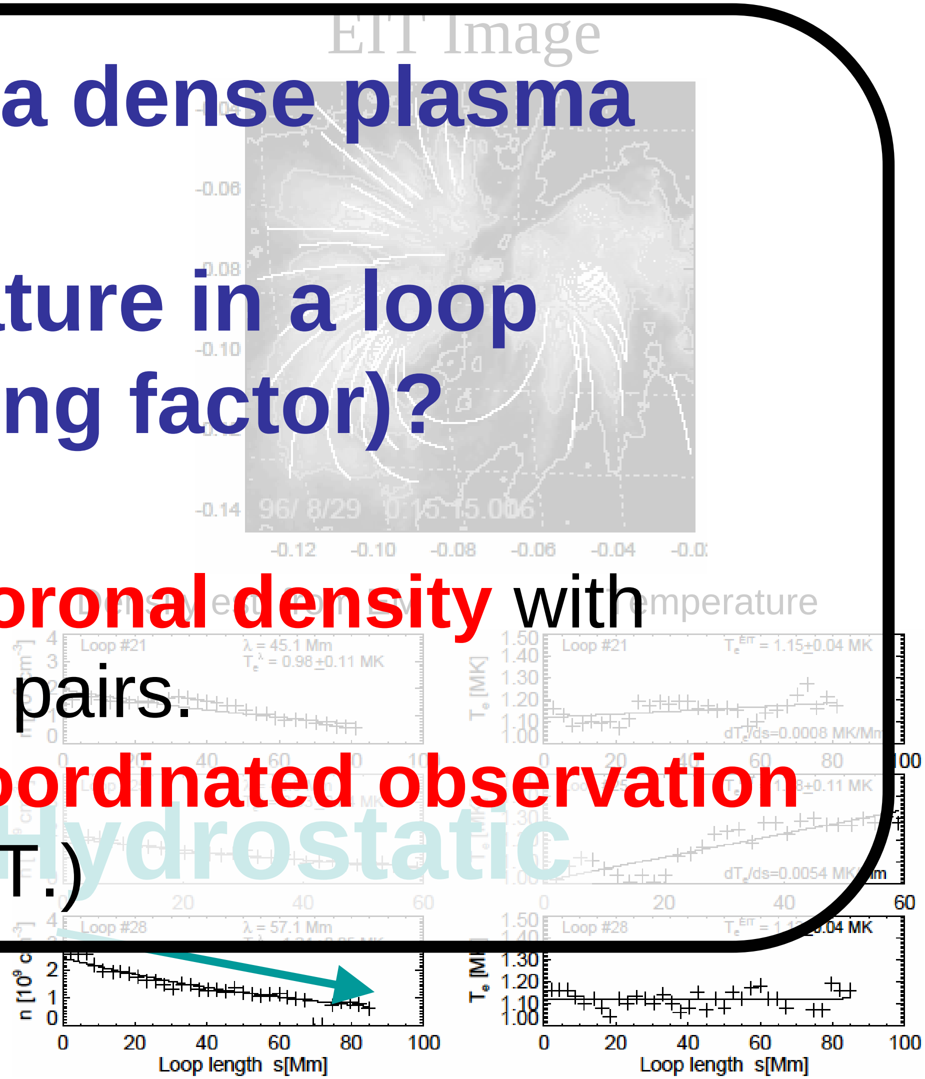
SXT Loops vs. EIT/TRACE Loops

Do SXT loops have a dense plasma at the top?
Is it an apparent feature in a loop (by change of filling factor)?

- EIS can derive **the coronal density** with density-sensitive line pairs. (Importance of the **coordinated observation** between EIS and XRT.)



Kano & Tsuneta (1996, PASJ)



Aschwanden et al. (1999 &2000, ApJ)

Solar-B/XRT vs. Yohkoh/SXT

	Solar-B/XRT	Yohkoh/SXT
Type of Optics	Grazing Incidence	Grazing Incidence
FOV	34 arcmin	42 arcmin
Pixel Size	**1 arcsec**	2.5 arcsec
PSF FWHM	**<1 arcsec** @ center	~ 3 arcsec
Bandpass	3 ~ 200Å	3 ~ 45Å
Temp. Coverage	**1MK** ~ 30MK	3MK ~ 30MK
Time Cadence		
Full Frame, Full-res.	min 9.5sec	256sec (Half Frame)
Full Frame, Half-res.	min 5.0sec avg. 102sec	128sec
Partial Frame, Full-res. (FOV = 300”~400”)	min 2.0sec avg. 15sec	8 sec in flare mode 32 sec in Quiet mode
Other New Items	Pre-flare Buffer Focus Mechanism	----

XRT characteristics

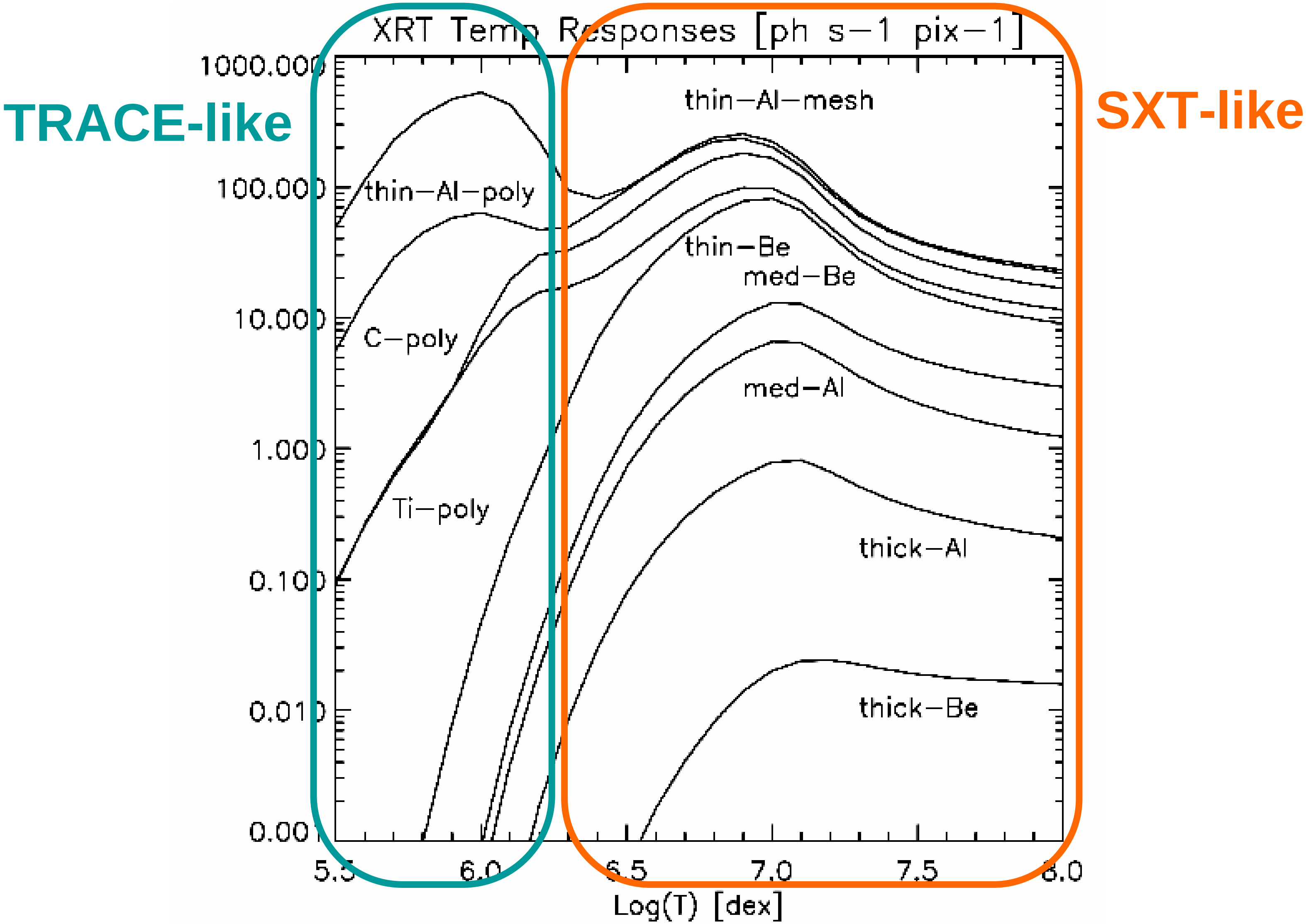
- **Temperature Response**
  - TRACE-like image and SXT-like image
- **Field-of-View and Spatial Resolution**
  - Focus Mechanism
- **Observation control by MDP**
  - Table Observation
  - Image Compression
  - Time Cadences
  - Preflare Buffer

X-ray Analysis Filters

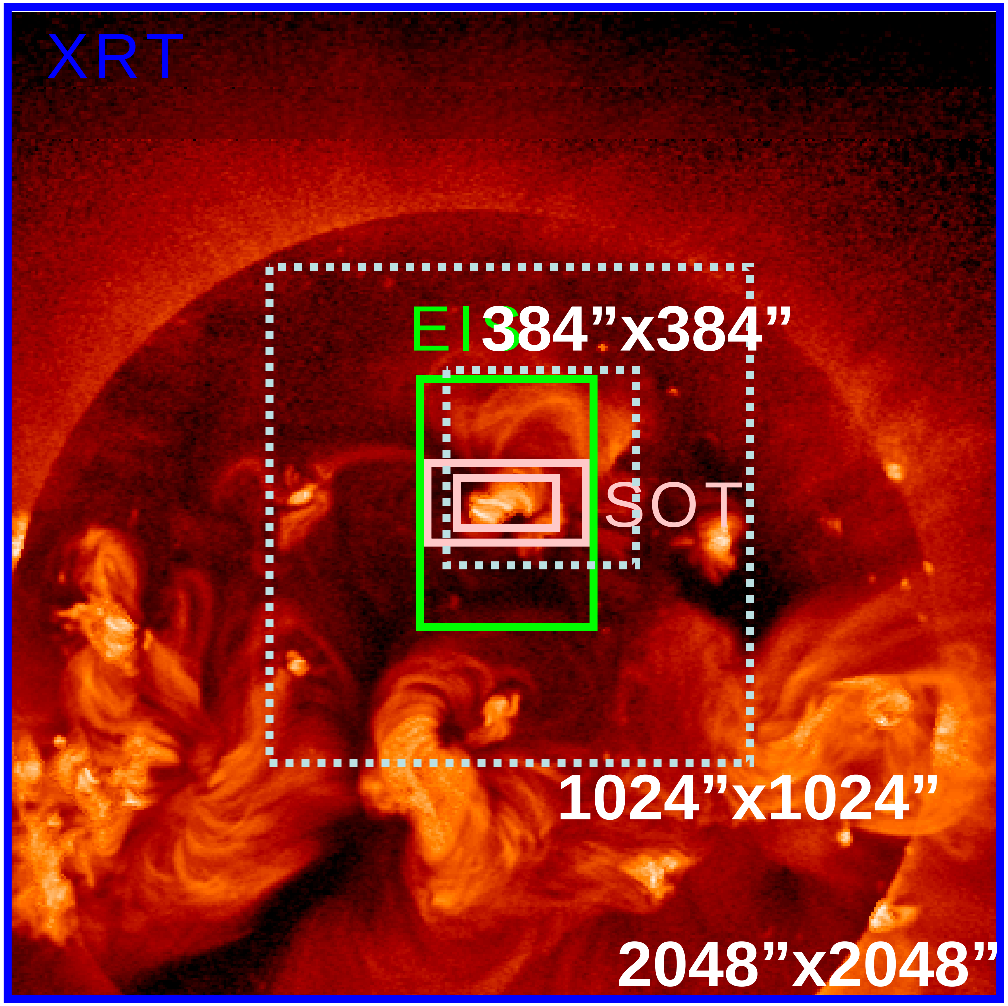
- XRT has 9 X-ray analysis filters and a G-Band filter.

Name	Metal	Metal Thickness	Substrate	Substrate Thickness
Thin-Al/Mesh	Al	1600 Å	Mesh	
Thin-Al/Poly	Al	1250 Å	Polyimide	2500 Å
C/Poly	C	6000 Å	Polyimide	2500 Å
Ti/Poly	Ti	3000 Å	Polyimide	2300 Å
Thin-Be	Be	9 μm	Mesh	
Med-Al	Al	12.5 μm		
Med-Be	Be	30 μm		
Thick-Al	Al	25 μm		
Thick-Be	Be	300 μm		

XRT Temperature Response

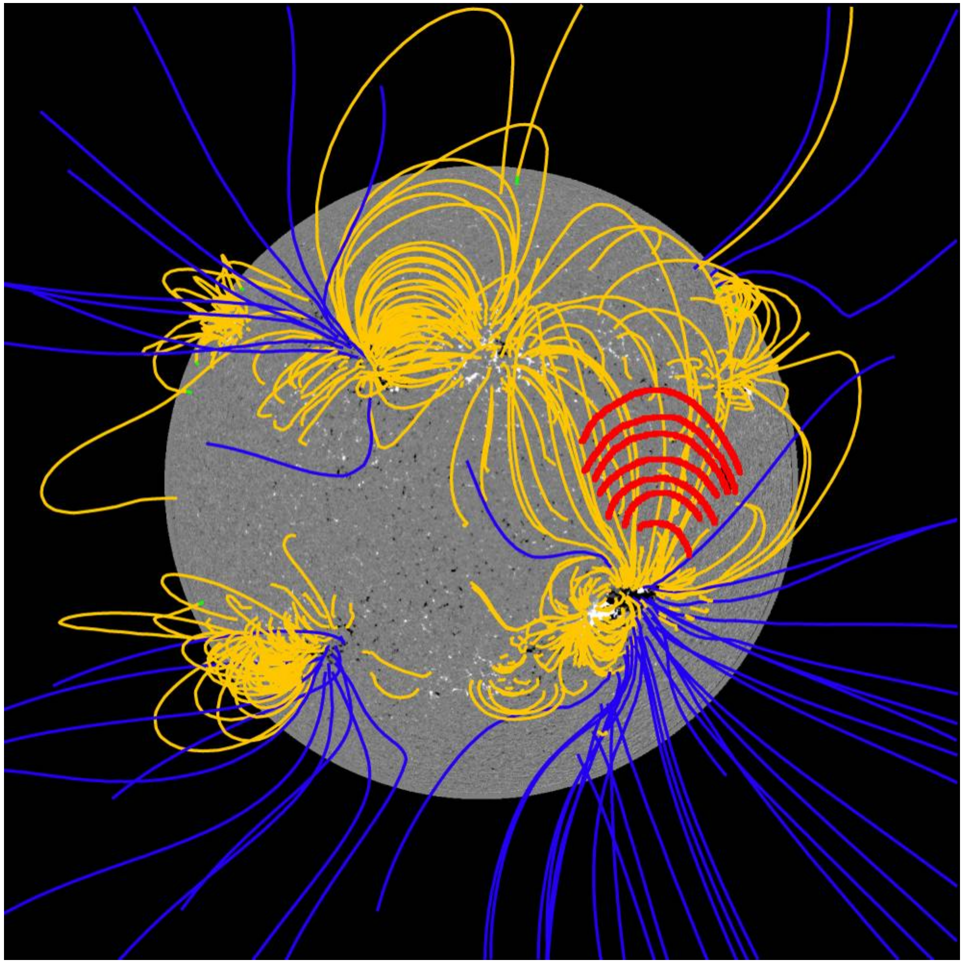


Field of View (FOV)



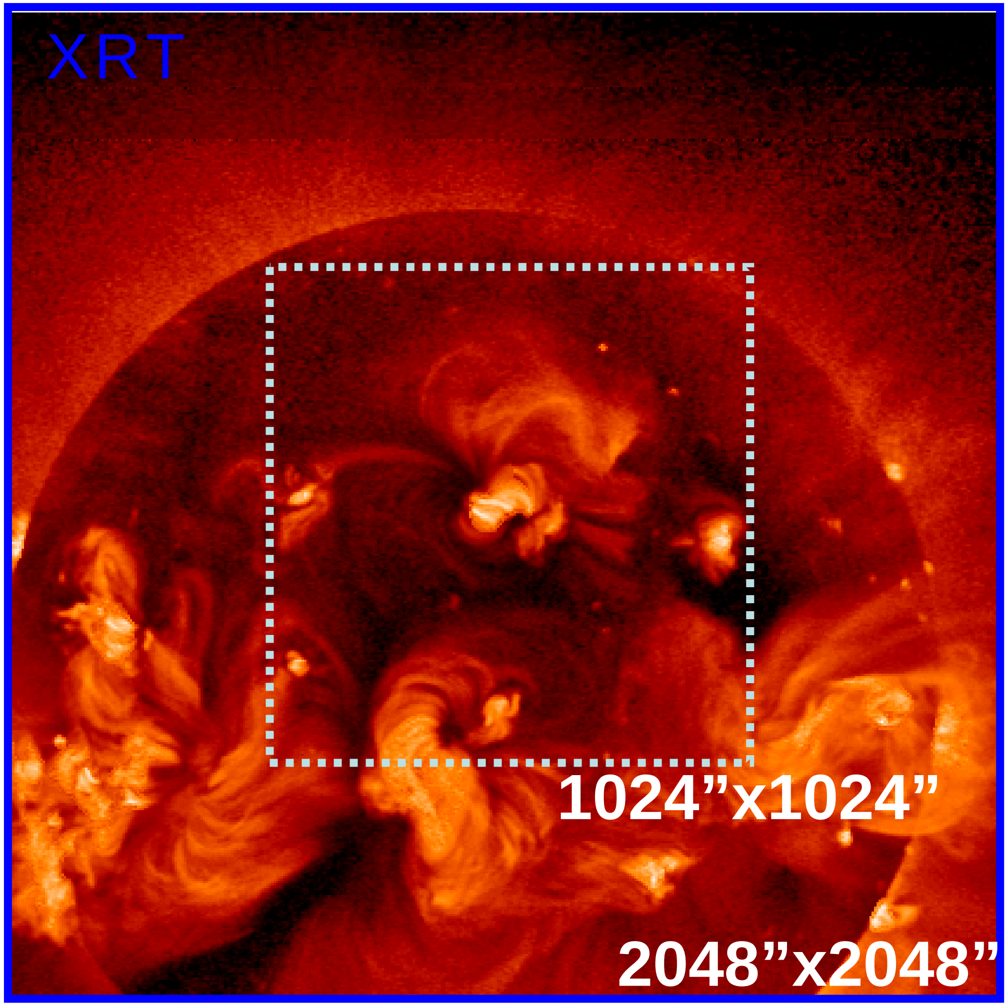
- To point SOT at a certain target on the solar disk, we have to change Solar-B pointing. Therefore, XRT will not always observe the full solar disk.
- Many varieties of FOV size are available.
- Especially, for high-res.-observation, we recommend FOV= 1024"x1024" around CCD center.

Importance of Wide FOV



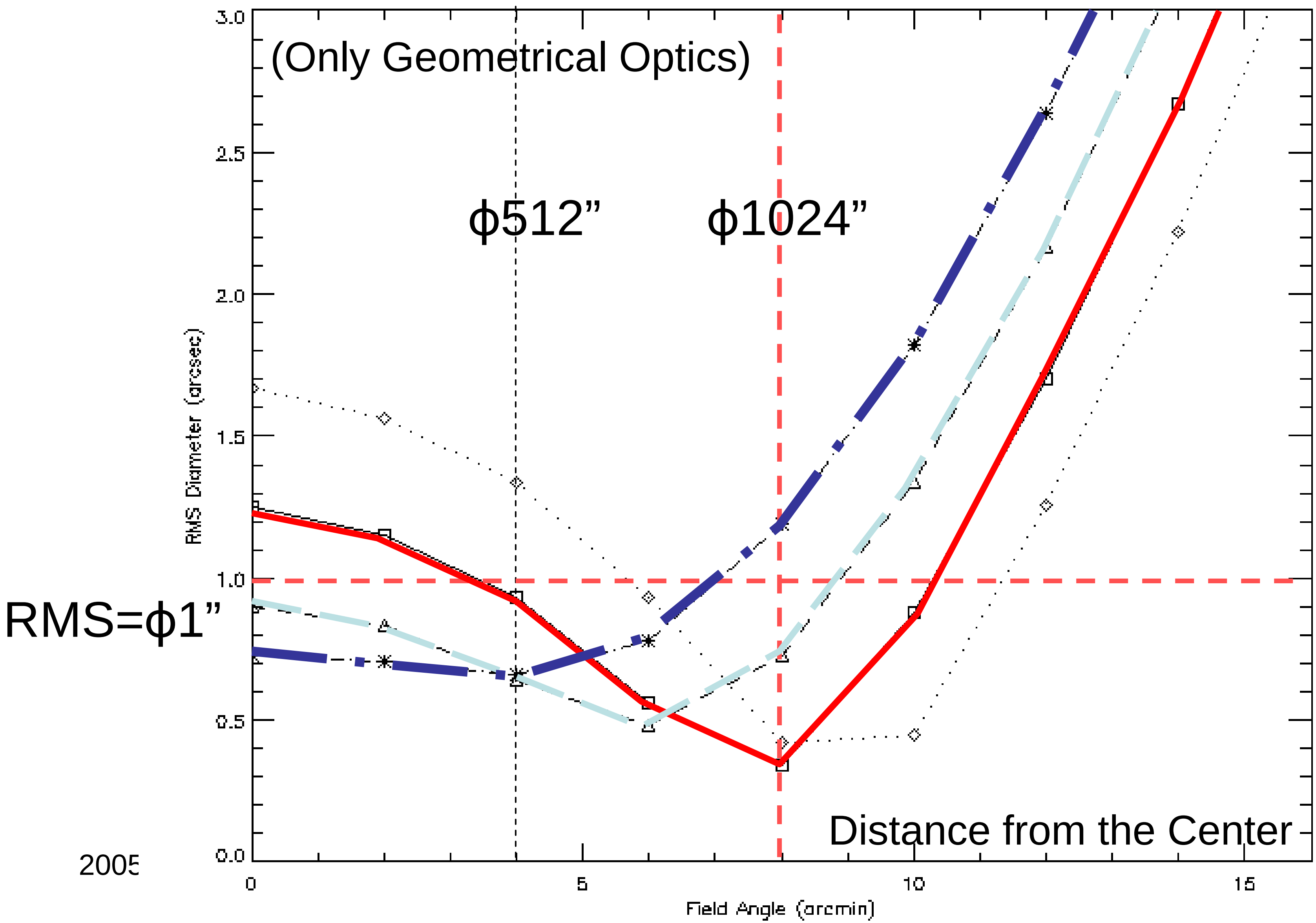
- Moreton waves tend to propagate along the global magnetic fields.
- X-ray waves also propagate with Moreton waves.

Field of View (FOV)



- To point SOT at a certain target on the solar disk, we have to change Solar-B pointing. Therefore, XRT will not always observe the full solar disk.
- Many varieties of FOV size are available.
- Especially, for high-res.-observation, we recommend FOV= 1024”x1024” around CCD center.

Aberration at Different Focus Pos.



Observation of XRT

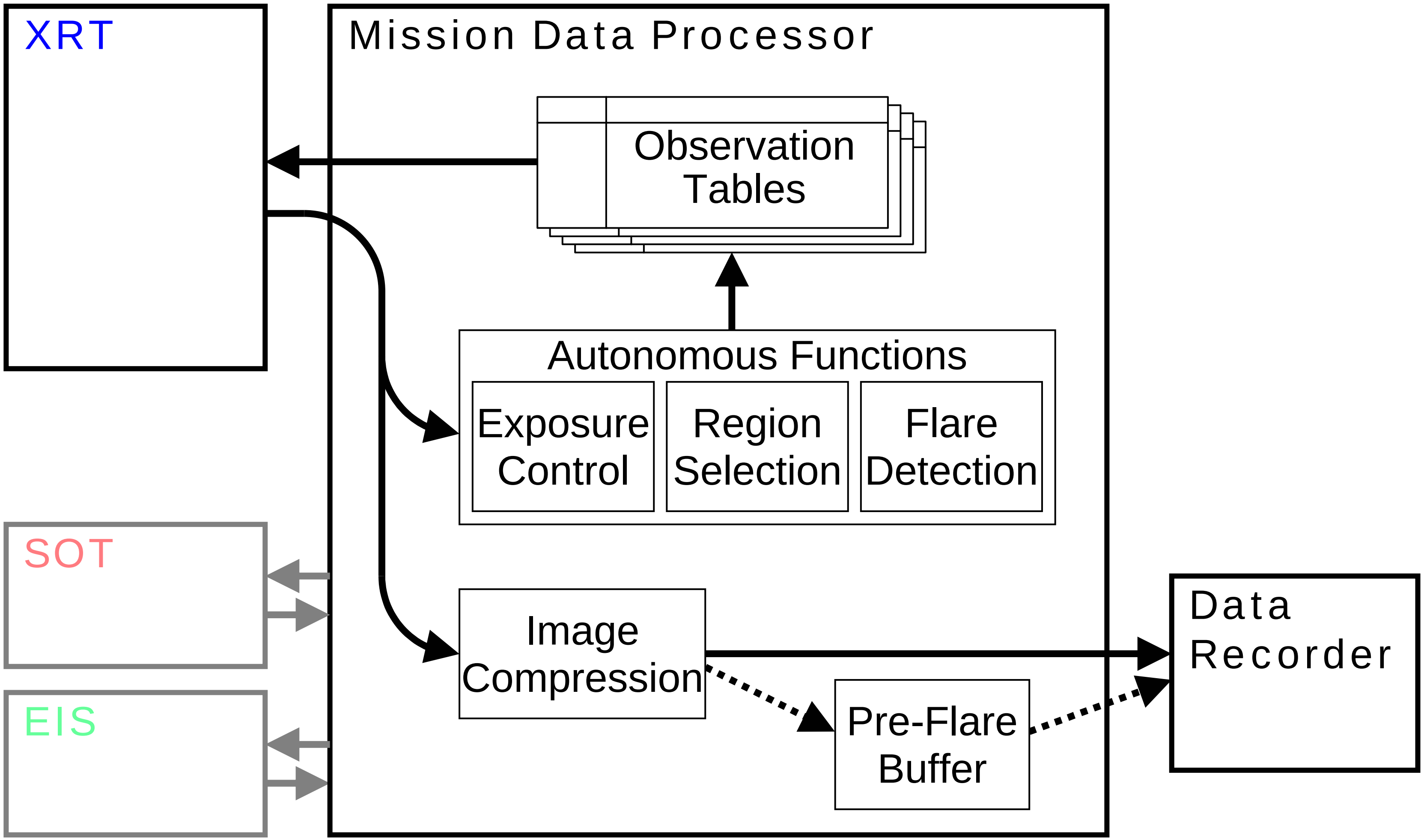
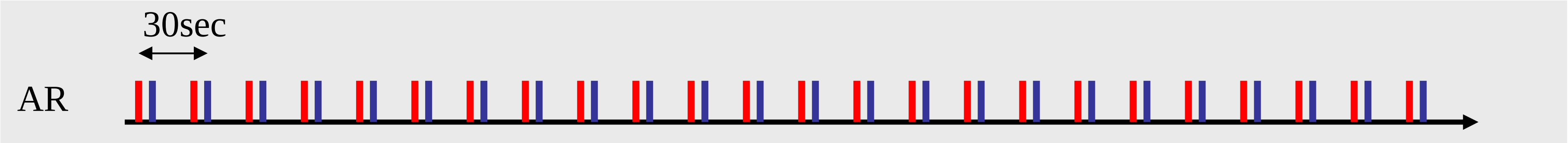


Image Compression

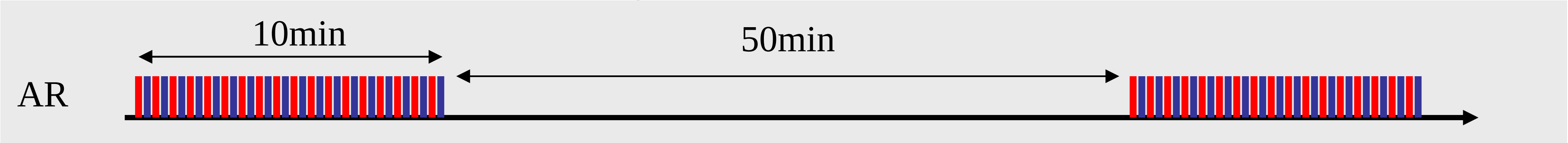
- MDP can compress the image data. Observer selects the following options.
  - No compression
  - DPCM (lossless) compression
  - JPEG (lossy) compression
    - Q-factor = 98, 90, … , 65.

Typical Time Cadences

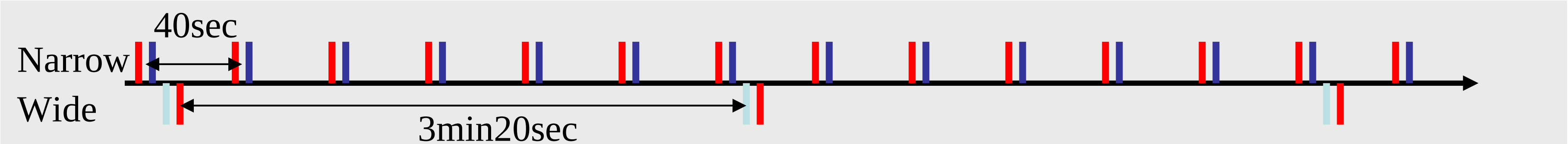
- typical data rate for XRT ~ 600 k pixel / min
  - ex.1: Continuous Observation for AR
    - AR FOV = 384”×384”, 1”-res.



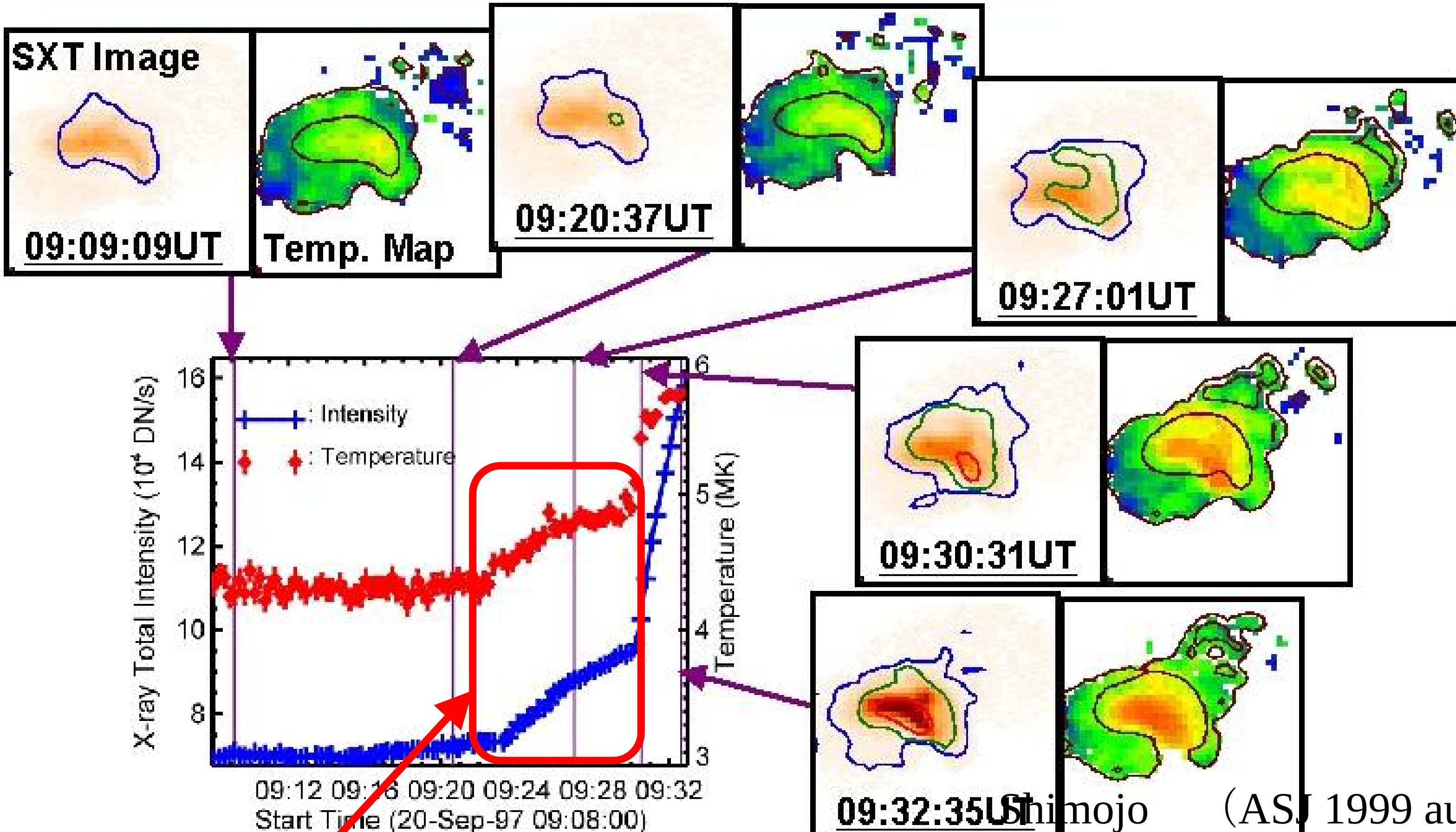
  - ex.2: High-Speed Observation for AR
    - AR FOV = 384”×384”, 1”-res.



  - ex.3: Combination of Narrow and Wide FOV
    - Narrow FOV = 384”×384” , 1”-res.
    - Wide FOV =2048”×2048”, 4”-res.



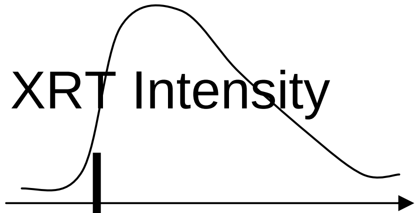
Pre-flare Observation



Shimojo （ASJ 1999 autumn）

FOV = 256”x256”, 1”-res.
Time Cadence = 10 ~ 20 sec for a filter pair

Flare Observation



XRT
- Detect a flare.
- Report the location to all telescope.

XRT
- Switch the current observation to Flare one.
- Lock the Pre-Flare Buffer.
- (There is a option not to switch to Flare obsevation.)

SOT
- Switch the current observation to Flare one, if the flare location is in SOT-FOV.
- (There is a option not to switch to Flare obsevation.)

EIS
- Switch the current observation to Flare one, if the flare location is in EIS-FOV.
- (There is a option not to switch to Flare obsevation.)

Solar-B/XRT vs. STEREO/EUVI

	Solar-B/XRT	STEREO/EUVI
Type of Optics	**Grazing Incidence**	**Normal Incidence**
FOV	34 arcmin	55 arcmin
Pixel Size	1 arcsec	1.6 arcsec
PSF FWHM	<1 arcsec @ center	<1.6 arcsec @ center
Bandpass	**3 ~ 200Å**	**He II 304Å** **Fe IX 171Å (1MK)** **Fe XII 195Å (1.5MK)** **Fe XIV 211Å (2MK)**
Temp. Coverage	**1MK ~ 30MK**	
Time Cadence		
Full Frame, Full-res.	min 9.5sec	min 11sec in Fe IX avg. 20min
Full Frame, Half-res.	min 5.0sec avg. 102sec	min 4.75sec avg. 2.5min
Partial Frame, Full-res. (FOV = 300”~400”)	min 2.0sec avg. 15sec	(No Option?)

Summary

- XRT has high sensitivity for **low (1MK) temperature plasma**, as well as high temperature plasma.
- XRT has the highest spatial resolution as GI imager.

Pixel Size = 1 arcsec

- **Observation Tables** respond to various observations.
- **Autonomous functions** support XRT automatic operation.
- Observers can select types of **Image Compression**.
- **Built-in visible light optic** allows us to align XRT images with SOT images with sub-arcsec accuracy.