



Extreme Ultraviolet Imager

**Instrument
Data
Operations**

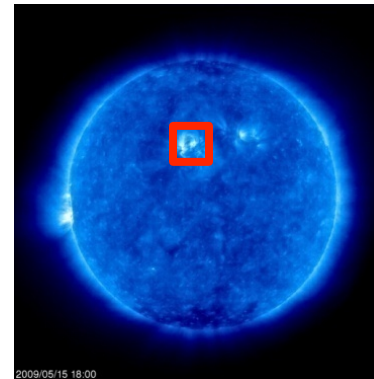
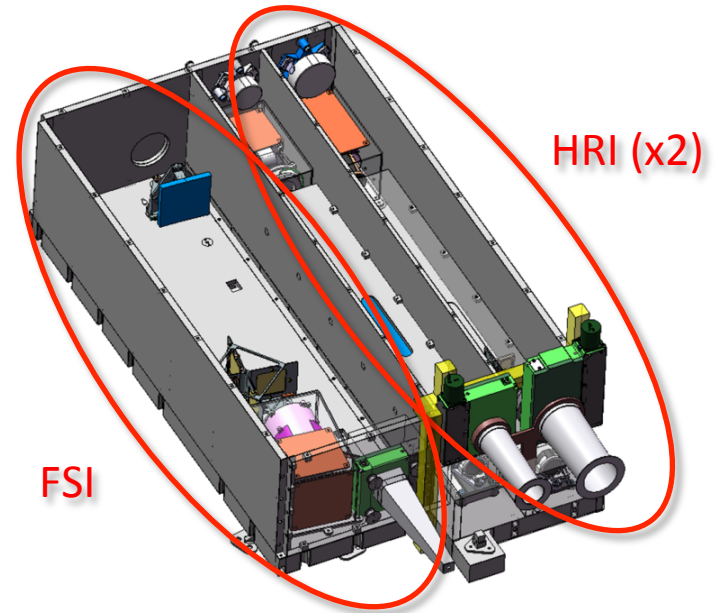
Frédéric Auchère

**Institut d'Astrophysique Spatiale
frederic.auchere@ias.u-psud.fr**

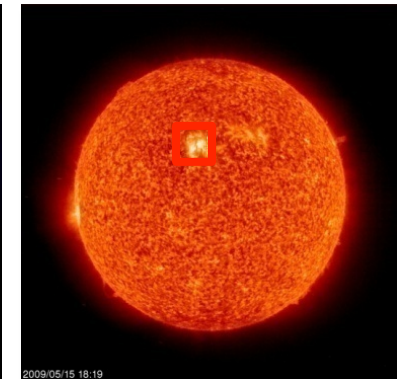


Main characteristics

Channel	Parameter	Values
	Dimensions	
	- Optical bench	- 550x175x785mm
	- CEB	- 120x300x250mm
	Mass	18.20 kg
	Nominal power	28 W
FSI dual EUV	Telemetry	20 kb/s
	Passband center	174 Å and 304 Å alternatively
	Field of View	3.8 arcdeg × 3.8 arcdeg
	Resolution (2 px)	9 arcsec
	Typical cadence	600 s
HRI EUV	Passband center	174 Å
	Field of View	1000 arc sec square
	Angular resolution (2 px)	1 arcsec
	Typical high cadence	2 s
HRI Lyman- α	Passband center	1216 Å
	Field of View	1000 arcsec square
	Resolution (2 px)	1 arcsec
	Typical high cadence	Sub-second



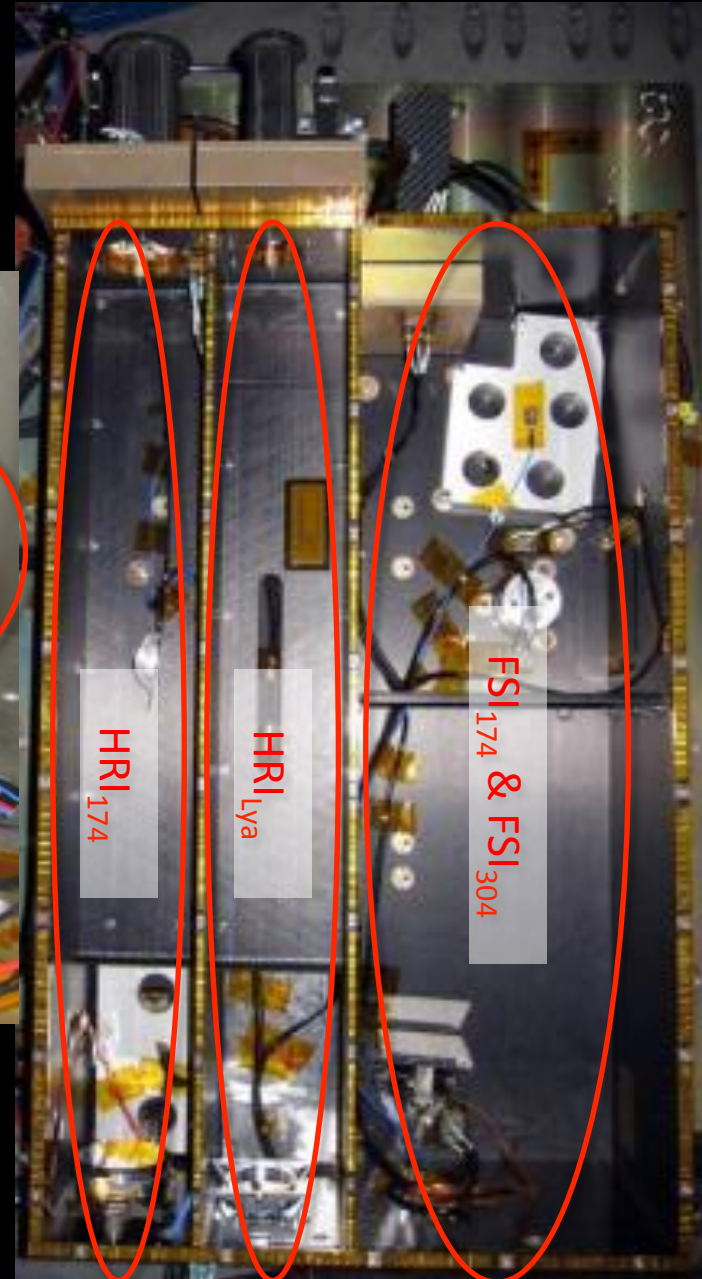
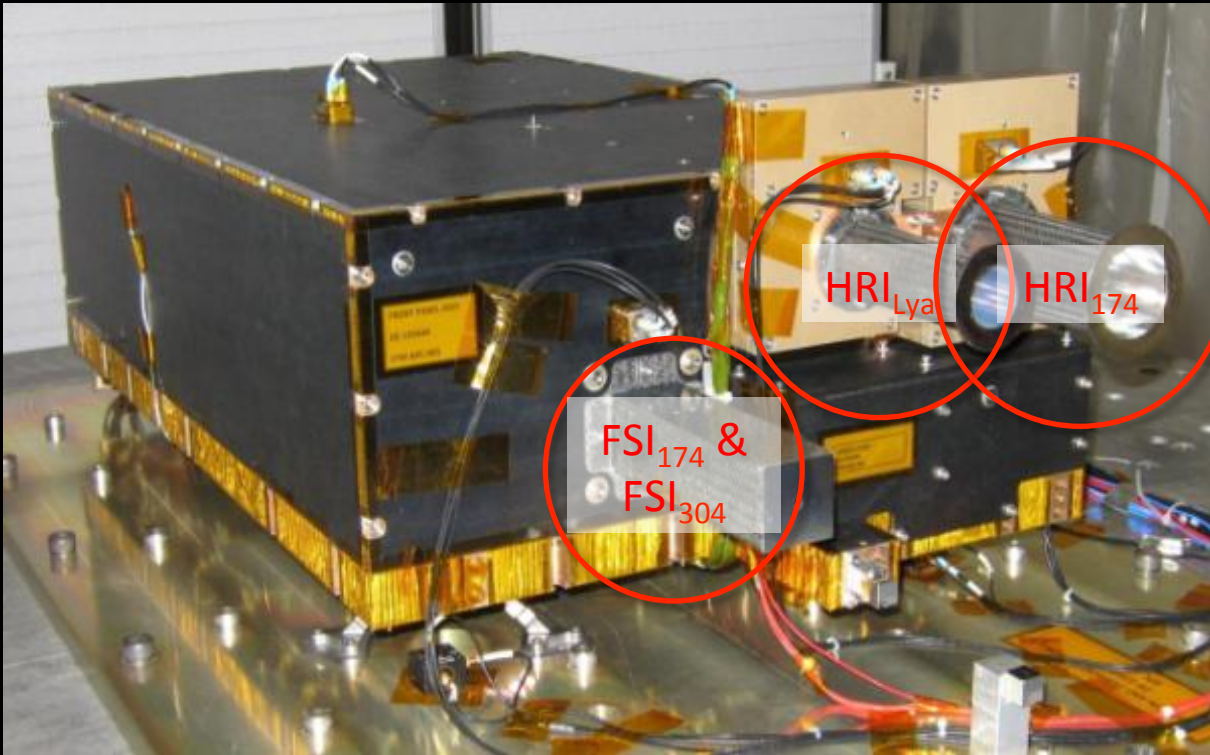
17.4 nm ~ 1MK



30.4 nm ~ 80 kK



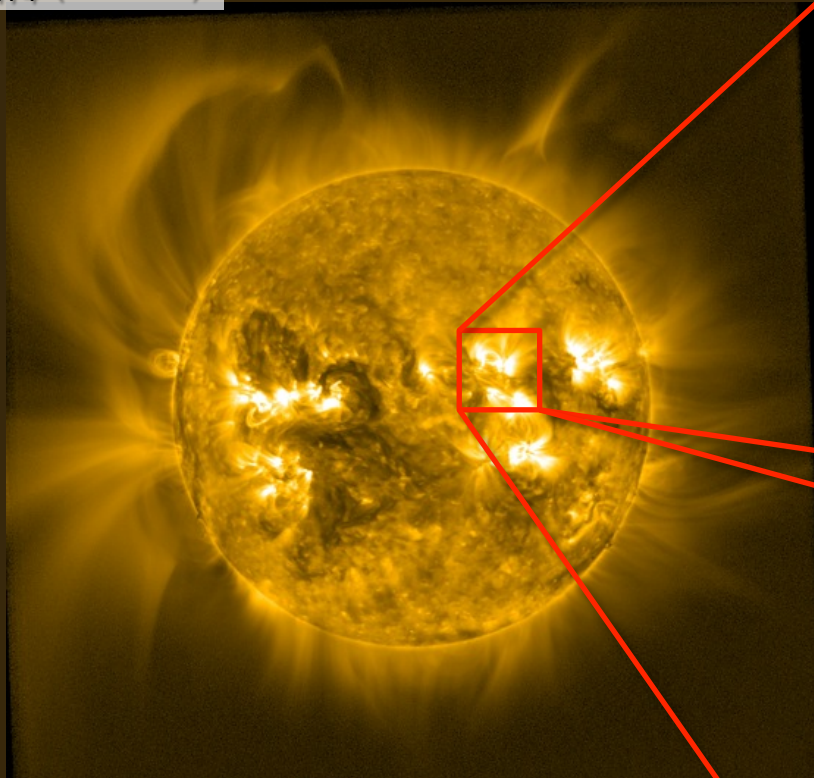
It's getting real



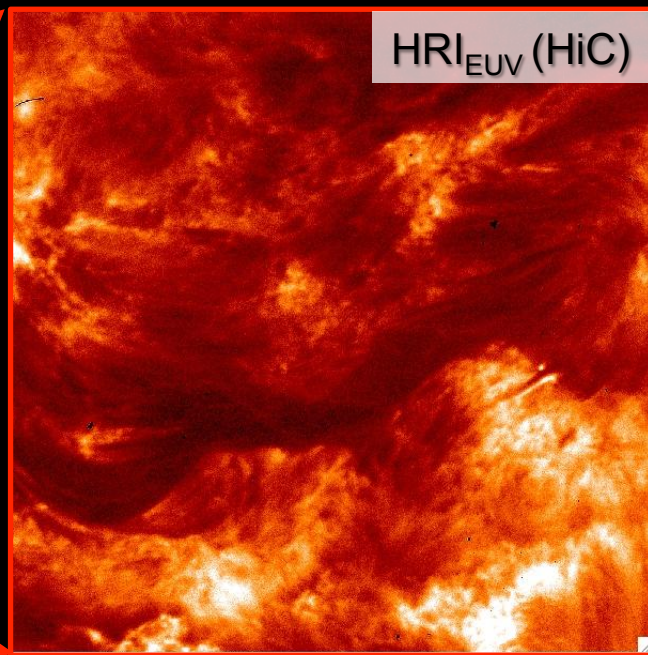


EUI @ perihelion

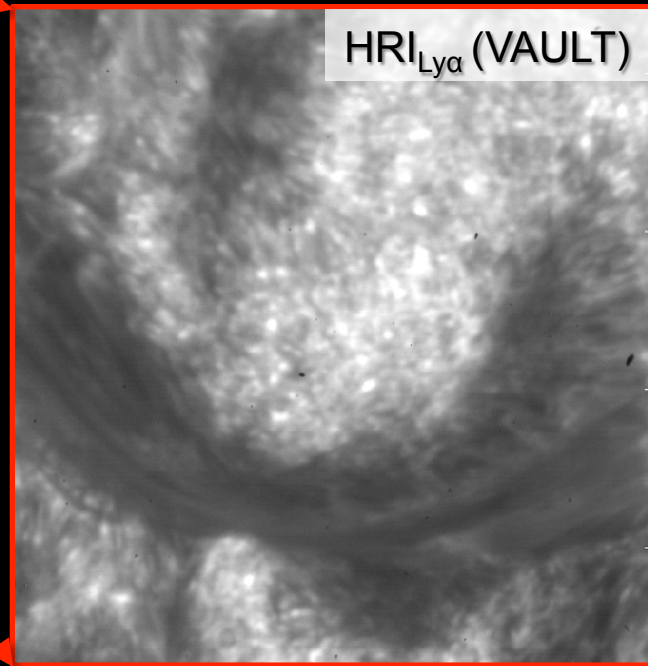
FSI₁₇₄ (SWAP)



HRI_{EUV} (HiC)



HRI_{Ly α} (VAULT)



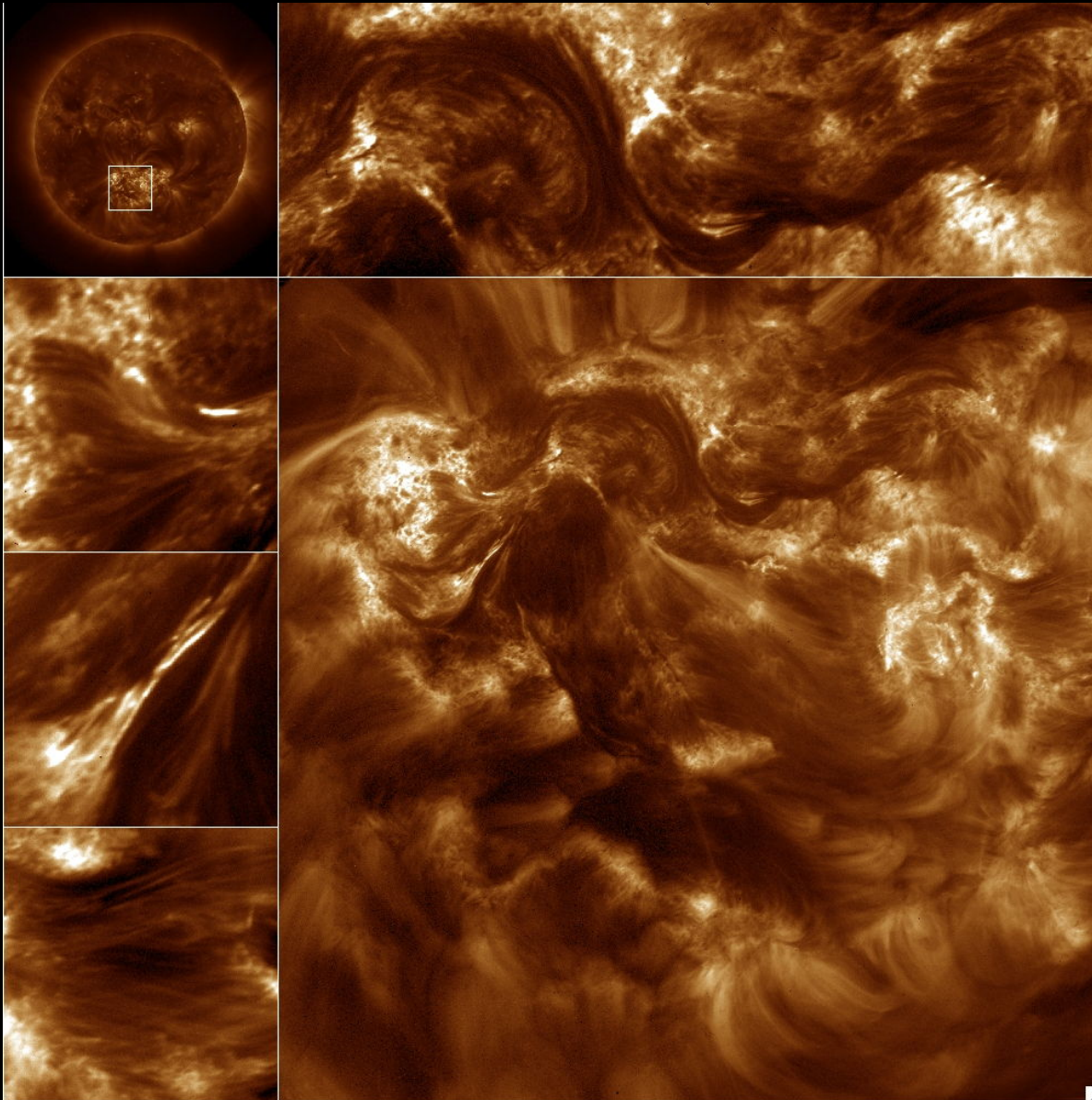
FSI: global morphology of the source regions
Active regions, coronal holes, CMEs, etc.

HRI: highest ever resolution UV images (200 km)
Fine scale structure, dynamics

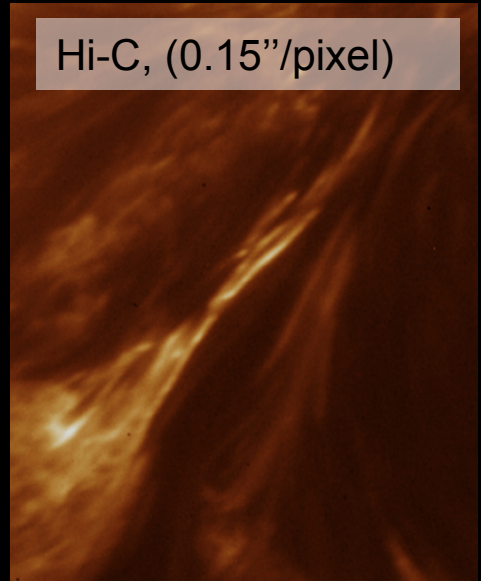


HRI: Extremely High Resolution

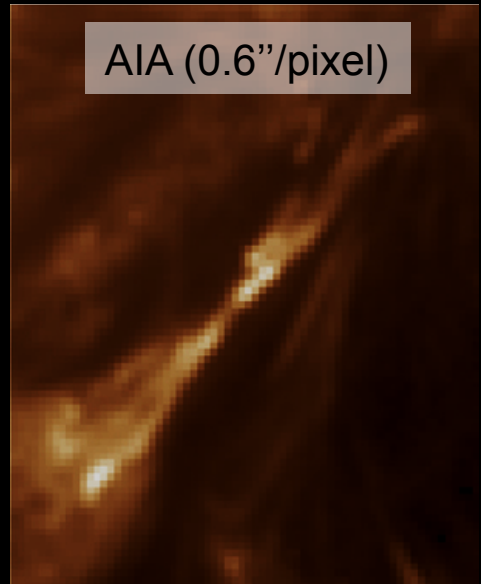
@ 0.28 A.U.: resolution = 100 km (0.14" / pixel equivalent @ 1 A.U.)



Hi-C, (0.15"/pixel)



AIA (0.6"/pixel)



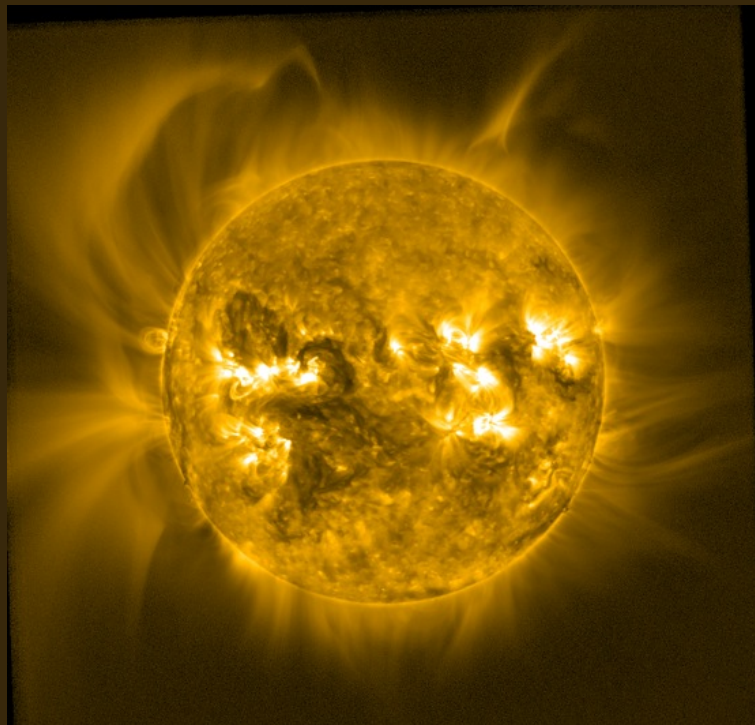


FSI: Extremely Wide Field of View

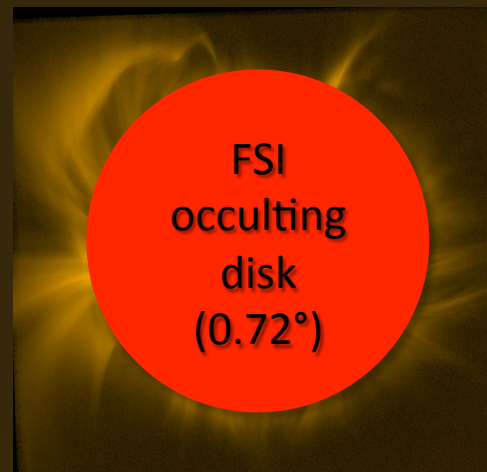
@ 0.28 A.U.

@ 0.43 A.U.

3.8°×3.8°



3.8°×3.8°



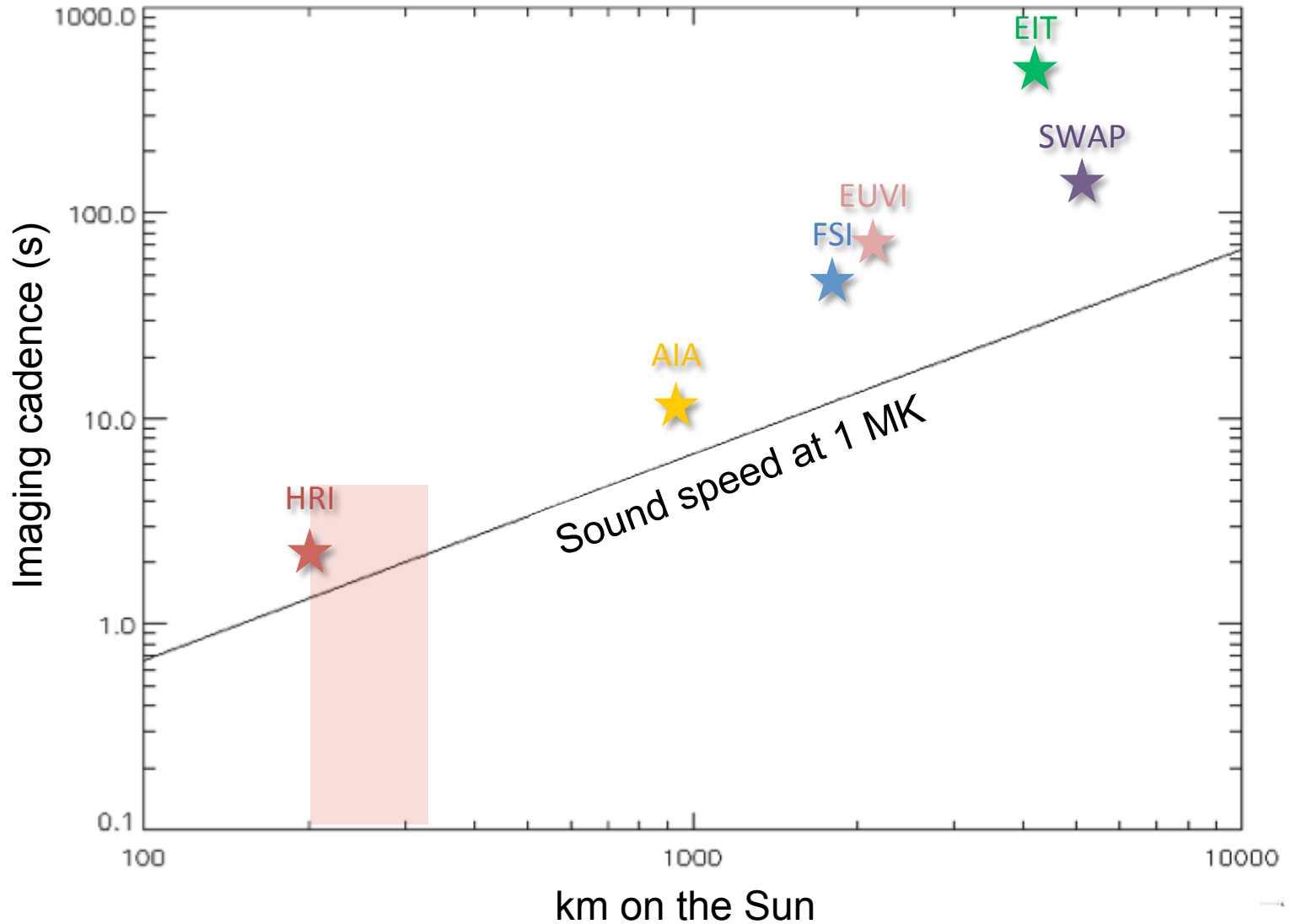
Terra

incognita

Occulter mounted on internal door: limited number of campaigns

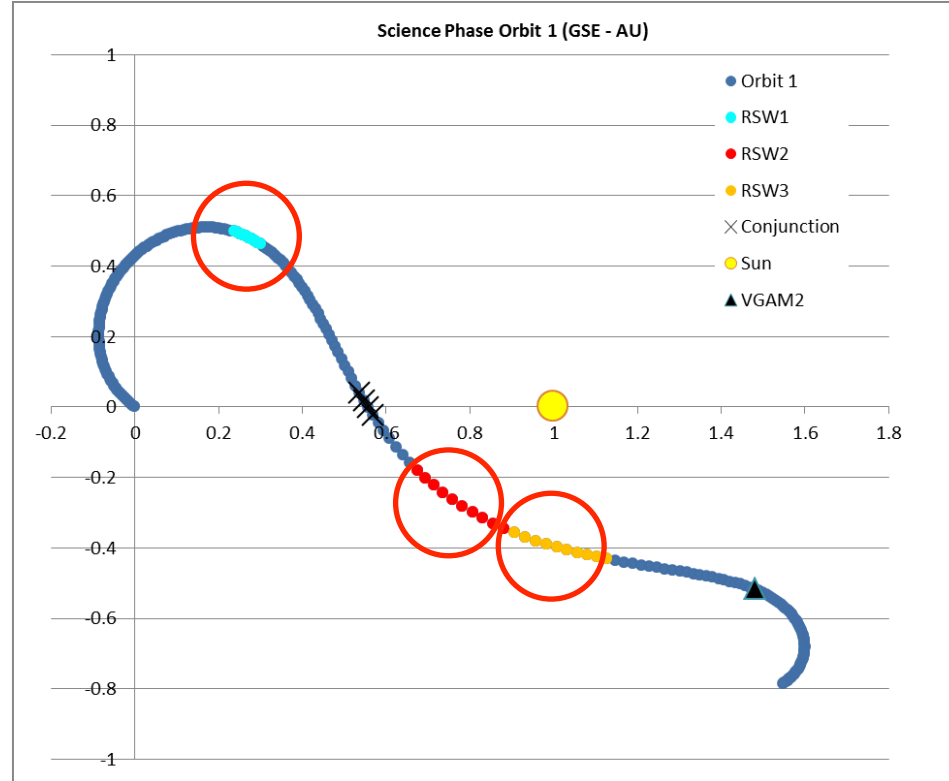


Cadence vs. Resolution





Specificity of RS operations



- EUI will observe only during the Remote Sensing Windows (~30 days / orbit)
- 50 Gbits TM allocation per orbit
- It can take up to 6 months (1 orbit) to get the data down



Typical Observing Programs

Science Program	Science Data Requirements	Channel	Cadence (sec)	Compression	TM (Gbits / h)
Synoptic	4 x 4 R _{sun} window centered on disc center	FSI ₁₇₄ FSI ₃₀₄	600	50	0.0075
Reference Synoptic	4 x 4 R _{sun} window centered on disc center	FSI ₁₇₄ FSI ₃₀₄	1day	4	0.0025
Global eruptive event	Full FOV centered on event.	FSI ₁₇₄ or FSI ₃₀₄	10	10	4.43
Coronal Hole	Full FOV centered on CH with boundary and/or plumes. High lat., perihel., possibly near co-rot.	HRI ₁₇₄ HRI _{Lyα}	30 30	5 15	1.75
Quiet Sun	Full FOV centered on QS. Perihelion/encounter, near co-rotation	HRI ₁₇₄ HRI _{Lyα}	8 1	7 15	16.6
Active region	Full FOV centered on AR. Perihelion/encounter, near co-rotation	HRI ₁₇₄ HRI _{Lyα}	2 1	15 15	19.7
Eruptive event	Perihelion/encounter, near co-rotation Full FOV	HRI ₁₇₄ HRI _{Lyα}	1 1	15 15	26.1
Discovery	High cadence dynamics Perihelion/encounter, near co-rotation, 645 x 645 FOV for Lyα	HRI ₁₇₄ HRI _{Lyα}	1 0.1	15 15	26.1



EUI is not EIT ... and certainly not AIA

4x higher resolution and cadence than AIA ... but

- Bandwidth is 3.66 kb/s over the full orbit (55Mbits/s for AIA, i.e. $\times 15000$)
- Total EUI archive (whole mission) ~ 50 GB ...
- EUI can produce $> 10^5$ more data than it can transmit

EUI has developed power compression capability and data selection algorithms, but

- EUI can only observe 1% of the Orbiter duty cycle
- EUI can only support high resolution imaging for a few hours per orbit
- HRI has a slim chance of catching an eruption during the entire mission
- FSI “CME watch” cadence is only about 10 minutes and heavily compressed
- etc.



Low latency data

No (very little) real time data

- It can take up to 6 months (1 orbit) to get the data down
- But need near real time images for
 1. Planning purposes (i.e retargeting)
 2. Verify instrument performances
 3. Selective data downlink

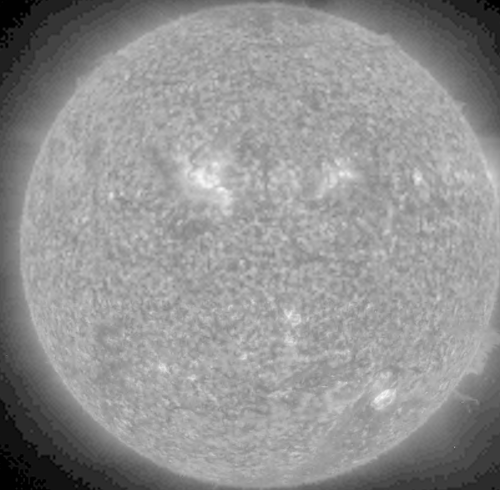
Low latency data concept

- Dedicated packet store (~hard drive partition) in the S/C SSSM
- High priority, part of the daily TM dump

Beacon data	Low-resolution (high compression) FSI ₁₇₄ & FSI ₃₀₄ images	~30 minutes	Max. 1.5 MBytes / day
Synoptic data	High quality, But low cadence, FSI ₁₇₄ & FSI ₃₀₄ images	1 set /day	
Sample HRI data	EUV & Ly α	1 set / day	



FSI beacon @ 0.0625 bpp (x192)



Same thing all along the orbit ?
(Support for IS instruments)

EUI flags & selective data downlink



EUI in high cadence mode

Activity detector

More than N 32x32 macropixels > tresh in more than M running difference images (30 min)

EUI burst flag
(171 or 304)

Freeze circular buffer
(16 Gbits ~ 1 RSW)

Broadcast EUI flag
over service 20

Other instruments react as
planned in current SOOP
(e.g. freeze circular buffer)

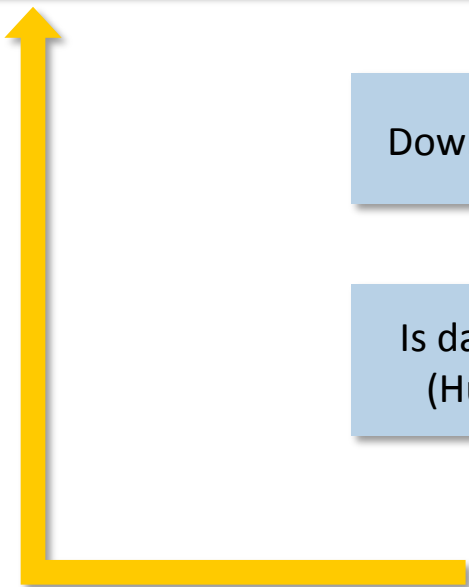
Download EUI beacon

Is data good or not ?
(Human decision)

Yes

No

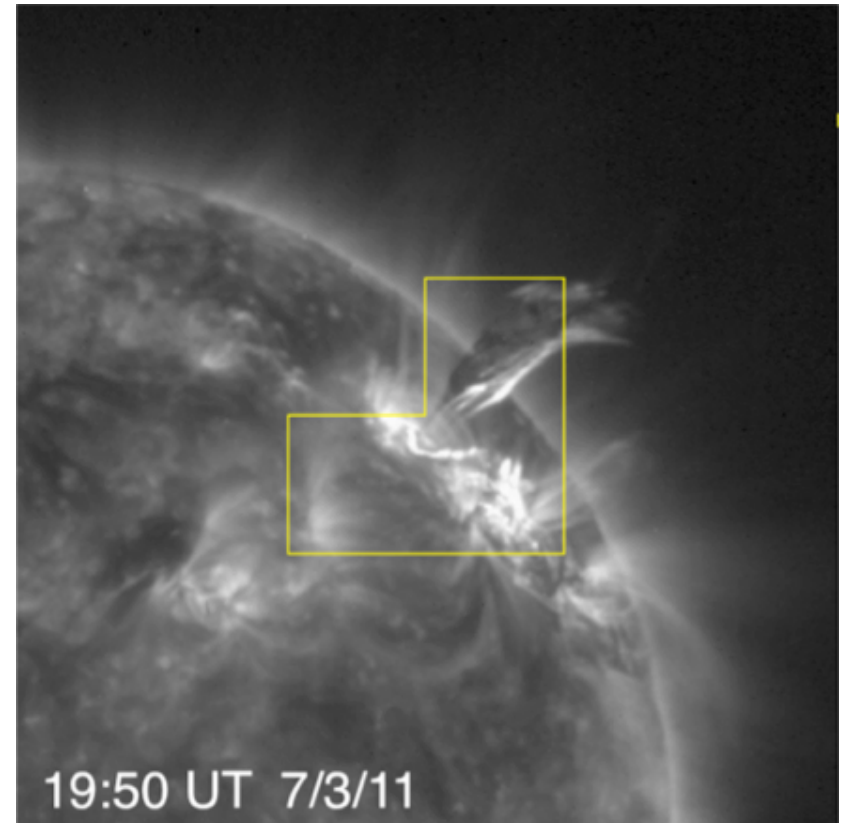
Send EUI data to S/C





EUI on-board event detection

- Runs (continuously) on FSI₁₇₄ & FSI₃₀₄ images
 - 10 minutes running differences
 - Macro-pixels
- 'Activity' detector will trigger on
 - Flares (174 & 304 on-disk)
 - CMEs (174 off-disk)
 - Filament eruptions (304 off disk)
 - Stuff ...



EUI service 20 content



Bit	Field	Description	
0	SID	(1 byte)	
1-4	Heartbeat	OBT Coarse Time Field (4 bytes)	
5-8	Seconds174Event	Time of occurrence last 174 event (Absolute OBT of detection)	
9	0	Spare	Undefined
	1	Spare	Undefined
	2	Spare	Undefined
	3	MechanismMove	Flag (1=moving) spanning a few seconds before and after
	4	FSI174FlareCloseHRI	(1/0)
	5	FSI174FlareDataGround	(1/0)
6-7	FSI174FlareTrigPos	2 bits + 8 more below	
10	0-7	FSI174FlareTrigPos	8 bits, see also last 2 bits of previous byte First 5 bits: signed. Unit: arcmins. SC Z offset component of source from SC +X (equiv to -ve rotn around SC +Y) Last 5 bits: signed. Unit: arcmins. SC Y offset component of source from SC +X (equiv to +ve rotn around SC +Z)
11-12	FSI174Brightness	(2 bytes)	
13-16	Seconds304Event	(4 bytes) (absolute OBT of detection)	
17	0	Spare	Undefined
	1	Spare	Undefined
	2	Spare	Undefined
	3	Spare	Undefined
	4	FSI304OffLimb	1/0 (1: off-limb)
	5	FSI304FlareDataGround	(0/1)
6-7	FSI304FlareTrigPos	2 bits + 8 more below	
18	0-7	FSI304FlareTrigPos	8 bits, see also last 2 bits of previous byte First 5 bits: signed. Unit: arcmins. SC Z offset component of source from SC +X (equiv to -ve rotn around SC +Y) Last 5 bits: signed. Unit: arcmins. SC Y offset component of source from SC +X (equiv to +ve rotn around SC +Z)
19-20	FSI304Brightness	(2 bytes)	
21-23	Spare	Undefined	



FITS files

- 1 image per file
- Header details TBD (similar to SECCHI)
- Level 0 (raw) + Level 1 (calibrated)

- $\text{HRI}_{\text{Ly}\alpha}$ & HRI_{EUV}
 - 2048 x 2048 max (subfields possible)
 - 17' x 17' FOV (full frame)

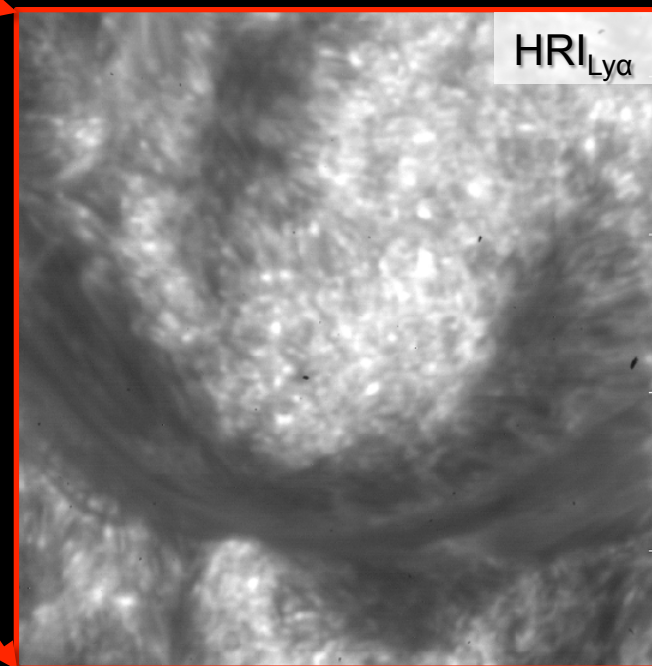
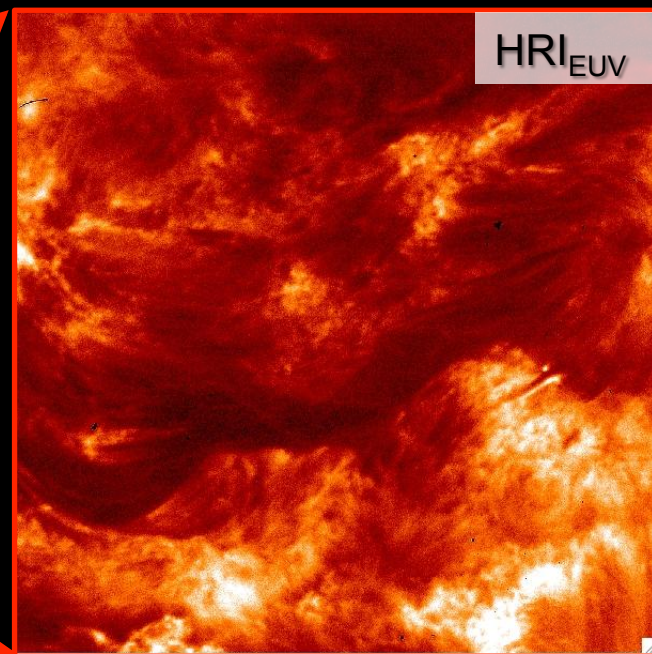
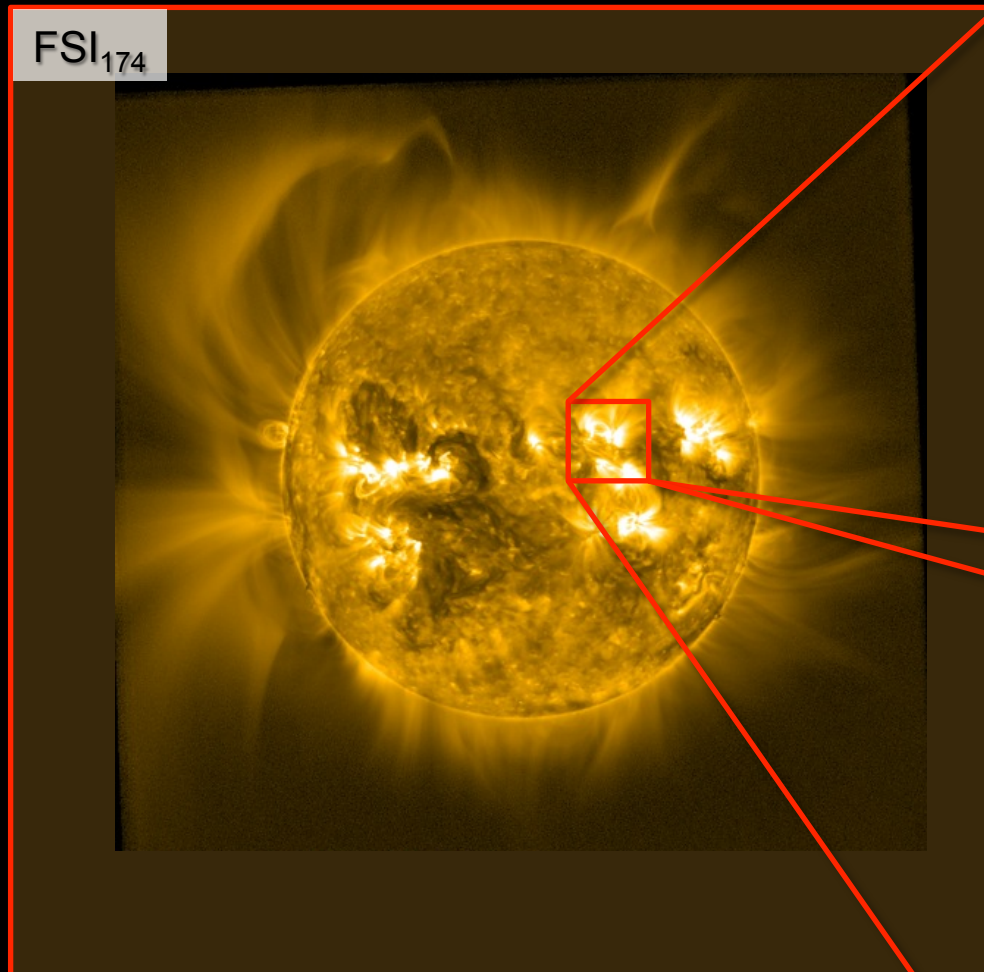
- FSI_{174} & FSI_{304}
 - 3072 x 3072 max (subfields possible)
 - 3.8° x 3.8° FOV (full frame)
 - Occulting disk mode (0.72° cutoff)

Other products

- Calibration software (L0 → L1)
 - SSW (IDL), Python TBD
- Higher level data TBD



EUI & connection science

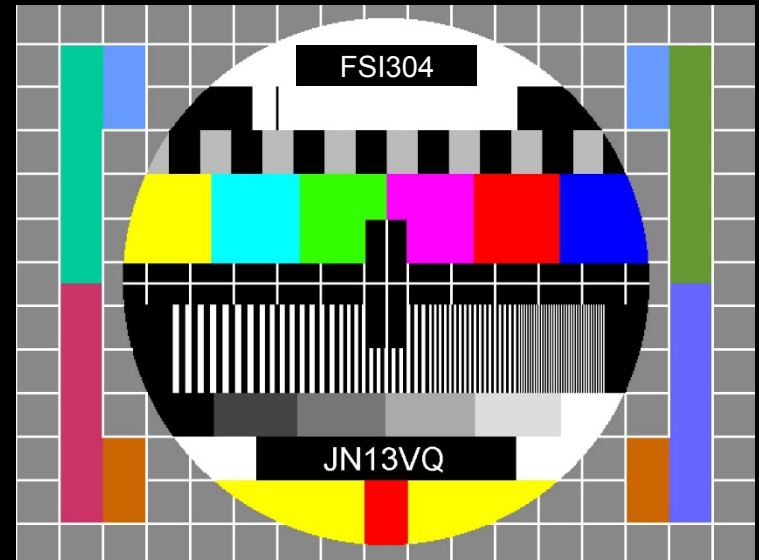
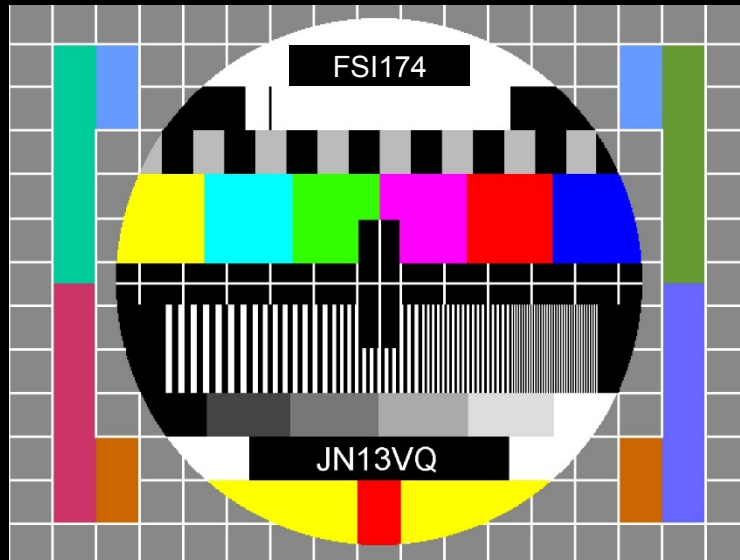


FSI: type & global morphology of source regions
Active regions, coronal holes, flares, filaments, CMEs, etc.

HRI: fine scale structure & dynamics



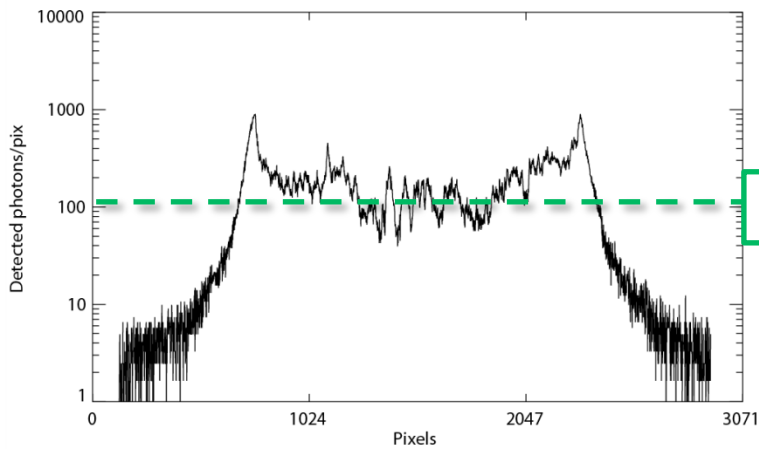
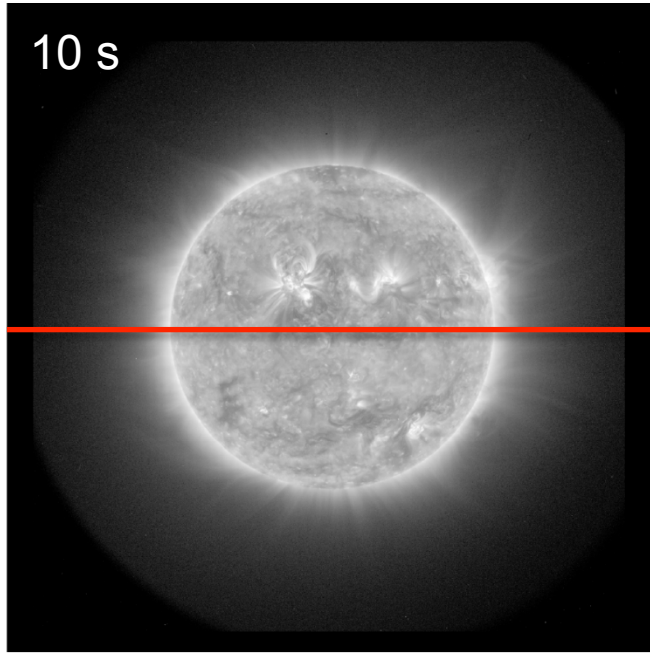
FSI beacon all along the orbit ... or not



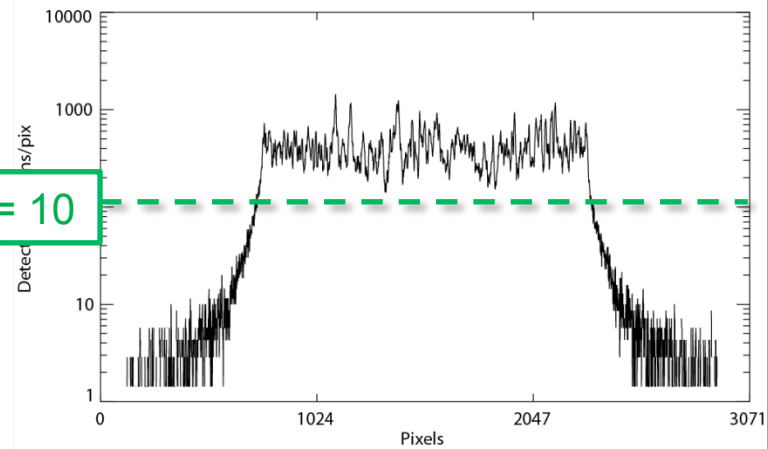
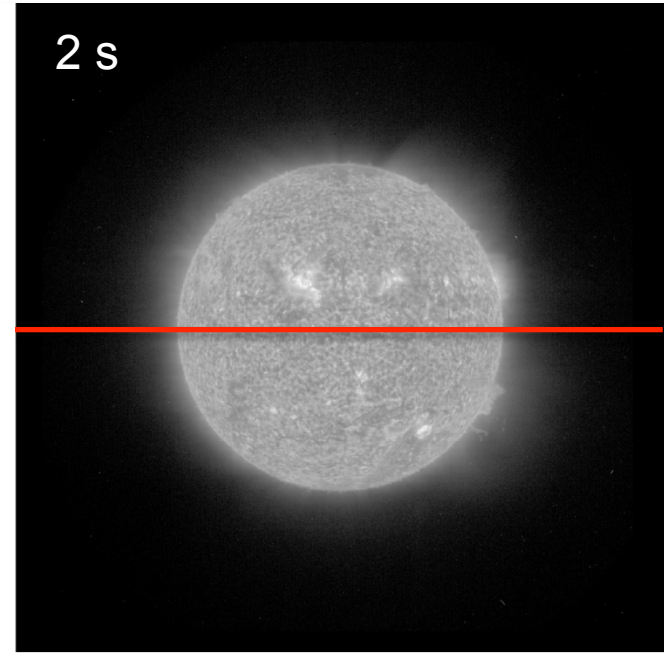


Expected count rates: FSI

174



304

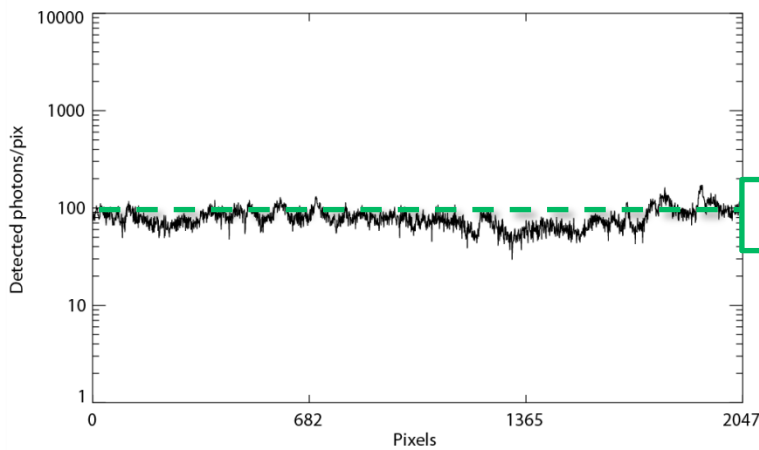
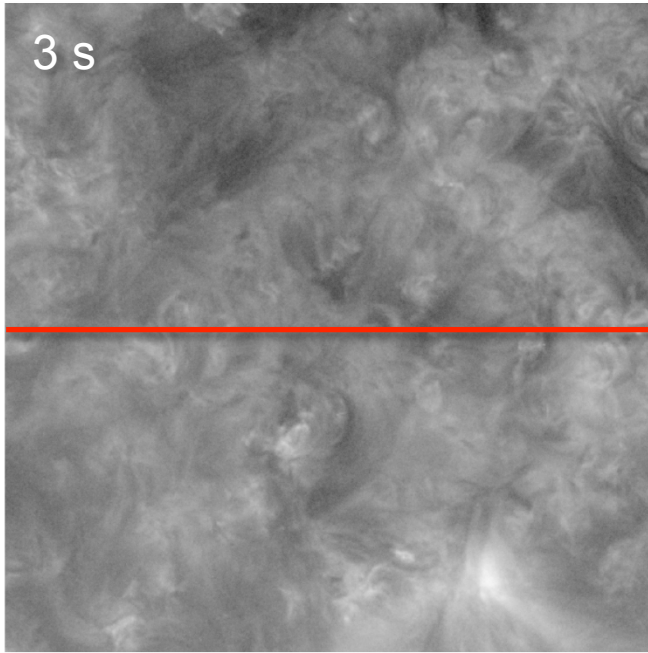


SNR = 10

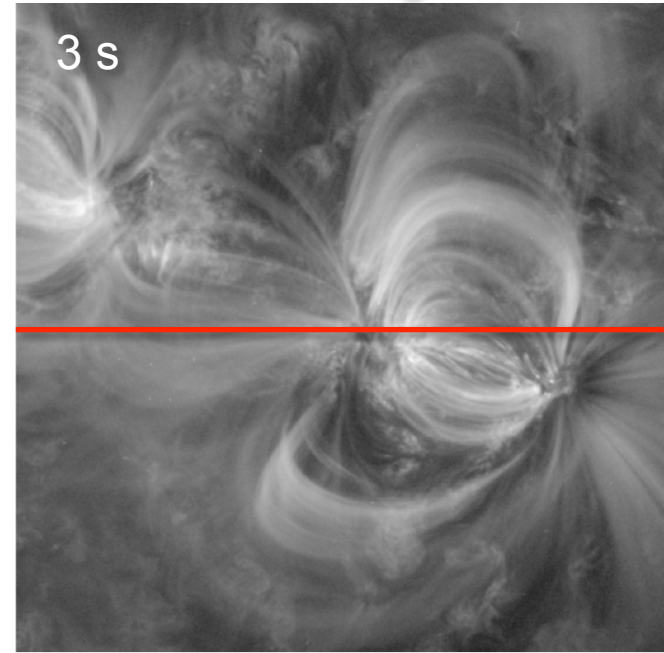


Expected count rates: HRI₁₇₄

Quiet Sun



Active Region



SNR = 10

