

# STIX flare observations

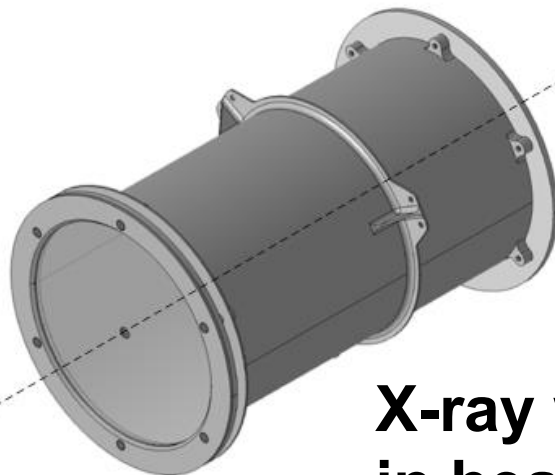
Säm Krucker (FHNW/UCB) and the STIX team



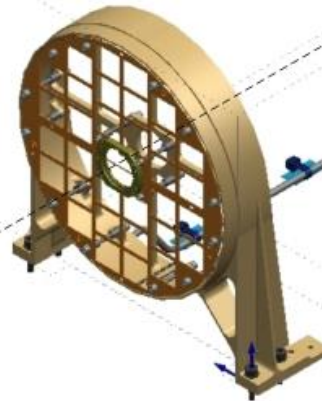
University of Applied Sciences  
Northwestern Switzerland



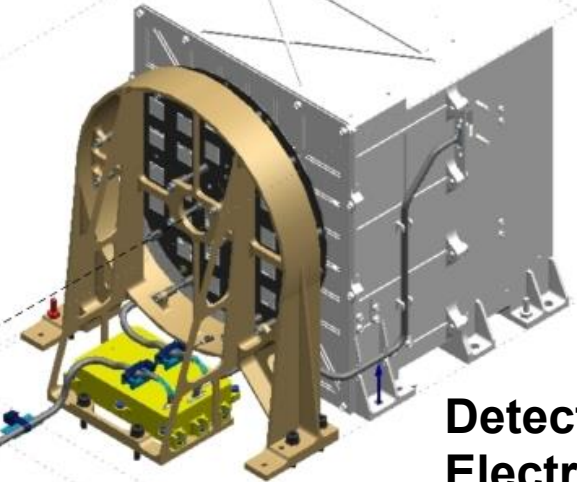
LESIA



**X-ray window  
in heatshield**



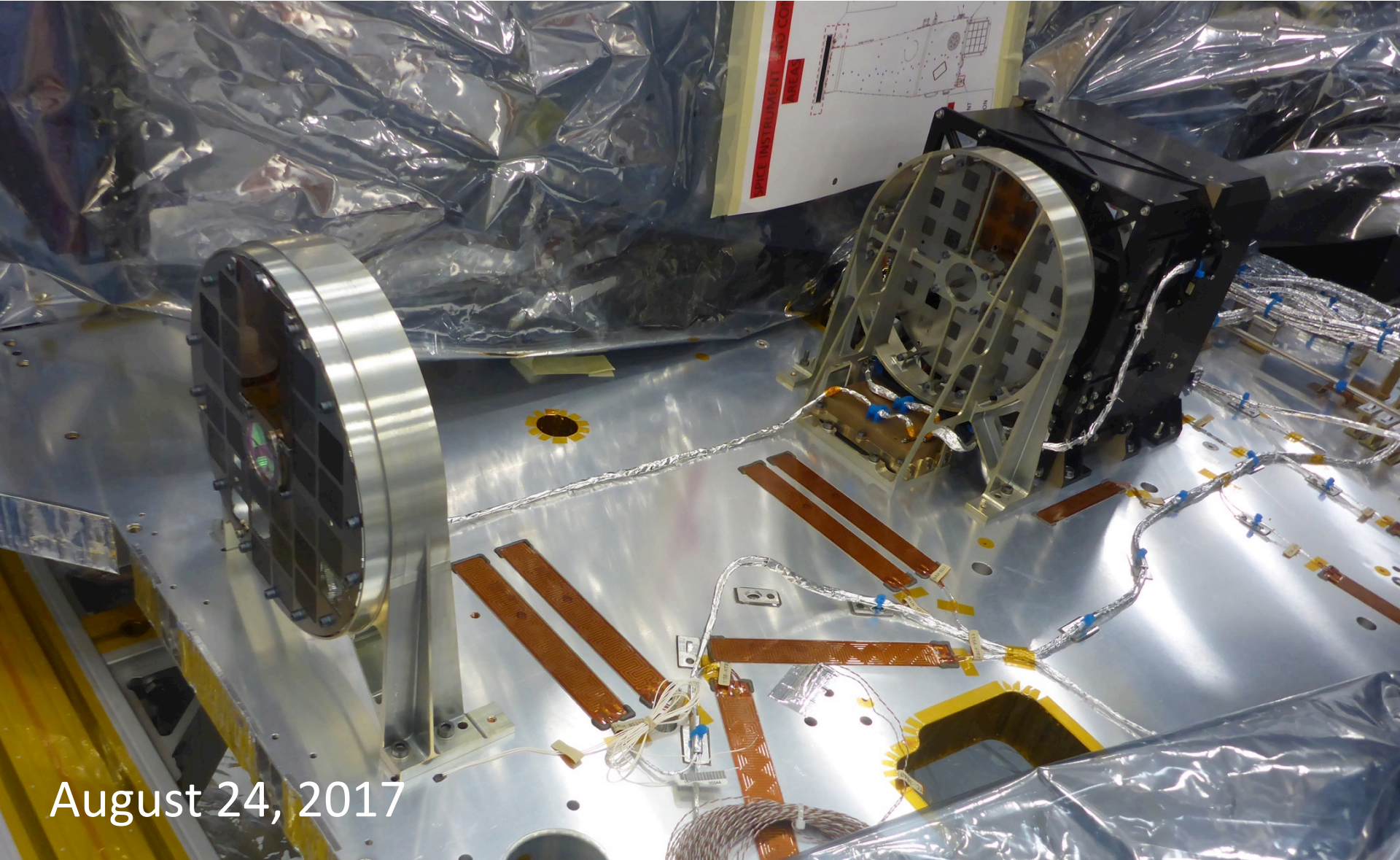
**STIX imager  
(‘grids’)**



**Detector  
Electronics  
Module**

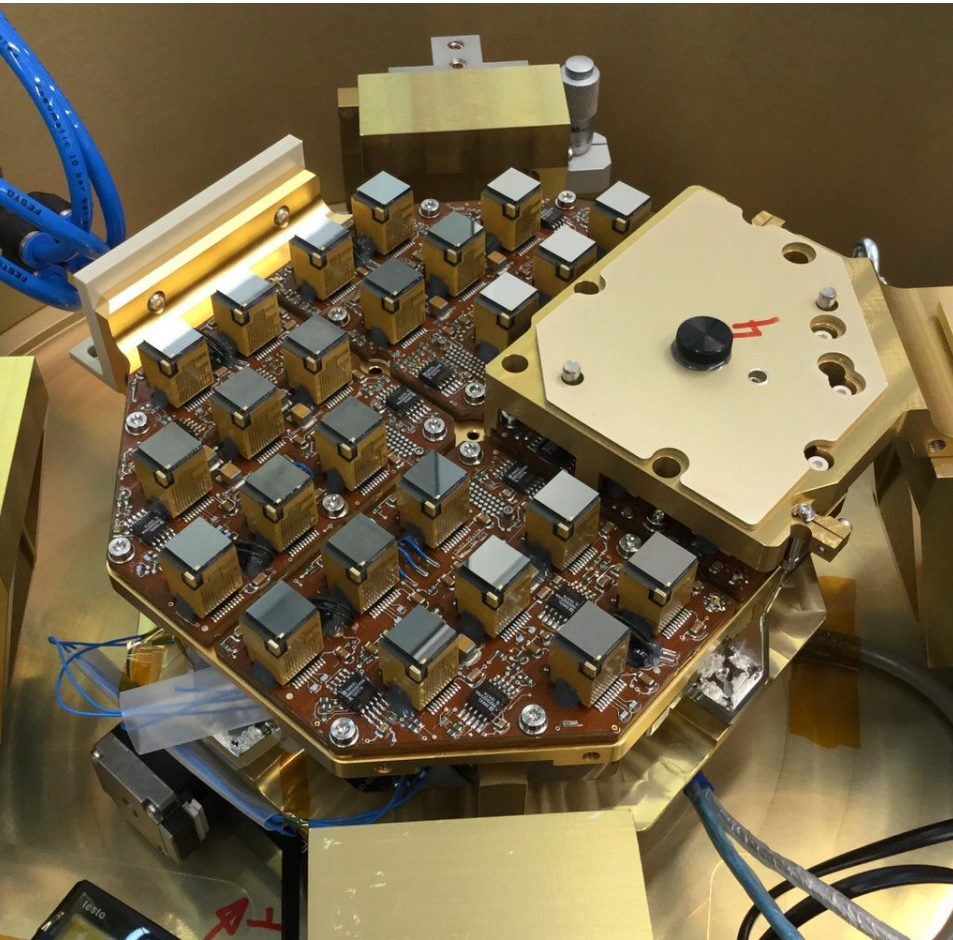
STIX investigates solar flares by providing diagnostics of the hottest ( $>8$  MK) flare plasmas and flare-accelerated electron above ( $>10$  keV).

# STIX integrated on spacecraft panel

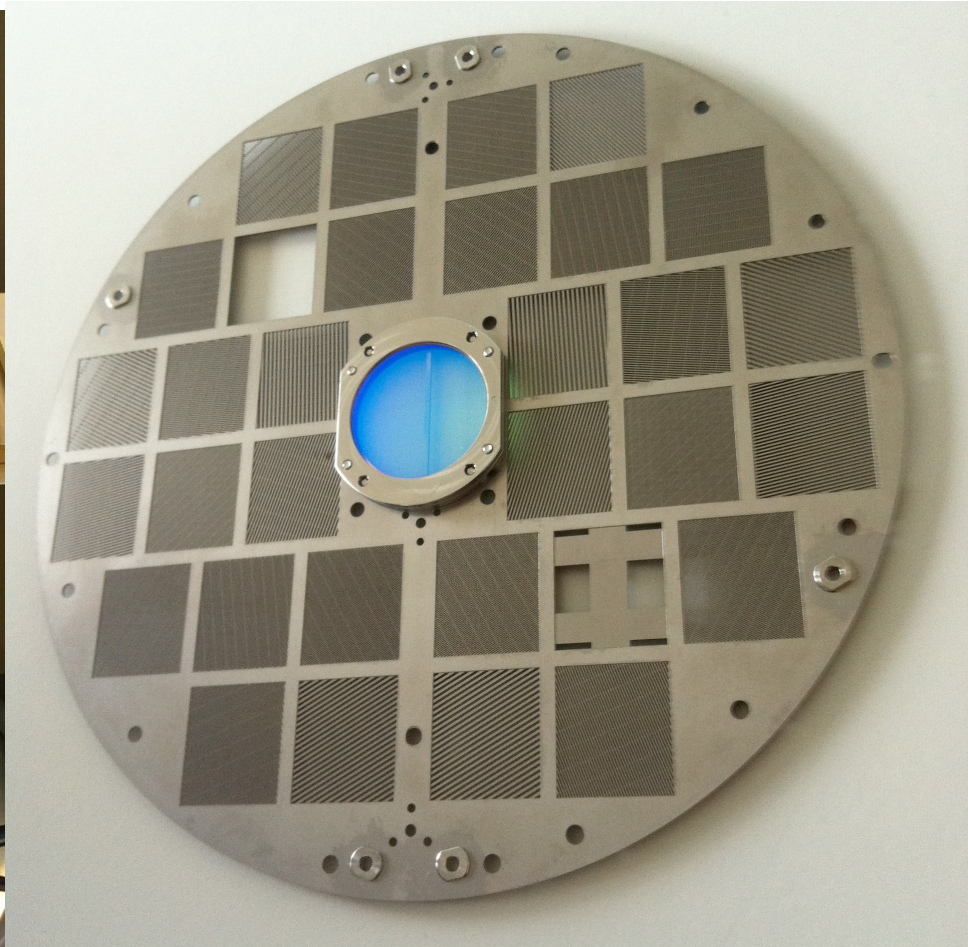


August 24, 2017

# STIX indirect imaging system

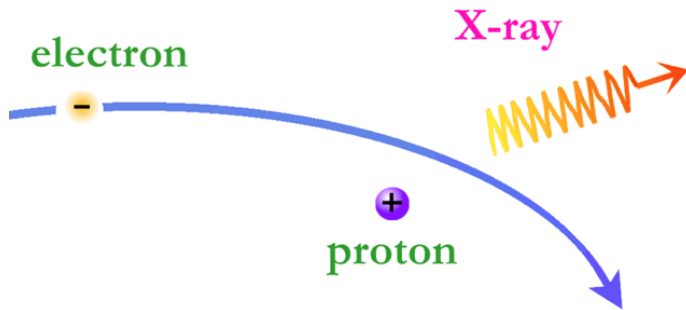


STIX detectors  
CEA, France

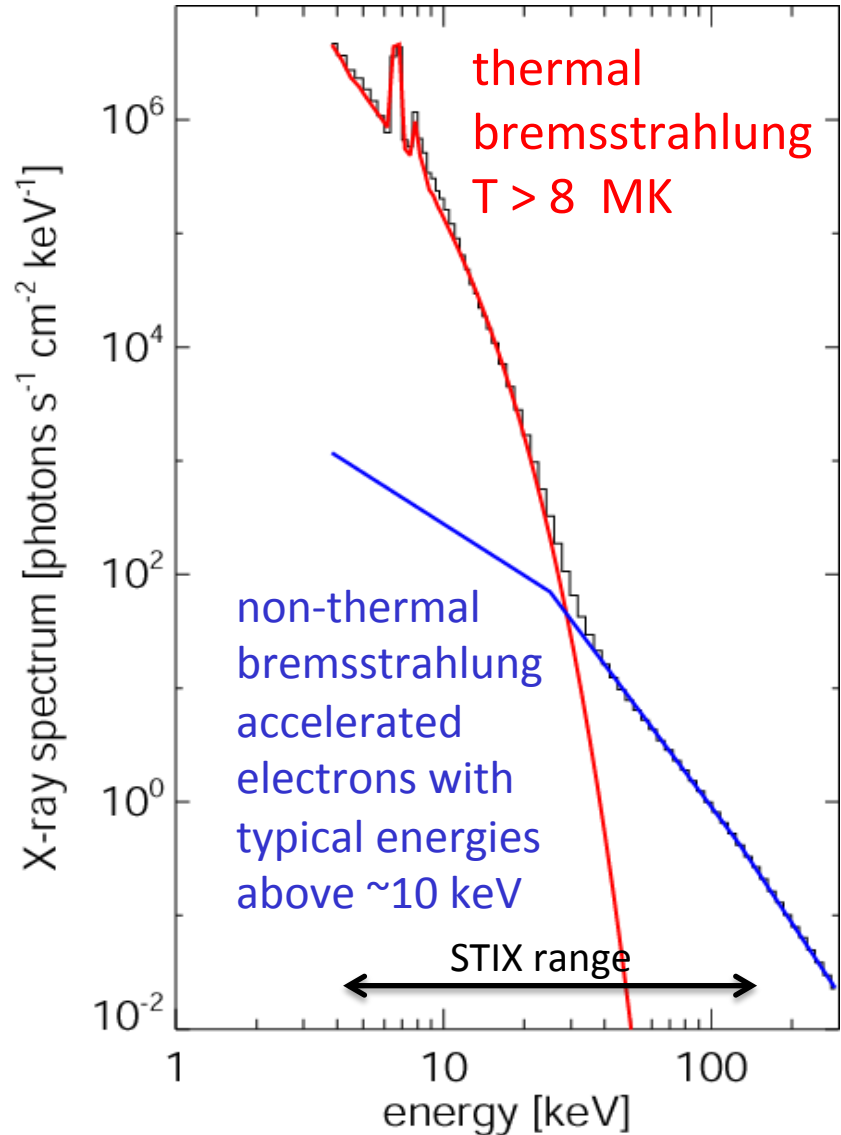
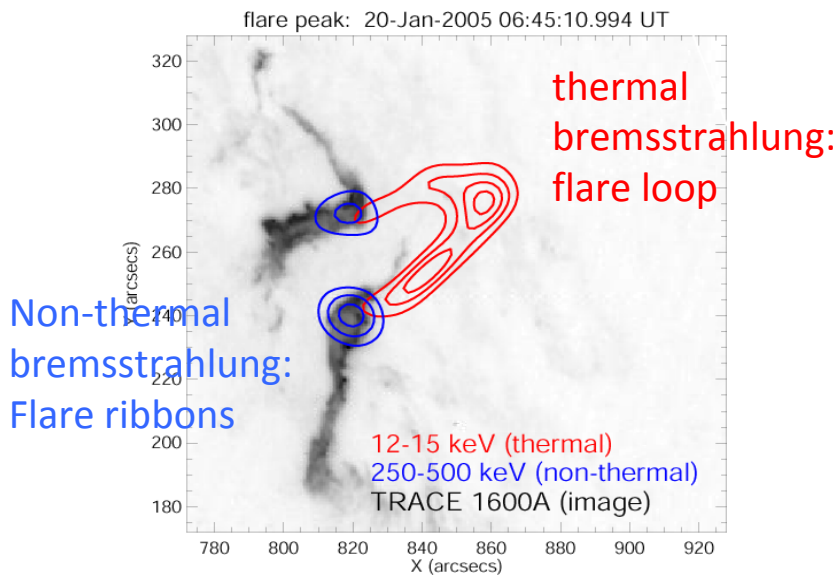


STIX tungsten grid

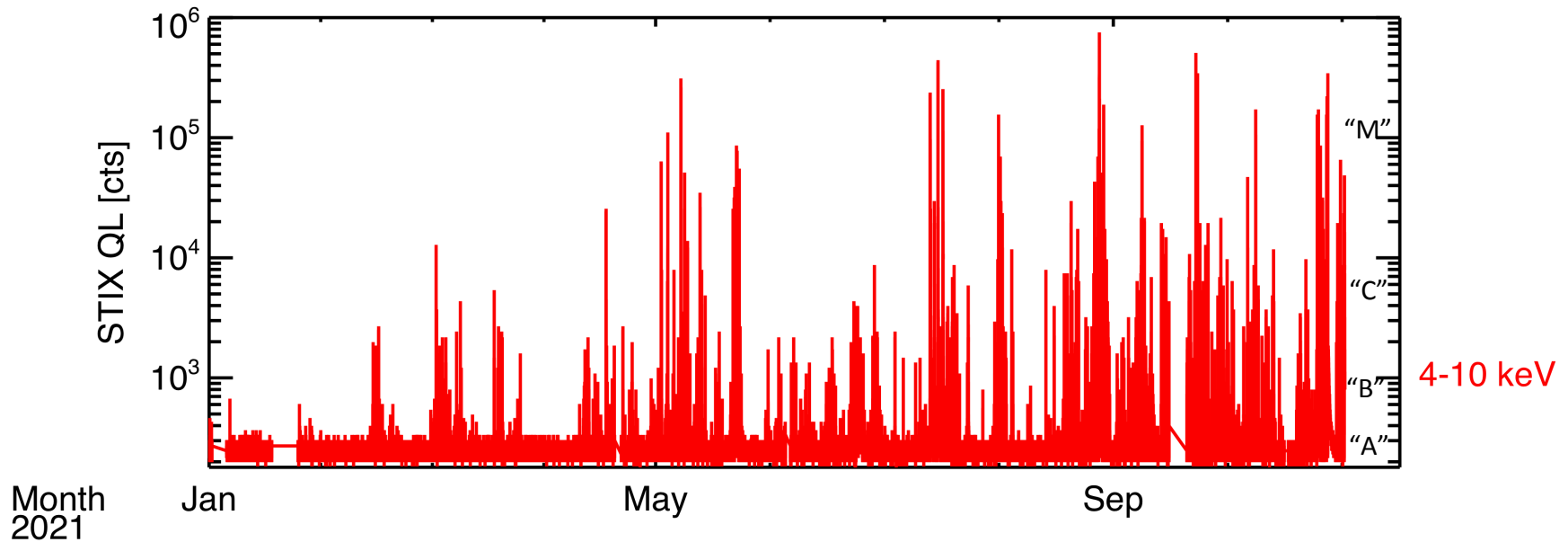
# Hard X-ray diagnostics



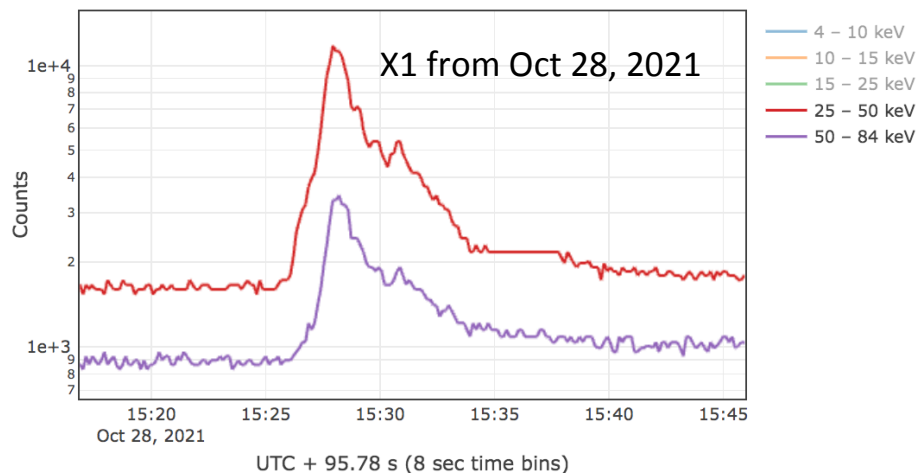
Bremsstrahlung  
plus a few lines (Fe/Ni)



# STIX has been operational almost continuously in 2021



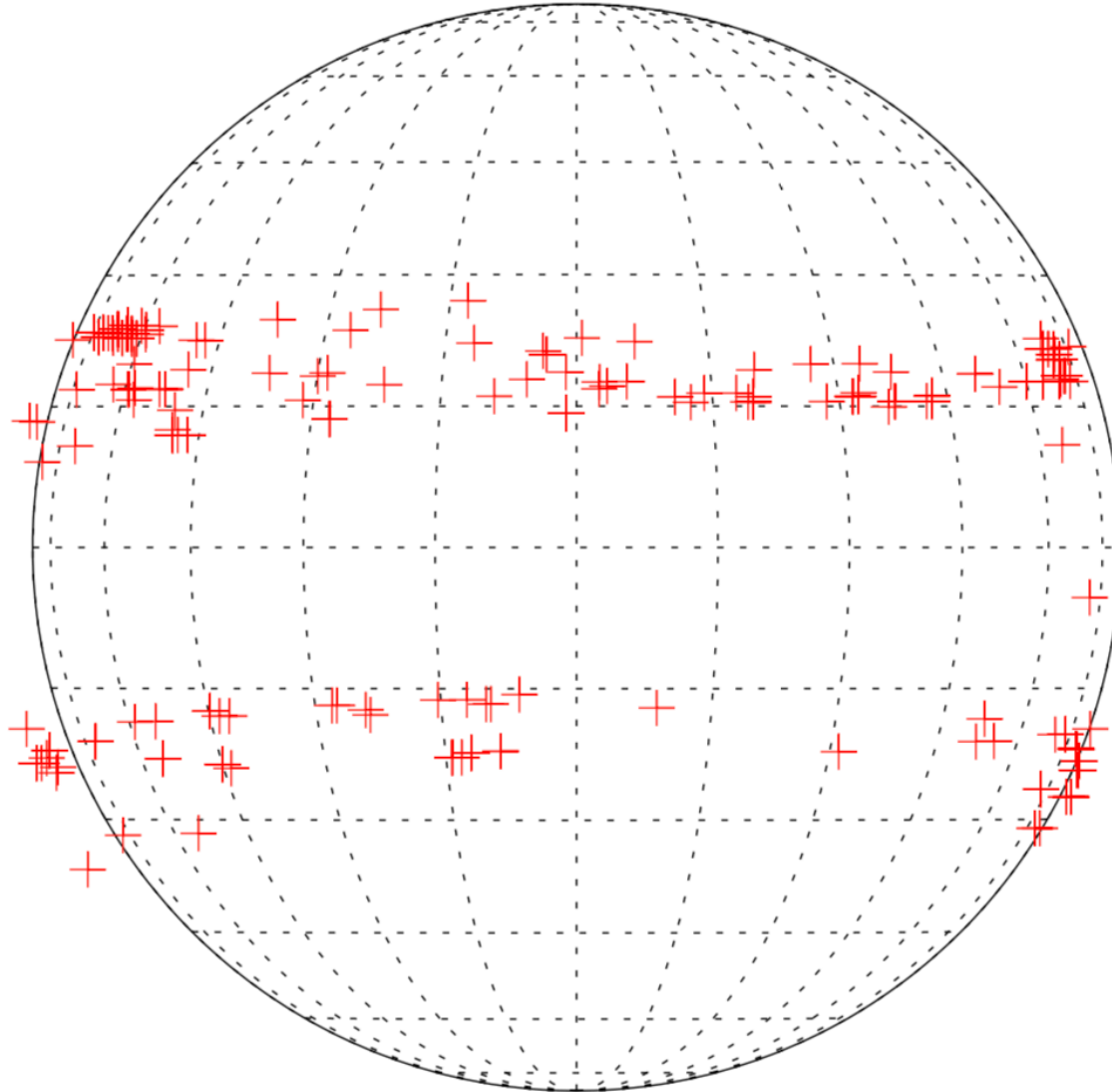
STIX Quick-look Light Curves

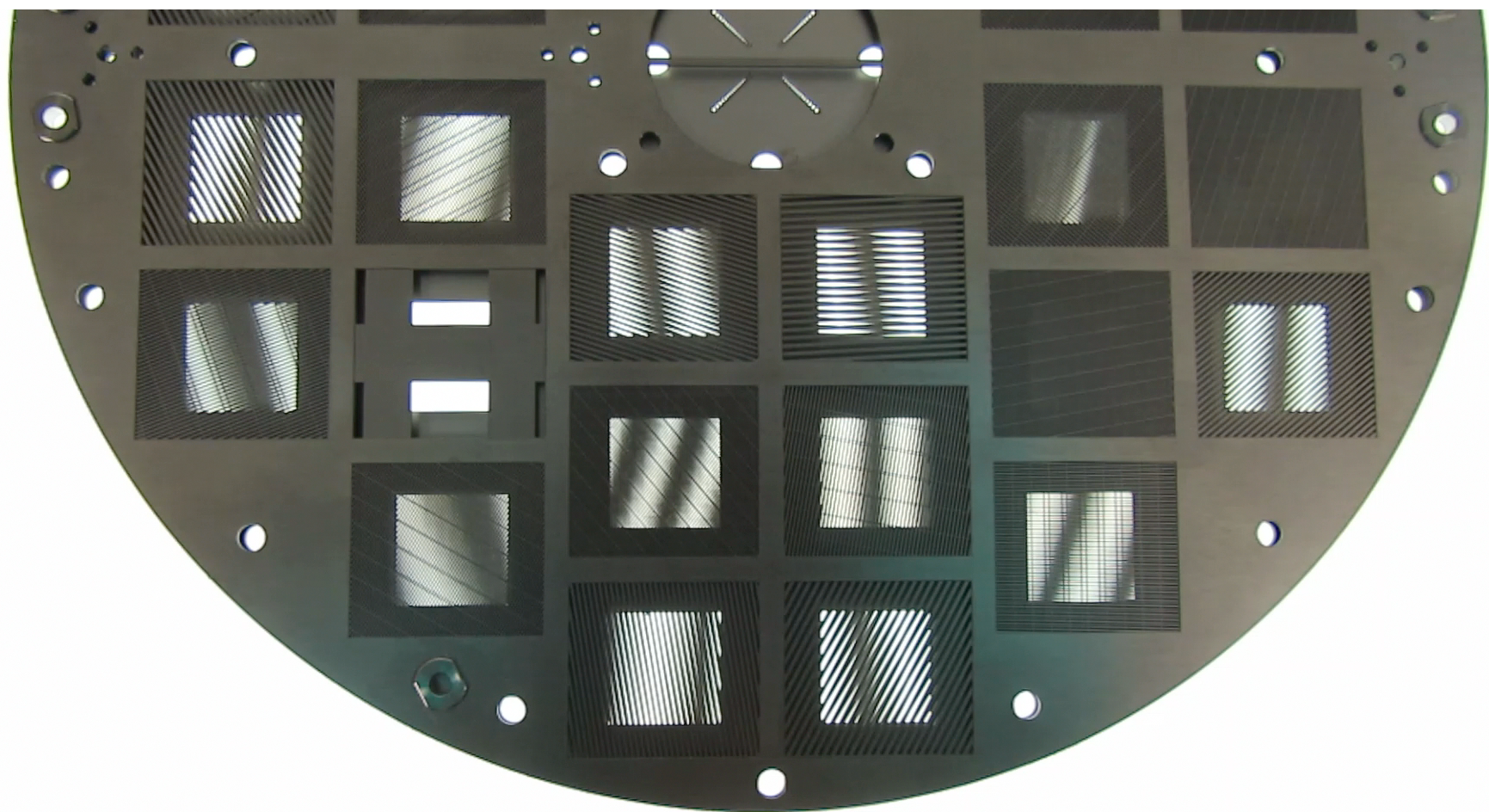


## STIX operation mode:

- only quicklooks are send down automatically
- Quicklooks are used to select flares
- data requests are send to STIX weekly
- Internal STIX memory holds ~6 months worth of data

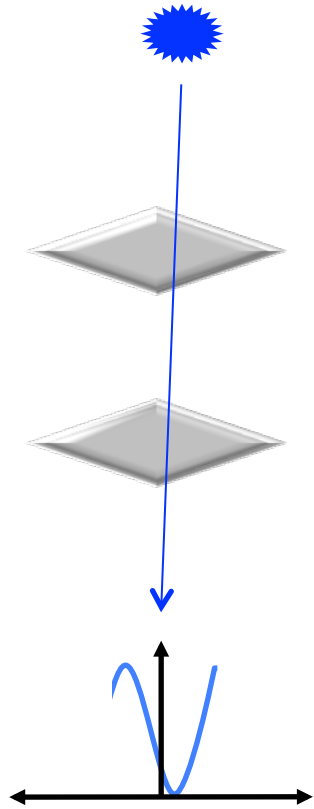
# Location of STIX flares in 2021 (264 events)





# STIX indirect imaging

X-ray source

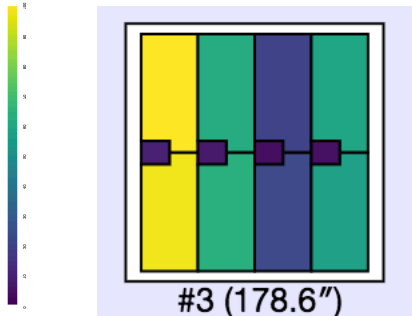


Pitch of grids  
→ Separation of strips

Orientation of grids  
→ Orientation of strips

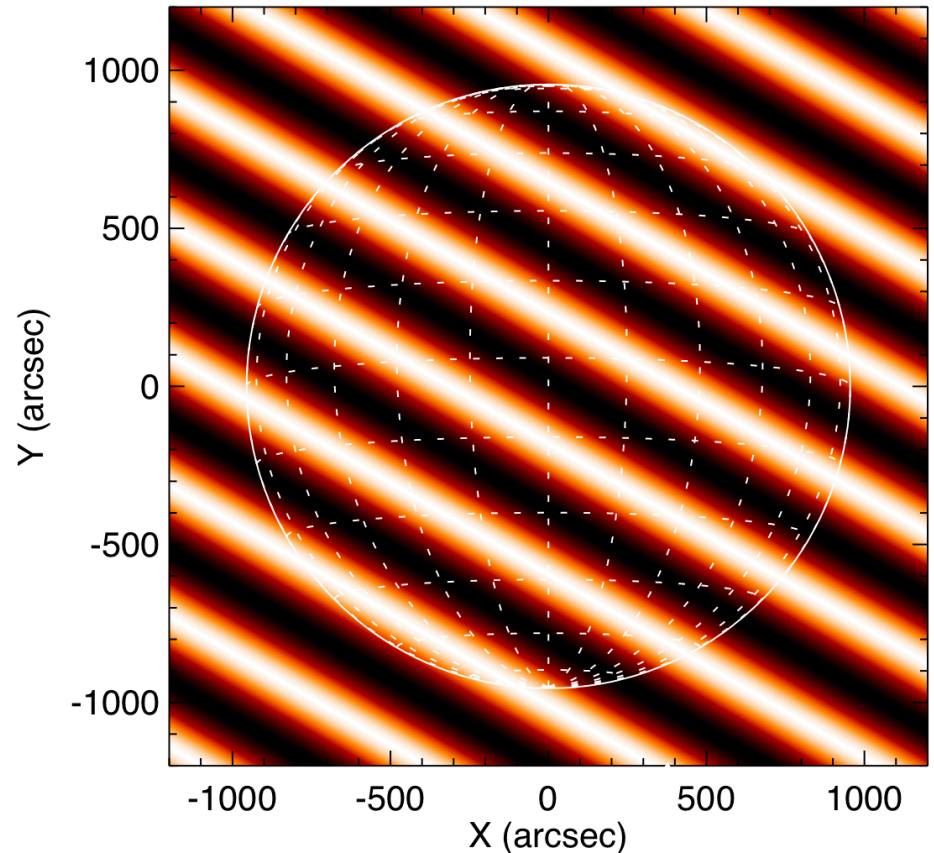
Relative phase of grids  
→ Location of strips

Grids produce  
moiré pattern on  
detectors



Observed moiré  
pattern:  
Counts in detector  
associated with  
subcollimator 10a

subcollimator 10a

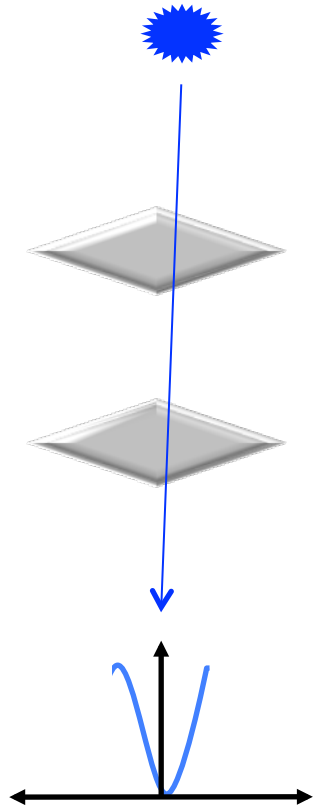


STIX 'image' from single  
subcollimator (grids-detector pair)



# STIX indirect imaging

X-ray source



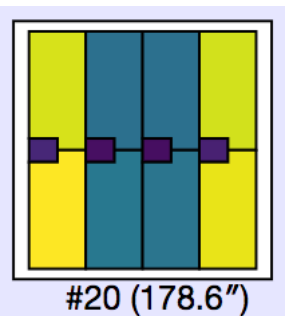
Pitch of grids  
→ Separation of strips

Orientation of grids  
→ Orientation of strips

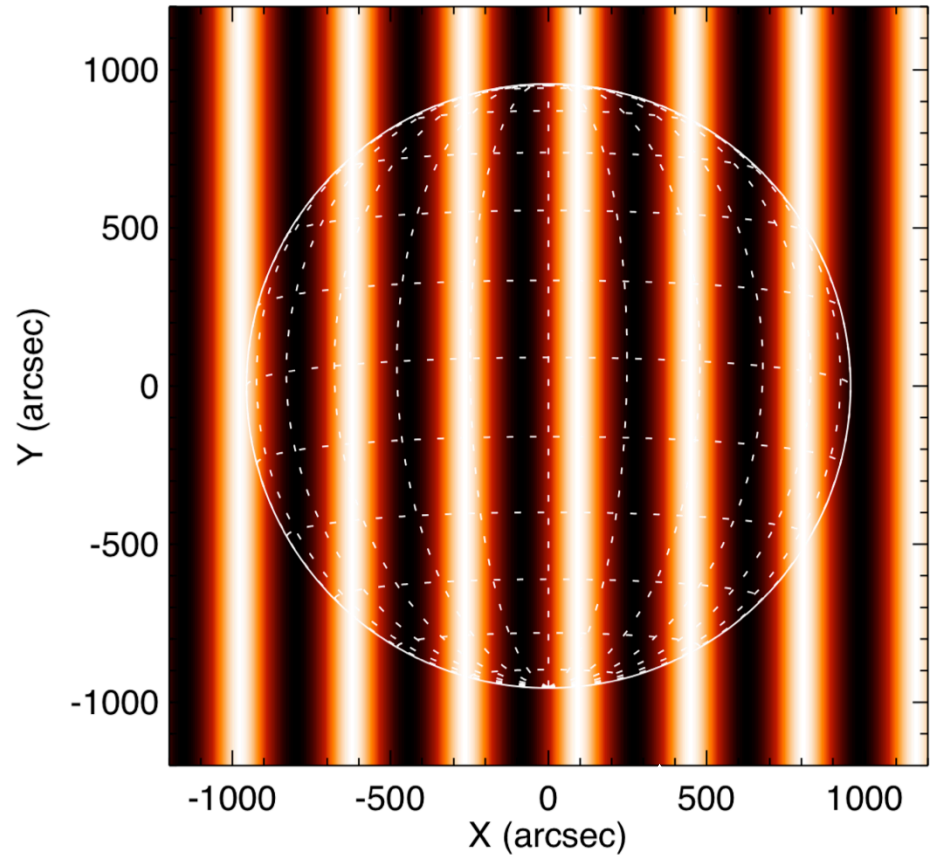
Relative phase of grids  
→ Location of strips

Grids produce  
moiré pattern on  
detectors

Observed moiré  
pattern:  
Counts in detector  
associated with  
subcollimator 10a



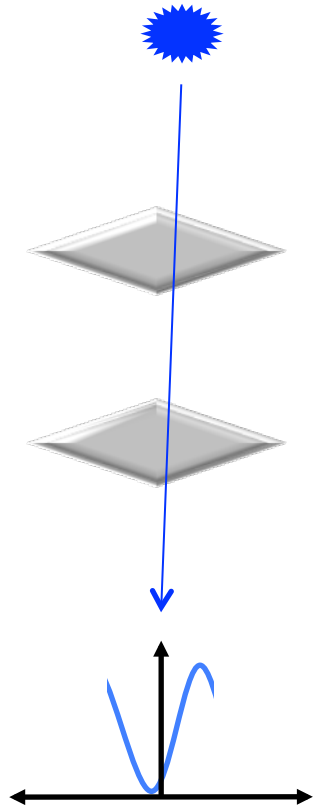
subcollimator 10b



Same resolution  
different orientation

# STIX indirect imaging

X-ray source



Pitch of grids  
→ Separation of strips

Orientation of grids  
→ Orientation of strips

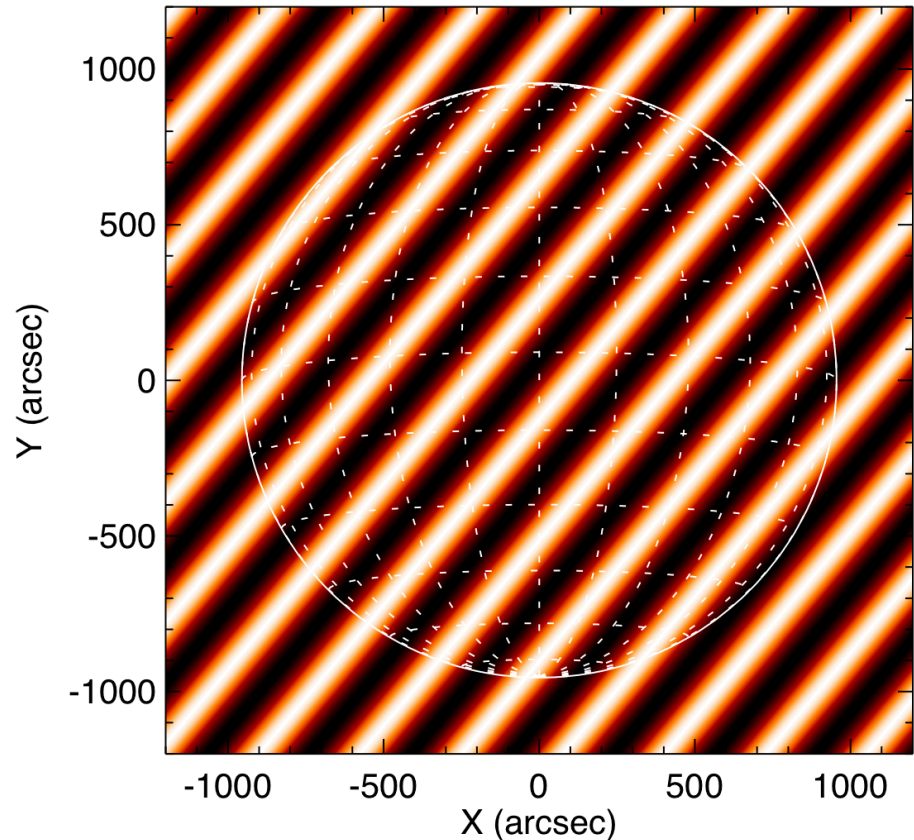
Relative phase of grids  
→ Location of strips

Grids produce  
moiré pattern on  
detectors

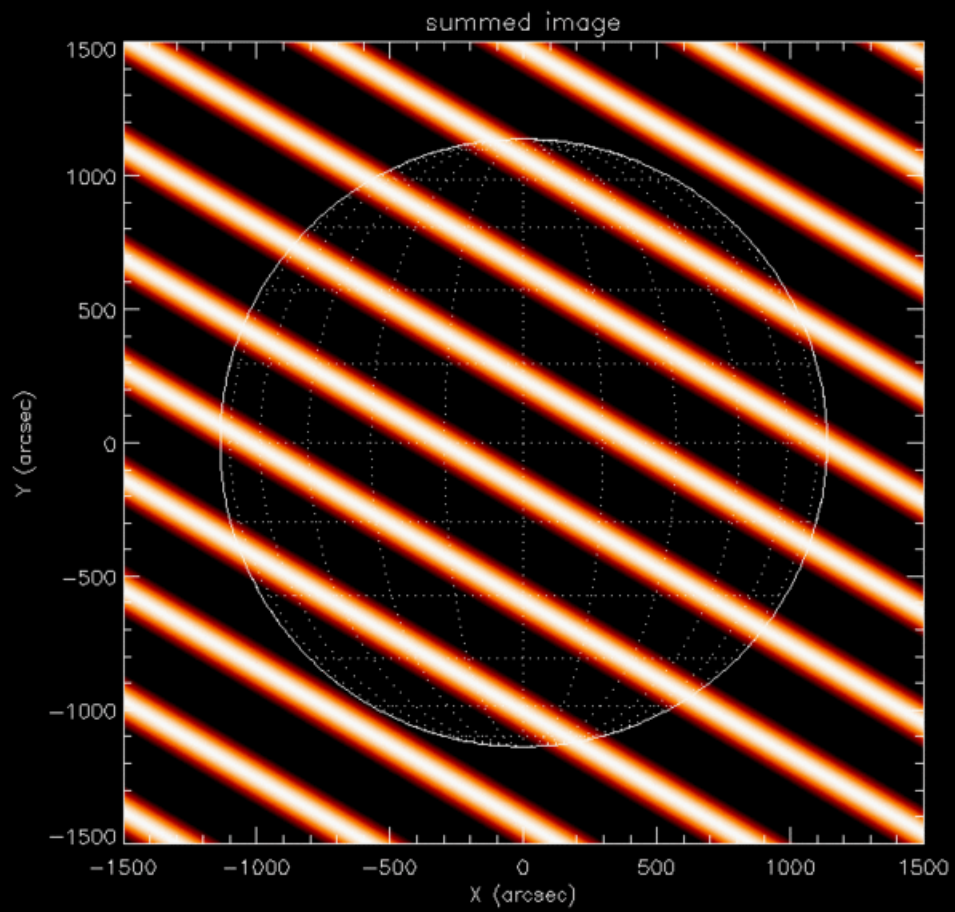
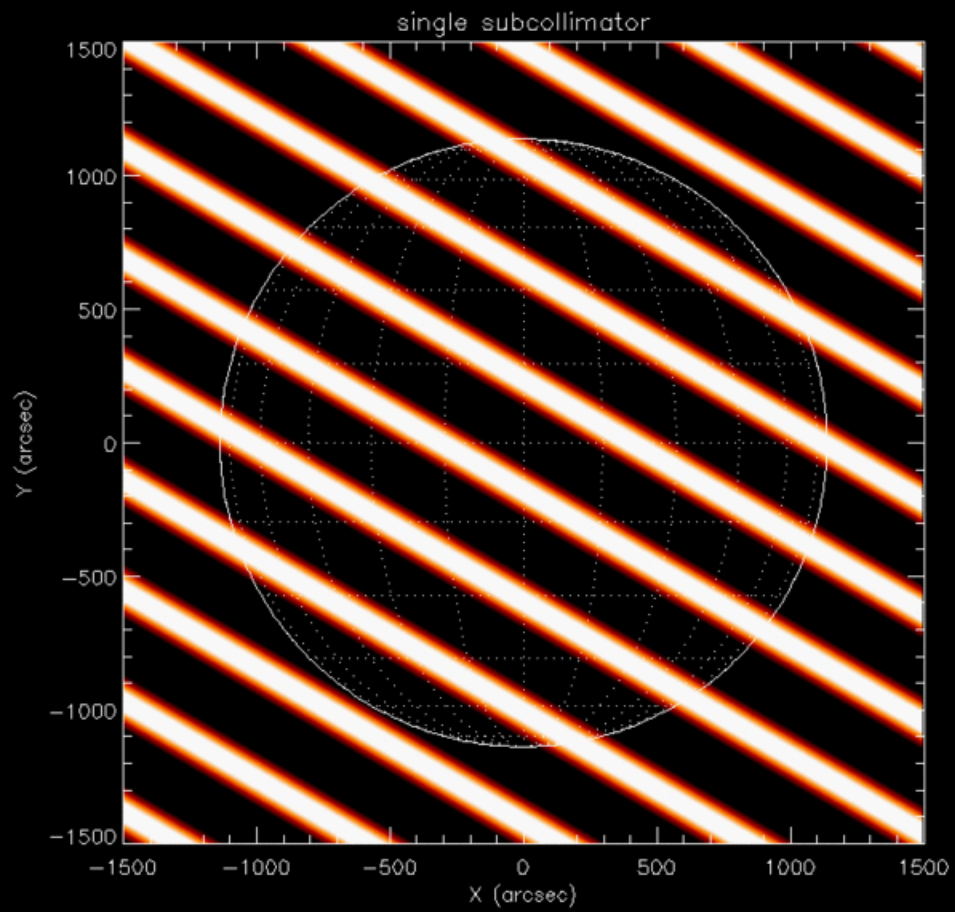
Observed moiré  
pattern:  
Counts in detector  
associated with  
subcollimator 10a

#32 (124.9")

subcollimator 9c

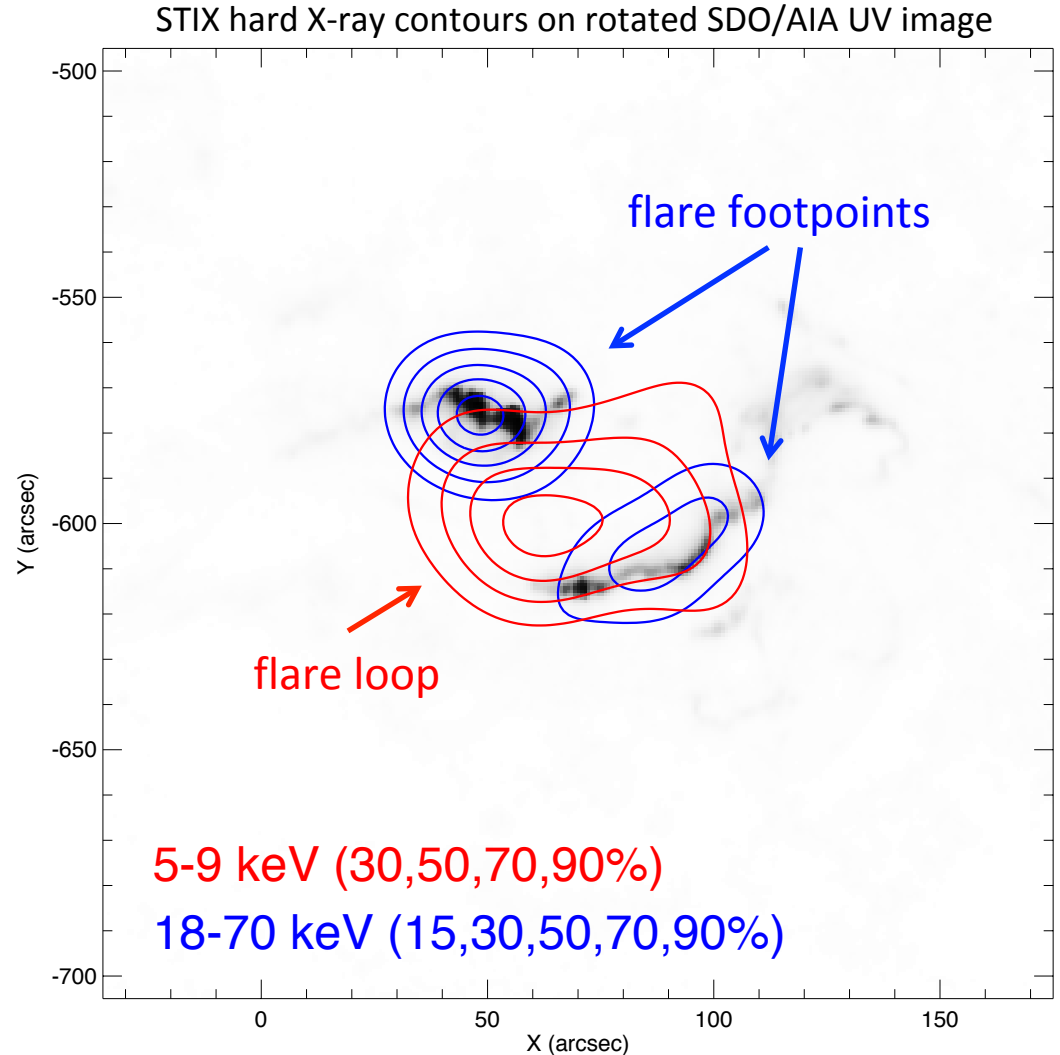
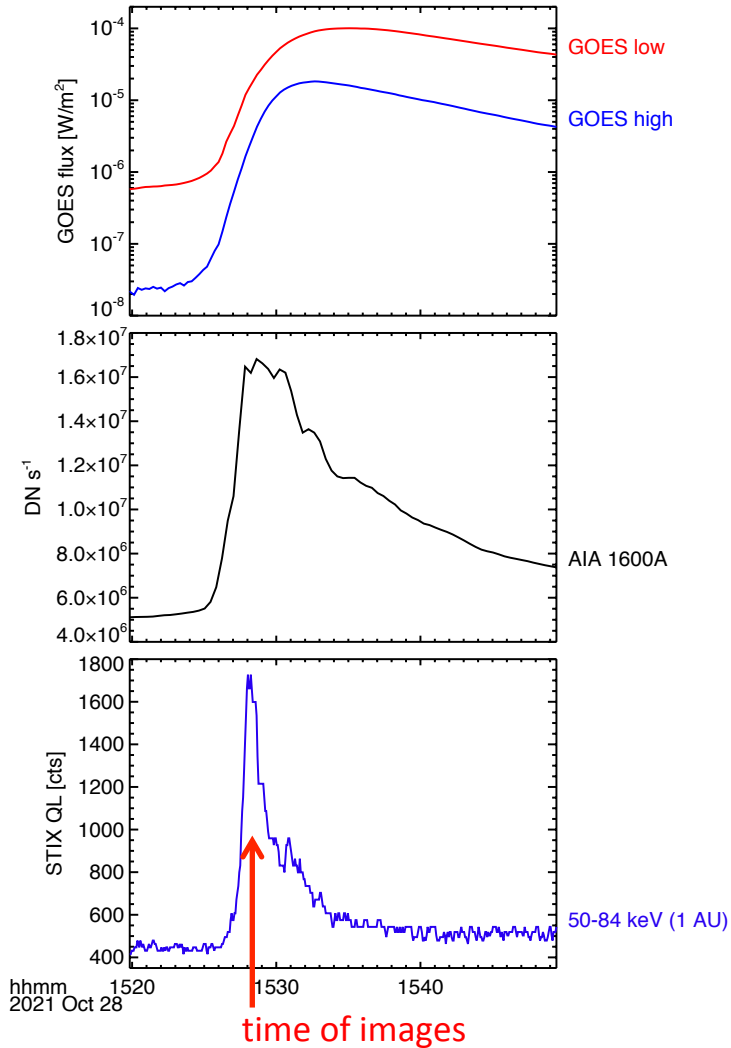


Finer resolution



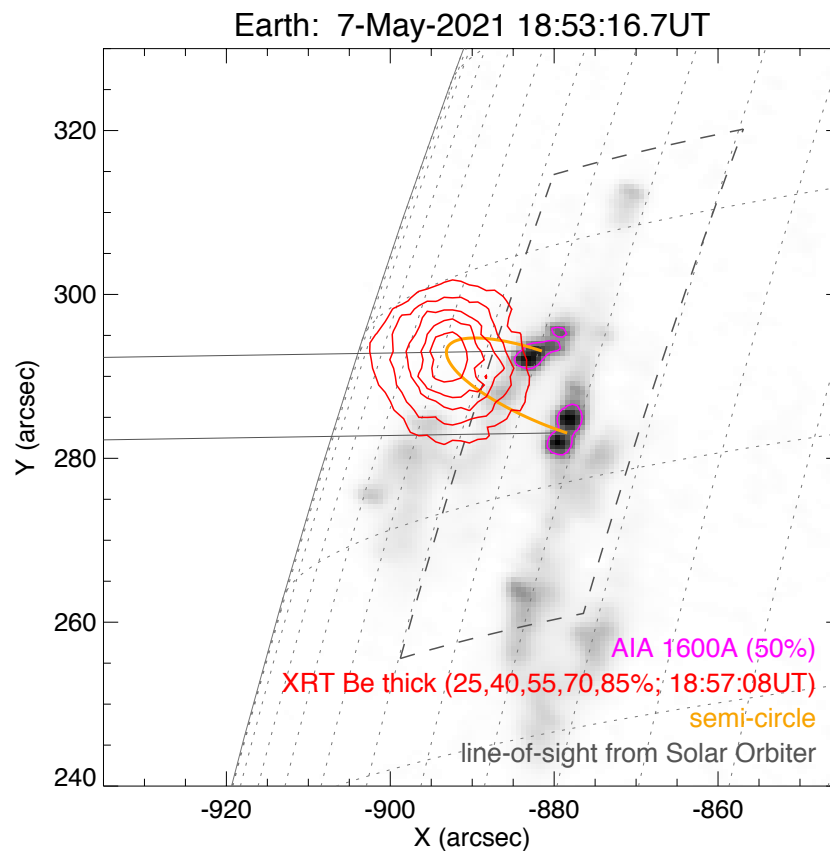
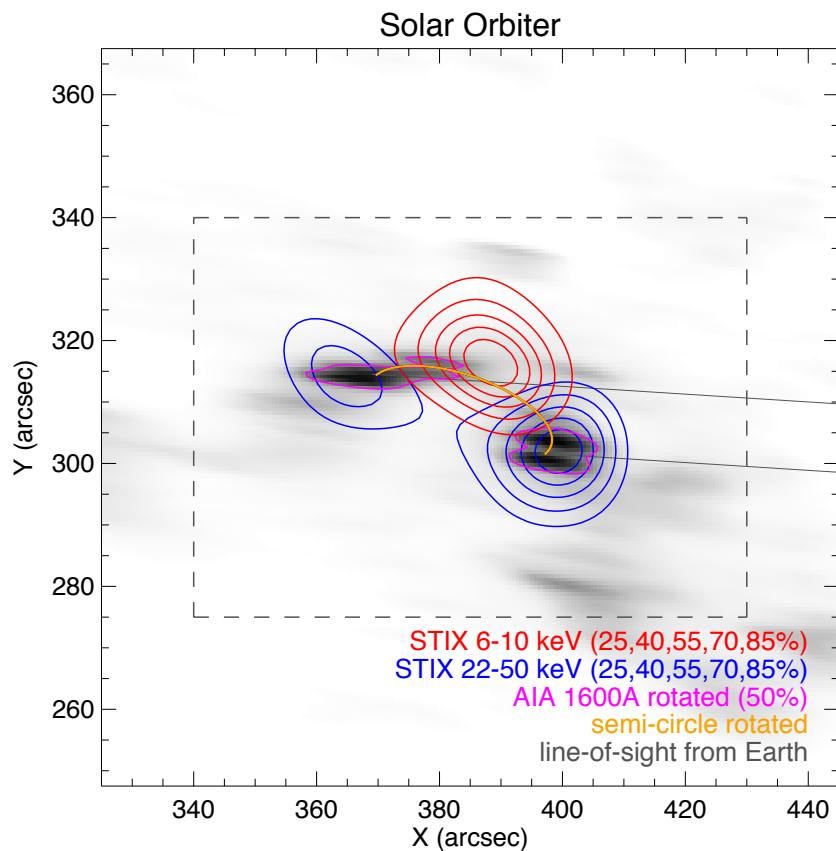
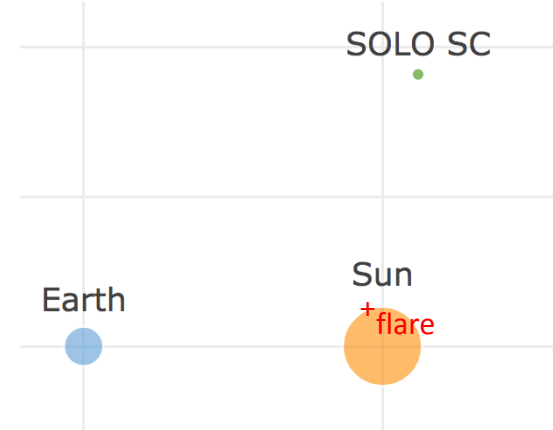
Flare of April 17, 2021

# October 28, 2021 X-class flare

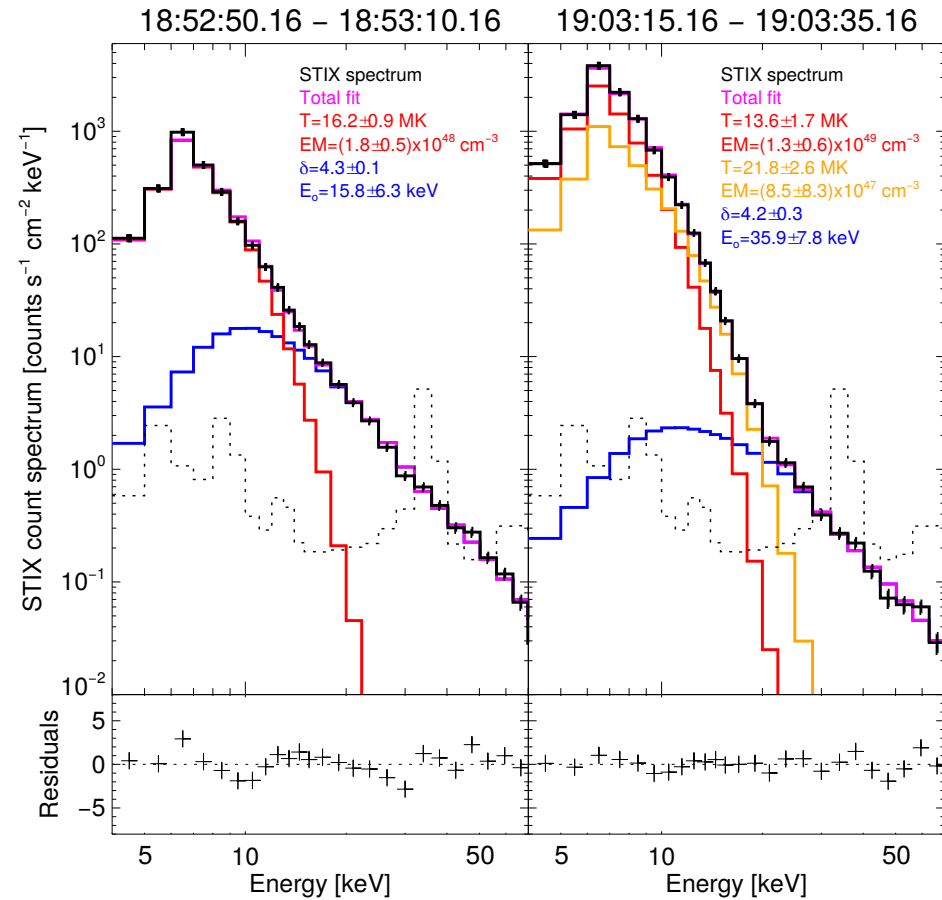
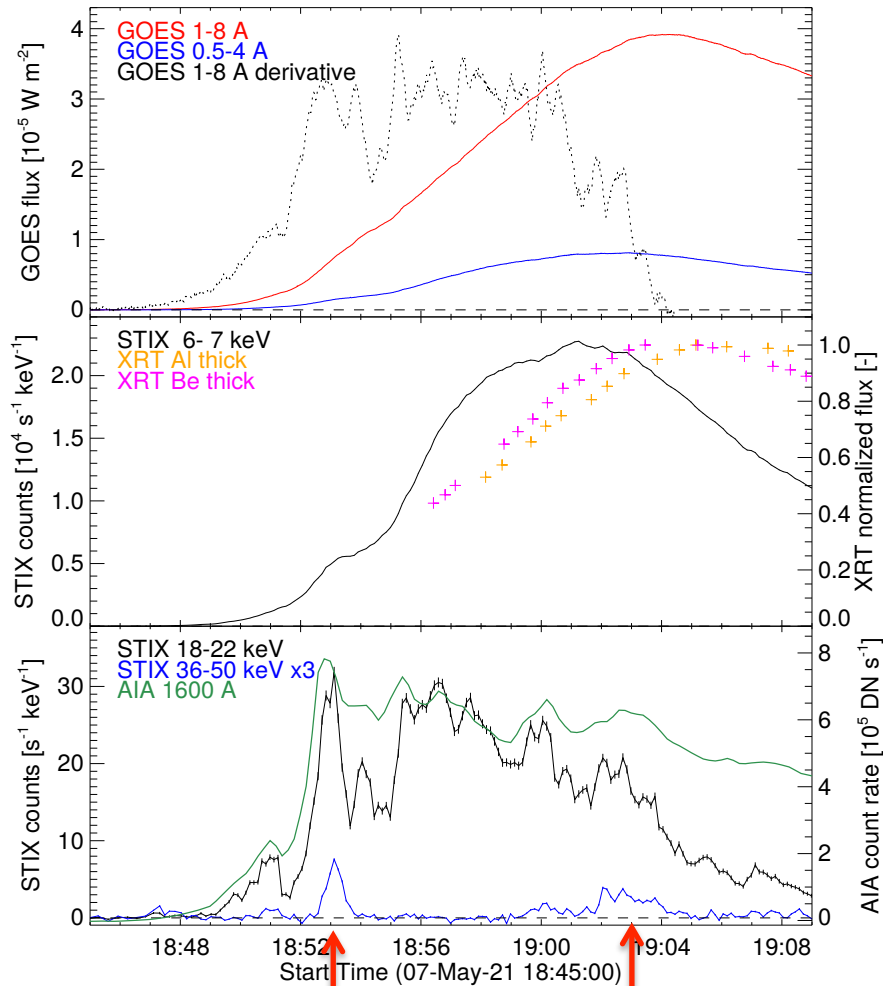


# STIX imaging diagnostics

## May 7, 2021 flare (GOES M4)

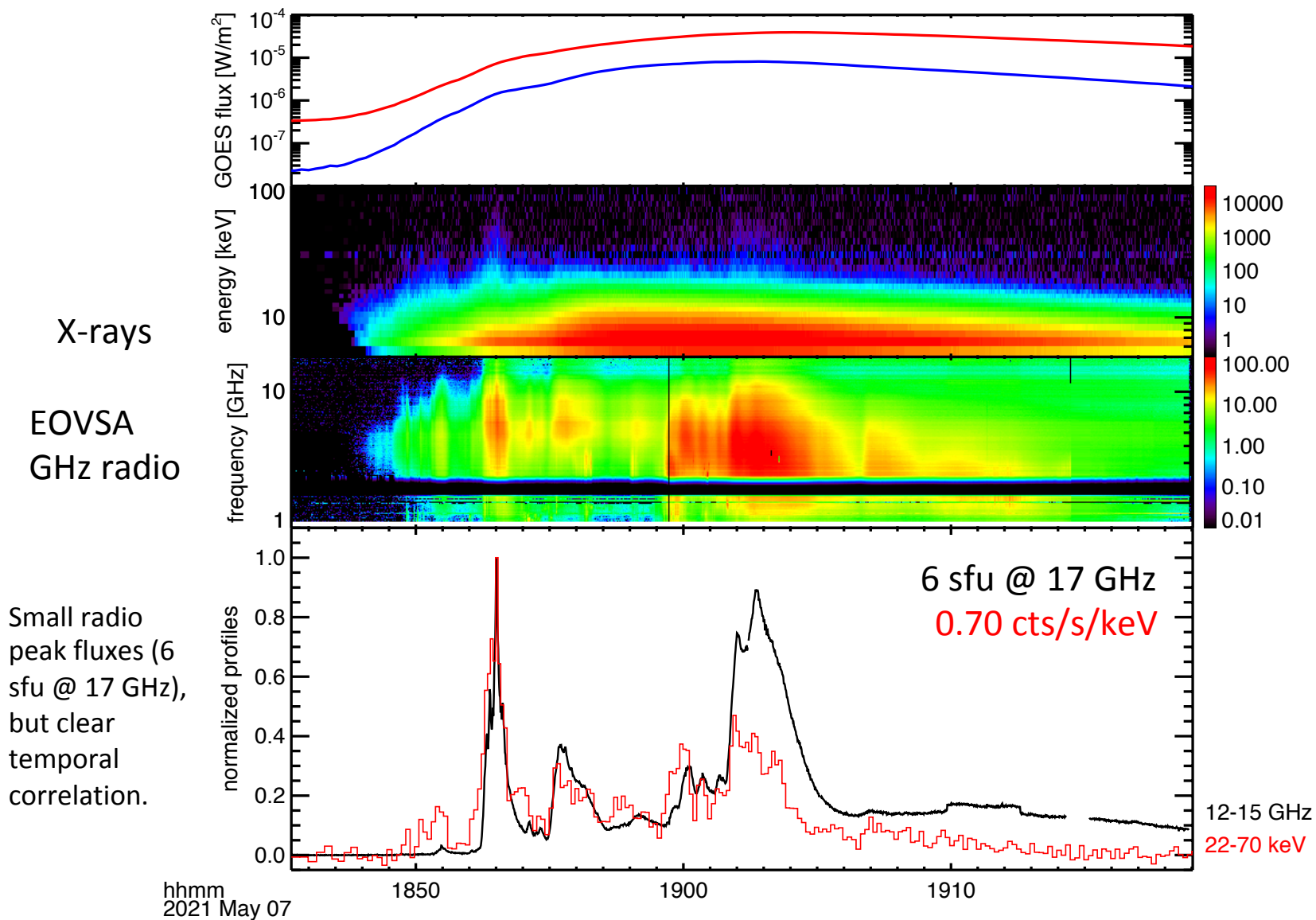


# Spectral diagnostics



→ flare energetics

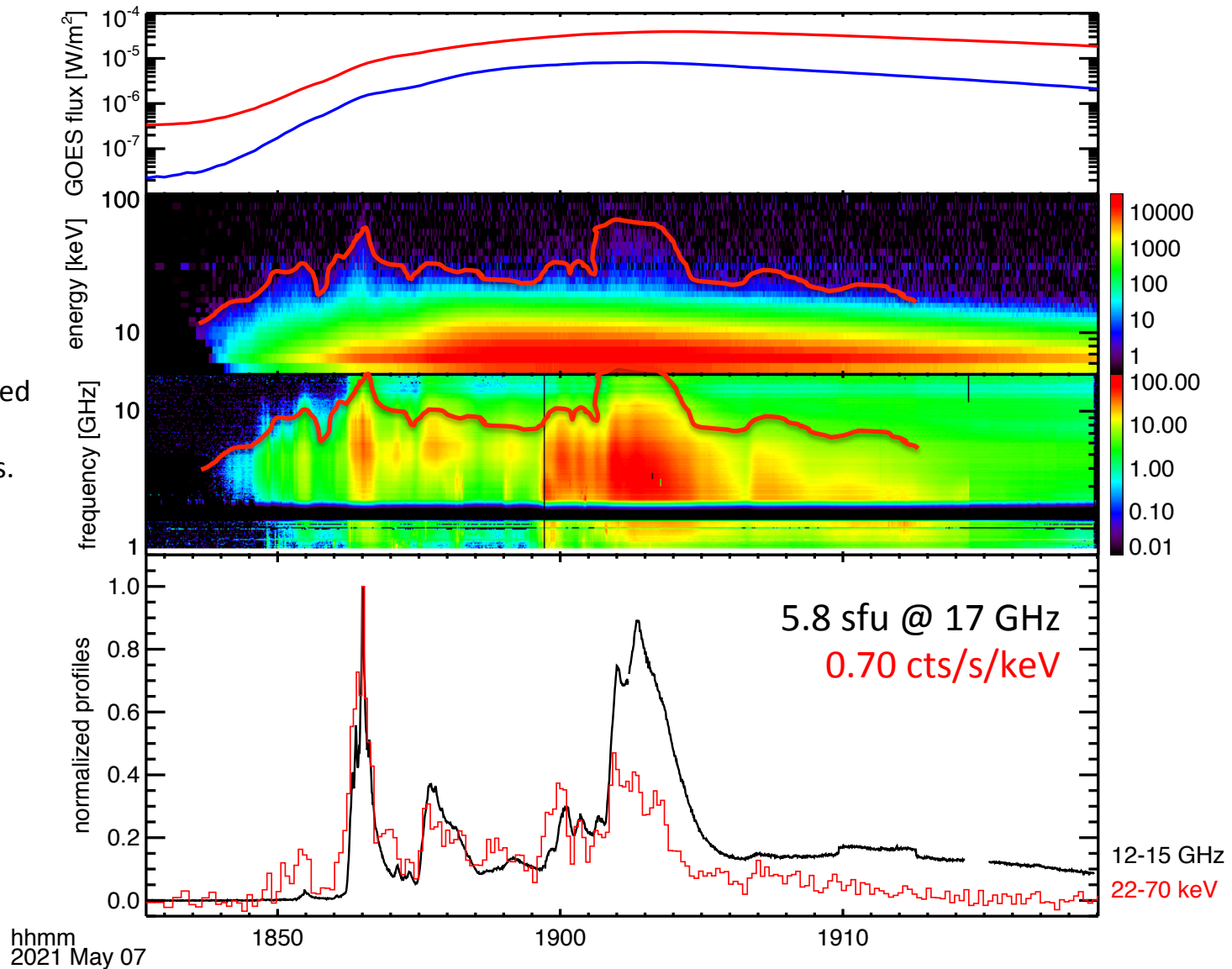
# May 7, 2021 (GOES M4)



Small radio  
peak fluxes (6  
sfu @ 17 GHz),  
but clear  
temporal  
correlation.

# May 7, 2021 (GOES M4)

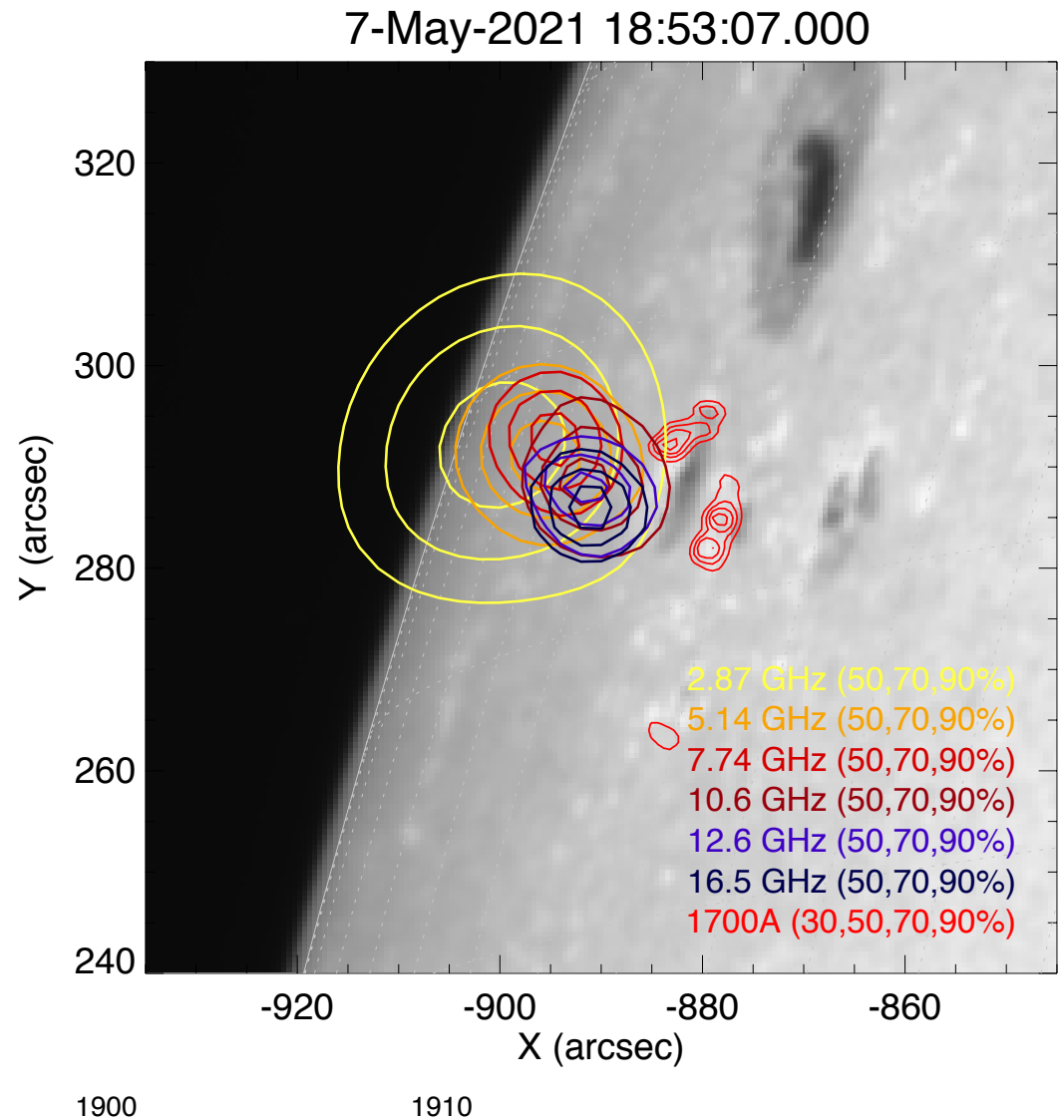
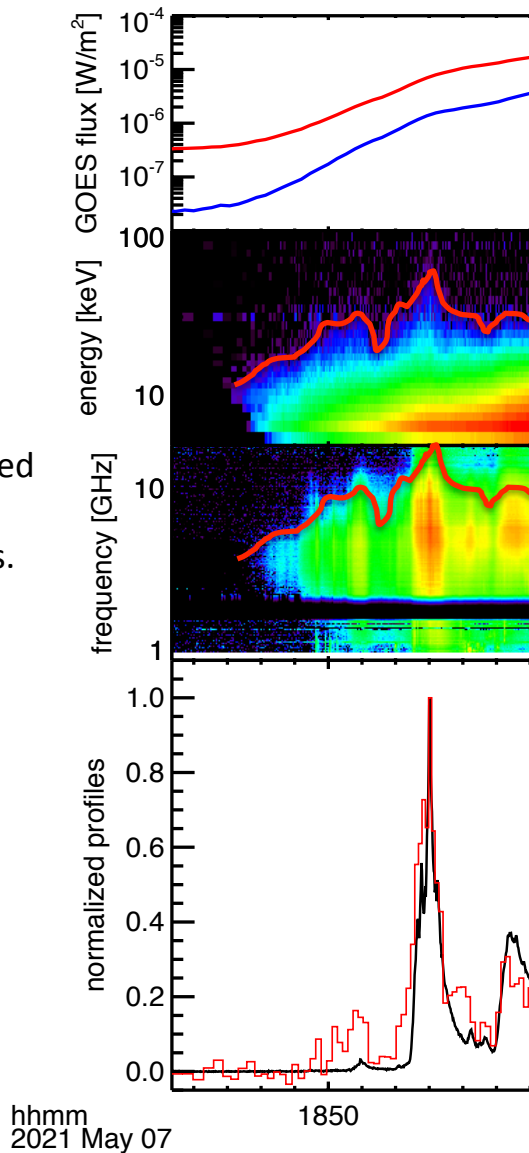
Envelope of highest emissions is closely related at both wavelengths.



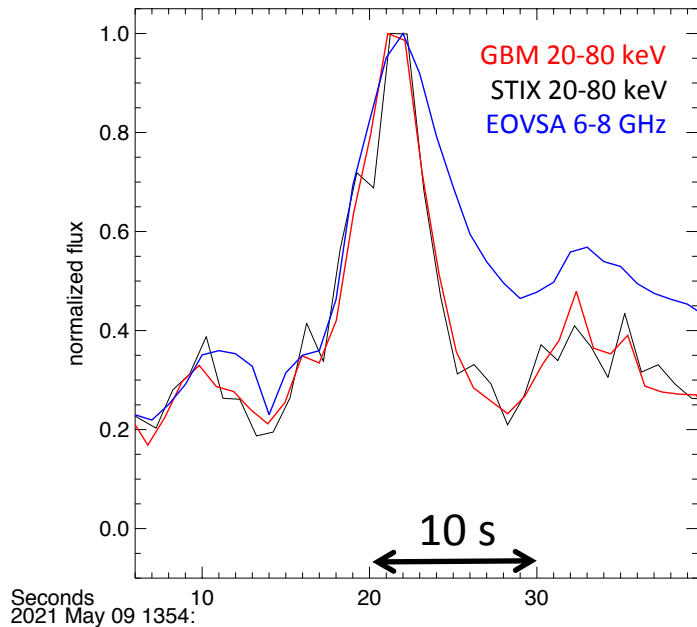
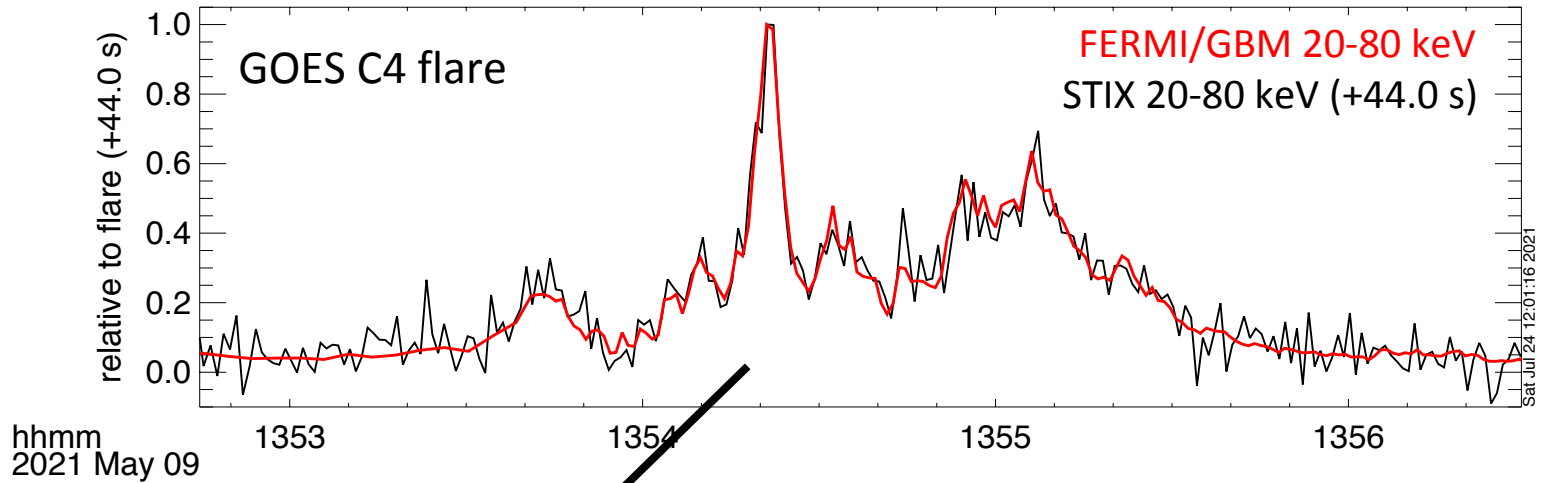


# May 7, 2021 (GOES M4)

Envelope of highest emissions is closely related at both wavelengths.



# Timing diagnostics

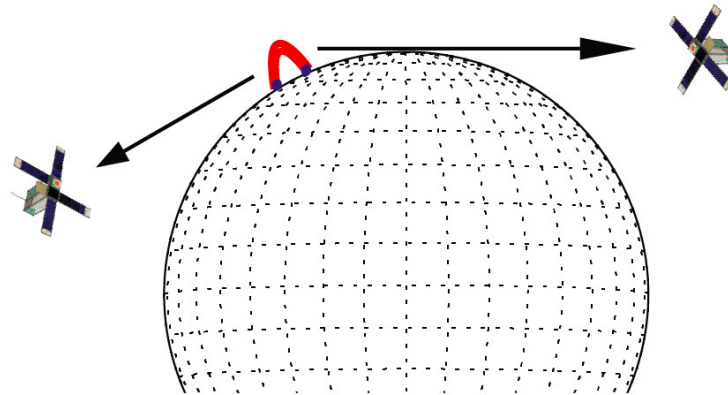
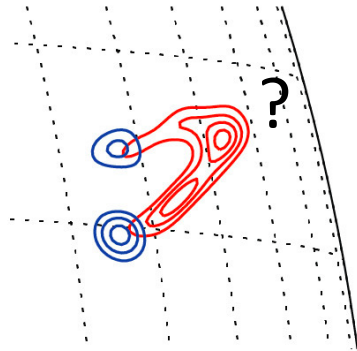


## High time cadence studies with STIX:

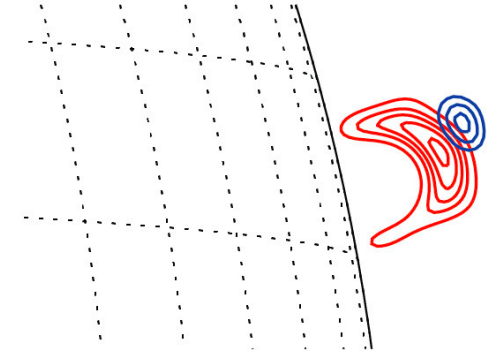
- as of Sep 6, 2021, STIX operates down to 0.5 s
- Flare location needs to be taken into account for accurate timing
- Directivity studies

# Occluded HXR observations with STIX

on-disk observation

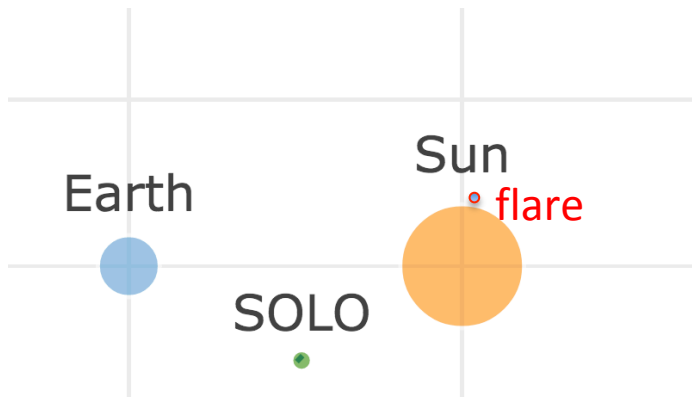


disk-occluded observation

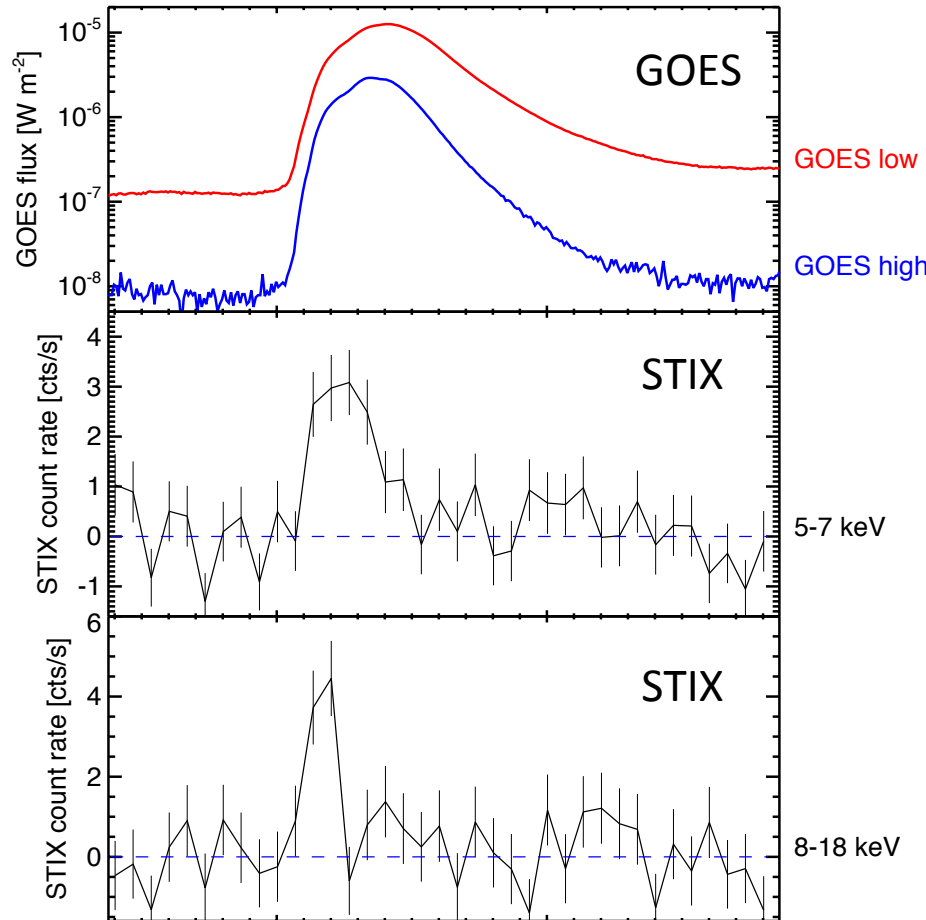


STIX in combination with Earth-orbiting instrument:





Solar limb partially occults view of flare site

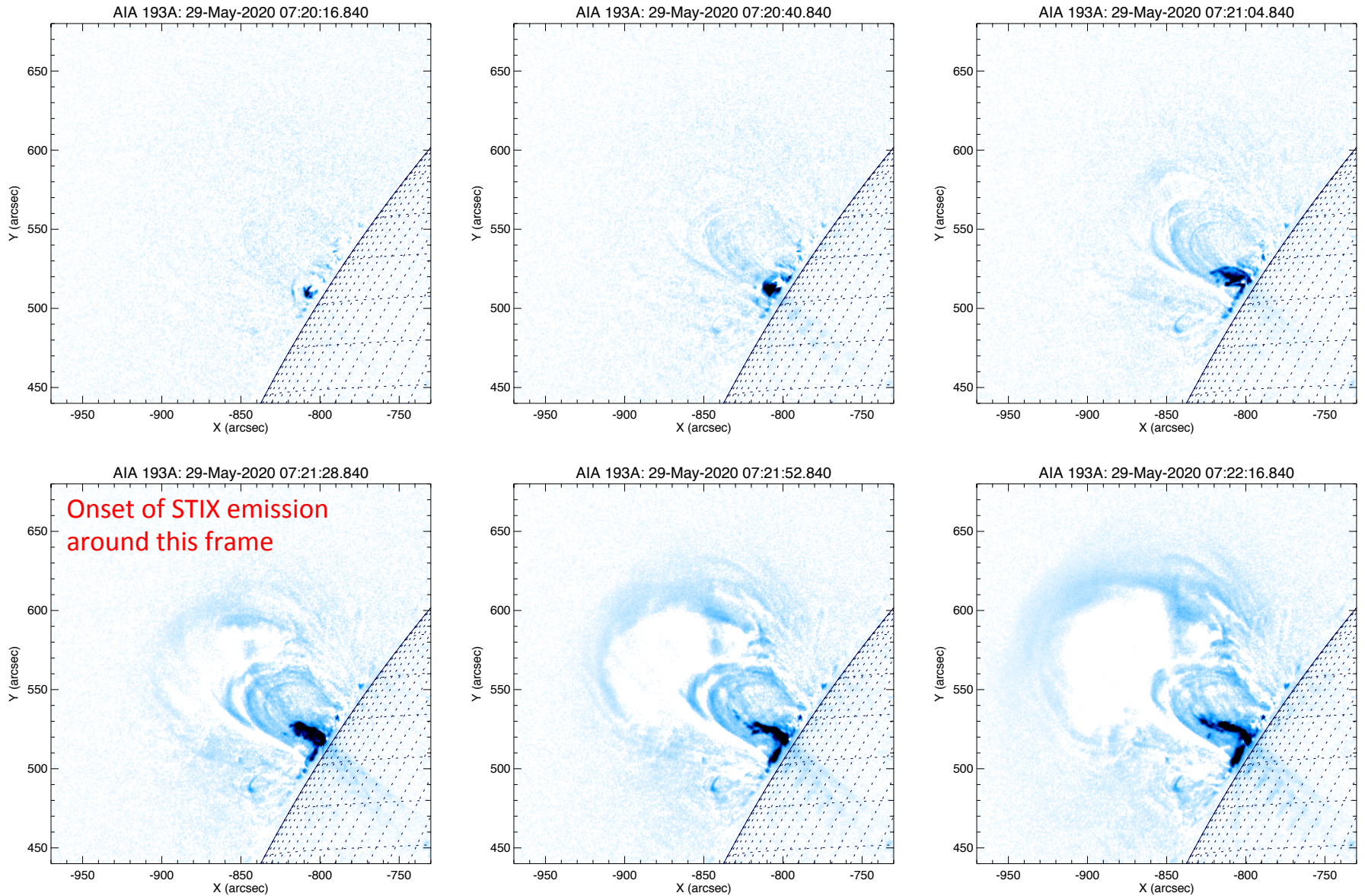


GOES M1 flare

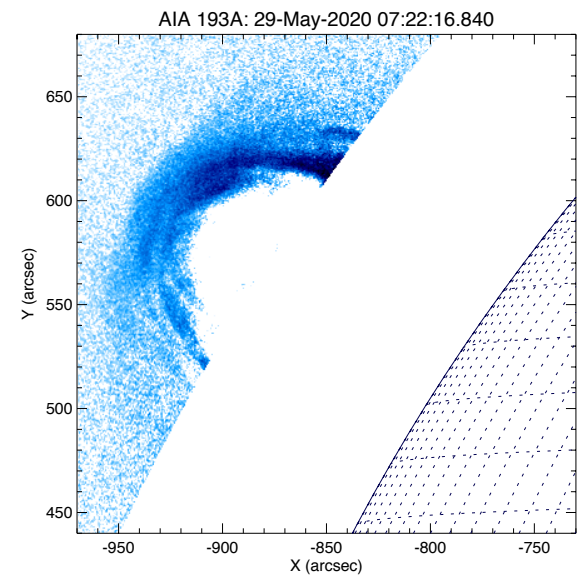
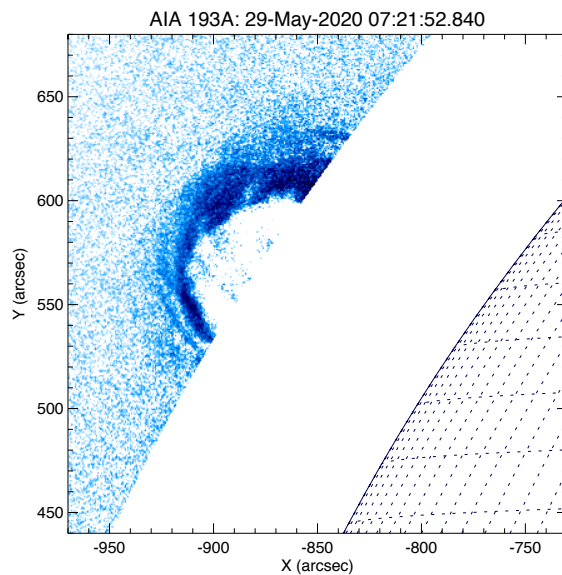
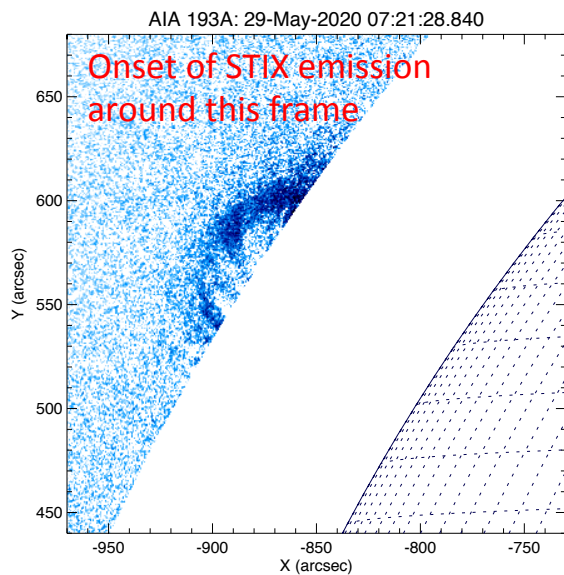
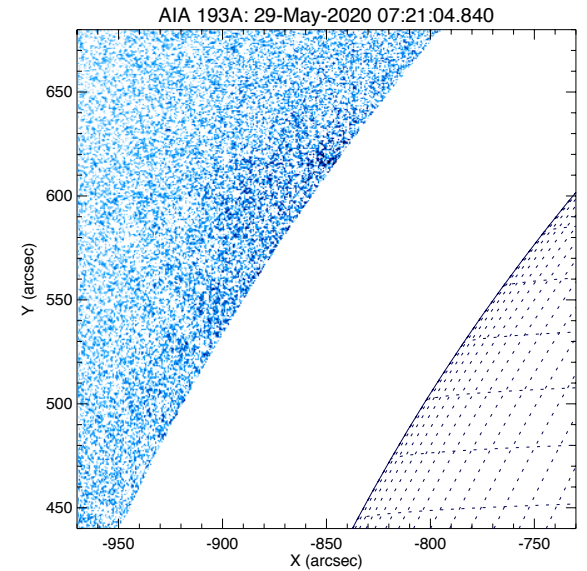
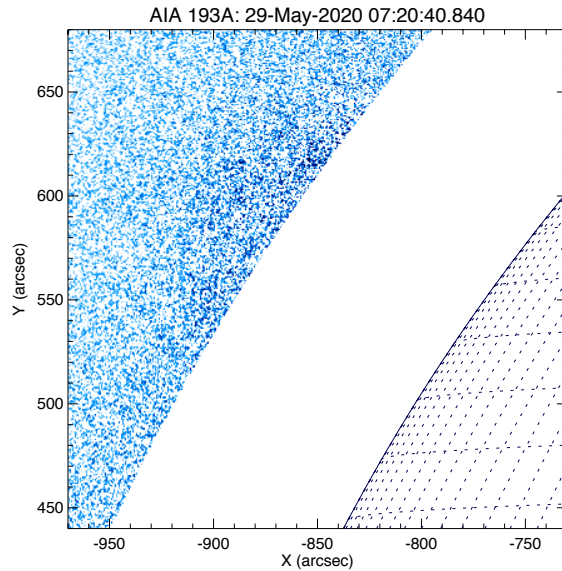
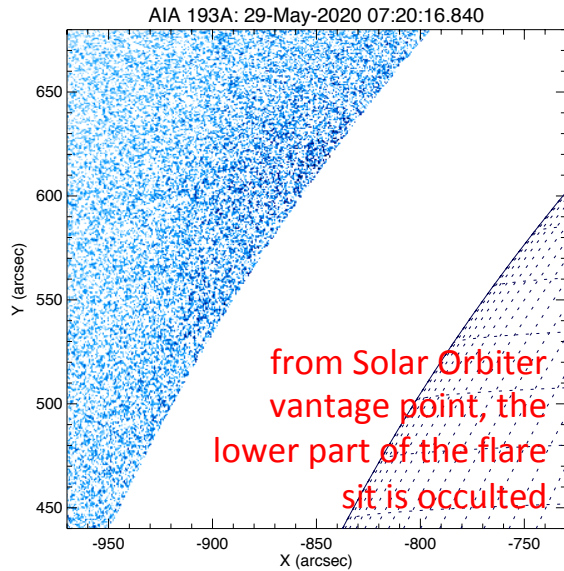
Faint, but high energy emission seen by STIX

STIX sees only emission from at least 0.1 solar radius above the flare site

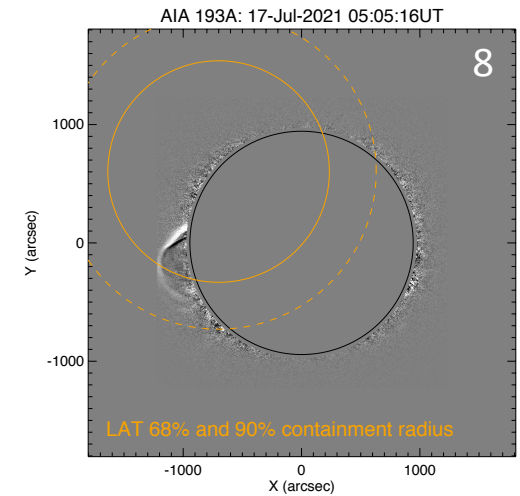
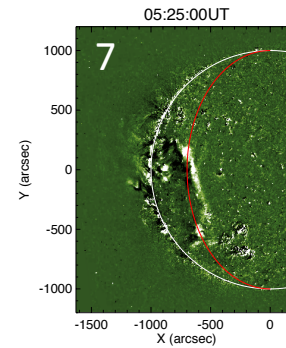
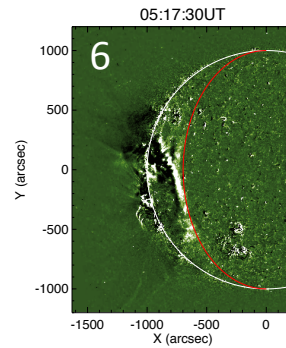
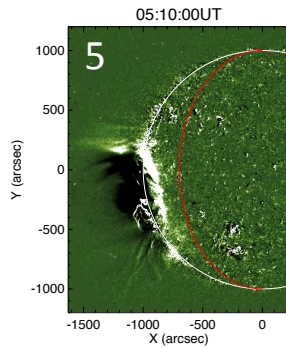
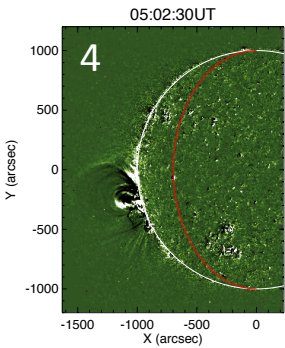
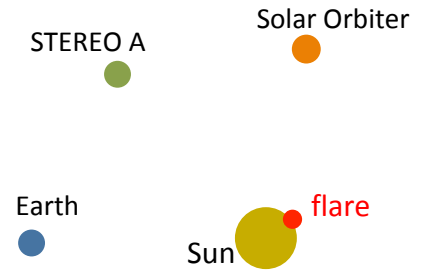
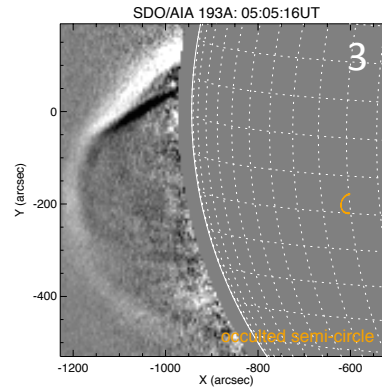
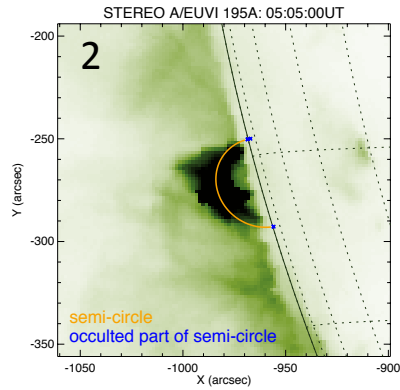
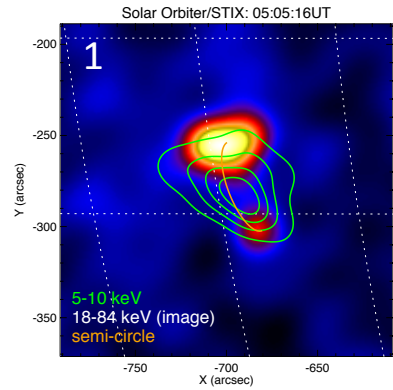
# AIA 193A: M1 flare and CME



# AIA 193A: M1 flare and CME



# FERMI/LAT, STIX, STEREO, & AIA

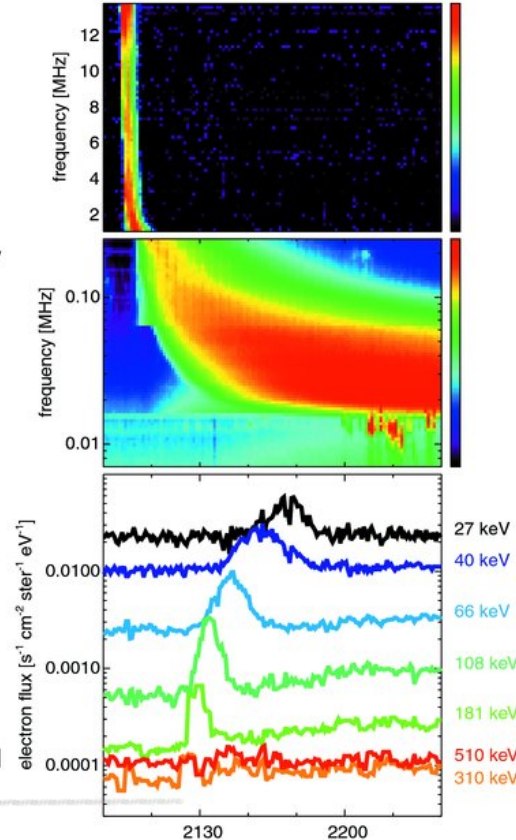
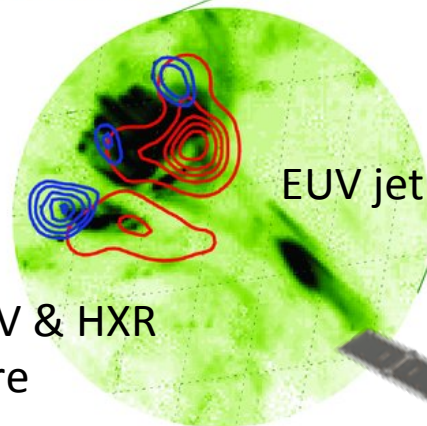
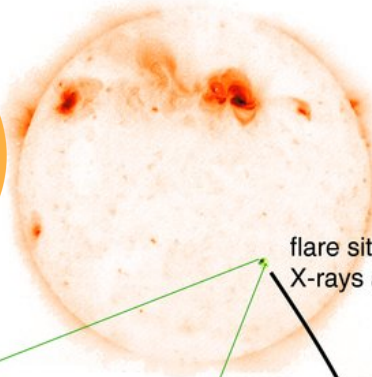
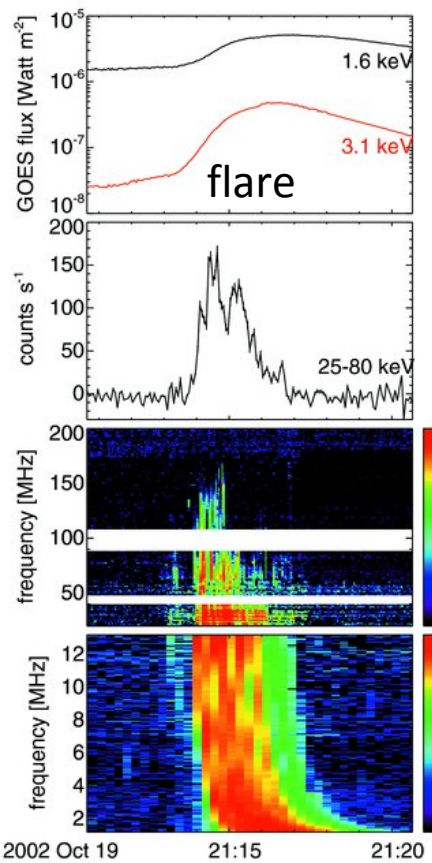


Flare from July 17, 2021

>100 MeV gamma rays from behind the limb flare

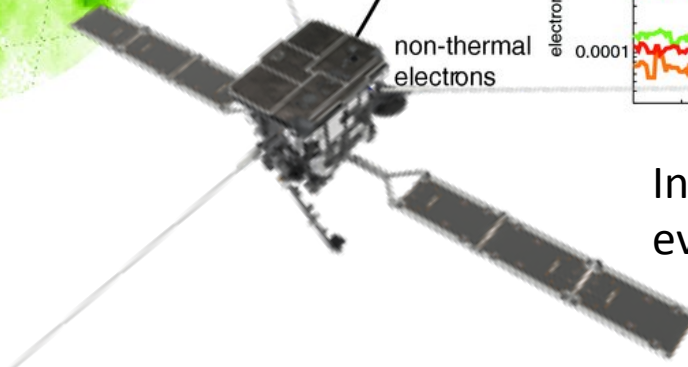
Pesce-Rollins et al. 2022

# Connecting in-situ observations back to the Sun



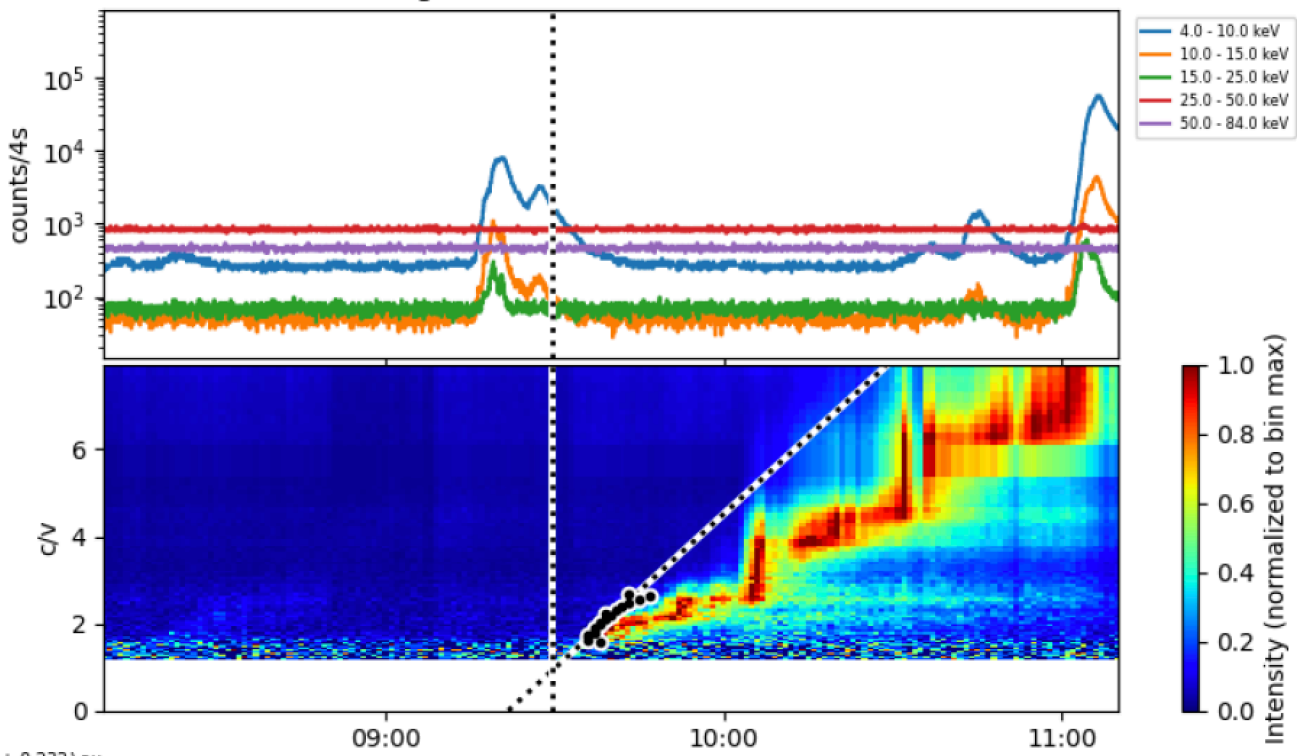
Radio type III  
burst

In-situ electron  
event





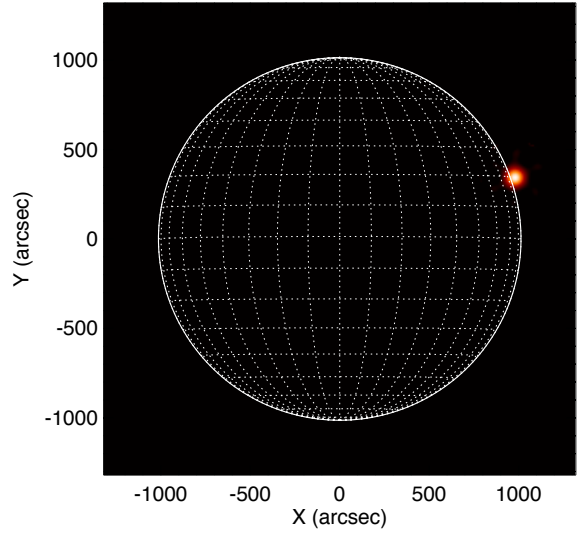
STIX LL Lightcurves/ STEP+EPT electron VDA



7 ± 0.232) au  
 21-05-23T09:21:48 ± 0.9 min  
 au; light time 7.873 min; shifted SRT: 09:29:40

2021-May-23 (DOY 143)

STIX 5-7 keV: 23-May-2021 09:27:29.150



Solar Orbiter  
 EPD team (Gomez et al.)

# Summary

- STIX is ready for nominal mission
- Contact STIX team for collaborations
- Webpage: <https://pub023.cs.technik.fhnw.ch/>
- open data policy; only include co-authors that actual are involved in your paper