ASO-S/HXI progress and a new database for flares

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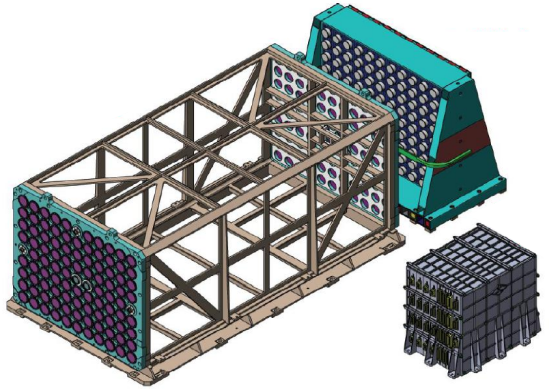
Content

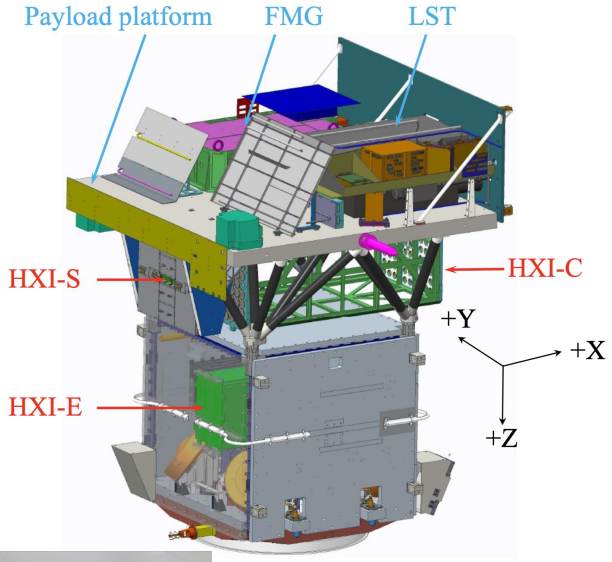
- ASO-S/HXI progress
- DEM analysis and the new version
- A new database for flares and coronal structures

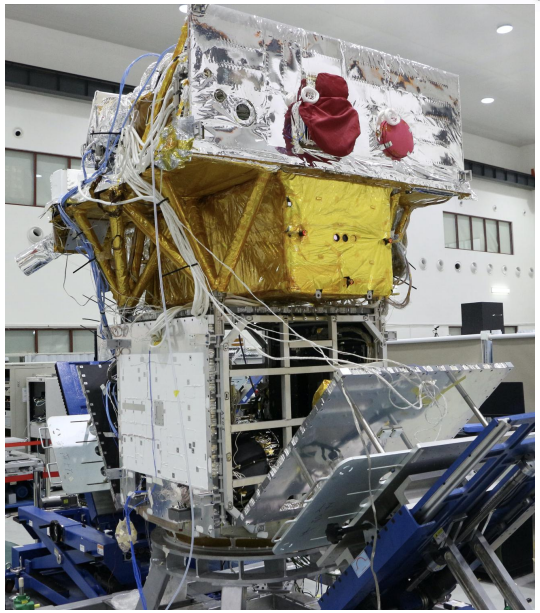
1. HXI progress

HXI (Hard X-ray Imager)

- energy range: ~30-200 keV
- recorded energy range: ~15-400 keV
- Spatial resolution: ~3 arcsec
- Energy resolution: ~27%@32keV
- pitch: 10 groups from 36 to 1224 μm;
  91 pairs of grids for imaging
- Detectors: 99
- background monitors: 5
- total flux monitors: 3 (one with high sensitivity)



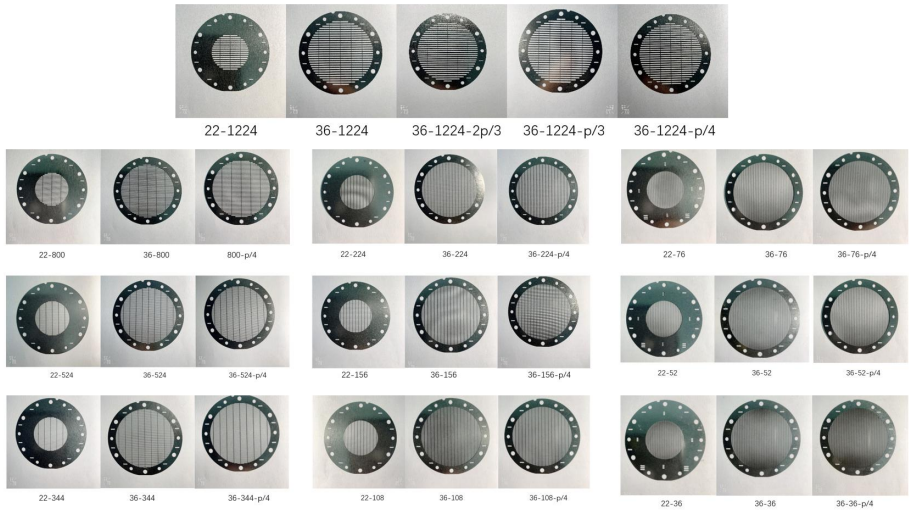




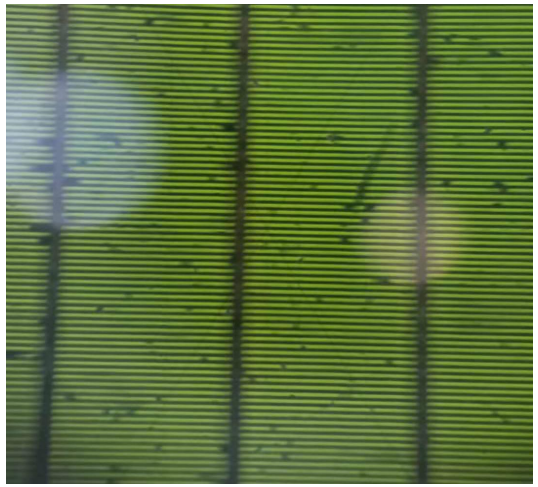
1. HXI progress

- HXI instrument (Zhe Zhang, Jian Wu, et al.)
  - Now in phase-D (HXI)
  - Calibration of 100 detectors (2021.06)
  - Ground test of SAS cameras
  - All the grids and detectors are ready

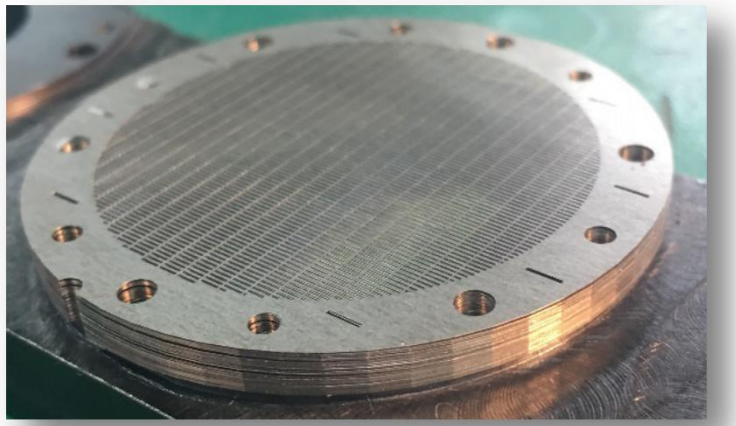
HXI grid, single layer, 10 groups
Over 3400 slices



36μm pitch

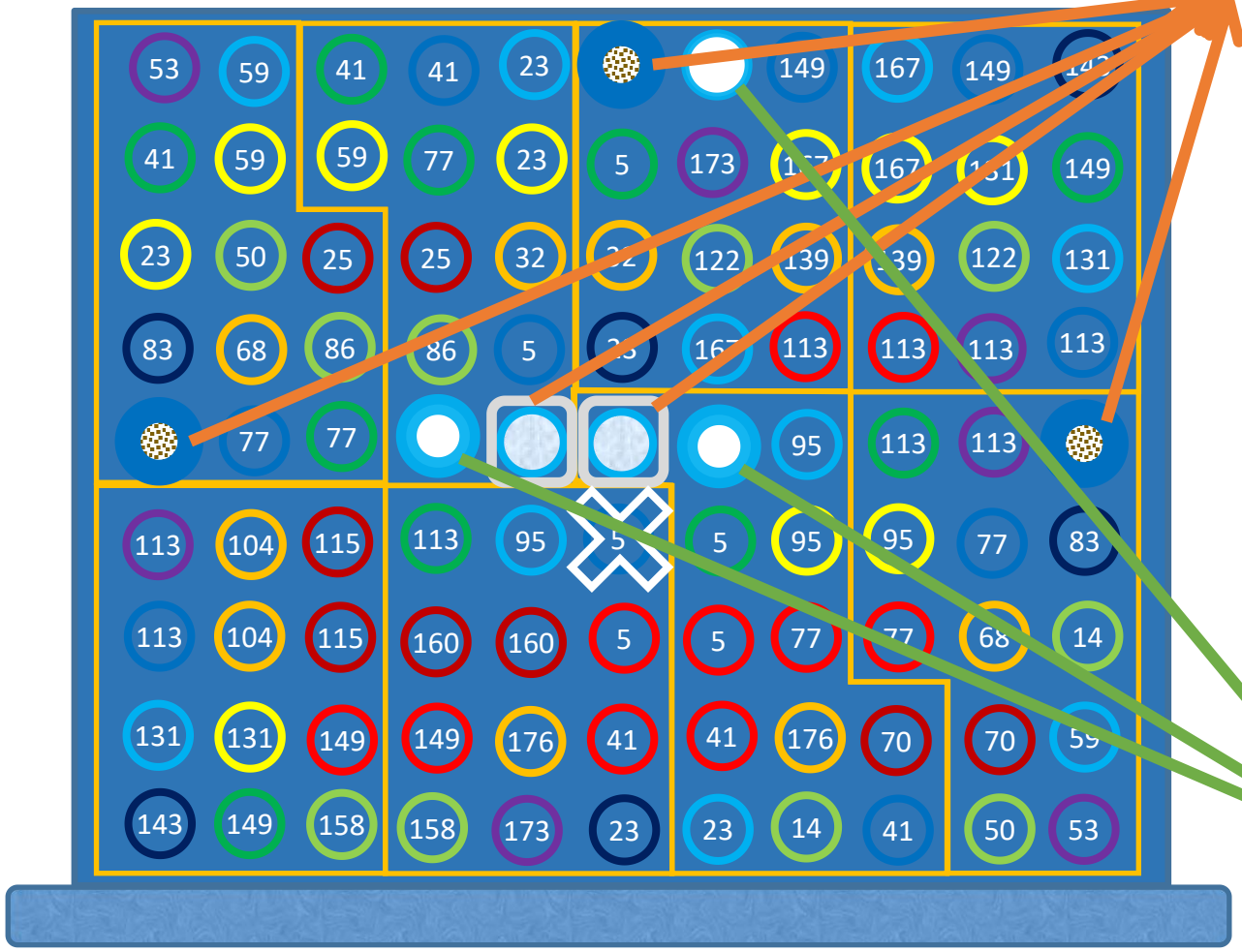


LaBr3 Detector:

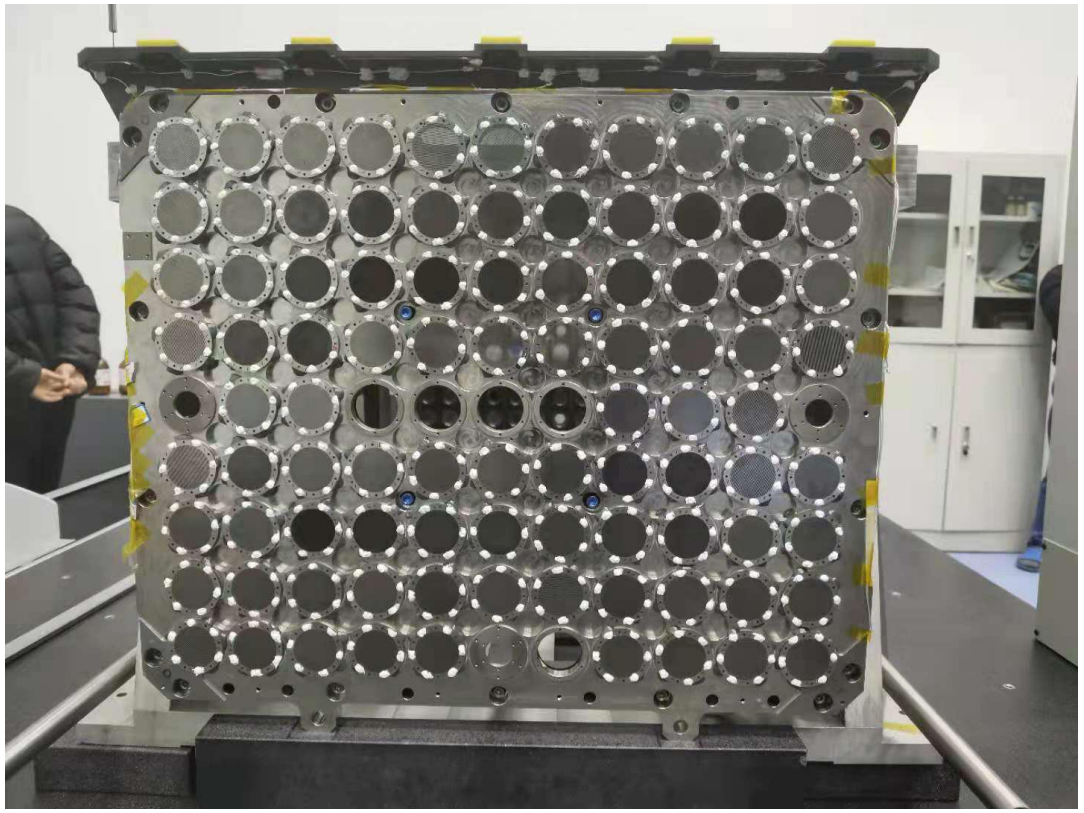


1. HXI progress

- HXI grid configuration



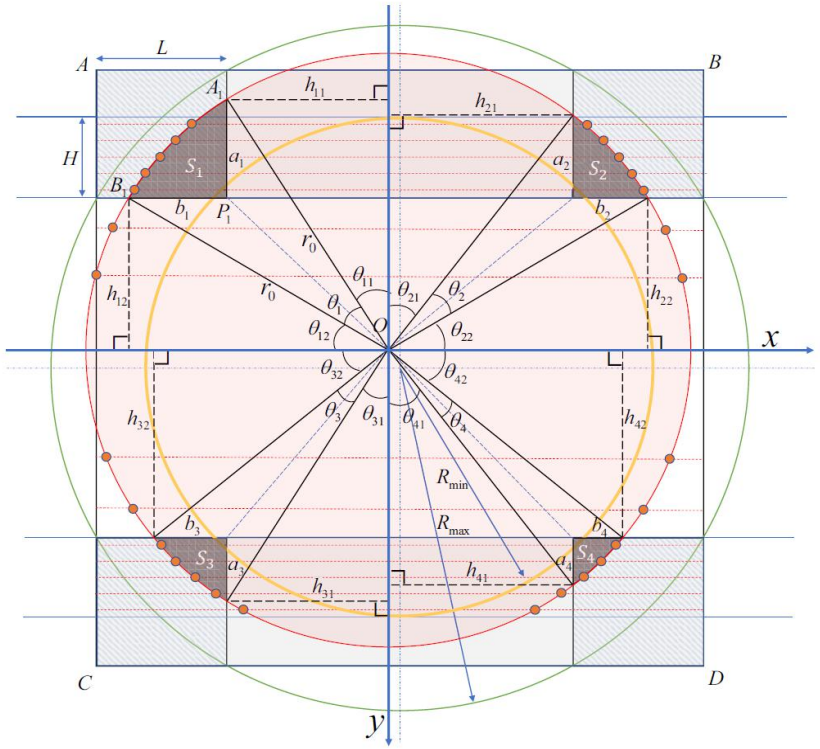
background monitors



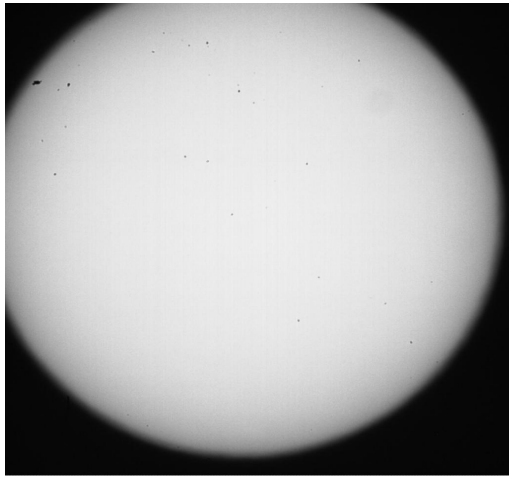
Total flux monitors

1. HXI progress

- SAS system: two cameras
- Two methods for determining solar disk center (Yu, Su, et al. 2020)
  - least-square circle fitting from (up to) 28 points at limb
  - Four quadrant method



Ground tests of SAS cameras

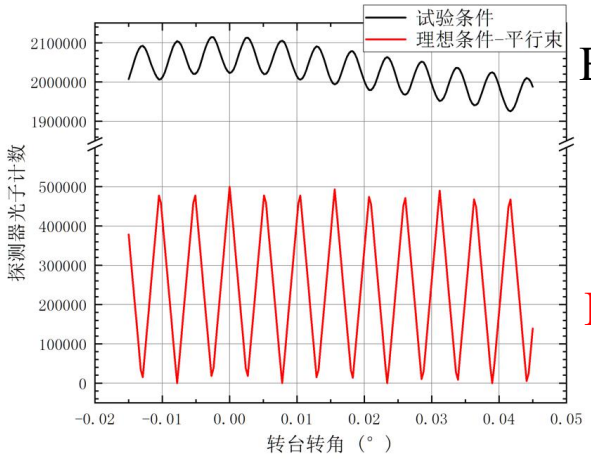


1. HXI progress

➢New X-ray generator, new beam tests

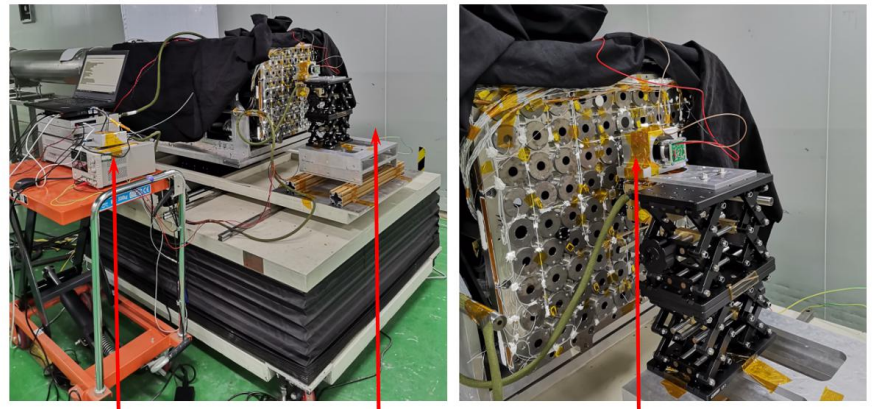
2021.03- 2021.04

108μm Grid
Geant4 simulation

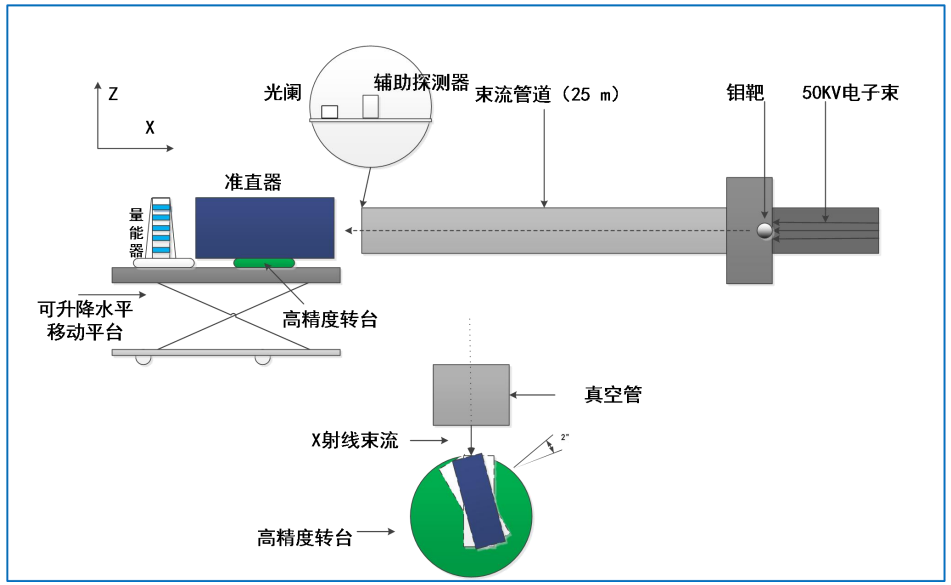


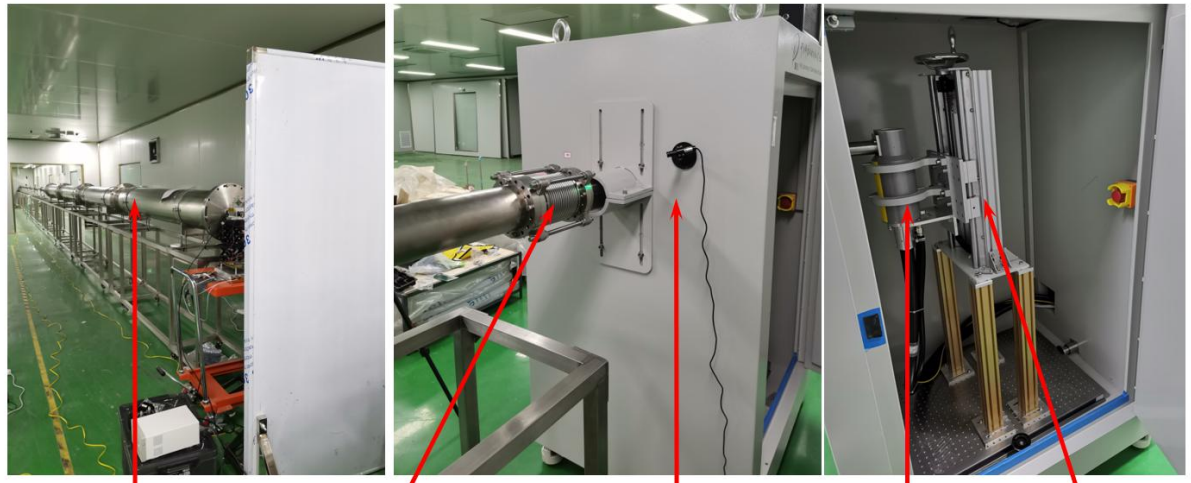
Beam test case

Ideal case



Ground Test Instrument　HXI-C　Detector module

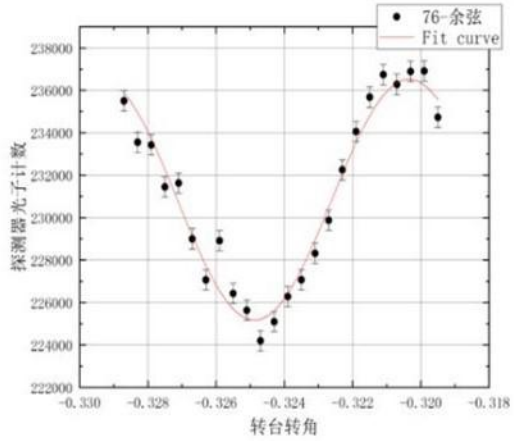




X-ray tube　Sylphon bellows　Shielded lead　X-ray generator & Lifting motion

1. HXI progress

Result of the improved experiment (beam tests)



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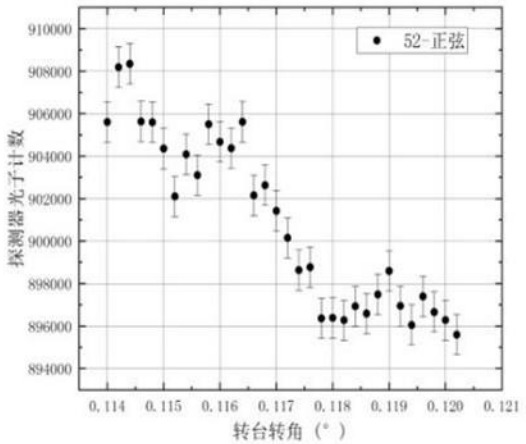

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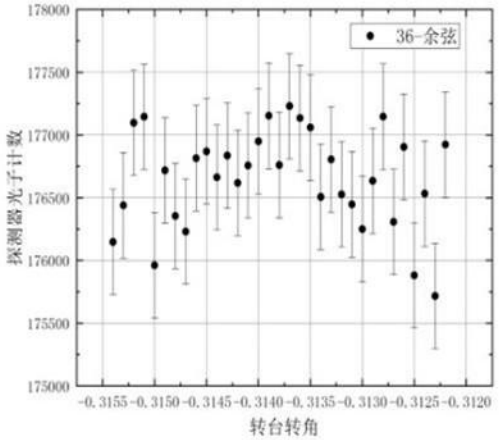

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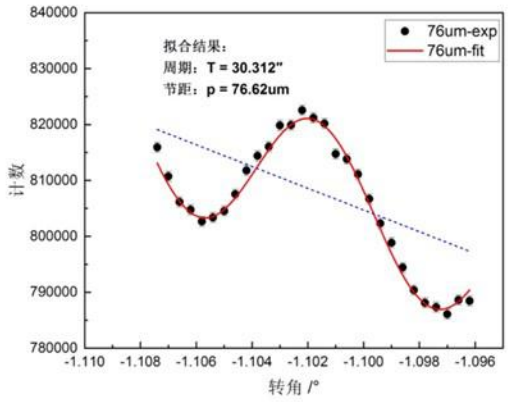
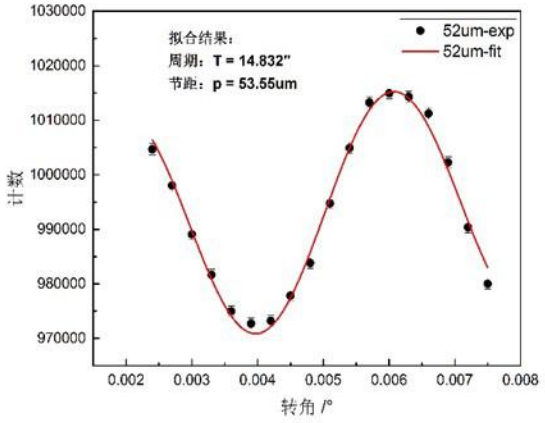
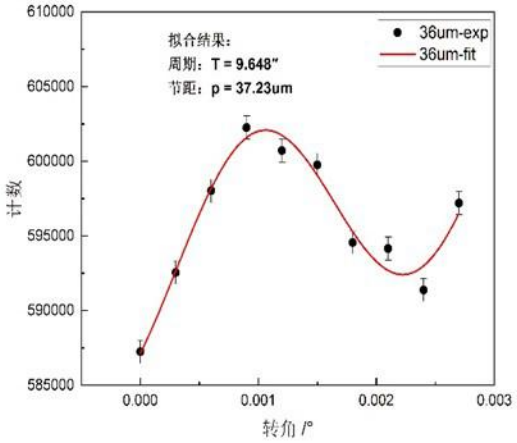
2020







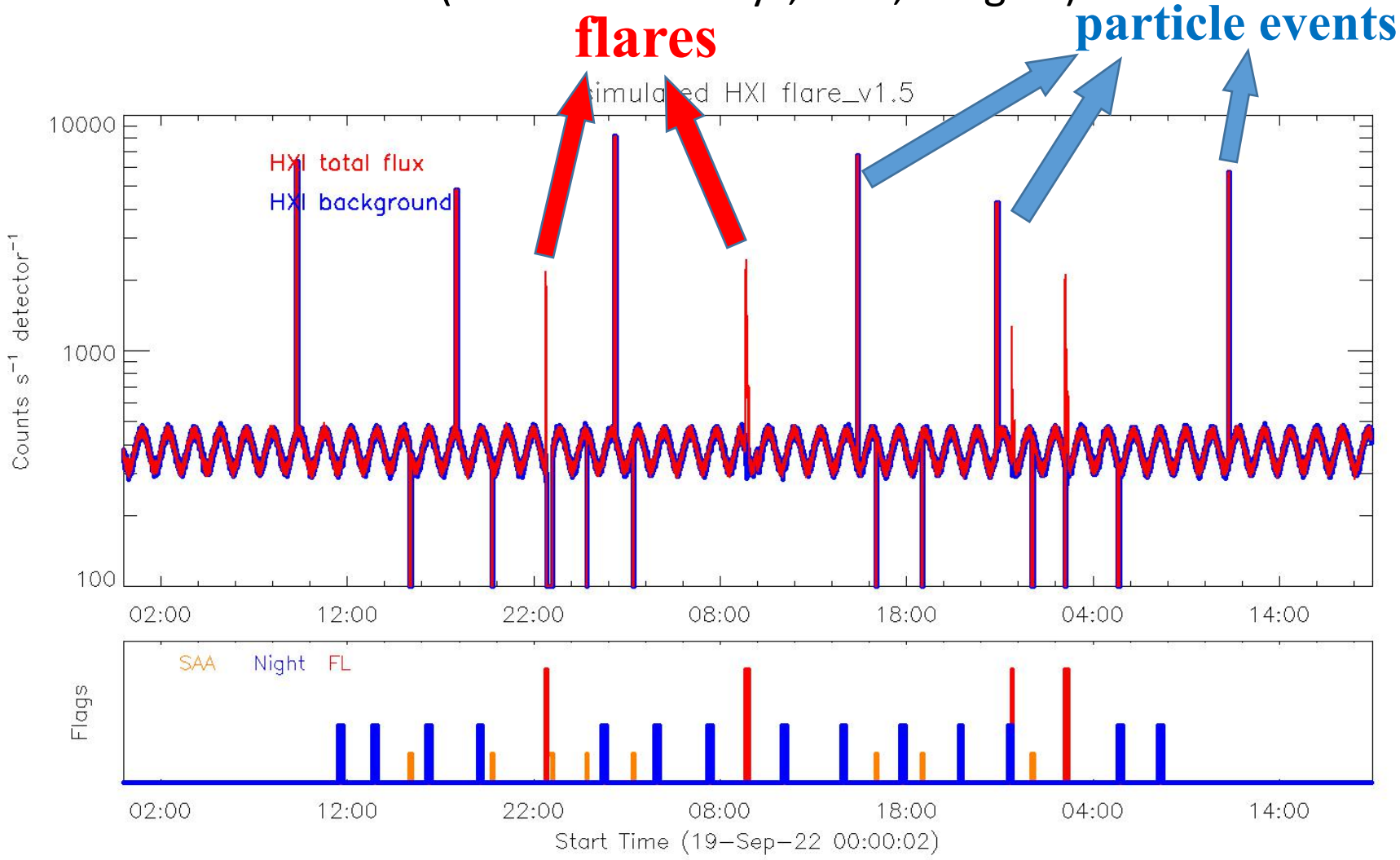
2021

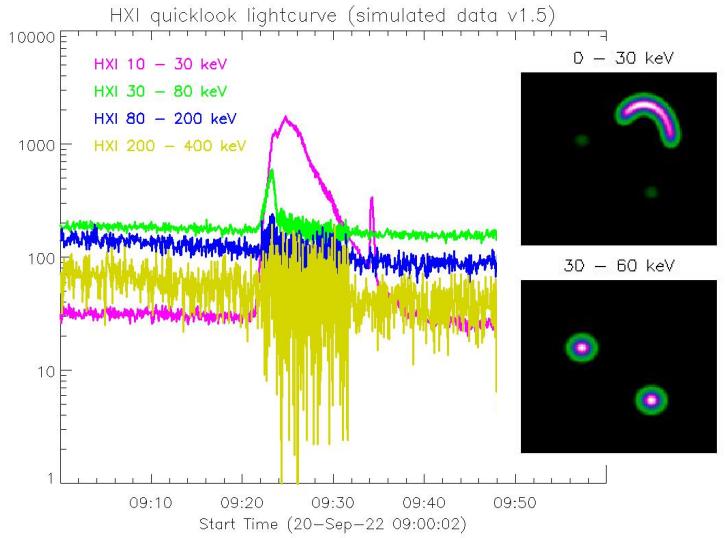
1. HXI progress

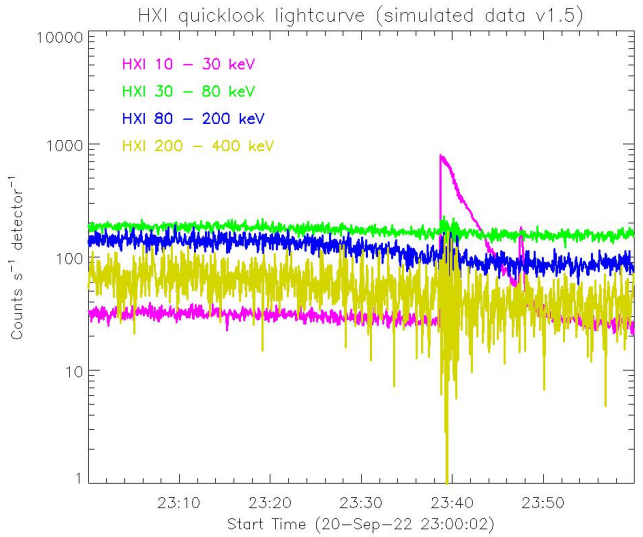
- HXI simulation, data and software (Yang Su, et al.)
  - Simulated flare data
  - Production software: level 0.5, level 1, level Q1
  - Analysis software: **HXI GUI + objects + plot_man** (Fanxiaoyu Xia)
  - Energy calibration
  - Imaging algorithms
  - Fast analytical calculations of patterns

1. HXI progress

Simulated HXI data (more than 2 days, v1.5, Yang Su)

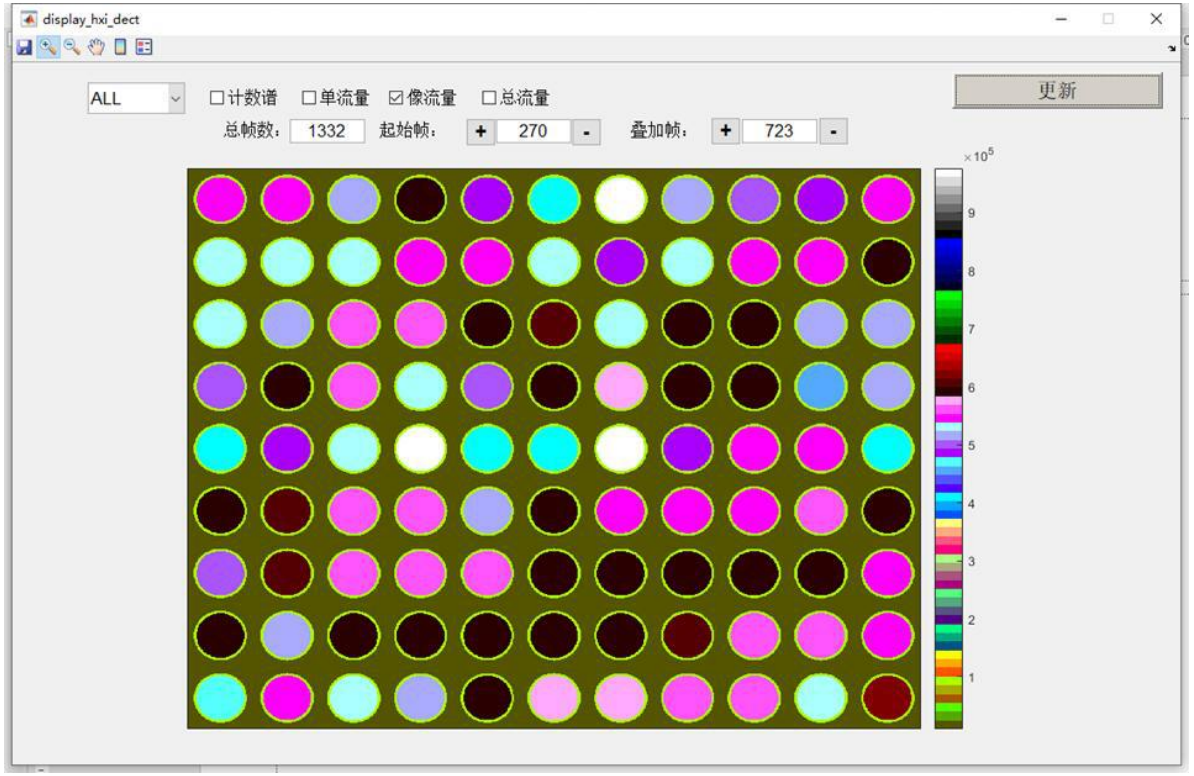


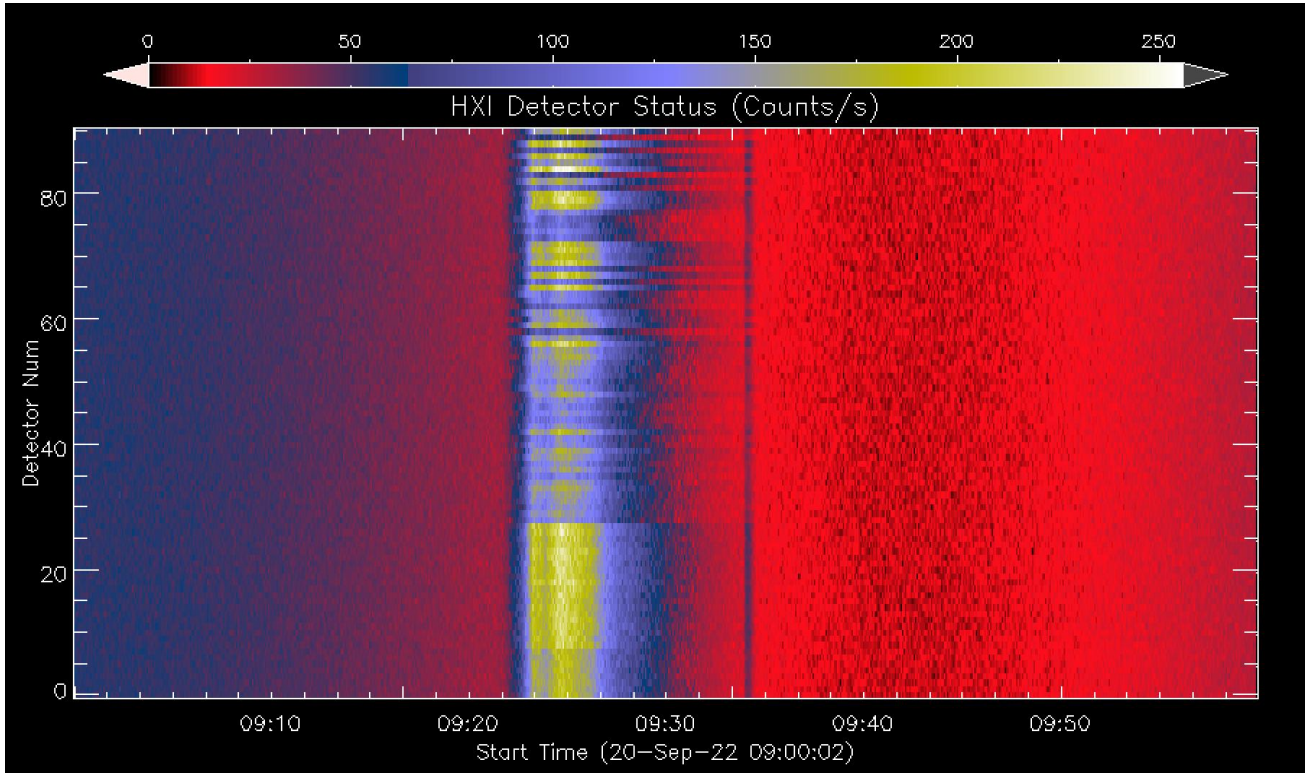




1. HXI progress

Quicklook tools for raw data (ongoing work, Yu Huang, Wei Chen, Yang Su)



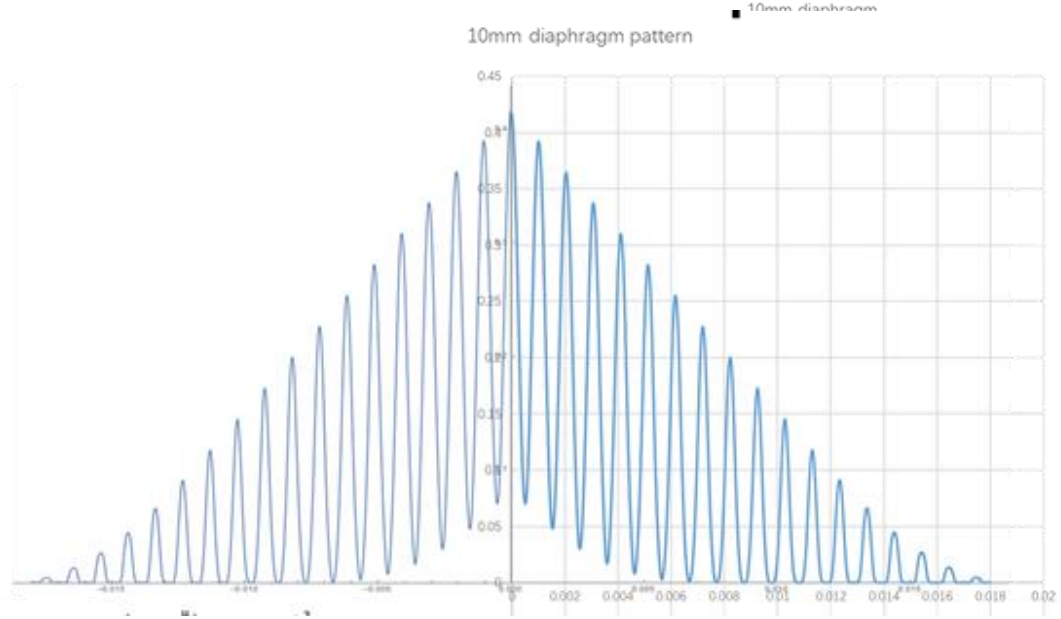


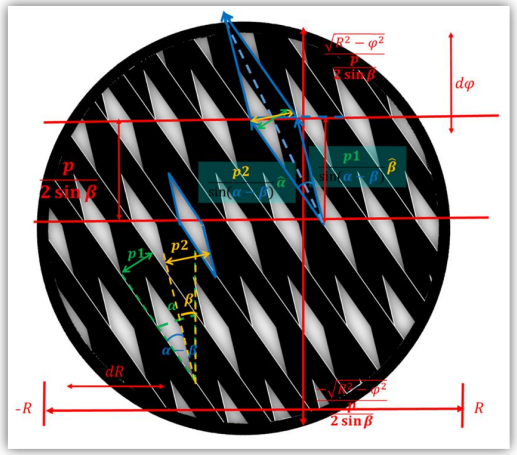
1. HXI progress

Fast, analytical calculation of pattern, by Xiankai Jiang

work in progress

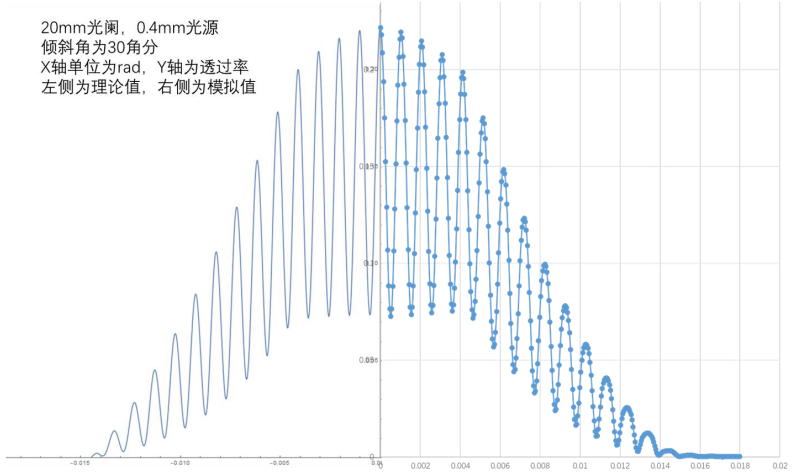
Calculation/Simulation





Rotated case

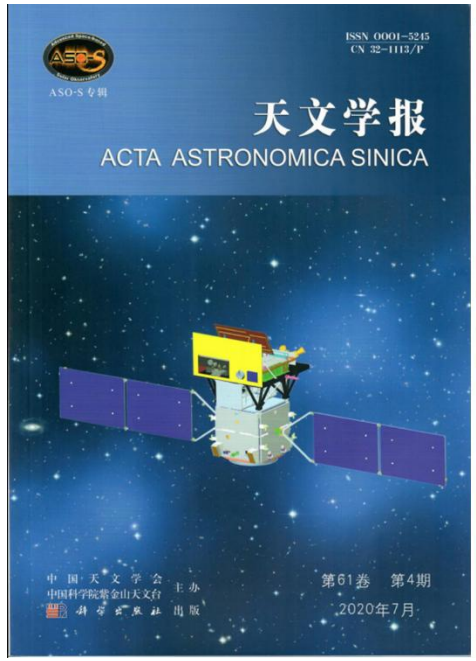
Calculation/Simulation of inclination

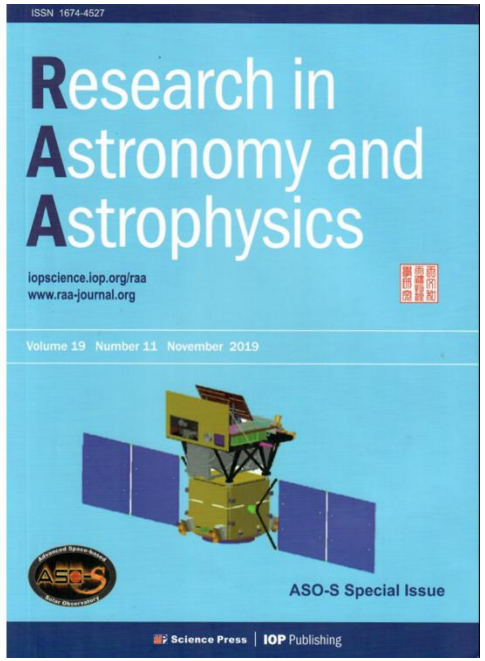


1. HXI progress

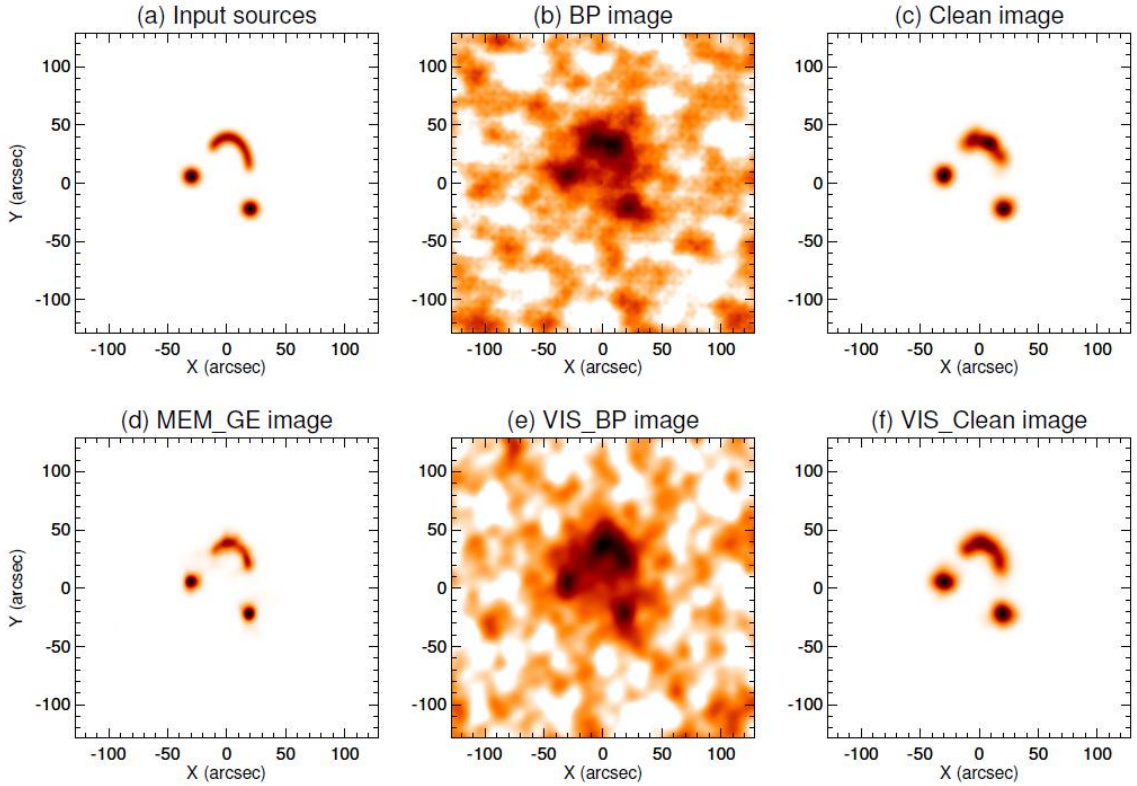
➢HXI-related publications (2019, 2020)

- ASO-S RAA special issue
  - Gan et al. 2019
  - Zhang et al. 2019
  - Su et al. 2019
  - Krucker et al. 2019



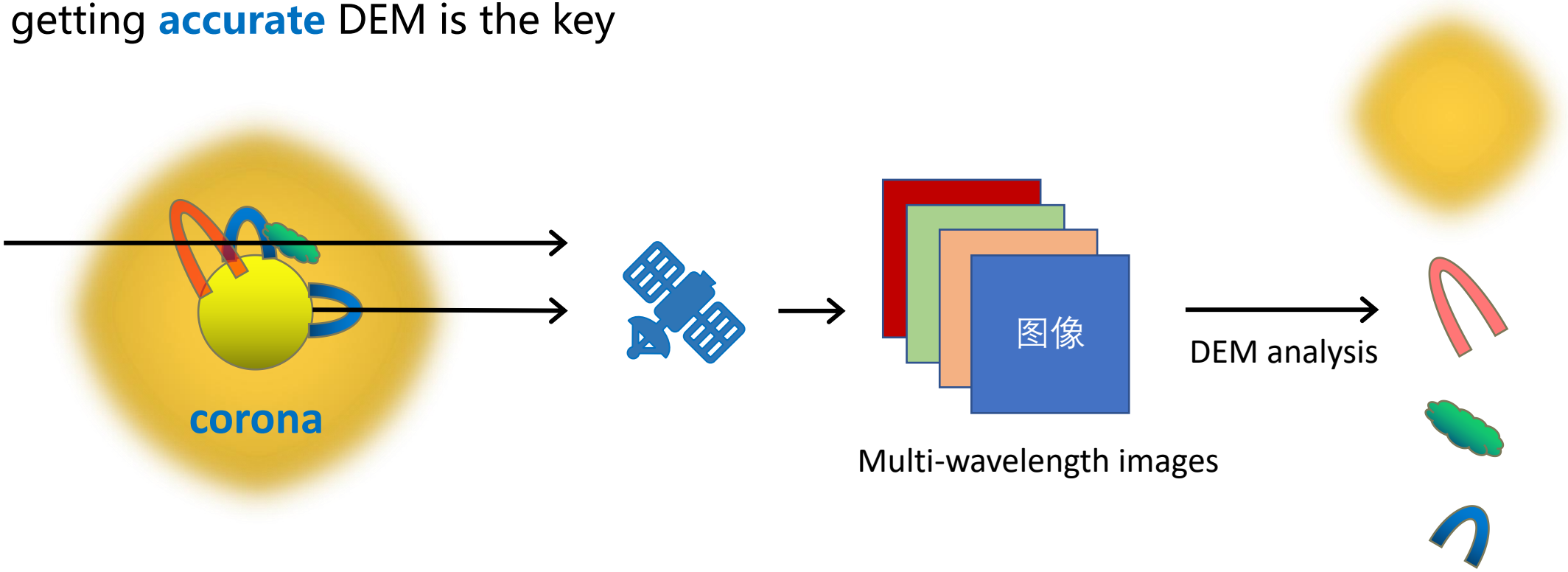


Reconstructed HXI images （Su et al. 2019）



2. DEM analysis

- DEM analysis is widely used in studies of coronal structures
- intensity to physical parameters; separate structures at different temperatures along LOS
- getting **accurate** DEM is the key

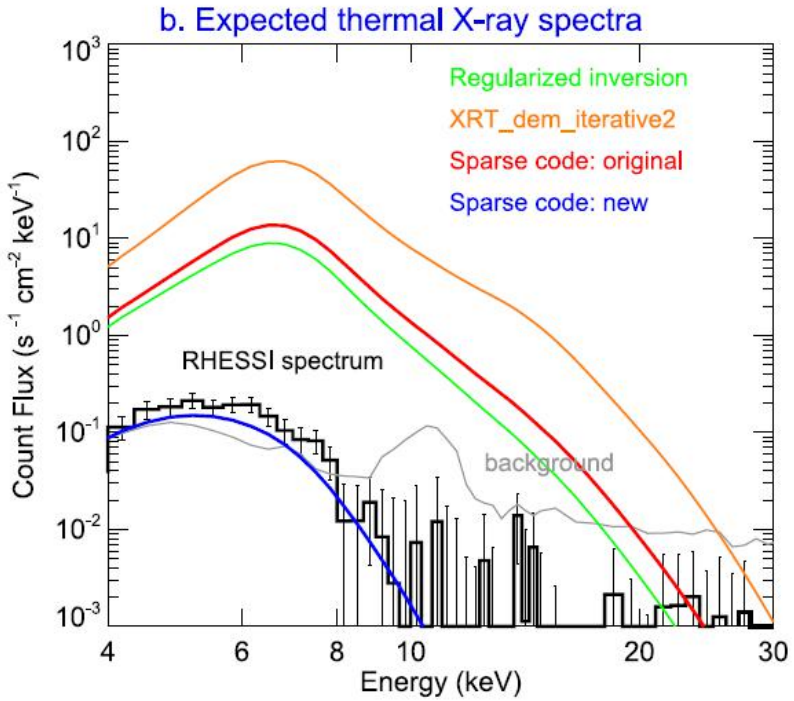


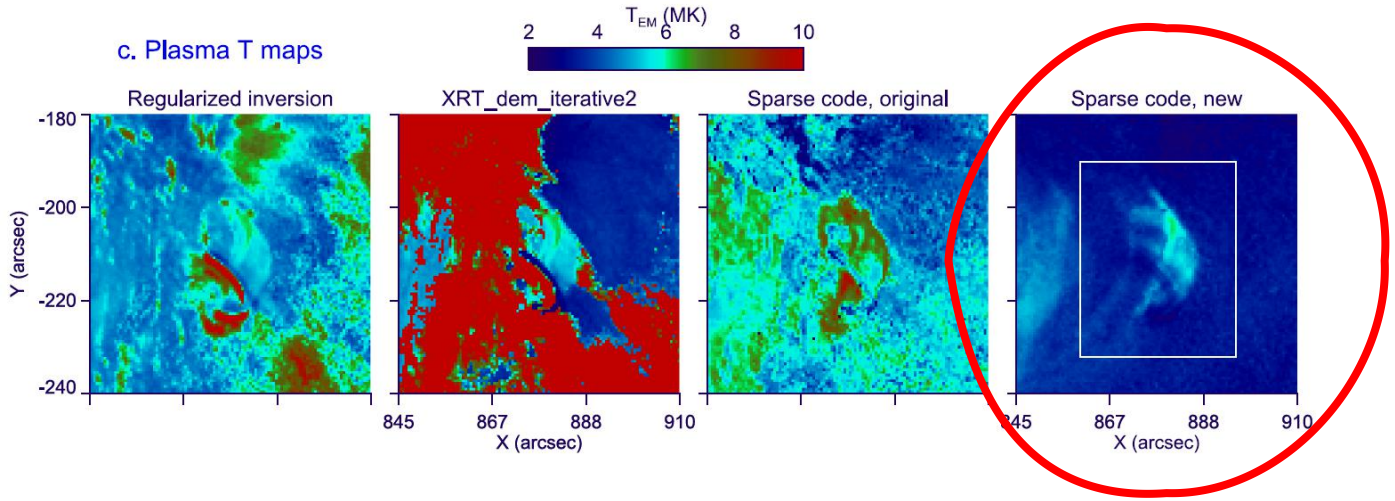
2. DEM analysis

- Improvements on the Sparse DEM code (Cheung et al 2015)

- 2018, **Su et al. 2018, ApJ Letters**
  - Best for flare and active regions
  - More accurate DEM at flare temperatures

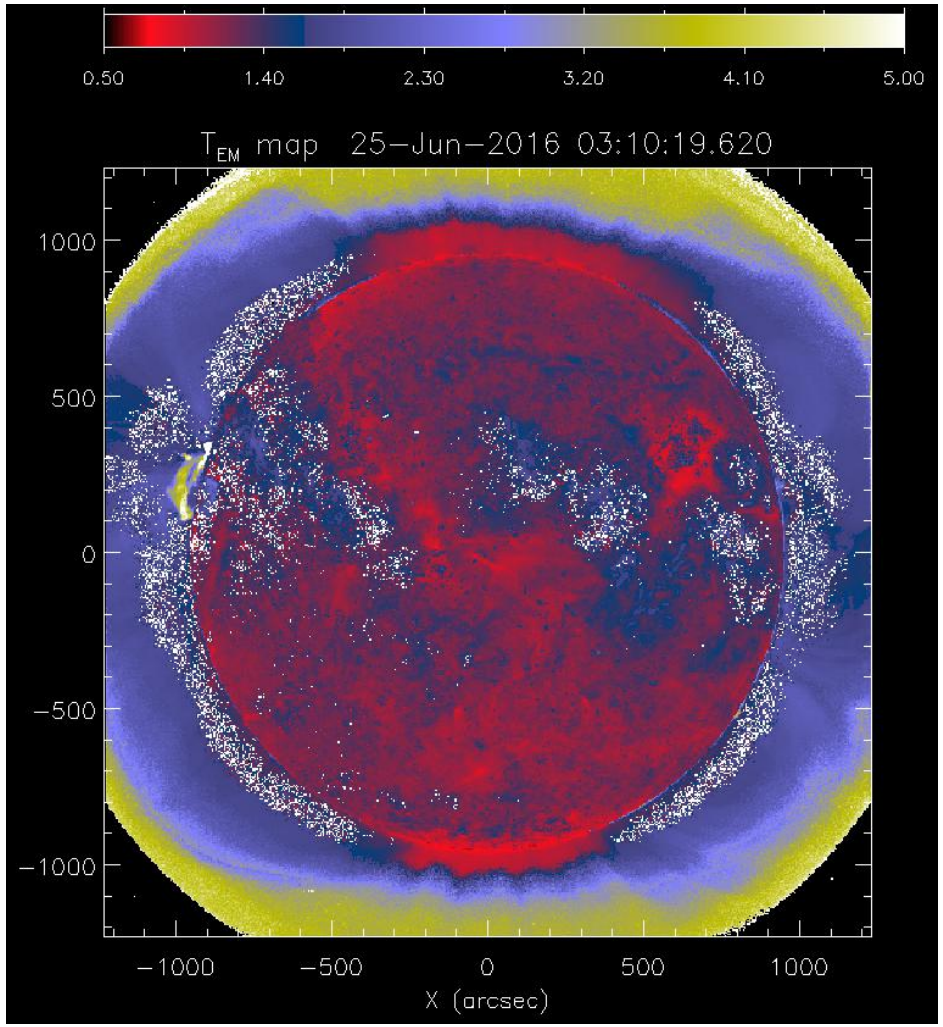
- **Li, Su, et al. 2021, in prep.**
  - for all types of corona structures (except filaments)
  - Solved problems with quiet regions
  - Under final tests



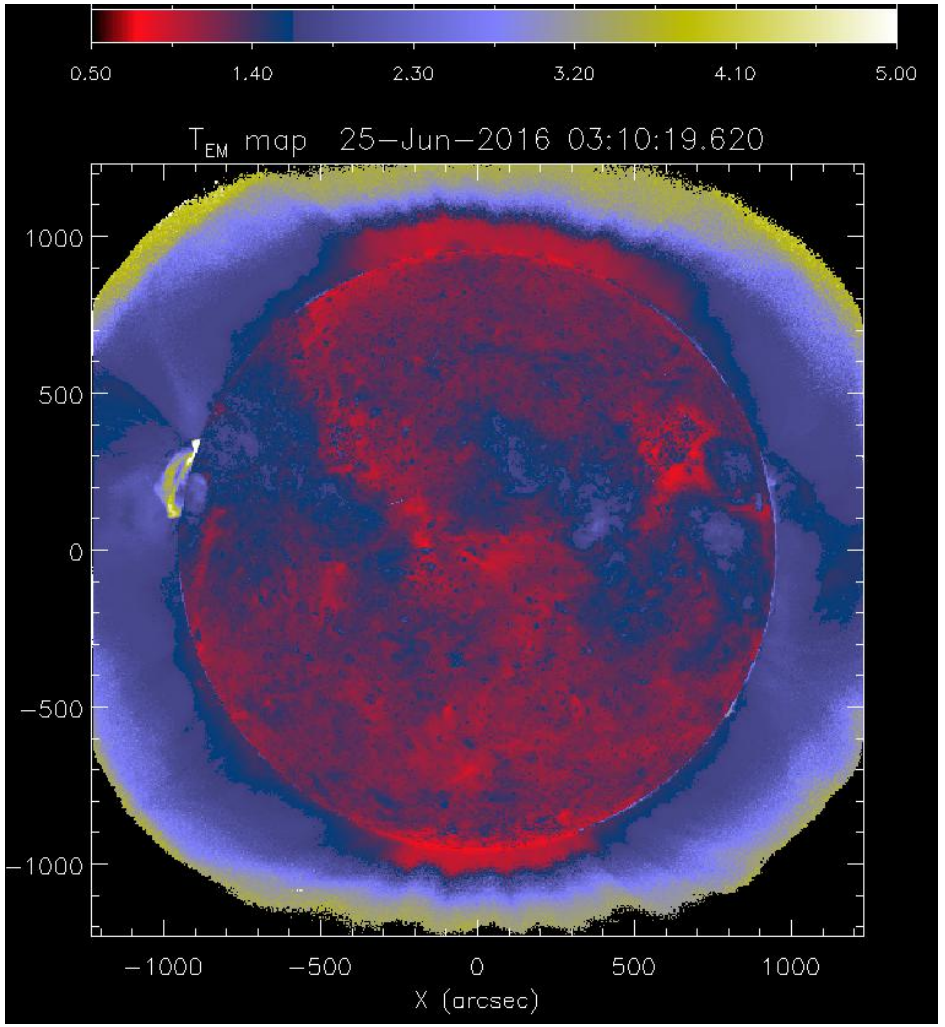


2. DEM analysis

- Original code and previous versions

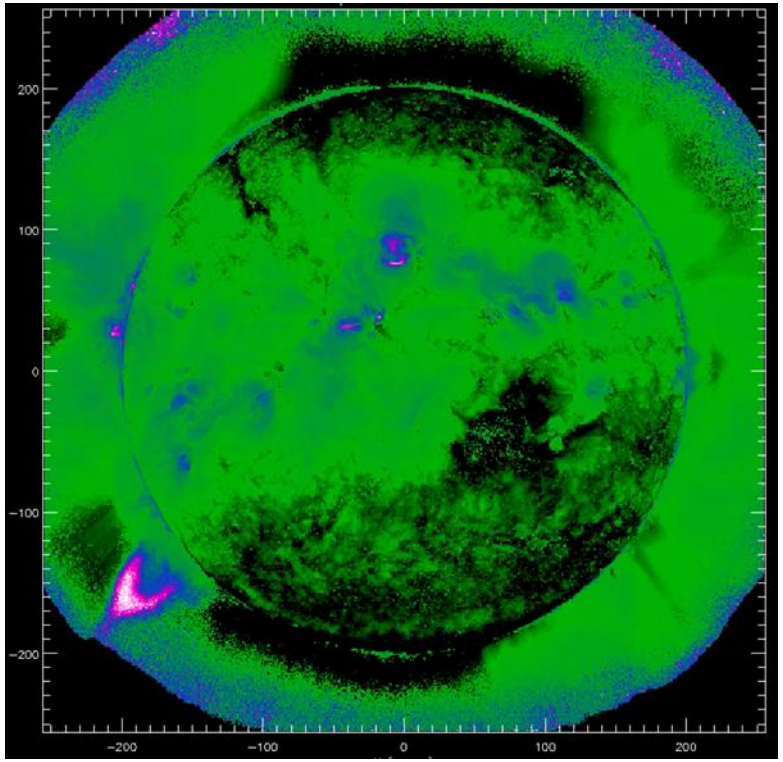


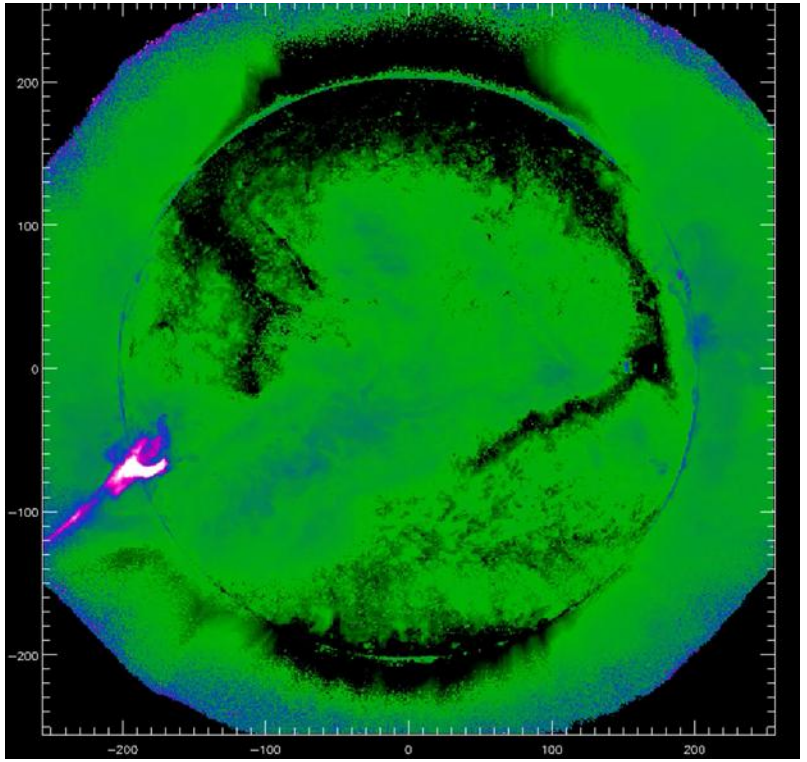
- latest version (Li, Su, et al. 2021, in prep.)

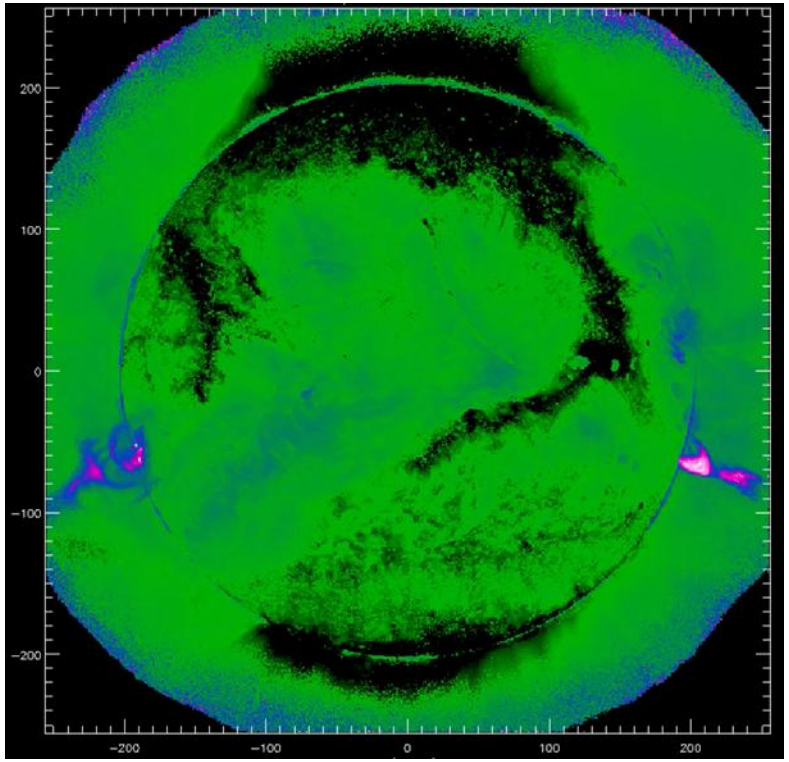


2. DEM analysis

Temperature evolution of large coronal structures (Xia, Su, et al. 2021, in prep.)

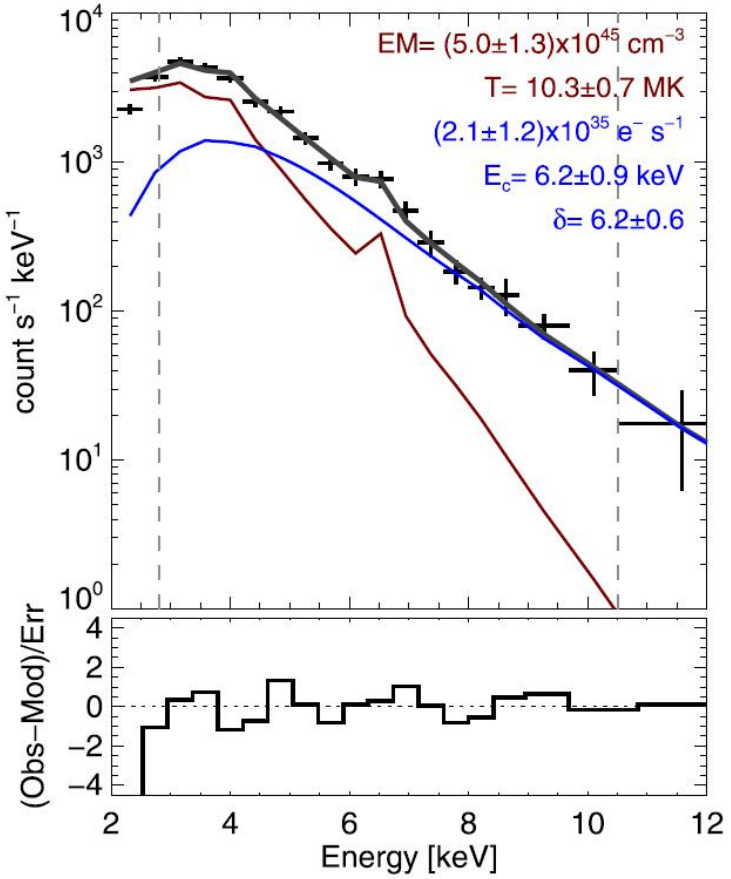






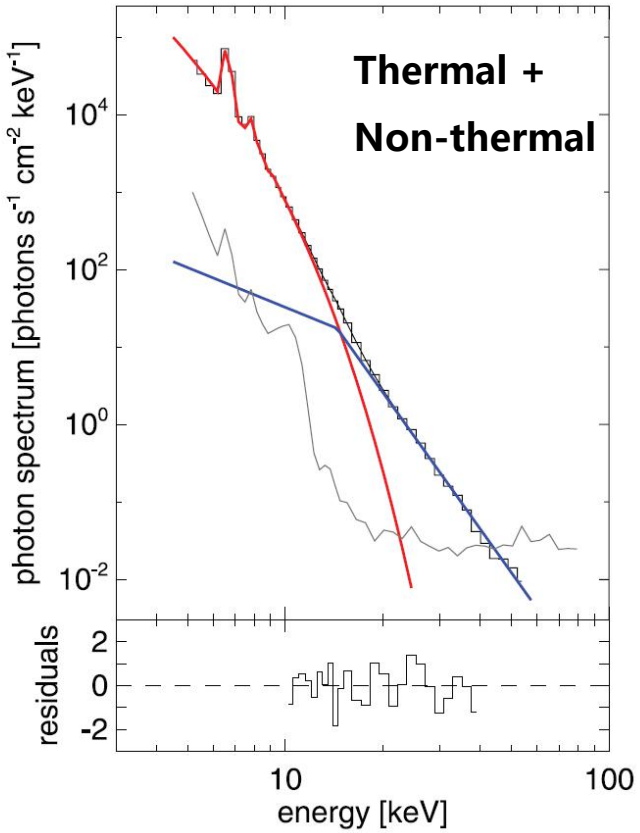
2. DEM analysis

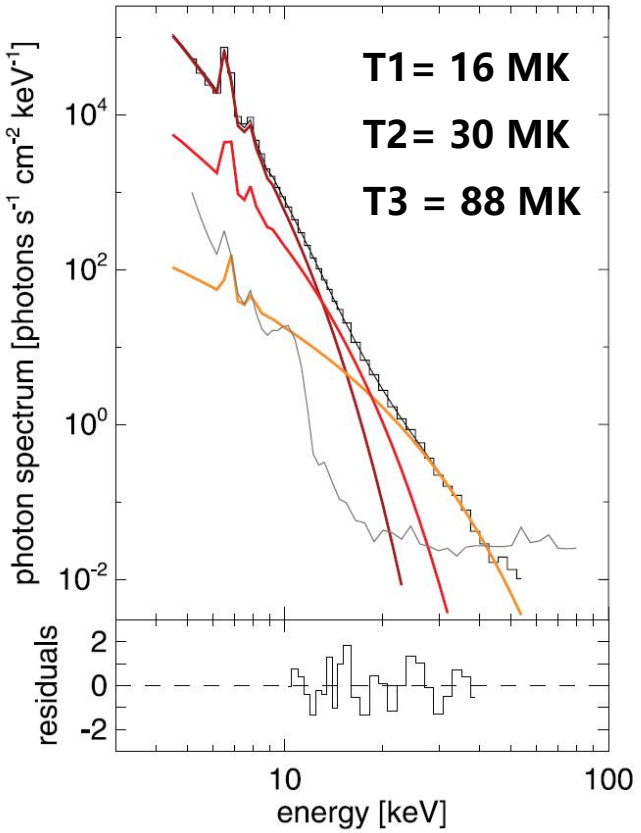
Non-thermal emission in a A-class flare (Glesener et. al. 2020)



However, spectral fitting results may not be enough for determining physical models.

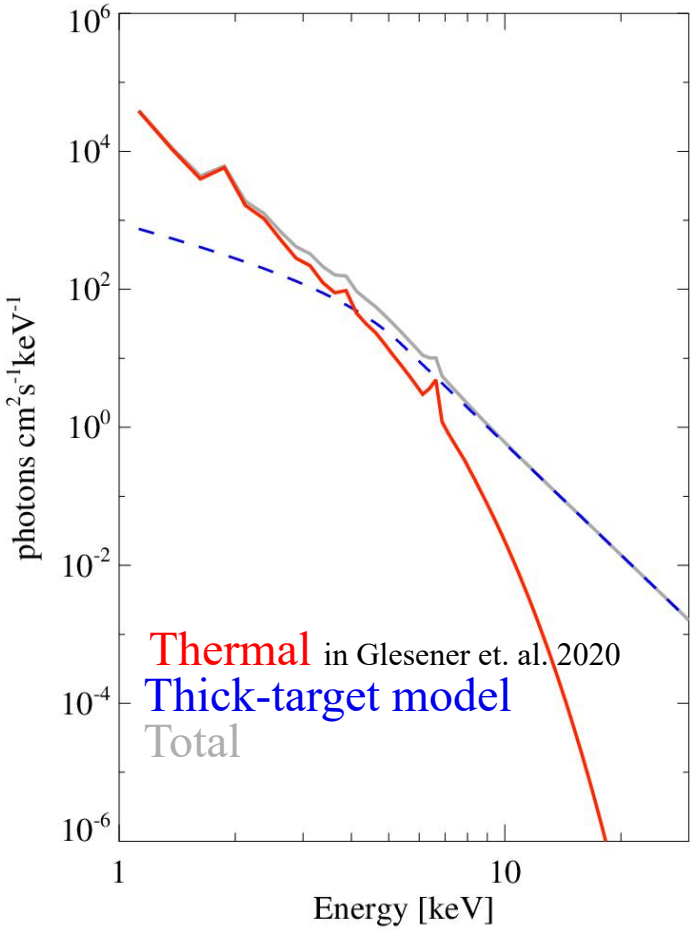
For example, Krucker and Lin 2008

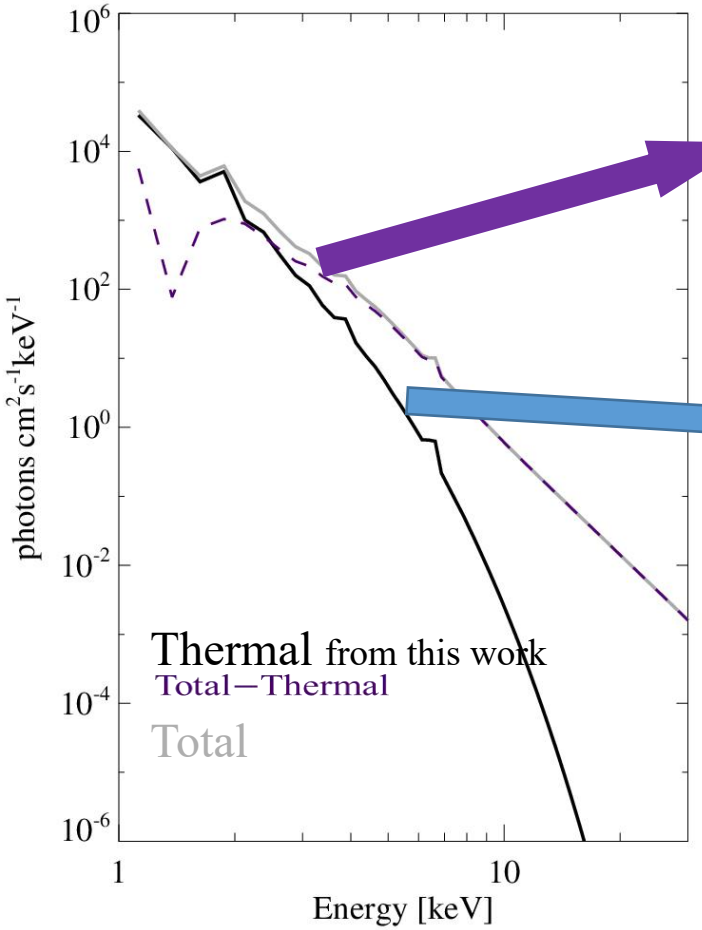




2. DEM analysis

Solid evidence of non-thermal component

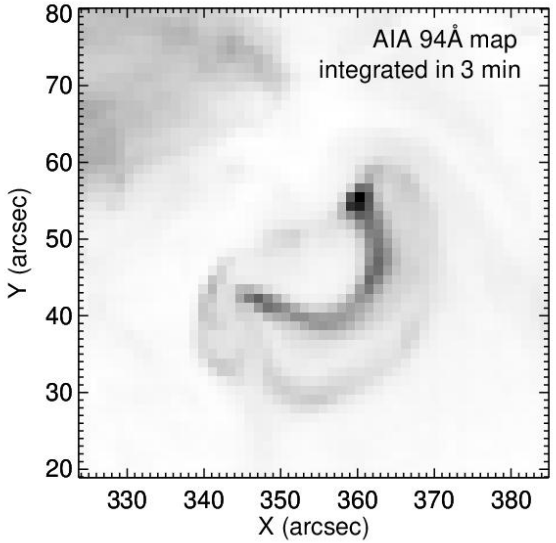




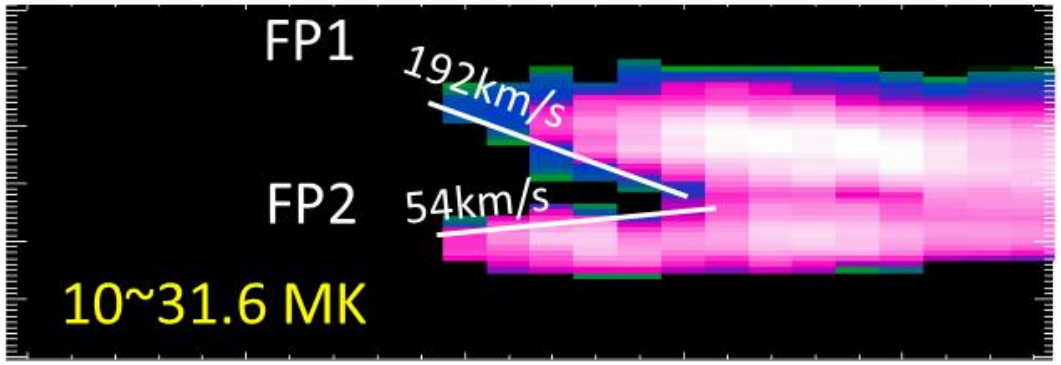
Remaining non-thermal component

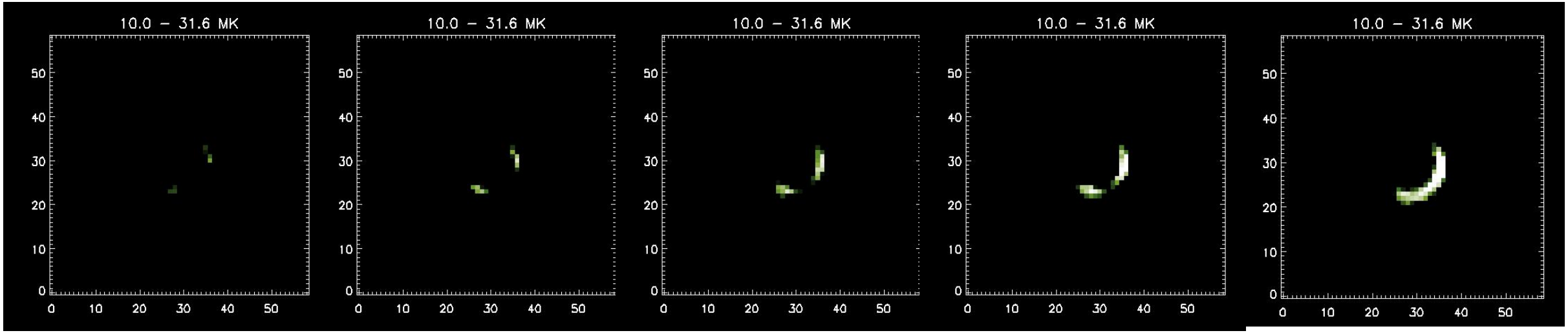
Thermal component calculated from DEM

2. DEM analysis



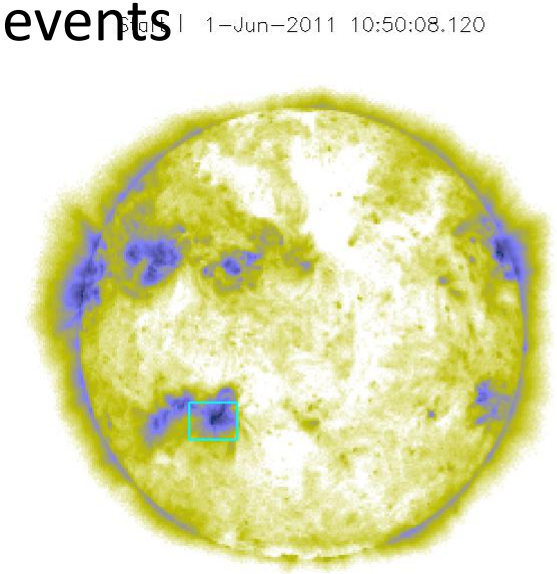
- Heating at footpoints and in flare loops
- Estimation of kinetic energy

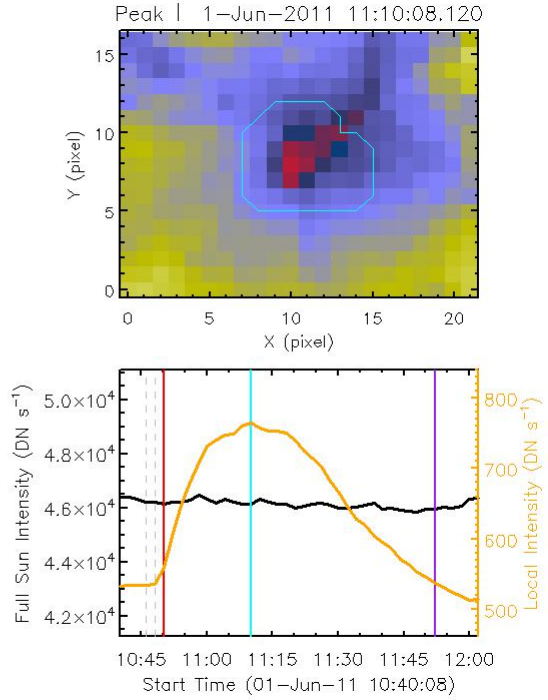




3. New flare list

- Regional flare detection (RFD)
  - Based on synoptic AIA 94 images (2min cadence)
  - More complete flare database （including microflares）
  - More sensitive than other flare detection codes
    - RFD： 2011.01, ~2300 events
    - GOES： 166
    - Solar Demon： 35?
      - Also based on AIA94 images
      - no result for 05 Jan. to 13 Jan.
      - http://solardemon.oma.be/

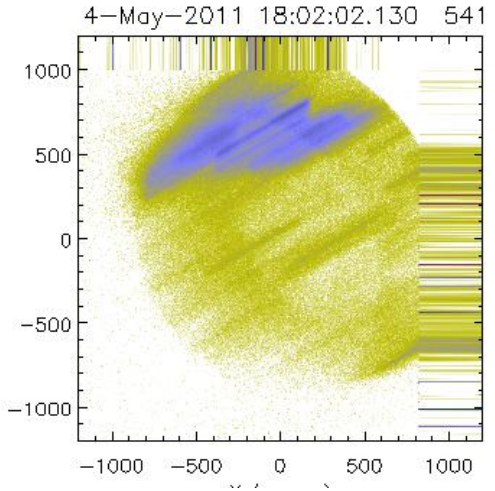


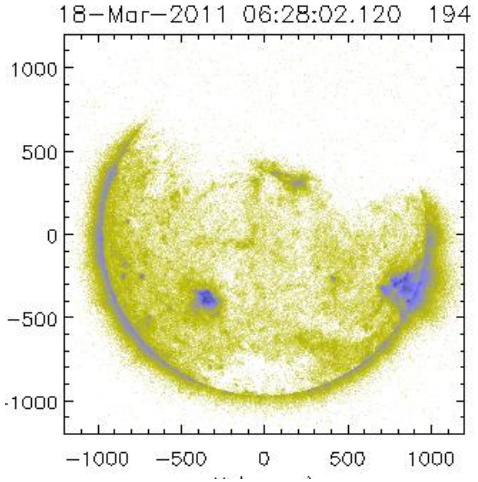


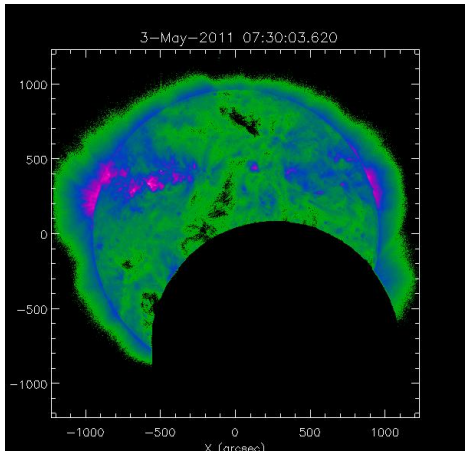
3. New flare list

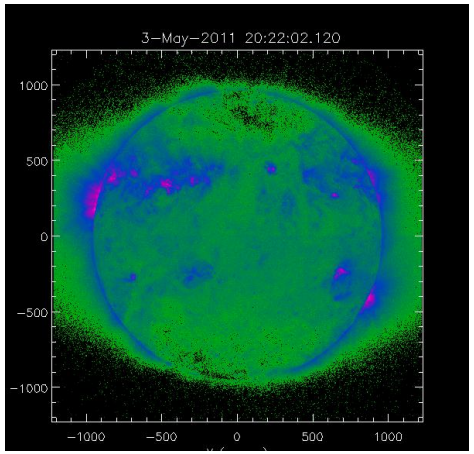
Data processing:

- Synoptic AIA 94 images (1024×1024, 2min cadence)
  - Read FITS and save maps into daily .sav files
  - Removal of bad images
  - alignment of all images
  - Rebin images to new dimension 256
  - Save shifted maps in daily .sav files
  - Detection of flares
  - Save flarelist into .sav and .txt (.json)
  - Save quicklook images



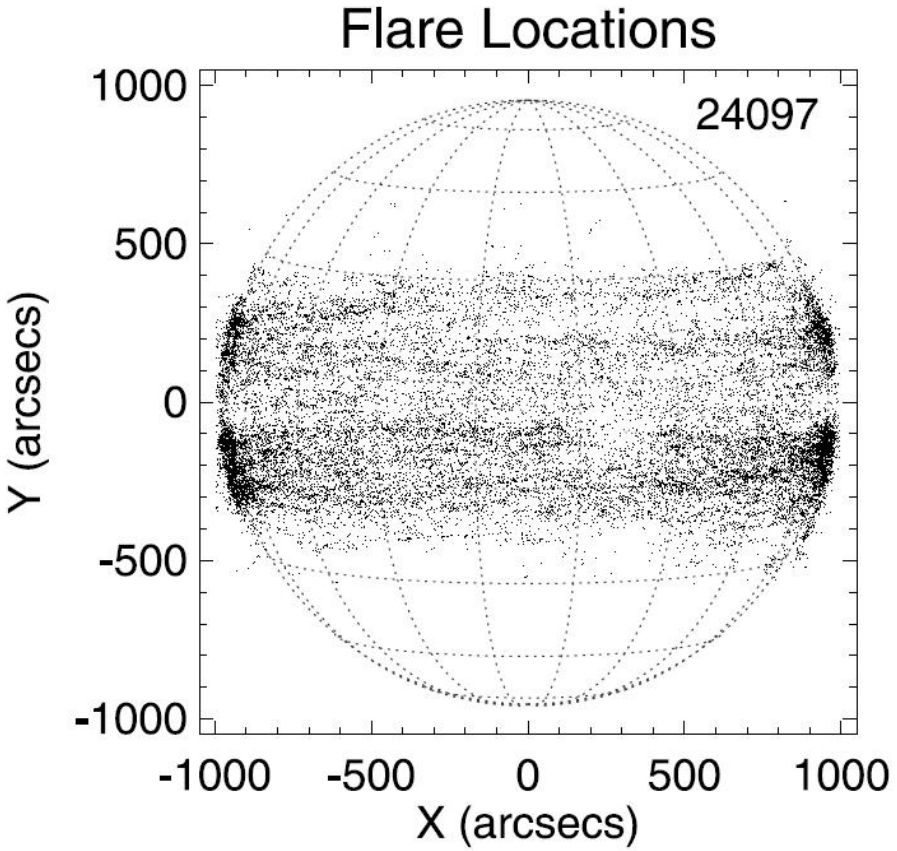




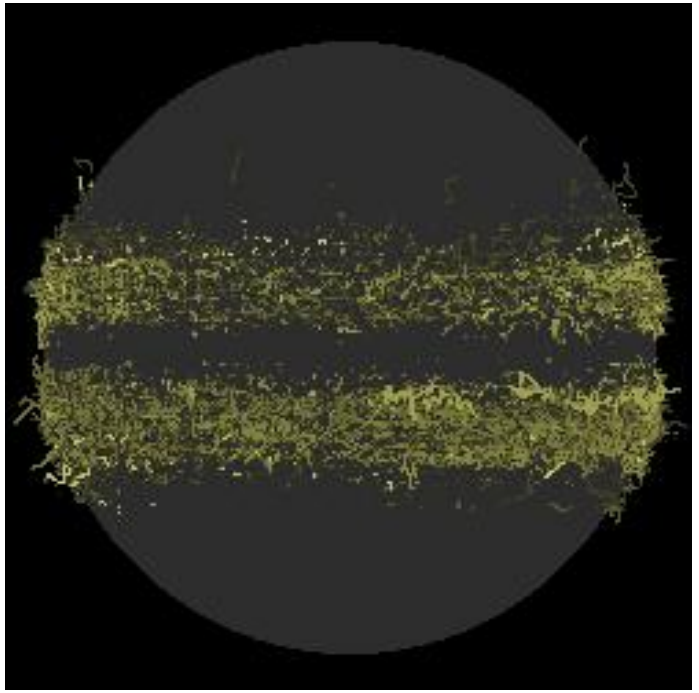


3. New flare list

RHESSI microflares: (Christe et al. 2008)

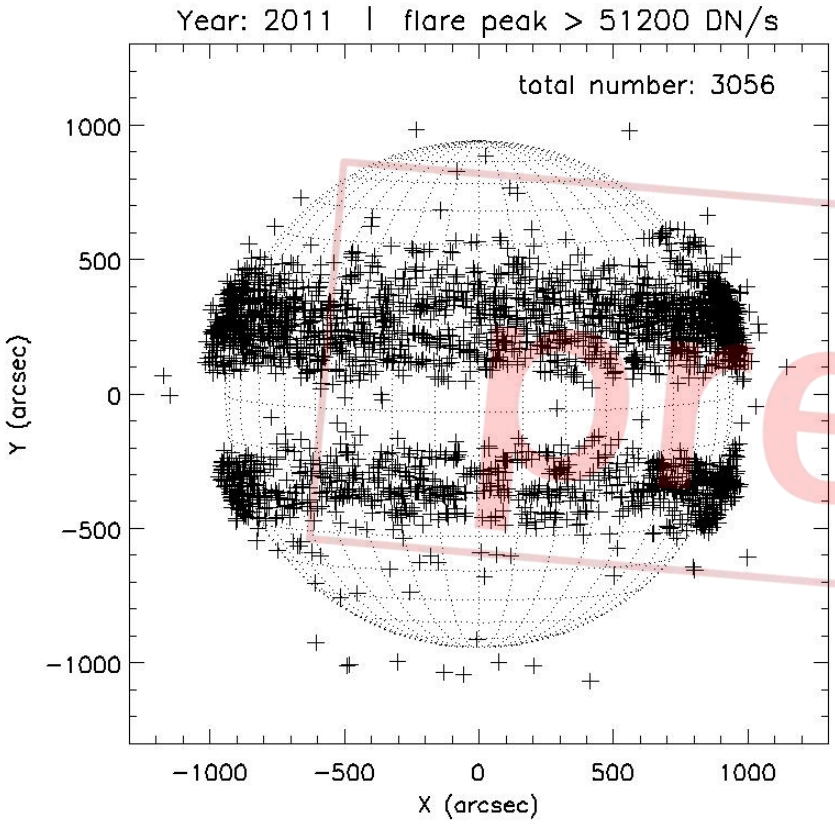


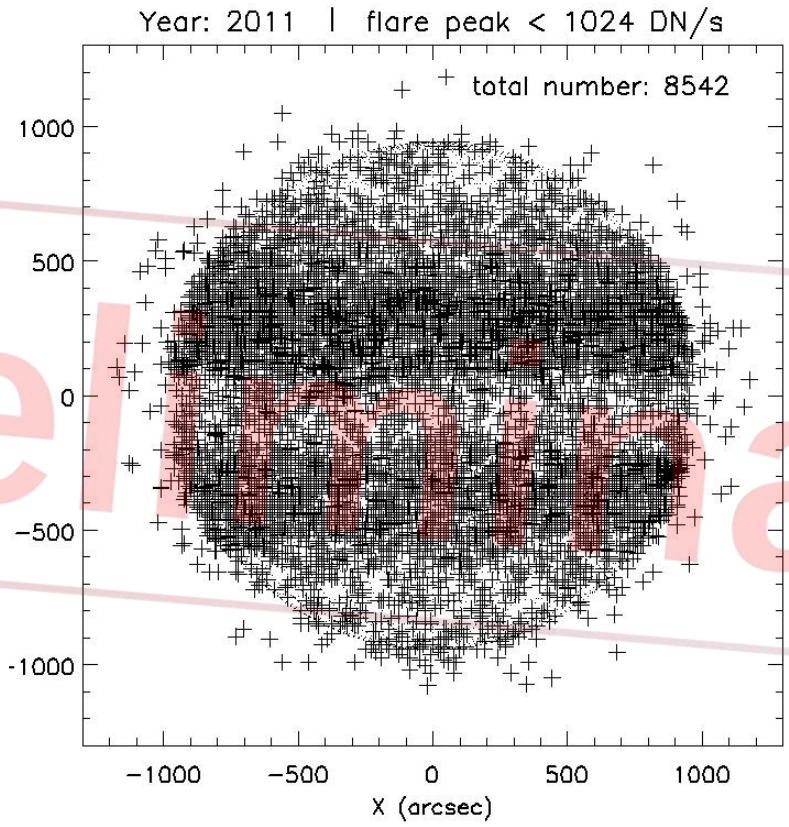
Solar Demon Flare Detection

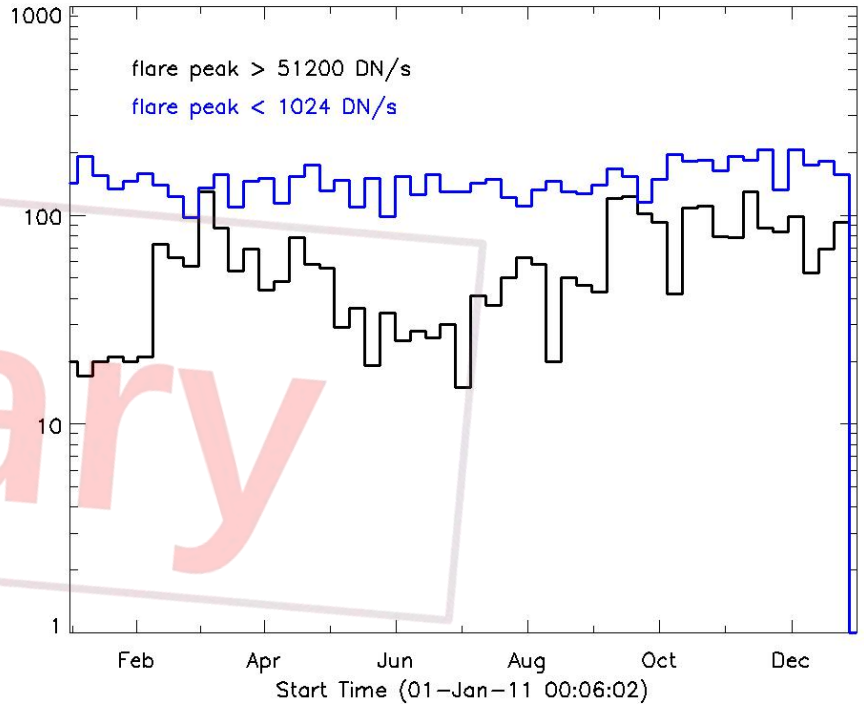


3. New flare list

Microflares and large flares (one year data, Su et al. 2021 in prep.)

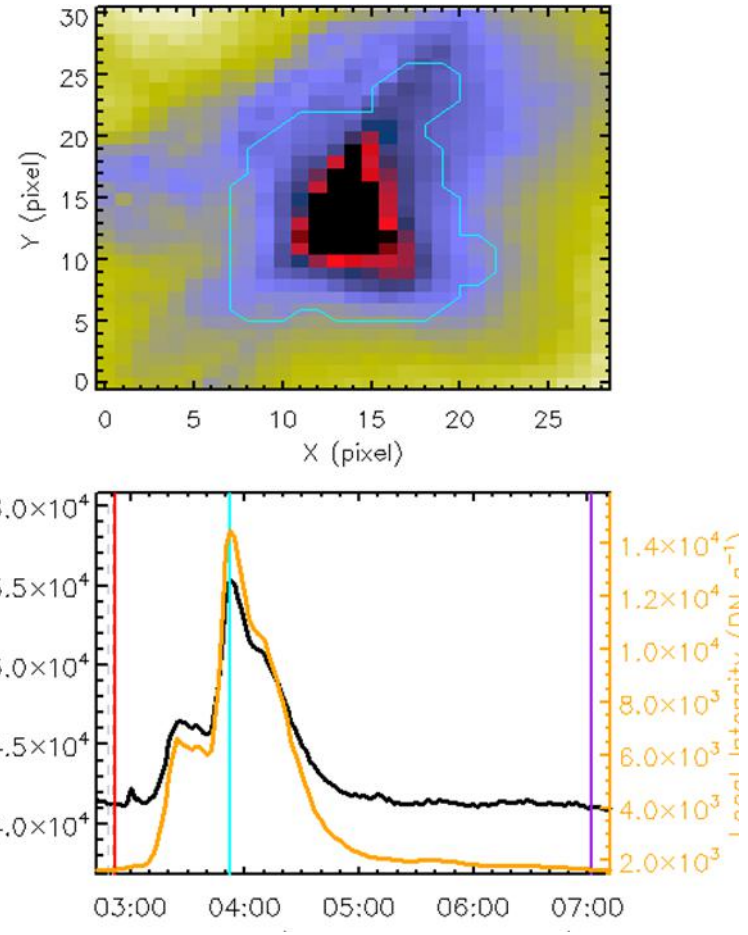


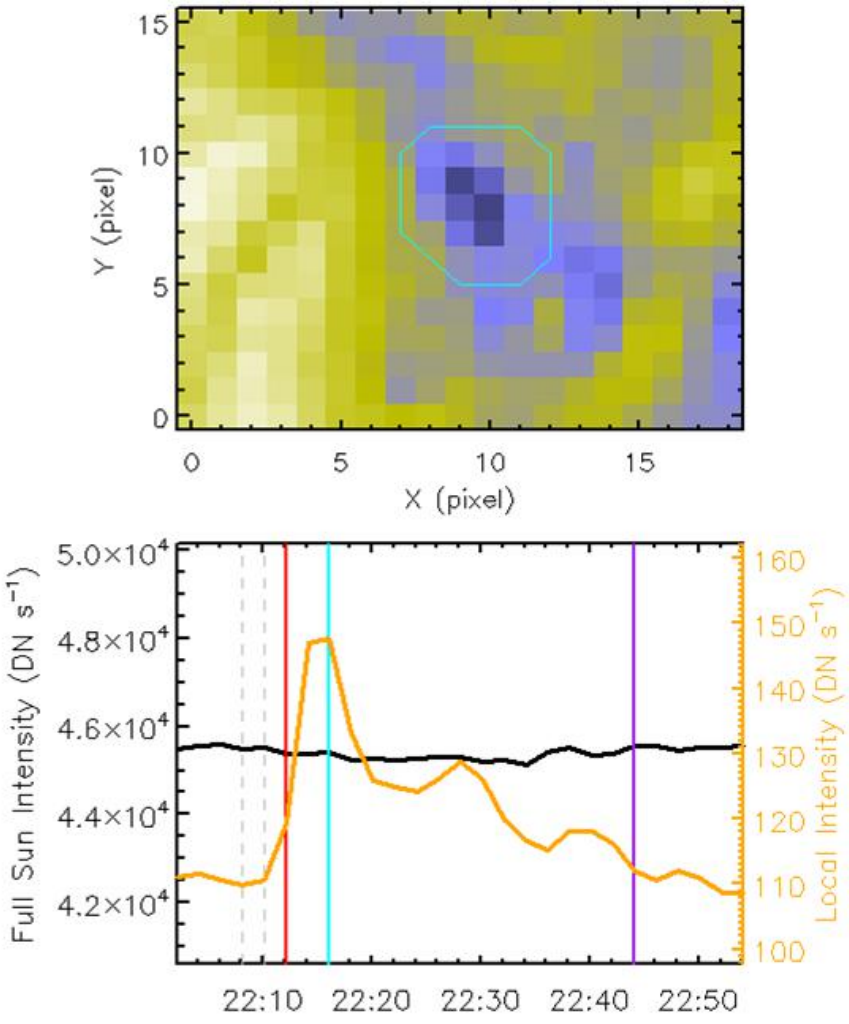




3. New flare list

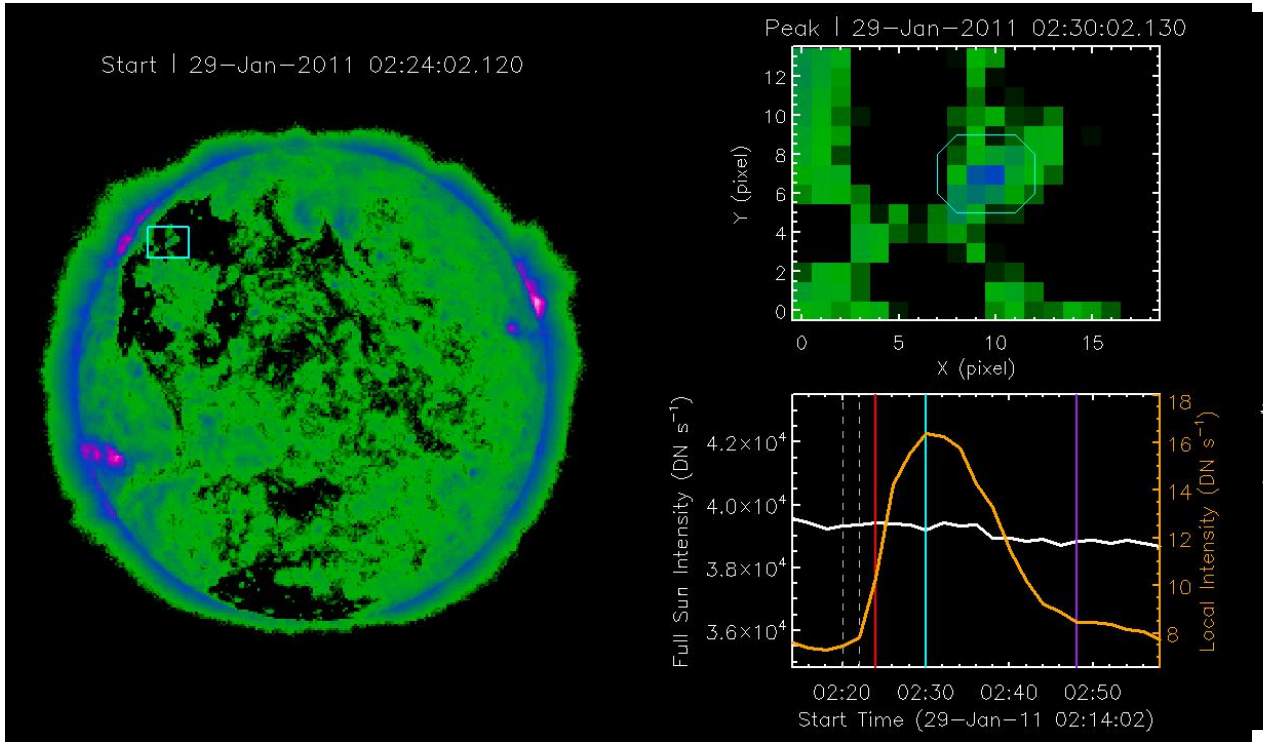
- Detected flares

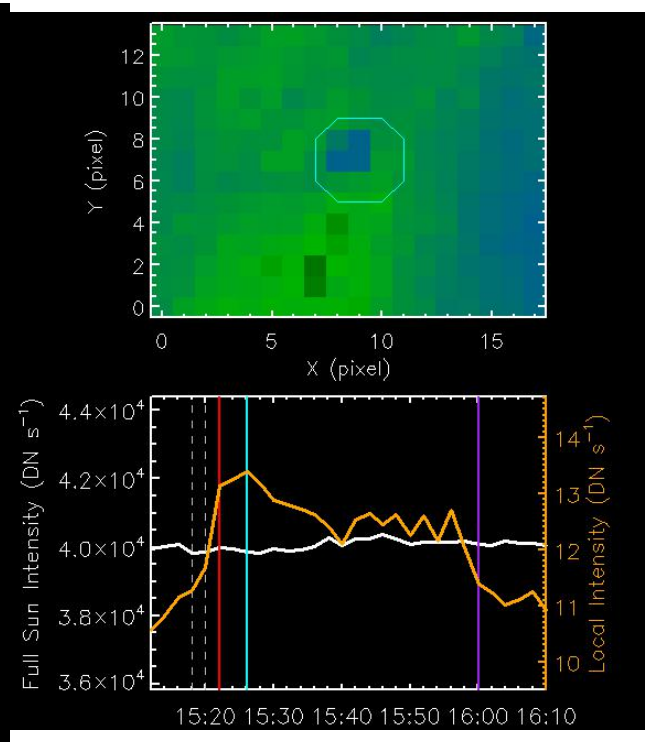


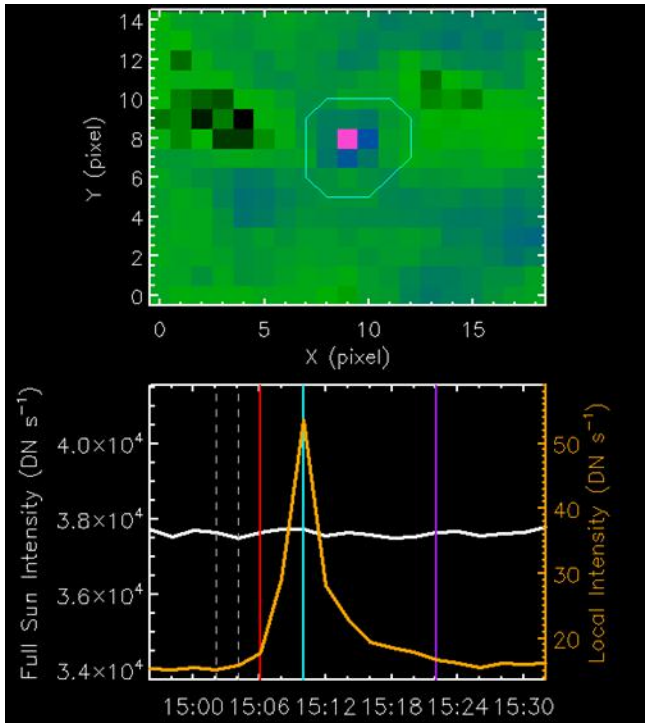


3. New flare list

the most complete flare database: sub-A level activities in quiet region

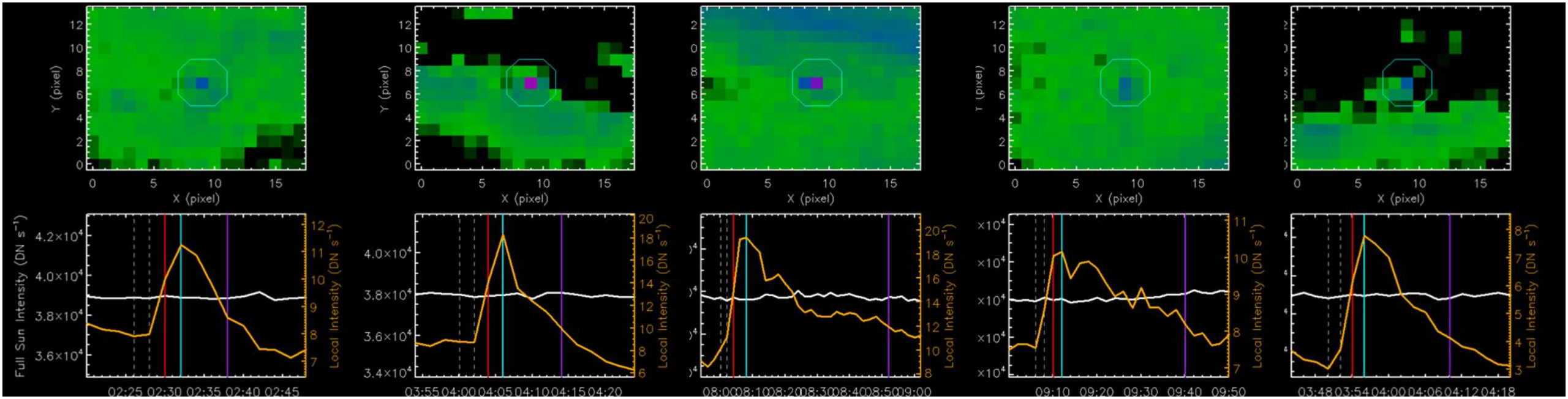






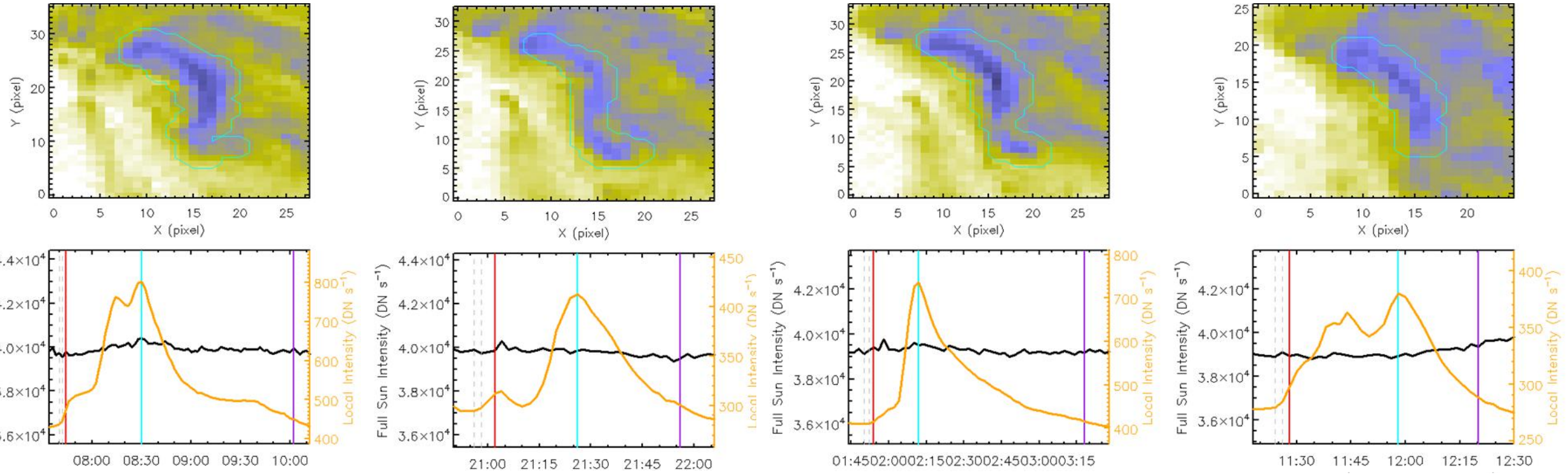
3. New flare list

Microflares (and nanoflares?) in polar region and coronal holes



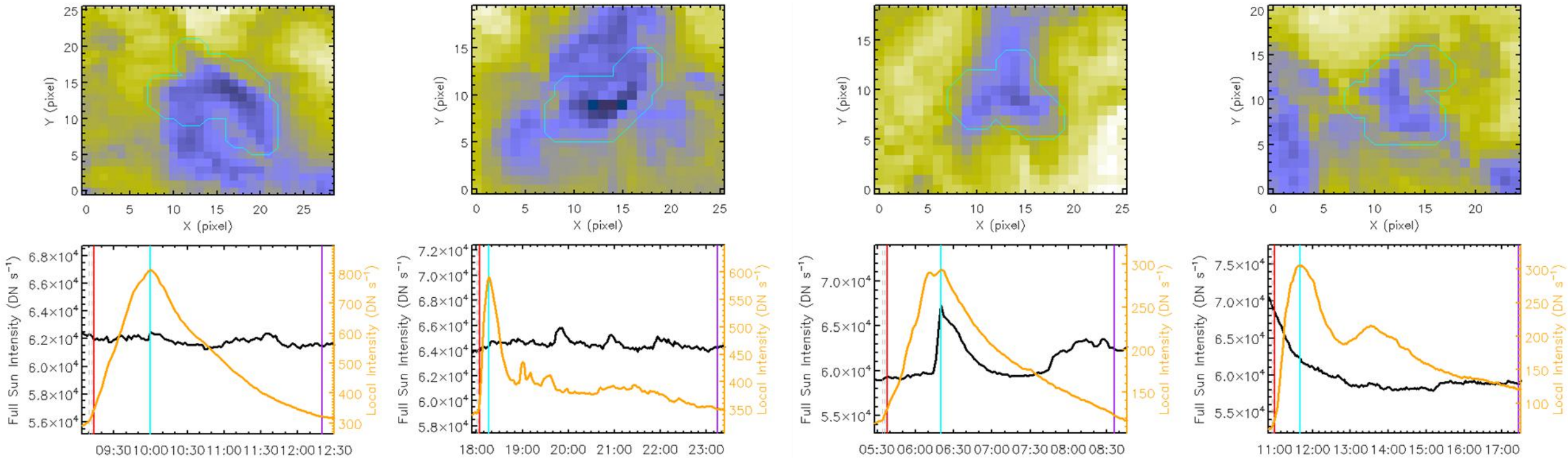
3. New flare list

- Recurrent heating events



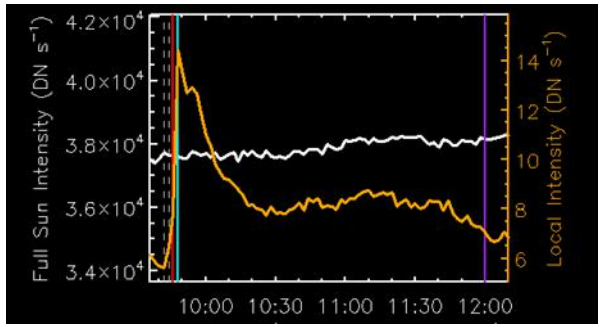
3. New flare list

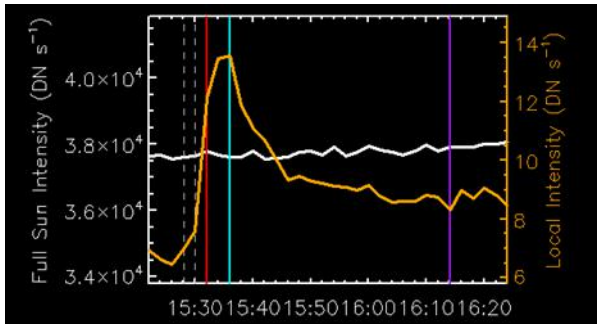
- long-duration (> 3 hours) small flares

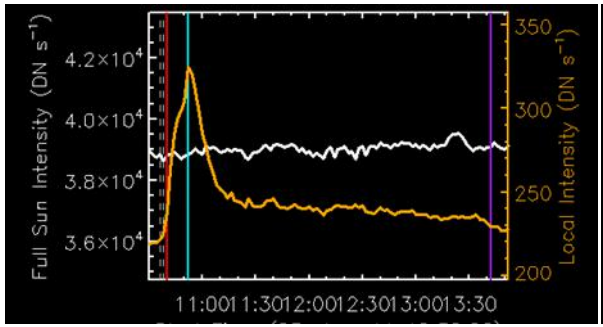


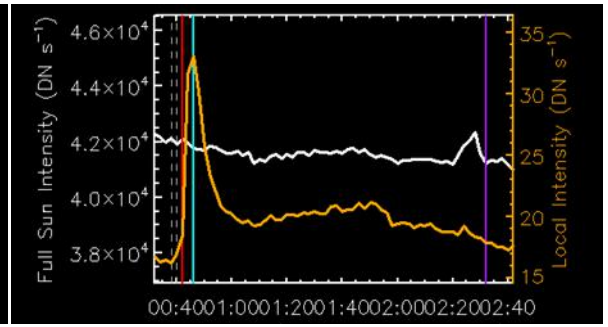
3. New flare list

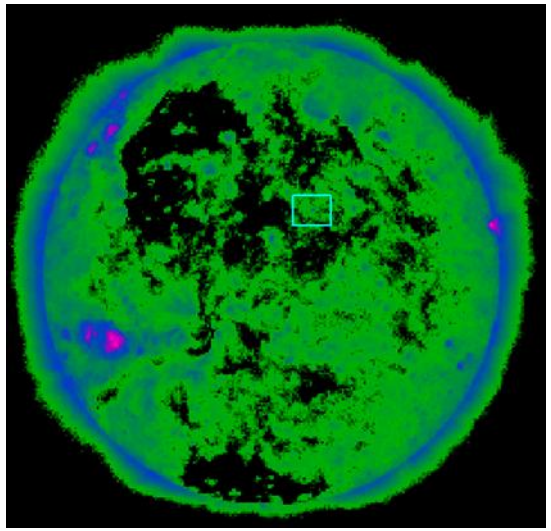
type of flares: case study + statistical study

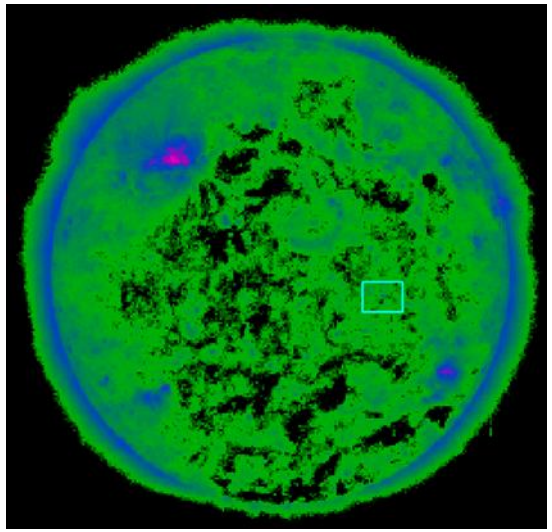


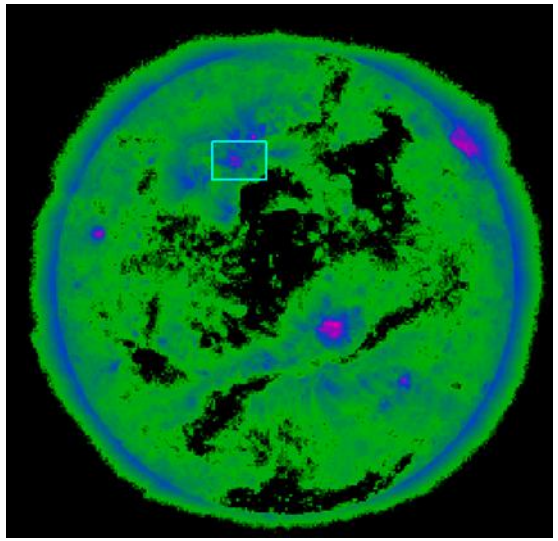


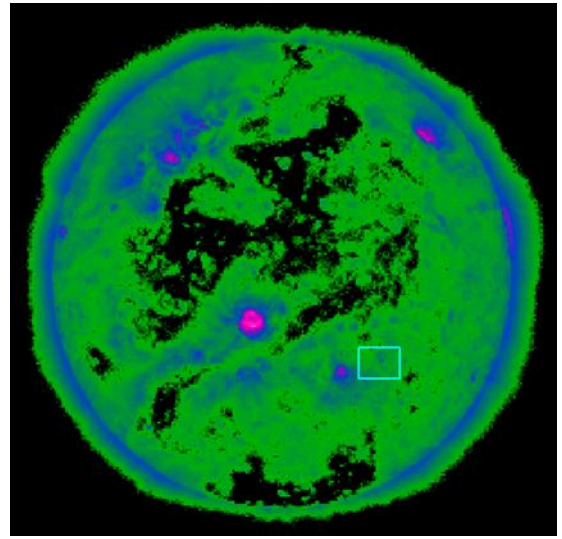




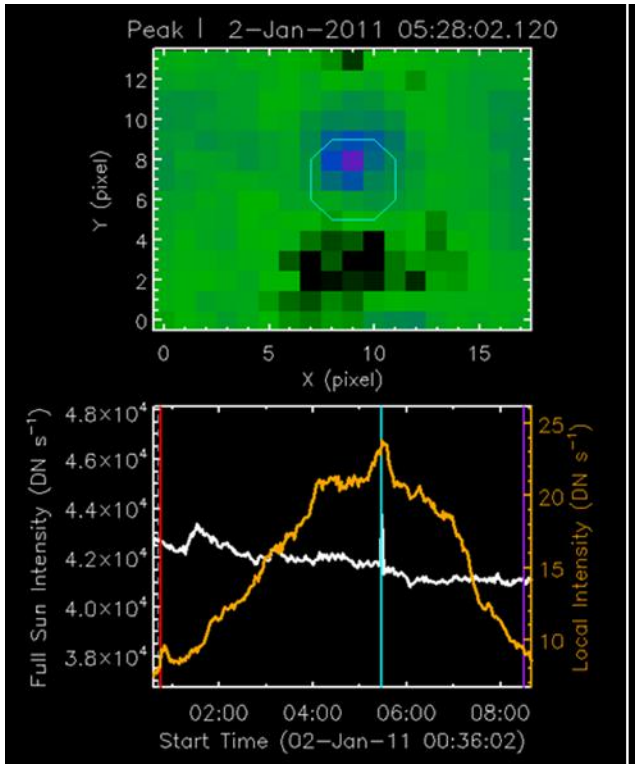


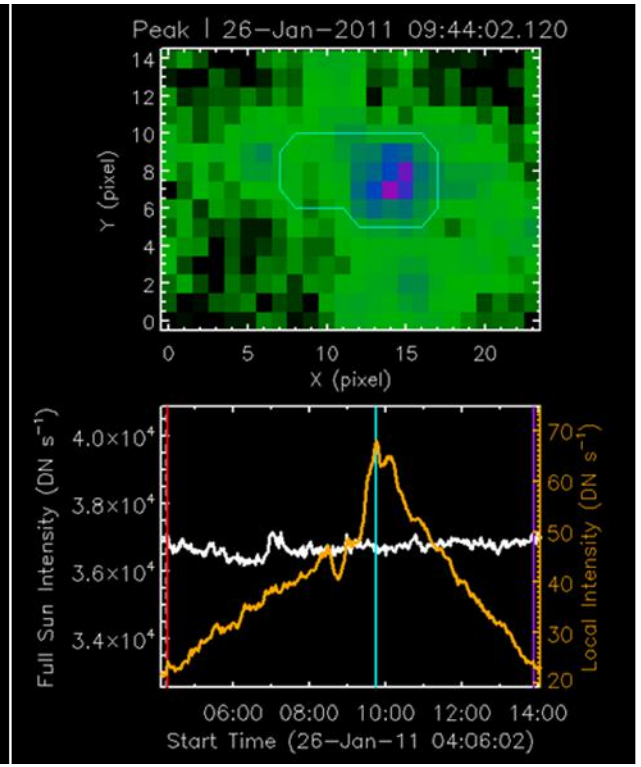


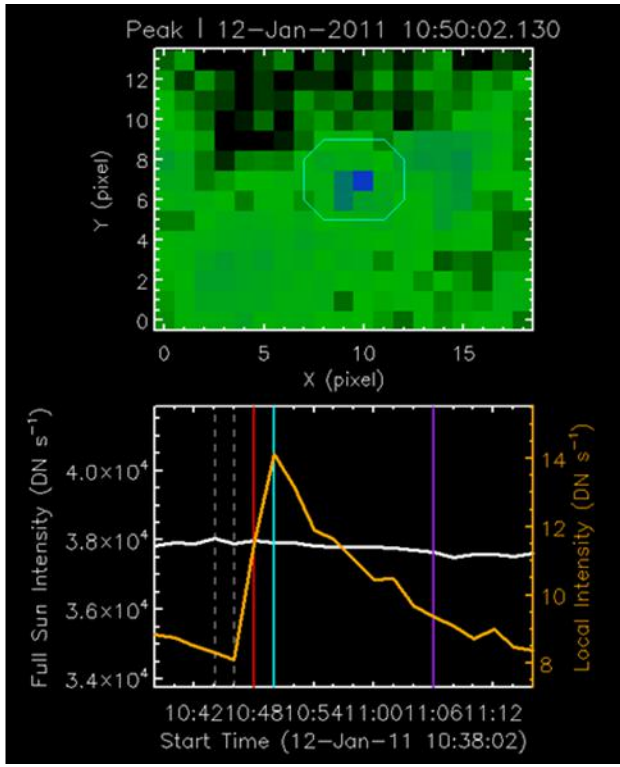


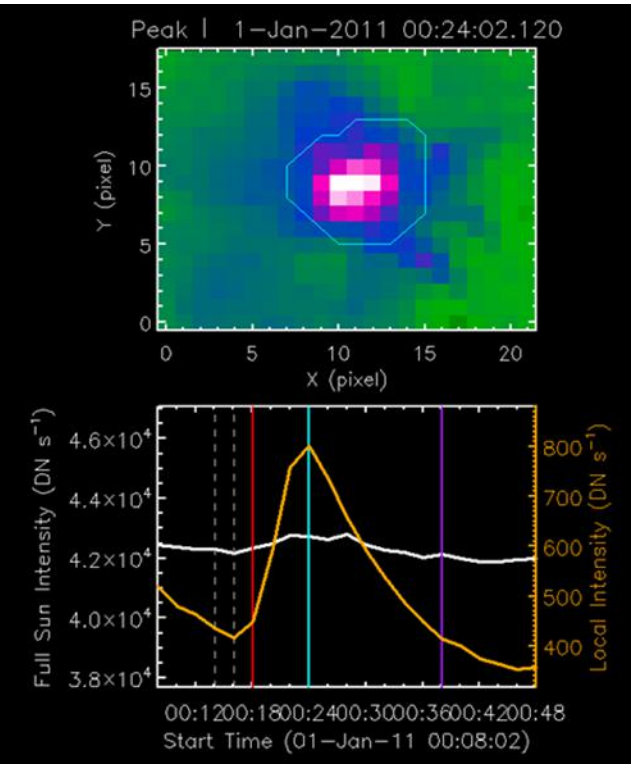


3. New flare list





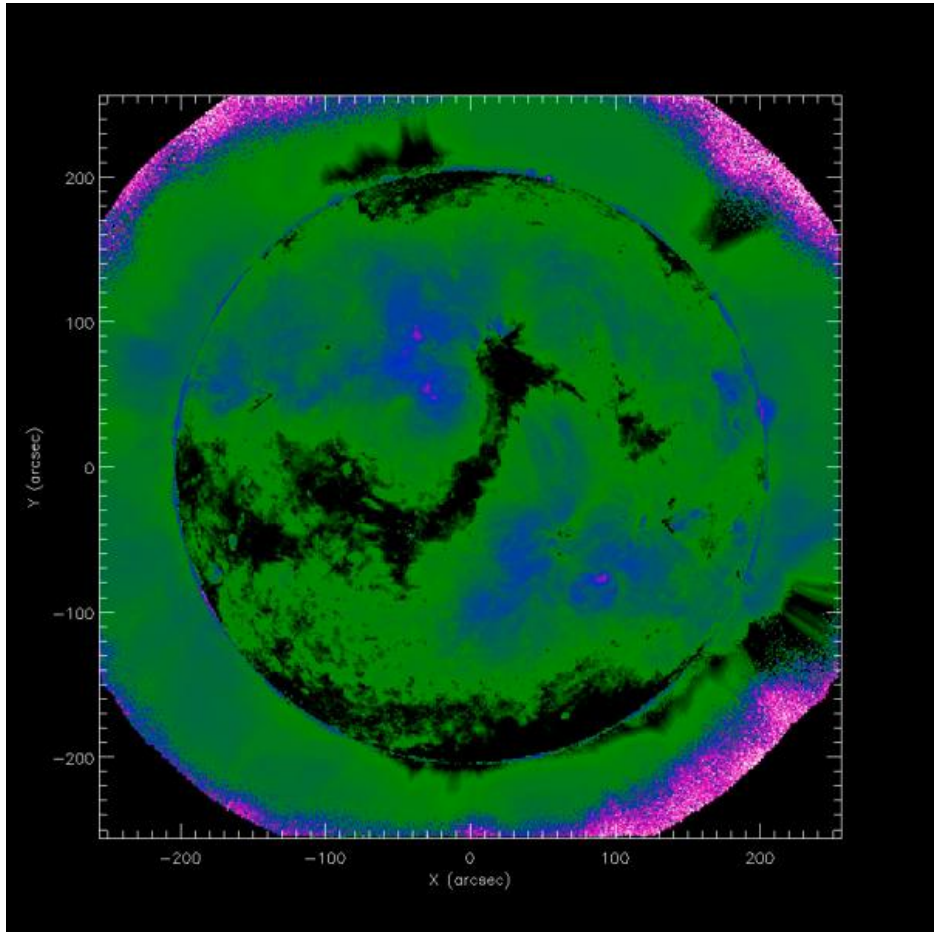




A new database

- High energy solar database in China
  - Offline (for team members):
    - Batse，YOHKOH，RHESSI（2002-2018），GOES，
    - SDO/AIA 94 Å （2010-2020）
    - SDO/AIA six channels （2010-2020，1h cadence）
    - POLAR，GECAM Solar data
  - **online (**~2021，after first publications**):**
    - **Corona DEM evolution database (2010-2021)**
    - **Coronal flare activity database (2010-2021)**

Temperature evolution of corona
XY unit: pixel



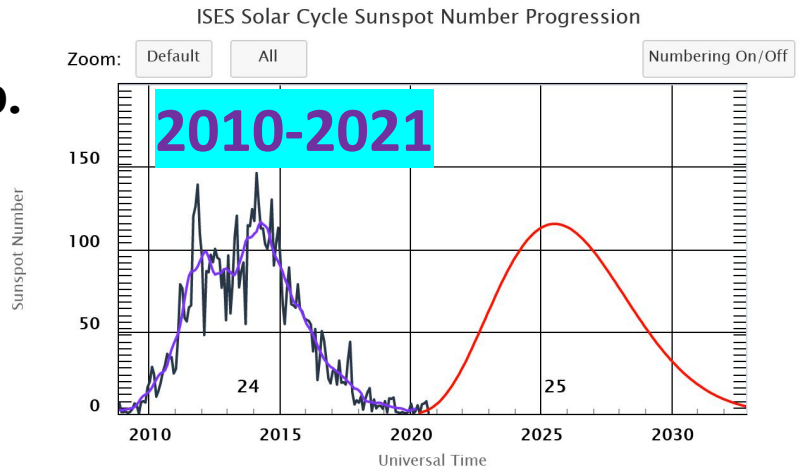
A new database

- Improved version of the sparse code
  - Su et al. 2018, ApJ Letters
  - **Li, Su, et al. 2021, in prep.**
- Regional Flare Detection
  - Yang Su, Lei Lu
  - Proposed in 2016

11year DATABASE

Corona DEM

Flare list



TOPICS

Large scale and long term

- coronal structure and magnetic field
- Active regions
- Quiescent filaments
- Coronal hole and solar wind

Flare statistics and types

- Microflares and coronal heating problem
- small activities and coronal evolution
- Flare trigger process

A new database

中国太阳高能数据库

High Energy Solar Database in China

This is a database for high energy solar physics. It presents the results from data mining of high energy solar data observed by different space missions.

The database is maintained by the high energy solar group (Su, Yang; Xia, Fanxiaoyu; Lu, Lei; et al.) at Purple Mountain Observatory, CAS.

The database is supported by the Joint Research Fund in Astronomy (U1631242) under the cooperative agreement between NSFC and CAS.

Current content

Regional Flare Detection code and AIA 94 flare list（分区域耀斑自动识别和AIA94耀斑列表， 2010-2021 ）

Based on the Regional Flare Detection (RFD) code developed by Yang Su and Lei Lu.

Data source: SDO/AIA 94 Synoptic Data (http://jsoc.stanford.edu/data/aia/synoptic/)

Temperature maps of solar corona（全日面日冕温度结构，2010-2021）

Based on the improved version (Su et al. 2018; Li et al. 2021, in prep.) of the sparse DEM inversion code (Cheung et al. 2015)

Data source: SDO/AIA images taken at six channels (JSOC, 1 hour cadence).

Data processing: Xia, Fanxiaoyu, et al.

Thank You !

AIA94爆发事件数据库

耀斑分区域自动识别程序RFD, V0.9, 苏杨,卢磊,等

网页技术支持： 葛蕴翊

开始日期 2014-01-01 00:00 结束日期 2014-01-03 00:00 peak_min: 默认0 peak_max: 默认100,000,000 xcO_min: 默认0 xcO_max: 默认255

ycO_min: 默认0 ycO_max: 默认255

根据时间筛选 重置

列表

	id	date	startTime	peakTime	endTime	dur(m)	peak	bk	pos	xc_O	yc_O	pixels	eclipse	type	图片预览
1	2014010001	20140101	2014-01-01 00:06:01:000	2014-01-01 00:14:01:000	2014-01-01 00:20:01:000	14.0	4096.54	3912.83	S17W36	185.93	103.60	90.00	0	1	
2	2014010002	20140101	2014-01-01 00:06:01:000	2014-01-01 00:10:01:000	2014-01-01 00:16:01:000	10.0	144.62	109.44	S13E15	103.29	110.09	34.00	0	1	
3	2014010003	20140101	2014-01-01 00:06:01:000	2014-01-01 00:28:01:000	2014-01-01 01:04:01:000	58.0	108.48	92.01	S15E12	108.60	107.60	15.00	0	1	
4	2014010004	20140101	2014-01-01 00:08:01:000	2014-01-01 00:08:01:000	2014-01-01 00:12:01:000	4.0	252.32	245.71	S13E84	30.50	105.50	14.00	0	1	
5	2014010005	20140101	2014-01-01 00:10:01:000	2014-01-01 00:48:01:000	2014-01-01 01:42:01:000	92.0	10593.39	5290.76	S10E90	24.65	110.08	224.00	0	1	
6	2014010006	20140101	2014-01-01 00:12:01:000	2014-01-01 00:12:01:000	2014-01-01 00:24:01:000	12.0	296.71	284.60	S15W89	227.00	102.50	12.00	0	1	
7	2014010007	20140101	2014-01-01 00:18:01:000	2014-01-01 00:34:01:000	2014-01-01 00:40:01:000	22.0	120.14	106.13	S14W21	163.94	108.41	17.00	0	1	
8	2014010008	20140101	2014-01-01 00:28:01:000	2014-01-01 00:58:01:000	2014-01-01 01:24:01:000	56.0	8001.68	4933.38	S18W34	182.48	102.16	163.00	0	1	
9	2014010009	20140101	2014-01-01 00:34:01:000	2014-01-01 00:34:01:000	2014-01-01 00:38:01:000	4.0	239.60	225.71	S19W76	221.60	96.40	15.00	0	1	
10	2014010010	20140101	2014-01-01 00:38:01:000	2014-01-01 00:50:01:000	2014-01-01 01:00:01:000	22.0	192.51	173.84	S13E87	29.88	106.13	8.00	0	1	

20 第 1 共28页 显示1到20,共560记录