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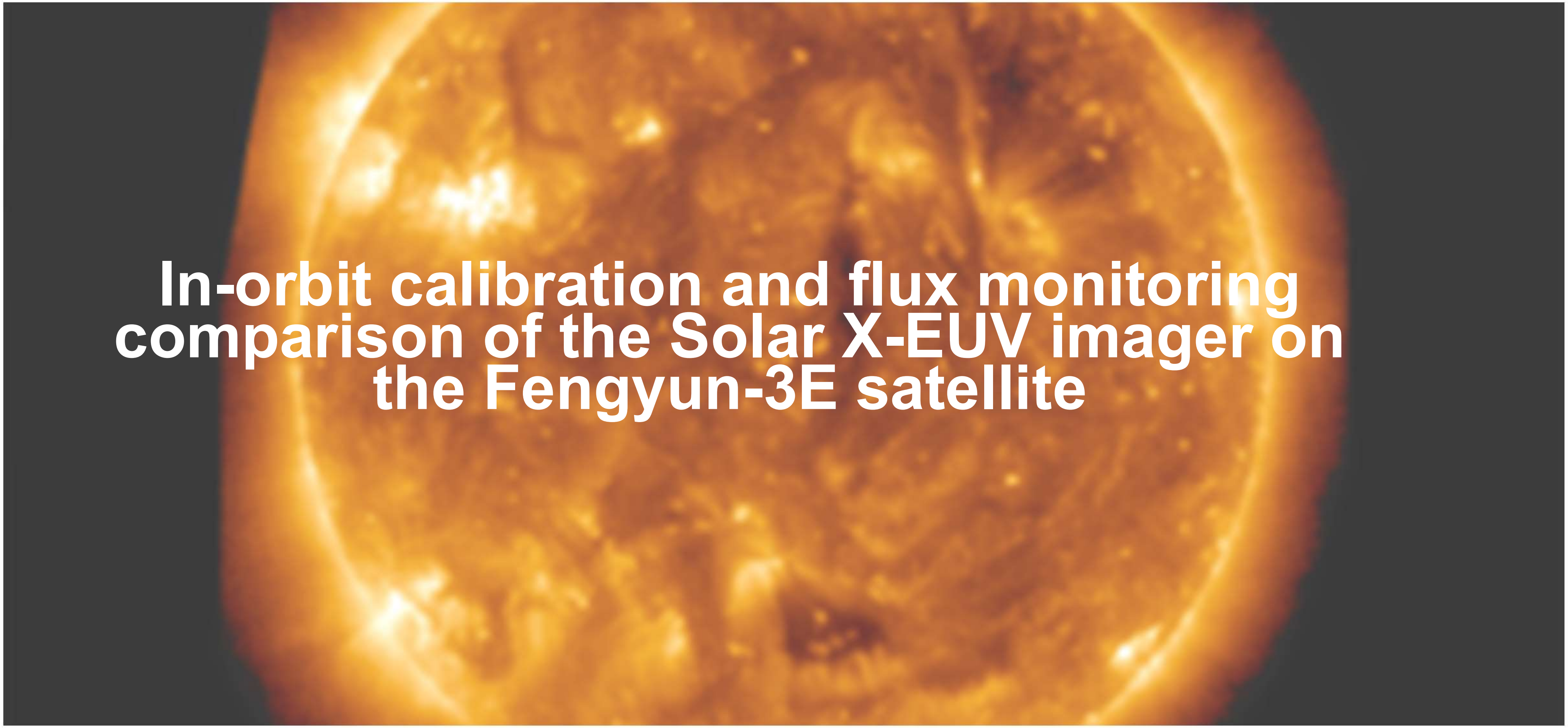

In-orbit calibration and flux monitoring comparison of the Solar X-EUV imager on the Fengyun-3E satellite

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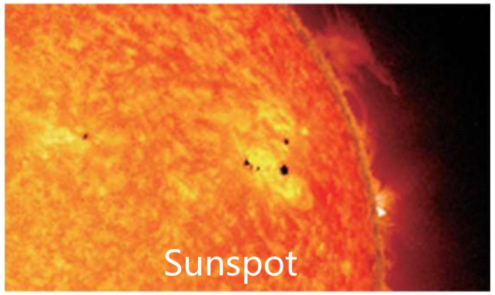
01 Research background and significance

研究背景与意义

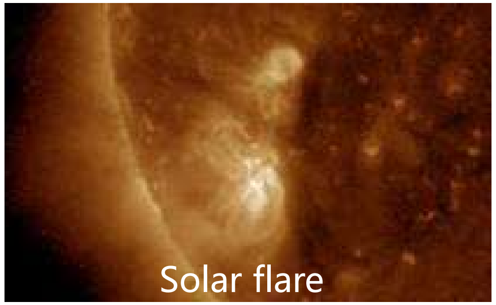
1. Research Background and Significance

1.1 solar activities

- The dark spots on the photosphere
- 11-year-cycle

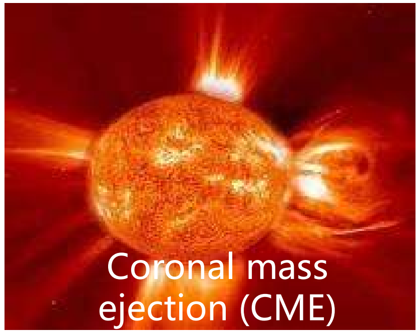


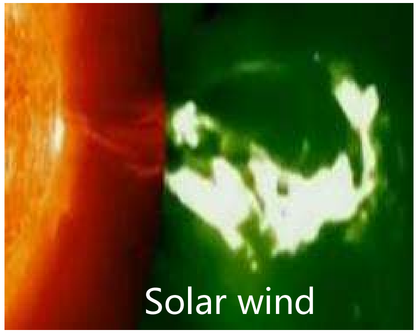
- large bright patches on the chromosphere
- Exhibiting simultaneity and spatial correlation with sunspot activity



- Chromosphere
- The gas ejection appears in an arc shape

- Corona
- The largest and most intense solar activity

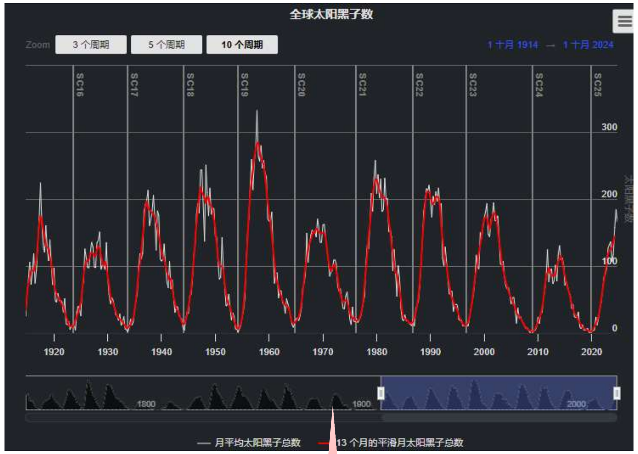




- High-speed streams of charged particles emitted from the corona

Solar activity is the source of changes in the space environment

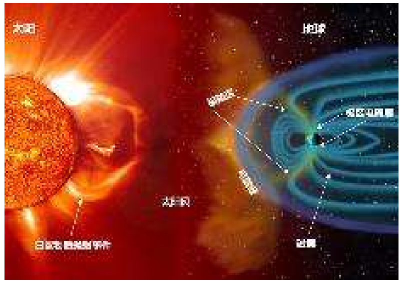
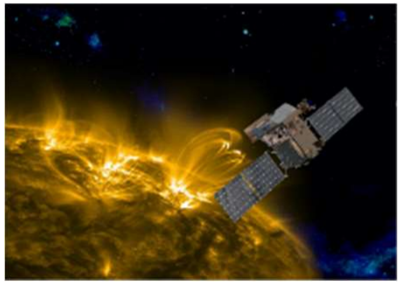
Solar cycle: 11 years

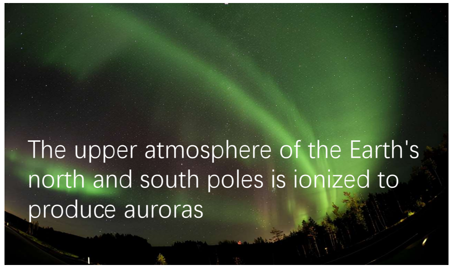


The peak of solar activity is expected to occur in 2025

1. Research Background and Significance

1.2 The impact of solar activity on Earth



Solar exploration instrument

Satellite/instrument	Wavelength/nm	year	Time resolution/s
SKYLAB/EUV	28-135	1973	300
Yohkoh/SXT	0.3-6.0	1991	0.5
GOES/EXIS	0.05-0.4/0.1-0.8/25-31/117-141	1975-	2/30
SOHO/EIT	17.1,19.5,28.4,30.4	1995	90
TIMED/SEE	0.1-200	2001	100/10
Hinode/XRT	Soft X-ray	2006	60/10
SDO/AIA	9.4， 13.1,17.1,19.3,21.1,30.4,et al.	2010	12
SDO/EVE	0.1-105	2010	10/1
MAVEN/LPW	0.1-50	2013	1

02 Design of X-EUV imager

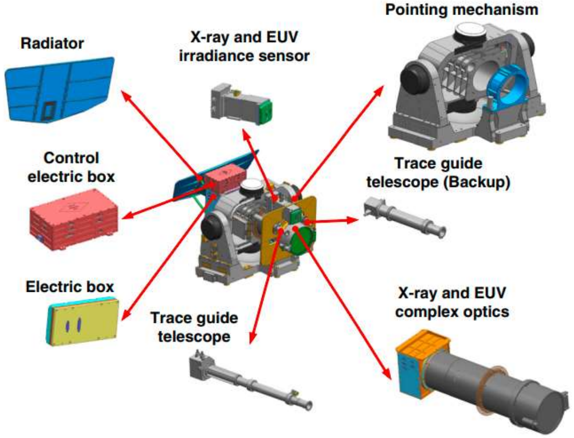
X-EUVI设计.

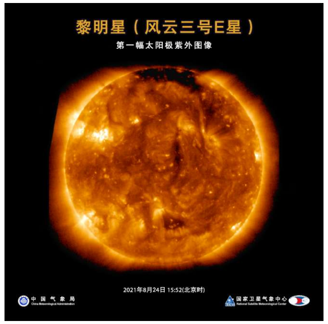
2、Design of FY-3E X-EUVI

2.1 FY-3E X-EUV imager introduction

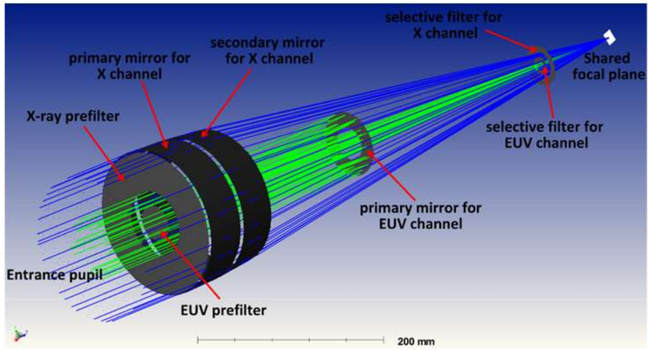
- **The first solar X-ray-EUV dual-band imager**
  - Two wavelength bands：X-ray（0.6-8nm）and EUV(19.5nm)
  - Seven channels： X1: 0.6-8.0 nm X2: 0.6-6.0 nm X3: 0.6-5.0 nm X4: 0.6-2.0 nm X5: 0.6-1.6 nm X6: 0.6-1.2 nm EUV:(19.5nm)
- The trace guide telescope employs a four-quadrant solar limb detection method, with a sampling frequency of 1 kHz and an angular resolution of 0.05'', enhancing observational accuracy. The in-orbit measured pointing stability is 0.3''/20S
- The irradiance sensor （X-EUVS）, which operates on the same channel as the X-EUVI, enables in-orbit radiometric calibration.

X-EUVI Composition





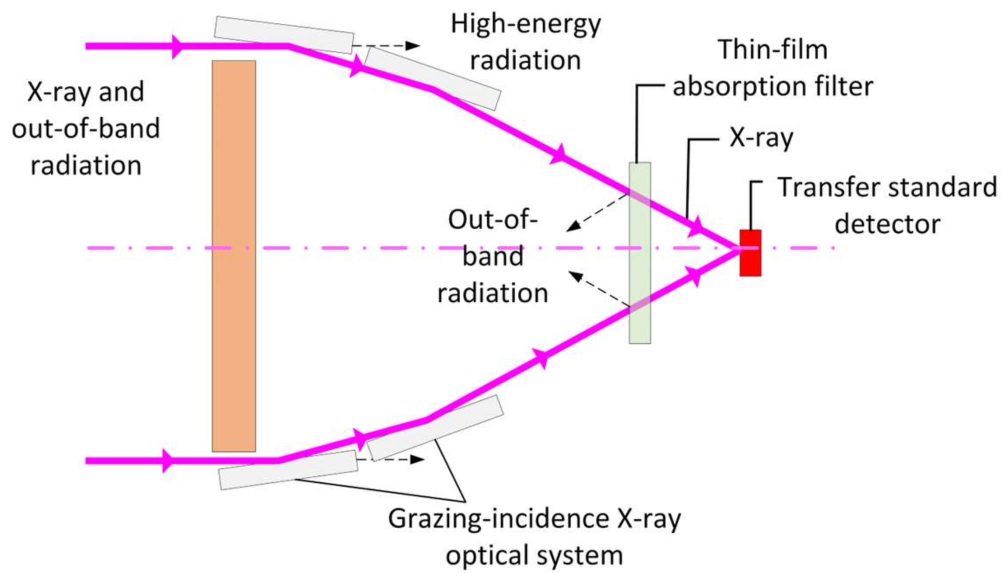
X-EUVI Design



2、 Design of FY-3E X-EUVI

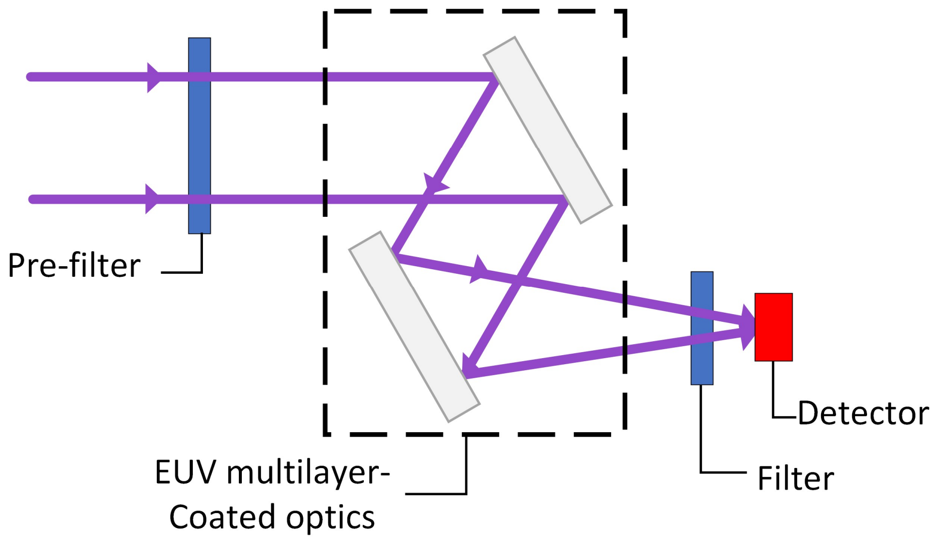
2.2 FY-3E X-EUVS introduction

- X-ray irradiance sensor



Channels: X1:0.6-8.0 nm X2:0.6-6.0 nm
X3:0.6-5.0 nm X4:0.6-2.0 nm
X5:0.6-1.6 nm X6:0.6-1.2 nm

- EUV irradiance sensor



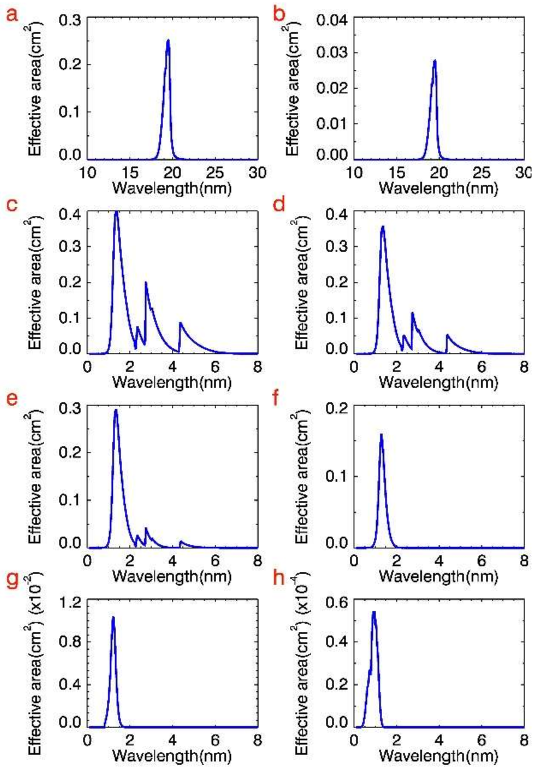
wavelength： 19.5 nm
bandwidth： 0.9 nm

2、Design of FY-3E X-EUVI

2.3 The spectral distributions of the irradiance sensor’s effective area

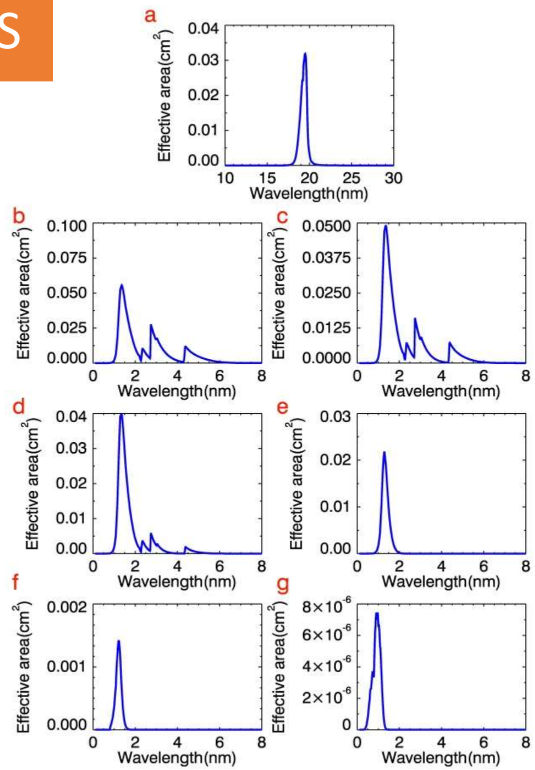
➢ X-EUVI

Channel	Out-of-band rejection(0.1-35 nm)
X1	0.7%
X2	0.6%
X3	0.7%
X4	0.3%
X5	1.4%
X6	2.1%
EUV1	4.1%
EUV2	2.9%



The effective areas distribution of **X-EUVI**. **a** EUV1 band, **b** EUV2 band.**c** X1 band, **d** X2 band, **e** X3 band, **f** X4 band, **h** X5 band, **g** X6 band

➢ X-EUVS



The effective area distributions of **X-EUVS**. **a** EUV band, b X1 band, **c** X2 band, **d** X3 band, **e** X4 band, **f** X5 band, **g** X6 band.

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03 In-orbit calibration and results

在轨定标与定标结果

3. In-orbit calibration and results

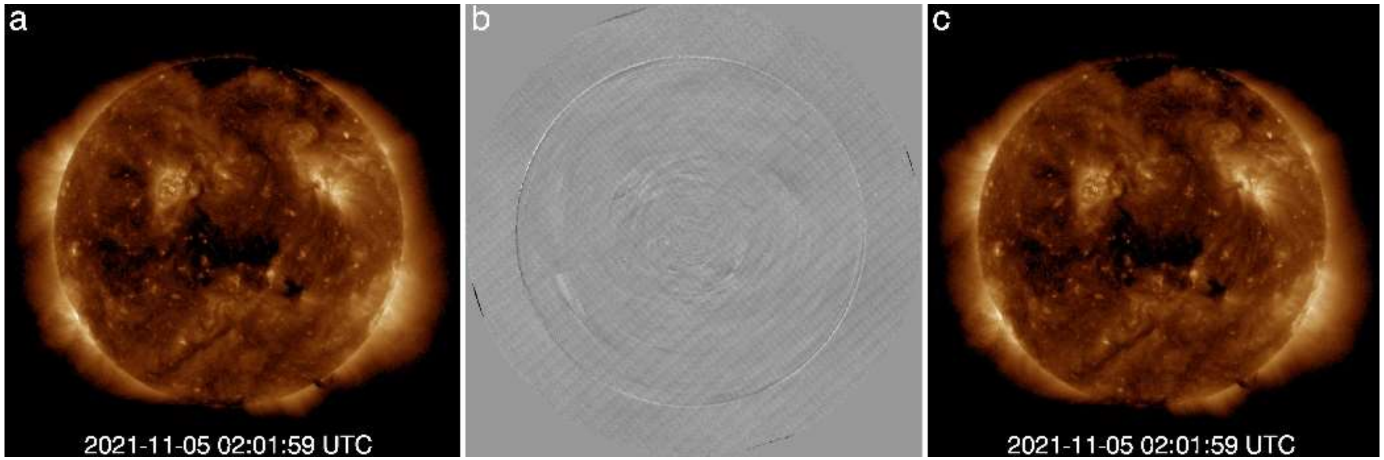
3.1 flat-field calibration

•In-orbit flat-field calibration process

Set the pitch direction to 0 degree → sequentially change the azimuth angle, capture images, and downlink them → Change the pitch direction → sequentially change the azimuth angle, capture images, and downlink them → processing yields the image plane uniformity distribution → Falt-field calibration

Acquired images

•In-orbit flat-field calibration result



The original solar image | The flat-field matrix | the corrected image

image plane non-uniformity is approximately 2.11%

3、 In-orbit calibration and results

3.2 Radiometric calibration

$$E_{sun} = \frac{I_d}{R_d \cdot A \cdot \tau} \quad (\mathrm{W.m^{-2}}) \quad (1)$$

Esun : the solar full-disk irradiance, Id is the photon-current tested by the sensor,

Rd : the response factor of the diode,

A : the entrance pupil area,

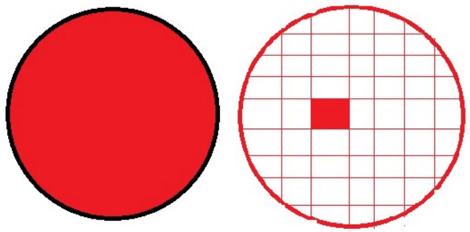
τ : system transmittance, which is the product of filters' transmittance and mirrors' reflectivity.

➢ **Ground calibration** $1/R_d \cdot A \cdot \tau$

Channel	Index（W·m-2·nA）
X1	2.71×10^{-3}
X2	2.27×10^{-3}
X3	2.27×10^{-3}
X4	1.54×10^{-3}
X5	8.84×10^{-3}
X6	4.75×10^{-3}
EUV	2.97×10^{-3}

conversion factors

➢ **In-orbit calibration**



In-orbit calibration accuracy is 15%

$$B_{pix} = \frac{E_{sun}}{DN_{sun}} \cdot \frac{DN_{pix}}{\omega} \qquad (2)$$

E_{sun}： the disk solar irradiance tested by X-EUVS

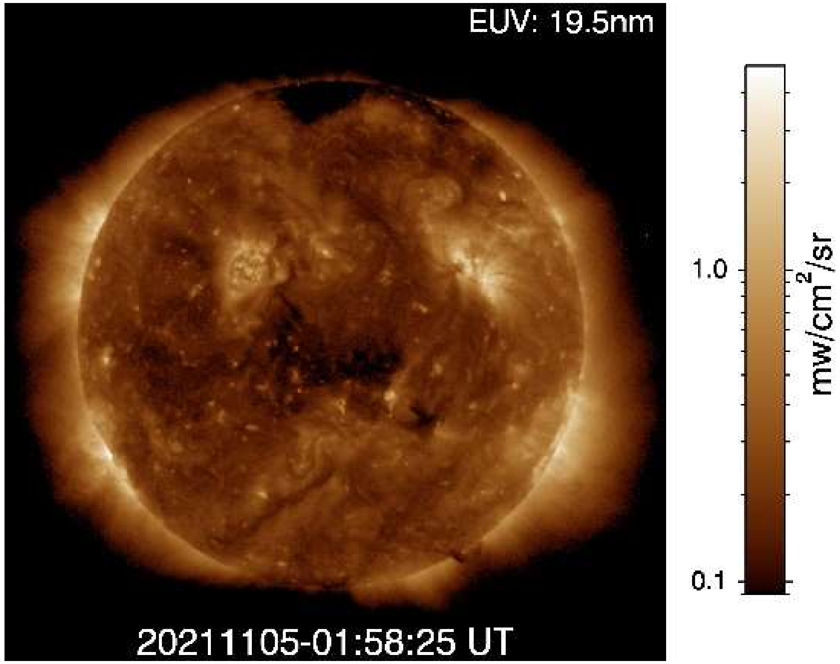
DN_{sun}： the pixel_value sum of a solar image observed by X-EUVI

DN_{pix}： the pixel_value of the pixel， ω the solid angle of the pixel

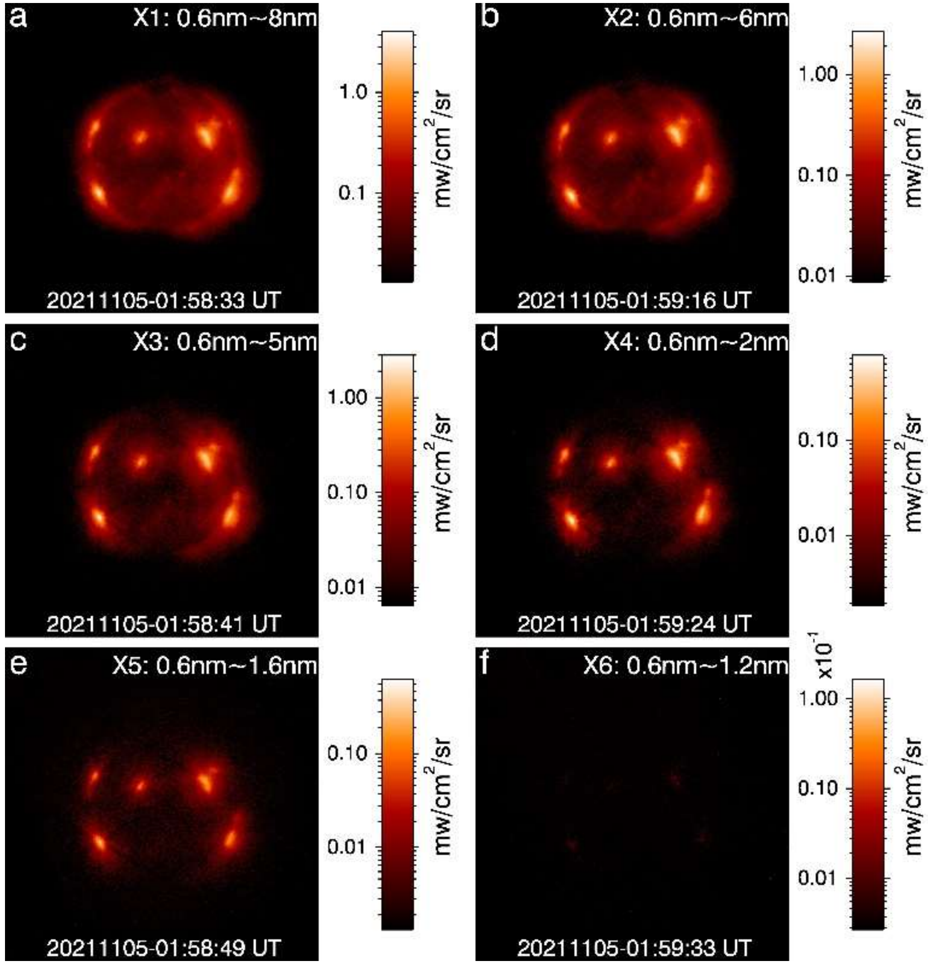
B_{pix} : the calibrated brightness of the pixel

3、 In-orbit calibration and results

3.2 Radiometric calibration



Absolute brightness EUV images



Absolute brightness X-ray images

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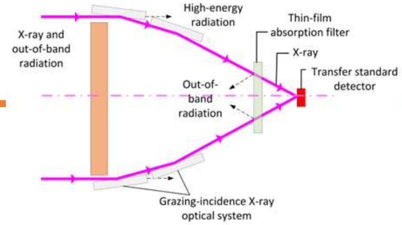
04 Flux monitoring comparison

辐射定标比对.

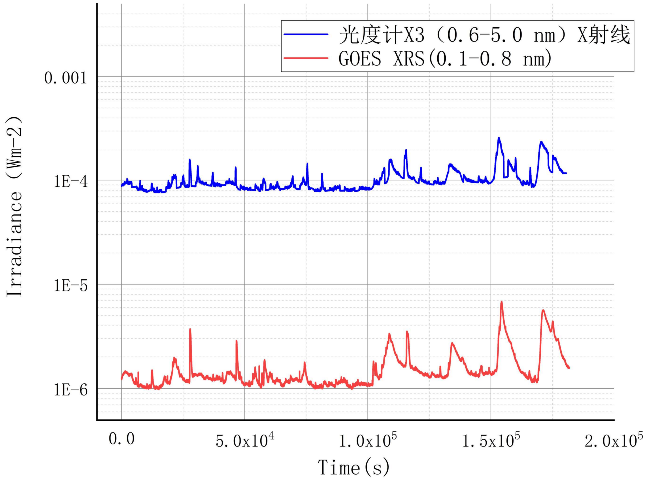
4. 1 Flux monitoring comparison



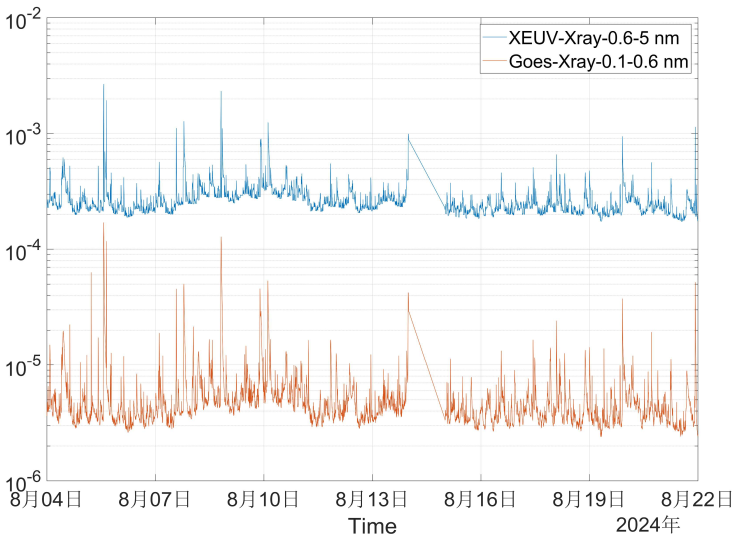
4.1.1 X-Ray

- Data comparison in a short time (several days)

Specific band monitoring



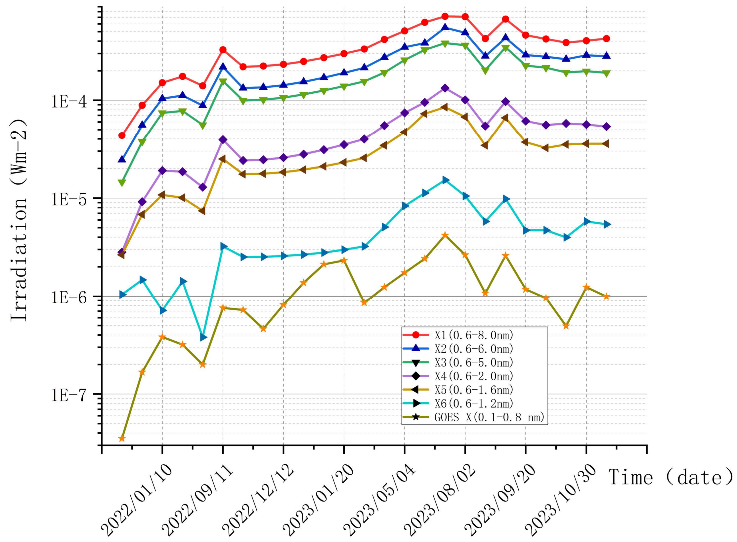
2023/11/26—2023/11/28



2024/8/4—2024/8/20

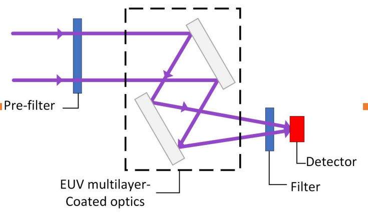
- Data comparison in a long time

Full band radiometric calibration



2021—2023 long-term monitoring

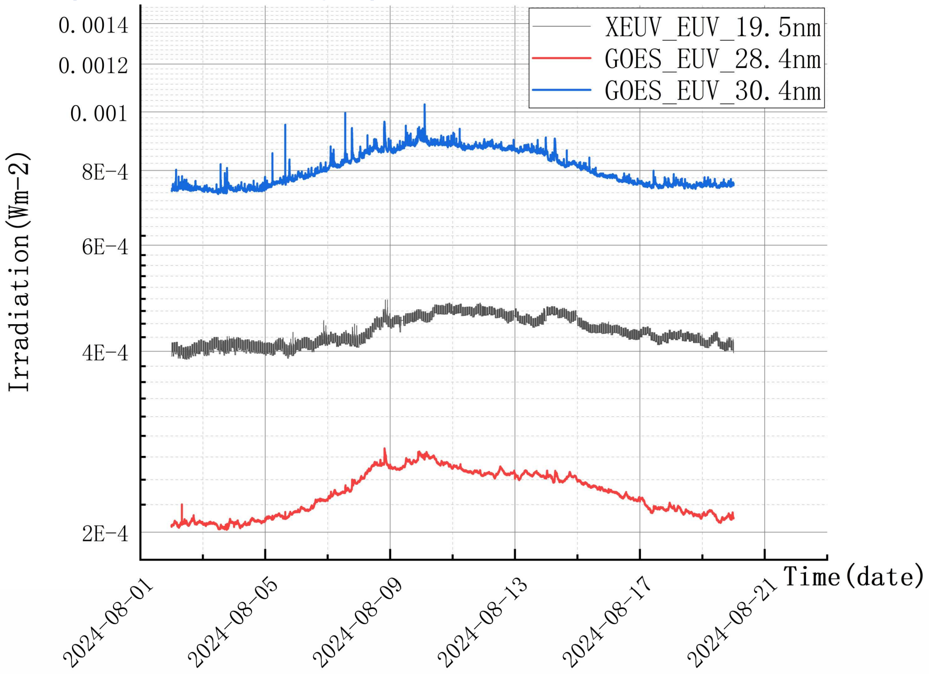
4. Flux monitoring comparison



4.1.2 EUV

Specific band monitoring

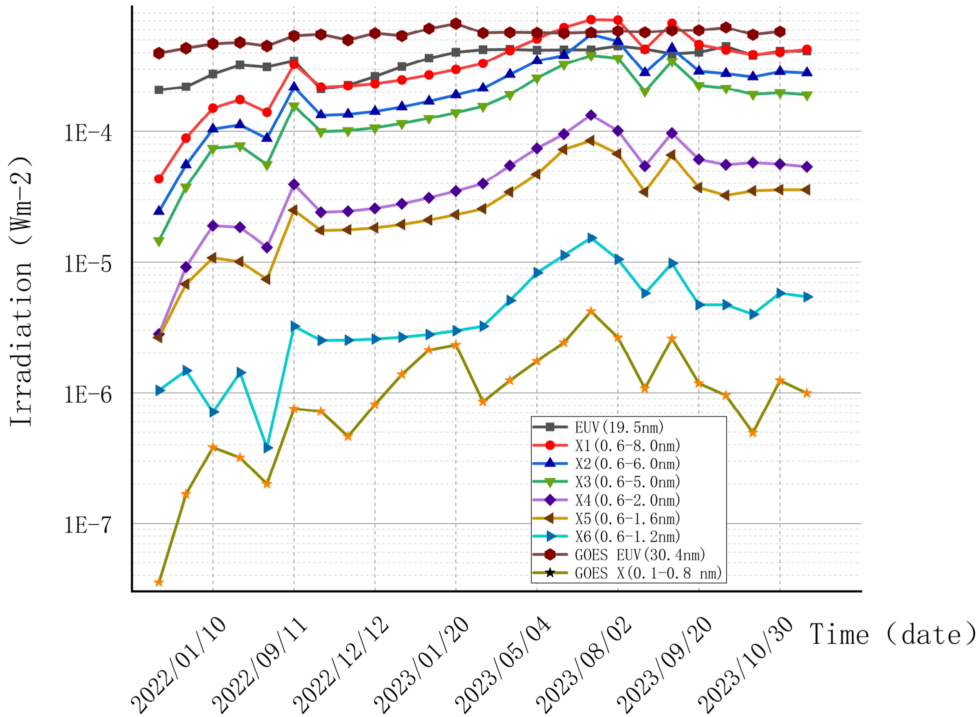
- Data comparison in a short time (several days)



2024/8/2—2024/8/19

Full band radiometric calibration

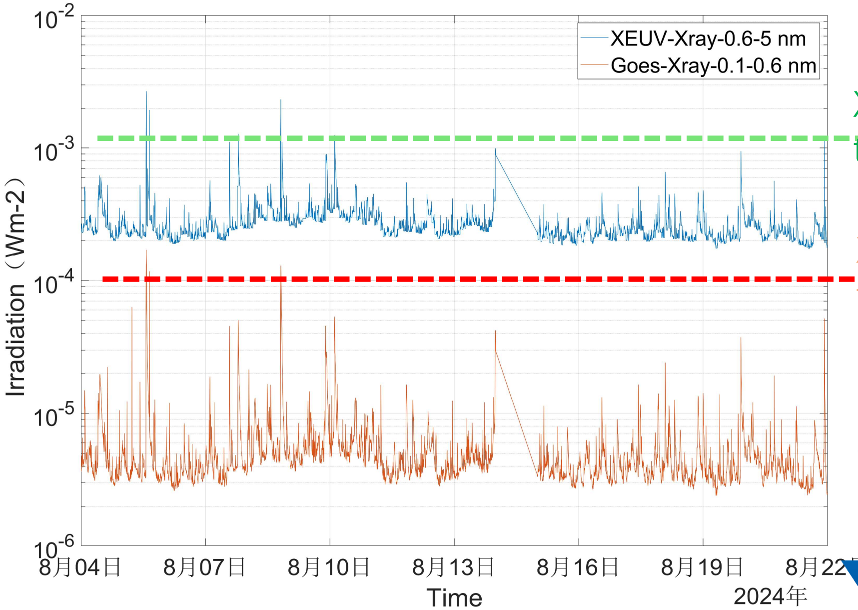
- Data comparison in a long time



2021—2023 long-term monitoring

4. 2 Solar eruption time comparison

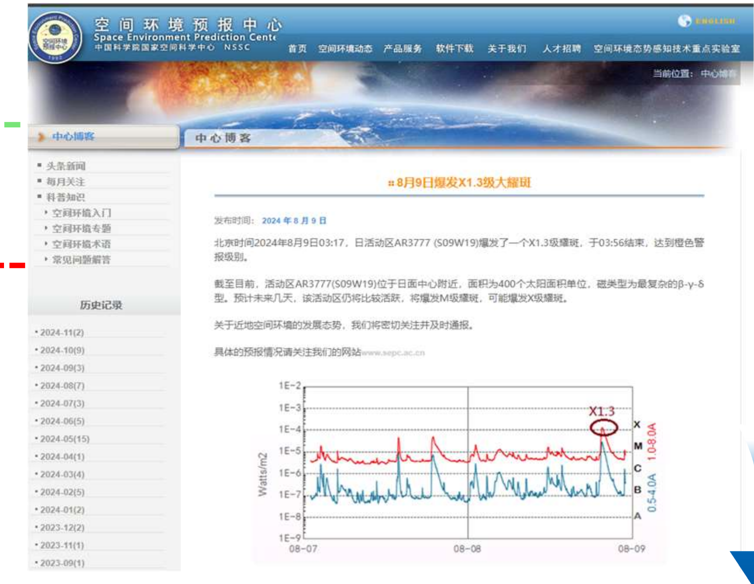
➤ X-EUVS predict solar eruption time



X-level burst threshold

X-level burst threshold（GOES）

➤ SEPC（GOES-R）



The sun erupts at Beijing time	Solar eruption reported time(Beijing time)
2024.08.05 21:46:12	2024.08.05 21:25—202408.05 21:53（X 1.7-level）
2024.08.05 23:27:27	2024.08.05 23:22—202408.05 23:31（X 1.1-level）
2024.08.09 03:33:59	2024.08.09 03:17—202408.09 03:56（X 1.3-level）

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Thank you for your attention!

请大家提出宝贵意见

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