# On-orbit cross-comparison results of electron flux from Fengyun-4B, GOES-16, and Himawari-8


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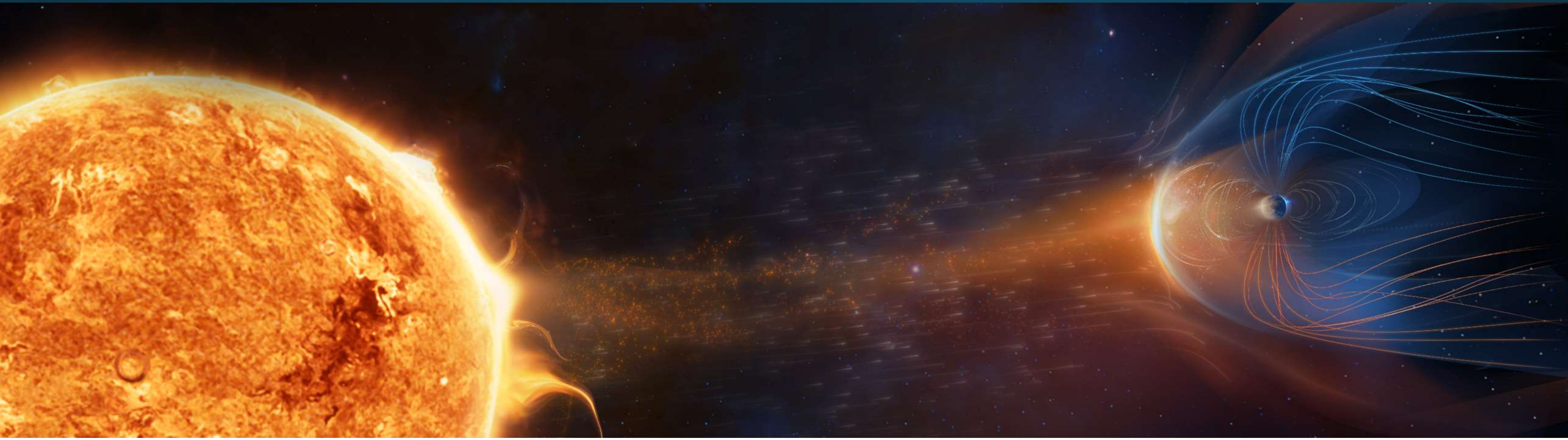
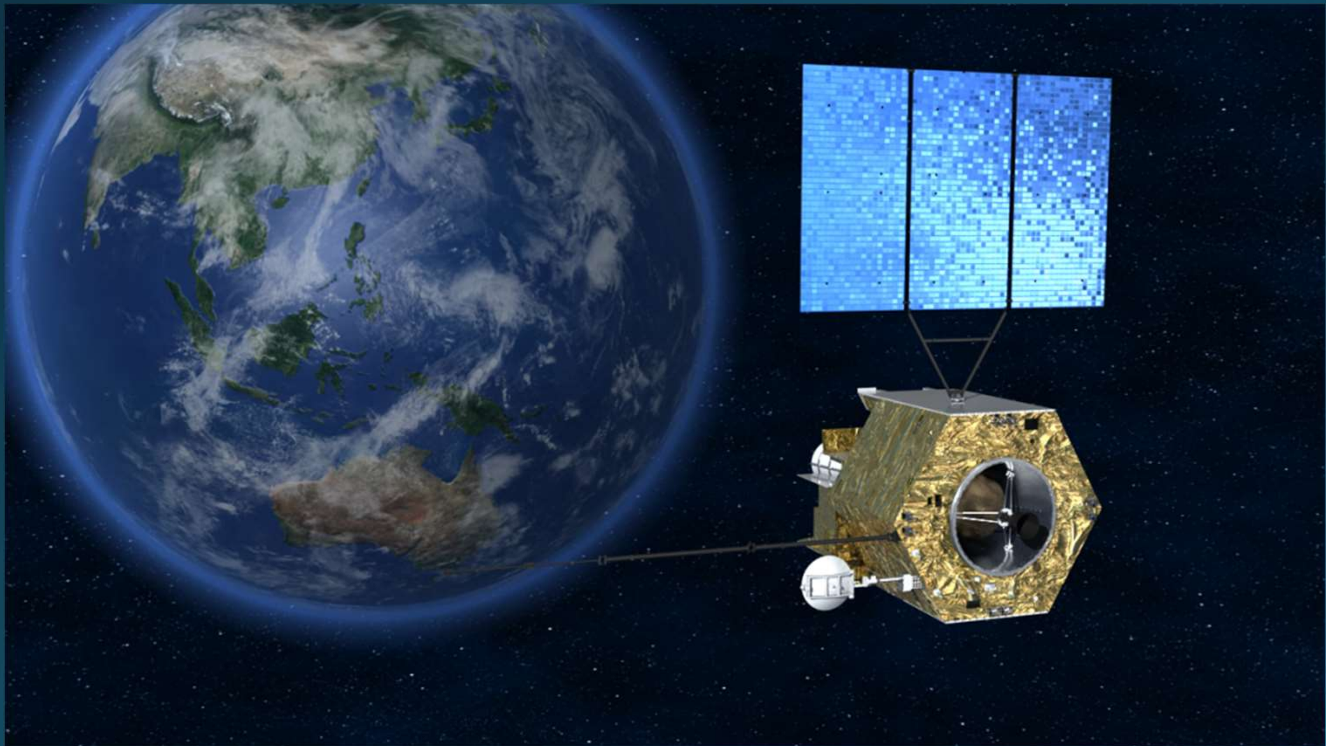
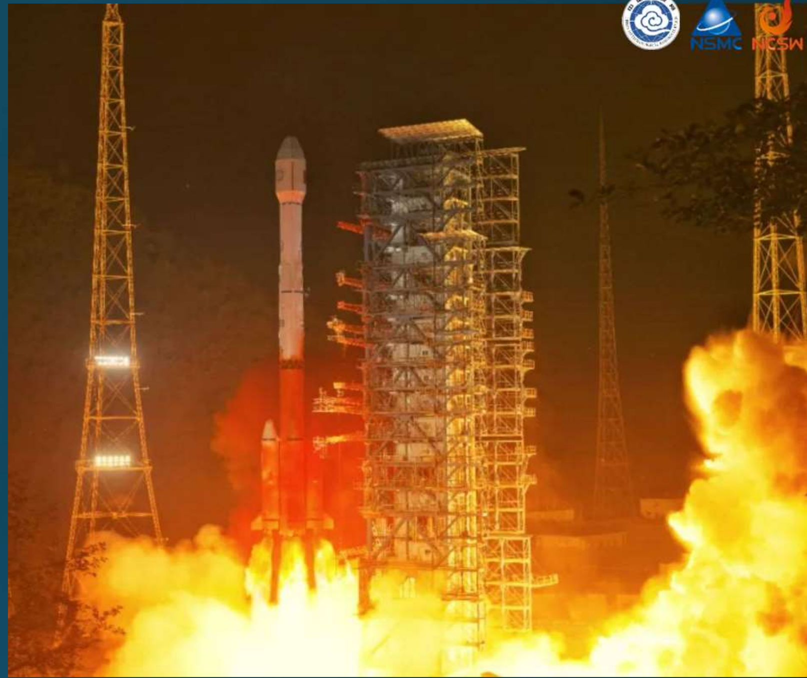


# 0. Introduction

- FY-4 is CMA's (China Meteorological Administration) second-generation three-axis stabilized, geostationary meteorological satellite series.
- The FY-4B GEO weather satellite was launched on June 02, 2021 (17:29 UTC) (~5300 kg) of China (CMA) on a CZ-3B vehicle from LC-2 at XSLC (Xichang Satellite Launch Center).
- Orbit: Geostationary orbit, altitude = ~35786 km, longitude = 133.0º E.





# 0. Introduction

Compared to the current FY-2 geostationary meteorological satellite series, the performance of the FY-4 series has been considerably improved in terms of data amount, network transmission bandwidth, product type and quantity and archiving data and applications.

| Parameter | FY-4 spacecraft series | FY-2 spacecraft series |
|---|---|---|
| Spacecraft stabilization | Three-axis stabilized | Spin stabilized |
| Spacecraft design life | 5-7 years | 4 years |
| Observation efficiency | 85% | 5% |
| Observation capabilities | Imaging +Sounding + Lightning Mapping | Imaging only |
| Main instruments | AGRI (Advanced Geosynchronous Radiation Imager)<br>14 channels<br>Spatial resolution: 0.5-4 km<br>FD (Full Disk) imaging: 15 minutes<br>Rapid Scan:2.5 minutes | VISSR (Visible and Infrared Spin-Scan Radiometer)<br>5 channels<br>Spatial resolution:1.25-5 km<br>FD imaging: 30 minutes<br>Rapid Scan: 3-6 minutes |
| | GIIRS:(Geostationary Interferometric Infrared Sounder)<br>913 channels<br>Spectral resolution: 0.8 to 1.6 $cm^{-1}$<br>Spatial resolution:16 km | N/A (Not Applicable) |
| | LMI(Lightning Mapping Imager)<br>SSP resolution:7.8 km | N/A |
| | SEP(Space Environment Package)<br>High energy particles<br>Magnetic field: Solar X ray fluxes | SEM (Space Environment Monitor)<br>High energy particles |


# 0. Introduction

- FY-4B : High-energy particle detector, Medium energy proton detector, Medium energy electron detector, Low energy particle detector, Radiation dosimeter, Potential detector and Magnetometer.
- **Space weather activities, satellite design**, **space science research** and **space weather warning** and **forecasting services**.
- FY-4B is the most comprehensive detection system of high orbit space environment monitoring elements in China.

# 0. Introduction

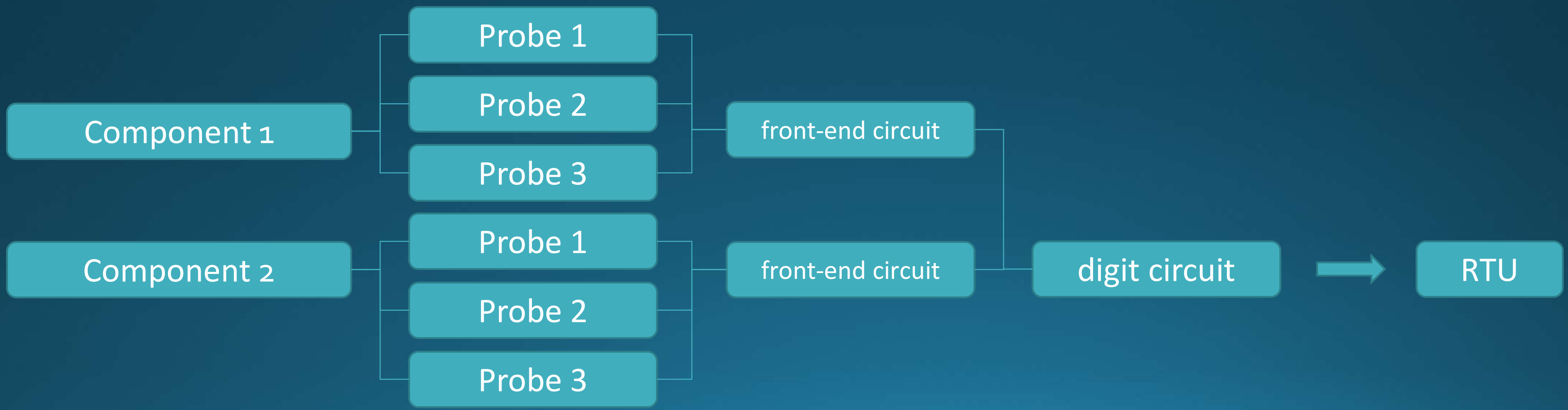
- Three high-energy particle detectors, each of which includes multiple telescope systems to achieve full spectrum detection of electrons and protons, as well as multi-directional detection of low-energy high-energy electrons.
- Each telescope system consists of three HET1s for low energy high energy electron detection, one HET2 for high energy high energy electron detection, one HPT1 and one HPT2 for high energy proton spectroscopy detection.

| Electrons Energy Spectrum | Name |
|---|---|
| 250-300 keV | HET1 |
| 300-400 keV | |
| 400-500 keV | |
| 500-600 keV | |
| 600-800 keV | |
| 800-1000 keV | |
| 1000-1200 keV | |
| 1200-1500 keV | |
| >0.8MeV | |
| >1.5MeV | |
| ≥1.5MeV | HET2 |
| ≥2MeV | |
| ≥3MeV | |
| ≥4MeV | |

| Protons Energy Spectrum | Name |
|---|---|
| 1-2 MeV | HPT1 |
| 2-4 MeV | |
| 4-6.3 MeV | |
| 2-4 MeV | HPT2 |
| 4-9 MeV | |
| 9-15MeV | |
| 15-23 MeV | |
| 23-40 MeV | |
| 40-80 MeV | |
| 80-165 MeV | |
| 165-300 MeV | |

# 0. Introduction

- The medium energy electronic detector consists of two single machines, medium energy electronic detector A and medium energy electronic detector B. It belongs to the space environment monitor subsystem.
- Detector A and B, 18 directions with an energy range of 30 ~ 600keV (divided into 8 exponential distribution energy blocks) in real time.
- 2 components, 1 and 2. Each component consists of three probes 1/2/3, each probe includes 3 groups of sensors, arranged in a fan shape.



# 0. Introduction

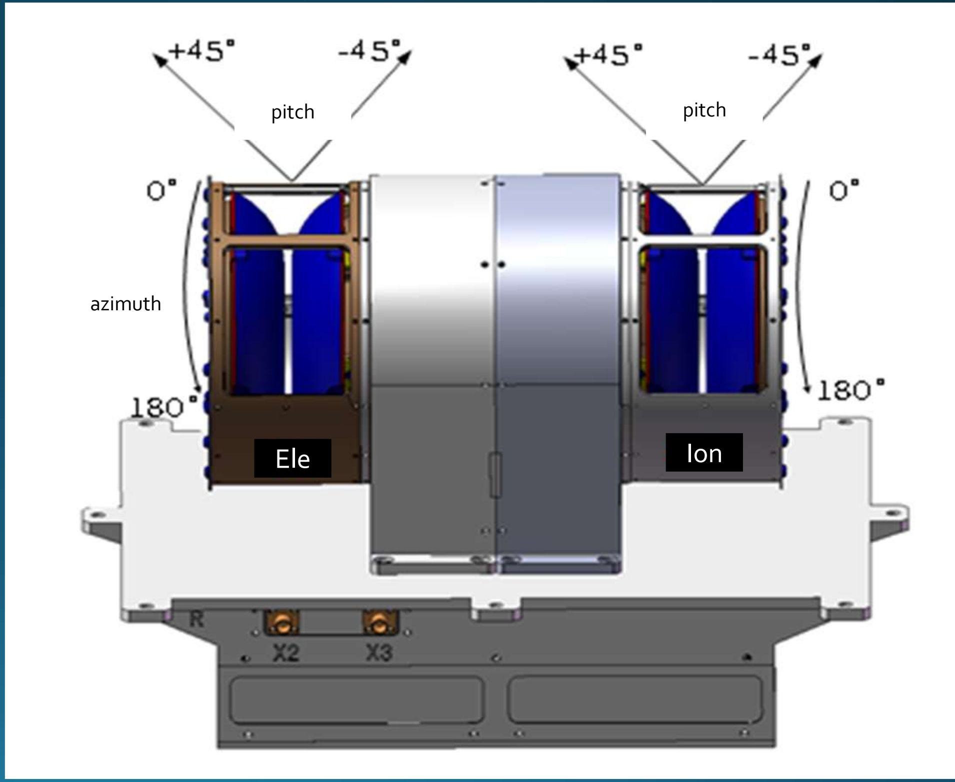
- The low-energy particle detector is one of the payloads of the space environment monitoring instrument package, which consists of two probes: the ion analyzer and the electron analyzer, both of which share a single electronics box. The low-energy particle detector is installed on the Z-plane of the satellite.

- Space coverage: Low energy particles in the equatorial plane 7 directions (near vertical magnetic field line direction), Meridian plane 9 directions (near along the magnetic field line direction).

- Low energy particle detector spectrum range:

  Ion : ~0.02 Kev-40.58 keV (measured)

  Electronic: ~ 0.022keV - 42.30keV (measured)



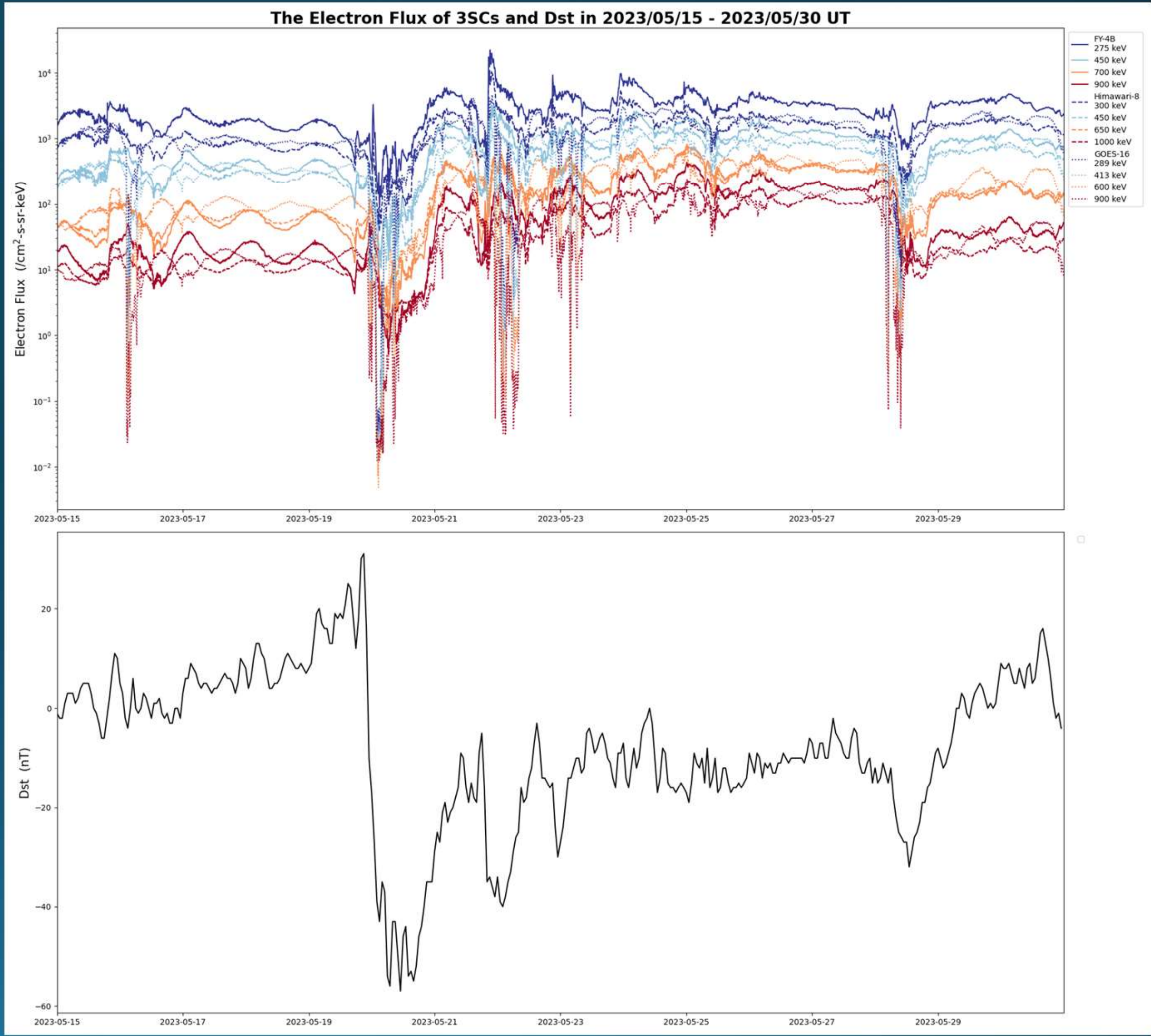
# 1. The timing diagram of electron flux of 3 SCs

- Time interval in **UT:** **2023/05/15 - 2023/05/30**
  Solid lines： FY-4B (A2 direction, PAD = 90°)
  Dashed lines： Himawari-8
  Dotted lines： GOES-16 (averaged teles)

| FY-4B (keV) | Himawari-8 (keV) | GOES-16 (keV) |
|---|---|---|
| 275 | 300 | 289 |
| 450 | 450 | 413 |
| 700 | 650 | 600 |
| 900 | 1000 | 900 |

- **Similar changing trends**
  FY-4B's data has good consistency with data from the other 2 SCs.

- **Consistent with the change of Dst index**
  FY-4B can effectively reflect information during calm and disturbed periods.

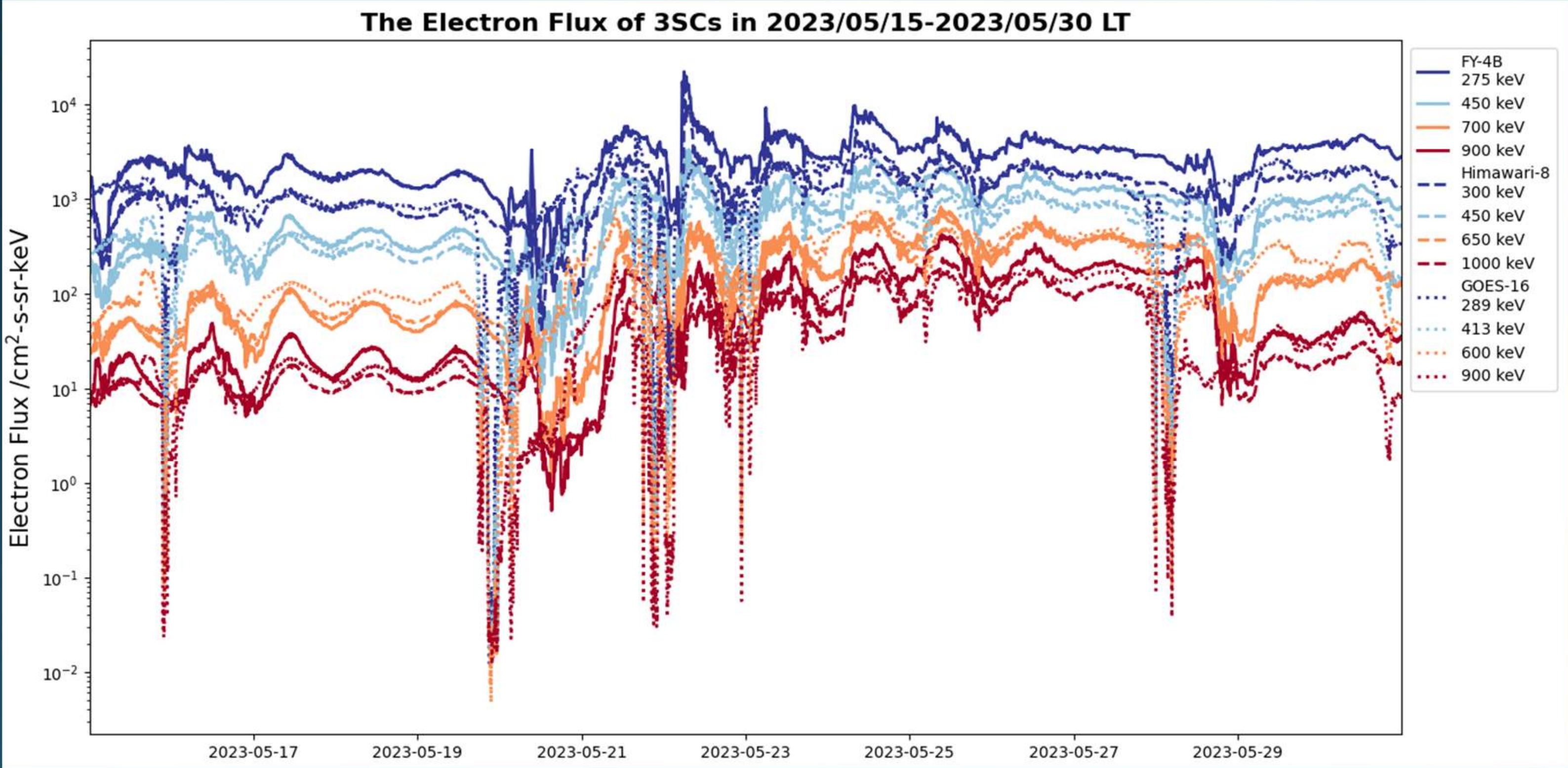


# 1. The timing diagram of electron flux of 3 SCs

- To better compare the data of 3 SCs， we convert the universal time into local time(**LT**).

| FY-4B | Himawari-8 | GOES-16 |
|---|---|---|
| 133° E | 140.7° E | 75.2° W |

- The flux trends of the 3 SCs are more consistent, especially during the calm period.
- We chose the duration **05/17 06:00 - 05/19 00:00 LT** in the following images.

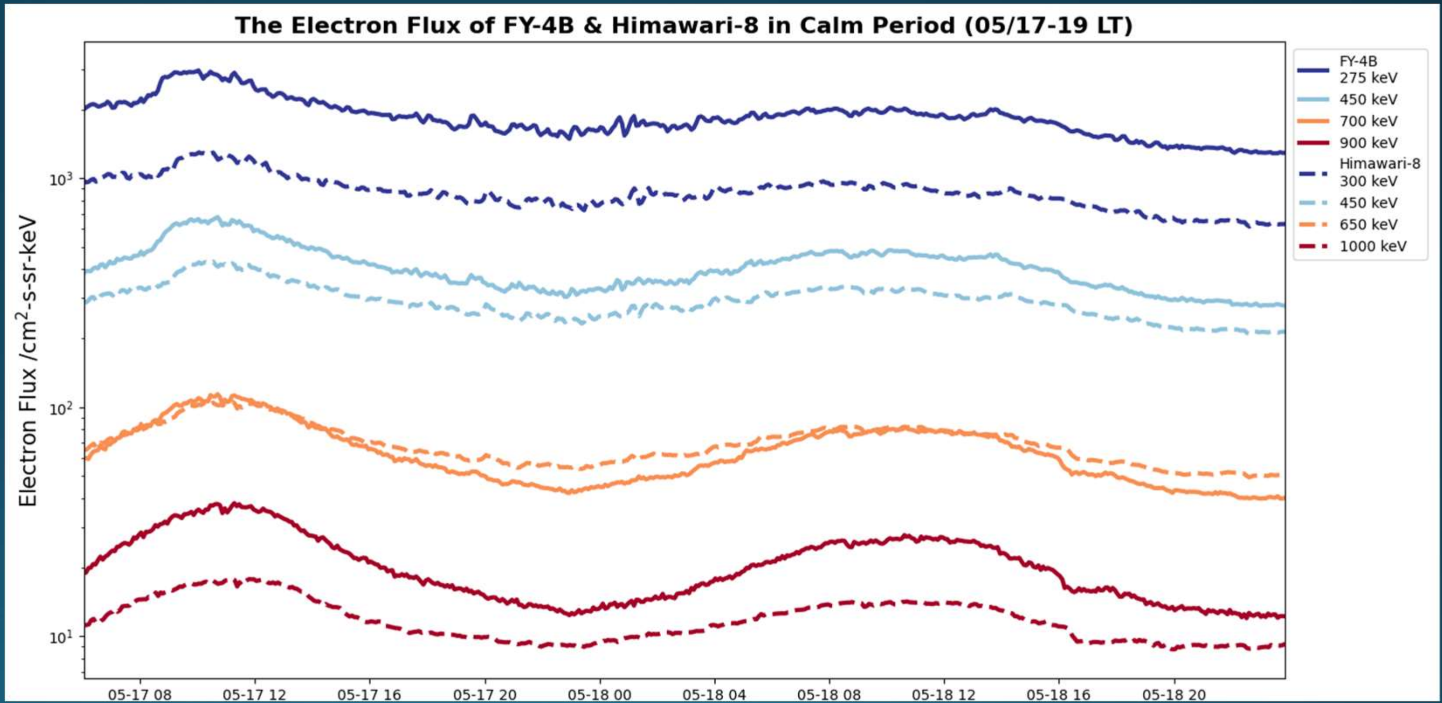


# 2. The comparison of electron flux between FY-4B and the other 2 SCs

2.1 FY-4B & Himawari-8

- Timing diagram **05/17 06:00 - 05/19 00:00 LT**

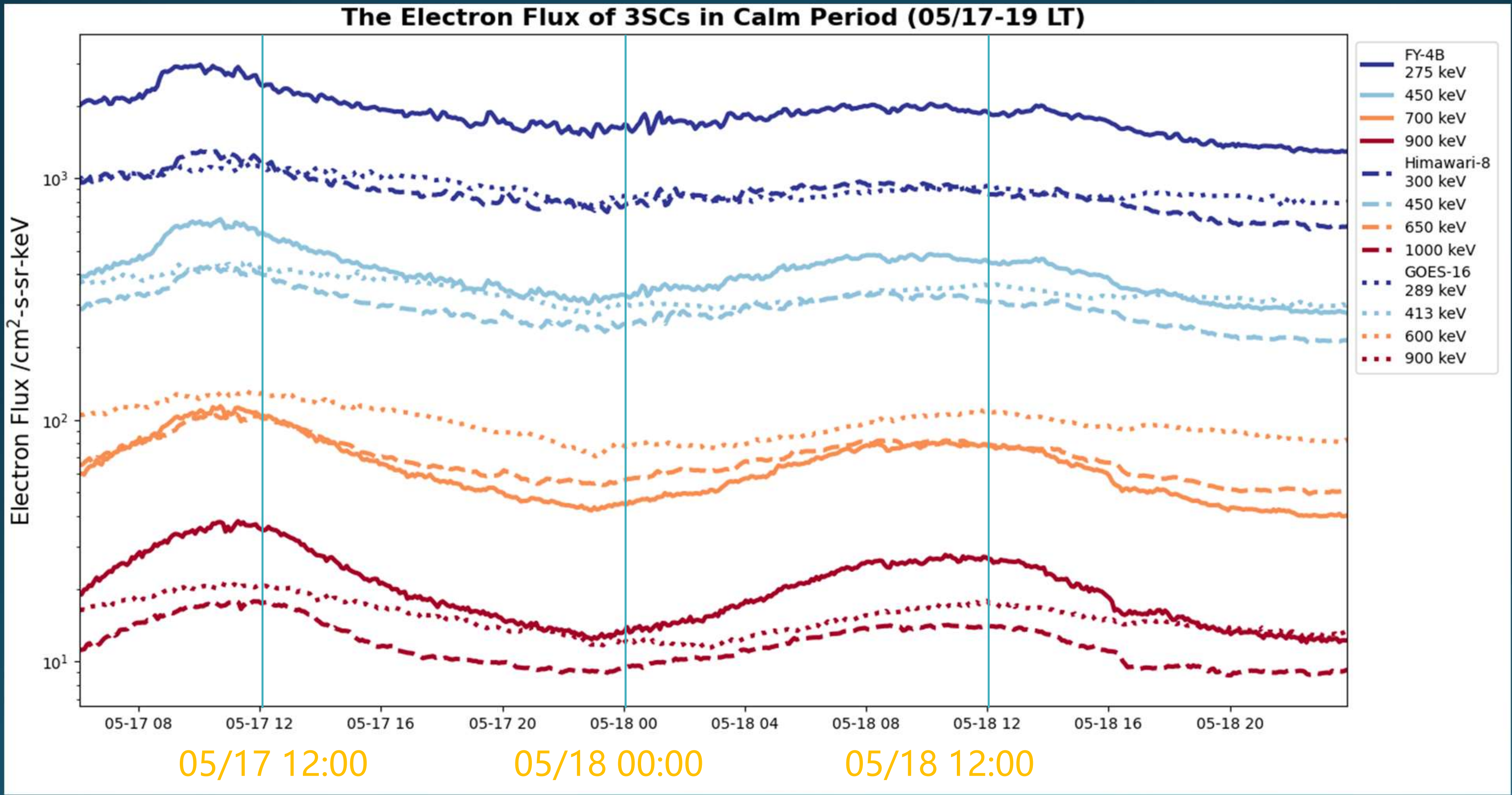
| FY-4B (keV) | Himawari-8 (keV) |
|---|---|
| 275 | 300 |
| 450 | 450 |
| 700 | 650 |
| 900 | 1000 |



# 3. The comparison of flux spectrom between the 3 SCs

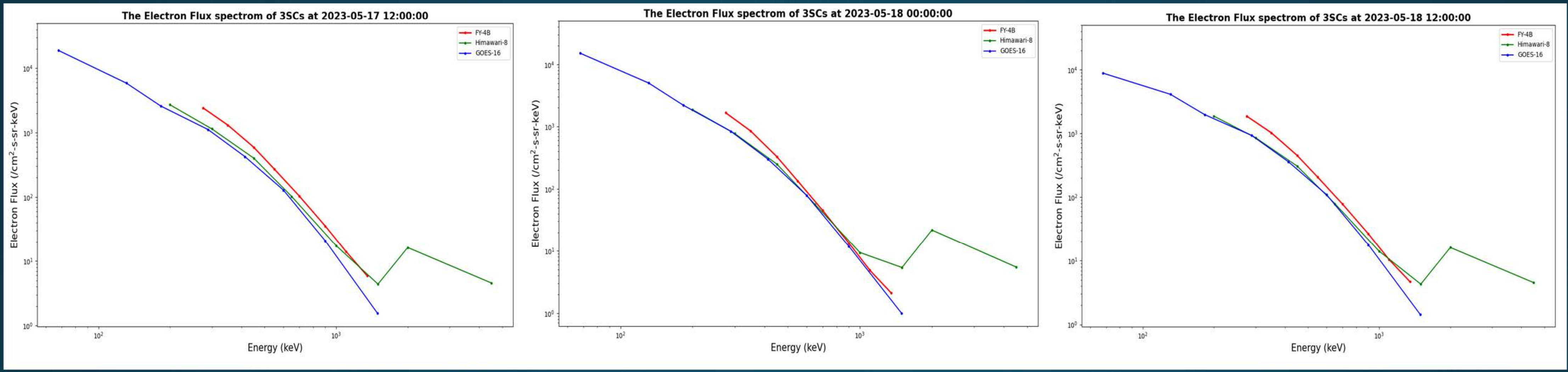
3.1 FY-4B & Himawari-8 & GOES-16(averaged teles)

- The timing diagram of the 3 SCs
- We chose 3 time points to compare their flux spectrom.



# 3. The comparison of flux spectrom between the 3 SCs

3.1 FY-4B & Himawari-8 & GOES-16(averaged teles)

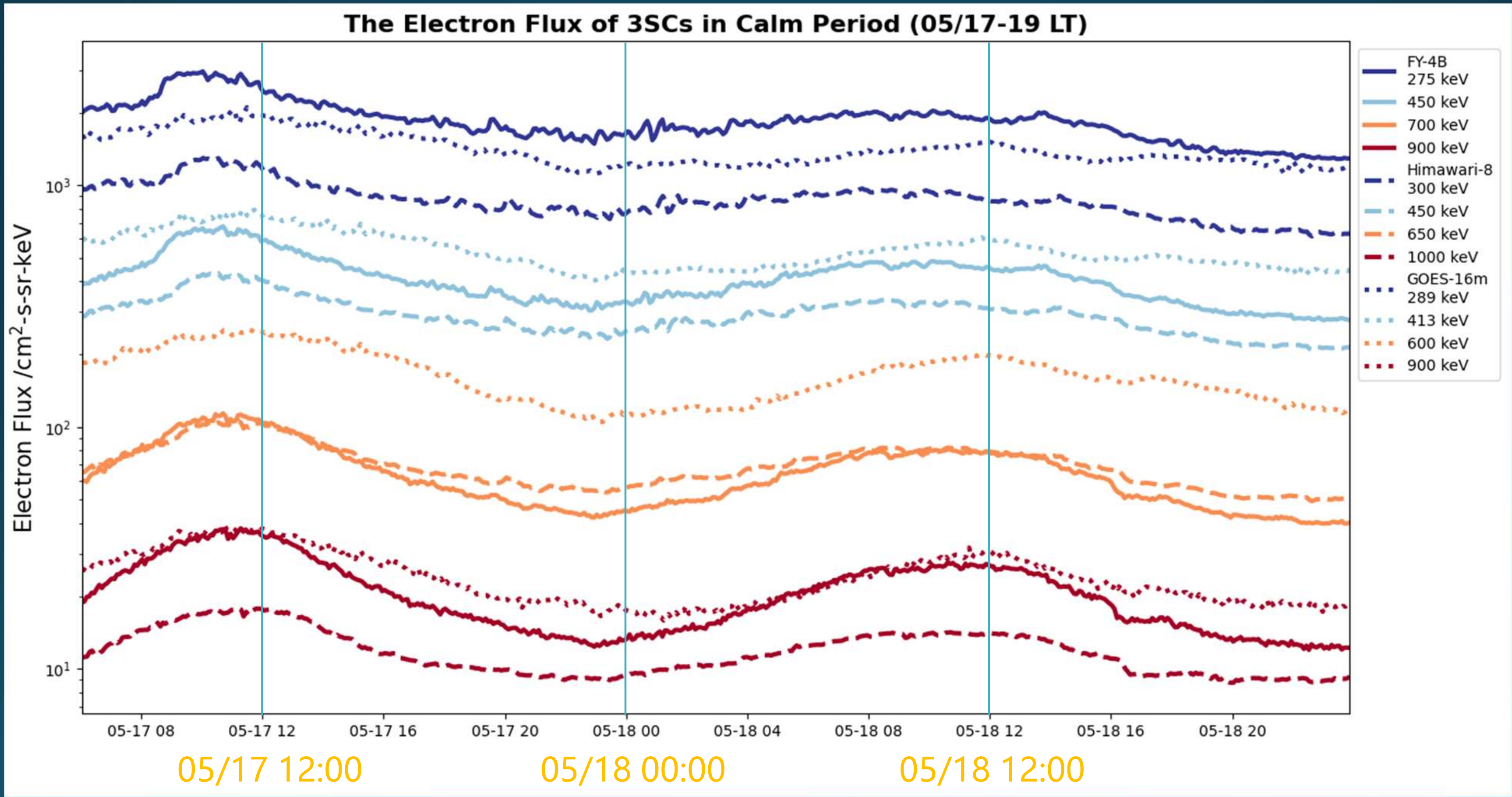



- The results of energy bands with similar energy are highly consistent
- The results of Himawari-8 and GOES-16(averaged teles) are more consistent.

# 3. The comparison of flux spectrom between the 3 SCs

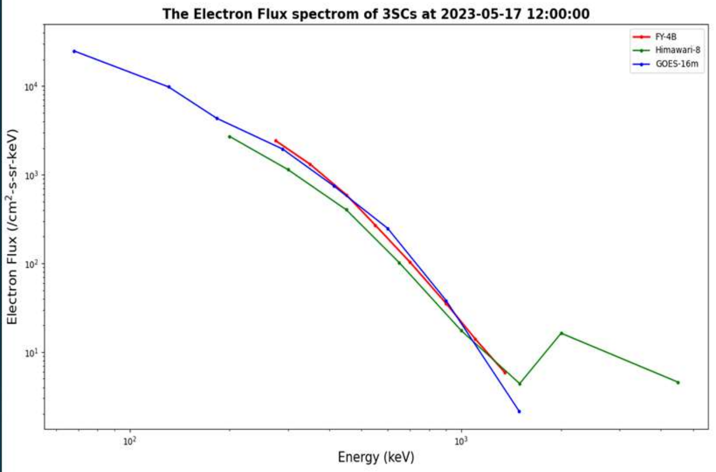
## 3.1 FY-4B & Himawari-8 & GOES-16(max tele)

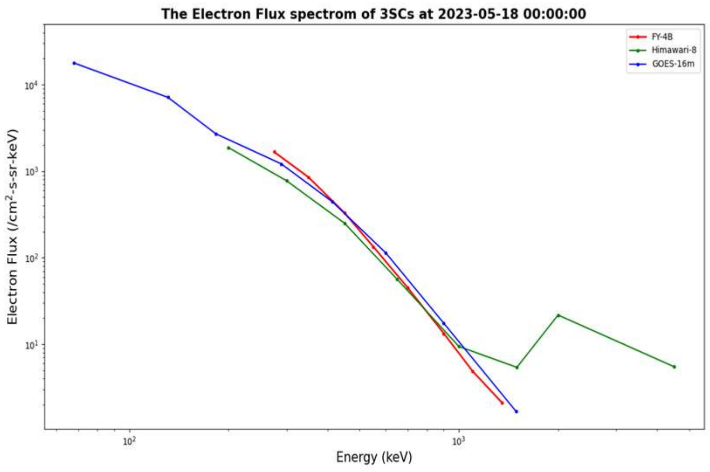
- The timing diagram of the 3 SCs

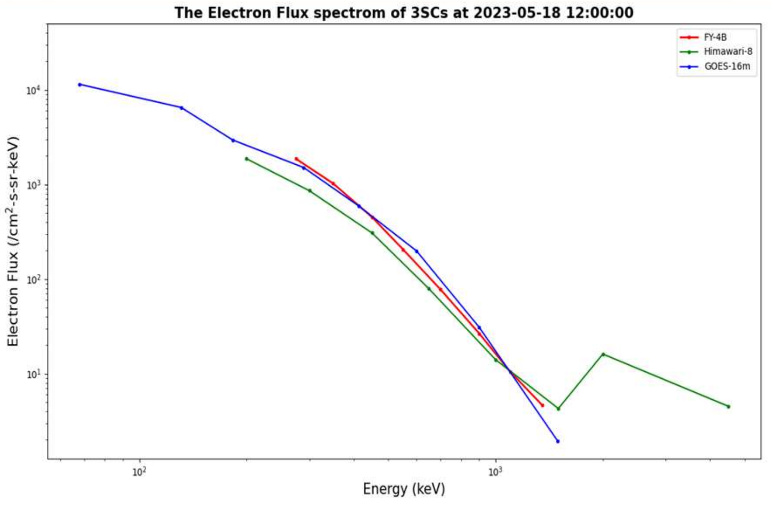


# 3. The comparison of flux spectrom between the 3 SCs

3.1 FY-4B & Himawari-8 & GOES-16(max teles)




- The results of energy bands with similar energy are highly consistent
- The results of FY-4B and GOES-16(maxd teles) are more consistent.

# 4. Summary

In this presentation, we introduce some basic information about FY-4B and its particle observations. We selected an event and compared the electron flux observation of FY-4B with GOES-16 and Himawari-8.

We summarize the comparison results as follows:

1、 During the development of geomagnetic activity, the observation of FY-4B has the same trend as the other two satellites.

2、 Compared with the trend of geomagnetic activity, the observations of FY-4B can well reflect the various phases of the storm, especially the main phase.

3、 Considering the changes in local time, the correlation between the observed data from the three satellites is closer to the flux, especially during quiet period.

4、 Compared with the GOES-16 average data, the observations of FY-4B is closer to the GOES-16 max data.

# Thank you for listening!