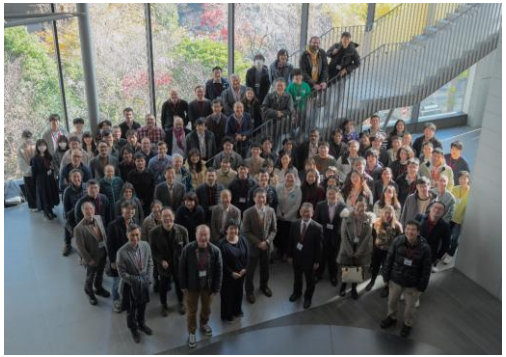
MAXI 15 years of instrument operation and calibration status



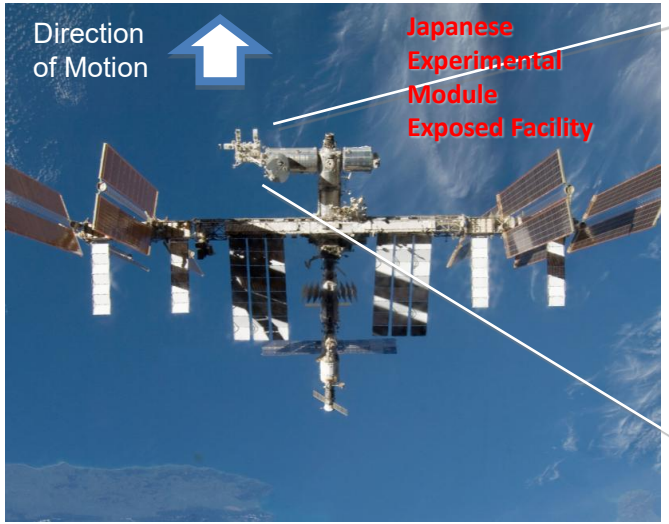
MAXI 15 years workshop at Tokyo

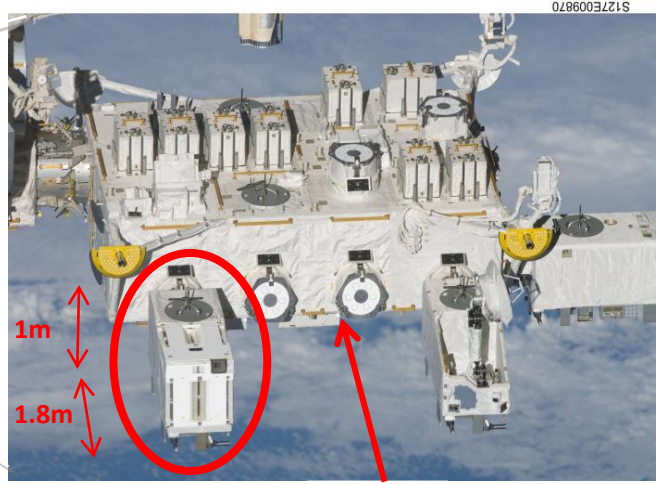
http://maxi.riken.jp/conf/15year

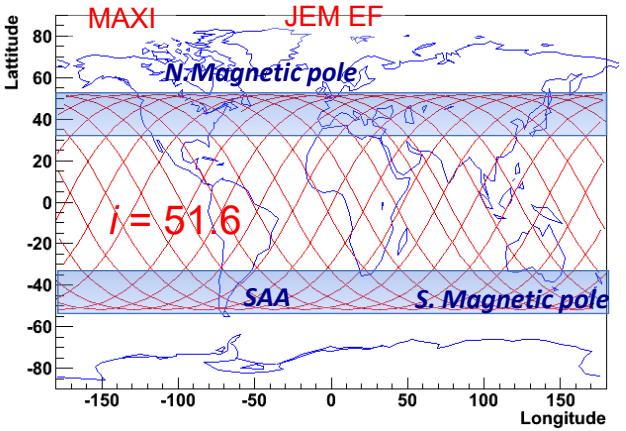
- Overview of MAXI 15 years
- GSC operation status
- Calibration for solar-flare X-ray contamination
- Summary

Mutsumi Sugizaki (Kanazawa Univ.) on behalf of MAXI Team

MAXI (Monitor of All-sky X-ray Image) on ISS

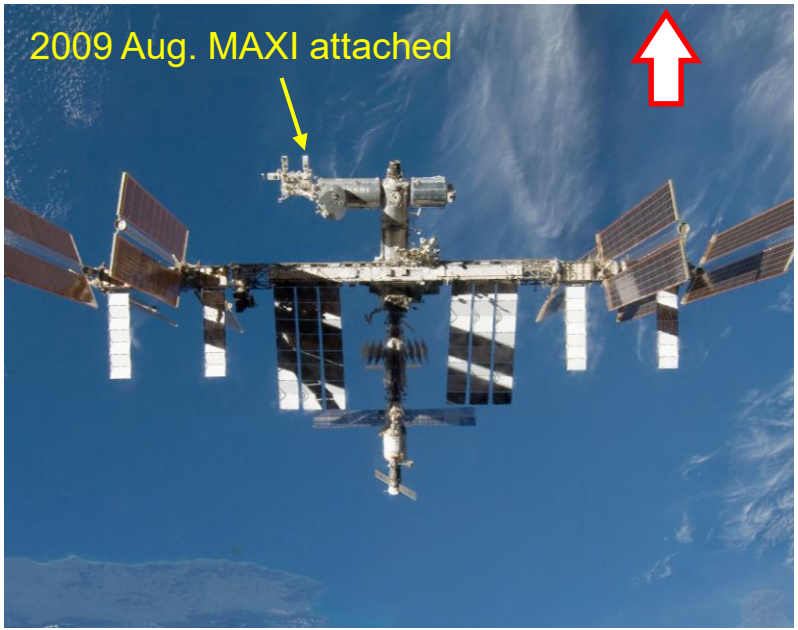


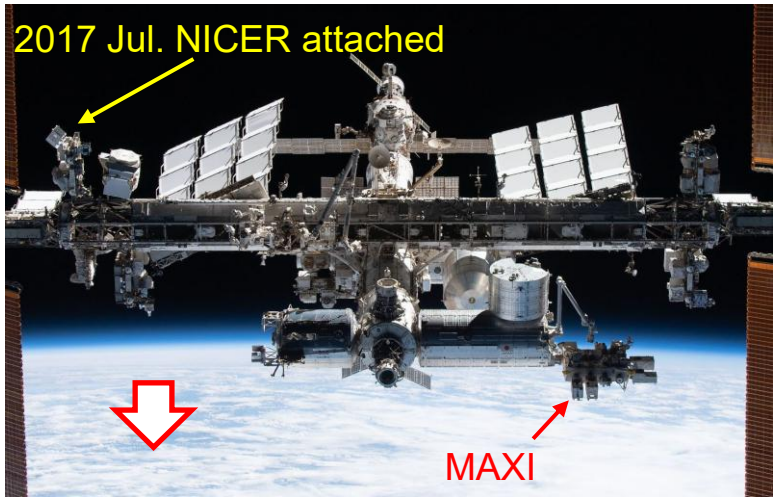


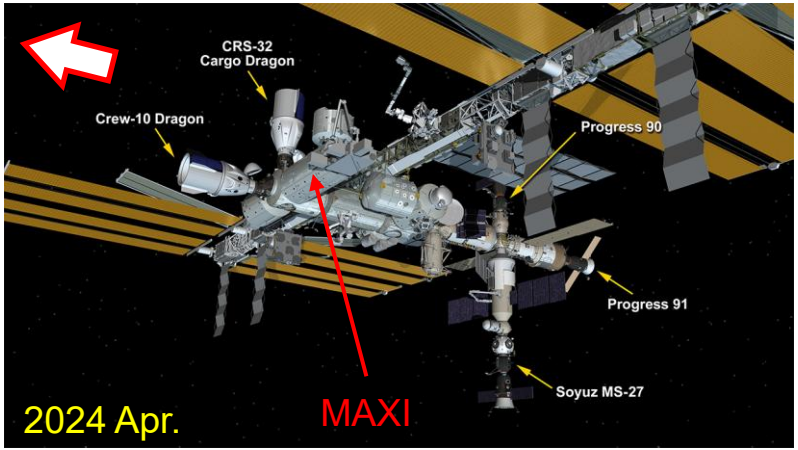


- MAXI 1-D slit camera has been scanning the whole sky according to the ISS orbital motion (90 min.) since 2009 August 15.
- Large inclination angle (51.6 deg)
- Various ISS structures sometimes interfere the MAXI FOV.

ISS configuration change

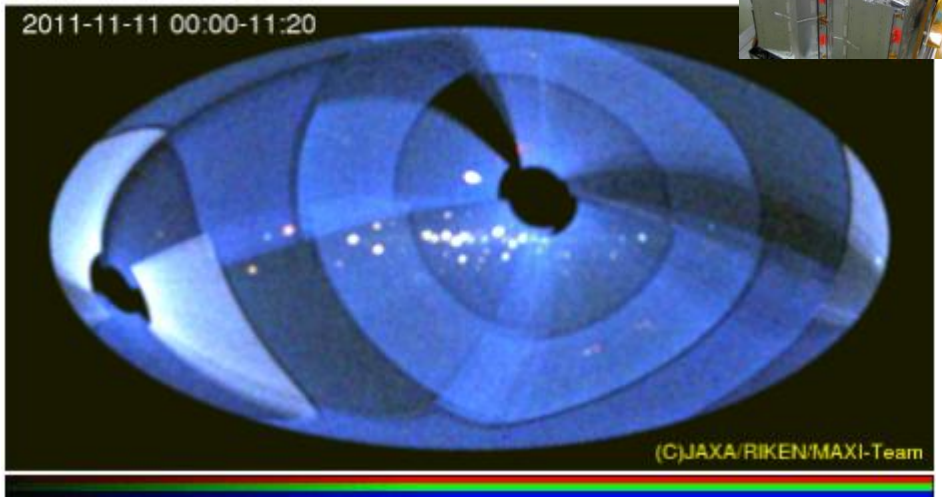






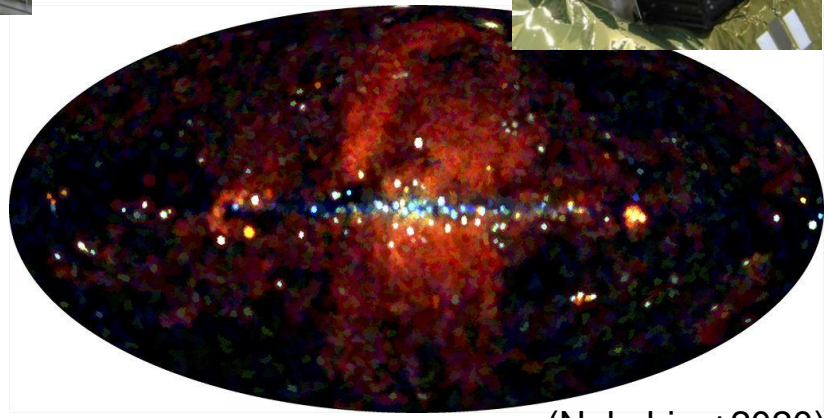
GSC (Gas Slit Camera) & SSC (Solid-state slit camera)

GSC image for 12 hours



- GSC Scanning almost all (>80%) sky every 90 min for 14 years

SSC image for 2 years



(Nakahira+2020)

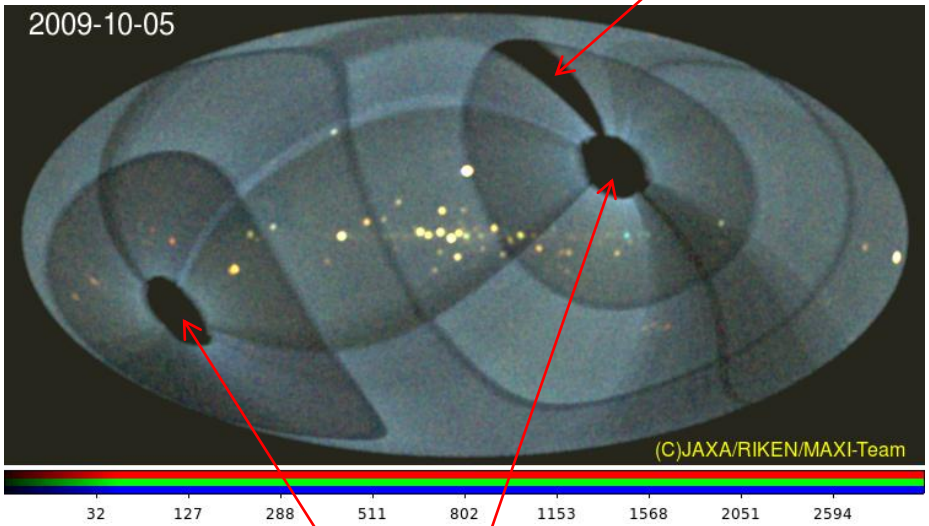
- SSC is tentatively suspended since 2022 June to saving electric power and CPU load

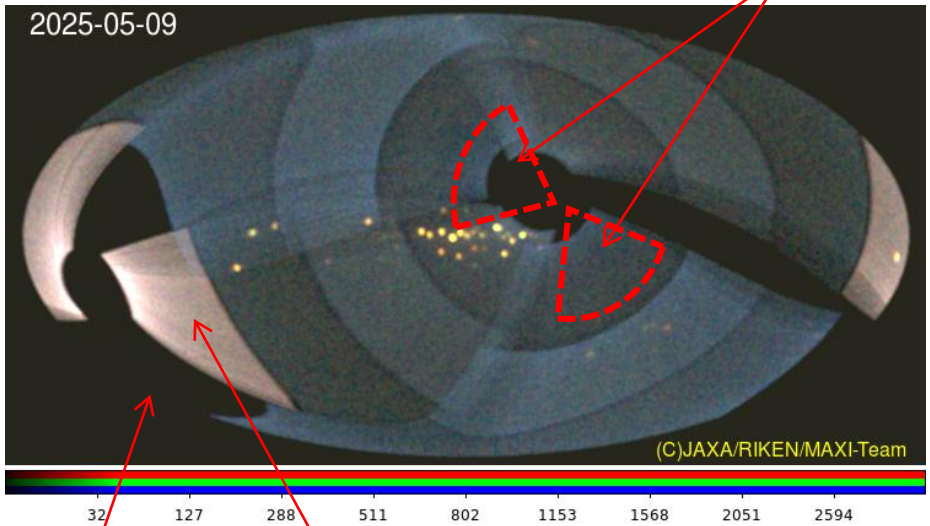
Daily GSC sky coverage

2009-Oct-05 → 15 years → 2025-May-09

Sun

Shadow of Space-X Dragon





rotation axis

GSC_0 lost for gas leak

GSC_3 BGD veto is malfunctional. BGD is ~10 times higher

The GSC still covers ~80% sky every 90 min of ISS orbital cycle

MAXI appearance in IACHEC meeting

- 2009 Shonan, Japan
- 2010 Woods Hole, USA
- 2012 Napa, USA

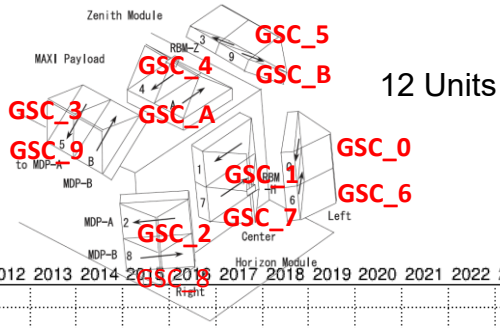
MAXI launch

- 2019 Shonan, Japan

- 2025 Osaka, Japan

We appreiatre for IACHEC collaboration!

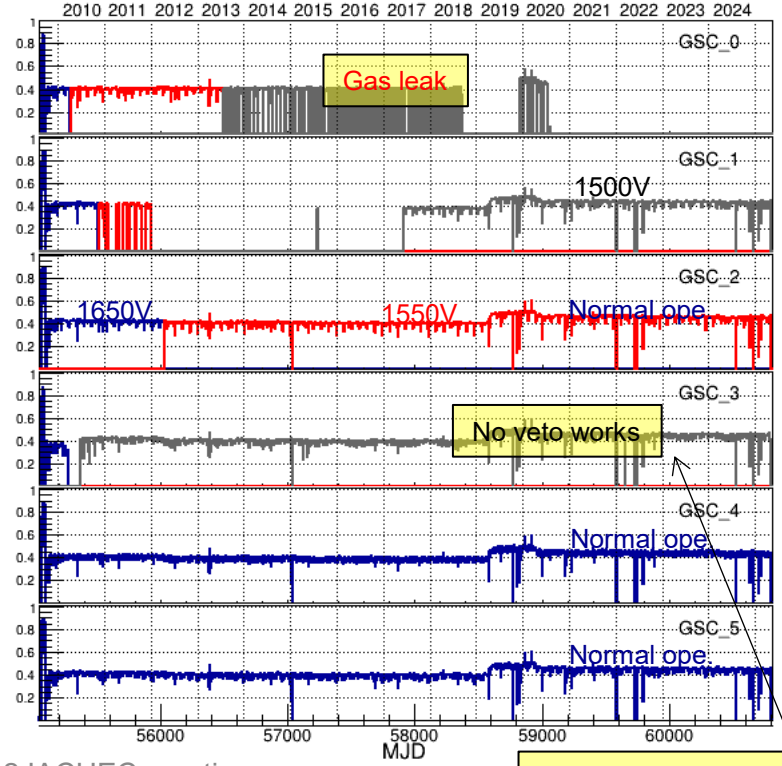
GSC daily observation duty cycle for 15 years

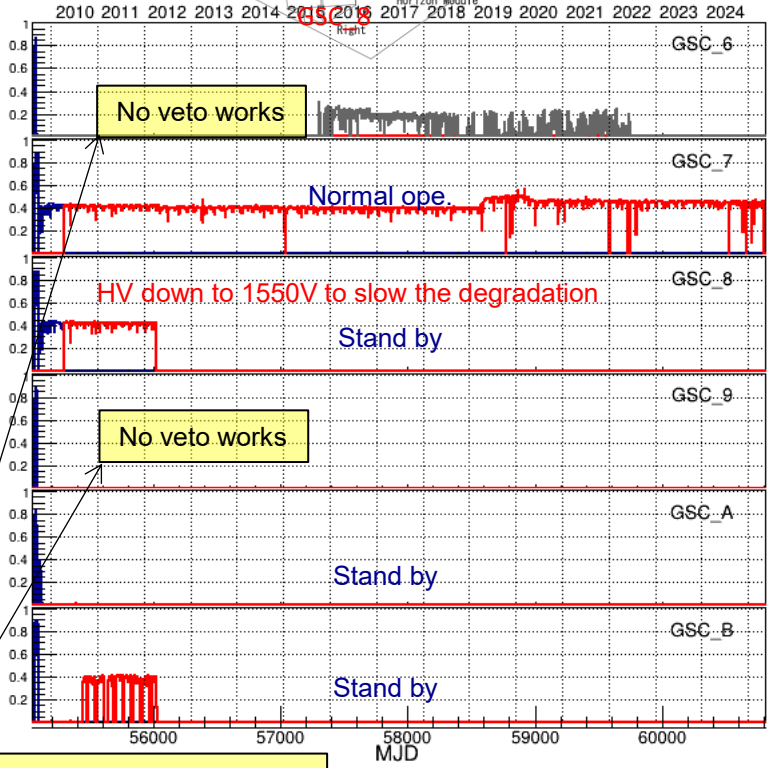


12 Units

2009 → 15 years → 2025

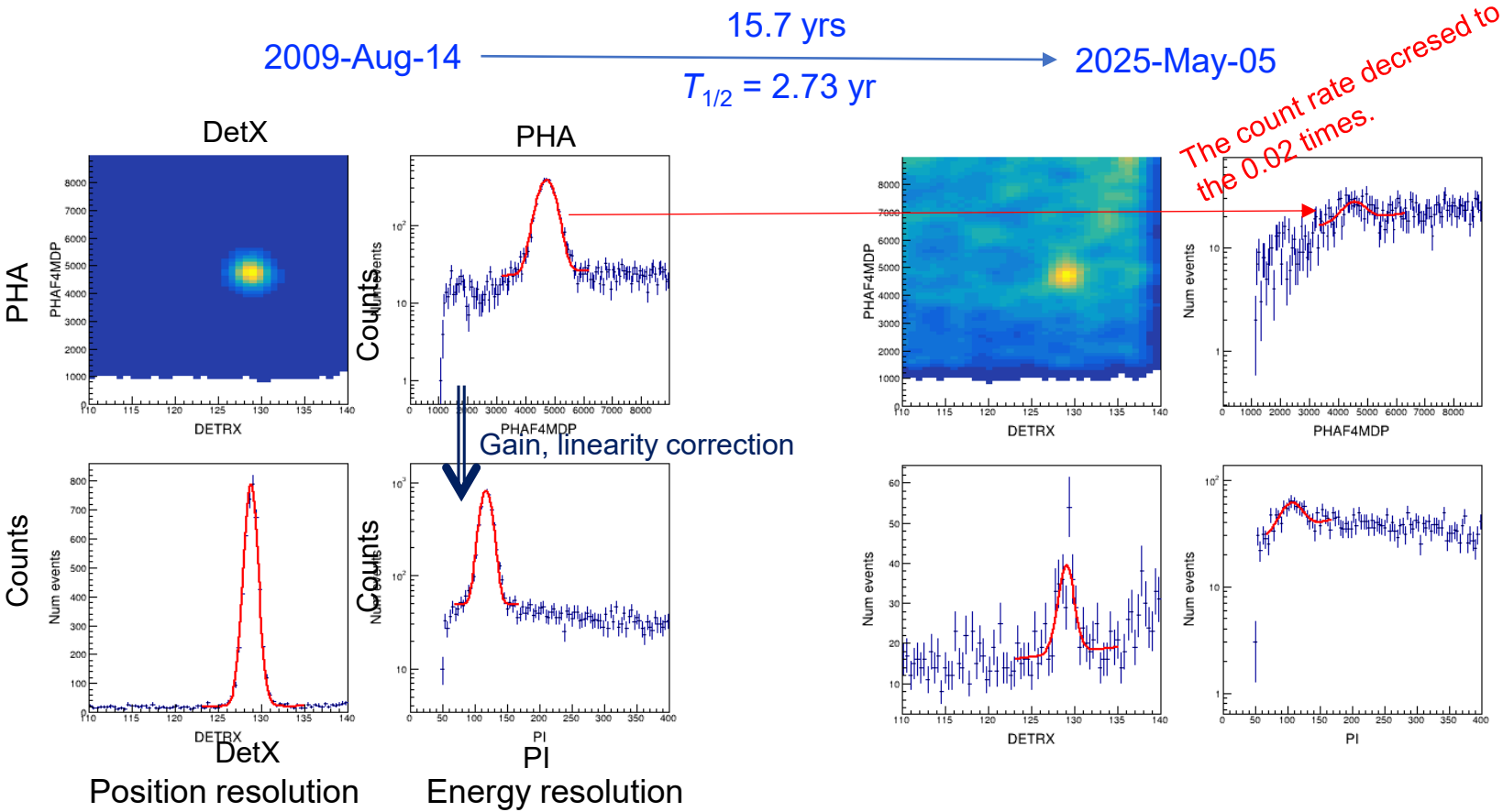
Working as a pair





These counters are operated under the limited functionality.

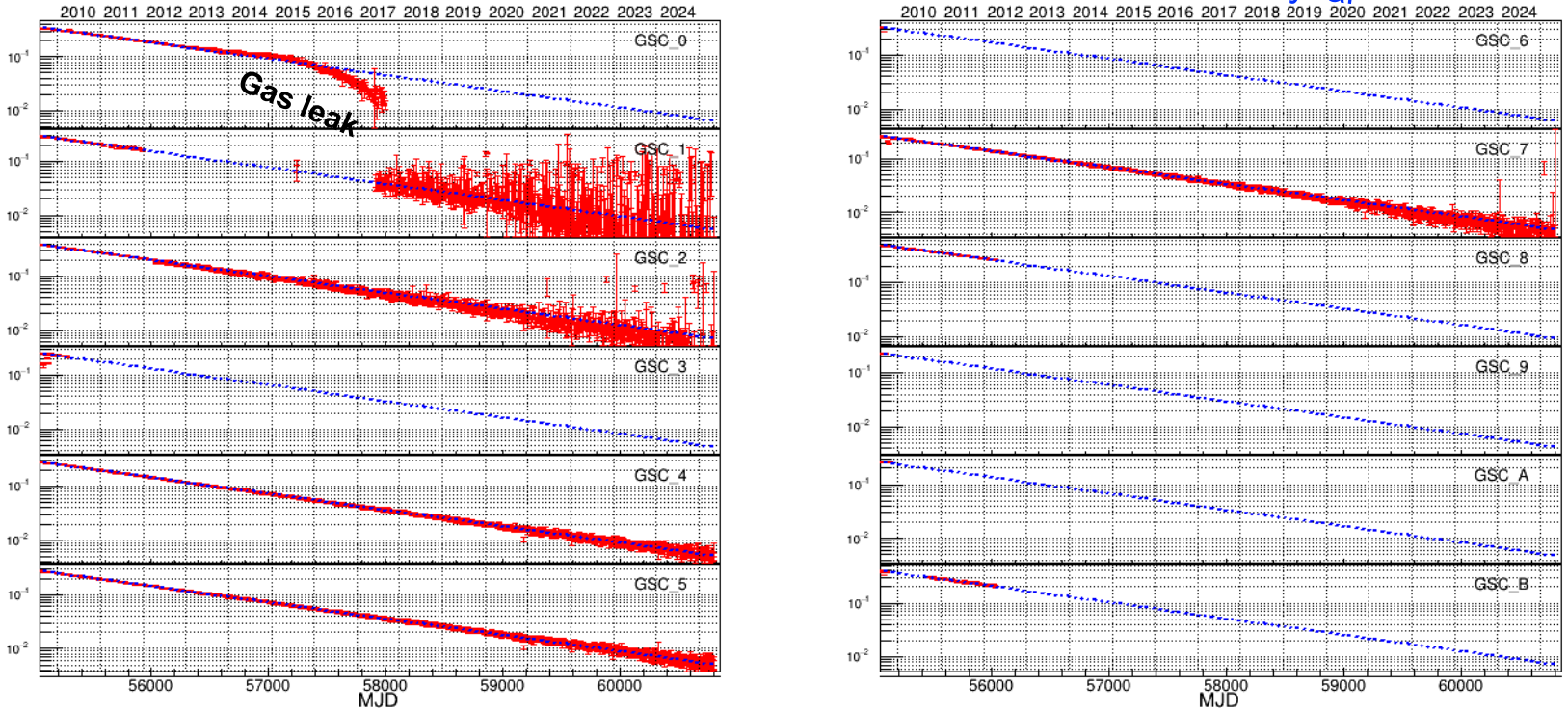
Gain & QE monitoring with ^{55}Fe 5.9 keV X-ray



^{55}Fe 5.9 keV cal. X-ray rate (for QE, gas pressure)

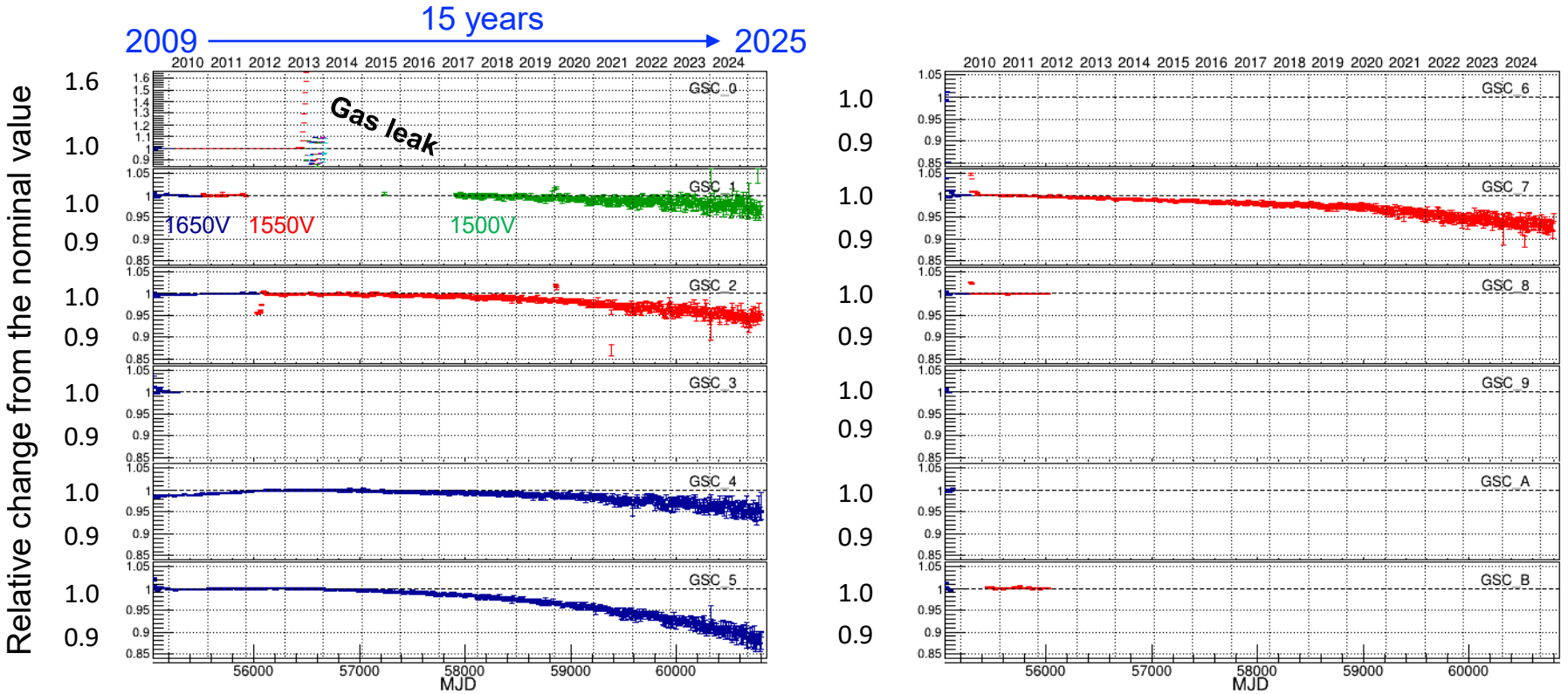
2009 ——— 15 years ———→ 2025

$T_{1/2}$=2.73 year



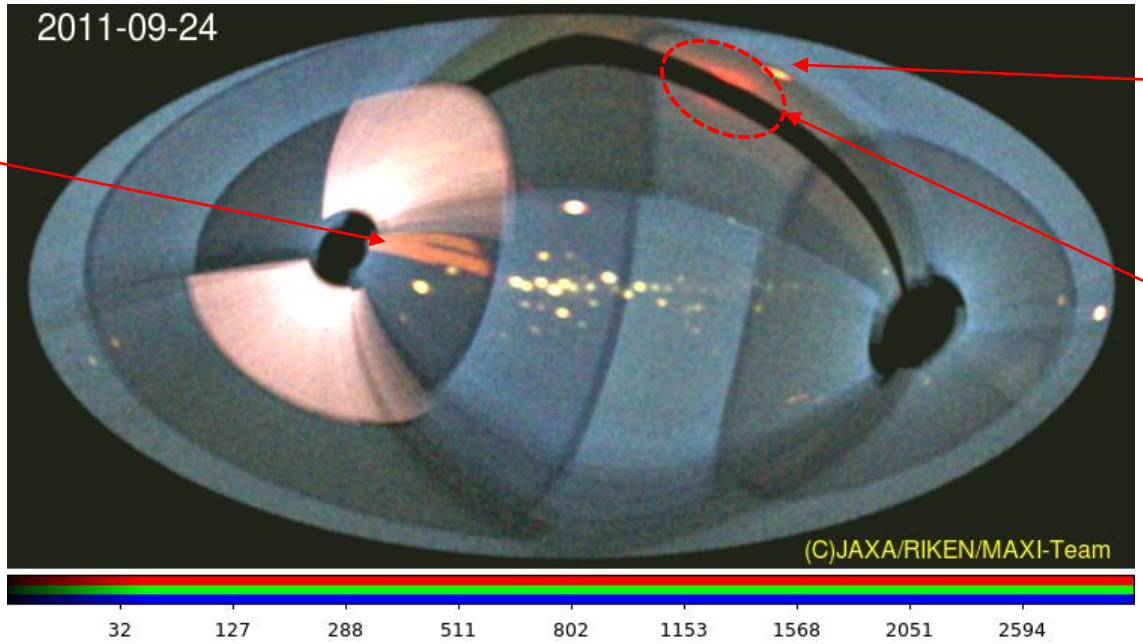
Except for GSC_0, the X-ray rate change agrees with that expected from $T_{1/2}$=2.73 yr.

^{55}Fe 5.9 keV cal. X-ray PHA (for gas/amplifier gain)



The gas gain is gradually decreasing, and its change rate seems to be increasing.
Are gas impurities increasing?

Leak / scattering of solar flare X-rays in GSC



Scattered at ISS solar panel

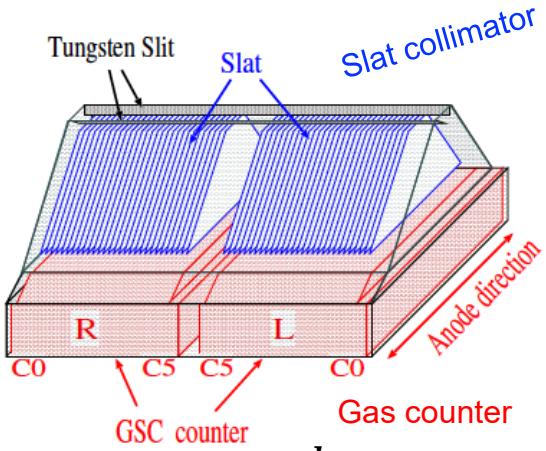
Leak through the collimator edge

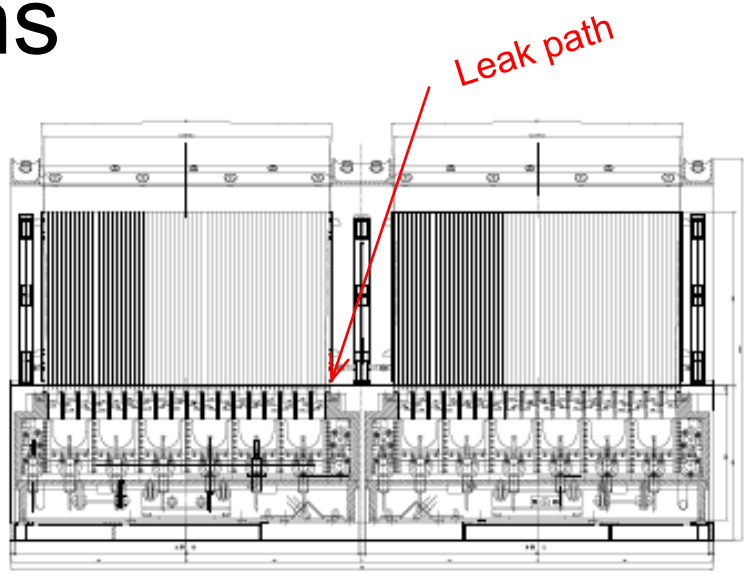
Scattered at collimator

Mostly soft X-rays (<4 keV)

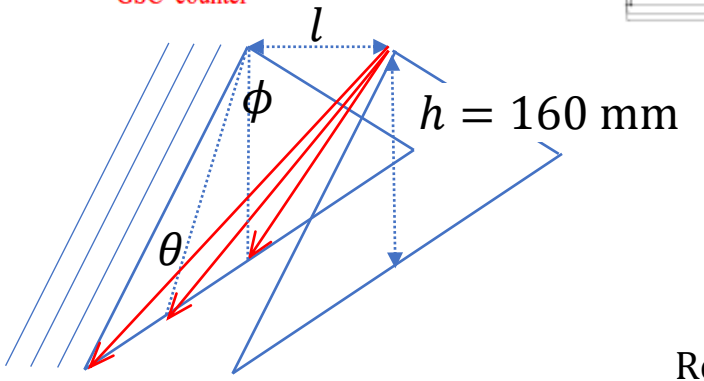
Expected leak paths

GSC schematic drawing





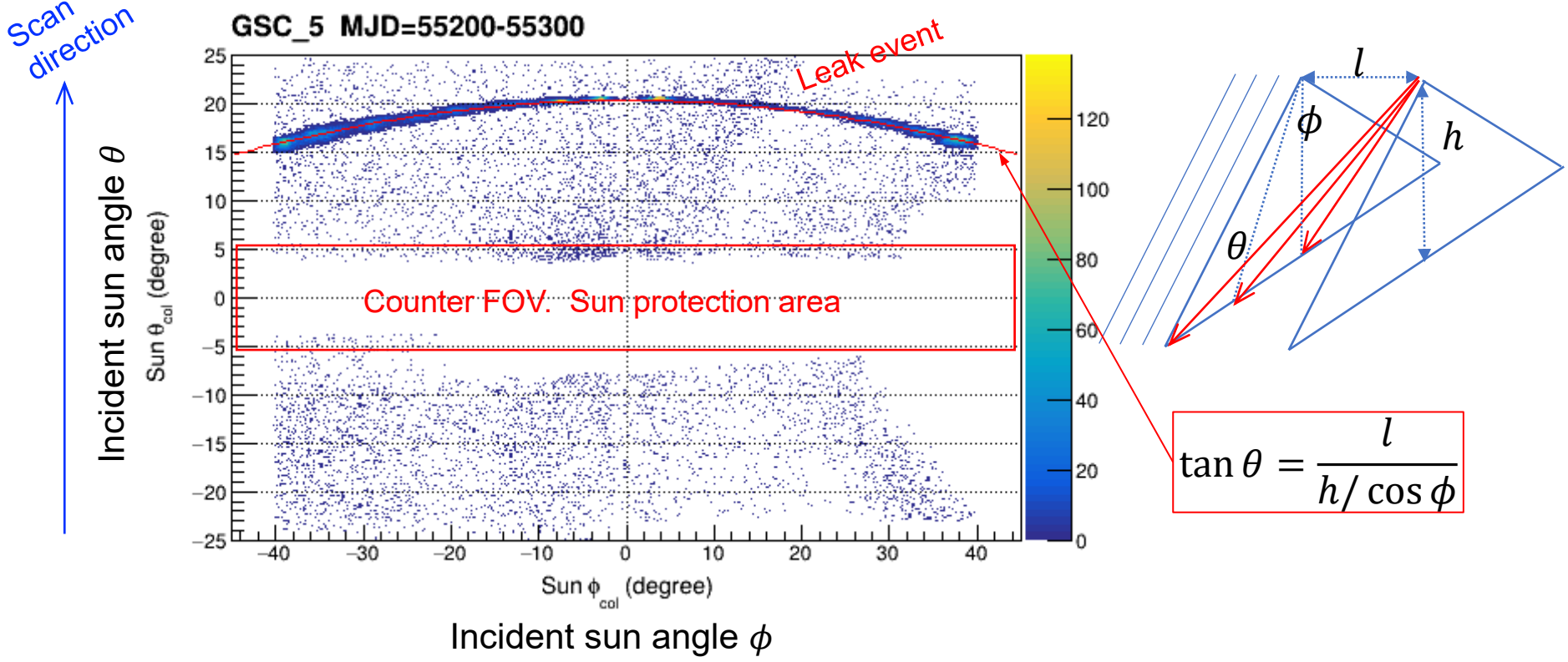
Cross section



$$\tan\theta = \frac{l}{h/\cos\phi}$$

Relation between θ and ϕ

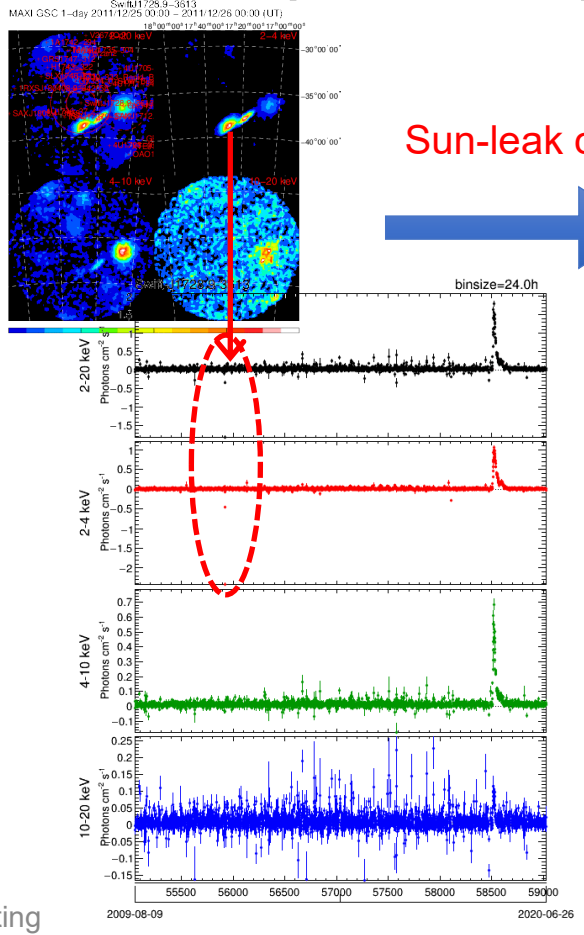
Stacked sun-scan data (in GSC_5 case)

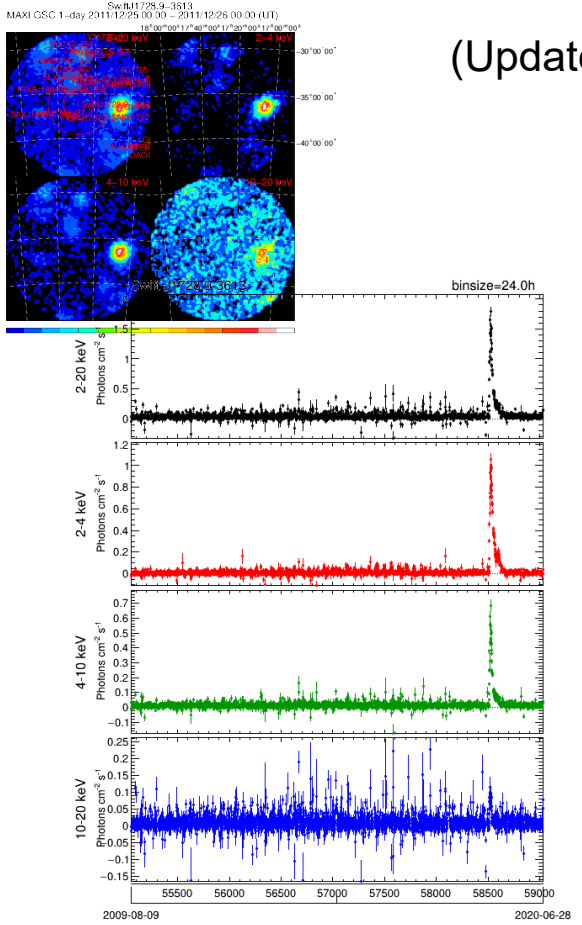


Data-process update to patch the solar flare events

(Updated in 2020)

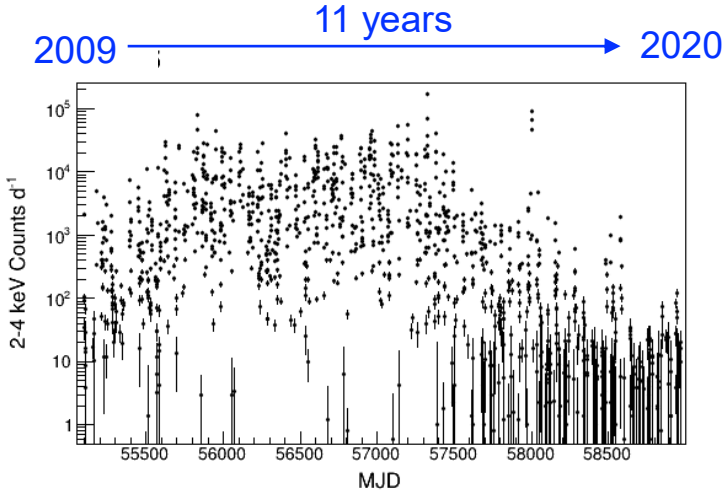
Sun-leak cut



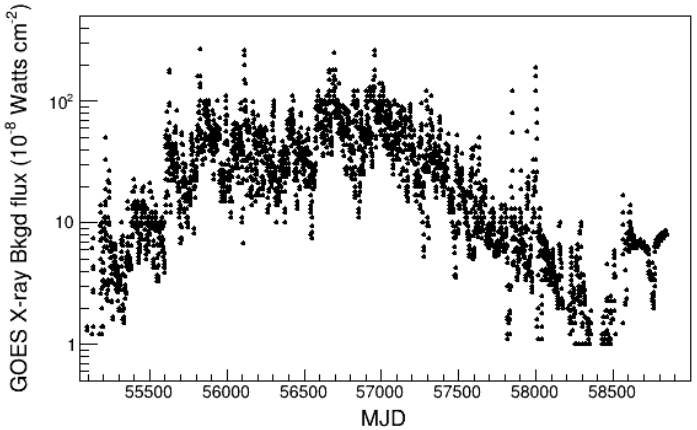


Monitoring Solar X-rays with leaked events

GSC_5 Sun-leak event counts (not corrected for exposure, effective area)



GOES X-ray bkgd flux



The two profiles appear to correlate well.

Summary

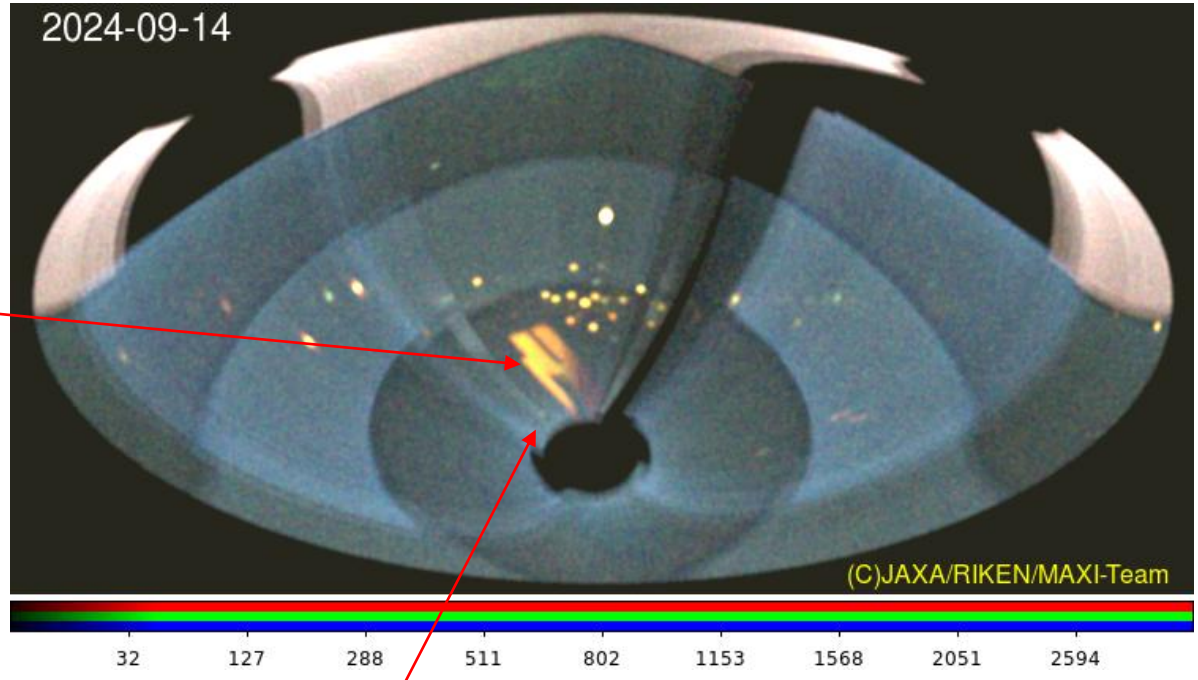
- MAXI operation is planned to extend until ~2030 (unless any major accident occurs) as it plays its important role in the era of time-domin / multi-messanger astronomy.
- Contaneous equal-quality data for over 15 years (over 30 years if RXTE/ASM data are combined) will provide a unique research opportunity

- The long heritage will be useful for current / new missions

- The calibration works continue…

Backup

Reflected solar-flare X-rays from Moon



Scattered at Solar panel

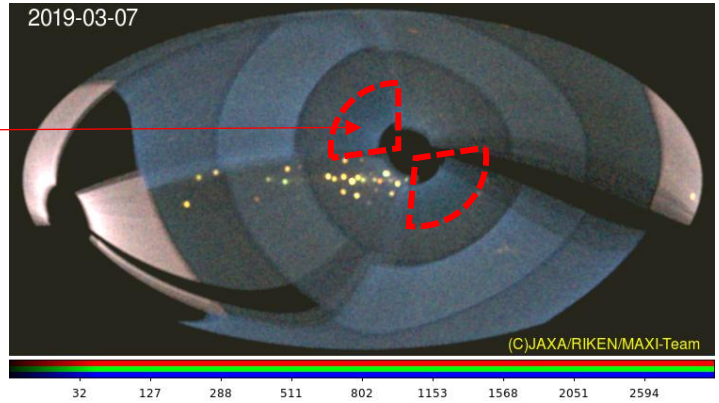
Significant X-rays from the position of the Moon.
Reflection on Moon (Mihara)

http://maxi.riken.jp/news/en/#news-1412

http://maxi.riken.jp/news/en/#news-1392

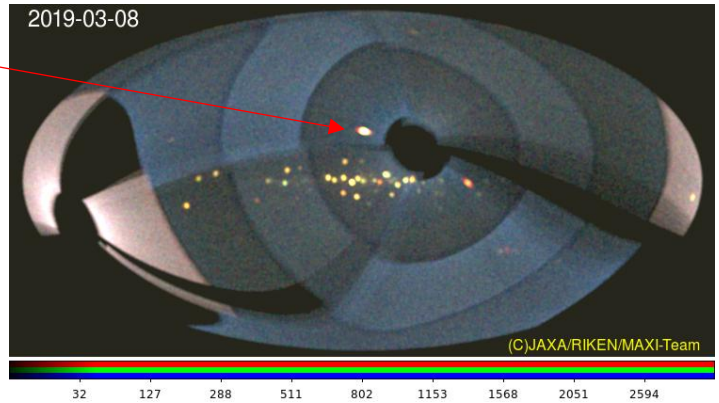
What caused the eclipse-like feature ?

Shadow of Space-X Demo-1



2009-03-07

Sco X-1



2019-03-08

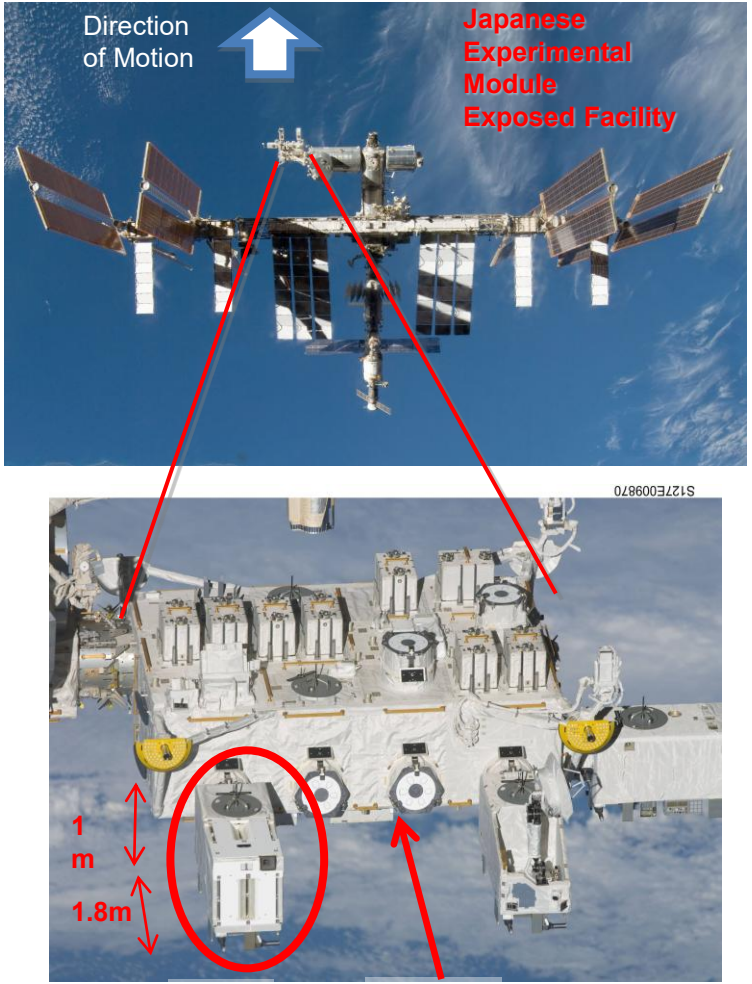
Undocked

One example.
Careful inspections are still required.

MAXI on the ISS

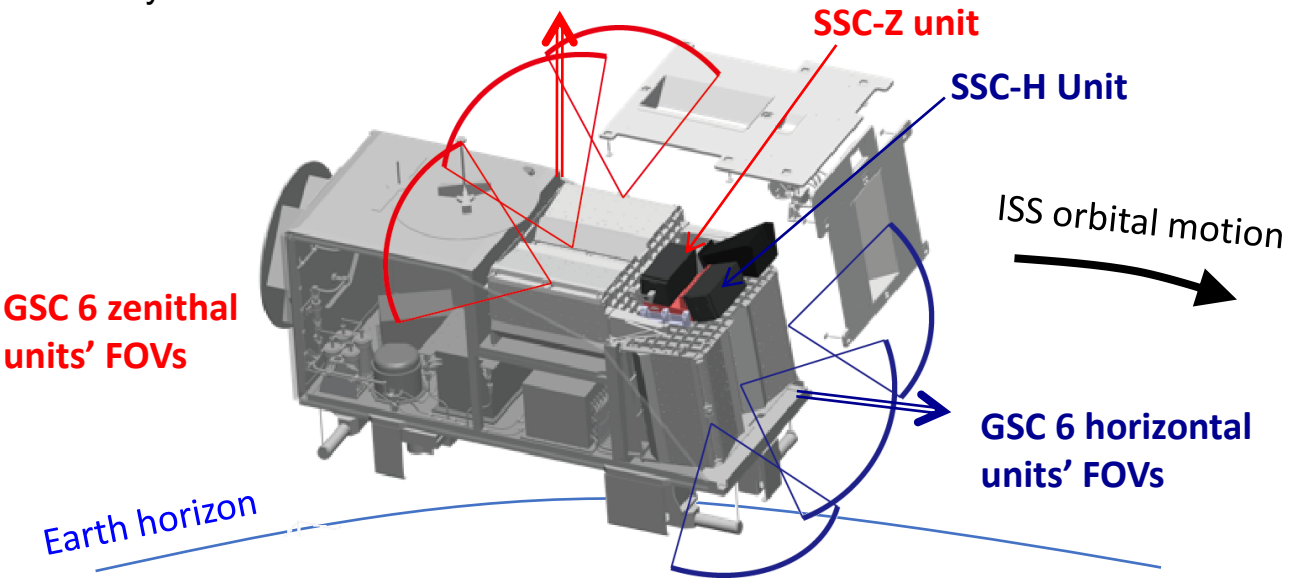
- **MAXI (Monitor of All-sky X-ray Image)** has been operated for 14 years on ISS
- **Two scientific instruments**
  - Gas Slit Camera (GSC) 2-20 keV
  - Solid-state Slit Camera (SSC) 0.7-10 keV
- **Large field of view**
  - covering almost all sky every 90 min
- **All-time monitoring**
  - Data before the trigger are available
- **Nova alert in real-time**
  - Alert message is issued automatically to MAXI mailing lists, 294 subscribers

Leading Time domain astronomy

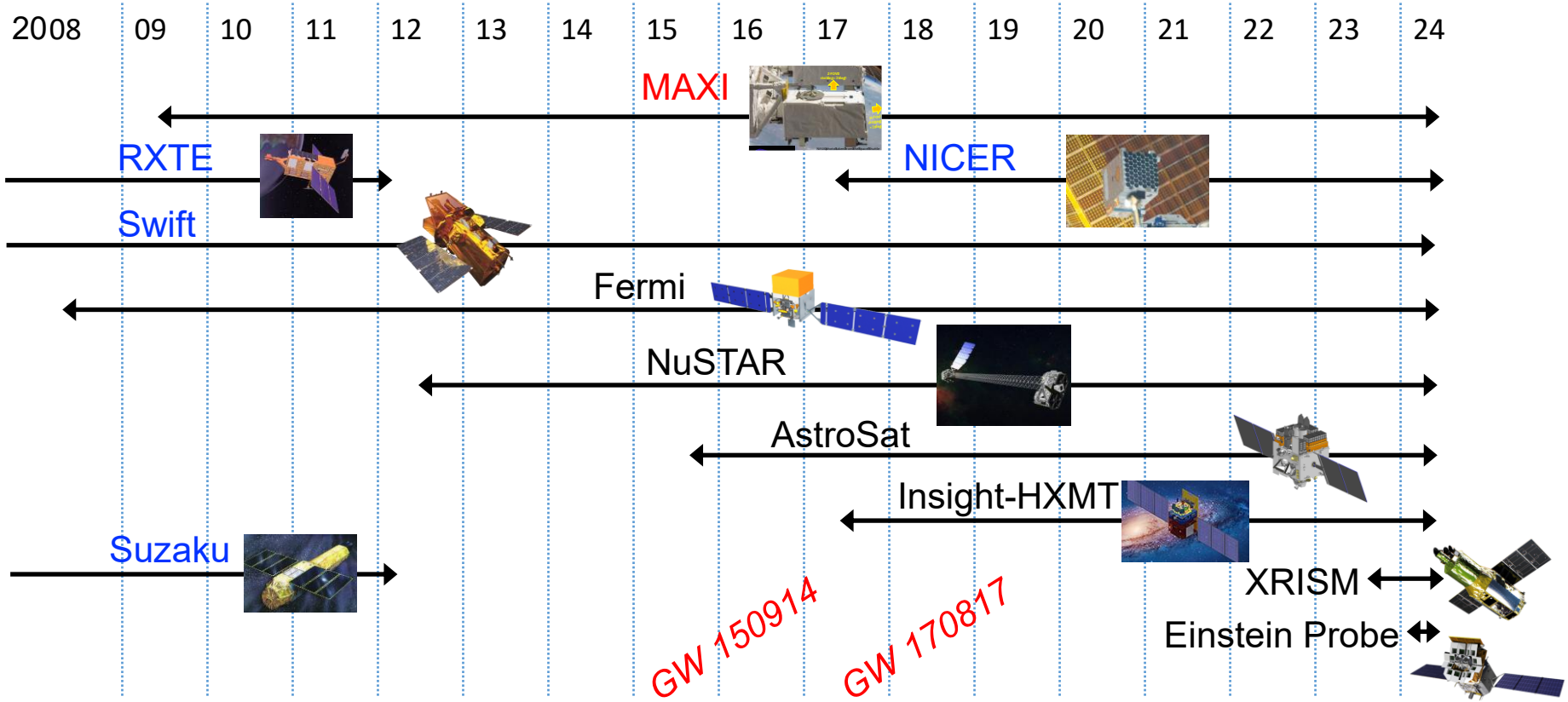


MAXI Mission Instruments

- **GSC (Gas Slit Camera)** 2-30 keV band **Large area**
  - 1-D position-sensitive Xe-gas counters and slat collimators with slit
  - Anti-coincidence BGD rejection (e.g. Ginga/LAC, RXTE/PCA, ASM)
  - 12 identical units to cover 1-D horizontal and zenithal FOVs.
- **SSC (Solid-State Slit Camera)** 0.5-12 keV band **Good energy resolution**
  X-ray CCDs + Slat Collimator and Slit



Cooperative / Competitive missions in 14 years



→ Multi-messanger astronomy