KOYOH science data analysis
Application to standard astronomical analysis framework

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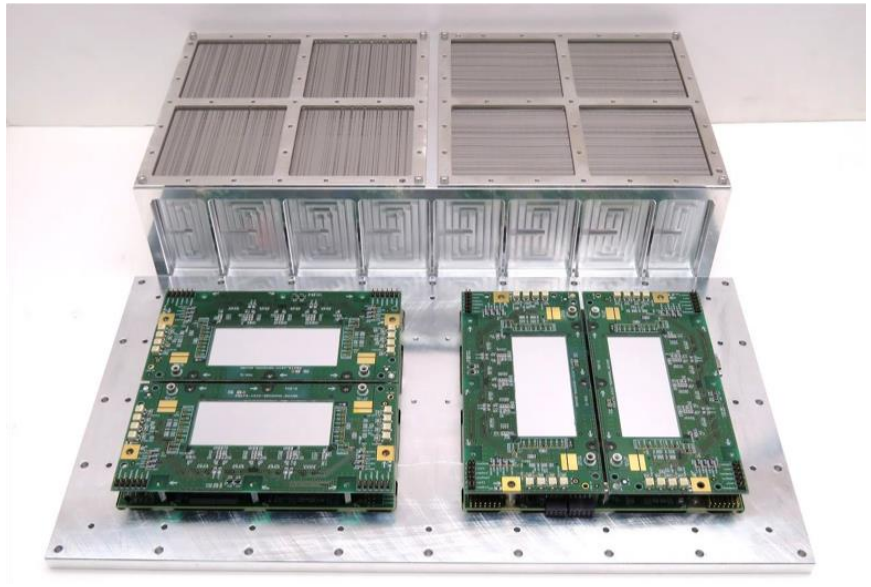
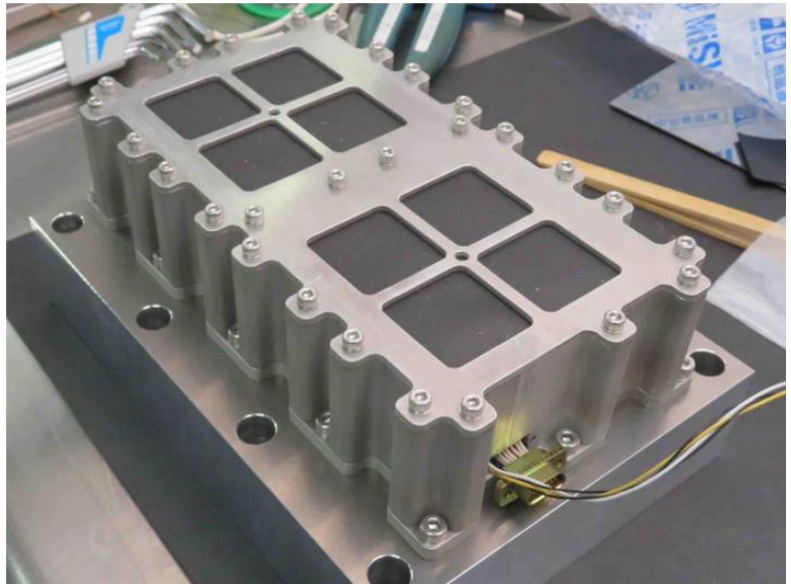
KOYOH satellite science instruments

- T-LEX
  - 1-D coded mask + silicon-microstrip X-ray detector



Energy band: 2-20 keV
Detector area: ~100 cm^2
Coded aperture ratio ~ 20%

- KGD
  - CsI scintillator + MPPC (Multipixel photon counter)



Energy band: 20-500 keV
Detector area: ~10 cm^2

Photos from https://arc-sat.w3.kanazawa-u.ac.jp/research/research-01/

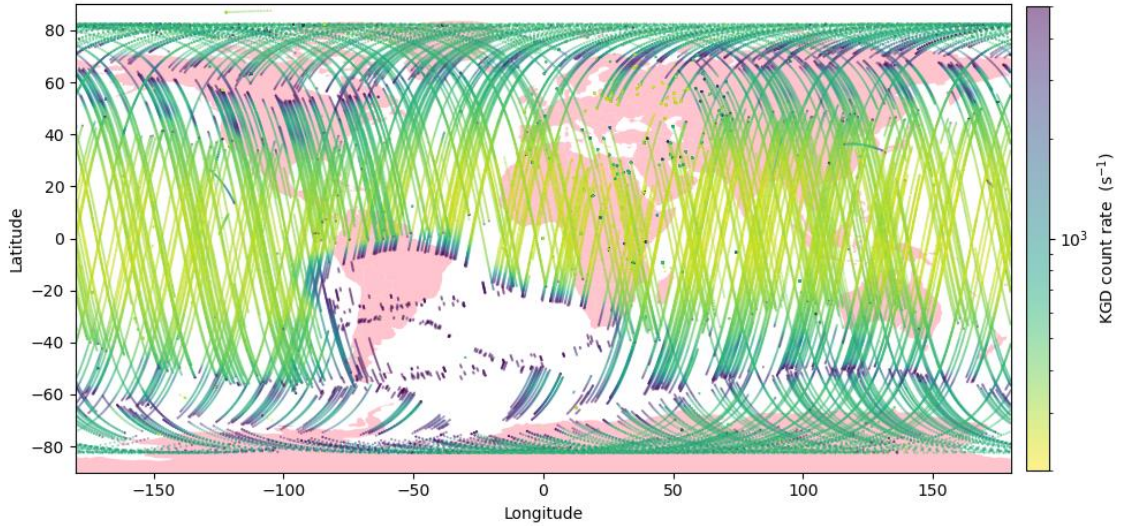
Present data

Operation from 2024 January to May (5 months)

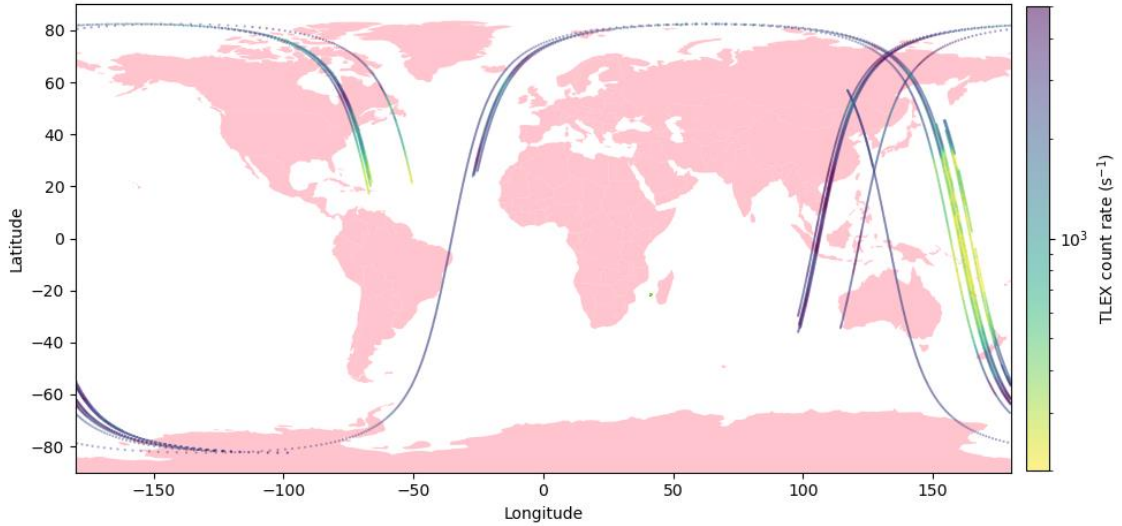
- Science mission data (KGD, T-LEX)
  - Standard (stored) HK data
    - Every 16 seconds
    - Detector count rates
    - GPS position (Lon., Lat., Alt.). No GPS time
    - OBC (On-board computer)
      boot count (BTC), 1 kHz clock time (TI)
  - Realtime HK data during contact passes
    - Every 8 seconds
    - GPS position and time
    - OBC BTC, TI

  No standard event data
- Auxilary data
  - Satellite orbit (Two line elements)
  - Attitude is not available

KGD

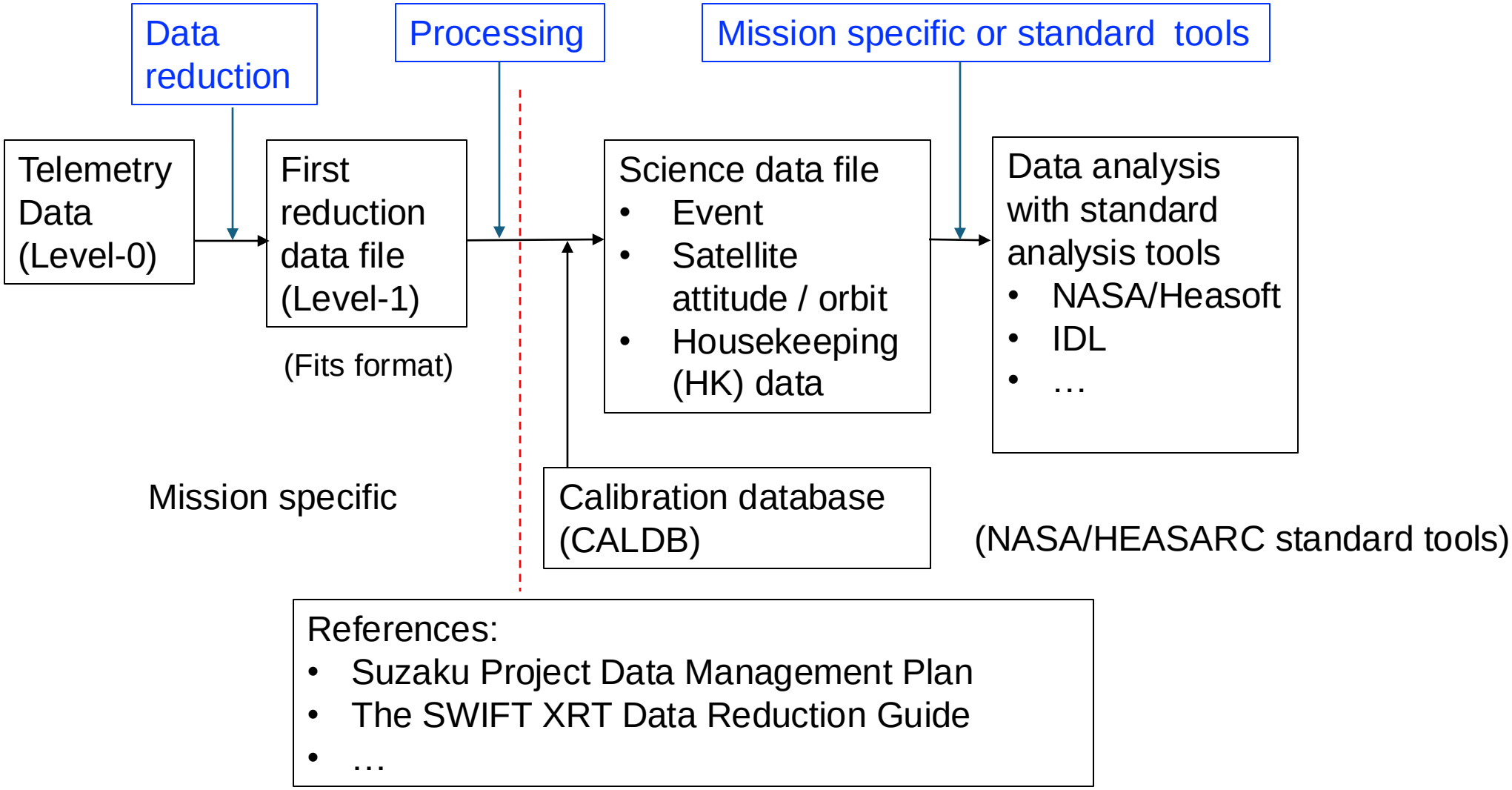


T-LEX



(Plots same as in presentations by Sawano, Takahashi)

Standard data-reduction and analysis framework in X-ray astronomical missions

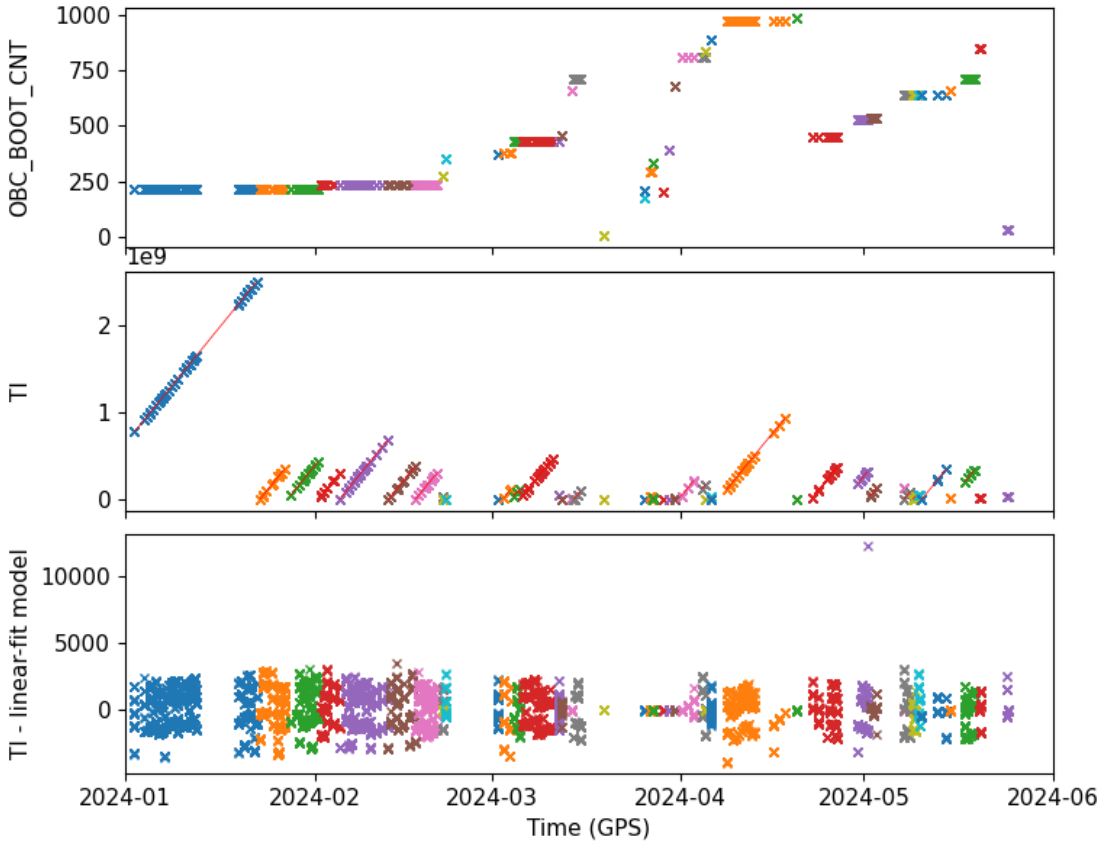


Absolute-time stamping on SHK data

- Realtime HK
  - OBC boot count, 1 kHz clock count (TI)
  - GPS Time

Interpolate or extrapolate

- SHK
  - OBC boot count, clock TI
  - (Absolute) Time



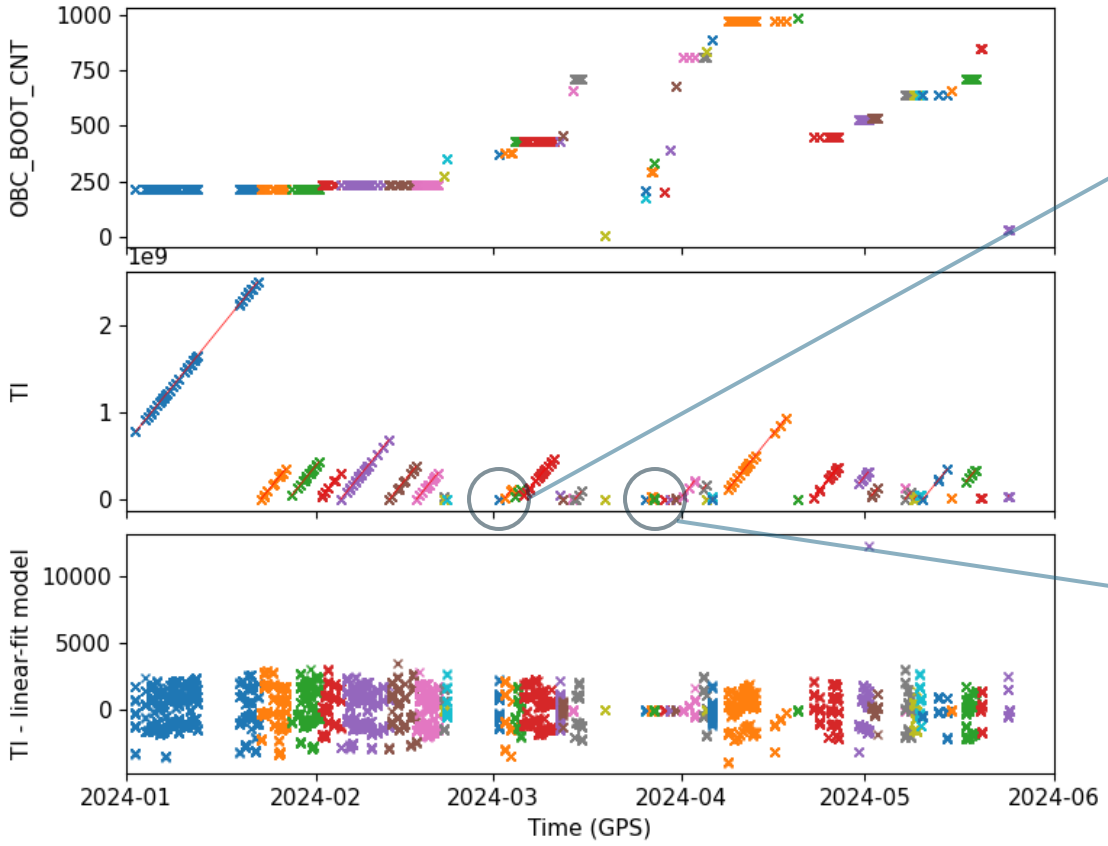
Relations between OBC boot count, 1 kHz clock count (TI) and GPS time in realtime HK data

Residuals of linear-fit models to TI-time relation.

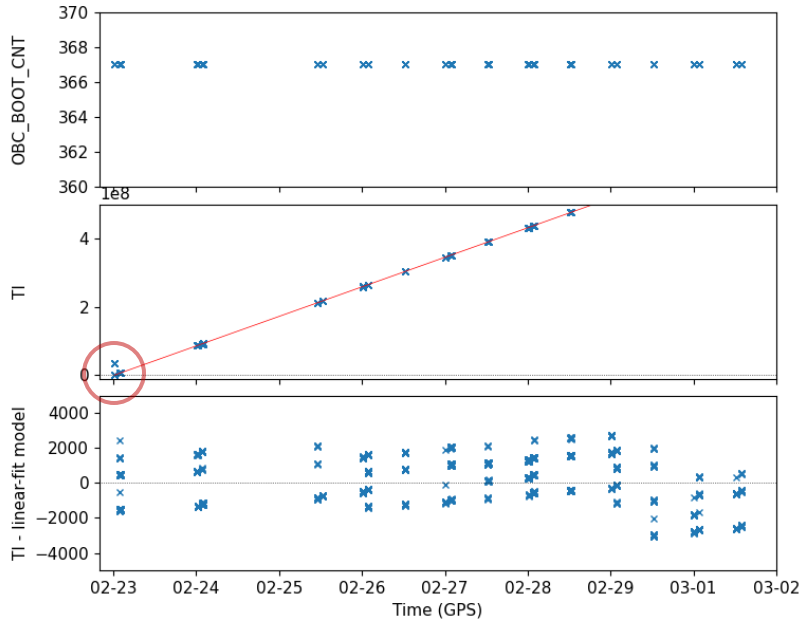
The residuals of ~3000 x 1ms ~3 s represent the uncertainty of the time stamp timing of ~3 s in the 16-s time bin data.

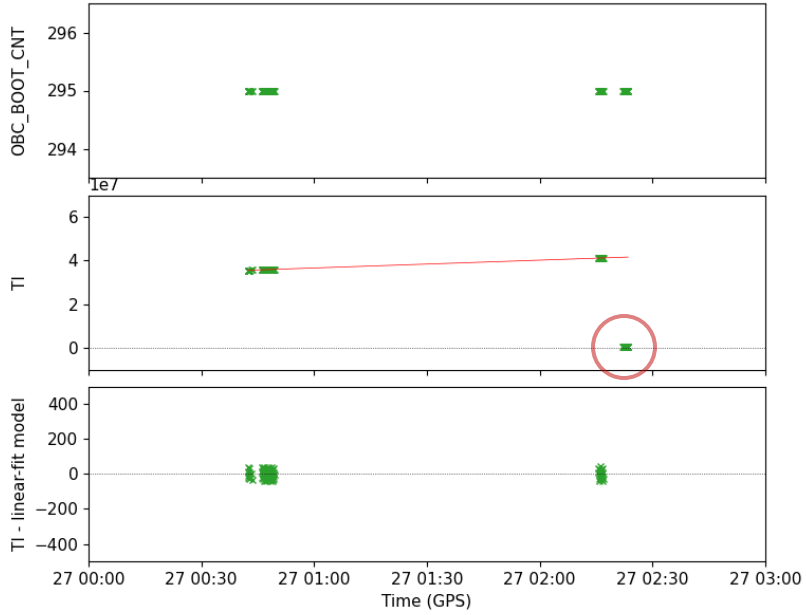
Some problems in HK time data

OBC boot count, TI – GPS time relation

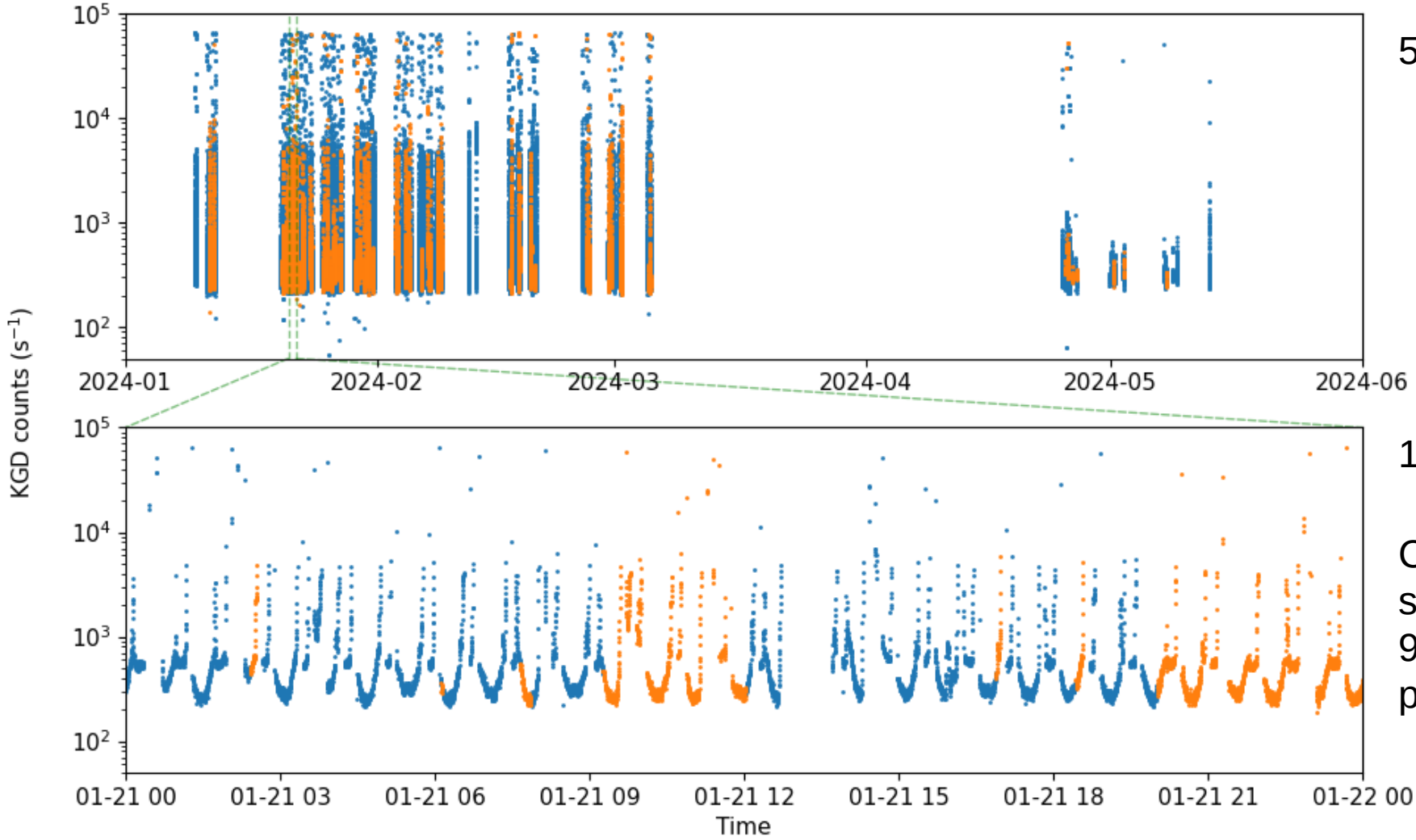


There are a few outliers that are not clearly on a straight line.





KGD count rate in 5 month SHK data



5 months

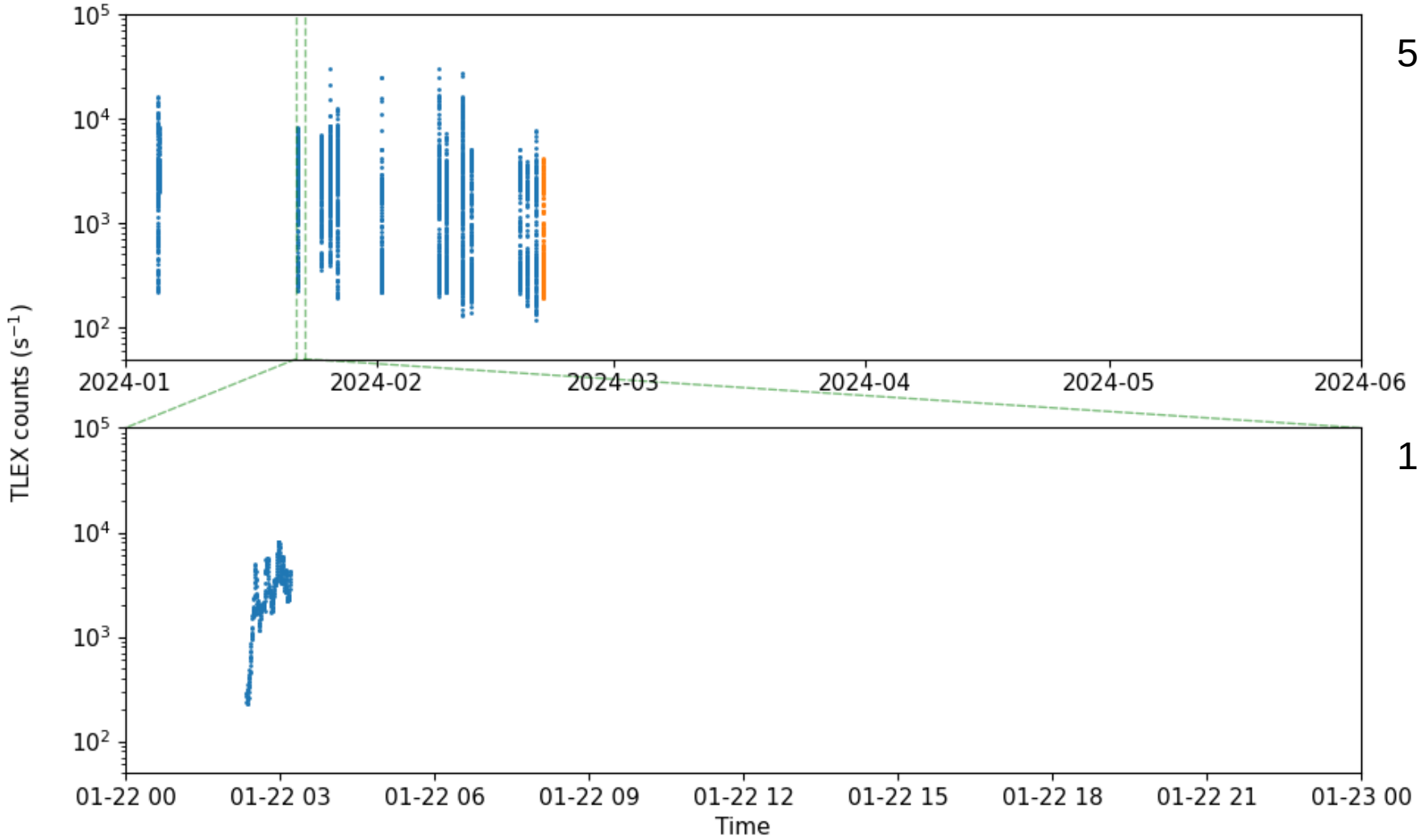
1 days

Count-rate change synchronized with 90-min orbital perood

Data with GPS position information / without GPS information

(Total 2.23 Msec = 620 hrs) (Total 0.39 Msec = 108 hrs)

T-LEX count rate in 5 month SHK data



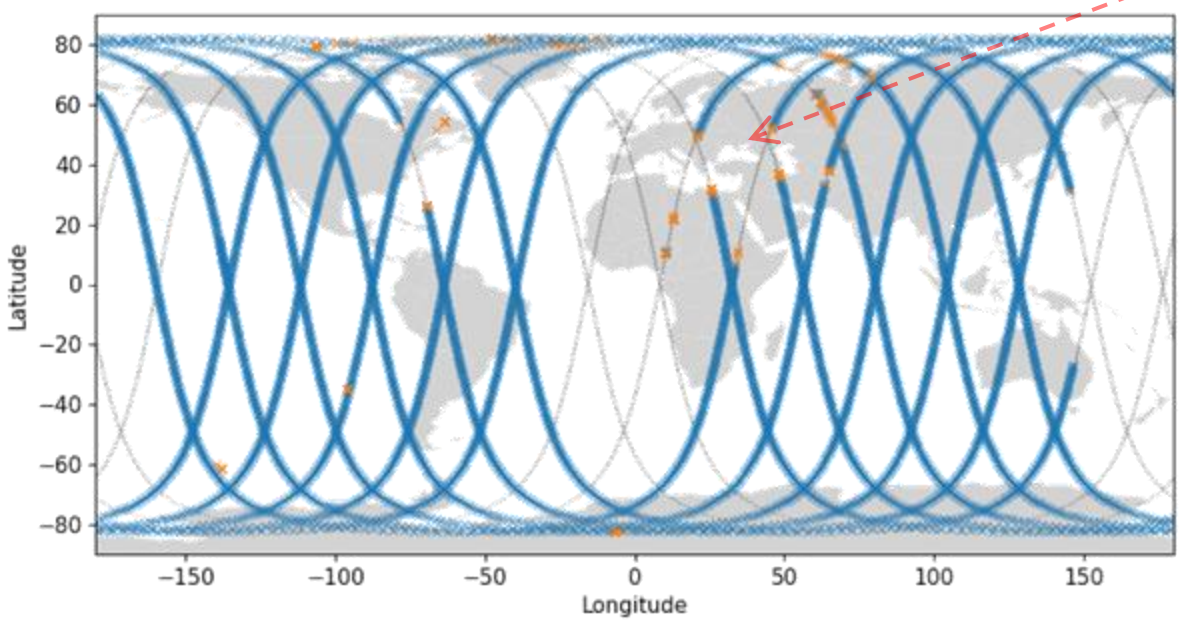
5 months

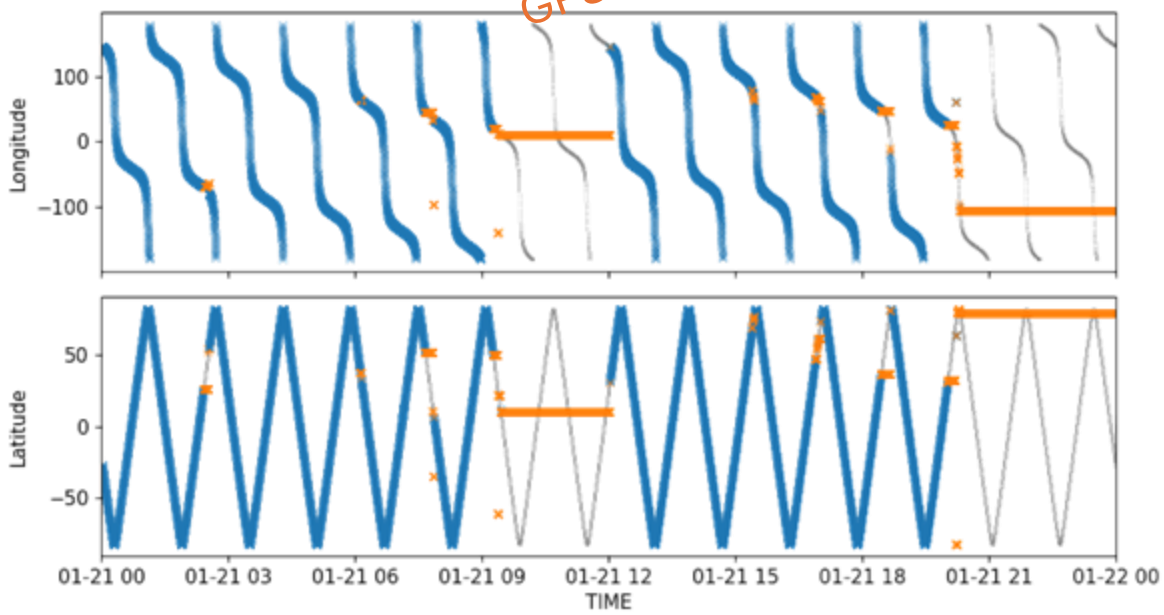
1 days

Data with GPS position information / without GPS information
(Total 88 ksec ~ 24 hrs) (Total 6.2 ksec = 1.7 hrs)

Satellite orbit data

- GPS data is mostly available, but sometimes corrupted (at like Ukline region).
- Calculate satellite orbital postion from orbital elements (Two Line Elements; TLE)
- Comparison betweem TLE predictions and GPS data.

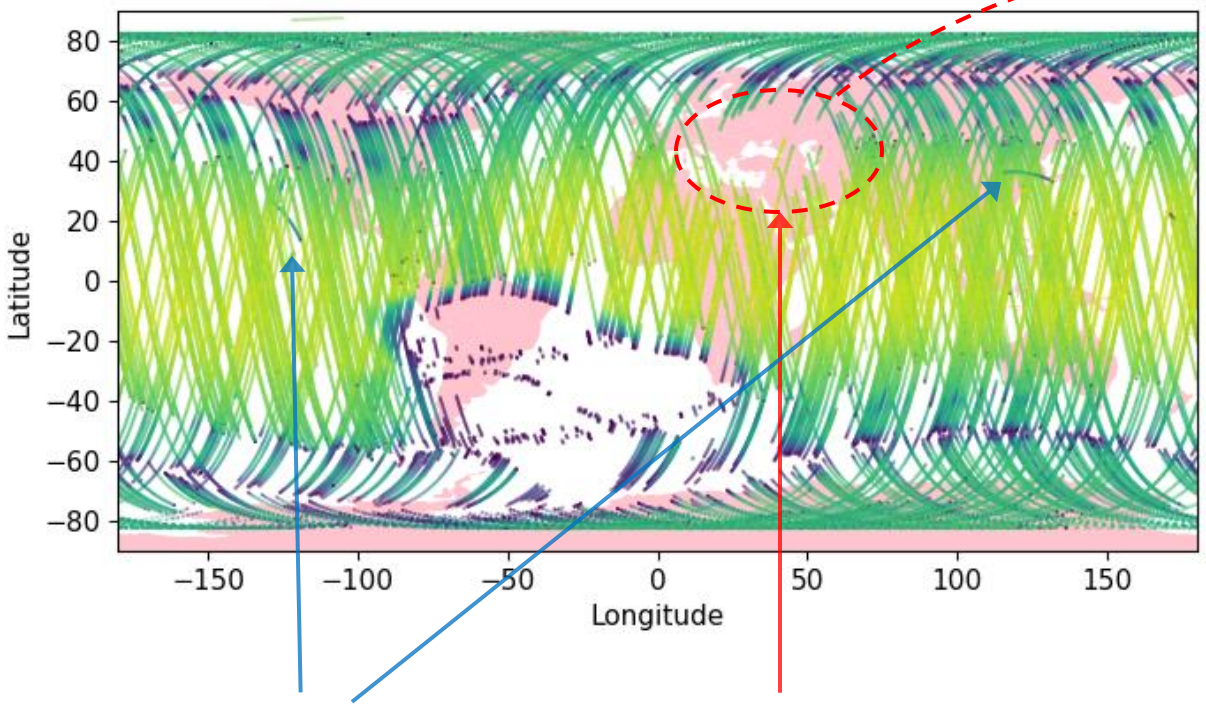




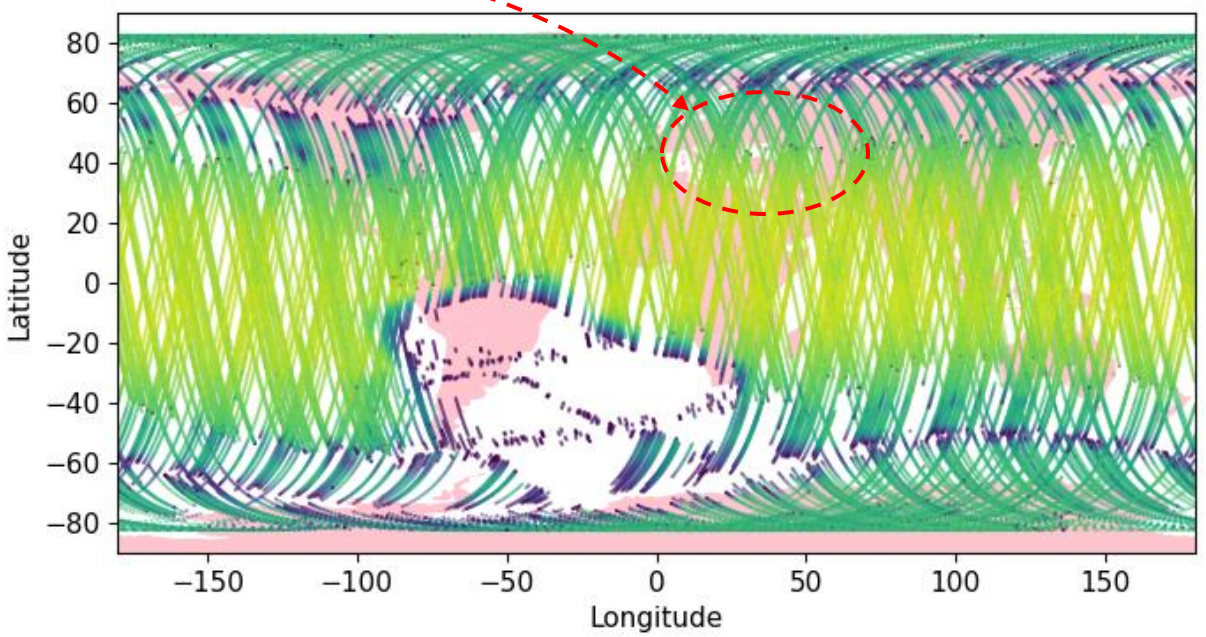
- 2024-01-21 SHK data
- GPS good data, GPS corrupted data
- TLE-predicted Longitude, Latitude (gray line)

Update on KGD count-rate map

Map using GPS position data
(Total 620 hrs)



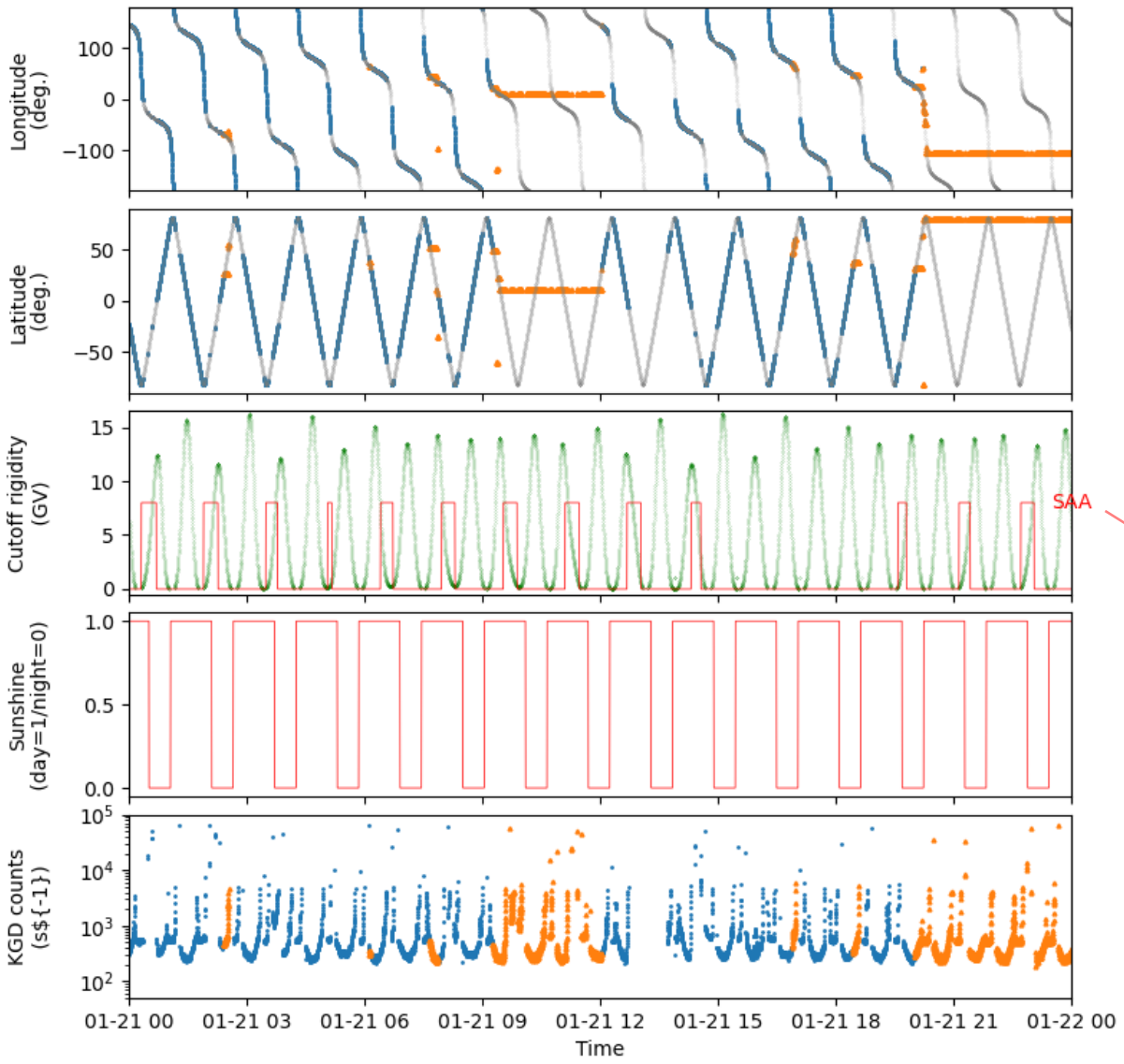
Map using satellite orbital elements
(Total 728 hrs)

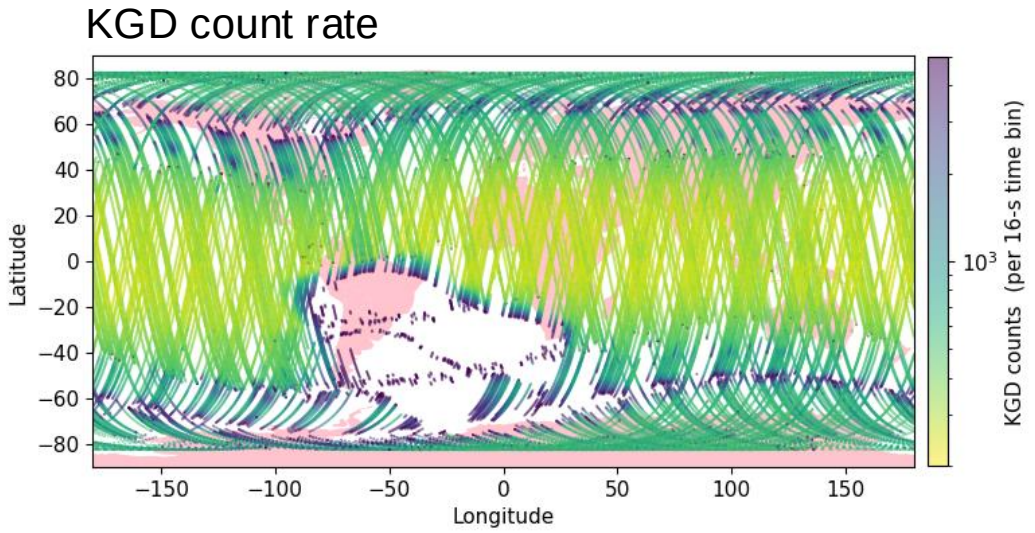


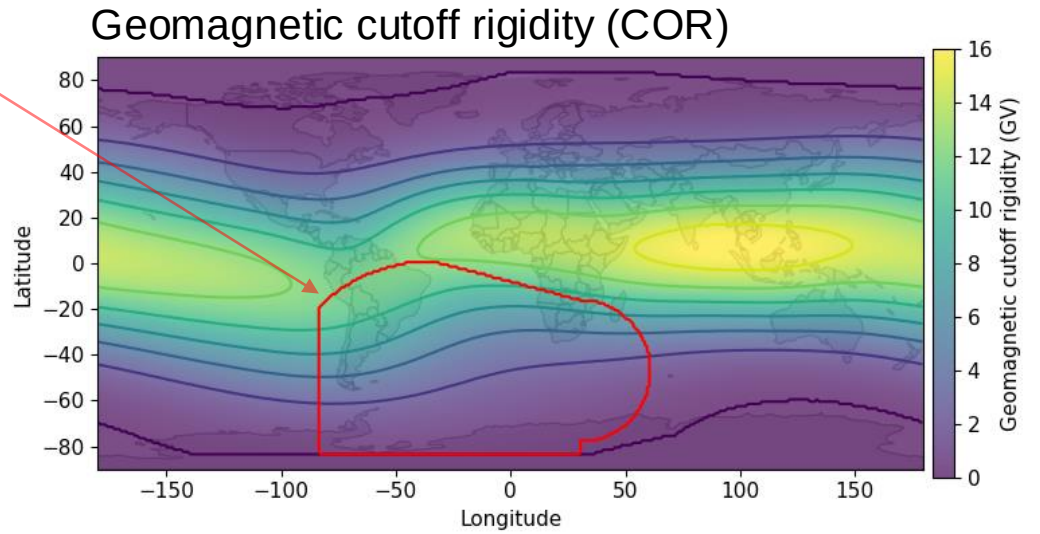
Some GPS data seem to be still bad.

Vacant around the Ukline region

KGD count rate – satellite location

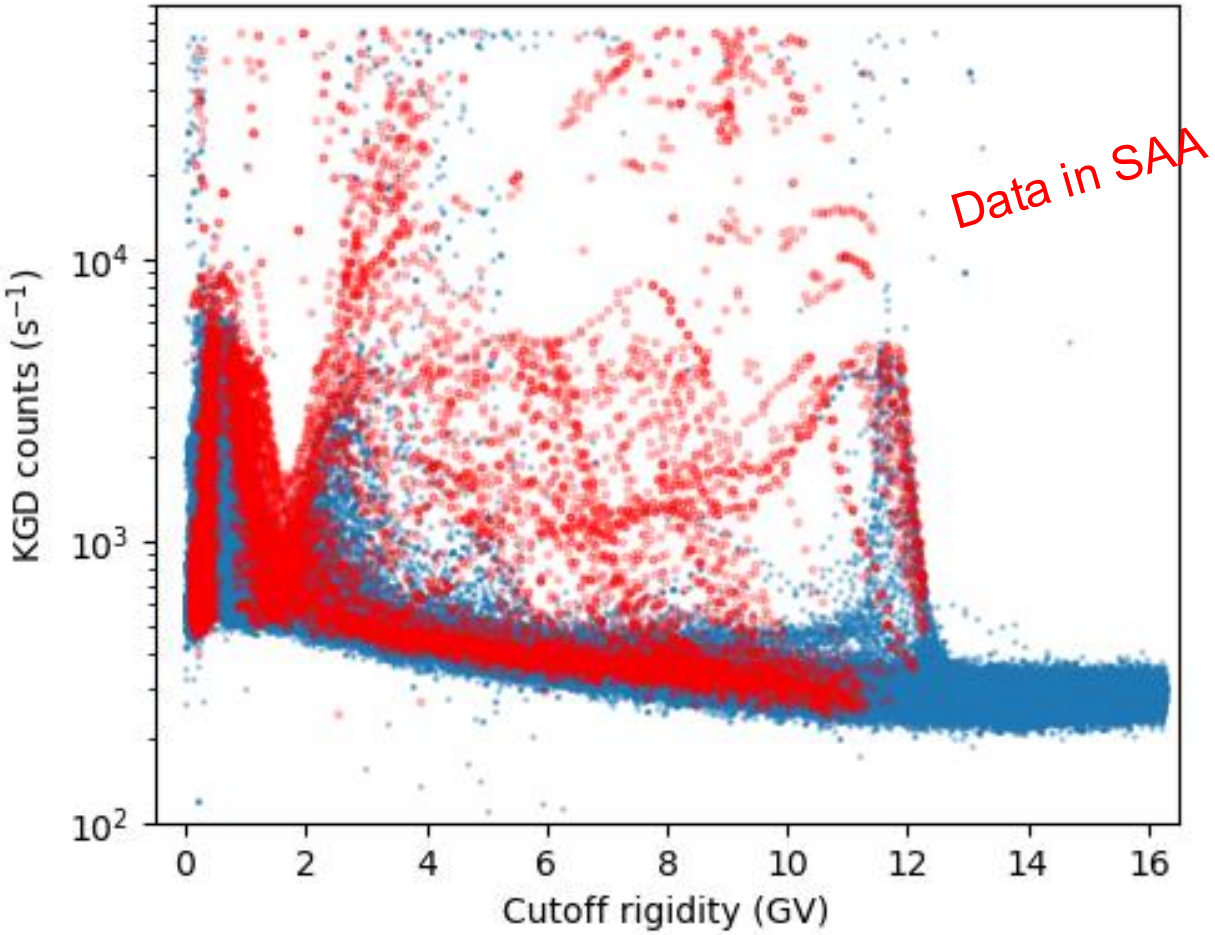




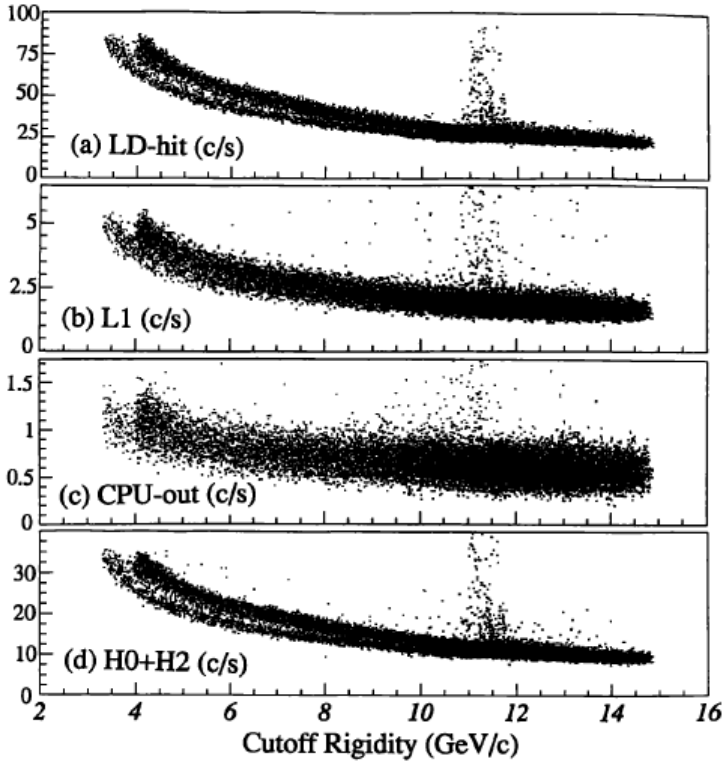


SAA region defined in Heasoft attitude library,

KGD count rate – cutoff rigidity

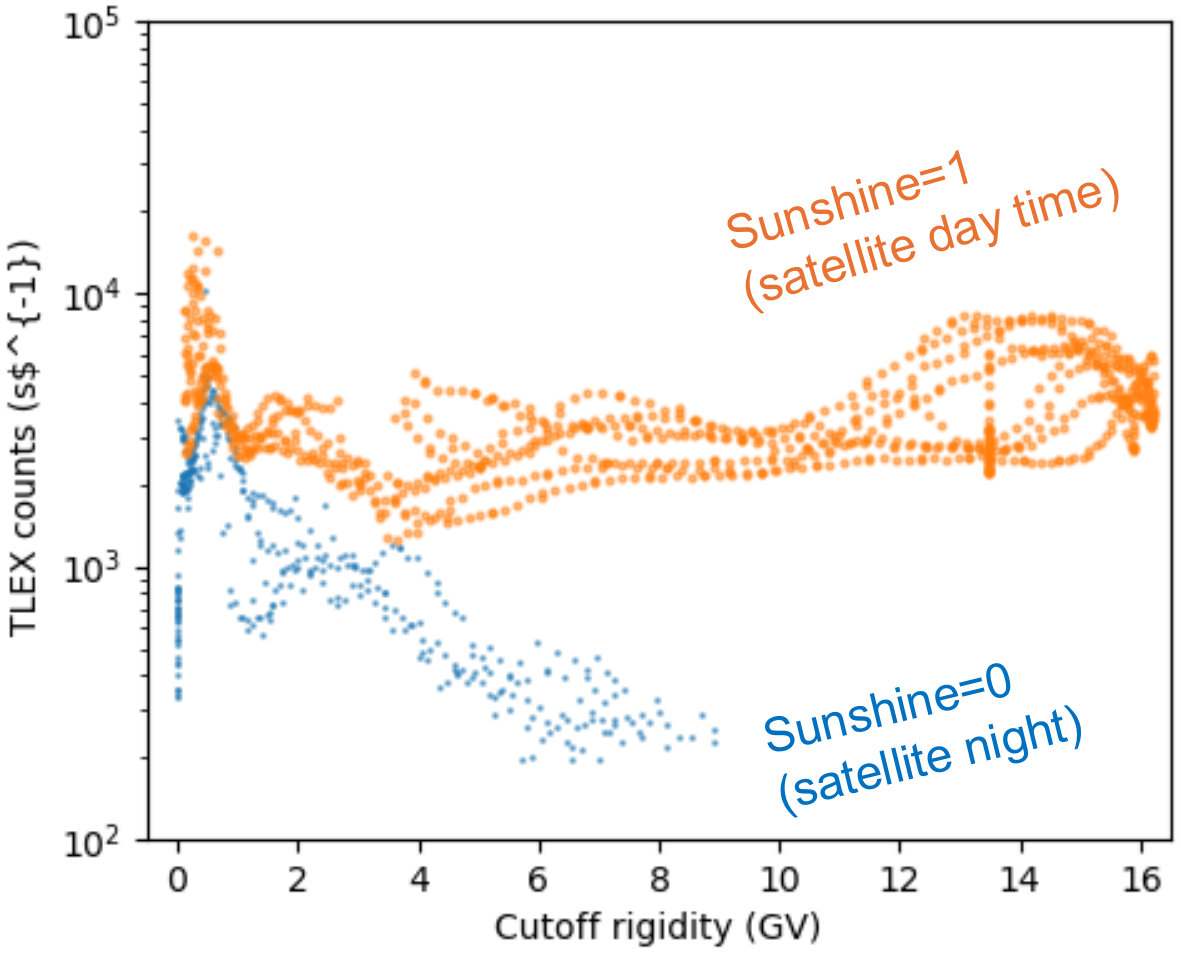


ASCA GIS
(Makishima+1996)



T-LEX count rate – cutoff rigidity

Preliminary results



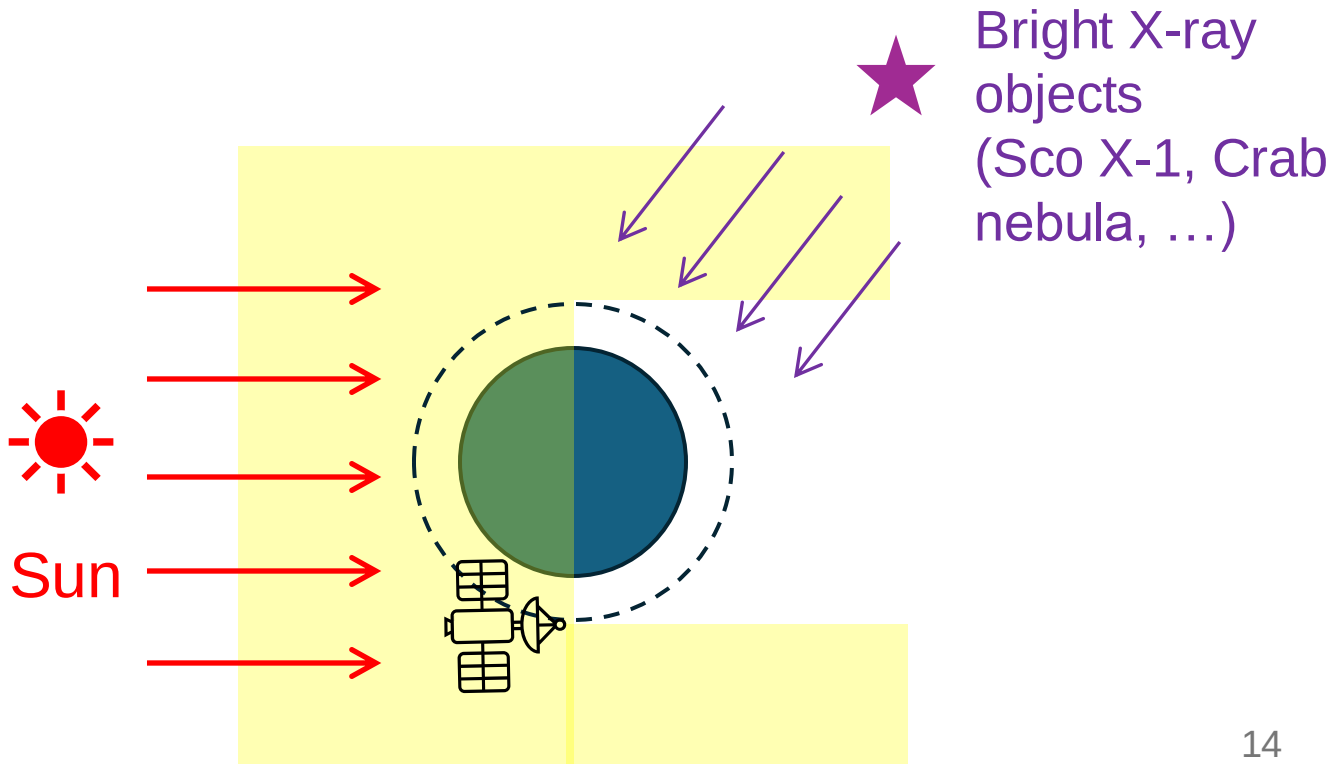
- Sensitive to sunshine?
- Any other reasons?

Summary

- KOYOH data analysis using standard astonomical tools dedicated to astronmical X-ray events just started.
- Although KOYOH‘s on-orbit satellite operation faces some significant challenges, we hope to still obtain some scientific results based on lessons learned from past X-ray satellite missions.

Next step

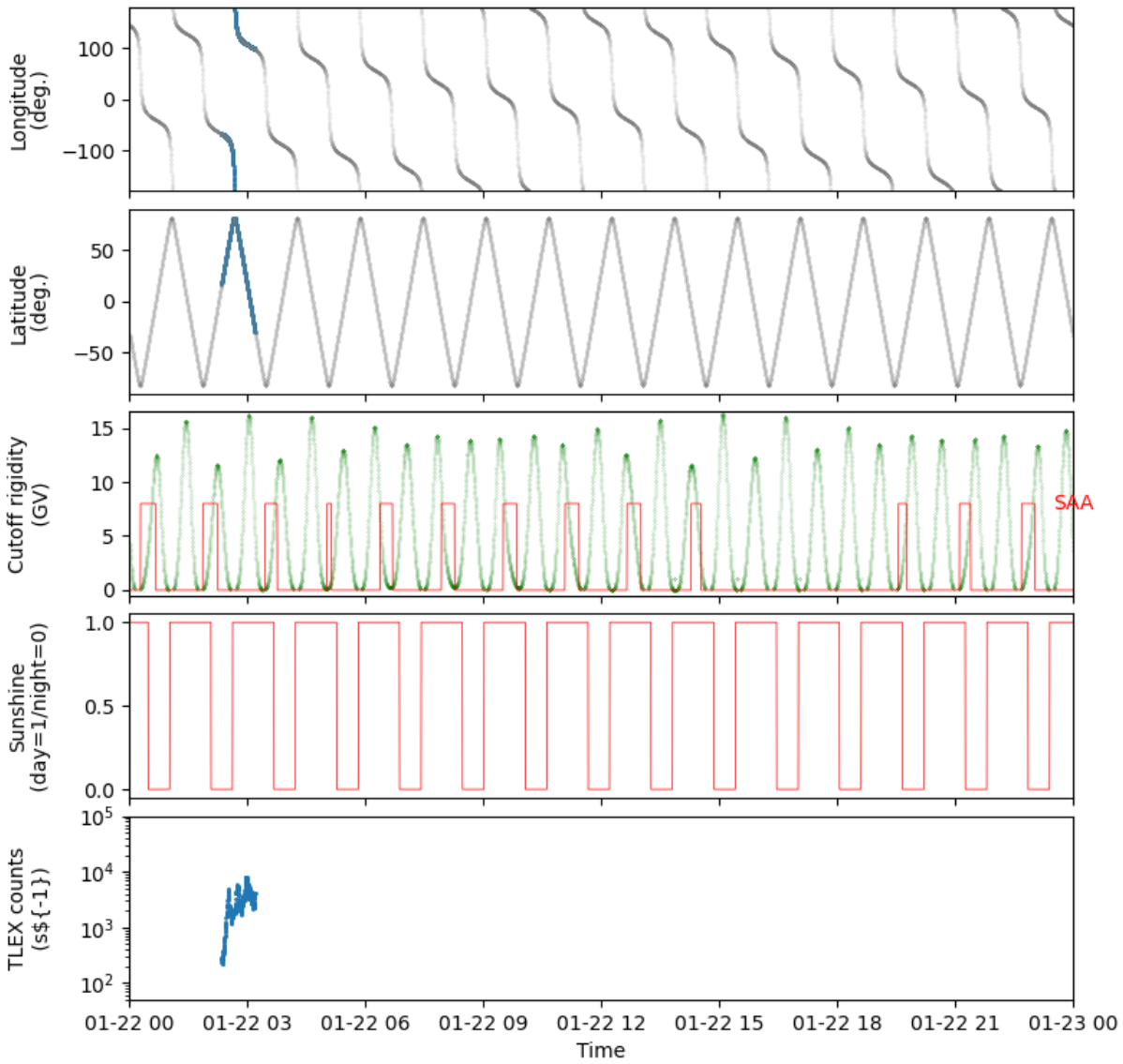
- Investigating orbital modulation synchronized with earth occultation of bright X-ray objects including Sun, Sco X-1, Crab nebra, … , taking accounf of the detctor response function.

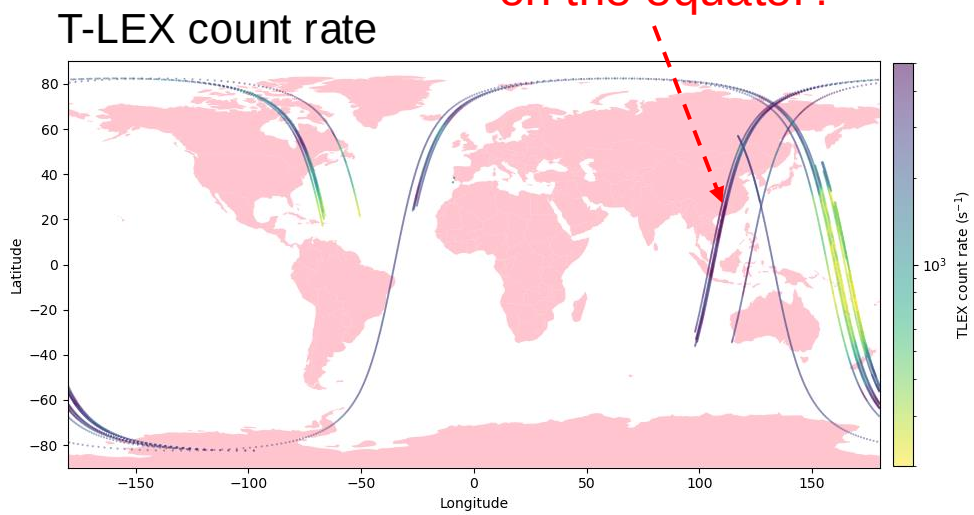


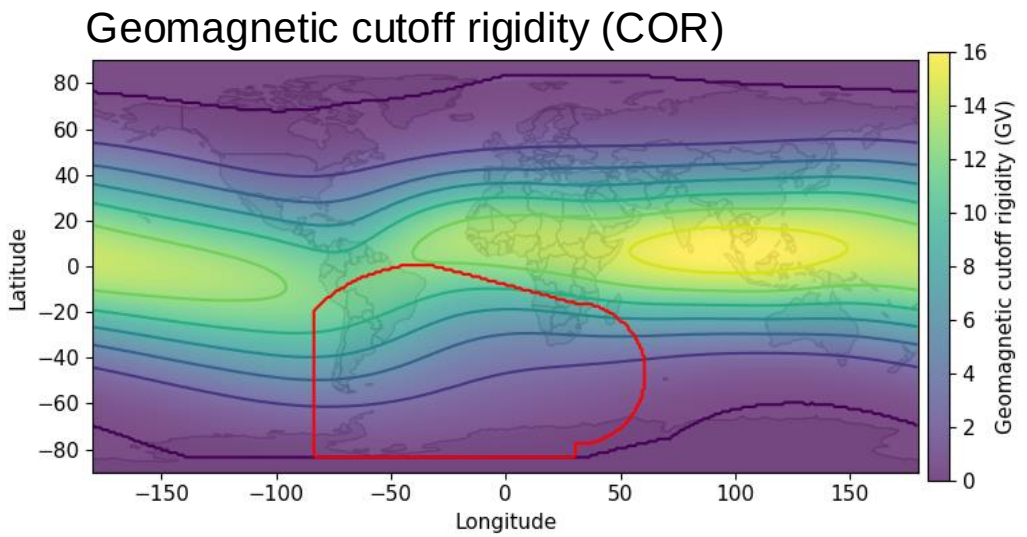
Appendix

T-LEX count rate – satellite location

Why count rate high on the equator?







Suzaku and Swift cases

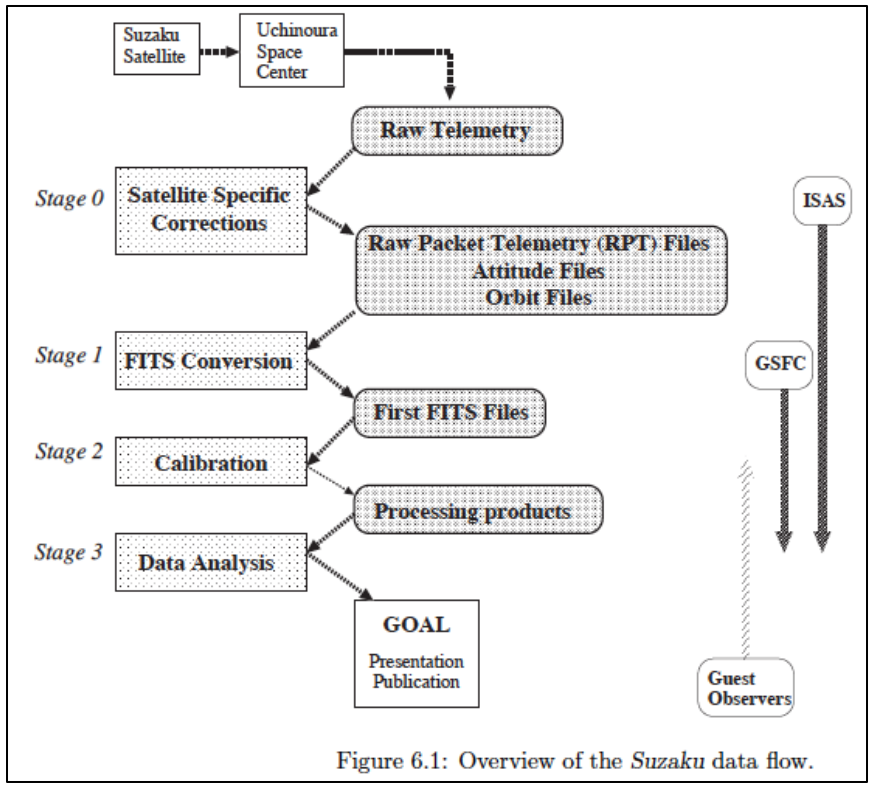


Figure 6.1: Overview of the *Suzaku* data flow.

(Suzaku Project Data Management Plan p.24)

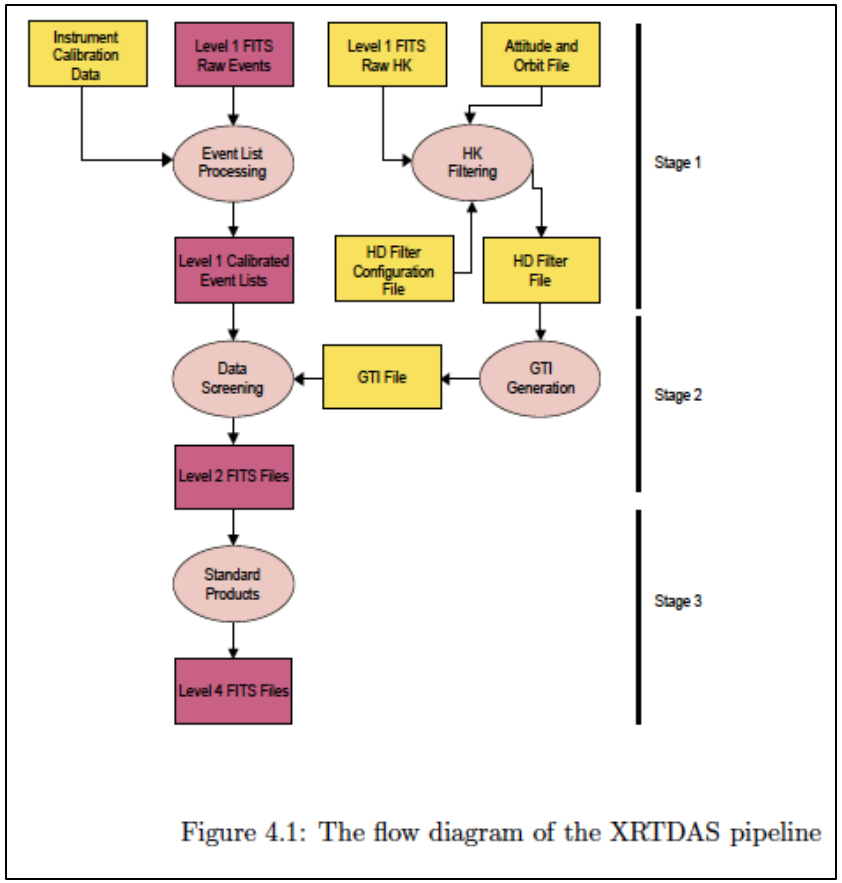


Figure 4.1: The flow diagram of the XRTDAS pipeline

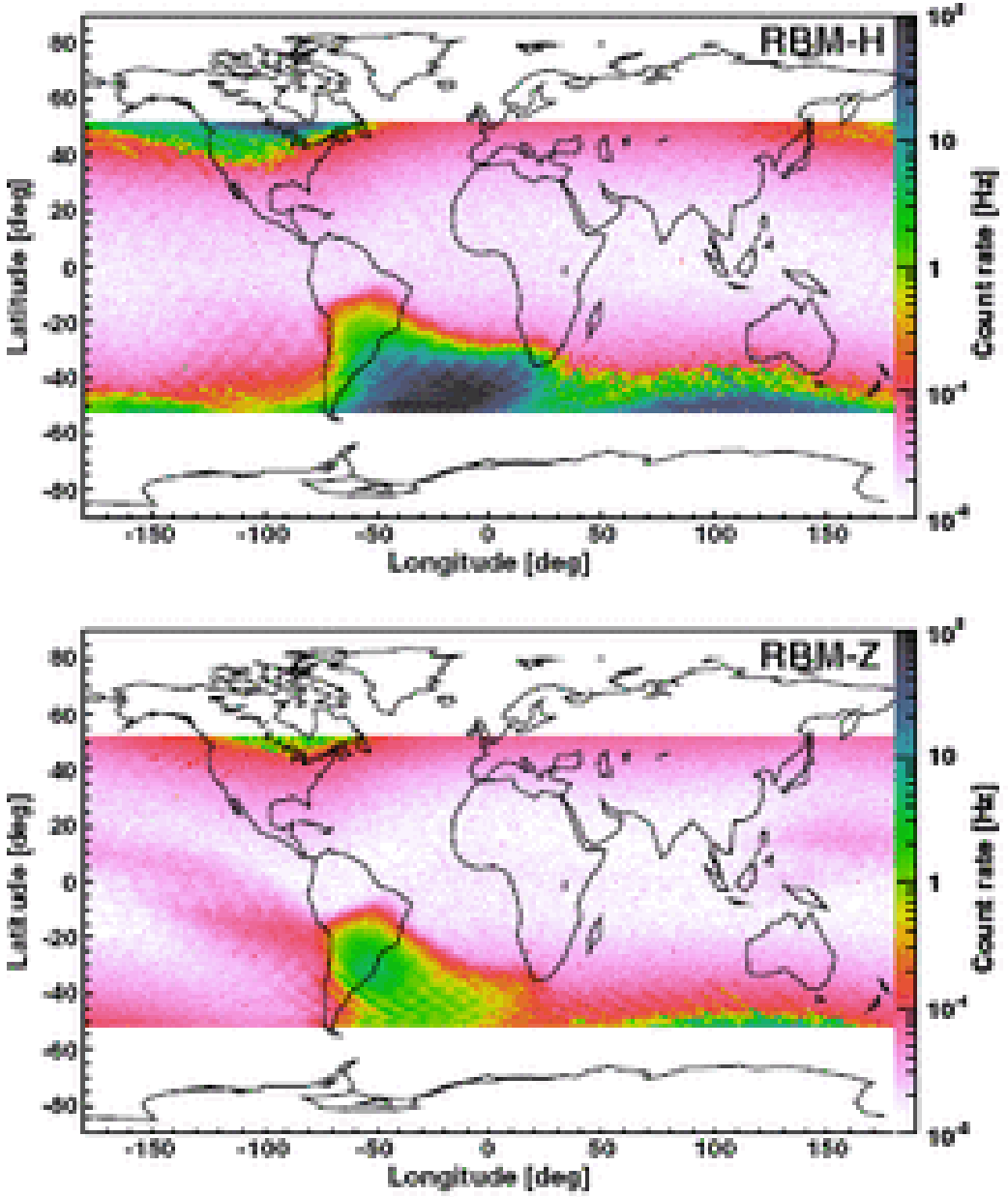
The SWIFT XRT Data Reduction Guide p.19

Almost same among all X-ray missions

- Cosmic-ray (charged particle) count rate map measured by MAXI RBMs (Radiation-Belt Monitors) onboard ISS.

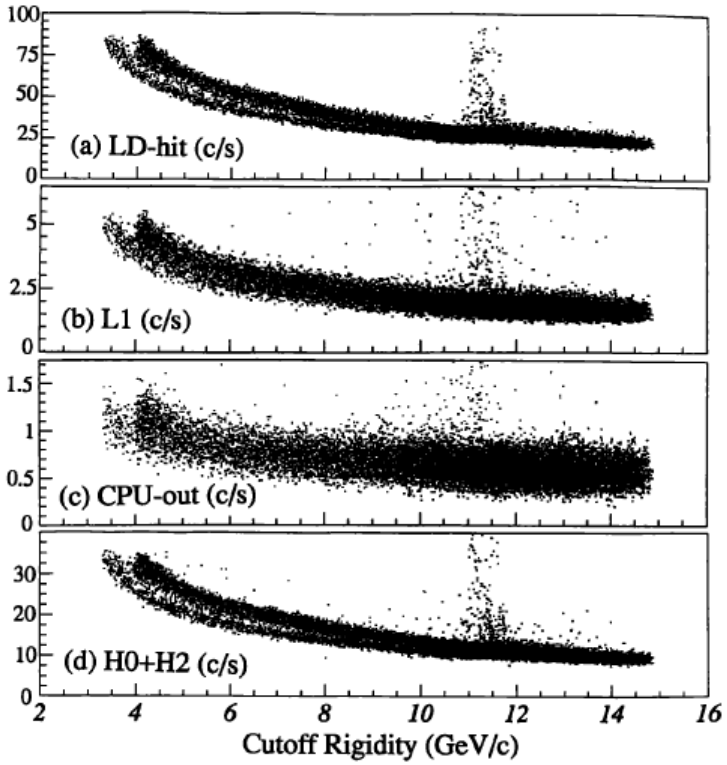
- Two RBM units oriented to the earth horizon (RBM-H) and zenith (RBM-Z) directions. The difference between the two measurements suggest the anisotropy in the motions of charge particles trapped in the geomagnetic fields.

(MS+2011)

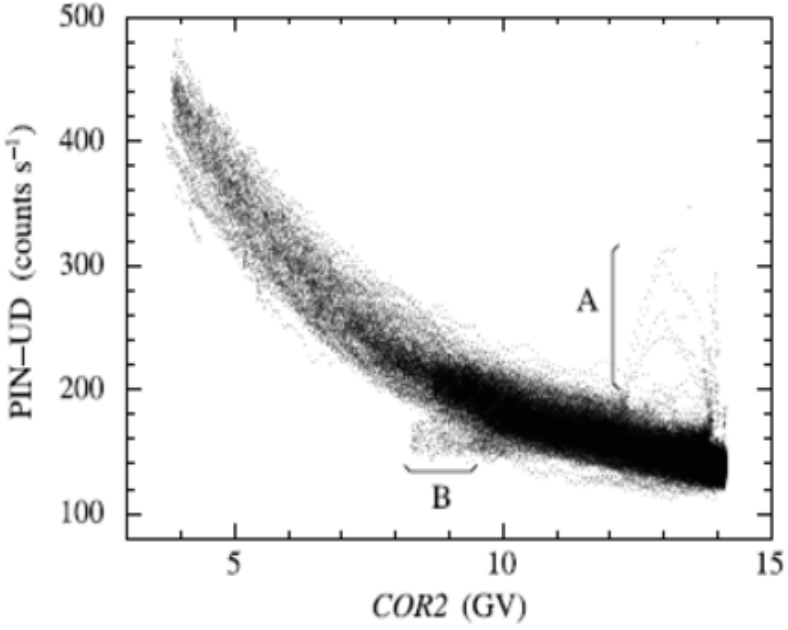


Cosmic-ray background – Cutoff rigifity correlation

ASCA GIS
(Makishima+1996)



Suzaku HXD-PIN
(Tawa+2008)



MAXI GSC
(MS+2011)