HISAKI Level2 data
IDL sample code to read & plot

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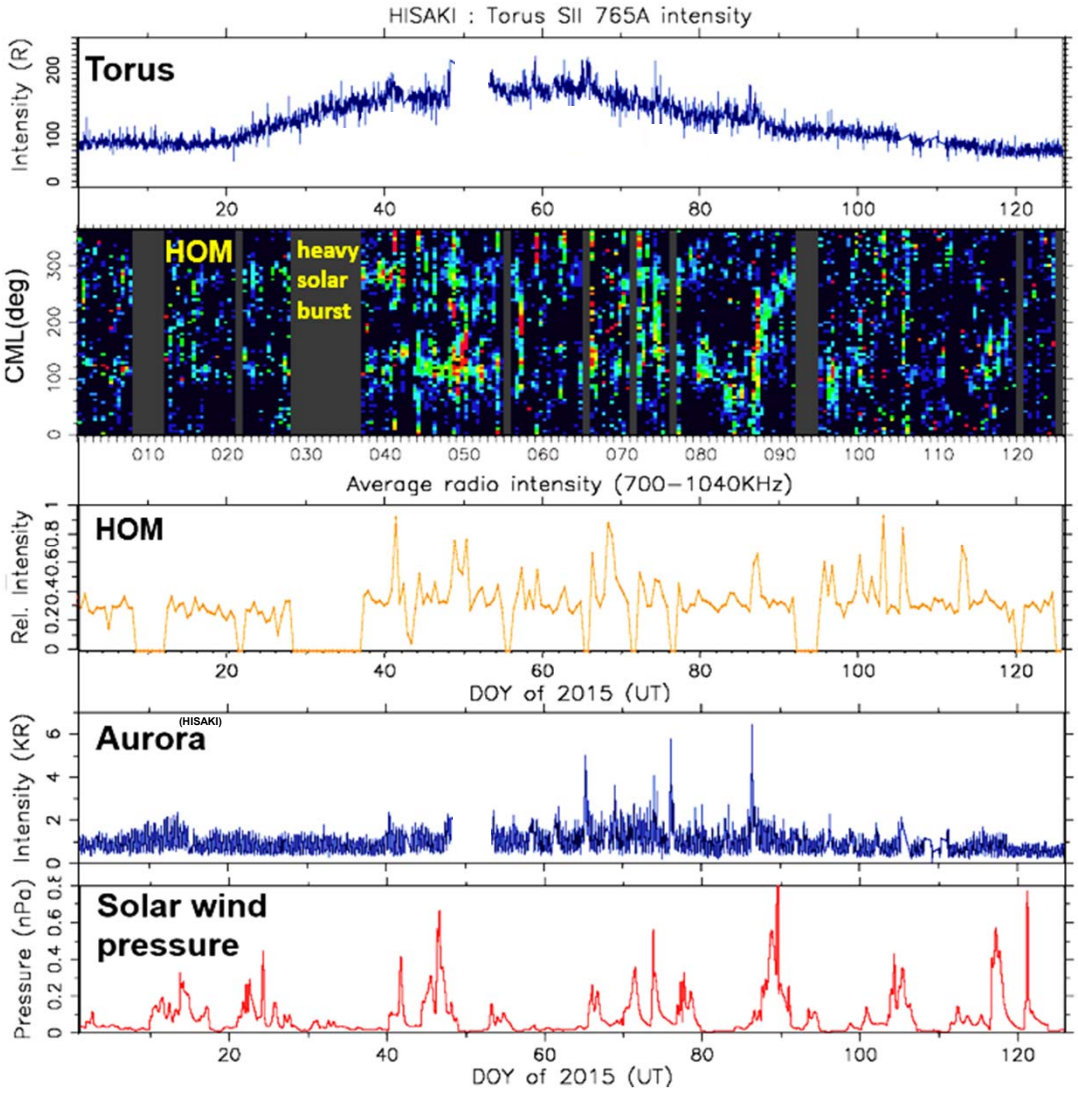
One of goals for the SAKURA project

- Comparison of radio data with HISAKI
  - Io-DAM vs. Io plasma torus density change (due to & Io's volcanic activity)
  - Non-Io-DAM vs. Aurora & Io's volcanic activity
  - HOM vs. Aurora & Io's volcanic activity

- Radio Data
  - NDA, LWA, IITATE, …
  - WIND, STEREO, …

HISAKI & HOM (WIND/WAVES)
（Misawa et al. 2016）

Example (2)



HISAKI
S+ brightness (765A)

WIND
HOM S3 dependence

WIND
HOM intensity

HISAKI
Aurora intensity

Solar wind dynamic pressure
Model (Tao et al. 2005)

HOM activity increased from DOY40, consistent with aurora activity.

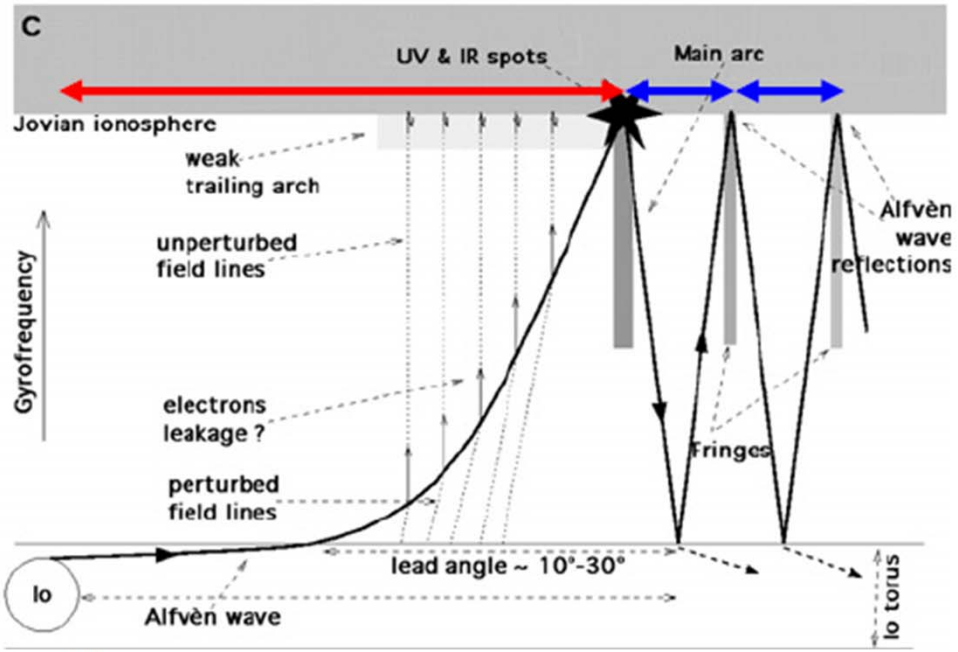
HISAKI & Tohoku-U Radio obs. (DAM)
（Kumamoto et al. 2016)

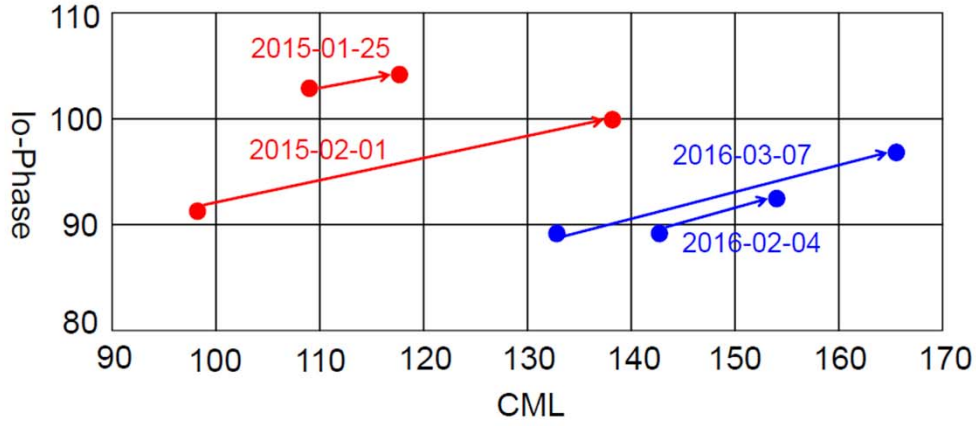
Example (1)

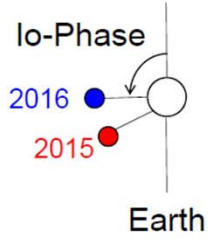
Alfven velocity

$$V_A = \frac{B}{\sqrt{\mu_0 mn}} \propto \frac{1}{\sqrt{n}}$$

➔Timing of main arc (decrease)
Repetition freq. of arcs (decrease)



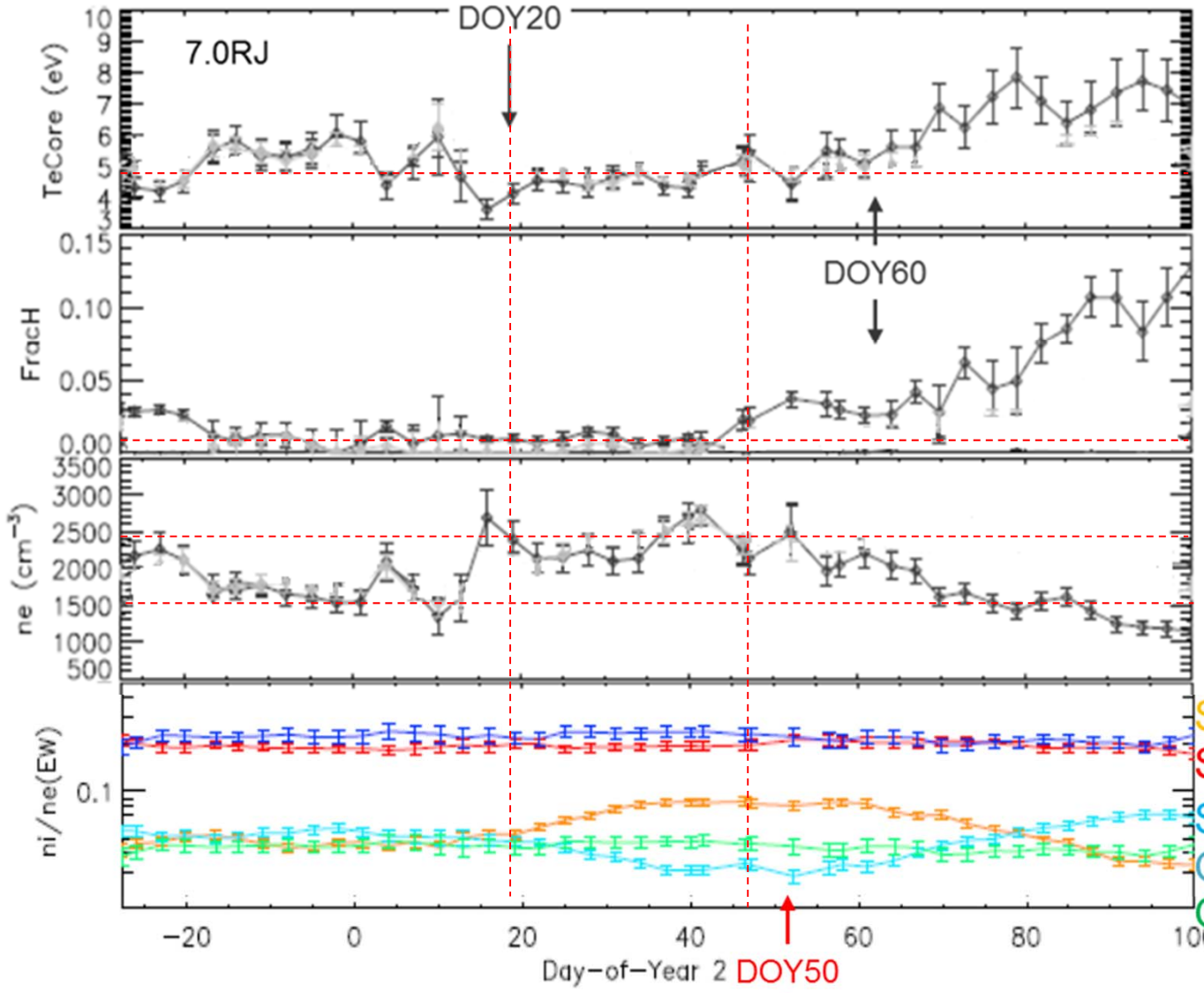




Due to increase of Lead angle?

Plasma parameter –Dec. 2014-May 2015-

Preliminary



Thermal electron temperature [eV]

Increase from DOY60

Hot electron fraction

(Th is assumed to be a few 100eV)

Increase from DOY45

Electron density

Increase from 1500/cc to 2500/cc

Ion composition

Increase in S+ & O+ from DOY20

Peak ~DOY50

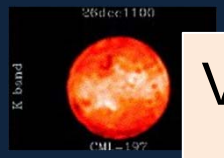
Plasma parameter of Io plasma torus (7RJ) in the spring of 2015 (Kagitani et al. 2016)

Sodium nebula: Neutral accelerated from IPT

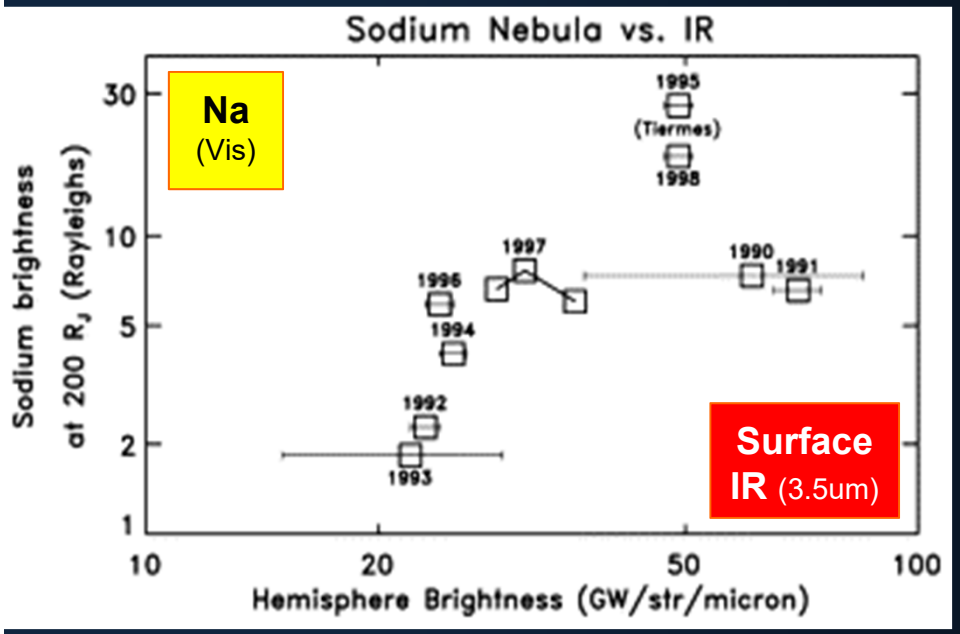
Io's volcanoes → NaCl gas → Io's atmosphere

Io ionosphere / Io plasma torus ← NaCl+

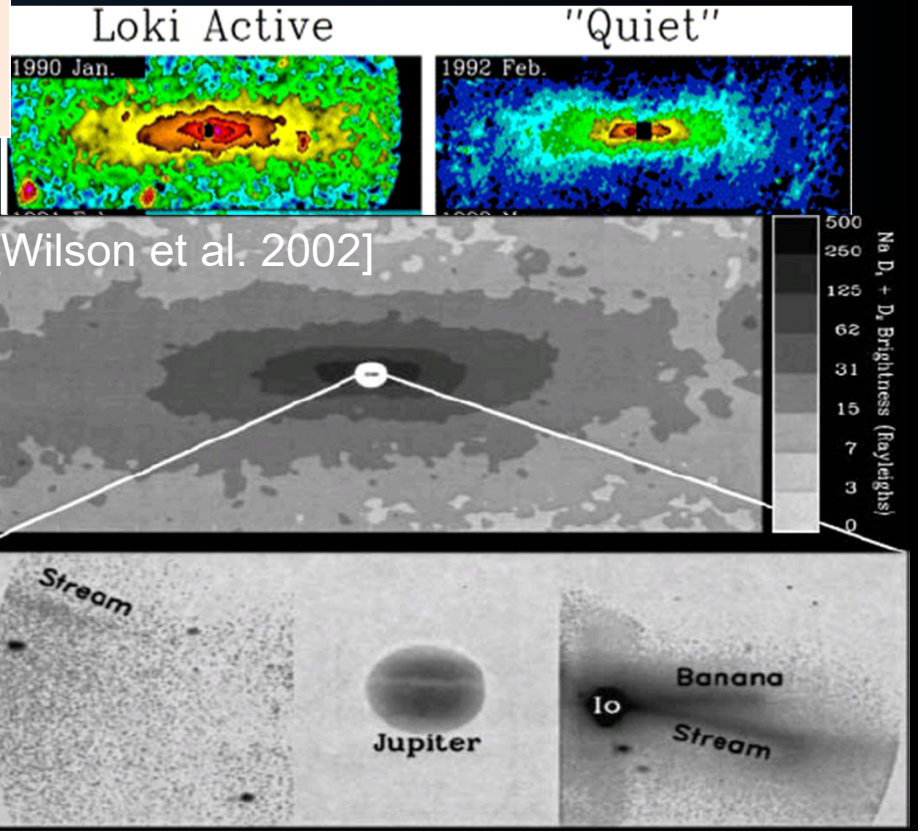
Io plasma torus → Na*, Cl* → Nebula



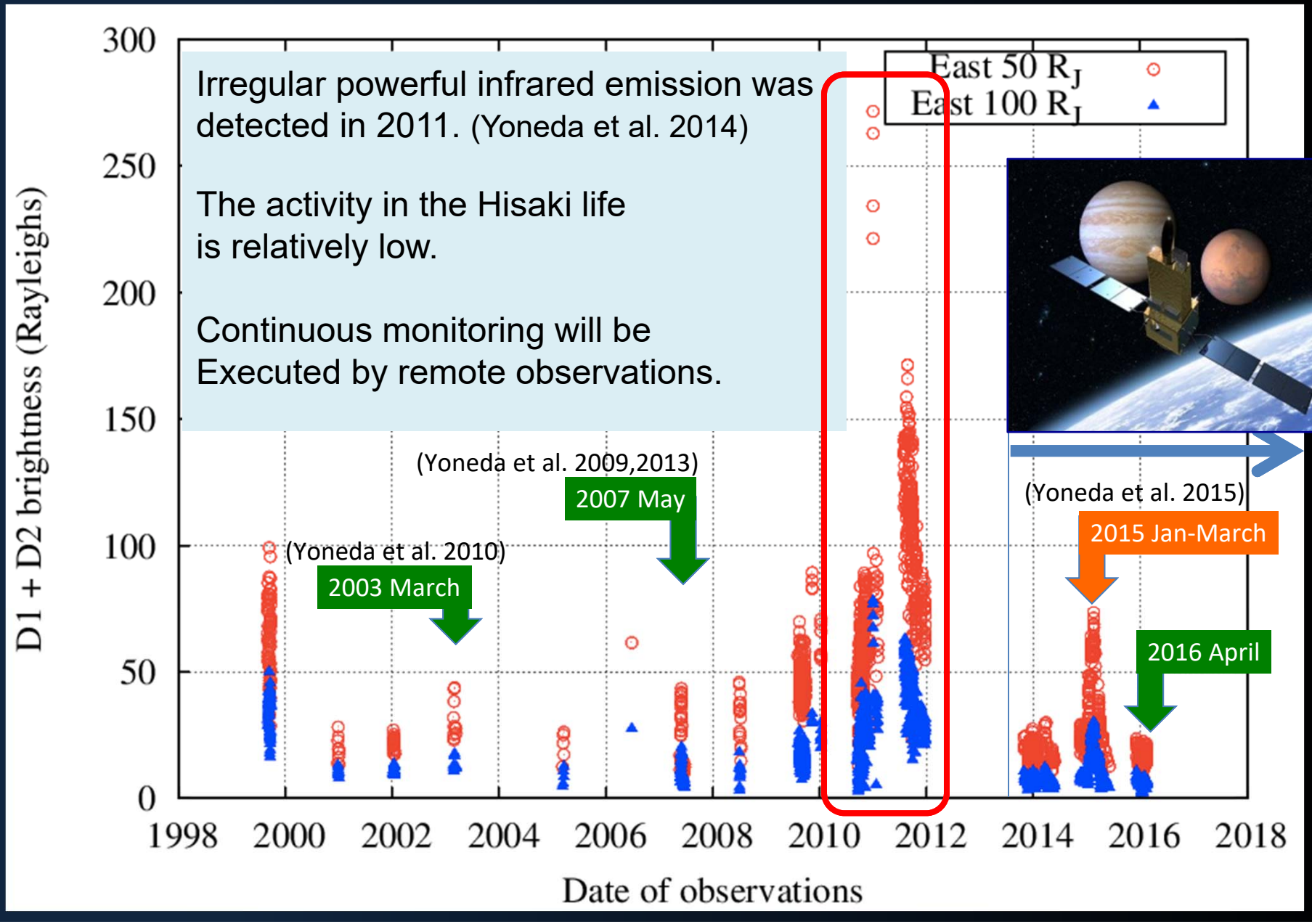
Volcanism (IR) v.s.
Sodium brightness (Vis)



[Mendillo et al. 2004]



Long Term Io Activity: from 1999

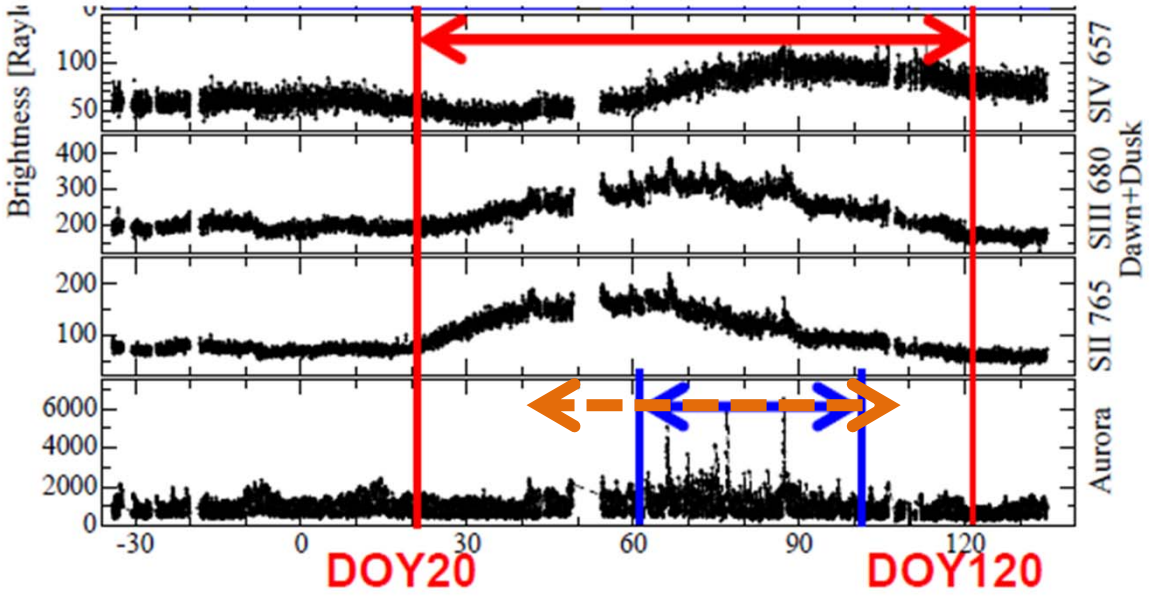


HISAKI Data analysis sample

- Doc and IDL sample code are temporally uploaded below:
  - http://pparc.gp.tohoku.ac.jp/~tsuchiya/HISAKI/
    Document: HISAKI_L2_Basic_v1_2.pptx
    Sample code: idl_sample_v1_2.zip
    Spice kernels: spice_kernels.zip
  - HISAKI L2 data

    https://www.darts.isas.jaxa.jp/stp/hisaki/

Possible use case: Jovian DAM during Volcanic activity detected by Hisaki



Io plasma torus (SII&SIII):

Increase from DOY20 to DOY120
due to volcanic activity

Aurora:

Increase from DOY60 to DOY100 **DOY40 - DOY110**

Jovian DAM:

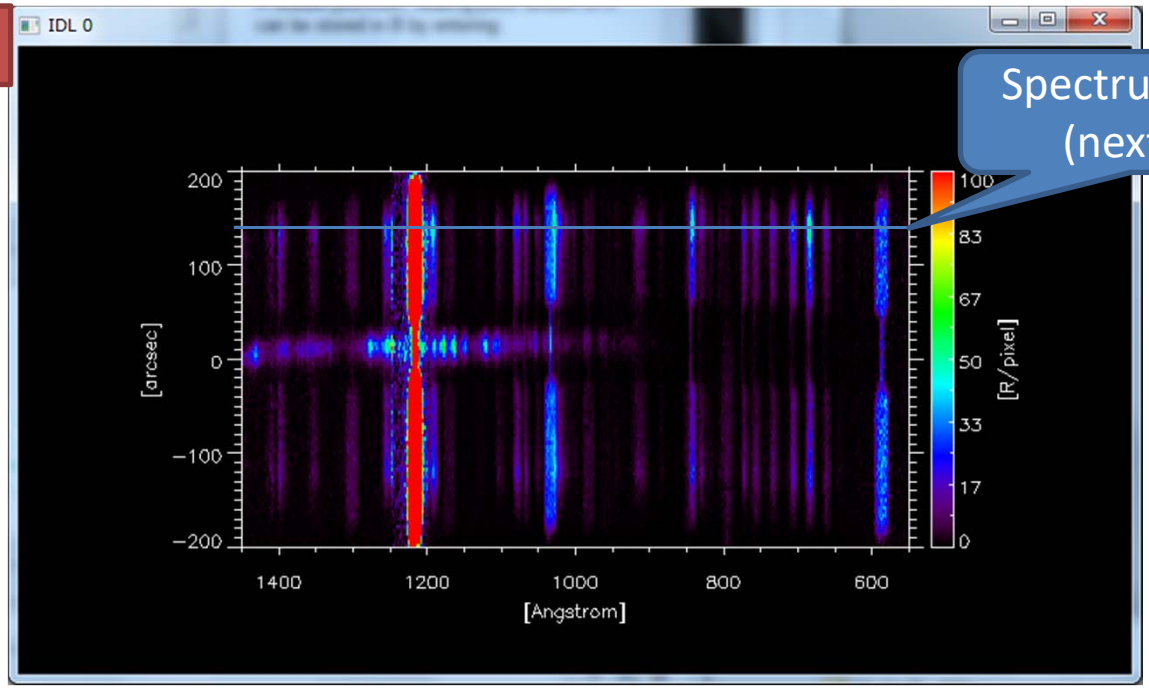
??? ➔ Analysis of Iitate HF data

What you can do with the sample code

- Doc and sample codes include
  - How to set up IDL and SPICE
  - How to read and plot spectrum of Io plasma torus
  - Calibration (photon count rate to intensity in Rayleigh)
  - How get light curve of a specific emission line/band (e.g. S+, S2+, H2 aurora, …)
  - How to find Io phase angle and Jovian longitude (CML) with SPICE
  - How to identify observation mode (on-Jupiter or off-Jupiter)
  - How to remove contamination from radiation belt

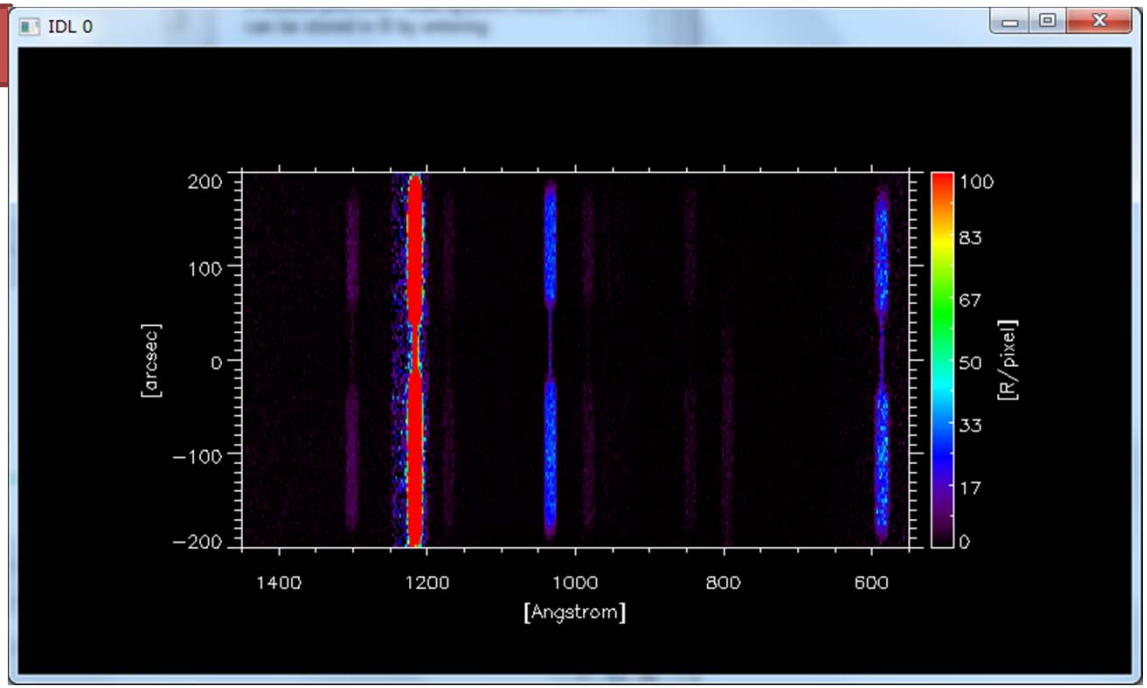
Result3

Jupiter
(+Sky)



Result4

Off-Jupiter
(Sky)



Sky =
foreground geo-coronal emission (H, O, O+) and interstellar emission (H, He)

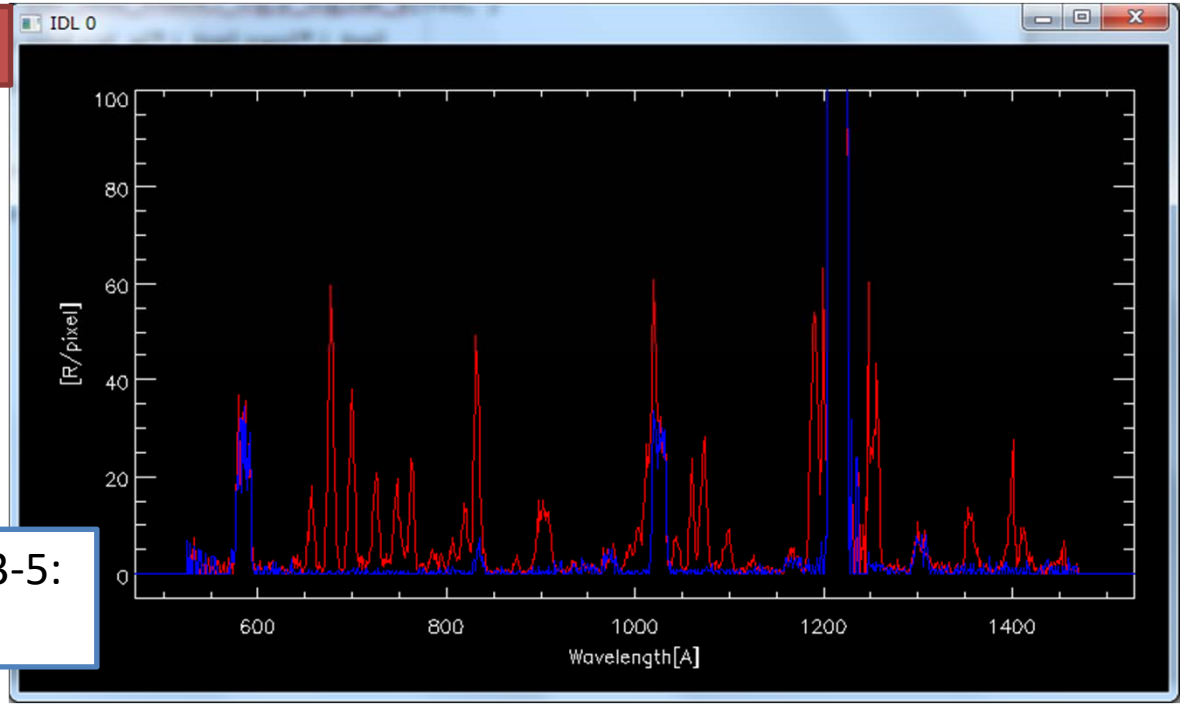
Continue

- Spectrum of Io plasma torus (at y=140[arcsec])

```
IDL> ret = min(abs(cal_y[512,*]-140.0), i_trg)
IDL> plot,cal_x[*,i_trg],zarr[*,i_trg]
IDL> plot,cal_x[*,i_trg],zarr[*,i_trg], yrange=[-5,100], xtitle='Wavelength[A]',
       ytitle='[Rayleigh/Angstrom]', xstyle=1, ystyle=1 , /nodata
IDL> oplot,cal_x[*,i_trg],zarr[*,i_trg], color=cgcolor('red')
IDL> oplot,cal_x[*,i_trg],zarr_sky[*,i_trg], color=cgcolor('blue')
```

Result5

Result5



Red: Io plasma torus
Blue: SKY

Sample code to show Result 3-5:
x_exc_sample1.pro

Result8

Blue : IPT short wavelength
Red: IPT long wavelength

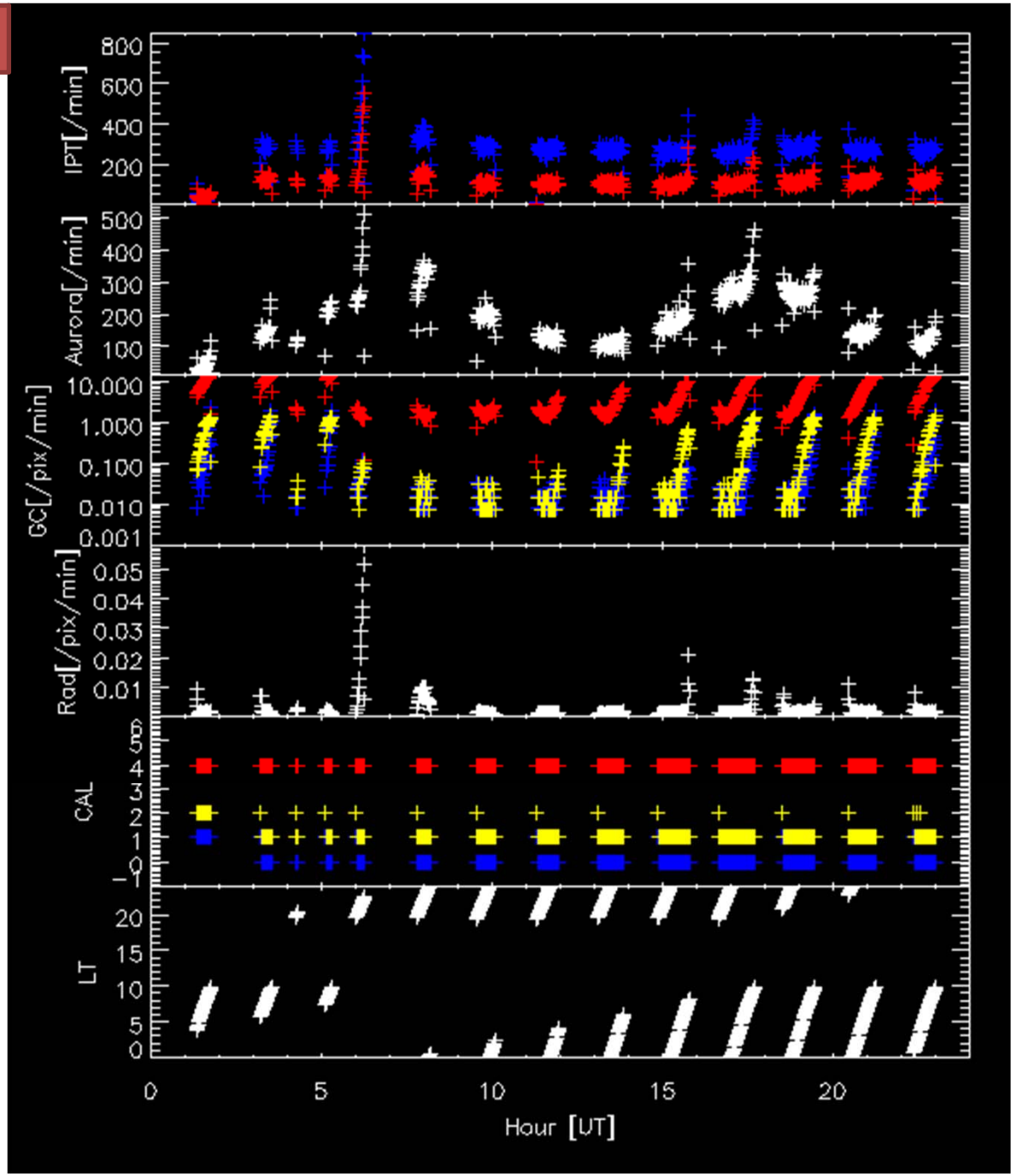
Jupiter northern UV aurora

Geocorona
- Red: HI1216
- Yellow:HeI584
- Blue:OI1304

Radiation belt contamination

Attitude flags
- Red: Sub mode
- Yellow: Sub mode status
- Blue:Cal flag

HISAKI Local time



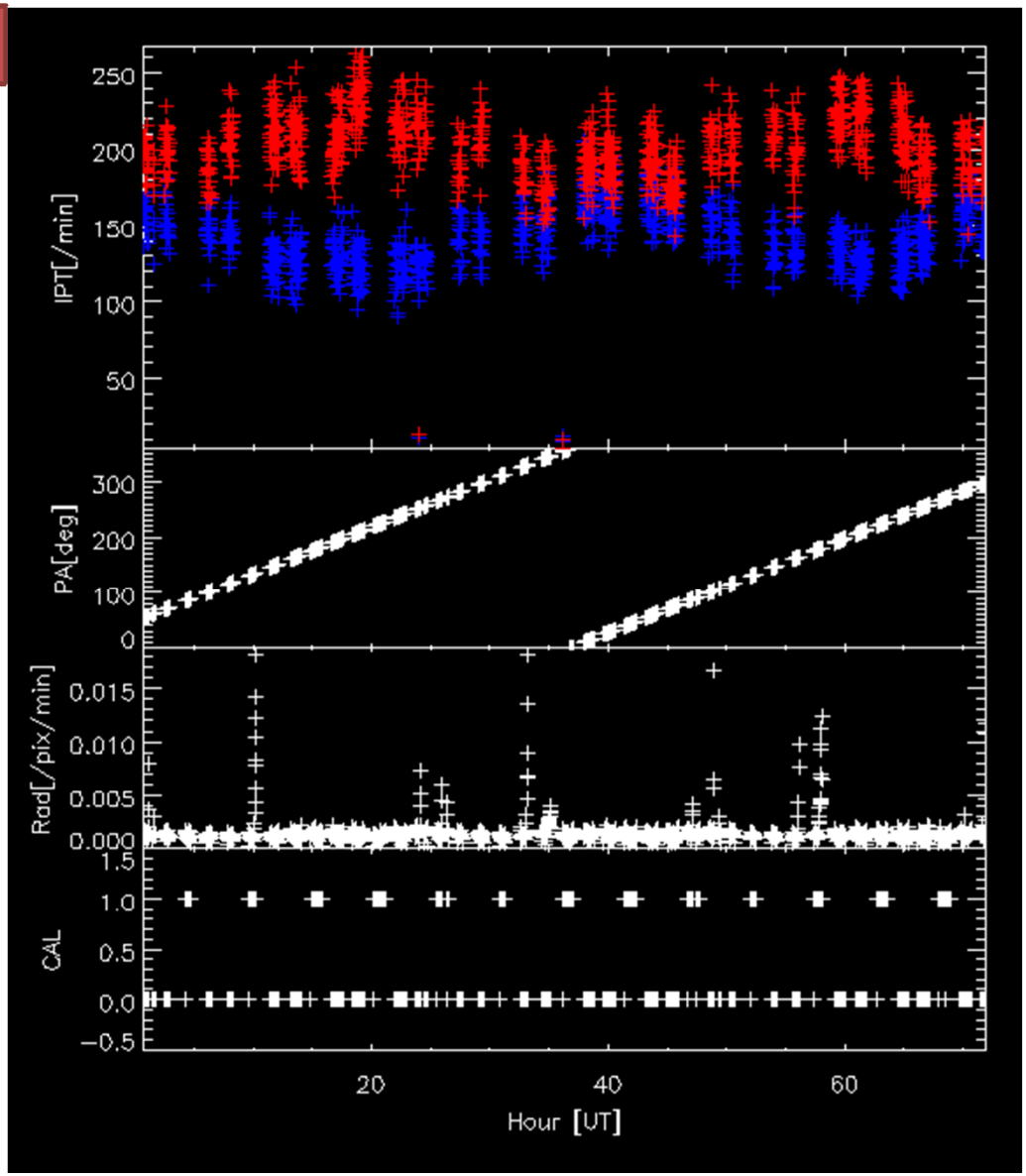
Result10

Brightness (total count in ROIs for 1-min) of Io plasma torus (blue : dawn, red: dusk)(65-78nm).

Io phase angle
(Io's orbital period = 42h)

Radiation belt contamination

CAL flag



Other things

- Solar radio data from IPRT
  (Iitate planetary radio telescope)
  - http://pparc.gp.tohoku.ac.jp/data/iprt/