MAXI detections of Superbursts

M. Serino
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based on "MAXI observations of long X-ray bursts"
Serino et al. (2016) PASJ in press

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MAXI observations of XRBs

Advantage

- MAXI monitors the persistent fluxes of X-ray bursters
  - unique capability to study correlations between the persistent fluxes and burst properties
- High efficiency for long (>92 min) lasting bursts

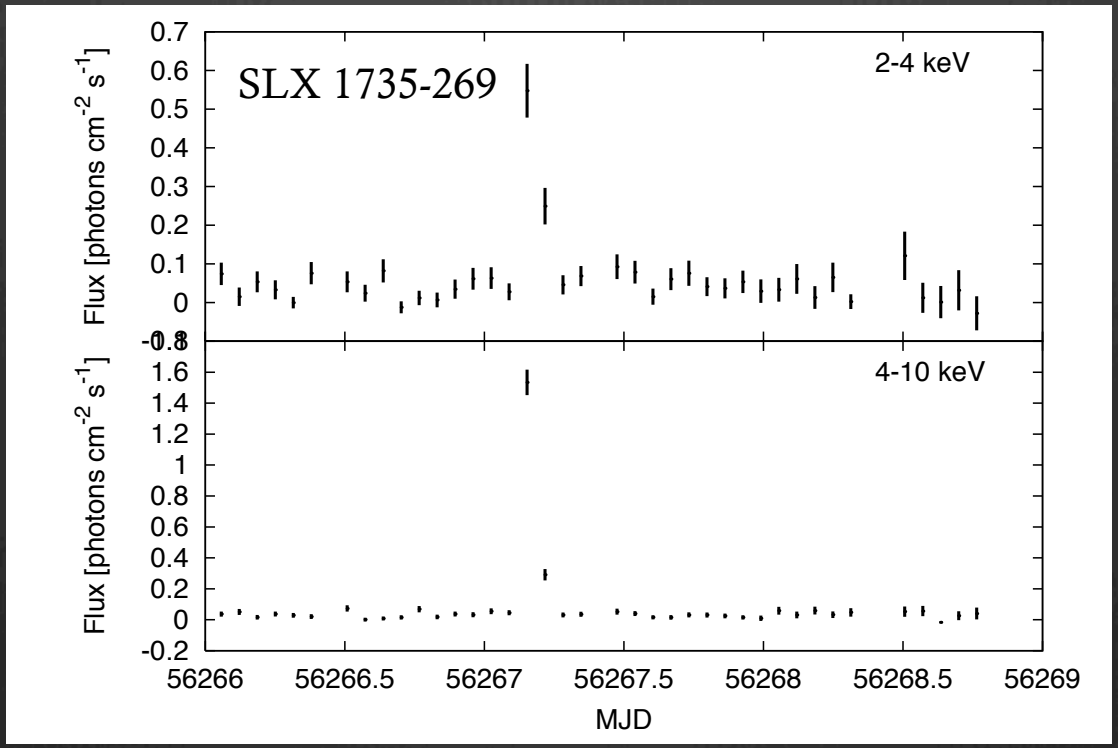
Disadvantage

- FoV is only 2% of the sky
  - a typical scan transit lasts ~50s
- MAXI detected
  more than 300 “normal” X-ray bursts and
  12 “long” X-ray bursts ⇨ rare events!

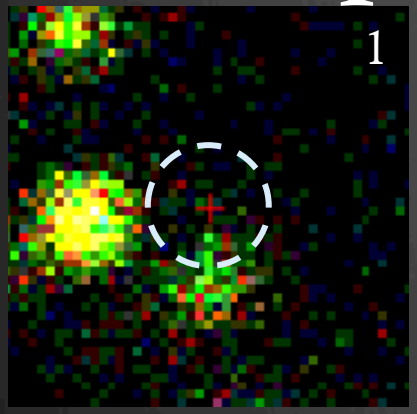
Superbursts and Intermediate duration bursts

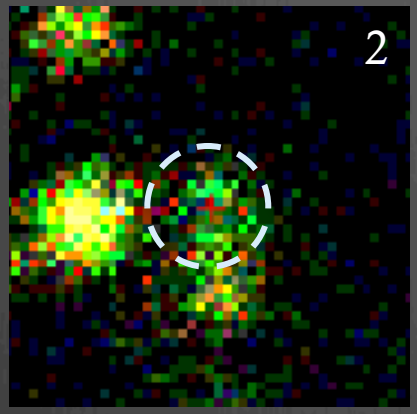
sample selection: "long" X-ray bursts

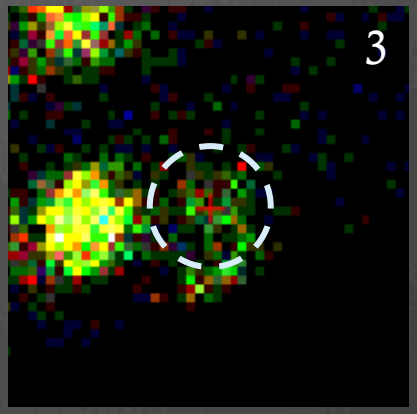
- bursts from known X-ray bursters
- bright in two or more consecutive scans

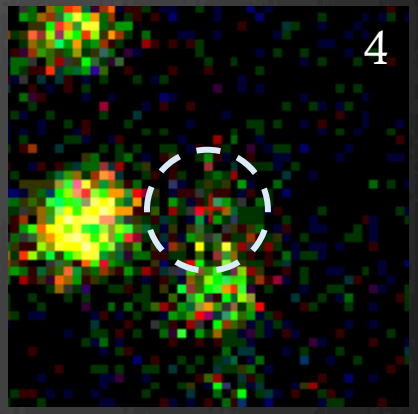


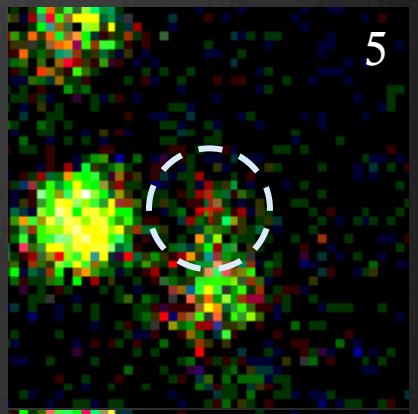
Example : EXO 1745-248

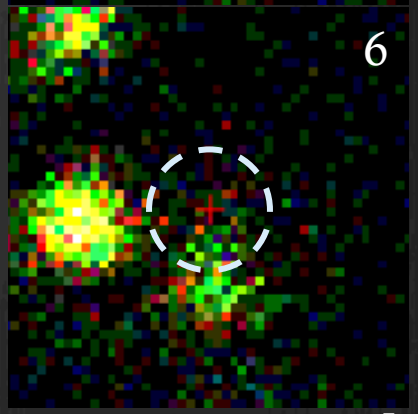


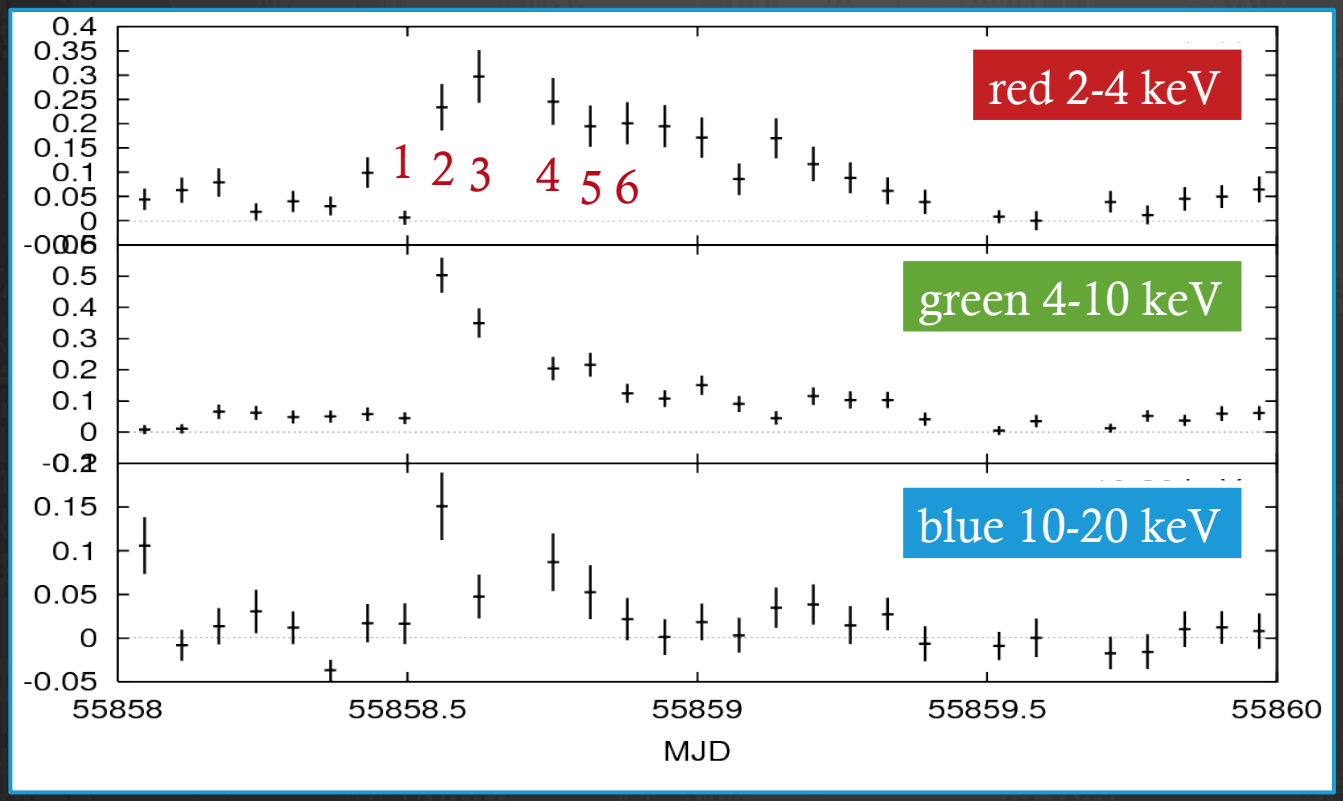












calculating burst parameters

1. fit the spectra of each burst
   - common persistent model (powerlaw)
   - burst component (blackbody)

   bolometric flux
   blackbody temperature
   } each scan

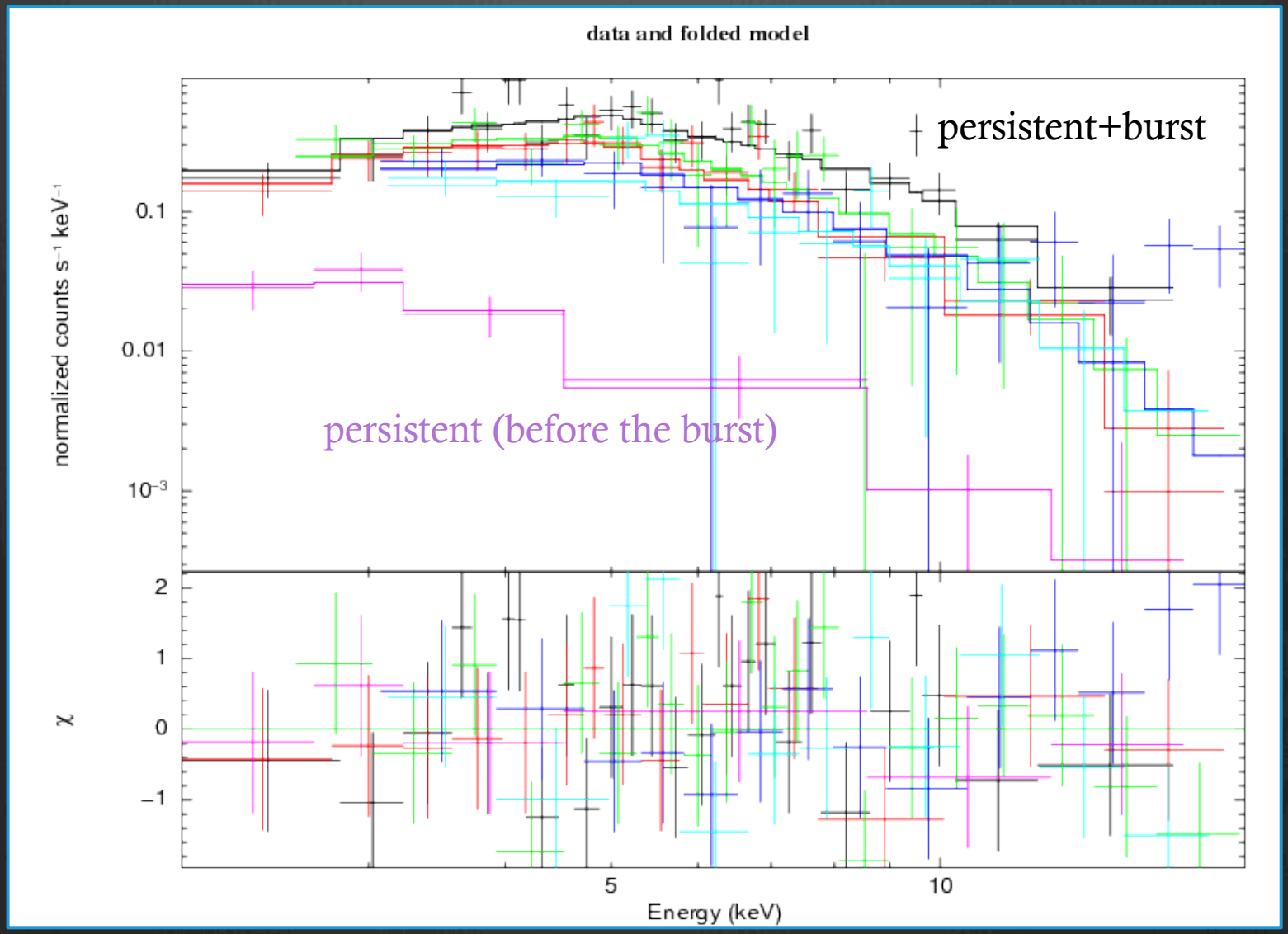
2. fit the time sequence of bolometric flux with exponential function

   e-folding decay time (τ)
   maximum peak flux

3. average persistent flux over 10 days before and after the burst

   persistent flux
   (ratio to the Eddington limit)

spectral fit



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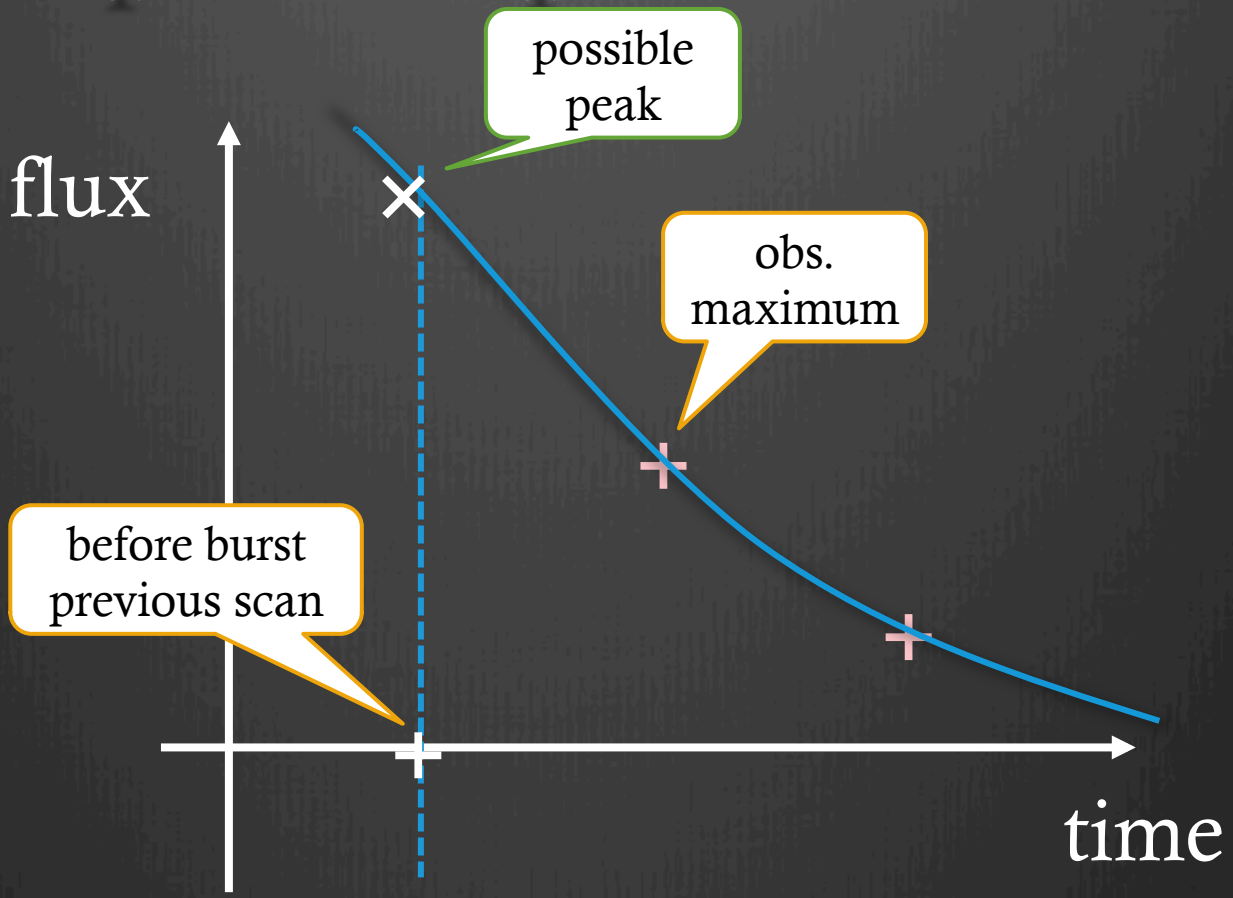
obs. maximum and possible peak flux



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   maximum peak flux
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   persistent flux
   (ratio to the Eddington limit)

Obs. Summary

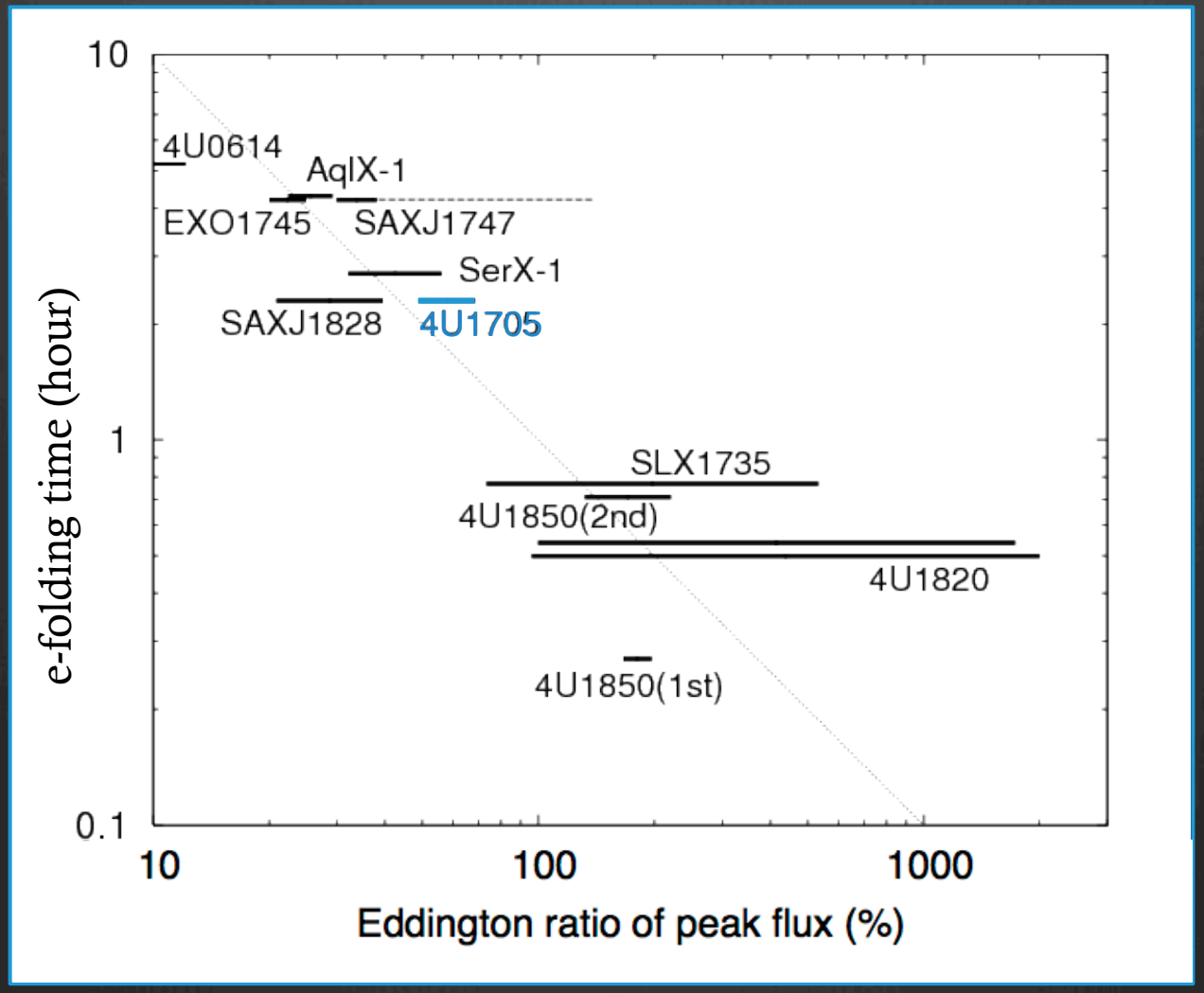
Object (transients are Red)	peak flux (10^{-8} erg cm^{-2} s^{-1})	e-folding time ▼ (hour)	Energy (10^{41} erg)
4U 0614+091	3.3 - 4.0	5.2	6.7
Aql X-1	2.0 - 2.6	4.3	9.3
SAX J1747.0-2853	1.5 - 1.9	4.2	22
EXO 1745-248	1.2 - 1.5	4.2	6.6/10
Ser X-1	0.7 - 1.3	2.7	5.1
SAX J1828.5-1037	0.9 - 1.7	2.3	3.4
4U 1705-44	1.9 - 2.7	2.3	-
SLX 1735-269	4.4 - 32	0.77	7.8
4U 1850-086 (2)	2.0 - 2.6	0.71	11
IGR J17062-6143	5.8 - 110	0.53	3.3
4U 1820-30	5.3 - 110	0.5	7.1
4U 1850-086 (1)	10.7	0.27	5.9

new

Superburst

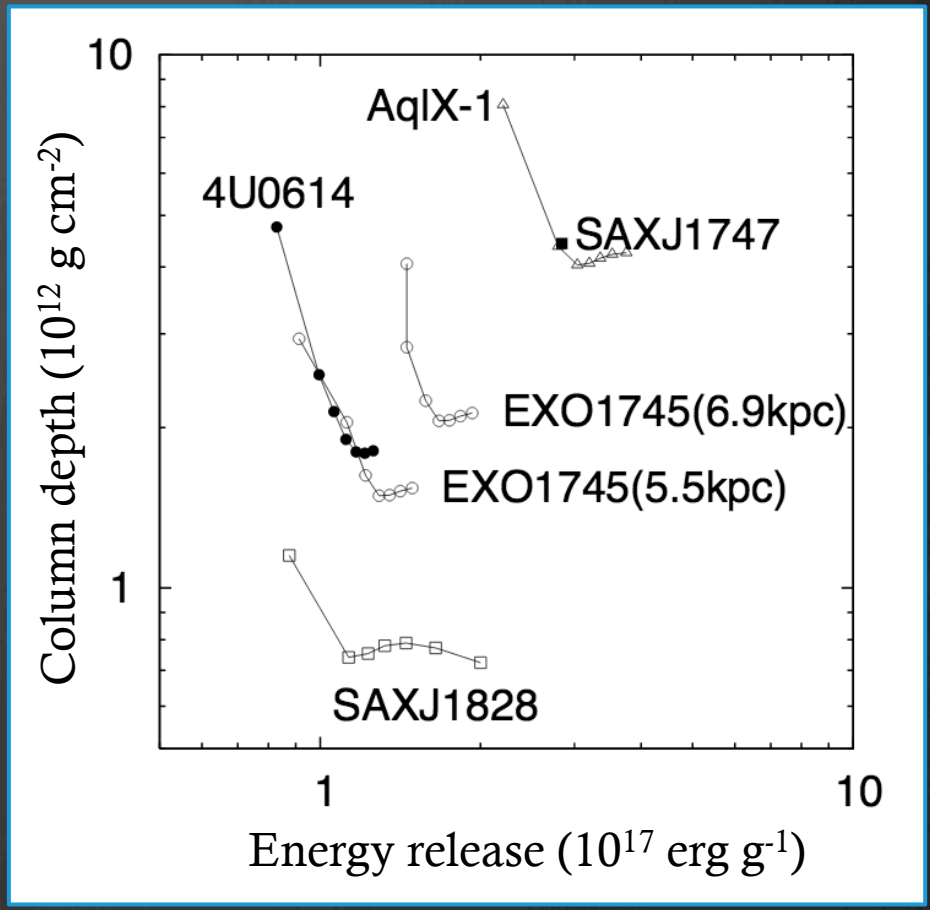
Intermediate

peak flux and e-folding time



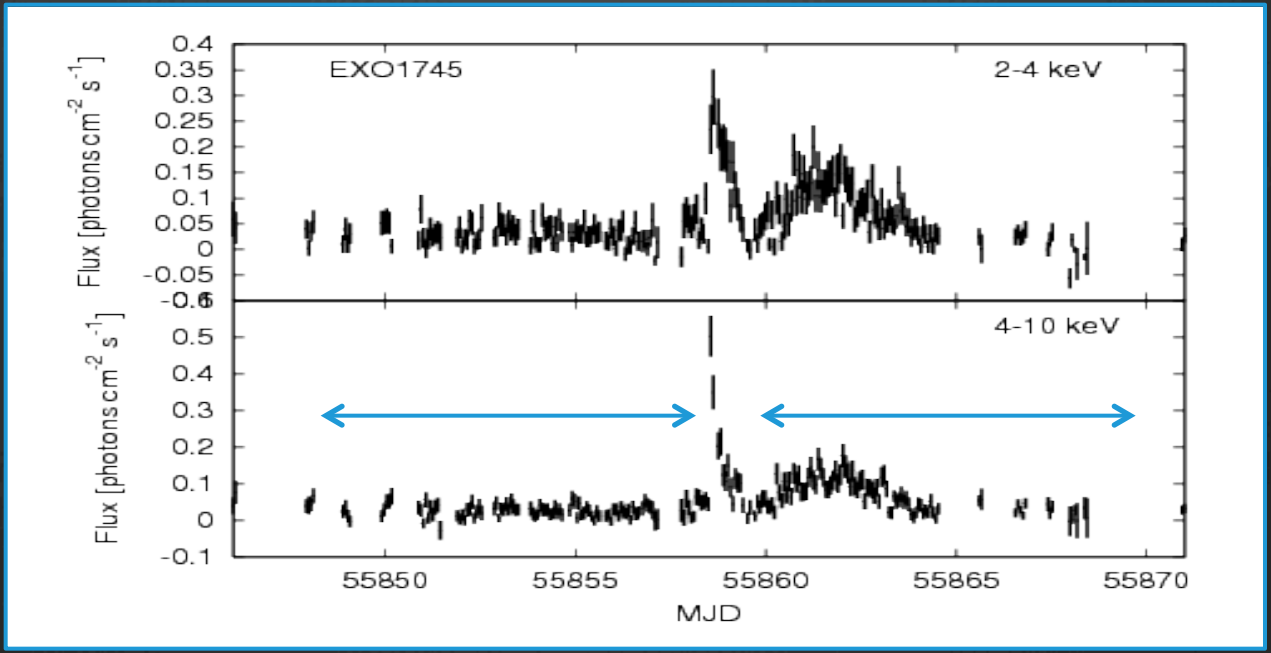
cooling model

- Using a model by Cumming et al. 2004
- Reasonable column depth and energy release parameters are obtained
- The burst start and peak time are unknown
  ↓
  major cause of the systematic error



Study of persistent flux

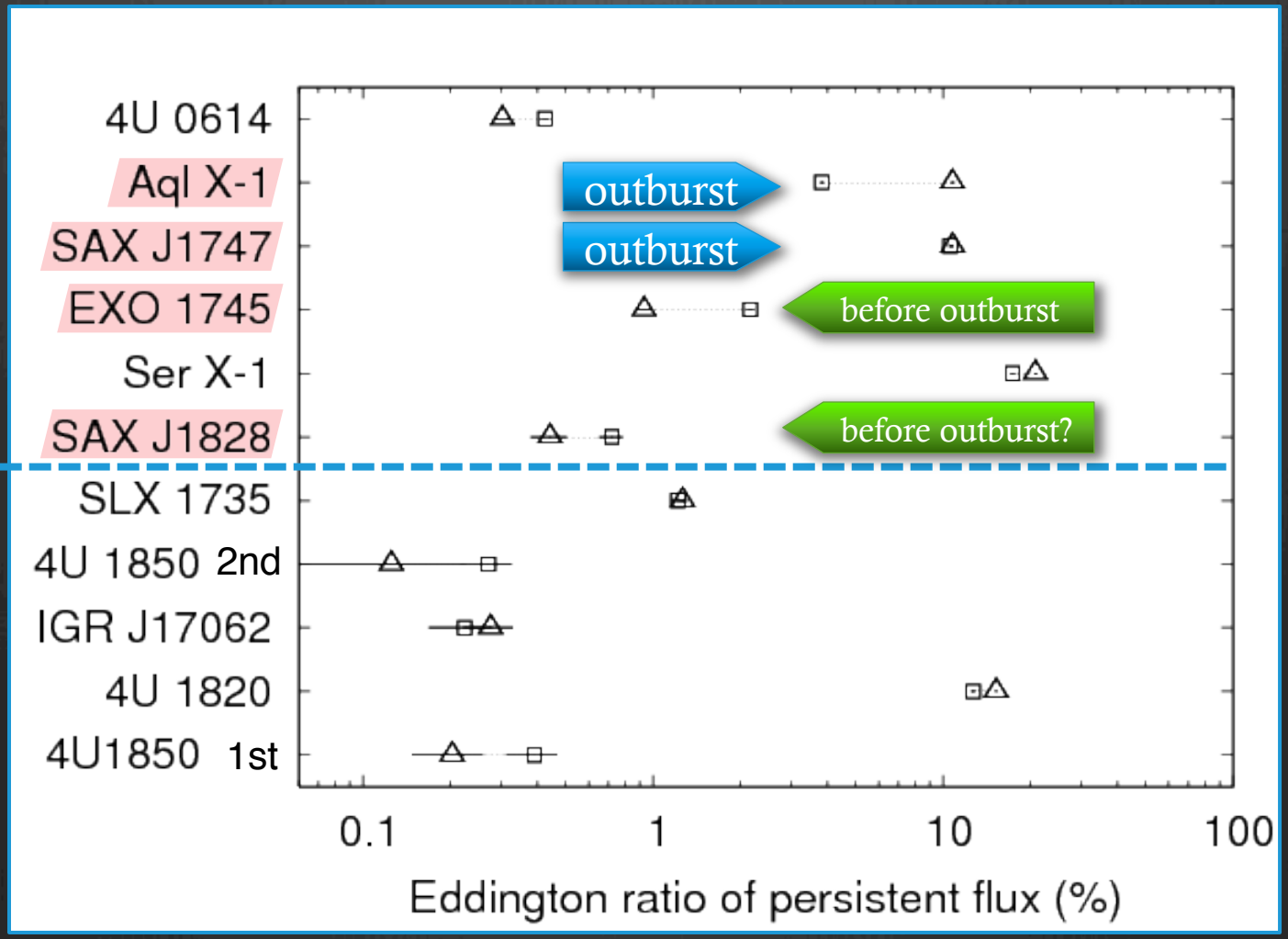
- Persistent fluxes before and after the superbursts are studied with MAXI archive
- Averaged over 10 days before and after the bursts



when the superbursts ignited?

Superburst

Intermediate

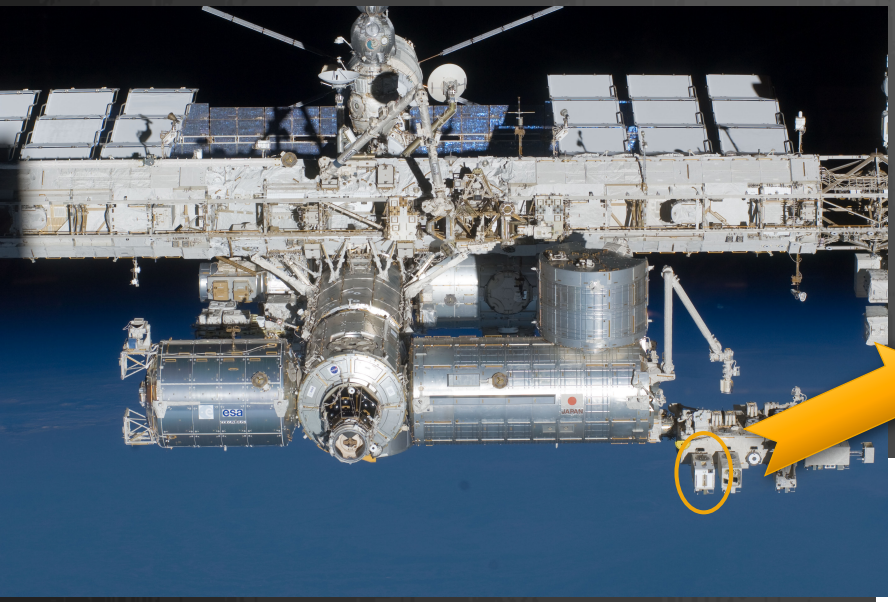


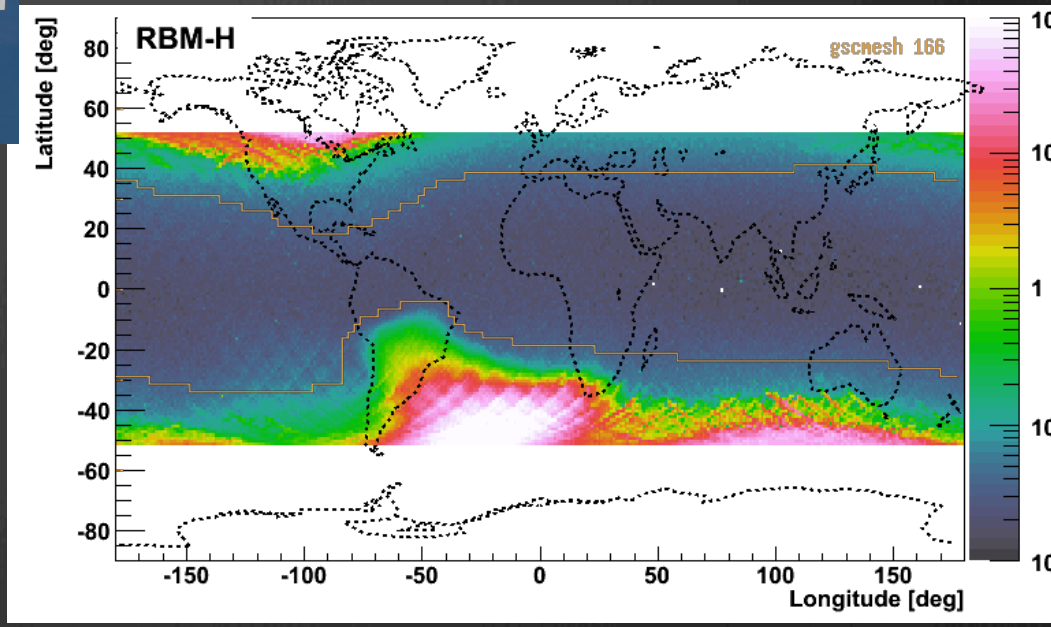
△ before
□ after

Summary

- 12 long bursts from 11 sources in seven years
  - 7 of them are superbursts
  - P-19 shows the details of the superburst from Ser X-1 and 4U 1705-440 (on Oct 22 this year)
- Possible anti-correlation between e-folding time and peak luminosity ⇨ constant energy
- Superbursts can occur when the persistent fluxes are very low (< 1% of Eddington)
  - The persistent fluxes at intermediate duration bursts are low, but 4U 1820-30

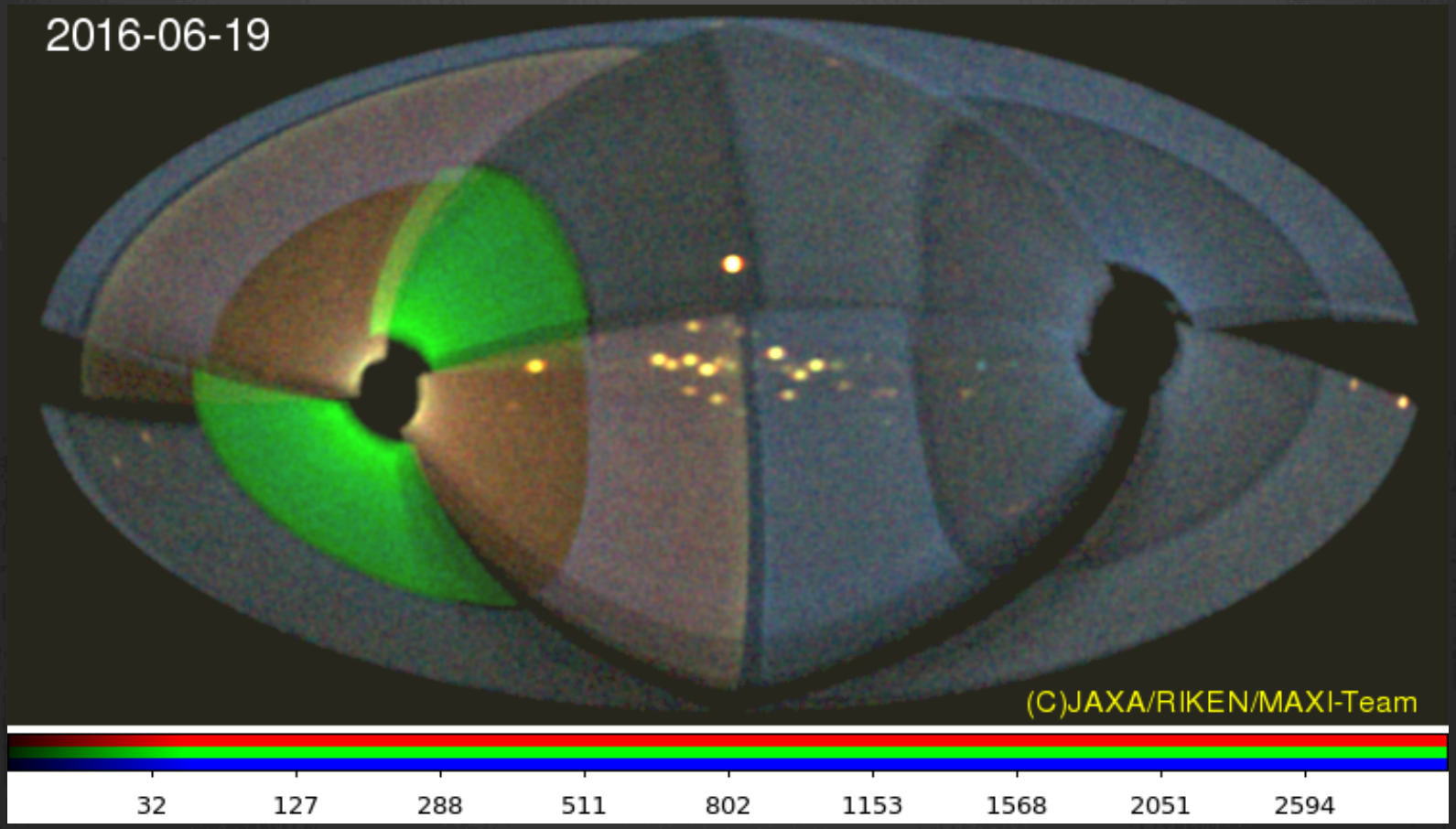
ISS and MAXI





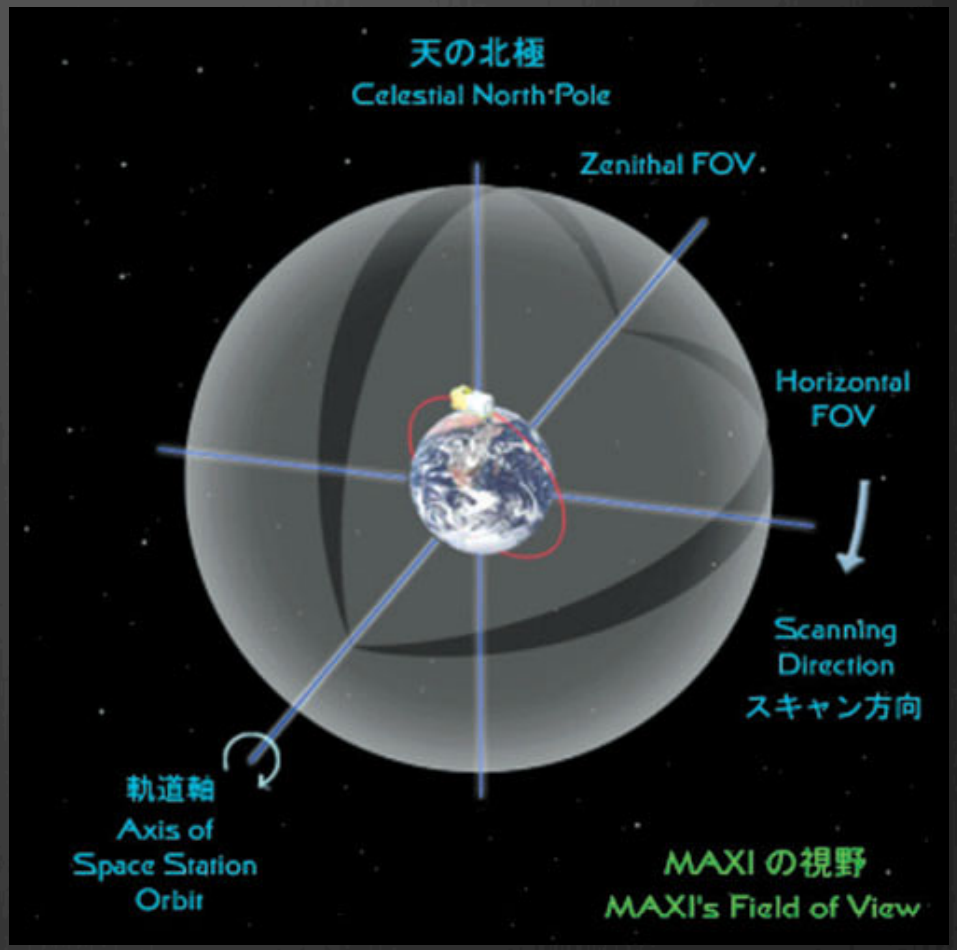
- Inclination angle of the orbit = 51deg
- Operate within ±40deg

GSC all-sky map



Observations by MAXI

- MAXI is on ISS
- Two field of views narrow in the scan direction and wide in the perpendicular direction
- A source is observed only ~40s in 92 min orbit
- X-ray bursts in 10kpc are observable
- High efficiency for long events such as superbursts
- Persistent emissions are monitored



observation in a scan