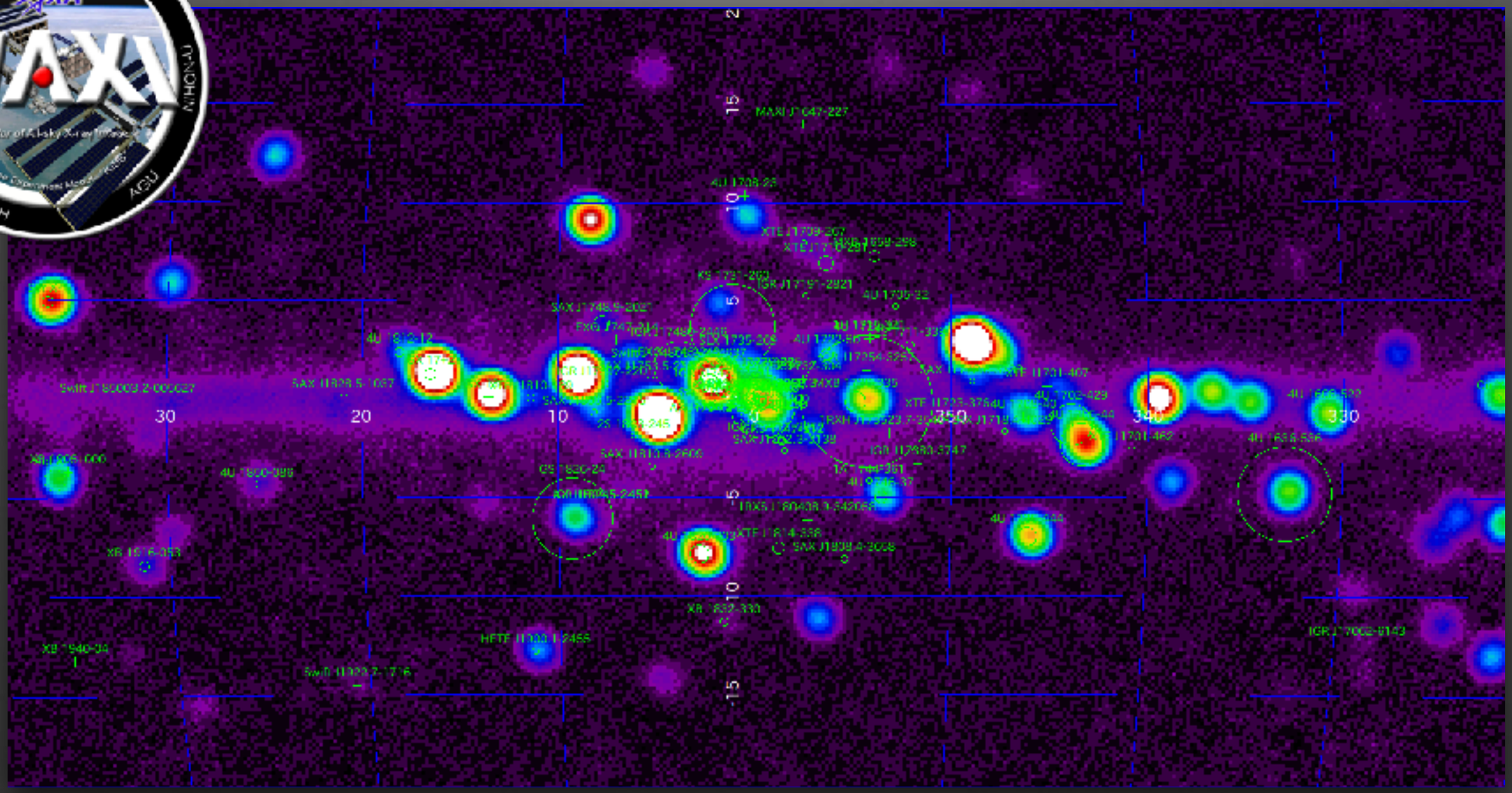


MAXI observations of X-ray bursts

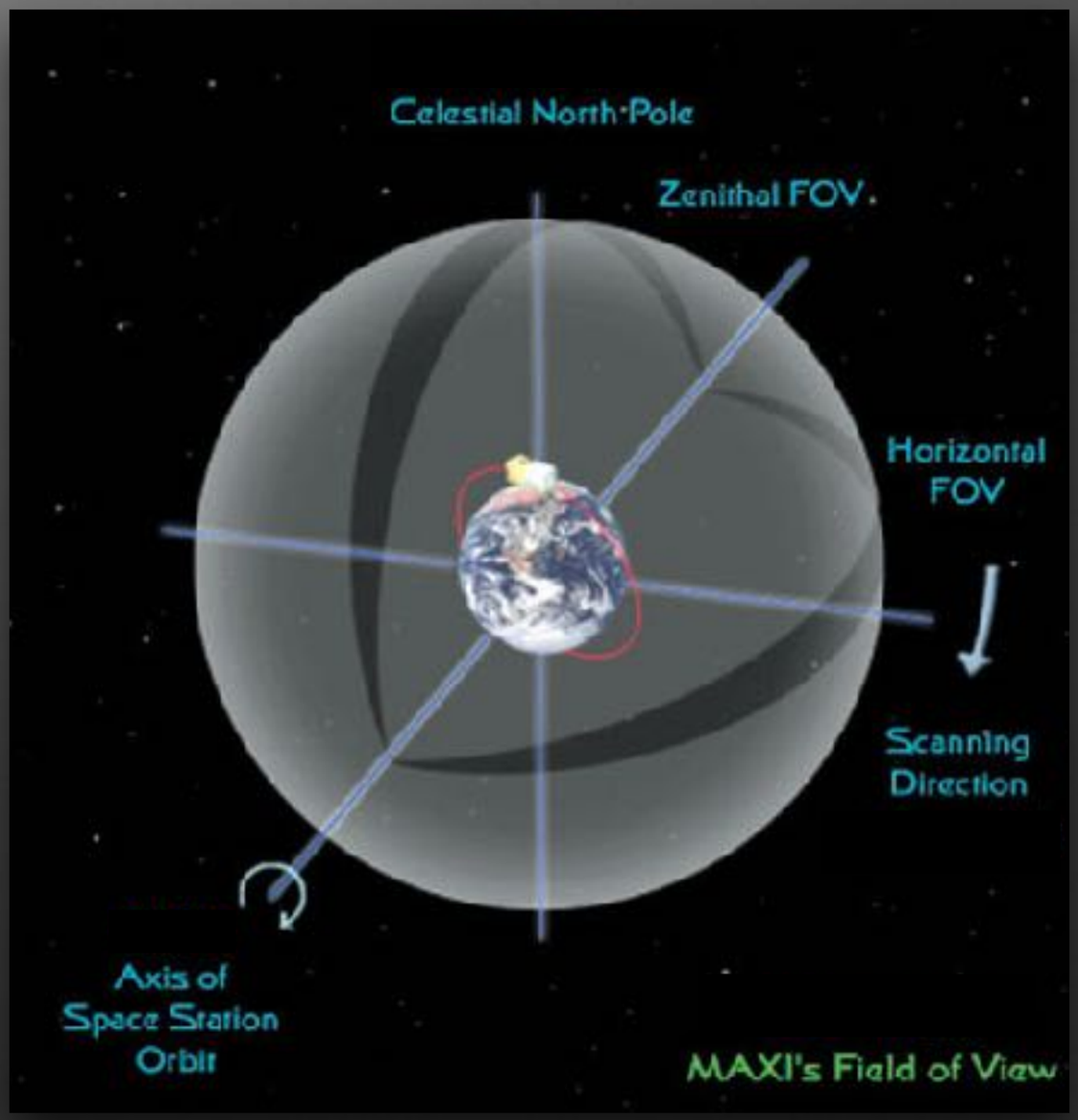
M. Serino (Aoyama Gakuin Univ.)

outline

- MAXI and long XRBs observed by MAXI
- Searching for superburst with MAXI/GSC public light curve
- MAXI alert to NICER (MANGA project)

MAXI on ISS

- Two field of views narrow in the scan direction and wide in the perpendicular direction
- A source is observed only ~50 s in 92 min orbit
- X-ray bursts in 10 kpc are observable in 2-20 keV
- > 80% of the whole sky can be covered in an orbit



Merits / Demerits

- MAXI monitors the persistent fluxes of X-ray bursts
  - unique capability to study correlations between the persistent fluxes and burst properties
- High efficiency for detecting long (>92 min) lasting bursts
- FoV is only 2% of the sky
  - a typical scan transit lasts ~50 s
- PSF size ~ 3 deg: not sufficient to monitor crowded regions (e.g. galactic center region)

MAXI observations of long XRBs

- MAXI observed 8(superbursts) + 6(intermediate) long XRB
- The majority of them are from transient sources
- Among four superbursts from transient sources, two occurred when the persistent flux were low
  - such an event was not observed before
- MAXI made things complicated …?

long XRB by MAXI

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
GS 1826-238	2.9 - 4.0	4.3	33.1
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	10.6
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
SAX J1712.6-3739	3.9	< 0.1?	< 0.8?

new ★

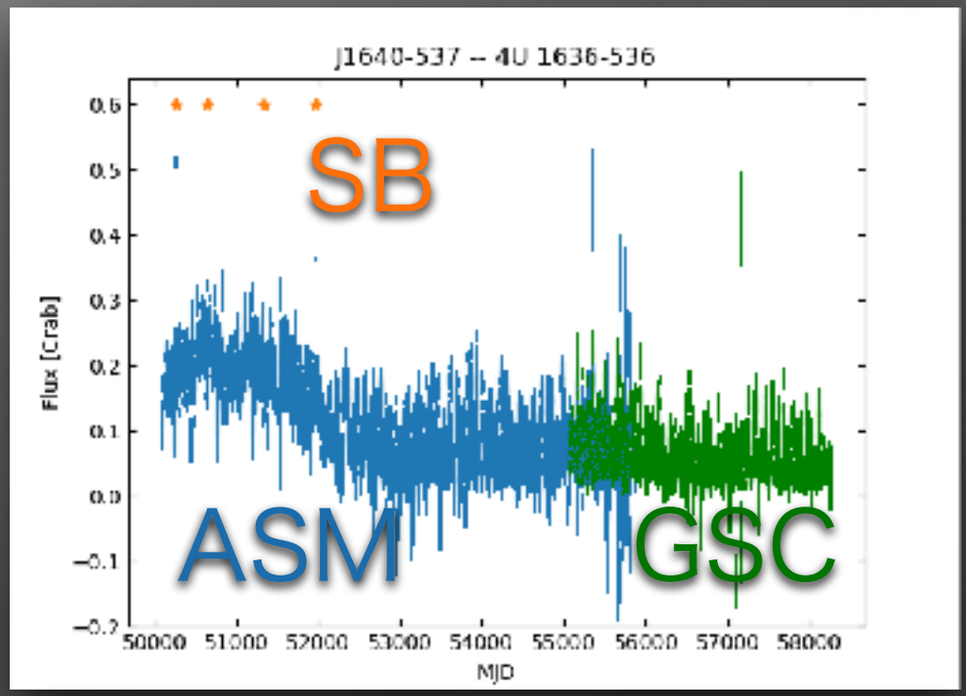
Superburst

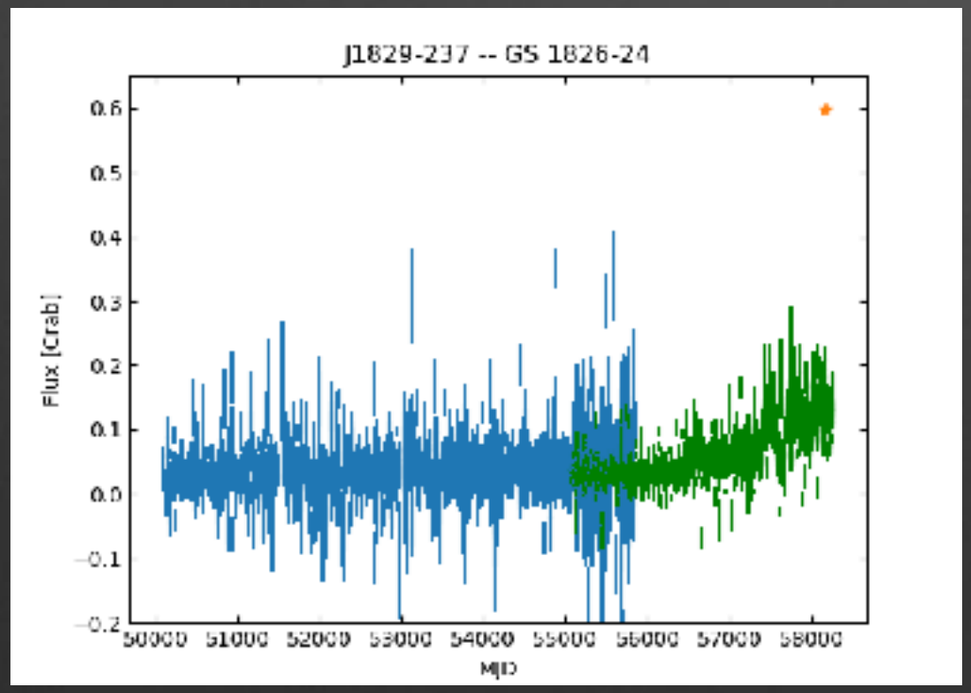
Intermediate

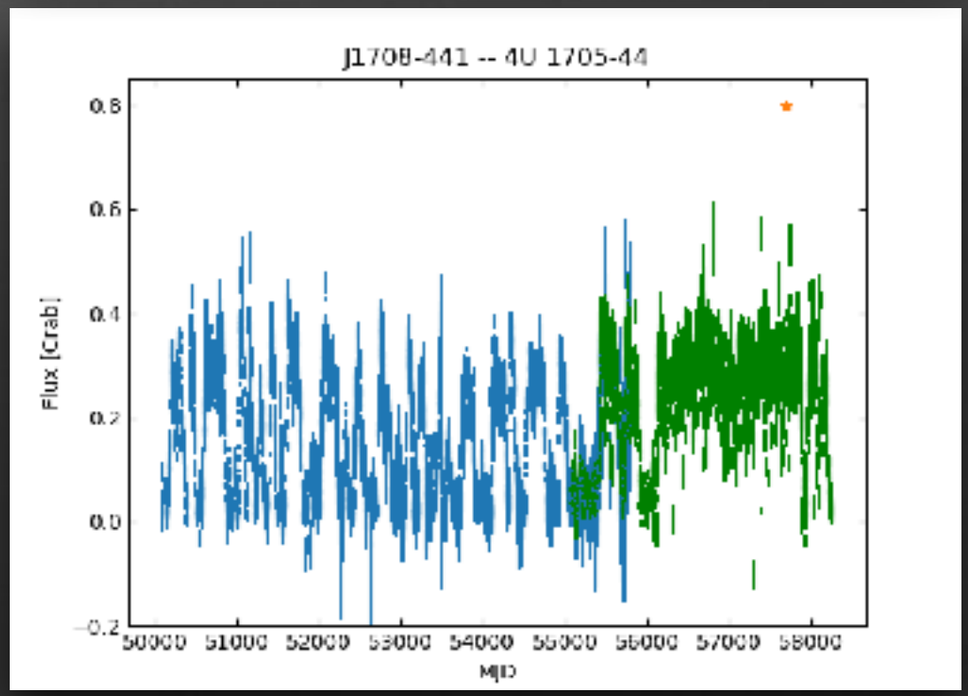
When superbursts ignite?

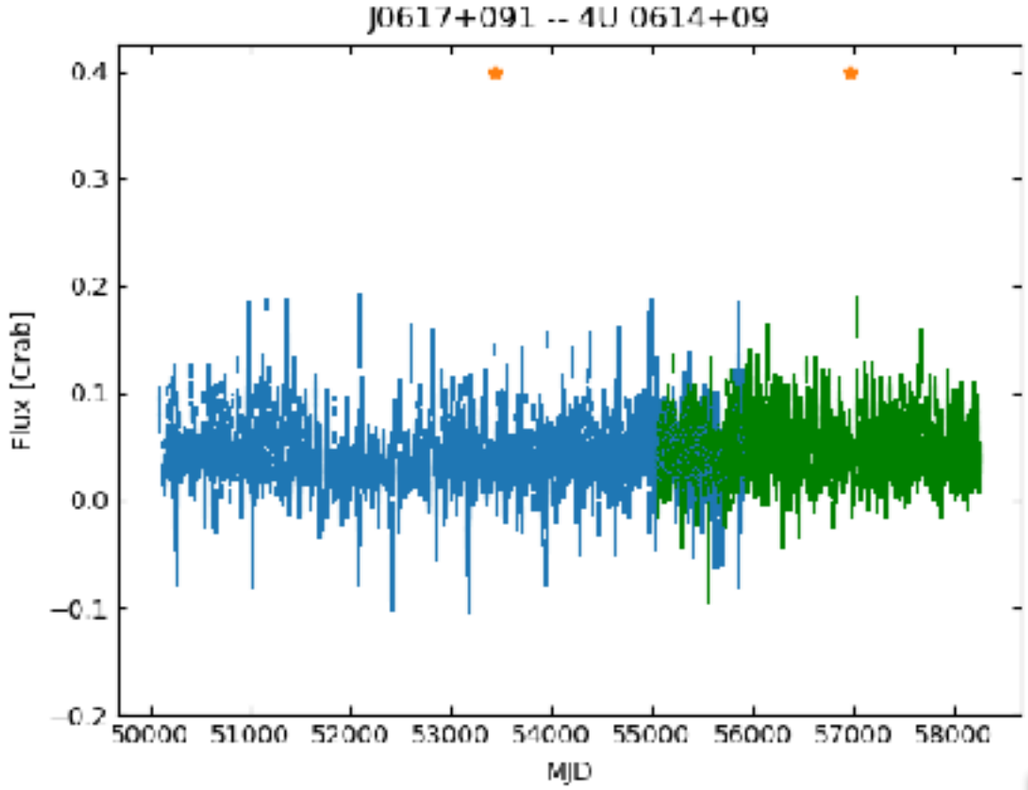
persistent flux and SB

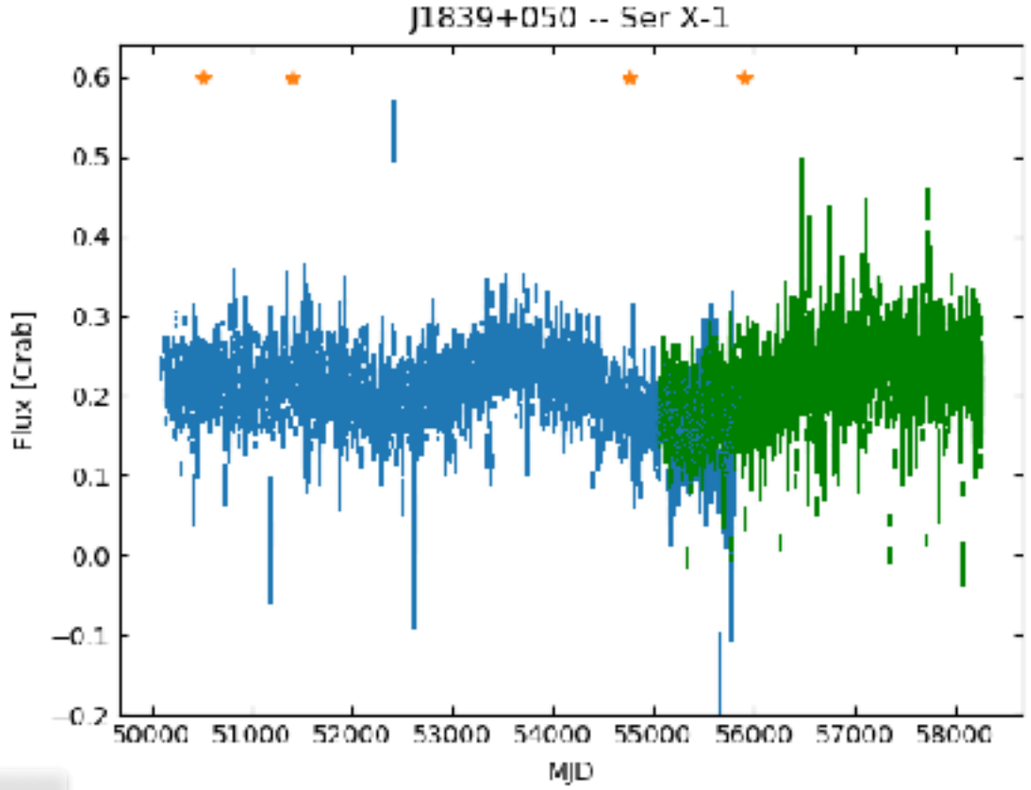
- Are there any flux conditions for ignition?
- They suggest …



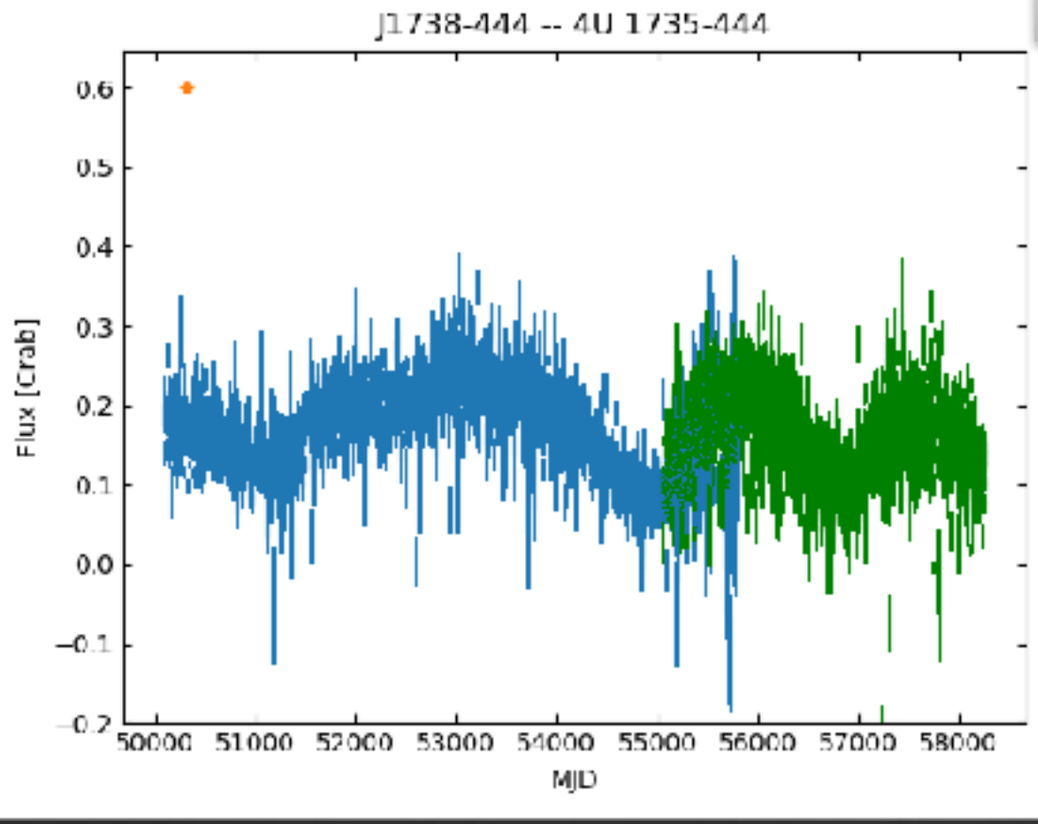


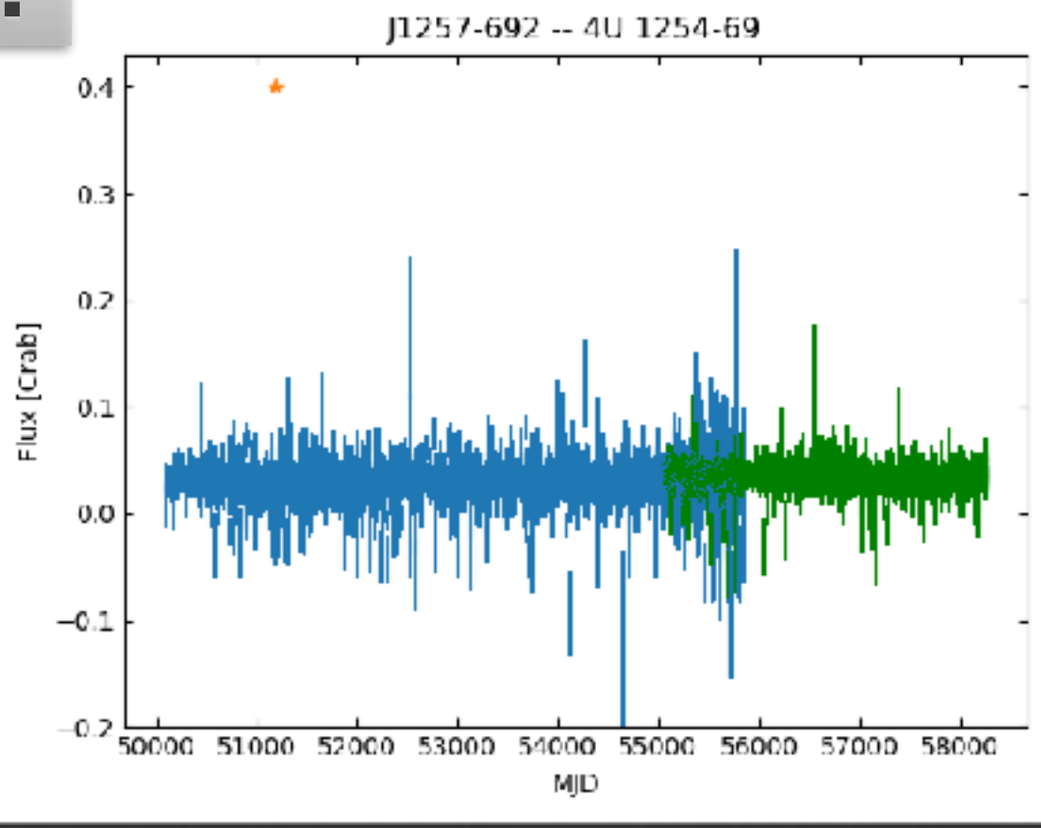



J0617+091 -- 4U 0614+09
Flux [Crab]
MJD


J1839+050 -- Ser X-1
Flux [Crab]
MJD

???


J1738-444 -- 4U 1735-444
Flux [Crab]
MJD


J1257-692 -- 4U 1254-69
Flux [Crab]
MJD

motivation

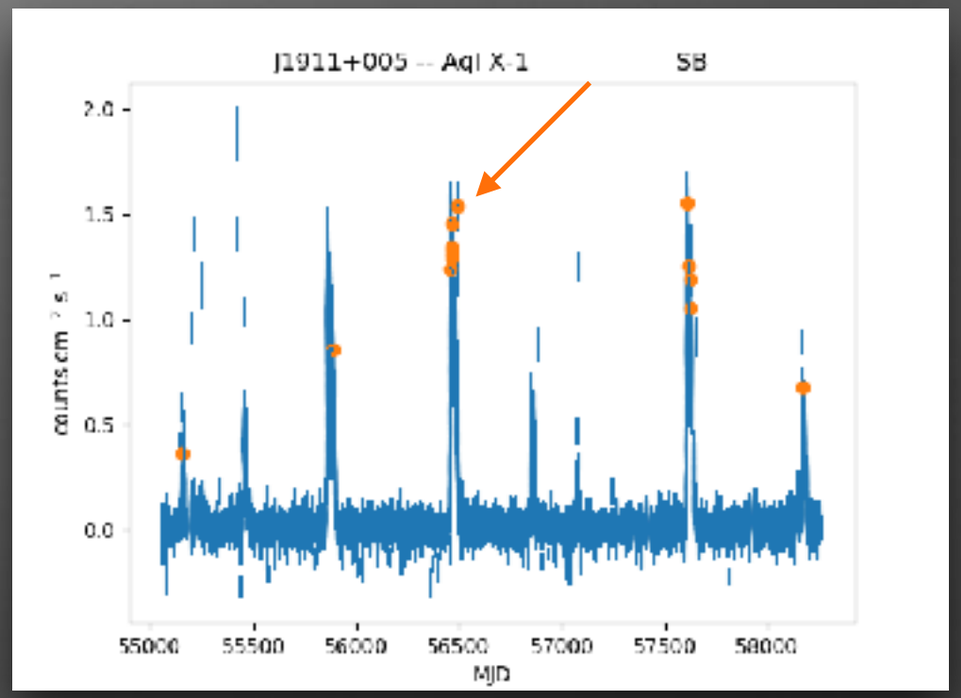
- More superbursts in MAXI data?
  - Will the correlation become clearer with them?
- We need more comprehensive search for superbursts
  - current “nova-alert system” is not suitable for superburst search, especially for bright sources
  - Six out of eight superburst were found by visual inspection

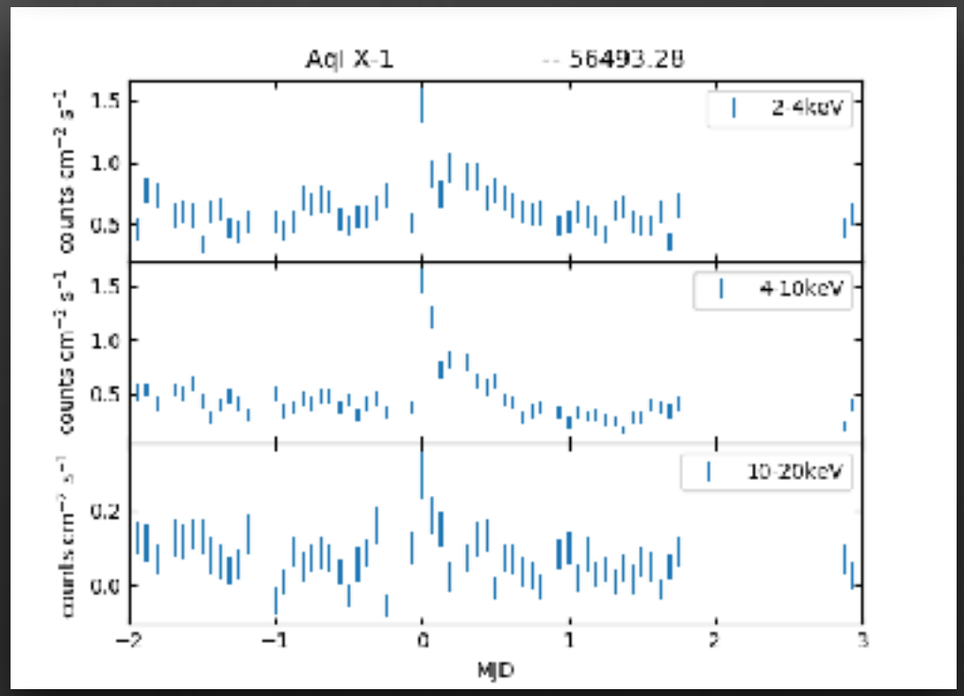
more comprehensive search for SB

- 47 XRB sources
  - with public GSC LC
  - not contaminated by other sources
    - include known superburst sources as a test
- select superburst candidate automatically
  - using 4-10 keV light cuves
- visual inspection of 3 band light curves

test with known SB

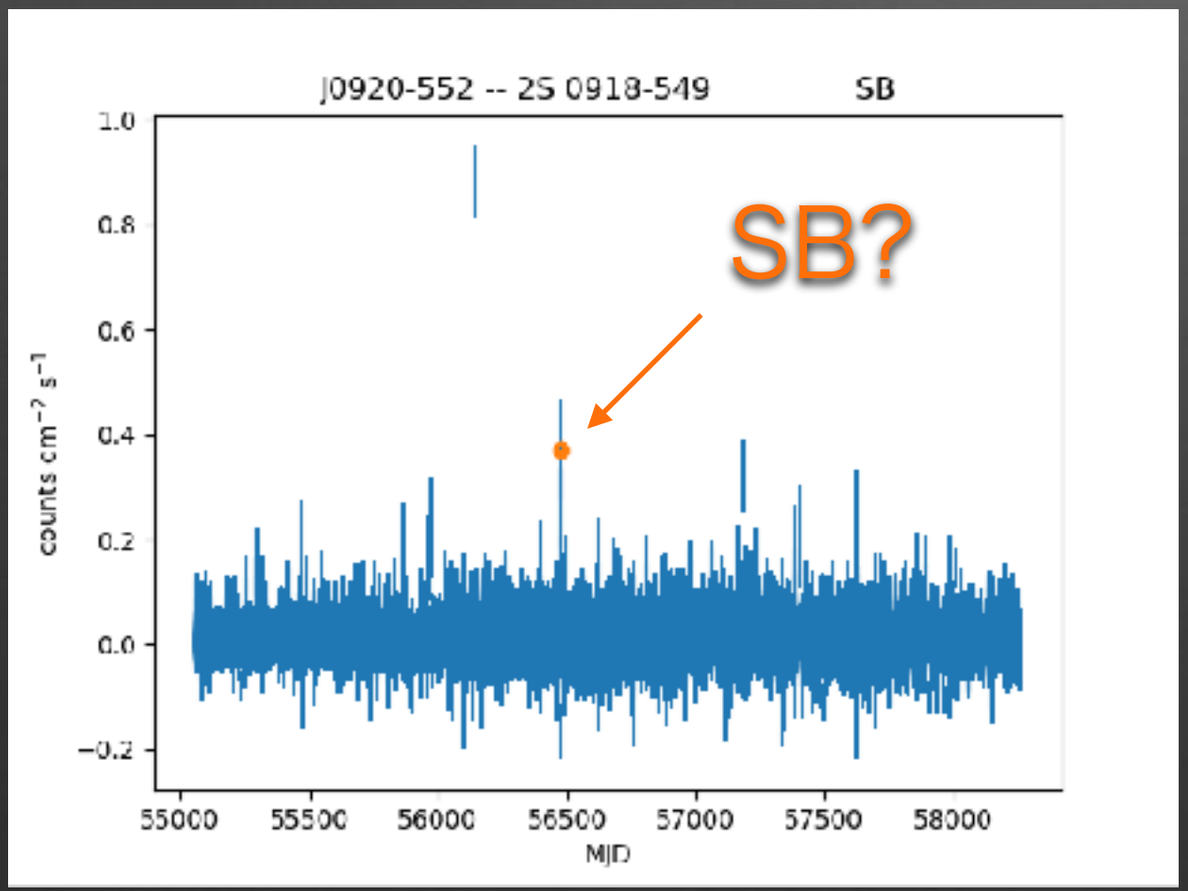
- 6 superburst and
  2 intermediate duration
  burst were found with
  this method



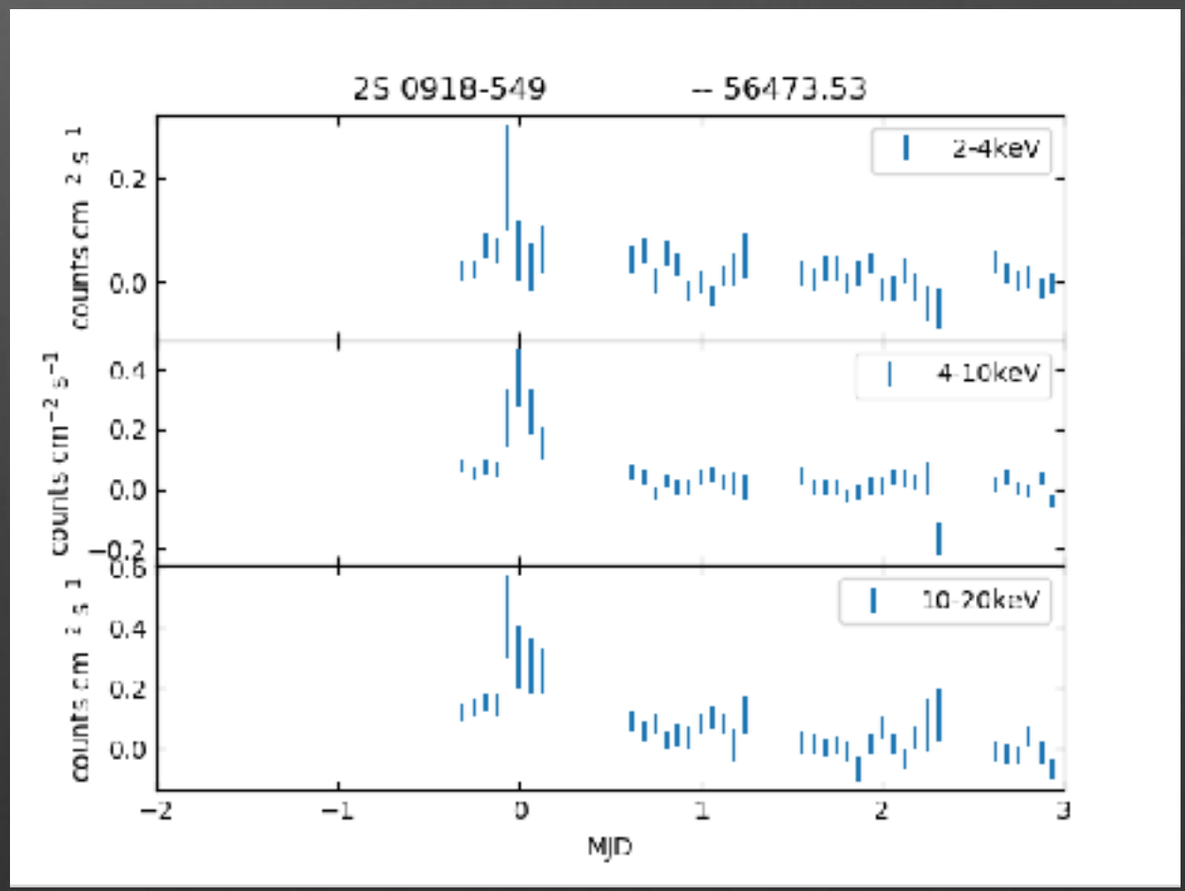


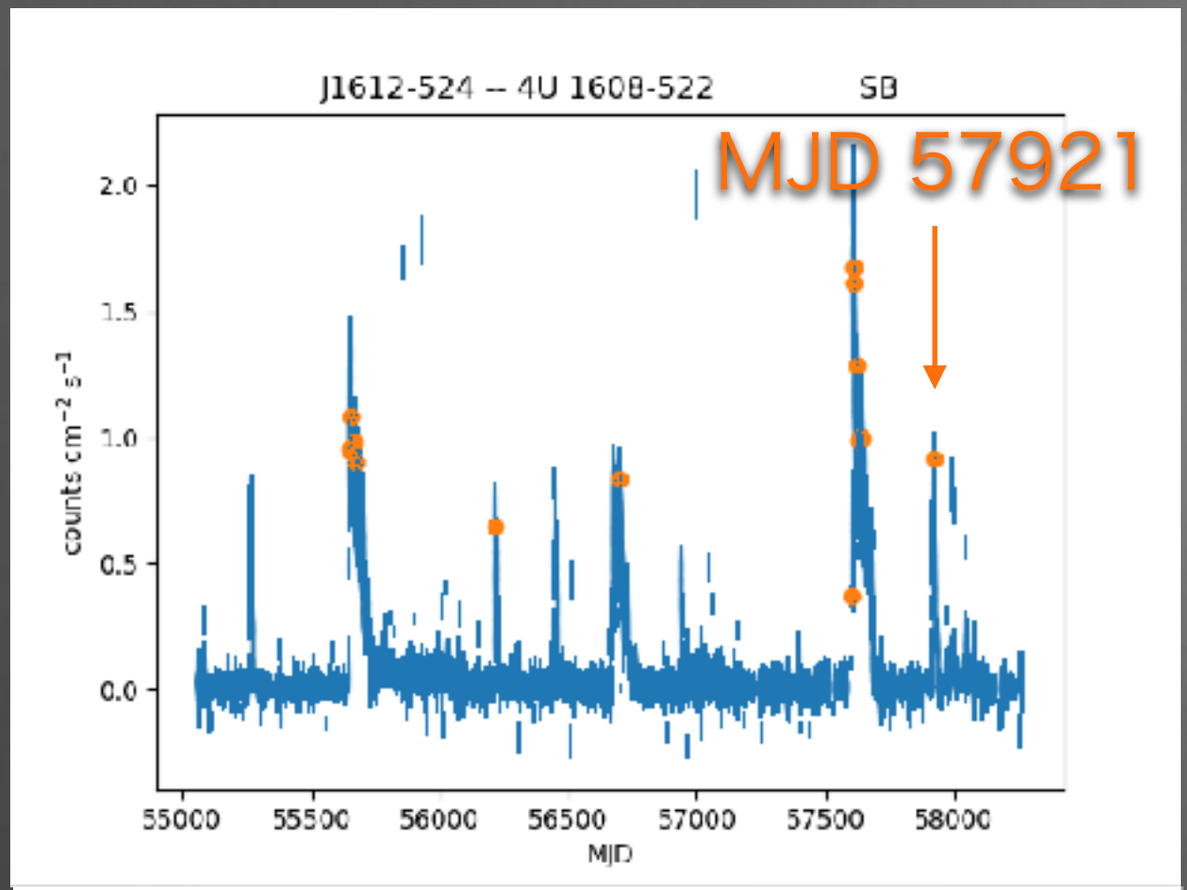
Superburst candidates

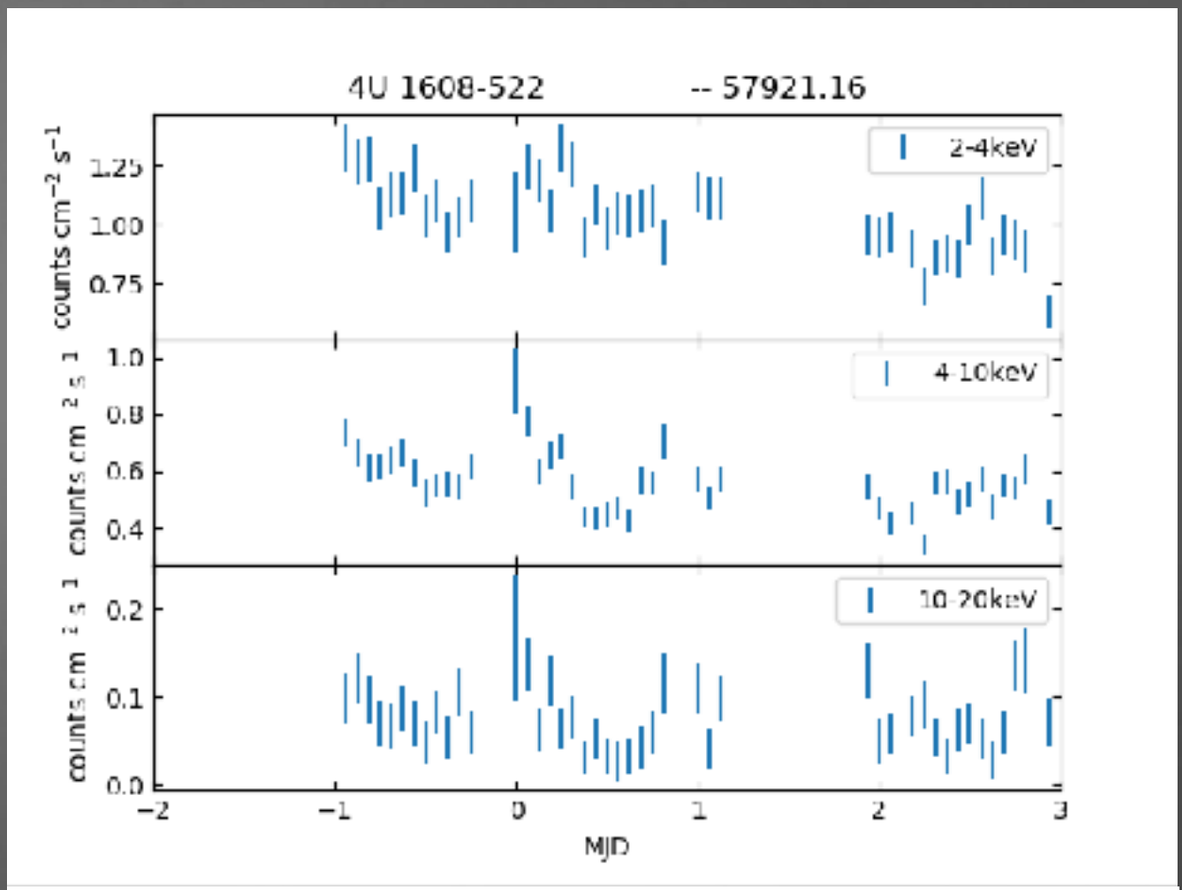
GSC 4-10 keV light curve 2009-2018

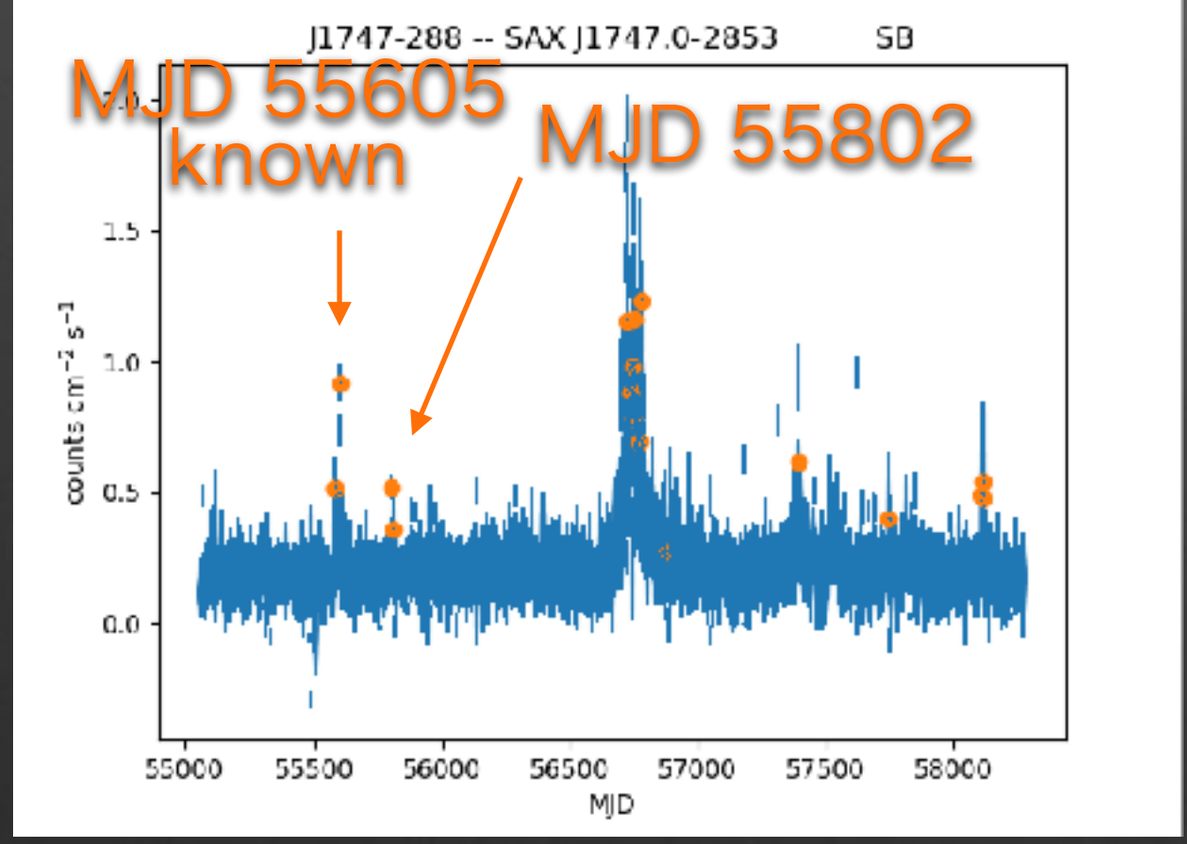


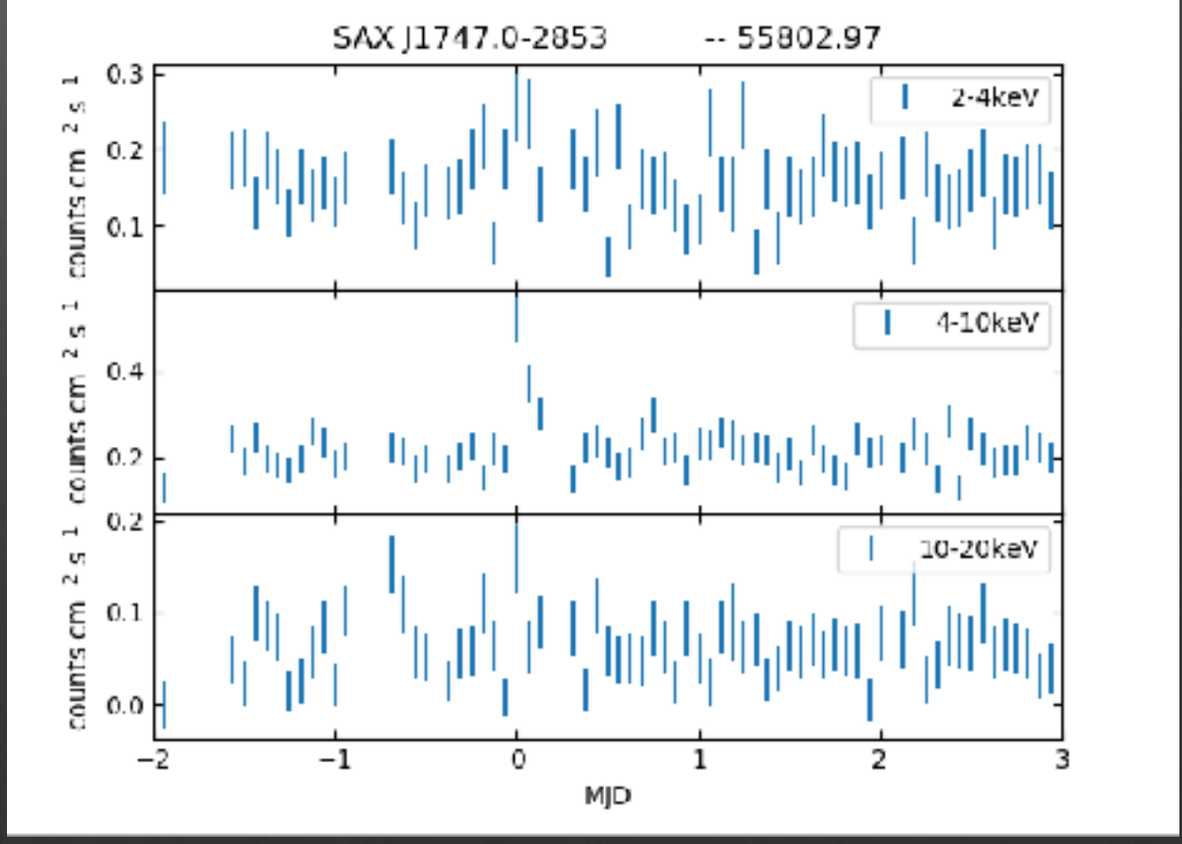
GSC light curves of 3 bands around the burst candidate




J1612-524 -- 4U 1608-522 SB
MJD 57921
counts cm^{-2} s^{-1}
MJD


4U 1608-522 -- 57921.16
2-4keV
4-10keV
10-20keV
counts cm^{-2} s^{-1}
MJD

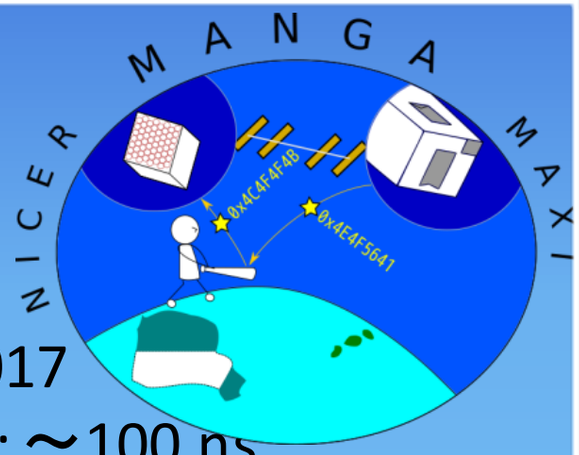

J1747-288 -- SAX J1747.0-2853 SB
MJD 55605
known
MJD 55802
counts cm^{-2} s^{-1}
MJD


SAX J1747.0-2853 -- 55802.97
2-4keV
4-10keV
10-20keV
counts cm^{-2} s^{-1}
MJD

However…

- After the detailed analyses with images and spectra, none of them were confirmed
- at least the method is useful
  - We can apply it to the sources without public LC

MANGA : MAXI And NICER Ground Alert

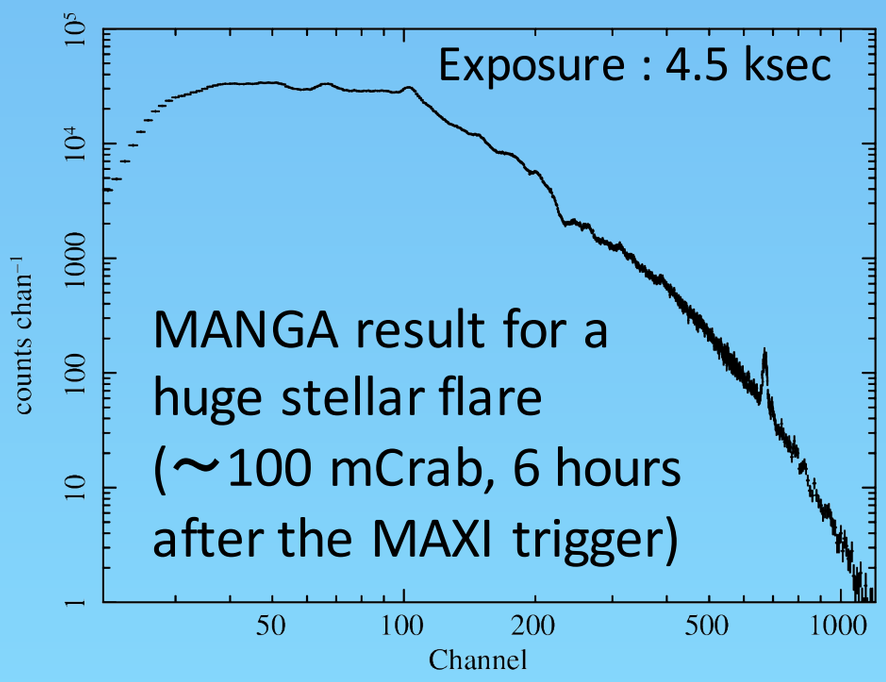


NICER(Neutron star Interior Composition ExploER)

- a NASA/GSFC mission.
- Installed at ISS on June 2017
- Absolute time resolution : ～100 ns
- Energy resolution : 2% @6 keV
- Large effective area : >2000cm^2
  10 times higher than Swift/XRT

ToO observations of NICER provide accurate timing and spectroscopy of MAXI transients

According to the discussion between the MAXI and NICER team before NICER launch, we already made 10 ToO observations within 10 months almost for stellar flares (its duration is about a day).
Unfortunately, superbursts have not observed yet by MANGA. MANGA must be a powerful tool for studying superburst properties (e.g, line emission, period).



We will continue MANGA in such a rate (～once a month).
We will try to shorten the time delay aiming upto 20 minutes.

summary

- MAXI observed 8(superbursts) + 6(intermediate) long XRB
  - Superbursts during low persistent flux state were found
- We searched 47 light curves of XRB sources for superbursts
  - There were 3 superburst candidates,
    but they were not confirmed
- MAXI and NICER Ground Alert (MANGA) project is ongoing
  - carried out ~ 1 ToO per month