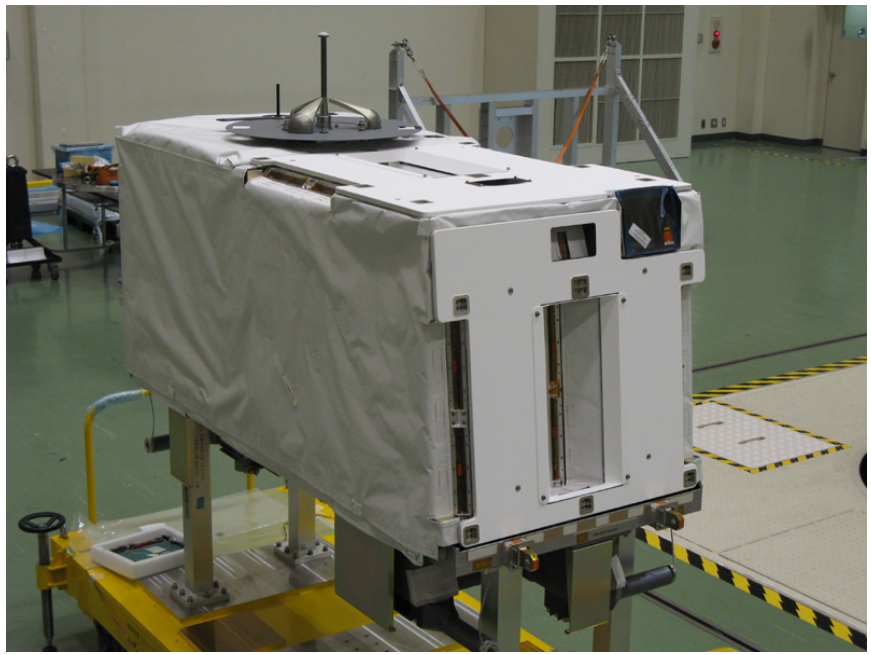
Monitor of All-Sky X-Ray Image (MAXI) on the International Space Station



T. Mihara, M. Sugizaki (RIKEN)

On behalf of MAXI Collaboration

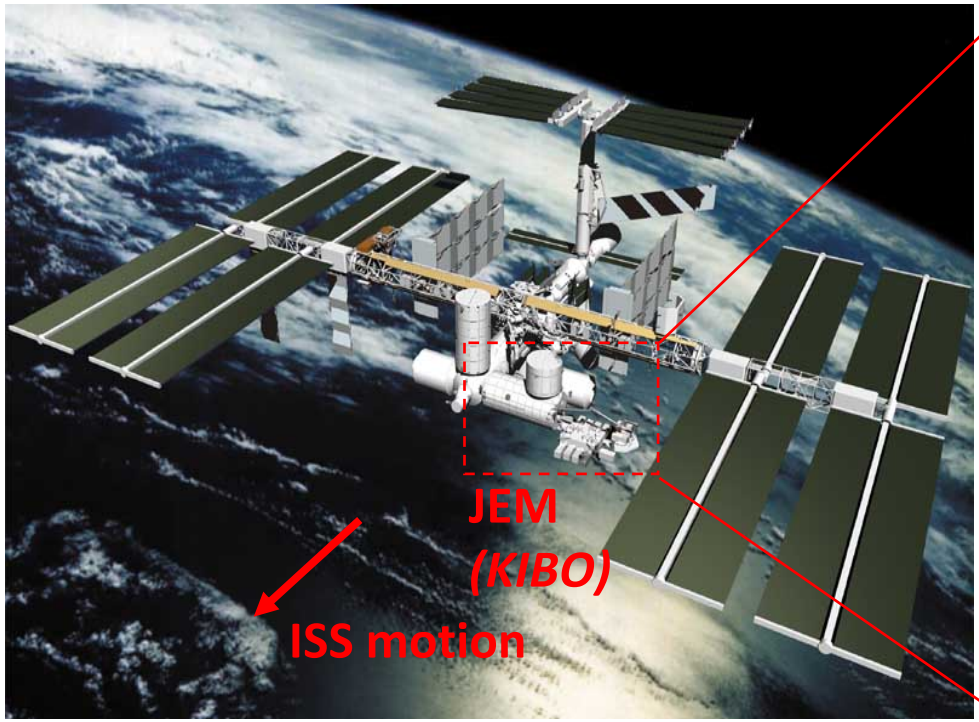
Matsuoka 2009 PASJ submitted. Sugizaki 2009 IEEE submitted.

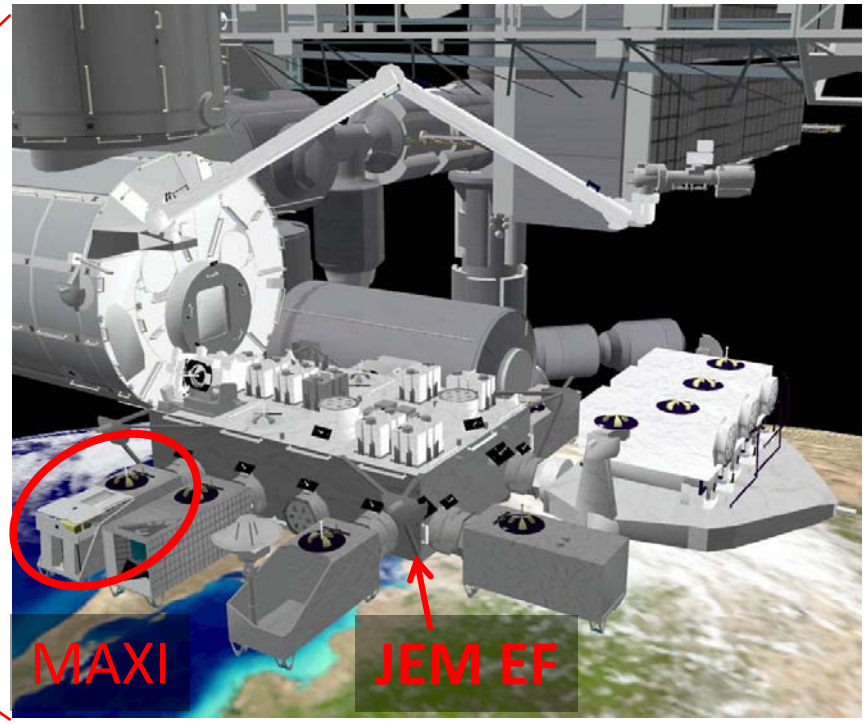
MAXI Collaboration

- **JAXA** M. Matsuoka, M. Kawasaki, S. Ueno, H. Tomida, M. Kohama, M. Suzuki, Y. Adachi, M. Ishikawa, H. Katayama, K. Ebisawa
- **RIKEN** T. Mihara, M. Sugizaki, N. Isobe, Y. Nakagawa
- **Osaka Univ.** H. Tsunemi, E. Miyata
- **Tokyo Institute of Technology** N. Kawai, J. Kataoka, M. Morii
- **Aoyama Gakuin Univ.** A. Yoshida, K. Yamaoka
- **Nihon Univ.** H. Negoro, M. Nakajima
- **Kyoto Univ.** Y. Ueda

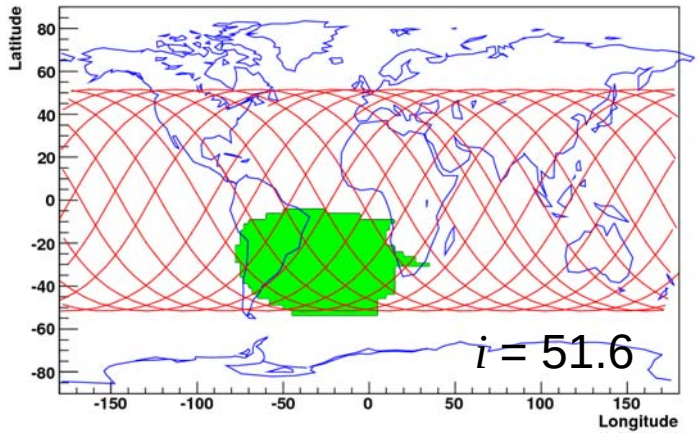
about 25 staffs + students

MAXI mission on ISS

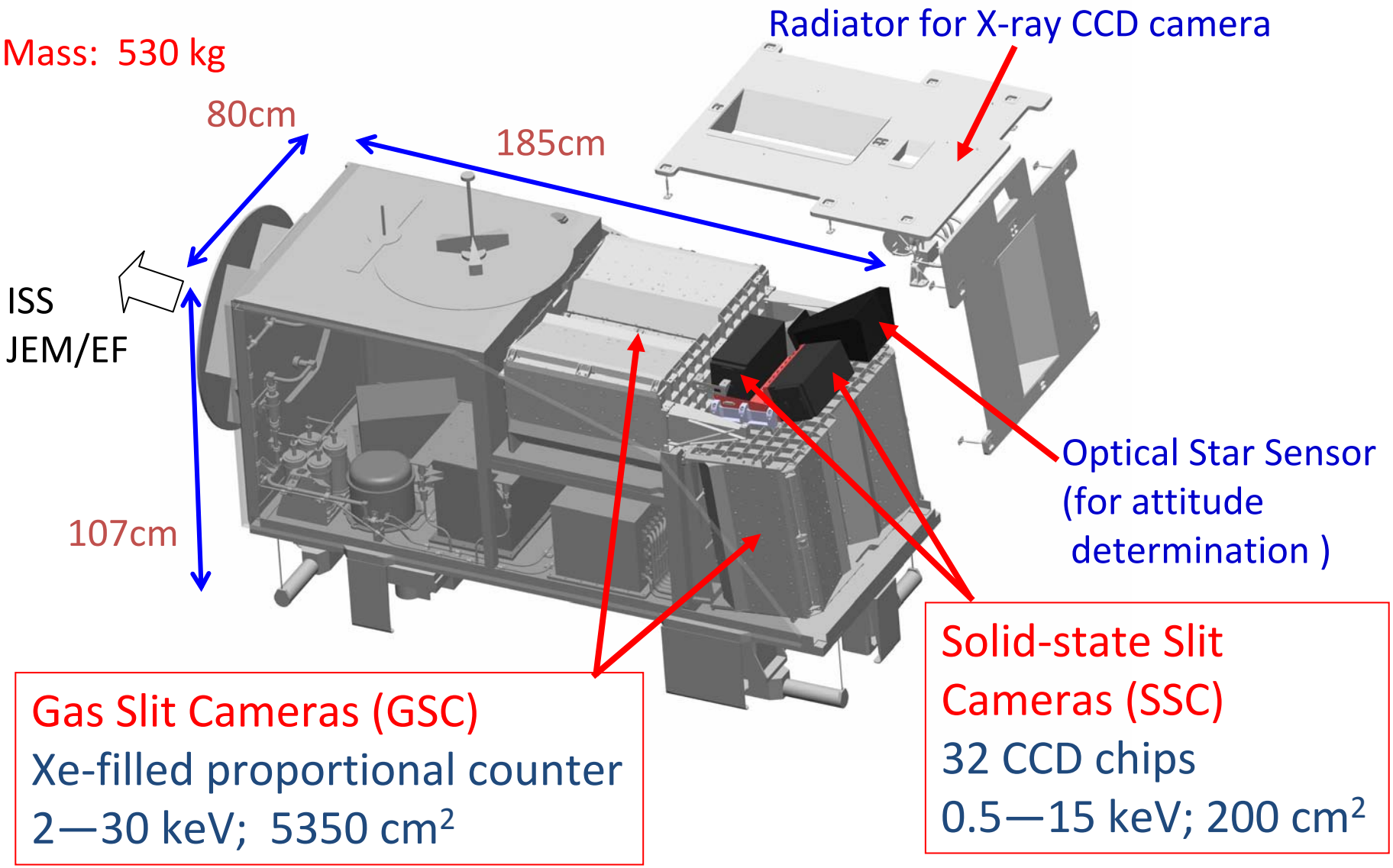




- The first astronomical mission on ISS for all-sky X-ray monitor
- attached on JEM (Japanese Experimental Module, KIBO)
  EF (Exposed Facility)
- launch: Space Shuttle (Endeavour) on June 2009

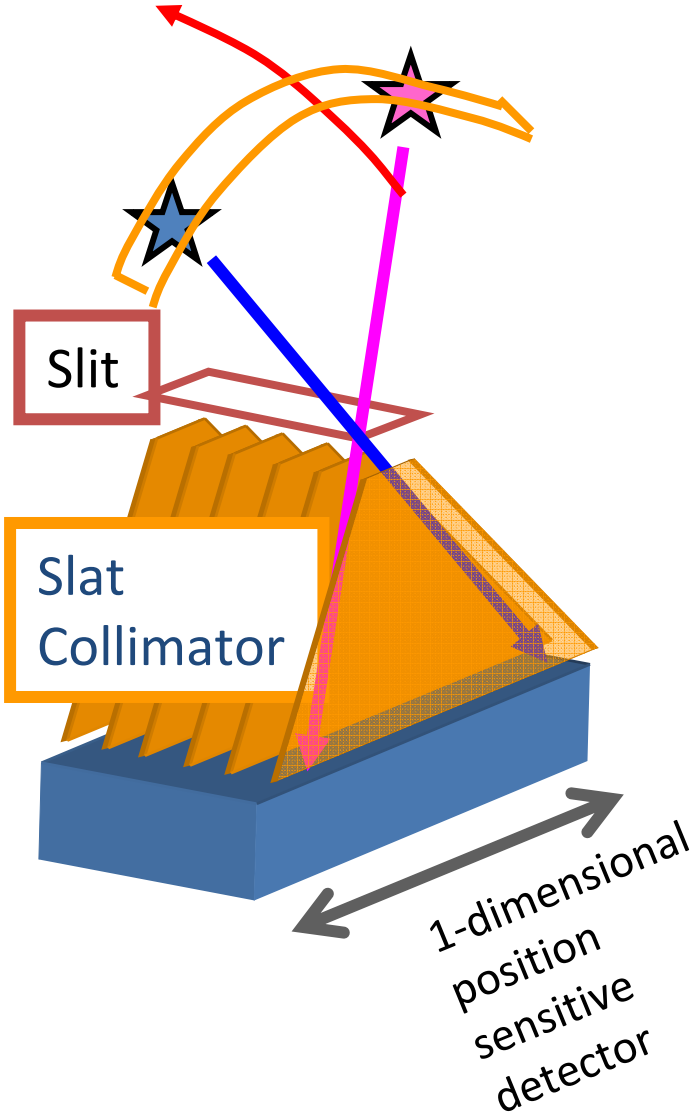


X-ray Slit Cameras on MAXI Payload

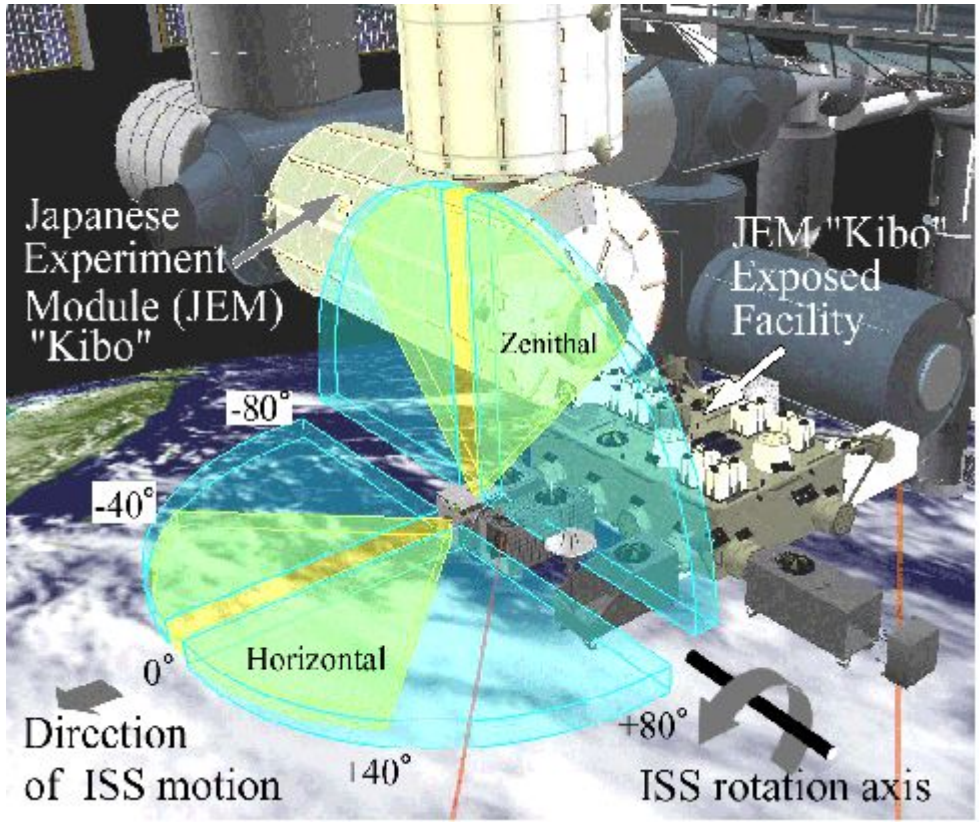


All-Sky Scan with Slit Cameras

Scan with
ISS rotation



Field of Views

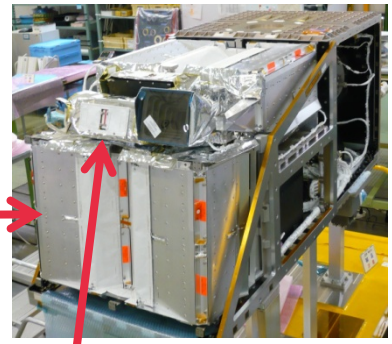


MAXI scans almost the entire (90%) sky twice in every ISS orbital period (~ 90 minutes).

Scientific Objectives

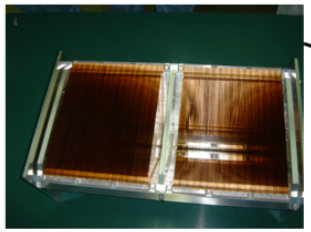
- Detection/monitor of transient X-ray sources in the whole sky
  - Galactic transient
    - X-ray binaries (Novae, QPOs, ..), AXPs, SGRs, flare stars, …
  - AGNs, GRBs, Supernova breakouts,…
- Rapid nova alerts
  - GRBs, new sources, and outbursts of known sources
- Complete all-sky catalog of X-ray sources
  - 0.5—30 keV, down to 0.2 mCrab in 2 years
  - Census of X-ray sources
- Large scale mapping of diffuse/unresolved X-ray Sky
  - Galactic ridge/loop structures with oxygen (and other) lines
  - Cosmic X-ray background fluctuations and anisotropy

X-ray detectors of MAXI

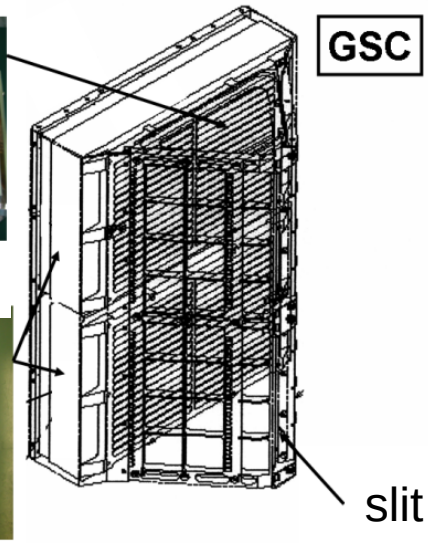


Gas Slit Camera (GSC)

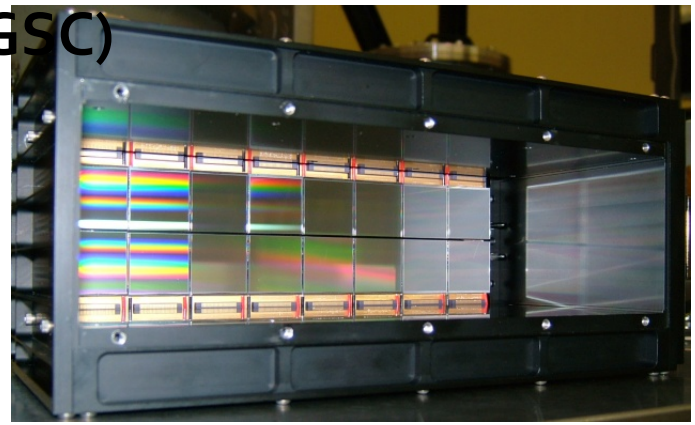
collimator



prop.counter



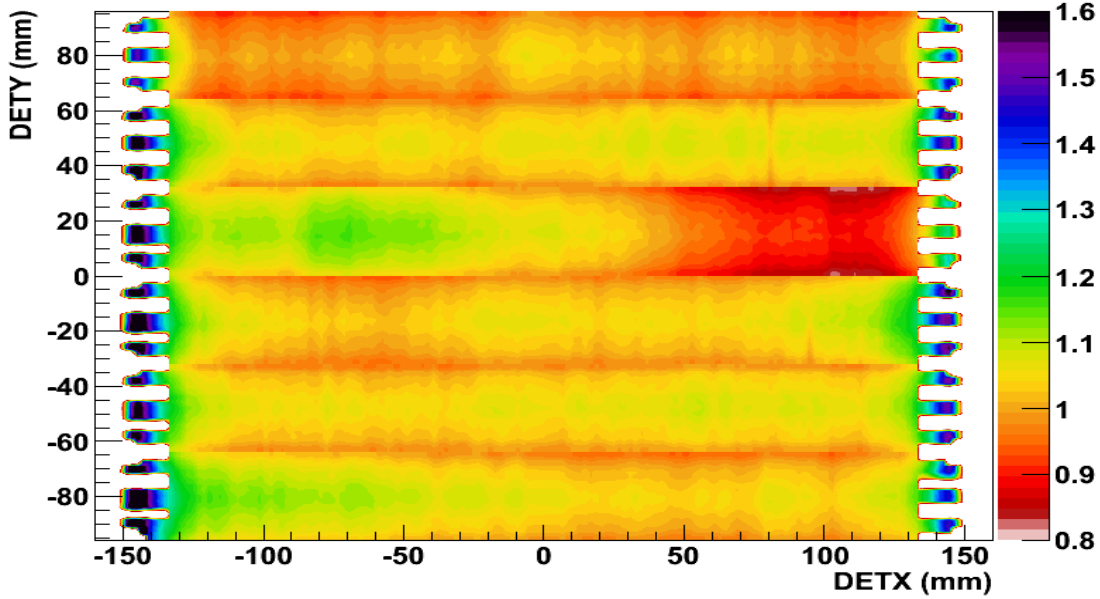
Solid-state Slit Camera (GSC)



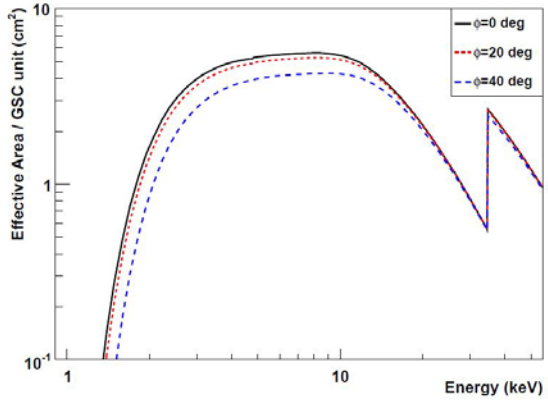
	GSC	SSC
detector	Xe Prop. Counter 12 cam	CCD 16chips x 2 cameras
Energy Band	2 - 30 keV	0.5 - 12 keV
Energy resol.	15.7% at 8.0 keV	150 eV at 5.9keV
Time resol.	～200 μ sec	6 sec
FOV	1.5 x 160 deg	1.5 x 80 deg
PSF FWHM	1.5 deg	1.5 deg
sensitivity	2 mCrab / week	5 mCrab / week

GSC counter properties

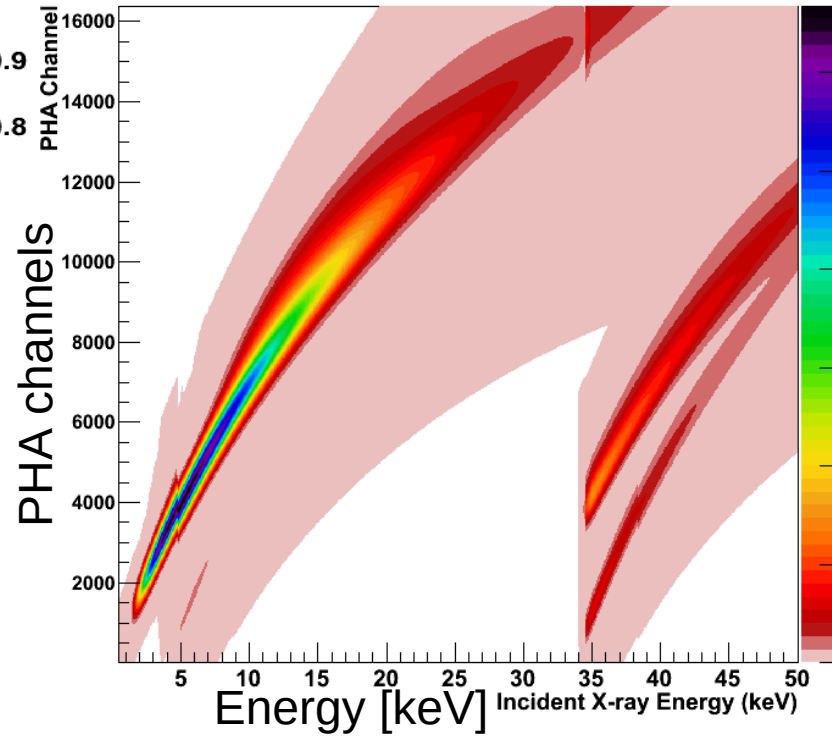
Gain: XY map



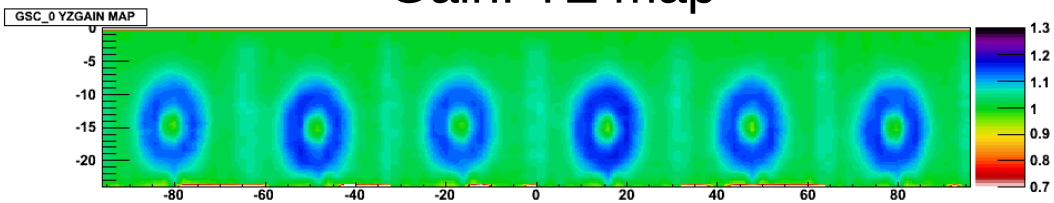
Effective area



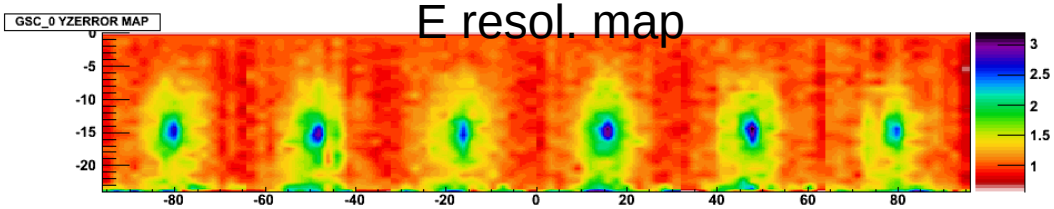
Response matrix in a position



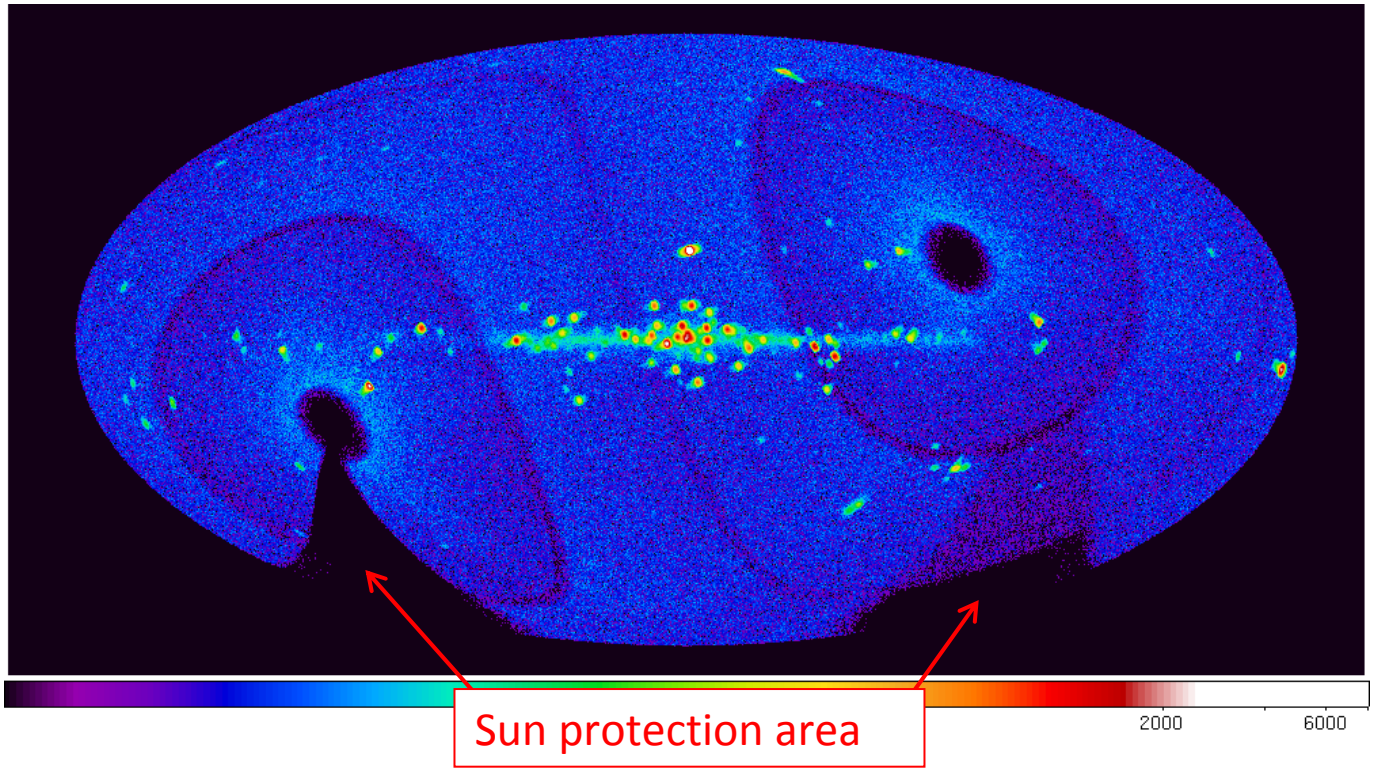
Gain: YZ map



E resol. map



Observation Simulation



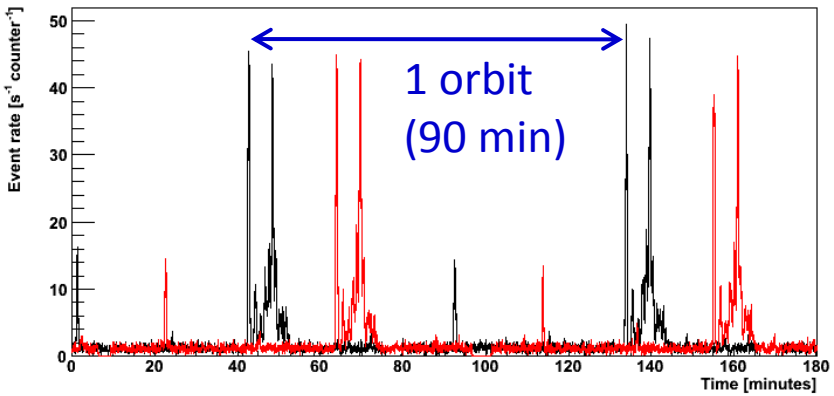
GSC 1-day observation image

2-30keV

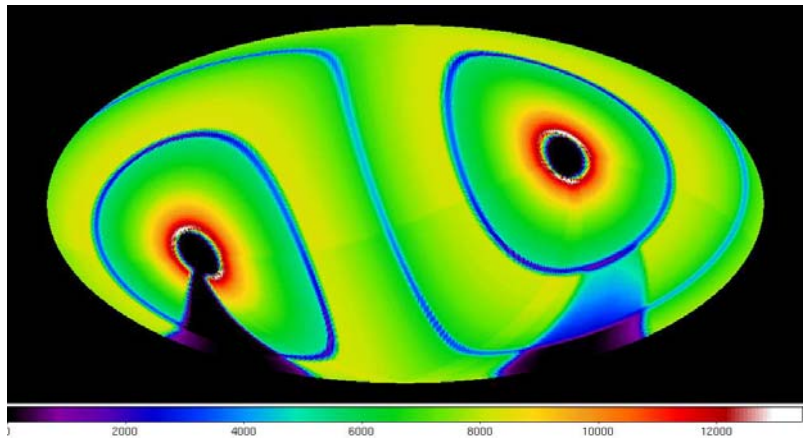
PSF~1.5 deg.

Sun protection area

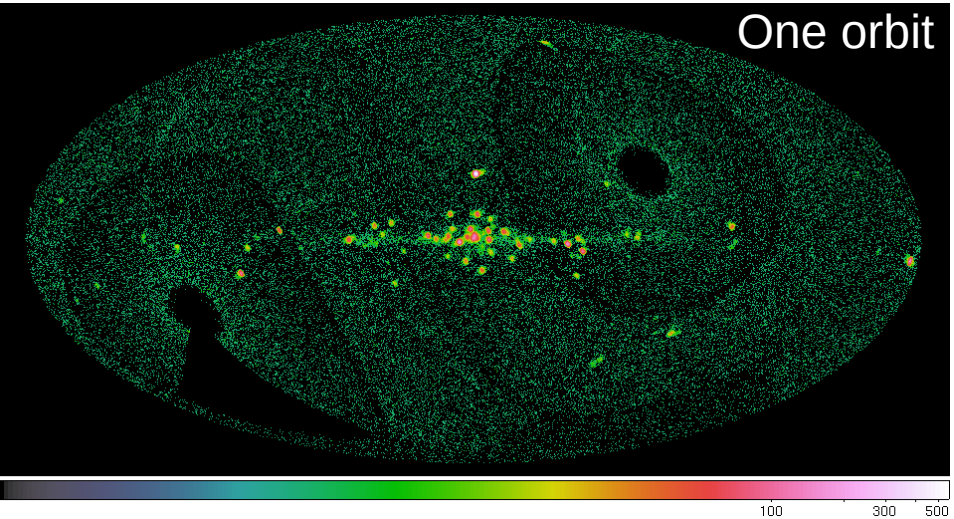
Event rate by 1-orbit scan

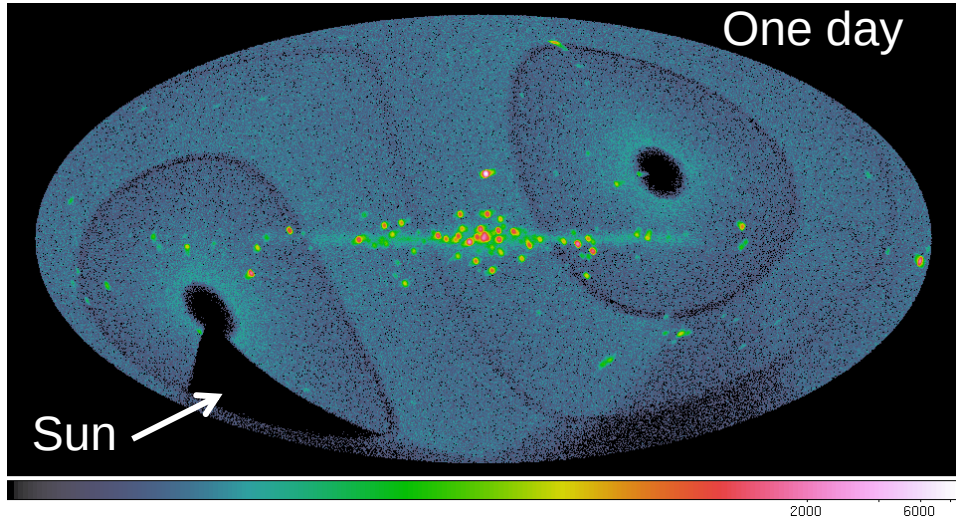


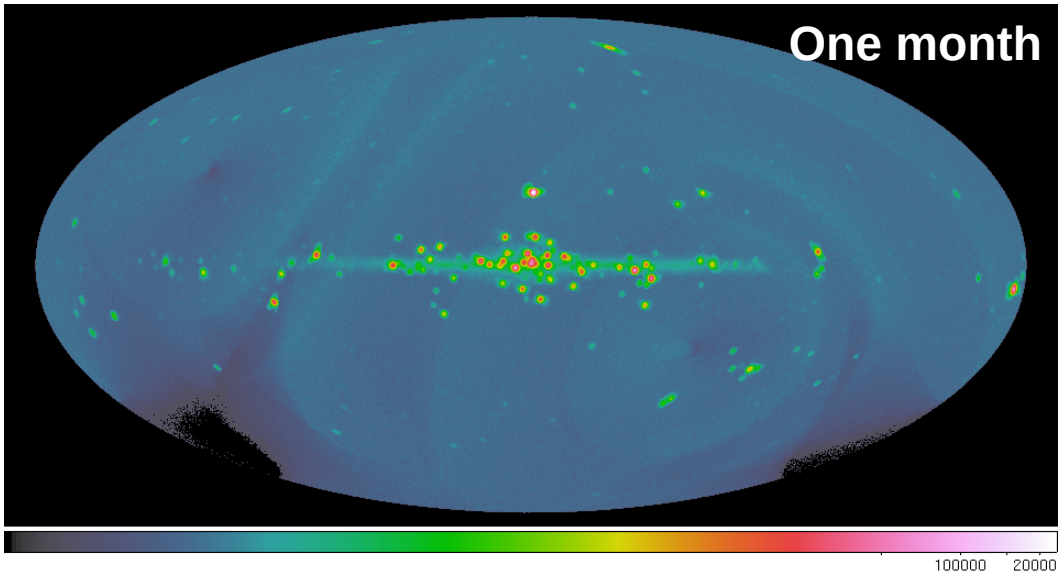
Exposure map



Simulated Sky Images by MAXI



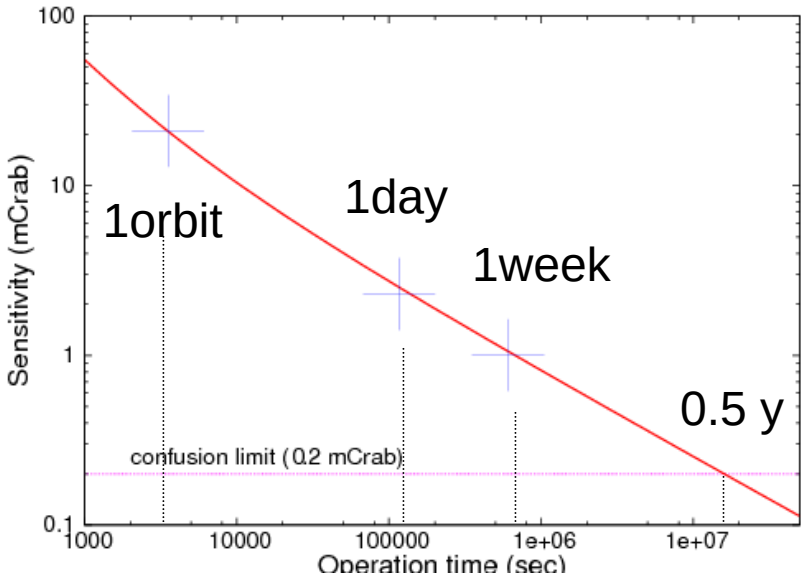




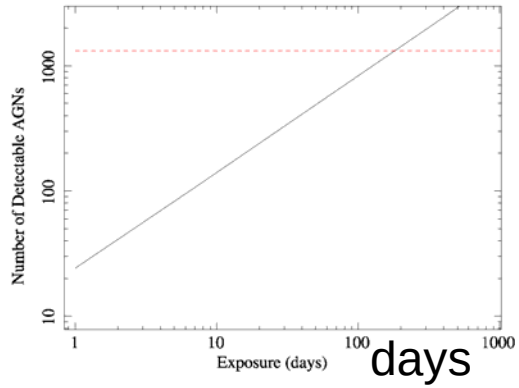
~ 1000 objects and
Diffuse hot sources!

GSC 2-30keV

Detection limit (5σ) of GSC by simulation



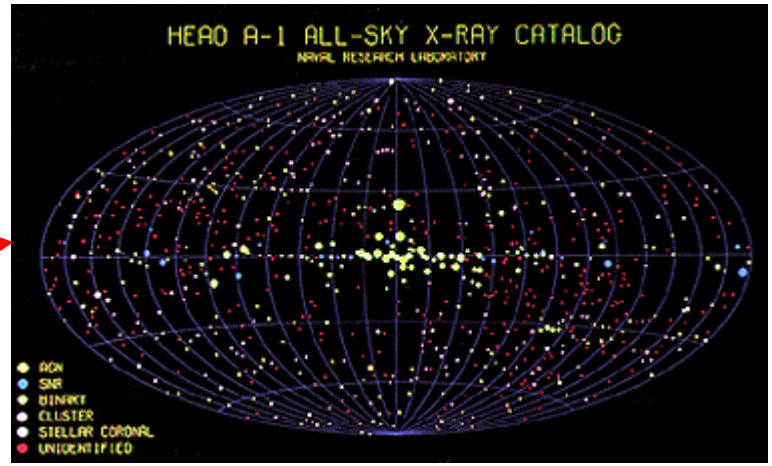
NAGN



|b| > 15

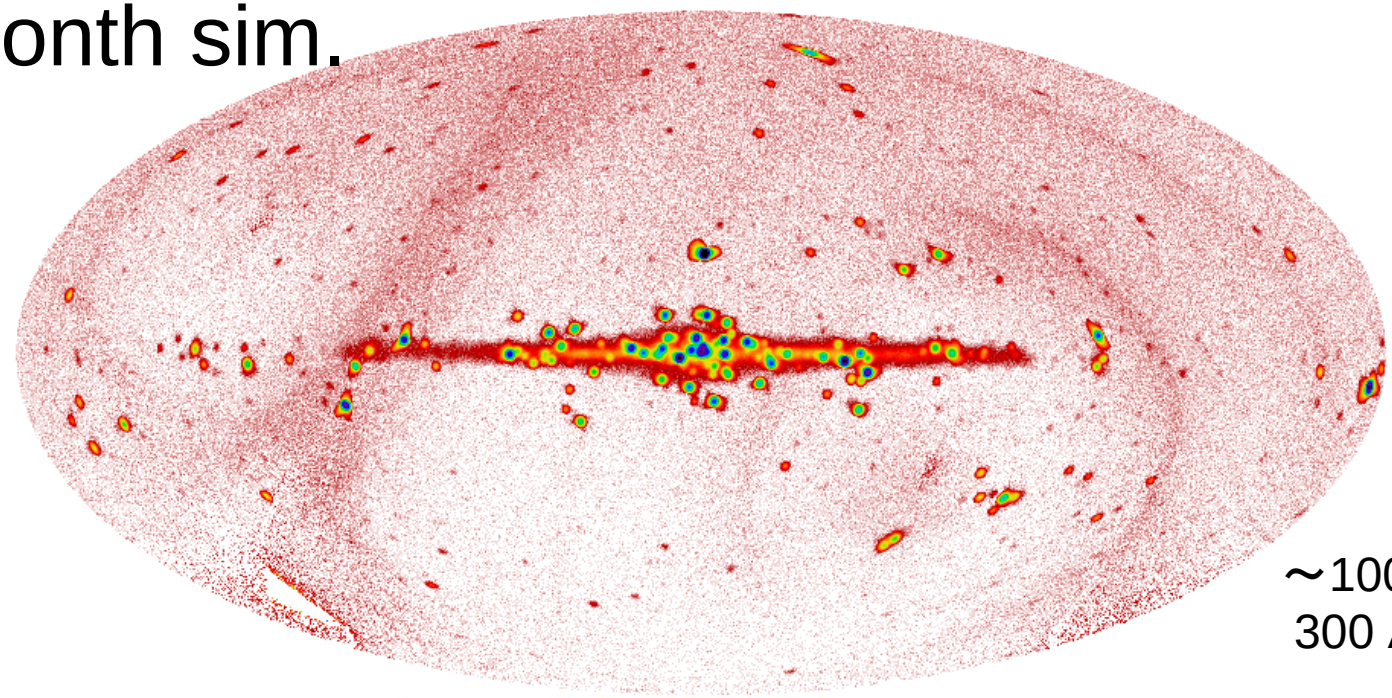
Total number of AGNs by GSC with time.
100 in one week,
1300 in 0.5 year or more (confusion limit).

1 orbit	20 mCrab
1 day	5 mCrab
1 week	2 mCrab
1 month	1 mCrab
2 years	0.2 mCrab (Source Confusion Limit)



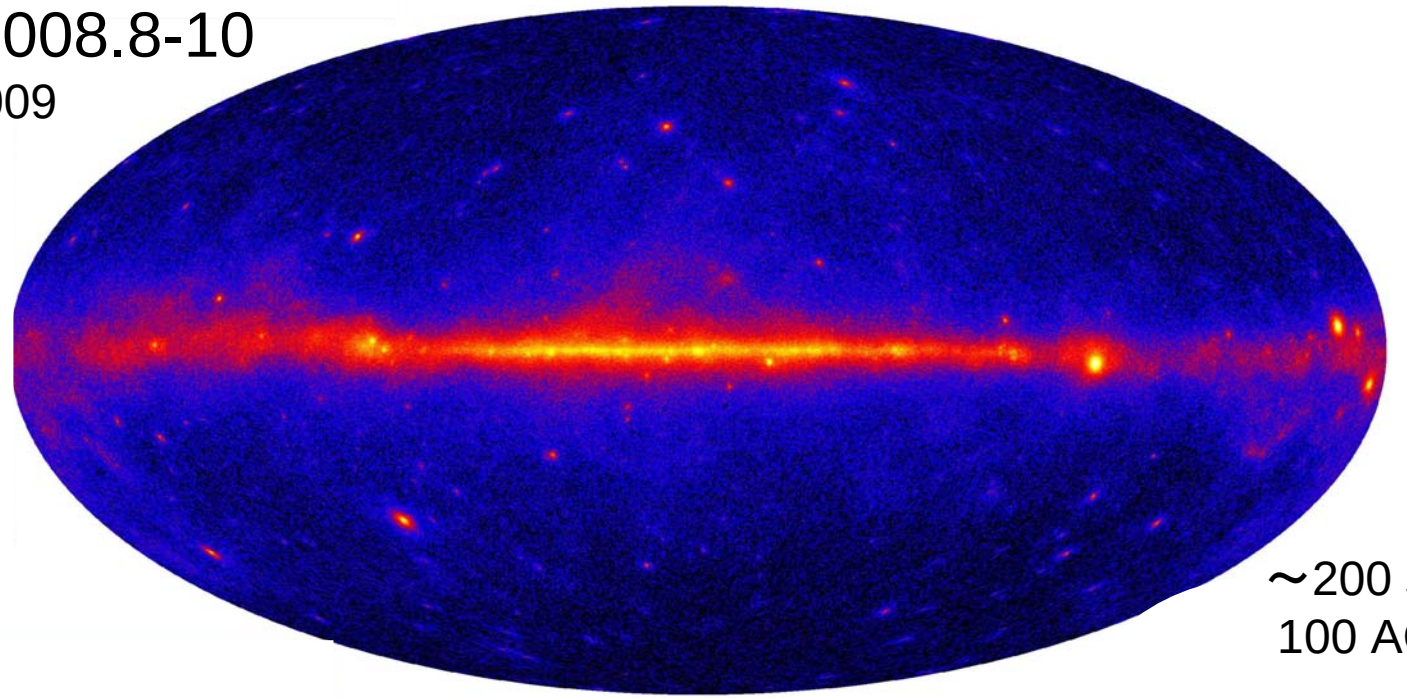
HEAO A-1 equivalent catalog every month!

One month sim.
MAXI



~1000 sources
300 AGN

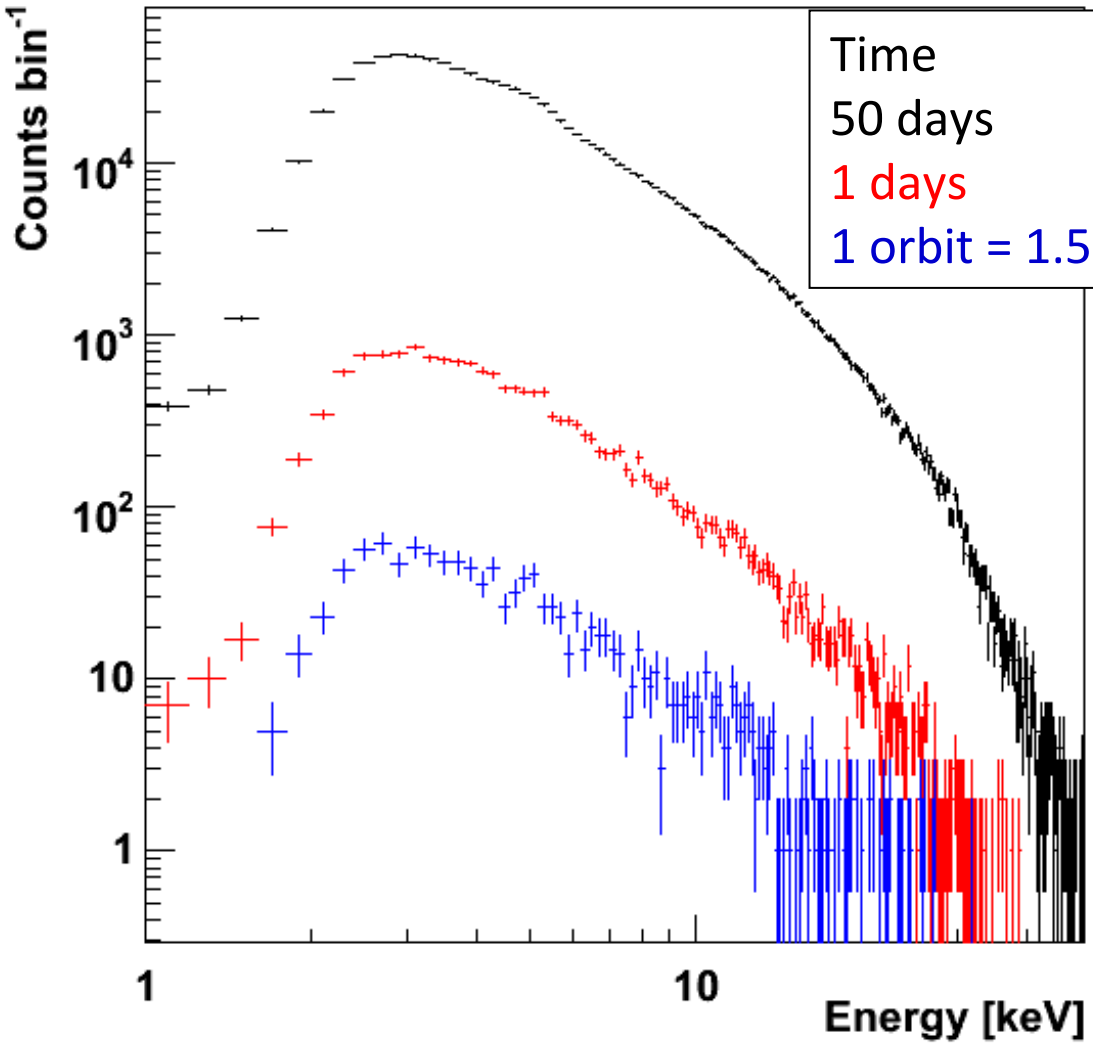
Fermi 2008.8-10
Ohsugi 2009



~200 sources
100 AGN

Energy Spectrum

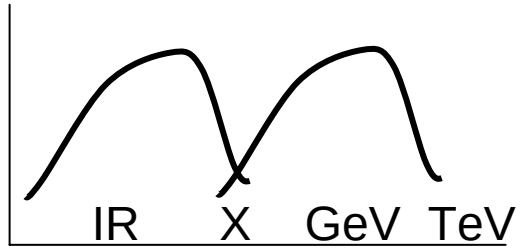
Crab by all 12 GSC counters

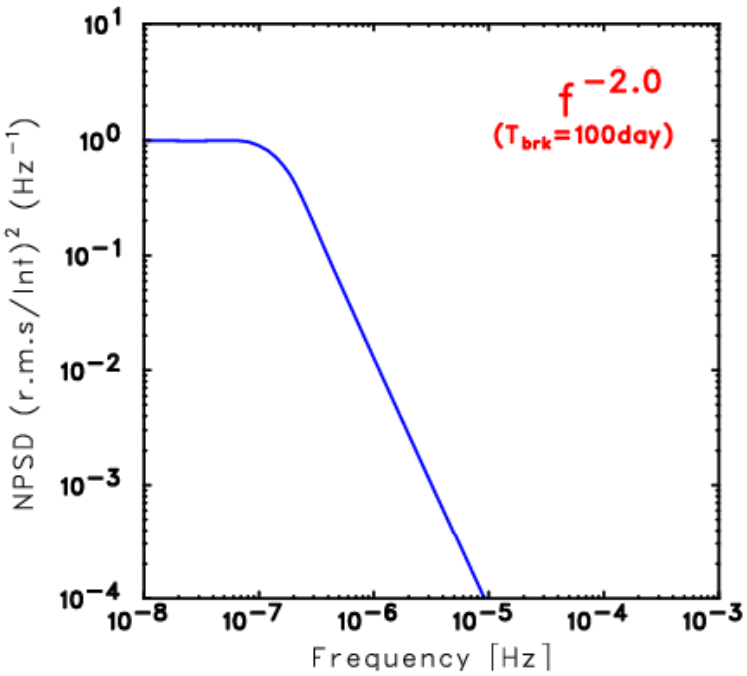


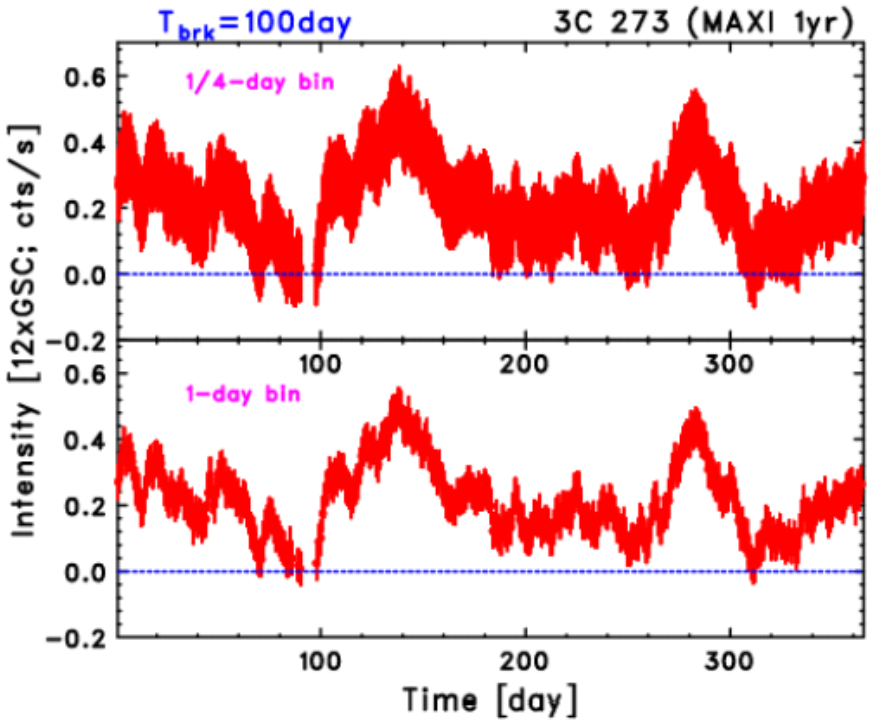
Area for one source
1 counter 7 cm^2
12 counters 84cm^2

Simulation of MAXI-GSC light curve for 3C273

- 5 mCrab variable source
- PSD slope = 2.0, T_{brk} = 100 day
- Xray flux and slope are useful for Blazars







Super massive Binary BHs in AGN

If the mass of BH is 1/50 of OJ 287,

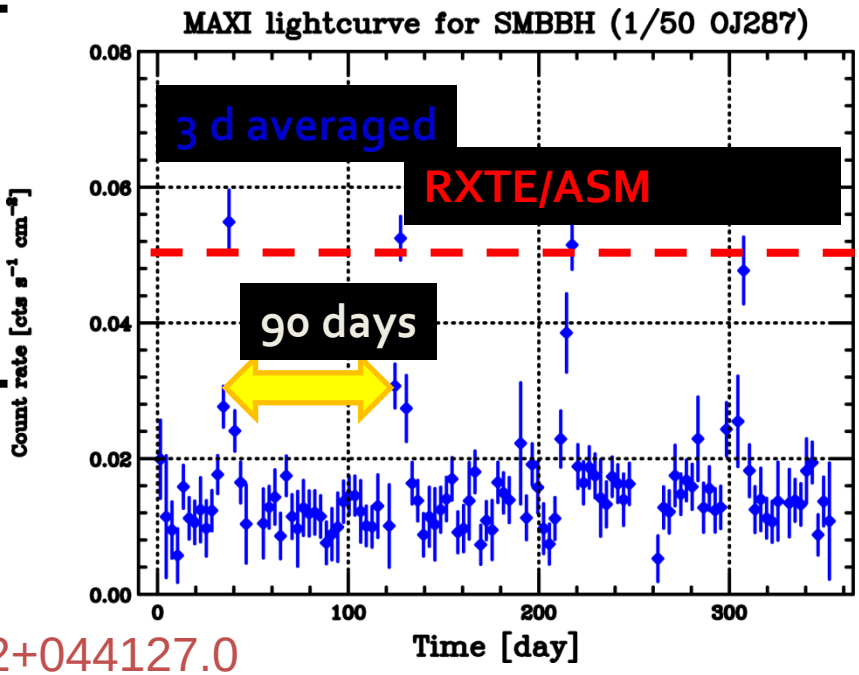
MAXI has a chance to detect the period.

	OJ 287	1/50 OJ 287
$M_1 / M_\odot$	1.8×10^{10}	3.6×10^{8}
Period	12 y	90 days
Active span	～1 y	1 week
Lx increase	5 times	5 times

$$P \propto M\, r^{3/2} (1+q)^{-1/2}$$

Estimated light curve of 1/50 OJ 287, 5 mCrab

(1.1×10^{-10} erg s^{-1} cm^{2} in 2 – 10 keV)

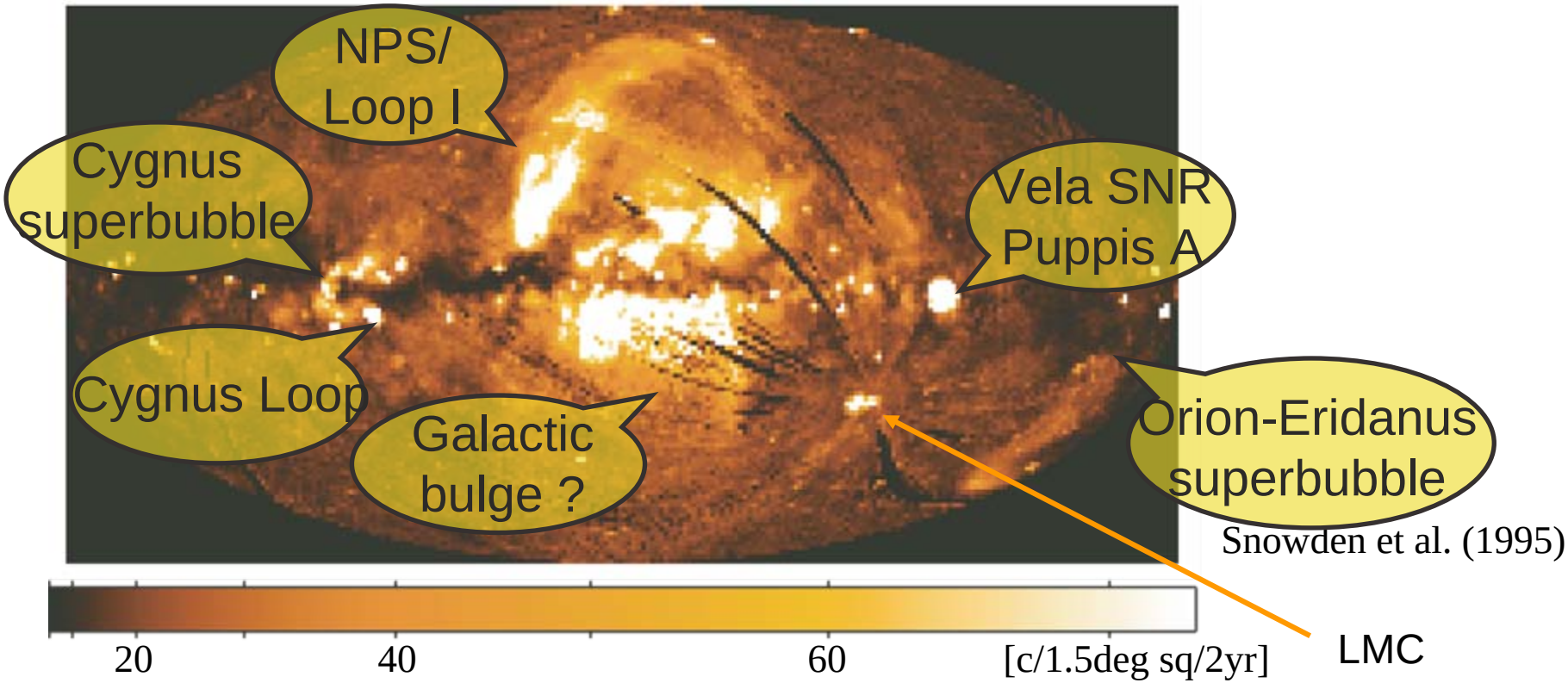


Persistent flux of SDSS QSO, J153636.22+044127.0 is too weak for MAXI. （Nature last week）

Oxygen (OVII+OLyα) Mapping

SSC resolves O lines of all-sky for the first time

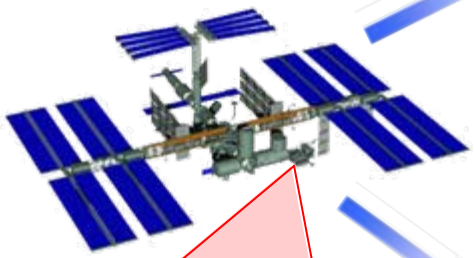
O VII+O Lyα traces warm gas in our galaxy



On-time Nova-Alert Network

Communication Outage
up to 3 hours

Data are stored on
mass storages
until next connection
is established.



White Sands,USA

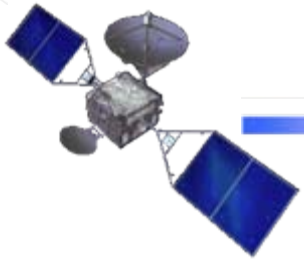
NASA Link

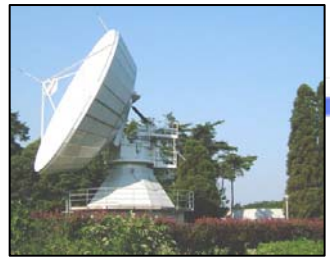
Real Time connection
> 50 % (max. 17 hrs/day)

NASA
MSFC

JAXA Link

~20 % (5 hrs/day)





Tsukuba Space Center

JAXA Tsukuba
Space Center

RIKEN

internet

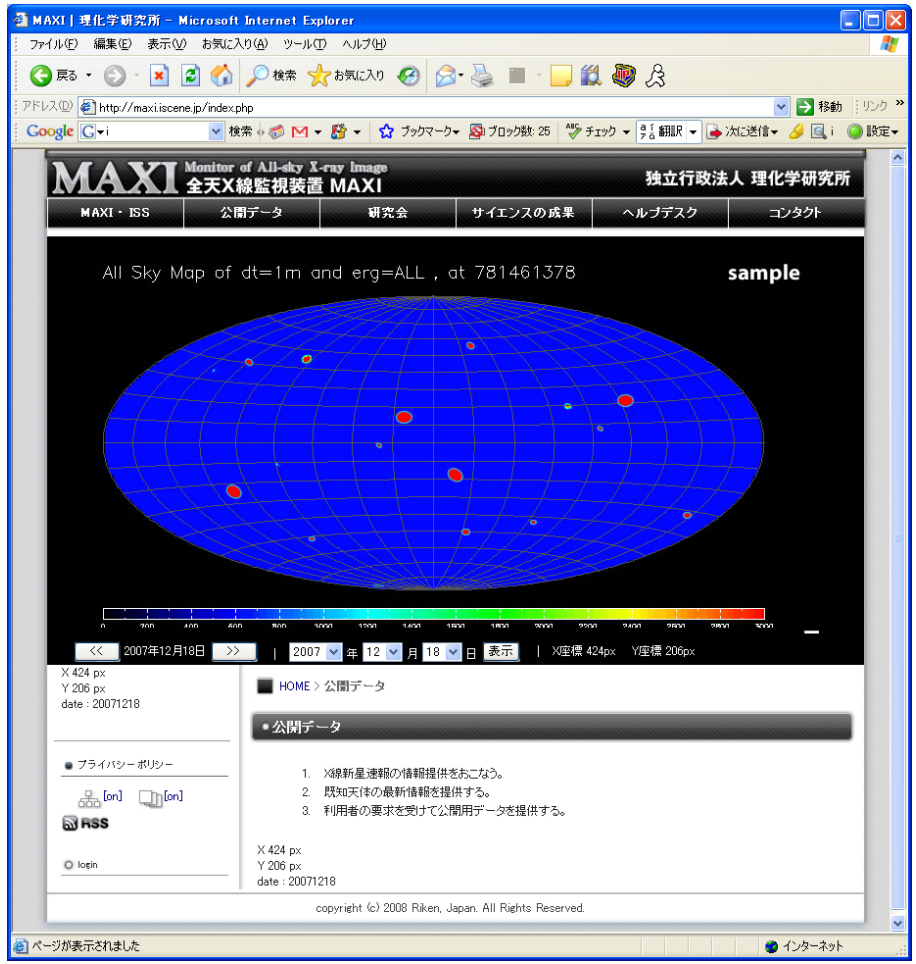
World
Astronomers

a few minutes
or less from
detection

Data Archive and Alerts

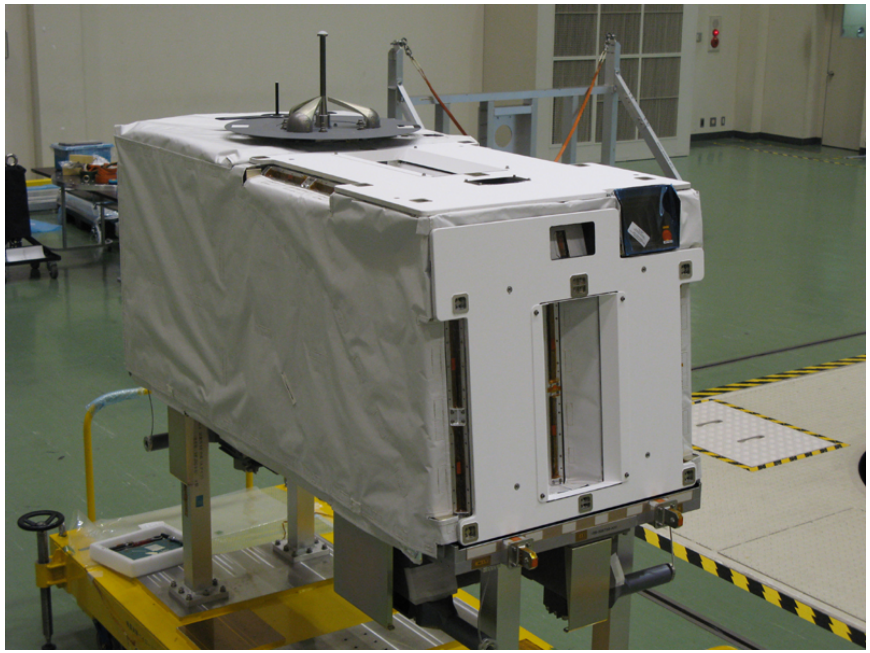
The MAXI team plans to start the data release
3 month after the in-orbit activation of MAXI.

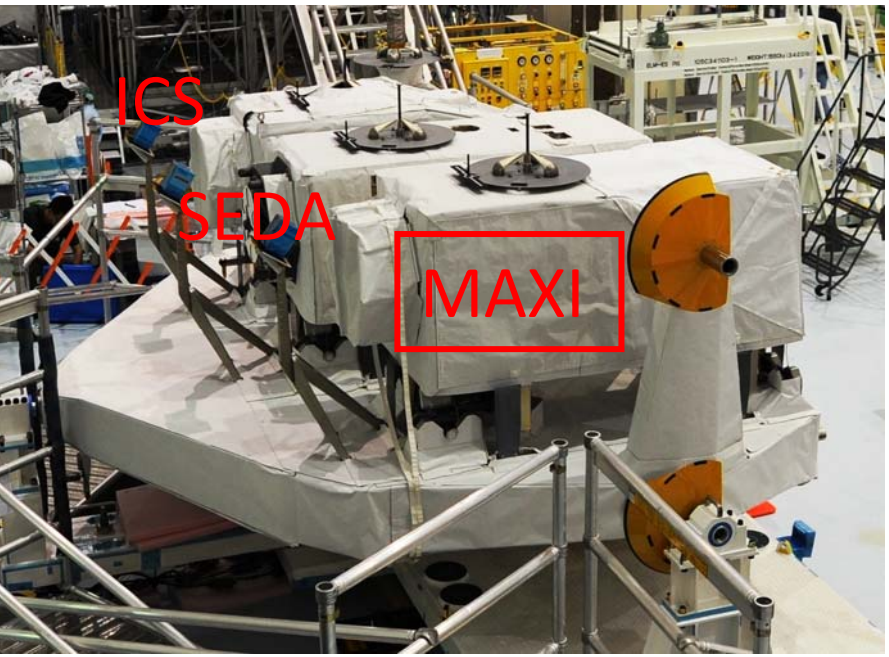
- Nova alerts (after 3months)
  - e-mail (+GCN, …).
- Periodical release (after 3months)
  - **Formatted science data**
    - ~1000 sources pre-selected
    - **light curves** (every day)
    - **Spectra** (week ~ 1 month)
  - **All sky image**
    (daily/weekly/monthly)
- On-demand (after 1 year)
  - specify the coordinates & time
  - for light curve and spectrum



http://maxi.riken.jp/

Schedule



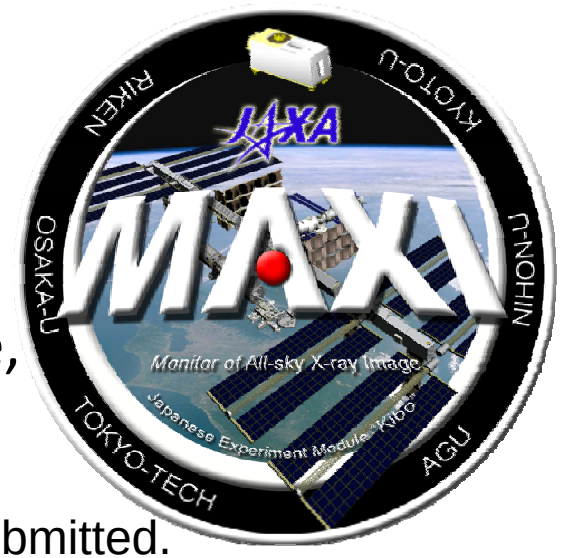


- ✓ 2007/10 Final integration Completed
- ✓ 2008/9 Final pre-flight tests in Japan
- ✓ 2008/10 Transport to KSC
- ✓ 2008/11 Final pre-flight test at KSC
- ✓ 2009/1 Mounted on Exposed Palette
- ➢ ***2009/6 Launch with Space Shuttle***
  - o Initial Phase, In-orbit calibrations
  - o L+3 months Start releasing pre-defined data of light curves and energy spectra.
  - o L+1 year Start releasing on-demand data

Current ISS Configuration

Summary

- MAXI is the first astronomical mission carried on ISS to monitor all-sky X-ray image.
- All the hardware is ready to be launched in June 2009 by Space Shuttle, Endeavour.
- Simulations, data processing, and response builder are been developed.
- After the operation on ISS starts,
  - Distribution of Nova alerts will start
  - Regular science products of pre-selected source will be open to public.
  - All on-demand data will be archived.
- Please check the latest news on our web site, http://maxi.riken.jp/



Matsuoka 2009 PASJ submitted. Sugizaki 2009 IEEE submitted.