Development of the MAXI alert system and the photon event database

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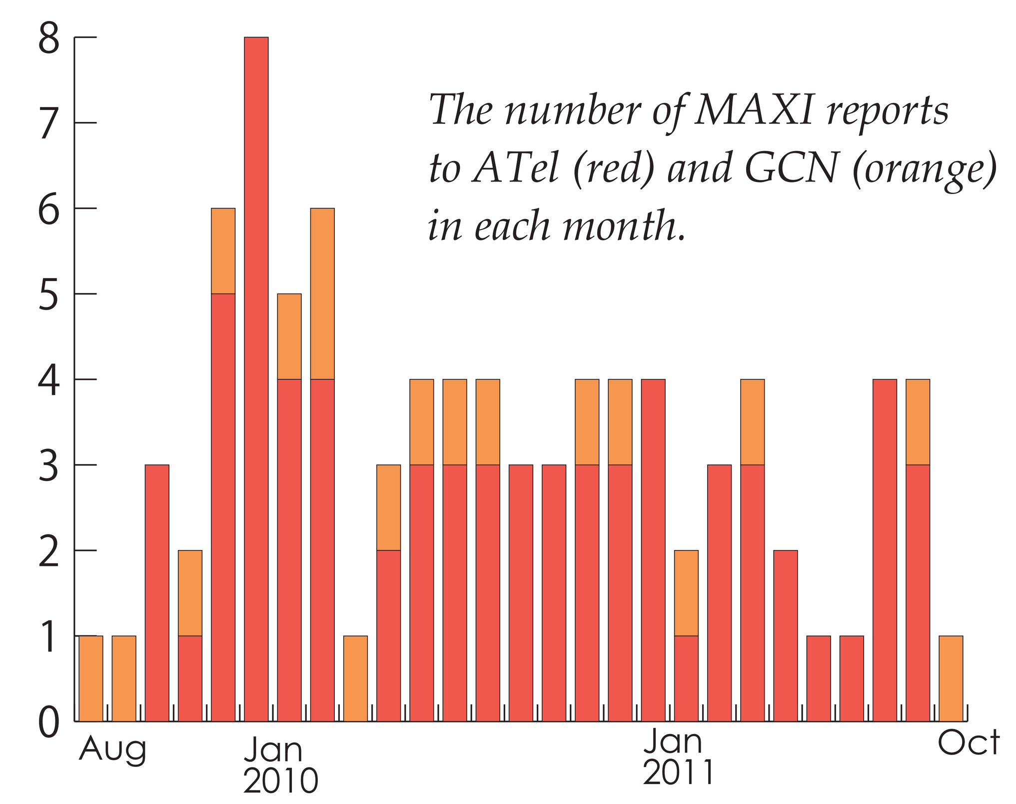
MAXI, Monitor of All-sky X-ray Image, is an all-sky X-ray monitor on the ISS. MAXI has provided prompt alert information on transient phenomena in X-rays through our mailing lists, the Astronomer's Telegram, and the Gamma-ray Coordinates Network. We present here recent development on the MAXI nova alert system and the related photon event database.

About MAXI..

MAXI is the first payload attached on the Japanese Experiment Module, Kibo, Exposed Facility. MAXI has continuously observed the X-ray sky since August 15, 2009. One of the main objectives of MAXI is to discover transient phenomena and new transients, e.g., X-ray novae and GRBs.

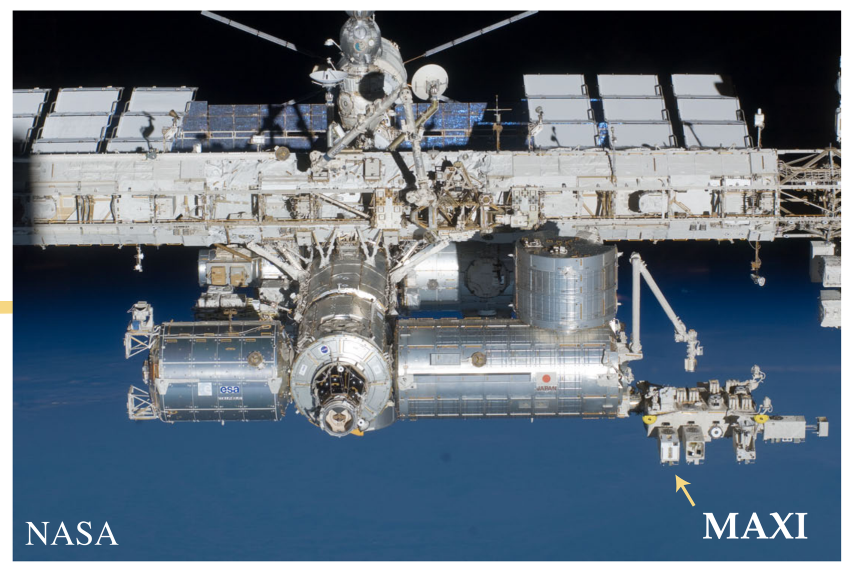
The MAXI nova alert system automatically detected a number of sources (right table, from Suwa et al. 2011). We reported some of them to our mailing lists, ATel, GCN (see the below graph.). [*Please visit http://maxi.riken.jp]*

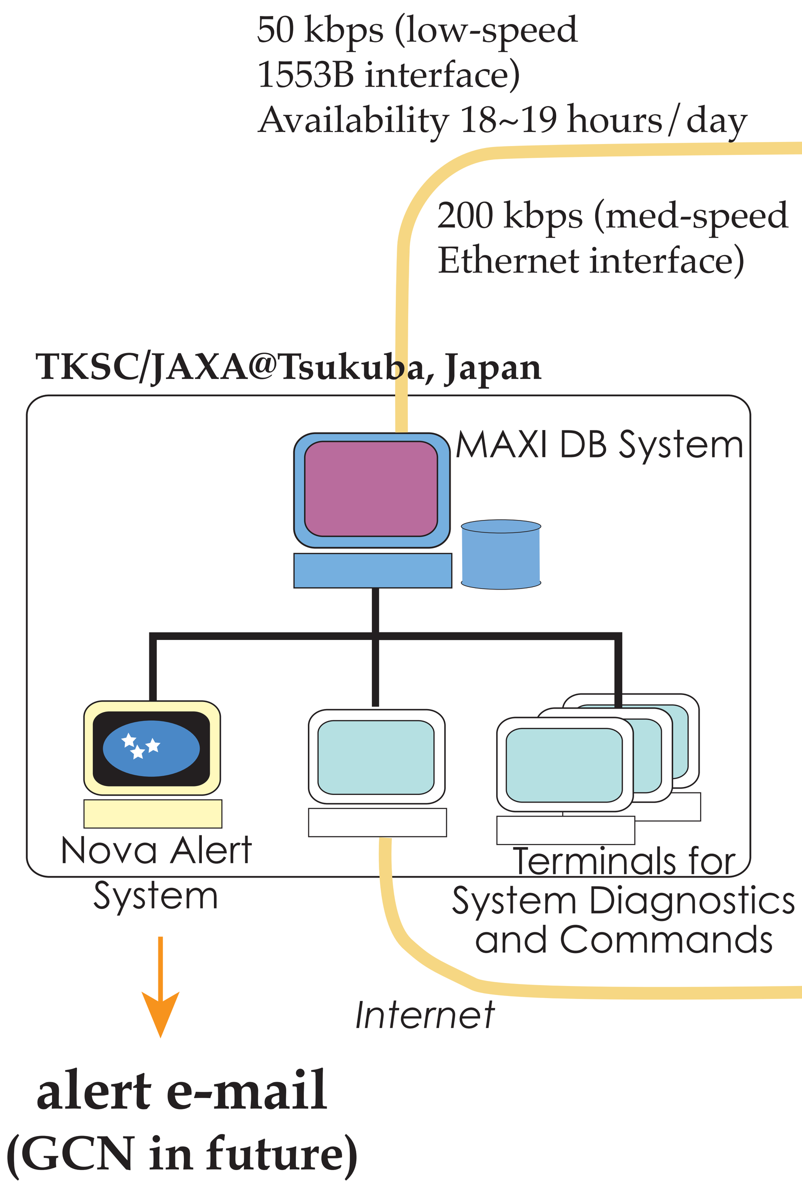


Source	#of Detections	Source	#
SMC X-1	7	4U 1630-472*	4
4U 0114+65	2	H 1636-536	1
Algol*	1	Her X-1	12
HR 1099*	2	MAXI J1659-152*	2
X Per	4	GX 339-4	3
LS V +44 17*	2	XTE J1709-267	1
4U 0513-40	1	RXS J172525.5	1
LMC X-4	5	SWIFT J1729.9-3437	1
A 0535+262**	5	Rapid/Slow Burster	13
H 0614+091	1	GX1+4	1
Vela X-1	25	H1743-322**	2
1H 0918-548	2	NGC6440*	1
GRO J1008-57*	2	4U 1746-37	1
Mrk 421**	2	GRS 1747-312	1
Cen X-3	1	XTE J1752-223*	1
GT Mus*	1	3A 1812-121	1
H 1145-619	1	GS 1826-238	10
4U 1210-64	1	XB 1832-330	1
EX Hya	1	RX J1832-33	1
GX 304-1**	4	AX J1841.0-0536*	1
4U 1323-619	1	4U 1850-086	2
SAX J1324.5-631	1	HETE J1900.1-2455	4
MAXI J1409-619*	1	Aql X-1	8
2S 1417-624	1	4U 1916-053	1
Cir X-1**	7	EXO 2030+375	3
4U 1538-52	2	4U 2206+543	1
4U 1543-624	1	II Peg	2
H 1608-522*	1	Short X-ray transient	7
H 1624-490	3	XRF	3
H 1627-673	1	GRB	3

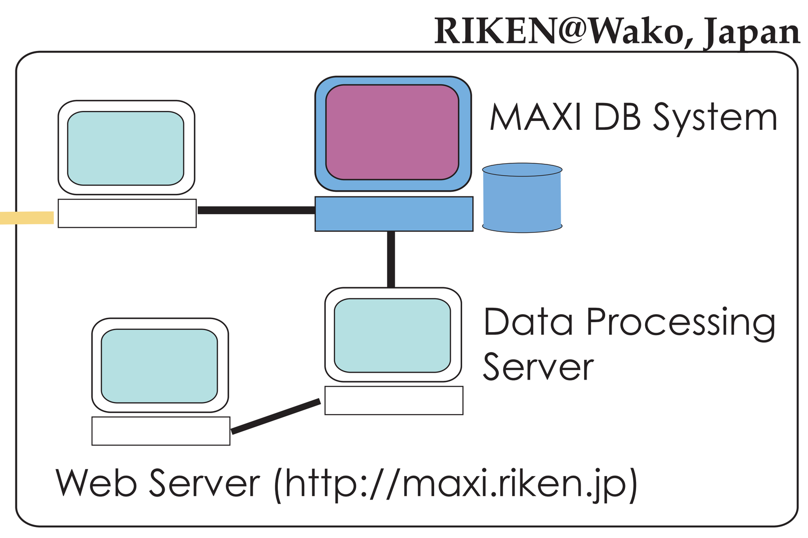
* reported to ATel.

Data Flow & Systems



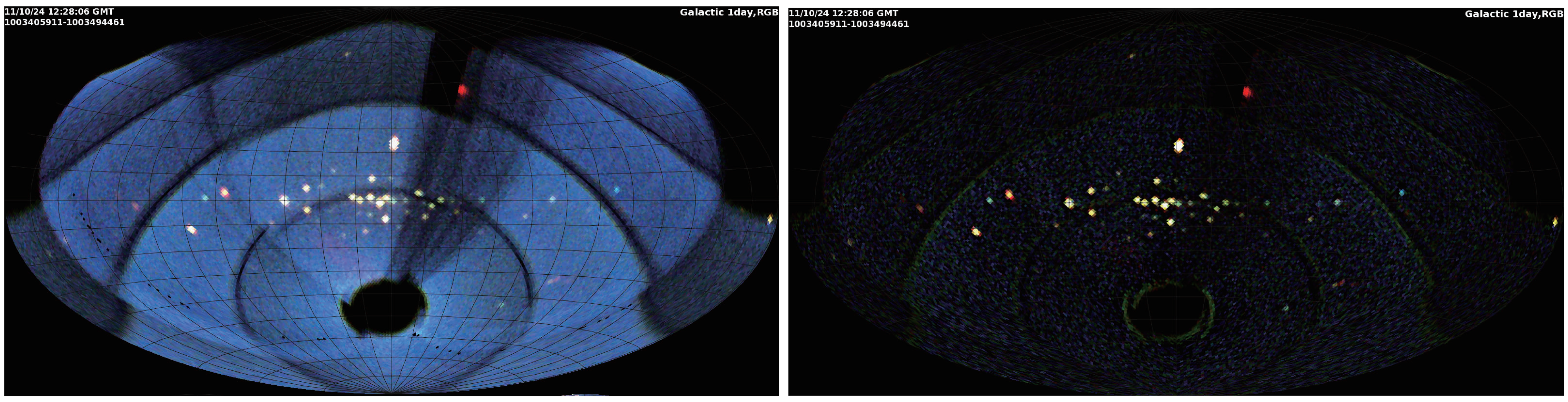


All the data from MAXI/ISS are stored into the MAXI DB system at TKSC. Simultaneously, the data are sent to the Nova Alert system to find transient, or time variable sources. The data are also sent to RIKEN.

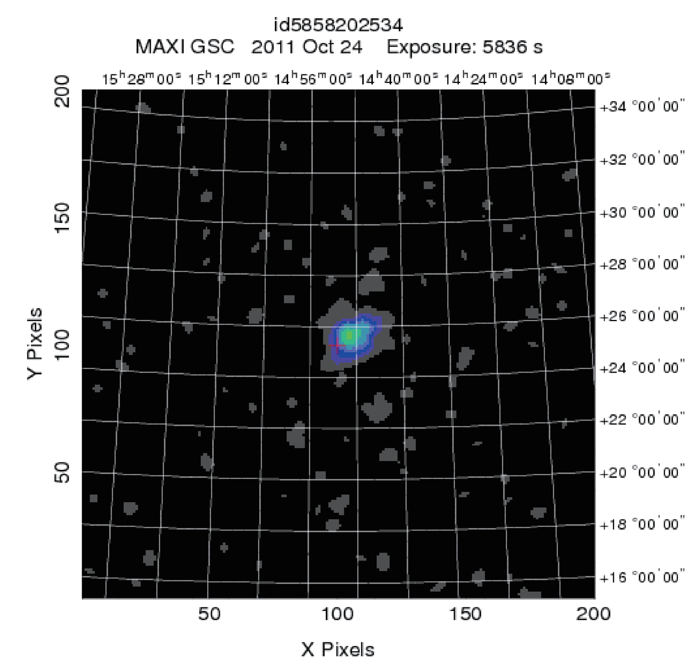


MAXI Nova Alert System

Realtime background subtraction in addition to effective area correction in data processing of the MAXI alert system enables us to detect fainter objects with flux down to 10-15 mCrab a day, and reduces the number of fake events due to the background variations significantly. We then starts to send a prompt E-mail alert automatically to our mailing list members since this July.



(left) A raw false-color X-ray image obtained with MAXI/GSC in a day. (right) Its background subtracted image. The background level is estimated and subtracted every second from the current and past data. We are still trying to subtract bg more perfectly.



The first event, GRB 111024A (GCN #12489), of which burst information was automatically sent to the world in a few minutes after downloading data.

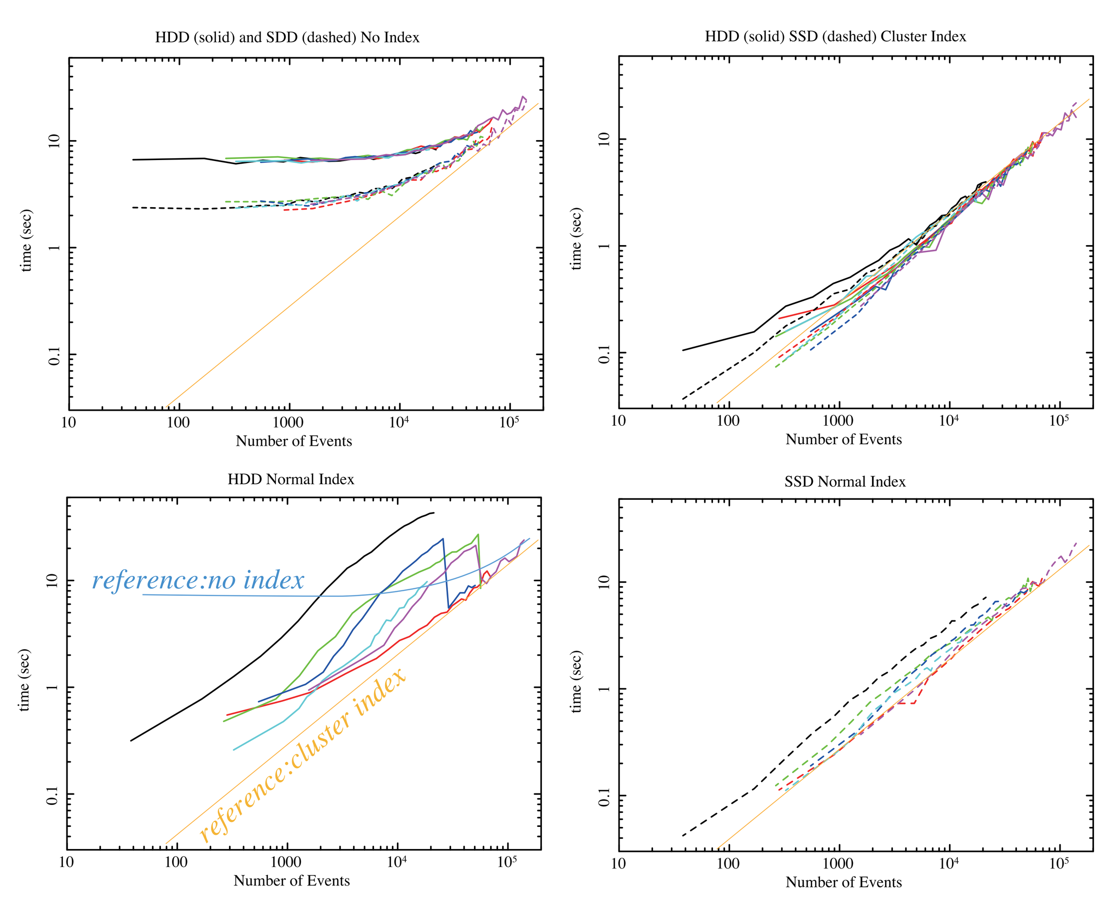
Photon Event Database

Another progress of our system is about the photon-event database. Currently a large number of X-ray events, about more than 1e10 events, are accumulated in our PostgreSQL database. The access time is limited by the seek/search time of the hard disks (RAID drives), a few msec per event on average. As a result, it takes much time to obtain a large number of events from the database. We are investigating much faster access using SSD RAID. We have found that the access time with the SSD RAID is faster than the hard-disk RAID by 10-100 times, as expected, which is compatible to the time for the cluster index table.

BASE System
Power Master server S8804
Xeon X5680 (3.33 GHz, 6 cores) x2, 48 GB memory

SSD RAID
*SUPER*TALENT, RGS0512M (RAID 0)*
Sequential read (by hdparm) 830 MB/s
(from the White Paper, by IO Meter)
IOPS 84,600 (seqential 4 kB)
26,700 (random 4 kB)

HDD RAID
SATA 3.0 Gb/s, 2TB, 7200rpm (8.2 ms),
32 MB cache x 4 (RAID 5)
Sequential read (by hdparm) 405 MB/s



We measure the elapsed times to obtain various numbers of events around some sources from a MAXI/GSC database, in which no index, a normal index or a cluster index is applied to (ra, dec) columns of the same X-ray event table. As shown in the left panels, the SSD shows much faster data access for the non-index table, which is due to the fast sequential data access of the SSD. Fast random access of the SSD is also obvious in the normal index table (lower-right panel). More quantitative discussion will be described in the proceedings.

References:
Matsuoka et al. 2008, PASJ, 61, 999)
Negoro et al., 2010, ADASS XIX, ASP Conf. Ser. 434, 127, [O07.2]