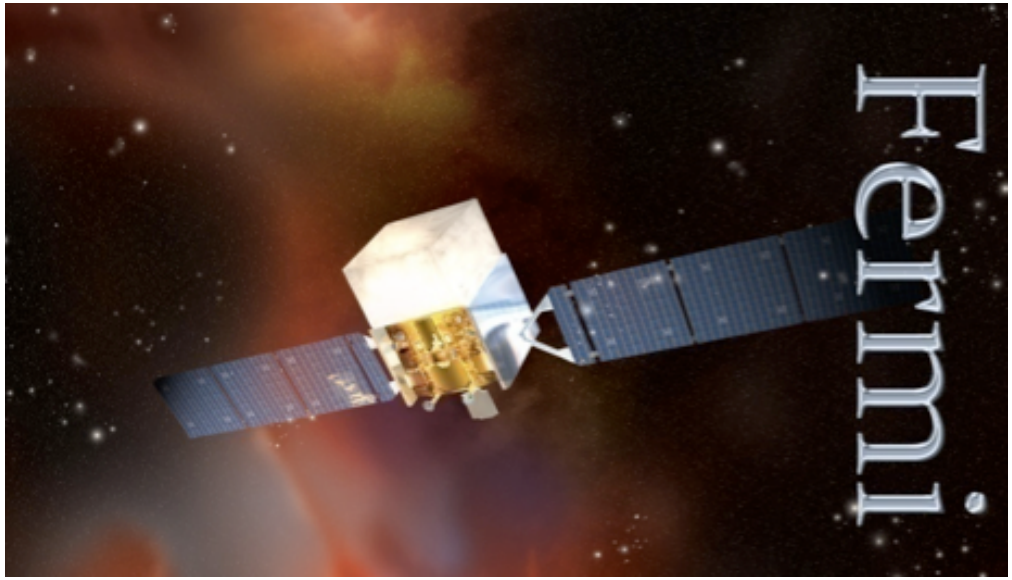
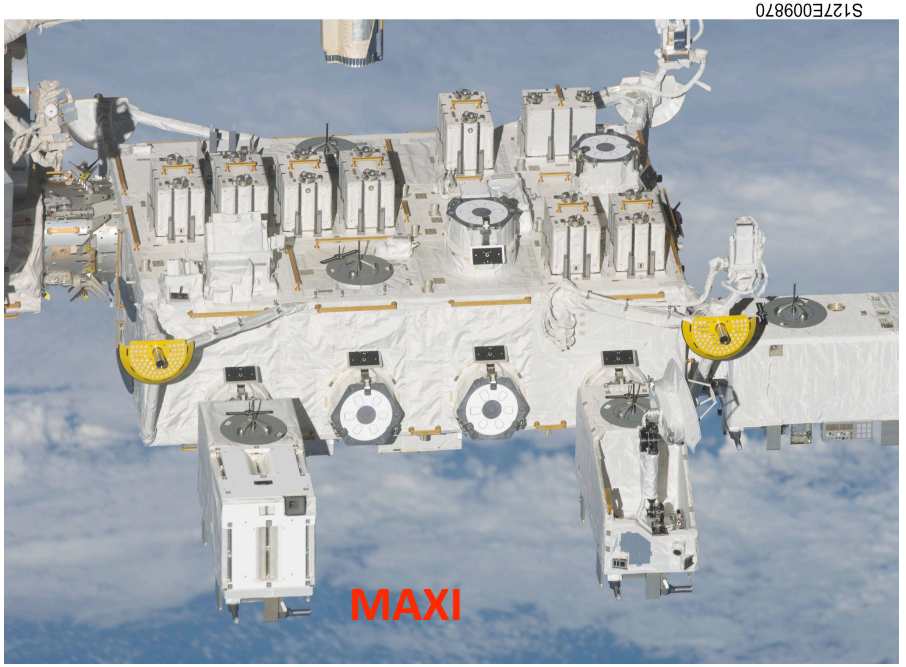
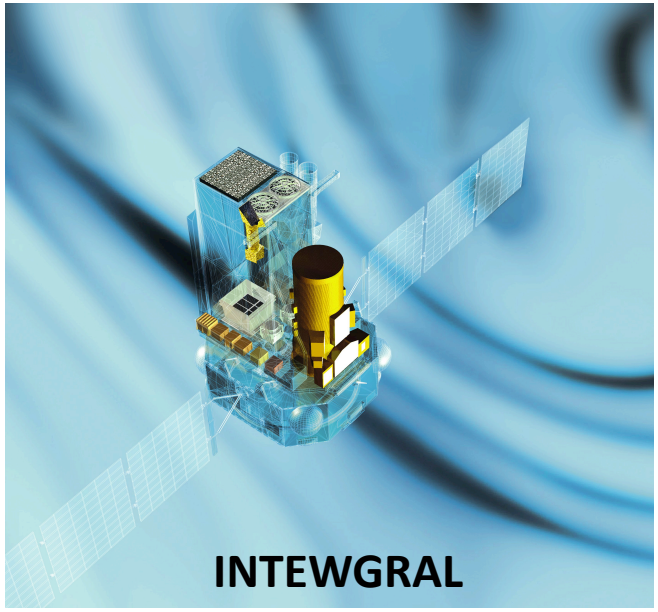
X-ray / Gamma-ray Astrophysics (*private press*)

Should be very biased

Atsu Yoshida

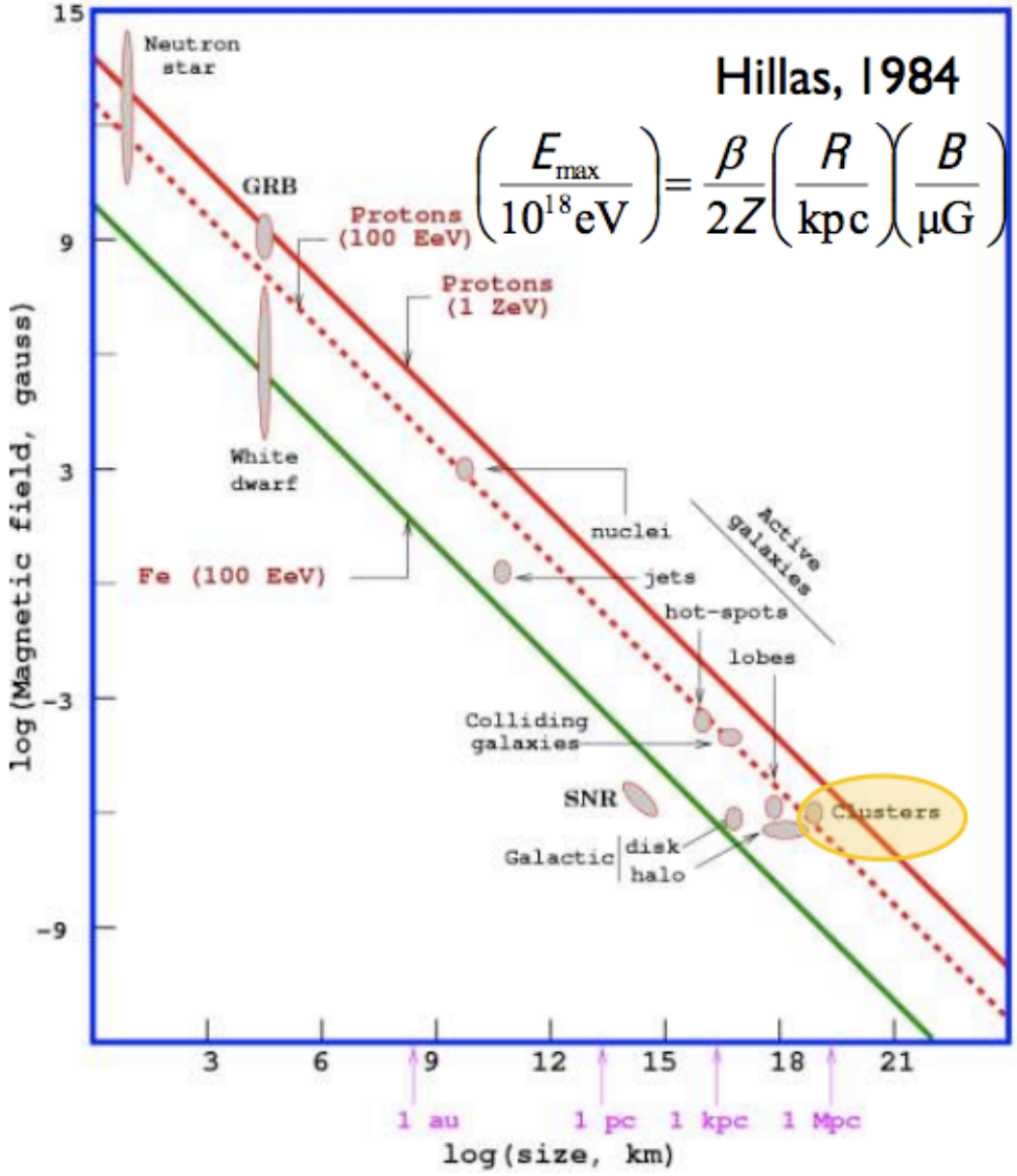






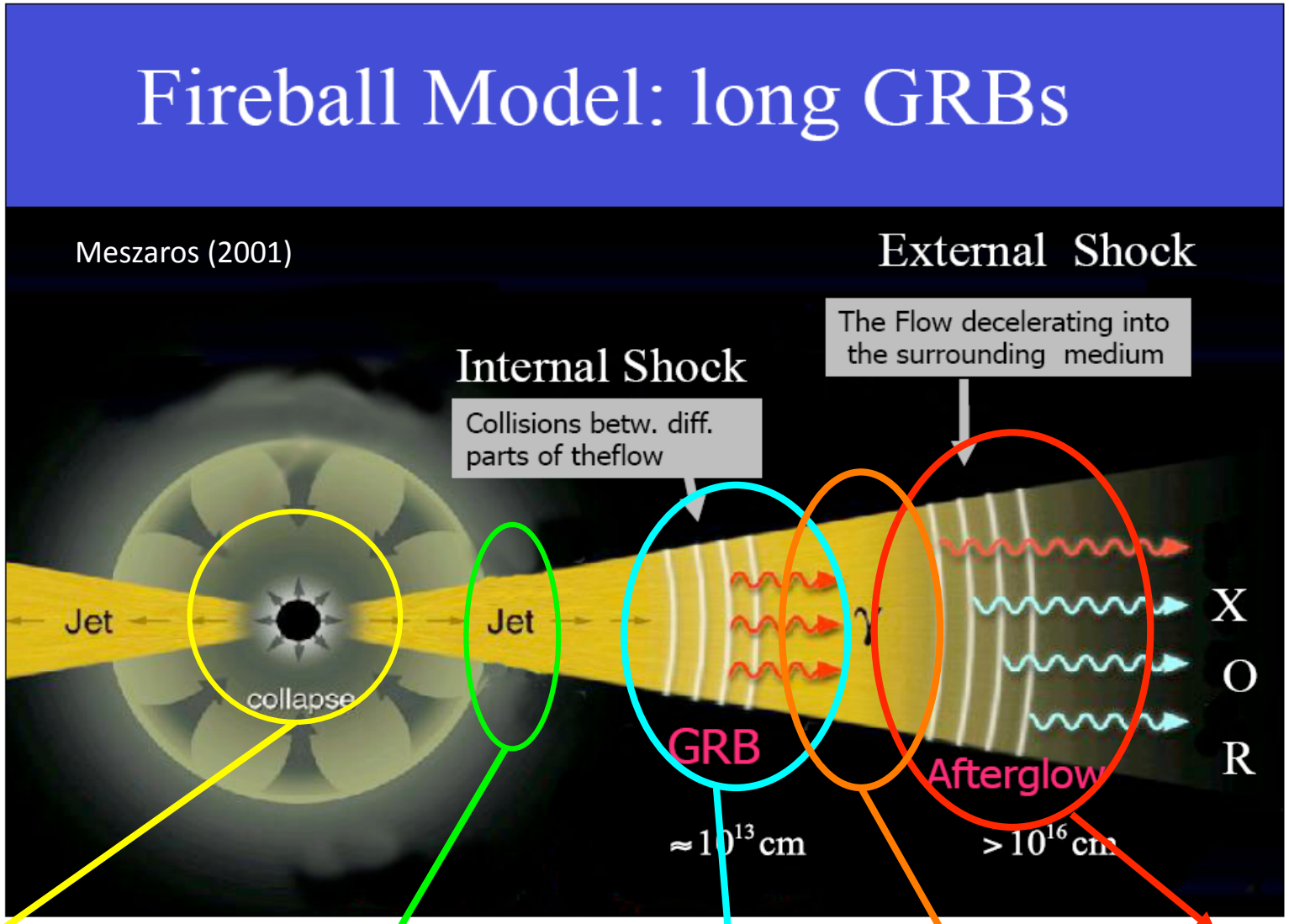
Survey observations

Possible Origin of UHECR?



- GRBs?
- Galaxy cluster?
  - Most of clusters are dark in gamma-ray compared with X-rays.
- Radio Quiet AGN?

Fireball Model: long GRBs



MeV neutrinos at collapse (e.g. Halzen & Jaczko 1998)

TeV neutrinos from inside the star (Meszaros & Waxman 2001) (Razzaque et al. 2003)

PeV neutrinos from internal shocks (Waxman & Bahcall 1997) (Asano & Nagataki 2006) (KM & Nagataki 2006) (Gupta & Zhang 2006)

PeV-EeV neutrinos from flares (KM &Nagataki 2006)

EeV neutrinos from external shocks (Waxman & Bahcall 2000) (Dermer 2001)

Is merging galaxy cluster possible?

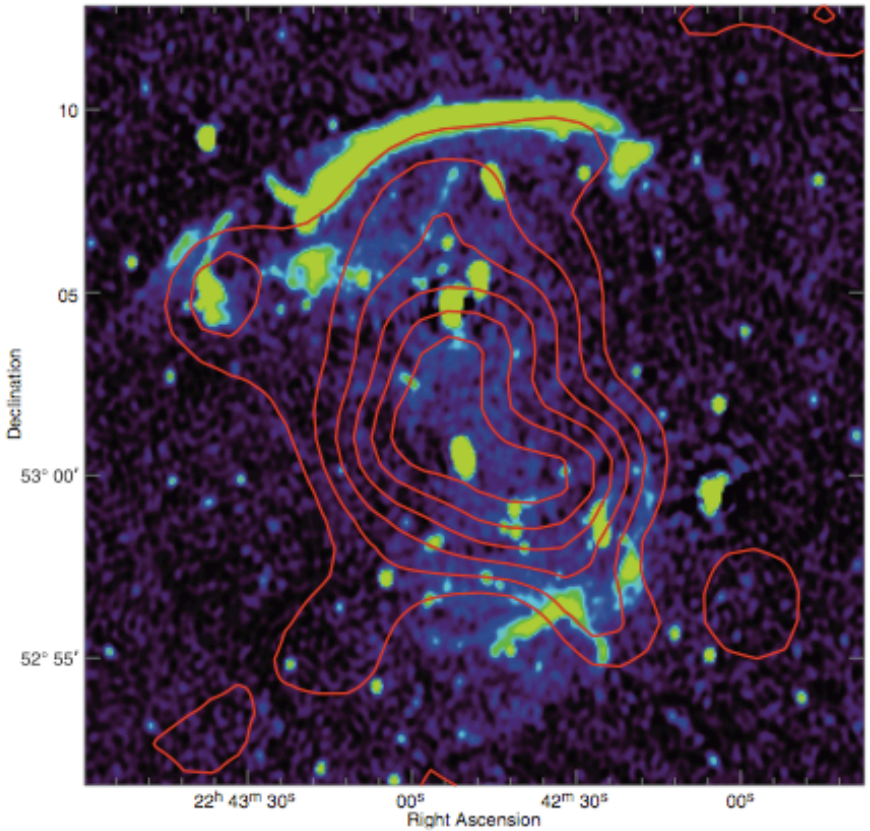


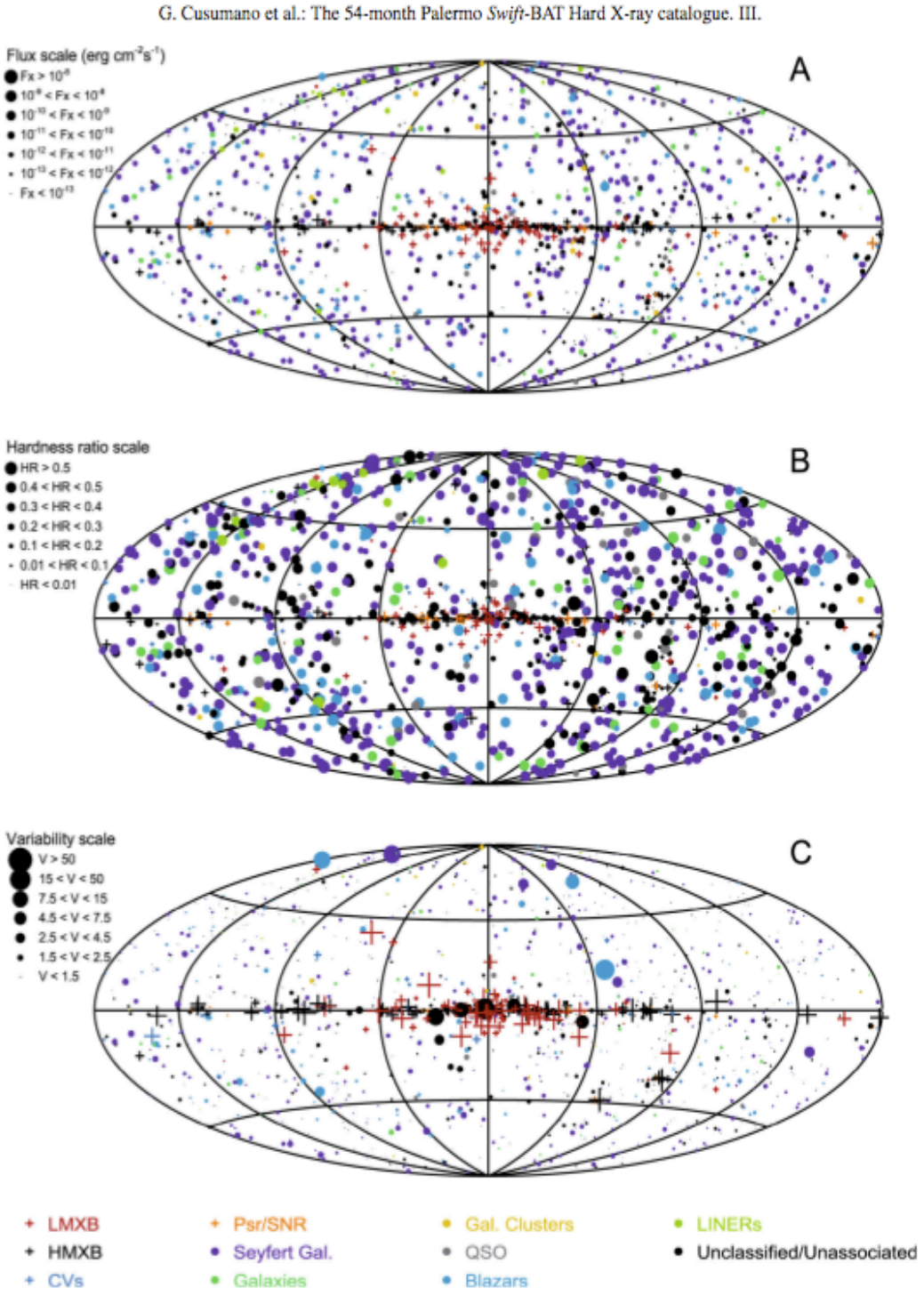
Fig. 1. WSRT radio image at 1.4 GHz. The image has a resolution of 16.5 arc sec × 12.9 arc sec and the root-mean-square (RMS) noise is 19 μJy beam^{-1}. Colors represent intensity of radio emission; red contours (linearly spaced) represent the x-ray emission from ROSAT showing the hot ICM.

van Weeren+
Science 330, 347 (2010)

Swift-BAT catalogue

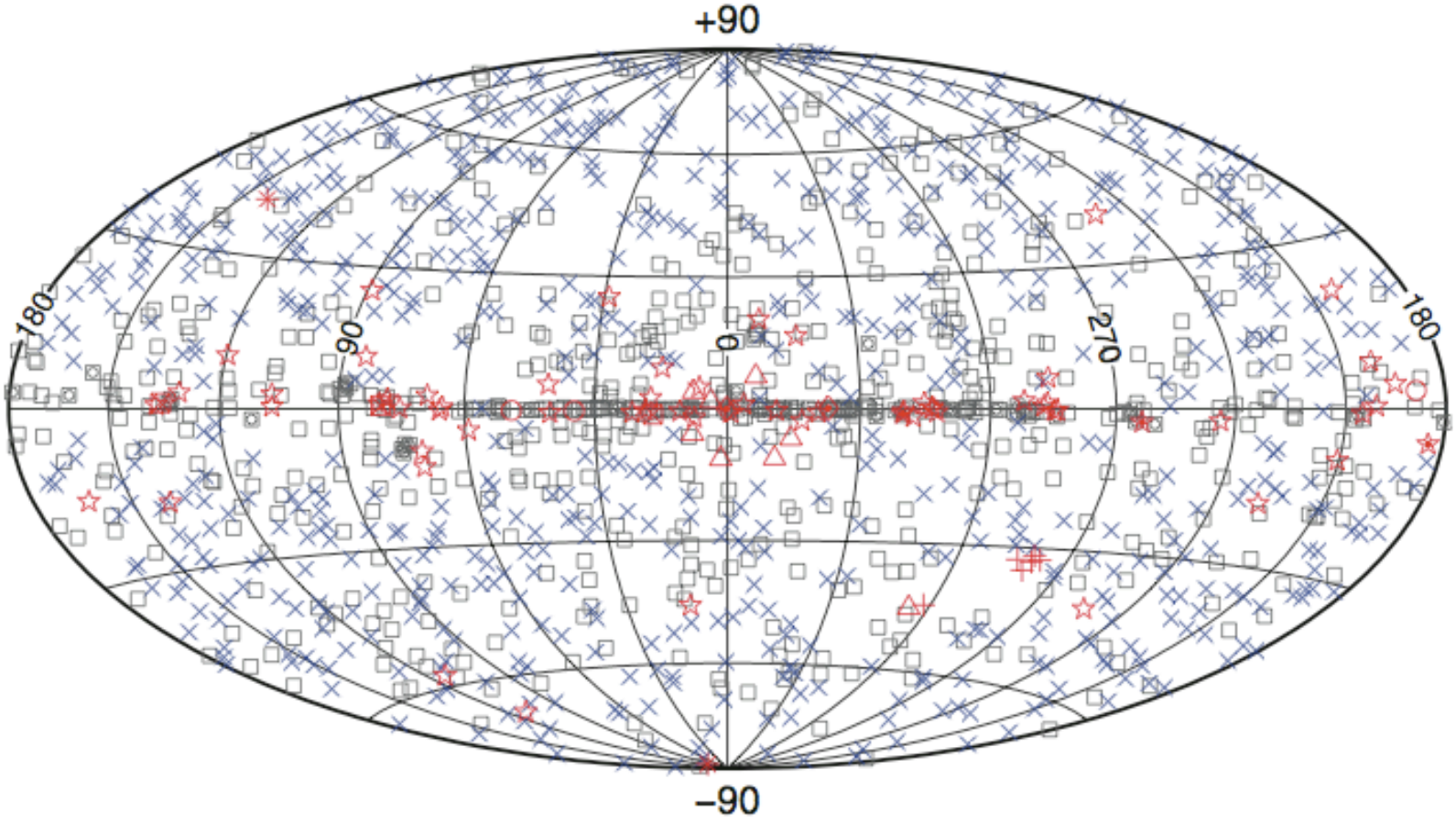
15-150keV

54months



Fermi LAT 1st Yr Catalogue

100MeV–100GeV



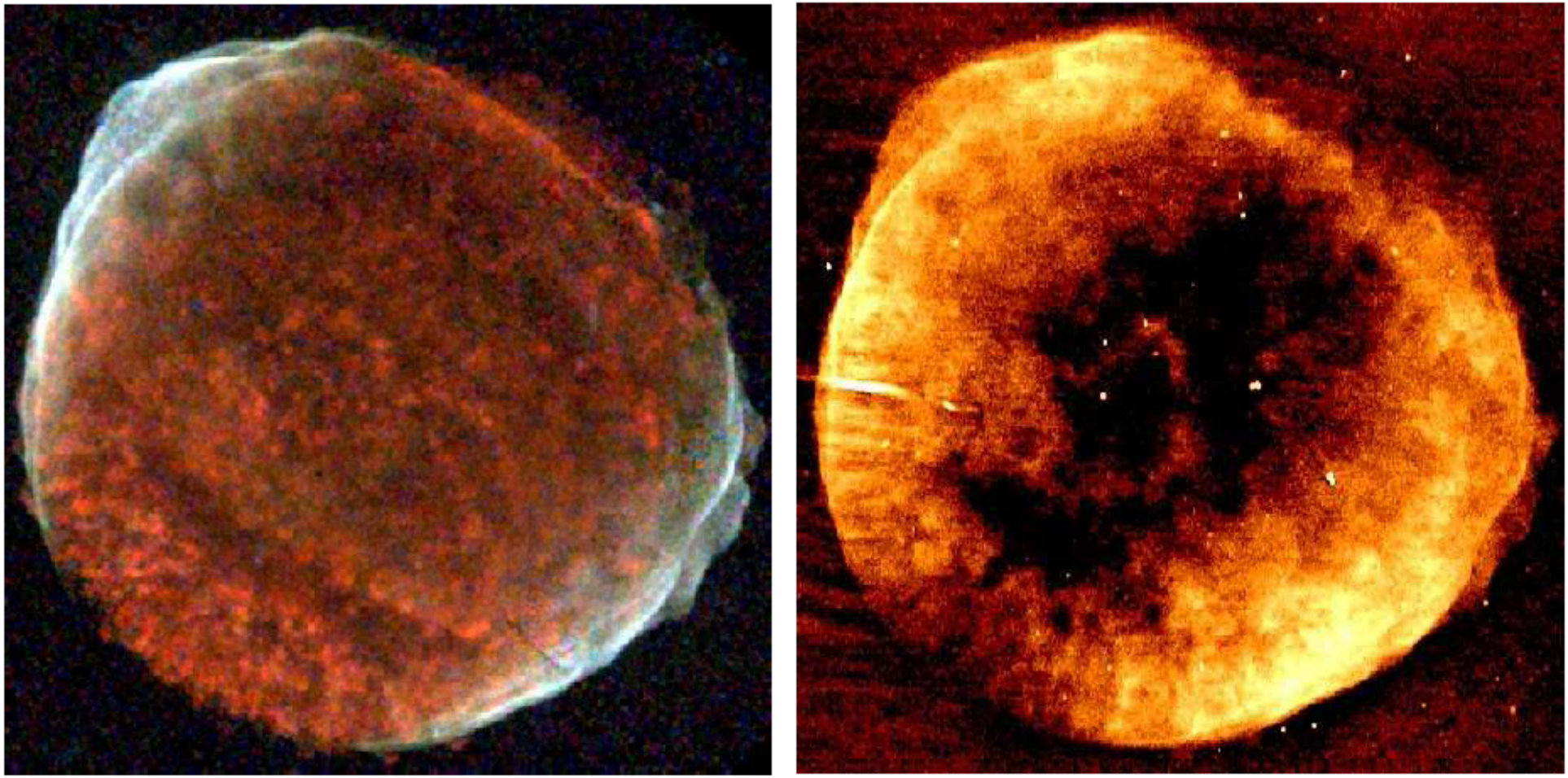
SNR

Synch. rad. of accelerated e^- at SN 1006

Direct evidence for electron acceleration up to ~10TeV.

Synch. X-rays (blue)
(tracing ~10TeV e^-)

1.5GHz radio
(tracing ~GeV e^-)



Cassam-Chenai et al.('08)

TeV gamma-rays from young SNRs

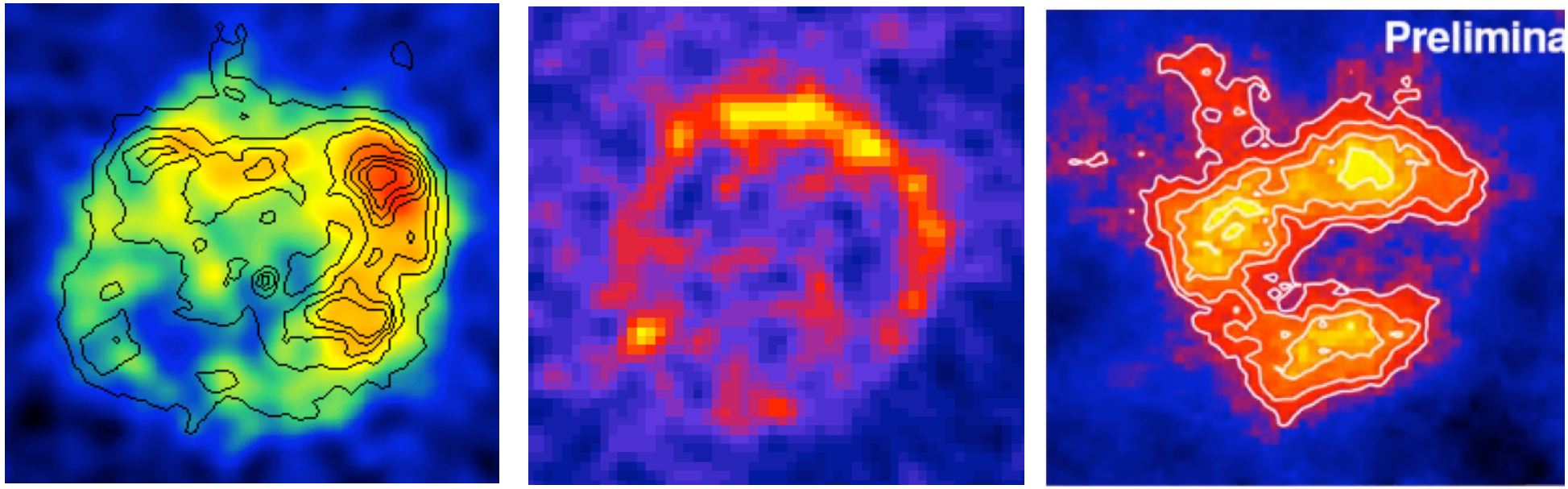
TeV γ-rays detected by H.E.S.S.

TeV's from shock waves of young SNRs

--- Direct evidence for 10-100TeV electrons and/or protons !!

BUT, we don't know whether the TeV emission is hadronic or letonic.

RX J1713.7-3946 RX J0852.0-4622 RCW 86

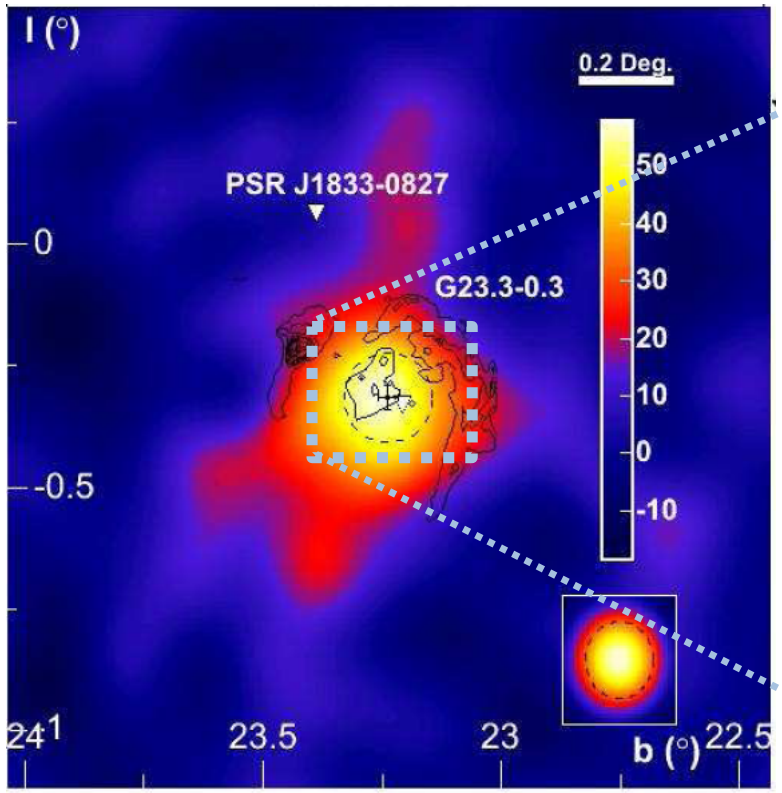


H.E.S.S.

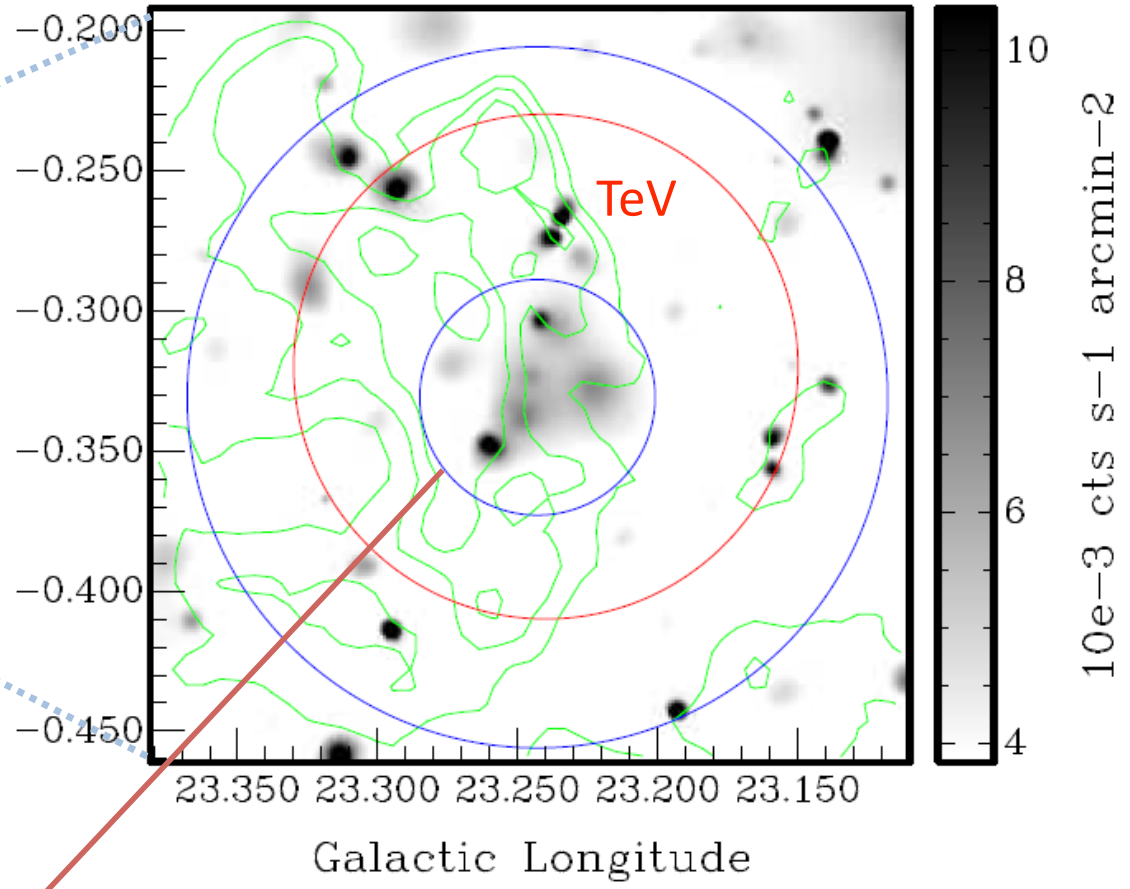
HESS J1834-087

Old SNR (8×10^4yr), G23.3-0.3 (W41) interacting with ^{13}CO and HI cloud (~4 kpc).

TeV image (HESS)



1.5-7keV image (Tian et al.'07)



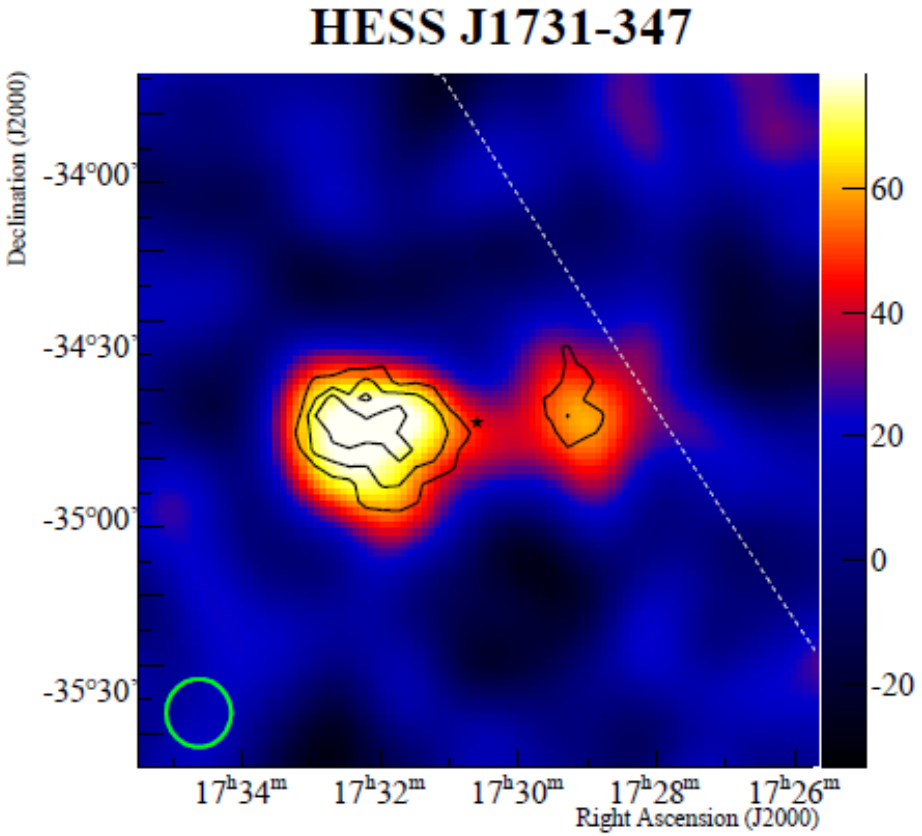
Diffuse X-rays

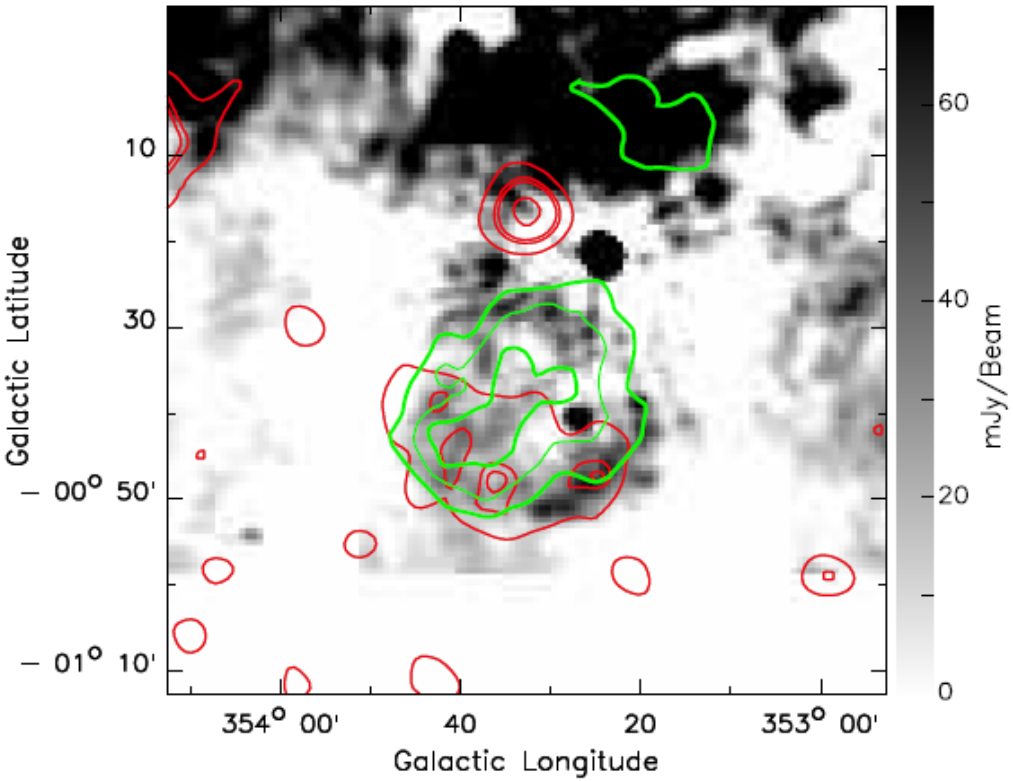
Green contour: ^{13}CO

HESS J1731-347

Associated with old SNR, G353.6-0.7, with t_{age}~27000yrs (~3.2kpc).

Grey scale: 1.42GHz (synch.)
Red: ROSAT X-rays (thermal?)
Green: HESS TeV's

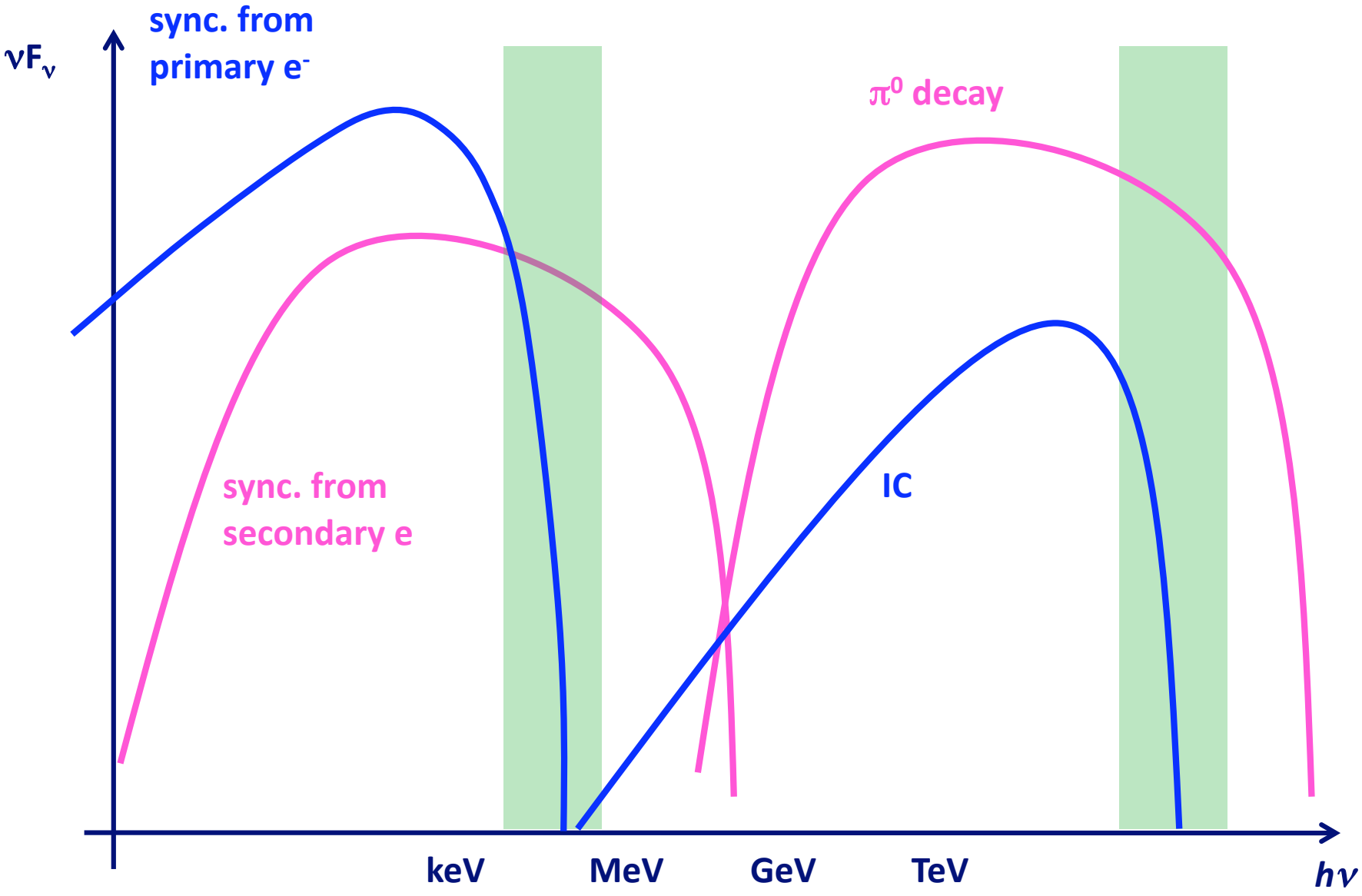




HESS

Tian et al. (2008)

Expected spectrum of old SNRs



(X-ray) Dark SNR = Dark Accelerator

Old supernova remnants (SNRs) can accelerate protons with 10-100 TeV, while E_{max} of electrons is < 0.1TeV that do not produce TeV-γ's.

Old SNRs may be possible origin of TeV unID sources with large $F_{TeV}/F_{X\text{-}ray}$, which radiate π^0-decay TeV-γ's and secondary synchrotron X-rays.

=> evidence for proton acceleration.

Possible candidates (Tian+07,08):

HESS J1834-087: SNR, W41(~8×10^4yrs)

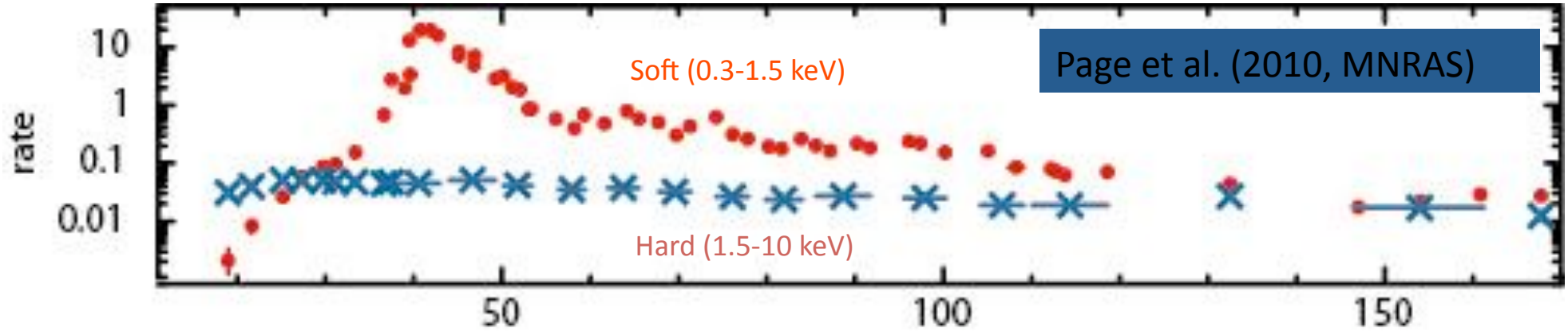
HESS J1731-347: SNR, G353.6-0.7(~3×10^4yrs)

Yamazaki et al. (2006), MNRAS, 371, 1975

Yamazaki et al. (2009), A&A, 495, 9

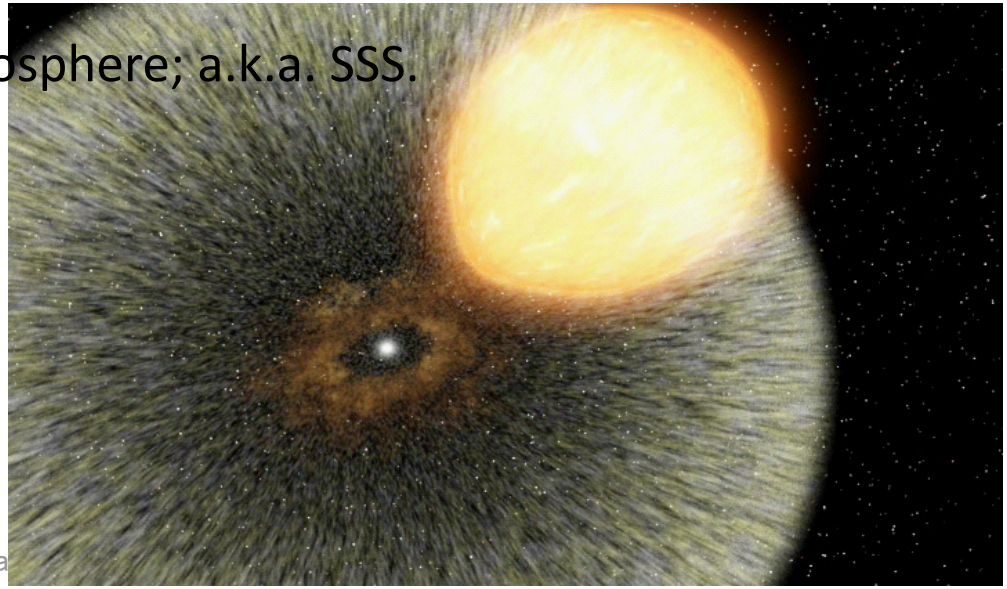
Classical Novae

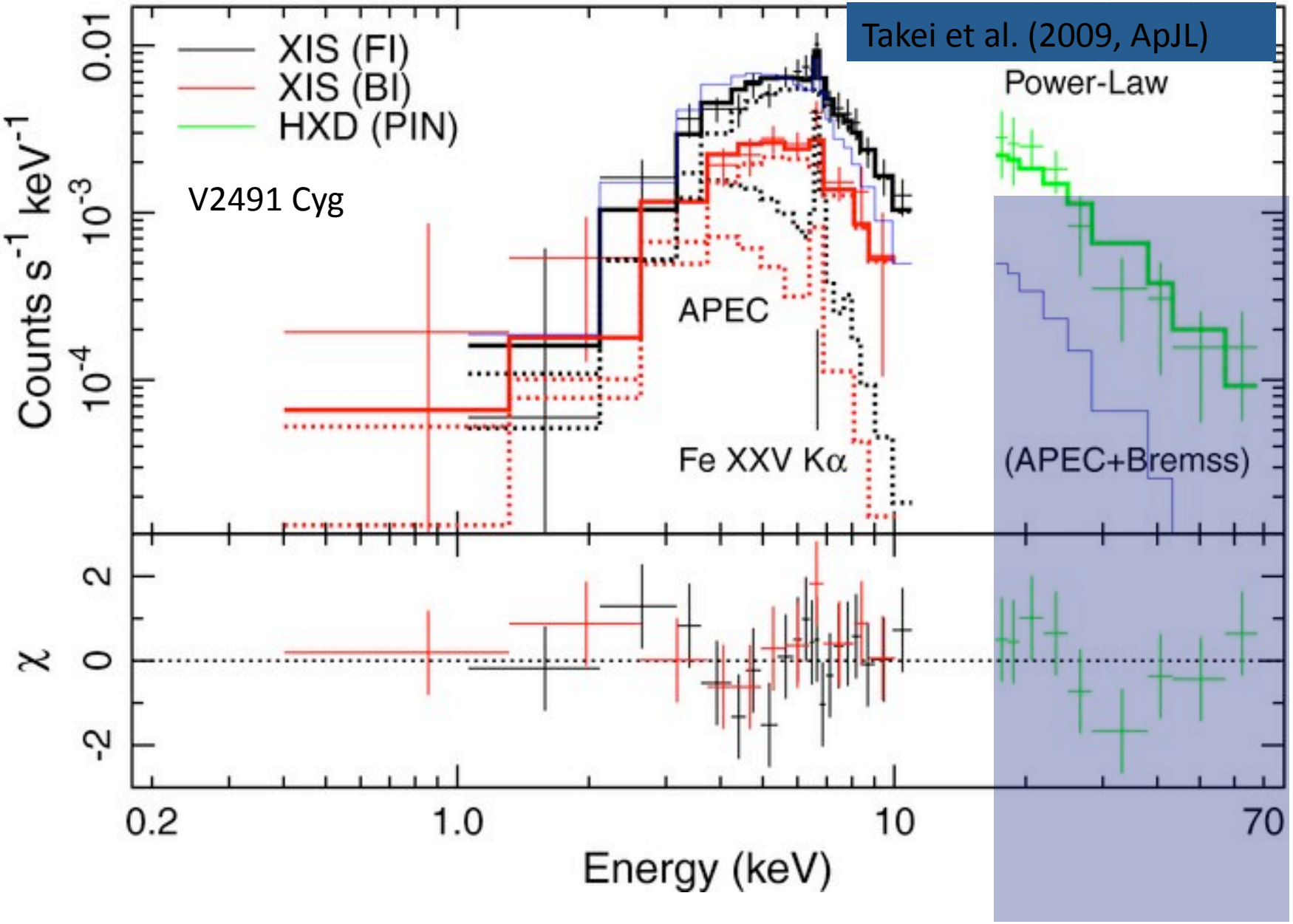
CNe and hard X-rays



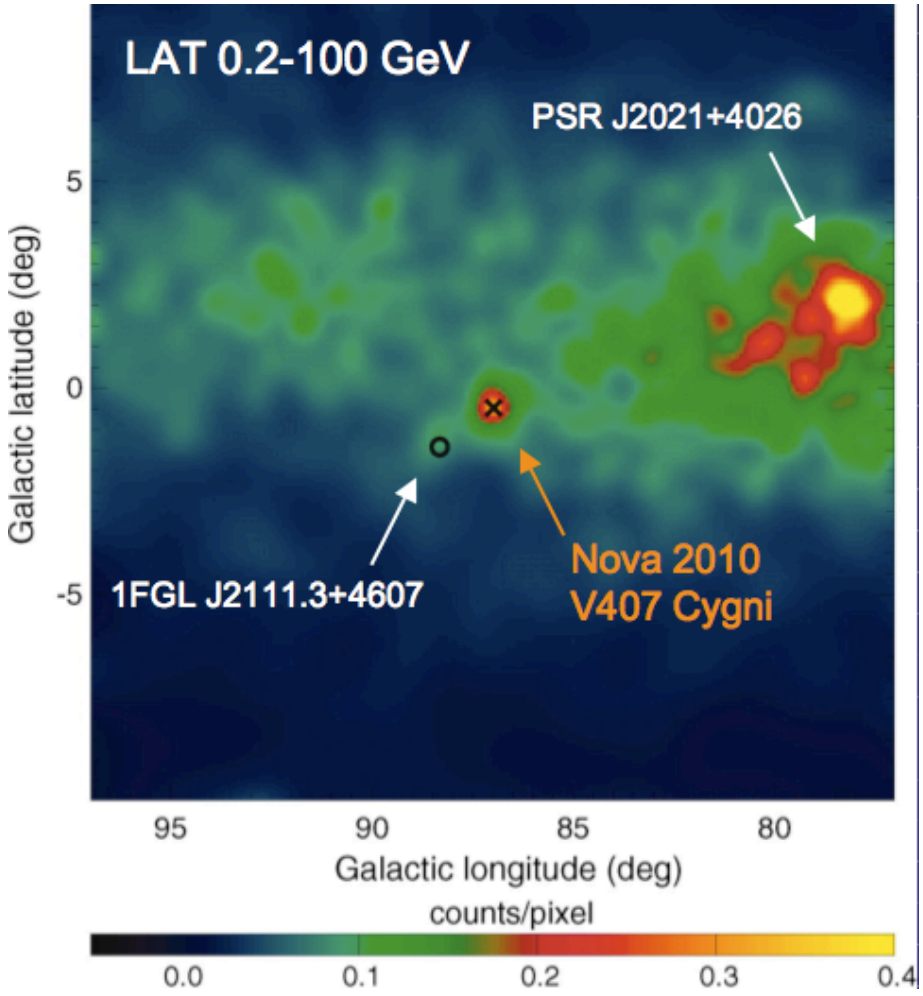
V2491 Cyg

- Soft (<~2 keV) X-rays
  - Emission from heated WD atmosphere; a.k.a. SSS.
- Hard (>1 keV) X-rays
  - Early appearance.
  - Different flux evolution.

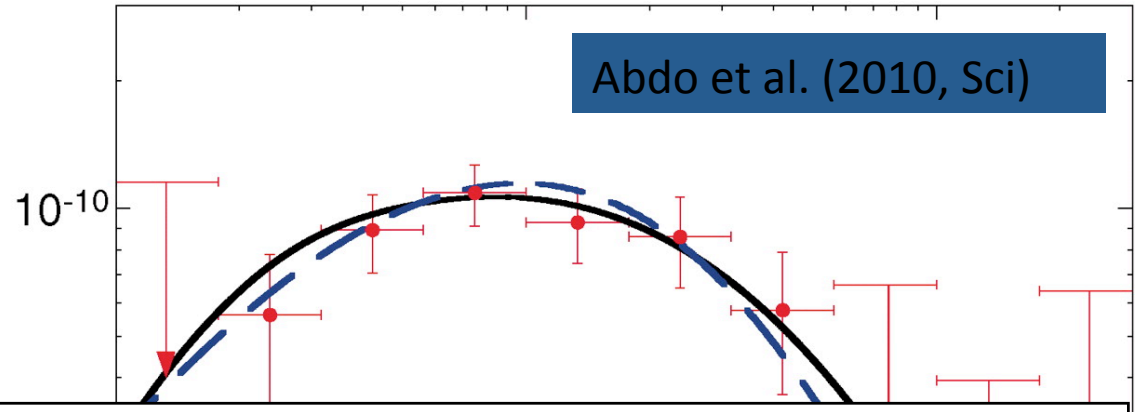


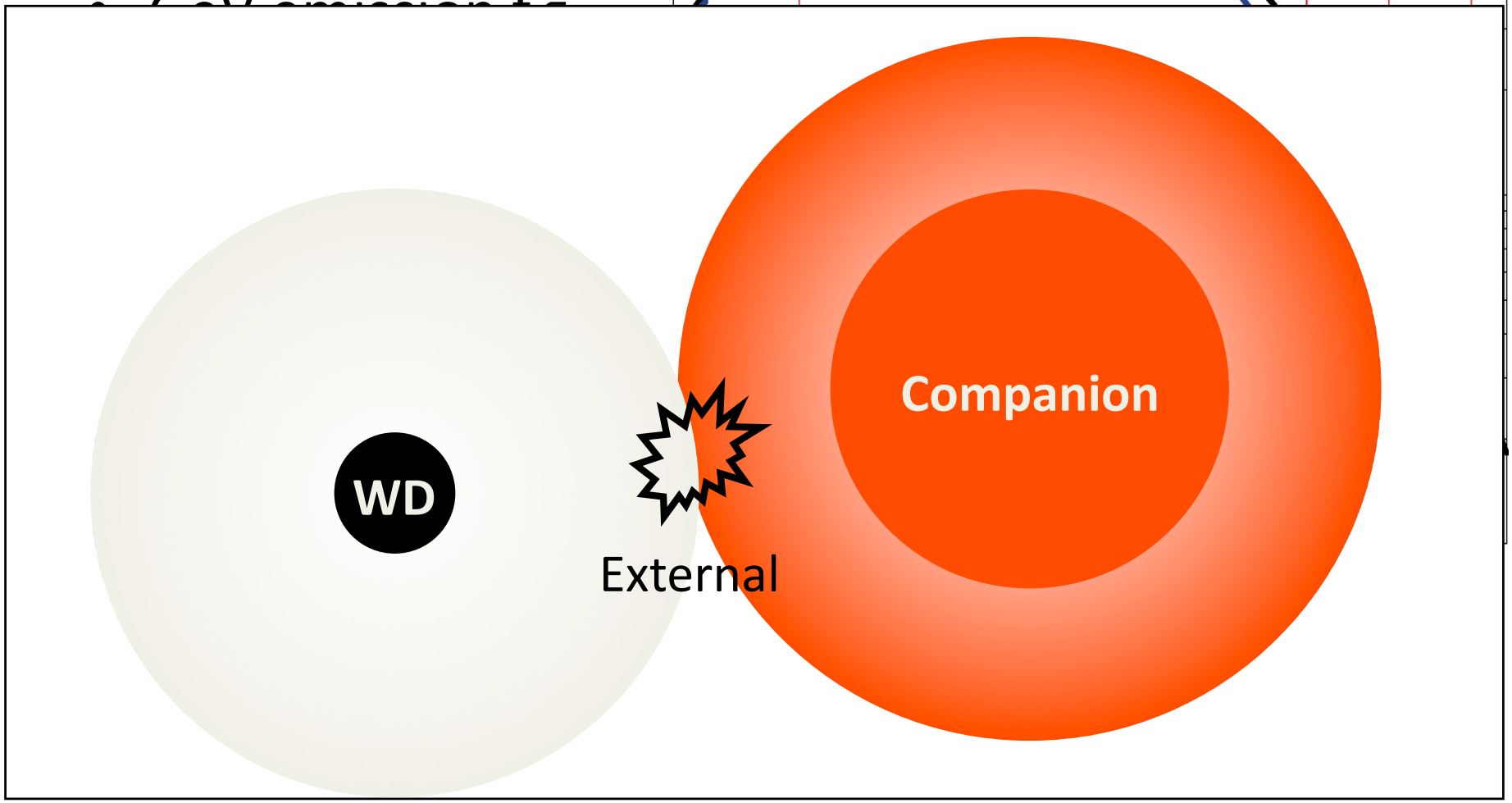

Takei et al. (2009, ApJL)
XIS (FI)
XIS (BI)
HXD (PIN)
V2491 Cyg
APEC
Fe XXV Kα
Power-Law
(APEC+Bremss)
Counts s^{-1} keV^{-1}
0.01
10^{-3}
10^{-4}
χ
2
0
-2
0.2
1.0
10
70
Energy (keV)

Fermi-LAT image of the flare



Non-





MAXI

MAXI Team

RIKEN: M. Matsuoka, T. Mihara, M. Sugizaki, M. Suzuki, Y. Nakagawa, T. Yamamoto, T. Sootome

JAXA: K. Kawasaki, S. Ueno, H. Tomida, M. Kohama, M. Ishikawa, K. Ebisawa, H. Katayama

Tokyo Inst. Tech.: N. Kawai, M. Morii, K. Sugimori, R.Usui

Aoyama Gakuin Univ.: A. Yoshida, K. Yamaoka, T. Kotani, S. Nakahira

Osaka Univ.: H. Tsunemi, M. Kimura

Nihon Univ.: H. Negoro, M. Nakajima, H. Ozawa, F .Suwa

Kyoto Univ.: Y. Ueda, N. Isobe, S. Eguchi, K. Hiroi

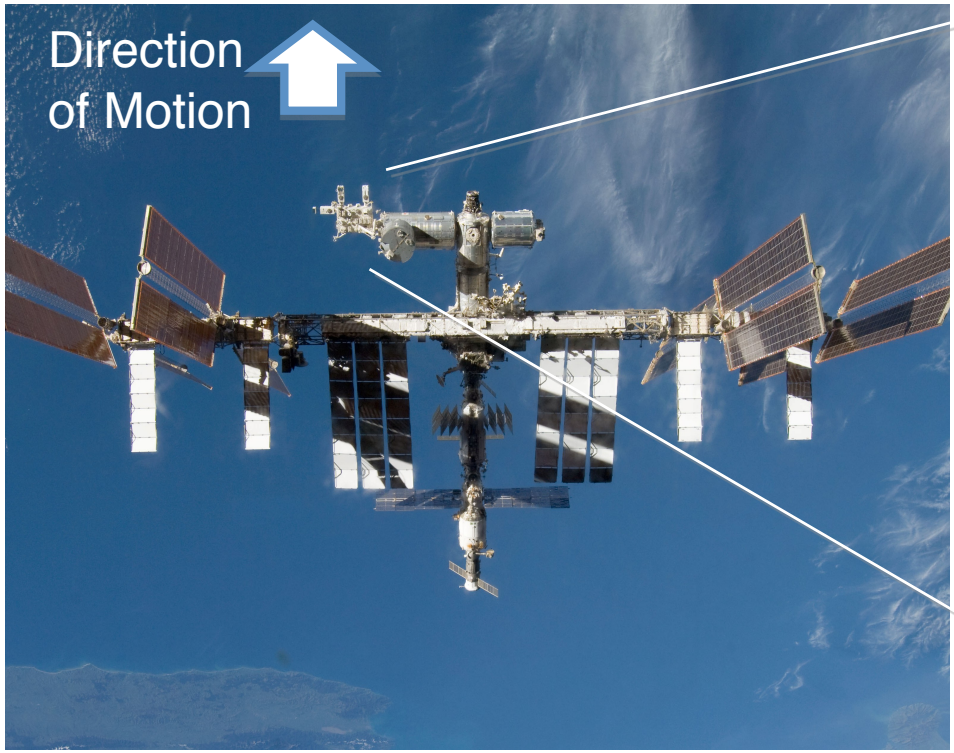
Miyazaki Univ.: M. Yamauchi, A. Daikyuji

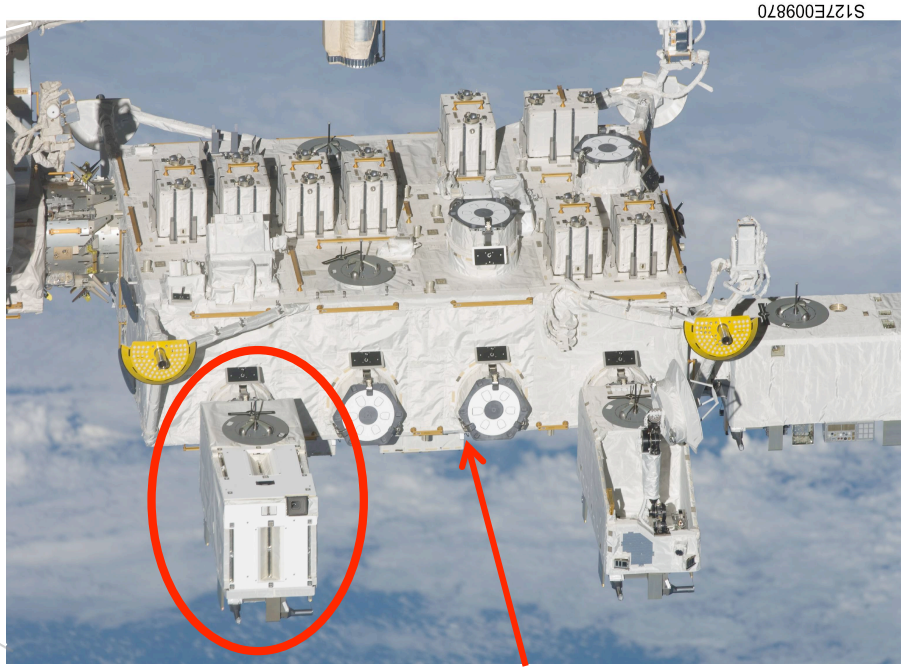
Chuo Univ.: Y. Tsuboi, A.Uzawa, T.Matsumura, K.Yamazaki

Outline

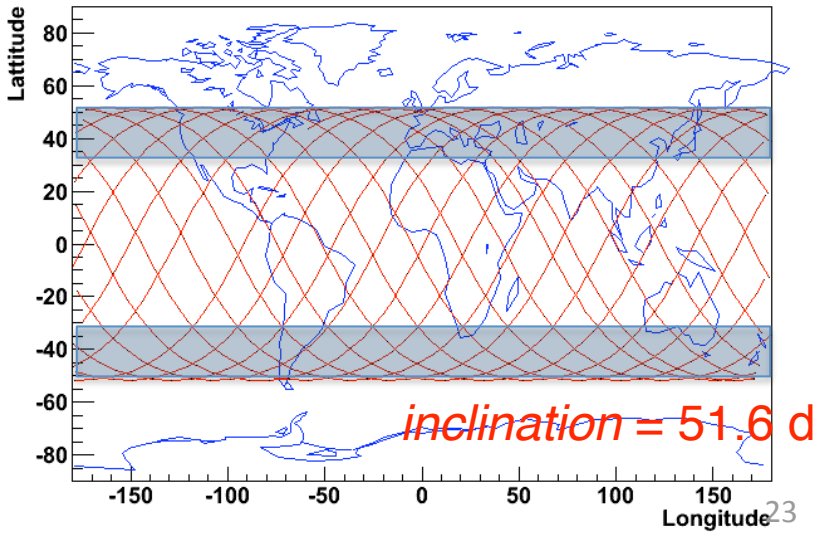
- Mission and Instruments
- X-ray sources seen by MAXI
  - Extra-galactic
    - Active galactic nuclei
    - Gamma-ray bursts
  - Galactic
    - Black hole candidates
    - Binary pulsars
    - Stellar flares
  - Others

MAXI (Monitor of All-sky X-ray Image) on ISS

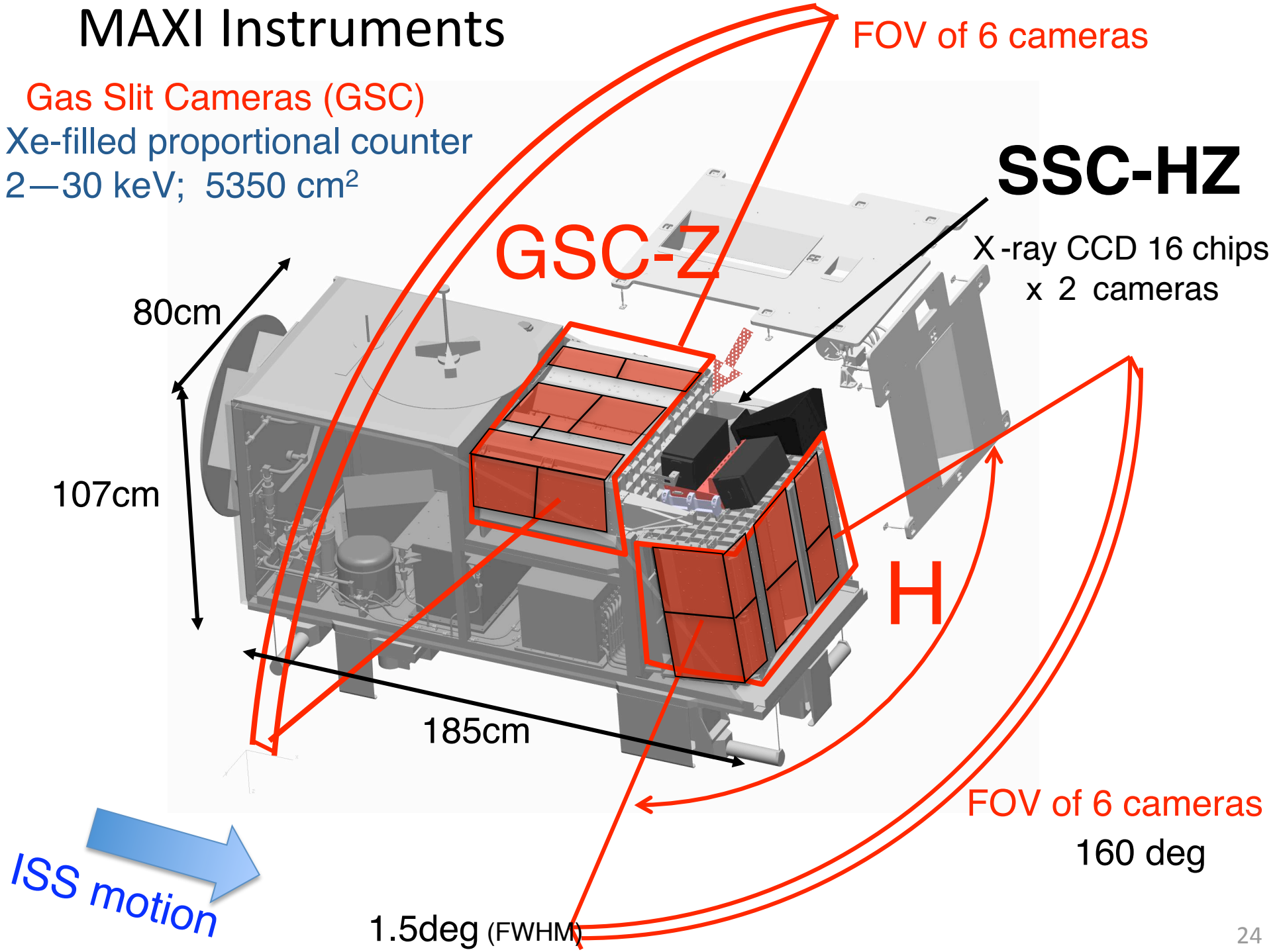




- The first astronomical mission on ISS
- Transported by Space Shuttle (Endeavour) on July16, 2009
- Installed on JEM (Japanese Experimental Module, KIBO) EF (Exposed Facility) on July 23.
- First Light on August 15.

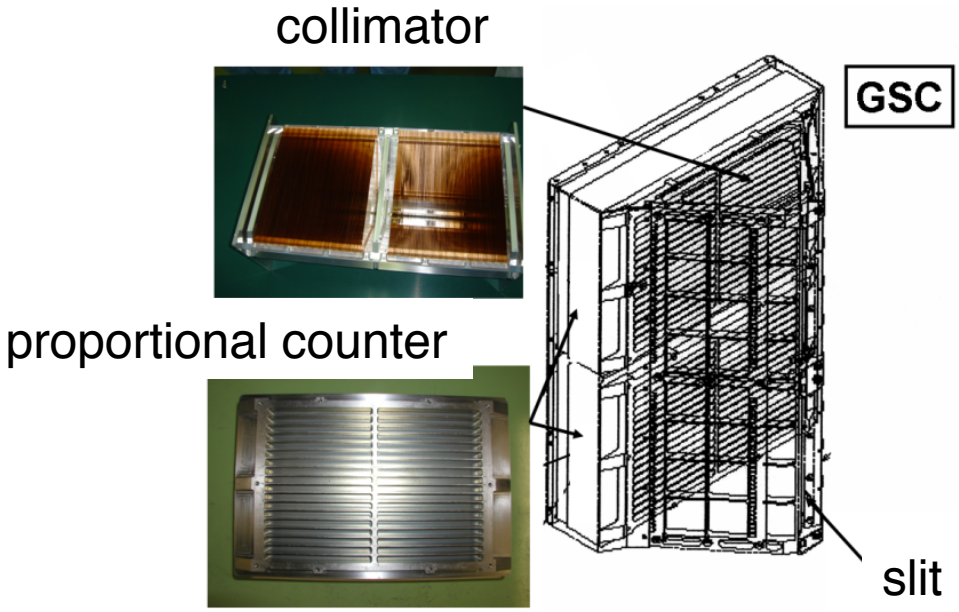


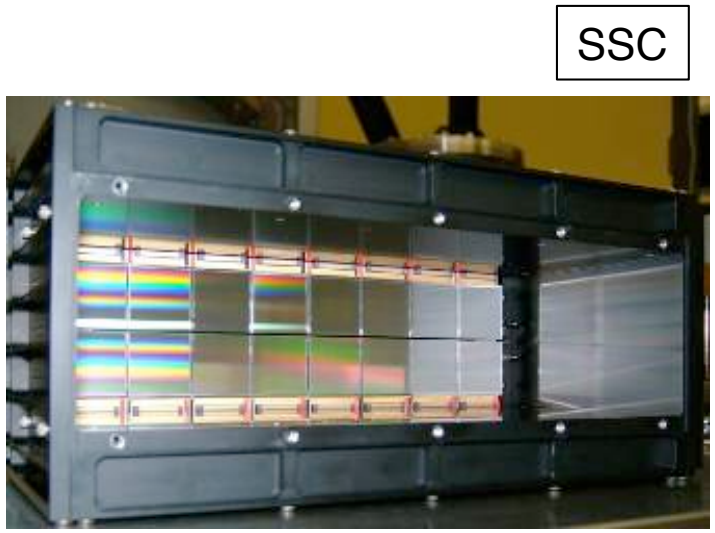
MAXI Instruments



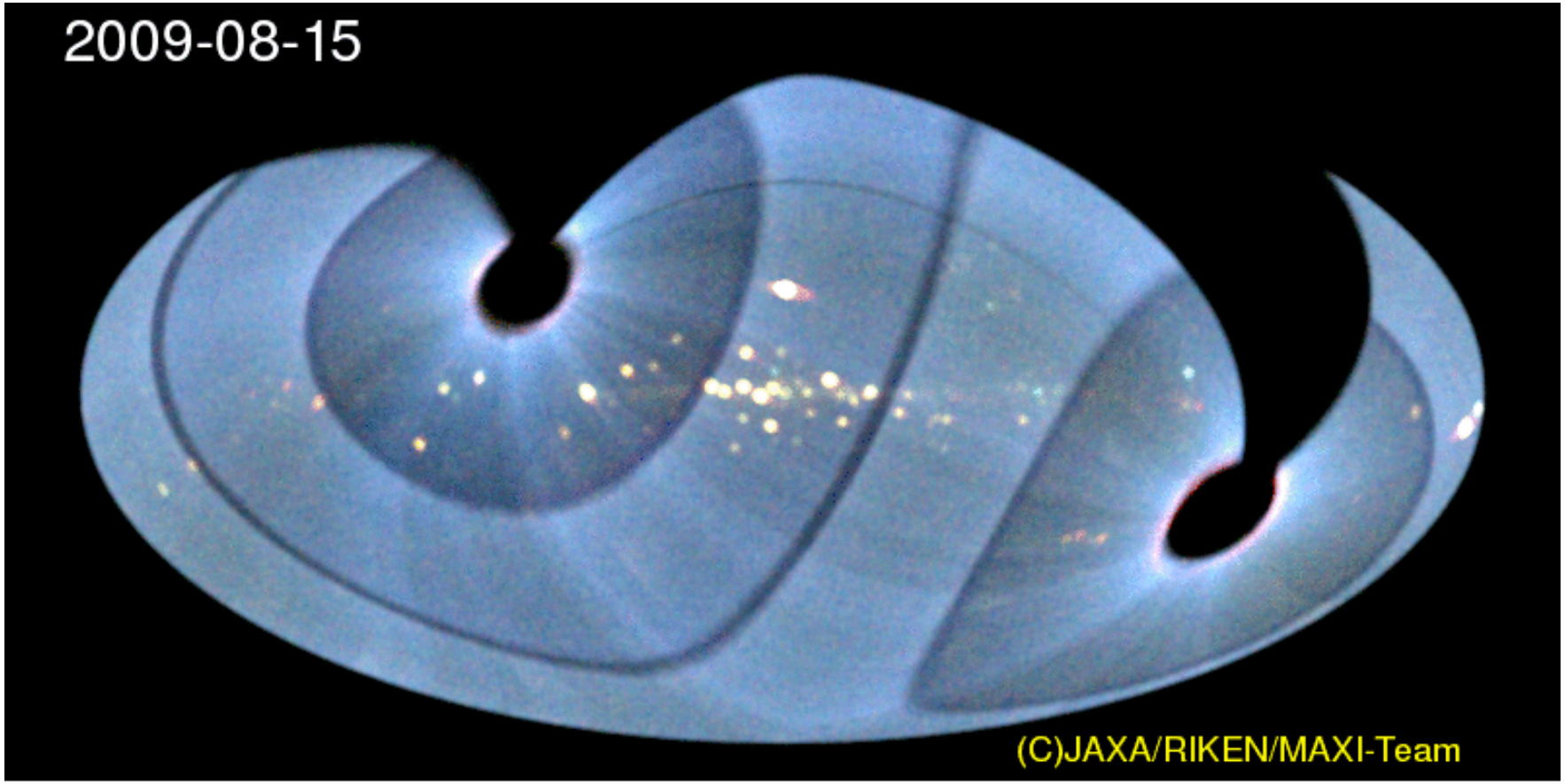
Detectors

	GSC (X-ray Gas Camera)	SSC (X-ray CCD Camera)
Detector	Gas(Xe) prop. counter x12	CCD 16 chips x 2 camera
Energy range (Q.E.>10%)	2－30 keV	0.5－12 keV
Energy resolution (FWHM)	15.7%(at 8.0keV)	< 2.5%(150eV) (at 5.9keV)
Time resolution & accuracy	＜200μsec	～6 sec
Instantaneous sky coverage	2.4 % of the whole sky (160 deg x 3 deg x 2 sets)	1.4% of whole sky (90 deg x 3 deg x 2 sets)
Point Spread Function	1.5 degree	1.5 degree
sensitivity	2 mCrab (week)	5 mCrab (week)



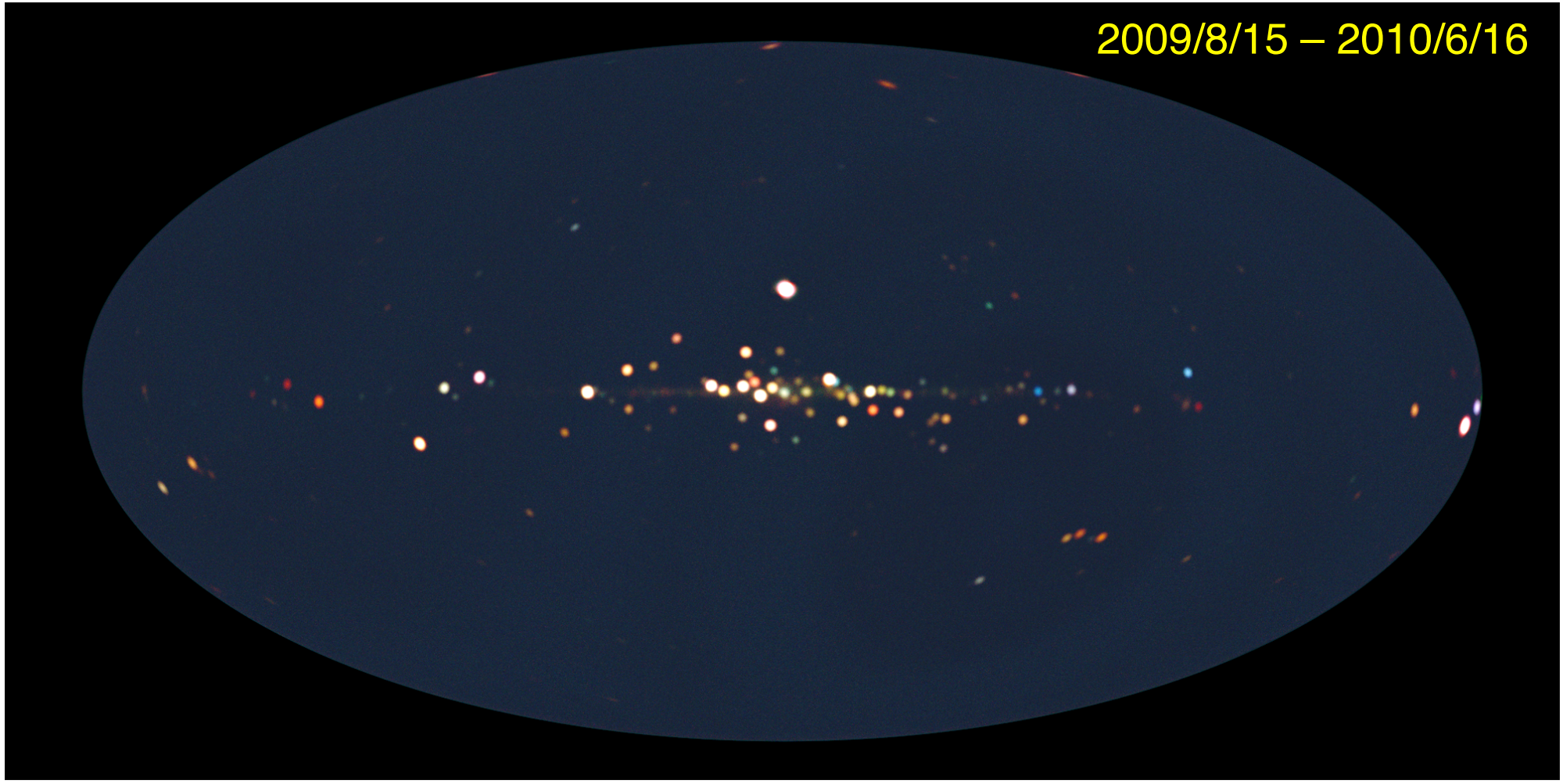


GSC All-Sky Scan Movie



- Red: 2-4 keV, Green: 4-10keV, Blue: 10-20 keV.
- Raw data. Exposure not corrected.
- Not cleaned for background variation, sun-light leak, and solar-paddle reflection.

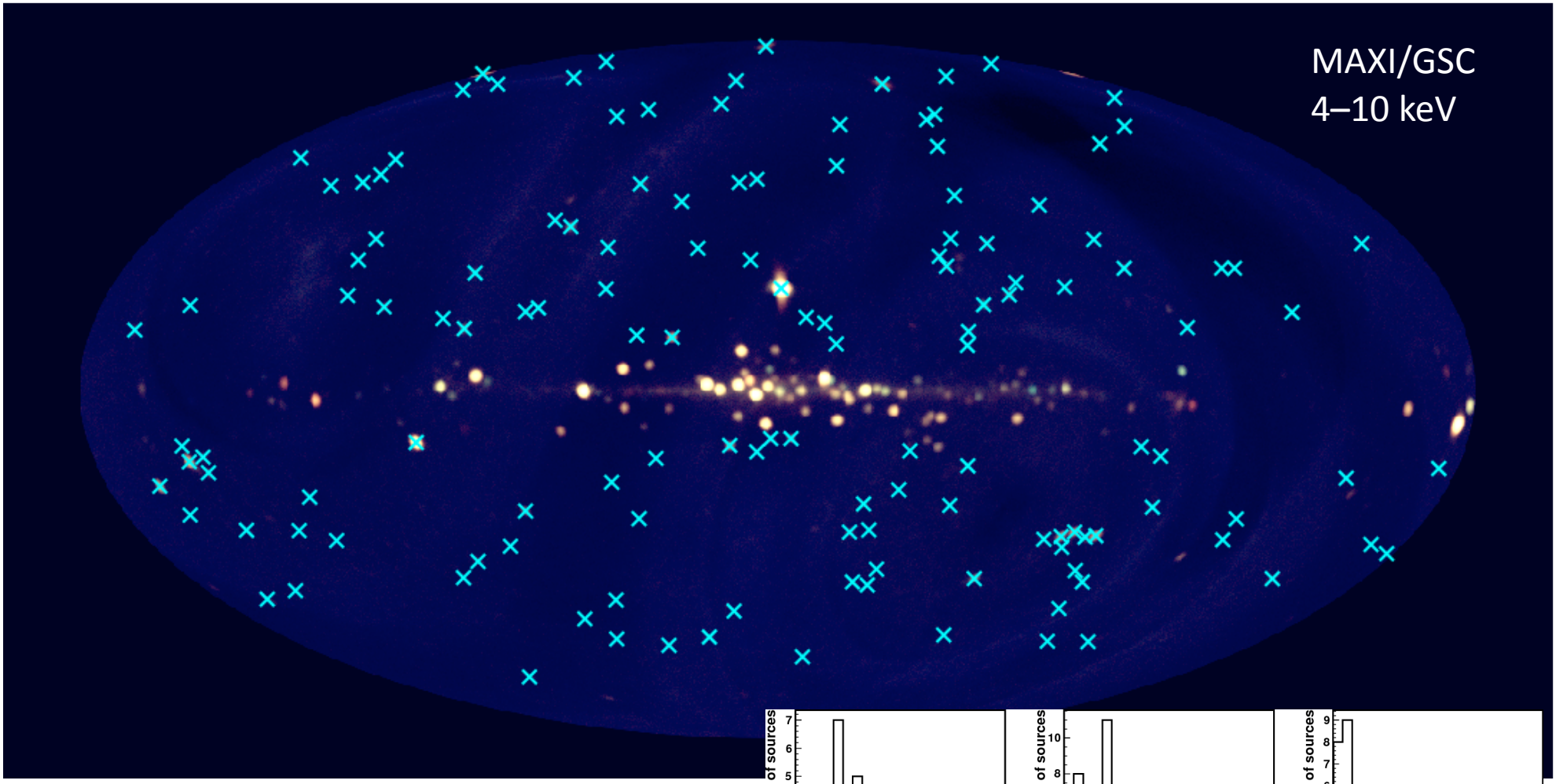
GSC All-sky map for the first 10 months

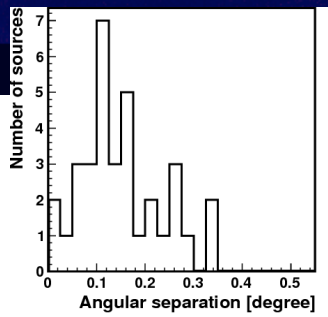


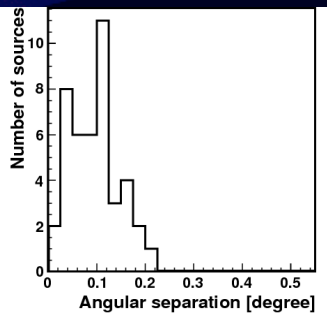
Red: 2-4 keV, Green: 4-8 keV, Blue: 8-16 keV (exposure not corrected)

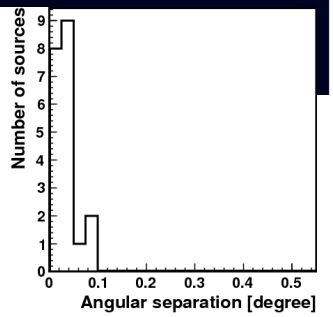
About 300 sources were detected.

MAXI 7-month catalog



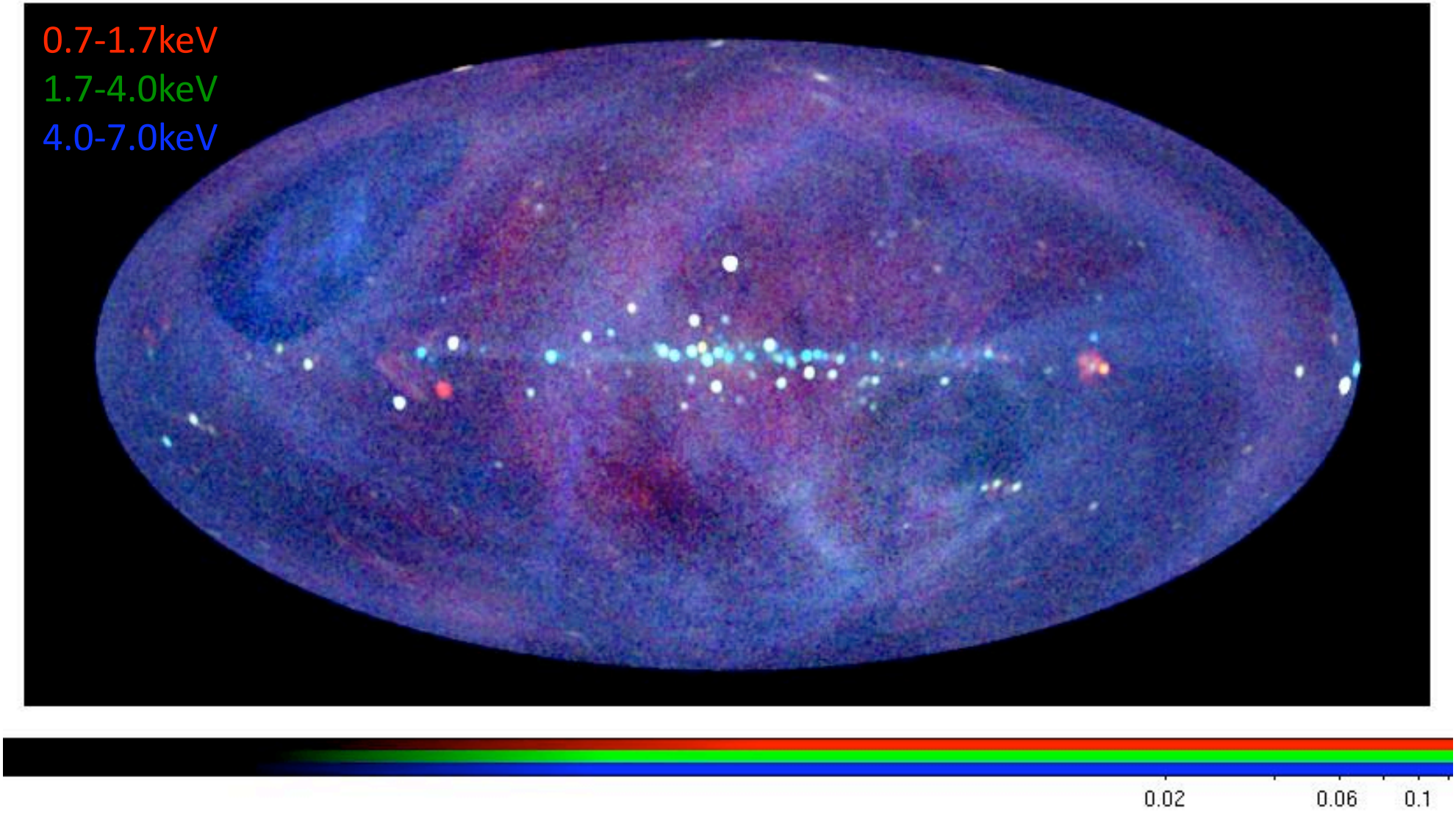






136 sources (>7 σ, |b|>10°)
position error < 0.3°
(systematic < 0.05°)

SSC 1-year all-sky map



ATEL with MAXI/GSC

< 2010 >

7/10	RX J1709.5-2639	Outburst
7/1	Cyg X-1	State transition ?
6/29	4U 1954+319	Outburst
6/28	Short X-ray transient	(RS-CVn?)
6/14	Cir X-1	Recurrent outburst
5/25	Cyg X-3	State transition
5/10	Cir X-1	Outburst
3/31	LSV +44 17	Outburst
3/30	Short X-ray transient	(XRF?)
3/12	Short X-ray transient	(X-ray burst?)
3/3	4U 1608-22	Flare
2/18	Mrk 421	Flare
2/10	V0332+53	Recurrent outburst
2/6	4U 1711-34	Flare
2/3	Short X-ray Transient	(X-ray burst?)
1/26	Cyg X-3	State Transition
1/24	HR 1099	Flare
1/23	4U 1323-619	Outburst
1/23	XTE J1752-223	State Transition
1/10	GX 339-4	Flare
1/ 9	H 1743-322	State Transition
1/5	V0332+53	Recurrent outburst
1/5	Mrk 421	Flare

< 2009 >

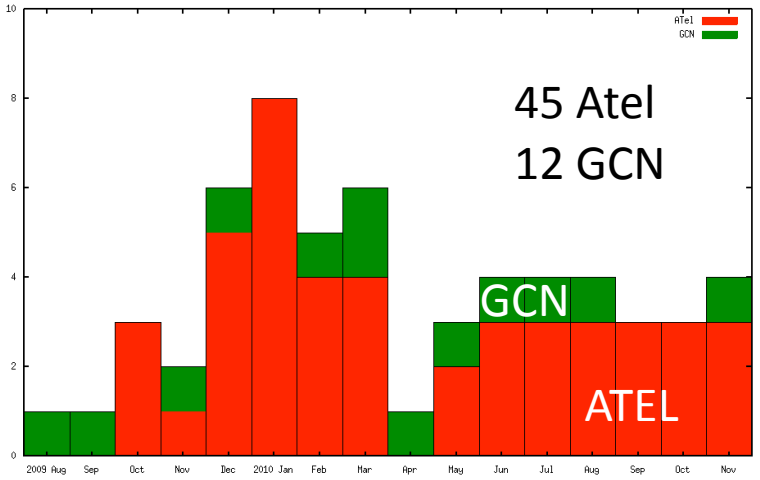
12/31	H 1743-322	Flare
12/31	4U 1630-47	Flare
12/28	NGC6440	Outburst
12/9	Swift J1753.5-0127	State transition?
12/2	Short X-ray Transient	(XRF?)
11/15	GX 304-1	Outburst
10/31	A0535+26	Recurrent outburst
10/29	4U 2206+54	Flare
10/25	XTE J1752-223	New source

Black-Hole Candidates
Binary X-ray Pulsars
Low-Mass X-ray Binaries
Stars
AGNs
Unknown (XRF?)

ATEL with MAXI/GSC

< 2010 > cont.

11/22	XTE J1946+274	Outburst
11/10	GT Mus	Flare
11/09	AX J1841.0-0536	Outburst
10/31	Short X-ray transient	
10/25	A0535+26	Outburst
10/20	MAXI J1409-619	Outburst
9/25	MAXI J1659-152	Outburst
9/13	Short X-ray transient	
9/09	TWA-7	Flare
8/07	GX 304-1	Outburst
8/02	GRO J1008-57	Outburst
7/23	A0535+26	Outburst



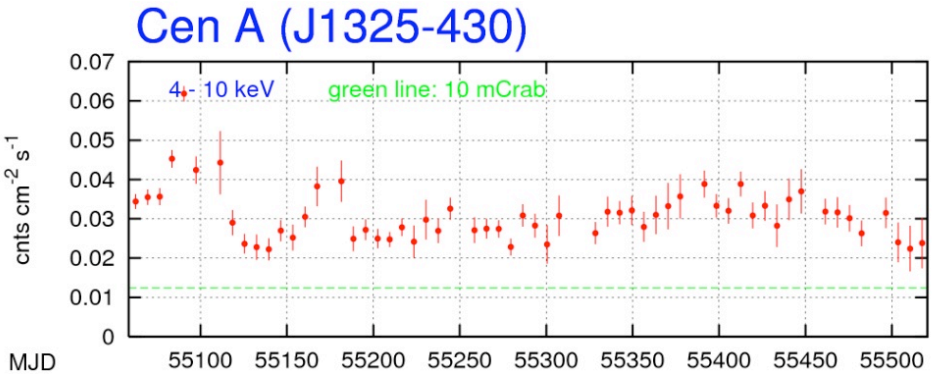
Aug 2009 Nov 2010

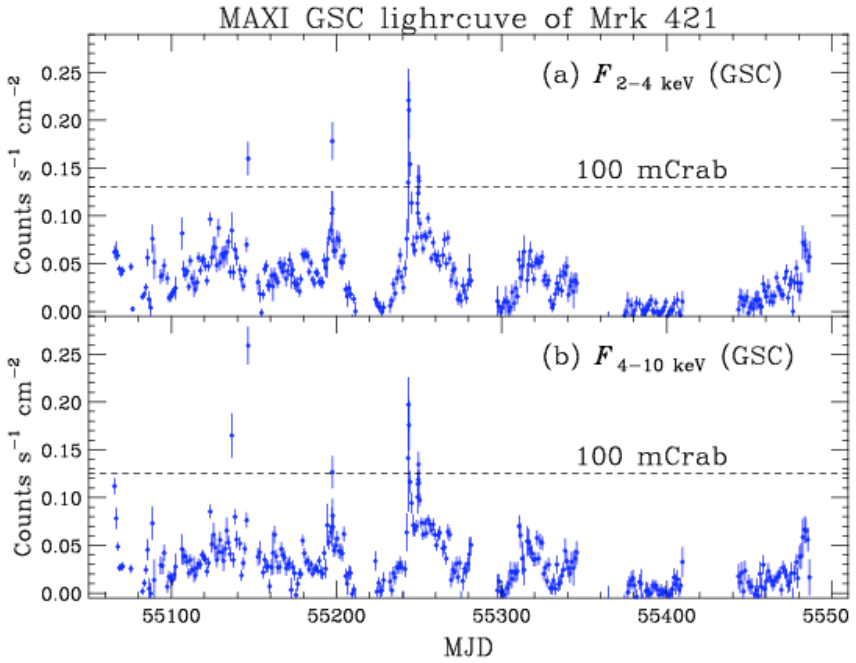
Black-Hole Candidates
Binary X-ray Pulsars and HMXB
Low-Mass X-ray Binaries
Stars
AGNs
Unknown (XRF?)

Active Galactic Nuclei

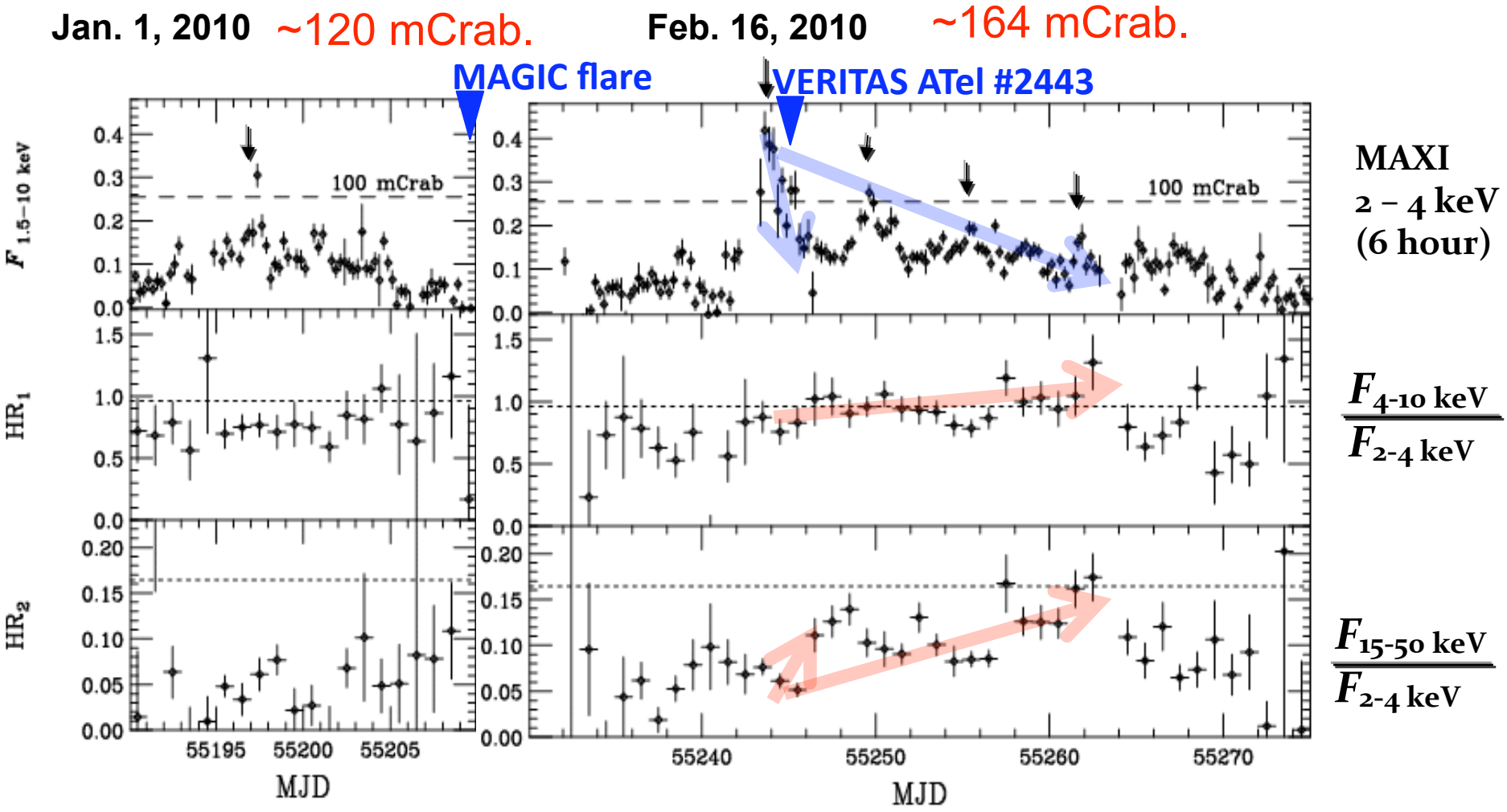
- Mrk 421
- 3C 273,
- Cen A,
- NGC 4151
- IC 4329A
- …

- Monitoring
  - Large flare events
  - Long term variation



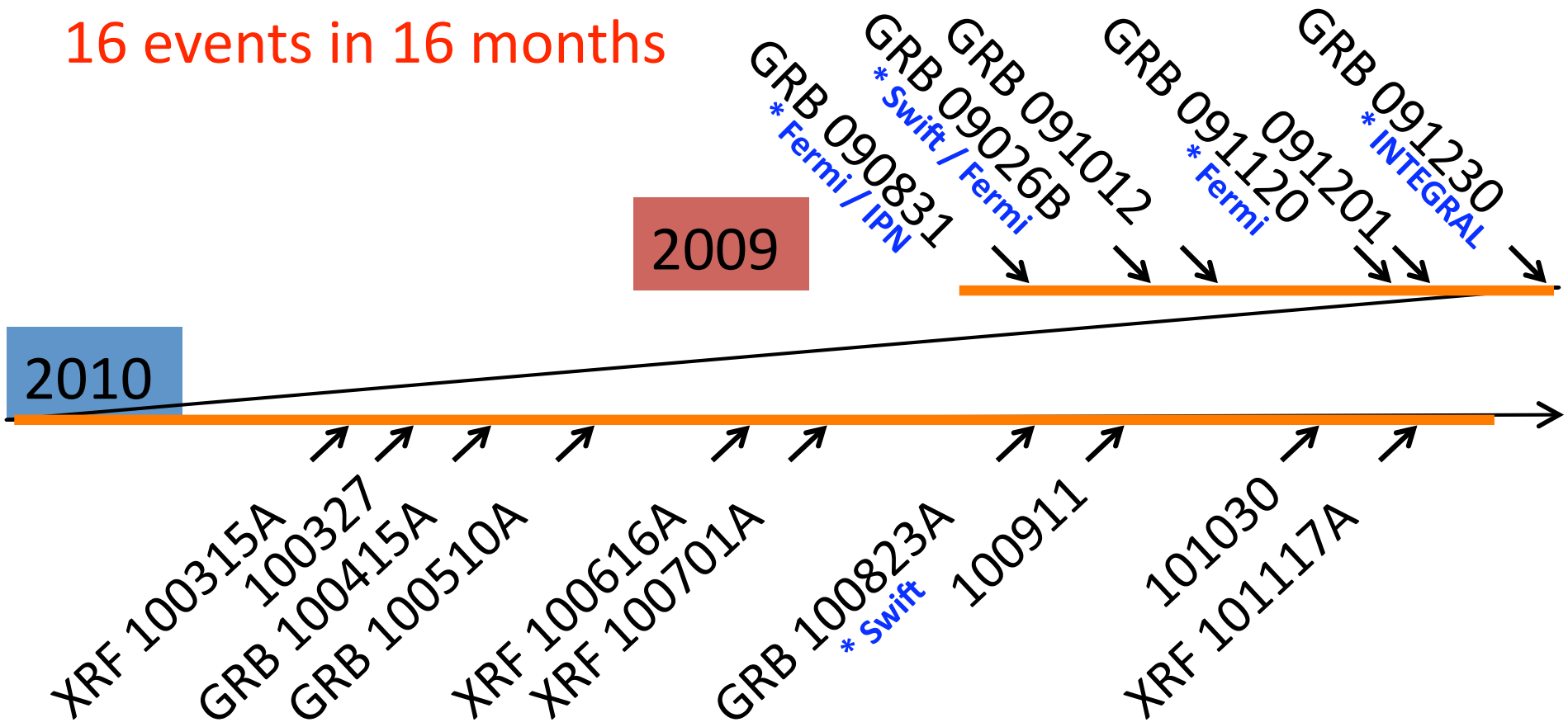


Two Flares from Mrk421



Isobe et al. 2010, PASJ

Gamma-ray bursts and X-ray flashes



* 5 are simultaneously detected by other satellites

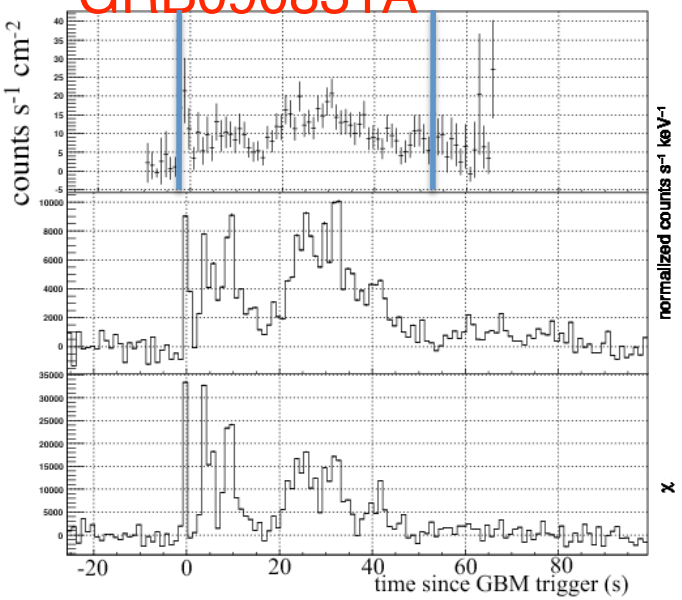
GRB: MAXI-Fermi/GBM Combined Analysis

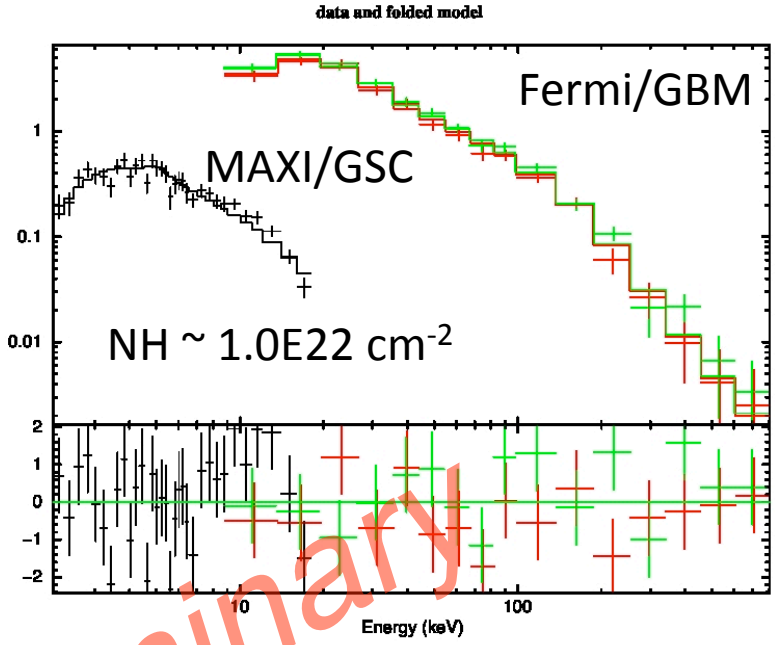
GRB090831A

MAXI/GSC 1.5-20keV

Fermi/GBM 15-50keV

50-500keV





GRB091120

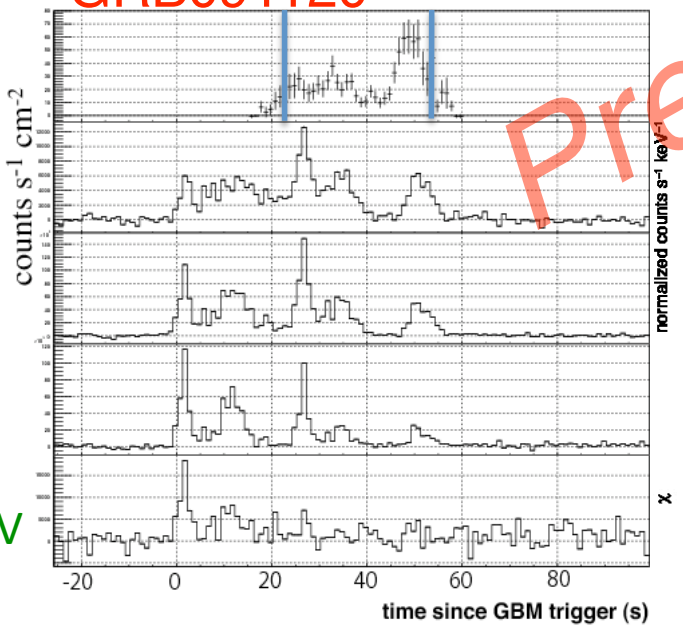
MAXI/GSC 1.5-20keV

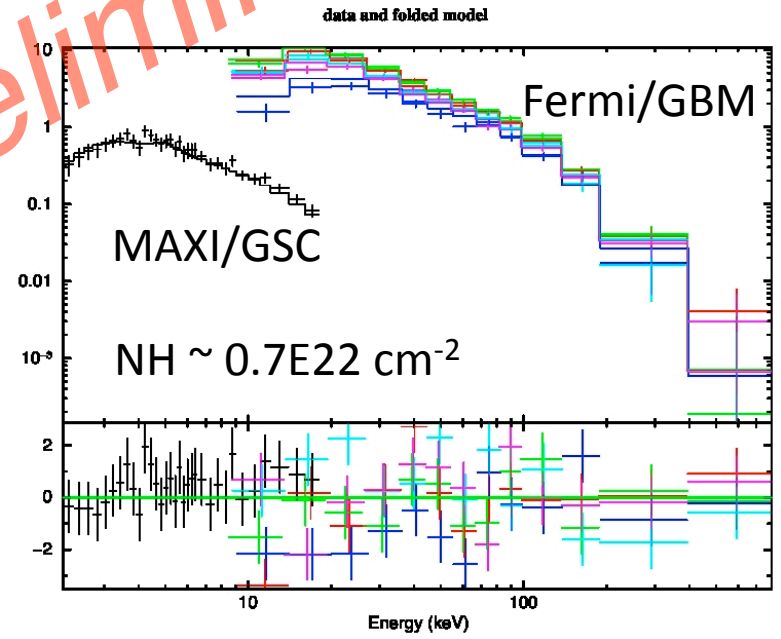
Fermi/GBM 8-20keV

20-100keV

100-300keV

300-1000keV

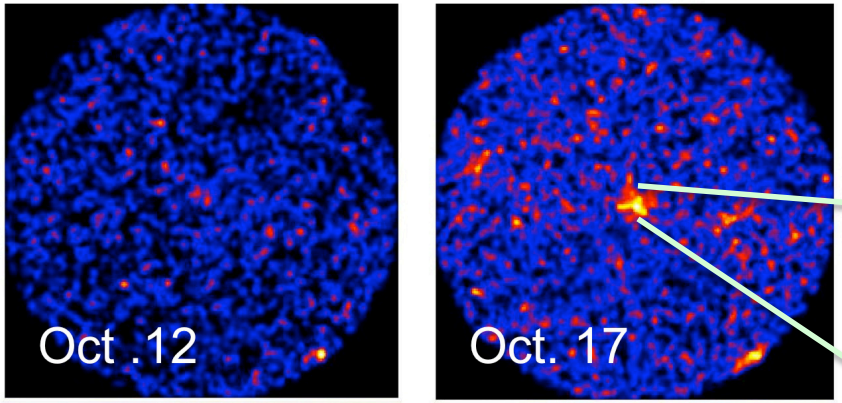


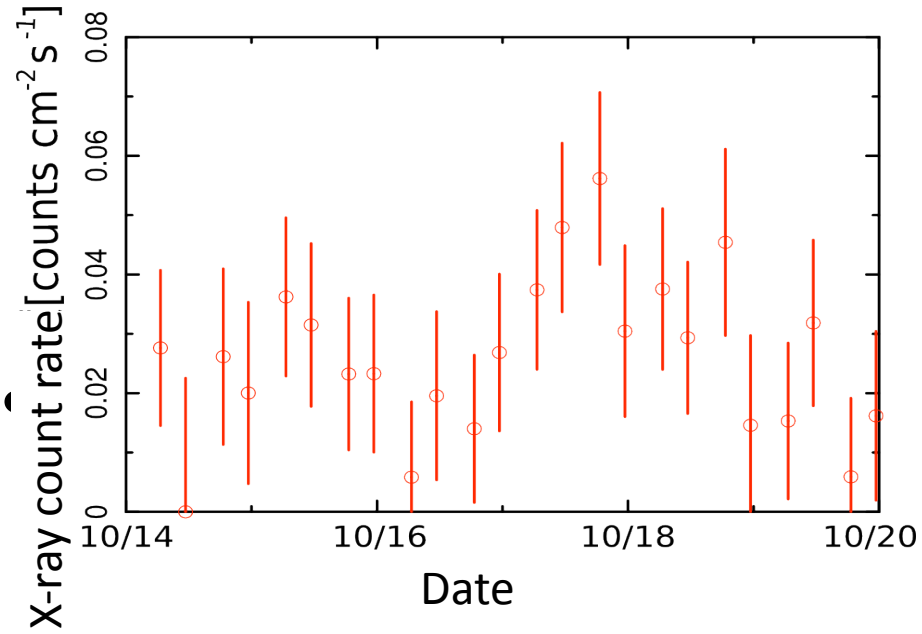


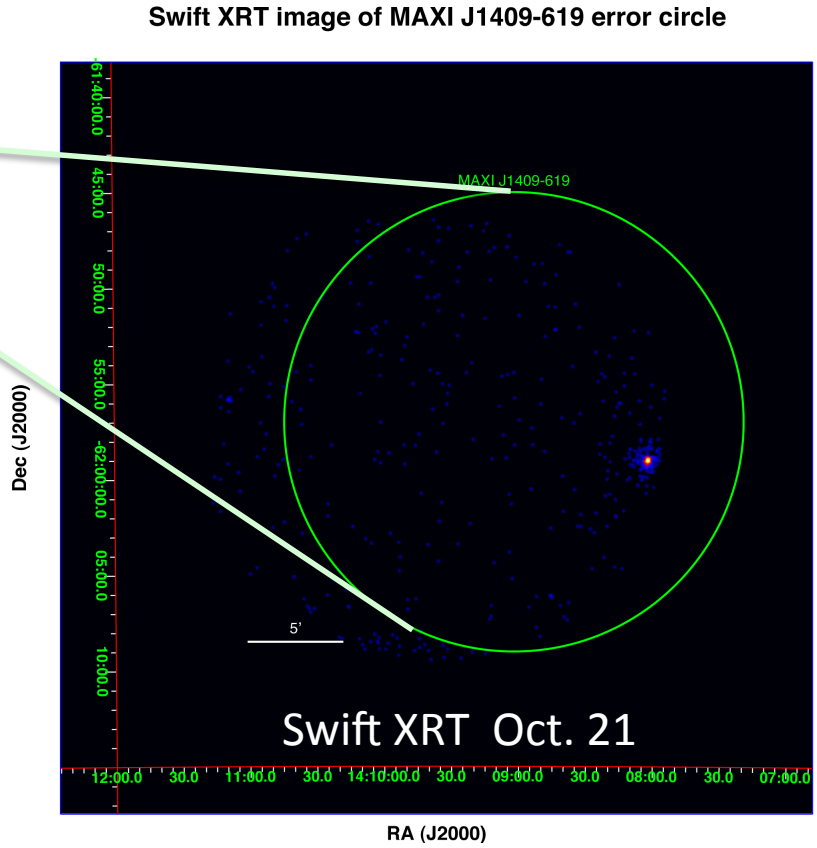
Preliminary

MAXI J1409-619

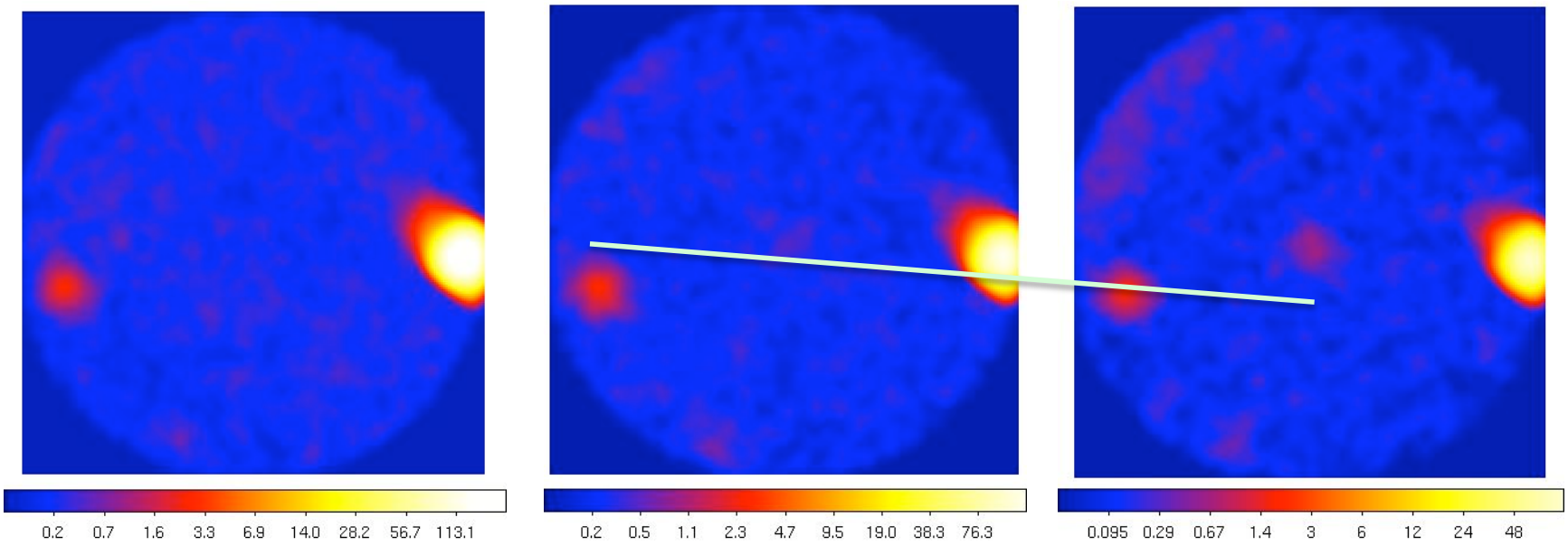
confirmed and accurately localized by Swift

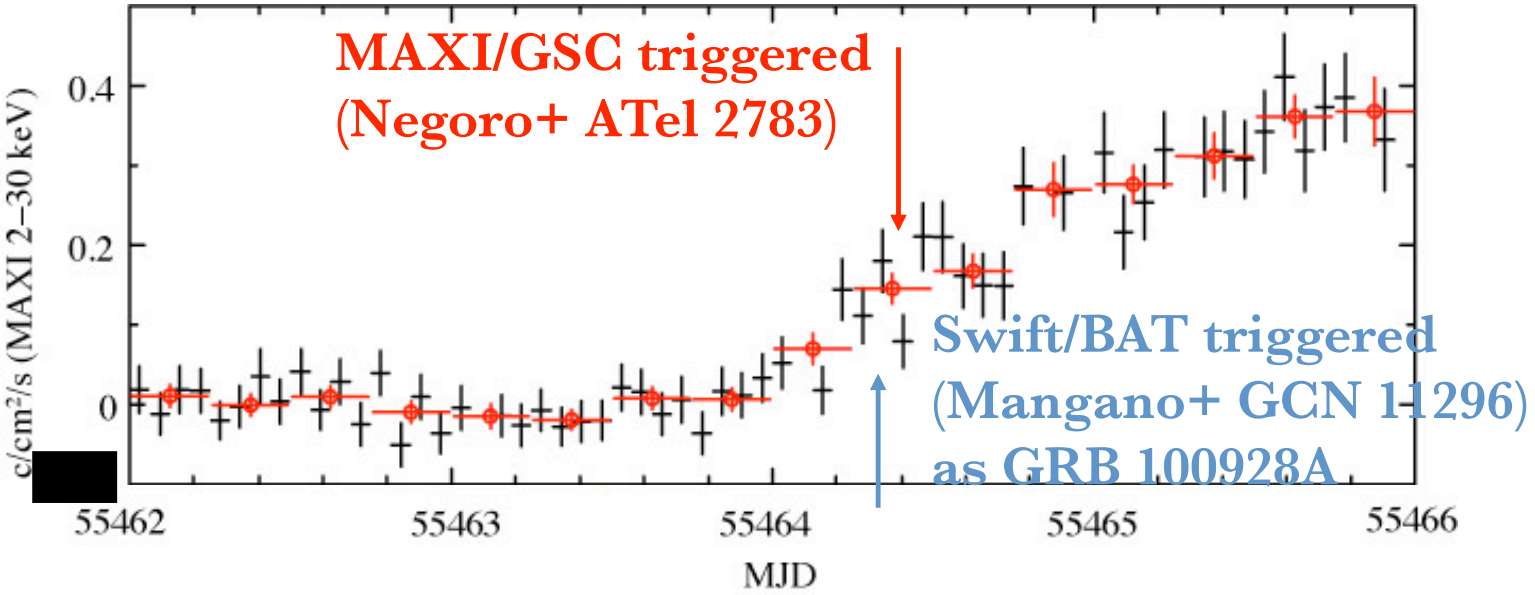






Discovery of MAXI J1659-152





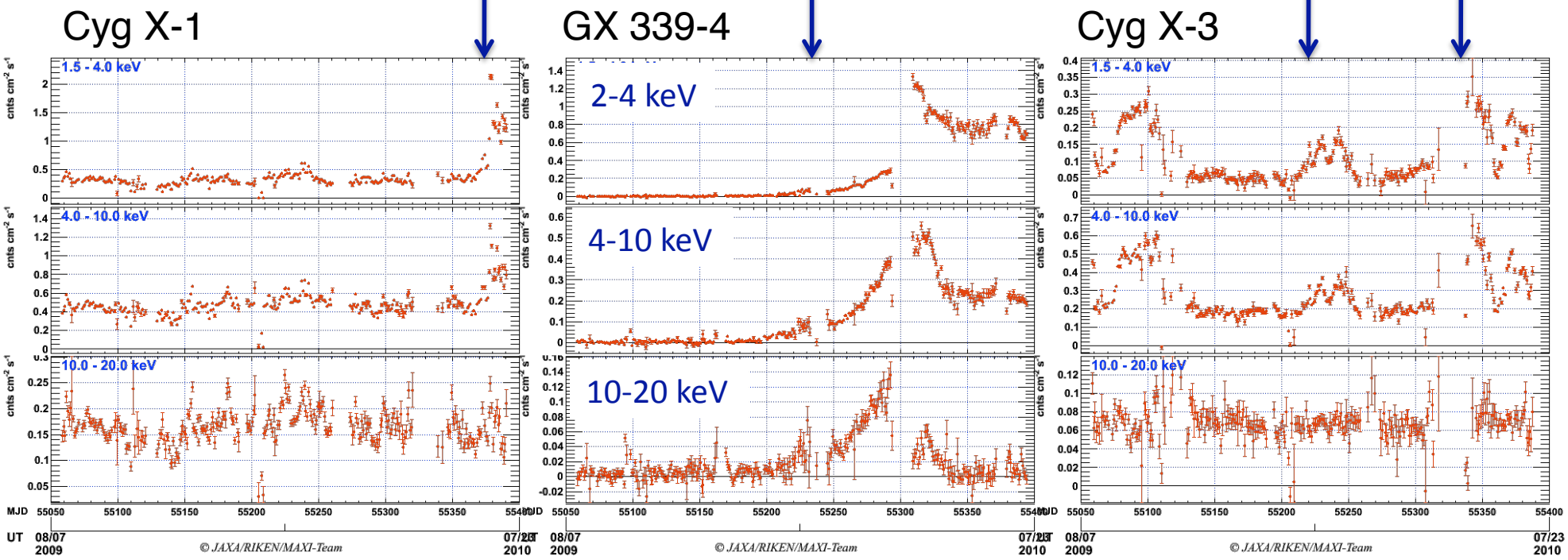
Black hole candidates

New Activity, Spectral Transition

ATEL#2711
Soft X-ray increase

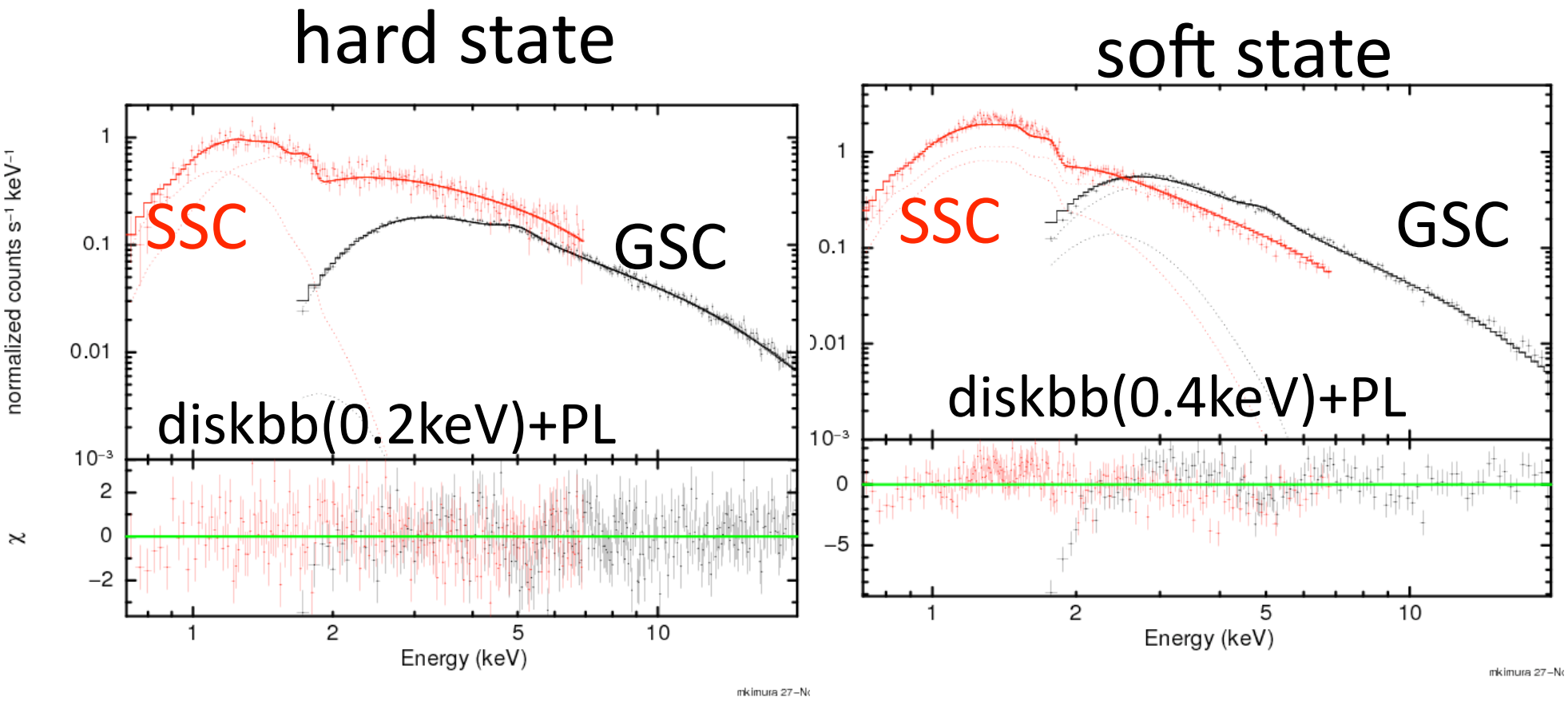
ATEL#2380
Beginning of new activity

ATEL#2404, #2635
State transition

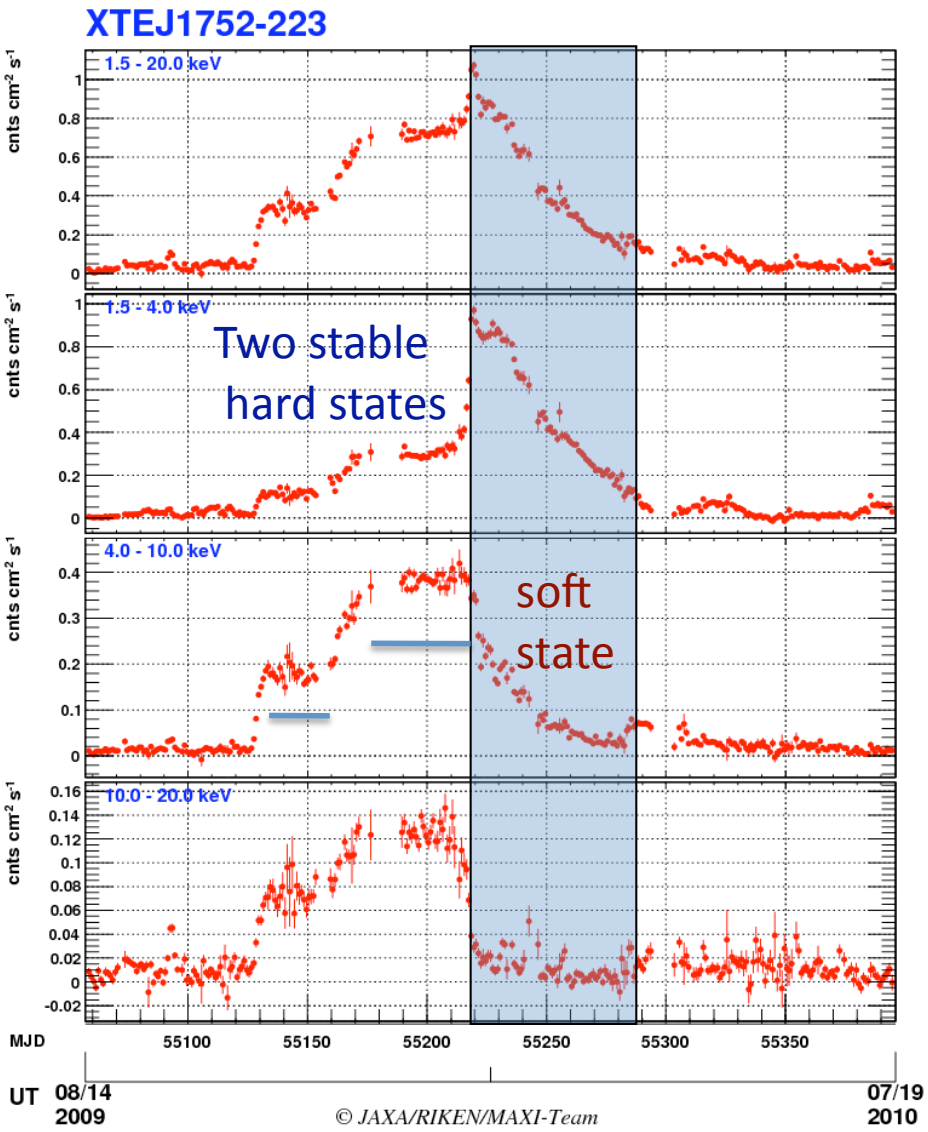


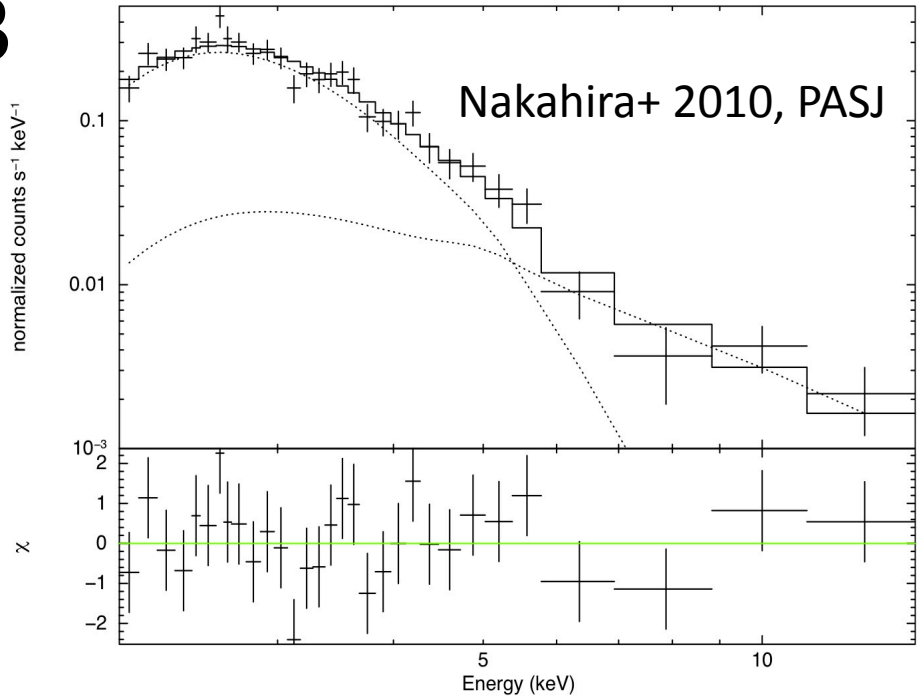
~ 1yr

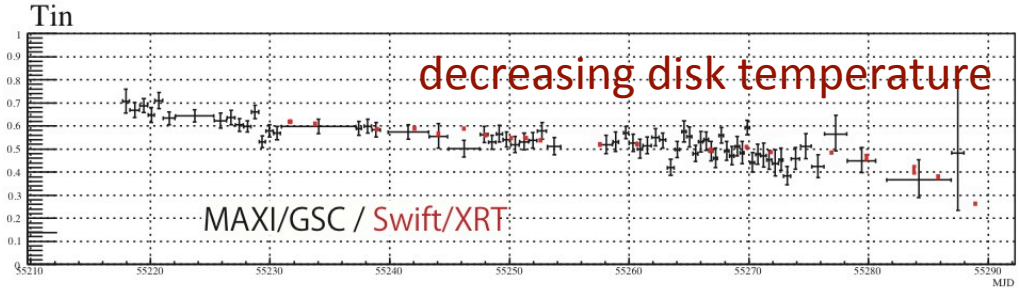
Cyg X-1 spectra

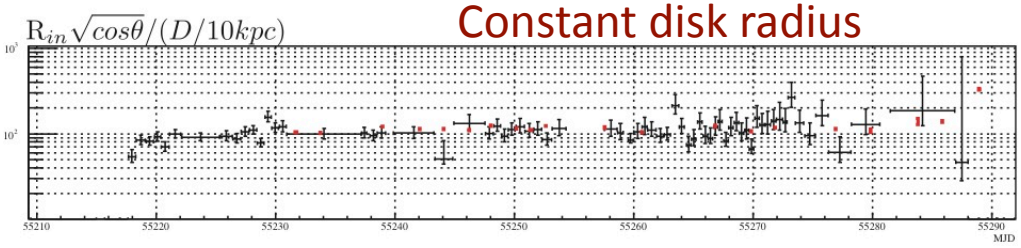


Continuous spectral monitoring of XTE J1752-223



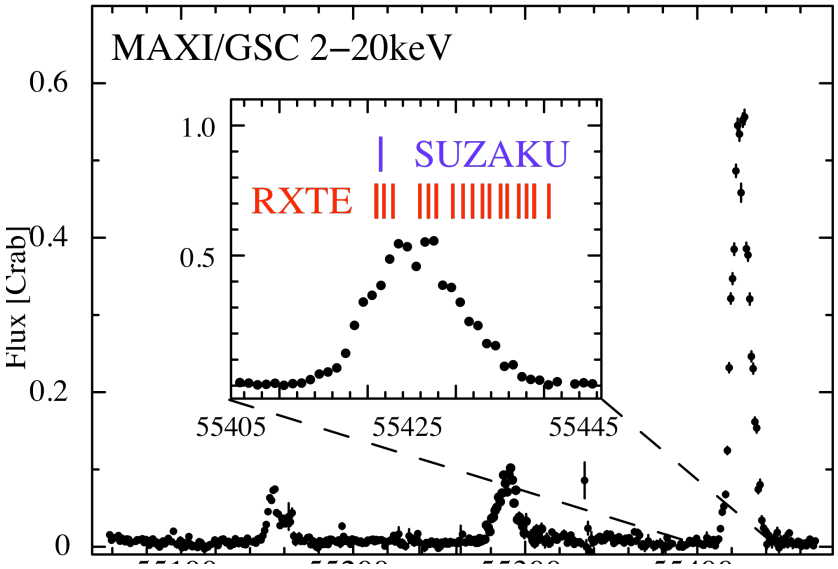




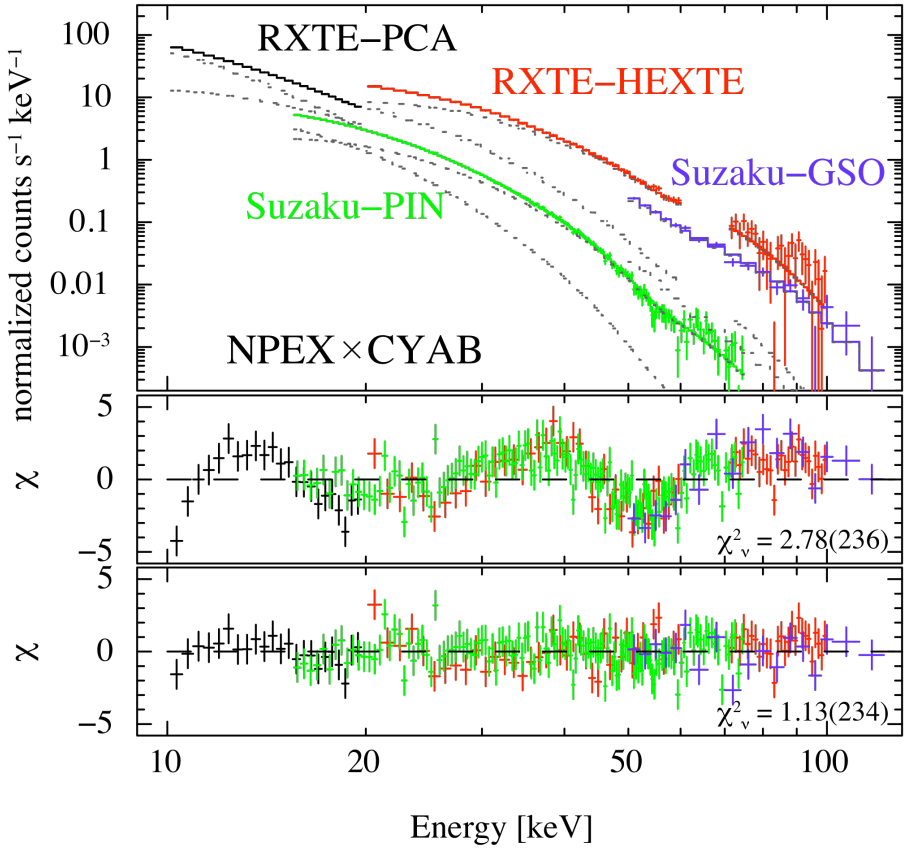


GX 304–1

Accreting X-ray pulsar with a Be star companion



- MAXI detection of outbursts

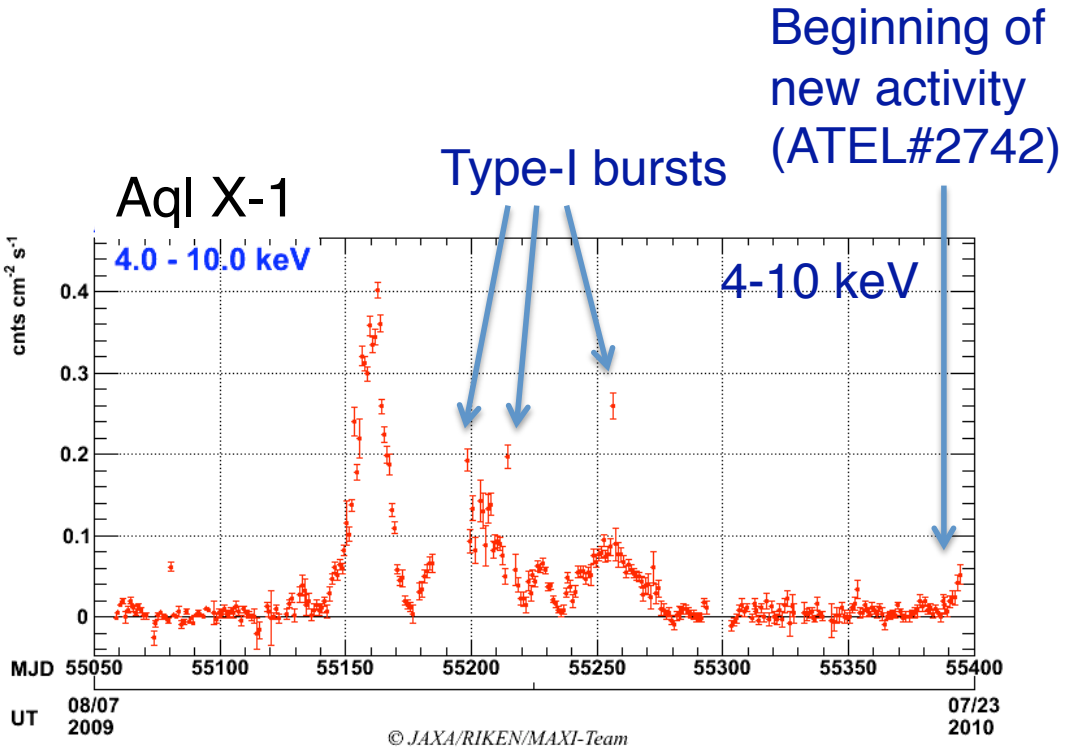


- Discovery of cyclotron line by Suzaku/RXTE follow-up observations

Low-Mass X-ray Binaries

- Aql X-1
- 4U 1608-22
- Cir X-1
- 4U 1323-619
- 4U 1954+319
- RX J1709.5-2639
- NGC 6640 X-2
  (SAX J1748.9-2021)
- Sco X-1
- GX 17+2
- .....

- Monitoring activities of bursts and jets.



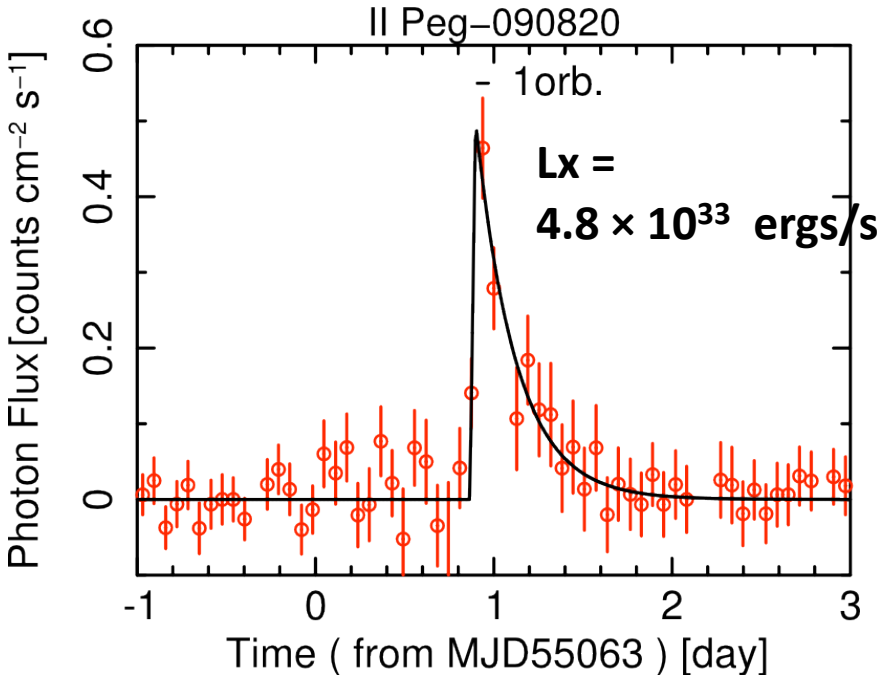
~ 1yr

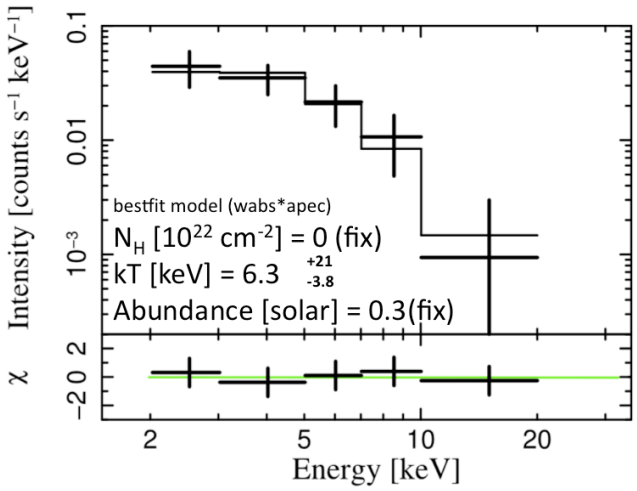
Some show hard tail in spectra in the INTEGRAL band!

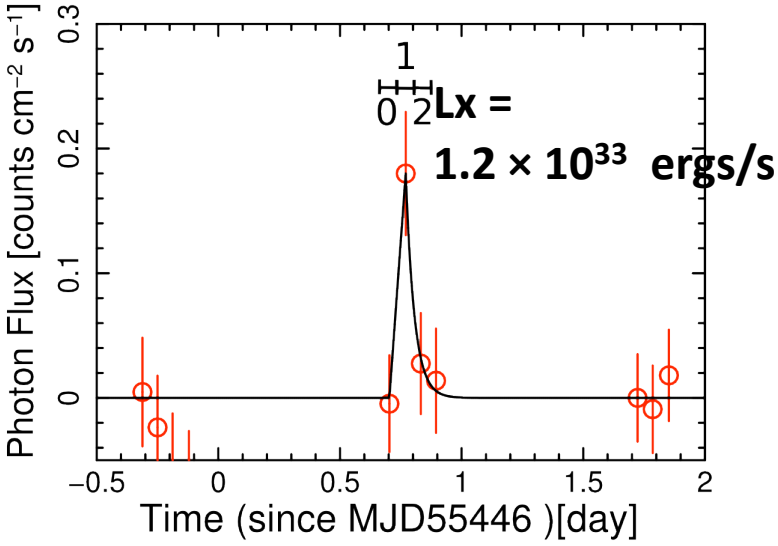
Active Stars (RS CVn, YSO, …)

- RS CVn: 14 flares from 7 sources
  - II Peg
  - AR Lac
  - UX Ari
  - HR1099
  - SZ Psc
  - …
- YSO (T Tauri)
  - TWA-7

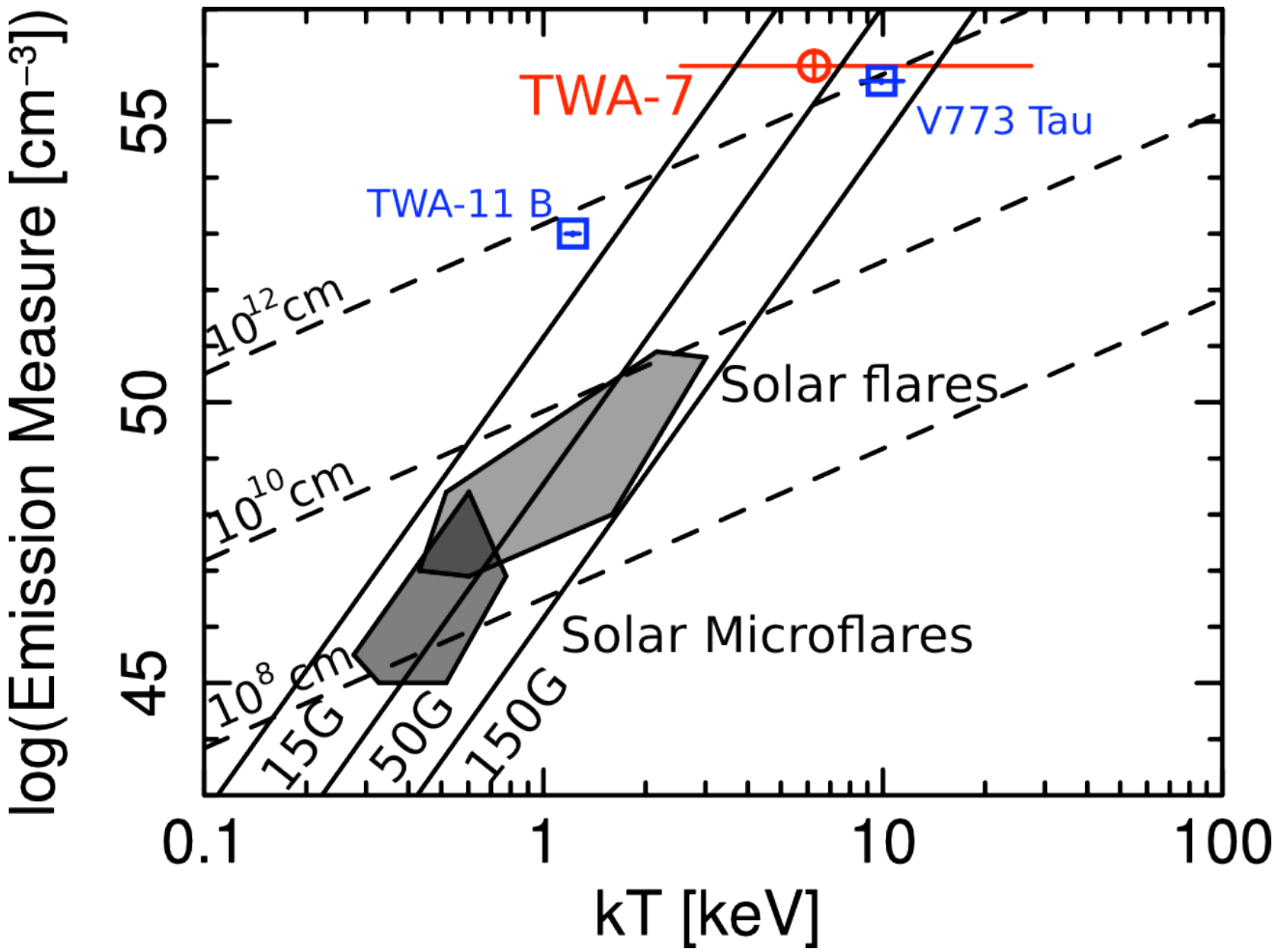
Historical brightest flares from these sources







Active Stars (RS CVn, YSO, …)



Scalable from solar flares with constant magnetic field

Crab Nebula is no longer standard candle?

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AGILE detection of enhanced gamma-ray emission from the Crab Nebula region

ATel #2855; *M. Tavani (INAF/IASF Romåa), E. Striani (Univ. Tor Vergata), A. Bulgarelli (INAF/IASF Bologna), F. Gianotti, M. Trifoglio (INAF/IASF Bologna), C. Pittori, F. Verrecchia (ASDC), A. Argan, A. Trois, G. De Paris, V. Vittorini, F. D'Ammando, S. Sabatini, G. Piano, E. Costa, I. Donnarumma, M. Feroci, L. Pacciani, E. Del Monte, F. Lazzarotto, P. Soffitta, Y. Evangelista, I. Lapshov (INAF-IASF-Rm), A. Chen, A. Giuliani(INAF-IASF-Milano), M. Marisaldi, G. Di Cocco, C. Labanti, F. Fuschino,M. Galli (INAF/IASF Bologna), P. Caraveo, S. Mereghetti, F. Perotti (INAF/IASF Milano), G. Pucella, M. Rapisarda (ENEA-Roma), S. Vercellone (IASF-Pa), A. Pellizzoni, M. Pilia (INAF/OA-Cagliari), G. Barbiellini, F. Longo (INFN Trieste), P. Picozza, A. Morselli (INFN and Univ. Tor Vergata), M. Prest (Universita` dell'Insubria), P. Lipari, D. Zanello (INFN Roma-1), P.W. Cattaneo, A. Rappoldi (INFN Pavia), P. Giommi, P. Santolamazza, F. Lucarelli, S. Colafrancesco (ASDC), L. Salotti (ASI)*
*on **22 Sep 2010; 14:45 UT***
Distributed as an Instant Email Notice (Transients)
Password Certification: Marco Tavani (tavani@iasf-roma.inaf.it)

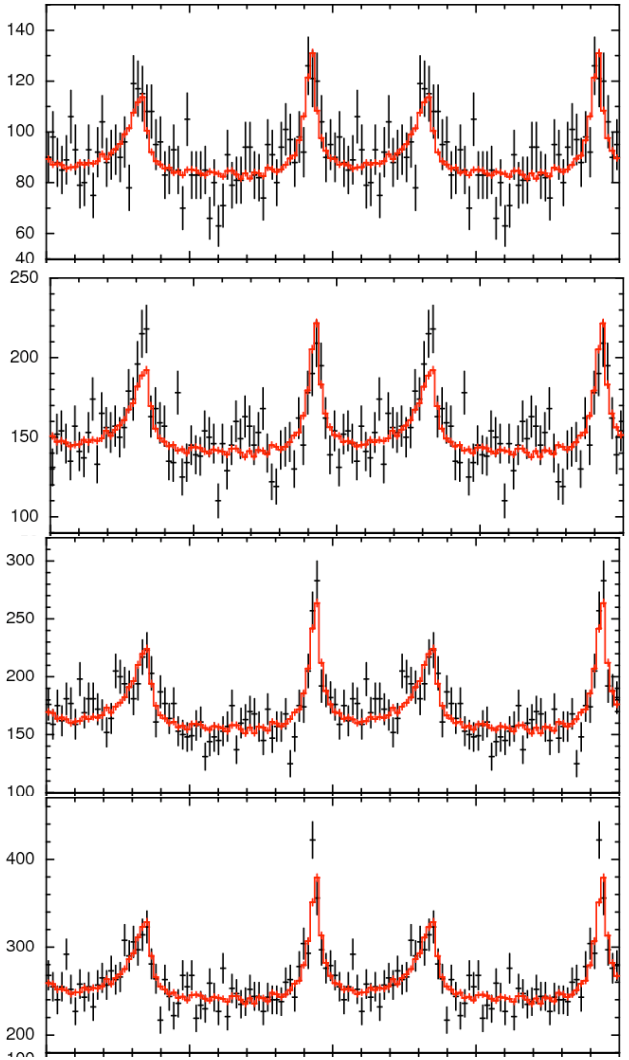
Subjects: Pulsars
Referred to by ATel #: 2856, 2858, 2861, 2866, 2867, 2868, 2872, 2879, 2882,2889, 2893, 2903, 2921, 2967, 2968, 2994, 3058

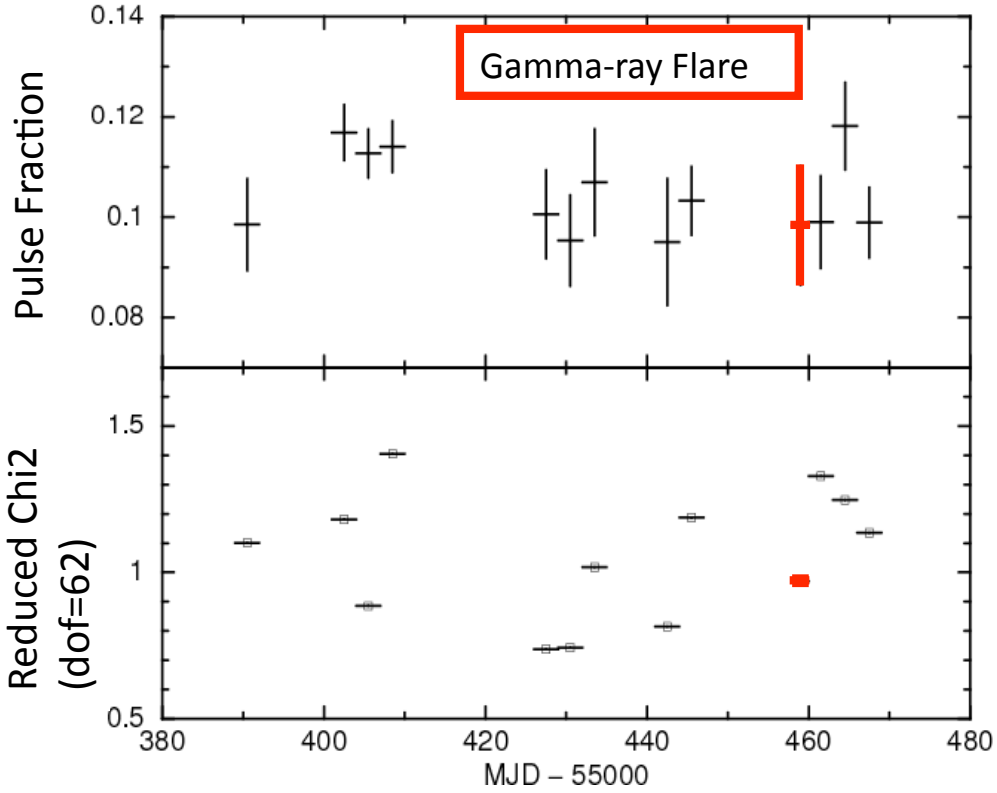
AGILE is detecting an increased gamma-ray flux from a source positionally consistent with the Crab Nebula.

Integrating during the period 2010-09-19 00:10 UT to 2010-09-21 00:10 UT the AGILE-GRID detected enhanced gamma-ray emission above 100 MeV from a source at Galactic coordinates (l,b) = (184.6, -6.0) +/- 0.4 (stat.) +/- 0.1 (syst.) deg, and flux F > 500 e-8 ph/cm2/sec above 100 MeV, corresponding to an excess with significance above 4.4 sigma with respect to the average flux from the Crab nebula (F = (220 +/- 15)e-8 ph/cm^2/sec, Pittori et al., 2009, A&A, 506, 1563).

We strongly encourage multifrequency observations of the Crab Nebula region.

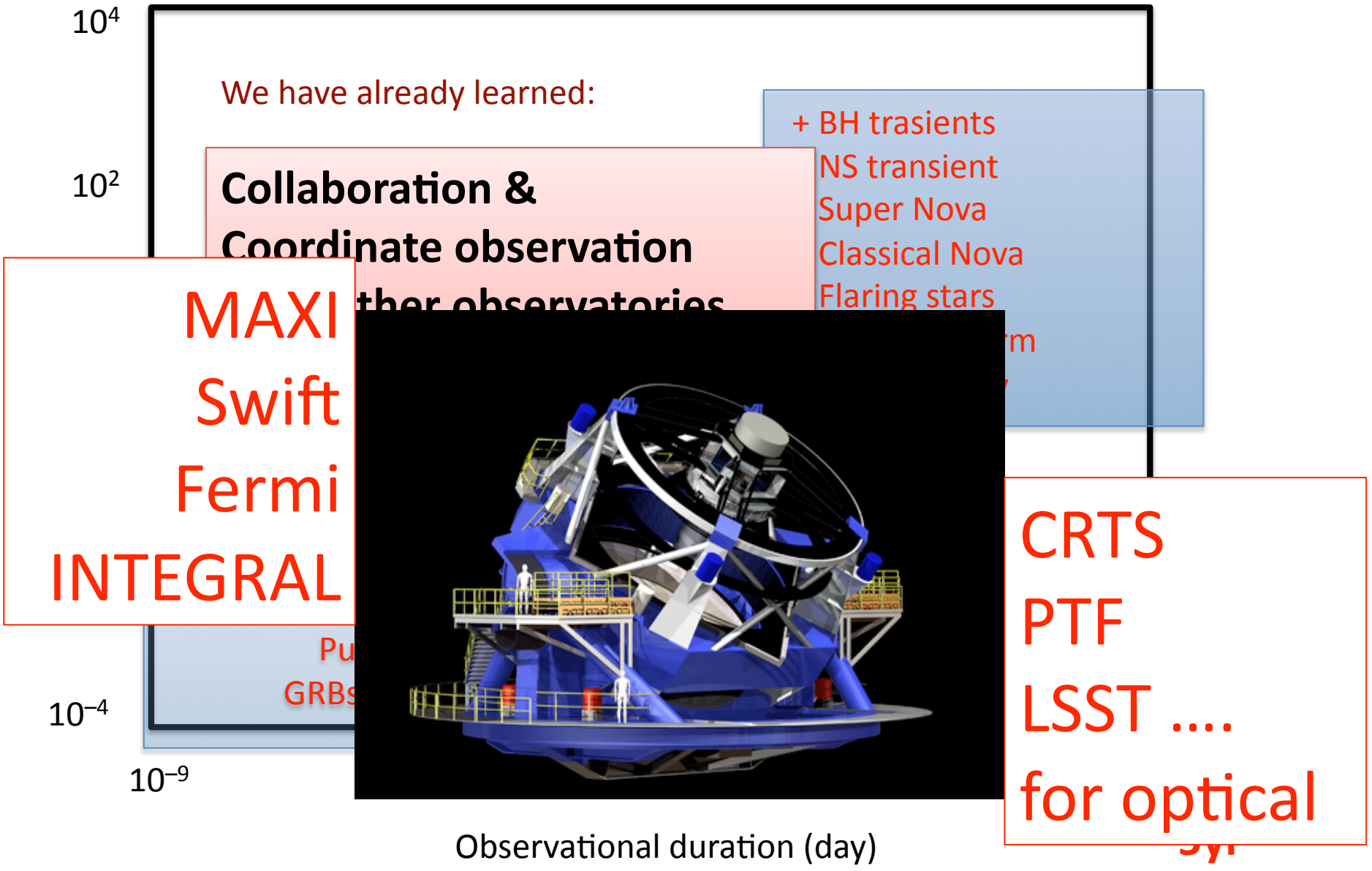
Crab Pulsar





- No significant variation in the pulse fraction during the gamma-flare in September 2011

Time domain


10^4
10^2
10^{-4}
10^{-9}
We have already learned:
+ BH trasients
NS transient
Super Nova
Classical Nova
Flaring stars
Collaboration &
Coordinate observation
MAXI
Swift
Fermi
INTEGRAL
CRTS
PTF
LSST ....
for optical
Observational duration (day)

Summary

- Site of CR acceleration could be found via electromagnetic waves.
  - For UHECR, needs some breakthrough.
- Combined multiwavelength observations are tremendously valuable!
- VHE-Gamma, Gamma, X, Optical +Cosmic Rays
- Pointing should follow survey observations.