Large Area X-ray Proportional Counter (LAXPC) instrument onboard ASTROSAT

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X-rays from the Sun

The first astronomical X-ray experiments were performed in the US in1948 and 1949 using captured WWII V2 rockets. X-rays were detected from the Solar corona by Herb Friedman and collaborators at the US Naval Research Lab (in Washington DC).

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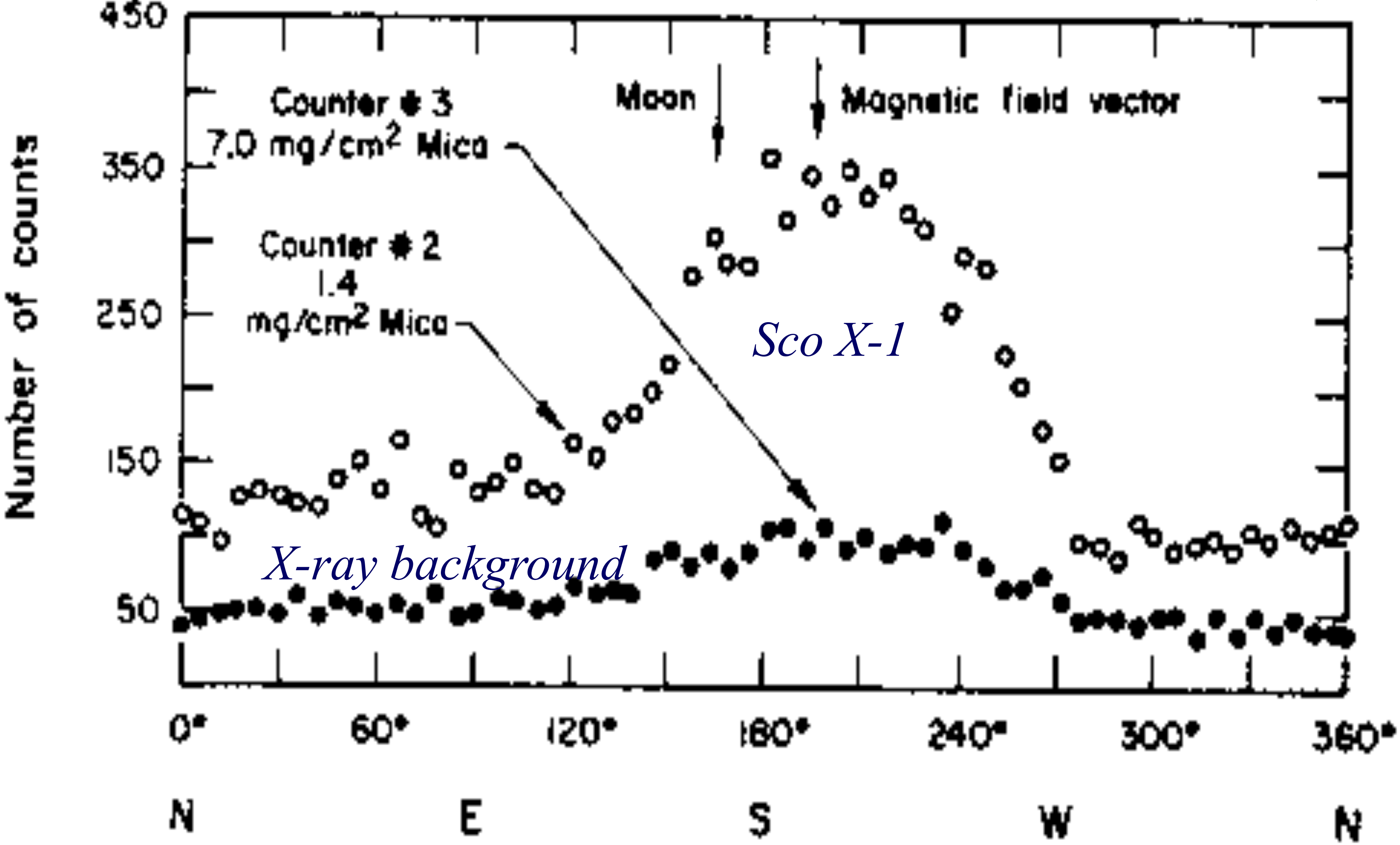
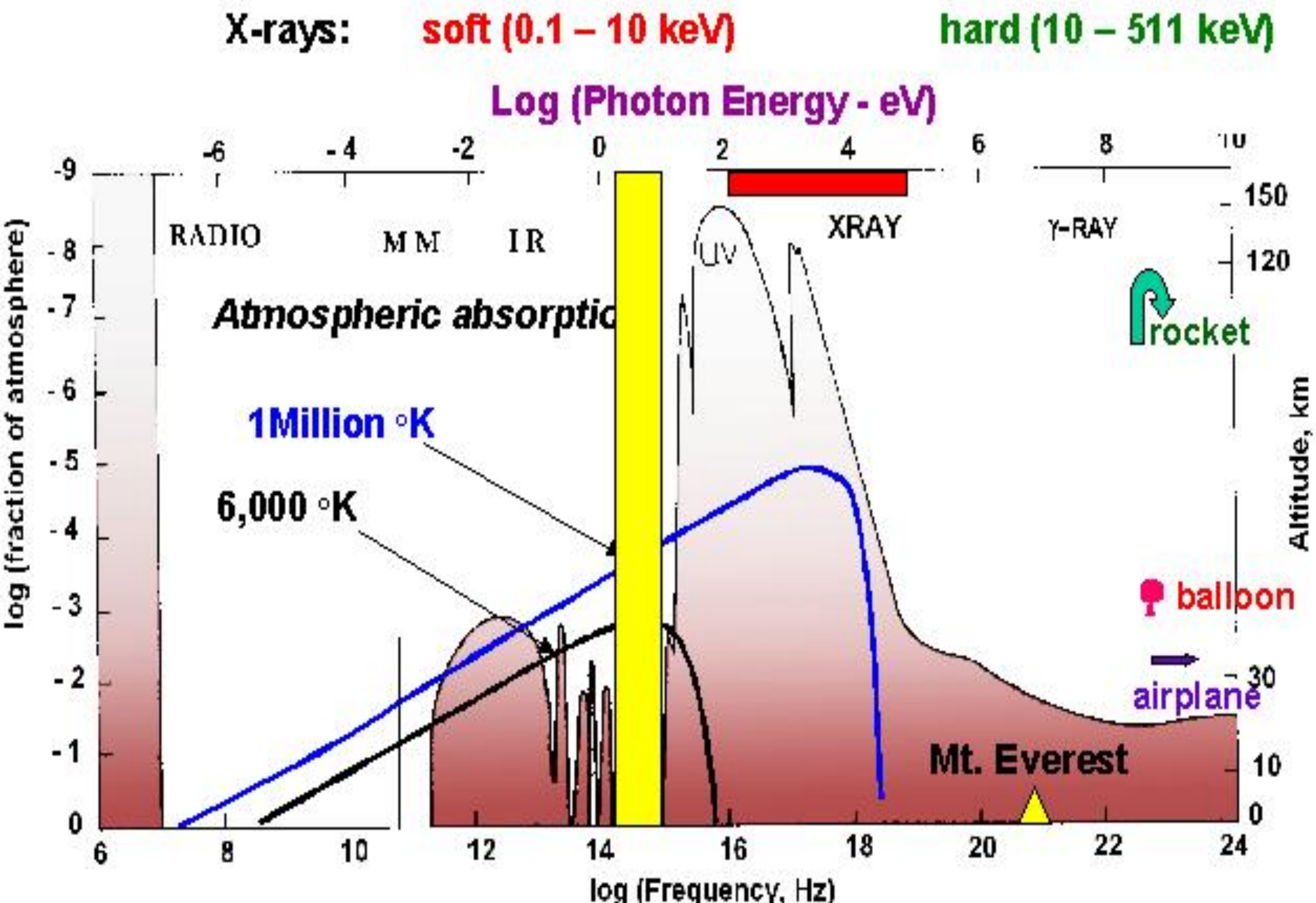
The First Extra-Solar X-ray Detection

Giacconi et al., 1962



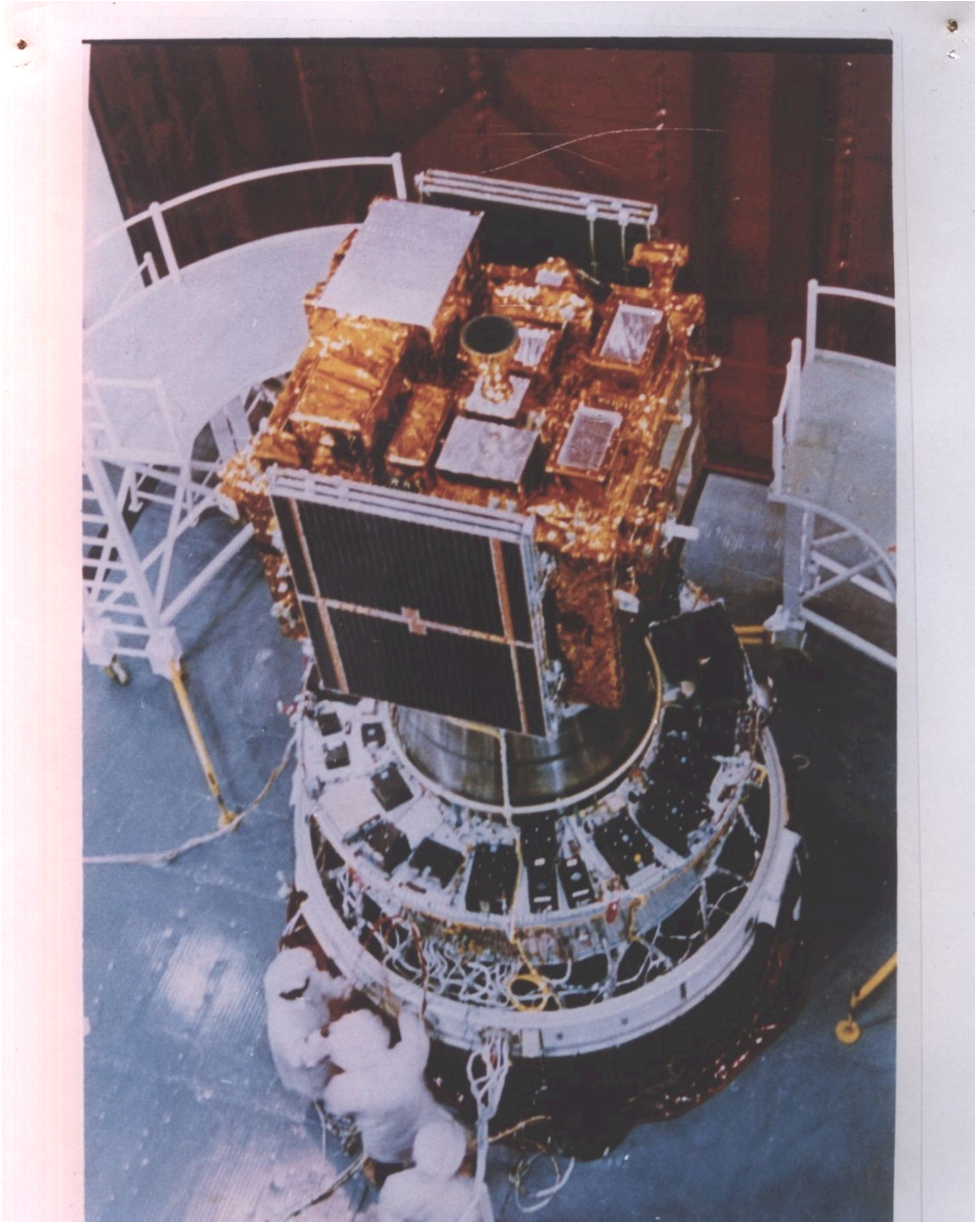
Riccardo Giacconi receives 2002 Physics Nobel Prize from King of Sweden



X-rays: soft (0.1 – 10 keV) hard (10 – 511 keV)
Log (Photon Energy - eV)
-6 -4 -2 0 2 4 6 8 10
RADIO
MM
IR
UV
XRAY
γ-RAY
Atmospheric absorptic
1Million °K
6,000 °K
rocket
balloon
airplane
Mt. Everest
log (fraction of atmosphere)
-9 -8 -7 -6 -5 -4 -3 -2 -1 0
Altitude, km
150 120 30 10 0
6 8 10 12 14 16 18 20 22 24
log (Frequency, Hz)

•IXAE on IRS-P3

- Launched on March 21, 1996 from SHAR
- IXAE PPCs on top deck with remote sensing instruments
- Stellar mode observations for about 2/3 months in a year
- IXAE switched off after 5 yrs of operation due to depletion of fuel for pointing control



ASTROSAT Mission Overview

- *Mission : Simultaneous Multi wavelength Astronomy observations visible to hard x-ray*
- *Orbit Altitude : 650 km, Inclination : 6 deg. – near equtorial*
- *Mass :1550 kg (~800 kg science payloads)*
- *Power: 2100 watts*
- *Payload pointing : 0.05 deg*
- *Slew rate : 0.6 deg/sec*
- *Launch: By PSLV XL, –From Sriharikota*
- *Initially planned in October, 2015*

preponed to September 2015

- *Operational life : 5 years*

RXTE Chronology

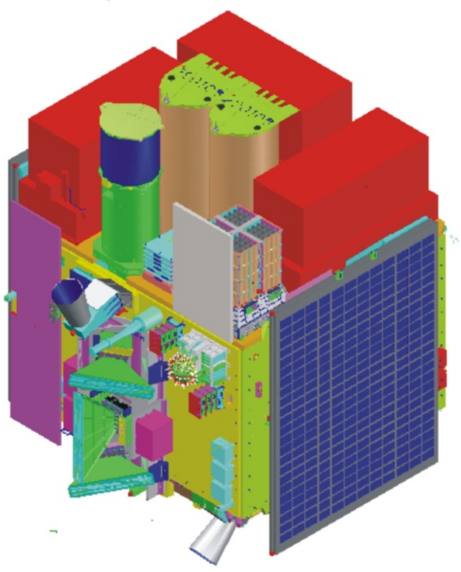
Proposal Phase	1974 -1980 (Oct 17, 1980)
Phase II	1980 – 1989
Phase III	1989 – 1995
Launch	Dec 30, 1995
Switched Off	January 5, 2012
Active life	16 years

ASTROSAT Chronology

Written proposal was submitted	2000
Seed Development Money	2002
Organization of Astrosat Project	2003
Management Structure	2004
Formal project approved	2005
Payload Delivery	2014
Launch	2015
Operation	10 Years nominal

ASTROSAT Payload Characteristics

	UVIT	SXT	LAXPC	CZTI	SSM
Detector	Intensified CMOS	X-ray CCD	Proportional Counter	CdZnTe Detector Array	Position Sensitive Proportional Counter
Type	Imaging	Imaging	Non-Imaging	Imaging	Imaging
Bandwidth	1300 - 5500 Ang.	0.3 - 8 keV	3 - 80 keV	10 - 100 keV	2 - 10 keV
Effective Area (Cm^2)	8 - 50 (Depends on Filter)	128 @ 1.5 keV, 11 @ 6 keV	8000 @5 - 20 keV	1000 @ E > 10 keV	~60 @ 5 keV
Field of View (FWHM)	28' Dia	~40' Dia	47' x 47'	4.6° x 4.6°	22° x 100°
Energy Resolution	< 1000 A	~ 5 - 6 % @ 1.5 keV	12% @ 60 keV	8% @ 100 keV	20% @ 6 keV
Time Resolution	1.7 ms	278 ms	10 µs	1 ms	1 ms
Total Mass (Kg)	230	65	414	50	48
Prime Responsibility	IIA	TIFR	TIFR	TIFR	ISAC



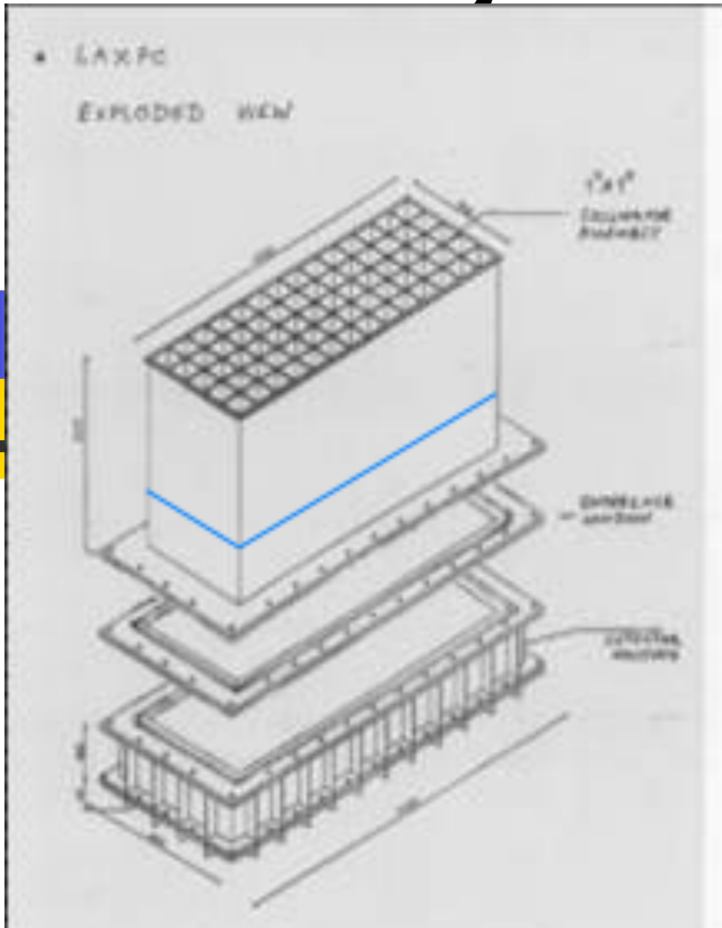
ASTROSAT has total five science instruments and LAXPC is one of the major instruments. It is a low resolution spectroscopy instrument with large effective area and very fine time resolution capabilities. There are three identical LAXPC units shown as red boxes in the figure.

Design Goals

- *All three detectors to use a common and accurate time reference.*
- *Three Independent and modular electronics systems for 3 LAXPC Detectors.*
- *To ensure high reliability and adequate safety measures against single-point failures.*
- *To have adequate redundancy built into the electronics to overcome any failure of critical processing components.*
- *Optimum design in terms of power consumption , package size, weight and resources utilisation like onboard storage memory.*

- Generate Stable & command selectable High Voltage for detector operation.
- Detector background reduction : Only accept events, which are qualified through (a) Level Discrimination (b)Mutual coincident & (c) Anti coincident.
- Design evaluation by balloon flight in 2008.

Detector System Brief description



- **LAXPC Instrument consists of 3 identical detectors.**
- **Each LAXPC has the following major components :**

Field of View Collimator (FOVC)

Window Support Collimator (WSC)

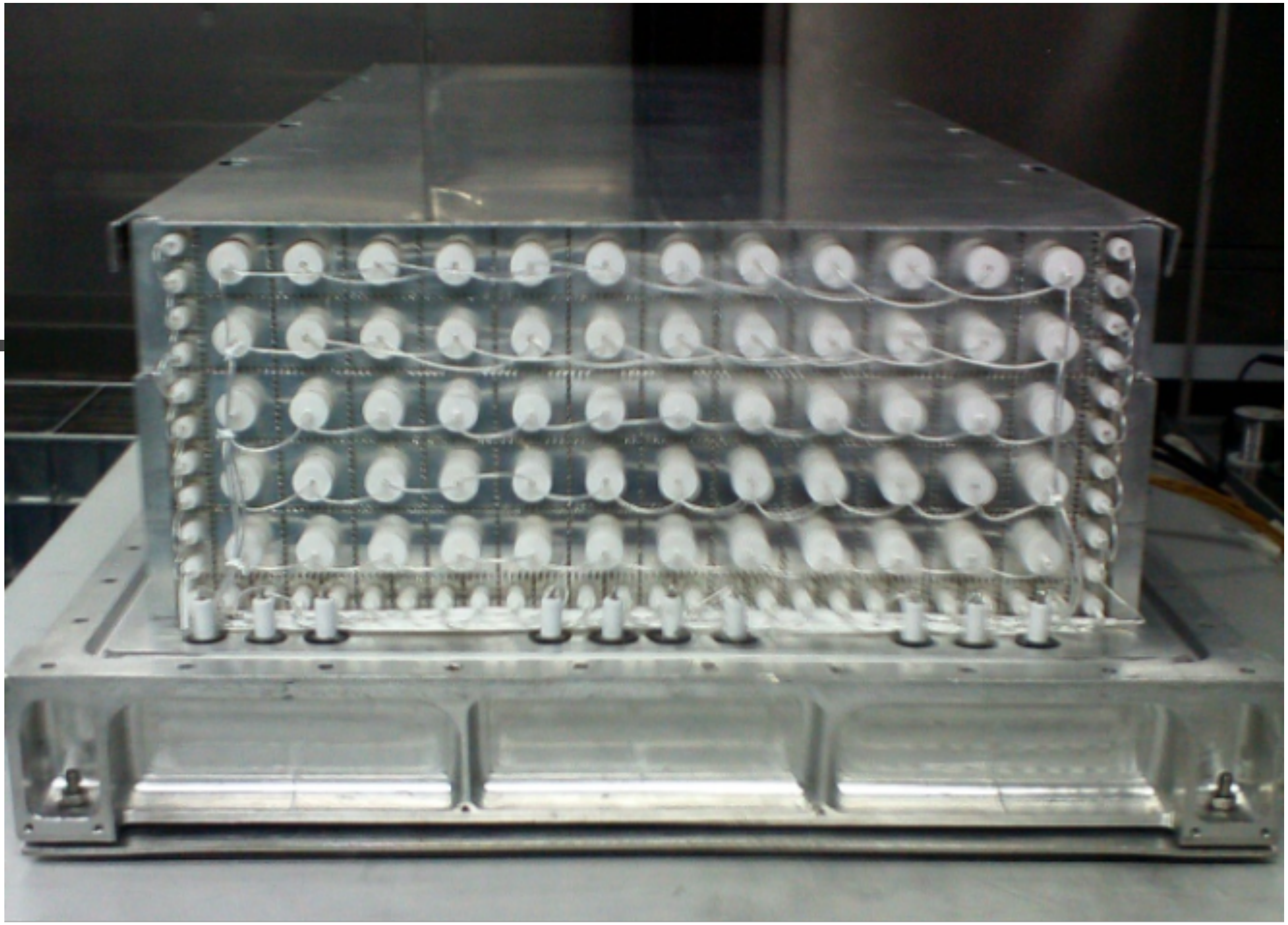
Collimator Housing

Anode Frames

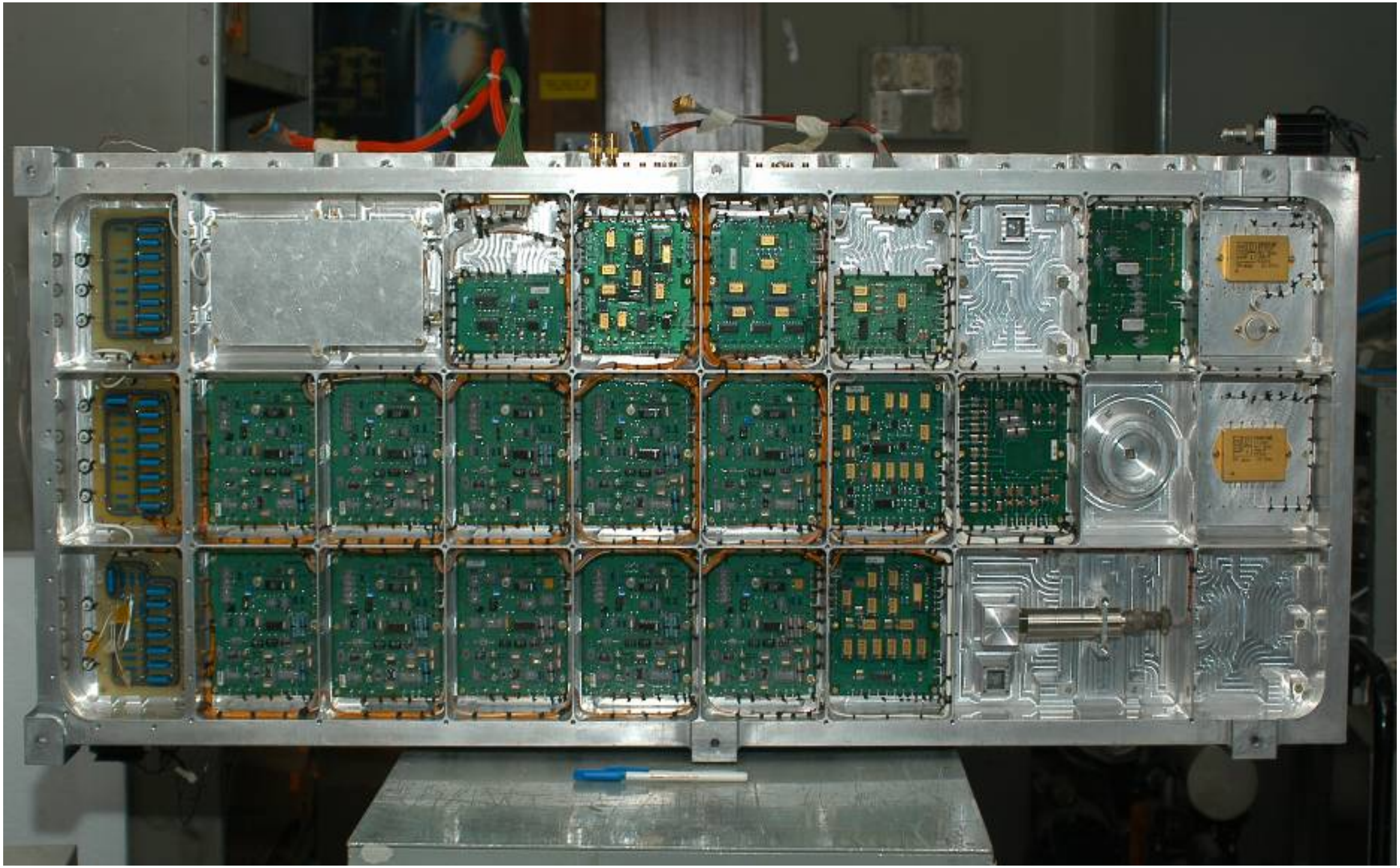
Detector Housing

Back Plate

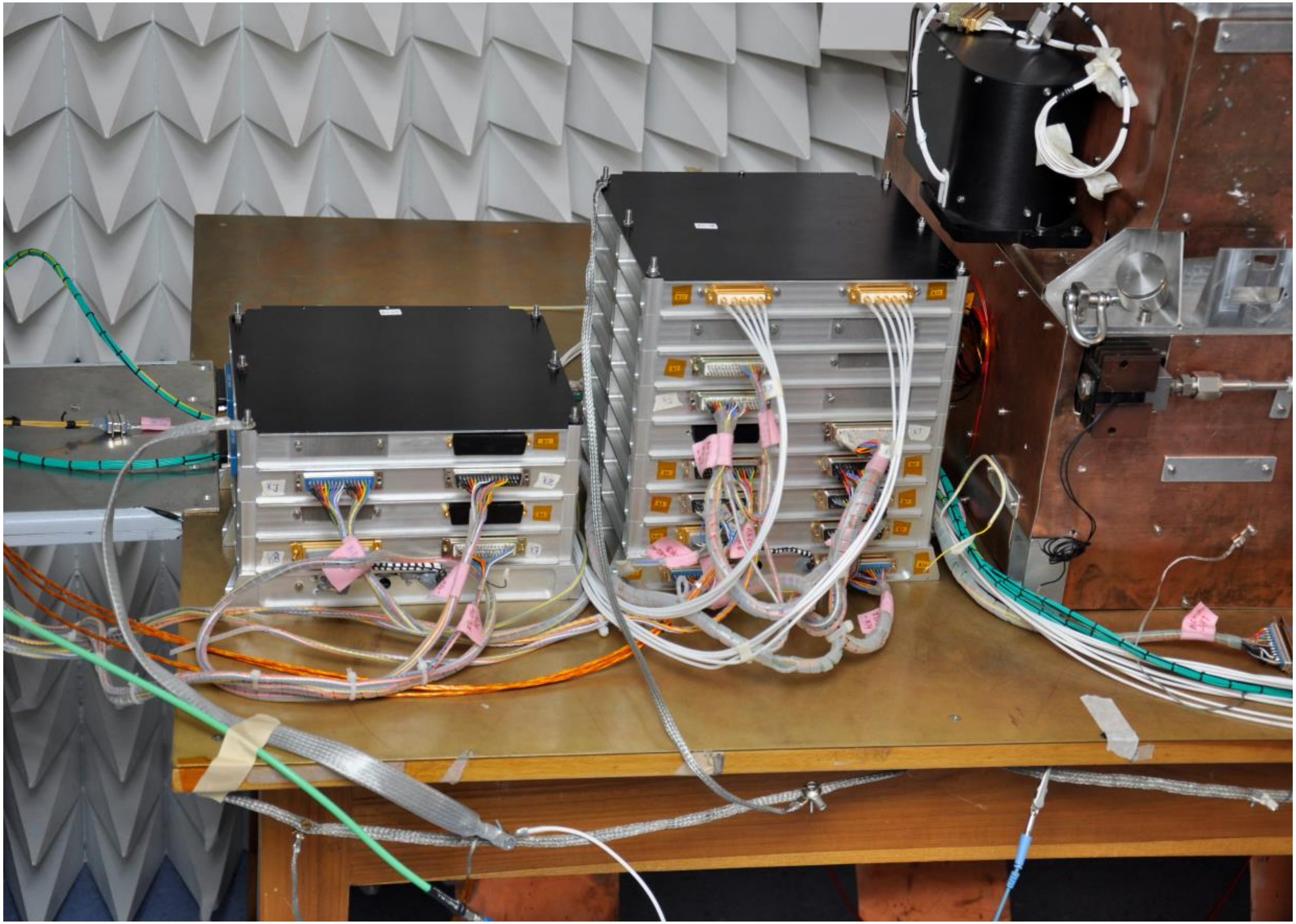
Harness wiring of detector



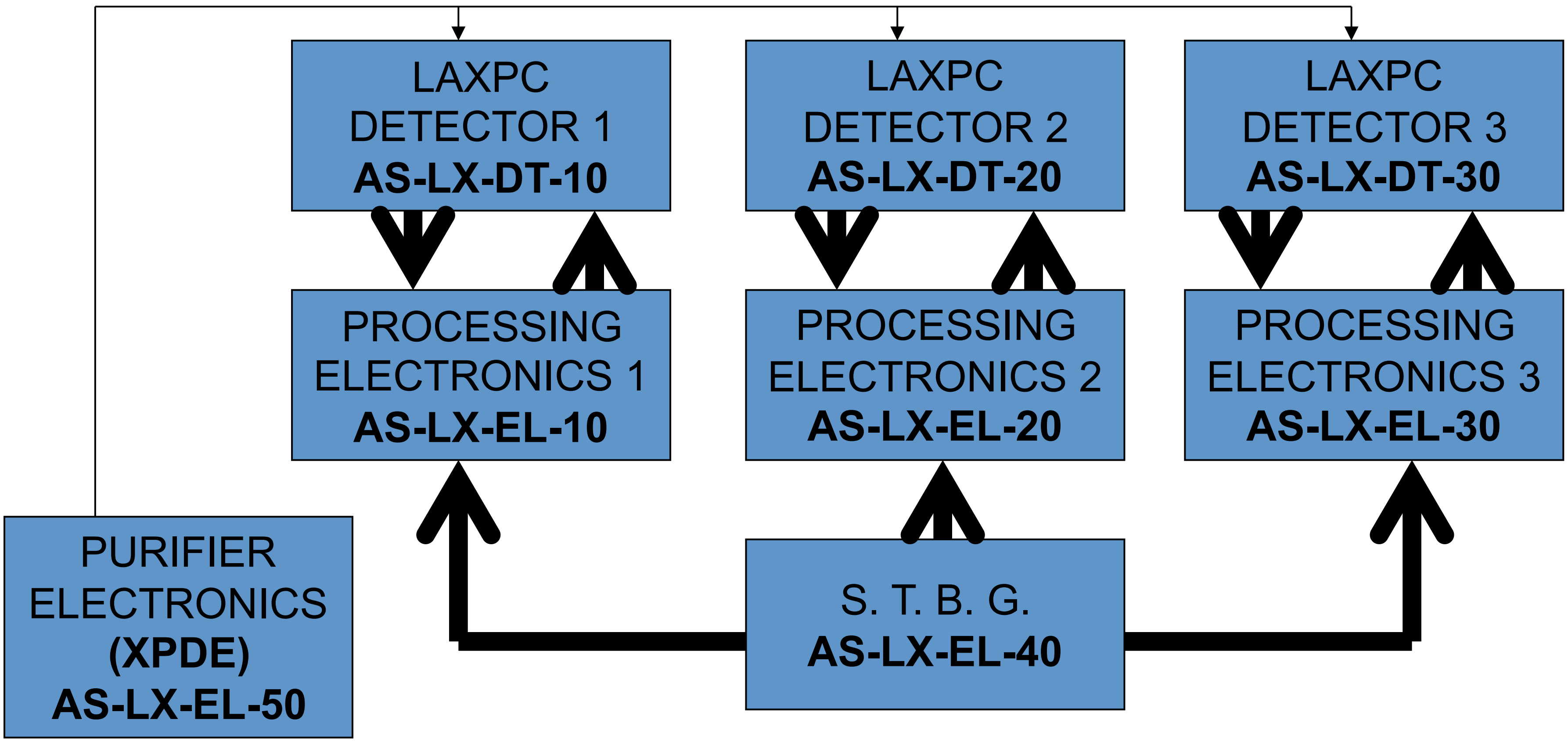
Detector Front-End Electronics



LAXPC Electronics



LAXPC Flight Packages



- LAXPC payload has 8 flight packages.
- Three Detectors,
- Corresponding Processing Electronics,
- Common STBG package, & XPDE package

In November 2012

Flight model Electronics On-Hold; Failure in hot cycle in Thermovac (both PE & STBG); New card fabrication in progress

New Problems pop up: *Capacitor issue, Pots issue, Purification issue ICs, noise current, clock speed and many other*

The CDR review of all other ASTROSAT instruments (except LAXPC) were completed in November 2012 when I was made in-charge of LAXPC instrument development. No CDR means that instrument design is not yet approved. One needs to develop first one unit and get CDR review only then work on other units can be started. It took 15 months to complete CDR review of LAXPC instrument. We worked at card level, stack level and finally at instrument level to sort out various problems.

Critical design Review

UVIT payload	*June 2011*
CZTI payload	*November 2012*
SXT payload	*November 2012*
SSM payload	*November 2012*
LAXPC payload	*January 2014*

ASTROSAT LAXPC Payload Development

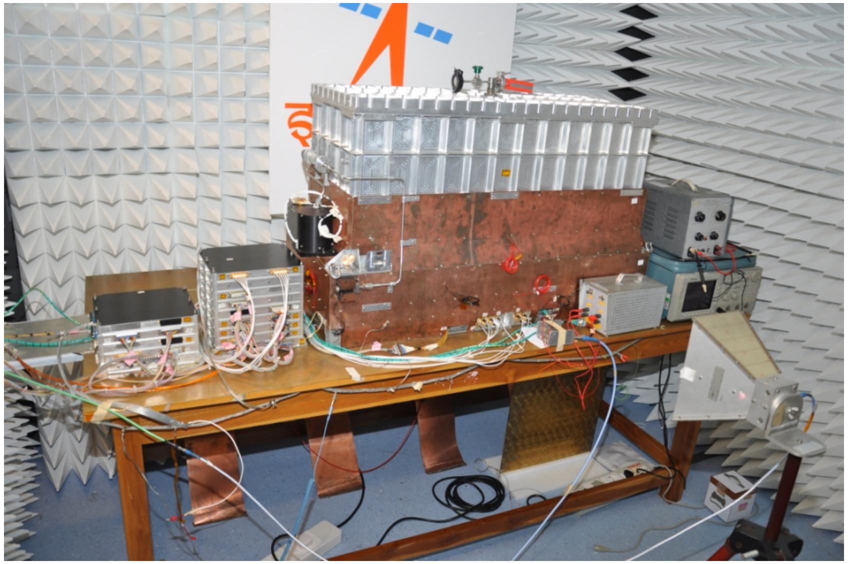
Model	Package Code	Shipment Date	Vibration Date	Vibration Level	Re-Vibration Date	Thermovac Date	Re-Thermovac Date	Calibration	Re-Calibration	Handed over to AIT
FM / Det	AS-LX-DT-10	24/01/2013	16/07/2013	Proto flight	--	20/10/2013	12/11/2013	12/13		(2)-04-2014
FM / Det	AS-LX-DT-20	16/03/2012	07/10/2013	Acceptance	--	27/12/2013	--	06/14		10-07-2014
FM / Det	AS-LX-DT-30	27/09/2013	18/07/2014	Acceptance	01/10/2014	24/07/2014	02/10/2014	21/08/2014	10/10/2014	20/10/2014
FSM / Det	AS-LX-DT-40	19-02-2010, 13-03-2013, 03-03-2015	04-05-2010	Proto flight	Waiting					
FM / PE	AS-LX-EL-10		03/04/2014	Acceptance		05/04/2014				11/04/2014
FM / PE	AS-LX-EL-20		10/04/2014	Acceptance	28/05/2014, 09/12/14	15/04/2014	30-05-2014, 11/12/2014			18/12/2014
FM / PE	AS-LX-EL-30	21/03/2014	01/05/2014	Acceptance		03/05/2014				10/09/2014
FSM / PE	AS-LX-EL-60	28-01-2013, 06-09-2013, 12-05-2014, 03-03-2015	22/10/2013	Proto flight	13/03/2015	15/03/15				
FM / STBG	AS-LX-EL-40	28/01/2013	20/11/2013	Acceptance		11/12/13				11/04/2014
FSM / STBG	AS-LX-EL-70	12/04/2013	31/07/2013	Proto flight		21/11/13				
FM / XPDE	AS-LX-EL-50	12/04/2013	Done by ISSU/VSSC							10/09/2014

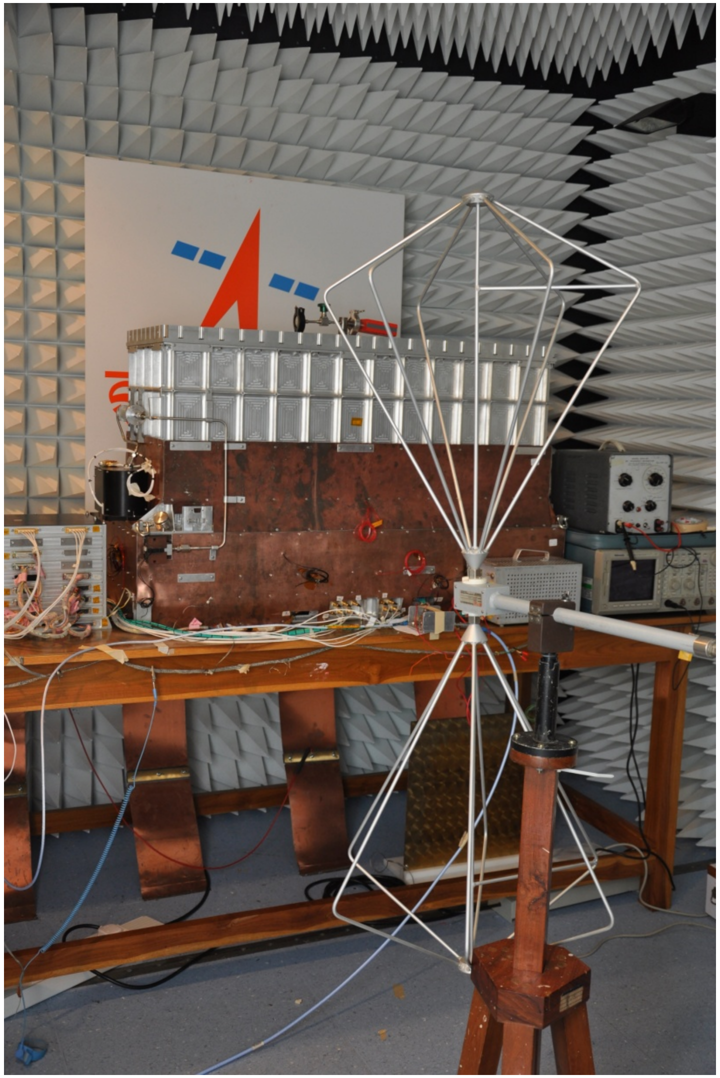
Shipping of last LAXPC detector to ISAC; 27 Sept. 2013

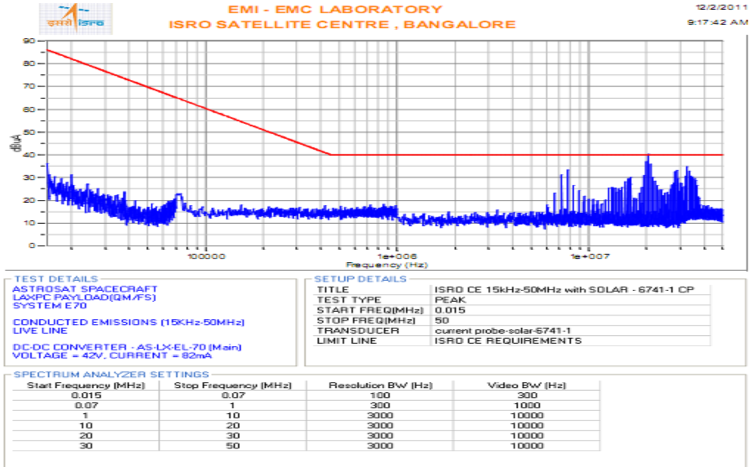
Qualification & Test sequence

- Initial Bench test
- EMI/EMC test
- Vibration test
- Thermovac test
- Purification
- Pre calibration Gain Equalisation
- Full chain Calibration
- Final Bench test
- Baking prior to AIT handover in clean room
- Interface test to satellite buses on open panel
- Disassemble mode test

LAXPC Full chain: Detector + PE & STBG on EMI/EMC Table






EMI - EMC LABORATORY
ISRO SATELLITE CENTRE , BANGALORE

12/2/2011
9:17:42 AM

TEST DETAILS
ASTROSAT SPACECRAFT
LAXPC PAYLOAD(QM/FS)
SYSTEM E70

CONDUCTED EMISSIONS (15KHz-50MHz)
LIVE LINE

DC-DC CONVERTER - AS-LX-EL-70 (Main)
VOLTAGE = 42V, CURRENT = 82mA

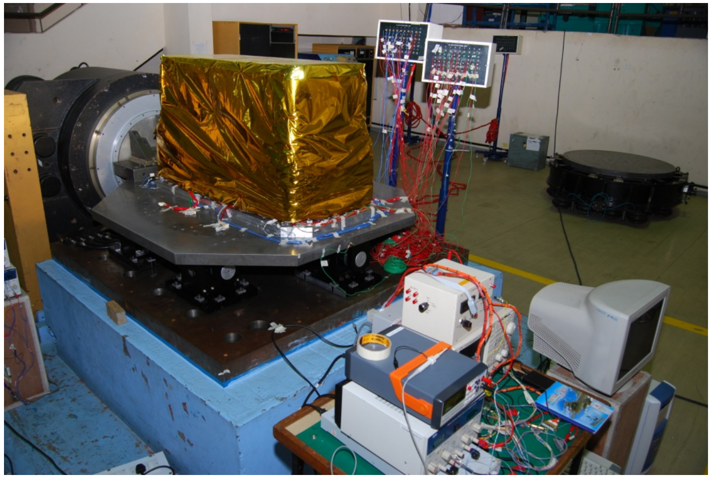
SETUP DETAILS

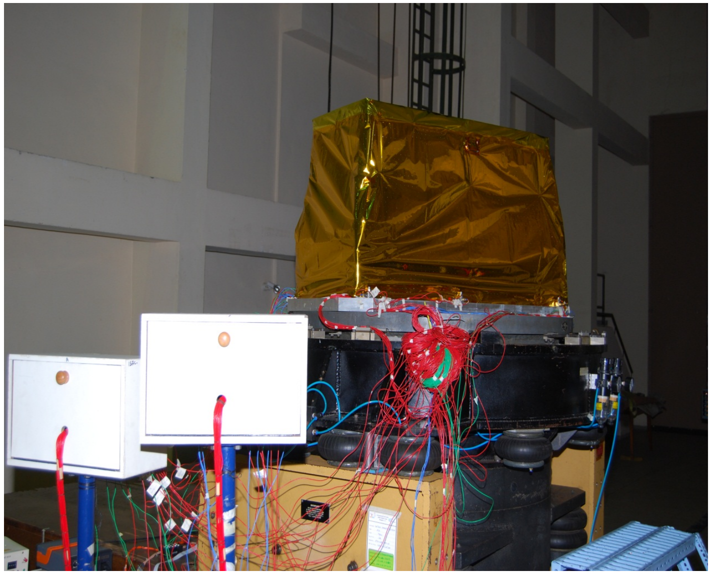
TITLE	ISRO CE 15kHz-50MHz with SOLAR - 6741-1 CP
TEST TYPE	PEAK
START FREQ(MHz)	0.015
STOP FREQ(MHz)	50
TRANSDUCER	current probe-solar-6741-1
LIMIT LINE	ISRO CE REQUIREMENTS

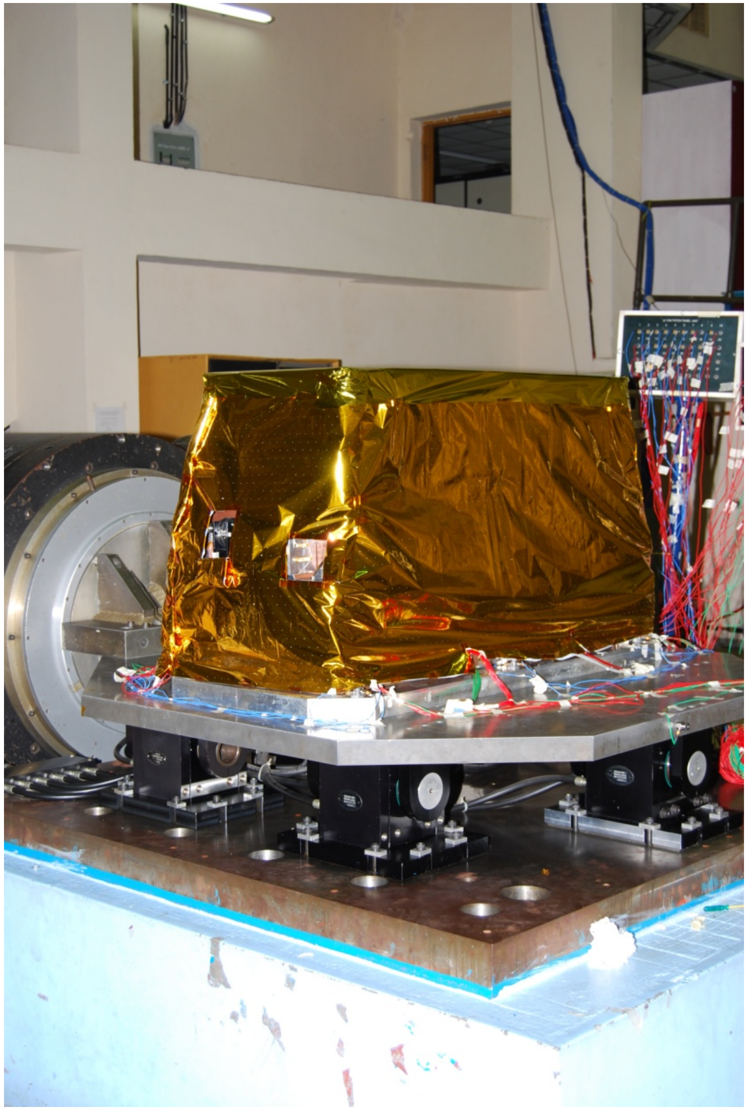
SPECTRUM ANALYZER SETTINGS

Start Frequency (MHz)	Stop Frequency (MHz)	Resolution BW (Hz)	Video BW (Hz)
0.015	0.07	100	300
0.07	1	300	1000
1	10	3000	10000
10	20	3000	10000
20	30	3000	10000
30	50	3000	10000

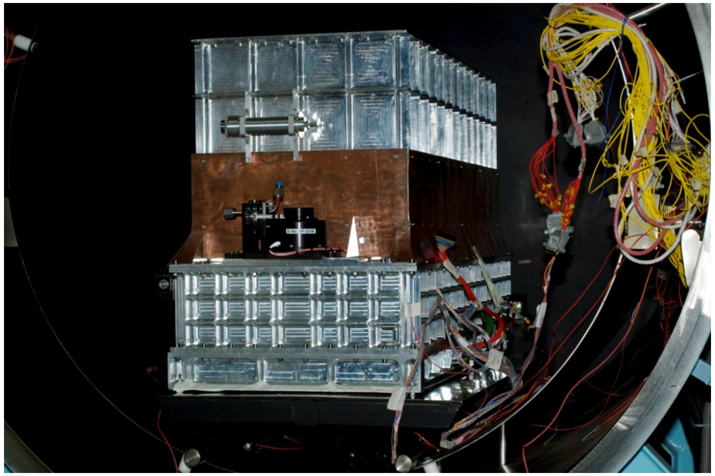
LAXPC Detector on vibration table

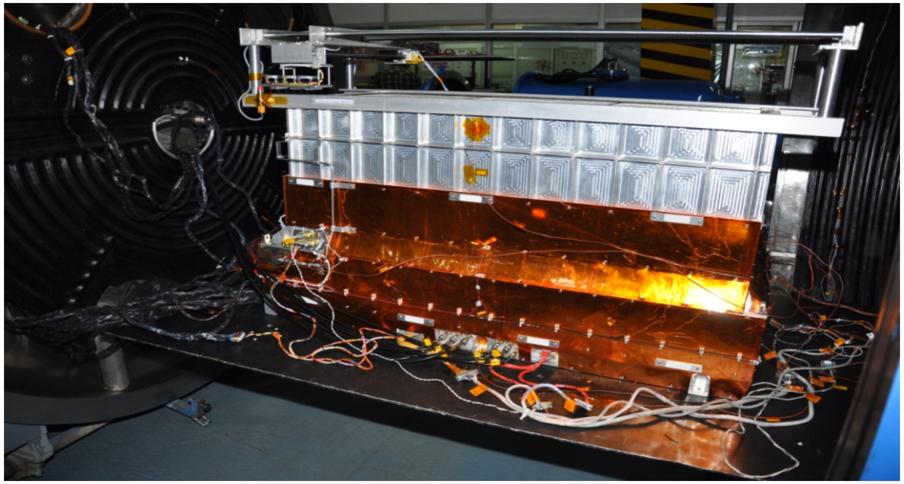






Thermovac test of LAXPC

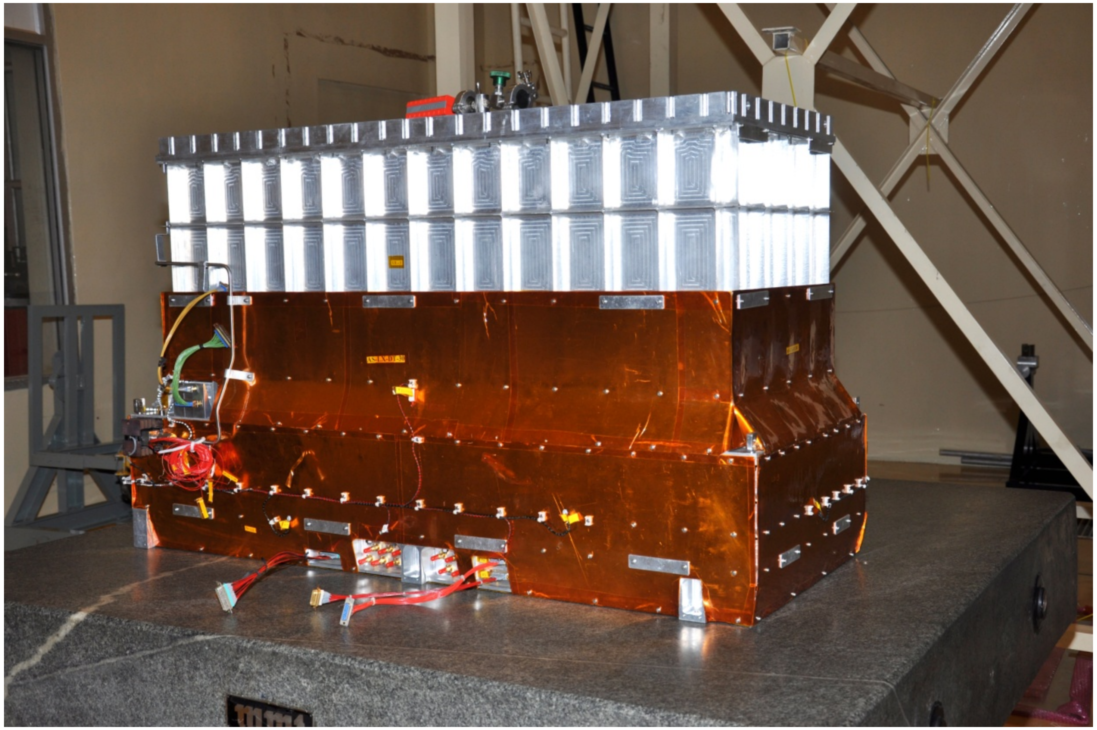




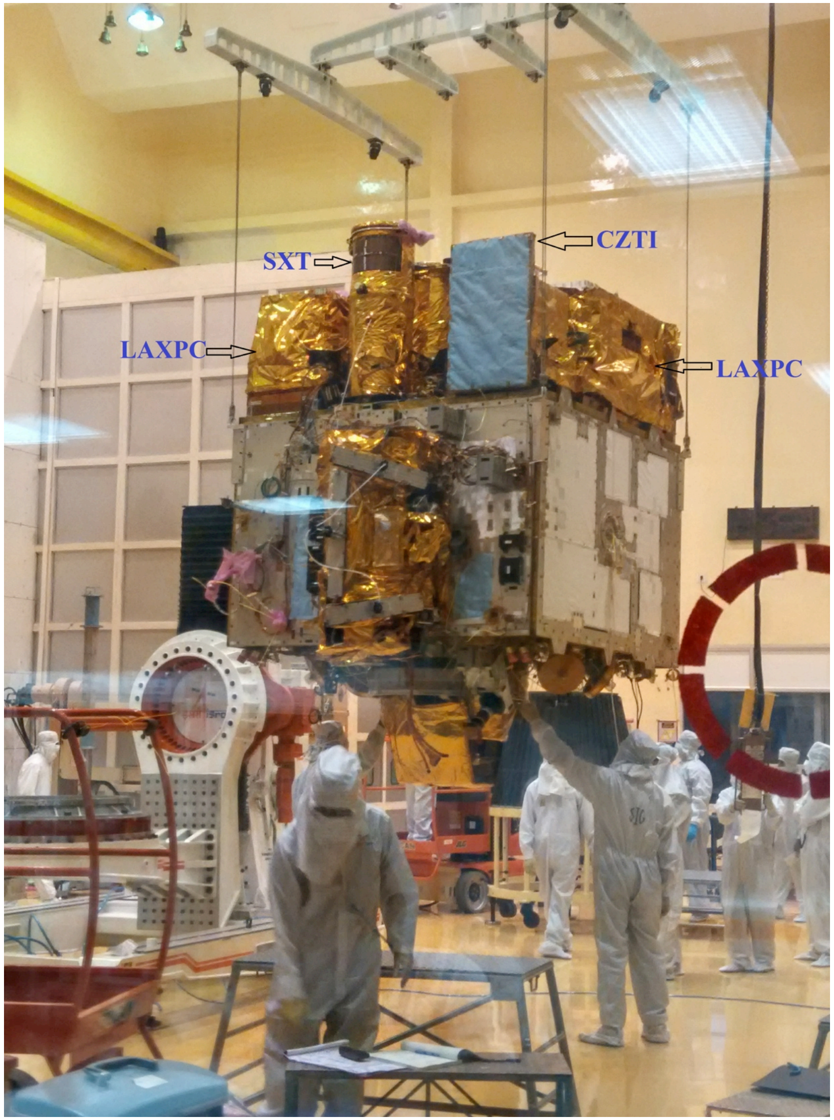
All the parameters and functionality found OK and tests successfully completed

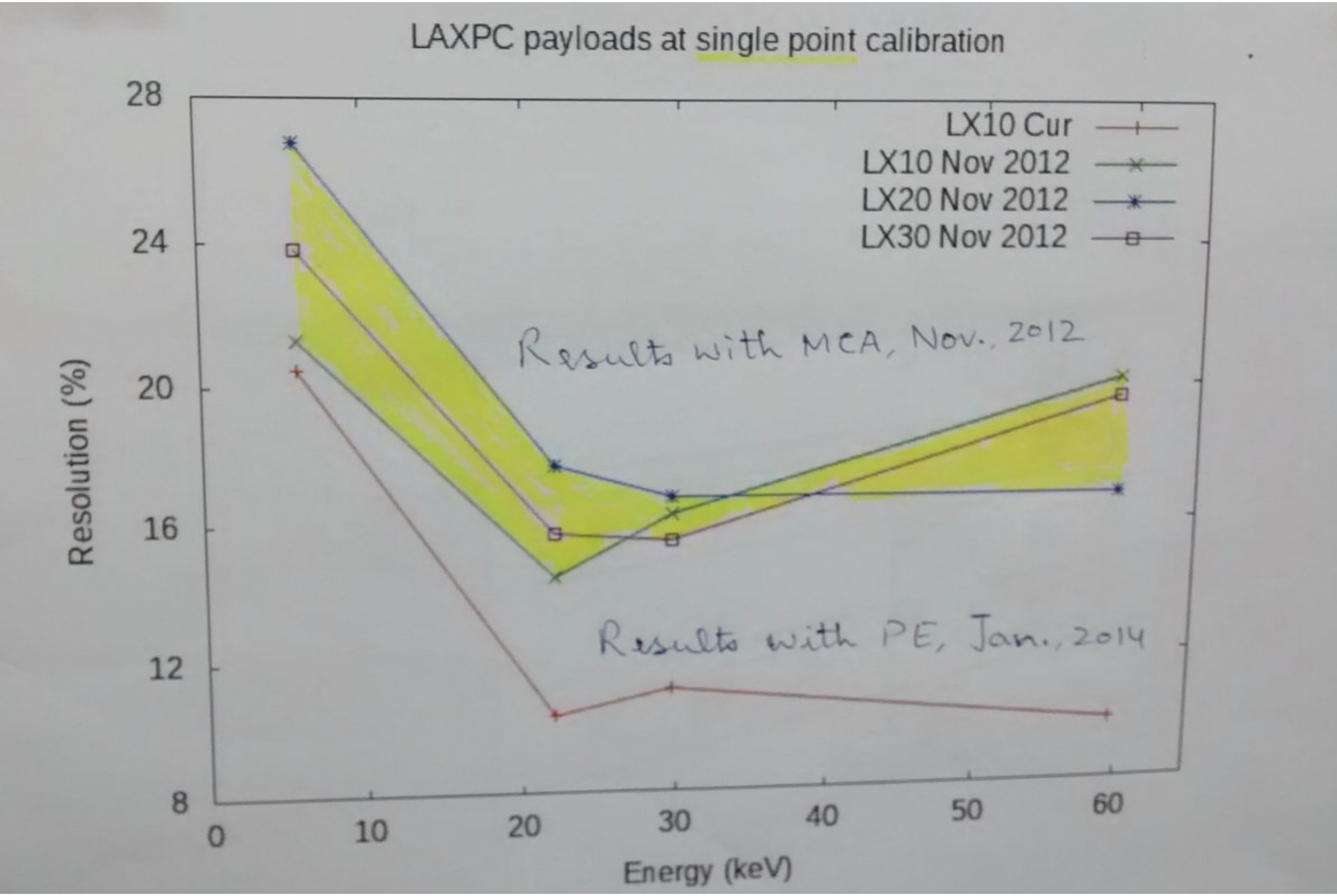
After completing all electronic & detector tests and final calibration, all three flight units of LAXPC instrument were handed over to ISRO for integration with satellite on 20th October, 2014. LAXPC instrument is the second instrument (after SXT) to be handed over to ISRO, although its development was way behind in Nov., 2012.

Alignment of LAXPC units; two units of LAXPC instrument are being tested on satellite bus



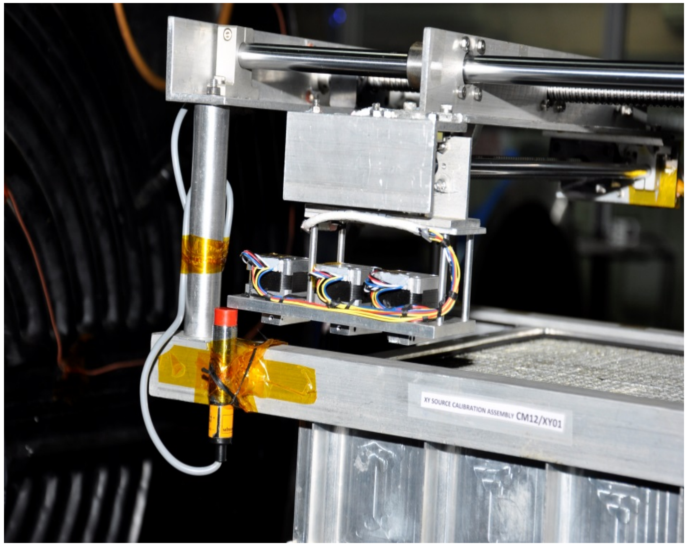
ASTROSAT assembled test in AIT, ISAC; May, 2015



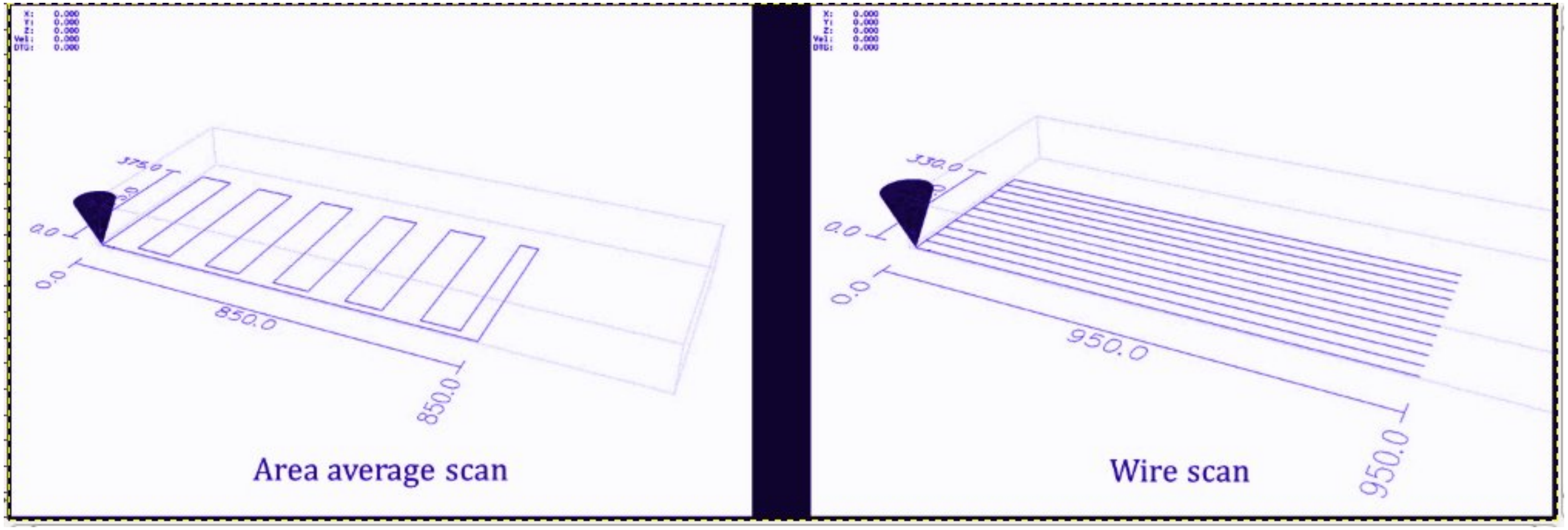

LAXPC payloads at single point calibration
LX10 Cur
LX10 Nov 2012
LX20 Nov 2012
LX30 Nov 2012
Results with MCA, Nov., 2012
Results with PE, Jan., 2014
Resolution (%)
Energy (keV)
28
24
20
16
12
8
0
10
20
30
40
50
60

Test set-up

- Three radioactive sources, Iron (Fe^{55}), Cadmium (Cd^{109}) & Americium (Am^{241}), were used for the calibration of LAXPC flight detector.
- The thermovac chamber pressure were about ~$1x10^{-6}$ mbar at various temperature.
- The complete chain (Flight Detector + PE + STBG) was setup.

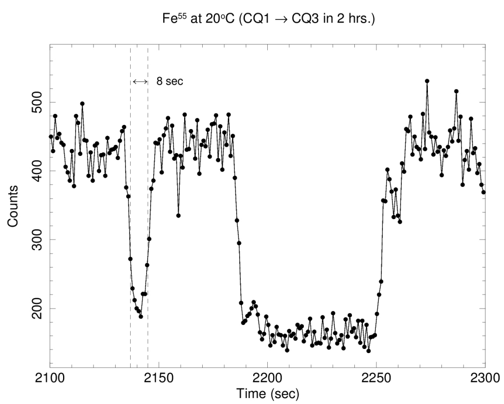


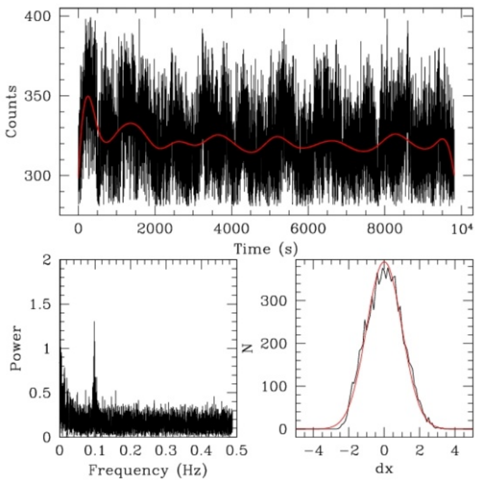
Calibration scan profile



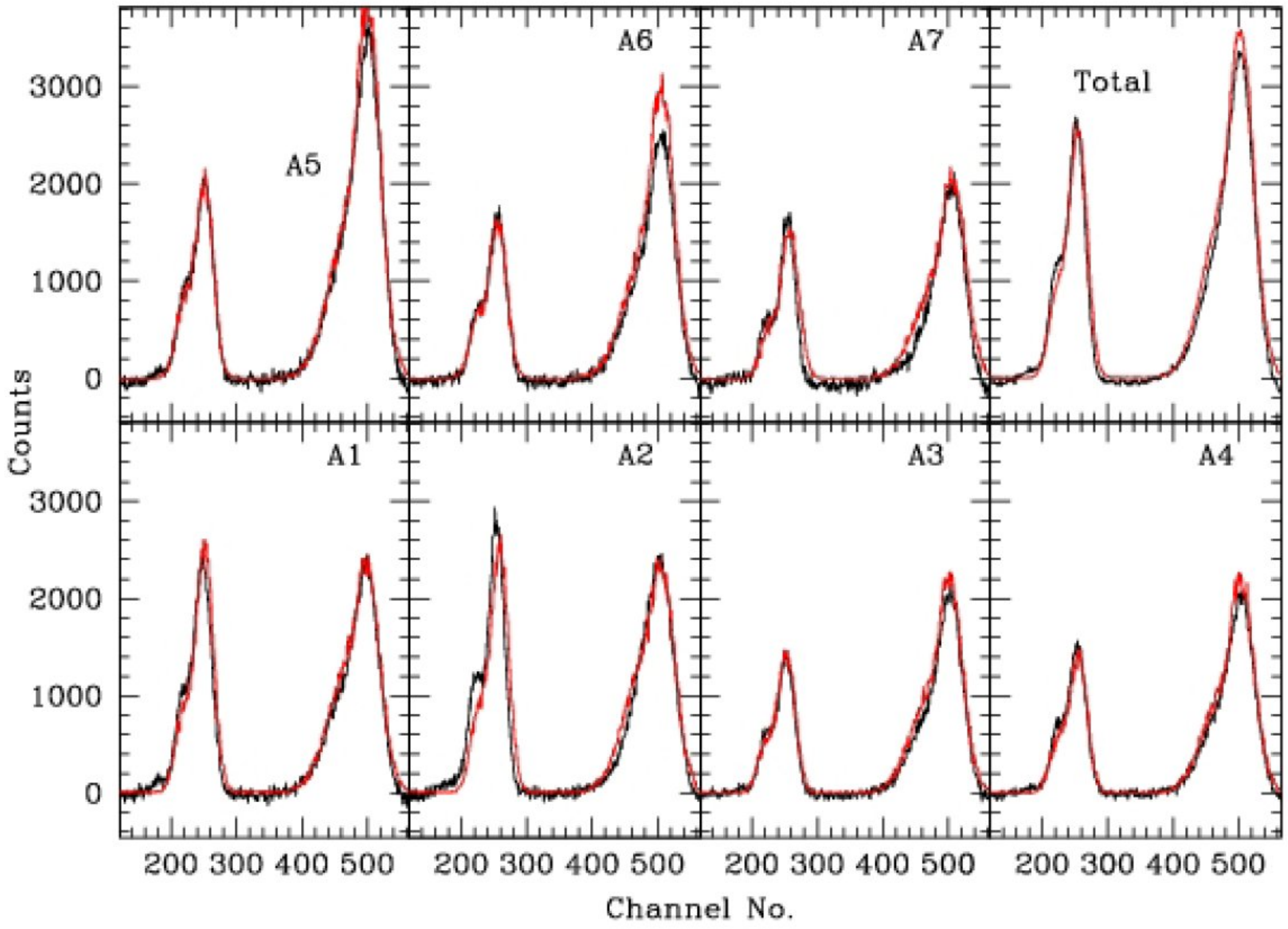
Study of collimator characteristics & GEANT4 simulation

- *Better calibration by developing remotely controlled x-y motion and on/off of radio active sources from out side the thermvac chamber*
- *Study of Collimator characteristics*
- *GEANT4 simulation of LAXPC detector*





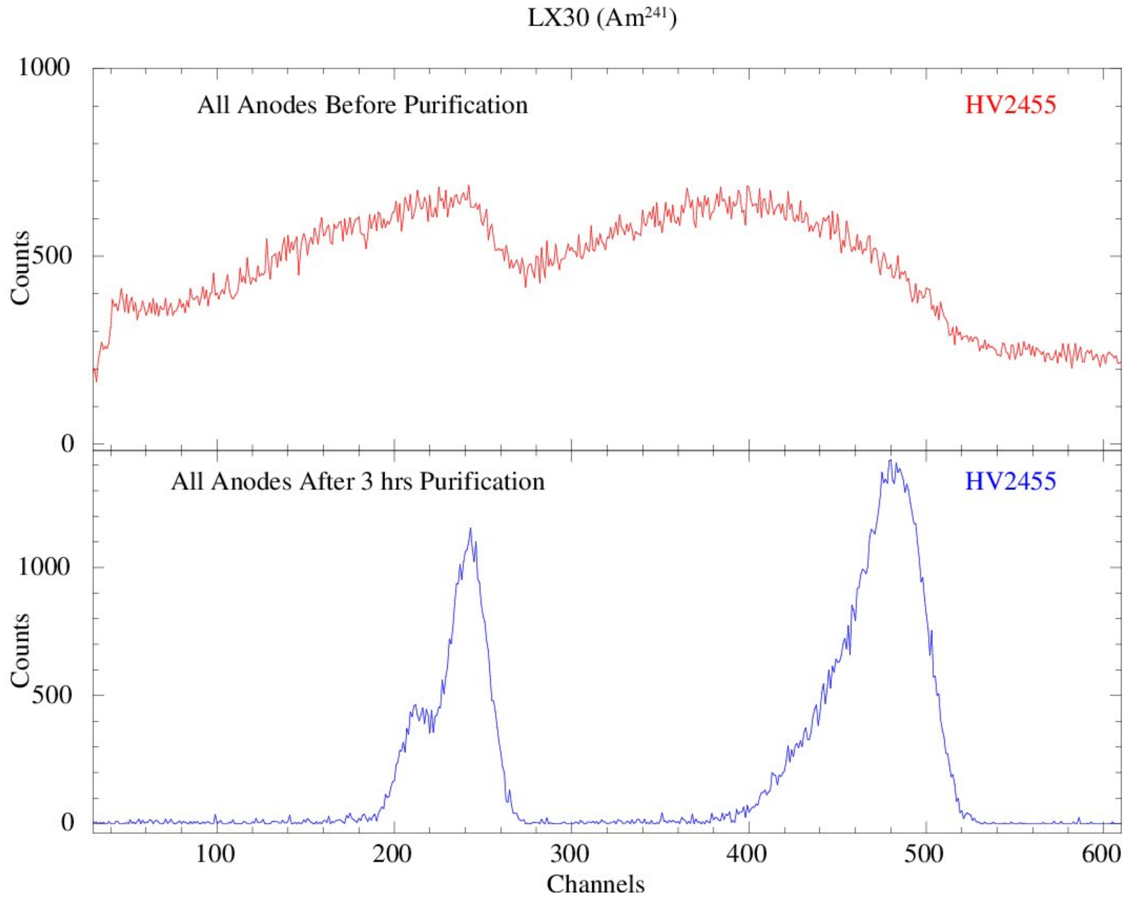
GEANT4 simulation for LAXPC30 unit & results for Am source (all 5 layers)

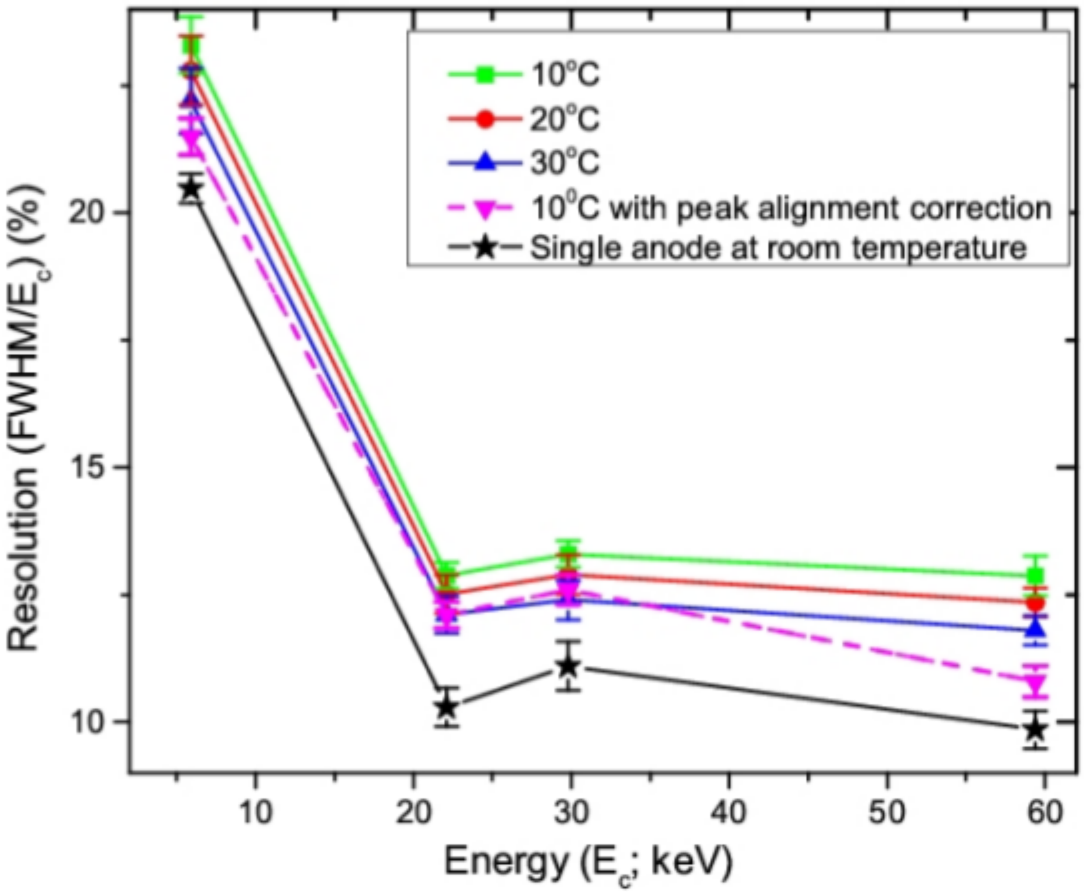


Sorting out purification cartridge issue in LAXPC30 at ISAC on 20th August, 2014

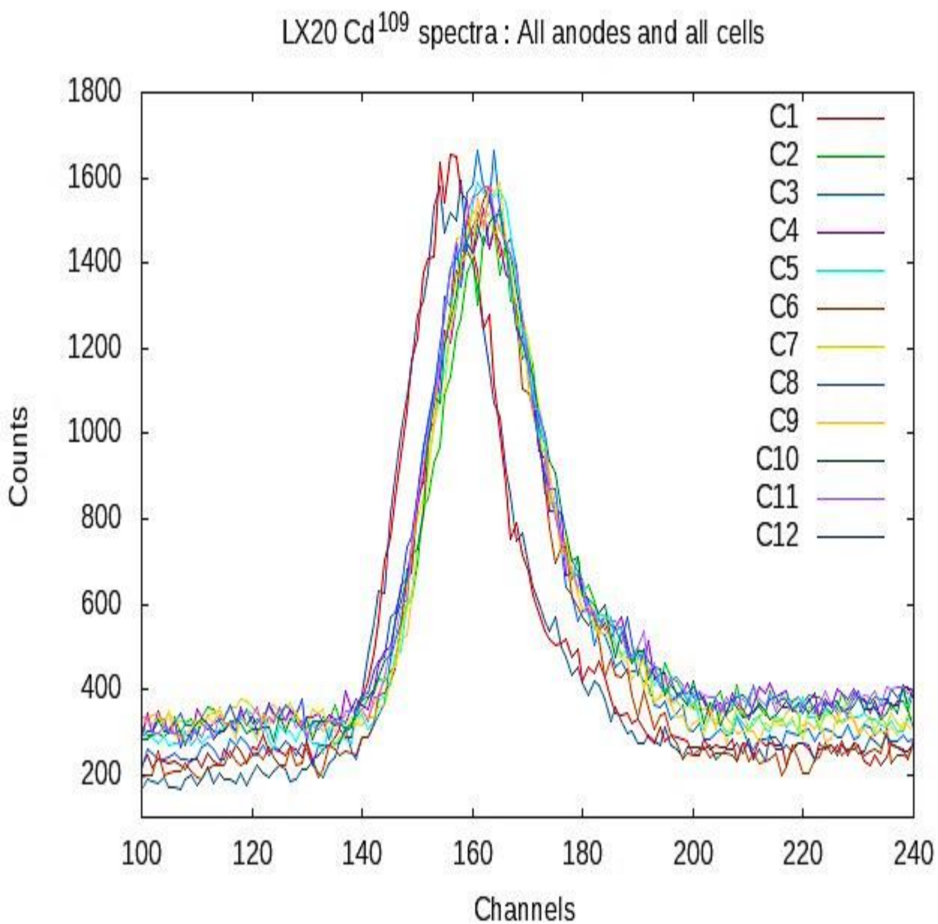
DT-30 (August-Sept. 2014)

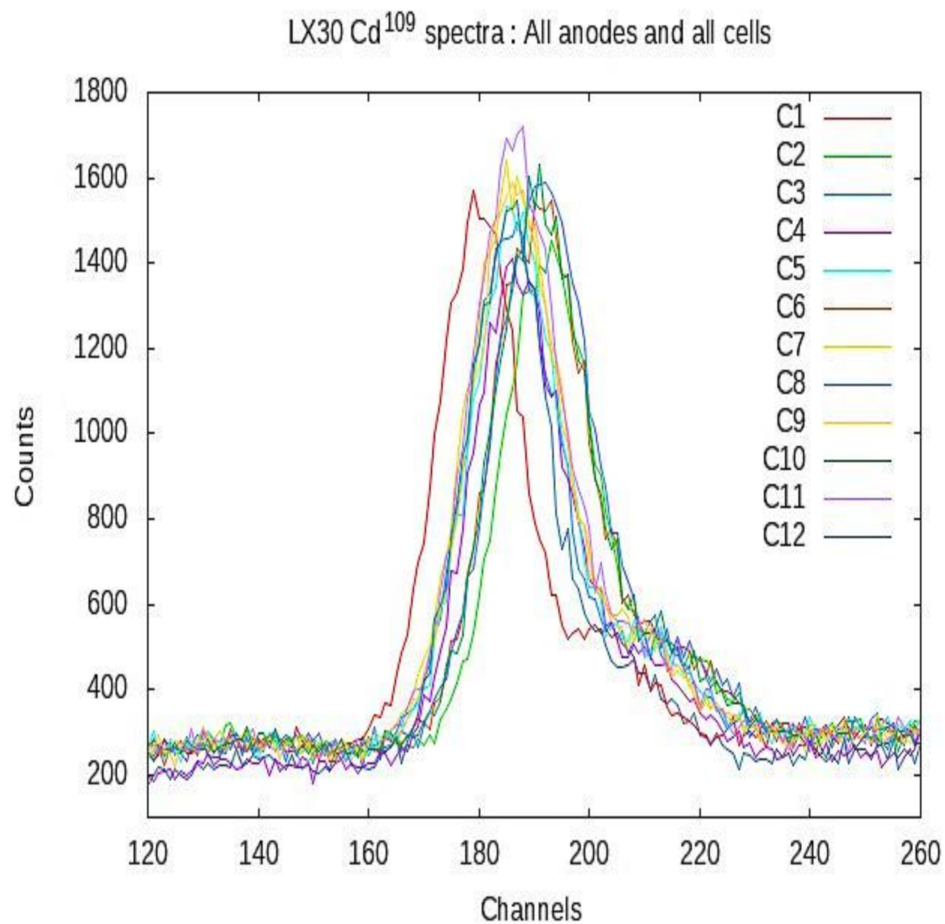
After 3 hrs purification Am241 source.



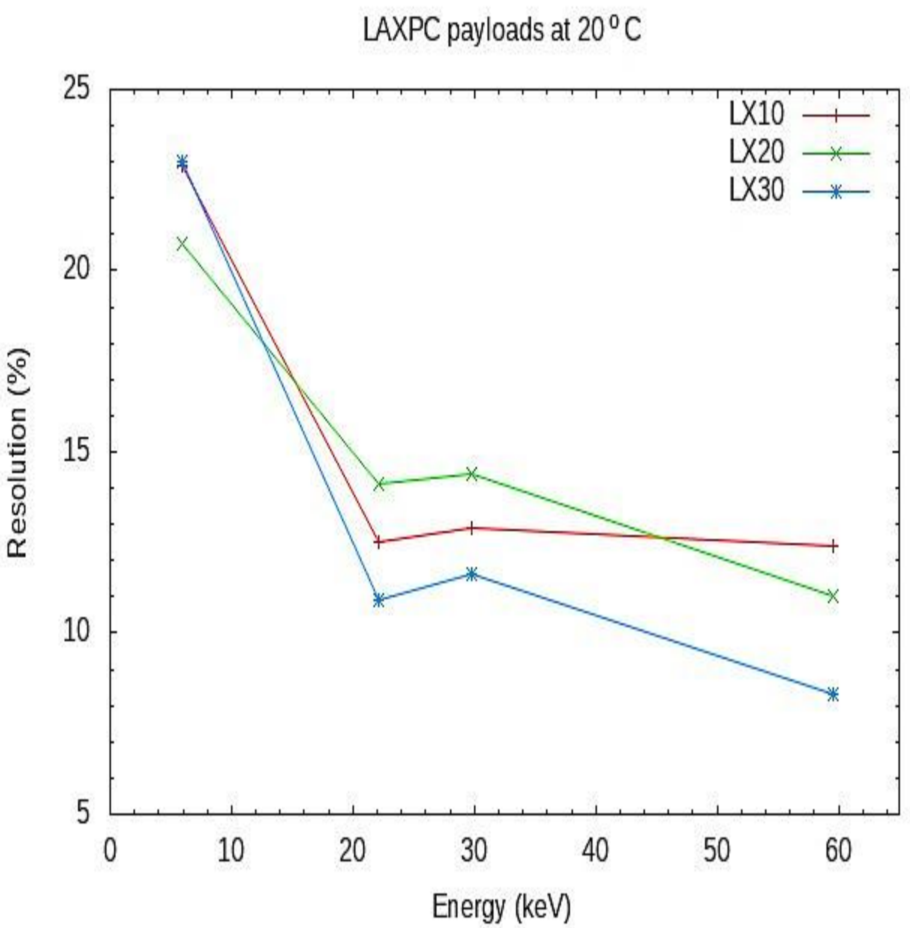

10°C
20°C
30°C
10°C with peak alignment correction
Single anode at room temperature
Resolution (FWHM/E$_c$) (%)
Energy (E$_c$; keV)
10
15
20
10
20
30
40
50
60

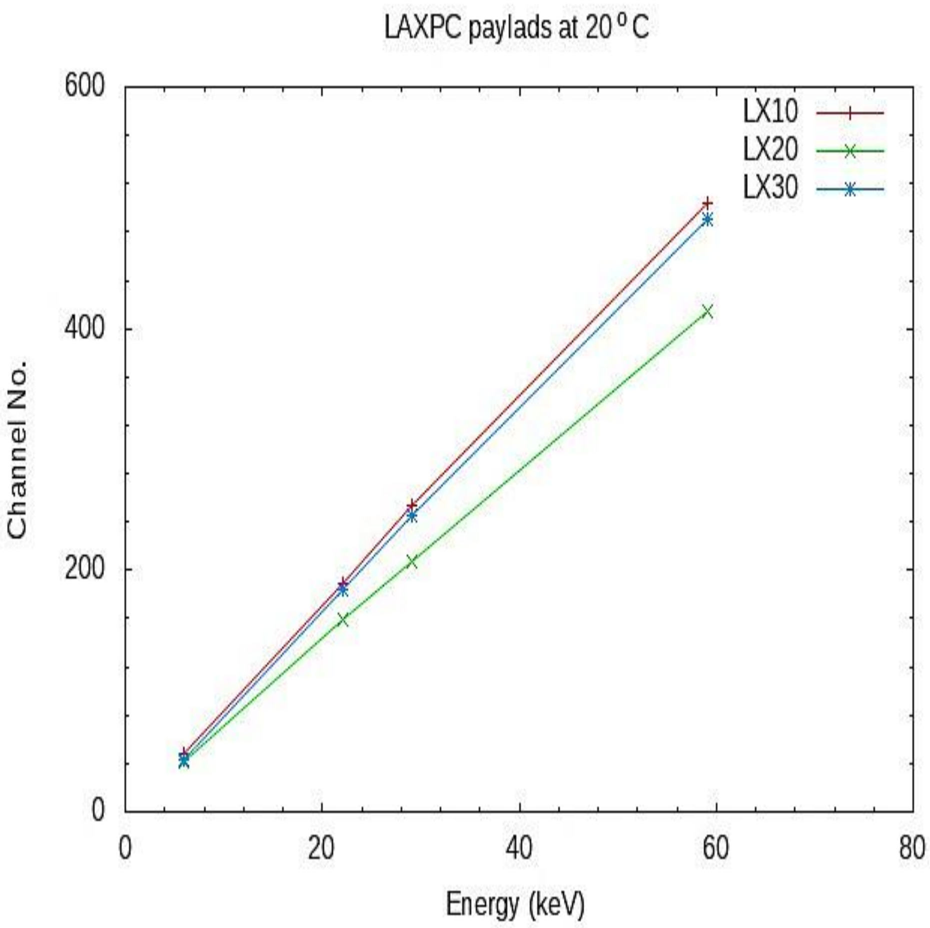
Lx20 & LX30 spectra of Cd^{109} from each cells





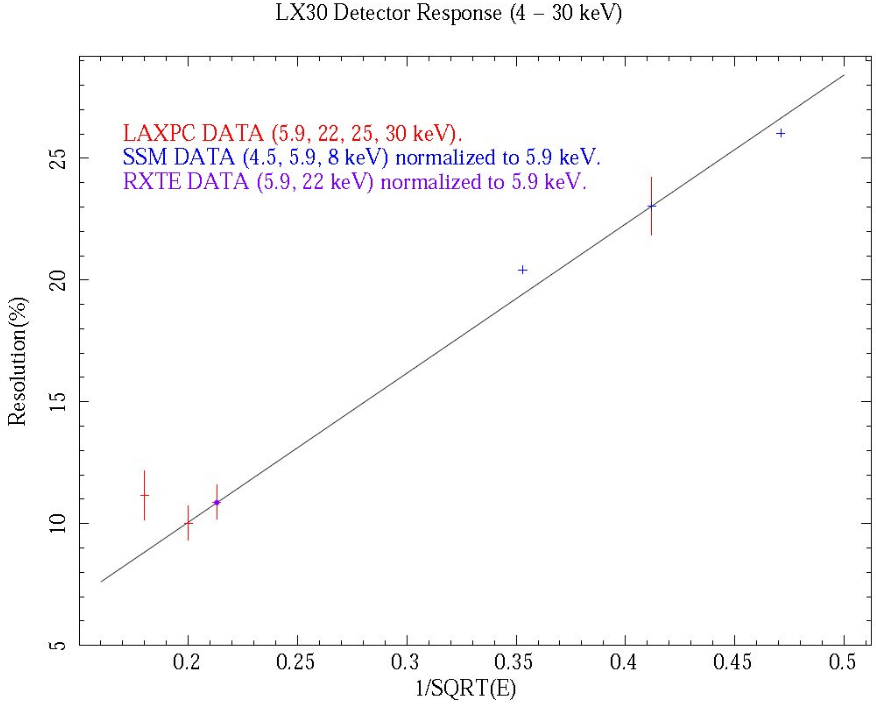
LAXPC payloads peak channel &





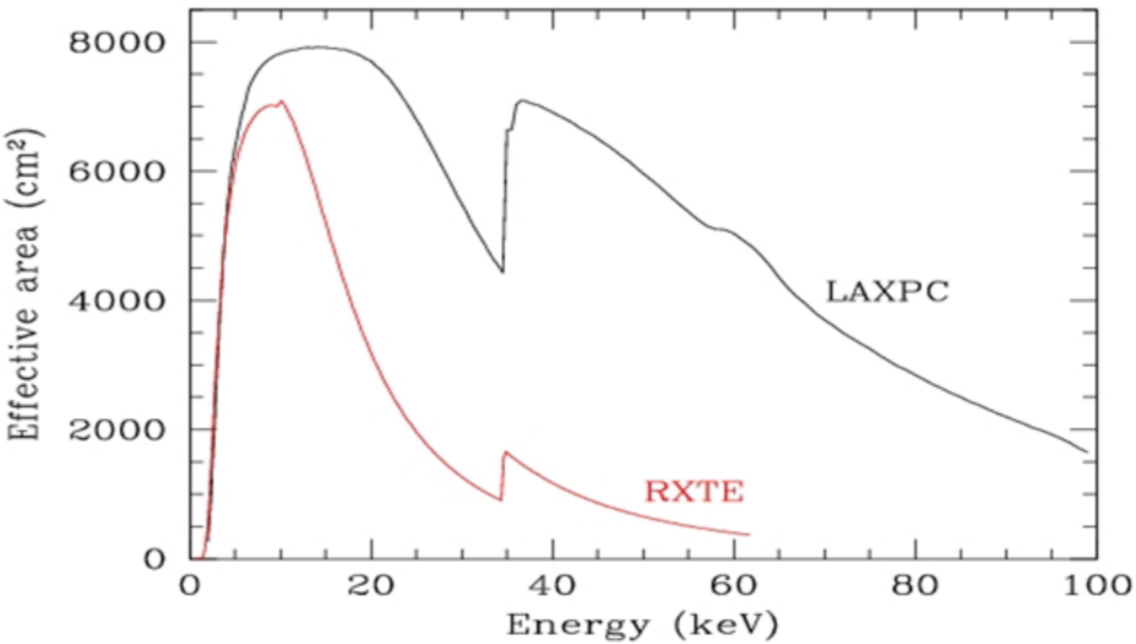
Energy resolution

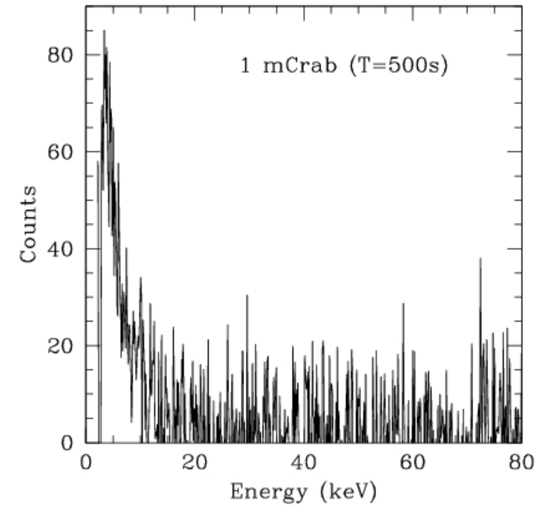
The energy resolution for LAXPC30 is plotted as function of 1/SQRT(E) In the low energy range (4-30 keV). The 30 keV is due to double events Of 60 keV line.



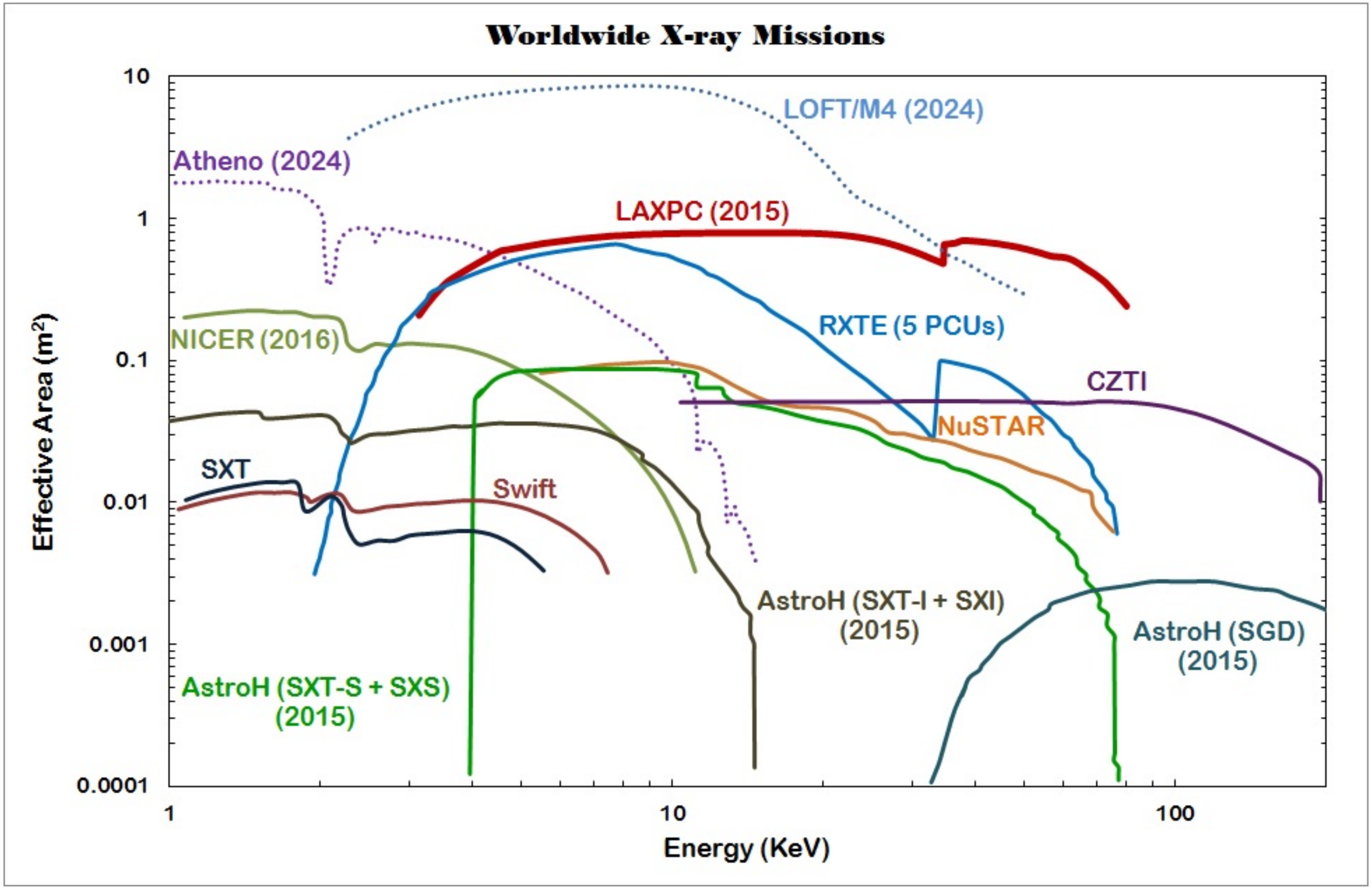
LAXPC energy resolution is similar to CZTI around 40 keV. While Below 40 keV, LAXPC energy resolution is better but worse at higher energies (at 22 keV ~12% For LAXPC and ~31% for CZTI while at 60 keV ~14% for LAXPC and 8% For CZTI.

Advantages of LAXPC over RXTE/PCA





RXTE/PCA is one of the most successful mission among all current/recent past X-ray space missions. LAXPC instrument will have four times or more effective area above 20 keV as compared to RXTE/PCA. It can detect 0.1 mcrab sources in few thousand second.

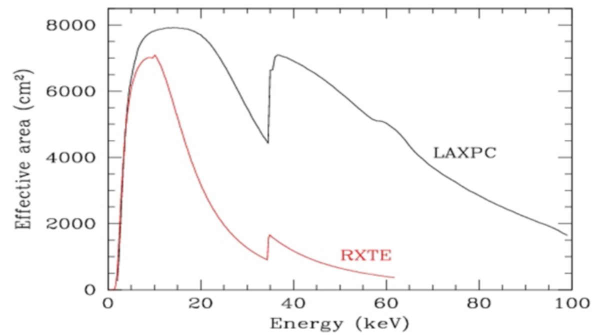


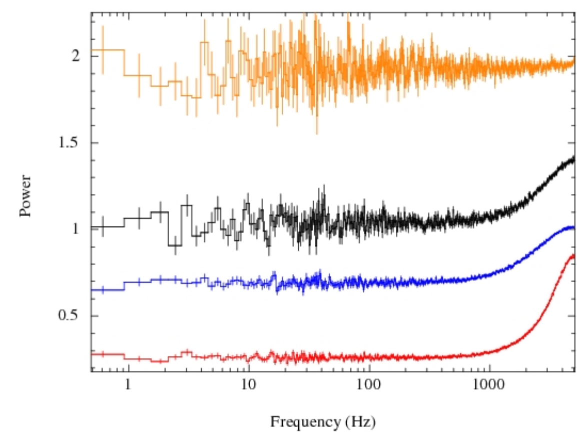
Worldwide X-ray Missions
LOFT/M4 (2024)
Atheno (2024)
LAXPC (2015)
RXTE (5 PCUs)
NICER (2016)
CZTI
NuSTAR
SXT
Swift
AstroH (SXT-I + SXI) (2015)
AstroH (SGD) (2015)
AstroH (SXT-S + SXS) (2015)
Effective Area (m²)
Energy (KeV)
10
1
0.1
0.01
0.001
0.0001
1
10
100

Science goals: Spectroscopy and temporal variability in 3-80 keV energy range

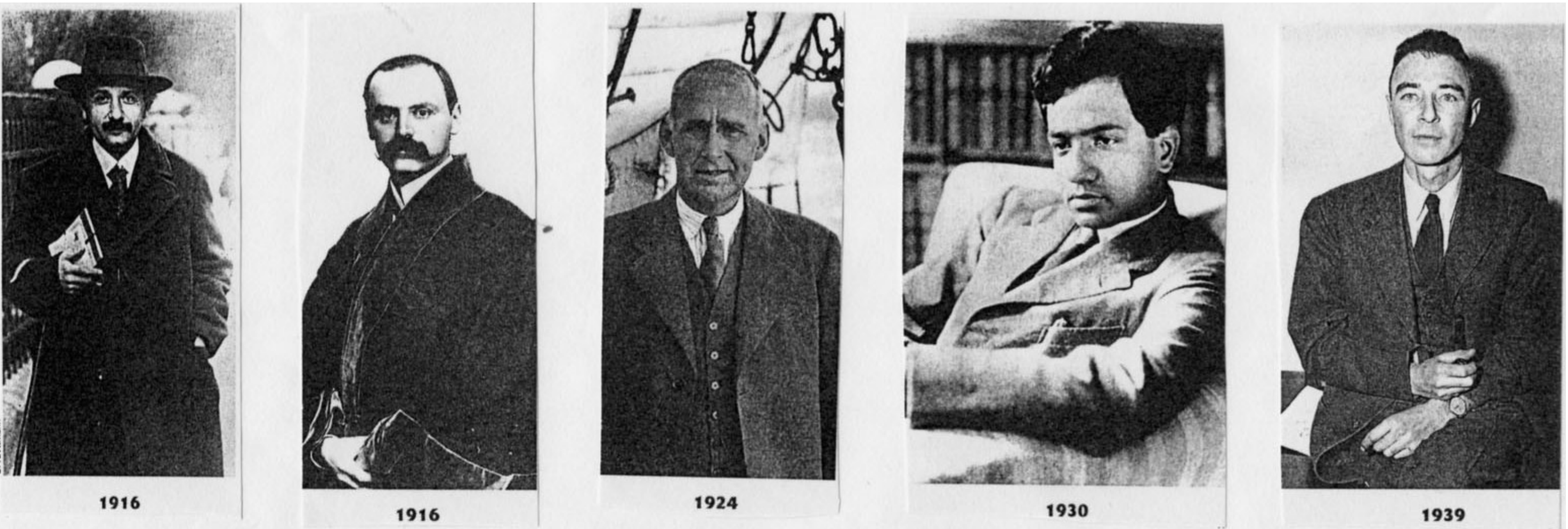
- Active Galactic Nuclei
- Astrophysics of Compact Objects

  Black hole and Neutron Star X-ray binaries
- Supernovae & Nucleosynthesis
- Origin and Nature of Gamma-ray Bursts
- Diffuse background





Einstein *Schwarzchild* *Eddington* *Chandrasekhar* *Oppenheimer*



Theory of gravitation: black holes should exist

Horizon: $R_s = 2\ G\ M/c$ $\sim 3\ M/M_\odot\ km$

White dwarfs: $R_{wd} = R_T$

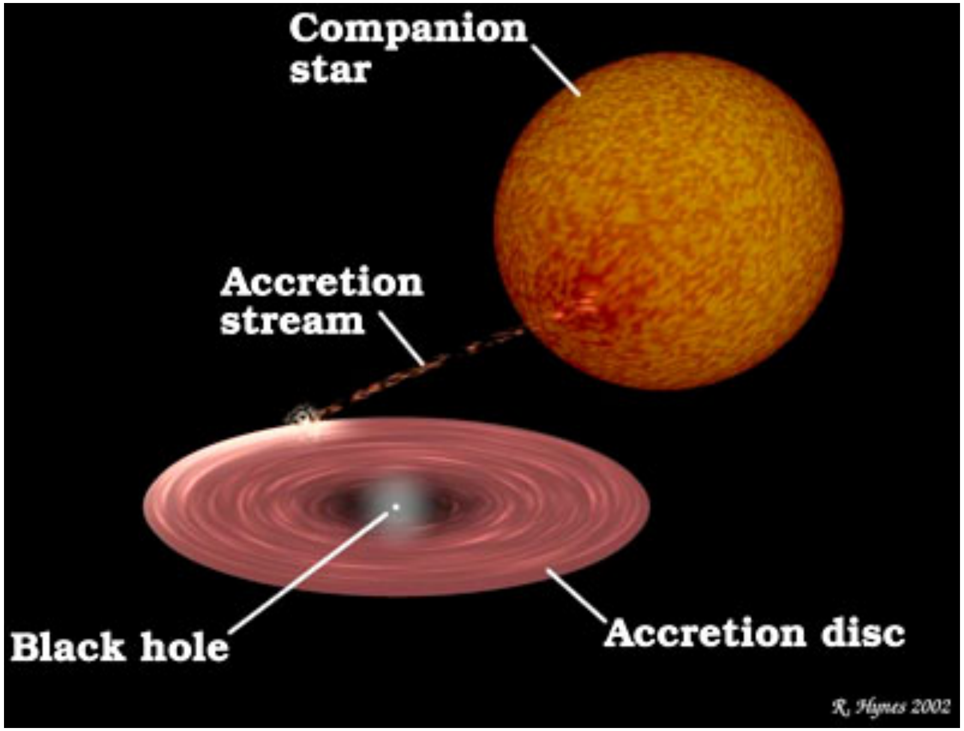
Limit of mass for white dwarfs: $M_{wd} < 1.4\ M_\odot \Longrightarrow$

Neutron stars: $M > 1.4\ M_\odot$ $R \sim 20\ km$ *Black holes:* $M > 3\ M_\odot$

Black holes have mass, angular momentum, charge (?), but no material surface

Accretor has mass M and radius R, gravitational energy release/mass is

$$\Delta E_{acc} = \frac{GM}{R}$$



For accretion on to a neutron star

$$(M = M_{sun}, R = 10km)$$

$$\Delta E_{acc} = 10^{20} erg / gm$$

compare with nuclear fusion yield (mainly H → He)

$$\Delta E_{nuc} = 0.007c^2 = 6 \times 10^{18}\, erg / gm$$

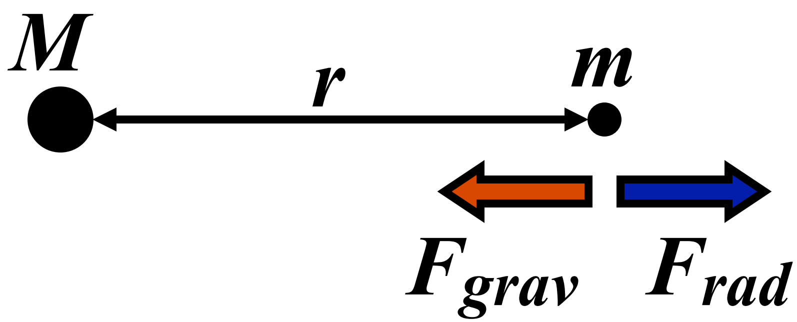
Accretion on to a black hole releases significant fraction of rest—mass energy:

$$R \approx 2GM / c^2 \Rightarrow \Delta E_{acc} \approx c^2 / 2$$

(in reality use GR to compute binding energy/mass: typical accretion yield is roughly 10% of rest mass)

This is the most efficient known way of using mass to get energy:

Eddington Luminosity



Accretion rate controlled by momentum transferred from radiation to mass

$$F_{grav} = G\frac{Mm}{r^2}\,Newton$$

Note that R is now negligible wrt r

Outgoing photons from M scatter material (electrons and protons) accreting.

thus accretion is inhibited once $F_{rad} \geq F_{grav}$ *, i.e. once*

$$\boxed{L \geq L_{Edd} = \frac{4\pi G M m_p c}{\sigma_T} = 10^{38} \frac{M}{M_{sun}} erg/s}$$

Eddington limit:
bright quasars must have

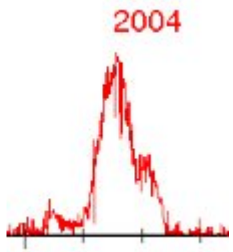
$$M > 10^8 M_{sun}$$

brightest X—ray binaries

$$M > 10 M_{sun}$$

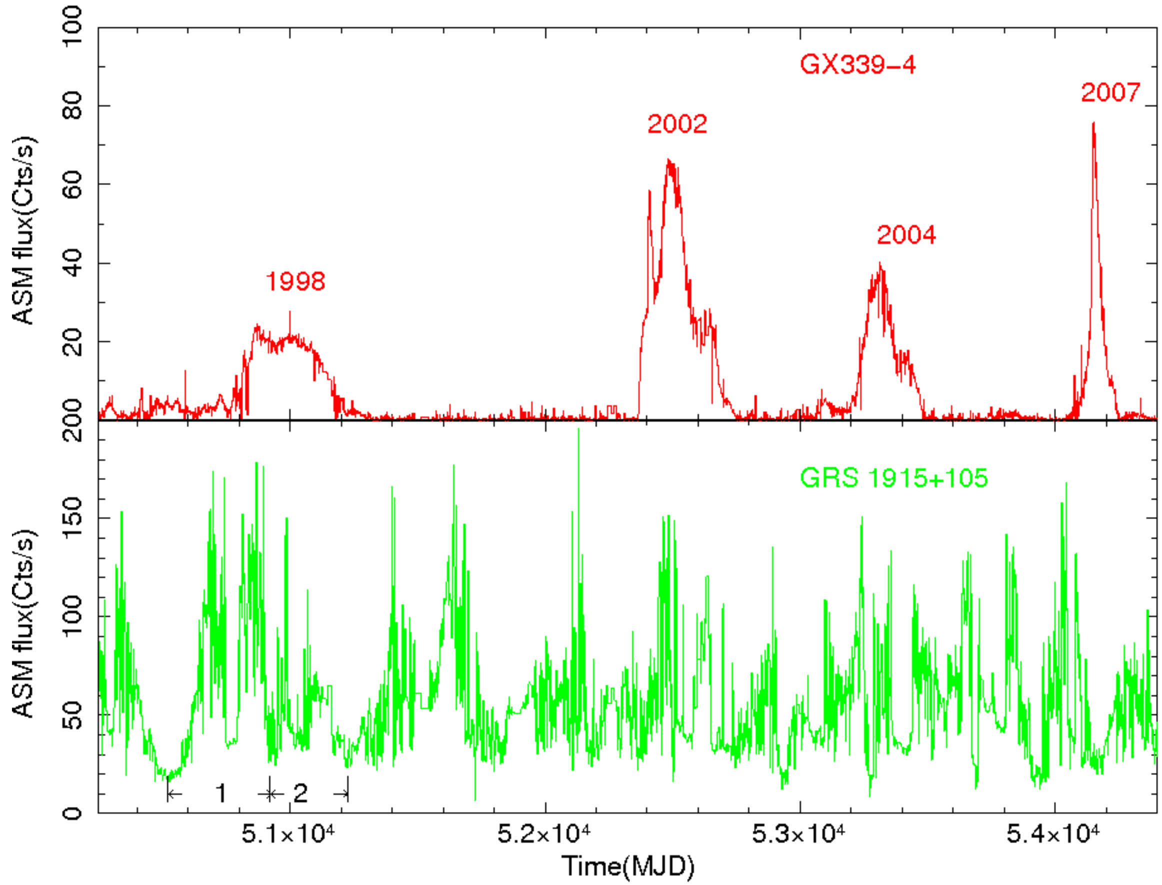
Science with LAXPC

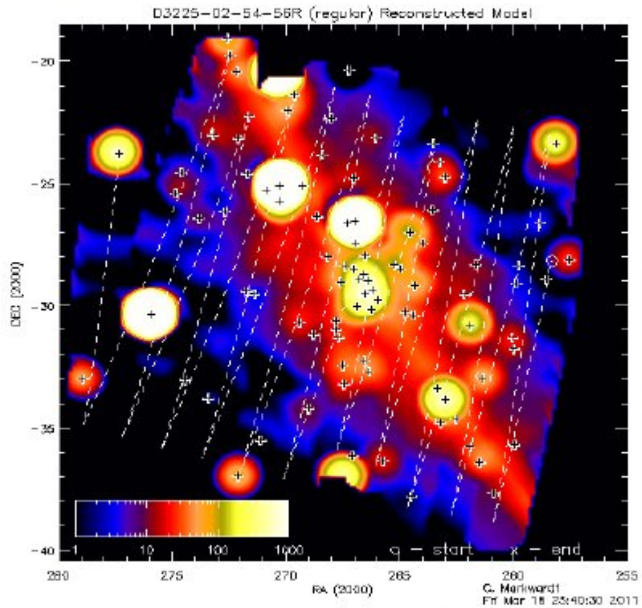
Outburst

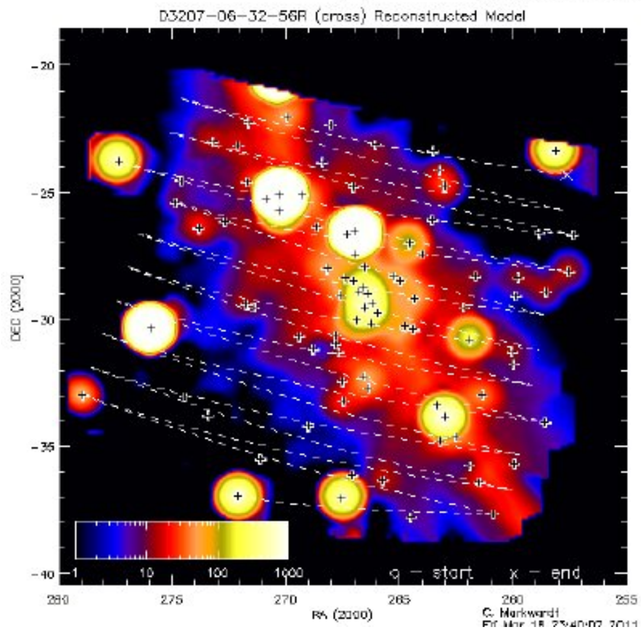


- *New transient sources (scan mode)*
- *Outbursts (only 3-4 sources fully covered)*
- *Number of X-ray states*
- *X-ray state corresponding to highest accretion rate*
- *Flares/ bursts (origin of these X-ray bursts)*
- *Transition of low hard to high soft state*
- *Low and high QPO*
- *accretion disk and radio jet connection; prediction of transient radio jets*
- *transient sources; black hole and neutron star binaries*
- *Many more*

Frequent outbursts; two sources







RXTE/PCA Galactic bulge scan

- 22° x 22° Galactic bulge scan across Galactic longitude (slew rate 6 degrees per min)
- ~Single scan of 480 sq degree covers appx. in 70 minutes
- Twice a week considering sun elevation angle restriction – cross scan confirms assigned flux to a point source
- Total ~8500 sec < 2 RXTE orbits (10800 sec)
- Image reconstructed based on fits to scan of different sources (sensitive to 0.5 - 1 mCrab)
- Bursts (> 2 mCrab) was be identified clearly

Similar scan program for LAXPC instrument (sensitivity around 0.1 mCrab). LAXPC instrument is likely to discover many new transient sources.

Importance (PCA background: 2.0 mCrab; ASM background: 30 mCrab)

Aim : to provide deeper monitoring for transients where source confusion makes the ASM less sensitive

184 sources currently listed –

52 XTE (~ 3 sources per year) (39 NSXBs and 13 BHXBs and BHCs)

25 IGR

17 4U

12 SAX

10 RXS

9 GX

AX, KS, MXB, SGR, NGC, EXO

ToO based on low flux ASM can be confirmed with a short PCA exposure

Example: SAX J2239.3+611 was monitored for recurrence to enable a BeppoSAX observation which found 1247 s period (in't Zand et al. 2001).

~ 1/3 discovered by PCA (How they were missed ?)

6-8 degrees sizes hot plasma contribution at the temperature of 1.6 keV, exceeding the known soft X-ray Galactic BG

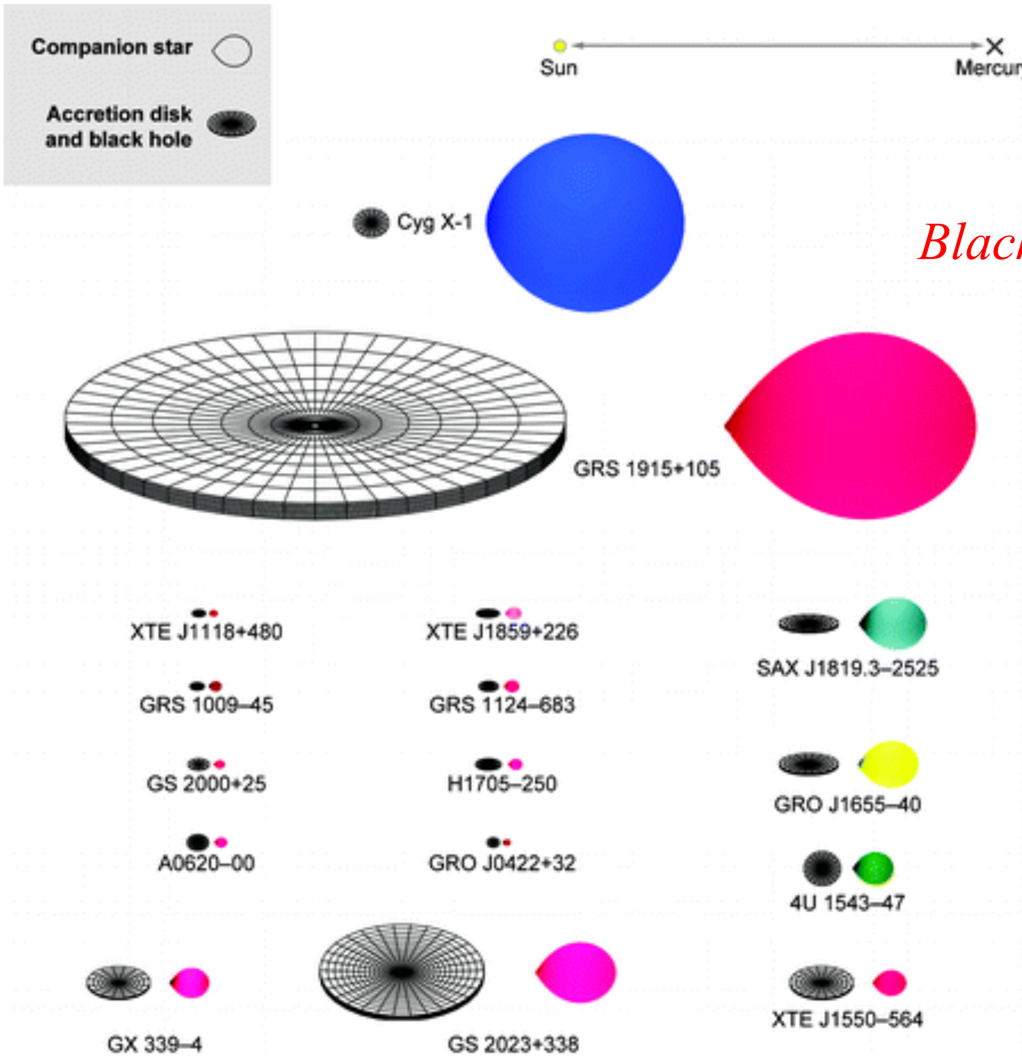
Revnivstev+ 2012

Transients

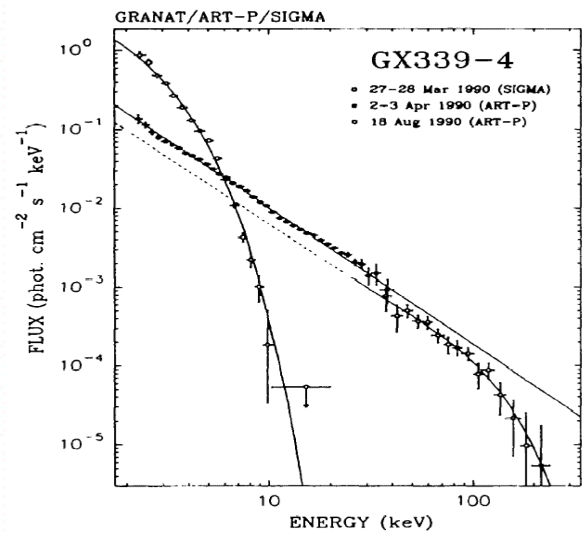
Historical context: Transients Detected by RXTE/ASM, 1996-2012:

- 210 outbursts detected from 106 infrequent transients (70% new sources)
- 109 outbursts detected from 6 frequent transients:
    - Black holes: GX 339-4, 4U 1630-47
    - Neutron stars: Aql X-1, 4U 1608-52, 4U 1700+24, Rapid Burster
- 40 gamma-ray bursts (GRBs)
- Nearly all the non-GRB sources were transient accretion episodes in binaries containing a neutron star or black hole

Black hole X-ray binaries



Remillard RA, McClintock JE. 2006.
Annu. Rev. Astron. Astrophys. 44:49–92



GX 339-4

X-ray outburst evolution & X-ray states

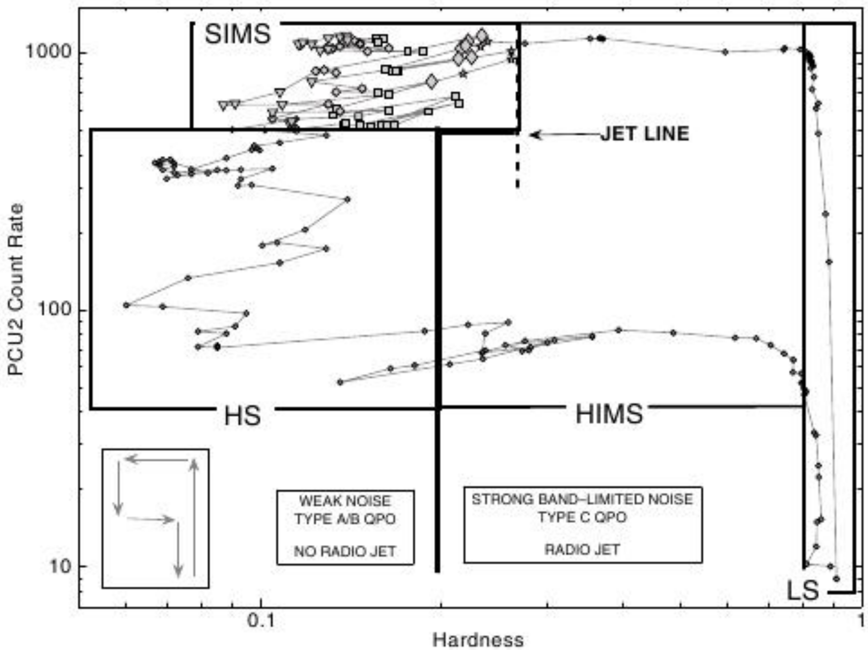
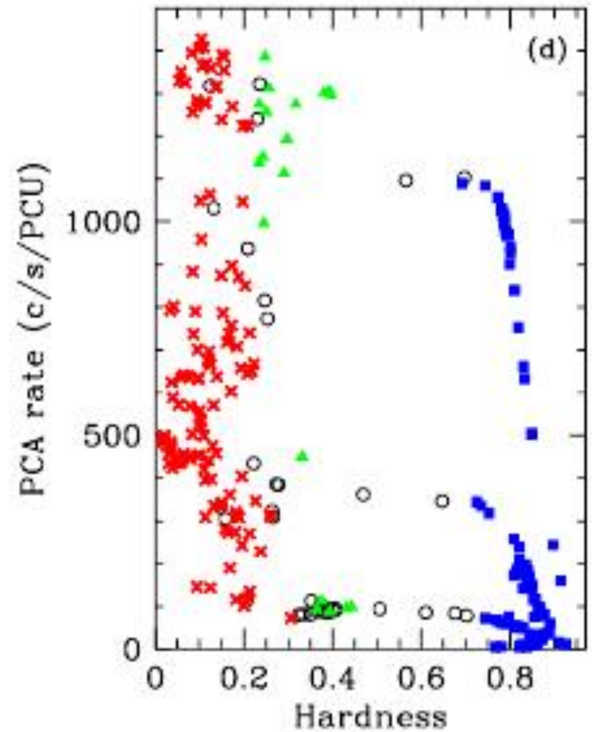


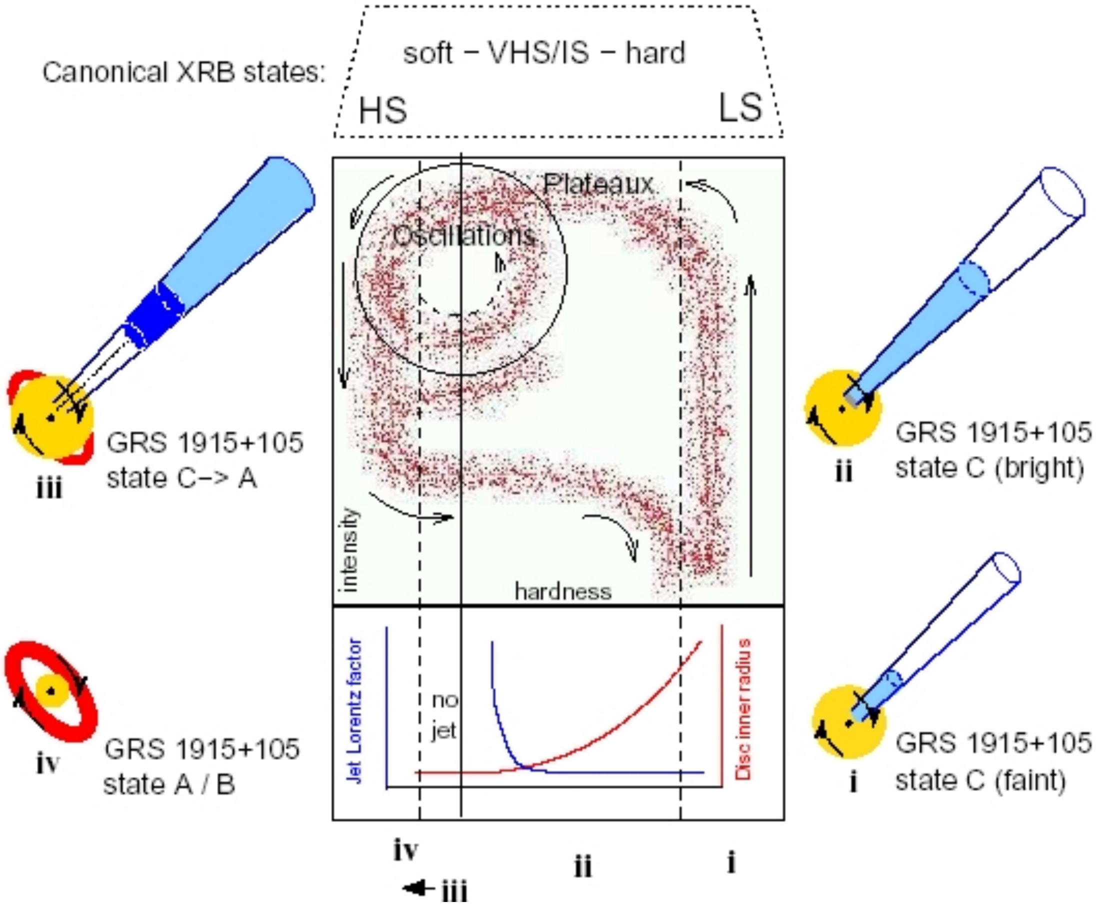
Fig. 1. Hardness-Intensity diagram of the 2002/2003 outburst of GX 339-4 as observed by the RXTE PCA. The lines mark the four source states

Belloni 2006

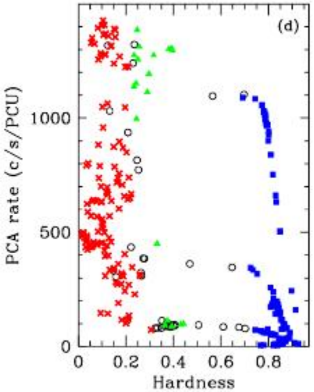


Remillard & McClintock 2006;

Outburst: X-ray and radio jet connection

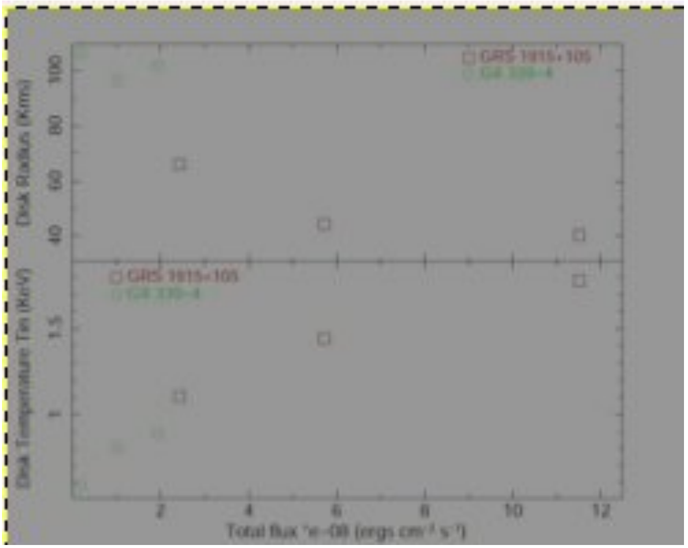


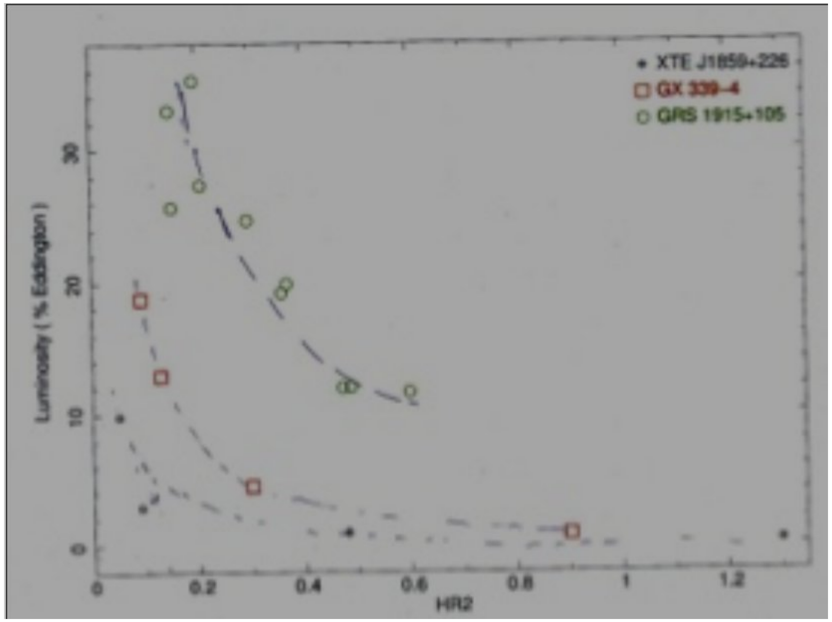
Fender and Belloni 2004; jet line , Unified jet model



Left vertical branch of Outburst for two source (HS)

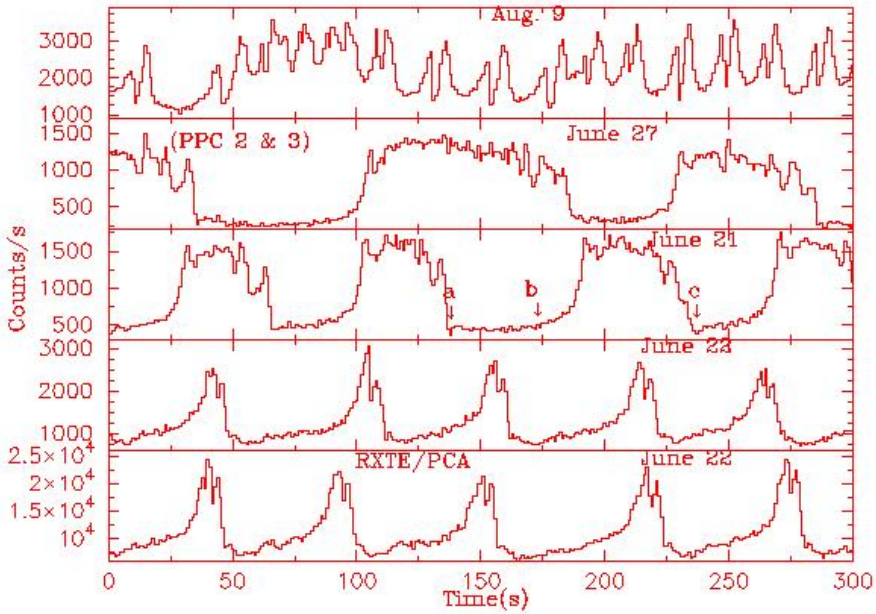
Lower horizontal branch of Outburst for three sources (HIMS)

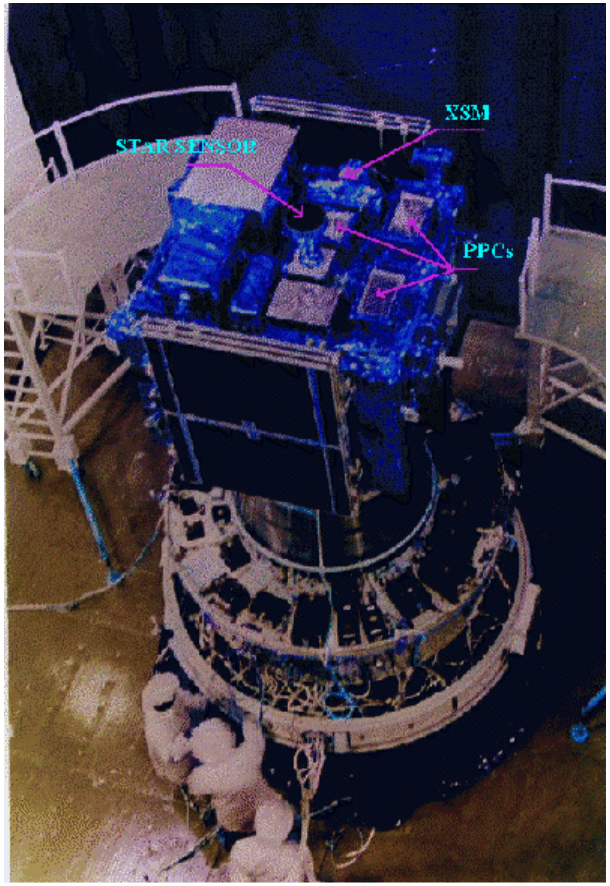




IXAE June-Aug. *1996-2001*

Data of GRS 1915+105 observed in June 1997





J. S. Yadav et al ApJ (1999) v. 517,p 935

Now two sources show such X-ray bursts

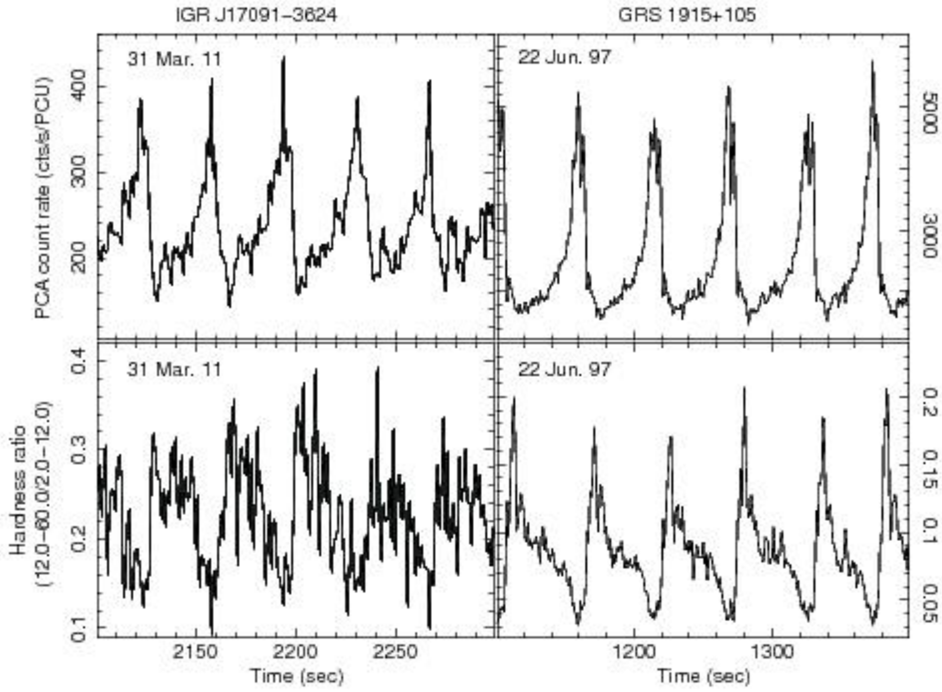
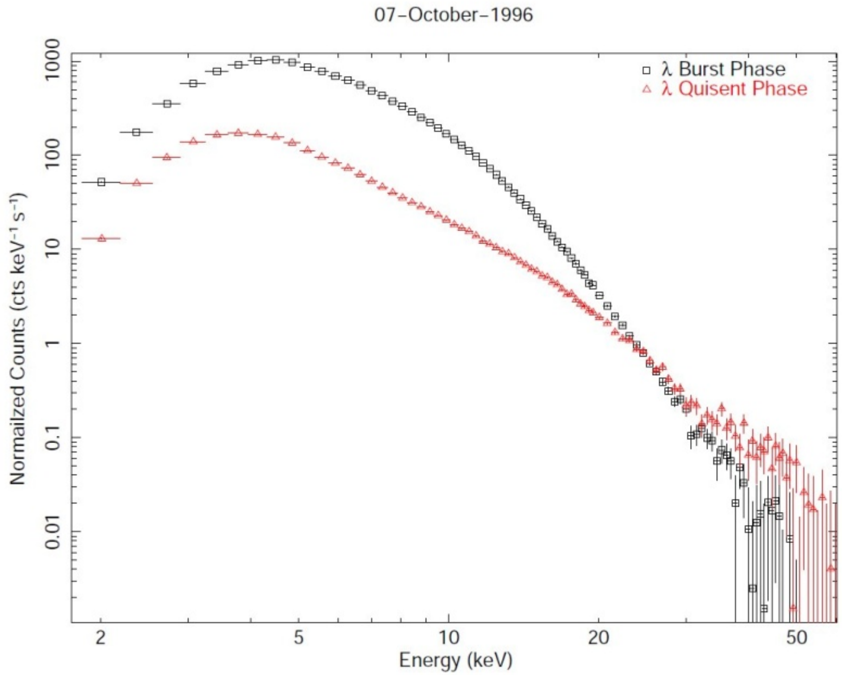


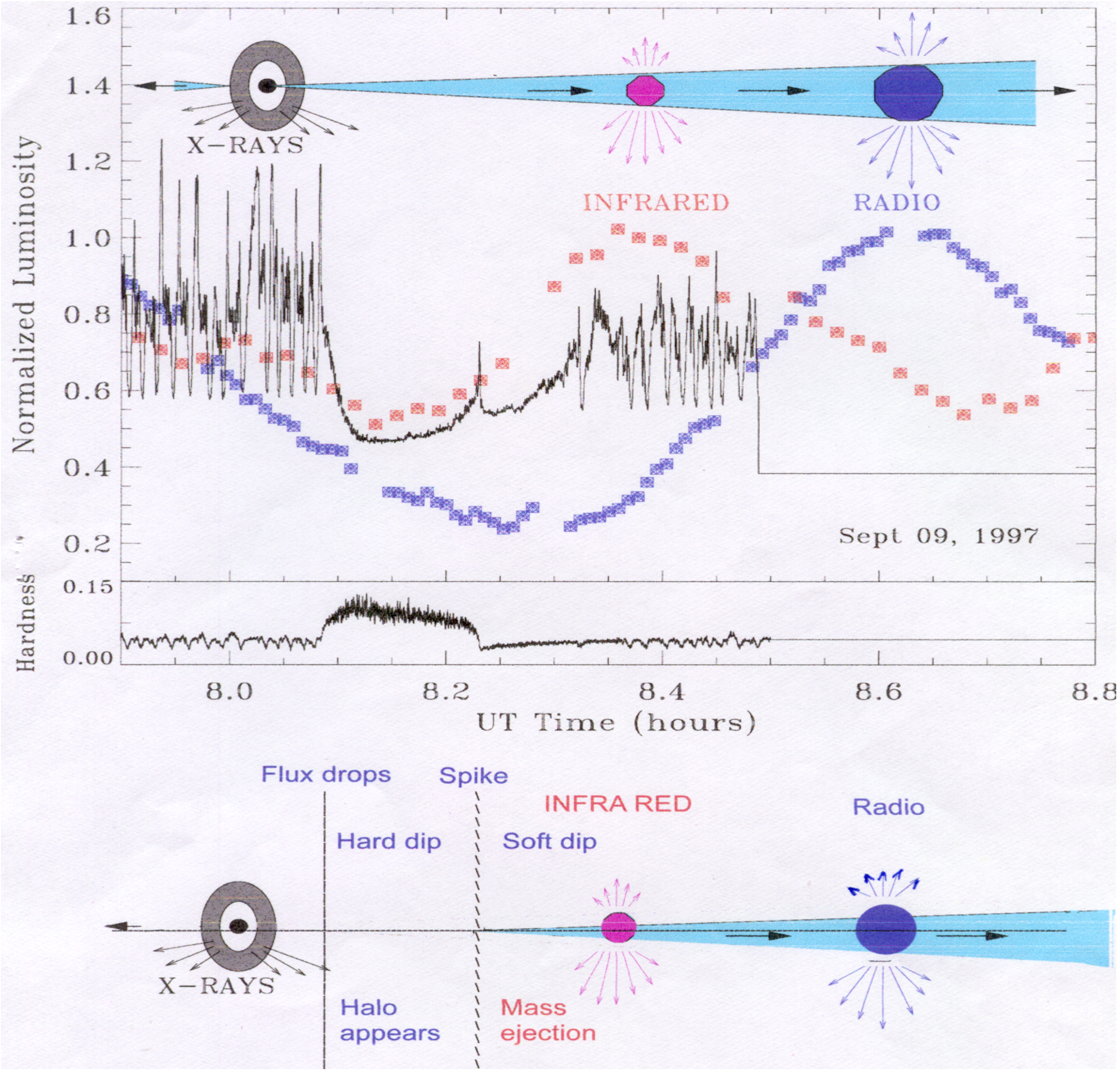
Fig. 6.— Comparative study between the CLS-II variability class of IGR J17091-3624 and the 'ρ' class of GRS 1915+105. Top panels show the 2.0-60.0 keV *RXTE*/PCA lightcurve of IGR J17091-3624 (left) and GRS 1915+105 (right). Bottom panels show the plot of hardness ratio (defined

Pahari, Yadav and Bhattacharyya ApJ (2014) 783, p141



Bursts are explained as removal
And replenishment of matter forming
Inner disk due to a thermal-viscous
instability
Belloni et al 1997, Paul et al 1998, Yadav et al 1999

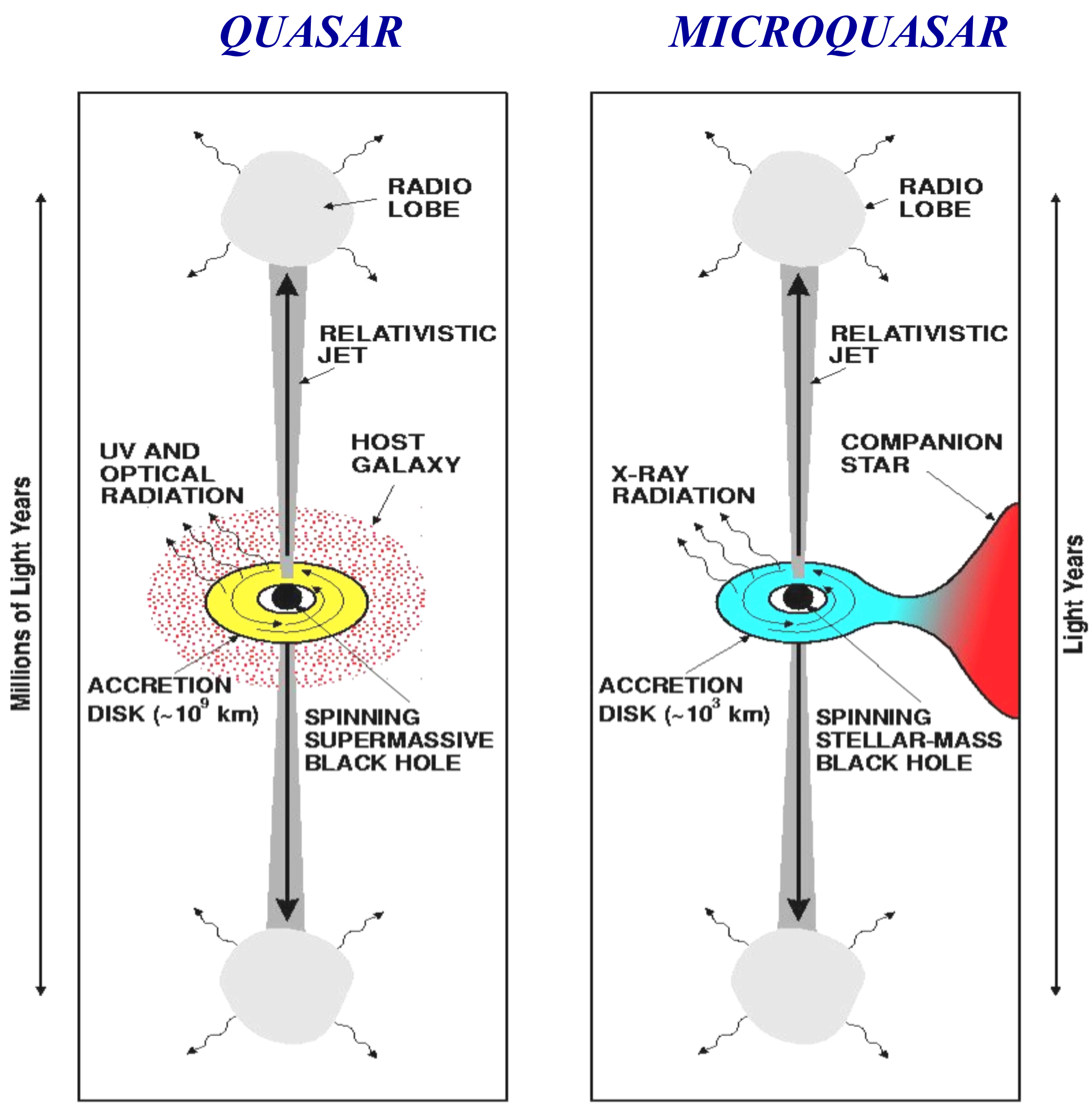
But it does not explain the source of hard
X-rays



Eikenberry et al 1998; Mirabel et al 1998

Yadav J S, ApJ (2001) 548,876

QUASAR-MICROQUASAR ANALOGY



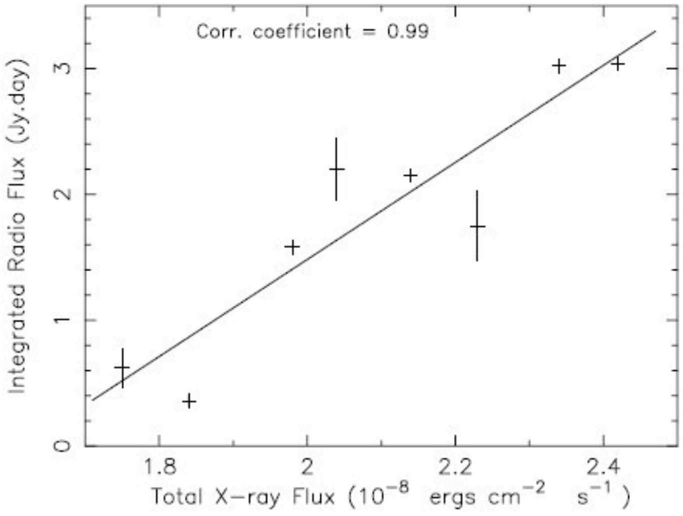
Mirabel & Rodriguez,

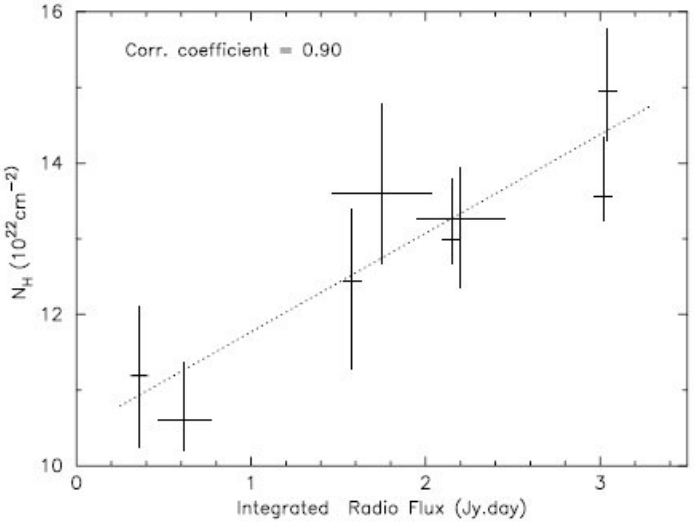
Nature 1998, 392

- The scales of length and time are proportional to M_{BH}
  $R_{sh} = 2GM_{BH}/c^2$; $\Delta T \ \alpha \ M_{BH}$

- The maximum color temperature of the accretion disk is $T_{col} \ \alpha \ (M/\ 10M_{\odot})^{-1/4}$

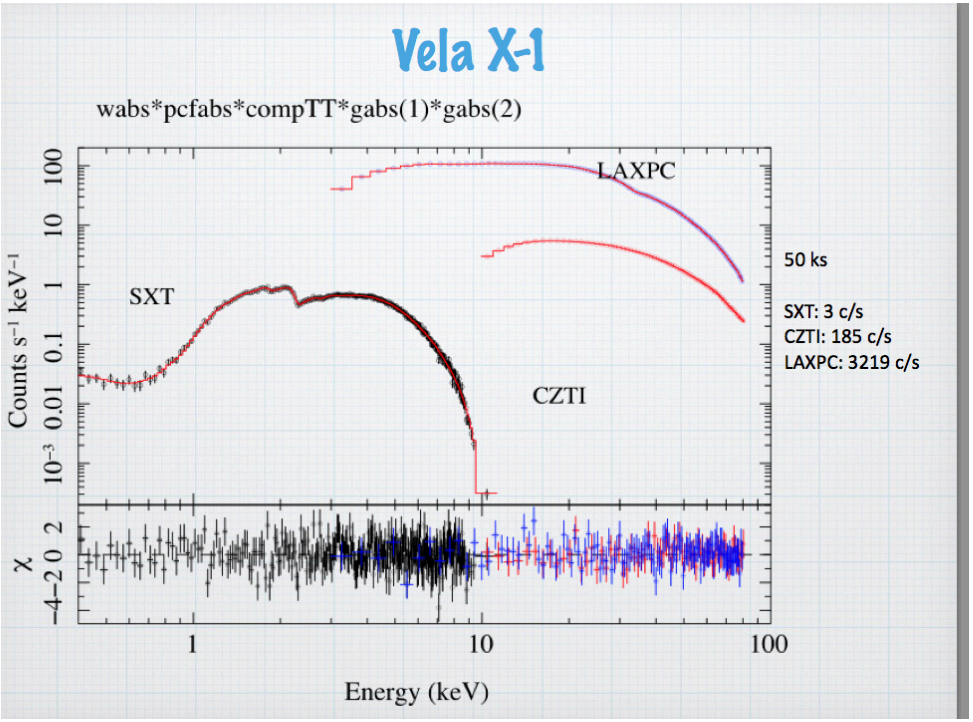
Connection between accretion disk and large superluminal radio jets





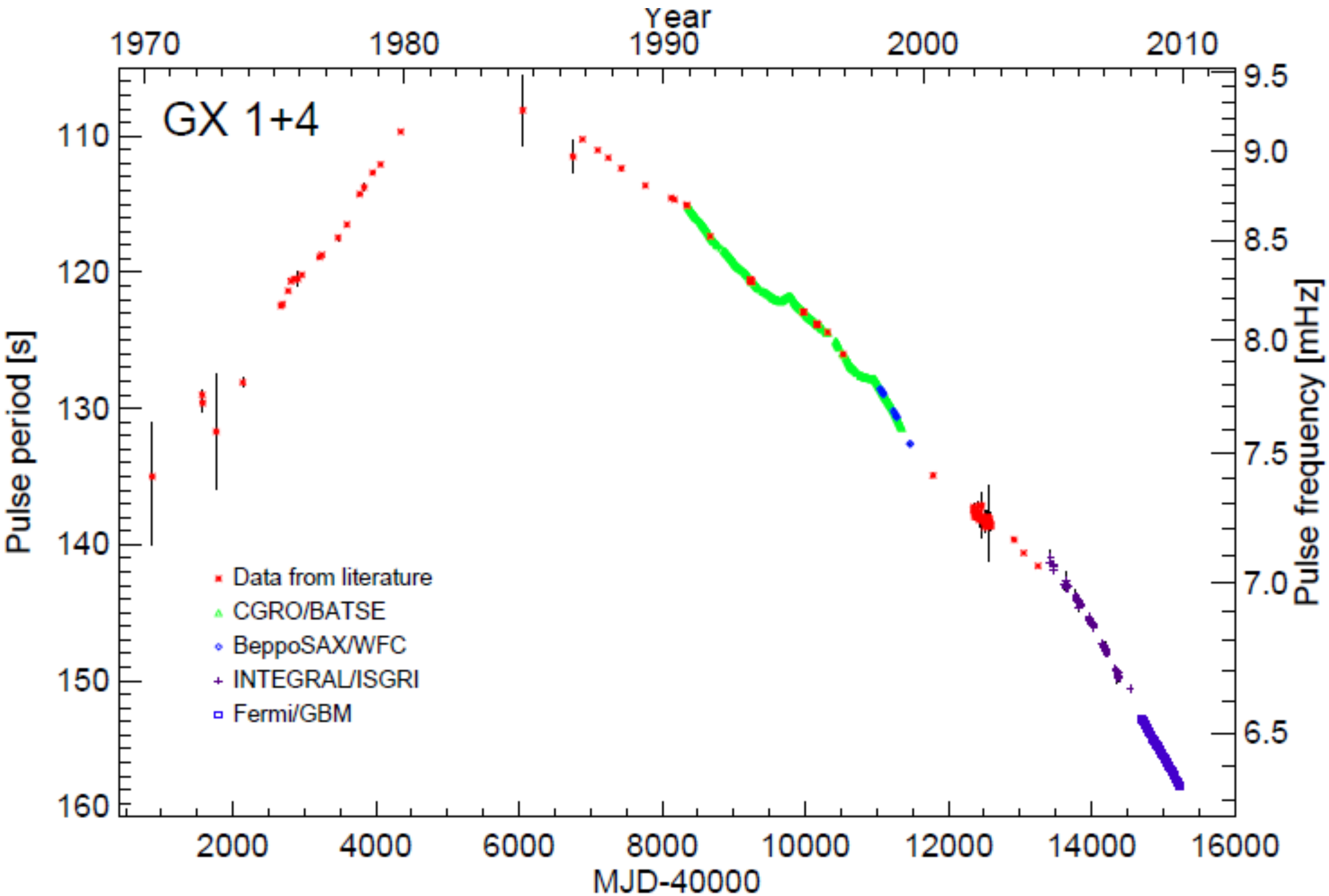
Yadav J S ApJ (2006) 646, p385

Neutron star X-ray binaries; cyclotron line

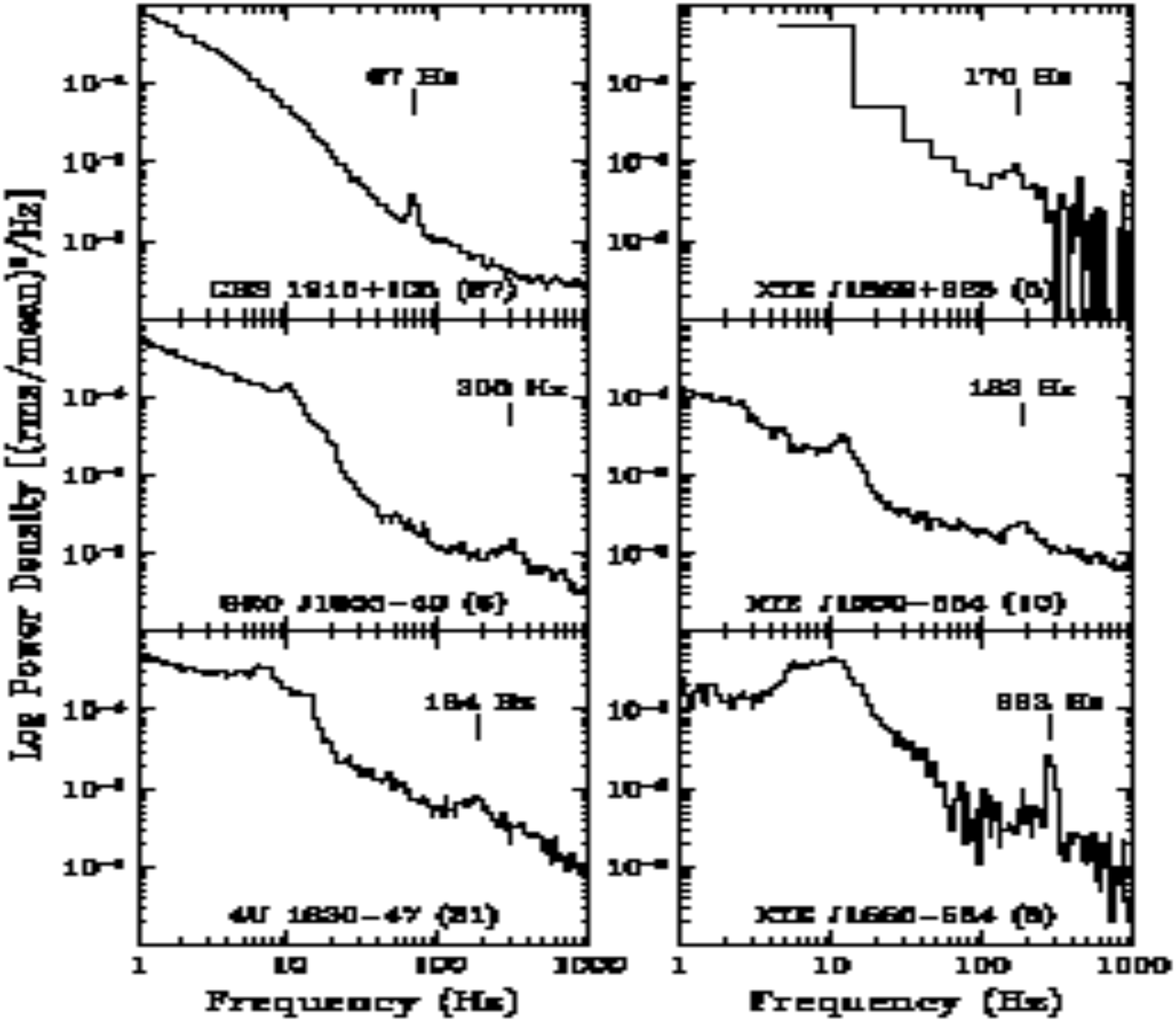


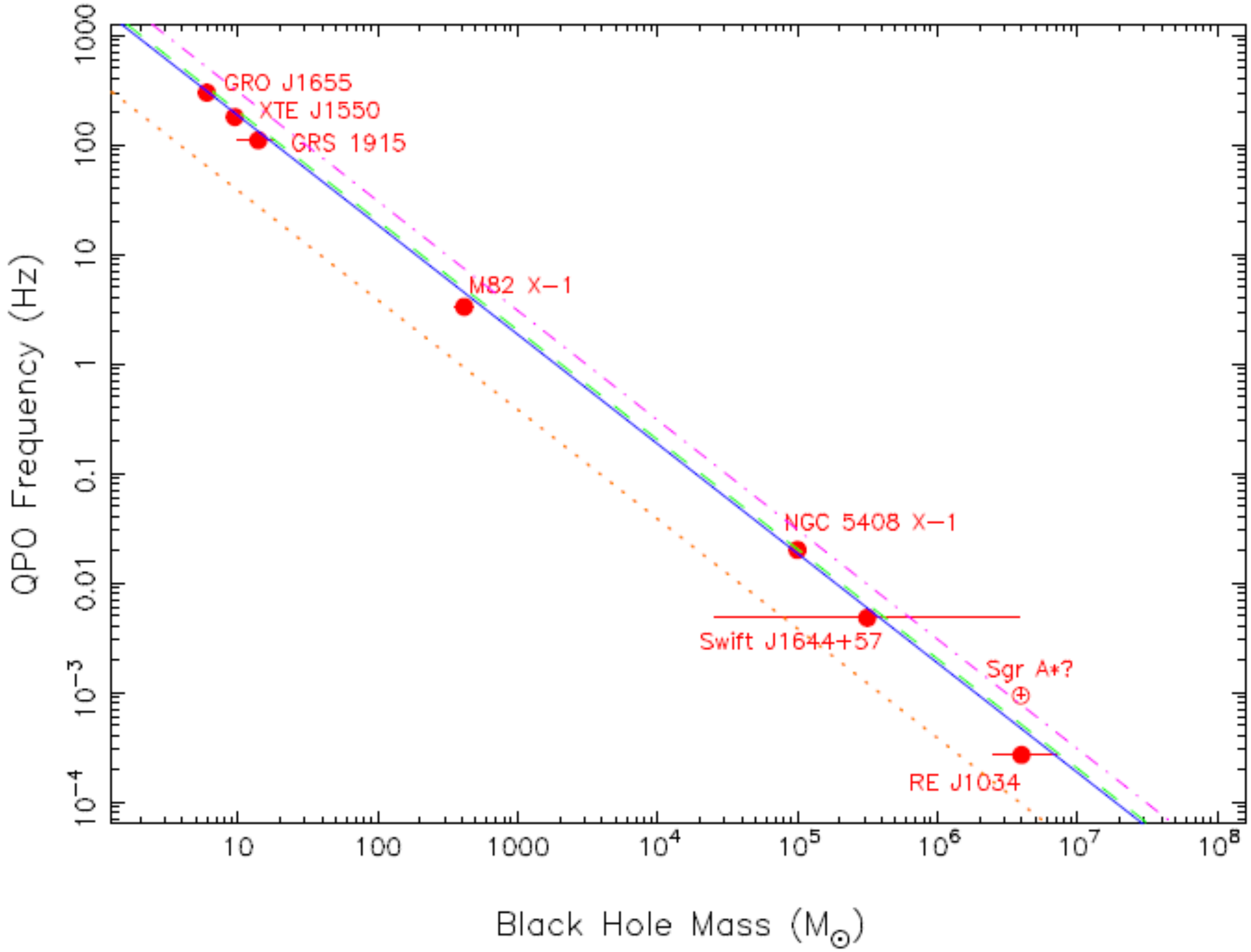
Cyclotron line sources known (24)	E_{cyc} (keV)
Swift J1626.6-5156	10
KS 1947+300	12.5
4U 0115+63	14,24,36,48,62
IGR J17544-2619	17
4U 1907+09	18,38
IGR J18179-1621	20.8?
4U 1538-522	22,47
Vela X-1	24,52
V 0332+53	27,51,74
Cep X-4	28
Cen X-3	29
X Per	29
IGR J19149+1036	31
RX J0520.5-6932	31
MXB 0656-072	33
4U 1822-37	33
XTE J1946+274	36
4U 1626-67	37
GX 301-2	37
Her X-1	41
1A 0535+262	50,110
GX 304-2	54
1A1118-61	55
GRO J1008-57	88? 79?

Ginga, BeppoSAX, CGRO, RXTE, INTEGRAL,Suzaku, NuSTAR,..



Spin period evolution of GX 1+4 (Gonzalez-Galan et al. A&A 2011)


67 Hz
170 Hz
300 Hz
183 Hz
184 Hz
Log Power Density [(rms/mean)²/Hz]
Frequency (Hz)
Frequency (Hz)



Relation between QPO Frequency and BH Mass

(Zhou et al. ApJ Lett, 2014)

The solid line denotes the relation, f (Hz) = 1862(MBH/M☉)−1 derived from three X-ray binaries (Remillard & McClintock 2006). The long-dashed line denotes the relation, f (Hz) =2030.8(MBH/M☉)−1 for a model of 3:2 resonance and spin parameter a = 0.996; the dotted-dashed line denotes the relation, f (Hz) =3068.9(MBH/M☉)−1 for a model of 3:1 resonance and spin parameter a = 0.996; dotted line denotes the Kepler frequency for a non-spinning Schwarzschild black hole at the innermost stable circular orbit.

Conclusions

1. All three LAXPC flight units were handed over to AIT on 20th Oct. 2014 after successfully completing all space qualification tests. This hand over was within 9 months of LAXPC payload CDR held on 27th January, 2014.
2. Now all Astrosat payloads are assembled at AIT, ISAC and the LAXPC payload has been tested successfully in May, 2015.
3. We have achieved detector performance as proposed initially. All observations are done in scan mode which is close to orbit mode.
4. In event mode, we have achieved 10 micro second resolution and all issues related to timing are resolved.

Conclusions

LAXPC instrument is about 4-5 times more sensitive then PCA/ RXTE and hence it has capabilities to define thermal and non thermal component contributions much better. LAXPC will have important contribution to X-ray binaries (black hole and neutron star binaries) and AGNs. In case of black hole binaries,

LAXPC will contribute to

- Discover many new transients.
- Full coverage of outbursts for many more sources (3-4 sources at present)
- Our understanding of X-ray states (state corresponding to highest accretion rate.
- X-ray burst in many more sources and their origin
- Low and high QPOs in many sources
- X-ray and radio connection for superluminal jets and many more

ACKNOWLEDGEMENTS:

ISAC: We acknowledge the strong support from ISAC in various aspect of instrument building and testing.

IISU: Providing us with bellow pump.

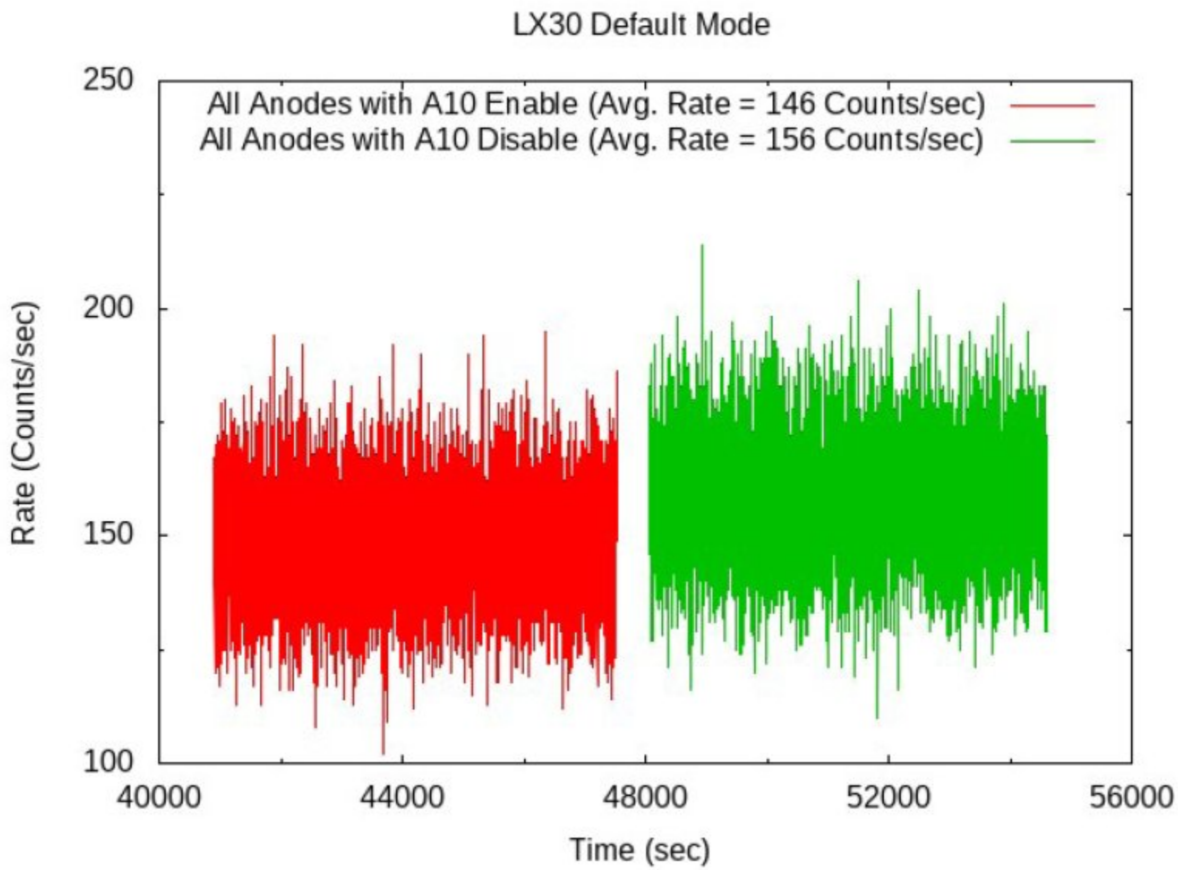
Central Workshop, TSR

Thank you

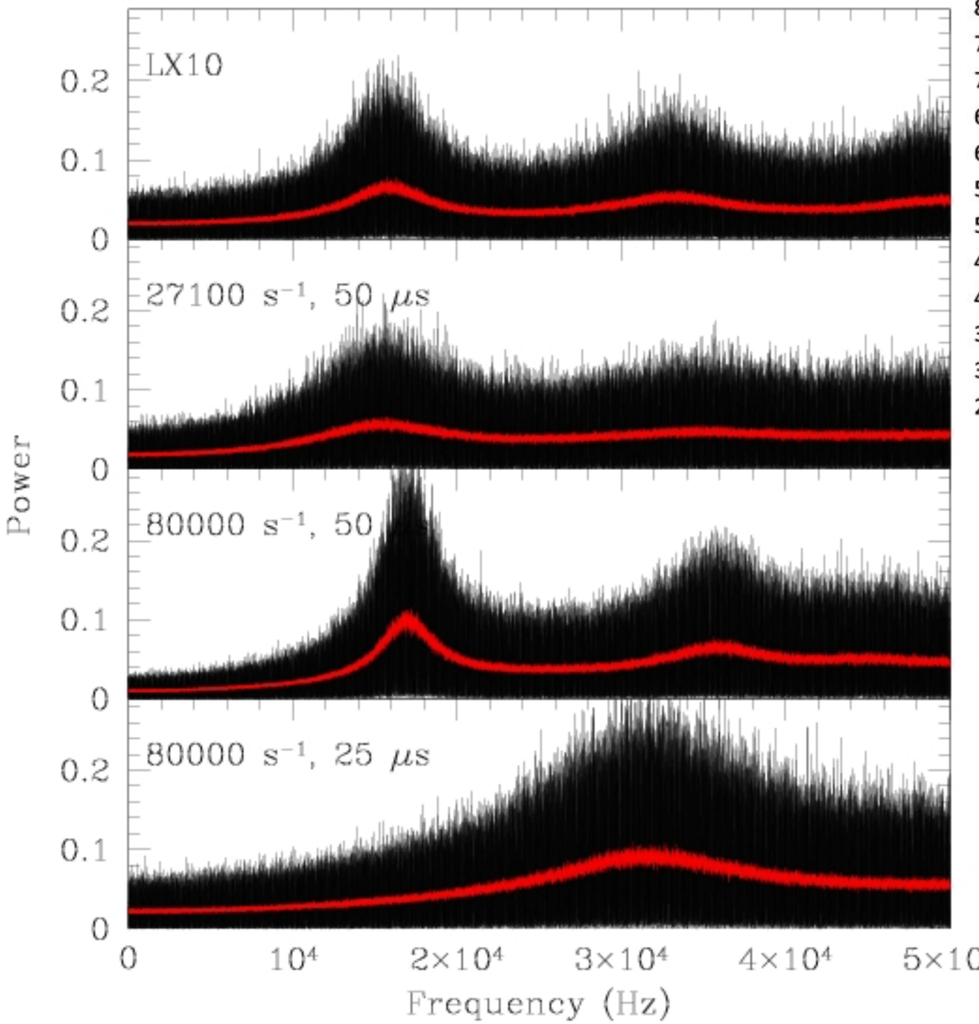
LAXPC Instrument Specification

No. of LAXPC Detectors (DT)	**Three (3) identical units**
Size of each LAXPC with collimator	**120 cm x 50 cm x 70 cm**
X-ray detection volume	**100 cm x 36 cm x 15 cm**
Collimator field of view	**47' x 47' for all the LAXPCs**
Detector Gas	**Xenon + Methane @ 1520 Torr**
Energy range	**3 - 80 keV**
Average detection efficiency	**100% Below 20 keV** **50 % in 20-80 keV**
Energy resolution	**12% FWHM at 60 keV**
Total Effective Area of 3 LAXPCs	**≈ 8000 cm^2 @ 5 - 20 keV**
Processing Electronic (PE)	**Three**
System Time Base Generator (STBG)	**10μsec time resolution**
Total weight of LAXPC Payload	**414 kg**

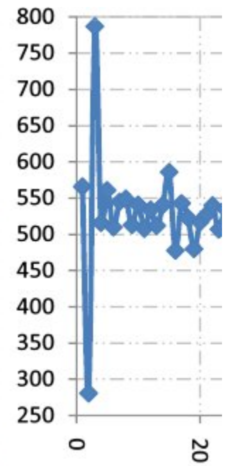
Anti Anode A10 of AS-LX-DT-10 package made in-operational due to HV loading in Anode 10 during Post vibration thermovac.

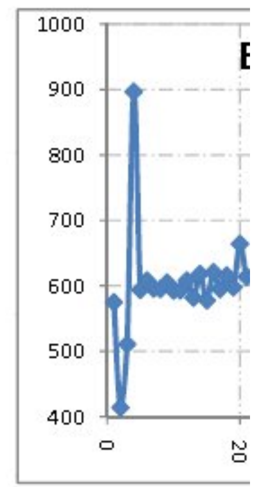


Timing characteristics: In event mode, there is no problem and 10 micros time resolution is achieved

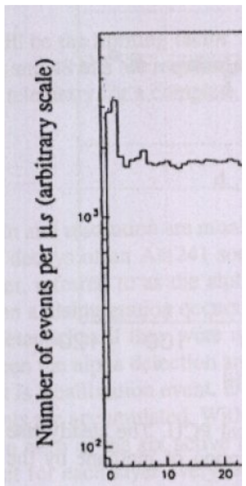


LAXPC 10 AND 30





RXTE/PCA



*Black line when period is n*10 μs*

*Red line when period is (n+0.02)*10μs*