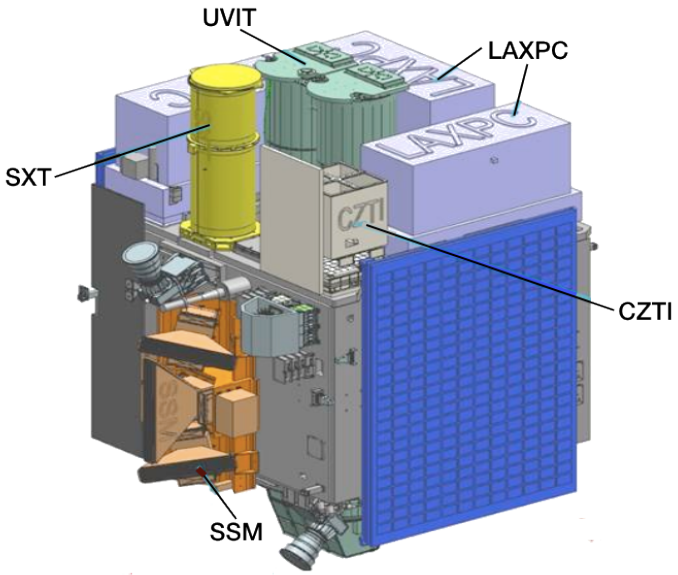
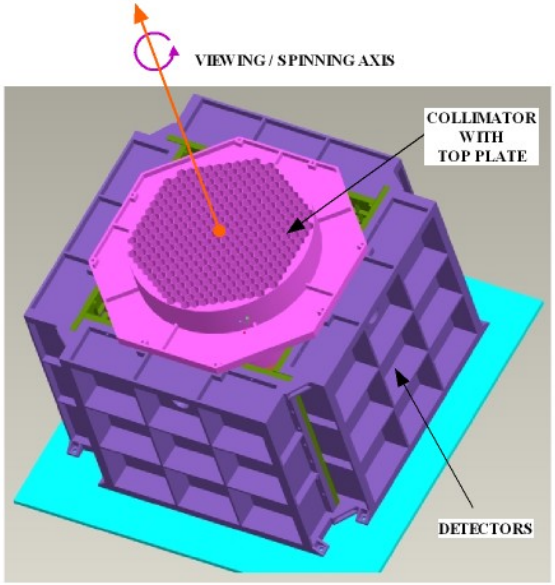
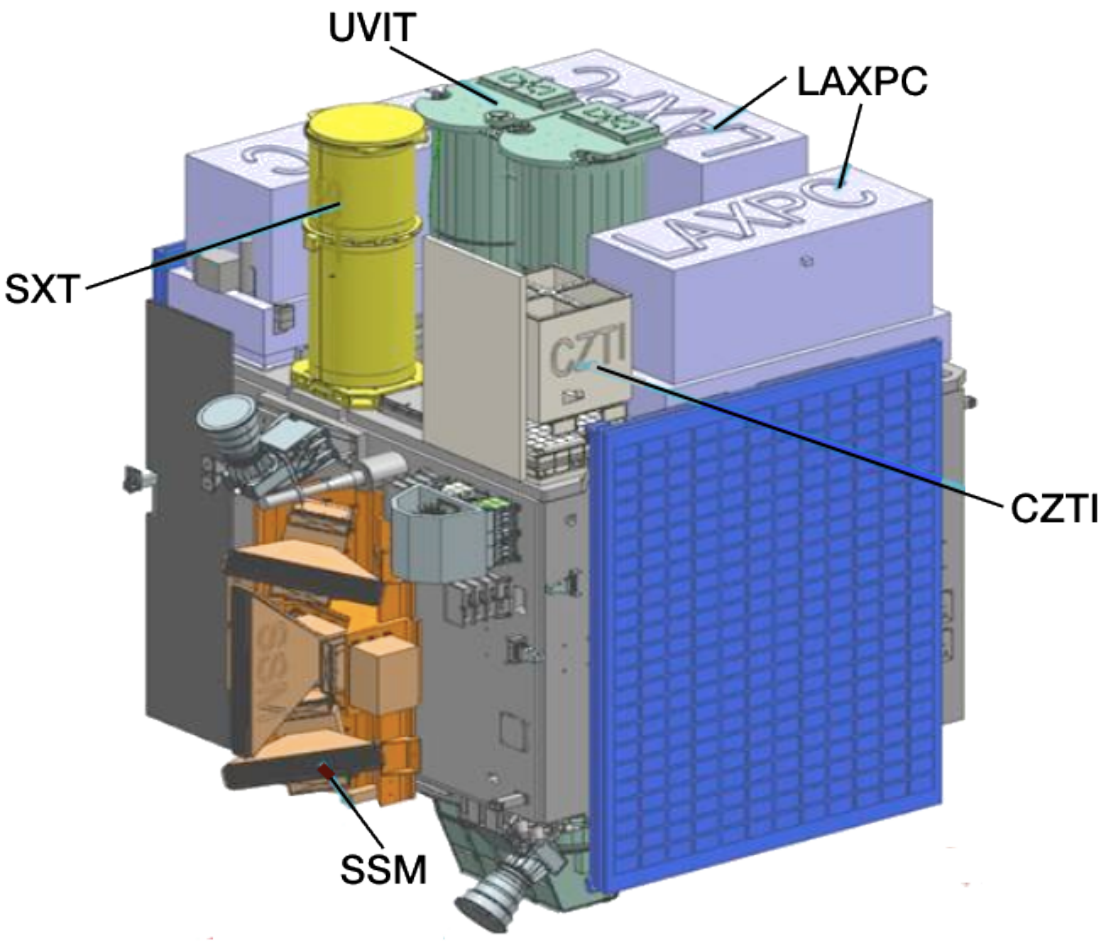
ASTROSAT and POLIX





Biswajit Paul
Raman Research Institute, Bangalore

ASTROSAT



UVIT: Twin Telescope, 1.8 arcsec
38 cm each, filters
130-180, 200-300, 320-550 nm

SXT: Soft X-ray Telescope, 2 arcmin
0.2-8 keV, CCD: 150 eV @ 5.9 keV
150 cm^2 at 1.5 keV

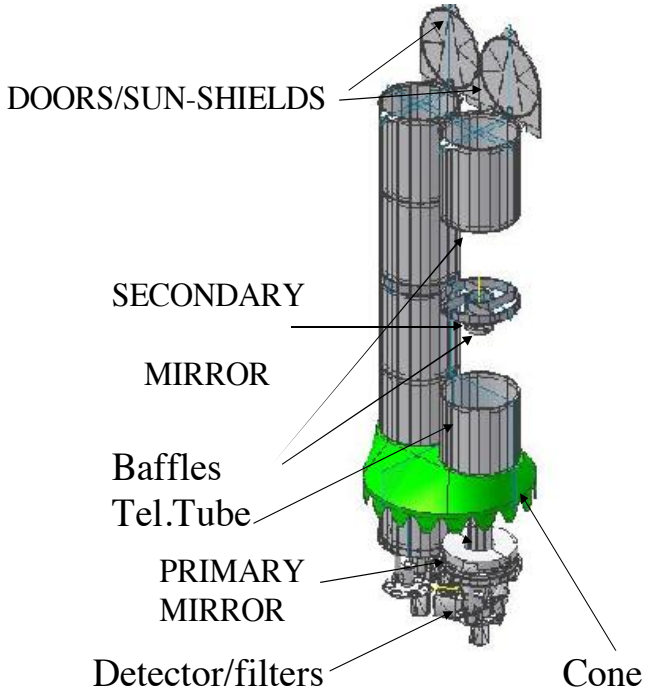
CZTI: CdZnTe pixelated detectors
2-D coded mask, 15-150 keV
6% @ 100 keV, 480 cm^2

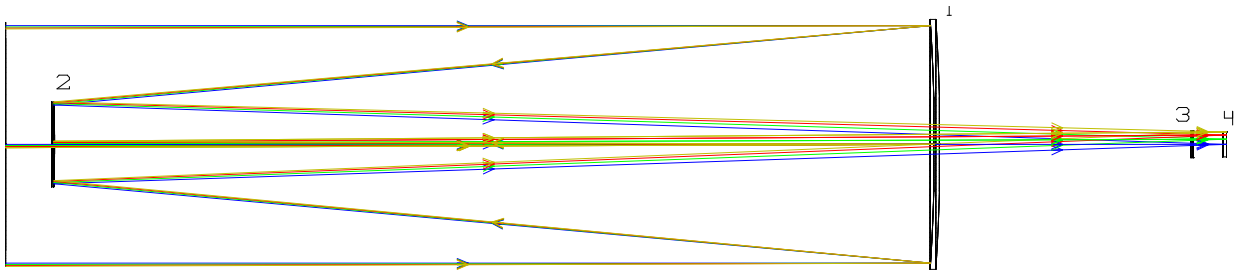
LAXPC: 3 Proportional counters
FOV 42 x 42 arcmin, 10 microsec
12% @ 22 keV, 6000 cm^2, 3-80

SSM: 3 Positional Sensitive PC
1-D coded mask, 2.5-10 keV
~50 mCrab per staring

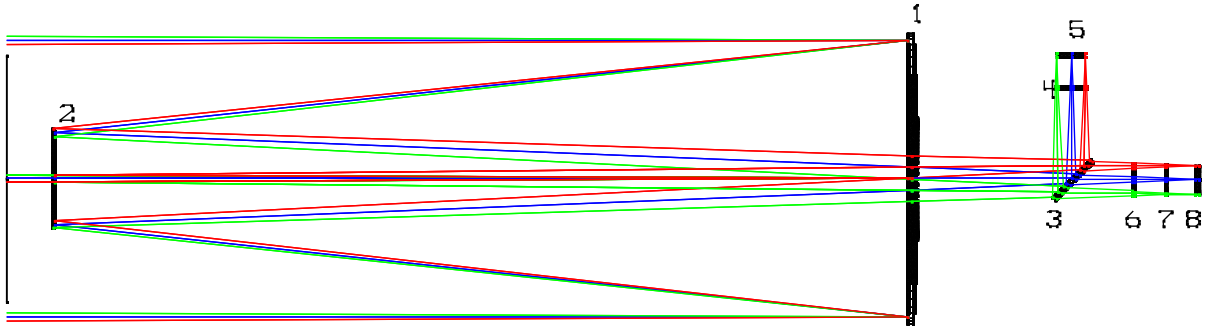
Launch: 28 Sep, 2015
650 km, 6 degree inclination

Ultra Violet Imaging Telescope (UVIT)

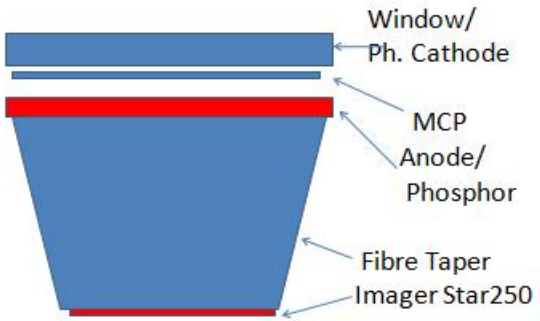




1- PRIMARY MIRROR
2- SECONDARY MIRROR
3- FILTER /grating
4- DETECTOR WINDOW

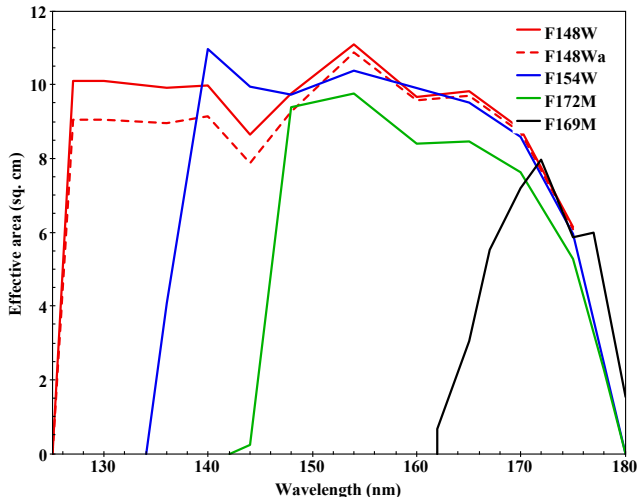


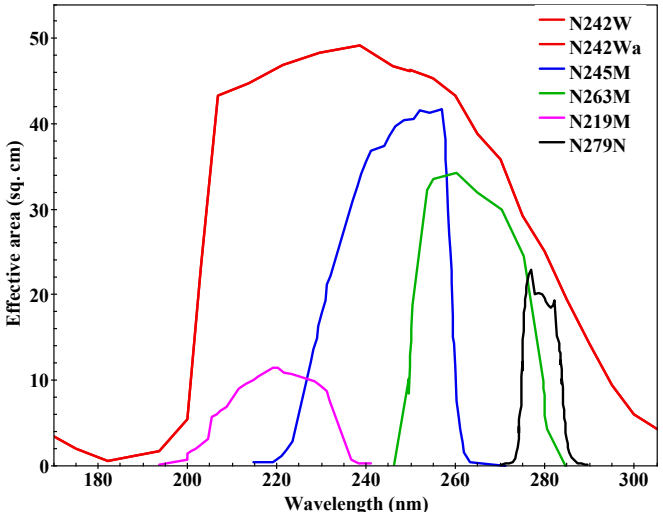
Detector Configuration

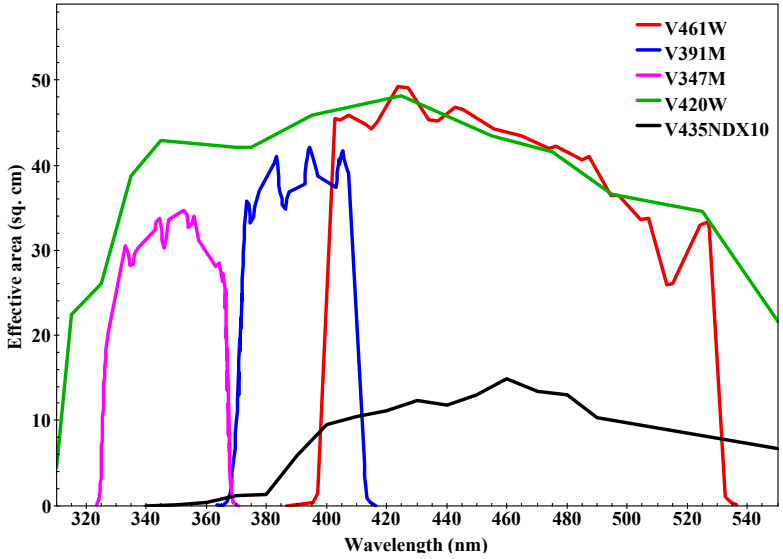


Tandon et al. 2016

UVIT filters

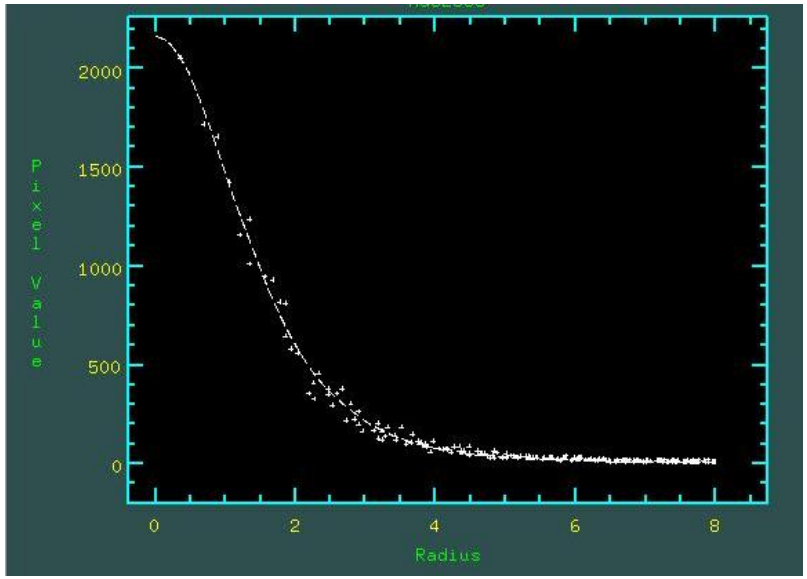


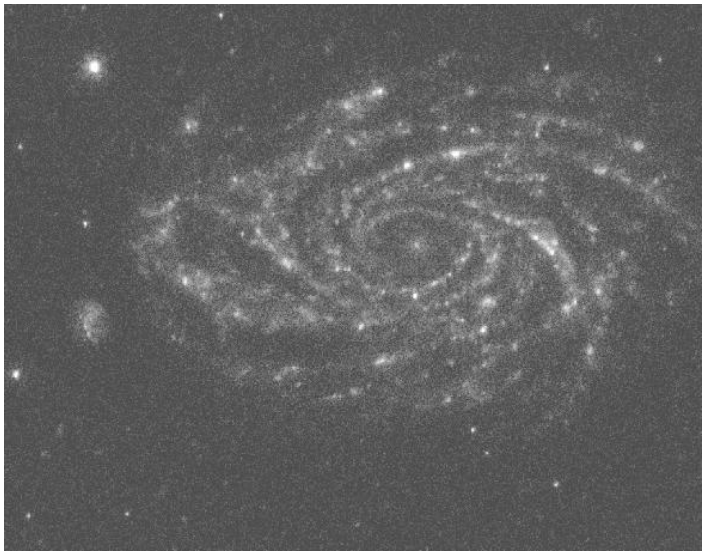


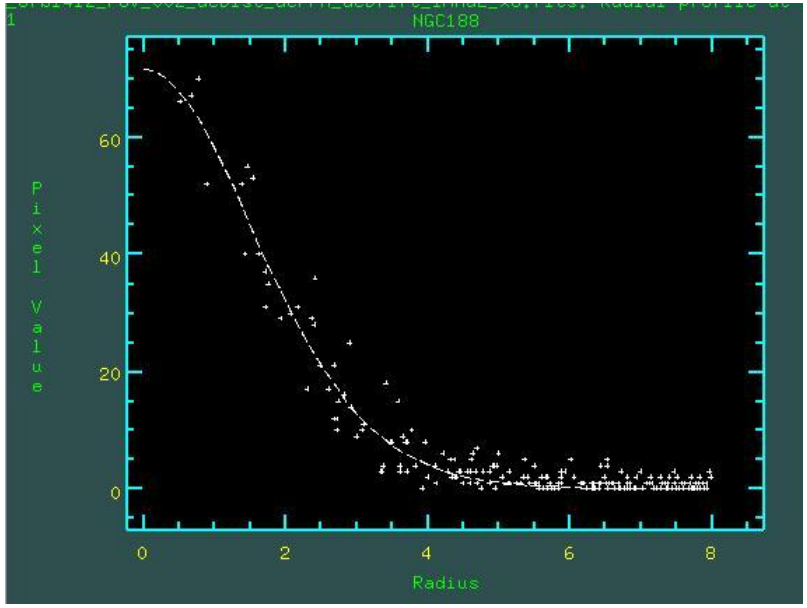


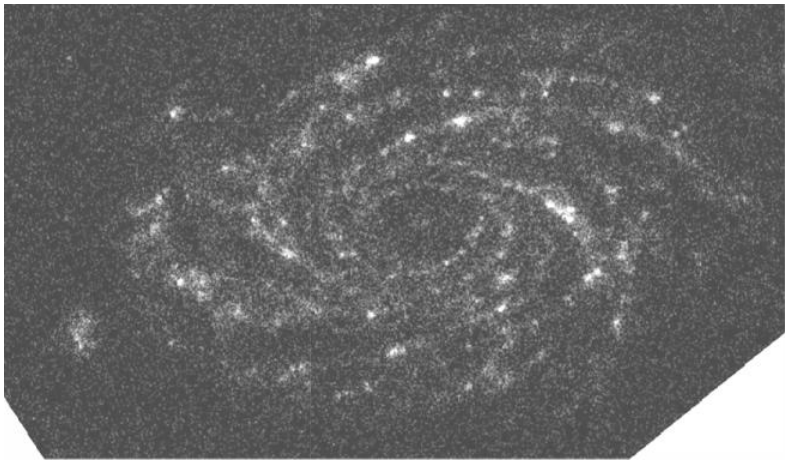
Tandon et al. 2016

UVIT image resolution



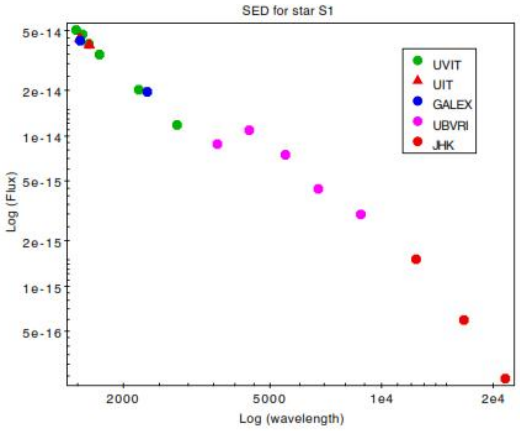






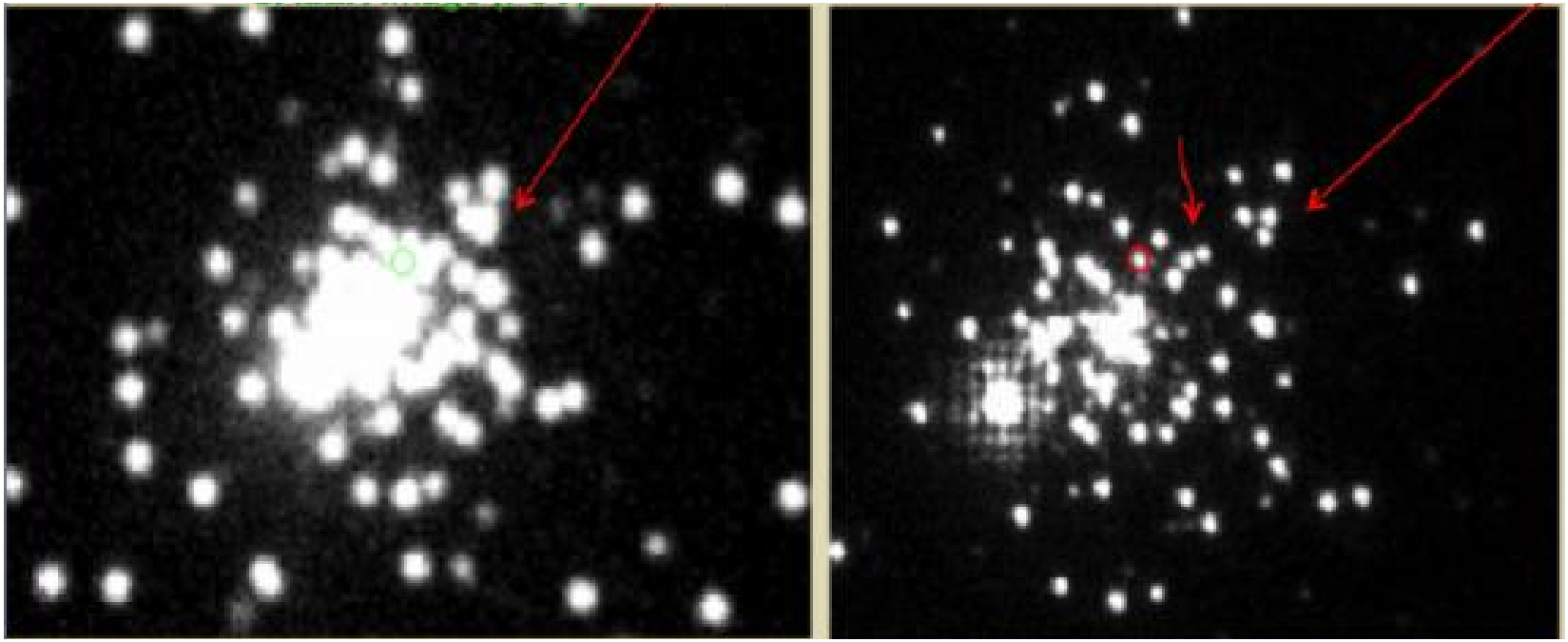
Tandon et al. 2016

Ultra Violet Imaging Telescope (UVIT)



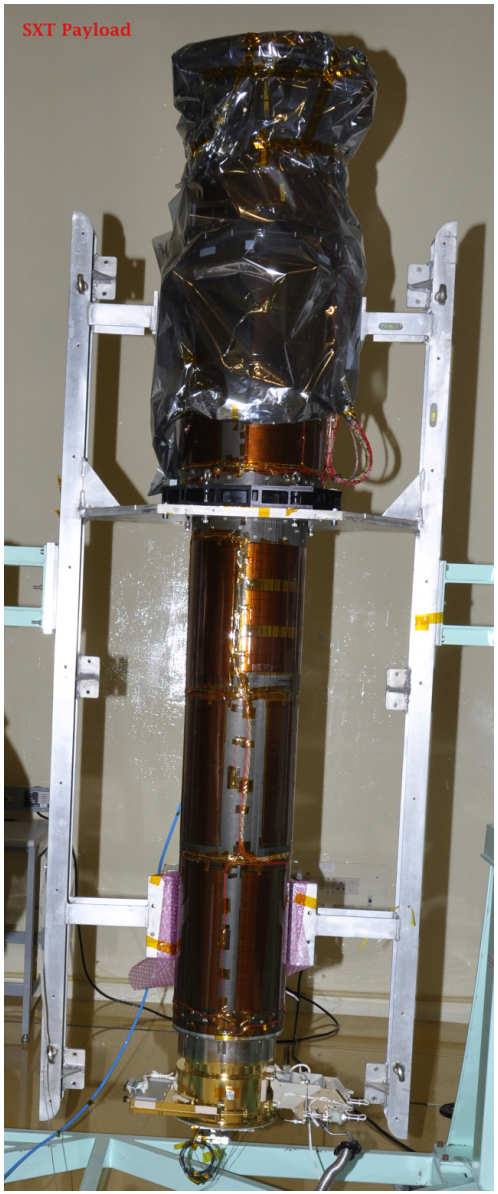
GALEX

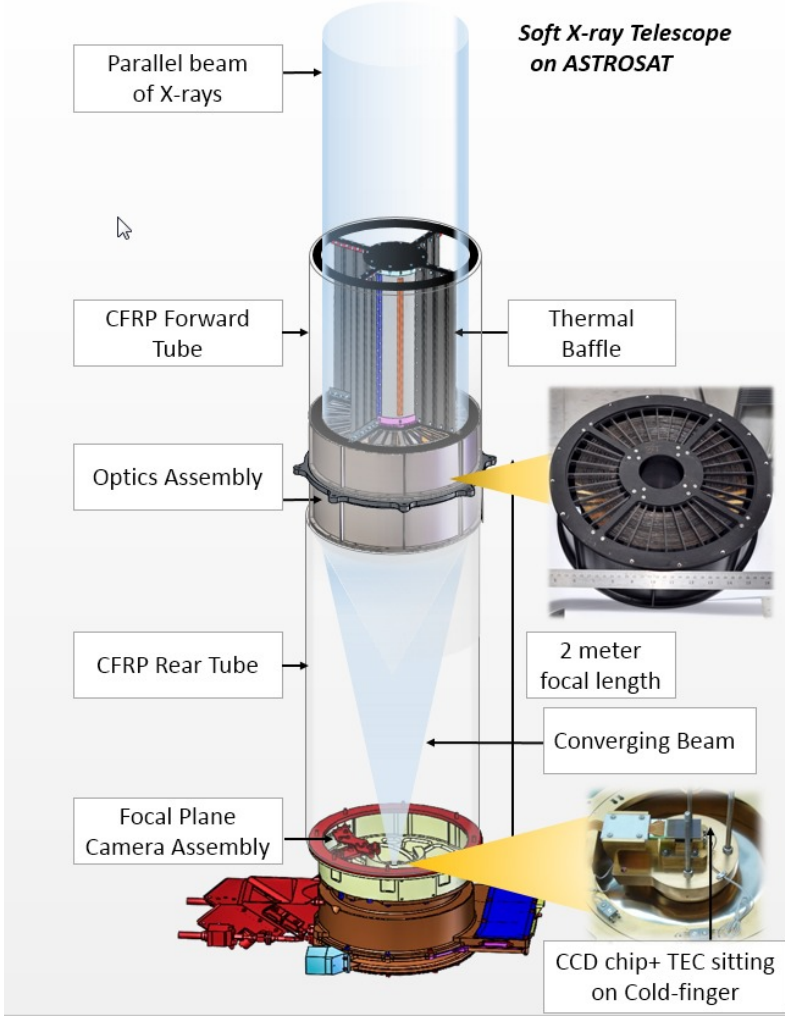
UVIT



Tandon et al. 2016

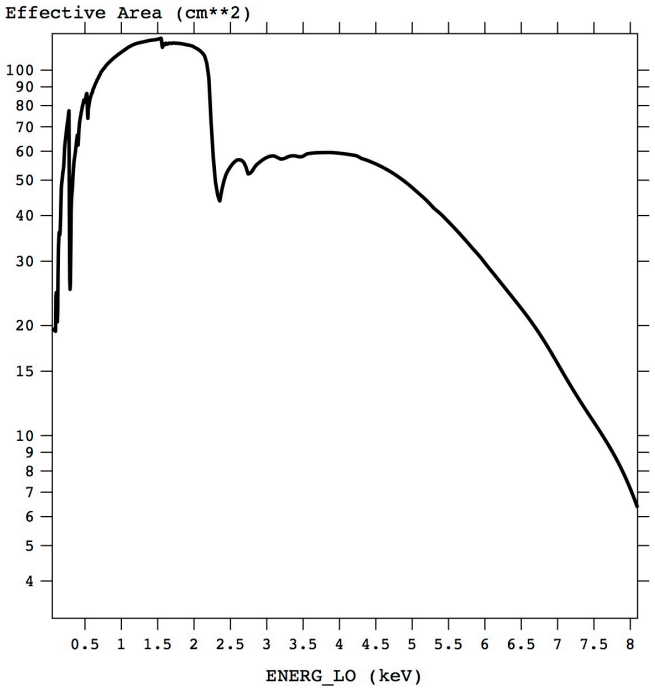
Soft X-ray Telescope (SXT)

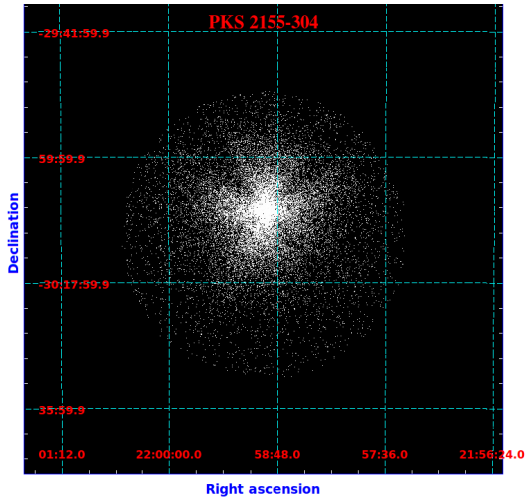


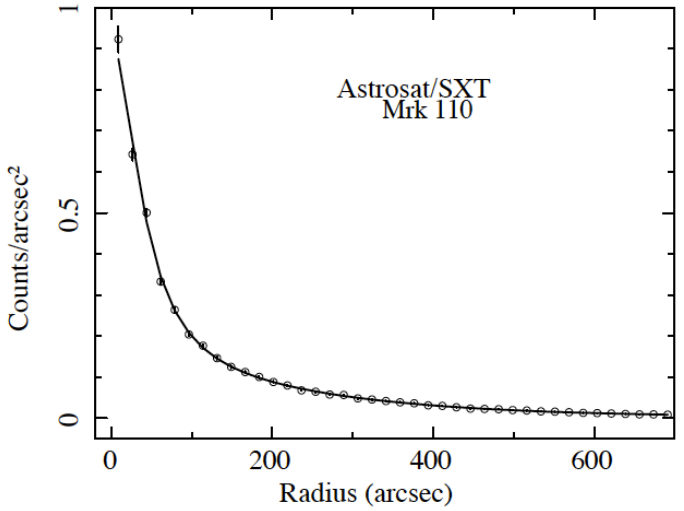


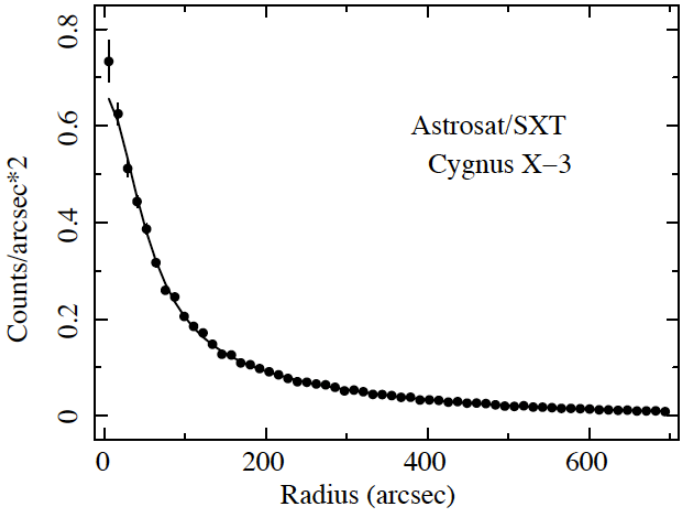
Singh et al. 2016

Soft X-ray Telescope (SXT)



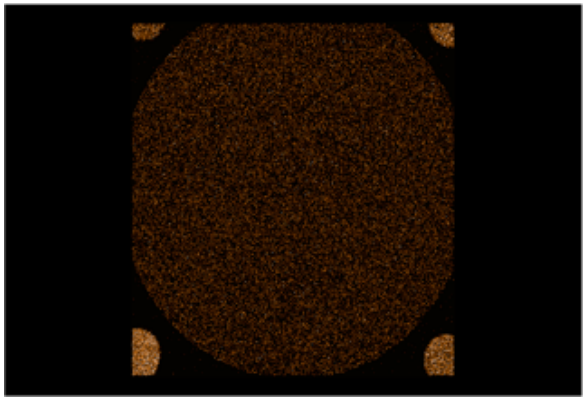


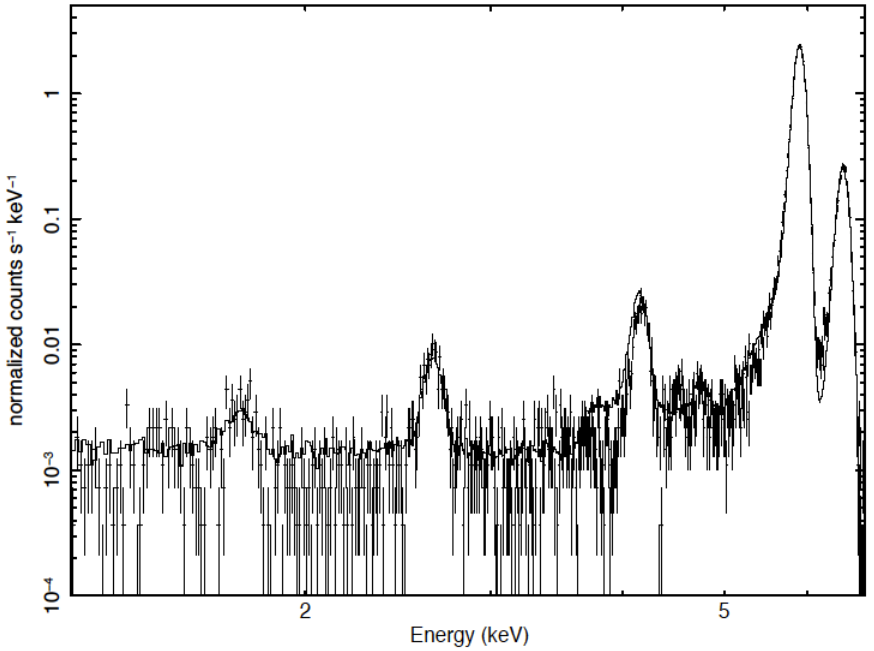




Singh et al. 2016

Soft X-ray Telescope (SXT)

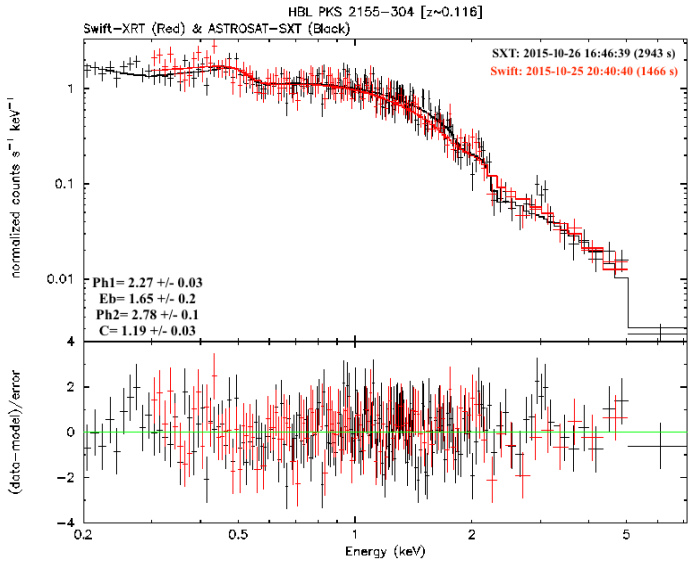


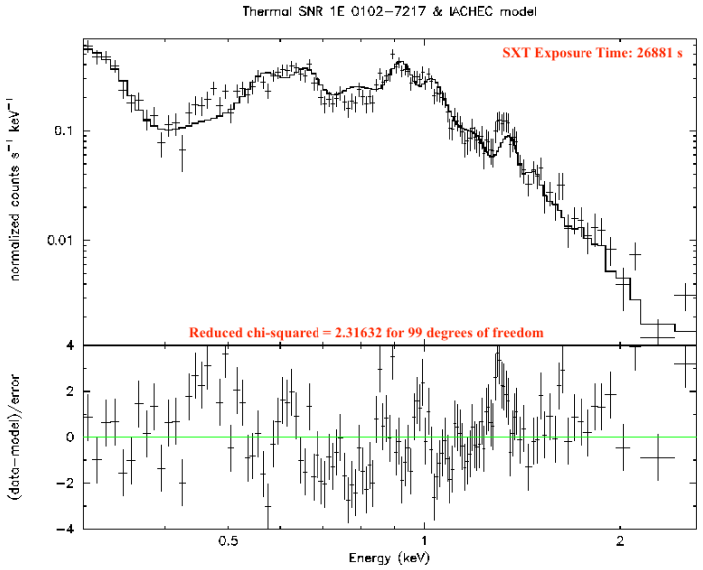


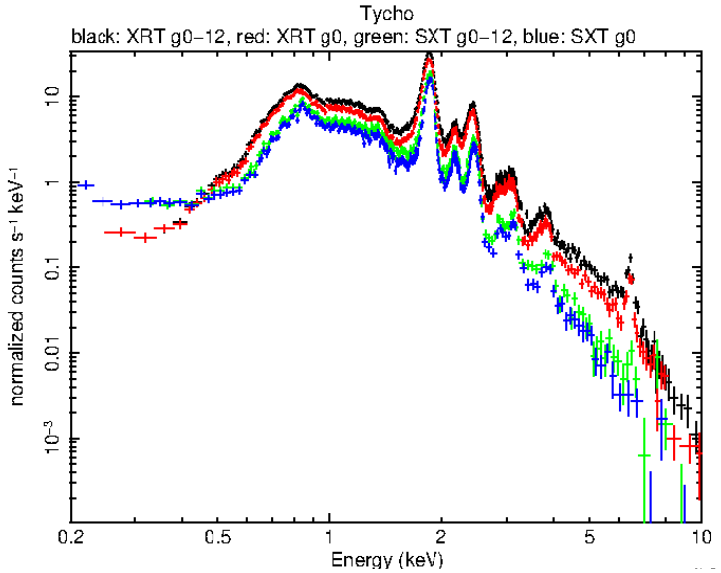
150 eV @ 5.9 keV

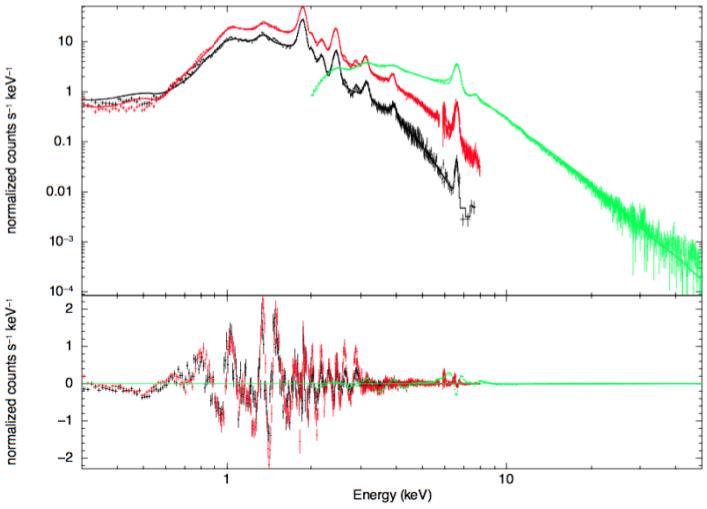
Singh et al. 2016

Soft X-ray Telescope (SXT)



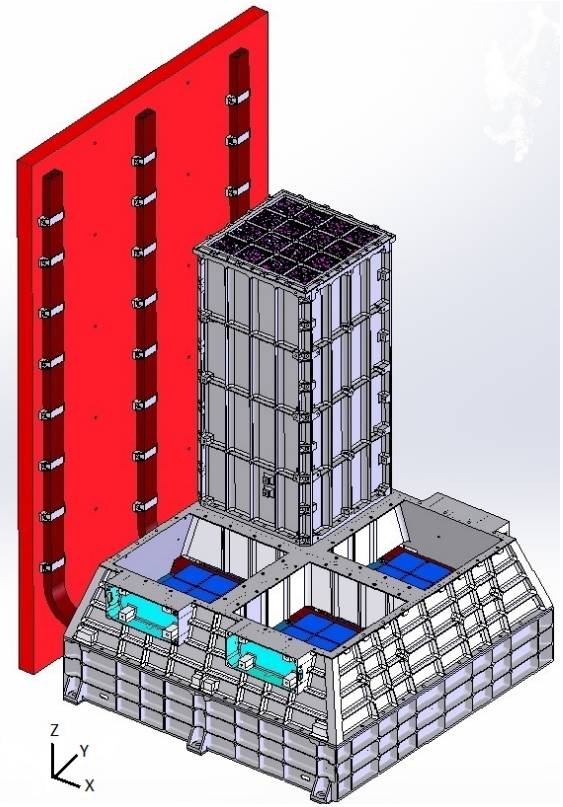


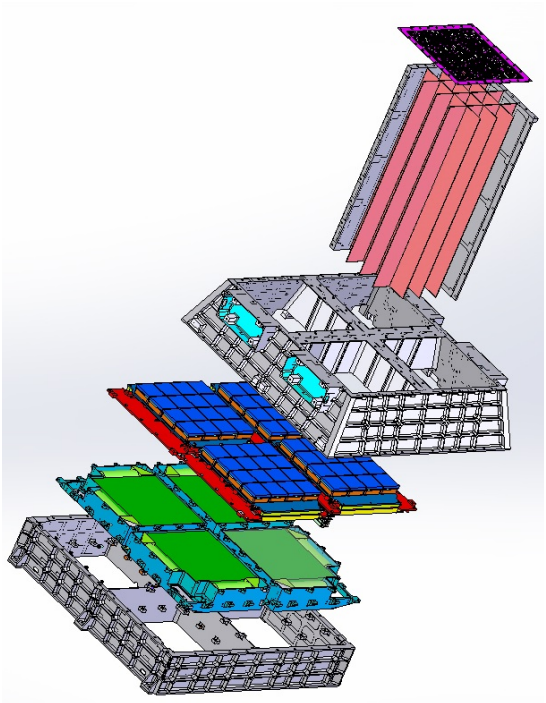


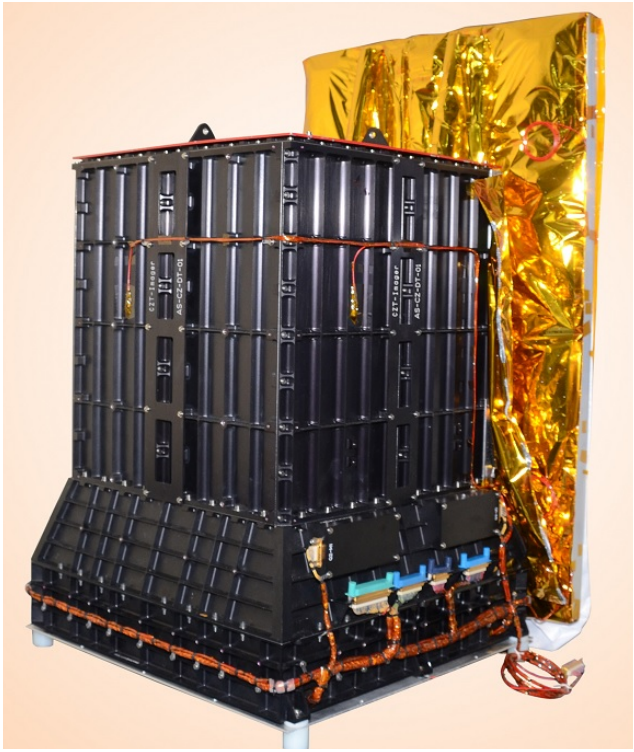


Singh et al. 2016

CdZnTe Imager (CZTI)





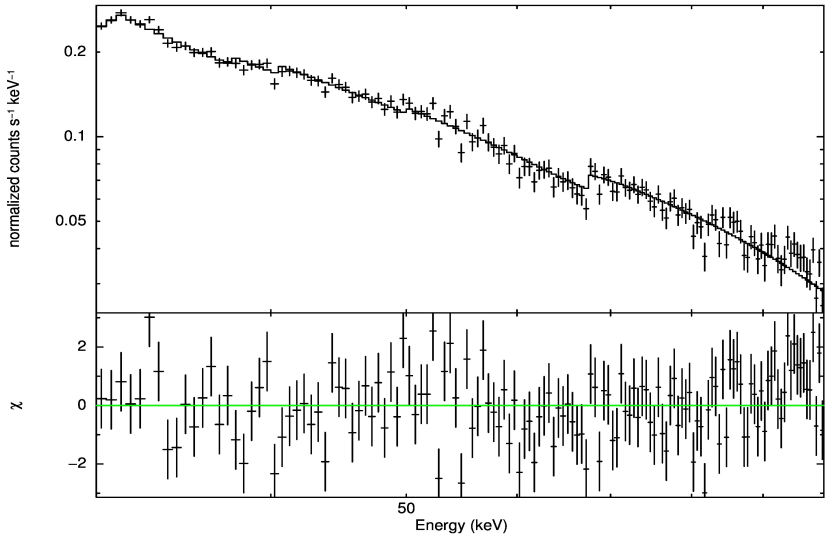


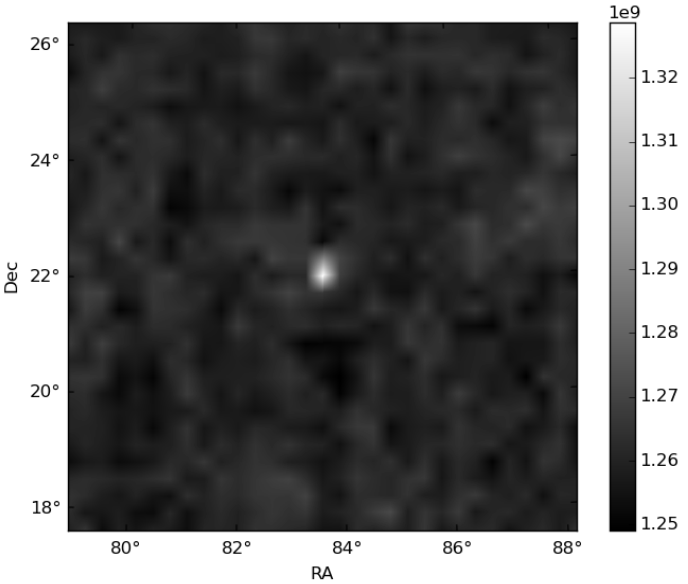
FWHM: 4.6 x 4.6 degree, CsI(Tl) veto detector

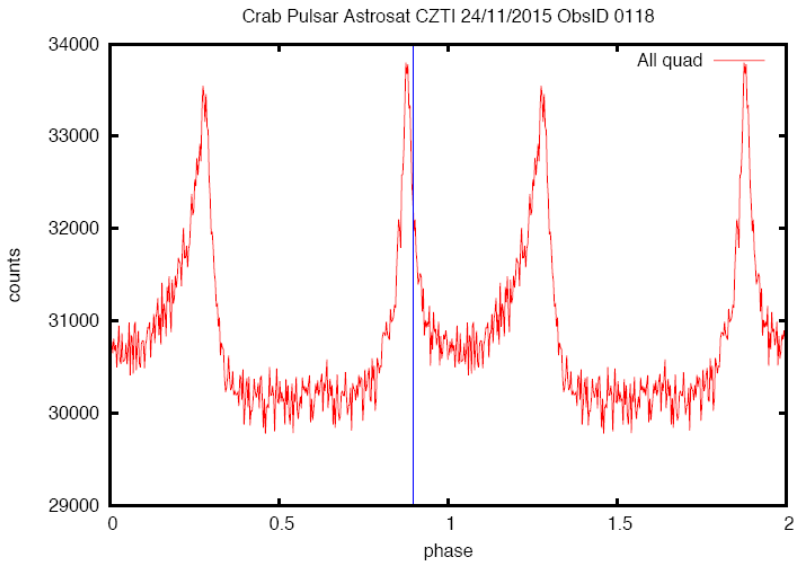
Angular resolution: 17 arcmin

Bhalerao et al. 2016

CZTI Instrument Performance: Crab observations



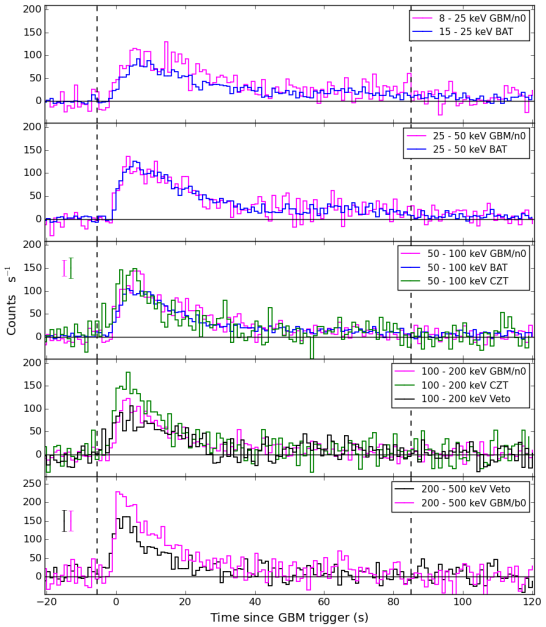


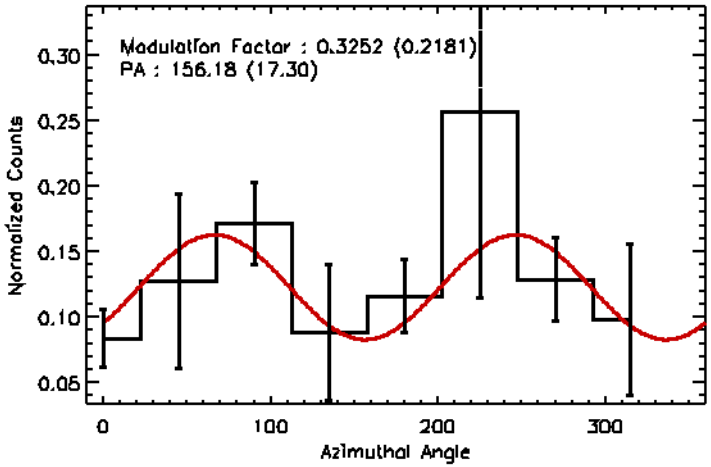


Rao et al.2016, Vadawale et al. 2016

CZTI detection of 151006A

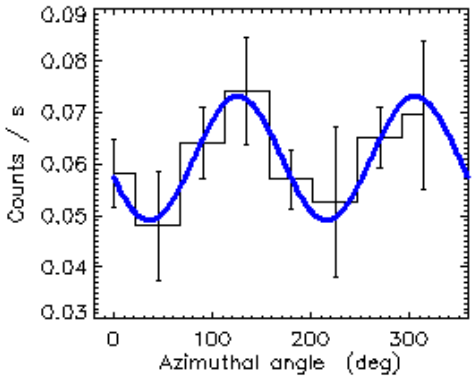
- On the first day of operation.
- Incident at 60°.7 from vertical (θ_x = 34°; θ_y = 58°)
- Material around CZT detectors are transparent to X-rays above 100 keV.
- Significant detection area for off-axis sources.

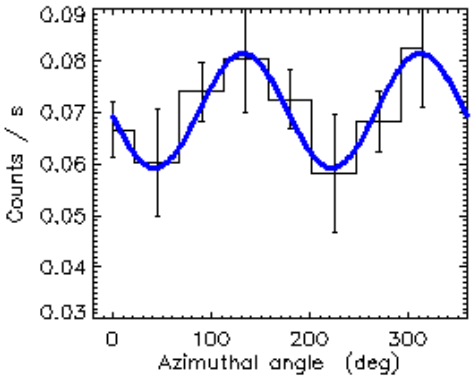


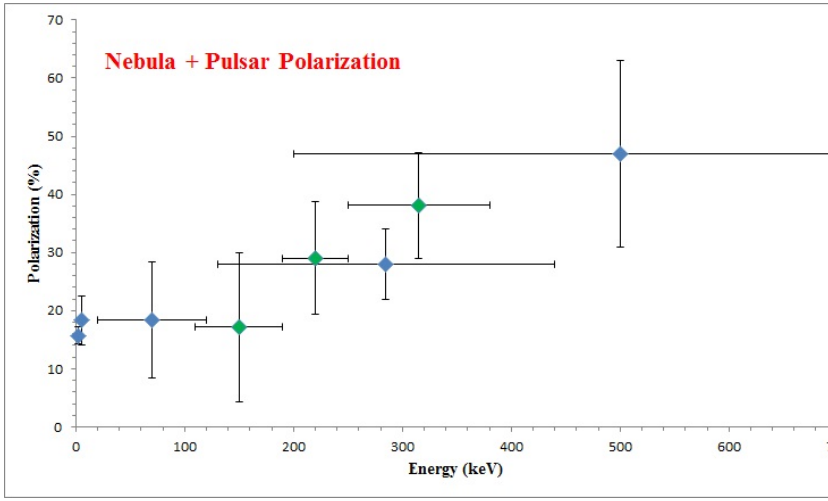


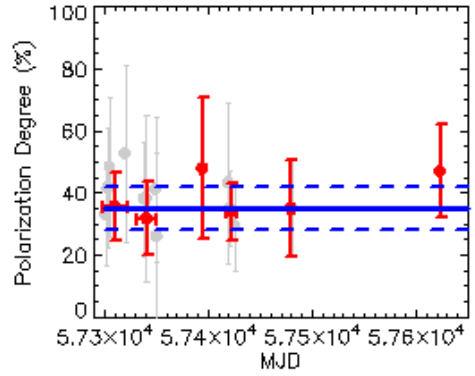
Rao et al.2016

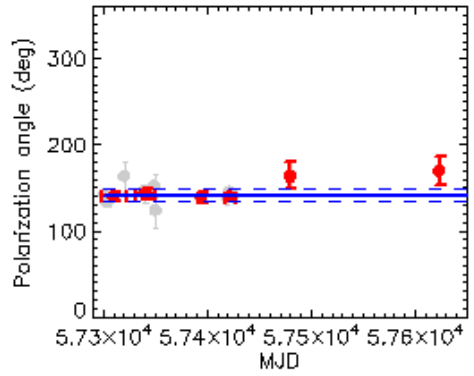
Crab Polarization

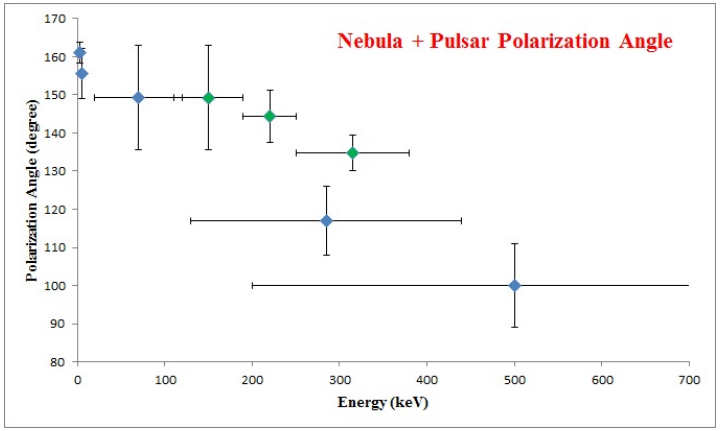


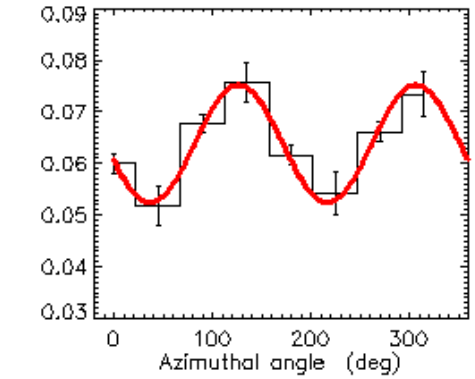


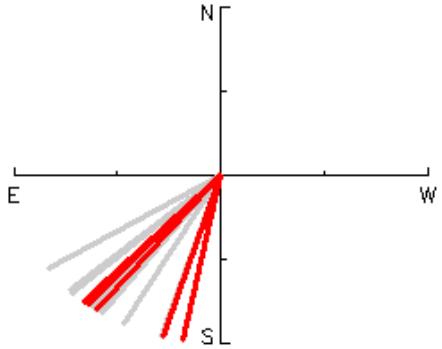






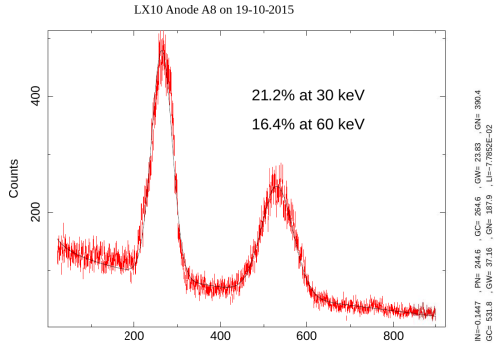


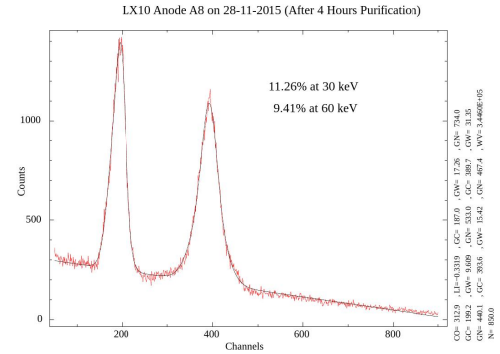


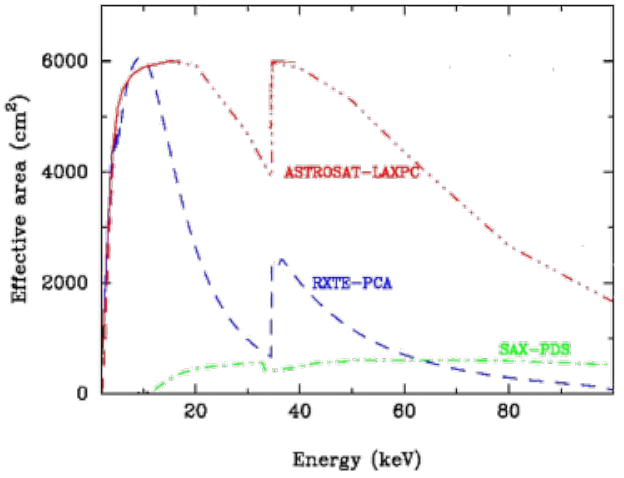


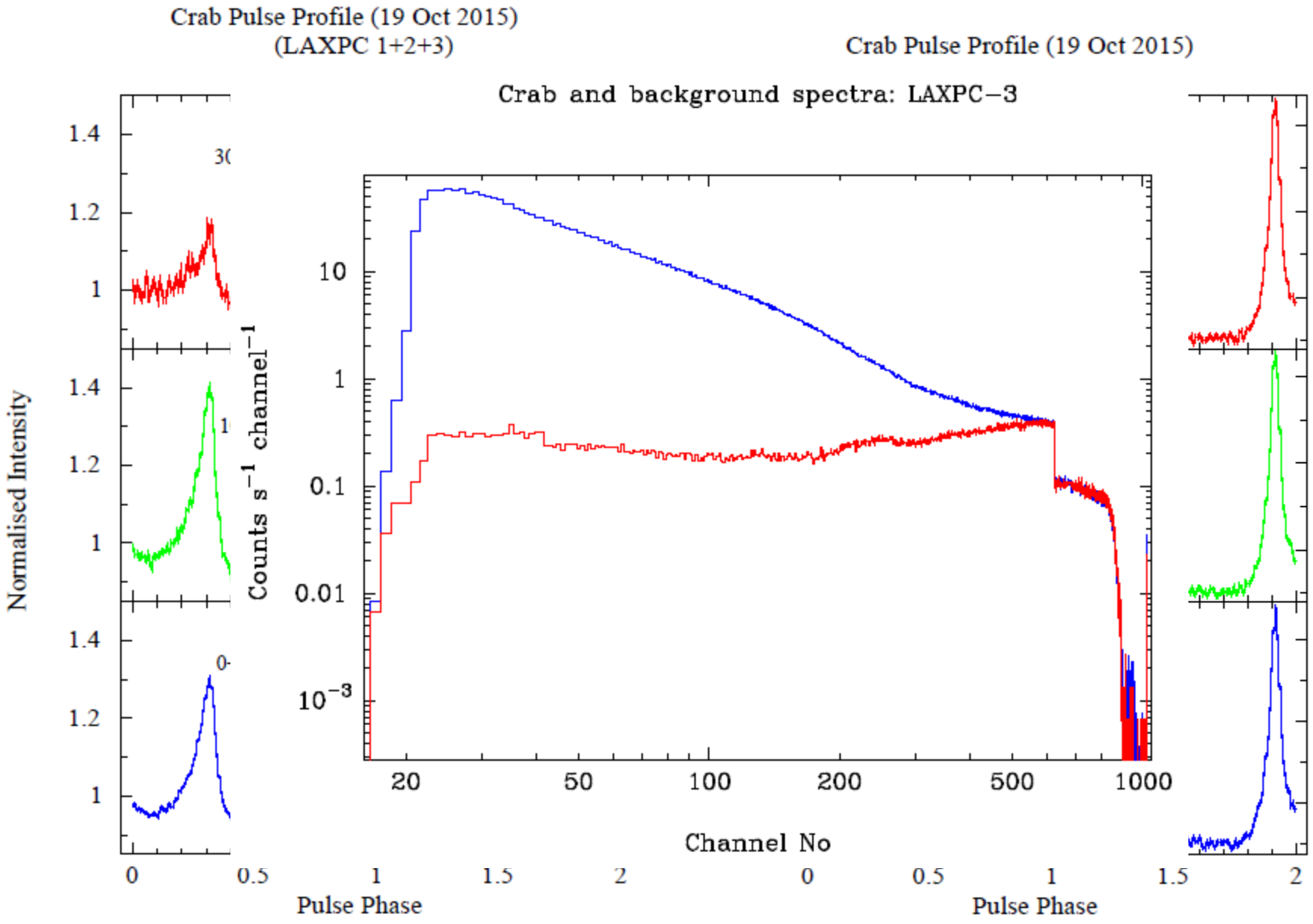
Vadawale et al. in preparation

Large Area X-ray Proportional Counter (LAXPC)

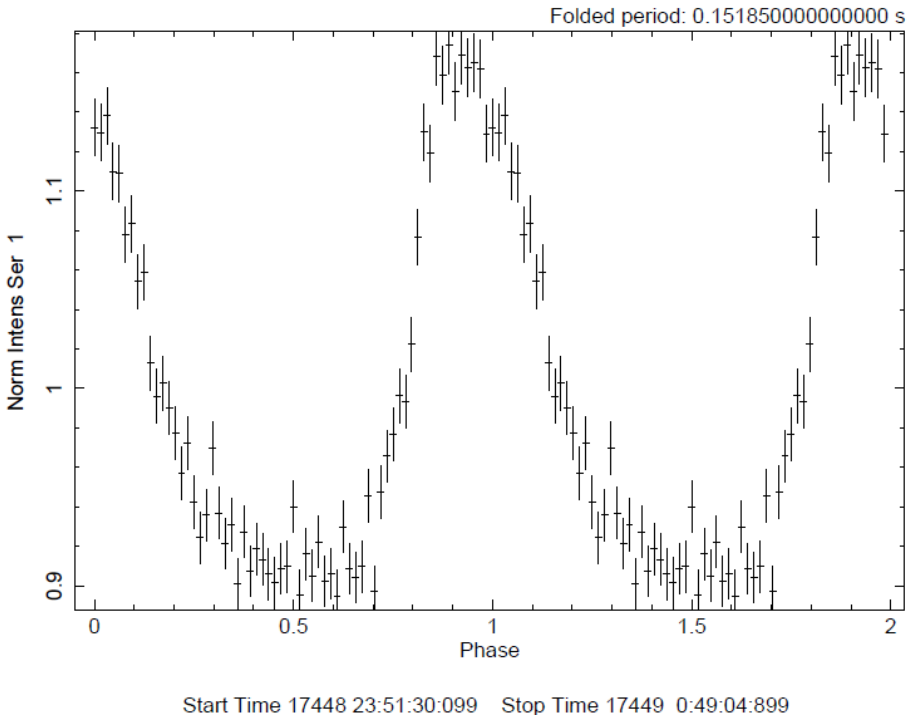







Crab Pulse Profile (19 Oct 2015)
(LAXPC 1+2+3)
Crab Pulse Profile (19 Oct 2015)
Crab and background spectra: LAXPC−3
Normalised Intensity
Counts s^{-1} channel^{-1}
Channel No
Pulse Phase
Pulse Phase

PSR 1509-586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Norm Intens Ser 1
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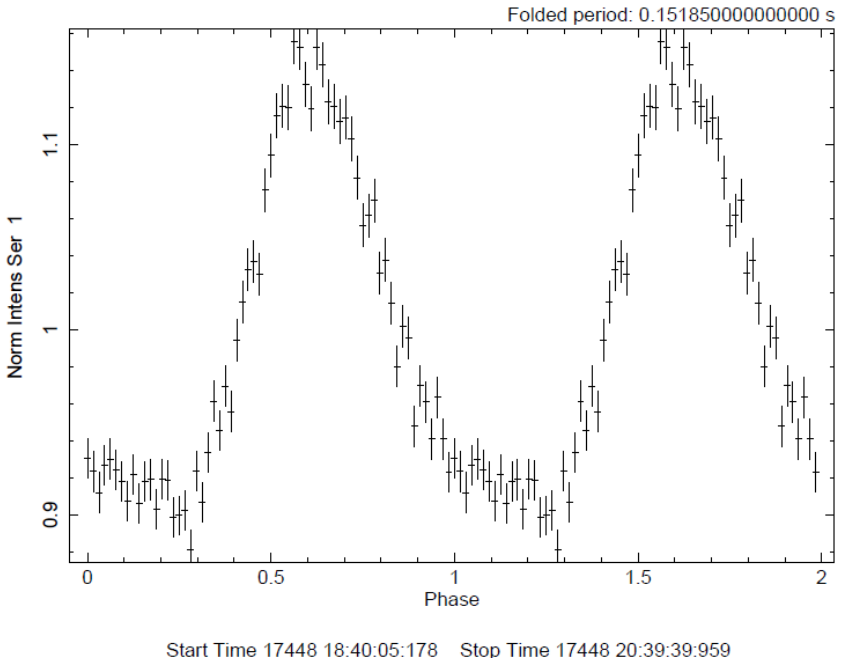
0
0.5
1
1.5
2
Phase
Start Time 17448 23:51:30:099 Stop Time 17449 0:49:04:899


Folded period: 0.151850000000000 s
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1.5
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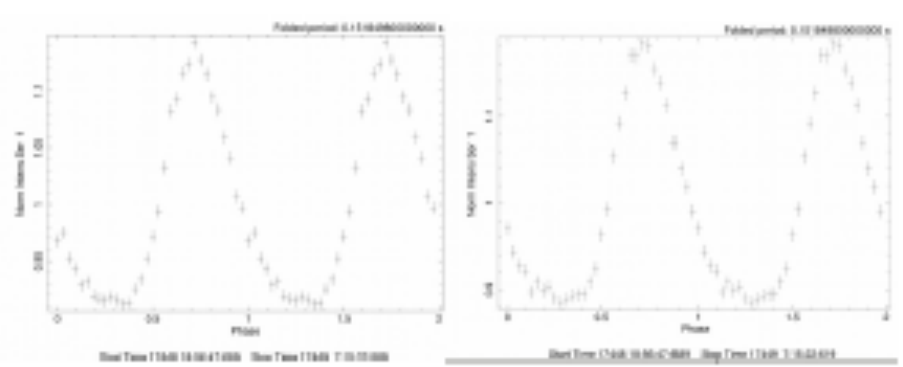
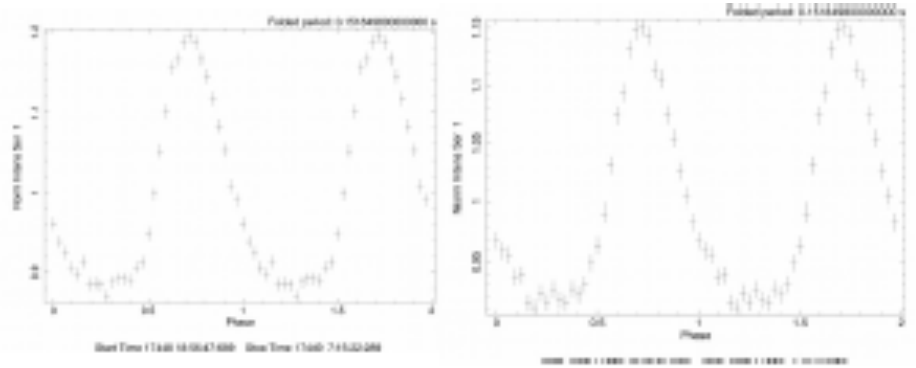
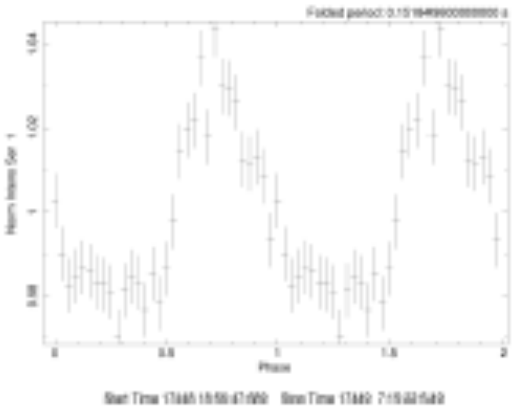
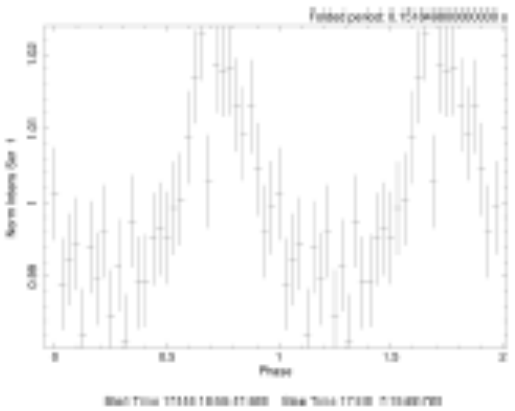
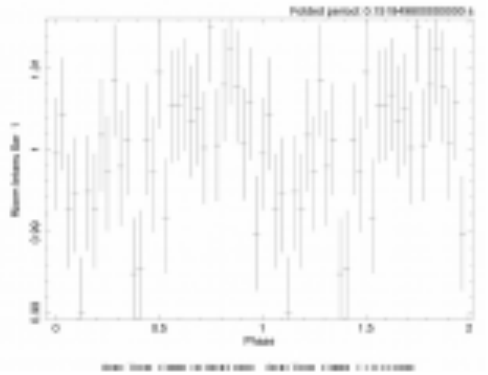
PSR 1509-586



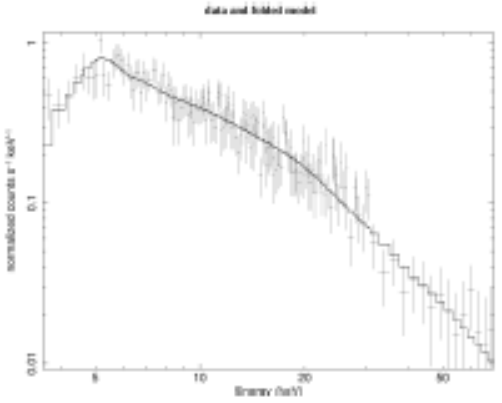


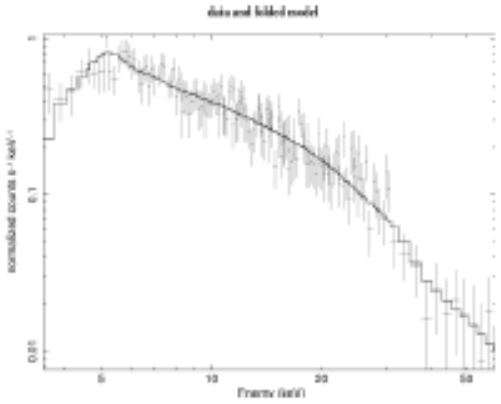


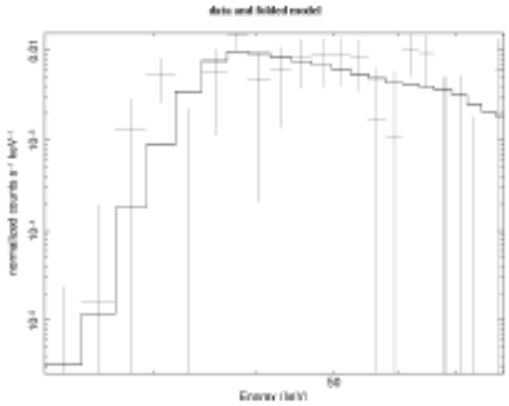


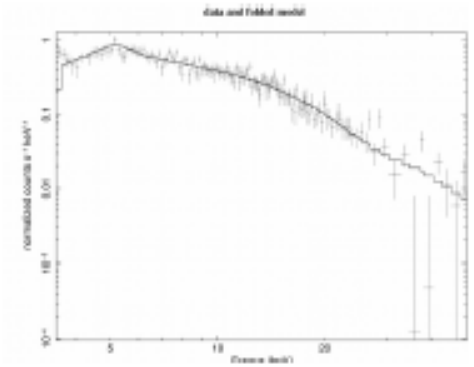


PSR 1509-586

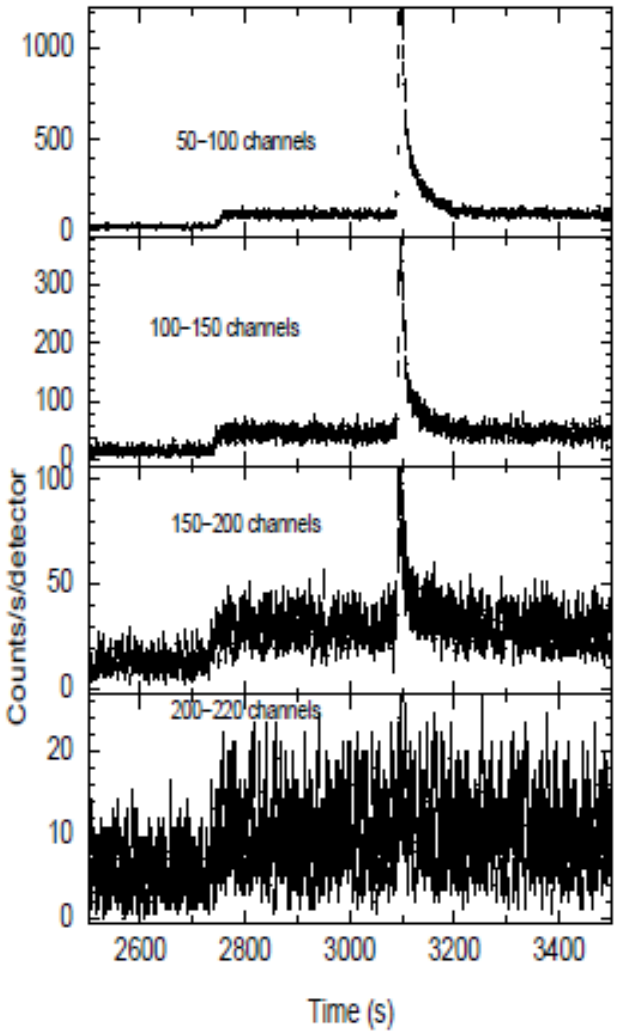




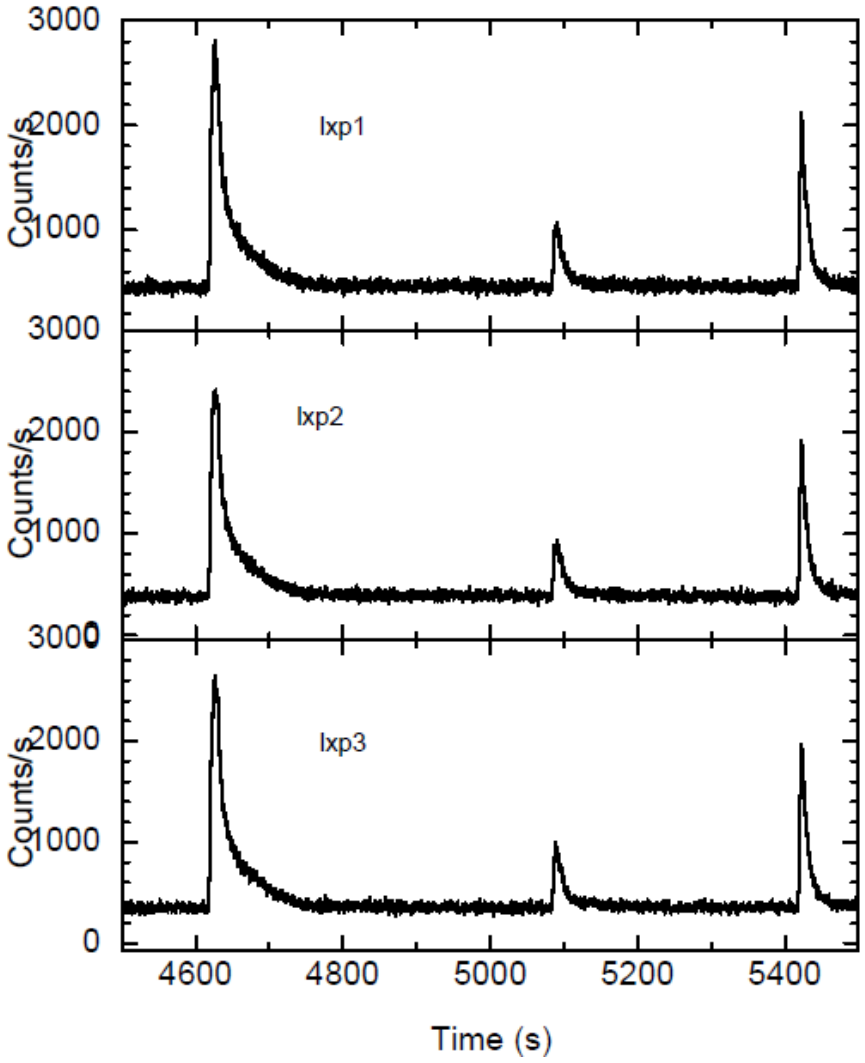


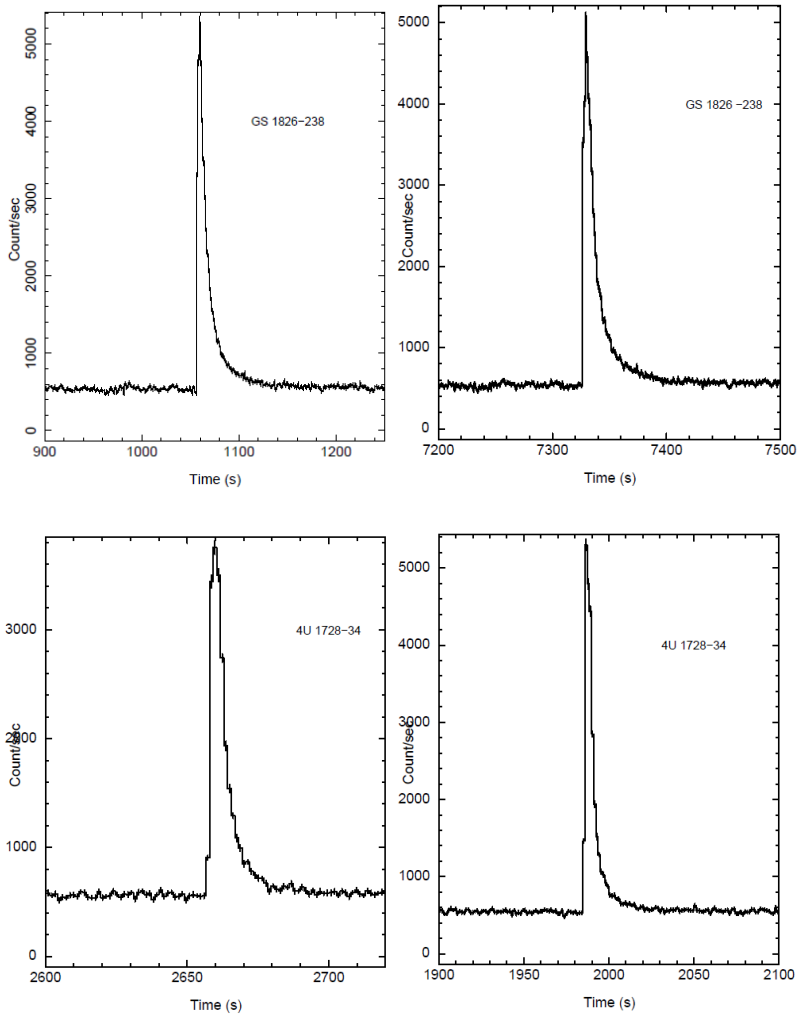


4U 1636-536: Thermonuclear X-ray bursts

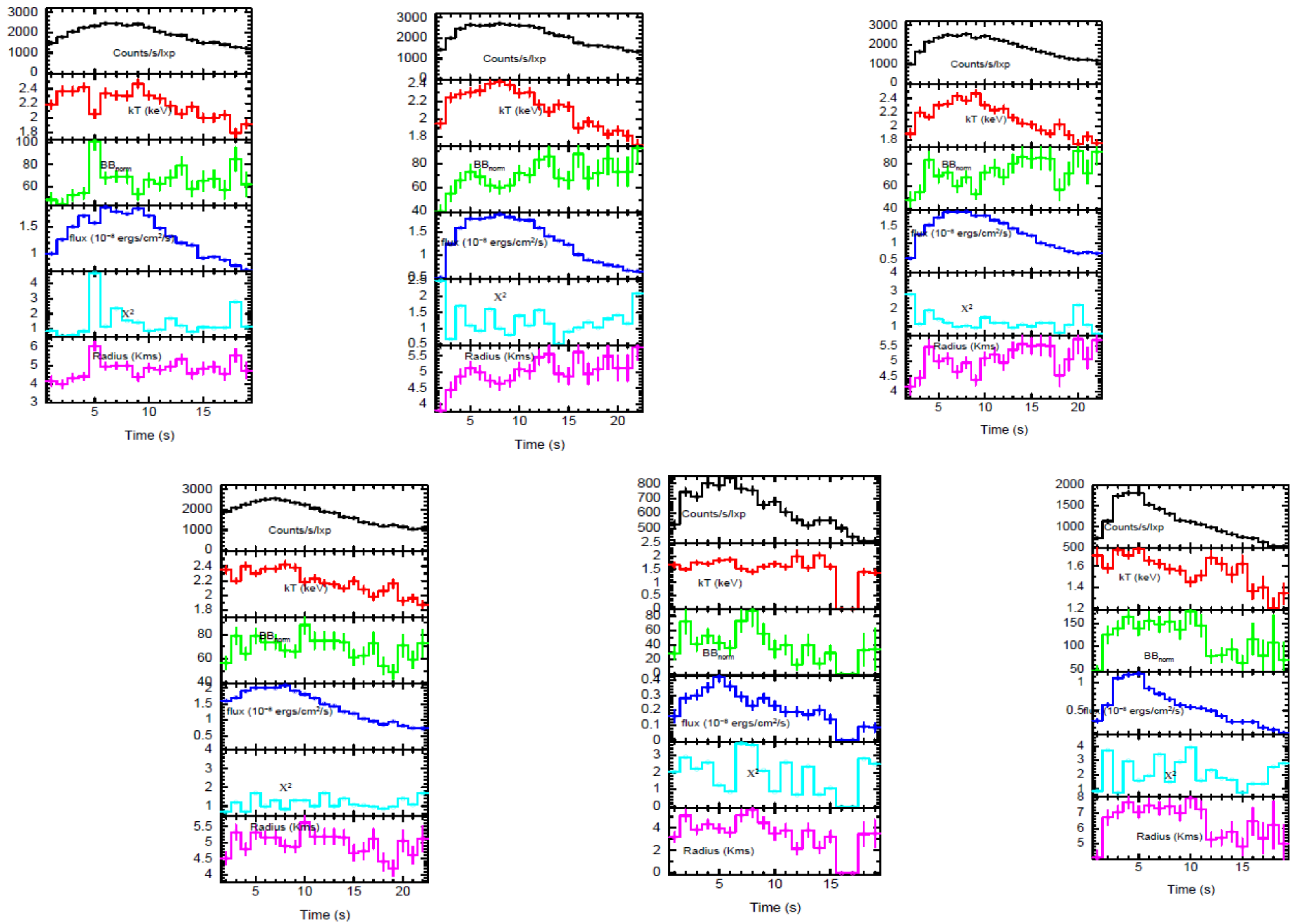


4U 1636-536: Thermonuclear X-ray bursts

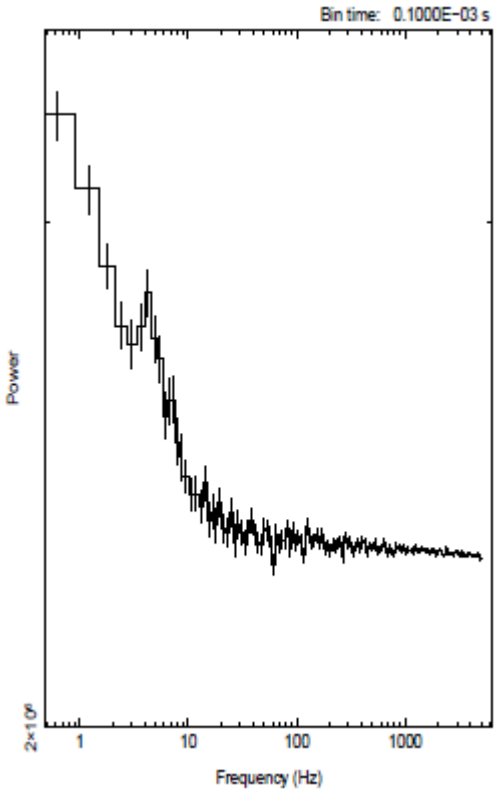




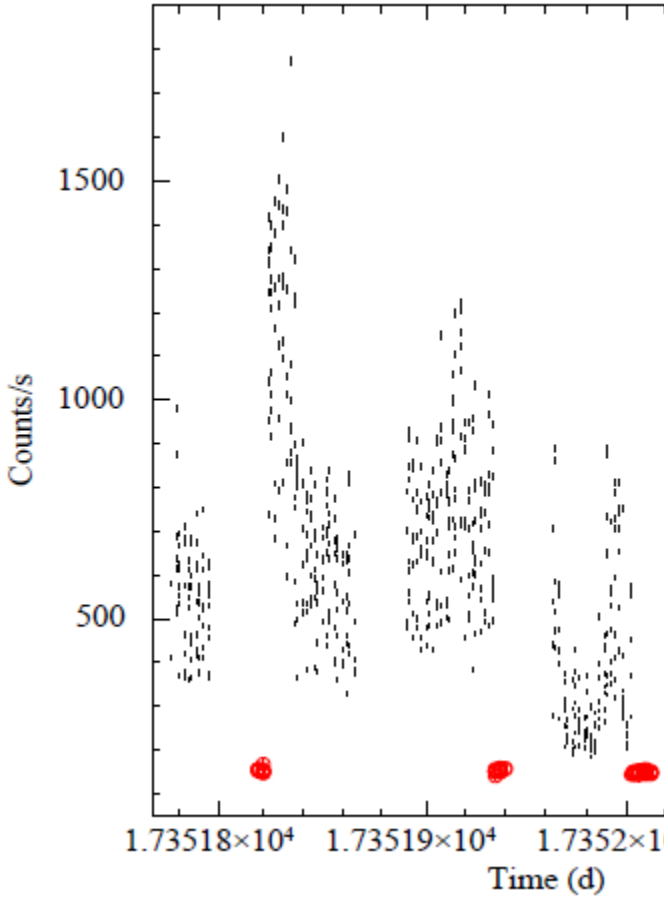
4U 1636-536: Thermonuclear X-ray bursts

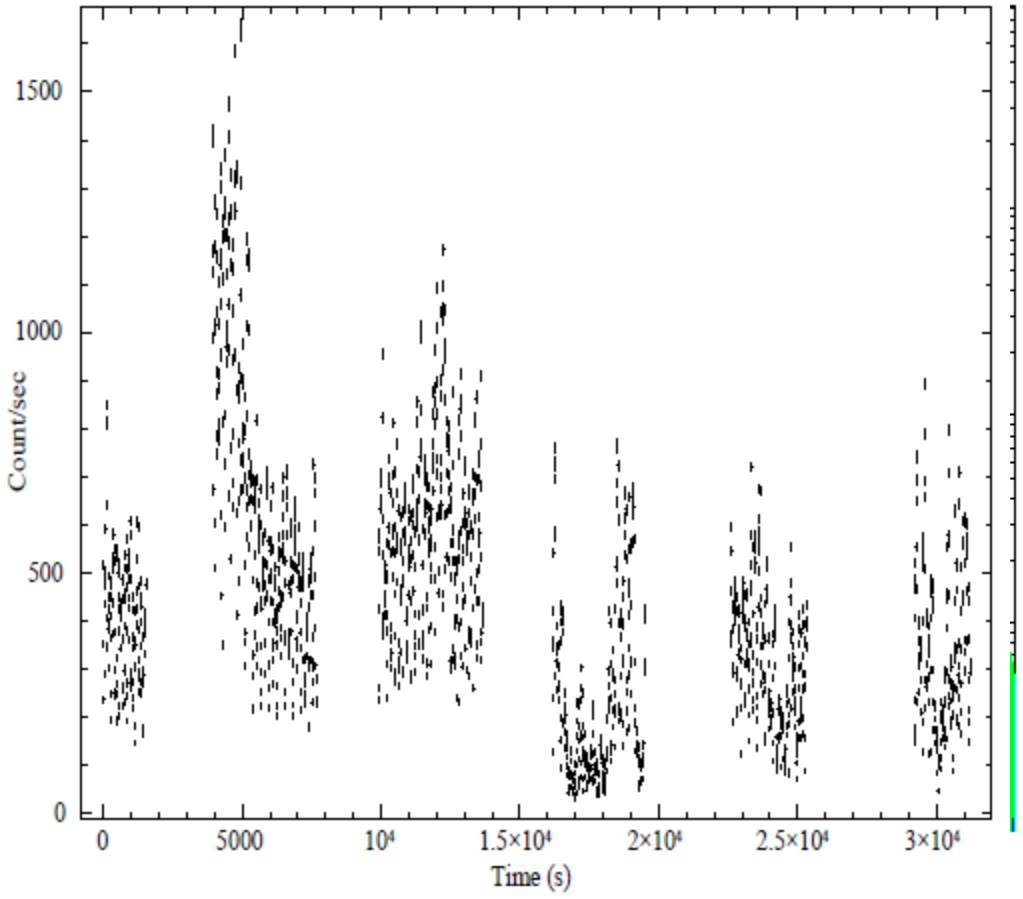


4U 1636-536: QPOs



HMXBs: Vela X-1





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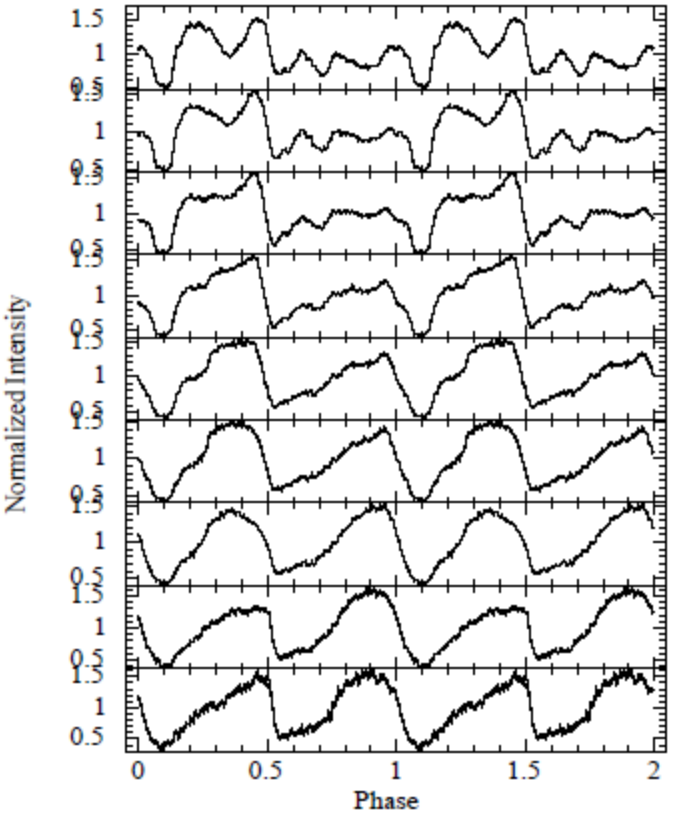

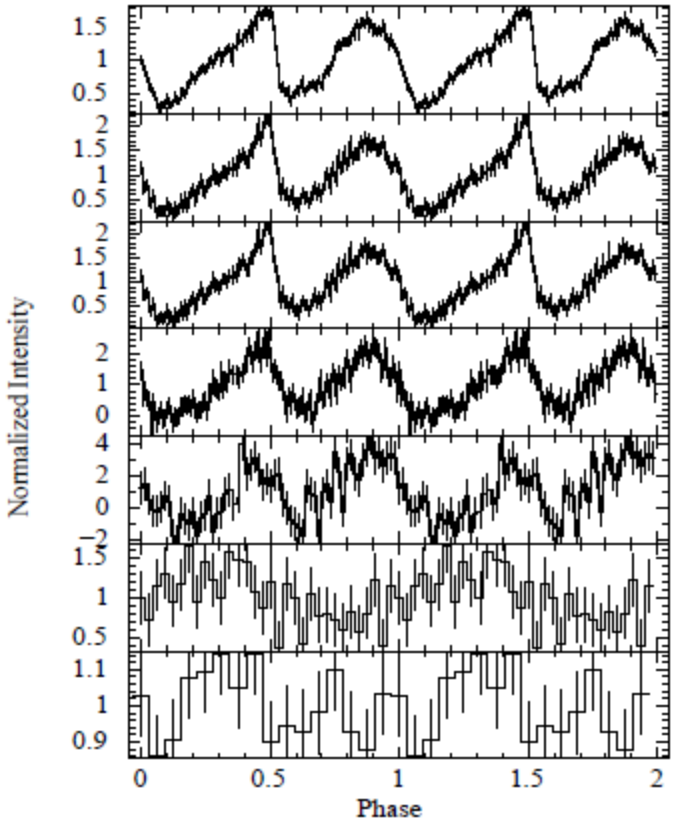

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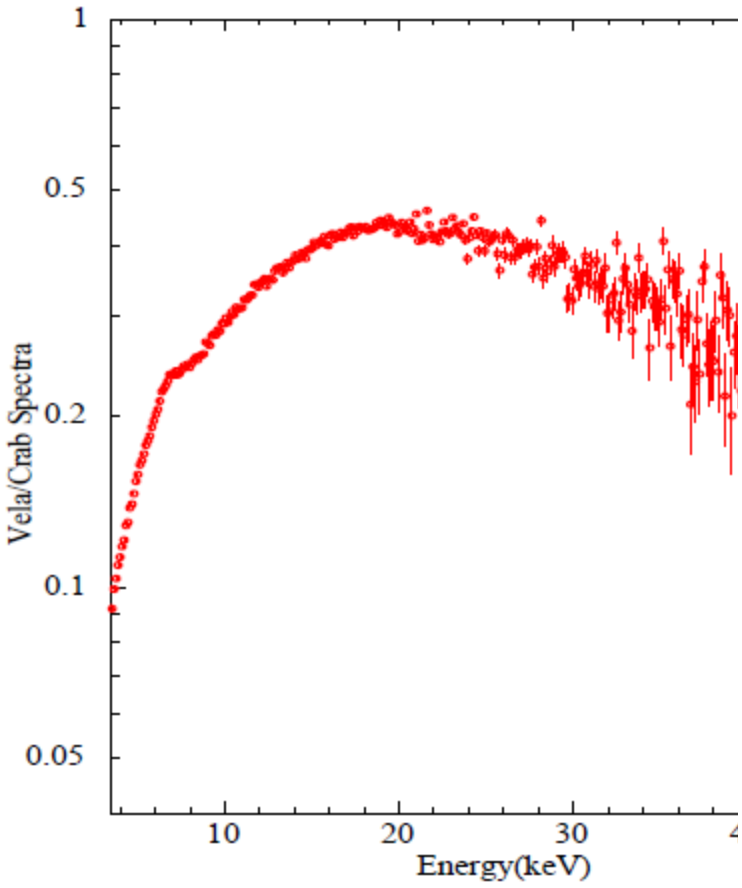
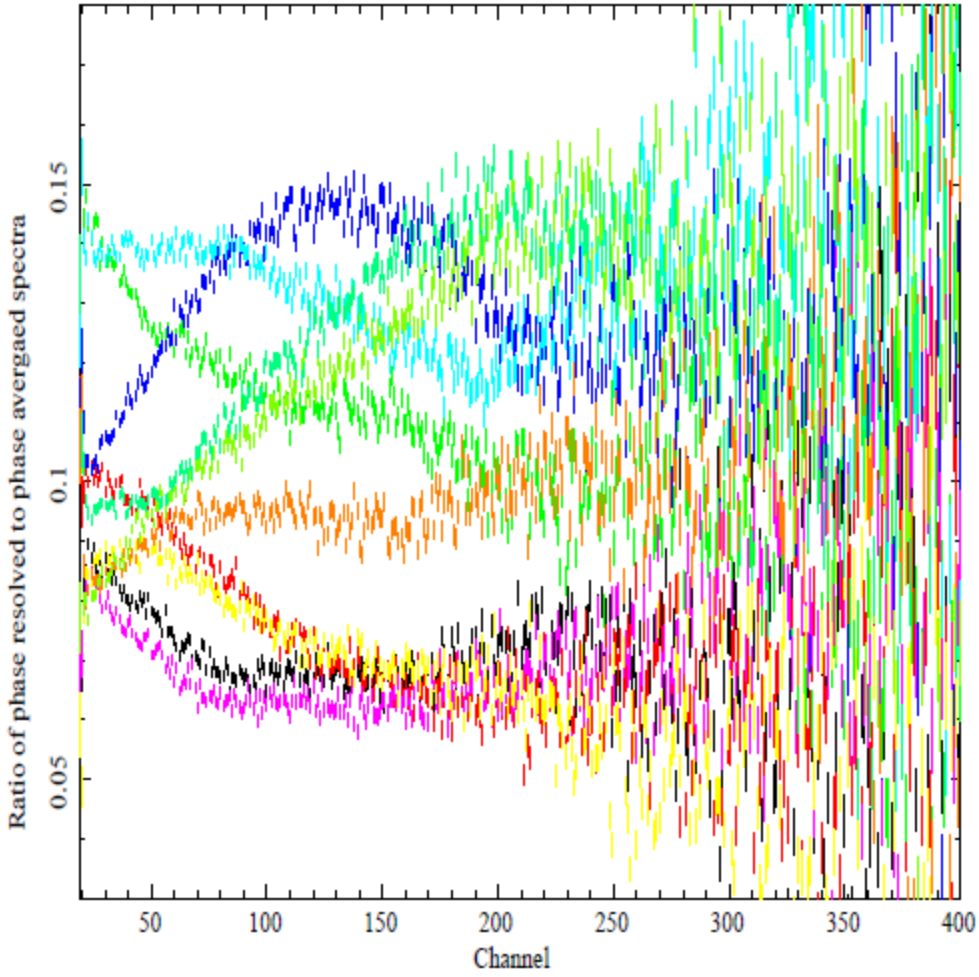
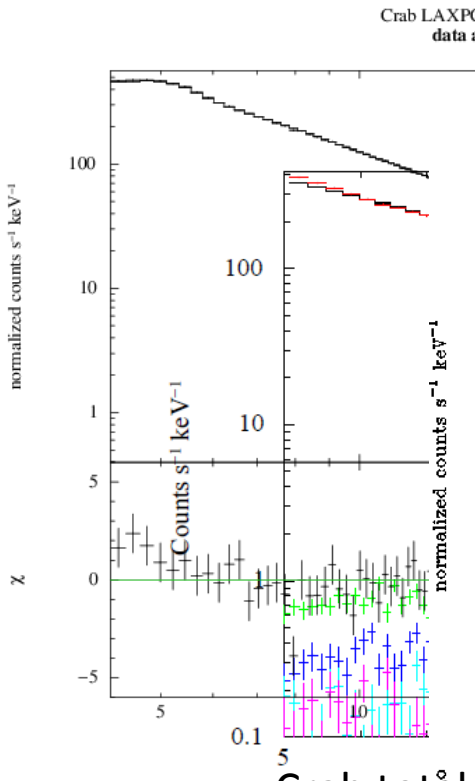
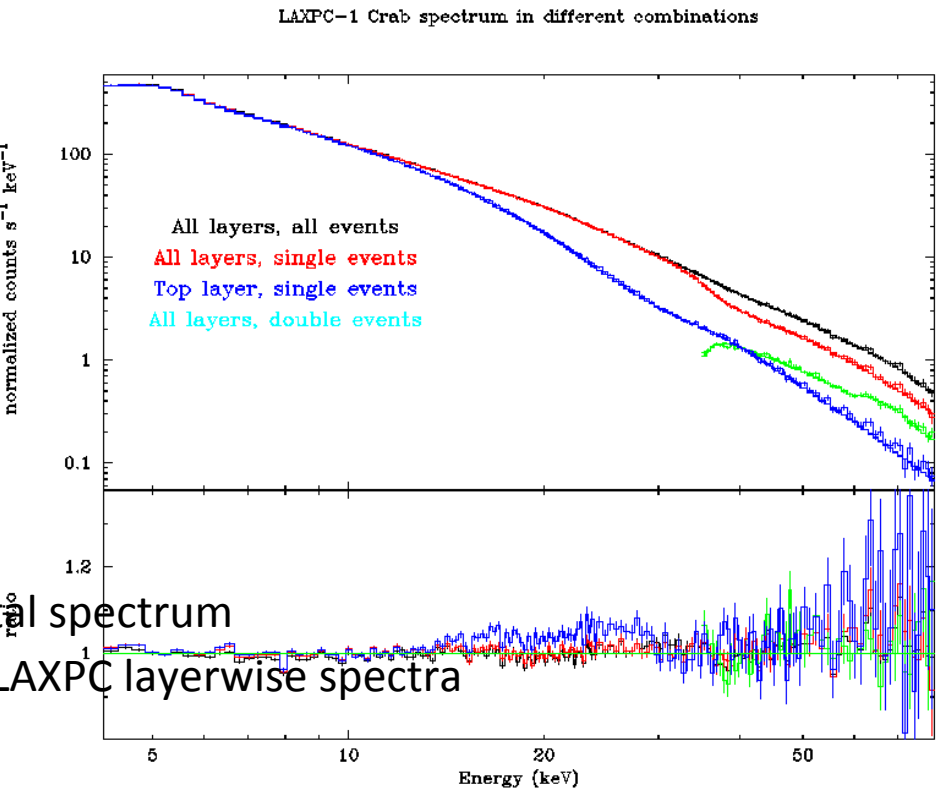




Spectroscopy with LAXPC

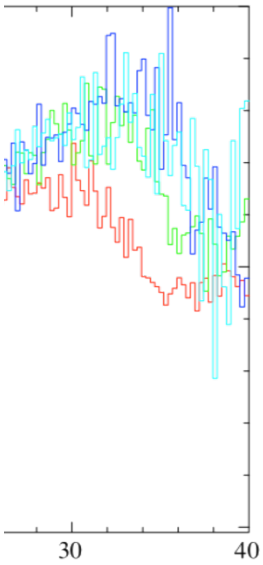


Crab total spectrum



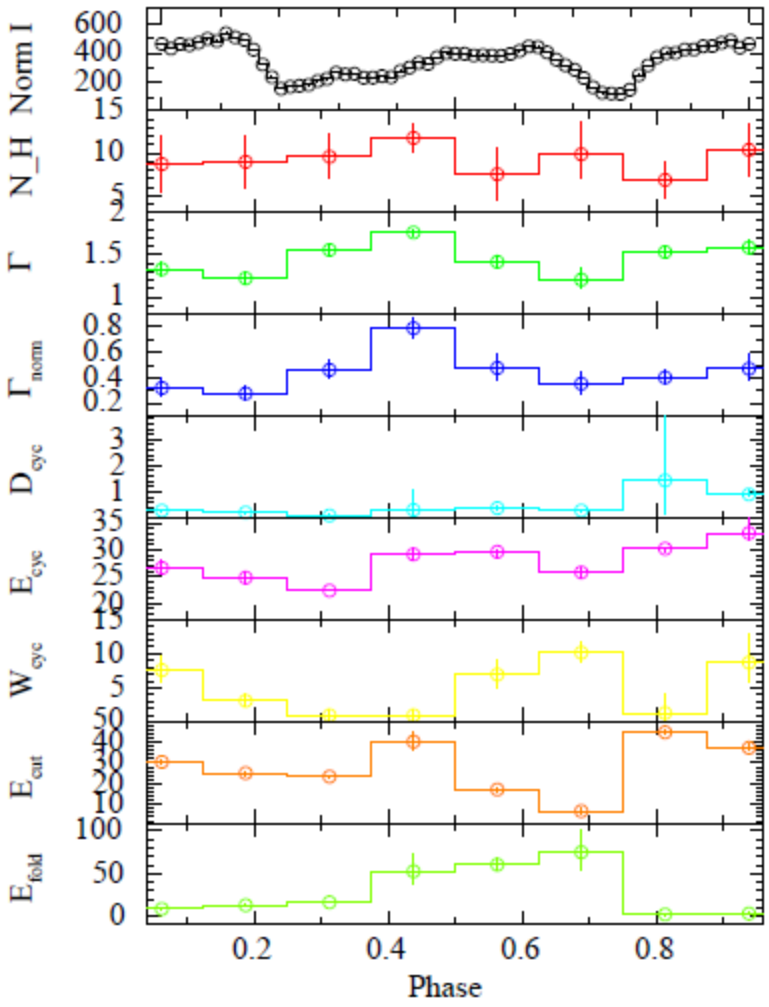
LAXPC layerwise spectra

Multiple Crab spectrum

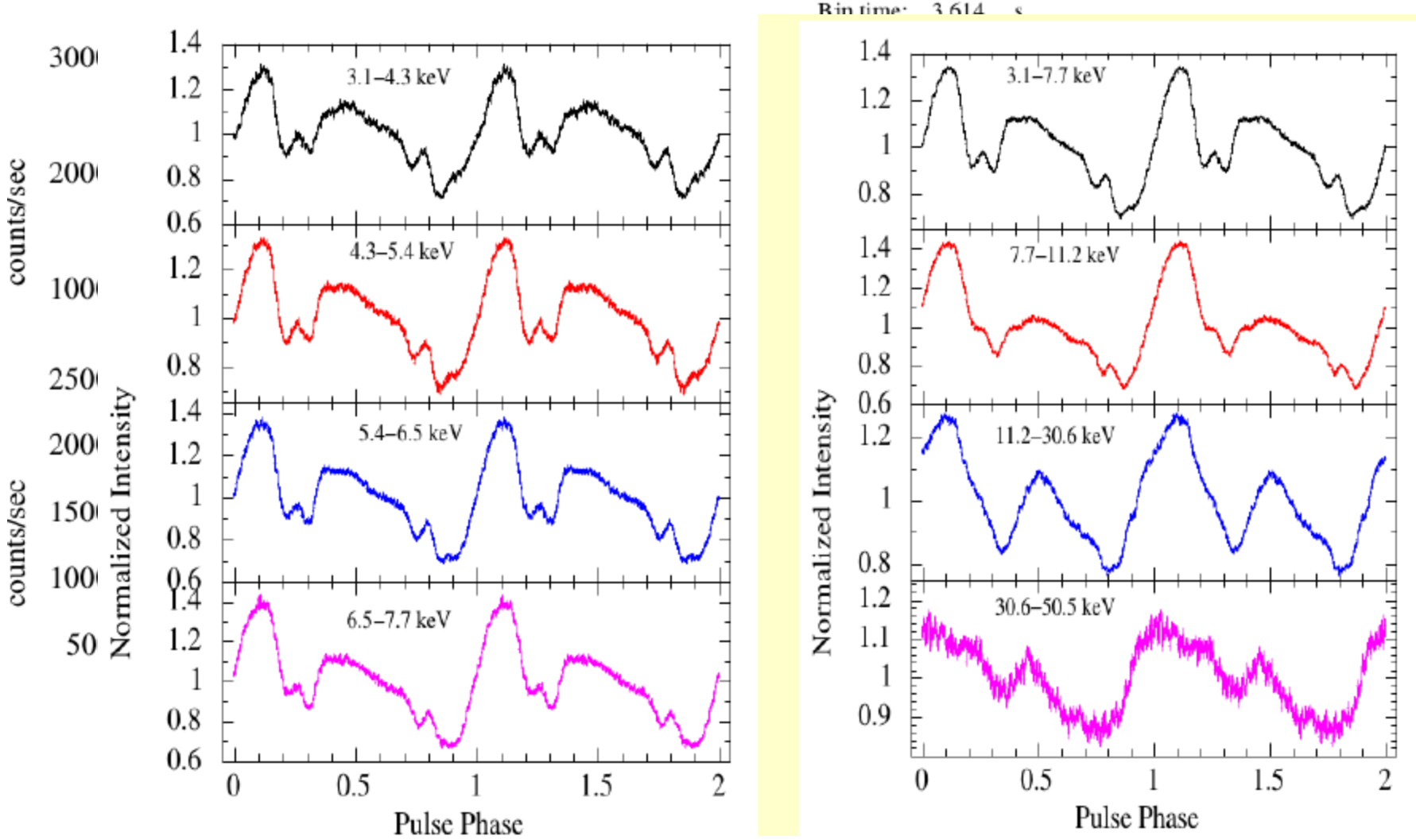


Transparency of LAXPC layers

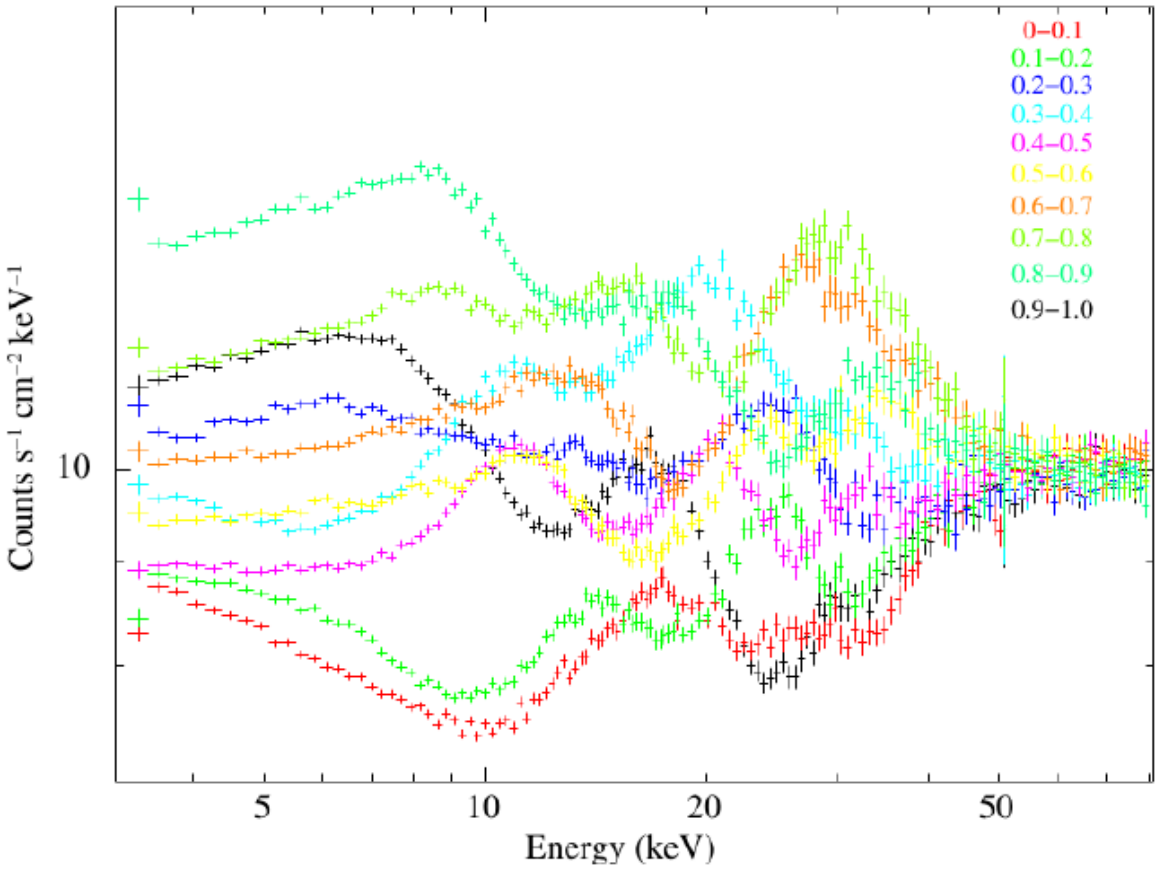
Vela X-1



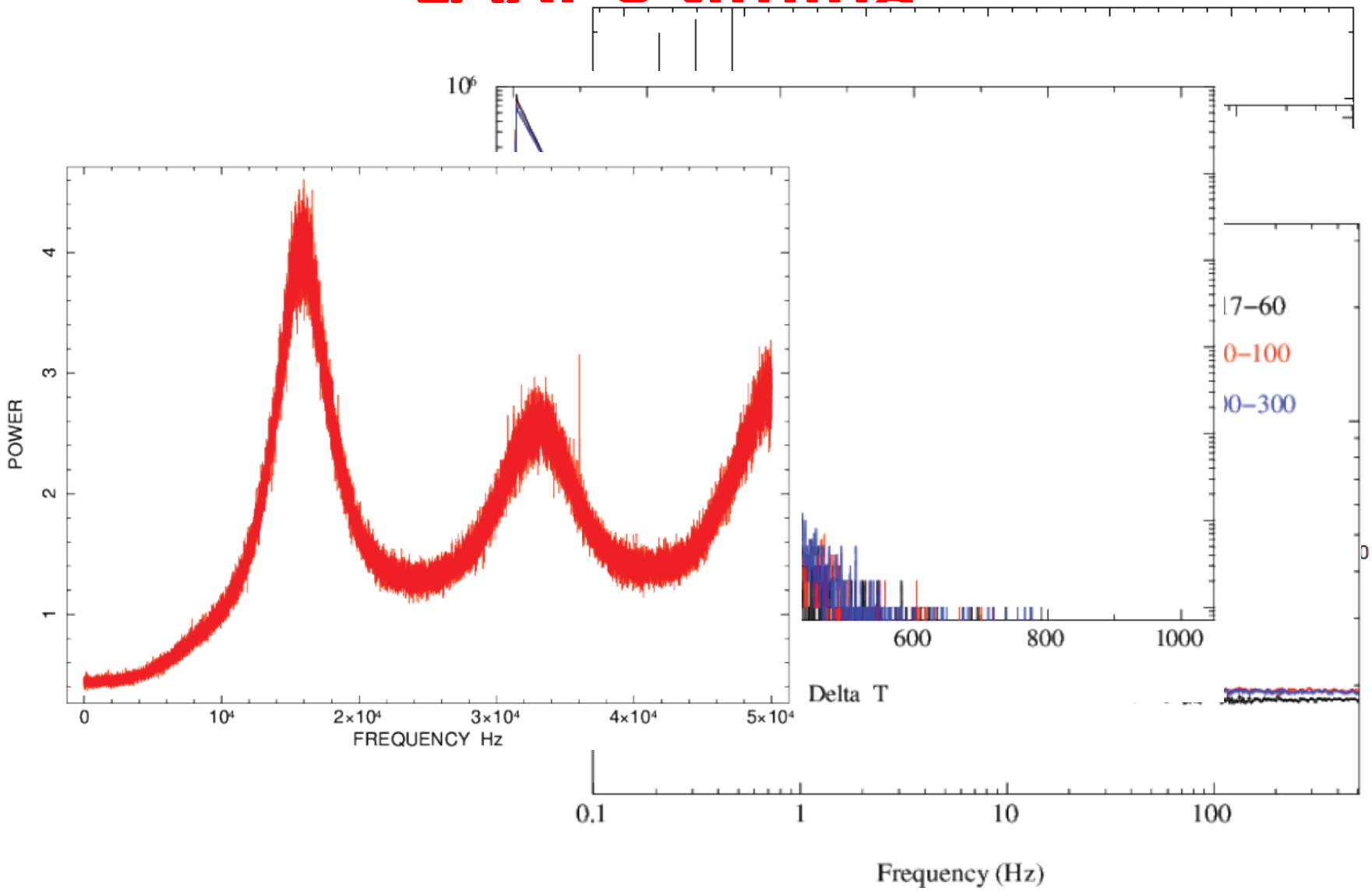
HMXBs: 4U 0115+63



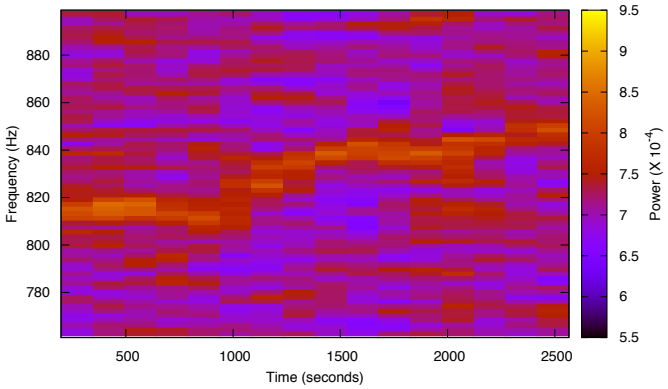
HMXBs: 4U 0115+63

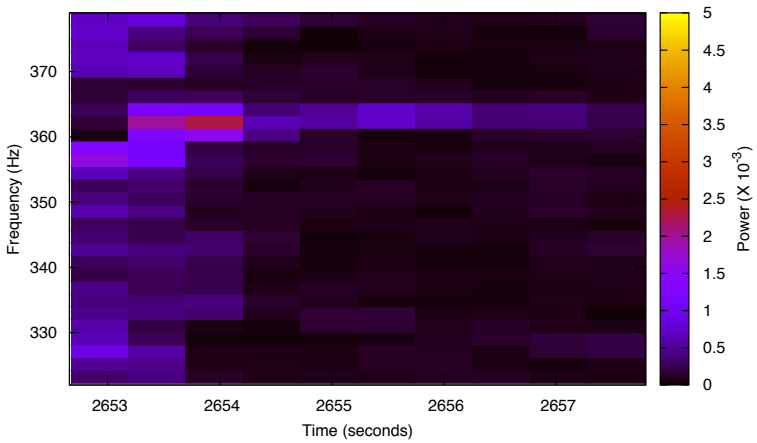


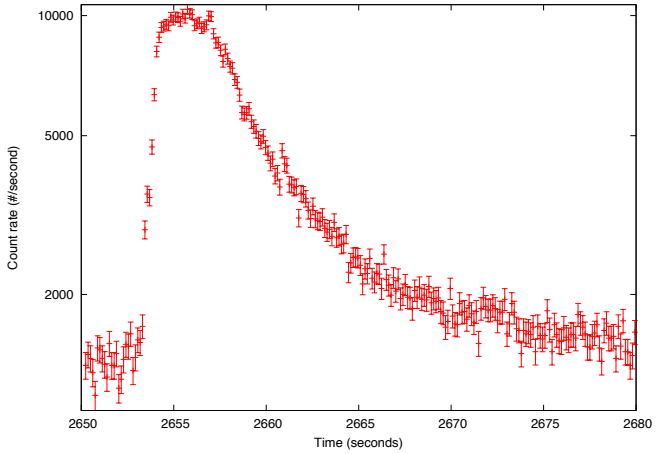
LAXPC timing



High frequency signlas with LAXPC

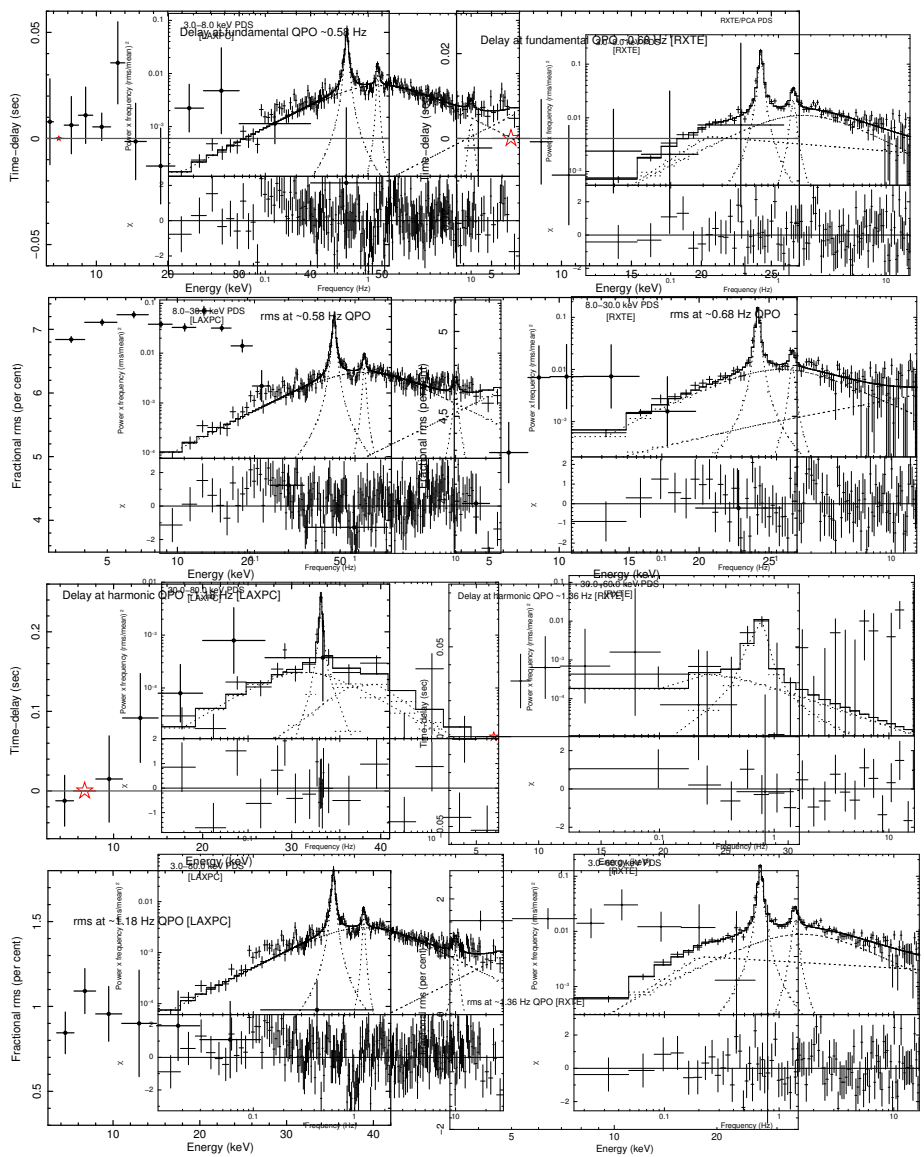


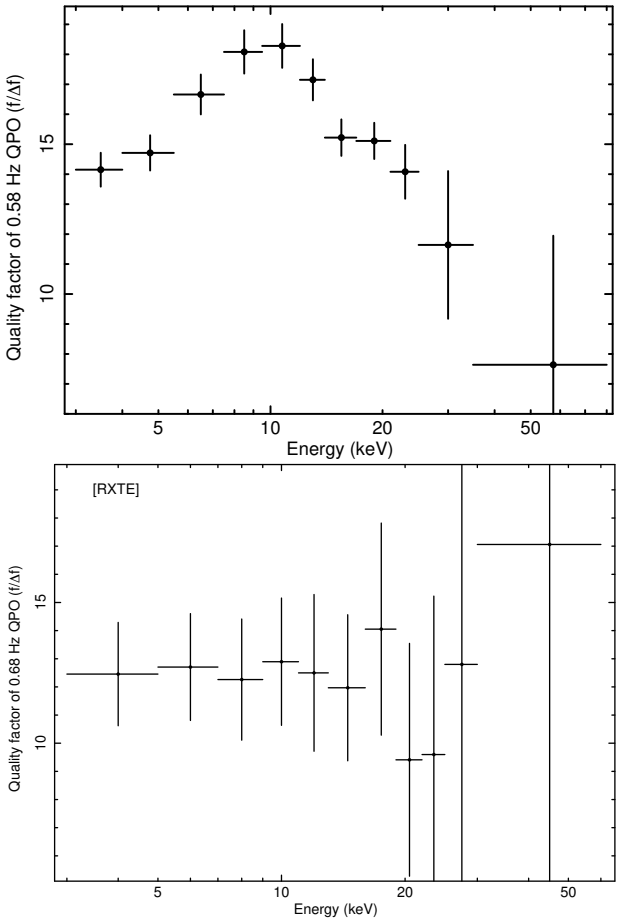




4U 1728-34; Cauhan et al. in preperation

Hard X-ray sensitivity of LAXPC





1H 1743-322; Pahari et al. in preperation

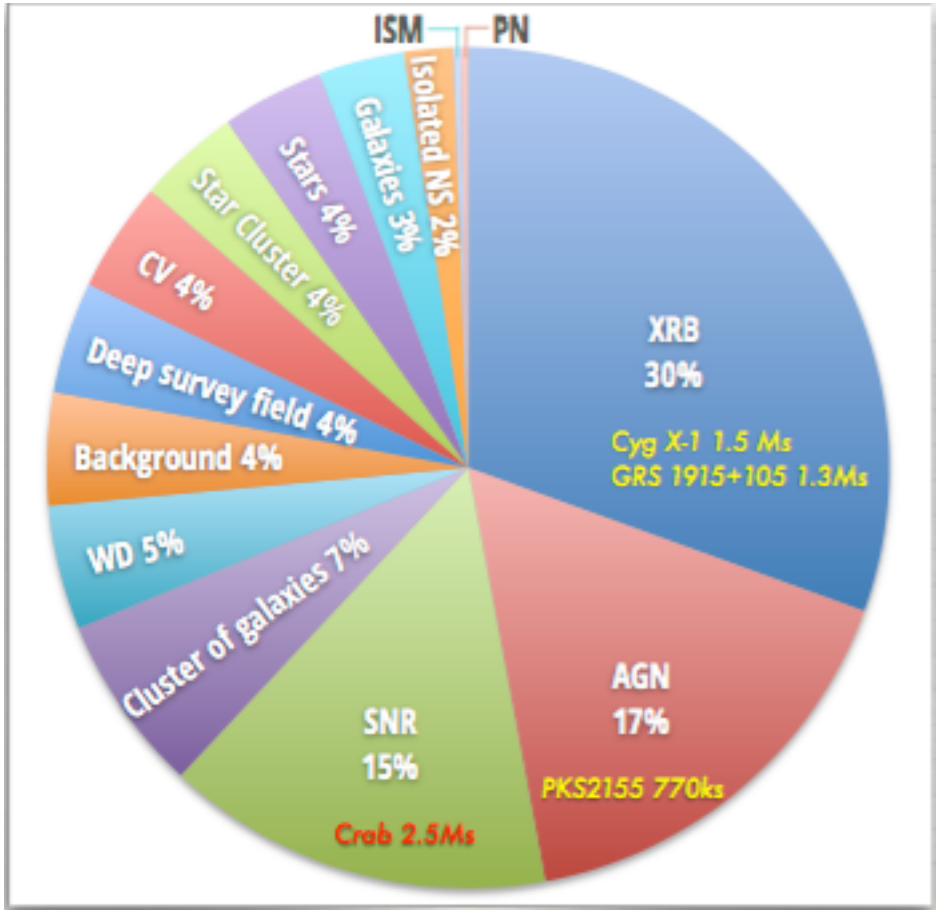
The first year of ASTROSAT

- Six months PV phase
- Six months GT
- 30 Ms

  Efficiency :

  ~10% (UVIT) to

  ~ 55% (CZTI)
- 140 sources, 337 targets



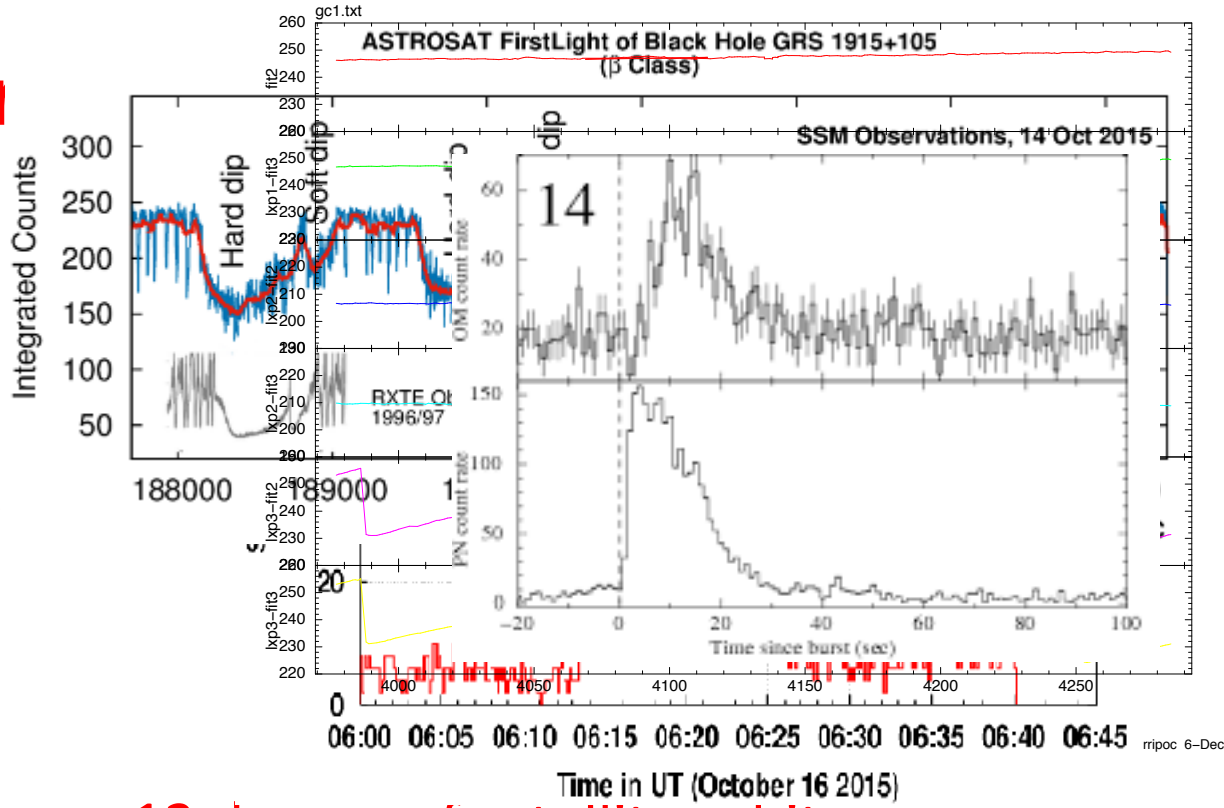
Courtsey: A R Rao

Looking For

SSM

Leak in one LAXP

UVIT Constraints



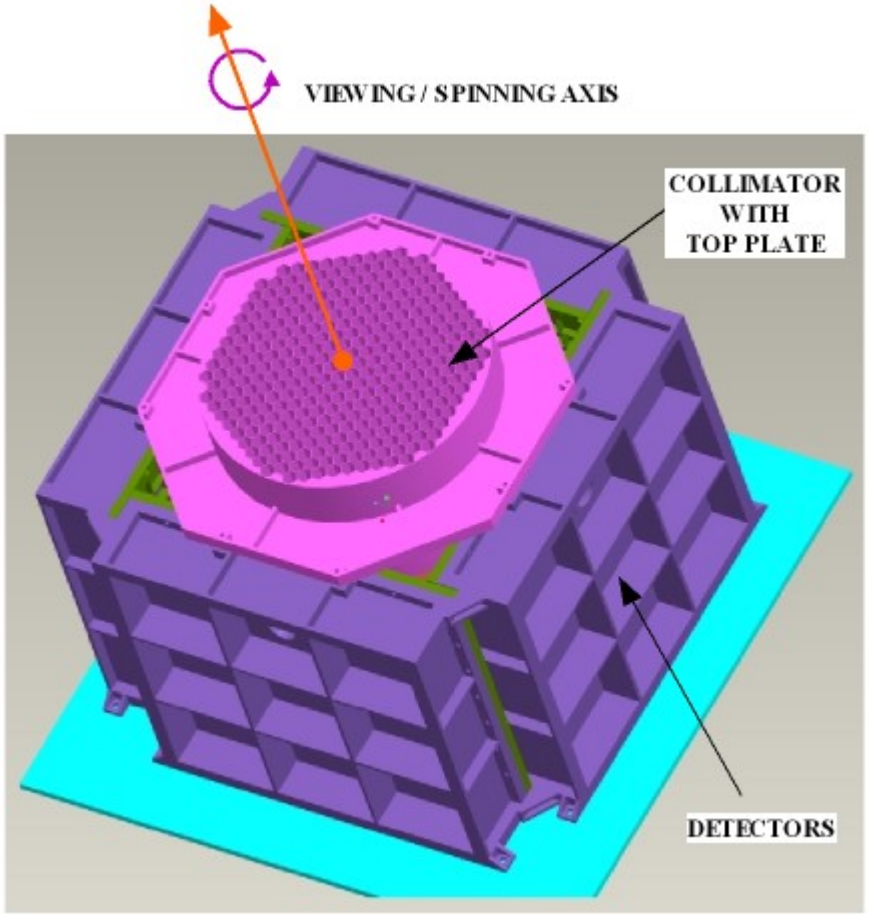
Ram Angle: +- 12 degree of satellite orbit

Bright Earth Avoidance

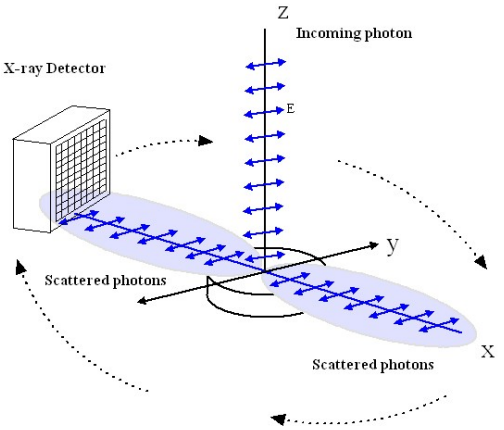
Limited maneuver

UVIT obs in crowded field

POLIX: Thomson X-ray Polarimeter



- Photoelectron/Bragg: < 10 keV
- Thomson: 5-50 keV
- Con



$$\mathrm{MDP} = \frac{4.29}{\mu r}\sqrt{\frac{r+b}{T}} = \frac{4.29}{\mu}\frac{1}{\sqrt{N}}\sqrt{1+\frac{b}{r}},$$

- 3% MDP for 50 mCrab

X-ray Polarisation

Polarisation is unexplored in High Energy Astrophysics

X-ray emission from the following processes should be polarised

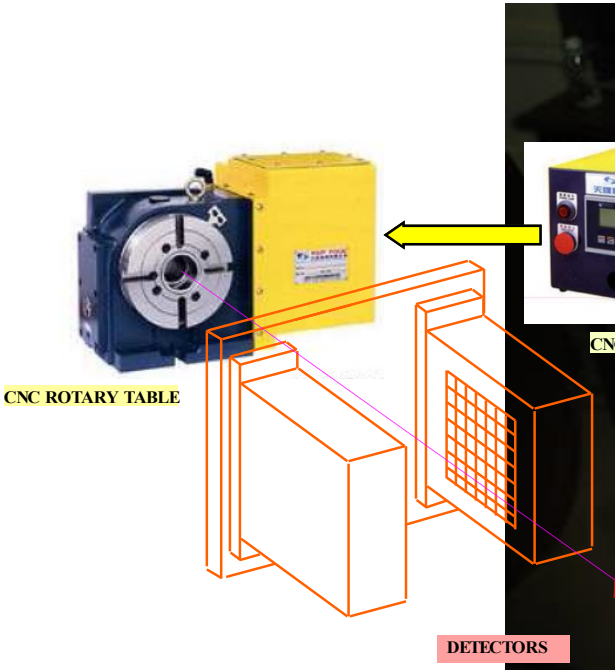
- **Emission, transmission through magnetic field**
- **Emission, scattering from non-spherical plasma**
- **Synchrotron, Cyclotron , Non-Thermal Bremsstrahlung**

These objects should produce polarised X-ray radiation

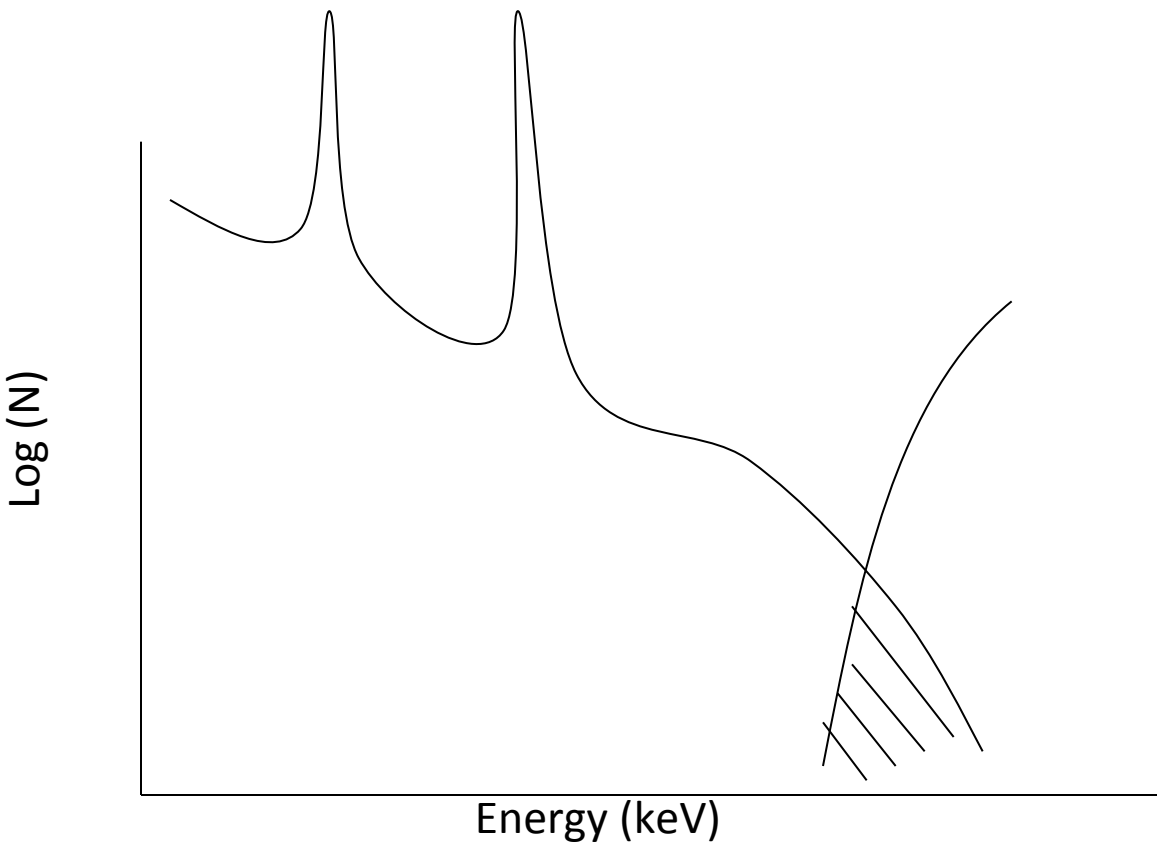
- **Accretion powered pulsars**
- **Rotation powered pulsars**
- **Magnetars**
- **Pulsar wind nebulae**
- **Non-thermal supernova remnants**
- **Black holes, micro-quasars and active galactic nuclei**
- **Solar X-rays**

Crab nebula is the only source for which high S/N X-ray polarisation Measurement exists.
This was made in 1976 !!

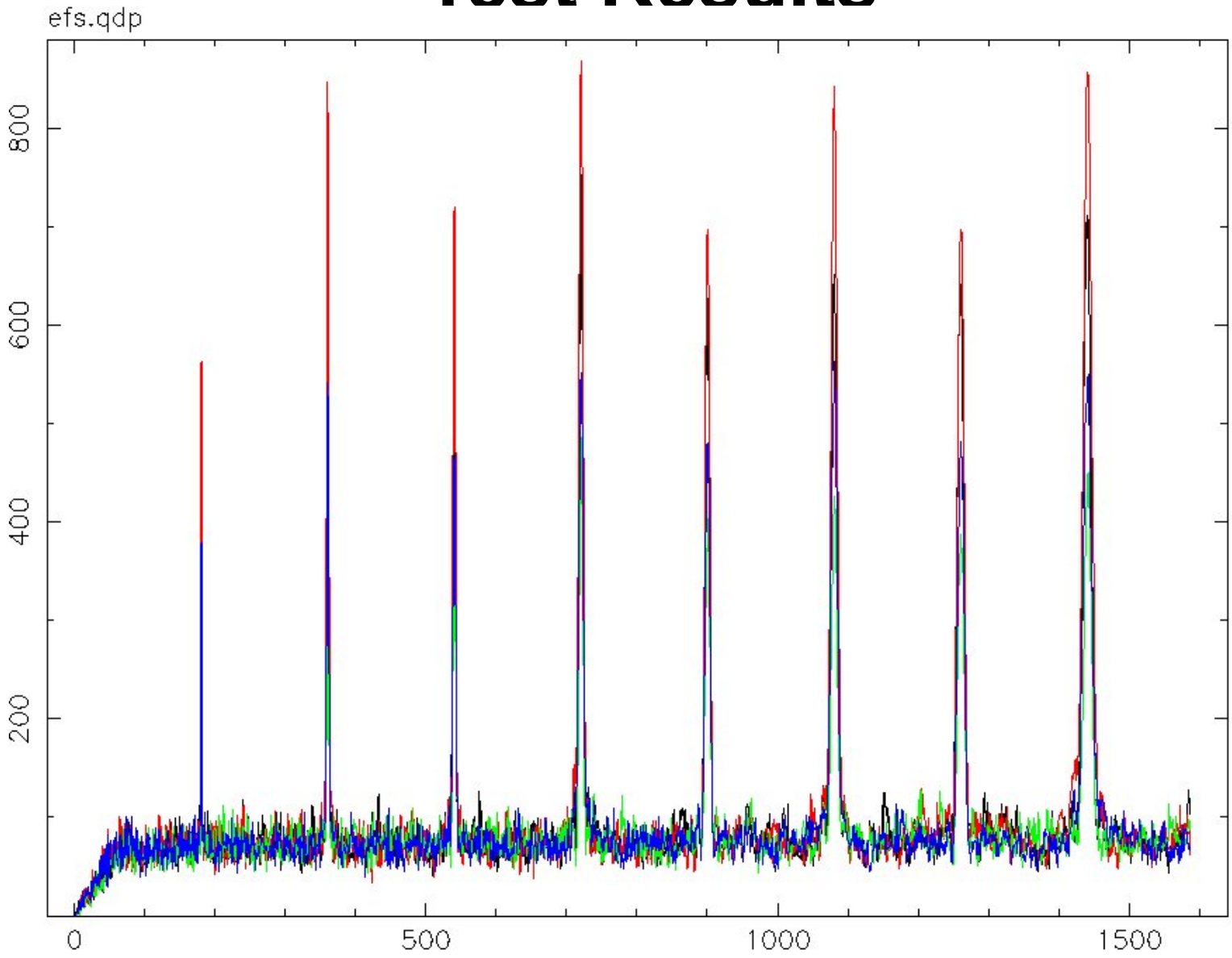
Laboratory Unit



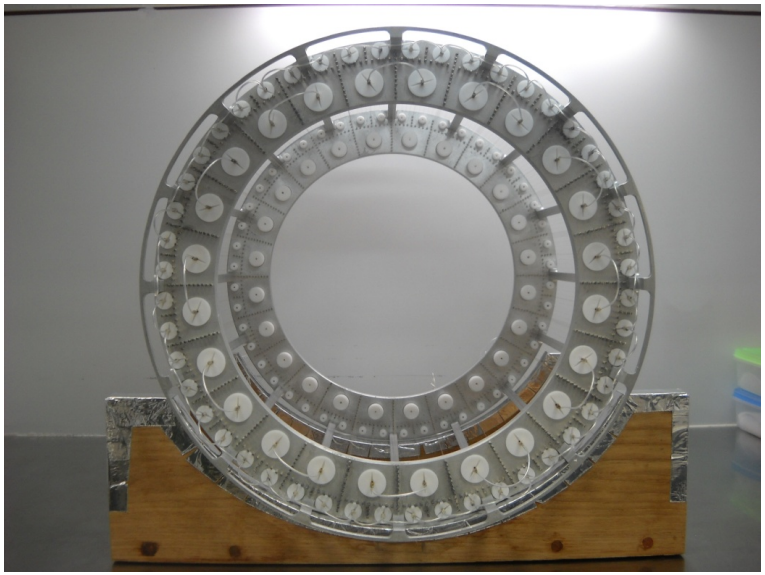
Polarised X-ray Source

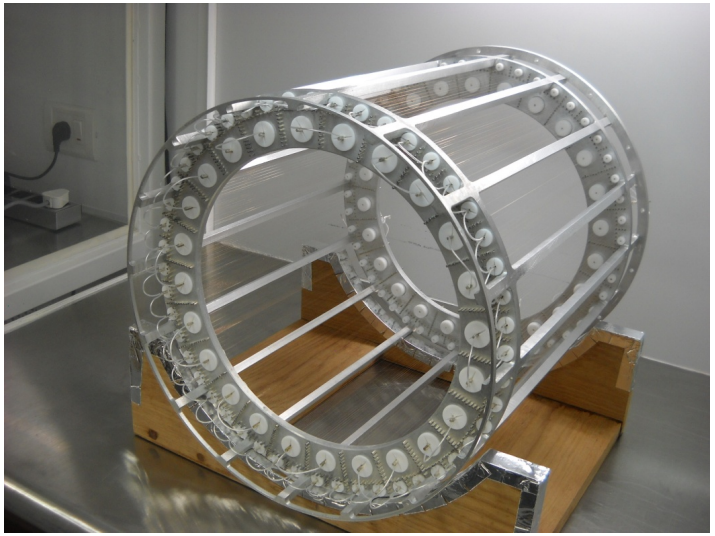


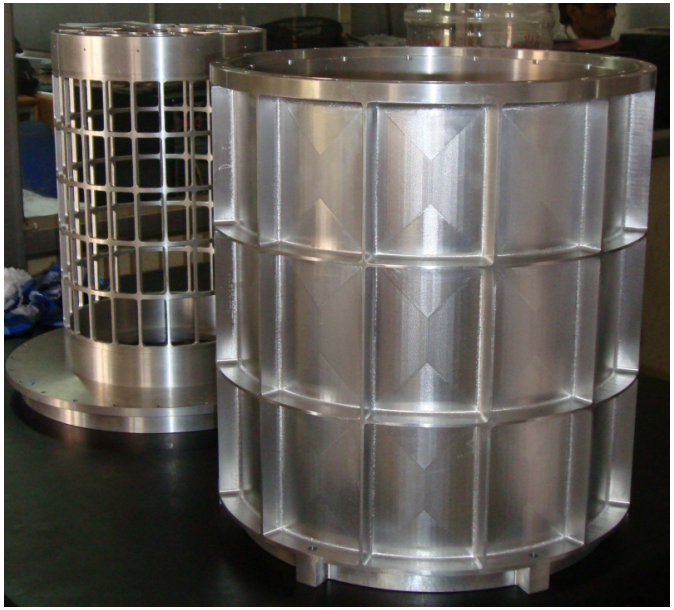
Test Results



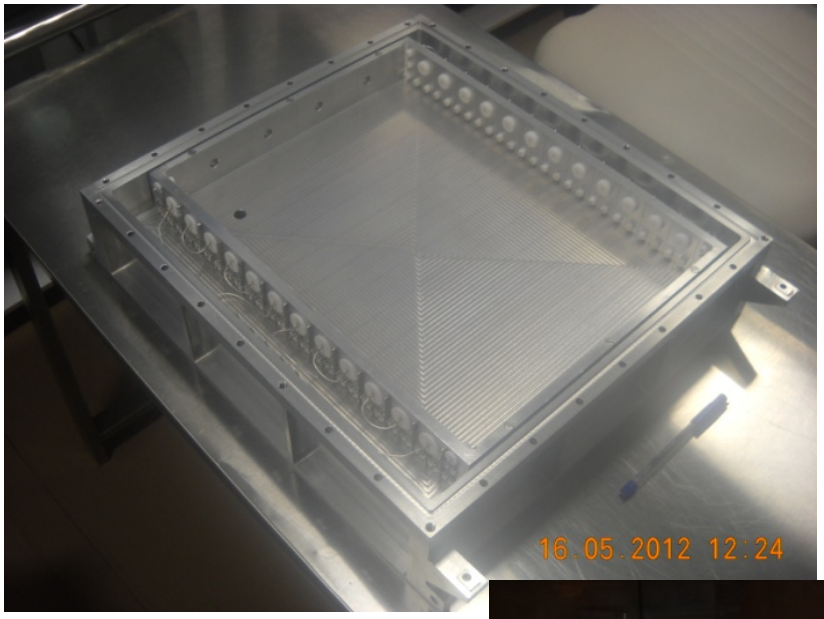
Cylindrical detector

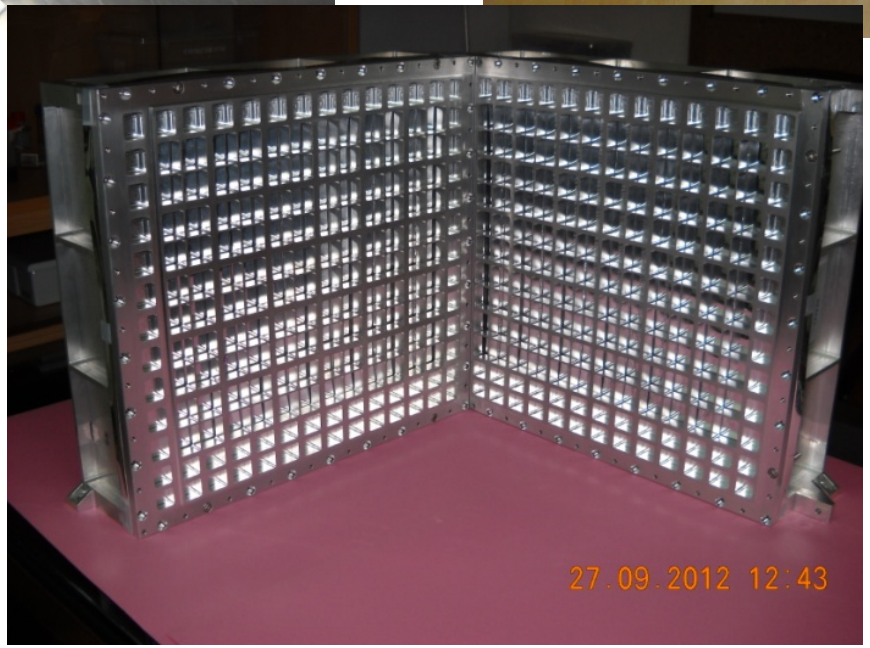


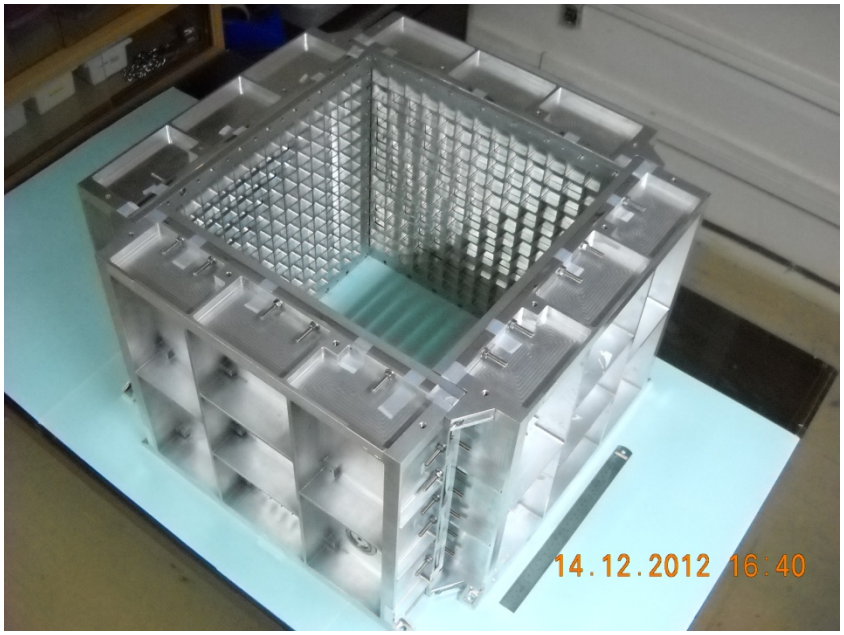




POLIX Detectors



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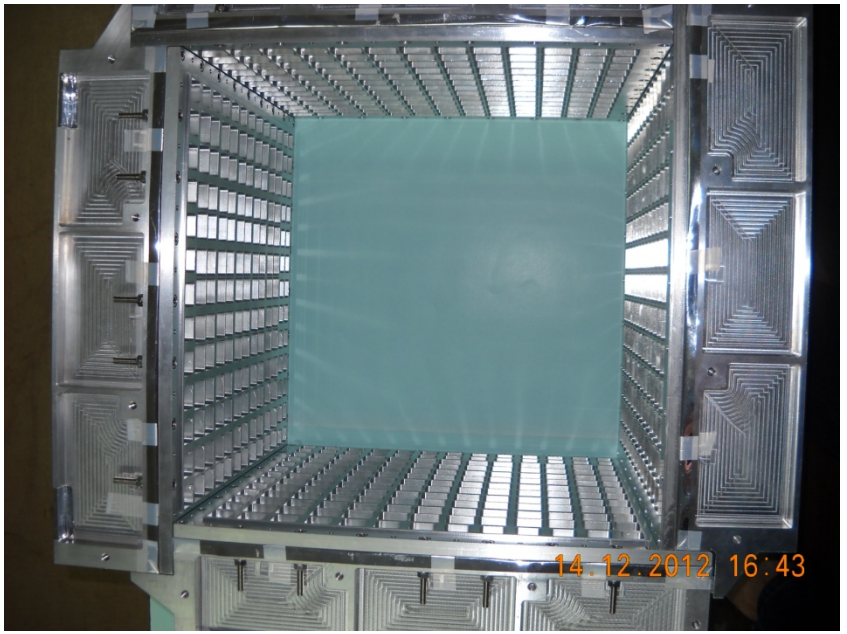
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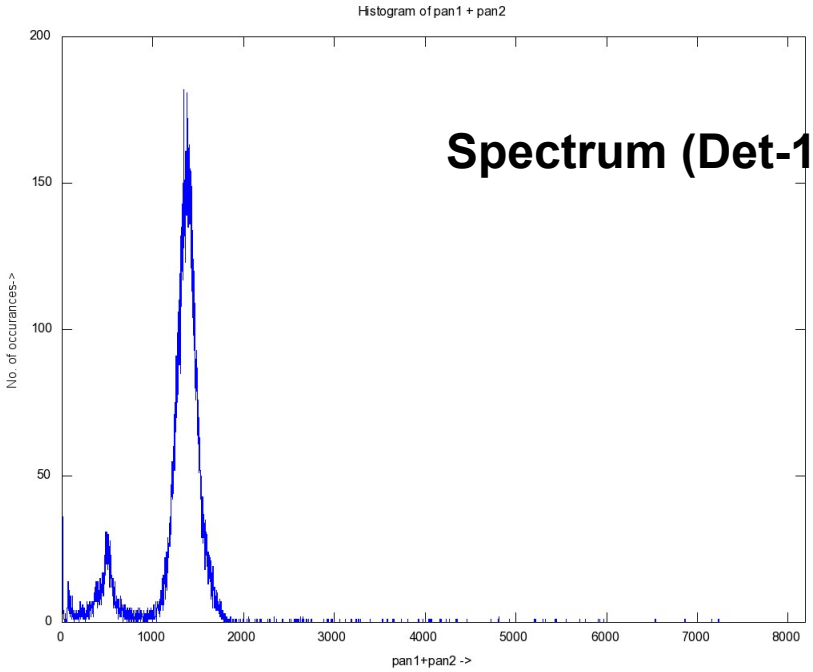
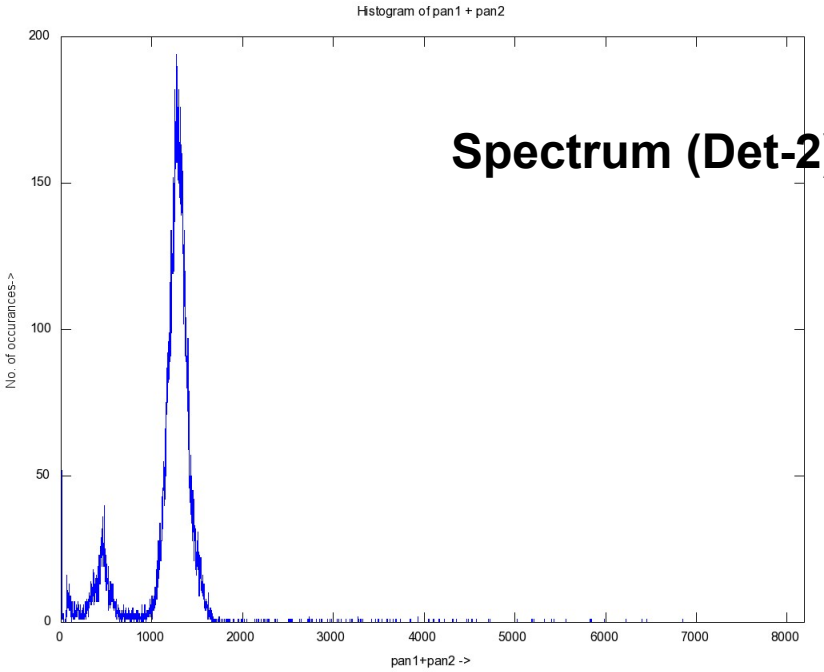
14.12.2012 17:49

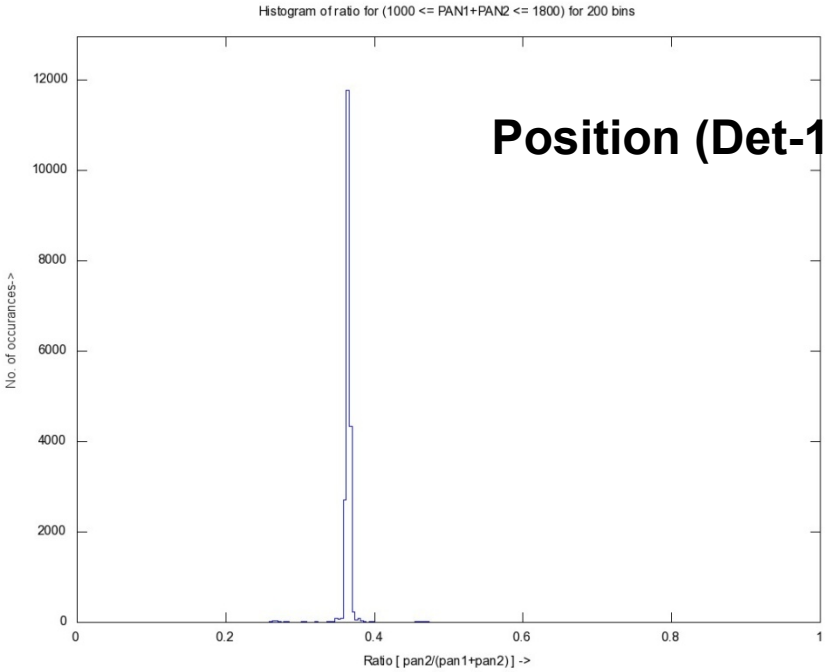

14.12.2012 17:51



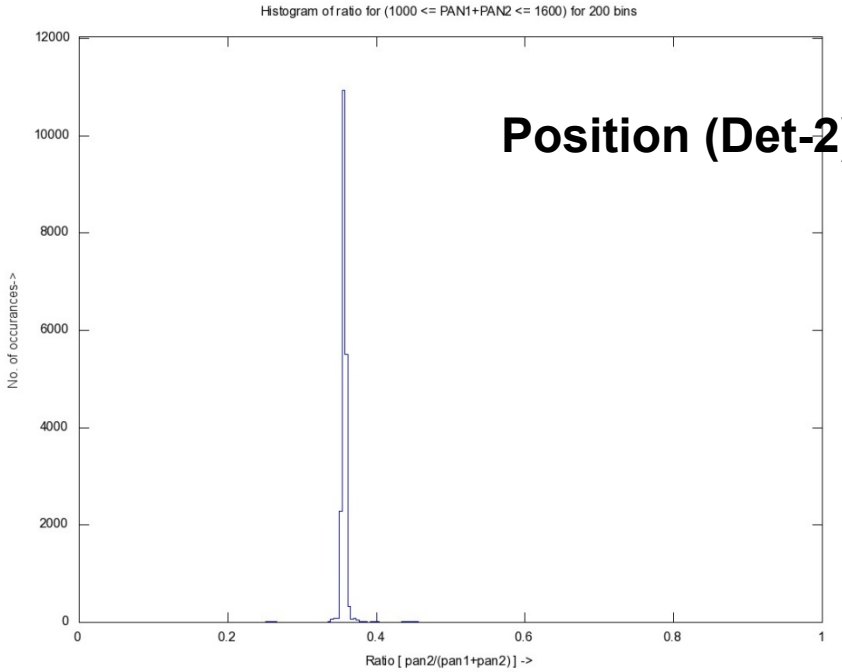
Spectrum (Det-1)



Spectrum (Det-2)



Position (Det-1)



Position (Det-2)

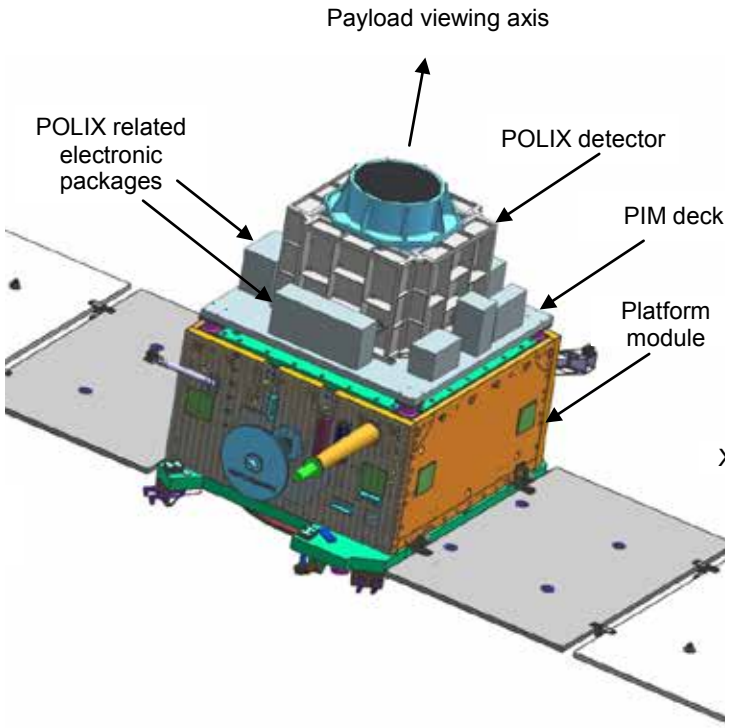
The Satellite Bus

- **3 Axis Stabilised**
- **200 kg Payload**
- **800 W power**

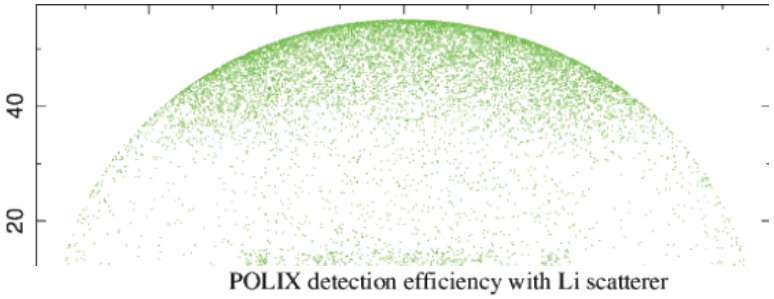
0.1 degree pointing

Spin

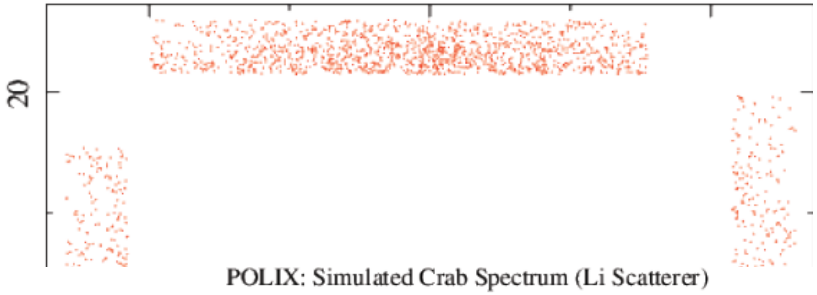
Long staring



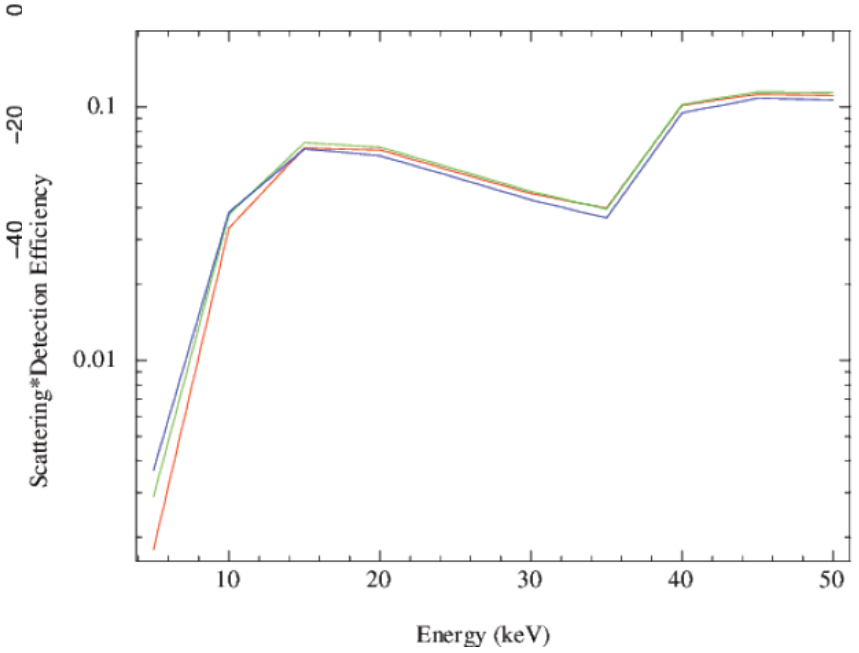
POLIX: Sensitivity

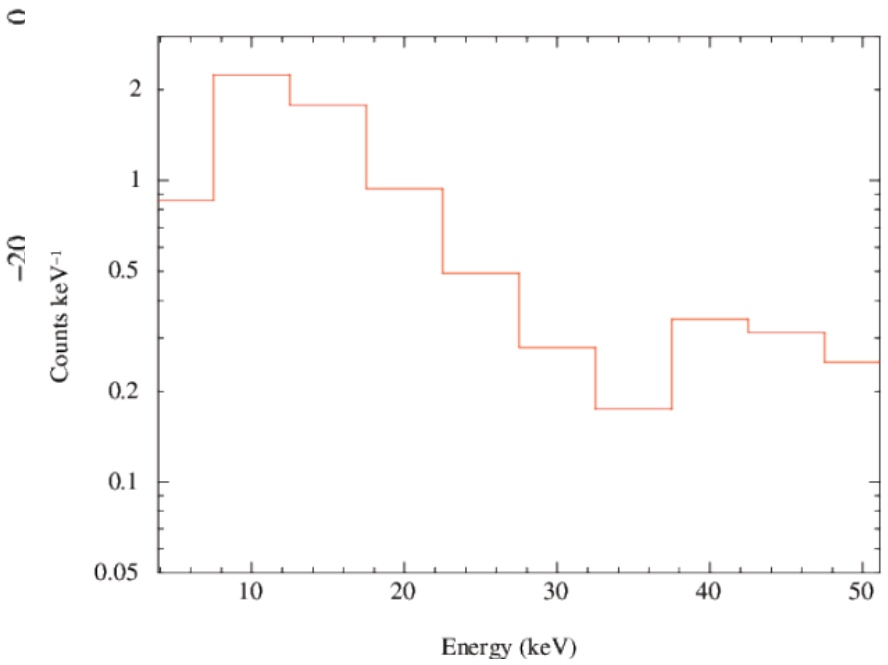


POLIX detection efficiency with Li scatterer

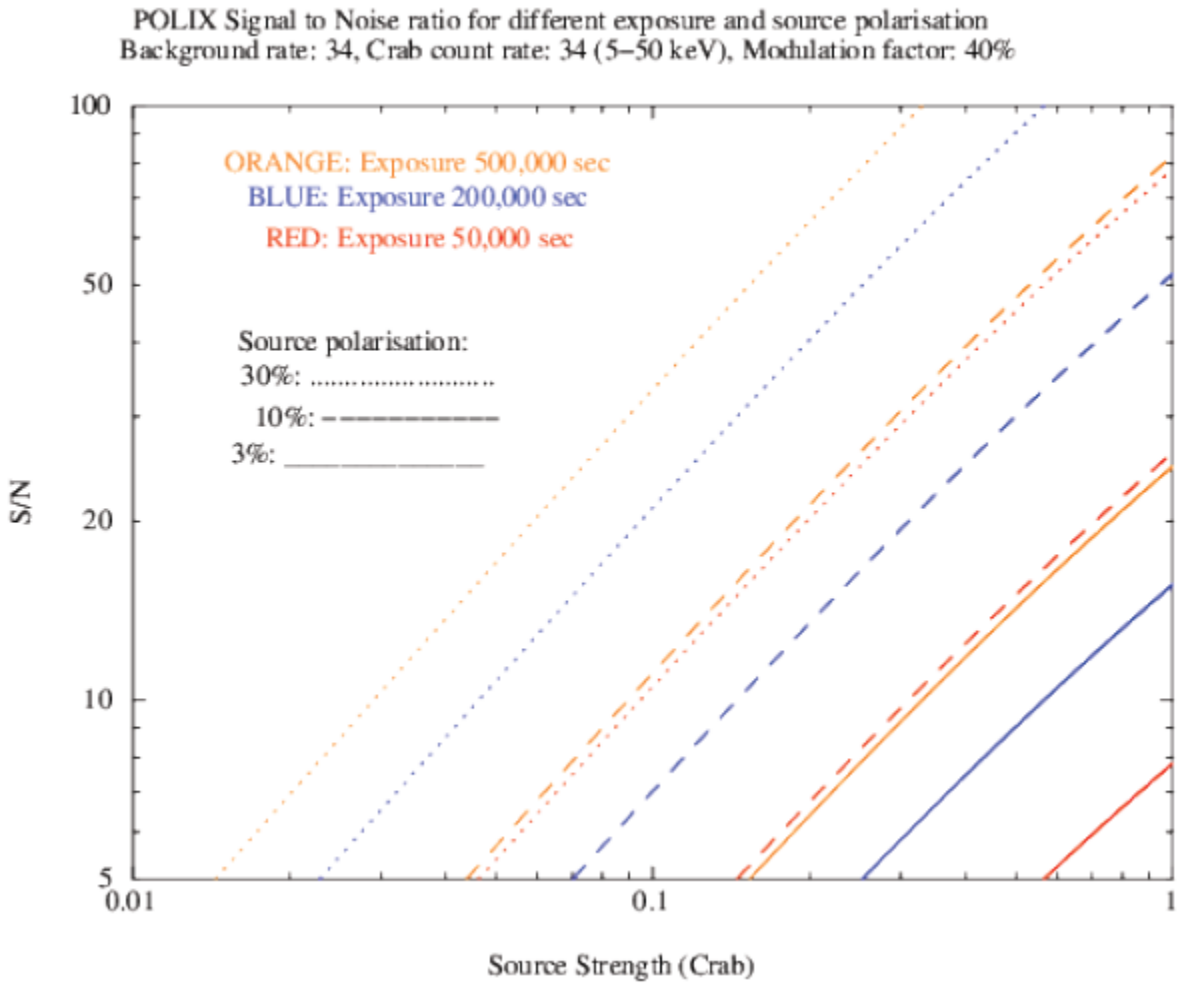


POLIX: Simulated Crab Spectrum (Li Scatterer)

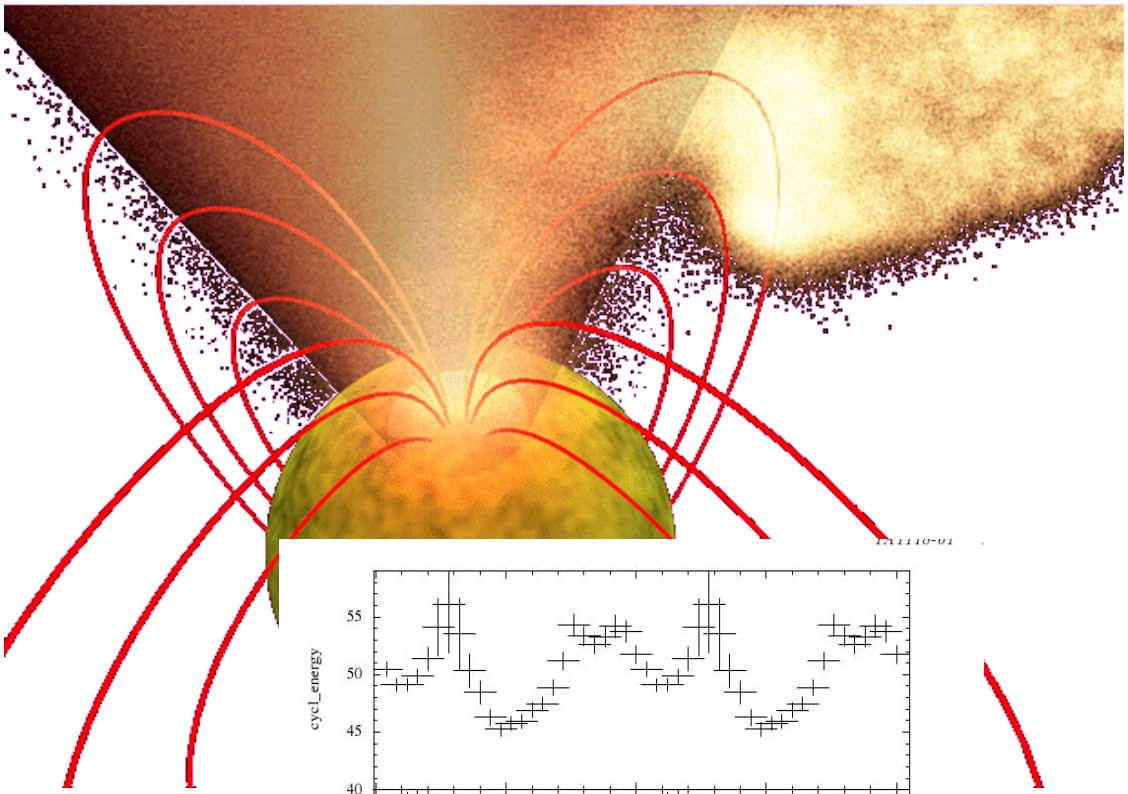


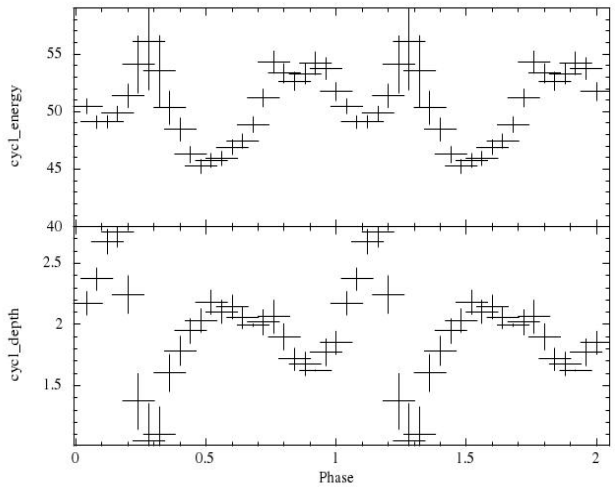


POLIX: Sensitivity

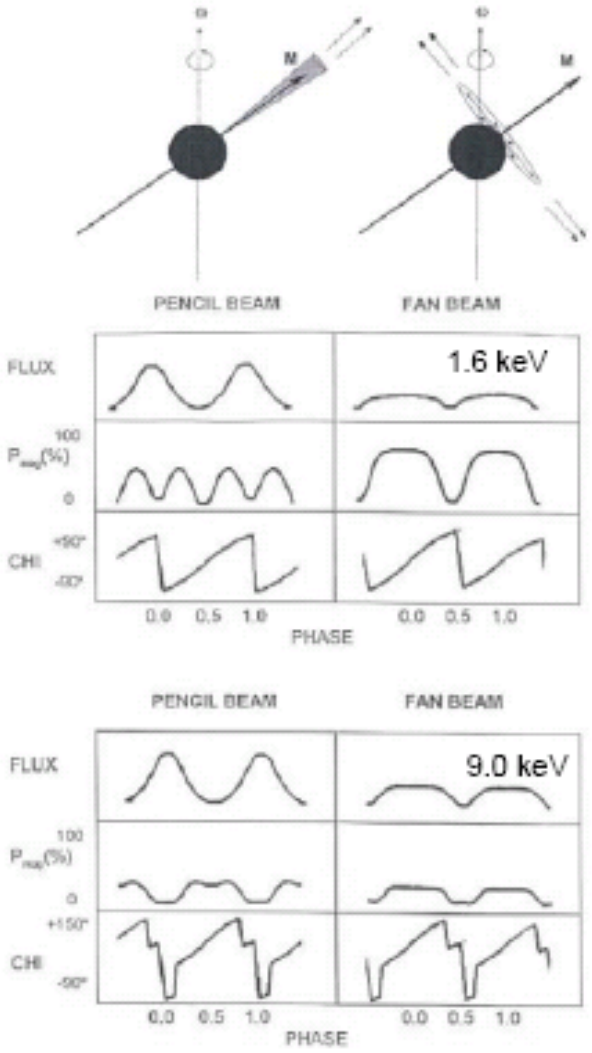


Accreting X-ray Pulsars





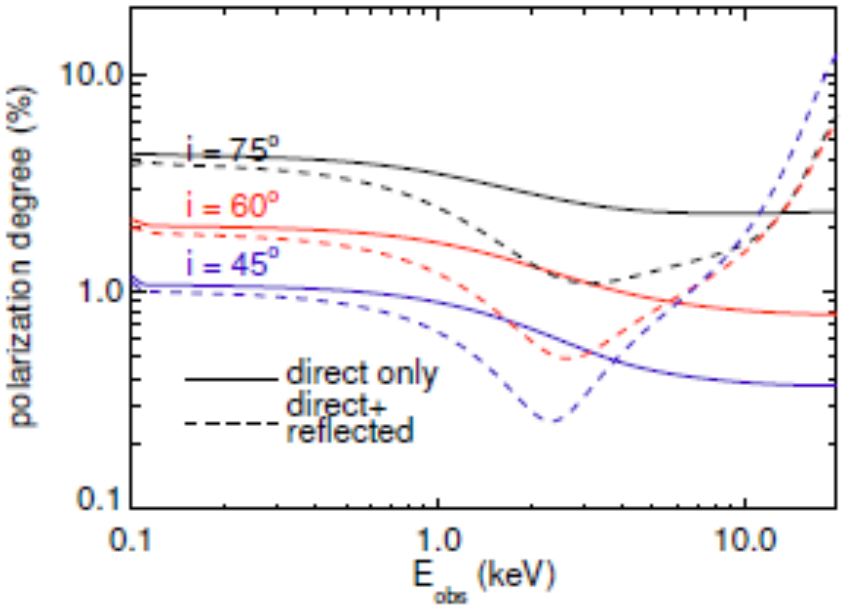
Ima

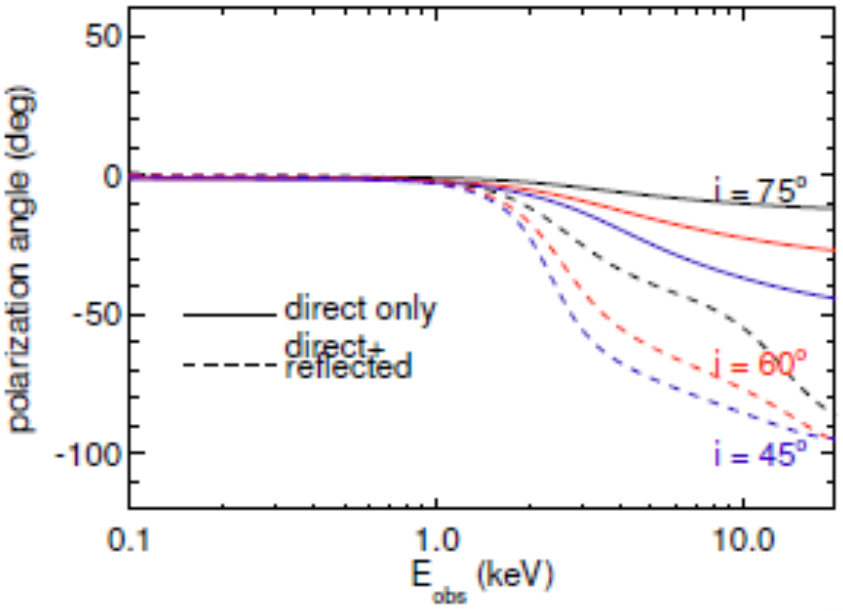


Meszaros et al. 1988

X-ray Polarisation in Black Holes

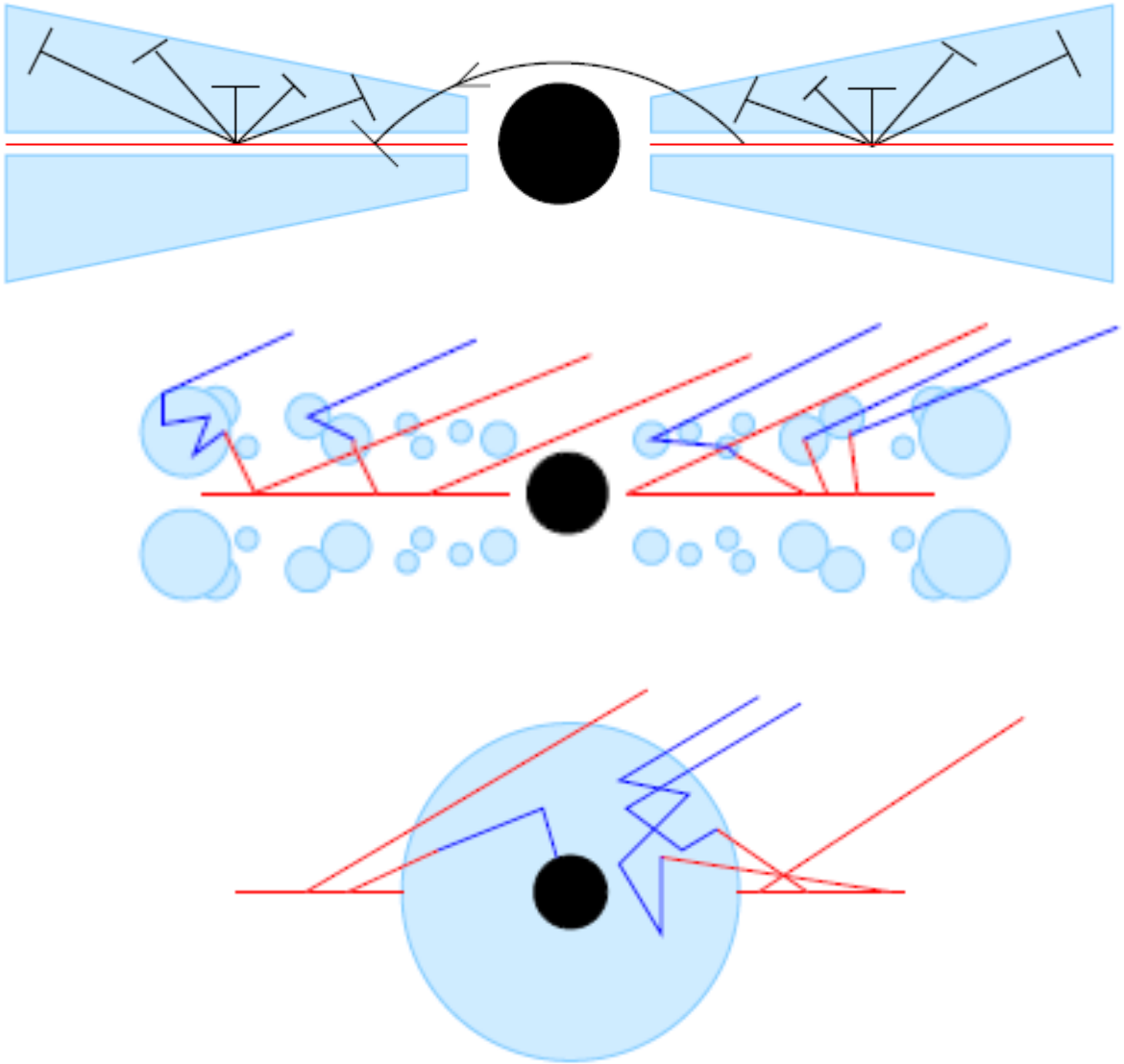
$M = 10M_{\odot}$ $a/M = 0.9$ $L = 0.1L_{\rm Edd}$





Schnittman et al.

X-ray Polarisation and Corona



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