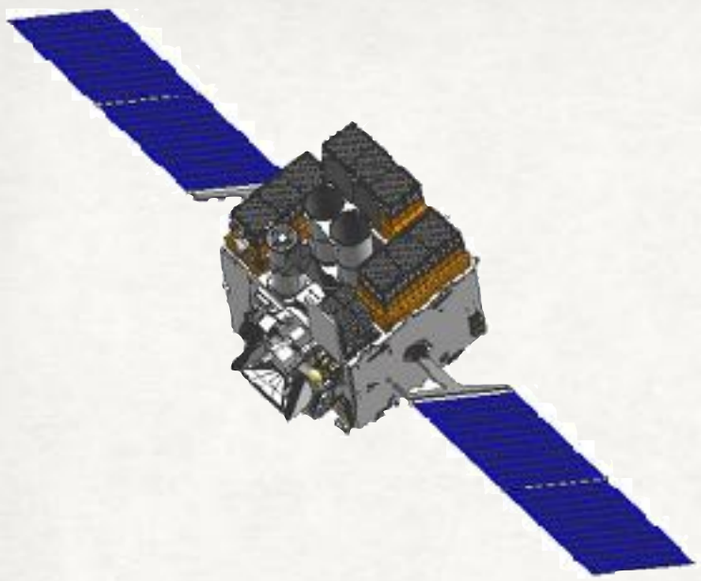
ASTROSAT

Dipankar Bhattacharya
IUCAA, Pune

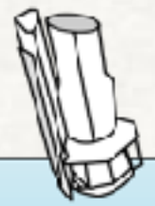
BRICS
Astronomy Meeting
IUCAA, Pune, 21 Sep 2017



AstroSat

An Indian Astronomical Observatory based in Space

Launched on 28 Sep 2015



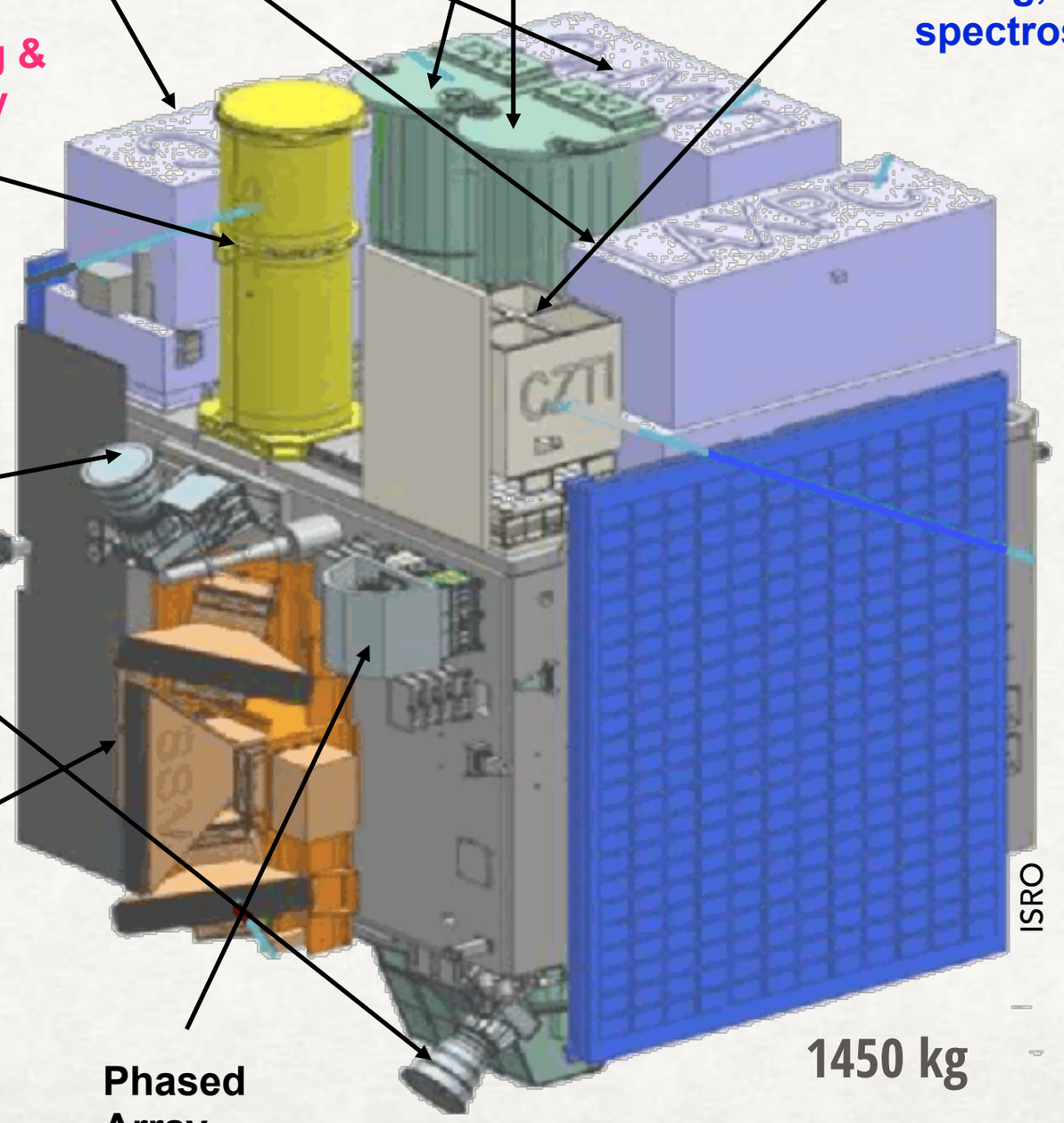
ASTROSAT

LAXPC
3-100 keV X-ray Timing, broadband spectroscopy

UVIT
1.4” UV imaging

CZTI
20-250 keV hard X-ray imaging, timing, spectroscopy

SXT
0.2-8 keV imaging & line spectroscopy



Star Sensors

SSM
rotating 2-10 keV monitor

Phased Array Antenna

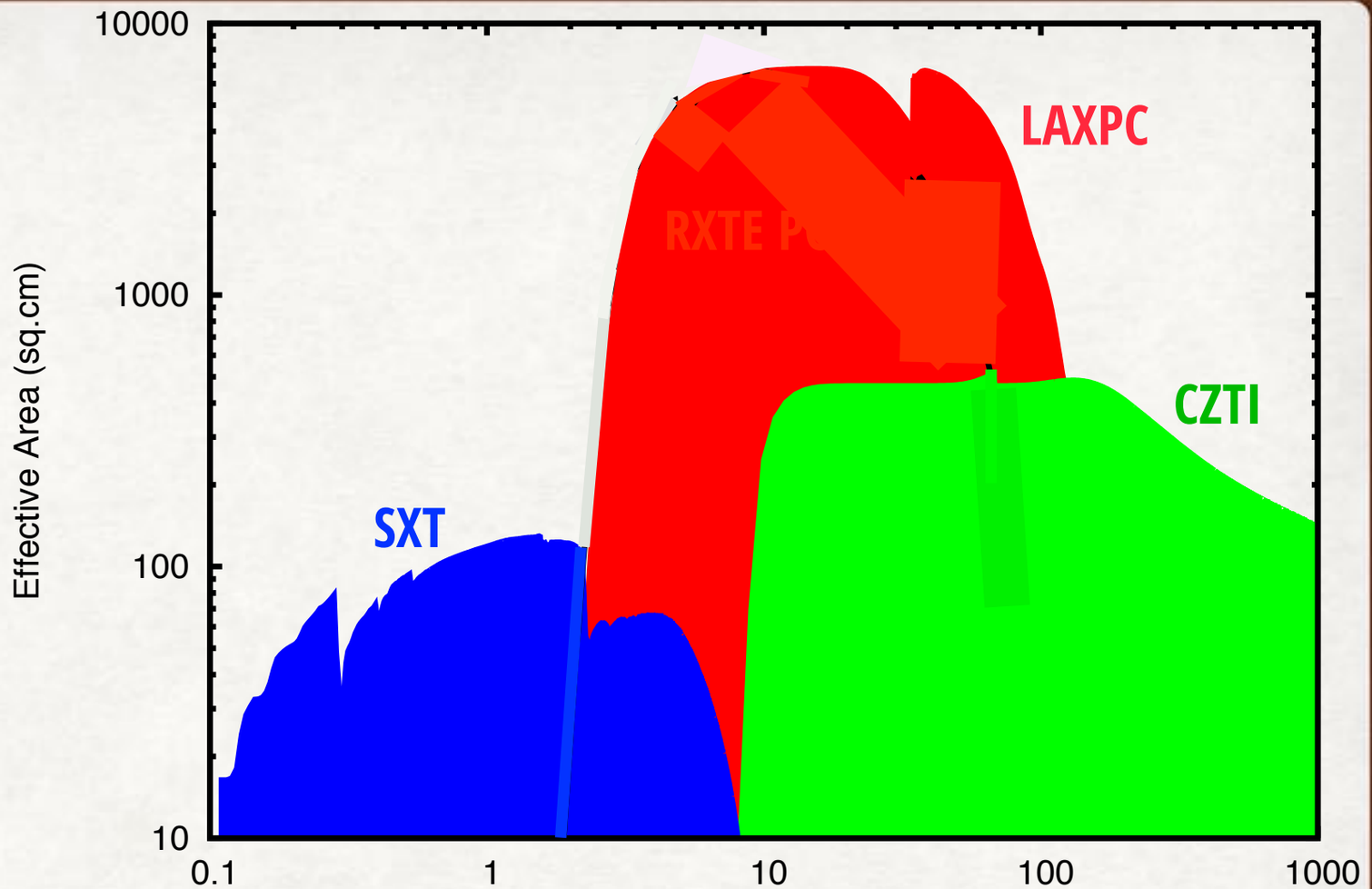
1450 kg

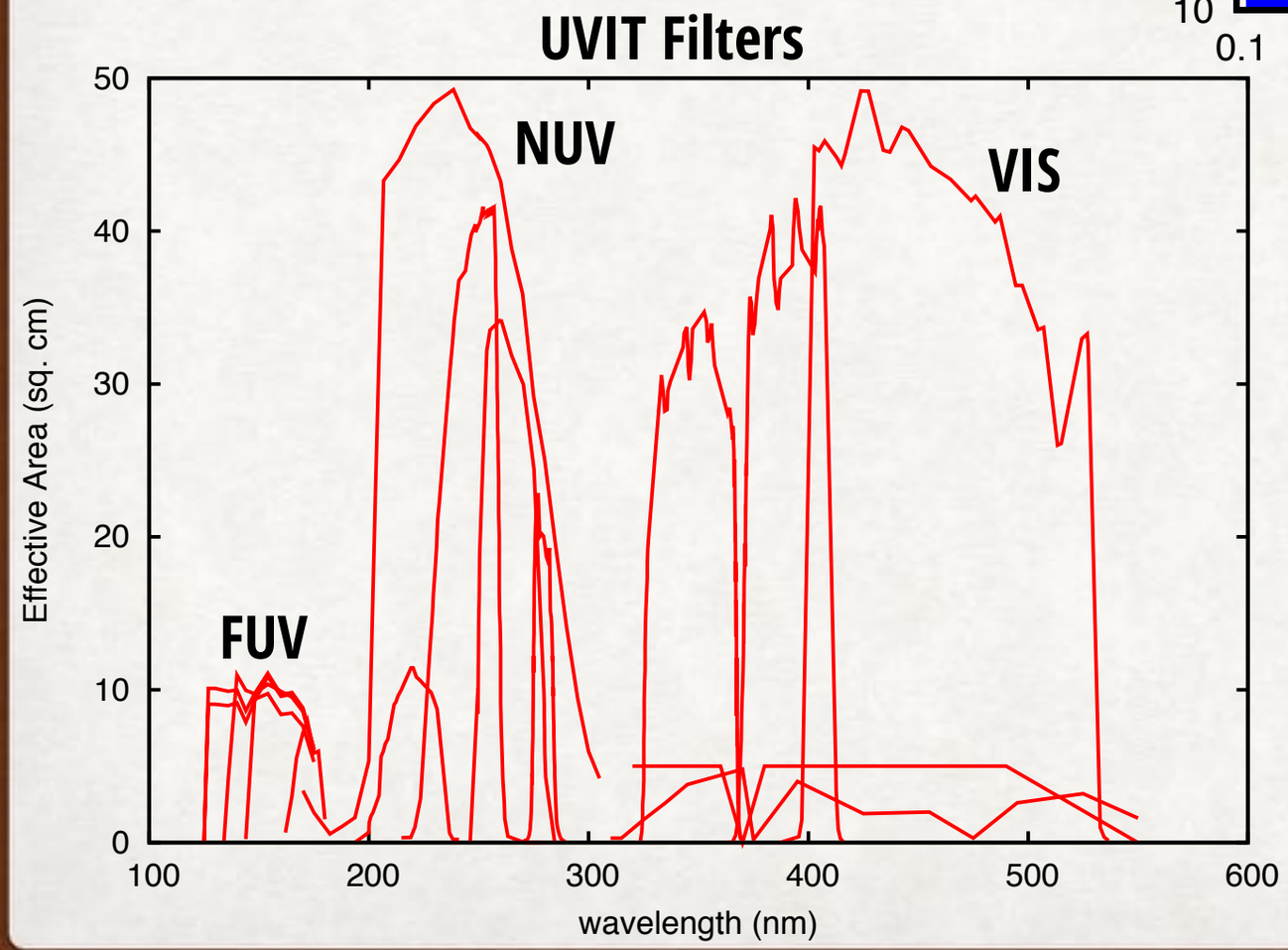
PI: S. Seetha (ISRO)
PMs: S.N. Tandon (UVIT),
J.S. Yadav (LAXPC),
S. Bhattacharyya (SXT)
A.R. Rao (CZTI)
M.C. Ramadevi (SSM)

LAXPC: TIFR, RRI
SXT: TIFR, ISRO, UoL
CZTI: TIFR, ISRO, IUCAA, RRI, PRL
SSM: ISRO, IUCAA, RRI
UVIT: IIA, ISRO, IUCAA, CSA

Spacecraft: ISRO
Operations: ISRO
Ground software: ISAC, SAC, TIFR, RRI, IIA, IUCAA, NCRA, PRL

AstroSat co-aligned payloads: effective areas





- Individual photon recording in all bands
- High time resolution: 10μs (LAXPC), 20μs (CZTI), 1.6ms (UV), 287ms (SXT)
- Simultaneous operation ~2ev to 150keV
- All sky transient monitoring at > 100 keV
- Hard X-ray polarisation capability (100-380keV)

PIC: ISRO

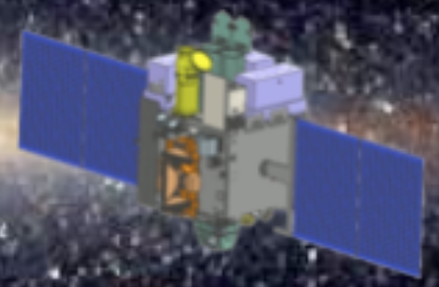
Integrated AstroSat before launch
weight: 1.5 ton

PSLV XL Rocket
weight: 320 ton

ASTROSAT

A Satellite Mission for Multi-wavelength Astronomy

Indian Space Research Organisation

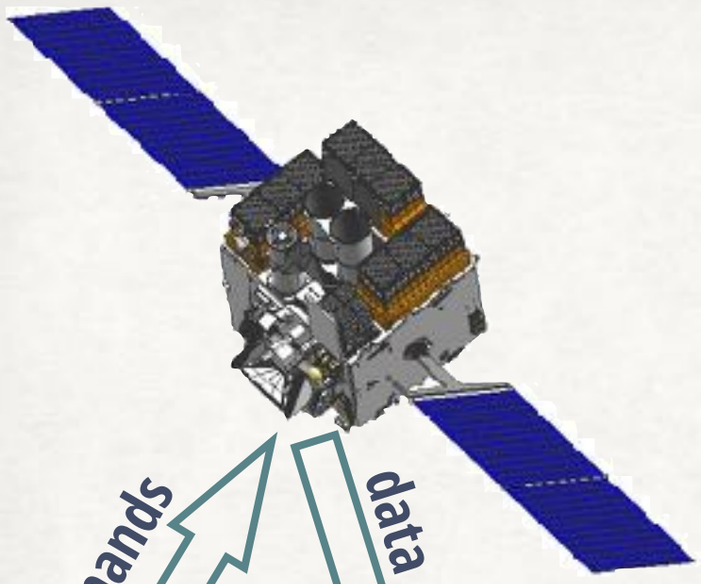


ASTROSAT orbit

650 km altitude, circular, 6 deg inclination, Period 98 min

worldsmapsonline.com

Operations



commands

data

ISTRAC, PEENYA

ISSDC, BYLALU

raw data

science products

POCs

LAXPC: TIFR, RRI

UVIT: IIA

SXT: TIFR

CZTI: IUCAA

SSM: ISAC, IUCAA

DATA ARCHIVE

USER

PROPOSALS

ASTROSAT SCIENCE SUPPORT CELL

REVIEW, TIME ALLOCATION, SCHEDULING

Proposal streams:
GT, AO : annual cycles
TOO, Cal: always open

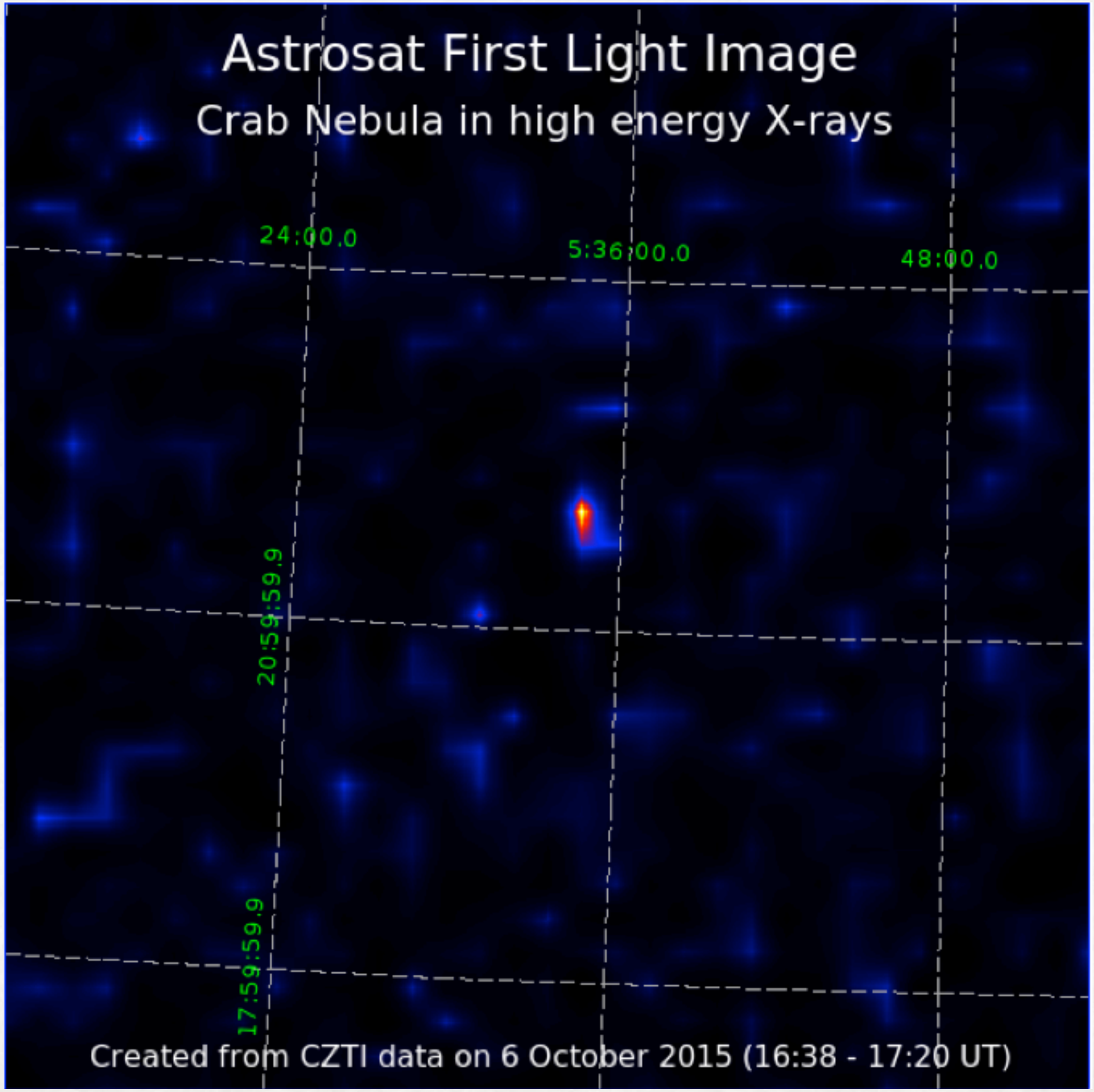
Operations

- Oct 2015 - March 2016 : Performance Verification and calibration
- April 2016 - Sept 2016 : First Science run (Guaranteed Time for Instrument Teams)
- Oct 2016 onwards : Indian Open Time
- Oct 2017 onwards : International Open Time

Observing proposals are invited for annual cycles, peer reviewed and time is allocated on the basis of the review outcome.

Target of Opportunity observations may be proposed at any time

Glimpses of Results


Astrosat First Light Image
Crab Nebula in high energy X-rays
24:00.0
5:36:00.0
48:00.0
20:59:59.9
17:59:59.9
Created from CZTI data on 6 October 2015 (16:38 - 17:20 UT)
A.R. Rao et al

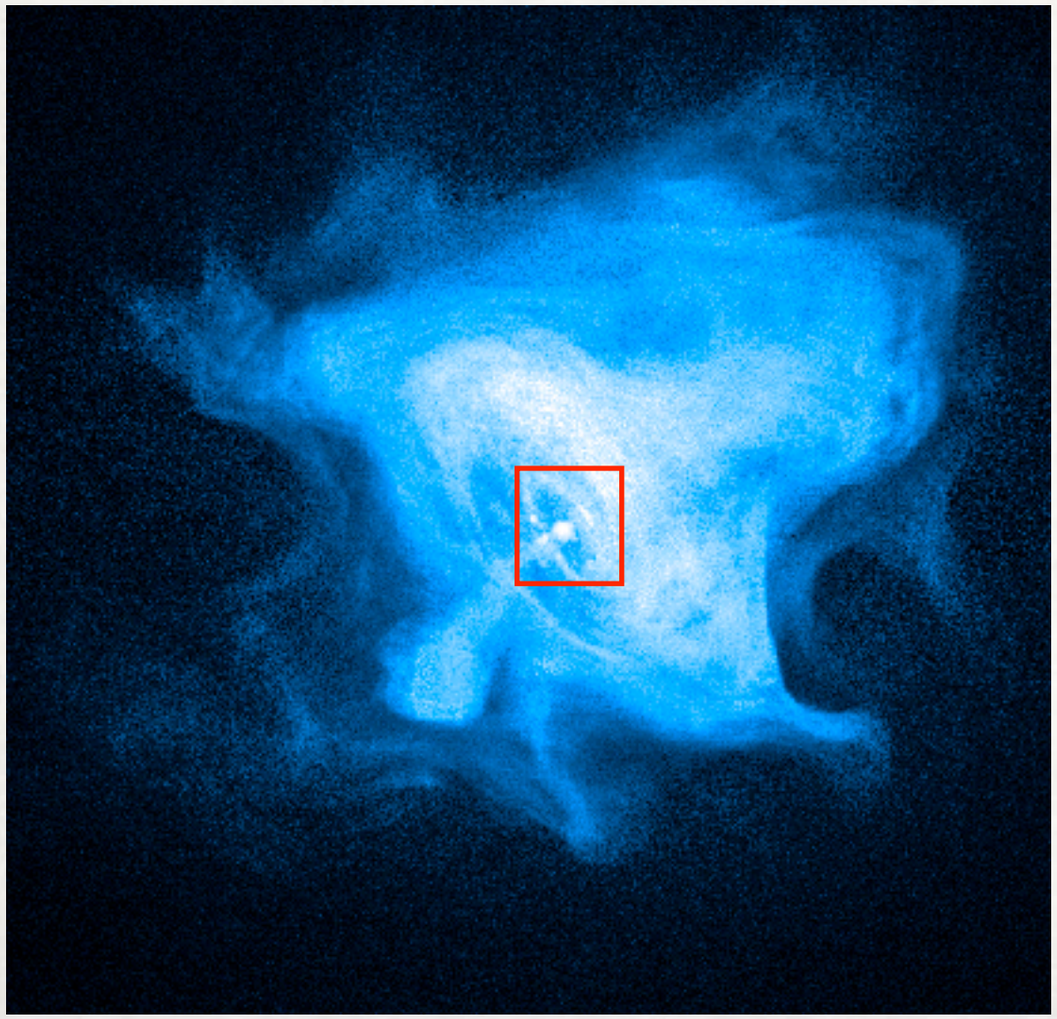
Test of AstroSat Timing capability

Crab Nebula Pulsar: X-ray bands

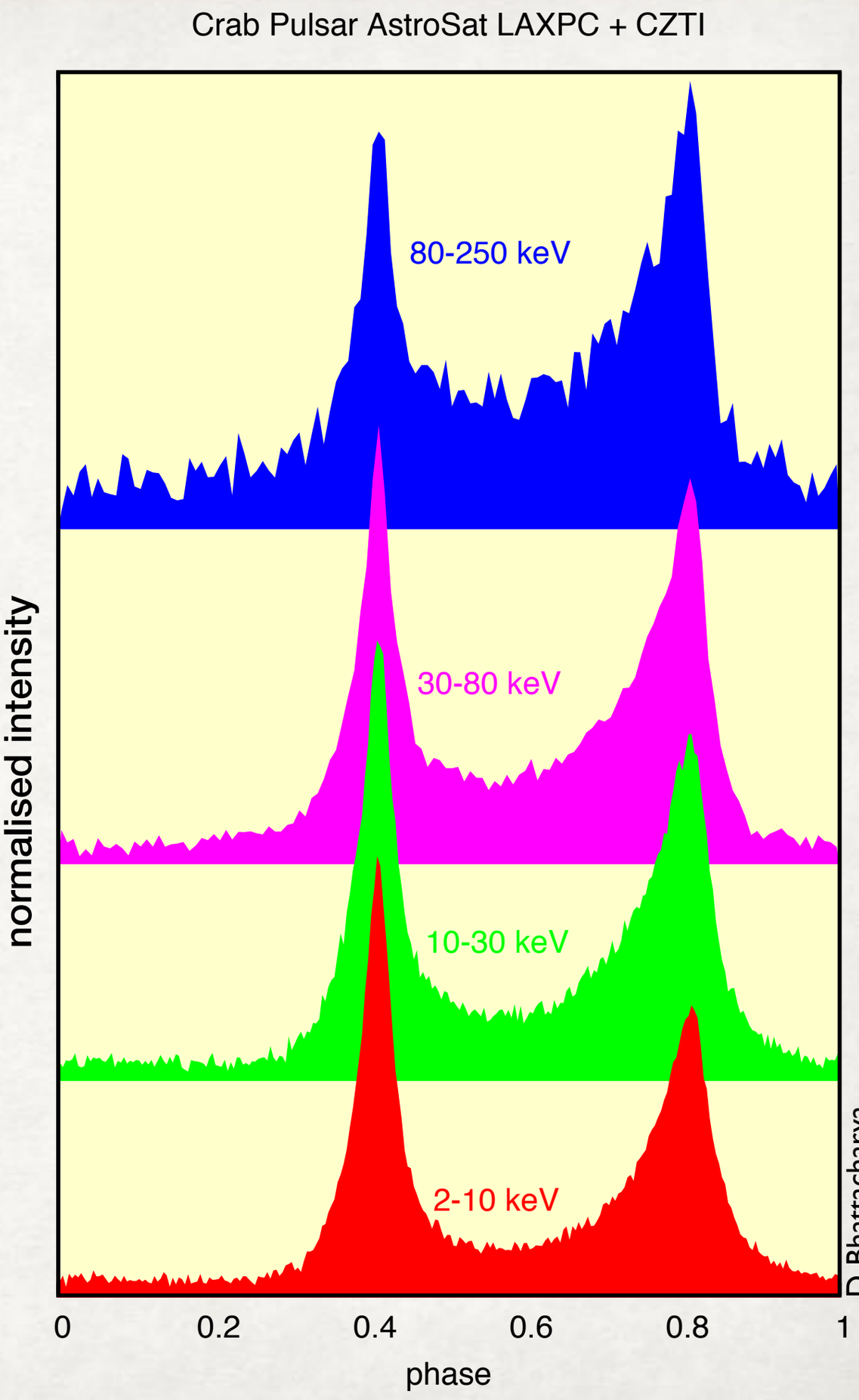
Pulse Period: 33.72 ms

Phase bin: 100 μs

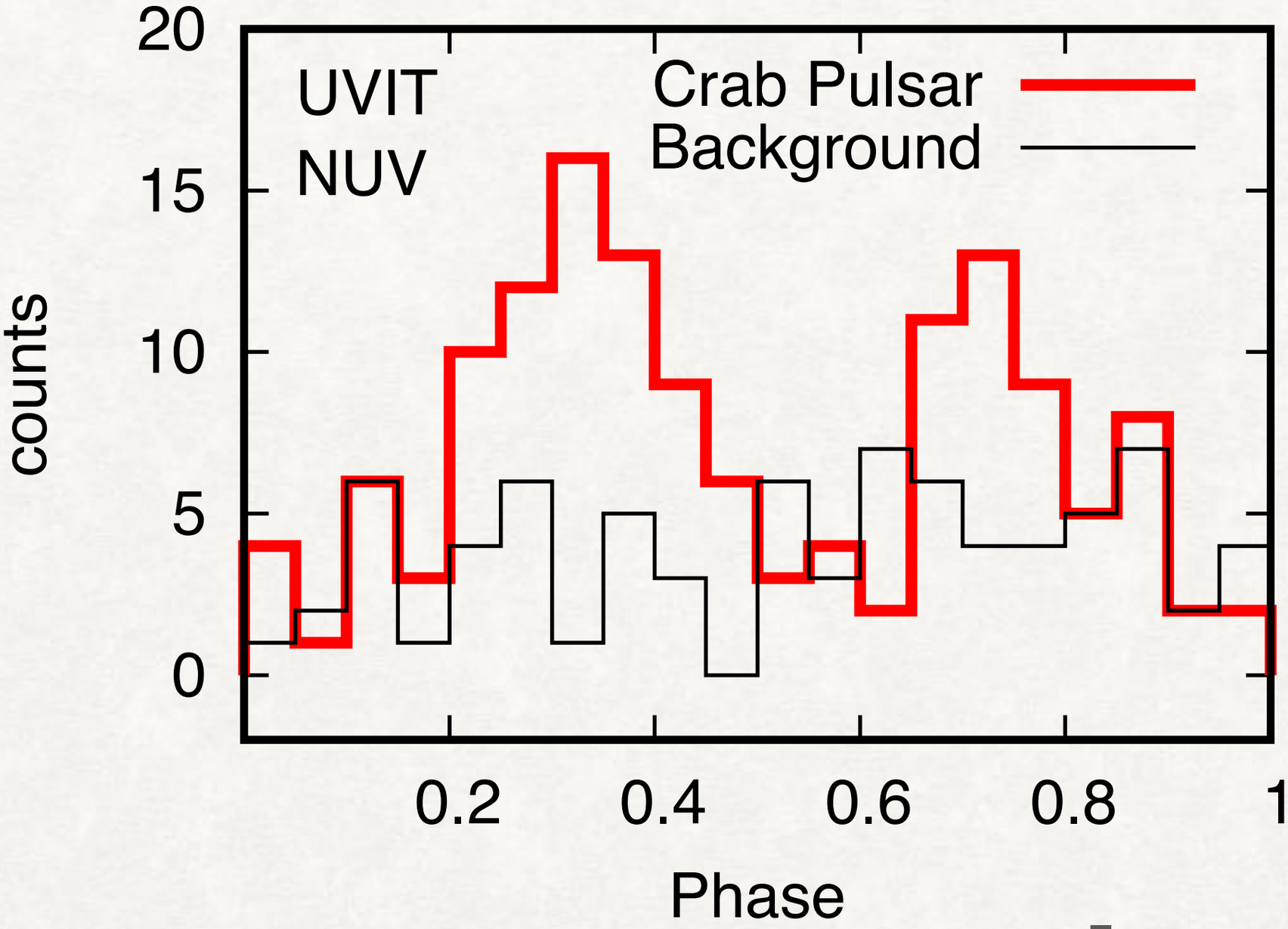
Data resolution: 10-20 μs



CXO



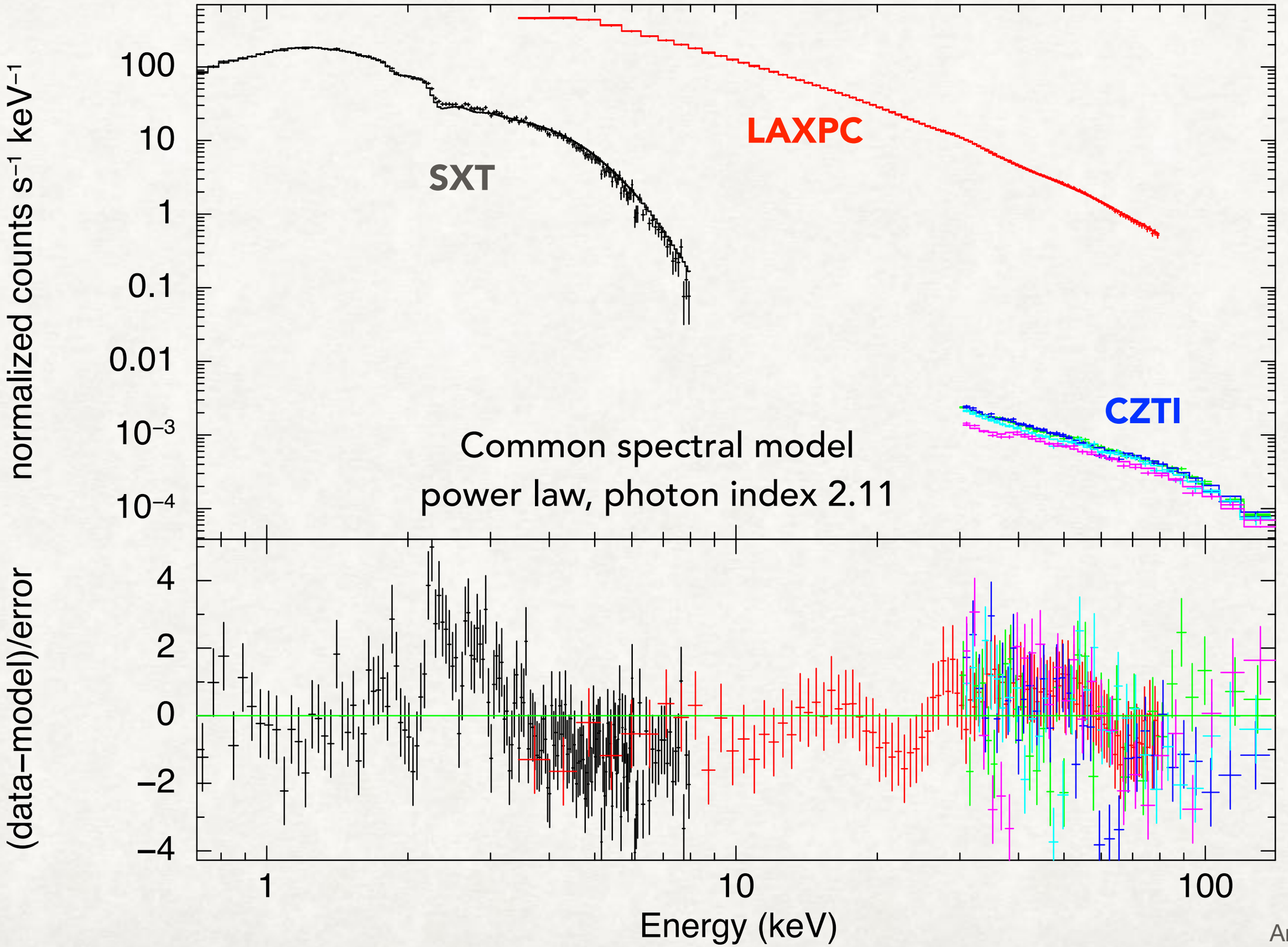
Crab Nebula Pulsar: UV band



Exposure: 221 s

Resolution: 1.6 ms

Broadband Spectroscopy: Crab Nebula

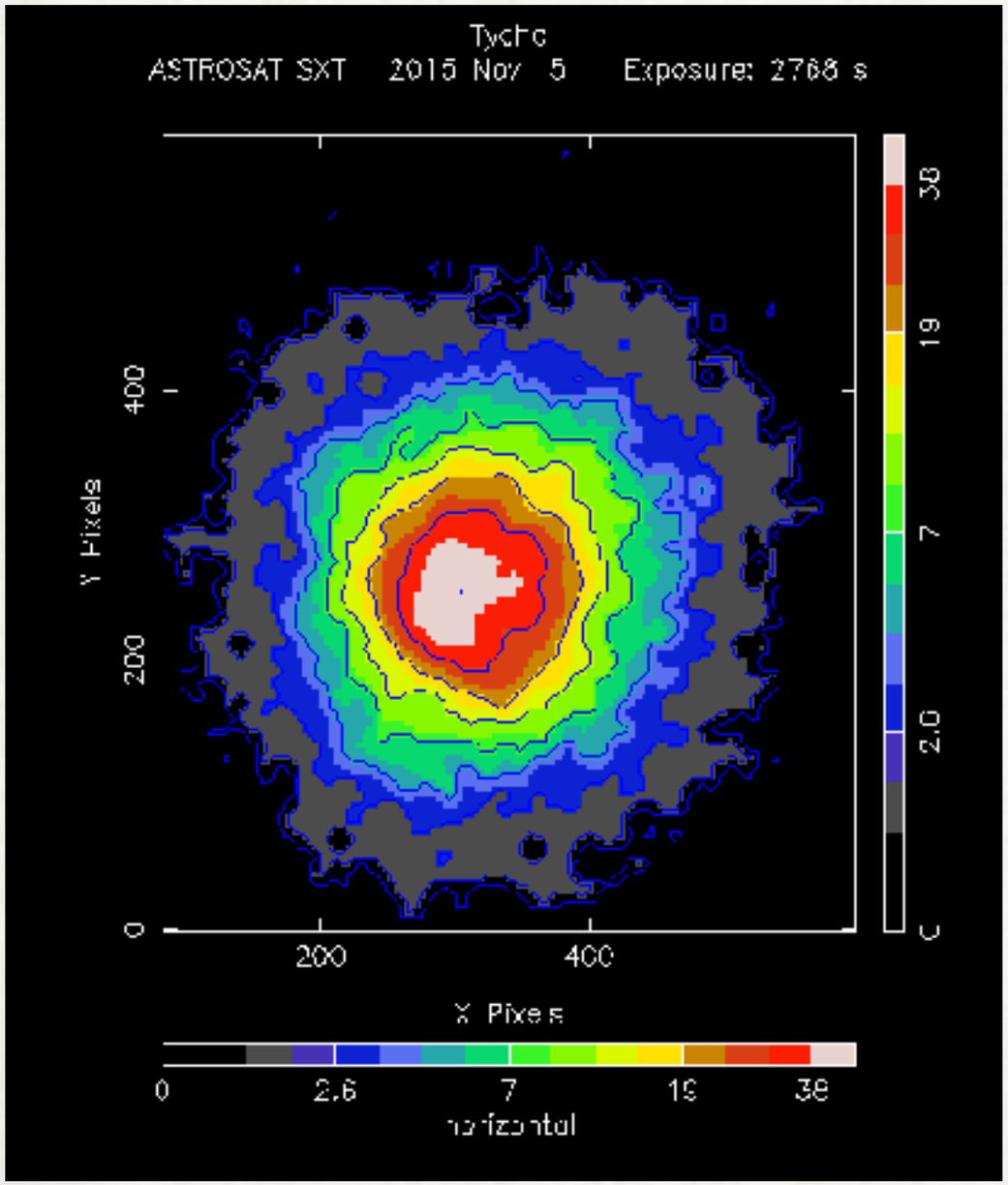


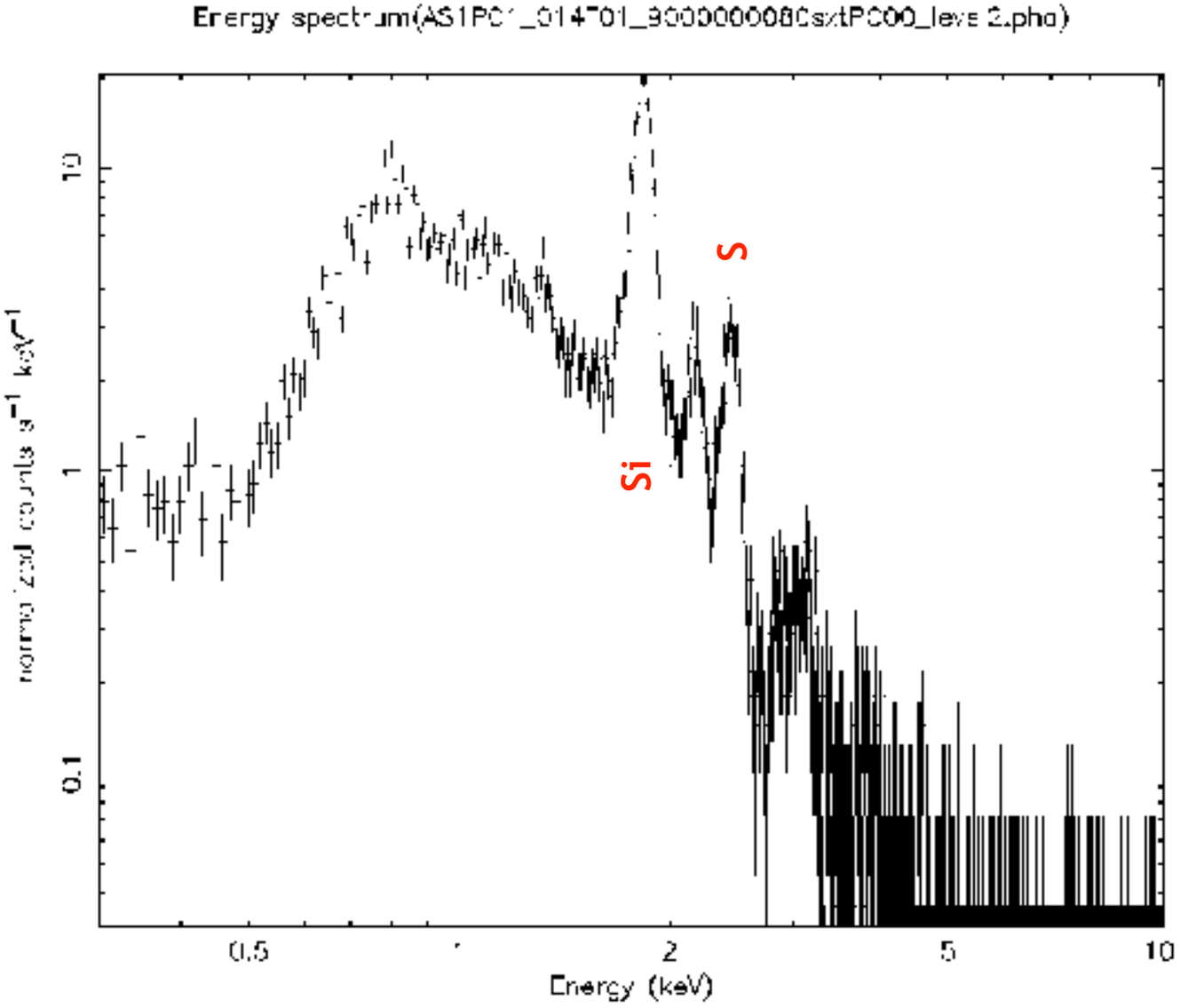
Anjali Rao
K.P. Singh

Imaging and spectroscopy with Soft X-ray Telescope

Diffuse Remnant of Tycho Brahe's Supernova (SN 1572)

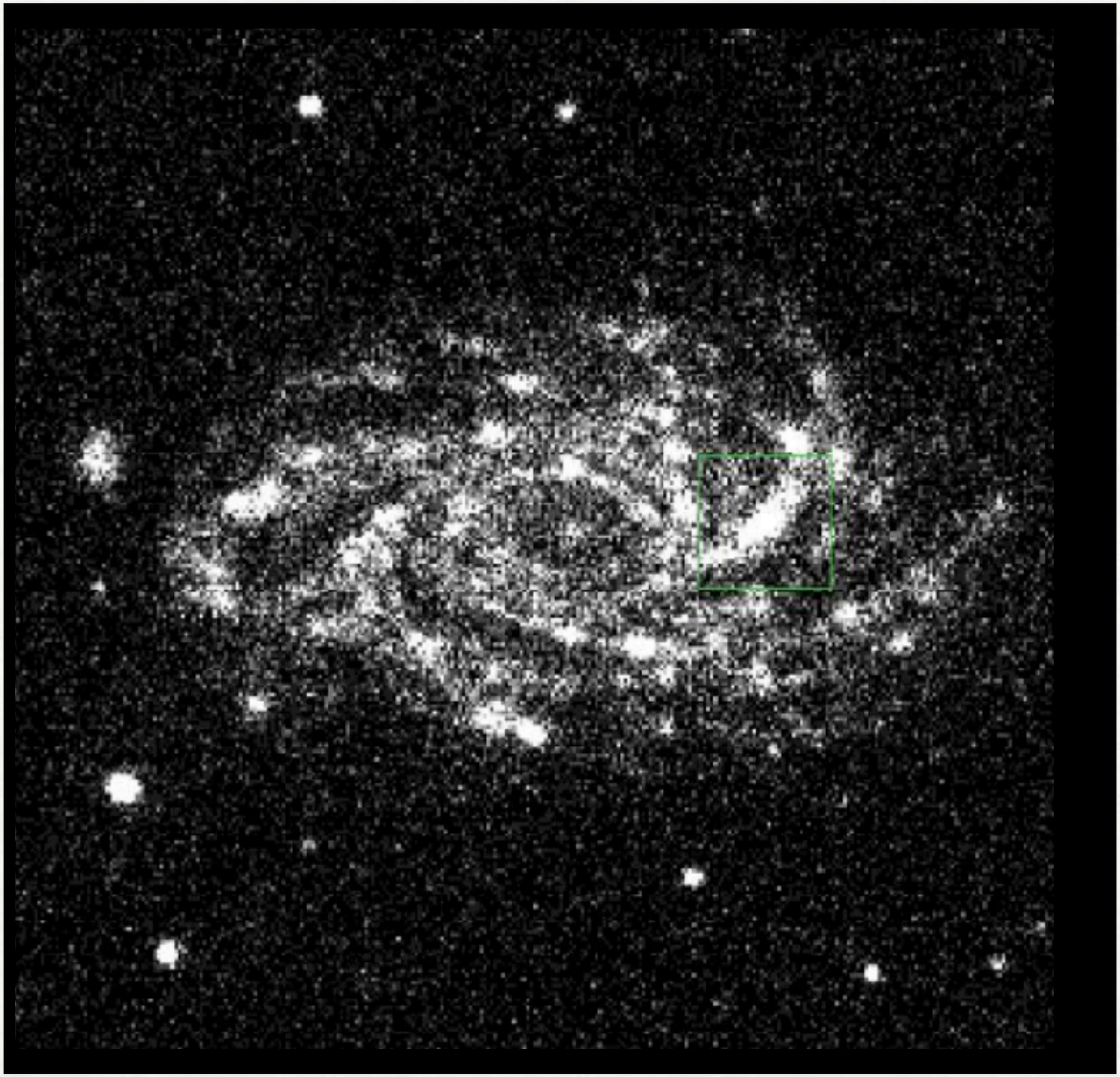
Astrosat SXT, 6 Nov 2015





K.P. Singh et al

NGC 2336



GALEX

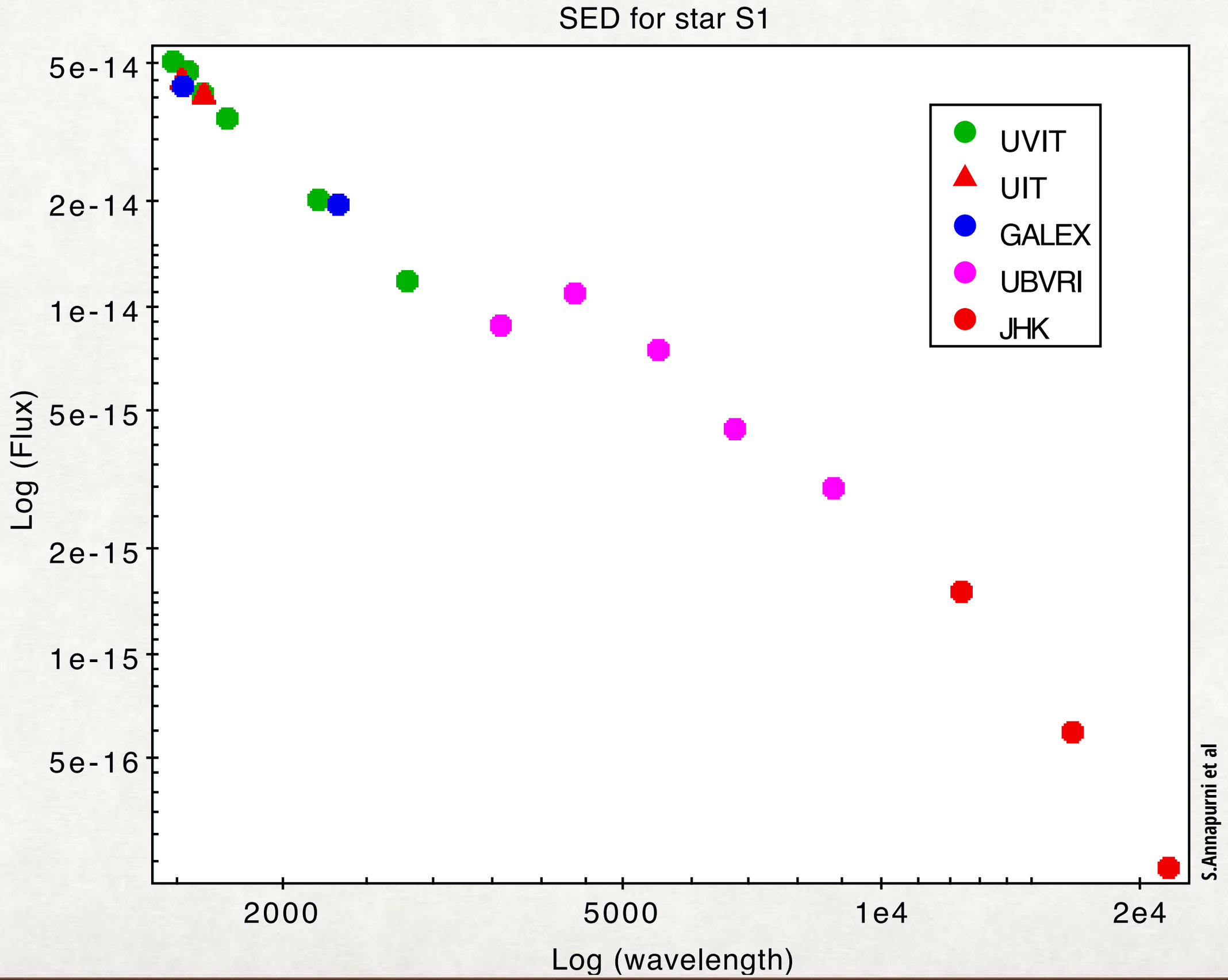
NGC 2336

Astrosat
UVIT
NUV
Dec 2015

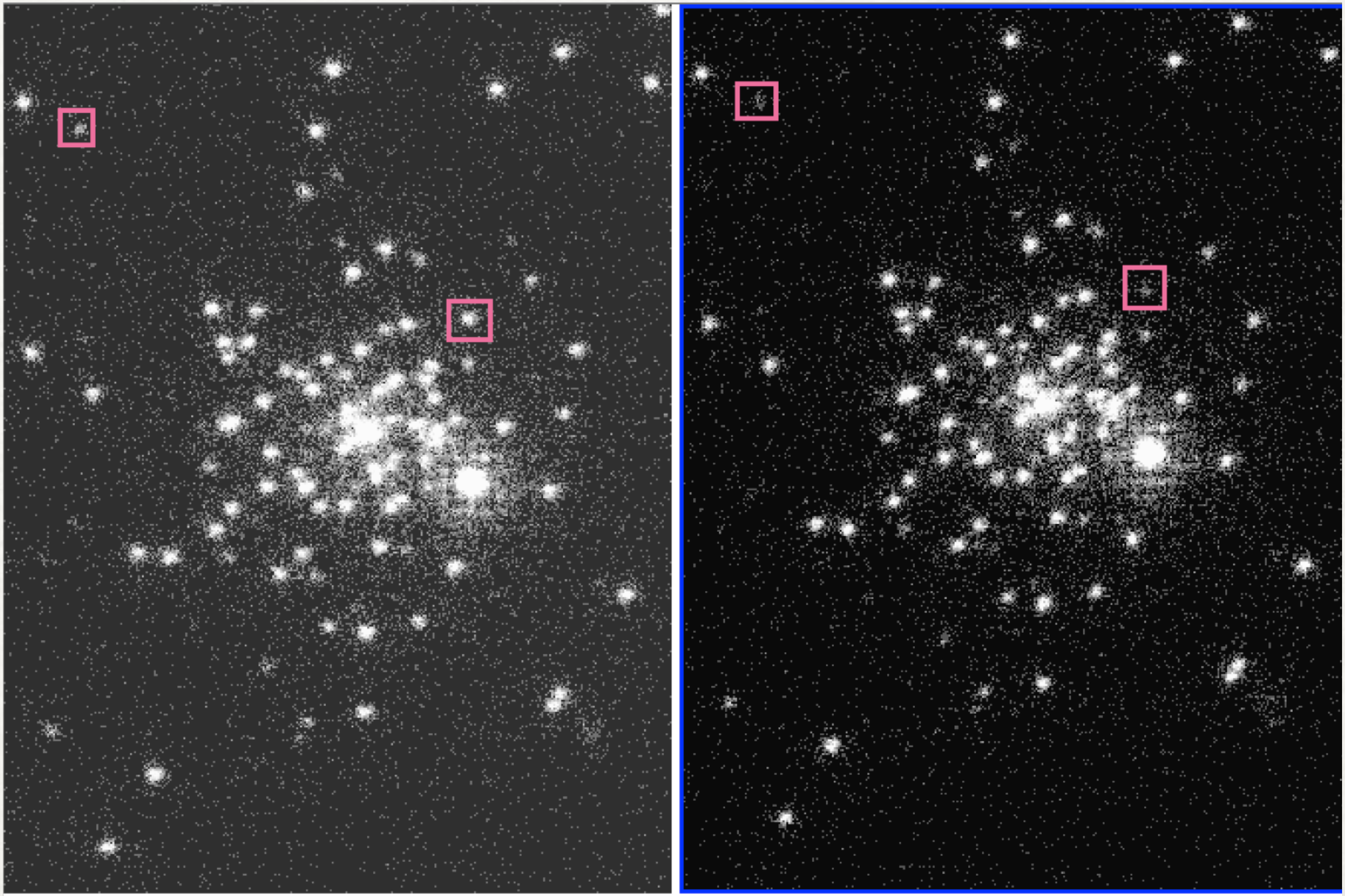
S.N. Tandon, J. Postma et al

NGC 362 is a globular cluster located in the constellation Tucana, in the northen edge of our satellite galaxy known as Small Magellanic Cloud (SMC). The tightly packed stars which appear as white spot in the image form the core of the cluster. The light blue dots surrounding the cluster core are extreme horizontal branch stars. These stars undergo helium fusion in their cores and have very thin hydrogen envelope. The bright blue dots scattered all over the image are hot, young stars in the SMC. This is a false-color composite image, where the light detected by the FUV and NUV channels of the UVIT telescope on ASTROSAT are colored in blue and yellow respectively. Credits: UVIT team/ISRO/CSA

Spectral signature of a binary star in NGC 188



Globular cluster NGC 1851: UVIT FUV time lapse image



S.Annapurni et al

Detection of RR Lyrae Variable stars: 10 min exposure each, separated by ~14 h

Cygnus Loop
Optical image
Hα

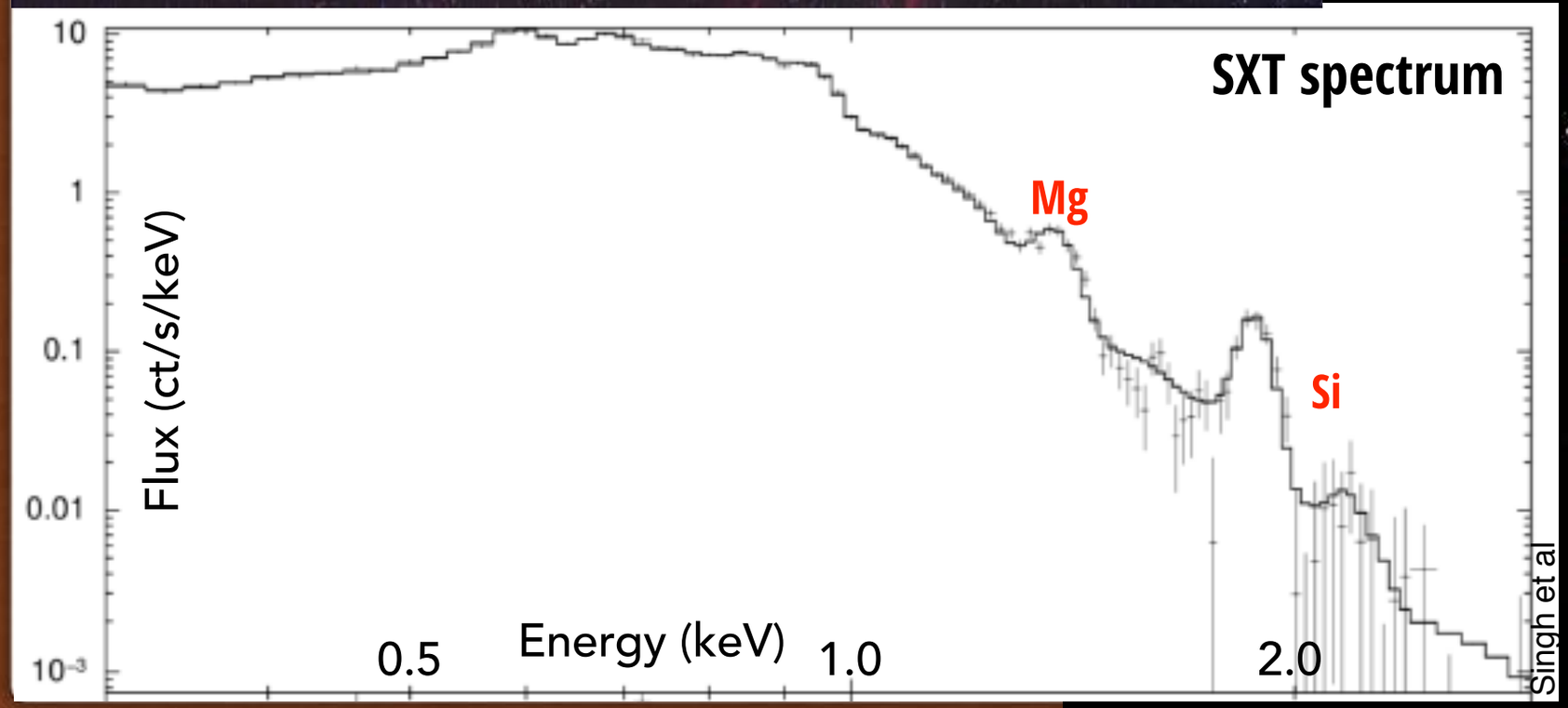
Steve Cannistra

Cygnus Loop
Optical image
Hα

Steve Cannistra

UVIT FUV

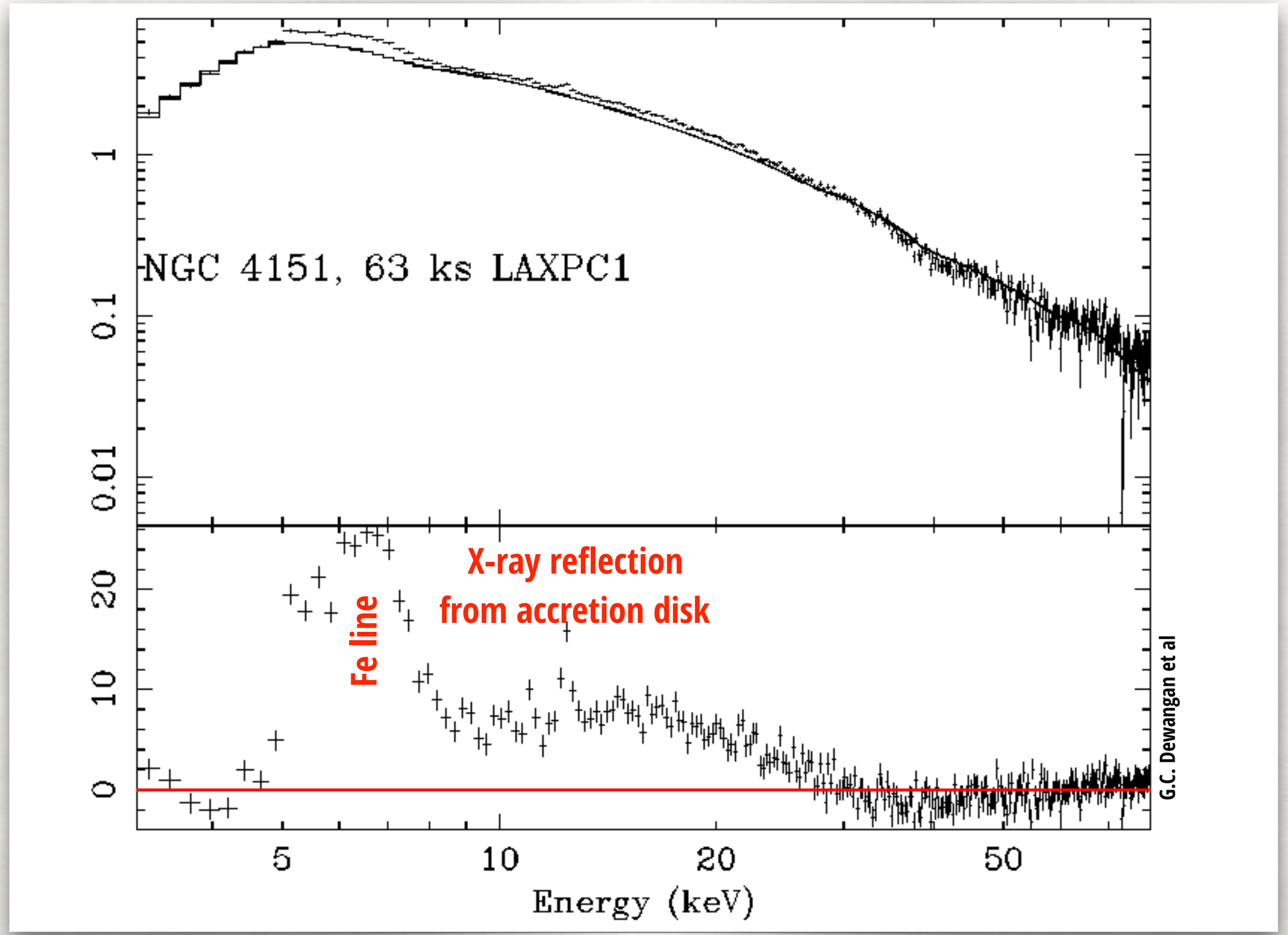
Sutaria, Rahna, Murthy, Singh, Rao, Tandon



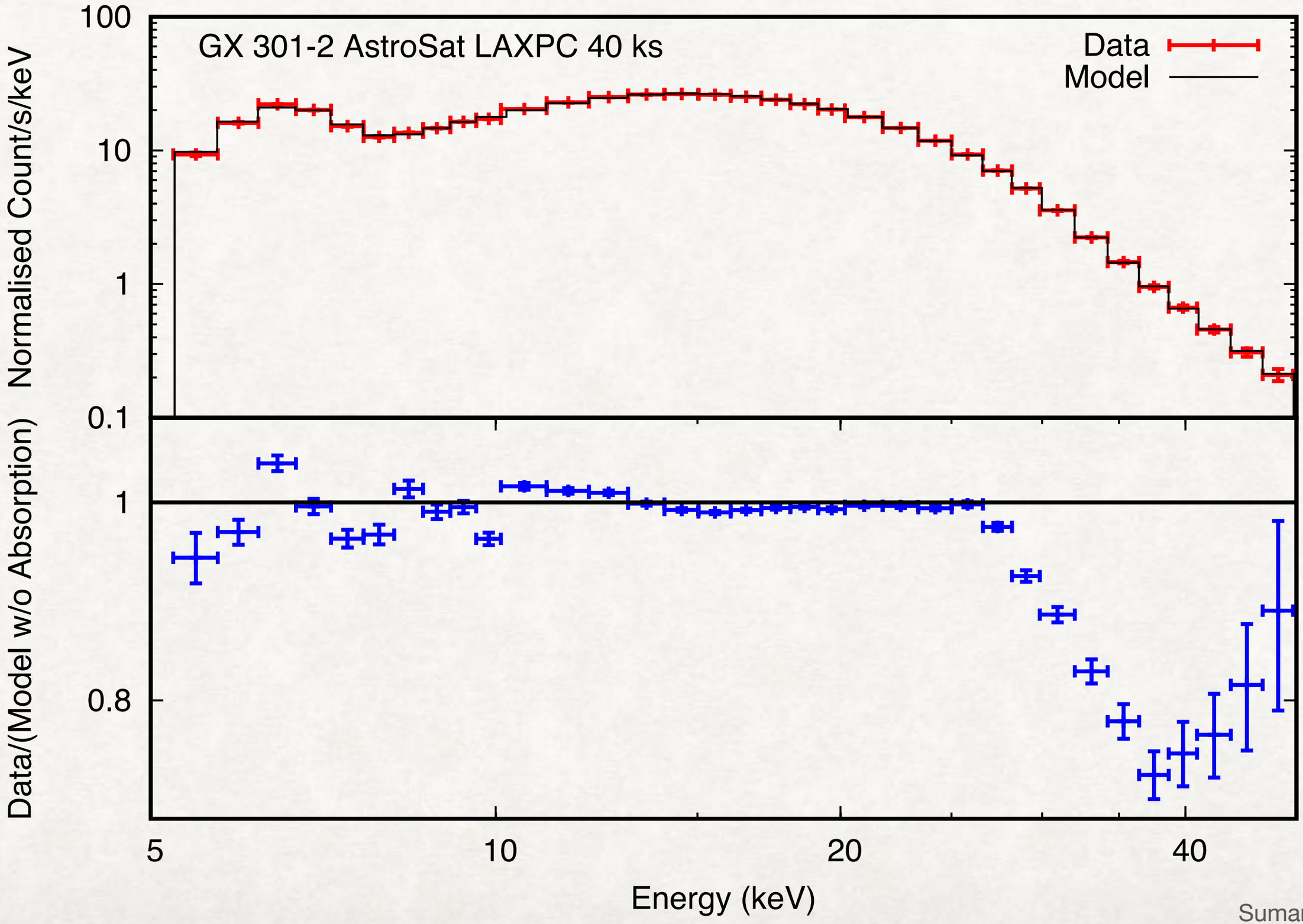
Singh et al

UVIT NUV

Accreting Supermassive Black Hole
in Active Galaxy NGC 4151

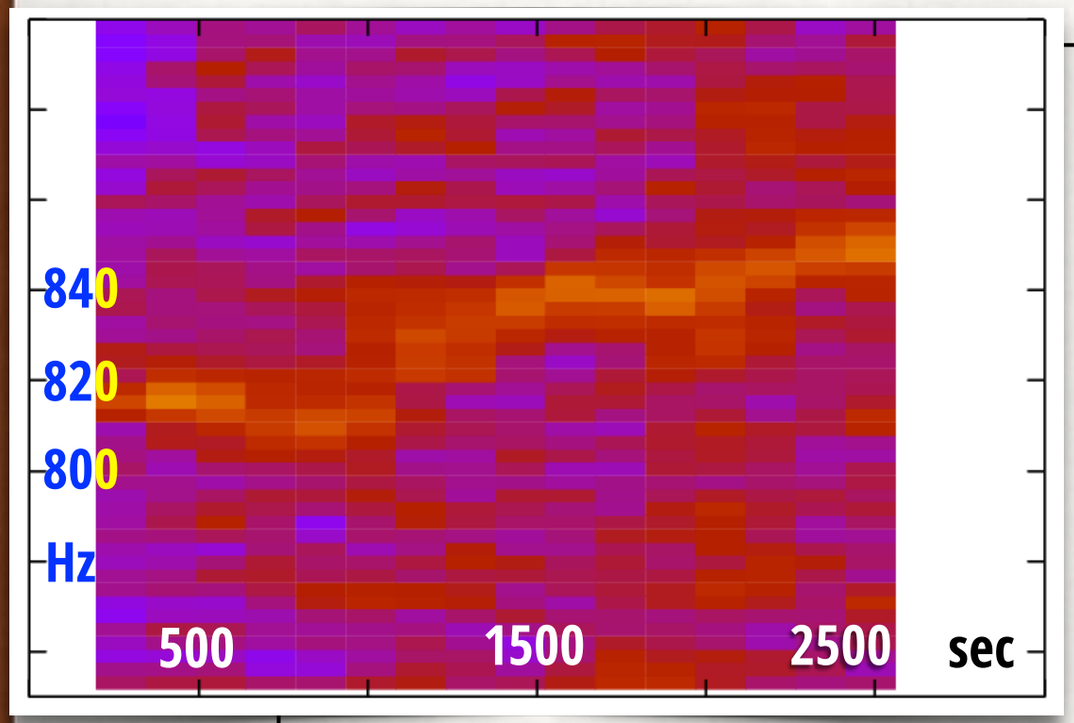


Cyclotron Resonance

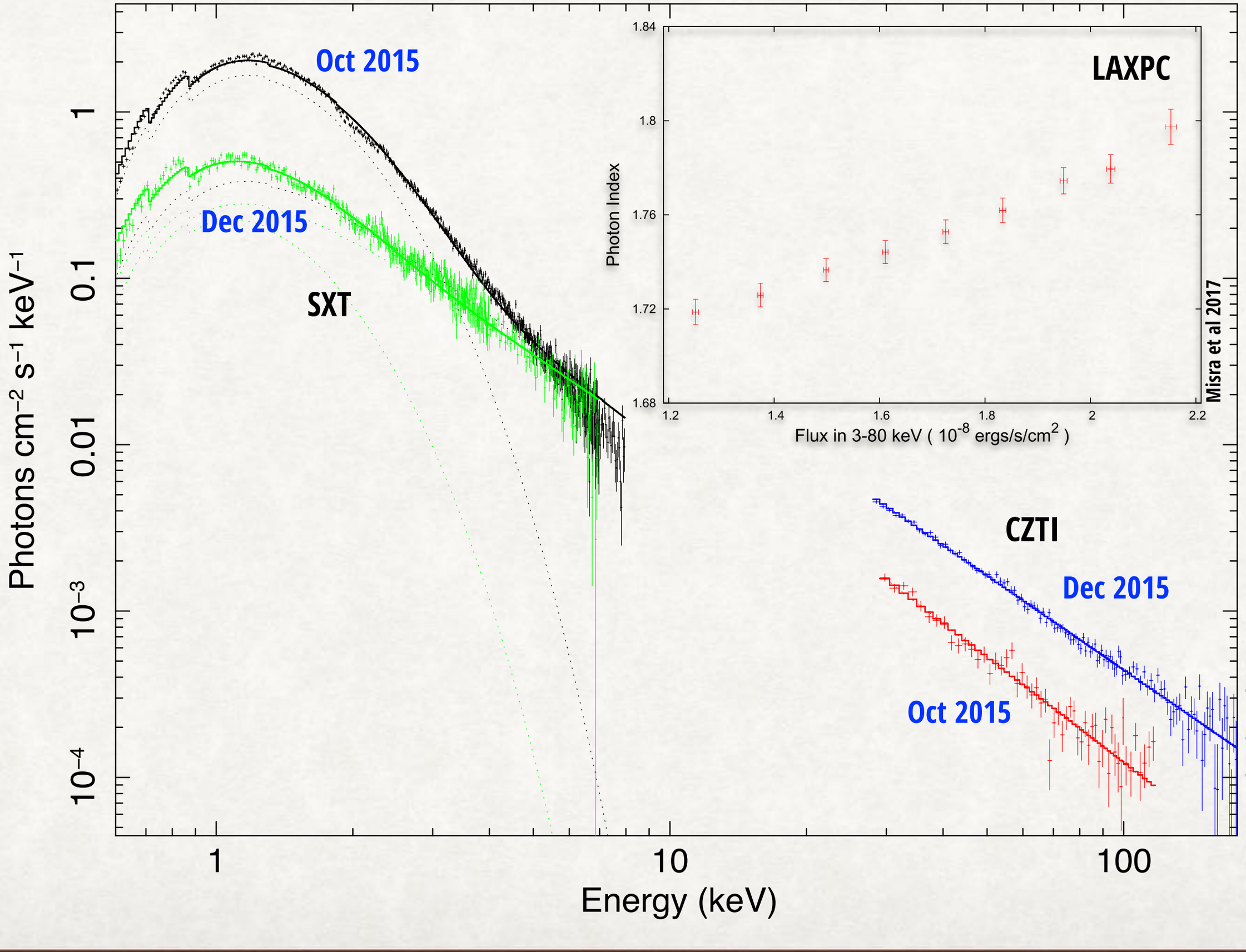


Suman Bala

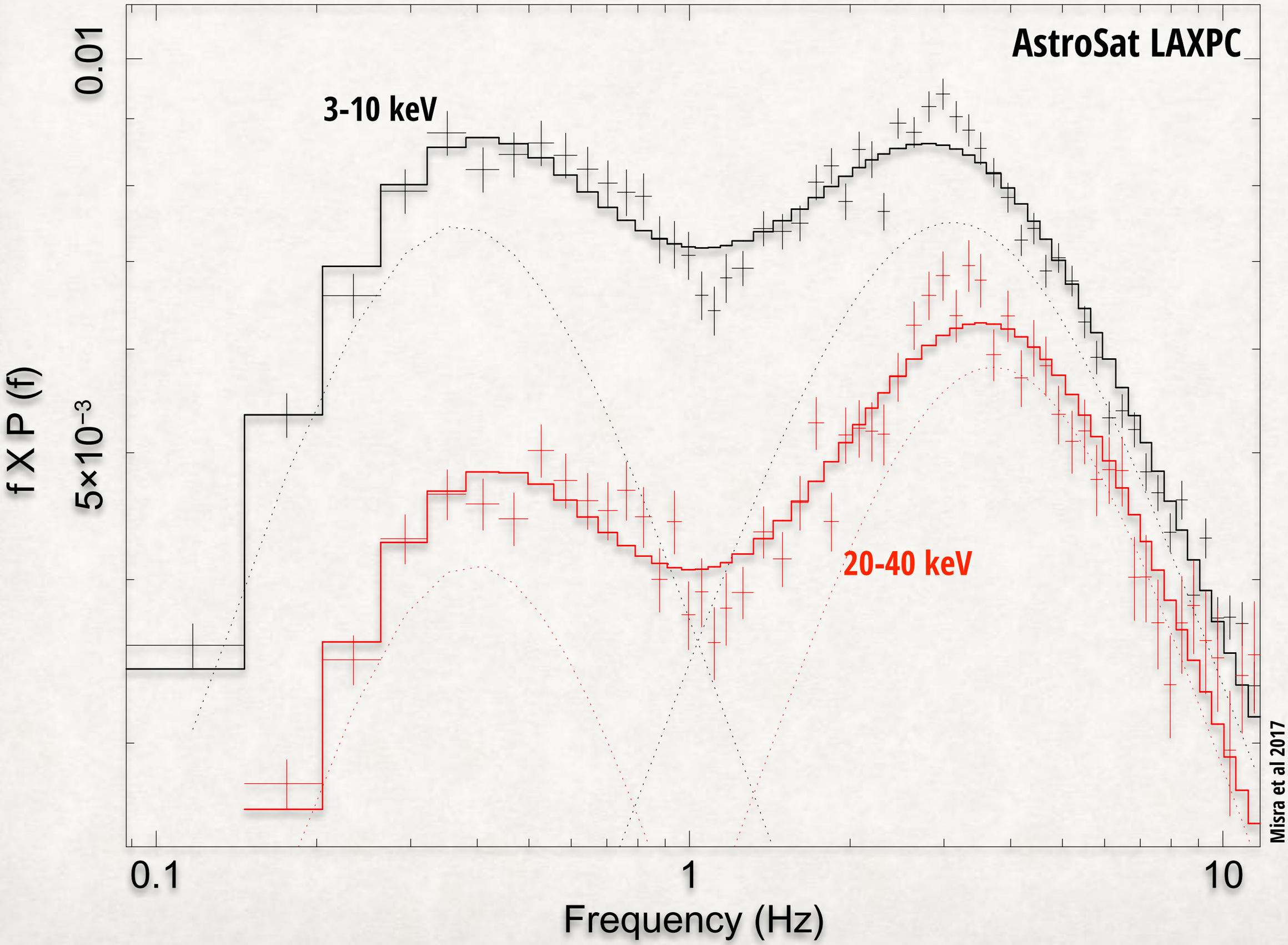
kHz QPO detection by LAXPC



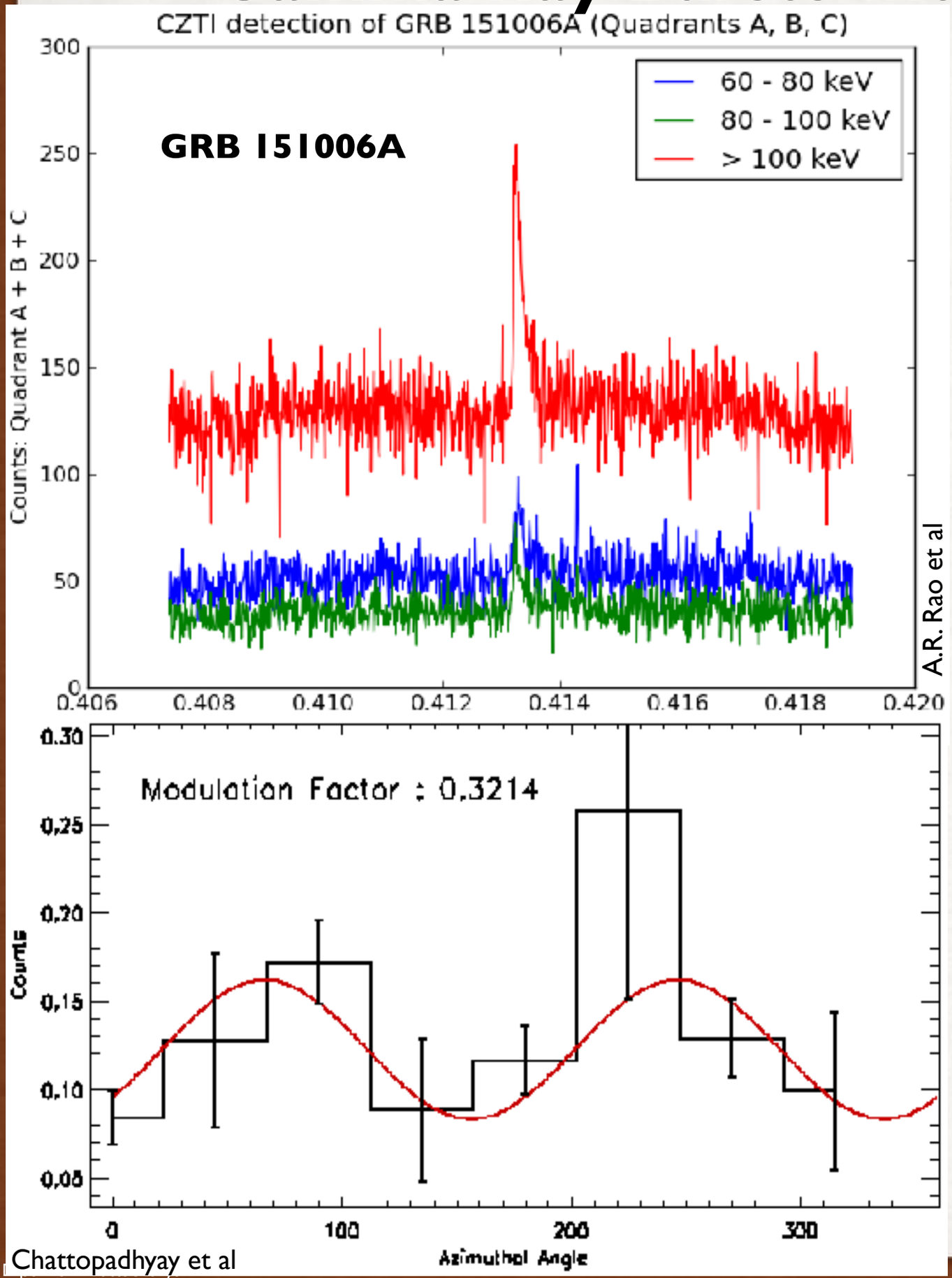
Accreting Black Hole Cygnus X-1: Spectral Variations



Cygnus X-1: Power Spectrum

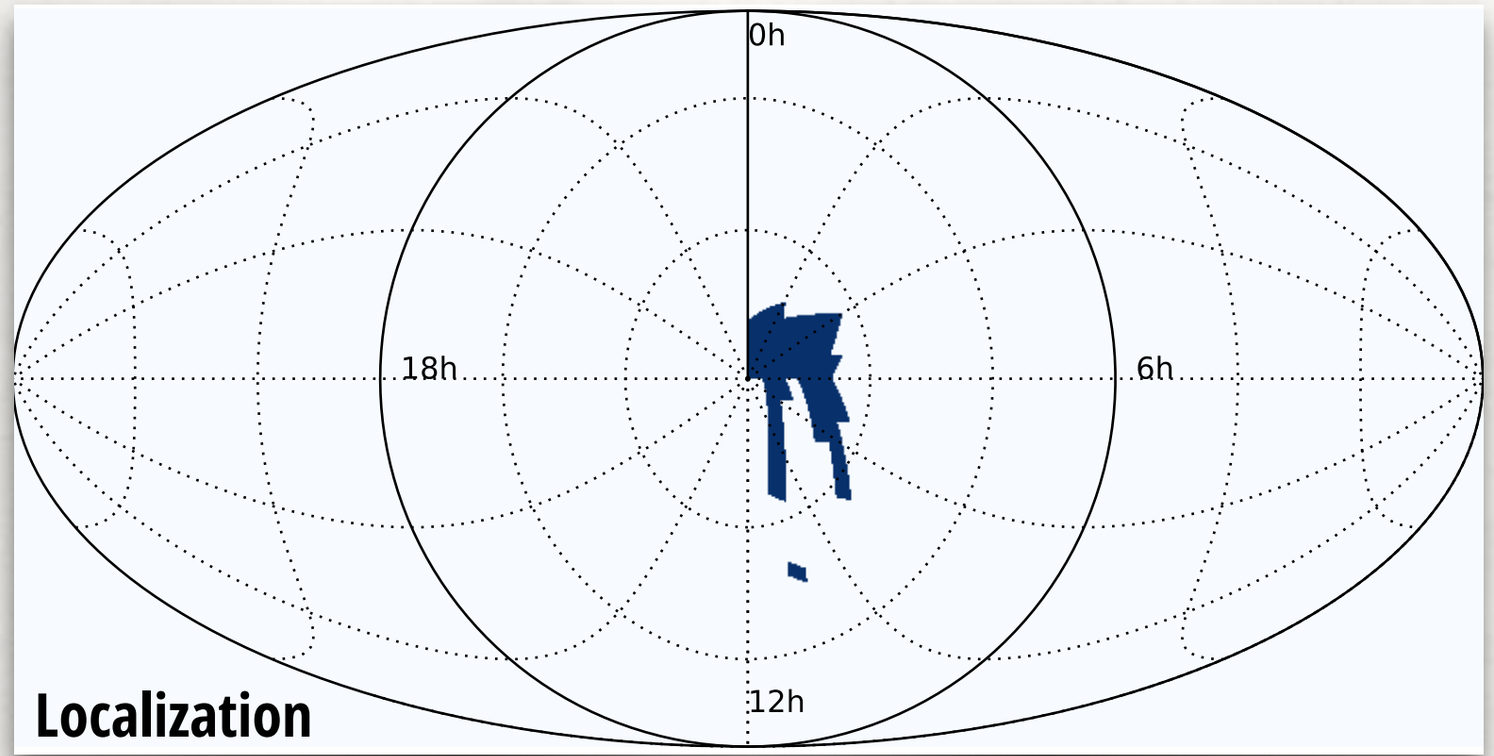


Gamma Ray Bursts with ASTROSAT CZTI



- First cosmic source detected by AstroSat was a GRB
- They signal birth of Black Holes
- AstroSat can detect polarisation of high-energy (> 100 keV) emission of Bright GRBs (~5/yr)
- > 100 GRB detections reported so far from AstroSat
- Positive detection of polarisation in 7 cases in the first year
- Estimated polarisation fraction between 48% to 96%
- Upper limits placed in 4 cases, lowest 35%

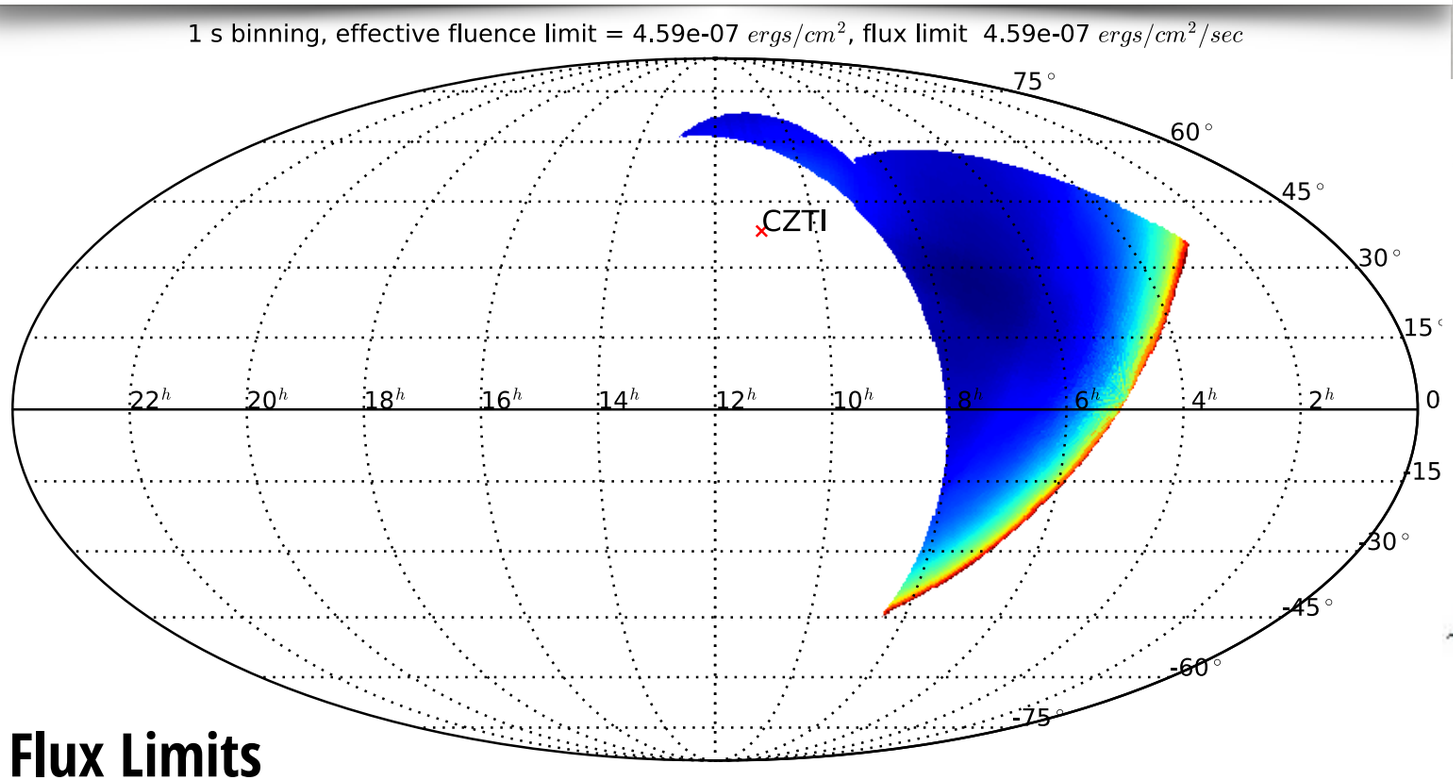
AstroSat CZTI search for EM counterpart of GW events



Localization

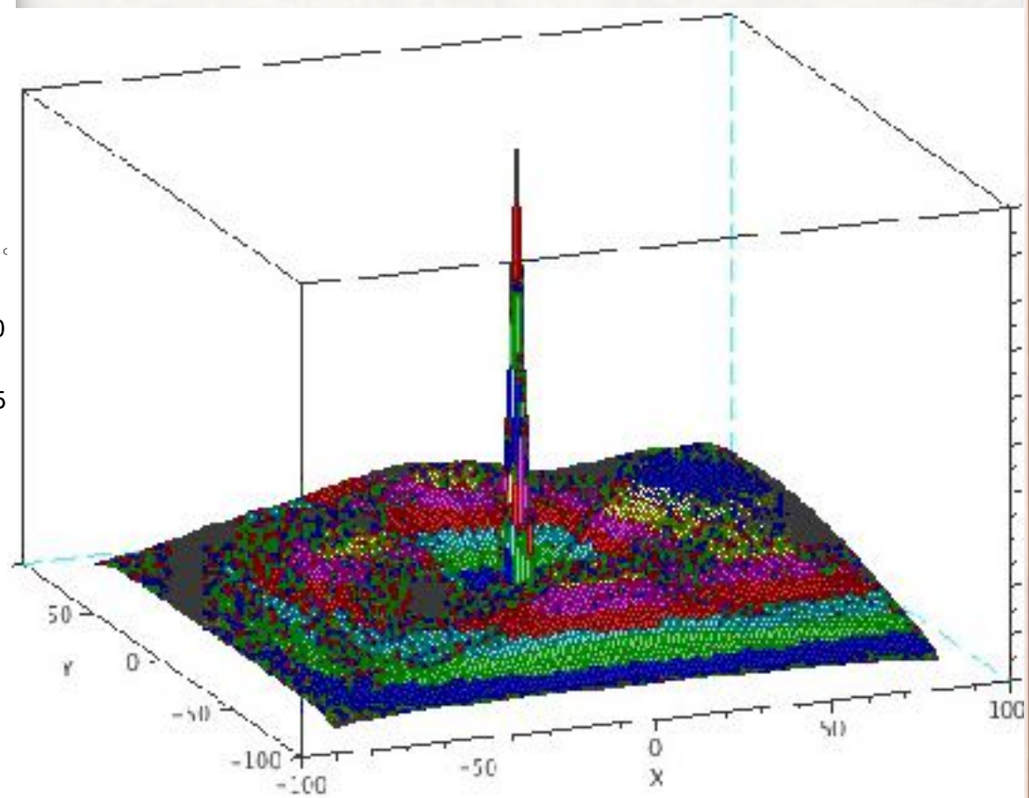
At energies above 60 keV CZTI FOV gradually opens up to the whole sky.

Can detect till 250 keV
Veto detector sensitive up to 1 MeV



Flux Limits

2.6e-07 8.6e-07 2.9e-06 9.5e-06 3.2e-05



Summary

AstroSat is addressing a wide range of science issues

Highly capable X-ray timing mission

Excellent UV imaging, resolution second only to Hubble Space Telescope

Simultaneous wideband spectroscopy

Transient detector and monitor

Hard X-ray polarisation

In operation for past 2 yrs, expected to last > 5 yrs

Observing opportunity is open to all, proposals sought

For information

http://astrosat.iucaa.in/

http://astrosat.iucaa.in/czti/?q=grb

http://astrosat-ssc.iucaa.in/

https://www.issdc.gov.in/astro.html