AstroSat CZTI studies of Gamma Ray Bursts

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Outline

CZTI

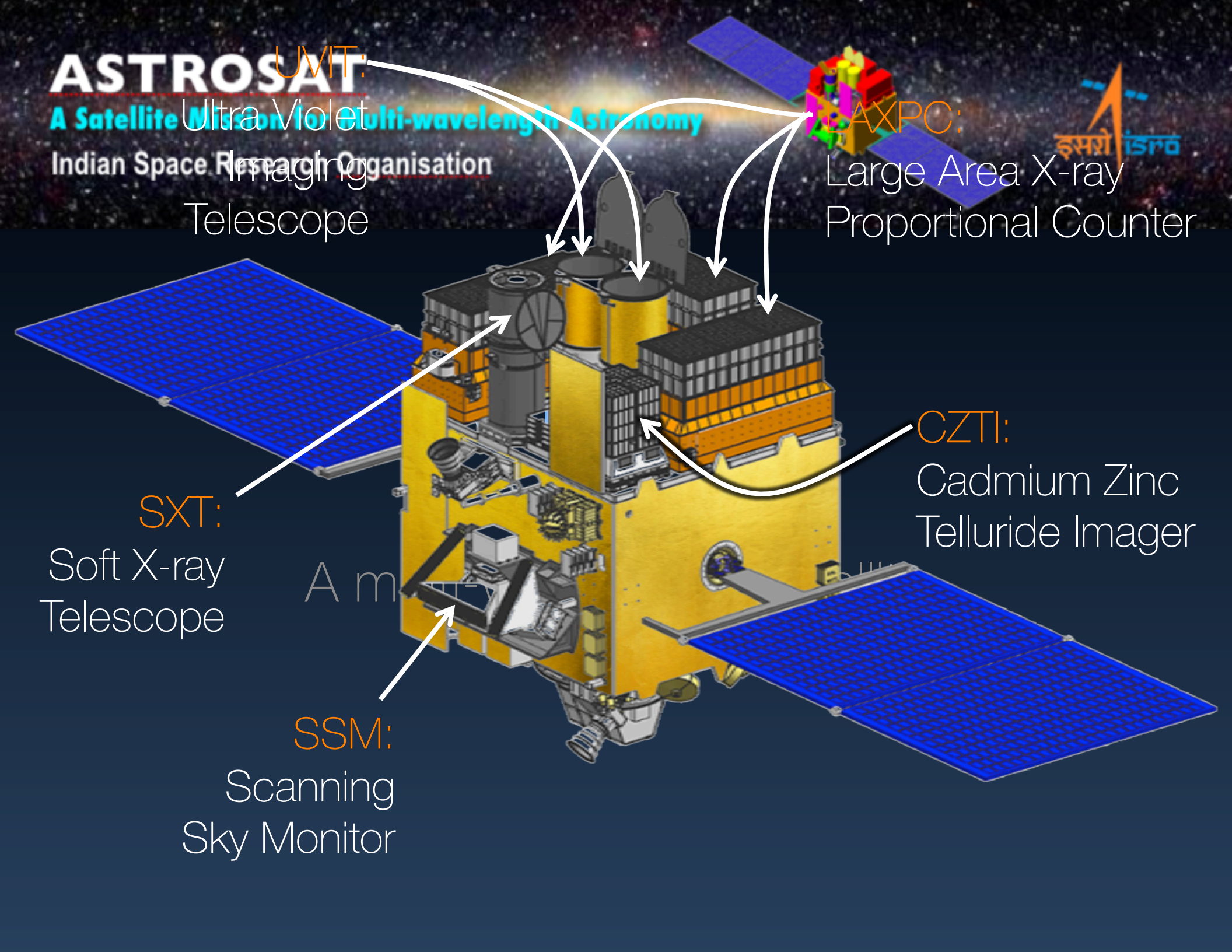
Detecting GRBs

Localisation

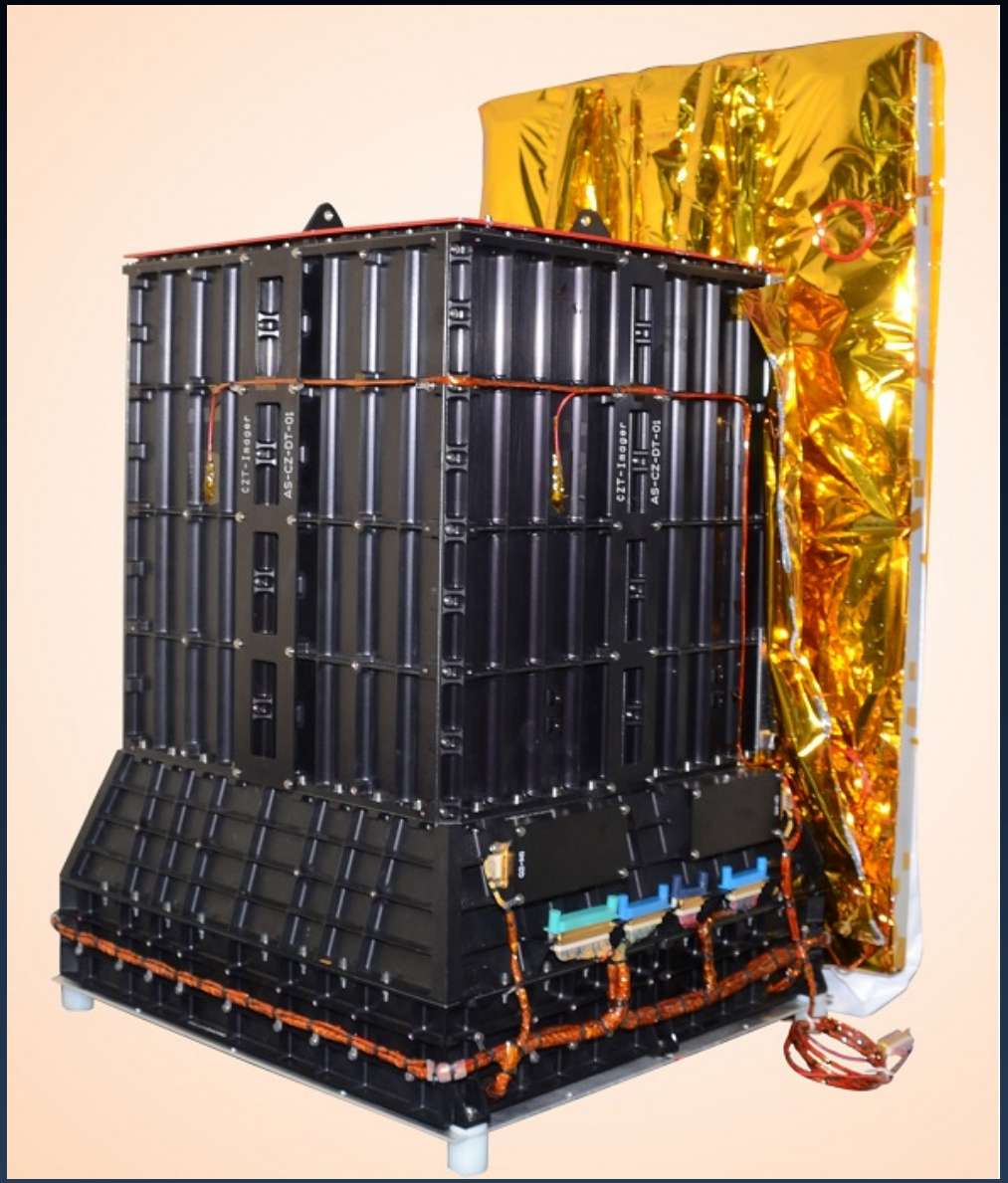
Polarimetry

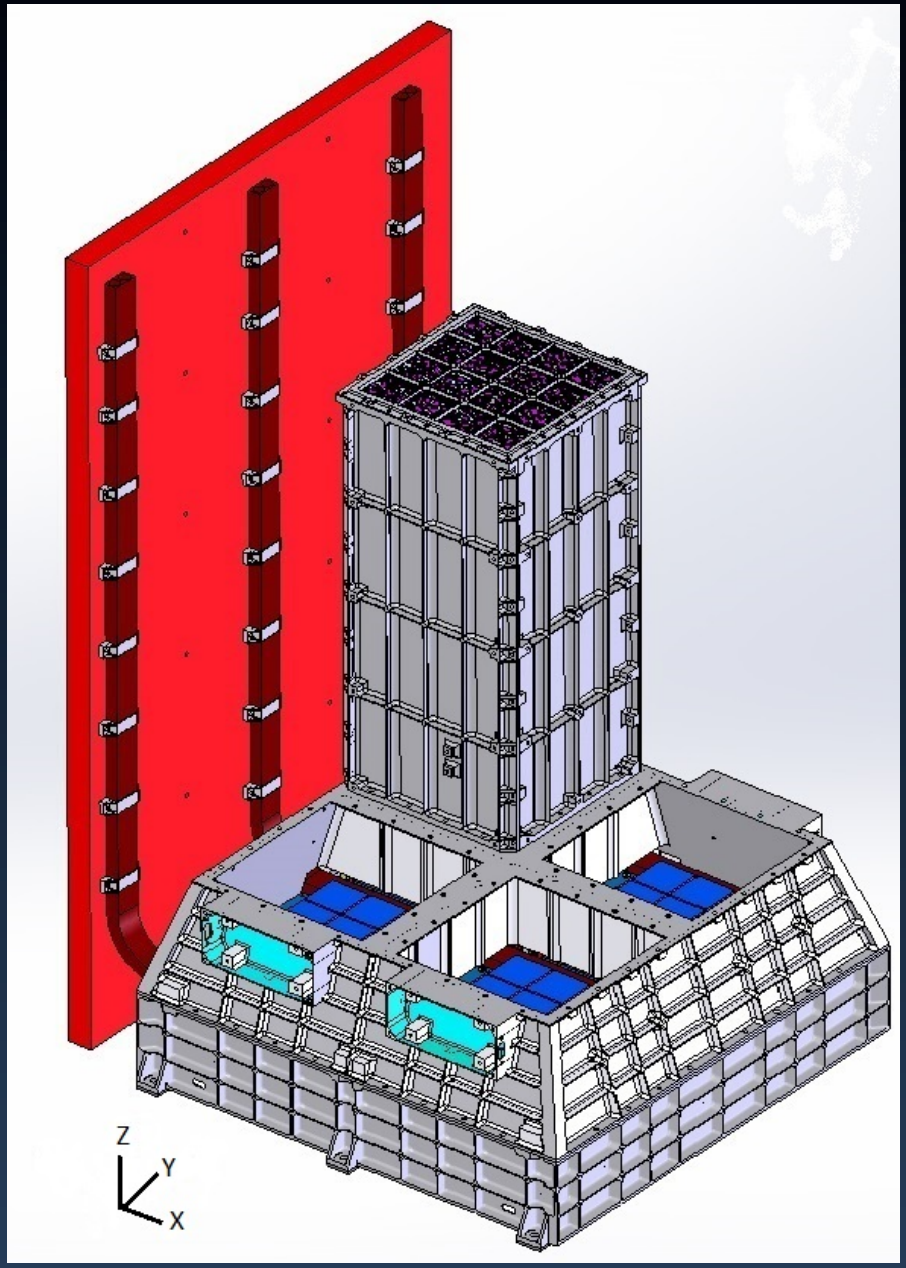
ASTROSAT

A multi-wavelength satellite


ASTROSAT
A Satellite Mission for Multi-wavelength Astronomy
Indian Space Research Organisation
इसरो ISRO
UVIT:
Ultra Violet
Imaging
Telescope
LAXPC:
Large Area X-ray
Proportional Counter
CZTI:
Cadmium Zinc
Telluride Imager
SXT:
Soft X-ray
Telescope
SSM:
Scanning
Sky Monitor

Cadmium Zinc Telluride Imager





Vital statistics

- Energy range: 20 to >200 keV
- Effective area: 487 cm^2
- Field of view: 4.6° x 4.6°
- Angular resolution: 17’
- Energy resolution: 11% at 60 keV

- CsI (veto) detector: 100 to 500 keV
  - » Effective area ~1000 cm^2

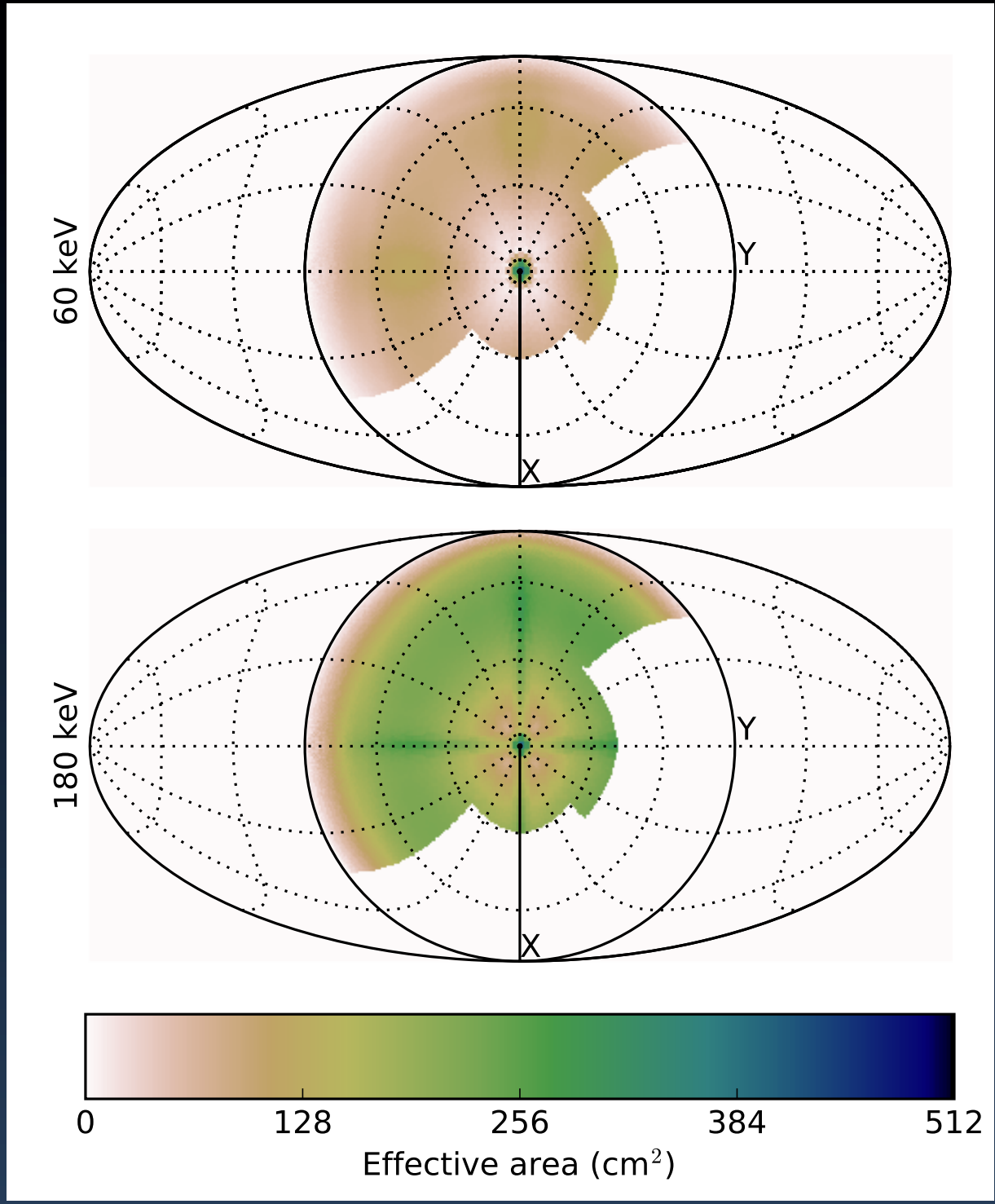
Detecting GRBs

CZTI field of view

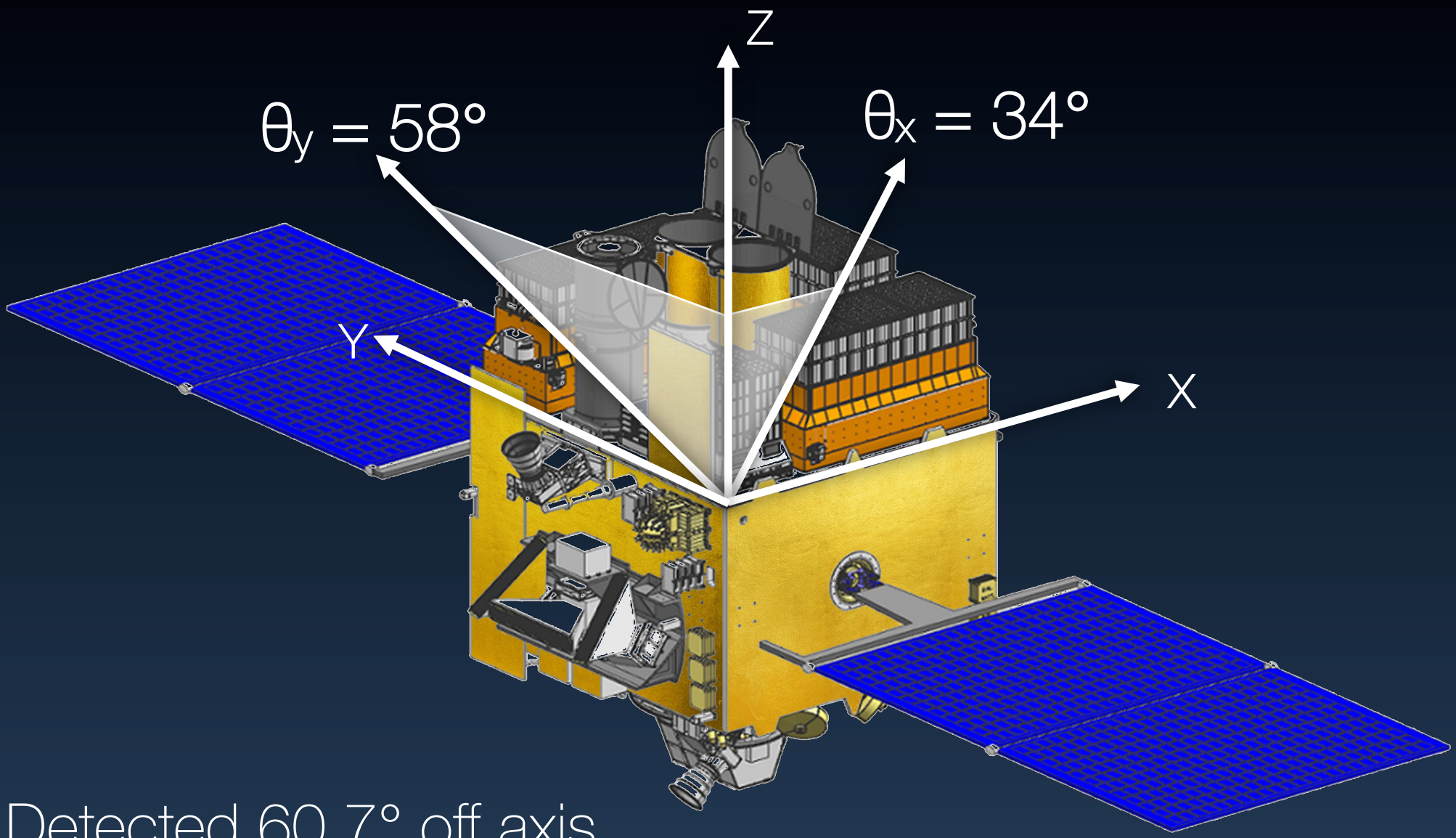
- Primary FoV: 4.5 degrees (FWHM)

- Overall sensitivity: >29% of the sky

- Median effective area at 180 keV = 190 sq cm ≈ 40% of peak



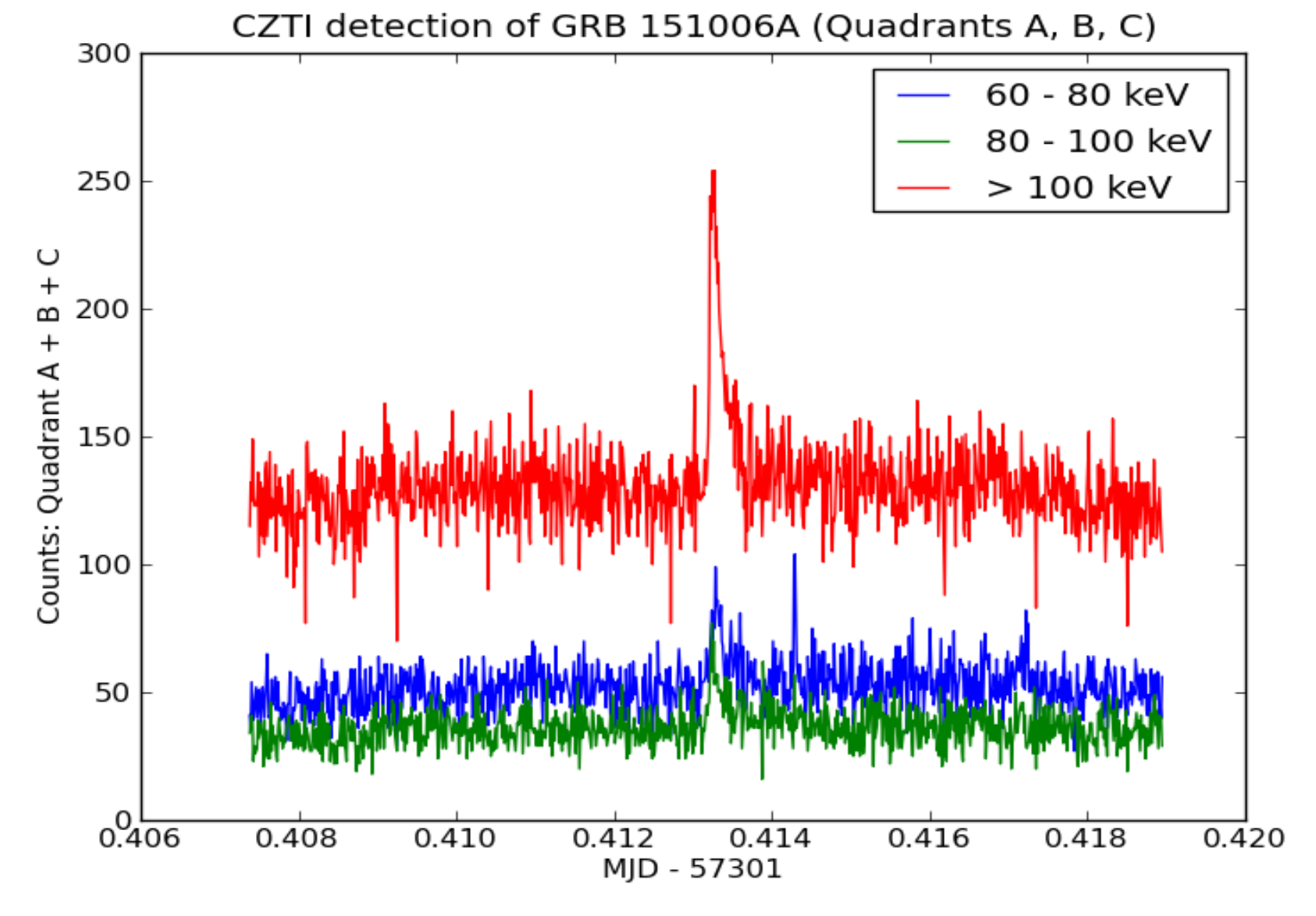
GRB151006A



Detected 60.7° off axis

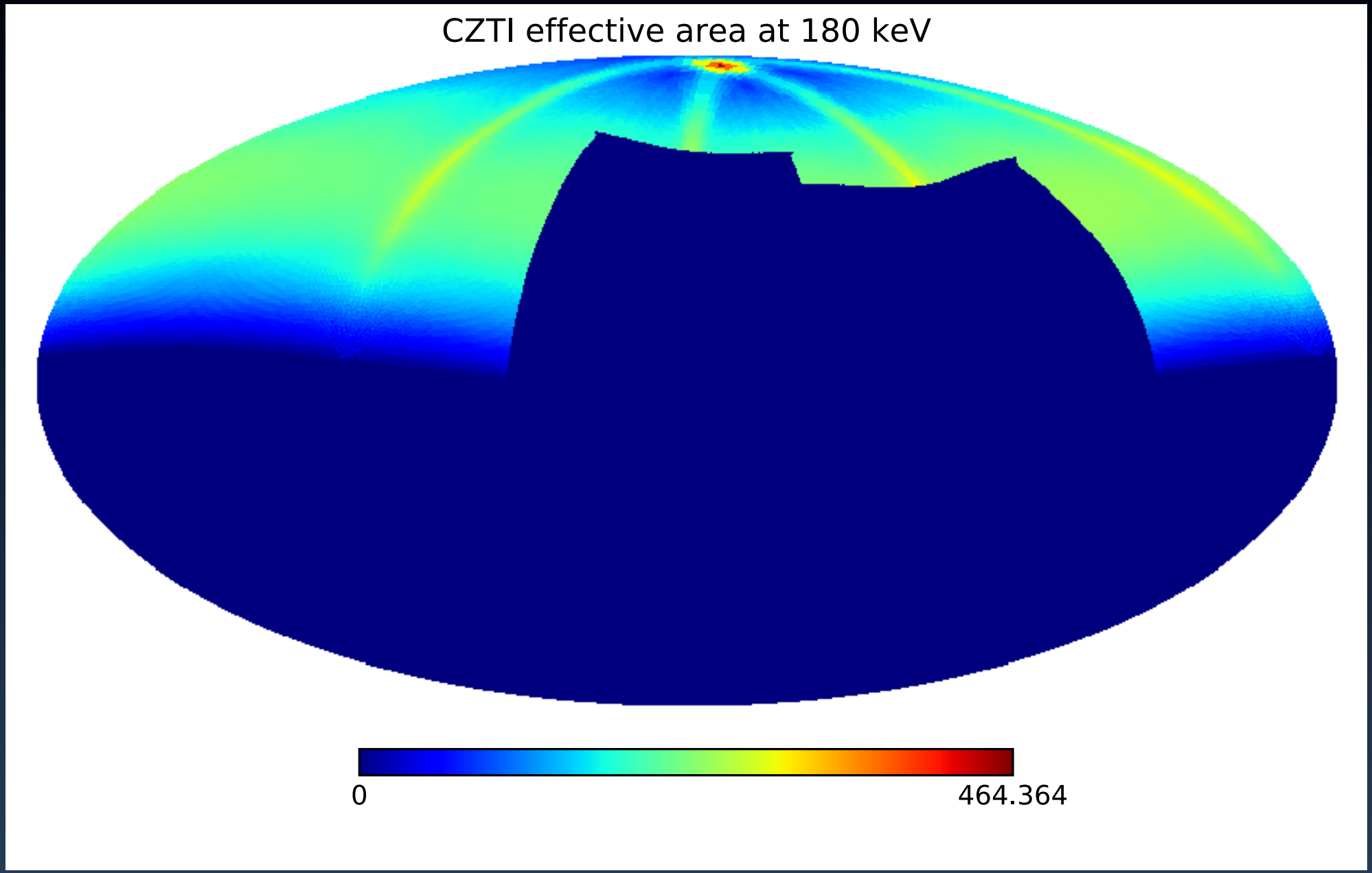
Bhalerao et al., 2015, GCN 18422

GRB151006A


CZTI detection of GRB 151006A (Quadrants A, B, C)
60 - 80 keV
80 - 100 keV
> 100 keV
Counts: Quadrant A + B + C
MJD - 57301
0
50
100
150
200
250
300
0.406
0.408
0.410
0.412
0.414
0.416
0.418
0.420

56 GRB detections

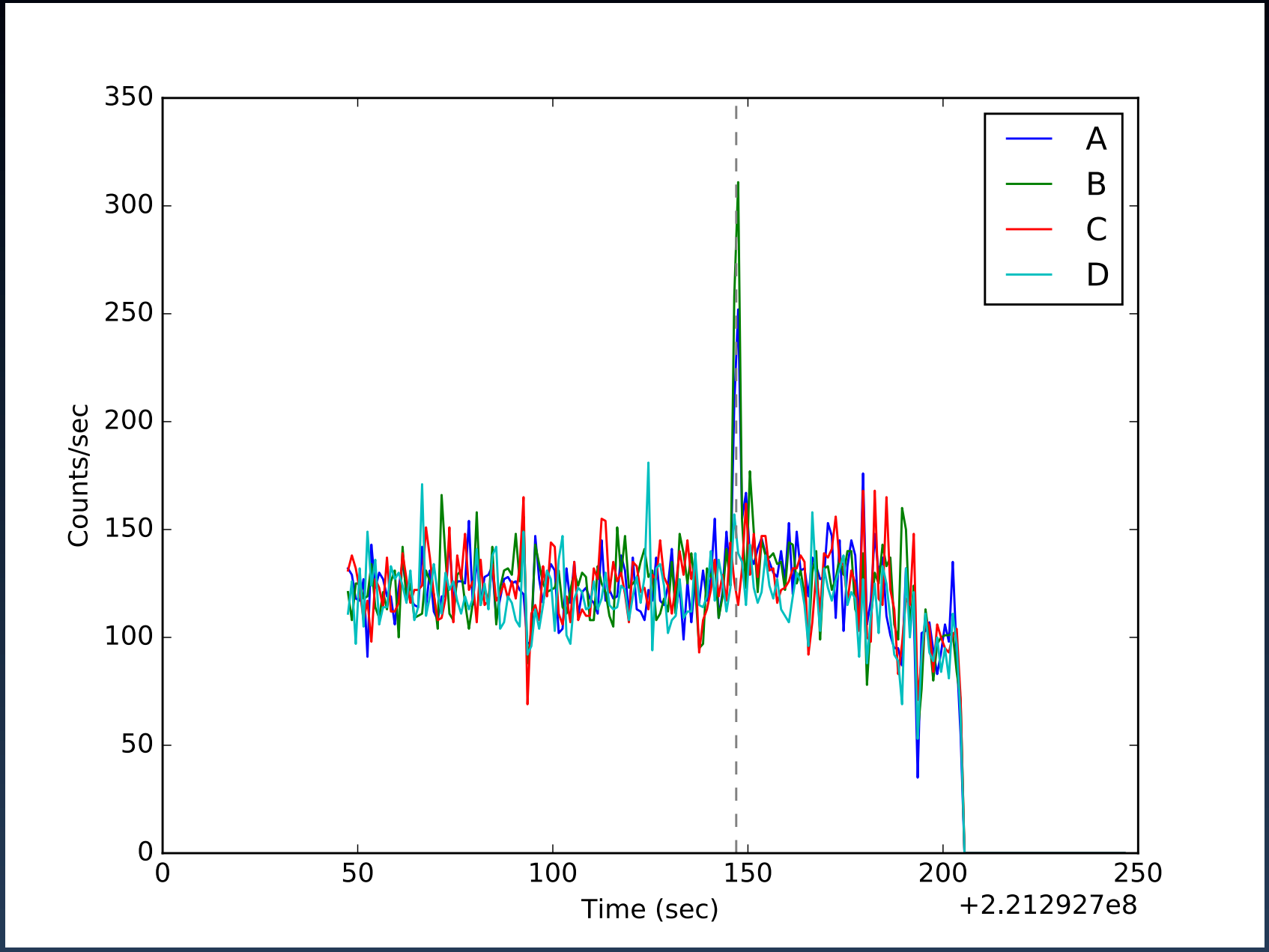
Coverage for GW151226



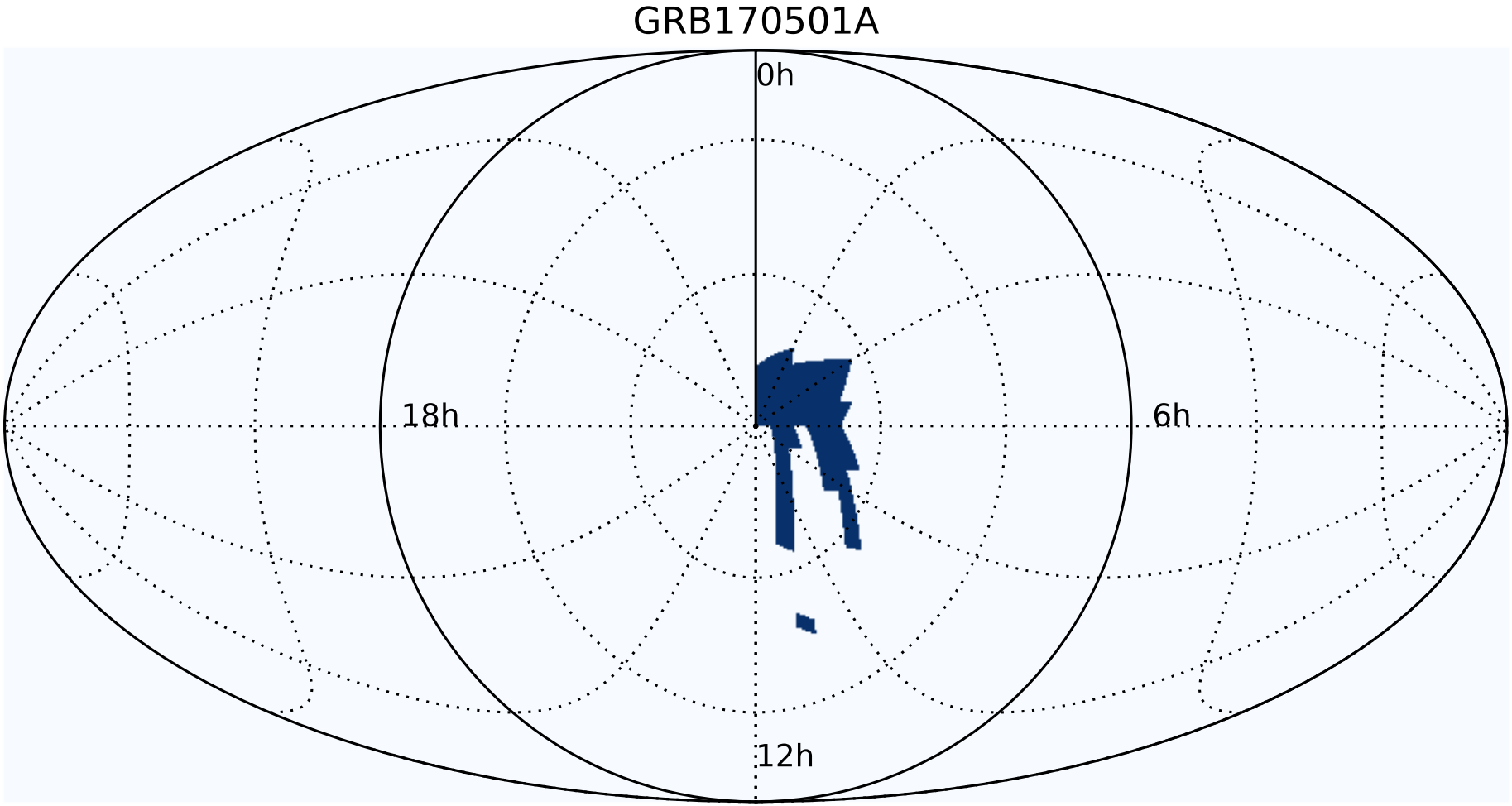
Skymap plotted using data provided by LSC.

GRB localisation

GRB170501A

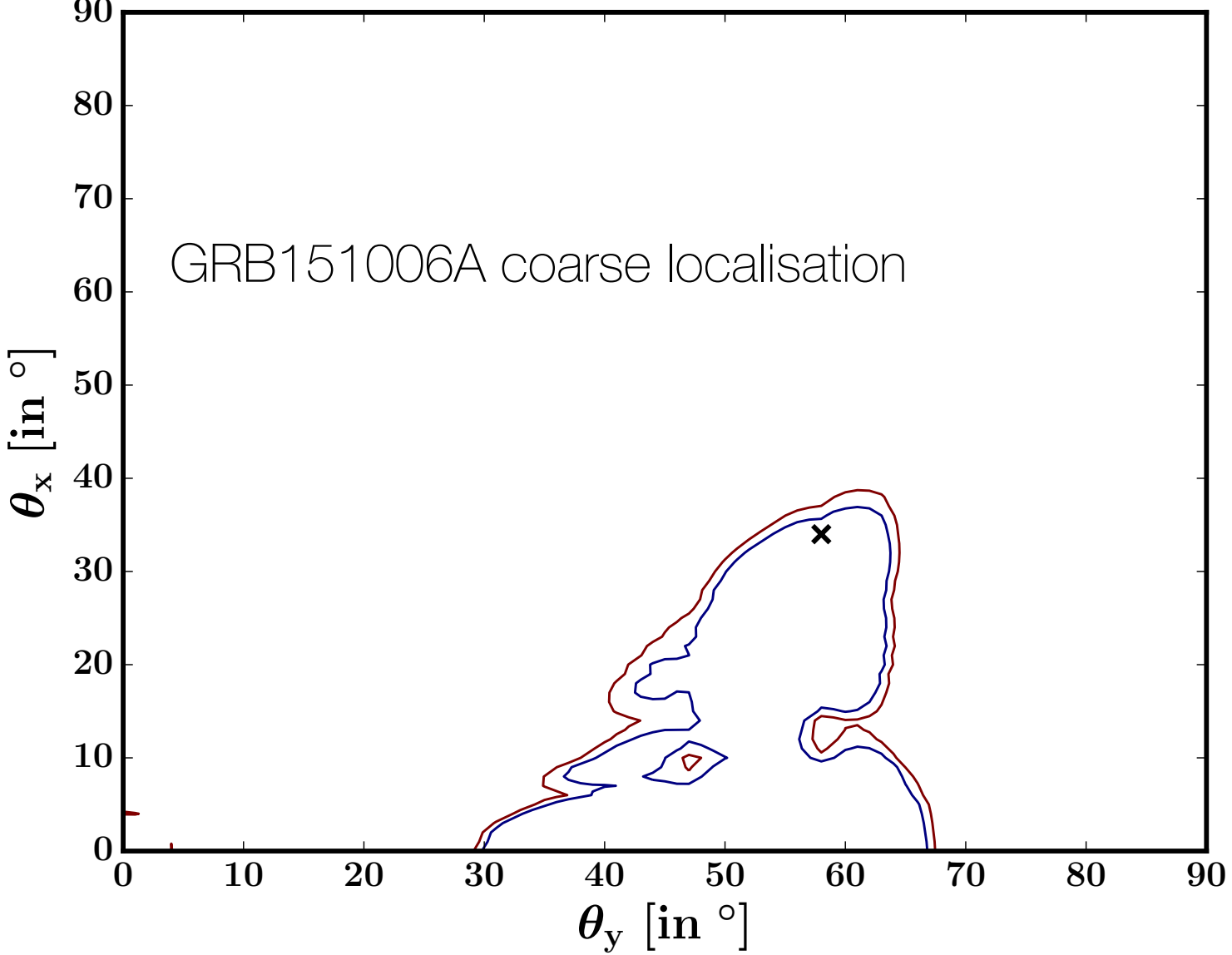

A
B
C
D
Counts/sec
Time (sec)
+2.212927e8
0
50
100
150
200
250
300
350

Use satellite as mask



Finer details: GRB spectrum

Rao et al, 2016, ApJ, 833, 86



Even more details?

- Scattering from satellite elements
- GEANT4 simulations
- Catch Sujay Mate / Mithun NPS / Aarthy

GRB polarisation

Polarimetry principle

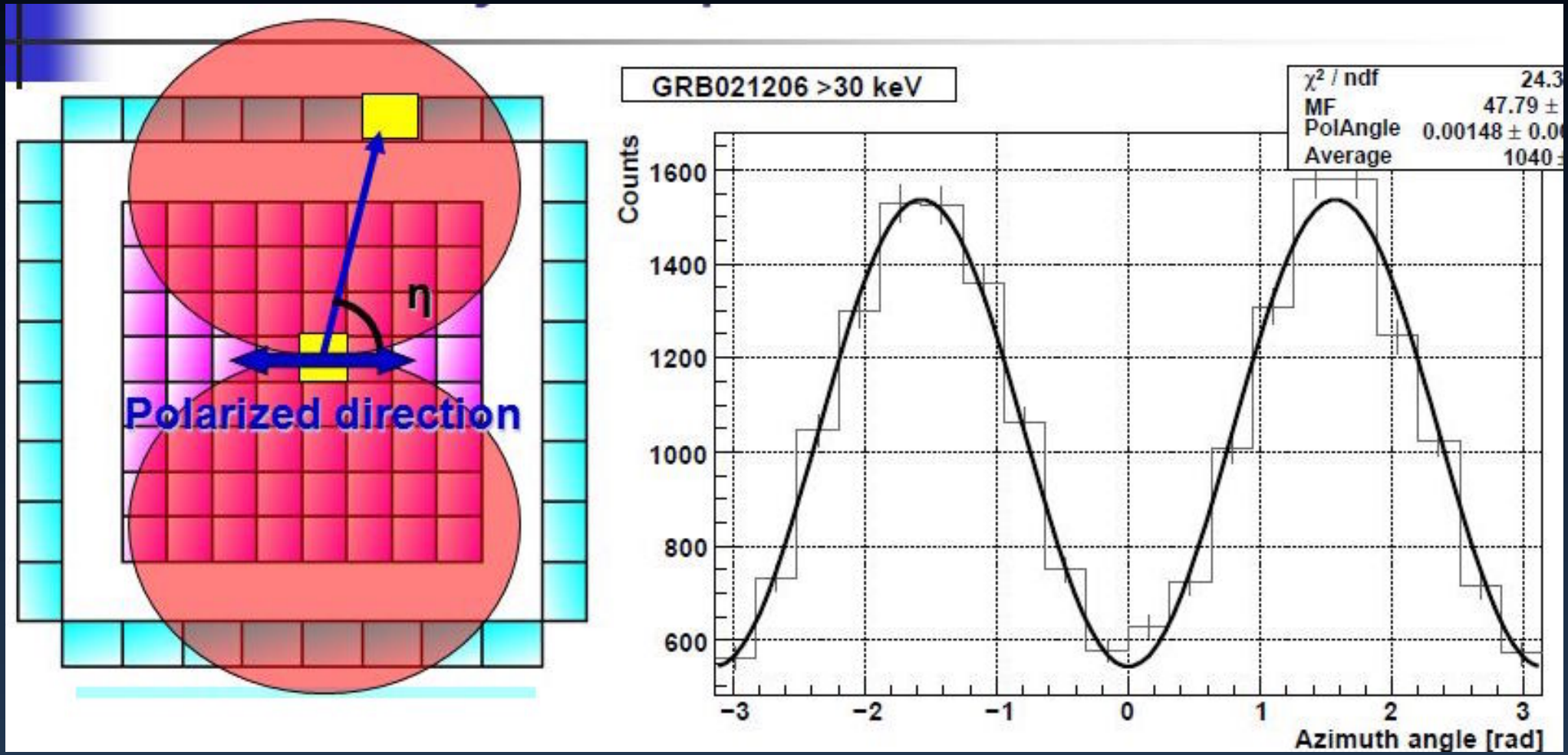
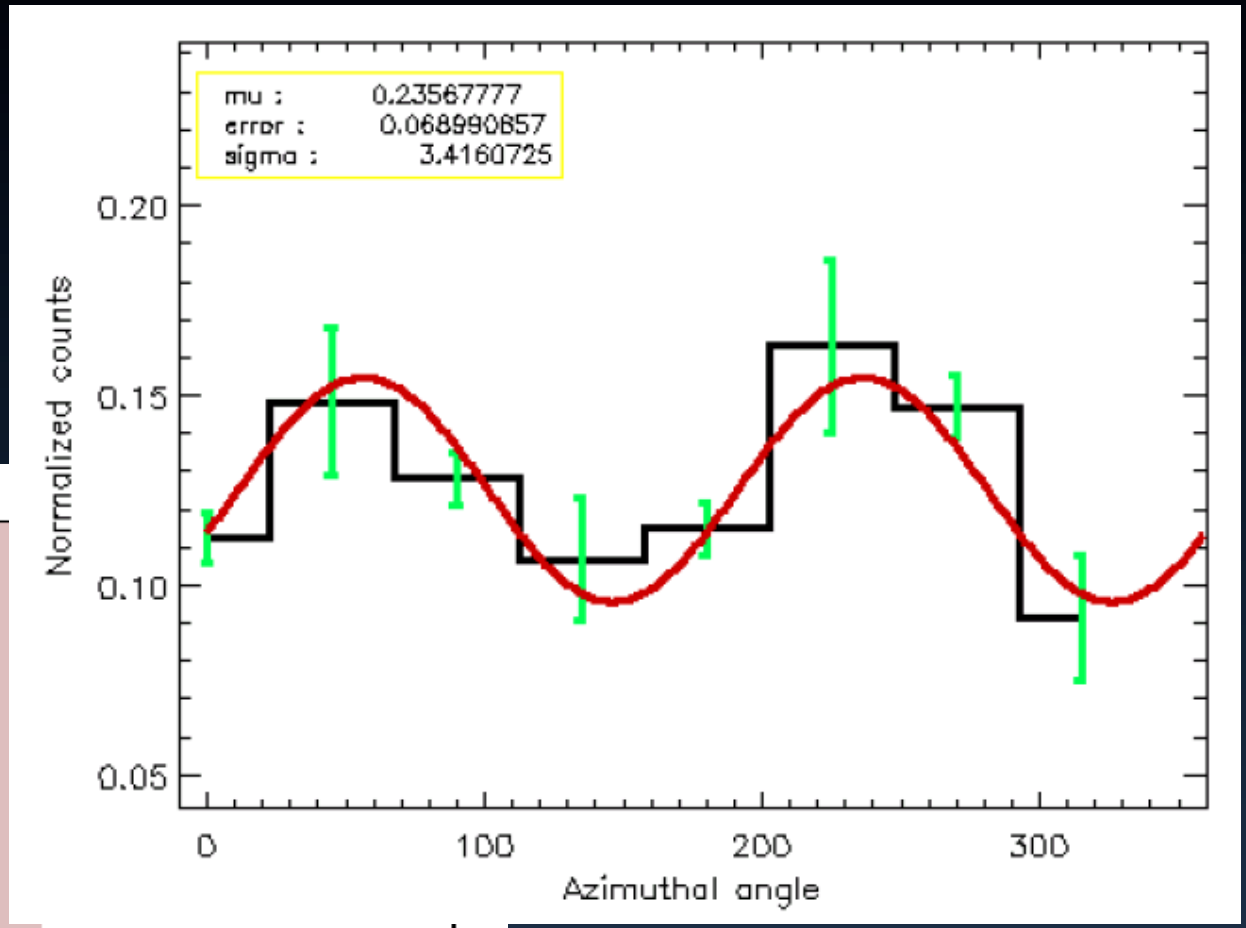
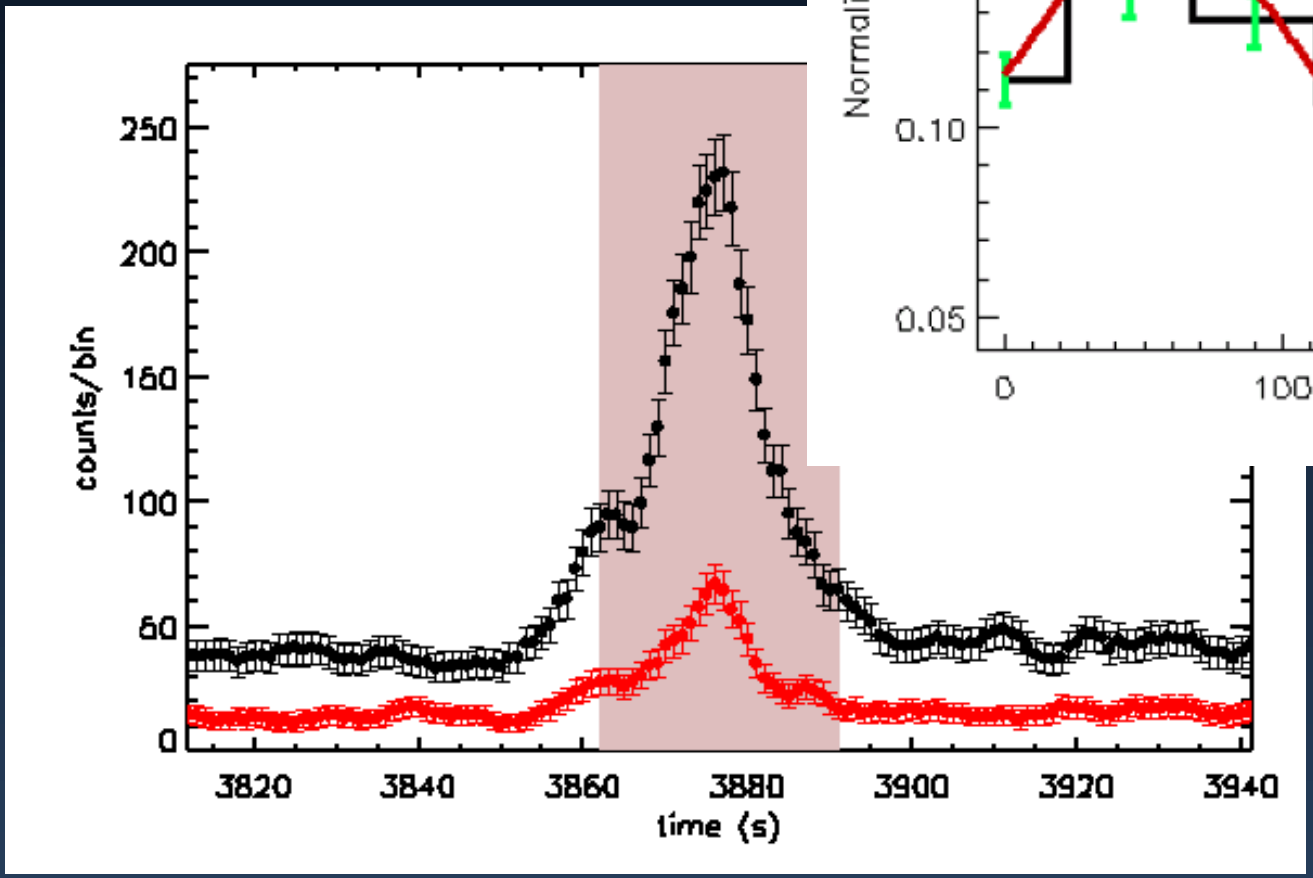


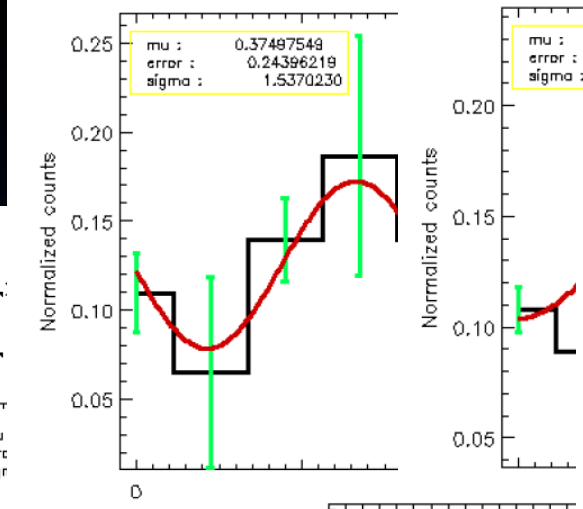
Image: Tsubame mission team

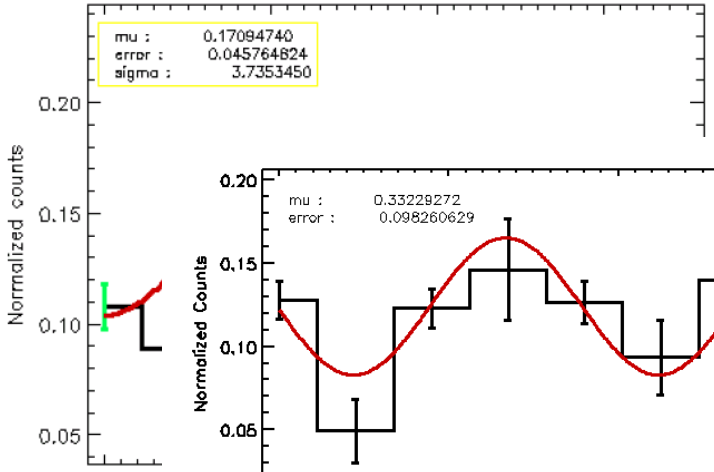
GRB polarisation



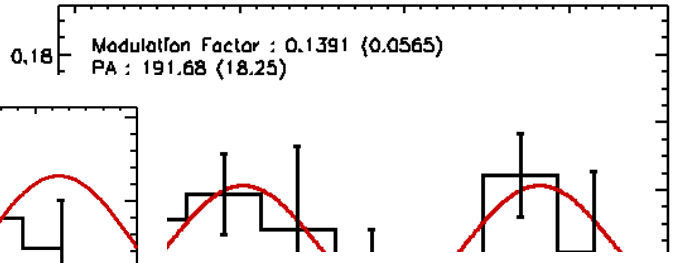


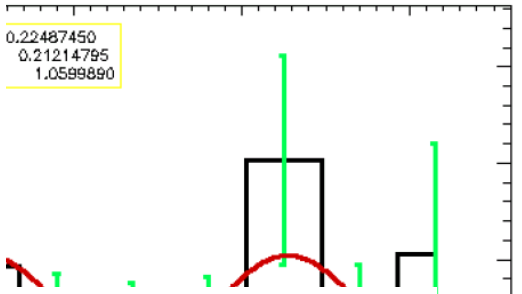
GRB160821A

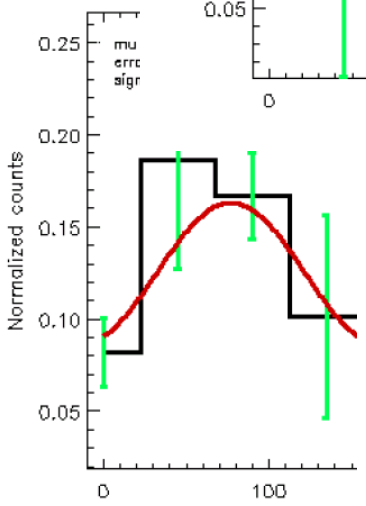

mu : 0.37497549
error : 0.24396219
sigma : 1.5370230
Normalized counts

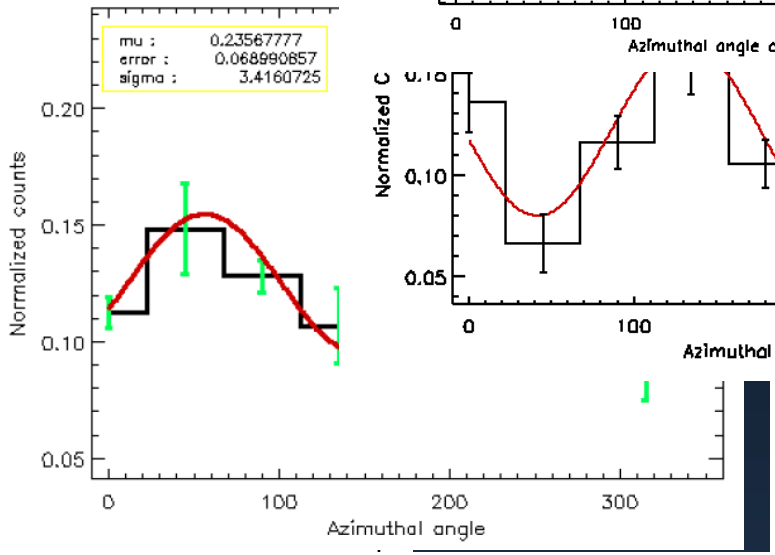

mu : 0.17094740
error : 0.045764824
sigma : 3.7353450
Normalized counts

mu : 0.33229272
error : 0.098260629
Normalized Counts
Azimuthal angle of Scattering

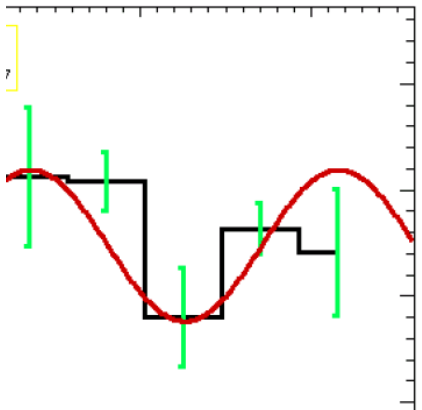

Modulation Factor : 0.1391 (0.0565)
PA : 191.68 (18.25)

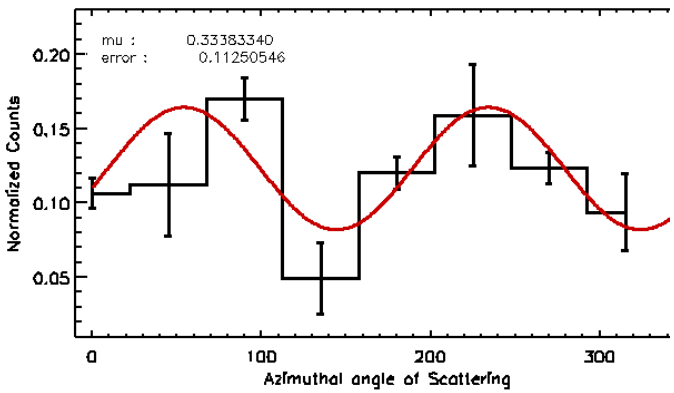

0.22487450
0.21214795
1.0599890

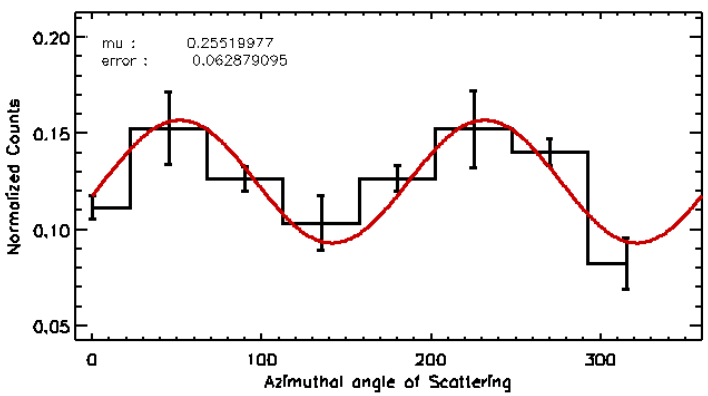

Normalized counts

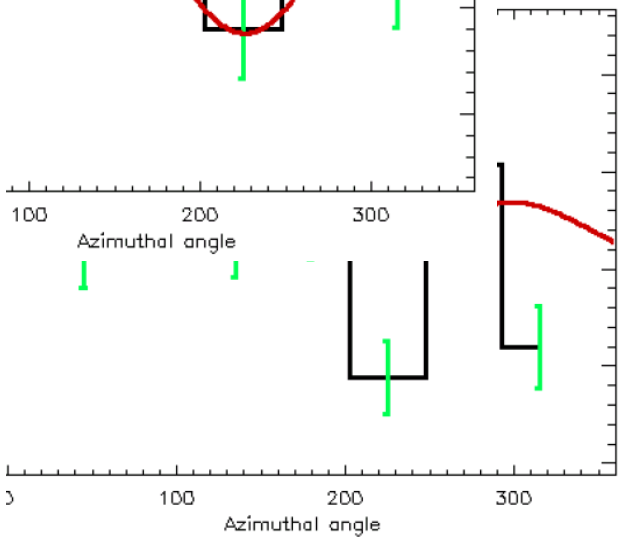

mu : 0.23567777
error : 0.068990857
sigma : 3.4160725
Normalized counts
Azimuthal angle

Azimuthal Angle




mu : 0.33383340
error : 0.11250546
Normalized Counts
Azimuthal angle of Scattering

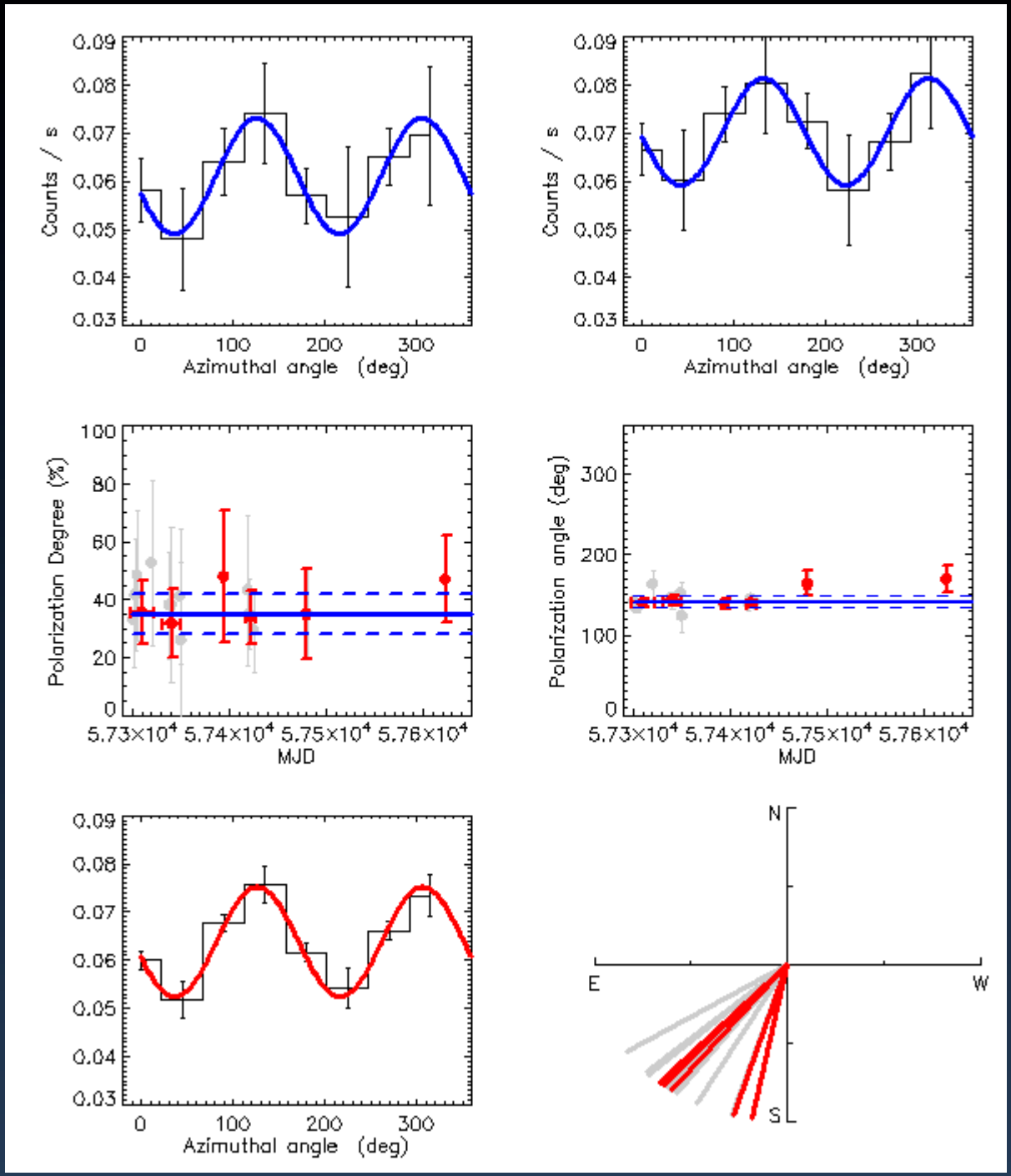

mu : 0.25519977
error : 0.062879095
Normalized Counts
Azimuthal angle of Scattering


Azimuthal angle

Rogues Gallery

GRB	Fluence (10^{-5}erg/cm^2)	Energy (keV)	PoI %
151006	1.15	100-300	90
160106	4.526	100-275	54
160131	32.6	100-290	70
160325	1.91	100-350	38
160607	4.12	100-400	-
160509	29.0	102-380	95
160623	66	100-300	19
160703	2.7	100-225	-
160802	10.4	130-225	72
160821	1.0	100-250	57
160910	8.41	100-330	81

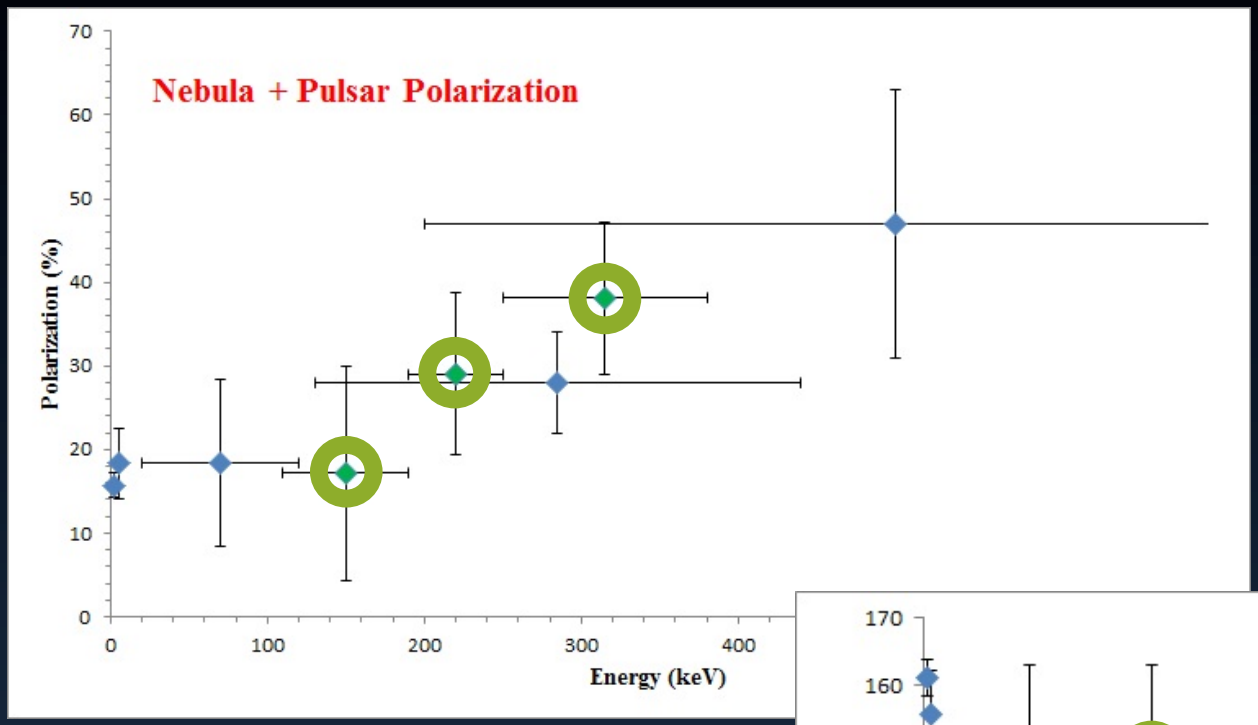
Crab polarization



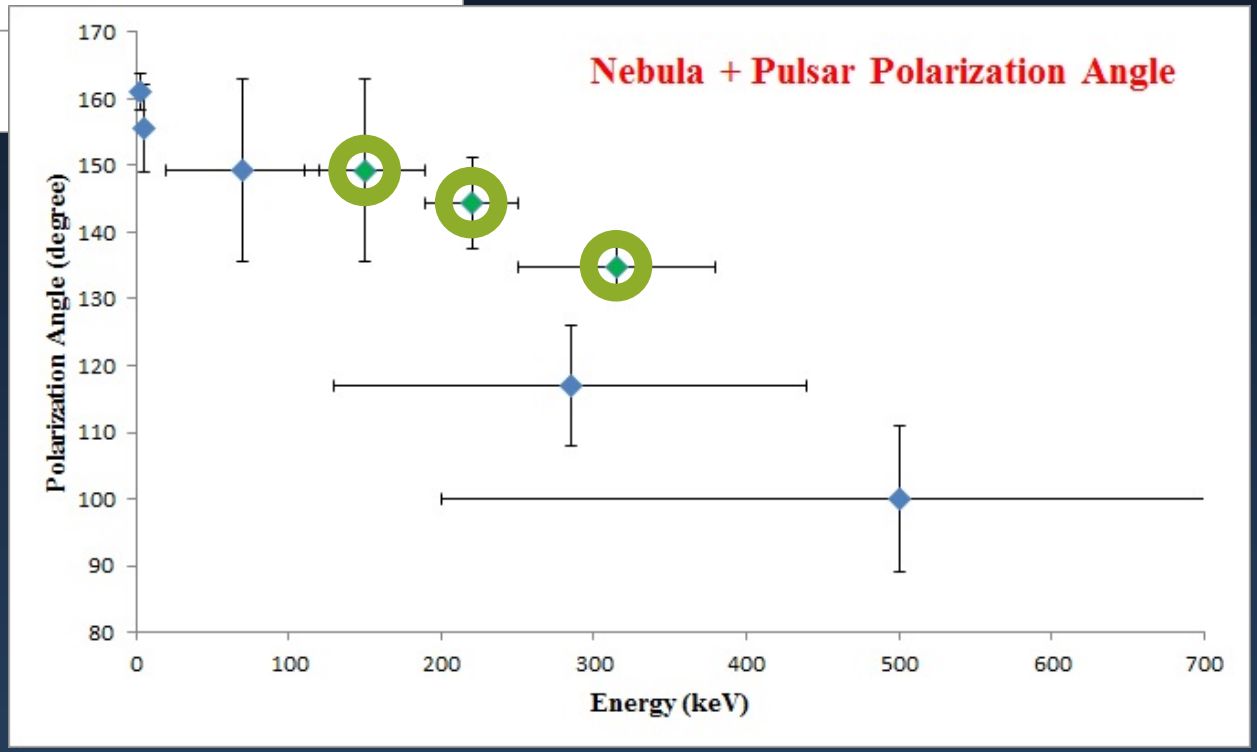
Measure with Compton scattering (double events)

Clear detection in 40-50 ks

Crab pulsar polarization



Green: CZTI
Blue: Literature



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Localisation

Polarimetry

Launch: 28 September 2015