SSM onboard ASTROSAT

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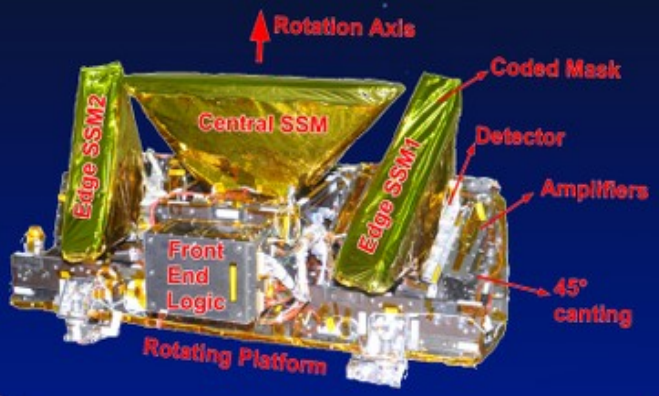
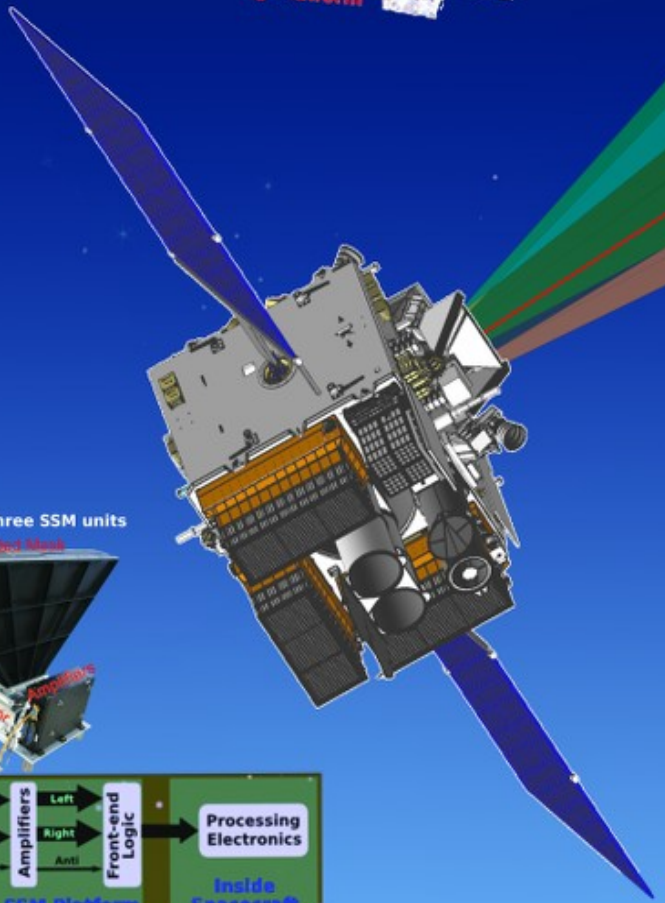
Bangalore, India

IACHEC, 27th March 2017

SCANNING SKY MONITOR (SSM) ABOARD ASTROSAT

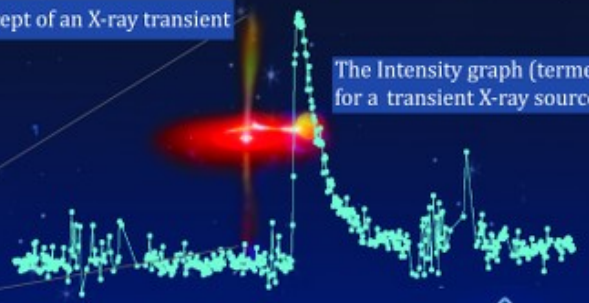
To detect and locate X-ray transients



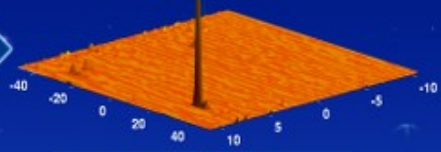


Artist's concept of an X-ray transient

The Intensity graph (termed light curve) for a transient X-ray source

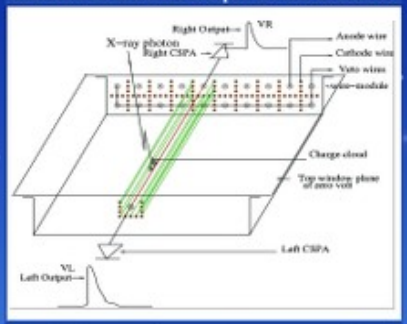


The shadow of the mask is processed to generate the X-ray sky image



A simulated Sky Plane image

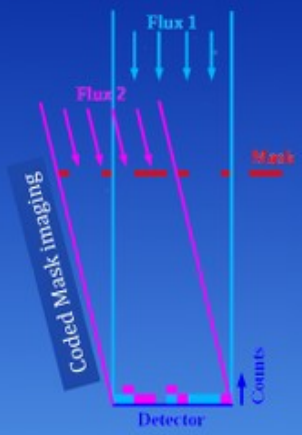
Position Sensitive Proportional Counter

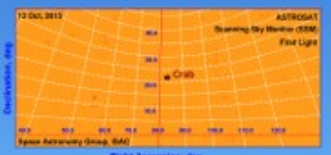


Each X-ray photon is converted into charge by the detector which is further processed by the electronics

X-ray photons from a celestial source cast the shadow of the coded mask on the detector plane

One of the three SSM units





SSM Firstlight image of Crab Nebula

SSM Specification Table

Parameters	Specification
Energy Range	2.5 keV - 18 keV
Detector	One-dimensional position-sensitive gas-filled proportional counter
Gas mixture	25% Xe + 75% P-10 (P-10 is 90% Argon + 10% Methane)
Gas pressure	800 torr
Diameter of anode	25 micron
Active length of anode	60 mm
Type of anode wires	Carbon-coated Quartz
Cell Size	12 mm square
Entrance Window	50 micron thick Aluminised Mylar (Al thickness ~ 1000 Å)
Detector operating voltage	~1500 Volt
Unit Bit size of coded mask	0.95 mm
Energy resolution	~25% at 6 keV
Position Resolution	~1.5 mm (FWHM)
Angular resolution	10' – 18' in the scaning direction, 2.5° across
Time resolution	0.1 ms
Sensitivity (6Sec, 3 sigma, 2.5-18 keV)	~23 milliCrab for SSM2 & 3 ~28 milliCrab for SSM1
Field of View (FOV) FWZM	Central SSM: 22.5° x 100° Edge SSMs: 26.8° x 100°
Payload Weight	65.5 kg
Payload Power	~49 W
Effective area (for all three SSM cameras)	~72 cm² @ 2.5 keV ~70 cm² @ 8 keV
Memory Required (for all three SSM cameras)	200 Mbyte per orbit
Event Rate	Nominal 400 c s⁻¹, max 5,800 c s⁻¹; electronics designed for 50,000 c s⁻¹

Credits: Artist's impression of GRS1915+105, CfA; ASM lightcurve of SWIFT J1753.5-0127

ISRO/IUCAA

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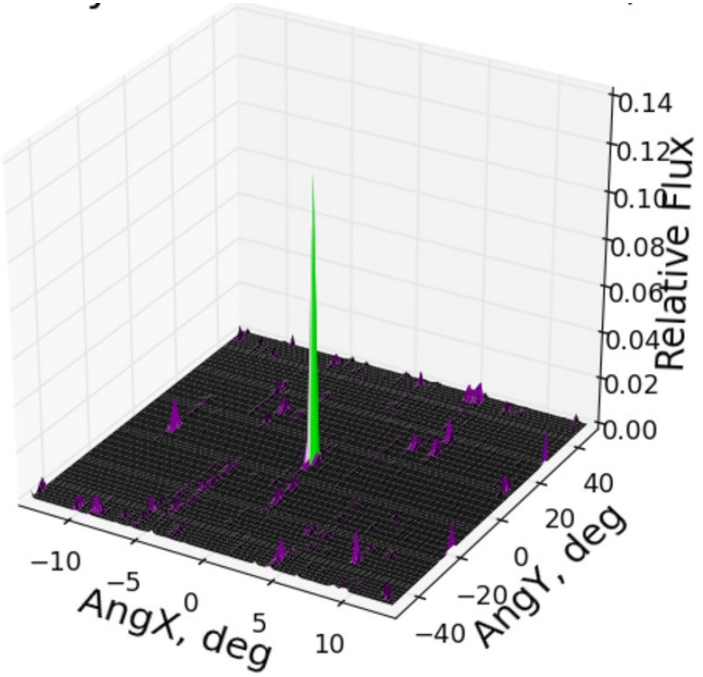
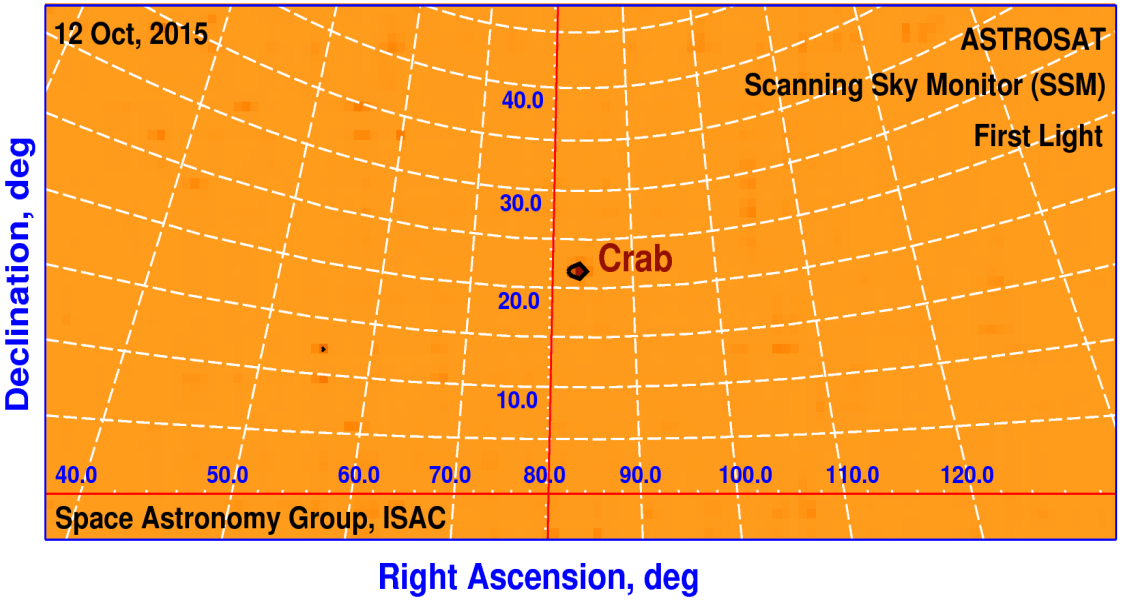
Crab in SSM FOV (First Orbit data after power ON)





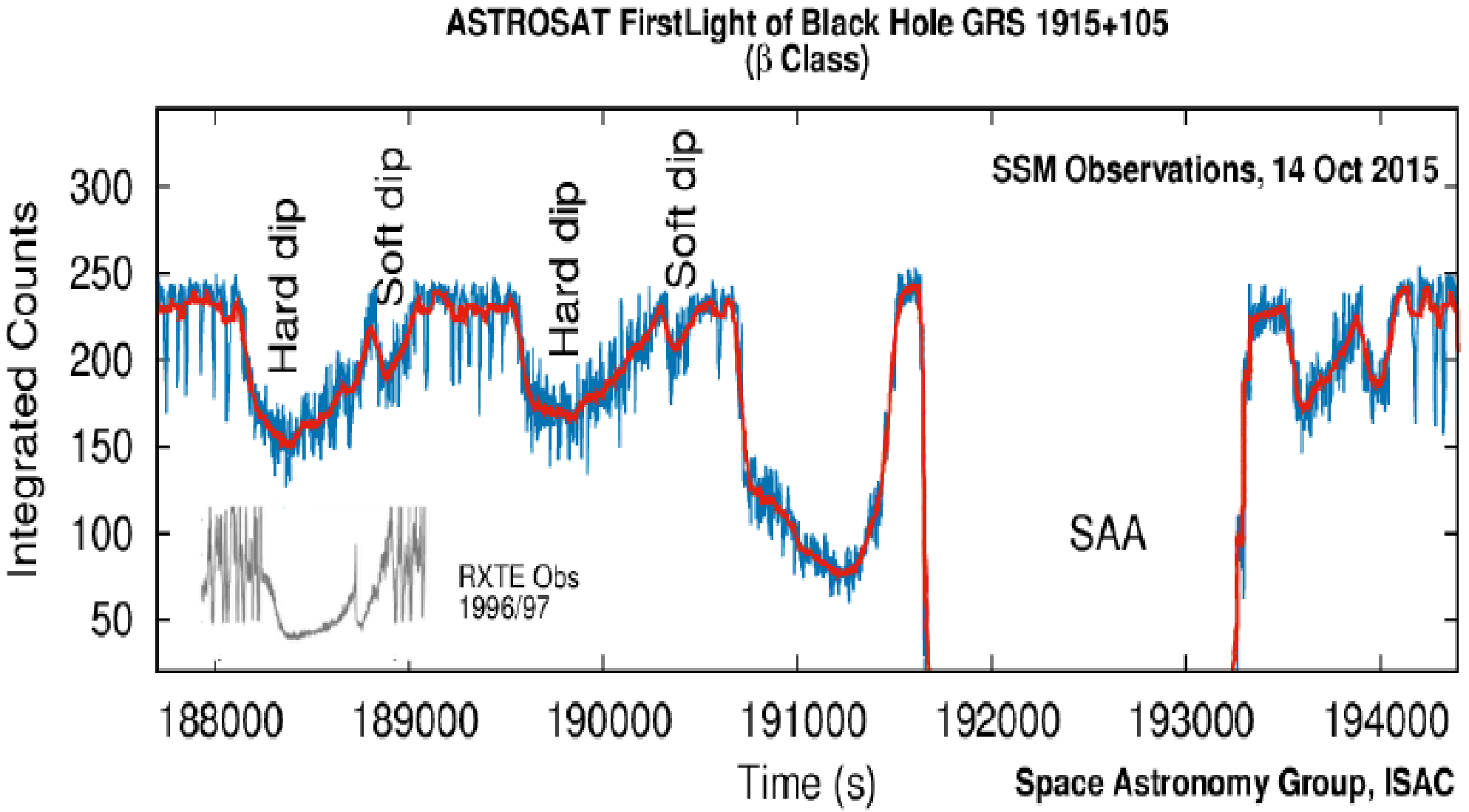
Angular resolution – expected 12 arcmin;

- Observed - Confined within a pixel (12 arcmin X 2.5 deg)

Crab localisation in all three SSM cameras were done similarly.

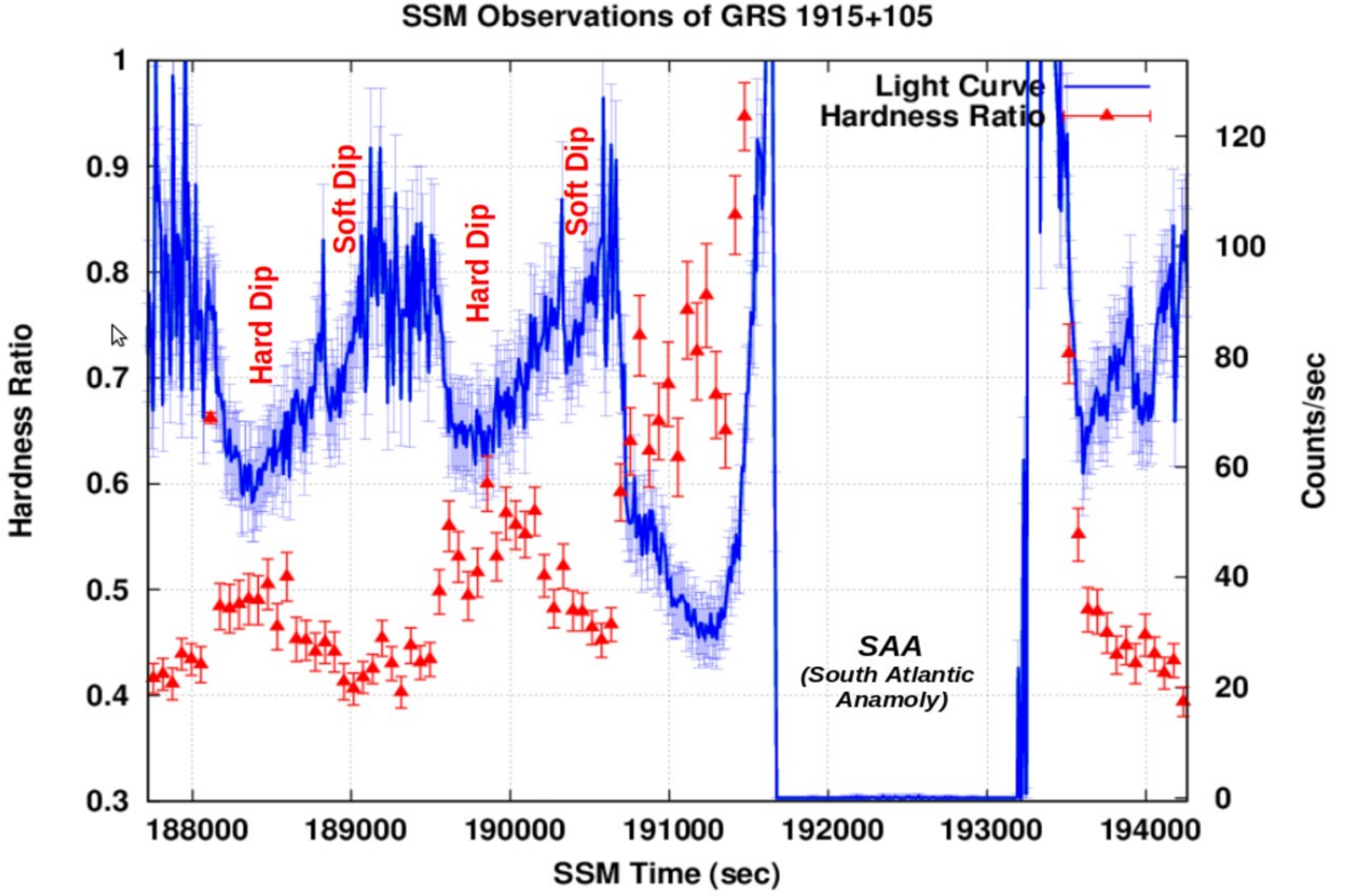
SSM – GRS 1915+105

Black Hole source Observations; Oct 15, 2015

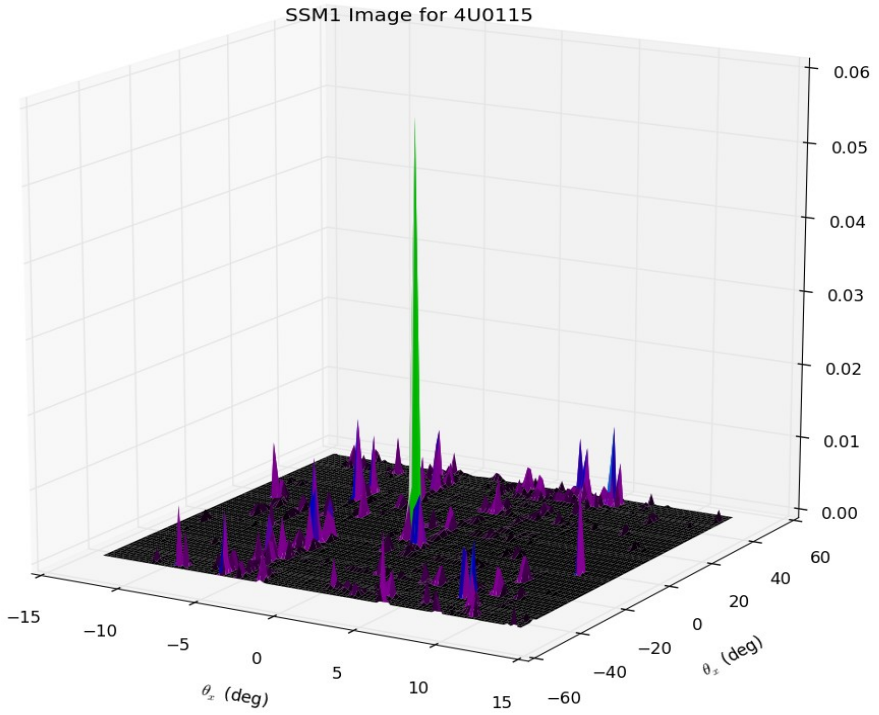


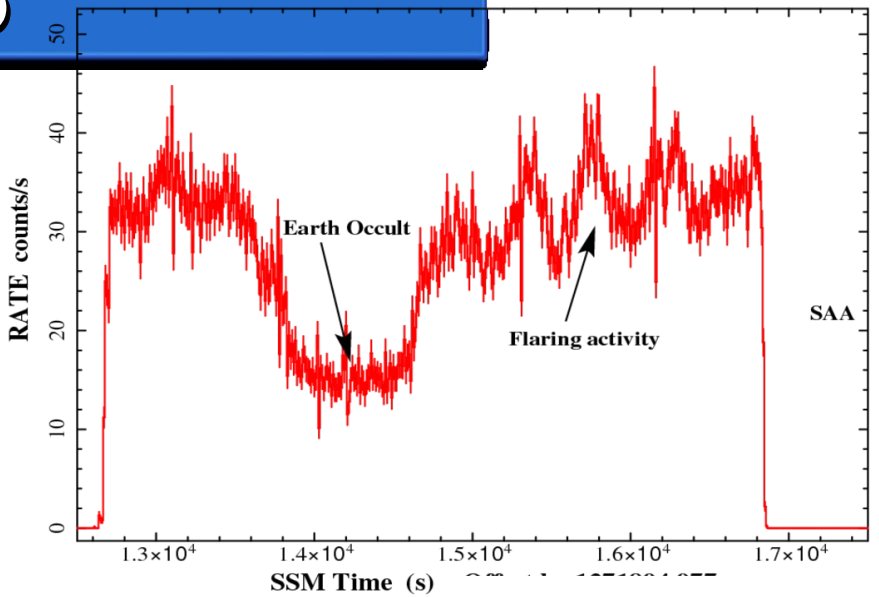
Astronomer's Telegram ATel#8185 generated on the above detection of variability in GRS 1915+105

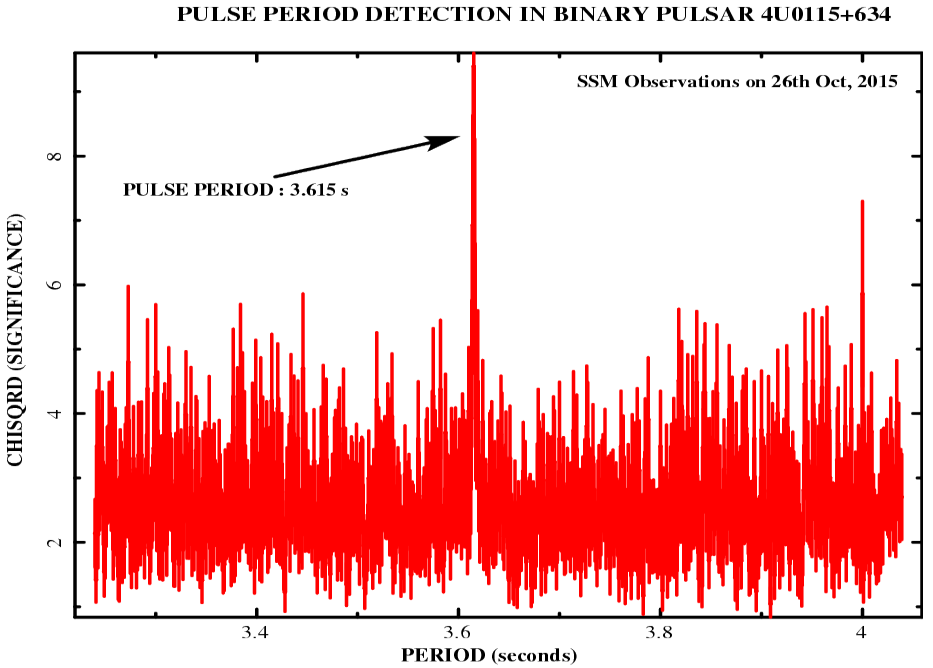
Hardness Intensity of GRS 1915+105 β-Class variability



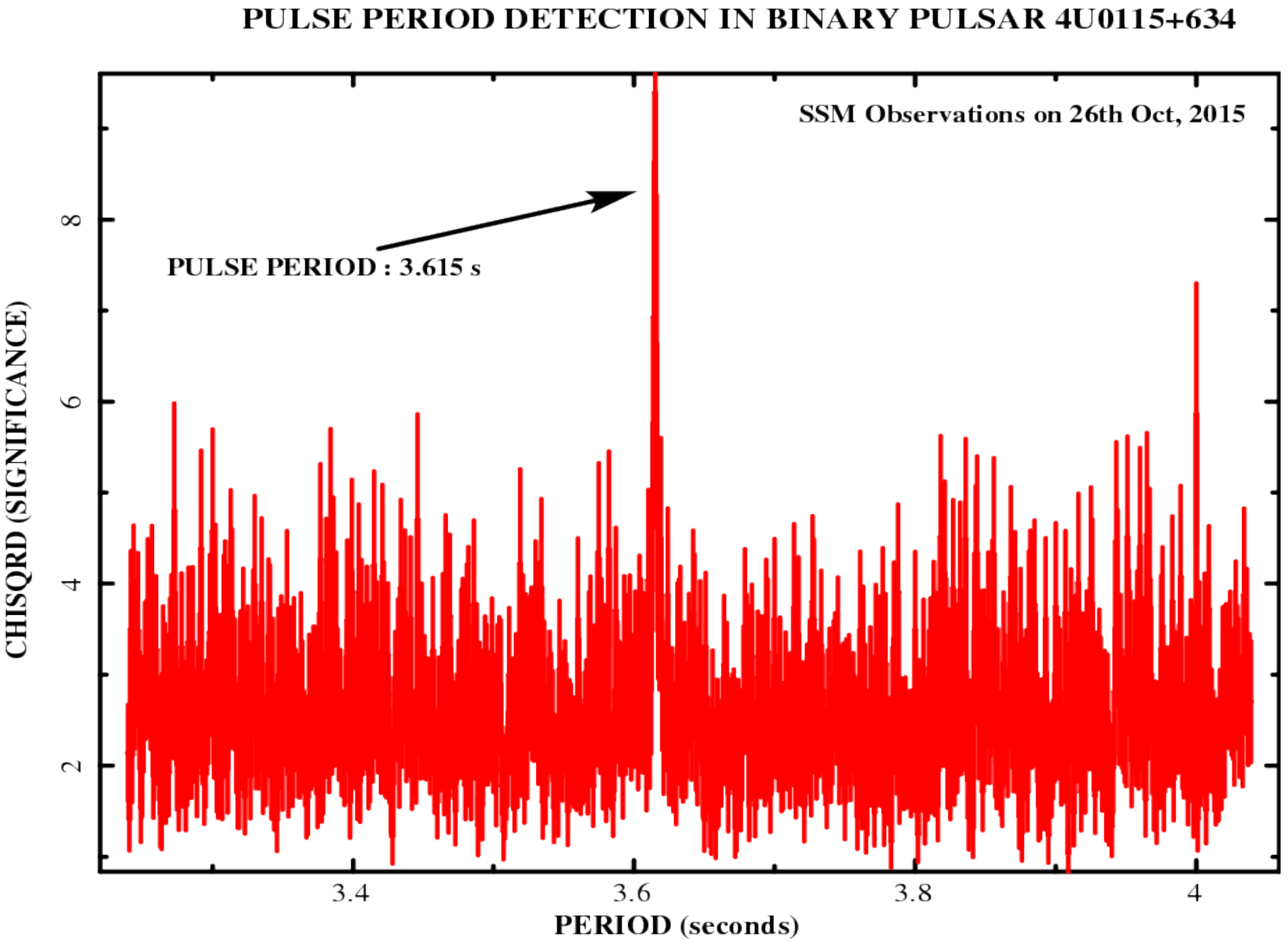
SSM Observations of a Be X-ray pulsar 4U0115+63 in its outburst Oct. 2015



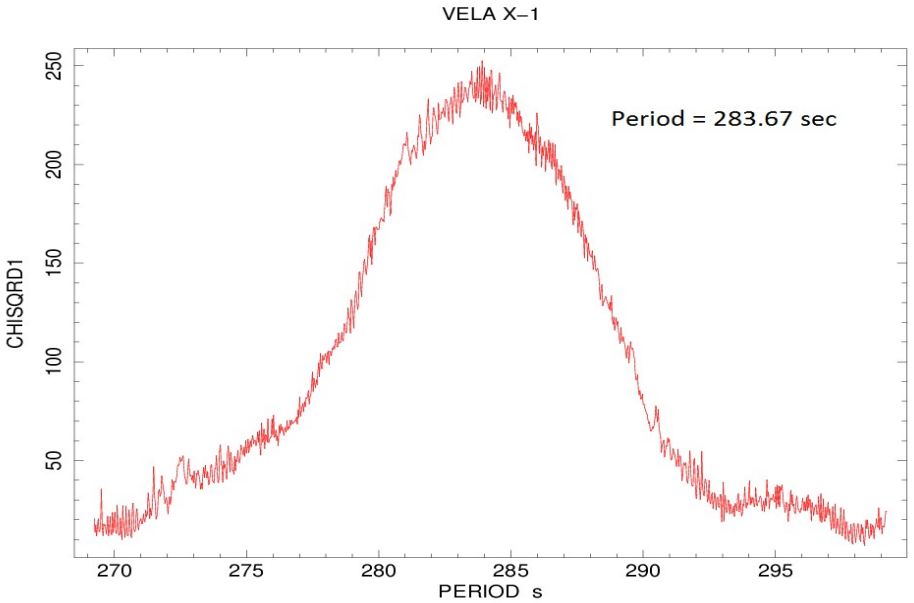




SSM Detection of Pulsations in binary pulsar: 4U0115+63

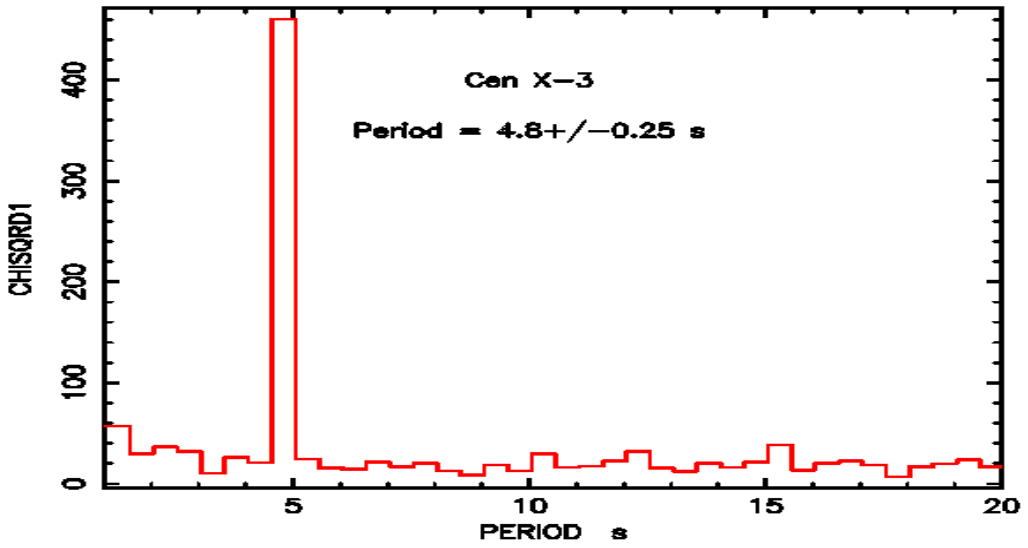


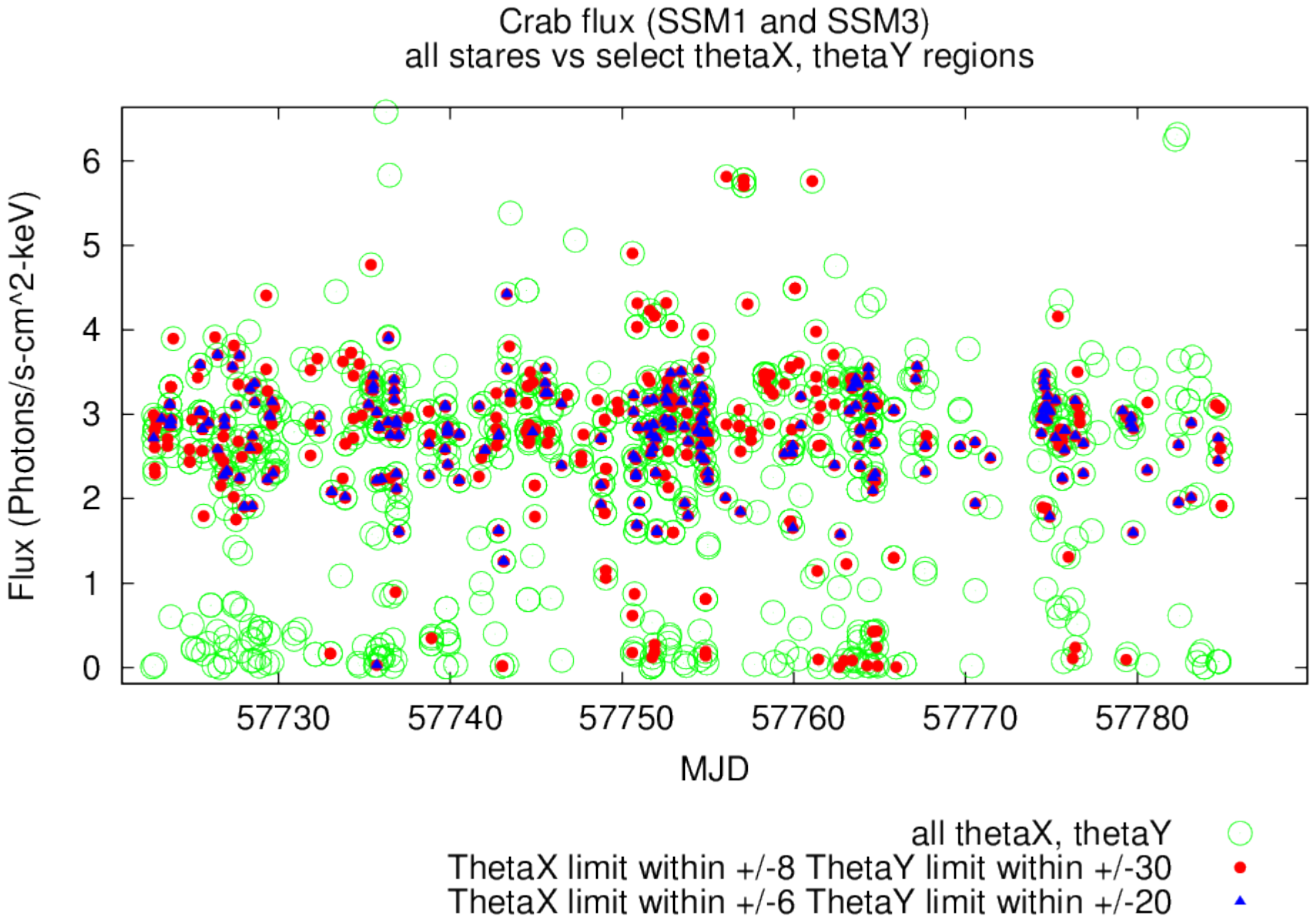
Pulsations from few other binary X-ay pulsars



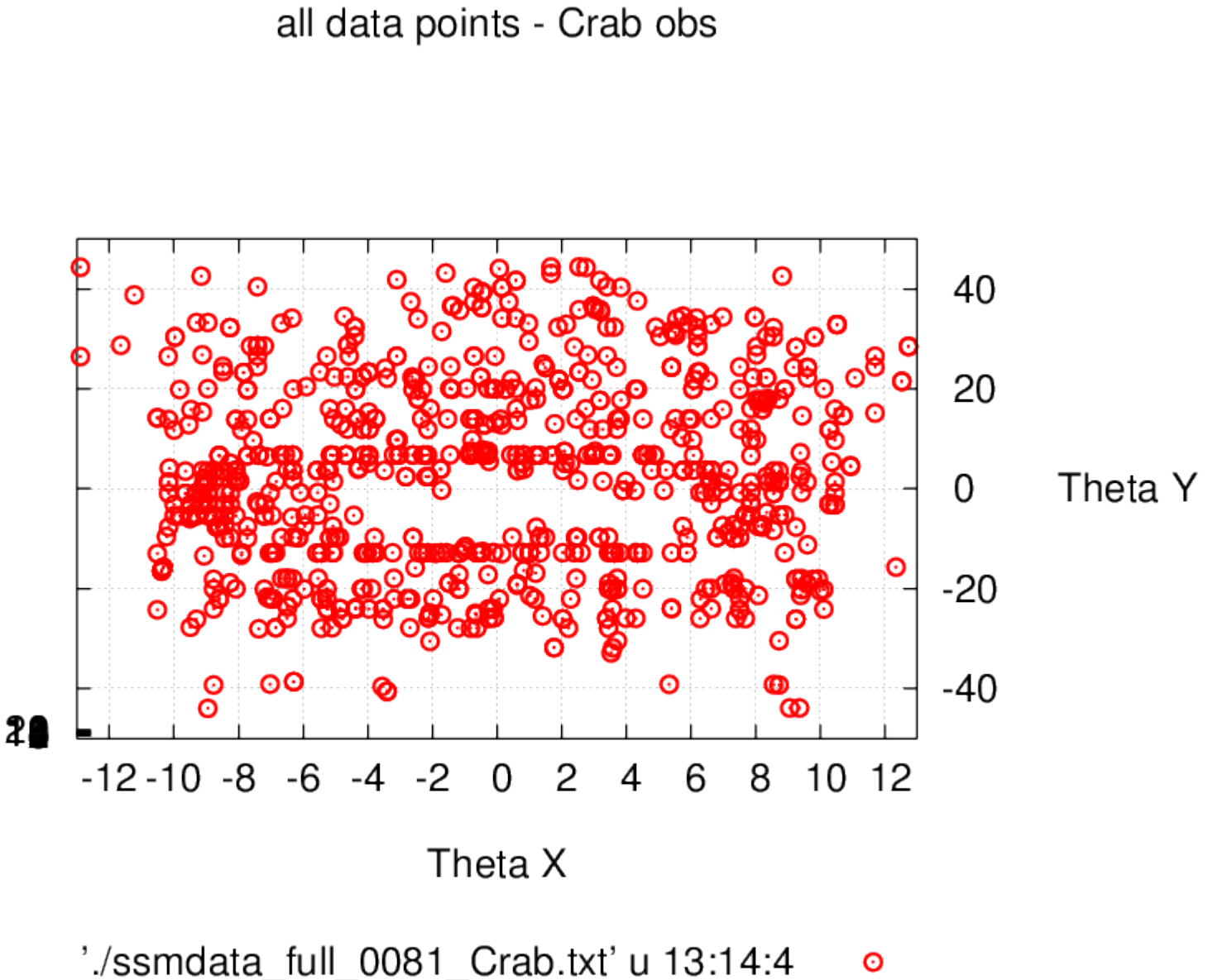
Vela X1
283+/-0.8 s

Cen X3
4.8+/- 0.25 s

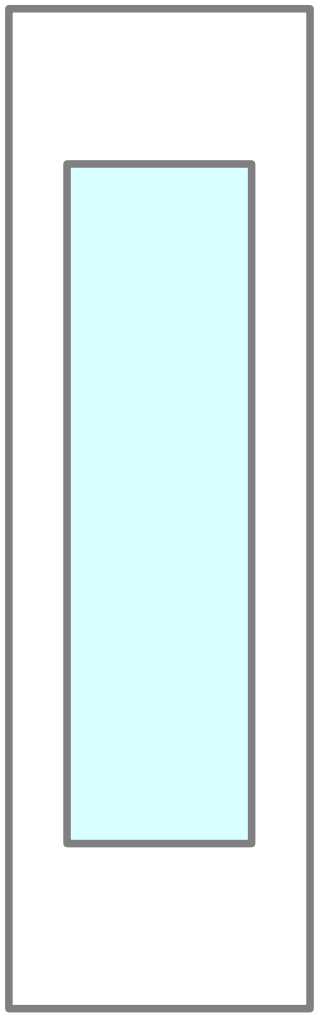


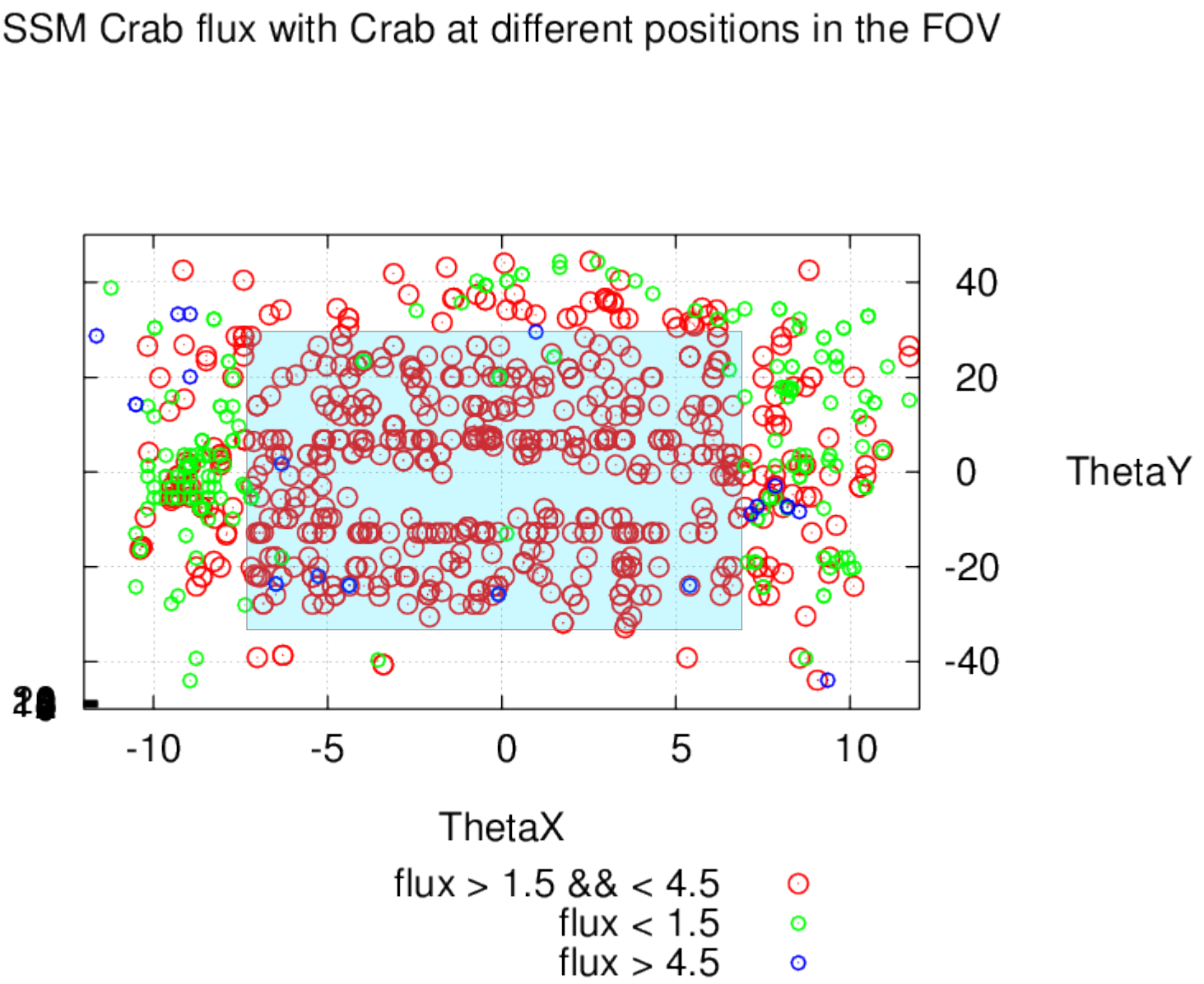


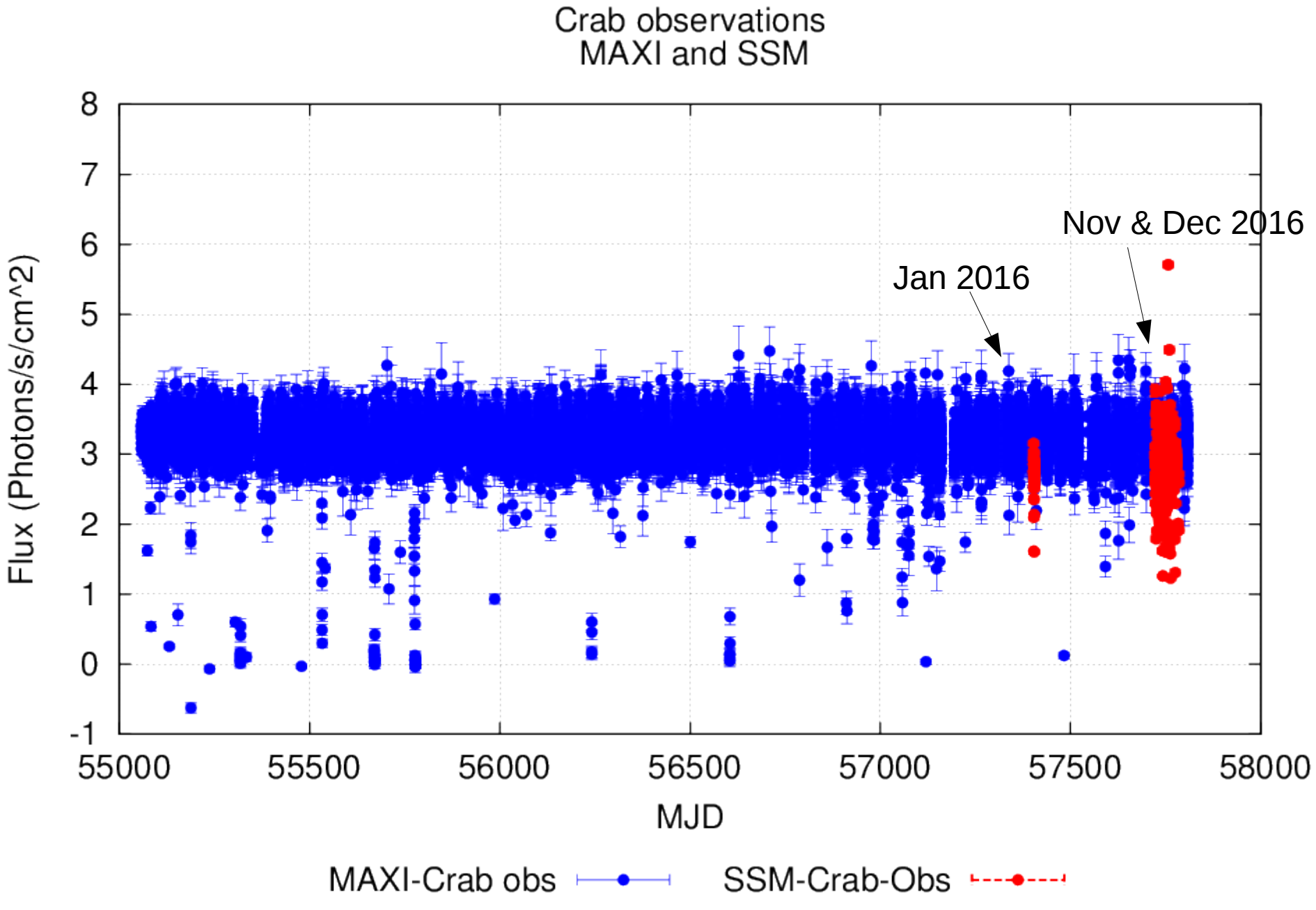
Earth in SSM FOV – smears out Detector Position Histogram – flux variations were large
Filters – Earth in FOV regions -removed and also select region of SSM FOV - applied


all data points - Crab obs
40
20
0
-20
-40
Theta Y
-12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12
Theta X
'./ssmdata_full_0081_Crab.txt' u 13:14:4

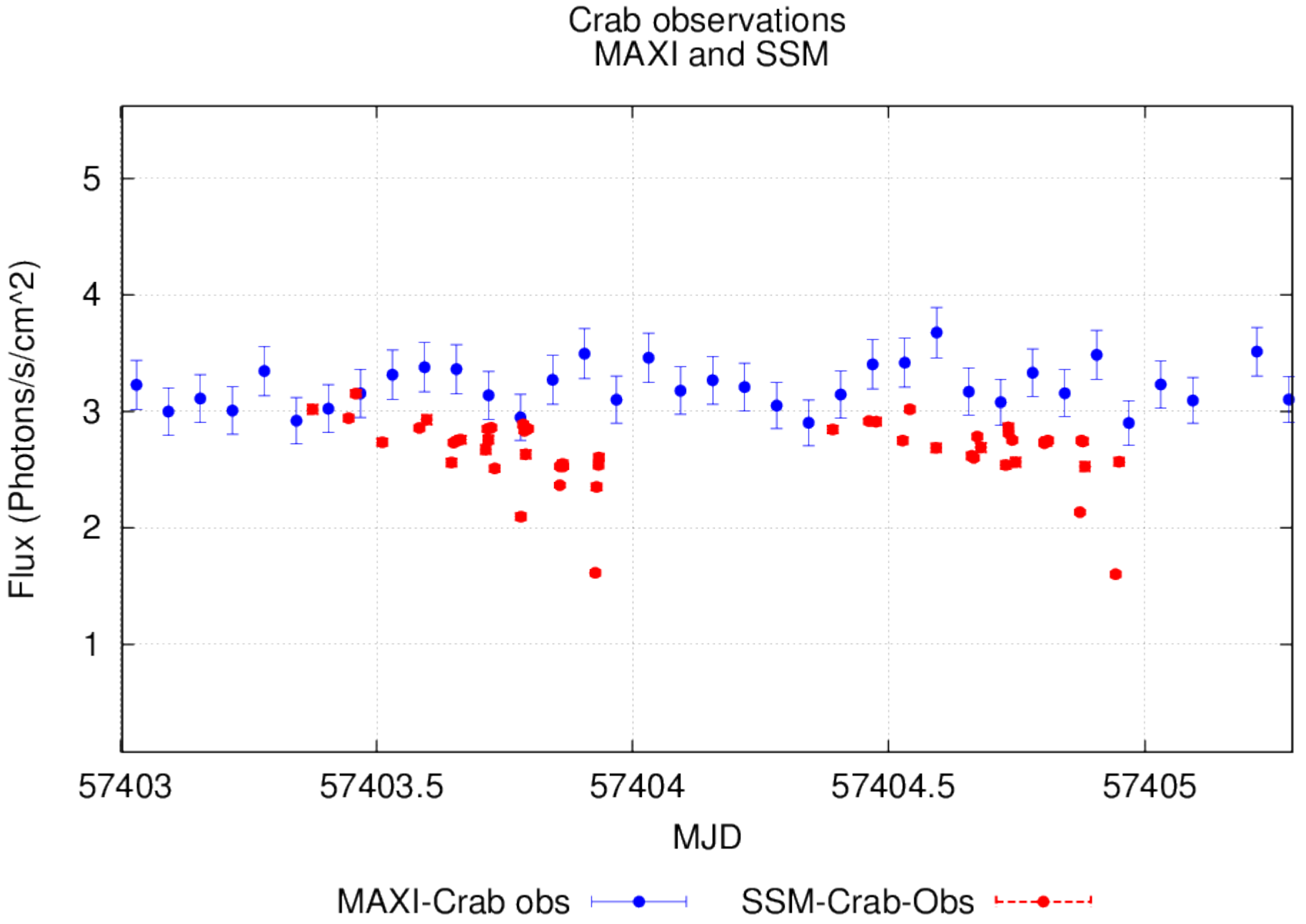
FOV to scale (ThetaX +/- 7 deg and thetaY +/- 30 deg



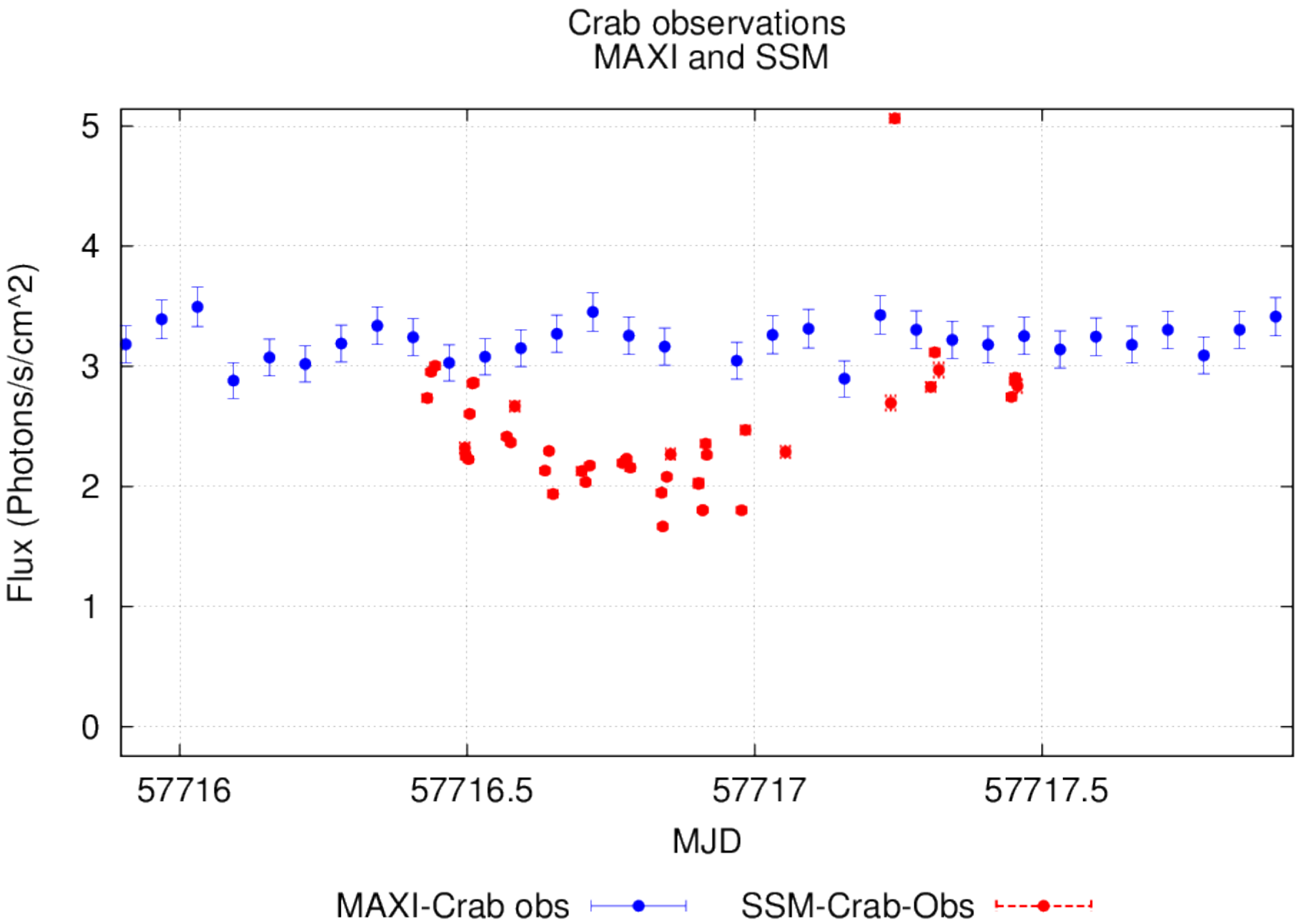



Crab observations
MAXI and SSM
Flux (Photons/s/cm^2)
MJD
Jan 2016
Nov & Dec 2016
MAXI-Crab obs
SSM-Crab-Obs
8
7
6
5
4
3
2
1
0
-1
55000
55500
56000
56500
57000
57500
58000

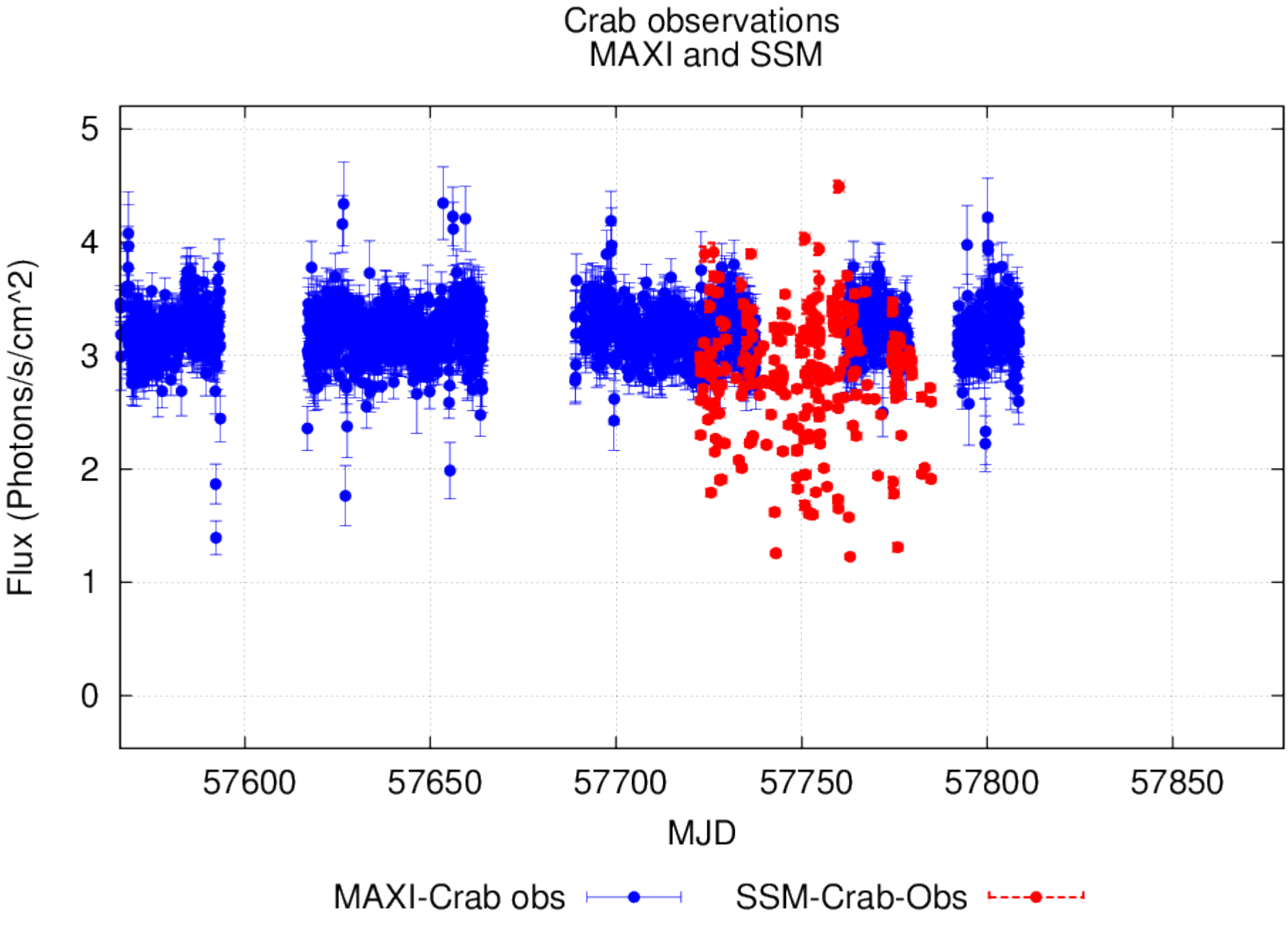
Crab at one particular location in SSM FOV – **Jan 2016 Observations**
Systematic changes seen in the flux attributed to orbital variations – one day periodic;
- yet to be modelled and corrected -



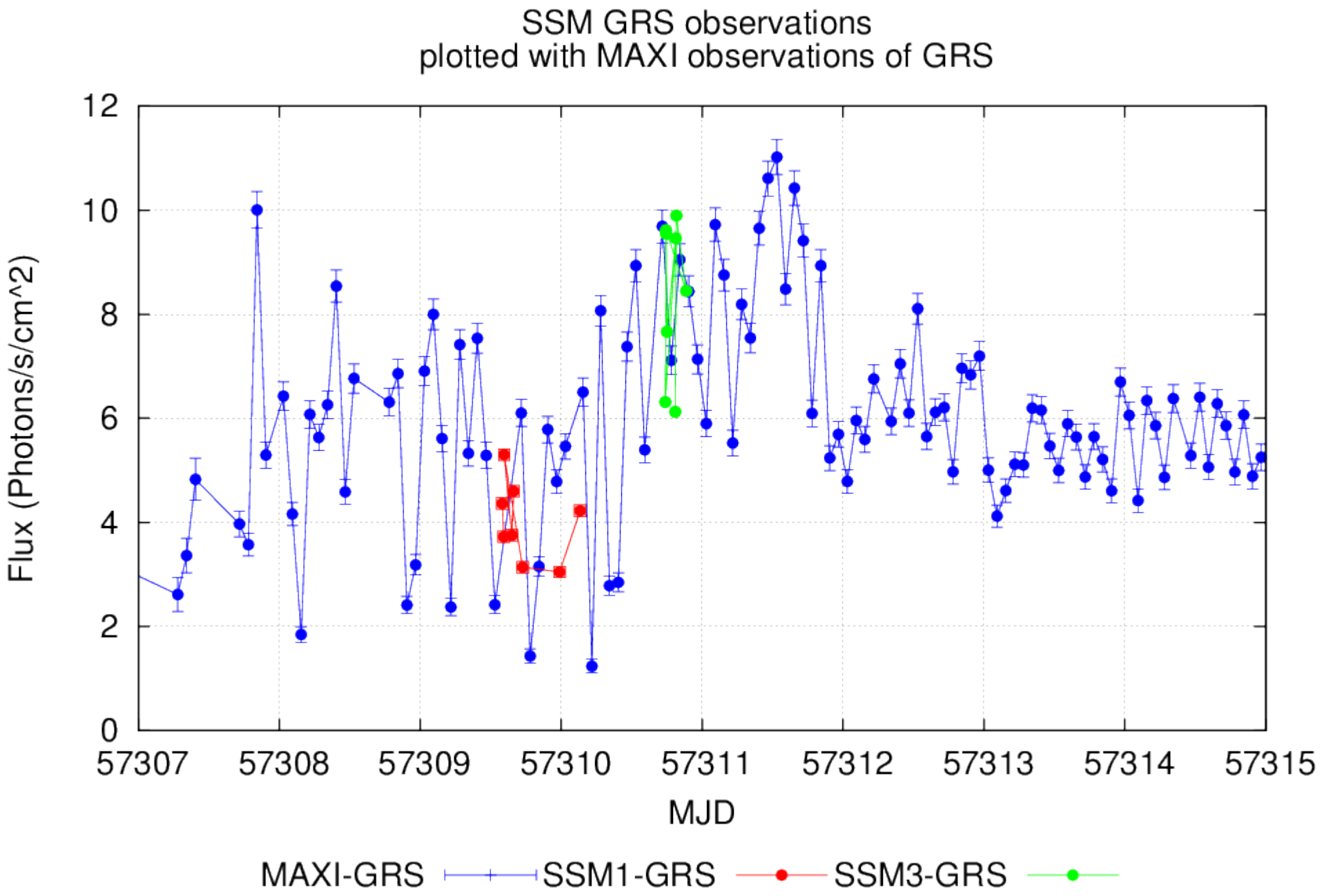
Crab at one particular location in SSM FOV – **Nov 2016 Observations**
Systematic changes seen in the flux attributed to orbital variations – one day periodic;
- yet to be modelled and corrected -

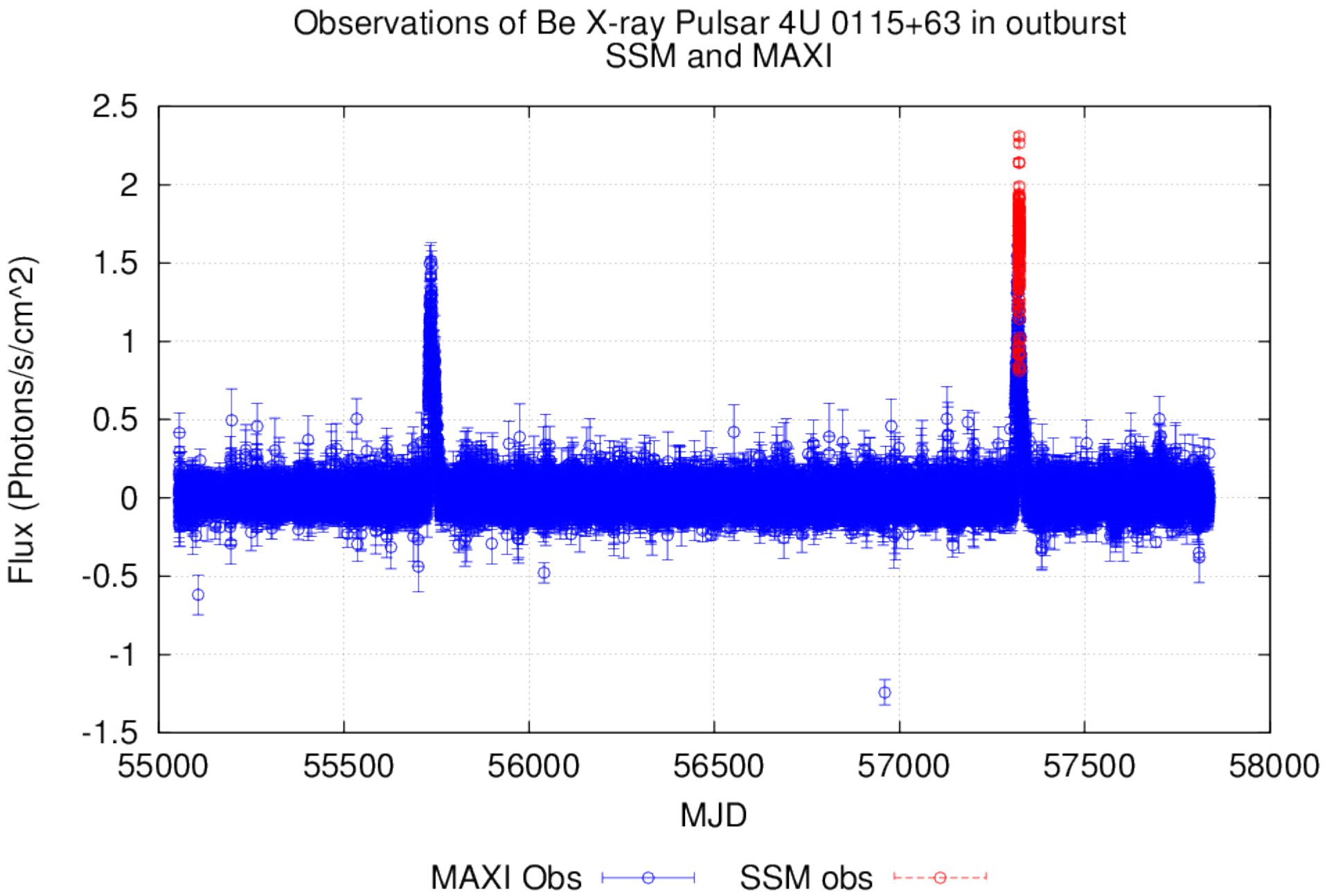


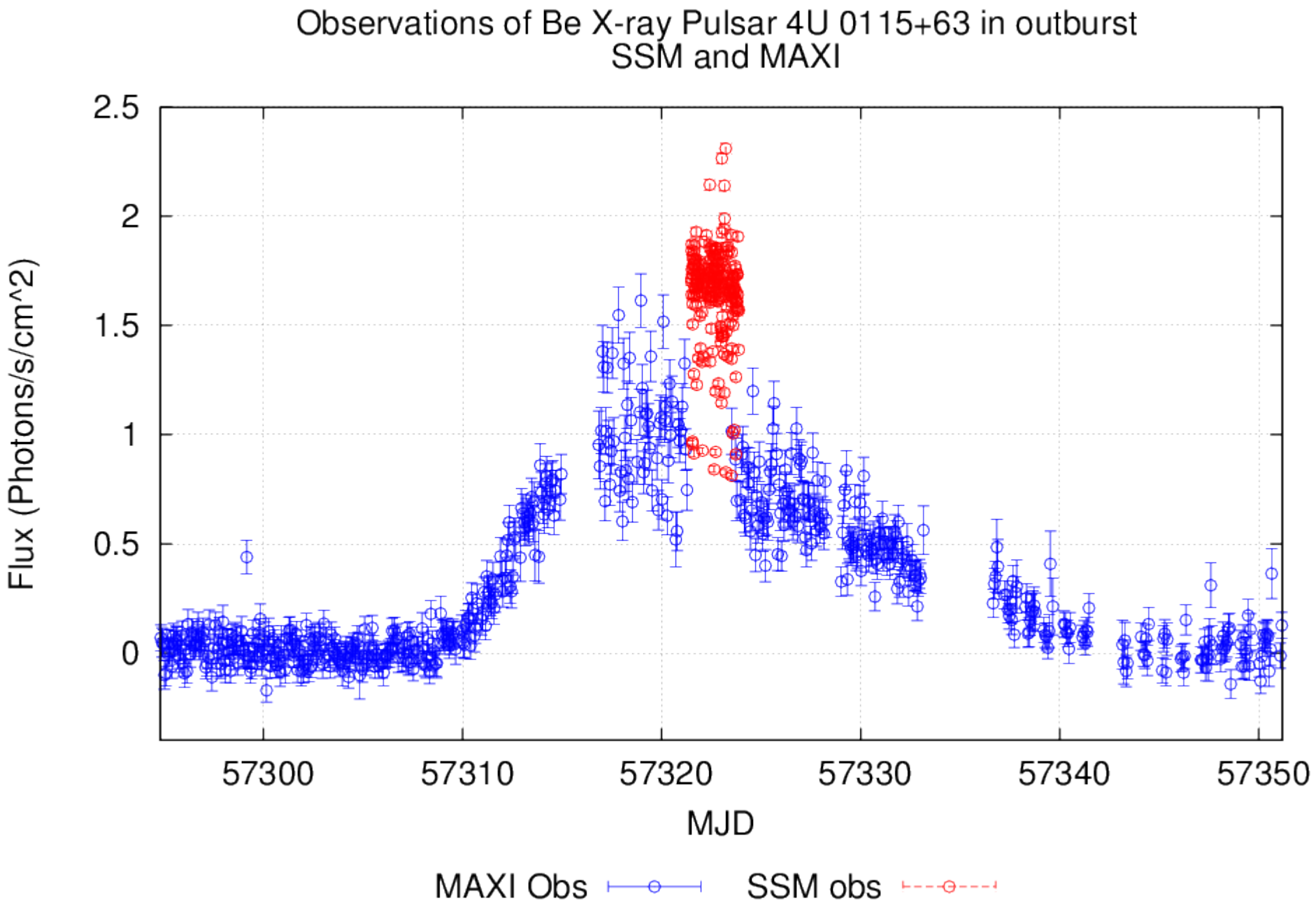
Crab at various locations in SSM FOV – **Dec 2016 Observations**
Changes seen in the flux include orbital effects, statistics of the data for observations away from the central regions of FOV, background modelling etc.
- yet to be modelled and corrected -



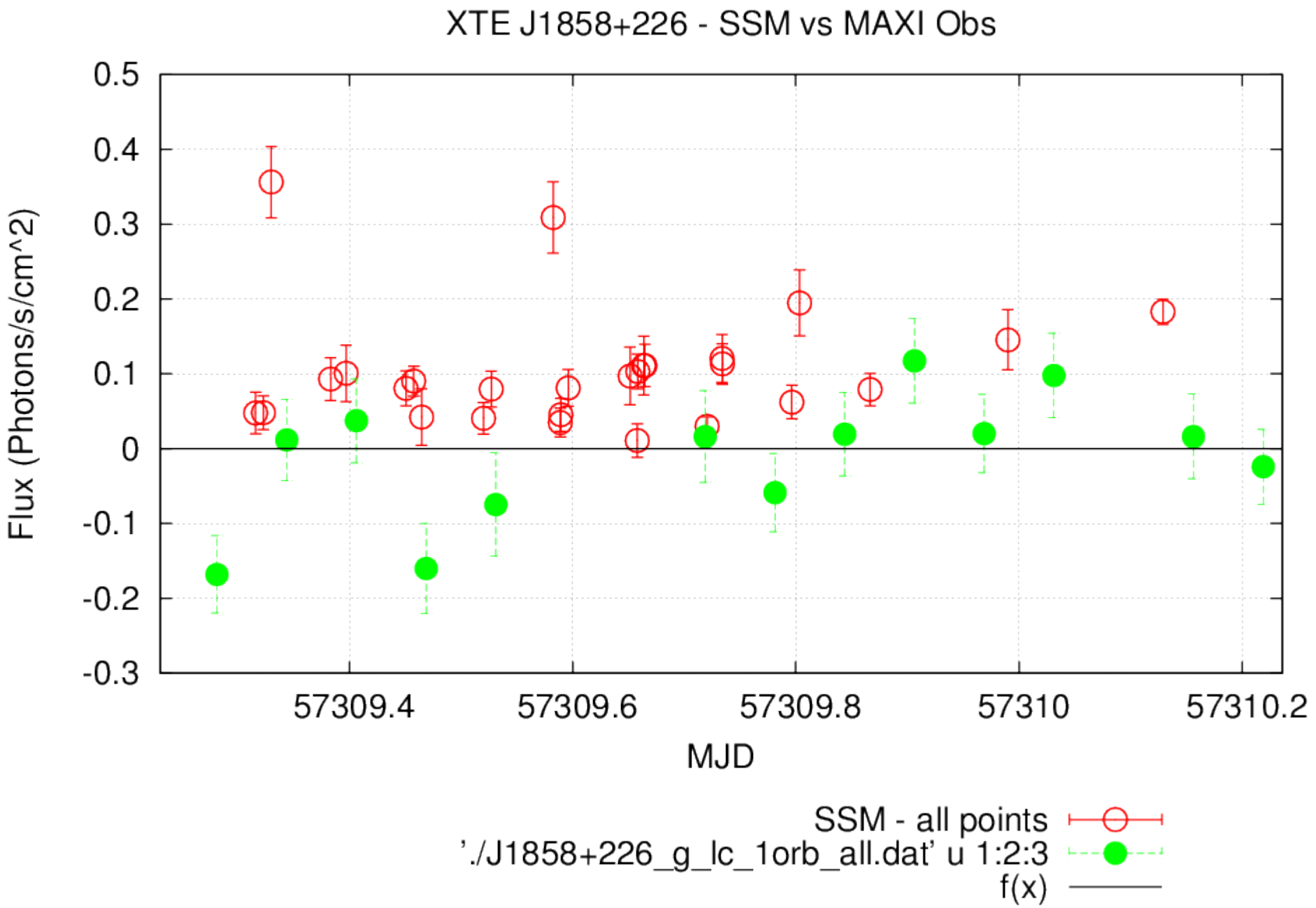
GRS 1915+105 – Oct 2015 Observations

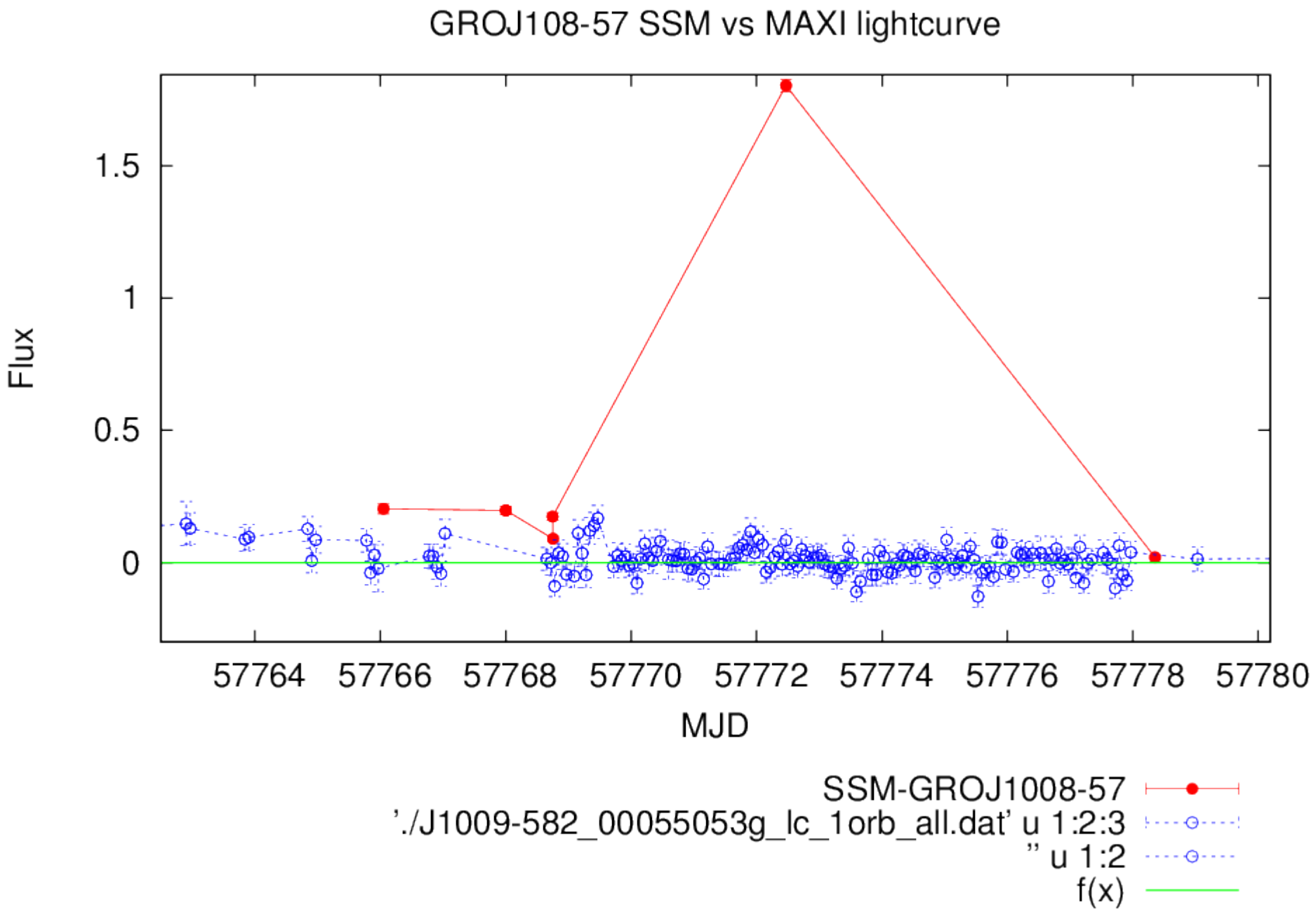



Observations of Be X-ray Pulsar 4U 0115+63 in outburst
SSM and MAXI
Flux (Photons/s/cm^2)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
55000
55500
56000
56500
57000
57500
58000
MJD
MAXI Obs
SSM obs

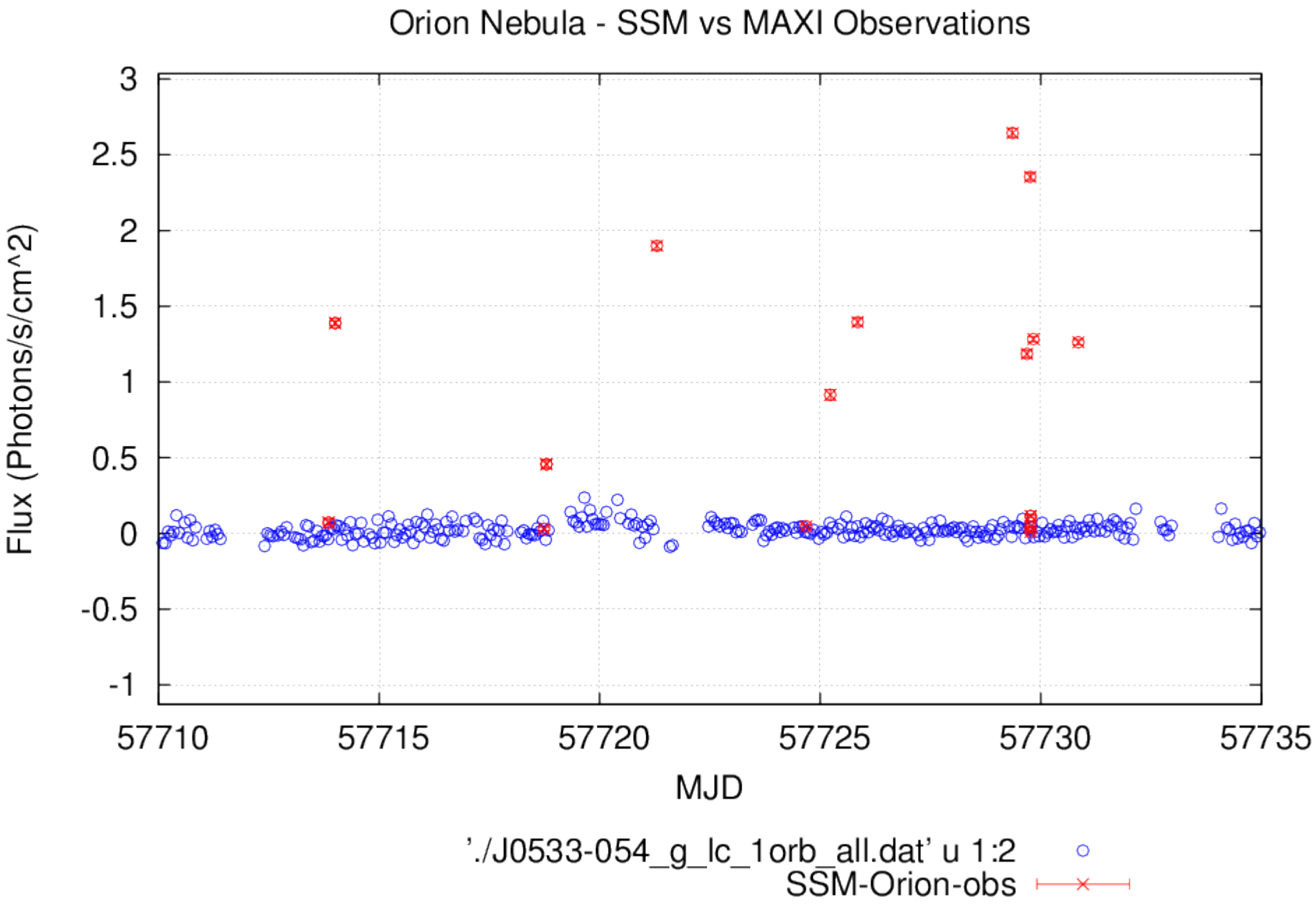

Observations of Be X-ray Pulsar 4U 0115+63 in outburst
SSM and MAXI
Flux (Photons/s/cm^2)
2.5
2
1.5
1
0.5
0
57300
57310
57320
57330
57340
57350
MJD
MAXI Obs
SSM obs

Flux for this faint source has been reported faithfully even without any background removal by SSM (this could be a rather faint field without any bright sources in the FOV)

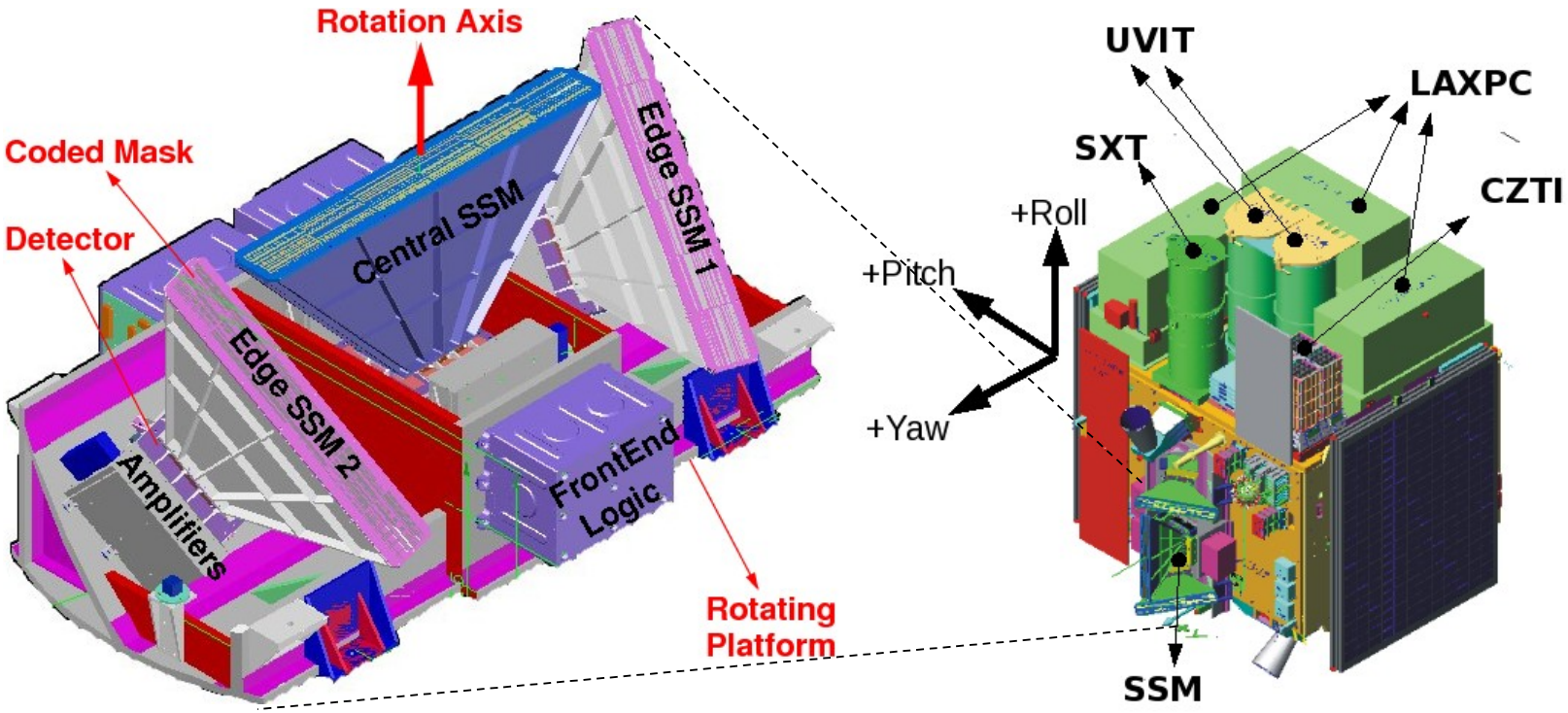


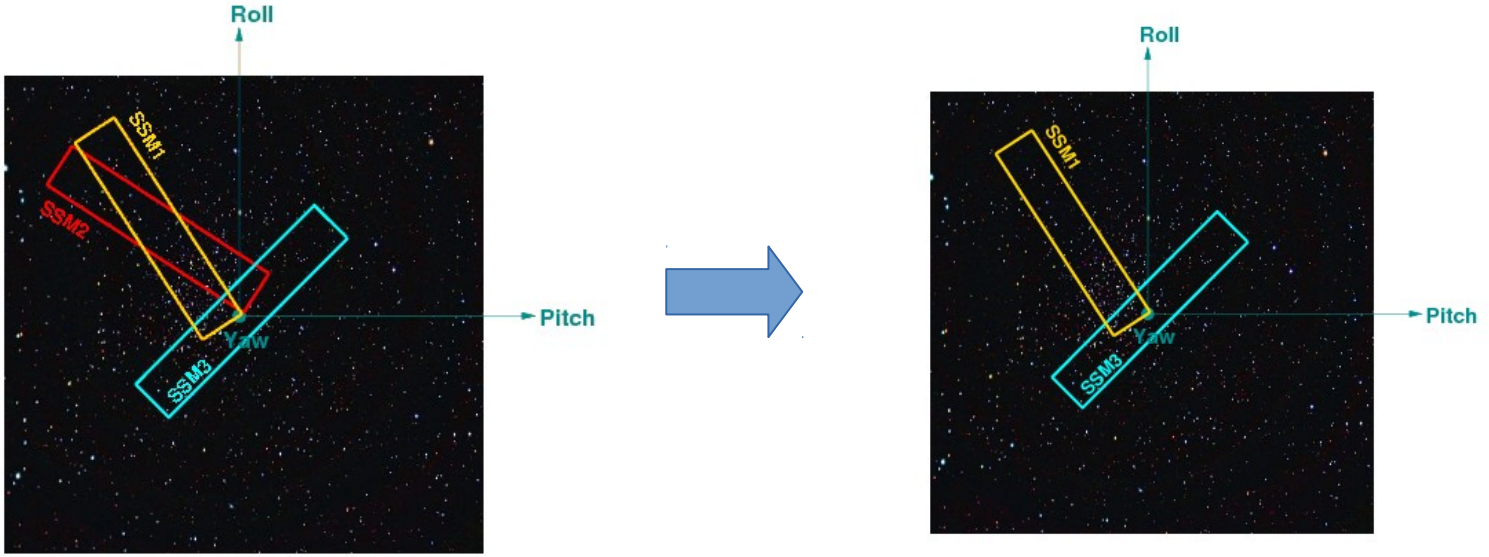

GROJ108-57 SSM vs MAXI lightcurve
Flux
1.5
1
0.5
0
57764
57766
57768
57770
57772
57774
57776
57778
57780
MJD
SSM-GROJ1008-57
'./J1009-582_00055053g_lc_1orb_all.dat' u 1:2:3
'' u 1:2
f(x)

This plot clearly shows that the flux extraction by Coded-mask Imaging is not OK for faint sources without removing the appropriately modelled background.



SSM1 and SSM3 Opertional (SSM2 Switched OFF)





Current Status

- SSM data to be made public with these filter of select region of FOV of SSM for bright sources for now.

- Define appropriate Sensitivity limits for SSM for the data with the present filter criteria of select region of FOV of SSM

- Background modelling for best usage of the data – higher duty cycle – being done

- SSM team (a small team though) was busy studying the data along with calibration activities till date

- SSM light curves for bright sources likely to be made public soon.

- We are yet to search for transients in the existing SSM data since Oct. 2015.

- We hope to generate SSM alerts in the neartime.

Thank You