

Searching for ultraviolet transients with Ultra Violet Imaging Telescope

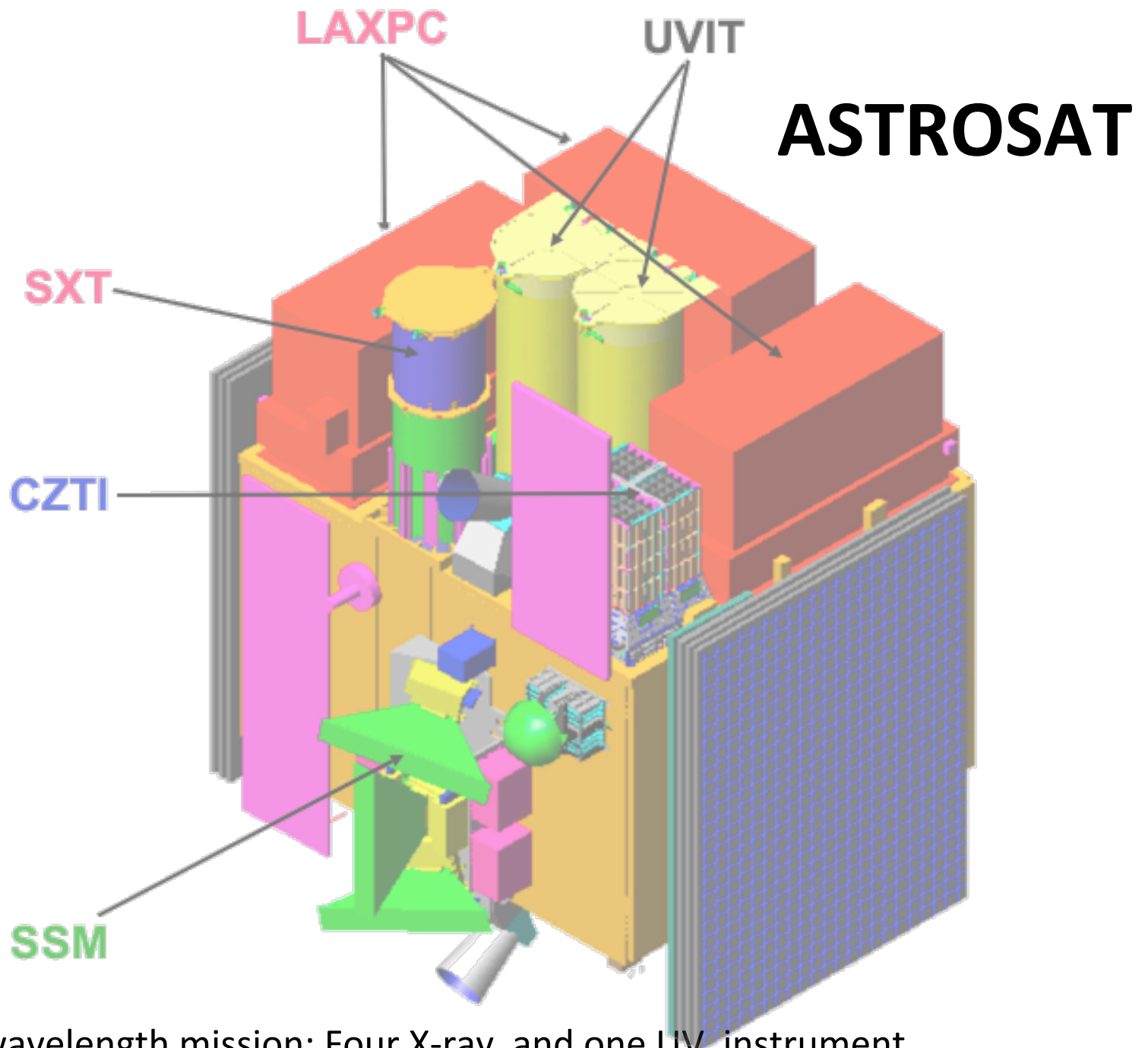
Koshy George

Indian Institute of Astrophysics

ASTROSAT



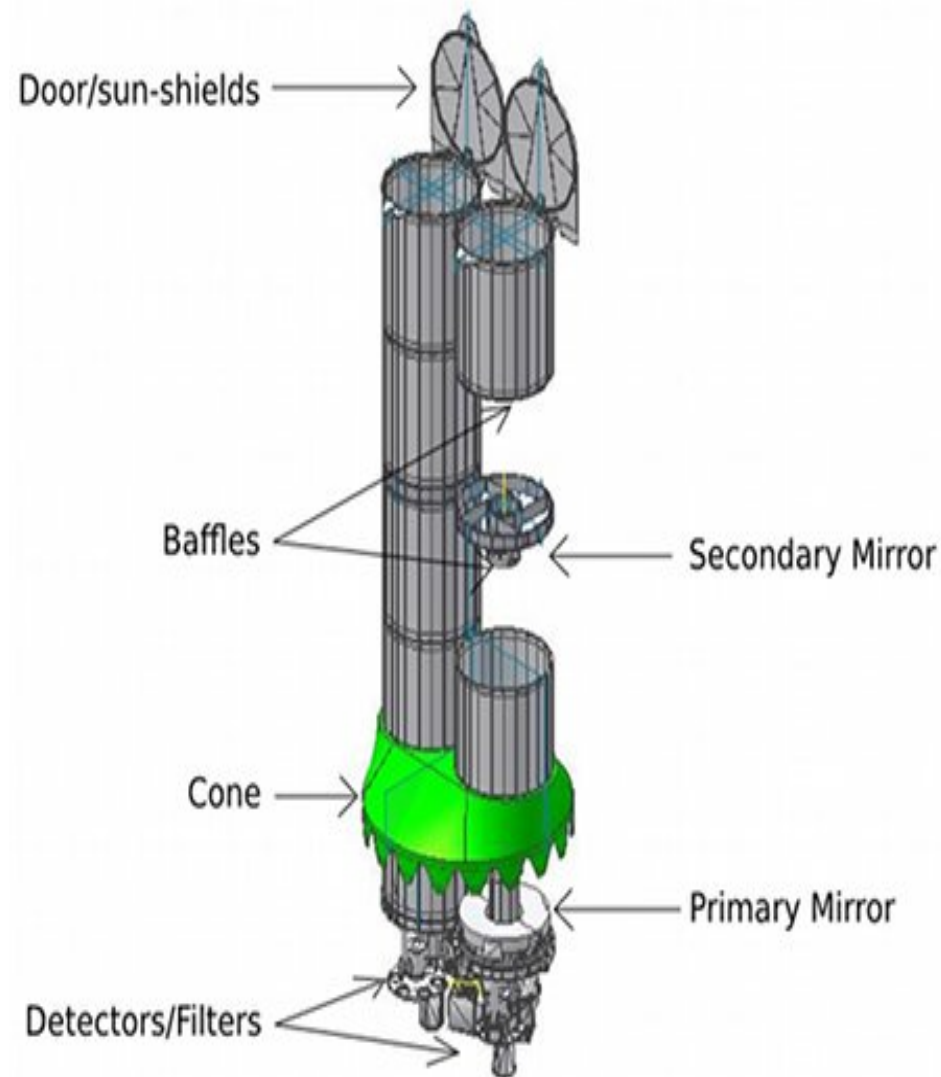
*Launched on 28th September 2015. PSLV C-30 lift off from Sriharikota
650km near-equatorial orbit with inclination of 6 degree.*



Multiwavelength mission: Four X-ray and one UV instrument

Ultra Violet Imaging Telescope

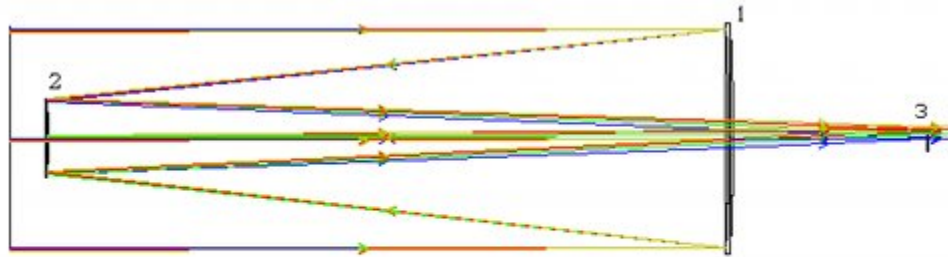
- Twin Telescopes.
 - Three channels
FUV (130-180nm), NUV(200-300nm)
& VIS (320-550nm)
 - Diameter = 37.5 cm
 - Field of view ~ 28.5 arcmin
 - Detector $\sim 512 \times 512$ pixels CMOS
(1pixel = 25×25 microns)
 - Mode of operation: photon counting.
512 X 512 pixels read at 29 frames/s.
window mode read at 200 frames/s.
- Spatial resolution: NUV < 1.5 arcsec**
FUV < 2 arcsec



Ultra Violet Imaging Telescope

- Time variations in UV of X-ray sources in coordination with the X-ray payloads
- Star formation in nearby galaxies
- Star formation in interacting galaxies
- Star formation history of universe
- Hot stars in Globular clusters
- Planetary nebulae

Ultra Violet Imaging Telescope

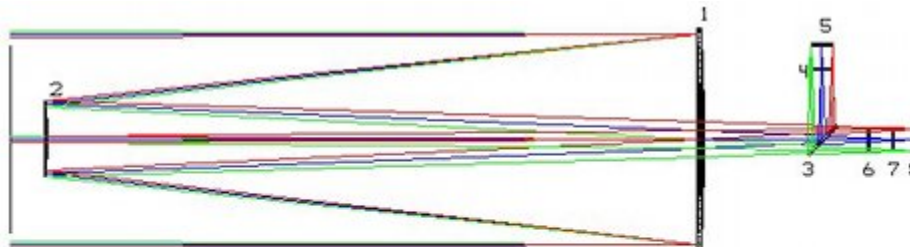


FUV optics design

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

Primary mirror $D = 37.5\text{cm}$

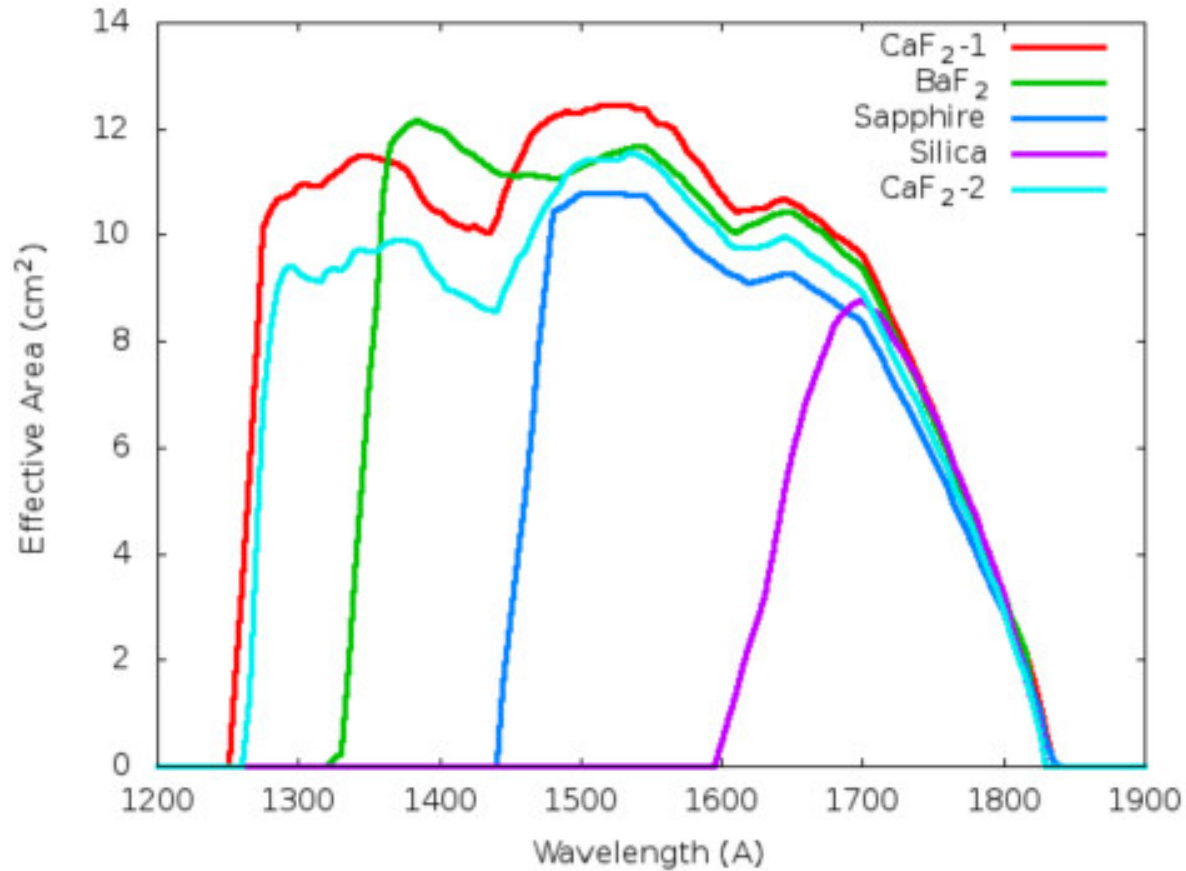
Secondary mirror $D = 14\text{cm}$



NUV optics design

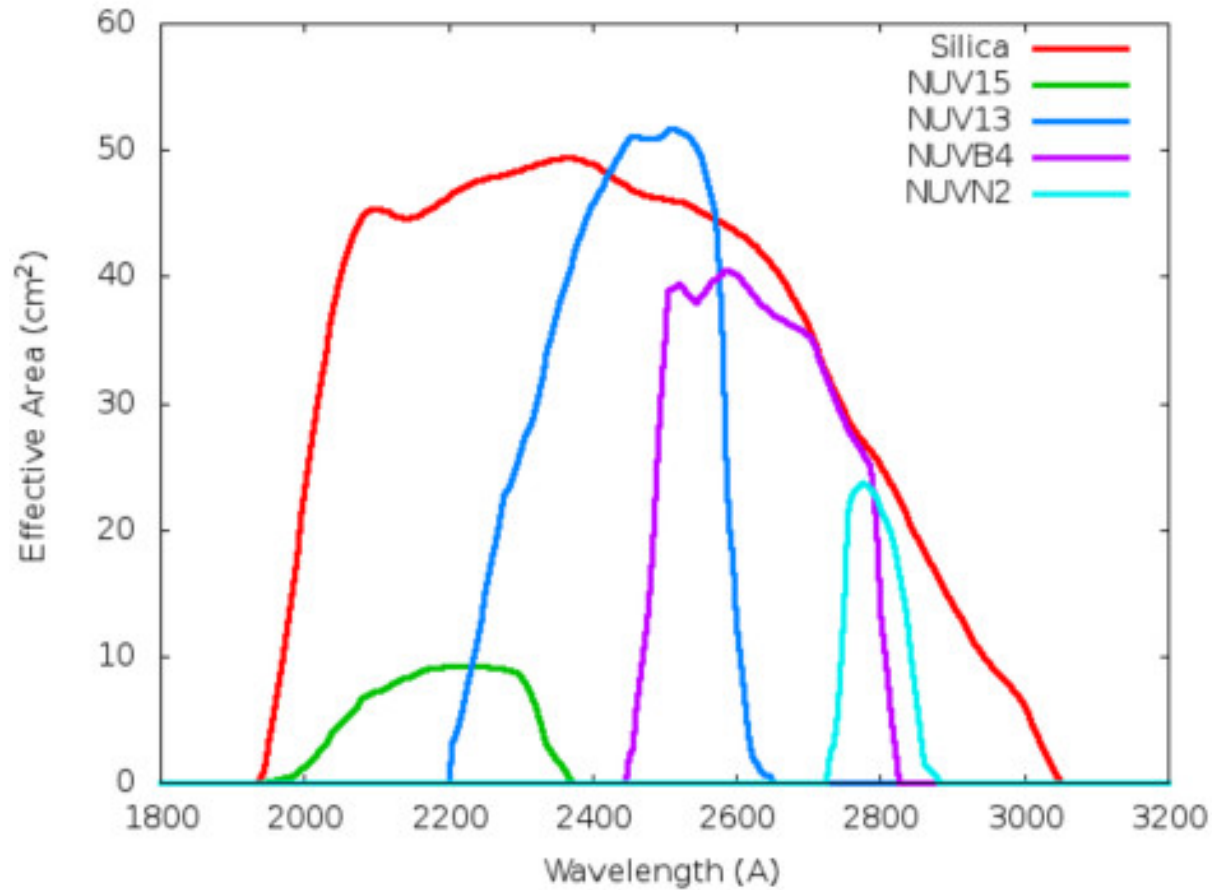
- 1- PRIMARY MIRROR
- 2- SECONDARY MIRROR
- 3- BEAM SPLITTER
- 4- NUV FILTER
- 5- NUV DETECTOR WINDOW
- 6- VIS CORRECTOR
- 7- VIS FILTER
- 8- VIS DETECTOR WINDOW

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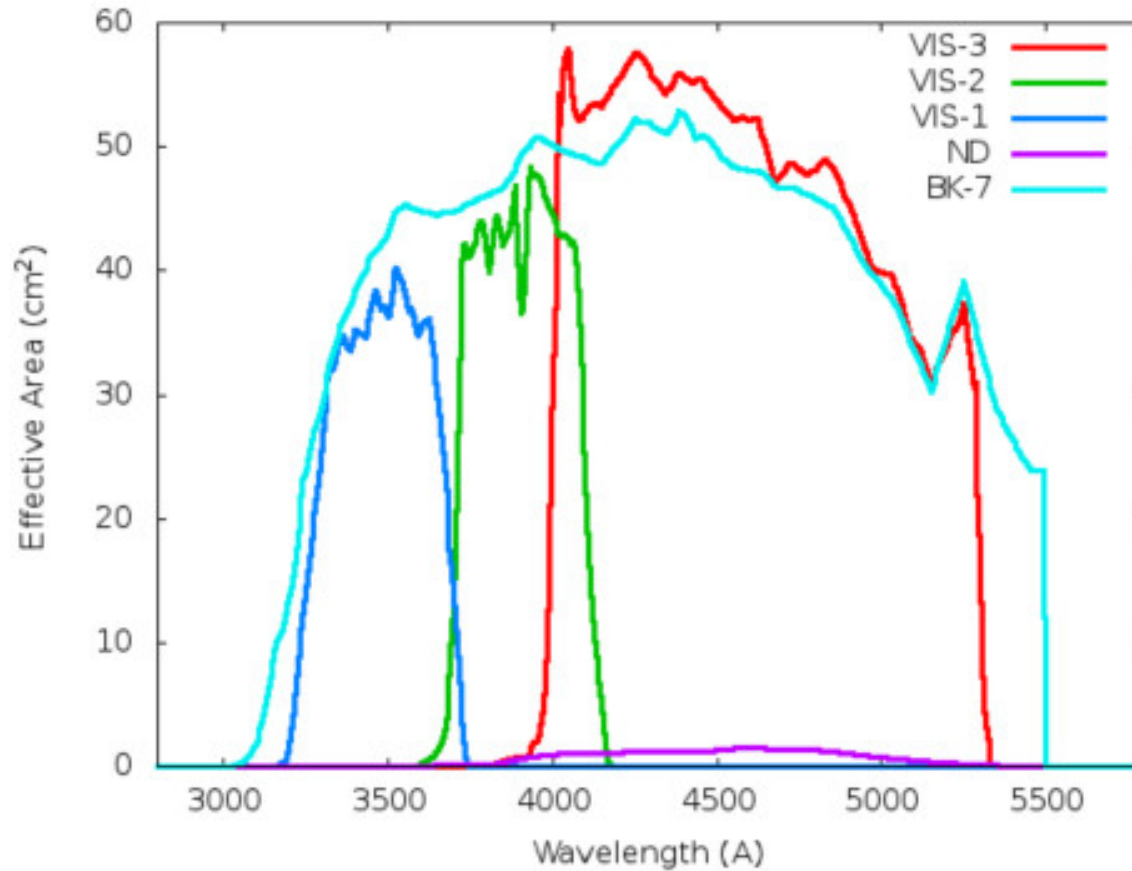
FUV filters

Ultra Violet Imaging Telescope



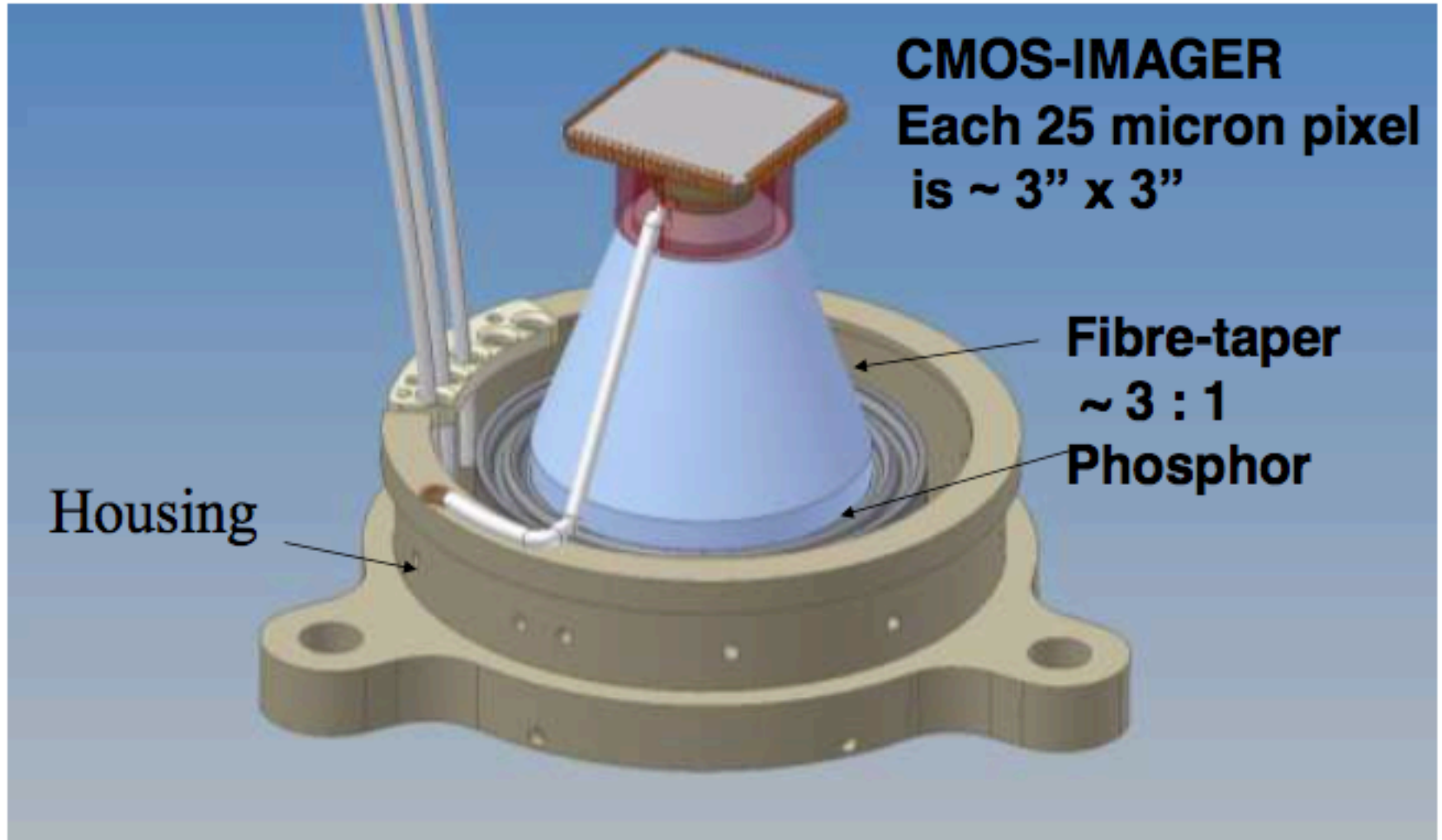
NUV filters

Ultra Violet Imaging Telescope

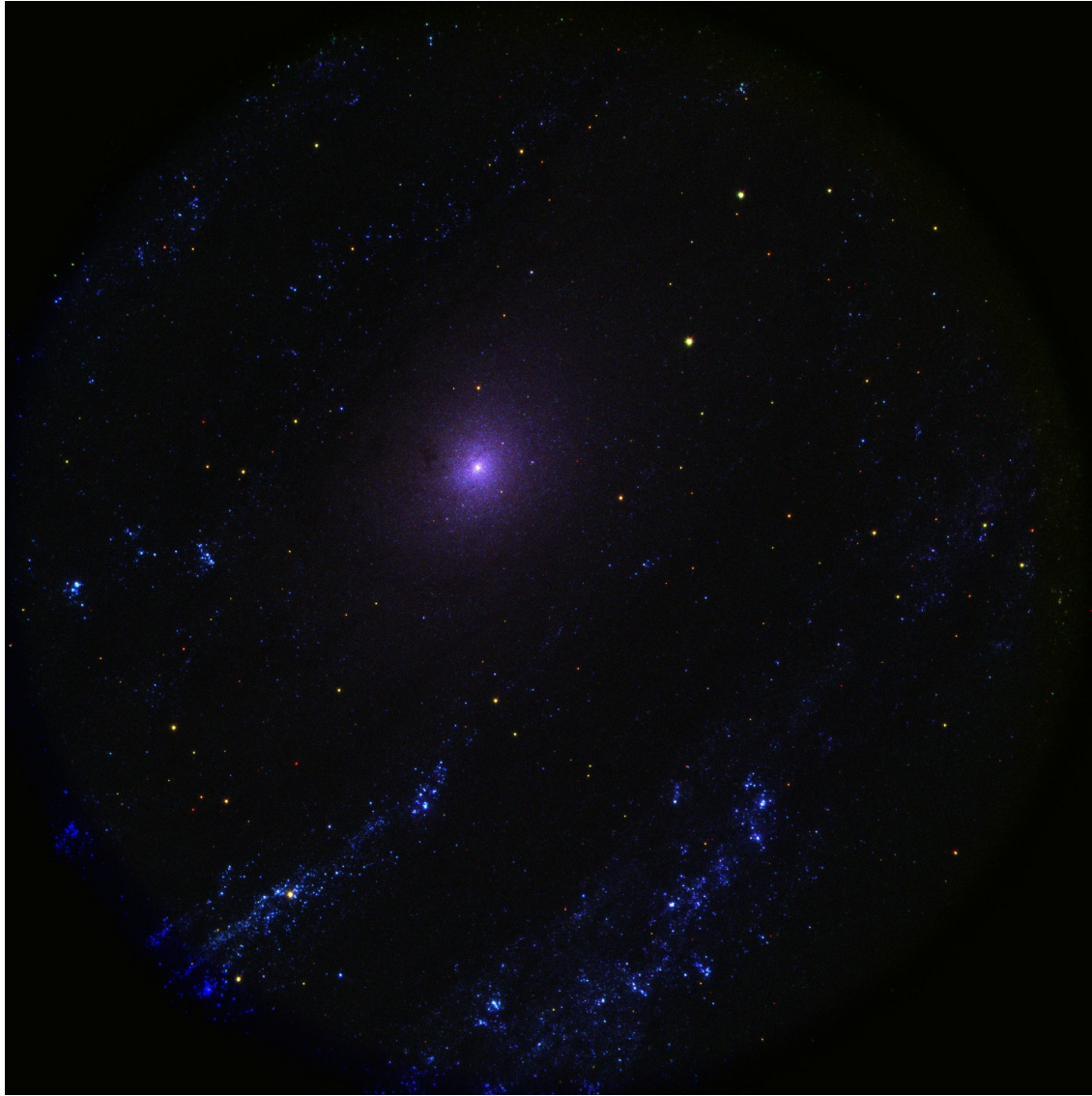


VIS filters

Ultra Violet Imaging Telescope



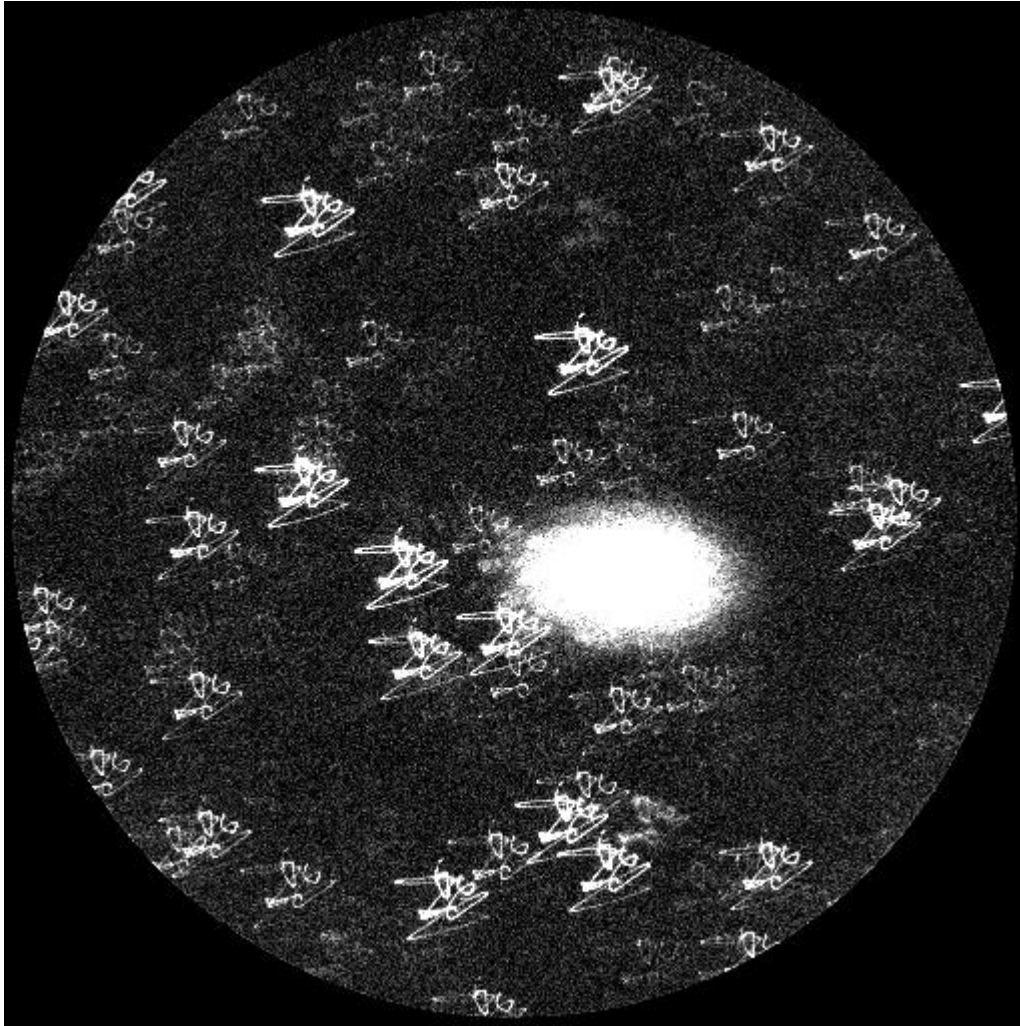
UVIT view of Andromeda galaxy



Credits: UVIT Team /ISRO/ CSA

Andromeda galaxy, also known as M31, is the closest large spiral galaxy similar to our own Milky Way. The UVIT telescopes aboard Astrosat observed in three different ultraviolet wavelengths the central region of M31, and this picture combines them in a false-colour image - the blue objects are hot stars and the red ones are cooler. The fuzzy bright object is the nucleus of M31, which contains a massive black hole, a surrounding population of faint hot stars, and regions of dust. The other bright areas are regions of massive hot stars that have recently formed in the spiral arms of the galaxy. The red stars are older M31 stars, and a few bright foreground stars in our own Milky Way galaxy. The entire M31 galaxy would fill four fields of view of UVIT and will be observed later. These images provide unique information on the processes of star-formation and activity near the nucleus of M31.

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- **Event list**

Centroid X,Y and Time

- **Time resolution**

34ms full frame

5ms window mode

	PacketSe...	FrameCo...	Time	Fx	Fy
1	32769	369	1.890887E8	1755.69824	652.96539
2	32769	369	1.890887E8	1790.94824	796.21539
3	32769	369	1.890887E8	2453.44824	796.71539
4	32769	369	1.890887E8	3656.69824	845.96539
5	32769	369	1.890887E8	1179.69824	865.96539
6	32769	369	1.890887E8	3937.19824	1152.46545
7	32769	369	1.890887E8	2795.44824	1292.96545
8	32769	369	1.890887E8	4135.69824	1545.46545
9	32769	369	1.890887E8	4347.94824	2435.21533
10	32769	369	1.890887E8	1092.94824	2569.71533
11	32769	369	1.890887E8	1592.69824	2610.46533
12	32769	369	1.890887E8	4309.19824	2628.46533
13	32769	369	1.890887E8	2704.69824	2639.21533
14	32769	369	1.890887E8	994.4483	2828.46533
15	32769	369	1.890887E8	2090.94824	2964.21533
16	32769	369	1.890887E8	2025.44824	2986.96533
17	32769	369	1.890887E8	497.94827	3039.71533
18	32769	369	1.890887E8	752.9483	3077.71533
19	32769	369	1.890887E8	3045.94824	3387.71533
20	32769	369	1.890887E8	3581.69824	3776.21533
21	32769	369	1.890887E8	2889.69824	3946.46533
22	32769	370	1.890887E8	1791.1825	795.17346
23	32769	370	1.890887E8	3285.18237	807.92346
24	32769	370	1.890887E8	1612.6825	853.42346
25	32769	370	1.890887E8	2498.93237	900.92346
26	32769	370	1.890887E8	3063.68237	979.67346
27	32769	370	1.890887E8	978.9325	1027.17346
28	32769	370	1.890887E8	1313.6825	1033.42346
29	32769	370	1.890887E8	1783.9325	1150.17346
30	32769	370	1.890887E8	2727.43237	1298.67346
31	32769	370	1.890887E8	2695.93237	1523.92346
32	32769	370	1.890887E8	1298.6825	1705.17346
33	32769	370	1.890887E8	3418.18237	1867.42346
34	32769	370	1.890887E8	1291.1825	1938.92346
35	32769	370	1.890887E8	1598.9325	2062.67334
36	32769	370	1.890887E8	1396.9325	2148.17334
37	32769	370	1.890887E8	3285.43237	2156.92334
38	32769	370	1.890887E8	2999.68237	2168.17334
39	32769	370	1.890887E8	2924.93237	2185.67334
40	32769	370	1.890887E8	2094.43237	2322.42334
41	32769	370	1.890887E8	3967.18237	2499.17334
42	32769	370	1.890887E8	2820.43237	2560.42334
43	32769	370	1.890887E8	1073.6825	2596.67334

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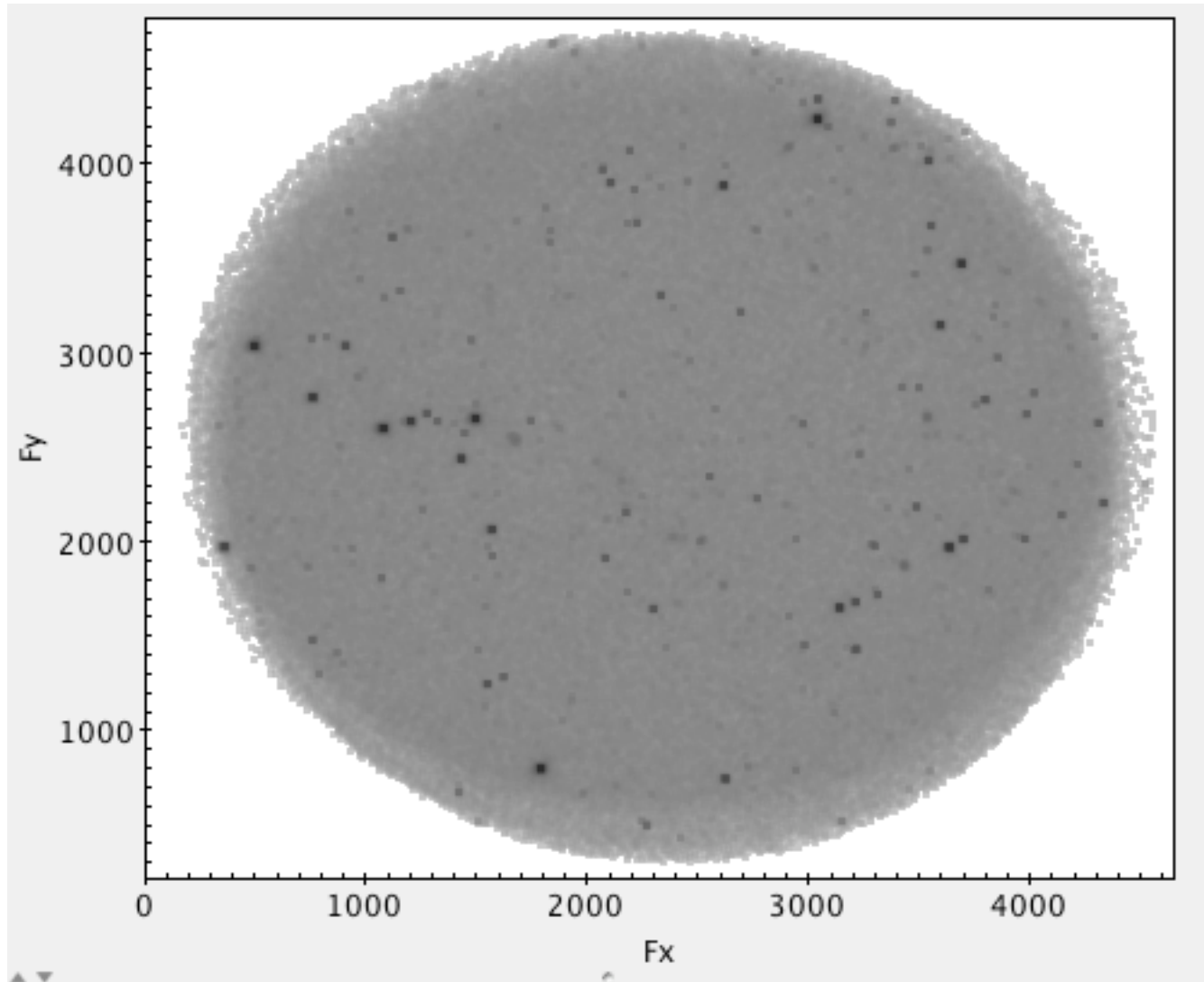


Image-
centroid map

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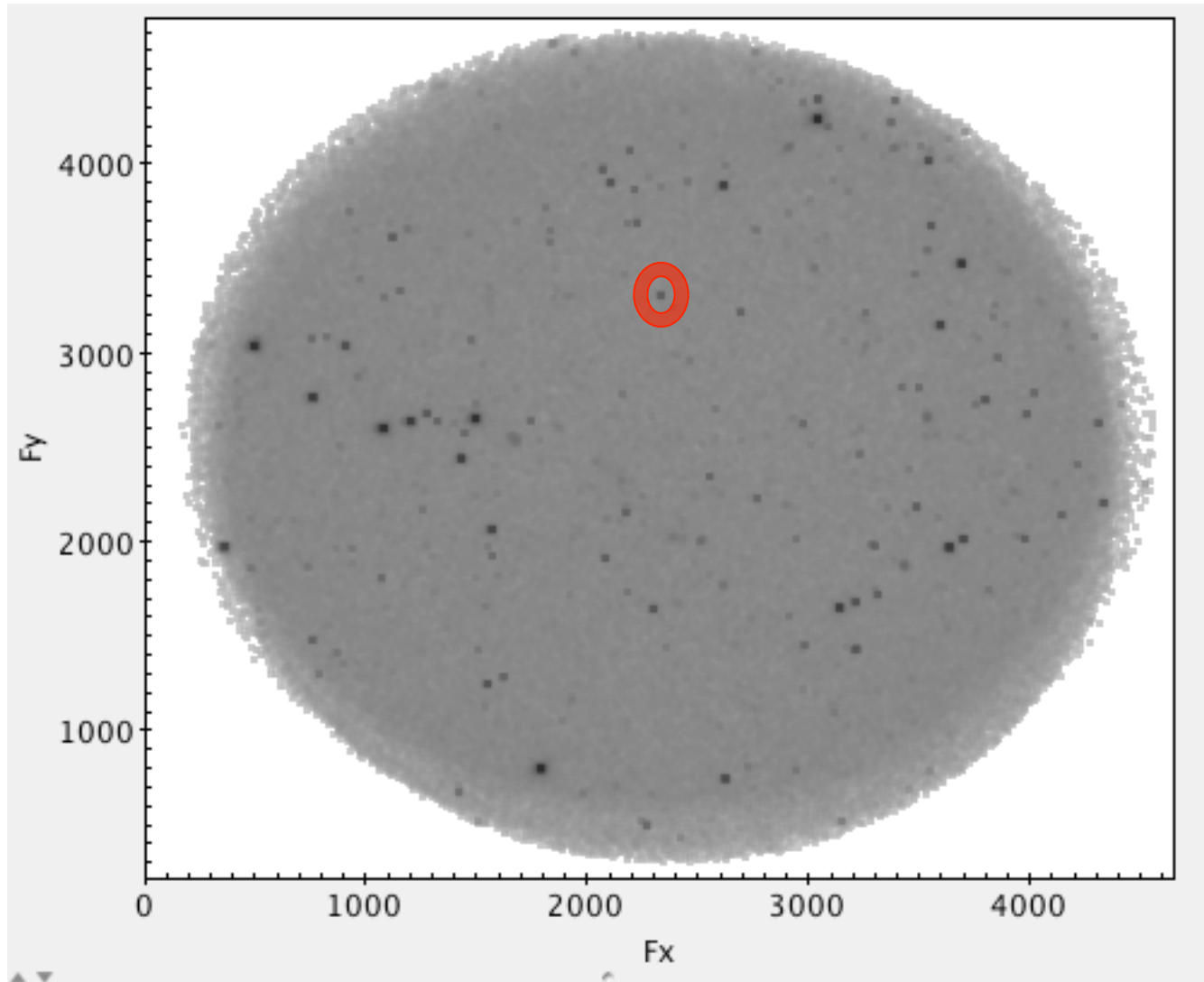
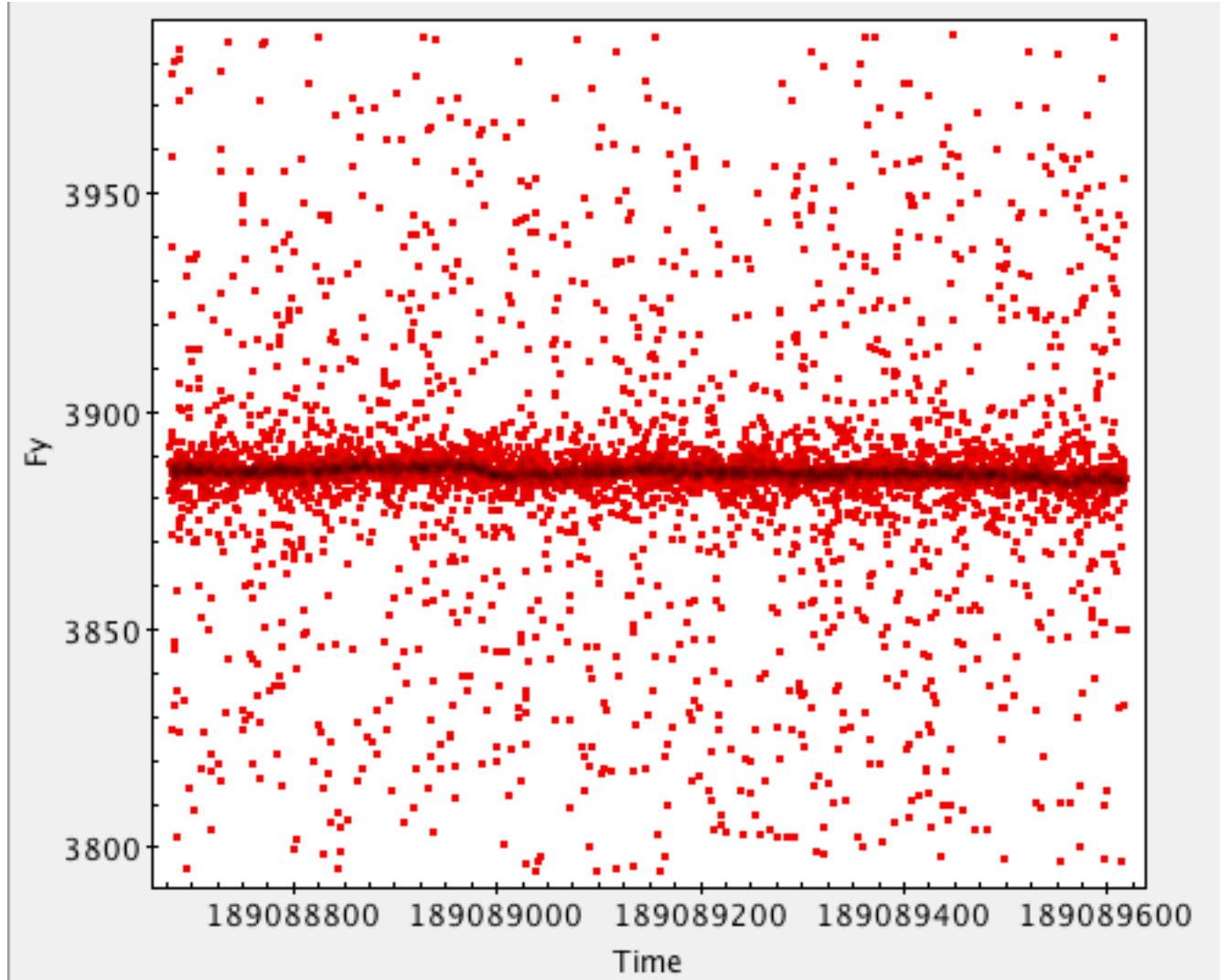


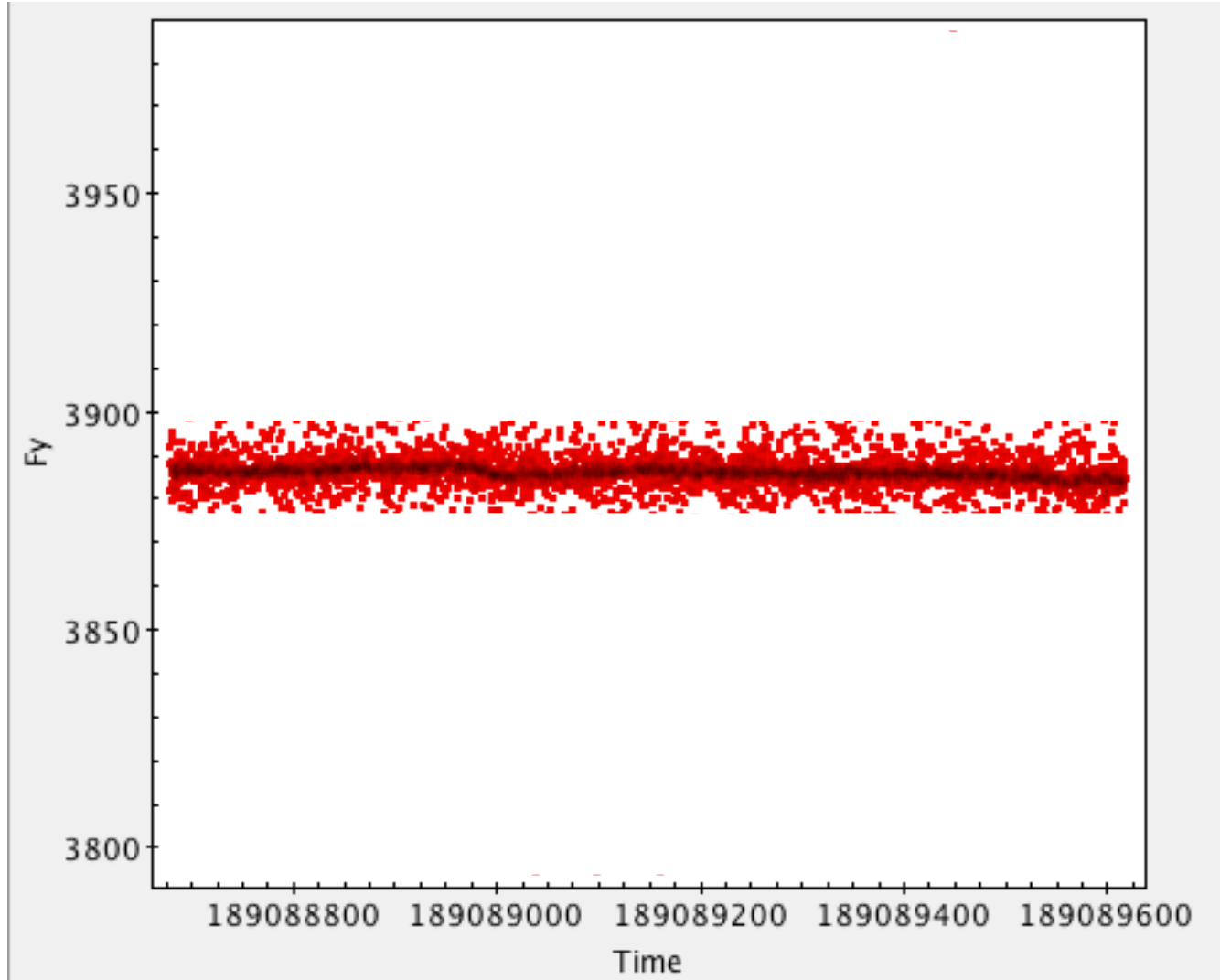
Image-
centroid map

Ultra Violet Imaging Telescope



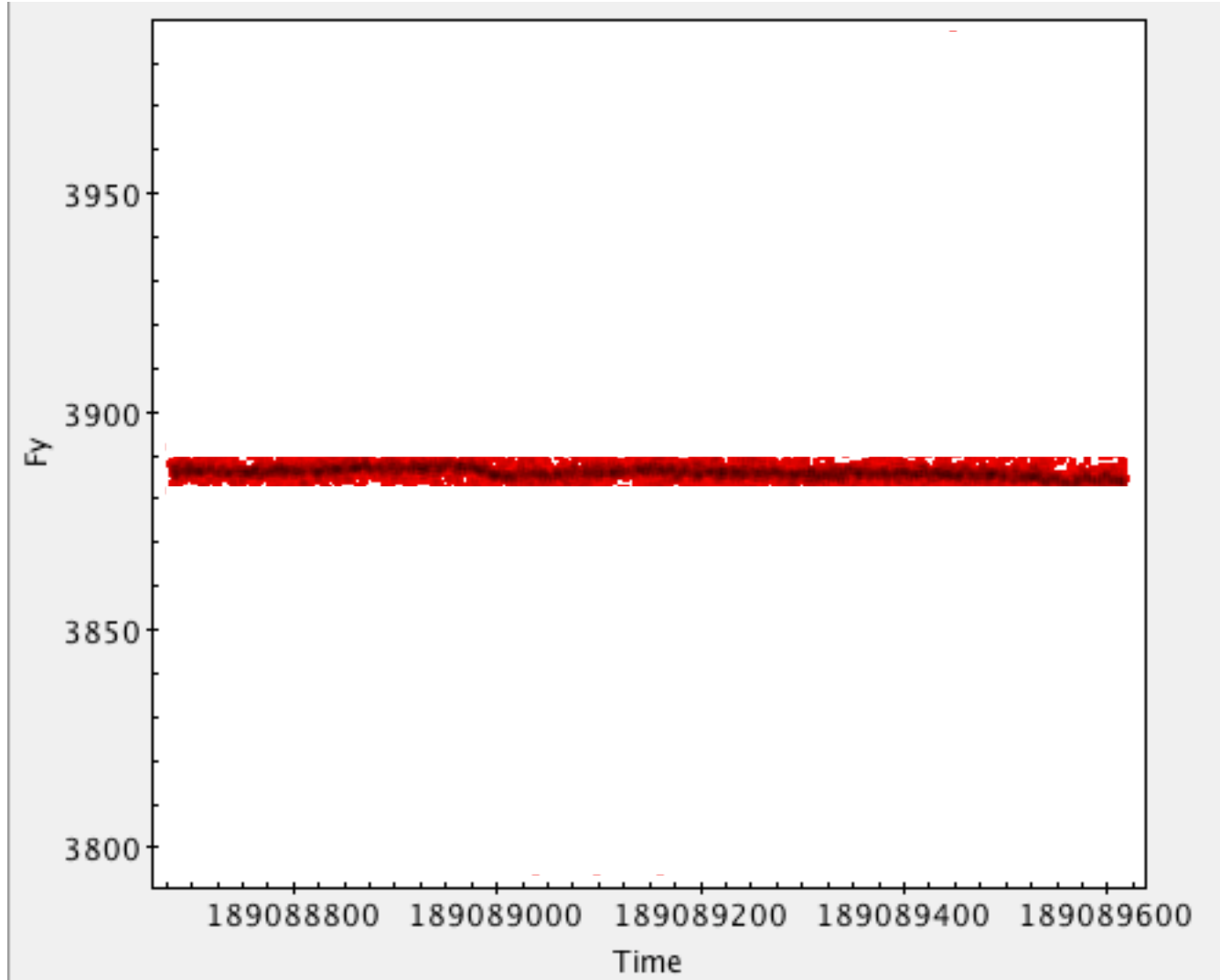
**Time series-
Centroid list**

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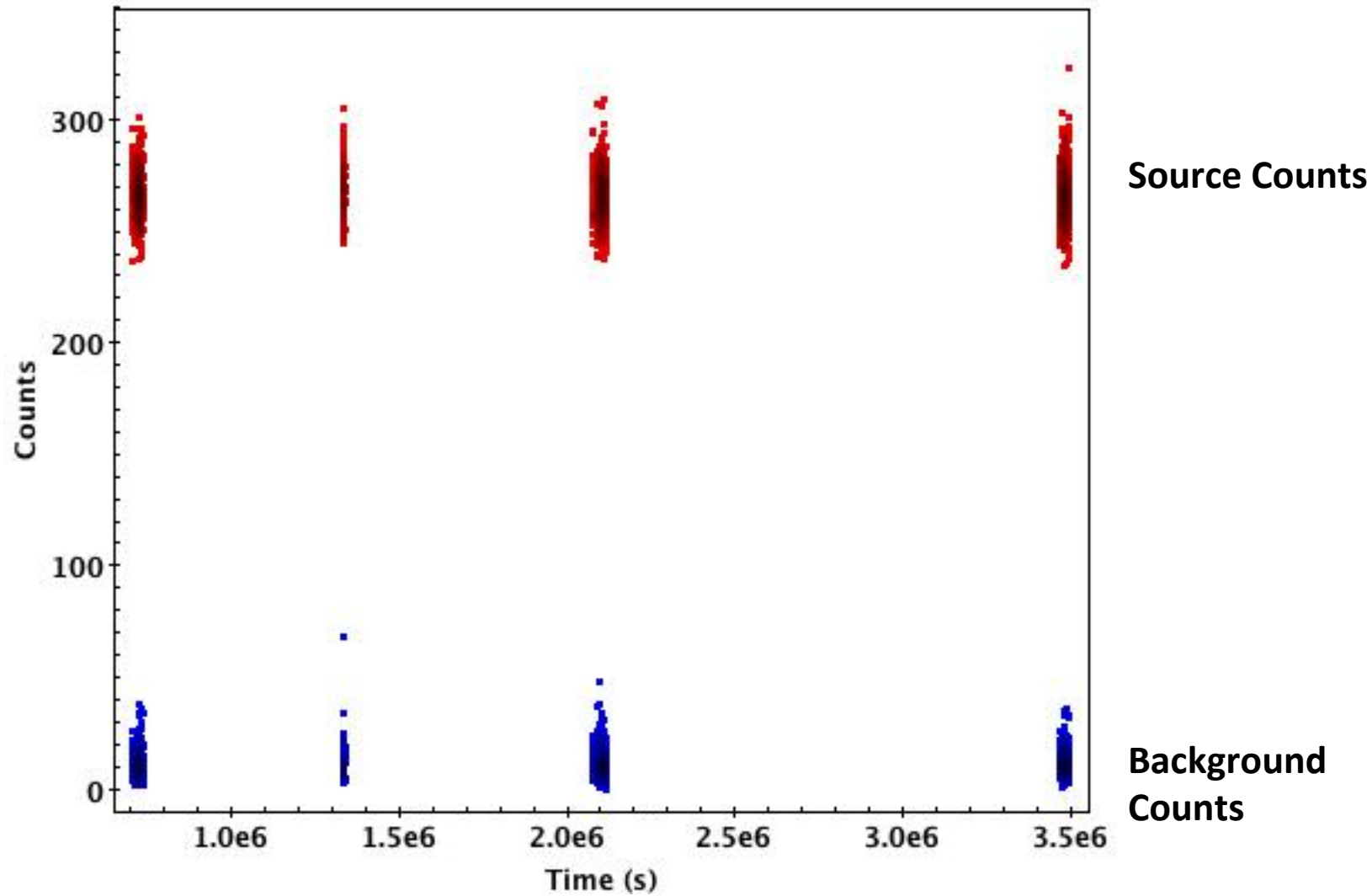
**Time series-
Centroid list**

Ultra Violet Imaging Telescope



**Time series-
Centroid list**

Ultra Violet Imaging Telescope



Stellar flares from Star-Planet interaction

Host star: G 0 spectral type, NUVmag ~ 13.93

Planet: HD 68988b, Mass: 1.86 M_J, Radius: 1.1 R_J

Star-planet separation: 0.0704 Au, P orb : 6.2 days ,

Eccentricity : 0.14

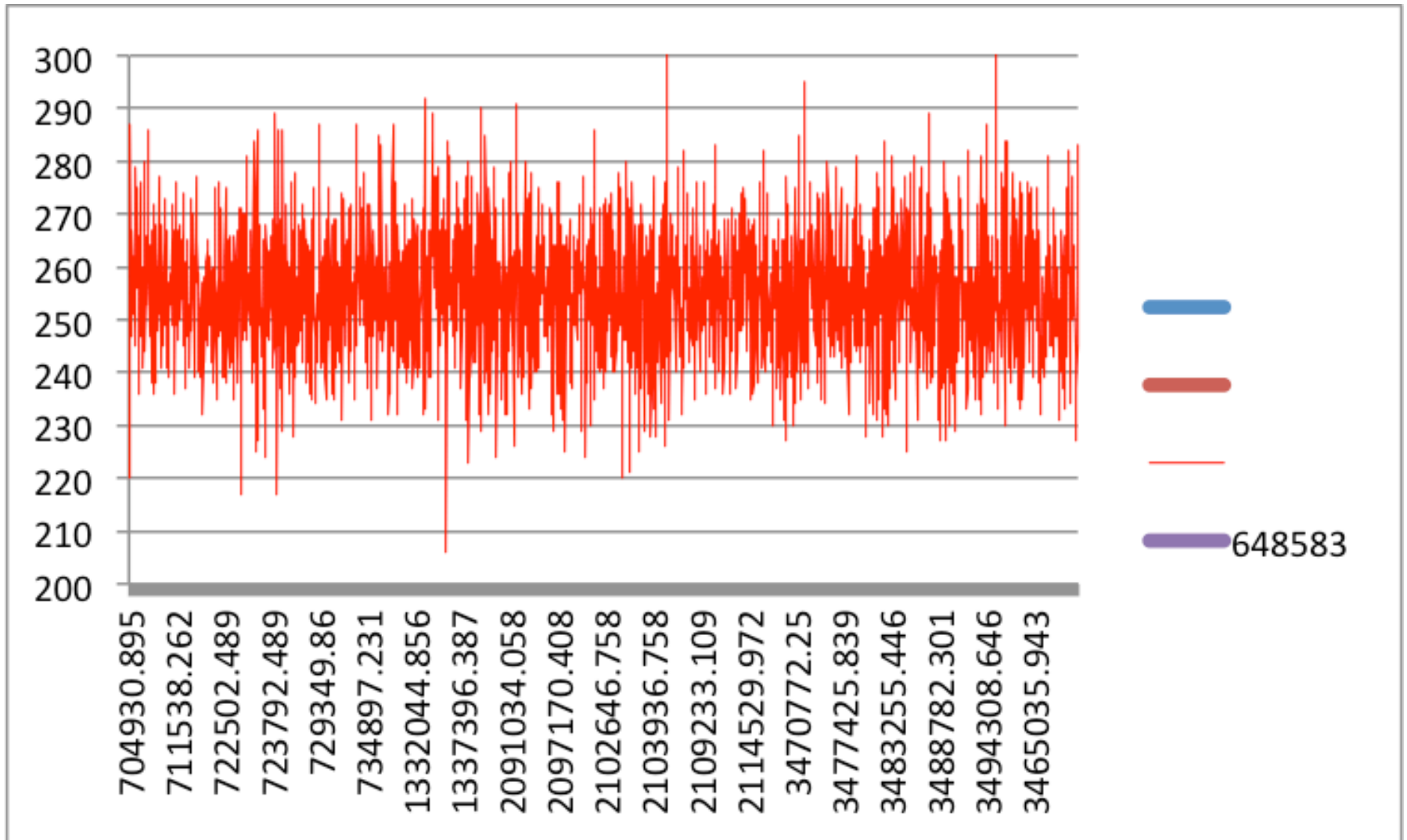
Plan:

Monitor the star-planet system for UV flaring activity when star-planet distance is at minimum and maximum

HD 68988 for ~ 70 ks with UVIT at perigee and apogee

4 epochs (each 8.4Ks) UVIT pointing at periastron and 4 epochs (each 8.4Ks) at apostron.

Stellar flares from Star-Planet interaction

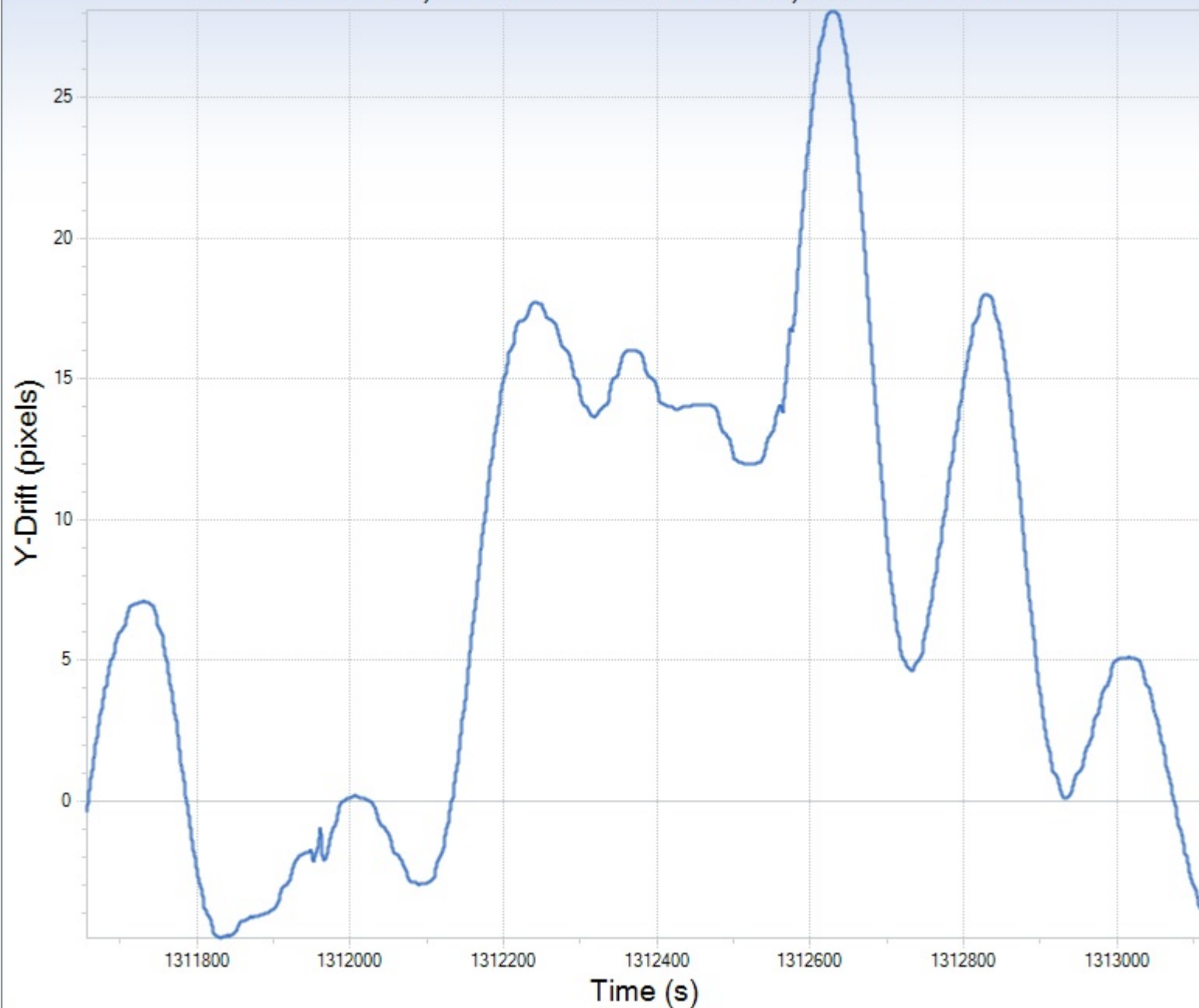


Challenge

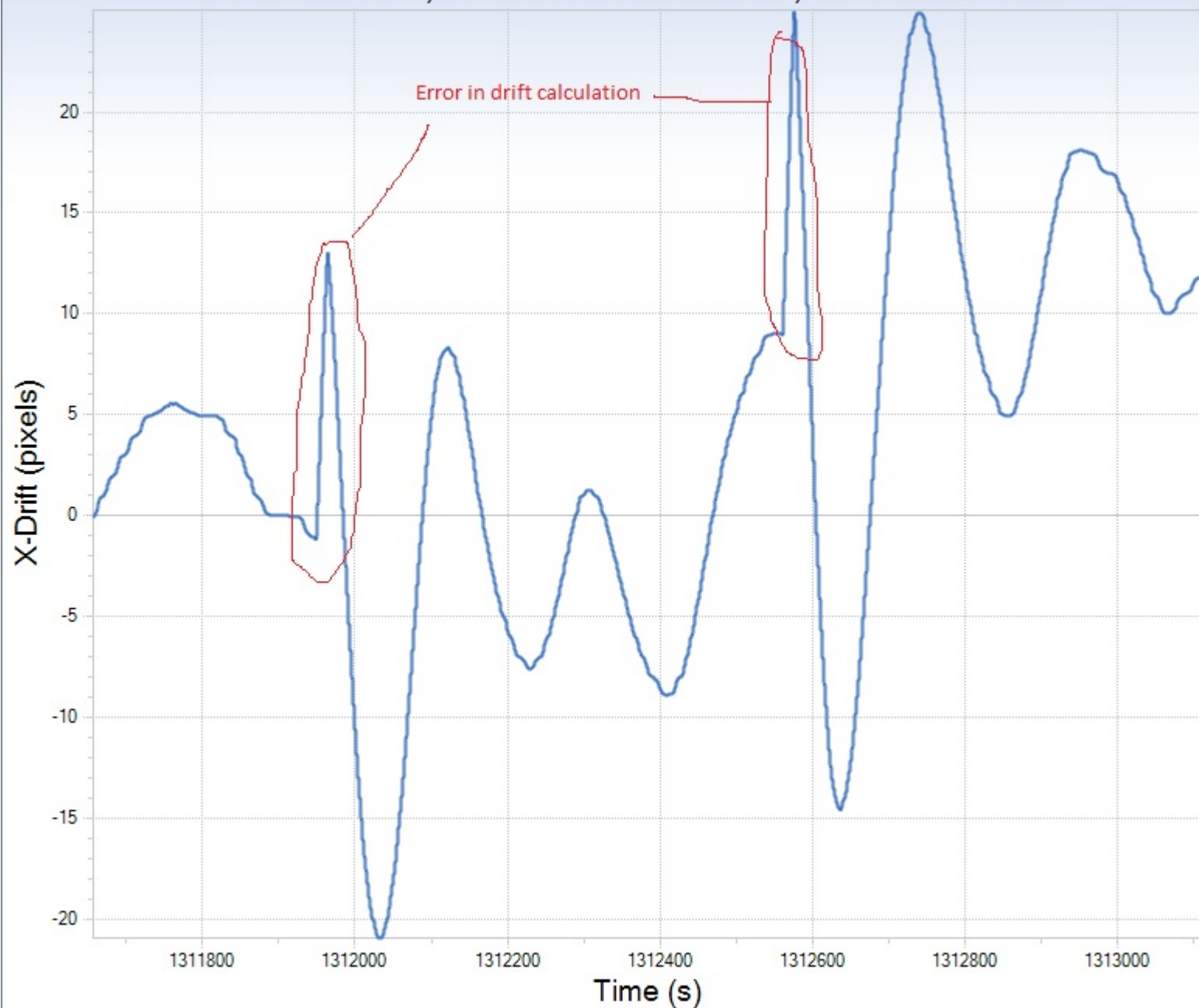
Detect unknown transients in UV from the observed event list

Thank You

Orbit: 1191; Source: NGC2336; Detector:NUV



Orbit: 1191; Source: NGC2336; Detector:NUV



Stellar flares from Star-Planet interaction

Hot Jupiters:

Gas giants similar to Jupiter but with short orbital periods (< 10 days), small orbital radii (< 0.1 AU) and high surface temperatures.

Test bed to understand the magnetic activity of the host stars and the subsequent energy pumped into the planetary atmospheres due to star-planet interaction.

The planet induced magnetic activity of the host stars can create short lived stellar flares which can last for several minutes with UV flux changing by a factor of 2

+ve result Shkolnik et al. (2003,2005,2008)

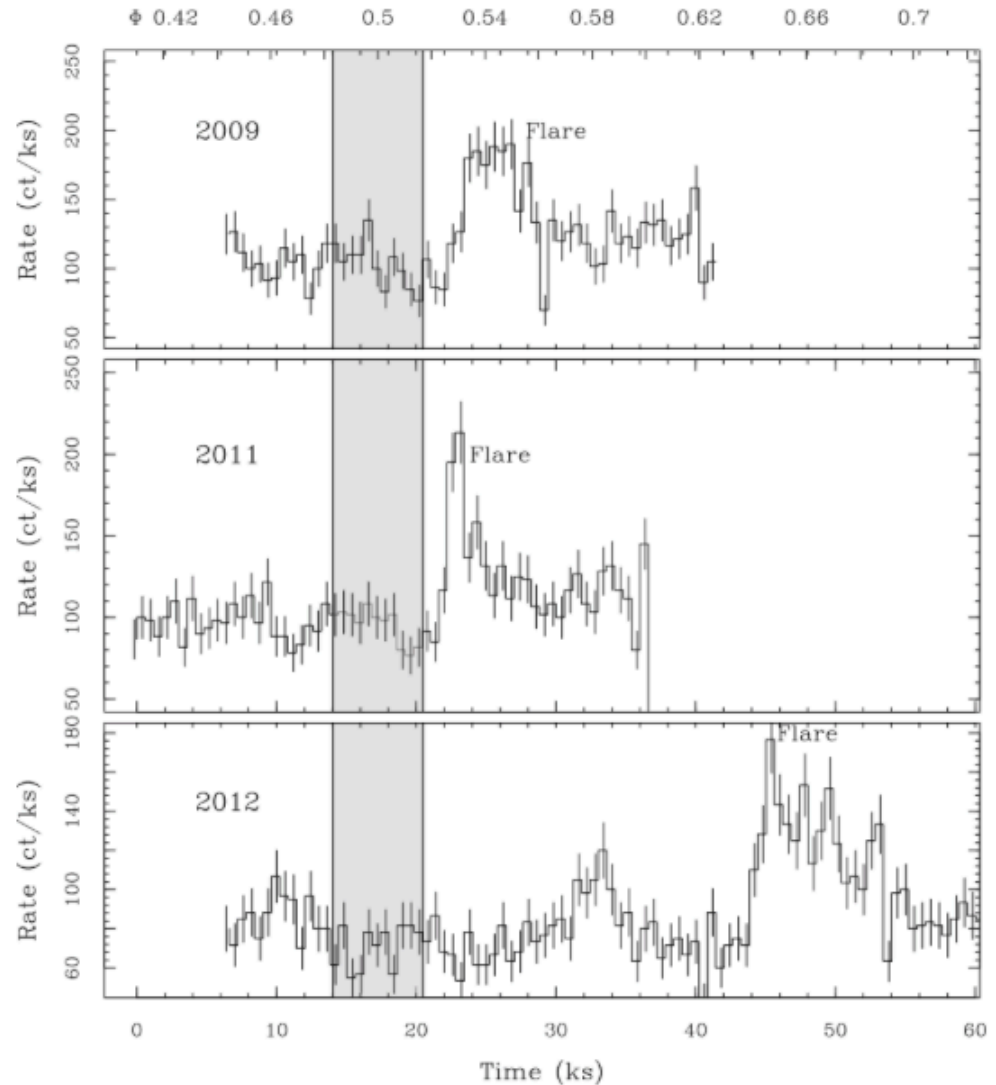
-ve result Poppenhager et al. (2011)

Stellar flares from Star-Planet interaction

Hot Jupiters:

Pillitteri et al. 2014
Observed flares at
similar orbital position
of HD 189733b

XMM Newton observation



Stellar flares from Star-Planet interaction

EK Dra EUV flare

