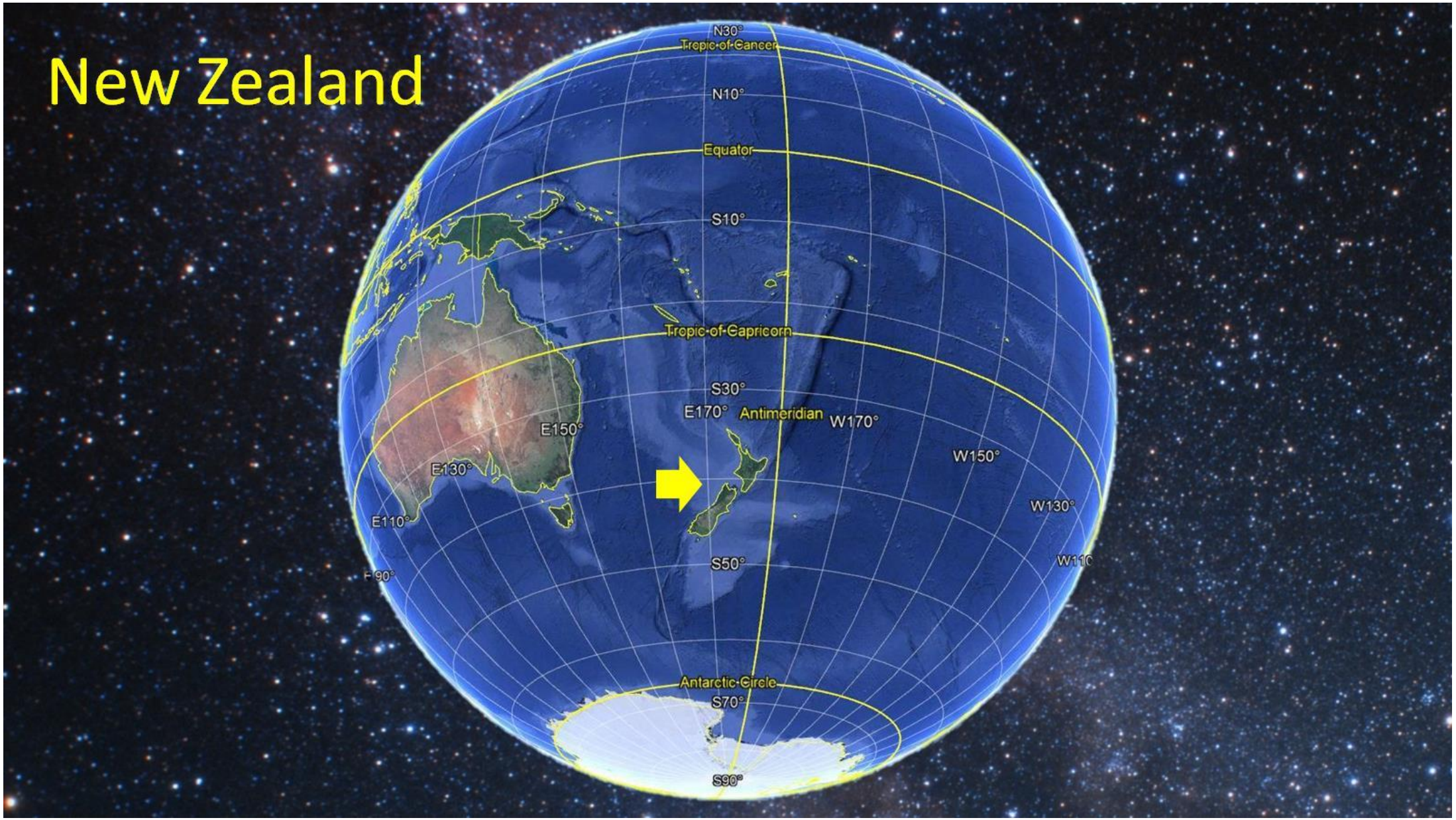
Sateliti južnog neba

Posmatranje Zemljinih veštačkih satelita sa Novog Zelanda

Dr Jovan Skuljan

Defence Technology Agency, Auckland, New Zealand

New Zealand


N30°
Tropic of Cancer
N10°
Equator
S10°
Tropic of Capricorn
S30°
E170°
Antimeridian
W170°
E150°
W150°
E130°
W130°
E110°
S50°
Antarctic Circle
S70°
S90°

Defence Technology Agency

Tiritiri Matangi

Whangaparaoa

DTA SSA
Observatory

North Shore

Rangitoto

dta
Defence Technology Agency

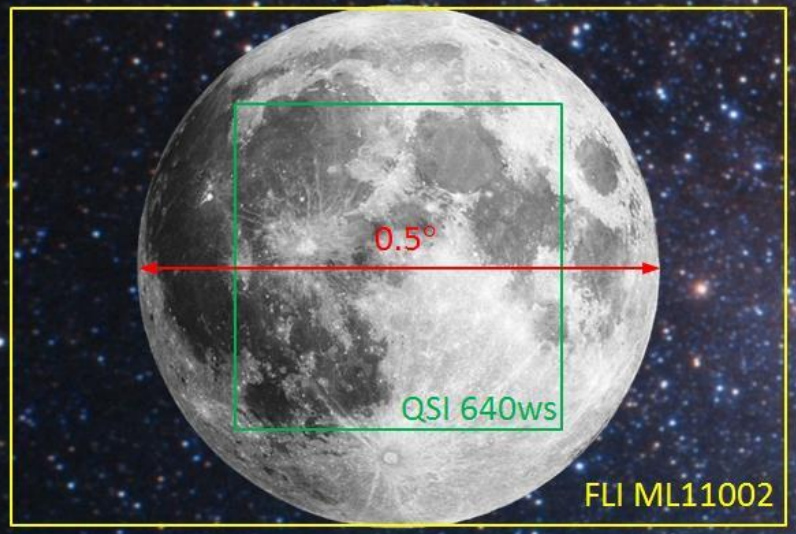
Harbour Bridge

Auckland CBD

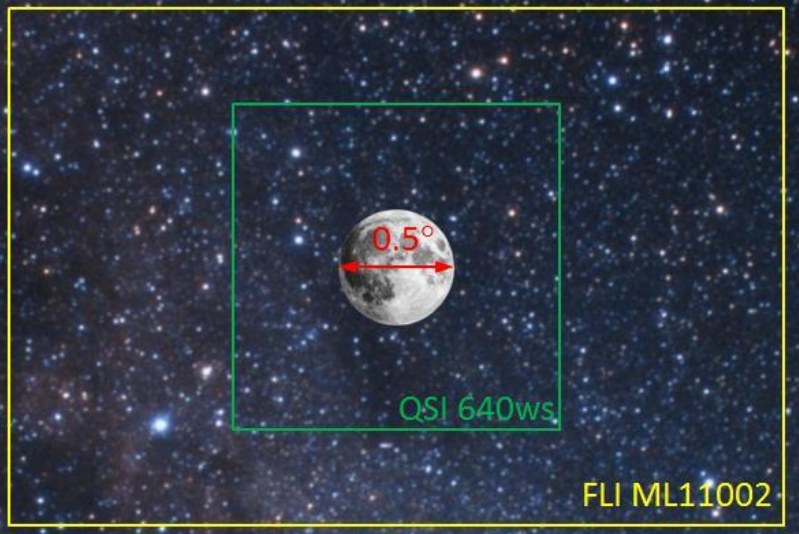

Paramount MEII
Celestron
EdgeHD 11
Celestron RASA 11
DTA QuadCam
FLI ML11002
QSI 640ws
DTA SSA Observatory
Whangaparaoa, Auckland, New Zealand
36° 36′ 08.5″ S
174° 50′ 05.6″ E
Elevation: 132 m (WGS84)
Ruru
Kiwi

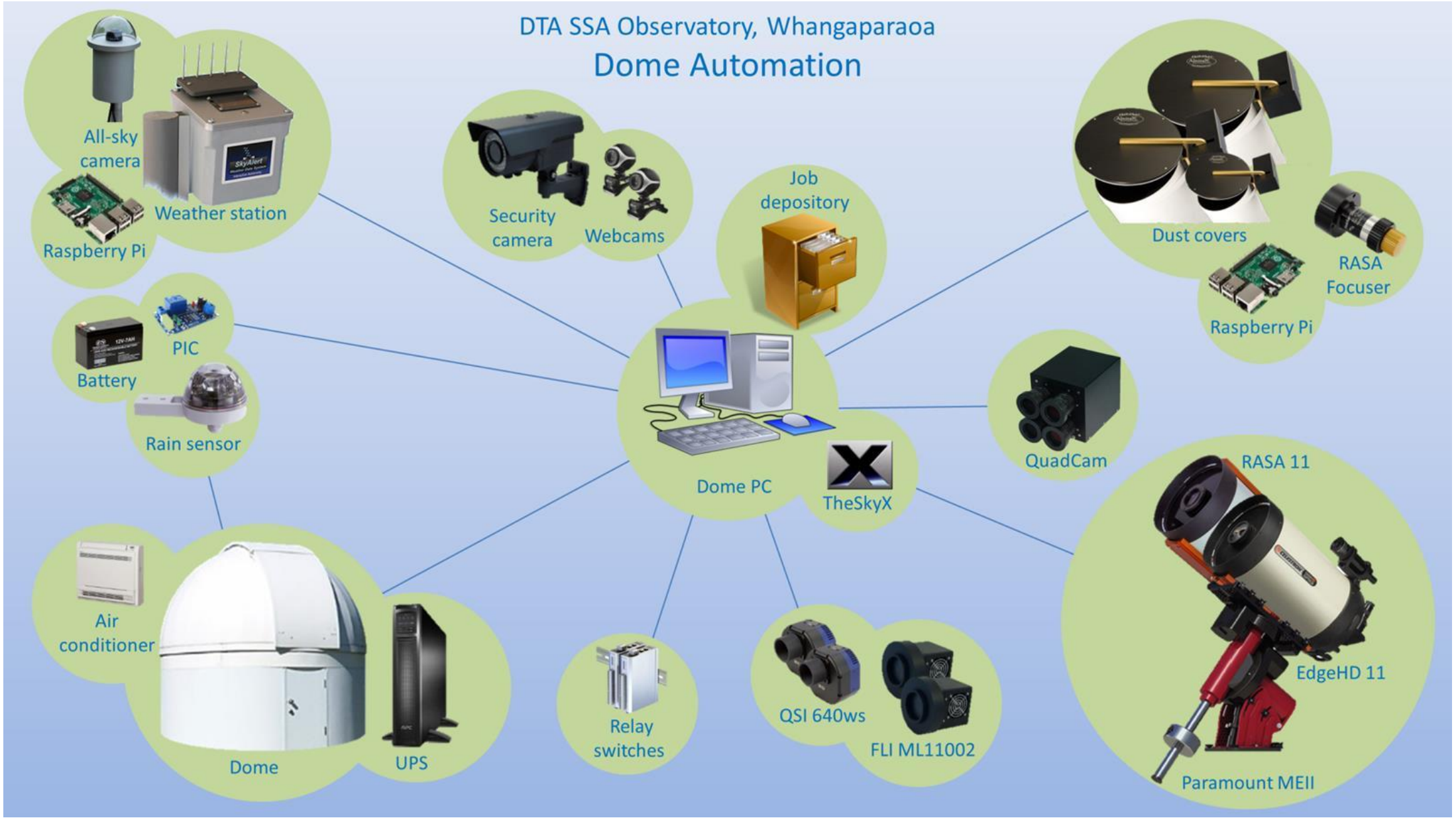
Field of view comparison

EdgeHD 11 (2800 mm)



RASA 11 (620 mm)




DTA SSA Observatory, Whangaparaoa
Dome Automation
All-sky camera
Weather station
Raspberry Pi
Security camera
Webcams
Job depository
Dust covers
RASA Focuser
Raspberry Pi
Battery
PIC
Rain sensor
Dome PC
TheSkyX
QuadCam
RASA 11
EdgeHD 11
Paramount MEII
Air conditioner
Dome
UPS
Relay switches
QSI 640ws
FLI ML11002

Orbit classification

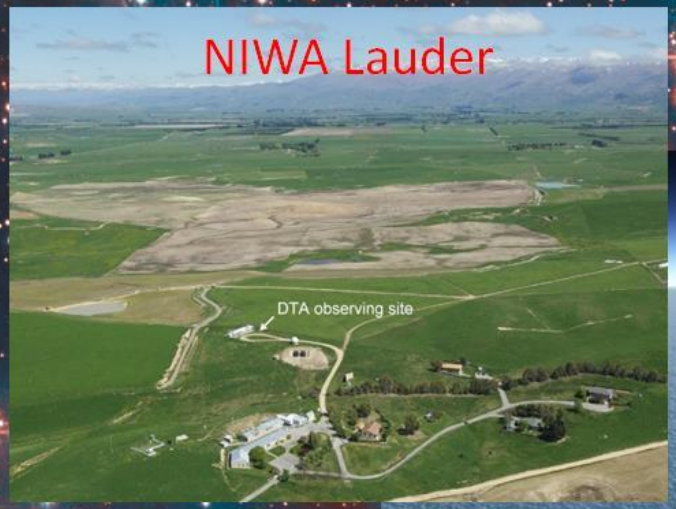
- Low Earth Orbit (LEO)
  - Altitude: 160 km – 2000 km
  - Period: 84 min – 127 min
- Medium Earth Orbit (MEO)
  - Altitude: 2000 km – 35786 km
  - Period: 127 min – 23 h 56 min
- Geostationary Earth Orbit (GEO)
  - Altitude: 35786 km
  - Period: 23 h 56 min
- High Earth Orbit (HEO)
  - Altitude > 35786 km
  - Period > 23 h 56 min

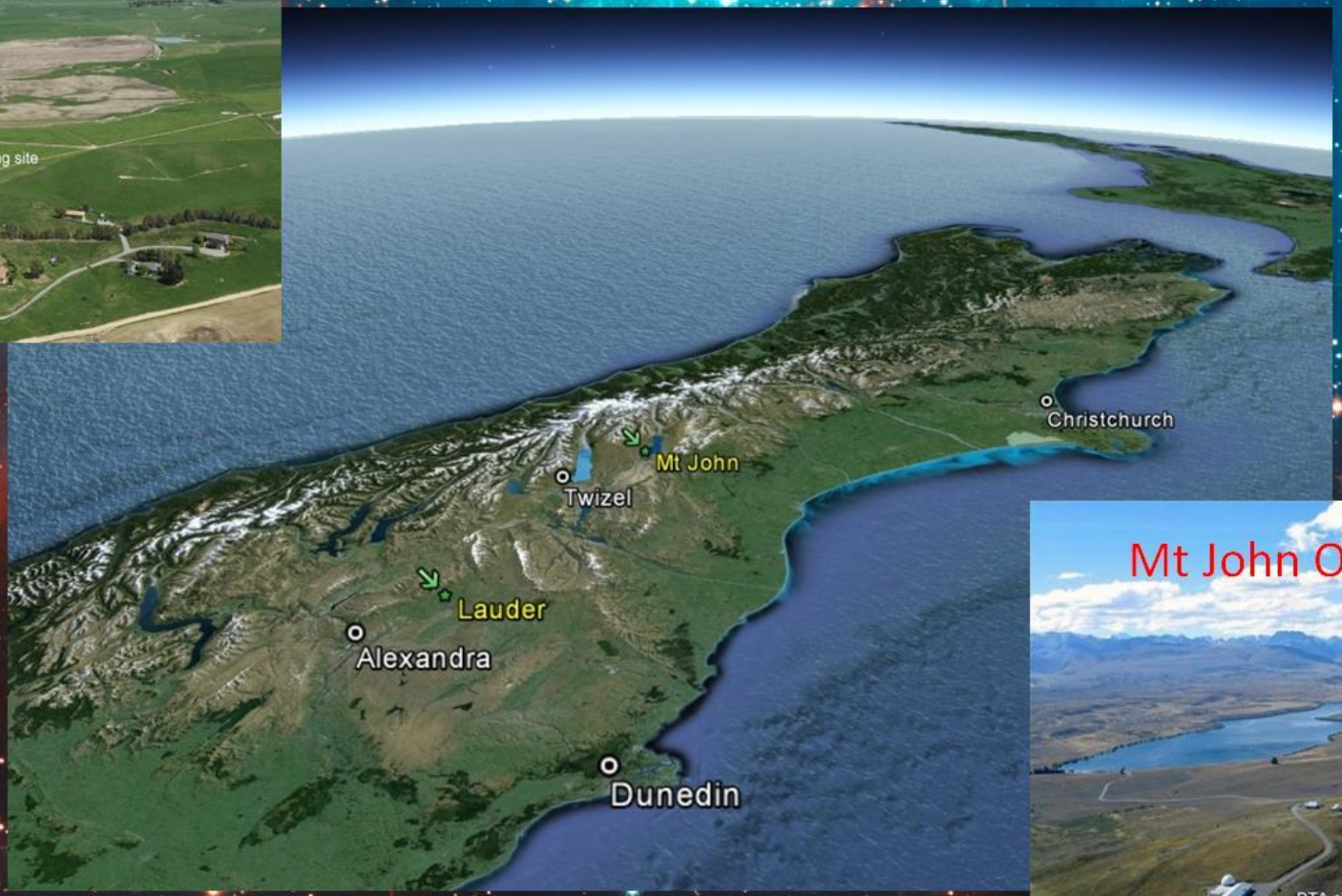

In the beginning...
Automated Transfer Vehicle ATV-5


ATV-5 atmospheric re-entry

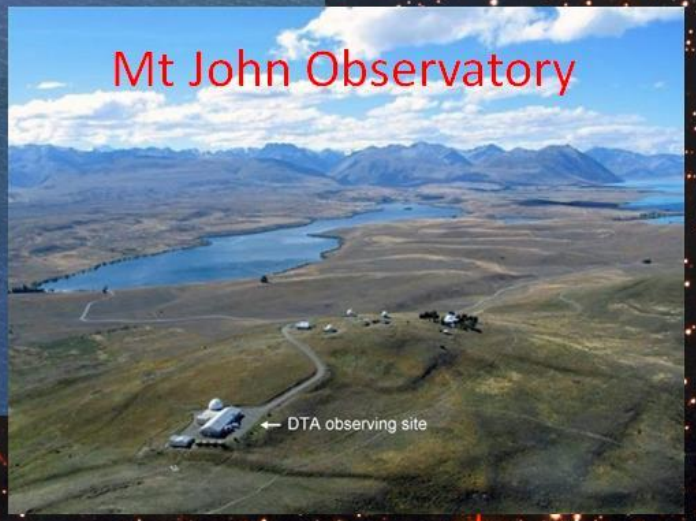
Locations

NIWA Lauder



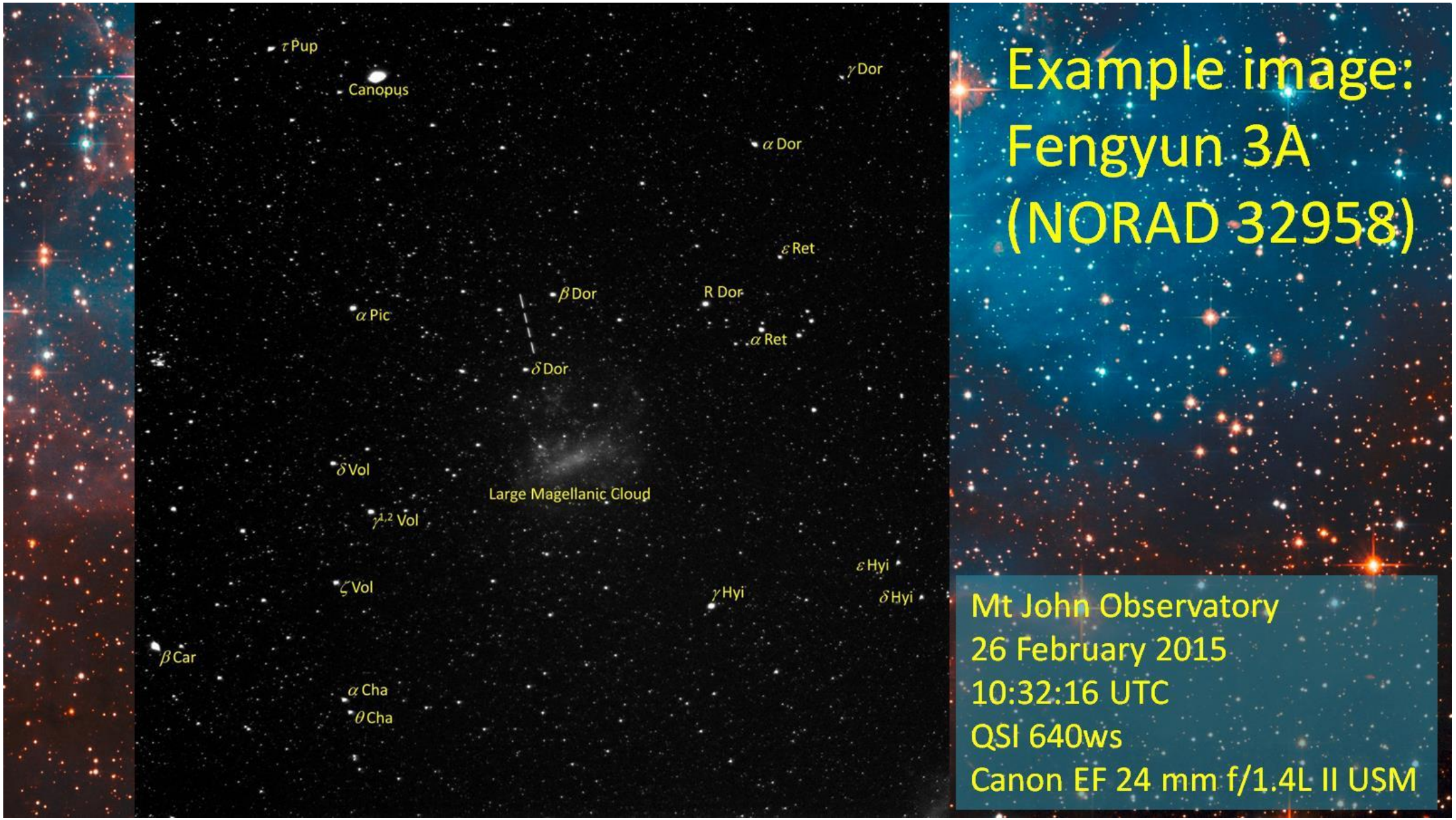


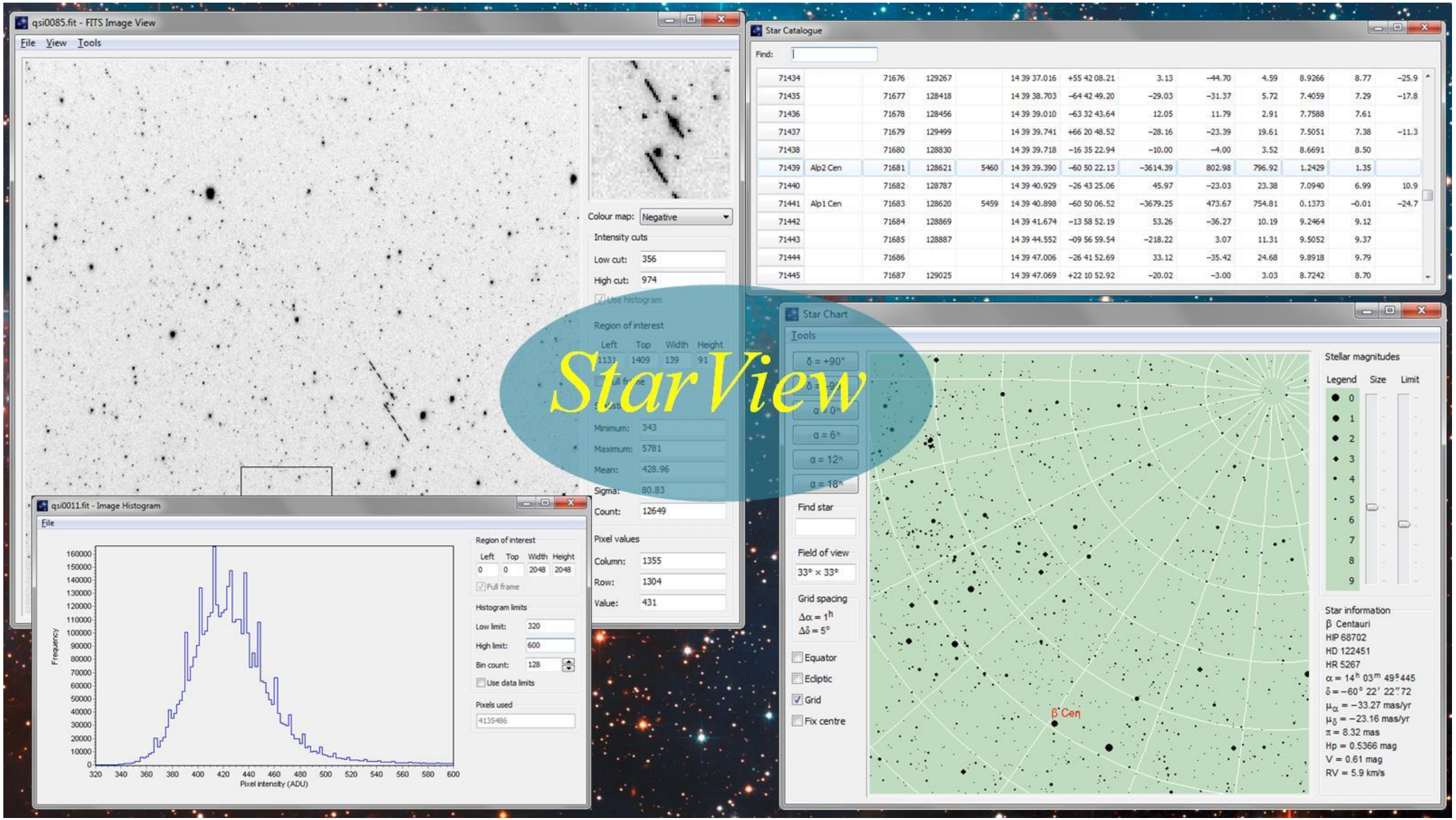
Mt John Observatory



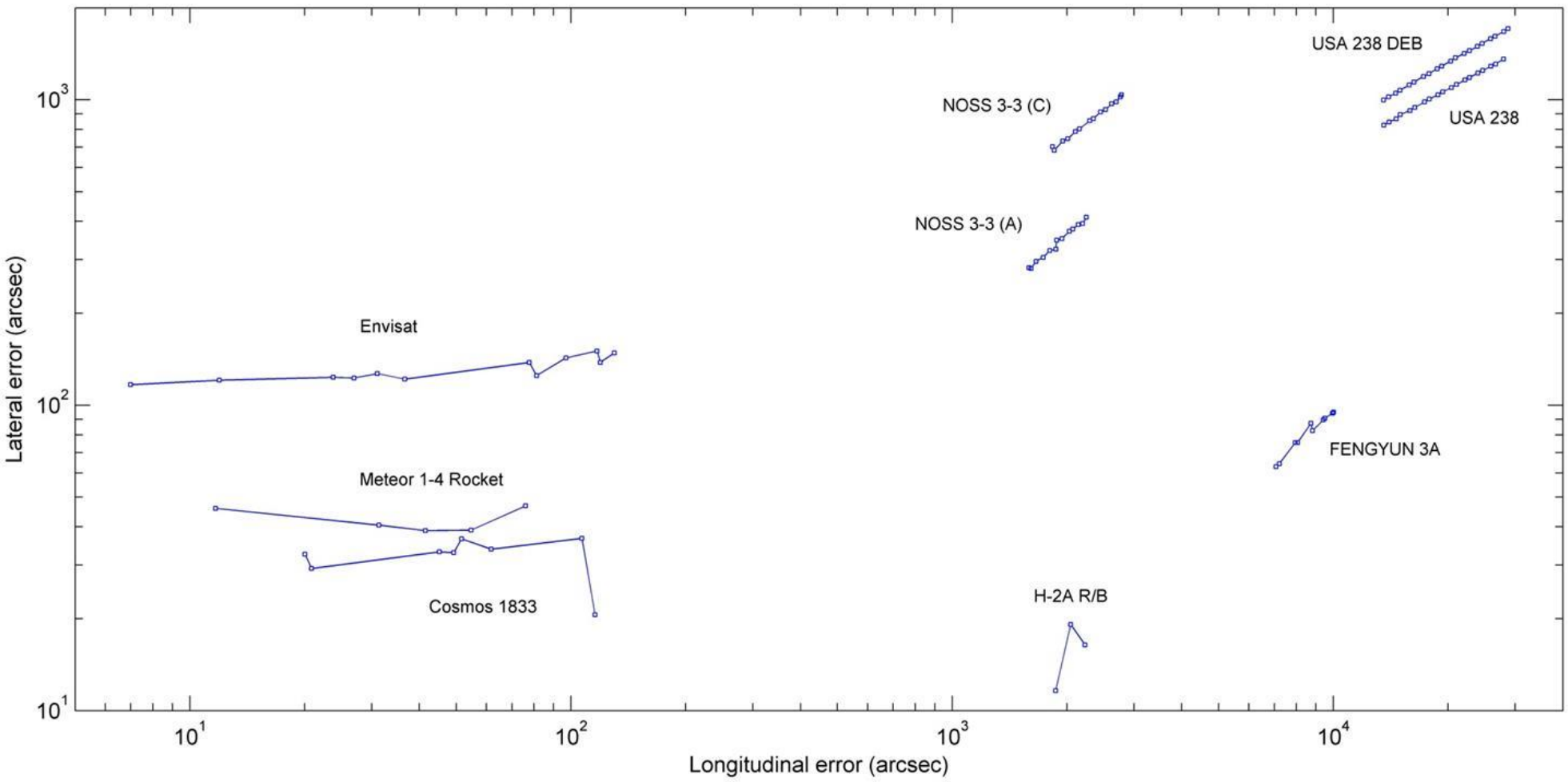
Equipment

Location	*Camera*	*Lens*	*Mount*
Mt John	Canon EOS 1000D	Canon EF 50mm f/1.4	Sky-Watcher EQ6 Pro
	Canon EOS 1200D	Canon EF 50mm f/1.8 II	Fixed tripod
	QSI 640ws	Canon EF 24mm f/1.4L II USM	Sky-Watcher EQ6 Pro
NIWA Lauder	Canon EOS 40D	Canon EF 50mm f/1.8 II	Sky-Watcher EQ6 Pro
	Canon EOS 6D	Canon EF 50mm f/1.8 II	Sky-Watcher EQ6 Pro
	QSI 640ws	Canon EF 24mm f/1.4L II USM	Sky-Watcher EQ6 Pro
	Olympus E-M1	Olympus M.Zuiko 17mm f/1.8	Fixed tripod


τ Pup
Canopus
γ Dor
α Dor
ε Ret
β Dor
R Dor
α Pic
α Ret
δ Dor
δ Vol
Large Magellanic Cloud
γ1,2 Vol
ε Hyi
ζ Vol
γ Hyi
δ Hyi
β Car
α Cha
θ Cha
Example image:
Fengyun 3A
(NORAD 32958)
Mt John Observatory
26 February 2015
10:32:16 UTC
QSI 640ws
Canon EF 24 mm f/1.4L II USM


qsi0085.fit - FITS Image View
File View Tools
Colour map: Negative
Intensity cuts
Low cut: 356
High cut: 974
Use histogram
Region of interest
Left Top Width Height
1131 1409 139 91
Full frame
Minimum: 343
Maximum: 5781
Mean: 428.96
Sigma: 80.83
Count: 12649
Pixel values
Column: 1355
Row: 1304
Value: 431
Star Catalogue
Find:
71434 71676 129267 14 39 37.016 +55 42 08.21 3.13 −44.70 4.59 8.9266 8.77 −25.9
71435 71677 128418 14 39 38.703 −64 42 49.20 −29.03 −31.37 5.72 7.4059 7.29 −17.8
71436 71678 128456 14 39 39.010 −63 32 43.64 12.05 11.79 2.91 7.7588 7.61
71437 71679 129499 14 39 39.741 +66 20 48.52 −28.16 −23.39 19.61 7.5051 7.38 −11.3
71438 71680 128830 14 39 39.718 −16 35 22.94 −10.00 −4.00 3.52 8.6691 8.50
71439 Alp2 Cen 71681 128621 5460 14 39 39.390 −60 50 22.13 −3614.39 802.98 796.92 1.2429 1.35
71440 71682 128787 14 39 40.929 −26 43 25.06 45.97 −23.03 23.38 7.0940 6.99 10.9
71441 Alp1 Cen 71683 128620 5459 14 39 40.898 −60 50 06.52 −3679.25 473.67 754.81 0.1373 −0.01 −24.7
71442 71684 128869 14 39 41.674 −13 58 52.19 53.26 −36.27 10.19 9.2464 9.12
71443 71685 128887 14 39 44.552 −09 56 59.54 −218.22 3.07 11.31 9.5052 9.37
71444 71686 14 39 47.006 −26 41 52.69 33.12 −35.42 24.68 9.8918 9.79
71445 71687 129025 14 39 47.069 +22 10 52.92 −20.02 −3.00 3.03 8.7242 8.70
StarView
qsi0011.fit - Image Histogram
File
Region of interest
Left Top Width Height
0 0 2048 2048
Full frame
Histogram limits
Low limit: 320
High limit: 600
Bin count: 128
Use data limits
Pixels used
4135486
Frequency
Pixel intensity (ADU)
Star Chart
Tools
δ = +90°
α = 0h
α = 6h
α = 12h
α = 18h
Find star
Field of view
33° × 33°
Grid spacing
Δα = 1h
Δδ = 5°
Equator
Ecliptic
Grid
Fix centre
β Cen
Stellar magnitudes
Legend Size Limit
Star information
β Centauri
HIP 68702
HD 122451
HR 5267
α = 14h 03m 49s.445
δ = −60° 22′ 22″.72
μα = −33.27 mas/yr
μδ = −23.16 mas/yr
π = 8.32 mas
Hp = 0.5366 mag
V = 0.61 mag
RV = 5.9 km/s

Prediction error



δ Mus

#10992

Polarimetric observations

(2017)

β Mus

γ Mus

α Mus

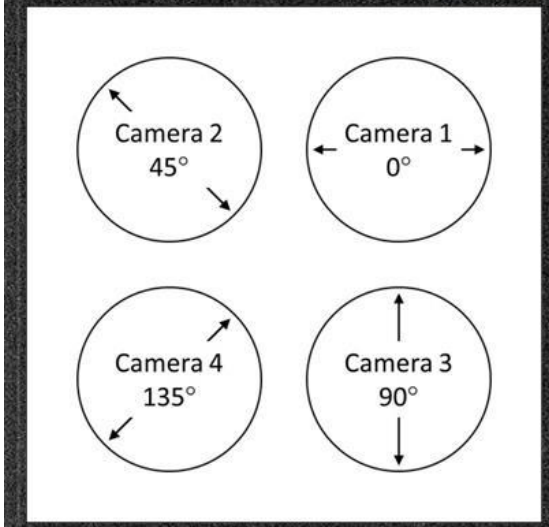
DTA QuadCam

- Original Dstl design (Privett et al. 2012)
- Four identical Starlight Xpress SuperStar CCD cameras (1392 × 1040, pixel size: 4.65 µm)
- Nikon AF NIKKOR 50 mm f/1.8D lenses
- UV/IR blocking filters + linear polarisers

DTA-specific features:

- Each camera controlled by a separate mini-computer (Raspberry Pi 3) for faster readout and to ensure that the four images are taken simultaneously.
- Specialised GPS unit used to monitor the shutter signals and record the time of exposure with accuracy better than 1 ms.

Stokes parameters

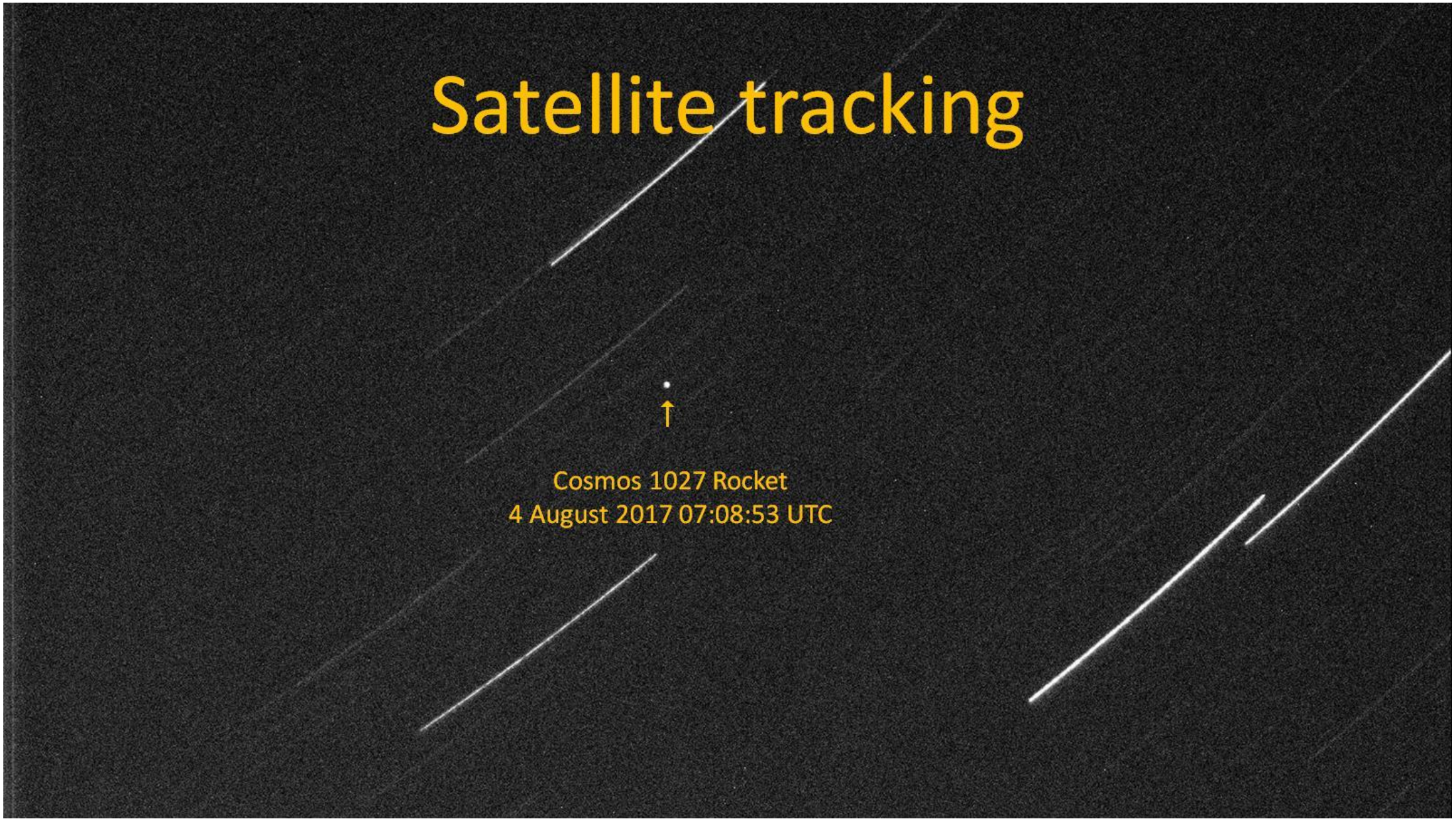


$$S_0 = I_{0°} + I_{90°} = I_{45°} + I_{135°}$$
$$S_1 = I_{0°} - I_{90°}$$
$$S_2 = I_{45°} - I_{135°}$$

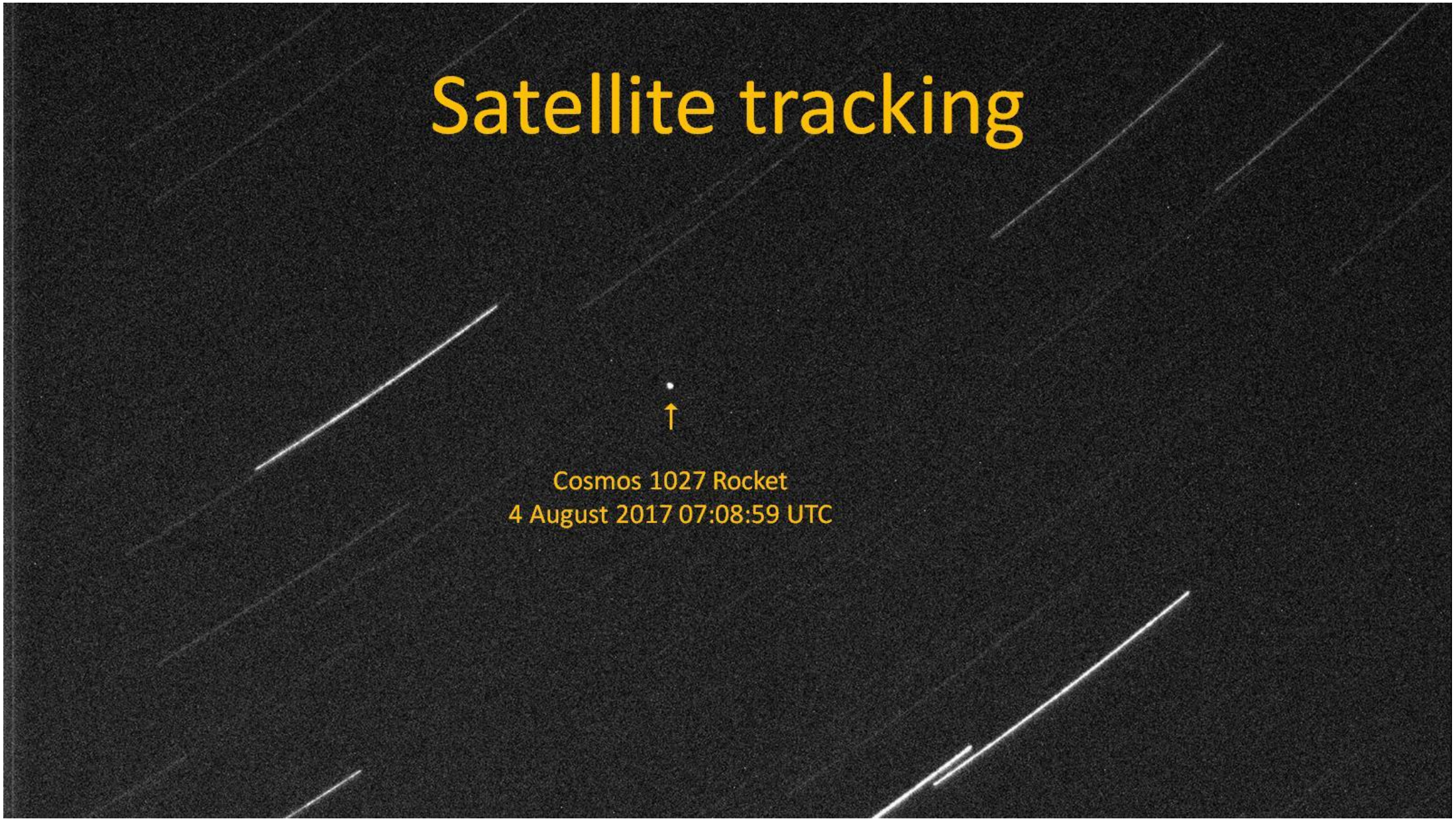
$$s_1 = 2\,S_1/S_0$$
$$s_2 = 2\,S_2/S_0$$

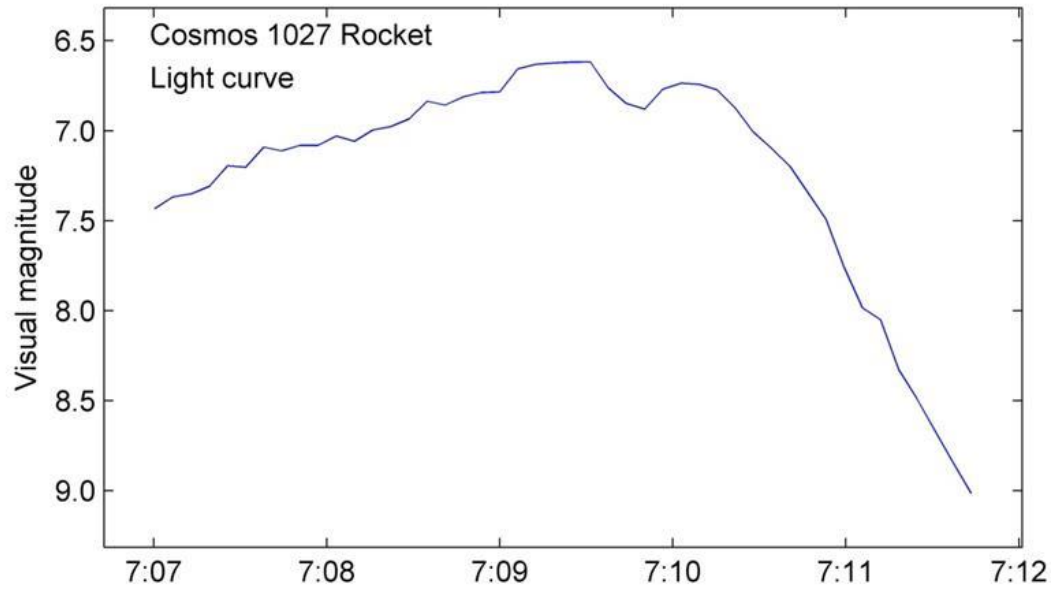
$$p = \sqrt{{s_1}^2 + {s_2}^2}$$
$$\theta = \frac{1}{2}\tan^{-1}\frac{s_2}{s_1}$$

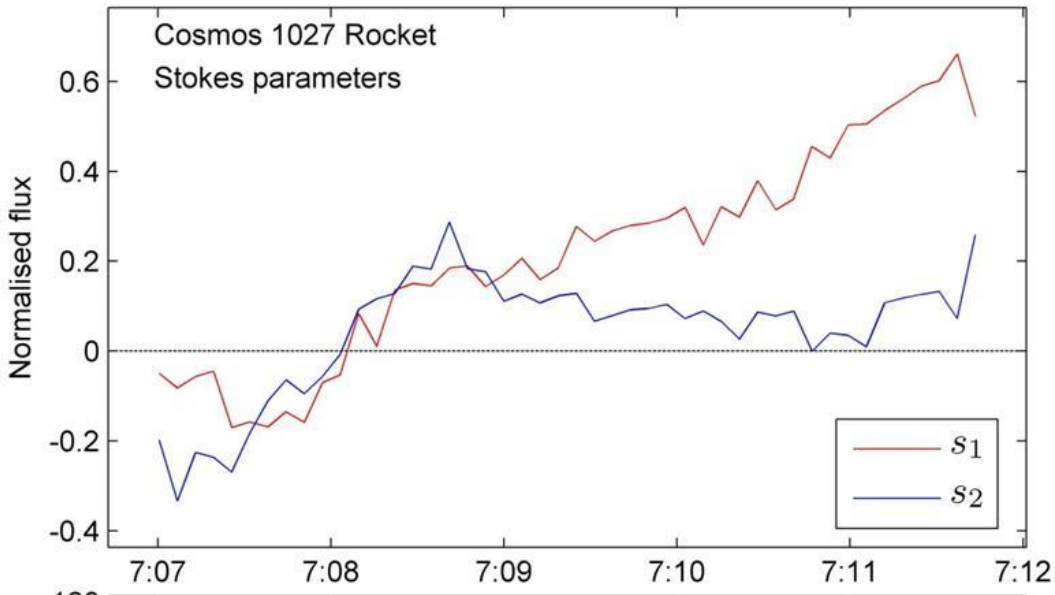
Satellite tracking

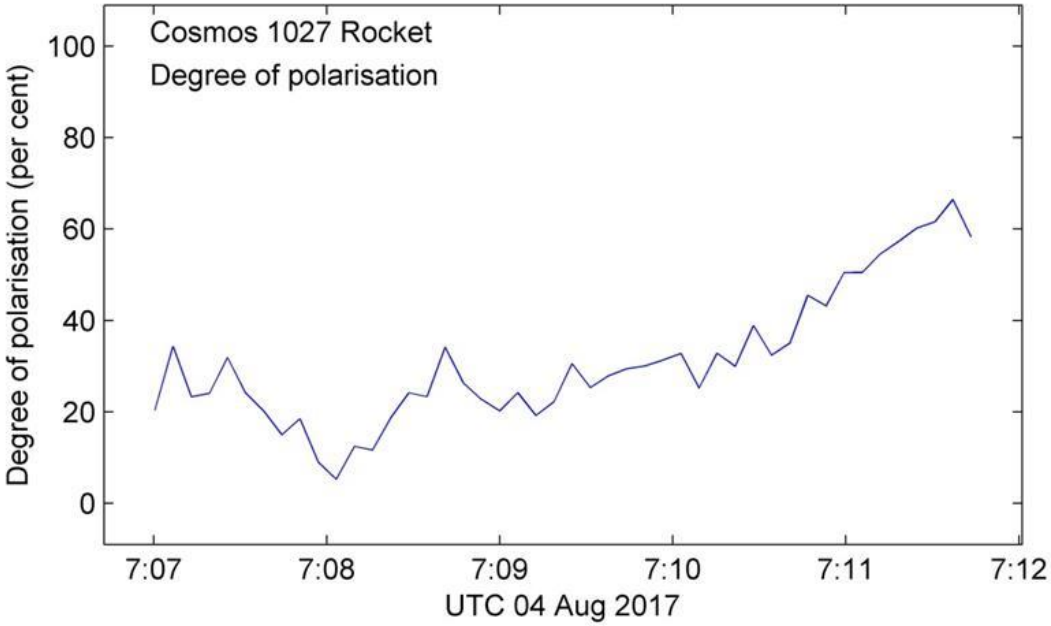


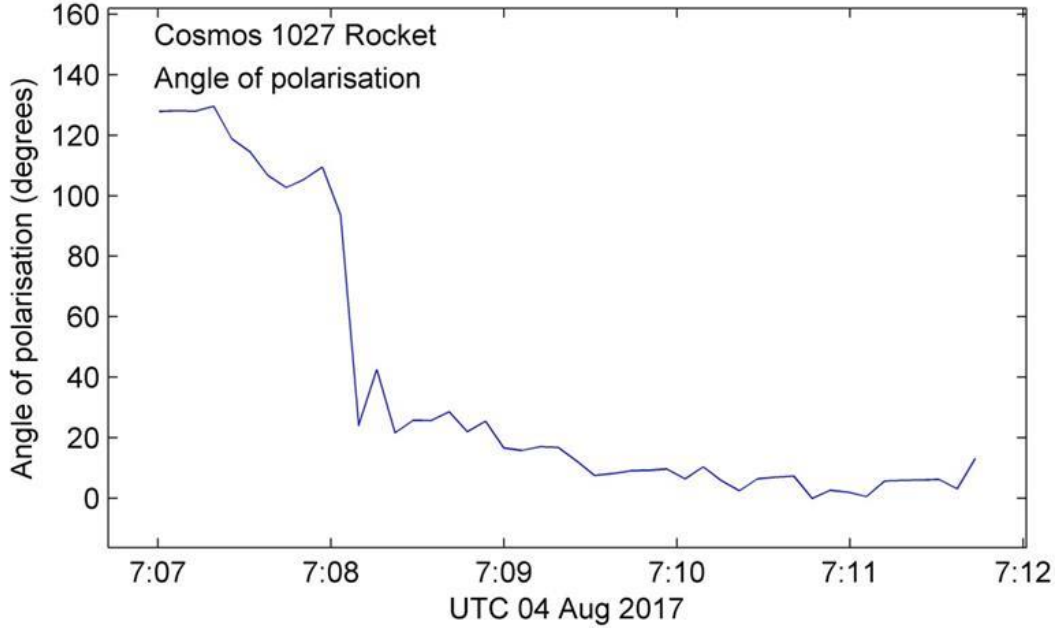
Satellite tracking

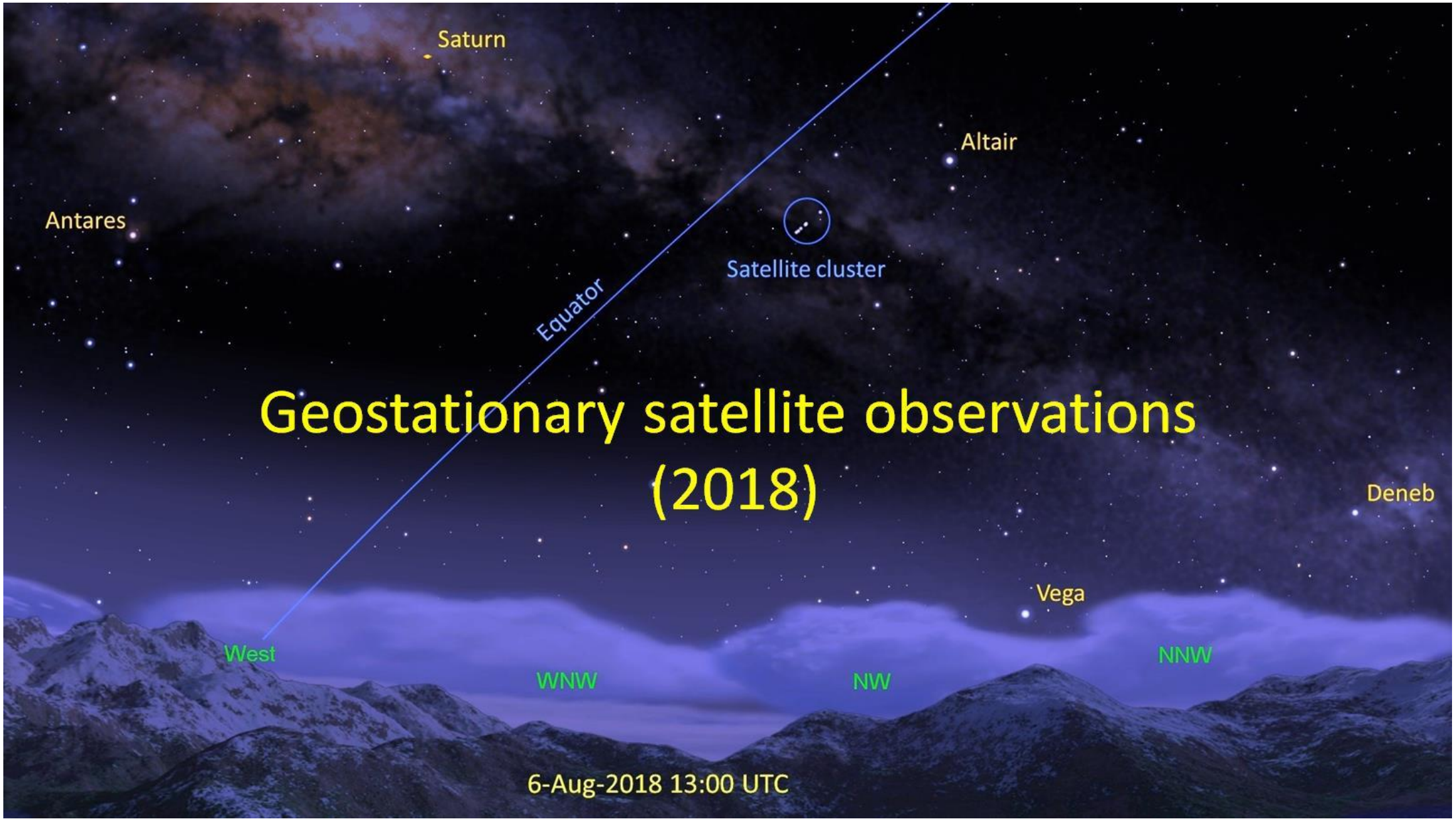


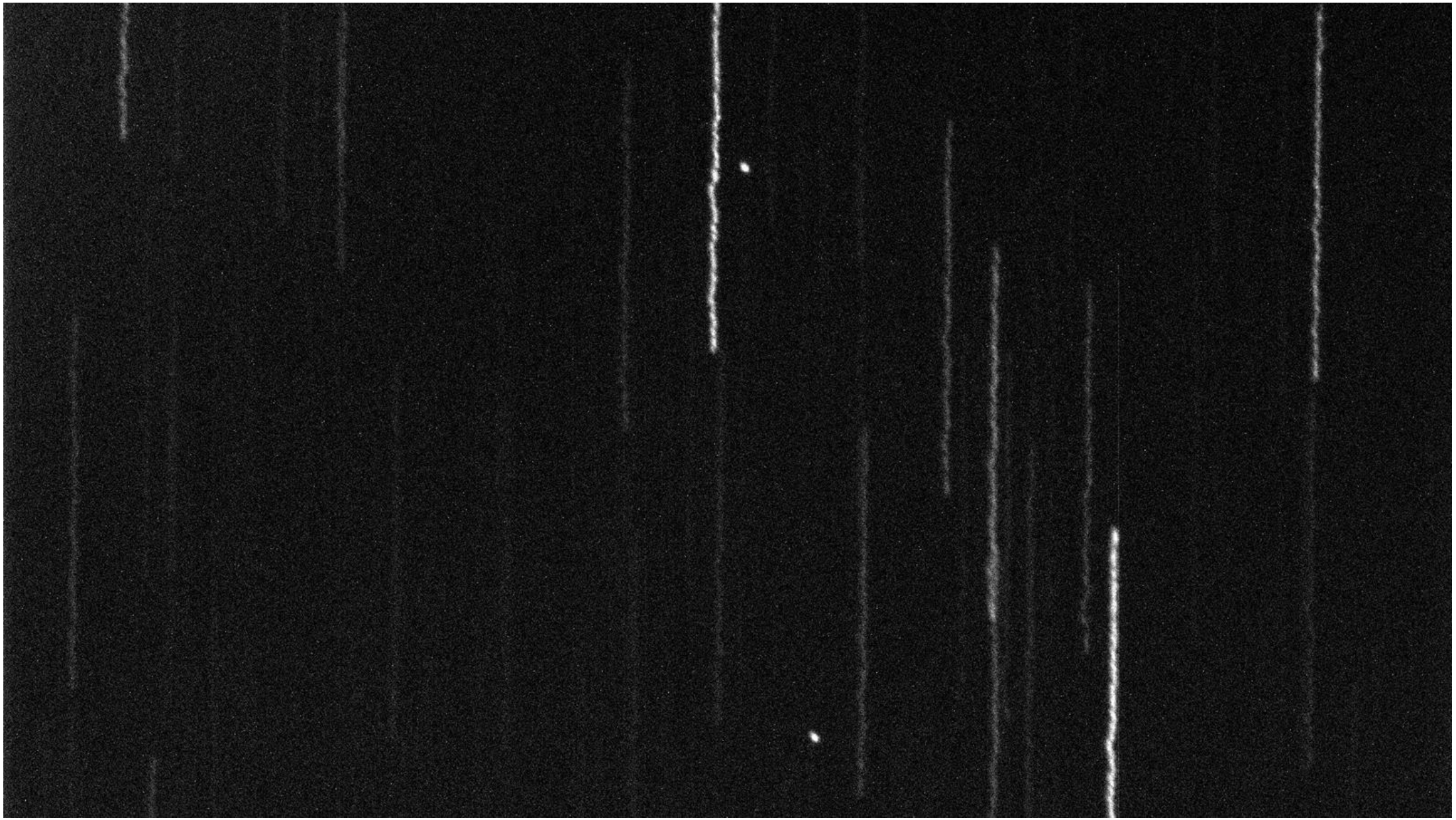

Cosmos 1027 Rocket
Light curve
Visual magnitude
6.5
7.0
7.5
8.0
8.5
9.0
7:07
7:08
7:09
7:10
7:11
7:12

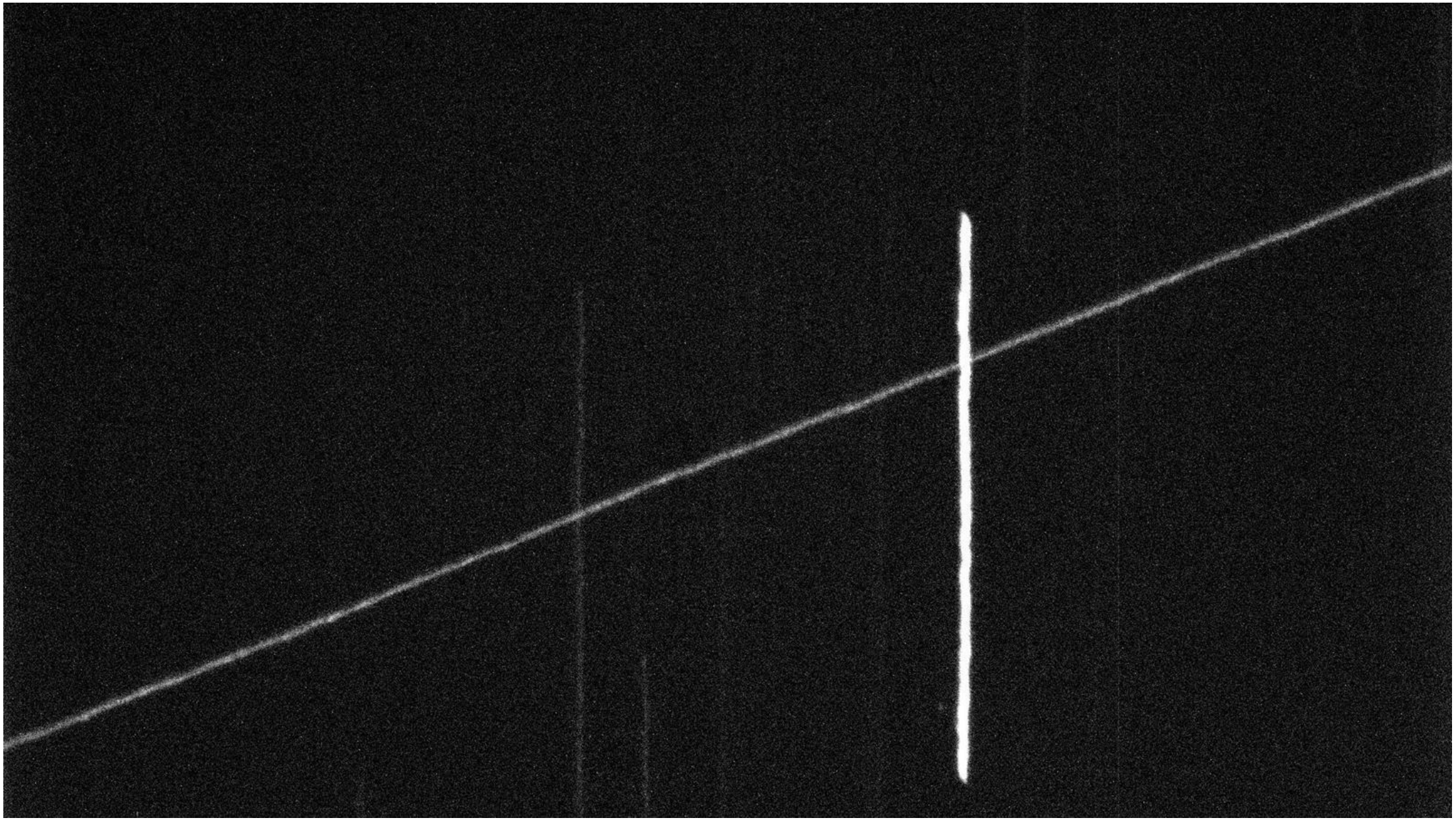

Cosmos 1027 Rocket
Stokes parameters
Normalised flux
0.6
0.4
0.2
0
-0.2
-0.4
s_1
s_2
7:07
7:08
7:09
7:10
7:11
7:12

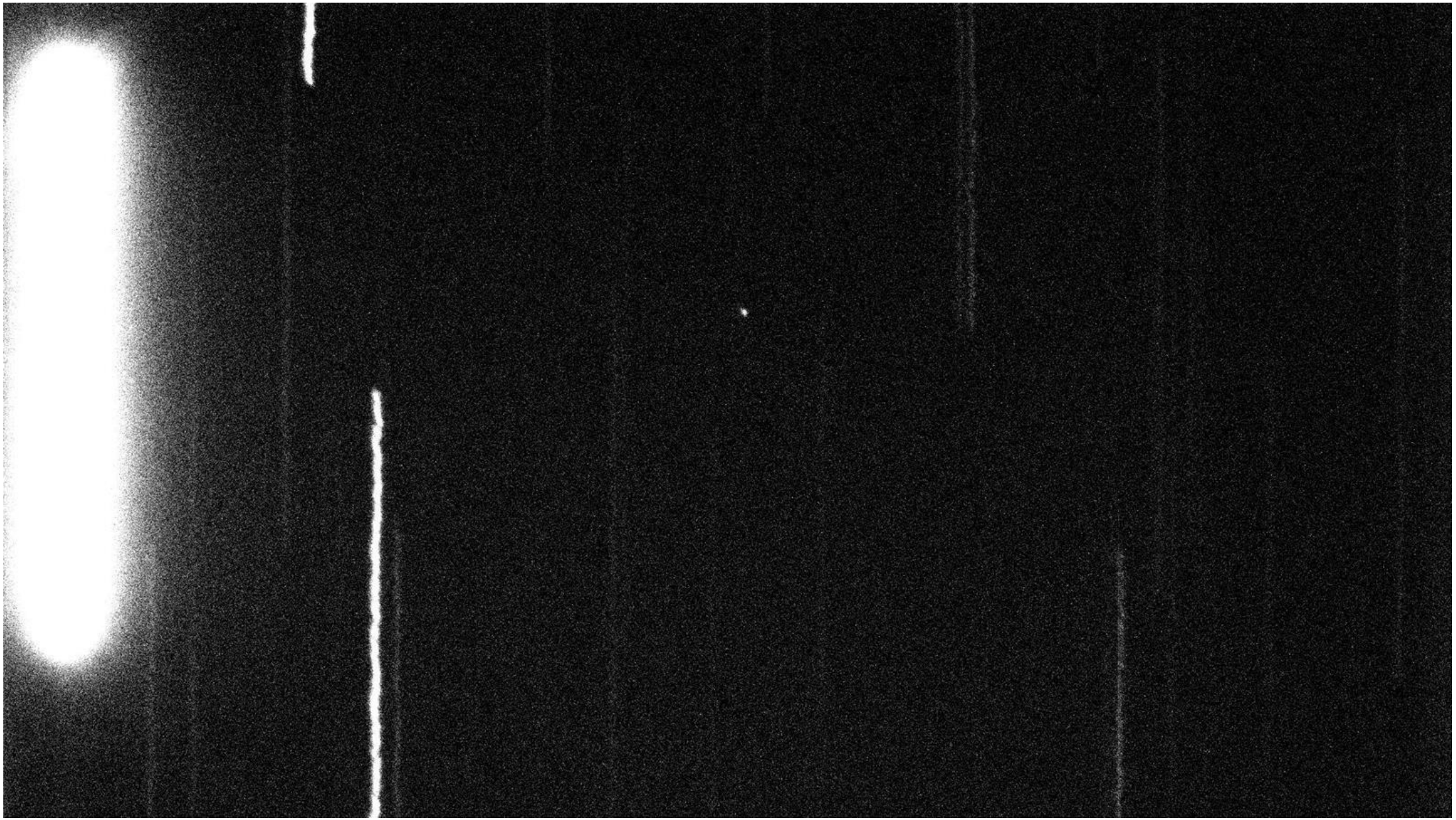

Cosmos 1027 Rocket
Degree of polarisation
Degree of polarisation (per cent)
100
80
60
40
20
0
7:07
7:08
7:09
7:10
7:11
7:12
UTC 04 Aug 2017

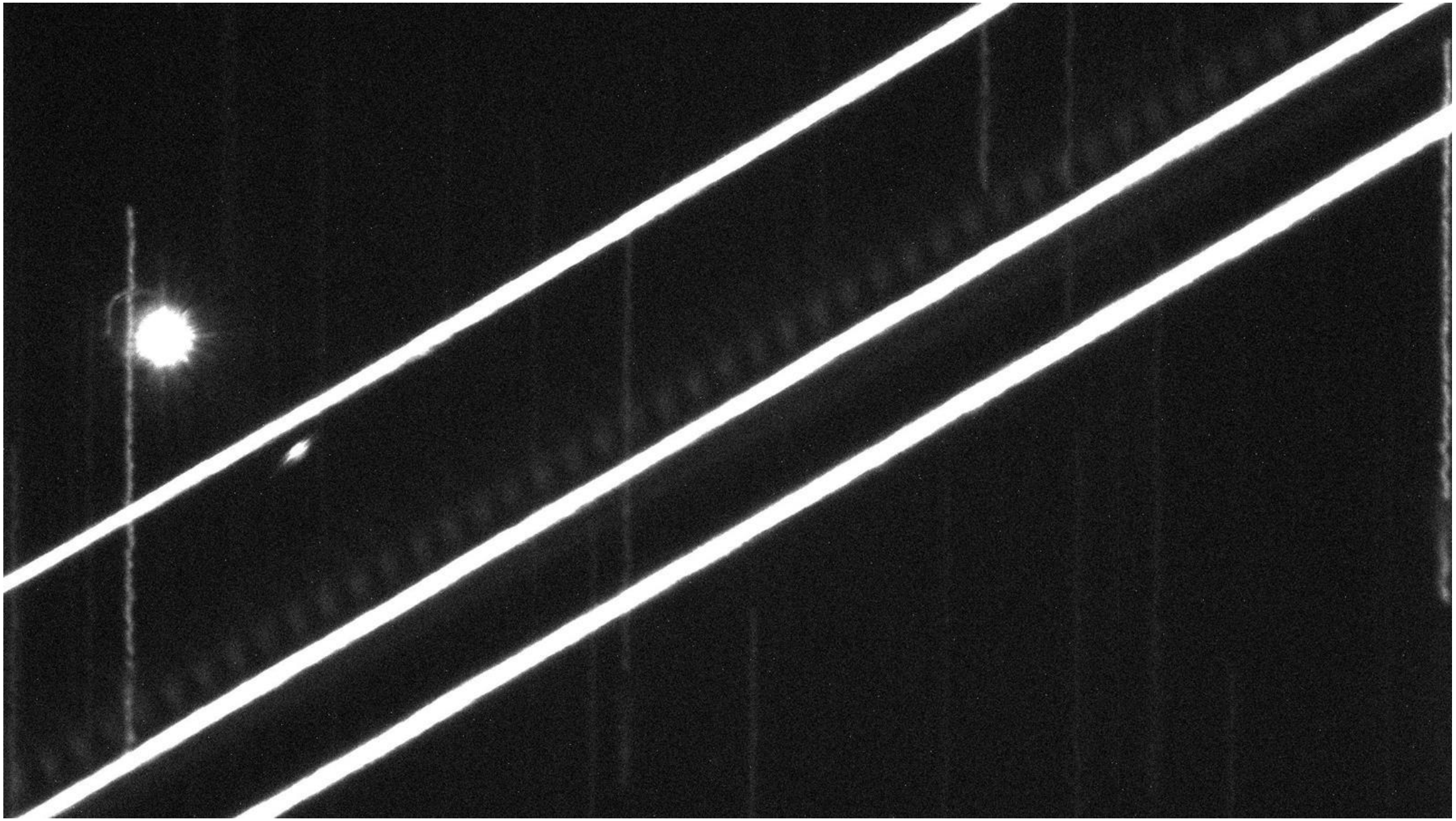

Cosmos 1027 Rocket
Angle of polarisation
Angle of polarisation (degrees)
160
140
120
100
80
60
40
20
0
7:07
7:08
7:09
7:10
7:11
7:12
UTC 04 Aug 2017

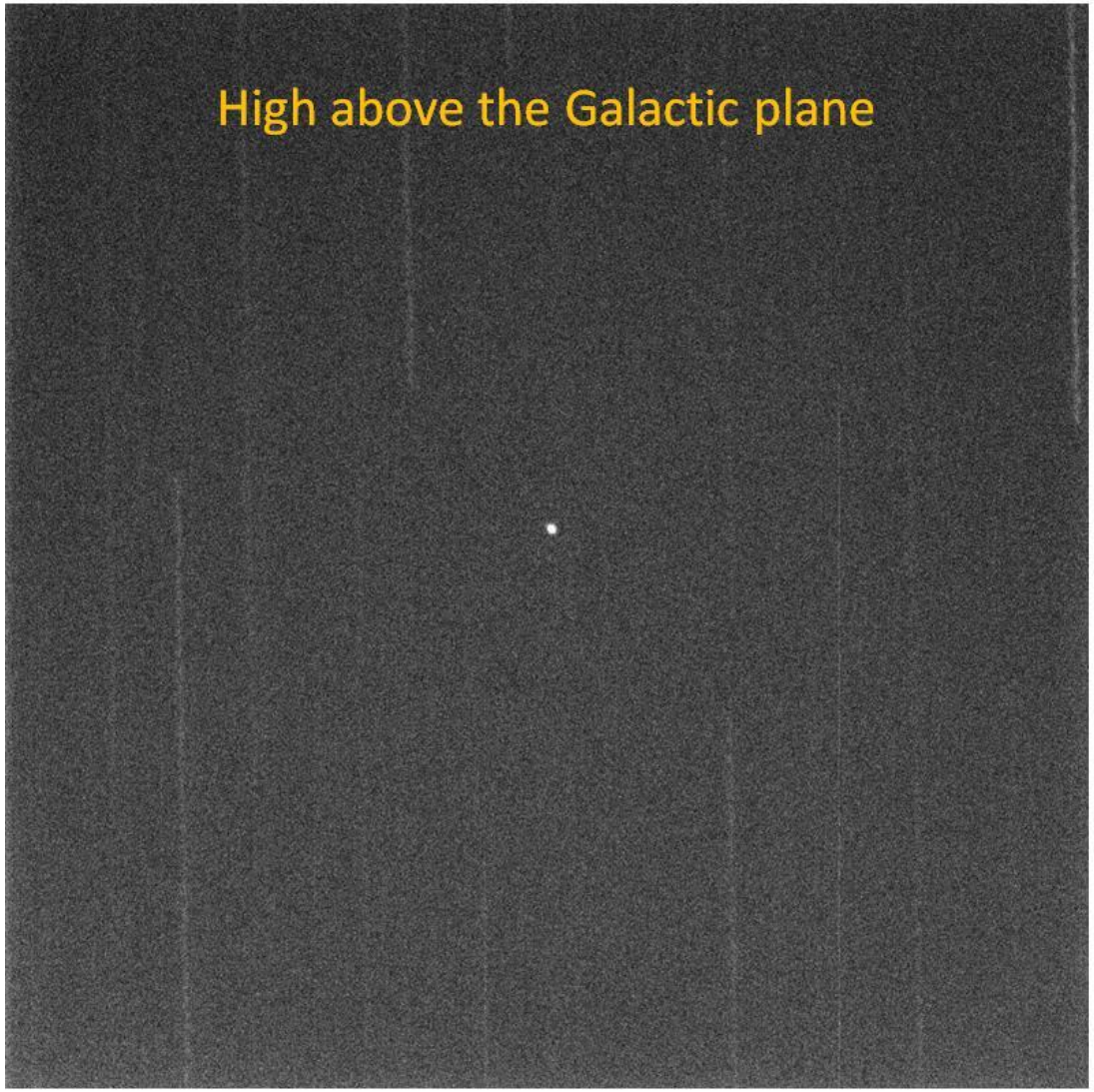

Saturn
Altair
Antares
Satellite cluster
Equator
Geostationary satellite observations
(2018)
Deneb
Vega
West
WNW
NW
NNW
6-Aug-2018 13:00 UTC

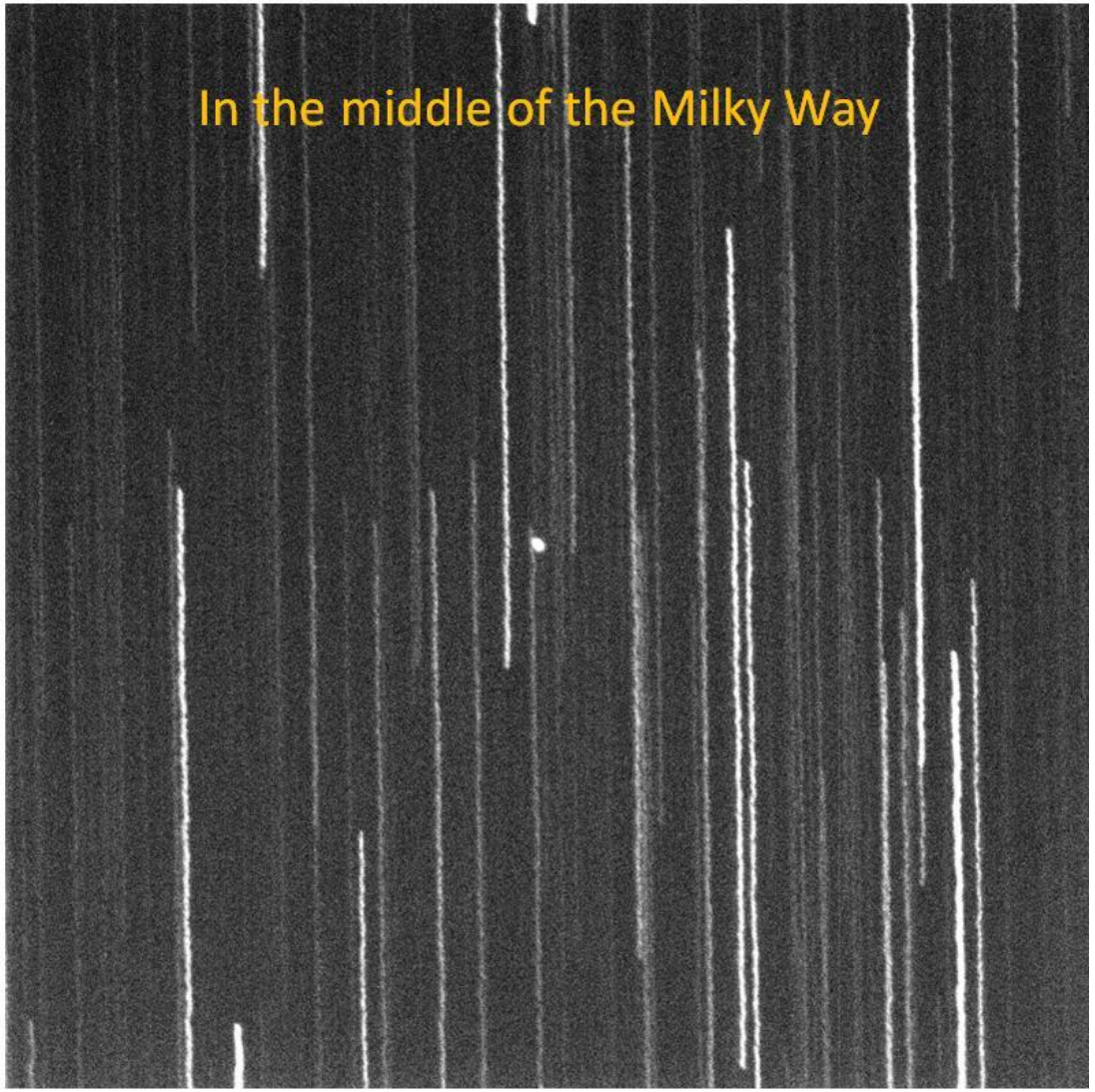


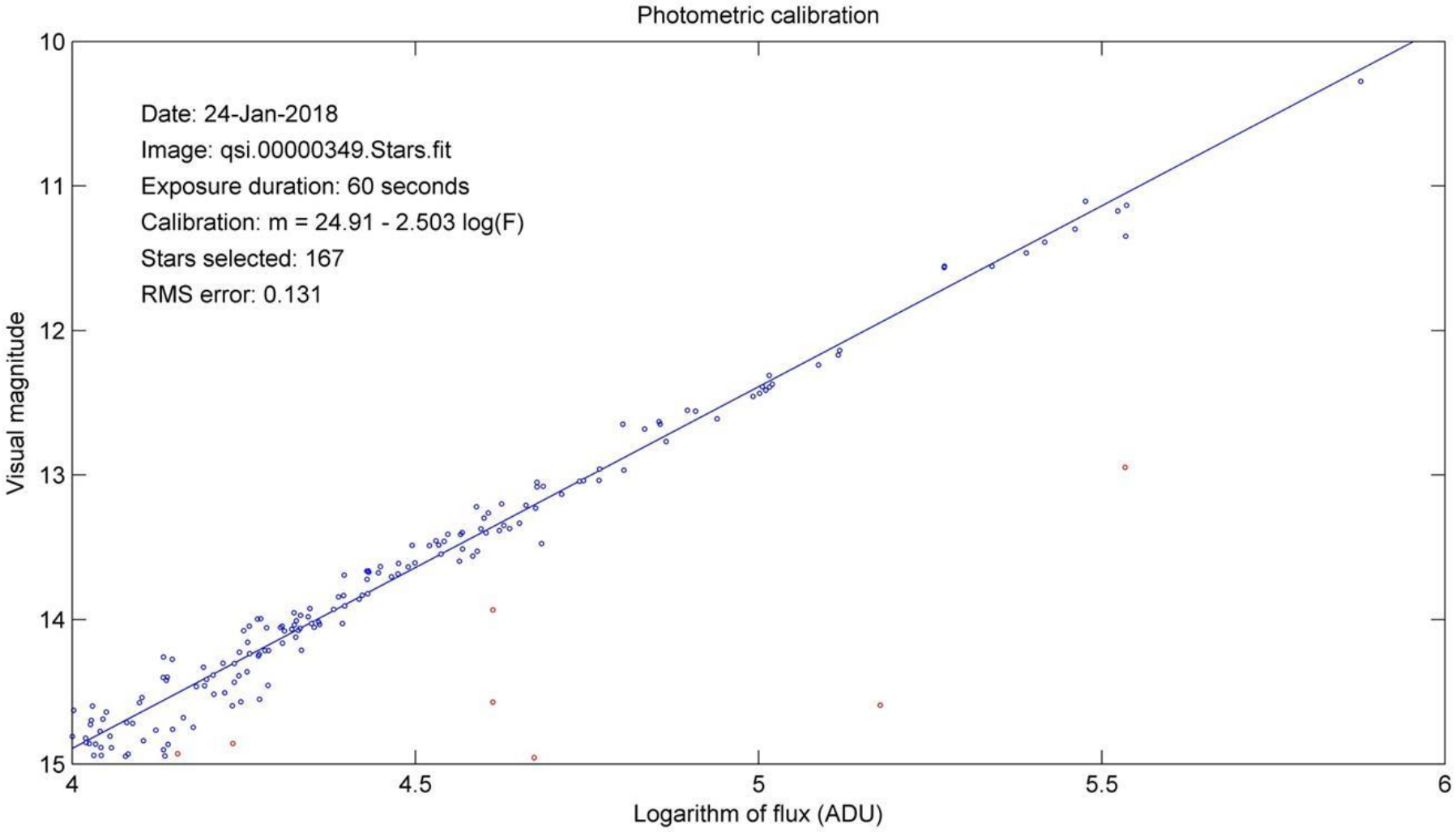




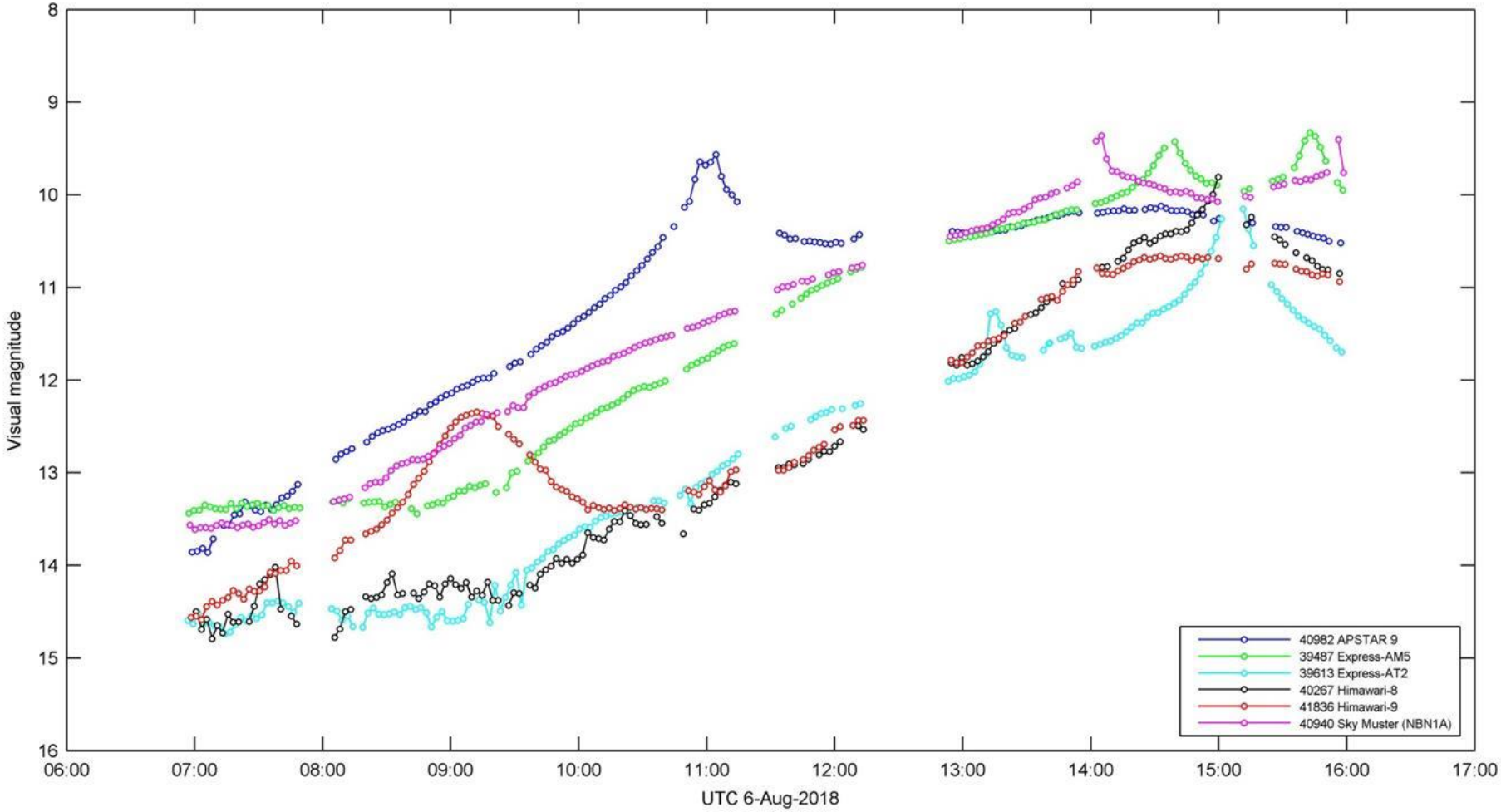


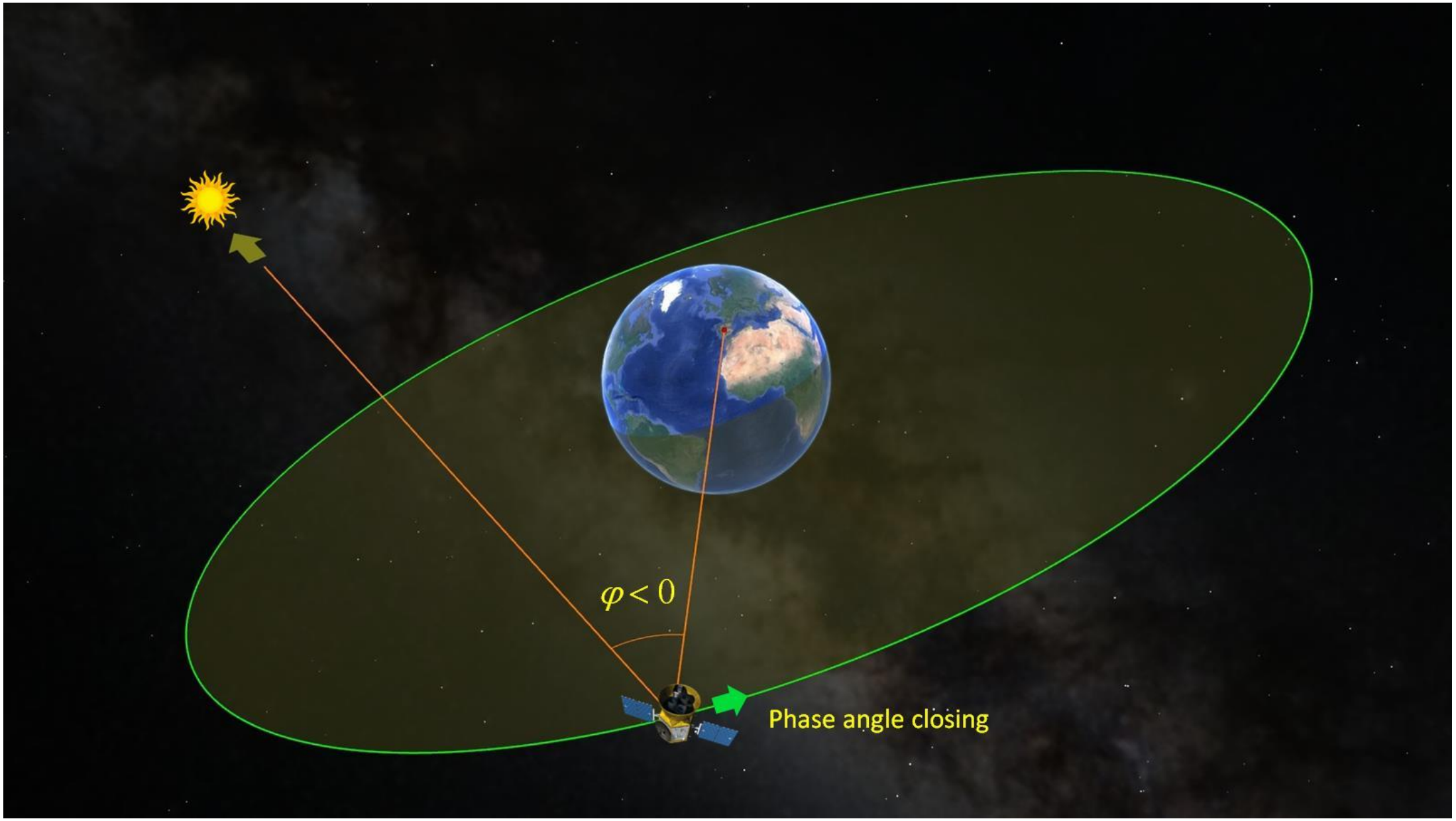

High above the Galactic plane

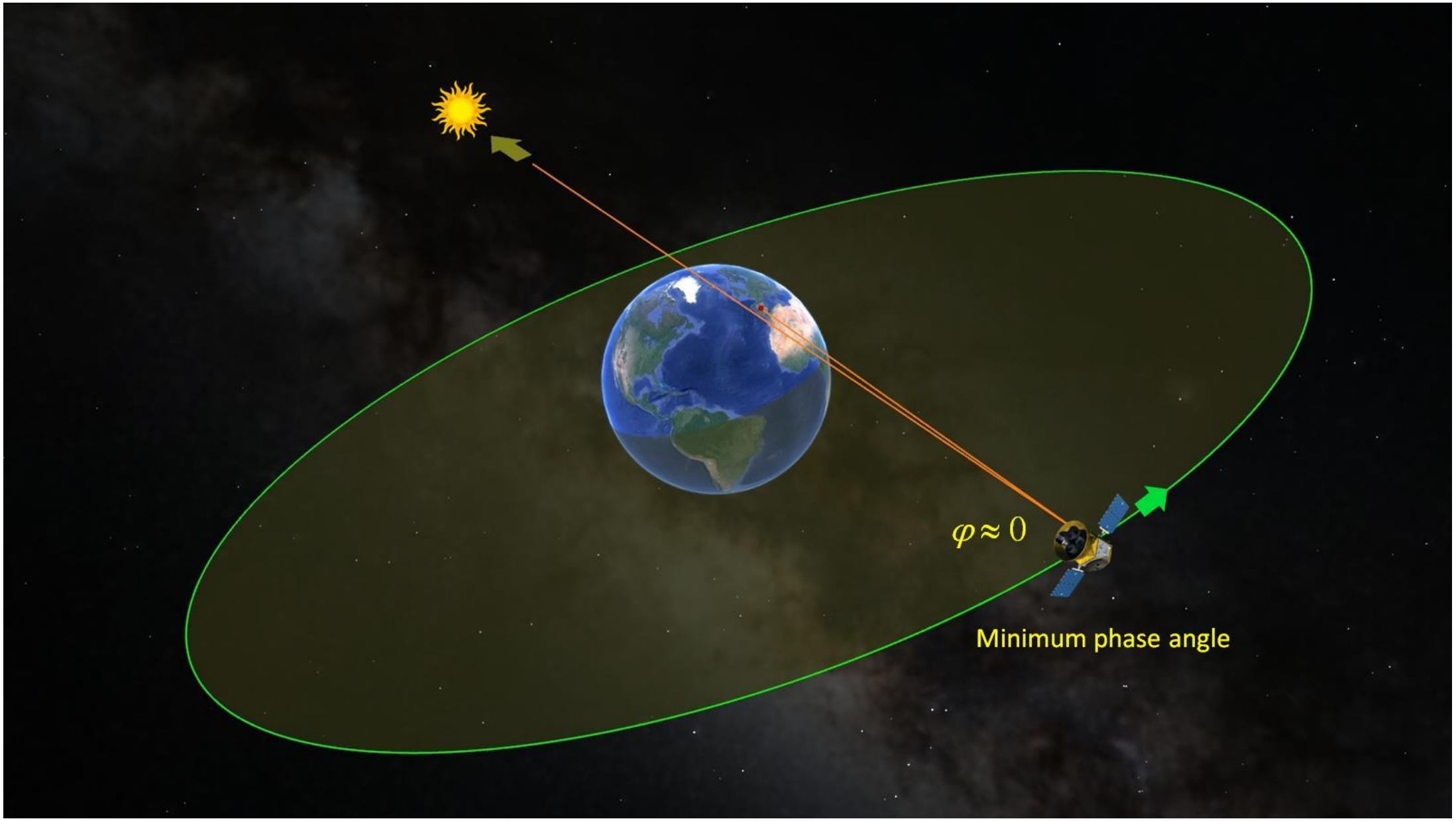

In the middle of the Milky Way

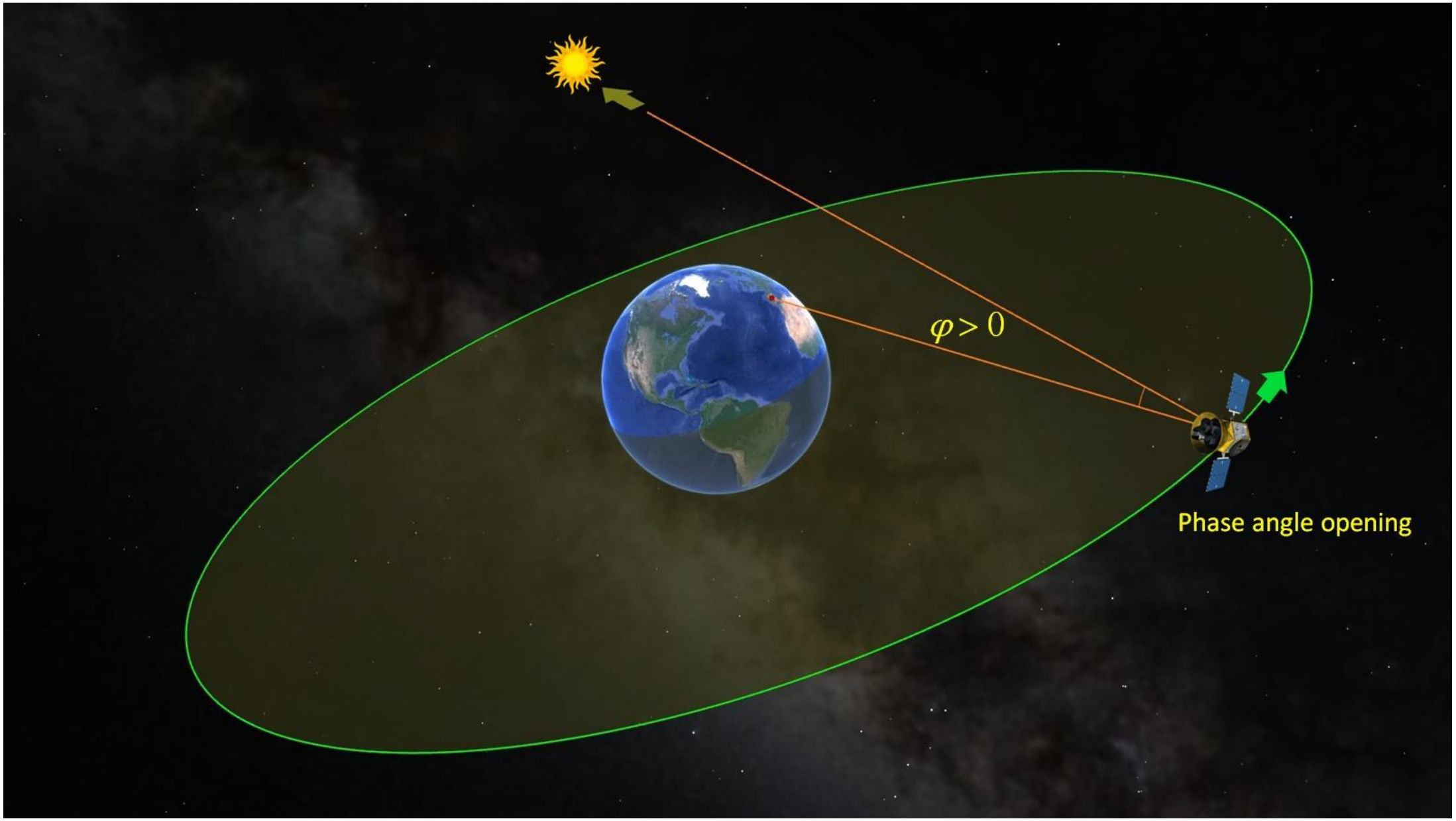

Photometric calibration
Date: 24-Jan-2018
Image: qsi.00000349.Stars.fit
Exposure duration: 60 seconds
Calibration: m = 24.91 - 2.503 log(F)
Stars selected: 167
RMS error: 0.131
Visual magnitude
Logarithm of flux (ADU)
10
11
12
13
14
15
4
4.5
5
5.5
6

Typical light curves

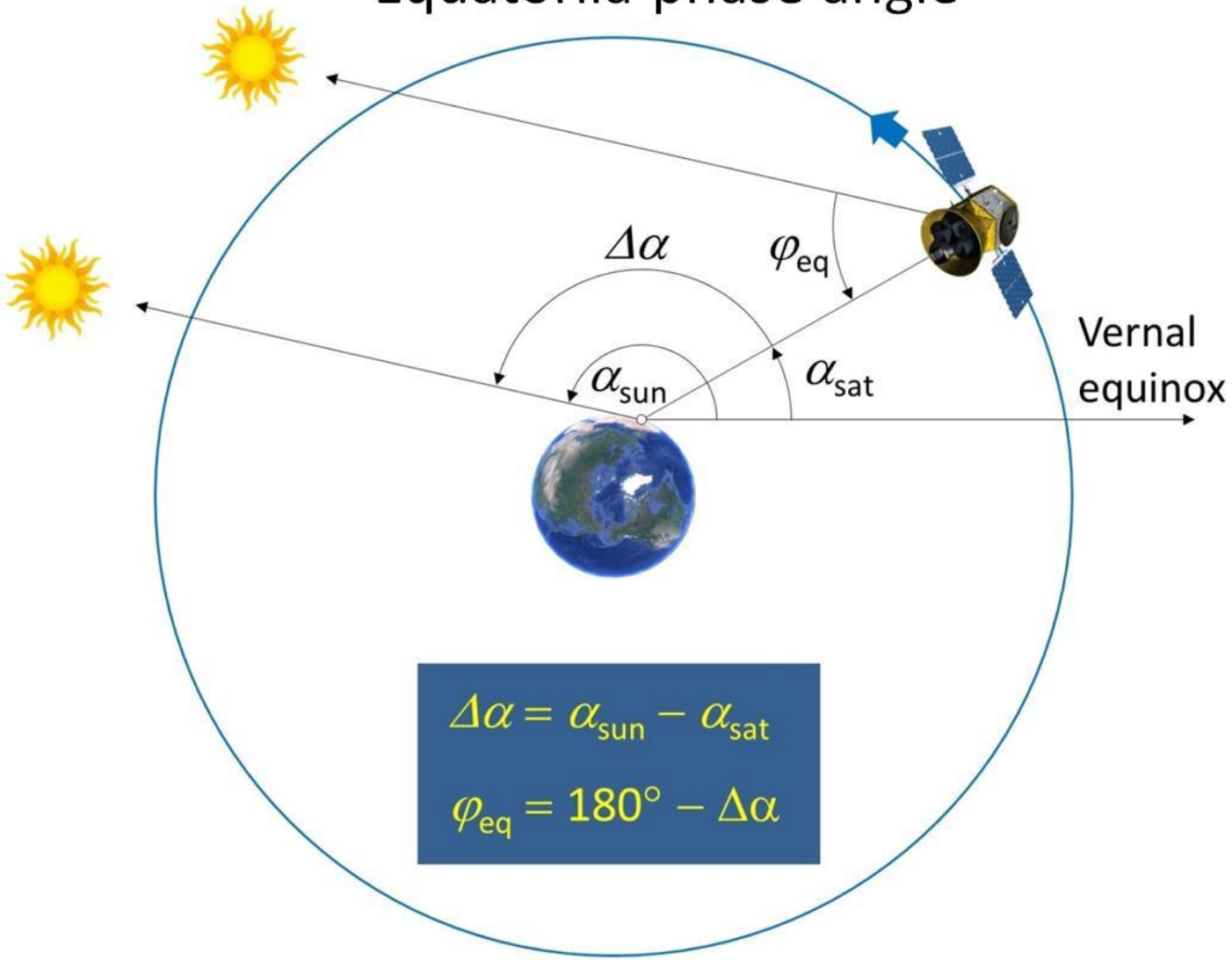



$\varphi < 0$
Phase angle closing


$\varphi \approx 0$
Minimum phase angle

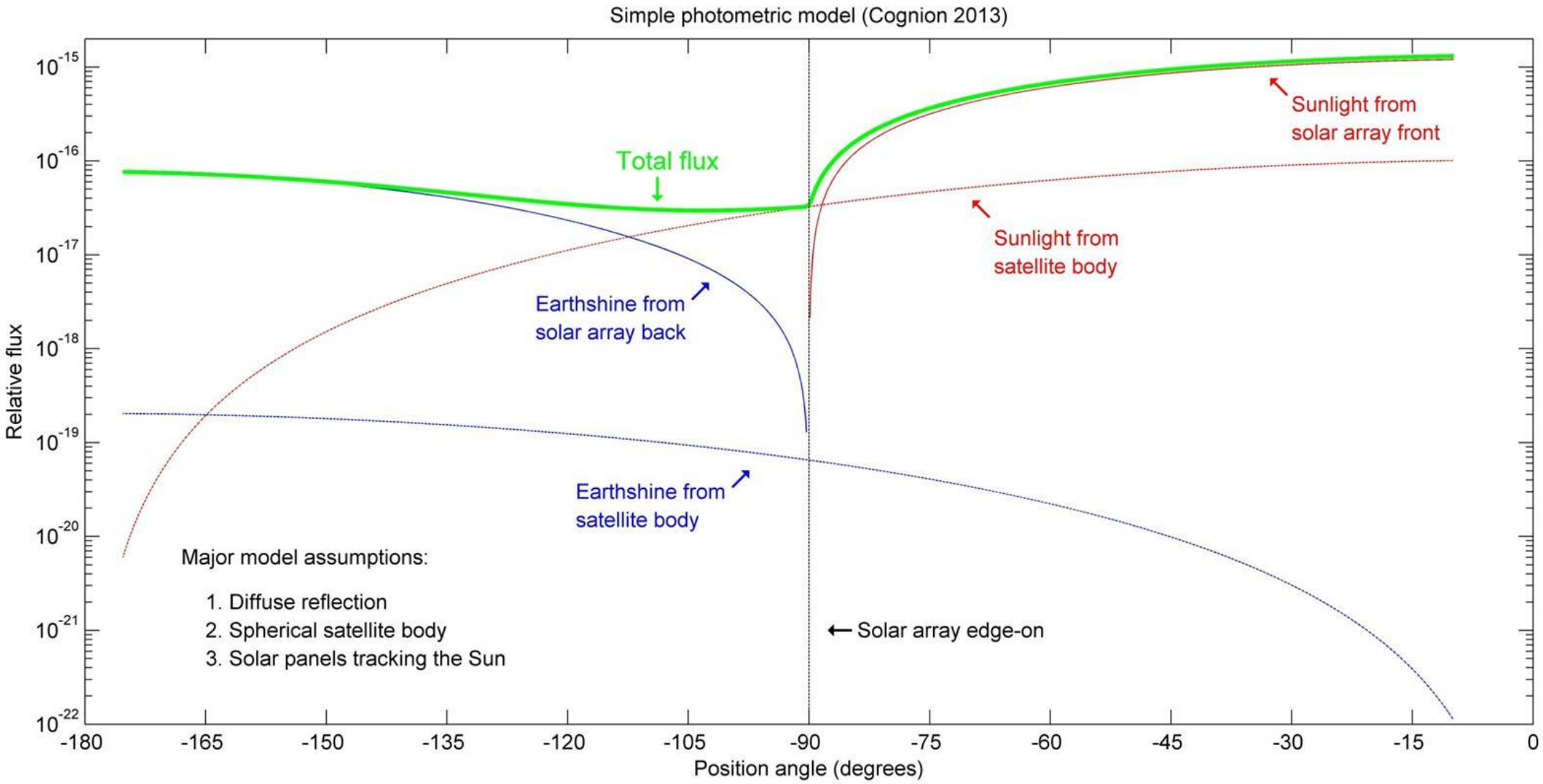

$\varphi > 0$
Phase angle opening

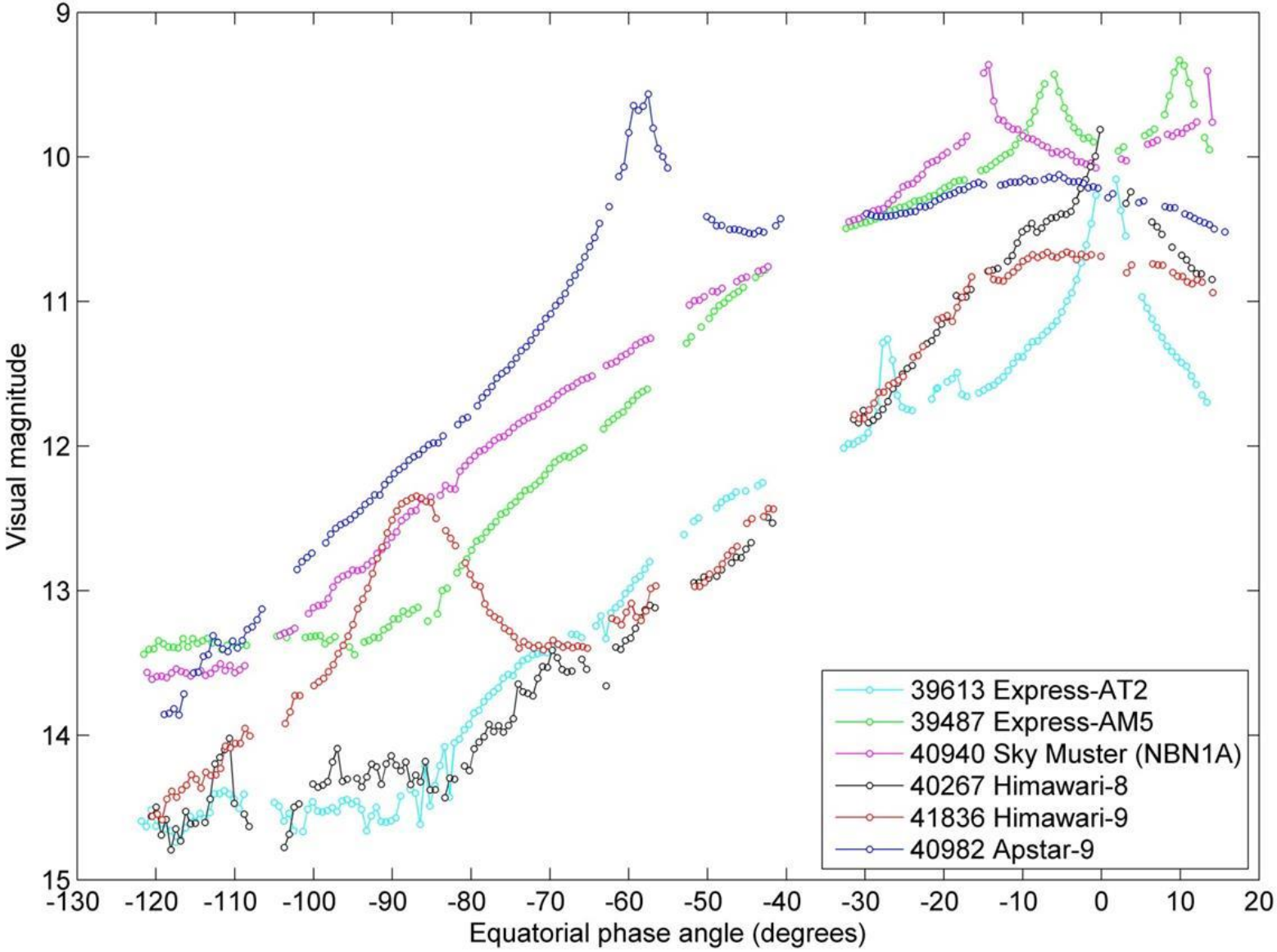
Equatorila phase angle

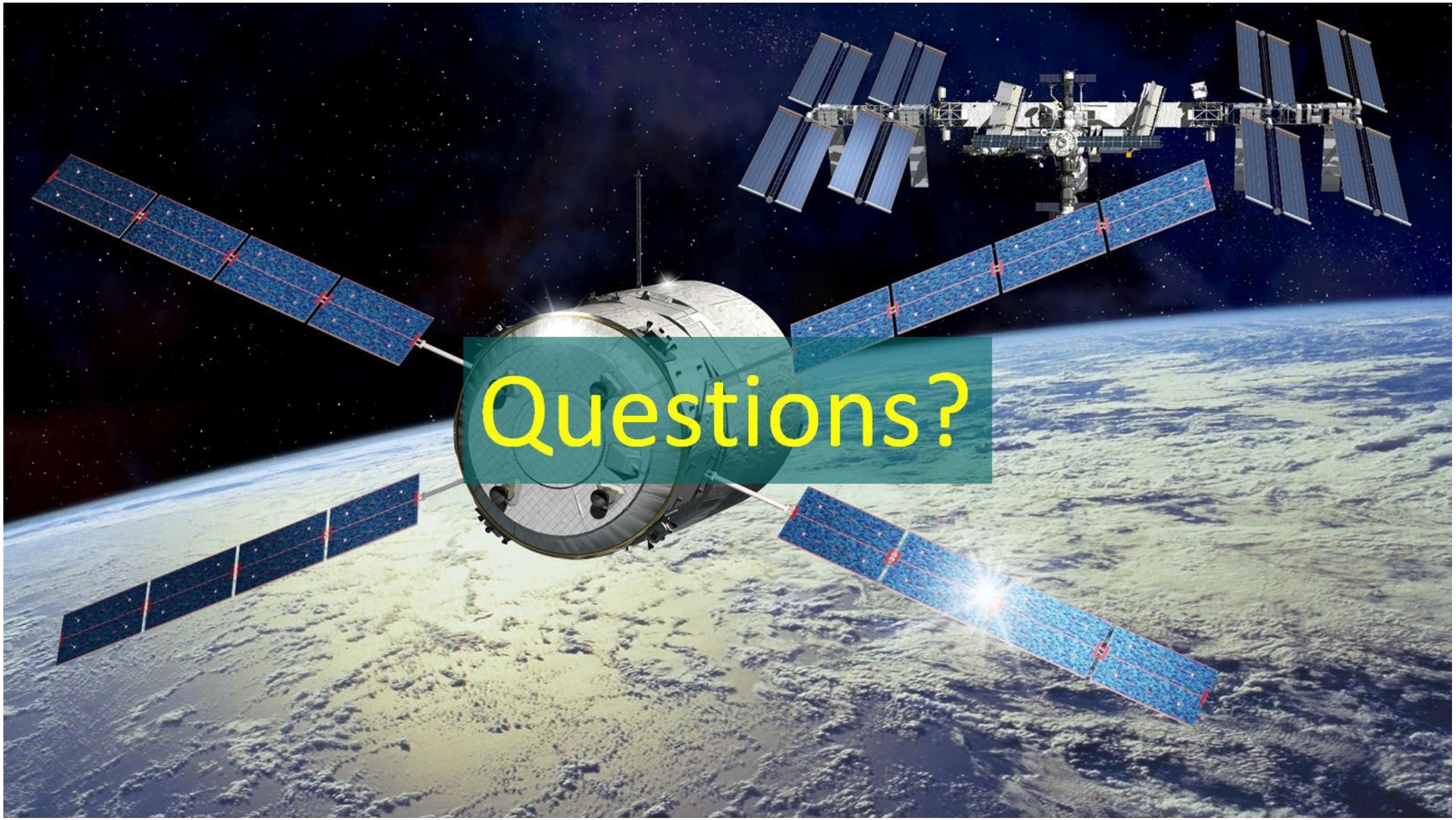


$$\Delta\alpha = \alpha_{sun} - \alpha_{sat}$$

$$\varphi_{eq} = 180° - \Delta\alpha$$


Simple photometric model (Cognion 2013)
Relative flux
Position angle (degrees)
Total flux
Sunlight from
solar array front
Sunlight from
satellite body
Earthshine from
solar array back
Earthshine from
satellite body
Major model assumptions:
1. Diffuse reflection
2. Spherical satellite body
3. Solar panels tracking the Sun
← Solar array edge-on


Visual magnitude
Equatorial phase angle (degrees)
9
10
11
12
13
14
15
-130
-120
-110
-100
-90
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
39613 Express-AT2
39487 Express-AM5
40940 Sky Muster (NBN1A)
40267 Himawari-8
41836 Himawari-9
40982 Apstar-9


Questions?