Is Oneweb a threath to Astronomy?

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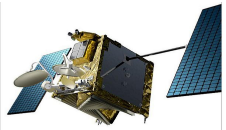
Oneweb constellation



- Phase 2: ~7000 planned satellites at 1200 km. As of October 2nd, there are 321 in orbit.

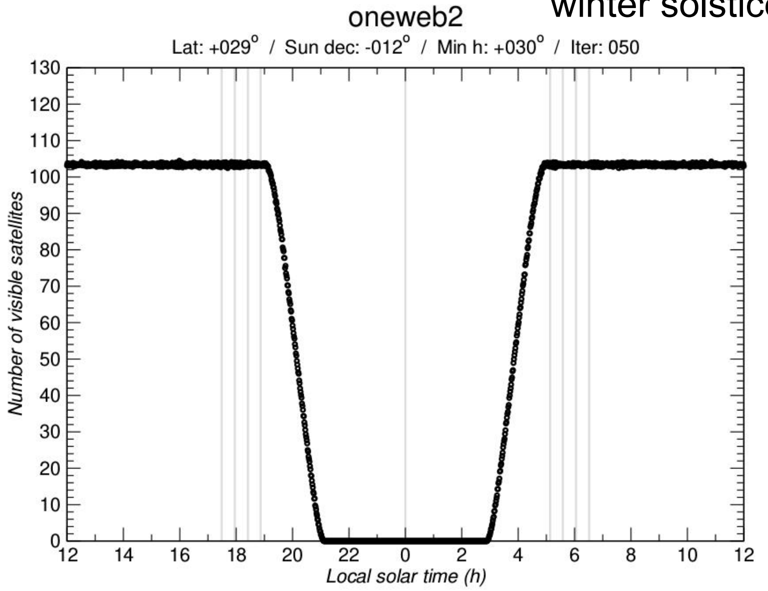
- Some key recommedations (SATCON & IAU/UNOOSA D&QS):

Design satellites to be fainter than 7.0 V mag +2.5 × log(r orbit / 550 km)
For an orbit at 1200 km, as Oneweb's, this means **V > 7.9 mag.**

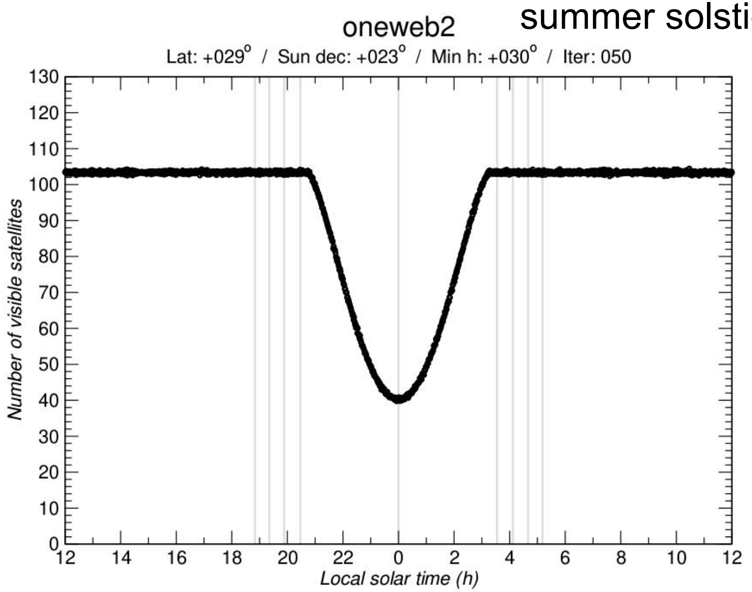
- Satellites at lower orbits are generally better for Astronomy as they are visible for a smaller fraction of the night and at lower elevations.

Simulations: 6372 sats at 1200 km, inclin. 89, 40, 50

winter solstice



summer solstice



Courtesy D. Galadí

Simulations: apparent magnitudes

	Latitude= +029 °		*FOV= 0060 '*		*T= 0060 s*		*Sun declination= +023 °*		
		PM			**AM**				
	Sun elevation →	**-12°**	**-25°**	**-37°**	**-37°**	**-25°**	**-12°**	← ***Sun elevation***	
S	Crossing expectance	00000.11	00000.12			00000.13	00000.10	Crossing expectance	**S**
	Expected path (')	00005.12	00005.15			00005.61	00004.49	Expected path (')	
	V (mag)	06.20±00.01	06.04±00.01			06.04±00.01	06.20±00.01	*V* (mag)	
	Speed ('/s)	13.54±00.55	13.59±00.54	00.00±00.00	00.00±00.00	13.55±00.53	13.63±00.52	Speed ('/s)	
W	Crossing expectance	00000.13	00000.13			00000.13	00000.13	Crossing expectance	**W**
	Expected path (')	00005.75	00005.85			00005.92	00005.73	Expected path (')	
	V (mag)	07.26±00.01	06.81±00.01			06.08±00.01	06.09±00.01	*V* (mag)	
	Speed ('/s)	13.83±01.05	13.94±01.02	00.00±00.00	00.00±00.00	13.83±00.98	13.88±01.04	Speed ('/s)	
N	Crossing expectance	00000.23	00000.23	00000.23	00000.22	00000.22	00000.23	Crossing expectance	**N**
	Expected path (')	00010.51	00010.01	00010.13	00009.96	00009.75	00009.87	Expected path (')	
	V (mag)	06.98±00.01	06.89±00.01	06.82±00.01	06.82±00.01	06.89±00.01	06.98±00.01	*V* (mag)	
	Speed ('/s)	14.23±00.72	14.26±00.71	14.29±00.69	14.23±00.75	14.32±00.69	14.25±00.74	Speed ('/s)	
E	Crossing expectance	00000.13	00000.14			00000.13	00000.12	Crossing expectance	**E**
	Expected path (')	00005.54	00006.20			00005.63	00005.85	Expected path (')	
	V (mag)	06.09±00.01	06.08±00.01			06.82±00.01	07.26±00.01	*V* (mag)	
	Speed ('/s)	13.77±01.00	14.00±01.07	00.00±00.00	00.00±00.00	13.90±01.01	14.03±01.15	Speed ('/s)	
Z	Crossing expectance	00000.10	00000.08			00000.09	00000.08	Crossing expectance	**Z**
	Expected path (')	00004.48	00003.68			00004.23	00003.52	Expected path (')	
	V (mag)	05.82±00.00	05.64±00.00			05.64±00.00	05.82±00.00	*V* (mag)	
	Speed ('/s)	20.13±00.40	20.05±00.36	00.00±00.00	00.00±00.00	20.06±00.37	20.10±00.39	Speed ('/s)	
	Pointing directions:				**S, W, N, E, at +45° elevation**			**Z: zenith**	

Observations at Teide Observatory

IAC80@CAMELOT2: FoV 23 '

TCS@MUSCAT2: FoV 7 ', griz simul.

Measuring Oneweb's dependence with elevation, height and colors.

Observations analysis: SATRED pipeline (Villafane-Calvo et al., in prep.)

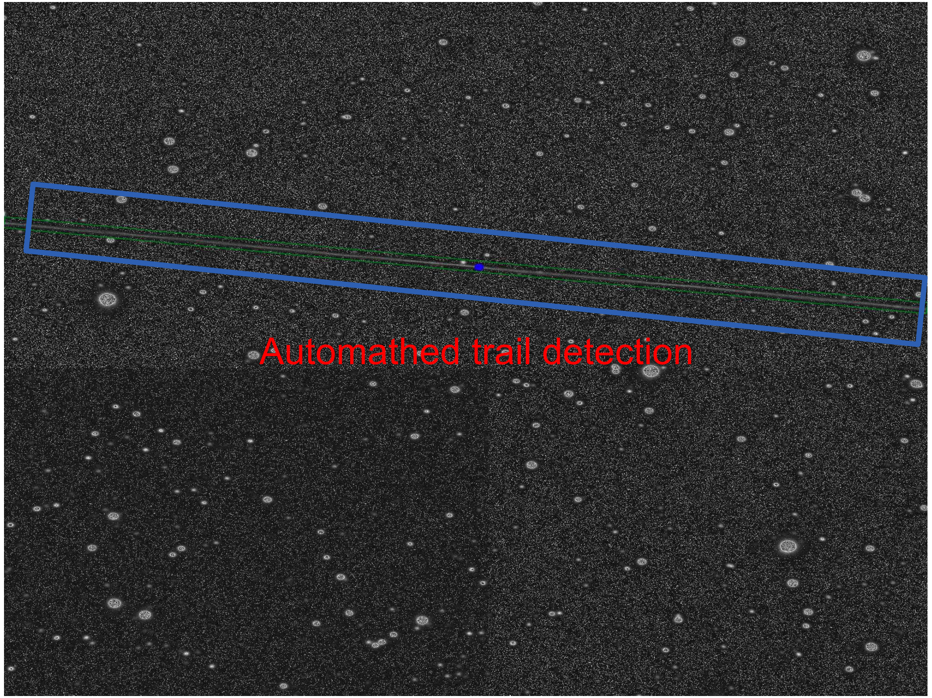
Bash script

↓

Python 3: Bias and flats are combined

→ …

Image 1	Image2
Python 3: -Reduction -Read img. headers -Trail detection -Astrometry (bash) -Results	Python 3: -Reduction -Read img. headers -Trail detection -Astrometry (bash) -Results



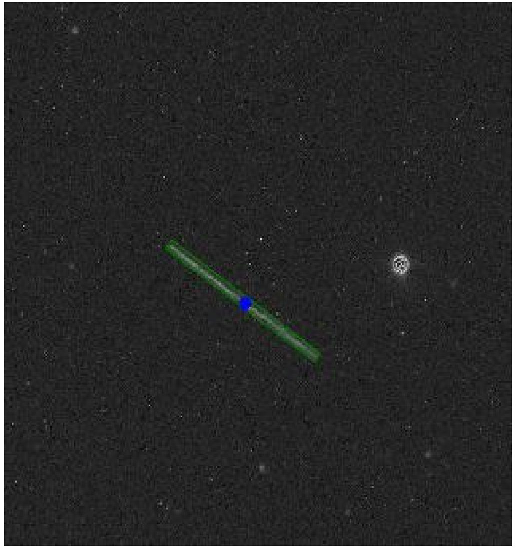
SATRED satellite detection

- Images are bias corrected and applied flat field correction.

- Second, images are filtered out so that point objects (stars) are removed. Detection of contours is done in the image using an operator that describes the structural shape of the objects that we want to detect (a rectangle).

Main steps:

- Extract pixels above 1 sigma from the background
- Smooth using Gaussian filter
- Group by blobs and adjust contours
- Select only very long contours: stars and large objects are removed, only traces remain.

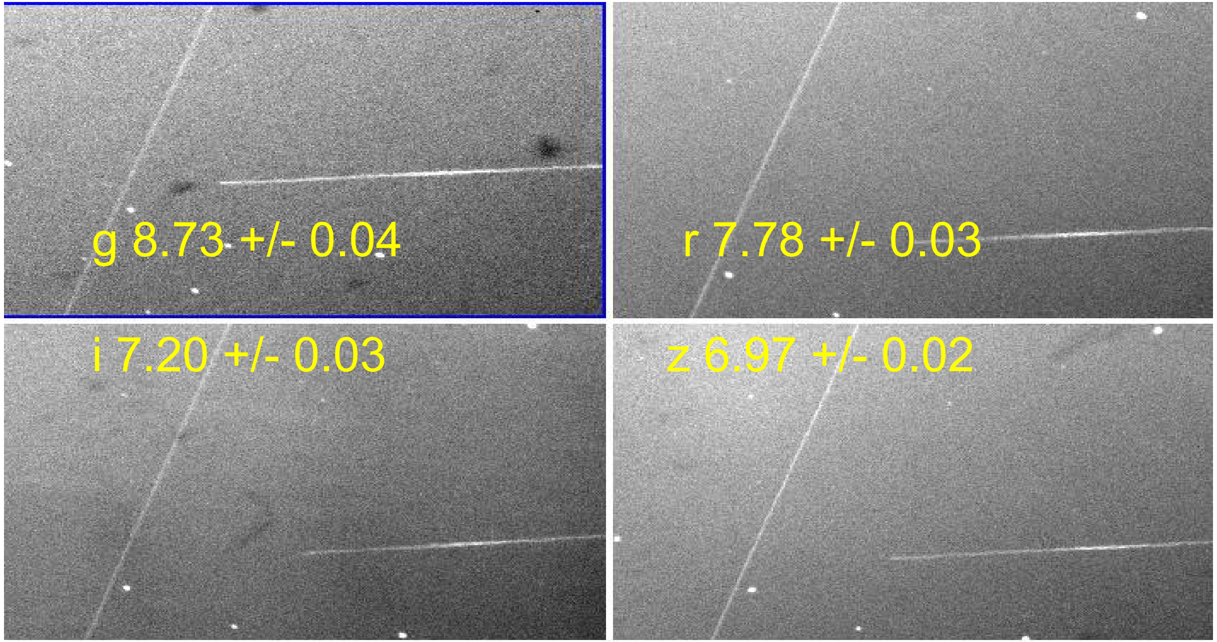


- SATRED outputs:
  SAT-ID, OBS-DATE, magnitude, velocity, altitude from TLE, zenith distance

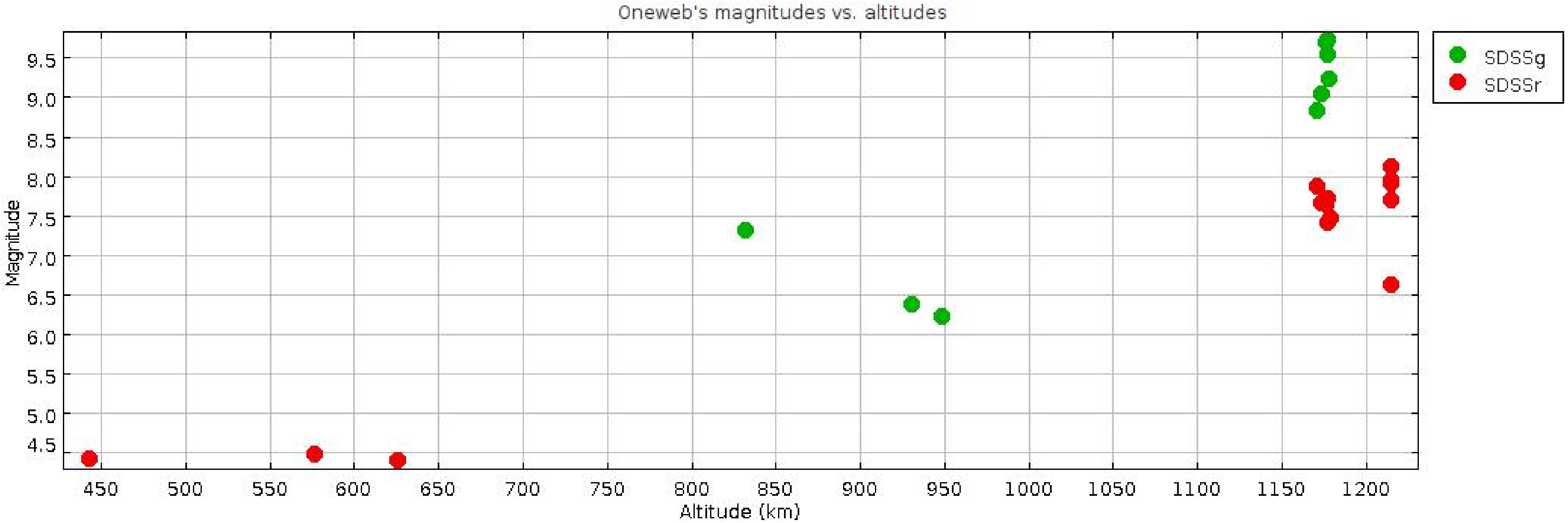
- Success-rate: 98%. Execution time: 0.5s per image running on an i7 2.8Ghz processor.

SATRED will be made public in the near future (Villafane-Calvo et al. , in prep.)

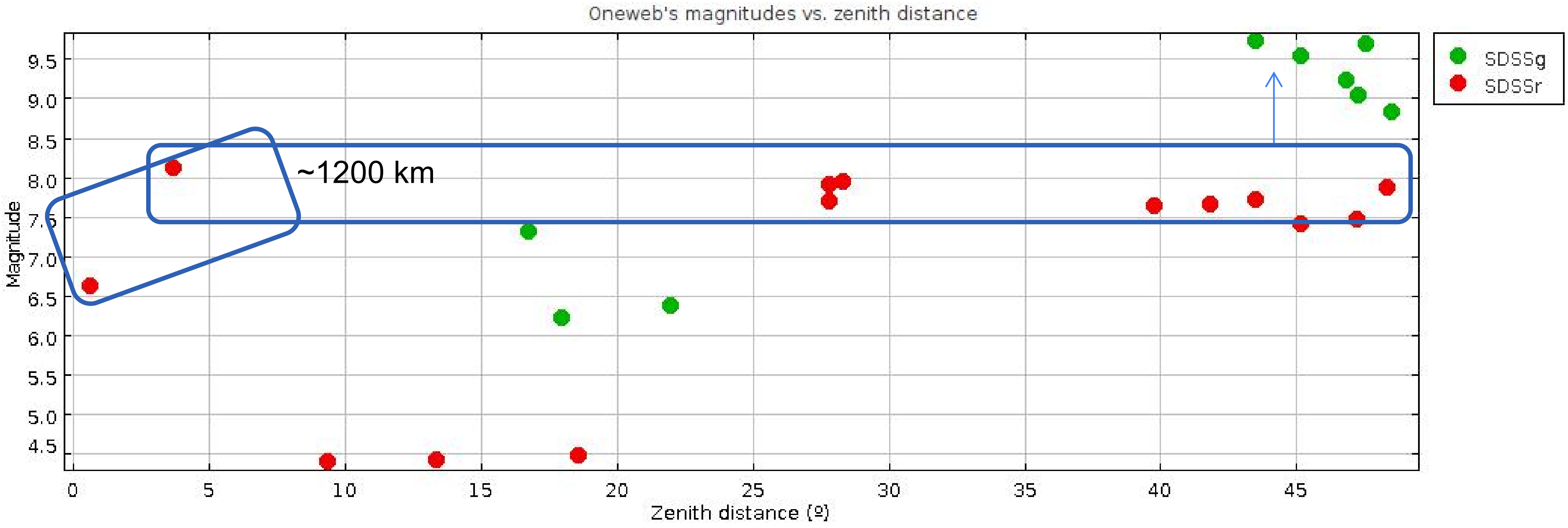
TCS@MUSCAT2 simultaneous griz observations



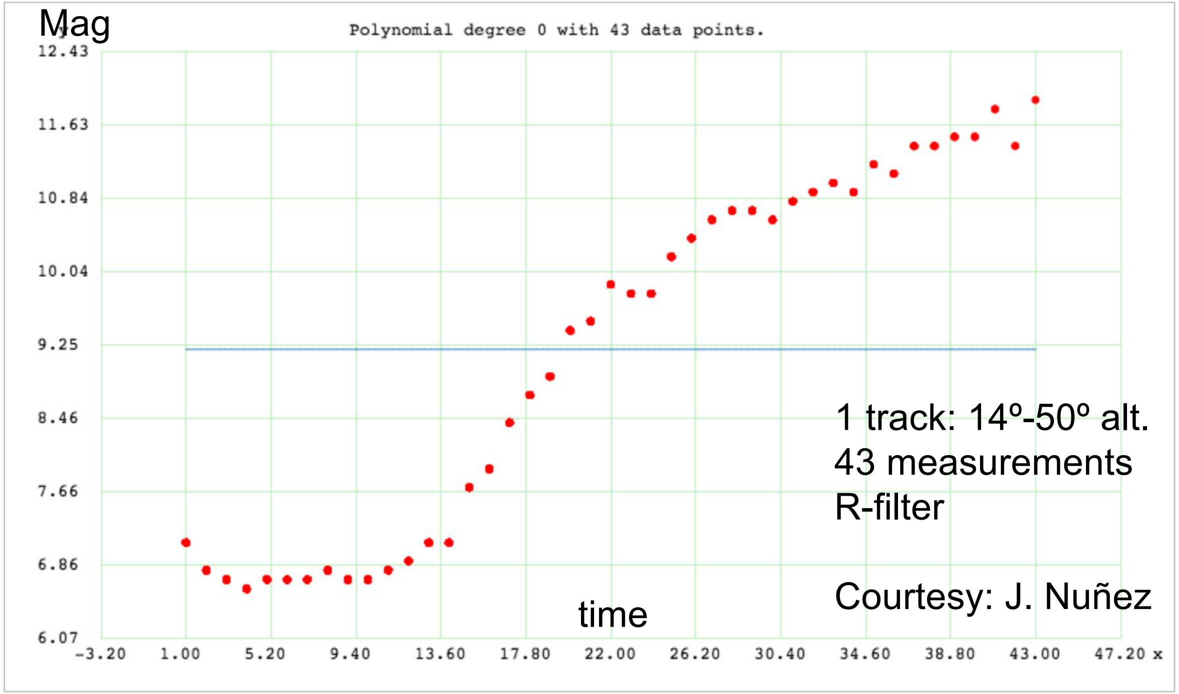
IAC80 observations



IAC80 observations

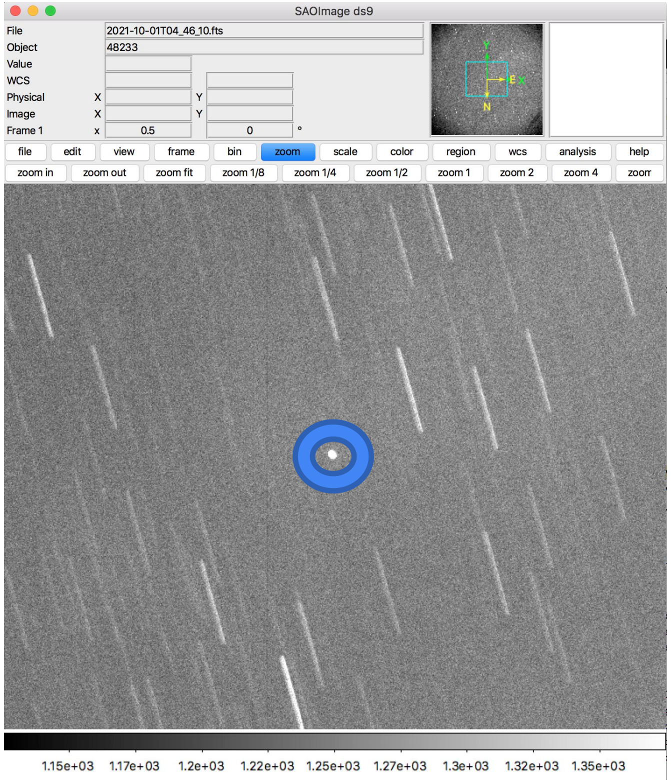


TRFM observations: Oneweb-0165



1 track: 14º-50º alt.
43 measurements
R-filter

Courtesy: J. Nuñez



Summary

- Oneweb constellation is a potential threat for astronomy, especially at longer wavelenghts and low altitudes.

- We found that Oneweb satellites are brighter in redder bands: g= 8.73 pm 0.04, r=7.78 pm 0.03, i=7.20 pm 0.03, z=6.97 pm 0.02 (elevation ~ 25º). This is also confirmed using the IAC80 telescope.

- Oneweb satellites show significant brightness variation with elevation (toghether with other factors as phase angle, albedo, attitude, etc.).

- We will continue monitoring the brigthness of Oneweb satellites at different positions in its orbit to determine how the brightness changes with time.

Thank you for your attention!

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https://www.sea-astronomia.es/grupo-de-trabajo-sea-icosaedro