



**Near Earth Object  
Modelling And Payloads  
for Protection**

# Surveying the interior secrets of the Solar System

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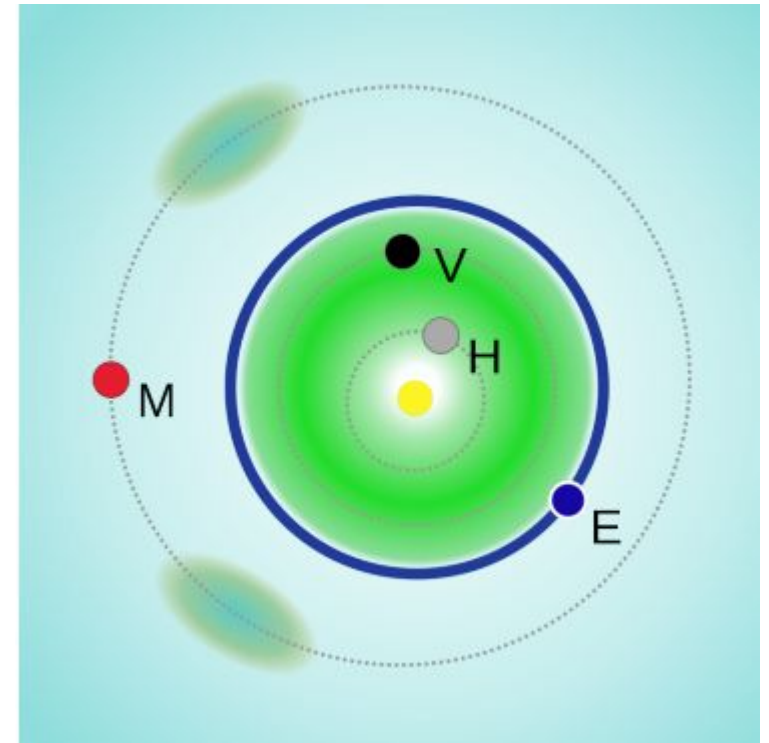


# Project background

- Atras are objects which stay always **within the Earth's perihelion**
- They have frequent close encounters with Mercury and Venus which **could eventually push an Atira-orbit into an Earth-crossing orbit**
- Only **30 objects** have been discovered to date (source JPL)
- Very **challenging** from an **observational point of view**



**The Atira objects represent a part of our Solar System which is poorly known**





# Project goals

Other very successful Atira-survey are ongoing, such as...

- Sheppard, DECam, 4 m Blanco telescope
- Giunta, LBC, LBT, 8.4 m telescope



**Both surveys can go very deep in magnitude (meaning small H), but have pointing limitations**

In contrast, our survey aims to...

- Discover large/medium size objects at extreme interior orbits

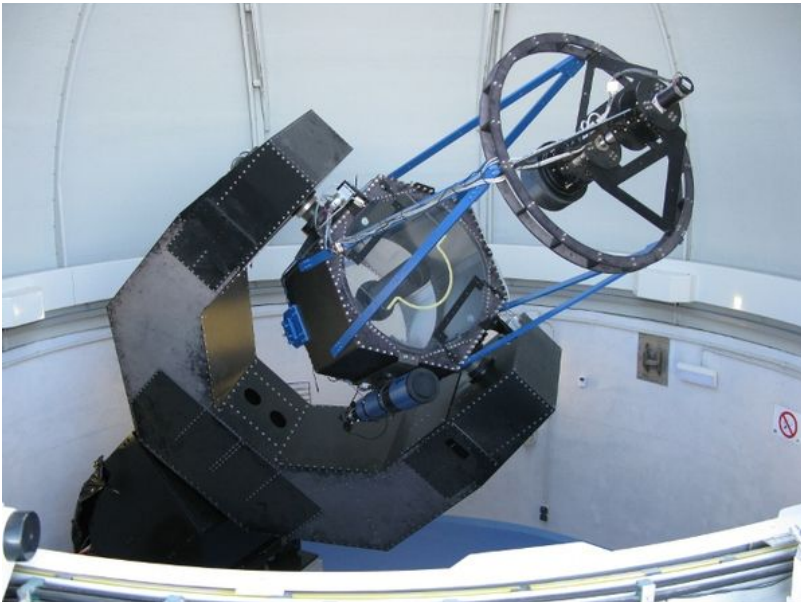
# Observational challenges for Atiras

FEATURE	ISSUE
Only observable during twilight	Limited time window (<1 hour)
Low elevations (<20 deg)	High airmass / extinction
Exposure time limited by their proper motion	Time lost during readouts
Unknown orbit	Need for follow-up!





# Telescopes selected



- Located at the Catalan Pyrenees
- 0.8 m robotic telescope
- 4k x 4k back-illuminated CCD
- FoV of 30'
- Elevation limit 5°
- 200 hours granted (p485)

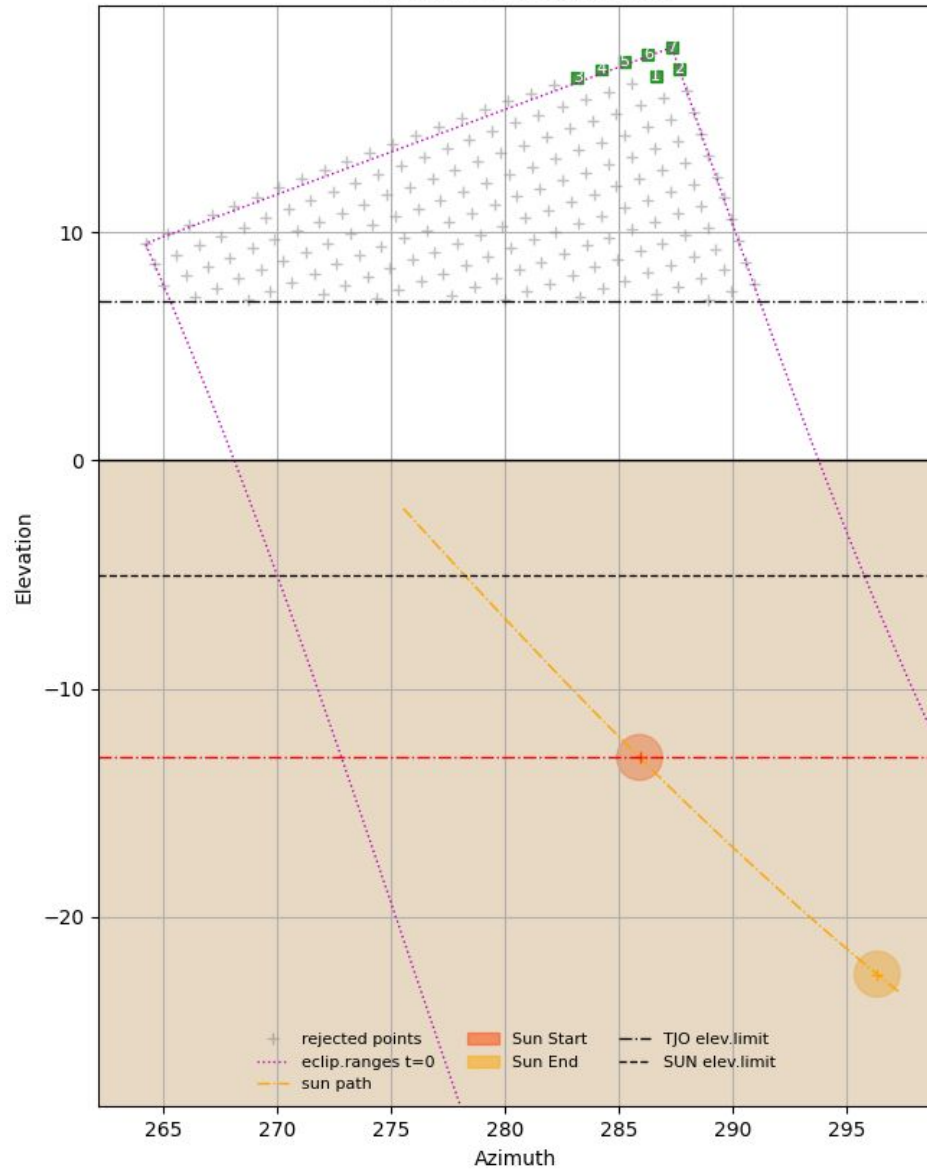


- Located in Namibia
- 0.4 m robotic telescope
- CMOS
- FoV of 157.2' x 105.2'
- Elevation limit 5°
- Agreement in preparation



# Selecting the fields

SUNSET 2023-03-27 19:23:33.080



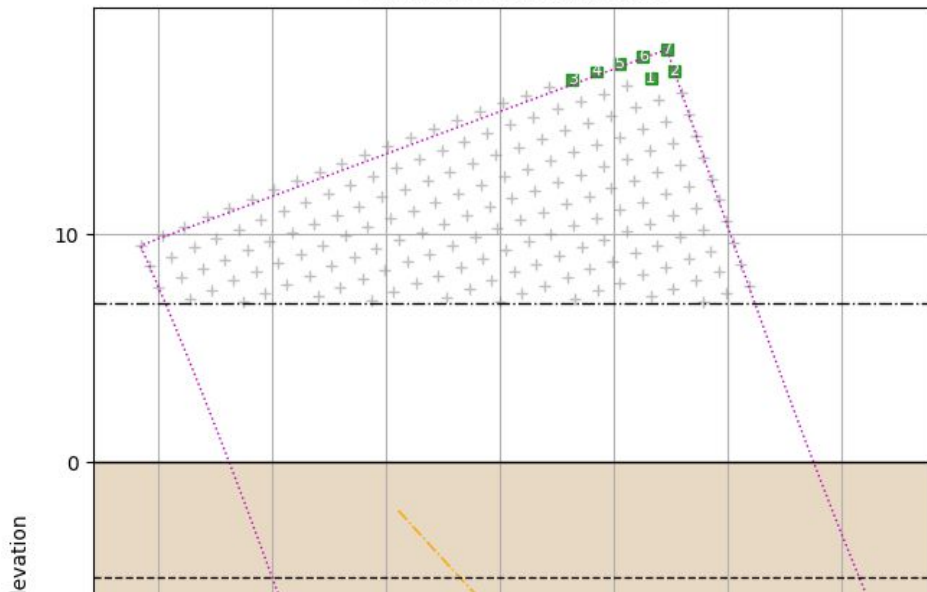
```
Computing for date: 2023-03-28 00:00:00.000
seq_duration      : 55
sunset_elev       : -13
sunrise_elev      : -18
lon_offset        : 29
lat_offset        : 12
mesh_gap          : 1.0
p_offset          : 0.5
noplots           : False
compute           : ['set', 'rise']
outfile           : None
```





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```

i	sun_obstime	sun_alt	sun_az	p_ra	p_dec	p_alt	p_az	p_dist2sun	p_center_mur	a_mur	b_mur	c_mur	d_mur
1	2023-03-27T19:23:33.080	-13.021913587619155	285.9179905665329	1:53:04.57	+23:18:37.82	16.8613256608793308	286.6185200803531	29.89125247722216	"1:53:04.57 0.0 +23:18:37.82 0.0 2000.0"	"1:50:53.41 0.0 +23:48:34.42 0.0 2000.0"	"1:55:15.73 0.0 +23:48:34.42 0.0 2000.0"	"1:50:54.40 0.0 +22:48:34.45 0.0 2000.0"	"1:55:14.75 0.0 +22:48:34.45 0.0 2000.0"
2	2023-03-27T19:23:33.080	-13.021913587619155	285.9179905665329	1:51:26.55	+24:17:04.97	17.186589599094482	287.6554486954767	30.257197359571624	"1:51:26.55 0.0 +24:17:04.97 0.0 2000.0"	"1:49:14.38 0.0 +24:47:01.42 0.0 2000.0"	"1:53:38.71 0.0 +24:47:01.42 0.0 2000.0"	"1:49:15.41 0.0 +23:47:01.45 0.0 2000.0"	"1:53:37.68 0.0 +23:47:01.45 0.0 2000.0"
3	2023-03-27T19:23:33.080	-13.021913587619155	285.9179905665329	2:01:52.67	+20:43:56.97	16.807100211005572	283.18432857086196	29.95104135113608	"2:01:52.67 0.0 +20:43:56.97 0.0 2000.0"	"1:59:43.94 0.0 +21:13:53.98 0.0 2000.0"	"2:04:01.40 0.0 +21:13:53.98 0.0 2000.0"	"1:59:44.78 0.0 +20:13:54.00 0.0 2000.0"	"2:04:00.56 0.0 +20:13:54.00 0.0 2000.0"
4	2023-03-27T19:23:33.080	-13.021913587619155	285.9179905665329	2:00:19.40	+21:42:39.63	17.146691332875324	284.2159622561636	30.215400877601382	"2:00:19.40 0.0 +21:42:39.63 0.0 2000.0"	"1:58:09.79 0.0 +22:12:36.49 0.0 2000.0"	"2:02:29.01 0.0 +22:12:36.49 0.0 2000.0"	"1:58:10.68 0.0 +21:12:36.51 0.0 2000.0"	"2:02:28.11 0.0 +21:12:36.51 0.0 2000.0"
5	2023-03-27T19:23:33.080	-13.021913587619155	285.9179905665329	1:58:44.85	+22:41:18.99	17.481030643683958	285.2513464311356	30.51004374386813	"1:58:44.85 0.0 +22:41:18.99 0.0 2000.0"	"1:56:34.31 0.0 +23:11:15.70 0.0 2000.0"	"2:00:55.39 0.0 +23:11:15.70 0.0 2000.0"	"1:56:35.26 0.0 +22:11:15.72 0.0 2000.0"	"2:00:54.44 0.0 +22:11:15.72 0.0 2000.0"
6	2023-03-27T19:23:33.080	-13.021913587619155	285.9179905665329	1:57:08.94	+23:39:54.84	17.809989629632394	286.29051225298576	30.8340949143345	"1:57:08.94 0.0 +23:39:54.84 0.0 2000.0"	"1:54:57.42 0.0 +24:09:51.38 0.0 2000.0"	"1:59:20.46 0.0 +24:09:51.38 0.0 2000.0"	"1:54:58.43 0.0 +23:09:51.41 0.0 2000.0"	"1:59:19.46 0.0 +23:09:51.41 0.0 2000.0"
7	2023-03-27T19:23:33.080	-13.021913587619155	285.9179905665329	1:55:31.59	+24:38:26.94	18.13344020240879	287.3334861910518	31.186630073904357	"1:55:31.59 0.0 +24:38:26.94 0.0 2000.0"	"1:53:19.04 0.0 +25:08:23.32 0.0 2000.0"	"1:57:44.15 0.0 +25:08:23.32 0.0 2000.0"	"1:53:20.10 0.0 +24:08:23.35 0.0 2000.0"	"1:57:43.09 0.0 +24:08:23.35 0.0 2000.0"



# Processing the data

**Verify Track**

Examine the track in the Image Viewer.  
If it appears valid, click the "Add Observations" button.

**Track Information**

Track: 390  
Label: Unidentified  
Speed: 6.61 arcsec/min  
PA: 136.8 degrees

**Animation**

Follow target  
1000 ms  
1 stack

Num obs to generate: 1 observation  Advanced mode  
Photometry of substacks: Highest Accuracy

<-- Prev Next --> Add Observations Pause Refresh

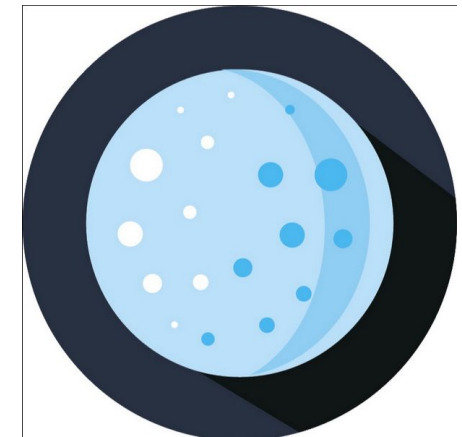
**Track - Navigator**

Num	calcSpeed	calcPA	ObjSpeed	ObjPA	ObjMag	ObjNum	ObjName	ObjDist	X	Y	Quality	Confide...	Distance
390	6.61	136.8	---	---	---	---	---	---	1370	104	17.12	High	---
519	5.91	136.6	---	---	---	---	---	---	1263	-9	15.51	High	---
606	7.80	132.1	---	---	---	---	---	---	1384	26	14.53	High	---
616	6.59	133.9	---	---	---	---	---	---	1362	82	14.40	High	---
62	6.02	29.5	---	---	---	---	---	---	1346	1391	24.61	Med	---
134	6.23	61.0	---	---	---	---	---	---	1388	1245	21.67	Med	---
354	4.51	71.7	---	---	---	---	---	---	1359	124	17.58	Med	---
199	6.48	47.2	---	---	---	---	---	---	1366	1376	20.15	Low	---
290	4.89	88.1	---	---	---	---	---	---	1372	1140	18.57	Low	---
316	4.88	166.9	---	---	---	---	---	---	864	-18	18.19	Low	---
333	5.04	248.3	---	---	---	---	---	---	46	9	17.86	Low	---
388	5.57	21.2	---	---	---	---	---	---	137	1389	17.13	Low	---
391	5.01	222.8	---	---	---	---	---	---	-7	98	17.12	Low	---
407	6.81	50.5	---	---	---	---	---	---	1374	1356	16.79	Low	---
409	7.13	223.8	---	---	---	---	---	---	35	11	16.75	Low	---
414	5.16	207.6	---	---	---	---	---	---	165	-4	16.71	Low	---
469	5.33	106.9	---	---	---	---	---	---	1373	206	16.14	Low	---

Track 390/1000 (1000 displayed, 0 filtered)

## Synthetic tracking analysis with Tycho Tracker Running on 2 workstations

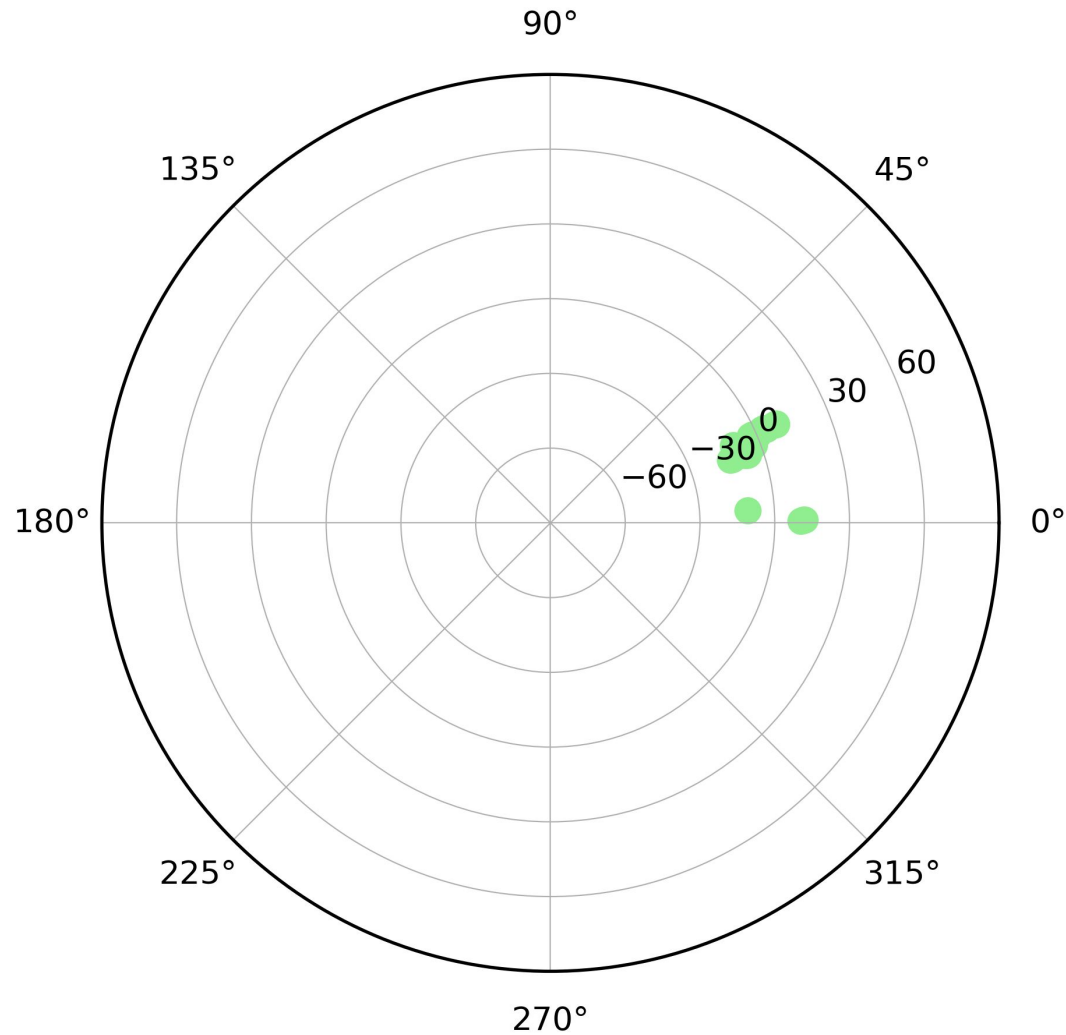
- Intel i7 7700HQ 2.80GHz with NVIDIA GeForce GTX 1070
- Intel i7 11800H 2.30GHz with NVIDIA GeForce RTX 3050







# Results so far



Fields observed at solar elongation  $28^\circ < \epsilon < 32^\circ$

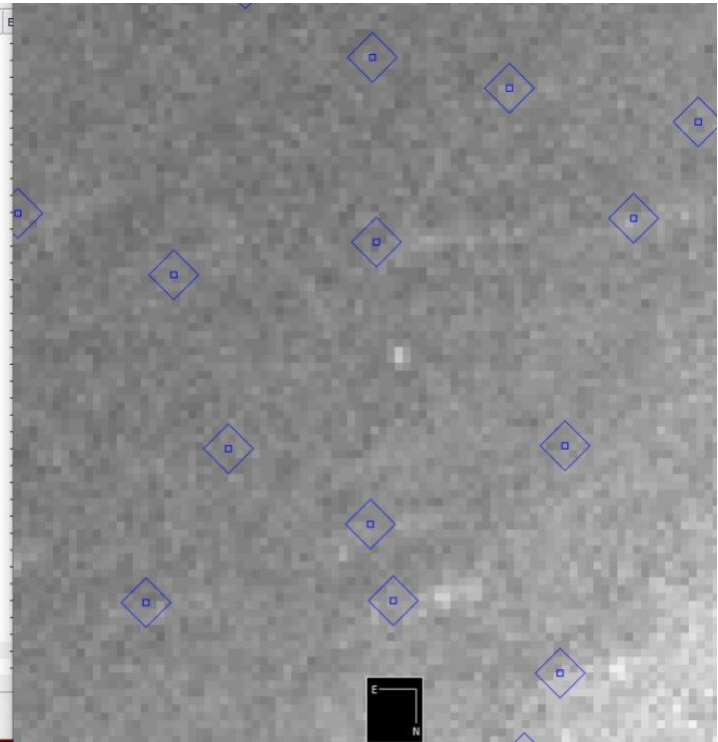
te	Width	Height	bpp	Filter	EPH_DATE	EPH_RA	EPH_DE	EPH_MAG	EPH_SPD
305.21033	669	671	16	R	-	-	-	-	-
305.21082	669	671	16	R	-	-	-	-	-
305.21140	669	671	16	R	-	-	-	-	-
305.21194	669	671	16	R	-	-	-	-	-
305.21249	669	671	16	R	-	-	-	-	-
305.21310	669	671	16	R	-	-	-	-	-
305.21364	669	671	16	R	-	-	-	-	-
305.21424	669	671	16	R	-	-	-	-	-
305.21476	669	671	16	R	-	-	-	-	-
305.21522	669	671	16	R	-	-	-	-	-
305.21576	669	671	16	R	-	-	-	-	-
305.21633	669	671	16	R	-	-	-	-	-

Mag /	Dist(AU)	Number	Name	X	Y	RA	DE
18.6	2.998	(6713)	Coggie	587	73	20 56 55.39	-02 2
21.2	4.423	(148019)	1997 YW19	139	334	20 58 08.06	-02 3
22.8	2.827	(445380)	2010 RM65	579	266	20 56 56.79	-02 3
23.1	2.570		2015 VZ114	339	473	20 57 35.61	-02 4
23.3	2.524		2018 VT155	535	414	20 57 03.98	-02 4
23.5	3.591		2019 TC65	526	317	20 57 05.44	-02 3

Key	Value
SNR	2.17
Flux	30
C	0.750
FWHM	4.26"
Peak_ADU	1654
Median	1642
Average	1642
Std_Dev	1.34
Noise_Max	1644
Noise_Min	1639
X	588.62
Y	71.90



V mag limit  $\approx 18.5$  mag  $\longrightarrow$  H = 16.3 (assuming detection at 60° phase angle)



# Future plans

- Explore the possibility of using more telescopes with similar capacities
- Extend the long-term project at the TJO
- Test different observation strategies (e.g. larger coverage vs deeper coverage)
- Consider the possibility of observing at even lower Solar elongation (Vulcanoids?)



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# THANK YOU!