This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870377.

Surveying the interior secrets of the Solar System

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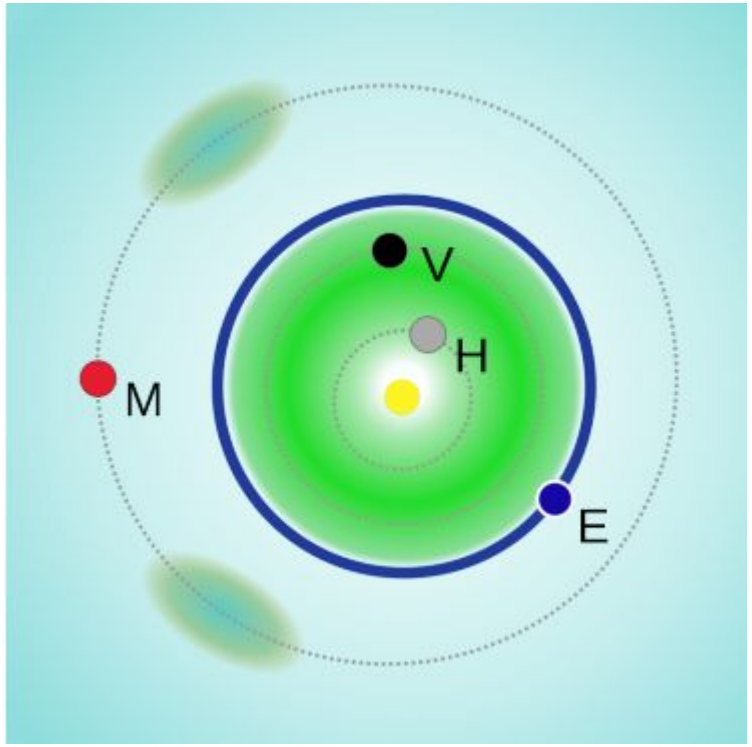
Near Earth Object Modelling And Payloads for Protection

8th IAA Planetary Defense Conference
3 - 7 April 2023, Vienna, Austria

Project background

- Atiras 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

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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

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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!

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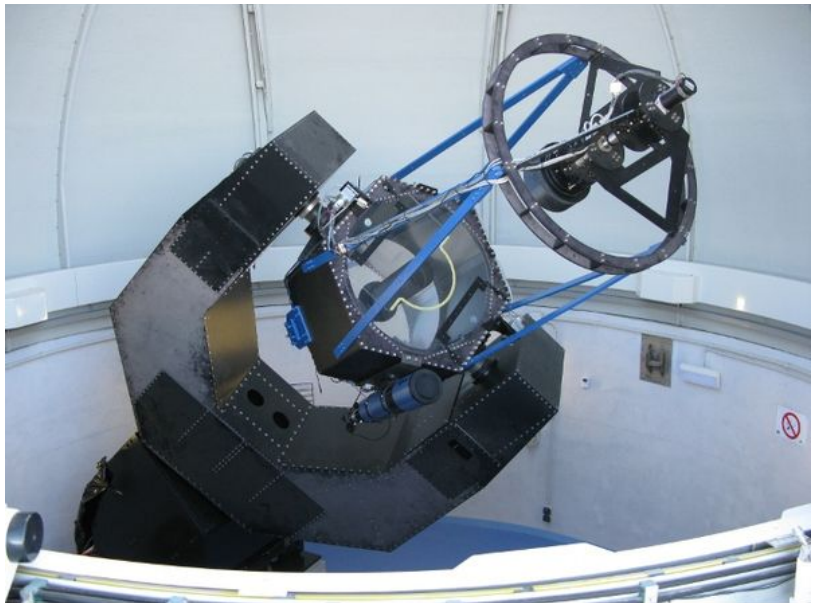
Telescopes selected



- 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

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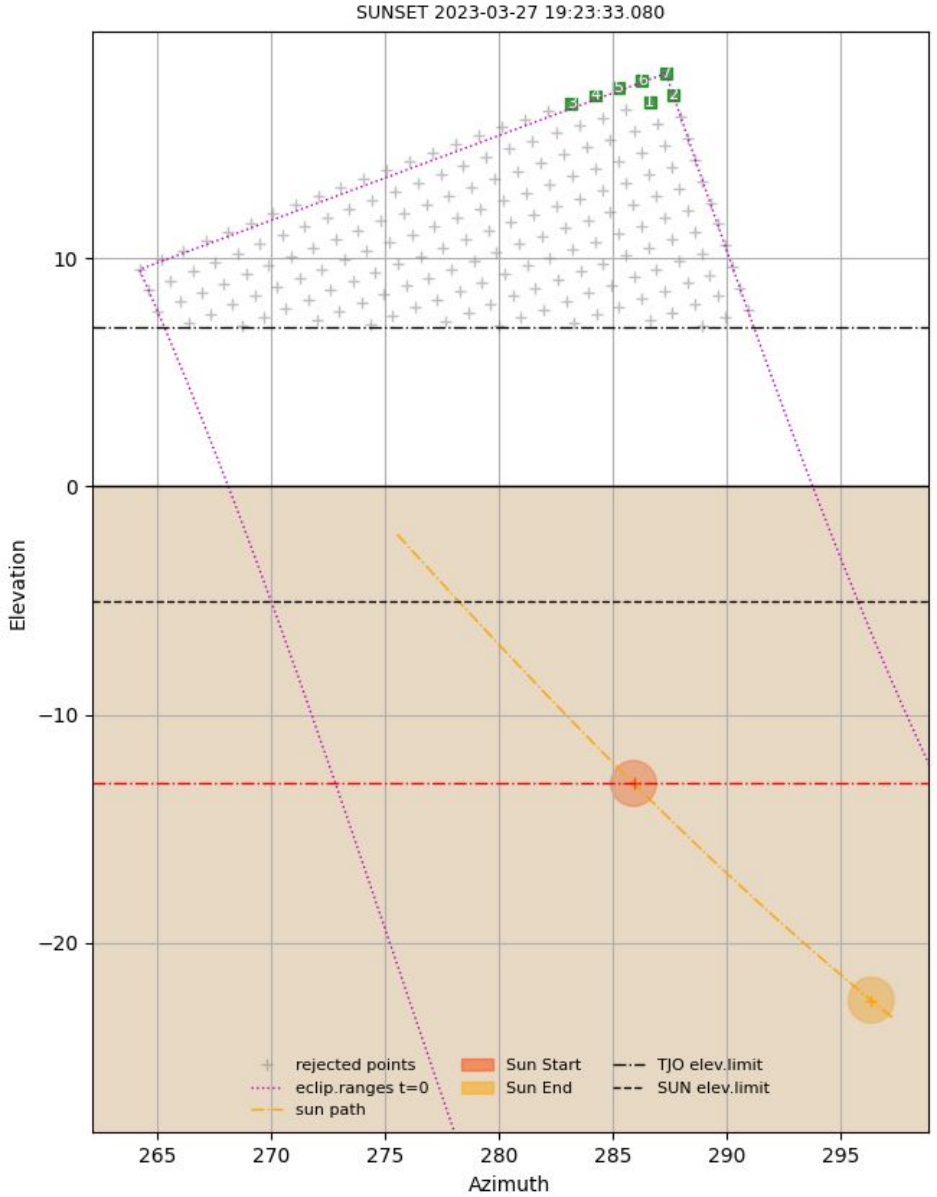
Selecting the fields

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   sunset_elev     : -13
   sunrise_elev    : -18
   lon_offset      : 29
   lat_offset      : 12
   mesh_gap        : 1.0
   p_offset        : 0.5
   noplot          : False
   compute         : ['set', 'rise']
   outfile         : None
```

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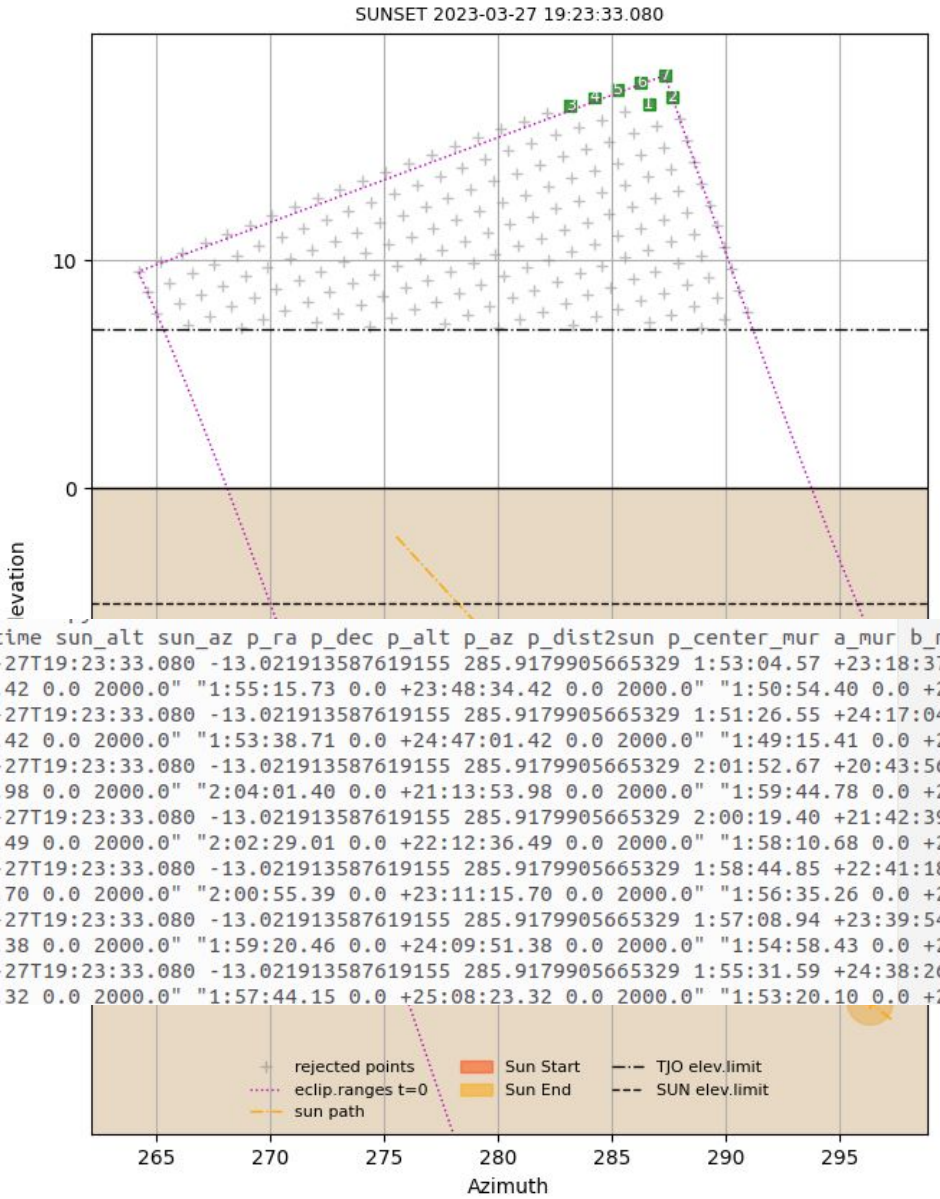
Selecting the fields




```
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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 16.861325608793308 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"
```

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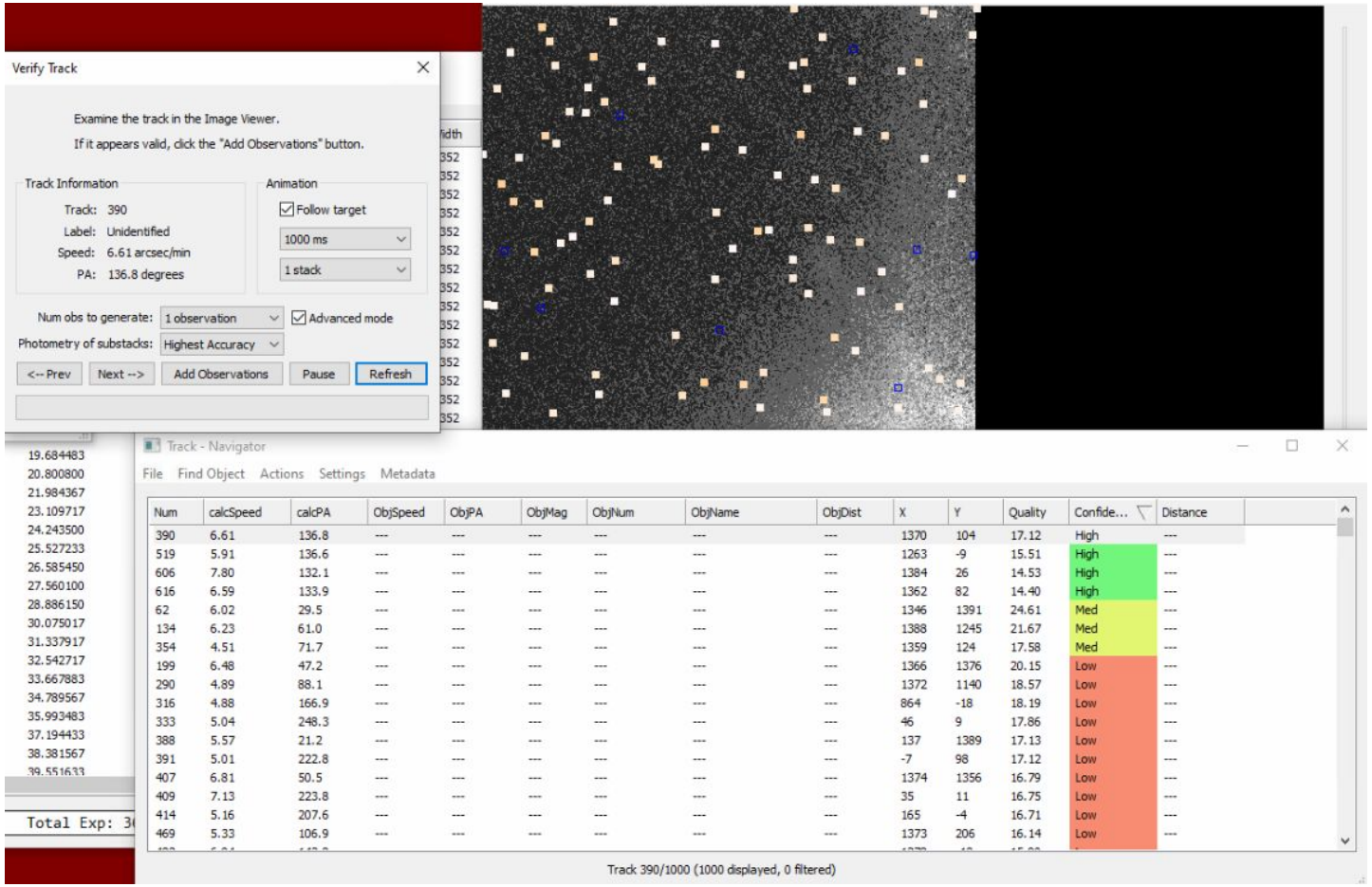
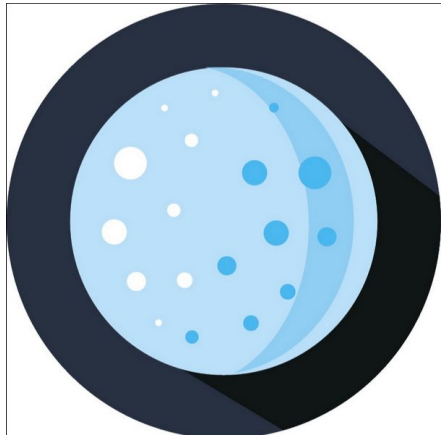
Processing the data



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



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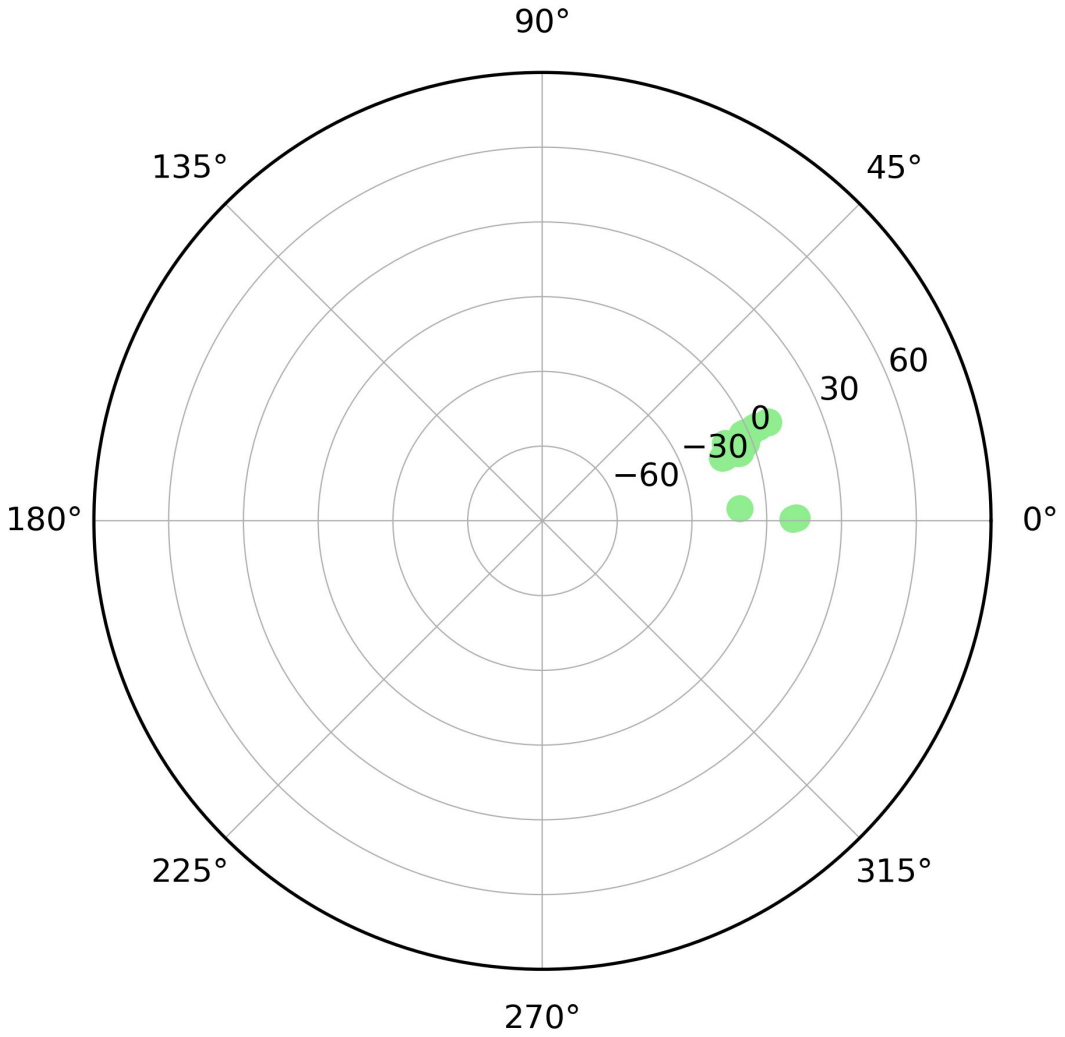
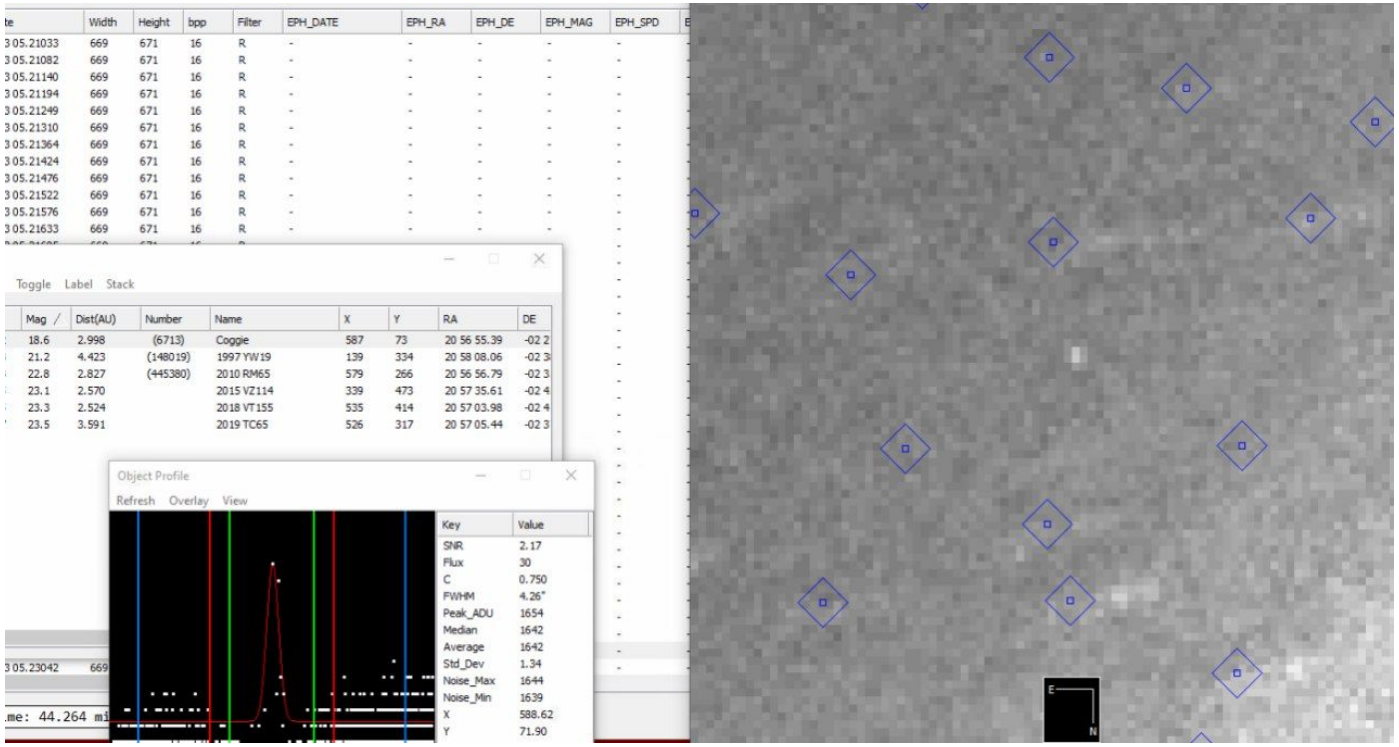
Results so far



Fields observed at solar elongation 28° < ε < 32°



V mag limit ≈ **18.5 mag** → H = 16.3 (assuming detection at 60° phase angle)

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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!

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