# Observation protocol for the August 8, 2020 occultation by the big TNO 2002 MS4

03/August/2020

## Rationale

This observational campaign is carried out under the "Lucky Star" umbrella. Lucky Star is an EU-funded research activity that agglomerates the efforts of the Paris, Granada and Rio teams. So different people from these three groups may contact you, but we are all working together. See Lucky Star web page for details: http://lesia.obspm.fr/lucky-star/

The aims are the physical characterization and study of its vicinity to sound for any putative surrounding material. This is one of the biggest TNOs and one of the few of which no satellite has been reported yet. If we discover a TNO satellite through occultation, it would be a great breakthrough.

## Event information

The occultation will cross Europe from Morocco and Portugal to Turkey and Ukraine on the night of August 08, 2020. The target star has **Gmag = 14.6** and the event will last for up to **38 seconds**. Prediction is very accurate due to (two and three-chords) stellar occultations detected in 2019 and last July 26.

Observations are recommended from **at least 20:38 to 20:48 UT**, or a larger interval to sound the object's vicinity.

The J2000 star position is (RA, DEC):
  18 47 29.9638
 -06 16 31.473

Further information can be found on the Lucky Star Cmapaign web page, and through Occult Watcher in the RIO-TNO feed: https://lesia.obspm.fr/lucky-star/campaigns/2020-08-08_2002MS4.html

## Finding Chart

Annotated finding charts can be found in the above link. The target is at about 1 degree from Messier Object 11 (M11). Reference star should not be a problem, as the target is in a very dense region of the sky.

## Exposure Time

This event may last up to 38 seconds so long exposure times up to a couple o seconds are possible. As the occulting object is very dim, the target star will

"disappear", so even if the target star looks very dim in the images, we will be able to measure the event, we don't need high signal over noise. These on/off events make the detection and determination of the correct ingress/egress times strait forward, by modeling the light curve. The most important thing is not to have short exposure time, but it is important to have short readout time.

**Beware of the dead time between the images:** if you manage an exposure time of 1 second (for example), but your camera takes 2 sec to read the image, then there is a 67% chance that you miss the dis(re)-appearance of the star [chance of missing = 1 - {1/(1+2)}]. So, it's better to have, for example, 4 sec integration, so you have 67% chance to get the occultation in one of your exposures [chance of getting = 4/(4+2)].

To reduce the readout time, and data amount, you can select just a window of your camera and bin the pixels. Note that we it is better to have all the star flux in 3 or 4 pixels than oversample the seeing. The benefits of it are the faster readout, smaller file size and better photometry.

**Absolute time accuracy is essential**, to connect all the observations together after the fact. Check the time of your computer with reliable sources. It's advised to check the registered time right after and right before the integrations, so if there is a drift, we can correct it by having the difference.

Apps such as Astro Flash Timer (for Apple) or Occult Flash Tag (for Android) can be used to check your times: https://occultations.org/observing/software/
If you need to use NTP, please read this article to get the best of it: http://www.iota-es.de/JOA/JOA2020_2.pdf


**After observation**

Please take darks. Cover your telescope to avoid any light contamination, and take a dozen frames with the same exposure time used to acquire data.

If possible, take flats. Make an evenly illuminated target (with board, back illuminated white sheet), and take "white" images avoiding saturation.

Please fill this Google form to establish a communication channel with us:
https://forms.gle/6UXXfCtPzn9w5kYy8


**Contact**

If you need any further assistance, you can contact us through these addresses:  Felipe Braga Ribas <ribas@on.br>; Josselin Desmars <josselin.desmars@obspm.fr>; Jose-Luis Ortiz <ortiz@iaa.es>; Sicardy Bruno <bruno.sicardy@obspm.fr>; Pablo Santos Sanz <psantos@iaa.es>


**Clear skies and good luck!**