# CHEOPS Guest Observers AO-6 Proposal Tutorial
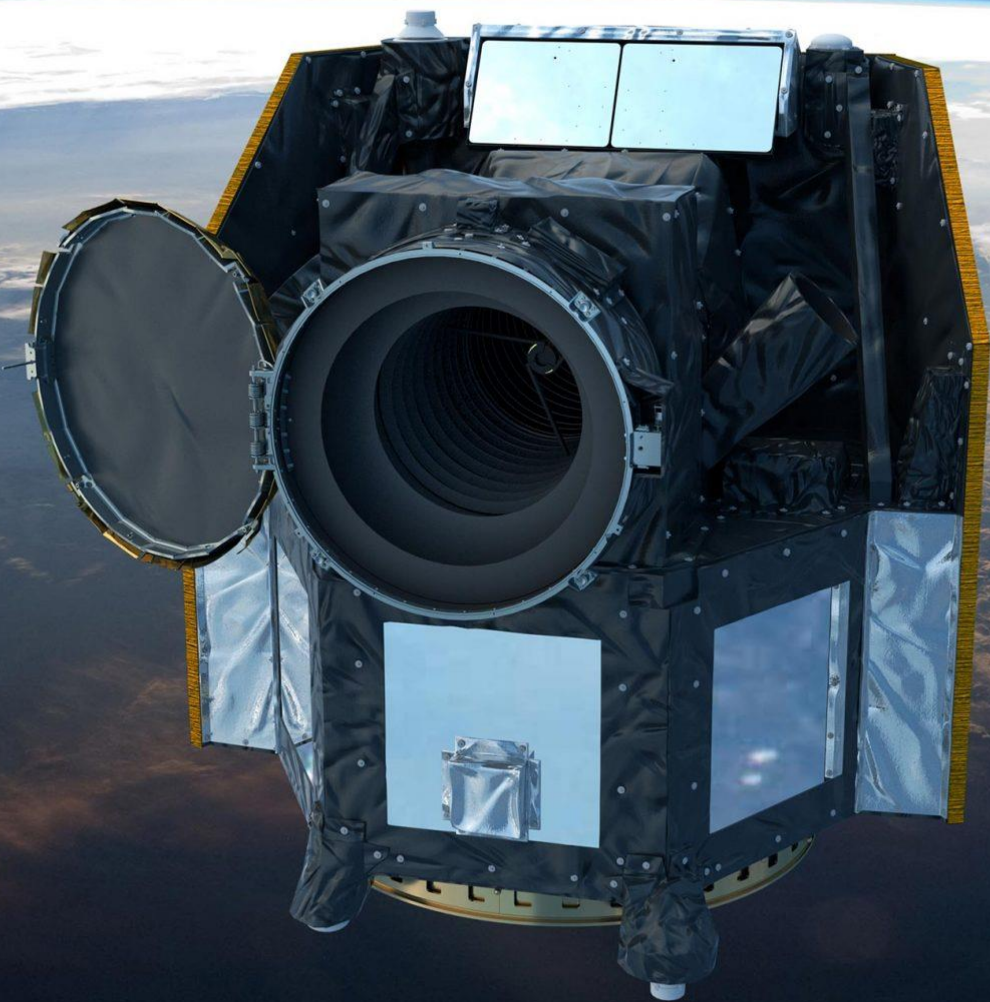
*Bruno Merín*

*Last update: 02/04/2025*

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# 7 steps to submit a CHEOPS proposal to its GO AO-6

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# Why observing your targets with CHEOPS ?

**More targets:** only 50 GTO reserved targets, with all the rest being open to the entire community
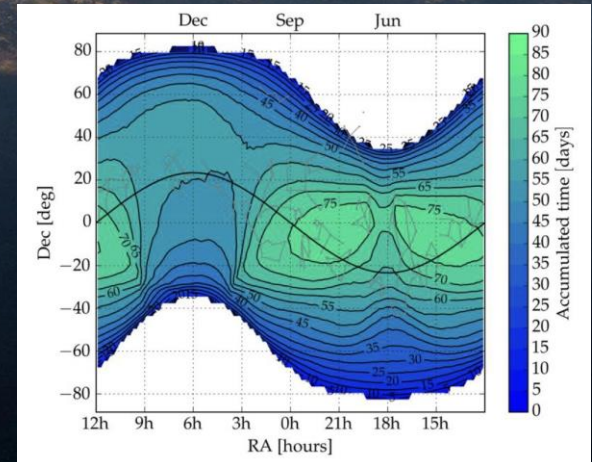
**More time:** 30% science observing time dedicated to the GO Programme

**Double anonymous** peer-review of proposals

Zero-installation, **cloud-based** target visibility checker

**Space-based ultra-high-precision photometry :**

- **20 ppm in 6 hrs (6 ≤ V ≤ 9); 85 ppm in 3 hrs (9 ≤ V ≤ 12)**

- **>50% of the sky observable**


Target visibility map

# Cool science with CHEOPS



**CHEOPS SHOWS SCORCHING EXOPLANET ACTS LIKE A MIRROR**

Data from ESA's exoplanet mission **Cheops** has led to the surprising revelation that an ultra-hot exoplanet that orbits its host star in less than a day is covered by **reflective clouds of metal**, making it the **shiniest exoplanet ever found**.

**LTT 9779**
Sun-like host star

**LTT 9779b**
Mirror-like exoplanet

A unique ultra-hot Neptune-type planet which likely began its life as a bigger gas giant, but lost mass over time

**Silicate** (glass) cloud layer

**Titanate** cloud layer

**Orbit**
~ 19 hours

**Cloud-filled atmosphere**
reflects 80% of incident light
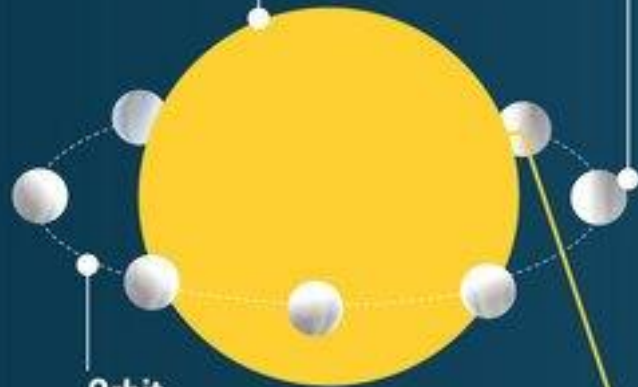
Cheops detected a small reduction in light coming from the system when the planet moved behind the star

#CHEOPS

**Mass**
1.7 × Neptune

**Radius**
1.2 × Neptune

**Dayside temperature**
~2000 ºC

esa

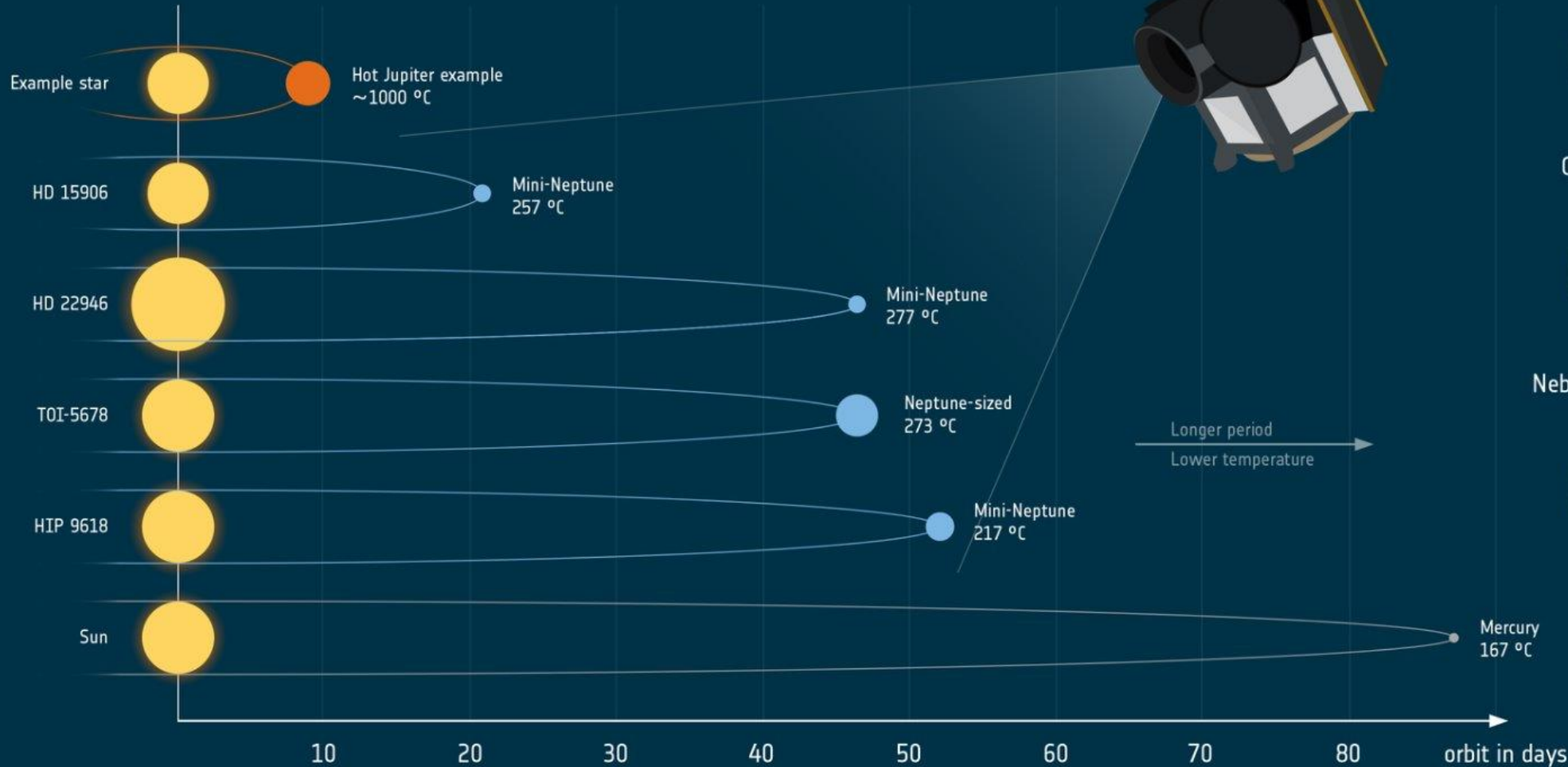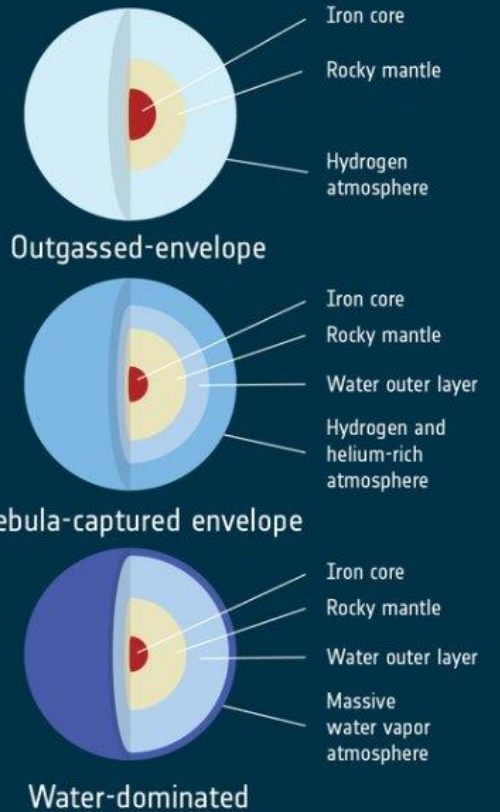Hoyer et al. (2023) https://www.aanda.org/10.1051/0004-6361/202346117

# CHEOPS EXPLORES MYSTERIOUS WARM MINI-NEPTUNES

ESA's Cheops confirmed the existence of four warm exoplanets with sizes between Earth and Neptune, orbiting their stars closer than Mercury our Sun. These so-called mini-Neptunes are unlike any planet in our Solar System and provide a 'missing link' that is not yet understood. Mini-Neptunes are among the most common types of planets known, and astronomers are starting to find more and more orbiting bright stars.

**Internal structure possibilities of mini-Neptunes**

Example star
Hot Jupiter example
~1000 °C

HD 15906
Mini-Neptune
257 °C

HD 22946
Mini-Neptune
277 °C

TOI-5678
Neptune-sized
273 °C

HIP 9618
Mini-Neptune
217 °C

Sun
Mercury
167 °C

Longer period
Lower temperature

Iron core
Rocky mantle
Hydrogen atmosphere
**Outgassed-envelope**

Iron core
Rocky mantle
Water outer layer
Hydrogen and helium-rich atmosphere
**Nebula-captured envelope**

Iron core
Rocky mantle
Water outer layer
Massive water vapor atmosphere
**Water-dominated**

10  20  30  40  50  60  70  80  orbit in days

Garai et al. 2023, Osborn et al. 2023, Tuson et al. 2023 and Ulmer-Moll et al. 2023

#CHEOPS

*Stars and planets not to scale*

ESA'S CHEOPS HELPS UNLOCK RARE SIX-PLANET SYSTEM

An uncommon family of **six exoplanets** has been unlocked with the help of **ESA's Cheops mission.**
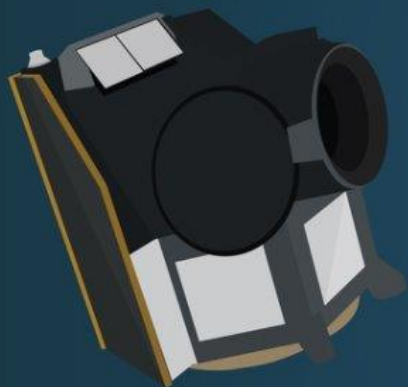
The six planets orbit their **central star HD 110067** in a harmonic rhythm with planets aligning every few orbits.
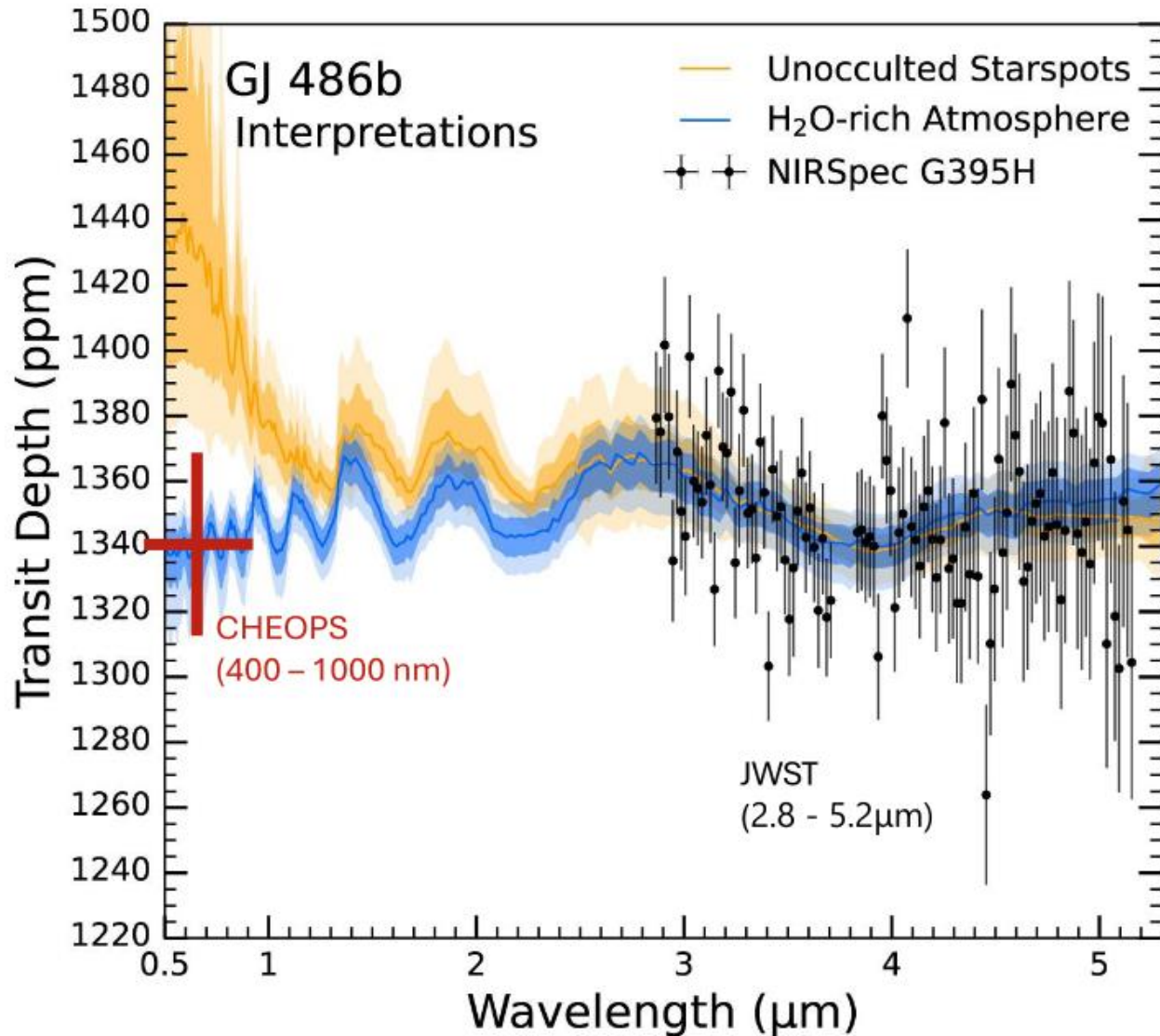
Planet b completes **six orbits** while planet g does **one**

6:1

Planet e completes **four orbits** while planet f does **three**

3:2  3:2  3:2  4:3  4:3

Planet c completes **three orbits** while planet d does **two**

Orbital period predicted and confirmed by Cheops
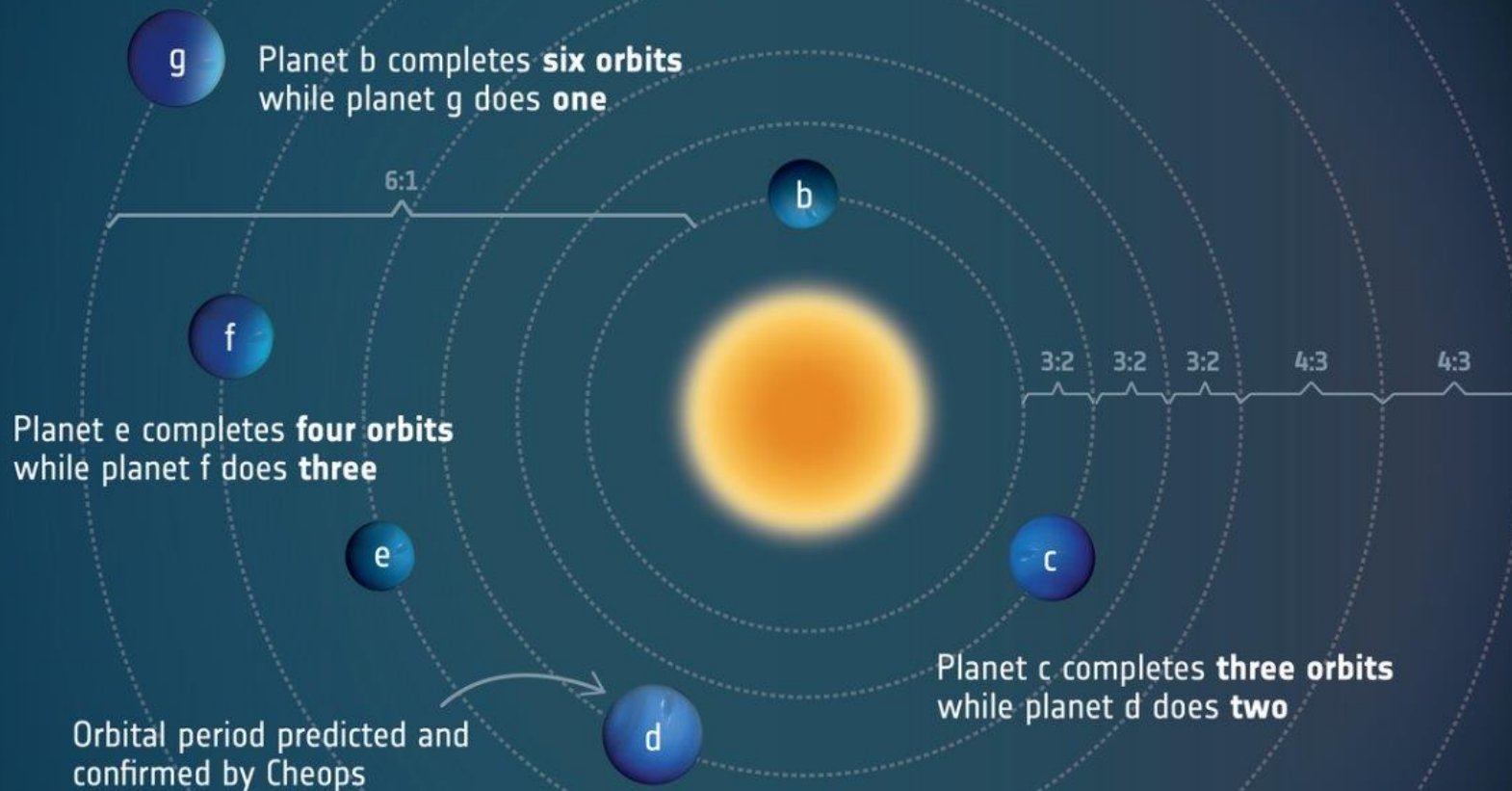
All planets are smaller than Neptune and have large atmospheres

*Star and planets not to scale

#CHEOPS

Luque et al. (2023) Nature.com/articles/s41586-023-06692-3

# Novelties in CHEOPS Cycle 6

- Large programmes are encouraged if teams can demonstrate that they will have the resources to produce a large and coherent dataset for further analysis by the scientific community.

- Simultaneous observations with JWST or other facilities could be requested, potentially enhancing the scientific impact of observations from both observatories (even if schedulability cannot be guaranteed in all cases). See next slide.

# Science Case



GJ 486b Interpretations

Legend:
- Unoccluded Starspots (orange line)
- $H_2O$-rich Atmosphere (blue line)
- NIRSpec G395H (black data points)

CHEOPS (400 – 1000 nm)

JWST (2.8 - 5.2μm)

X-axis: Wavelength (μm)
Y-axis: Transit Depth (ppm)

**Simultaneous observations:**

- Example of super-Earth GJ 486b studied with JWST

- High-profile science (NASA media release, worldwide coverage)

- Simultaneous CHEOPS observations could have broken this degeneracy and given the full picture

- CHEOPS will help HST and JWST to reach full potential

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# 1. Registration

1. Go to https://www.cosmos.esa.int/web/cheops-guest-observers-programme/ao-6
2. Then click on "Proposal submission"

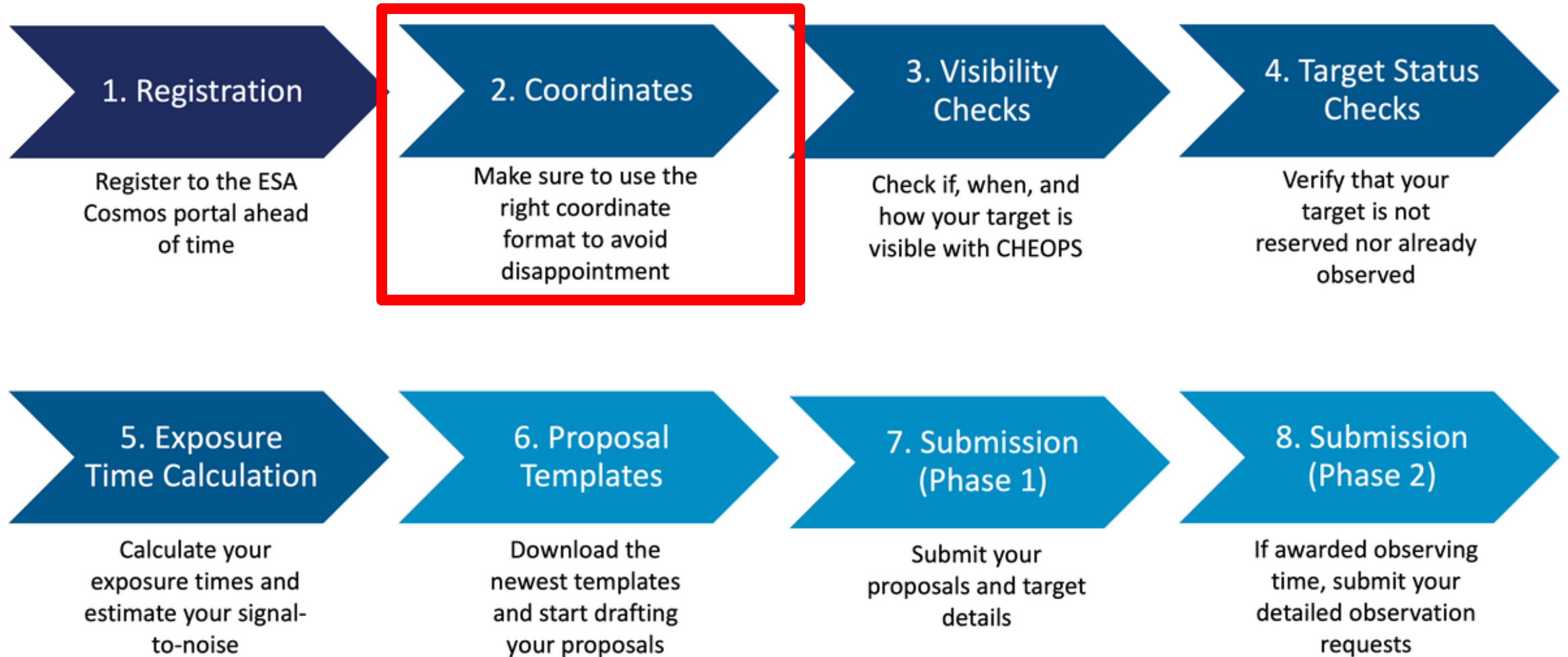# 1. Registration

3. Then click on "Registration"

# 1. Registration

4. Follow the instructions
5. This will create a so-called "cosmos" account that you will need to submit your proposals, and to submit your Observation Requests (ORs) once you have your proposal approved.

(this account also gives you access to other ESA Science user services like other archives, ESASky, helpdesks or to ESA Datalabs)

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# 2. Coordinates check

1. CHEOPS consistently uses "ICRS, epoch J2000" SIMBAD (neither Gaia nor ExoFOP coordinates)
2. Go to https://cheops.unige.ch/pht2/search-reserved-targets/ and resolve your target

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# 3. Visibility checks

1. Go http://datalabs.esa.int and login with your cosmos account (you need to register first)
2. Click on flask icon
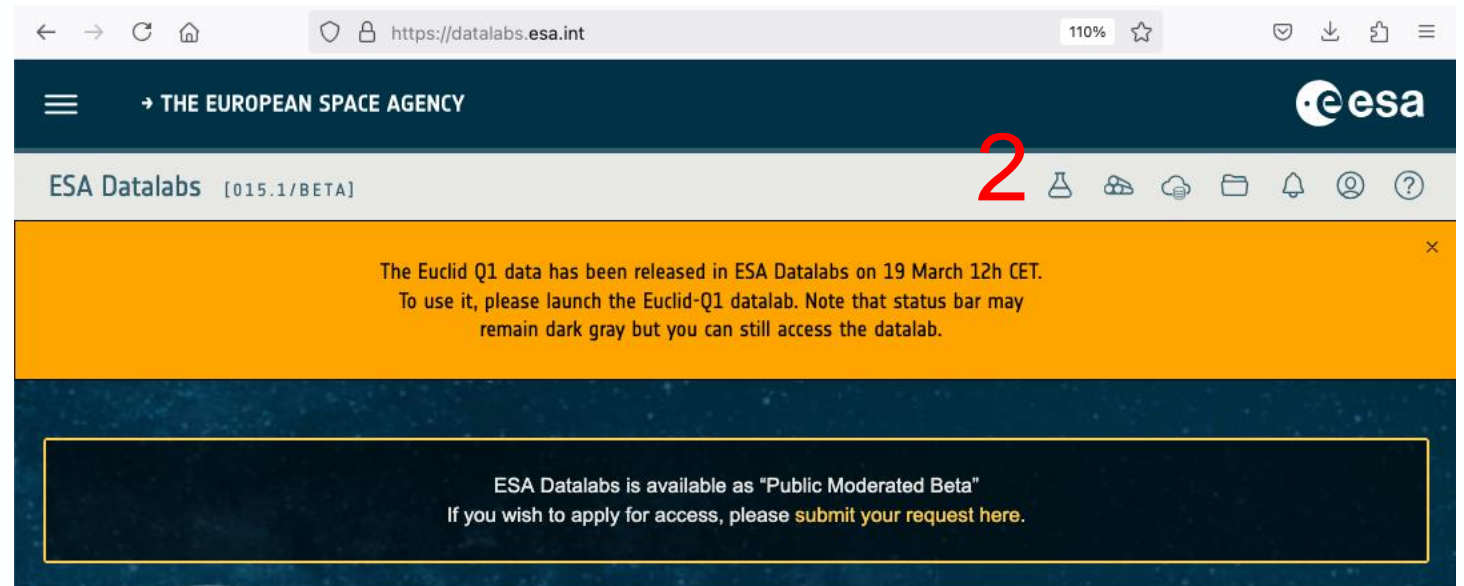
# 3. Visibility checks

3. Click on "Launch new"
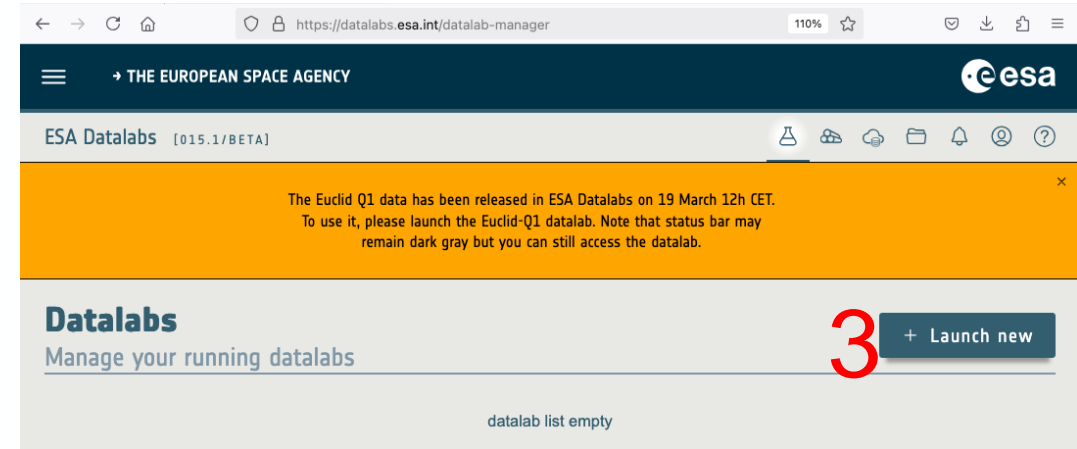
4. Type "cheops" in search field
This shows both CHEOPS applications in Datalabs
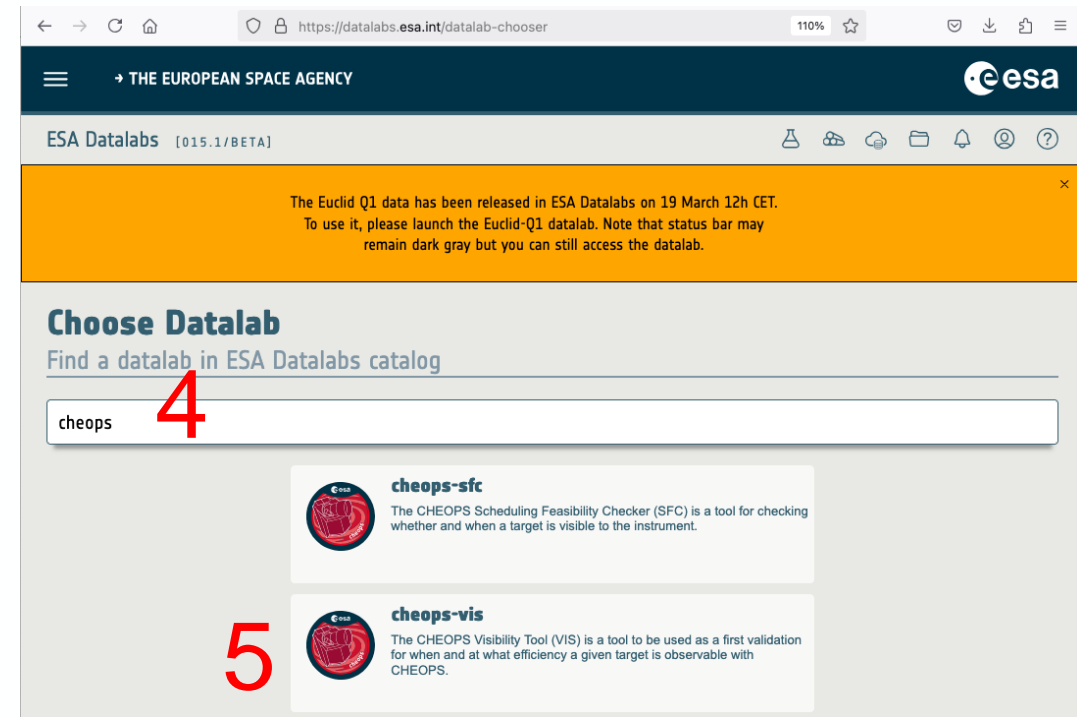
5. Click on "cheops-vis" card

# 3. Visibility checks

6. Click on "Launch it!"

# 3. Visibility checks

7. Once the application starts, press "enter" to get the console prompt

# 3. Visibility checks
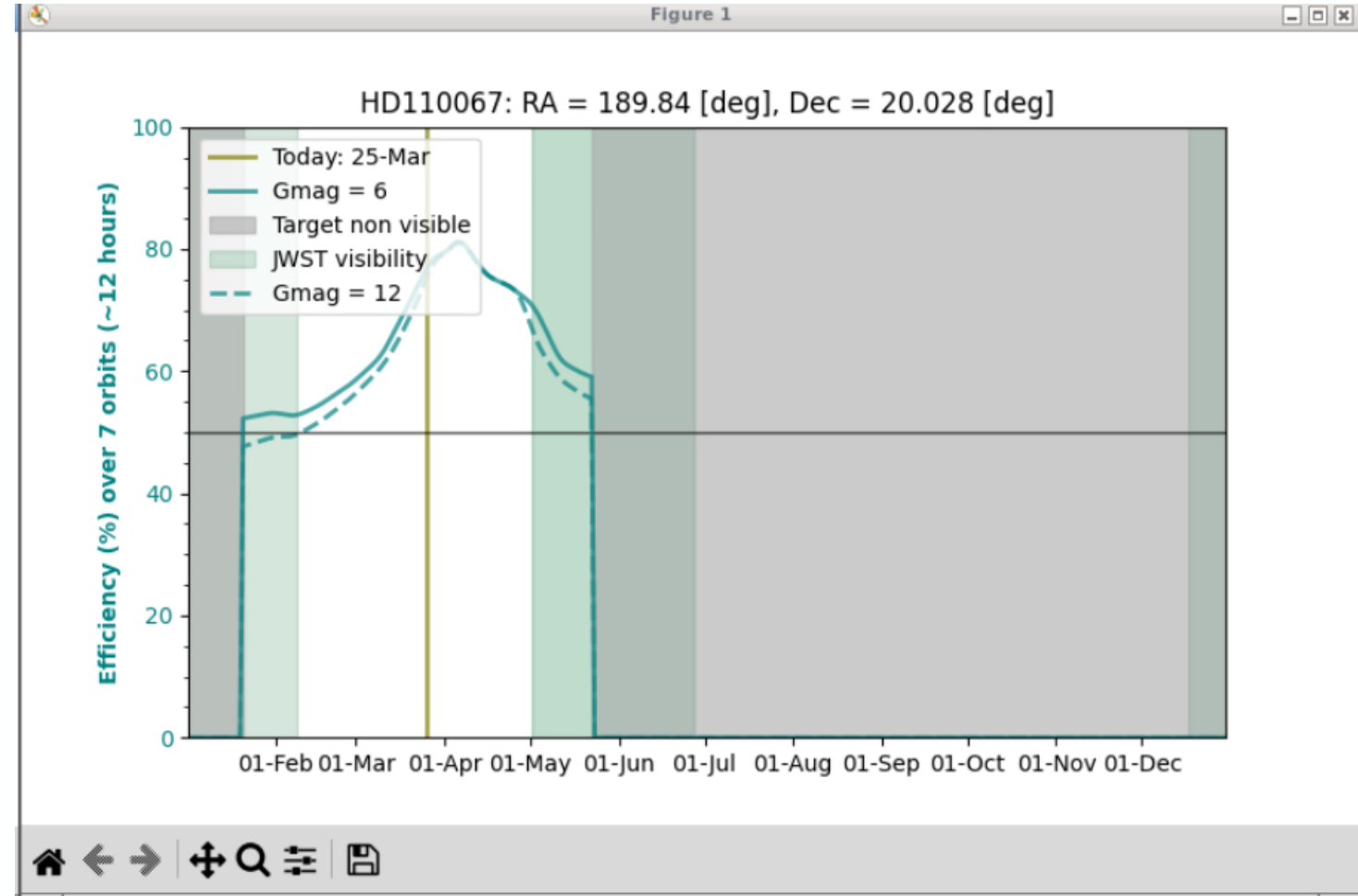
8. At the prompt type "CHEOPS_VIS --target_name" and the name of your target (or other options)
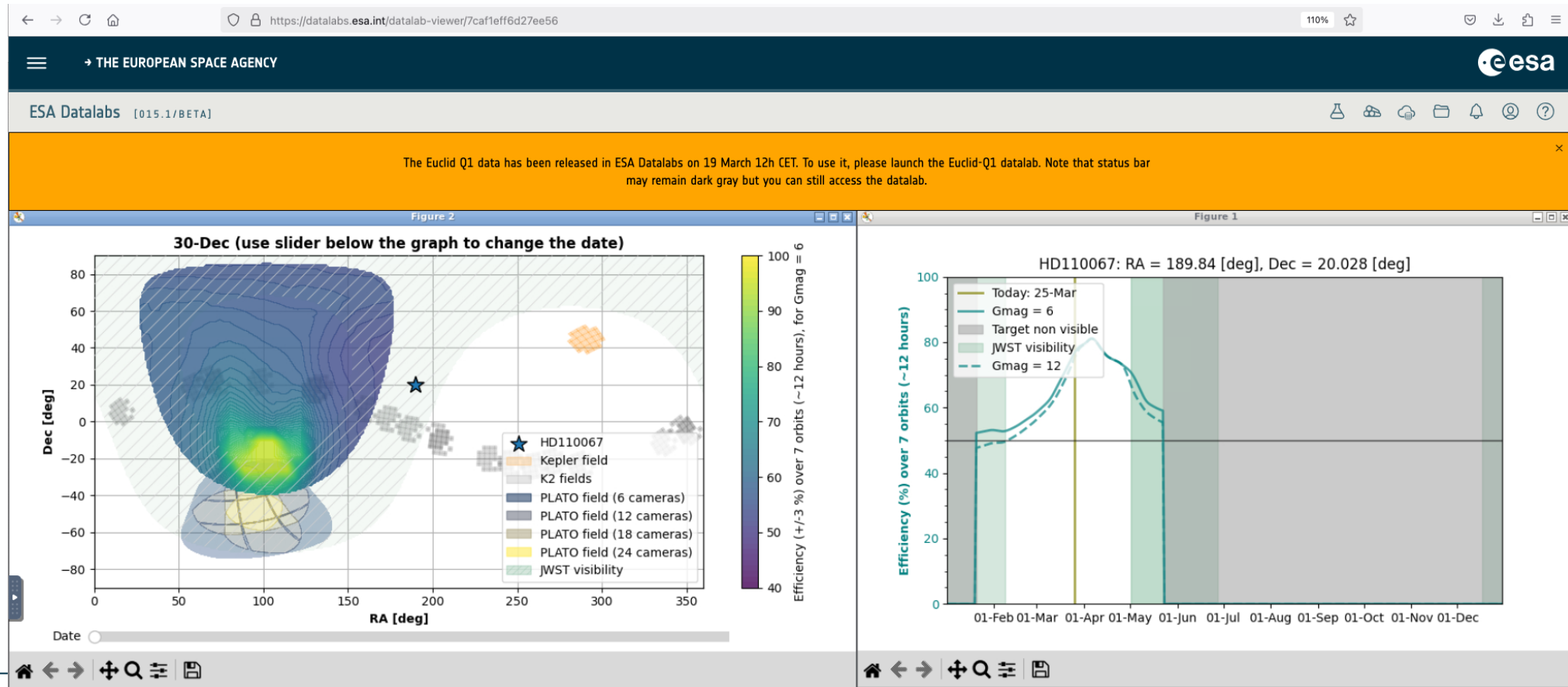
8. Figure shows efficiency as a function of time

You can also use the **cheops_sfc** tool in Datalabs to calculate possible visits for a given transit.

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# 4. Target status checks

1. Go to https://cheops.unige.ch/pht2/search-reserved-targets/ and check your target versus the Reserved Target List

## Target and Programme Information

### Search Targets

Search radius : 10 arc seconds

**Target name**

| HD 110067 | Resolve with Simbad |

**Right ascension** ✓

189.8395986915799

**Declination**

20.02778777129

Clear

### CHEOPS Extended Mission

List of reserved targets

List of programmes

GO proposals for this target are not possible.

This target (i.e., line of sight) is reserved by active GTO programmes (**PR140080**).

GO proposals for this target are not possible.

This target (i.e., line of sight) is reserved by active GTO programmes (**PR140080**).

# 4. Target status checks

2. Go to https://cheops-archive.astro.unige.ch/archive_browser/ and check your target has not been observed yet

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**eesa**

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# 5. Exposure time calculation

1. Go to https://cheops.unige.ch/pht2/exposure-time-calculator/ and calculate exposure times

# 5. Exposure time calculation

2. Download the PDF export of the best-fiting exposure times for your science goal

## CHEOPS Exposure Time Calculator

Comment

### Input Parameters

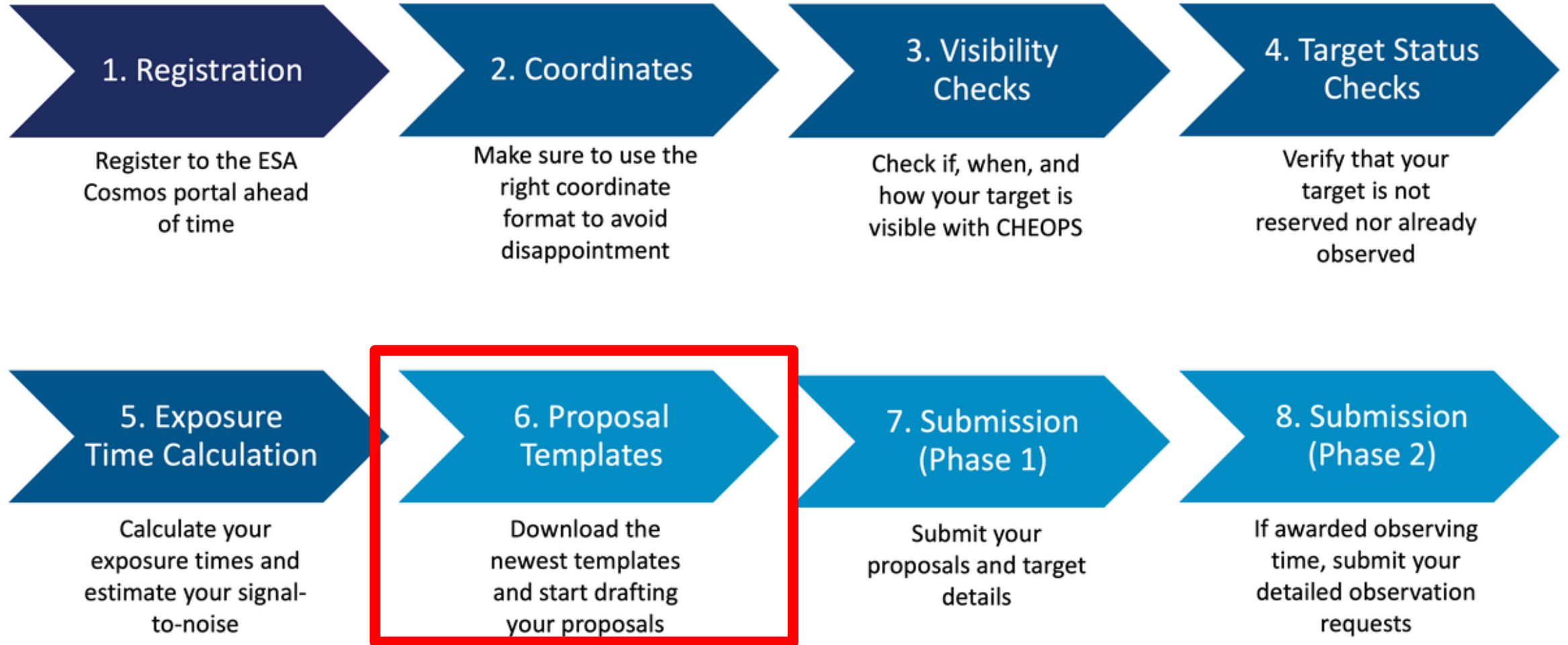| | |
|---|---|
| G Magnitude : | 8.18 |
| Effective Temperature : | 5240.00 |
| Spectral type (stellar granulation) : | K0V |
| Exposure Time : | 20.00 [s] |
| Right Ascension : | 189.84 [deg] |
| Declination : | 20.03 [deg] |

### Additional Parameters

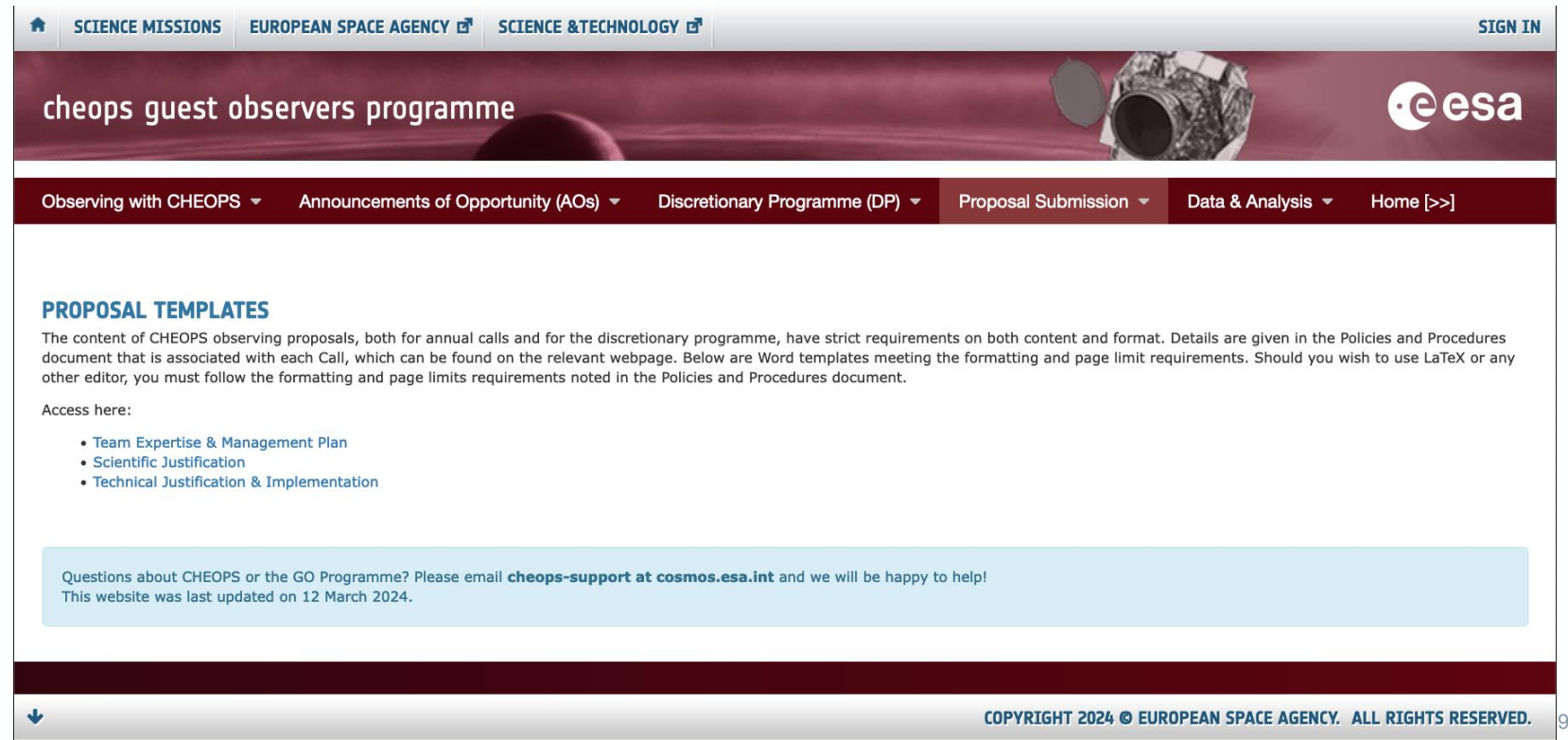| | |
|---|---|
| Specify observation duration | YES |
| Defined time interval : | 3.00 [h] |
| Specify flux in CHEOPS passband | NO |
| Specify visit/observation efficiency | NO |

### Calculation Results

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Saturation level at PSF peak [% FWC] : | 82.18 | | | | | | | [%] |
| | User input | 1 min | 10 min | 30 min | 1 h | 3 h | 6 h | |
| **Assuming 100% efficiency** | | | | | | | | |
| Stellar granulation noise : | 6.44 | 8.60 | 7.83 | 7.62 | 7.38 | 6.44 | 5.03 | [ppm] |
| Photon noise : | 9.69 | 130.00 | 41.11 | 23.73 | 16.78 | 9.69 | 6.85 | [ppm] |
| Total noise including stellar granulation : | 16.06 | 191.94 | 71.95 | 41.36 | 25.61 | 16.06 | 12.03 | [ppm] |
| Total noise without stellar granulation : | 14.71 | 191.75 | 71.52 | 40.65 | 24.52 | 14.71 | 10.93 | [ppm] |
| **Assuming computed maximum efficiency :** | **83.30** | | | | | | | **[%]** |
| Stellar granulation noise : | 6.44 | | 7.83 | 7.62 | 7.38 | 6.44 | 5.03 | [ppm] |
| Photon noise : | 10.63 | | 45.96 | 26.18 | 18.45 | 10.63 | 7.51 | [ppm] |
| Total noise including stellar granulation : | 17.22 | | 77.88 | 46.83 | 27.81 | 17.22 | 12.80 | [ppm] |
| Total noise without stellar granulation : | 15.97 | | 77.49 | 46.20 | 26.81 | 15.97 | 11.77 | [ppm] |
| **Assuming computed median efficiency :** | **61.60** | | | | | | | **[%]** |
| Stellar granulation noise : | 6.44 | | 7.83 | 7.62 | 7.38 | 6.44 | 5.03 | [ppm] |
| Photon noise : | 12.36 | | 53.07 | 30.36 | 21.47 | 12.36 | 8.73 | [ppm] |
| Total noise including stellar granulation : | 19.43 | | 87.54 | 55.21 | 35.09 | 19.43 | 14.30 | [ppm] |
| Total noise without stellar granulation : | 18.33 | | 87.18 | 54.68 | 34.31 | 18.33 | 13.38 | [ppm] |

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# 6. Proposal templates



1. Fill in the *Team expertise and management Plan* template (list team members, their expertise and describe how do you plan to reduce and analyse the data). This document is not anonymised.

2. Fill in the *Scientific Justification* template (<span style="color:red">IMPORTANT: respect the dual anonymous conditions!</span> E.g. make it impossible to guess who you are to reviewers)

3. Fill in the *Technical Justification & Implementation* template with the details from your visibility and exposure time calculations. (<span style="color:red">IMPORTANT: respect the dual anonymous conditions!</span> E.g. make it impossible to guess who you are to reviewers)

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# 6. Submision (Phase 1)

1. Go to [https://www.cosmos.esa.int/web/cheops-guest-observers-programme/pht1](https://www.cosmos.esa.int/web/cheops-guest-observers-programme/pht1) and click on "Submission Phase 1"
2. Then click on "Sign in" to log-in into the Proposal Handling Tool 1 (PHT1)

# 6. Submission (Phase 1)

3. Login with your "cosmos" account (from the registration, step 1)

# 6. Submission (Phase 1)

4. Click on CHEOPS AO-6

5. Click on the + sign to create a proposal

# 6. Submission (Phase 1)

6. Fill in the PI details in page 1
7. Upload the PDF with the *Team Expertise and Management Plan* file

# 6. Submission (Phase 1)

8. Fill in the details on the contact's name and other collaborators

# 6. Submission (Phase 1)

9. Enter the proposal details (title, science category, abstract and upload justifications)

10. Enter info on the target(s), including time-critical info if needed and observation parameters

11. Click on the boxes related to Data privacy and then click "Finish" to submit

# Questions and answers

# Extra material

# Visibility checks (without Datalabs account)

1. Go to [https://gitlab.unige.ch/cheops/CHEOPS_visibility_tool](https://gitlab.unige.ch/cheops/CHEOPS_visibility_tool) and download the visibility checker python package (it requires python installed and scipy later than 1.9)

2. After installation, run command:

```
# 1. For a single target, run (RA/Dec are optional, see definitions of command line arguments below)
$ python3 mk_CHEOPS_eff_maps.py --target_name TARGET_NAME --RA RA --Dec DEC --obs OBS --mode mode


# 2. For multiple targets, use the targets_file argument (definition below), run
$ python3 mk_CHEOPS_eff_maps.py --targets_file PATH_TO_YOUR_TARGETS_FILE --mode mode
```

# Visibility checks (without Datalabs account)

1. The package will show the visibility map and efficiency values for one year (Remember: AO-6 runs from 1 Oct 2025 to 30 Sept 2026)