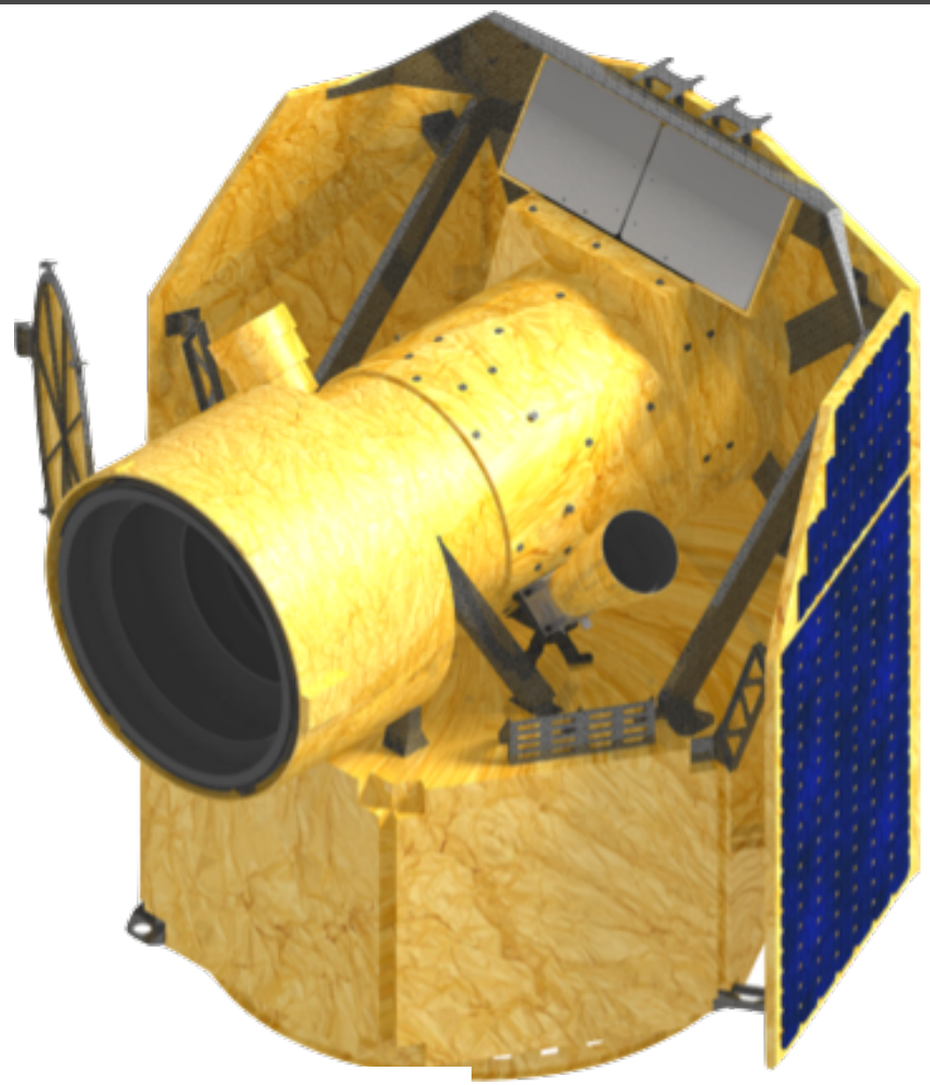
UNIVERSITÄT BERN

CHEOPS: towards exoplanets characterisation

Pathways 2015

13-17 July, Bern, Switzerland



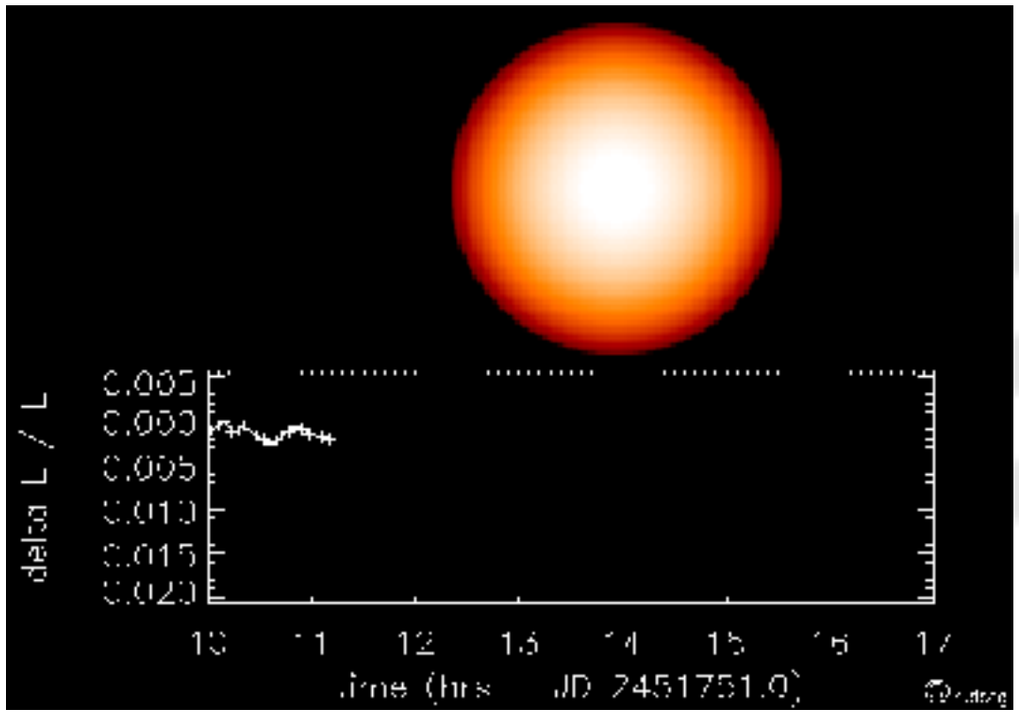
Andrea Fortier

On behalf of the CHEOPS Team

CHEOPS science case

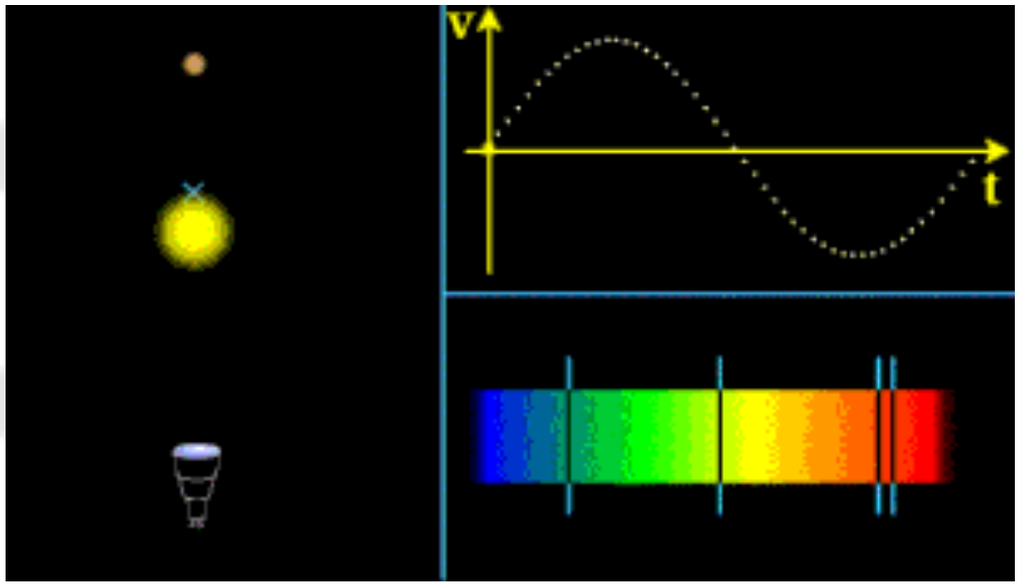
- **Scientific Motivation for a CHaracterising ExOPlanets Satellite**

Transit technique



➔ radius of the planet

RV technique

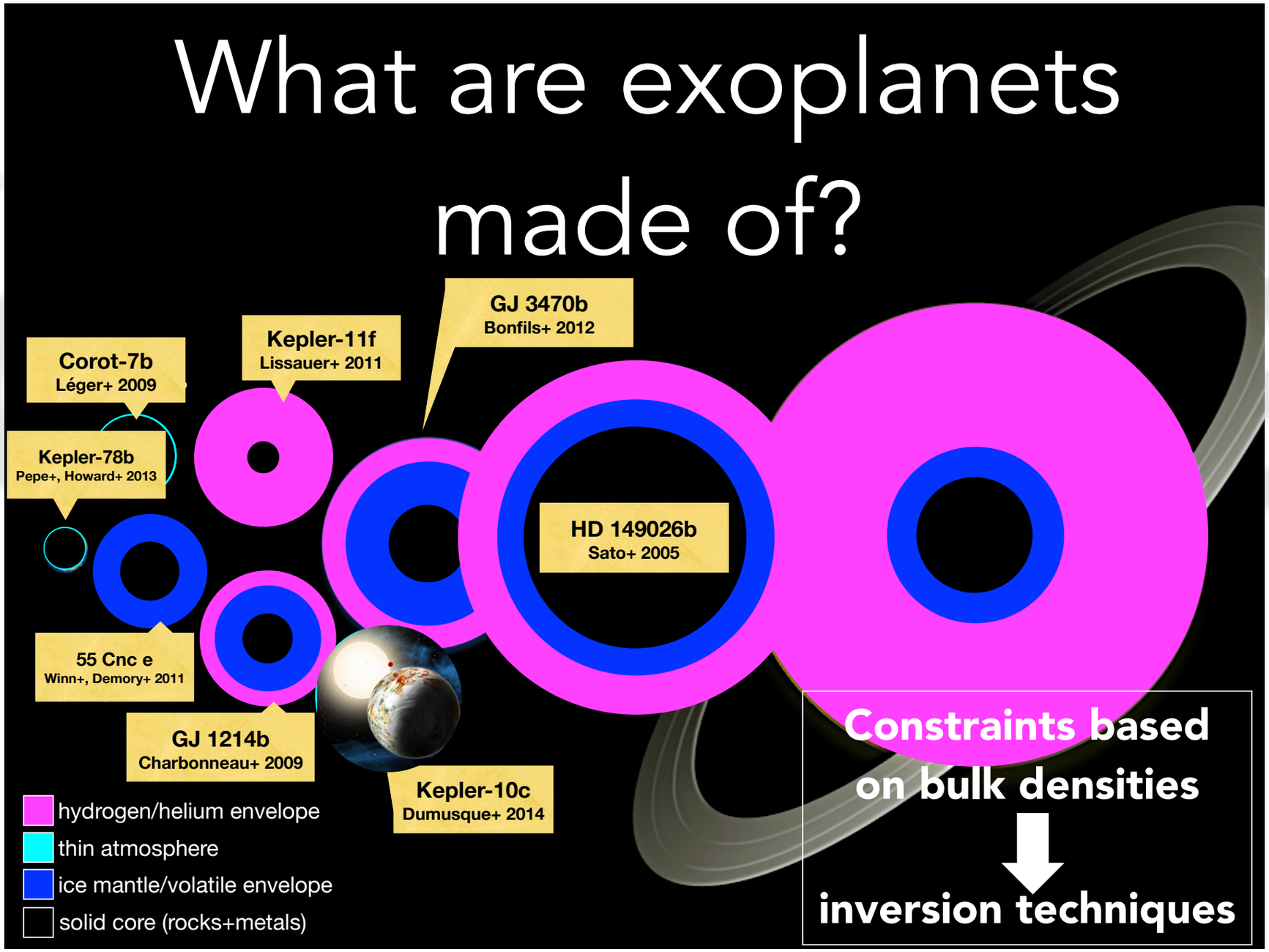


➔M sin(i)

$M_p + R_P \rightarrow \rho_P$

CHEOPS science case

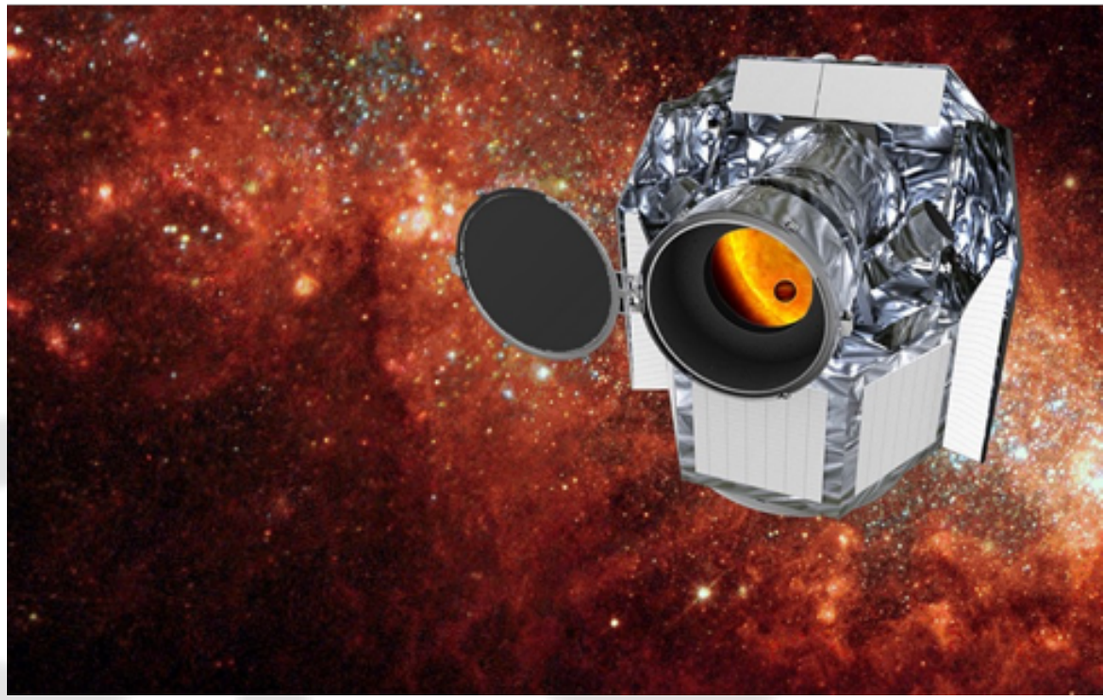
- **Scientific Motivation for a CHaracterising ExOPlanets Satellite**



see Dorn et al. (2015)

The CHEOPS Mission in numbers

CHEOPS: First ESA small mission



ESA S-class mission in Cosmic Vision 2015-2025:

- ❖ Science
  - ➢ top rated science in any area of space science
- ❖ Cost
  - ➢ total cost ~ 110 M€
  - ➢ cost to ESA: not to exceed 50 M€
- ❖ Schedule
  - ➢ developed and launched within 4 years
- ❖ Consortium: Switzerland + 10 European Countries

Timeline

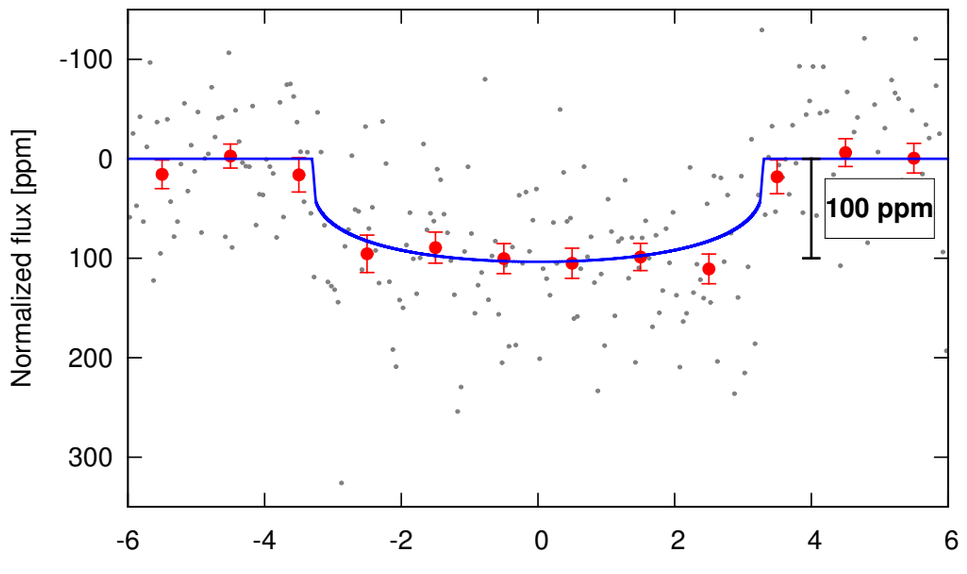
call issued	March, 2012
proposal due	June, 2012
mission selection	October, 2012
mission adoption	February, 2014
launch	end 2017
nominal lifetime	3.5 years

Photometric accuracy

CHEOPS Science Requirements

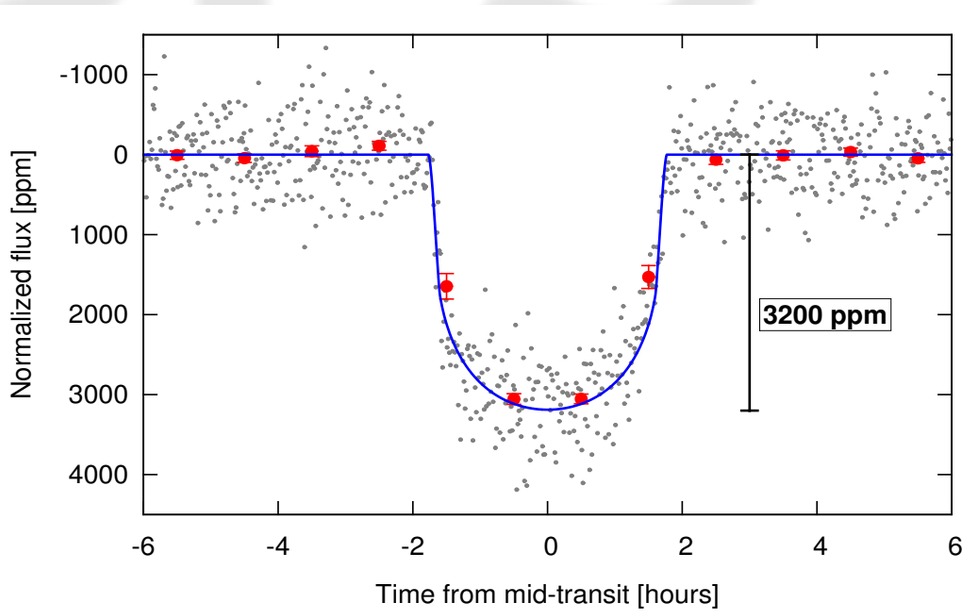
Photometric accuracy for Earth and Super-Earth detection: 20 ppm over 6 hour transit

6<V<9, G5 dwarf stars, P_{planet} ~ 50 days ➔ primary targets coming from RV surveys



Photometric accuracy for Neptune characterisation: 85 ppm over 3 hour transit

9<V<12, K dwarf stars, P_{planet} ~ 13 days ➔ primary targets coming from NGTS survey

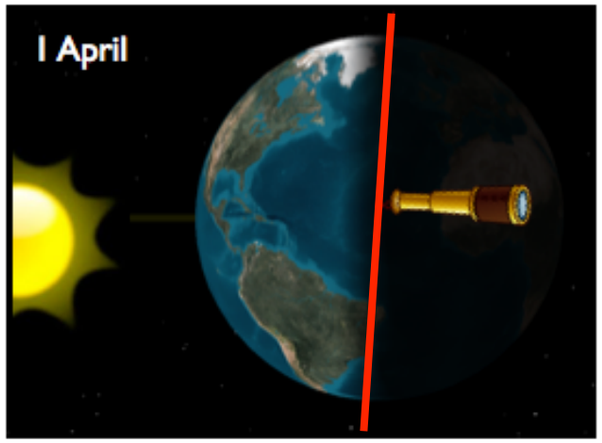


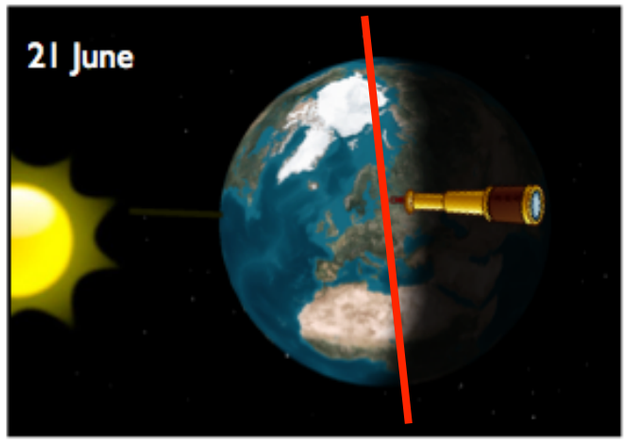
The sky of CHEOPS

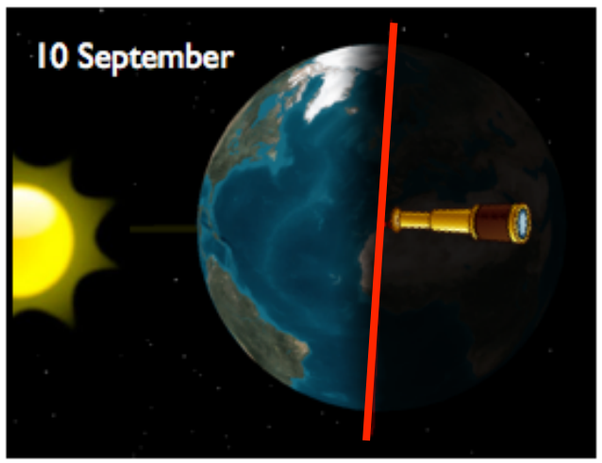
CHEOPS orbit

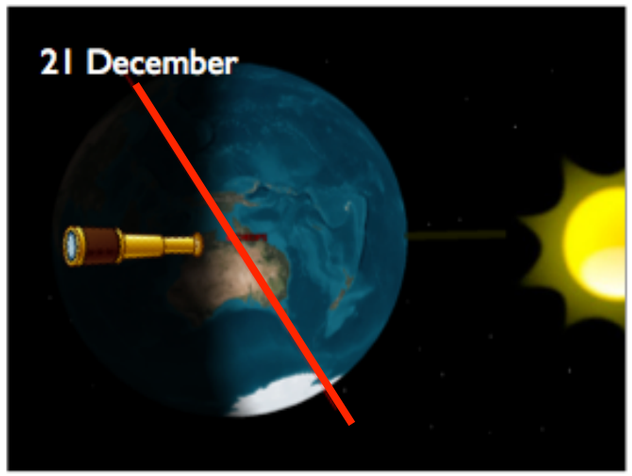
Sun Synchronous, Low Earth Orbit, LTAN 6am/6pm (dawn-dusk: the satellite rides the day-night terminator)

Possible altitudes: 650, 700, 800 km

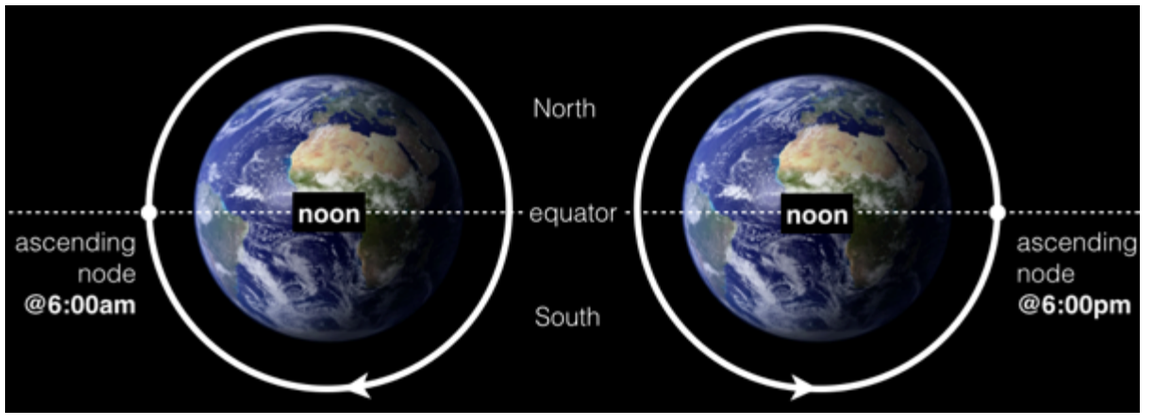








- A Sun-synchronous orbit is a geocentric orbit which combines altitude and inclination in such a way that an object on that orbit will appear to orbit in the same position, from the perspective of the Sun, during its orbit around the Earth. More technically, it is an orbit arranged in such a way that it precesses once a year. The nodes of an orbit are the two intersection points of the orbital trajectory with the equatorial plane of the Earth. The point where the satellite passes from the southern hemisphere to the northern hemisphere is the ascending node.



The sky of CHEOPS

- **Observability requirements**

Science Requirements on sky coverage are different for different target groups:

Targets from Doppler surveys: detection of transits of super-Earths ➡ 50% of sky accessible for 50 days per year and per target with <50% interruption per orbit

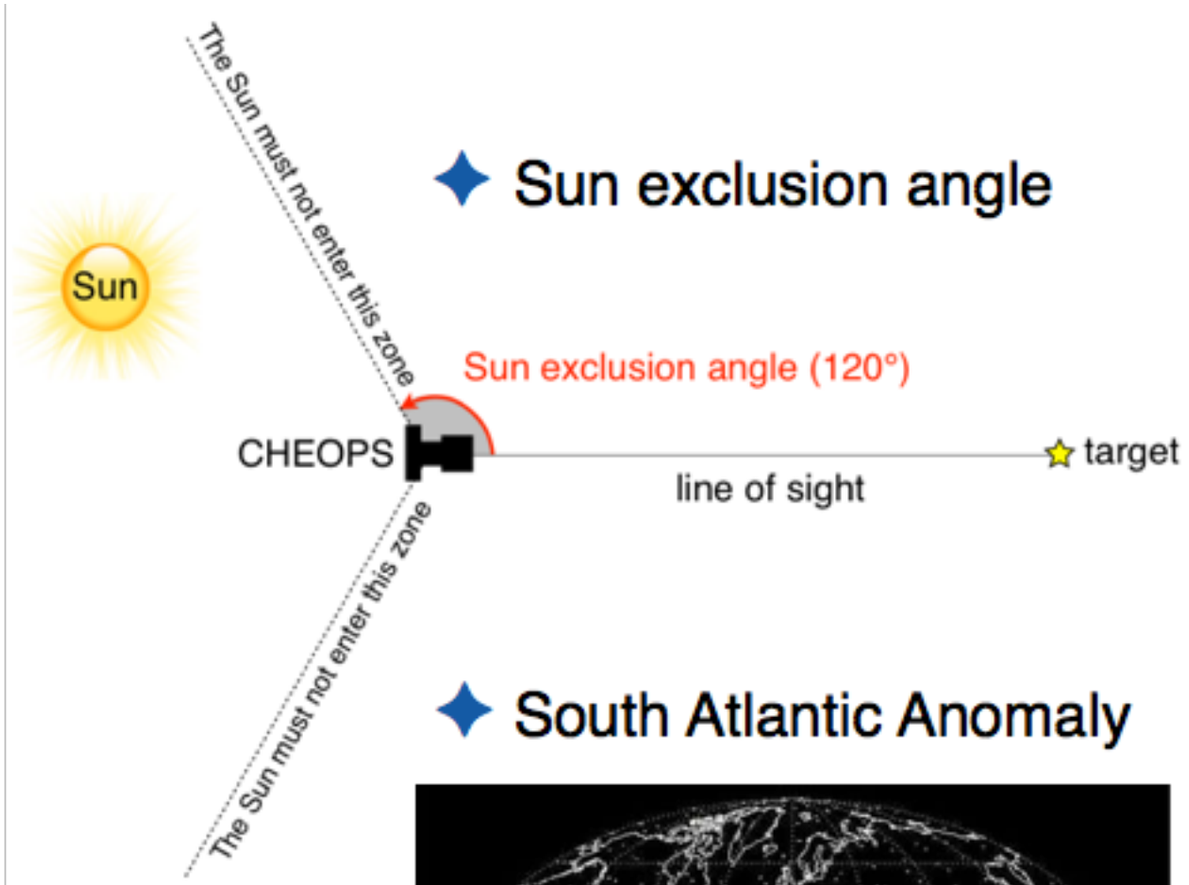
Targets from ground-based transit surveys: Characterising transits of Neptune-size planets ➡ 25% of sky accessible for 13 days per year per target with <20% interruptions

The sky of CHEOPS

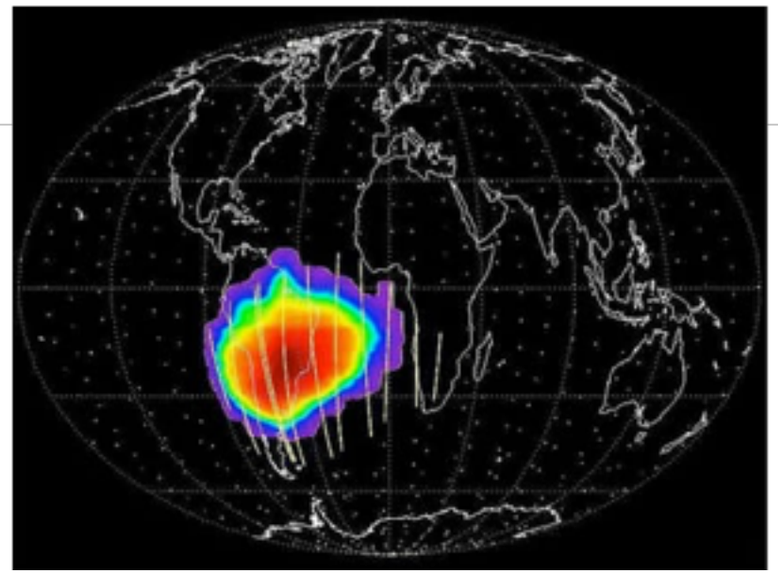
Observability constraints

Earth occultation & stray light exclusion angle

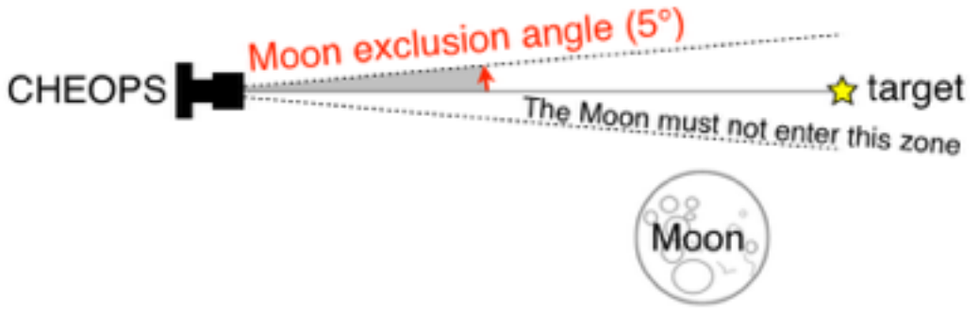
Sun exclusion angle



South Atlantic Anomaly



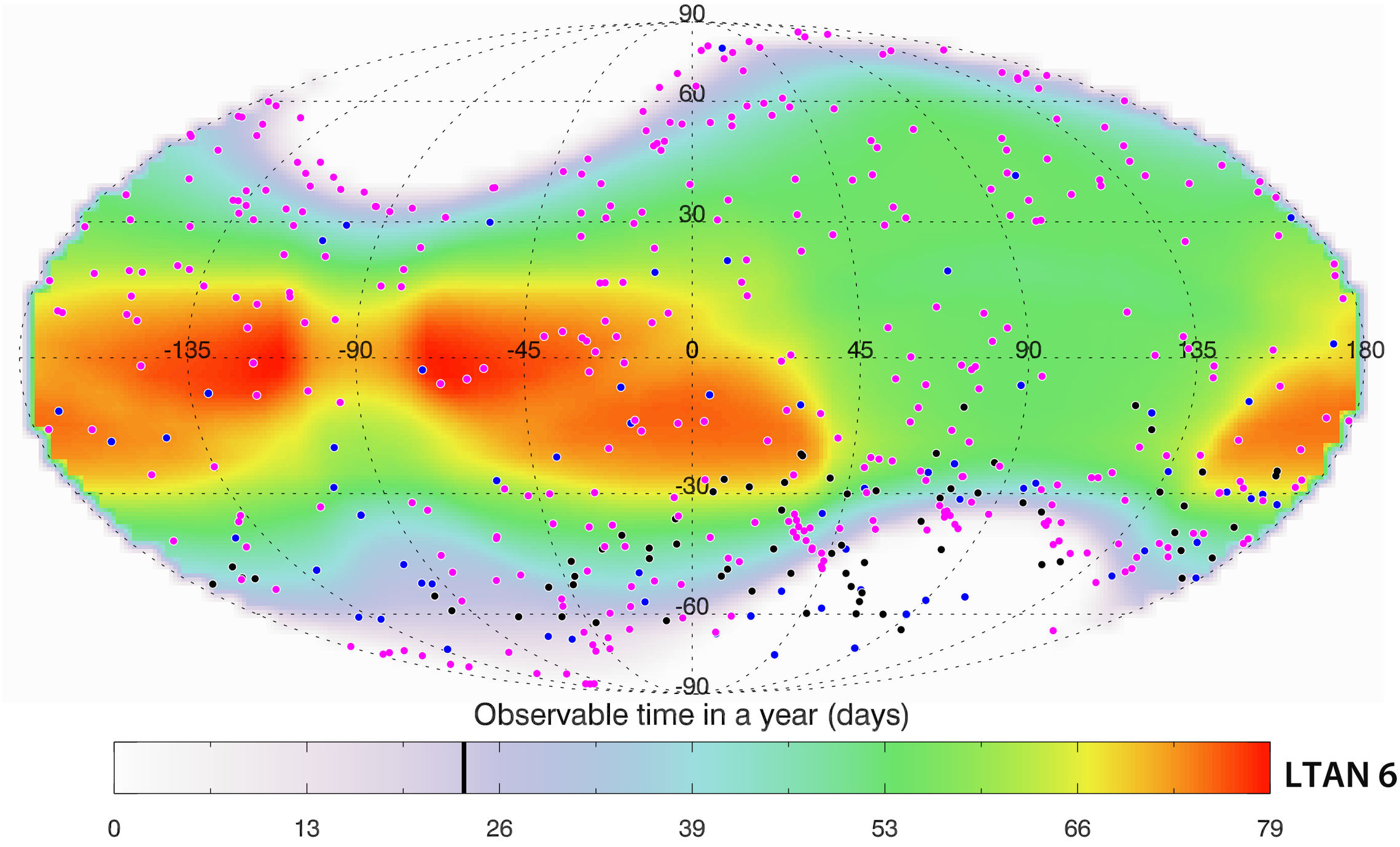
Moon exclusion angle



The sky of CHEOPS

CHEOPS targets

RV, TESS, NGTS



The sky of CHEOPS

- Orbit trade-off

  - Analysis performed on the 6am/6pm orbits:
    - sky observability: the 6pm orbit favours the northern hemisphere, therefore is not complaint with the requirement of southern coverage
    - the 6pm orbit loses all NGTS targets
    - RV / TESS targets are shifted 16 degree northward
    - some targets will fall outside ELT observable range

  - 6pm orbit was flagged as less performant

  - 6am orbit is preferred for the science case of CHEOPS

CHEOPS Mission Team

CHEOPS Mission Team: ESA + CHEOPS MISSION CONSORTIUM

Willy Benz
PI, U. Bern

Switzerland
Mission Lead
Instrument Team
Science Operations Center

esa
Launch campaign
Platform prime
CCD
Participation in MOC

Sweden
Data Flow Simulator

UK
Quick Look

France
Data Reduction Software

Portugal
Mission Planning, Archive, & Data Reduction Software

Spain
Mission operations centre

❑ **GROUND SEGMENT**

Germany
Focal Plane Assembly

Belgium
Baffle

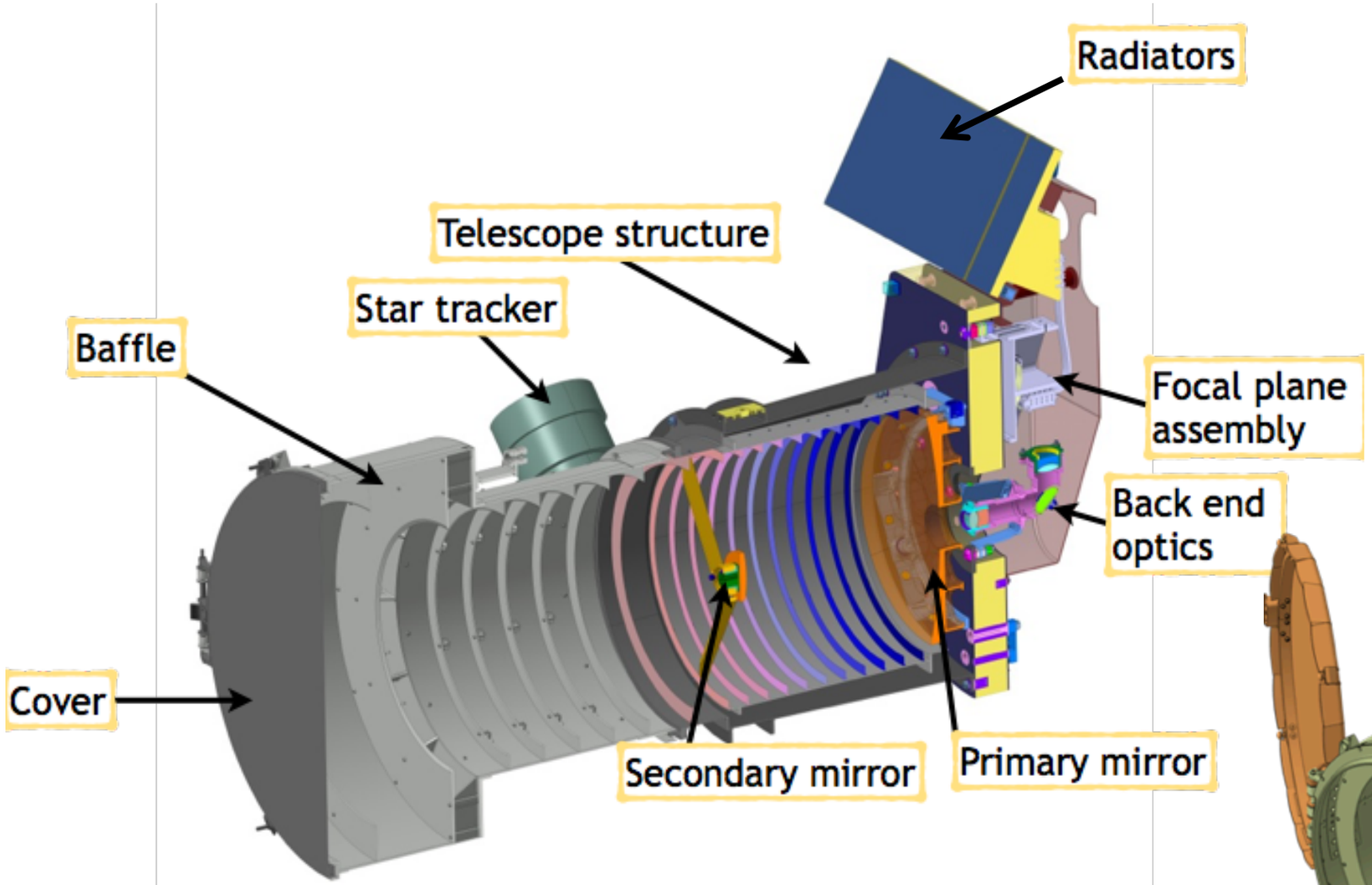
Italy
Optics

Austria
Digital Processing Unit, SW

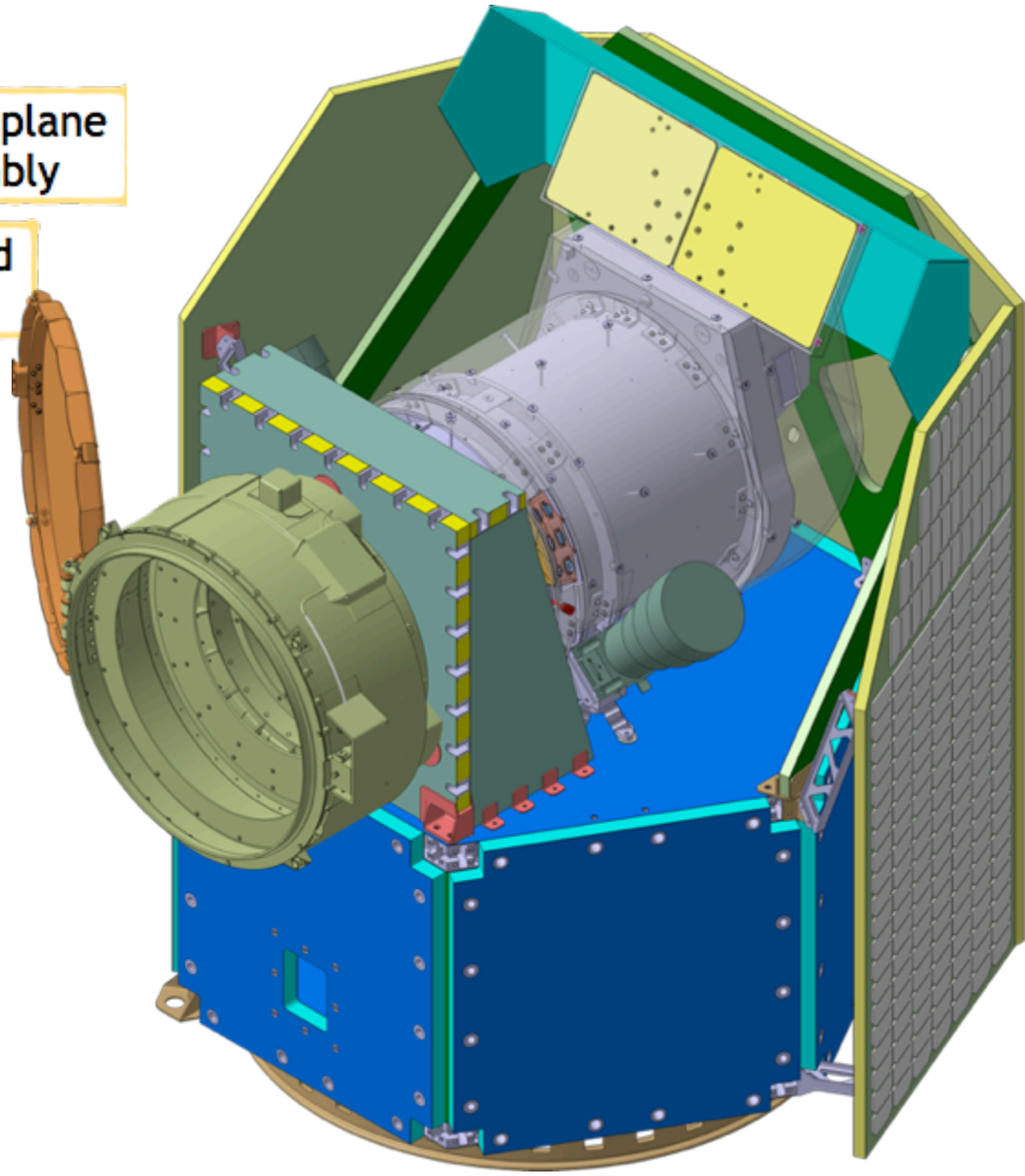
Hungary
Radiators

❑ **INSTRUMENT**

CHEOPS Instrument



Platform

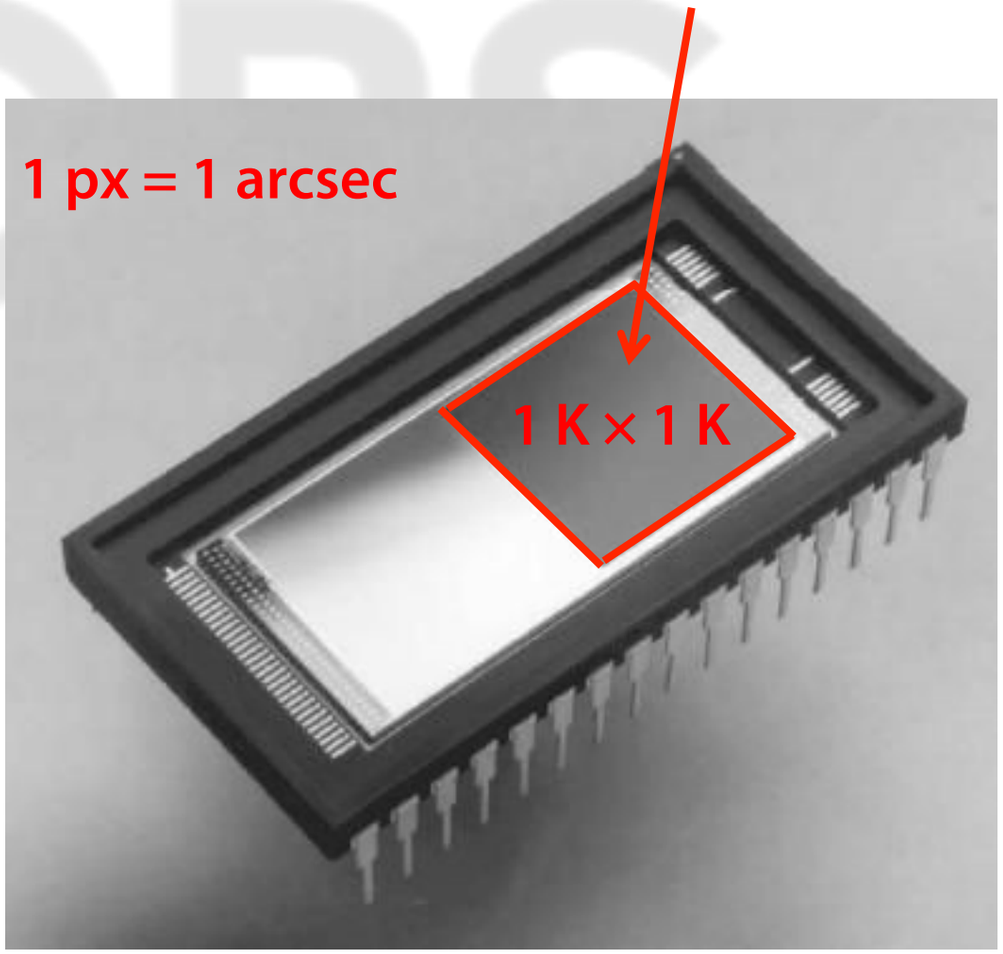


CHEOPS Instrument System

- 30 cm effective diameter on axis telescope
- payload mass: 60 kg
- total mass (payload + platform): 280 kg

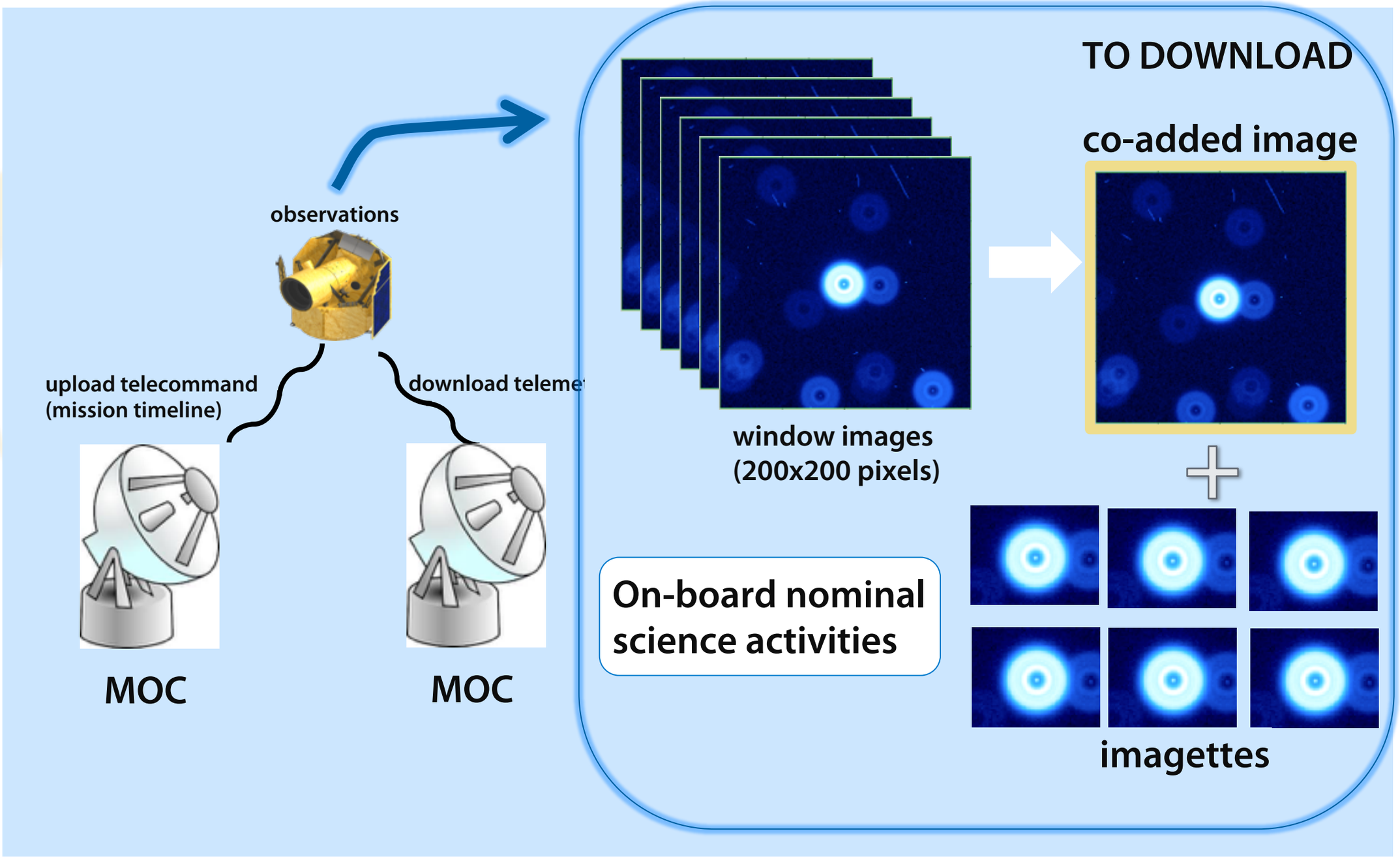
Flight CCD

- CHEOPS CCD: frame transfer, e2v back illuminated AIMO
- 3 CCDs have already been delivered to the University of Geneva, where the calibration will be performed
- The first CCD has already been integrated on a cryostat and the optical set up is ready to start measurements
- After all three CCD are tested they will be sent to DLR (Germany) for integration



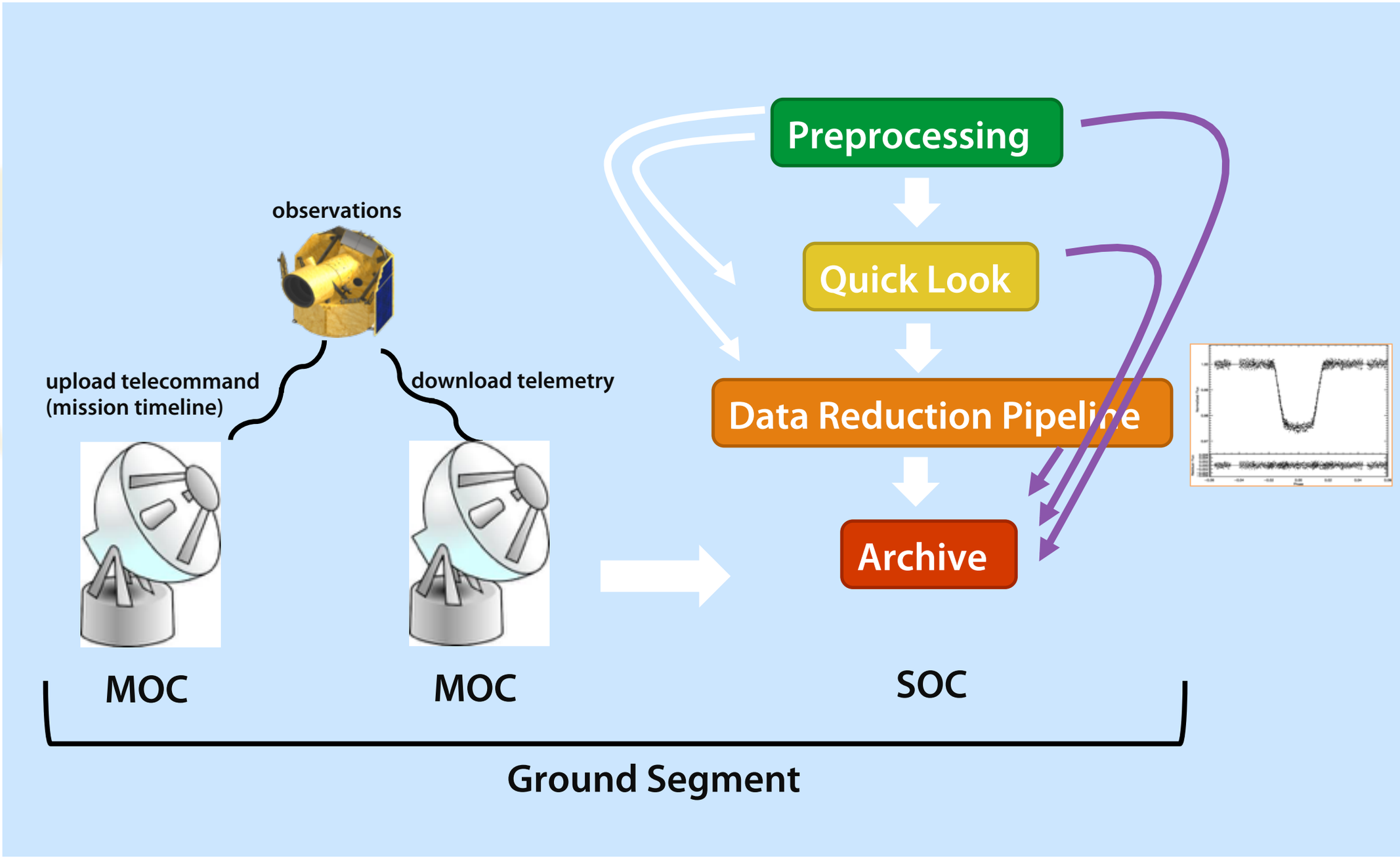
CHEOPS images

What do we get and how do we get it?



CHEOPS Ground Segment

What do we get and how do we get it?



Critical Design Review

- Next big milestone: CDR
- Instrument
  - Opto-mechanical CDR will take place after stability tests on STM-2 to be completed by Mid-September.
  - Electrical SubSystem CDR will take place after Electrical Model tests ➔ to be completed by October
  - One CDR of Optical and Electrical SubSystems together if possible
  - CIS CDR expected for October
- Ground Segment: November 2015 (TBC)
- SC / System: January 2016 (TBC)

CHEOPS Open Time

- **20% open time for the community**
  - ~6’100 hours, equivalent to 600-800 “nights”
- **Competitively attributed by ESA**
  - 1 Announcement of Opportunity/year
- **Cycle 1: Announcement of Opportunity**
  - mid-2017

Outreach

- CHEOPS website in new look
  - CHEOPS paper model for download
  - Transit simulator paper model for download (PlanetS)
- School plate
  - drawing collection information online
  - Location of school plate defined (detailed interface on-going)
  - Drawing format defined
  - First Swiss drawings collected

http://cheops.unibe.ch/