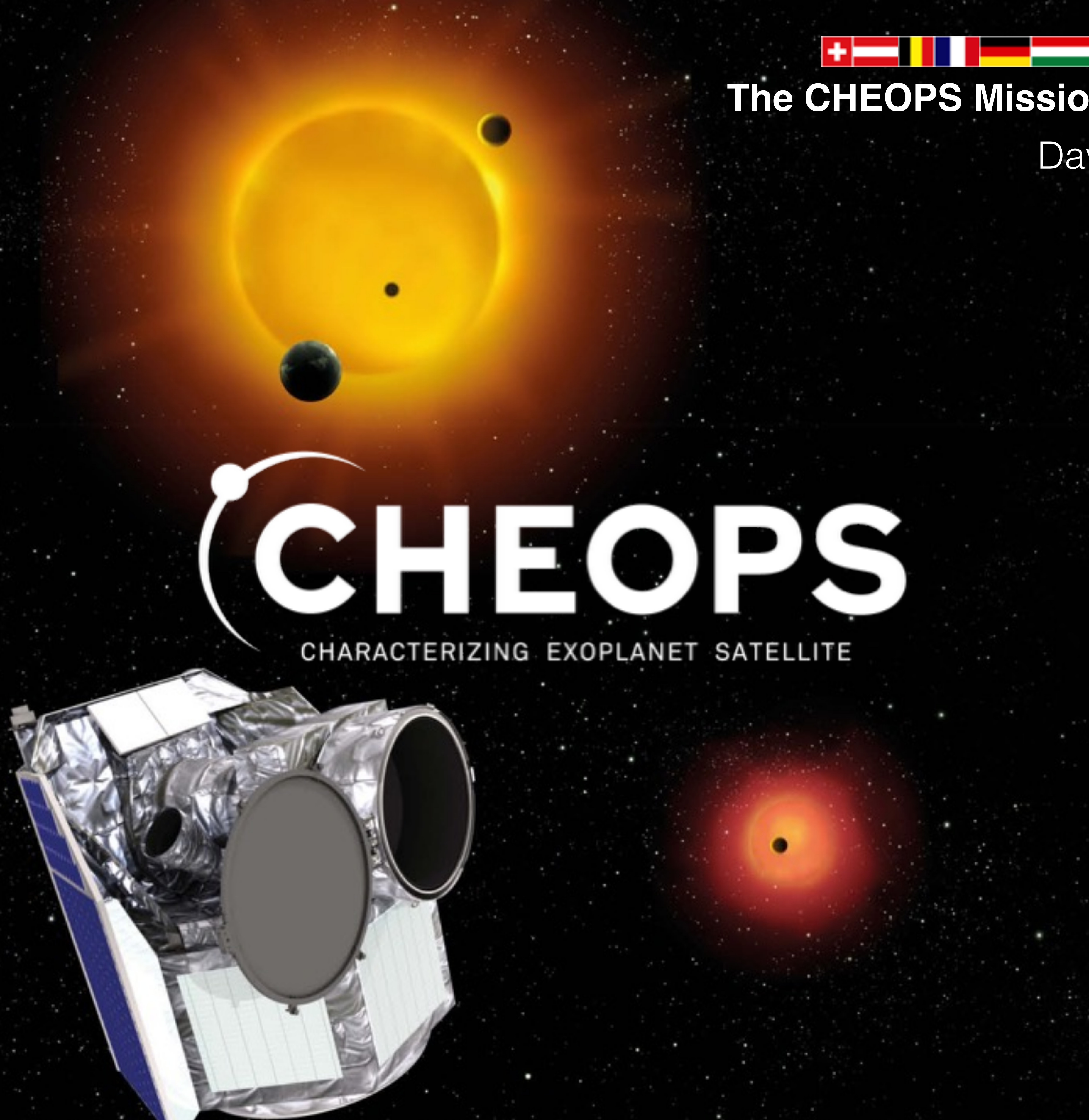
esa

The CHEOPS Mission Consortium

David Ehrenreich

UNIVERSITÉ DE GENÈVE



CHEOPS

CHARACTERIZING EXOPLANET SATELLITE

From super-earths to brown dwarfs: Who's who? — Paris, 30 June 2015

Main science goals

CHEOPS

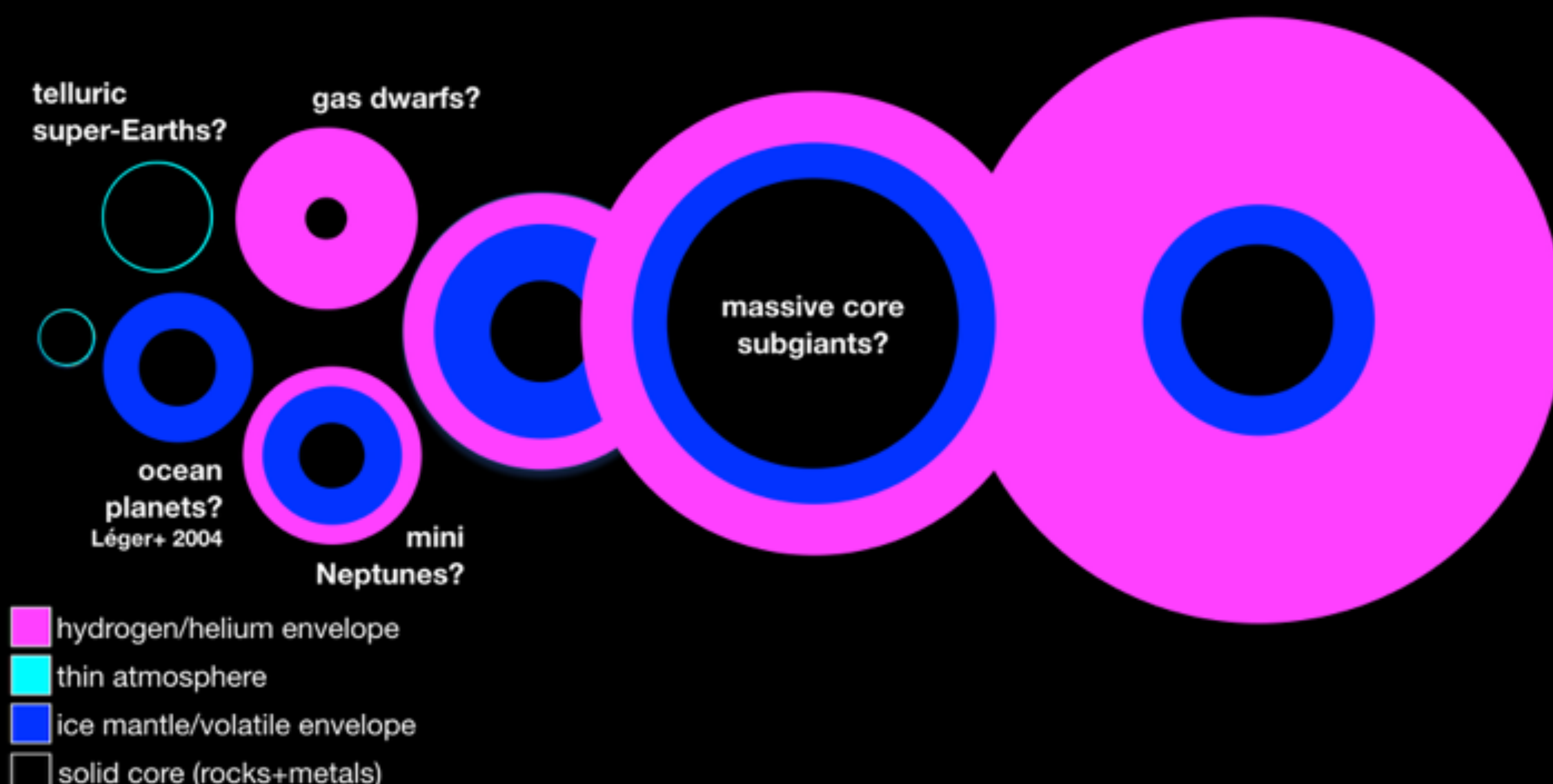
What CHEOPS will do:

➡ Perform 1st-step characterisation of super-earths & neptunes

by measuring accurate radii & bulk densities for such planets orbiting bright stars

➡ Provide golden targets for future atmospheric characterisation

by finding the planets most amenable to deep atmospheric studies



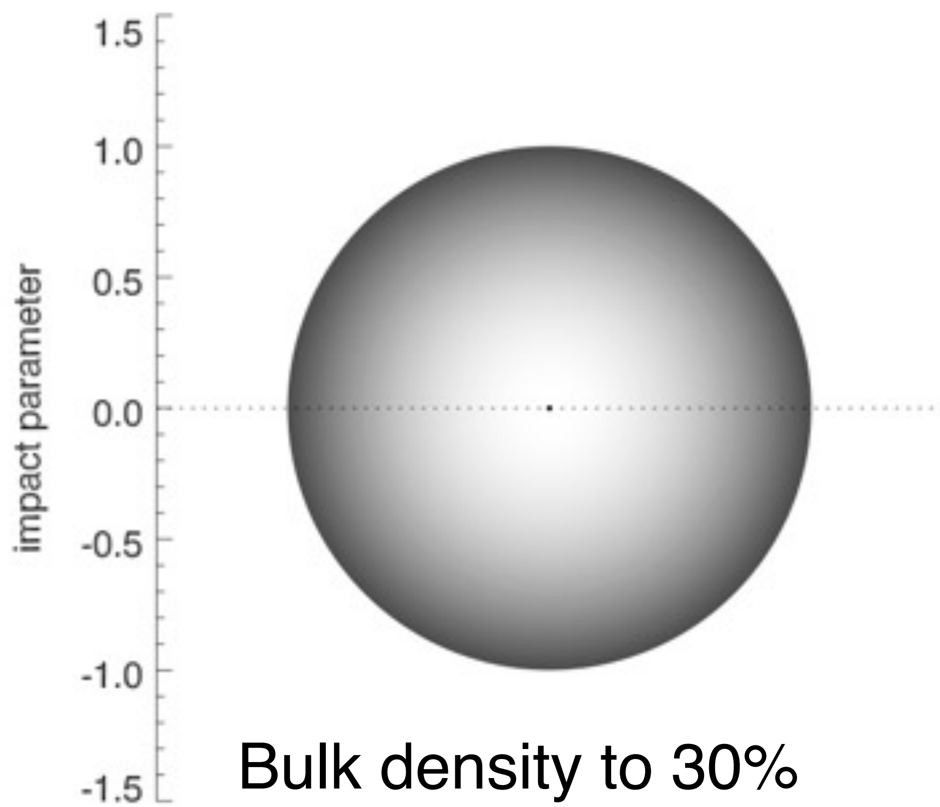
nilar to *Kepler*

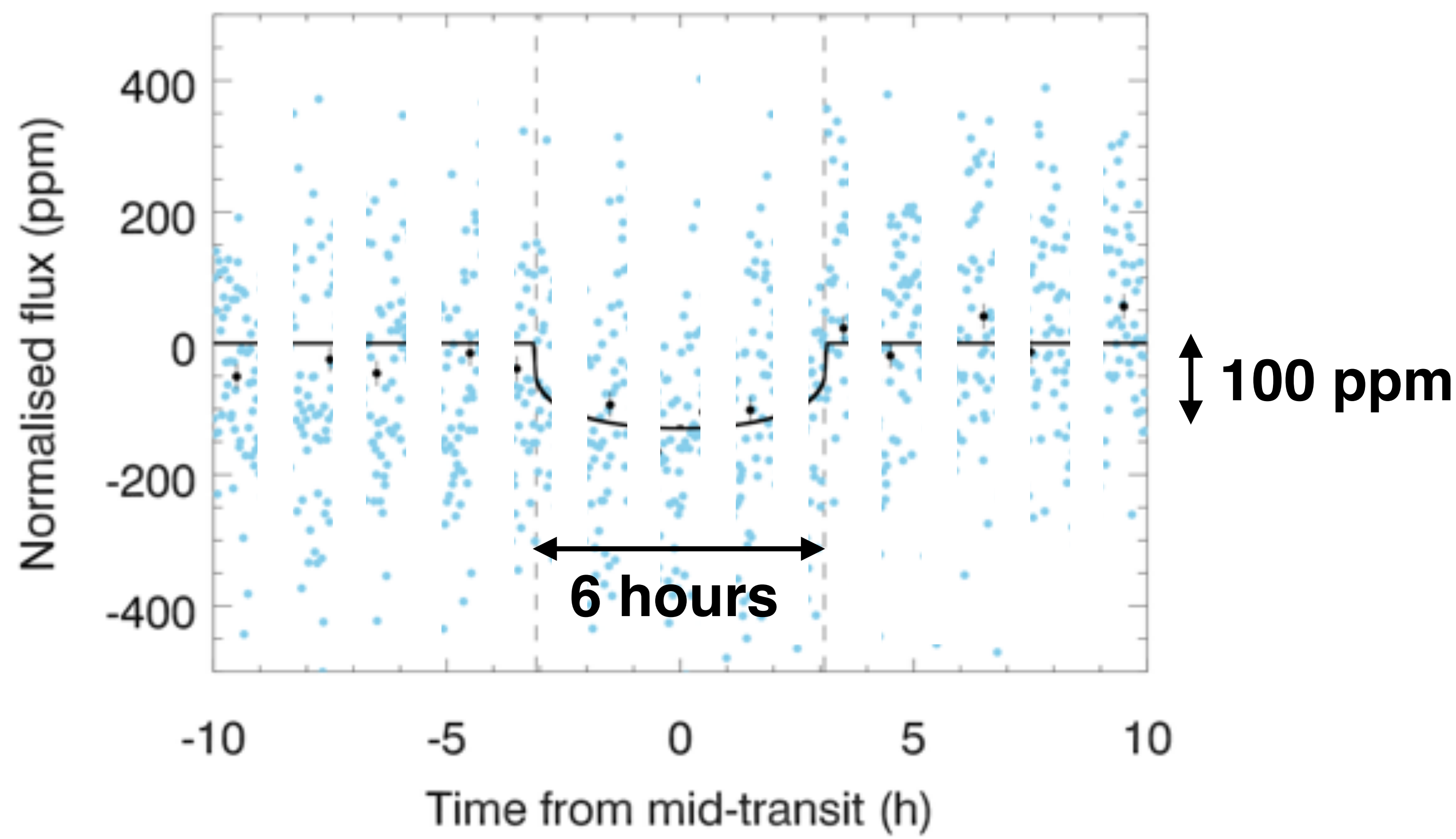
on the sky

Photometric precision

CHEOPS

Detection of super-earths transiting bright stars (6<V<9)





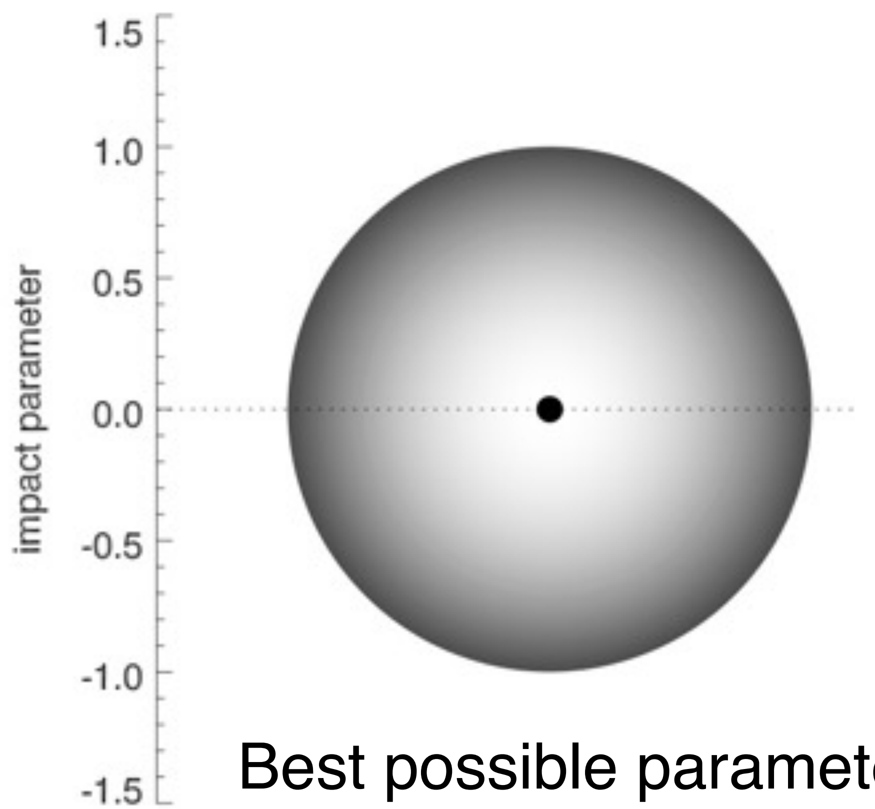
Bulk density to 30%
➡ radius to 10%
➡ transit depth to 20%
➡ $S/N_{\mathrm{transit}} = 5$

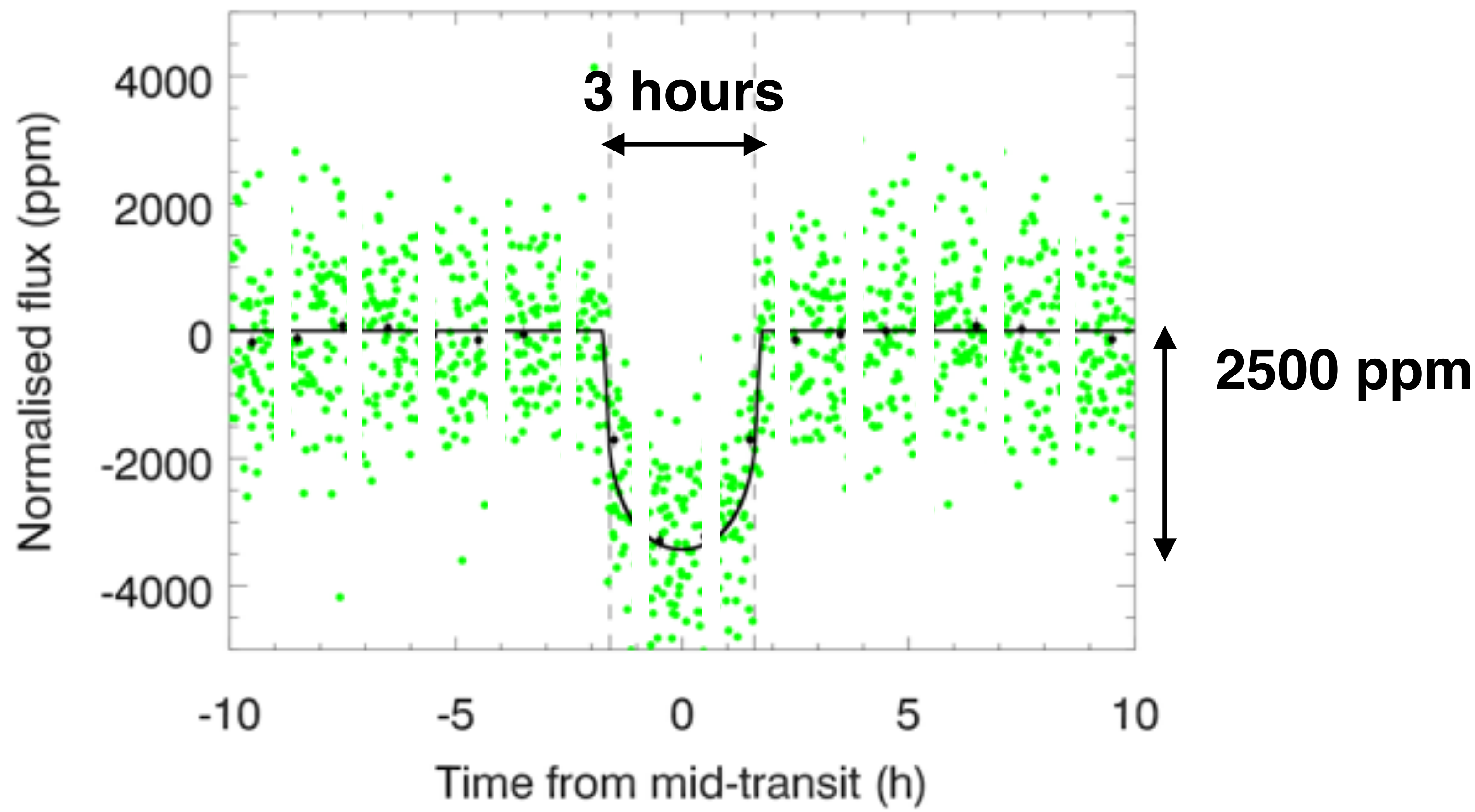
➡ 20 ppm accuracy over 6 hours for G-type stars with V < 9
(<50% interruptions ➡ 2 transits)

Photometric precision

CHEOPS

Characterisation of neptune transit light curves (9<*V*<12)





Best possible parameters

➡ radius to $R_\star$

➡ transit depth to <5%

➡ $S/N_{transit}$ = 30

➡ 85 ppm accuracy over 3 hours for K-type stars with V < 12 (<20% interruptions)

Strategy: Follow-up

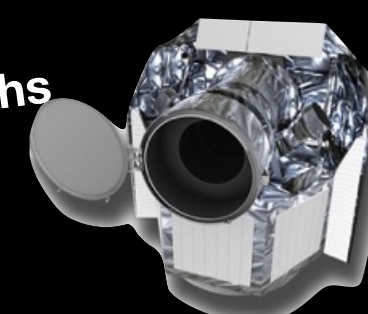
CHEOPS

TESS (2017)

K2

Ground-based transit surveys
NGTS *(2014)*

Measure accurate light curves for Neptunes



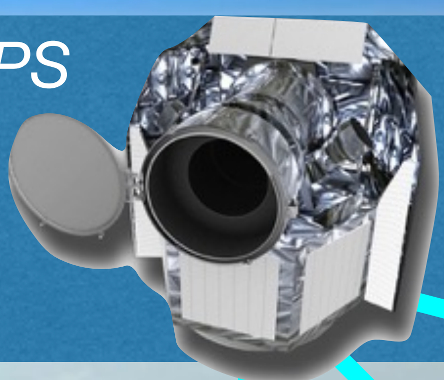
Detect the transit of known super-Earths

Ground-based RV surveys
HARPS, HARPS-N, HIRES, SOPHIE *(on going)*
CARMENES, SPIRou, ESPRESSO *(incoming)*

20% open time
(3.5-yr mission)

TESS as target provider for CHEOPS follow-up

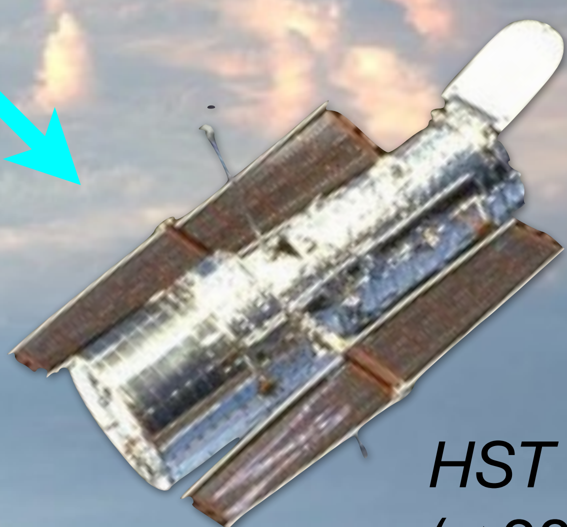
CHEOPS
(2017)



Reconnaissance

- Validate long-period candidates (only 2 good TESS transits for P > 9 days)
- Get precise radii & densities for most interesting planets (3 low S/N TESS transits)

Ground-based
HR spectroscopy



HST
(➠2020)

JWST
(2018➠)

Requirements of a small mission

CHEOPS

- ESA S-class mission in Cosmic Vision 2015-2025
- Science: top rated science in any area of space science
- Cost to ESA not to exceed 50 M€ **(platform+launch+detector)**
- Schedule: developed and launched within 4 years

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

- Current status: phase C / approaching Critical Design Reviews

CHEOPS mission consortium

Switzerland	University of Bern (project lead) University of Geneva Swiss Space Center (EPFL) ETH Zürich
Austria	Institut für Weltraumforschung, Graz University of Vienna
Belgium	Centre Spatial de Liège Université de Liège
France	Laboratoire d’astrophysique de Marseille
Germany	DLR Institute for Planetary Research
Hungary	Konkoly Observatory ADMATIS
Italy	Osservatorio Astrofisico di Catania – INAF Osservatorio Astronomico di Padova – INAF Università di Padova
Portugal	Centro de Astrofisica da Universidade do Porto Deimos Engenharia
Spain	Instituto de Astrofísica de Canarias Centro de Astrobiologia – INTA Institut de Ciències de l’Espai, CDTI, GMV
Sweden	Onsala Space Observatory, Chalmers University University of Stockholm
UK	U. Cambridge, U. Warwick, U. St Andrews

CHEOPS mission consortium

CHEOPS mission consortium

Switzerland
Mission lead
Instrument team
Science operations centre

PI: Willy Benz, U. Bern

Instrument

Switzerland
Mission lead
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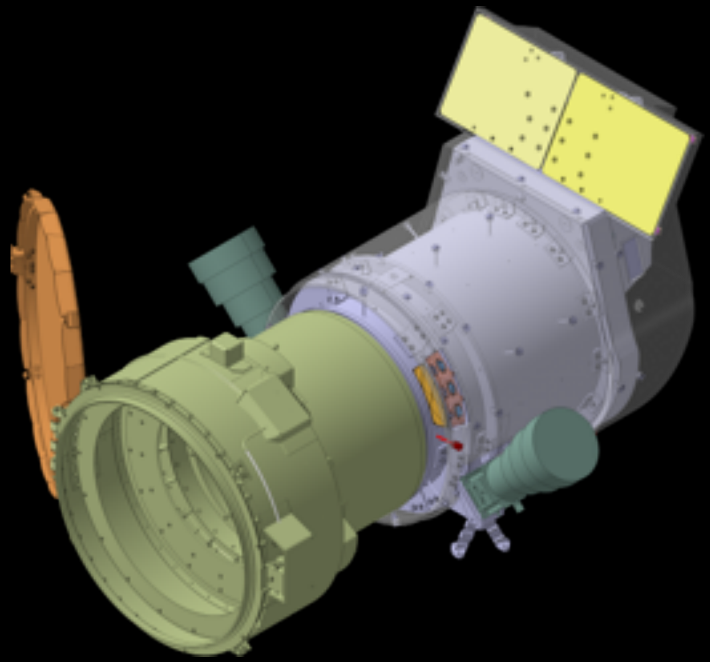


CHEOPS instrument
32-cm Ritchey-Chrétien telescope

Hardware contribution

Germany
Focal plane assembly

Belgium
Baffle

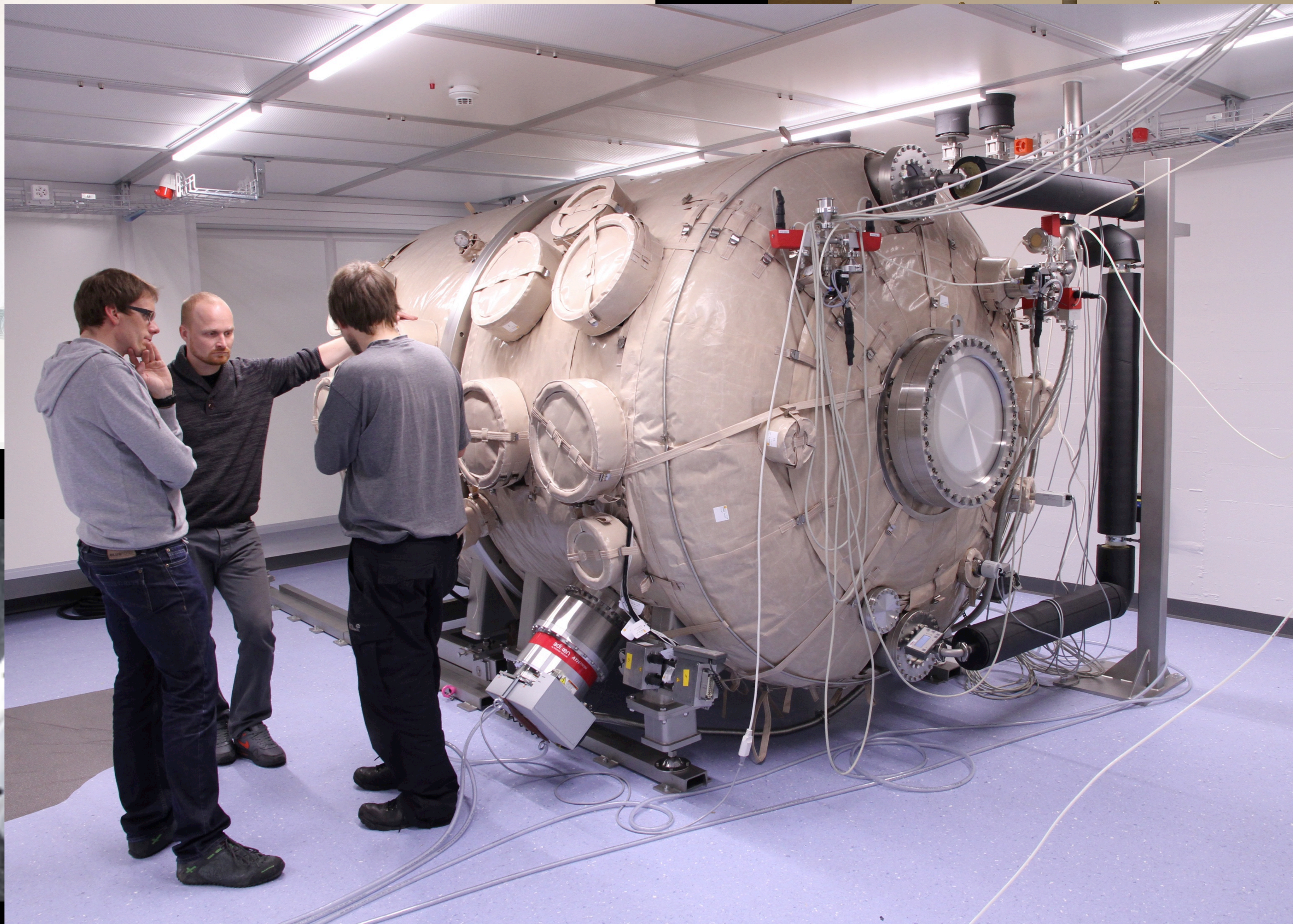
Italy
Optics

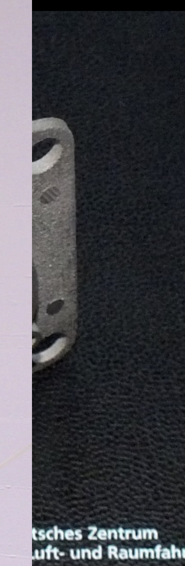
Austria
Digital processing unit

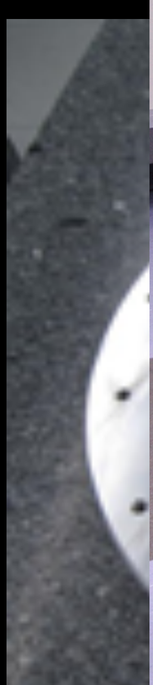
Hungary
Radiators

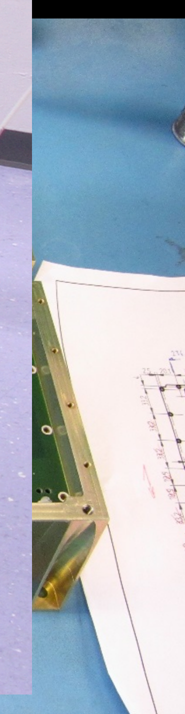
Instrument

CHEOPS





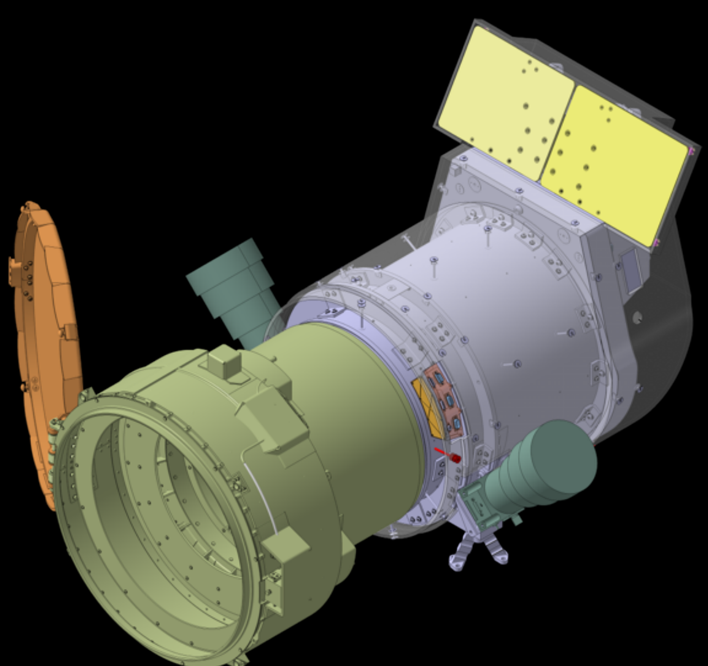




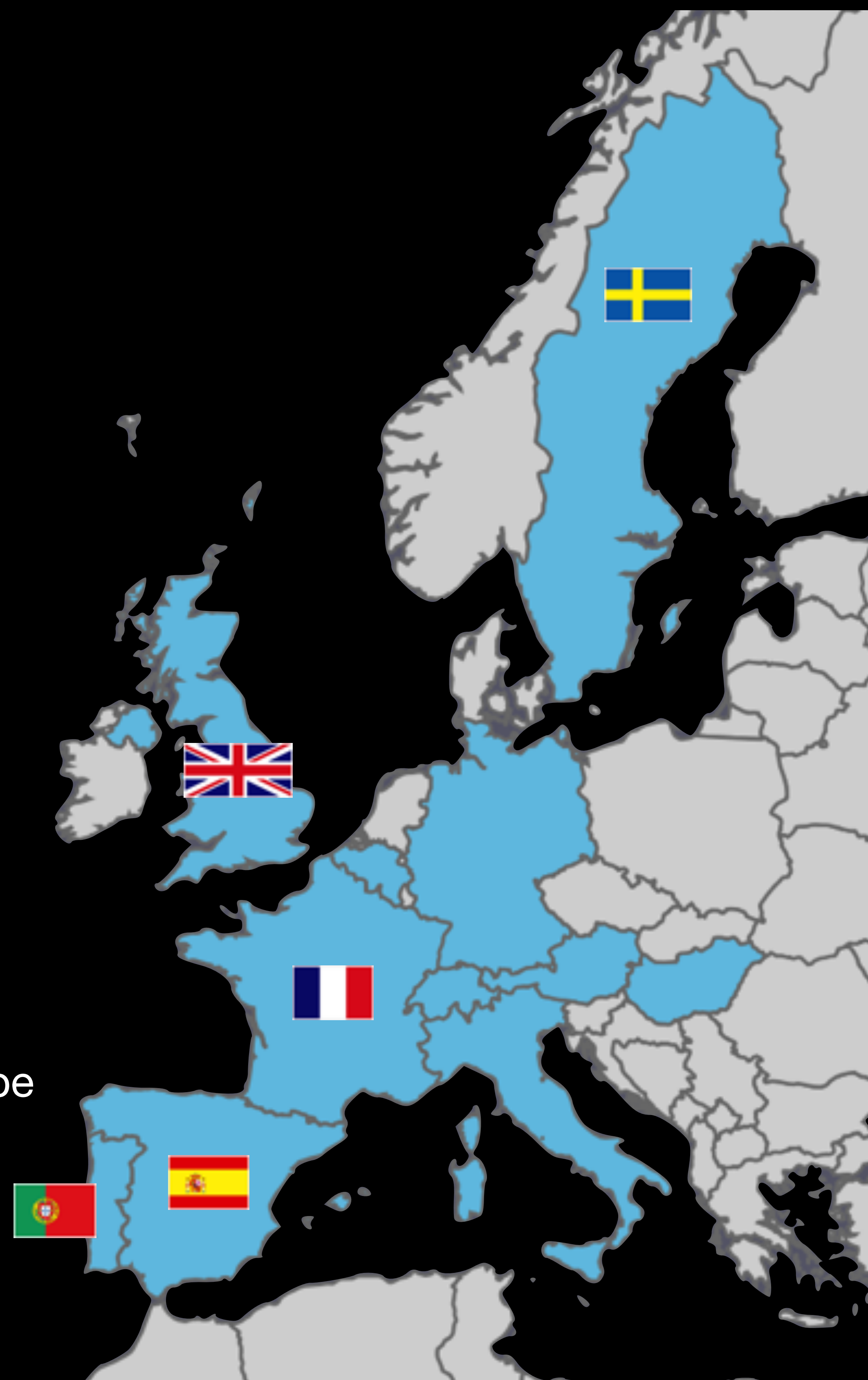
Instrument

CHEOPS

Switzerland
Mission lead
Instrument team
Science operations centre



CHEOPS instrument
32-cm Ritchey-Chrétien telescope



Hardware contribution

Germany
Focal plane assembly

Belgium
Baffle

Italy
Optics

Austria
Digital processing unit

Hungary
Radiators

Ground segment

CHEOPS

Switzerland
Mission lead
Instrument team
Science operations centre

Sweden
Data flow simulator

UK
Quick look

France
Data reduction pipeline

Portugal
Mission planning, archive,
& data reduction pipeline

Spain
Mission operations centre

Hardware contribution

Germany
Focal plane assembly

Belgium
Baffle

Italy
Optics

Austria
Digital processing unit

Hungary
Radiators

Ground segment

Spacecraft platform
ADS/CASA (via ESA)

sees ground station 1–2x/day
downlink data at 1 Gbit/day

Ground segment

Science team

CHEOPS

D. Queloz
Science Team Chair

 Y. Alibert

 R. Alonso

 D. Barrado

 F. Bouchy

 A. Brandeker

 J. Cabrera

 A. Cameron

 S. Charnoz

 A. Erikson

 D. Gandolfi

 M. Gillon

 M. Güdel

 K. Heng

 L. Fossati

 J. Laskar

 C. Lovis

 M. R. Meyer

 I. Pagano

 G. Piotto

 R. Ragazzoni

 I. Ribas

 S. Sousa

 G. Szabó

 T. Spohn

 V. Van Grootel

CHEOPS

C. Broeg
Project Manager

CHEOPS

A. Fortier
Instrument Scientist

CHEOPS

D. Ehrenreich
Mission Scientist

Orbit

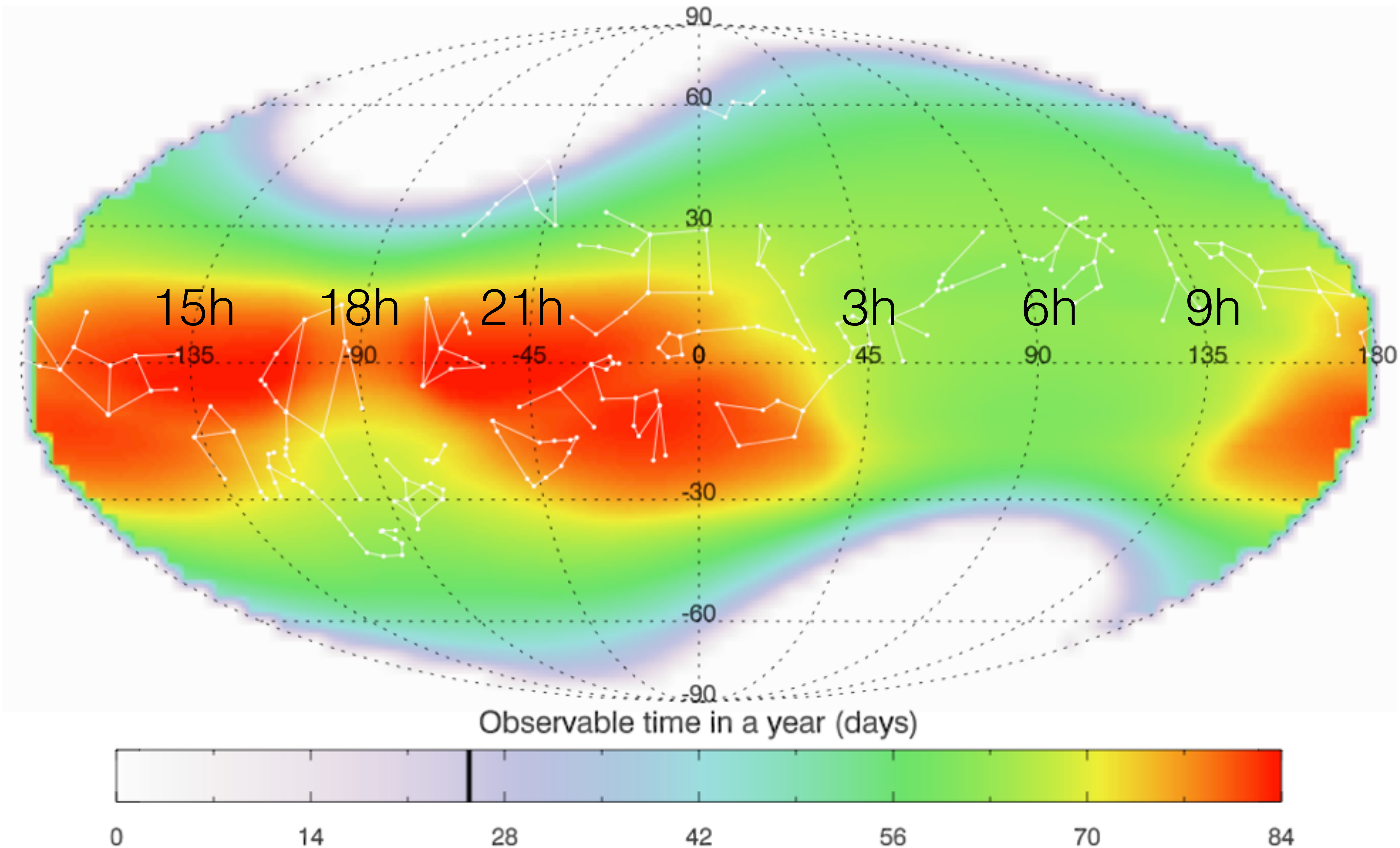
CHEOPS

Sun-synchronous orbit

Altitude 650–800 km

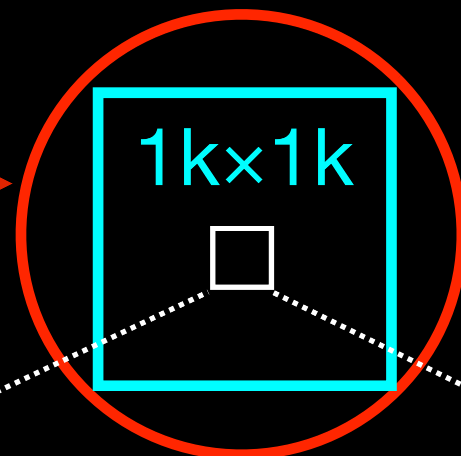
Local time of ascending node 6:00 am

Sky visibility

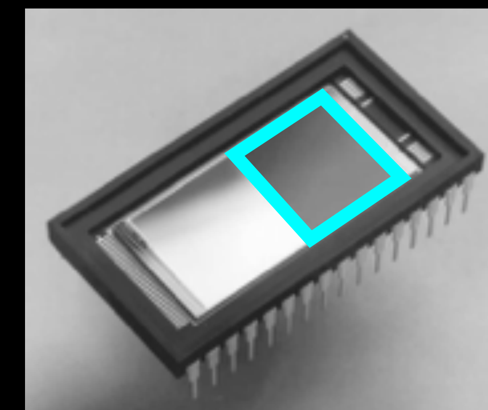


Observation principle

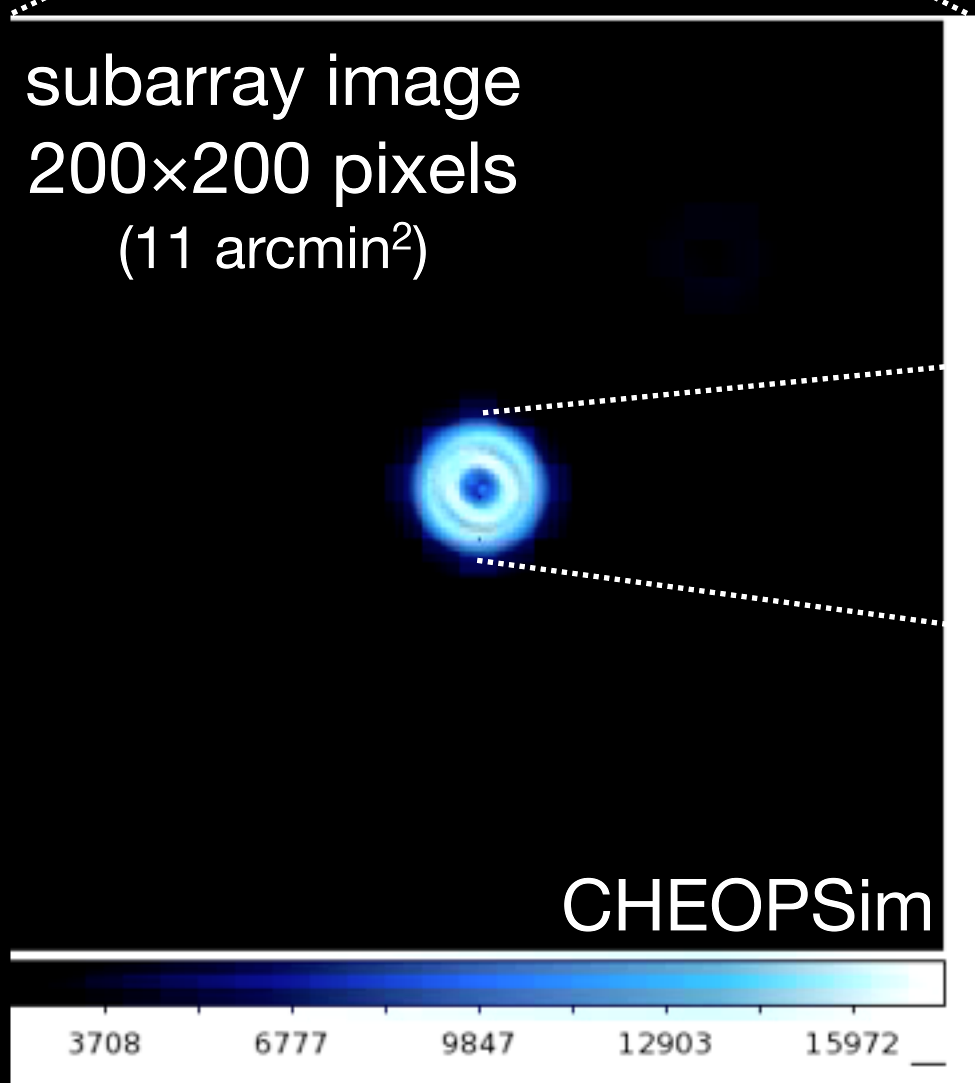
CHEOPS
Science Ops

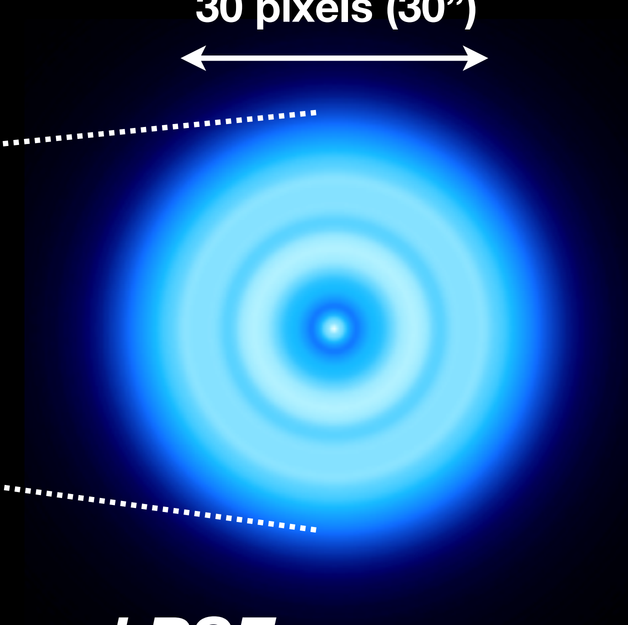


Frame-transfer CCD



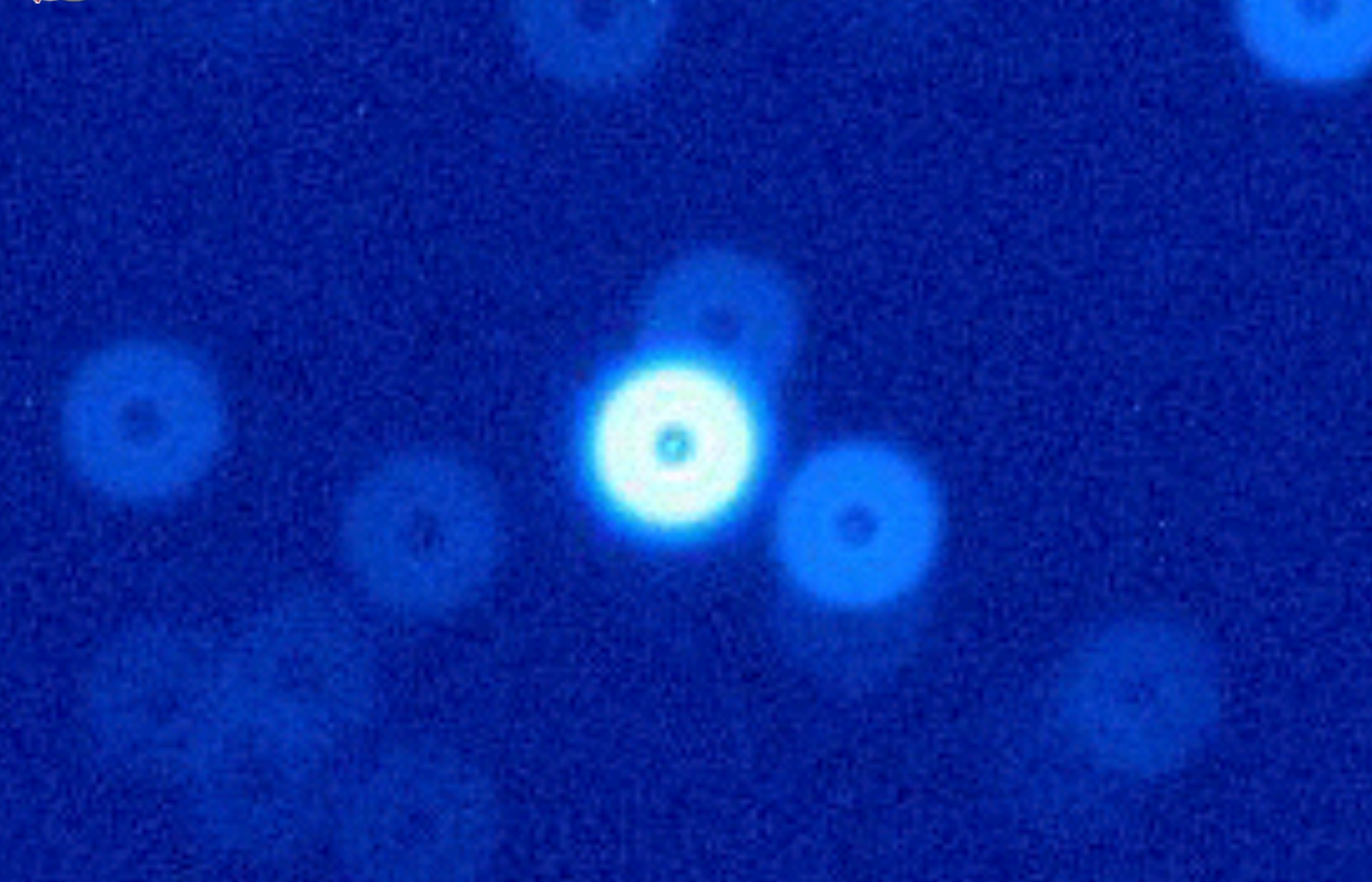
On-board data stacking
Measurement cadence: 20–60 s^{-1}





- ***Defocused PSF***
- ***Pointing stability: 8" (rms) jitter***
- ***Pixel-to-pixel flat field precision: 0.1%***

Observation simulation



CHEOPSim

Open time

CHEOPS

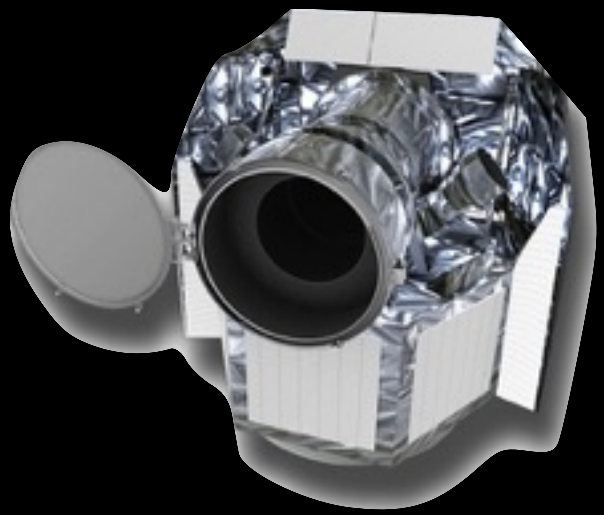
20% open time for the community
≈6,100+ hours
≈600–800 "nights"

Time-critical & non time-critical!

Competitively attributed by ESA
~1 AO / year

Consortium to publish GTO target list
6m before launch

Cycle-1 AO
~mid-2017



Thank you!