CHEOPS

An exoplanet follow-up mission

Willy Benz, University of Bern, Switzerland on behalf of the CHEOPS Team

**CHEOPS**

ESA’s first S-mission

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Kourou: 18.12.2019 (credit: Arianespace)
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1) Transits of super Earth-size planets around G5 dwarfs of V < 9 and radius to < 10% accuracy:
   20 ppm in 6h of integration

2) Transits of Neptune-size planets around K dwarfs of V < 12 and radius to < 2% accuracy:
   85 ppm in 3h of integration

January 12: CHEOPS as seen from the SAINT-EX robotic 1m telescope located at the National Astronomical Observatory of Mexico at San Pedro Martir. Estimated visual magnitude: ~ 8.4
CHEOPS

CHEOPS is ESA’s first S-mission, with the goal of measuring the size of planets orbiting bright stars. The mission targets V<12 stars already known to host planets. The wavelength for the observation is optical, ranging from 400 to 1100 nm. The telescope is a Ritchey-Chretien telescope with an effective aperture of 30 cm, F/5 optics, and a FoV of 17' x 17' arc min. The spacecraft is an Airbus D&S design, 3-axis stabilised, nadir locked, with dimensions of 1.5 x 1.5 x 1.5 m and a mass of 290 kg. The orbit is a LEO sun-synchronous, LTAN 6am, at an altitude of 700 km. The timeline includes selection in November 2012, adoption in February 2014, launch in December 2019, and operations for 3.5 years nominal.
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- **Targets**: V<12 stars already known to host planets
- **Wavelength**: Optical: 400 to 1100 nm
- **Telescope**: Ritchey-Chretien telescope, effective aperture 30cm, F/5 optics, FoV 17'x17' arc min.
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**CHEOPS: an ESA small mission**

- ESA S-class missions approved by SPC in 2011 and first call issued in February 2012

**Requirements**
- Scientific excellence in any area
- Cost
  - Total cost < 150 M€
  - Cost to ESA: not to exceed 50 M€
- Schedule
  - Developed and launched within 4-5 years

- CHEOPS selected in 2012 as a Partnership with Switzerland with important contributions from 10 other member states

The mission has been launched within schedule and allocated budget
The CHEOPS organisation

Joint overall lead: ESA - Switzerland

**CHEOPS**
Consortium: institutes from 11 countries

**Payload**
- Switzerland: Payload system engineering & AIT telescope structure
- Austria: DPU, PSDU flight software
- Belgium: baffle
- Germany: Focal Plane Assembly
- Hungary: radiators
- Italy: optical system

**SOC**
- Switzerland: Operations Data products
- France: Data Reduction Software
- Portugal: Mission Planning, Archive, & Data Reduction Software
- Sweden: data simulator
- UK: Quick look

**MOC**
- Spain: Mission Operations Center

New approach to mission development had to be implemented to allow meeting schedule and budget requirements

- launching state
- platform procurement
- launch services
- CCD
- space debris service
CHEOPS Science

defined by the CHEOPS science team

accurate sizing: M/R relation

Atmospheres: phase curves

Exomoons, rings, etc.

Discovery and masses

Golden targets for future facilities

CHESS
CHEOPS-TESS collaboration

+ 20% open time
CHEOPS-TESS Synergy: CHESS

targets:
planets orbiting bright stars

sky coverage:
bright stars are everywhere

Complementary in science goals and sky coverage!
Science programme: 2 pillars

Garanteed time observing (GTO): 80%

- Ancillary 20%
- Improving radii 25%
- Exploring new planets 15%
- Characterising atmospheres 20%
- Uncovering new features 5%
- Finding transits 15%

Defined by the CHEOPS Science Team
(proprietary time: ~1 year)

Guest observing (GO): 20%

- Open to all
- Two options for obtaining time:
  1. yearly ESA call for proposals (AO); selection on scientific merit by ESA appointed TAC
  2. director’s time (DT, up to 25% of GO), will start after launch with a focus on new targets; proposals selected by ESA Director of Science
- Result of first AO: https://www.cosmos.esa.int/web/cheops-guest-observers-programme/ao-1-programmes
- Next AO: TBD (probably autumn 2020)

get more infos at:
https://www.cosmos.esa.int/web/cheops-guest-observers-programme
and poster at this conference

Defined by the community
(proprietary time: ~1 year)
January - March 2018
CHEOPS Lab
University of Bern

- Flat fields in multi-color (narrow & broad-band)
- PSF over field of view and multi-color
- Gain sensitivities
- Dark current maps
- Bad pixels / full well depth
- Stability tests using super stable light source

Noise curve of corrected and de-trended light curve
Data acquisition

- **Telescope**: FoV: 24' (1'' / pixel)
- **BEO**: FoV: 20'
- **CCD**: 1k x 1k
- **Subarray image**: 200×200 pixels
- **Defocused image**: 90% of energy in 24 px
  - S/C jitter 4'' rms
- **Sun-synchronous polar orbit**: Measuring overnight side
  - Radiators always pointing to space
- **CHEOPSIm**: The field is rotating around the target star because CHEOPS is nadir-locked
Data acquisition

- Spacecraft platform ADS/CASA (via ESA)
- Ground station downlink at ~1.2 Gbit/day
- Mission Operation Centre (MOC) Madrid
- Science Operation Center (SOC) Geneva
- Back-up ground station Villafranca (ESAC)
- Data archive mirror Rome
Latest news

- Launch and Early Orbit Phase (LEOP) concluded successfully

- January 8: Beginning of in-orbit commissioning
  - Instrument switched on successfully, health-check passed
  - Telescope temperature stabilisation successfully achieved
Latest news

• January 9:
  - First dark (cover closed) image taken and successfully transmitted to ground station

• January- March
  - In-orbit calibration of CCD and read-out electronics
  - opening of the cover
  - Testing all requirements, determining performances

• ~ April 1
  - Nominal start of science operation