DUNE

A new infrared planet hunter

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IACTEC-SPACE

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CELESTE

Universidad de La Laguna

Gobierno de España · Ministerio de Ciencia, Innovación y Universidades

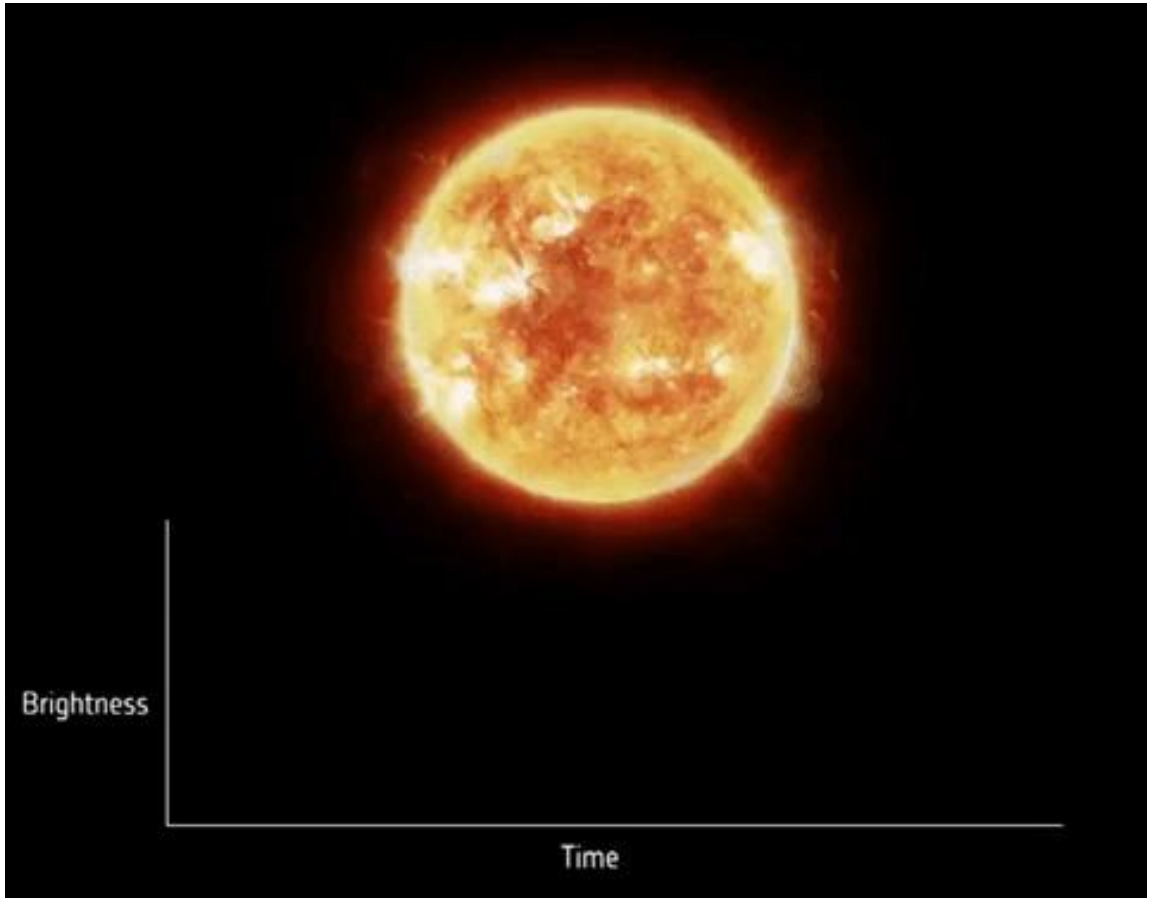
Gobierno de España

Plan de Recuperación, Transformación y Resiliencia

Funded by the European Union

Goal

Confirmation of Earth-like planets orbiting nearby low-mass stars



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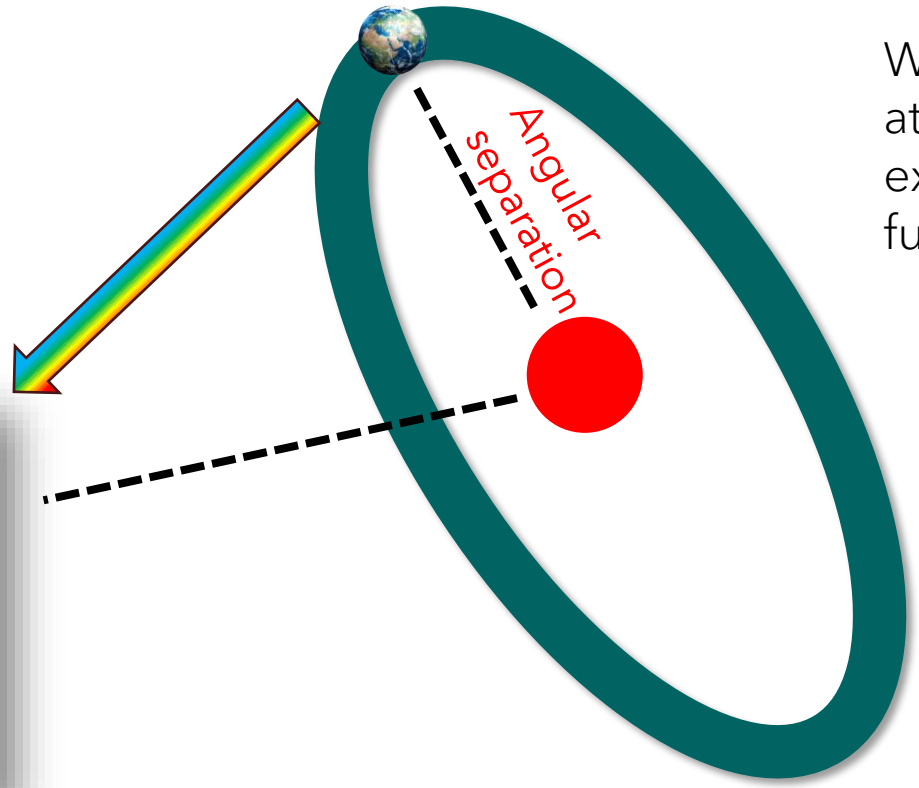
Confirmation of Earth-like planets orbiting **nearby** low-mass stars



We can only study the atmospheres of **nearby** low-mass exoplanets using current, or future, facilities.

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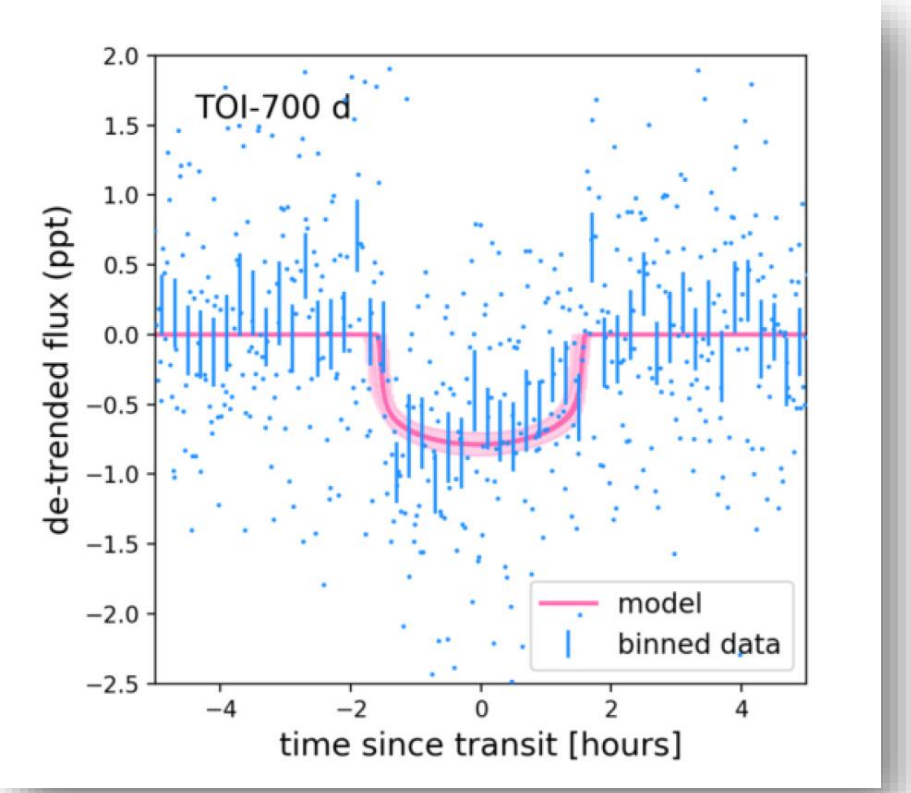

$$D = \left(\frac{R_p}{R_s} \right)^2$$

Transit depth decreases quadratically with stellar radius

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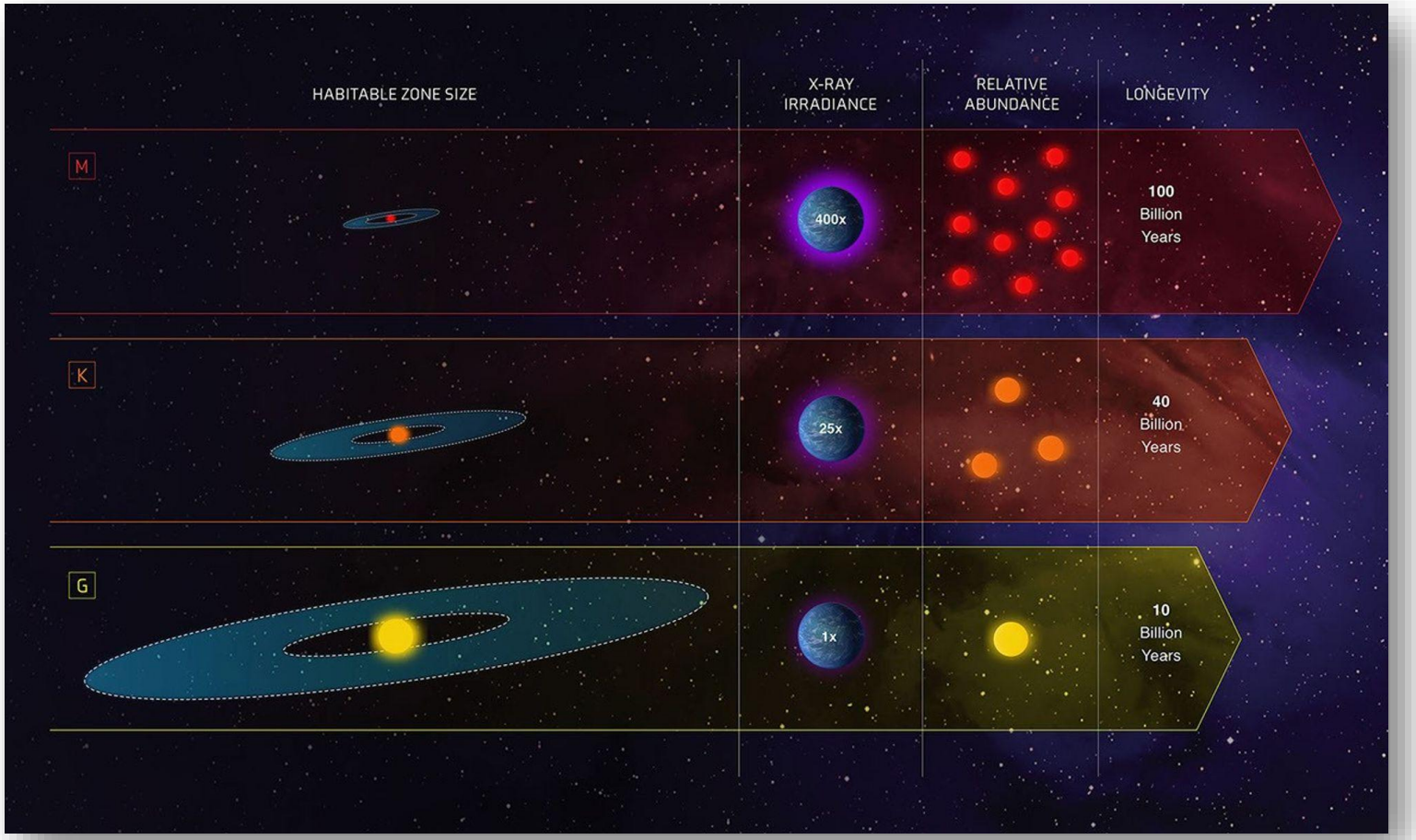

$$Tp = R/a$$

Transit probability decreases with orbital distance

Number of potential targets increases at lower stellar masses

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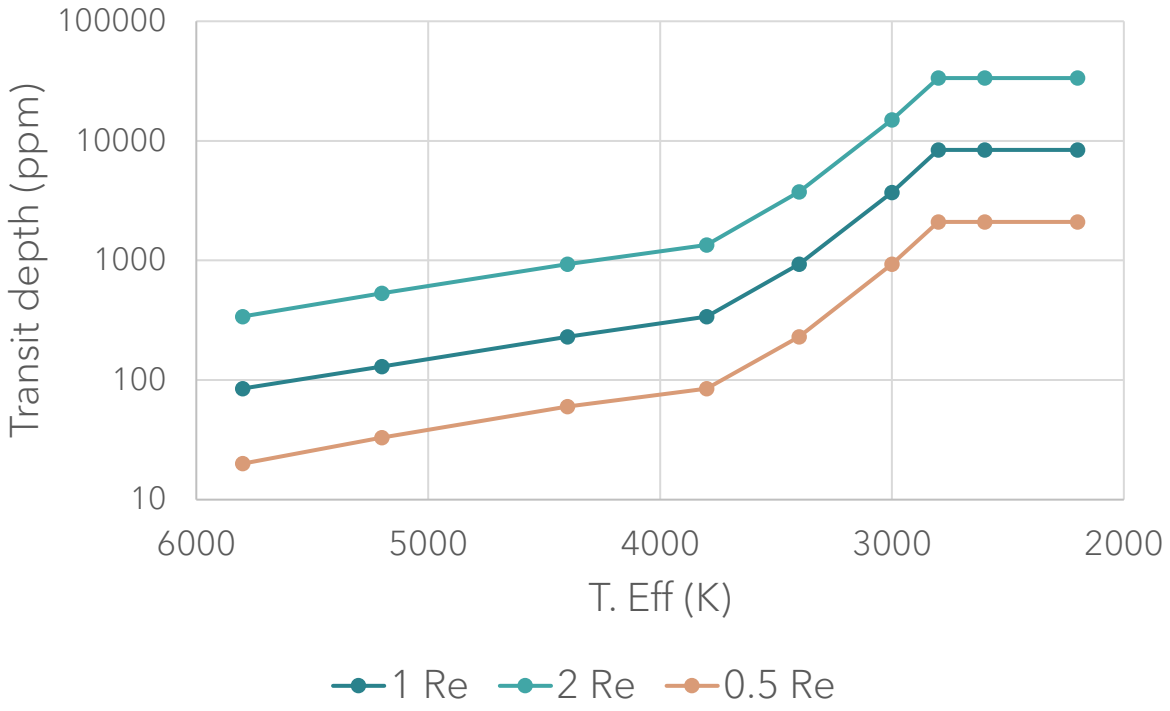
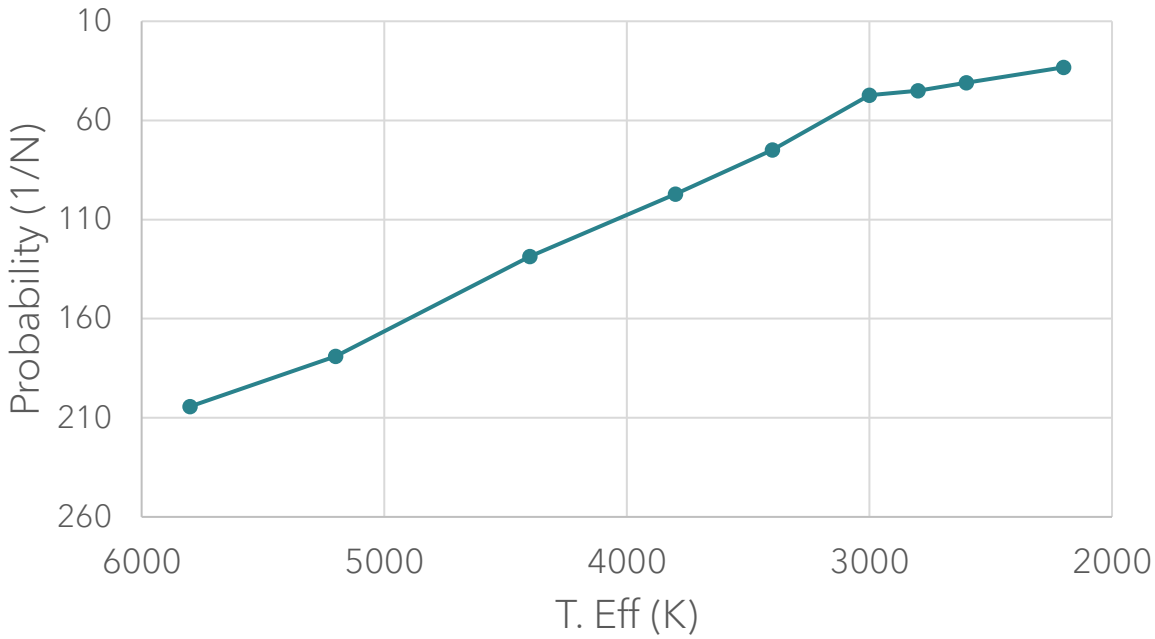
Transit depth as a function of stellar temperature



Transit probability (HZ) as a function of stellar temperature



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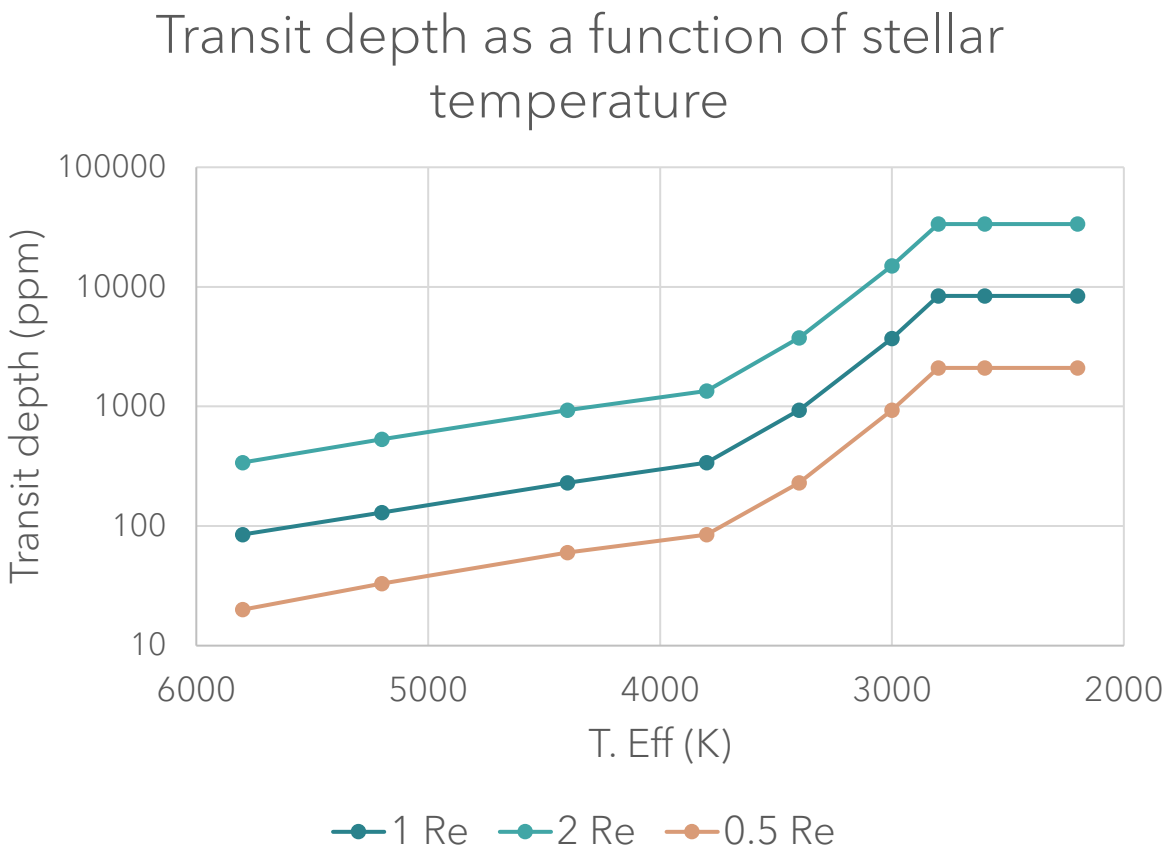

Planet 1 Re

G2 – 90 ppm → Precision 30 ppm
K0 – 150 ppm → 50 ppm
M0 – 350 ppm → 100 ppm
M4 – 950 ppm → 300 ppm
M6 – 3500 ppm → 1 mmag
M8 – 8500 ppm → 2.5 mmag
L3 – 10000 ppm → 3 mmag

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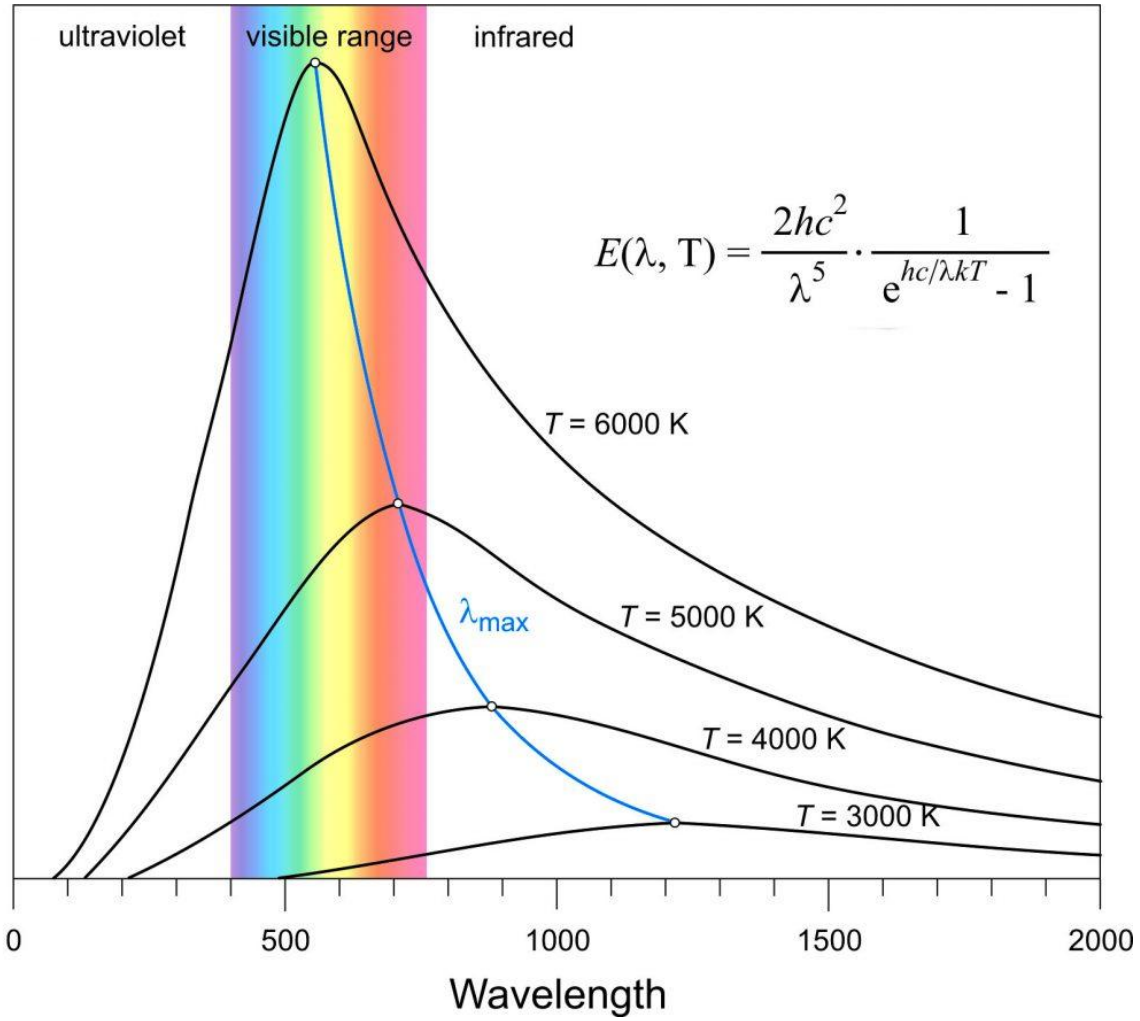


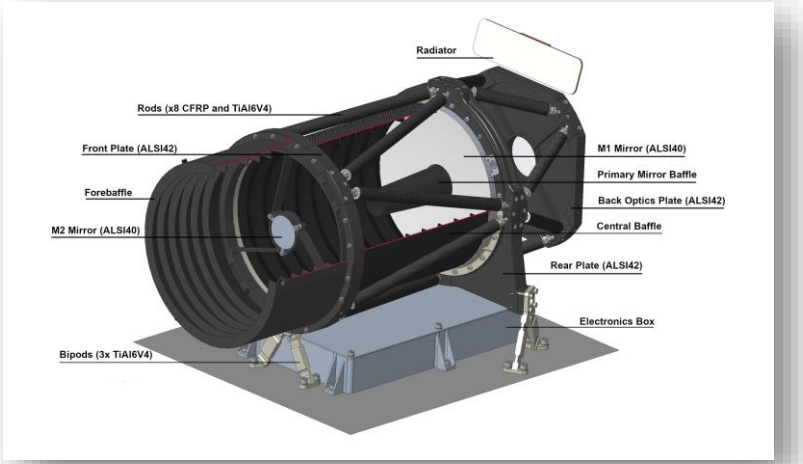
Low-mass stars are cold and red

→ Infrared measurements

DUNE

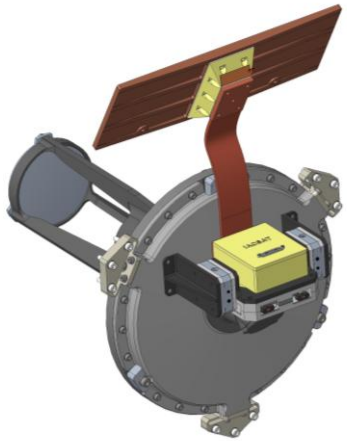
(Discoverer of Uncharted Nearby Earths)

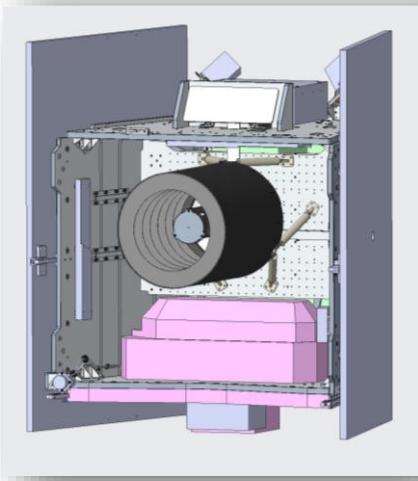
Design and development of a space telescope optimized for the detection of Earth-like exoplanets orbiting M-dwarfs, using high precisión photometry.

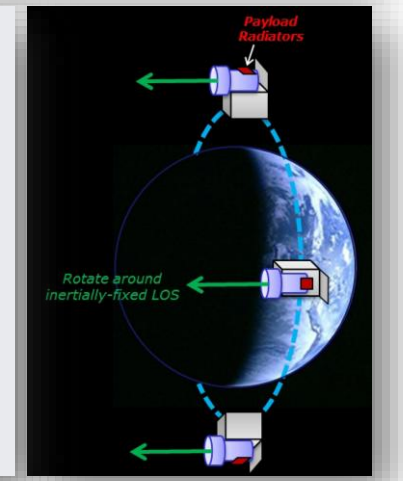


Characteristics:

- Primary mirror 23 cm
- e-InGaAs detector 500 – 1700 nm
- Sun-synchronous orbit, riding the terminator
- Narrow PSF 8″







Currently in phase B

- Payload SRR – February 2025
- Mission SRR – June 2025
- Mission PDR (Summer 26)

Expected launch 2030

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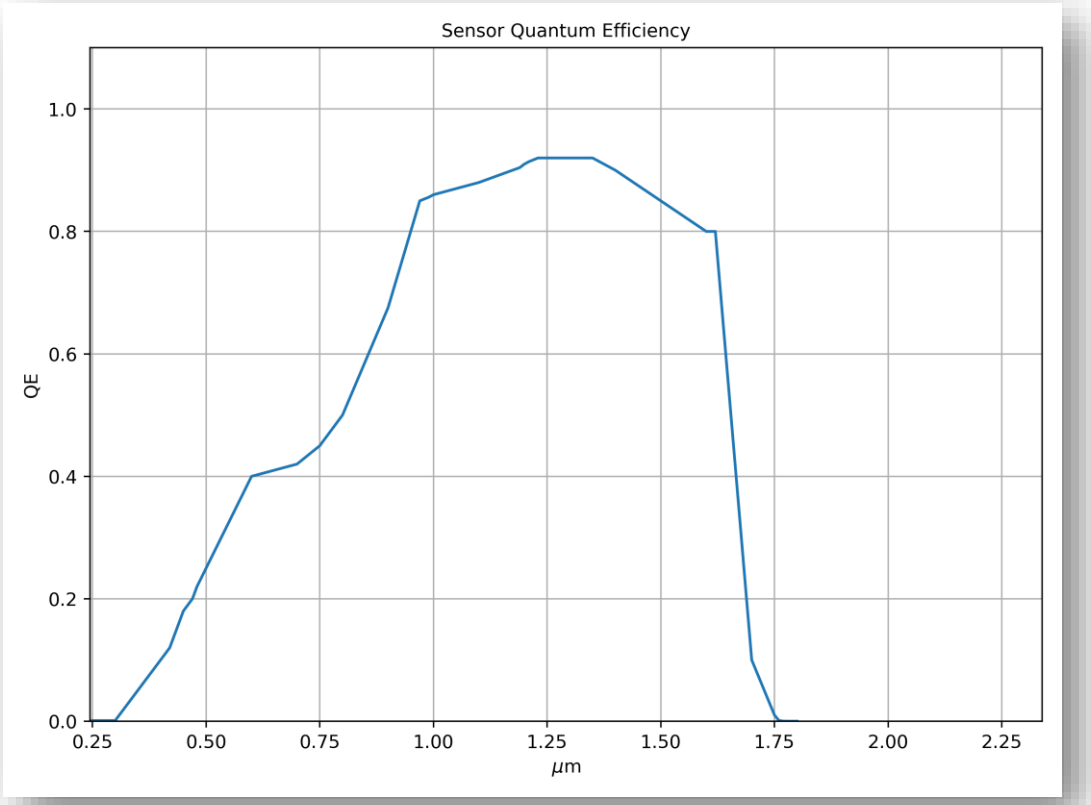
    - High readout noise
    - High dark current level
    - Already tested for astronomical observations
        - Pedersen et al. 2024, SPIE



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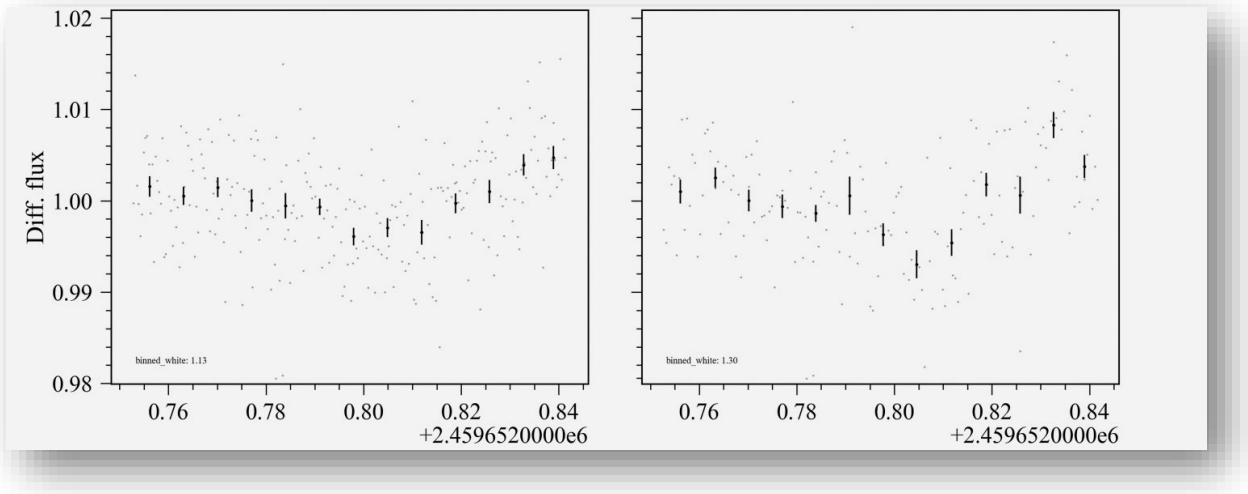
e-InGaAs CCD



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    - High readout noise
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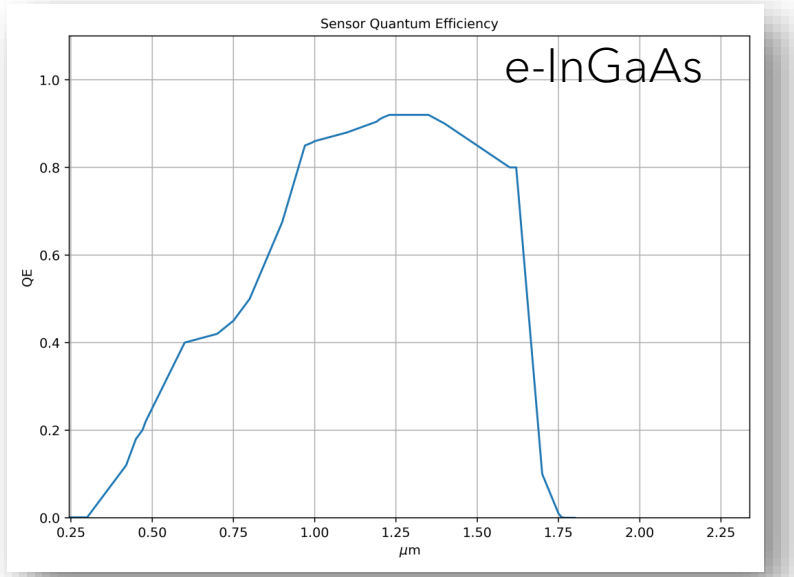
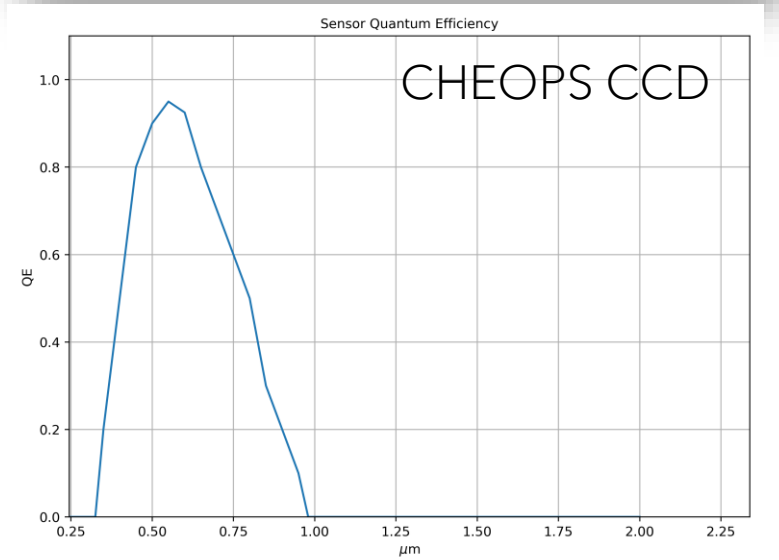
CHEOPS:

- Primary mirror 32 cm
- Teledyne CCD 300 – 1000 nm
    - Narrow spectral range
    - Low noise
- Confirmed operation until 2026, maybe until 2029

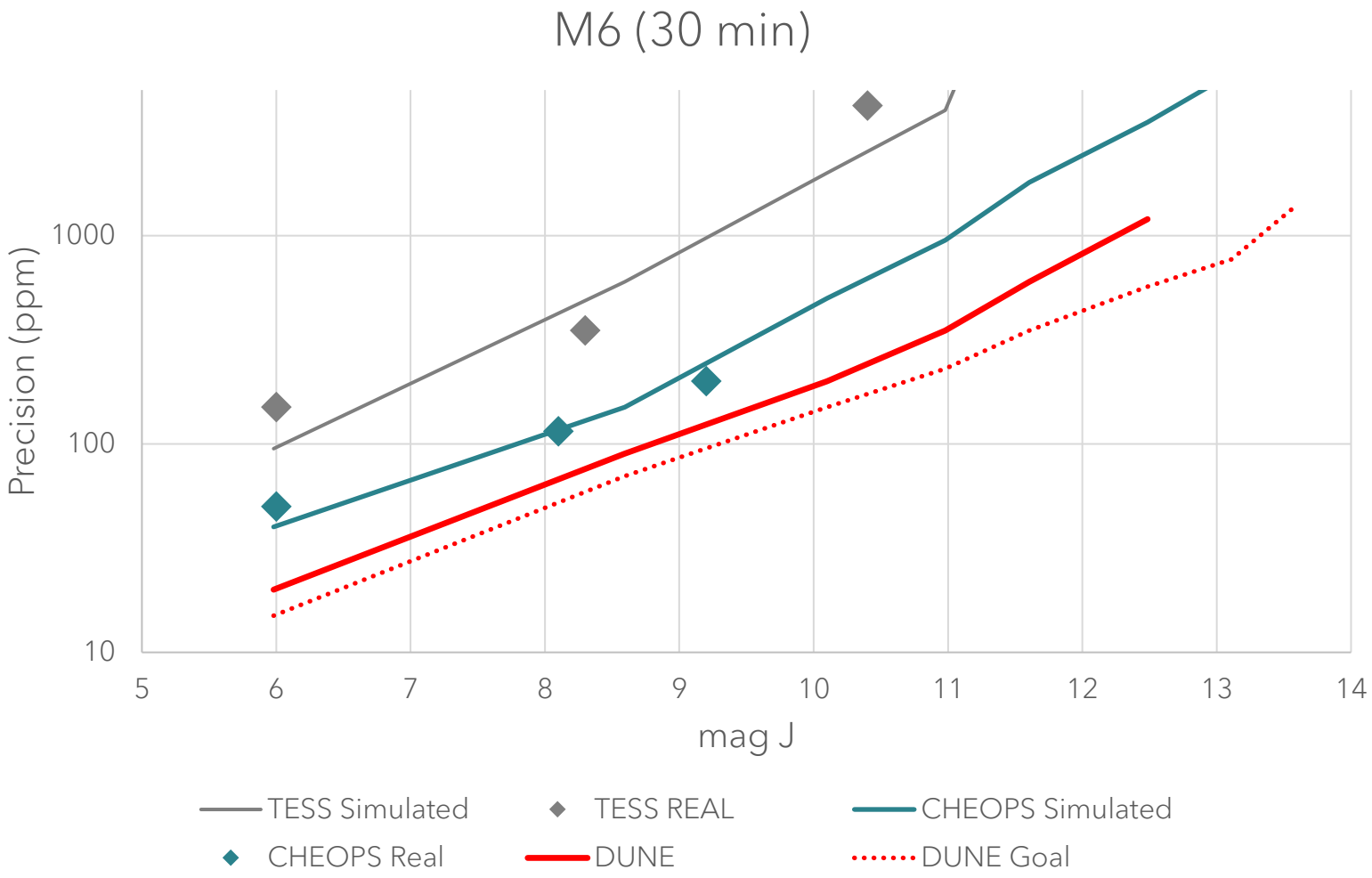




Performance

Optimised for the detection of exoplanets orbiting M-type stars

- Far superior performance to TESS
- Superior performance to CHEOPS
- sub-mmag measurements up to J~12

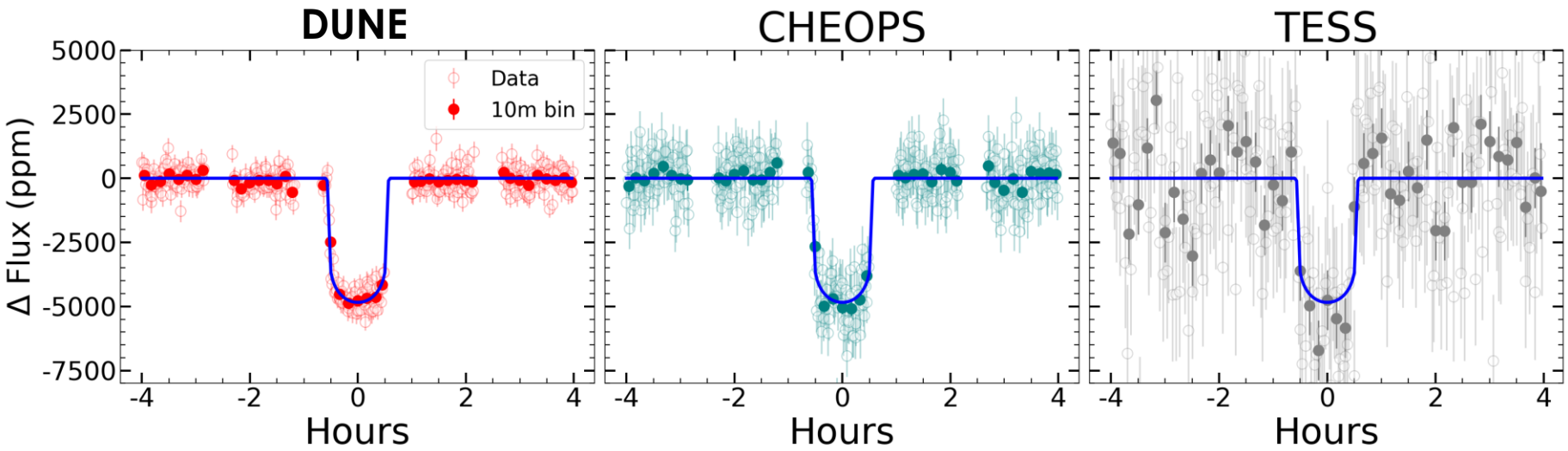


M6-type star (Transit depth 3000 – 5000 ppm)

Performance

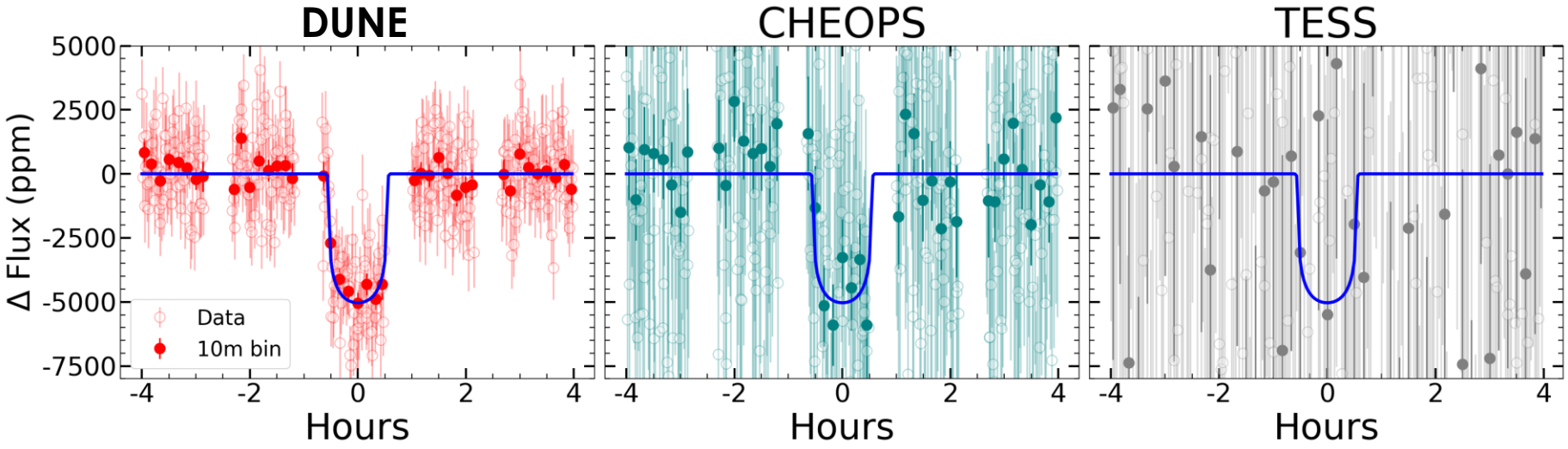
M6-dwarf
1 Re, P 10d

magJ 8.5

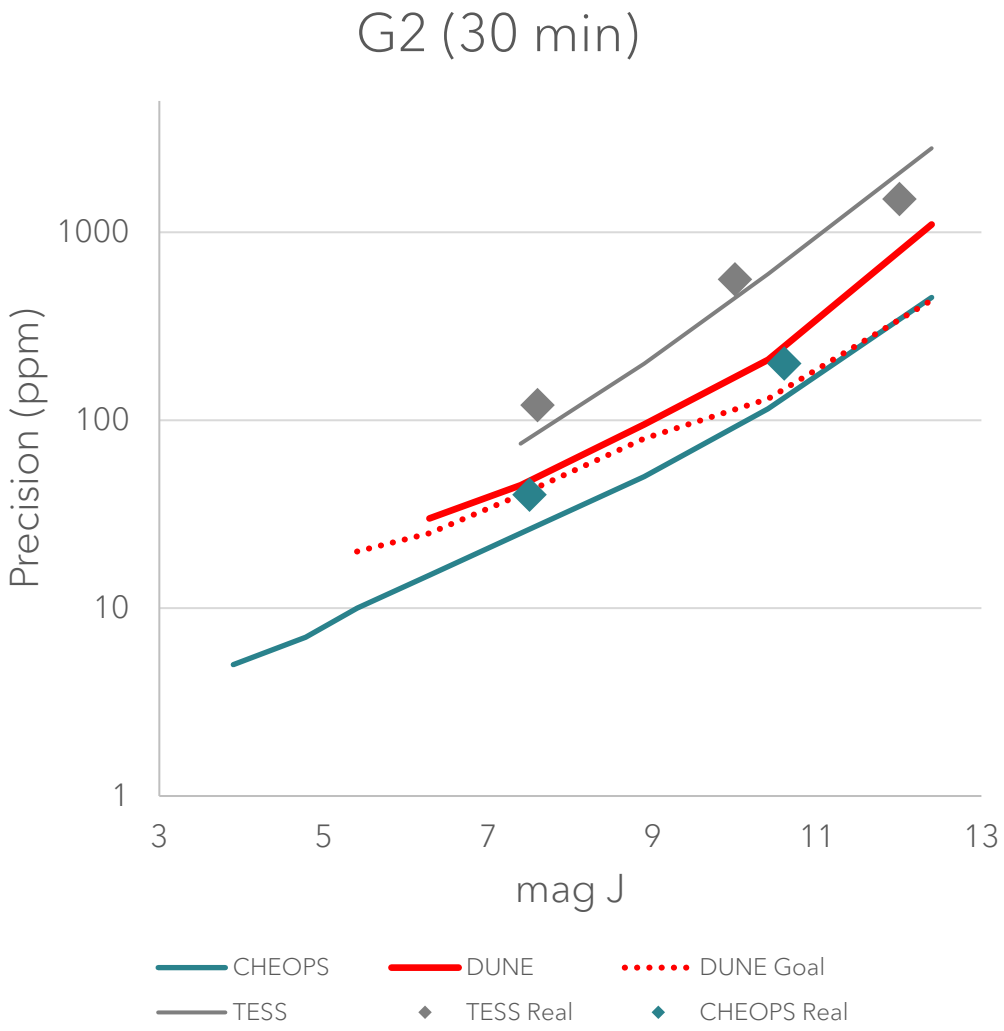


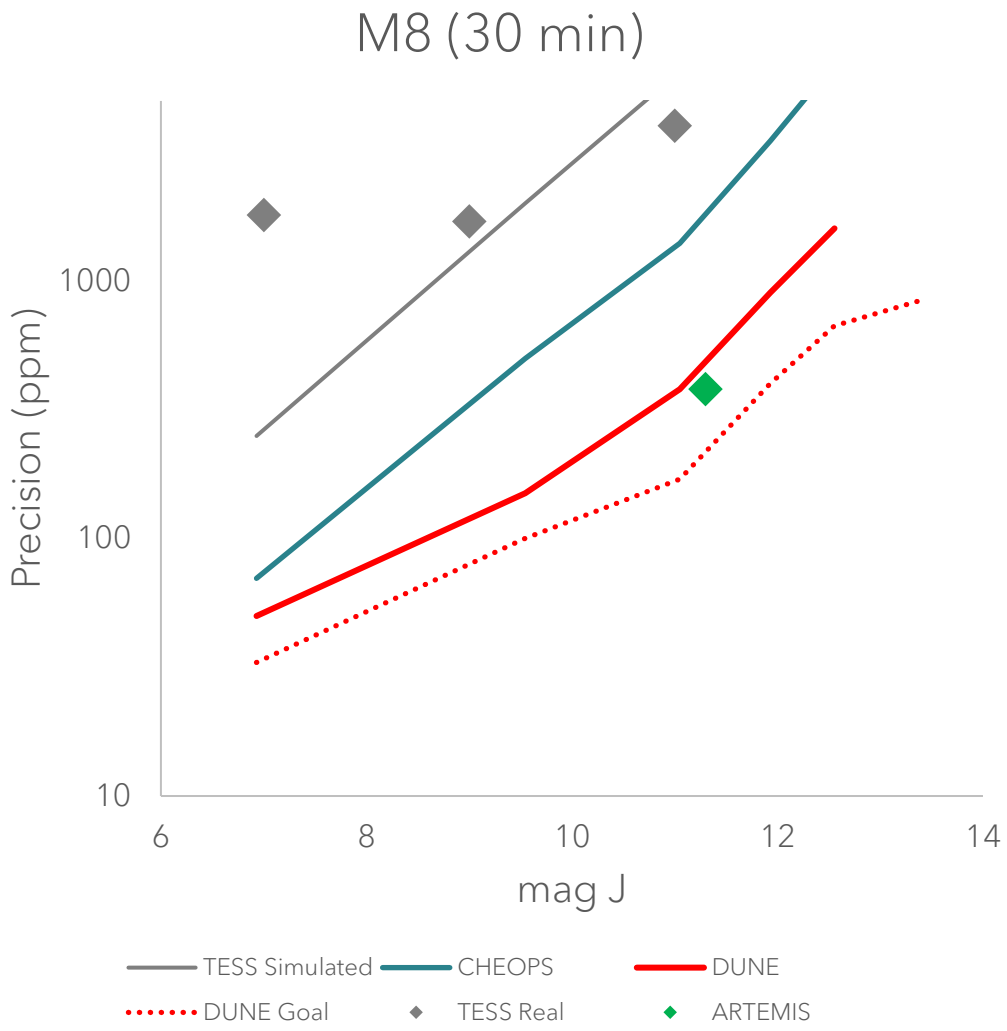
M6-dwarf
1 Re, P 10d

magJ 11



Performance

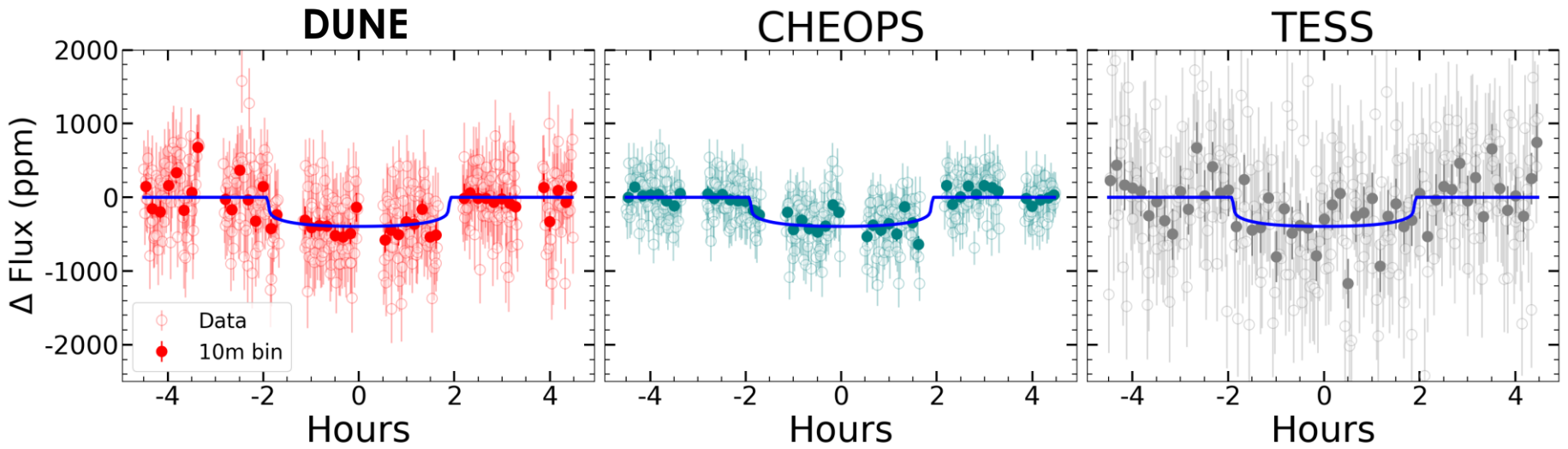




Performance

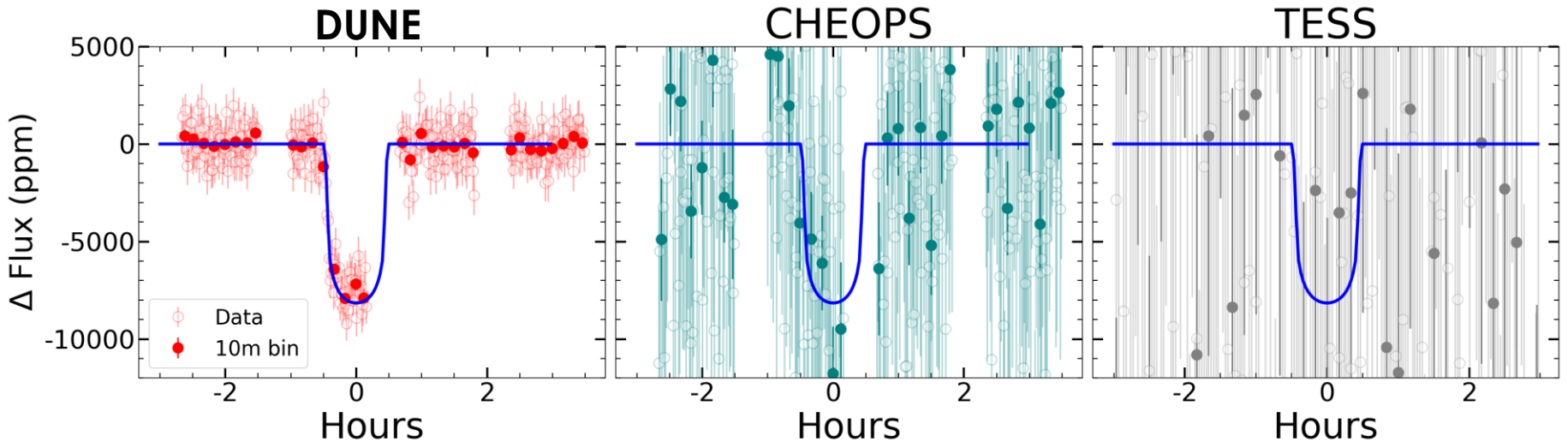
G2-dwarf
1 Re, P 10d

magJ 10



M8-dwarf
1 Re, P 10d

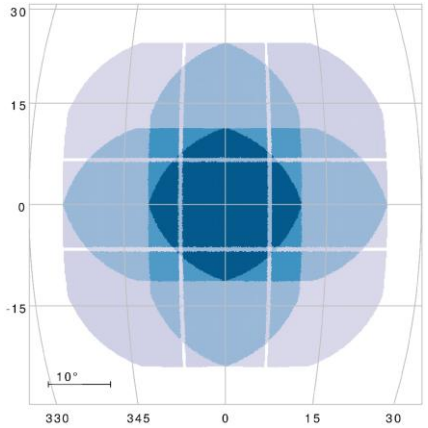
magJ 10



Science program

Goal: Discovery of 50 Earth-like planets and mini-Neptunes orbiting M-dwarfs and ultra-cool dwarfs

- Confirmation of TESS candidates
  - In depth analysis of TESS lightcurves – Low S/N events
- Confirmation of PLATO candidates – M-dwarfs in the outer PLATO field →
- Confirmation of SPECULOOS candidates
- Exploratory program to survey nearby brown dwarfs
- Chromatic studies with CHEOPS (VIS+NIR) and PLATO (3rd color)

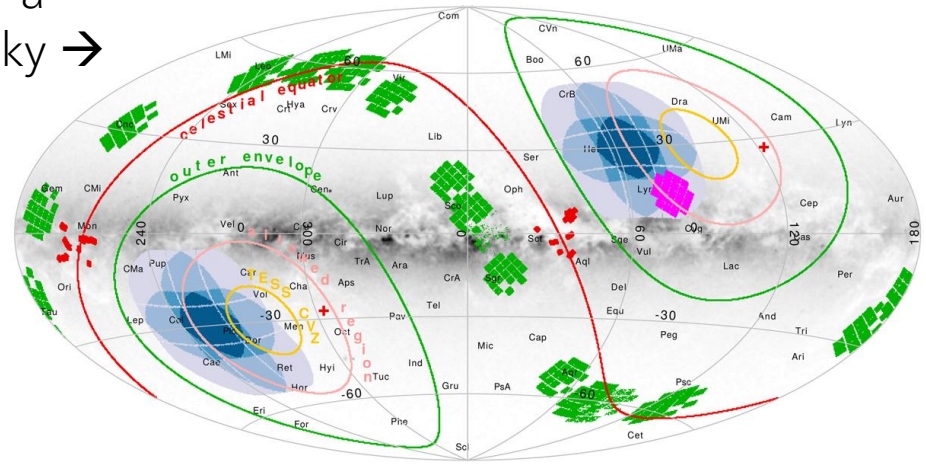


Additional science

- Asterosysmology
- Stellar parameters
- Follow-up of transients
- …

20-30% time open for the community (TBC)

PLATO will only cover a small fraction of the sky →



Project status

Science team

PI/Mission scientist: Alejandro Suárez Mascareño

Co-Is (TBC): R. Rebolo, M. R. Zapatero Osorio, F. Javier de Cos, A. Pérez Garrido, C. Broeg, M. Lendl, S. Sousa, A. Triaud, L. D. Nielsen, X. Delfosse, J. de Wit, R. Alonso, H. Deeg, B.-O. Demory, D. Ehrenreich, E. Pallé, V. S. Béjar, B. Schölkopf

Engineering

PI: A. Oscoz

Manager: J. A. Burgal

Systems engineer: A. Y. Rivera

Team: S. Sordo, C. Colodro, P. G. de Chaves, J. C. Sanluis, X. Delpueyo, D. Rodriguez + IACTEC Space team

Current situation

- Funding secured to build an engineering model of the payload and to design the platform
- Payload detailed design (IACTEC)
    - e-InGaAs detector characterisation
- Platform design
    - Contracted with Airbus
- Expansion and deepening of the scientific program
- Consortium with CAB – CSIC, Universities of Oviedo, Cartagena, Bern, Geneva, Porto, Munich, Grenoble, and MIT
- Proposed as ESA mini-F mission
- Expected launch 2030

Thank you!

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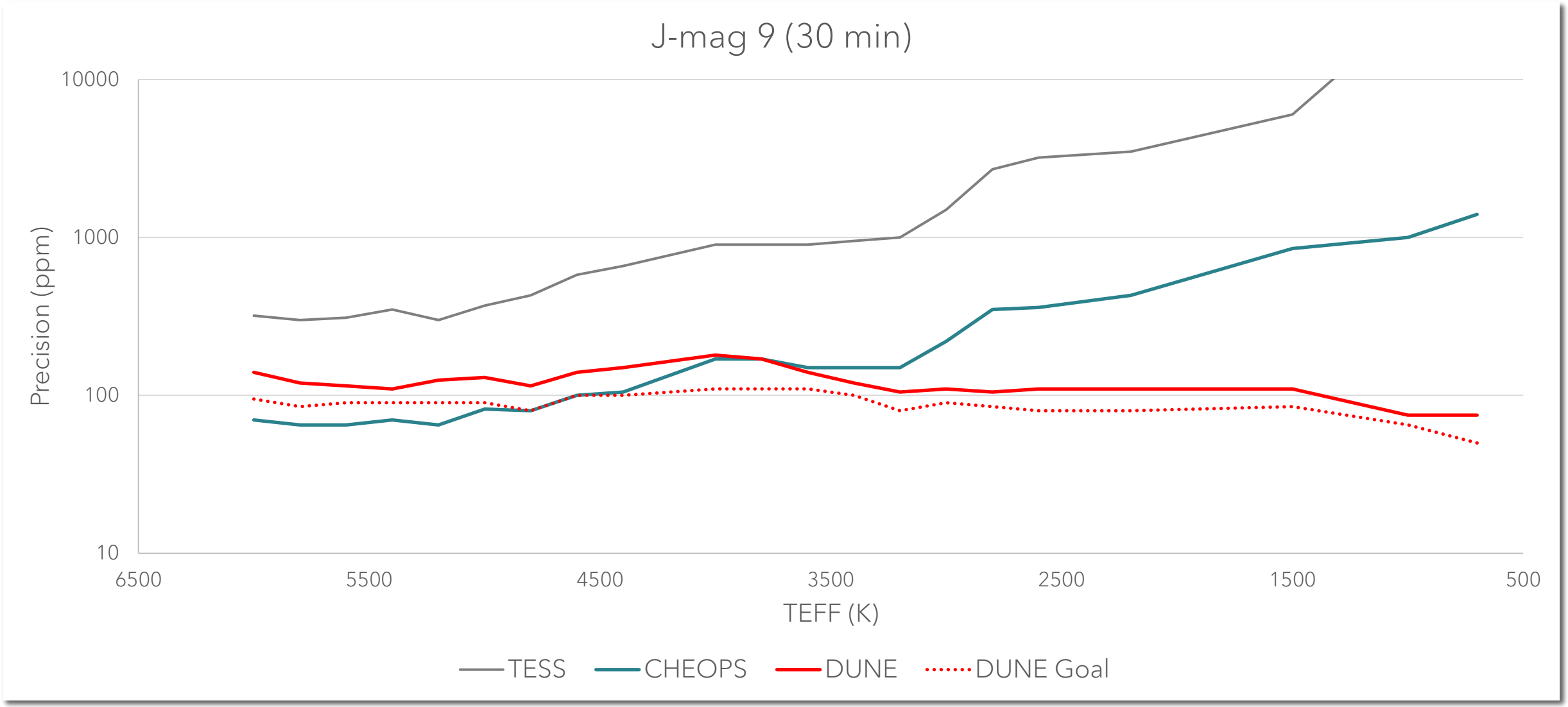
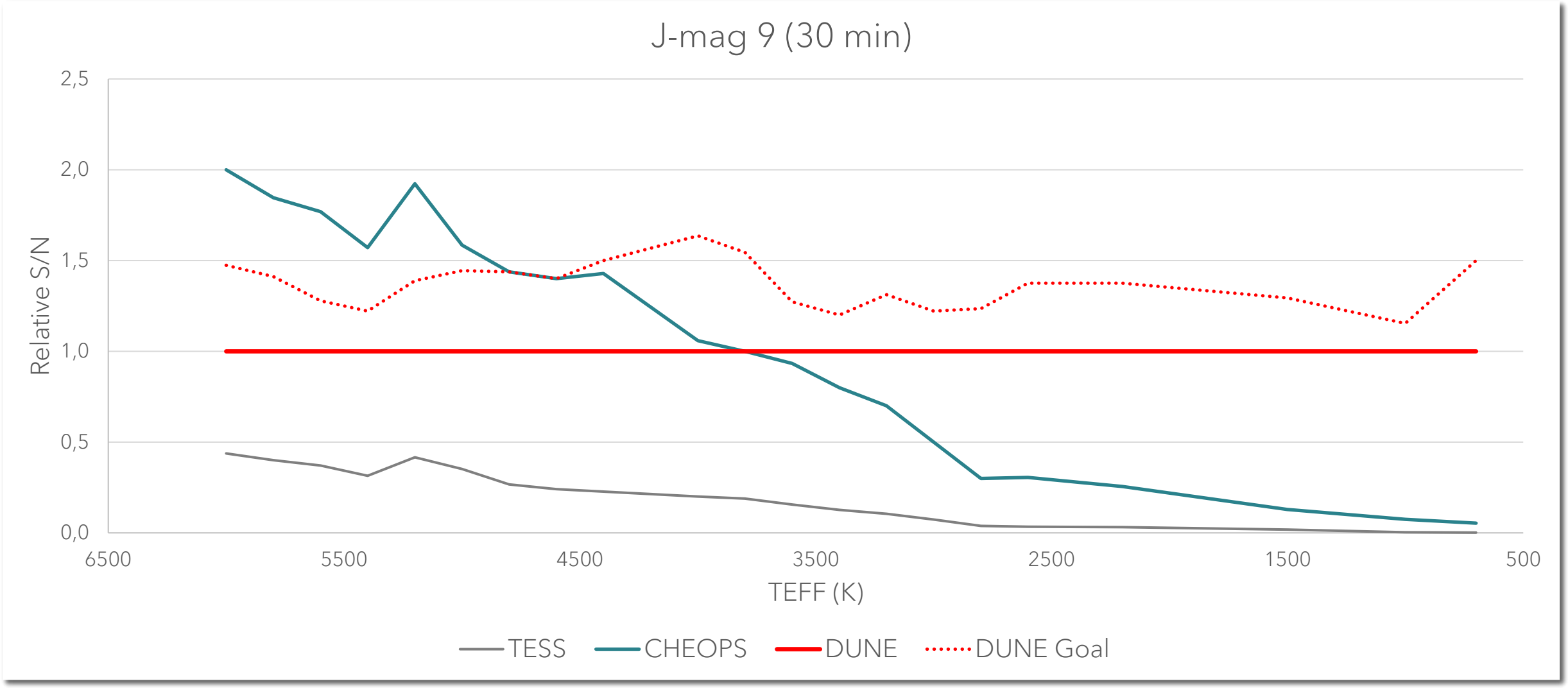
Relative performance



Relative performance



Project status

Timeline

Phase A (2021)

Call for project ideas (Ene)
Conceptual design

Mission PRR (Oct 21)

Phase B (2022 – 2026)

Platform preliminary design
Payload preliminary design
- Engineering model

Platform design

Platform design contract (Oct 23)
KO Plat. design (Airbus, Jan 25)
Payload SRR (Feb 25)
Mission SRR (June 25)
Mission PDR (Summer 26)

Phase C+D (2026 – 2029)

Platform final design
- Engineering+flight model

Payload final design
- Flight model

Platform contract (Winter 26)
Payload CDR (Spring 27)
Platform KO (Summer 27)
Mission CDR (Summer 28)
Payload AR (Autumn 28)
Mission AR (Summer 29)