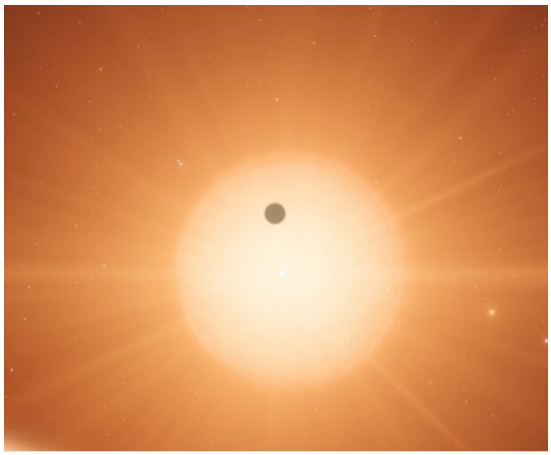
Exoplanet Hunter Instruments Performance Prediction



SUMMARY.
The Extremely Large Telescope (ELT) will provide unprecedented capabilities for high-angular-resolution astronomy and exoplanet characterisation. One of its future instruments, the Planetary Camera and Spectrograph (PCS), is designed to directly image and spectroscopically characterise exoplanets and circumstellar environments at extremely high contrast levels. This project focuses on predicting and evaluating PCS scientific performance using analytical and simulation-based tools. Particular emphasis is placed on adaptive optics performance estimation through analytical frameworks such as TipTop. The work includes the study of atmospheric turbulence, wavefront correction, coronagraphic performance, and resulting science metrics

— OBJECTIVES

- *Understand the scientific objectives and architecture of PCS.*
- *Study high-angular resolution techniques and in particular extreme adaptive optics and how they are used in direct exoplanet imaging systems.*
- *Learn analytical performance prediction methodologies.*
- *Use TipTop to estimate PCS extreme adaptive optics performance metrics (contrast, Strehl, wavefront error, etc).*
- *Analyse observing scenarios and performance trade-offs.*

Particular emphasis is placed on adaptive optics performance estimation through analytical frameworks such as TipTop.

— INSTITUTE

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— THEORY

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The work includes the study of atmospheric turbulence, wavefront correction, coronagraphic performance, and resulting science metrics.

— APPLICATIONS

by Carlos M. Correia

Adaptive optics performance simulations. Evaluation of Strehl ratio and residual wavefront error. Performance analysis under different atmospheric conditions. Comparison between analytical and simplified numerical approaches. Scientific plotting and interpretation of PCS performance metrics.

— MAIN PROGRESSION STEPS

- `Weeks 1-2`: Introduction to PCS, ELT instrumentation, and adaptive optics.
- `Weeks 3-4`: Training on TipTop and analytical prediction methods.
- `Weeks 5-7`: Performance studies and observing scenario analysis.
- `Weeks 8-9`: Result interpretation and preparation of final report.

— EVALUATION

- `Theory grade [30%]`
  Comprehension of theoretical background as part of the written report.
- `Practice grade [30%]`
  [20%]: Project development, progress, analysis, and conclusions, as detailed in the report.
  [10%]: Initiative, pro-activity, teamwork.
- `Defense grade [40%]`
  - Oral and slides quality
  - Context
  - Project / Personal work
  - Answers to questions

— BIBLIOGRAPHY & RESOURCES

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- Neichel et al, "TipTop: toward a single tool for all ELT instrument's PSF prediction," Proc. SPIE 13097, Adaptive Optics Systems IX, 130972Y (27 August 2024)
- Kasper, et al "PCS — A Roadmap for Exoearth Imaging with the ELT" The Messenger 182 (March 2021): 38–43.

— CONTACT

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