EPOL: the Exoplanet Polarimeter for EPICS at the E-ELT

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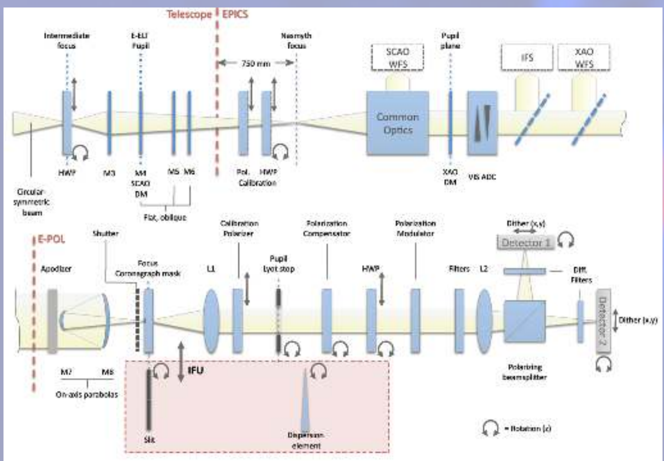
Summary

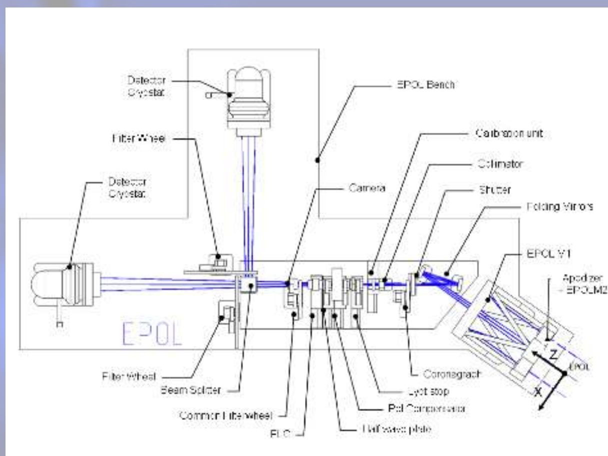
EPOL is the imaging polarimeter part of EPICS (Exoplanet Imaging Camera and Spectrograph) for the 42-m E-ELT. It is based on sensitive imaging polarimetry to differentiate between linearly polarized light from exoplanets and unpolarized, scattered starlight and to characterize properties of exoplanet atmospheres and surfaces that cannot be determined from intensity observations alone. EPOL consists of a coronagraph and a dual-beam polarimeter with a liquid-crystal retarder to exchange the polarization of the two beams. The polarimetry thereby increases the contrast between star and exoplanet by 3 to 5 orders of magnitude over what the extreme adaptive optics and the EPOL coronagraph alone can achieve. EPOL operates between 600 and 900 nm, can select more specific wavelength bands with filters and has an integral field unit to obtain linearly polarized spectra of known exoplanets.

Specifications

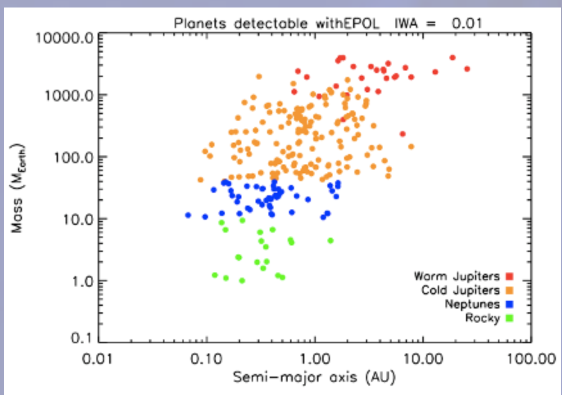
Requirement	Value
Spectral range	600 – 900 nm
Spatial sampling	At least 2 pixels per resolution element at shortest wavelength (3 mas)
Field of view (FoV)	1.37 x 1.37 arcsec
Off-axis FoV	2 x 2 arcsec
Filters	> 10 filters for both arms, same of different filters in the 2 arms, neutral density for flux reduction
Total transmission of EPOL and detector quantum efficiency	> 0.125 (goal >0.2) for the sum of the 2 EPOL arms
Operational efficiency of all modes including any required calibrations	> 50% (goal >70%)
Maximum wavefront error	< 75 nm RMS (goal <50 nm RMS)
Polarized ghosts	< 5% of azimuth fraction covered by polarized ghosts with polarized flux >10^{-7} of PSF peak flux
Polarization states modulation frequency	~10 Hz and ~1000 Hz
Detector read-out overhead	< 5% for full frame read-out and 1s integration time
Polarimetric sensitivity	better than 10^{-5} (goal 10^{-6})
Accuracy of polarimetric zero point	better than 10^{-3}
Relative polarimetric accuracy	better than 5%
Polarimetric efficiency	> 0.75 (goal >0.9)

Design

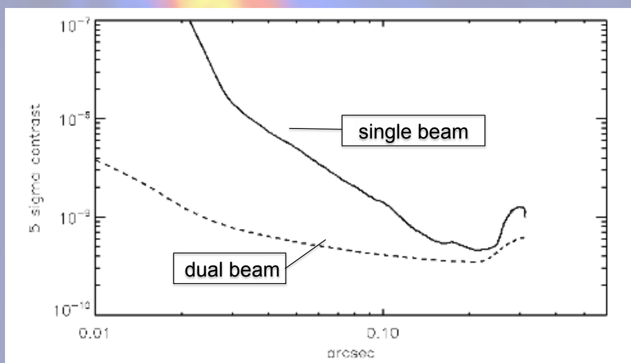




Performance



Simulations by: Mariangela Bonavita



Simulation of difference between true dual-beam (dashed line) versus single-beam (solid line) analysis for a bright, close-by star. The difference is a full order of magnitude or more over much of the field of view.

Background image: False-colour, near-infrared image of the disc around Beta Pictoris. Credit: J.-L. Beuzit et al., European Southern Observatory.