

Discovery space and science with the PLACID stellar coronagraph

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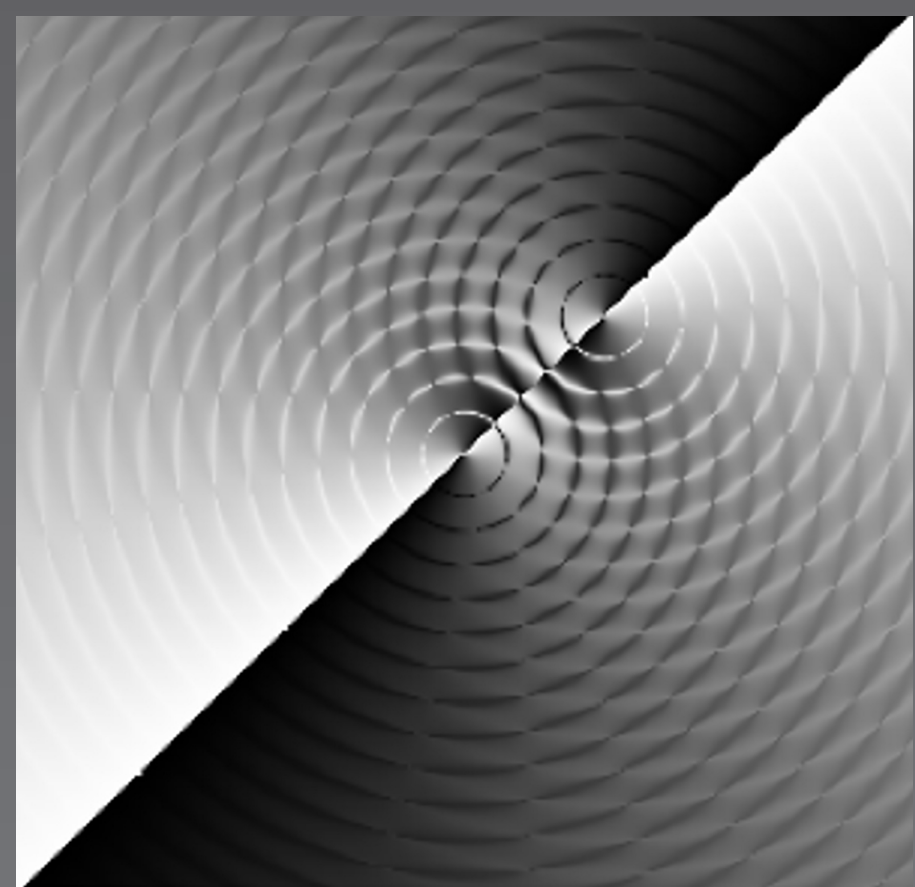
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Introduction

- PLACID (Programmable Liquid-crystal Active Coronagraph Imager for the DAG telescope) is a coronagraphic instrument, providing adaptive high-contrast imaging capabilities from H - to Ks - band
- PLACID uses a pixelated Spatial Light Modulator (SLM) to generate coronagraphic focal-plane masks (FPMs) for the first time on a telescope (4 m, DAG observatory, Erzurum, Turkey)
- Instrument delivered in March '24, first light expected by end of 2024
- Remote reconfiguration on-demand to adapt to e.g. observing conditions, multiple star coronagraphy, correcting aberrations, segmented primary mirrors (ELTs, HWO, ...)



Vortex FPM ($n=2$) programmed for a binary star (can be rotated in time to perform ADI) [1]

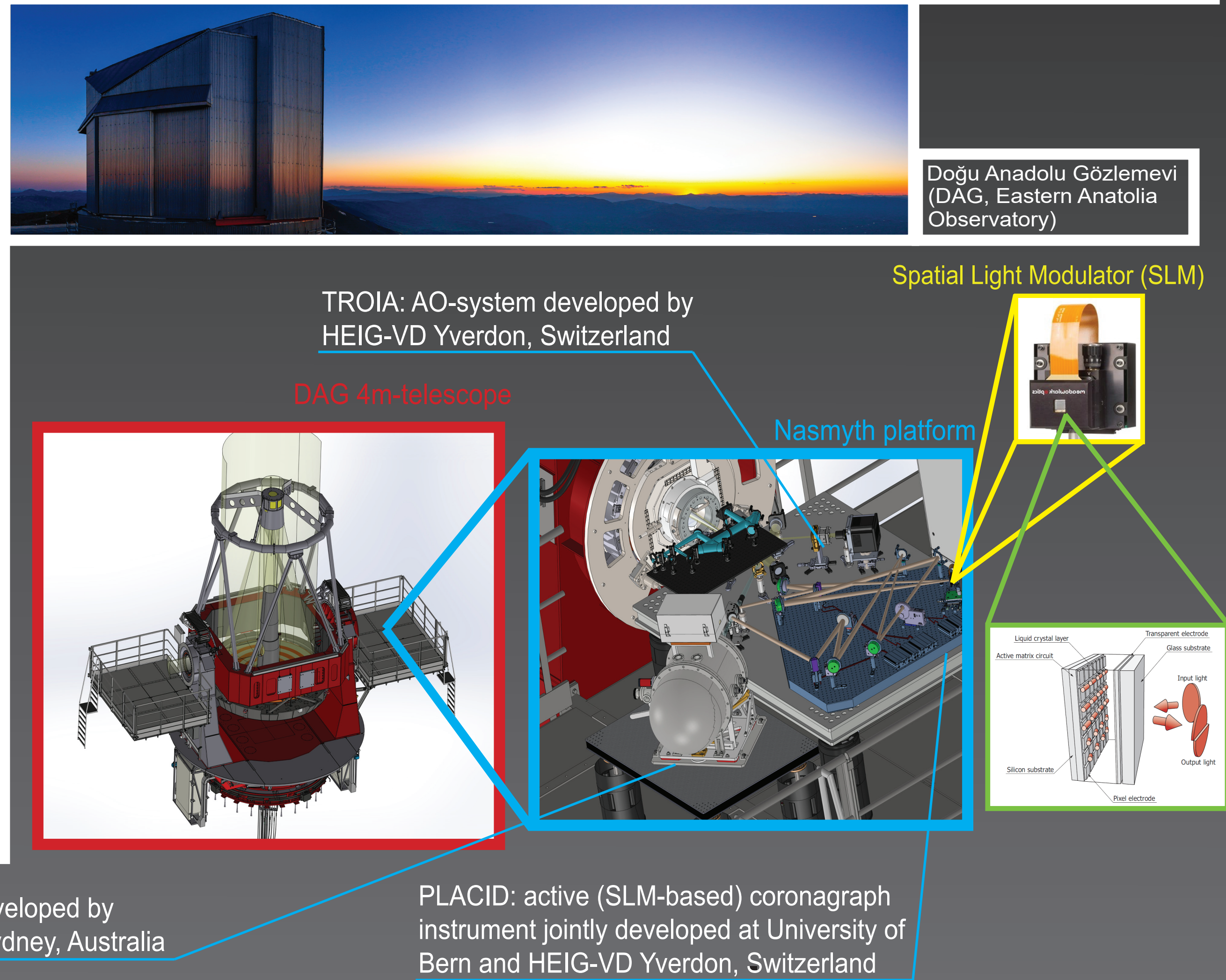
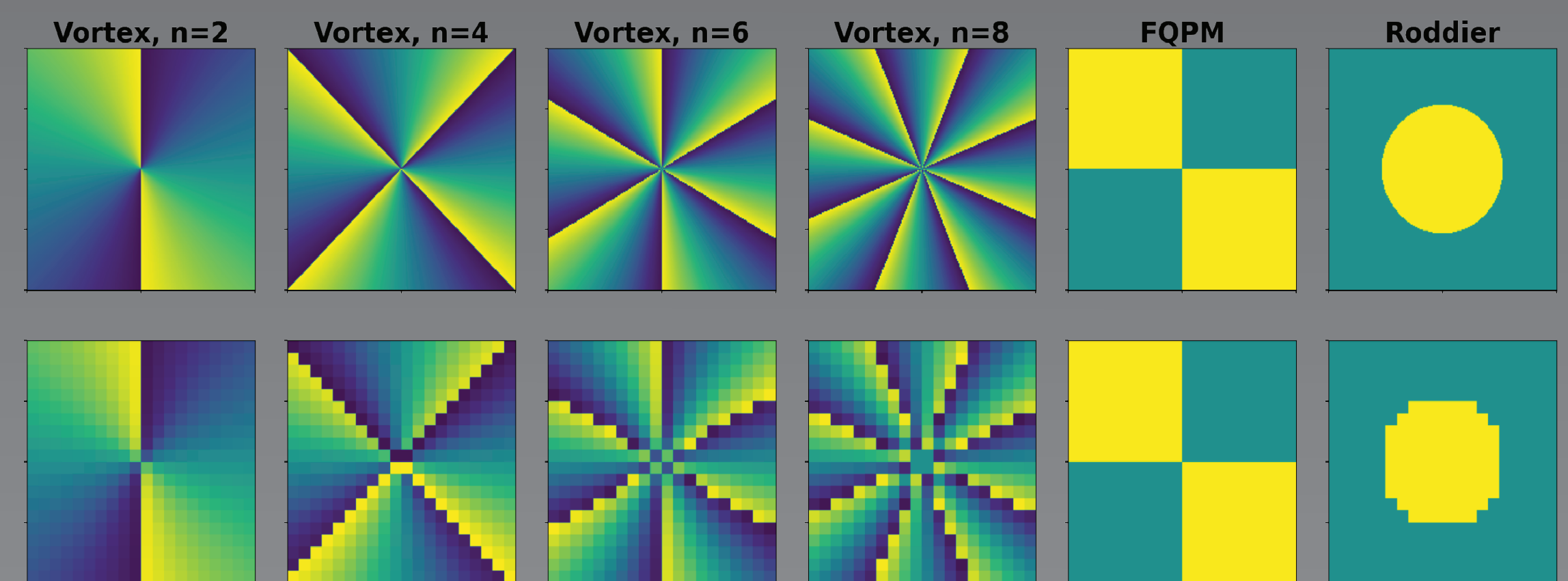


Have a look at a related poster on simulations of an SLM-based coronagraph!

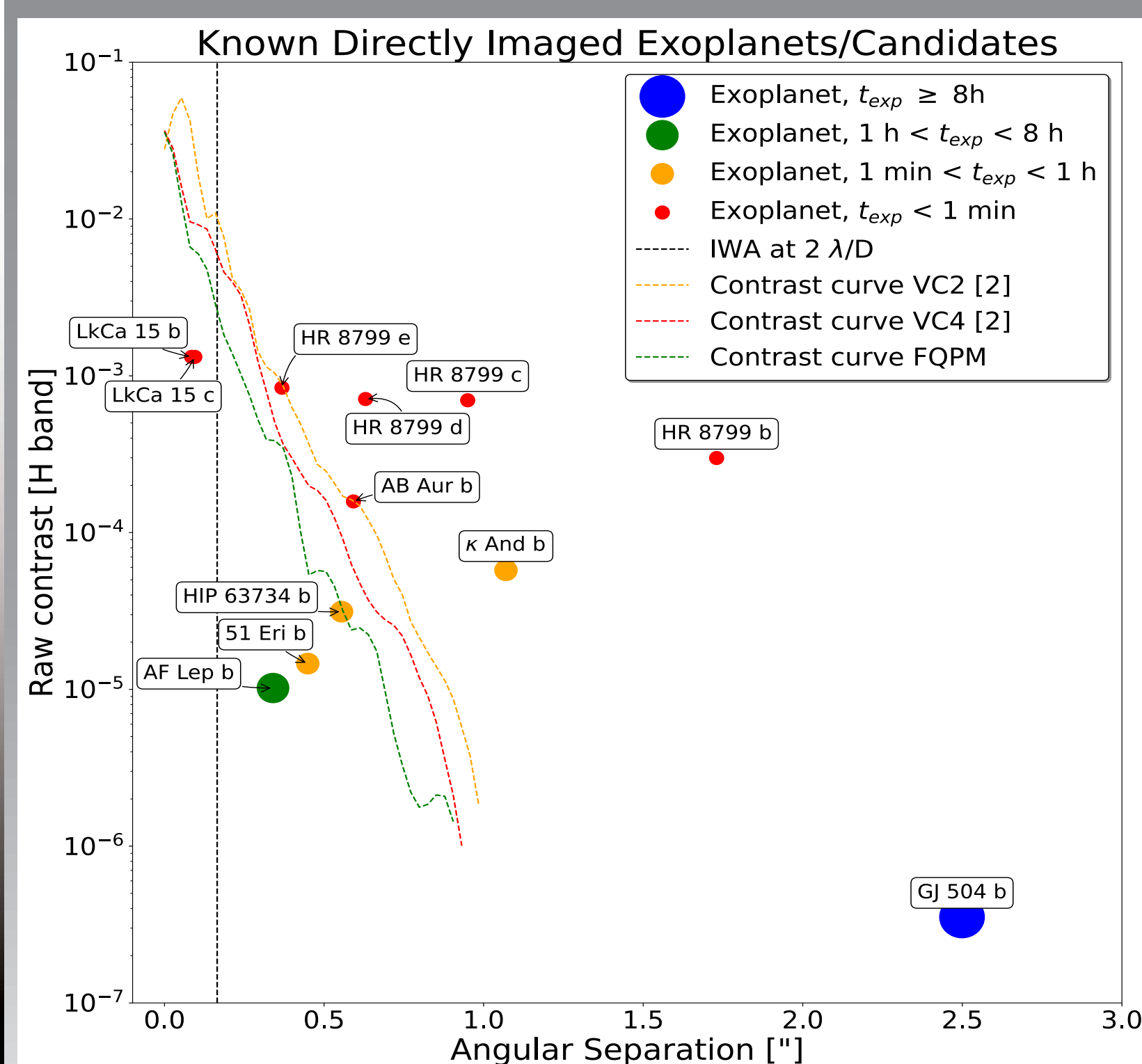
The SLM as an FPM

- Liquid Crystal on Silicon (LCOS, Meadowlark) Spatial Light Modulator (SLM) used to program adaptive FPM
- Micron sized pixels provide sampling of (>10 px per λ/D units) $\rightarrow \sim 10 \mu\text{m}$ pixels provides exquisite spatial sampling in the focal plane
- Simulations: sampling of 10 px per λ/D sufficient in most cases
- Scalar phase shift applied:
 - Chromatic, requires linearly polarized light

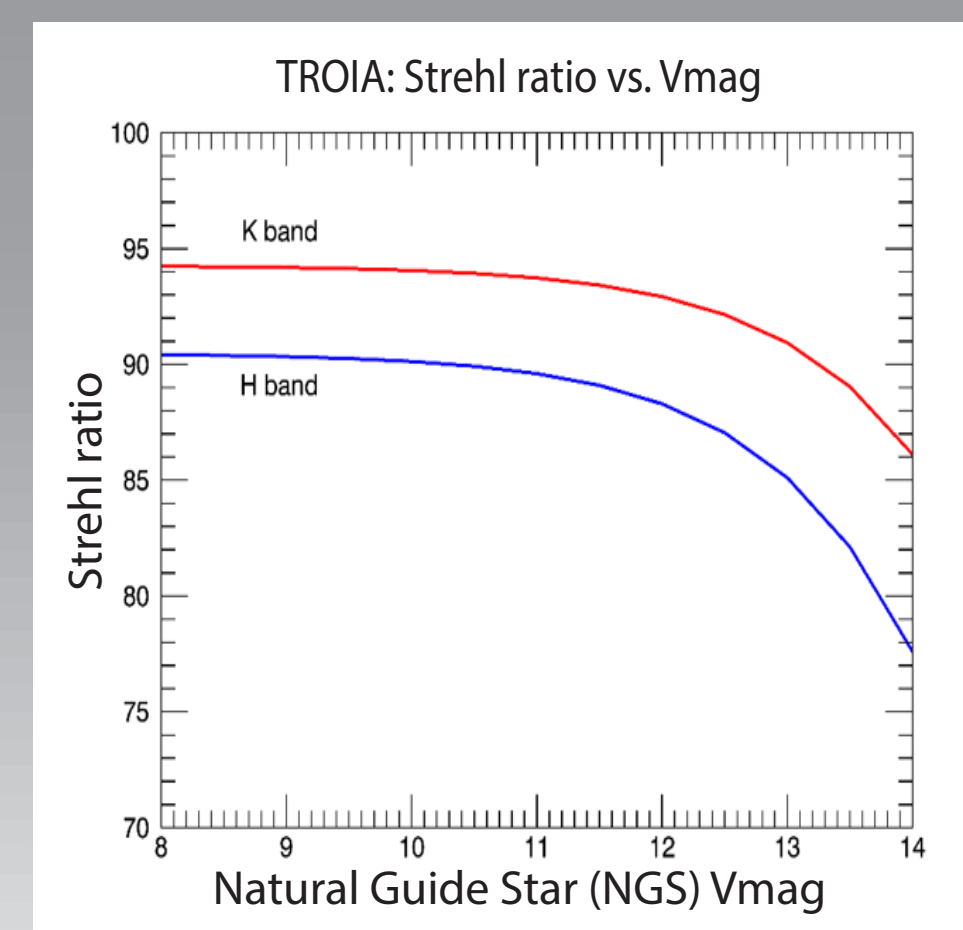
Figure: commonly used FPMs with left column: 10 px per λ/D and right column: 100 px per λ/D



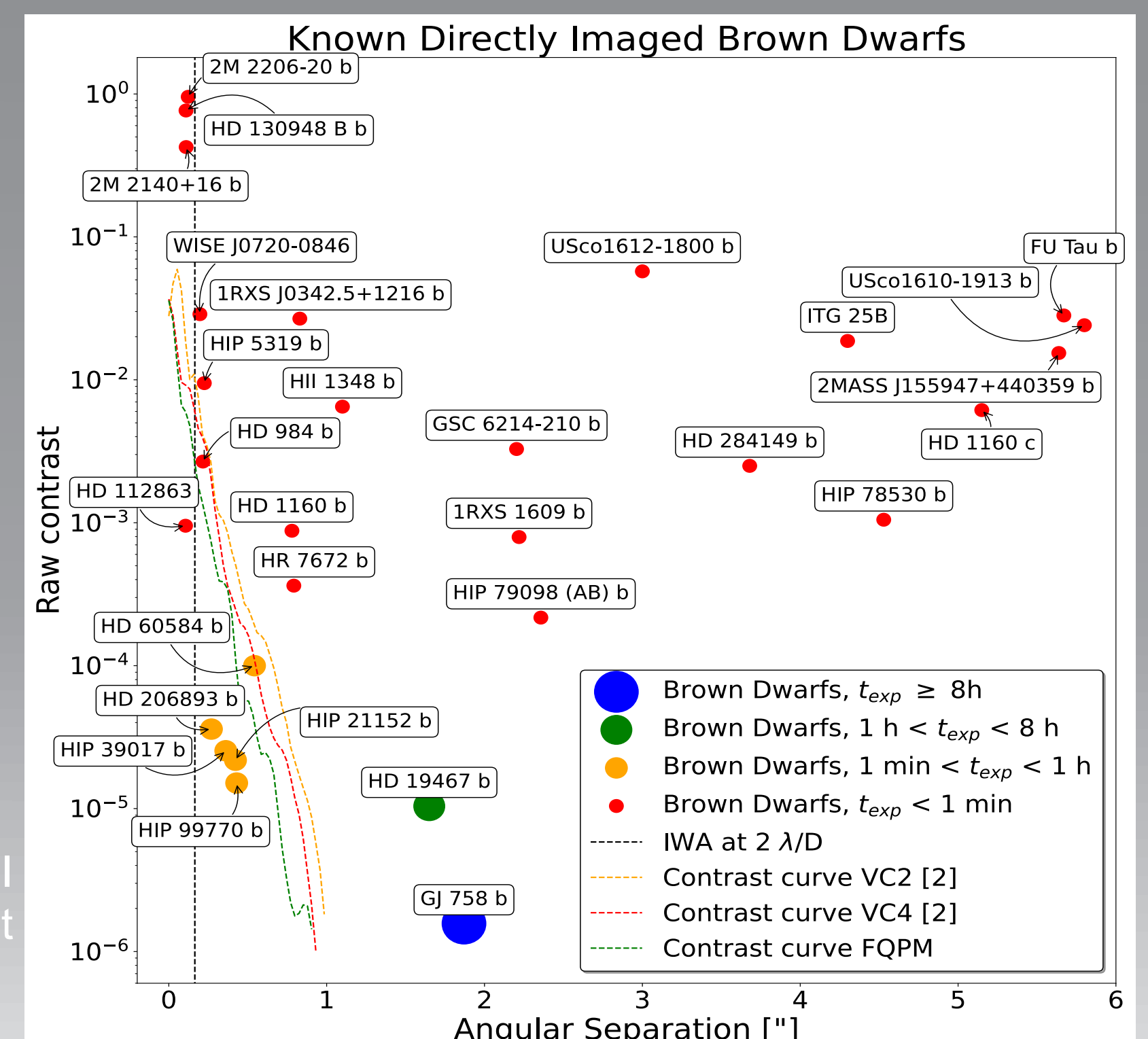
PLACID targets and discovery space



- Known exoplanets / candidates, Brown Dwarfs, circumstellar disks, binaries/triples
- Gaia, TESS, PLATO direct-imaging follow-ups in the North
- PLACID observational constraints:
 - Site: DEC: $\geq -24^\circ$
 - TROIA AO guide star: $V \leq 13$ mag
 - On-sky FOV: $16'' \times 9.6''$



- Plots: lab contrast curves
- Exposure time t_{exp} required for SNR = 5
 - without coronagraph
 - no speckles
- Post-processing, ADI, CDI \rightarrow factor 10 improvement



Outlook

- Obtaining on-sky contrast curves for PLACID
- Upgrading Exposure Time Calculator
- Setting up data reduction pipeline

References

- [1] Jonas G. Kühn et al. SLM-based digital adaptive coronagraphy: current status and capabilities. Advances in Optical and Mechanical Technologies for Telescopes and Instrumentation III, volume 10706 of SPIE Conference Series, page 107062N, July 2018. doi: 10.1117/12.2312554.
- [2] Jonas G. Kühn et al. SLM-based Active Focal-Plane Coronagraphy: Status and future on-sky prospects. Advances in Optical and Mechanical Technologies for Telescopes and Instrumentation IV, 114511S, Proceedings of SPIE 11451, February 2021. doi: 10.1117/12.2562579