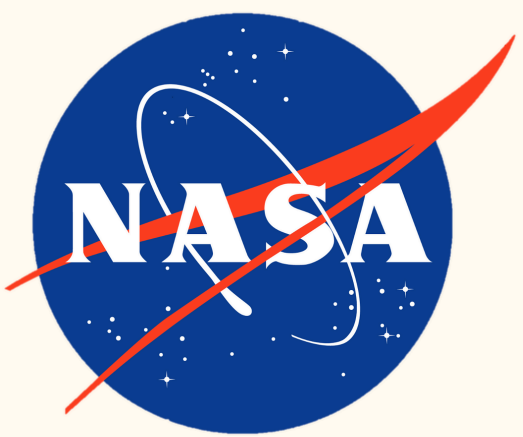


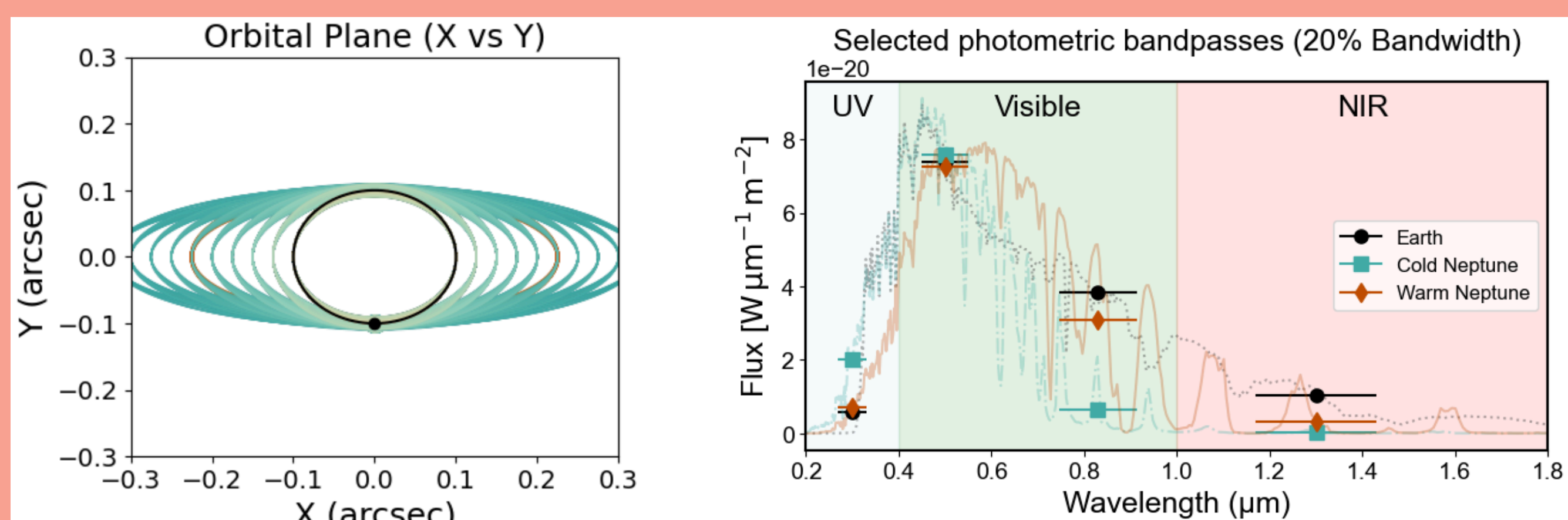
Multi-Bandpass Exoplanet Atmosphere Reconnaissance (MPEAR): Optimizing HWO's First-Visit Photometric Strategy



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The Problem



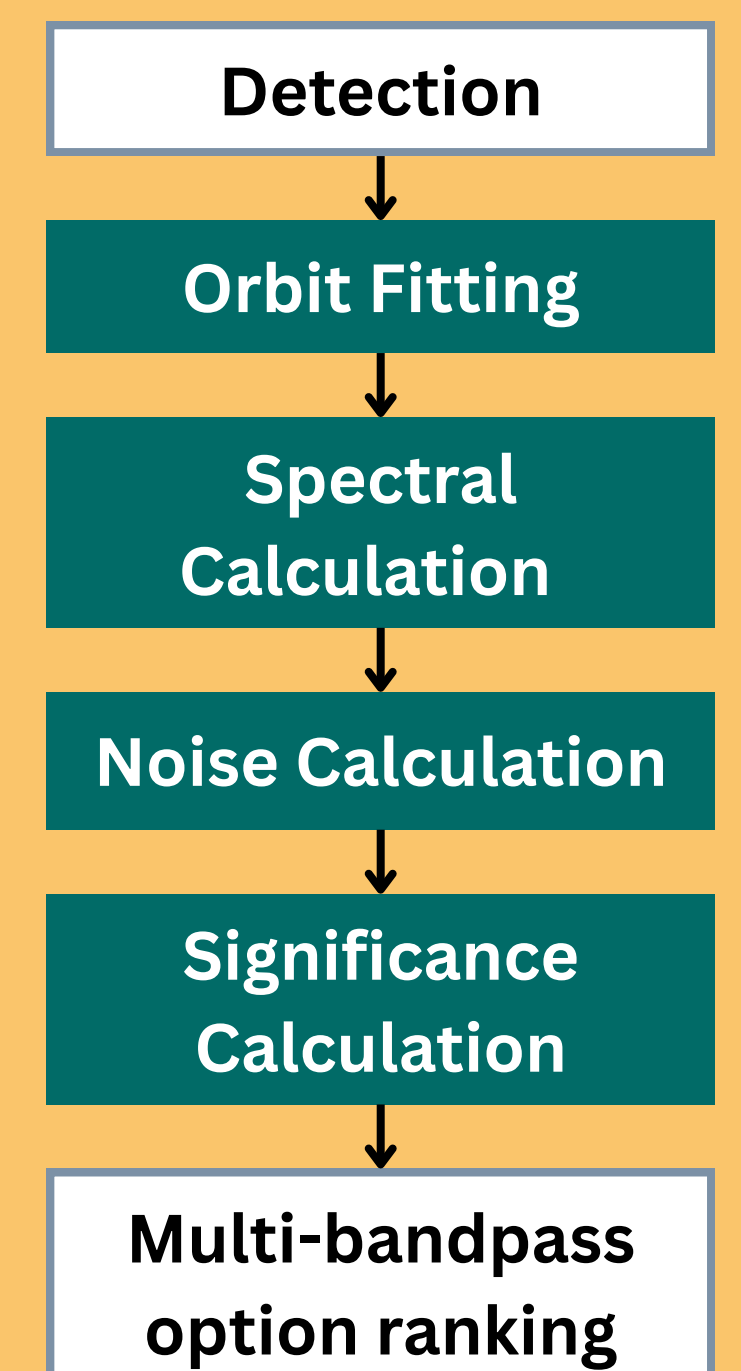
When first visiting a planetary system, HWO will observe in broadband photometry at 500 nm (discovery bandpass). Multiple orbital configurations can explain a single detection (left), AND different planet types can have similar flux at 500 nm (right). **HOWEVER: spectra diverge at other wavelengths → Multi-bandpass photometry can break the degeneracy.**

Methodology

- Systematic sweep of entire HWO wavelength range for 5%, 10% and 20% bandwidth.
- Calculating the significance:

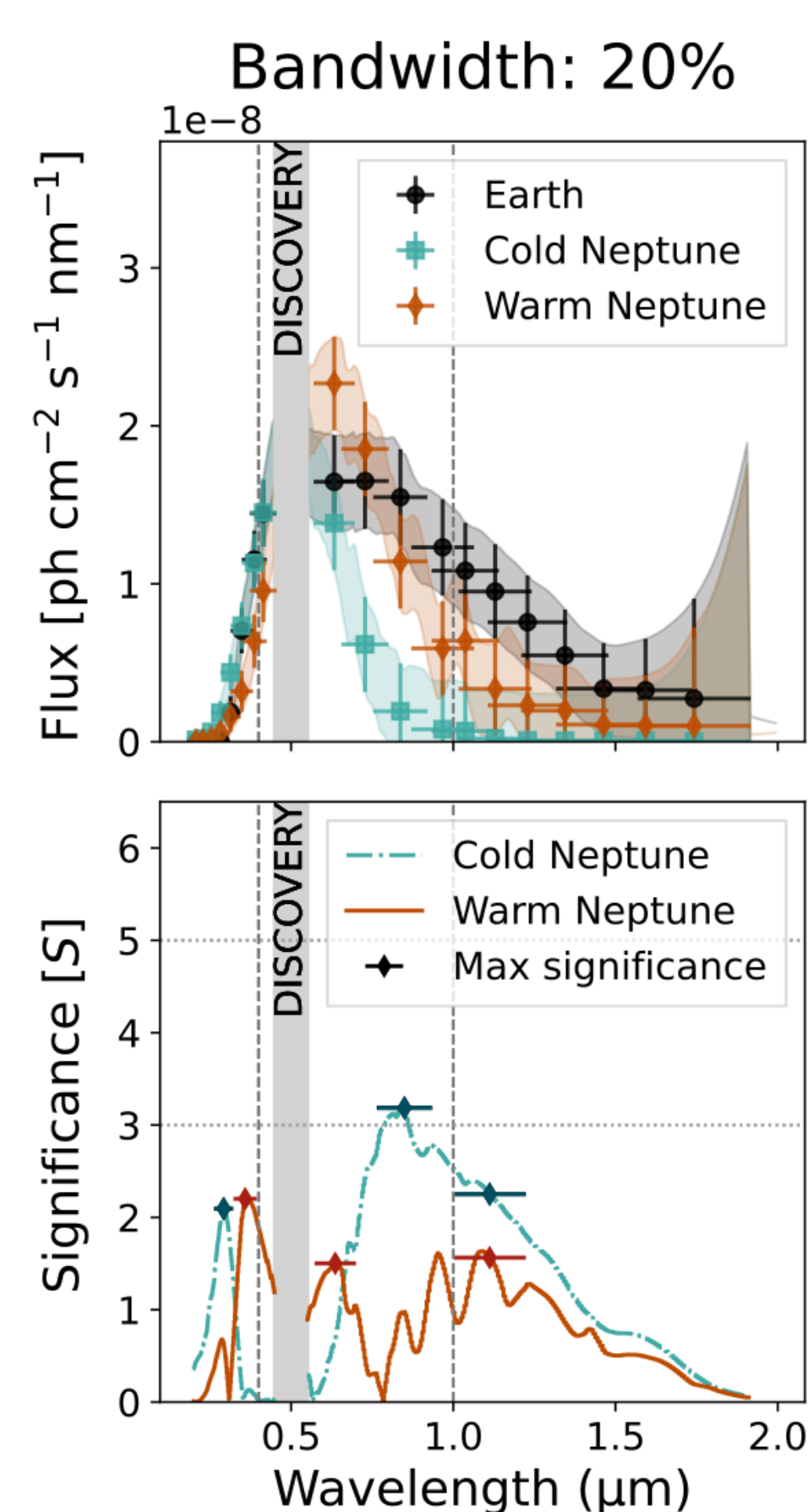
$$S = \frac{|F_{Earth} - F_{Neptune}|}{\sigma}$$

- Testing combinations of 2-3 simultaneous bandpasses:
 - $S \geq 3$ → qualitative differentiation
 - $S \geq 5$ → reliable differentiation



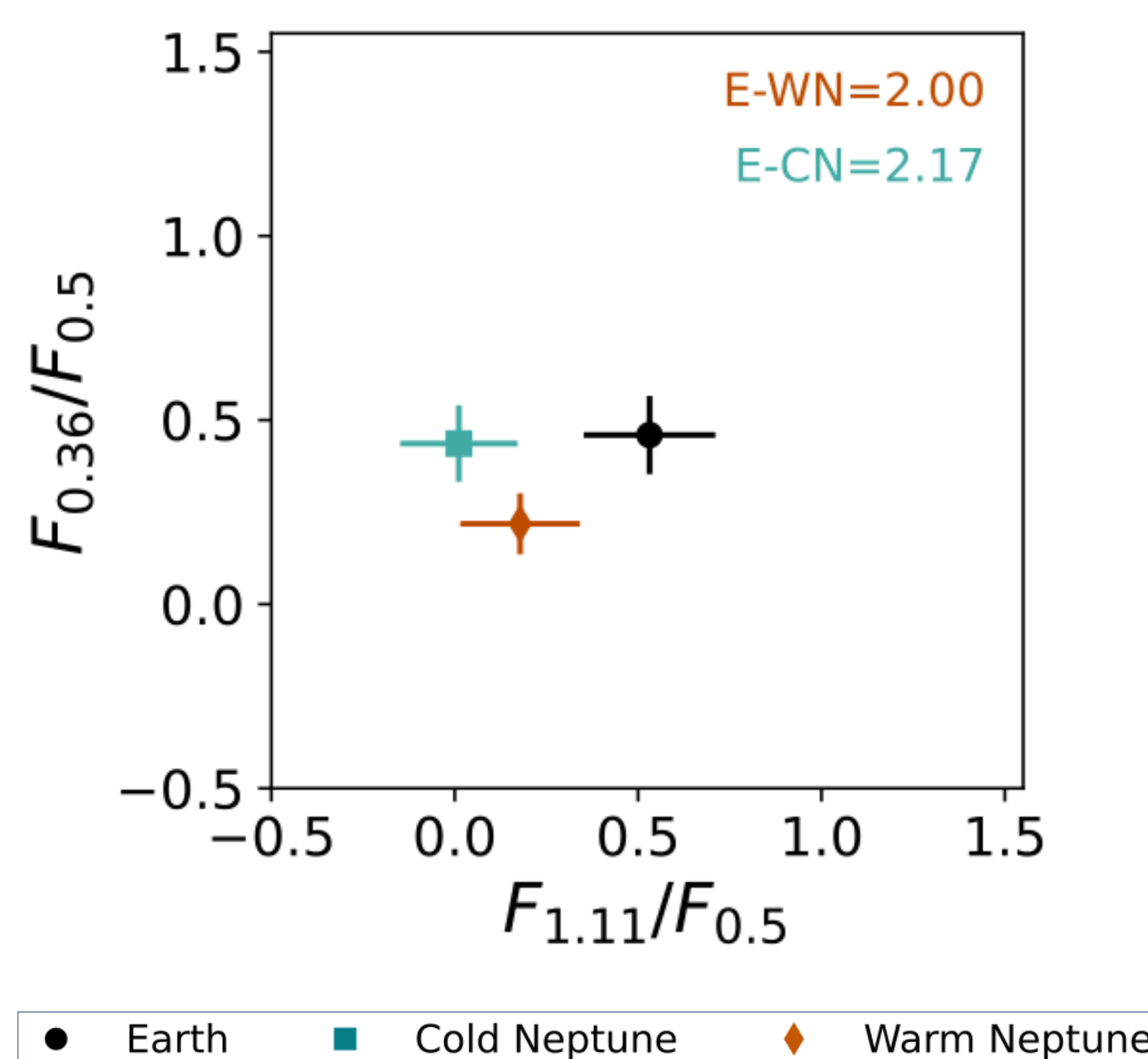
The multi-band photometry opportunity

① Finding Best Filters



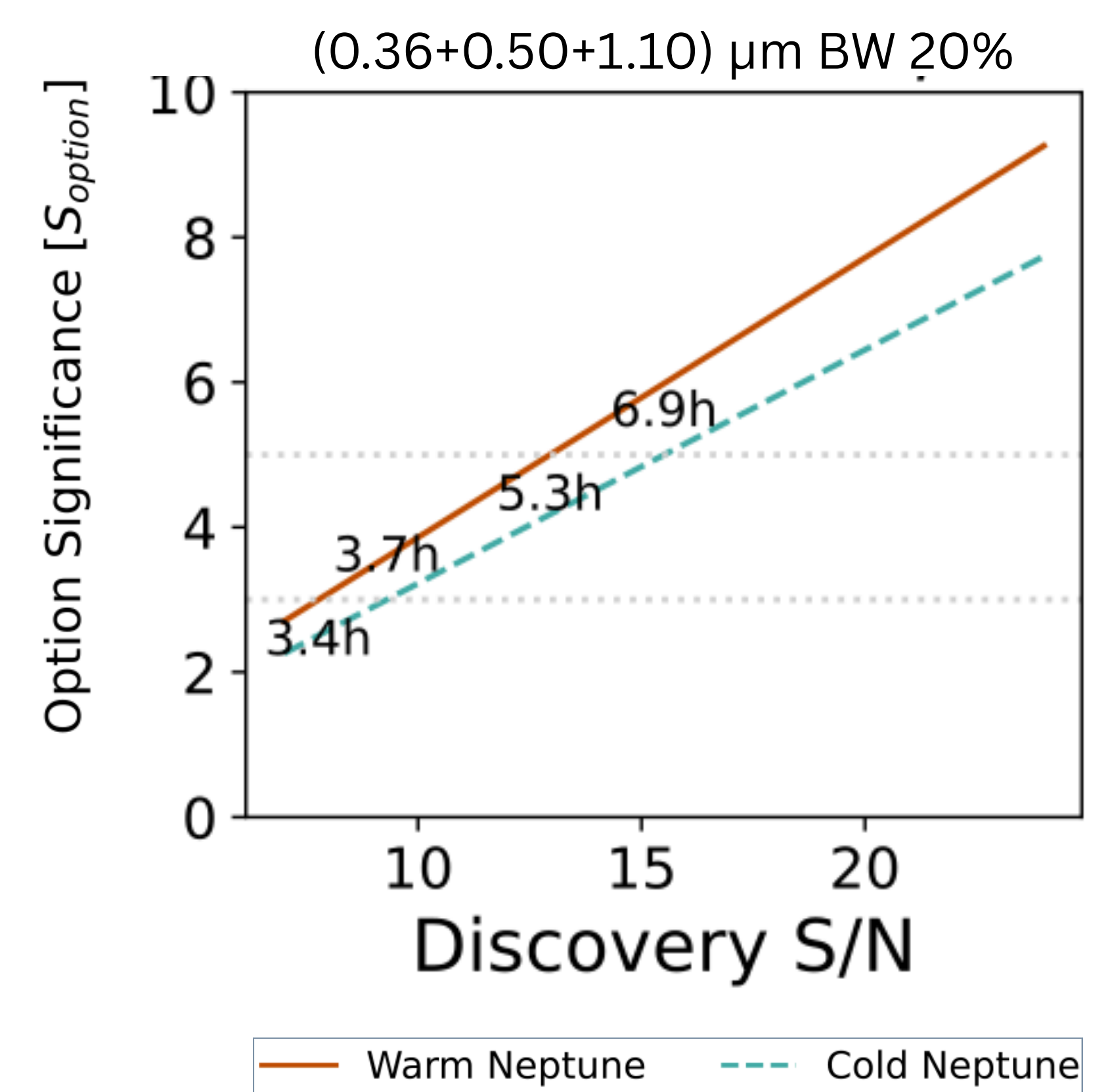
The systematic bandpass sweep identifies optimal secondary filters at UV (~360 nm), VIS (~640-880 nm), and NIR (~1.1 μm).

② Performance (S/N=7)



An additional band in the UV (360 nm) and one in the NIR (1.1 μm) separate planets in color-color space. Moderate differentiation is achieved at baseline S/N = 7.

③ Increasing S/N



Longer integration enhances differentiation. Discovery S/N > 15 achieves decisive separation ($S > 5$) in around 7 hours observation time (instead of ~3.2 hours for S/N=7).

Conclusions

Optimized Filter Options:

1. (0.36+0.50+1.10) μm
2. (0.50+0.64+1.10) μm (no UV)
3. (0.50+1.10) μm (2-bandpass)

Results are model-dependent. **Higher exposure time → reliable differentiation for all cases.**

Paper:



Next Steps

- Explore diverse stellar, planet, and atmospheric types
- Study impact on yield and survey strategies
- Vary HWO instrument parameters
- Integration with HWO target prioritization algorithms

Github: <https://github.com/eleonoraalei/mpear>

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