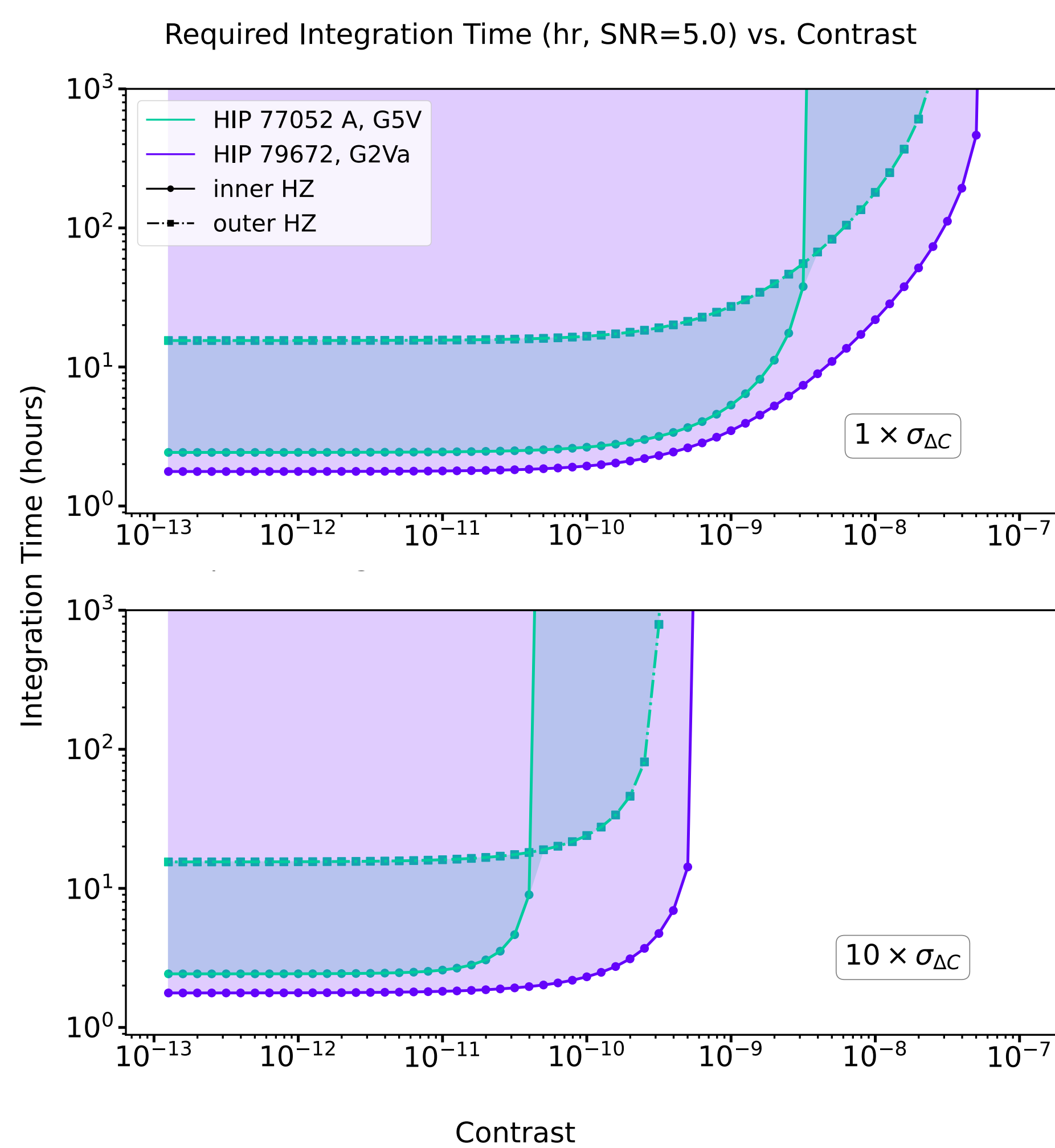


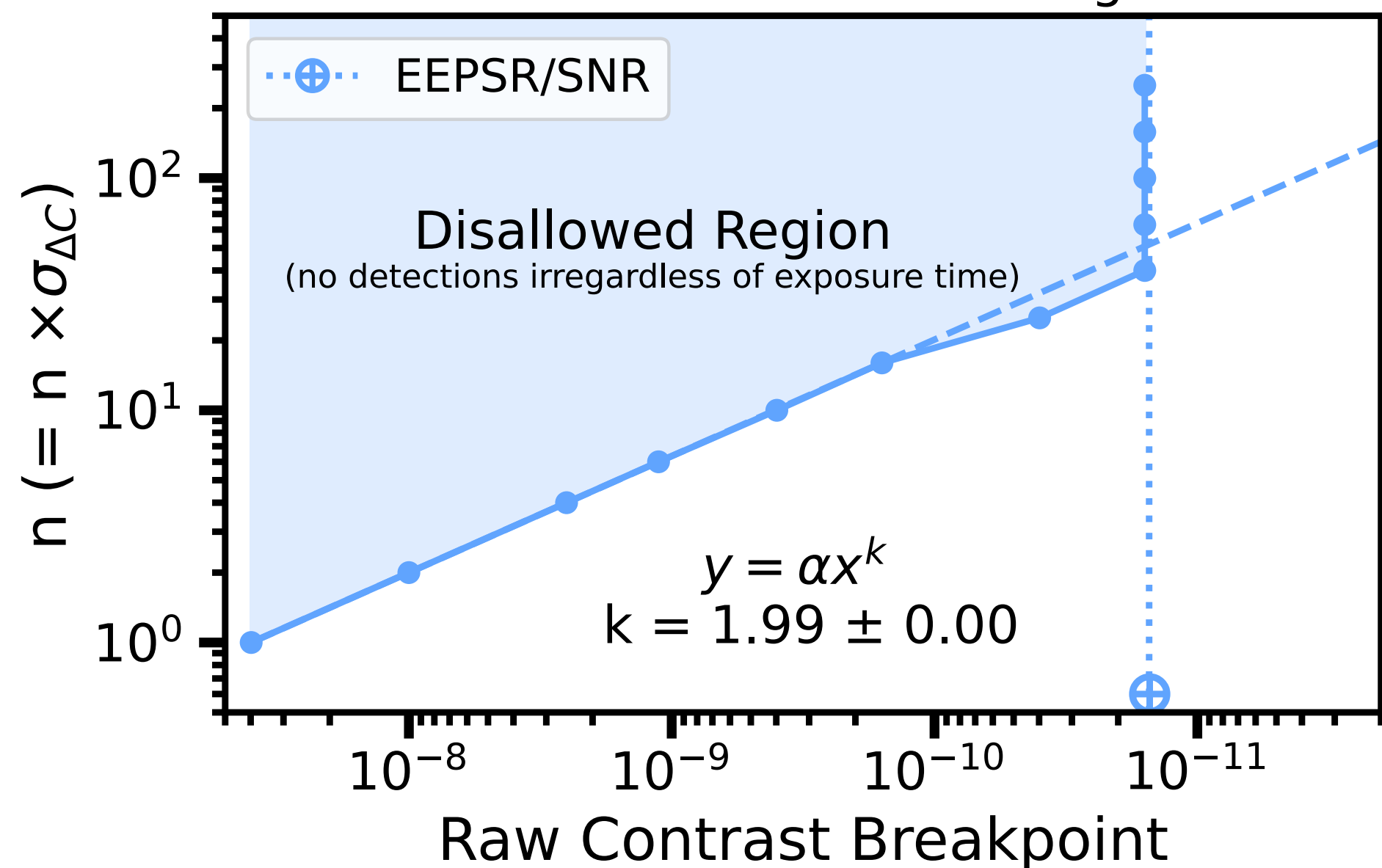
Introduction

WFE, WFS&C and coronagraph sensitivity have a profound impact on expected exposure times (and therefore yields) for exo-Earth detection and characterization. These parameters have been studied extensively in the context of error budgeting for missions such as Roman CGI^{1,2}, but despite this there is no easy and accessible way to incorporate this information into existing exposure time calculators. We present the Error Budget Software (EBS) as an open-source tool to synthesize WFE, WFS&C and sensitivity information and feed it into the existing EXOSIMS ETC to perform trade studies for HWO.

WFE vs. Raw Contrast



WFE and Raw Contrast Detection Space for an Earth-Sun Analog



Experiment:

Plot exposure times for exo-Earth detection as a function of coronagraph raw contrast at different WFE values.

Observations:

Follows a power law up to the raw contrast of the planet scaled by the desired SNR.

Conclusion:

Once planets can be detected in single exposures, increasing WFE has no effect. Stability can be traded against raw contrast (and vice versa).

The Error Budget Software (EBS)

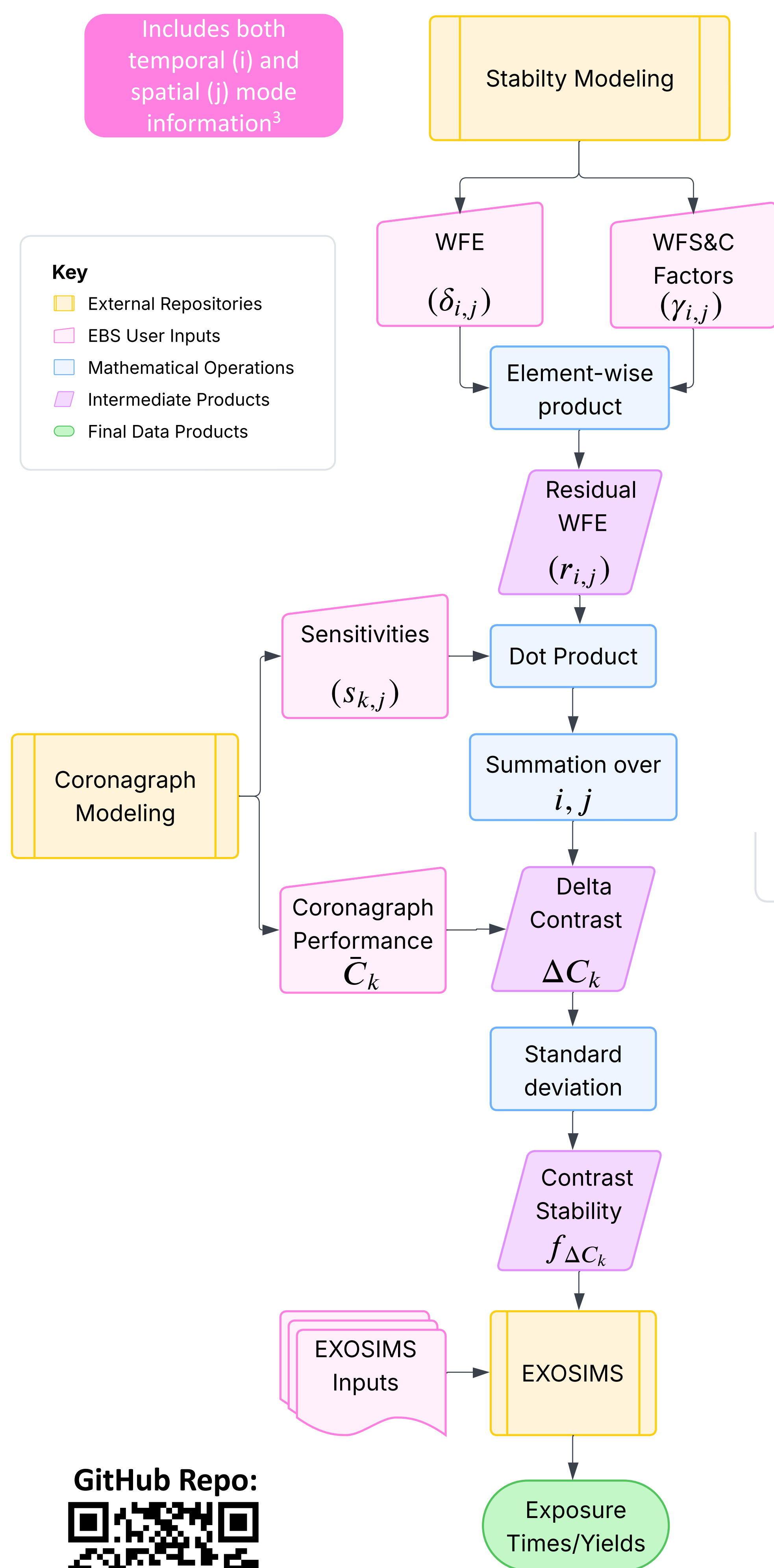
Time to SNR equation:

$$t_{req} = \frac{r_n}{\left(\frac{r_{pl}}{SNR}\right)^2 - r_{\Delta I}^2}$$

Contrast stability
(encodes WFE information)

$$r_{\Delta I} = f_{\Delta C} f_{pp} r_{sp}$$

How is this calculated
in EBS to yield
exposure times?



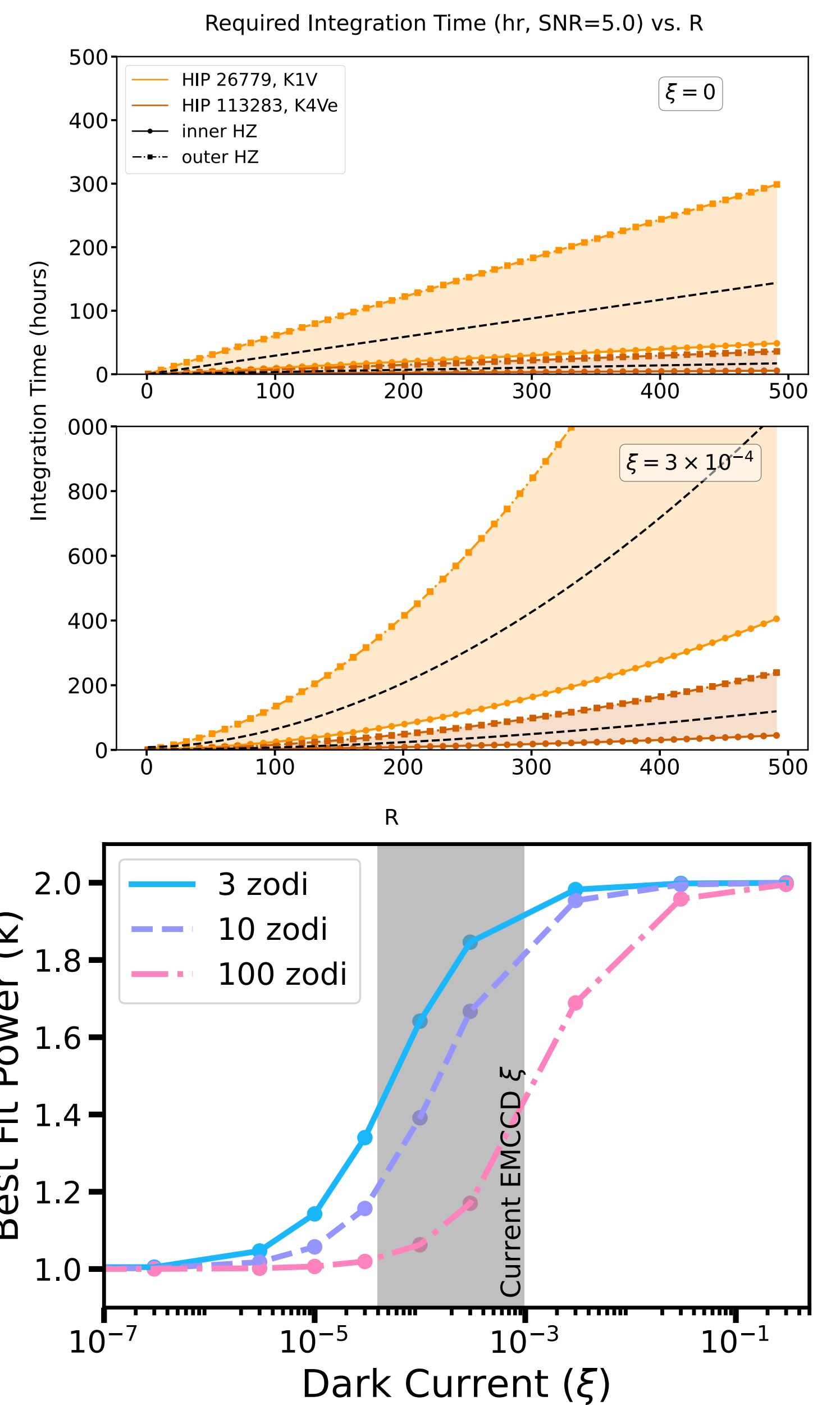
GitHub Repo:



References

- Results published in S. Steiger, P. Chen, L. Pueyo, JATIS (2026)
1. B. Nemati, J. Krist, Poberezhskiy, et. al. (2023)
 2. B. Nemati, H.P. Stahl, M.T. Stahl, et. al. (2020)
 3. L.E. Coyle, J.S. Knight, L. Pueyo, et. al. (2019)

Dark Current



Experiment: Sweep exposure time (t_{exp}) as a function of dark current (ξ) for differing values of exo-zodi.

Conclusion: $t_{exp} \propto R^2$ for large values of ξ and $\propto R$ for small values. The transition depends heavily on astrophysical noise sources such as exo-zodi.

Multivariate Studies

EBS contains both MCMC and Nested Sampling modes to enable high-dimensional exploration of parameter space to identify breakpoints, correlations between parameters, and validate single parameter sweeps

Experiment:

MCMC run for R=70 spectroscopy case

Observations:

- Positive correlation between throughput and dark current
- Best contrast at EEPSSR/SNR

Conclusion:

Verified results of single parameter sweeps

