Orbit Retrieval of Directly Imaged Exoplanets: When and How to Look

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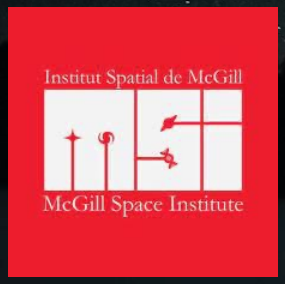
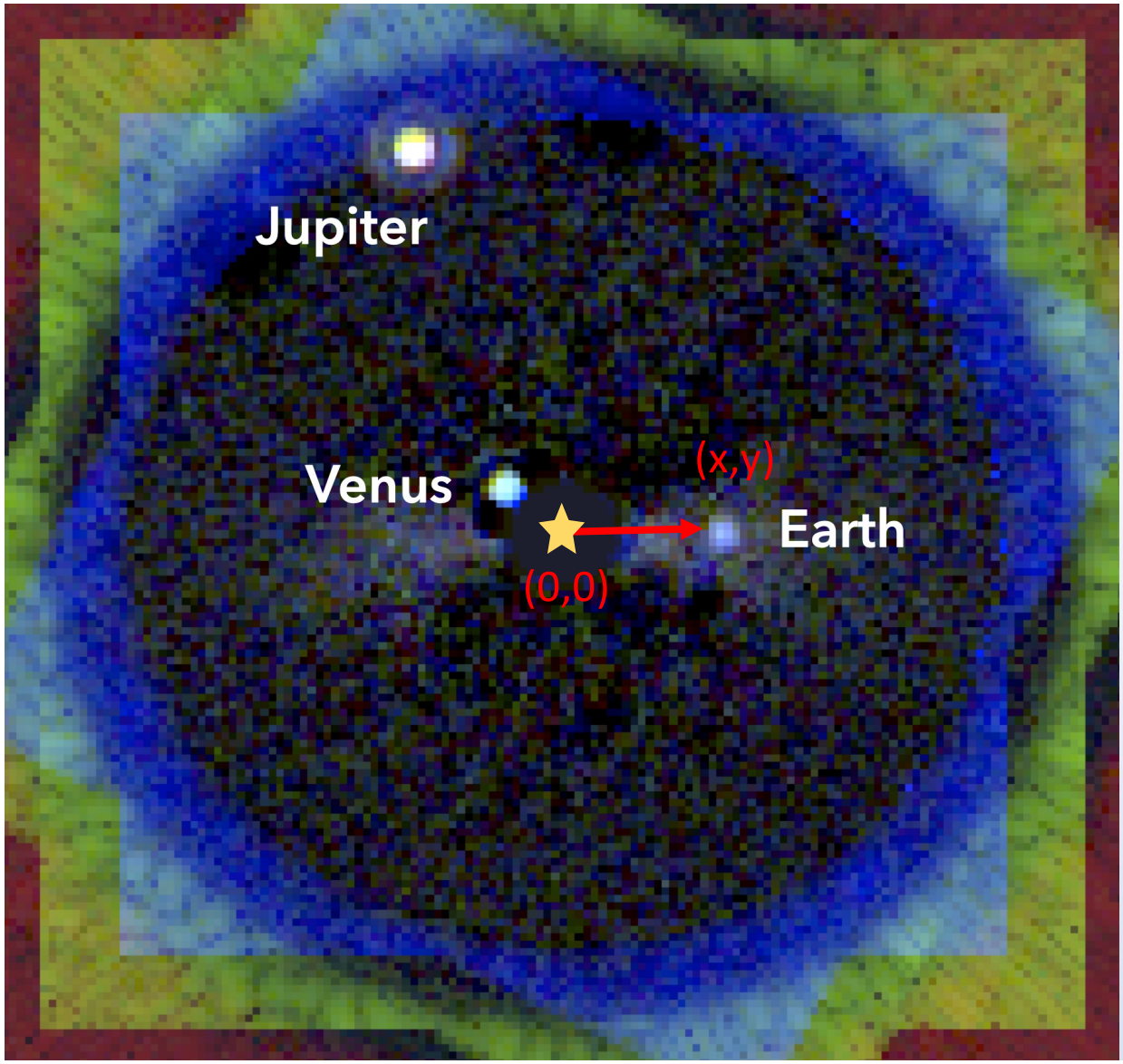
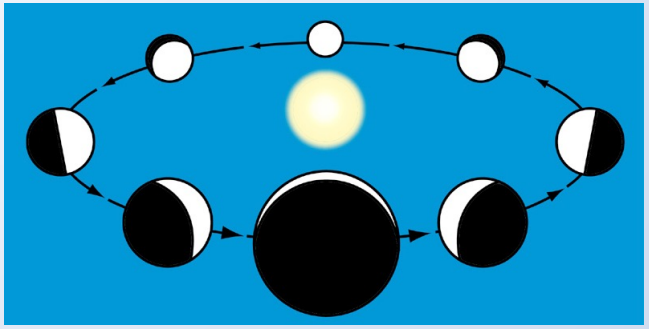




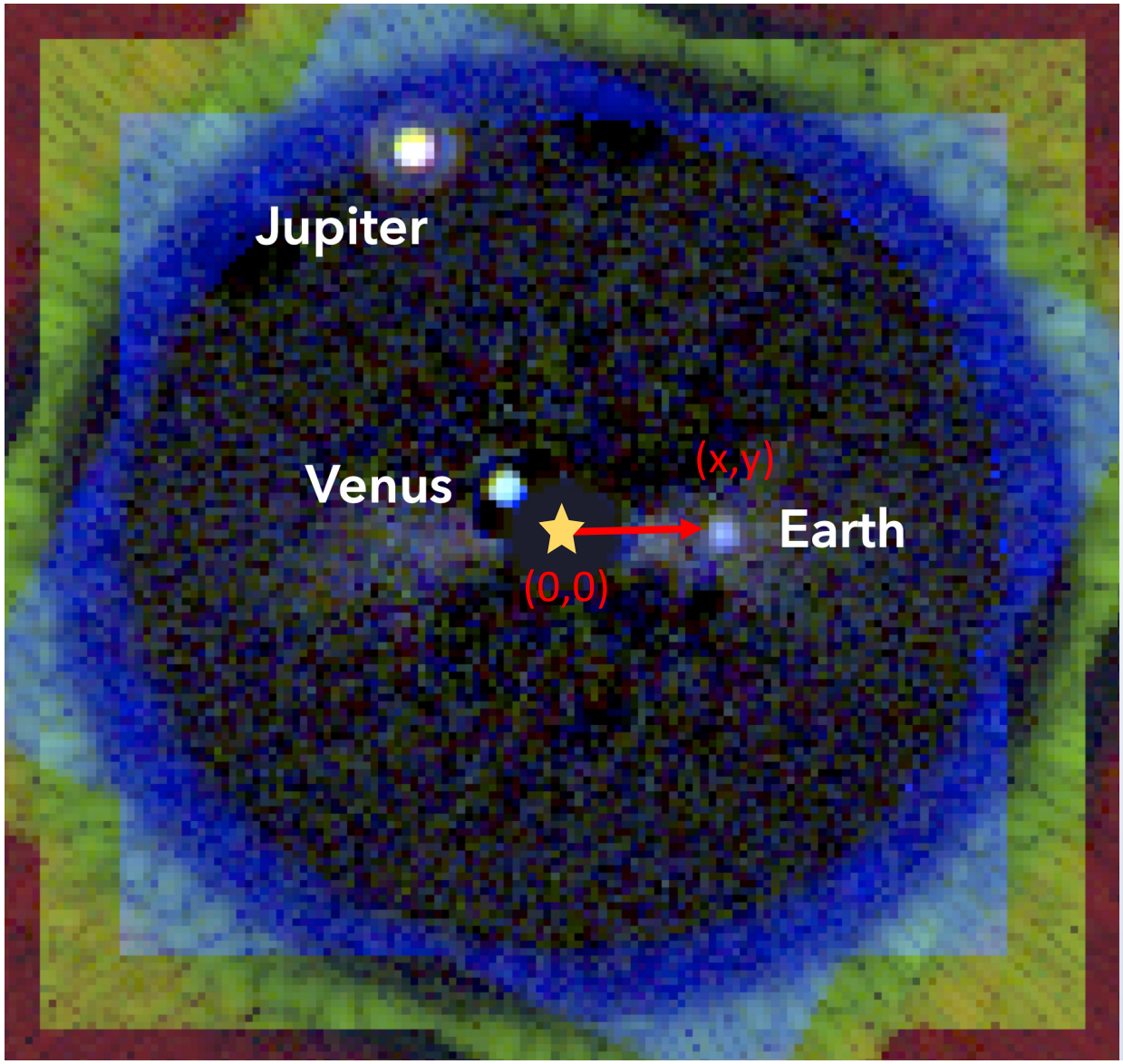
Simulated inner solar system in visible light. R. Juanola Parramon, N. Zimmerman, A. Roberge (NASA GSFC)

Current ground-based telescopes use infrared

Future space-based missions will be able to use visible light!



European Southern Observatory, eso.org

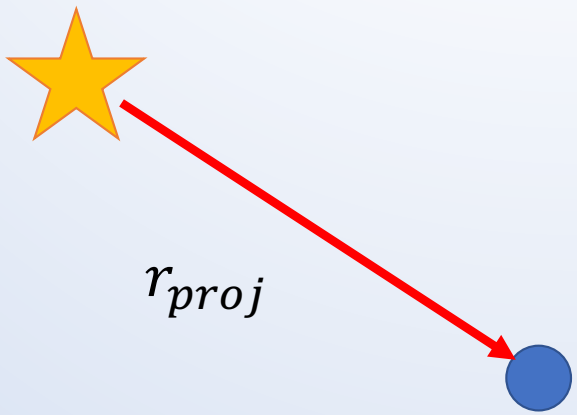


NASA 2002

This will be the best way to find Earth twins orbiting in the habitable zone!

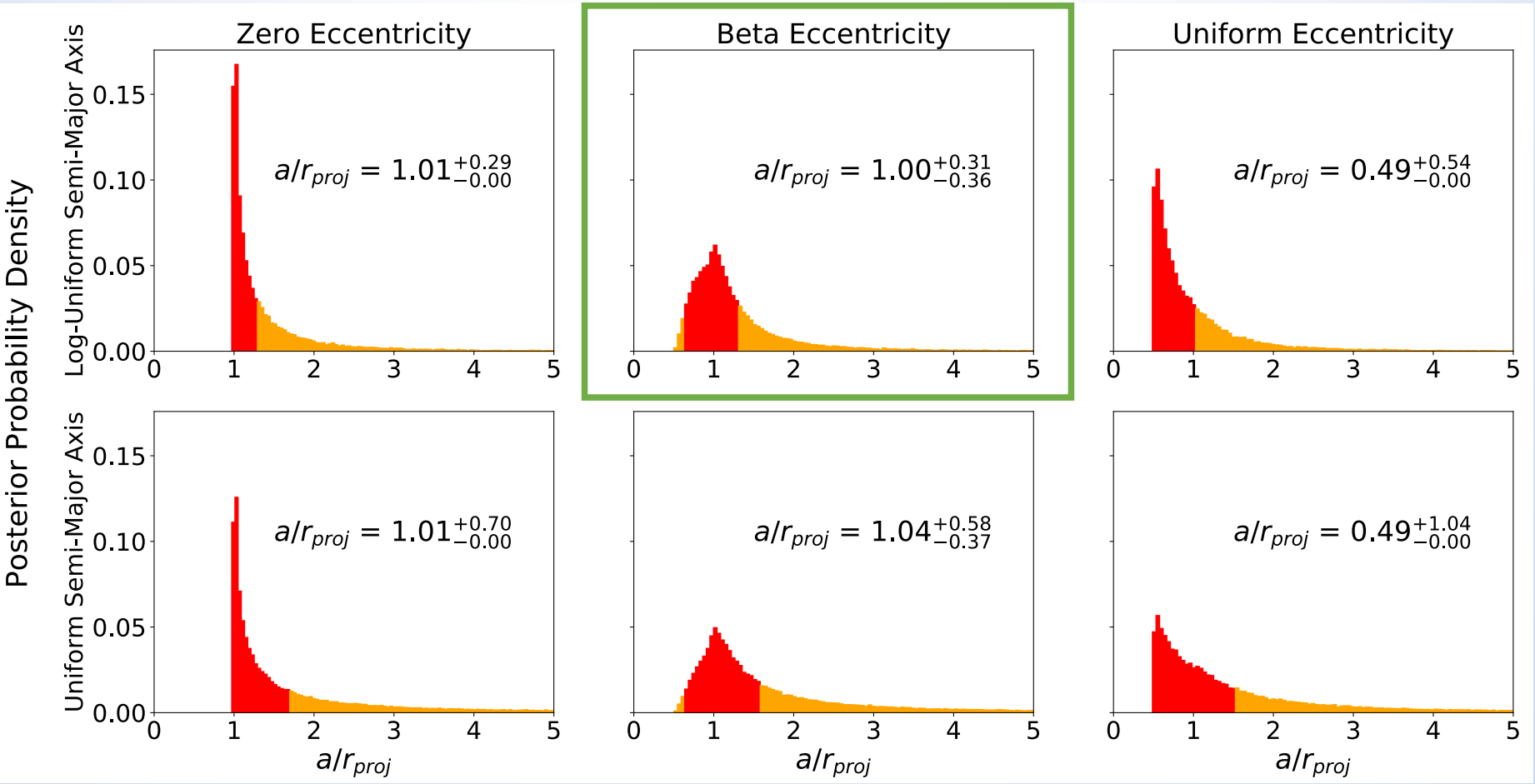
Simulated inner solar system in visible light. R. Juanola Parramon, N. Zimmerman, A. Roberge (NASA GSFC)

One direct image can
constrain the semi-major axis
of a planet



A single direct image provides the projected separation (r_{proj}) between the planet and the host star

Single Epoch Results

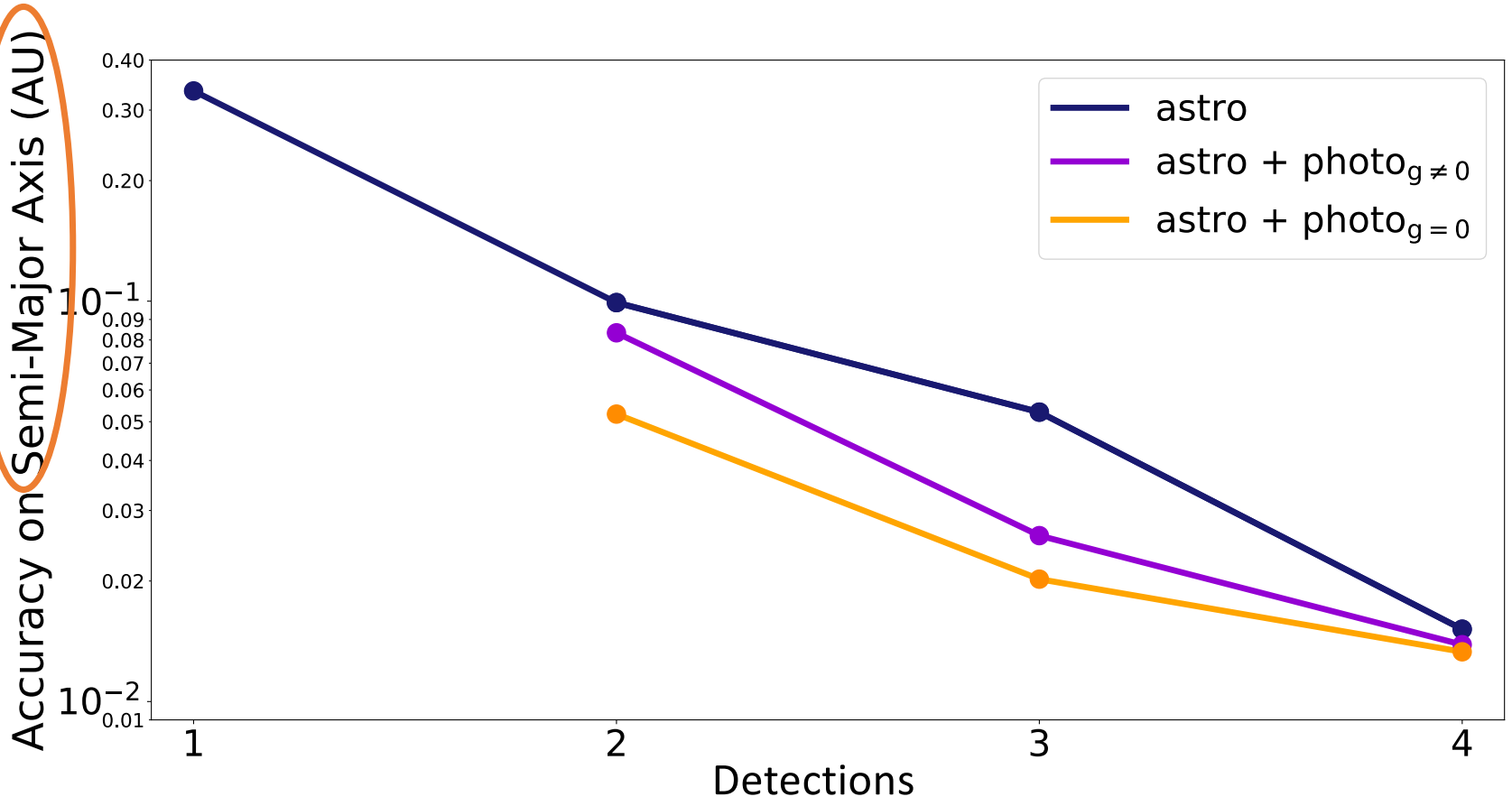


Photometry improves the accuracy and efficiency of orbit retrieval

Multi Epoch Results

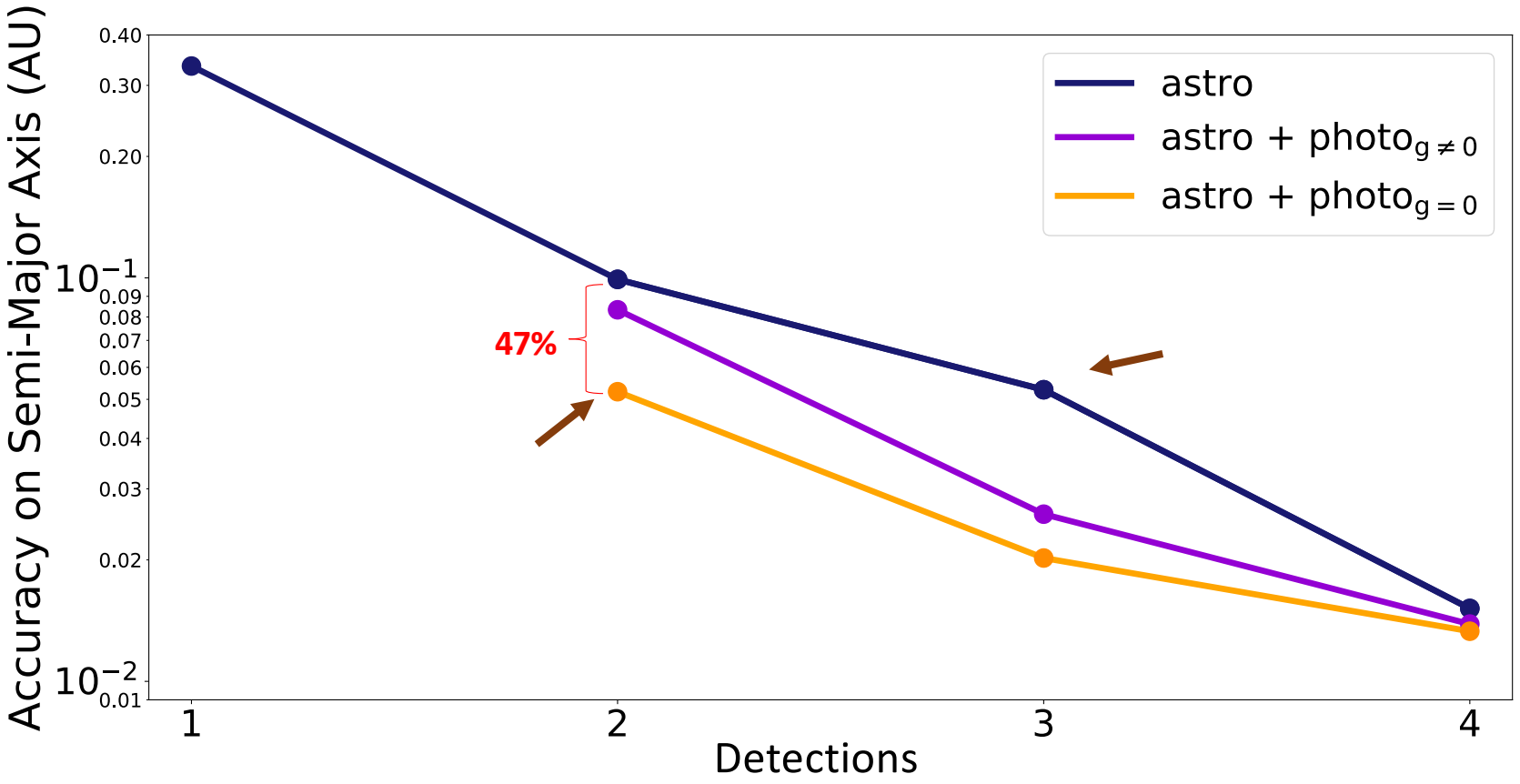
$stand.dev.(a_{true} - a_{retrieved})$

Bruna et al. (2023)



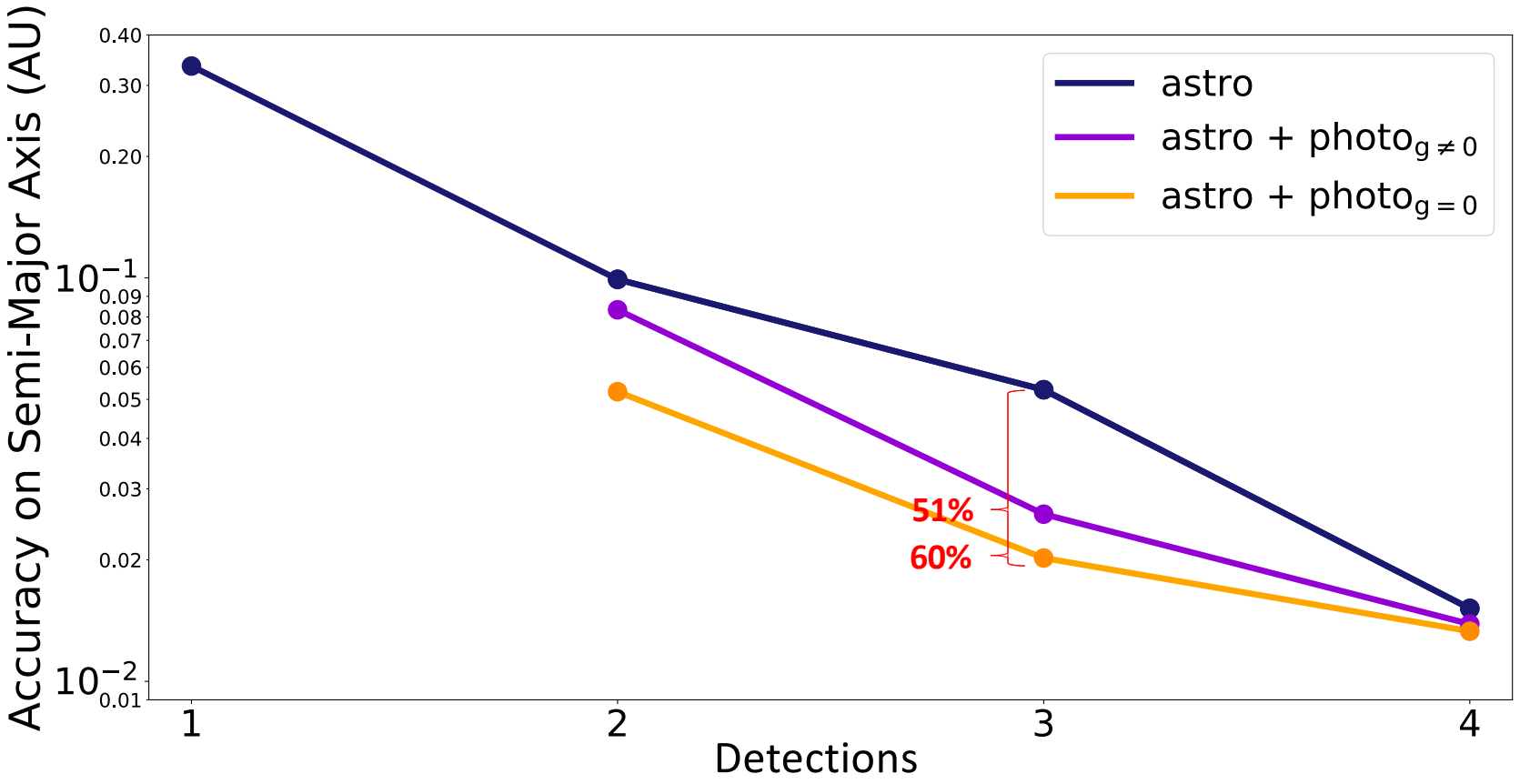
Multi Epoch Results

Bruna et al. (2023)

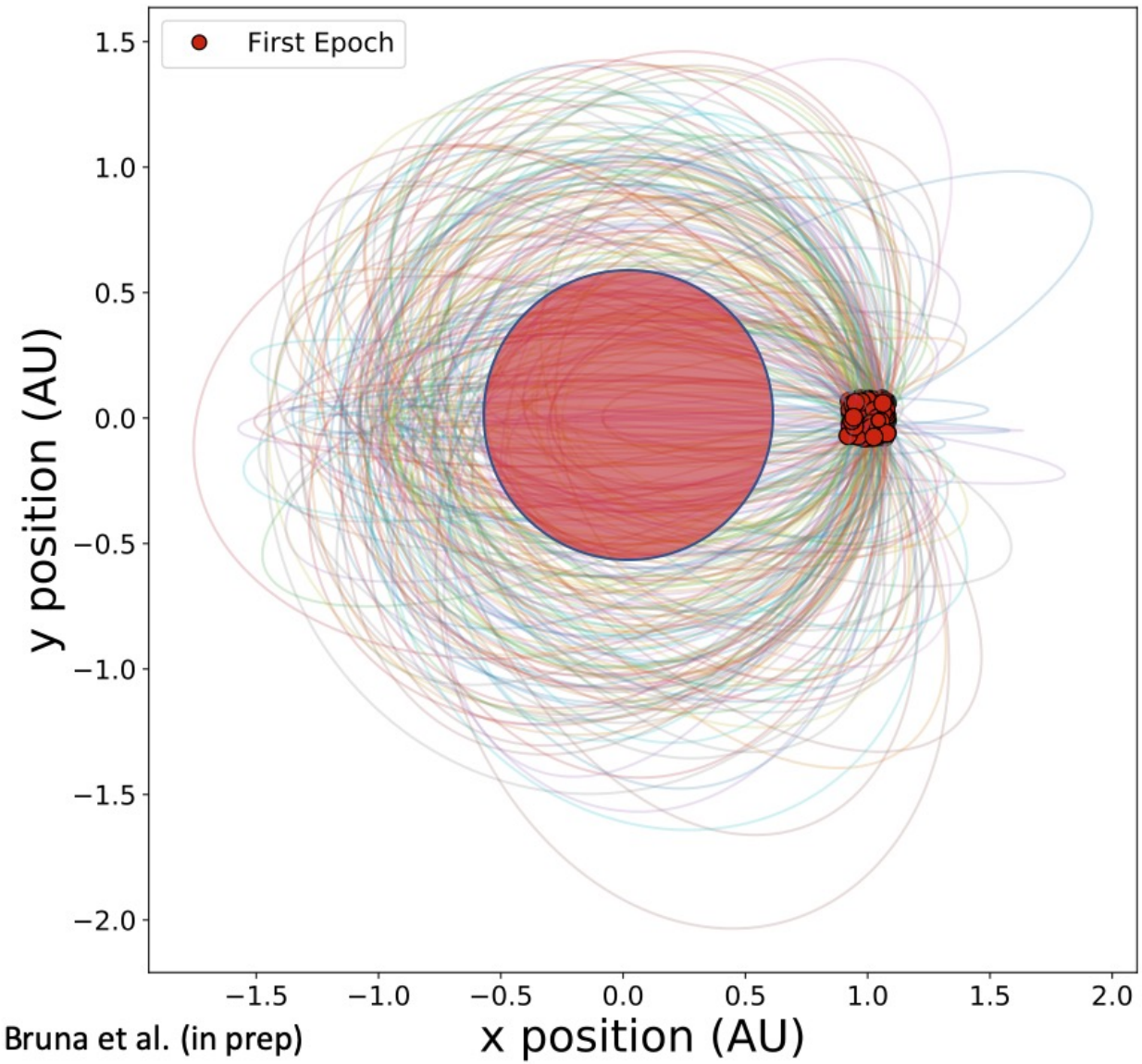


Multi Epoch Results

Bruna et al. (2023)



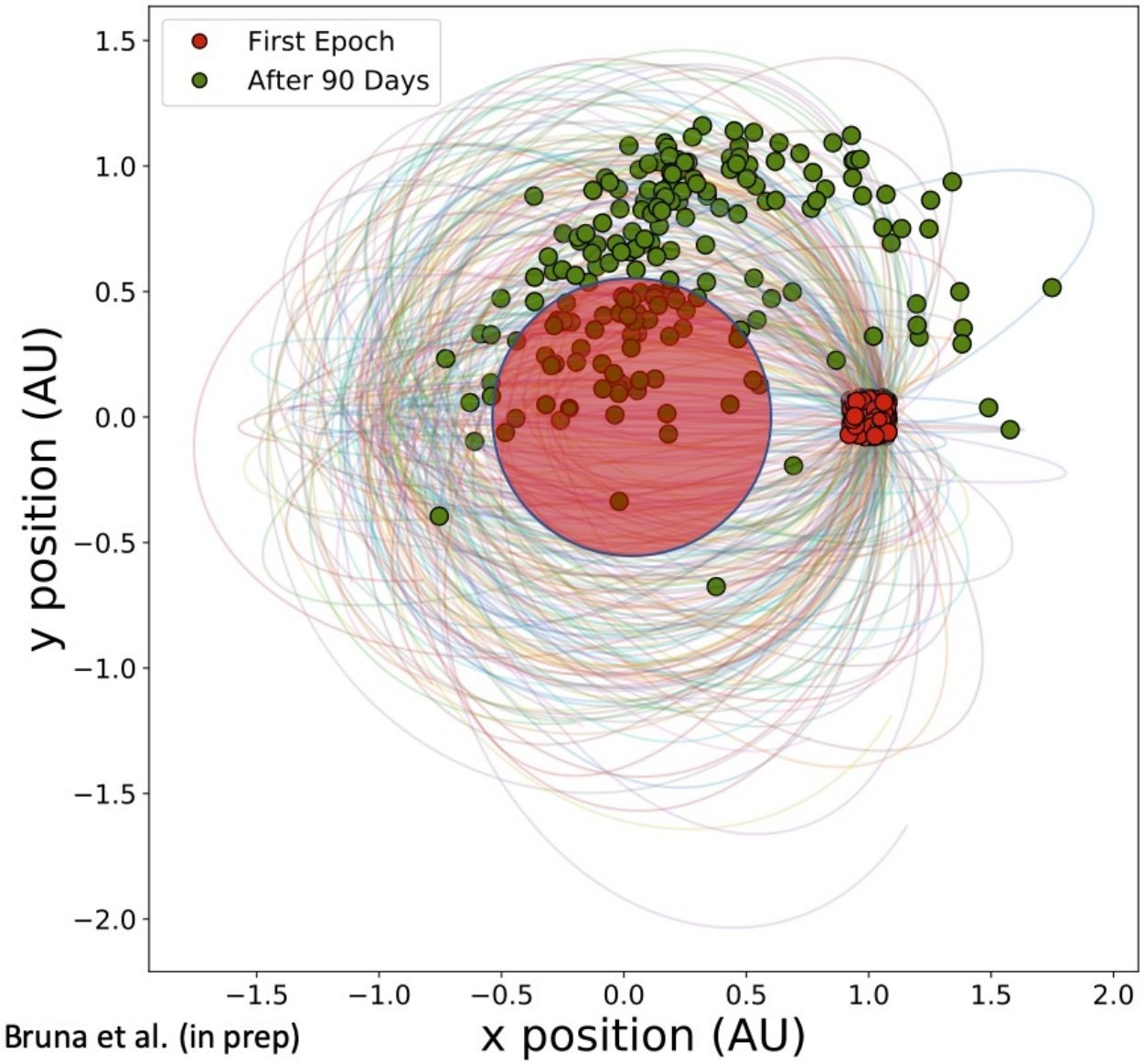
When is the best time to re-image a planet after an initial detection?



First detection of planet constrains *a* (and *P*), so **when to schedule 2nd epoch?**

Hypothesis: Optimal 2nd epoch maximizes the variance between possible orbits…

…while also maximizing odds of detecting the planet

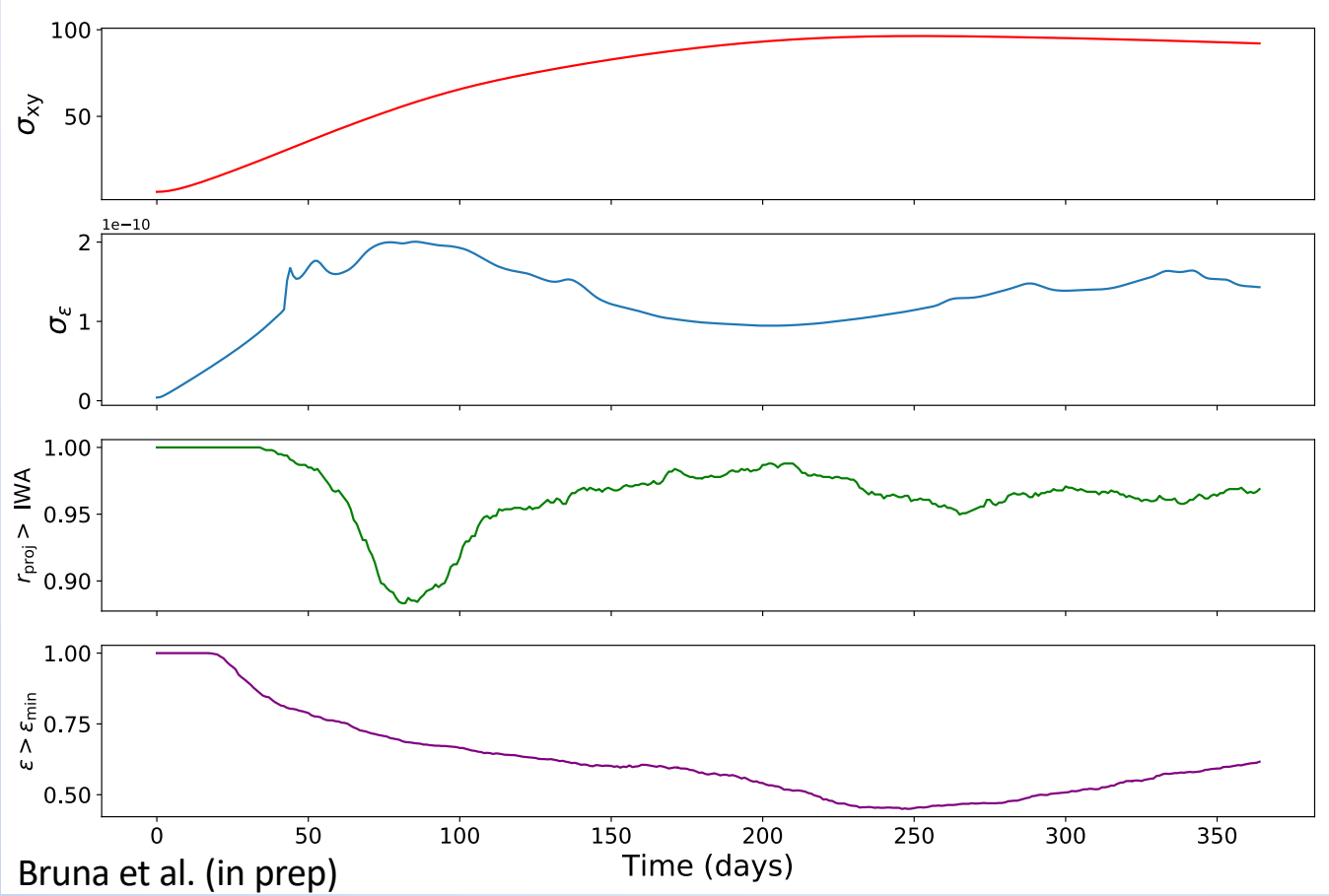


Bruna et al. (in prep)

Non-detections are a challenge…

- Planet can be within IWA
- Planet can be too dim

Optimal Cadence Prediction



Bruna et al. (in prep)

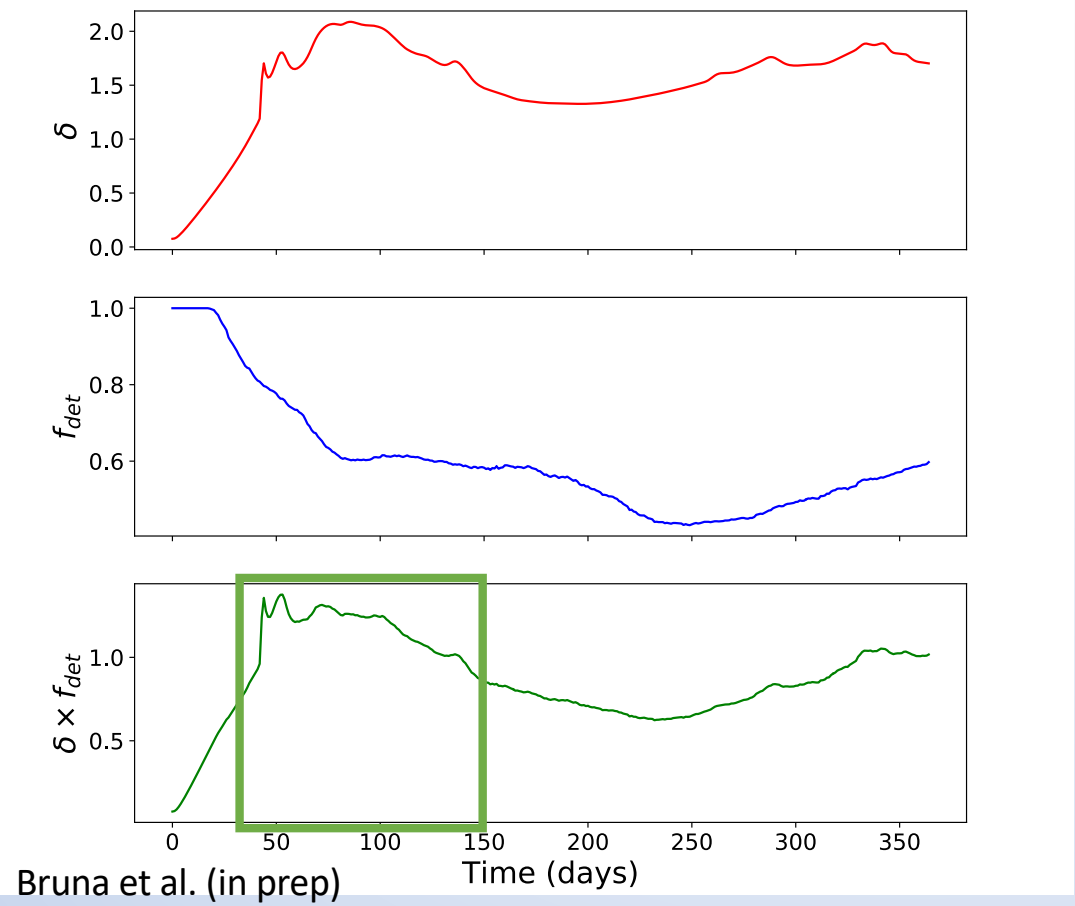
Variance in Sky-Projected Position

Variance in Planet/Star Flux Ratio

Obscuration by Coronagraph

Below Faintness Limit

Optimal Cadence Prediction



Bruna et al. (in prep)

Variance in (x,y,ε) increases sharply, then plateaus

Detection probability drops with time due to faintness and obscuration

Determine if this is actually optimal

Main points:

1. One direct image can reasonably constrain a planet's semi-major axis

2. Photometry (when combined with astrometry) improves the accuracy and efficiency of orbit retrieval

3. We have started to determine when is the best time to re-image a planet after an initial detection

Thank you!

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