Science with NEID Guaranteed Time Observations

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NEID (noo-id) is a stable spectrograph designed for extremely precise radial velocity work for exoplanet detection and orbital characterization. It will be a queue-scheduled, facility instrument on the WIYN 3.5m telescope at Kitt Peak National Observatory, available for TESS follow-up to the public through the NN-EXPLORE program in 2019B.

NEID capabilities

The NEID instrument team has 30 nights per year for 5 years of Guaranteed Time Observations. GTO targets are not proprietary, but most targets and an outline of the program will be described in advance, and the NN-EXPLORE TAC will consider the effects of target duplication across all NEID programs when evaluating guest observer (GO) NEID proposals.

NEID has an instrumental stability goal of below 30 cm/s, significantly below the astrophysical noise.

Mitigating stellar noise requires large numbers of observations at the highest possible RV precision, so we will pursue an unprecedented combination of:

**precision × cadence × duration × # of targets**

Most targets will be bright (V<7) and nearby, many being RV “classics” with many dozens of archival RV observations made over decades from Lick 3m, APF, Keck, HET, ELODIE, CORALIE, HARPS, and other instruments.

Science Goals

**Nearby Habitable Zone Terrestrial Planets:** For GK stars these will require hundreds of observations over many years with careful stellar noise mitigation. Most targets will have RV “histories” so we can focus on stars with apparently empty Habitable Zones

**Future Direct Imaging Targets:** We will favor nearby stars whose RV planets have the widest angular separation

**Controversial and Low-Amplitude Planets:** The unprecedented precision of NEID will allow us to confirm and improve the ephemerides of important and controversial low-amplitude planets.

**Targets of Opportunity:** The queue of NEID will allow us to quickly pursue science on important planets discovered by TESS

P-mode oscillations

- Below 1 m/s, many stars exhibit noise from p-mode oscillations that interfere with precise radial velocimetry.
- By choosing exposure times equal to an integer number of p-modes, we ensure that this contribution is minimized.

![P-mode-limited exposure times for some typical potential GTO targets](image)

Estimated exposure times for some potential GTO targets. Calculation is for longer of time to integrate over integer numbers of p-modes or to achieve 30 cm/s of shot noise. Vertical lines indicate where obtaining 50 observations per year of all stars to the left consume a given fraction of GTO time.