Architecture, Algorithms, and Performance of the NEID Data Reduction Pipeline Abstract

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The NEID spectrometer operates every day at the WIYN 3.5m telescope on Kitt Peak, capturing data sets consisting of standardized calibrations, queue driven night-time on-sky exposures, and regular day time solar telescope exposures. These data are automatically transferred to the NASA Exoplanet Science Center, processed using the fully automatic NEID Data Reduction Pipeline, and ingested into a public facing archive and database. Data and derived products from GO programs are released within 24 hours to program PIs, and to the general community following a proprietary period; data from calibrations and the solar telescope are released immediately with no proprietary period. The data pipeline was written in Python by the NEID software team, and is capable of converting, without human interaction, nearly any raw data product obtained by NEID into a uniformly extracted, wavelength calibrated product. Stellar and solar observations are automatically further analyzed to produce standard radial velocity and stellar activity measurements, as well as telluric and sky spectrum models. Pipeline RVs include noise from the instrument, photons, stellar activity, and pipeline algorithms; observations of several standard stars with rollup RMS of < 50 cm/s were used to demonstrate that NEID achieves its instrumental precision goals of ~30 cm/s. Pipeline automation is facilitated by strict requirements on data formatting, standardization of calibration sequences, and the highly predictable nature of the stabilized spectrometer hardware. I will describe our pipeline architecture, algorithms, and performance, and discuss some of the decisions we made to facilitate a pipeline that can operate in a fully automated mode. We hope that lessons learned from the NEID pipeline development can be leveraged in future EPRV pipelines.