Breathing New Life Into An Old Pipeline: Precision Radial Velocity Spectra of TESS Exoplanet Candidates

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Abstract.

The High Resolution Echelle Spectrograph (HIRES) at the W.M. Keck Observatory (WMKO) is one of the most effective Precision Radial Velocity (PRV) machines available to U.S. astronomers, and will play a major role in radial-velocity follow-up observations of the tens of thousands of exoplanets expected to be discovered by the Transiting Exoplanet Sky Survey (TESS) mission. To support this community effort, the California Planet Search (CPS) team (Andrew Howard, PI) has made available a PRV reduction pipeline that will be available to all U.S. astronomers from February 2019 onwards. Operation of the pipeline has strict requirements on the manner in which observations are acquired, and these will be fully documented for users at the telescope.

The pipeline is written in IDL, and was developed over time for internal use by the CPS team in their local processing environment. Development of a modern version of this pipeline in Python is outside the scope of our resources, but it has been updated to support processing in a generic operations environment (e.g. changes to support multiple simultaneous users) We have developed a modern, Python interface to this updated pipeline, which will be accessible as a remote service hosted behind a firewall at the NASA Exoplanet Science Institute (NExScI). Users will be able to use Python clients to access data for input to the pipeline through the Keck Observatory Archive (KOA). The pipeline which will create calibrated and extracted 1D spectra and publication-ready time series, which can be visualized and analyzed on the client side using tools already available in Python. The Python client functions interface with the pipeline through a series of server-side web services. Users will have access to a workspace that will store reduced data and will remain active for the lifetime of the project. This design supports both reduction of data from a single night or long-term orbital monitoring campaigns.

The service is on-schedule for deployment in December 2018.

This project is a collaboration between NExScI, WMKO, KOA and CPS.

1. Introduction

What Is the Old Pipeline? An IDL Precision Radial Velocity (PRV) pipeline developed by the California Planet Survey (CPS). It has been developed and maintained since

1987 to support exoplanet PRV spectroscopy with Keck/HIRES instrument. The CPS has generously donated this pipeline as a public service to enable mass determination of the thousands of exoplanets cexpected to be discovered by TESS. The CPS has determined pipeline will not be released with an Open Source license, for several reasons: it requires IDL license; it is sensitive to IDL version and machine architecture; the project needs to build a persistent database of reference stars for wavelength calibration. The pipeline will be made available to Keck PIs starting in February 2019. It will process data acquired with the HIRES instrument in a prescribed fashion, fully documented at the Observatory. The raw data will be archived at the Keck Observatory Archive (KOA) in the same fashion as all ither data acquired at Keck. Support for PRV data previously acquired with HIRES is anticipated to be offered in Fall 2019.

2. Architecture

There were too few resources to rewrite the IDL code in Python, and the code cannot in any case be released as Open Source. Thus the code will operate on a remote server, and users have secure access to it through Python and CGI scripts. We have modified the IDL code to run in this operational environment. The server side archictecture is shown on thr the right hand side of Fig 1. Users are allocated a permanent (for the lifetime of the project) workspace to store data processed by the pipeline. fThe pipeline is seamleslsly interoperable with KOA: once users acess the pipeline, raw data for the program to be processed are automatically transferred to the workspace and reduced to spectra for each order. Users then invoke, and control, the creation of radial velocity calculations. User access, summarized on the right hand side of Fig 1 and presented in more detail in Figure 2 consist of Pythn and CGI scripts that provide log-on access with credentials issued by KOA, and automatic data reduction of raw datainvoking the creations

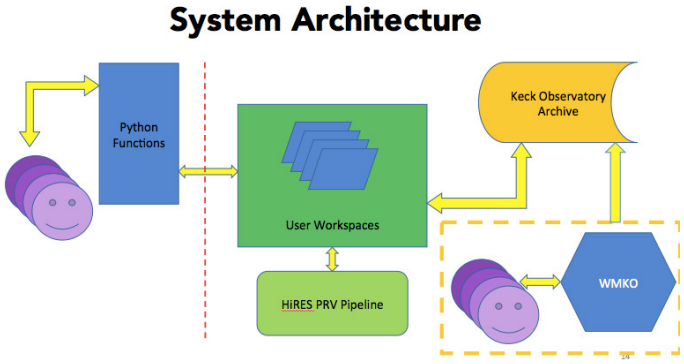

Figure 1. Block diagram of architecture

3. Performance and Architecture

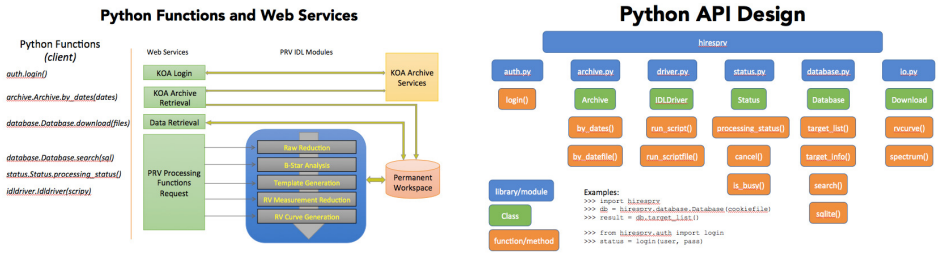

Figure 2. Performance

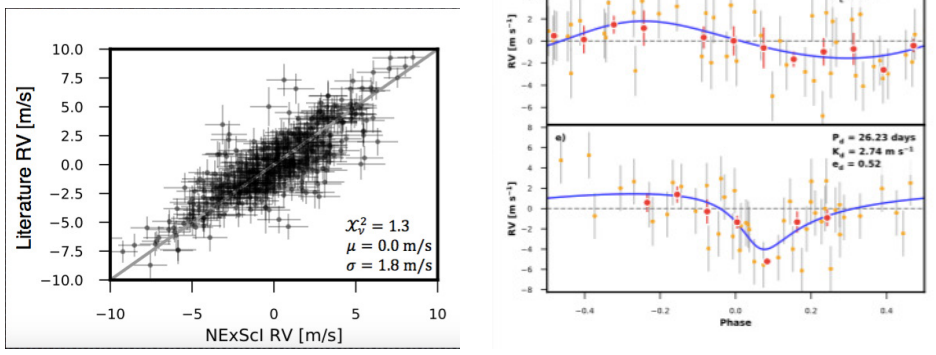

Figure 3. Performance

Acknowledgments. The PRV pipeline is a collaboration between the NASA Exoplanet Science Institute, the Keck Observatory Archive, the California Planet Survey and the W. M. Keck Observatory.