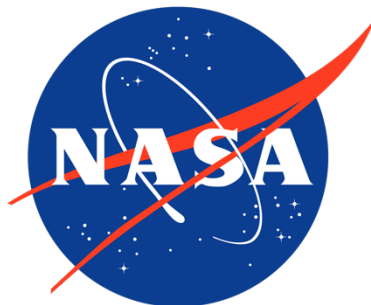# Using the NEID Precision Radial Velocity Spectrograph

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NEID: The Basics

Extreme Precision Radial Velocity Spectrometer on WIYN 3.5m Telescope

Waveband & Resolution: 380 – 930 nm, complete coverage, R ~ 110K in HR mode

Precision: <30 cm/s (single measurement precision)

Available to the Public via NN-EXPLORE **and WIYN Partners** through institutional time

NEID Solar Feed takes ~300 solar spectra every clear day; data made public immediately upon reduction
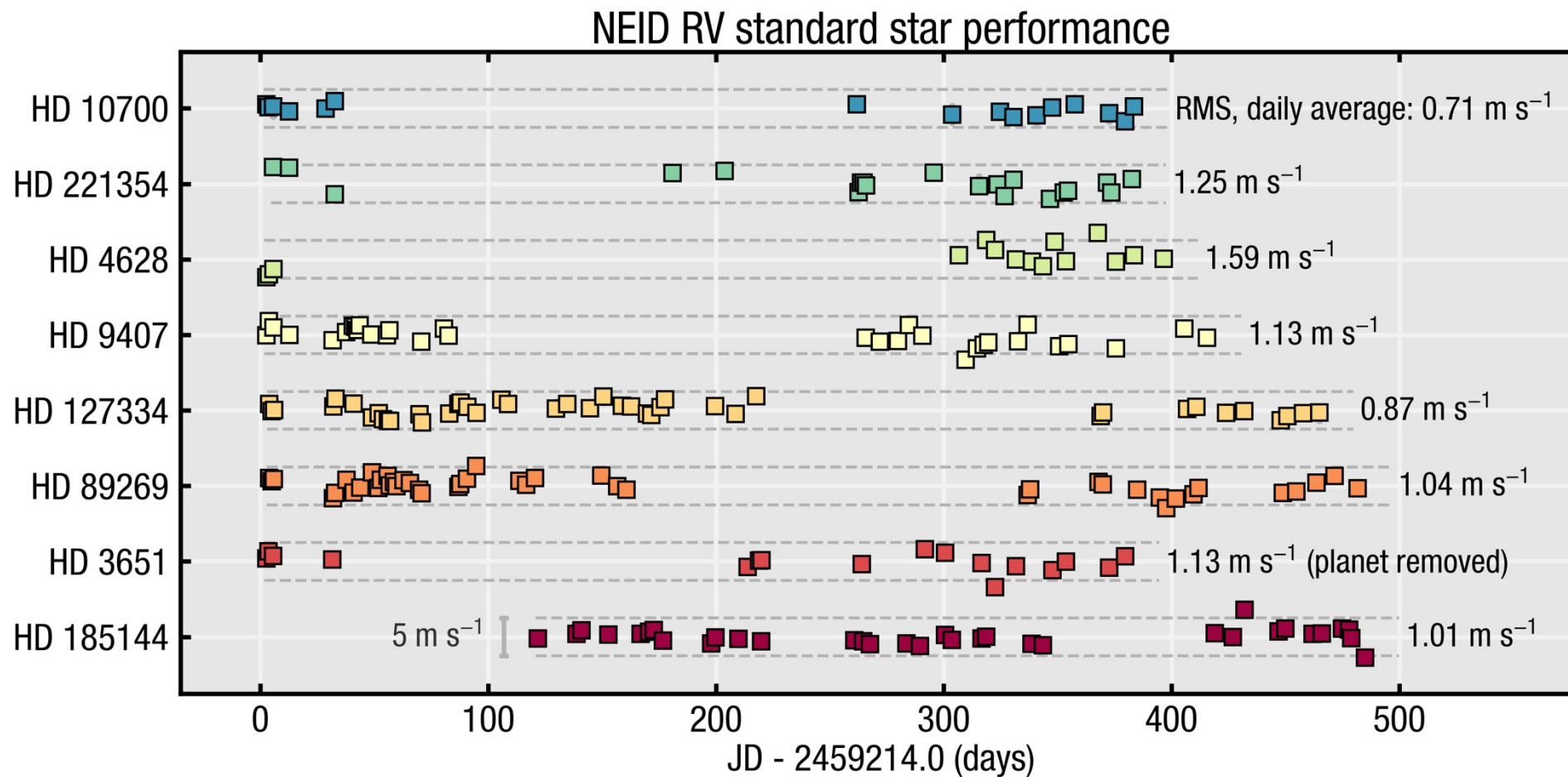

Dec. 13, 2019. NEID First Light: 51 Pegasi

Calibration

51 Peg

930nm   Wavelength   380nm
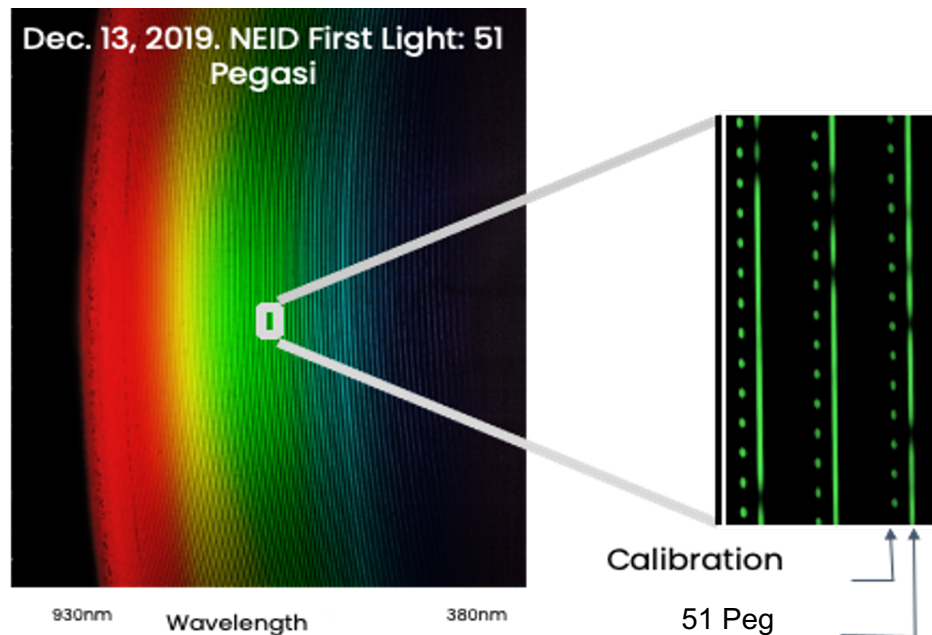
Credit: NEID team; Guðmundur Stefánsson

Solar Telescope

Periheliometer (aka "cloud measurer")

On-Sky Performance

NEID RV standard star performance

Credit: NEID team; Sam Halverson (JPL) and Chad Bender (UArizona)

Example NEID Science Cases
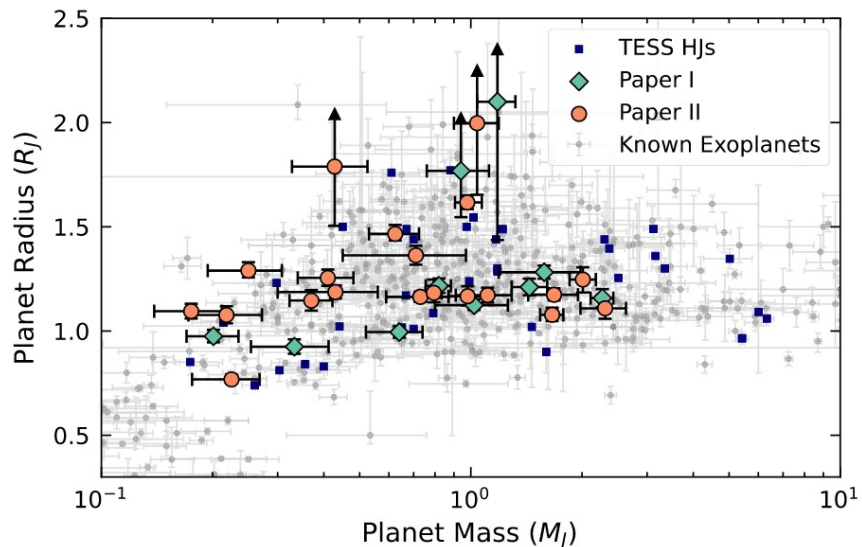
Building a statistical sample of hot Jupiters around FGK Stars

As expected, NEID is working to help confirm and characterize TESS-discovered massive planets around FGK stars. **Yee et al. 2022, 2023** confirmed 30 new hot Jupiters, 10 of which used NEID data in the analysis.

NEID users are using the **Rossiter-McLaughlin effect** to probe a broader planet parameter space than previous generations of instruments – larger orbital separations and smaller planets – **to answer broader questions of planet formation and evolution.**

GJ 3470b (Stefansson et al. 2022)
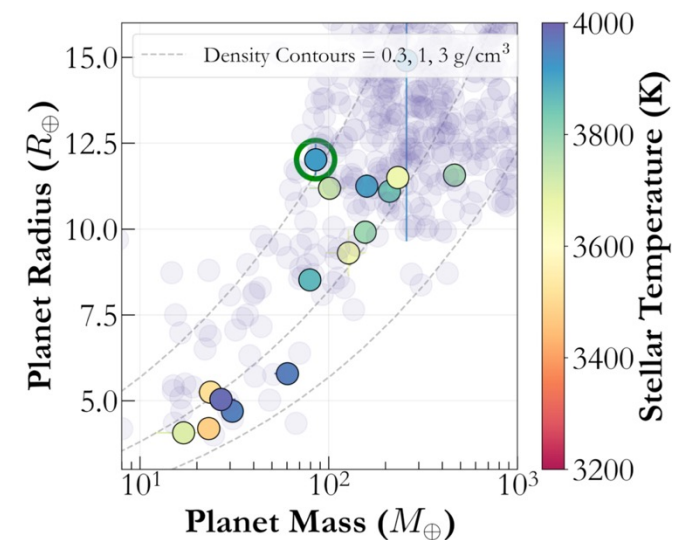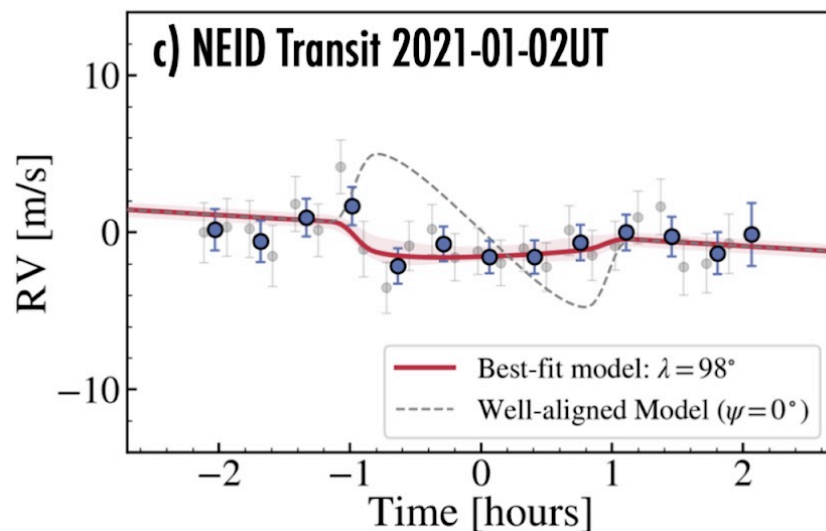
Measuring masses of giant (and not so giant) planets around M dwarfs

Kanodia et al. 2022 discovered TOI 3757b – the lowest density transiting gas giant planet around an M dwarf known to date. NEID results from this work and others have contributed to the characterization of targets that are scheduled to be followed-up with JWST in Cycle 2 for atmospheric characterization.

What should I consider when proposing to use NEID?

NEID: Choosing a Spectral Resolution

- **High Resolution** or **HR** mode (R~110,000)
  - ~0.92'' fiber
  - Highest precision RVs on bright targets (V<12, e.g. TESS)
  - Allows for simultaneous calibrations
    - Specified at Phase 2
    - Requires OD filter selection to balance etalon and science light on the detector

- **High Efficiency** or **HE** mode (R~70,000)
  - ~1.5'' fiber
  - Faint targets (12<V<16)
  - Poor weather
  - No simultaneous calibrations

Credit: Roy et al. (2020)

HR Fiber core

HR Fiber cladding
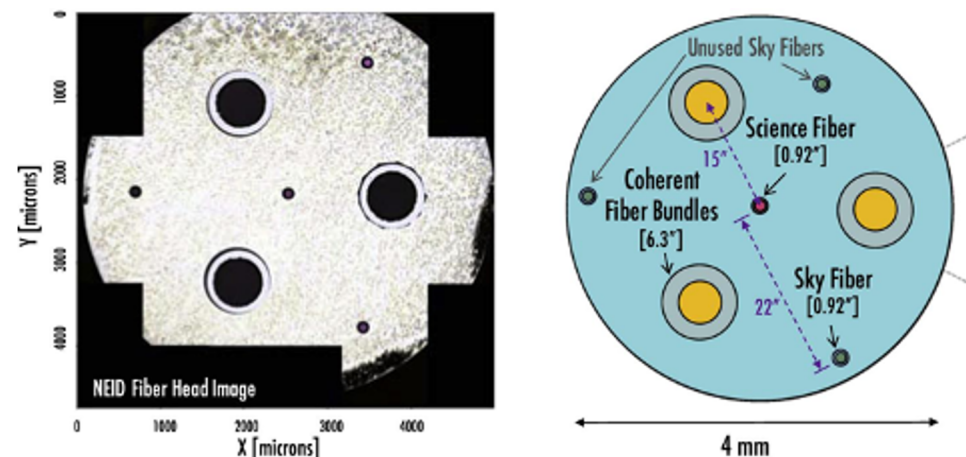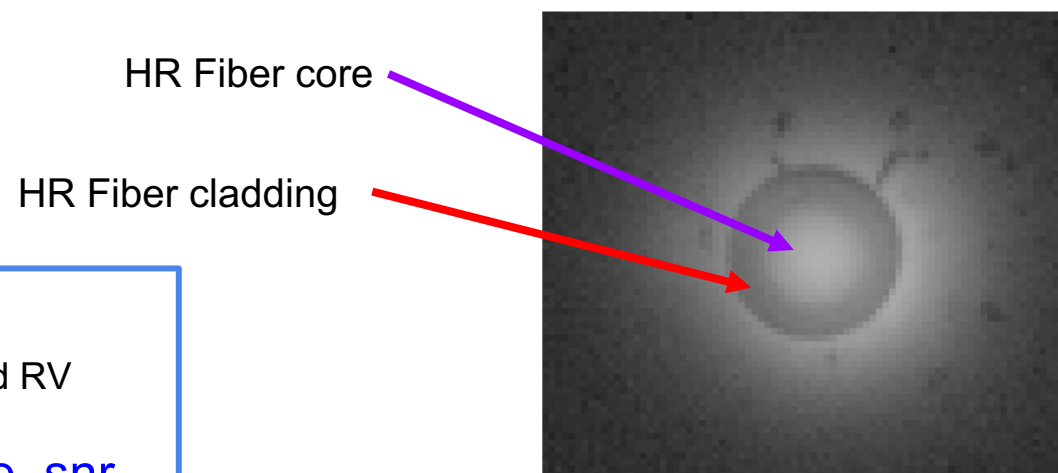
Exposure Time Calculator:
Allows proposers to estimate exposure times, SNRs, and expected RV precision assumes HR mode--
http://neid-etc.tuc.noirlab.edu/calc_shell/calculate_snr

NEID Calibrations

Standard Calibrations (not charged to PIs):

- *Daily:* Morning/afternoon cals -- darks, flats, wavelength calibrators (i.e. arc lamps, fabry-perot etalon, laser frequency comb)
- *Every NEID night:*
  - 1-2 RV standards (List at https://www.wiyn.org/Instruments/wiynneid_observers.html)
  - 25 - minute intermediate cals near midnight
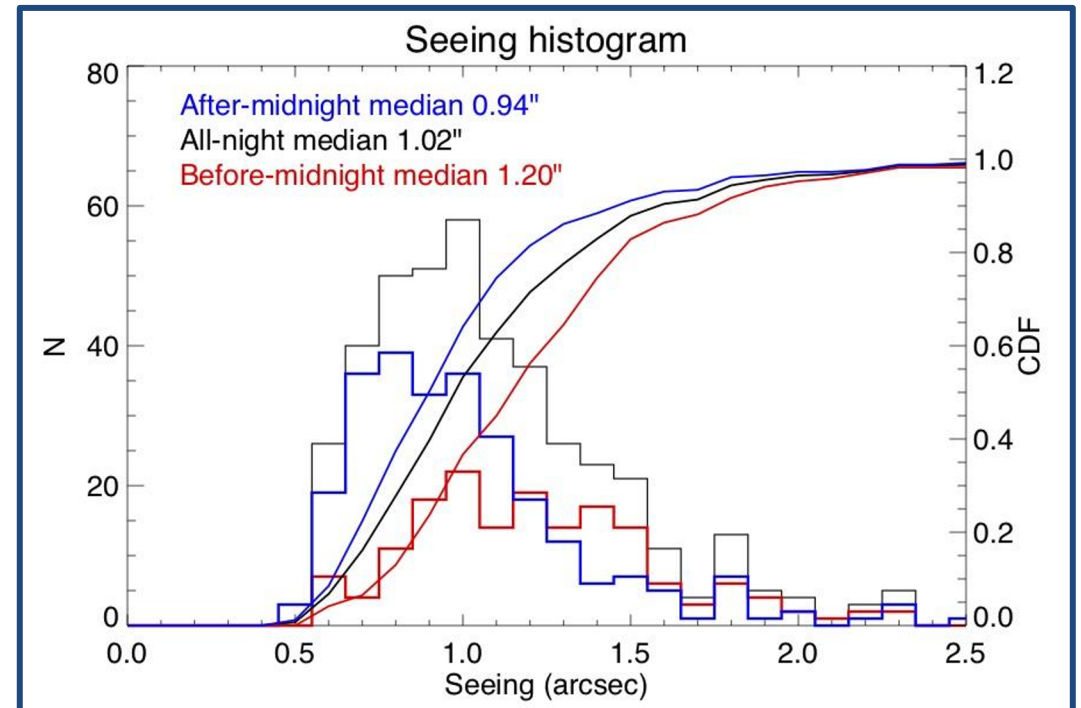 - 1-2 "bracketing" etalon exposures between each target

Other calibrations are considered specialty calibrations and should be requested in your proposal (including spectrophotometric standards). They will be charged to your program.

Basic observational considerations @ WIYN

- **Elevation limit:** 15 deg (note: no requirement on NEID ADC performance below 19 deg)
- **"Cone of Avoidance:"** Cannot track a star within ~3 deg of zenith
- **Seeing:**

Seeing measured with NEID from Dec '20-March '21

Seeing histogram

After-midnight median 0.94"
All-night median 1.02"
Before-midnight median 1.20"

Observing in Queue: How to choose observing priorities

P0 - Highly time sensitive observations
- *e.g. transits such as R-M observations*

P1 - Moderately time sensitive observations
- *e.g. quadrature, periastron, small number of observations evenly spaced in orbital phase; transits such as R-M observations*

P2 - Lowest priority for programs needing a high completion rate

P3 - Programs that can be executed during sub-optimal conditions
- *e.g. non-time sensitive observations, programs not needing a high completion rate*

P4 - Programs that can be executed in poor conditions
- *e.g. bright targets needing single visits, low-RV precision targets*

Each partner receives *a portion of time* at each priority level:

  P0 = 8%, P1 = 17%, P2 = 25%, P3 = 25%, P4 = 50%

The NEID proposal process happens in phases.

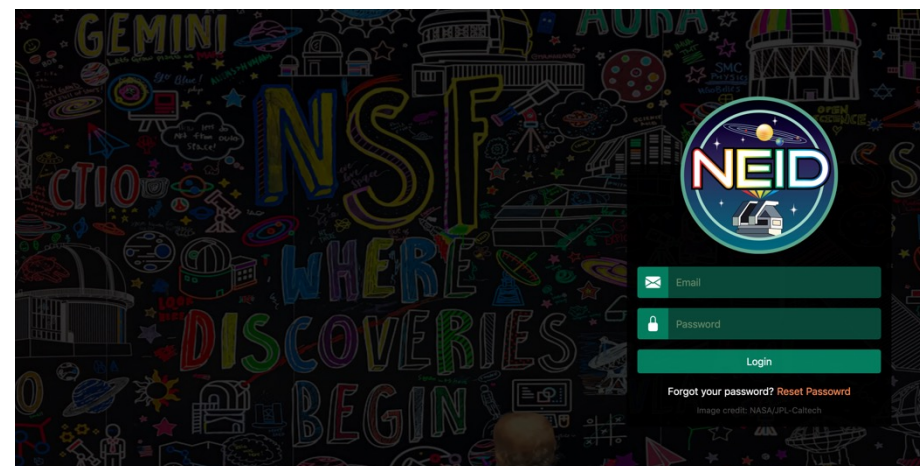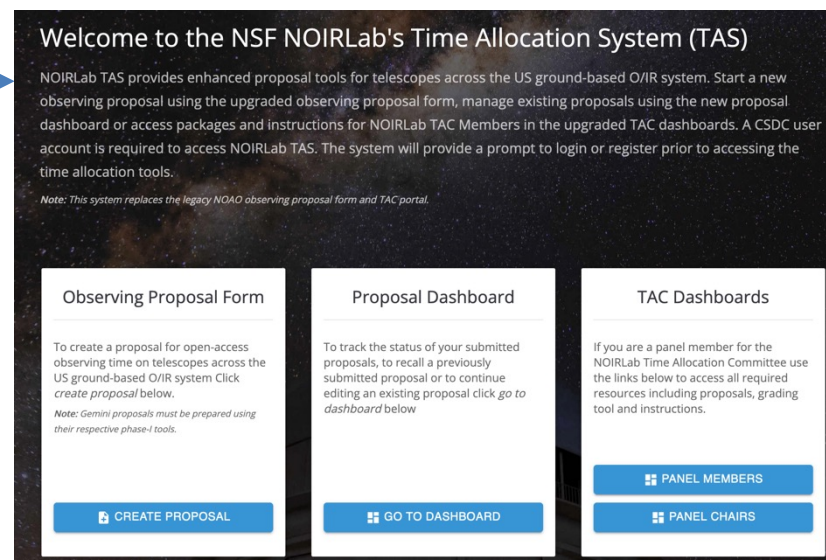**Phase 1:** Typical NOIRLab proposal process

Phase 2: For accepted programs -- PIs input target and observation details to the NEID Queue web portal
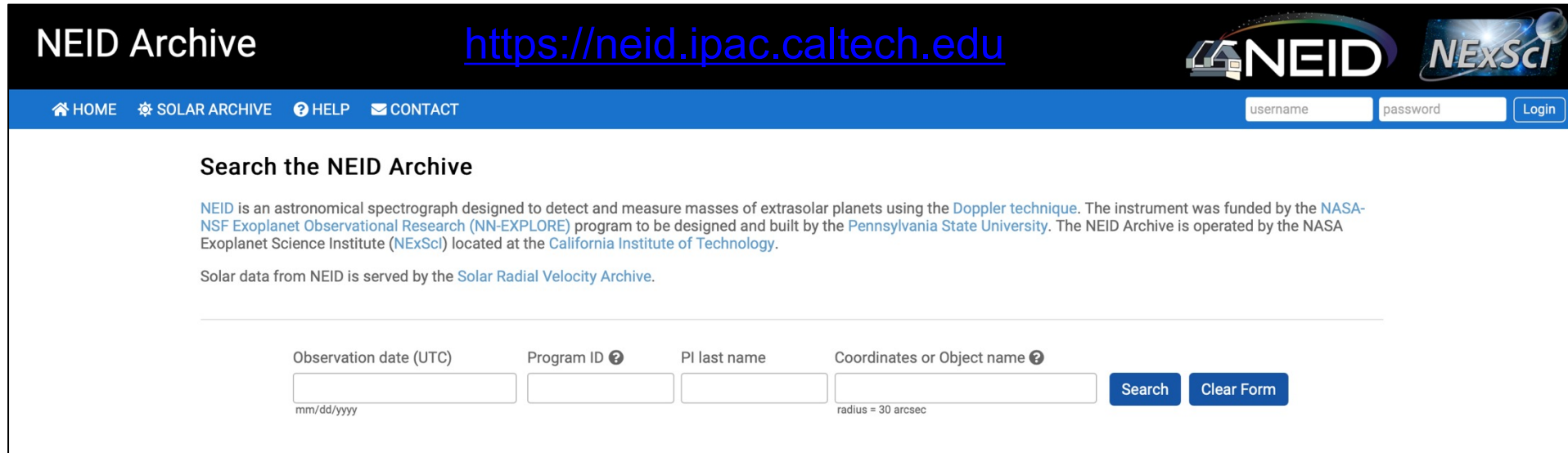
Phase 3: (optional) PIs may change observing parameters or request new targets during the semester

Note: The more technical information you can provide in Phase 1 (e.g. targets and specific timing windows) and Phase 2 (e.g. observing constraints and finding charts) the better.

Raw and reduced data (including solar) available via NExScI NEID archive website or Python API

Website provides:
- Simple search boxes
- Tables are sortable and filterable
- Download one file at a time or an auto-generated wget script
- Interactive plots of segment of spectrum and RVs

Slide modified from original, credit: BJ Fulton

Important Dates and Notes for 23B

Semester 24A: 1 February- 31 July 2024

NOIRLab proposal deadline expected **2 October 2023** at 11:59 pm (MST)
Proposal call will be released 1st September and can be found here:
https://noirlab.edu/science/observing-noirlab/proposals

Long Term Proposals: NEID will be available for long-term program proposals (2-4 semesters) via NN-EXPLORE time. Details will be available in the proposal call.

Time Available in 24A
- ~40 nights for NOIRLab/NN-EXPLORE time (subject to change)
  - Includes all instruments (*NEID, NESSI, Hydra, IFUs, ODI, WHIRC*).
  - Note that NEID nights are assumed to be 9 hrs; all other instruments are assumed to be 10 hrs.
- University allocations are still TBD

For questions, please e-mail: neid_info@noirlab.edu