



Promises, Promises

Radial Velocity in the Era of Extreme Precisions

Arpita Roy

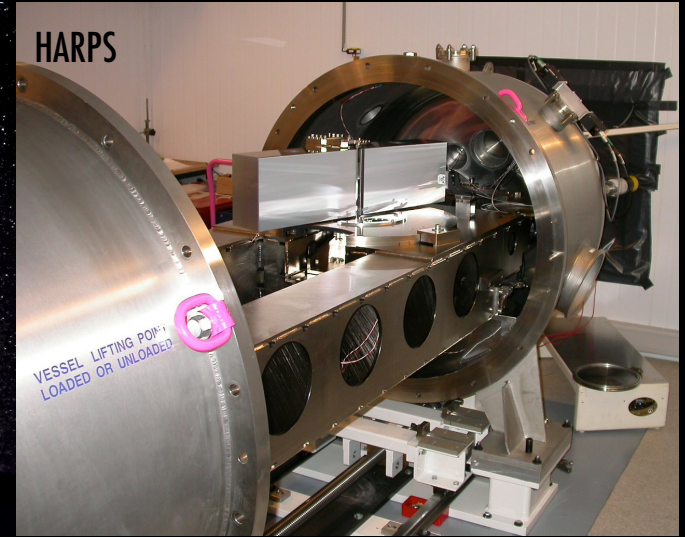


Robert A. Millikan Prize Postdoctoral Fellow
California Institute of Technology

La Silla 3.6m Telescope



HARPS

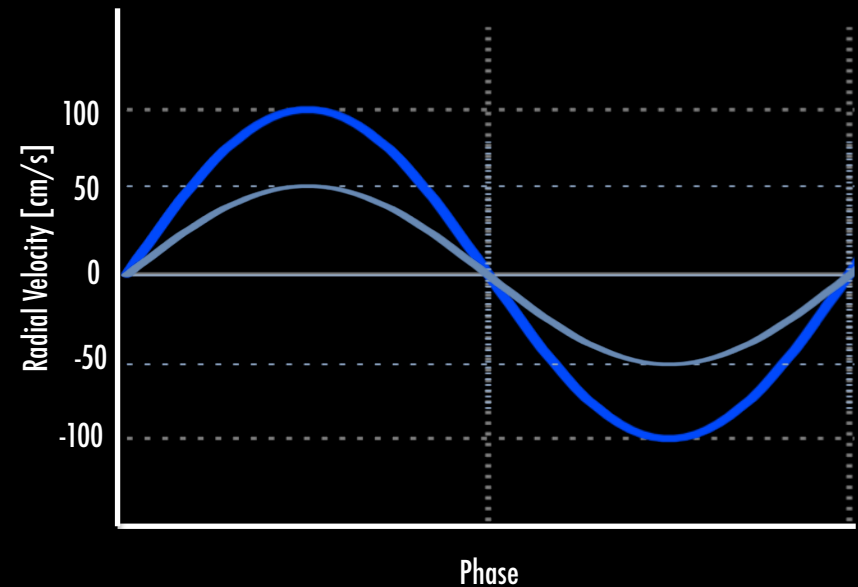
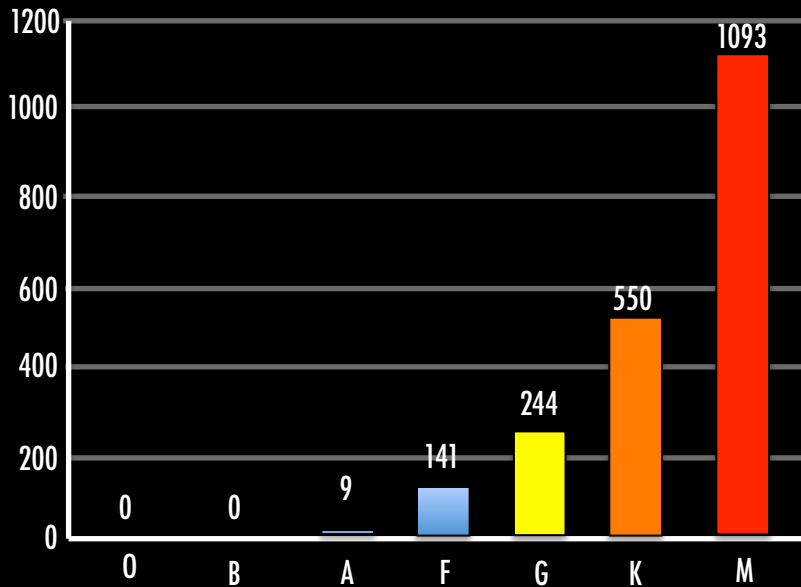
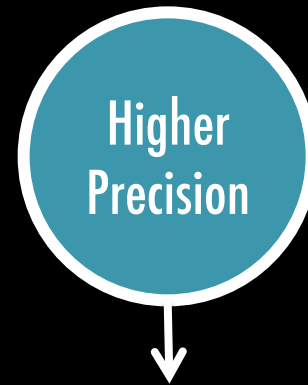


The study of exoplanets, more than any other field of astrophysics, has grown in direct consonance with new instrumentation.

It is now time to define the direction we need to take for the next generation of ground-based instruments for precision spectroscopy.

Two Paths to Finding Earth-like Planets

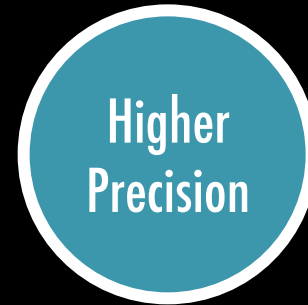
Going **Redder** or **Getting Better**



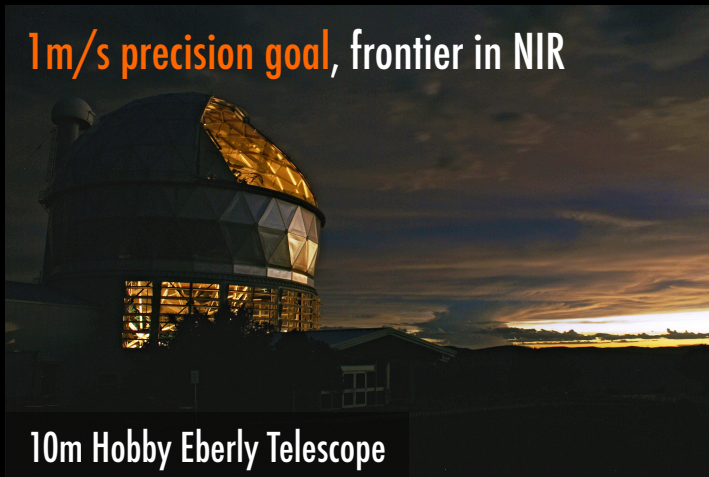
Distribution of stellar spectral types within 25 pc. Over 50% of nearby stars are M dwarfs. [RECONS]

Two Paths to Finding Earth-like Planets

Going **Redder** or **Getting Better**

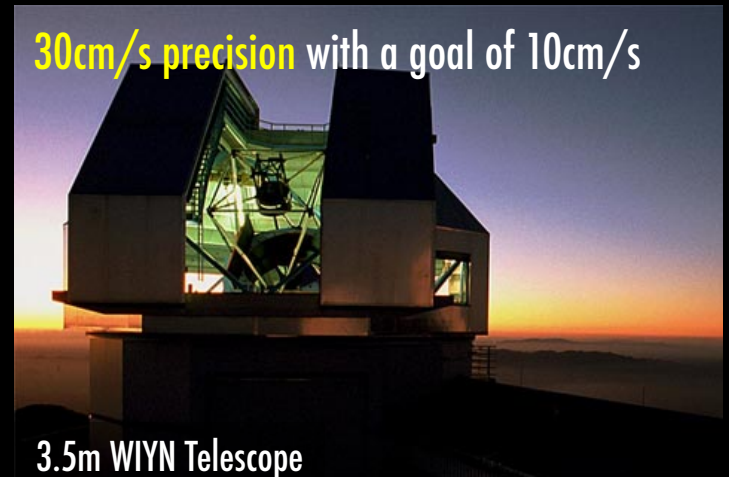


1m/s precision goal, frontier in NIR



10m Hobby Eberly Telescope

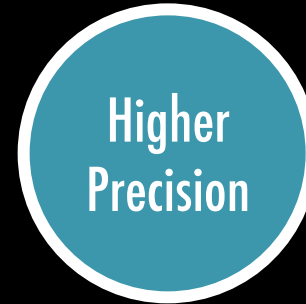
30cm/s precision with a goal of 10cm/s



3.5m WIYN Telescope

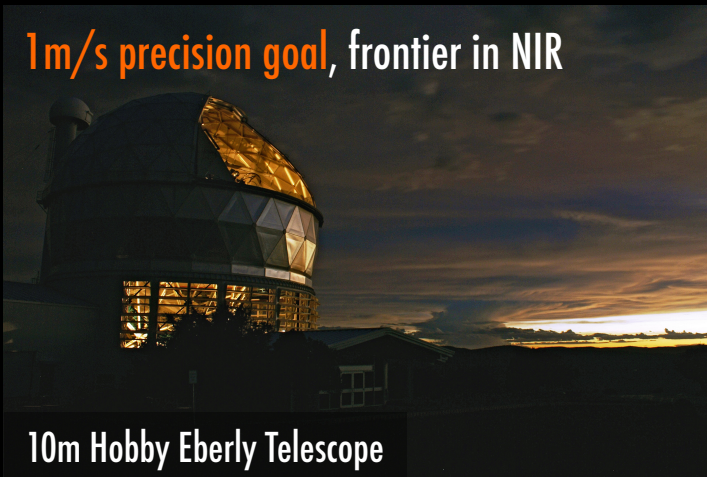
Two Paths to Finding Earth-like Planets

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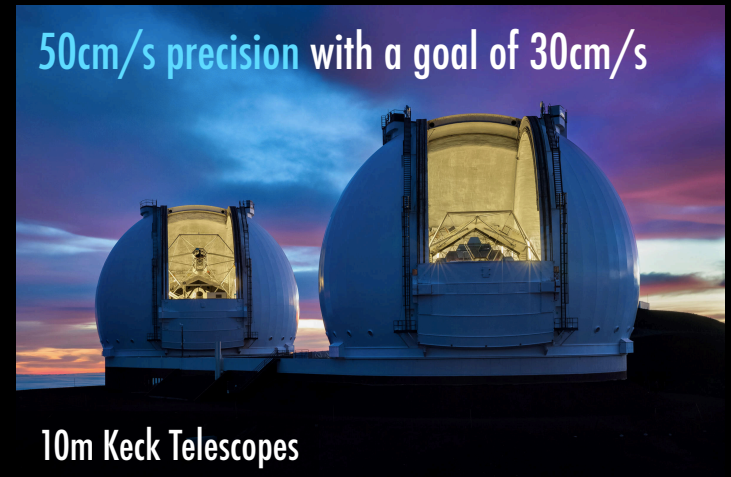


Keck Planet Finder

1m/s precision goal, frontier in NIR

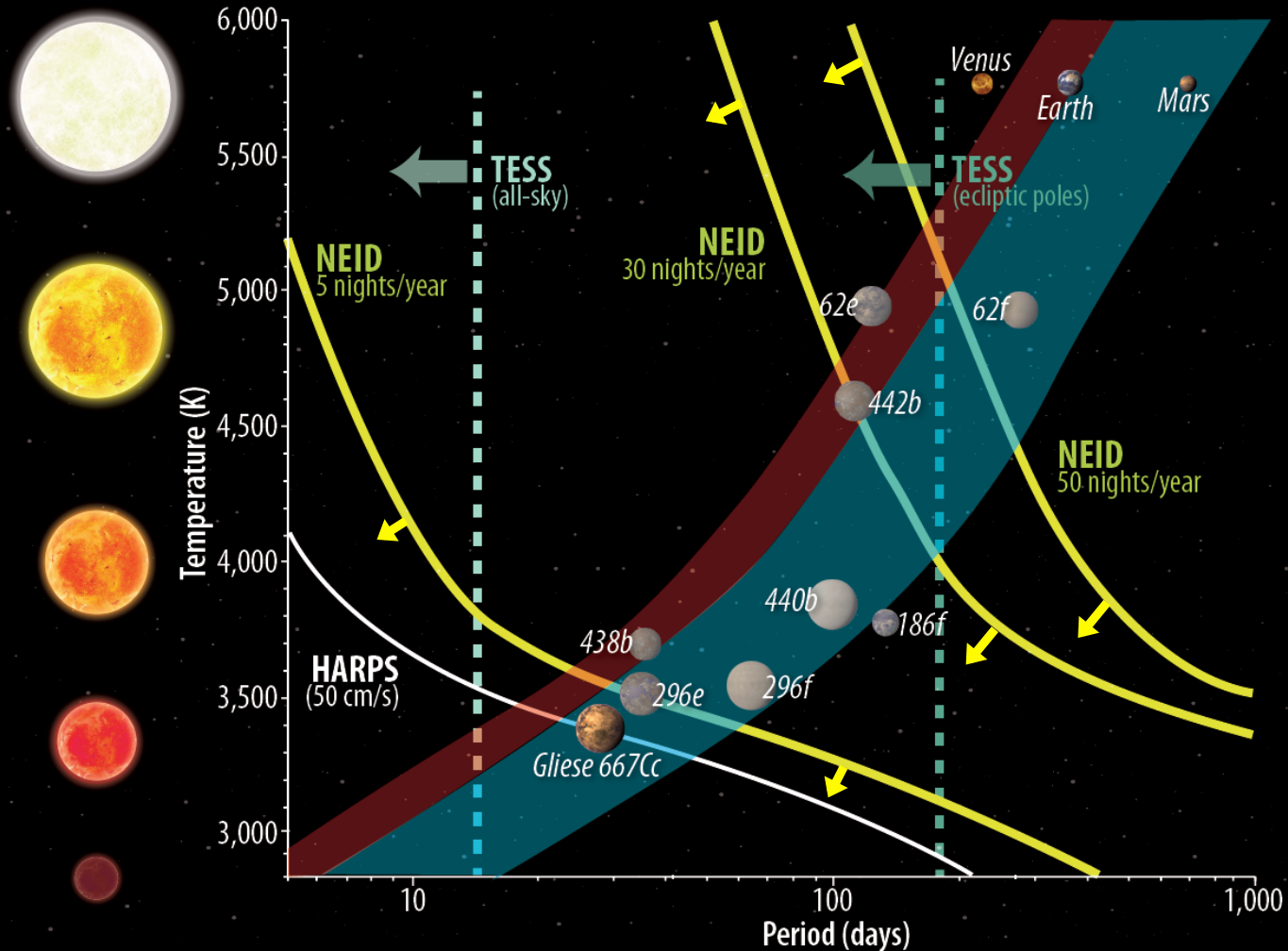


50cm/s precision with a goal of 30cm/s



Ultimate goal of NN-explore program, NEID is to detect Earth-twins

What Do You Gain With Sub-m/s Precision?



Earth-mass planets in the HZ have 10-30 cm/s RV amplitudes. Need 10-100s of nights at <50cm/s precision

NEID

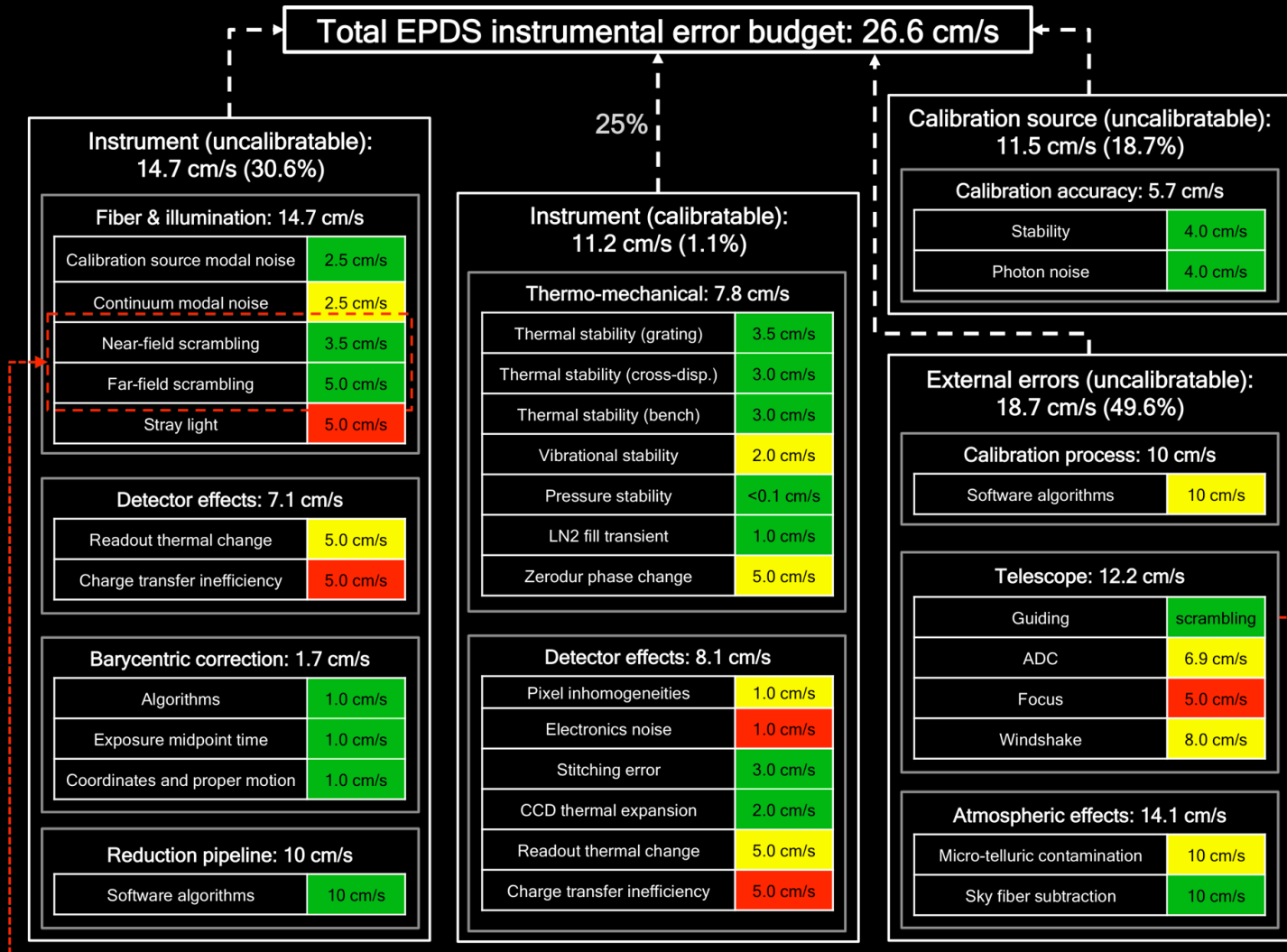
Heralding Extreme Precision Spectroscopy

NEID will attempt to achieve unprecedented levels of precision approaching 10cm/s



Measure 1 part per billion changes
Translates to 10^{-4} of pixel

Beyond the Era of Single Dominant Sources of Error

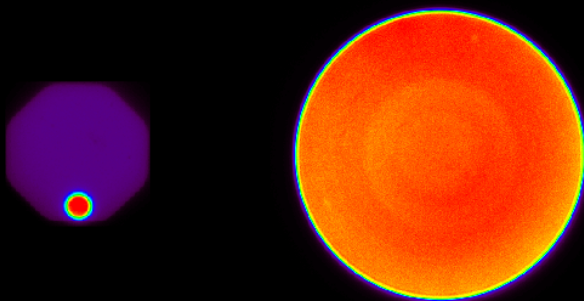


Bottom-up systems engineering approach is key to performance estimation

NEID

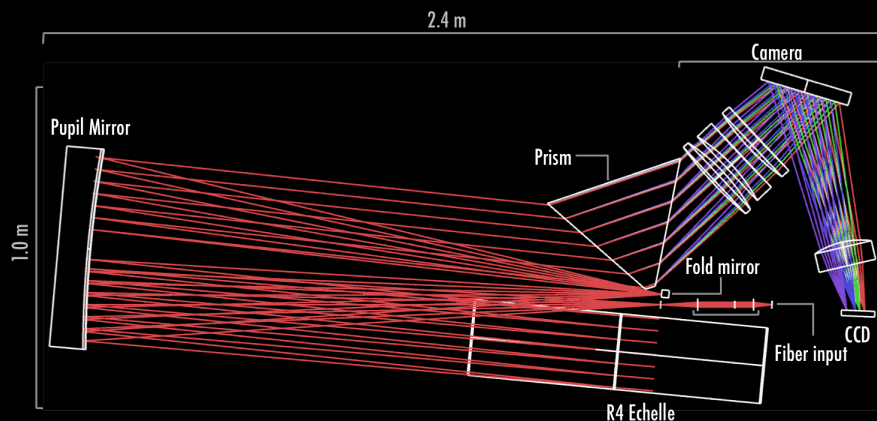
Implementing Stability at Every Level

Fiber Feed Scrambling



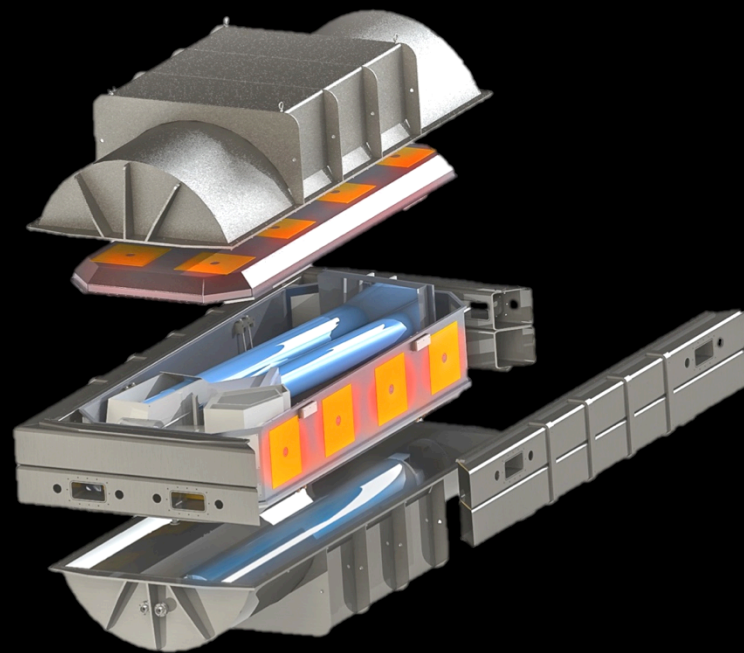
Make sure spectrometer illumination insensitive to guiding/seeing

Elegant Optical Design



High-performance, exquisite image quality boosts optical stability

Ultra-Stable Thermo-mechanical Control



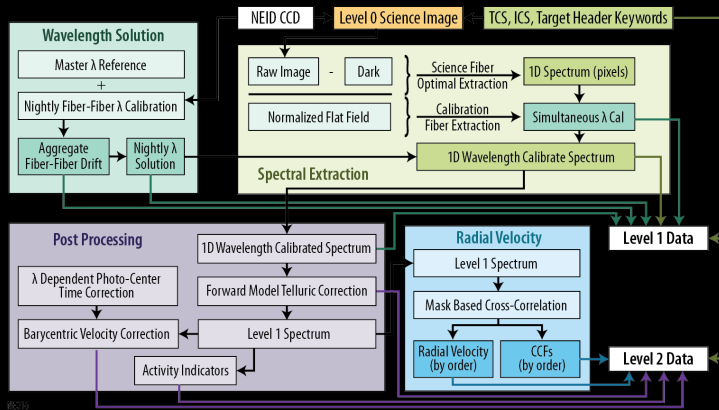
Demonstrated sub-millikelvin stability

"The Most Stable Tonne of Matter Ever Created By Humans"

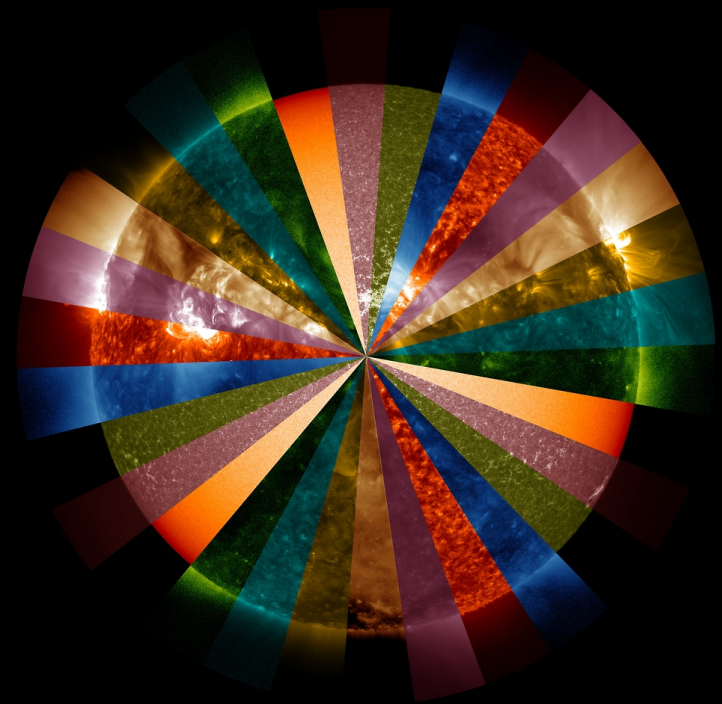
NEID

Implementing Stability at Every Level

Extreme Precision Pipeline

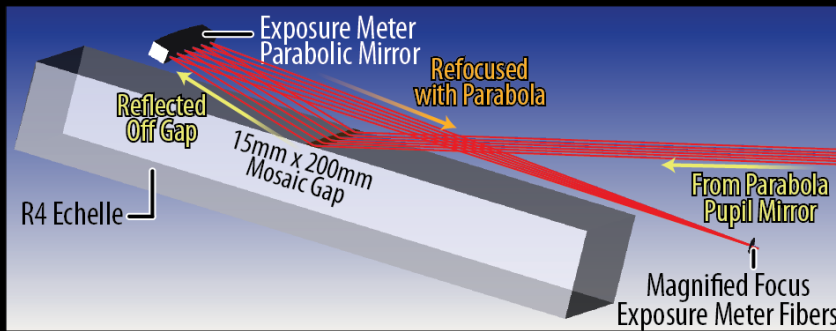


Full Suite of Canonical Stellar Activity Indicators



Not Part of the Instrument Error Budget
Acute awareness that this will be the limiting factor

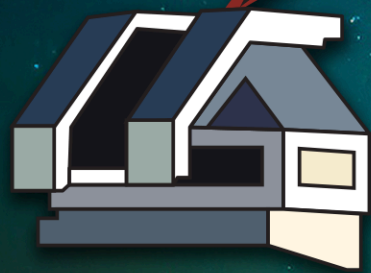
Chromatic Barycentric Correction



Dispersed exposure meter to ensure $<1\text{cm/s}$ correction

23 New RV Instruments Presented at EPRV 2017

The Fleet Is Coming in Me'Hearties!



NEID

NN-explore Exoplanet Investigations with Doppler Spectroscopy

