A UV Double Pass Spectrograph for Monitoring Stellar Activity for the Keck Planet Finder

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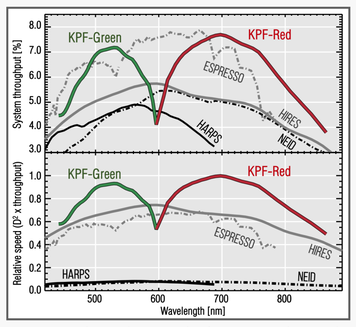
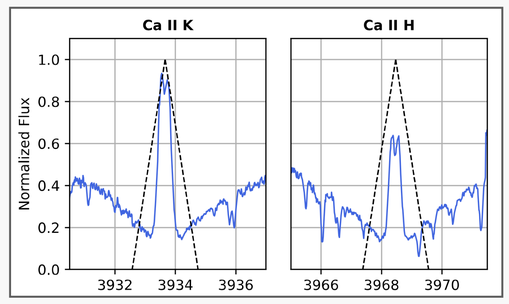
What & Why?



^ KPF system throughput and relative speed considering telescope aperture compared to other RV instruments.

The Keck Planet Finder (KPF) is a radial velocity (RV) spectrograph commissioned on Keck I in the fall of 2022 with the science objective of measuring precise masses of exoplanets. **KPF will use a separate instrument to cover the Ca II H&K wavelength region. This instrument is called the H&K spectrometer** and is presented here. Decoupling this UV coverage from the main spectrometer alleviated constraints on KPF's design, which needed to achieve high throughput out to 880nm. The Ca II H&K lines are canonical stellar activity indicators that will help KPF distinguish exoplanet RV signals from stellar noise.

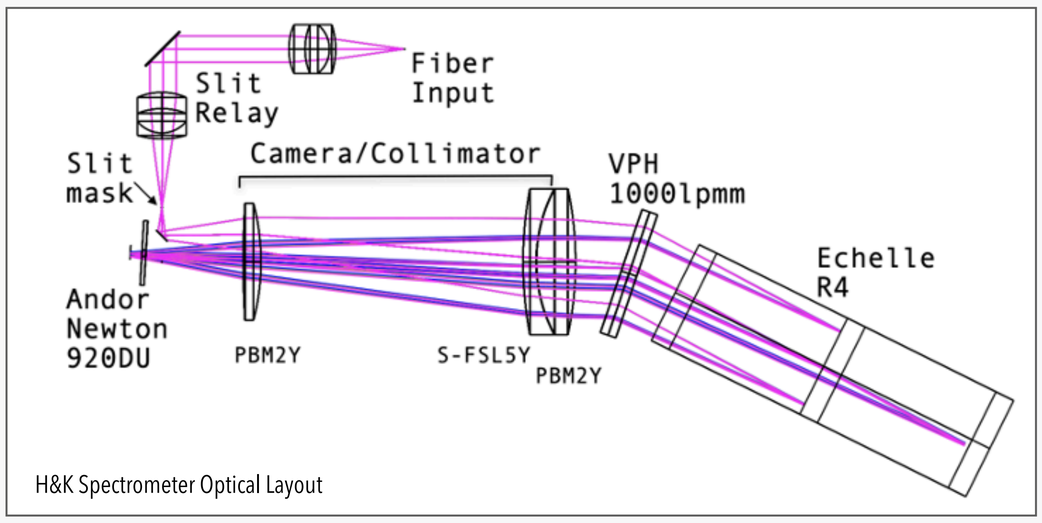


^The Ca II H&K core emission tracks chromospheric activity.

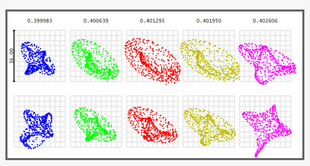
Optical Design & Requirements

Simulations from Ishikawa et al. (in prep) determined the instrument requirements to achieve the science goal of $\sigma_{S_{HK}} < 0.001$, where S_{HK} is the Mt. Wilson activity index.

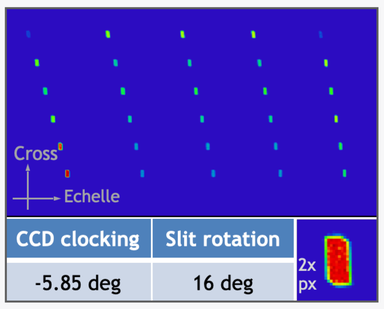
Resolution:	~16,000
Throughput:	4-7%
Bandpass:	383 - 403nm
Sampling:	~4pix



H&K Spectrometer Optical Layout



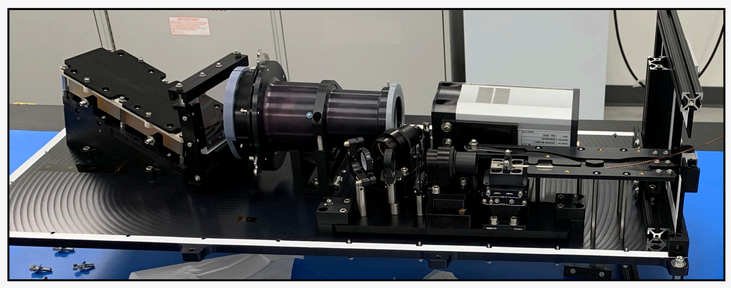
^Spot diagrams from sky (top) and science (bottom) fiber inputs as seen at the Andor.

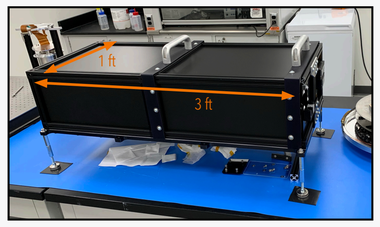


Max Footprint: 60mm
Bench Size: 1ft x 3ft

< Echelle gamma angle separates beams but causes tilt. Resolution elements and orders were straightened with respect to pixel grid and resolution element rectified for easier data reduction and to preserve resolution

Mechanical Design

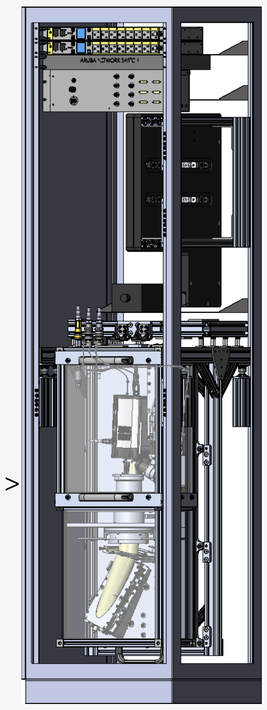




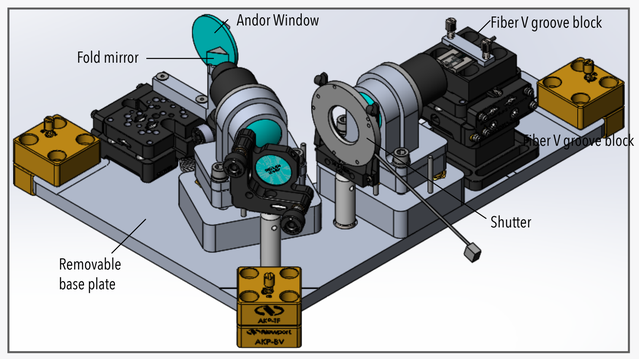
^ With the light tight enclosure installed. The Andor will be cooled with Glycol. The fibers and electronics cables enter through the right panel.

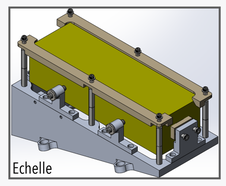
^ KPF's H&K spectrometer at Caltech where it was assembled and initially aligned before testing and integration at Space Sciences Lab.

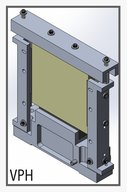
The final position of the H&K > spectrometer in a rack in the AO electronics room at Keck I. A kick stand allows for a horizontal position for maintenance.

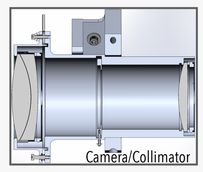


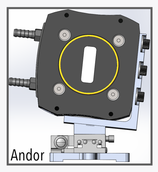
v Mechanical drawings of the input relay and other custom optomechanics.



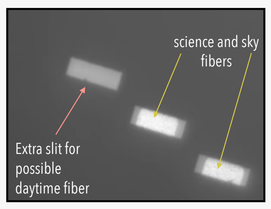




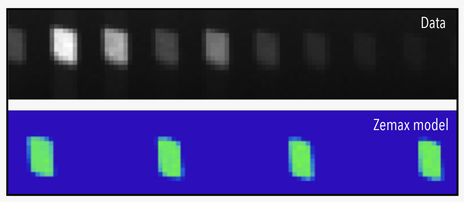




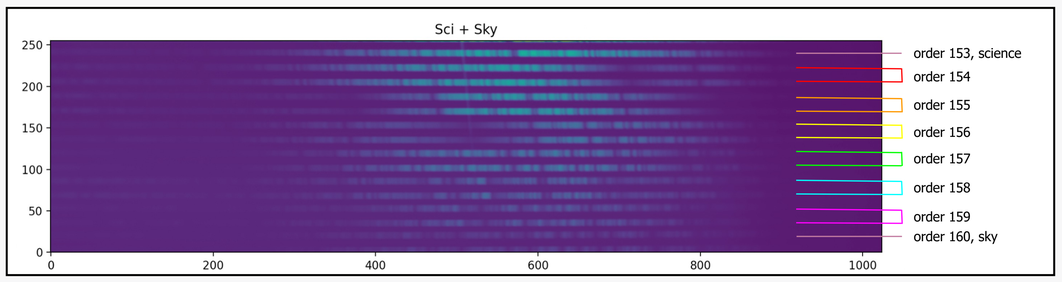
Performance Verfication

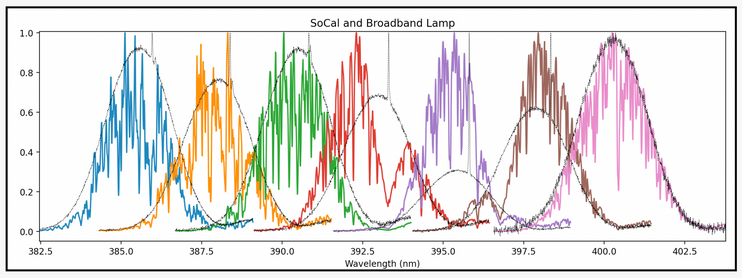


<A ZWO CMOS and achromatic double pair were used as a slit viewing camera to align the fiber to the slit



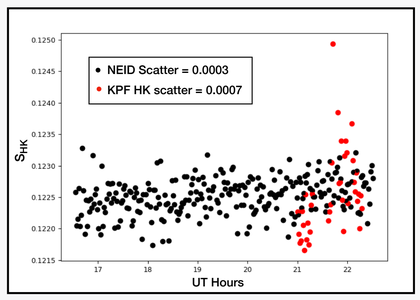
^The spectrometer was aligned using a Thorlabs 404nm laser. Zemax footprints were used initially as guides. Alignment was fine tuned with a UNe lamp.





<Spectral extraction is done with a simple sum in the cross dispersion direction. Extracted solar spectra were fit with Kurucz models to get an initial wavelength solution. S_{HK} indices for a data stream on 04/29/22 were extracted.

<Solar light was injected into science and sky fibers separately. Tweaks to the spectral format and the position of a VPH ghost will be done during the instrument's final alignment at Keck before installation in fall 2022.



^ Comparison of S_{HK} indices over an overlapping time period on 04/29/22 (UT). Outliers are related to poor dark subtraction due to day time testing.

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