



Keck Planet Finder

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Introduction

KPF is a fiber-fed, high-resolution, high-stability spectrometer in development for the W.M. Keck Observatory. KPF will characterize exoplanets via Doppler spectroscopy with a single measurement precision of 0.5 m s^{-1} (requirement) to 0.3 m s^{-1} (goal).

Fabrication of the majority of KPF subsystems is currently underway. Assembly of the main spectrometer will begin in early 2021.

Optical Fiber Cables

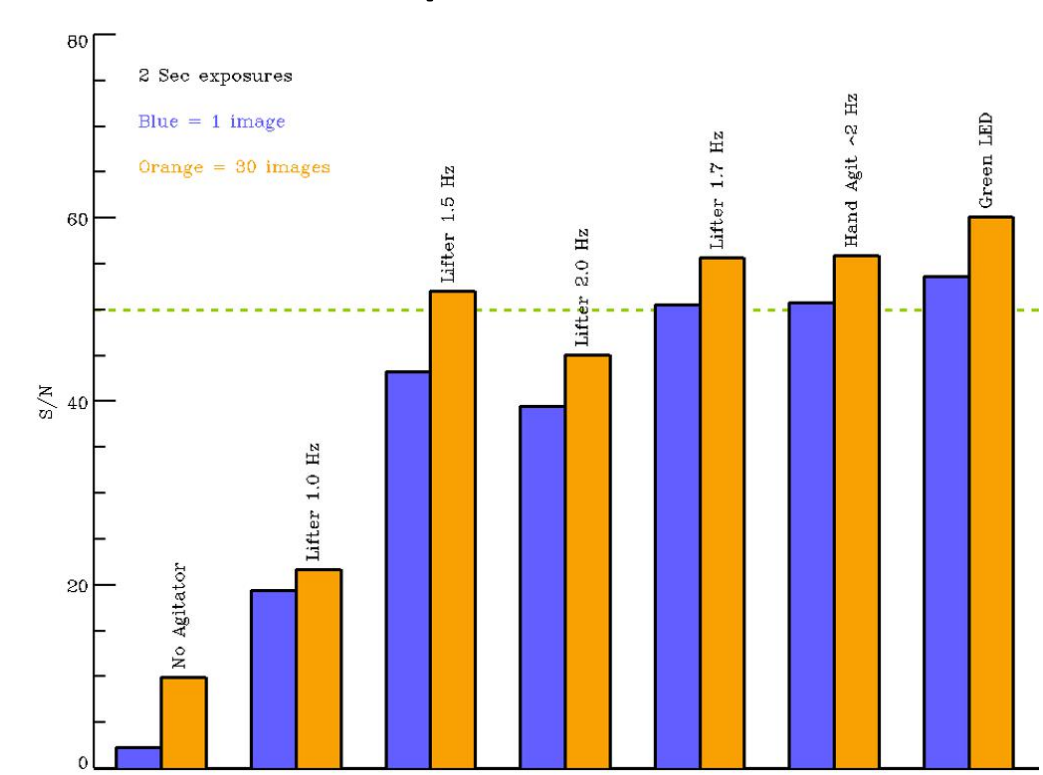
Optical fibers are protected by Miniflex PBT tubing. A strain relief box is placed at the mid-point of the ~60 m fiber cables, to absorb relative movements between fiber and Miniflex.



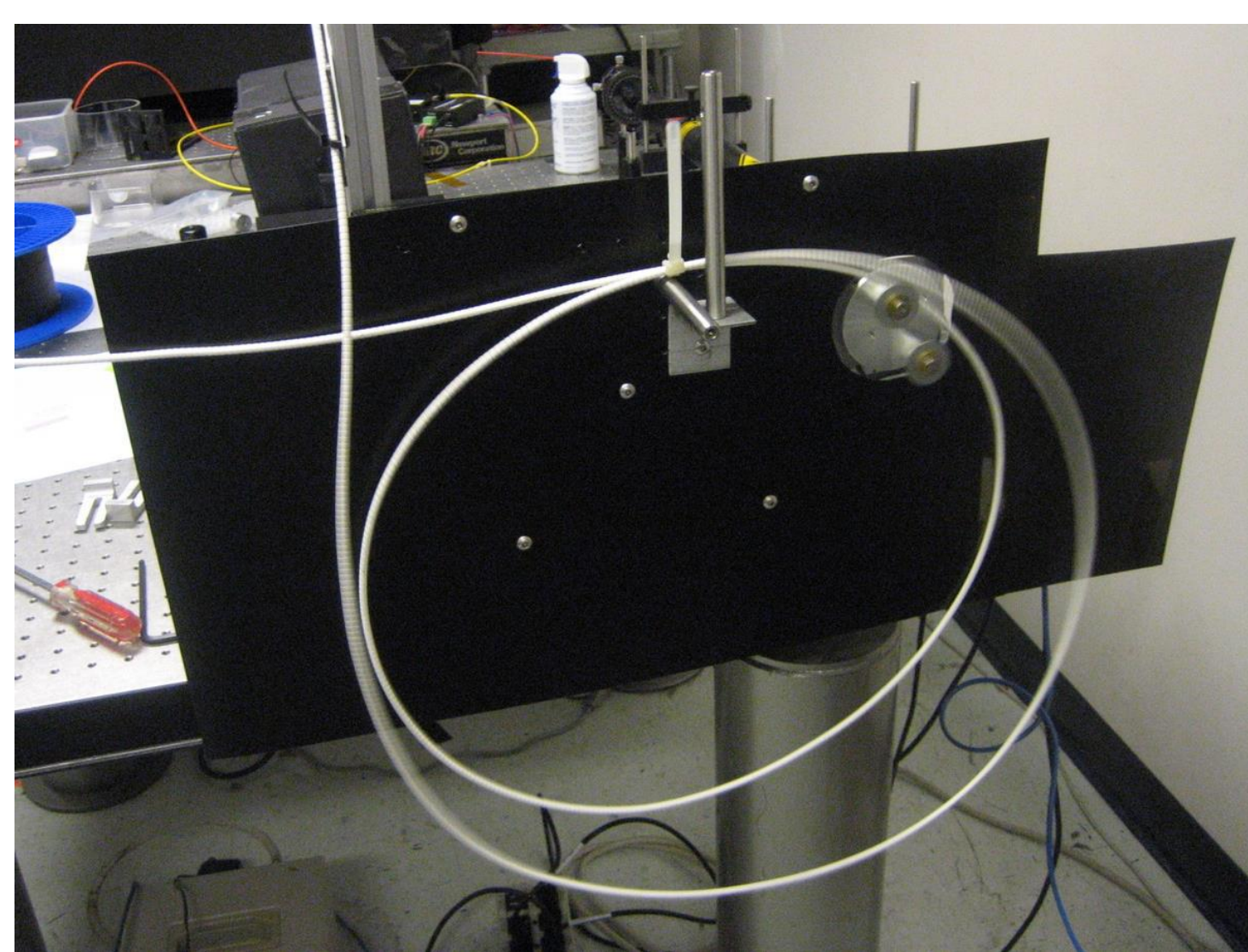
Left: Strain relief box (inside). Smaller circle is set at fiber minimum bend radius. Center: Miniflex storage spool mounted on strain relief box. Right: Strain relief box and spool in fiber AR-coating configuration.

Fiber Agitator

- Suppresses modal noise within science, sky and simultaneous calibration fibers
- New design comprised of fiber within two $\varnothing 0.5 \text{ m}$ loops of Miniflex PBT tubing.
- As motor-driven disk spins, the bars tap the fiber loops, which oscillate and resonate in three directions at several different frequencies.



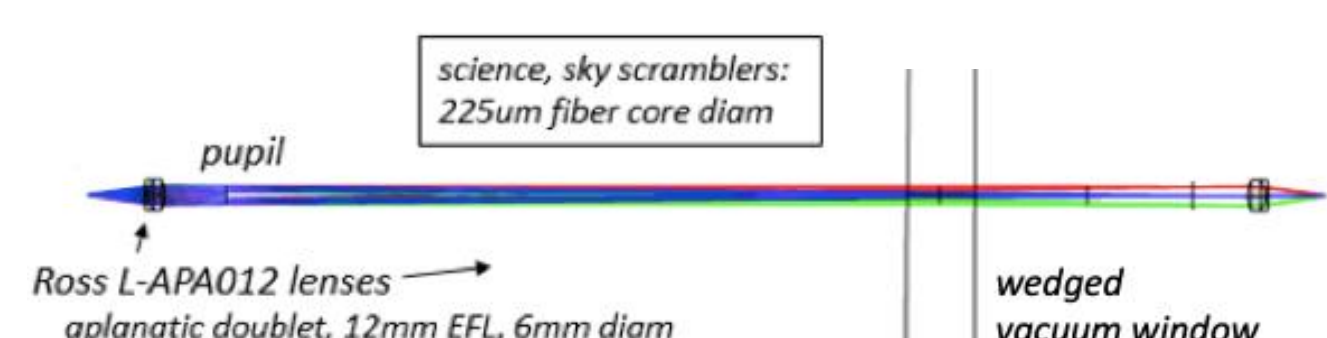
Lab tests with laser input light show SNR post-agitation nearly equivalent to green LED.



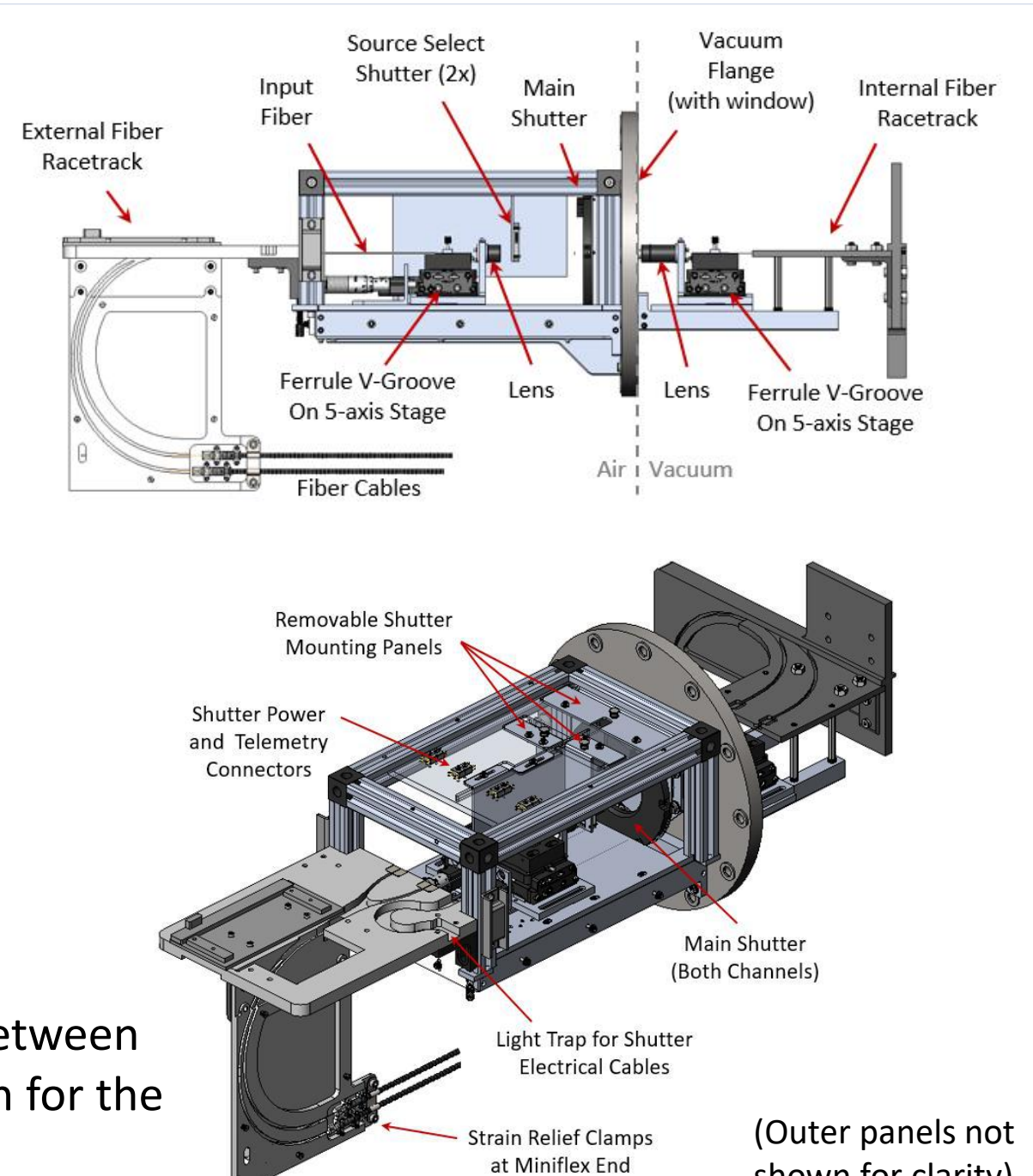
The KPF fiber agitator prototype in operation at ~2 Hz. Blurring of PBT tubing gives a sense of size of oscillations.

Double-Fiber Scrambler

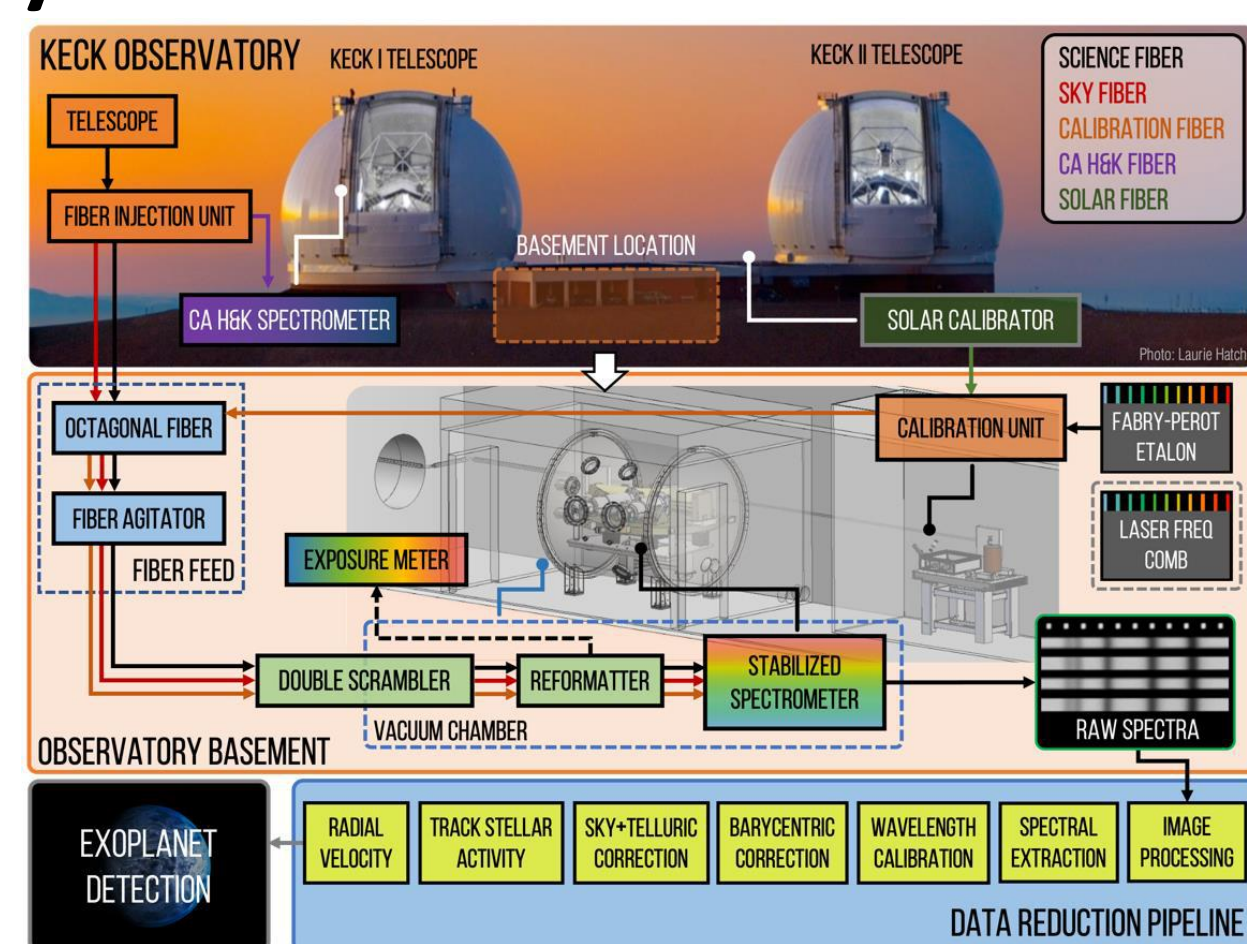
- A double-fiber scrambler is utilized to stabilize and homogenize the illumination of the main spectrometer
- Optical and mechanical parts have been fabricated and final assembly is underway.



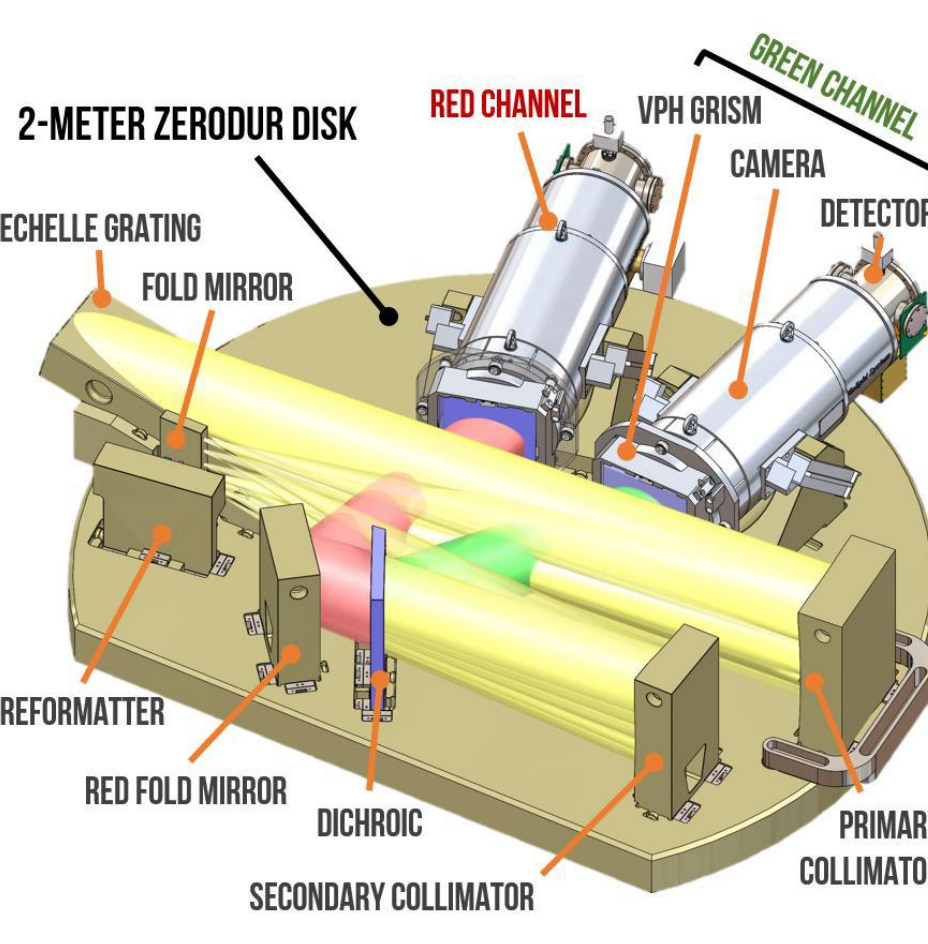
Above: Optical layout. A vacuum window is placed in the air space between the two lenses, allowing the scrambler to act as an optical feedthrough for the main spectrometer vacuum chamber. Right: Opto-mechanical design.



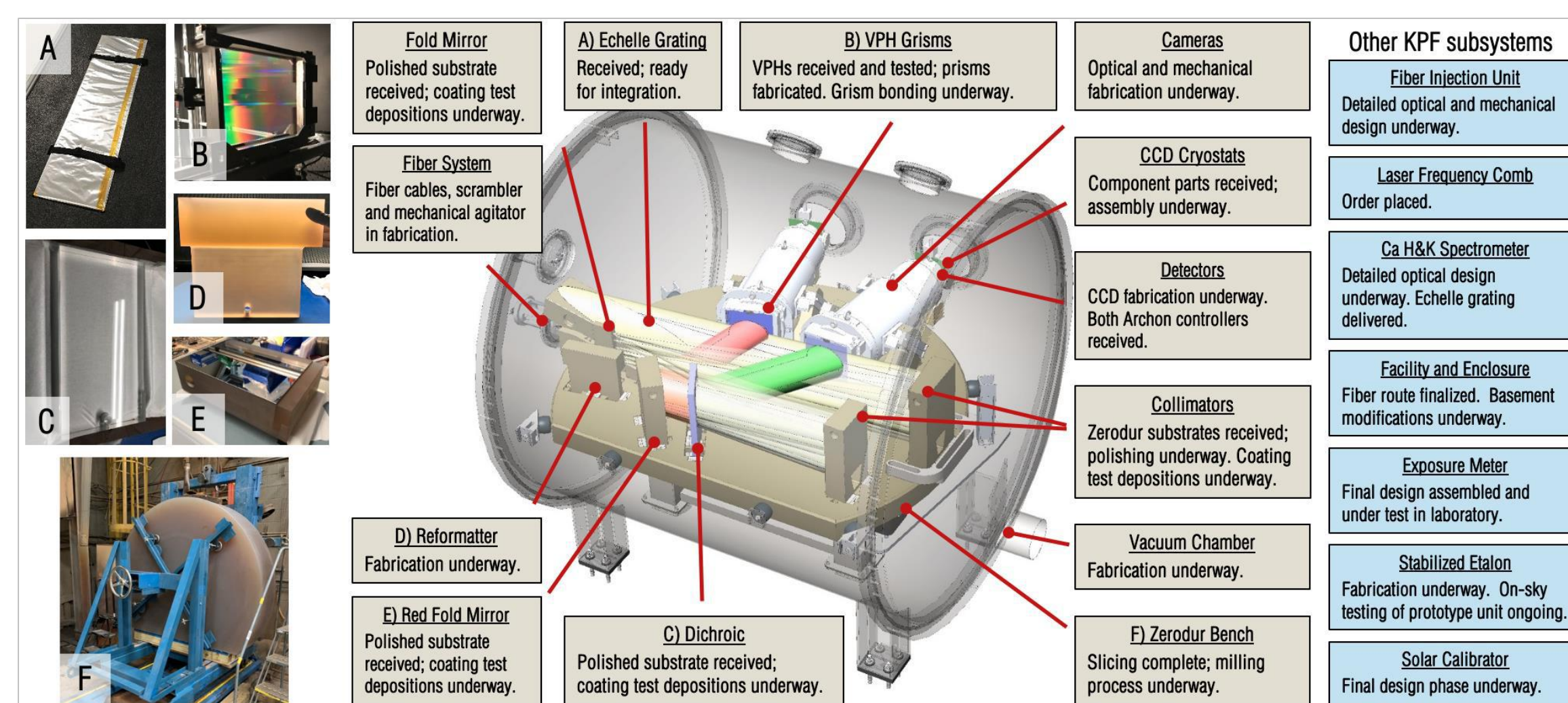
System Overview



The KPF instrument, spanning subsystems from the telescope fiber injection unit to the data reduction pipeline.



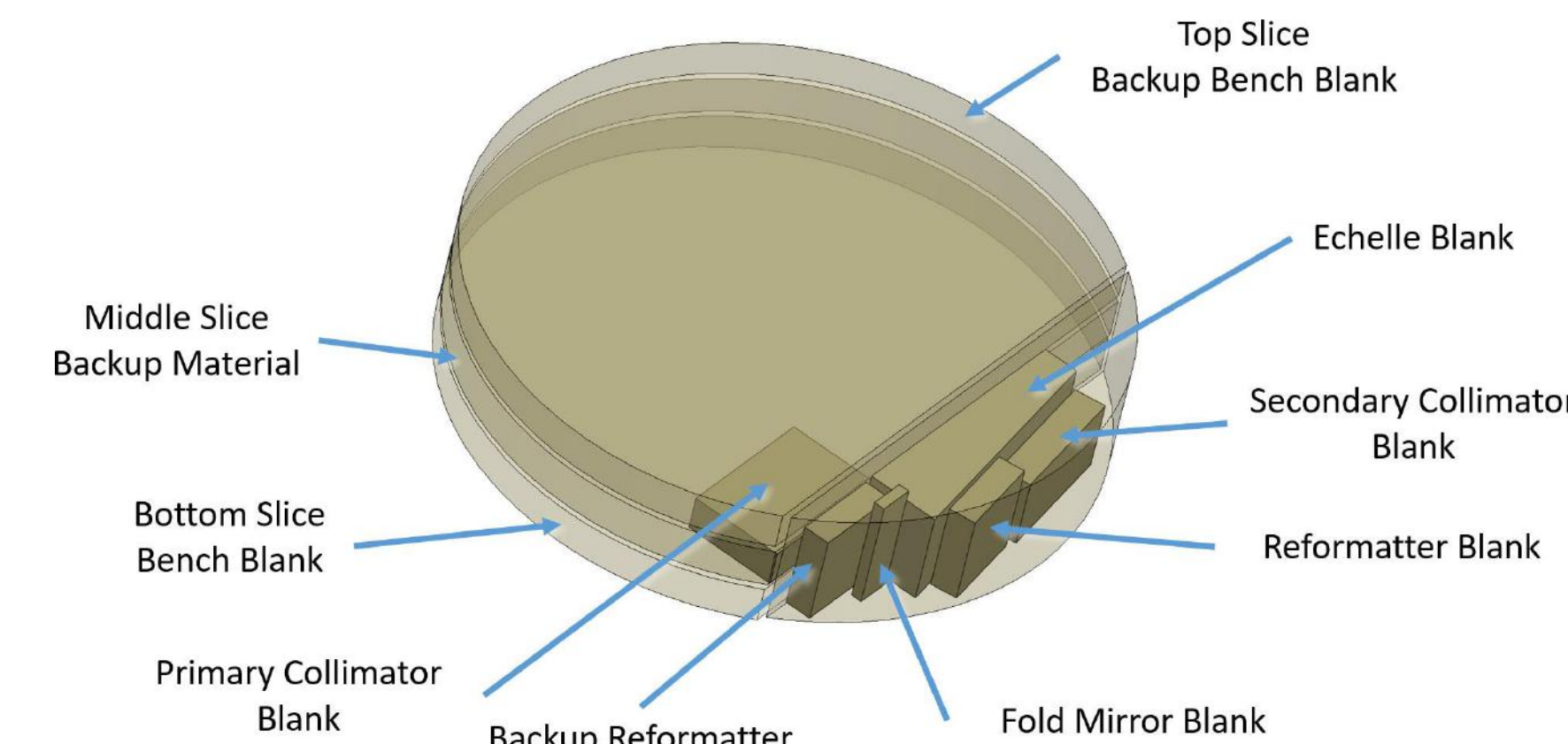
At the core is an asymmetric white-pupil spectrometer on a Zerodur mount with Zerodur mounts and optics.



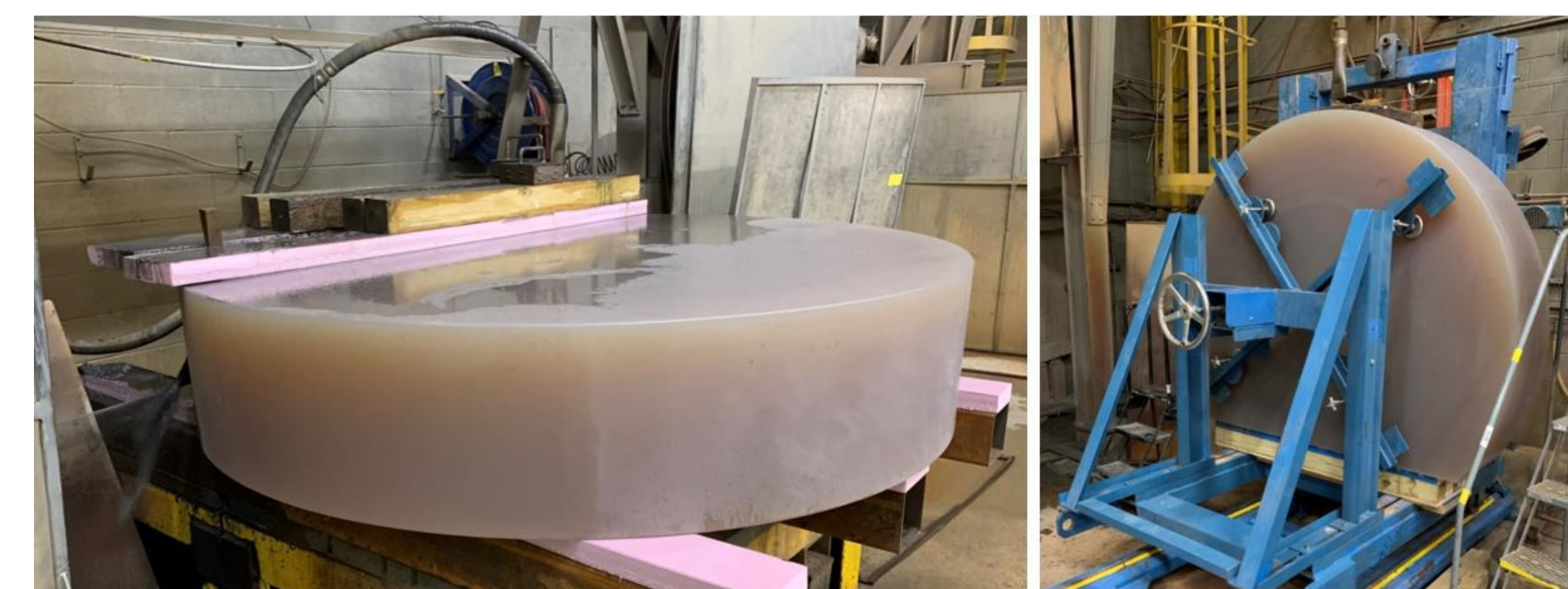
Overview of the development status of KPF components and subsystems.

Zerodur Bench Fabrication

The KPF Zerodur disk has been sliced into sub-components at Corning. It is currently at Schott being prepared for final milling.



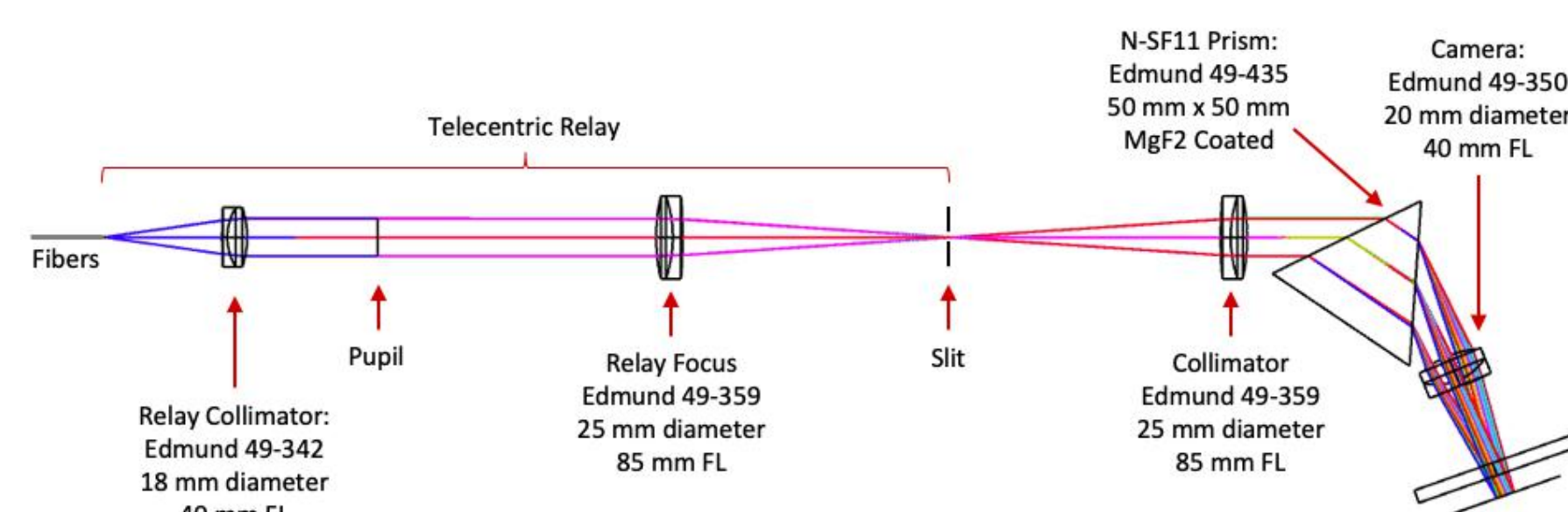
A Zerodur disk measuring 2m diameter x 0.4 m thick supplied the material for the optical bench as well as several mirrors and mounts.



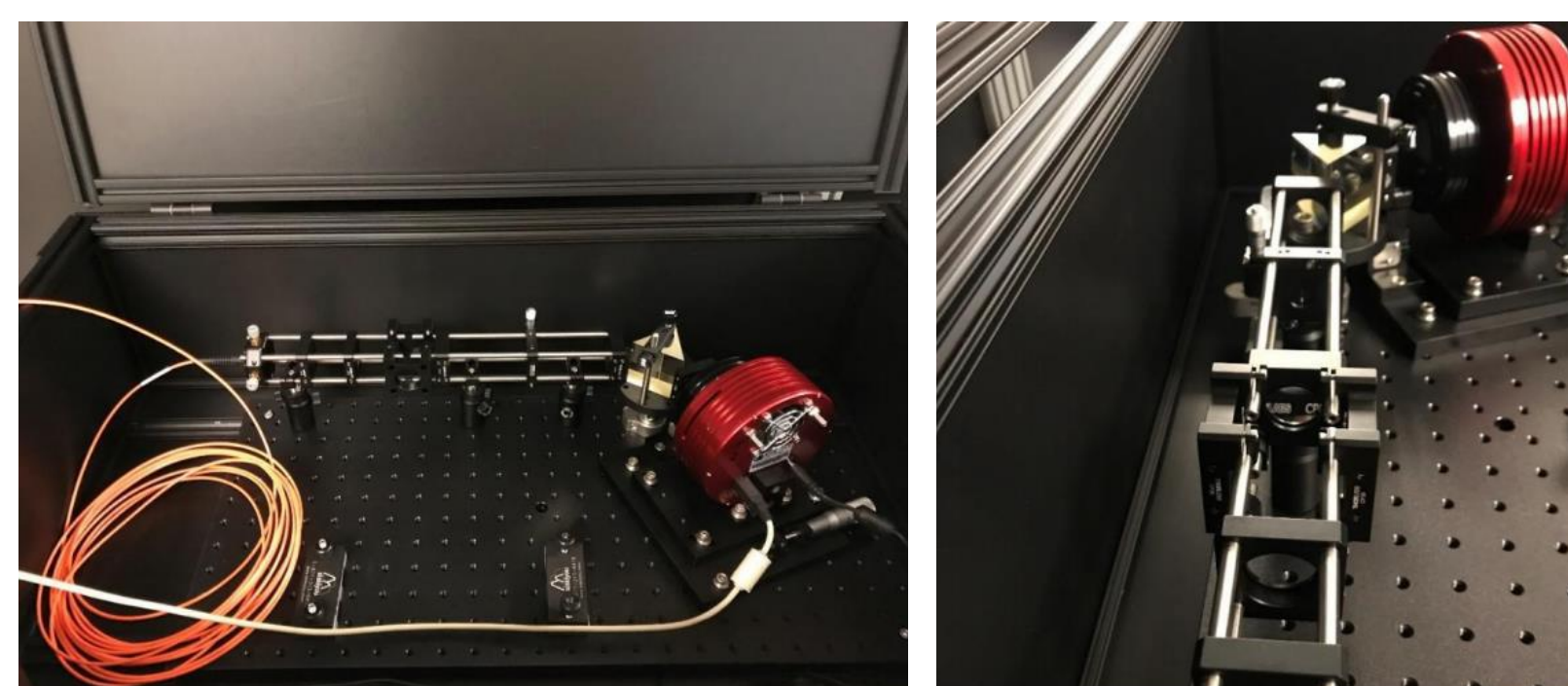
The KPF Zerodur disk on a wire saw at Corning. Left: D-Cut slice. Right: Bench slicing.

Exposure Meter

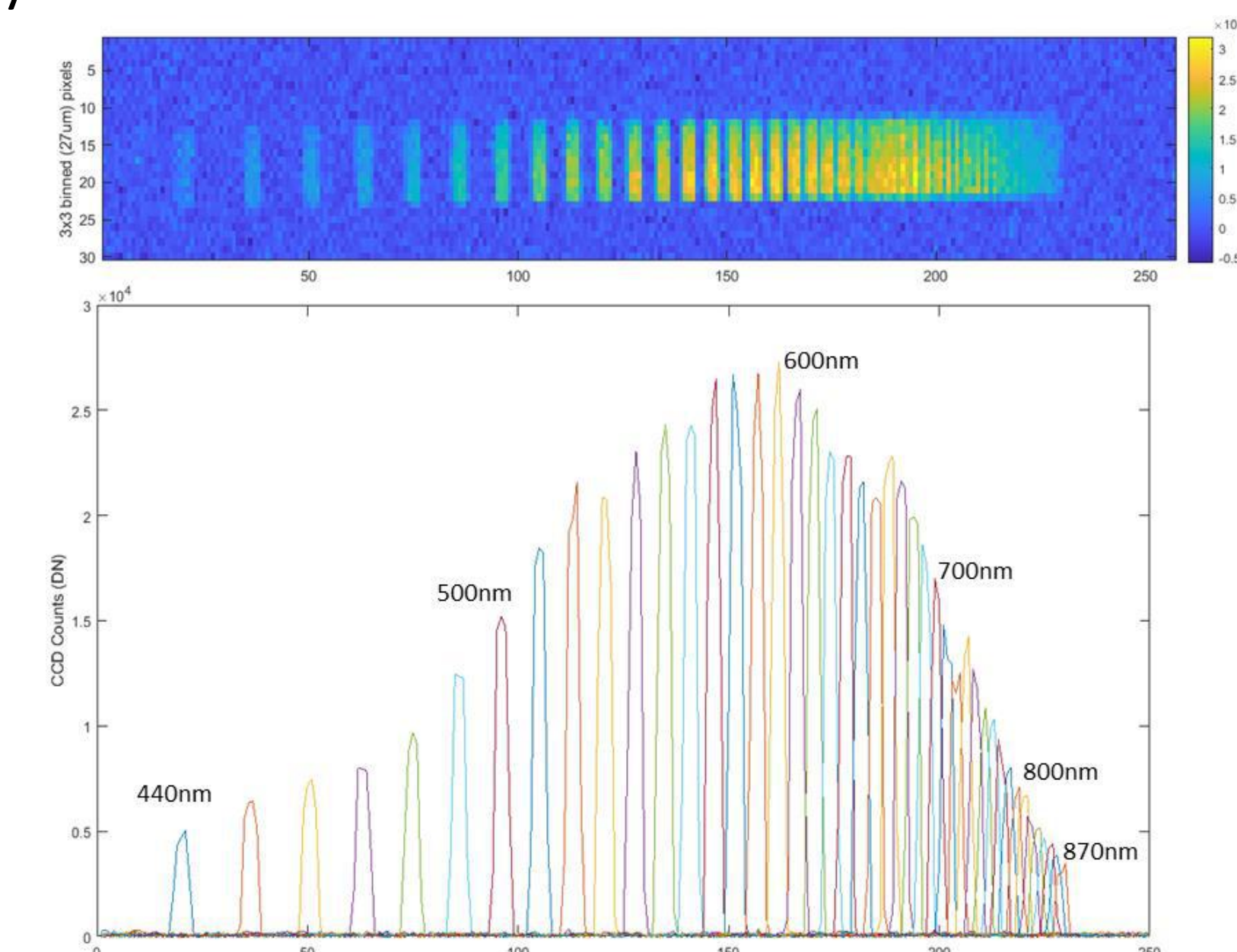
- Prism-based spectrometer ($R \sim 100$) allows chromatic barycentric corrections



Optical design of the KPF exposure meter. Collimated beam diameter is 12 mm.



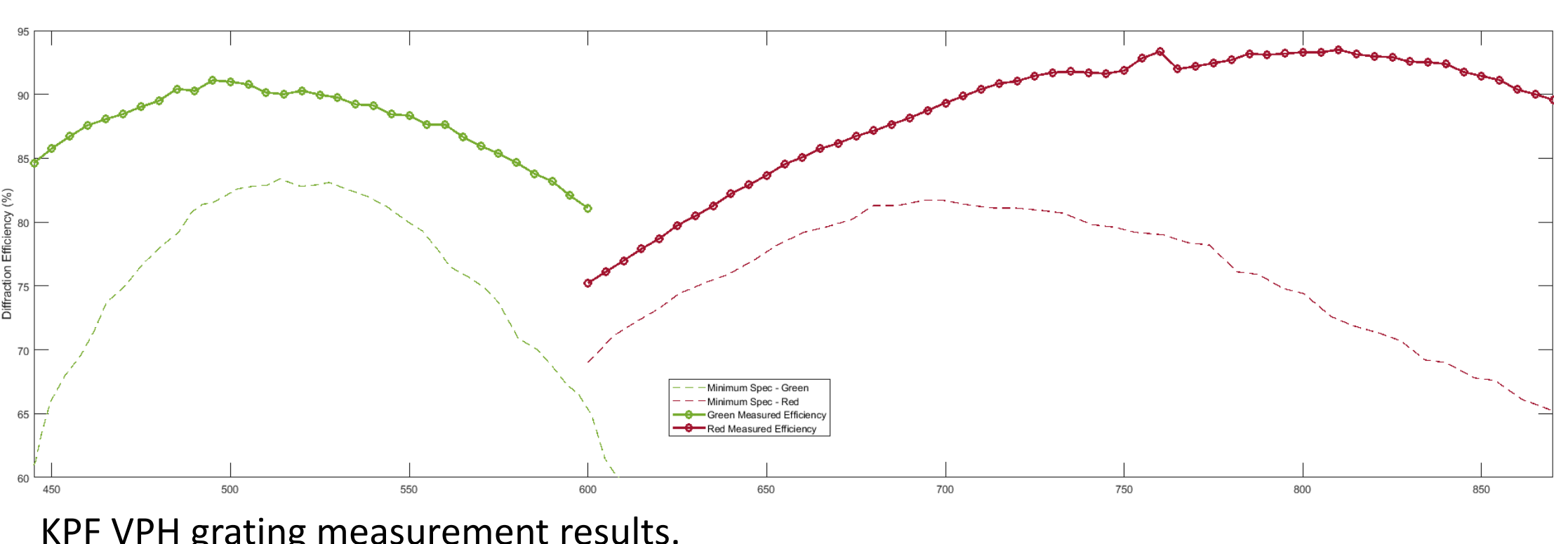
Exposure meter with ATIK detector used for preliminary testing.



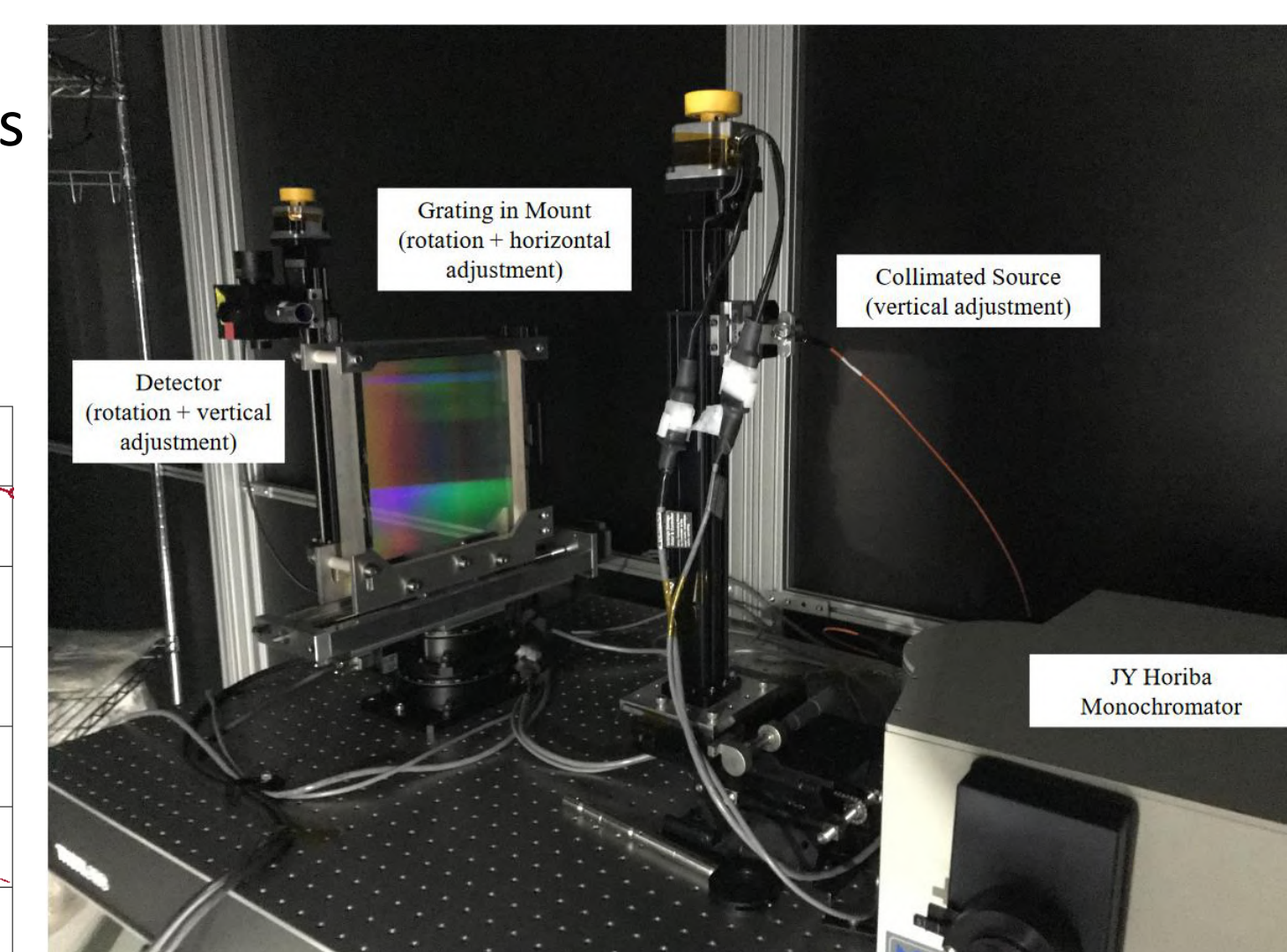
Co-added image of an exposure meter wavelength scan, using a monochromator as the source. The redward falloff is dominated by the ATIK 11000 detector used for preliminary lab tests.

VPH Grating Testing

- Green and Red VPH gratings fabricated by Kaiser Optical Systems
- Grating throughput measured by KPF team
- Measured throughput exceeds expected 'production minimum'



KPF VPH grating measurement results.



KPF VPH grating under test.

The authors thank the Heising-Simons Foundation, the National Science Foundation (award 2034278 through the Mid-Scale Innovations Program in Astronomical Sciences), private donors, the W.M. Keck Foundation, the University of California, Berkeley, the California Institute of Technology, the University of Hawaii, the Jet Propulsion Laboratory, and the Mt. Cuba Astronomical Foundation for financial support of KPF. The authors also wish to thank Winlight Systems for their valuable contributions to the designs of the reformatter and cameras, as well as the DESI project for sharing their camera designs and their expertise with optical fibers.