Splitting Hairs ---------- From Across the Room

Positioning fibers to ~3 micron precision using Yale's Fiberview Camera on the Dark Energy Spectrographic Instrument

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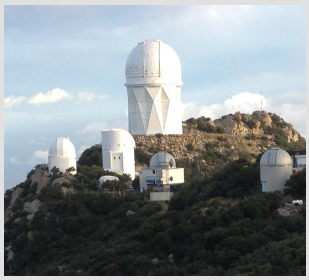
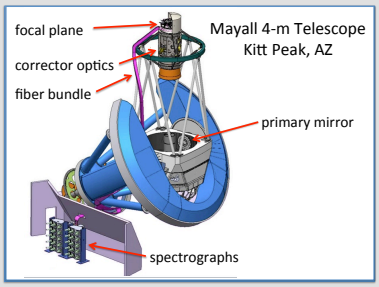
The Dark Energy Spectrographic Instrument (DESI)

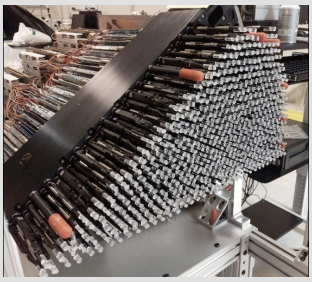
To study the effects of Dark Energy, DESI will measure the redshifts of 30 million galaxies using the Mayall 4-m aperture telescope at Kitt Peak, AZ.



Kitt Peak Observatory, AZ. The dome of the 4 meter Mayall Telescope is the largest.



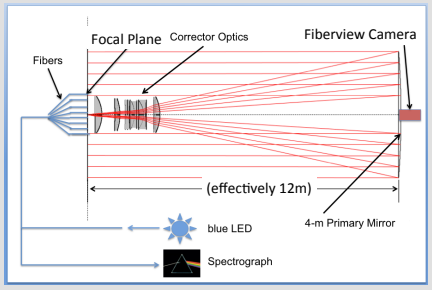
At the focal plane, each of 5000 separate fibers transmit the light from a targeted galaxy to spectrographs one floor below.



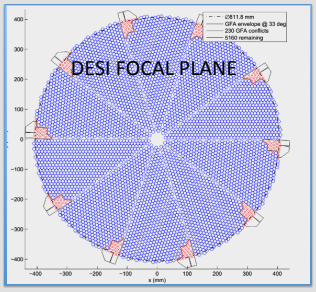
Robotic actuators move the fibers in the focal plane to align with the targeted galaxy images.

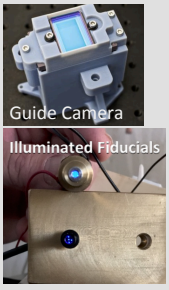
The Fiberview Camera

The purpose of the Fiberview Camera is to measure the fiber locations and direct the motion of the actuators. Each fiber must be centered on a previously mapped galaxy position to 6 micron precision.



To measure fiber positions, the Fiberview Camera looks back at the focal plane from a hole in the center of the primary mirror. The fibers are illuminated by blue LED light injected at the spectrograph end. The effective distance (looking through the corrector optics) is ~12 m.

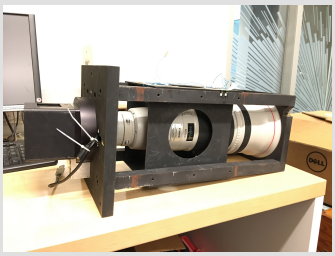




To register the fibers with known galaxy positions, 10 small cameras at the edge of the focal plane (red shaded areas) record positions of known stars in the field. The Fiberview Camera measures the location of illuminated fiducials on each camera. This ties the fiber positions to the sky positions of the stars.

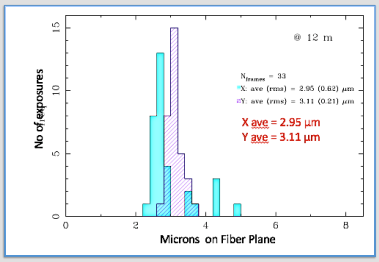
Testing the Fiberview Camera at Yale

To measure the camera distortion and precision, calibration targets were set up at 12 m distance in the labs, hallways, and exterior at Wlab.



The Fiberview Camera consists of a 600-mm Canon lens mounted on 6K x 8K digital camera (Finger Lakes Instruments). The assembly is enclosed by a rigid truss to prevent vibration and flexure at the telescope mount.

Jau Tung Chan ('21) measuring the distortion of the Fiberview Camera at 0°C outside Wlab. The calibration target is in the distance, illuminated by blue LED lights.



The precision of the Fiberview Camera determined from Yale measurements. At 12 m distance, we obtain a precision of ~3 microns.