Florida IR Silicon immersion grating spectromeTer (FIRST) and its science

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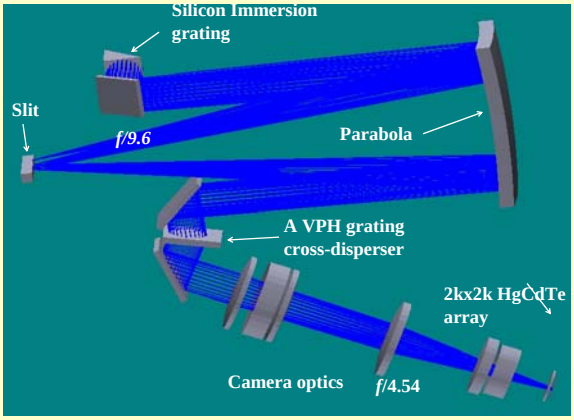
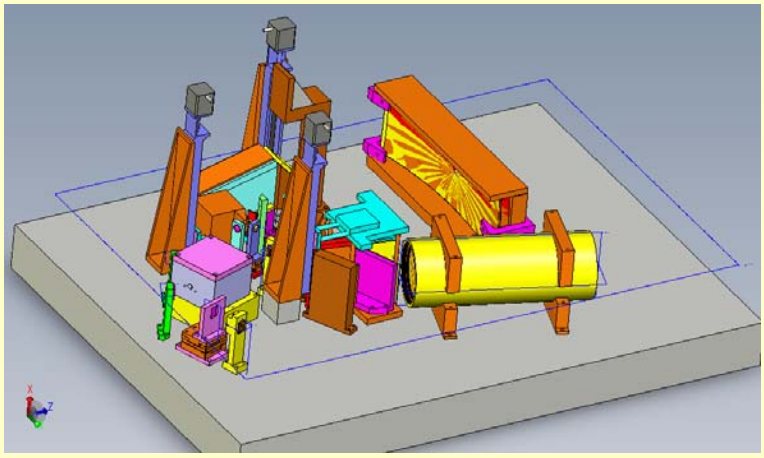
ABSTRACT

At University of Florida, a Florida IR Silicon immersion grating spectromeTer (FIRST) is being developed for the Apache Point Observatory 3.5m telescope. FIRST can offer R=55,000 in the near IR wavelengths and can simultaneously cover the J and H band in a single exposure with a 2kx2k IR array. FIRST will be commissioned in the fall 2010. Science operation will begin in the Spring 2011. This instrument will be primarily used for high precision Doppler measurements of nearby M dwarfs for detecting habitable planets. It will also be used for general high resolution IR spectroscopy.

FIRST Optical Design



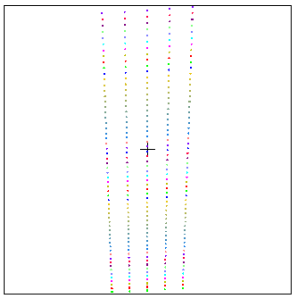
FIRST Mechanical Design



White pupil design

Triple-pass parabola as the collimator and lenses camera

Spectral format on a 2kx2k H2RG array (1.4-1.8 μm)

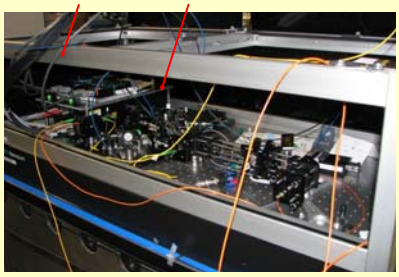


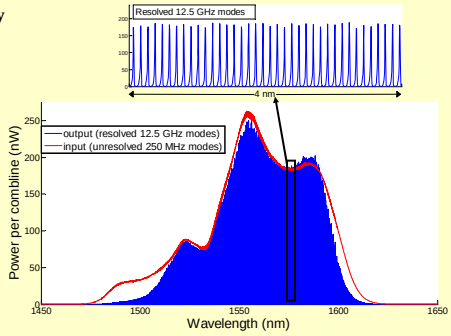
80% EE covered by 2 pixels for 90% FOV

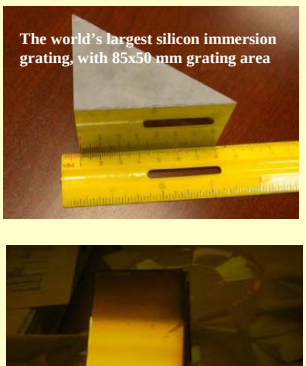
FIRST Parameter	
Fiber core diameter	50 μm
Fiber input focal ratio	*f/3*
Image size on sky	1 arcsec
Slit width	0.5 arcsec
Collimator beam diameter	49 mm
Camera focal ratio	*f*/4.54
Wavelength coverage	1.4-1.8 μm
Order separation	~26 pixels
Main disperser	16.1 l/mm SIG, θ_B =54.74°
Cross-disperser	A VPH grating, θ_B = 17.3°, 380 l/mm
Resolution elements	2.1 pixels
Spectral resolution	55,000
IR detector	2kx2k H2RG

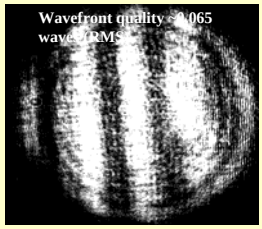
IR Laser Comb for Radial Velocity Calibration being Built by NIST, Colorado

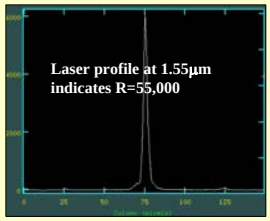
Frequency Comb + Self-Referencing + Filter Cavity



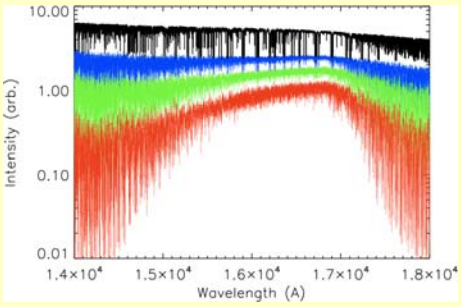






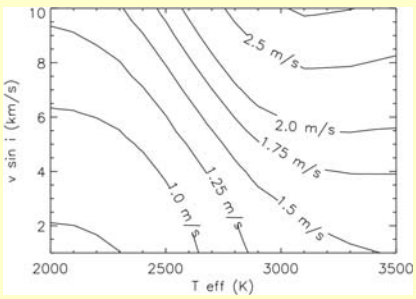


Model spectra from M dwarfs



Data from spectra generated by PHOENIX:
T_{eff} = 3500 K, 2800 K, 2400 K, 2000 K

Photon Noise limited Doppler Sensitivity of FIRST



Parameters:
H = 7.5
Total efficiency = 10%
Exposure time = 15min

- **FIRST will be commissioned in Fall 2010 and begin operation in Spring 2011.**
- **FIRST has an IR Dispersed Fixed Delay Interferometer mode for RV measurements at 0.8-1.35 μm.**

Acknowledgement: The construction of FIRST instruments for the APO 3.5m was support by DoD, NASA, NSF and Univ. of Florida.