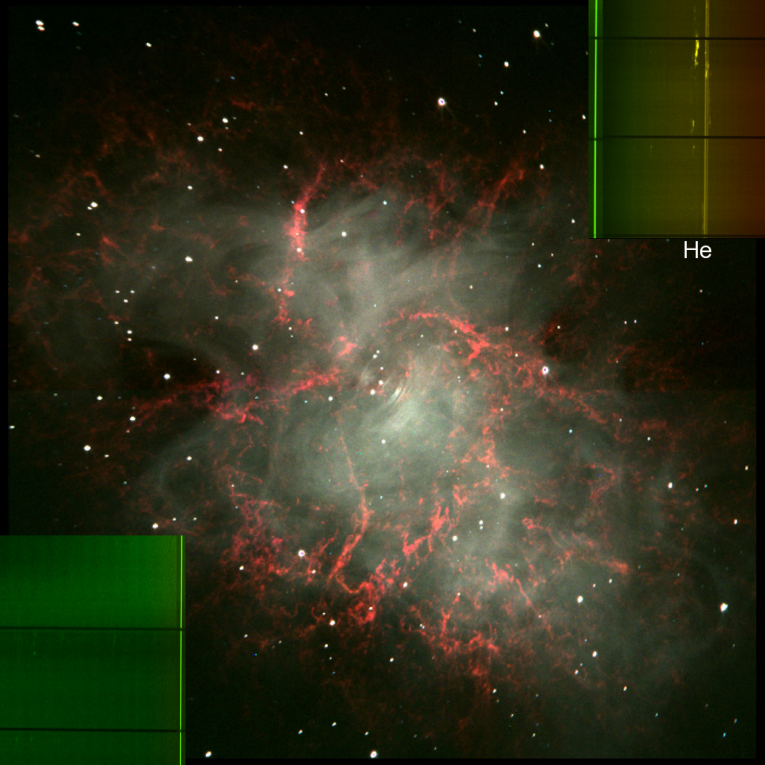
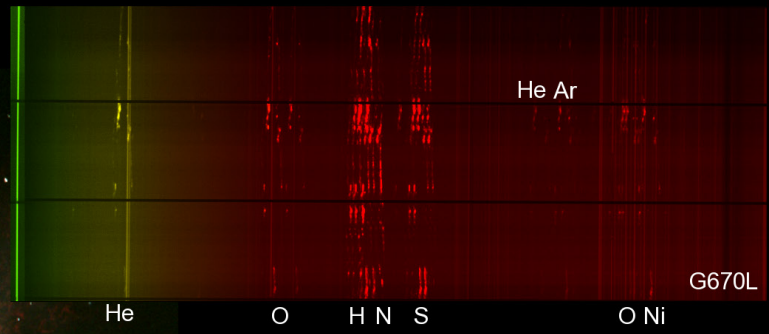
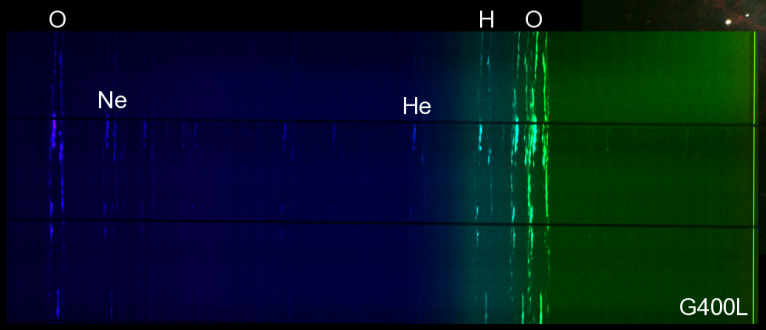
MODS
The Multi-Object Double Spectrographs





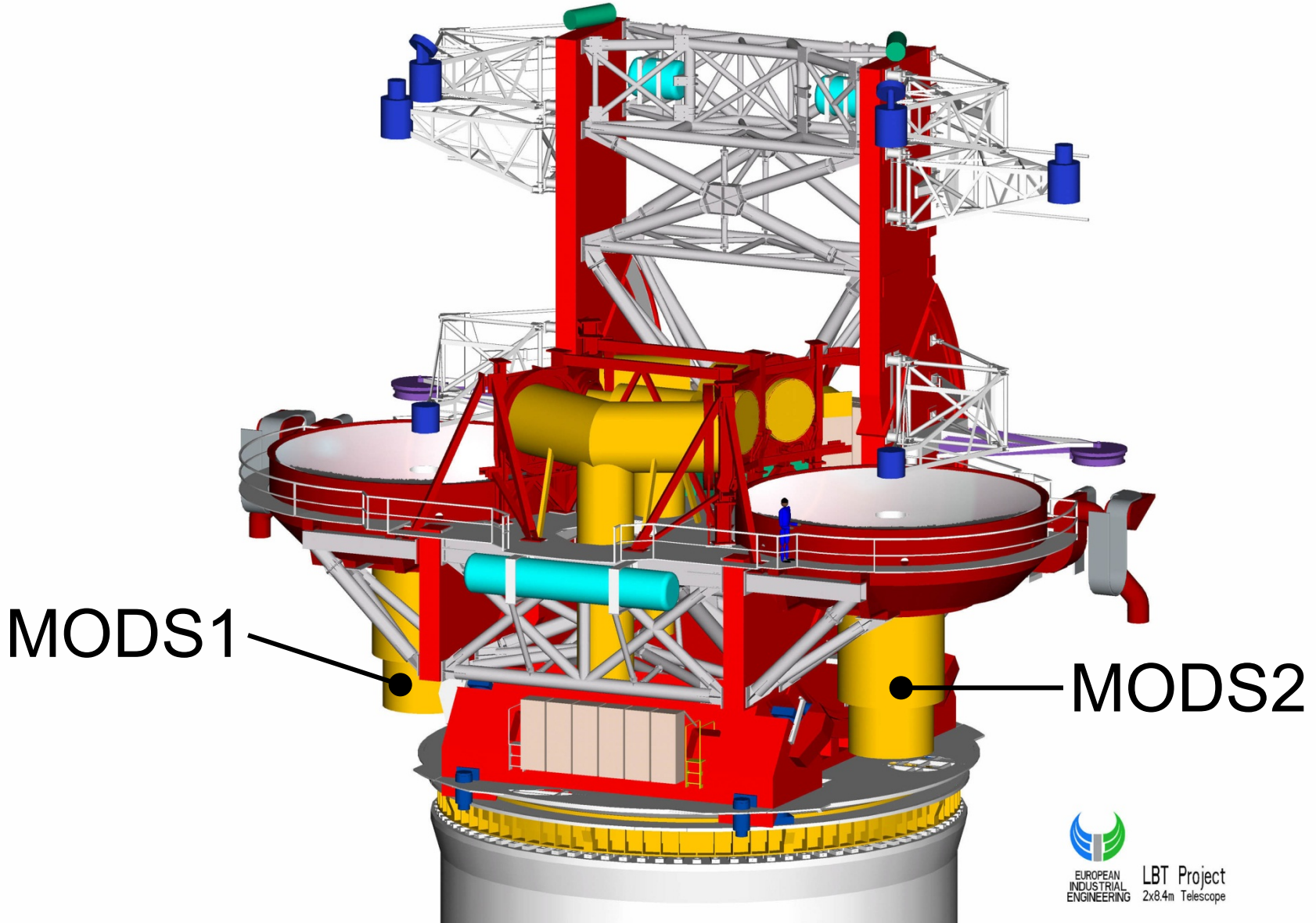


Richard Pogge for the MODS Team
The Ohio State University
2014 March 23 – LBTO 2014 Users Meeting

LARGE BINOCULAR TELESCOPE

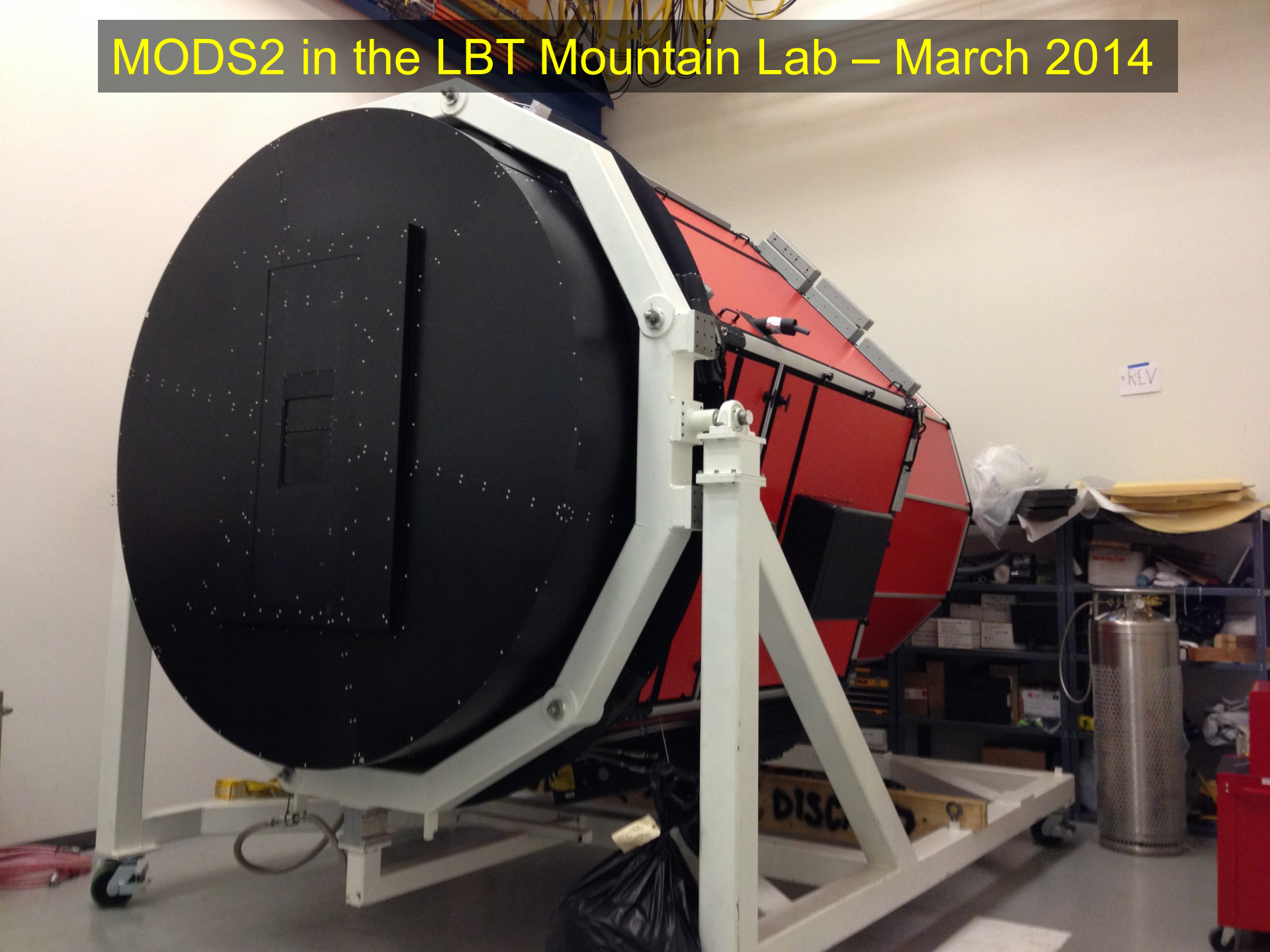
THE OHIO STATE UNIVERSITY

MODS are two facility UV-to-Near IR spectrographs for the LBT f/15 Direct Gregorian foci



MODS1 at the LBT Left Direct Gregorian Focus

MODS2 in the LBT Mountain Lab – March 2014



MODS Vital Statistics

Diameter: 2.5 meters

Length: 4.5-meters

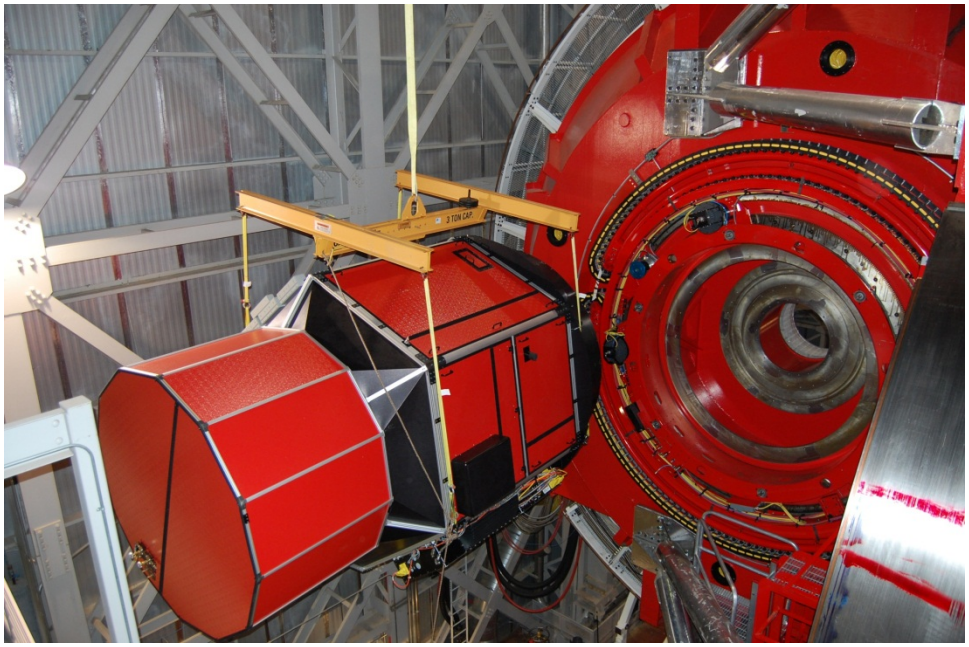
Mass: 3079 kg w/o cart

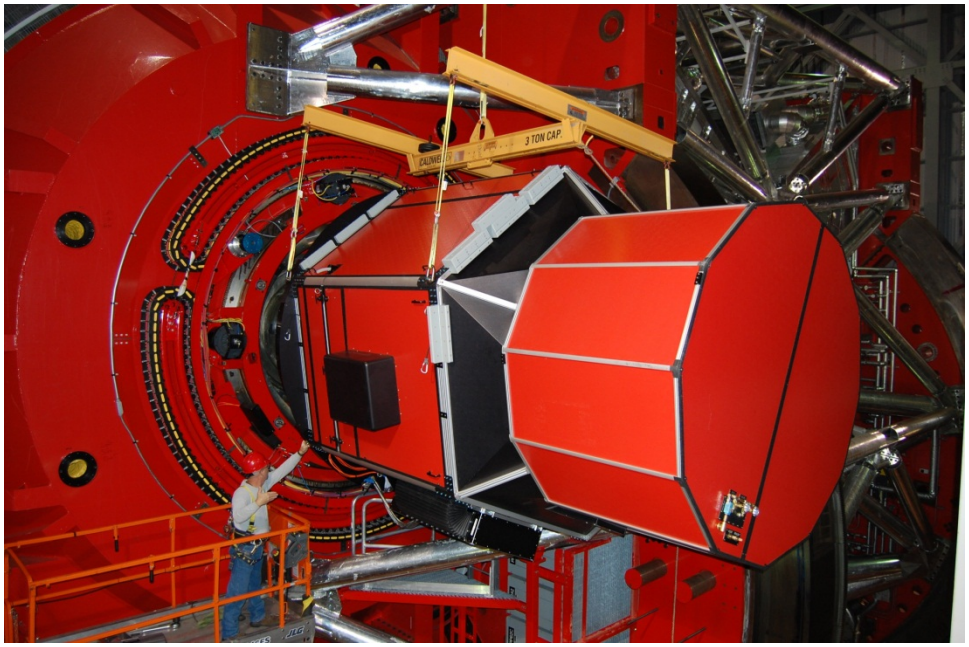
Reflective Collimators and decentered Schmidt cameras optimized for high-efficiency

e2v CCD231-68 8x3K CCDs

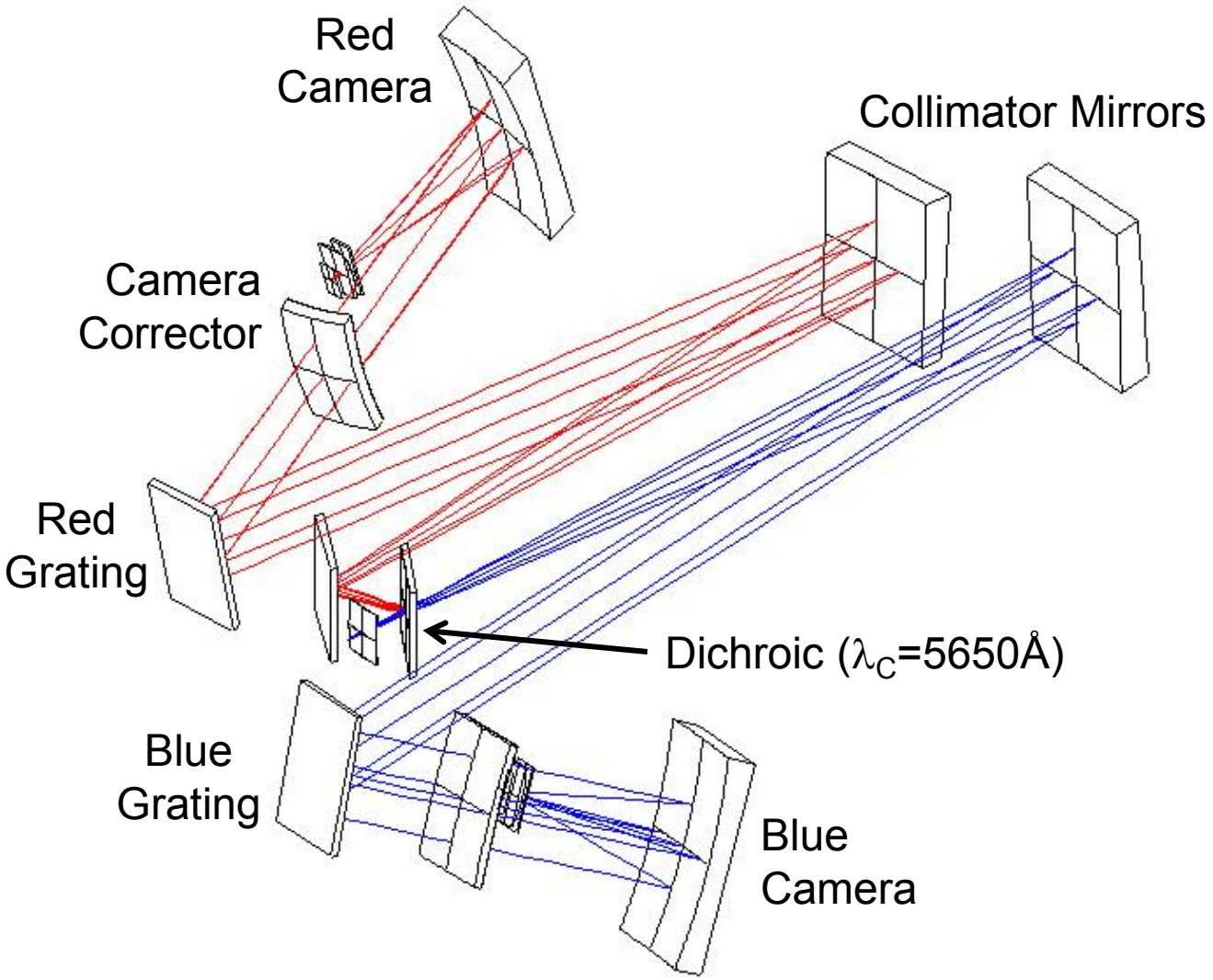
Closed-loop image motion compensation system

Integrated calibration and guiding/WFS systems



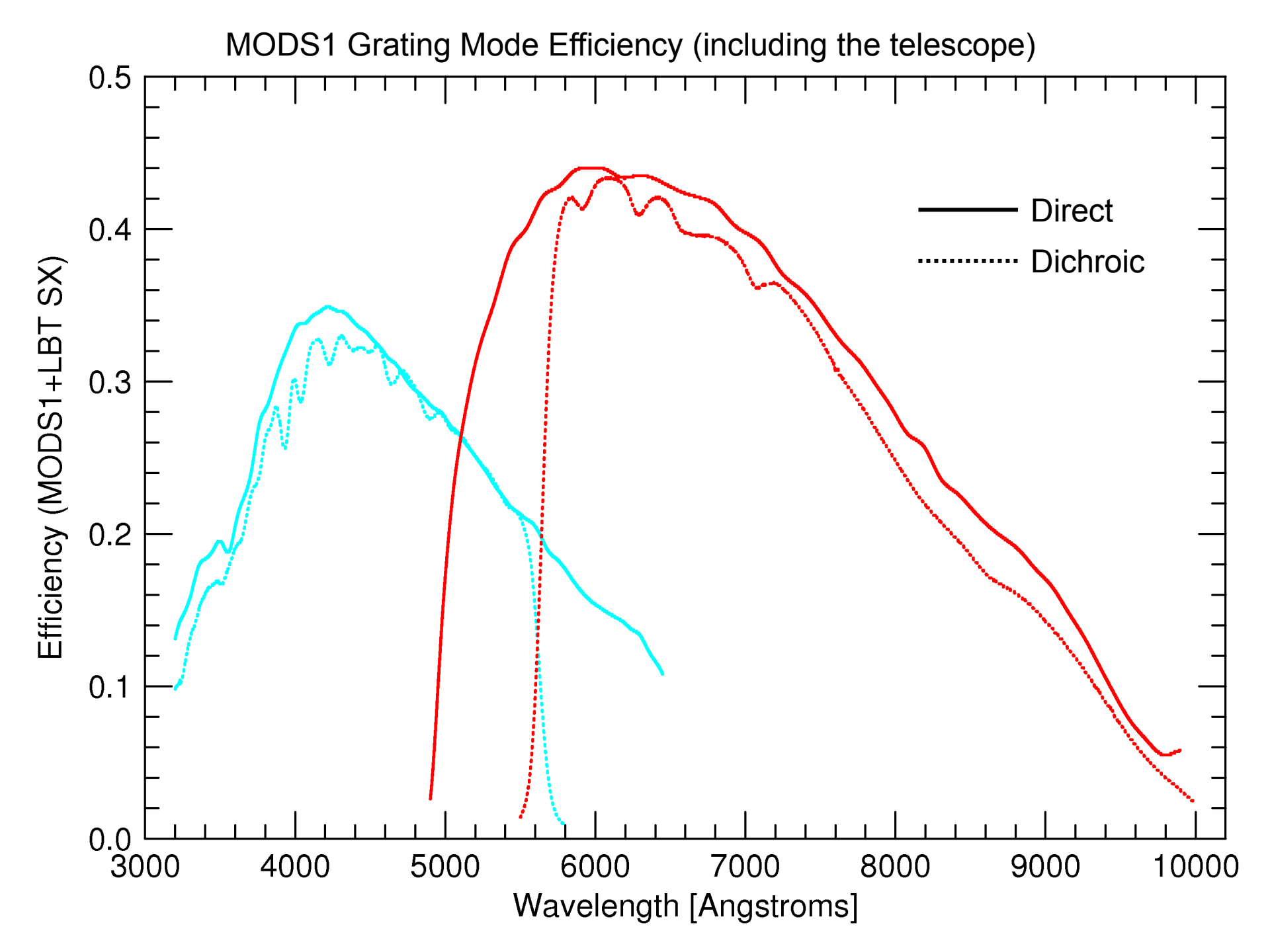


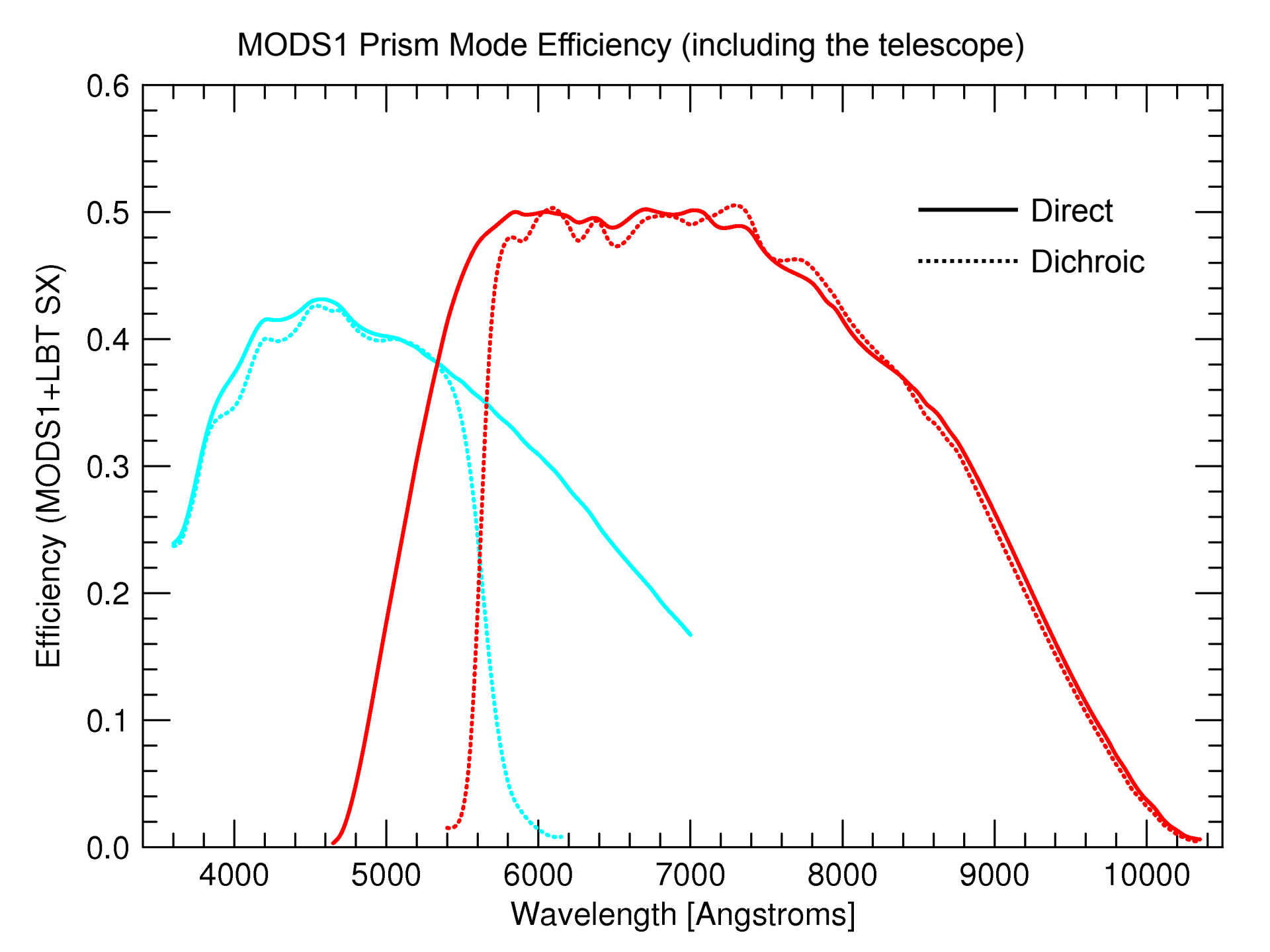
MODS are a variation on the classic Oke-Gunn Double Spectrograph design



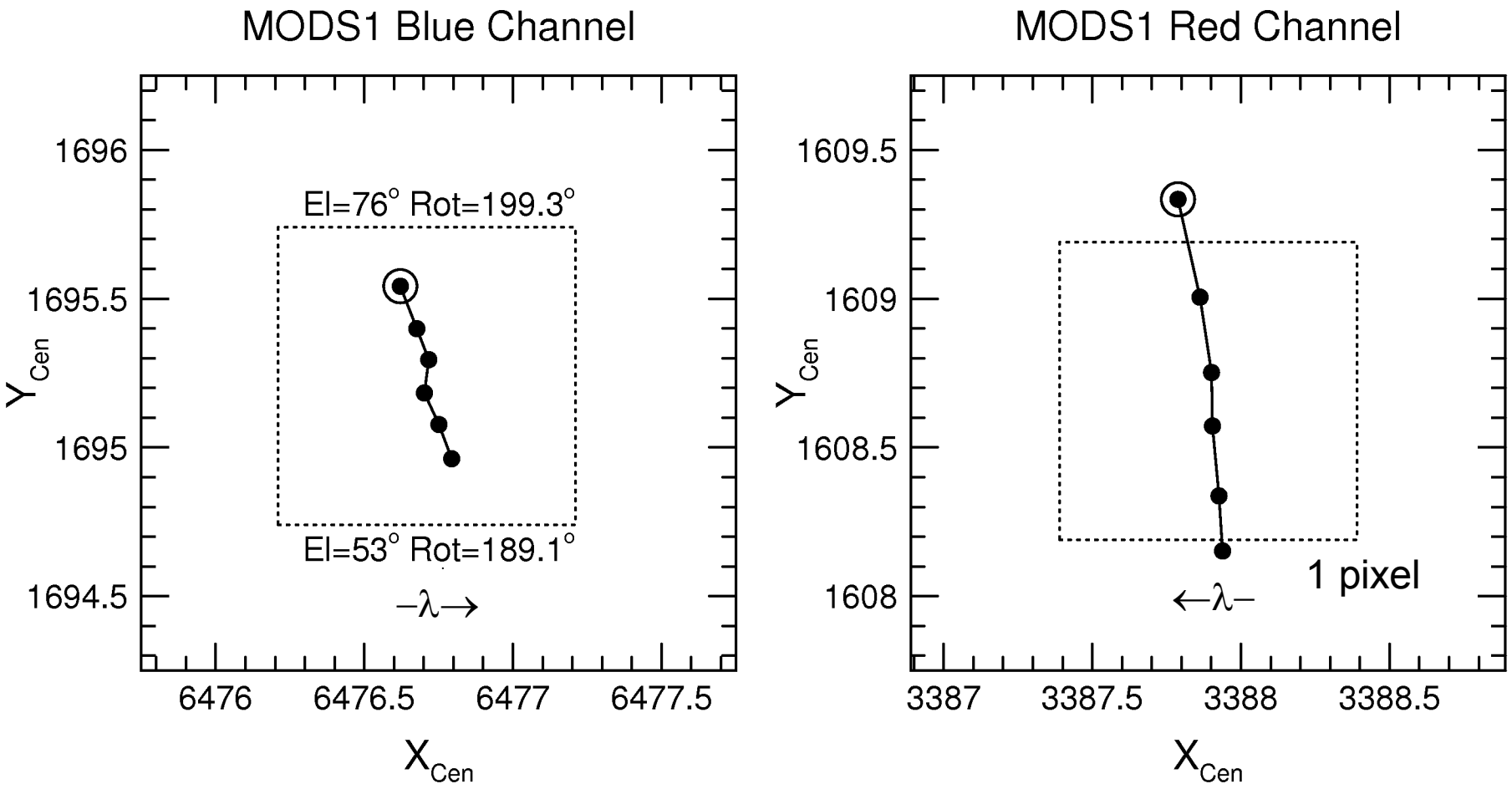
MODS are seeing-limited instruments with 3 baseline observing modes per channel.

	Blue	Red
Spectral Range	3200–6000Å	5000–10000Å
Mode	Spectral Resolution (0.6" slit, ~5 pixels)	
Low-Resolution Gratings	1850 (@4000Å)	2300 (@7500Å)
Double-Pass Prisms	400–125 (3200–6000Å)	600–180 (6000–10000Å)
Direct Imaging	ug (0.120"/pix)	riz (0.123"/pix)


MODS1 Grating Mode Efficiency (including the telescope)
Efficiency (MODS1+LBT SX)
Wavelength [Angstroms]
Direct
Dichroic
0.0
0.1
0.2
0.3
0.4
0.5
3000
4000
5000
6000
7000
8000
9000
10000


MODS1 Prism Mode Efficiency (including the telescope)
Efficiency (MODS1+LBT SX)
Wavelength [Angstroms]
Direct
Dichroic
0.0
0.1
0.2
0.3
0.4
0.5
0.6
4000
5000
6000
7000
8000
9000
10000

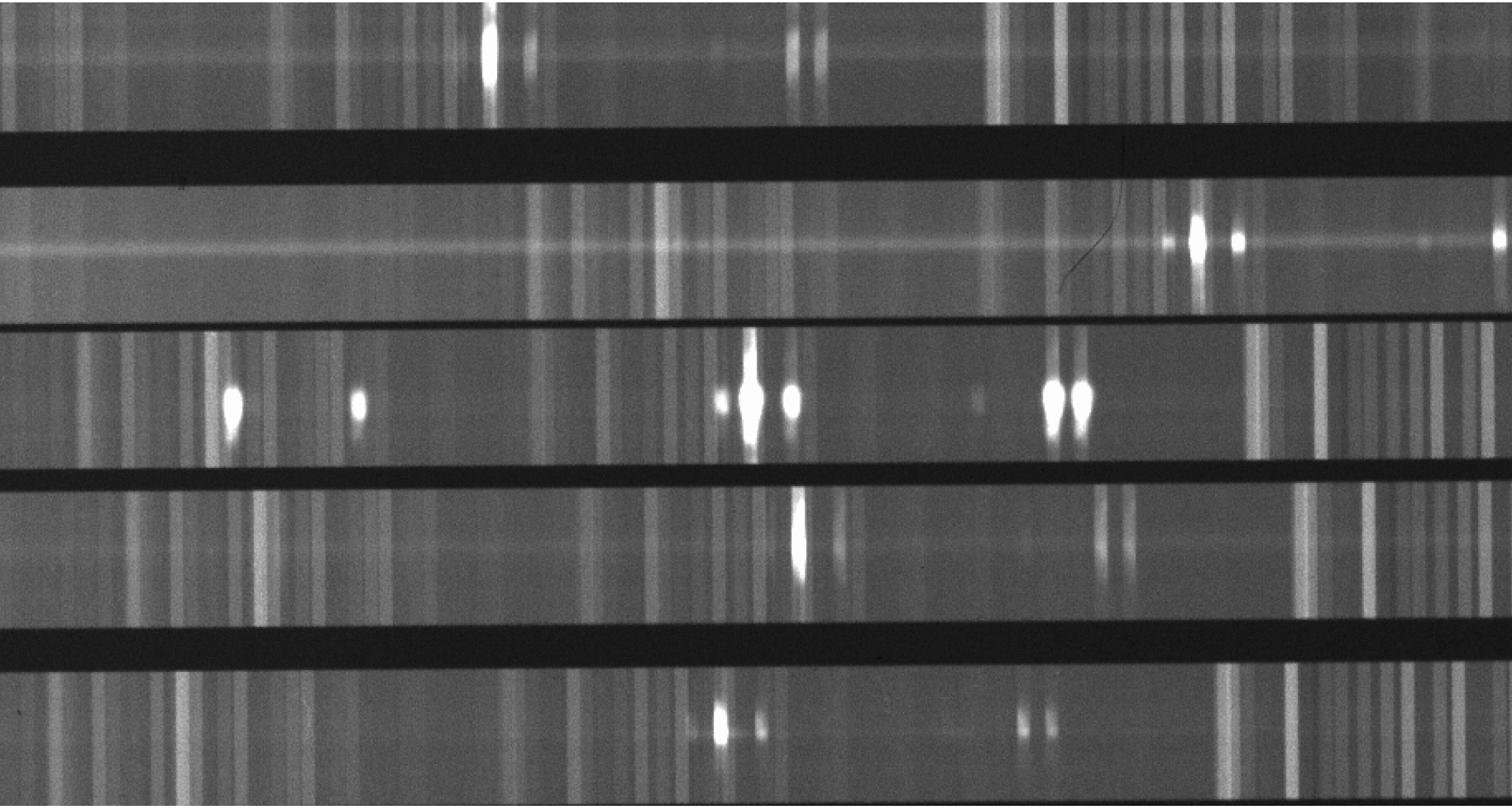
An active, closed-loop flexure compensation system maintains instrument alignment during changes in elevation and rotation.



1 pixel ≈ 120 mas

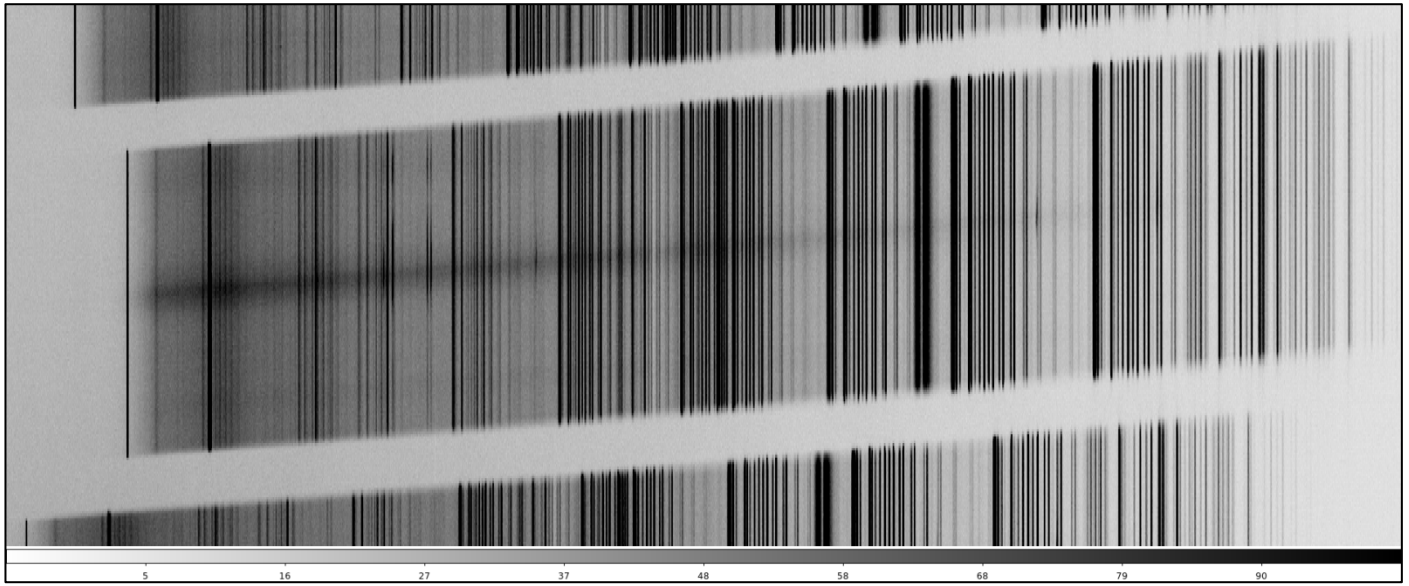
MOS spectra of NGC 925 – 2^h09^m of sidereal tracking

Internal and external baffling provides excellent control of scattered light, and the line spread function is very sharp.

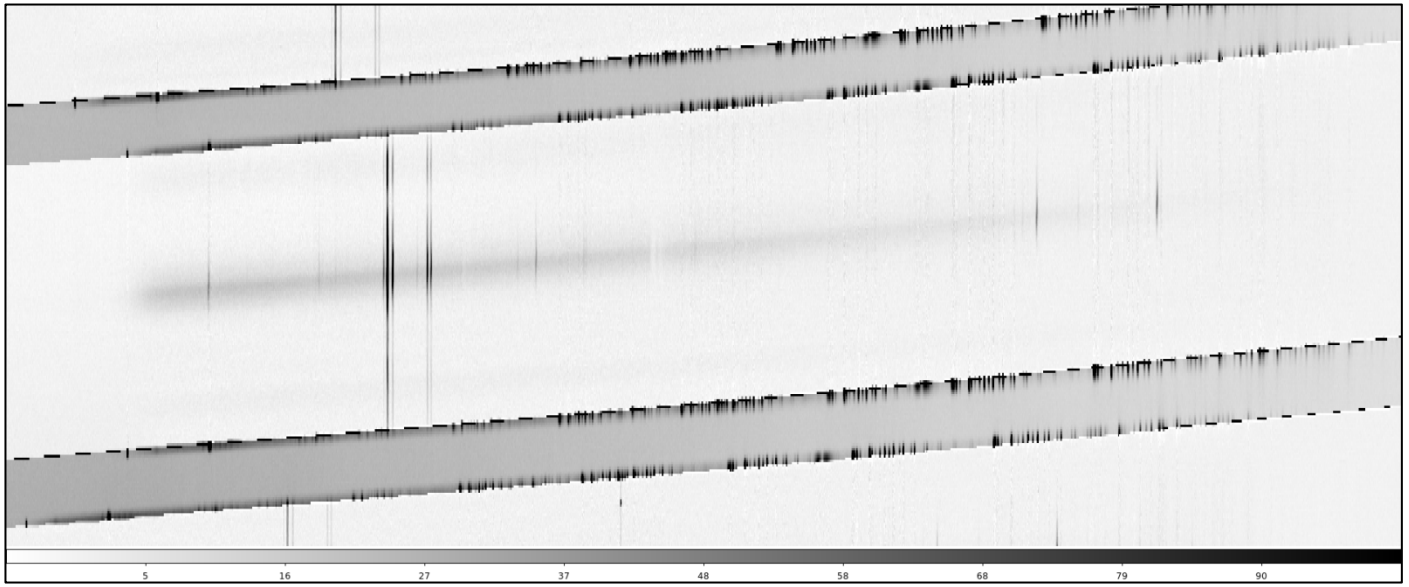


2^h of integration in grating mode during last-quarter moonlight.

Sky subtraction on short (10-15 arcsec) multislits is very clean,
Indicative of good slit cut quality and scattered light control.

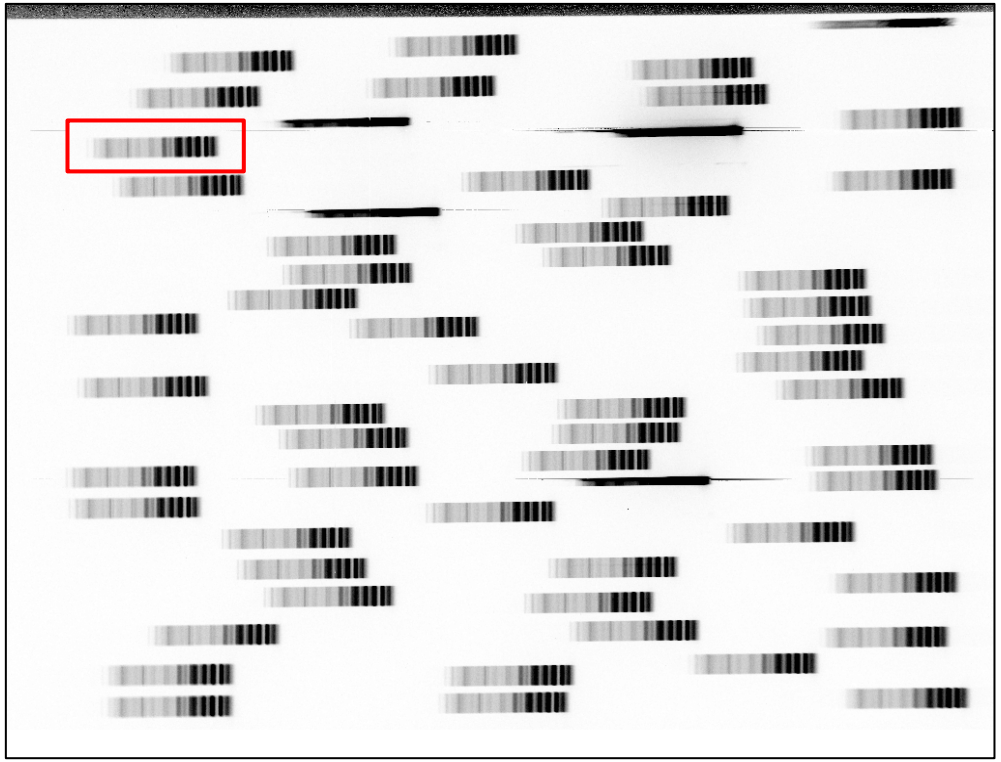


Raw



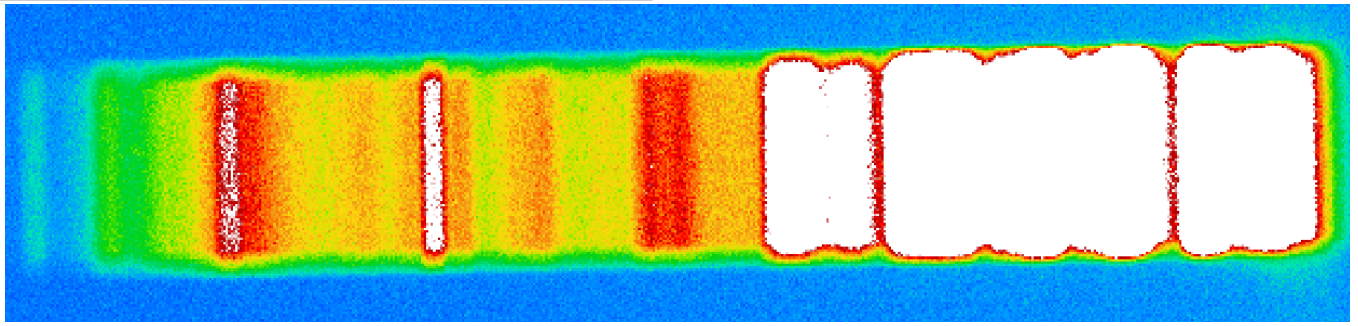
SkySub

Same scale!



Adams et al. in prep.
53 slits in prism MOS mode
15^{m} total integration in a deep galaxy field near a z=4 QSO1145.

Target: $r=25^{mag}$ galaxy.



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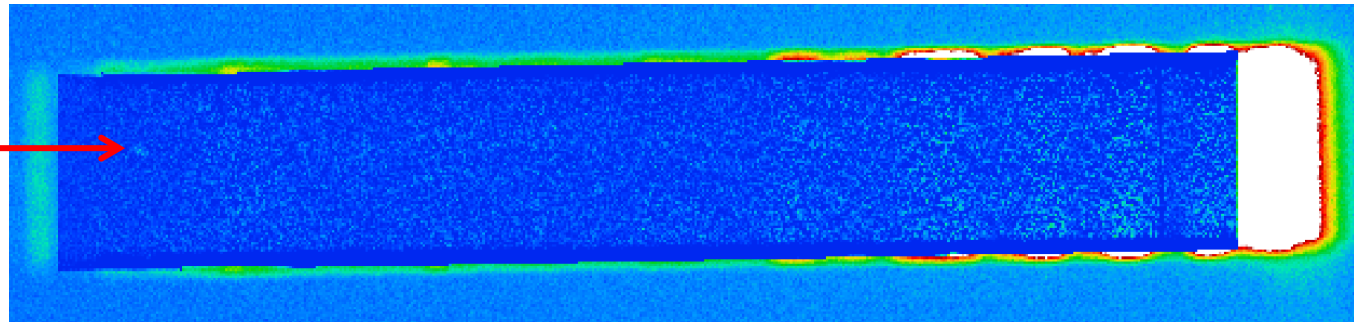


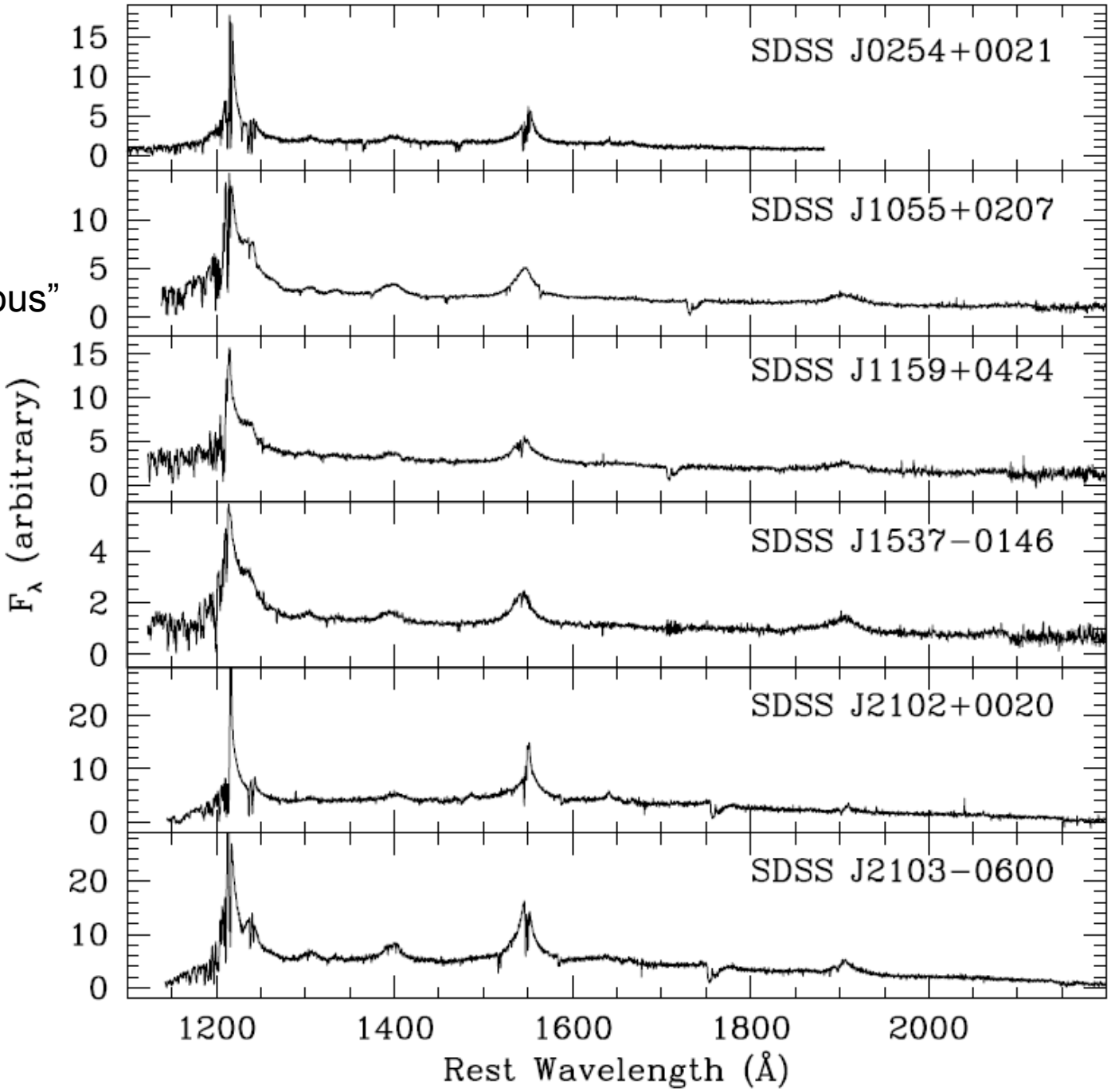
SkySub

Lyα Emission
@ Z=3.71

Denney et al. 2013
(ApJ, 775, 60)

Found that “anomalous” CIV line widths were an artifact of low signal-to-noise spectra.

MODS1 Spectra cleared up the CIV width anomaly.

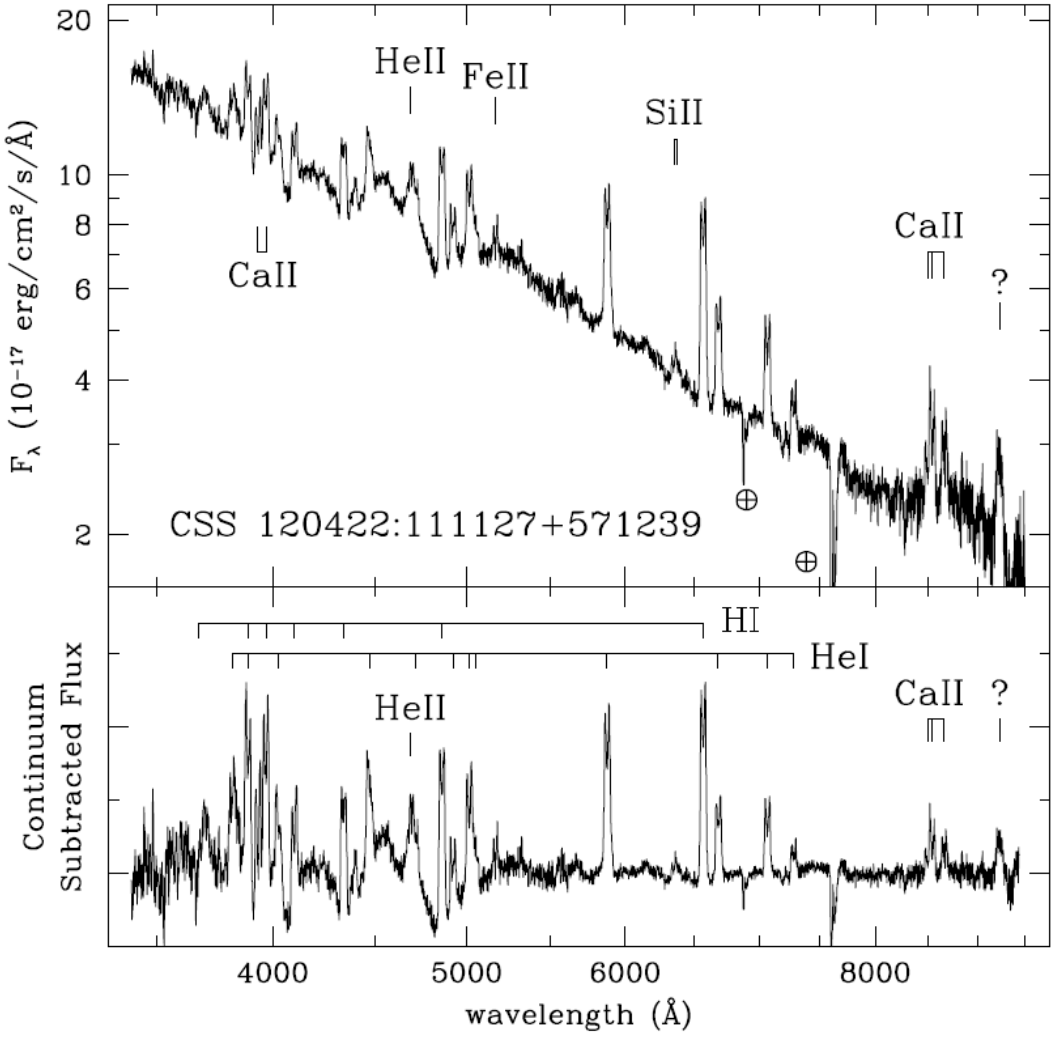


CSS 120422 – 52.2^{m} period CV
Littlefield et al. (2013, AJ, 145, 145)

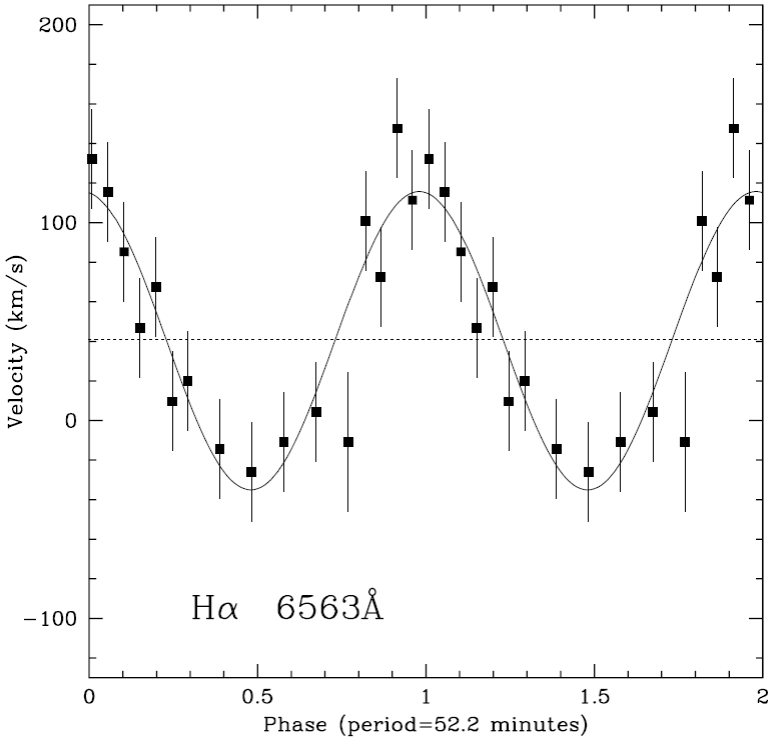
UTC 2012 June 16 (1.25^{h} total)

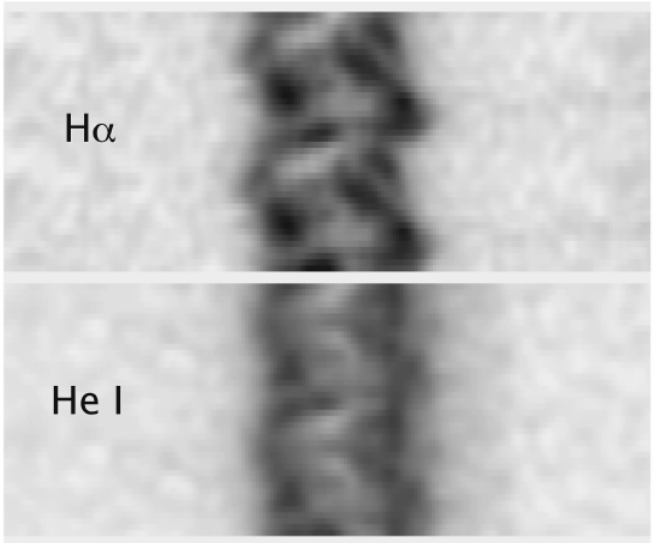
16 - 400s grating spectra in a continuous sequence.

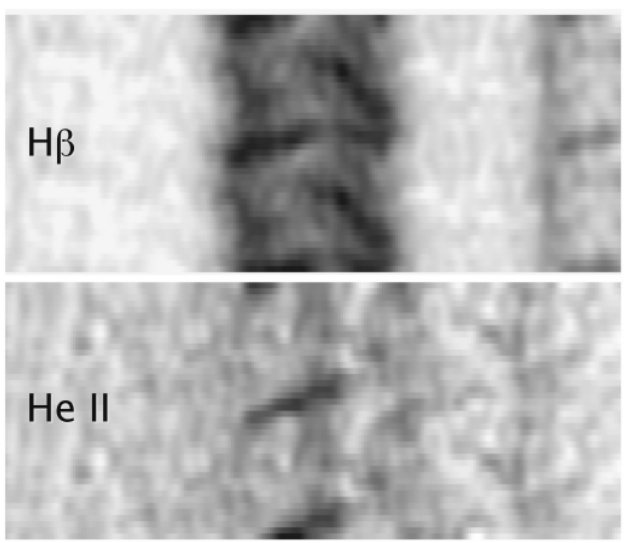
Composite Spectrum



Hα RV curve







time

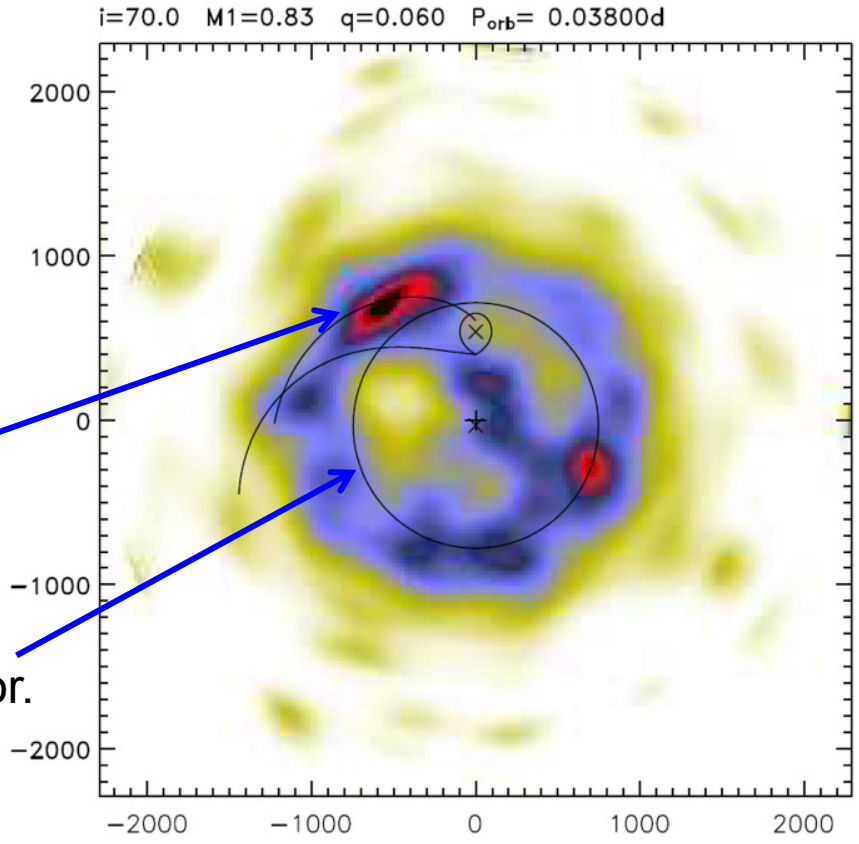
Trailed spectra of H, He^{+} & He^{++}

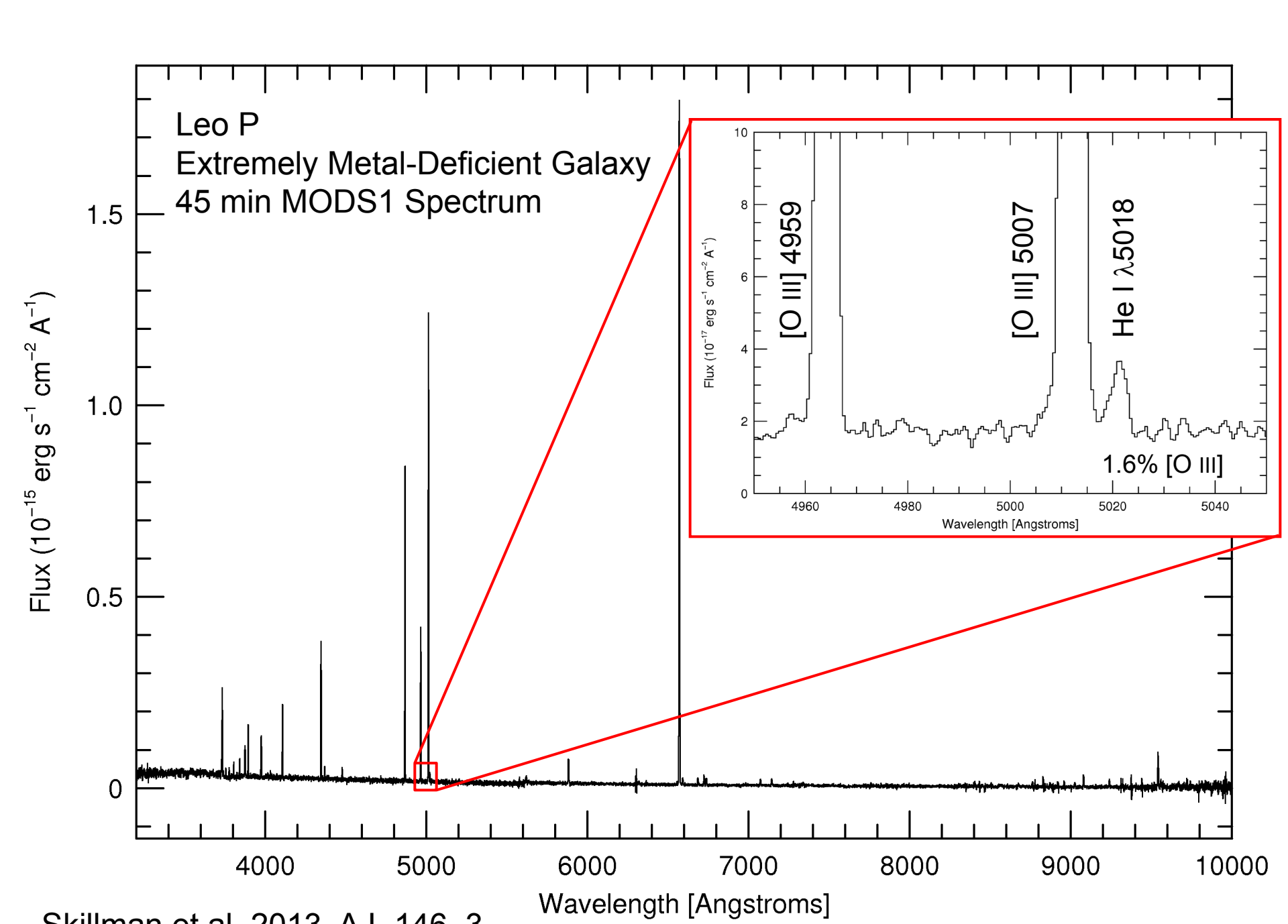
Doppler tomographic reconstruction of the accretion disk in Hα emission

Two distinct regions emerge:

1) Stream-disk interaction shock

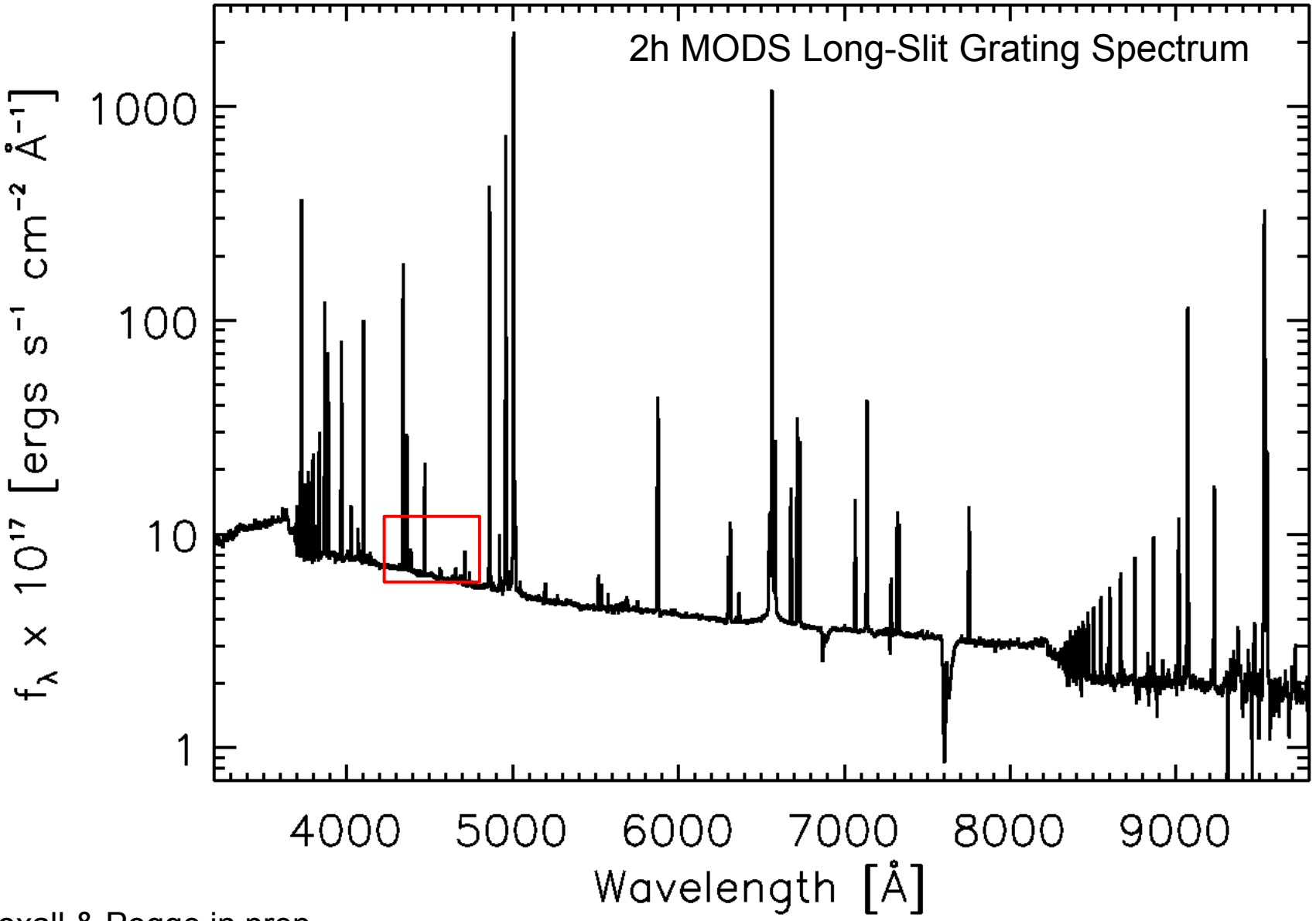
2) Spiral structure arising out of a 2:1 orbital resonance between the outer disk & donor.



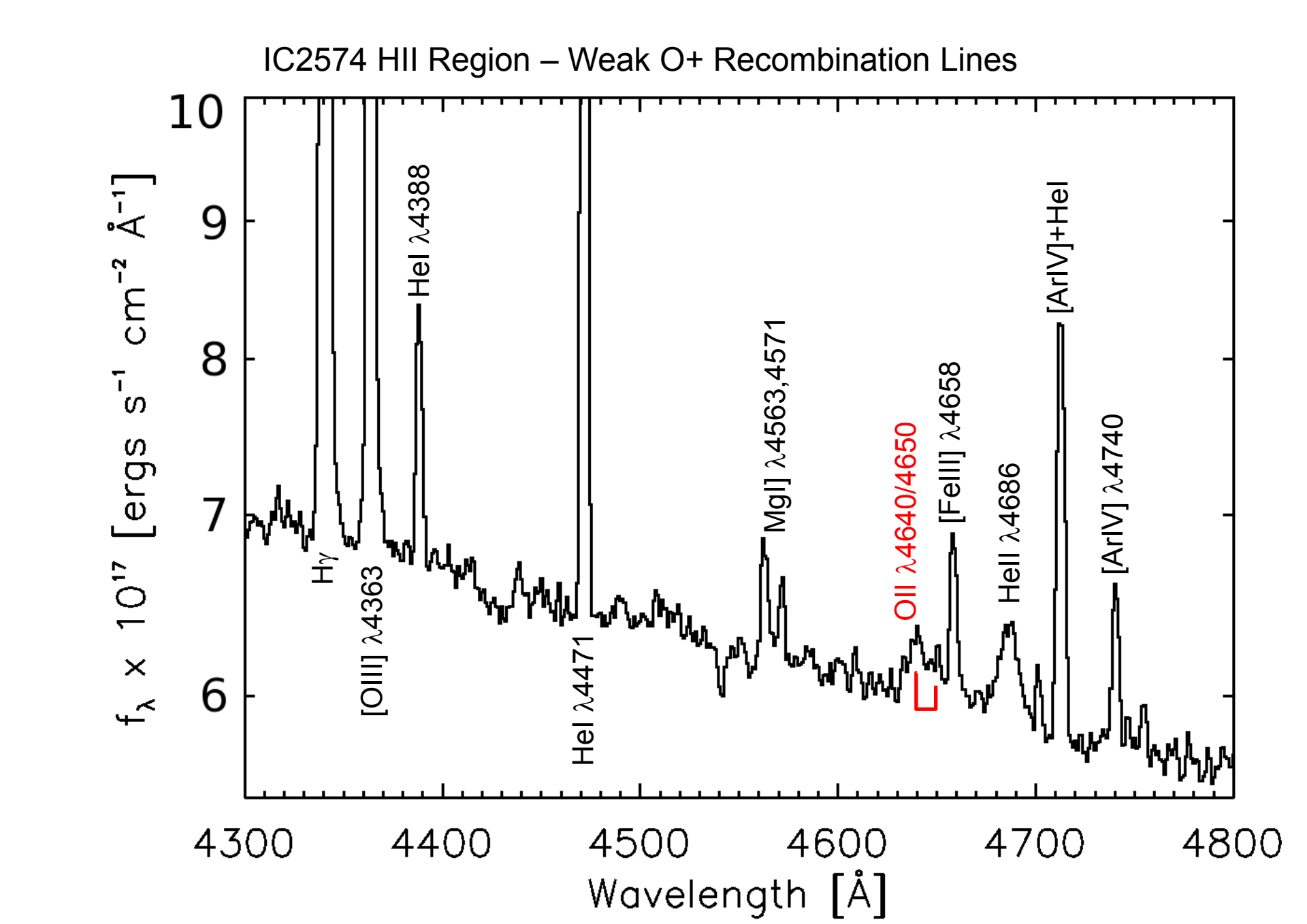


Skillman et al. 2013, AJ, 146, 3.

IC2574 Dwarf HII Region Galaxy



Croxall & Pogge in prep.



Croxall & Pogge in prep.

Coming Developments

MODS2 on-telescope start of April, start of focal station commissioning end of April

MODS2 one-eye commissioning and early binocular operation 2014B

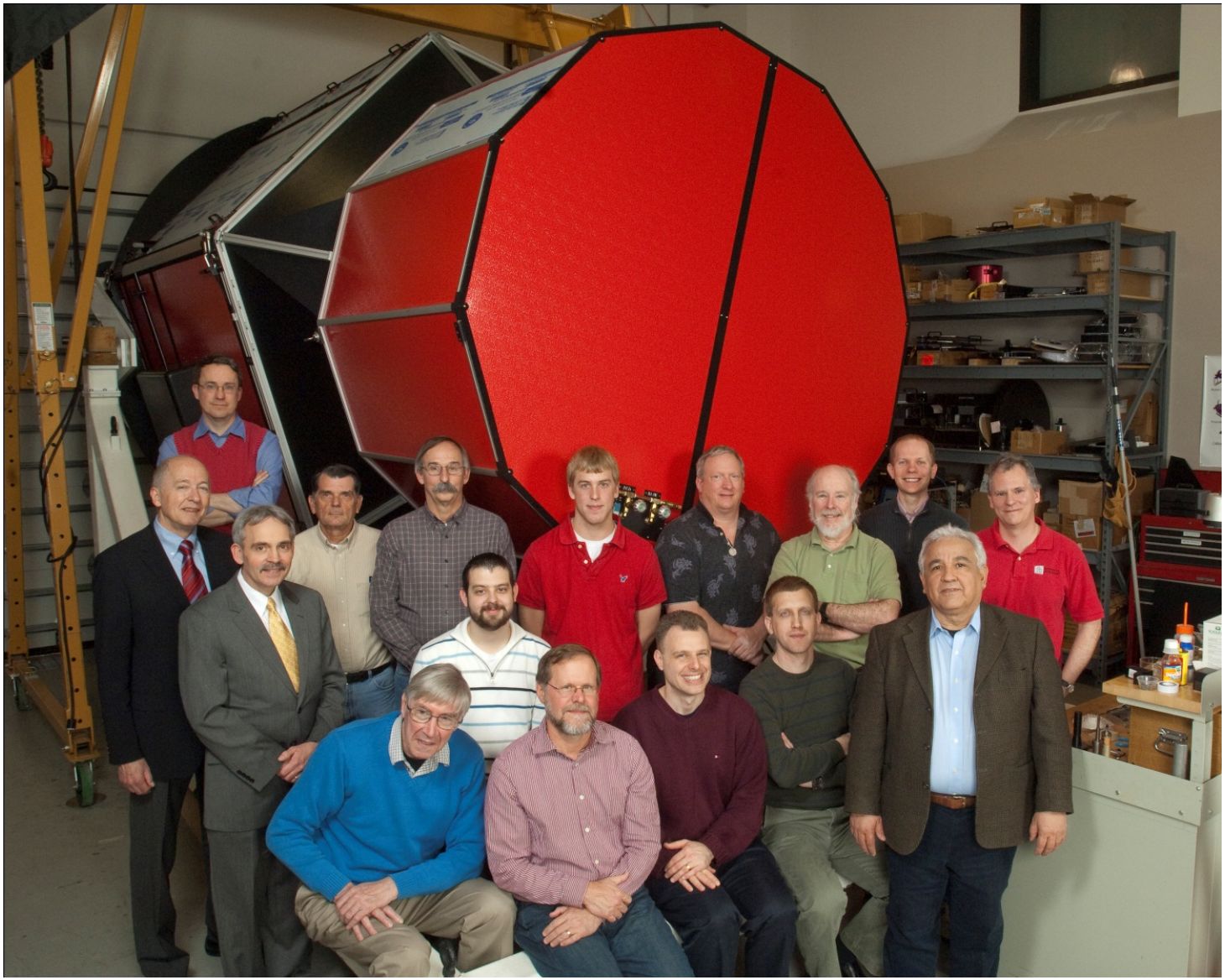
Expect release to community and binocular operation in 2015 (TBD)

Full MODS Reduction Pipeline to be given general release in April 2014.

MODS quick-look pipeline at the mountain for rapid evaluation of spectra:
- Alpha testing completed during Feb 2014 OSU/RC Run
- Beta release later in 2014B for all partners
- Full release for all observers

Updated modsAlign (newer/better/faster algorithm) in development.

Binocular observing planning tools in development.



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National Optical Astronomy Observatory