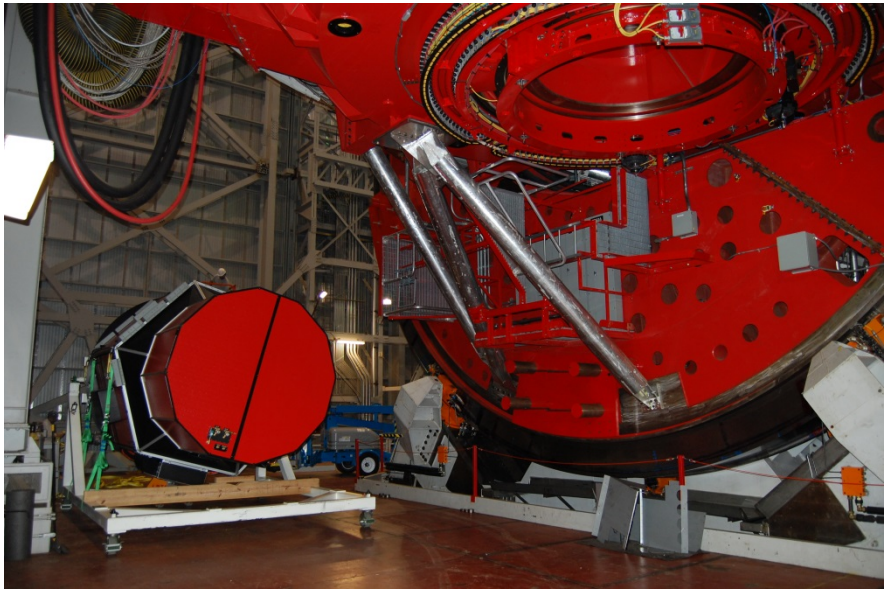
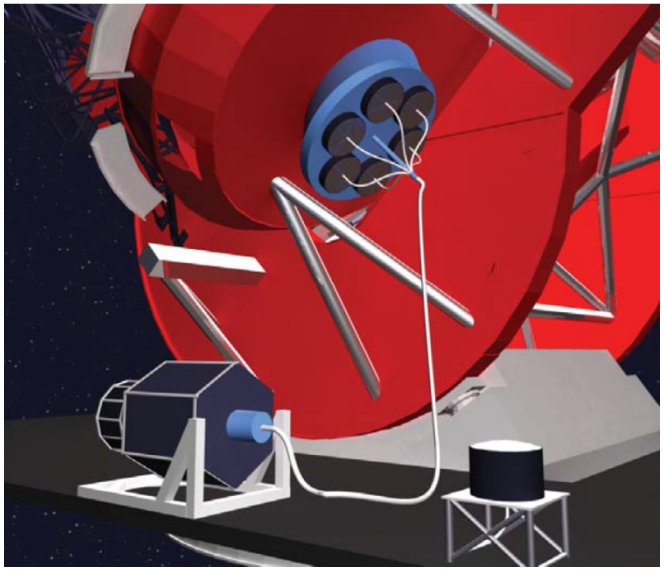
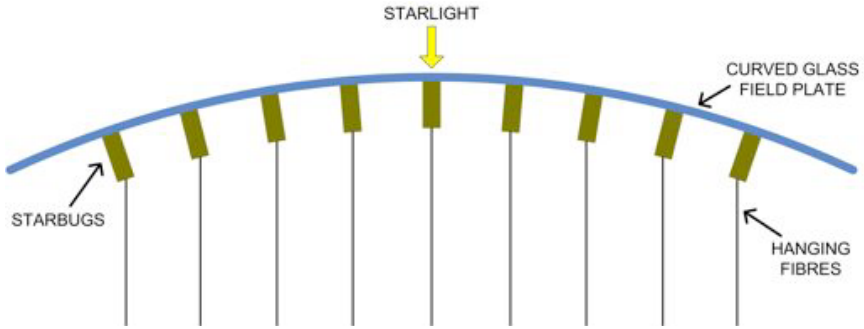
Flexible Multi-Instrument Multi-Object Spectroscopy Gregorian Fiber Positioner







R. Pogge & T.P. O'Brien (OSU)

J. Wilson & M. Skrutskie (UVa)

LBTO 2014 User's Meeting

Moderate-multiplex R>1000 optical spectroscopy on large aperture telescopes is a critical enabling technology for many frontier scientific programs.

Spectroscopic follow-up of targets from medium- to large-scale imaging surveys to obtain

- Redshifts
- AGN identification
- Supernova type and monitoring

Large-scale sample measurement

- Abundances of galactic and local-group halo stars
- Stellar pops, abundances, & masses in galaxies
- Black hole mass estimates in AGN
- Galaxy cluster membership determination
- Cosmic structure studies.

Identified as a key “workhorse” capability for 8-10m class telescopes for all areas of astrophysics by the recent NSF Portfolio Review

Case Study: A Multi-Fiber Augmented MODS

Current MODS configuration:

- 5 arcminute diameter primary field-of-view
- R=2000 Grating, R=200 Prism
- Grating-mode multiplex: ~20-30 targets
- Prism-mode Multiplex: ~50-60 targets

Full Direct-Gregorian Field:

- ~0.2-degree diameter unvignetted FoV
- Excellent seeing-limited image quality

R=2000 on 8.4m telescope

- Extragalactic: ~3000 targets/deg^2/mag at i=21
- In full DG field, ~400 targets per field at i=21

Even full DG presents us with a very “target-rich” environment.

MIMOSA

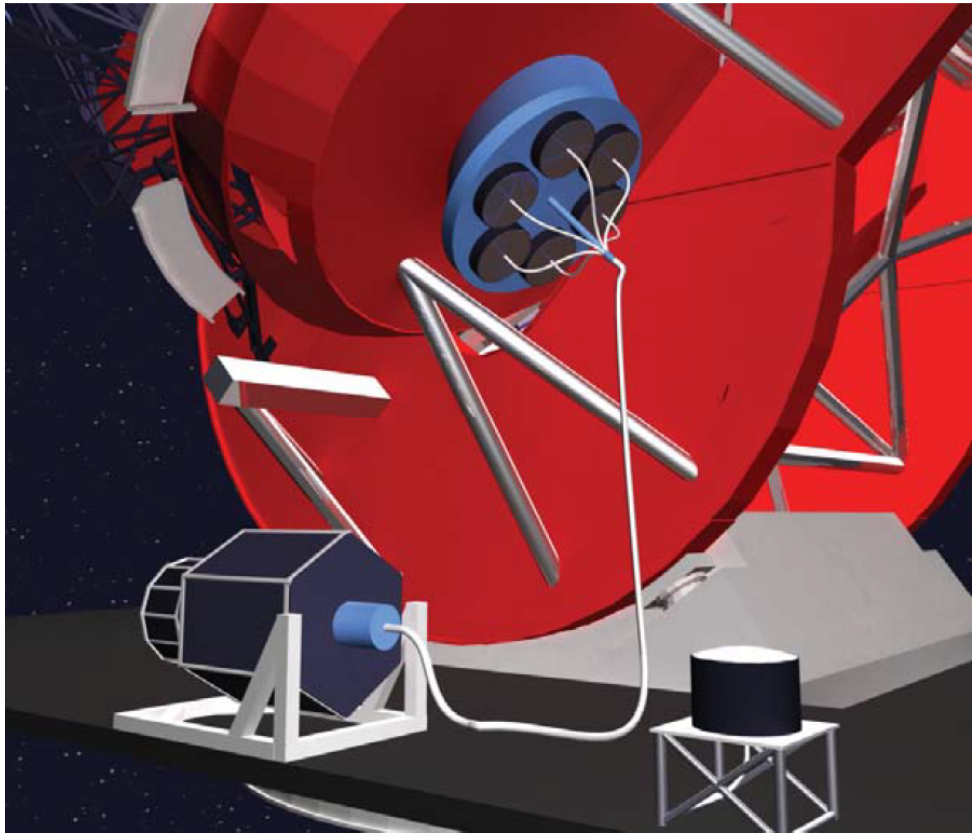
Minimum Investment Multi-Object Spectrograph for Astronomy

2008 Gen 2 white paper by Bell, Herbst, Rix, & Bizenberger (MPIA)

Replace MODS by a revolver mechanism carrying up to 6 pre-plugged full fiber plates.

Feed fibers to MODS or another spectrograph.

Also proposed considering a robotic fiber positioner.



Wide-Field Moderate-Multiplex Spectroscopy

Two Performance Metrics defined by DESI (ex-BigBOSS) project:

Spectrographic Efficiency:

$$\varepsilon = (Aperture)^2 \times N_{obj} \times \eta$$

Sky Mapping Efficiency:

$$\mu = (Aperture)^2 \times FoV \times \eta$$

Normalized to SDSS/BOSS having $\varepsilon=\mu=1$

	ε	μ
DESI	14.6	2.9
Current MODS	0.4	0.03
W-F Fiber MODS	6.4	0.48

AAO Star Bug Fiber Positioner

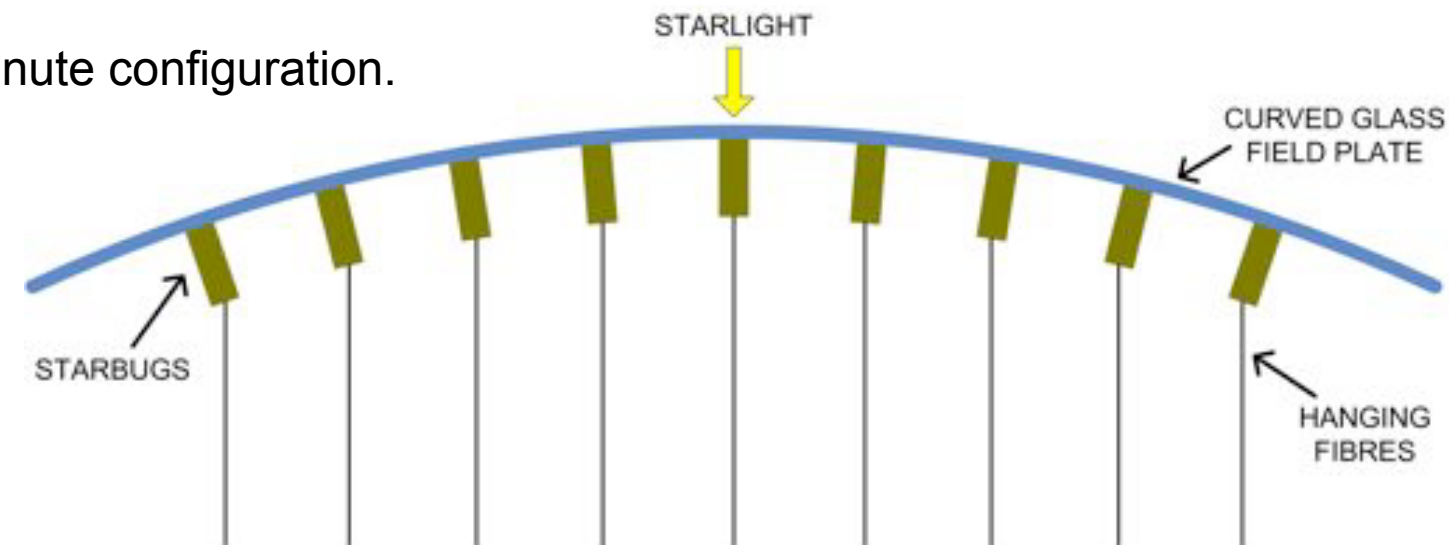
Gilbert et al. SPIE 2012, 8450

Mini, self-propelled piezo-electric robots.

Crawl on protected side of a glass field plate with LBT DG 1055mm radius of curvature.

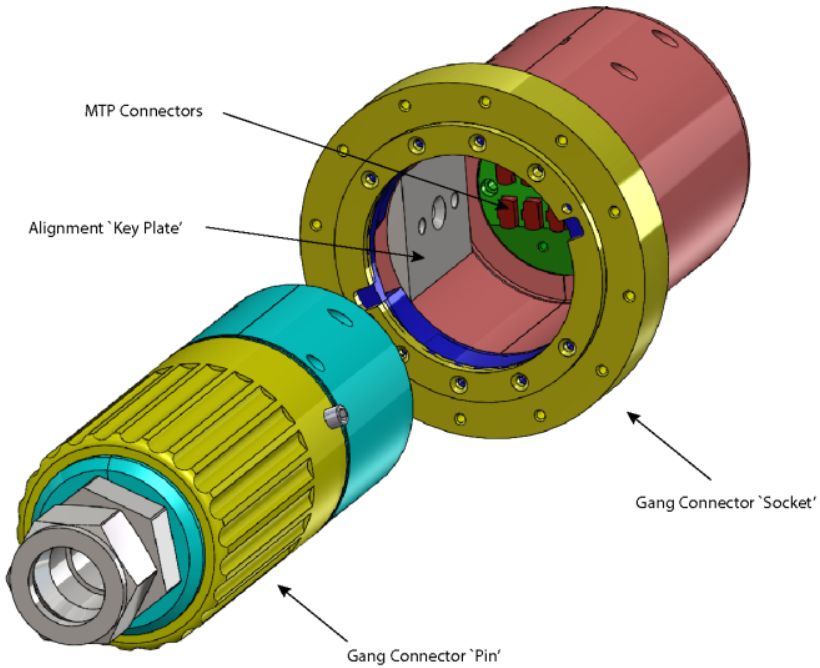
But units could be single fibers, object/sky pairs, or multi-fiber IFU bundles.

1-3 minute configuration.



Enabling Technology: Fiber Gang Connector

Developed for APOGEE for SDSS



Allows simultaneous plug/unplug of fibers, even during a night.

Could serve multiple instruments and science modes with the same fiber positioner facility on the telescope.

A pathway to creating a moderate-multiplex fiber spectroscopic capability for the LBT

Fiber feed technologies?

- Choice of Fiber Positioner Technology
- Focal Coupling Schemes
- Connectorization from Direct Gregorian to Spectrograph
- Type of Fiber (low-OH “dry” FuSi, Fluorite for IR)?

Spectrograph to Use?

- Suitability of MODS (UV to Near-IR R=100 to 2000/ 8000)
- APOGEE Clone (0.8-2.5μm Near-IR R=10,000?)

Operational Issues:

- Fiber Positioning Configuration Efficiency?
- Instrument Setup and Night-Time Utilization?

Technology Development Roadmap

Phase 1: Lab Prototyping and Positioner Evaluation
- 2014 – 2015:
- Cost: $45K (Hardware, Travel)
- OSU contributes prototype design and fabrication
- Outcome: NSF proposal in 2015

Phase 2: Demonstrator Project
- few $100K NSF ATI proposal, 2-3 years
- ~20-fiber telescope demonstrator: DG to MODS on floor

Phase 3: Full Binocular Fiber Facility (and Instrument?)
- few $M NSF MSIP proposal
- 4-5 year development to deploy
- New feed instrument: APOGEE clone? Other?