FOBOS

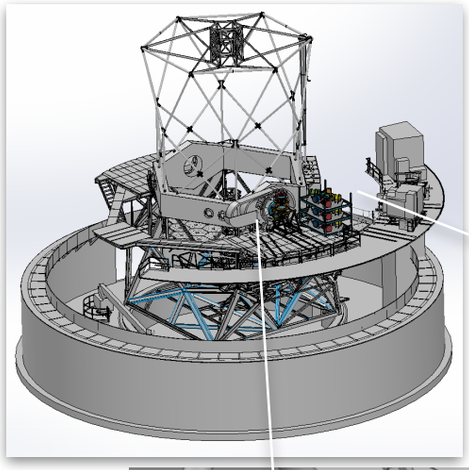
FIBER OPTIC BROADBAND OPTICAL SPECTROGRAPH

Project Overview and LSST Science Links

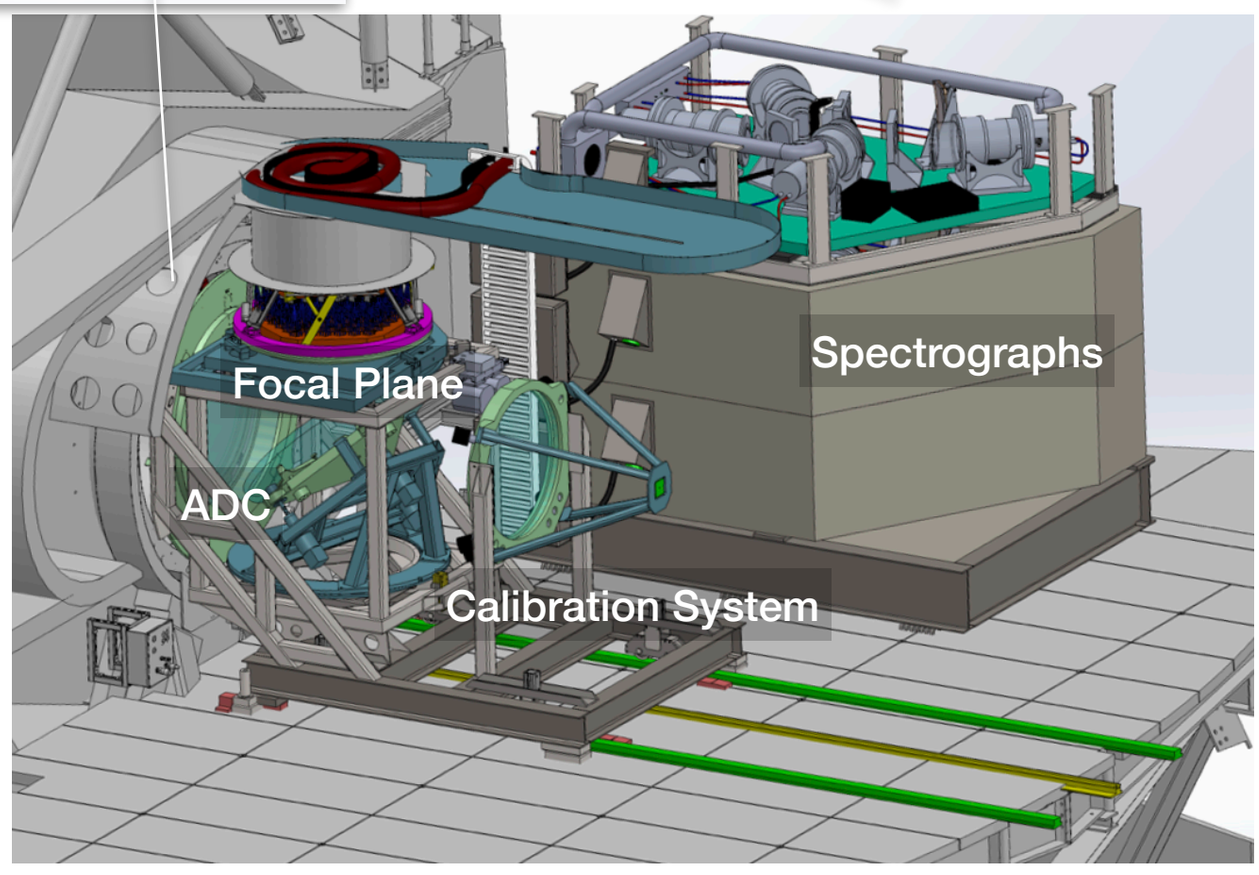
Kyle Westfall (UC Observatories)
for the FOBOS team

Instrument Overview

FOBOS
FIBER-OPTIC BROADBAND OPTICAL SPECTROGRAPH

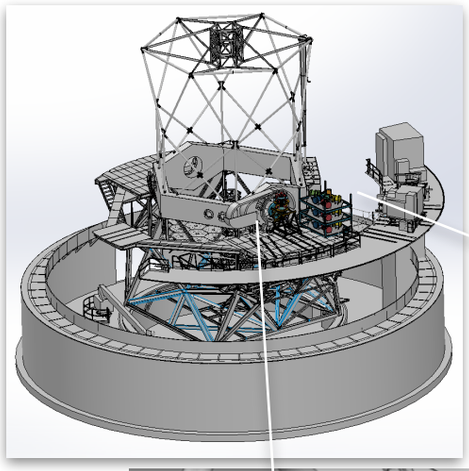


FOBOS: Deep spectroscopy at high multiplex

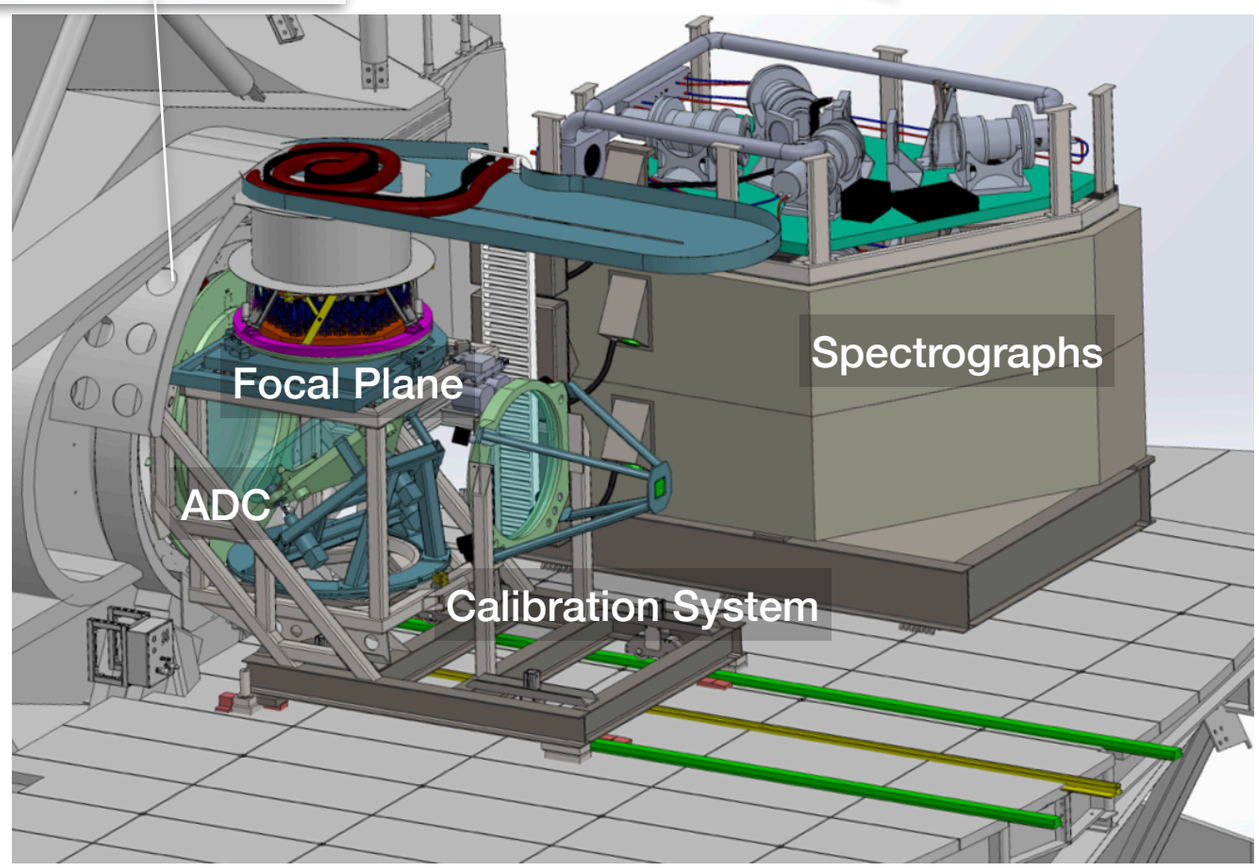


Telescope Mount	Keck II Nasmyth
Field Diameter	20 arcmin
Spectrographs	3 x 4-channel DESI-like
Wavelength range	310-1000 nm
Fiber run	~15 m
Spectral Resolution	R ~ 3500
Total Fibers	1800
Apertures	Single-fiber Multi-IFUs, Mono IFU
Positioners	Starbugs
Throughput	≳30% (over 95% of the spectral range)
Limiting Magnitude	r_{AB} ~ 24.5 (S/N~1 after 1 hr)

Key Capabilities

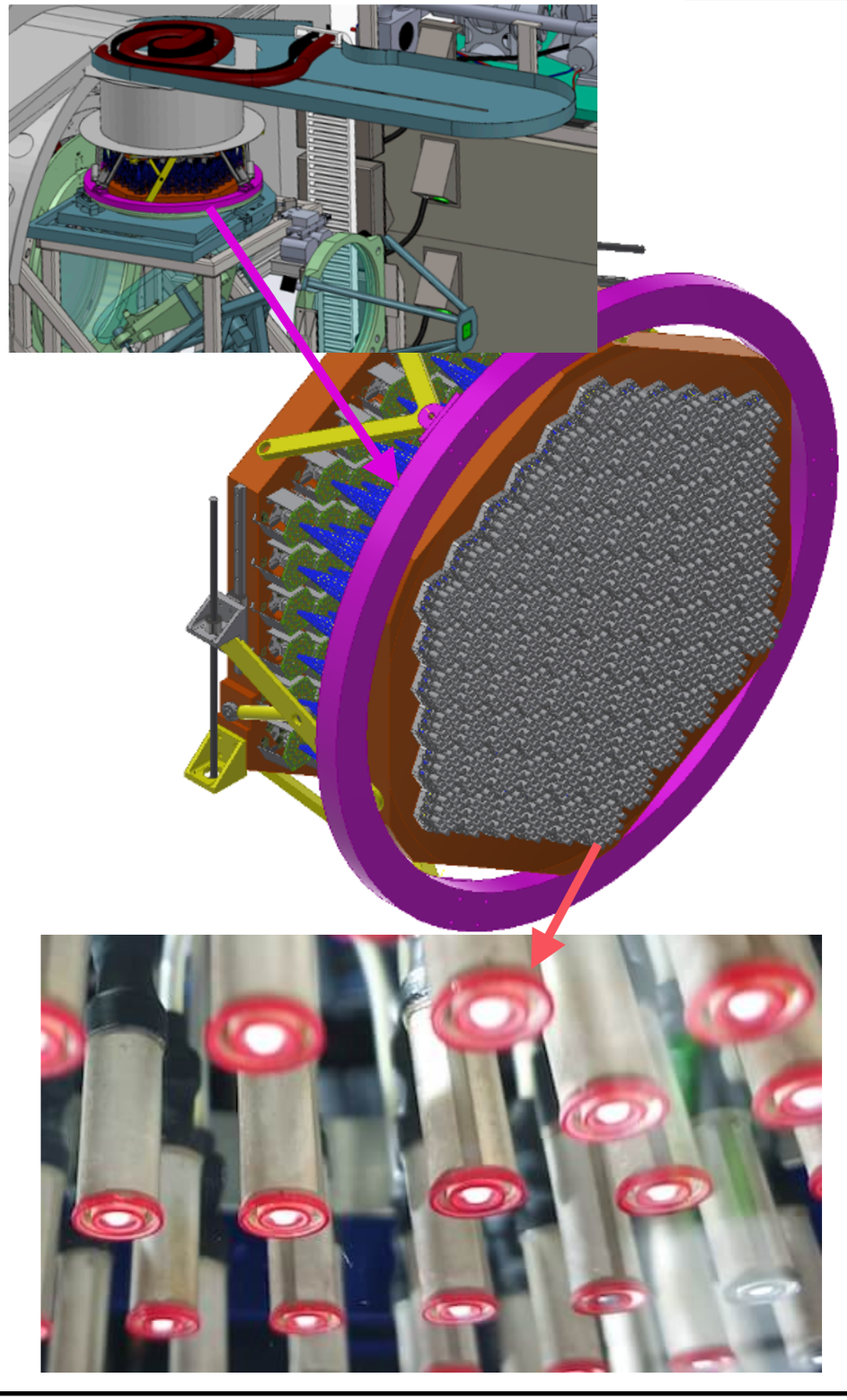


FOBOS: Deep spectroscopy at high multiplex



- **Blue Sensitive**
  - Telescope + Site + Short fiber run
  - No redshift desert
- **Stable, well-calibrated performance**
  - Support *long* integrations (10s of hours)
- **Flexible focal plane**
  - Both single aperture and IFU positioner payloads
  - Single apertures can achieve high densities (>5 arcmin^{-2})

Focal Plane Apertures



- FOBOS uses Starbugs to move aperture payloads in the field
- FOBOS has five aperture types
  - 0.8” Single-fiber
  - 5.6” 37-fiber multi-IFU
  - 37.6” 3x547-fiber Monolothic IFU
  - 7-fiber flux-calibration bundle
  - Pointing/Focus tracking bundles
- Each spectrograph can be put in 1 of 3 modes

Active Payload	MOS Mode	Multi-IFU	Monolithic IFU
Designated Sky (single fiber)	0	56	27
Single-fiber	546	0	0
37-fiber IFU	0	14	0
Monolithic IFU	0	0	1
7-fiber Flux Cal	4	4	4
Total Active Fibers	574	602	602

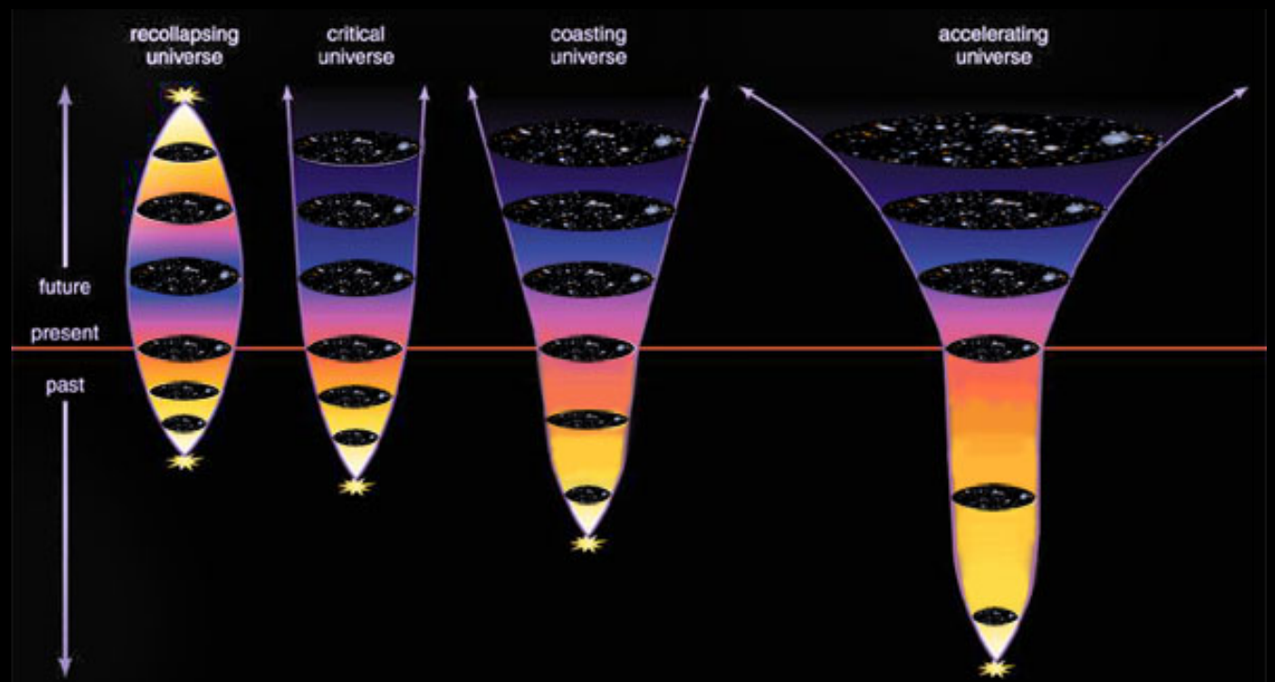
FOBOS Science

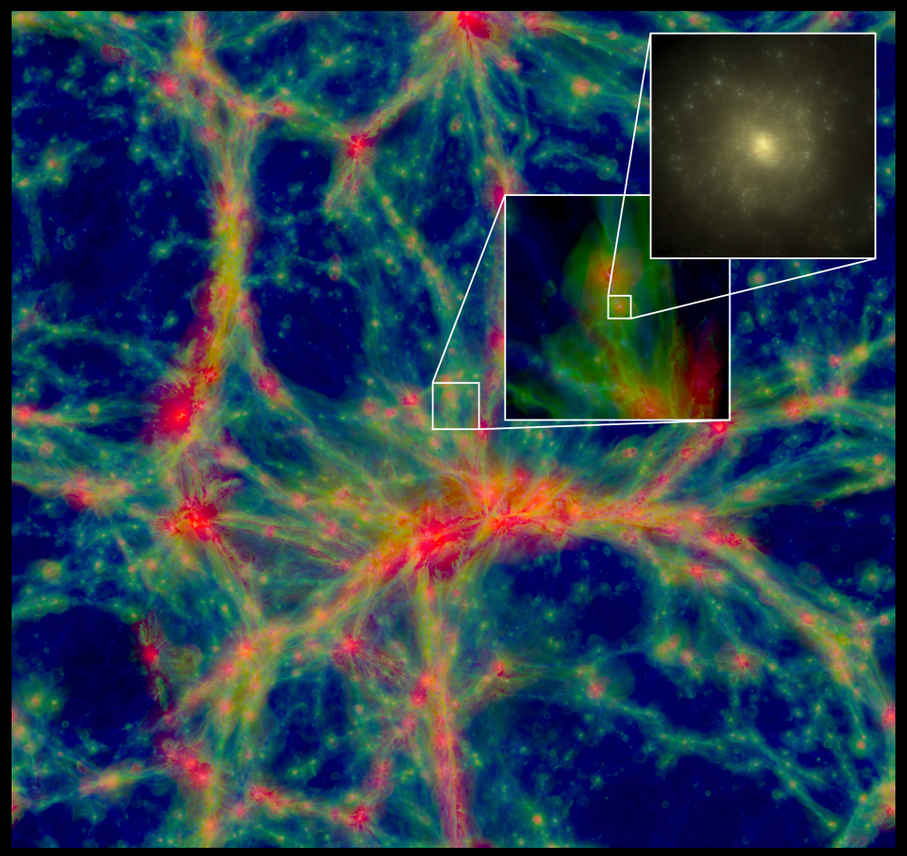
FOBOS Science Themes

The Dark Sector

Dark Energy Photo-zs

Dark Matter in Dwarfs





The Cosmic Ecosystem Across All Scales

IGM Tomography

CGM Characterization

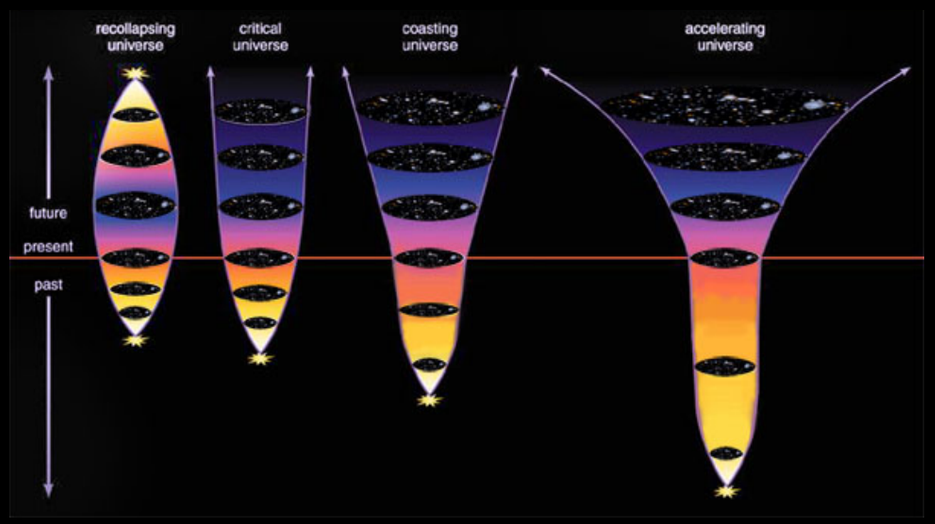
Galaxies and baryons at z~3

M31 Disk

Kilonovae Enrichment

The Dark Sector

Significant “Added Value” to LSST/Roman Mission Goals



Dark Energy Spec-z’s

Spec-zs for photo-z training: 15,000 galaxies in 12 fields with **$24 < i_{AB} < 25.3$**
(Matches “Ensemble Spectra Program”)

This “FOBOS Dark Energy program” would effectively *double* the cosmological per-night value of LSST.

Dark Matter: Nearby Dwarfs

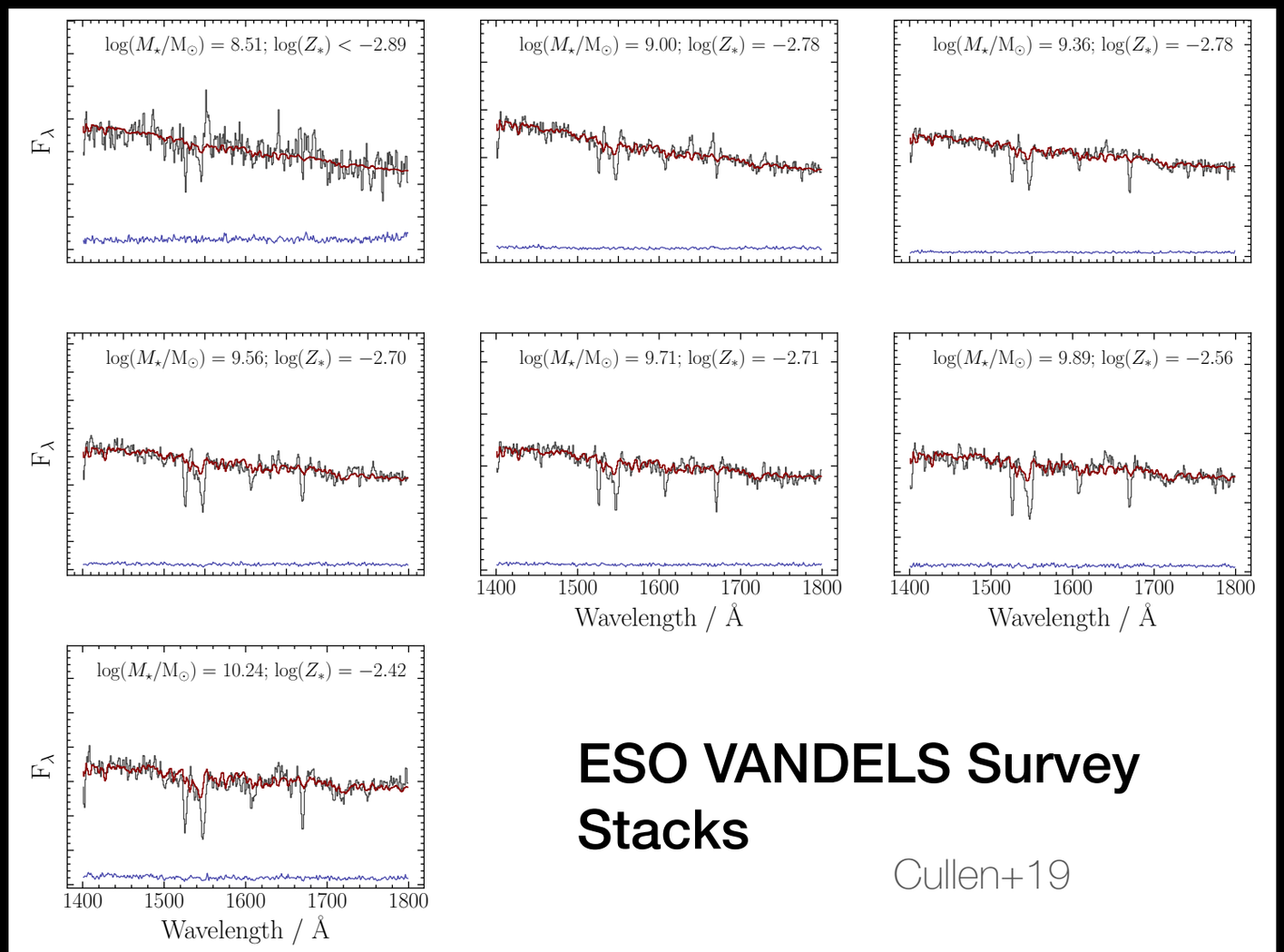
Confirmation of ~200 LSST/Roman dwarf galaxies candidates
1000-star dwarf dynamics
Dwarf galaxy assembly/enrichment

The Cosmic Ecosystem

Ensemble UV Spectra of the Galaxy Population at z~2

- Stellar and nebular abundances across the population
- Wind and outflow signatures
- Ensembles drawn from 15,000 galaxies: z = 2–5, i_{AB}=25.3
- Flexible binning. 15 bins : S/N~67. 150 bins : S/N~20

(Matches spec-z program for Dark Energy)



ESO VANDELS Survey Stacks

Cullen+19

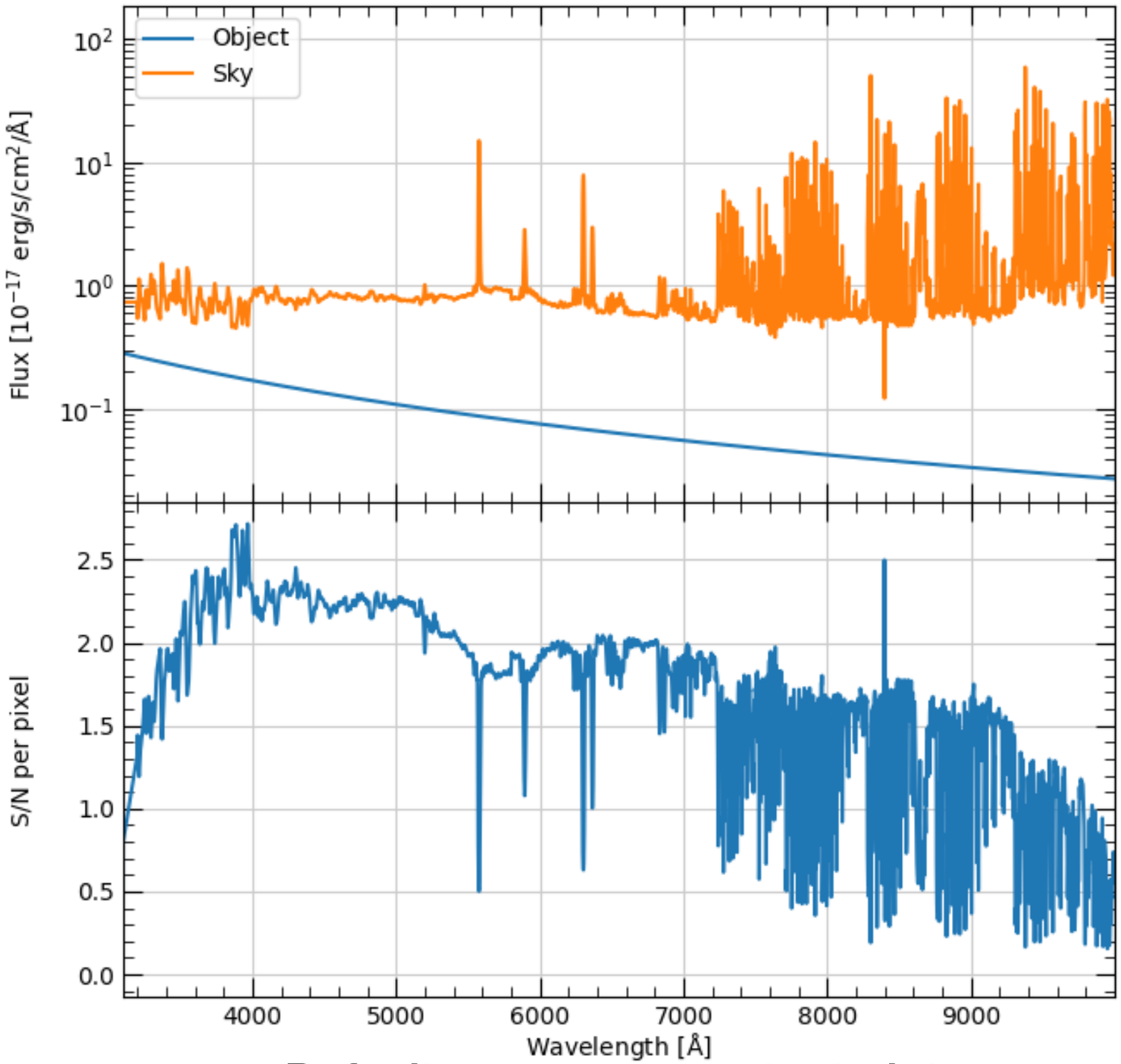
ESO VANDELS Survey (McLure+18)

VLT-VIMOS
Ngal = 2100, z=2–5
R~500
20-80 hour integrations (per-source)

FOBOS Planning Tools

FOBOS Exposure Time Calculator

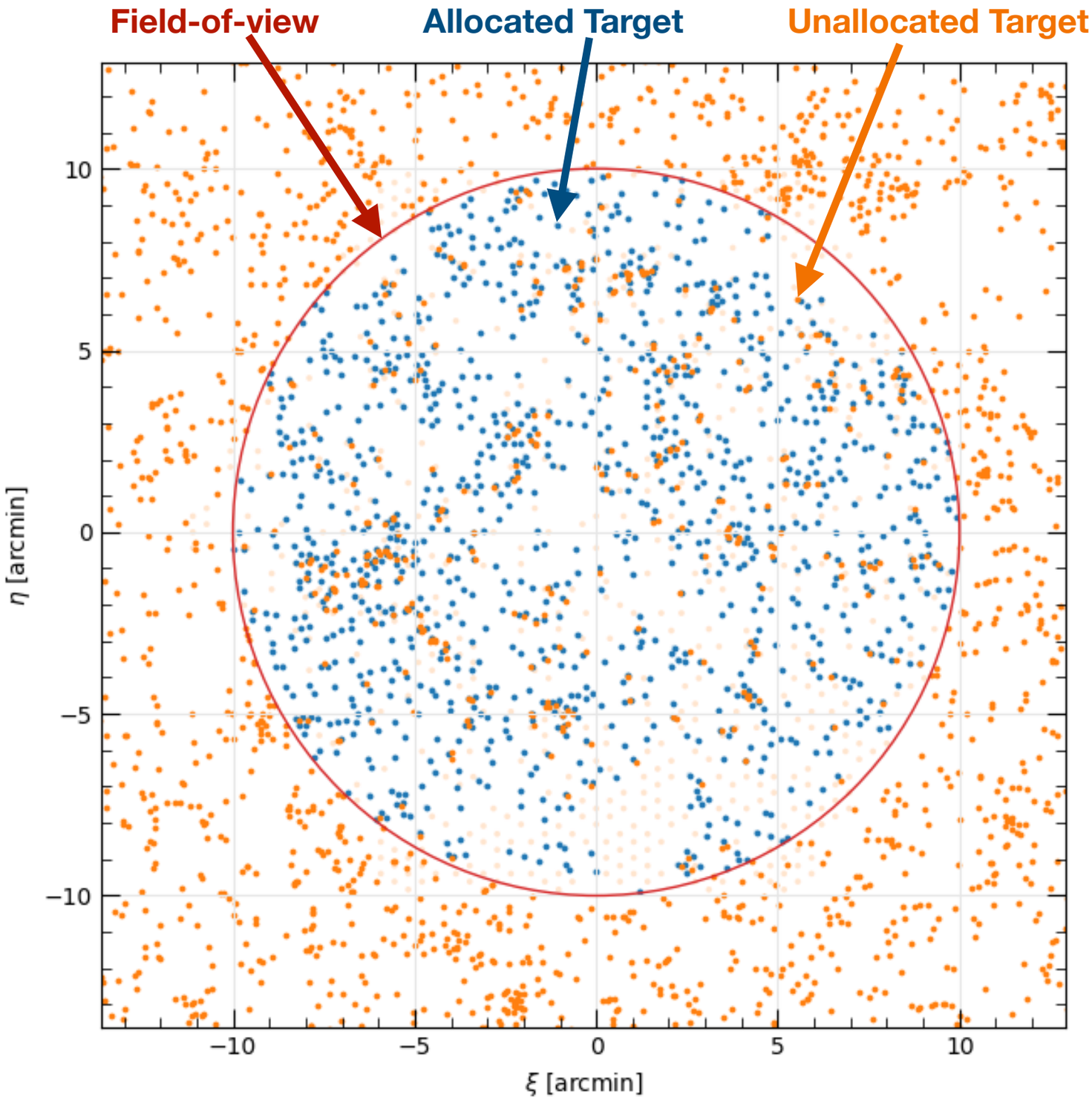
- FOBOS ETC is part of KBW's SynOSpec package
  synospec.readthedocs.io
- Options include:
  - User-provided spectrum
  - Point-source vs. Sersic
  - General observing parameters



Default `fobos_etc` output plot:
r=24 AB mag, point source, 1 hr exposure

FOBOS Target Allocation Planning

- FOBOS Producer fobos-producer.readthedocs.io
- Show the focal-plane layout using `fobos_layout`
- Tile a set of targets using `fobos_makeplan`
- Construct a set of field configuration files using `fobos_makeplan`
- Show the field configuration using `fobos_showcfg`



Project

Leadership Team

- Kevin Bundy (UCSC): Primary Investigator
- Kyle Westfall (UCO): Project Scientist
- Nick MacDonald (UCO): Lead Engineer, Project Manager
- Claire Poppett (UCB/LBNL): Front-end Instrument Scientist
- Renate Kupke (UCO): Spectrograph Instrument Scientist

Status

- Successful Conceptual Design Review in July, 2021
- Currently performing risk retirement activities and seeking funding
- (Funding contingent) Deployment goal is early 2030s

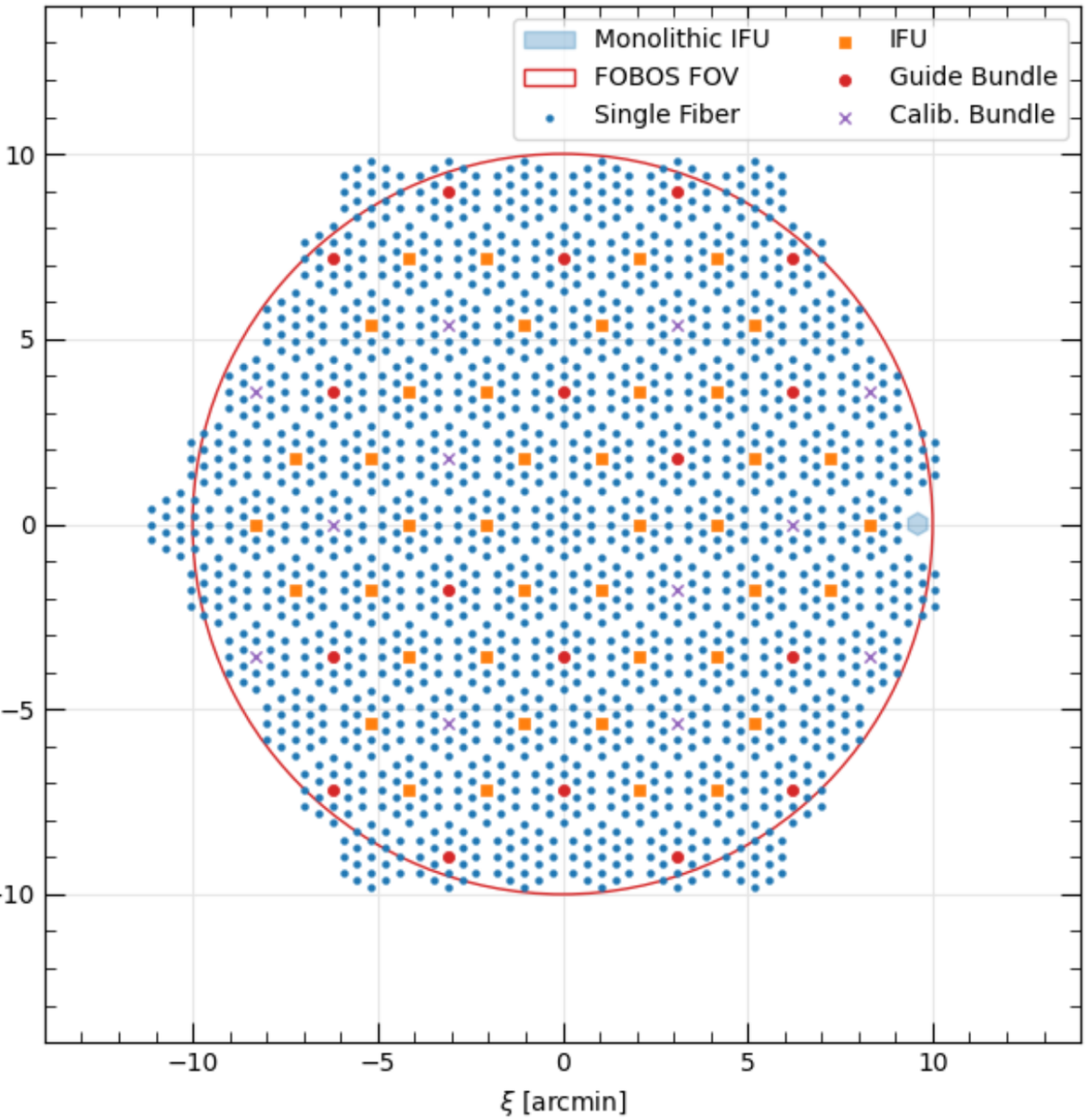
Contact

Kevin Bundy (kbundy@ucolick.org) and I (westfall@ucolick.org) are happy to answer any questions and discuss science programs!

Backup Slides

FOBOS
FIBER-OPTIC BROADBAND OPTICAL SPECTROGRAPH

Focal Plane Apertures



- FOBOS uses Starbugs to move aperture payloads in the field
- FOBOS has five aperture types
  - 0.8” Single-fiber
  - 5.6” 37-fiber multi-IFU
  - 37.6” 3x547-fiber Monolothic IFU
  - 7-fiber flux-calibration bundle
  - Pointing/Focus tracking bundles
- Each spectrograph can be put in 1 of 3 modes

Active Payload	MOS Mode	Multi-IFU	Monolithic IFU
Designated Sky (single fiber)	0	56	27
Single-fiber	546	0	0
37-fiber IFU	0	14	0
Monolithic IFU	0	0	1
7-fiber Flux Cal	4	4	4
Total Active Fibers	574	602	602

FOBOS
FIBER-OPTIC BROADBAND OPTICAL SPECTROGRAPH

Instrument Throughput