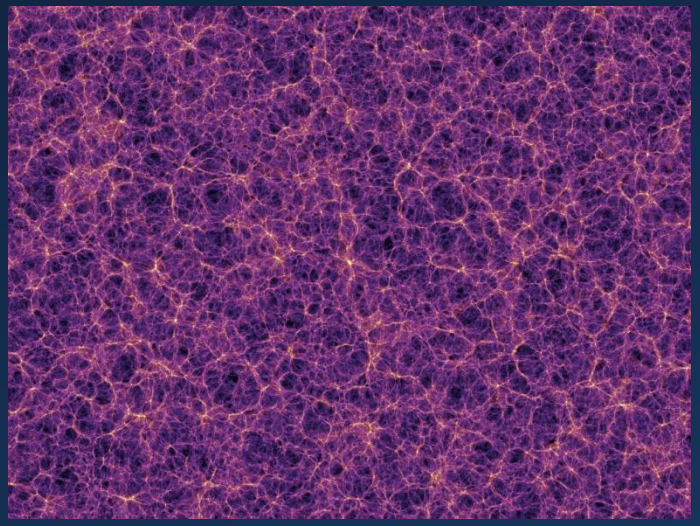
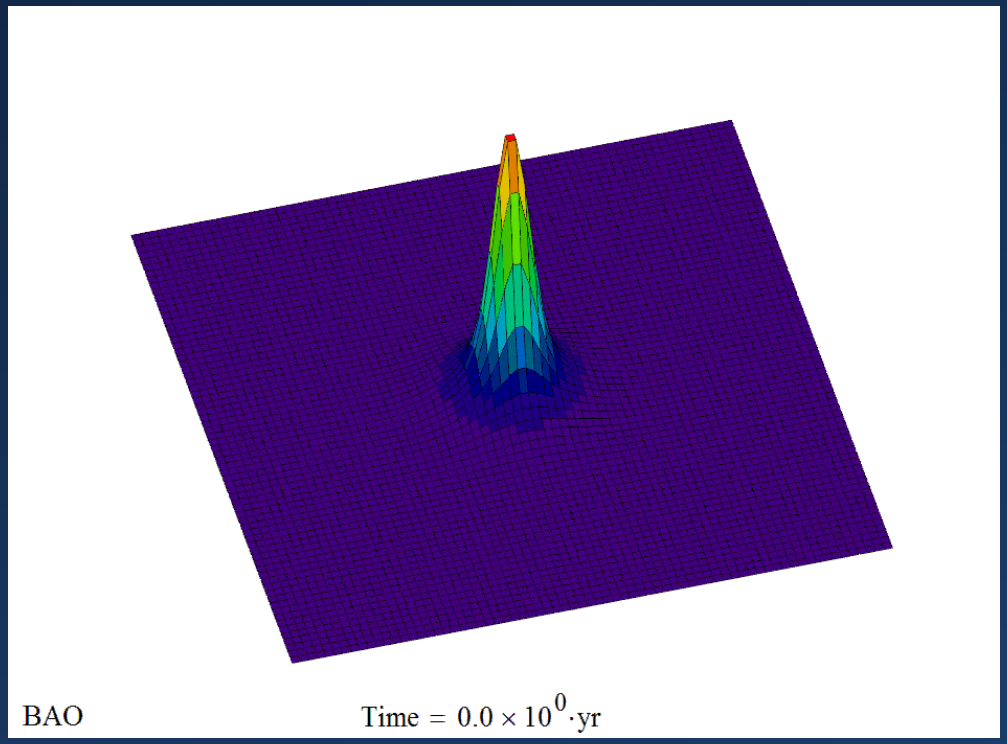
BOSS Calibration
A Step Towards BigBOSS



Evan Losh, Advisor Greg Tarle
University of Michigan
REU Symposium 8/8/2012

BAO

- Baryon Acoustic Oscillation
  - Shells of high density
  - Standard ruler
  - 100 Mpc scale
  - Map galaxies and quasars
  - DE information



One source

BAO

- Baryon Acoustic Oscillation
  - Shells of high density
  - Standard ruler
  - 100 Mpc scale
  - Map galaxies and quasars
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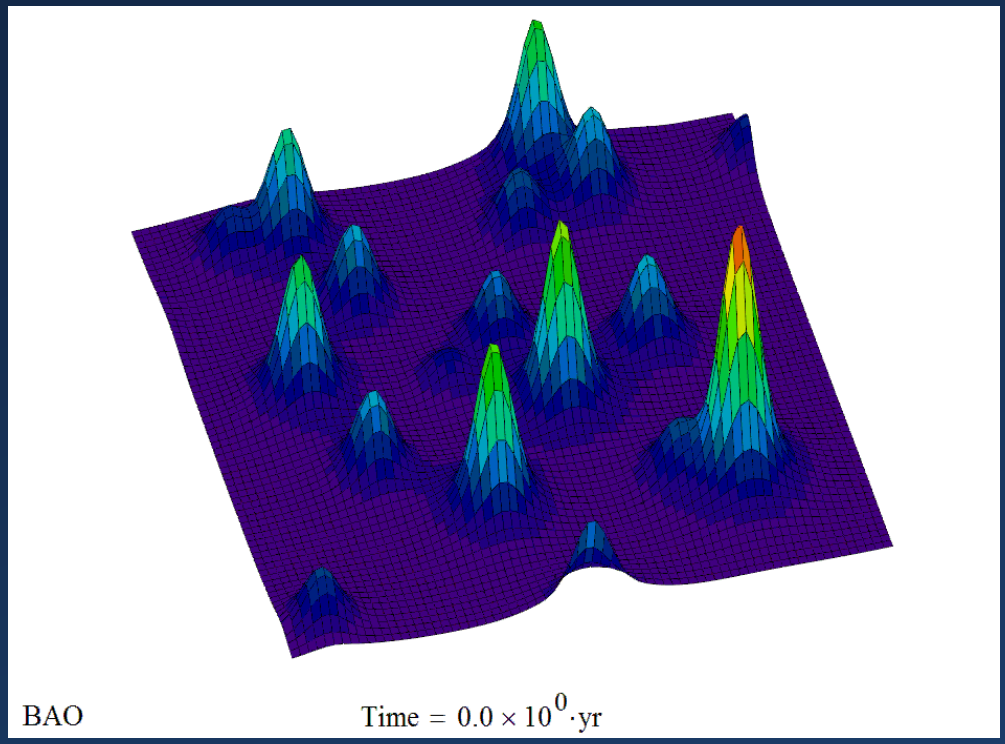
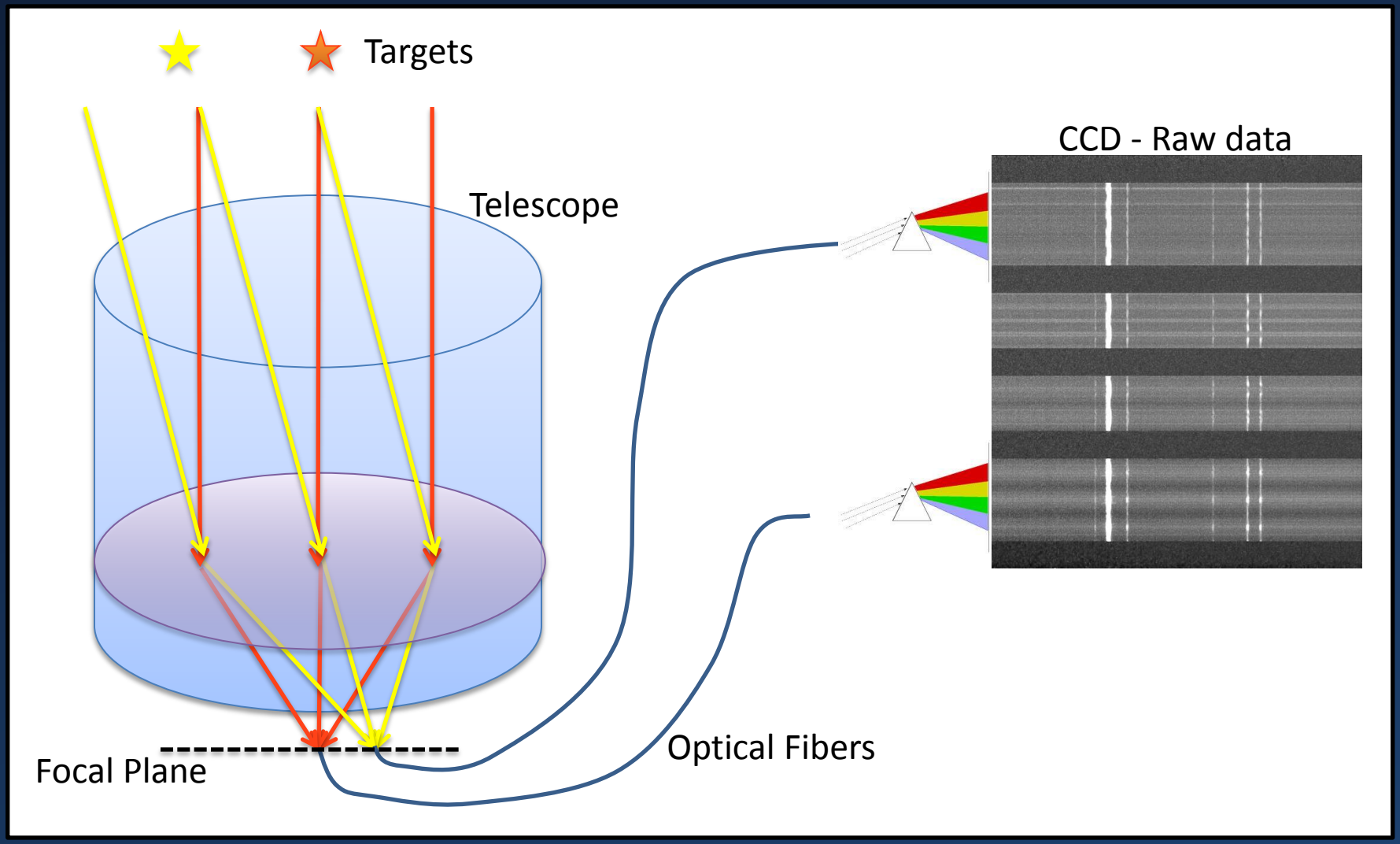


Many sources

Astronomical Spectroscopy



http://ifs.wikidot.com/reducing-fibre http://spiff.rit.edu/classes/phys312/workshops/w10b/spectra/mystery_spectra.html

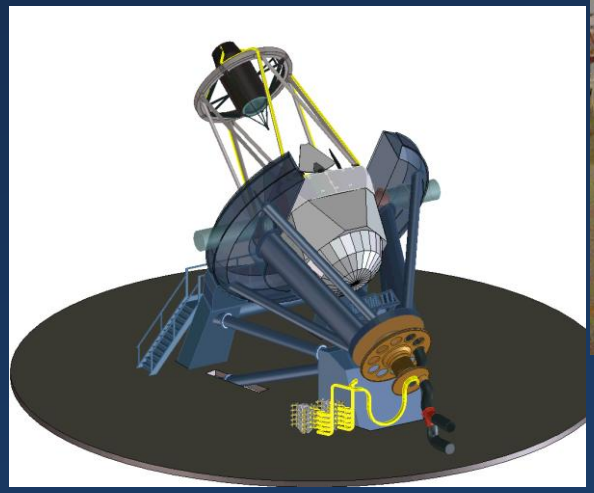
BOSS

- Baryon Oscillation Spectroscopic Survey
- Sloan Digital Sky Survey (SDSS) 2.5m telescope
- Room for Improvement
  - Plug plates
  - Too slow
  - Depth of field
  - Unstable

http://blog.galaxyzoo.org/2009/04/01/a-visit-to-apache-point/
http://www.sdss3.org/press/20101001.bossfirstlight.php

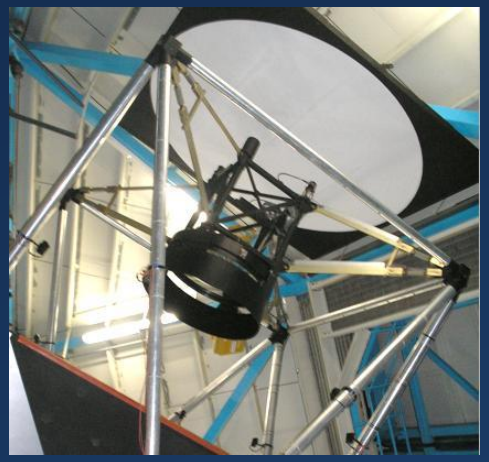
BigBOSS

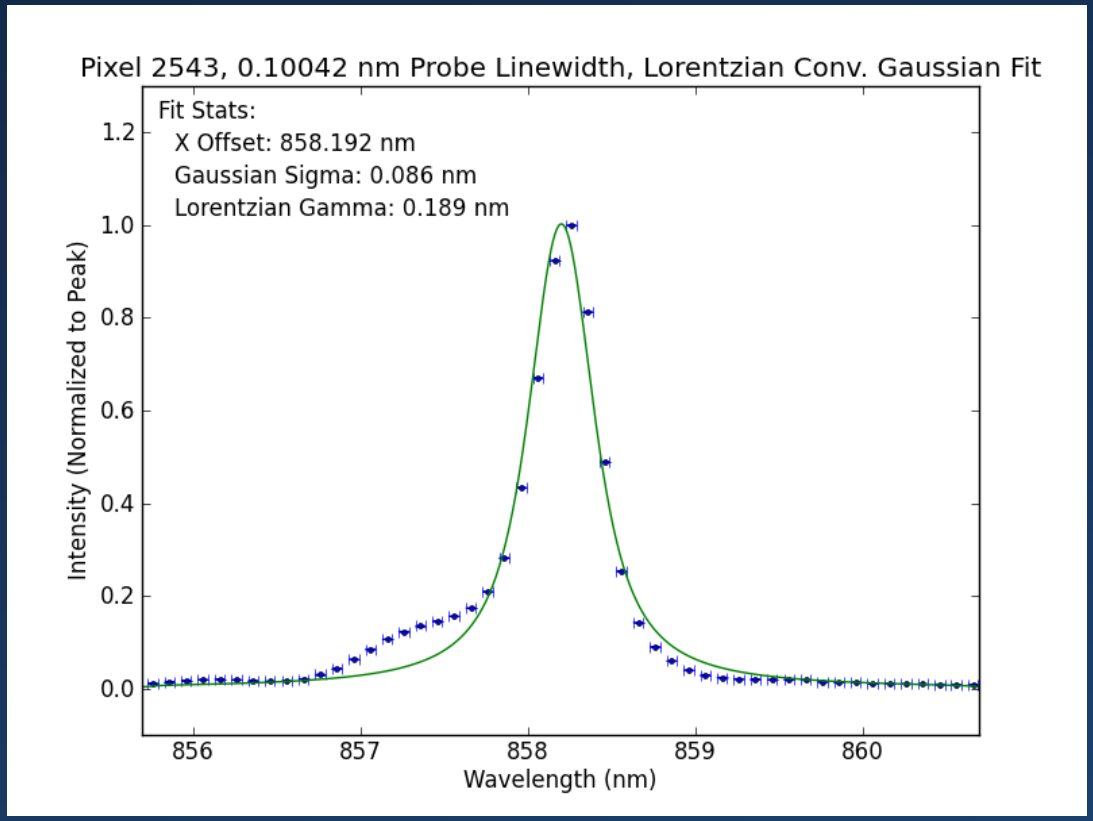
- Mayall 4m Telescope
- Robotics
- More fibers
  - 5000 spectra/12 minutes
- Stable
- 5 years
  - 10 million spectra



Calibration Goals

- Fiber Variations
- Response of each pixel to each wavelength
  - 340 nm to 1060 nm
  - 0.01 nm bandwidth
  - 0.01 nm increments
  - Absolute wavelengths to 0.1 pixel error
- Fast
- Current methods
  - Dome and sky flats
  - Arclamp

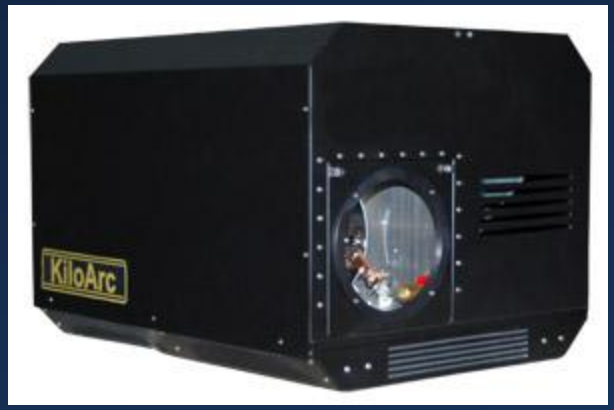




http://www.astro.wisc.edu/~morscher/index.html

Calibration Method

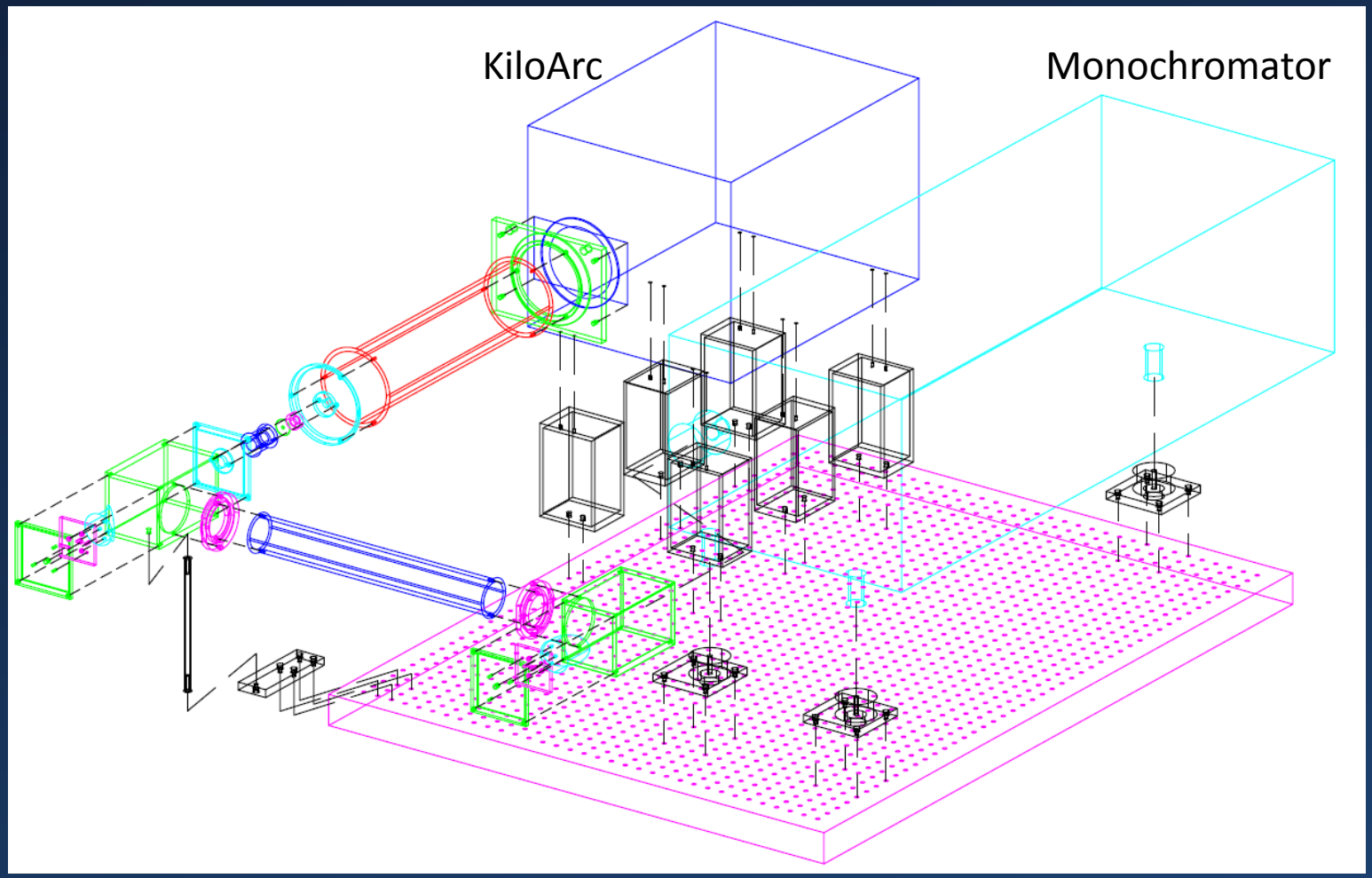
- KiloArc
  - 1000 W Xe lamp
  - Lines
  - Fireball



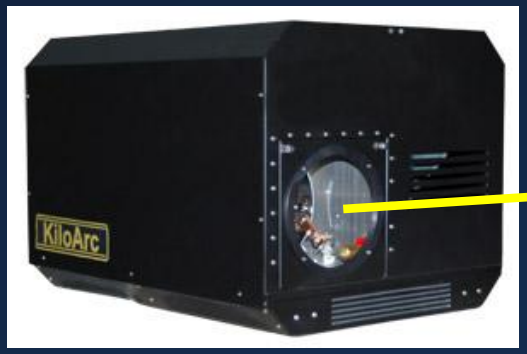
- Monochromator
  - Broadband input
  - 0.01 nm band output
  - High speed

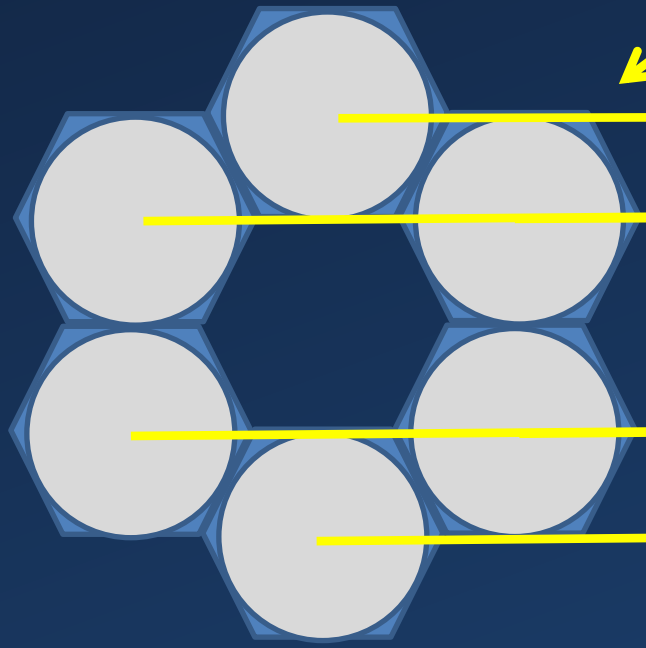
Calibration Method

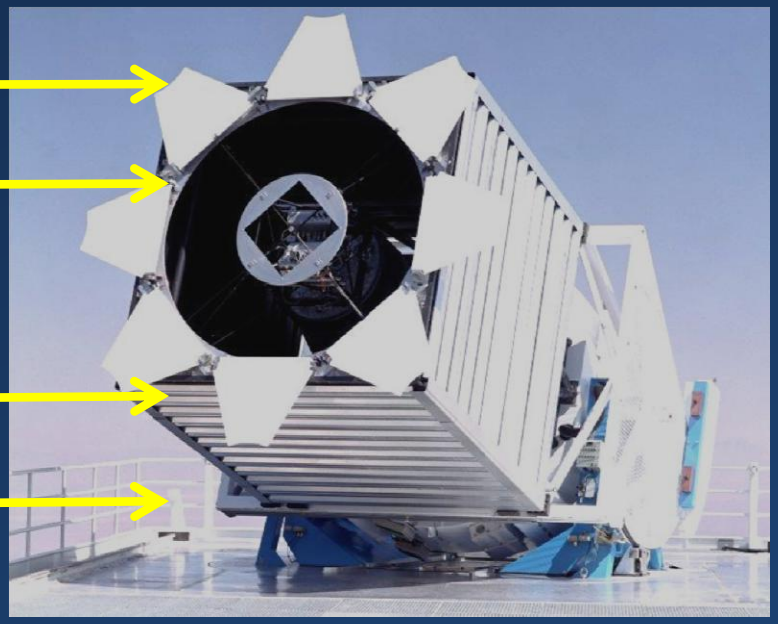
- Monochromator Input optics



Calibration Method



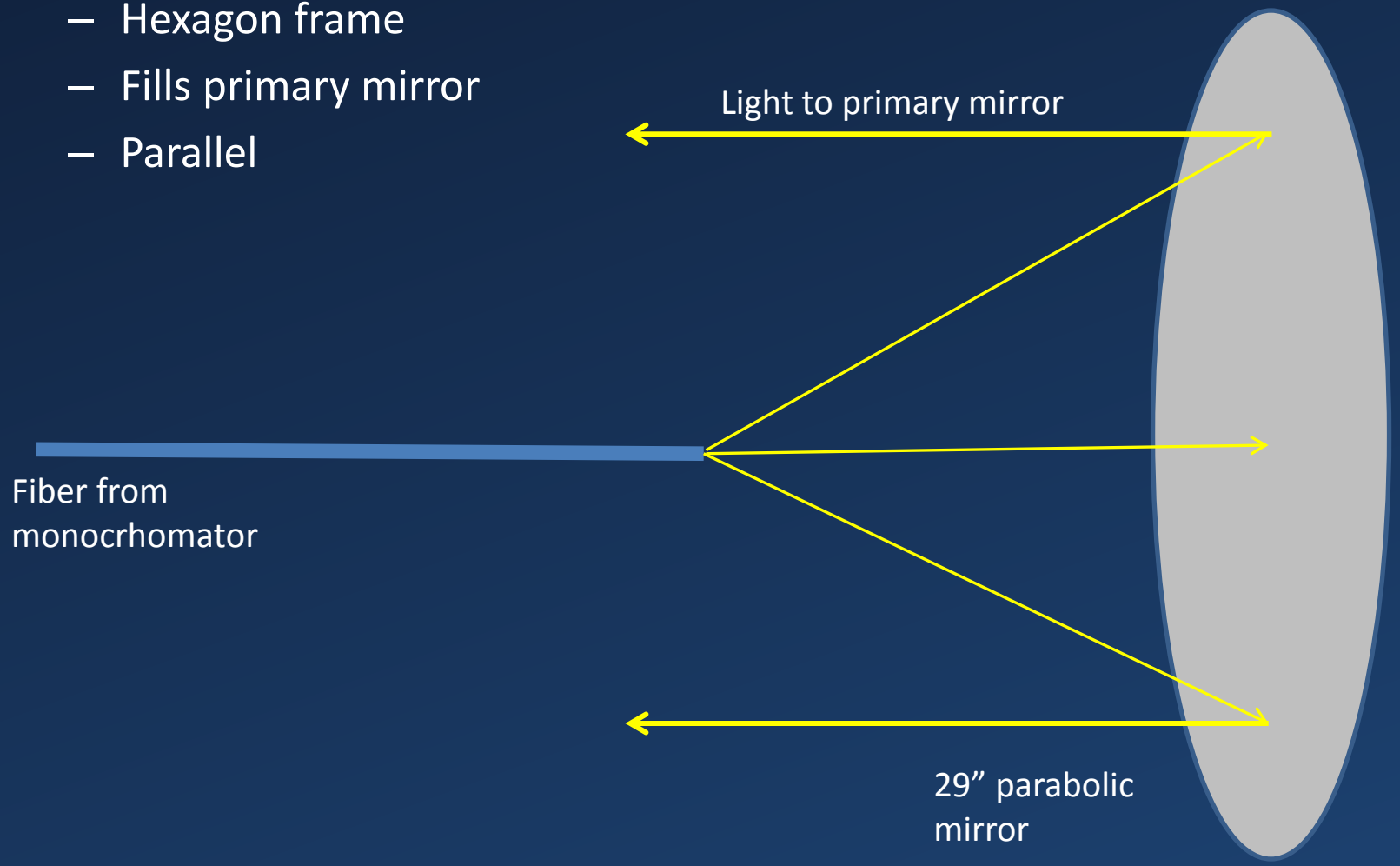




http://www.sdss3.org/instruments/telescope.php

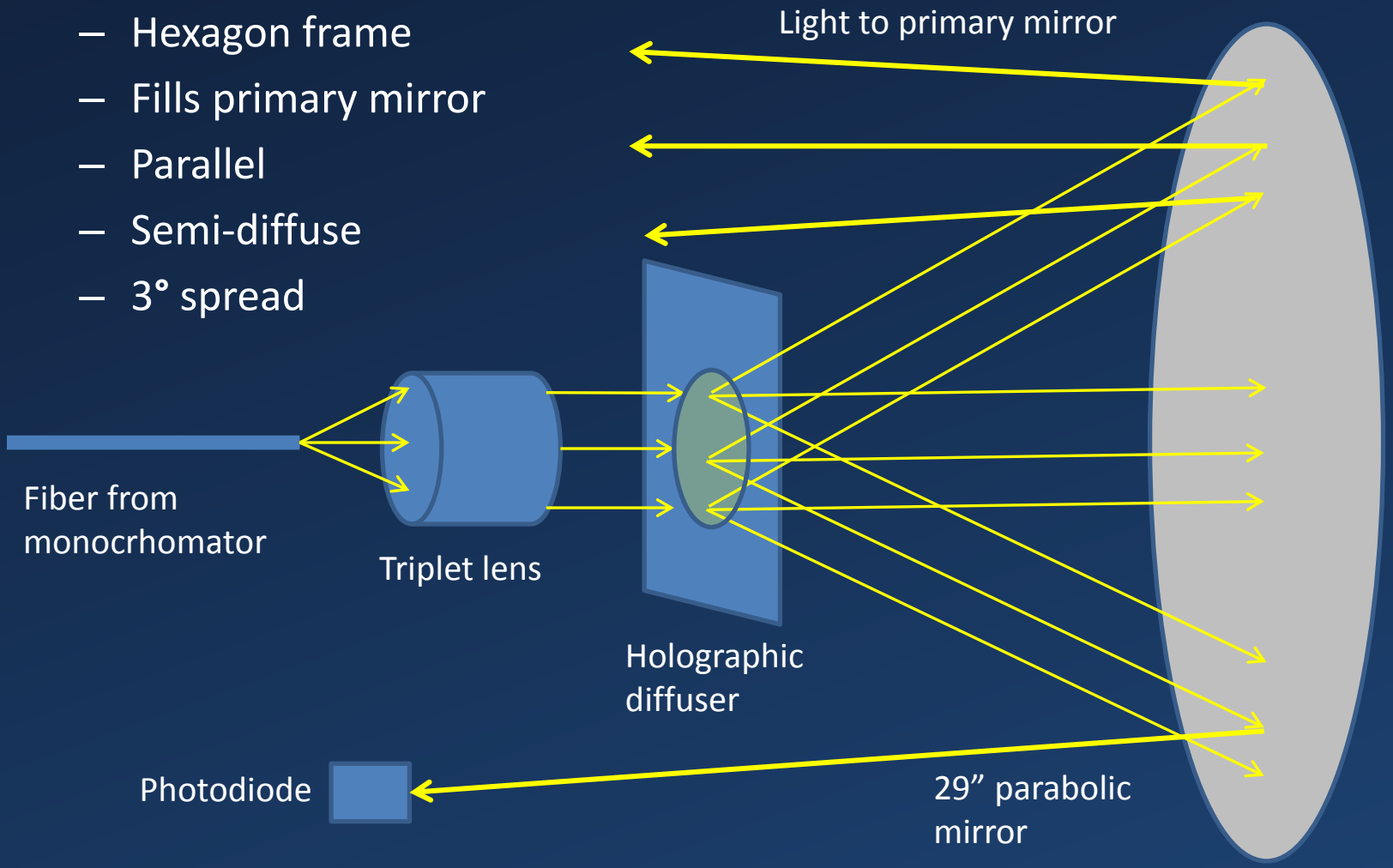
Calibration Method

- Projector
  - Hexagon frame
  - Fills primary mirror
  - Parallel



Calibration Method

- Projector
  - Hexagon frame
  - Fills primary mirror
  - Parallel
  - Semi-diffuse
  - 3° spread

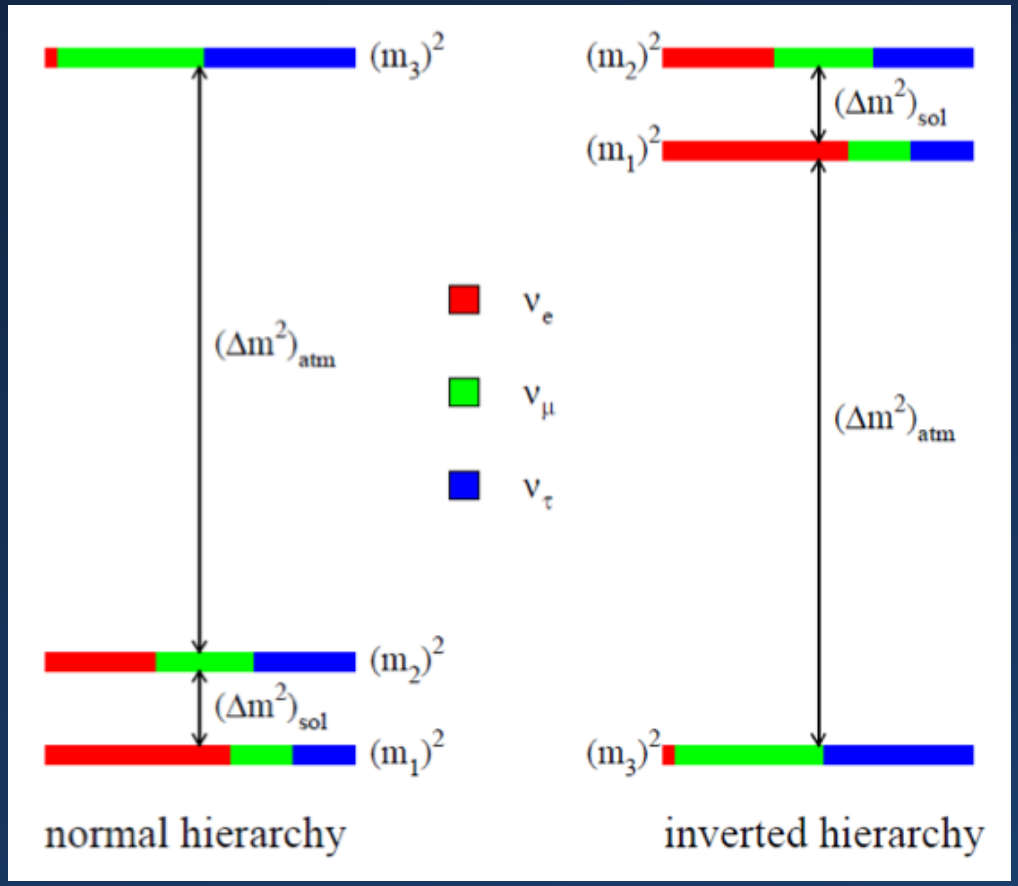


Calibration Method

- Photodiode
  - Pixels illuminated at different times
  - Normalize power input
  - Light source varies
  - Fibers move

Near Future

- Assemble input optics and projector
  - Alignment
  - Apache Point, NM
  - Calibrate BOSS!
- Distant Future
  - Replace KiloArc with OPO
  - Add mirrors to projector
  - Calibrate BigBOSS!
- Questions

Neutrinos

- Uniform background mass
- Measure Σm_ν to 0.024 eV
- Resolve Hierarchy degeneracy?