WEAVE: A New Wide-Field MOS for the WHT

Gavin Dalton

RAL Space &
University of Oxford, UK



WEAVE Team

- Science: Scott Trager, Marc Balcells, Chris Benn, David Carter, GBD, Sofia Feltzing, Marc Verheijen, Will Percival, Anthony Brown, Chris Evans, Amina Helmi, , Matt Jarvis, Lex Kaper, Ross McLure, Reynier Peletier, Ismael Perez-Fournon, Ignacio Trujillo, Kyle Westfall, John Magorrian, Mark Sullivan, Nic Walton
- Instrument: GBD, Scott Trager, Ian Lewis, Don Carlos Abrams, Tibor Agocs, Diego Cano, Ian Tosh, David Carter, David Terrett, Phil Rees, Ray Sharples, Craig Bevill, Angus Gallie, Ian Bryson, Kevin Dee, Iain Steele, Ramon Navarro, Matthew Brock

Overview

- WEAVE: WHT Enhanced Area Velocity Explorer
  - Link to GYES
  - Complement to 4mMOSST
- New PF corrector (2 degree FOV) for the WHT
- Buffered fibre positioner (2dF-like), short fibres.
- 1000 simultaneous targets
- Single dual-beam spectrograph, VPH gratings
  - R=5000, simultaneous 370nm-1μm coverage
  - Possibility of R~25000 via grating exchange
- Single/Deployable IFU modes

WEAVE Science

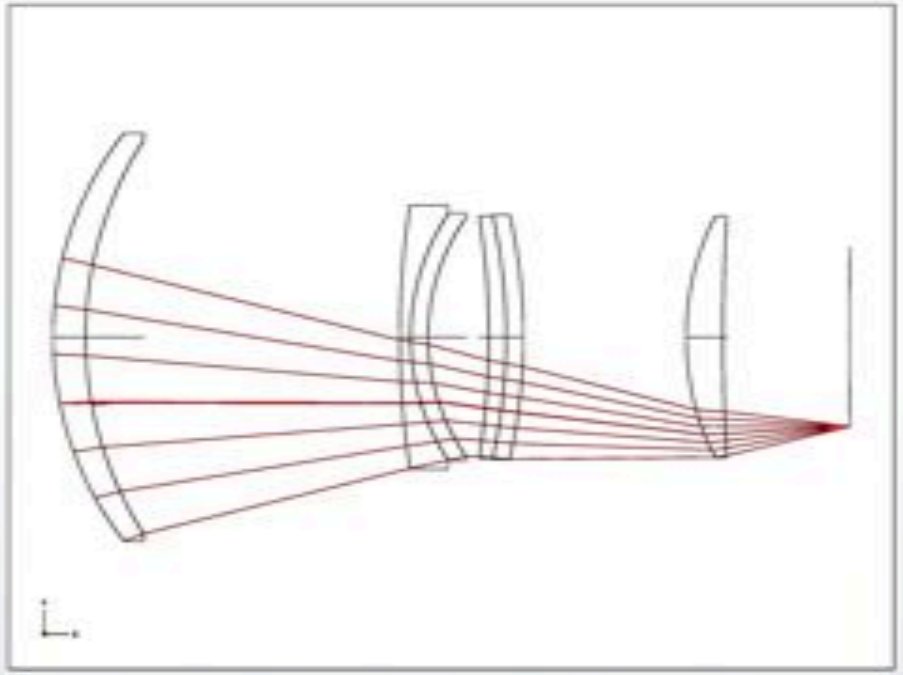
- Radial velocities to complement GAIA, 17<V<20, accuracy 2-5km/s – PRIMARY DESIGN DRIVER
- R~20000 spectroscopy to V~17, abundances better than 0.1dex. (Thick disk/halo)
- BAO measurements (0.6<z<1.4)
- Galaxy Formation and Evolution (multi-IFUs, single IFU >2 arcmin^2, R~10000)
- Transient follow-up (e.g. PTF)

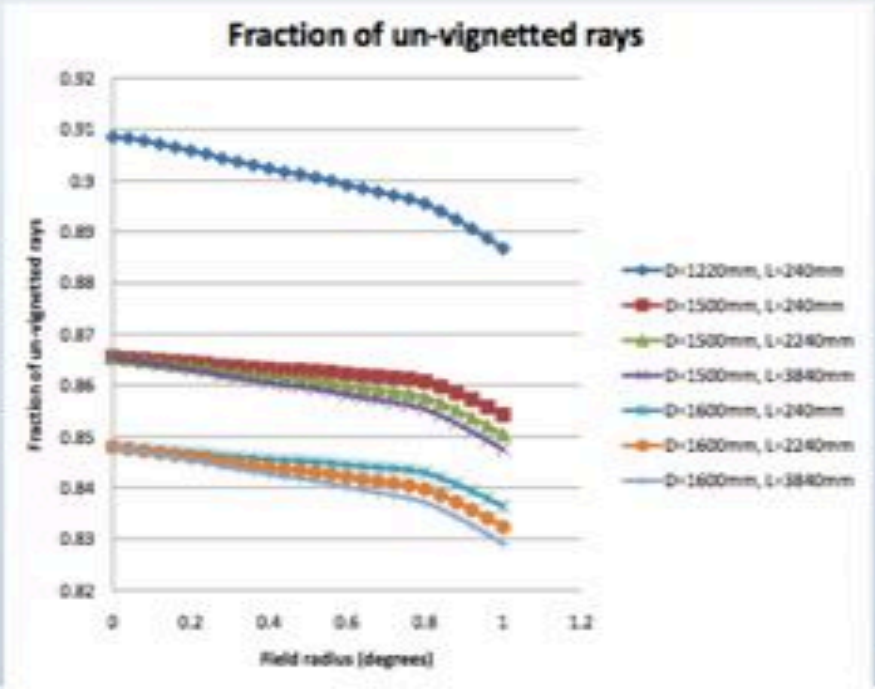
Design Specifications

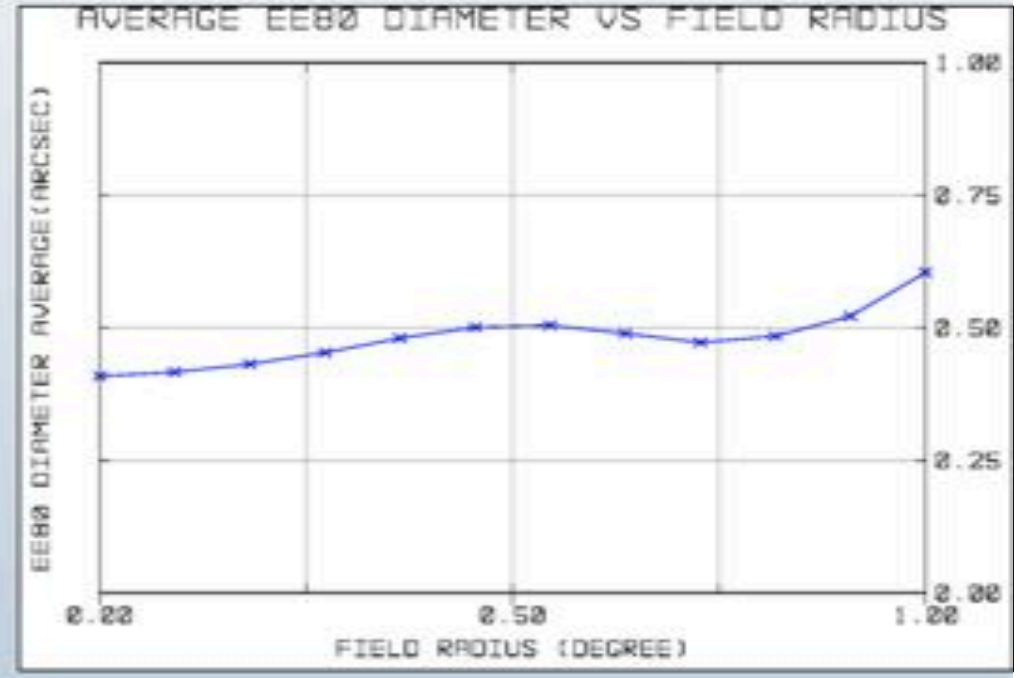
Specification	Requirement	Goal
Field of View diameter	2 degrees	2 degrees
MOS multiplex	800	1000
Atmospheric Dispersion Compensation	0.4-1.0μm, 50° ZD	0.37-1.0μ, 60° ZD
MOS fibre aperture	>=1.2"	1.5"
Open shutter efficiency (1 hour observations)	70%	90%
Wavelength Coverage	400-950nm	370-1000nm
Spectral Resolution (full simultaneous coverage)	5000	5000
Spectral Resolution (reduced coverage)		20000
Stray Light as function of faintest target intensity	<1%	
Blue System Efficiency (sky-computer)	20%	25%
Red System Efficiency (sky-computer)	25%	30%
Multi-IFU multiplex	10	30
Multi-IFU FOV	9"x9"	9"x12"
Multi-IFU spaxel size	0.8"	>1.2"
Single IFU FOV	3'x3'	
Single IFU spaxel size	2.5"	Inner 1", outer 2.5"

Prime Focus Corrector

- 2 degree diameter field of view (f/2.7)
- 940mm first lens
- 290mm back focal distance
- Counter-rotating ADC
- Polychromatic image quality degrades by only 0.1" at 55 degrees ZD with ADC.
- Flat focal plane with tolerable non-telecentricity

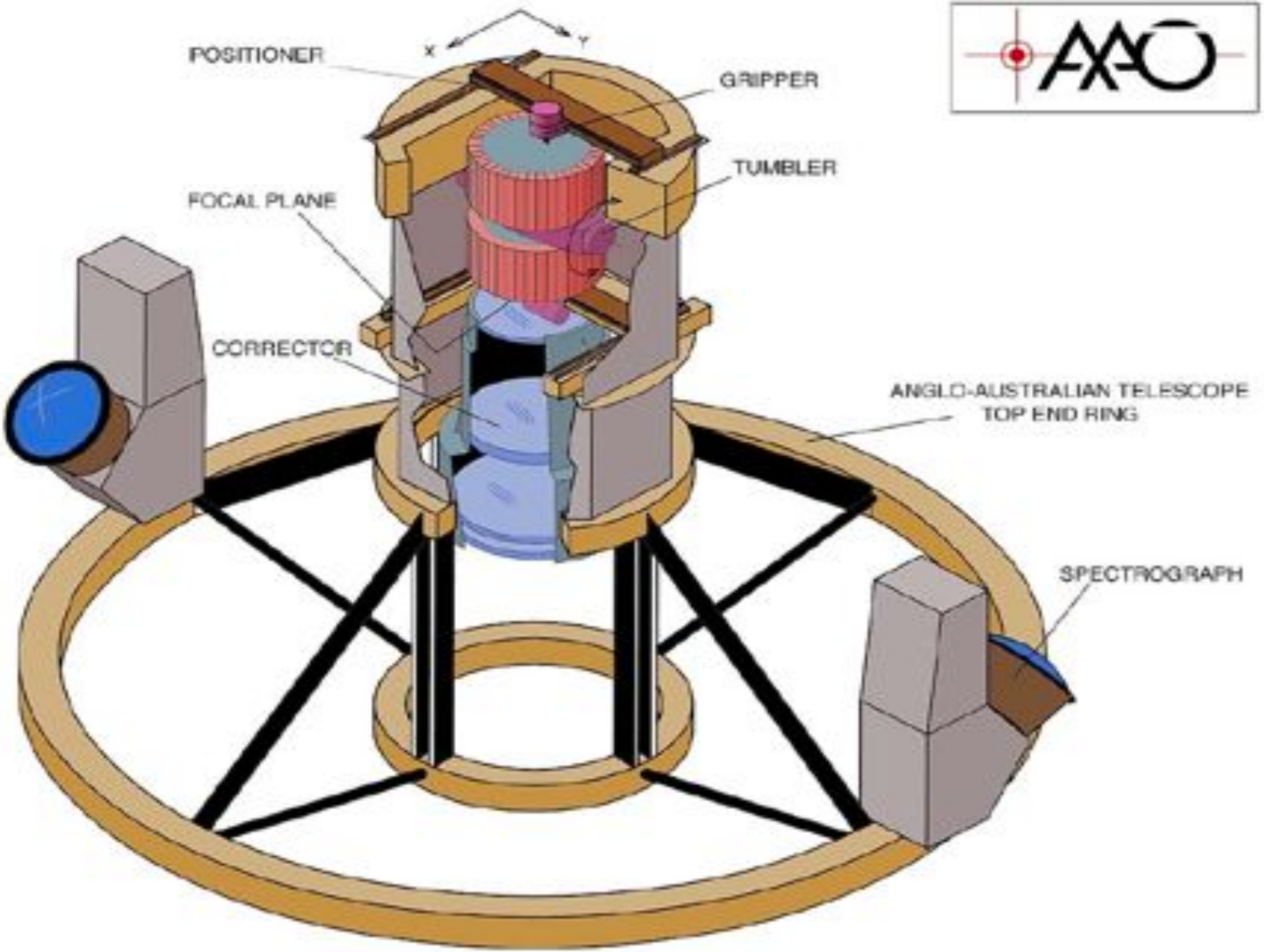


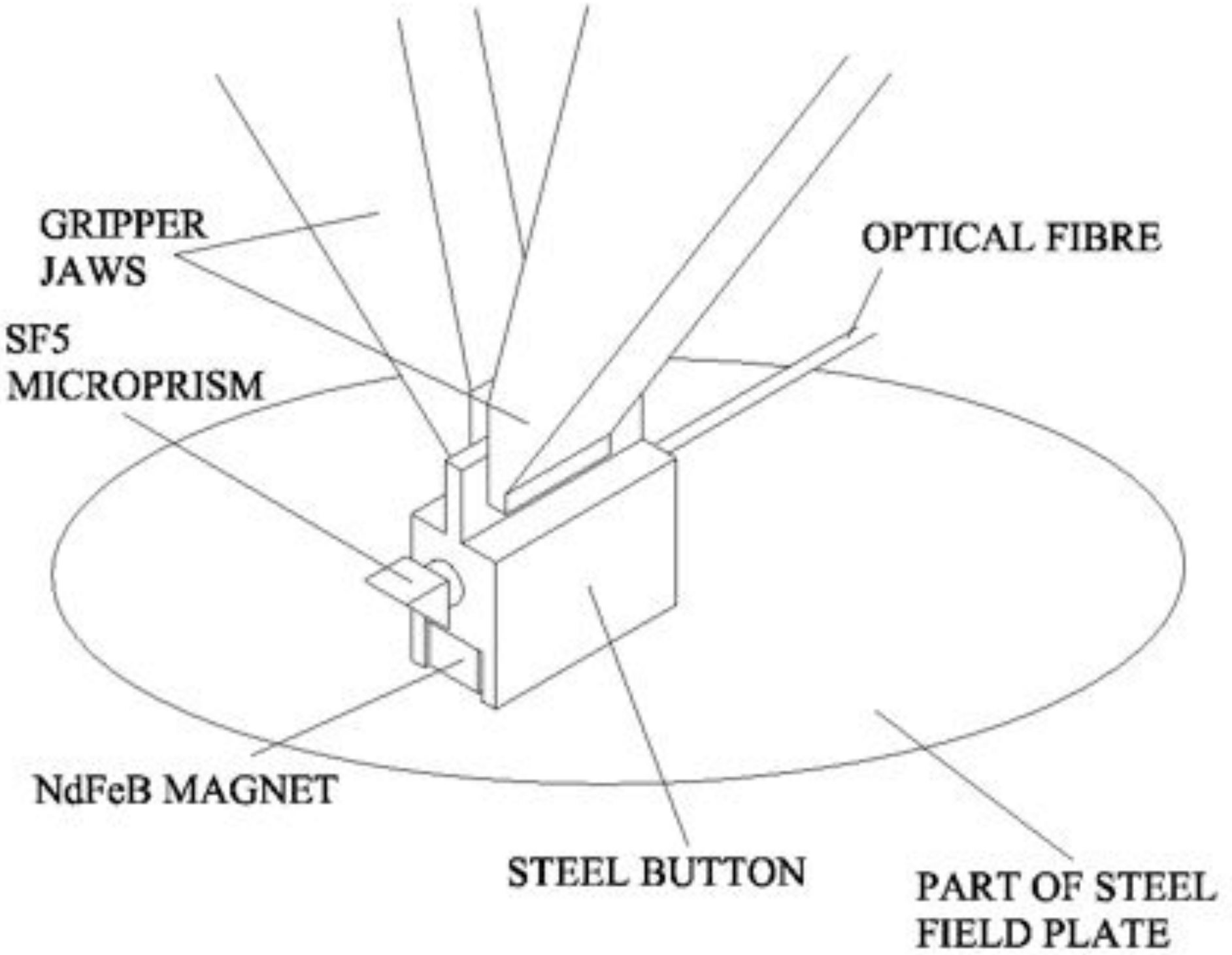


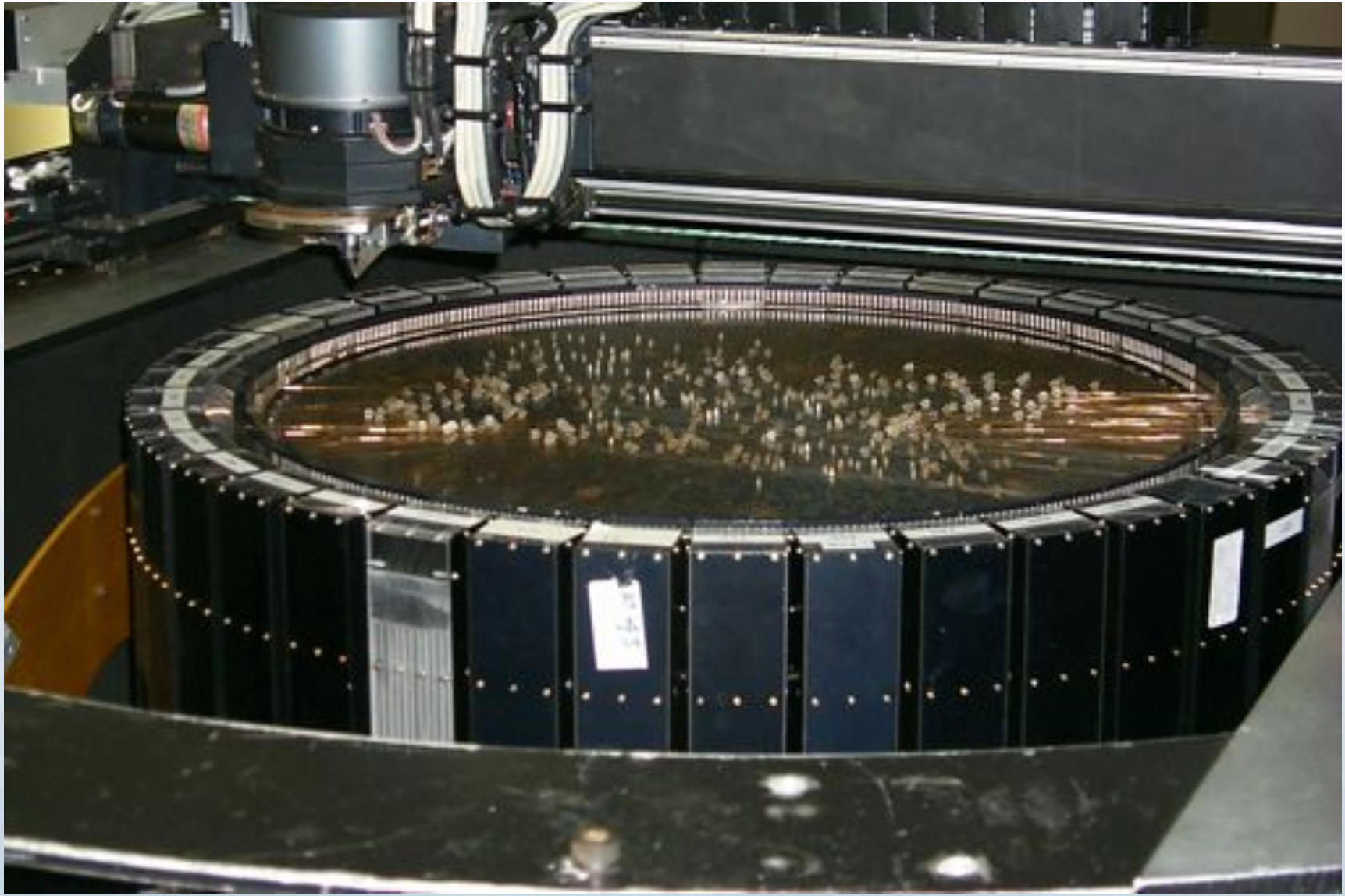


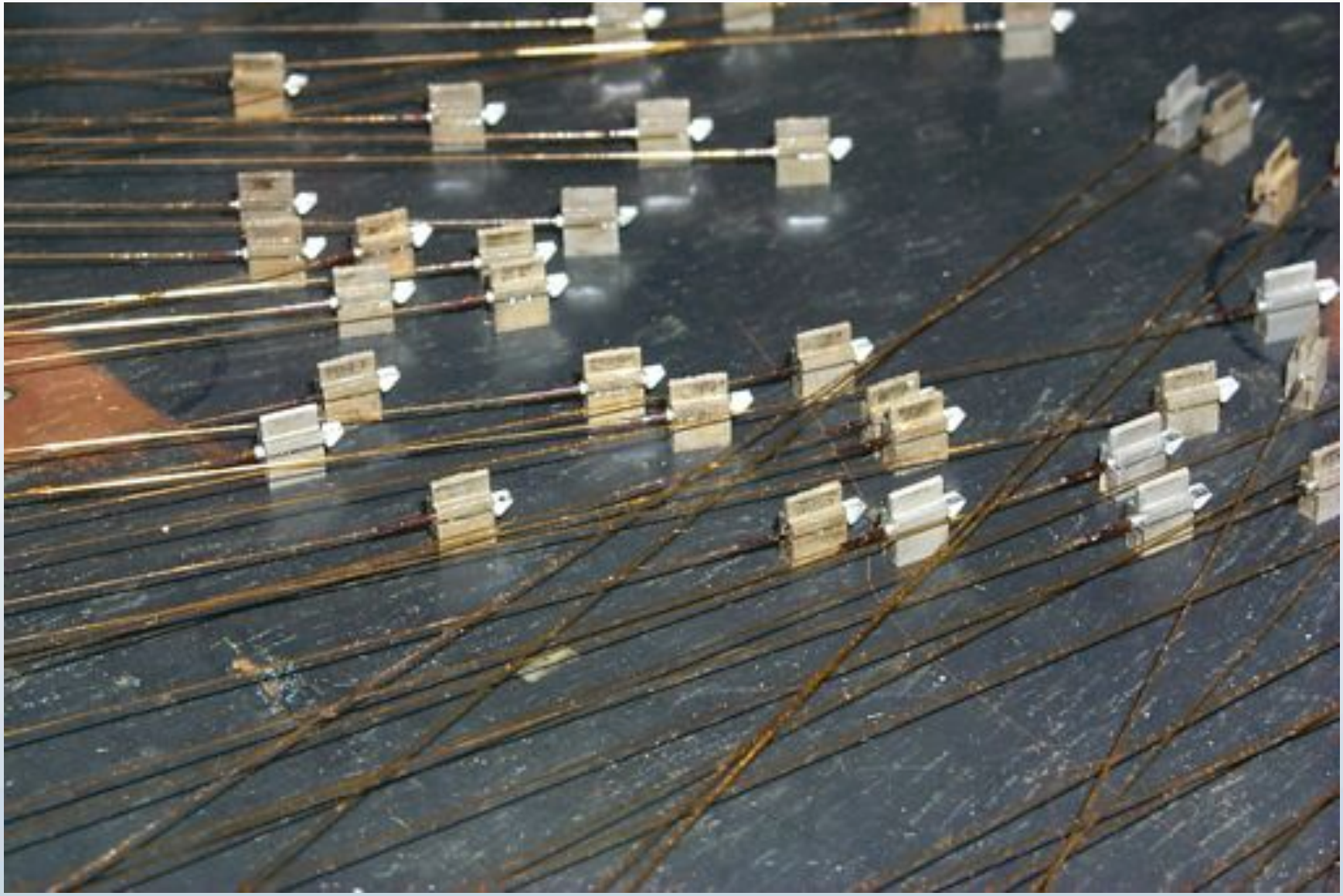
Positioner

- Builds on successful 2dF design
- COTS robot parts
  - Now available with high accuracy (5μm)
  - Robust low-level software control
  - Try to keep costs as low as possible
- More fibres, smaller field
  - Need to reassess retractor design
  - Retractors in separate housings for access and reliability


POSITIONER
X
Y
GRIPPER
TUMBLER
FOCAL PLANE
CORRECTOR
ANGLO-AUSTRALIAN TELESCOPE
TOP END RING
SPECTROGRAPH


GRIPPER
JAWS
OPTICAL FIBRE
SF5
MICROPRISM
NdFeB MAGNET
STEEL BUTTON
PART OF STEEL
FIELD PLATE



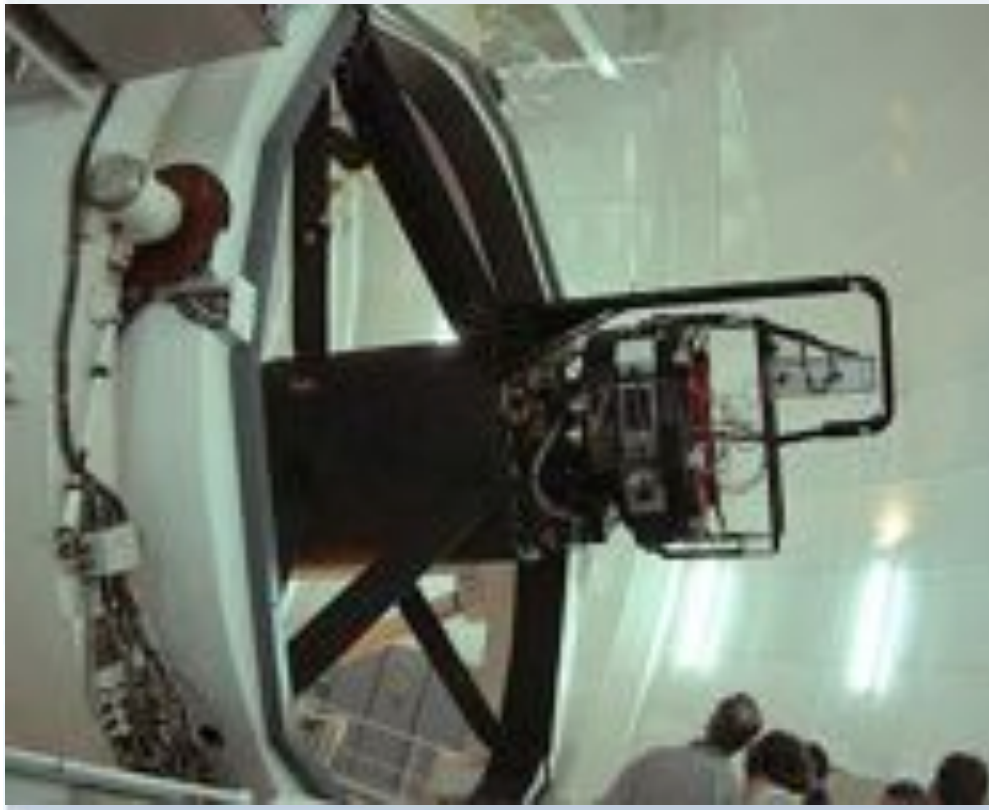


Positioner

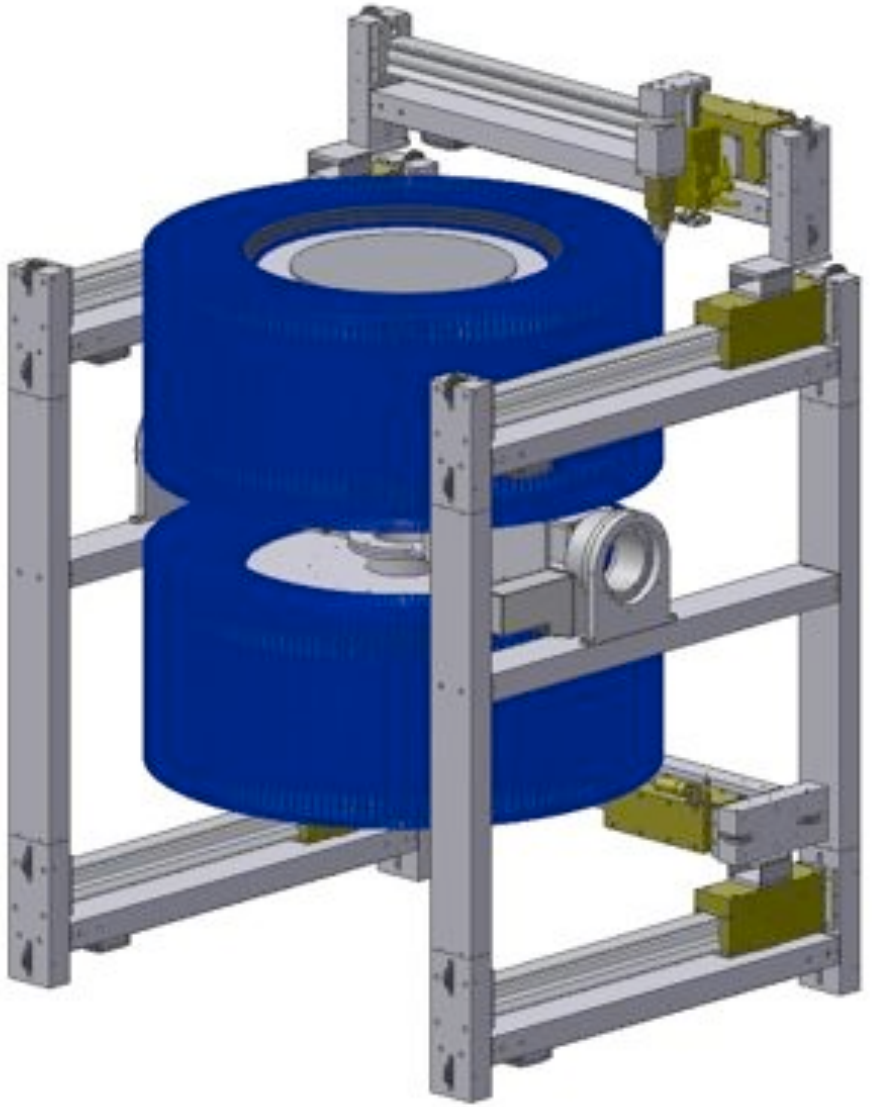
Total positioner mass
~400kg (including anti-vibration counterweights)

Obstruction diameter
~1.5m

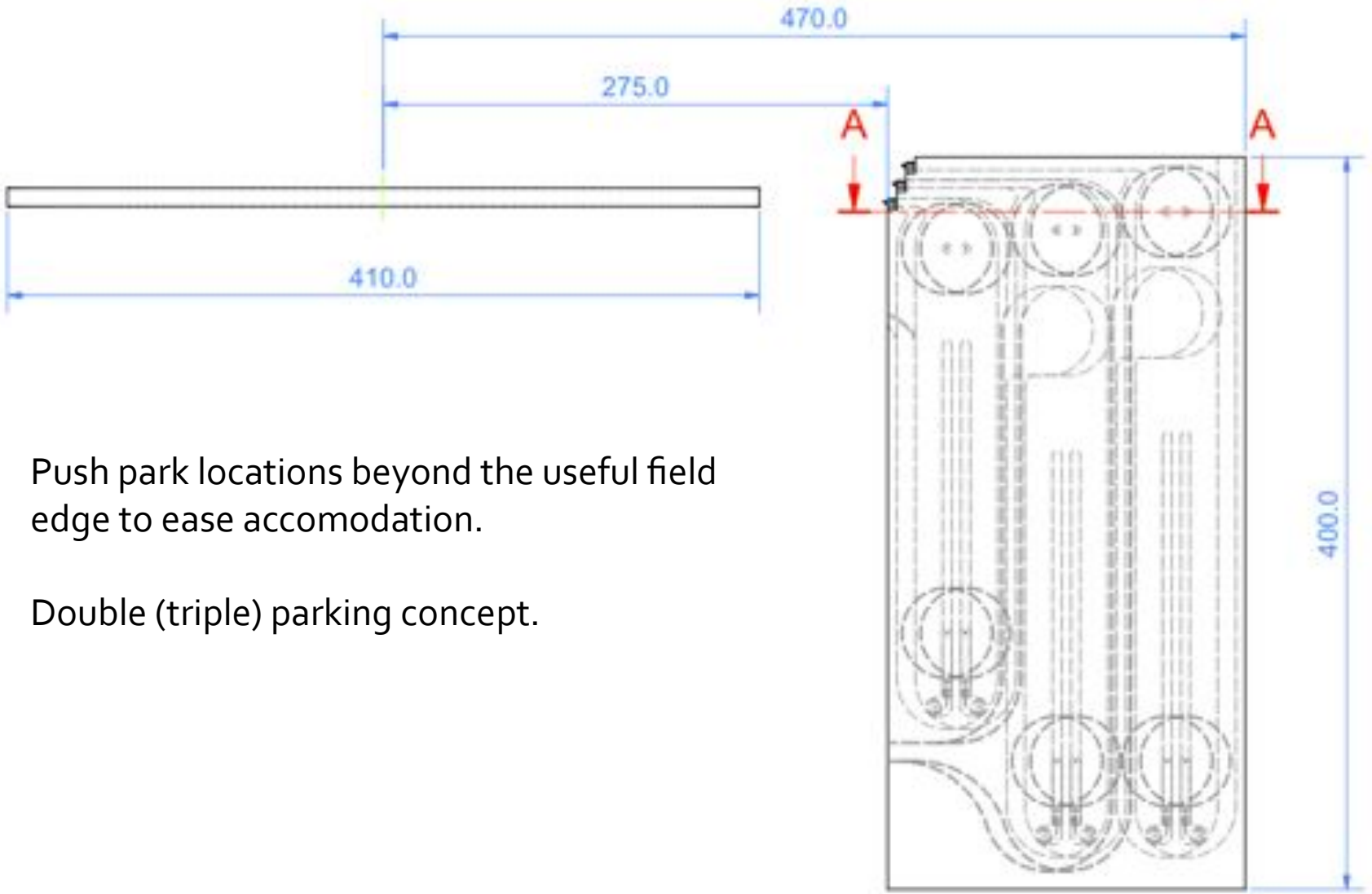
Tumbler clears corrector by
~100mm



Fits inside the available vertical space envelope… (just)



Retractor Concept



Push park locations beyond the useful field edge to ease accomodation.

Double (triple) parking concept.

FIELD SIMULATION

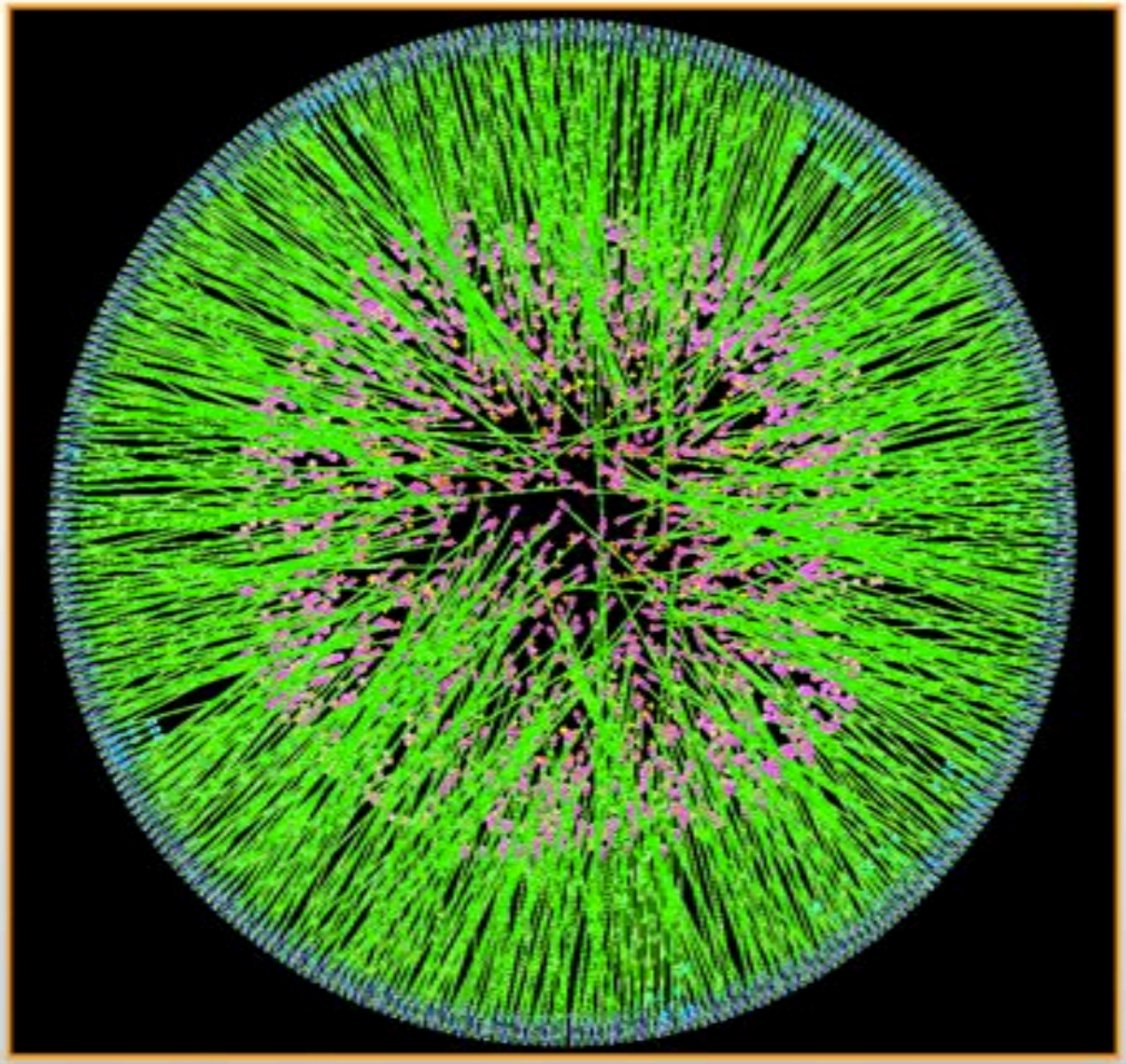
Random target distribution, oversampled (1800 targets)

920 targets allocated

8300 fibre crossings

Reconfiguration simulations imply ~1600 moves to reconfigure…, but some optimisation still to be done…

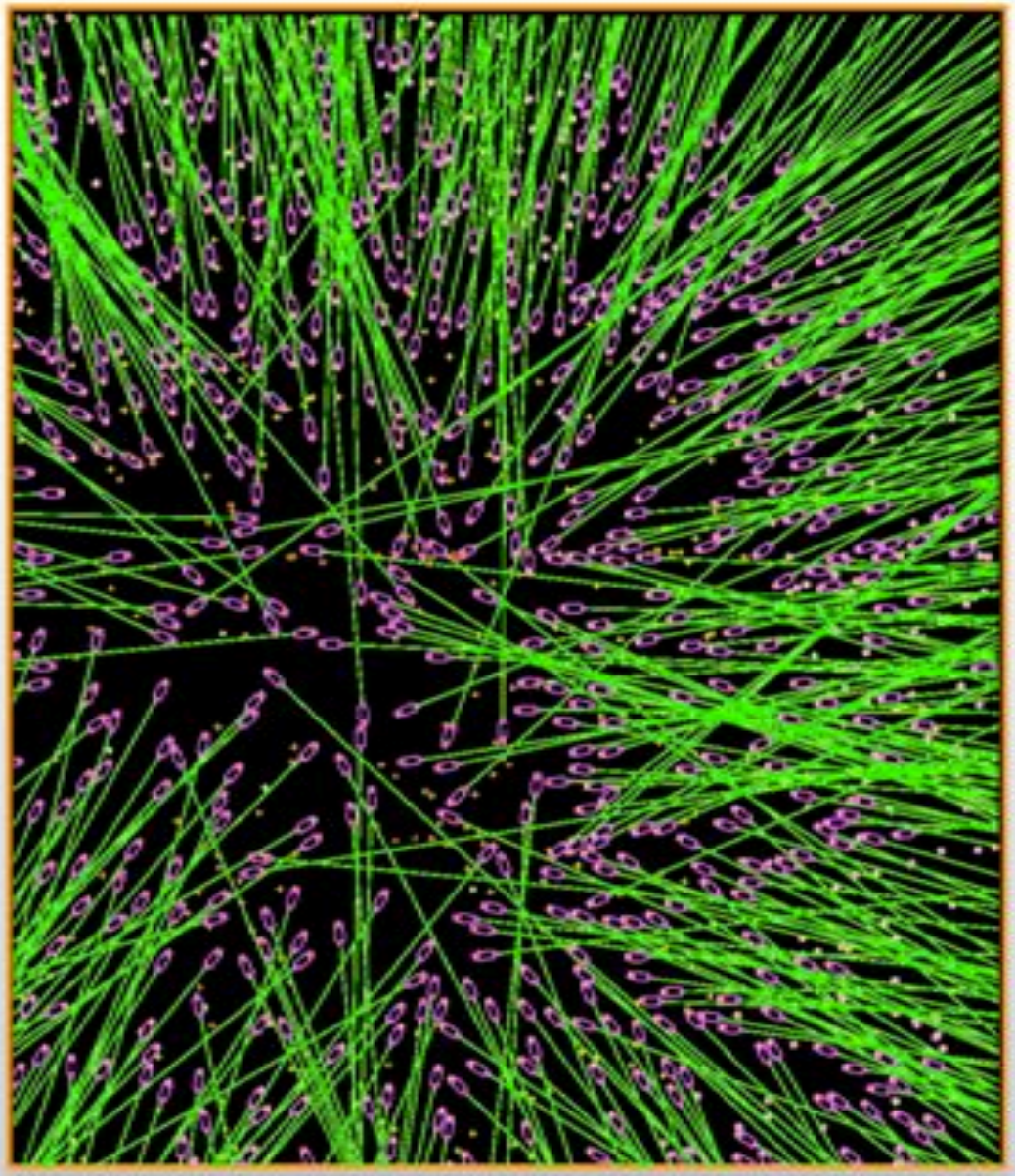
-may need to add a second Y-gantry to achieve timing performance



Simulations will be used for considering impacts of any suggested design changes on the overall survey efficiencies.

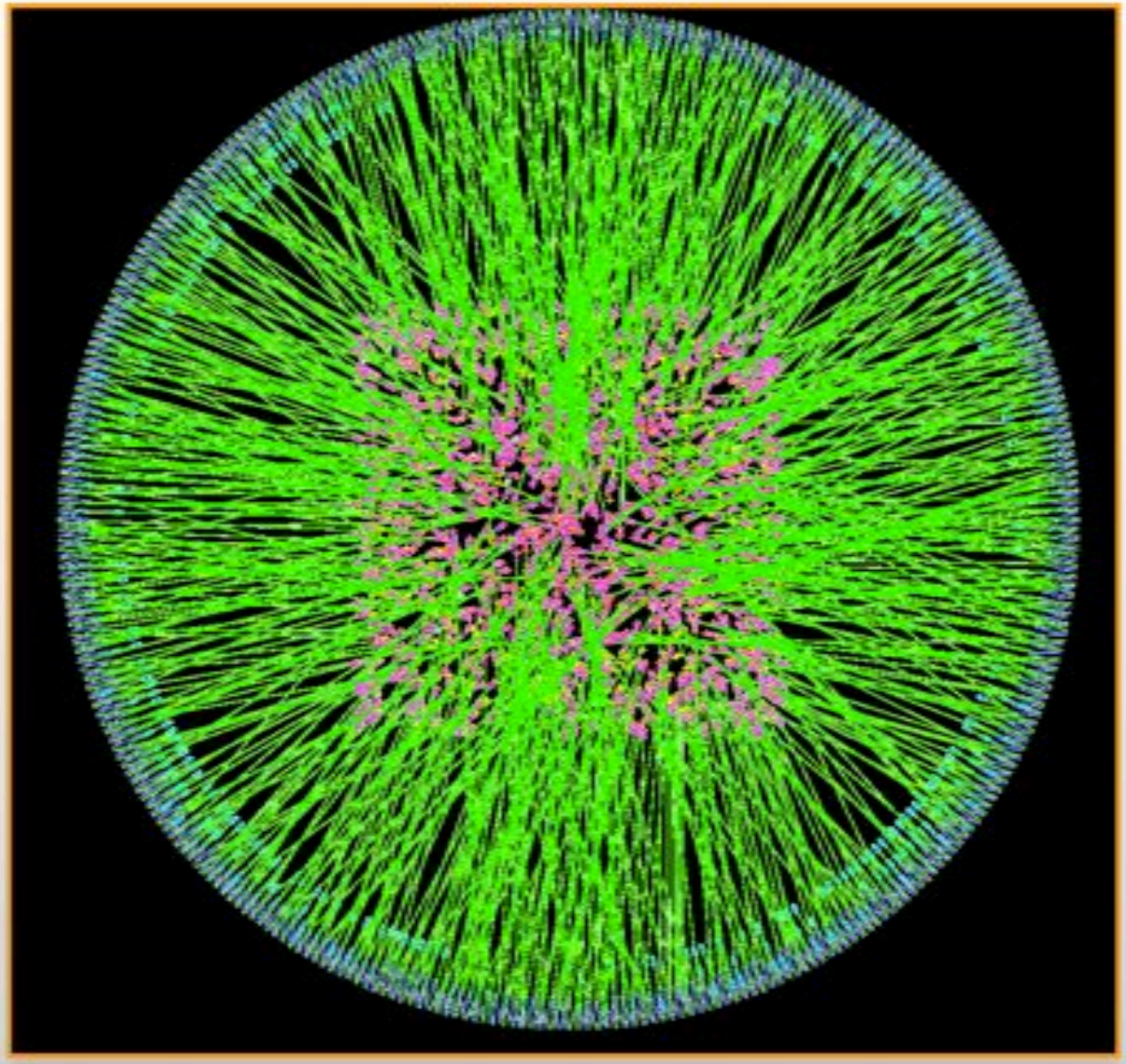
Realistic button and retractor geometries

Algorithm developed for 2dF surveys

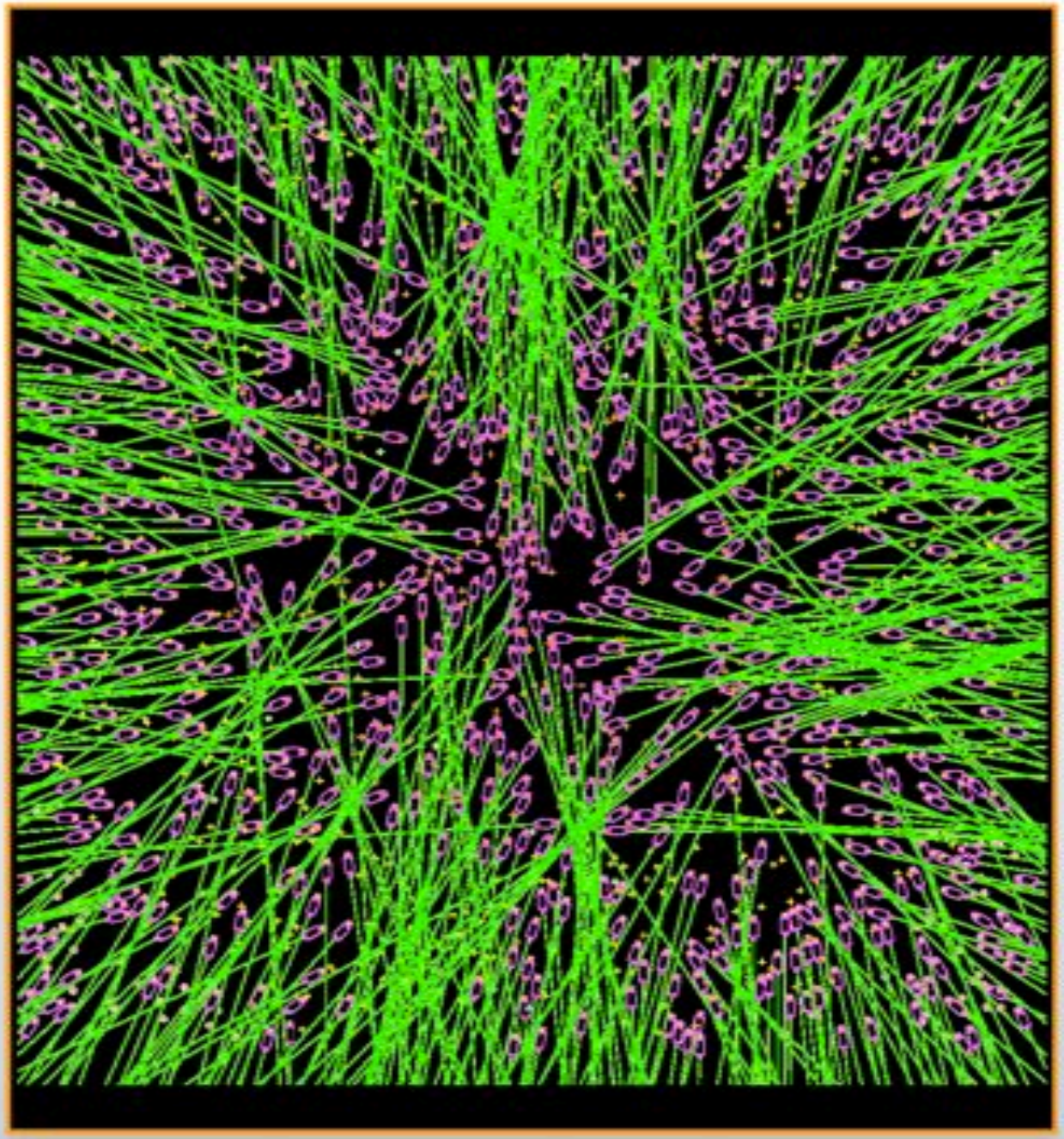


CLUSTER SIMULATION
Worst-case

11500 fibre crossings



CLUSTER SIMULATION
Could only allocate 730
Targets in this field…



Retractor Prototype

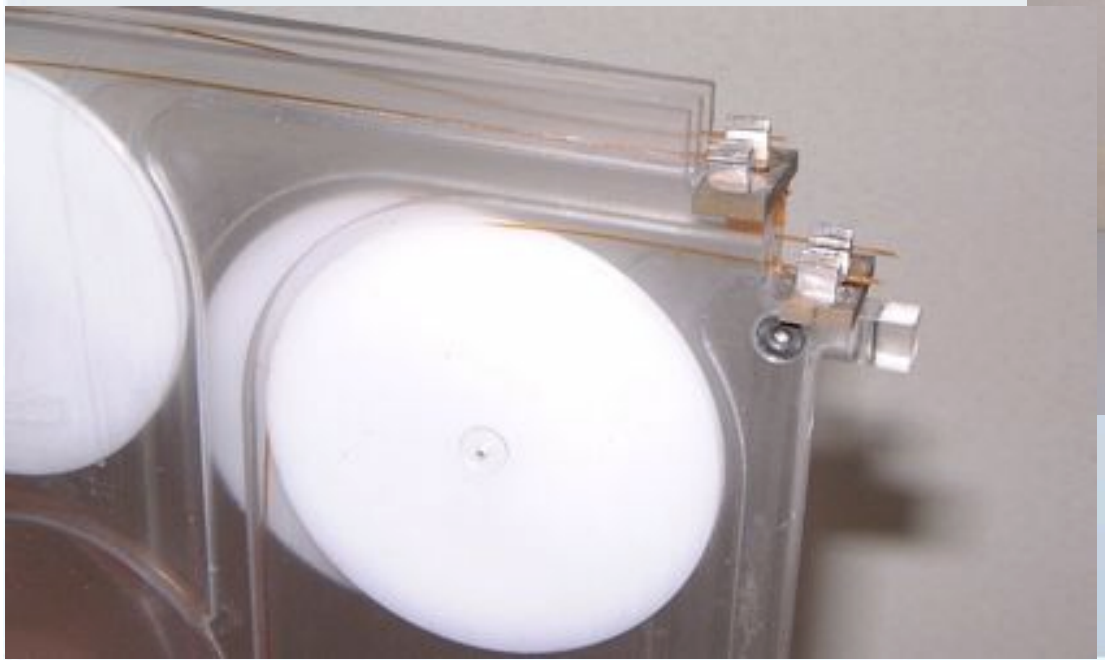
- Completed 25/10/10 (!)

- Some issues already identified (no surprise)

- Evolve design details by experience

- Test reliability under 1000's of repeated operations

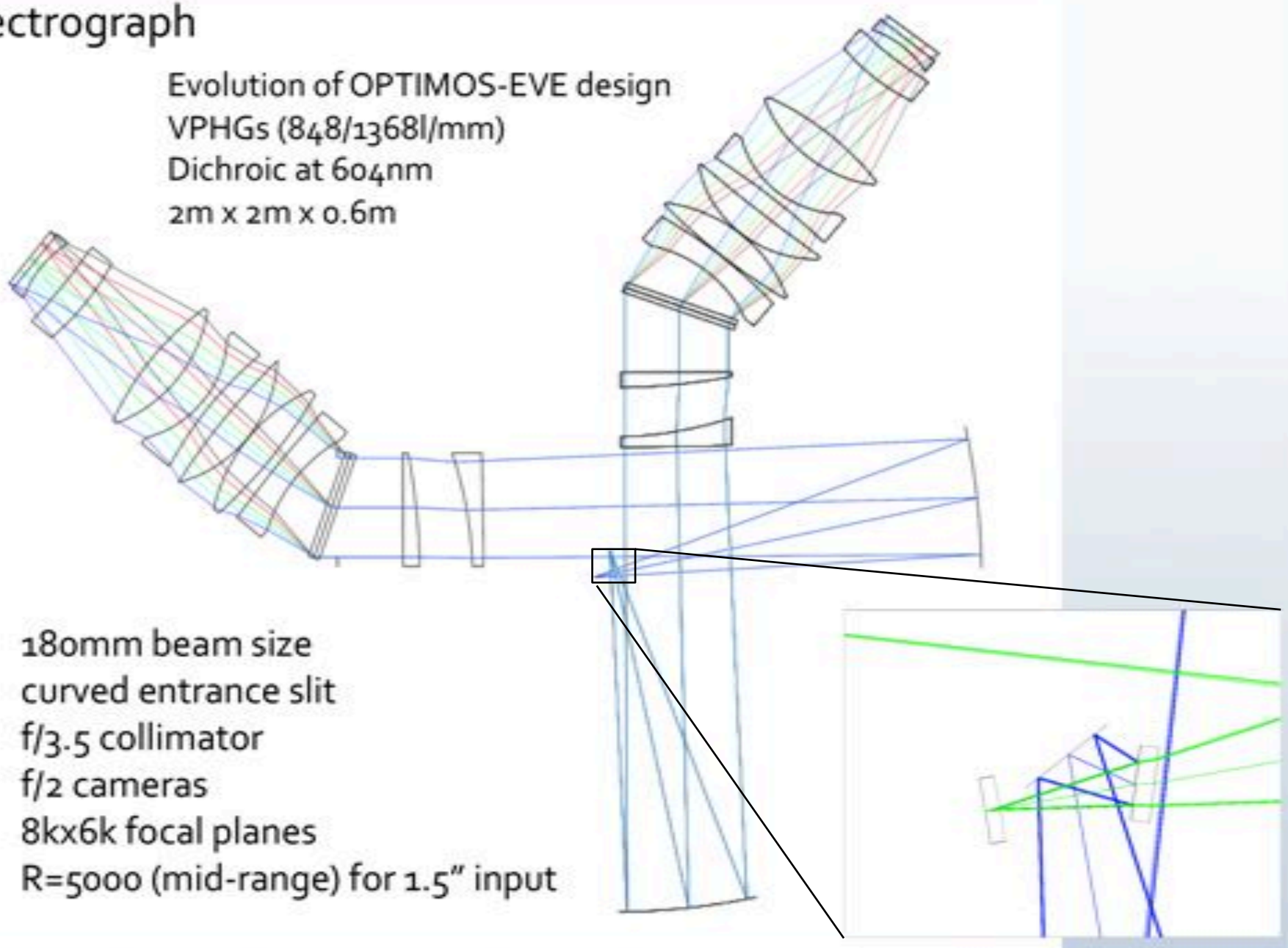




GYES version...

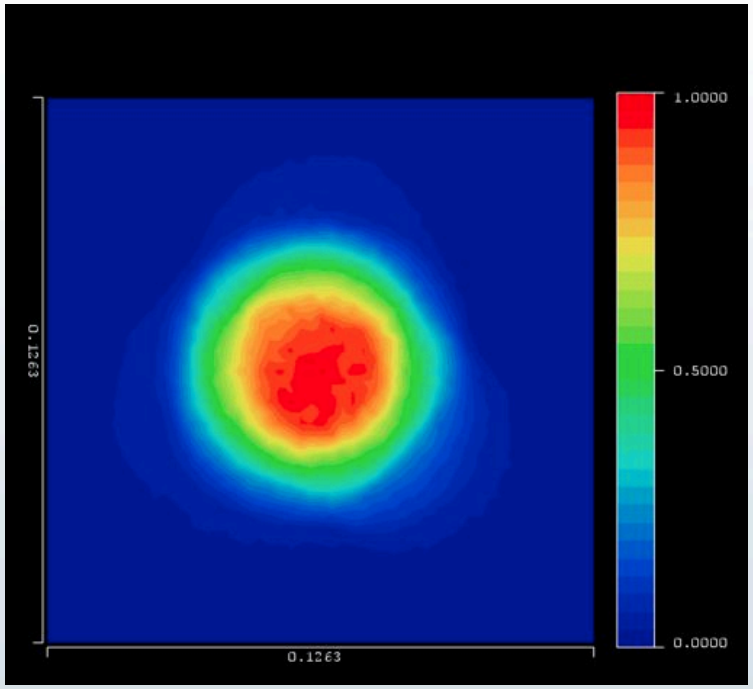
Spectrograph

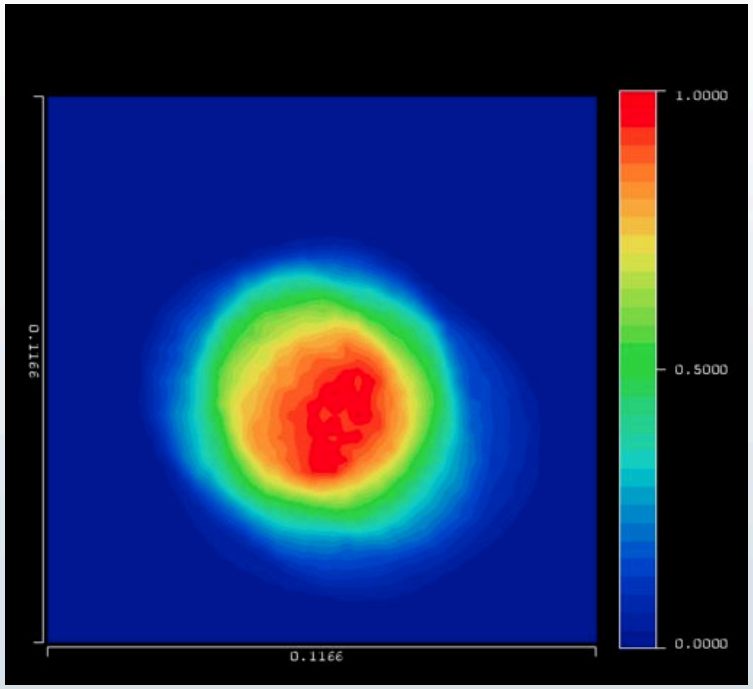
Evolution of OPTIMOS-EVE design
VPHGs (848/1368l/mm)
Dichroic at 604nm
2m x 2m x 0.6m



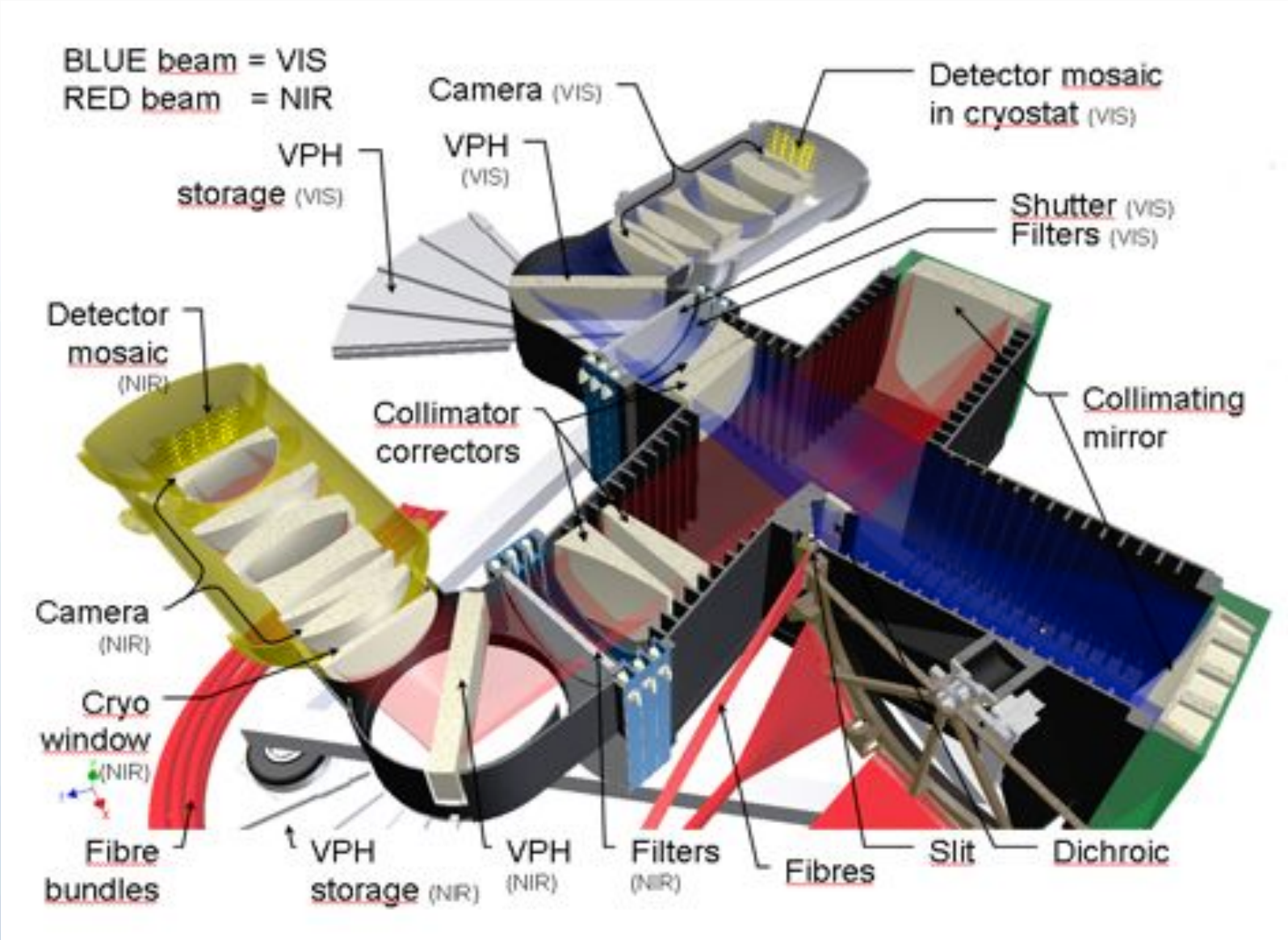
180mm beam size
curved entrance slit
f/3.5 collimator
f/2 cameras
8kx6k focal planes
R=5000 (mid-range) for 1.5" input

Fibre core images (51µm) at the detector (603nm), extreme slit, 93µm fibre core spacing at the detector

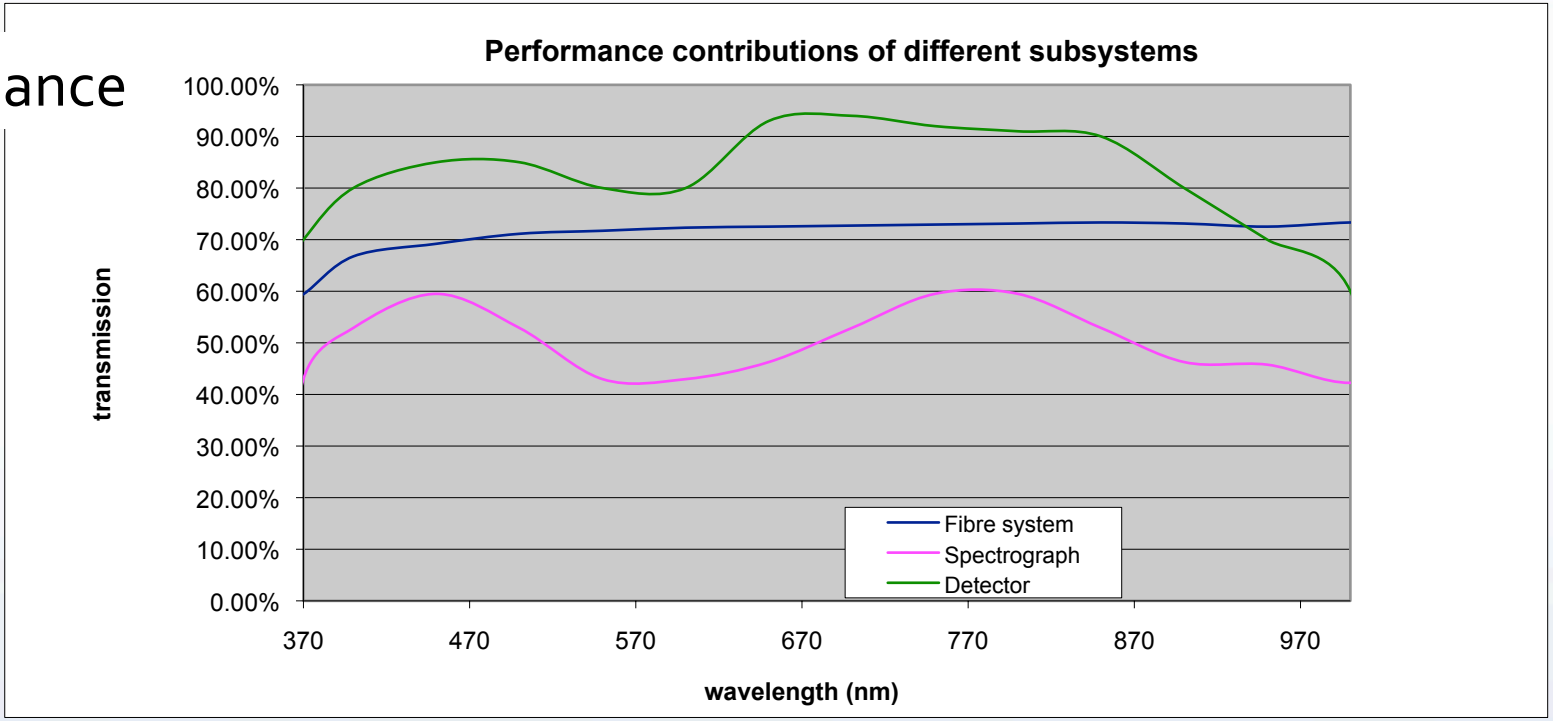


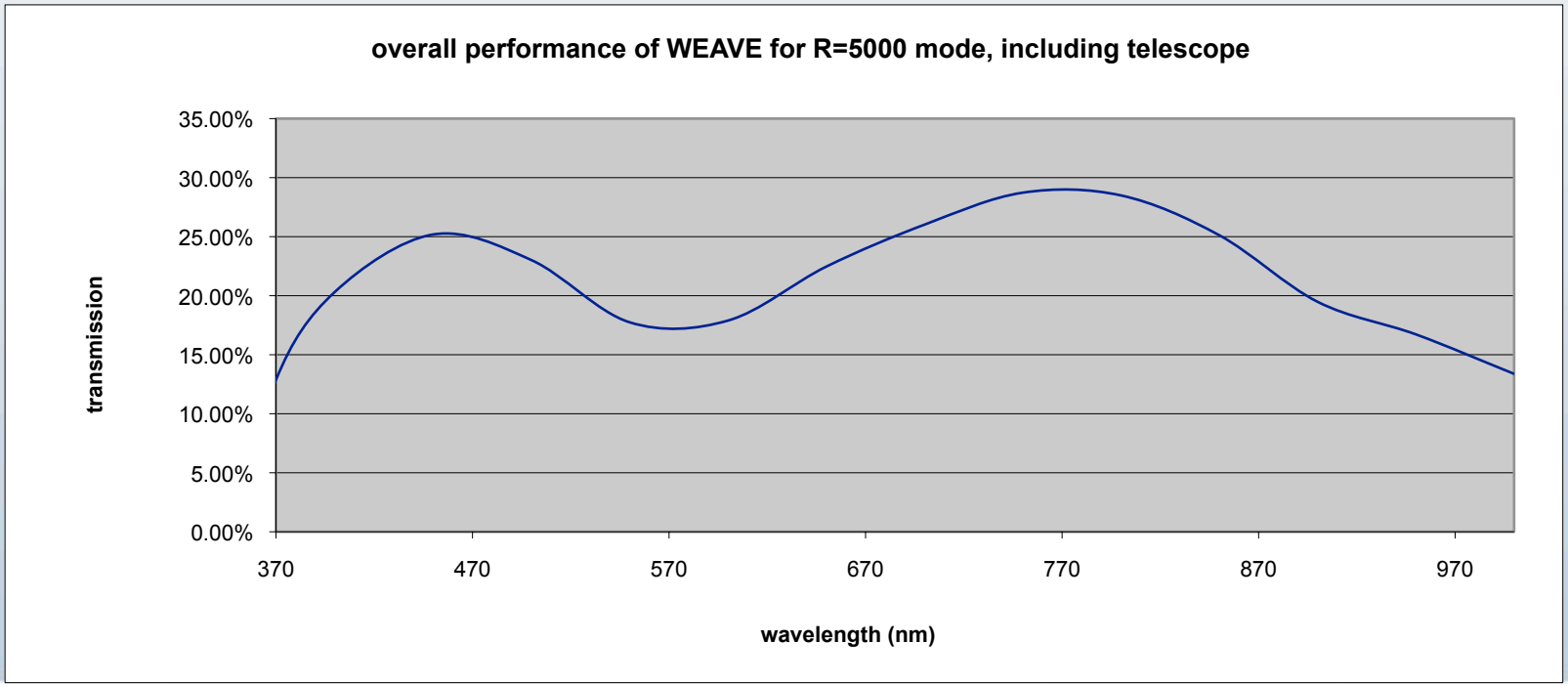


Mechanical layout (EVE, Astron design)



Performance





Summary

- Relatively straightforward to put a 1000 fibre, 2 degree spectrograph on the WHT
- Short fibre run to Nasmyth maintains good throughput
- Could be on-sky in 2016. 10,000 stars/night @R=5000, full wavelength coverage.
- Can achieve R~20000
- Could expect to devote a substantial fraction of WHT time to an instrument with these capabilities