WEAVE: The next-generation spectroscopic survey facility for the WHT

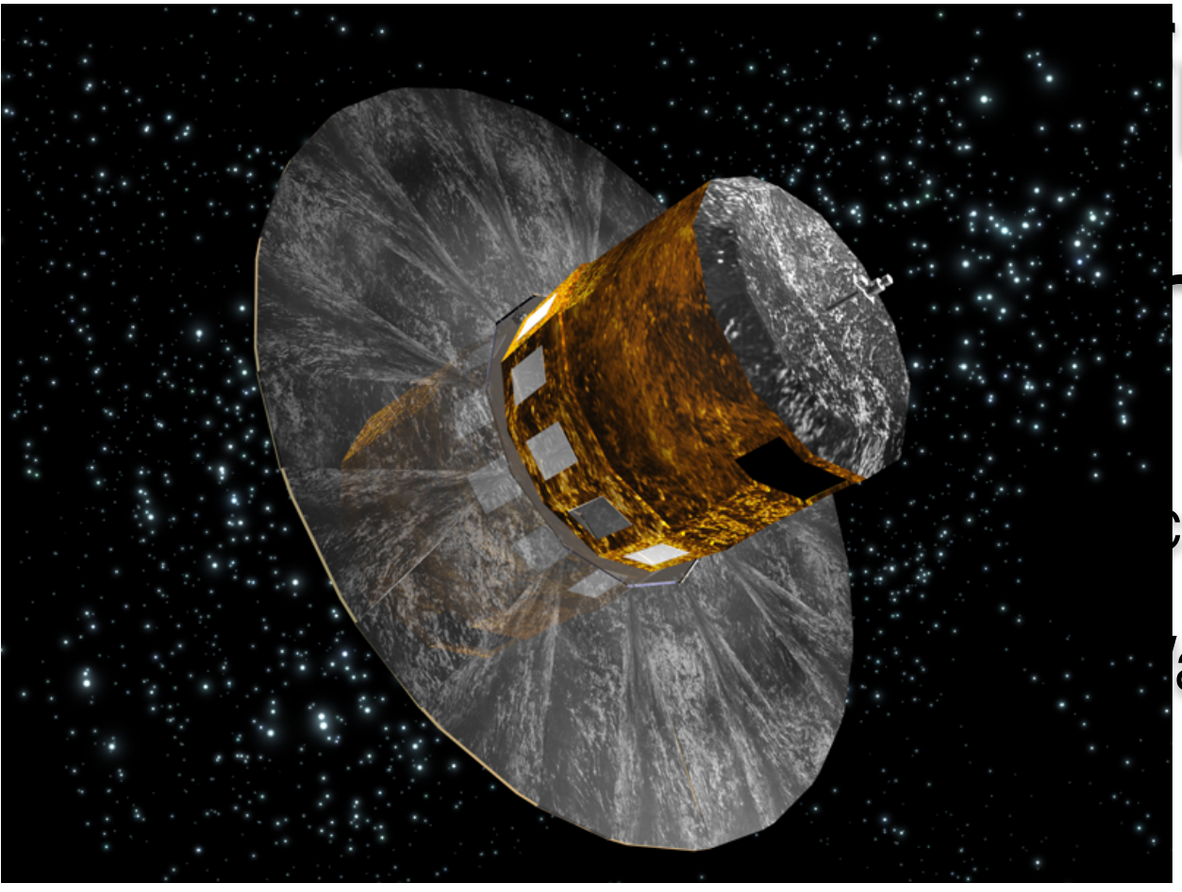
S.C. Trager (Project Scientist + NL co-PI)

Kapteyn Astronomical Institute, U. Groningen

university of groningen / faculty of mathematics and natural sciences / astronomy

New survey frontiers from new survey instruments

- Gaia: Astrometry at microarcsecond precision
  - The history of the Milky Way
- SKA Pathfinders:
  - LOFAR:
    - The history of star formation and AGN in the Universe
    - Precision cosmology
  - Apertif:
    - HI at cosmological distances



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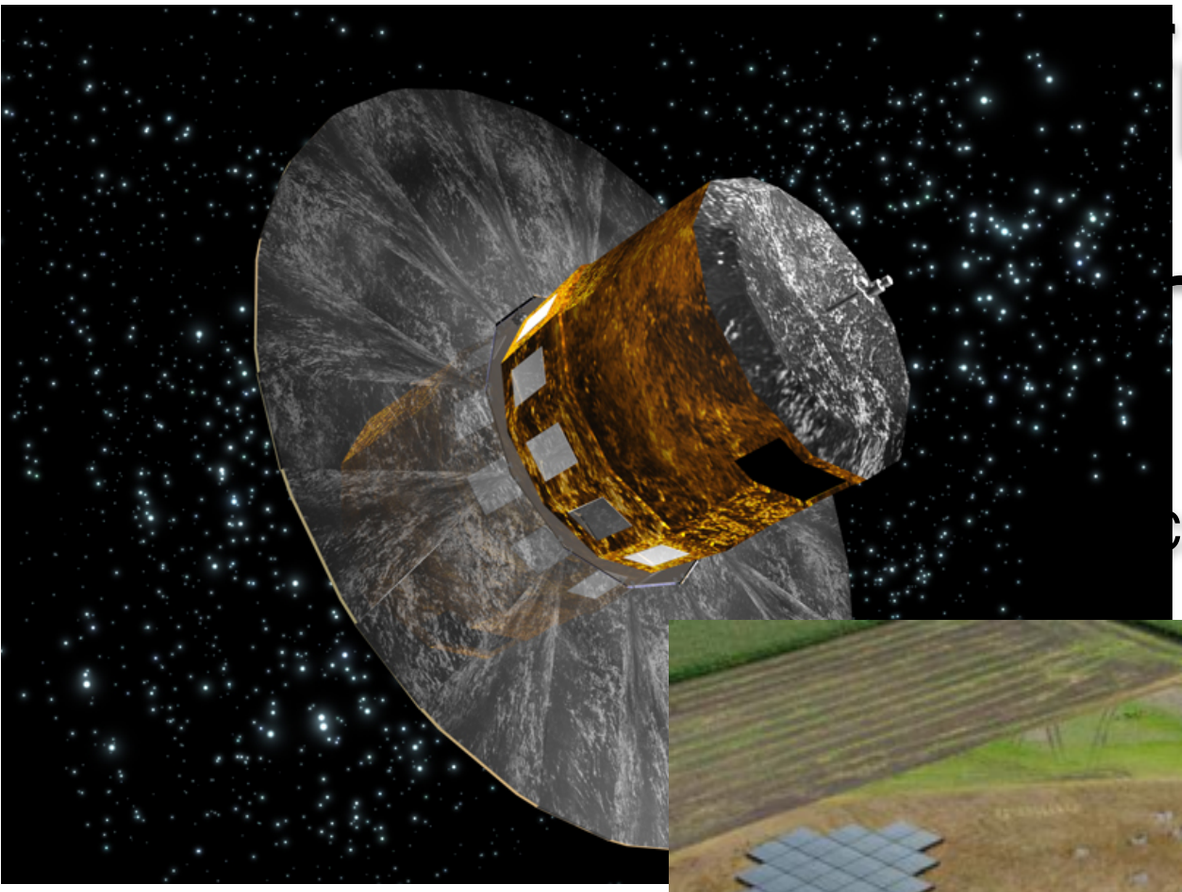

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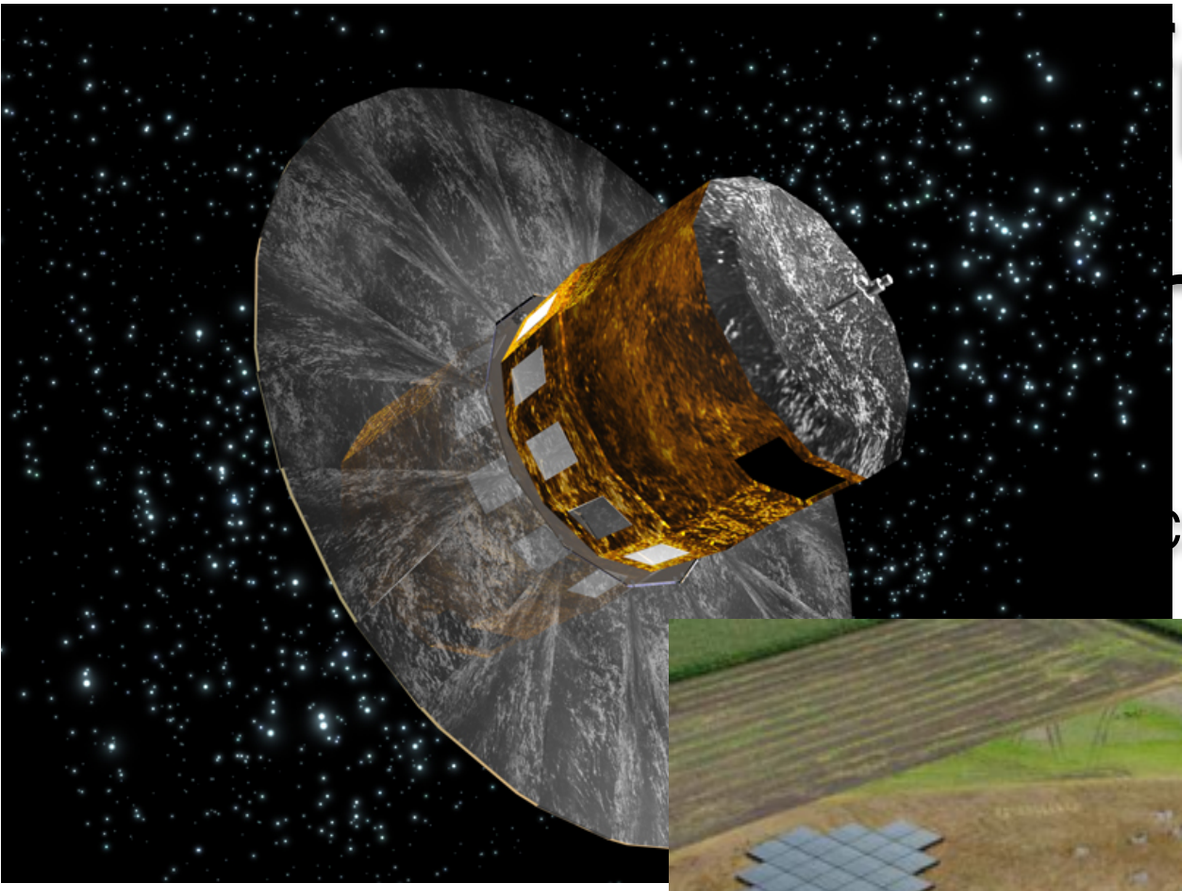

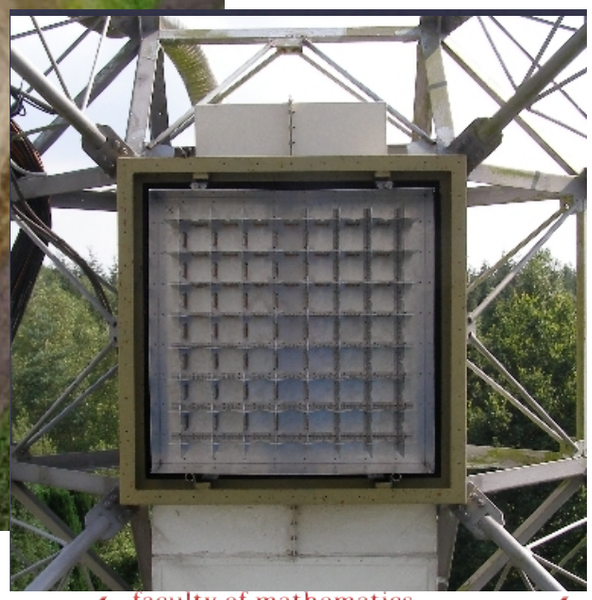

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  - The hist
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- Apertif:
  - HI at cc

New survey frontiers from new survey instruments

- All of these are, by themselves, incomplete!
  - Gaia: no radial velocities at V>17 mag, no abundances at V>12 mag
  - LOFAR: just continuum, no redshifts
  - Apertif: just neutral gas kinematics, limited (SDSS) or no stellar info

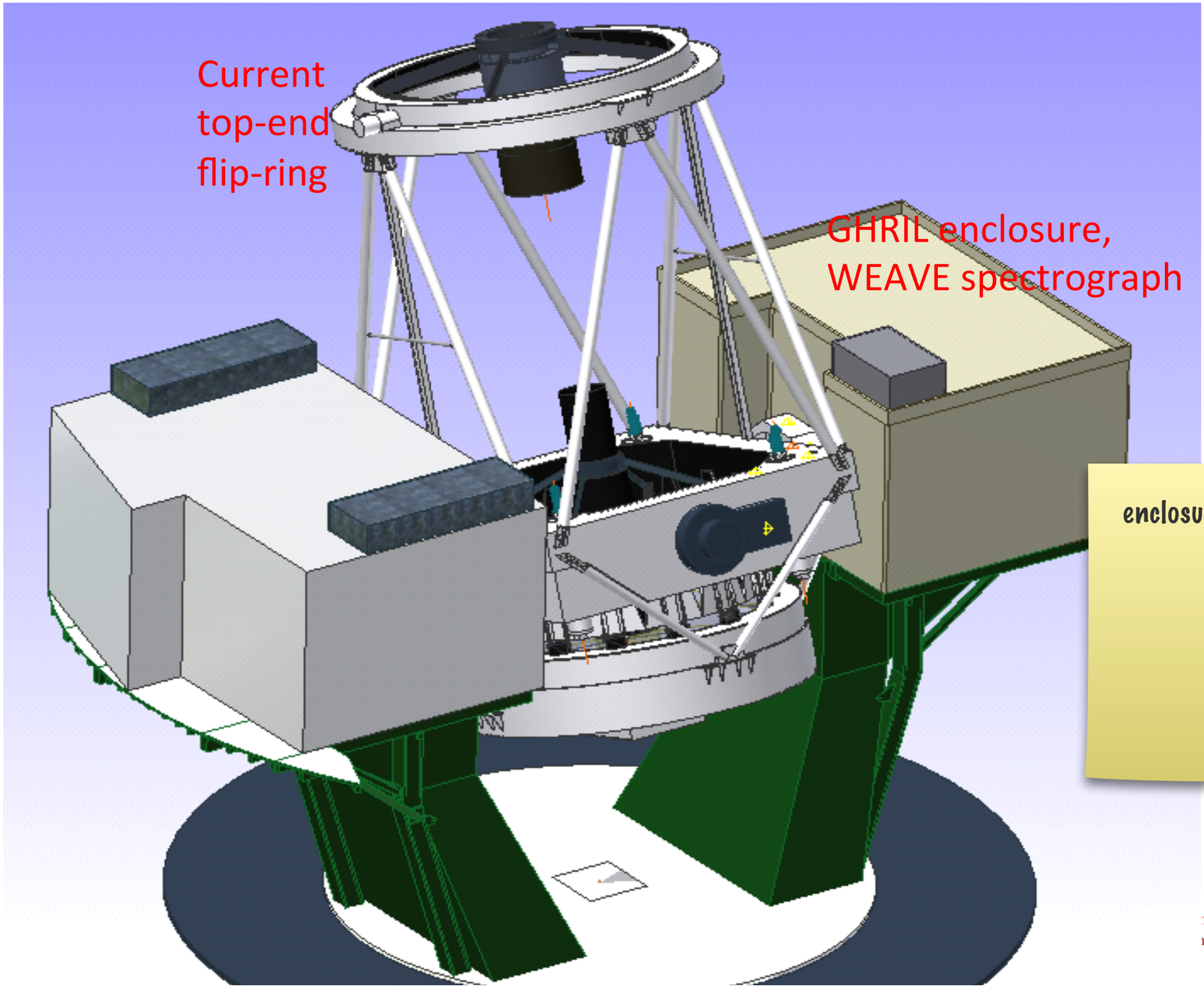
What do we need to exploit these new facilities?

Gaia	R=5000 for radial velocities at 17≤V≤20 R=20000 for stellar abundances at 12≤V≤17 10^7 stars over 10^4 degrees
LOFAR	λ370–980nm and V≤21.5 at S/N=5 (continuum) for redshifts 10^7 galaxies over 10^4 degrees
Apertif	mini-IFUs and Large IFU for 2D spectra of gas-rich galaxies 10^4 galaxies over 10^4 degrees

Why a 4m telescope?

- Two words: *plate scale*
- The combination of wide fields (few degrees) and reasonable fiber sizes (e.g., 100 μm fibers ~ 1.5”), together with efficient instruments, means **rapid survey speeds**

WEAVE: A new facility instrument for the WHT



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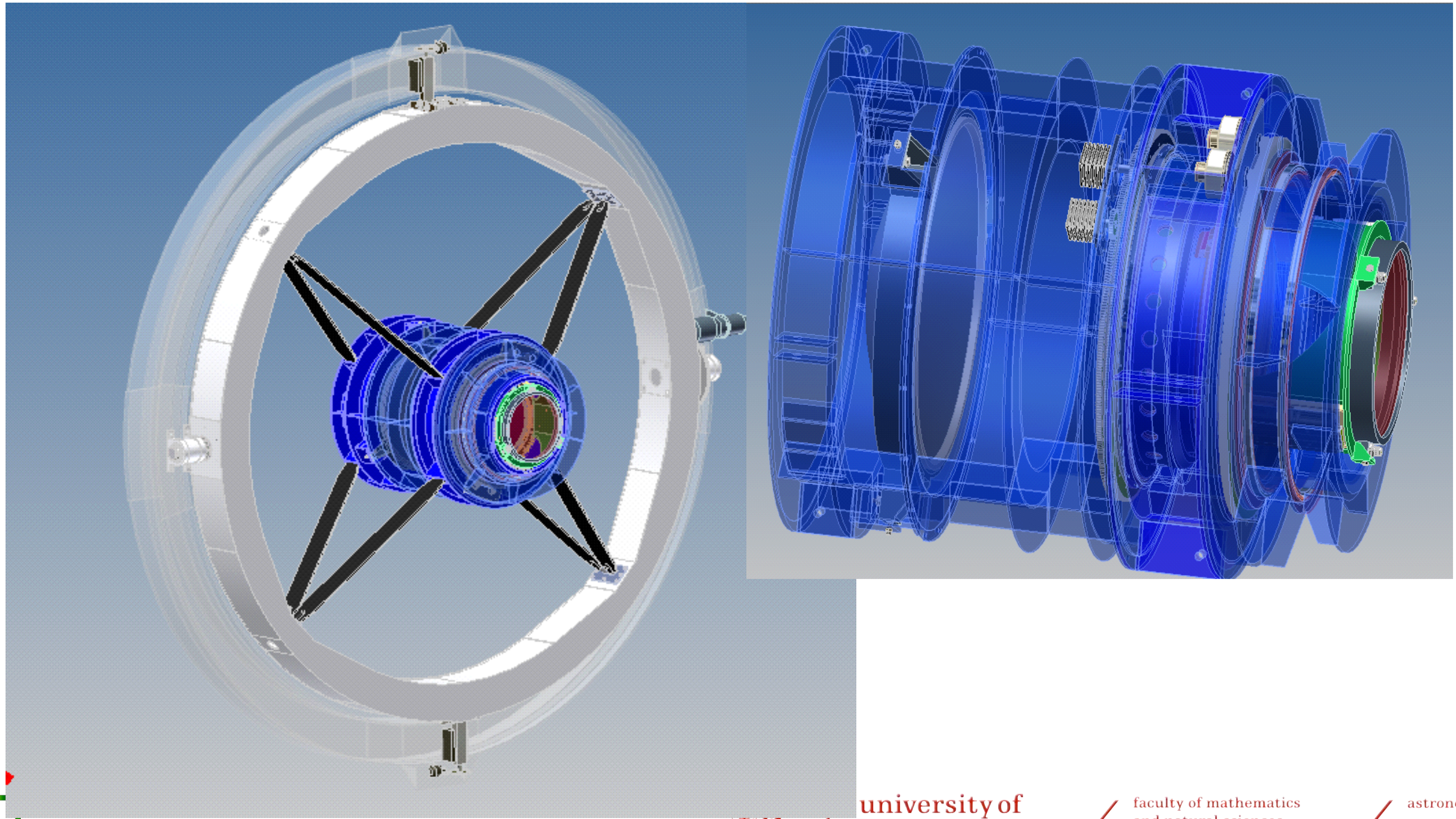
WEAVE: New top end ring

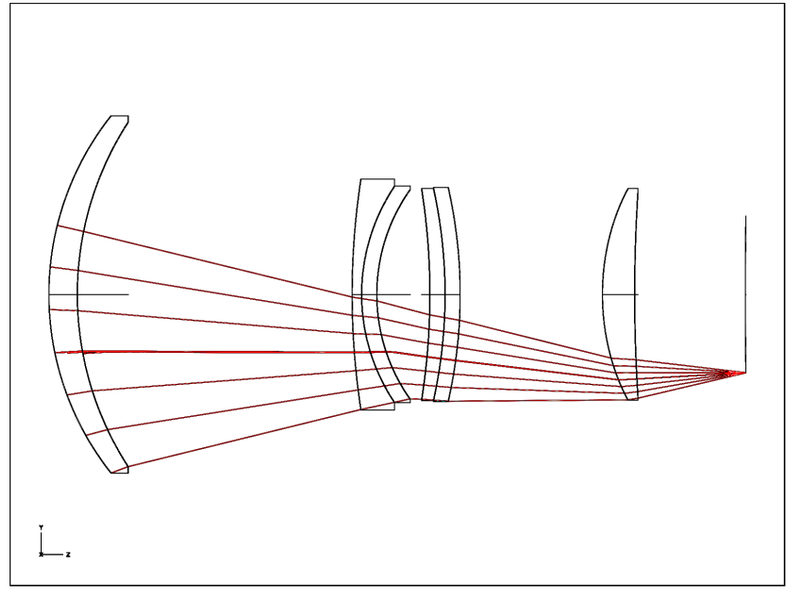
fully exchangeable w/old top-end ring

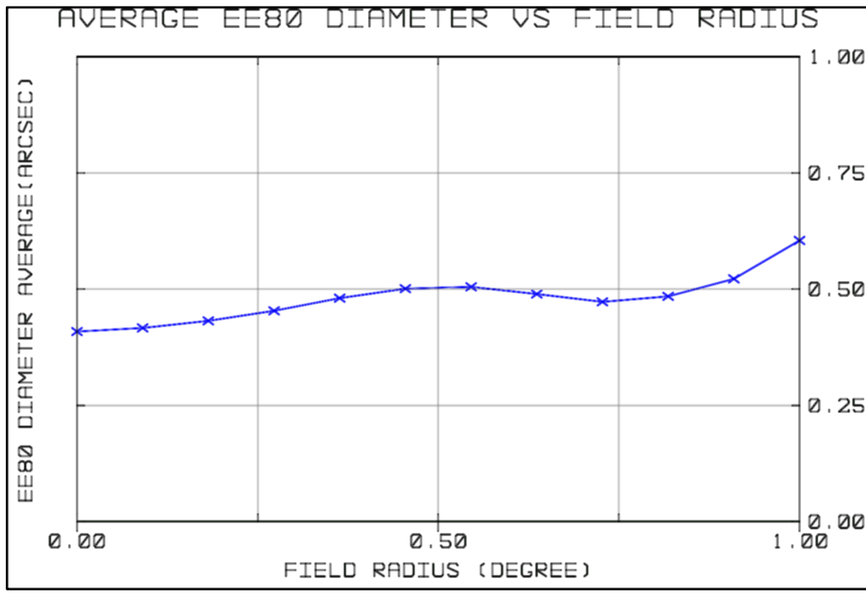
New 2º Prime Focus Corrector + ADC

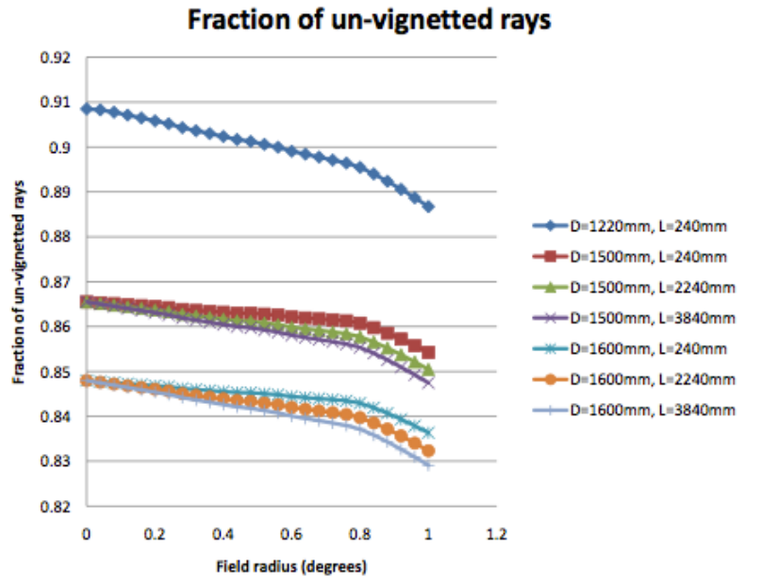


Prime Focus Corrector + ADC

- 2º diameter FOV
- 940mm first lens
- 290mm back focal distance
- Counter-rotating ADC
  - Polychromatic image quality degrades by *only* 0.1” at 55º ZD with ADC
- Flat focal plane with tolerable non-telecentricity



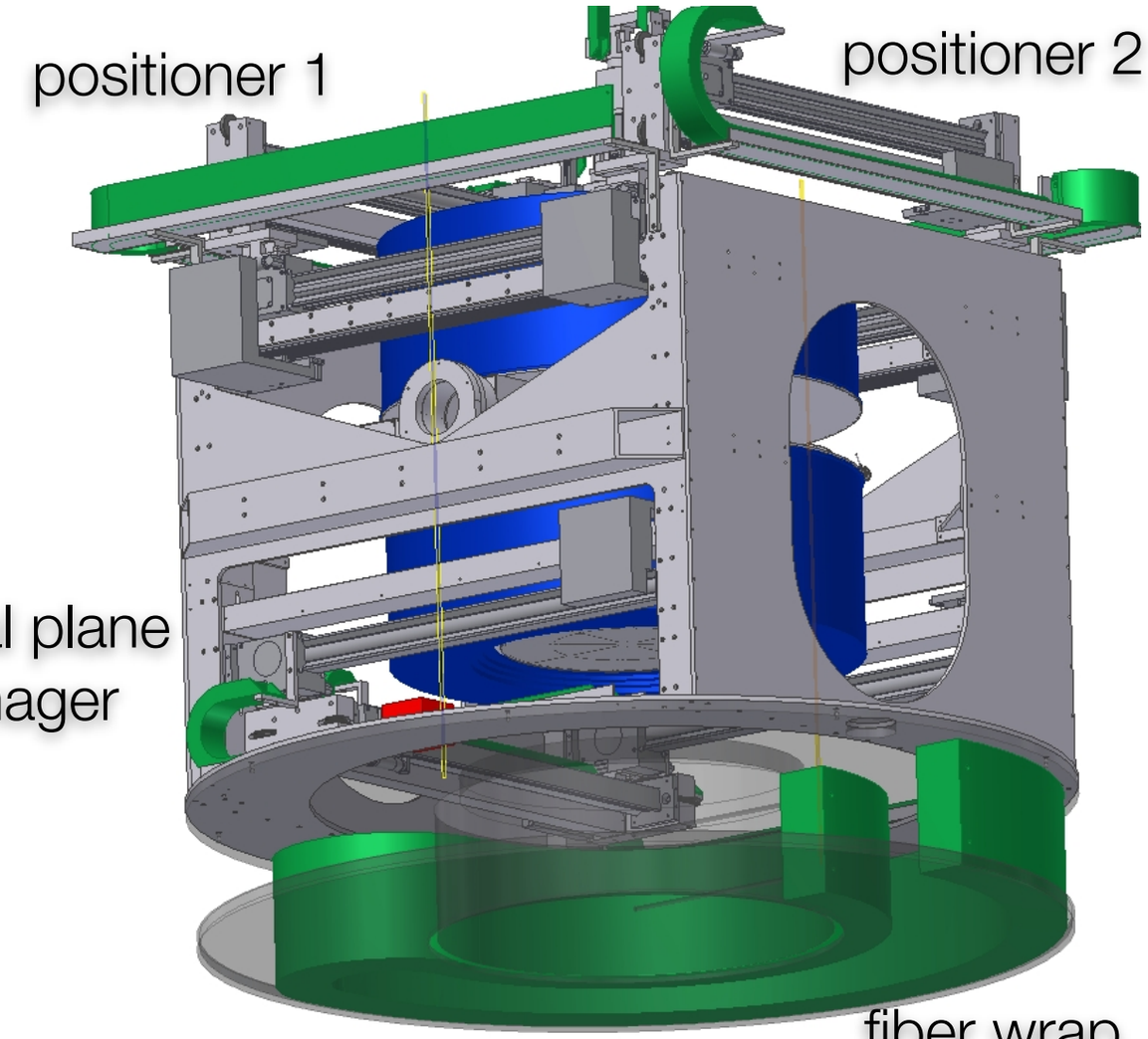




Fibre positioner

- Pick-and-place fiber positioner: COTS components
  - 2dF-like
  - tumbler with 2 field plates
  - 2 robots working in parallel
  - low-risk, low-cost
  - high flexibility

existing technology!



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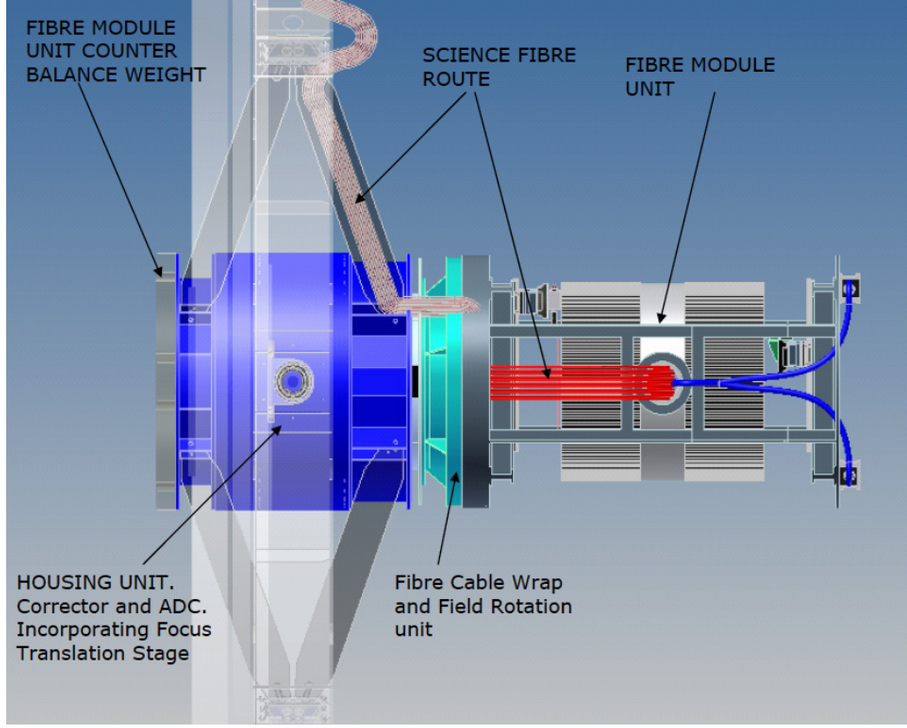
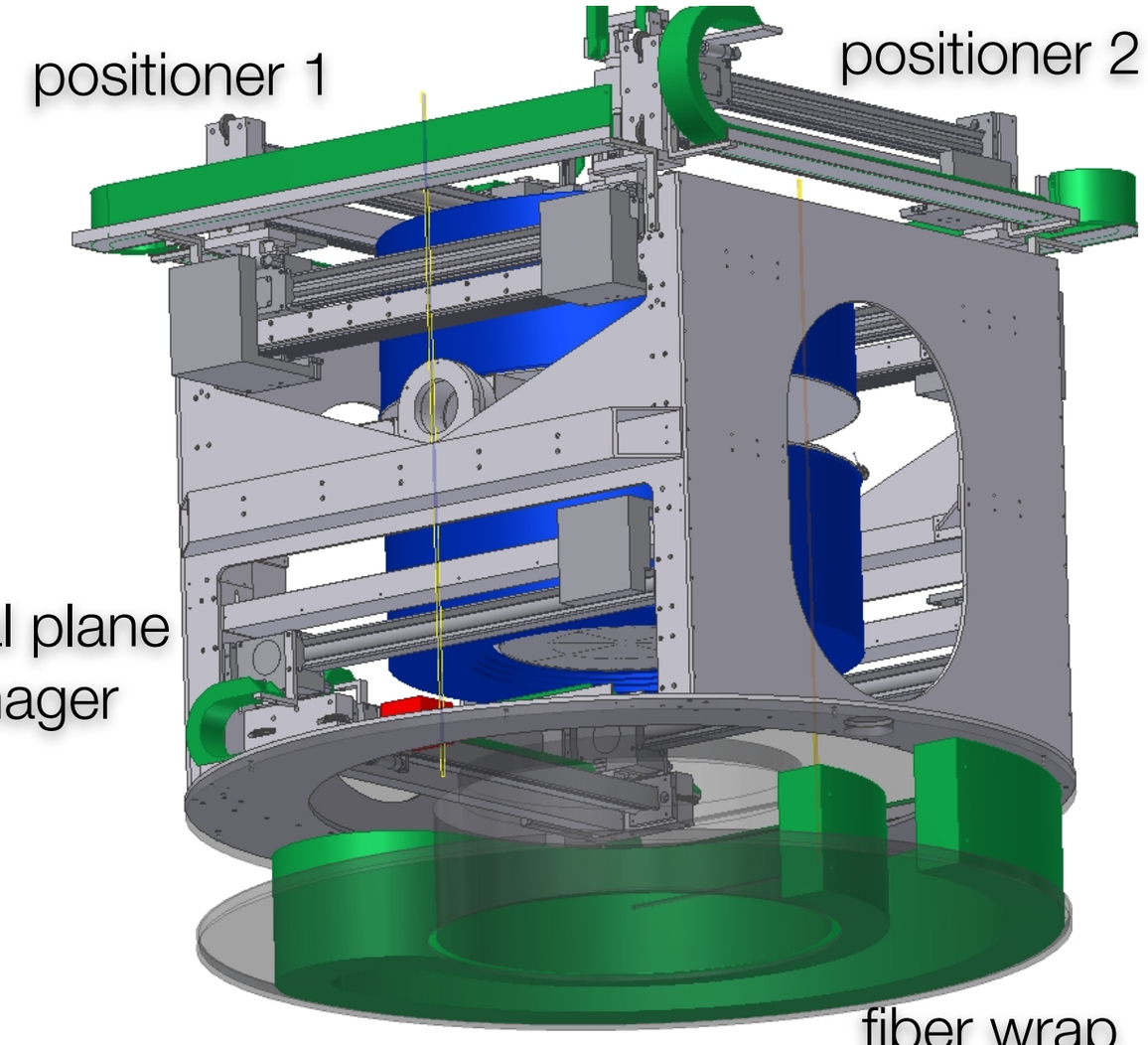
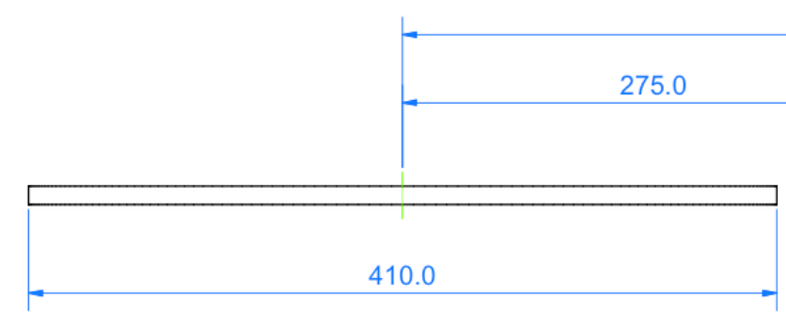
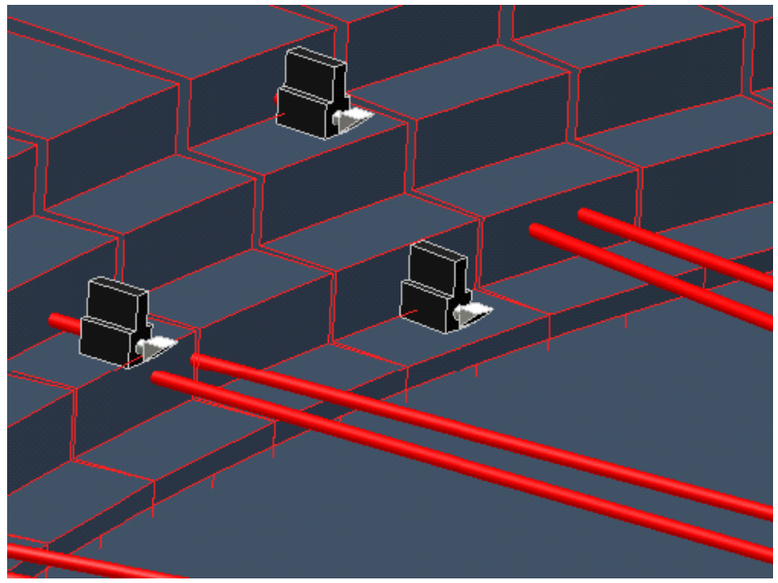


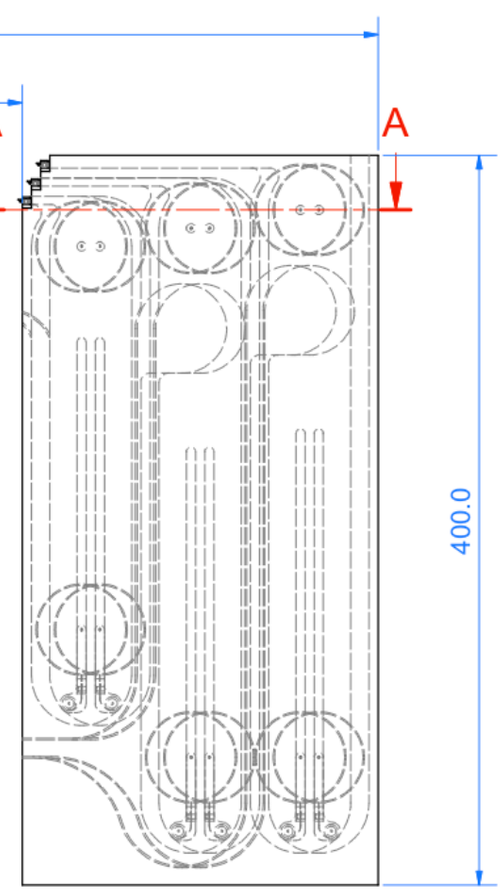


Fibre retractors

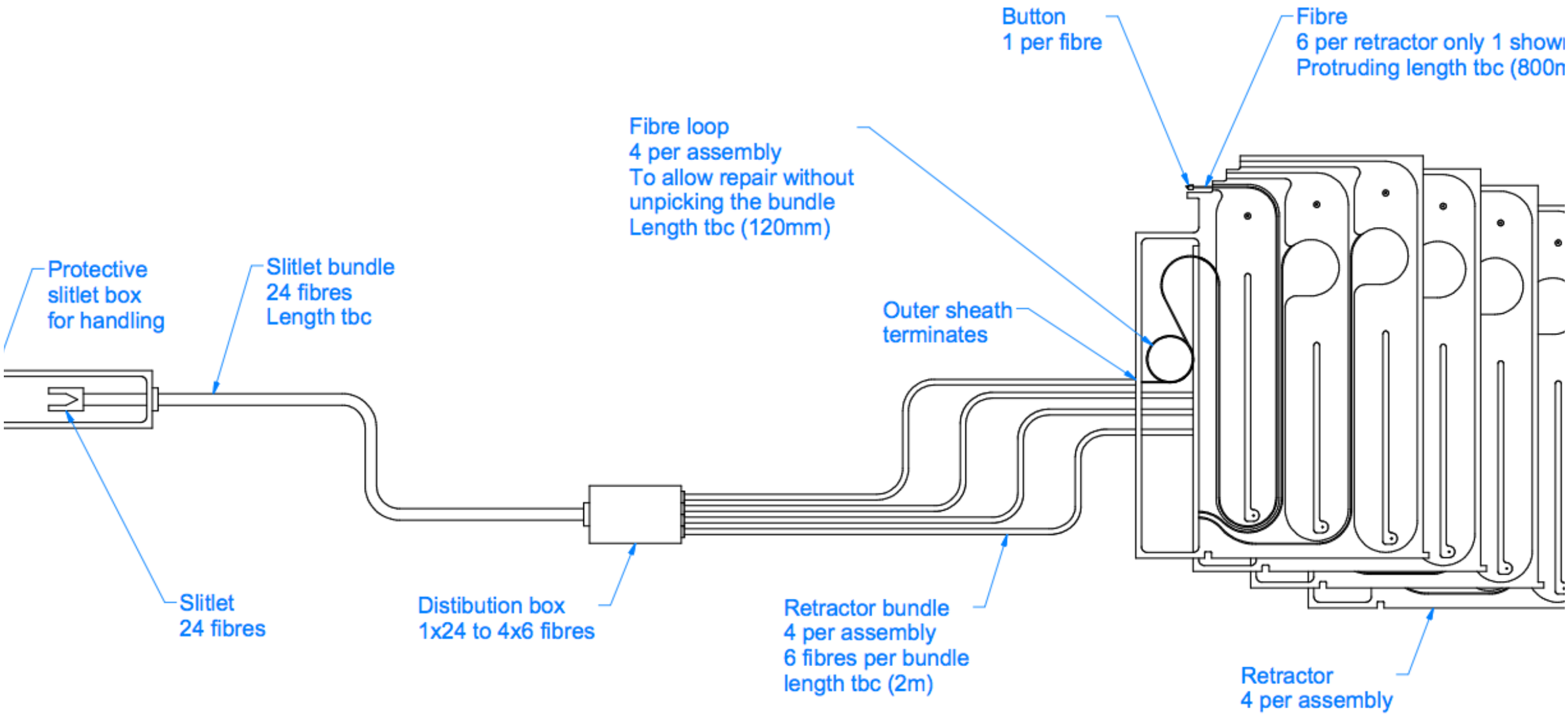
- Push park locations beyond useful field edge
- 1000 MOS buttons
- “Bull-ring” triple-parking concept







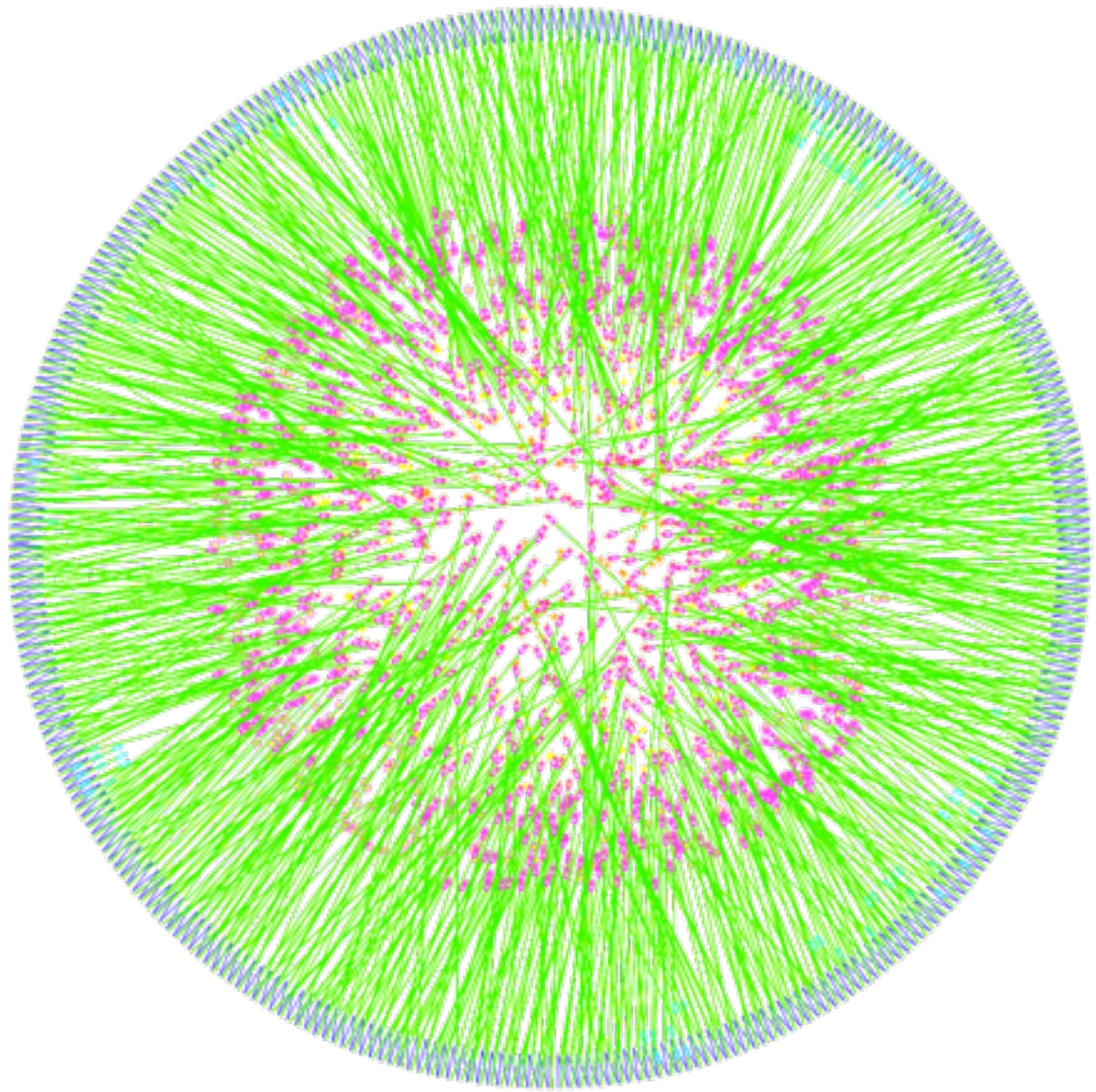
Fibre cables



Fibre systems

LIFU: big spaxels to get to lowest surface brightnesses

- 3 fibre systems:
  - 2x 1000 MOS fibres, 1.3” pitch
    - one set/field plate
  - ~25 miniIFUs on one field plate, ~9”x9”, 1.3” pitch
  - Large IFU with ~547 fibres ~90” x ~60”, 2.6” pitch



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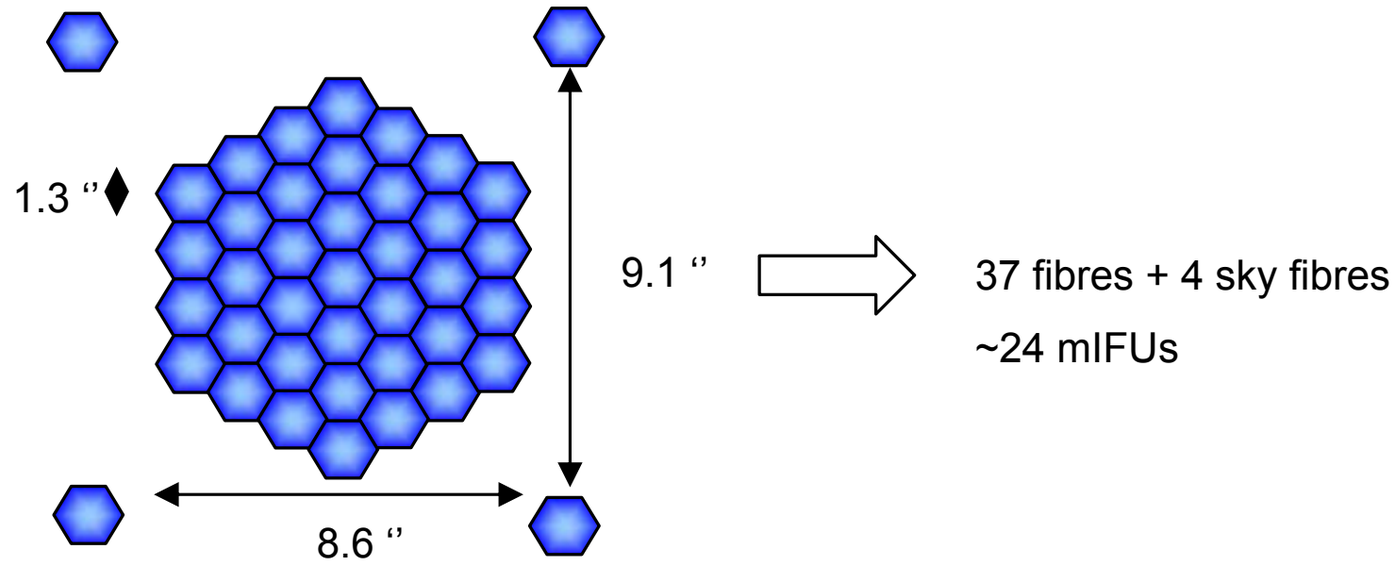

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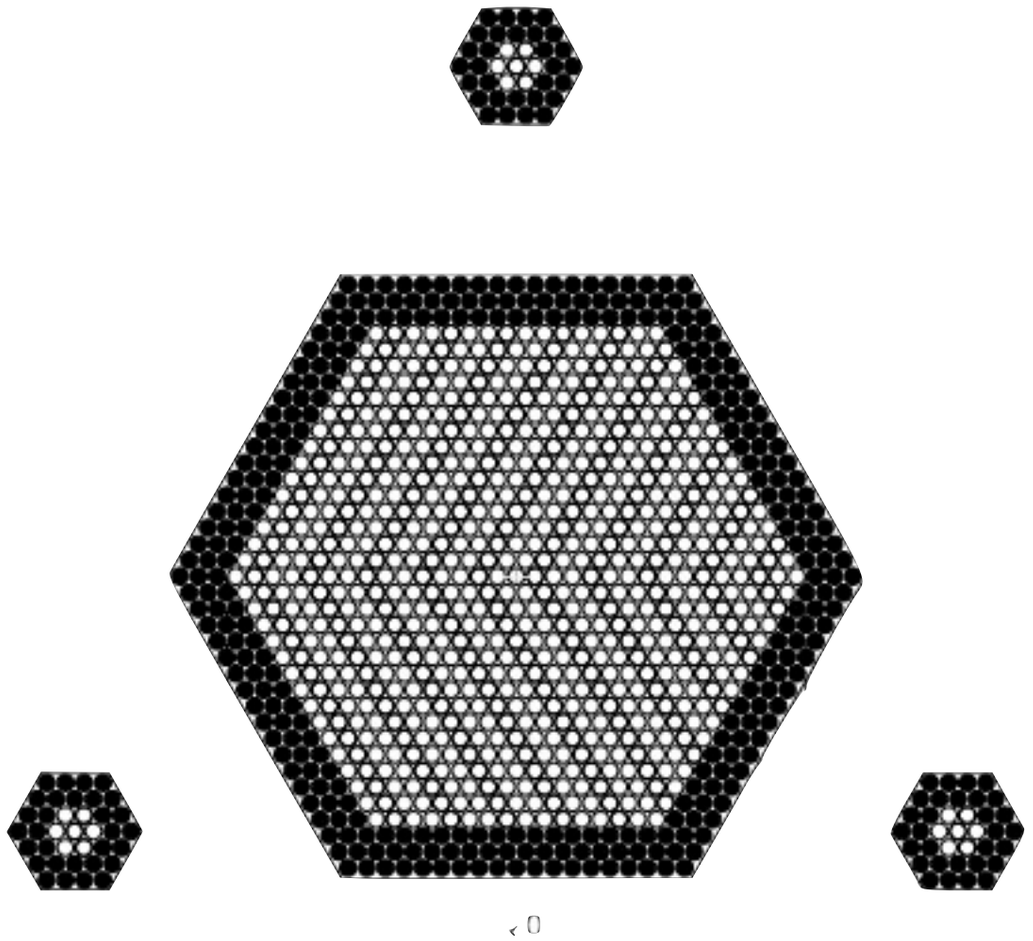
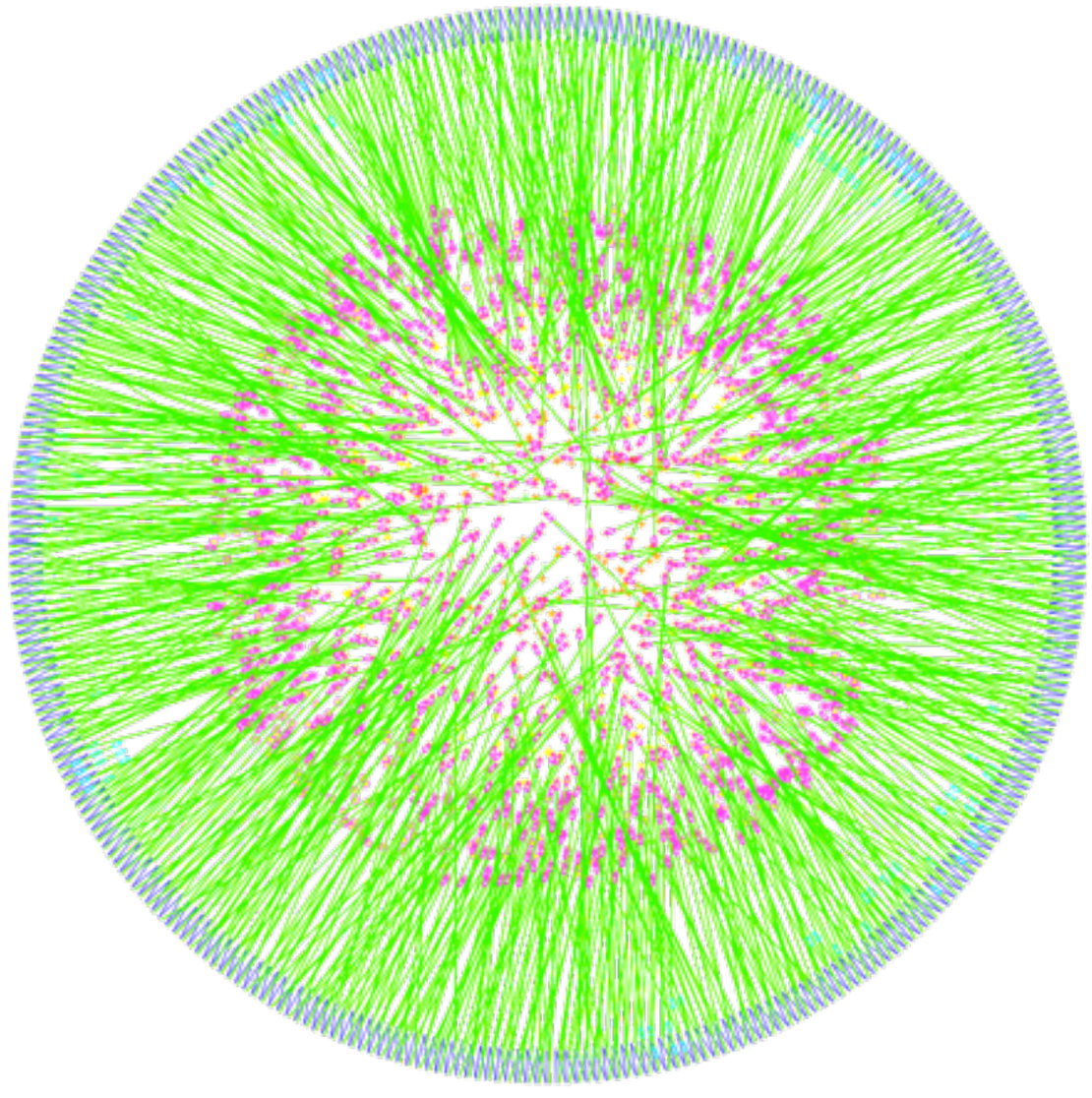
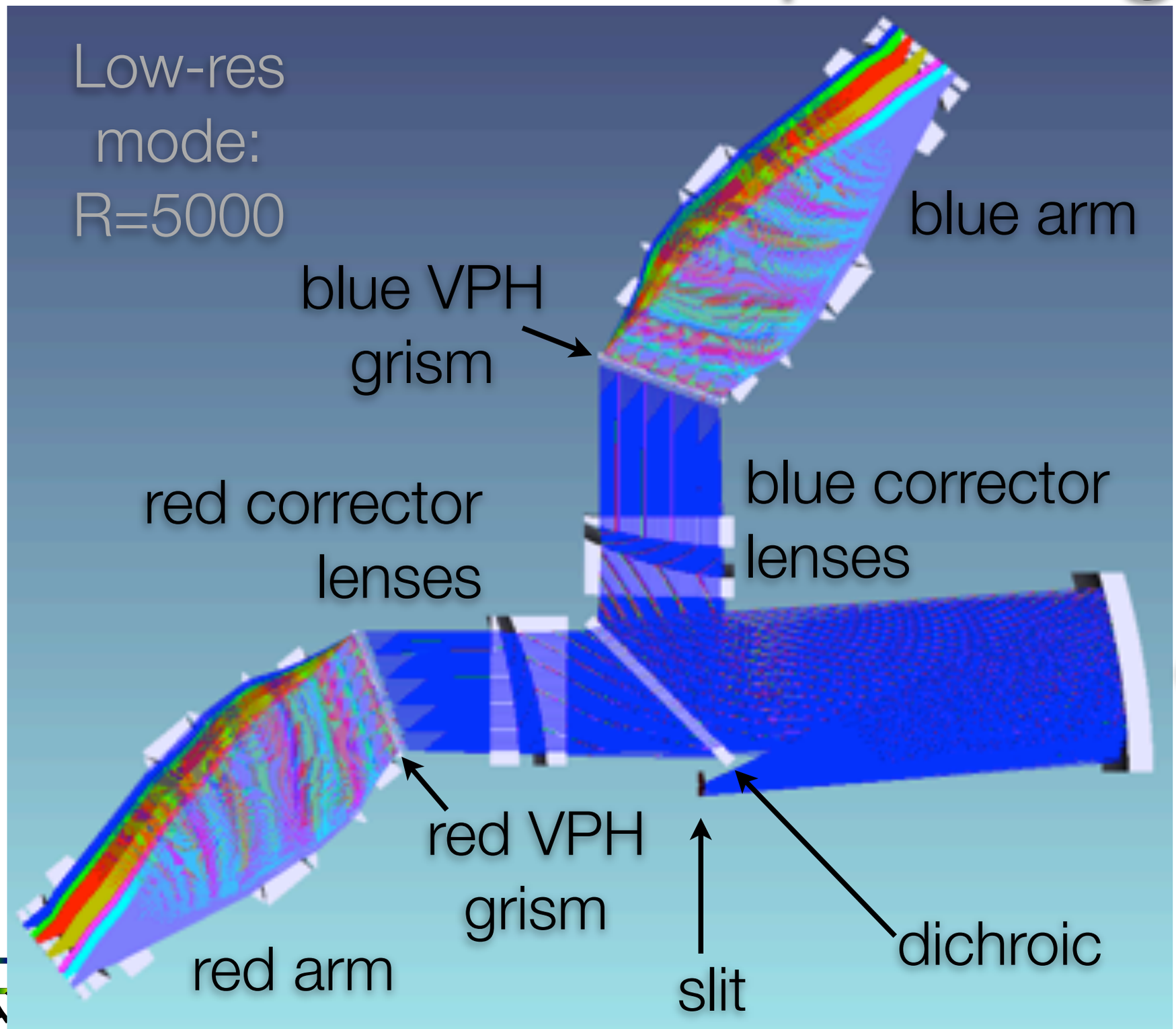


MOS field configuration

- 97% of fibres allocated in test simulation (1.8x oversampled targets)
  - 8300 fibre crossings!
- ~1600 moves within ~55 minutes with two robots



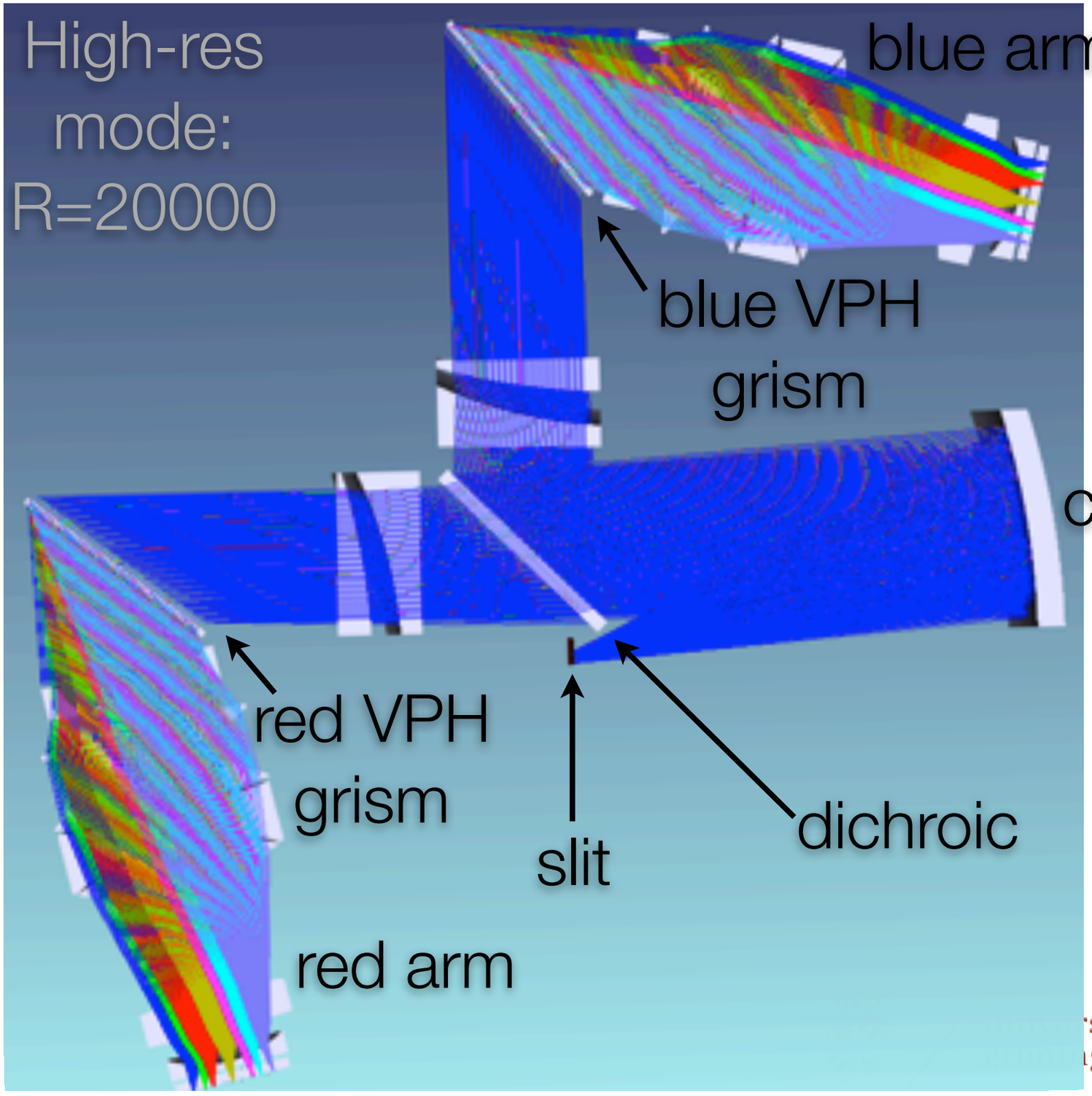
The WEAVE spectrograph



f/3.2 input
f/1.7 camera
2 x 3k x 8k CCD in each arm

outgrowth of Optimos-EVE Phase A study: E-ELT feeding back to community!
also: same spectrograph for ESO 4MOST Phase A study

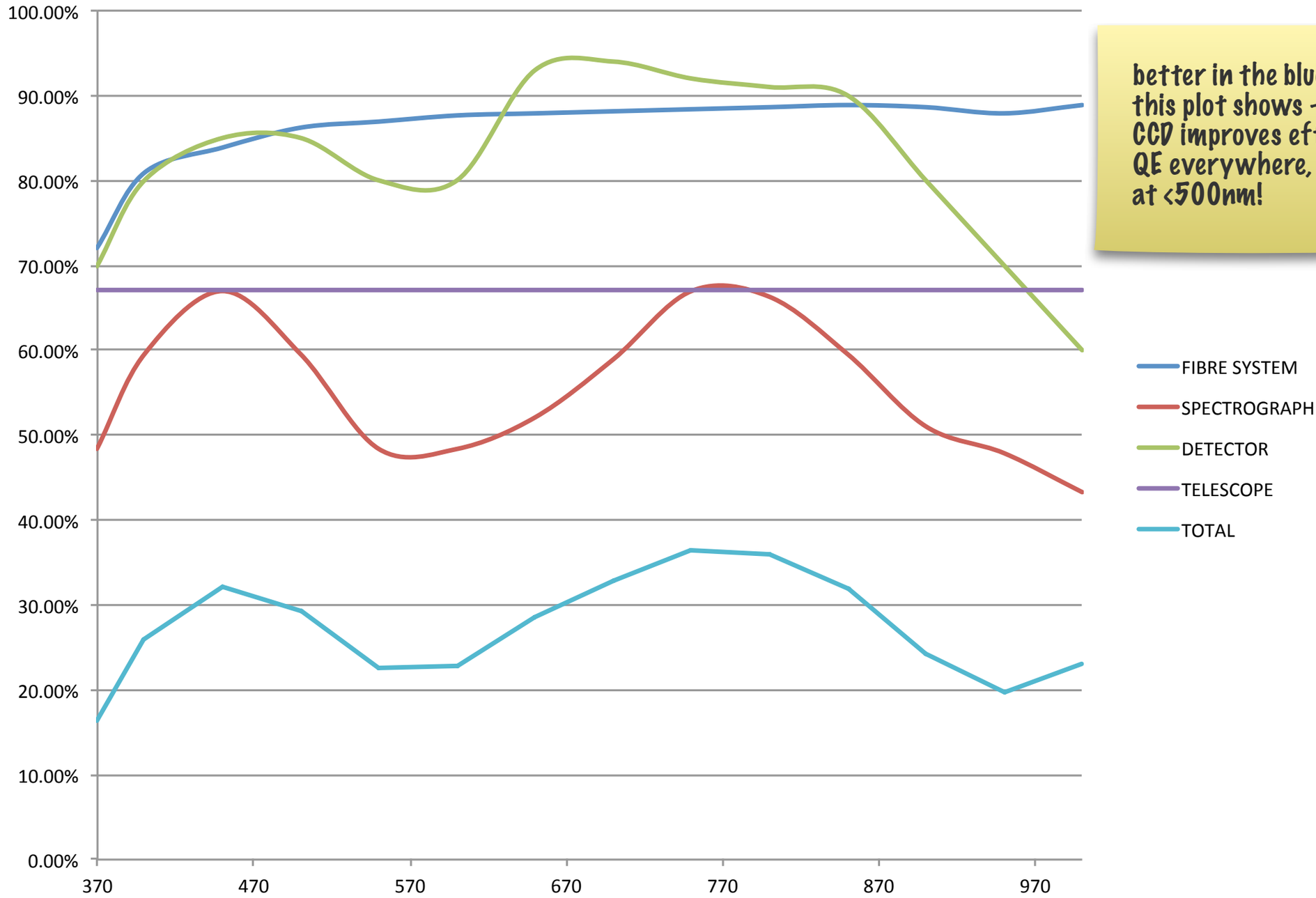
The WEAVE spectrograph



f/3.2 input
f/1.7 camera
2 x 3k x 8k CCD in each arm

same spectrograph, moving cameras and exchangeable grisms

WEAVE throughput



better in the blue than this plot shows -- new CCD improves effective QE everywhere, and 95% at <500nm!

WEAVE characteristics

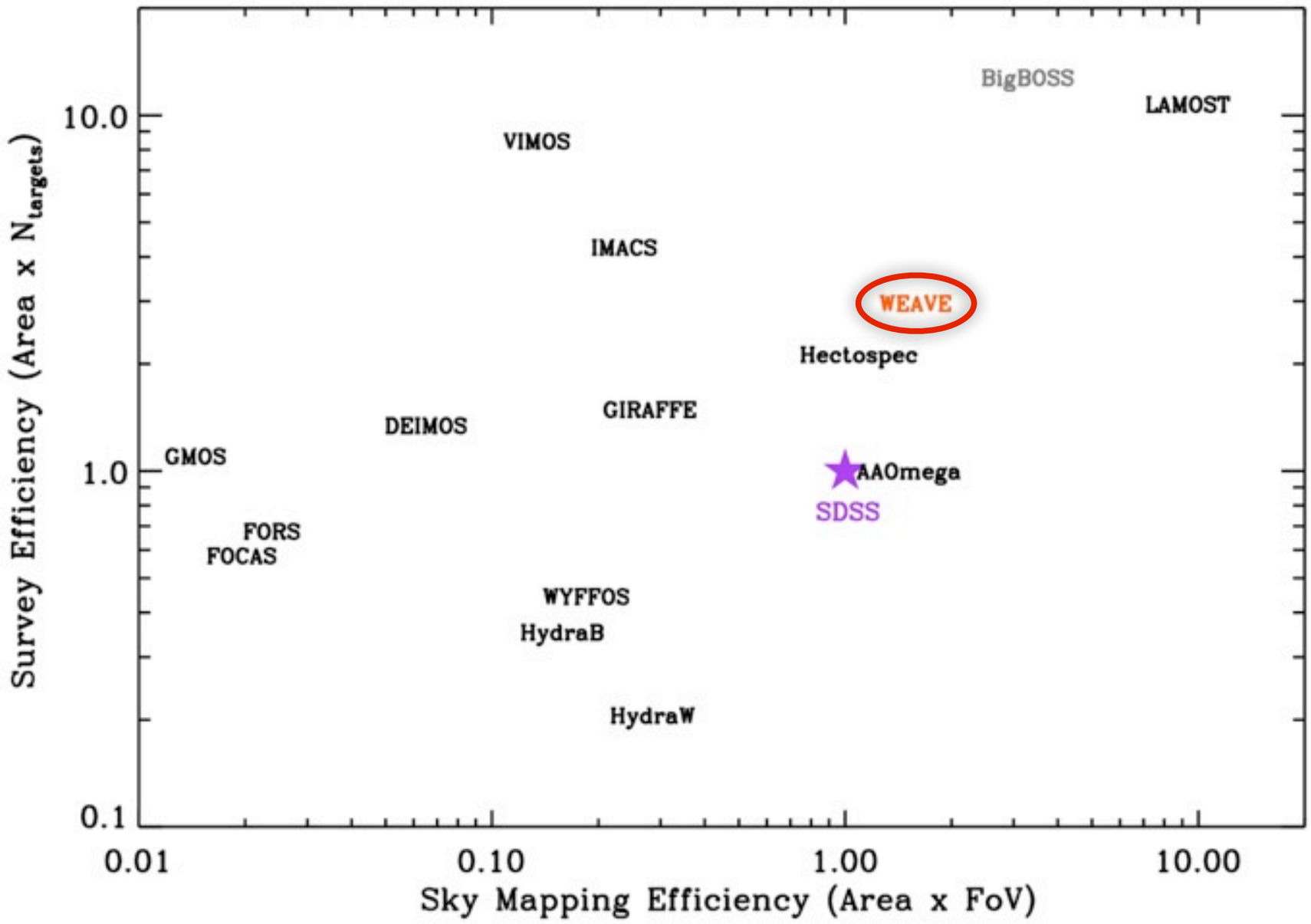
Telescope, diameter	WHT, 4.2m
Field of view	2º
Number of fibers	1000
Fiber size	1.3”
Number of small IFUs, size	~25, 9”x12” (1.3” spaxels)
LIFU size	~2‘x1.5’ (2.6” spaxels)
Low-resolution mode resolution	4300–7200
Low-resolution mode wavelength coverage (Å)	3660–9840
High-resolution mode resolution	18560–21375
High-resolution mode wavelength coverage (Å)	4040–4650, 4730–5450 5950–6850

WEAVE organization

- PI: Gavin Dalton (RAL/ Oxford)
- Deputy PI: Dave Carter (LJMU)
- Project Scientist & Dutch co-PI: SCT (Kapteyn)
- Project Manager: DC Abrams (ING)
- Systems Engineer: Mike McIntosh (UKATC)
- French co-PI: Piercarlo Bonifacio
- Spain co-PI: J. Alfonso Aguirre Lopez
- Instrument Scientist: Chris Evans (UKATC)
- Contributions from STFC (RAL/Oxford/LJMU/UKATC/ IoA), NOVA+NWO, GEPI, ING

WEAVE as a survey instrument

Note: WEAVE can collect >36M individual spectra (>12M objects) in 5 years if 100% of the time allocated...



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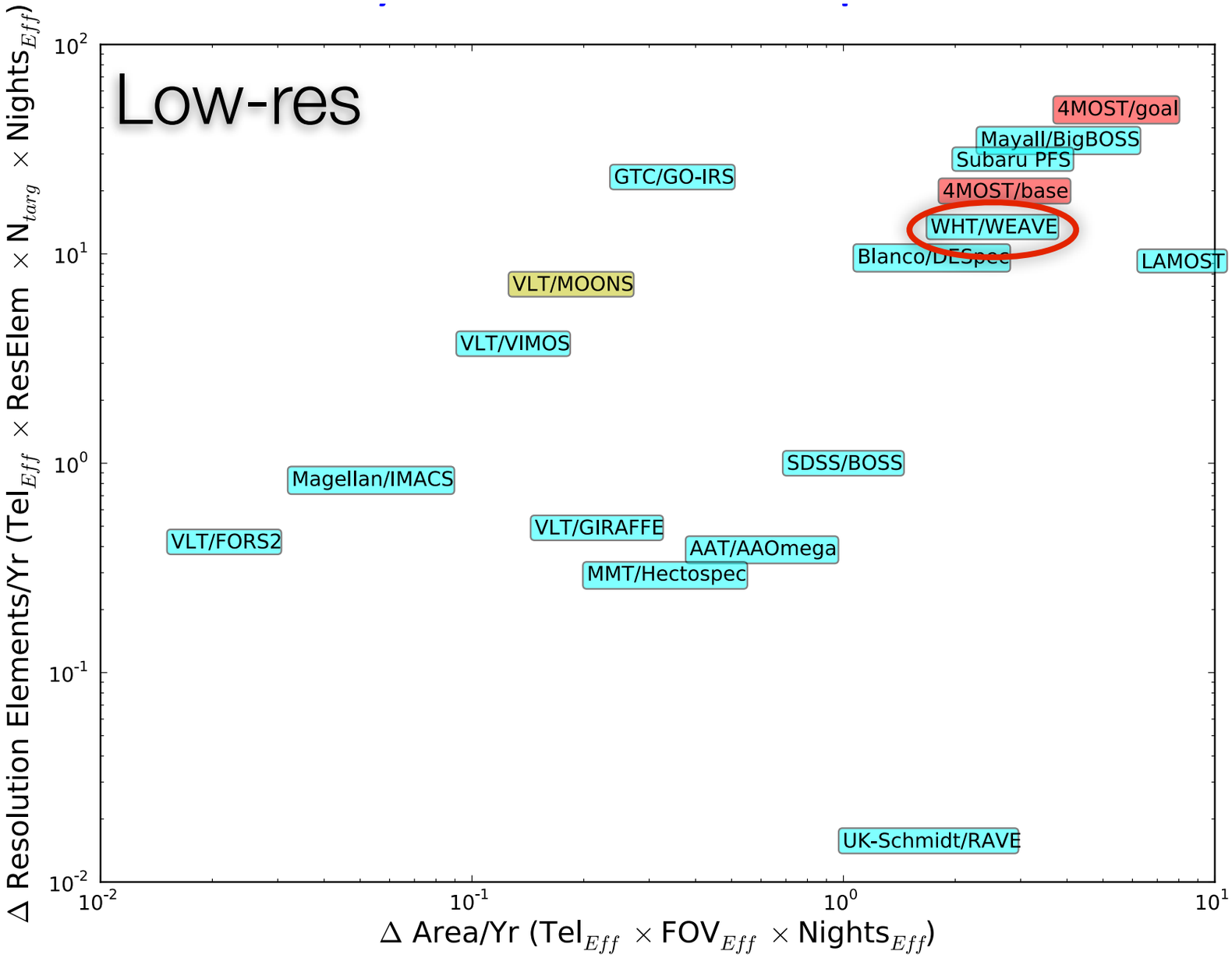

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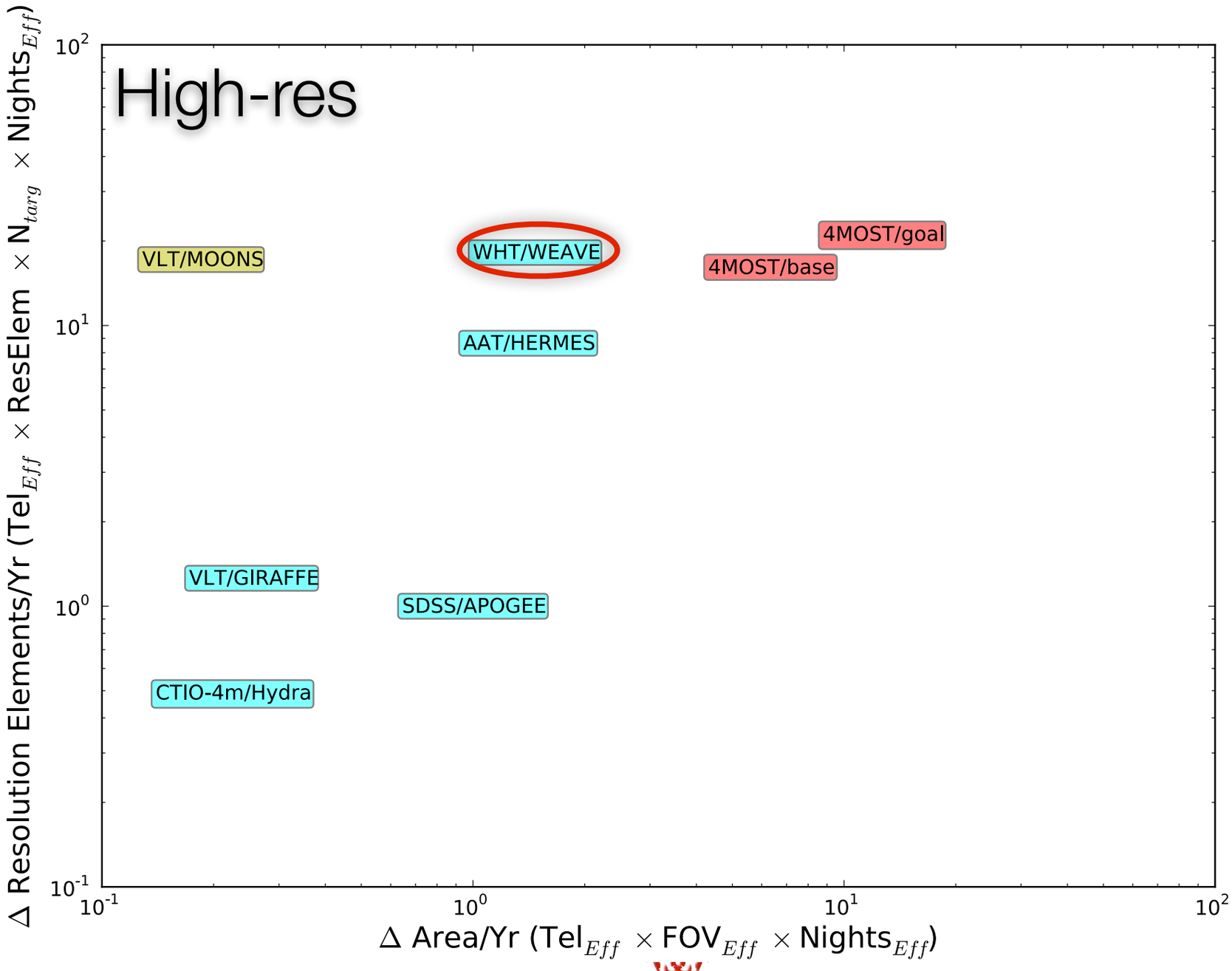

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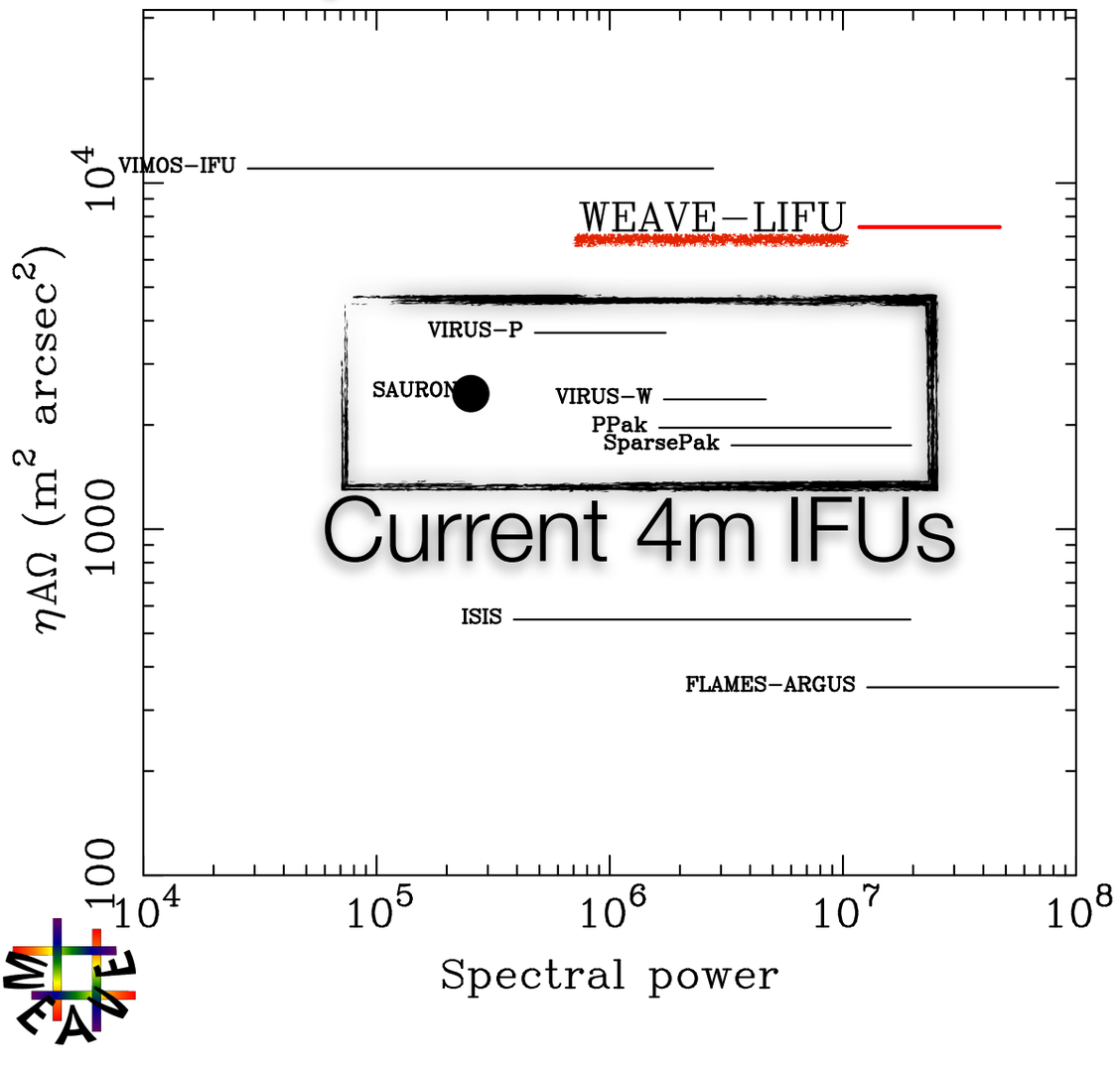
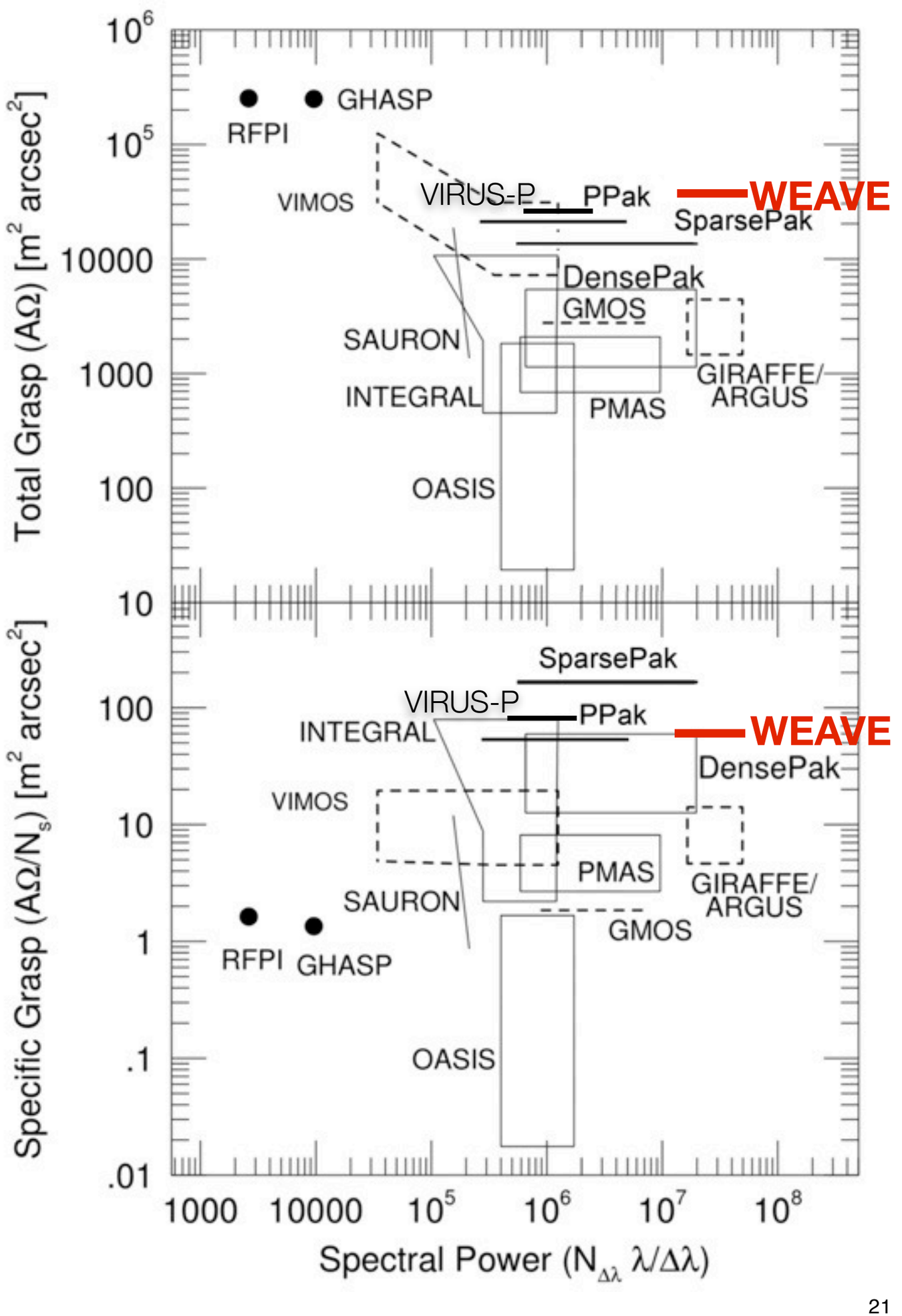
IFU metrics

Effiency-corrected étendue





Conclusions

- WEAVE will be a *wide-field*, *moderate-resolution* spectrograph + IFUs ideal for following up *Gaia* and the SKA Pathfinders
  - and lots of other cool science topics!
- Cost-effective and straightforward technology!