WEAVE AND OTHER SURVEY CAPABILITIES AT THE WHT

2012 March 30

Marc Balcells

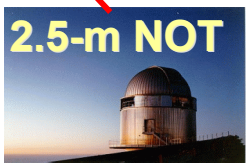
Director, Isaac Newton Group of Telescopes (ING)

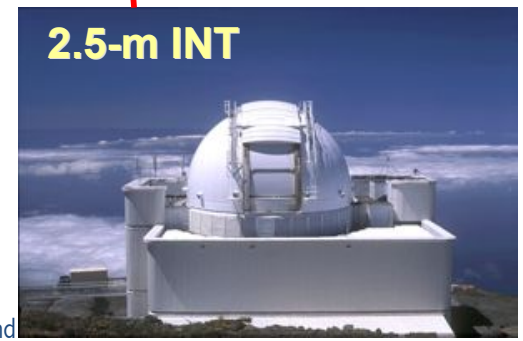
La Palma - Europe's Prime Observatory Site in the North:
Observatorio Roque de los Muchachos (ORM)

2.0-m LT

1.0-m MT

1.0-m JKT





10.2-m GTC

Kish Island
size telescopes

Isaac Newton Group of Telescopes

- ING operates three telescopes for UK, NL, ES

WHT	**4.2m**
INT	2.5m
JKT	1.0m (not offered)

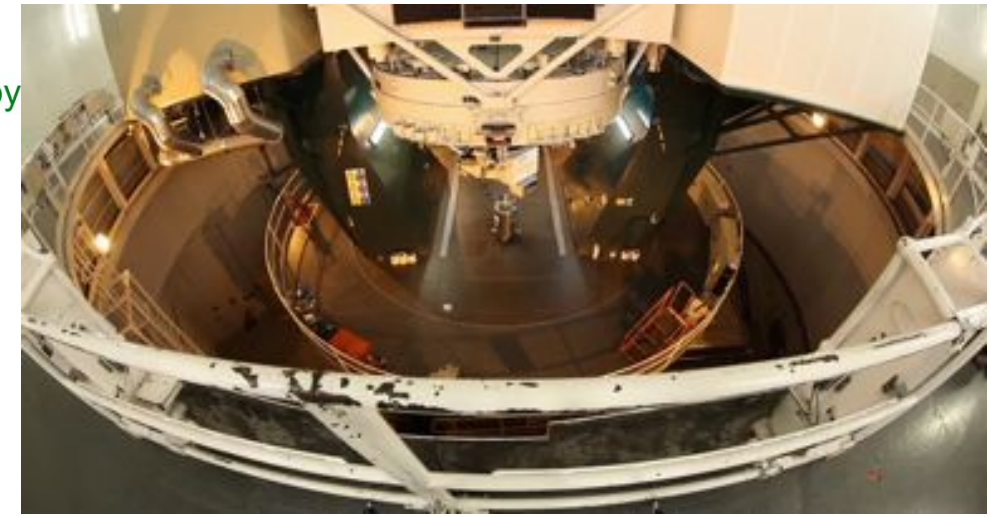
- Oldest, largest ORM user institution
  - At ORM since 1982
  - ~40 staff, 25 years operating telescopes
  - Leading scientific production

- Currently planning for next 10 years

Instrumentation

http://www.ing.iac.es/astronomy/observing/instruments.html

WHT CASS	ISIS	Optical medium res. spectroscopy spectropolarimetry
	LIRIS	NIR multi-object spectrograph, NIR spectropolarimetry NIR imaging
	ACAM	Optical low-res spectrograph, Optical imager permanently mounted
GHRIL	WYFFOS	Multi-fibre spectrograph
GRACE	NAOMI	Adaptive optics system
	INGRID	AO-assisted NIR imaging
	OASIS	AO-assisted integral-field spectrograph
PF	AF2	Fibre positioner robot
	PFIP	Prime focus CCD imaging
INT	WFC	Wide field optical CCD imaging
	IDS	Medium res. optical spectroscopy



WHT developed as versatile telescope with easy switching between focal stations

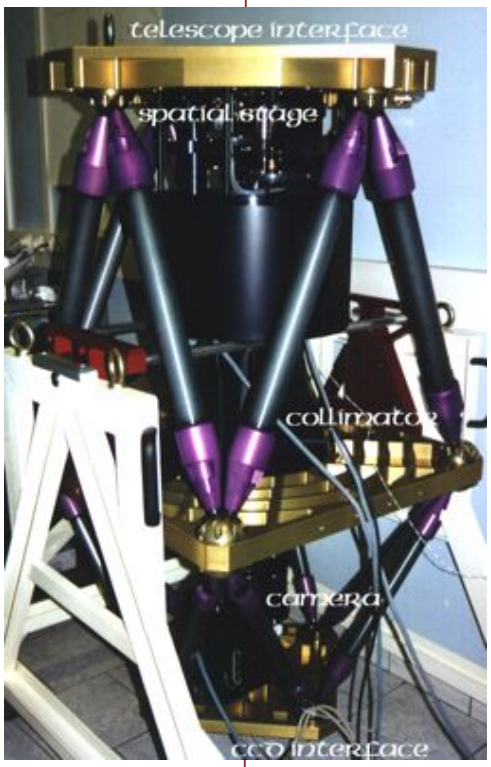
Program of Visiting Instruments

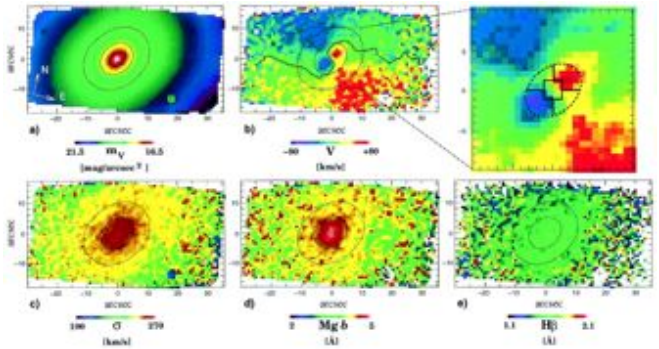
Successful program of easy deployment of private instruments

- SAURON
- PNS
- PlanetPol
- ExPo
- INTEGRAL
- ULTRACAM
- FastCam
- GHaFaS
- SPIFS

•Future

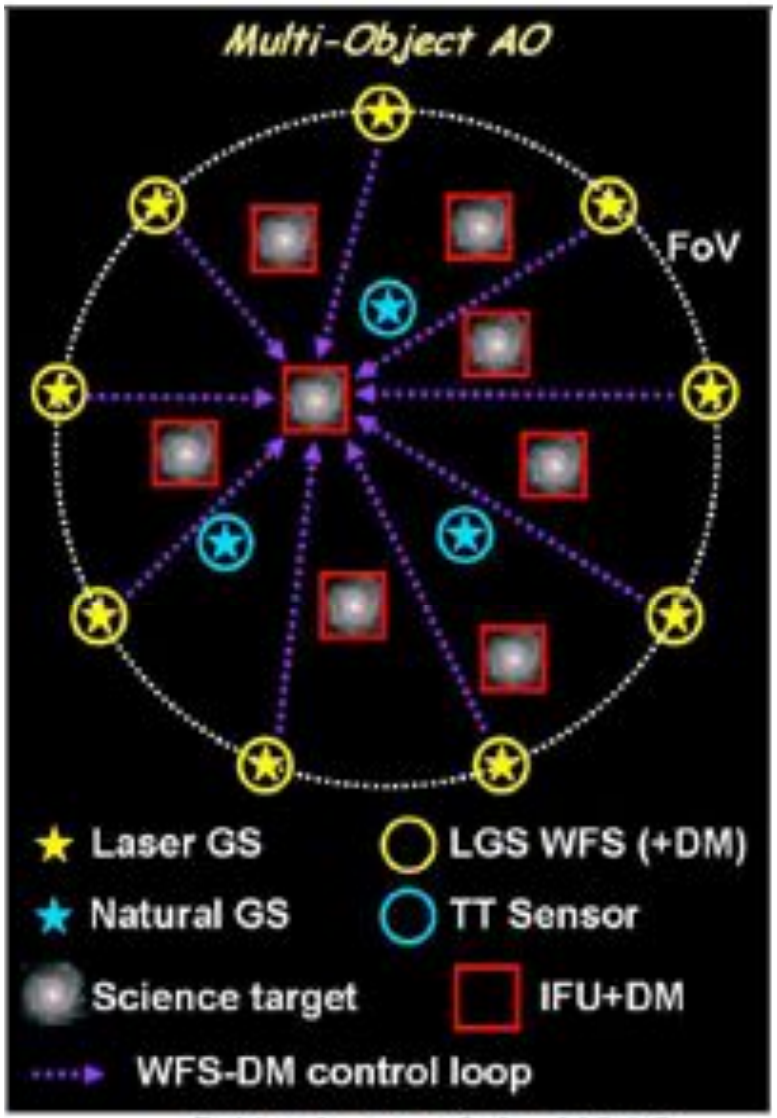
- PAUCam
- AOLI Lucky Imager





Test-bed for E-ELT technologies

- CANARY system for multi-object adaptive optics (MOAO) for EAGLE (E-ELT)
- Durham, UKATC, Paris-LESIA, Marseille, ING
- Phase A (NGS) successful
- Now preparing Phase B, 4 LGS, open loop.



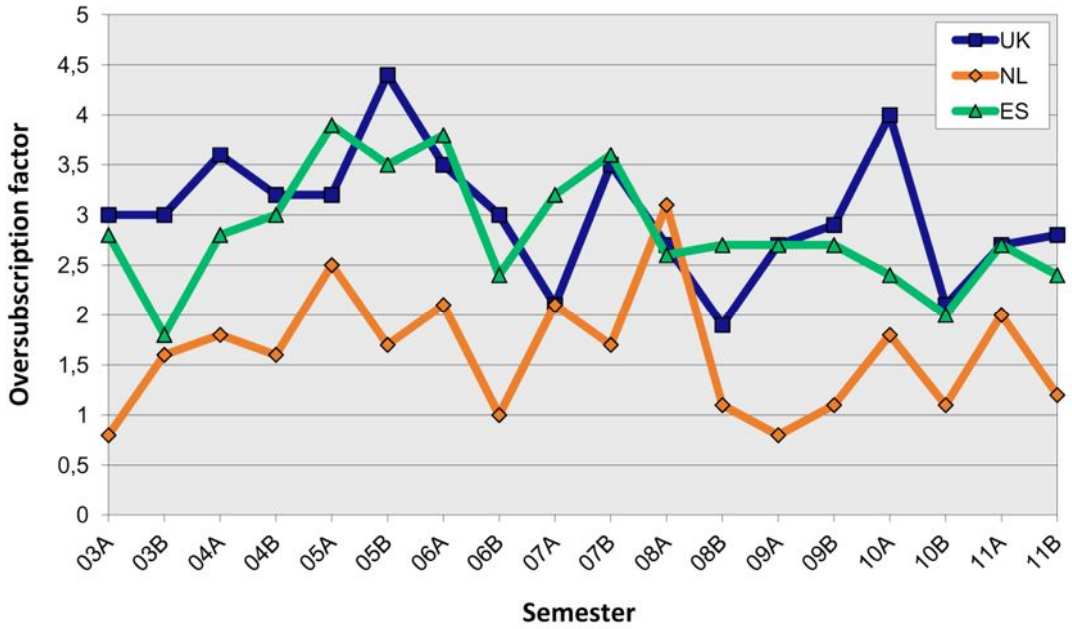
Training

- ING resident student programme
  - 4 PhD students spend 1 yr at ING
  - Manage and support all INT observations
  - Many PhD students learn to be astronomers at ING
  - ➢ 2012-13 student selection open
    - ➢ Deadline 2012 April 6
    - ➢ http://www.ing.iac.es/astronomy/science/studentship.html

Collaboration with GTC

- An ING-GTC alliance at ORM: the *T&Inet MoU*
  - *ING-GTC Telescope and Instrumentation Network*
  - Signed 2011
- Collaboration projects
  - OSIRIS cryostat (2011 Jan – June)
  - Alignment of GTC primary mirror segments(ongoing)
- Potential for growth

WHT usage, oversubscription



- Spain oversubscr: 2.5-3
  - Remains high after accession to ESO
- VLT oversubscr: 3.2

High-impact scientific productivity

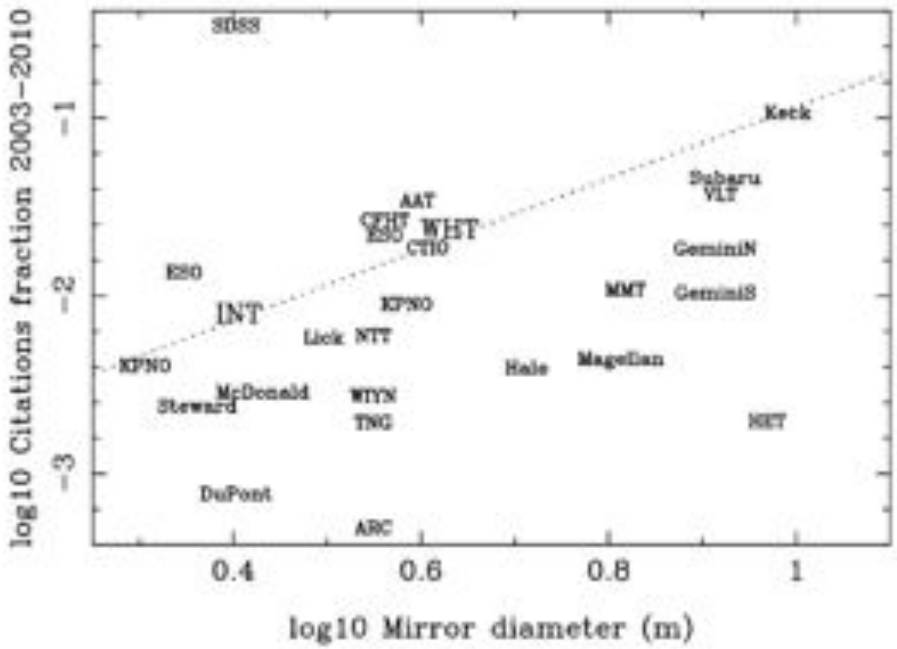


Figure 3. Relative scientific contributions of the highest-impact ground-based optical telescopes, plotted as a function of mirror diameter (for diameter > 2 m). The WHT is one of a small group of 4-m-class telescopes with consistently high scientific impact. The WHT's impact exceeds that of some larger telescopes e.g. Gemini North. The scientific contributions were measured by assigning the citations for each of the ~3% highest-cited papers (published in refereed astronomical journals 2003 - 2010) to the telescopes on whose data the paper was based. The points for Keck, VLT and Magellan refer in each case to one telescope, e.g. that for VLT refers to 1/4 of the total VLT citation impact. The dotted line has gradient 2 (i.e. science proportional to diameter^2), and arbitrary intercept.

Forthcoming paper:

Benn & Jiménez-Luján, *Scientific impact of large telescopes 1991-2010*, in prep.

Plans for next decade

Thinking ING's future

- ING Board

Simon Berry	*Christoph Keller (Chair)*
Ramón García López	*Alfonso López Aguerri*
Paul Hewett	*Ronald Stark*
Matt Jarvis	

- ING SAC

Paul Groot	*Ross McLure*
Amina Helmi	*Francisco Najarro*
Henk Hoekstra	*Will Percival*
Mike Irwin (Chair)	*Ismael Pérez-Fournon*

- ING Manag.

Don C. Abrams	*Juan Martínez*
Marc Balcells	*Ian Skillen*
Chris Benn	

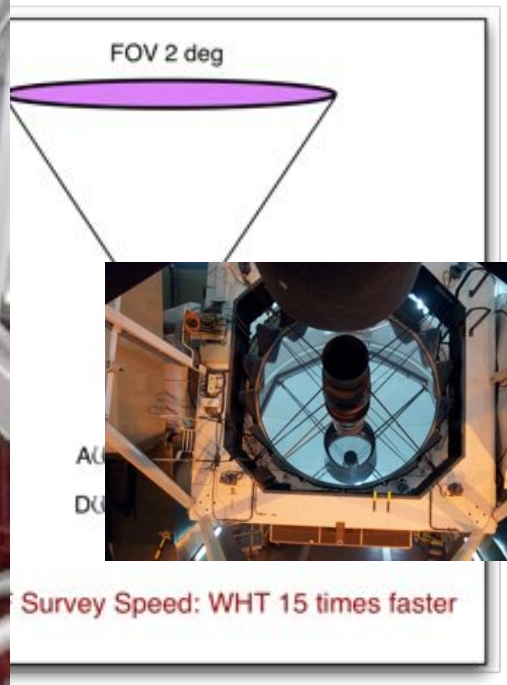
- STFC-NWO-IAC-GTC working group

Pedro Alvarez	*Ronald Stark*
Marc Balcells	*Colin Vincent*
Ramón García-López	*John Womersley*
James Hough	
Rafael Rebolo	

4m in 10m era

- Do what you do better than the 10m

- *Wide field astronomy*



Strategic planning 2013-2022

http://www.ing.iac.es/about-ING/strategy/

- 2013-2016
  1. Maintain current model of general purpose telescope
  2. Introduce long-term programmes
  3. Build, commission WEAVE
- 2017-2022
  - WEAVE surveys
    - Retain access to other instruments (?)

Long-term programmes

- Expect increase telescope productivity
- ONLY IF demmanded by the community
- Requires changes in TAC processes
  - Common UK, NL, ES TAC for long programmes
- **Upgrade 'survey' instruments**
  - AF2/WYFFOS
    - 4k Red+CCD. Throughput/operational issues
  - ISIS, LIRIS, …

2017-2022 Surveys in the WEAVE epoch

- WEAVE surveys, see below
- 50%? 70%? **100%**? time to WEAVE surveys?
- Scientific complementarity WHT – GTC
  - Classical : WHT – imaging, GTC – Spectroscopy??
  - Alternative:
    - Spectroscopy, WHT: V=17=20 // GTC: V=20-23
    - WHT/WEAVE combined with GTC/MEGARA
- Powerful opportunities for Spanish astronomy

WEAVE

Instrument Concept

Gavin Dalton (RALSpace/Oxford)

RIA CAHA/ORM 23/3/12

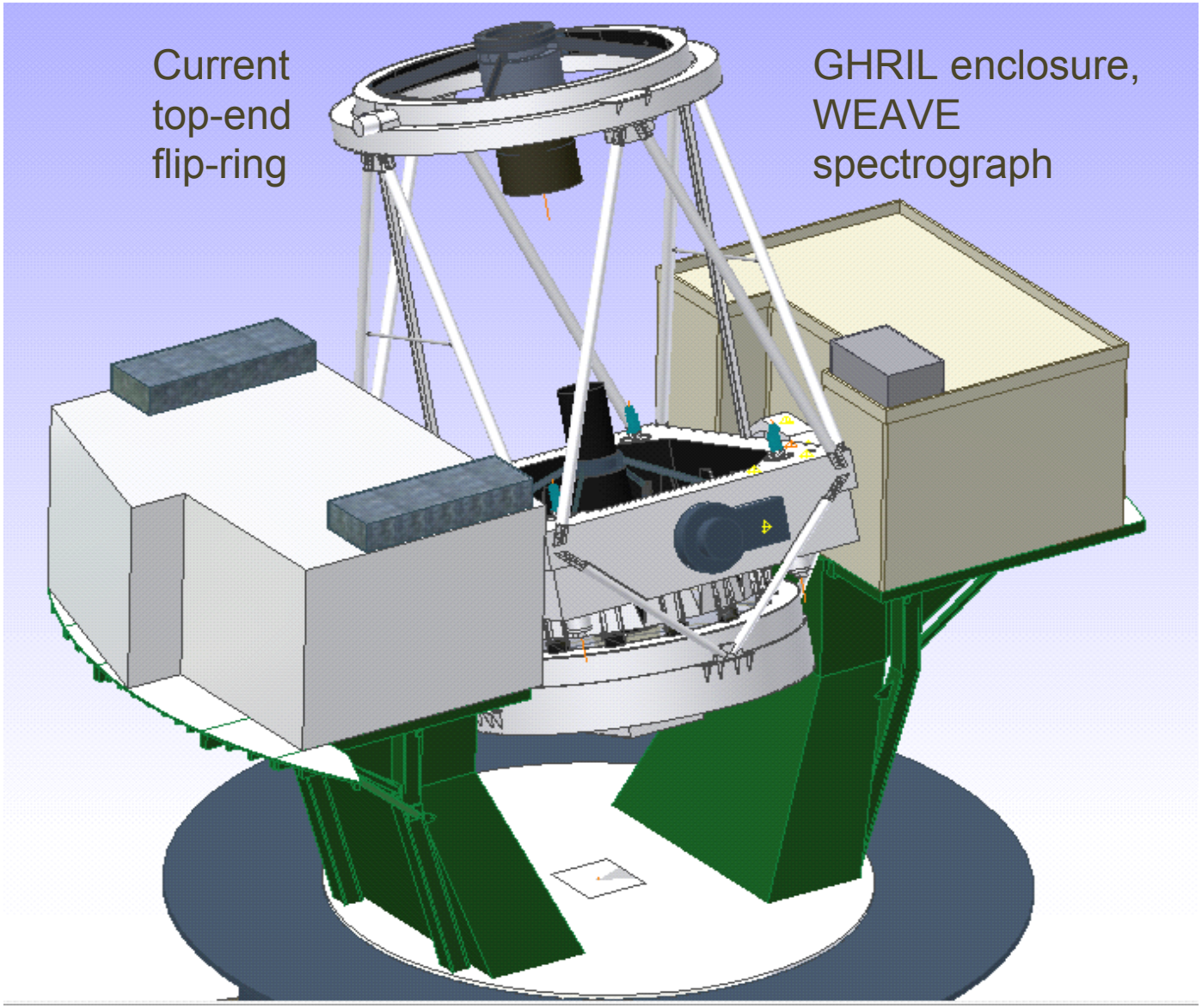
Background

- Community discussion meetings in early 2010
  - (see Marc's talk from yesterday)
  - Very strong case for wide-field MOS
  - Summarised in Balcells et al. 2010 (SPIE)
  - Objective to develop a powerful but realistic instrument for the next phase of the WHT.
- Instrument consortium phase A KO July 2010 timeline for key 'visibility' proposals in Jan 2011.
  - UK: Top ranked wide field MOS proposal (vs Big-BOSS, Subaru-PFS, 4MOST, MOONS, VXDS …)
  - NL: Key ranking in overall strategic plan (decadal survey).
- Critical strategic decisions on ING long term plan happening now.

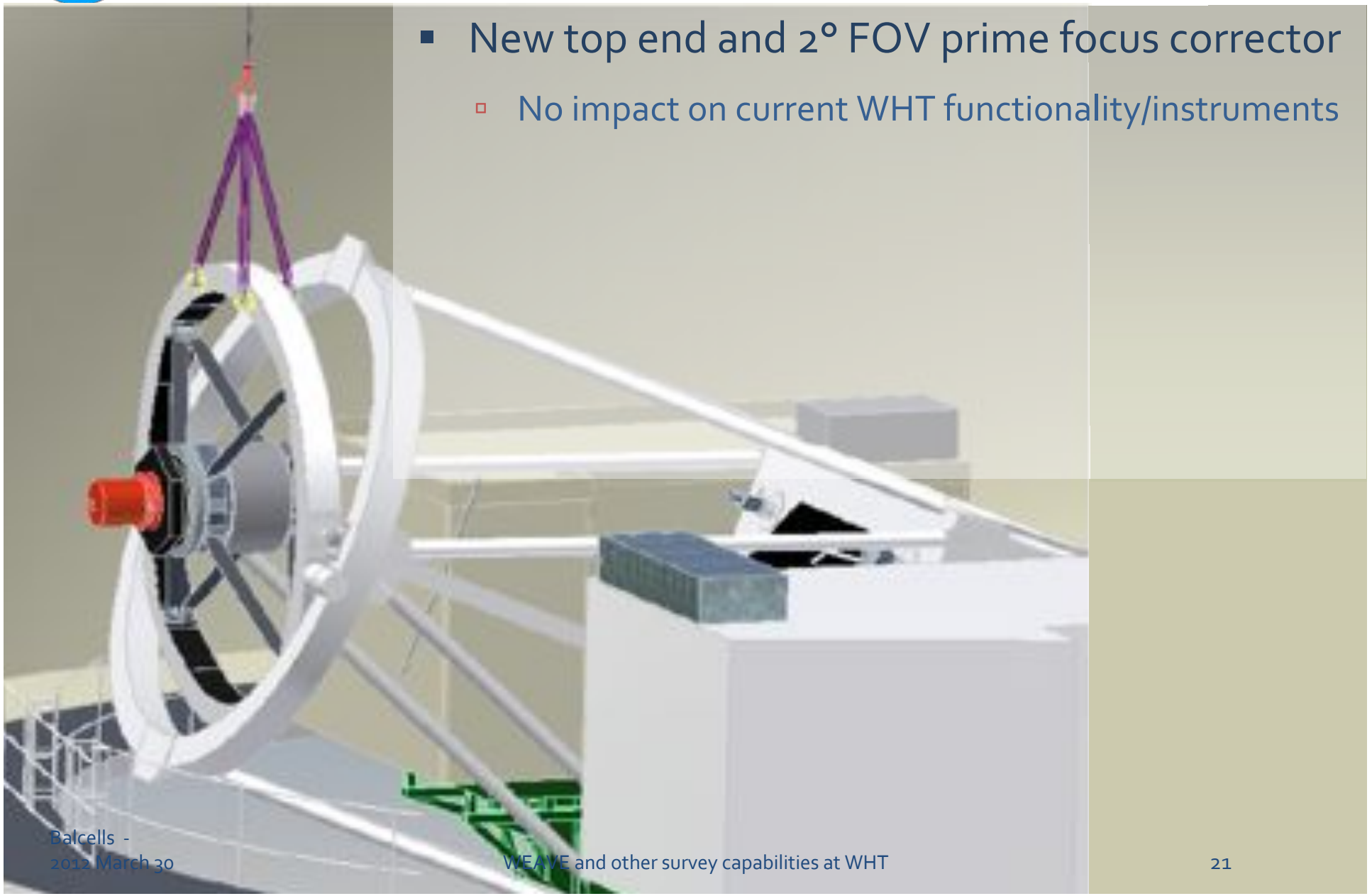
Phase B timeline

- KO September 22-23/9 2011
- Science requirements closed-out Dec 2011
  - Flow down to subsystem specifications and instrument design.
  - Ongoing development of science cases and survey planning once requirements fixed.
- Preliminary Design Review Jan/Feb 2012.
  - Stage-gate for funding.

General Layout of WHT



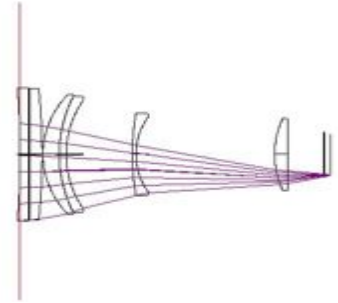
Instrument Overview

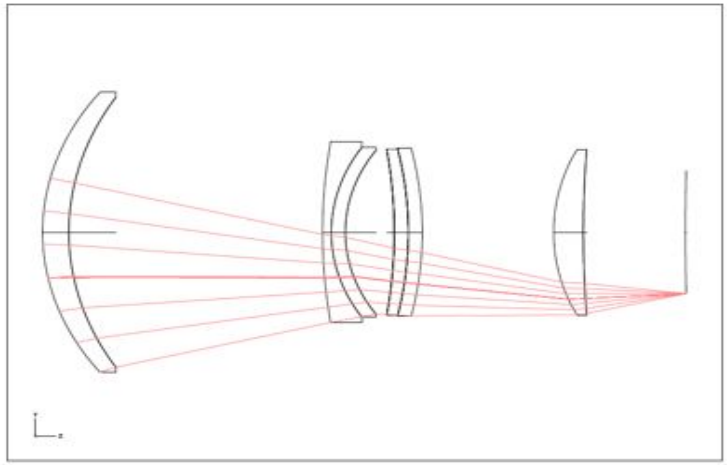


- New top end and 2° FOV prime focus corrector
  - No impact on current WHT functionality/instruments

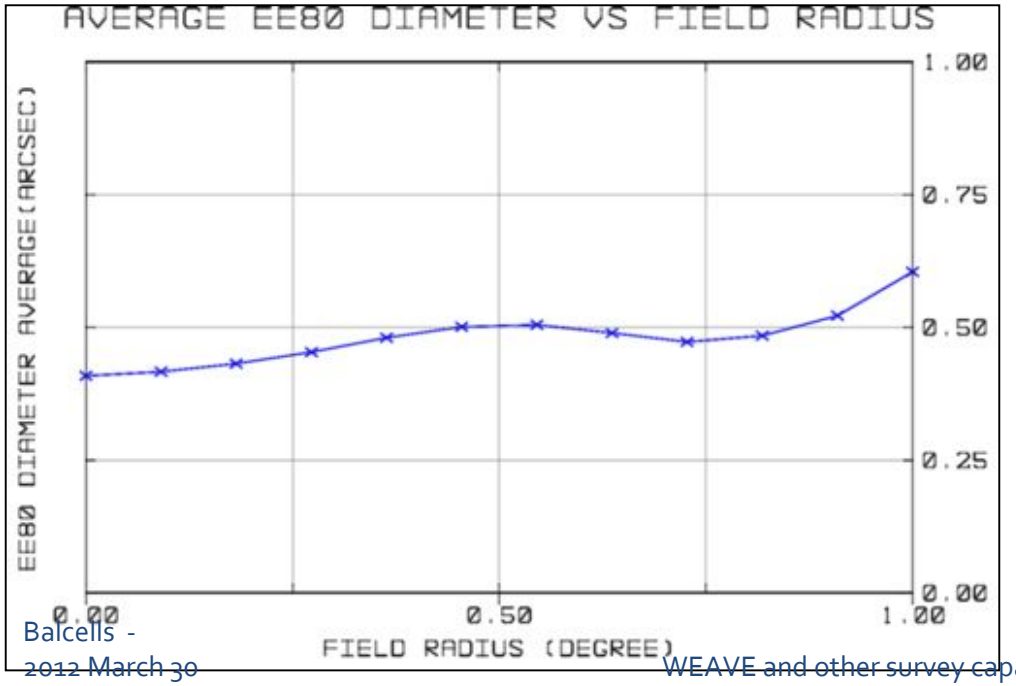
Prime Focus Corrector

- 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

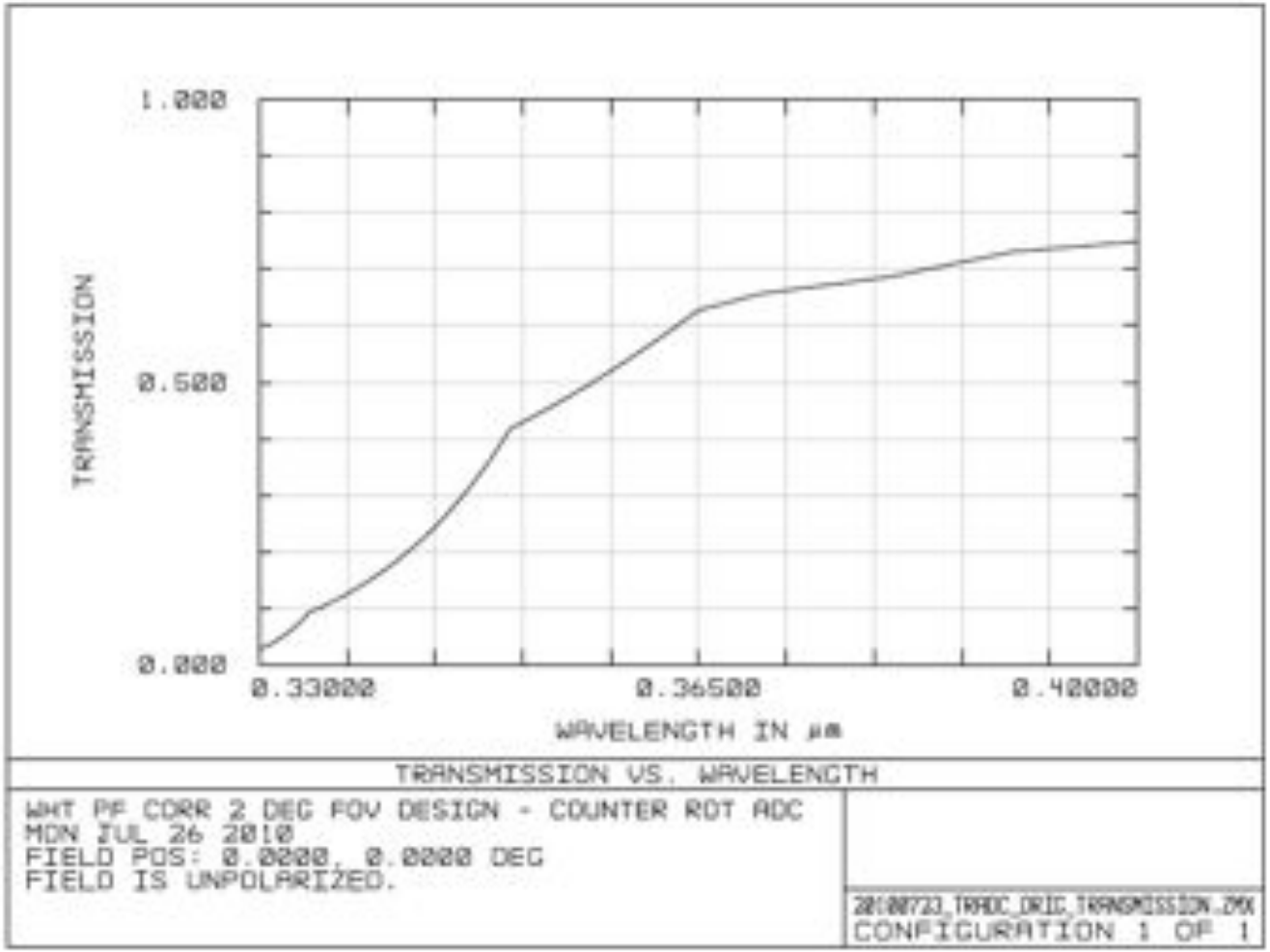




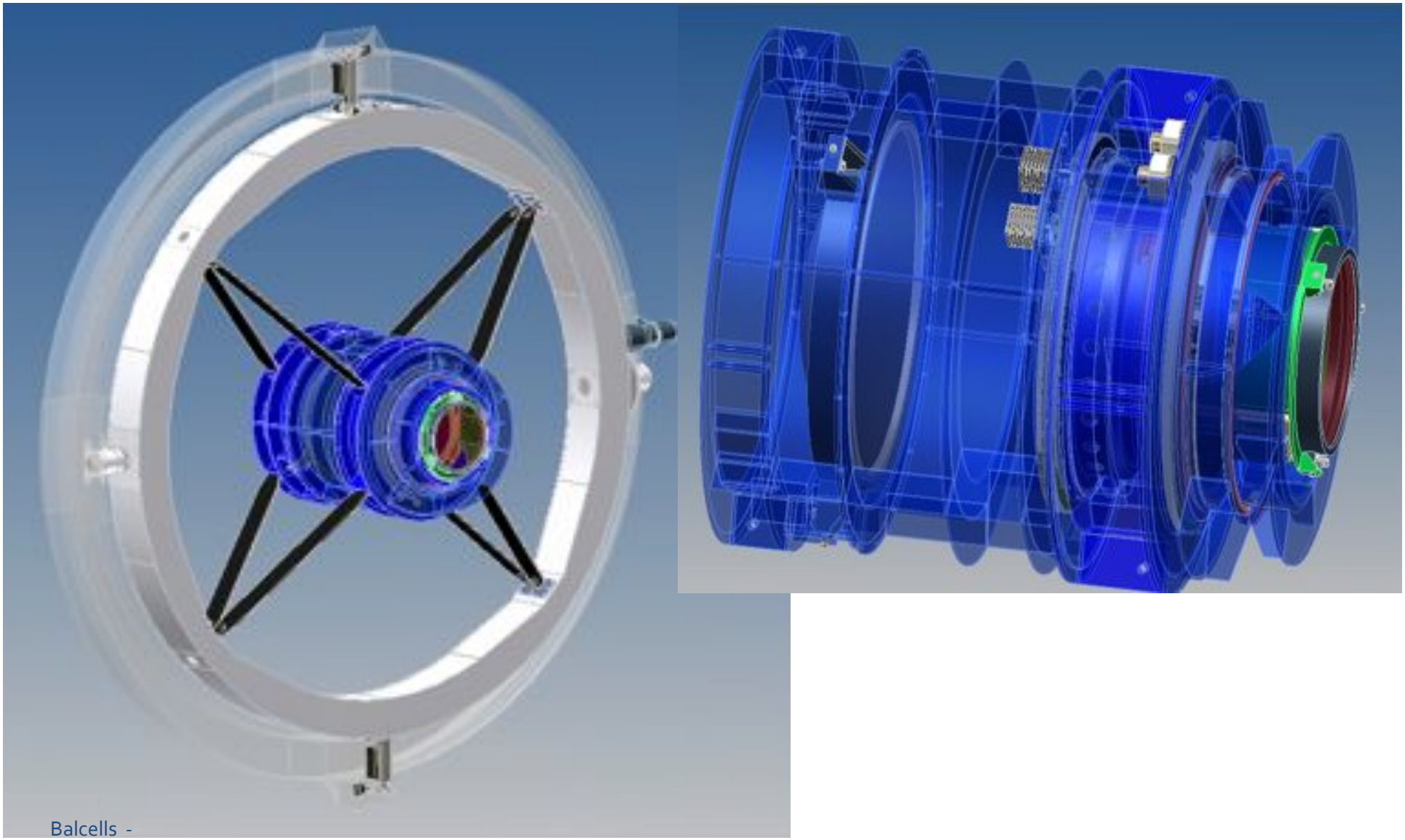
Corrector: 40’ vs 2 deg



2-deg corrector – blue throughput



Prime Focus Corrector & ADC



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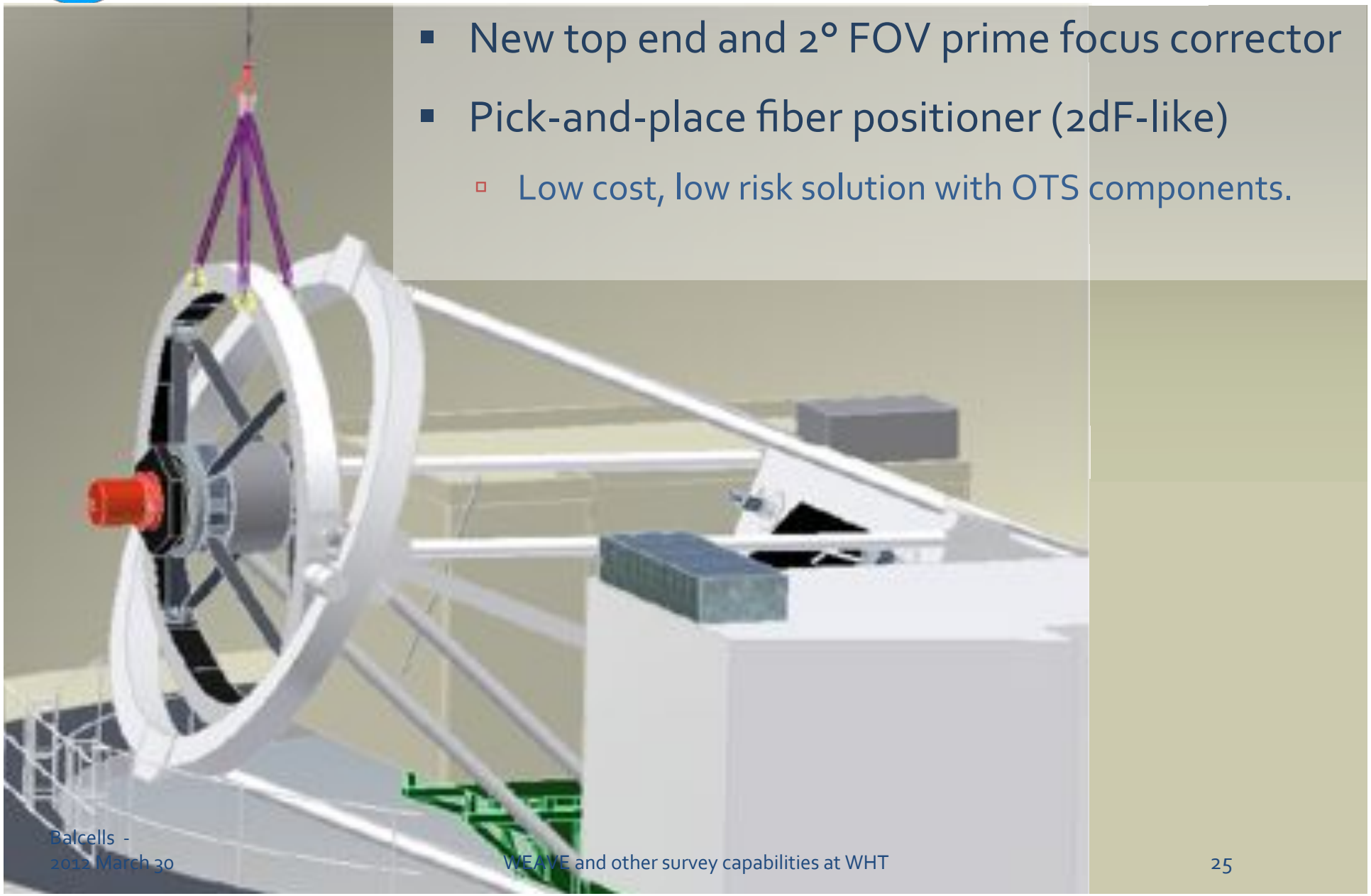


- New top end and 2° FOV prime focus corrector
- Pick-and-place fiber positioner (2dF-like)
  - Low cost, low risk solution with OTS components.

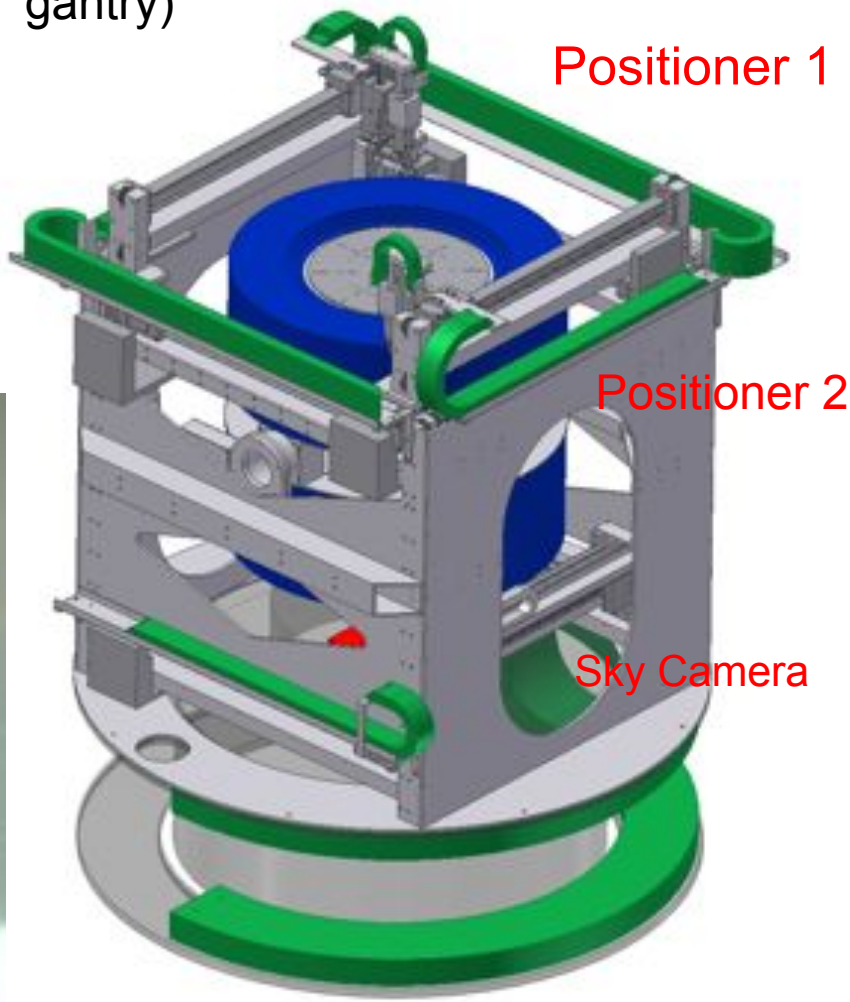
Positioner

Total positioner mass
~600kg (including anti-vibration counterweights)

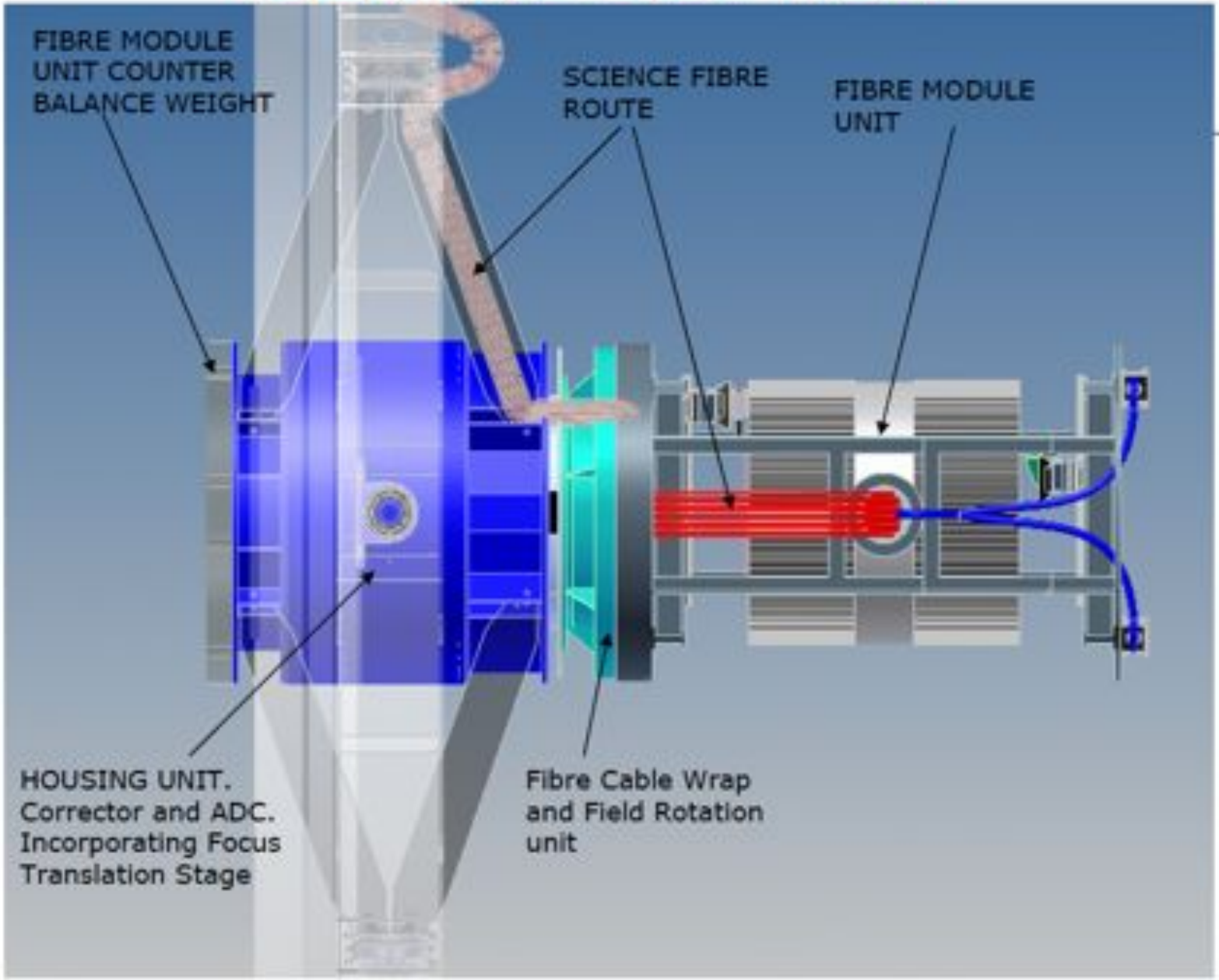
Obstruction diameter
~1.5m

Tumbler clears corrector by
~30mm

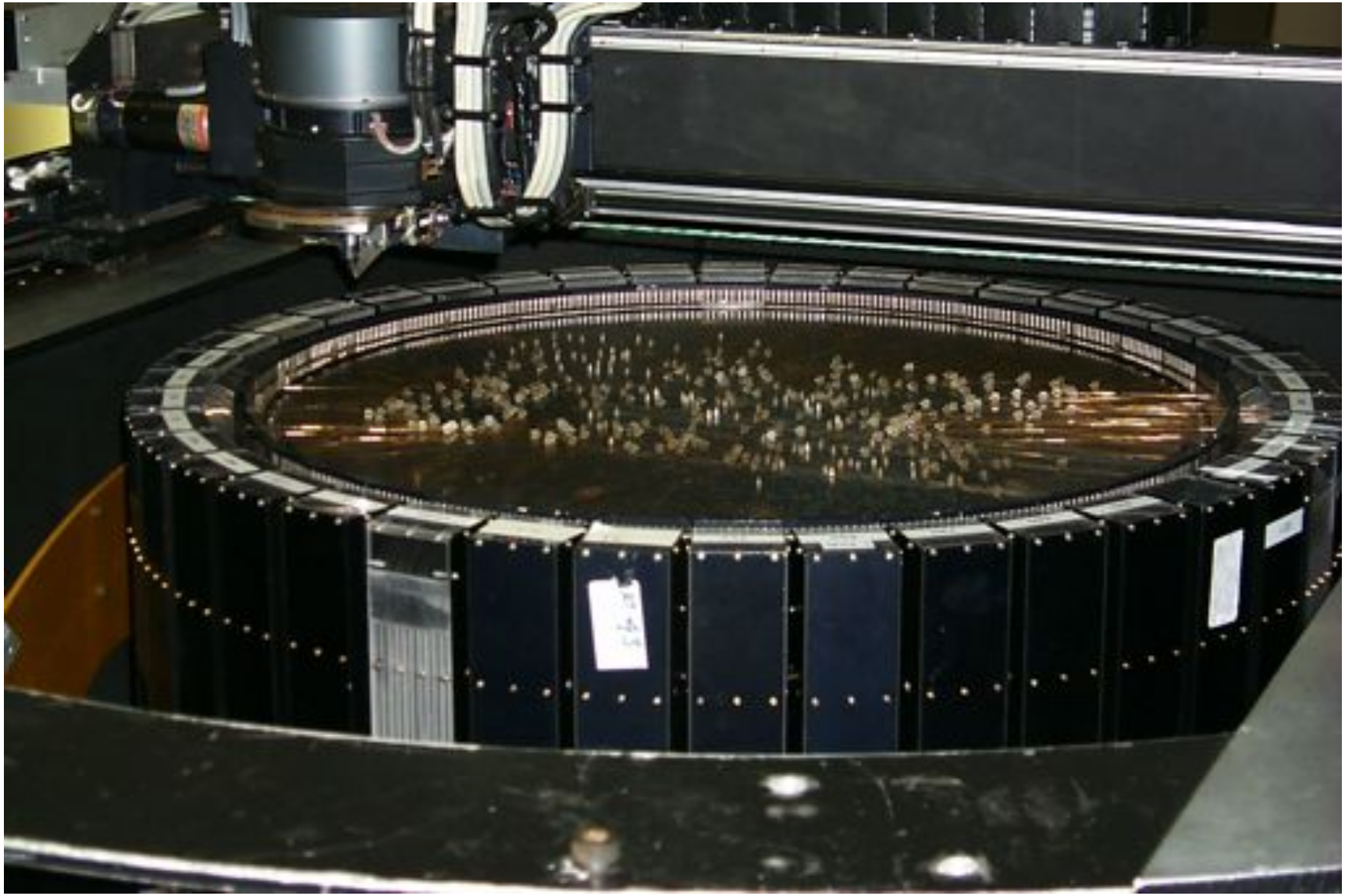
Fits inside the available vertical space envelope… (just clears the crane gantry)

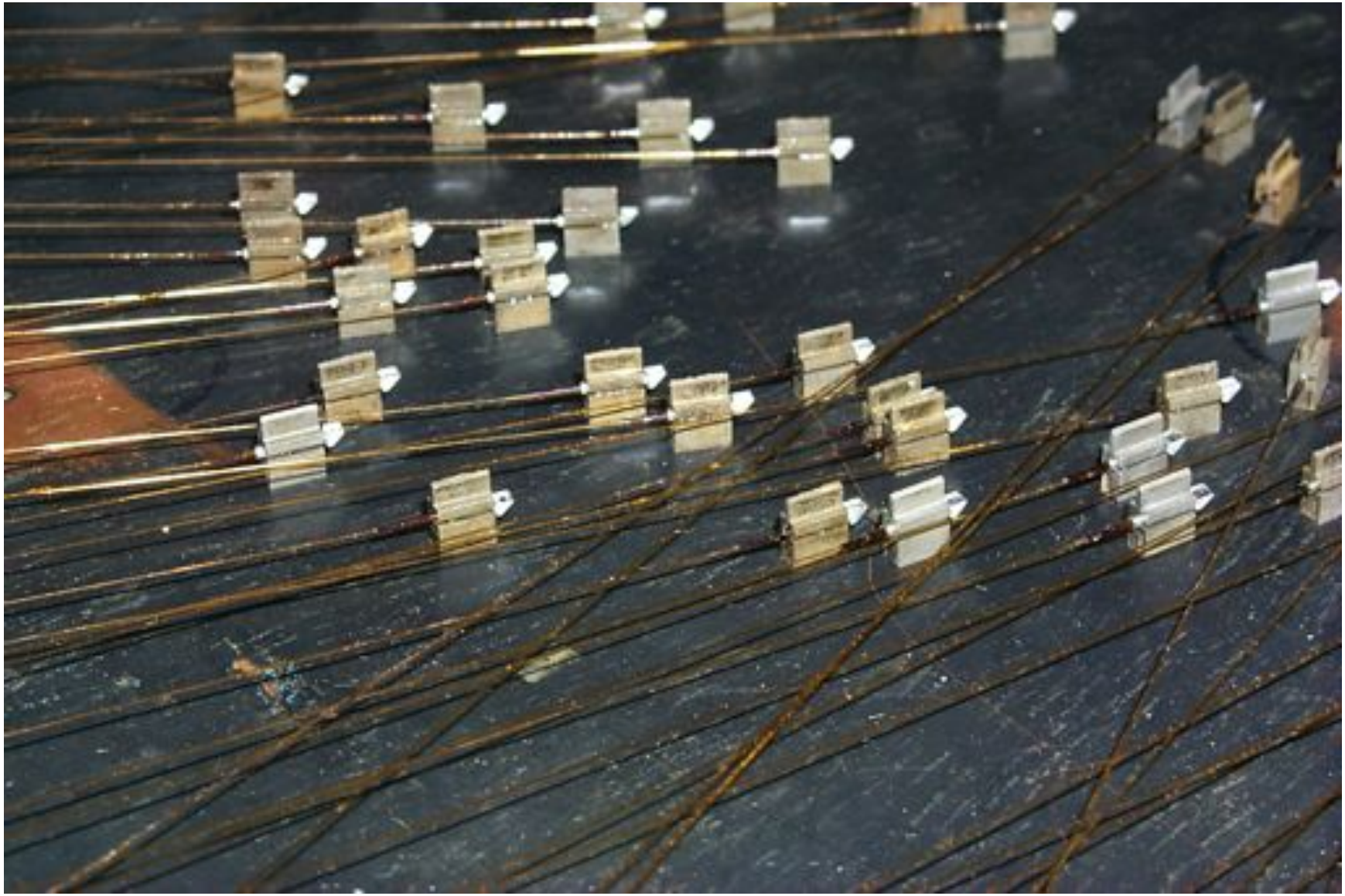


CENTRE SECTION



Positioner concept similar to AF2/2dF, but all COTS components…





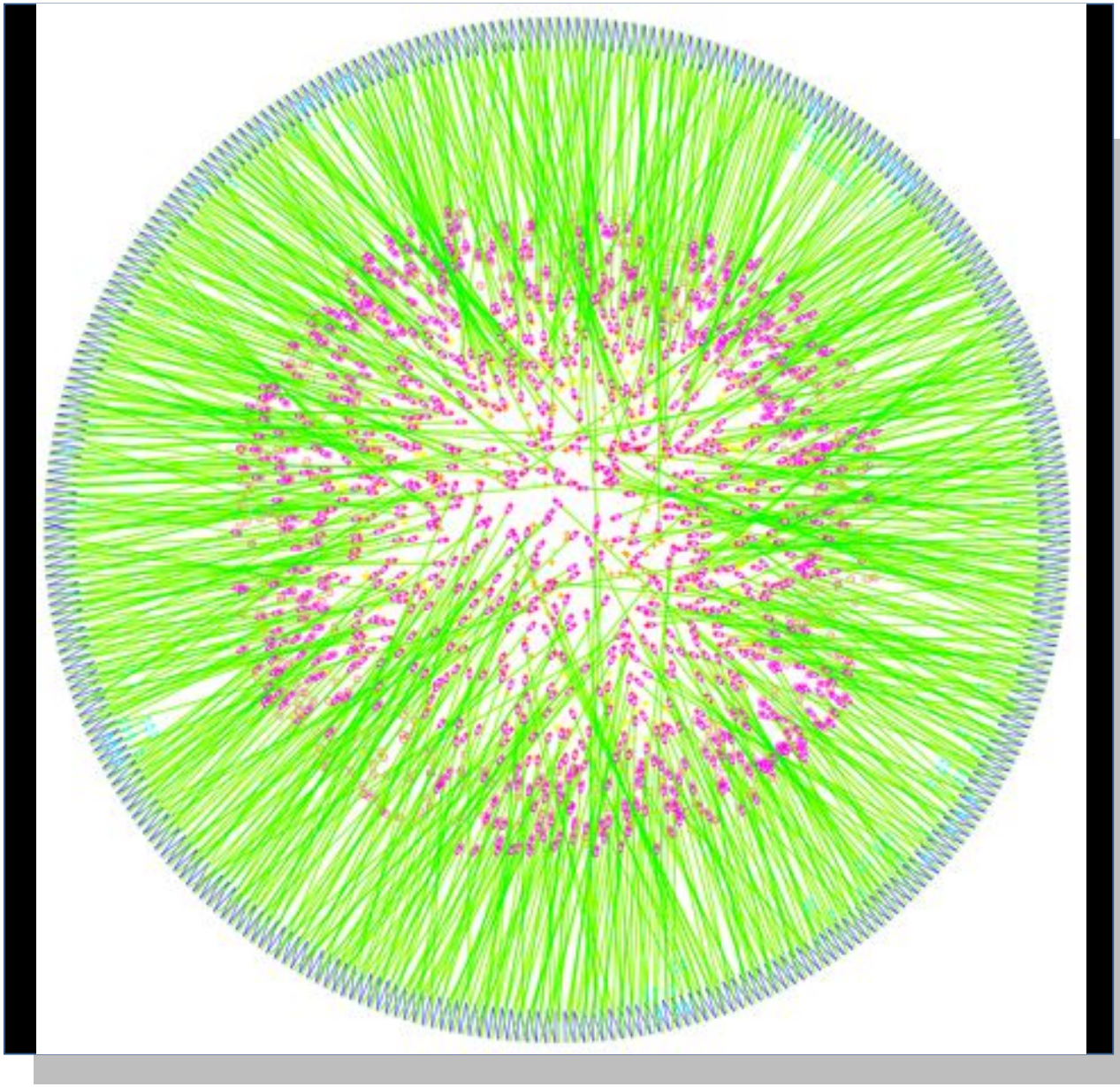
FIELD SIMULATION

Random target distribution, oversampled (1800 targets)

970 targets allocated

8300 fibre crossings

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



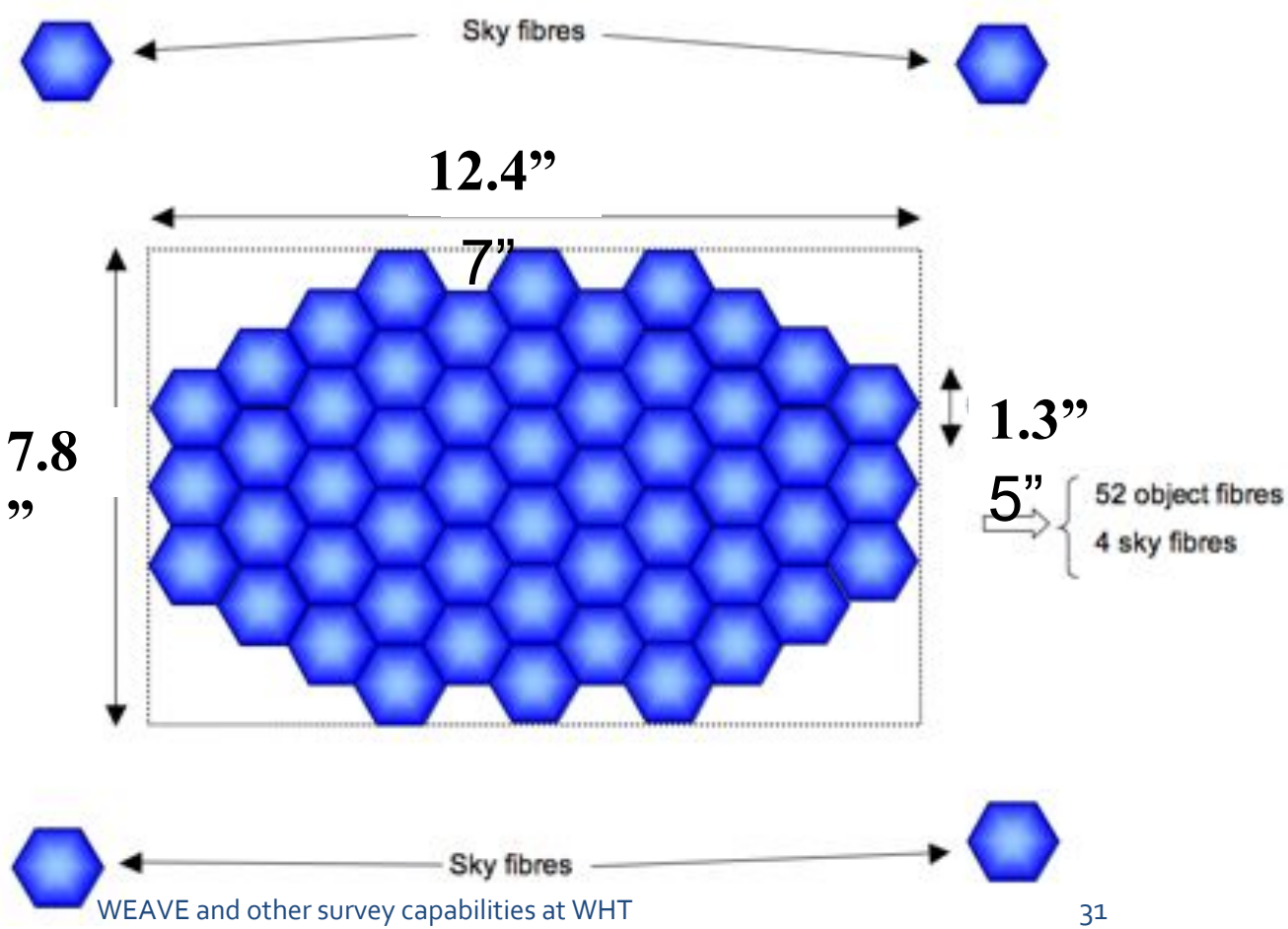
WEAVE IFUs

Use the full available slit length of the spectrograph.

- 20-30 small field IFUs, same fibre size as MOS
- 50-30 fibres/unit, e.g.
- Large single-field IFU uses full slit length in a single IFU located at 90° tumbler position

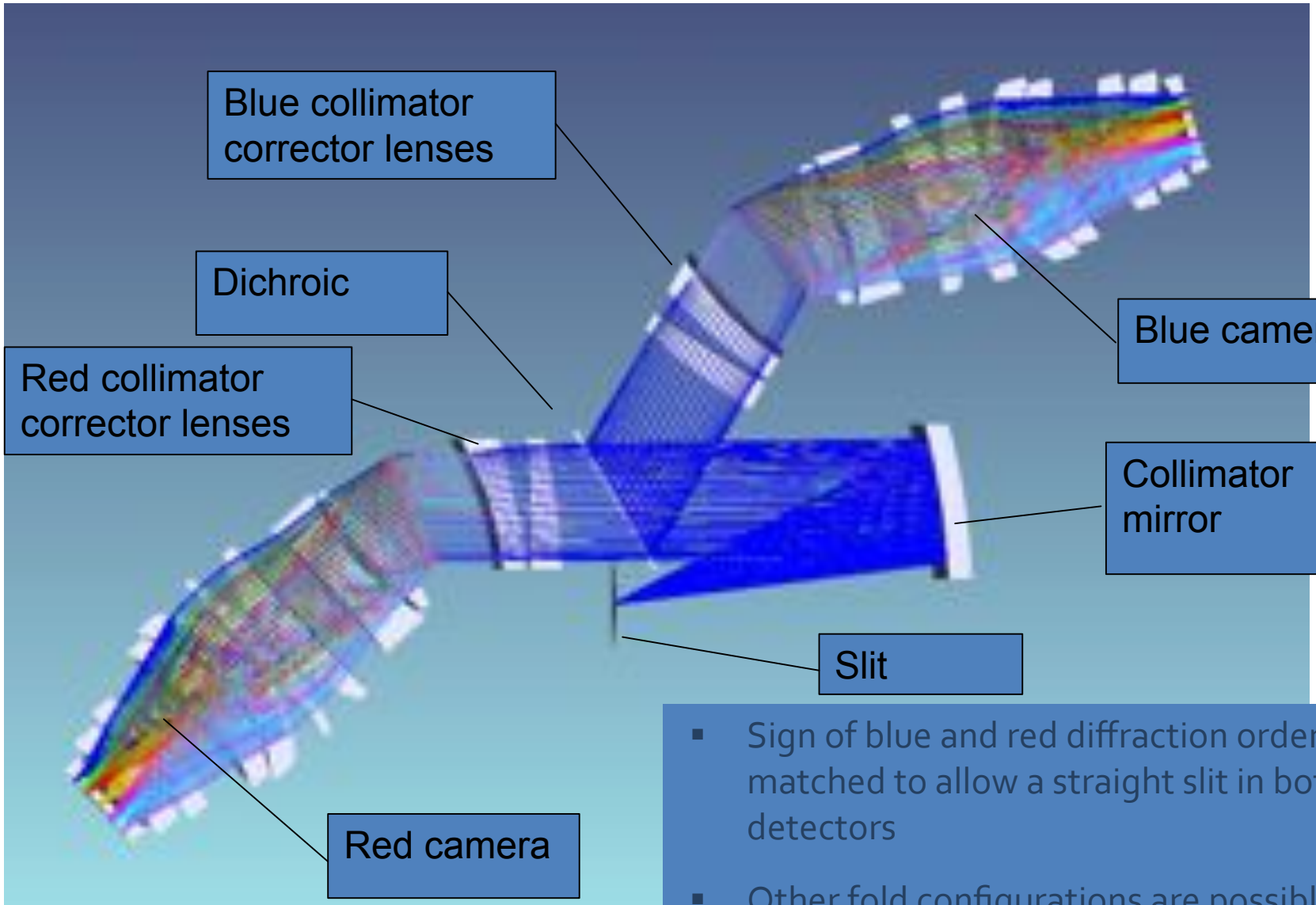
IFUs stored on one MOS field plate, at the cost of a small number of MOS science fibres.

Physical size of IFU unit still governed by 57µm/" plate scale, so still only a few mm button size.



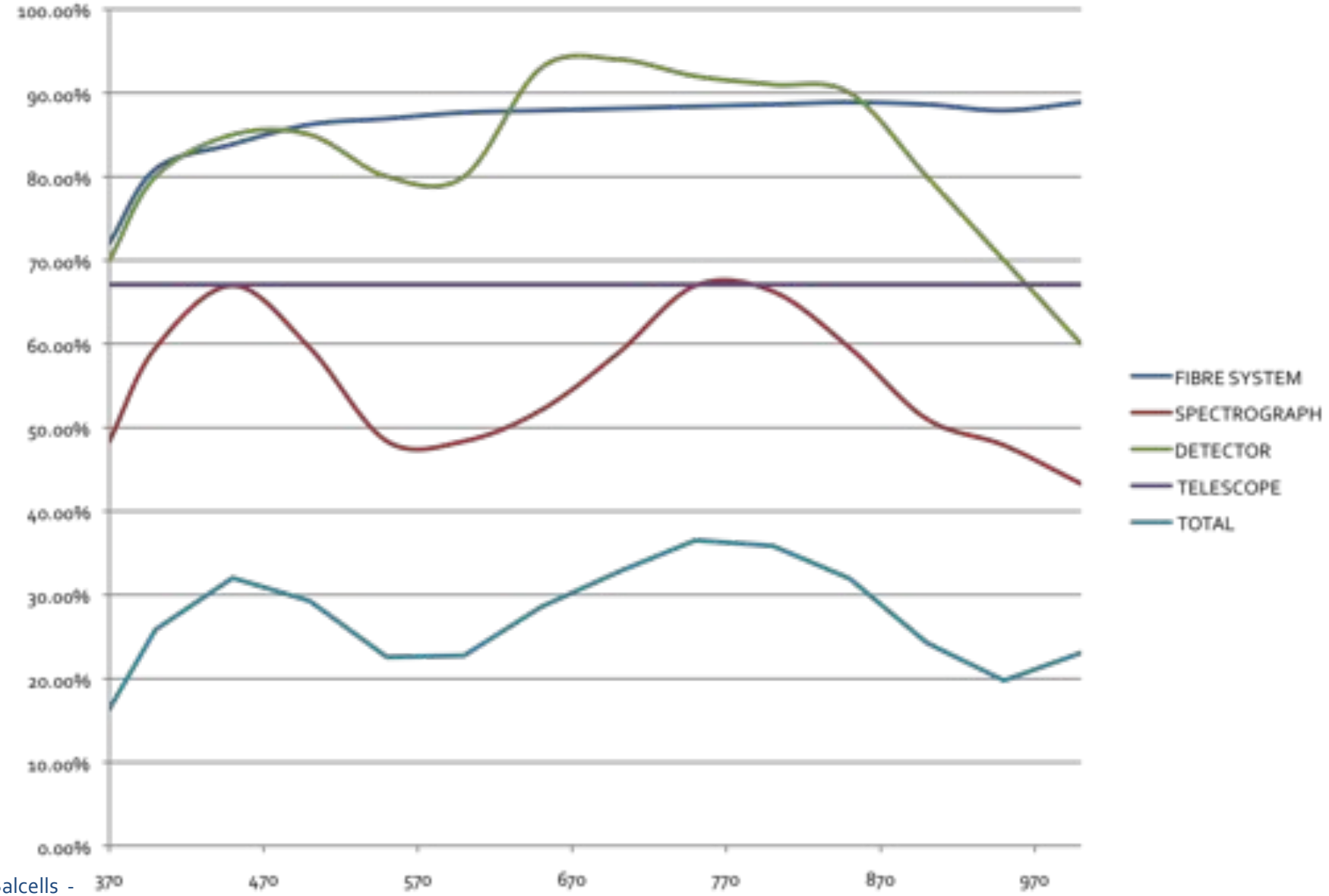
Dual-Beam Spectrograph Early Design (RAL/ASTRON)

f/3.0 input, f/1.75 camera, 180mm beam diameter. 2x8kx3k e2V CCDs in each camera.



- Sign of blue and red diffraction orders matched to allow a straight slit in both detectors
- Other fold configurations are possible

WEAVE throughput



WEAVE science priorities

- Classical science cases for WF MOS:
  1. *GAIA follow-up*
     - *R=5,000 for radial velocities with errors < 3 km/s*
     - *R=20,000 for chemical 'tagging'*
  2. *Galaxy evolution*
     - *(with large IFU, mini-IFUs)*
     - *Follow-up of upcoming surveys (LOFAR, Pan-STARRS)*
  3. *Cosmology redshift surveys*

Survey Profile

- Gaia low-res survey in grey/bright. (700 nights)
- High Res survey in bright time. (80 nights)
- LOFAR/APERTIF surveys in dark time, but combine with outer halo stars (800 nights)
- 5 year programme
  - Simultaneous execution all surveys + PI projects
  - Each country could retain a bit of time for small projects

WEAVE Cost

- Hardware €5270k, including corrector and top-end modifications.
- Effort: 47 FTEs
- Total instrument: €12M
- Funding:
  - UK, NL, ES,
  - Non-ING partners: France, Germany (ongoing discussions)
  - ASTRONET planning schemes for cross-European funding schemes
- Current funding status:
  - To PDR (NL; STFC; ING)

WEAVE

Name	Affiliation	Post
Gavin Dalton	*Oxford/RAL*	P.I.
David Carter	*Liverpool J.M.*	Deputy P.I.
Don Carlos Abrams	*ING*	Project Manager
Scott Trager	*Groningen*	Project Scientist
Chris Evans	*UK ATC*	Instrument Scientist
Phil Rees	*UK ATC*	Systems Scientist

Package	Institute
Spectrograph optics	*Oxford/RAL*
Spectrograph mechanics	*NOVA*
Fibres	*Paris*
Positioner robot	*Oxford*
Advanced positioners	*UK ATC*
Detectors, electronics	*Liverpool J.M.*
Systems engineering	*UK ATC*
WHT top end, PF corrector	*ING, Nice*
Electronics, Software	*IAC, ING*

WEAVE TIMELINE

- Feb 2013: PDR / Corrector FDR
- 2017: Goal is to complete construction and be on-sky for science.

- 5 years of operations 1.3×10^7 spectra!

Summary: survey capabilities at WHT

- 2013-2016
  - AF2-WYFFOS
  - PAUCam
    - 40' diameter, 150 multiplex
- 2017-2022
  - WEAVE
    - R = 5000 & 20,000
    - Key surveys including cosmology

Cosmologists of Spain:

1. Do plan to exploit WEAVE
2. Do plan to exploit WHT MOS capabilities pre-WEAVE
   - AF2
   - PAUCam
3. Coordinate with UK cosmology groups seeking
   - A share of Big-BOSS
   - A powerful European MOS capability - WEAVE

THANKS