WEAVE: A new multiobject spectrograph for the William Herschel Telescope

Cristina Zurita

Instituto de Astrofísica de Canarias

Isaac Newton Group

- WHT operation 25 years
  - General purpose telescope
  - multi-focal stations
  - Short allocations, PI programmes
  - Visitor instruments, versatile Nasmyth platforms
  - Visitor, not queue mode
- Successful model of operations, excellent site
  - Among top most productive 4m telescopes
    - » 110 papers / yr

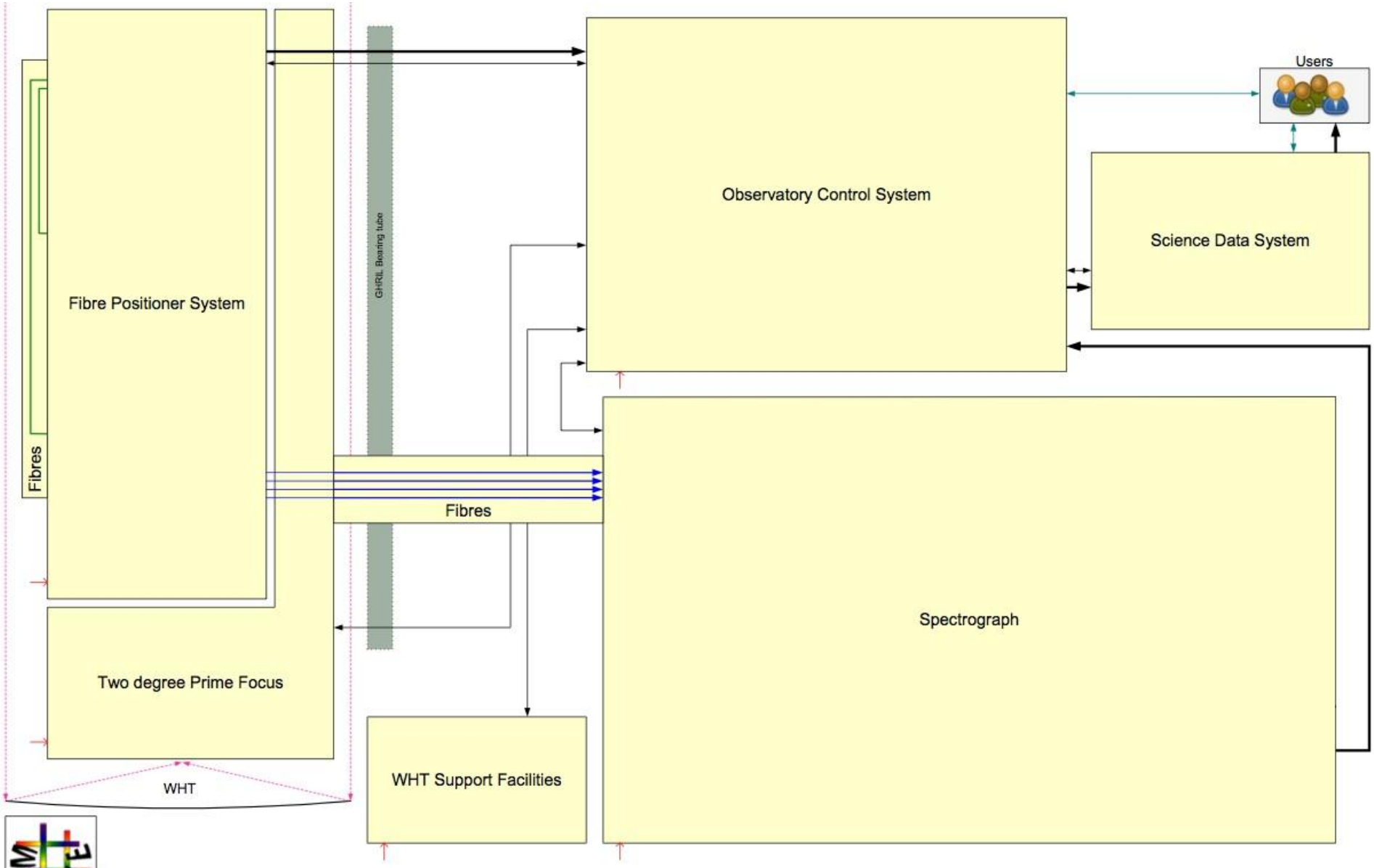
The WEAVE Spectrograph

- In response to the recommendations of different European advisory bodies, the ING partners decided to lead and construct and advanced optical spectrograph combining: Wide field and high multiplexity.
- This facility will keep to WHT between the most competitive 4m telescopes in the world
- This instrument will specialize to the WHT in wide-field surveys

http://www.ing.iac.es/weave

WEAVE characteristics

Telescope, diameter	**WHT, 4.2m**
Field of view	**2º**
Number of fibers	**1000**
Fiber size	**1.3”**
Number of small IFUs, size	**~20, 9”x11” (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**

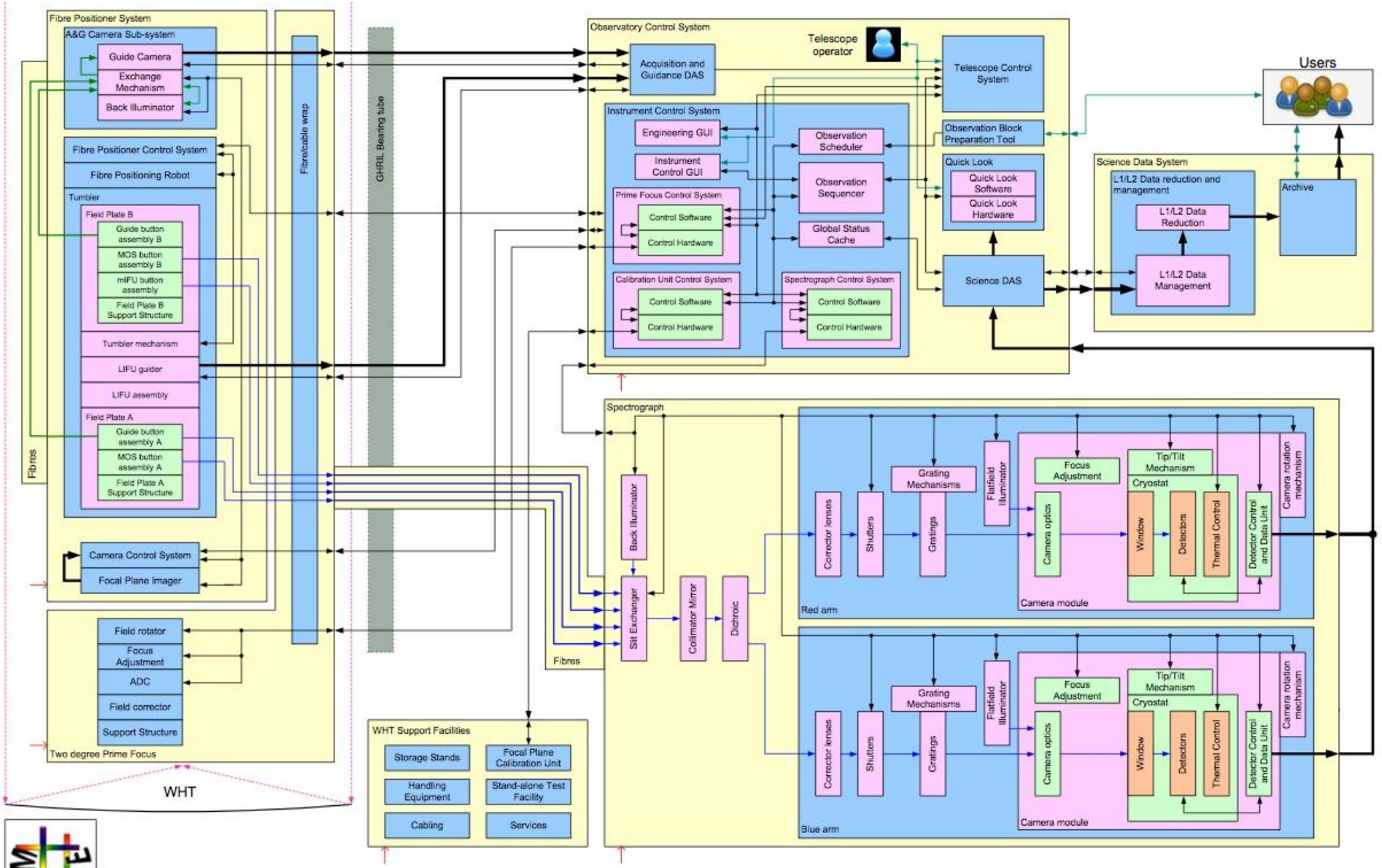


Drawn by	Mike MacIntosh/Phil Rees			**Project**	WEAVE
Date	08 FEB 13	**Doc No**	WEAVE-MAN-013	**Title**	Instrument Block Diagram Top Level
Version	1.00	**Size**	A3	**Location**	http://www.ing.iac.es/bscw/bscw.cgi/236162

Key

- Object Fibre/Light
- Fully Coherent Fibre/Light
- Calibration Fibre/Light
- Science Light
- Data
- Services
- Control and status signals
- User I/O

System	1
Sub-System	2
Module	3
Assembly	4
Sub-Assembly	5
Component	6



Drawn by	Mike MacIntosh/Phil Rees			**Project**	WEAVE
Date	08 FEB 13	**Doc No**	WEAVE-MAN-013	**Title**	Instrument Block Diagram by System
Version	1.00	**Size**	A3	**Location**	http://www.ing.iac.es/bscw/bscw.cgi/236162

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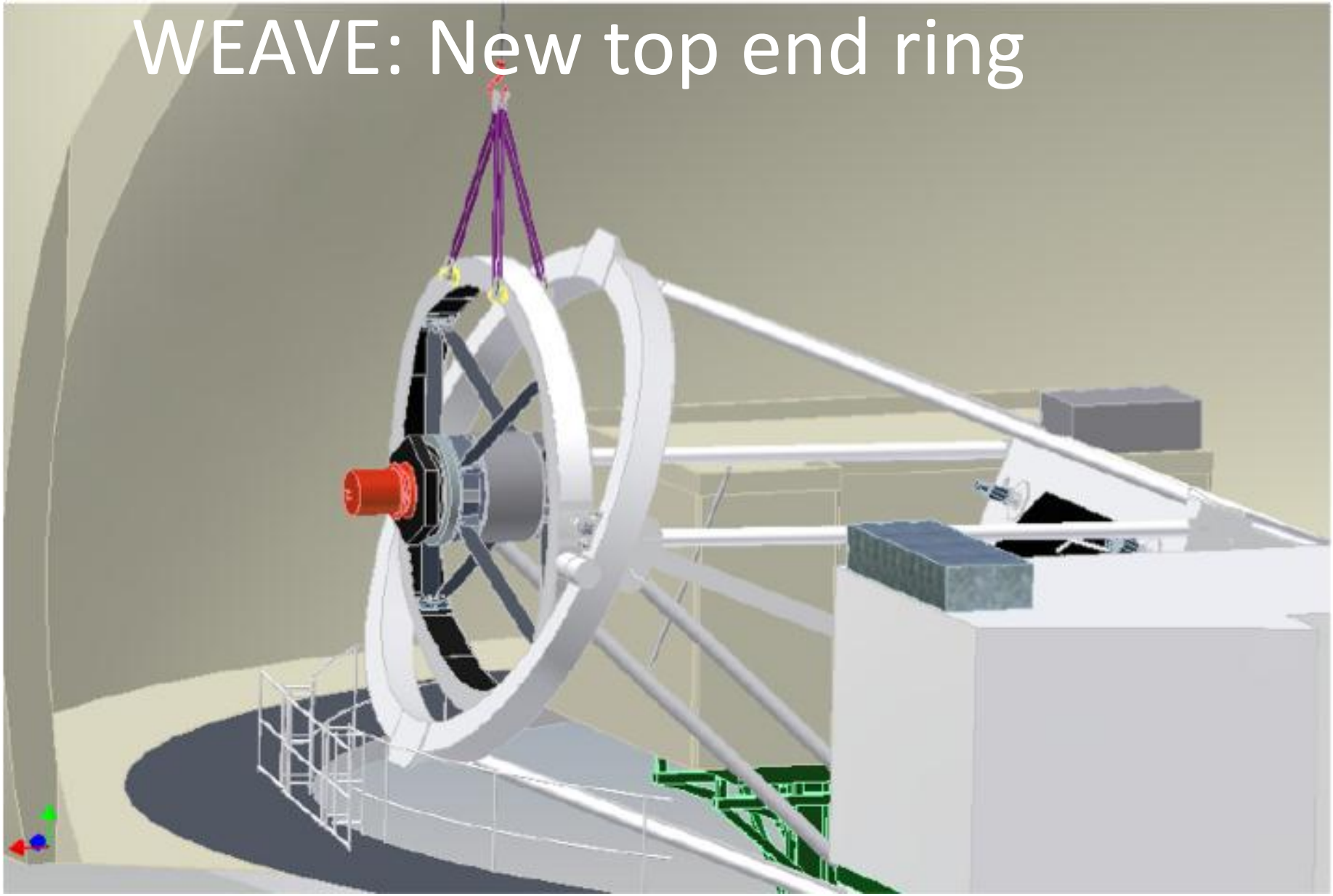
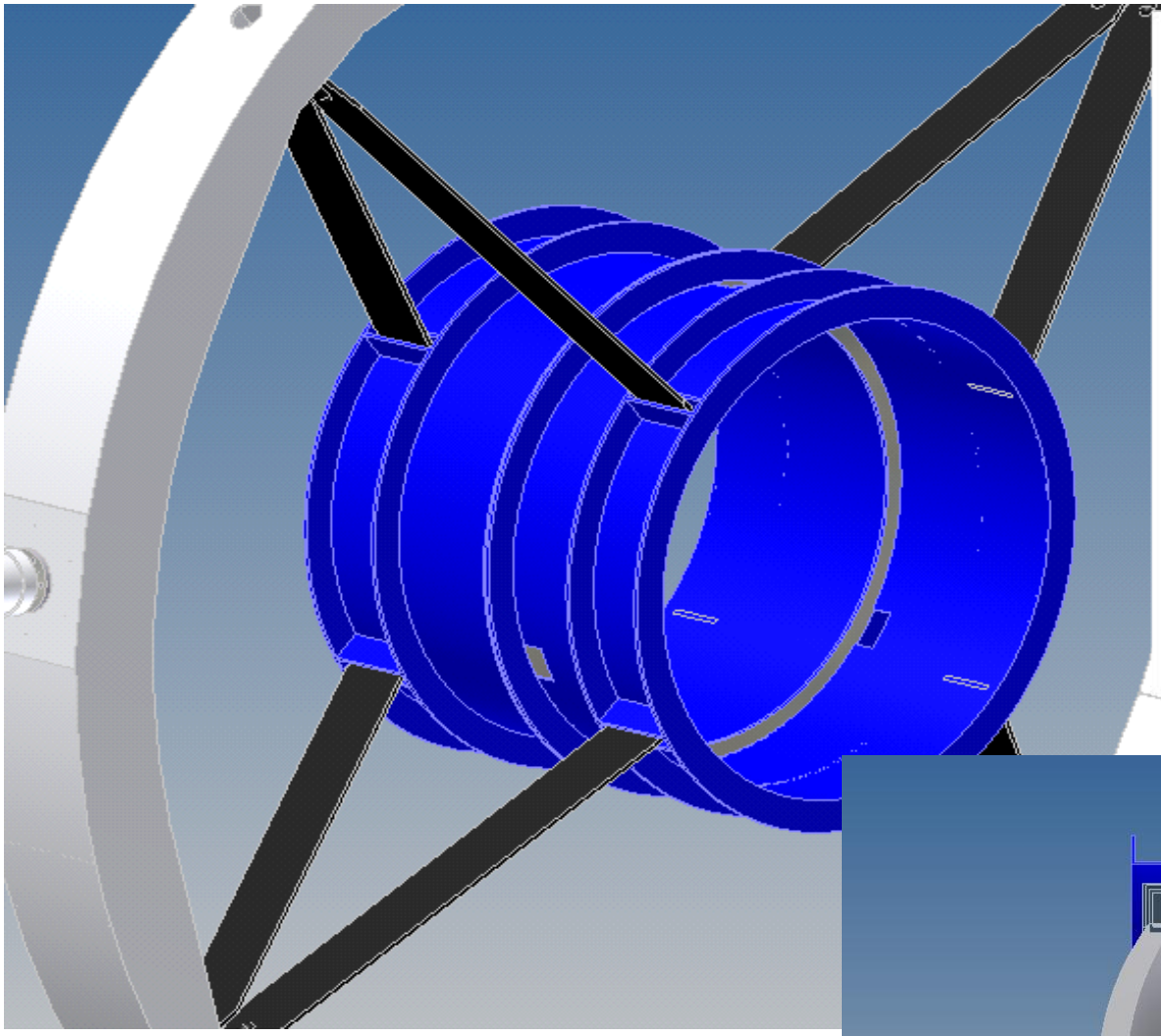
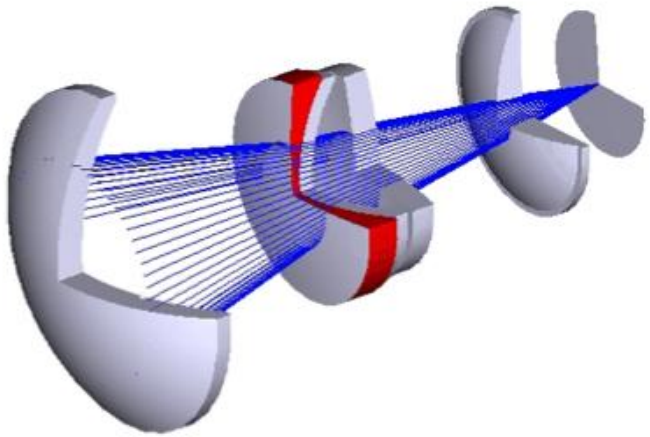
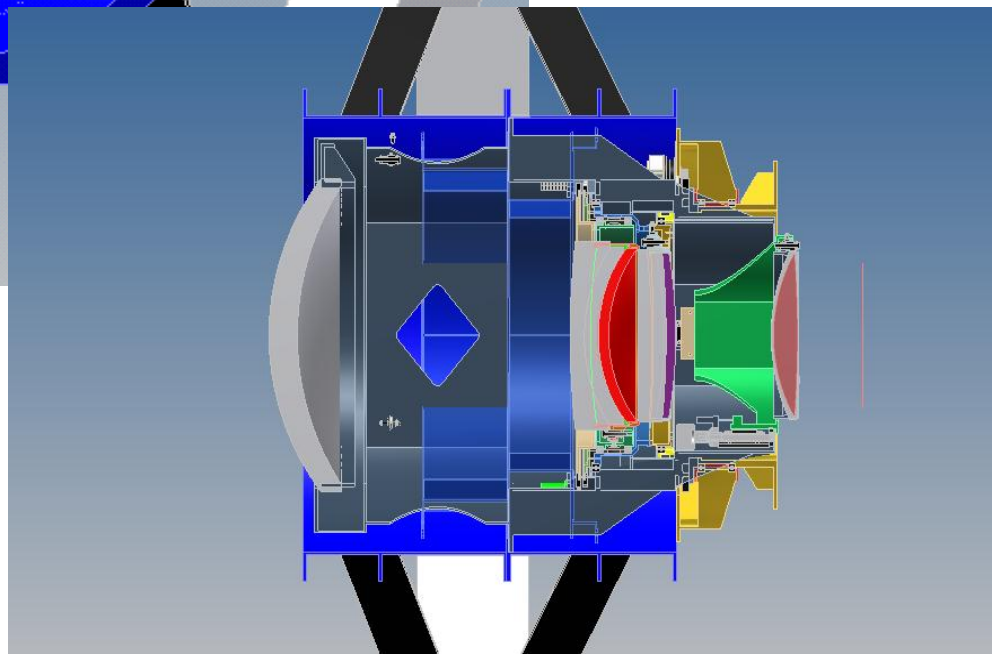
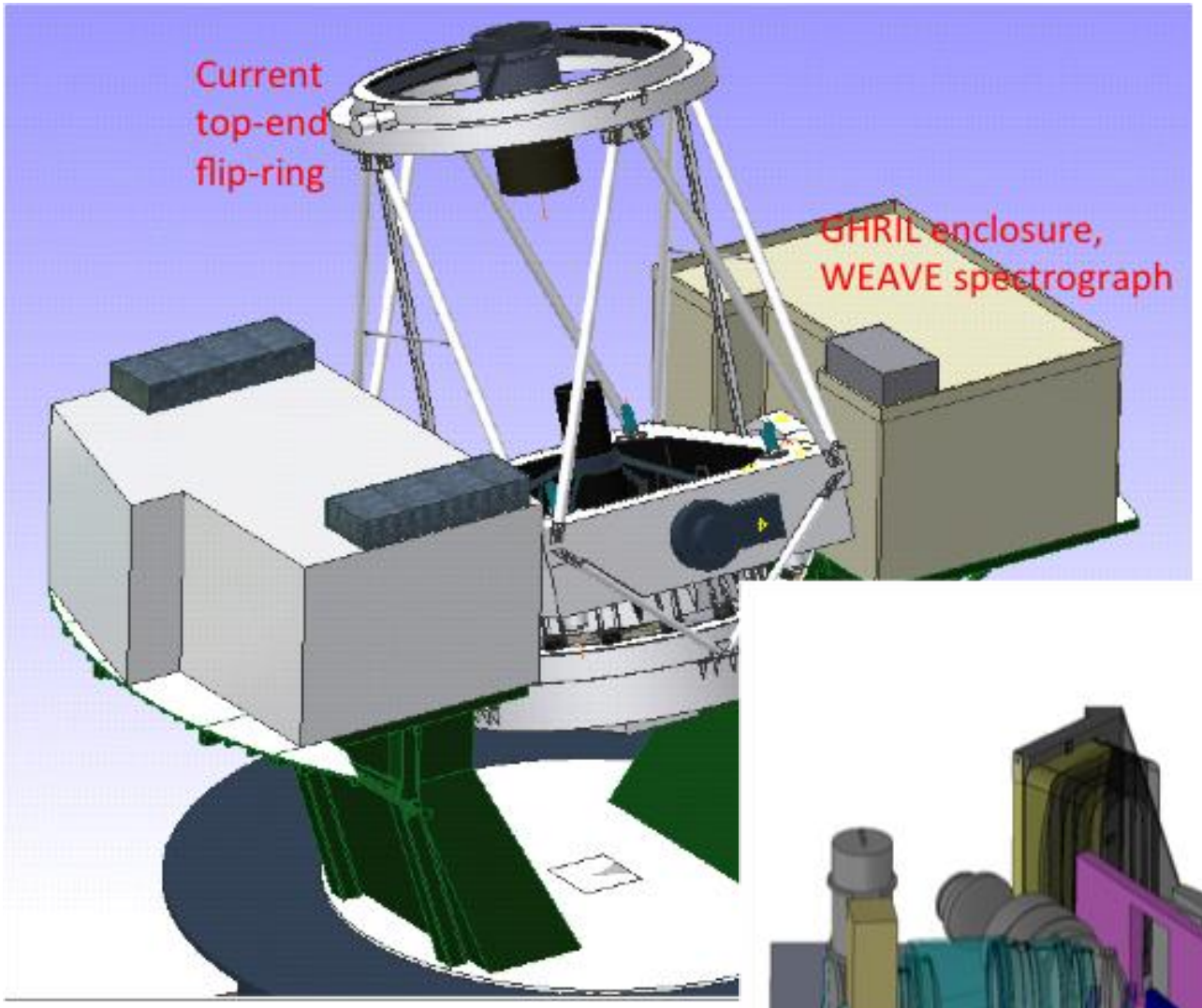
WEAVE: New top end ring

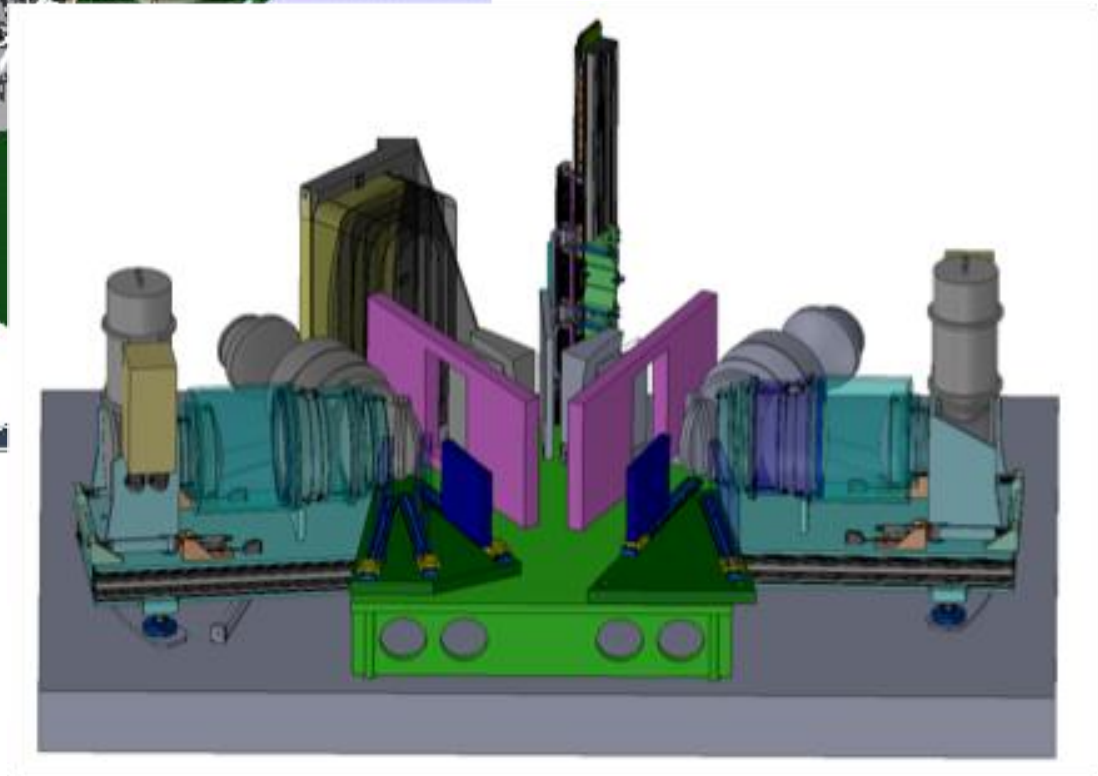


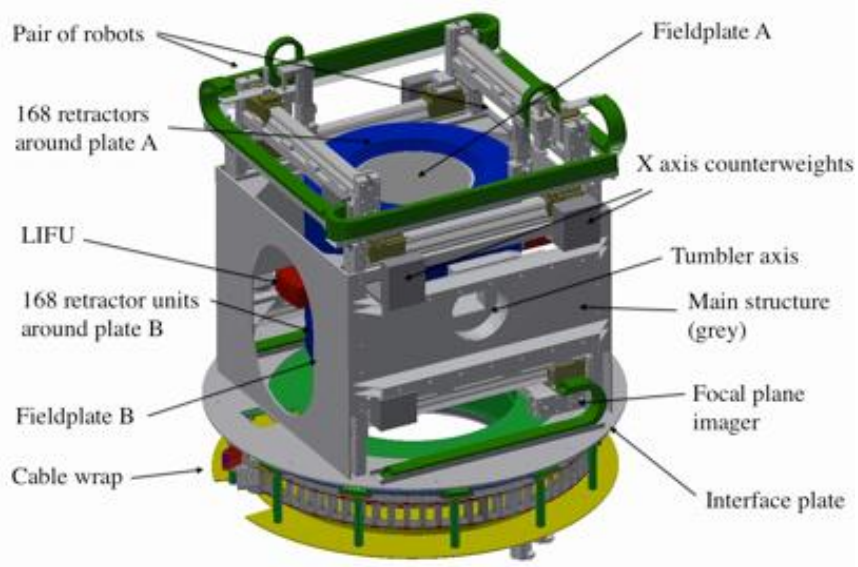


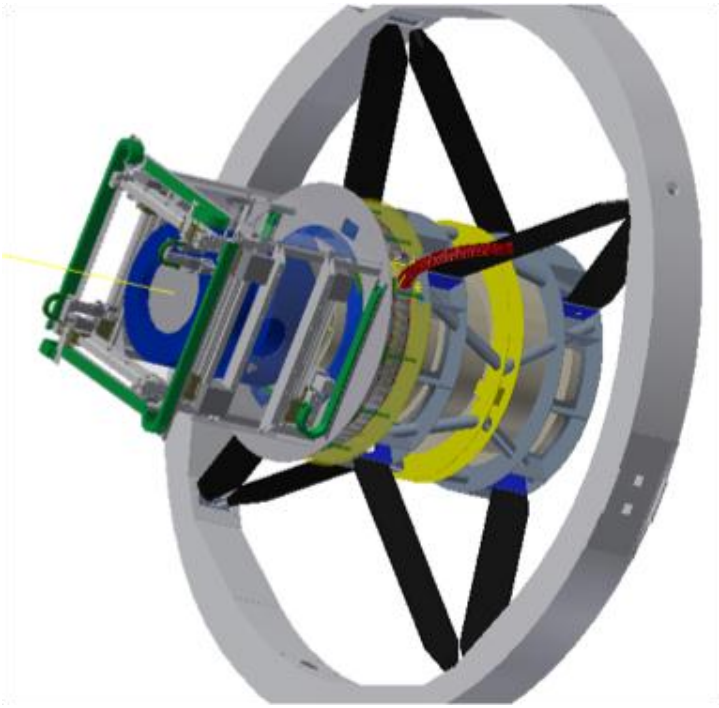


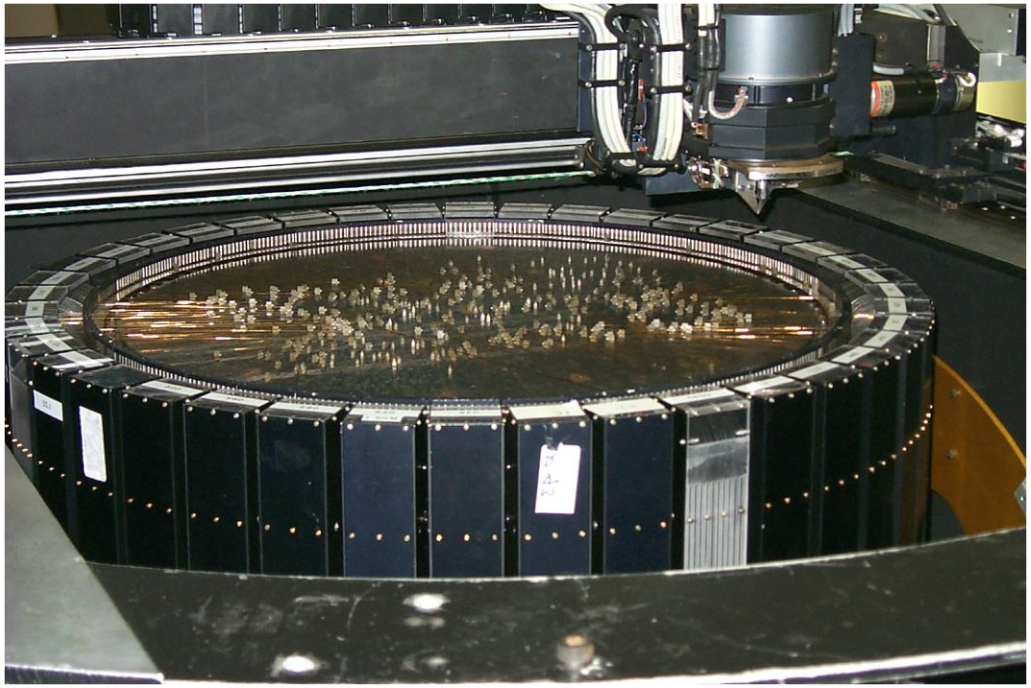



Current
top-end
flip-ring
GHRIL enclosure,
WEAVE spectrograph







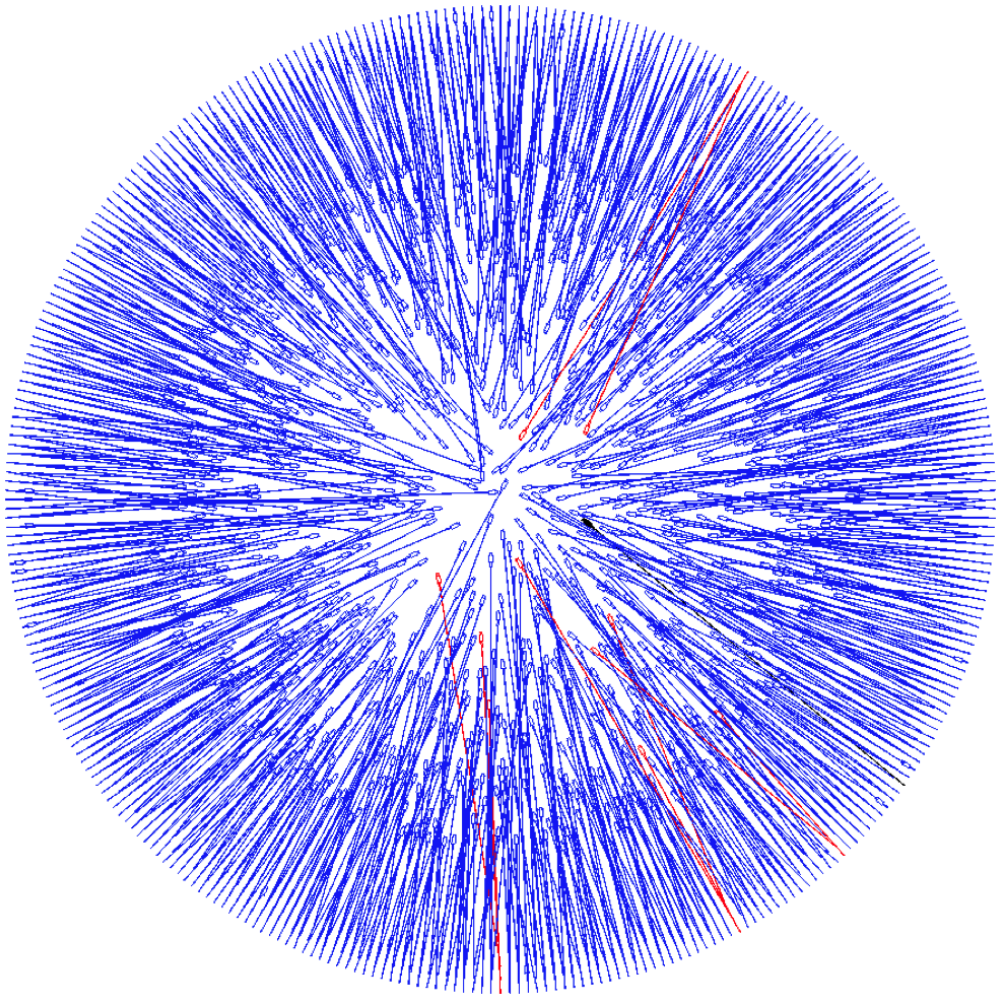


Fibres in AF2, WEAVE precursor

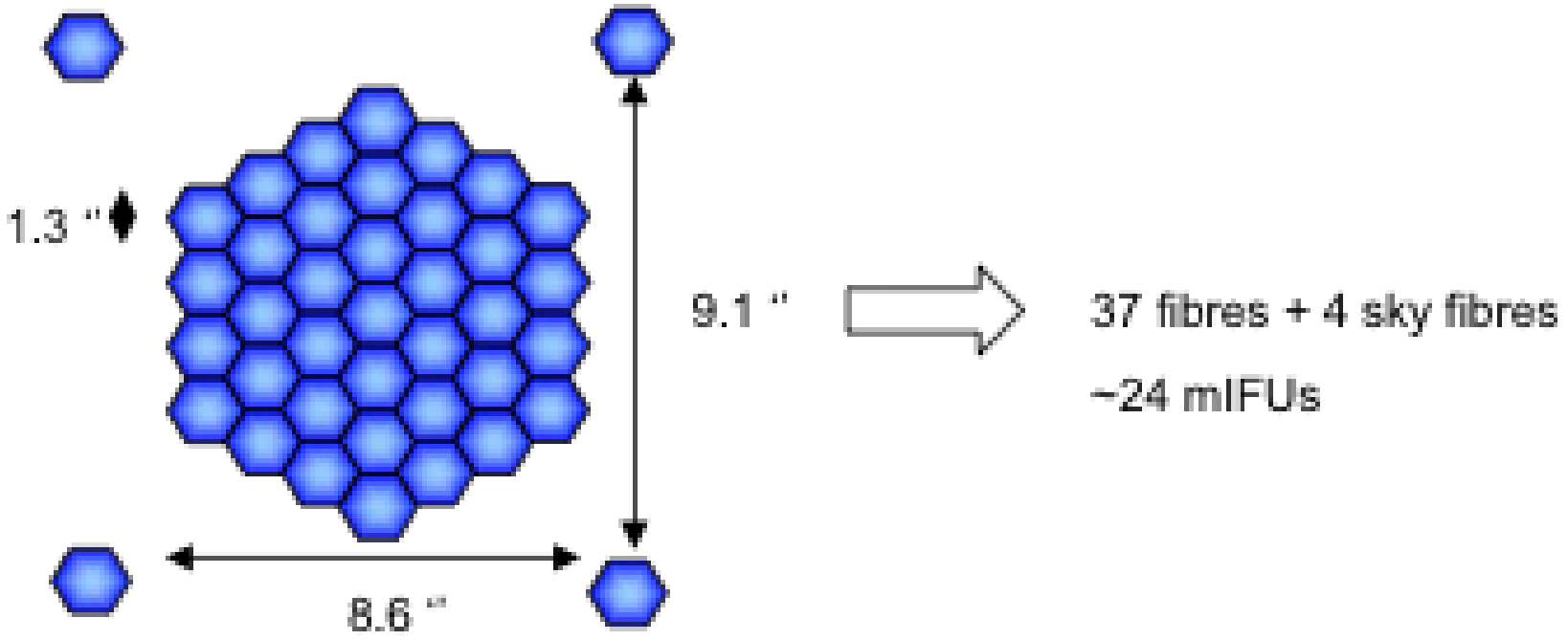
Observational Modes

- MOS mode
- 97% of fibres allocated test simulation

  ~8500 fibre crossings!
- ~1800 moves within ~55 minutes with two robots
- High and low resolution



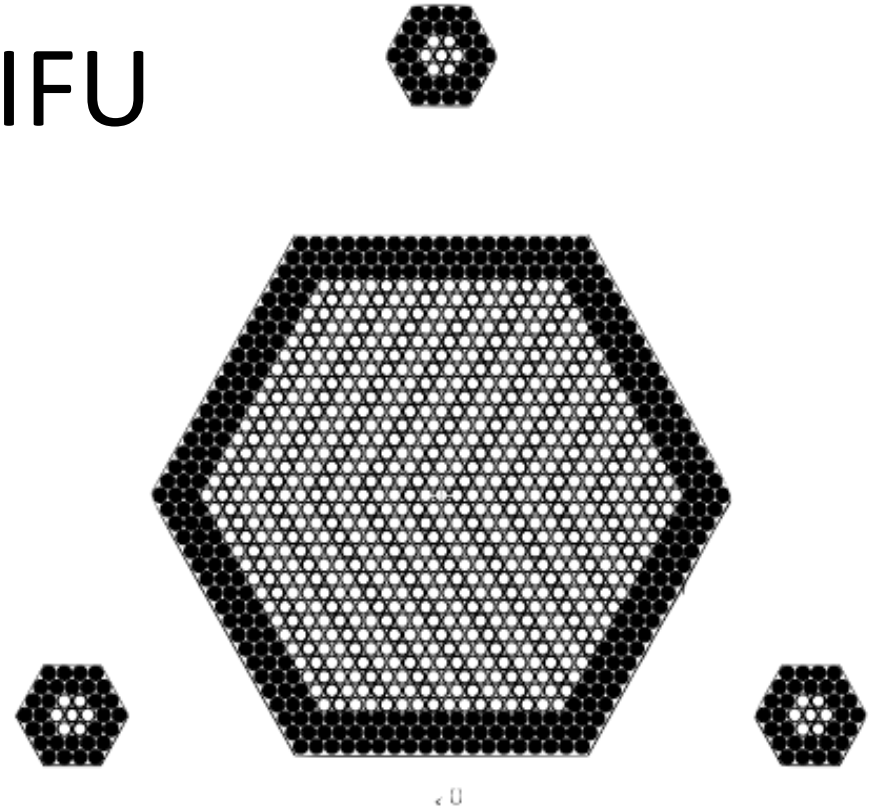
Mini IFU units

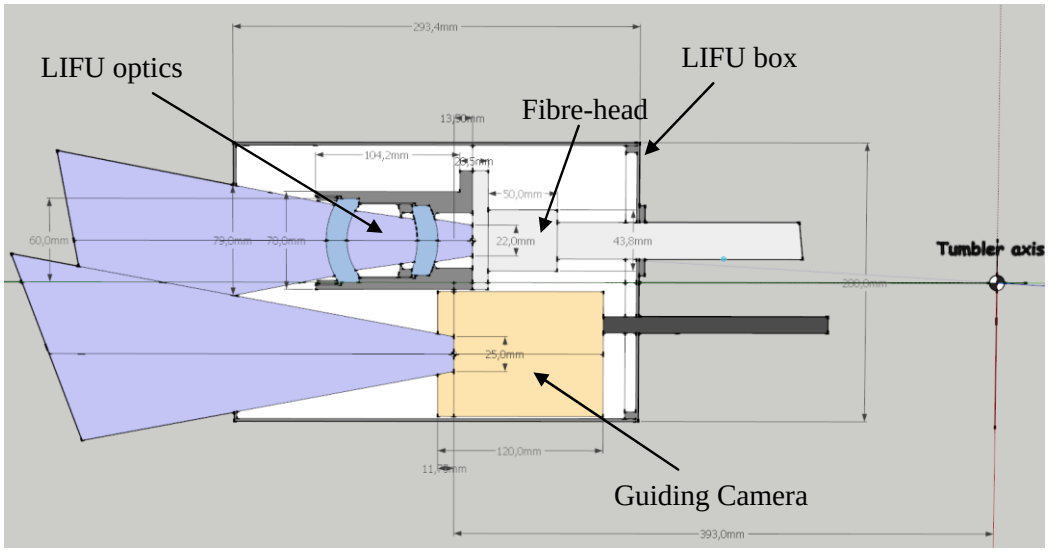


- ~20-25 mini-IFUs on one field plate, ~9”x9”, 1.3” pitch

Large IFU

- Large IFU with ~547 fibres ~90” x ~60”, 2.6” pitch





LUND UNIVERSITY

NWO

Science & Technology
Facilities Council

university of
groningen

ASTRON

WEAVE organization

- WEAVE Board:
  - agencies of the consortium
    2 Spanish representatives: J. Knapen (IAC) and J. Torra (UB)
  - ING Director

- WEAVE Executive:
  - PI: Gavin Dalton (RAL/Oxford)
  - Project Scientist & Dutch co-PI: Scott Trager (Kapteyn)
  - Spanish co-PI: J. Alfonso L. Aguerri (IAC)
  - French co-PI: Piercarlo Bonifacio (GEPI)
  - Project Manager: Don C. Abrams (ING)
  - Systems Engineer: Kevin Middleton (RAL)
  - Italian PI: Antonella Vallenari (INAF)

Spanish contribution to WEAVE

- Develop of technology by the Spanish institutes and/or industry.
- We have identify several WEAVE systems:
  - Mechanical part of the new top ring, new prime focus corrector, and fibre retractors (Effort on the desing plus manufacturation). **Kevin Dee (ING**), Jose Peñate (IAC), Jose Alonso (IAC)
  - Hardware control system of the spectrograph and prime focus corrector (developed from PDR) → **Luis Fernando Rodriguez (IAC**), Jose Miguel Delgado (IAC)
  - Science data system→ the Advanced Data System (developed from PDR). **Carlos Allende (IAC)**, Cristina Zurita (IAC)

WEAVE status and timescale

- Kick off of the project: September 2011
- PDR 18 March 2013
- Final Desing Review: Q4 2014
- Construction phase: 2015-2016
- Funding:
  - NL funding approved 2012
  - UK funding approved end of 2013
  - France partially approved in 2013. Final decision in 2014
  - Spain: Support from RIA (2013), Nacional Plan (pending), FEDER funding approved (May 2014). IAC
- Instrument at the telescope Q4 2107
- Surveys period 2018-2023

WEAVE Science Group

- The WEAVE science group is formed by about 145 researchers from: UK, NL, SP, FR and IT.
- About 30% of researchers belong to Spanish institutions.
- Strong science cases (16) have been presented by Spanish PIs
- Strong support by the Spanish Network for Scientific Exploitation of Gaia data (REG)
  - See the summary of RIA meeting: "*La contribución de las ICTS españolas a la misión Gaia de ESA*"

The WEAVE Science case

- These three surveys are the “design reference surveys” driving the requirements for the WEAVE design:
  - Galactic Archaeology
  - Galaxy Clusters
  - Galaxy Evolution
  - Cosmology

Cosmology

WEAVE BAO Survey

WEAVE Ly-alpha forest survey

Additional Cosmology cases

Cosmology group leader: Matt Jarvis (matt.jarvis@astro.ox.ac.uk)

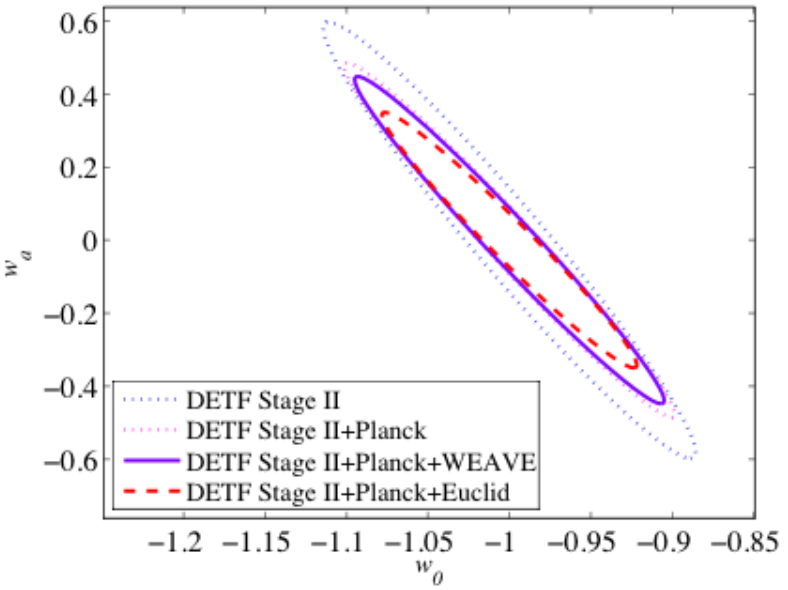
Spanish Cosmology group members: J. Cepa, J. Miralda, J.A. Rubiño, J. Betancort, R. Rebolo…

WEAVE-LOFAR as a BAO Survey

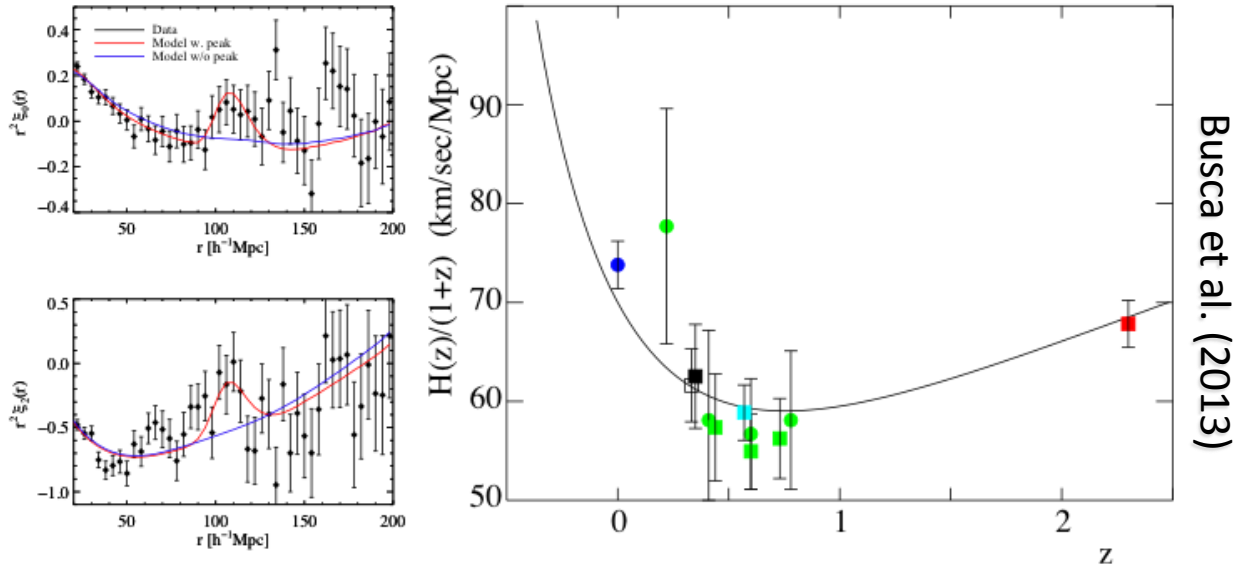
- The Low Frequency Array (LOFAR) is the world's largest low-frequency radio telescope array
- The LOFAR Surveys will deliver ~10^7 continuum targets over ~10^4 deg^2 at 30, 60, 120, 200 MHz
- Radio source population extremely diverse. It will be *strongly* biased towards emission-line galaxies, especially *star-forming galaxies,* and radio-quiet AGNs at cosmological distances.
- WEAVE can obtain redshifts for ~10^7 emission-line galaxies detected by LOFAR at z<1.3 (OII) and z>2.3 (Lyα). This will give us an excellent BAO survey.

BAO constraints

- Baryon acoustic oscillations (BAOs) provide a *standard ruler* for measuring the size of the Universe
  - By comparing the BAO spectrum at different epochs, the expansion of the Universe can be measured
  - WEAVE-LOFAR will fill the gap in BAO surveys between BOSS (z<0.7) and Euclid (z>1.2)



BAO constraints from the Lyman-α forest



- The scale of BAOs can also be determined by studying the flux correlation function of the Lyman-α forest at various redshifts
  - Cleaner than galaxy-based BAO measurements: lower bias
  - SDSS3-BOSS has already begun to do this at z~2.2 (Busca et al. 2013)
- WEAVE can provide a large survey of bright (g<20) and faint (22<g<23) LyAF QSOs from other surveys: Gaia, J-PAS, PAU.

Additional Cosmology science cases

- Spectroscopic confirmation of J-PAS photometric redshifts
- Observations of Euclid strong lenses

More information …

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