4MOST – 4m Multi-Object Spectroscopic Telescope

Richard McMahion, Extragalactic Project Scientist
(IoA, Cambridge)

PI: Roelof DeJong (AIP)

2021 May 11th

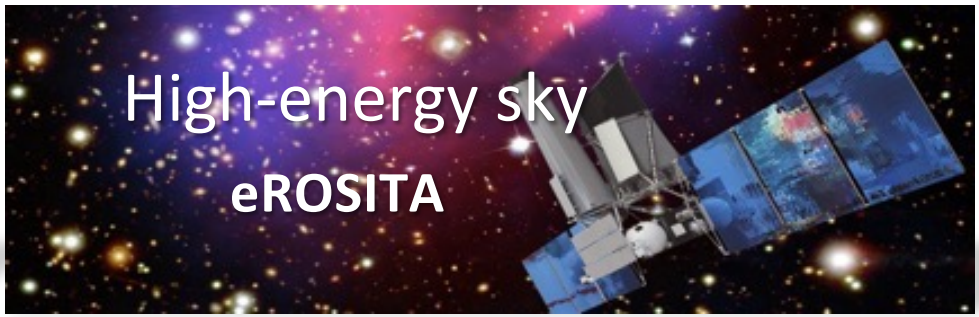
www.4MOST.eu

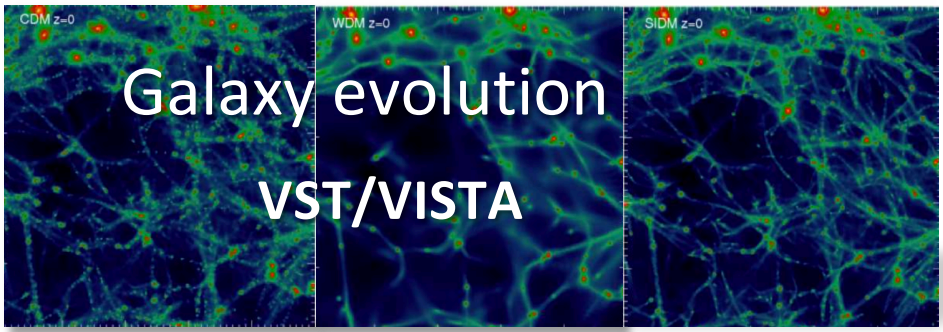
4MOST: Wide-field, high-multiplex optical spectroscopic survey facility for ESO

- Status:
  - ESO Council approved 4MOST in June 2015, ESO contract signed
  - Final Design Review in 2019, 4MOST is in full construction phase
  - Operations start on 4m **VISTA** telescope Q3-2023 (at least 2 x 5-year Surveys)

- Survey facility:
  - 4MOST Consortium delivers instrument, science operations, data products, science (70% of observing time)
  - All-sky 5 x 2 year public surveys in parallel, with yearly PUBLIC data releases
  - Key surveys organized by consortium in coordination with community
  - *Additional surveys from ESO community and Chile through ESO peer-review applications*

Science Themes





Ten Consortium Surveys

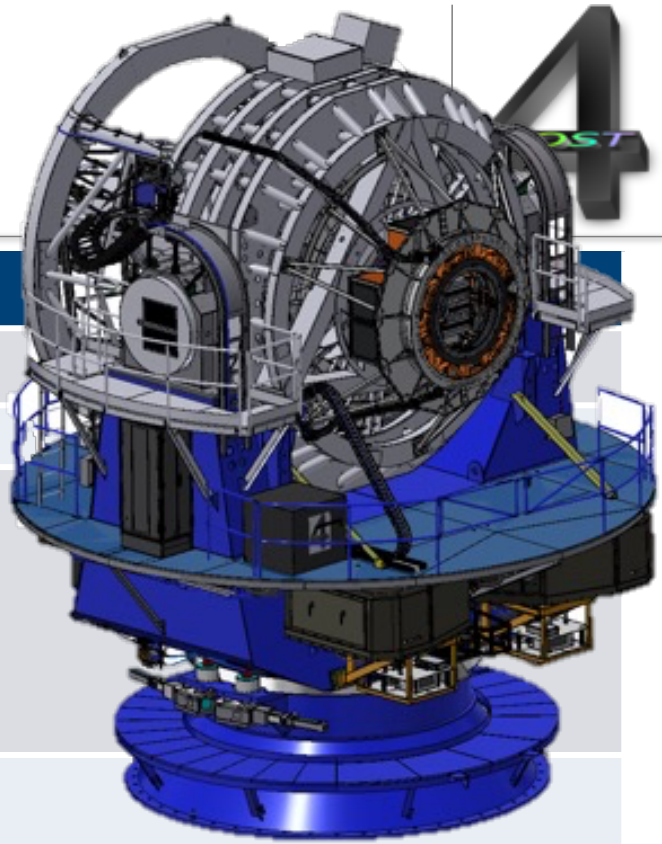
No	Survey Name	Survey (Co-)PI
S1	Milky Way Halo LR Survey	Irwin (IoA), Starkenburg (RuG)
S2	Milky Way Halo HR Survey	Christlieb (ZAH)
S3	Milky Way Disk and Bulge LR Survey	Chiappini (AIP), Minchev (AIP)
S4	Milky Way Disk and Bulge HR Survey	Bensby (LU), Bergemann (MPIA)
S5	Galaxy Clusters Survey	Comparat (MPE)
S6	AGN Survey	Merloni (MPE)
S7	Galaxy Evolution Survey (WAVES)	Driver (USW), Liske (HHU)
S8	Cosmology Redshift Survey	Richard (CRAL), Kneib (EPFL)
S9	Magellanic Clouds Survey	Cioni (AIP)
S10	Time-Domain Extragalactic Survey (TiDES)	Sullivan (Southampton)

Science Themes

See also ESO Messenger (2019Msngr.175) articles for more details
https://www.eso.org/sci/publications/messenger/toc.html?v=175&m=Mar&y=19

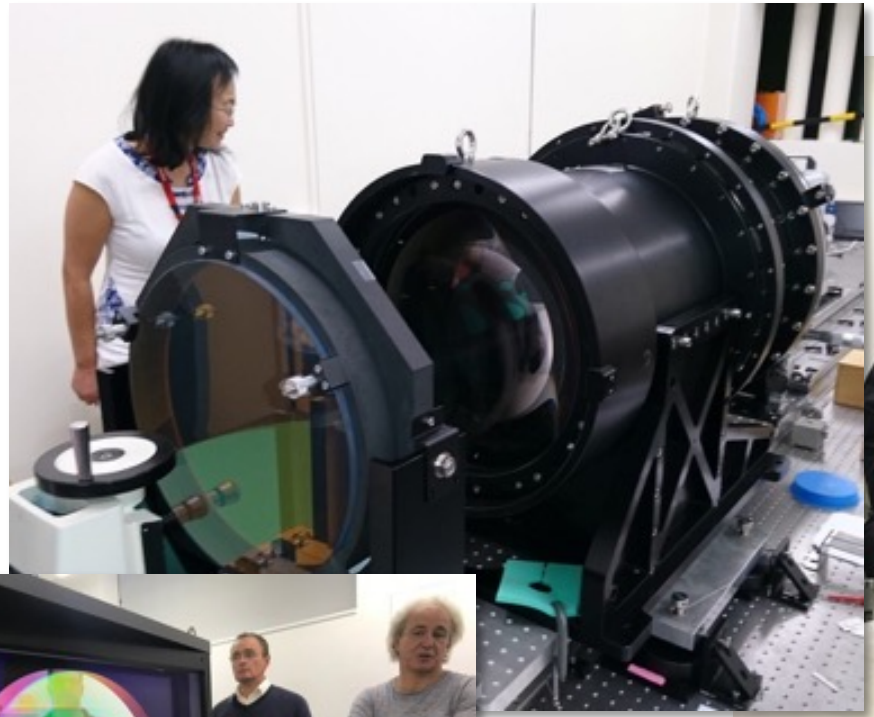
- Cosmology Survey: 10 million galaxy redshifts
- WAVES survey: 1.5 million galaxy redshifts
- eRosita X-ray Cluster survey: 50,000 cluster redshifts and velocity dispersions
- Supermassive Black Hole formation and evolution: 1.0 million AGN redshifts
- Distance Scale and Transient Universe: 200k SN (incl host galaxy) redshifts
- First Stars, Chemical Evolution of Milky Way: 2million high resolution spectra
- Merger, Accretion and Dynamical evolution of the Milky Way: 1million low(medium) resolution spectra

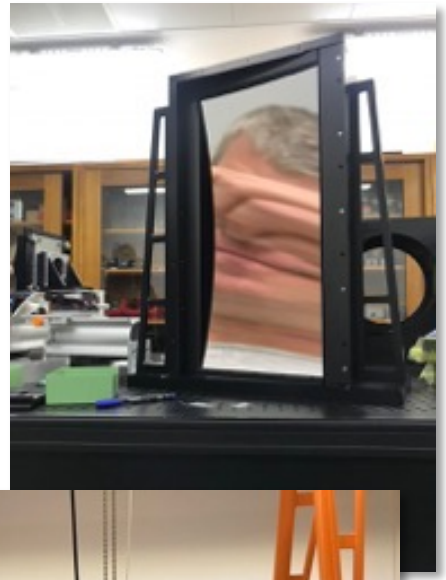
Instrument Specification

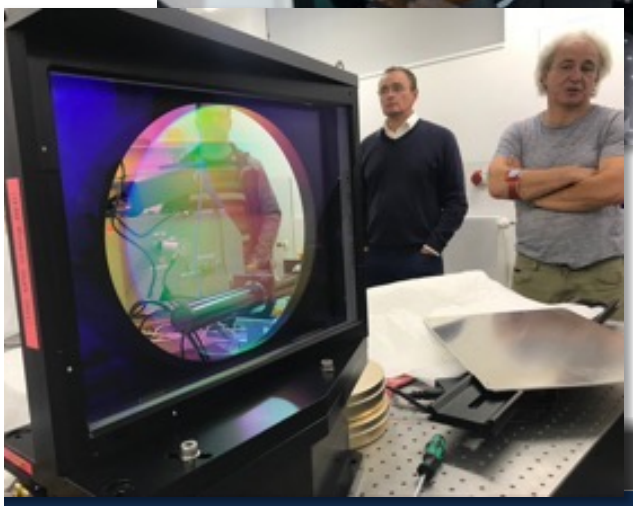


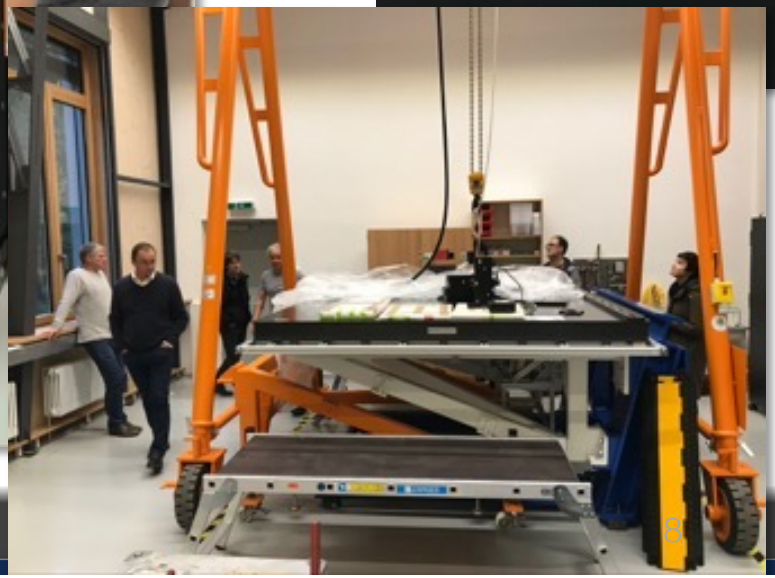
Specification	Design value
Field-of-View (hexagon)	~4.2 degree^2 (⌀>2.6°)
Multiplex fiber positioner	2436
2 Low/Medium Resolution (LR) Spectrographs	R~4000–7500
Fibres	812 fibres (2x)
Passband	370–950 nm
Velocity accuracy	< 1 km/s
Spectral sampling (pixels/FWHM)	> 2.8 pixels
High Resolution (HR) Spectrograph	R~20,000
Fibres	812 fibres
Passband	392.6–435.5 nm, 516–573 nm, 610–679 nm
Velocity accuracy	< 1 km/s
Spectral sampling (pixels/FWHM)	> 2.56 pixels
# of fibers in ∅=2’ circle	>3
Fibre diameter	∅=1.42 arcsec

High Resolution Spectrograph (HRS)









High Resolution Spectrograph (HRS)

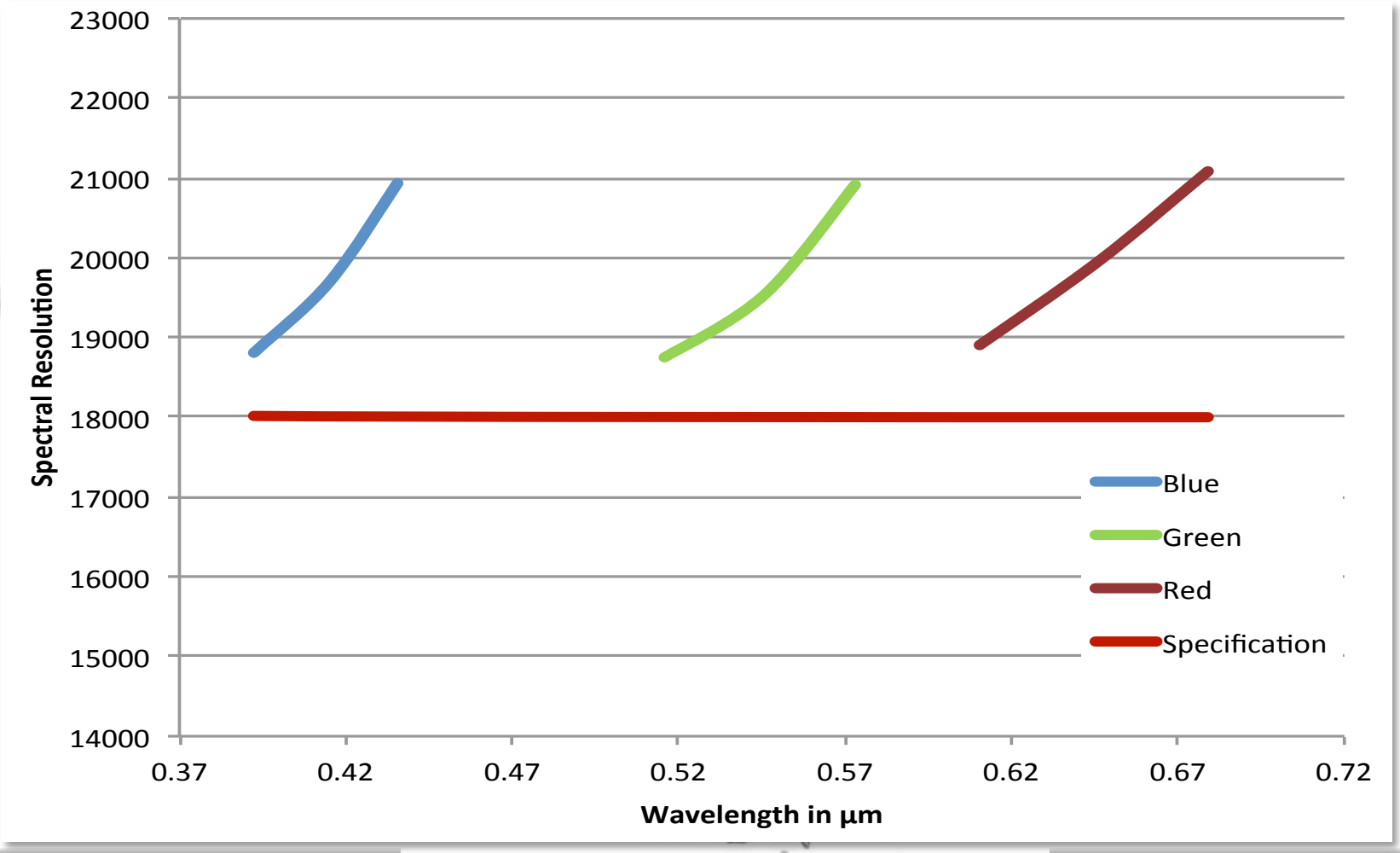
3 arms spectrograph
3 CCDs 6k x 6k

250 mm beam size

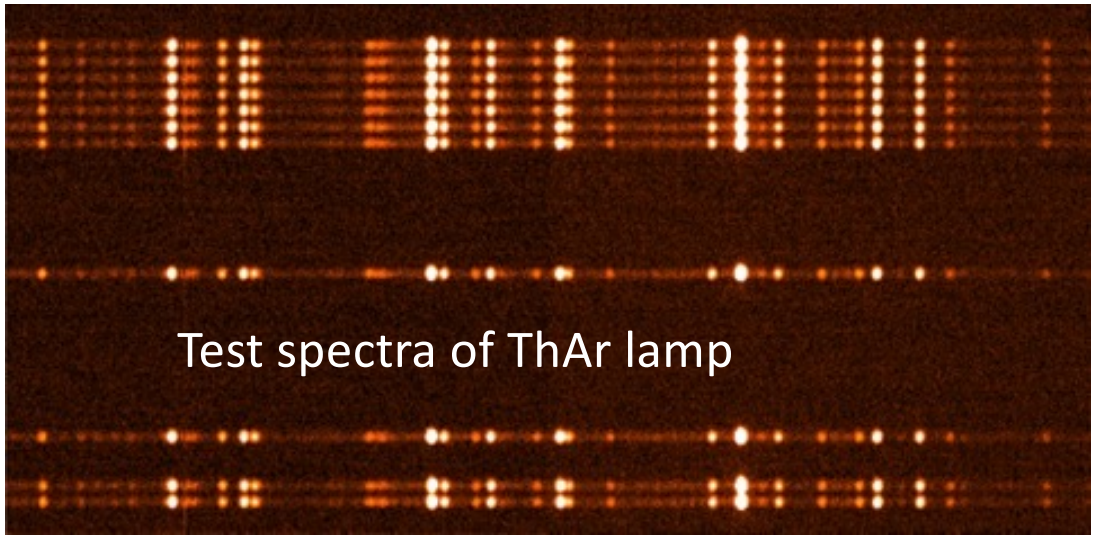
812 science fibres

1 spectrograph

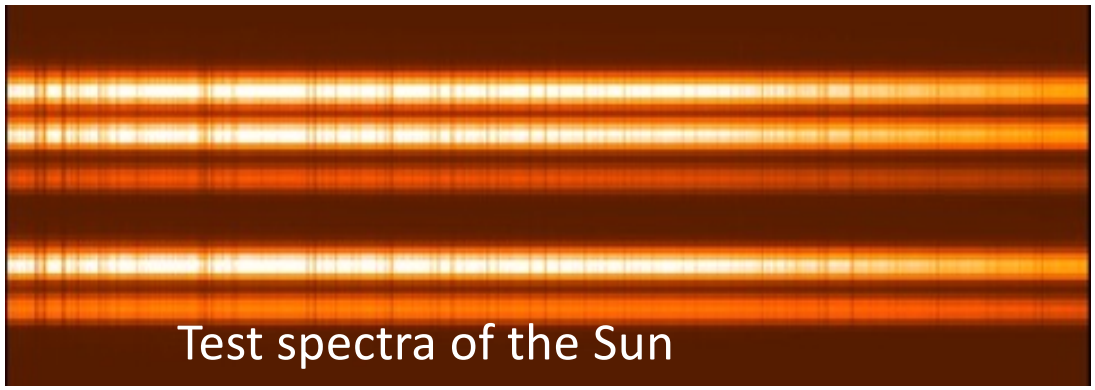
Design and build at ZAH/LSW in Heidelberg



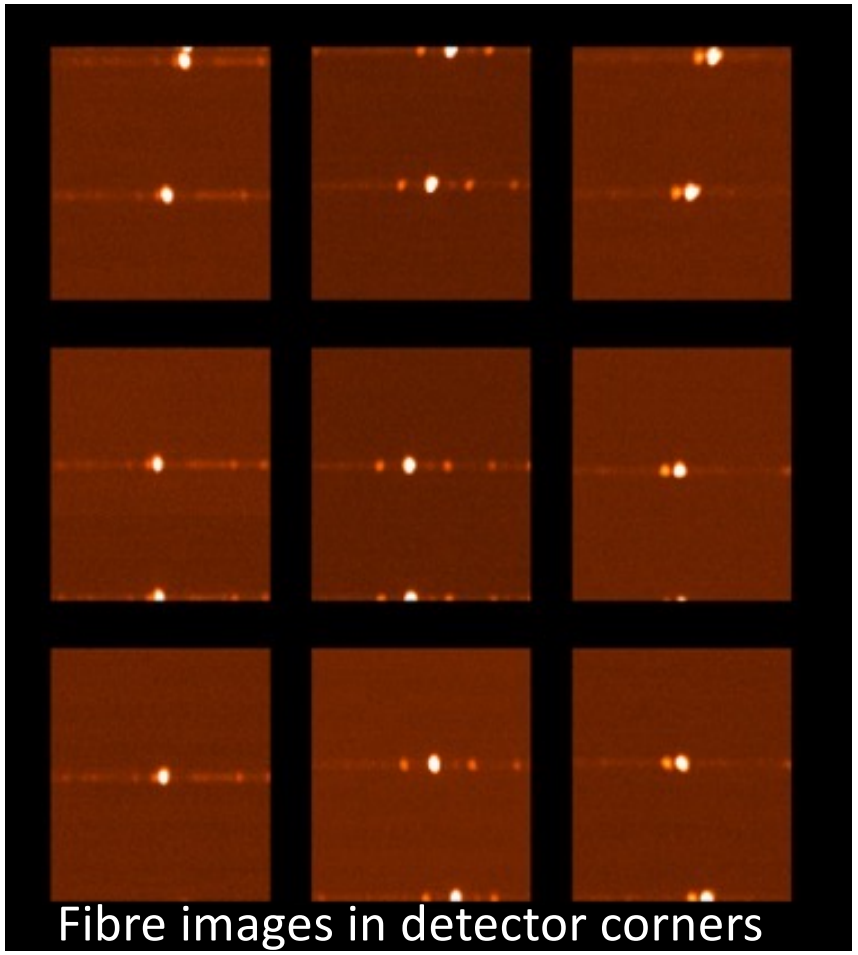
High Resolution Spectrograph (HRS)



Test spectra of ThAr lamp

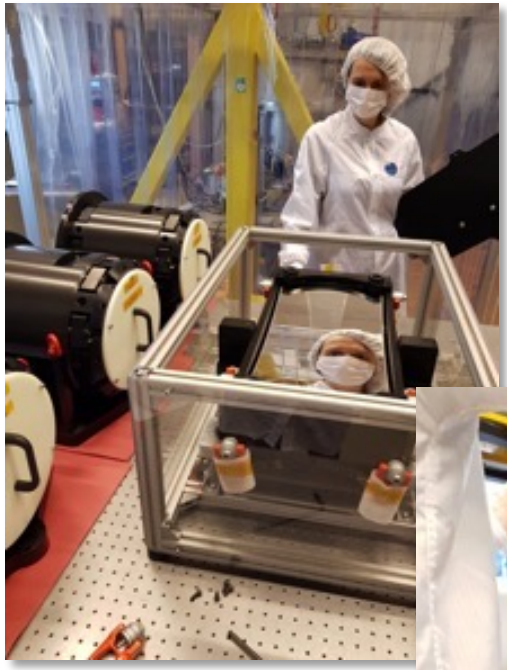


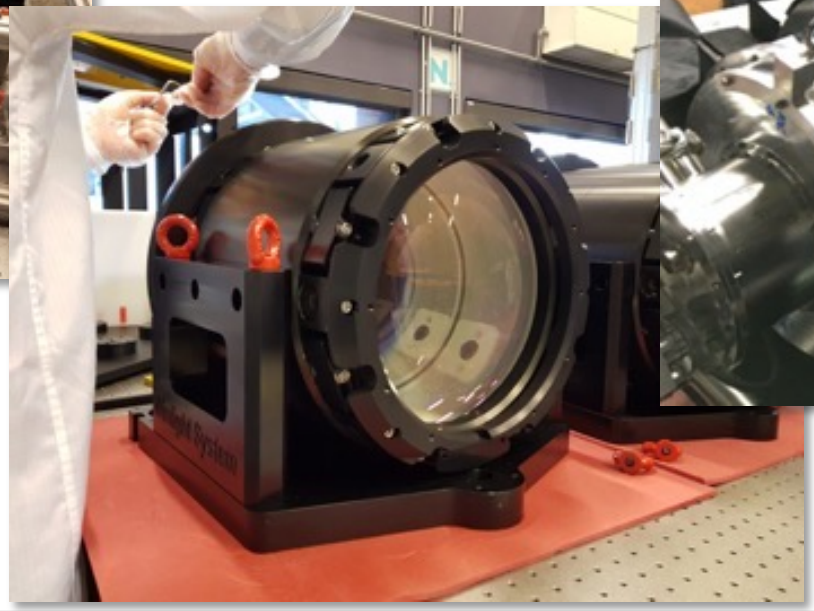
Test spectra of the Sun

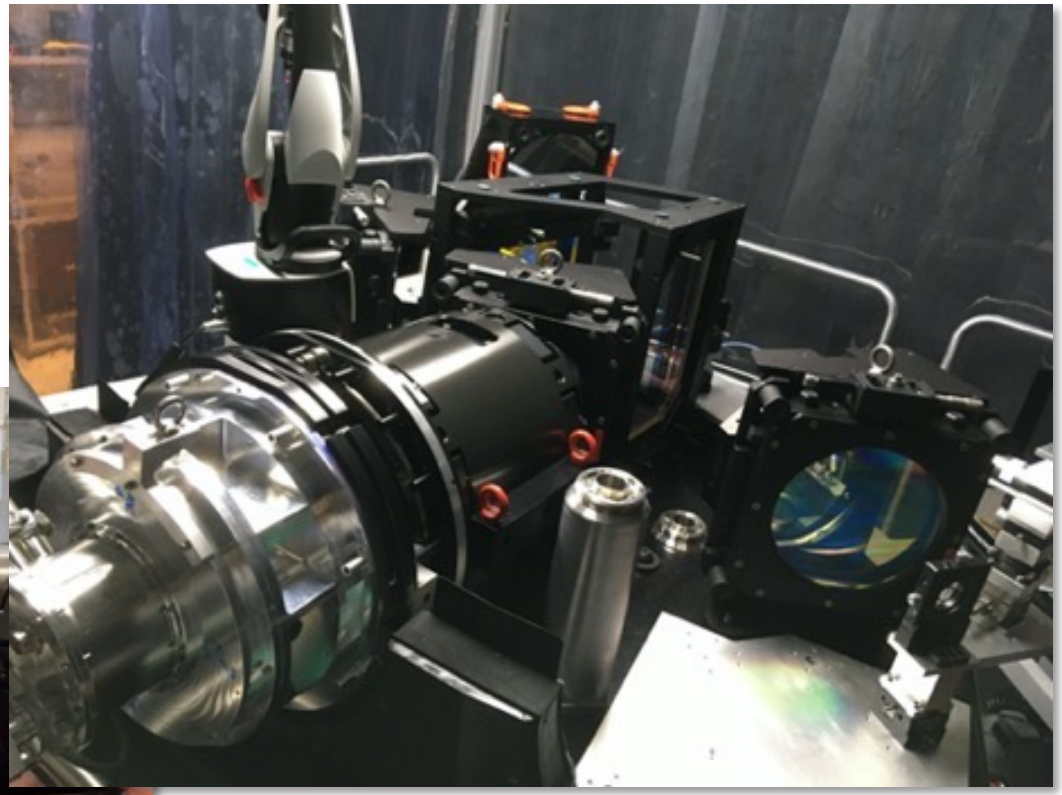


Fibre images in detector corners

Low Resolution Spectrograph (LRS)







Low Resolution Spectrograph (LRS)

3 arms spectrograph
3 CCDs 6k x 6k

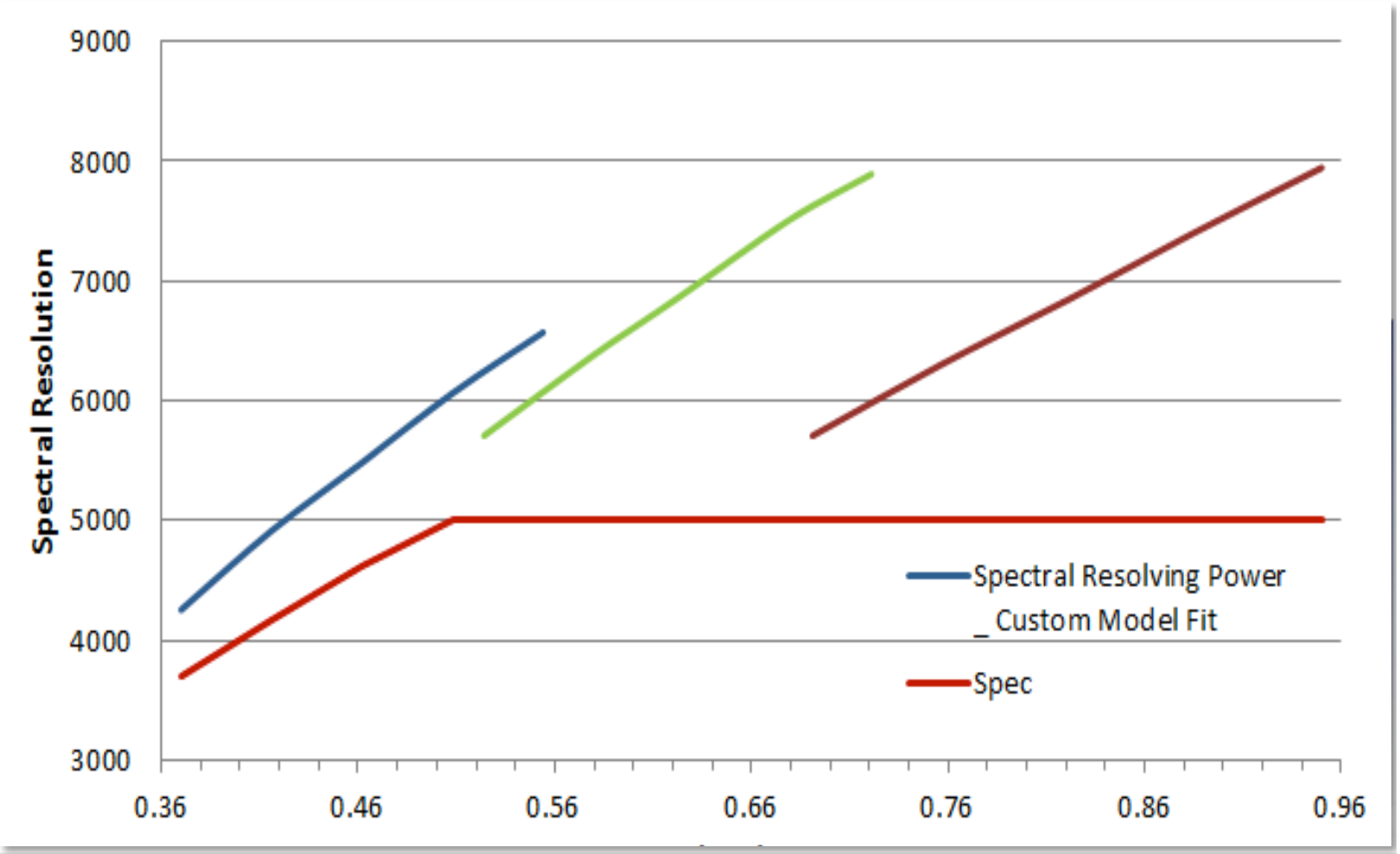
200 mm beam size

812 science fibres per spectrograph

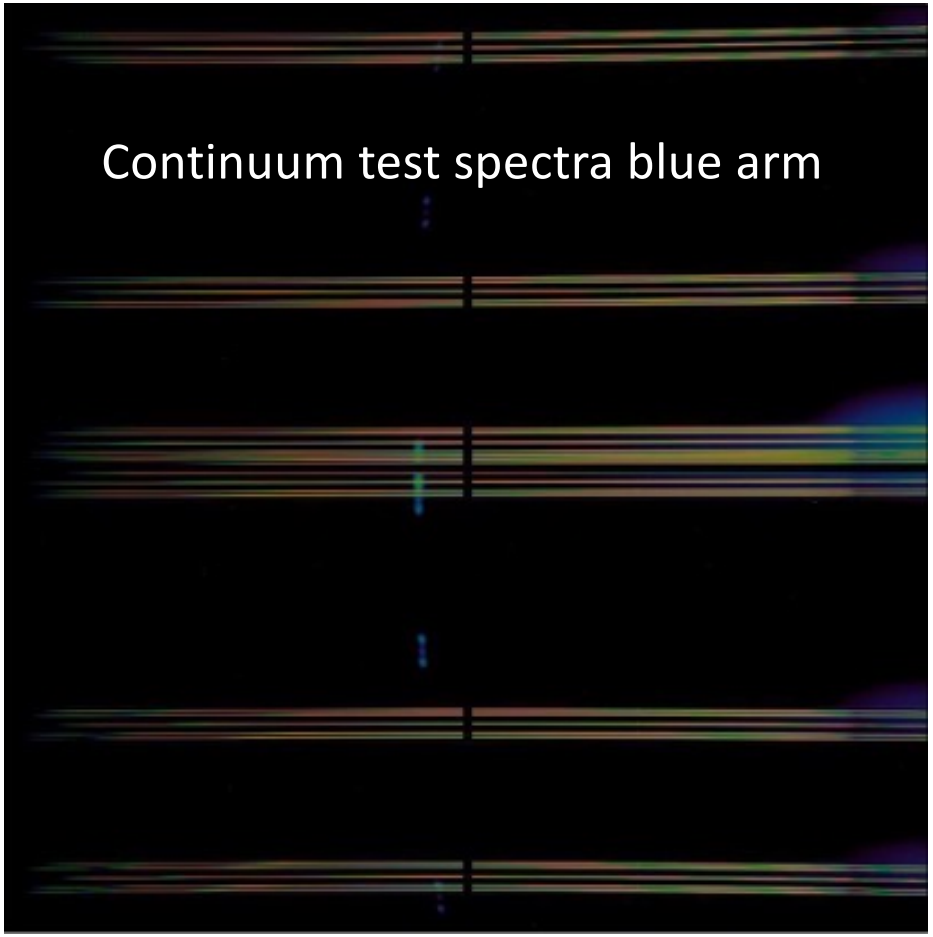
2 mirrored spectrographs

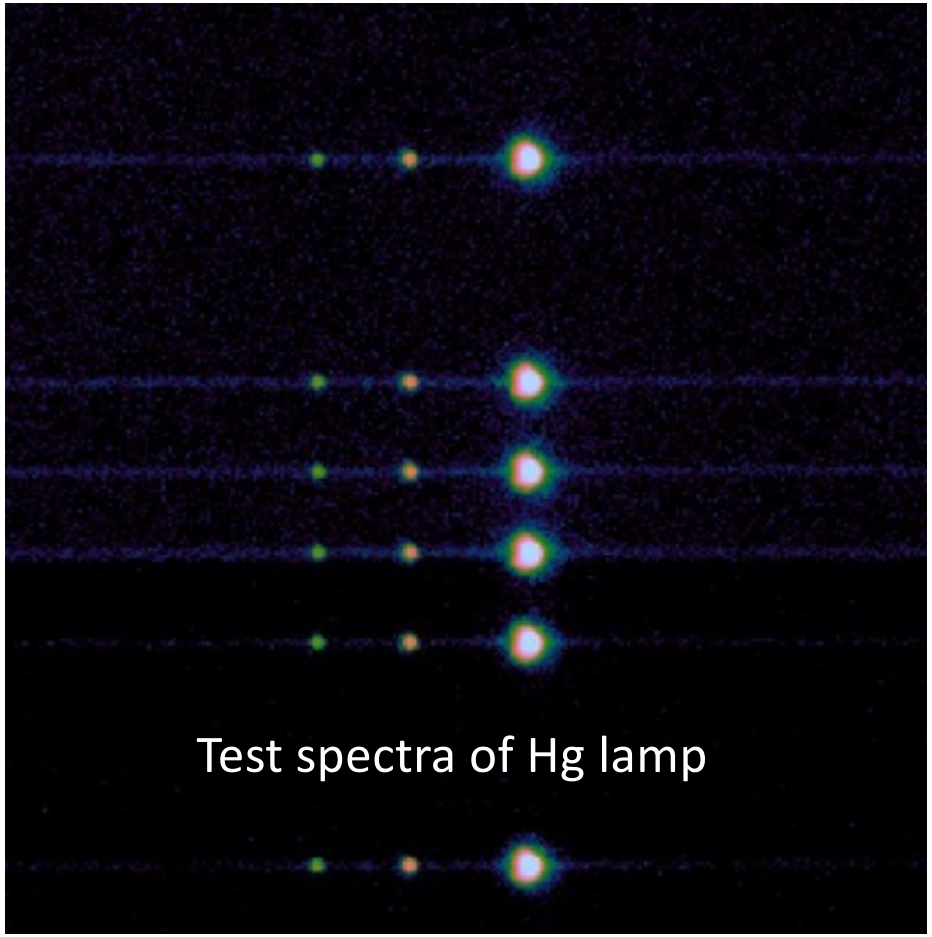
Thermally stabilized

Design and build at CRAL in Lyon



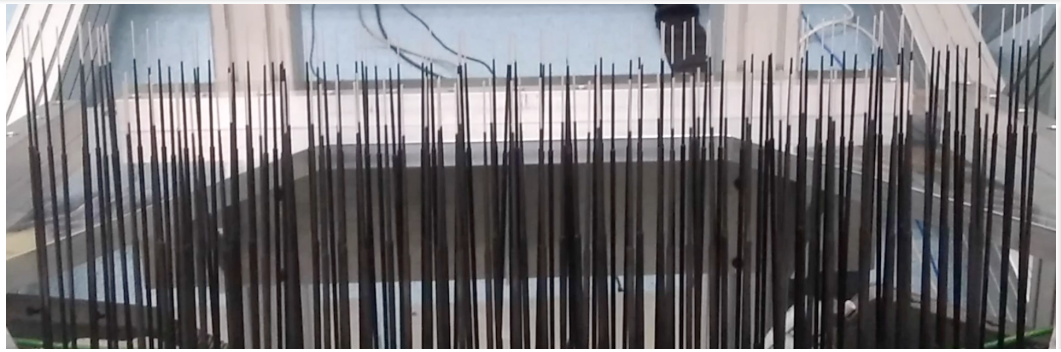
Low Resolution Spectrograph (LRS)

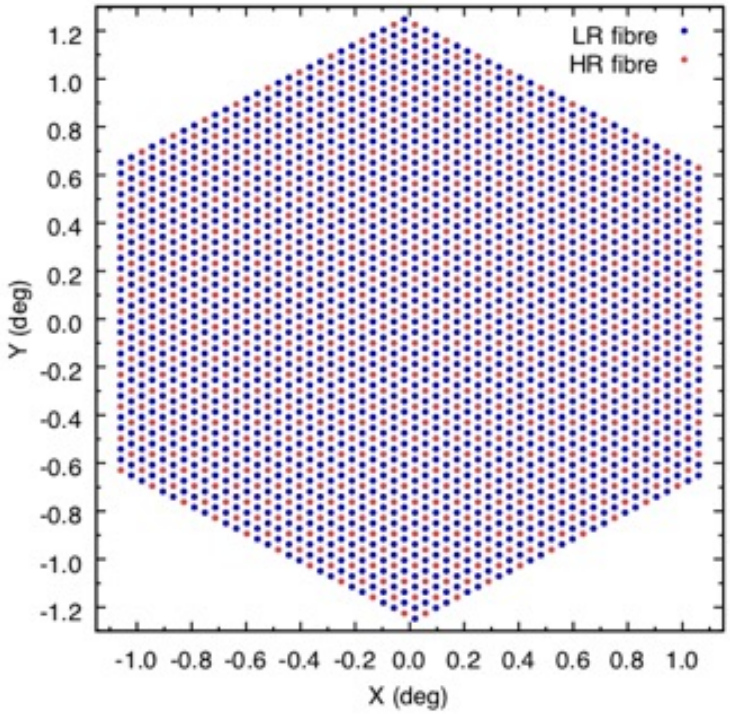


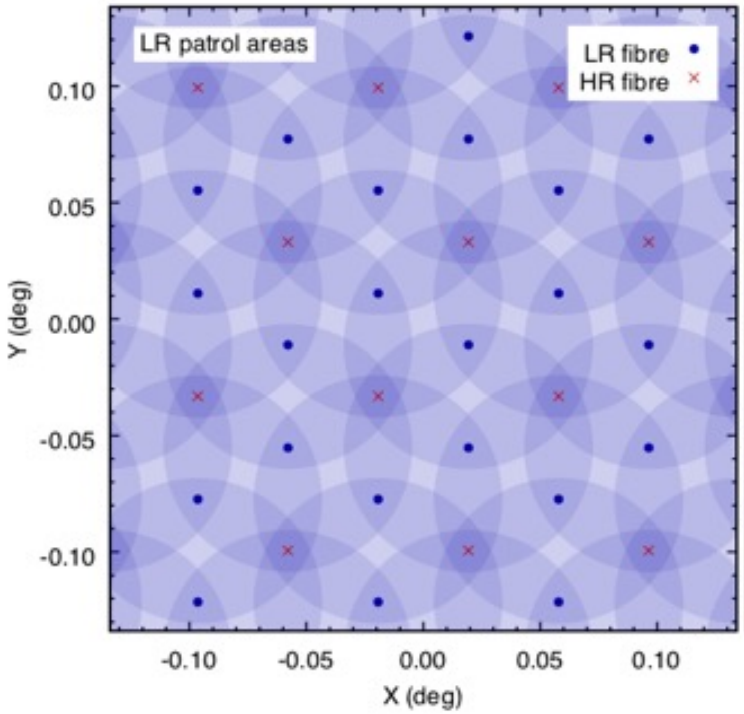


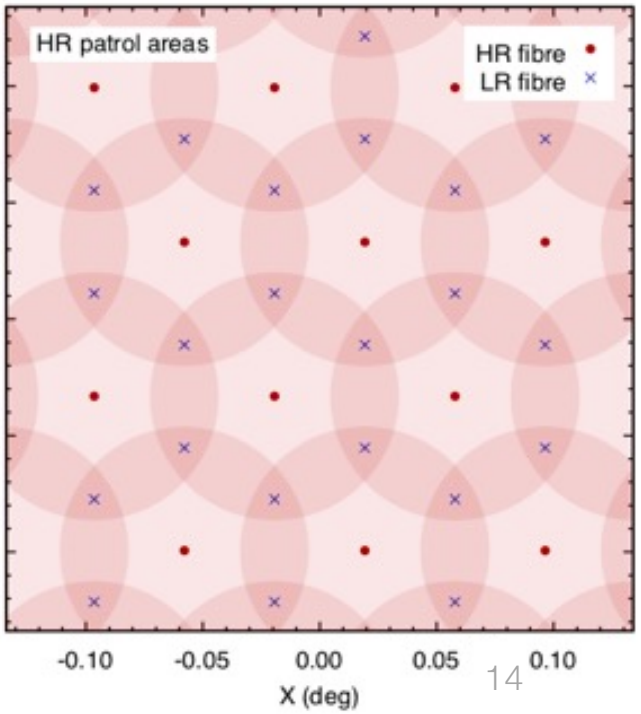
AESOP Fibre Positioner and Metrology System

2436 Fiber Probes
- patrol diameter
  = 3.23 arcmin
- RMS accuracy < 10µm / 0.17″
- minimum separation ~20″
- reconfiguration time <2 min



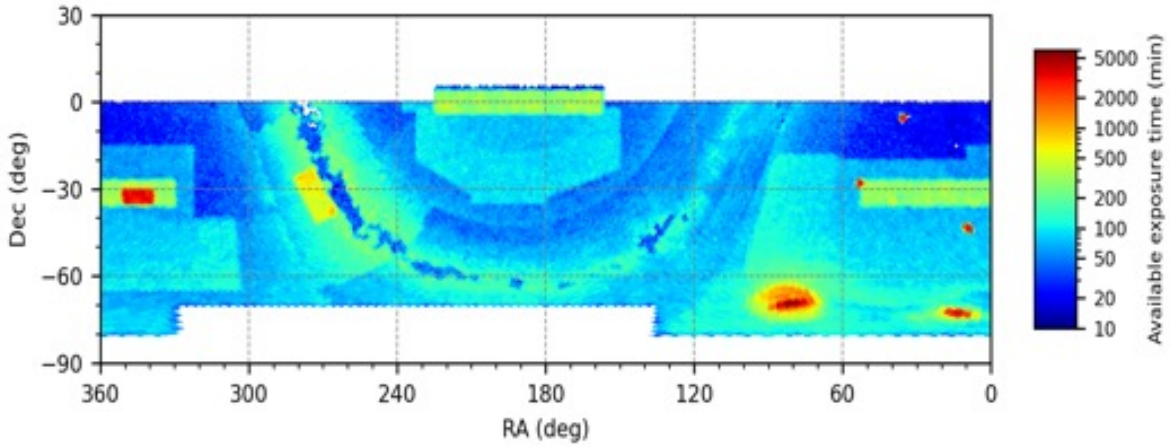






4MOST Operations

- Unique operations model for MOS instruments suitable *for most* science cases
- Surveys will be defined by ***Consortium*** and ***Community***
- All Surveys will run ***in parallel***
  - Surveys share fibres per exposure for increased efficiency
- ***Key Surveys*** set observing strategy
  - Millions of targets all sky
  - Fill all fibres
- ***Add-on Surveys*** for smaller surveys
  - Small fraction fibres all sky or
  - dedicated areas
  - 10^3 to 10^6 targets
- Several passes of sky with exposure
- Wedding-cake distribution for total time 1h to 10h



Policies: data and publication rights

- Data releases:
  - L0 (raw data): public immediately
  - L1 (extracted, calibrated spectra): yearly
  - L2 (derived products): negotiated by each Survey with ESO
- All data of all Surveys are accessible to all Science Team members
- Publications are limited to approved Projects. Consortium Projects may be rejected if overlapping with Community Survey Core Science and vice versa (SDSS-like policy). Also PhD Projects extra protected

4MOST who is who?

And 350+ others!

Roelof de Jong
Principal Investigator

Joar Brynnel
Project Manager

Jakob Walcher
Operations Manager

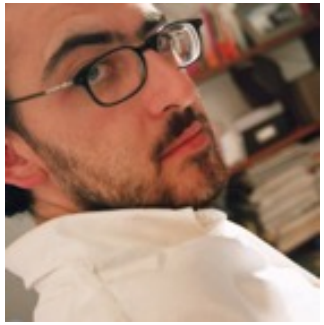
Genoveva Micheva
Instrument Scientist

Vincenzo Mainieri
Project Scientist ESO

Sofia Feltzing
Project Scientist
Galactic

Richard McMahon
Project Scientist
extragalactic

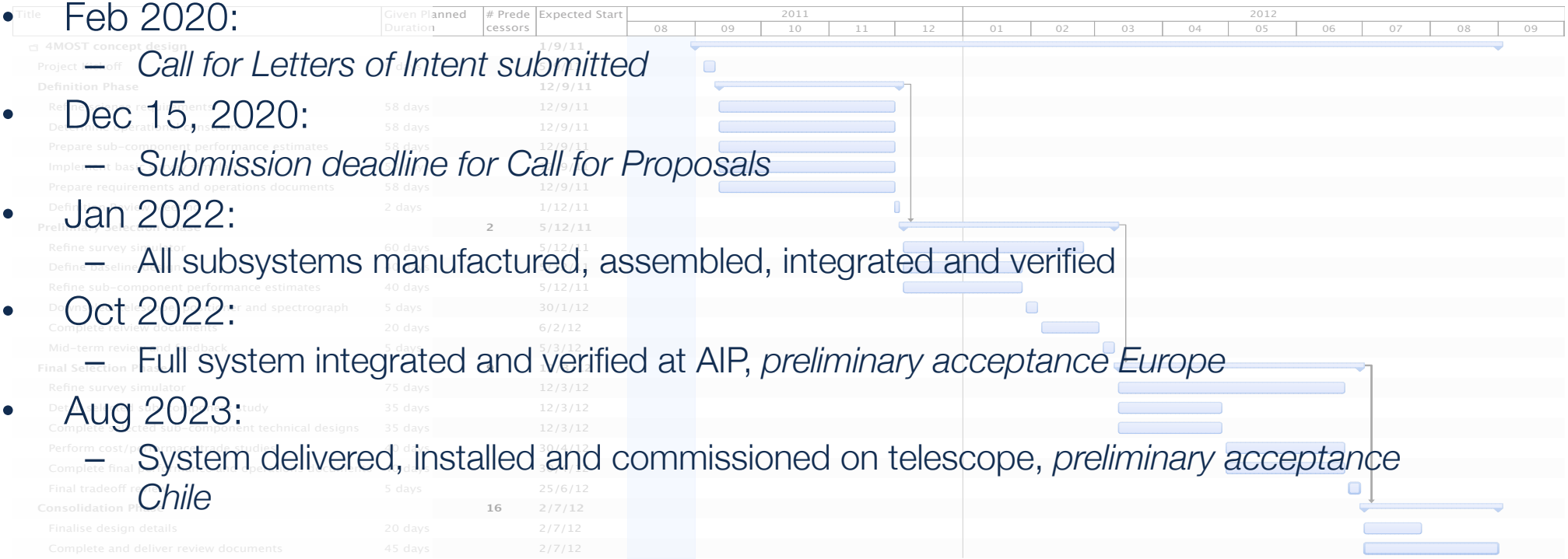
Joe Liske
Chair Science
Coordination Board



Andrea Merloni
Lead Operations
System

Nic Walton
Lead Data
Management

Schedule and Milestones



- Feb 2020:
  - *Call for Letters of Intent submitted*
- Dec 15, 2020:
  - *Submission deadline for Call for Proposals*
- Jan 2022:
  - All subsystems manufactured, assembled, integrated and verified
- Oct 2022:
  - Full system integrated and verified at AIP, *preliminary acceptance Europe*
- Aug 2023:
  - System delivered, installed and commissioned on telescope, *preliminary acceptance Chile*
- Sep 2023 – Aug 2028:
  - First science survey of 4MOST, 30% of targets available for Community Surveys


AIP
ASTRON
CRAL
WARWICK
UNIVERSITY OF HULL
UCL
UPPSALA UNIVERSITET
LUND
University of Portsmouth
Queen's University Belfast
MPE
THE UNIVERSITY OF WESTERN AUSTRALIA
UNIVERSITY OF CAMBRIDGE
Durham University
Lancaster University
University of Southampton
ESO
rijksuniversiteit groningen

Wide-field, high-multiplex optical spectroscopic survey facility for ESO

www.4MOST.eu

- Status:
  - FDR completed, in construction phase, *operations start Q3-2023* (≥2x 5 year)
  - Call for Proposals 15 Dec 2020!
- Science:
  - *Cosmology, galaxy evolution, high-energy and Galactic* science
  - Complement large area space missions: Gaia, eROSITA, Euclid, PLATO
  - Complement ground-based surveys: VISTA, VST, DES, LSST, SKA, etc.
- Survey facility:
  - Instrument, science operations, data products, science
  - Run all-sky 5 year *public* surveys in parallel with yearly data releases
  - Key surveys organized by consortium, add-on surveys from community through ESO
- Instrument specifications:
  - High multiplex: 1600 fibres @ R~6000 + 800 fibres @ R~20,000 in parallel
  - Wavelength: LR: 370-950 nm HR: 392-437 & 515-572 & 605-675 nm
  - Large field-of-view on VISTA, 4m-class telescope: ⌀=2.6°