



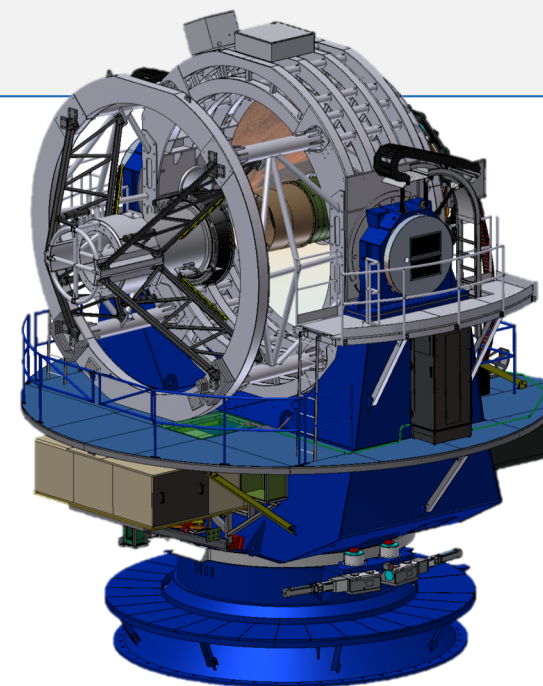
4MOST

Operations, Surveys and Policies

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VLT Programme Scientist



- Instrument
- Surveys
 - consortium surveys
 - open-time surveys
- Operations
 - differences to the current ESO model
 - handled by 4MOST consortium
 - implications for applications, observations and data reductions
- Procedures and policies



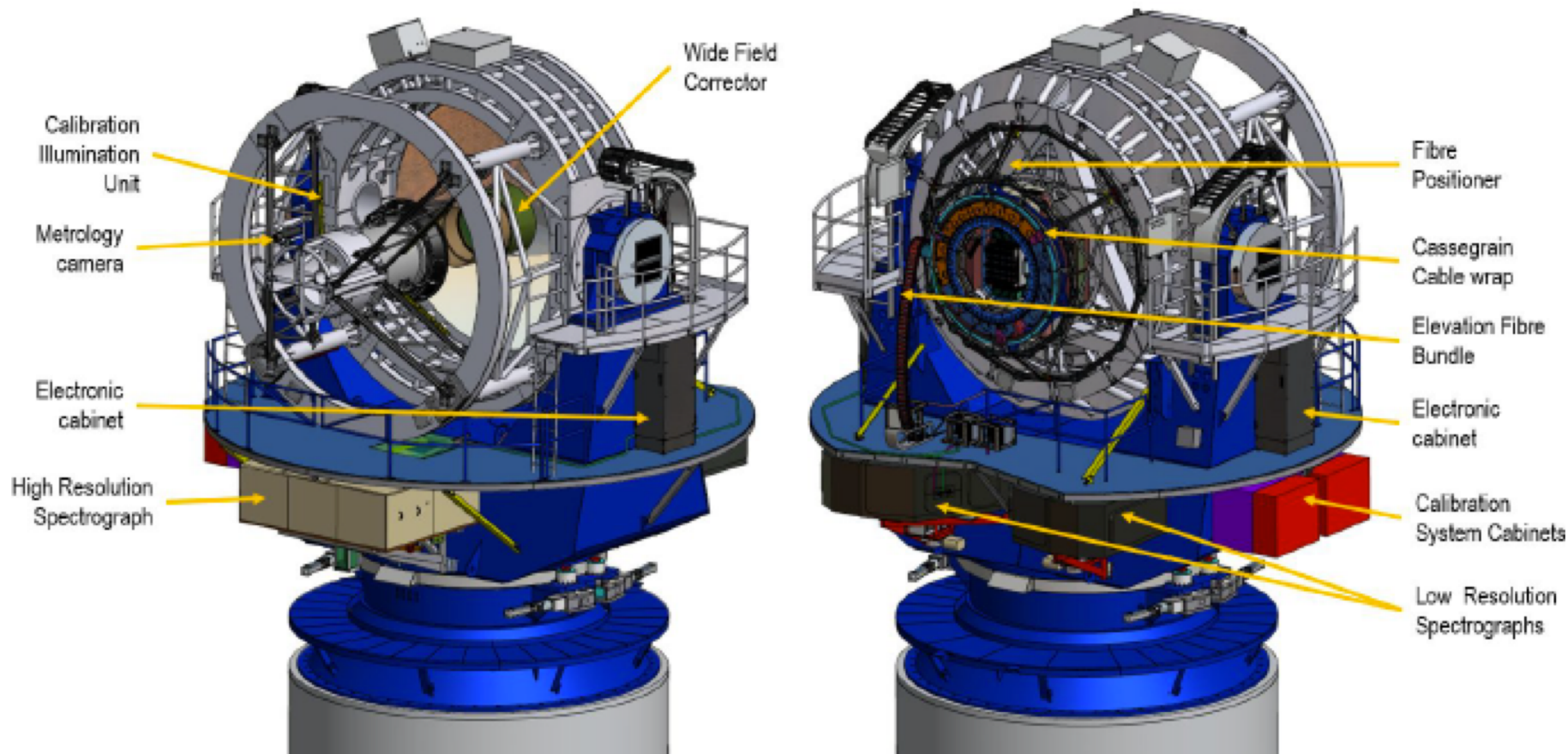
4MOST Overview

- Wide-field multi-object spectrograph for VISTA
 - field of view 4.2 deg^2
- Two simultaneous resolutions
 - medium ($R \sim 4500$ to 7000) with 1600 fibres
 - high ($R \sim 20000$) for 800 fibres
- [Messenger 175](#) (March 2019)
- ESO workshop
 - [Preparing for 4MOST. A community workshop introducing ESO's next-generation spectroscopic survey facility.](#)
 - 6-8 May 2019, Garching
- Also: <http://www.4most.eu/>



4MOST Instrument

- Integrated system
 - VISTA and 3 spectrographs



4MOST Instrument

■ Significant changes to VISTA

- optics
- electronics

■ Fibre positioner

■ Spectrographs

- 2 low-resolution
 - 812 fibres each
- 1 high-resolution
 - 812 fibres

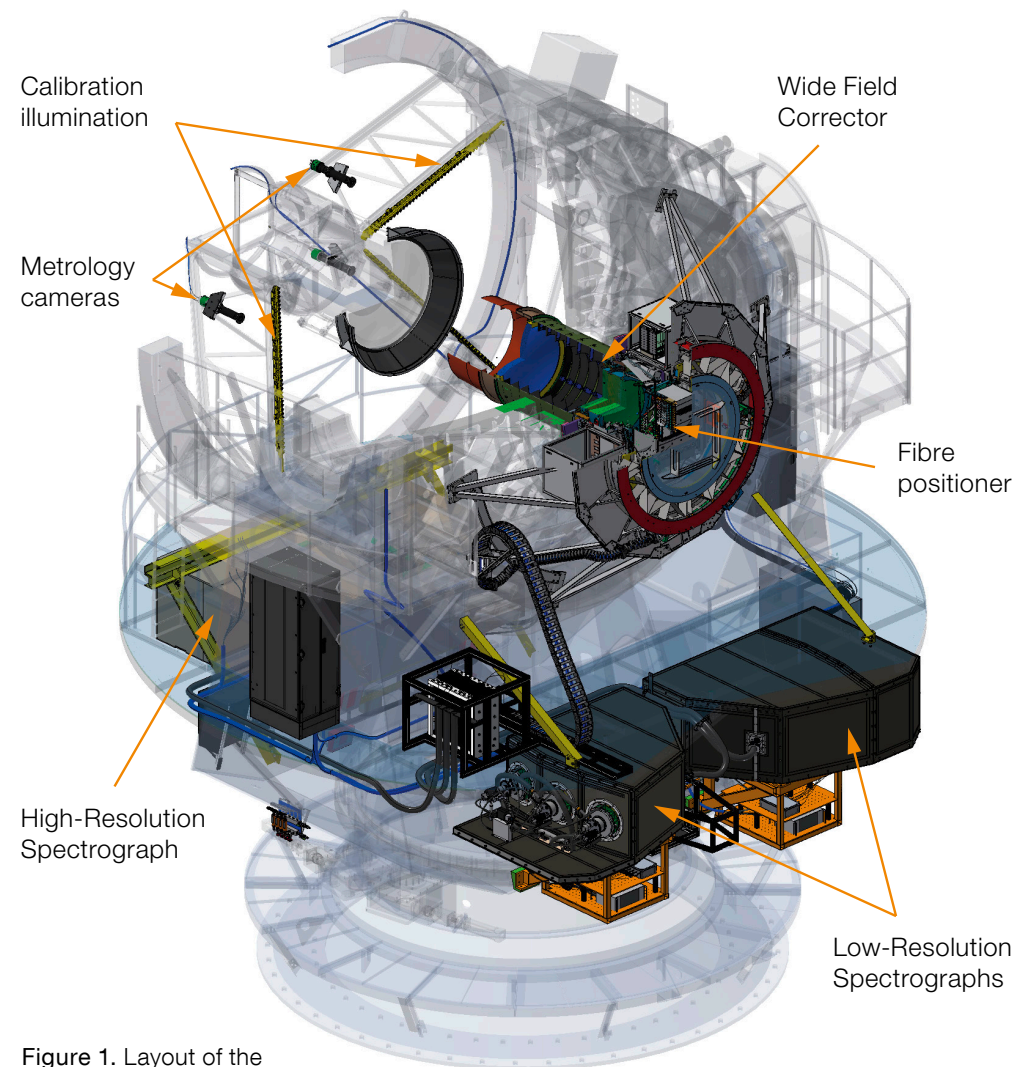


Figure 1. Layout of the different subsystems of 4MOST on the VISTA telescope.

de Jong et al. 2019



4MOST Instrument

■ Specifications

de Jong et al. 2019

Table 1. 4MOST key instrument specifications.

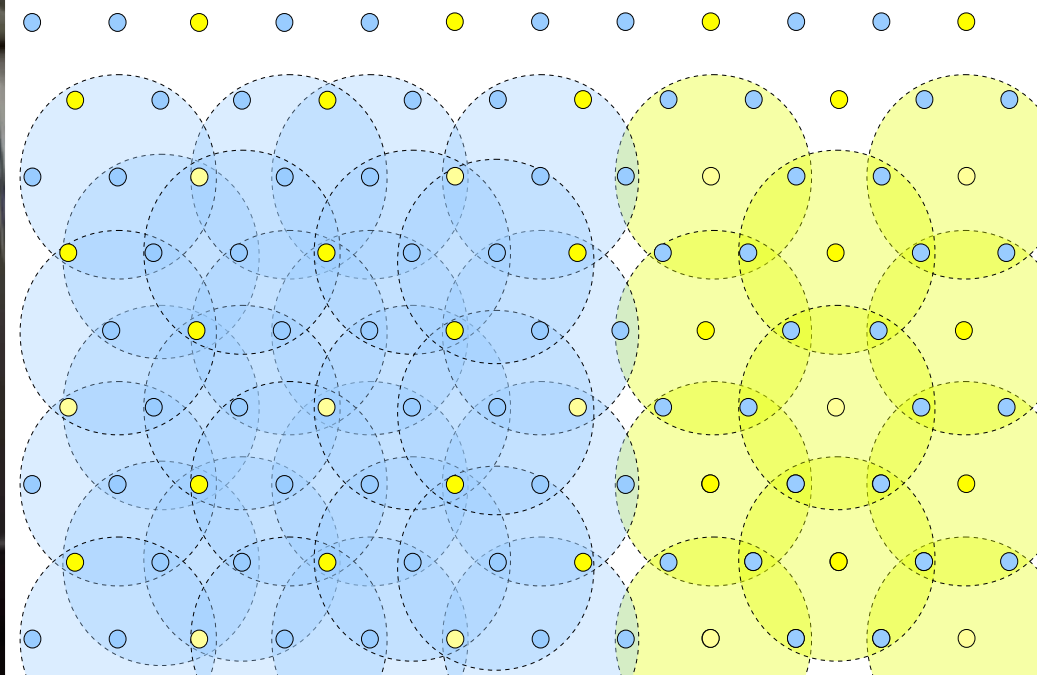
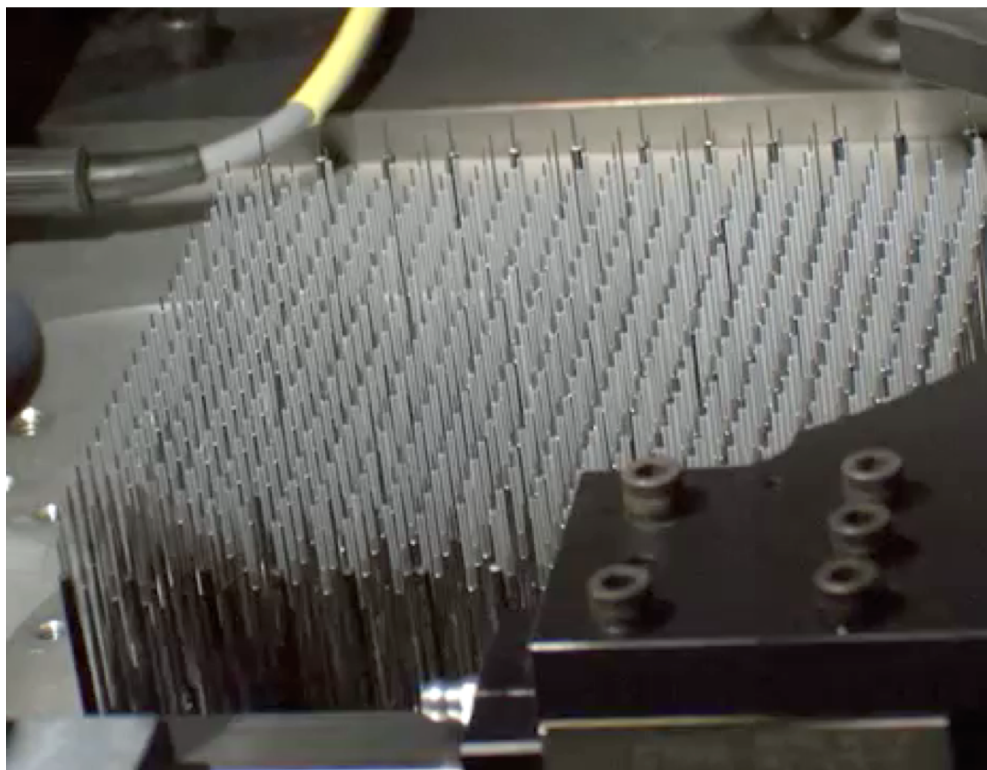
Instrument parameter	Design value
Field of View (hexagon)	~ 4.2 square degrees ($\emptyset = 2.6$ degrees)
Accessible sky (zenith angle $< 55^\circ$)	$> 30\,000$ square degrees
Expected on-target fibre-hours per year	LRS: $> 3\,200\,000$ h yr $^{-1}$, HRS $> 1\,600\,000$ h yr $^{-1}$
Multiplex fibre positioner	2436
Low-Resolution Spectrographs LRS ($\times 2$)	
Resolution	$\langle R \rangle = 6500$
Number of fibres	812 fibres
Passband	3700–9500 Å
Velocity accuracy	< 1 km s $^{-1}$
Mean sensitivity 6 \times 20 min, mean seeing, new moon, S/N = 10 Å $^{-1}$ (AB-magnitude)	4000 Å: 20.2, 5000 Å: 20.4, 6000 Å: 20.4, 7000 Å: 20.2, 8000 Å: 20.2, 9000 Å: 19.8
High-Resolution Spectrograph HRS ($\times 1$)	
Resolution	$\langle R \rangle = 20\,000$
Number of fibres	812 fibres
Passband	3926–4355, 5160–5730, 6100–6790 Å
Velocity accuracy	< 1 km s $^{-1}$
Mean sensitivity 6 \times 20 min, mean seeing, 80% moon, S/N = 100 Å $^{-1}$ (AB-magnitude)	4200 Å: 15.7, 5400 Å: 15.8, 6500 Å: 15.8
Smallest target separation	15 arcseconds on any side
# of fibres in random $\emptyset = 2$ arcminute circle	≥ 3
Fibre diameter	$\emptyset = 1.45$ arcseconds

4MOST Instrument

■ Fibre positioner

➤ 2436 fibres

- patrol diameter 2.4x pitch
- minimum separation $\sim 20''$
- reconfiguration time < 2 min during CCD readout





4MOST Instrument

- 2 low-resolution spectrograph and 1 high-resolution spectrograph, each with:
 - 3 arms spectrograph, 3 CCDs 6k x 6k
 - 812 science fibers per spectrograph
 - Thermally stabilized

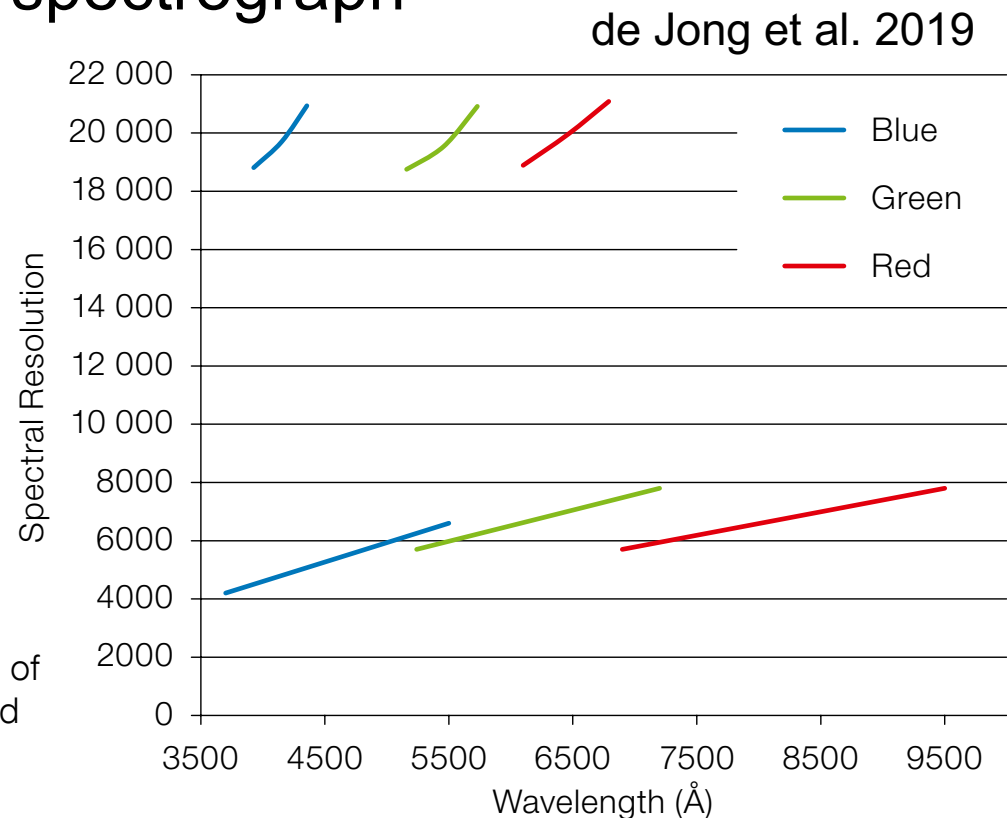


Figure 2. Spectral resolution in the three channels of the 4MOST High-Resolution (HRS, upper lines) and Low-Resolution Spectrographs (LRS; lower lines).



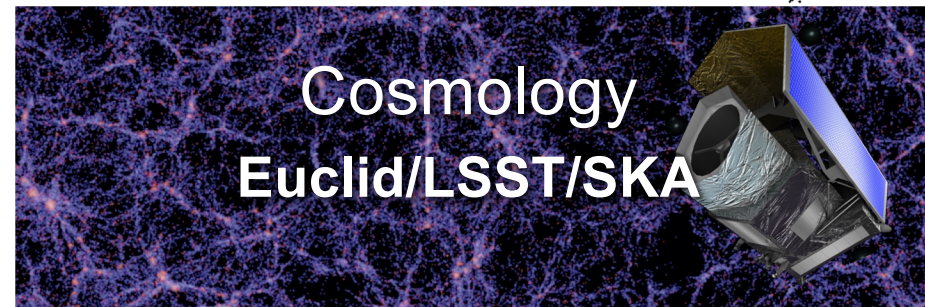
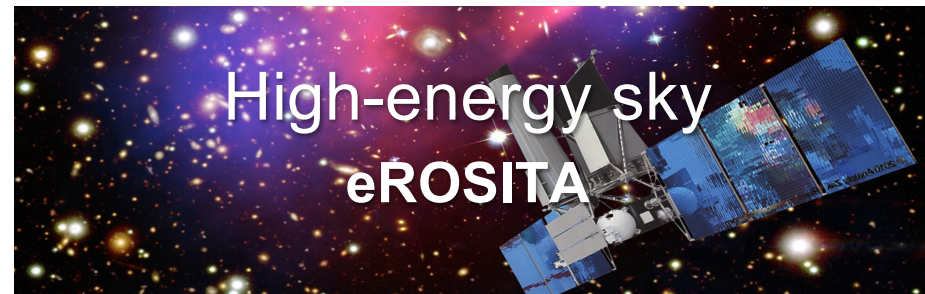
4MOST Surveys

- 4MOST will be a survey facility
- 4MOST will run GTO (“consortium”; 70% of fibre hours) and open-time (“community”; 30%) surveys
- **Only one call for open-time surveys**
 - duration 5 years
- Both consortium and community surveys will be public surveys → raw data public immediately
- High multiplexing requires that 4MOST surveys are executed in parallel observing mode: different surveys share the 4MOST focal plane
- Due to survey nature no ToO possible



4MOST Consortium Surveys

■ Science themes





4MOST Consortium Surveys

■ Description in Messenger 175

➤ <https://www.eso.org/sci/publications/messenger/toc.html?v=175&m=Mar&y=19>

■ Presented at 4MOST workshop in May

Table 2. 4MOST Consortium Surveys and their Principal Investigators.

de Jong et al. 2019

No	Survey Name	Survey (Co-)PI
S1	Milky Way Halo LR Survey	Irwin (IoA), Helmi (RuG)
S2	Milky Way Halo HR Survey	Christlieb (ZAH)
S3	Milky Way Disc and Bulge LR Survey (4MIDABLE LR)	Chiappini, Minchev, Starkenburg (AIP)
S4	Milky Way Disc and Bulge HR Survey (4MIDABLE HR)	Bensby (Lund), Bergemann (MPIA)
S5	Galaxy Clusters Survey	Finoguenov (MPE)
S6	AGN Survey	Merloni (MPE)
S7	Galaxy Evolution Survey (WAVES)	Driver (UWA), Liske (UHH)
S8	Cosmology Redshift Survey	Richard (CRAL), Kneib (EPFL)
S9	Magellanic Clouds Survey (1001MC)	Cioni (AIP)
S10	Time-Domain Extragalactic Survey (TiDES)	Sullivan (Southampton)



4MOST Consortium Surveys

Consortium Survey	Brightness range (magnitudes)	Targets (millions)
S1 Milky Way Halo LR	$15.0 \leq G \leq 20.0$	1.5
S2 Milky Way Halo HR	$12.0 \leq G \leq 17.0$	1.5
S3 Milky Way Disc and Bulge LR (4MIDABLE-LR)	$4.0 \leq G \leq 19.0$	10.0
S4 Milky Way Disc and Bulge HR (4MIDABLE-HR)	$10.0 \leq G \leq 15.5$	2.5
S5 Galaxy Clusters	$18.0 \leq r \leq 22.0$	1.7
S6 AGN	$18.0 \leq r \leq 22.8$	1.0
S7 Galaxy Evolution (WAVES)	$18.0 \leq r \leq 22.5$	1.6
S8 Cosmology Redshift Survey	$20.0 \leq r \leq 23.9$	8.0
S9 Magellanic Clouds (1001MC)	$10.5 \leq G \leq 19.5$	0.5
S10 Transients (TiDES)	$18.0 \leq r \leq 22.5$	0.3
Total		> 28

Guiglion et al. 2019

4MOST Surveys

■ Open-time surveys (“community surveys”)

- selected through the ESO Public Survey process
 - Call for Letters of Intent
 - Evaluation by the ESO Public Survey Panel
 - assessing conflicts with consortium surveys
 - Invitation to selected projects to submit a proposal
 - Evaluation by PSP with recommendation to OPC and ESO DG
 - Recommendation by OPC to ESO DG
 - Negotiations of Survey Management Plan with ESO

■ Distinction between two survey types

- “participating” surveys
 - share the focal plane (and operations) with consortium surveys
- ”non-participating” surveys
 - ‘stand-alone’ surveys → operational impact

4MOST Surveys

■ Participating surveys

- will be executed together with the consortium surveys
 - common observation preparation
 - common selection function computation
 - multiple surveys in same observation, i.e. sharing of focal plane
 - sharing of 1-dimensional spectra (reduction level 1)
 - accounting in fibre hours

■ Non-participating surveys

- will **not** be executed together with the participating surveys
 - no sharing of the focal plane, i.e. observation restricted to particular survey
 - software and support for OB preparation by 4MOST consortium
 - raw data will be reduced by the 4MOST Consortium and 1D calibrated spectra delivered to the PIs



4MOST Surveys

■ Participating surveys

- fully integrated approach
- fibres mixed together for the observations
- uniform data reductions of all observations
- reduced data distributed to the individual surveys
- reduced data delivered to ESO according to single survey management plan

■ Non-participating surveys

- independent of the participating surveys
- receive individual observing nights
 - each exposure counts as 2436 fibres, whether allocated or not
- higher-level data products according to survey management plan agreed with ESO



4MOST Surveys

More information at www.4most.eu/cms/science/community

4MOST – 4-metre Multi-Object Spectroscopic Telescope

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Applying for time on 4MOST: Community Surveys

During the initial 5-year period of 4MOST operations, 30% of the total available observing time will be available to the ESO community. The following provides information for members of the community interested in applying for this time.

4MOST was designed as a *survey* facility, and for a period of at least 5 years, 4MOST will be entirely dedicated to executing a comprehensive survey programme, to the exclusion of all other types of observing programmes. Furthermore, all 4MOST surveys will be [ESO Public Surveys](#) (meaning that their science case and scope need to be comprehensive enough to be of significant legacy value to the astronomical community at large). Therefore, it will not be possible to apply for time on 4MOST in response to the usual biannual Call for Proposals issued by ESO. Instead, ESO will issue a single Call for Proposals for Public Surveys with 4MOST that will cover the entire initial 5-year period of 4MOST operations.

Application and Selection Process

The [Science Policy Interface Control Document](#) is the document that governs the process by which the final, complete 4MOST Survey Programme will be defined. In particular, it governs the application and selection procedure for Community Surveys, a process which will be managed by ESO.

In brief, this process was set in motion with the 4MOST Consortium publishing a set of 13 articles in the [March 2019 issue of the ESO Messenger](#), providing extensive information on the 4MOST project, the facility, the operations scheme, the survey strategy and the Consortium Surveys. The Consortium and ESO will then further engage with the community by jointly organising a workshop, entitled [Preparing for 4MOST: A community workshop introducing ESO's next-generation spectroscopic survey facility](#), to be held in Garching on 6 – 8 May 2019. This workshop will again provide interested members of the community with information about 4MOST, as well as with an opportunity to ask questions and discuss ideas and tentative plans for surveys. Members of the community considering applying for 4MOST time are strongly encouraged to attend this workshop.

Workflow resulting in the final definition of the 4MOST Survey Programme.

Search

Register Account

In order to register please go to the [registration page](#). At this point, only consortium members are eligible for an account.

Important Dates

6-8 May 2019: 4MOST Science Community Workshop at ESO
 9-10 May 2019: Science Team Meeting in Garching

News

WFC lenses inspected 2019-03-20
 New appointments in the 4MOST organisation 2019-03-12
 Final Design Review – Part 2 2019-03-10





4MOST Operations

- Survey solicitation and selection done by ESO through Public Survey process (Phase 1)
- Operations handled by
 - 4MOST consortium (Phase 2 and data reductions)
 - ESO (observations)
- Data distributed through the ESO Science Archive Facility (Phase 3)



4MOST Survey Selection

- 10 consortium surveys presented to community
 - Messenger 175, March 2019
 - 4MOST workshop, May 2019
- Call for Letters of Intent
 - 2nd half 2019
 - tools (ETC) provided by ESO and 4MOST consortium
 - present science project, required observations and team
 - time unit will be fibre hours
 - number of fibres times exposure time
- Public Survey Panel (PSP)
 - evaluates the science cases of the projects
 - may recommend merging of surveys
 - recommends survey projects for proposals



4MOST Survey Selection (2)

- Proposal solicitation to selected projects
- Proposal selection
 - recommendations by PSP
 - will assess how the surveys will match overall observing efficiency
 - recommendations by OPC
 - approval by ESO DG
- Selection is independent of whether a survey is participating or non-participating
- Participating surveys are merged with the consortium surveys into a single survey
 - they are handled identically for all following steps

4MOST Operations

■ Participating surveys

- target catalogues merged (consortium and participating surveys)
- single joint survey plan
- 4MOST operations group prepares OBs
- single Science Team
- PIs form the Science Coordination Board
- shared effort on
 - survey strategy
 - selection functions
 - quality assurance
 - higher-level pipelines
- high-level data delivered to ESO archive



4MOST Operations

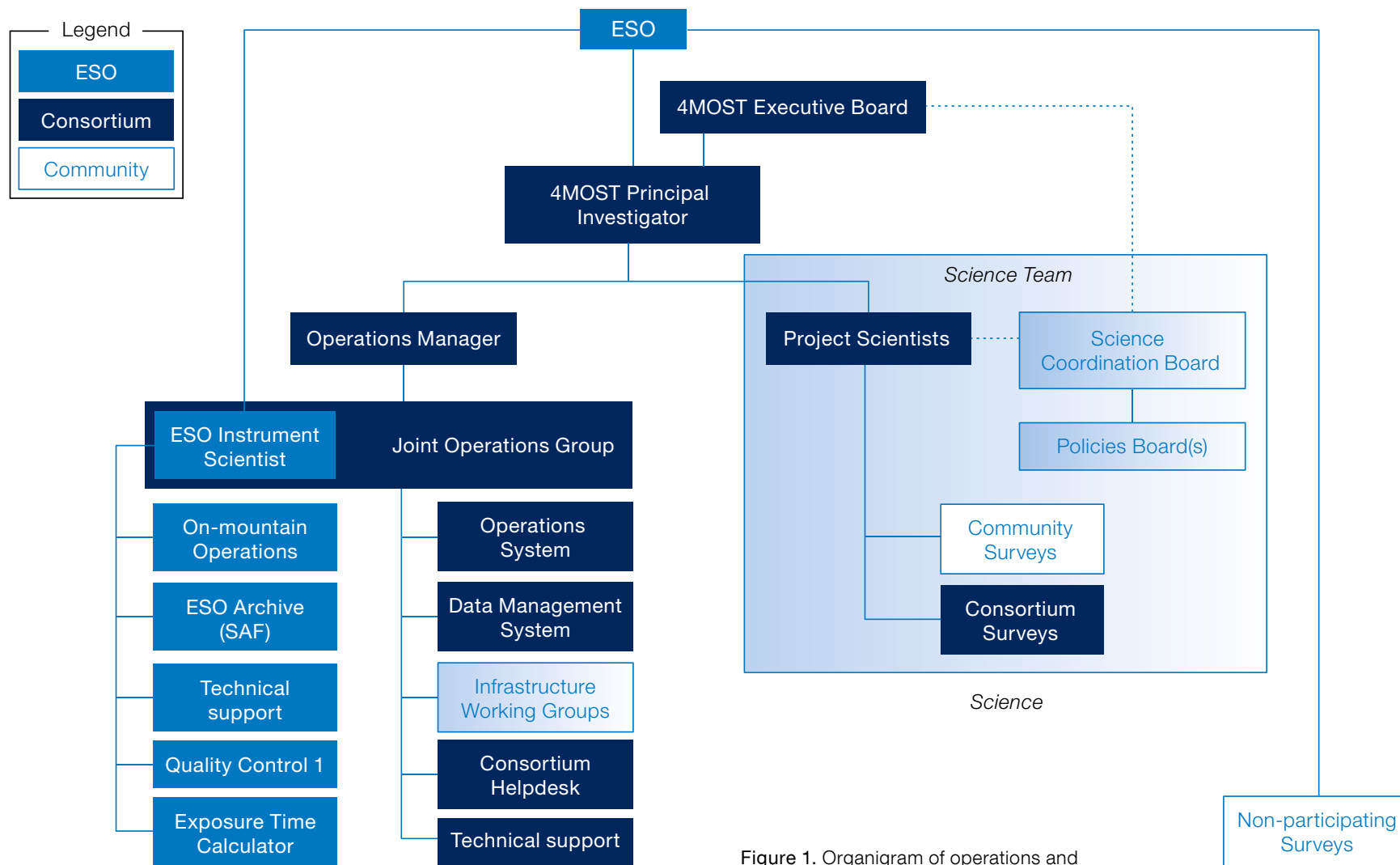


Figure 1. Organigram of operations and science-related work packages during the operations phase of 4MOST.

Walcher et al. 2019

Operations

4MOST - Santiago, 4 April 2019

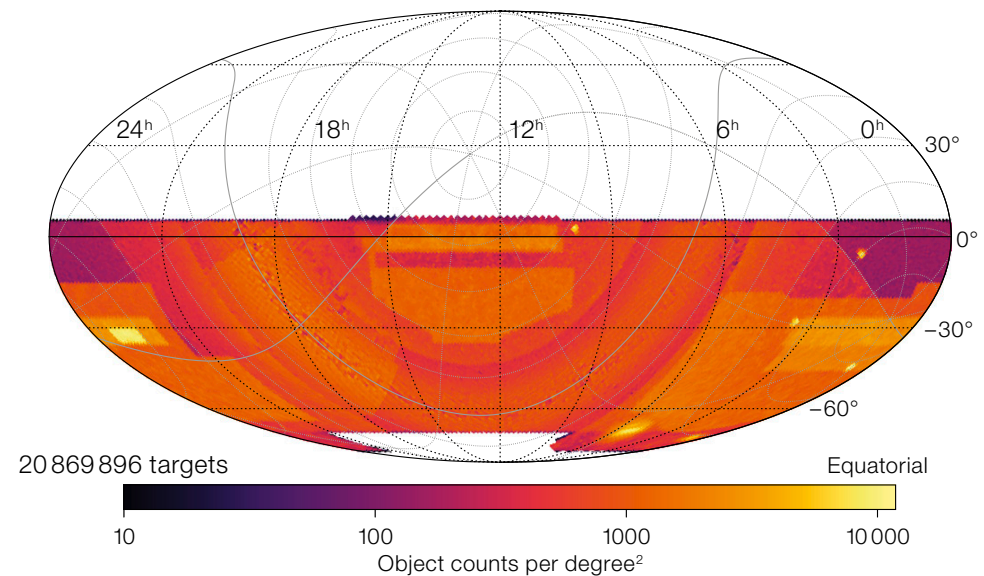
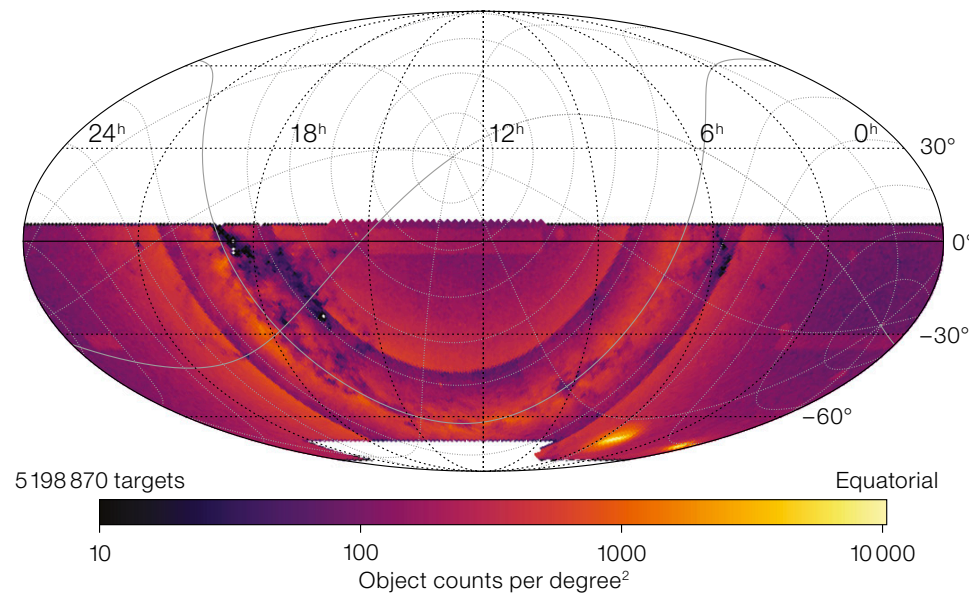


4MOST Operations

■ Extensive survey strategy planning

- survey area $-70^\circ < \delta < -5^\circ$
- currently based on the 10 consortium surveys
- will be extended to include the participating surveys, when they are selected

Guiglion et al. 2019





4MOST Operations

■ Three data levels

➤ Level 0

- raw data

➤ Level 1

- 1-dimensional, calibrated, science-ready spectra

➤ Level 2

- products from data analysis
 - examples include
 - » elemental abundances
 - » redshifts
 - » emission line fluxes
 - » stacked spectra



4MOST Operations

■ More details at

www.4most.eu/cms/operations/operations-model/

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Operations Model

4MOST is conceived as a survey facility that comprises the instrument as well as associated operations and data management services. The VISTA telescope will spend 100% of its observing time on Public Surveys with 4MOST for a minimum of 5 years. The largest fraction of the observing time on 4MOST will be allocated to a unique operations concept in which 5-year Public Surveys from both the 4MOST Consortium and the ESO community will be combined and executed in parallel, with multiple surveys sharing the available fibres in any given observation. These surveys are jointly called Participating Surveys.

However, it will also be possible to operate 4MOST efficiently in the more traditional single survey mode, provided a sufficiently high target density is available, and this mode will also be available to Community Surveys. Community Surveys using 4MOST in single survey mode are called Non-Participating Surveys.

Note that *all* surveys executed by 4MOST (irrespective of whether they are Participating or Non-Participating, Consortium or Community Surveys) will be **ESO Public Surveys**. That means that all raw data will become public immediately (through ESO's [Science Archive Facility](#)), and that all surveys will have to deliver a set of data products back to ESO for publication (Phase 3), where both the contents of the data set and the schedule of the delivery will have been previously agreed upon by ESO and the surveys.

Participating Surveys

Participating Surveys will be executed in parallel, not sequentially. They will pool their targets such that in any given observation 4MOST will typically obtain spectra for many different science cases simultaneously. Parallel observing enables efficient use of 4MOST for surveys that have compatible observing conditions requirements and/or a target density lower than the 4MOST multiplexing capability. Note that in this mode, each Participating Survey will only be "charged" the observing time for the fibres actually used by that survey (including fractional overheads and any residual inefficiencies). This mode does imply, however, that all Participating Surveys will have to agree on a common survey strategy and prepare Observation Blocks (OBs) jointly. As a consequence, all Participating Surveys will have to fully share the raw data as well as the calibrated spectra in order to be able to assess selection functions and mitigate the impact of any cross-talk effect on their science.

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[New appointments in the 4MOST organisation](#) 2019-03-12
[Final Design Review – Part 2](#)



4MOST Policies

■ Participating surveys

- Single science team for all surveys
- share survey strategy, OBs, level 1 data products, selection function analysis and optionally level 2 data products
- data open to all science team members, but core science protected per survey
- publications limited to approved projects



4MOST Messenger

<https://www.eso.org/sci/publications/messenger/toc.html?v=175&m=Mar&y=19>

Messenger No. 175 (March 2019)

[« Back to The Messenger home](#)

4MOST

R.S. de Jong et al.

4MOST: Project overview and information for the First Call for Proposals

[More Info](#)

C.J. Walcher et al.

4MOST Scientific Operations

[More Info](#)

G. Guiglion et al.

4MOST Survey Strategy Plan

[More Info](#)

Surveys

A. Helmi et al.

4MOST Consortium Survey 1: The Milky Way Halo Low-Resolution Survey

[More Info](#)

N. Christlieb et al.

4MOST Consortium Survey 2: The Milky Way Halo High-Resolution Survey

[More Info](#)

C. Chiappini et al.

4MOST Consortium Survey 3: Milky Way Disc and Bulge Low-Resolution Survey (4MIDABLE-LR)

[More Info](#)

T. Bensby et al.

4MOST Consortium Survey 4: Milky Way Disc and Bulge High-Resolution Survey (4MIDABLE-HR)

[More Info](#)

A. Finoguenov et al.

4MOST Consortium Survey 5: eROSITA Galaxy Cluster Redshift Survey

[More Info](#)

A. Merloni et al.

4MOST Consortium Survey 6: Active Galactic Nuclei

[More Info](#)

S.P. Driver et al.

4MOST Consortium Survey 7: Wide-Area VISTA Extragalactic Survey (WAVES)

[More Info](#)

J. Richard et al.

4MOST Consortium Survey 8: Cosmology Redshift Survey (CRS)

[More Info](#)

M.R.L. Cioni et al.

4MOST Consortium Survey 9: One Thousand and One Magellanic Fields (1001MC)

[More Info](#)

E. Swann et al.

4MOST Consortium Survey 10: The Time-Domain Extragalactic Survey (TiDES)

[More Info](#)

4MOST - Santiago, 4 April 2019





4MOST Website

https://www.4most.eu/cms/



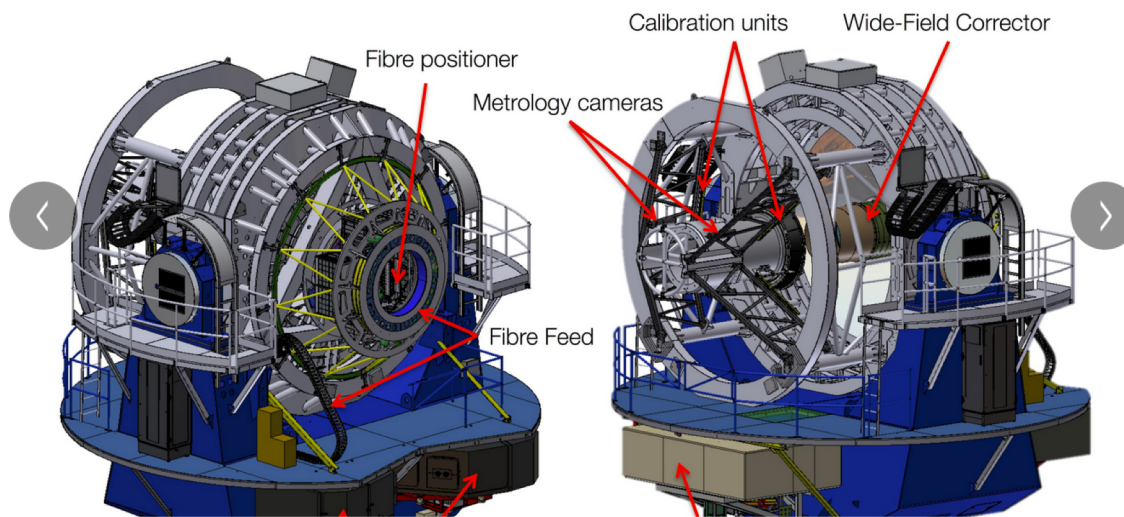
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Overview



The 4MOST consortium has been selected by the [European Southern Observatory \(ESO\)](#) to provide the ESO community with a fibre-fed spectroscopic survey facility on the [VISTA telescope](#) with a large enough field-of-view to survey a large fraction of the southern sky in a few years. The facility will be able to simultaneously obtain spectra of ~2400 objects distributed over an hexagonal field-of-view of 4 square degrees. This high multiplex of 4MOST, combined with its high spectral resolution, will enable detection of chemical and kinematic substructure in the stellar halo, bulge and thin and thick discs of the Milky Way, thus help unravel the origin of our home galaxy. The instrument will also have enough wavelength coverage to secure velocities of extra-galactic objects over a large range in redshift, thus enabling measurements of the evolution of galaxies and the structure of the cosmos.

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