Plan

Survey Management Plan: Organisation

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0.01	2023-08-23	All	New document
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1.01	2024-06-25	Minor edits throughout, update WP leads, DRP updates	Addressing review panel RIXes, change of WP leads
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2.01	2024-10-14	Minor edits, DR0 shift by 1 month	Address ESO/PSP RIXes
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Table of contents

List of Figures

List of Tables

1 Scope

This document describes the top-level organizational elements of the Survey Management Plan for the Surveys conducted during the first five years of operations of 4MOST. It provides the main organizational structure and associated conflict resolution paths, the work and data-flow concepts, the top-level Work Breakdown Structure, the top-level science schedule, and the resourcing devoted to overall management. This document is complemented by the accompanying Survey Management Plan documents on the Front-end and Back-end Operations and on the Individual Surveys.

2 Applicable Documents (AD)

The following applicable documents (AD) of the exact issue shown form a part of this document to the extent described herein. In the event of conflict between the documents referenced herein and the contents of this document, the contents of this document are the superseding requirement.

AD ID	Document Title	Document Number	Issue	Date
[AD1]	4MOST Survey Management Plan – Front-end Operations	VIS-PLA-4MOST-47110-9220-0002	3.00	2024-10-08
[AD2]	4MOST Survey Management Plan - Back-end Operations	VIS-PLA-4MOST-47110-9220-0003	3.00	2024-10-15
[AD3]	4MOST Survey Management Plan - Individual Surveys	VIS-PLA-4MOST-47110-9220-0004	3.00	2024-10-17
[AD4]	Survey Simulation Prediction website		ExID=156, RunID=513, 516	2024-10-08
[AD5]				

3 Reference Documents (RD)

The following reference documents (RD) contain useful information relevant to the subject of the present document.

RD ID	Document Title	Document Number	Issue	Date
[RD1]	Science Policy ICD	ESO-287481	1.00	2018-11-12
[RD2]	ESO Science Data Product Standard	ESO-044286	8	2022-03-15
[RD3]	Science Team Policies	VIS-POL-4MOST-47110-9213-0001	7.00	2024-10-13
[RD4]	Operations Plan	VIS-PLA-4MOST-47110-9720-0001	5.00	2019-09-24
[RD5]	4MOST Science Management Plan	VIS-PLA-4MOST-47110-9210-0001	3.00	2024-07-03

RD ID	Document Title	Document Number	Issue	Date
[RD6]	Data Release Plan	VIS-PLA-4MOST-47110-9210-0003	3.00	2024-10-17
[RD7]	4MOST Operation and Science Schedule Plan	VIS-PLA-4MOST-47110-9320-0008	5.00	2021-10-19
[RD8]	IWG7 - Galactic Pipeline (4GP) Requirements Specification	VIS-SPE-4MOST-47110-9237-0001	2.00	2023-11-20
[RD9]	IWG8 - Extragalactic Pipeline (4XP) Requirements Specification	VIS-SPE-4MOST-47110-9238-0001	3.00	2024-07-11
[RD10]	IWG4 - Selection Functions (4SP) Requirements Specification	VIS-SPE-4MOST-47110-9234-0002	1.00	2022-10-11
[RD11]	IWG9 - Object Classification Pipeline (4CP) Requirements Specification	VIS-SPE-4MOST-47110-9239-0001	2.00	2023-11-20
[RD12]	4MOST Project Work Breakdown Structure (WBS)	VIS-PLA-4MOST-47110-9410-0001	26.00	2022-11-08
[RD13]	4MOST Acronym List	VIS-LIS-4MOST-47110-9350-0001	6.00	2020-07-08
[RD14]				
[RD15]				

4 Definitions

- **Data levels**:
  - Level 0: Raw data with associated meta-data
  - Level 1: Calibrated 1D spectra, catalogue of targeted objects
  - Level 2: Derived scientific parameters, e.g., elemental abundances, redshifts, selection functions, etc.

5 Pre-amble

An efficient use of 4MOST is maximal if the Consortium's surveys and all other approved Participating Community Surveys are executed in parallel observing mode (ESO-287481, [RD1]). Parallel observing mode means that targets from several surveys (Consortium and Participating Community Surveys) with clearly different target classes and science aims are targeted simultaneously by different fibres of the 4MOST instrument.

Consortium and Participating Community Surveys will join a common Science Team and this document is part of a series of documents that together provide a coherent and unique Survey Management Plan (SMP). The full set of documents are:

- *4MOST SMP: Organisation* [this document] containing the organisational structure of the project including conflict resolution pathways, the work-flow and data-flow concepts, the work breakdown structure, and the schedule including data releases.
- *4MOST SMP: Front-end Operations* [AD1] describing the survey strategy concept, the front-end operations plan including the feedback loop, special survey strategy considerations like deep fields and poor observing conditions program, and the calibration plan.
- *4MOST SMP: Back-end Operations* [AD2] describing the back-end process with an overview of the hardware required, the creation and quality control of L0, L1, L2 data, and the overall quality control and data delivery, archiving, and publishing process.
- *4MOST SMP: Individual Surveys* [AD3] describing in more detail the management aspects of the individual Surveys in the 4MOST Project, highlighting in particular those aspects where a Survey deviates from the general plan in terms of target scheduling, data analysis and data products, and/or data publication schedule.
- *4MOST SMP: Survey Simulation Prediction* [AD4] a restricted access web site showing the input catalogues and simulation predictions for both the overall survey as well as for the individual (sub-)Surveys.

In agreement with the Science Team Policies ([RD1], ESO-286592), the 4MOST PI will represent the full Science Team towards ESO and is responsible for the delivery of the 4MOST survey programme. The joint SMP documents should capture the full details of the delivery of one dimensional, calibrated, science-ready spectra extracted from the raw data, which are in common to all surveys (Level-1 data), as well the delivery of the additional science products that may differ from survey to survey, including further processed Level-1, aka stacked 1D spectra to different depth/sensitivities, and the Level-2 data, aka catalogues of physical measurements for the targeted objects/science aims.

Both Level-1 and Level-2 data will be ingested into the ESO Archive and shall adhere to the ESO Science Data Product Standard (ESO-044286, [RD2]).

The 4MOST Survey Management Plan will be made public via the ESO Public surveys web pages.

6 Organisational structure

The organisational structure of the 4MOST Project once it has moved in its operational phase is shown in Figure 1, showing lines of management and normal communication. The Project has two main branches in this phase. The first is the Operational Brach, led by the Operations Manager mostly covered by Work Package 7 (WP7) in the Work Breakdown Structure (WBS), but also including warrantee and repair aspects of the hardware (WP6) and instrument scientist aspects like instrument health monitoring and maintaining the Instrument Configuration Repository (WP7). Details are covered in the 4MOST Operations Plan [RD2].

The second main branch is the Science Branch, managed by two Project Scientists (one Galactic and one extra-galactic), dealing mainly with the science planning and exploitation of the survey. The Science Branch has its own coordination and policies oversight bodies as described below.

Further details on the organisational and management structure can be found in the 4MOST Science Management Plan [RD3].

The entire Project is overseen by the 4MOST PI, who also manages a number of WPs that provide services to the entire Project, grouped in WP1. The content of the associated WPs shown in Figure 1 are described in Section 8, as are the leadership selection and length of tenure of these WPs.

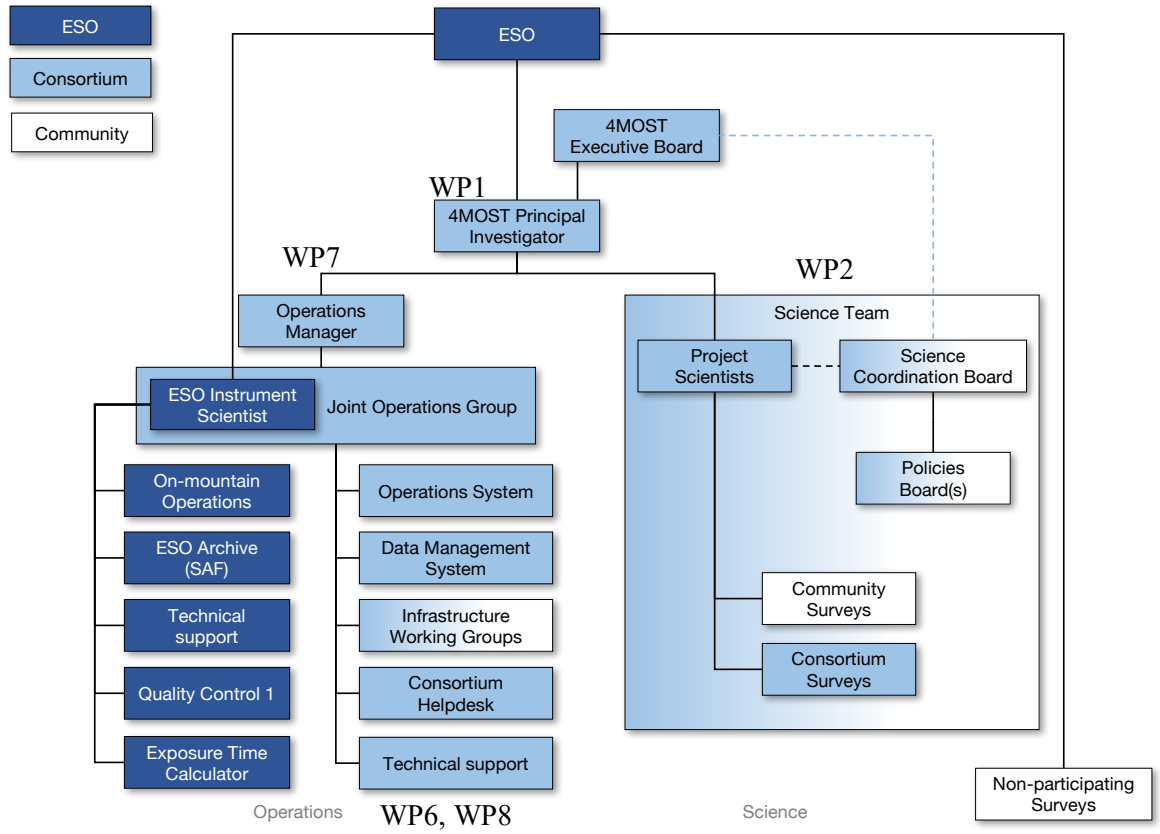

Figure 1: Top-level 4MOST Project organisational diagram during operations. The associated work packages (WPs) with further details of the Work Breakdown Structure (WBS) are described in Section 8. Dual coloured boxes indicate entities that have representatives from the Consortium Surveys as well as the Community Surveys. Please note that during the first five years of operations there are no Non-Participating Surveys.

6.1 Science Governance

The policies that govern the scientific collaboration of the 4MOST Project recorded in the 4MOST Science Team Policies [RD1] and are applicable to all Consortium and Community Surveys and all Project members.

The Project has two Project Scientists (one Galactic and one extra-galactic) supported by two deputy Project Scientists. The Project Scientists are the day-to-day executive managers of the Science Team (which consists of all members of all Participating Surveys) and maintain the

science schedule, organise the work of the Science Team for document and product deliveries, oversee the science advisory structure guiding the development of science requirements, help organise the validation and testing of survey implementation and operations (i.e. the Operation Rehearsals), and are representatives of the Project towards the outside science community.

The Science Coordination Board (SCB) is the central body in charge of the planning of the 4MOST science programme and the science policies guiding the 4MOST Project members. It consists of the Consortium and Participating Community Survey PIs. The SCB defines, manages, implements and enforces the 4MOST Science Team Policies [RD1] with approval of ESO, who represents the science community at large. The SCB has delegated a subset of its activities to two sub-boards:

- Science Policies Board (SPB): responsible for the day-to-day management of Project memberships, science project registrations, and 4MOST publication registrations. The SPB has one representative from each Survey and conflicts get escalated to the SCB.
- Catalogue Coordination and Change Control Advisory Board (4CAB): a review board examining proposed changes by the Surveys to their input catalogue packages. The 4CAB reviews shall avoid unintended or unmanageable effects on other Surveys and shall ensure resource availability for the Operations team to manage the changes.

6.2 Project Culture

6.2.1 Code of Conduct

The 4MOST Project is a large collaborative enterprise realised by people from different backgrounds and cultures. Its ability to provide excellent service to the astronomical community is enhanced by establishing a truly collaborative, team-oriented, and inclusive project culture. Embracing differences and fostering an inclusive environment creates opportunities for participation and innovation and contributes to a productive, high-achieving workforce. Maintaining a strong and healthy collaboration requires open, respectful communication and a shared commitment to a set of values that include ethical conduct, civility, inclusiveness, and diversity. The 4MOST Project has therefore adopted this Code of Conduct, which is linked from all pages on the 4most.eu web site, and expects its members to adhere to the important principles described in their work environment.

6.2.2 Ombudspersons

The 4MOST Project being a large collaboration, conflicts cannot always be avoided. The 4MOST Consortium has therefore three Ombudspersons who are available to members of the 4MOST Project. The role of the Ombudspersons is to provide informal, confidential, nonjudgmental, impartial, and independent advice and arrange mediation for 4MOST members for the purposes of dispute resolution. There are three 4MOST Ombudspersons to provide a choice of whom to speak with, and to ensure that there is at least one Ombudsperson available at Collaboration meetings. The Ombudspersons are available to 4MOST members who are experiencing conflicts or disputes as part of their 4MOST activities. However, matters that are related to Good Scientific Practice – like overlap in science projects, authorship and work acknowledgement issues, and Survey membership problems – shall be dealt with by the SPB

and/or SCB in first instance and only by an Ombudsperson when considered a personal and not a scientific conflict.

The Ombudspersons will work together with the members who consult them to identify options for managing and resolving disputes and conflicts. This includes providing advice and support, referring individuals to appropriate resources, organizing informal mediation, and ensuring that the 4MOST Principal Investigator is made aware of any systemic issues in the collaboration. The 4MOST Executive Board (EXB) appoints the Ombudspersons for a term of 3 years, with the option of renewal. Due consideration will be given to the diversity of the candidates. The 4MOST Ombudspersons will be full members of 4MOST, with a strong understanding of the organizational structure of the collaboration. They will not hold any other leadership positions within the collaboration and will report only to the 4MOST PI.

A detailed description of the guidelines and roles of Ombudspersons can be found in this document.

The current Ombudspersons are Alastair Edge and Caroline Foster.

6.2.3 Project Culture Working Group

The 4MOST leadership has also created an independent group that advises the 4MOST management and oversight bodies on matters related to project culture and values, for instance related to diversity, equity and inclusion. The charge of this Project Culture Working Group (PCWG) is to assess project climate and demographics, to provide recommendations on policies or practices to increase inclusiveness and promote a positive work culture, and to assist management with implementing such actions. Any 4MOST Project member can apply to become member of the PCWG.

7 Work- and data-flow concepts

A short summary of the work and data-flow is provided here, such that the Work Breakdown Structure in the next Section is easier to comprehend. Far more details are provided in the associated 4MOST SMP: Front-end Operations [AD1] and 4MOST SMP: Back-end Operations [AD2] documents.

Figure 2 provides a top-level overview of the work-flow within the 4MOST Project. All Participating Surveys in the joint Science Team submit their target catalogues with (sub)Survey success criteria to the Front-end Operations System (OpSys) to create a joint database for the survey. The 4MOST Facility Simulator (4FS) is used to optimise the survey strategy parameters before the start of the operations phase. Once operations start, the OpSys selects during the night the next field to visit, assigns science and calibration targets to fibres according to an optimised weighting probability scheme, and then creates an Observing Block (OB) with telescope and instrument instructions to be executed for the next observation(s). Using the designated Visitor Mode (dVM), OpSys sends the OB to the ESO OB database, which is then used by the Telescope Operator (TO) to start the next observation as soon as the previous one is finished. After the exposure is finished and checked against technical failures by the TO using the QC0 process, the obtained data is sent by the end of the night to the ESO Science Archive Facility (SAF).

On the back-end, the Data Management System (DMS) fetches the raw data (L0), performs the data reduction and creates calibrated 1D spectra (L1) which are stored in the 4MOST Operational Depository (4OR). Spectral Success Criteria are evaluated by DMS and the results retrieved by OpSys to inform on the necessity of further observations of individual targets and to analyse the overall progress of the survey, reported through the Survey Progress Monitor system. The various science pipelines fetch the L1 spectra, determine physical parameters, and feed the resulting data products (L2) back to the 4OR. The data is transferred to the 4MOST Pre-Release Access Point (4PRAP) and to attach survey wide quality control flags. At set times, based on Data Release flags set by the Data Release Manager on data quality and ending proprietary period, the data is transferred to the 4MOST Public Archive (4PA) for project internal and to 4PA and ESO SAF for public data releases at pre-agreed dates. At very limited intervals during the five years duration of the survey, feedback from the science analysis of the Surveys may be used to adjust the survey strategy parameters to improve the science goals. As this complicates the calculation of the selection function, such modification shall be minimised as much as possible.

Derived from this work-flow, Figure 3 provides the overview of the data-flow structure in the Project. It highlights the central role of data repositories and processing nodes for the front-end at MPE, Garching, and for the back-end at CASU, IoA, Cambridge. The node interfaces with ESO are managed through separate front-end and back-end Interface Control Documents (ICDs). The Project internal interfaces at the back-end are managed through Data eXchange Unit (DXU) documents and connected to machine readable configuration verification files.

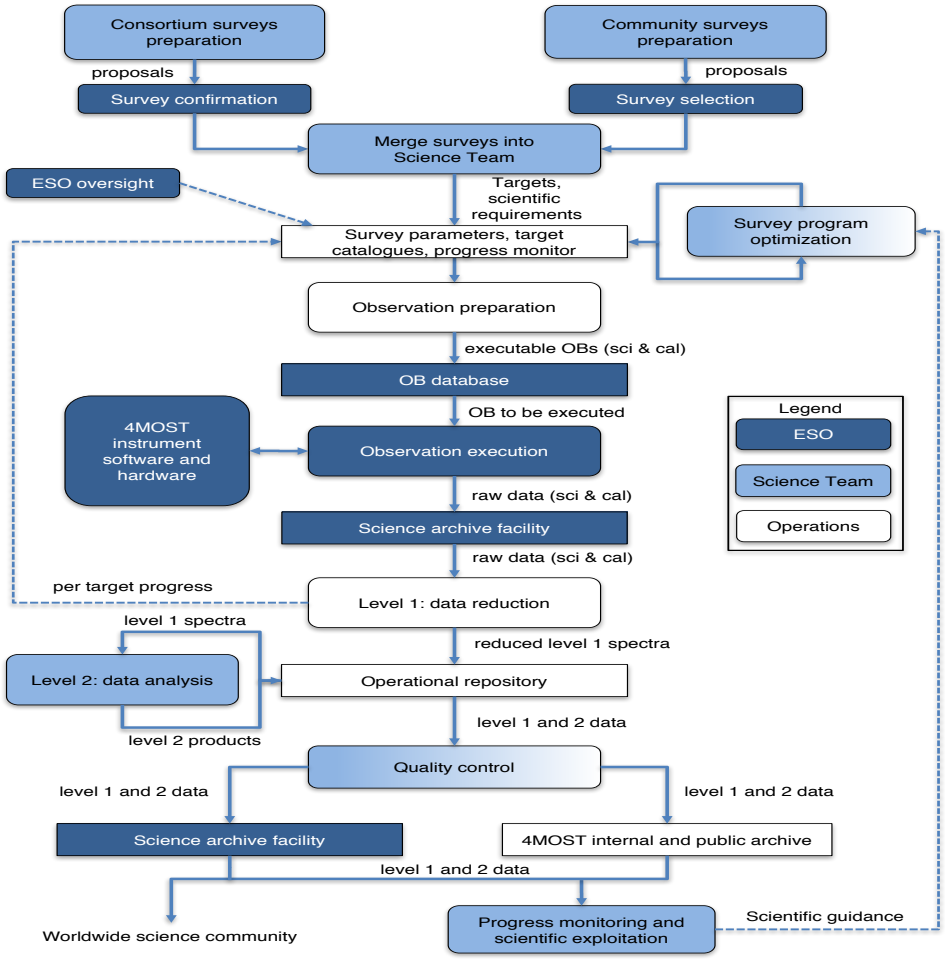

Figure 2: Highly simplified, linear overview of 4MOST operations, with some critical feedback loops indicated with dotted lines.

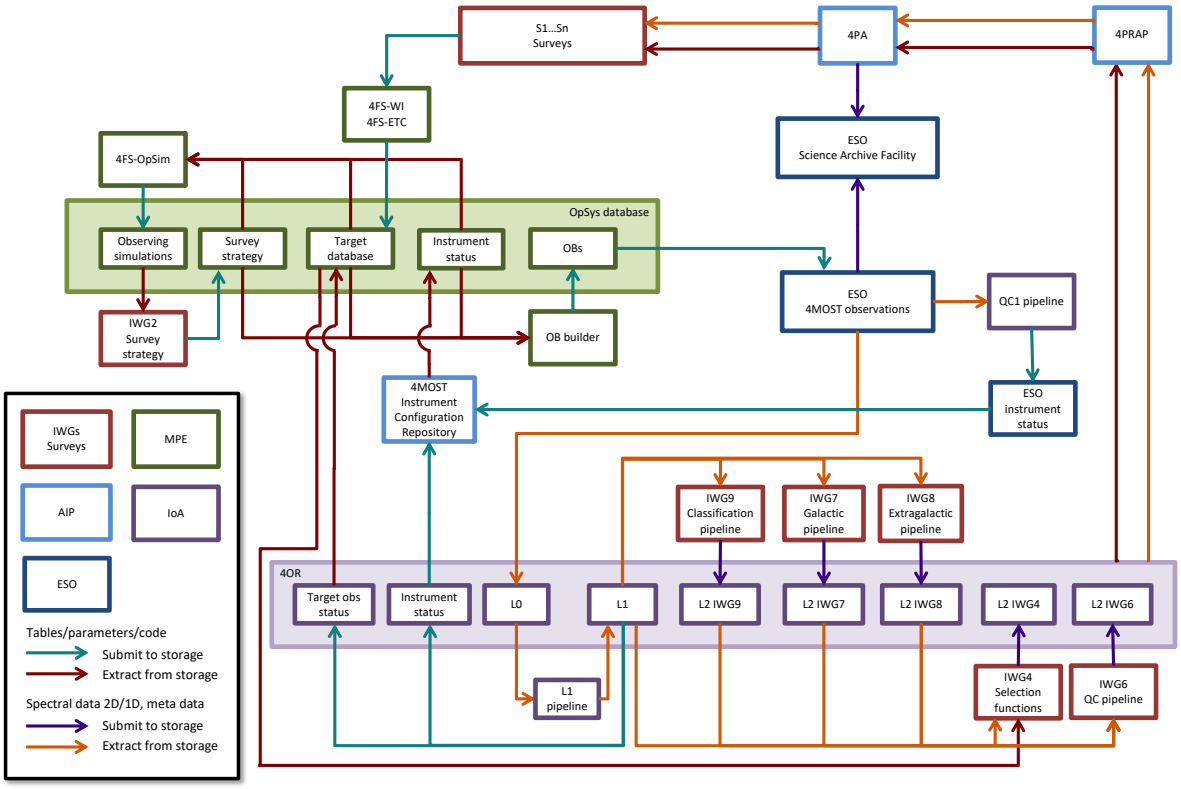

Figure 3 Data flow between Surveys, IWGs and operations compute and storage nodes developed by the different WPs.

8 Work-breakdown Structure of the 4MOST Project

The top-level WBS is provided in Figure 4 and Figure 5, with a description of the WP content provided in the following subsections. These diagrams are derived from the full 4MOST Project WBS [RD12].

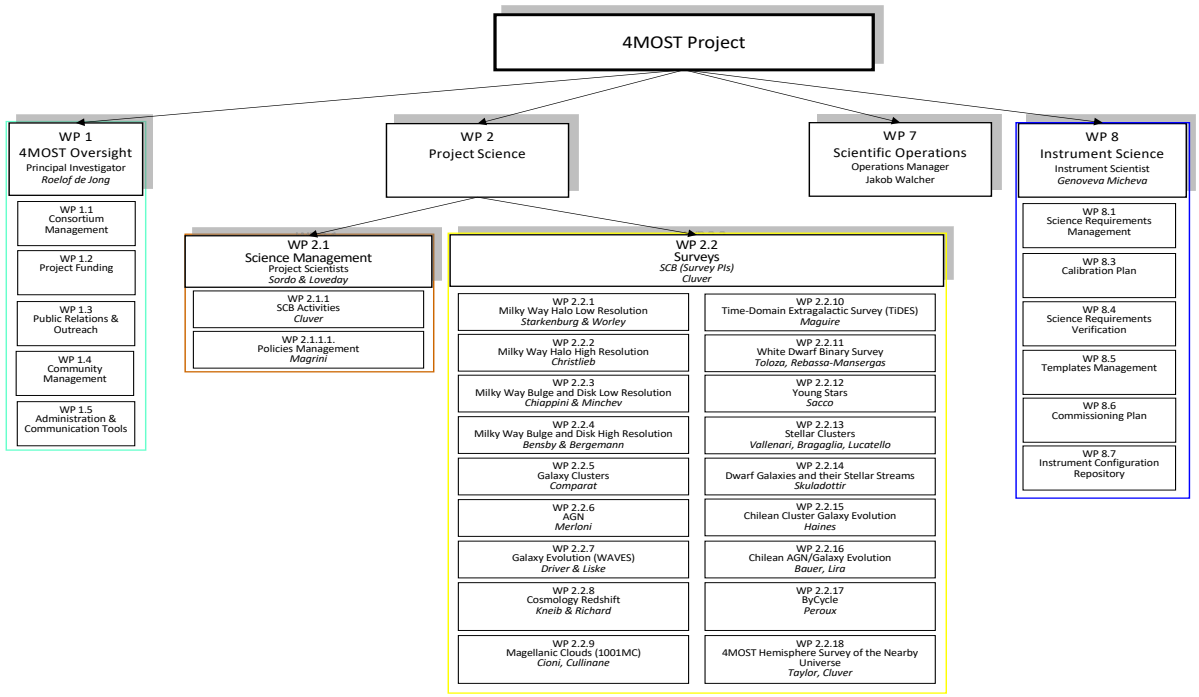

Figure 4: Work Breakdown Structure diagram for the Management, Science, and Instrument related WPs during the Operations phase of the 4MOST Project. The Scientific Operations WPs are presented in more detail in Figure 5.

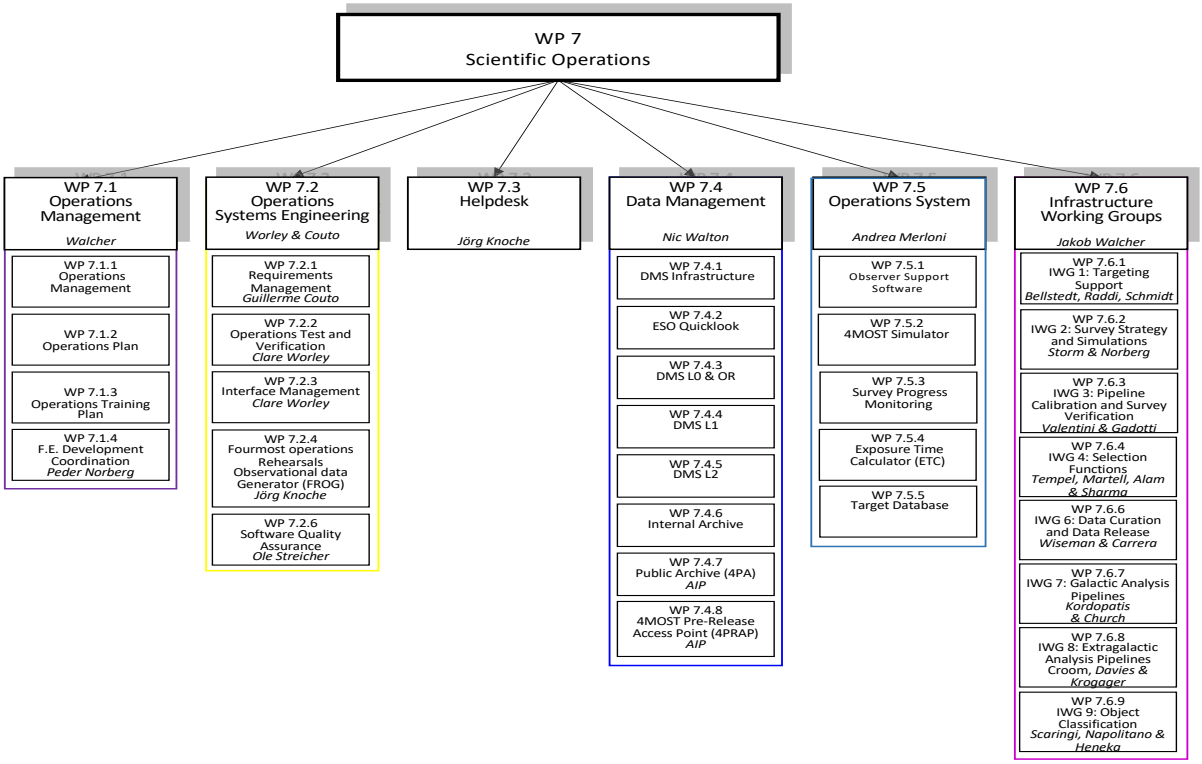

Figure 5: Detailed Work Breakdown Structure diagram for the Science Operations WPs during the Operations phase of the 4MOST Project.

8.1.1 WP1 4MOST Oversight

8.1.1.1 WP1.1, 1.2, 1.4 Consortium Management, Project Funding, Community Management

These WPs deal mainly with the overall effort to manage the Project, ensure sufficient staffing and funding. It also coordinates Project Culture efforts, guided by the Project Culture Working Group, responsible for, for instance the Code of Conduct, yearly Project demographics and climate surveys, and making recommendations to 4MOST leadership on Diversity, Equity and Inclusion. Finally, also the efforts of the 4MOST Ombudspersons fall in these WPs.

These WPs are overseen by the 4MOST PI, Roelof de Jong.

8.1.1.2 WP1.3 Public Relations and Outreach

This WP coordinates science communication and education activities that work internally in the Project and to the outside world. These include

- 4MOST Newsletter with Project news, grant opportunities, personnel changes and new people, PhD defences, etc...
- Web site content management with e.g. image/video gallery
- News items blog
- Coordinating outreach activities with outreach contact persons of participating institutes
- Press releases and outreach event coordination
- Speaker bureau and maintaining presentation materials
- Announcements of relevant external conferences
- Laypersons/schools community science communication
- Social media science communication

The WP lead of WP1.3 is Henri Boffin.

8.1.1.3 WP1.5 Administration and Communication Tools (ACT)

The Administration and Communication Team (ACT) provides tools for and coordinates the support services for the Project that allow the scientists and engineers to work together, exchange information, and prepare publications. In particular, the ACT will provide the infrastructure to support activities related to Survey Team and IWG membership management, Science Projects management, and Publication management. Web and Wiki pages, email lists, and similar communication tools will also be created and maintained by the ACT. The ACT reports to the PI. Organizationally the ACT is part of WP1.5, which is led by the PI. The ACT Lead is proposed by the PI and approved by the SCB.

The WP lead of the ACT is Joe Liske (Hamburg).

8.1.2 WP2 Project Science

WP2 contains all efforts to prepare observing catalogues for observations and to exploit all the data once delivered by the pipelines and made available by the archive.

8.1.2.1 WP2.1 Science Management

The WP is managed by two Project Scientists (PSs), supported by two deputy Project Scientists (dPSs). The PSs and dPSs validate the development of 4MOST science cases up to delivery of target catalogues with assigned priorities and an agreed upon survey strategy. They also oversee the development of the data and science analysis from extracted 1D spectra through publication. Both of these tasks are done in collaboration with the Operations Manager (OM), the Survey (Co-)PIs and relevant members of the Infrastructure Working Groups (IWGs).

The PSs oversee the science advisory structure guiding the development of science requirements imposed on the 4MOST facility and its operations. In this role they become the internal leaders of the Science Team and are responsible for organising the Science Team and creating and maintaining the Science Schedule. They also help organise the validation and testing of survey implementation and operations (i.e. the OpRs).

All of the above is done in close collaboration with the 4MOST PI, Instrument Scientist and OM.

The PSs and dPSs promote 4MOST science to the scientific community to ensure a strong engagement in and visibility of 4MOST. They also interact with the community to ensure that the community is well prepared to propose community surveys.

The PSs are non-voting members of the SCB.

The PSs are proposed by the 4MOST PI and approved by the 4MOST Executive Board for a period of three years initially, renewable. The dPSs are proposed by the 4MOST PSs and approved by 4MOST PI for a period of two years initially, renewable.

The 4MOST Project Scientists are Rosanna Sordo and Jon Loveday.

The 4MOST deputy Project Scientists are Michal Hayden and Chris Frohmaier.

8.1.2.1.1 WP 2.1.1 SCB activities

The Science Coordination Board (SCB) is the central body in charge of the planning of the 4MOST science programme, including both Consortium and Participating Community Surveys. It consists of the Consortium and Participating Community Survey PIs. In addition, the following are also members of the SCB but without voting rights: the 4MOST PI, the 4MOST PSs and the ESO 4MOST PS. The roles of the SCB are defined in the Science Team Policies [RD1].

The chair of the SCB is elected by the SCB and approved by the 4MOST PI. The PI proposes the chair to the Executive Board, who appoints the chair. The SCB chair is appointed for two years, unlimited renewable.

The Chair of the SCB is Michelle Cluver.

8.1.2.1.2 WP2.1.2 Policies Management

The SCB defines, manages, implements and enforces the Science Team Policies [RD3]. The day-to-day implementation of the Science Team Policies is delegated to the Science Policy Board (SPB).

The main tasks of the WP are

- Maintain a central register of all scientists and their membership of the different working groups. Manage the processes to become, resign or revoke memberships.
- Maintain a register of on-going Science Projects. Manage the processes surrounding on-going Science Projects including conflict management.
- Maintain a register of 4MOST Publications in preparation, submitted, and accepted. Ensure that all scientists that have the right to be on a paper get the opportunity to review the paper and to opt in on authorship.

The SPB has one member per Survey, appointed by the Survey PIs for a period of two years. The SPB elects one Chair from their members.

The Chair of the SPB is Kate Maguire.

8.1.2.2 WP2.2 4MOST Surveys

The different 4MOST science programmes of both the Consortium and the Community are grouped in Survey Teams. All Survey Team members are members of the Science Team. The Survey Teams are led by one or more Survey (Co-)PIs.

All surveys are required to develop and implement a standard Survey Management Plan similar to what is summarized in the 4MOST Survey Management Plan - Individual Surveys document [AD3]. Each survey has to implement at least structures for management, survey strategy coordination, target selection, data reduction and analysis, calibration and quality control, and publishing and archiving. These entities will interface on these topics in their respective counter-part IWGs.

The IWGs are populated from the surveys. Each survey is expected to contribute at least 2 FTEs per year towards the joint infrastructure work.

All Surveys with their Survey PIs and merged community programmes are listed in Table 1.

Table 1: 4MOST Surveys with merged programmes and their Survey PIs

Survey	Title	PI
S1	The Milky Way Halo Low-Resolution Survey	Else Starkenburg, Clare Worley
	4MOST Gaia RRLyrae Survey (4GRoundS)	Rodrigo Ibata
S2	The Milky Way Halo High-Resolution Survey	Norbert Christlieb
S3	Milky Way Disk and Bulge Low-Resolution Survey (4MIDABLE-LR)	Cristina Chiappini, Ivan Minchev
S4	Milky Way Disc and Bulge High-Resolution Survey (4MIDABLE-HR)	Thomas Bensby, Maria Bergemann
S5	eROSITA Galaxy Cluster Redshift Survey	Johan Comparat
S6	Active Galactic Nuclei	Andrea Merloni
	The 4MOST–Gaia Purely Astrometric Quasar Survey (PAQS)	Jens-Kristian Krogager
S7	Wide Area VISTA Extragalactic Survey (WAVES)	Simon Driver, Jochen Liske

	4C3R2: 4MOST Complete Calibration of the Color-Redshift Relation	Daniel Gruen, Jamie McCullough
	Optical, Radio Continuum and HI Deep Spectroscopic Survey (ORCHIDSS)	Kenneth Duncan
	4MOST-StePS (A Stellar Population Survey using 4MOST)	Angela Iovino
S8	Cosmology Redshift Survey (CRS)	Johan Richard, Jean-Paul Kneib
S9	The One Thousand and One Magellanic Fields (1001MC) Survey	Maria-Rosa Cioni, Lara Cullinane
	Spectroscopic Discovery of Binaries with Dormant Black Holes	Michał Pawlak
S10	The Time Domain Extragalactic Survey (TIDES)	Kate Maguire
	4SLSLS: The 4MOST Strong Lens Spectroscopic Legacy Survey	Thomas Collett
S11	The White Dwarf Binary (WDB) survey	Odette Toloza, Alberto Rebassa-Mansergas
S12	The 4MOST Survey of Young Stars (4SYS)	Giuseppe Germano Sacco
S13	Stellar Clusters in 4MOST	Sara Lucatello, Antonella Vallenari, Angela Bragaglia
S14	4MOST survey of dwarf galaxies and their stellar streams (4DWARFS): Small but fundamental	Asa Skúladóttir
S15	CHANCES: CHileAN Cluster galaxy Evolution Survey	Christopher Haines, Yara Jaffé
S16	4MOST Chilean AGN/Galaxy Evolution Survey (ChANGES)	Franz Erik Bauer, Paulina Lira
S17	Transform our Understanding of the Baryon Cycle with High-Resolution Quasar Spectroscopy	Celine Peroux
S18	4HS: The 4MOST Hemisphere Survey of the Nearby Universe	Edward Taylor, Michelle Cluver

8.1.3 WP7 Scientific Operations

This WP implements and executes all activities related to the scientific operations of the Project, except for operation activities at the observatory which are under the responsibility of ESO. It is central to the entire data-flow in the Project.

The WPs in WP7 are overseen by the Operations Manager, Jakob Walcher.

8.1.3.1 WP7.1 Operations Management

This WP coordinates the overall activities of all WPs in WP7. Before the start of observations, this is mainly coordinating the development of all software needed and running the various Operation Rehearsals. This work is managed through the Operations Development Group. After the start of operations, the emphasis will shift to monitoring the running of the operations work- and data-flow and the continued improvement of the software, to be caried out through the Joint Operations Group.

WP7.5 is managed by Jakob Walcher.

8.1.3.2 WP7.2 Operations Systems Engineering

This WP is responsible for the System Engineering aspects of the Operations effort and its associated work- and data-flow. Key aspects include:

- Requirements management
- Operations Test and Verification
- Interface Management
- Software Quality Assurance

A special role here is the "Fourmost Operations Rehearsal data Generator (FROG)" sub-WP, which consists of both the full instrument simulator to create simulated 2D spectrograph images for all three spectrographs as well as the computer cluster infrastructure needed to generate 100s of such images in a short amount of time. This system plays a crucial role in the Operation Rehearsals, where the entire data-flow is tested from end-to-end.

WP7.2 is managed by Guilherme Couto.

8.1.3.3 WP7.3 Helpdesk

This WP implements the central 4MOST helpdesk. The Helpdesk serves the following user groups: ESO User Support Department, the users of 4MOST public data release, users of the 4MOST Public Archive, members of the science team and non-participating survey teams. Using a ticketing system, it typically answers user inquiries about the 4MOST instrument and its operations, including passed on ESO inquiries, within 24 hours. Complex queries shall be resolved within 72 hours. The Helpdesk shall have specific procedures for instrument health alerts.

WP7.5 is managed by Jörgen Knoche.

8.1.3.4 WP7.4 Data Management System (DMS)

The Data Management System includes all backend data processing and associated archiving and publication of data. A detailed description can be found in the accompanying SMP – Backend Operations document [AD2]. The following WP have been defined:

- **DMS Infrastructure.** This WP includes creating and maintaining the hardware and infrastructure of the 4MOST Data Processing Centre (4DPC) that holds and processes all 4MOST data and manages the interfaces between the various pipelines.
- **ESO Quicklook:** This WP provides and maintains the QC1 pipeline that is run by ESO at the Paranal observatory for instrument health monitoring.
- **DMS Operational Repository:** The 4MOST Operational Repository (4OR) holds all L0, L1, and L2 data. The 4MOST Data Access Point (4DAP) manages the communication between the different pipelines, such that these can automatically fetch and return any newly available data from the 4OR. The 4OR also provides a daily trickle of reduced data to the 4MOST Pre-Release Access Point (4PRAP).
- **DMS L1 Pipeline:** This work package creates and maintains the pipeline that takes the raw 2D data from the telescope and removes the instrumental profile, extracts the spectra including wavelength and flux calibrations. It also performs spectral stacking

from multiple observations and between the spectral channels of the LRSs. Finally, a spectral success criteria and redshift estimation codes are run the 1D spectra.

- **DMS L2 Pipelines:** This WP creates the environment such that the L2 pipelines created by the IWGs are executed. The pipelines are: 4MOST Galactic Pipeline (4GP, stellar science cases), 4MOST eXtragalactic Pipeline (4XP, Galaxies and Quasar spectra), 4MOST Classification Pipeline (4CP), 4MOST Selection Function Pipeline (4SP), 4MOST Quality Control Pipeline (4AP).
- **4MOST Public Archive (4PA):** This WP provides the archive database to serve the data to the 4MOST Science Team through three monthly Internal Data Releases and to the general public at large according to the Public Data Release described in Section 9.
- **4MOST Pre-release Access Point (4PRAP):** This WP provides access to all data for the purposes of quality control, data curation, and data release management. As part of this WP, the 4MOST Data Release Manager will use QC flags and agreed policies to create Data Release candidates. When an internal or public data release has been finalized, it is ingested in to the 4MOST Public Archive (4PA), or sent from the 4PRAP to the ESO Science Archive Facility (SAF).

WP7.5 is managed by Nicolas Walton.

8.1.3.5 WP7.5 Operations System (OpSys)

The Operations System includes all front-end activities from ingesting target catalogue packages from the Surveys, through running survey simulations to creating Observing Blocks (OBs) and sending them to the telescope for near-immediate execution. A detailed description can be found in the accompanying SMP – Front-end Operations document [AD1]. The following WP have been defined:

- **Observer Support Software:** This WP uses the information from the target data base and their current execution status, the information from the simulator on the survey strategy, and the current observing conditions (moon, seeing, wind, transparency, lasers, etc.) to create the OB for the next observation using the designated Observing Mode. Backup OBs are also generated and daily updated to ESO's OB database in case the connection between MPE/Garching and Paranal is interrupted. No observers are directly involved in this process; the somewhat misleading name of the WP derives from the standard nomenclature used by ESO for the instrument software that generates OBs.
- **4MOST Simulator:** This WP simulates and entire 5-year survey with 4MOST in order to optimise the synergies between the different Surveys and to determine the optimal survey strategy for the optimal result for the Surveys. The generated tiling strategy with observing condition and execution times is used by the Observer Support Software during real-time operations.
- **Survey Progress Monitoring:** This WP monitors the progress of individual targets towards their success criteria defined by the Surveys (S/N or redshift success). For this, it receives information from the DMS and provides tools to plot and tabulate progress at subsurvey, Survey, and overall level, also in comparison to previous simulator predictions.
- **Exposure Time Calculator (ETC):** The ETC WP enables the calculation of exposure times for millions of targets under various observing conditions in a short time. Its

output is used both for simulations and during real-time operations, where it can take into account the S/N already achieved from previous observations.

- **Target Database**: This WP maintains the interface that allows Surveys to upload and modify their target catalogue packages (e.g. target lists, associated spectral templates for ETC calculations, spectral success and observing continuation criteria, completeness requirements, etc.). It also provides an automatic interface for Target of Opportunity (transients) uploads once a day.

WP7.5 is managed by Andrea Merloni.

8.1.3.6 WP7.6 Infrastructure Working Groups

All the science activities that provide common services between multiple Surveys are performed in Infrastructure Working Groups. The labour resourcing of these WPs is provided by the scientists in the Surveys and is not provided by the Consortium.

8.1.3.6.1 WP7.6.1 - IWG1: Targeting Support

The Targeting Support IWG is a cross-surveys IWG with the task of coordinating activities necessary to create the 4MOST input target catalogues and ensuring that these meet the 4MOST Operations requirements, as well as developing targeting tools that are required across several different surveys. Survey specific targeting tools are expected to be developed within the individual Science Teams.

IWG1 interacts strongly with the Operations Development Group (ODG), Operations System Group (OpSys), IWG2 (Survey Strategy), the individual Science Survey teams, as well as a number of the other Infrastructure Working Groups.

The target catalogues need to be verified in terms of having the same astrometric reference frame and sky fiber positions allocated based on the target densities. It is agreed that all target catalogues will use the Gaia astrometric reference frame.

The objectives and deliverables of IWG1 are:

1. IWG1 will ensure that the survey catalogues comply with the 4MOST survey requirements.
2. IWG1 will maintain an up-to-date repository of the target-selection approaches for each survey. Each survey will need to provide a summary and documentation to IWG1 that is sufficiently detailed that the input target catalogues can be independently reproduced. IWG1 will be responsible for defining what information will be required in this documentation (e.g., the magnitude system used; image de-blending approach; assumed spectral templates).
3. IWG1 will deliver a software tool to verify and validate the astrometry precision of the surveys' input target catalogues and the 4MOST guide star catalogues, via cross matching of the target positions with selected reference objects from Gaia eDR3. A catalogue of reference objects will be created within IWG1 together with OpSys and made available to the surveys.
4. IWG1 will work with OpSys to verify and test software tools for identifying shared targets between surveys. This task becomes increasingly important as the surveys shift from simulated targets to real targets.

5. IWG1 will develop algorithms for 4MOST sky-fibre allocation and produce a Master Sky Fibre catalogue.
6. IWG1 will assess the photometry, SNR requirements, and object classification of the 4MOST input target catalogues.

IWG1 Leads are Sabine Bellstedt, Roberto Raddi, Robert Schmidt

8.1.3.6.2 WP7.6.2 - IWG2: Survey Strategy and Simulations

This WP is a cross-surveys WP with the task to coordinate which areas on the sky will be observed under what kind of conditions (dark/gray/bright, seeing) for what kind of exposure times. Further items to coordinate are target and field priorities, observing timing and cadence, maximum magnitude range, quality criteria for re-observing, etc. The simulation, verification, and implementation of the proposed survey strategies are the responsibility of the Operations System and defined in WP 7.5, but analysing and providing feedback on the results is the responsibility of this WP.

During the operations phase this WP will be critical for any updates to the input target catalogues or the survey strategy. Any changes need to be extensively similated and go through a change control process before being implemented for execution.

IWG2 Leads are Peder Norberg and Jesper Storm.

8.1.3.6.3 WP7.6.3 – IWG3 Calibration and Survey Verification

The 4MOST L2 pipelines require training and calibration samples, both to function properly and to be able to verify how well they function. In the same vein, scientific cross-calibration to other big survey projects (WEAVE, DESY, etc.) is of general interest for all surveys. There is time during the Survey Programme Validation (SPV) phase to observe some calibration and training sample objects. IWG3 is in charge of designing this observing campaign, as well as coordinating potential observations of training and calibration objects during normal science operations.

During the SPV phase the main goal is to verify the survey strategy on the real instrument. A special survey program with a length of about 2 months will be carried out for this science verification. Because this task interleaves with the training and calibration sample observations it is hosted in the same IWG.

The Calibration Plan is in the hands of the instrument scientist. This covers all basic instrument calibration tasks required to run the L1 pipeline, such as flats, darks, and the like. IWG3 will thus focus on calibrations required for the L2 pipelines. Some more activities are not included in IWG3 and need to be addressed elsewhere in the project. These are: Science calibration within surveys (Surveys), Supplementary targets (Science Team), sky fiber locations (IWG1).

In addition, IWG3 is responsible for creating a catalog with bright targets to be observed during poor observing conditions (seeing >1.5″, cirrus, full moon) and twilight.

IWG3 Leads are Marica Valentini and Dimitri Gadotti.

8.1.3.6.4 WP7.6.4 – IWG4: Selection Functions

This WP will create the posteriori selection functions of the probability that a target was (or was not) observed given the input catalogues, the target priorities, instrument and observing conditions, extraction software, etc. It will also create tools such that it is straightforward to perform statistical analyses on certain classes of objects and their probability distribution in the sky, where possible in 3D (e.g., Milky Way distribution for Gaia targets, redshift distribution of galaxies, etc.).

IWG4 Leads are Shadab Alam, Sarah Martell, Sanjib Sharma and Elmo Tempel.

8.1.3.6.5 WP7.6.6 – IWG6 Data Quality Control

This WP performs the overall Quality Control on all data streams. It verifies at aggregate level the accuracy and precision of the data, determines which part of the data is fit for data release, verifies whether all data products comply to the defined standards, and checks if all documents are complete and according to standard. It furthermore monitors that all pipelines are implementing the necessary QC measures and does the overall management of official Data Releases.

IWG6 Leads are Ricardo Carrera and Philip Wiseman.

8.1.3.6.6 WP7.6.7 – IWG7: Galactic Analysis Pipelines

This WP will create the Level 2 data analysis pipeline that, for stellar targets, extract from the 1D calibrated spectra a radial velocity, stellar parameters and abundances of selected elements together with their precision and accuracy.

IWG7 Leads are Ross Church and Georges Kordopatis.

8.1.3.6.7 WP7.6.8 – IWG8: Extragalactic Analysis Pipelines

This WP will create a Level 2 data analysis pipeline that provides PDFs of at least redshifts, Star Formation Rates and Histories, reddening, and velocity dispersion of all extra-galactic targets. For AGN also emission lines and absorption systems will be measured.

IWG8 Leads are Scott Croom, Jens-Kristian Krogager and Luke Davies

8.1.3.6.8 WP7.6.9 – IWG9: Object Classification

This WP of IWG9 will operate software that performs automatically classification of spectra of objects. It will in particular identify outliers, be it due to instrument or software problems or real outliers in a scientific sense.

IWG9 Leads are Caroline Heneka, Nicola R. Napolitano, and Simone Scaringi.

8.1.4 WP8 Instrument Science

This WP is strongly involved in the interface between instrument requirements and performance analysis and the feasibility of scientific usage. While strongly focused on the development phase of the instrument, it will still have key functions during the operations phase of the Project. We recognise the following sub-WPs.

This WP is led by the Instrument Scientist Genoveva Micheva.

8.1.4.1 WP8.1 Science Requirements Management

This WP will be mostly defunct during the operations phase, unless any hardware modifications or malfunctions surface that require new science-based trade-off input.

8.1.4.2 WP8.3 Calibration Plan

Even though the Calibration Plan is finished before start of operations, this WP will analyse any trends in the performance of the instruments and update the Instrument Configuration Repository (ICR) as required. The ICR stores for instance the (non-)performance of fibre positioner spines and fibre throughputs that are used by the Science Operations team to create fibre configurations for observations.

8.1.4.3 WP8.4 Science Requirements Verification

The WP is mainly active during Instrument Commissioning, but may be reactivated after a major intervention of the instrument during the operations phase.

8.1.4.4 WP8.5 Template Management

This WP will be mostly dormant during the operations phase, but may be required when a new special operations mode needs to be implemented for a special science case.

8.1.4.5 WP8.6 Commissioning Plan

The WP is mainly related to planning the Instrument Commissioning activities, but may be reactivated to plan for a major intervention of the instrument during the operations phase.

8.1.4.6 Instrument Configuration Repository (ICR)

The ICR stores all instrument parameters that are necessary to operate the instrument. It stores files that describe for instance the focal plane configuration, instrument performance for the ETC and the instrument simulator TOAD, overhead parameters, properties of individual detectors, etc. These files are expected to be mostly static, but some may need irregular updates for broken and/or replaced components, changed performance (fibres, fibre spines, detectors, dusty mirrors, etc.). Performance monitoring through the L1 pipeline plays a key role in this process.

9 Schedule including Data Release Plan

9.1 Top-level Schedule

A graphical representation of the current top-level schedule leading up to the start of operations can be found in Figure 6. This schedule is still in active development and can be changed on short term notice due to unforeseen developments in the instrument assembly, integration and verification activities. Currently it is foreseen that the first transport of the 4MOST hardware that is needed to recommission the VISTA telescope with the new Wide Field Corrector starts Q4 2024. The process continues with further instrument shipments, and installation, verification and commissioning of the rest of the instrument. The survey preparation activities continue with Operations Rehearsal 4 (OpR4), where the entire data flow from creating and schedule OBs with the Designate Visitor Mode (dVM) to reduced data archiving is tested, and culminates

with the Survey Program Validation (SPV) process, where the scientific feasibility of the survey strategy is validated using a dedicated target catalogue and survey programme. This entire process is expected to take almost a year.

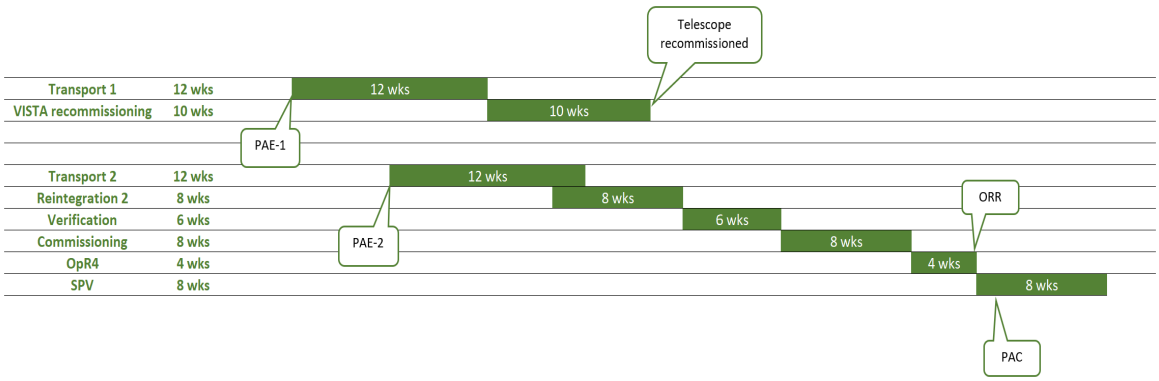

Figure 6: Scheduled activities to prepare the 4MOST Facility for the Operations Phase. Of particular relevance for this SMP are here the Operations Rehearsal 4 (OpR4) and the Survey Program Validation (SPV) phases.

Once the SPV phase has been completed, the operations phase for 4MOST will start for the first 5-year survey. We expect that after one year of operations a review with all stakeholders (Surveys, ESO, PSP) will take place to evaluate actual versus predicted survey progress and decide on adjustments of the survey strategy when needed. It is expected that at least two more 5-year surveys will be performed with the 4MOST instrument as also indicated in Figure 7. The selection process for the second 5-year survey will most likely commence in 2027 with final programme submission and selection taking place after DR1 of the first 5-year survey (see next subsection).

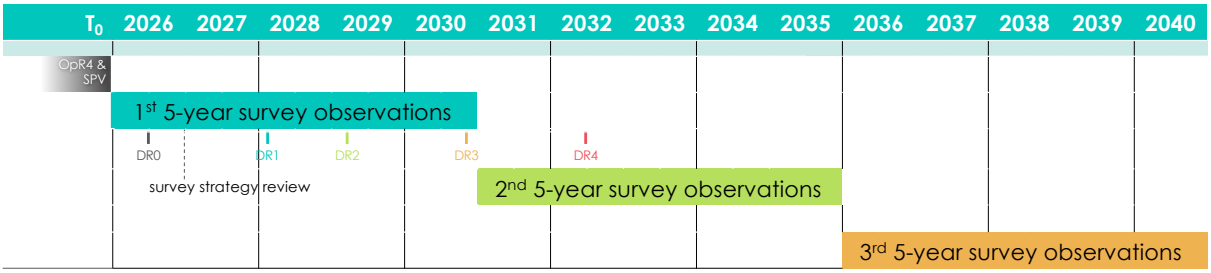

Figure 7: The approximate schedule expected for the three 5-year surveys to be executed with the 4MOST Facility. Approximate locations for the Data Releases (DR) for the first 5-year survey are also indicated (see next subsection).

9.2 Public Data Release Schedule

The Data Release Plan [RD6] describes in detail the timeline of the public Data Releases (DRs) of the 4MOST Project. Only the main points are summarised here.

The schedule for the public Data Releases is presented in Figure 8. An early DR0 is foreseen that will contain data obtained during the Survey Programme Verification phase before the start of the first five-year survey.

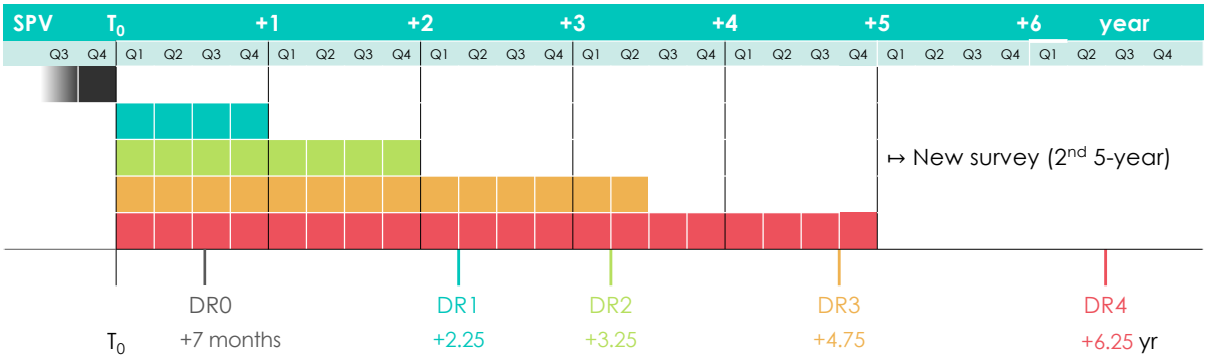

Figure 8: GANTT chart representation of the Public Data Release schedule. Here SPV stands for Survey Programme Validation phase, to be conducted between completion of instrument commissioning and the official start of the 1st 4MOST five-year survey after the final Operations Readiness Review (T0). Each block stands for data taken in 3 months of observing time. The number of months/years after T0 at which each Data Release is to take place is indicated at the bottom.

Each DR shall contain all quality verified data products for data obtained up to one year and three months prior to the DR date. This includes input catalogue values associated with the release L1 products and all versions of the extracted, calibrated 1D spectra as described in 4MOST SMP: Back-end Operations [AD2], Section 9.

The different PDRs shall contain at least the following data products and parameters plus, where appropriate, the associated precisions and uncertainties as described in 4MOST SMP: Back-end Operations [AD2], Section 10.

DR0 An early Data Release based on data taken during the SPV. DR0 will contain all targets observed during SPV for Calibration and Science Verification purposes. This release shall contain:

a. For all targets released, the 4MOST input target catalogue values relevant to their selection and observing requirements,
b. L1 extracted, calibrated 1D spectra plus the associated quality meta-data/spectra.
c. For stellar targets: radial velocities (RV), Teff, log(g), and [Fe/H], as far applicable for each stellar class (e.g., no [Fe/H] for White Dwarfs and parameters for pulsating variable stars), and
d. For extragalactic targets: Redshifts and the probability of being the correct redshift, best fit template.

DR1 A DR containing targets observed up to 1 year after start of operations. This release shall contain:

a. The same parameters as DR0, plus
b. For stellar targets adhering to the standard 4GP pipelines: abundances and their uncertainties for the following elements: Li, C, Mg, Ca, Ti, and Fe. Abundances of all other elements will only be released when they pass quality control data curation to be done on a best effort basis,
c. For extragalactic targets: D4000 and characterization of selected absorption/emission line indices (H-alpha, H-beta, [OIII] 5007, [OII] 3726,3729, [NII] 6583) as well as luminosity-weighted average ages of target

galaxies (as far as applicable for each target class and on a best effort basis for a given S/N of a targets), and

d. For all targets a basic (AGN/Galaxy/QSO/Star/Unknown) classification parameter for all released spectra based on a Machine Learning algorithm.

DR2 A DR containing targets observed up to 2 years after start of operations. This release shall contain:

a. The same parameters as DR1, plus
b. For stellar targets: all parameters described in the IWG7 - Galactic Pipeline (4GP) Requirements Specification document [RD8] including where detectable, e.g., parameters quantifying variability and/or binarity (RV or spectral features) and stellar activity features, and
c. For extragalactic targets: all parameters described in the IWG8 - Extragalactic Pipeline (4XP) Requirements Specification document [RD9], including where detected, identification and/or parametrization of secondary spectral features.
d. The geometric selection function parameters for the released targets as described in the IWG4 – Selection Function Pipeline (4SP) Requirements Specification document [RD10].
e. For all targets all classification parameters described in the IWG9 – Object Classification Pipeline (4CP) Requirements Specification document [RD11].

DR3 A DR containing targets observed up to 3.5 years after start of operations. This release shall contain:

a. The same parameters as DR2, plus
b. The geometric and object selection function parameters described in the IWG4 – Selection Function Pipeline (4SP) Requirements Specification document [RD10] of all released targets.

DR4 A DR containing all targets observed for the 5-year survey. This release shall contain:

a. The same parameters as DR3, plus
b. Any new parameters not described in the current plans for the pipelines described above but developed in during the 5-year survey period and that were not released in one of the previous releases.

9.2.1 Timeline for each Public Data Release

A large number of activities need to be performed before a Public Data Release can happen. This includes data processing including pipeline improvement and maintenance, quality control, data curation and documentation. The expected timeline of activities leading up to each DR is depicted in Figure 9.

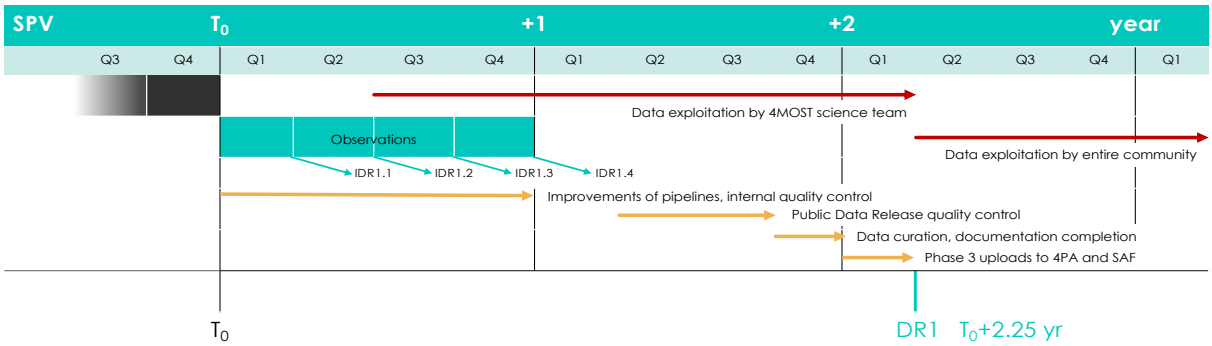

Figure 9: GANTT chart representation of the developments leading to Data Release 1. The next DRs will follow the same scheme. Here IDR1.1/2/3/4 stands for the Internal Data Releases that take place every three months and make quality verified data available internally to the 4MOST Science Team. Each IDR has its own 3-month schedule for L1 and L2 data processing, quality control, archiving, and publishing.

10 Organisation Staff Effort

Table 2 provides an overview of the top-level staff effort dedicated to the overall management of the 4MOST Science and Operations effort in the operations phase that is not already listed in the other associated SMP documents.

Table 2: Staff effort associated with the management and system engineering of the Science and the Operations effort.

Name	Institute	Contribution, WP	FTE/yr
Roelof de Jong	AIP	Principal Investigator	0.5
Jakob Walcher	AIP	Operations Manager	0.3
Guilherme Couto	AIP	Operations System Engineer	0.1
Ole Streicher	AIP	Software Quality Assurance	0.5
Genoveva Micheva	AIP	Instrument Scientist	0.3
Rosanna Sordo	OAPd	Galactic Project Scientist	0.3
Jonathan Loveday	US	Extragalactic Project Scientist	0.3
Michael Hayden	SIFA	Deputy Galactic Project Scientist	0.2
Christopher Frohmaier	Southampton	Deputy Extragalactic Project Scientist	0.2
Michelle Cluver	CAS	Chair Science Coordination Board	0.2

Name	Institute	Contribution, WP	FTE/yr
Lara Magrini	OAA	Chair Science Policies Board	0.1
Henri Boffin	ESO	Lead Science Communication and Education	0.1
Jochen Liske	UHH	Lead Administration and Communication Tools (ACT)	0.1
Jörge Knoche	UHH	Helpdesk, maintainer Administration and Communication Tools (ACT), System Engineer (FROG)	0.5

Appendix A List of Acronyms

List of Acronyms	
4MOST	4-metre Multi-Object Spectroscopic Telescope
4CP	4MOST Classification Pipeline
4GP	4MOST Galactic Pipeline
4PA	4MOST Public Archive
4SP	4MOST Selection Function Pipeline
4XP	4MOST eXtragalactic Pipeline
AL2	Additional Level 2
DL2	Deliverable Level 2
DL2-SURV	Deliverable Level 2 - Survey (data product not delivered by an IWG, but by a 4MOST Survey)
DR	Data Release
FTE	Full Time Equivalent
IDR	Internal Data Release
IWG	Infrastructure Working Group
L1	Level 1
L2	Level 2
PDR	Public Data Release
QC	Quality Control
RV	Radial Velocities
SCB	Science Coordination Board
SMP	Survey Management Plan

List of Acronyms	
SPV	Survey Programme Validation
ST	Science Team