



Preparatory Phase for the Einstein Telescope Gravitational Wave
Observatory

Deliverable D5.1

Project Office structure and mandate

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EXECUTIVE SUMMARY

This document, D/5.1 Project Office structure and mandate, is a deliverable of the ET-PP Project, which is funded by the European Commission Framework Programme Horizon Europe Coordination and Support action under grant agreement 101079696.

This document outlines the mandate and structure of the Einstein telescope Project Office. Starting with the mandate and organizational structure, the document illustrates, in a logical sequence, the Project Office strategy, its main activities and main deliverable. Considering these boundary conditions, the structure of the Project office is proposed, divided into work packages pertaining to the different project management competences, and adapted to the context of the Einstein Telescope project.

List of acronyms and abbreviations

CDR	Conceptual Design Report
CERN	Conseil Européen pour la Recherche Nucléaire
CI	Configuration Items
ET	Einstein Telescope
ETC	Einstein Telescope Collaboration
ET-PO	Einstein Telescope Project Office
ET-PB	Einstein Telescope Project Board
ET-PP	Einstein Telescope Preparatory Phase
EVM	Earned Value Management
INFN	Istituto Italiano di Fisica Nucleare
IT	Information Technology
LHC	Large Hadron Collider
OBS	Organization Breakdown Structure
ORAMS	Operability, Reliability, Availability, Maintainability and Safety
PBS	Product Breakdown Structure
PM	Project Management
PMP	Project Management Plan
RACI	Responsible, Accountable, Consulted, Informed
RMP	Requirements Management Plan
RR	Requirements Register
SEP	System Engineering Plan
SMP	Schedule Management Plan
TDR	Technical Design report
TRL	Technical Readiness Level
WBS	Work Breakdown Structure
WG	Working Group

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1) The Project Office mandate and organizational framework

The Einstein Telescope Preparatory Phase (ET-PP) proposal provided the framework of the mandate for the Einstein Telescope Project Office (ET-PO). Its main goal has been identified as guaranteeing that the as-built research infrastructure fully complies with the requirements, the parameters and the technical layouts detailed in the project baseline configuration included in the TDR. This objective must be achieved without making changes that were not endorsed by the stakeholders and adhering to the final schedule and the estimated budget.

In this context, the first need is to choose a *System Engineering (SE) framework defining the project lifecycle and the associated deliverables*. This framework

must indicate *the procedures, and the practices* aimed at providing a functioning facility complying with *the initial requirements*; these must be unambiguously identified, hierarchically structured and globally optimized by the ET Consortium. This will lead to the choice and the realization of the most '*elegant*' solution [1]. The Project Office selected the openSE framework, focused on the needs of scientific projects [2, 3].

Currently, the activities of the project office are embedded in the context of the ET Organization (ETO). This body has been established in 2023 and received a clear mandate from the ET Coordinators [4] to finalize the preliminary phase called ET 'Phase 1,'. This is mainly defined by its goal, which is the choice of the site, of the interferometer configuration and of the governance of the future organization.

In the ET framework the Board of Governmental Representatives (BGR) represents the political stakeholders in charge of the ET site(s) and the choice of the legal entity. The 'Coordinators' represent the national agencies having a co-leading role in the ET project. They report directly to the BGR on the progress of Phase 1. To assure the operativity, the 'Coordinators' have named and mandated the ETO Directors to steer the work of different departments, coordinating respectively the engineering, the administration and communication and the project management activities. In the management activities the directorate is supported by the directors' office. The ETO structure is illustrated in fig.1.

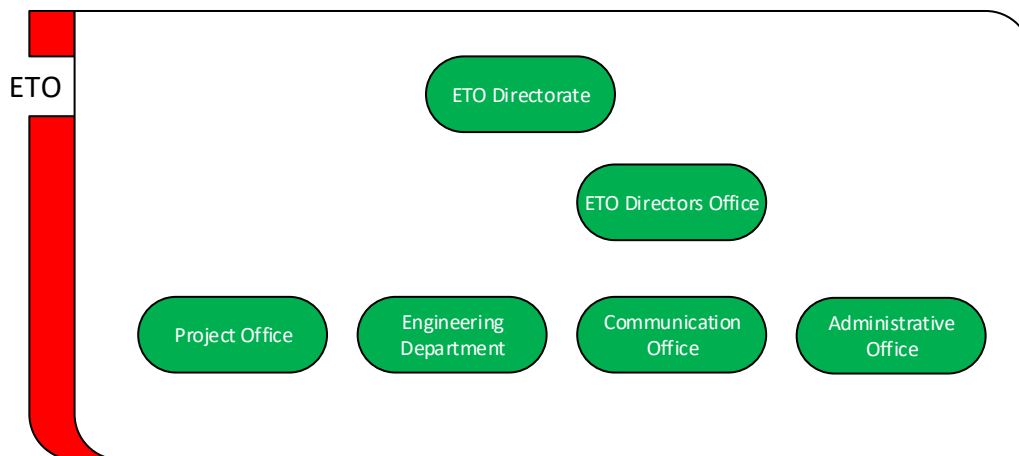


Fig.1 Structure of the Einstein Telescope Organization (ETO).

In this area, the project office works within its mandate and as a support to the Directorate in supporting the two directors in achieving the ETO mandate objectives, and in defining the organizational aspects and the roadmap for Phase1. It is therefore within this coordination structure that the project office harmonizes its activities with the Engineering Department and the Communications Office.

At present, the ET Collaboration (ETC), being responsible for the physics case definition and of the interferometer design, is a main stakeholder for the ETO. In this framework the Project Office is actively collaborating with ETC in the definition of different processes.

2) Project Office strategy

The mandate and the organizational framework of the Project Office, results in a linear high-level strategy that includes to deliver and manage:

1. The *budget* (cost estimate in Phase 1)
2. The *schedule*
3. The *project configuration* including the process of change requests in a System Engineering and Quality framework.

Technical & Safety, associated Information Technology, Quality and Risk Management activities shall ensure the completeness of the definition of processes and of the required information to effectively implement these three pillars of the project office strategy. In this context, the Project Office will therefore be engaged in applying Project Management and System Engineering processes to implement its plan. At the same time the Project Office shall support the Directors in the establishment of the project roadmap and of the organizational processes.

3) Project Office main deliverable

The Project Management Plan (PMP) will be the main deliverable document of the Project Office [2, 5]. It will be released in the study phase, ending with the release of the preliminary TDR, then revised and complemented at least at the beginning of every new phase of the project lifecycle, and whenever needed as the project progresses. It will illustrate the procedures for editing, informing, verifying, and validating all the processes ruling the project lifecycle. The objective of the Project Management Plan is twofold:

1. Giving the future ET organization governing board (ET Project Board) the assurance that the project expectations are well understood and that everything is done to ensure the operational success of the project.
2. Ensure that the Project participants agree upon a common framework for organizing their project and commit to follow its prescriptions.

4) The Project Office activities

As a matter of principle, to fulfill its duty, the Project Office must successfully manage, harmonize and coordinate the following activities:

1. *define, monitor and validate the processes* ruling the project execution, namely the management of the budget and of the schedule. This includes providing the WBS, the PBS, the PMP, the nomenclature, editing the quality plan, defining the change request process, and editing the risk register;
2. *lead* the harmonization of the procedures of the ET project bodies, of the best practices and of the project management tools;
3. *coordinate* the processes resulting in the availability of a baseline technical design and the consequent engineering specifications;
4. *provide* IT support for the configuration management (PLM included), the project management, and the financial management tools (EVM);
5. *assure* training and support in the editing of the processes' plans and ensure the availability of document templates;
6. *integrate* the documents lifecycle management framework; integrate the appropriate document verification and validation tools; verify and validate the different Project Management processes;
7. *organize* Quality, Configuration, Schedule and Budget Audits;
8. *report* the project schedule and budget to the shareholders and to the stakeholders' boards.

The backbone of these Project Office activities is represented by the management processes. These are all anchored to a standard scheme composed of actors, objects, and actions to provide deliverables, where:

- the *actors* are the process responsible and the participants;
- the *objects* are the documents or other deliverables;
- the *actions* are the processes and their verification and validation.

This scheme must provide the entire correct framework to develop the Project Office Organizational Structure and to identify the processes for the management of the stakeholders [6].

5) The Project Office structure

Once the mandate and the organizational structure are defined and the overall strategy adopted, the internal organization of the project office follows. The structure is a classic hierarchical tree structure where the different project management activities, structured into work packages, are defined according to the required expertise. Thus, the structure is led by a Coordinating Office (composed of the project office head and his deputy, the technical coordinator), assisted by two support offices, transversal to the different work packages, that are responsible for respectively:

- (a) administrative management and reviews management.
- (b) IT support and application development.

The coordination office manages the activities of ten different WPs defined by the management activities: WP1 Scope management, WP2 Technical coordination, WP3 Safety management, WP4 Schedule management, WP5 Resources and financial management, WP6 Quality management, WP7 Risk management, WP8 Configuration management, WP9 Commissioning management, WP10 Communication management.

The ET-PO structure is illustrated in Fig. 2.

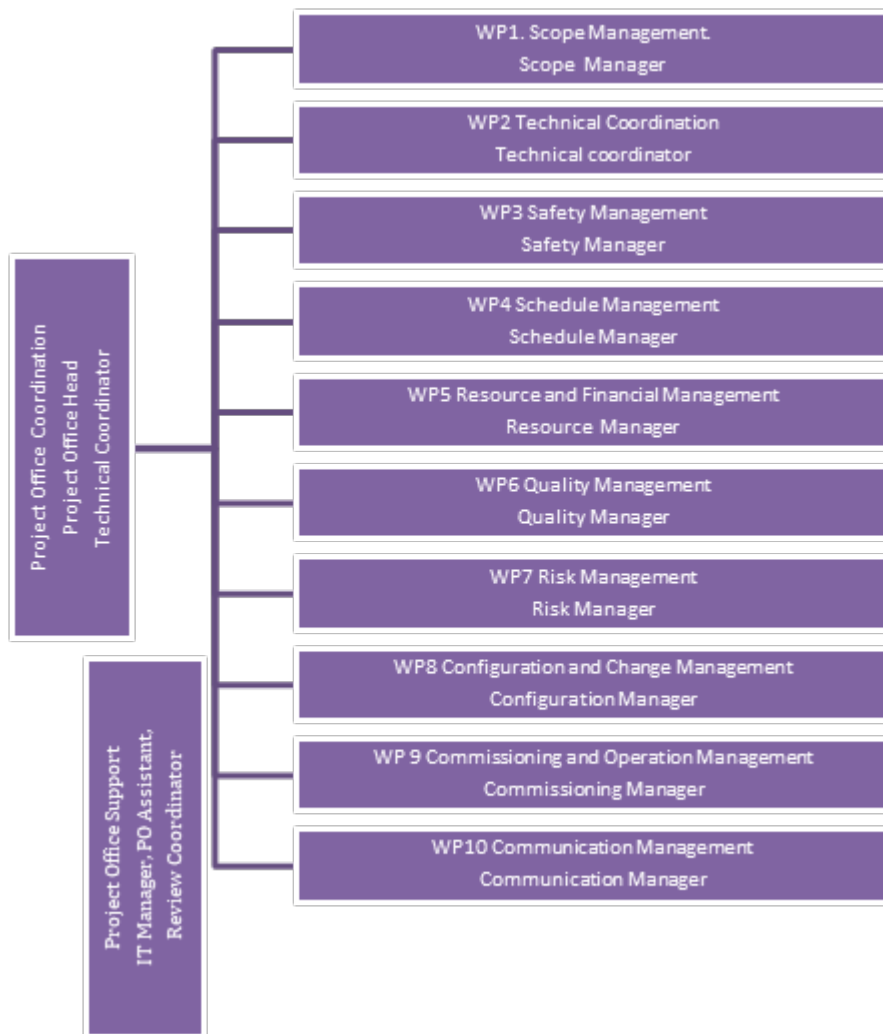


Figure 2: Project Office OBS structure. The WP responsible roles are also illustrated.

To describe all the activities and responsibilities of the Project Office, the contents of the different WP are hereafter summarized; this also helps to better identify the frame of the PO structure.

5.1) WP1. Scope management

This WP looks after all the processes aiming at the definition of the project objectives, deliverables, constraints and general assumption. This is also considering all the procedures that give the breakdown in systems, roles, actions and phases. It considers therefore, the drafting of the main project management tools like the project WBS, the PBS and the OBS.

This management activity includes the processes leading to the:

- identification and management of the involved stakeholders;
- definition of the methodology for the establishment of the project roadmap and support to the definition of organizational aspects;
- the processes ruling the setting-up of working groups with the subsequent editing of the WG result reports;
- the definition of the CDR and TDR structures.

This will support the finalization of the project roadmap, the CDR and TDR validation and the definition of their modification procedures.

WP1 Responsible - Head of the Project Office and Technical Coordinator.

5.2) WP2. Technical coordination.

Technical management is devoted to the organization of the processes governing the technical aspects of the project. This work should be carried out in close collaboration with the activities of WP1 and with the Engineering Department. In this context the PO shall define the framework, the processes and the procedures for:

- the preparation and the editing of the verification plan and the verification reports;
- the preparation and editing of the to-build and as-built documentation;
- the preparation and editing of the maintenance plan;
- the potential editing of the remote operations and handling plan;
- the analysis of the interfaces and the consequent drafting of the Utility Matrix;
- the change requests procedures for all the different documents.

WP2 Responsible - Technical Coordinator.

5.3) WP3. Safety management.

Safety management is one of the key elements in openSE framework, where the systems fundamental requirements are given by Operability, Reliability, Availability, Maintainability and Safety (ORAMS). This shall be set up from the beginning of the project definition and design providing the general safety legal and operative framework of the project. In the Project Office context safety management includes:

- the editing of the safety agreement and the relative process for validation by the ET Project Board;
- the establishment of consistency of the general safety plan and the procedure for its submission to the authorities with the project office Quality Assurance Plan;
- the processes for the modification of the Safety Agreement.

WP3 Responsible - Safety Manager.

5.4) WP4 Schedule management.

Schedule management is a procedure that requires the establishment of policies and documentation for developing, maintaining, managing, and controlling the resources loaded schedules for the completion of the project. The strategic benefit of the schedule management process is that it will monitor and manage the schedule throughout the project. This considers:

- the preparation of the master and detailed resource loaded schedule;
- the editing of the Schedule Management Plan (SMP);
- the setting of the process for change request of the documents;
- the procurement of the supporting software application;

The SMP shall include:

- the description of the schedule management processes;
- the definition of the schedule methodology (especially for the resource loaded schedule) and the employed tools;
- the acceptable range and buffer for the activities;
- the standard units of measure;
- the schedule updating procedures;
- the control thresholds;
- the rules for % completion;

- the schedule variance and performance index;
- the schedule report format;
- EVM application procedures.

EVM management responsibility will be shared with the Resource Manager, responsible for WP5. Budget and schedule review audits and reporting will be processes shared with the resource and financial management group activity.

WP4 Responsible - Schedule Manager.

5.5) WP5. Resources and financial management.

Resource and financial management are one of the most critical aspects of the project management. The development of an integrated administrative and financial policy must be elaborated in the ET-PP framework because of the ET preparatory phase. This will definitively establish the WP5-specific processes and deliverables.

Nevertheless, it is possible to define immediately, as elementary activities, the drawing up of the Resources and the Procurements Plans. Change request processes identification will also be considered.

At the same time, in Phase 1, a fundamental activity is the project cost estimate. Therefore, at this stage, the main activity of this WP will be to produce a cost estimate with a maturity level defined by top management. This work should be done in close cooperation with the activities of WP1. This WP will therefore have to:

- Define the cost estimate methodology;
- Identify the stakeholders;
- Produce the cost estimate by defining its boundary conditions and main assumptions.

As previously mentioned, the setting up of the EVM framework for the project management and the budget and schedule reviews, is shared between WP4 and WP5.

WP5 Responsible – Financial Manager.

5.6) WP6. Quality management.

The main deliverable of this WP will be to set up the Quality Plan. In this context WP6 will also oversee the organization of the Quality Assurance reviews and audits.

The other core activity is to provide an operative and general change request process, supported by the appropriate informatic tools for its implementation in collaboration with WP8,

The other processes included in WP6 are:

- the nomenclature editing;
- the nomenclature change request;
- the document lifecycle process definition and the choice and acquisition of the dedicated software;
- the establishment of the document repository database, in collaboration with WP8, to match the requirements of the Configuration Management;
- definition and implementation of project changes, both for modifications to the technical baseline (ECR, following prescriptions defined in WP8) and violation of requirements (NCRs).

WP6 Responsible – Quality Manager.

5.7) WP7. Risk management.

The basic processes for the risk management are:

- *risk identification*, namely the risk recognition and their source identification;
- *risk evaluation*, namely the determination of the occurring likelihood and the impact evaluation. This provides a risk order of priority;
- *risk handling*, namely the process that identifies, evaluates, selects, and implements various options to obtain an acceptable risk threshold compliant with the constraints and objectives of the project. It includes what must be done, when, who is responsible for it and the related cost and schedule;
- *risk controlling*, namely the continuous reporting and monitoring of both risks and their management processes.

All these aspects are considered and illustrated in the WP7 main deliverables, the Risk Register and the Risk Management Plan. WP8 shall also provide the TRL classification for the systems and proposed R&D technology, following the EU standards [7].

WP7 Responsible – Risk Manager.

5.8) WP8. Configuration and change management.

The project Configuration is supposed to provide time snapshots of the global project parameters' status, thus controlling the alignment of the project baseline

definition with the implemented modifications. The main process shall provide the Configuration Management Plan where:

- the Configuration Management strategy is described;
- the Configuration Schedule is given with the milestones;
- the Configuration terminology is defined;
- the responsibilities are assigned;
- the Configuration and the Configuration Change Request procedures are illustrated. Different modifications category must be identified, and the modifications impact evaluated;
- the working tools are described.

Configuration management will include the editing of the Requirements Register (RR) and in the Requirements Management Plan (RMP). In the RR all the project requirements shall be listed inserted with an appropriate hierarchical structure and coding to track their interdependence. In the RMP the dynamical management of the requirements is described, including the change processes.

After this process the first step is to set up the project baseline configuration by:

- choosing the appropriate physical and non-physical configuration items (CI) with the associated parameters;
- define the critical issues in respect to modifications;
- provide the Configuration Items interfaces.

This must be supported by the insertion of the configuration data into a relational database linked to a CAD tool.

Configuration Change process shall be integrated into the project lifecycle and, periodically, the nth level configuration shall be reviewed. The project snapshots will be provided by the Physical and Functional Configuration audits, generating the Configuration Progress Reports.

WP8 responsible – Configuration Manager.

5.9) WP9. Commissioning and operation management.

The main activity of this working package is the editing of the Validation Plan and its modification procedures. This document describes the strategy that is agreed to be followed, in different phases, to demonstrate to the ET Project Board and the other Authorities that the final deliverable is compliant with the requirements.

The Validation Plan is a fundamental document since it provides to the project the agreed framework for the transition of two project lifecycle nodes:

- a) Construction to Commissioning.
- b) Commissioning to Operation.

In this framework the main contents of the Validation Plan are:

- Integrated hardware and sub-systems performances parameters to be measured to validate transition a);
- facility and systems performances, to be satisfied to validate transition b).

This must be complemented by the measurement's description including the envisaged techniques, the tools, the standards, and the expected results.

The results of the measurements in the different phases must be illustrated in the Validation Reports.

The commissioning management processes must also generate the operation manuals for the operation team training and the operation management plan to organize this phase.

WP9 Responsible – Commissioning Manager.

5.10) WP10. Communication management.

All the WPs' activities in the project office shall be efficiently communicated and shared with the various stakeholders, through defined procedures and channels. In this context the project office's communication manager must therefore:

- identify the different Project Office internal communication contexts (project report, budget and schedule report, reviews outcomes...);
- identify the stakeholders involved in the different contexts;
- establish the right channels and methodologies for communicating the results of activities;
- provide the information following the proposed methodologies;
- collaborate with the communication office for the sharing of the information to be treated at general level.

WP12 Responsible – Communication Manager.

5.11) Project Office support

This activity is dedicated to the different activities assisting the application of the project management methods across the project office. Three main support classes have been individuated:

- IT support. This includes the identification, the acquisition, the configuration, the maintenance and the user support for all the IT tools employed in the different PO assets. It also foresees the development and the maintenance of the configuration relational database.
- PO Assistant. This resource must provide the daily practical, administrative and organizational assistance to the ET-PO components.

- Audit and Review Coordinator. In different WPs many verification and validation processes will be represented by internal or external reviews and audits. This will require a considerable effort in the organization and the harmonization of these processes' procedures.

Activities Managers– IT Manager, PO Assistant, Audit and Review Coordinator.

6) The setting up of the Project Office

To fulfil its duties the project office will be set up by professionals with different skills and professional profiles.

The Project Office, in its minimal configuration, should consist of the PO Coordinator, the person in charge of the technical coordination and the planning, the IT Support Manager, the Project Office assistant, the Audit Coordinator, the Risk Manager, the Configuration Manager, the Commissioning Manager, the Quality Manager, the Communication Manager, the Schedule Manager and a System Engineer.

Other professional profiles can be added to the future organization, following the requirements and the constraints set by the work organization.

References

1. M.D. Watson, B.L. Mesmer and P.A. Farrington: Engineering Elegant Systems: Theory of Systems Engineering. NASA/TP–20205003644;
2. OpenSE booklet, version 1.0, February 2016. Available at: <https://opense.web.cern.ch/framework>;
3. P. Bonnal et al. "openSE: a Systems Engineering Framework Particularly Suited to Particle Accelerator Studies and Development Projects" in *Proceedings of the 7th International Particle Accelerator Conference (IPAC2016)*, Busan, Korea, 2398-2401;
4. ET Coordinators "Mandate for the ET Directors for the 'Design and Preparatory Phase I and description of the project organization under their responsibility in Phase 1"; <https://edms.cern.ch/document/3161920/1>
5. openSE WG: Setting up a ProjectManagement System. Drafting and Releasing a Project Management Plan, Geneva, Switzerland. openSE Guidelines no. 1000;
6. PMBOK® Guide (2021), seventh edition;
7. "Technology readiness levels (TRL); Extract from Part 19 - Commission Decision C (2014)4995" . ec.europa.eu. 2014. Retrieved 11 November 2019.



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Observatory

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project management*

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Executive Summary

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This document describes the Functionalities required from the tools in support of the ET Project Office in the Preparatory Phase. This document describes for each expertise or project management domain the requirements and the assessed tools that will be proposed at the end of the ET-PP phase.

Reference Documents

Ref	Title	Version
[1]	D5.1 Project Office structure and mandate	2.0
[2]	D5.3 Structure and Mandate of the Engineering Department	1.0
[3]	WBS/PBS Organization	1.0
[4]	Configuration Management Plan	1.0
[5]	Requirements Management Plan	1.0
[6]	ET PBS Database & Application	0.1
[7]	ET PBS WG report	0.1
[8]		
[9]		
[10]		
[11]		

List of acronyms and abbreviations

CAD	Computer-aided design
CAE	Computer-aided engineering
CDR	Conceptual Design Report
CE	Civil Engineering
ED	Engineering Department
EDMS	Electronics Data Management System
EMR	Euregio Meuse-Rhine
ESFRI	European Strategy Forum for Research Infrastructures
ET	Einstein Telescope
ET-PO	Einstein Telescope Project Office
ET-PP	Einstein Telescope Preparatory Phase
ETO	Einstein Telescope Organization
GW	Gravitational Waves
OBS	Organisation Breakdown Structure
PLM	Product Lifecycle Management
RACI	Responsible, Accountable, Consulted, Informed
TDR	Technical Design Report
TETI	Team for Einstein Telescope in Italy
WBS	Working Breakdown Structure
WP	Work Package
WYSIWG	What You See Is What You Get

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1. Project Office working goals

The Einstein Telescope Project Office (ET-PO) will set up the project management environment for the construction of the ET Research Infrastructure (RI). The ET-PO will define processes and tools for planning, implementing, monitoring, control and reporting the entire project management during all the different phases (concept, design, manufacturing, reception, integration, validation and commissioning).

In particular, the ET-PO will provide executive support for key project objectives, such as:

- establish agreed and efficient decision-making processes;
- define and maintain science and technical requirements;
- flow-down requirements and their dependencies at all levels;
- identify expectations and resources constraints from the stakeholders;
- capture requirements, constraints, and interfaces into a technical baseline;
- provide a schedule and budget management framework
- kick-off and control the project baseline implementation;
- introduce and monitor the processes of technical and processes change requests
- report the progress to the stakeholders.

All these activities shall be developed in line with the main ET-PO mandate [1].

The ET-PO will need to select and adopt suitable IT tools to support this work in each expertise domain covered by Project Management processes.

This document defines the requirements for this task and a list of specific functions required to the tools that will be selected by the PO in consultation with ET project executive boards.

We describe for each tool the evaluation process implemented and preliminary conclusions and recommendations.

This document is the D5.2 deliverable of the WP5 of the ET-PP HORIZON-INFRA-2021-DEV-02 proposal.

2. General Requirements

With reference to the ET-PO Mandate and Structure document, the PO activity is organized in ten areas of expertise, which we call Working Package (WP).

Each WP will need to rely on specific IT tools for developing, sharing and delivering its outputs.

As significant data, which evolve with the project, are shared across many WPs (eg PBS, WBS, schedule), a general requirement is that **the tools used in different WPs reference to the same database of project deliverables and therefore have an I/O function towards external data.**

This database, shared by the different work packages, is the subject of a specific chapter.

For some years now there has been PLM (Product Life Management) software which would seem to group together, in an Enterprise Project Management (EPM) framework, the main functions required by the PO's work groups. A special chapter at the end of the document will present an analysis of the leading products on the market and our analysis and evaluation of this type of tool.

On the other hand, some flexibility in the choice of tools may be motivated by the existence of multiple stakeholders and collaborators, with specific constraints in the choice of tools and/or formats (eg open-source vs licensed tools, procurement practices across different administrations ...).

We shall therefore first list general requirements for all tools, and later indicate requirements for specific functions or needs

Each IT tool for each expertise or WP to be adopted by the ET-PO shall:

1. Be cloud based with server-side backend for data storage and backup. In this context European rules require that the tools used, and the associated data be stored on servers in one or more EU member states;
2. Enable simultaneous use by several users, by means of multiplatform web interfaces, thus allowing collaborative work distributed between all the members participating in the ET project;
3. Implement secure user identification for data checkout and check in. Implementing access rights to certain areas of the database and to certain functions of the tools deployed;
4. Implement version control and comparison (track history of an object or product);
5. Offer the ability to securely share data in real time with internal and external stakeholders.
6. Ability to customize information and dashboard adapted to each internal or external stakeholders;
7. ensure integration with other existing databases or systems and with other tools used by the ET-PO or other ET project teams;
8. Be compatible with required support contractors and/or suppliers (i.e., can accept data from a third party as required);
9. Be available and maintained for the entire duration of the project (which means at least two to three decades for ET projects). This parameter of tool durability is crucial but extremely difficult to guarantee.
10. Allow updates with a strong maintenance policy.

3. The Project Office list of tools

While the work of the ET-PO is organized in WPs with specific deliverables, there will be significant overlap of data and software tools across different WPs and identifying specific tools with single WPs is not necessarily the best choice.

We shall instead ensure the full coverage of the PO IT needs by matching the PO activities to a list of functions, as typically administered by commercially available PM software tools, which will be exercised in the PO working units. The table below reports such activities in each row, and their main correlation with functions of standard project management tools which are reported in the columns.

We shall identify these functions in the specific classes of IT tools and define requirements for all of them in the remainder of this document.

For each function, we will indicate the tool selected and evaluated where appropriate.



4. Functions of Work-package requirements and tools evaluated

The following chapters describe the specifications and requirements for function or expertise as well as the tools evaluated and proposed to meet the needs refers to each work package.

At the end of this document, a table of links to more detailed information via web links lists each tool evaluated.

4.1. Project Management requirements

As generic as this definition might sound, the ordinary functions offered in this area by commercial software cover time and resource management, with a solid anchor to the project WBS/PBS organization [3].

The PM tool to be adopted by the ET-PO shall therefore:

1. The PM is responsible for setting up and monitoring a project organisation in this way the PM tool has to allow. To this end, the tool or tools used must provide an overview of all the activities of each part of the project through dashboards and relevant associated indicators.
2. The tool must enable problems encountered during the course of the project to be monitored, as well as the actions taken on a daily basis to resolve them.
3. Offer multiple visualizations of the time sequence (table, Gantt chart, Kanban dashboard);
4. Manage costs, separating actual costs from planned costs at the overall project level and at the level of each sub-project. Each sub-project should be the responsibility of different organisations (countries, laboratories or private companies).;
5. Refer to the project resource pools (organisation chart and general human resources). To report on the time spent at the level of each sub-project and at the level of the overall project, enabling the involvement of staff and the associated salary costs to be monitored.
6. Offer interface to a portfolio manager to allow a project tailoring decomposition (e.g. for structuring the various ET-PO WP as separate projects within the same portfolio);
7. Allow export of time, budget and resource summary data at specified dates and for specific periods of activity.
8. Integrated document life cycle for a complete workflow of validation, versioning, traceability and ensure the archiving and protection of all project-related documents ET.

4.2. Project Management tools evaluated

ID Requirement	Easyredmine	MS Project Server	EDMS CERN	JAMA Connect
1	OK	OK		
2	OK	OK		
3	OK	OK		
4	OK	OK		
5	OK	OK		
6	OK	OK		
7	OK	OK		
8			OK	

4.3. Documents repository requirements

The document management system is a general underlying service common to all functional areas of a project. Besides the general requirements listed above, any content management solution shall:

1. Allow multiple level of access and data segregations in response to specific permissions associated to single or groups of users;
2. Implement a complete version control and traceability;
3. Allow concurrent editing from multiple users with revision tracking and comments management;
4. Implement document lifecycle management and approval workflow including notifications processes;
5. Offer dedicated storage options for classified documents, possibly by interfacing remote, proprietary backend servers;
6. Offer a user-friendly, complete, powerful search engine, ideally with full text search capability extended to the entire document and not limited to the document metadata (title, file name, originator ...);
7. Allow easy ingestion and further management of documents generated with the document system currently in use within the ET Collaboration (TDS).
8. Allow storage and handling (directly or interfacing with another platform) of CAD files.

4.4. Documents Repository tool evaluated

ID Requirement	Easyredmine	MS Project Server	EDMS CERN	JAMA Connect
1			OK	
2			OK	
3			OK	
4			OK	
5			OK	
6			OK	
7			OK	
8			OK	

During the process of evaluation we have evaluated EDMS CERN but also ATRIUM IN2P3 and Alfresco.

4.5. Configuration Management requirements

A Configuration Management Plan (CMP) details the methodology that the project manager, systems engineer and relevant project collaborators will use to control the programme documentation and the programme baseline (technical, functional and allocated).

It is a tool and methodology used within a project or programme to define, document, control, instruct, implement and manage changes to the various components integrated into subsystems throughout a project.

Configuration management programmes ensure that the construction, operation, maintenance and testing during the integration of the physical installation are consistent with the design requirements as expressed in the design documentation, and that they maintain this consistency throughout the operational life cycle phase, particularly when changes are made, especially for ET during the phases of upgrade installations to increase detection sensitivity.

These basic relationships are illustrated in Figure 1 : Work Processes must ensure that: 1) Elements conform all the time 2) All changes are authorised 3) Conformance can be verified

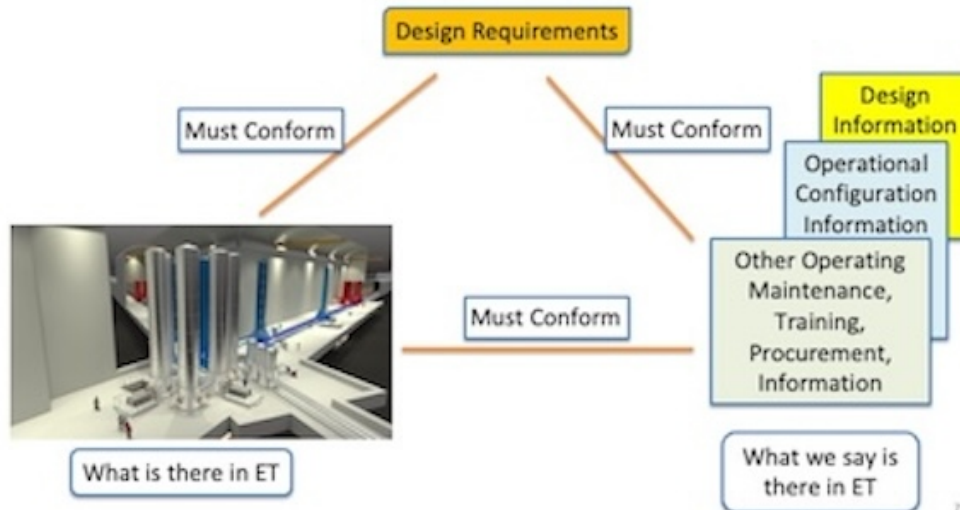


Figure 1: Relationships between design, manufacturing and integration/operation

A wiki page dedicated specifically to the CMP has been created, providing a summary of all the requirements relating to this very important area of the project, to ensure that the configuration is monitored throughout all phases of the project, from design to operation and updates. ([Configuration Management Wiki page](#))

The selected CM software shall:

- 1.Enable management of configuration items (CI) and configuration data (CD);

2. Implement configuration rules for baseline identification;
3. Manage bill of materials (BOM);
4. Manage change process, including notifications and reporting;
5. Track as-designed and as-built configurations;
6. Export configuration changes for audits and periodic reports;
7. Report delivered configuration for certification and warranty.
8. Manage CI identification and visualization in CAD environment.
9. Strong synchronization with other (PLM/CAD/Sim/...) software packages
10. Workflow of change request/revision for requirements.

4.6. Configuration Management tools evaluated

After an analysis of more than 5 tools (Jama Connect, Regsuite, Visure, IBM DOORS and PT Codebanner) the choice of JAMA Connect seems to be a good candidate, evaluation in progress with a view to meeting the following requirements: 1 to 10 (To Be Check)

ID Requirement	Easyredmine	MS Project Server	EDMS CERN	JAMA Connect
1				OK (TBC)
2				OK (TBC)
3				OK (TBC)
4				OK (TBC)
5				OK (TBC)
6				OK (TBC)
7				OK (TBC)
8				OK (TBC)
9				OK (TBC)
10				OK (TBC)

4.7. Interfaces management requirements

Effective interface management goes beyond keeping track of relationships in periodic static tables, whether they are physical connections between sub-systems or hierarchical representations of requirements.

It instead follows the evolution of the interfaces with the system configuration as tracked by the CM service and through its proper authorization flow.

Consequently, the IM management tool for the EP-TO shall:

1. Tag and release a reference interface table and/or diagram;
2. Tag and release the hierarchy of requirements;
3. Keep track of the history of the changes to the interface matrix;
4. Integrate a change request system which shall highlight all the elements (physical and requirements) connected to the requested change and force cascaded updates to all related objects (documents, procedures, design and drawings), in compliance with the role-based permissions set by the organization.

4.8. Interfaces management requirements tool evaluated

After an analyze more than 5 tools (Jama Connect, Regsuite, Visure, IBM DOORS and PT Codebanner) the choice of JAMA Connect has been done and this tool is currently being evaluated with a view to meeting the following requirements: 1 to 4.

ID Requirement	Easyredmine	MS Project Server	EDMS CERN	JAMA Connect
1				OK
2				OK
3				OK
4				OK

4.9. Users Communication management and training support

The project office is responsible for internal relating to the project. To this end, various communication tools as well as information dissemination and change management support for employees must be put in place and evaluated in order to meet the following requirements.

The PO will organize frequent online meetings and point-to-point working sessions and shall rely on a communication tool that:

1. Is delivered by cross-platform, web-based applications, accessible from portable devices (smartphones and tablets);
2. Allow access of separate groups of registered users as well as external guests from outside the organization;
3. Include calendar of events and notifications of planned events;
4. Allow real-time group meetings without prior scheduling;
5. Includes public group and private chat services;
6. Enables meetings recording and playback.
7. Provide strong change management support to project staff to ensure that they fully embrace the project culture based on international project management standards.
8. Generate both written report and summary presentations
9. Apply projects templates for needs (reports, presentations, reviews organisation, indicators)

4.10. Users Communication management and training support tools evaluated

ID Requirement	Easyredmine	MS Project Server	EDMS CERN	ZOOM	Youtube Channel
1	OK	OK			
2	OK	OK			
3	OK	OK			
4				OK	
5				OK	
6				OK	
7					OK
8			OK		
9			OK		

4.11. Project Workflow management

Definition and control of the project workflows will be managed using a dedicated tool that allows establishing decisional and executive processes, monitor the status of all active flows, and provide feedback to the stakeholders involved.

The tool implementing the ET-PO workflow management shall:

1. Represent workflows with WYSIWIG, user-friendly, code-free graphical representation;
2. Feature a role-based user accessibility;
3. Implement a dynamical user assignment and e-mail notification system;
4. Offer a control dashboard on the status of the active workflows with increasingly complex information on the advancement of the flow and its level of completion (eg simple done/not-done indicators, semaphores, full color-coded SLA indicators);
5. Include reporting capabilities.

4.12. Project Workflow Management tool evaluated

ID Requirement	Easyredmine	MS Project Server	EDMS CERN	JAMA Connect
1			OK	
2			OK	
3			OK	
4			OK	
5			OK	

4.13. Budget and Resources management

As part of the ET-PP project, a specific work package will study and propose the legal and financial organisation of the ET project, work package 4.

We only mention here the budgetary organisation of the project office linked to the ET technical project.

The breadth of these functions spans a vast variety of scales, both in the area of finances, eg from top-level monitoring of the funding agencies contributions to single research unit specific parts procurement, and in the area of human resources, eg from generic allocation of professional resources down to the tracking of individuals' timesheet.

As of now, it will suffice to state general considerations to be considered when evaluating tools that implement functions in these areas:

1. Security: both storage and access to sensitive financial information shall require secure and controlled access;
2. Cost: tools for managing finances and purchase orders can have significantly different costs depending on the level of integration and scale they offer, and should therefore be tailored to size of the organization and fit a pre-allocated budget;

3. Remote versus local storage and operations: while a general requirement for the ET-PO tools is to rely on cloud-based applications, both security and practical considerations (eg use in case of limited internet access) might relax this requirement. It should be noted that on-premise installations are in general more expensive;
4. Compatibility with partner institutions financial department tools: while a full interoperability may not be possible or even desirable, a very close link to accounting and financial management at participating institutions through tools and budget code structures is highly recommended; the possibility to extract and import relevant data for reporting purposes should be granted as a minimum.
5. Reporting on the time spent on the project for all employees in order to be able to detail the consolidated budget including salaries and employee involvement.
6. Capability to export to financial department all informations relative to the technical project with a good compatibility and import data with specific Financial Department too

4.14. Budget and resource management tool evaluated

Several tools are currently being evaluated, although the Easyredmine tool could meet our needs in terms of reporting and budget monitoring. The export data compatibility to financial department tool has to be verified.

ID Requirement	Easyredmine	MS Project Server	EDMS CERN	JAMA Connect
1	OK			
2	OK			
3	OK			
4	OK			
5	OK			
6	OK			

4.15. Database Management

A centralised database for recording and managing information from the whole project office is necessary and must answer to requirements:

1. Centralised database with web access and user's rights management
2. Merge and manage different informations related to WBS, PBS, Parameters, and others CI
3. A dropdown capability to follow the PBS organization to simplify the research and relations hierarchy inside the PBS levels and interfaces.
4. Upload and download csv file format to upgrade the database
5. Export reports and informations in standard format
6. Capability to interface others database of the project.
7. Provide a full filters capability for data searching perhaps with new AI based technology.

4.16. Database Management Tool evaluated

A web application (App) including a database (DB) with a front-end and a back-end system has been developed in order to manage the large number of elements and the large number of parameters associated to each element.

This application is designed to be used by a large number of ET collaborators who will have to maintain up-to-date information on their system, to keep track of modifications through change-request procedure, and to provide precise information about interdependency between elements.

This data base is operational and evolutes according to additional requests.

4.17. Risk Management

Risk arises from the potential occurrence of specific hazard during a project's lifecycle that can impact the project success negatively. A project's objectives are assessed in terms of its ability to be delivered on time and on budget, while meeting its performance and safety requirements.

Risk management aims to identify, assess, and prioritize potential risks that could impact the project's objectives.

The main purpose of a risk analysis is to develop a consistent mitigation strategy across the entire project. That is, which risks are acceptable and which require action.

Risk management shall be used over the course of the development and implementation phases of the project.

The importance of risk management in project management is critical for large-scale projects. Where high costs are associated with very low risk tolerance.

Einstein telescope obviously falls into this category, but is all the more vulnerable because of its complexity.

A specific wiki page has been written to describes Risks management policy and organisation ([Risks Management Wiki page](#))

The tool implementing the ET-PO Risks management shall:

1. Provide a comprehensive understanding of risks and their potential impact
2. Creation of a risk register and editing of risk reports
3. Ensure harmonisation of risk management across all systems and subsystems following PBS organization levels.
4. Allow a strong effective risk mitigation strategies with a complete traceability of analyse and action to mitigate risks.
5. Foster collaboration and feedback among all stakeholders by reporting and indicators like risks matrix and others graphics.

4.18.Risks Management tool evaluated

After an analyze more than 5 tools (Jama Connect, Regsuite, Visure, IBM DOORS and PT Codebanner) the choice of JAMA Connect has been done and this tool is currently being evaluated with a view to meeting the following requirements: 1 to 5.

ID Requirement	Easyredmine	MS Project Server	EDMS CERN	JAMA Connect
1				OK
2				OK
3				OK
4				OK
5				OK

4.19.Schedule Management

Project management is a multifaceted discipline that involves planning, executing, and closing projects. At the heart of successful project management lies an efficient scheduling process. Scheduling is a critical component that helps organizations allocate resources, manage timelines, and achieve project objectives in a systematic manner.

The particularity of ET project is to have a big organization with more than 1800 collaborators around the world mainly in Europe.

In order to deploy a schedule management tool inside a type of huge scientific project, the tool shall:

1. To be accessible by web application to garanty maintenance, upgrade and accessibility by any collaborator independently of OS used.
2. The schedule of the project has to be upgraded and followed in real time.
3. Each Project's Manager (PM, estimated at 200) should be able to organize the different projects and subprojects under his responsibility and be able to report in the best possible way both technical & financial resources and requested collaborator's level of involvement in the project (see picture below)
4. It has to be a support reporting tool for ET governance and useful indicator for effective management of the project for the European Union supervisors.
5. visualisation of global project's progress in real time in various forms (especially Gantt) with display of the critical path in particular; visualisation tools in the form of customisable dashboards with indicators and alerts.
6. the tool must be accessible online with any operationg systems for viewing only by a total of ~1300 collaborators and accessible for modification by ~200 project managers in charge of the different sub-projects; likewise if a milestones in a sub-project is delayed, the impact on the overall project schedule must be instantly known.
7. the storage, protection and durability of the information contained on the servers must comply with European Union regulations and cover the entire lifespan of the project (several decades).

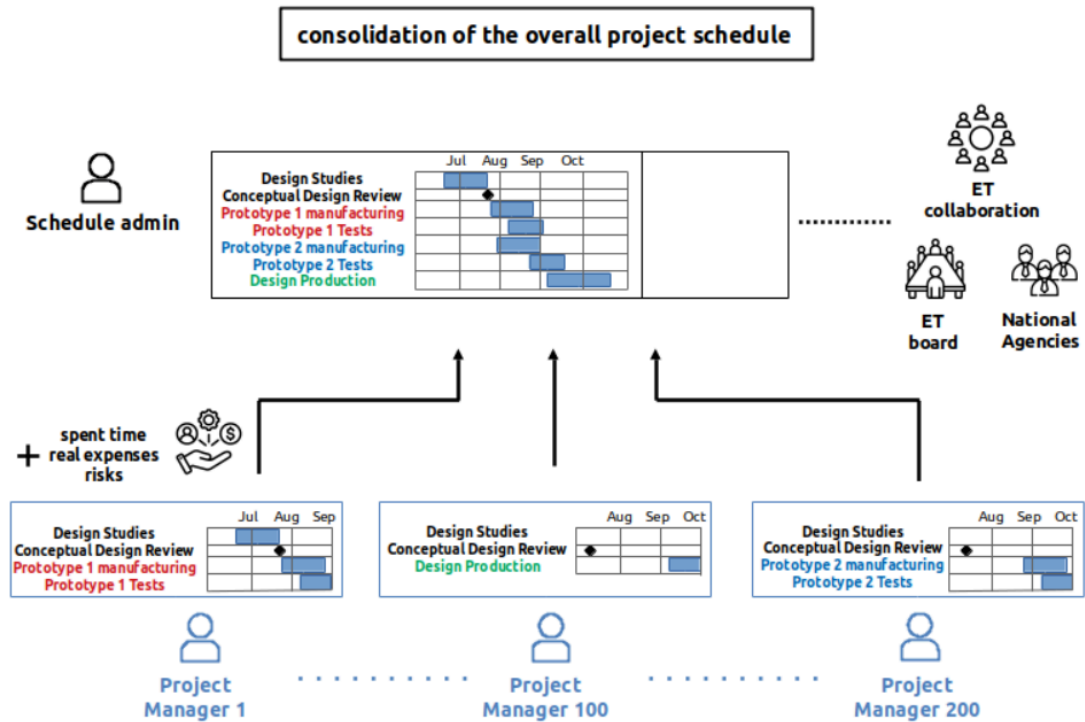


Figure 2: Consolidation in real time of project's schedule by few hundred sub-projects.

4.20. Schedule management tool evaluated

Two tools are currently being evaluated with a view to meeting the following requirements: 1 to 7

ID Requirement	Easyredmine	MS Project Server	EDMS CERN	JAMA Connect
1	OK	OK		
2	OK	OK		
3	OK	OK		
4	OK	OK		
5	OK	OK		
6	OK	OK		
7	OK	OK		

5. PLM tool analyse and evaluation

The needs of major industrial projects have led specialist companies to design, propose and deploy tools. PLM (Product Lifecycle Management) is an information management system. It integrates data, processes and business systems throughout the entire product lifecycle.

With PLM software, you can reduce time to market, improve quality and sustainability, increase efficiency and reduce costs by making more informed decisions.

In fact, few PLM can potentially answer all the functions requirements described above.

The main advantage of deploying this type of tool, which brings together all the functions described above, is that it enables all the project data to be exchanged and made co-extensive, without the need to develop interfaces and bridges between the different tools.

What's more, the coverage of this type of tool extends from 3D design to manufacturing, monitoring and product configuration, so it covers the entire design-to-integration chain and not just the project management needs of the project office.

Today we are in discussions with the three leaders on the market (Dassault, Siemens and CERN ARAS). The main difficulty is to have the possibility to evaluate these tools, to access of all modules needed for ET project without have a huge financial investment.

We hope to start the evaluation of Siemens and Dassault PLM tool before the end of 2024 with the aim is to have feedback on the possibilities and cost estimation of these tools in order to assess the advantages and disadvantages between specifics tools and global unique tool like PLM.

6. Conclusions

The choice of the right IT tools to support the ET-PO activity descends from the analysis of the PO mandate and the deliverables assigned to its Work Packages.

Availability of commercial, licensed or proprietary software, as well as heritage tools help but not drive the selection.

This document provides a general, complete list of requirements generated by reviewing the WP tasks and list a certain number of tools which have or are currently being evaluated.

At the end of the preparatory phase, the Project Office will be able to propose a set of tools which will have been the subject of a complete evaluation and will be able to meet the requirements of the PO.

7. Table Tools Links

This table lists the different links of the tools evaluated as part of the Project Office team for.

JAMA Connected	Link to JAMA Connected website
EASYREDMINE	Link to Easyredmine website
MS Project Server	Link to MS Project Server
EDMS CERN	Link to EDMS CERN
TDS EGO	Link to TDS EGO
TEAMS	Link to TEAMS by Microsoft
YOUTUBE	Link to ET Youtube channel training
3D Experience	Link to Dassault 3D Experience PLM tool
SIEMENS	Link to Siemens PLM tool



Preparatory Phase for the Einstein Telescope Gravitational Wave
Observatory

Deliverable D5.3

*Structure and the mandate of the Engineering
Department*

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Executive Summary

This document, D5.3, Structure and the mandate of the Engineering Department, is a deliverable of the ET-PP Project, which is funded by the European Commission Framework Programme Horizon Europe Coordination and Support action under grant agreement 101079696.

This document describes the structure and the mandate of the Engineering Department for establishing the Einstein Telescope Infrastructure and special systems. The report also includes the description of the teams in the Engineering Department, the resources needed for phase 1 and the engineering tools needed for working effectively and efficiently together.

List of acronyms and abbreviations

CAD	Computer-aided design
CAE	Computer-aided engineering
CDR	Conceptual Design Report
ED	Engineering Department
EMR	Euregio Meuse-Rhine
ESFRI	European Strategy Forum for Research Infrastructures
ET	Einstein Telescope
ET-PP	Einstein Telescope Preparatory Phase
ETO	Einstein Telescope Organization
GW	Gravitational Waves
PLM	Product Lifecycle Management
MoU	Memorandum of Understanding
TDR	Technical Design Report
TETI	Team for Einstein Telescope in Italy
WP	Work Package

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1. Introduction

The underground Einstein Telescope (ET) will be a research infrastructure using state-of-the-art technologies to measure gravitational waves. The Engineering Department (ED) will provide the competences required to design, install, operate, maintain and eventually disassemble the Einstein telescope complex and its facilities.

In 2023 the Einstein Telescope Organization (ETO) was established by the ET ESFRI Project Coordinators [1]. In this mandate the ET directors are mandated to setup and manage the organisational structure of the ETO (phase 1 of the Preparatory Phase). INFRA-Dev WP5 provided the framework for the Engineering Department, which is now fully integrated into the ETO.

This document describes the structure and the mandate of the Engineering Department. The structure and mandate of the CERN technical departments [2] was used as an initial guidance to formulate the structure and the mandate for the Engineering Department.

The life cycle of the Einstein Telescope project, and thus the Engineering Department, will go through different phases with their own specific objectives:

1. Preparatory Phase 1: This phase will end with the selection of the ET site(s). The deliverables of this phase will provide all the documentation needed for the decision: preliminary TDR*, costing overview, risk assessment, planning report and, organizational report;
2. Preparatory Phase 2: This phase will end with the approval to start the construction of the ET infrastructure. The deliverables of this phase will provide all the documentation in its final form needed for the approval: final infrastructure TDR, bid and costing overview, risk assessment, planning report, organizational report;
3. Implementation Phase: this phase will end with the Einstein Telescope commissioned.
4. Operation phase: during this phase frontier research will be produced and upgrades developed.
5. Termination phase: this phase will end with the Einstein Telescope dismantled.

During the different phases of the project life cycle, the activities of the Engineering Department will change: plan versus reality. Specifically in phase 1, the mandate of the engineering Department may change if the ETO Director's mandate or the role of ETO within ET changes. For this reason, the structure of the Engineering Department will have to be flexible and able to adjust to changing factors, conditions and environments. Regular evaluation of the department's mandate and structure will ensure alignment with the Engineering Department's objectives.

* Preliminary TDR: The first version of the TDR containing all the required technical information for site selection.

2. Mandate

The Engineering Department is mandated for the design, procurement, installation, commissioning, operation, maintenance and eventually dismantling of:

- The civil and technical infrastructures needed to host the interferometer;
- The special systems needed to operate the gravitational wave detector.

The Engineering Department is active in the following fields:

- Civil engineering construction: shafts, caverns, tunnels, buildings, roads;
- Technical infrastructures: cooling, ventilation, electricity, access and alarms, transport and handling;
- Scientific systems: vacuum and cryogenics;
- Systems for surveying and monitoring;
- Engineering integration, logistics and installation, and safety in the field.

The Engineering Department will provide technical support for:

- Coordination on-site in close collaboration with the project office;
- ET collaboration activities.

3. Structure and Activities

A vertical team structure with the focus on the specific competences is chosen to be able to grow or scale the teams. This type of structure is characterized by organizing employees into separate teams based on their areas of expertise. Figure 1 shows the organization chart of the Engineering Department. The various teams in the chart reflect the mandate and its activities. In the following paragraphs the specific competences and responsibilities of each team is described.

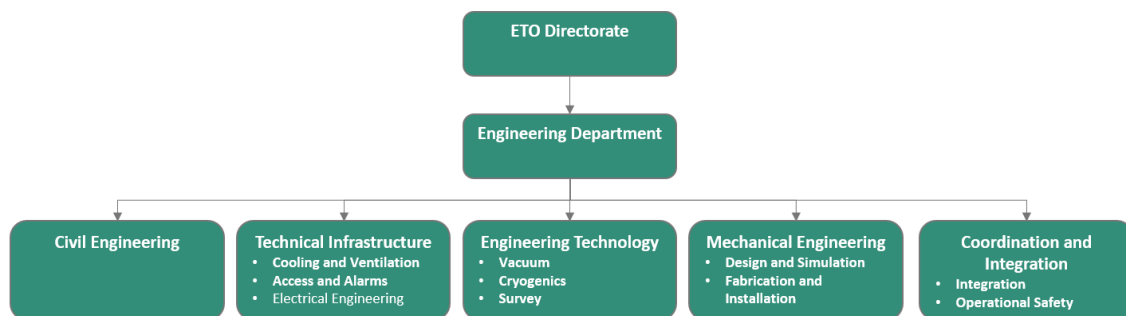


Figure 1: Engineering Department organizational chart

The ET project will go through different phases as mentioned in the introduction. In Phase 1 the teams will be responsible for doing feasibility studies, propose alternatives and carry out investigations for the research infrastructure up to site selection.

In Phase 2 the teams will shift their focus on the technical design of the ET project. This involves detailed engineering and planning for the selected site(s) to ensure the project feasibility and successful implementation. As the project progresses the teams will play a crucial role in implementing the plans and turning the project designs into reality.

The effort of the teams depends on the phase of the project and its status. Table 1 shows the teams and their importance per phase.

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Table 1: Teams within the Engineering Department and their weight. More X means more importance.

	Preparatory Phase 1	Preparatory Phase 2	Implementation Phase	Operation Phase	Termination Phase
Civil Engineering	XXX	XXX	X	X	X
Technical Infrastructure	XXX	XXX	XX	X	X
Engineering Technology	XX	XXX	XXX	XX	X
Mechanical Engineering	XX	XXX	XXX	XX	XX
Coordination & Integration	X	XXX	XXX	XX	XX

The ET Collaboration is responsible for the physics case and the detector design, setting requirements for the activities in the Engineering Department. Within this framework, the Engineering Department is actively collaborating and sharing information with the ET Collaboration.

3.1 Civil Engineering

The Civil Engineering team is responsible for the design, procurement, construction, monitoring, maintenance and eventually dismantling of the underground and surface civil infrastructure.

The activities of the Civil Engineering team are in the following fields:

- Translating relevant scientific requirements into civil engineering constraints, conditions and qualifications.
- Define and supervise studies for underground works: tunnels, caverns, shafts, accesses and recesses.
- Define and supervise studies for surface works: offices and meeting rooms, technical buildings and proximity areas, including roads and natural areas ;
- Structural requirements for the technical infrastructures and other systems;
- Set-up the procedure for the final design of the underground and surface works;
- Environmental impact assessment;
- Procurement and supervision during the construction phase;
- Asset management: inspection and maintenance, digital data management, etc.
- Dismantling.

Two candidate sites are currently under investigation: one in Sardinia (TETI) and one in the Euregio Meuse-Rhine (EMR). Site characterization studies are being carried out by the local teams, the Collaboration and INFRA-Dev WP 4.

The work plan for the civil engineering team in the preparatory phase 1, will be dedicated to the preparation of the preliminary TDR on the configuration, cost estimation and risk assessment for the civil engineering aspects.

3.2 Technical Infrastructure

The Technical Infrastructure team is responsible for the design, procurement, installation, operation, maintenance, renewal and eventually dismantling of the systems associated with the technical infrastructure for the civil infrastructure and the interferometer.

The activities of the Technical Infrastructure team are for the following systems:

- Access and alarms: systems that ensure the safety of the personnel, users and visitors;
- Cooling and ventilation: cooling systems, pumping stations, air conditioning plants and fluid distribution systems;
- Electricity;
- Water management;
- Cleanrooms;
- Dismantling.

3.3 Engineering Technology

The Engineering Technology team is responsible for the design, engineering, procurement, manufacturing, installation, operation, maintenance and renewal of the special systems associated with the interferometer.

The activities of the Engineering Technology team are for the following systems:

- Vacuum beampipe and interfaces with other systems;
- Cryogenic systems;
- Monitoring and Survey;
- Materials management;
- Engineering support to other teams;
- Systems associated with the GW detector;
- Workshop: conventional and CNC machines, welding, cleaning facility, metrology, etc.;
- Dismantling.

3.4 Mechanical Engineering

The Mechanical Engineering team is responsible for the design, engineering, manufacturing, procurement and installation of mechanical systems associated with the interferometer.

The activities of the Mechanical Engineering team are for the following fields:

- Mechanical designs using computer-aided design software.
- Design, integration and feasibility studies related to the transport and handling operations for the GW Detector;
- Workshop with state-of-the-art equipment: conventional and CNC machines, welding, cleaning facility, metrology;
- Sub-contracting
- Responsible for the clean operations;

Deliverable 5.3. Structure and the mandate of the Engineering Department

- Management, maintenance and renewal of all transport, handling and lifting equipment;
- Dismantling.

3.5 Integration and Coordination

The Integration and Coordination team is responsible for coordinating the activities for installation, interventions and changes to the GW detector and its infrastructure.

The activities of the Coordination and Integration team are for the following fields:

- Integration studies and maintenance of the related 3D-CAD representations;
- Organization and scheduling of the installation and interventions;
- Follow up of the planning;
- Coordination of safety in the field;
- Site supervision;
- Support for engineering information management;
- Dismantling.

4. Resources

To successfully complete preparatory phase 1 for the Engineering Department, more resources are needed beyond what is currently available through the INFRA-DEV ET-PP Project, and the in-kind contributions from INFN, Nikhef and IFAE. 20 additional engineers have been identified, to match the goals completing phase 1 by the end of 2026 [3].

Finding qualified personnel through national institutes or universities can be challenging, particularly in the areas such as underground civil engineering, technical infrastructures, and occupational health and safety. CERN and the Einstein Telescope have several similarities, specifically related to vacuum, cryogenics and large underground infrastructures.

ETO has an Memorandum of Understanding (MoU) with CERN for their support on technical subjects. By having dedicated ET human resources inside the different departments at CERN, we benefit from highly experienced specialists and the knowledge available within CERN. Additionally, CERN benefits from a vast network across Europe and beyond, facilitating the identification and recruitment of the right personnel. The Engineering Department should prioritize efforts to hire these engineers from CERN after they have completed their contracts.

Not all development work can be done through in-kind contributions or via CERN. Particularly, industrial developments for civil engineering, technical infrastructure, sustainability, cryogenics, etc., which will need the involvement of commercial companies. A budget estimate of 2.94 M€ has been allocated for these developments.

5. Tools

To be able to full fill the mandate and activities within the Engineering Department tools are needed across the different disciplines and to be able to share information and work together. These different tools include:

- Product Lifecycle Management (PLM) is a software-based system that helps engineering departments manage the lifecycle of their products. It provides a framework for integrating and managing product-related data, processes, and workflows across departments.
- Building Information Modelling (BIM) software is a digital representation of the physical and functional characteristics of a building or infrastructure. It is a collaborative process that involves the creation and management of digital models of a building or infrastructure's design, construction, and operation.
- Computer-aided design (CAD) software: This is software used to create 2D and 3D models of structures and its products.
- Computer-aided engineering (CAE) software: This software is used to simulate and analyse the behaviour of structures.
- Simulation software: This is software used to simulate the behaviour of complex systems or processes
- Office software: This includes tools such as Microsoft Excel, Word, and PowerPoint, which are used for data analysis, report writing, and presentation creation.

6. References

[1] Mandate of the ET Directors, 09.02.2023, <https://apps.et-gw.eu/tds/ql/?c=16590>

[2] CERN, 09/09/2024, <https://www.cern.ch>

[3] ETO request for resources for Phase 1, 26.06.2024