

# ET Civil Engineering Roadmap for Phase 1 Context

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# Objectives



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## ETO-Civil Engineering Roadmap for Phase 1

### Abstract

This document is intended to contribute to the definition of the Einstein Telescope (ET) Roadmap Deliverables in relation to the preparation of the WBS (Work Breakdown Structure) and will only focus on the Civil Engineering activity in Phase 1. The text outlines the key areas involved in designing an underground civil project, starting from the major field deliverables or products that are expected to be prepared by the end of Phase 1 by the different stakeholders engaged in the civil engineering feasibility studies.

### KeyWords

ET Roadmap, Phase 1, civil engineering feasibility design, site investigation, technical systems, environmental assessment, modelling, cost and risk assessment

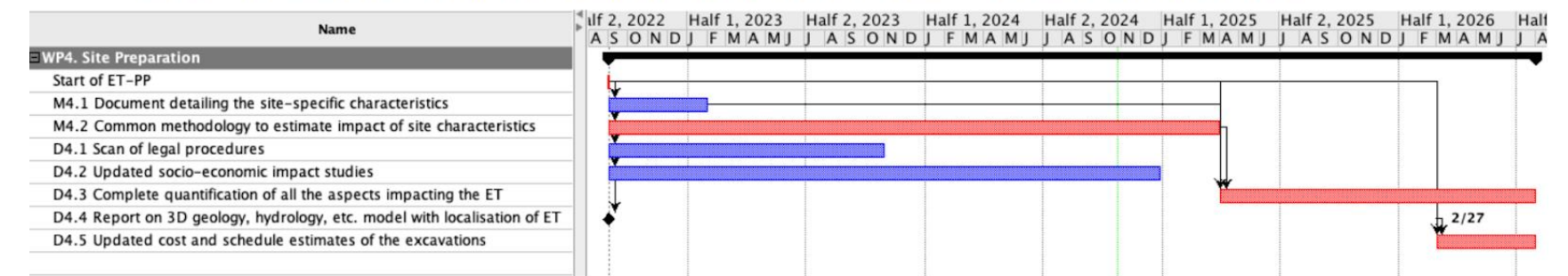
- Contribute to the overall ET roadmap
- Identifying potential gaps and defining responsibility roles for (civil engineering related) deliverables
- Assisting in coordinating activities with local teams involved in the site studies.
- To be agreed upon not just by ETO, but also with the 2 (3?) local teams bidding for ET, both for the **deliverables** and also the **non-aligned schedules** of ETO, LTs & ET-PP
- Clarification on the approach of ETO-ED with local teams is also needed.



# Timeline Discrepancies

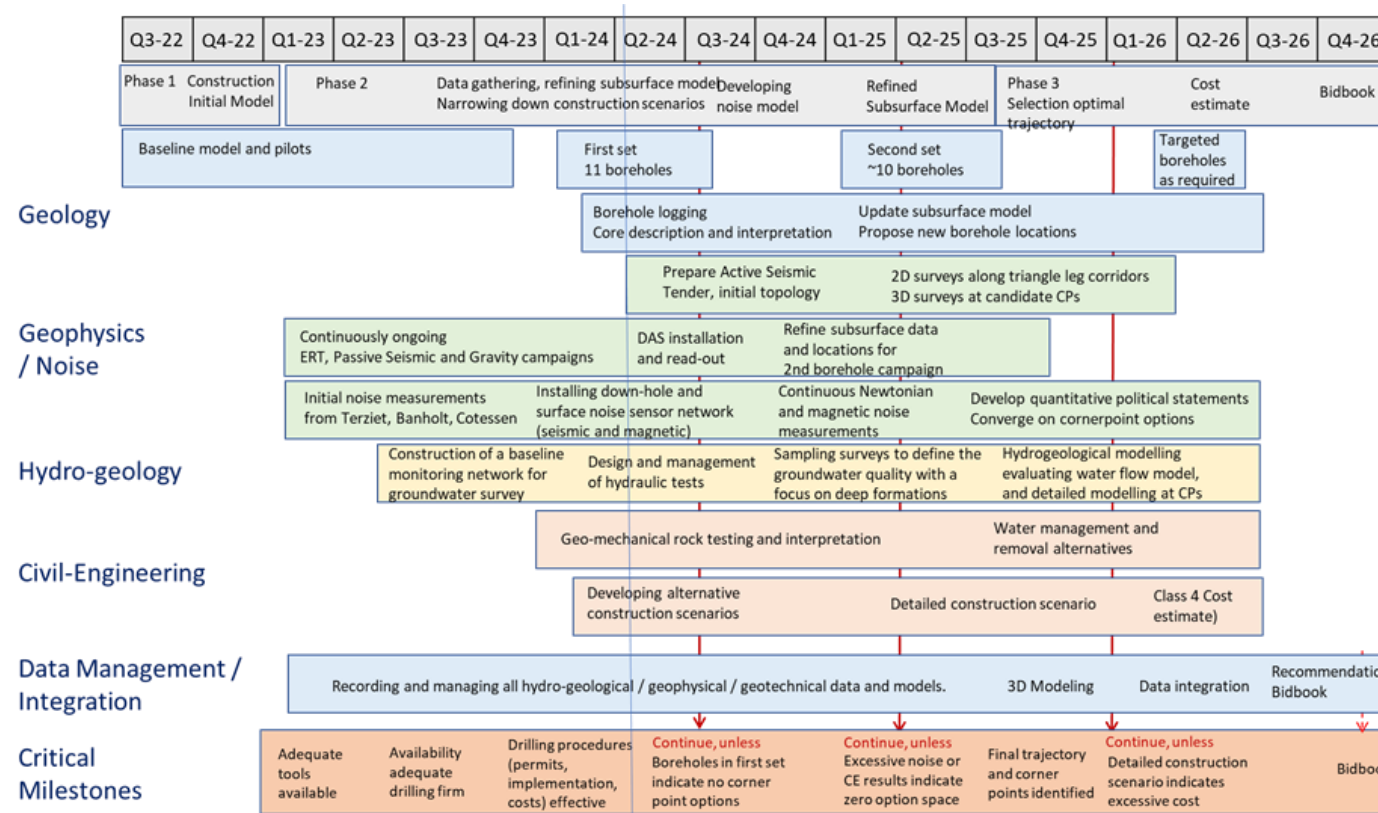
Timeline		2022		2023				2024				2025				2026			
Activities	ET	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
		<b>EMR (Update May 2024)</b>																	
Construction Initial Model																			
Data gathering, refining subsurface model																			
Narrowing down construction scenarios																			
Developing noise model																			
Refined subsurface model																			
Selection optimal trajectory																			
Cost estimate																			
Bidbook defined																			
<b>TETI (Update May 2024)</b>																			
PNNR ETIC_WP6 (30 MONTHS) - INFRASTRUCTURE STUDY																			
Programming - Requirements Framework																			
Drafting of Tender Documents																			
PROCEDURE AND PROCUREMENT (control)																			
Assignment Procedures																			
STATES OF PROGRESS (SDA): contract EXECUTION OF THE SERVICE																			
POSITIONING underground structures																			
CONSTRUCTION underground structures																			
Carrying out INVESTIGATIONS AND SURVEYS																			
SURFACE Works																			
Underground SYSTEMS																			
Estimation of Costs and Schedule																			
OPINIONS AND PERMISSIONS																			

## WP 4: Deliverables and milestones – New Timeline



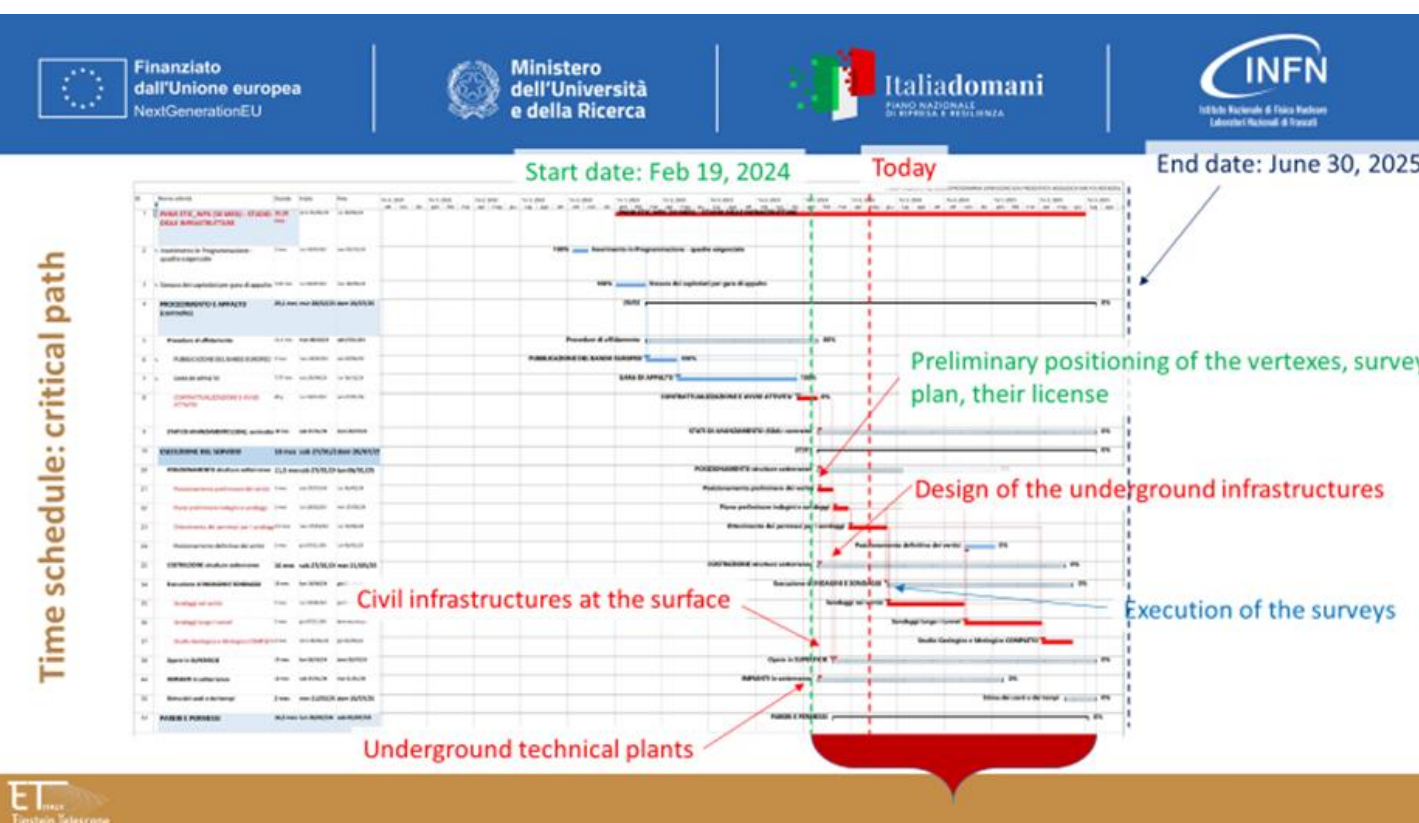
Code	Name	Original date
4.1	Scan of legal procedures	M14/Jun23 => M18/Oct.23
4.2	Updated socio-economic impact studies	M15/Dec23 => M27/Dec24
4.3	Complete quantification of all the aspects impacting the ET performance for each site	M28/Dec24 => M47/Jul26
4.4	Report on 3D geology, hydrology, etc. model with localization of the ET infrastructure	M30/Feb25 => M42/Feb26
4.5	Updated cost and schedule estimates of the excavations	M42/Feb26 => M47/Jul26

**End Jul 2026**



**EMR: End date 2026**

**Lusatsia: ?**



**TETI: End date Jun 2025 (now Oct 2025)**

- Initially intended to have a better understanding of the current plan of events and deadlines tied to civil engineering activities for ET.
- Then to agree upon deadlines of civil engineering related activities and deliverables.
- Master schedule possible to be made?

# Logic behind the organization of the document

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**Grouping of the deliverables, partially work package/working group-based division, but subject to change if necessary, as many aspects are interrelated:**

1. Standards and formats for site studies
2. Technical studies for subsurface assessment and risk analysis
3. Design and construction feasibility assessment
4. Cost and time estimation
5. Environmental impact assessment, permits, and noise mitigation measures
6. Safety and security plan
7. Technical Infrastructure (underground and surface)



# Logic behind the organization of the document

Each deliverable is linked to key information, including

- The **responsible unit** for tasks or WPs,
- **Target delivery dates**, which are not final and subject to change as new information regarding the timelines of ETO, ET-PP, and the local teams are agreed upon and inconsistencies are sorted out
- Necessary **intermediate actions**,
- **prerequisites/required inputs**, and
- its correspondence with the potential **WBS element** (work in progress in ETO-PO).

Standards and Formats for Site Studies						
Deliverable		Responsible Unit-Dept	Target Delivery Date	Intermediate actions	Prerequisite/ Input	Corresponding WBS Element
3.1.1	Standards for data exchange formats, BIM Modelling guidelines, and ET Modelling Coordination including process for model changes and updates	ETO-CE	Q4 2024	Consultation with ET-PP WP8	Confirmed alignment with ET-PP WP8	3
...	...	...	...	...	...	...

# Standards and formats for site studies

Standardize the modelling work methodology for the ET engineering group and to prevent issues related to model compatibility and coordination

With the initial aim to aid the ET taskforce work

**High priority/urgency, since it is a bottleneck in the delivery process of any other document from ETO**

Common methodology for attributing the maturity level of the CE design and subsequent cost estimation

Connected to risk campaign conducted by ETO-PO

To include (among other things) the comparison of the design of all bidding sites. Timeline to be discussed further

Overall ET roadmap related to civil engineering deliverables

Currently "taken over" by ET Taskforce?

Timeline to be discussed further

Timeline to be discussed further

Standards and Formats for Site Studies					
Deliverable	Responsible Unit-Dept	Target Delivery Date	Intermediate actions	Prerequisite / Input	Corresponding WBS Element
3.1.1 Standards for data exchange formats, BIM Modelling guidelines, and ET Modelling Coordination including process for model changes and updates	ETO-CE, ETO-PO-QA	Q1 2025	Consultation with ET-PP WP8	Confirmed alignment with ET-PP WP8	3
3.1.2 Model-based analysis methods (Cost estimation/verification, GIS-BIM combination, Take offs, ...)	ETO-CE	Q1 2025?	?	?	2.2
3.1.3 Validation procedures/review procedures	ETO-PO, ETC (science case)	Q2 2025?	Consultation and approval from ETO needed before delivering any docs	ETO approval and ETC	3
3.1.4 Cost standards and validation methodology (CE related only)	ETO-CE	Q4 2024	Ref.doc on methodology	- CERN-CE MOU - alignment with ETO-PO	7
3.1.5 Risk standards and validation methodology (CE related only)	ETO-PO and ETO-CE	Q2 2025?	Ref.doc on methodology; has to be integrated in the general methodology	- CERN-CE MoU specifically for geohazards? - local & intl. code compliant	10, 5
3.1.6 Preliminary TDR CE underground infrastructure (from PBS ?)	ETO-CE	Q4 2026	Overall agreement on the methodology is needed	- PBS is fully reviewed sept. 24 - CERN-MOU	2.2
3.1.7 Reference schedule for preparation, construction, and implementation of CE works (ROADMAP)	ETO-PO and ETO-CE	Q1 2025	Alignment with LTs schedules.	LT acceptance	3
3.1.8 Process for changes request of detector configuration	ETO-PO	Q4 2024	On-going informally	ETC-ISB approval	3
3.1.9 ET reference detector layout(s)	ETC and ETO	Ref. detector layout - triangle: Q4 2024? 2L: Q1 2025?	Ref. Detector layout in collaboration with ETC	Ref. optical layout, ETC collaboration	2.2, 9
3.1.10 ET baseline civil infrastructure layout	ETO	Baseline civil infrastructure layout Q4 2026?	Ref. Technical Infrastructure layout	ETC input, configuration decision has been made	2.2, 9

# Technical studies for subsurface assessment and risk analysis

Separate activities usually with/without their own separate reports, leading to the end product of the site characterization chapter in the “bidbook” and/or a GIR (or equivalent) for engineering purposes

**Geotechnical Interpretive Report (GIR) or equivalent:** A factual report on geophysical and geotechnical site investigation along with the data interpretation, and the associated field investigations and laboratory tests. In this case, it acts as a summary and conclusion of the previous deliverables within this section.

Technical Studies for Subsurface Assessment and Risk Analysis					
Deliverable	Responsible Unit	Target Delivery Date	Intermediate actions	Prerequisite/ Input	Corresponding WBS Element
3.2.1 Data collection & surface surveying	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs with WP4 coordination	Input from WP4	8.2
3.2.2 Borehole campaigns at potential vertex locations	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs with WP4 coordination	Input from WP4	8.2
3.2.3 Borehole campaigns at potential tunnel locations	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs with WP4 coordination	Input from WP4	8.2
3.2.4 Prospection and laboratory testing report	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs with WP4 coordination	Input from WP4	8.2
3.2.5 3D geological and hydrogeological model	LT	Q4 2025(TETI) / Q4 2026(EMR), 02/2026 (WP4)	Conducted by LTs with WP4 coordination	Input from WP4	8.2
3.2.6 Geotechnical Interpretive Report	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs with WP4 coordination	<ul style="list-style-type: none"> <li>– Input from WP4</li> <li>– General ET layout</li> <li>– Reviewed by CERN (CE MOU)</li> </ul>	8.2

# Design and construction feasibility assessment

Design and Construction Feasibility Assessment					
Deliverable	Responsible Unit	Target Delivery Date	Intermediate actions	Prerequisite/Input	Corresponding WBS Element
3.3.1 Report on positioning/Location Scenarios of underground design (Triangle and 2L)	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs	Requirements, General ET layout	2.2, 9
3.3.2 Drawings and conceptual design of underground structure (including resulting surface structures) for: 1. Caverns, 2. Tunnels, 3. Intersurface connections (access tunnels/shafts, boreholes, etc.), 4. Technical rooms, 5. Dewatering, 6. Emergency exits, 7. Monitoring systems, 8. Other auxiliary structures	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs	Requirements, ET reference layout, defined requested minimum level of detail	2.2, 9
3.3.3 Report on optimised construction solutions for the underground facility	LT, in consultation with ETO-ETC	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs	Requirements, General ET layout	2.2, 9
3.3.4 Logistics plan during construction including: 1. Layout of the construction site(s), 2. Personnel, 3. Flow of equipment and material, 4. Transportation of structural components from surface to underground site level	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs	ED input needed	2.2, 9
3.3.5 Construction risk assessment	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs	ETO inputs	2.2, 3.5, 9, 10
3.3.6 Specific reports on the feasibility of construction solutions able to mitigate level of noise	LT, in consultation with ETO-ETC	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs	ISB input needed, ET-PP WP4/SCB	2.2, 9

Report on positioning, including showing the compliance with all the needed local requirements to host and strategy to build ET at the location

Level of detail according to the specified maturity level. Compliant with all relevant local/international standards/best practices

Explanation and justification for changes made to the reference layouts released by ETC/ETO. Tied to 3.3.1.

Any during construction plans which are tied to the local studies are the responsibility of the local teams (phase 1)

Any specific alterations done to meet the required sensitivity/noise budget, tied to 3.3.1 and 3.3.3



# Cost and time estimation

Cost estimation based/compliant with a common methodology for a minimal level of maturity level of the CE design

Estimated scheduling of construction works

Cost and Time Estimation					
Deliverable	Responsible Unit	Target Delivery Date	Intermediate actions	Prerequisite/Input	Corresponding WBS Element
3.4.1 Cost estimation report for the construction of underground and surface facilities	LT, ET-PP WP4, in consultation with ETO	Q4 2025(TETI) / Q4 2026(EMR), 07/2026 (ET-PP WP4)	Conducted by LTs with ET-PP WP4 coordination	Defined requested minimal level of detail	7.4
3.4.2. Scheduling for construction underground and surface facilities (preparation, construction and implementation)	LT, ET-PP WP4, in consultation with ETO	Q4 2025(TETI) / Q4 2026(EMR), 07/2026 (ET-PP WP4)	Conducted by LTs with ET-PP WP4 coordination		3
3.4.3 Scheduling for civil works permitting (authorizations, expropriations, and easements)	LT, ET-PP WP4, in consultation with ETO	Q4 2025(TETI) / Q4 2026(EMR), 07/2026 (ET-PP WP4)	Conducted by LTs with ET-PP WP4 coordination	Ref. ET-PP WP4	3



# Environmental impact assessment, permits, and noise mitigation measures

Related to 3.3.1, showing the compliance with all the needed local requirements to host and strategy to build ET at the location

Site independent and site specific aspects

Tied to ET-PP WP9 deliverable. Certain aspects might be connected to LTs' responsibilities

Environmental Impact Assessment, Permits, and Noise Mitigation Measures					
Deliverable	Responsible Unit	Target Delivery Date	Intermediate actions	Prerequisite/Input	Corresponding WBS Element
3.5.1 Land development strategy accomplishing local urban planning and land use/zoning	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs	Bid book defined	6
3.5.2 Excavation material treatment and management plan (feasibility)	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs	ET-PP WP9 strategy	6
3.5.3 Cultural heritage preservation report	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs	Bid book defined	6
3.5.4 Assessment of noise levels and mitigation strategy (e.g. construction typologies, buffer zones)	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs	SCB input	6
3.5.5 Environmental impact assessment and management (water treatment, gas emission, habitats, and ecosystems protection)	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs	ET-PP WP9 strategy	6
3.5.6 Strategy for connections to public networks & utilities	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs		6
3.5.7 Environmental risk assessment	LT/ETO	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs & ETO	ET-PP WP9 strategy	6
3.5.8 Legal studies for site construction permitting	LT	Q4 2025(TETI) / Q4 2026(EMR)	Conducted by LTs	ET-PP WP4	6
3.5.9 Long term assessment and sustainability plans, including: 1. Lifespan evaluation, 2. Resilience and Climate Adaptation, 3. Maintenance costs analysis (structural), 4. Plan to accommodate potential future upgrades	ETO	Q4 2025(TETI) / Q4 2026(EMR)	CERN model	ET-PP WP9	6



# Safety and security plan

Concerning activities during construction, tied to local/international safety regulations/standards

Concerning activities during operation; ETO to set the safety standards for operation (in addition to local/international safety regulations/standards)

Safety and Security Plan						
Deliverable	Responsible Unit	Target Delivery Date	Intermediate actions	Prerequisite /Input	Corresponding WBS Element	
3.6.1 Strategy on safety and security during construction	LT, eventually a separate dedicated department within ETO	Q4 2025(TETI) / Q4 2026(EMR)	LT prepare site-dep. plan	ED defines standards	5	
3.6.2 Strategy on safety and security during operation	ETO-ED, eventually a separate dedicated department within ETO	Q4 2026	LT prepare site-dep. plan (if necessary)	Acquisition of required expertise	5	
3.6.3 Risk assessment and mitigation (impact on performance, cost, schedule)	LT, ETO	Q4 2025(TETI) / Q4 2026(EMR)	LT prepare site-dep. plan	ED defines standards	10	
3.6.4 Planning of mitigating measures	LT, ETO	Q4 2025(TETI) / Q4 2026(EMR)	LT prepare site-dep. plan	ED defines standards	5, 10	

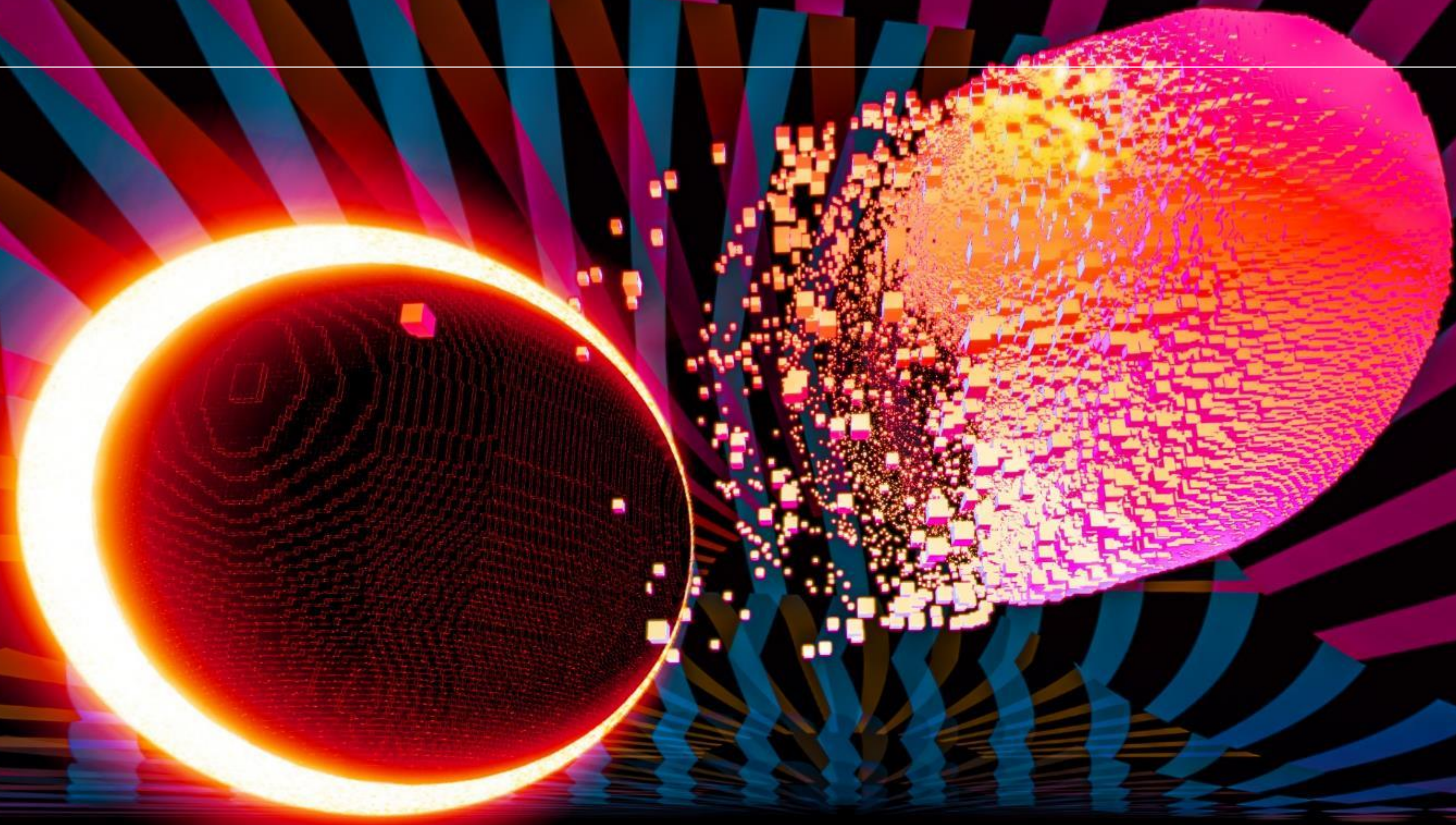


# Technical Infrastructure (underground and surface)

Tied to MOU with CERN regarding technical infrastructure. Timeline and plan moving forward to be discussed further

Technical Infrastructure (Underground and Surface)						
Deliverable	Responsible Unit	Target Delivery Date	Intermediate actions	Prerequisite/Input	Corresponding WBS Element	
3.7.1 Cooling and ventilation: Design and integration – technical reports and drawings – Design technical solution for HVAC of surface and underground; – Design technical solution for (water) cooling of surface and underground; – Integration with the infrastructure design; – Underground installation plan; – CFD simulations and fluid flow analysis.	ETO	<del>Q4 2026?</del> <b>Q3 2027</b>	LTs to coordinate and adjust for site specific solution/layout	CERN MOU	2.2	
3.7.2 Electrical Engineering: Design and integration – technical reports and drawings: – First Single Line Diagram design (HV / MV / LV distribution); – Develop AC grid solution, evaluation DC option (if necessary); – Study compact surface sub-stations; – Study connection to public HV grid; – Study energy storage requirements regarding renewable energy supply and networks stability; – First integration model for underground and surface areas; – Cabling and FO routing; – CAPEX / OPEX modelling.	ETO	<del>Q4 2026?</del> <b>Q3 2027</b>	LTs to coordinate and adjust for site specific solution/layout	CERN MOU	2.2	
3.7.3 Access and Alarms: Design and integration – technical reports: – Identify all the prevention and mitigation barriers or systems to be implemented; – Document safety requirements; – Document safety solutions.	ETO-ED	<del>Q4 2026?</del> <b>Q3 2027</b>	LTs to coordinate and adjust for site specific solution/layout	CERN MOU	2.2, 3.5, 5.3, 10	
3.7.4 Occupational Health and Safety: Design and integration – technical reports: – Underground risk assessment – Fire Safety Concept report: Partitioning and smoke extraction; – Smoke / leak detection report – Evacuation concept report; – Implosion risk assessment report.	ETO-ED	<del>Q4 2026?</del> <b>Q3 2027</b>	LTs to coordinate and simultaneously work on (for site specific aspects)/adjust for site specific solution/layout	CERN MOU	2.2	
3.7.5 Evaluation of requirements related to technical infrastructure technical report	ETO-ED	<del>Q4 2026?</del> <b>Q3 2027</b>		CERN MOU	2.2	
3.7.6 Validation of cost, planning, and risks for technical infrastructure technical report	ETO-ED	<del>Q4 2026?</del> <b>Q3 2027</b>		CERN MOU	3.5, 5, 7.4, 10	
3.7.7 Preliminary Technical Infrastructure TDR, including (but not limited to): – HVAC chapter – Electrical chapter – Access and Alarms chapter – Safety chapter	ETO-ED	<del>Q4 2026?</del> <b>Q3 2027</b>		CERN MOU	2.2	





Thanks!



## Discussion points (tbc)

- Identify a reference person from CERN, ETO, EMR, and TETI for each deliverable.
- How to further develop the document
- Understand how to define the level of details
- Address content and timeline inconsistencies and possible solutions
- Establish a tool for tracking the status of documents
- Agree on the method for effective information sharing among team members
- Define the procedure for submitting and handling change requests
- Identify and internal review Board
- Assign responsibilities and schedule follow-up meetings to monitor progress.