Einstein Telescope

Progress Report
Period 2024-Q4

P1.3_018 Version 1.0

ET-EMR project office

Authorisation

Name	Position	Initials
Stan Bentvelsen	Director	Adopted in the POD meeting of 31 March 2025
Arjen van Rijn	Director	
Hans Plets	Director	
Martijn Rumpen	Senior Strategist - Advisor	
Henk Schroen	Communication Manager - Advisor	
Theo Reinders	Project Manager	
Wim Walk	Technical Manager Subsurface	
Joseph Ickmans	Technical Manager Facility Infrastructure	
Johan Rutten	Environment Manager	
-	Contract Manager[1]	
John Kerstjens	Project Control Manager	

[1] In the current phase of feasibility studies, Project Control also includes Contract Management.

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Management Summary

Feasibility studies

Preparations have started for a second evaluation focussed on noise levels at the bottom on the newly drilled boreholes. To this extent, a start has been made to equip six new boreholes with seismic and magnetic sensors. Also, a plan to measure noise from wind turbines has started implementation by measuring noise levels as a function of distance from a selected wind turbine.

In Q4, the environment manager prepared an environmental scoping by listing all potential environmental impacts that may occur during the research, construction and operation phases. That matrix is used to determine which topics the project office will focus on in the feasibility phase as input for the feasibility study. A workshop was held in December 2024 with various project partners to further address Montzen as a logistics hub as part of the feasibility studies

Much of the focus with regard to communications efforts in 2024 Q4 was on rolling out communications from the first passive seismic campaign and preparations for the active seismic campaign, which starts in early 2025.

Project Office funding

The Project Office has been provided with funding by the Government of the Netherlands (23 M€) and the Province of Limburg of the Netherlands (2 M€). The Flemish funding agency (FWO) added a contribution (0.345 M€). As the Project Office Directorate estimates the total budget required for the preparatory phase to be 49 M€, it requested the governments supporting the site candidacy for the additional funding of 24 M€ (dated 8 November 2023). The status of the requested additional budget looks as follows:

- Belgium: 12 M€ has been committed;
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An Addendum to the DoI (of EMR Ministers) has been signed 30 May 2024, with the intent to clarify the responsibilities and the working relationship of the Task Force and the Project Office. In this addendum it is further stated to draw a Memorandum of Understanding to manage the financial contributions collected into a joint ET-EMR fund. The ET-EMR common fund MoU has been signed by Nikhef, FWO, BELSPO and SPW-EER.

Progress reports

The Project Office is preparing a new format for the progress reports from 2025 Q1 onward.

1 Introduction

This Progress Report 2024-Q4 provides an overview of the progress in the fourth quarter of 2024.

The Einstein Telescope opportunity

The objective of the Einstein Telescope is to build a large-scale research infrastructure that will be the next generation gravitational wave detector for further scientific research of the cosmos. The Einstein Telescope is adopted in the 2021 European roadmap for research Infrastructures (ESFRI). This confirms the excellent science case and the plans to construct the Einstein Telescope in Europe including the following steps towards a site selection.

The starting conditions of the Euregion Meuse-Rhine to host the Einstein Telescope are favourable. The unique soil allows for dampening vibrations and building the research infrastructure in a relatively quiet landscape. This region offers strong research institutes and high-tech industry. And the infrastructure and international living and business climate are attractive. There is already a high-level gravitational waves infrastructure with the ETpathfinder and E-TEST research centres and the Einstein Telescope Education Centre. Governments of the three EMR countries are cooperating and are open to other countries joining their ambition to host the Einstein Telescope.

The Einstein Telescope offers the Euregion Meuse-Rhine an unique opportunity to take a global leadership position in a new pioneering area of science: gravitational wave research. Housing the Einstein Telescope in this region will boost a positive impact on science, economy and society.

ET-EMR Taskforce and ET-EMR Project Office

At the ET Ministerial Conference 26 September 2023 in Brussels, delegates from Belgium, the Netherlands and the German Federal State of North Rhine-Westphalia agreed to prepare a bidbook and joint consortium to establish the Einstein Telescope in the Euregio Meuse-Rhine. The ET-EMR Taskforce has several tasks, including delivering the bidbook and the host consortium proposals. The ET-EMR Project Office is tasked to deliver all the feasibility studies (civil engineering, geology, environmental planning and cost) to realise the Einstein Telescope in the Meuse-Rhine. On 30 May 2024 the EMR ministers signed an addendum to the Declaration of Intent. This addendum aims to strengthen the governance of the project by clarifying the division of responsibilities and establishing transparent, multilateral decision-making mechanisms and delegates the necessary preparations of the bidbook to the Project Office.

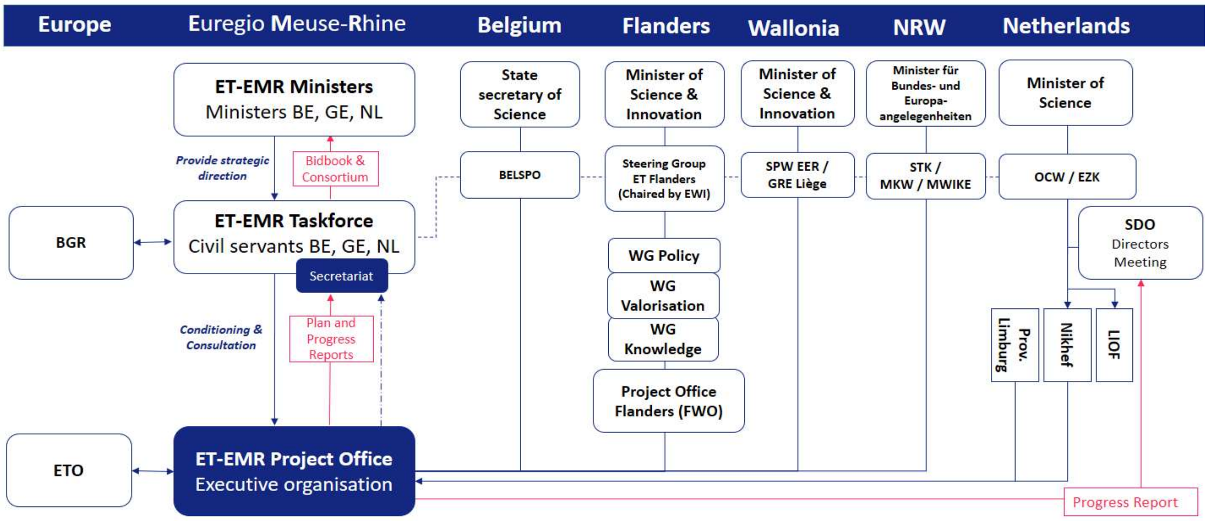
Feasibility studies and progress reports

It is clear that a feasible plan to construct and operate the Einstein Telescope strongly relies on necessary governmental conditions, both financial and legal. The ET-EMR Project Office therefore addresses these issues at the ET-EMR Taskforce to provide these conditions. To ensure a clear understanding of each other's expectations, a close cooperation and open communication between the Project Office and the Taskforce is of crucial importance. In that respect, the Project Office provides the Secretariat to the Taskforce. There is a monthly meeting with the Taskforce Steering Group. And the Taskforce also receives and discusses all quarterly progress reports.

2 Project management

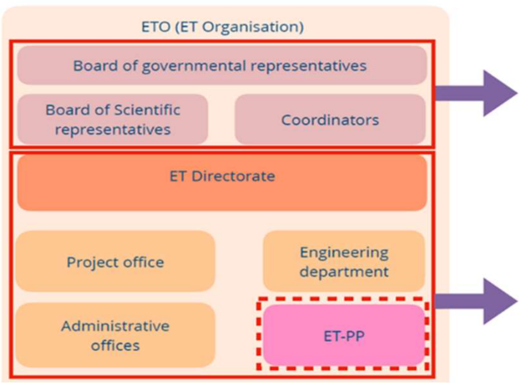
2.1 Administrative and political context

ET-EMR context
In 2023, the Project Office Directorate decided to work according to the IPM (integrated project management) model structure and implement this. The following figure below shows the position of the Project Office in the ET-EMR governance structure and the international cooperation:



European context

While the ET-EMR Project Office is focused on site-specific aspects, the European ET Organisation (ETO) is setting up the organisation to prepare a plan for the Einstein Telescope: the technical design, the organisation and financial management. The ETO Directorate has announced to develop a roadmap to deliver this plan. A proposal for the necessary ETO funding is prepared and discussed. The highest decision making body at European level, the Einstein Telescope Board of Governmental Representatives (BGR), will also have to agree on the process of realizing the Einstein Telescope, including the procedure and criteria for site-selection. The European timeline and requirements are ambitious and at the same time still uncertain. The Project Office Directorate is therefore in close contact with the ETO Directorate.



BGR
- The site selection procedure;
- The legal entity and statutes;
- The financial framework;
- The Terms of Reference for the decisive interim Council.

ETO
- Technical Design Report
- Site Evaluation Report
- Planning report (phase 2-4)
- Organisation report (phase 2-4)
- Budget and Risk report (phase 2-4)

Scope; ETO design process for the civil engineering

The ETO is responsible for the civil engineering design process. One of the key basic requirements for the design of the Einstein Telescope (L-shape versus triangle) is still under investigation. In the scope of the European Strategy Forum on Research Infrastructures (ESFRI) and Nationaal Groeifonds (NGF) application, a triangle configuration was selected as the baseline design. For this reason, the Project Office's feasibility study assumes for the moment a full-scope Einstein Telescope in the shape of a triangle. The Project Office Directorate is in a frequent dialogue with the ETO Directorate to monitor the design process and outcome. The risk of a change in the scope is also included in the register of risks.

Board of Governmental Representatives (BGR); European site selection procedure

At the BGR meeting of 4 October 2024, the Terms of Reference for a Working Group on Site Selection Procedure and Criteria were approved. This Working Group will provide advice to the Board of Governmental Representatives on a procedure to select the host country for ET, including the criteria to be taken into account as well as their respective weighting, the decision procedure, and the timeframe and intermediate steps. This Working Group will be expected to deliver an interim version of its draft execution plan on the site selection procedure by the beginning of the year 2026 and a final version no longer than six months before the submission date of the bidbook. Each BGR member was invited to nominate one expert from their country to this working group. The BGR can furthermore nominate up to four other experts with relevant expertise, on the basis of suggestions by BGR members.

Commitment of Belgium, Germany, and the Netherlands

Nikhef has been provided with funding by the Government of the Netherlands (23 M€) for the feasibility studies. The Province of Limburg of the Netherlands agreed to contribute (2 M€). The Flemish funding agency (FWO) also added a contribution (0.345 M€). As the Project Office Directorate estimates the total budget required for the preparatory phase to be 49 M€, it requested the governments supporting the site candidacy for the additional funding of 24 M€ (dated 8 November 2023). The status of the requested additional budget looks as follows:

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The Dutch government earmarked funds (€870 million) for the bidbook and realisation in spring 2022. The Flemish government made a reservation (€200 million) for the bidbook and realisation. The government of North Rhine-Westphalia (NRW) did announce in January 2023 its intention to co-finance the candidacy, provided federal Germany will do the same. The German national Roadmap process aims for a shortlist in mid-2025; a German commitment for the Einstein Telescope will depend of the outcome of this procedure.

2.2 EMR Project Office organisation

The project roles within the Project Office and following the IPM-model were implemented since January 2023. The chart below is regularly updated with regard to implementing the IPM-model, the plan 2024-2026 and the desired further internationalisation of the Project Office.

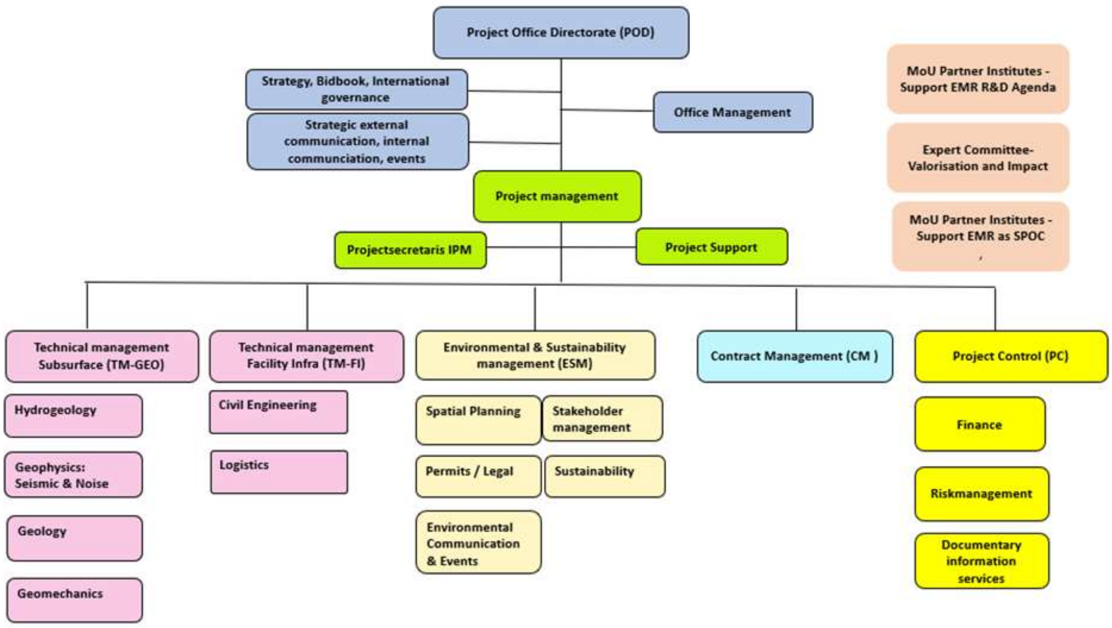
The Project Office

<u>Directorate</u>

• Director	Stan Bentvelsen
• Director	Arjen van Rijn
• Director	Hans Plets
• Senior Strategist (advisor)	Martijn Rumpen
• Communication Manager (advisor)	Henk Schroen

<u>IPM-managers</u>

• Project Manager	Theo Reinders
• Technical Manager Subsurface	Wim Walk
• Technical Manager Facility Infrastructure	Joseph Ickmans
• Environment Manager	Johan Rutten
• Project Control	John Kerstjens
• Contract Manager	-[2]



[2] In the current phase of feasibility studies, Project Control also includes Contract Management.

3 Contract management

3.1 Purchasing & Tendering

Tenders in Q4-2024:

Engineering		
•	Analysis of drilling data Cottessen (and Banholt) Note: the analysis has been completed; a second opinion will follow.	completed
•	Minimum requirements for tunnel, shafts, caverns (tunnelling technology)	completed
•	1st Drilling campaign (Flanders, Wallonia, Netherlands)	completed
•	Borehole measurements	completed
•	Three component seismic nodes	completed
•	Civil Engineering (study of alternatives, draft design, cost estimation, logistics plan, register of risks)	completed
•	Seismic Campaign Feasibility Phase	completed
Environment		
•	GIS support/support of Landscape design	completed
•	Pre-planning study	completed
•	Drilling permits	completed
•	Private-law study	completed
Project organisation Project Office:		
•	Project control manager	completed
•	Project manager	completed
•	Environment manager	completed
•	Sustainability manager	aborted[3]
General:		
•	Safety assessment & guidance	completed

The Q4-2024 ongoing analysis of the results of the first drilling campaign, on the basis of which the locations for the 2nd campaign will be determined, has led to the postponement of the start of the tender for the 2nd drilling campaign to Q1-2025.

Progress reports
The quarterly progress reports are made available on the website www.einsteintelescope.nl.

[3] This function has been integrated into the function of environment manager.

4 Technical management

4.1 General

This quarter, subsurface investigations remained focused on gathering and analysing geo-data.

The first drilling campaign of 11 boreholes was completed successfully.

Workshops are ongoing to evaluate the cores from all finished boreholes and to develop an updated geomechanical understanding of the search area. Seven out of 11 well reports were completed.

4.2 Continue, unless…

Following the successful passing of the first "Continue, unless…" evaluation and criterion in the previous quarter, preparations have started for a second evaluation focussed on noise levels at the bottom on the newly drilled boreholes.

To this extent, a start has been made to equip six new boreholes with seismic and magnetic sensors. These installation efforts will continue throughout the next quarter.

4.3 Technical progress

In Q4-2024, the following progress was made:

Geological model

- The subsurface model continued to be updated with new geological, geomechanical and geophysical data. All new subsurface data (such as core logs, rock stress tests and water flow measurements) are being stored centrally and integrated into a consistent model.
- Geo-technicians have completed 7 out of 11 core investigations, including logging and evaluating cores for their geotechnical characteristics and to determine the rock's properties and suitability for tunnelling.

Boreholes

- The drilling of the planned first set of 11 boreholes has been completed. Next, six of these boreholes are being prepared to accommodate seismic sensing equipment to measure noise levels at ET target depth.
- Collaboration with the drilling company Stump proved very effective throughout the entire campaign, with good safety inspection review results.
- The Core House in Aubel has filled up with core material, and a second hall has been hired to house the next batches of cores. Workshops were held at that location to evaluate the rocks from 7 out of 11 boreholes. Core measurements by specialised companies (Terratec and SolExperts) have completed and geomechanical tests are completing the geotechnical understanding of the subsurface.

Noise and seismic measurements

- The activity to equip the first new borehole with noise sensors has started. Throughout the next quarter a network of permanent and mobile sensors will be completed to supplement the analysis and derivation of the ET noise budget at EMR.
- Also, a plan to measure noise from wind turbines has started implementation by measuring noise levels as a function of distance from a selected wind turbine. The number of measurements at the surface as well as at the bottom of borehole will ramp up next quarter to eventually develop recommendations to mitigate this type of noise and to advise on the development of regulations and permits for companies interested in deploying wind turbines.
- A tender to execute a large campaign of active seismic measurements has been completed and a contract has been awarded to Faraday Geophysics. A test line has already been completed successfully, and the actual campaign is planned to start early Q1 – 2025.

Hydrology

- Water flow measurements and pressure tests have been completed at selected completed boreholes with specialized equipment and will continue the next year to obtain more data, allowing a refinement of the subsurface water model, and to study dependencies on temperature and seasonal effects. This model will be used to estimate the risk and mitigation of water encounters during tunnelling and to develop mitigating measures to seal off and remove excess water during the operational phase of ET.

3D-subsurface modelling

- A design for a full 3D subsurface data model has been completed. This complex activity is harvesting all different types of geo-data (cores, noise, seismic, water flow and pressure, rock properties, etc.) into a consistent and integrated model allowing evaluations and interpretations of the subsurface and the feasibility to construct the Einstein Telescope.

5 Environmental management

5.1 Environmental impact

Environment matrix

In Q4, the environment manager prepared an environmental scoping by listing all potential environmental impacts that may occur during the research, construction and operation phases. That matrix is used to determine which topics the project office will focus on in the feasibility phase as input for the feasibility study and which topics will not be considered further at this stage of the project. The focus is to be provided in 2025 Q1.

5.2 Public and private law aspects

End of 2024 Q3 a study was completed on the public law situation; conclusions were included in the 2024 Q3 report. In addition to public law aspects private law aspects are also considered, regarding how to deal with land ownership and land use during construction and during the operation of the tunnel. It turns out that the legal situation in the countries and regions within the search area is also here not uniform. In cooperation with University Hasselt several scenarios of these private law aspects are studied.

5.3 Preventing inconvenient activities or plans

As a result of the moratorium, introduced by the Dutch Province of Limburg ordinance, it is forbidden to realise new wind turbine projects. Mining and excavations are only allowed if they do not hinder the Einstein Telescope.

Administrative commitments have been received from Flanders and Wallonia regarding the exclusion of subsurface noise in the search and protection area. Administrative guidelines have been formulated in that context on how to act in the case of new initiatives. Further legal safeguards are an issue and, for now, it seems that the interests of the Einstein Telescope candidature are sufficiently safeguarded.

In North-Rhine Westphalia State Secretary Gonca Türkely-Dehnert has made the following statement during the interministerial conference in Brussels (26 September 2023) : "*Minister Nathanael Liminski has reached an understanding with the mayor of Aachen to the effect that the expansion of wind energy there should not compromise the development of the Einstein Telescope. The huge opportunity provided by the Einstein Telescope are in the shared interest of the entire region and therefore also the City of Aachen*." To complete the feasibility studies and necessary conditioning aspects the Project Office Directorate has requested the NRW Ministries represented in the Taskforce to provide the necessary underpinnings.

5.4 Stakeholder management and regional communication

Much of the focus with regard to communications efforts in 2024 Q4 was on rolling out communications from the first passive seismic campaign and preparations for the active seismic campaign, which starts in early 2025. In Q4 ties have been strengthened in terms of cooperation with the project organisation of the international Bocage Landscape Park. The idea is to work towards a cooperation agreement because there is a large overlap between the search and protection area for the Einstein Telescope and the international Bocage Landscape Park.

The topic of valorisation/business is admittedly not delegated to the EMR Project Office and therefore not in its communication efforts. Based on the observation that there are major differences between the way the subject is on the agenda (from a communications perspective) in the various countries and regions, the communications team has taken the lead to have the (valorisation) partners communicate in a more unambiguous and synchronized manner. This is important not only for the valorisation and business itself, but also for the overall balance of all Einstein Telescope topics. In the valorisation and impact expert group, in which these partners are represented, everyone was in favour of this. The concrete suggestions (video series, meetings aimed at regional industry, unambiguous messages) are currently being tested for feasibility in terms of manpower and budget. An initial impetus for the same cross-border movement on the topic of talent and education was also given from communication. This too will be followed up in 2025.

In relation to the above, the second vacancy within the communications team has deliberately not yet been filled in. Once it becomes clear whether and how the ET-EMR communication team should play a role in the themes of valorisation/business and talent/education, the vacancy text will be drawn up. We are in contact with Wallonia on the in kind support related to this topic. The procedure concerning the first vacancy (content director) within the communication team was finalised in November.

5.5 Sustainability

The aspect of sustainability is an integral part of the work packages within both the field of technology and the field of environment. Sustainability is a subject in civil design, implementation methods, logistics during construction and operation, as well as in subjects such as landscape integration, materials extraction, energy consumption and energy and materials supply. Sustainability has explicitly been assigned to the environment manager.

The logistics surrounding the handling of large quantities of materials excavated from the subsurface, combined with the delivery of construction materials and the location of the work site, are the subject of the feasibility study. Discussions are taking place with Infrabel-NMBS about possible options relating to rail logistics and the use of the railway yard at Montzen in this regard. It is also being discussed with the Walloon and federal governments. In that context, a workshop was held in December 2024 with various project partners to further address Montzen as a logistics hub in relation to the Einstein Telescope as part of the feasibility studies.

6 Project control

6.1 General

A number of operational management and project control topics are dealt with in the field of Project Control. These topics focus on facilitating the Project Office and the managers of the specialist fields, guiding processes, monitoring the goal of the feasibility study, and managing risks.

6.2 Finances

<u>Plan and budget 2024-2026</u>

Nikhef has been provided with funding by the Government of the Netherlands (23 M€) for the feasibility studies. The Province of Limburg of the Netherlands agreed to contribute (2 M€). The Flemish funding agency (FWO) also added a contribution (0.345 M€). As the Project Office Directorate estimates the total budget required for the preparatory phase to be 49 M€, it requested the governments supporting the site candidacy for the additional funding of 24 M€ (dated 8 November 2023). The status of the requested additional budget looks as follows:

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6.4 Quality

To ensure quality, a start was made on setting requirements. The requirements encompass:

- The process of preparing and submitting a compelling bidbook;
- The process of meeting the terms of the Nationaal Groeifonds (NGF) grant decision;
- The Einstein Telescope system (below and above ground);
- The temporary system serving the construction of the Einstein Telescope.

The timely input from the European ET organisation ETO is crucial:

- Baseline design detector;
- Demarcation of the system breakdown structure between ETO and ET-EMR/TETI.
- Functional requirements for infrastructure and above surface facilities;
- Change procedure.

6.5 Risks

Below are the risks that were specifically addressed in 2024-Q2:

Risk	Management
Co-financing entities have	Careful scrutiny by Project Office, based on expert advice, of

diverging views on what is needed for the bidbook.	propositions from co-funding entities
Subsurface noise; plans for wind turbines, mining activities and geothermal energy in the protection area could emerge.	We monitor the conditions. The Taskforce is provided with the information to discuss the conditioning aspects. A study on mitigating measures will be carried out. We refer to paragraph 5.2 for the current situation.
Longer lead time because of, e.g., • deliverables from ETO • decision-making in various countries • subsurface studies	Monitor ETO closely Intensive coordination within Task Force Carry out studies simultaneously Planning and budget have been adjusted based on the indication from ETO.
Stress on budget	Manage costs Additional cover (partners) is proposed; see paragraph 6.2.
No scientific consensus on the shape of the Einstein Telescope (triangle versus L). Unstable scope ETO – ET Collaboration (optical design, detector design, design- and operational requirements)	Focus on current scope as adopted by ESFRI and Nationaal Groeifonds NGF (triangle); Monitor development closely; Establish a formal framework and information exchange between the ETO and Project Office directorates. Put on the agenda for the ETO directorate – PO directorate meeting.

6.6 Information management

Document management/control information
After the system for archiving, document management (SURFdrive) and project information was set up and put into operation since Q1-2023, it is structurally and systematically filled from Q2 onwards, so that this information is available to the members of the Project Office.

In Q2-2024 Relatics was adopted as a central tool for project management.

6.7 Facilities

Based on the action plan and in consultation with the managers of the specialist fields, it will be ensured that appropriate staffing of the Project Office; accommodation; integrity and social safety protocols in the workplace; insurance cover; complaints protocol, etc., are in place.
These issues were successively addressed during the first half of 2023.

Annex 1 Project planning

ET Productenplanning 22-4-2024

Id	Taaknaam	Start	Eind
	0. Start	2-1-23	2-1-23
	0. Start	2-1-23	2-1-23
	B. Subsurface	3-1-23	31-12-25
	1.20 Organisation	3-1-23	31-12-25
	3.01 1st set Boreholes	21-3-23	11-10-24
	3.02 2nd set Boreholes	7-6-24	22-5-25
	3.04 Noise (ERT, passive seismic, anthropogenic noise measurements)	23-6-23	13-3-25
	3.06 Active Seismic	21-2-23	13-5-25
	3.10 Geomechanics, -fysics, -hydrology	16-5-23	31-12-25
	3.20 Collect/Analyse existing data	21-3-23	21-12-23
	3.25 Data management / 3D modelling	21-2-23	3-3-25
	3.30 Design	26-12-23	31-12-25
	D. Project Office	3-1-23	6-1-27
	0.40 ETO-BGR-Taskforce	1-8-23	27-5-24
	1.10 Administrative decision making	22-7-26	6-1-27
	1.20 Organisation	3-1-23	31-12-25
	1.40 Implementation plan - Tender dossier	28-5-24	20-7-26
	2.10 Procurement	21-2-23	13-10-25
	4.60 Logistics	18-8-23	8-10-26
	5.10 Planning & Finance	1-10-24	31-12-25
	E. Communication	3-1-23	22-6-26
	1.20 Organisation	3-1-23	31-12-25
	4.40 Stakeholdermanagement	21-2-23	22-6-26
	F. International strategy	3-1-23	31-12-25
	1.20 Organisation	3-1-23	31-12-25
	G. Spatial planning	3-1-23	31-12-25
	1.20 Organisation	3-1-23	31-12-25
	4.10 Spatial planning	3-1-23	31-12-25
	4.60 Logistics	11-7-23	31-12-25
	4.70 Environment / Landscape	21-2-23	31-3-25
	H. NGF-finance	3-1-23	9-11-26
	5.20 NGF	3-1-23	9-11-26
	Z. End	21-7-26	21-7-26
	Z. End	21-7-26	21-7-26