The Working Group on Site Selection Procedure and Criteria for the Einstein Telescope

Presentation of the Final Report

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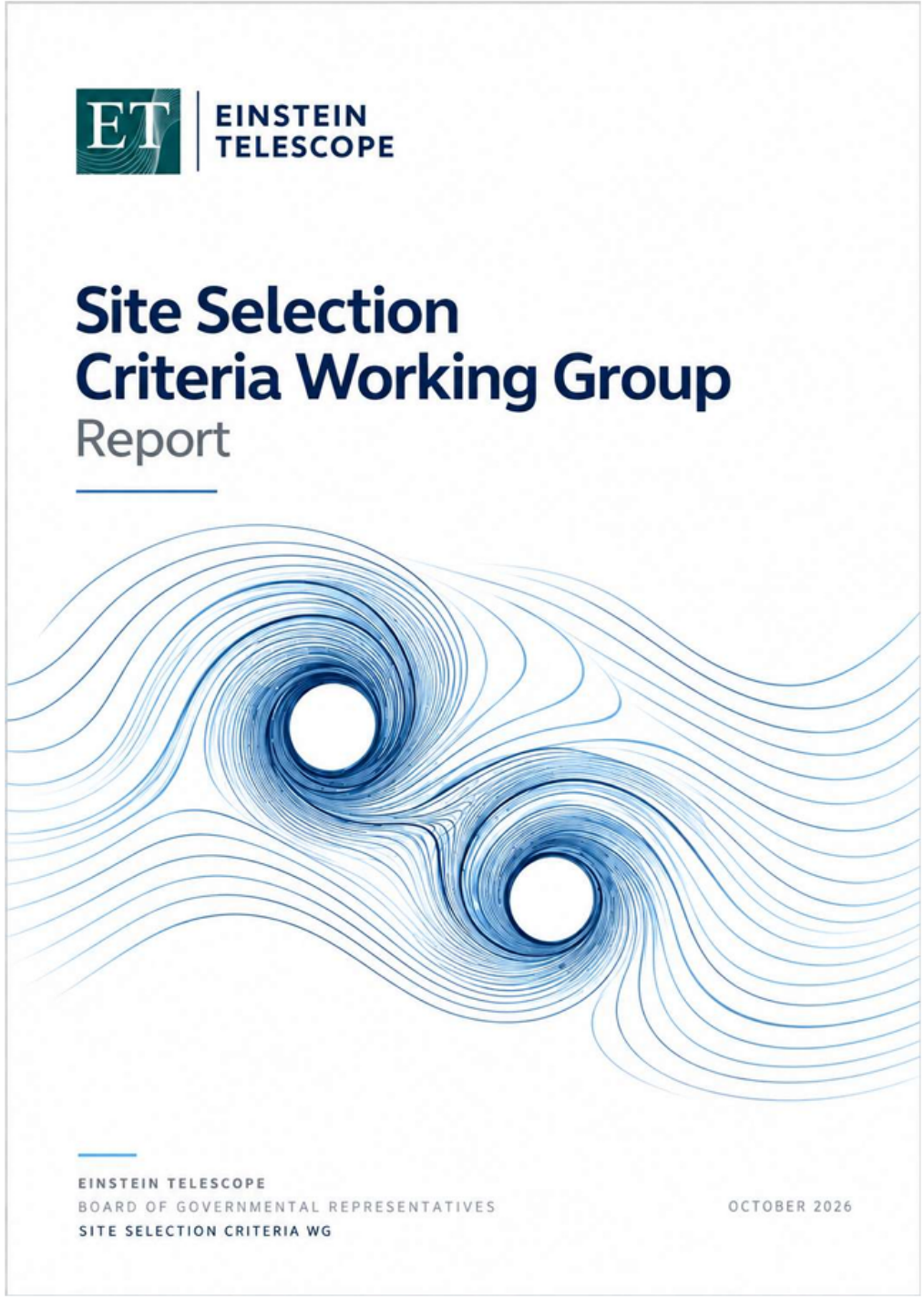
WG Chair

ET-PP Meeting

November 2-3rd 2026



- **Terms of reference and working methods**
- **Key points of the WG report**
  - Criteria and subcriteria
  - Site assessment process

- **Points remaining**
- **Next steps**

Working Group on Site Selection Procedure and Criteria

Terms of Reference

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The Working Group (WG) shall provide a draft execution plan to the Board of Governmental Representatives (BGR) on the site selection procedure for the ET that ensures its fairness and transparency. This will include:

- the identification and the definition of the criteria to take into account,
- their respective weighting,
- the decision procedure,
- timeframe and intermediate steps.

The WG is NOT involved in the execution of the site selection process and the criteria should be agnostic of the geometry chosen for the ET (one triangle or 2L solution) – subject of the Geometry Comparison Report

Working Group on Site Selection Procedure and Criteria

Terms of Reference

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To this aim, the WG will:

- build on the preparatory work done by ETO, within the relevant activities of the INFRA-DEV ET-PP (Preparatory Phase) Project, and by the “Site Characterisation Board” of the ET Collaboration,
- analyse existing information, including procedures and criteria used for site selection for other research infrastructures, and identify demonstrated good practices,
- apply them to the specific case of the ET, in all its dimensions,
- adopt a comprehensive approach, including technical, economic, environmental and societal impact, costs, risks, and governance,

The WG should deliver a preliminary report to the BGR for its meeting in June 2026 and its final report by October 2026. Templates for the

Name	Country	Affiliation	SG1	SG2	SG3	SG4
Ken Haenen	Belgium	Hasselt University			1	
Frédéric Nguyen	Belgium	Liège University	1	1		
Vibor Jelić	Croatia	Ruđer Bošković Institute		1		
Vernesa Smolčić	Croatia	University of Zagreb	1			1
Reynald Pain	France	CNRS				1
Vincent Poireau	France	CNRS			1	
Harald Lück	Germany	MPI Gravitational Physics	1*			
Guido Müller	Germany	MPI Gravitational Physics		1		
Andrew Harrison	International	CERIC-ERIC				
John Osborne	International	CERN		1		
Helle Pedersen	International	University Grenoble Alpes	1			
David Reitze	International	LIGO, Caltech		1*		1
Giovanni Bisoffi	Italy	INFN	1	1		
Monique Bossi	Italy	INFN				1
Stan Bentvelsen	Netherlands	University of Amsterdam	1			
Hans Chang	Netherlands	Consultant and Nikhef			1	1
Tomasz Bulik	Poland	University of Warsaw	1		1*	
Rafael Rebolo	Spain	Inst. of Astrophysics of the Canaries	1		1	1
Stephen Fairhurst	United Kingdom	Cardiff University				
Sheila Rowan	United Kingdom	University of Glasgow	1			1
Andreas Rietbrock	Germany	KIT		1		
Marius Groll	Germany/support	DESY	1			
Florian Weissbach	Germany/support	ESS				1
Luca Latronico	Italy/support	INFN			1	
Lars Börjesson	Sweden	Chalmers University				1*
Tamara Bud	UK/support	CERN		1		
Vicky Kalogera	USA	Northwestern University	1*			

○ WG composition

- Range of experts from Member countries plus 'International' members to provide expertise where there were gaps.

○ Working methods

- Meet monthly plus full-day meeting in Munich, Sept 2026
- Divide work up into Subgroups:
  - Site-related noise impact on ET performance
  - Civil works, environment and geology
  - Costing and finance
  - Contextual factors
- Aim for consensus – challenging !

44 subcriteria contributing to 13 criteria organised in 4 subc

SG1 Site-related noise impact on ET performance

4 criteria | 13 subcriteria

C1 Seismic Noise and its Effect on ET

- Frequency band below 1 HZ
- Frequency band at or above 1Hz
- Local and regional seismicity
- Knowledge and impact of noise sources

C2 Atmospheric, Infrasound and Acoustic noise and its Effect on ET

- Atmospheric noise
- Infrastructure-generated acoustic noise
- Underground acoustic and infrasound environment

C3 Newtonian Noise and its Effect on ET

- Estimated Seismic Newtonian Noise Impact on ET Performance Before Mitigation
- Estimated Atmospheric Newtonian Noise Impact on ET Performance Before Mitigation
- Quality of the Models Used to Estimate NN and Associated Uncertainty
- Residual Newtonian Noise After Mitigation

C4 Magnetic and Electrical Noise and its Effect on ET

- Anthropogenic and Natural Magnetic and Electrical Noise
- Magnetic and Electrical Noise from the Technical Infrastructure

SG2 Civil works, environment and geology

4 criteria | 16 subcriteria

C5 Underground infrastructure & site conditions

- Underground layout including shaft/ramp/access routes, caverns, tunnels
- Underground conditions and site investigations
- Site installations and above ground structures
- Site suitability against future design changes

C6 Construction methodology & design

- Excavation and support concepts
- Groundwater control
- Ventilation concept
- Operational reliability, maintainability and long-term performance
- Safety and emergency measures
- Logistics and construction delivery

C7 Design risks & associated mitigation

- Site Specific Risks
- Resilience to Seismic Hazards
- Resilience to Climate Change

C8 Environmental impact & sustainability

- Preliminary environmental impact analysis
- Life cycle assessment (CO_2)
- Sustainability and reuse of excavated materials and groundwater

SG3 Costing and finance

2 criteria | 7 subcriteria

C9 Costing (site-dependent)

- Quality, maturity and Bill of Quantities underpinning of the cost estimate
- Treatment of site-specific risk
- Treatment of external infrastructure
- Operations costs

C10 Financing

- Financial readiness and durability of commitments
- Fiscal regime
- Permitting and construction logistics

SG4 Contextual factors

3 criteria | 8 subcriteria

C11 Institutional readiness

- Legal + regulatory capacity
- Human Capital
- Political and strategic commitment

C12 Description of the region

- Communities and locations
- Quality of life
- Staff and families

C13 Description of the ecosystem

- Innovation and research ecosystem
- Socio-economic impact of the ET

SG1: Site-related noise and its impact on ET performance

Criterion	Index	Weighting / %	Subcriterion	Index
Seismic Noise and its Effect on ET	C1	35	Frequency band below 1 HZ	SC1.1
			Frequency band at or above 1Hz	SC1.2
			Local and regional seismicity	SC1.3
			Knowledge and impact of noise sources	SC1.4
Atmospheric, Infrasound and Acoustic Noise and its Effect on ET	C2	15	Atmospheric noise	SC2.1
			Infrastructure-generated acoustic noise	SC2.2
			Underground acoustic and infrasound environment	SC2.3
Newtonian Noise and its Effect on ET	C3	35	Estimated Seismic Newtonian Noise Impact on ET Performance Before Mitigation	SC3.1
			Estimated Atmospheric Newtonian Noise Impact on ET Performance Before Mitigation	SC3.2
			Quality of the Models Used to Estimate NN and Associated Uncertainty	SC3.3
			Residual Newtonian Noise After Mitigation	SC3.4
Magnetic and Electrical Noise and its Effect on ET	C4	15	Anthropogenic and Natural Magnetic and Electrical Noise	SC4.1
			Magnetic and Electrical Noise from the Technical Infrastructure	SC4.2

SG1: Site-related noise and its impact on ET performance

Methodology of assessment for SG1 does not relate simply to whether sites are judged to be ‘quiet’ or ‘noisy’ but is rather an evidence chain of measured data, validated modelling, uncertainty assessment, and mitigation-adjusted performance predictions to determine how well each site could support the Einstein Telescope's required sensitivity and operational availability.

- **Characterise the site environment**

Collect and analyse measurements (or justified predictions) of seismic, atmospheric, acoustic, magnetic and electrical disturbances relevant to Einstein Telescope operation.

- **Translate site conditions into detector impact**

Use validated ET noise-coupling and performance models to determine how environmental disturbances would affect detector sensitivity, duty cycle and scientific performance.

- **Evaluate evidence quality and uncertainty**

Assess the reliability of measurements, modelling assumptions, data coverage and associated uncertainties, distinguishing between measured and estimated values.

- **Score residual risk after mitigation**

Judge each site on the expected remaining impact after realistic mitigation measures are applied, assigning scores according to compliance with ET requirements and the credibility of any proposed remediation. Note that mitigation measures will add to cost so this should be linked to SG3

SG1: Site-related noise and its impact on ET performance

C1. Seismic Noise and its Effect on ET (35%)

Assesses how ground motion and seismic activity affect detector sensitivity and operating stability.

SC1.1 Frequency band below 1 Hz

Low-frequency ground motion and tilt that can affect isolation systems and detector control.

SC1.2 Frequency band at or above 1 Hz

Higher-frequency ground motion that can directly couple into the detector and contribute to Newtonian noise.

SC1.3 Local and regional seismicity

Earthquakes and blasting activity that could interrupt operations or require recovery.

SC1.4 Knowledge and impact of noise sources

Understanding and characterisation of noise sources to support mitigation and forecasting.

C2. Atmospheric, Infrasound and Acoustic Noise and its Effect on ET(15%)

Assesses noise caused by atmospheric pressure fluctuations and acoustics.

SC2.1 Atmospheric noise

Pressure fluctuations that contribute to atmospheric Newtonian noise.

SC2.2 Infrastructure-generated acoustic noise

Noise from ventilation, pumps and other site systems.

SC2.3 Underground acoustic and infrasound environment

How underground geometry affects sound propagation and resonance

SG1: Site-related noise and its impact on ET performance

C3. Newtonian Noise and its Effect on ET (35%)

Assesses gravity-gradient noise caused by fluctuating mass densities that cannot be isolated mechanically.

SC3.1 Seismic Newtonian noise before mitigation:

Predicted impact of ground-motion driven gravity fluctuations.

SC3.2 Atmospheric Newtonian noise before mitigation:

Predicted impact of atmospheric density fluctuations.

SC3.3 Quality of Newtonian-noise models:

Confidence and uncertainty associated with prediction models.

SC3.4 Residual Newtonian noise after mitigation:

Remaining Newtonian noise after mitigation measures are applied.

C4. Magnetic and Electrical Noise and its Effect on ET (15%)

Assesses interference from magnetic and electrical fields.

SC4.1 Anthropogenic and natural magnetic/electrical noise:

Noise from industry, power systems, transport and natural phenomena such as lightning.

SC4.2 Infrastructure-generated magnetic/electrical noise:

Noise produced by the observatory's own equipment and services.

SG2: civil works, environment and geology

Feasibility of the underground infrastructure design, taking account of local geology, the engineering basis of construction cost and schedule, and preliminary environmental impact and sustainability

Criterion	Index	Weighting %	Subcriterion	Index
Underground Infrastructure and Site Conditions	C5	30	Underground layout incuding shaft/ramp/access routes, caverns, tunnels	SC5.1
			Underground conditions and site investigations	SC5.2
			Site installations and above ground structures	SC5.3
			Site suitability against future design changes	SC5.4
Construction Methodology and Design	C6	30	Excavation and support concepts	SC6.1
			Groundwater control	SC6.2
			Ventilation concept	SC6.3
			Operational reliability, maintainability and long-term performance	SC6.4
			Safety and emergency measures	SC6.5
			Logistics and construction delivery	SC6.6
Main technical risks of the design and associated mitigation	C7	30	Site Specific Risks	SC7.1
			Resilience to Seismic Hazards	SC7.2
			Resilience to Climate Change	SC7.3
Preliminary Environmental Impact Assessment and Sustainability	C8	10	Preliminary environmental impact analysis	SC8.1
			Life cycle assessment (CO2)	SC8.2
			Sustainability and reuse of excavated materials and groundwater	SC8.3

SG2: civil works, environment and geology

C5. Underground Infrastructure and Site Conditions (30%)

Evaluates whether the site and underground layout are suitable for ET construction and operation.

SC5.1 Underground layout:

Adequacy of tunnels, caverns, shafts and access routes

SC5.2 Underground conditions and investigations:

Quality of geological, hydrogeological and geotechnical conditions and studies.

SC5.3 Site installations and above-ground structures:

Suitability of surface infrastructure, especially power supply and support facilities.

SC5.4 Suitability for future design changes:

Flexibility to accommodate upgrades and design

C6. Construction Methodology + Design (30%)

Assesses feasibility and quality of construction and operational infrastructure.

SC6.1 Excavation and support concepts:

Appropriateness and durability of excavation methods and structural support.

SC6.2 Groundwater control:

Ability to manage water ingress reliably.

SC6.3 Ventilation concept:

Adequacy and reliability of underground ventilation systems.

SC6.4 Operational reliability and maintainability:

Long-term maintenance needs and infrastructure performance.

SC6.5 Safety and emergency measures:

Compliance with safety requirements and emergency preparedness.

SC6.6 Logistics and construction delivery (cf SC11.2):

SG2: civil works, environment and geology

C7. Design Risks and Associated Mitigation (30%)

Evaluates major technical hazards and resilience.

SC7.1 Site-specific risks:

Identification and management of geological and location-specific hazards.

SC7.2 Resilience to seismic hazards:

Ability to withstand earthquake-related risks.

SC7.3 Resilience to climate change:

Ability to cope with long-term climate-related threats.

C8. Environmental Impact and Sustainability (15%)

Assesses environmental footprint and sustainability performance.

SC8.1 Preliminary environmental impact analysis:
Identification and mitigation of environmental impacts.

SC8.2 Life-cycle assessment (CO_2):
Carbon footprint of construction and operation.

SC8.3 Reuse of excavated materials and groundwater:
Sustainable handling and reuse of materials and water.

SG3: costing and finance

Cost – the maturity of the estimating method, the traceability of the quantities and prices, and the treatment of uncertainty - and **financing**, the security and durability of the funding commitment offered by the host(s) , and the effect of the host's fiscal arrangements on the net cost.

Criterion	Index	Weighting/%	Subcriterion	Index
Total Cost	NA	NA	Total construction cost	NA
Costing (site dependent)	C9	Under discussion	Quality, maturity and Bill of Quantities underpinning of the cost estimate	SC9.1
			Treatment of site-specific risk	SC9.2
			Treatment of external infrastructure	SC9.3
			Operations costs	SC9.4
Finance	C10	Under discussion	Financial readiness and durability of commitments	SC10.1
			Fiscal regime	SC10.2
			Permitting and construction logistics - check with SG2 and SG3	SC10.3

- Total cost is a further, unscored criterion
- Weighting of criteria not complete
- Technical validation of elements of cost and schedule to come from EVC studies for SG1 and SG2

SG3: costing and finance

C9. Site-dependent Costing

Assesses the quality and credibility of site-specific cost estimates.

SC9.1 Quality and maturity of cost estimate:

Robustness of cost methodology and bill of quantities.

SC9.2 Treatment of site-specific risks:

How cost risks are identified, quantified and managed.

SC9.3 Treatment of external infrastructure:

Cost, adequacy and delivery of external utilities and transport links.

SC9.4 Operations costs:

Estimated lifetime operating costs of the facility (note likely redundancy with WP2 item 5 of GCR)

C10. Financing

Assesses security and durability of funding commitments.

SC10.1 Financial readiness and durability:

Strength and reliability of capital and operating funding commitments.

SC10.2 Fiscal regime:

Impact of taxation, VAT, customs and exemptions on project costs.

SC10.3 Permitting and construction logistics (cf C11):

Financial implications of permits, approvals and construction support arrangements.

SG4: contextual factors

Comprises: the preparedness of the proposing entity or entities to implement and host the project; accessibility, living environment and broader social aspects; the wider innovation and support environment relevant to the project.

Criterion	Index	Weight-ing/%	Subcriterion	Index
Institutional Readiness	C11	37.5	Legal and Regulatory Capacity	SC11.1
			Human Capital	SC11.2
			Political and Strategic Commitment	SC11.3
Description of the Region(s)	C12	37.5	Communities & Location	SC12.1
			Quality of life	SC12.2
			Staff & Families	SC12.3
Description of the Ecosystem	C13	25	Innovation & Research ecosystem	SC13.1
			Socio-economic impact of ET	SC13.2

- Weighting of criteria based on equal weighting of 8 subcriteria – i.e. 12.5 % each

SG4: contextual factors

C11. Institutional Readiness (37.5 %)

Measures the host's ability to support and govern the project.

SC11.1 Legal and regulatory capacity:

Ability to provide the legal rights, permits and hosting framework required.

SC11.2 Human capital (cf SC6.6):

Availability of scientific, engineering and technical workforce.

SC11.3 Political and strategic commitment (cf SC10.1):

Long-term support from governments and regional authorities

C13. Description of the Ecosystem (25%)

Assesses the wider research and innovation environment.

SC13.1 Innovation and research ecosystem:

Strength of universities, research institutes, industry and collaboration networks.

SC13.2 Socio-economic impact of ET:

Potential contribution to regional development, economic growth and funding attraction.

C12. Description of the Region (37.5 %)

Assesses the attractiveness and liveability of the host region.

SC12.1 Communities and locations:

Accessibility, infrastructure, amenities and social environment.

SC12.2 Quality of life:

Healthcare, wellbeing, childcare and safety.

SC12.3 Staff and families:

Housing, education and support for relocating staff and families.

Scoring and weighting

- All subcriteria to be scored on a 4-point scale, for which the descriptors are adapted to be specific to the SG. The generic (ESFRI) scale is:

• **Very high**	4	requirements are outstandingly met
• **High**	3	requirements are comprehensively met
• **Medium**	2	partly met, with weaknesses
• **Low**	1	insufficiently met

- The scoring of criteria is based on scoring of subcriteria. SG1, 3 and 4 have provided input on subcriteria weighting but ultimately relative weightings of subcriteria should be determined by the Site Review Committee (SRC) to provide . Some subcriteria are closely interconnected: SC2.1 with SC3.2, and SC3.3 with SC3.1, SC3.2 and SC3.4 and there are local ‘rules’ to indicate how they should be combined e.g. to avoid double-counting

- Any subcriterion or criterion that is judged to be insufficiently met triggers a red flag to be raised against the bid throughout subsequent stages of the assessment process

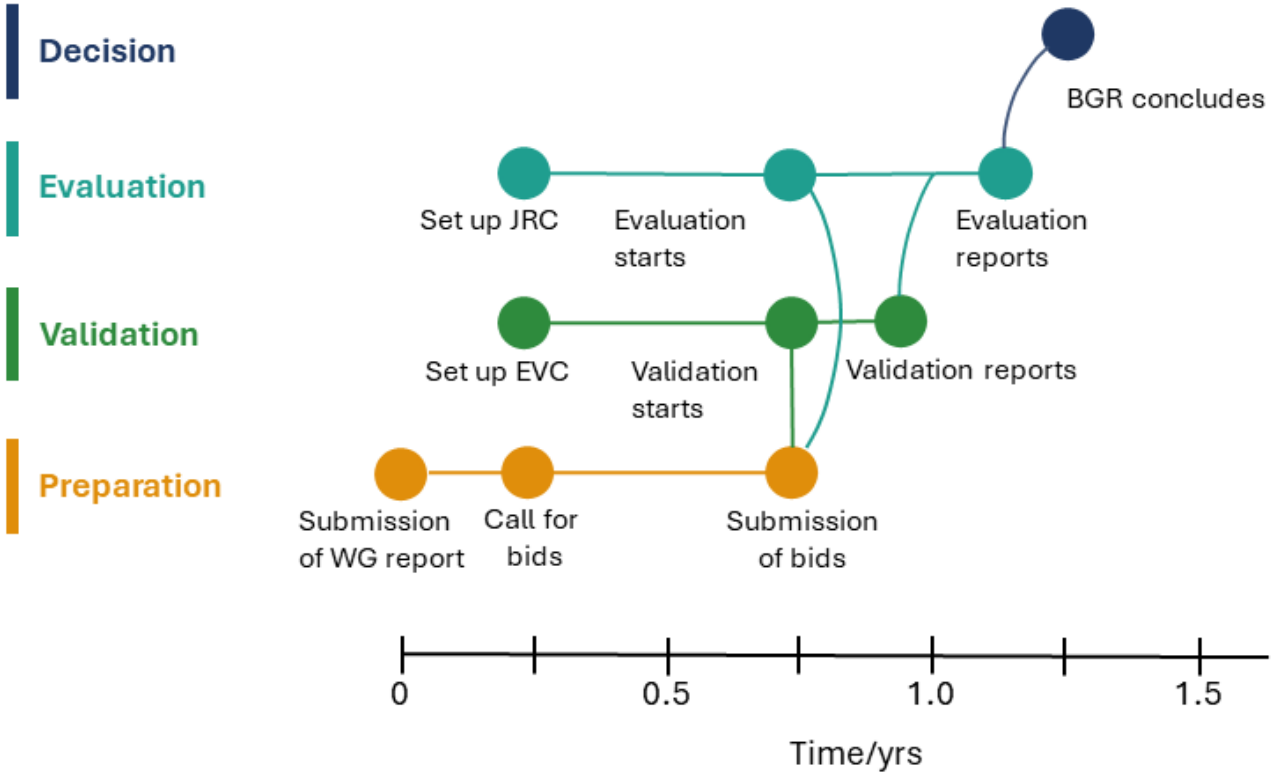
Proposed assessment process

- The assessment of bids is to be conducted by an independent body – the Site Review Committee (SRC) – with a range of experience covering all key areas of the assessment and trusted to act in a fair and transparent manner.

- It is the firm view of the WG that the technically complex and substantial inputs for SG1 and SG2 requires expert validation before assessment by the SRC, and proposes that this should be done by 2 Expert Validation Committees (EVCs). The EVC Chairs should be members of the SRC, bringing its size up to 7. Membership of the EVCs should be approximately 5.

- The WG could assist in preparing elements of the assessment process – for example the preparation of the bidbook templates and the framework for the assessment process, including guidelines for the EVCs and SRC. It is assumed that the overall process will be overseen and individual steps validated by the BGR, and that the BGR will set up the EVCs and SRC, possibly with suggestions for membership from the WG

Proposed assessment process



- SRC evaluates all subcriteria and criteria and report their scores with summary of strengths, weaknesses and red flags for all bids to the BGR
- EVC validate bids for input for SG1 and SG2, with their Chairs as members of SRC
- Prepare assessment process. Produce bidbook templates, agree on guidelines for working processes and establish SRC and EVCs

Outstanding points

- SG1 and SG2 still have to provide technical appendices (A2 and A3) with detailed information about validation and assessment of their subcriteria and criteria and expected to complete these sections by early December. This should not hold up working on the bidbook templates.
- SG1 will hold workshops with relevant ET experts in the next weeks on the common measurement and analysis procedures, reference assumptions and models that all bidders should use:
  - Site-characterisation with seismic, acoustic and magnetic experts: measurement protocols, indicator algorithms, coverage requirements and uncertainty treatment.
  - Instrument Science Board and the relevant detector groups: reference detector configuration, noise allocations, applicable coupling models and baseline mitigation, especially for suspension transmission and Newtonian Noise.
  - ETO engineering and infrastructure experts: common infrastructure assumptions and the information needed to estimate infrastructure-generated disturbances. Allowed deviation for the bidders from common infrastructure realisations e.g to accommodate site specific needs such as rock quality that may limit certain cavern sizes, country dependent safety requirements
  - Observational Science Board: agreed methods and benchmarks for interpreting changes in sensitivity and observing availability in terms of individual science cases. According to OSB chairs the code and knowledge exists, but it needs to be discussed, who uses this knowledge and the code when, to assess the impact of the

Outstanding points

- The WG discussed the weighting of SGs relative to each other but did not find consensus. After this difficulty was reported at the last BGR meeting, it was indicated that we should not let progress with the report be held up by a search for consensus. Given the other demands on our time, we did not explore the issue further.
- SG3 (costing and finance) did not reach a conclusion on weighting for their two criteria, essentially because it did not find the time to do so in recent months and did not wish to make a clear commitment to a position on this matter when pressed to do so in the concluding phase of writing the report.
- Towards the end of producing the report, the WG realised that it could be important to establish a way to aggregate scores across two sites for bids to host one or two L-shaped detectors. Preliminary work indicates that the best method of aggregation will depend on the criterion in question: for some subcriteria an average of the two scores may be the most appropriate means of aggregation while in others the overall score may be determined by the weaker one. This analysis could not be completed in the time remaining.

Next steps for the WG ?

- WG to engage with ETO in critiquing the report, especially technical sections (SG1, SG2)
- WG to complete Appendices A2 and A3 of the report (first week in December 2026)
- WG to provide input on suitable members of the SRC and EVCs (ASAP)
- The BGR to meet to discuss and decide on the criteria (early December)
- Some WG members to provide input on drafting bidbooks and other elements of preparation for the assessment process as requested by the BGR, up to February 2027 in anticipation that a call for bids will be made from the end of February.

Questions ?