ET history

2000
ILIAS (FP6)
Networking activity of future GW

2005
ESF exploratory workshop in Perugia on 3G GW detectors
http://esf-gw.pg.infn.it/

2010
ET R&D funded by ASPERA-2

2015
ELiTES (FP7) Project (KAGRA-ET synergies)

2020
ESFRI proposal

11th ET symposium

Enabling technologies (seeds)

Idea
CDR

ET conceptual design study (FP7)
ET – New phase

• A key step to enter in a new phase of the ET project has been the preparation and the submission of the ET proposal to the “2021 update of the ESFRI* roadmap”
  • Prepared by the ET steering committee
  • It allowed to focalise the science, the design, the timeline, the cost and the organisation of the project
• Updated science case
• Updated design of the ET infrastructure
• New timeline
• Updated cost evaluation
• Evaluation of the social and economic impact
• A teams of European governments supporting ET
• A large consortium of institutions promoting the ET project

*ESFRI – European Strategy Forum on Research Infrastructures
ET science case

- Original work in the ET conceptual design (ET-0106C-10)
- Recent update by the GWIC*-3G** subcommittee:
  - The Next-Generation Global Gravitational-Wave Observatory: New Astrophysics with the Farthest, Oldest, and Most Violent Events in the Universe
  - Focus on low frequency characteristics of ET and triangular shape
- We are forming a team, within the ET project, that will develop the ET science case, from the theory to the data analysis requirements and potential

*GWIC - Gravitational Wave International Committee (https://gwic.ligo.org/about.html) is a committee of delegates of GW experiments and communities.

**GWIC-3G (https://gwic.ligo.org/3Gsubcomm/) The GWIC Committee on Third Generation Ground-based Detectors is charged with examining the path to the development of a network of future ground-based gravitational-wave (GW) observatories
Updated Design

• The design of ET is an iterative process with two main components:
  • The infrastructures
  • The Detectors

• Iterative:
  • We can distinguish different phases:
    • (1) Conceptual Design ✓
    • (2) ESFRI proposal ✓
    • (3) Common pre-preliminary design
    • (4) customised designs (infrastructures)
    • (5) final design of the infrastructures and of the detectors

• We are now focusing on the design of the detectors and infrastructures that will serve as starting point for the site-dependent design options (“customised design”)
**ET Roadmap**

<table>
<thead>
<tr>
<th>ID</th>
<th>Activity Type</th>
<th>Duration (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Design phase</td>
<td>892 g</td>
</tr>
<tr>
<td>2</td>
<td>Underground RI design</td>
<td>890 g</td>
</tr>
<tr>
<td>3</td>
<td>Pilot civil engineering study</td>
<td>261 g</td>
</tr>
<tr>
<td>4</td>
<td>In house 2D design of the site</td>
<td>600 g</td>
</tr>
<tr>
<td>5</td>
<td>Pre-terimonal design by external company</td>
<td>230 g</td>
</tr>
<tr>
<td>6</td>
<td>Environmental impact certification</td>
<td>60 g</td>
</tr>
<tr>
<td>7</td>
<td>Surface RI Design</td>
<td>523 g</td>
</tr>
<tr>
<td>8</td>
<td>Detector Preliminary design</td>
<td>784 g</td>
</tr>
<tr>
<td>9</td>
<td>Detector preliminary design Delivering</td>
<td>0 g</td>
</tr>
<tr>
<td>10</td>
<td>Design phase Cost evaluation</td>
<td>892 g</td>
</tr>
<tr>
<td>11</td>
<td>Preparation phase</td>
<td>1811 g</td>
</tr>
</tbody>
</table>

**Site candidates**

- Detailed Geological studies at the two sites: 806 g
- Seismic, acoustic, magnetic measurements in the first vert: 784 g
- Boreholes excavation at the other 2 corners: 300 g
- Boreholes seismic measurements: 300 g

**Site customisation of the design**

- Preliminary customisation activities: 261 g
- Final customisation and design delivering: 60 g
- Site dependent cost evaluation and funding schemes for each: 150 g

**Site dependent socio-economic study**

- Updated socio-economic impact study for each site: 586 g
- Finalising socio-economic impact study: 60 g
- Candidature document package writing: 30 g
- Site bid document delivering: 0 g

**Implementation phase**

- Excavation: 1555 g
- Direction of the civil works: 2112 g
- Services underground (ventilation ...): 1044 g
- Civil works in Surface: 1566 g
- Detector components production: 1458 g
- ET installation: 806 g
- ET pre-commissioning: 632 g
- ET commissioning: 230 g
- Detector Technology Development (R&D): 2610 g

*Note: g = days*
Sites qualification

Enabling technologies development

3G idea

ET CDR

ET EINSTEIN TELESCOPE

Raising Construction funds

ESFRI Phases:
- Design
- Preparatory
- Implementation
- Operation

Raising initial funds

ESFRI proposal

Pre-engineering studies

Building the ET collaboration

Building ET consortium

Costs evaluation

ET RI construction

ET detectors construction

ET Installation

ET detectors construction

ESFRI Phases:
- Design
- Preparatory
- Implementation
- Operation

Detector Operative TDR

RI operative TDR

Site Decision

ET EINSTEIN TELESCOPE

ET detectors construction

ET Installation

ET detectors construction

ET Investigation

ET Installation

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Cost Evaluation

• The first cost evaluation has been realised in the Conceptual Design phase

• The cost evaluation for the ESFRI proposal has been realised thanks to the updated design and to the external advice of two large private companies in Europe

• In the next months the financial models to support ET will be elaborated with the help of the involved government and agencies

<table>
<thead>
<tr>
<th>Phase</th>
<th>Euro [M€]</th>
<th>Committed</th>
<th>Years</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total investment</td>
<td>1912</td>
<td>2,8%</td>
<td>2008-2035</td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td>5</td>
<td>100%</td>
<td>2008-2017</td>
<td>ET-DS + other grants</td>
</tr>
<tr>
<td>Preparation</td>
<td>171</td>
<td>25%</td>
<td>2018-2027</td>
<td>Main activities are site selection, legal structure of ET, ET technology development, site preparation.</td>
</tr>
<tr>
<td>Implementation</td>
<td>1736</td>
<td>0%</td>
<td>2026-2035</td>
<td>The implementation cost will depend upon the selected site.</td>
</tr>
<tr>
<td>Operation</td>
<td>37</td>
<td>0%</td>
<td>2035-2080</td>
<td>Per-year cost</td>
</tr>
<tr>
<td>Termination</td>
<td>40</td>
<td>0%</td>
<td>2081</td>
<td></td>
</tr>
</tbody>
</table>

ESFRI evaluation
ISB design
Pre-preliminary ISB common cost evaluation
Site teams
North site cost evaluation
Site Selection
Cost finalisation
Pre-preliminary ISB common cost evaluation
Site teams
South site cost evaluation
11th ET symposium
Q1-2024
Q4-2024
2025/26
Socio-Economic Impact

• ET-ESFRI is a proposal “submitted by governments” (see later)
  • Then the economic return is a key parameter to be evaluated

• Socio-economic impact study(ies)
  • Support by academic economists or external companies
  • Main numbers:
    • Implementation phase:
      • 1€ invested in ET generates 3.6€ of Total Output (TO*) or between 1.4 and 1.55 of Value Added (VA**)
      • Total Output of 6100M€ or 2400-2600M€ VA
      • Estimated overall employment effect of about 34,000 py over the construction period (about 1,500 construction site workers and the remaining 32,500 are jobs created along ET supply-chain).
    • Operation phase:
      • The annual cost of ET has been evaluated in 37M€
      • The annual TO being 133 M€, the VA outcome ranging between 52 and 57 M€ and overall estimated employment of about 883 py of which 163 is the ET staff and 720 are jobs created along ET supply-chain.

*TO measures the increase of the volume of economic activity induced by the project.
**VA measures the new value generated by the project, i.e. its contribution to the GDP, net of the duplication effects due to the production of intermediate goods and services along the supply chain.
Services and Impacted communities

- ET will be a research infrastructure and in the EU jargon it has to provide services to a wider community
- In the proposal we defined a package of “services” (OPA, DBs, Public Analysis Software for MMA, ...) and we identified the impacted communities analysing the relationship between them using WebOfScience
ET organisation (Thursday morning session)
ET - ESFRI: the Governments level

• An ESFRI proposal is submitted by an European country government ("lead country") representing a group of at least 3 countries
  • The Italian minister of Research signed the political and financial support letter, leading the proposal
  • The Belgian, Dutch, Polish and Spanish governments signed the political support letter as perspective countries
ET-ESFRI: The consortium level

• The ET ESFRI consortium is composed by the institutions signing the ET Consortium Agreement (CA)
  • Very light CA at this level
  • 41 Institutions signed the ET consortium
    • Both national funding/research agencies (RFOs, RPOs) and "local" research performing organisations (RPOs)
• The ET consortium is coordinated by INFN and Nikhef
• The European Gravitational Observatory (EGO, Pisa, Italy) is the headquarter of the proposal
  • EGO is the institution managing the Virgo infrastructure
ESFRI roadmap: next steps

• OPEN CALL FOR PROPOSALS - 25 September 2019
• SUBMISSION OF PROPOSALS - 9 September 2020
• CRITICAL QUESTIONS & INVITATION TO HEARINGS – February-March 2021
• HEARINGS – April-May 2021
• ESFRI FORUM DECISION - June-September 2021
• ESFRI ROADMAP LAUNCH - October - November 2021

1st meeting of the ESFRI and Ministry delegates “supporting ET” (17 Sept 2020)
ET sites under characterisation

Euregio Meuse-Rhine
• A 250-m deep borehole has been excavated
  • Seismic data under acquisition and analysis
• 2 other boreholes expected
• A network of seismic sensor will be deployed to characterise the seismic noise
• ET pathfinder centre under construction
• 15+15M€ funding through Interreg grants

Sardinia
• Long standing characterisation of the mine in one of the corners continuing
  • Seismic, magnetic and acoustic noise characterisation ongoing at different depth in the mine
• Underground laboratory under construction (SarGrav)
• Call for tender for the excavation of the boreholes at the other two corners almost ready to be open
• Surface investigations in progress
• 17+3.5+1M€ funding through national and regional funds

We have to:
1. Evaluate common parameters
2. Define common/comparable measurement methods → SPB duty
Sites qualification

Enabling technologies development

3G idea

ET CDR

ET EINSTEIN TELESCOPE

Building the ET collaboration

Building ET consortium

Raising initial funds

ESFRI proposal

ESFRI decision

Pre-engineering studies

Costs evaluation

RI operative TDR

Detector Operative TDR

RII operative TDR

ET detectors construction

ET RI construction

ET Installation

ESFRI Phases:
- Design
- Preparatory
- Implementation
- Operation

Sessions “Instrument Science” Wednesday Afternoon and Thursday late Morning and afternoon
709 registered participants to the 11th ET symposium