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PIANO NAZIONALE  
DI RIPRESA E RESILIENZA



# Preparatory activities for the ET sustainable design

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ET Symposium –Cagliari – 8-12 may 2023



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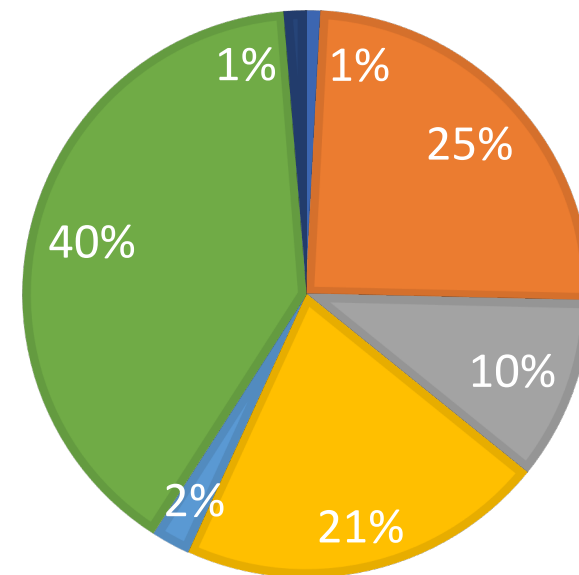


## Einstein Telescope Infrastructure Consortium (ETIC)

- WP1 Management
- WP2 Optics, Electronics and Photonics
- WP3 Vacuum and Cryogenics
- WP4 Suspension and Interferometric large facilities
- WP5 Computing & DAQ
- WP6 Sustainable Design*
- WP7 Outreaching, dissemination, training

WP BUDGET ETIC

■ WP 1 ■ WP 2 ■ WP 3 ■ WP 4 ■ WP 5 ■ WP 6 ■ WP 7





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ET-3G AB

DICEA – Sapienza

multidisciplinary lab focused on **civil and environmental engineering** for optimized civil work design using advanced tools for surveying and modeling

Mapping and surveying

Reference geodetic network and local geoid

3D modelling (BIM&GIS multicriteria analysis)

Geotechnical investigations

Geotechnical modeling

Hydrogeological modelling

Structural models (digital twins)

Energy and transportation and strategy

Digital platform for design management

AT-LAB

Univ. Cagliari

support for the definition of the spatial components of the research infrastructure and study of the effects on **territorial, urban and landscape systems**

Tender preparation

Tender and contract

Contract progress: SdA01

Contract progress: SdA02

Contract progress: SdA03

Contract progress: SdA04

Contract progress: SdA05

Verification and validation

LNS-INFN

Catania

collect specifications and requirements for ET **pre-feasibility project tender**

Lab for architectural feasibility study of ET

Architectural and landscape aspects of ET

Scienza delle Terra U

niv. Pisa

in-situ seismic network for contributing to the extraction of a detailed **geological model**

GNSS equipment an installation contract

Geodetic tripod/pillars construction

Assembly and installation

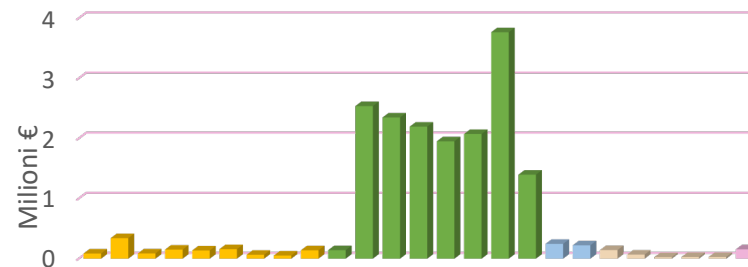
GNSS network calibration

Gravimetric calibration

Italian Space Agency (ASI)

Establishment of a **geodetic control network**

Purchase Design and installation of seismometer



5 civil engineers

- Geodesy
- Geotechnics
- Hydraulic construction
- Structure
- Underground water management



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## Preparatory studies for ET design

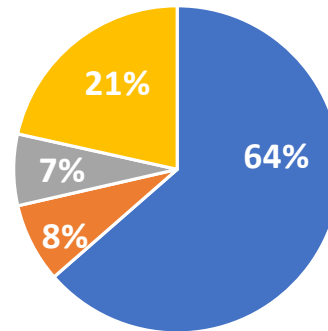
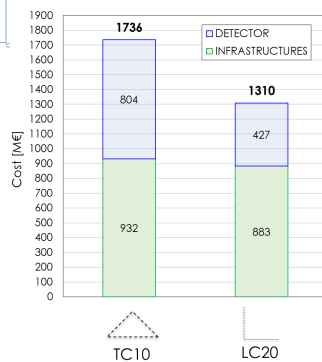
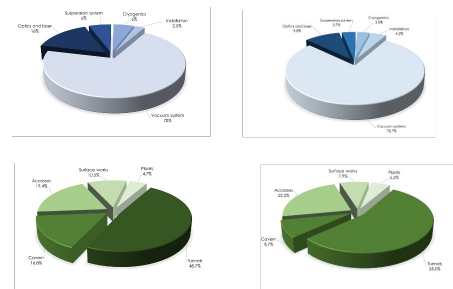
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Avviso pubblico rep.3264 del 28-12-2021 per "Rafforzamento e creazione di Infrastrutture di Ricerca" da finanziare nell'ambito del PNRR, Missione 4, "Istruzione e Ricerca" - Componente 2, "Dalla ricerca all'impresa" - Linea di investimento 3.1, "Fondo per la realizzazione di un sistema integrato di infrastrutture di ricerca e innovazione"

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Progetto IR0000004 - ETIC, decreto di ammissione al finanziamento n. 410 del 27/10/2022  
CUP\_I53C21000420006 - CUI\_SB4001850589202300015

**ETIC - EINSTEIN TELESCOPE INFRASTRUCTURE CONSORTIUM**

"Studio propedeutico allo sviluppo del progetto di fattibilità tecnica ed economica dell'osservatorio di onde gravitazionali Einstein Telescope nella Regione Sardegna, in diverse configurazioni, comprensivo della esecuzione delle indagini e dei sondaggi e della valutazione preliminare di impatto ambientale, per le opere infrastrutturali, in sotterranea e in superficie, edili e impiantistiche"



- Studio delle opere in sotterraneo
- Studio delle opere in superficie
- Studio degli impianti
- Rilievi, indagini, sondaggi e prove di laboratorio

Works and services for preliminary surveys and investigation	3 M€
Engineering service	11 M€
▪ Study of underground works	9 M€
▪ Study of surface works	1 M€
▪ Study of technical plants	1 M€

Gaetano Schillaci –LNS- INFN– Responsible for the tender and contract



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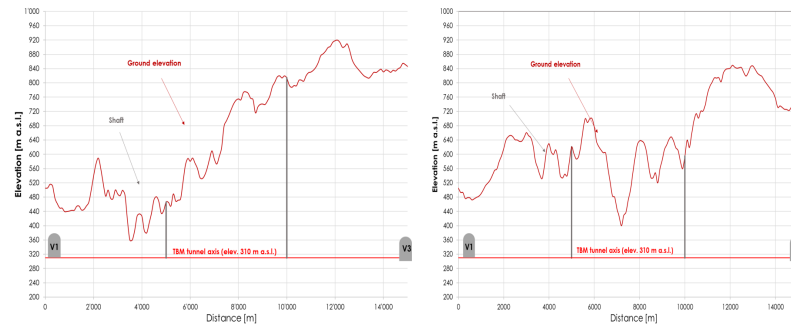
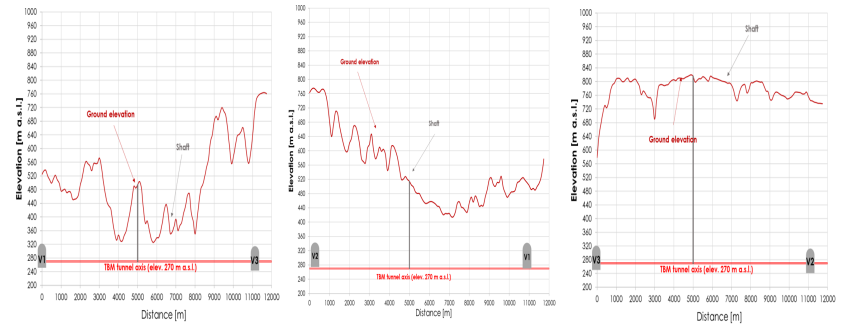
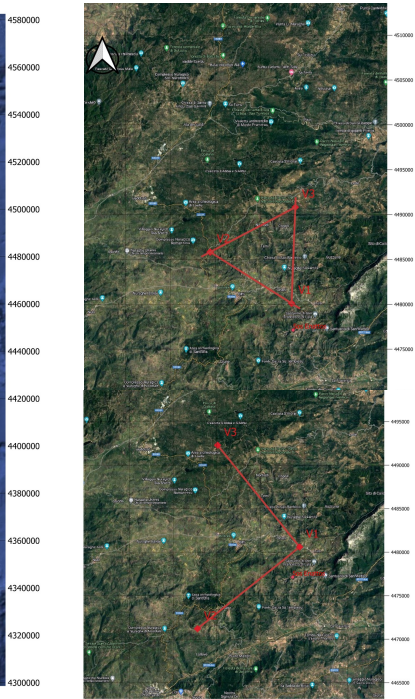
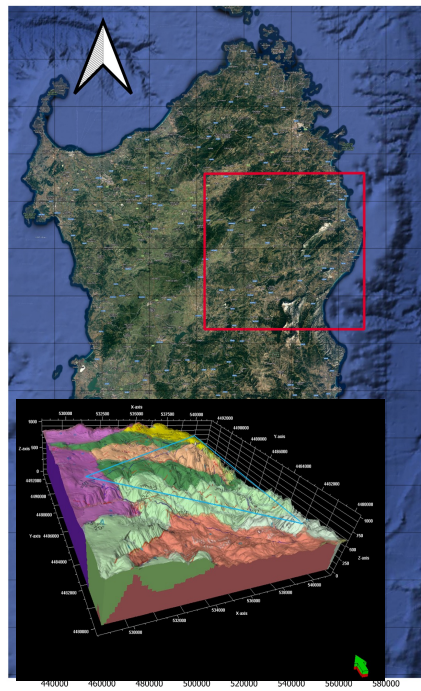
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## Territorial framework







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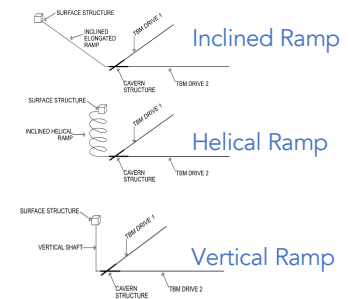
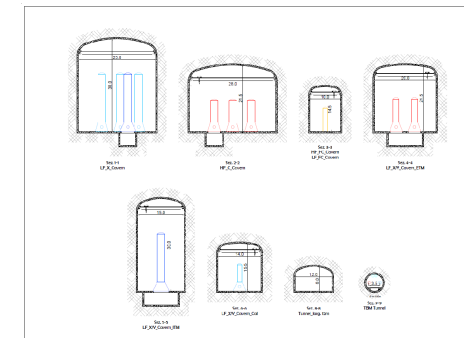
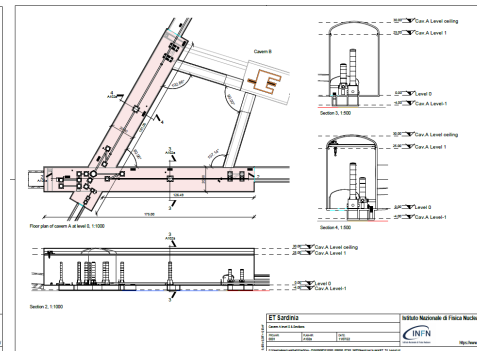
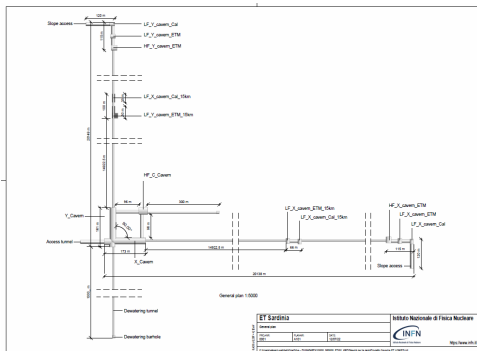
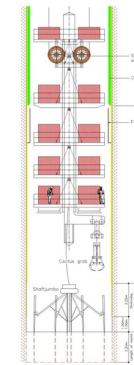
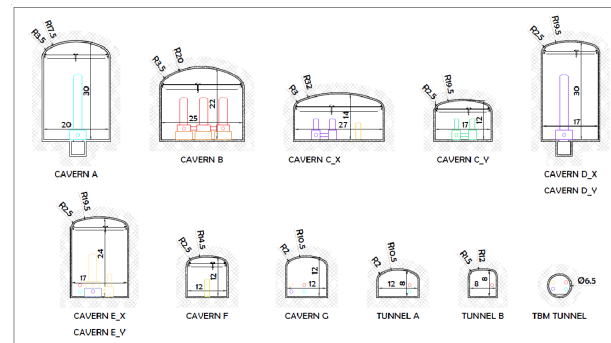
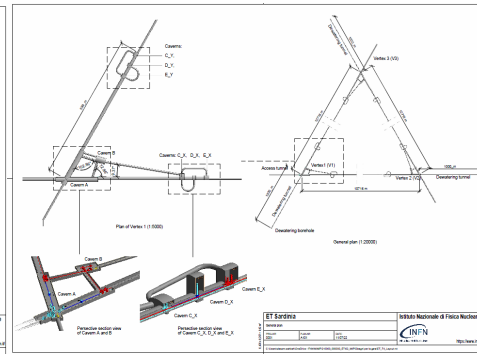
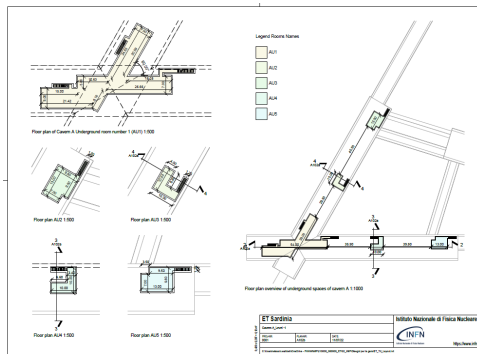
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## Modeling and Layouts





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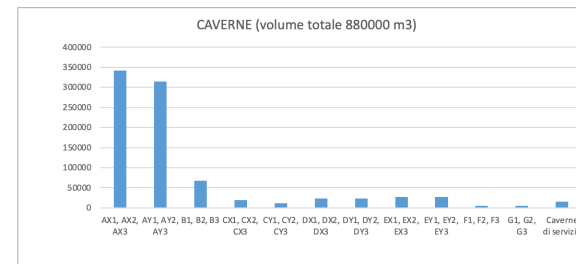
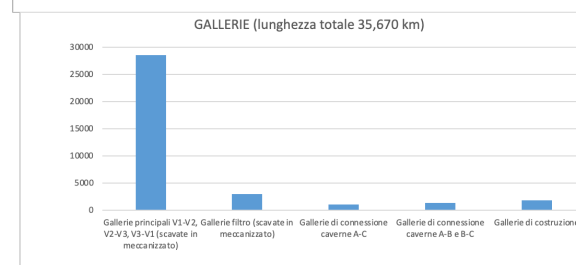
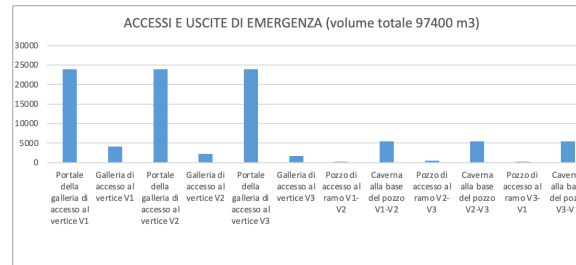
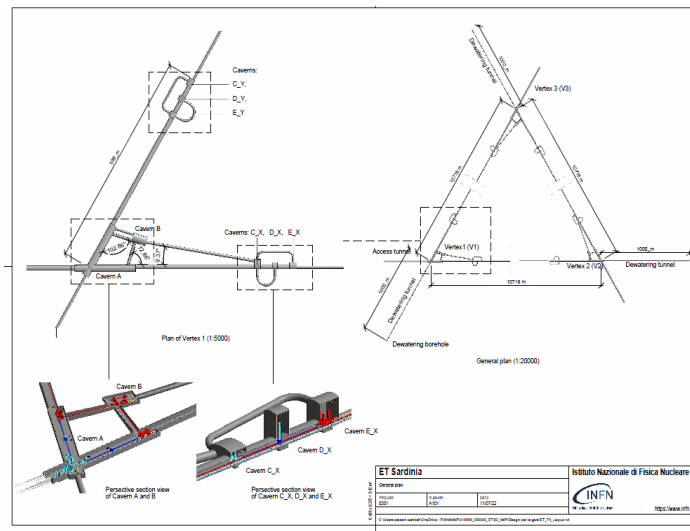
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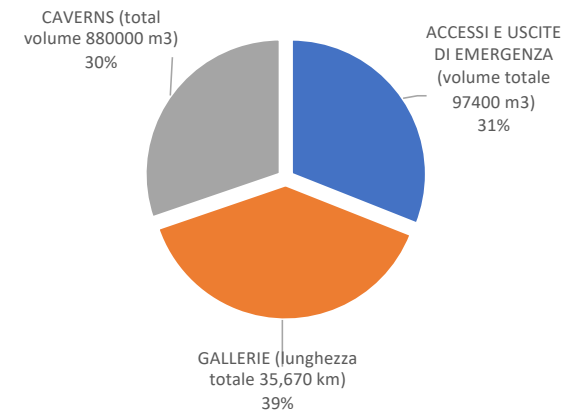
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# Preliminary cost estimate (excavation)



TRIANGLE 10Km (~ 1,5 Mleuro)





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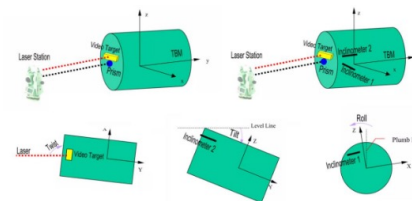
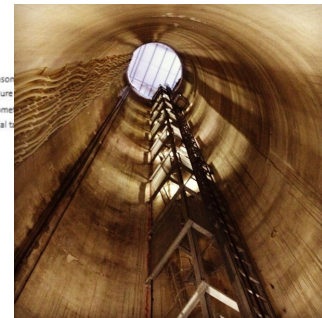
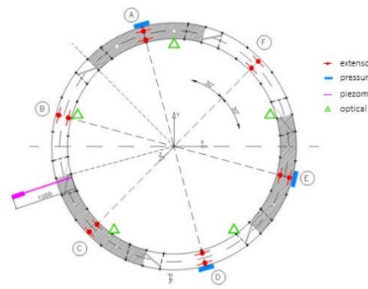
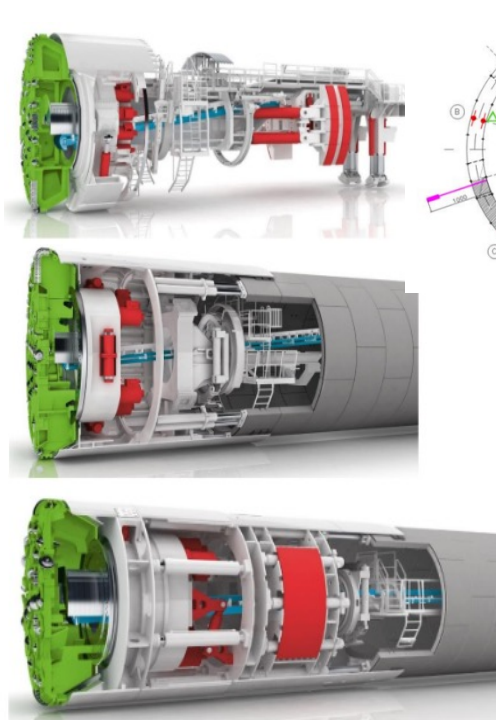
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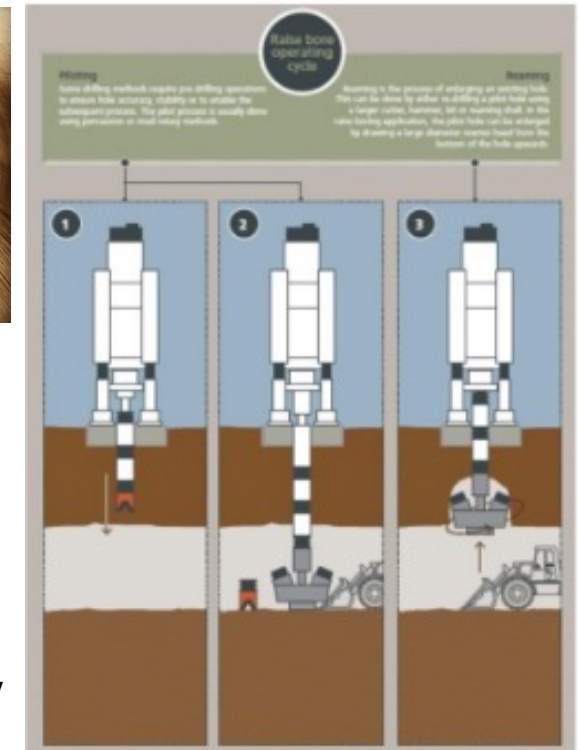
## Evaluation of TBM configuration and tunnel monitoring

Advantages and disadvantages of excavation with TBM and traditional method

- Gripper TBM
- Single shield TBM
- Dual shield TBM



Methodology of excavation of emergency exits, tunnels accessories and wells







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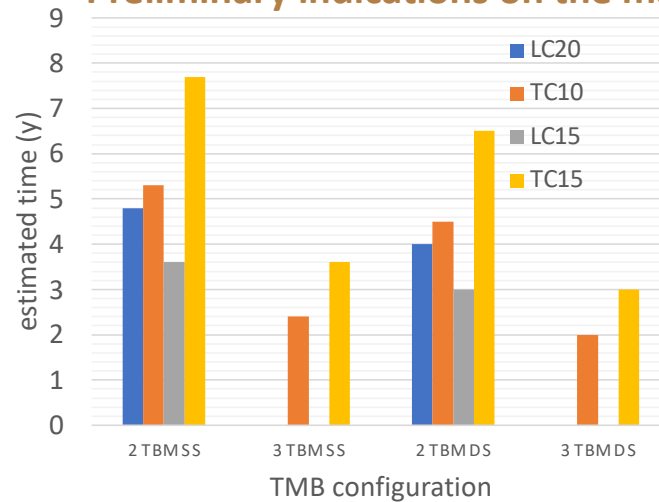


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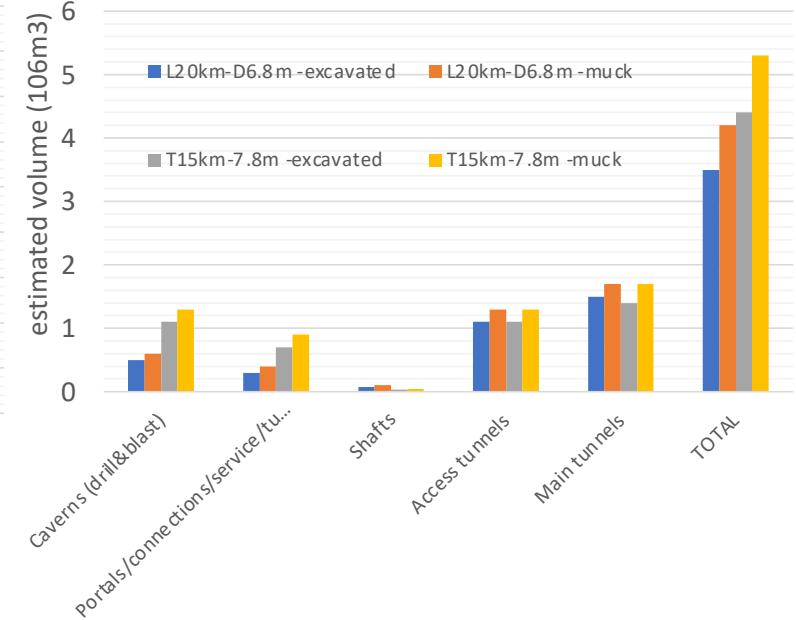


- TC10 and LC20 configuration
- two or three TBMs already positioned at the vertices advancing in parallel; digging from one vertex to another without intermediate exits.
- two TBMs of the triangle configuration, to consider the passage of a machine from one tunnel to another;
- feed speed calculated considering the ROP and U values averaged with respect to the occurrence of the formations encountered along each route
- These values are in the range 14-19 m/dayshifts of 24 hours and 345 working days per year

### Preliminary indications on the management of excavated lands and rocks



Estimated time for the construction of the main tunnels considering different configurations and assuming - ROP=2m/h for both formations.



The volume of excavated and crushed material was obtained by multiplying by a factor of 1.2 the volume of the rock in place, in order to take into account the voids in the pile.



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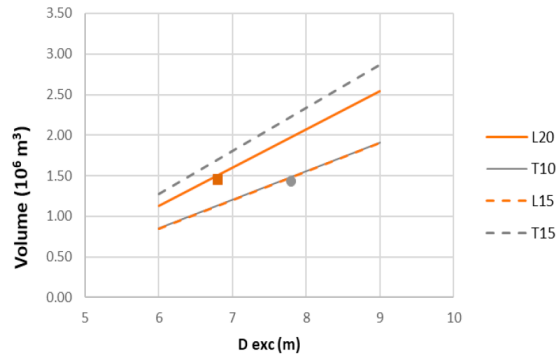


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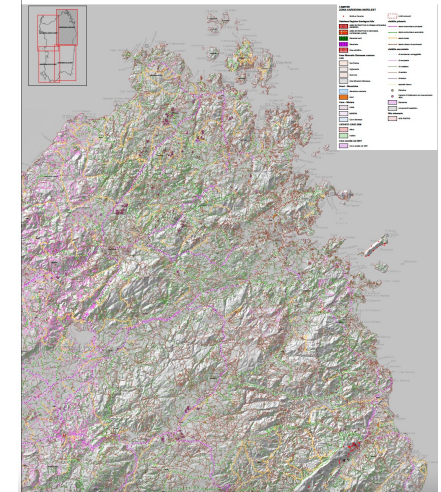
**DAVIDE BONEDDU**

**GEOLOGO  
NUORO**

## Preliminary strategy on the management of excavated soil and rock



	L20 (D=6.8 m)		T10 (D=7.8 m)	
	Excavated volume (10 <sup>6</sup> m <sup>3</sup> )	Muck volume (10 <sup>6</sup> m <sup>3</sup> )	Excavated volume (10 <sup>6</sup> m <sup>3</sup> )	Muck volume (10 <sup>6</sup> m <sup>3</sup> )
Surface excavations	-	-	-	-
Caverns (drill&blast)	0.5	0.6	1.1	1.3
Portals/connections/service tunnels	0.3	0.4	0.7	0.9
Shafts	0.07	0.1	0.03	0.04
Access tunnels	1.1	1.3	1.1	1.3
Main tunnels	1.5	1.7	1.4	1.7
<b>TOTAL</b>	<b>3.5</b>	<b>4.2</b>	<b>4.4</b>	<b>5.3</b>



internal diameter of 5.5 m and 6.5 adding a thickness of the coating and the back filling of 0.65 m and multiplying by 1.2 to account for voids

## Regulatory framework

- Excavated soils and rocks classified or not as waste
- Characterization of excavated soils and rocks in the design and execution phases
- End of Waste

## Reuse plan

- fillings and substrates for construction
- aggregates in the preparation of concrete/mortar
- pea-gravel
- building material for embankments
- filling of abandoned quarries
- landscaping arrangements



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## Design optimization

- Energy demand vs low carbon footprint
- environmental noise level reduction
- Digital Twin, IoT, GIS/BIM Modelling
- Interference/connection with exiting service networks
- New power plants
- Refurbishment of existing plants

2 engineers from INFRADEV

- WP5 - Project Office and Engineering Department – Roma1 INFN
- WP9 - Sustainable Development Strategy – EGO
- 





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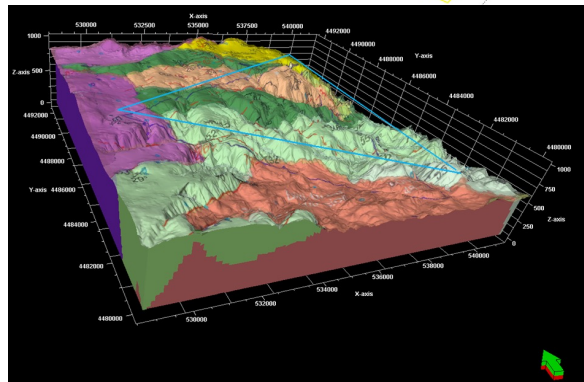
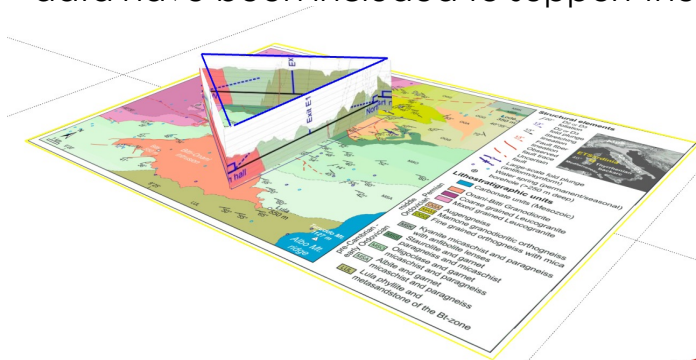
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3D Geological Model – collect and harmonize homogeneous geodatabase (geological, geophysical and geographical data have been included to support the subsequent modelling phases



- Digital terrain models
- Topographic maps / aerial / satellite photos
- Geological and thematic maps (sometimes already available in GIS environment), such as structural maps, hydrogeological maps.
- Geological/structural sections
- Well data for deep geognostic surveys (e.g. lithology, stratigraphy and digital logs,) and for water (e.g. presence and distribution of water, their characteristics, and piezometric levels)
- Geophysical acquisition data (geoelectric, tomographic and seismic line sections)
- Geotechnical data (e.g. properties of soils and rocks, and geomechanical characterizations)
- Gravimetric charts. Magnetic or magneto-telluric
- Seismic reflection data
- Soil and rock velocity data



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## ETIC spill-overs for ET

- ETIC invest on engineering services, modeling labs and higher education jobs for the pre-feasibility phase of the ET civil engineering design
- Call for tenders of the PNRR ETIC project has been published for the preliminary feasibility study for ET in Sardinia (14 Million of euro , to be assigned by dec. 2023 and delivered by dec. 25) in different geometric configurations
- WP6 " Sustainable Design" in ETIC project gathers a multidisciplinary working group to
  - ✓ support the formulation of engineering solutions satisfying scientific requirements
  - ✓ applying environmental sustainable strategies (*talk of Sara Mangifesta tomorrow at 9:30*)
  - ✓ define a shared eapproach for the optimization of the ET geolocalization on the surface and underground (*talk of Wissam Wahbeh today at 16:30*)

## Next steps

- share the specialized studies with scientific boards and experts (MOU with CERN)in ETO
- enforce engineering team to consolidate specifications for civil works design (CE – INFRADEV)
- interact with thematic working groups to gather relevant parameters for design, risk identification, maintenance and operations needs