

Einstein Telescope

Status of the Project

Michele Punturo

INFN Perugia

On behalf of the ET steering committee

ET-0009A-19

Last year activities

- The key events determining the current status of the project are:
 - 9th ET symposium (EGO, 19-20th of April 2018)
 - ET project Roadmap presentation
 - Kick-off the ET collaboration forming procedure
 - Letter of Intent
 - ET steering committee
 - 10th ET symposium (Sardinia, 11-12th of April 2019)
 - Presentation of the ET management bodies and of the first ET statute
 - ET Writing Team activity presentation
 - Visit at the local site candidate to host ET
 - Hot discussion on geometries, costs, national engagement

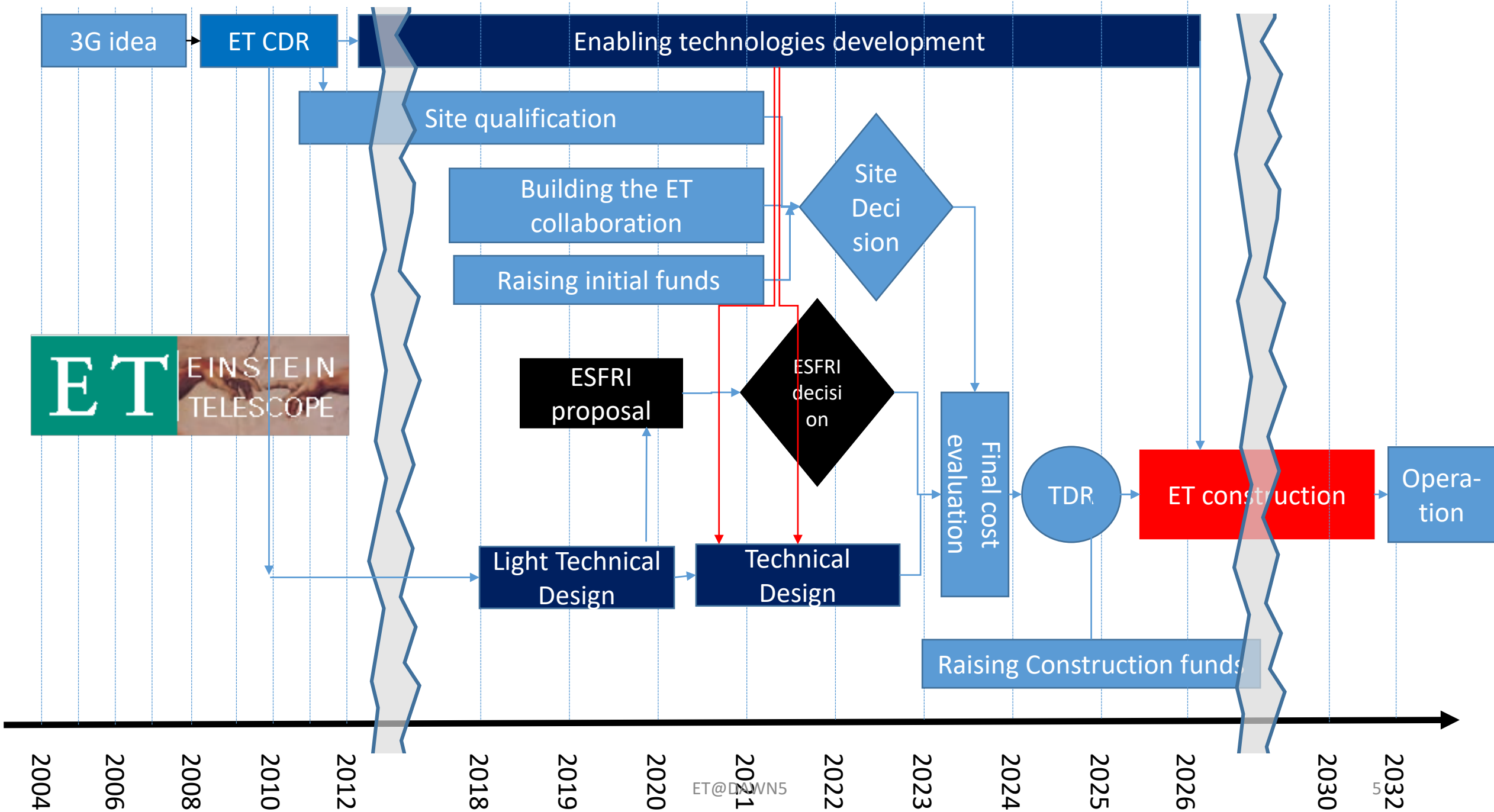
Phases of the ET project



Name	Idea	CDR	Project Roadmap	Initial preparatory funds	Enabling Technologies, Site	TDR	Bulk Funds	Construction
ET 	2004-	2011	2017-	2018	2008-	2019-		

ET: project roadmap

- ET has a clearly defined project roadmap:
 - 2018-2019 Form the ET collaboration
 - 2019-2020 ESFRI roadmap
 - Light TDR to be realised, refine CDR cost evaluation, key options to be selected, ESFRI proposal
 - 2022 Site Selection
 - Technical/political activity
 - Requirements need to be compared with the site characteristics through an intense experimental activity in the next 3 years
 - 2023 Full Technical Design Report
 - Cost definition
 - 2025 Infrastructure realization start (excavation,)
 - 2030 -2031 end of infrastructure construction, beginning of installation
 - 2032+: installation / commissioning / operation

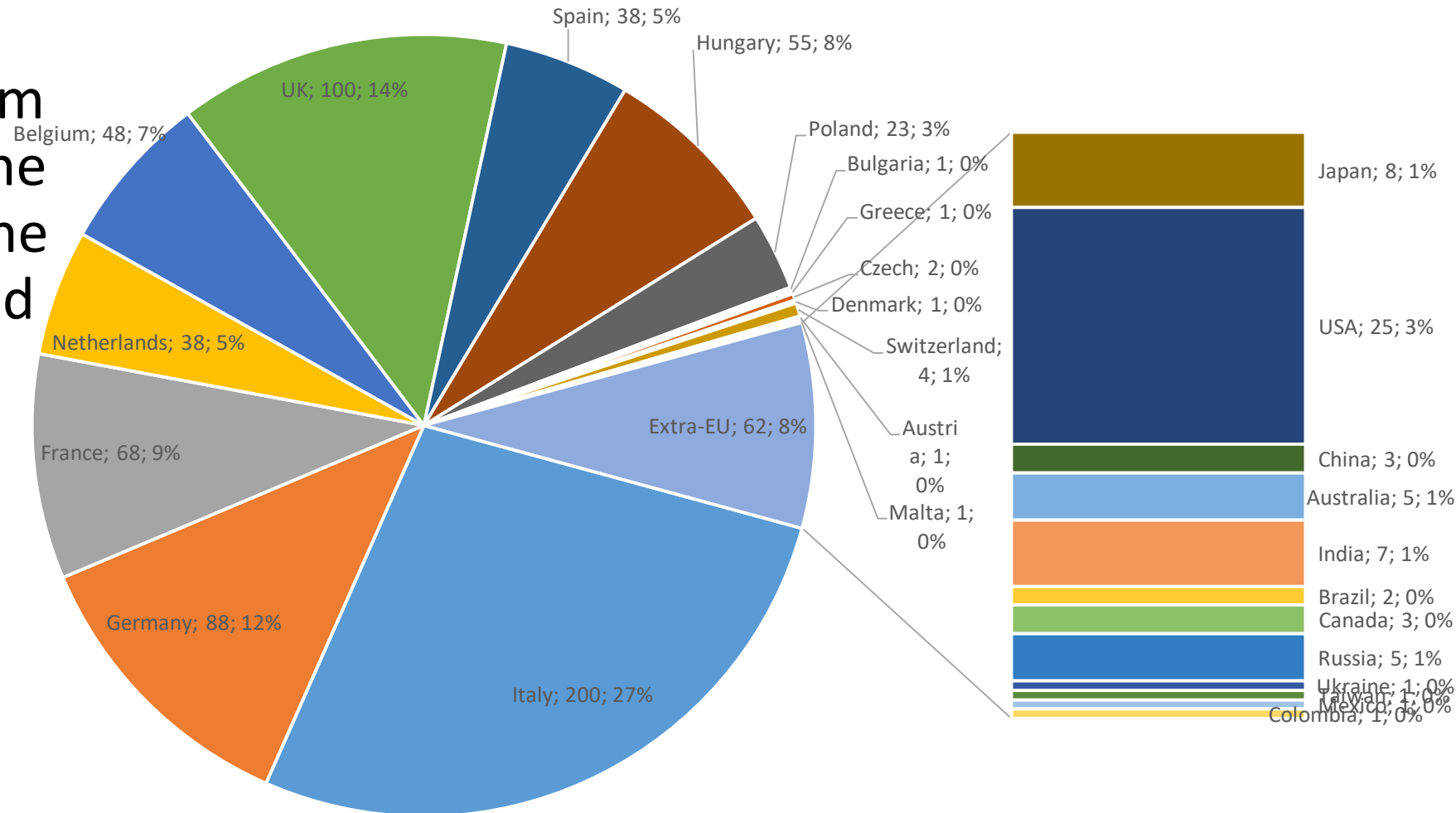


ET collaboration



- Kick-off discussion at the 9th ET symposium
 - Launched the ET letter of intent: 731 signatories

- At the 10th ET symposium we decided to initiate the procedure to approve the collaboration statute and to transform the ET community to a collaboration

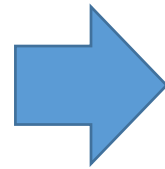


ET collaboration

- Transition in the management structure of the collaboration

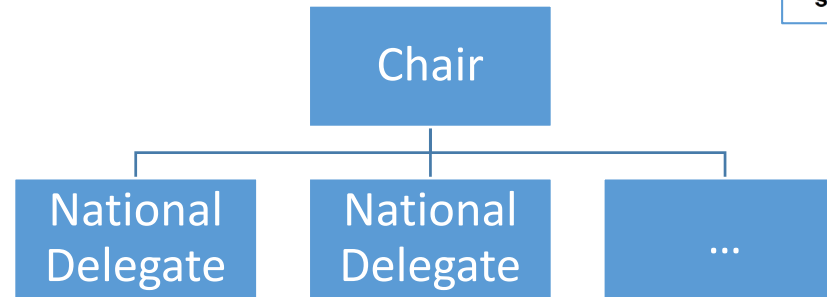
ET steering committee

Name	Country
Nick van Remortel	Belgium
Nelson Christiansen	France
Matteo Barsuglia	France
Raffaele Flaminio	France
Karsten Danzmann	Germany
Harald Lueck	Germany
Achim Stahl	Germany
Peter Levai	Hungary
Michele Punturo	Italy
Enzo Brocato	Italy
Fulvio Ricci	Italy
Tomasz Bulik	Poland
Jo van den Brand	The Netherlands
Frank Linde	The Netherlands
Sheila Rowan	UK
Stefan Hild	UK
Andreas Freise	UK
Stavros Katsanevas	Observer-EGO
David Reitze	Observer-LIGO

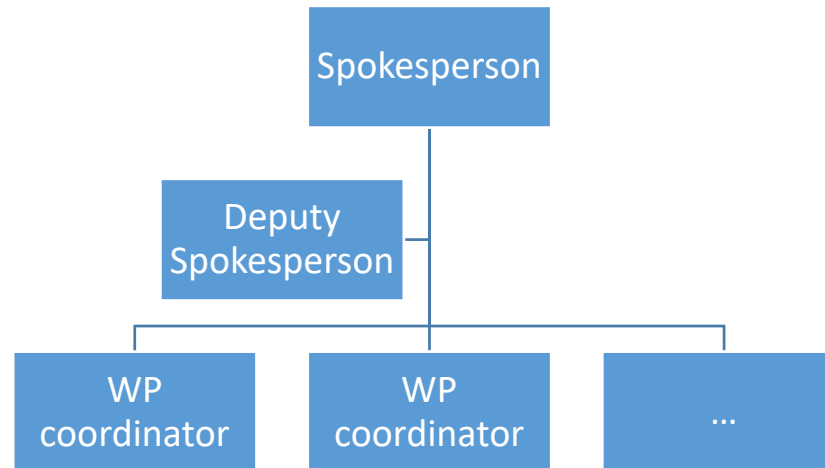


➔ David Shoemaker

General Assembly



Executive Board

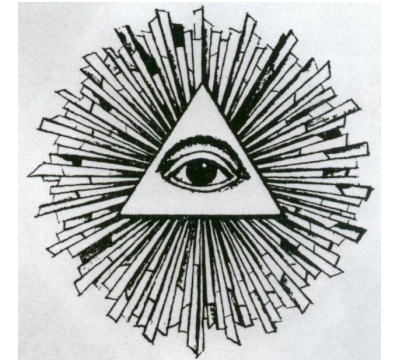


Management structure of the ET Collaboration

ET Steering Committee

Introduction: start-up of the collaboration and of its management structure

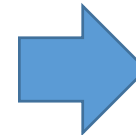
Oversight Committee



Funding Agencies

ESFRI roadmap proposal

- The procedure for the update of the ESFRI roadmap should open in June 2019 and close in April 2020
 - The proposal should be ready in advance to be submitted to the national government
 - Jan 2020 for The Netherlands
 - Preparation based on 2018 questionnaire:
 - We don't expect major differences
 - ET CDR has been delivered in 2011
 - We need a Light TDR for the technical part of the ESFRI proposal
 - We need to refine our cost evaluation



ET ITDR writing team

Name	Country
Marie Anne Bizouard	FR
Raffaele Flaminio	FR
Andreas Freise	UK
Gianluca Gemme	IT
Jan Harms	IT
Stefan Hild	UK→NL
Giovanni Losurdo	IT
Harald Lück	DE
Ettore Majorana	IT
Michele Maggiore	CH
Cristiano Palomba	IT
Michele Punturo	IT
Jo van den Brand	NL
Chris van den Broeck	⁸ NL

ESTIMATED COSTS

Summarise the real or estimated costs for your RI:

- CAPITAL VALUE:	€ <INSERT>
- DESIGN:	€ <INSERT>
- PREPARATION:	€ <INSERT>
- IMPLEMENTATION (CONSTRUCTION):	€ <INSERT>
- AVERAGE ANNUAL OPERATION COSTS:	€ <INSERT>



Engineering support Team:

- Engineers belonging to the institutions behind ET
 - Andrea Paoli (EGO)
 - Martin Doets (Nikhef)
 - Lutz Lilje (Desy)
 - (INFN)

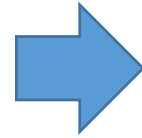
ET@DAWN5

Cost (ri-)evaluation

ESTIMATED COSTS

Summarise the real or estimated costs for your RI:

- CAPITAL VALUE:	€ <INSERT>
- DESIGN:	€ <INSERT>
- PREPARATION:	€ <INSERT>
- IMPLEMENTATION (CONSTRUCTION):	€ <INSERT>
- AVERAGE ANNUAL OPERATION COSTS:	€ <INSERT>



- Engineering support Team:
 - Engineers belonging to the institutions behind ET
 - Andrea Paoli (EGO)
 - Martin Doets (Nikhef)
 - Lutz Lilje (Desy)
 - (INFN)
- Need for additional experts on large cryogenic, high vacuum, underground infrastructures
 - ?????? CERN!!
 - Bottom-up approach with “relevant” persons
 - Paolo Chiggiato (Vacuum), Johan Bremer (Cryogenics), John Andrew Osborne (Infrastructures)
 - Positive feedback from long telephone call
 - Direct contact with Eckhard Elsen
 - Positive feeling from email exchange
 - Positive direct discussion at the Granada meeting

2018 ESFRI questionnaire

POLITICAL SUPPORT

A) LEAD COUNTRY/ENTITY

Identify the Member State (MS), Associated Country (AC) or the EIROforum member, which leads the preparation of your RI:

- COUNTRY NAME FOR MS OR AC (limited dropdown list)
- EIROFORUM MEMBER (dropdown list)

Upload the Expression of political Support (EoS) of the lead country; in the case of a EIROforum member, please upload the Council resolution: (upload with limit 1 MB)

B) PROSPECTIVE MEMBER COUNTRIES/ENTITIES

Identify at least two MS and AC, which have submitted Expressions of political Support (EoS) signed by the national ministries responsible for RI or other entities such as EIROforum members of which the mandated authorities have expressed interest to join your RI. You may also identify any additional third country that has signed an EoS:

- COUNTRY NAMES (extensive dropdown list allowing for multiple entries)
- FULL NAMES OF OTHER ENTITIES (maximum 200 characters with spacing allowing for multiple entries)

Merge all corresponding EoS and Council resolutions and upload: (upload with limit 10 MB)



TBD



IT
NL
BE?
PL?
UK?
DE?
HU?
FR?

2018 ESFRI questionnaire

FINANCIAL COMMITMENT

A) LEAD COUNTRY/ENTITY

Identify the authority¹ from the lead country that has signed Expression of Commitment (EoC) or provided a Council resolution to financially contribute to the preparation and implementation:

- NAME (maximum 200 characters with spacing)
- CONTACT PERSON (maximum 200 characters with spacing)
- EMAIL & TELEPHONE (email & telephone fields)

Upload the corresponding EoC or Council resolution: (upload with limit 1 MB)

B) PROSPECTIVE MEMBER COUNTRIES/ENTITIES

Identify the authorities from prospective member countries that have signed an Expression of Commitment (EoC) and other entities such as EIROforum members that have provided a Council resolution to financially contribute to the preparation and implementation:

- NAME (maximum 200 characters with spacing)
- CONTACT PERSON (maximum 200 characters with spacing)
- EMAIL & TELEPHONE (email & telephone fields)

Merge all corresponding EoC and Council resolutions and upload: (upload with limit 10 MB)

C) COVERAGE OF REAL AND ESTIMATED COSTS

Specify the amounts that have already been financed or are fully agreed to be financed and specify the share of costs covered by the commitment (-s) for the real or estimated costs:

- | | | |
|-----------------------------------|------------|--------|
| - CAPITAL VALUE: | € <INSERT> | <XXX>% |
| - DESIGN: | € <INSERT> | <XXX>% |
| - PREPARATION: | € <INSERT> | <XXX>% |
| - IMPLEMENTATION (CONSTRUCTION): | € <INSERT> | <XXX>% |
| - AVERAGE ANNUAL OPERATION COSTS: | € <INSERT> | <XXX>% |

Negotiation Committee

We need to set up a “negotiation” committee composed by high level representatives of the (research) institutions that build a bridge between the project (the steering committee) and the Ministries

Problem: in the new ESFRI procedure seems requested to “promise” the coverage of the 50% of the total costs through EoS
Need of a common action to solve this point

Preparation activities

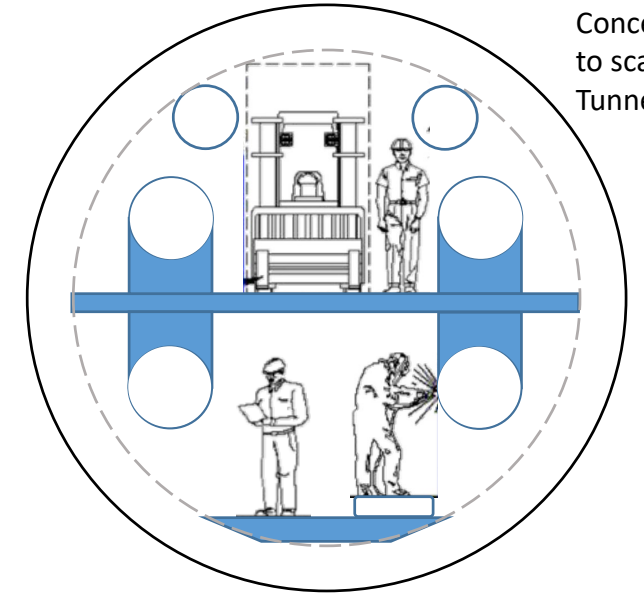
- Light TDR
- Qualification requirements document
 - A team chaired by Jan Harms has been set up to define the qualification parameters to be measured to evaluate a site:
 - Geology, rocks quality, natural radioactivity
 - Seismicity
 - Environmental noise
- Update of the CDR geometry and infrastructure requirements:
 - Discussion at the ET Steering Committee level with the support of engineers and external experts

Current points of discussion

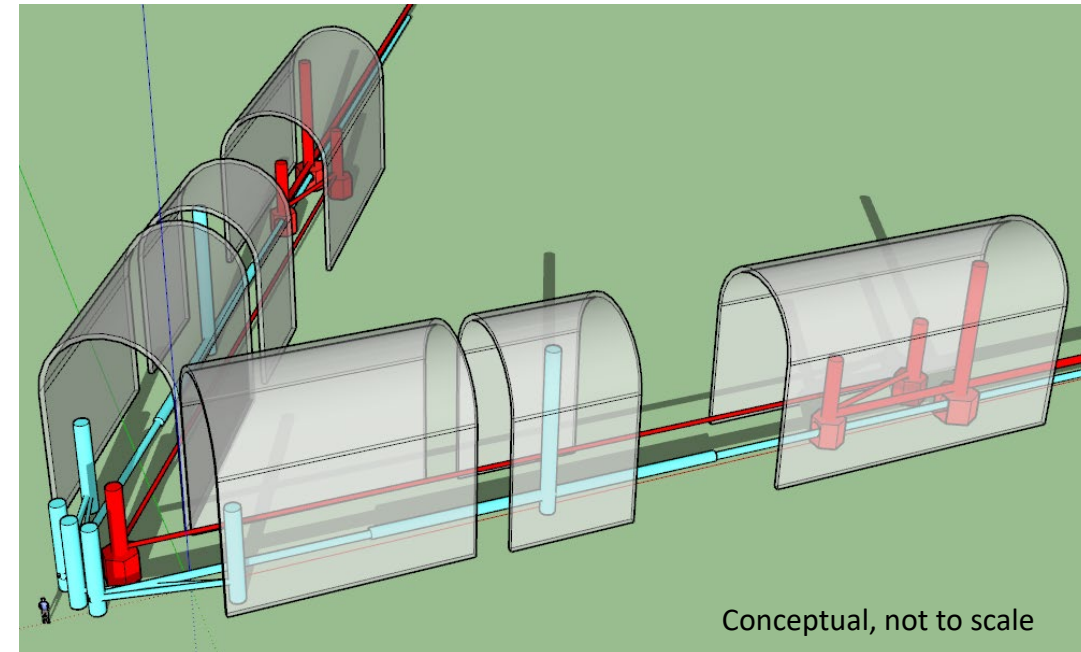
Mostly driven by the need of rapid costing, good enough for ESFRI roadmap

- Vacuum arrangement; how to fit the tubes into tunnels
- → tunnel diameter determined by
 - # of tubes
 - Effective outer diameter of tubes
 - Margin needed for installation, maintenance, repair, etc.
 - Safety issues (escape, ventilation,...)
- Positions of towers along the arms
 - # of caverns
 - Size of caverns
- Vacuum tube
 - Diameter needed, material, design, fabrication methods
 - Baking (requirements, procedure, ...)
 - Baffles for beam tubes
 - ...

Harald Lueck @ GWADW2019



Conceptual,
to scale
Tunnel 6.5 OD

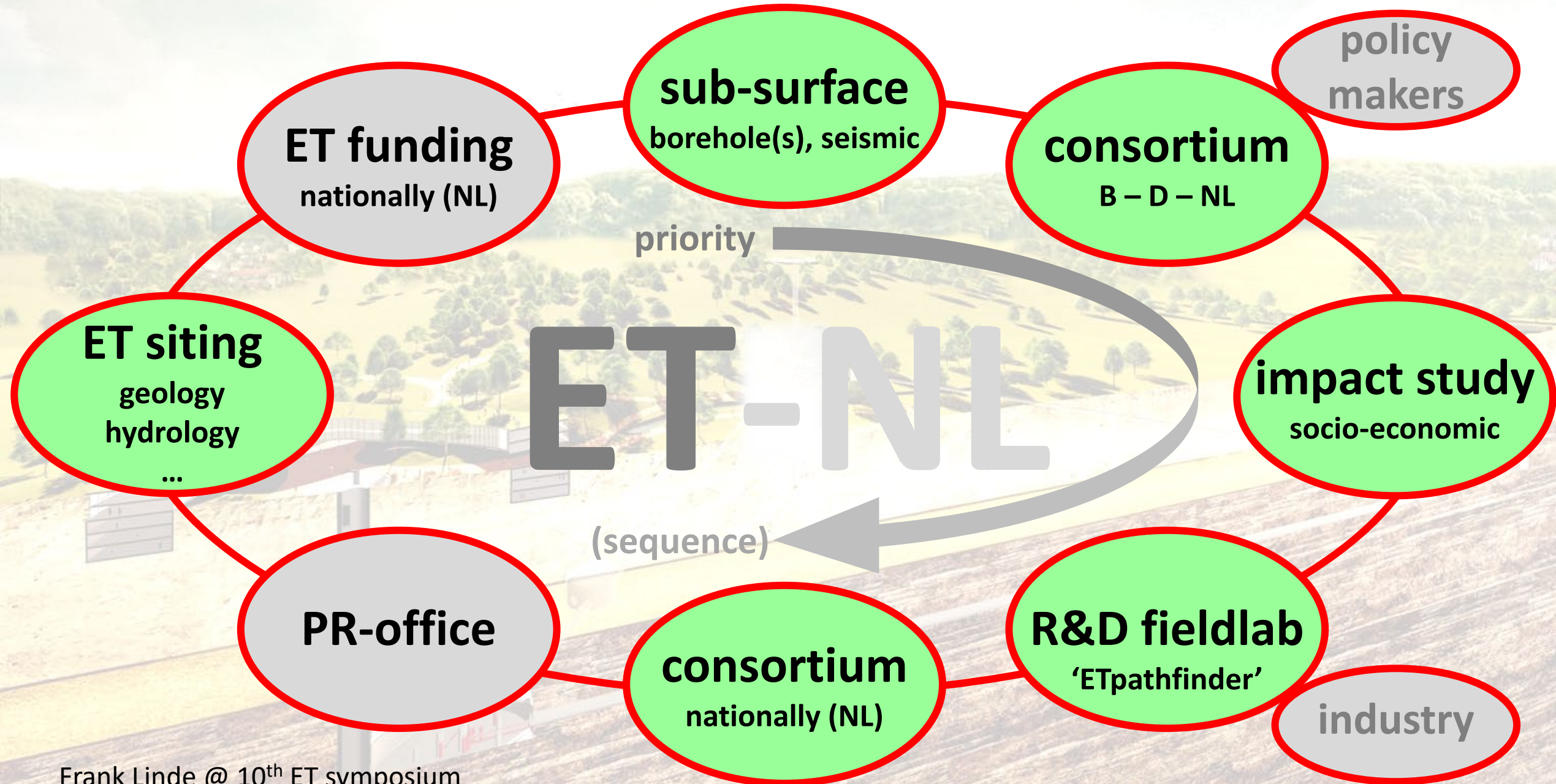


National activities

- Currently only two sites are candidate to hosts the ET infrastructure
 - The three borders region (NL, BE, DE)
 - Sos Enattos (Sardinia, Italy)

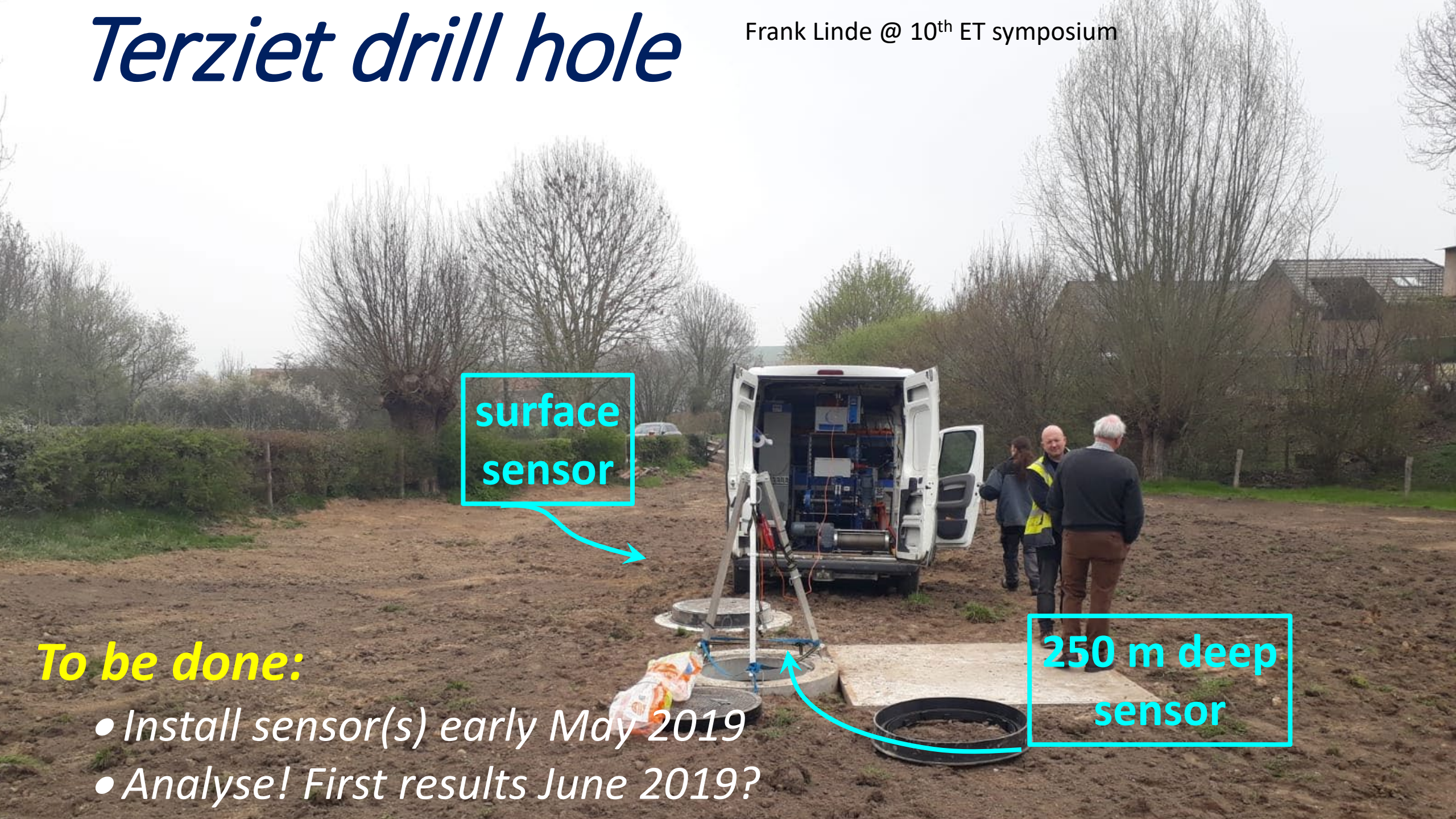
Activities . . .

apologies: a bit Dutch dominated . . .



Terziet drill hole

Frank Linde @ 10th ET symposium



surface
sensor

250 m deep
sensor

To be done:

- Install sensor(s) early May 2019
- Analyse! First results June 2019?

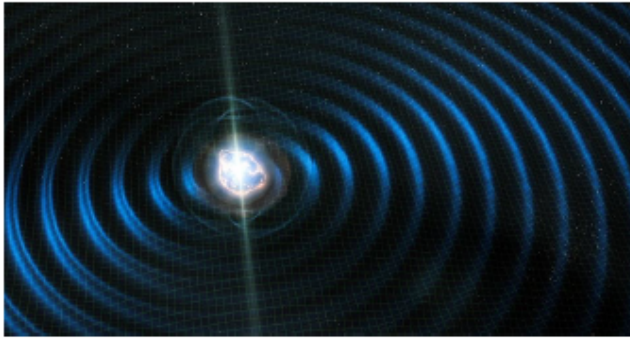
Socio-economic impact study

Frank Linde @ 10th ET symposium

technopolis_{group}

Impact assessment of the Einstein Telescope

Final report, 28/09/2018



Impact assessment of the Einstein Telescope

Final report, 28/09/2018

technopolis_{group} September 2018

Joost van Barneveld
Lisanne Saes
Ivette Gomens
Geert van der Veen

www.technopolis-group.com

Scenarios	Baseline	ETpathfinder	Einstein Telescope (ET)	
	Baseline: No ET participation	ETpathfinder	ET-ELAt	ET- elsewhere
Investments (rough estimate ^{**})	0	Limited (M€10-30)	Very large (M€400-700)	Large (M€100-325)
Operational costs (rough estimate ^{**})	0	M€0,1-0,2/y	M€ 10-20/y	M€7-13/y
Regional economic effects	0	Limited	Large	Limited
Organisational impact	0	Can be fairly large	Very Large	Large
Visibility, reputation	0	Limited	Large	Limited
Scientific impact	0	Limited	Very Large	Large
Innovation impact and long term economic impacts	0	Possibly large	Possibly very large	Possibly very large

Gravitational-waves: booming!



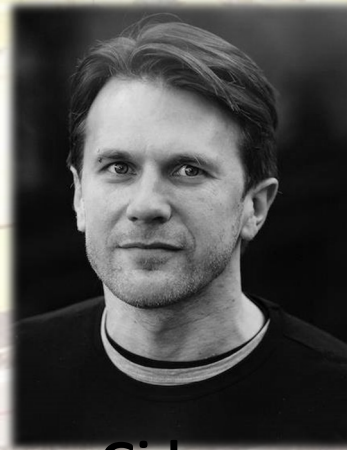
**Maastricht
University**

Also hiring:

*Utrecht, Amsterdam,
Ghent, Antwerp, Brussels,
Leuven, . . .*



Jessica
Steinlechner



Gideon
Koekoek



Sebastian
Steinlechner



Stefan
Danilishin

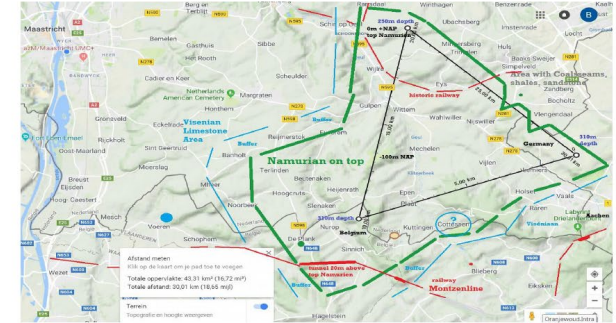


LHCb
CERN
Jacco
de Vries

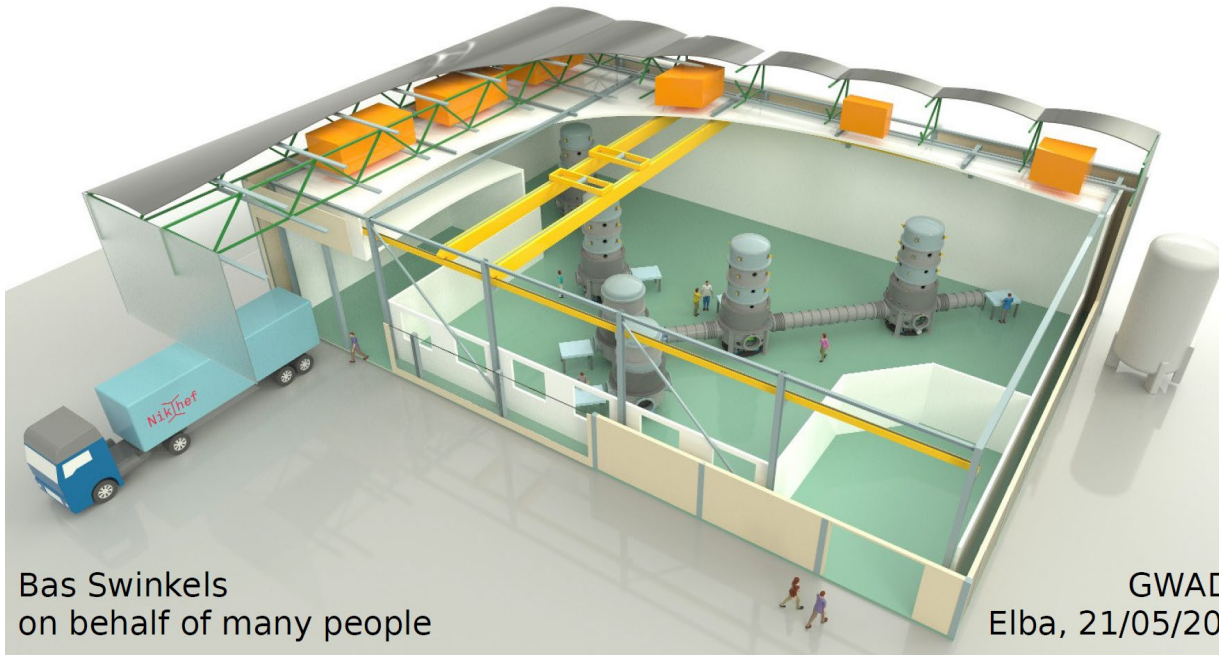
Why in Maastricht?



ET Pathfinder activities



ET Pathfinder in Maastricht



Bas Swinkels
on behalf of many people

GWADW
Elba, 21/05/2019



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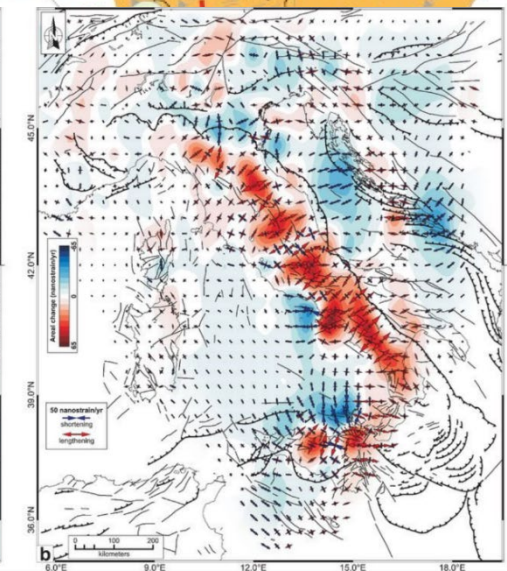
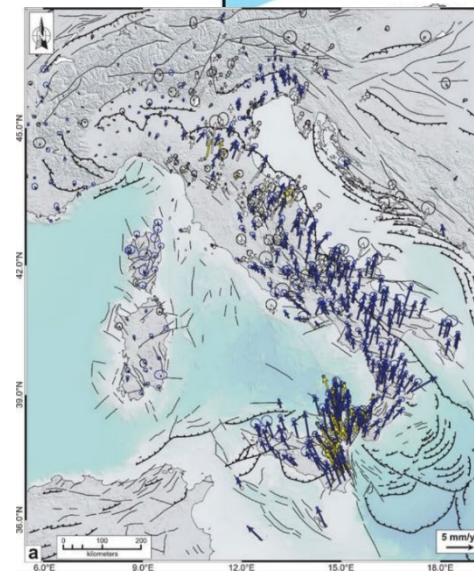
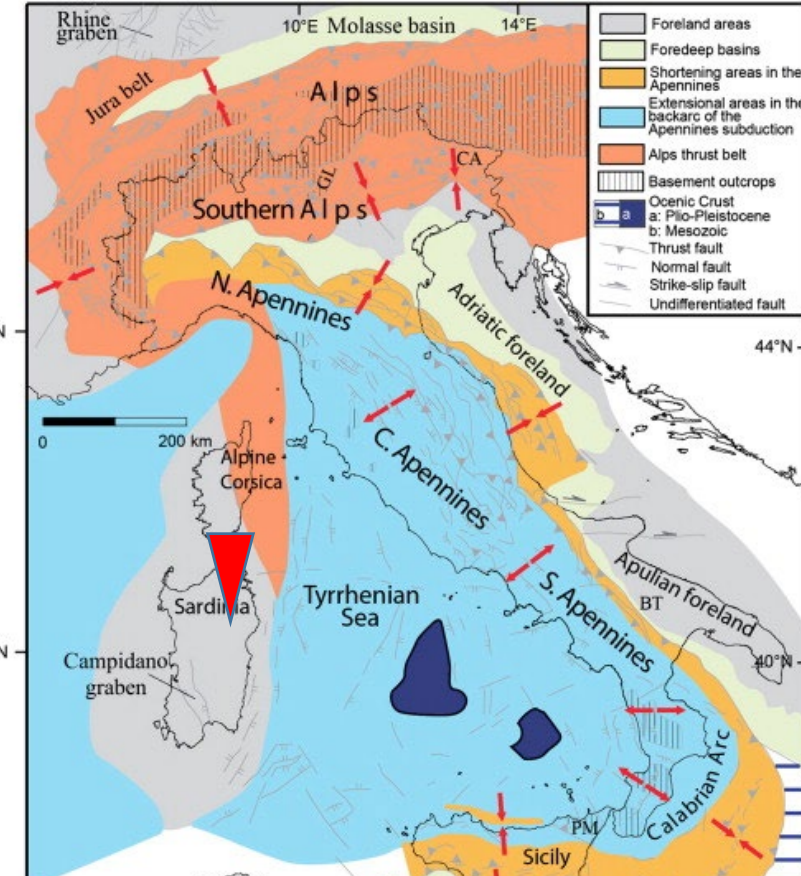
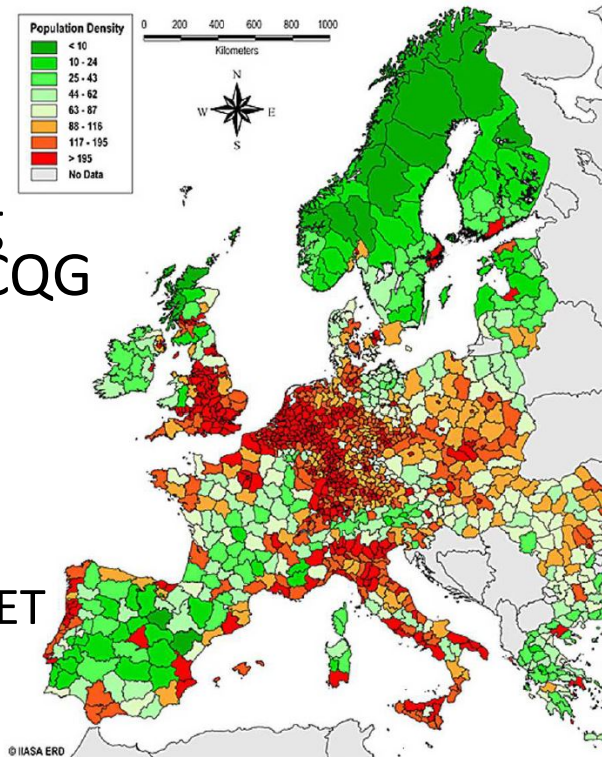
Funding & partners



- Obtained ~14.5 MEuro funding from unconventional sources:
 - InterReg Flanders-South of NL (European fund for cross-border development)
 - Province of Limburg (NL), Dutch and Belgian national ministries
 - Matched contribution by partners
- Partners: Nikhef, universities of Antwerpen, Eindhoven, Ghent, Hasselt, Leuven, Maastricht
- Satellite partners: Aachen, Brussels, Fraunhofer, Liège, Louvain la Neuve, Twente, TNO
- Additional input from Glasgow, AEI, Perugia ...
- 100+ person-years (staff scientists and engineers) committed over the next 5 years
- New collaborators are welcome

Sardinia - Italy

- Site (preliminarily) qualified with a long measurement campaign, published in CQG
- Very high quality geological, seismic, constructive and environmental characteristics
- Support of the Italian Government
 - 17 M€ promised to support AdV+ and the ET site candidature
 - 5.5M€ delivered in 2018
 - 2.5M€ delivered by Sardinia region
 - **1M€ from Research Ministry (PRIN)**
- Direct involvement of the largest academic institutions in Italy:
 - INFN, INAF, INGV
 - University La Sapienza Rome
- Direct involvement of the Sardinian Universities:
 - UniSS, UniCa



Activities at the Sos Enattos site

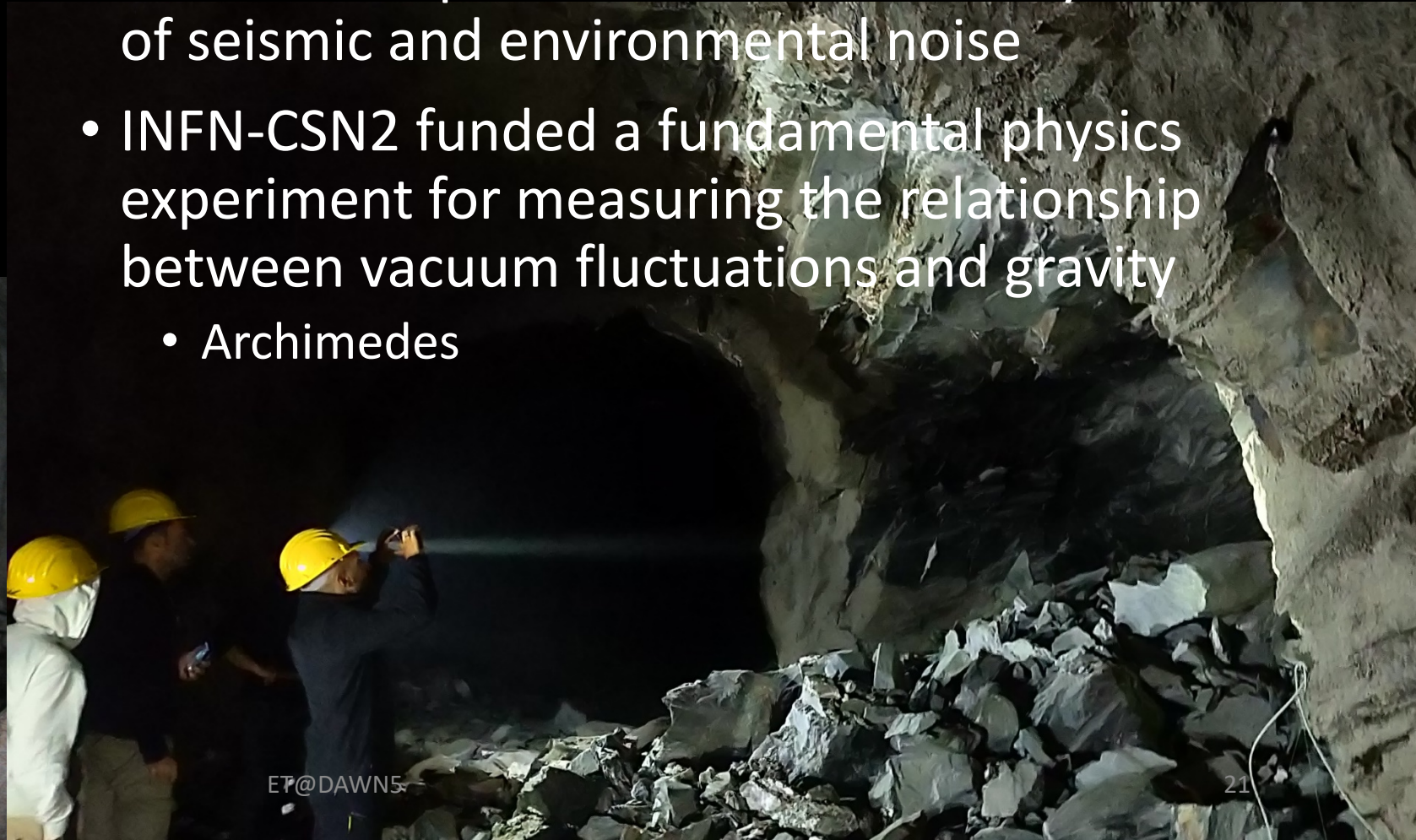


04.10.2018

- The site needs to be further qualified with seismic and environmental measures
- Thanks to the support of the Regione Sardegna is under construction an underground lab (SarGrav) for all the experiments that need very low level of seismic and environmental noise
- INFN-CSN2 funded a fundamental physics experiment for measuring the relationship between vacuum fluctuations and gravity
 - Archimedes



04.10.2018



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Inauguration of the control room

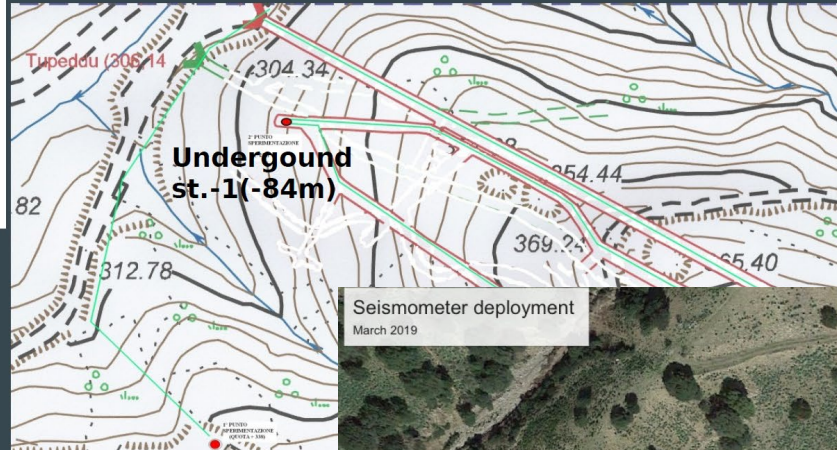
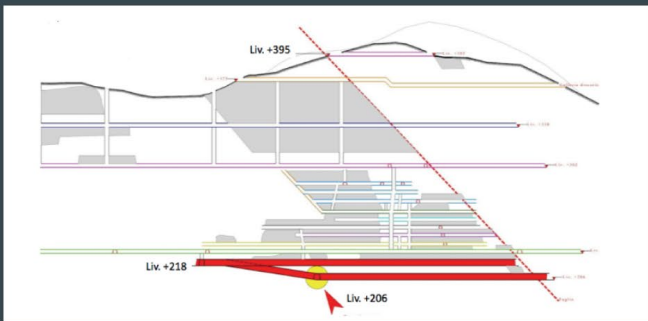


10th ET symposium: visit at the site

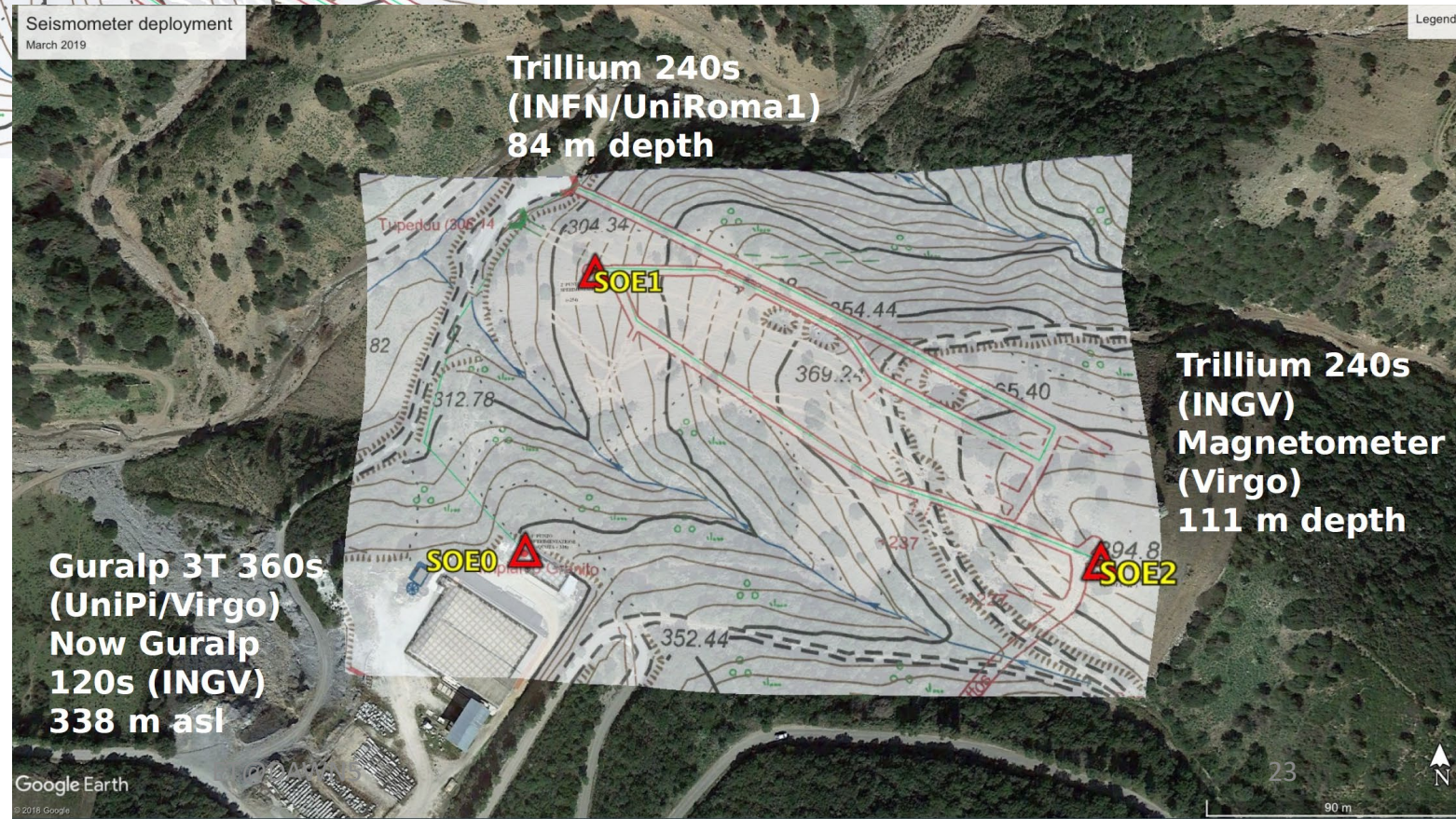
The Sos-Enattos site: long-term characterisation of seismic noise (2012-2015).

L Naticchioni, M Perciballi, F Ricci, E Coccia, V Malvezzi, F Acernese, F Barone, G Giordano, R Romano and M Punturo, 2014, *Class. Quantum Grav.* **31** (10)

Sos Enattos Site qualification



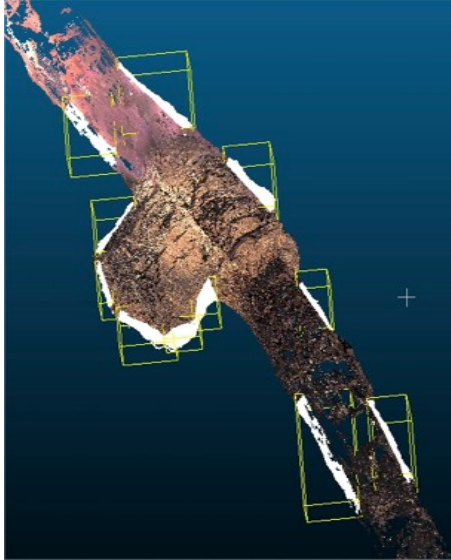
ST-2: TRILLIUM 240 Seismometer
ST-1 Seismometers from UNISA
ST-0 Meteo Station



G. Saccarotti (INGV) @ 10th ET symposium



Laser scanning for geo-structural surveying



- ❑ Rock discontinuities identified by the dense laser point cloud
- ❑ Laser scans at different orientations and position along the galleries

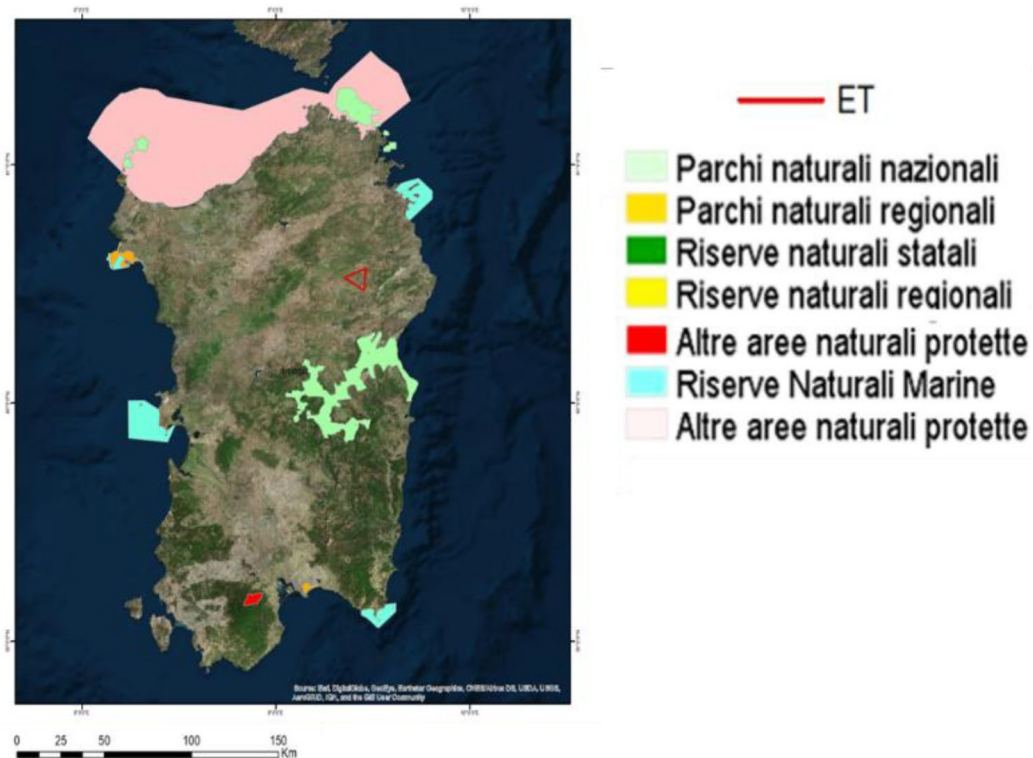


Interference Analysis

A.Paoli @ 10th ET symposium

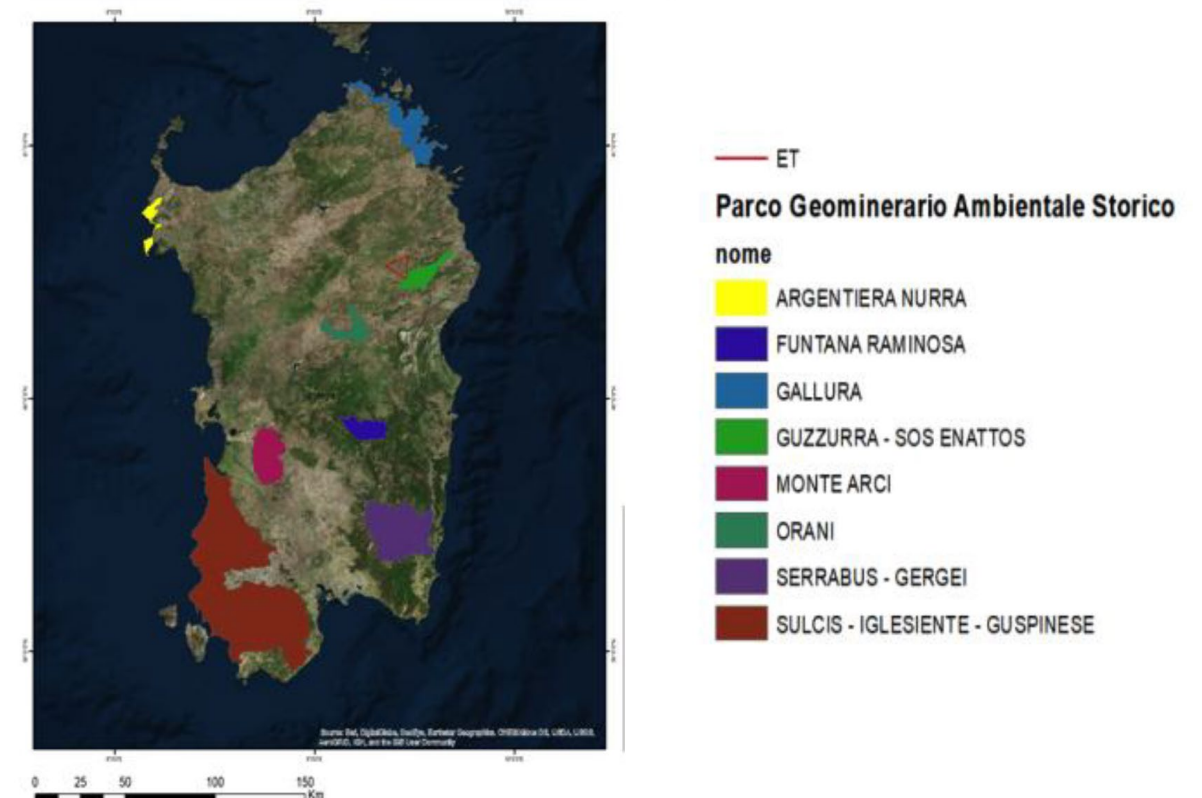
INTERFERENCE ANALYSIS

Protected areas – Regional and National Parks



INTERFERENCE ANALYSIS

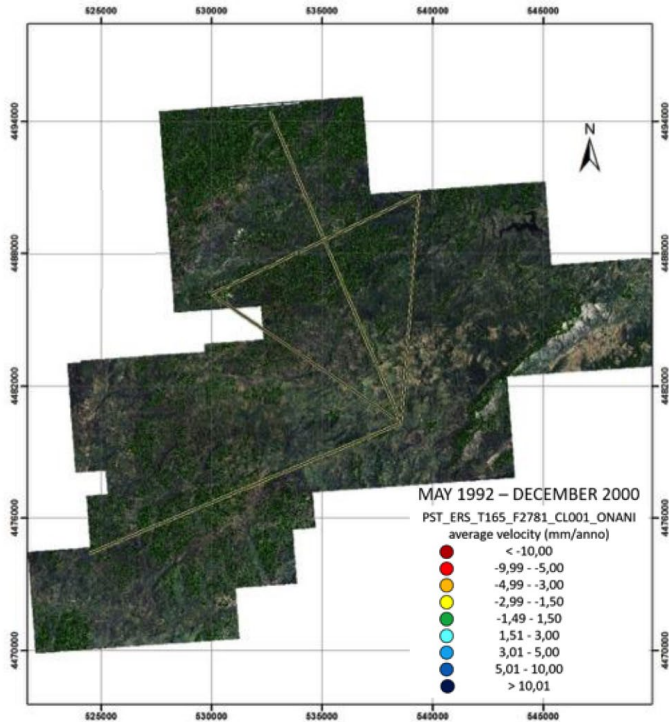
Geo-Mining Parks



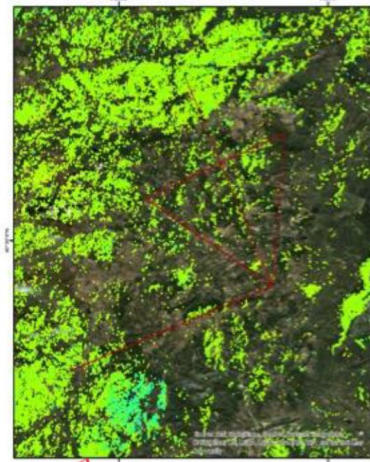
Sos Enattos site qualification

A.Paoli @ 10th ET symposium

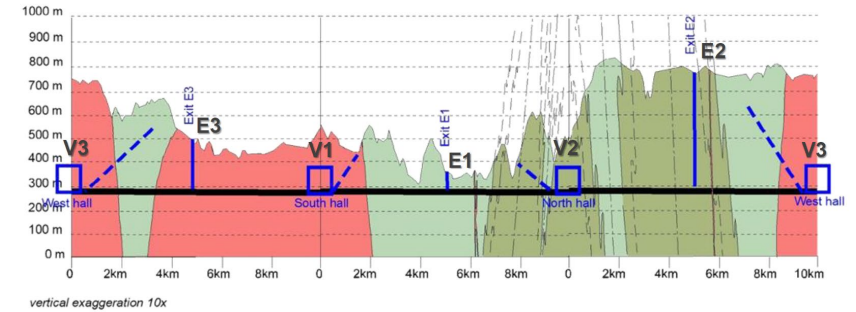
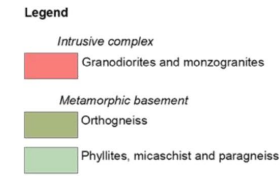
Crustal Deformation and Ground Motion DInSAR Analysis



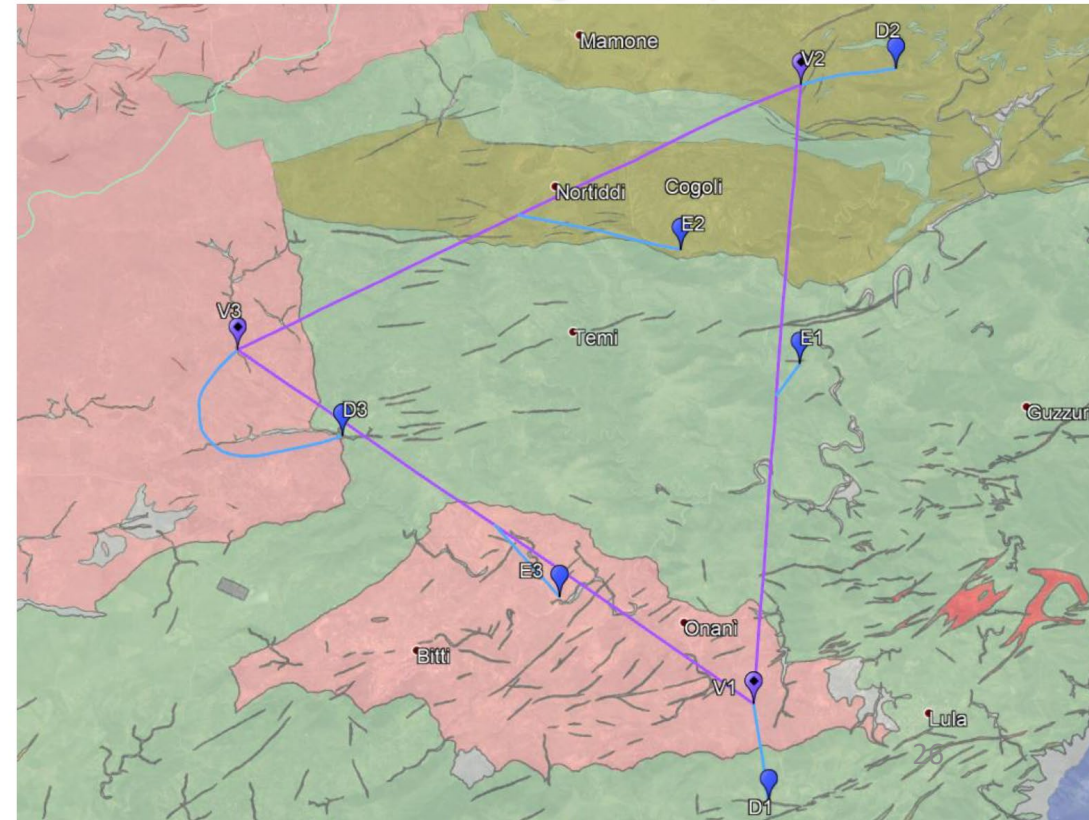
- Very stable geodynamic setting
- No evidence of ground settlements due to local factors
- Link to the Space Geodesy Center in South Sardinia for reference frame issues



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Geological Map



TRIANGLE CONFIGURATION

It is fitting?



Vertexes UTM coordinates $H_{ITF} = 290m$

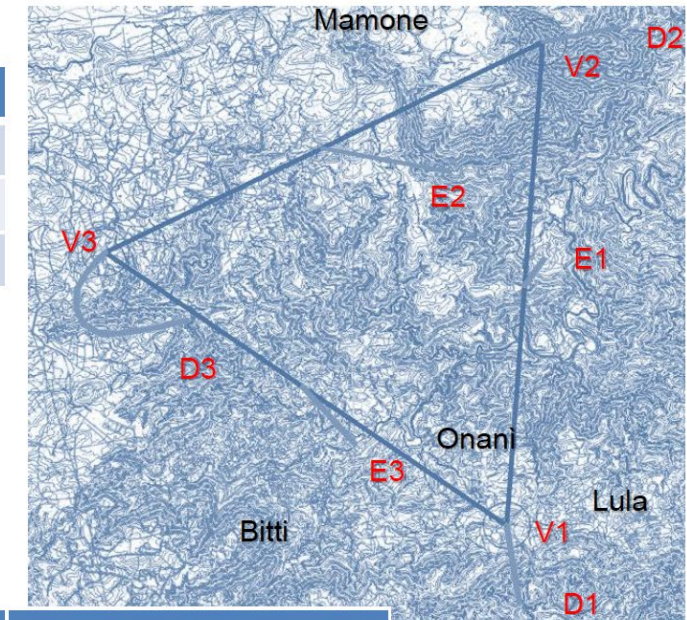
P.Id.	E [m]	N [m]	H_{sur} [m.a.s.l.]	cover [m]
V1	538 588	4 480 305	540	250
V2	539 361	4 490 666	500	210
V3	530 001	4 486 155	755	465

Vertexes GPS coordinates

P.Id.	Lat	Long
V1	40° 28' 21.10" N	9° 27' 18.78" E
V2	40° 33' 56.99" N	9° 27' 53.92" E
V3	40° 31' 32.10" N	9° 21' 15.12" E

Descenderies UTM coordinates

P.Id.	E [m]	N [m]	H_{sur} [m.a.s.l.]	L [m]	s_{aver} [%]
D1	538 858	4 478 652	395	1 675	6.27
D2	540 984	4 490 986	390	1 730	5.78
D3	531 748	4 484 700	575	4 100	6.95



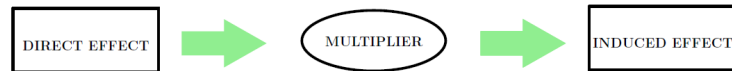
Safety Exits UTM coordinates

P.Id.	E [m]	N [m]	H_{sur} [m.a.s.l.]	L [m]	s_{aver} [%]	note
E1	539 375	4 486 001	325	680	5.15	Alternative: shaft 100m deep
E2	537 350	4 487 888	450	2 750	5.82	Alternative: shaft 490m deep
E3	535 331	4 482 062	410	1 630	7.36	Alternative: shaft 200m deep

ET @ Sos Enattos: Socio-economic impact

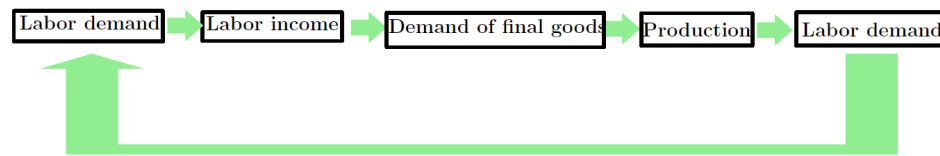
L.Deidda (UniSS) @ 10th ET symposium

From direct effects to induced effects: The role of multipliers

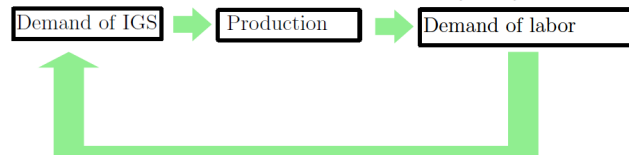


▶ Two sources of induced impact:

1. Demand of labor

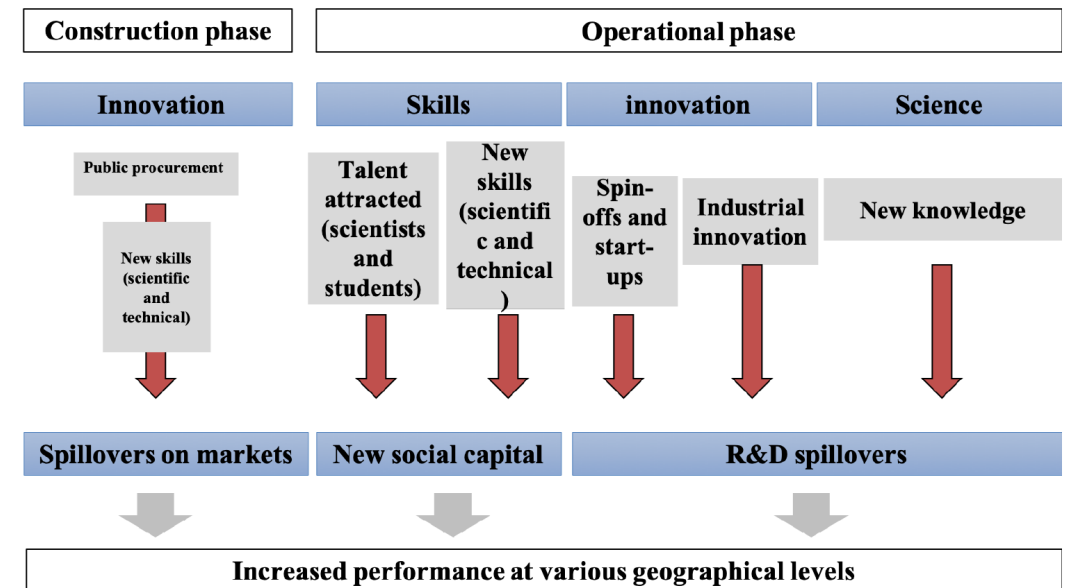


2. Demand of intermediate goods and services (IGS):



- ▶ Three types of induced effects → three different multipliers: (i) Total output; (ii) Value added; (iii) Employment
- ▶ Estimates of the multipliers at industry level based on I-O data provided by ISTAT
- ▶ Robustness analysis by estimating multipliers based on EU data

Determinants of social impact: General approach



Conclusions

- ET activities are acquiring momentum, but the ESFRI deadline is quite close
- Freezing the major options of the infrastructure is the highest priority
 - Cost evaluation must be based on these options
- ET project is suffering of
 - Lack of human resources fully devoted to the project
 - We encourage LVC to include 3G into their core programmes to help with the progress of 3G efforts
 - Lack of engineering staff fully devoted to the projects
 - We encourage institutions and funding agencies to support ET through special technical positions