1st ET-PP review meeting: WP9 – Sustainability

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On behalf of the working group

Horizon Europe: Coordination and Support Actions

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WP 9: Introduction and objectives

- Sustainable development strategy for Einstein Telescope (ET)
  - Minimize the global carbon footprint of the Einstein Telescope (ET)
  - Evaluate landscape, environmental and societal impact and how to implement valorization and mitigation actions
  - Contribute to sustainable goals (enforce a strong multidisciplinary approach by addressing other science-based targets for natural hazards and climate change mitigation)
- WP coordinators
  - Initially: Prof. Stavros Katsanevas, EGO director (he passed away end of 2022)
  - Now: **Nicolas Arnaud – CNRS researcher, seconded to EGO**
    Maria Marsella – Roma Sapienza University, professor

- Participants
  - CNRS, EGO, INFN, MUL (Montanuniversität Leoben)
- First year goals
  - Identify all sustainability issues linked to ET
  - Encourage the research community to raise awareness on sustainability
  - Establish a methodology to measure the impact and Identify best practices and mitigation actions

WP 9: Tasks

- ET carbon footprint assessment and mitigation
  - ET carbon budget
  - Optimization of the ET energy consumption

- Landscape, environmental and societal impact
  - Assessing and minimizing the ET impact on the environment
  - Environmental management approach
  - Analyze and define an overall strategy for the reclamation, reuse and recycling of the excavated materials (MUL)

Critical (and time consuming) prerequisite

- Follow the documentation to use updated reference (rapidly evolving)
- Establish contacts within ET and its different bodies or technical boards
- View beyond ET research, industry, social sciences
- Establish collaboration with research centers or large collaborations to examine bottom-up approaches
- Identify standard metrics to measure impacts

WP 9: Analyze and define an overall strategy for the reclamation, reuse and recycling of the excavated materials

- MUL Participants
  - Robert Galler, Univ. Prof. Dr. mont, DI, Head of Subsurface Engineering
  - Elisabeth Hauzinger, DI, PhD student on topic of reuse of excavation material
  -
- Einstein Telescope: a civil engineering challenge
  - Triangular or L-shape, total tunnel length of 30 km & diameter of 7 m
  - Together with caverns, service & access tunnels and shafts
    - Total excavated volume ~ 4.4 Mio m3 ↔ muck volume ~ 5.3 Mio m3
  - Exact location not yet determined

  - identify site-specific parameters since a lot depends on geology and the regional market/industry
  - Strategy to keep anthropogenic pollution of excavated material to a minimum (excavation method)
  - Identify possible reuse scenarios for the excavation material which have a low impact on environment

WP 9: Critical risks, deviations from Annex I, contingency plans

Need for experts to define precisely what sustainability means (for ET) in different contexts

- focus on all aspects of sustainability
- establish priorities

Improvement and Mitigation

- ❑ fully dedicated person (to be recruited in 2024)involvement
- ❑ involvement of more people within ET-PP, ETO and the ET collaboration (including research units)
- ❑ Liaisons with other WPs (starting with computing), departments/working groups (engineering), technical and scientific boards

WP 9: Deliverables and milestones

- First milestone: preliminary sustainability plan
  - Delivered on October 31st

Executive summary

The preliminary sustainability plan describes how sustainability questions will be addressed as part of the Einstein Telescope (ET) project.

After an introduction motivating the importance of sustainability for a large and durable future research infrastructure like ET, this report presents the methodology that will be used to study this topic and emphasizes on the relevant sustainability figures of merit.

Then, the different phases of the ET project for which sustainability will be relevant are presented in detail. Finally, the main goals of the ET sustainability plan are discussed.

WP 9: Preliminary sustainability plan key messages

Sustainability should not be a brake on the development of ET's unique scientific program and it should accompany the development of ET and help optimizing (reducing) its impacts In all the successive ET phases

- Preparatory phase and design
- Construction
- Operation
- Upgrades
- Dismantling

Across all fields relevant for ET

- Instrumentation, engineering, computing (hardware, software computing centers), data analysis
- Open science
- Applications to society, outreach and communication

Over several decades

- During which the climate will continue changing and have impact on humankind

Based on the UN Sustainable Development goals

- Account for the three pillars of sustainability: environmental, social and economic

WP 9: Preliminary sustainability plan key messages

- A wide set of targets
  - Greenhouse gas emissions - Energy management system, Optimizing the usage of natural resources
  - Infrastructure impact - Sustainable procurement strategy
  - Travels
  - Life-cycle analyzes

- Overall goals: reducing impacts as much as possible

  - Estimating and measuring these impacts
  - Quantitative recommendations: scope by scope or sector by sector
  - Define set of standards and references to monitor progress over time
  - skilled people and Experts to identify new sustainability-wise solutions

WP 9: Contribution from each partner

- Reflect WP internal delays (coordination, etc.) + lack of personpower
  - Significant step forward since September: 1st WP milestone produced + well-attended sustainability workshop

INSTITUTION		PM as per Annex I	PM in the period
2 INFN	CONTRIBUTIVES	39,2	0
	REQUESTED EC	18	0
4 CNRS	CONTRIBUTIVES	13	0,33
	REQUESTED EC	0	0
8 EGO	CONTRIBUTIVES	12,6	1,5
	REQUESTED EC	18	0,1
11 MUL	CONTRIBUTIVES	4	0
	REQUESTED EC	12	0,9
Total Person Months	**CONTRIBUTIVES**	**68,8**	**1,83**
Total Person Months	**REQUESTED EC**	**48**	**0,99**
		116,8	**2,83**

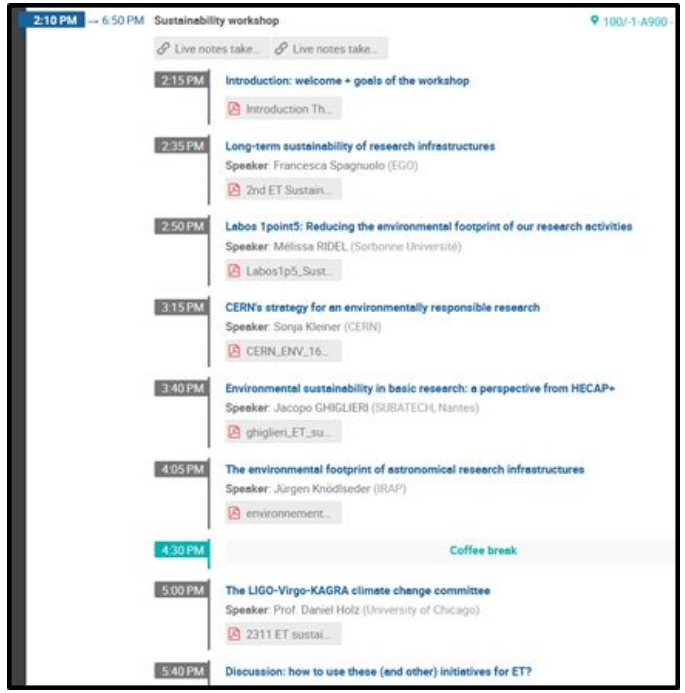
WP 9: Outlook and perspectives

- A challenging first year to start coordination and involve people
- Situation improving in the second year of the project
  - WP (slowly) attracting more people
    - Francesca Spagnuolo (EGO), Florent Robinet (CNRS), etc.
  - Used the 2nd ET annual meeting to advertise the WP
    - Issues, actions and difficulties
    - In particular: organization of a dedicated one-day workshop next to the ET annual meeting – see next slide
  - Work has started on the 2024
    - Deliverables
      - 29/02/2024: ET Sustainable development implementation strategy
      - 31/08/2024: ET Environmental impact assessment and mitigation strategy
    - Milestone
      - 29/02/2024: ET sustainability workshop + report
        → All the material already available

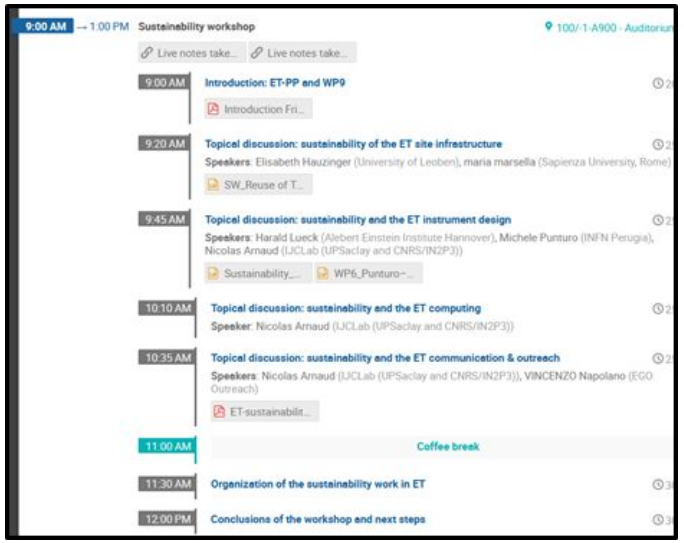
→ Challenge: to keep the current momentum on a long timescale

WP 9: Outlook and perspectives

- Sustainability workshop: https://indico.ijclab.in2p3.fr/event/9686/timetable/?view=standard
  - About 50 participants: half in person, half remotely
  - All talks available online – plus some live minutes not curated
- First half-day: external inputs



Second half-day: focus on sustainability for ET



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WP 9: MUL contribution to civil engineering

- Investigations of the underground
  - A wide range of methods

Geotechnical
UCS, Tensile Strength, CERCHAR Test Point Load, LCPC Test, …

Geochemical & Petrophysical
Eluate, water absorption, porosity & permeability, density, TOC, …

Mineralogical
XRD, XRF, ICP-MS, Optical Microscopy, FTIR, …

(Borehole-) Geophysics
Gamma-Gamma, SP, Dilatometer, Seismics, …

→ Geological characterisation

Classification of Subsurface		
Rock classification	**Mineral composition**	**Rock descriptions**
Very weak marl	-	Numerous, closed micro-fissures, low stiffness, ductile behaviour, swelling potential
Weak marl	Clay=45-60, quartz=15-30, calcareous minerals=20-30	Micro-crystalline quartz, medium-high plasticity, minor micro-fissures, swelling potential
Medium-weak marl	Clay=20-45, quartz=20-40, calcite=20-30	Well cemented, low plasticity
Weak sandstone	Clay=5-20, quartz=40-70, calcareous minerals=5-45, feldspar=5-10	Fine-grained, poorly cemented
Medium sandstone		Rare discontinuities
Strong sandstone		Better cemented, fewer discontinuities

- Strategies for the reuse of excavated material should at least meet the following requirements

Technical Feasibility

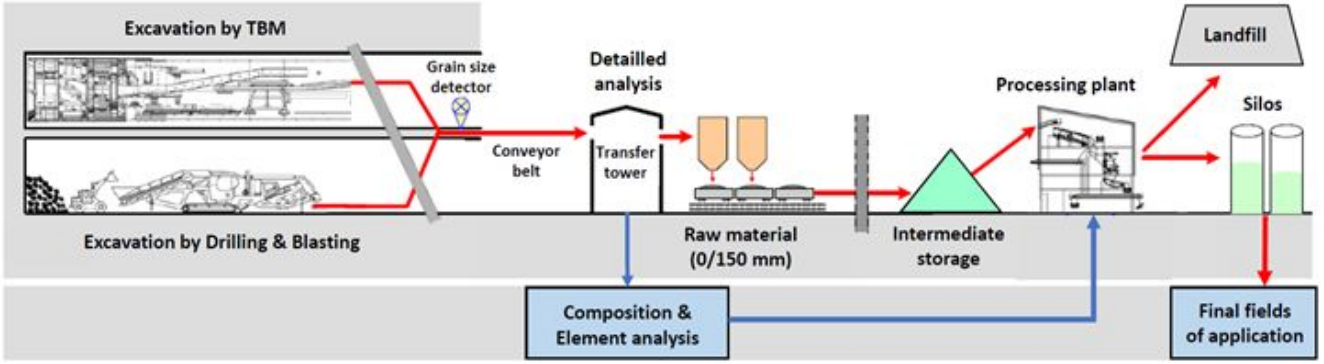
Economic Viability

Social Benefits

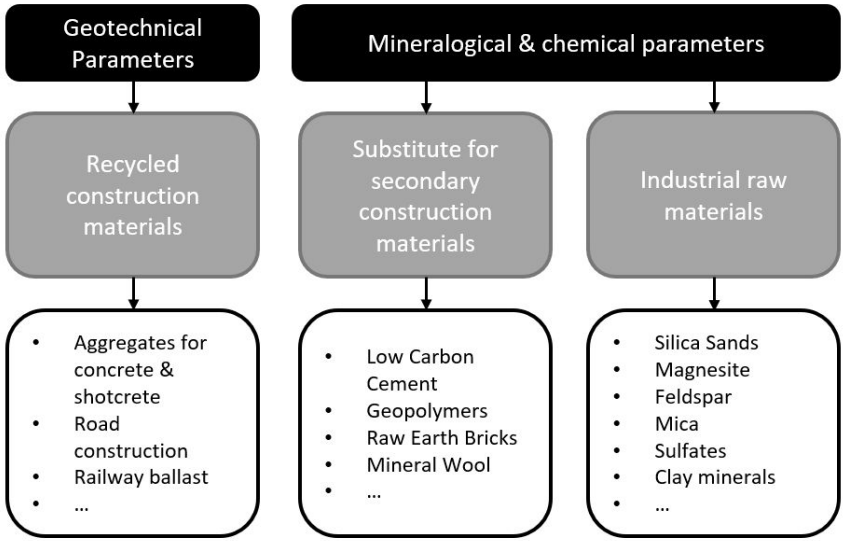
Project Relevance

WP 9: MUL contribution to civil engineering

- Real time characterisation of material
  - Onsite online-analyses on conveyors to detect impurities and pollutions as well as grain size
  - Sorted and classified material is processed further into respective products



- Many potential outlets for excavated materials



- Graphic representation of underlying forecast reliability and associated recovery and landfill classes of a tunneling project in phase A of the main investigations (ÖBV 2015)