Sustainability workshop

Introduction to the Friday November 17th session

Nicolas Arnaud
Maria Marsella
Florent Robinet

ET-Preliminary Phase WP9 Milestone 9.1: Preliminary sustainability plan

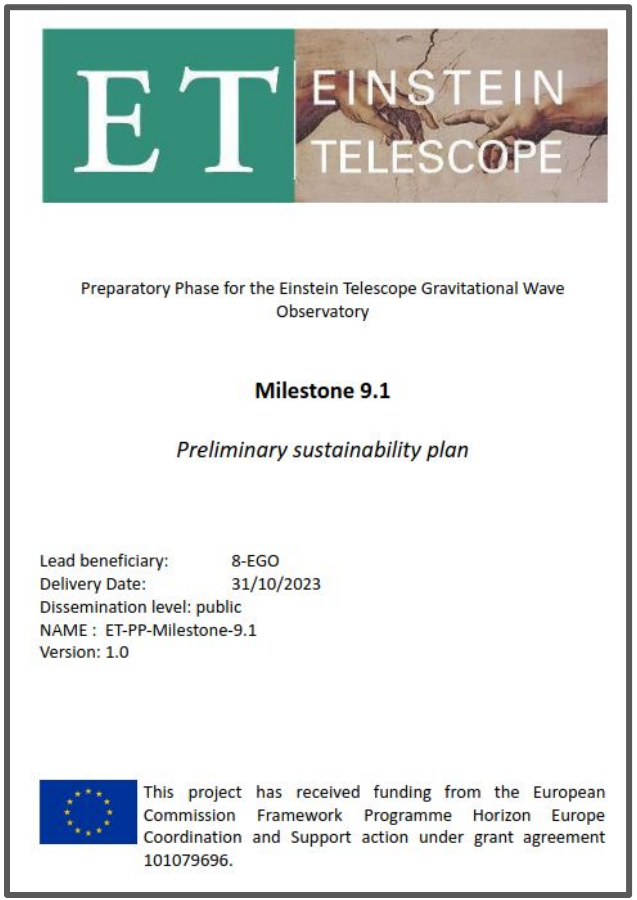


Table of Contents

Next deliverables

- 29/02/2024: ET Sustainable development implementation strategy
- 31/08/2024: ET Environmental impact assessment and mitigation strategy
- 31/08/2025: ET CO_2 footprint assessment and mitigation strategy

Next milestones

- 29/02/2024: ET sustainability workshop + report
- 31/07/2026: ET Final sustainability plan

Sustainability figures of merit and methodology

Emission of greenhouse gasses	● Direct emissions coming from owned or controlled source ● Energy indirect emissions, including the generation of purchased electricity ● All the other indirect emissions derived from purchases (goods and services)
Sustainability of the site as a whole	● Treatment and reuse of the large amount of excavation materials ● Minimize the impact on ET on the natural environments and biodiversity ● Optimize the use of the available resources
Purchase policy	● Reduce misspends and environmental waste
Life-cycle analysis	● To be implemented

Sustainability topics relevant for Einstein Telescope

- Travels
  - To the site, to workshops & conferences, to labs and partner sites
- Computing
  - On site, data transfers, clusters, video conferences, etc.
  - Partners: other large research infrastructures, community as a whole, industry
- “Eco-design” after selection of the ET site(s)
  - Example of CERN’s FCC project
- Development of technologies for ET
  which may become a reference for the community
- Construction
- Energy system and sources
- Future work conditions on site to operate the detector

→ Different phases of ET: preparatory phase and design, construction, operations + upgrades, dismantling

Sustainability plan goals

- Provide recommendations to reduce impacts of all kinds
  - Without jeopardizing the ET scientific goals
  - Coming into the game after detector configuration choice and site selection

- Define set of standards and references
  - Assess the quality of the plan
  - Quantify what has been achieved

- Follow what others are doing in all related fields
  - Develop actions jointly, at the scale of the whole community

Open questions (I)

(hopefully we will answer some of these before the end of the workshop)

- Carbon footprint
  - Methodology to evaluate the ET carbon emission over the entire project?
  - What sub-categories should we consider (e.g computing, travels...)?

- Energy
  - Use a green energy provider?
  - Produce energy on site?
  - How to minimize energy consumption?

- Construction
  - How to minimize the impact on the environment? How to compensate?
  - How to choose the best materials, technology?
  - Should we consider environmental issues to best choose the ET site?

Open questions (II)

(hopefully we will answer some of these before the end of the workshop)

- Computing
  - Optimize the computing around the globe?
  - Optimize algorithms: profile analyses? train physicists? code reviewed by experts?
  - Optimize the analysis workflow, remove redundant analyses, select the best application to perform a task, run analyses only once, run analyses only when the energy is the "greenest".

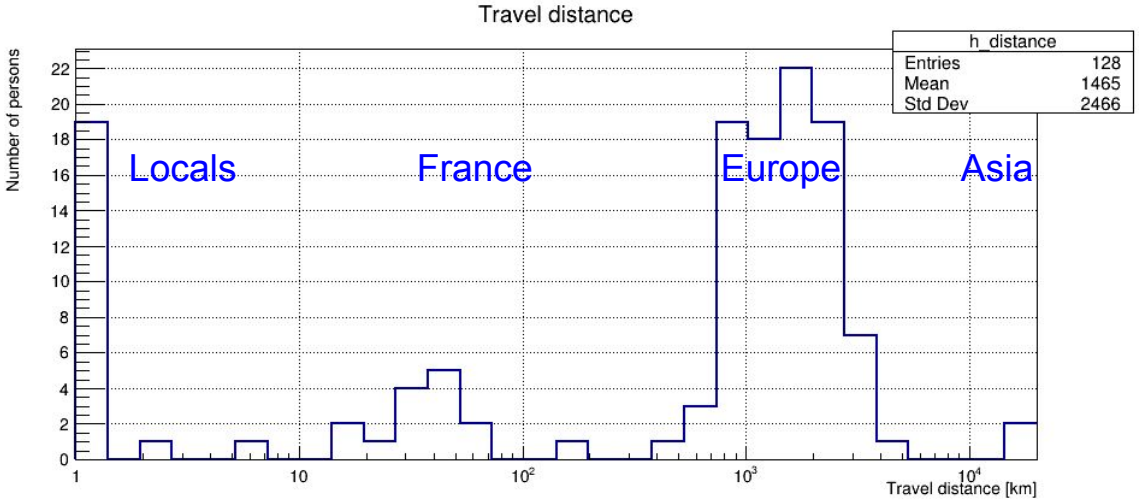
- Expenses
  - How to fold the environmental impact in purchases?
  - How to limit expenses?

- Work conditions
  - What is it like to work (and live) in Europe in 2050?
    Do we need to select a time of the year to operate the detector?
  - Can we limit the number of travels? How?
  - Can we prefer low-emission transportation?
  - Local population acceptance?
  - Impact on the society?

Travel carbon footprint

We have estimated the carbon footprint associated to travels for this ET collaboration meeting

Participants have provided the carbon footprint of their travel when they registered

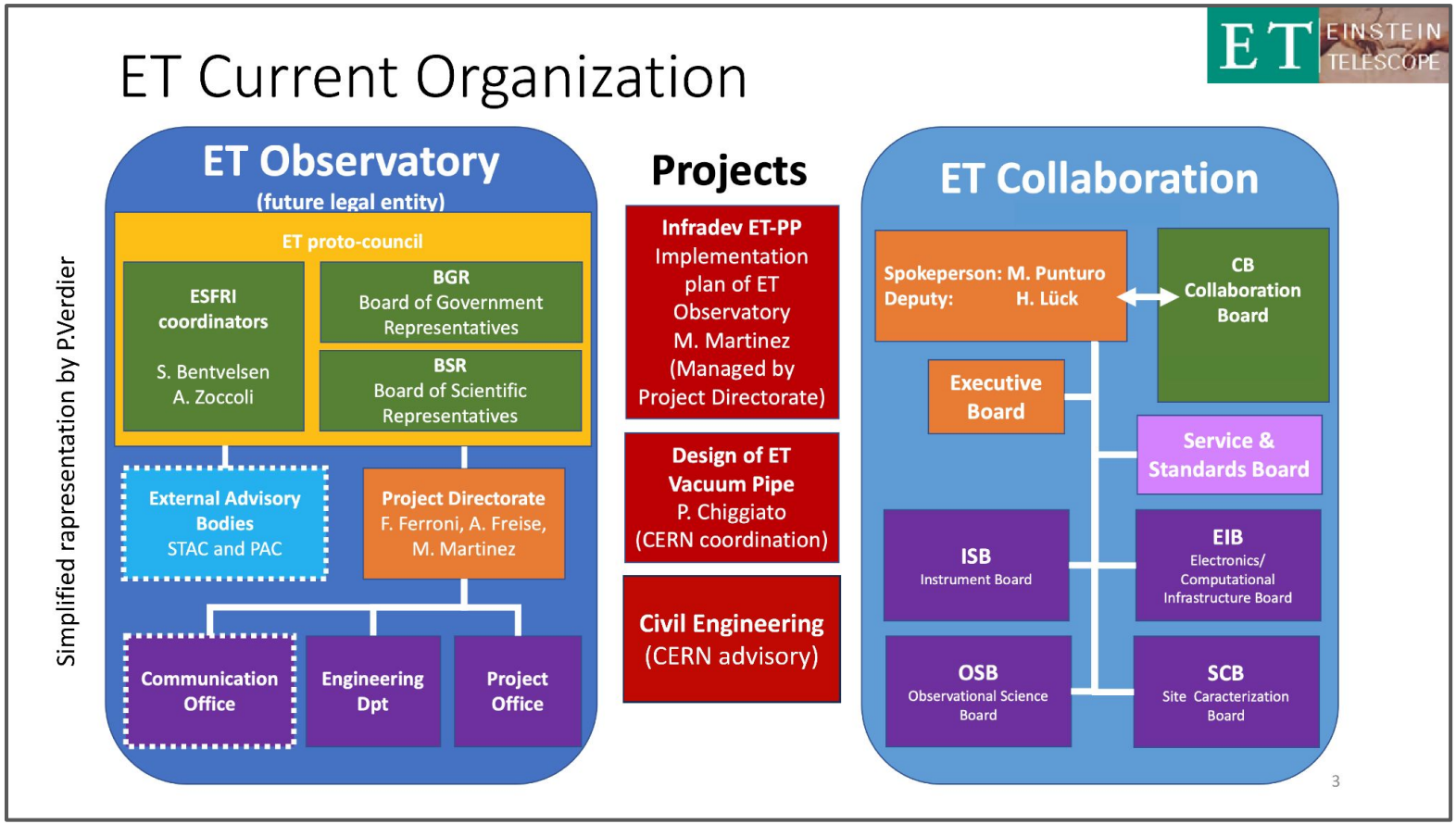


146 participants
18 persons did not provide information about their trip
CO2 emission w/o contrails = 17717 kg → 19901 kg (extrapolating missing info)
CO2 emission w/ contrails = 31480 kg → 35361 kg (extrapolating missing info)
CO2 emission per person = 30000 kg / 146 = 205 kg for 4 days of meeting

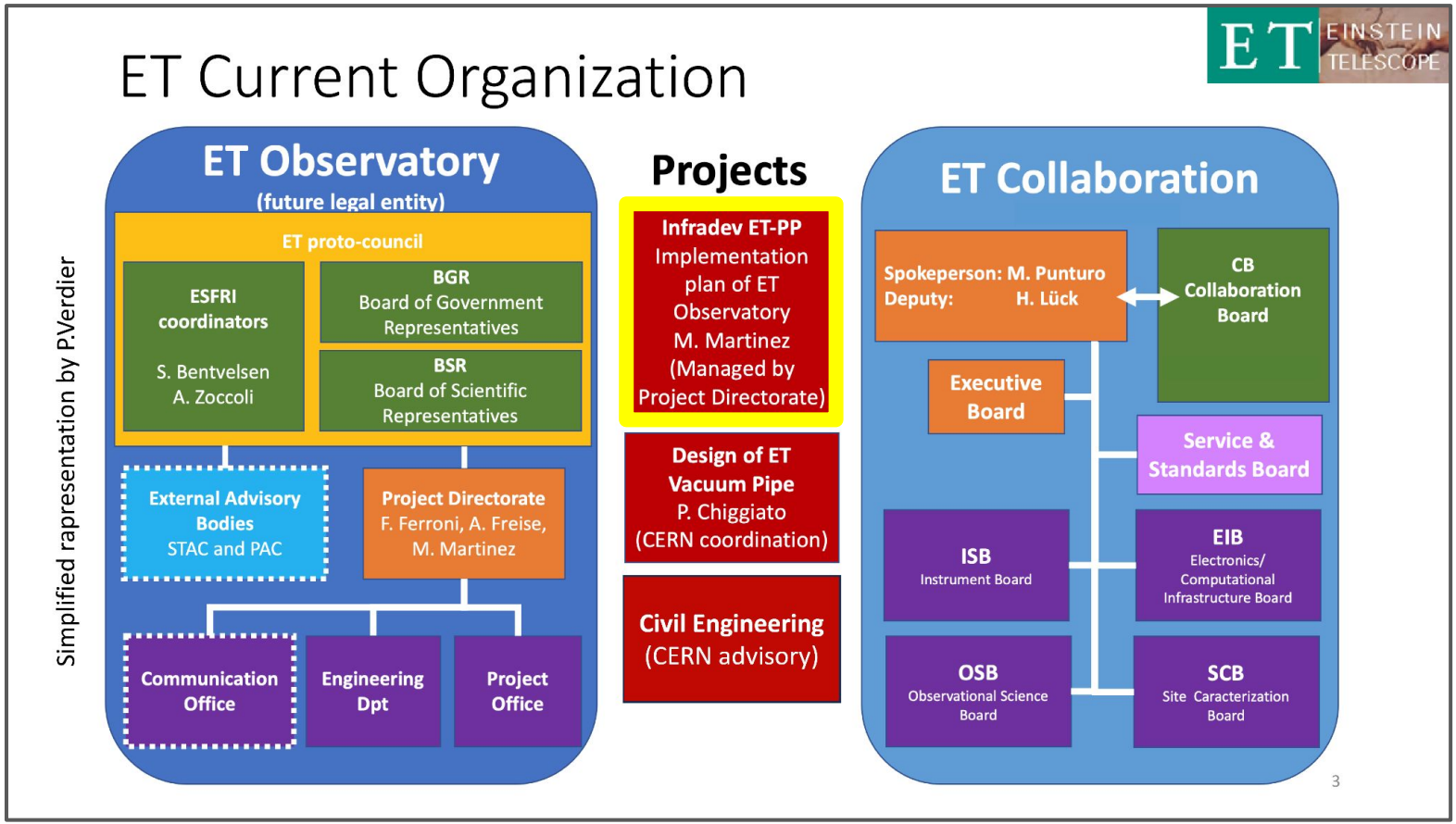
In average a French person emits ~10 t / year of CO2 (2050 target: 2 t / year)
~ 27 kg / day (2050 target: 5 kg / day)

ET-PP WP9: Sustainability

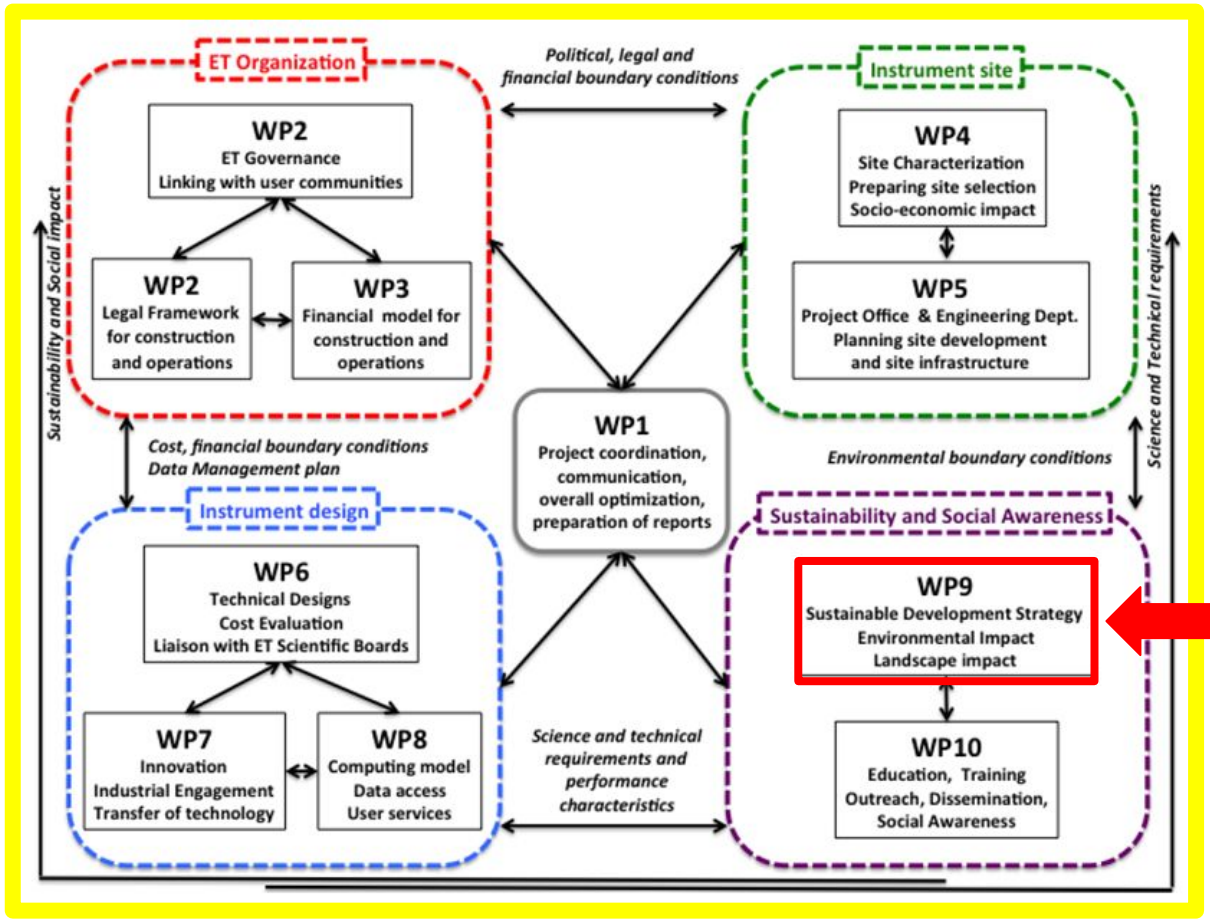
ET-PP WP9 on Sustainability



ET-PP WP9 on Sustainability



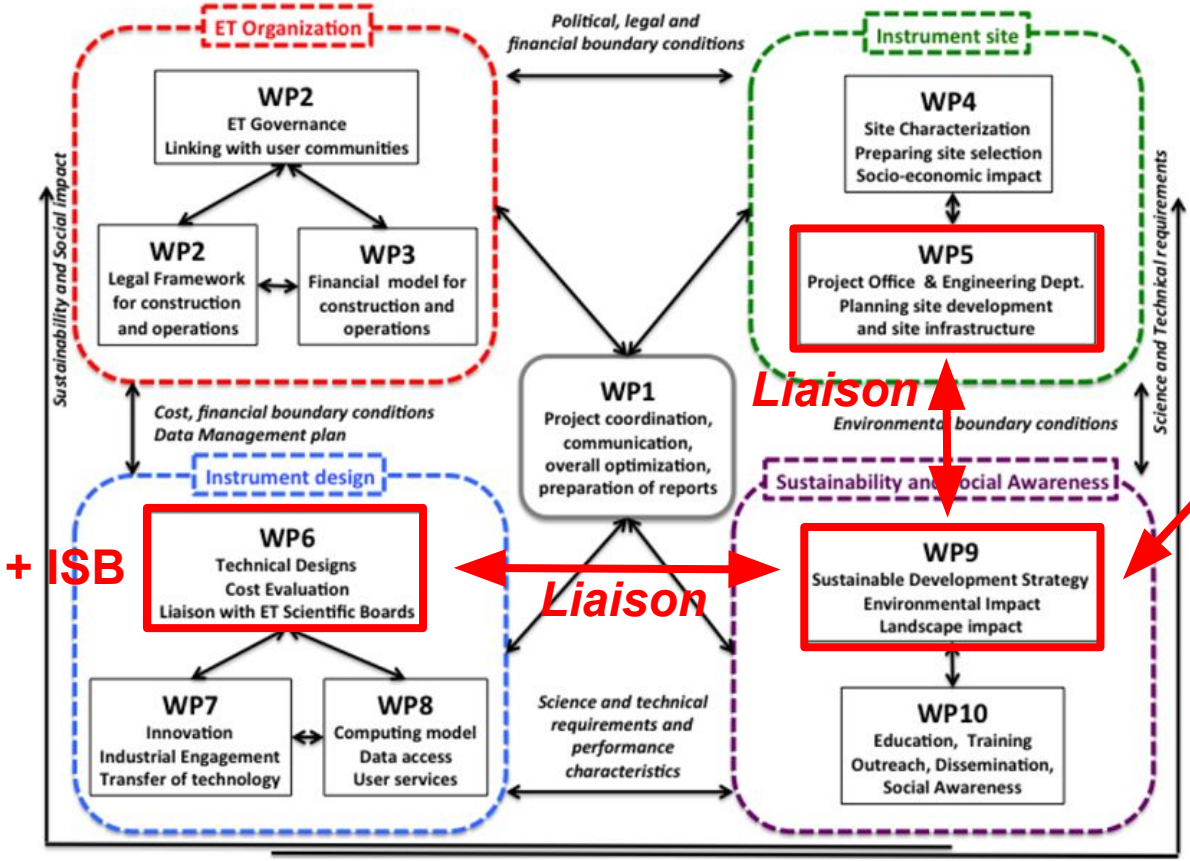
ET-PP WP9 on Sustainability

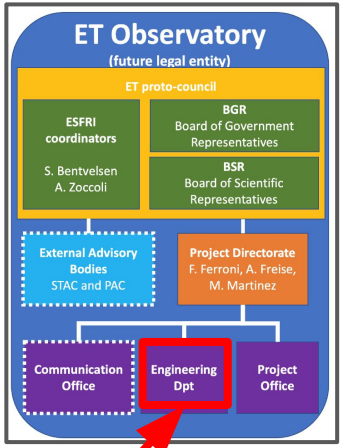


Topical discussion: sustainability of the ET site infrastructure

Topical discussion: sustainability and the ET instrument design

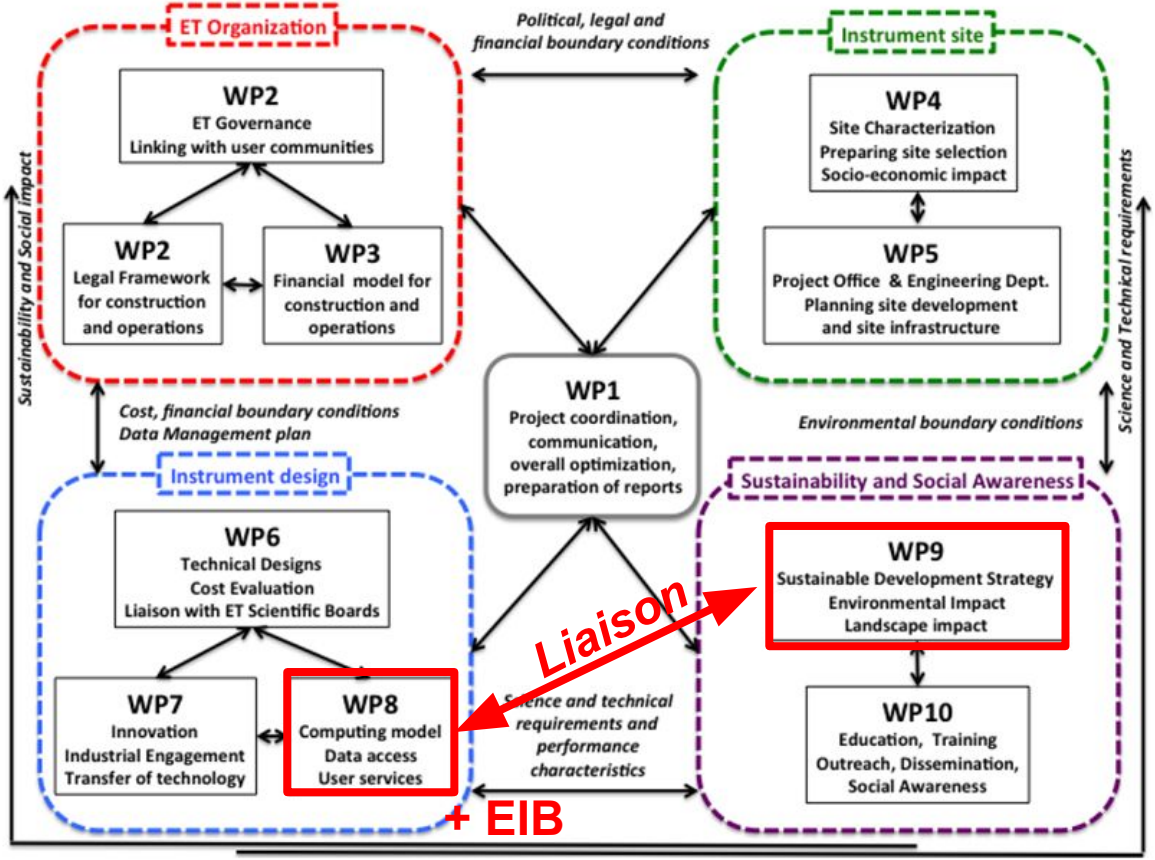
ET-PP WP9 on Sustainability





Topical discussion: sustainability and the ET computing

ET-PP WP9 on Sustainability



From the preliminary sustainability document

Many developments will occur in the long lifetime of ET, from now until the end of operations, to improve the sustainability of **computing facilities** - this is a complex subject. If new infrastructures will be built for ET, one should make sure they will be energy-efficient, with a low Power Usage Effectiveness (PUE). ET is not alone in tackling these issues: the community as a whole is now starting to prioritize the importance of sustainability in computing and software, even while recognising that we do not yet have the tools to e.g. estimate full lifecycle costs. Industry has a major role to play here, especially in providing accurate carbon costs for hardware production. ET will follow the developments in the wider community closely, working with stakeholders like the WLCG (LHC computing) to establish best practice in its (mostly shared) data centers. ET will need to invest in computing expertise that can understand this evolving computing landscape and adapt to new computing paradigms as they appear over ET's long lifetime.

A further computing challenge for ET will be the rapidly evolving and heterogeneous computing architectures that ET **software** will need to use. These resources will mostly be in shared computing facilities, which will in turn place some demands on efficiency. For example, apart from the most trivial programs, a program written to run on a CPU (central processing unit) will not run efficiently on a GPU (graphical processing unit). The need for ET to have efficient software requires a paradigm shift. ET will need software engineers to design software frameworks that scientists can plug their algorithms into. ET software engineers will work with ET science domain experts to optimize components critical for performance, including the algorithmic code, e.g. adapting to run on GPUs, TPUs, or whatever new developments appear in the coming decades. Modern software practices and constant code profiling will need to be adopted and wherever possible enforced early to reduce, if not eliminate, inefficient or buggy code using automated continuous integration / continuous development (CI/CD) pipelines. The training and retention of this computing and software expertise will be critical to ensuring ET uses computing resources in a sustainable manner.

ET Computing and Data Requirements Workshop Report

Workshop highlights - expertise

The rapidly evolving computing landscape will be the biggest challenge for ET

Apart from onsite, ET will largely use shared computing resources, where ET will typically be a small %

Heterogeneity of computing architectures will be standard (not just CPU, GPU/TPU, hybrid clusters)

Meanwhile efficiency will become more important, from sustainability to demonstrating scientific value for money

All of the above motivates a paradigm change, ET will work *iff we can leverage the best in class solutions*:

ET will need experts in computing infrastructure to adapt to (r)evolutions (across many computing centres)

ET will need experts in software to design frameworks allowing optimisation for different compute architectures

This expertise is highly sought after in industry, experts will demand viable careers if we want to retain them

UNIVERSITÉ DE GENÈVE FACULTÉ DES SCIENCES Département d'astronomie

10

GWSC GRAVITATIONAL WAVE SCIENCE CENTER

Deliverable status

Table of Contents

We have a good structure for the document, finalised during the workshop, with good progress on text
Expect the final document to be similar in length

After introducing the scope, defining the baseline and assumptions we lay out the computing requirements separately for

1. ***Online (onsite)***
2. ***Low latency***
3. ***Offline***

We will have a dedicated section on computing and software expertise, training and retention

UNIVERSITÉ DE GENÈVE FACULTÉ DES SCIENCES Département d'astronomie

11

GWSC GRAVITATIONAL WAVE SCIENCE CENTER

From Paul Laycock:
"*Meanwhile the efficiency of software will become more important for several reasons. First of all from the point of view of sustainability, we should only use the resources that we **need** to use and not waste computing hardware and the energy to run it. As we will be using shared resources, we will also need to demonstrate that ET provides good scientific value for money, funding agencies will demand this, and data centres will be monitoring how well we use the resources we ask for.*"

M2TECH WP6 PROPOSAL

- "Technologies for MultiMessenger Astronomy" proposal for INFRA-TECH call that was not funded in 2022
- Partners are ET+Virgo, CTA and KM3Net
- WP6 is "Efficient and sustainable computing" (WP leader Steven Schramm)
  - T6.1 "Fast data processing and edge computing"
  - T6.2 "Sustainable large-scale computing"
  - T6.3 "Multimessenger alert tools"
- Several important topics
  - E.g., CC involvement, multimessenger alert system development, ML technologies,...

BY-NC-SA

SUSTAINABILITY

- What do **we** mean by "sustainability"?
  - Just the explicit "carbon footprint" of power consumption
  - All the activities needed to build and operate our computing infrastructure in the long term
  - Including skills and personpower?
- How do we measure it?
  - Metrics (kWH, FTEs,...)
  - Measurements
- How do we reduce it?
  - Do we need to take into account things that are not under our control (e.g., CCs using "green power")

BY-NC-SA

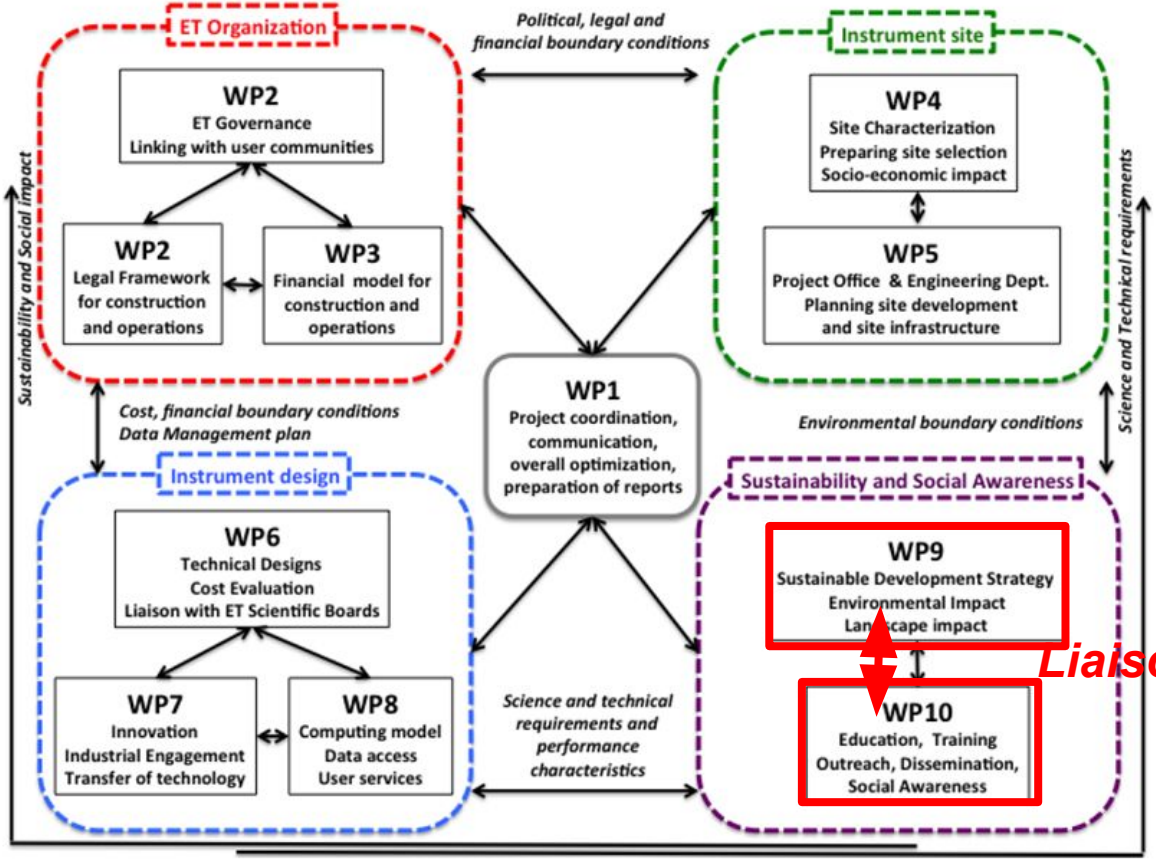
THANKS!

- Development of Computing Model
  - Requirements, architecture, resources,...
  - Computing TDR, PBS, WBS as tools to implement the Computing Model
- Focusing on Mock Data Challenges
  - As a tool for developing analysis techniques, gathering requirements and exercising infrastructure
  - Also, start promoting good practices for sustainability and manageability
- Liaising with the wider physics computing community
  - ESCAPE, IGWN, WLCG,...
- Low-latency alerts also a core item
  - Need not to be left behind

BY-NC-SA

Topical discussion: sustainability and the ET communication & outreach

ET-PP WP9 on Sustainability



+ ETO Communication

Organisation of sustainability work in ET
Workshop conclusions and next steps

2024: a busy year to come

Next deliverables

- 29/02/2024: ET Sustainable development implementation strategy
- 31/08/2024: ET Environmental impact assessment and mitigation strategy
- 31/08/2025: ET CO_2 footprint assessment and mitigation strategy

Next milestones

- 29/02/2024: ET sustainability workshop + report ⇐ Simplest to do
- 31/07/2026: ET Final sustainability plan

Work ↔ Personpower

- Not enough personpower at the moment in the WP
  - Too few people
  - Too busy with other commitments (ET or outside)

→ How to get more?

- Liaisons from other WPs / ET(O) groups
- Reinforcement from ET collaboration?
- Hiring people?
- Contacts with external people

Organizing the work

- Digest the workshop
- Use more extensively existing resources
  - Mailing list
  - Wiki
  - Google Drive
- More regular meetings
  - WP-specific
  - Extended – with liaisons, etc.
- Retro-planning for future deliverables and milestones

→ Challenge: keeping the momentum