WP9

Work Plan

WP9 Sustainable Development Strategy

Working document

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SubWorkpackages

1. **Low Carbon footprint**
2. **Liaison with Climate Change and Geoscience**
3. **Landscape and Environmental impact**
4. **Transportation**

What is the energy consumption of EGO/LIGO/KAGRA and Other RIs ET

- Questions to Andrea Paoli:
  - What are the numbers of consumption at EGO, a projection to ET ?
  - What is the % of consumed energy
    - offices ?
    - vacuum ?
    - cryogenics
    - Injection and detection chain ?
    - computing?
- Means to reduce the carbon print , green energy plant revive the old discussion we had at EGO (Andrea Paoli):
- Reuse dissipated energy from computing center (Nicolas Arnaud)
  - *Le supercalculateur Jean-Zay du CNRS va alimenter le réseau de chaleur et de froid du campus urbain de Paris-Saclay.*
  - "Green Cube" at GSI, 4% de l'energie pour le refroidissement.
  - "Virtual Data" at IJCLab (-> Michel Jouvin)
- Reuse dissipated energy from vacuum and cryogenic installations ?
- Efficient internet / wifi distribution?
- Organize passive house buildings, green car shuttle,
- **Use as a measure Passivhaus**? the German label for energy performance in buildings. It is granted to new homes with heating needs of less than 15 kWh / m^2 / year. The total consumption, calculated as primary energy, taking into account heating, ventilation, lighting, domestic hot water, auxiliaries and household appliances, must be less than 120 kWh / m^2 / year. It also emphasizes the airtightness of the building (n50 ≤ 0.6 vol/h). Passive house methodology (n50) states that the Passive house standard measures the Air Change Rate (ACH) @50Pa (the n50 measurement), or in other words the number of times the volume of air within the building is changed in an hour. So, it is a purely volumetric measure. The Passive houses methodology considers the volume of air which needs to be heated. Therefore internal walls and floors are excluded. This is a measure of air infiltration, and hence the heating energy cost of the building. This sealing is indeed essential to ensure proper operation of the mechanical ventilation system (VMC), and thus be able to use double-flow ventilation with heat recovery.

Liaison with climate change I

- In the last years, there appeared many areas of natural synergy between Geosciences and Astroparticle Physics. Earth and Astroparticle sciences share a mutual scientific culture based on common objects of study, methods and approaches. First, the Geosphere, a direct object of study of Geoscientists, is both the target and the detecting medium for Astroparticle observatories. Second, Astroparticle Physicists and Geoscientists both deal with complex natural large scale systems, deploy large sensor networks, sometimes in extreme environments (sea, desert, underground, space), use long series of precise observations acquired over long time scales, use discovery instruments, develop models relying on the state-of-the-art in fundamental physics, chemistry, biology and computer sciences. They also use large infrastructures (such as fibre optic cables telecommunication networks and satellites), which allow for fast and massive data manipulation and worldwide networking, including distribution of alert. Both develop techniques of monitoring, new technologies (e.g., Innovation can come through new "smart" technologies (Industry 4.0)), new deep and machine learning tools. In particular, main synergies concern:
- Imaging (gravimetric, seismic, acoustic, muon, neutrino);
- Data collection in extreme environments;
- New technological means for parameter monitoring;
- Contribution to the understanding and forecasting of natural hazards.

Liaison with climate change II

- One should note, in summary that both the developments at low frequencies and the ones at higher frequencies, have a very rich valorisation potential respectively to one side earth-science (seismology, climate change) and distributed smart networks of sensors (Industry 4.0) as well as state of the art technology on quantum sensors.The above make EGO and ET, an interdisciplinary and technological hub, open to interdisciplinary collaboration, with Geoscientists (e.g. the Instituto Nazionale di Geofisica e Vulcanologia - INGV, the Institut de la Physique du Globe de Paris – IPGP, and other Geoscientific organisations in Europe), Atmospheric Scientists and Ecology scientists (UniPi), measure and electromagnetic compatibility experts at the University of Pisa and data science experts, from low latency distribution of alerts, to state of the art data analytics and machine and deep learning techniques of data analysis. We also have the ASPIS project which is INGV-EGO co-project for fast (few sec) warning,, we also have a collaboration with the network of EM sensors of Renato Romero, the online data streaming is active (see http://www.vlf.it/virgo/virgo.html) and is being very useful to learn about low noise EM pollution at EGO site, the aim is to have clean monitoring of EM Earth global noise. Futhermore, on the ET occasion we will deploy:

Liaison with climate change III 3 exemples

- **A 30 km fiber distributed acoustic sensor** along the arms of the interferometer to create a network of 3000 sensors (one every 10m of fiber) a most sensitive network to detect and localise earthquakes, determining with precision their value, serving also as a low latency alert producing instrument. The above network will also measure the wave impact at the shore increasing the coast erosion (both south and north ET sites are within reach of sensibility from the sea),
  - The same network will serve to measure temperature and more generally acoustic variations along the tubes and the receiving centres (networks DTS, idaS)
- A **cosmic ray detection scheme** at the corners to monitor Cosmic rays, as indicators of atmospheric changes Newtonian Noise , but also preseismic signal, in complementarity according to recent publications, to the fiber network. An atmospheric obseravtory, associated with lidars, classical pressuremeteres etc. associated with lidars etc S
- **Distribution of Low Latency alerts.** The GW network has an advance in the distribution of Low latency alerts in its program, serving the Multi-Messenger studies, and can serve and profit reciprocally with thee equivalent worldwide seismic and catastrophy low alert system

Landscape and Environmental impact

- Site mostly underground
- Surface buildings + access roads + site roads
- Power grid infrastructure (EGO, Virgo, LIGO, KAGRA,extension)
- Excavations: access pipes and tunnels: what to do with the excavated material?

Transportation

- 100% electrical vehicles on site
- Green transportation (on-site and to/from site)
- Charging stations
- Transportation to/from campus: regular schedule
- Videoconferences instead of travels? how much we gain , find the numbers
- Reduce travels , Use trains/ships instead of planes/cars when possible

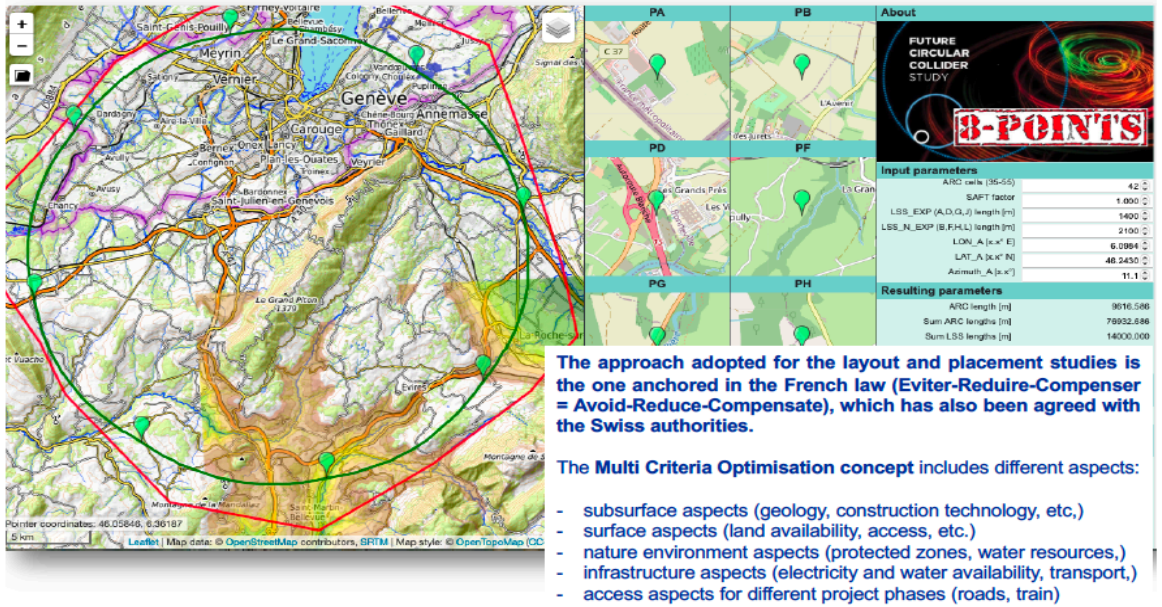
Whom to contact

- General Power issues
  - EGO: 20 years of experience as Virgo host site (S.K)
  - Budget / expenses
  - Site assets and weak points
  - LIGO/KAGRA/GEO Initiate a discussion and comparison ? (S.K)
- ET Computing/infrastructure/Vacuum (N.A)
- Labs & Facilities: CERN, Fermilab, SLAC, KEK (N.A)
- Collaborations: LHC, LSST, SKA (N.A)
- Use GWIC documents
- Projects: FCC, ILC [?] (N.A)
  - FCC: FCC Feasibility Study (FS) 2021 -> 2025
    https://indico.cern.ch/event/1055562/contributions/4460980/attachments/2286764/3886757/ECFA-FCC-2021.pdf
    French contacts: Angeles Faus-Golfe (FCC machine) et Gregorio Bernardi (FCC physique).

Discussion with FCC experts

1. concepts for electricity supply and distribution; optimise electrical system efficiency and stability;
2. design of cooling and ventilation systems; cryo plants and distribution; efficiency via e.g. waste heat recovery;
3. safety;
4. integration and logistics: integration of the various components for installation, maintenance and operation;
5. transport concepts on surface and underground for personnel and materials; etc.
6. Civil engineering and Host-State processes
7. planning and management of high-risk area site investigations;
8. pre-design of tunnel and underground structures, including shafts and caverns;
9. development of layout concepts for each of 2 currently foreseen surface sites, taking into account technical requirements and territorial constraints (buildings, streets, parking spaces, storage, integration of general services, etc.); preliminary concepts and requirements for access to each site; pre-design of surface buildings;
10. development and deployment of communications plan for local areas to support the site investigations;
11. identification and execution of Host-State admin processes needed for possible construction start early 2030s;
12. development of integrated process for environmental evaluation in agreement with regulations in both Host States, and first part of environmental evaluation process and impact study from 2023 onwards;
13. roadmaps and plans for processes that will begin after project's possible approval (e.g. acquisition of land plots for surface sites, public debates, environmental impact study and compensation procedures).
14. Ptrovide a Gantt-table and deliverables along the lines above.
15. Graphics ? as below for FCC

On-going work: placement studies



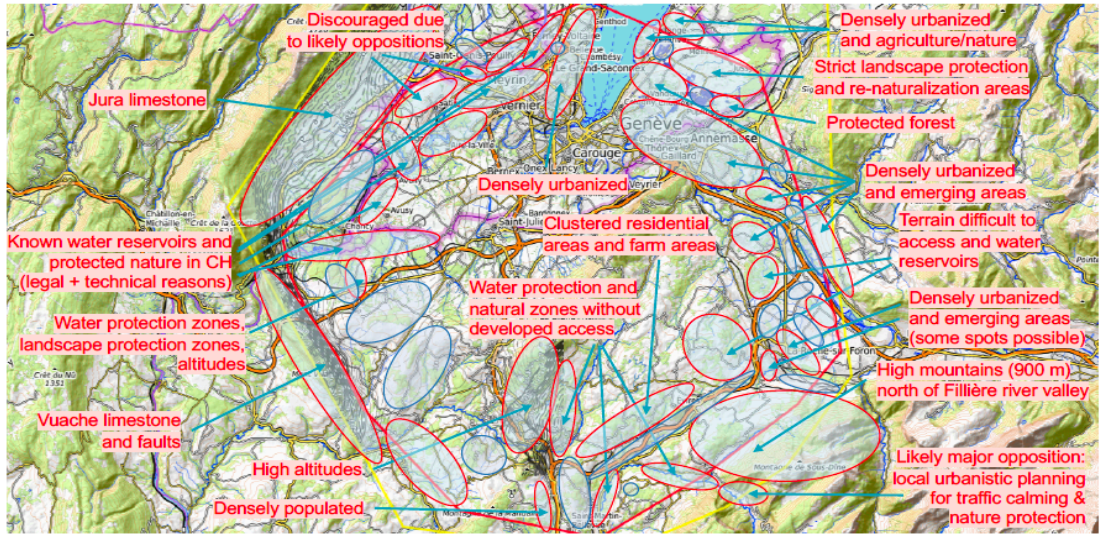
The approach adopted for the layout and placement studies is the one anchored in the French law (Eviter-Reduire-Compenser = Avoid-Reduce-Compensate), which has also been agreed with the Swiss authorities.

The **Multi Criteria Optimisation concept** includes different aspects:

- subsurface aspects (geology, construction technology, etc,)
- surface aspects (land availability, access, etc.)
- nature environment aspects (protected zones, water resources,)
- infrastructure aspects (electricity and water availability, transport,)
- access aspects for different project phases (roads, train)
- synergies (tourism, water re-use, sharing of electricity lines, etc.)

Equivalent study of imbedding in the environment

On-going work: placement studies (constraints)



Answers to Mario's demands

1. Status of process for collecting objectives/deliverables (see previews slides)
2. Interaction with the ET boards (started), more actors in the process of contact
3. WP subdivisions inside each WP. Are you considering slightly revisiting it ? NO
4. Person-months and how you will be collecting participants. A mail to ET when program is stabilised ?
5. Start considering personnel needs from the INFRA-DEV funds.
    1. Needed minimum 2x3 personyear 300 KE
    2. Travel/Preliminray measurement campaigns 50 KE
    3. 2 Workshops on WP9 25 KE