



MINUTES

SUSTAINABLE ACCELERATOR PANEL

MEETING No. 1

2023-03-23

Present: Gianluigi ARDUINI (BE-HDO), Michael BENEDIKT (ATS-DO), Ana-Paula BERNARDES (SY-STI), Marzia BERNARDINI (EN-ACE), Luca BRUNO (HSE-RP), Serge CLAUDET (ENP Chair), Anna COOK (HSE-ENV), Critiana COLLOCA (EN-HE), Alessandro DANISI, Lukas FELSBERGER (TE_MPE), Frederic FERRAND (TE-CRG), Cedric GARINO (SCE-SSC), Marco GARLASCHE (EN-MME), Karsten KAHLE (SY), Sonja KLEINER (HSE-ENV), Roberto LOSITO (ATS-DO), Alessandro MASI (BE-CEM), Pierre NININ (EN-AA), Mario PARODI (EN-EL), Ingo RUEHL (EN-CV), Leonardo SITO, Steinar STAPNES (ATS-DO), David WIDEGREN (EN-IM), Carlo ZANNINI (BE-ABP).

The slides of all presentations can be found on the [Indico page](#) of the 1st Sustainable Accelerator Panel Meeting.

1. [CERN Efforts towards Sustainable Accelerators](#)

Roberto Losito opened the meeting explaining the purpose of the Panel. Sustainability is one of the goals of the CERN Management, and it is defined via three main streams: minimize the Laboratory's impact on the environment, pursue actions and technologies aiming at energy saving and reuse, identify and develop CERN technologies that may contribute to mitigate the impact of society on the environment. Roberto pointed out that environment and sustainability are crucial aspects of projects and activities in the HEP field and will be key to integrate the sustainability in the update of the European Strategy for Particle Physics. In particular, sustainability will be a parameter to address the choice of future projects.

Then Roberto described the current CERN environmental objectives, as well as the CERN panels acting on various aspects of sustainability, and the related subjects being addressed. He explained the Mandate of the Sustainable Accelerators Panel: the liaison with future accelerator projects. In particular the Panel has the mandate to identify and quantify the potential of energy efficient accelerator technology for use in present and future accelerators, and to provide a framework to Studies for future accelerators to harmonise their views on sustainable development. In the frame of the mandate, it will be important to focus on applications and collate and publicize CERN's efforts in the sustainable accelerator technology domain. The panel will work in parallel with the ongoing Energy Management Panel and Energy Coordination.

The chair of the Panel underlined that the objectives fixed by the CERN management target the preparation of the Sustainability chapter for the next European strategy. To achieve this objective, it will be necessary to understand the needs of Studies for future projects and make

an inventory of the efforts ongoing in the ATS sector. It will be important to be open to bottom-up ideas and report them to the ATS management. Regarding the Resources and Organization, the panel count on the commitment of the members and will meet on a monthly basis. Personal initiatives and proposals are very welcome.

Pierre Ninin inquired about the acceptance criteria of an initiative or proposal; Roberto replied that some standards already exist for the environmental aspects, but they do not consider all the aspects related to sustainability. Anna Cook and Sonja Kleiner underlined that the CERN's Environment Report outlines the Organization's commitment to becoming a role model for environmentally responsible research and sets out concrete objectives for environmental stewardship.

2. [Future Circular Collider: Expectations from FCC Study](#)

[Mickael Benedikt](#) described the expectations for support, from the FCC Study, in matter of sustainability. The requested support covers multiple domains. Major support is expected in the Technical and Environmental aspects, also if the Socioeconomical impact and other General aspects are also important. Mickael explained that in February 2023 was published the [Report on placement studies and reference scenario](#) for FCC, including sustainability and environmental aspects as well as territorial constraints. This document is now the reference for further studies and interaction with host state authorities and other services; in addition, it is the reference baseline for environmental analysis and subsurface investigations. The report developed the methodology used to define the FCC placement, as well as the identified constraints and requirements. Mickael underlined that one of the major challenges is the availability of the land, for FCC, therefore a process started to encourage the authorities to "reserve" the land for FCC, for about two-three years. He also underlined that it would be crucial for the FCC Study to be aware of what the authorities will require from the Project once approved in terms of environmental impact and sustainability.

Sonja Kleiner inquired about the role of the Panel for the FCC study. Roberto Losito replied that the study related to the FCC sustainability will be done by FCC Study, but the approach and new ideas must be harmonised with other projects via the Sustainability Panel.

3. [Metamaterials as Room Temperature Superconductors](#)

[Alessandro Danisi](#) showed a [research](#) which is on-going, regarding metamaterials. The objective is to use metamaterial to approach superconductive-like properties, including very high electrical conductivity at room temperature.

Metamaterials properties are therefore investigated. He presented the possible application for sustainable accelerators. Alessandro recalled that Metamaterials are *"Structures and composite materials that either mimic known material responses or qualitatively have new, physically realizable response functions that do not occur or may not be readily available in nature."* He recalled the material characteristics and how to produce metamaterial, which have negative constitutive parameters, like ϵ (electrical permittivity)(ENG) and/or μ (magnetic permeability) (MNG). Metamaterial as ENG or MNG have specific properties under a specific electromagnetic field. Using optical metamaterials, one could make surrounding objects invisible to light.

Metamaterials could therefore be used to mask the properties of other material and improve

their conductivity properties beyond normal capabilities. The speaker then described the analytical model of the meta conductive transition. Therefore, knowing the frequency at which the metamaterial should operate, one can estimate the required thickness and properties. Carlo Zannini explained then the proof of concept. He reported on the first experiment, set using a WR284 rectangular waveguide as a cavity. As result, the electrical conductivity increased of about two orders of magnitude, demonstrating the predicted decrease of transported surface impedance. The possible applications of this principle for sustainable accelerators include the feeding of waveguides (WG) for future colliders, which will lead to a significant reduction of RF losses, and therefore reduce the electrical consumption. Carlo Zannini concluded indicating that Metamaterials are interesting composite materials showing negative constitutive parameters. The insertions of metamaterials have been analytically modelled with a transmission-line equivalence and have shown to dramatically reduce the surface impedance of a conductor, when applied on the same, above a transition frequency. A first proof of concept has shown positive results. Possible applications in accelerators include high-Q cavities, very low loss propagation in waveguides. Finally, sustainability of accelerators could be significantly improved with adequate research on employment of metamaterials for RF waveguides, with the aim to drastically reduce power consumption. Plans for the near future includes a controlled design, fine tuning and production of metamaterials, as well as the investigation on accelerator physics applications. Roberto Losito commented that using metamaterial, the electrical consumption of FCC's RF will be decreased by about 3÷4%, which may represent up to 5 MW with a negligible cost. Therefore, the potential of metamaterial is very interesting, and the range of material to be used is quite large, and can be defined in accordance to the required electromagnetic field. Also if the application for WG could be easily implemented, for the Superconductive Cavities the required frequency should be duly assessed.

4. Next Meeting Schedule

Next Meeting is foreseen on Thursday 27th April at 14h30 in BE Auditorium, 774/R-013.

Minutes reported by Marzia Bernardini on 2023-03-23.