HEARTS kick-off meeting 20-01-2023

Minutes of Meeting

Participants:

European Commission:

Fabio Vitobello (FV), Simon Conticello (SC)

CERN:

Ruben Garcia Alia (RA), Rende Steerenberg (RS), Sabrina El Yacoubi (SE), Pablo Lopez (PL), Andrea Coronetti (AC), Andreas Waets (AW), Mandy Stewart (MS), Cloe Levointurier-Vajda (CL), Svetlomir Stavrev (SS), Eliott Johnson (EJ), Viktor Varga (VV), Antoine Le Gall (AL), Julia Heilemann (JH), Luigi Salvatore Esposito (LS), Natalia Emriskova (NE), Matthew Fraser (MF), Enrico Chesta (EC, online)

GSI:

Marco Durante (MD), Tim Wagner (TW), Christoph Schuy (CS)

UniPD:

Simone Gerardin (SG), Marta Bagatin (MB)

Airbus:

Renaud Mangeret (RM, online)

TAS:

Stefano Francola (SF), Luca Bocchini (LB), Roberta Mancini (RO, remote)

List of Actions:

- A definition of TRL when it comes to the HEARTS infrastructures needs to be formulated, based on existing TRL definitions for facilities and including examples. As input to this TAS, Airbus and UniPD will contribute to set the testing requirements as outlined in Task 5.1 of WP5. The responsible for this task will be CERN. An expected delivery date is 6 weeks from now (end of February 2023). NSRL can be taken as a baseline example.
    - Responsible: CERN + GSI
    - Due date: 6 weeks from now (end of February 2023)
- Create a project video for communication and dissemination.
    - Responsible: CERN
    - Due date: To be determined. Preferably well before the end of the project to enhance the impact of dissemination.

- Create a proposal on how to disentangle, from a naming point of view, CHIMERA and the HEARTS activity in CHARM
    - Responsible: CERN
    - Due date: M3
- Assess the situation in GSI given the evolution of the geopolitical situation and electricity prices. Make an estimate of delays and a new timing schedule, including a request for a zero-cost extension of the project to complete Task 8.3.
    - Responsible: GSI
    - Due date: Review in December 2023.
- Discussion to include a EEE manufacturer as an industrial member of the Advisory Board
    - Responsible: CERN
    - Due date: M6
- Double check and clarify the discrepancy in quoted 9 (4 electronics + 5 GCR simulator) shifts for testing in GSI + confirm if the increase from 9 to 20 shifts is still achievable.
    - Responsible: GSI
    - Due date: ASAP
- Make amendment for (i) financial changes for update on equipment costs, and (ii) D2.1 update of the description to include HEARTS video
    - Responsible: CERN
    - Due date: ASAP
- Provide the sentence to be written for acknowledging EU support, including Space programme
    - Responsible: FV, CS
    - Due date: ASAP

Introduction to CERN and the Accelerator Complex

Rende Steerenberg

Questions & comments:

(RA) Ion operation is guaranteed in CERN's accelerator complex until Long Shutdown 4 (2033), however the schedule shows no ions in the Proton Synchrotron in 2027?

➔ (RS) It is not foreseen to start LINAC & LEIR with ions then for now, but things can still change

(RA) A few years back there was the so-called BioLEIR proposal (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3700518/)?

➔ (RS) There is an interest to reconfigure one of the LHC experiments to be running with many different ions, since this is post 2035, it is not approved,

but plans are made to make injectors more versatile. There will potentially be Oxygen ions available in July 2024 (under discussion in the PS-SPS experimental committee)

Participation of CERN in EU projects

Svetlomir Stavrev

Questions & comments:

(AW) The success rate of CERN projects in H2020 was 33% (significantly higher than average of 14%), how come that CERN seems much more successful?

- ➔ (SS) CERN has acquired a lot of experience in writing proposals and is very familiar with EU programmes. In addition CERN's EU project office offers the proper guidance. A certain luck factor is also possible.

(FV) What is the typical role of CERN in terms of development and fostering technology and innovation?

- ➔ (SS) CERN projects have an extended scope. For most projects CERN is a coordinator, these are often aimed at societal impact (e.g. spin-off technologies that are useful in space, medical sectors, …)

(FV) Is it a problem in case a database of tested components is created at CERN?

- ➔ (SS) The constraints for CERN are resources. Commercial testing for space-rated components is not included in the CERN MTP (Medium-Term strategic and financial plan), funding has to come from within the project itself.
- ➔ (RA) CERN has become a hub for modelling, testing and interpretation of radiation effects. The Radiation-to-Electronics project, which was conceived to address radiation effects-induced downtime during LHC operation, will come to an end in 2025. However, it is deemed to be a core activity for CERN in terms of accelerator operation and will hence move to the MTP. Hence, CERN will continue to have a leading role and provide knowledge, experience and infrastructure that can be exploited by external projects, e.g., CERN having an engineering role for radiation effects in ITER.

New WP2023-2024 and related strategy for critical space technologies for European non dependence

Fabio Vitobello

Questions & comments:

(CS) How long would the revision process for publications be?

- ➔ (FV) In principle the revision will happen as soon as possible so one can assume a normal revision loop timeline

(SG) Are there any restrictions on publishing such as e.g. a proceeding in a US conference?

- ➔ (FV) No, this is ok.

Horizon Europe context and project implementation guidelines

Simon Conticello

Questions & comments:

(SC) There was a 2022 publication in which there was an unclear reference to the EC Horizon programme and Space Programme

- ➔ (RA, MD) Please provide a tailored statement that can be copied and pasted in each publication. We can make it available to the partners through the HEARTS website
- ➔ (FV) It has to include the Space Programme

(RA) What exactly are the conditions to provide two separate access slots per year for beam time? What are the constraints and what is a reasonable separation? We can work together between the two infrastructures (CERN and GSI) to provide a redundancy in which a standard testing approach can be used to do reproducible experiments in either facilities.

- ➔ (FV) How is equal access to industry provided, the facilities are also complementary in a sense? Will this be based on the content of the request, what is the most interesting research?
- ➔ (RA) There will be a central access point between GSI and CERN. We need to make sure the requirements are not in contradiction with the EC requirements.
- ➔ (MD) The access and availability of high-energy heavy ion facilities will not stop with HEARTS, it is a preparatory project for an ensured availability in the future. HEARTS will have a long legacy.

(RA) In what way does the Technology Readiness Level (TRL) metric map to the development of a facility? Are there any examples of what this means? User facilities exist that are up and running that can be taken as reference.

- ➔ (CS) One of these examples is the NASA Space Radiation Laboratory in the US, where the needed information for users is directly available upfront. Is there a specific licence approved by the EC needed to share this information?
- ➔ (FV) There should be no blocking points, results from the tests are of course a different story.

(VV) Is the screenshot of the grant agreement the final version?

- ➔ (SC) This will be checked when it is updated.

(FV) It is very important that the website is properly implemented and gathers the right information, how will this be done? It is a legal obligation that the website remains live after the end of the HEARTS project. In this sense the website should be in the EU domain, not the CERN domain.

- ➔ (AL) The website will be mentioned in the WP2 presentation.
- ➔ (RA) Having the website in the CERN domain ensures long duration maintenance. In this sense also RADNEXT can help, the website gives information and access to the user portal, where proposals can be submitted.

HEARTS overview, objectives and partners

Ruben Garcia Alia, Marco Durante, Stefano Francola, Renaud Mangeret, Marta Bagatin

Questions & comments:/

WP1: Project Management

Pablo Lopez, Viktor Varga, Mandy Stewart

Questions & comments:

(SC) Where is the EC link with the governing board? This needs to be present. Who is part of the governing board?

- ➔ (RA) The governing board consists of the Scientists-in-charge of each partner. TESAT will be part of the governing board as an observer only.

(RA) The advisory panel can be appointed any time by M6.

Constitution and responsibility of boards and panels

Ruben Garcia Alia

Questions & comments:

(FV) We need to elaborate on the "need-to-know" basis for project information given to the Advisory Panel.
(FV) People from non-EU nationalities are subject to some restrictions

- ➔ (MS) An NDA as annex to the Consortium Agreement needs to be signed by all members of the Advisory Panel.
- ➔ (FV) Under certain conditions this is not sufficient.

(MD) Is 10 people in the Advisory panel not too much?

- ➔ (RA) We can select among the profiles listed on an 'or' basis, more likely there will be 4 to 5 profiles and not the full Advisory Panel will be invited to each meeting
- ➔ (SC) It is conceivable that depending on the phase of the project we can have a different pool of experts.
- ➔ (MD) What are the priorities in expertise?
- ➔ (SC) Academia, industry and agency are standard, facilities are a plus. The composition of the Advisory Panel is a consortium decision.
- ➔ (RM) Is it interesting to include here a representative from EEE manufacturers? Since they can be users it can help for them to understand the testing complications with the current state-of-the-art in packaging.
- ➔ (RA) This can indeed be a good option to cover this part of the sector, it gives complementary industrial involvement with respect to industrial partners which as integrators are already beneficiaries in the project.

WP2: Communication and dissemination

Antoine Le Gall

Questions & comments:

(FV) We will provide the guideline for references from the EC with regards to communication
(FV) The website will also represent the access gateway for users

- ➔ (RA) This is indeed logical but has not yet been decided, we need to consider what the most user-friendly option is. User access is anyway expected only later in the project. An online form to collect user beam requests may be useful.

(FV) Typically there is a deliverable on how a website should look like, how it should work and track with metrics what the performance is.

- ➔ This is part of Deliverable 2.4: Final report on communication, dissemination, outreach and exploitation

(FV) A promotional video for the project with all partners involved can be created. This video can build the narrative such that it can be used for dissemination. It can include footage of work on the beam lines, testing, and equipment.

- ➔ (MD) We can create it in a long and a short version. It will cost some money but is very effective.

WP3: Monte Carlo simulations

Luigi Salvatore Esposito

Questions & comments: /

WP4: Beam Instrumentation and Dosimetry

Tim Wagner

Questions & comments:

(RA) Iron is very important in radiobiology and shielding, it should also be important for SEE testing because of their prevalence in space (half of the SEEs are induced by Fe). However the testing standards require higher LETs than can be achieved with Fe.

- ➔ (MD) GSI is happy to provide Uranium since it is an ion that is used very much in the accelerator complex.
- ➔ (CS) In terms of dosimetry: the requirements for Fe beam instrumentation and detectors are not the same as for U!
- ➔ (SF) Facilities are used to mimic SEE rates in orbit. Risk avoidance and reliability assurance requires high LET. For risk management low- and mid-LET are important. There are sweet spots that should be investigated.
- ➔ (MD) For high-energy heavy ions there is a track structure effect: different ions at the same LET can have a very different track structure and induced effect by consequence.

WP5: Radiation effects testing with VHE ions

Simone Gerardin

Questions & comments:

(FV) Are target devices (GPUs and/or FPGAs) already identified?

- ➔ (SF) No final decision yet, there is a shortlist, but it is too early to decide and over the course of the project also the interest can shift since technology evolves very fast.

- ➔ (SG) There is no data with heavy ions on these devices because of the need to dissipate power during testing which is an issue.
- ➔ (SF) A candidate tested with proton is available for board-level testing, it will be based on power converters (it is an architecture based on PWM driven power MOSFET). All of the board will be irradiated, including passive devices.
- ➔ (FV) Why not use GaN components?
- ➔ (SF) It can be done but this is riskier because of the higher probability of SEEs than with Si.
- ➔ (RA) There is SiC and GaN experience from CERN and Airbus for building converters with wide bandgap devices.
- ➔ (SF) There is interest to procure a commercial device that is in line with the new space era. NASA has proton testing guidelines for components going to space.

(CS) Is there a risk of catastrophic failure, such that in case the needed safety measures can be implemented during testing?

- ➔ (SG, RA) Safety procedures exist to ensure the destructive events are limited to the board itself.
- ➔ (SG) Board-level testing has an economical advantage but years ago nobody trusted it and only component-level testing was standard practice. However, examples exist already where boards are tested with irradiation from different sides to account for possible different LET values.

(SC) What is the interaction with WP4?

- ➔ (SG) Deliverable 5.1 will provide information about dosimetry requirements to be used as input for WP4. Each partner will be developing a setup for each device.

WP6: Quantitative estimates of shielding effectiveness using GCR simulator

Christoph Schuy

Questions & comments:

(SC) Have some modulators already been designed?

- ➔ (CS) For the SPE simulator yes, but they are not user-friendly since they are still in the experimental phase. Characterization of the mixed field wanted upon user request takes time.

(SC) Can one change from solar minimum to solar maximum?

- ➔ (CS) Yes, the shift in energy can happen through a change in modulator.

(RA) How is the homogeneity in the particle spectra achieved?

- ➔ (CS) The beam travels through air to lose the modulator structure and become uniform over a large area. This was verified with CMOS detectors.

(RA) Can one forget about the neutron contribution to the mixed field? In this sense the spectrum behind a modulator does not represent “free” space?

- ➔ (CS) The material of the modulator changes a lot the neutron field, characterization of neutrons at the target position will be carried out in case simulations cannot be trusted.
- ➔ (MD) We indeed don’t simulate the free spectrum but in reality there is always some object close by anyway, this is a caveat compared to the NSRL GCR

simulator but the big advantage is the much higher energy with SIS-100 (10 GeV/n).

(RM) Is there any possibility to use an electronic device as a target with the GCR simulator? What is the connection with what will be developed as a (simplified) GCR simulator?

- ➔ (CS) In a way yes, but it requires optimization of the modulator because GSI uses scanning methods to create large area beams while CERN uses broad shaped beams by default.
- ➔ (MD) These limitations need to be carefully considered, also lead beams are a bit too heavy for the purpose of the GCR simulator at GSI.

WP7: Upgrade of CHARM beam line at CERN for VHE ion electronics testing

Ruben Garcia Alia

Questions & comments:

(FV) How will the effects of the beam particle type and energy on SEE rates be analysed and taken into account within the project? Which WPs will take care of this? We should make sure there are no artefacts.

- ➔ (RA) This will be tackled by WP5 and WP3, but it is limited within the scope of HEARTS. However, for this type of testing the ion penetration within the components is more important than accurately representing the GCR spectrum.
- ➔ (MB) Link to a publication describing these effects will be provided.
- ➔ (RM) In case discrepancies between standard and high energy heavy ion testing appear these need to be understood before the facilities are routinely used.
- ➔ (MD) The question is what type of testing comes closest to telling the truth? E.g., a typical standard energy heavy ion such as 1 MeV/n Kr used for testing is something you don't see in space, low-energy experiments are a worst case scenario, but they are not realistic. In reality with higher energy ions found in space the energy is more distributed and not concentrated in a smaller volume.
- ➔ (SG) In a complex device, high energy becomes worse because you hit many more cells.
- ➔ (CS) Low energy ions just stop somewhere in the component. This is however less error prone because energy deposited locally is much higher.

(MF) User requirements can help drive the infrastructure activity at CERN and determine what priorities are needed. E.g., some extraction techniques might not be compatible with all the testing requirements.

(SC) The EU contribution to the HEARTS might be overshadowed if the name of the CERN facility is CHIMERA.

WP8: Upgrade of the FAIR facility for shielding testing

Marco Durante

Questions & comments:

(CS) We lose a lot of time since the beam is not necessarily on target when setting up the beam at GSI for users, standardisation can help a lot in this sense because beam time is restricted, and the goal is to reduce the time lost.
(FV) There seems to be a mismatch between this presentation and the proposal text.

- ➔ (MD) 4 shifts are for microelectronics testing, 5 shifts are for the GCR simulator. An increase to 20 shifts is questionable and can't be promised now.
- ➔ (FV) A workaround for this should be considered, for example by evolving to a situation where CERN and GSI are complementary. This is to be taken as an action and discussed again at the end of 2023.
- ➔ (MD) There will be a sharp increase in available shifts when FAIR can start since the facility will be in operation for 10 months per year. A larger amount of time for microelectronics testing will be negotiated, but not within HEARTS timeframe.
- ➔ (RA) Two weeks of ions per year corresponds to 48 hours of shifts, however, the readiness level at CERN is lower than at GSI now. If the readiness level of the test needs to be higher it can be shifted to later in the project.
- ➔ (CS) In terms of user-friendliness there is an effort needed in communication. E.g., GSI uses scanning, while other facilities don't and this has to be explained every time to the users.

(SC) What is the impact of using the CBM cave with respect to the APPA cave?

- ➔ (MD) The beam will be exactly the same. There is a time delay since the CBM cave belongs to another collaboration. However, the CBM cave wants to host the experiment, therefore, there will be no technological objective issues.
- ➔ (SC) Hence all tasks can be done within HEARTS, with exception of the last one (Task 8.3) which is actually carrying out the test at 10 GeV/n.
- ➔ (MD) It is very important to go to 10 GeV/n, not only because it will be the very first time it has been attempted, but ions between 1 and 10 GeV give 35 - 40% of the dose in space. The request to the EC is therefore to be flexible given the current geopolitical situation. A zero-cost extension beyond HEARTS could be considered?