

Minutes: HEARTS Knowledge Transfer Meeting

Date of the meeting: 20.04.2023

Participants:

Natalia Emriskova (*CERN*), Andreas Waets (*CERN*), Christoph Schuy (*GSI*), Tim Wagner (*GSI*), Uli Weber (*GSI*), Vanessa Wyrwoll (*University Oldenburg*)

Short Summary:

During the meeting both facilities GSI and CERN have been presented and the experimental locations, Cave A and CHARM respectively, along with their challenges and restrictions have been discussed. This has helped tremendously for the understanding of the other facility and the challenges one is facing. All kind of detector options, which are in use at either of the facilities, or are available to the group of University Oldenburg, were presented. Challenges and opportunities for the use of each of the detector types for the usage at either facility were evaluated.

No final conclusion could be made, as most of the time was dedicated to completely understand the other facility and discuss various detector options in terms of their use and potential installation (including the challenges) at either facility. Therefore, a concept for a first benchmark experiment at both of the facilities shall be developed from both parties, circulated offline and discussed in a follow up meeting (online).

List of Actions:

- Concept for a first benchmark experiment: Each party should propose 1–2 experiments to be performed for dosimetry, which are functioning at both facilities (GSI and CERN).
- Write a short (ca. 1 page) document suggesting possible solutions for the challenges discussed during the meeting and have a follow up meeting (online) in 1 – 2 months to discuss these and the next steps.
 - The following challenges have already been identified:
 - Beam purity: With a pure beam, one can use precise dosimetry to determine the fluence of the beam. In case of a non-pure beam, ion counting is required, as (potentially multiple) fragments can generate the same dose as a primary ion. In both cases, the fluence of the primary ions is the value of most interest, as it reflects the primary LET value.
 - Space and weight: While Cave A is easily accessible, for CHARM the Montrac has to be used for sample positioning, which restricts the size and weight of instrumentation, which can be used at the target position.
 - Electronics positioning: The required distance (cables) between the detectors and the readout electronics is significantly different between Cave A and CHARM.
 - Beam shape or beam application: Counting particles in a small area while irradiating with a broad beam, requires the detector to be at the peak of the (Gaussian) beam shape. This problem will later on be alleviated by making the beam shape at CERN uniform.

Talks and Discussions:

- Topics presented and discussed during GSIs talk (Uli Weber and Christoph Schuy):
 - History of the Biophysics at GSI: Development of Carbon ion beam therapy applications, raster scanning beam application, etc.

- Definition of terms for the dose and all the connected quantities. Different approaches to measure the fluence or dose and derive the other property from it.
 - Definition of the term **“Dosimetry” for HEARTS to be meant as “Characterization of the radiation field”**. For the connected quantities associated to this, refer to slide 8 and 9 of GSIs presentation.
 - Setup of the experimental room Cave A at GSI and its raster scanning capabilities
 - Detailed explanation of the raster scanning principle. Explanation of the dosimetry needed for the proper functionality of the beam application with raster scanning, including its calibration.
 - Here some discussion for further clarification of the concept, its implementation and its flexibility happened.
 - Discussion about the calibration of detectors for absolute dosimetry.
 - Presentation of parts of the GSI dosimetry paper for HZE particles; Luoni et.al, 2020 [DOI: 10.3389/fphy.2020.568145](https://doi.org/10.3389/fphy.2020.568145)
 - Discussion of GSI Uranium dose measurements; Horst, Weber, 2020, [DOI: 10.1088/1748-0221/17/12/P12019](https://doi.org/10.1088/1748-0221/17/12/P12019)
 - Improvement of k_Q values (correction factors) for dosimetry chambers for very high-energy (FAIR) particles and very heavy particles (Uranium): MC simulations planned.
 - Showcase of existing, and typically used, instrumentation for beam monitoring and dosimetry at GSI. Here the devices themselves were shown in a hands-on session, accompanied with slides detailing their use case and functionality.
 - Presentation of the current GCR simulator developments at GSI for future use within the HEARTS project, including the challenges with the characterization of it.
 - Various questions about the GCR simulator were discussed.
- Visit of Cave M and Cave A at GSI:
 - Opportunity to see more beam instrumentation and the beamlines themselves.
 - Demonstration of the raster scanning system in action and clarification of further questions about it.
 - Topics presented and discussed during CERNs talk (Andreas Waets):
 - Layout of CERNs accelerator structure to give context for the T8 beamline in the PS East Area. Operation of the accelerators to provide heavy ion beam to the T8 beamline.
 - Typically only 2 weeks per year ion operation at CERN in the last quarter.
 - Attempts to use protons and lead at the same time, but posed too much of a challenge and will not be used for any user experiments
 - Presentation of new developments for adjusting the beam energy and intensity for heavy ion operation.
 - Presentation of the already installed beam monitoring hardware in the T8 beamline and presentation of the T8 beamline itself.
 - Here some discussion happened about the different detector types, their accessibility or adjustability (only in coordination with other groups) and the structure of the beamline itself, to make it clear to everyone what kind of challenges exit with the usage of the T8 beamline.
 - Presentation of the target station installed in CHARM, beam quality (e.g. energy degradation, fragmentation and shape) and online monitoring tools available.
 - Cross calibration of the beamline detectors with a silicon diode (counting ions and having a known surface area) installed at the DUT location, showcasing the possibility to accurately measure the beam over a large intensity range
 - Discussion about the future beam shaping (uniformity and size) plans.
 - Detailed discussion about the silicon diode, its related electronics and capabilities. Also previous measurements done in CHARM were shown.

- For the silicon diode, some discussion was dedicated to the challenges measuring with it and the challenges coming alongside (e.g. housing of the diode causing energy loss of the beam and afterwards still detecting it).
 - Installation of extra hardware in the beamline is challenging due to the coordination with all other groups whom use the same beamline. One time uses of detectors possible, but permanent installations require agreement by many different departments.
 - Discussion about beam delivery at CERN and how to start & stop the beam and attempt to deliver a certain number of particles.
 - Start and stop only possible via call to the control room. Delivery of a certain number of particles only possible up to a certain precision and not really required for electronics testing.
- Topics presented and discussed during the talk by University Oldenburg (Vanessa Wyrwoll):
 - Presentation about the background and expertise.
 - Presentation about various activities that the group of University Oldenburg is involved.
 - Detailed presentation about the PTW Octavius detector array, including a measurement already performed at CERN (North Area, 150 GeV/n Lead)
 - Challenges with beam purity (only 70% lead remaining) and detector calibration
 - Explanation for the calibration of the array and the related correction factors.
 - Discussion about other dosimetry options e.g. modified arrays, Farmer chambers, etc.
 - Conclusion and discussion of the possible contributions to the HEARTS project.
 - Discussions about the use of the PWT Octavius (potentially a modified one) chamber as a comparison tool for 2D dosimetry at GSI and CERN with measurements done by the Oldenburg group with the same detector at both facilities.
- Important side discussions (beam time):
 - Although in the past year, RADNEXT users were more interested into the heavy Uranium ions, it seems that in the next year CERN, or HEARTS participants in general, are now more interest into Fe-56 beam. However, the available 4 days slot for Fe beam seems to be already overbooked for IBPER and GCR modulator commissioning / calibration (all experiments with granted proposals). On the other hand, a long period for Uranium beam is scheduled in 2024, and a dedicated block for RADNEXT experiments in June is foreseen, see: https://www.gsi.de/work/organisation/wissenschaftliche_gremien/user/beamtime