HEARTS 1st Annual Meeting: WP4

6 February 2024

https://indico.cern.ch/event/1314502/

GSI

Funded by the European Union

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Tasks & Objectives

- **Task 4.1:** Knowledge transfer between CERN and GSI
  - Exchange on beam instrumentation and characterization methods
  - Visit of CERN colleagues to GSI to see beam instrumentation in Cave A
  - Discussion with related experts
- **Task 4.2:** Calibration of beam instrumentation for VHE ion beam extraction
  - Calibration and exploitation of existing beam instrumentation
  - Identification and installation of new beam instruments and detectors
  - Closely linked to Task 3.1 and Task 7.2
- **Task 4.3:** Beam delivery monitoring
  - Define necessary beamline instrumentation for beam monitoring during space radiation testing
  - Platform should handle both high intensities (10^8 – 10^{10} ions/s) for shielding measurements and low intensities (10^2 – 10^5 ions/s) for SEE cross-section measurements
  - Dedicated set of dosimeters, thin gas ionization chambers and plastic scintillators

Tasks & Objectives

- **Task 4.4:** Target Station
  - Optimization of GSI sample handling to increase TRL
  - Remotely controlled holder for microelectronics with input from industrial partners
  - Automatic placement and removal of material for shielding measurements
  - Standardization between GSI and CERN device under test (DUT) holder
- **Task 4.5:** GCR/SPE simulator dosimetry
  - Definition and standardization of Dosimetry-on-target
  - Explore possibility of microdeosimetry behind shielding to characterize the quality factor Q of the mixed field
  - Dedicated measurements for the GCR/SPE simulator measuring the LET spectrum and charge composition of the mixed field
- **Task 4.6:** Intercomparison between CERN and GSI
  - Transfer of experience between CERN and GSI
  - Dedicated comparison measurement between the facilities (e.g. with the same beam instruments and reference electronics)

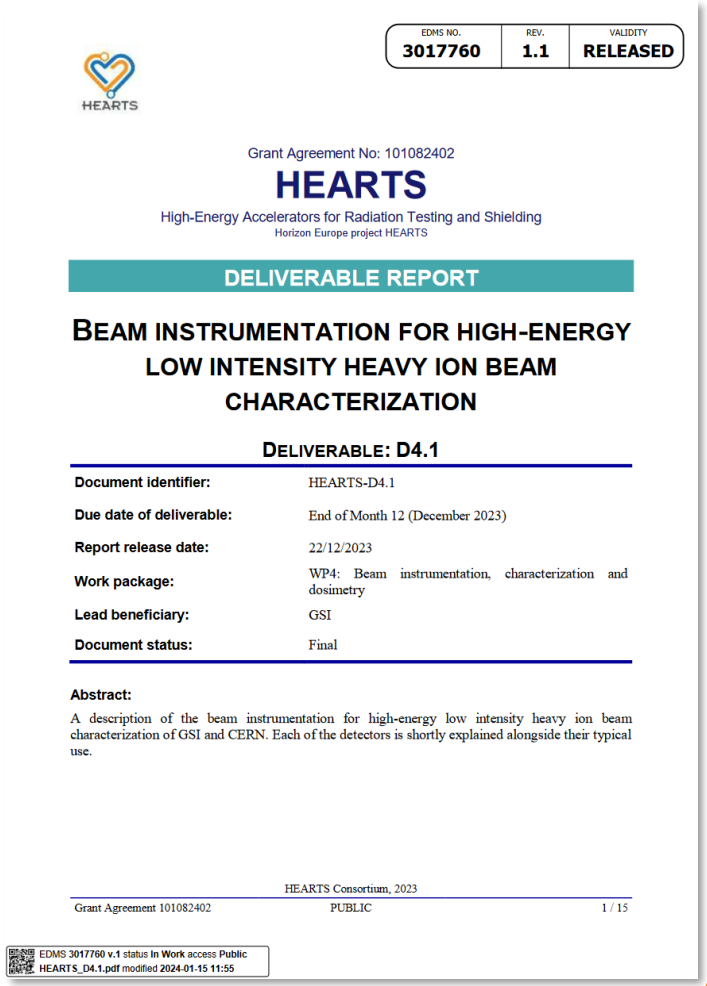
Status Task 4.1: Knowledge transfer between CERN and GSI (1/2)

- Knowledge Transfer Meeting at GSI on 20.04.2023
  - Participants from GSI, CERN and Univ. Oldenburg
- Discussions about:
  - The challenges at each of the two facilities
  - Dosimetry detectors used for beam characterization and monitoring
  - Plans for a comparison measurement between the standard detectors available CERN and GSI
    → Beamtime October 2023 @ CERN (see Task 4.6)

Picture by: A. Waets, CERN

Status Task 4.1: Knowledge transfer between CERN and GSI (2/2)

- Deliverable D4.1: Beam instrumentation for high-energy low intensity heavy ion beam characterization
- Reporting on the different detectors used for characterization and monitoring used at CERN and GSI
  - Examples GSI: Parallel Plate Ionization Chamber; Scintillators; various standard dosimetry detectors (Farmer Chambers, etc.); Octavius detector; and more
  - Examples CERN: Silicon diode; Secondary emission chambers (XSEC, XION); Multi Wire Proportional Chamber



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HEARTS

Grant Agreement No: 101082402

HEARTS

High-Energy Accelerators for Radiation Testing and Shielding

Horizon Europe project HEARTS

DELIVERABLE REPORT

BEAM INSTRUMENTATION FOR HIGH-ENERGY LOW INTENSITY HEAVY ION BEAM CHARACTERIZATION

DELIVERABLE: D4.1

Document identifier:	HEARTS-D4.1
Due date of deliverable:	End of Month 12 (December 2023)
Report release date:	22/12/2023
Work package:	WP4: Beam instrumentation, characterization and dosimetry
Lead beneficiary:	GSI
Document status:	Final

Abstract:

A description of the beam instrumentation for high-energy low intensity heavy ion beam characterization of GSI and CERN. Each of the detectors is shortly explained alongside their typical use.

HEARTS Consortium, 2023

Grant Agreement 101082402 PUBLIC 1 / 15

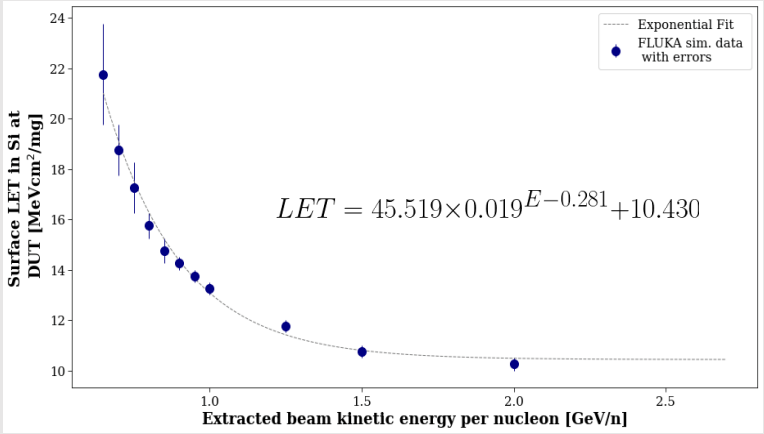
EDMS 3017760 v.1 status In Work access Public
HEARTS_D4.1.pdf modified 2024-01-15 11:55

Status Task 4.2: Calibration of beam instrumentation for VHE ion beam extraction

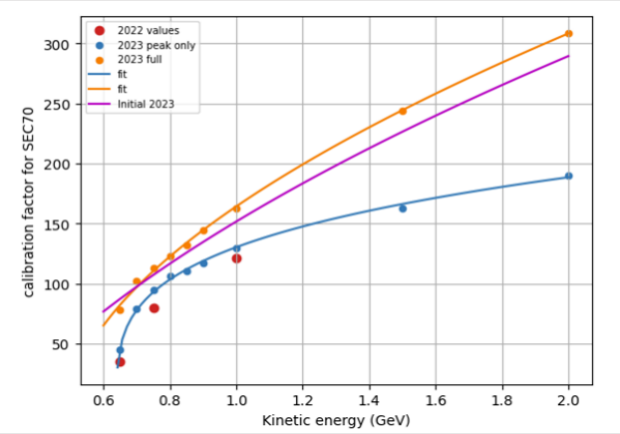
- CERN approach: accurate provision of **LET** and **flux/fluence** as dosimetric quantities for users as function of extracted beam energy.
- Energy/LET and flux/fluence calibration achieved after Oct. 2023 test campaign (further detailed in WP7 update)

LET

Calibration using energy deposition measurements using Si diode at DUT + beam line simulations in FLUKA to extract LET



Calibration of relative beam monitor signal (emission chambers), provided by Si detector at DUT



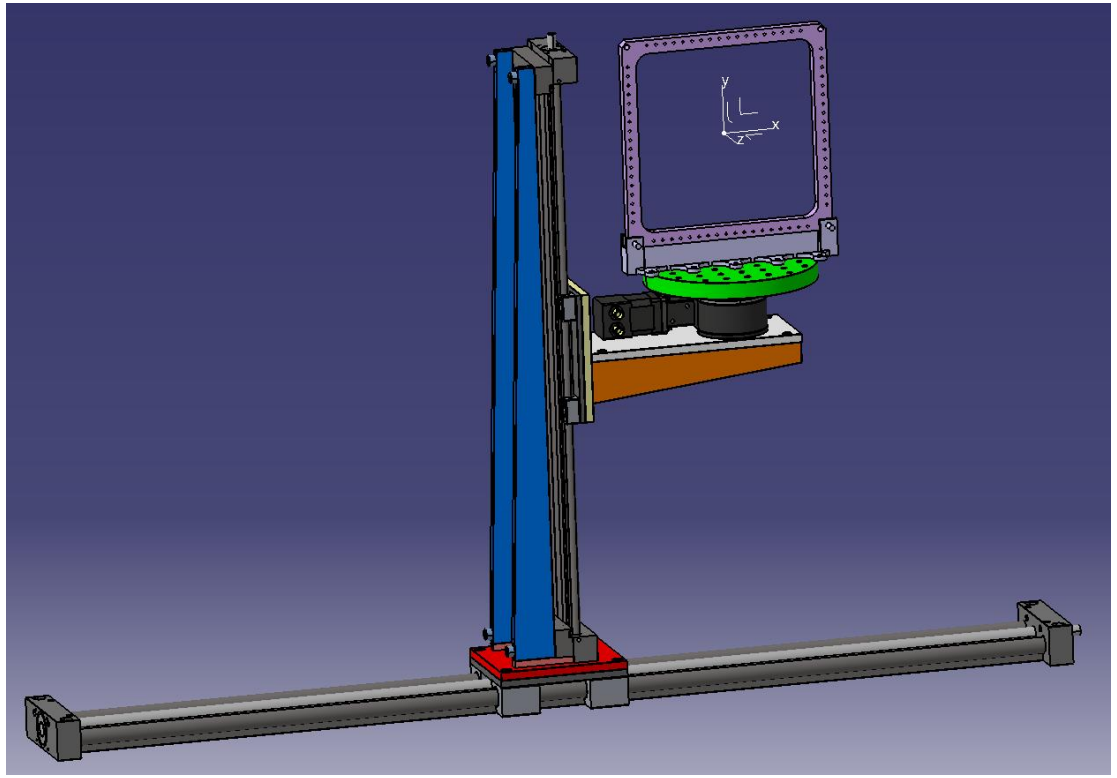
Flux/fluence

Status Task 4.3: Beam delivery monitoring

- Standard GSI beam monitoring detectors:
  - Parallel Plate Ionization Chambers
    - Used for medium to high intensities
  - Scintillators
    - Used for low intensities, as single particles are counted
- Calibration detectors:
  - Farmer Chamber
  - Octavius detector array
  - Various other absolute dosimetry detectors, e.g., Pinpoint, Markus Chamber, etc.

Status Task 4.4: Target station (1/3)

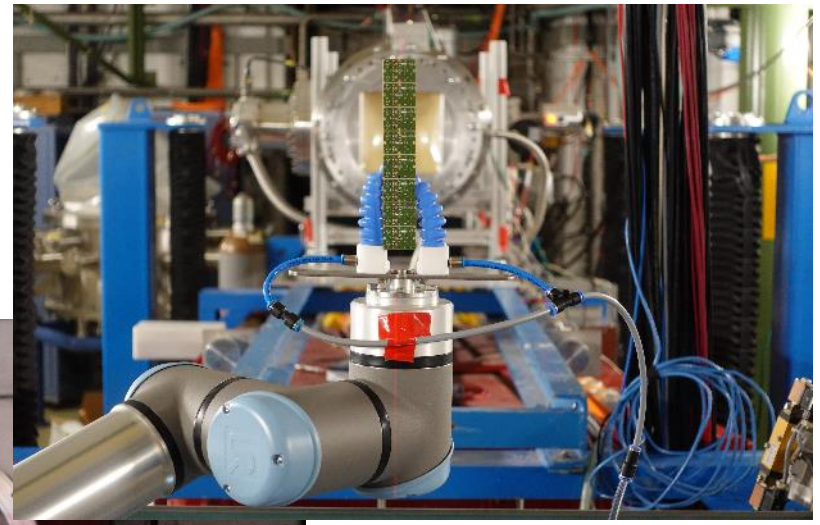
- Movement in 2 dimensions + 1d rotation possible
  - 2d movement for the positioning of the sample
  - 1d rotation for irradiation with grazing angles, if desired by the use
- Compatible with the “ESA standard frame”
  - “ESA standard frame” allows users familiar with other electronics irradiation facilities to mount their samples quicker and easier
- Assembly and testing ongoing, expected to be fully assembled and tested early 2024

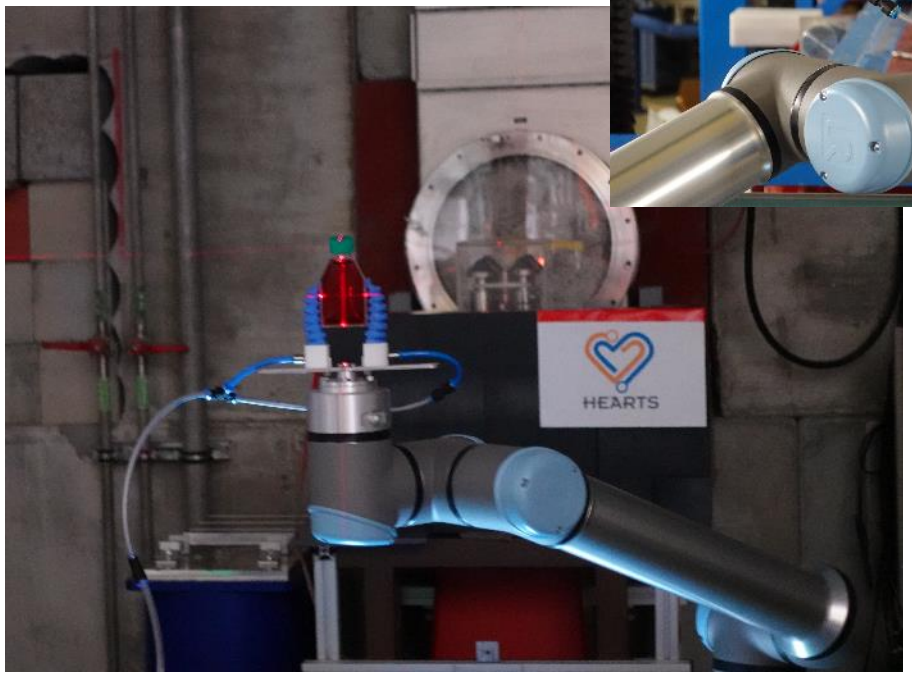


Picture by: A. Gera, GSI

Status Task 4.4: Target station (2/3)

- Robotic arm UR10e with a reach of 1300 mm and a payload of 12,5 kg
- Will be used for sample handling on complex parts and biological samples
- Confirmed operation in an environment with ionizing radiation (December 2023)

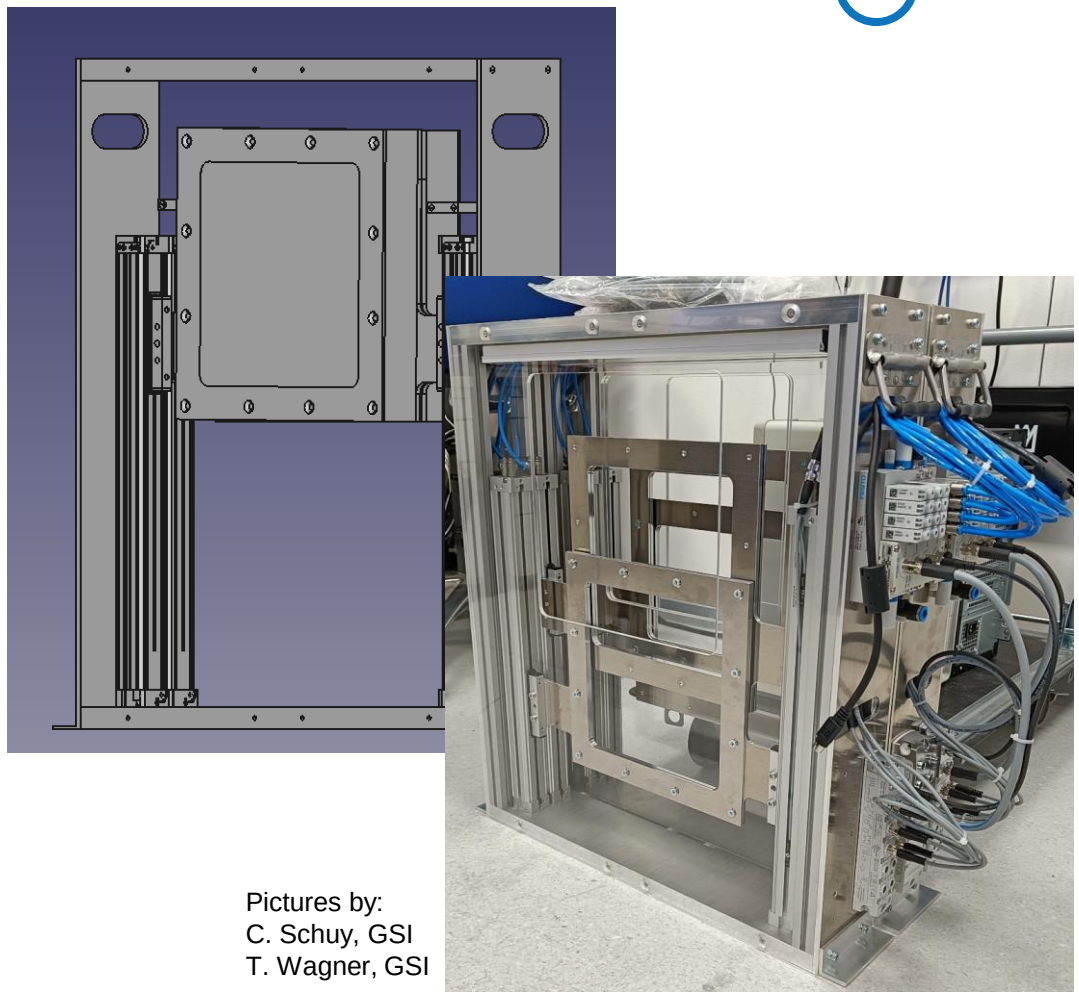




Pictures by:
C. Schuy, GSI

Status Task 4.4: Target station (3/3)

- New modular range shifters for positioning of shielding material
- Two plates / elements can be mounted to each of then
  - Three modular range shifters for a total of 6 plates / elements
- Distance between the individual range shifters can be varied for a more diverse application
- Added flexibility as more complicated structures can also be mounted to them, e.g., modulators for the beam



Pictures by:
C. Schuy, GSI
T. Wagner, GSI

Status Task 4.5: GCR simulator dosimetry

- Detailed characterization of the GCR Simulator for Cave A in April 2024
- Plan to use various different detectors:
  - Standard dosimetry detectors
  - Microdosimetry detectors
  - Neutron detectors (Bonner Spheres)
  - Silicon diode
  - etc.
- In the future:
  - Measurements of the GCR Simulator with shielding
  - Faster validation of the GCR field with a quick dosimetry measurement compared to full characterization for regular operation

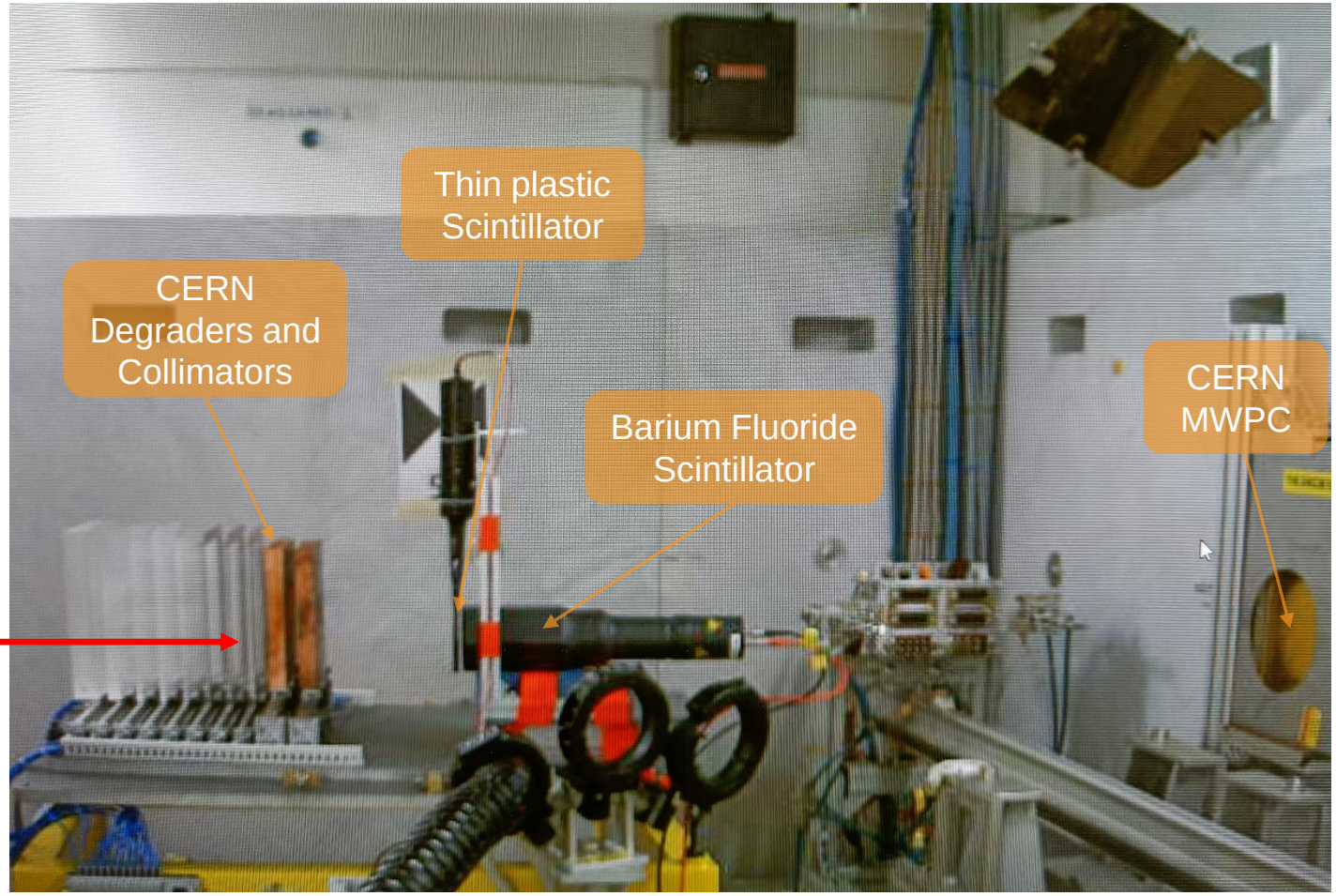
Status Task 4.6: Intercomparison between CERN and GSI (1/2)

- Cross comparison of GSI and CERN detectors during a beamtime in October 2023 @ CERN
- Analysis of data still ongoing → Will be reported on in D4.6

Detector 1	Detector 2	Reason
Parallel Plate Ionization Chamber (GSI)	Farmer Chamber (GSI)	Calibration of IC with an absolute detector and Cross-check of RF-gain intensity adjustments
Parallel Plate Ionization Chamber (GSI)	Silicon Diode (CERN)	Comparison between standard GSI and CERN detectors
Thin plastic Scintillator (GSI)	Silicon Diode (CERN)	Comparison between standard GSI and CERN detectors (for lower intensities)
Thin plastic Scintillator (GSI)	Barium Fluoride Scintillator (GSI)	Measurement of beam spectra and Characterization of the fragments

The CERN emission chambers (XSEC and XION) were always placed in the beam.

Status Task 4.6: Intercomparison between CERN and GSI (2/2)



Experimental setup for the measurement of the thin plastic scintillator vs the Barium Fluoride scintillator in October 2023 at CERN.

Picture by:
T. Wagner, GSI

Deliverables due in Y1

Deliv. No.	Deliverable name	Due date	Status	Summary
D4.1	Beam instrumentation for high-energy low intensity heavy ion beam characterization	2003-12-31	Achieved	A description of the beam instrumentation for high-energy low intensity heavy ion beam characterization of GSI and CERN. Each of the detectors is shortly explained alongside their typical use.

The achieved deliverables are available on HEARTS website page:
https://hearts-project.eu/project/deliverables/

Milestones due in Y1

- No milestones due in Y1 for WP4

Milest. No.	Milestone name	Due date	Status	Summary
-	-	-	-	-

The achieved milestones are available on HEARTS website page:
https://hearts-project.eu/project/milestones/

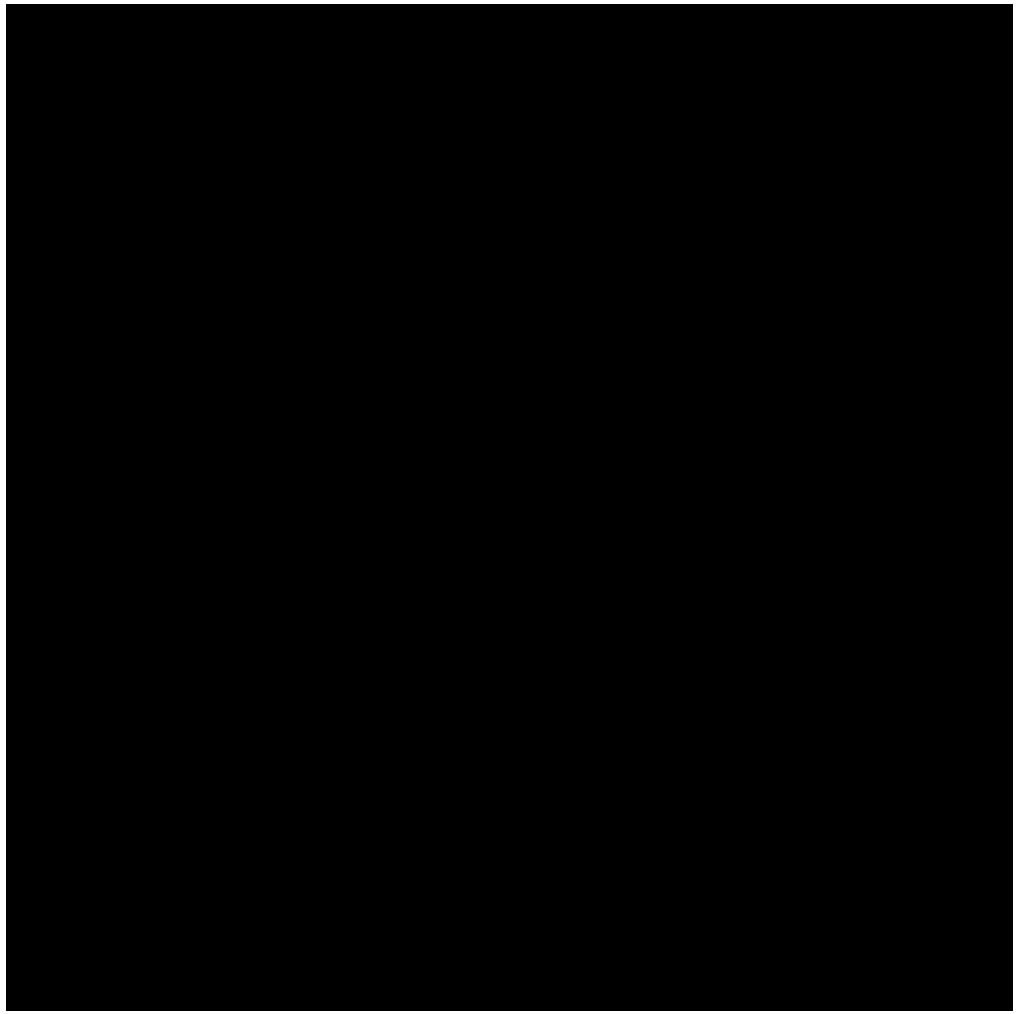
Upcoming Deliverables & Milestones

Deliv. No.	Deliverable name	Due date	Status
D4.2	Calibrated CERN beam instrumentation documented and installed in the accelerator	2024-12-31	Pending
D4.3	Experimental measurements on GSI beam instrumentation and dosimetry	2025-12-31	Pending
D4.4	Documentation on the target station construction and use	2025-12-31	Pending
D4.5	Report on microdosimetry for GCR simulator calibration	2025-12-31	Pending
D4.6	Intercomparison between CERN and GSI instrumentation and standardisation	2026-12-31	Pending
Milest. No.	**Milestone name**	**Due date**	**Status**
M12	CERN beam instrumentation and dosimetry installed and running	2024-12-31	Pending
M13	GSI beam instrumentation and dosimetry installed and running	2025-21-31	Pending

Plans for the (near) future

- **Task 4.4:** Target Station
  - Finish building and commissioning the target station
  - Test and use the robotic arm for first experiments and tests with cells
  - Detailed report on the GSI target station → Deliverable D4.4
- **Task 4.5:** GCR simulator dosimetry
  - First measurements in April 2024
- **Task 4.6:** Intercomparison between CERN and GSI
  - Analysis of measured data from October 2023 @ CERN
  - Further comparison measurements planned, e.g. Silicon Diode in GSI Iron beam

Thank you for your attention



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* Some pens were harmed in the creation of this video
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