



HSE
Radiation Protection

RP feedback of the HEARTS run 2024 at T8-IRRAD

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Context and key numbers

- **Heavy-ion beam** (Pb^{54+}) of various energies (between 500 MeV/n and 3 GeV/n) in **T8-IRRAD (East Area)**: Beam commissioning, Development and control, Energy deposition measurements with diodes, Single Events Effects testing, Detector characterizations & Calibrations
- **Activities:**
 - **Commissioning** (IMPACT [238105](#))

“HEARTS @ CERN heavy ion testing commissioning in IRRAD Zone 1, to be carried out during MDs, the first (13-19/11) and last (29/11 - 2/12) segment of the test campaign. We will perform installation, internal calibrations and benchmark tests.”
 - **Run** (IMPACT [237518](#))

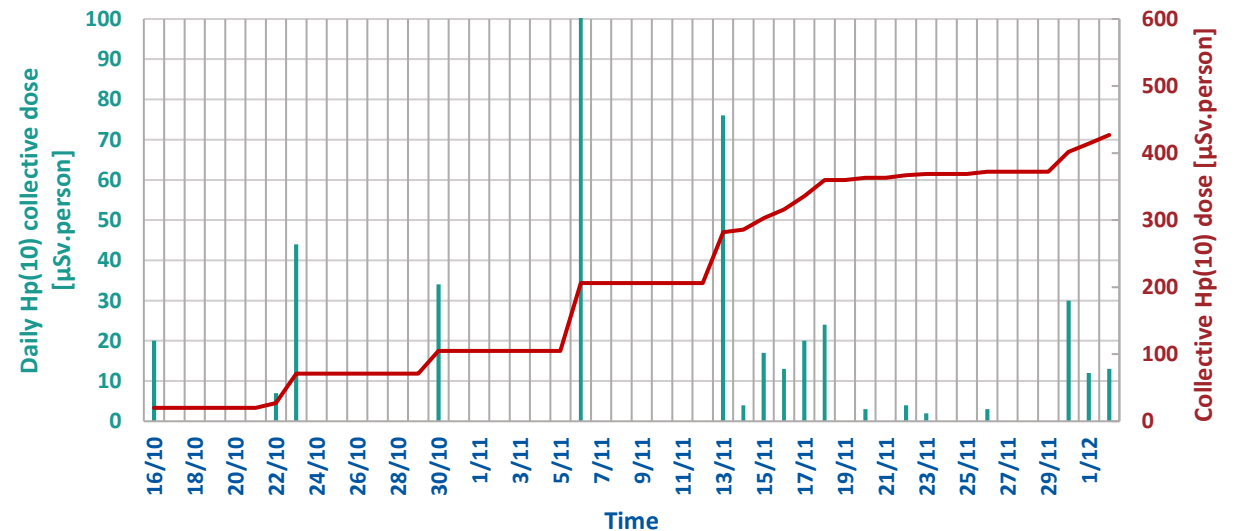
“HEARTS @ CERN heavy ion testing in IRRAD. We will have 19 days of ions in East Area, with frequent accesses to change setups. We will perform internal calibrations and tests and we will also have about 44 external users (to be added later).”



Commissioning

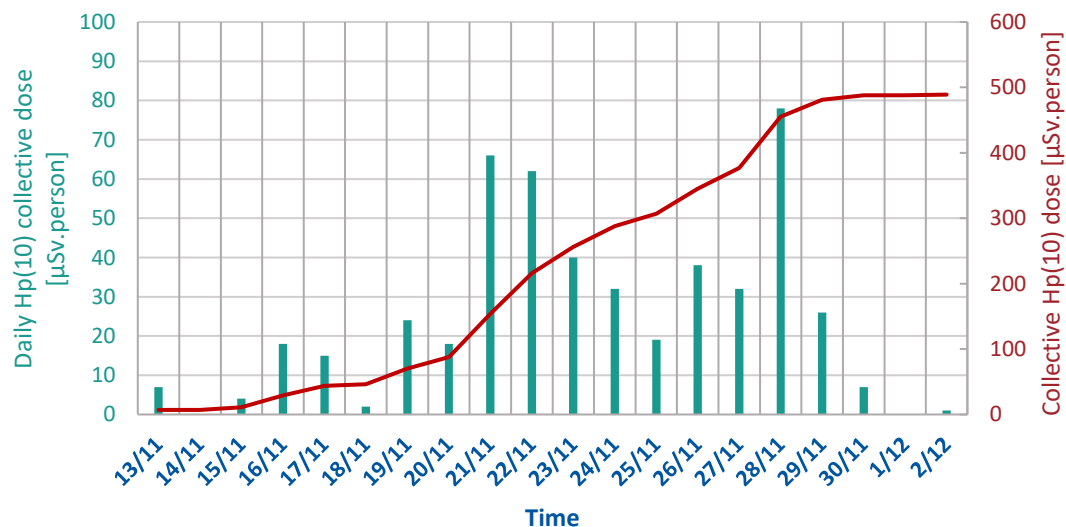
“HEARTS @ CERN heavy ion testing commissioning in IRRAD Zone 1, to be carried out during MDs, the first (13-19/11) and last (29/11 - 2/12) segment of the test campaign. We will perform installation, internal calibrations and benchmark tests.”

- Number of workers: **21**
- Duration of the activity: **47 days** from 16.10.2024 to 02.11.2024
- IMPACT [238105](#), DIMR [8030074/2](#) classified as **ALARA Level 1** (see backup)
- WDP [3501/2](#)
 - Estimated Total collective working time: 17 h person
 - Estimated maximum individual working time: 5.3 h
 - Estimated Total collective dose: 324 μSv person
 - Estimated maximum individual dose 99 μSv (initial 76)
 - Estimated Average dose rate: 19 $\mu\text{Sv}/\text{h}$
- Final collective dose: **427 μSv (+31%)**
- Final maximum individual dose: **84 μSv (-15%)**

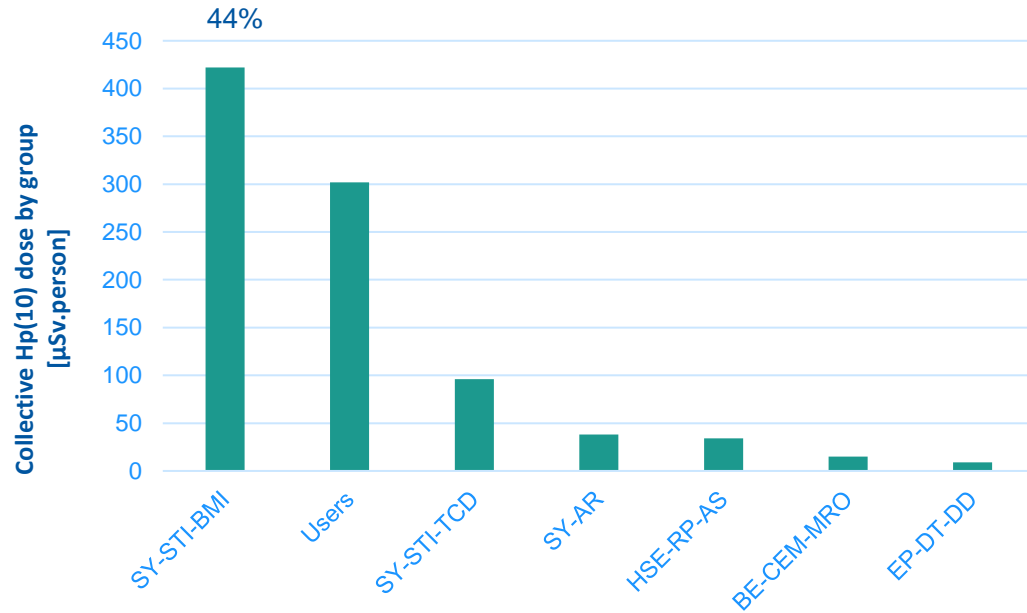


Run

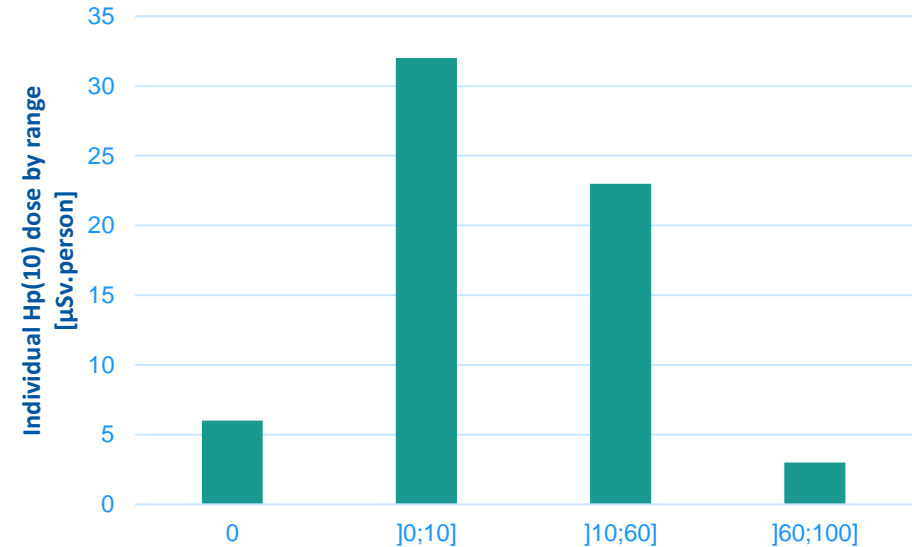
- “HEARTS @ CERN heavy ion testing in IRRAD. We will have 19 days of ions in East Area, with frequent accesses to change setups. We will perform internal calibrations and tests and we will also have about 44 external users (to be added later).”
- Number of workers: **79**
- Duration of the activity: **19 days** from 13.11.2024 to 02.12.2024 (~150 accesses)
- IMPACT [237518](#), DIMR [8030614/2](#) classified as **ALARA Level 1** (see backup slides)
- WDP [3566/2](#)
 - Estimated Total collective working time: 24.1 h person
 - Estimated maximum individual working time: 3 h
 - Estimated Total collective dose: 482 μSv person (initial 62)
 - Estimated maximum individual dose 60 μSv (initial 20)
 - Estimated Average dose rate: 20 $\mu\text{Sv}/\text{h}$
- Final collective dose: **489 μSv** (+1%)
- Final maximum individual dose: **56 μSv** (-7%)



Repartition of doses (commissioning + run)



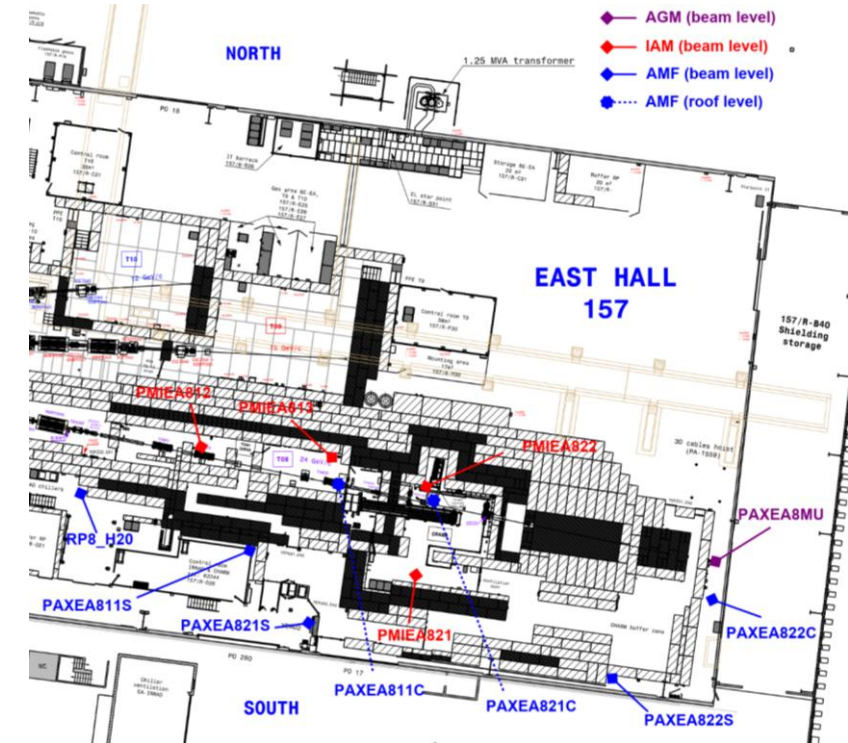
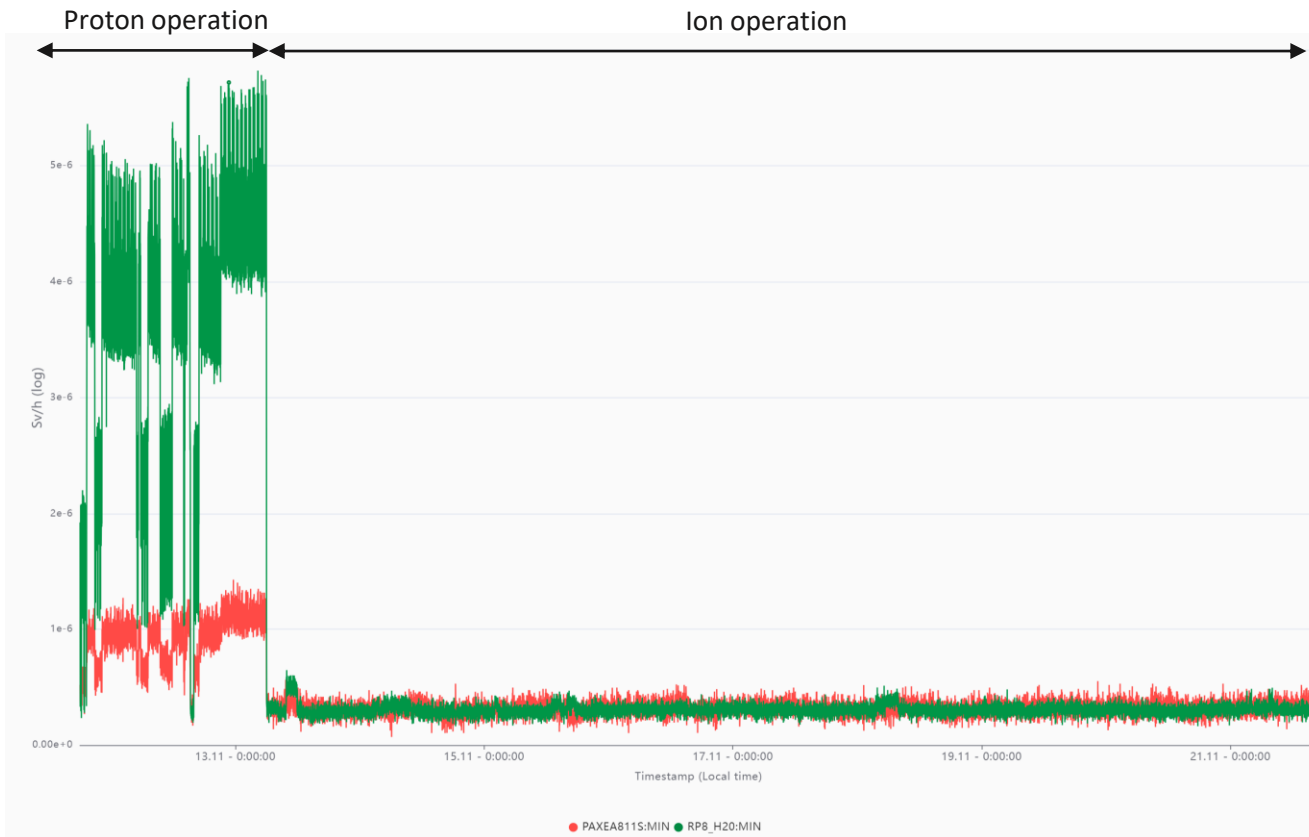
- Doses by group: **~44%** of the total dose is received by **SY-STI-BMI** as main party involved, **~33% by the Users** and **~4% by HSE-RP-AS** (surveys, measurements, follow-up, and supervision of activities)



- Repartition by dose range:
 - ~50% of the workers less than 10 μSv
 - ~5% close to ALARA Level 1 limit



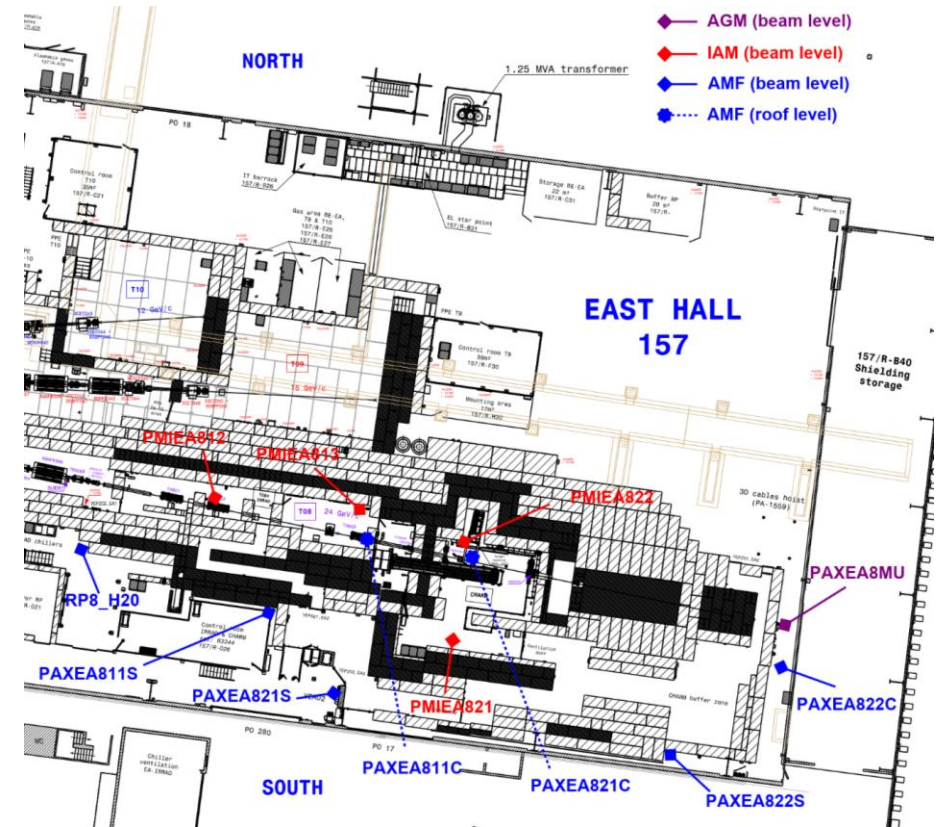
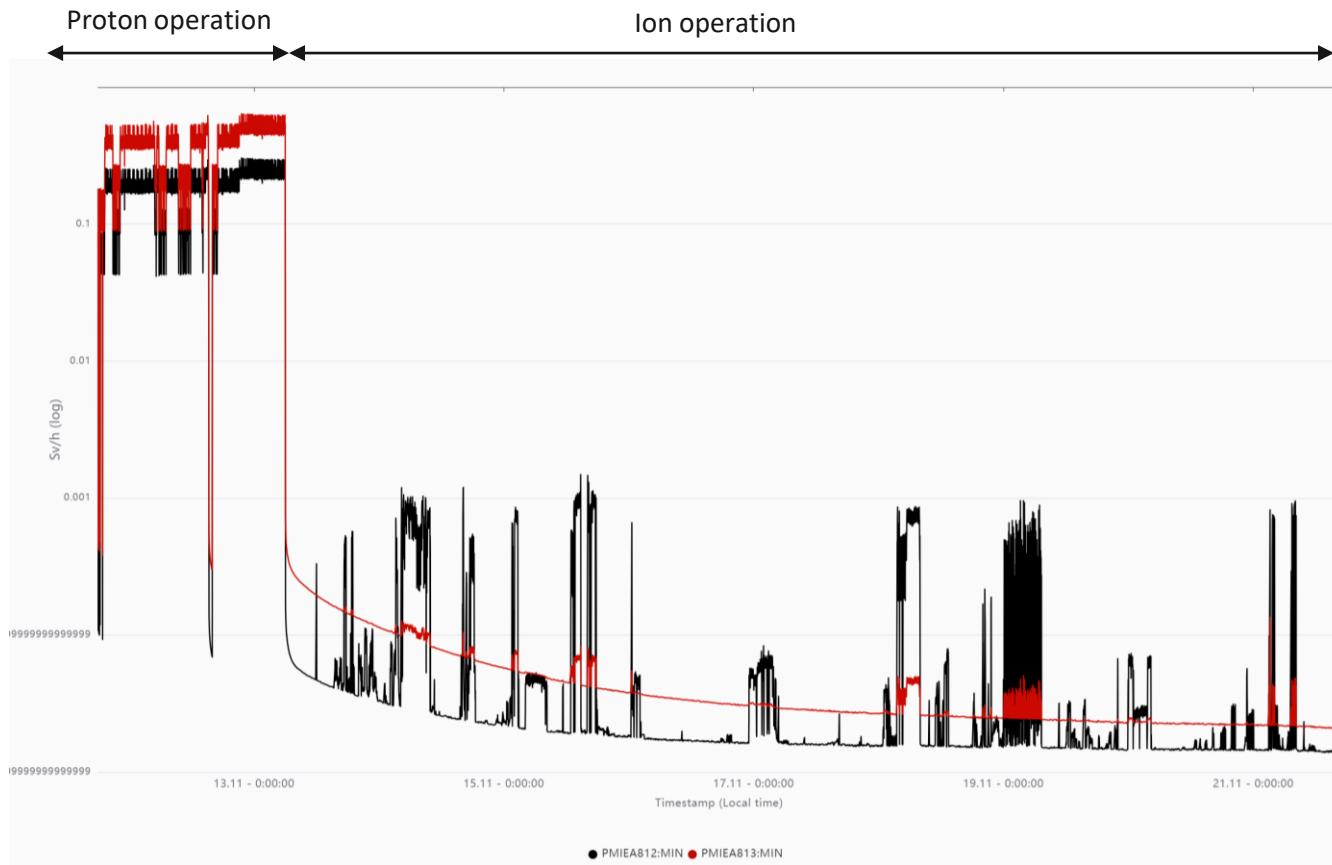
Prompt radiation monitoring



- At the current intensities, the ion operation at T8 for prompt radiation monitoring outside IRRAD is well contained within the envelope of proton operation.



Residual radiation monitoring



- At the current intensities, the ion operation at T8 does not contribute significantly to the activation of the IRRAD area compared to proton operation.

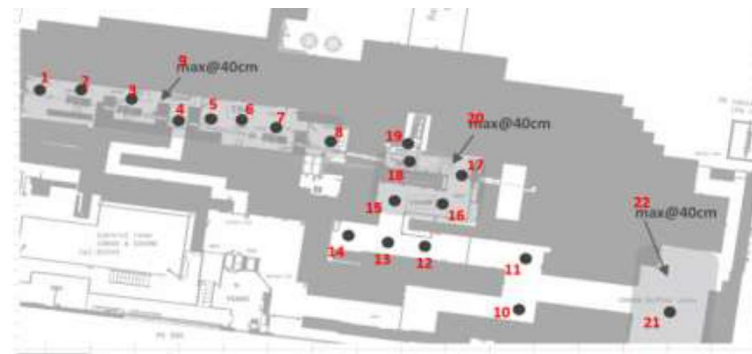


Residual Dose Rates in IRRAD

- Survey realized during RP accesses in HEARTS@CERN working position in IRRAD area:

Débit de dose ambiant ($\mu\text{Sv/h}$)

Positions	13/11/2024 debut HEARTS	13/11/2024 debut HEARTS	18/11/2024 HEARTS	21/11/2024 4 HEARTS	22.11.2024 a 13h40 H,A	30/11/24 9h50 MS	01.12.2024 04h00 T.A	01/12/24 14h05 MS
1	30	12	7,5	8	7	6	6	6
2	37	15	17	15	8	13	14	14
3	55	20	23	25	15	14	10	16
4	90	34	32	40	27	20	22	21
5	160	ferme	ferme	ferme	ferme	ferme	ferme	ferme
6	750	ferme	ferme	ferme	ferme	ferme	ferme	ferme
7 a 22	inaccessible		inaccessible		inaccessible		inaccessible	



Measurements on materials

- Material that has been exposed to the beam may be radioactive.
- Considering that the operation is in IRRAD, it is unlikely that irradiated objects should be placed first in hot buffer zone.
- During the activity the irradiated materials should be placed in the buffer zone in the south side of the East Hall (157/R-O21) and be registered in TREC for RP measurements (e.g. verification measurements) (1 issue reported)
- Some irradiated material were classified radioactive as per procedure after verification measurements right after irradiation with Ion beam. For information, ~90% of irradiated materials were declassified 24 hours after irradiation.

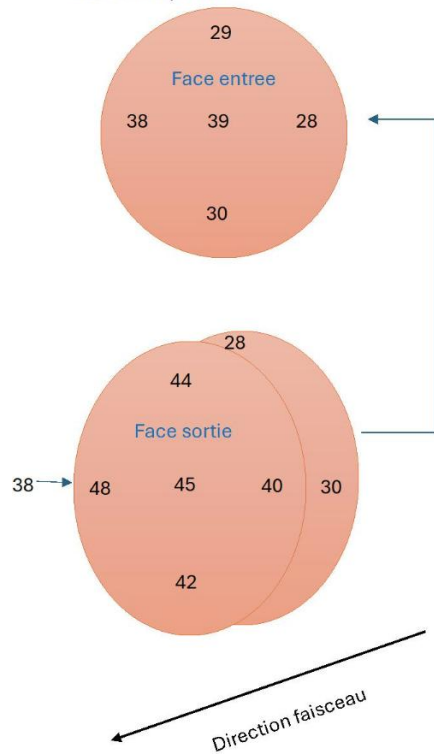


Measurement on Ion Dump

DUMP CUIVRE (HEARTS).

Mesure DeD au CT a l'AD6 du Dump réalisé 15/11/2024 a 12h00.

valeurs en $\mu\text{Sv/h}$



Débit de dose ambiant ($\mu\text{Sv/h}$)

Positions	13/11/2024 debut HEARTS	13/11/2024 debut HEARTS	18/11/2024 HEARTS	21/11/2024 4 HEARTS	22.11.2024 a 13h40 H,A	30/11/24 9h50 MS	01.12.2024 04h00 T.A	01/12/24 14h05 MS
1	30	12	7,5	8	7	6	6	6
2	37	15	17	15	8	13	14	14
3	55	20	23	25	15	14	10	16
4	90	34	32	40	27	20	22	21
5	160	ferme	ferme	ferme	ferme	ferme	ferme	ferme
6	750	ferme	ferme	ferme	ferme	ferme	ferme	ferme
7 a 22	inaccessible		inaccessible		inaccessible		inaccessible	

Débit de dose au CT du DUMP CUIVRE ($\mu\text{Sv/h}$)

Position	15.11.2024	16.11.2024	22.11.2024	26.11.2024	30.11.2024	01.12.2024	01/12/24 14h05
face entree milieu	39	28	26	15	16	14,5	24
face entree max	45	30	35	17	17	15	24
Face sortie milieu	45	35	25	27	20	19	24
Face sortie max	48	37	32	30	21	22	24

- Measurements performed on ion dump for operational RP during ion commissioning (+ end of proton operation)
- Measurements performed on ion dump for operational RP during ion run
- The ion dump does not have a significant contribution to the ambient dose in IRRAD
- Dedicated benchmark campaign on activation with ion beam could be planned for next ion run at T8



Summary

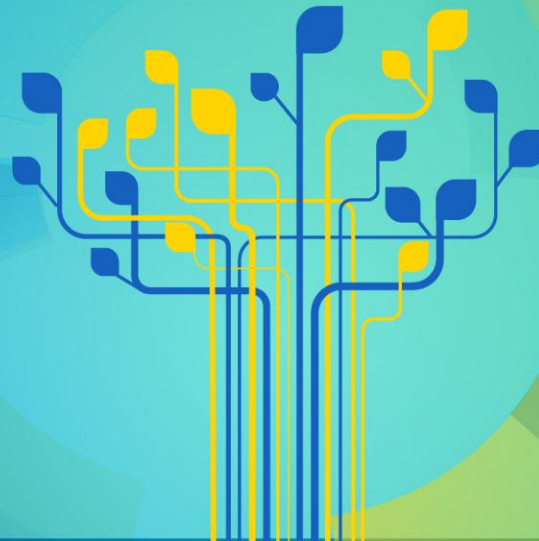
- 2024 HEARTS@CERN run was performed in T8-IRRAD.
- IRRAD is classified as **Controlled – Limited Stay Radiation Area**. Residual ambient dose equivalent of the order of tenth of $\mu\text{Sv/h}$ in the irradiation rooms of IRRAD during the ion run.
- **Additional RP support** outside working hours (~150 accesses)
- Optimization measures should be envisaged, for instance:
 - **reduce the time or number of interventions (use of cameras for follow up of activities inside IRRAD?)**
 - **work in low dose rate areas (ALARA shelters);**
 - **Limit number of workers accessing the IRRAD area to the strict minimum;**
 - **alternate in tasks to distribute the dose and avoid high individual doses;**
- 2024 HEARTS@CERN activities have been divided in a **Commissioning** activity and a **Run activity**. DIMRs still classified as ALARA Level 1, but once again **doses were close to the limits**. For next run, 1 DIMR for both activities (to be evaluated with WDP if ALARA Level 2).
- **Work and Dose Planning should be performed as accurately as possible** when preparing the IMPACT to enter precise dose estimates from the beginning and **to avoid blocking the IMPACTs during the activities**.













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Radiation Protection

Back up slides



Radiation Areas classification

[EDMS 810149](#)

Area	Annual dose limit (year)	Ambient dose equivalent rate		Sign 	
		permanent occupancy	low occupancy		
Non-designated	1 mSv	0.5 µSv/h	2.5 µSv/h		
Radiation Area	Supervised	6 mSv	3 µSv/h	15 µSv/h	Dosimeter obligatory Dosimètre obligatoire 
	Simple Controlled	20 mSv	10 µSv/h	50 µSv/h	SIMPLE CONTROLLED / CONTRÔLÉE SIMPLE Dosimeter obligatory Dosimètre obligatoire 
	Limited Stay	20 mSv	-	2 mSv/h	LIMITED STAY / SÉJOUR LIMITÉ Dosimeters obligatory Dosimètres obligatoires  
	High Radiation	20 mSv	-	100 mSv/h	HIGH RADIATION / HAUTE RADIATION Dosimeters obligatory Dosimètres obligatoires  
	Prohibited	20 mSv	-	> 100 mSv/h	NO ENTRY DÉFENSE D'ENTRER 
Controlled Area					

*Normal working time: 40h per week, 2000h per year

**Low occupancy means <20% of working time



ALARA Levels at CERN

Group 1 criteria: 'hard' limits used to determine the minimum ALARA Level

Individual dose equi.	Level I	100 μ Sv	Level II	1 mSv	Level III
Collective dose equi.		500 μ Sv		5 mSv	

Group 2 criteria: base of a radiological risk assessment, can be used to increase the ALARA level

Ambient dose equivalent rate	Level I	50 μ Sv/hr	Level II	2 mSv/hr	Level III
Airborne activity in CA		5 CA		200 CA	
Surface contamination in CS		10 CS		100 CS	

EDMS 1751123

CERN
CH1211 Genève 23
Suisse

N° EDMS 1751123	REV. 1.2	VALIDITÉ Released
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REFERENCE

Date: 19/4/2017

Operational Radiation Protection Rule

ALARA rule applied to interventions at CERN

DOCUMENT PRÉPARÉ PAR :
H. Vincke / HSE-RP

DOCUMENT VÉRIFIÉ PAR :
S. Roesler / HSE-RP
D. Forkel-Wirth / HSE-RP
RSOC members
(Florence Pirrotte BE, Ans Pardons EN, Michael Jonker TE, Alexis Vidal TE, Marc Vadon SMB, Federico Ravotti EP, Robert Froeschli HSE, Klaus Barth ALICE, Giancarlo Spigo ATLAS, Stéphane Bally CMS, Gloria Corti LHcb)

DOCUMENT APPROUVÉ PAR :
S. Baird / HSE
F. Bordry / DG

GRUPE D'APPROBATION



Clearance of radioactive materials

According to CERN regulations ([EDMS 942170](#)), any irradiated device/object can be removed from regulatory control if the following conditions are satisfied:

- i. the **ambient dose equivalent** rate measured at 10 cm distance from the item surface is **lower than 0.1 μSv/h** after subtraction of the background
- ii. the **specific activity** is below the **clearance limit (LL)**, i.e. for a mix of radionuclides if:

$$\sum_{i=1}^n \frac{a_i}{LL_i} < 1$$

- iii. the **surface contamination** is below the **surface contamination limit (CS)**, i.e. for a mix of radionuclides if:

$$\sum_{i=1}^n \frac{c_i}{CS_i} < 1$$

Note: CERN adopted LL and CS from the Swiss Radiation Protection regulation (ORAP 814.501)

In-situ measurement procedures detailed in [EDMS 1968658](#)

CERN CH1211 Genève 23 Suisse		NO EDMS 1968658	REV. 2.3	VALIDITÉ RELEASED
RÉFÉRENCE				
20 May 2020				
OCCUPATIONAL HEALTH & SAFETY AND ENVIRONMENTAL PROTECTION UNIT				
Procédure				
Mesures radiologiques du matériel et des déchets au CERN				
DOCUMENT PRÉPARÉ PAR : F. Aberle G. Dumont R. Froeschl	DOCUMENT VÉRIFIÉ PAR : C. Ahdida, R. Charousset, N. Conan, T. Frosio, A. Herve, T. Levi, N. Menaar, Y. Pira, F. Pozzi, C. Theis, C. Tromel, L. Ulrici, Heinz Vincke, Helmut Vincke, M. Witorski	DOCUMENT APPROUVÉ PAR : S. Roesler		
GROUPE D'APPROBATION				

