

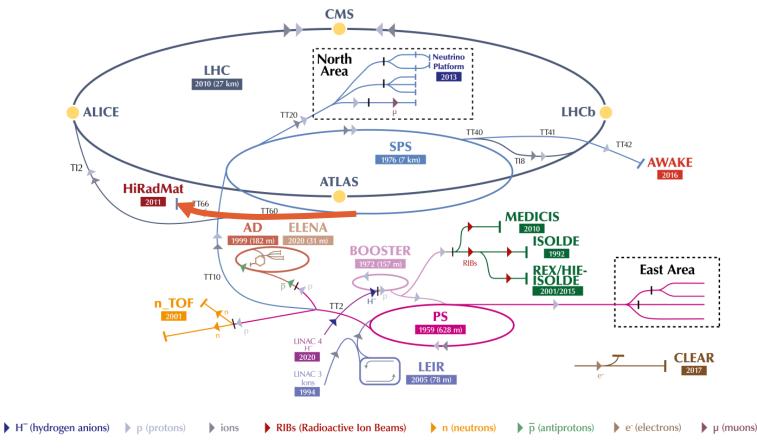
# HiRadMat: a high power targetry facility at CERN



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10th November 2023 – HPTW2023

# **Beam Testing facilities at CERN**



The CERN accelerator complex, layout in 2022. © CERN



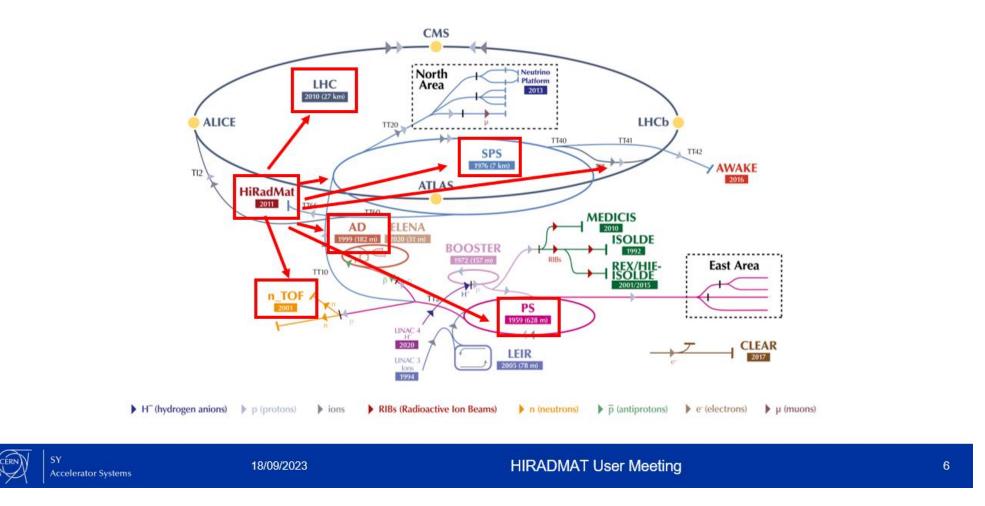
**HiRadMat** 

**High-Radiation to Materials** 

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### On which HIRADMAT has/will have an impact@CERN?







# **HiRadMat Facility**

Short-pulse high-energy proton irradiation facility

LHC-like Beam Parameters Up to 288 bunches, ≤2.3×10<sup>11</sup> protons per bunch ≤6.6×10<sup>13</sup> protons per pulse at 440 GeV/c ~1.5 ns long bunches, 25 ns bunch spacing Beam size at target: flexible between 0.1 - 4 mm (1 σ)

 Maximum flexibility to accommodate most of the requests

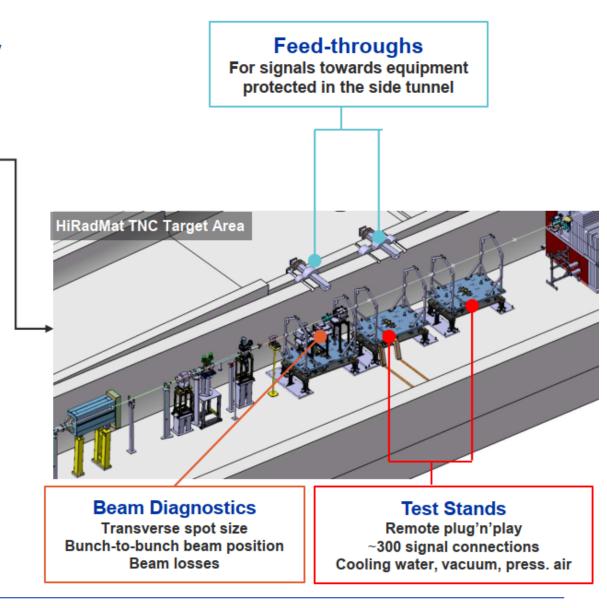
P[J/pulse] = 440 GeV x 1.6x10<sup>10</sup> J/p x 288 p/b x 2.3x10<sup>11</sup> ppb = 4.7 MJ/pulse

 Ions also available – However never extracted to the facility. A test is planned for 2025/6 to validate this.

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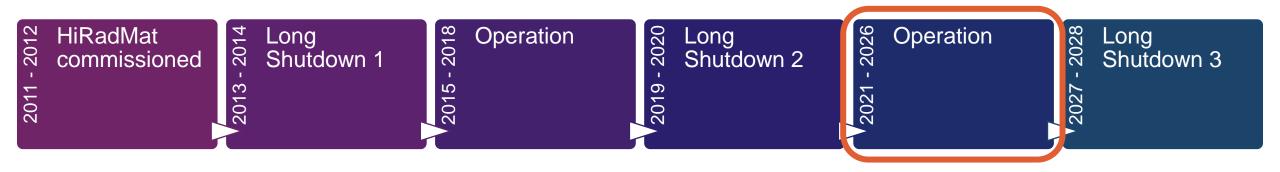
**iRadMat** 

Radiation to Materials





# **Operation schedule**



### **Experiments**

- 18 Materials R&D
- 11 Accelerator component prototyping
- 6 Targetry R&D
- 9 Beam diagnostics
- 2 Particle detectors
- 3 Plasma Physics

### 60 publications

### **Future experiments**

- Beam diagnostic devices
- Material for nuclear reactor
- Superconducting material damage mechanisms
- Muon collider (and other) windows
- DPA theory research
- Plasma physics for astrophysics phenomena
- Also look for more



# 2024 summary

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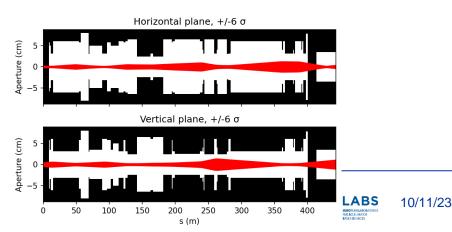


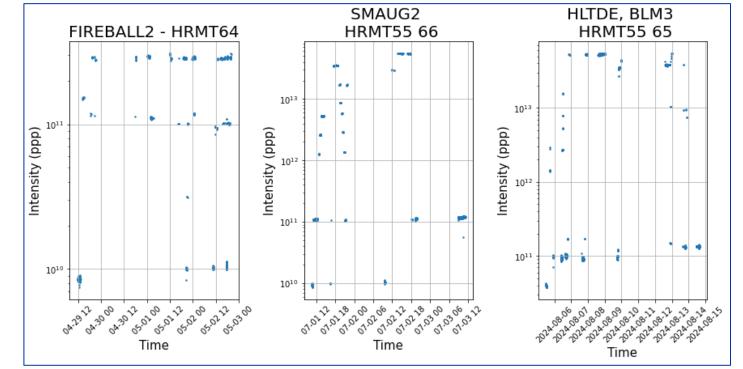
# **Overall run feedback**

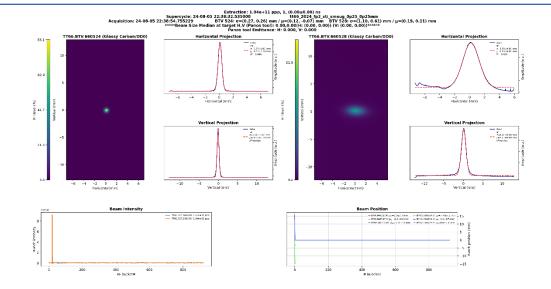
1500 extractions including
→ 475 with 288 bunches
→ 950 with 1 bunch

Precommissioning helped to be more efficient during data taking

- New version of our **vistar and logbook**
- Scripts for the experiment controls and data taking
- **Beam size** computing new tool the at the experiment live (input: emittance in SPS, dispersion estimation, beam shape, size at BTV)







# 23/24 (last) YETS upgrade

Please see last year presentation for details (<u>https://indico.cern.ch/event/1321764/</u>)

- 1. Dump upgrade [SY-STI]
- 2. Downstream experiment OTR BTV [SY-BI, BE-EA]

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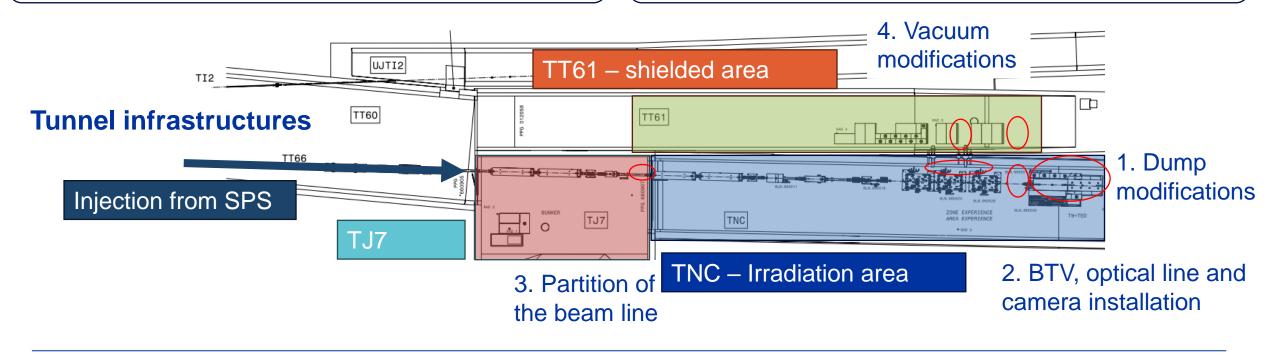
- 3. Partition of TT66 Vacuum Sector [TE-VSC]
- 4. Vacuum upgrade [TE-VSC & BE-CEM]

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High-Radiation to Materials

Dump did not reach critical temperature None of the windows (dump, BTV, beam line) failed Implementation (mechanical and controls) was a success

BTV study ongoing, will likely change the tank material





# HiRadMat Outlook for 2025+

- 4 [+1 tentative] experiments being planned for 2025
- HRMT-63 DPA
  - Measurement of displacement cross-sections
- HRMT-68 Fireball-III
  - Follow-up of measured instability with further improved setup
- Radiate-II
  - Test of various materials for future target systems
- SCcoils-II
  - Study of damage limit in SC coils for HL-LHG magnets
- BLM-IV
  - Test and validate multiple types and production runs of Beam Loss Monitors (BLMs)

### **ENLARGE THE POSSIBILITIES**

- lons beams
- Lower momentum (<440 GeV)
- Improve the softwares



### **2025 schedule**

Start BC/		O BC LN3 EL	ars to ENA ics start Physi A (EHN1) SPS-N	HIE-	isolde isolde is start ENA May		ions LEIR		PS Jun sta		ions Physics SPS HIE-IS	acuit	ions LHC
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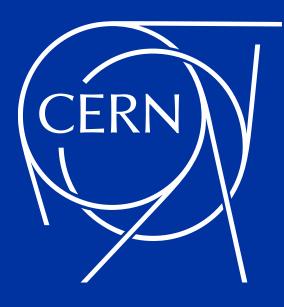


A big thank you to the members of the working group and also everyone else along the ATS sector for their dedication and help in the operation of HiRadMat facility since 2011!



SY-STI EN-MME SY-BI BE-ASR TE-MPE BE-GM BE-CEM HSE-RP SY-ABT BE-OP EN-HE BE-EA



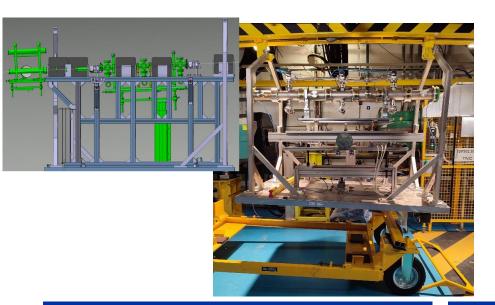




This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101057511.



# **Expertise provided to users**





**Experiment preparation** 

3D integration & mechanical studies

Installation & survey

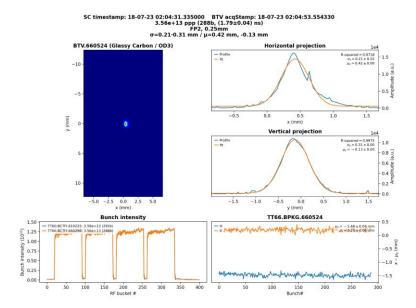
**Transport and handling** 

On-line diagnostic equipment and expertise

Sensors, Cameras & LED

Movable stages (H&V)

Remote control of the equipment



Beam diagnostics Beam parameters Automatic parameter display Auto-logging in CERN infrastructure

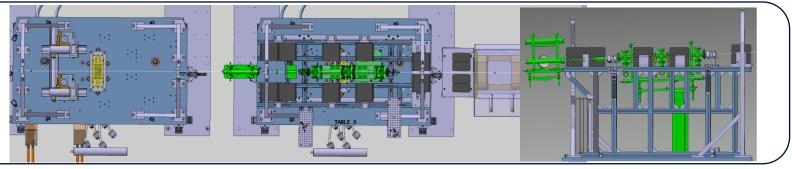




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### **Experiment preparation**

- Integration in 3D layout
- Mechanical evaluation



- Assembly
- Installation



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Survey (alignment precision < 1 mm)</li>



- Handling and transport
- Disassembling







# **Beam diagnostics**

- Beam TeleVision
- Beam Current Transformer
- Beam Position Monitor
- Bean Loss Monitor

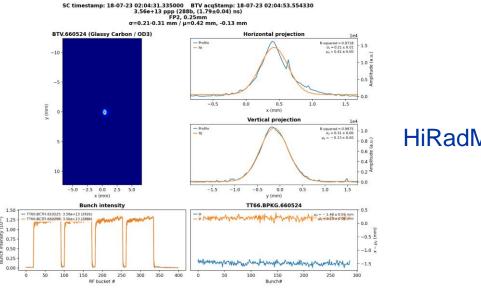
 Vistar and logging automatisation for each shot

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#### HiRadMat vistar

J Sunday, November 7th 2021 03 23 43	unteen by among @cross.513-cp:241 came of (2021/11/07/03.23.42) 34:55779
HiRadMat Extraction	3.47e+13 protons (288 b)
FP2, 0.25mm	sigma: x=0.32 mm, y=0.26 mm
07-11-21 03:23:37.964025	position: x=-0.48 mm, y=0.07 mm
Cycle timestamp: 07-11-21 03:23:15.735000 Average bunch length: 1.9520.04 ns TTOD DCT ND of bunches: 288 5	

BTV Beam signs and position measurement: 6lassy Carbon #1 / 00 vertical 0.01 0.26 0.00 0.52 inot size, signs (no) 0.00 position. (mm) 0.00 0.07 Beam Loss Monitors: 01191.660043 0.0 81/91.660518 106.1 TT64 Vacuum Window 0.0 BL/91.660523 172.7 Table B 81,191, 660122 01/94.660225 0.0 01/01-002126 278.4 Table C 01191.660304 0.0 81/91.660530 278.4 Beam Dump Front 81/91.660531 01194.440411 0.544 270.4 Dean Dung 8.576 01/91-660535 278.4 01194.660511 FTHE MARK HIT CO. OF BE IN THE ADDRESS. MI. BT AN AD AD AD AD A THINK 1111

#### HiRadMat auto e-logbook

# **Flexible software for users**

- Interface for motor stage control:
  - DC stage
  - Step-motor stage
- Beam based alignment automatisation
- Data acquisitions (temperature, cameras, pressure...)

¢	Form - StepperStageWidget.ui			
StageName				
Absolute Movement (mm)	Endswitch Status	Status		
MOVE	- ENDSWITCH + -		TextLabel	
Rel. Movement (mm)	TextLabel TextLabel	Controller Position (mm): Motor Position (mm):	TextLabel TextLabel	
MOVE		states a second a state of states a second states		
The second second second second second second	STOP	Axis State	TextLabel	

