HiRadMat
A Unique Facility Testing Materials with High Power Pulsed Beam

F.J. Harden, A. Bouvard, N. Charitonidis, Y. Kadi
f.harden@cern.ch
Interested? Contact hiradmat.sps@cern.ch

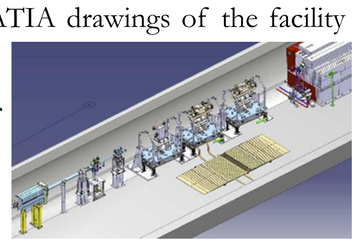
Abstract

The advancement of high power targets and accelerator components is dependent on the exploitation of irradiation facilities to assess these constituents for R&D purposes. HiRadMat (High Radiation to Materials) is an irradiation facility at CERN designed to provide material testing capabilities to a range of R&D projects using pulsed high energy, high intensity, proton and ion beams. Since its commissioning in 2011, HiRadMat has successfully delivered single pulsed proton beams to a multitude of novel experiments. The beam obtained directly from the TT60 line of the SPS, comparable to that extracted by the LHC, is at 440 GeV/c. A 1σ r.m.s. beam radius of 0.25 – 2 mm can currently be delivered in the range of 1 to 288 bunches at 1.2×10^{11} protons per bunch maximum (equivalent lead/argon ion beams available). Over 30 experiments have utilised this unique environment to test not only materials, but electronic devices, detectors and optical systems. Through Transnational Access support, currently under WP10 of ARIES, financial assistance can be provided to external users enabling an increase in the use of this irradiation facility by global institutes.

The future strategy of HiRadMat is currently under examination. Facility consolidations, considering the increasing experimental demands from experiments and with the upgrade to High-Luminosity LHC with up to 2.3×10^{11} protons per bunch expected for LIU beams (LHC-Injector Upgrade), is presented. Similarly, expansion into scientific areas beyond the accelerator physics community are highlighted.

The Beginning

Approved experiments are provided with multiple HiRadMat consultations, including discussions/assistance with design and set-up ideas, integration design model checks and CATIA drawings of the facility areas.



3D model of HiRadMat Experimental Area

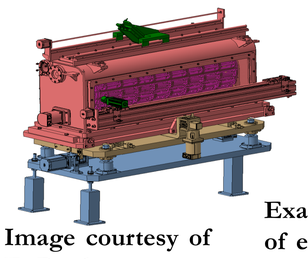
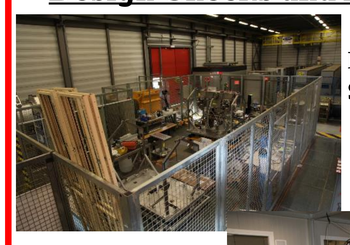


Image courtesy of E. Berthome

Example of 3D model of experimental set-up (HRMT36), for integration checks

Design Checks and Alignments



HiRadMat Surface Lab

HRM Control Room

The HiRadMat Surface Laboratory is classified as a Supervised Radiation Area. Here experiments are installed on the HiRadMat interface tables and experimental checks are made (e.g. electronics, alignment). DAQ and offline monitoring systems are cross-checked in the HiRadMat Control Room.

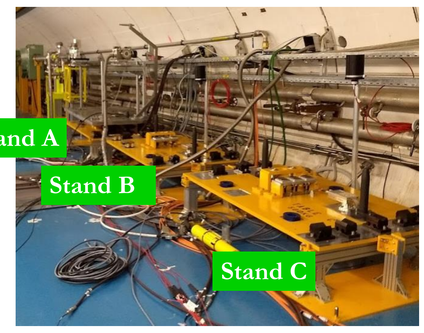
Installation

Experiments are transported to the HiRadMat Experimental Area. Using a crane (capacity of 7 T) the experiment is installed on the allocated fixed table.

HiRadMat Experimental Area

Installation of Experiment using Crane

HiRadMat Experimental Area

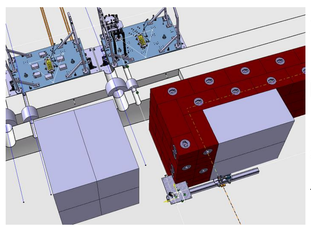


3 Experimental Stands in HiRadMat Experimental Area

Stand A: Dedicated Beam Instrumentation Stand providing beam diagnostics and monitoring systems.

Stand B & C: Dedicated Experimental Stands enabling different optics to be achieved.

Electronics



3D model of feed-through between HiRadMat Experimental Area and Electronics Area.

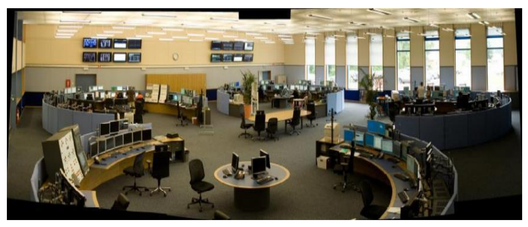
Adjacent Tunnel

Beam Optics Feed-Through

HiRadMat has dedicated feed-throughs into an adjacent tunnel where additional electronic & measurement systems can be added. Progress has been made to shield this area from radiation effects.

Experimental Run & Beam Time

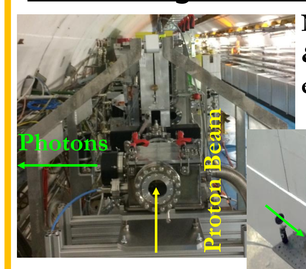
Beam is extracted directly from the SPS enabling a comparable LHC type beam to be provided to experiments.



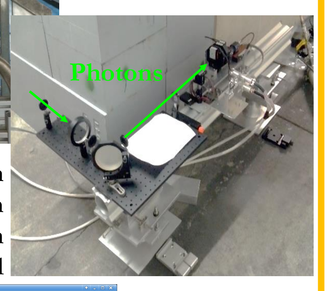
CERN Control Centre

During the experimental beam time the co-ordination and data taking is performed in the HiRadMat Control Room and at the CERN Control Centre.

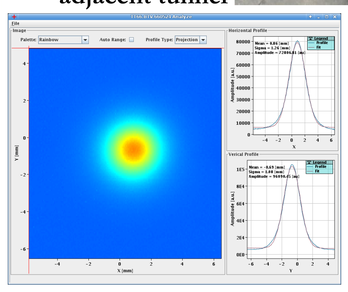
Beam Diagnostic Instrumentation



New beam diagnostic & monitoring equipment



Optical path relating to beam profile capture in adjacent tunnel

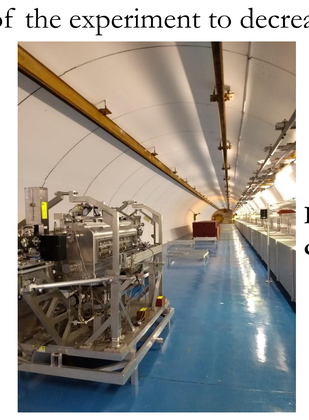


Image/Data acquired from the HiRadMat beam diagnostic and monitoring system

Images courtesy of S. Burger

Experiment Decommissioning

Experiments are moved to the HiRadMat cool-down area to enable the integral dose of the experiment to decrease.

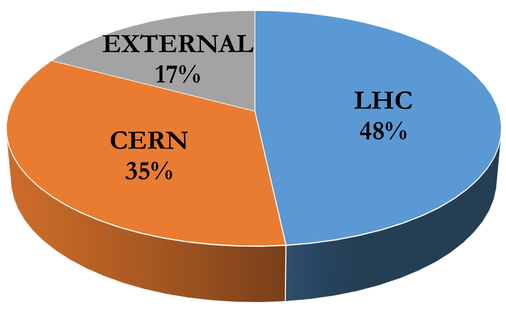


HiRadMat cool-down area

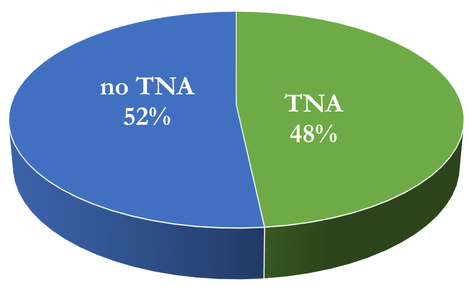
After a sufficient cool-down period, Radiation Protection release the experimental container from HiRadMat. It is then transported to an appropriate irradiation facility for post-irradiation experimental analysis by the user.

Access & Funding Opportunities for External Experiments

HiRadMat, throughout operation, has been supported by various funding bodies (EuCARD, EuCARD2, ARIES). With this support the facility has collaborated with multiple external users, where 48% of completed experiments gained support provided by external funding bodies. HiRadMats utilisation has been dominated by the accelerator physics community. However, post-LS2, HiRadMat aims to expand this outreach beyond Accelerator Physics to further scientific fields.



Context of HRM Experiments 2012 – 2017



Acknowledgments

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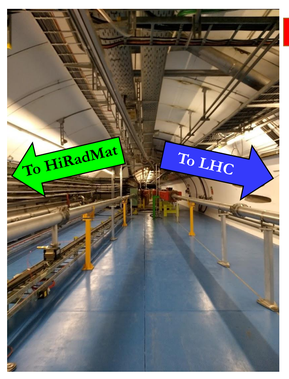
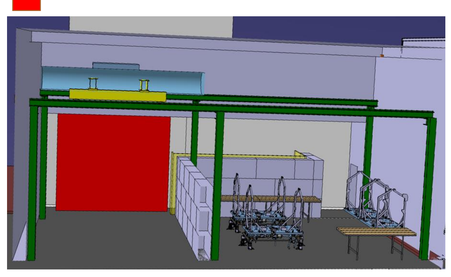
HiRadMat & the Future

Expansion into other fields of scientific interest, beyond the Accelerator Physics community, including Materials Science & Condensed Matter Physics, Engineering, Plasma Physics, Fusion Energy and Nuclear Physics. To continue collaboration, potential upgrades of the facility are presented:

Proposed upgrade of the surface lab to accommodate an increase of user requests and to improve the range of materials testing capabilities offered.



HL-LHC type beams foreseen: Increase expected, to approx. 6×10^{13} protons/pulse.
Results in necessary facility upgrades.



Expansion of the diagnostic and monitoring capabilities provided, to improve/increase experimental information available to the users.

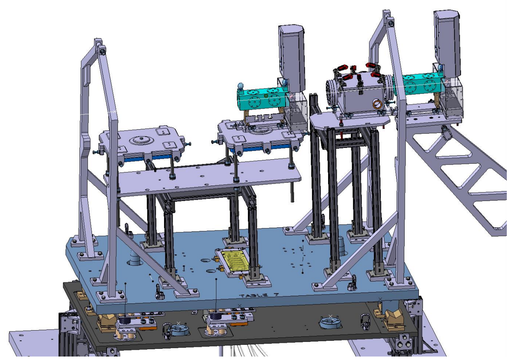
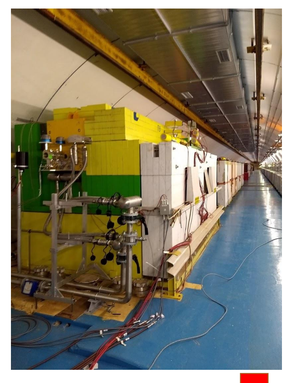


Image courtesy of V. Clerc



Anticipated Upgrades to Beam Dump/Beam Line.