First Year of Operations in the HiRadMat facility

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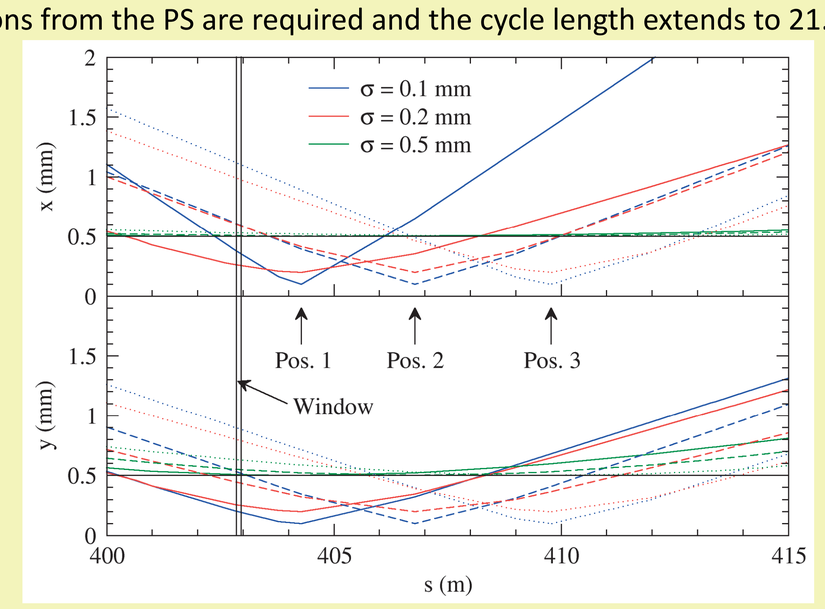
HiRadMat (High Irradiation to Materials) is a new facility at CERN constructed in 2011. It is designed to provide a test area where the effect of high-intensity pulsed beams on materials or accelerator component assemblies can be studied. The HiRadMat facility is situated in the former West Area Neutrino Facility (WANF) target tunnel and is about 35 m below ground. It takes the fast extracted beam from the long straight section LSS6 of SPS, the same used for the TI2 injection line to LHC. For 2012, the first year of operations of the facility, 9 experiments were scheduled and completed data-taking successfully. The experience gained in operating this unique facility, along with highlights of the experiments and the instrumentation developed for online measurements are reported.

BEAM PARAMETERS

Particle type	**protons**	**ions (lead)**
Beam Energy	440 GeV	173.5 GeV/nucleon
Pulse Energy	up to 3.4 MJ	up to 21 kJ
Bunch intensity	$3.0*10^{9}$ to $1.7*10^{11}$	$3*10^{7}$ to $7*10^{7}$ ions
Number of bunches	1 to 288	52
Max. pulse intensity	$4.9*10^{13}$ protons	$3.7*10^{9}$
Bunch length	11.24 cm	
Bunch spacing	25, 50, 75 or 150 ns	100 ns
Pulse length	7.2 µs	5.2 µs
Minimum cycle length	18.0 s	13.2 s
Beam size at target	variable around 1 mm	

For the beam cycle, HiRadMat uses different cycle schemes of the SPS depending on the requested pulse intensity (1-8 injections from the CERN PS). For up to 72 bunches or $8.0*10^{12}$ protons where two injections from the PS are required, the cycle length is 7.2 s. For higher intensities up to the maximum of 288 bunches or $3.3*10^{13}$ protons, multiple injections from the PS are required and the cycle length extends to 21.6 s.



The beam size and the focal position are fully adjustable along the experimental target positions.

EXPERIMENTS

Robustness tests related to LHC collimation system

- on a fully assembled LHC phase-II collimator, looking in particular to qualify the setup against beam shock impact (HRMT09).
- on a UA9 crystal assembly, required to validate the device before its installation in the LHC machine, and last (HRMT16)
- on a protecting collimator (TPSG4) for the SPS magnet septum (MSE), using beam pulses at the highest possible beam intensity (HRMT06)

Material properties

- investigated the impact of a loss of the full LHC beam on solid materials. Solid copper cylinders were exposed to the SPS proton beam investigating the beam tunnelling effects and benchmarking of numerical models, using sequences of high-intensity (HRMT12).
- on different candidate materials for beam intercepting devices like collimators, in a fully instrumented setup using fast photography, laser-Doppler vibrometer and strain gauges measurements, in order to compare the online measurements with numerical models (HRMT14).
- target elements and structural materials used in ion source units to produce secondary radioactive ion beams at future CERN-HIE-ISOLDE and in general for Isotope Mass-Separation OnLine (ISOL) facilities were tested. The goal of the experiment was to study micro-structure evolution (ageing) under proton pulsed beams by performing post-irradiation microscopic analysis (HRMT01).

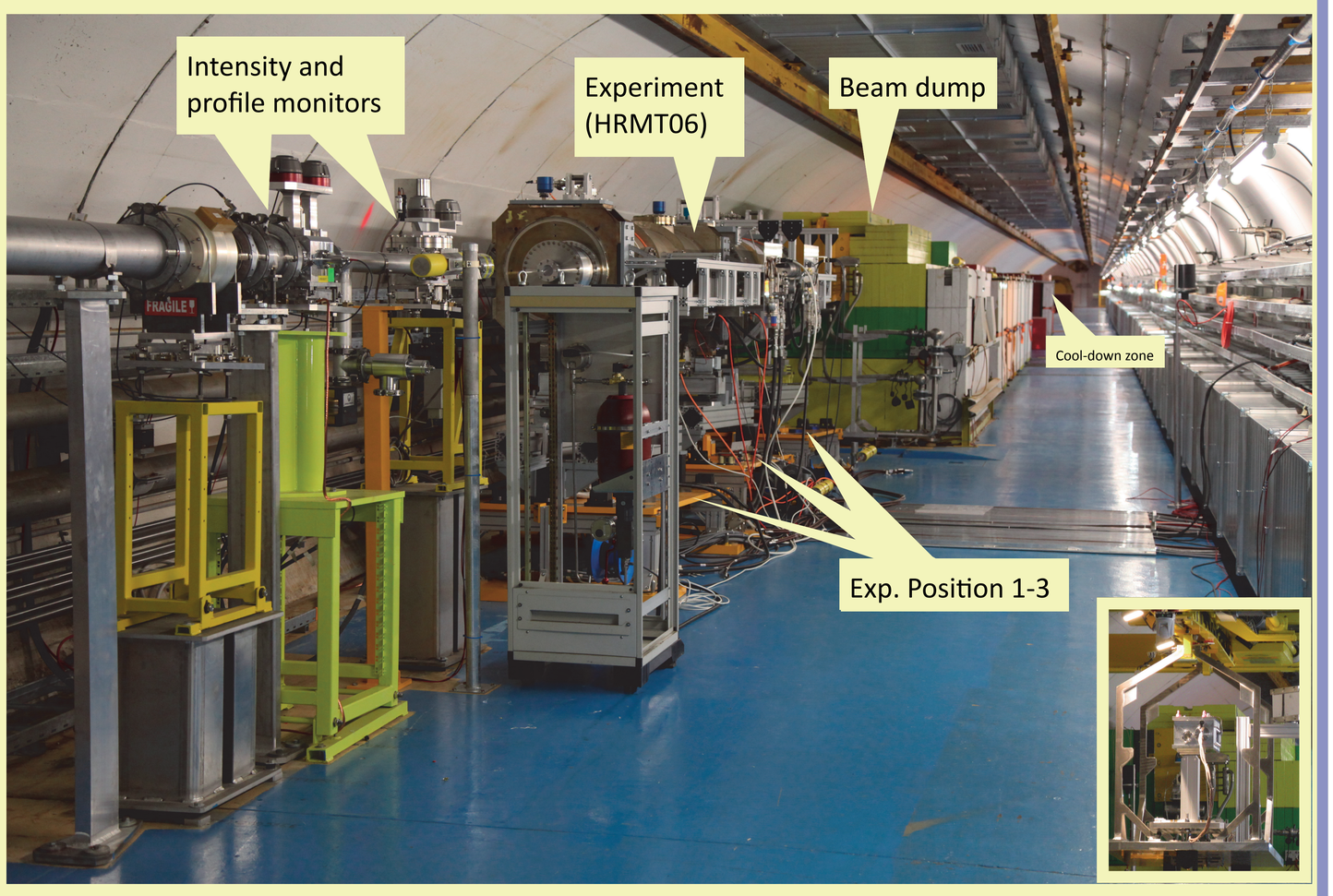
High power target R&D

- exposing a Tungsten powder target to a proton beam. The test aimed to validate the potential application of such granular target concepts in future high-power proton beam facilities (HRMT10).

Detector tests in the secondary radiation field of the beam dump

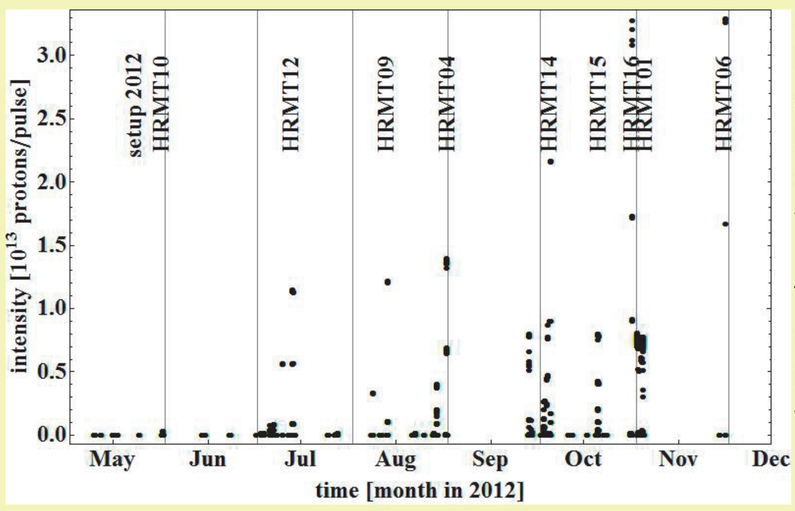
- testing and calibrating new types of beam loss monitors (BLM) designed to extend the dynamic range to higher radiation fluxes, particularly interested for the LHC upgrades (HRMT04).
- exposing five radiation detector types to the generated neutron field for inter calibration but also to compare their performance and capacity to detect high-intensity radiation bursts (HRMT15).

EXPERIMENTAL AREA



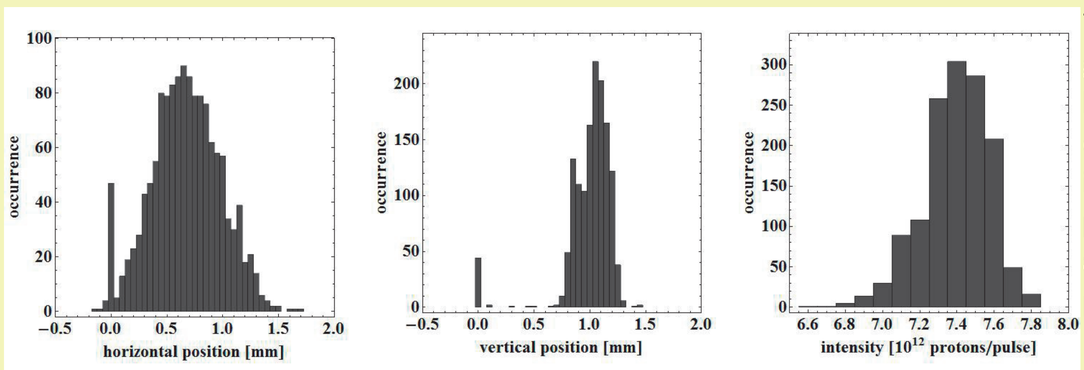
The HiRadMat experimental area is located at the TNC tunnel (ex. WANF facility target & secondary beam tunnel) in the SPS-BA7 area. The facility offers the possibility of three test stands receiving beam at the same time. Installation of the test material is done remotely using specially designed platforms.

OPERATIONS



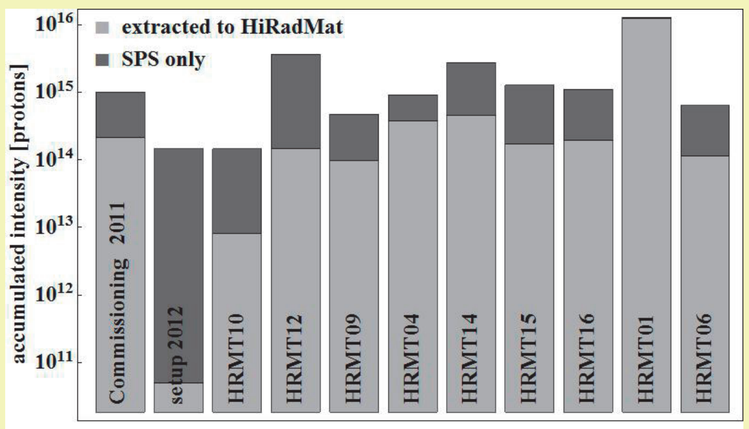
For the HiRadMat experiments, the interesting beam parameters are the intensity, spot-size and repetition rate for the beam pulses. The beam intensity is measured for each pulse (integral) and per bunch using current transformers in the line.

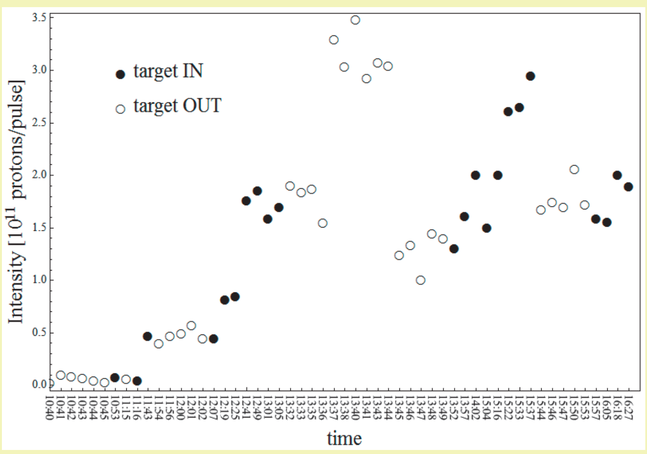
The integrated beam time for all HiRadMat experiments sums up to 48 hours, with 75% of it in "parasitic" mode cycles, without affecting the other physics program of SPS.



The spot size at the target is determined by the beam optics, validated during the commissioning tests, while the **beam position and intensity are quite stable** from pulse-to-pulse.

In total $1.4*10^{16}$ protons were delivered to the facility. HRMT01 on ISOL target development used by far the largest budget. Most HiRadMat experiments work on the basis of single pulses.





APPLICATION FOR BEAM TIME

The HiRadMat facility will be again available for experiments with the SPS restart in autumn 2014, and as part of EUCARD-2 the HiRadMat Transnational Access can provide also financial support to the users.