HIGHRADMAT, A FACILITY FOR PULSED IRRADIATION

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HiRadMat @ SPS

2 Description

- The HiRadMat@SPS facility will use the extracted **proton and ion beams** from the existing CERN **SPS synchrotron** in a time-sharing mode.

- An existing fast extraction channel coupled to a new beam line will transport the high-power short-duration beam from SPS to the test area, where **samples of materials** will be exposed to beam-induced shock waves for the study of the robustness of accelerator components.

- In addition, the facility can be used for test of **electronics systems**, mainly for radiation induced effects (single event upsets)

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3 Location

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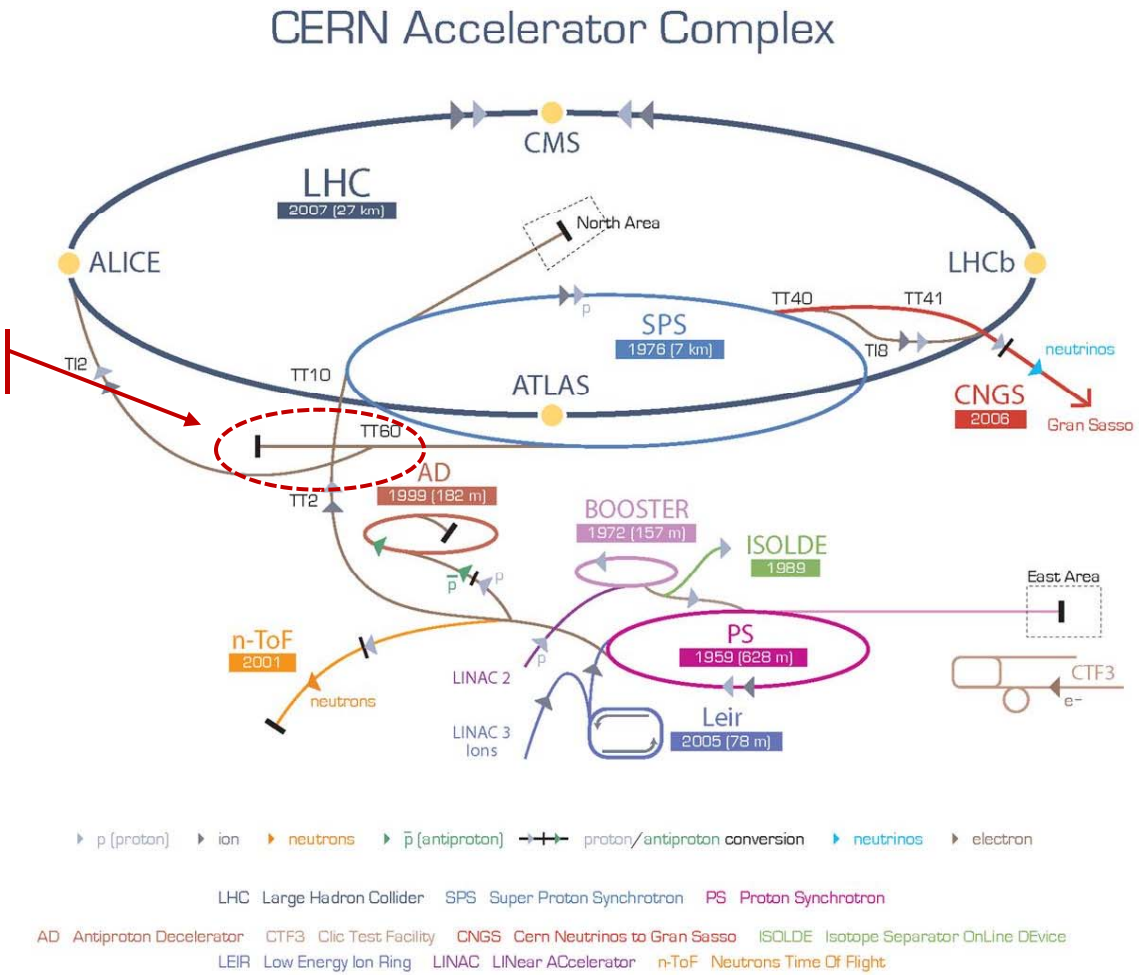

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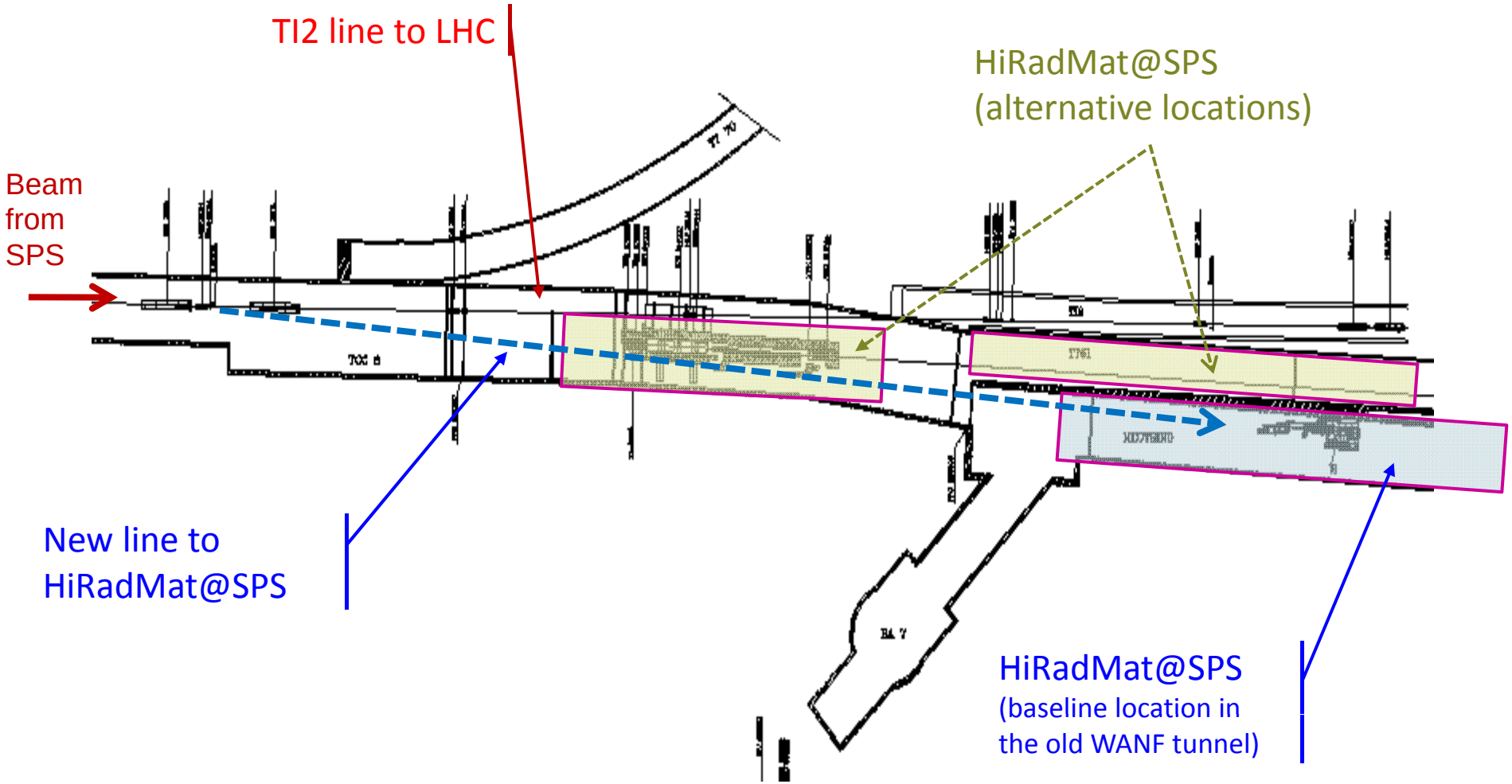
4 Location – TT60 extraction line



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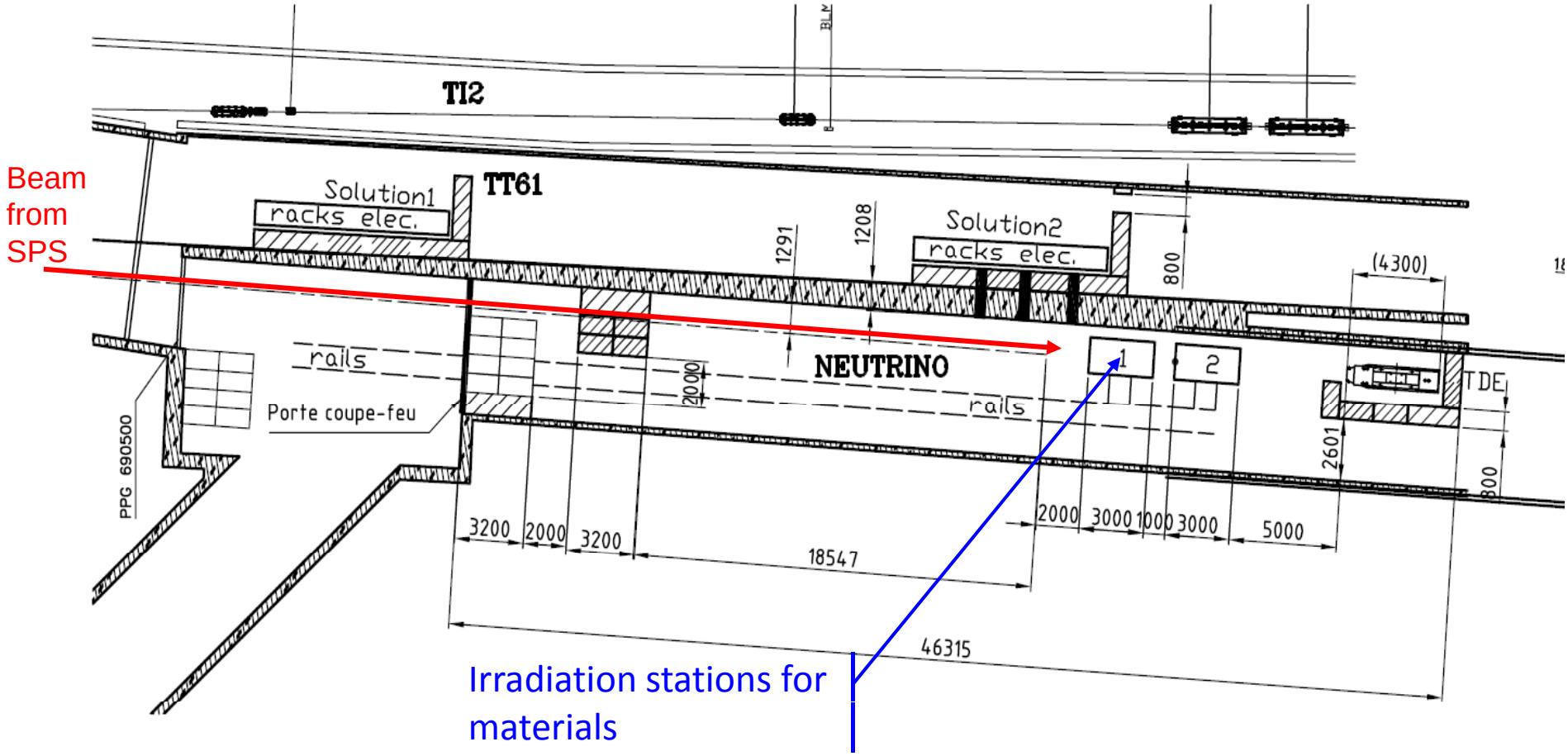
5 Experimental Area



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Specification for a Test Facility with High Power LHC Type Beam

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Abstract

The characteristics of the LHC beam mean that the energy deposited in the event of interaction with accelerator components can be much above the damage thresholds of materials. This report specifies a test facility with high intensity LHC-type beam, as included in the framework of the "phase 2 LHC collimation project" and the "EUCARD proposal to FP7". The specified facility is required to test accelerator components and materials for sufficient robustness with beam shock impact, prior to installation into the LHC or its injectors. A 7 μs long pulse can be extracted about every 30 seconds and delivered into a small transverse area (controllable around 1 mm^2), carrying an energy of up to 2 MJ. The corresponding pulsed peak power is 340 GW for protons and 2.3 GW for lead ions. The facility will also provide opportunity for reproducing and analyzing any possible primary and secondary effects from beam-induced damage encountered during LHC operation.

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7 Beam parameters

Parameter	Unit	Value (proton beam)	Value (lead ion beam)
Beam energy	GeV	450 ± 10	36.9×10^{3} (177.4 GeV/n)
Bunch intensity	particles	5×10^{9} to 1.15×10^{11}	5×10^{9} to xxx
Bunch length	cm	11.24	11.24
Number of bunches	-	1 – 288	1 – xxx
Bunch spacing	ns	25	xxx
Pulse energy	MJ	2.4	28×10^{-3}
Pulse length	μs	7.2	xxx
Peak power	GW	340	2.3
Normalized emittance (1σ)	μm	3.5	xxx
$\sigma_x \times \sigma_y$ at exp. (baseline)	mm^2	1.0	1.0

xxx = not yet specified

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Specifications for the test area

4.1. Baseline Requirements

Table 4 specifies the maximum extensions and weight of equipment to be installed for the tests. Many much smaller objects could be tested but should not constrain the overall required space. In the interest of limiting the complexity of the facility it is proposed to have only one experiment installed at a time. This can be upgraded later.

Parameter	Unit	Value
Number of installed experiments		1
Material exposed to beam		C, CFC, Cu, W, hBN, Al, Be, …
		advanced composite materials
Volume of exposed material	cm^3	≤ 16,800
Equipment size		
Length (flange-to-flange)	m	< 7.0
Width	m	≤ 1.0
Height below beam line Height above beam line	m m	1.1 ≤ 0.8
Weight	kg	≤ 4,000
Handling zone (L × W × H)	m×m×m	15 × 2.0 × 2.2
Equipment support **Cool-down space**		comes with experiment – quick installation interface required see equipment size
Crane support		mobile cranes sufficient
Handling		no full remote handling, prepare fast handling (e.g. rails)

Table 4 Specification of maximum allowed dimensions for equipment to be installed into the experimental zone. The experimental area shall be designed to be compatible.

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Specifications for the test area

Required infrastructure	Unit	Value
Cooling water availability		
Pressure	bar	16
Flow rate (regulated)	m^3/h	≤ 4.0
Water temperature (inlet)	°C	≤ 27
Cabling		as needed by equipment
Rack space		as needed by equipment
Isolated vacuum pumping unit		
Pumping speed	l/s	40
Pressure	mbar	10^{-9}
Services		
LAN		required
Natel		required

Table 5 Specification of required infrastructure and services in the experimental area.

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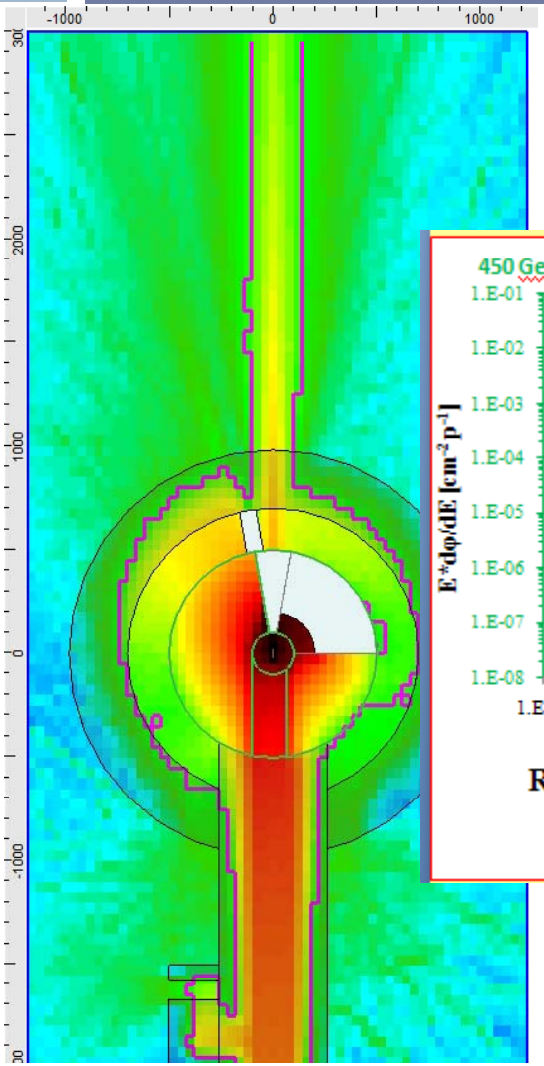
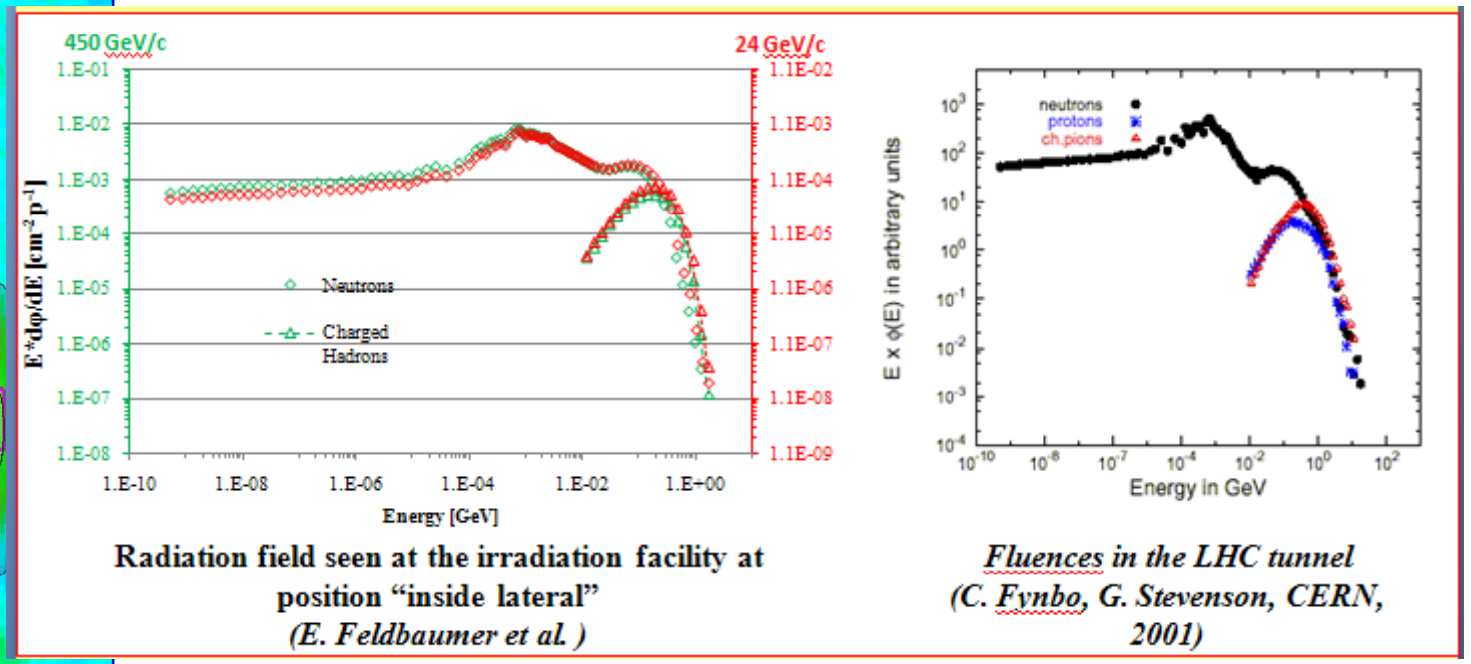
10 Expected radiation field



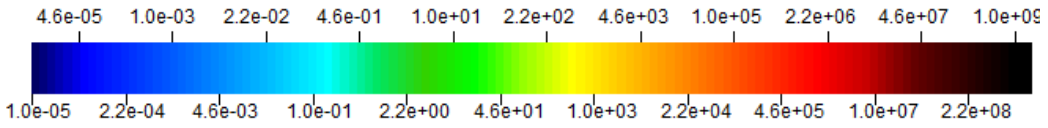
Simulation of irradiation fields using simplified geometry

- 450 GeV/c proton beam , 10^{10} protons/bunch
- 7cm Cu target, 50cm long



Radiation field seen at the irradiation facility at position "inside lateral"
(E. Feldbaumer et al.)

Fluences in the LHC tunnel (C. Fynbo, G. Stevenson, CERN, 2001)



µSv/h

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11 International Access

Modality of access under this project:

- The beam will be provided **free of charge to the external users**. During several periods of the SPS operational year, windows for experiments with beam will be provided. The dates for these windows will be defined in the framework of the yearly SPS operation scheduling.

Support offered under this project:

- The budget from FP7 will be used to support collaborators for travel expenses, for expenses related to the stay at CERN and for transport of material related to experiments at the facility and safety RP issues.

- CERN operates the accelerator complex including the SPS and HiRadMat@SPS facility based on a yearly schedule. CERN support includes the basic infrastructure for the experiments (electricity, network connectivity, office space, internet connections, control room, limited technical support for last minute corrections or modifications, etc.), installation of the experiments, preparation of the beams, and the beam operation during the experiments.

- One experiment is expected to require **two beam-hours**, possibly **in several sequences.** Preparation of the experiment and first evaluation of the results will depend on the experiment complexity and will require a few days of presence, up to five.

Schedule :

- Design review : **February'09** ; Design and preparation <Nov'09
- Installation : **shutdown 09/10** → Facility ready for startup '10 ; access for external users **>October'10**