Irradiation Facilities at CERN

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ABSTRACT

CERN provides **unique irradiation facilities** for applications in many scientific fields. This paper summarizes the facilities currently operating for **proton, gamma, mixed-field** and **electron irradiations**, including their **main usage, characteristics** and

information about their **operation**. The new **CERN irradiation facilities database** is also presented. This includes not only the **CERN facilities** but also **irradiation facilities worldwide**.

CERN Facilities

Proton Energy

LHC	SPS	PS	PSB	Linac
7 TeV	450 GeV	23 GeV	1.4 GeV	50 MeV

Facility	Location	Particle Type	Energy / Momentum	Intensity / Activity	Beam Spot	Beam structure	Availability
CHARM	PS East Area (T8)	Mixed-field (24 GeV/c p ⁺)	n ⁰ (thermal - HE) < 100 MeV	Lateral: 10 ⁷ -10 ¹⁰ HEH/cm ² /h Long.: 10 ⁸ -10 ¹¹ HEH/cm ² /h TID: 0.01-100 Gy/h	Secondary environment from target	1-3 spills/CPS (30s) spill = 0.4s	May-November (PS operation)
IRRAD	PS East Area (T8)	p ⁺	24 GeV/c	~1.3x10 ¹⁰ p/cm ² /s	12x12mm ² (FWHM)	1-3 spills/CPS (30s) spill = 0.4s	May-November (PS operation)
GIF++	SPS North Area (H4)	γ, μ	0.662 MeV + 100 GeV μ	14TBq (~0.5Gy/h at 1m.) 10 ⁸ particles/spill	Panoramic (±37°) + 100x100mm ²	Continuous + Spills/SPS cycle	All year + 6-8 weeks/year (SPS operation)
CERF	SPS North Area (H6)	Mixed-field (120 GeV/c HEH)	n ⁰ (< 10-100 MeV) + HEH	Max: 10 ⁸ particles/spill (on the target)	Tertiary environment from target	Spills/SPS cycle (few sec. spill)	Few weeks/year (SPS operation)
VESPER	CTF3	e ⁻	200MeV	~1x10 ⁸ e/cm ² /s	20x12mm ²	0.8-5Hz frequency/pulse = ~1ms	CTF3 operation
HiRadMat	SPS West Area (TT60)	p ⁺ or H ⁺	max 440 GeV(p ⁺) max 173GeV/u (H ⁺)	3x10 ¹³ (p ⁺) 4x10 ⁹ (p ⁺)	≤ 1 mm ²	1 pulse/SPS cycle pulse = 7.2ms	May-November (SPS operation)
CALLAB	Preessin Site	γ, β, n ⁰ , X-Ray	Several: depending on the source	From 100MBq to 3TBq	Several: depending on the source	Continuous	All year
CC60	Preessin Site	γ	1.17 MeV 1.33 MeV	10TBq (~3Gy/h at 1m.)	Standard	Continuous	All year

Applications

➤ Radiation damage studies:

on materials used around accelerators/experiments, on semiconductor devices, on electronic components (COTS, ASIC, etc.) as well as on specific accelerator elements exposed to high-intensity pulsed beams

➤ Test and development of prototypes:

final assemblies and/or electronic equipment before installation to study their performance degradation after long exposure/ageing (TID, NIEL, etc.) or their functional degradation (SEU, latch-up, etc.)

➤ Test and calibration of components:

personal dosimeters, radiation monitoring and measurement devices, as well as to provide benchmark data for Monte Carlo particle transport codes

CHARM

CERN High energy Accelerator Mixed field facility

- For testing electronic components/systems for accelerators
- 24 GeV/c p⁺ beam impinges on **moveable target** (Cu, Al)
- Mixed field (**neutron, HEH, gamma...**)
- Intensity: Lateral: 10⁷-10¹⁰ HEH/cm²/h, Long.: 10⁸-10¹¹ HEH/cm²/h
- Dose rate: 0.01-100 Gy/h
- Different irradiation positions
- Also for Low Earth Orbit (LEO) and atmospheric testing environment
- Heavy Ion beam to be commissioned by the end of 2017

IRRAD

CERN Proton IRRADiation Facility

- For qualification of components of the HEP experiments
- 24 GeV/c pulsed p⁺ beam with size of 12x12 mm²
- Spills of 400 ms every ~10 s
- Fluence of 1x10¹⁶ p⁺ cm² in 14 days
- Scanning also in dimensions of 10x10cm²
- 3 irradiation zones for low-Z, electronics and high-Z samples
- Low temperature irradiation (-25°C) and Cryostat with LHe 1.9K
- Dedicated monitoring and management system

GIF++

Gamma Irradiation Facility

- Typically for muon systems of HEP experiments
- 14 TBq ¹³⁷Cs source with energy of 0.662 MeV
- Max. dose-rate ~0.5 Gy/h @ 1m from glass (±37° angle), 2.5 Gy/h @ glass contact
- Several attenuation factors available (up to ~50'000)
- μ-beam from T2 on H4 beam-line (up to 100 GeV; ~10⁴ /spill)
- Detectors preparation area (gas, electronics)
- Gas service system
- Control system to monitor operational parameters
- Real-time dosimetry with 12 moveable PH-RADMONs

CERF

CERN-EU high-energy Reference Field

- For testing and calibrating passive and active RP instruments
- SPS (H6) secondary beam, 120 GeV/c hadrons
- HEH beam (about 2/3 π⁺, 1/3 p⁺) on Cu target
- Intensity max 10⁸ particles/pulse (slow extraction) resulting in up to few Gy/h
- 80 cm thick concrete or a 40 cm thick iron roof shield
- 16 reference exposure locations on the top of the two roofs

VESPER

Very energetic Electron facility for Space Planetary Exploration missions in harsh Radiative environments

- For characterization of electronic components for the operation in a Jovian environment and in purely electron-magnetic beam for HEP
- 200 MeV pulsed electron beam
- Flux 10⁸ e/cm²/s
- Copper blocks in the beamline for conversion to bremsstrahlung photon beam
- FLUKA Monte Carlo model to determine the contribution of various particles
- Lower beam energies (≥20MeV) being commissioned

HiRadMat

High-Radiation to Materials

- For tests of material samples and accelerator components in a controlled environment in an accelerator tunnel
- 440GeV p⁺ pulsed beam with intensity up to 3x10¹³ p⁺/pulse
- Heavy ions: 137.5 GeV/nucleon and max. intensity up to 4x10⁹ nucleons/pulse
- Experiments performed underground on 3 stands
- Automatic connections for signals, power and water on the stands
- Beam Loss Monitor, Laser-Doppler Vibrometer and high speed cameras for beam monitoring

CALLAB

CALibration LABoratory

- For calibration of personal dosimeters and RP instrumentation
- Two irradiation rooms: 1. main calibration hall 2. CC60
- Main calibration hall: 13x13x13 m³ concrete vault, half underground
- 4 Am-Be sources, providing ambient dose equivalent H*(10) rates between tens of nSv/h and 700 μSv/h
- 5 Cs-137 sources and 1 Co-60 source (H*(10) rates between tens of nSv/h and 200 mSv/h)
- 2 beta sources (1.85 GBq Sr-90 and 4 GBq Kr-85)
- X-ray tube having a peak voltage of 320 kV

CC60

Cobalt-60

- For qualification of the electronic components against TID effects
- 10 TBq ⁶⁰Co source, providing low and high dose rates through position modification and using absorbers
- Large systems, from 1 to 10 kGy total dose rate
- Smaller samples up to 100 kGy total dose rate
- Beam spot of 23.5 mm diameter
- Control software for the monitoring of the test conditions
- Planned to be upgrade with a 100 TBq ⁶⁰Co

IRRADIATION FACILITIES DATABASE

- For additional irradiation tests complementary to those of CERN
- Unified entry point for irradiation facilities at CERN and worldwide
- Search filters by country, source or radiation field
- Possibility to create and edit new facilities by the facility coordinator
- Auto-maintenance (regular reminders)
- Open access data but secured with the CERN authentication system (SSO)
- Facilities details:
 - Facility coordinator
 - Institute
 - Facility data
 - Irradiation conditions
 - Safety
 - Accessibility
 - Additional comments

200 Irradiation Facilities entries from around the world with 50 different types of sources

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