WP 15.5 - IRRAD and GIF++ Facilties Infrastructure Upgrade

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Contents

- Overview of CERN Irradiation Facilities
  - GIF++
  - IRRAD
- Status of Millstones & Deliverables under CERN responsibility
  - 1 sub-task - D15.10 (GIF++)
  - 5 sub-tasks - D15.6 and 15.7 (IRRAD)
CERN Irradiation Facilities

Proton Energy

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

Upgrade projects carried out during LS1 (2012-2014)

also:
SPS: CERF
SPS: HiRadMat
CC60

SPS: GIF++
new Gamma Irradiation Facility with 100 GeV μ beam

137Cs source ~×30 more intense

Operational since November 2014

PS: IRRAD & CHARM
new Proton & Mixed-field Facilities with 24 GeV/c slow extracted beam

~×4 more intense proton beam

Operational since April 2015
GIF++ Facility Layout

- $E_\gamma = 0.66$ MeV; max. dose-rate $\sim 0.5$ Gy/h @ 1m ($\pm 37^\circ$ angle)
- Several attenuation factors available (up to $\sim 50'000$)
- $\mu$-beam from T2 on H4 beam-line (100 GeV; $\sim 10^4$ /spill)

137Cs Irradiator (14 TBq)

Radiation attenuator

Upstream Area

User Infrastructure from AIDA: cosmic & beam tracker, etc.
GIF++ Aerial View

www.cern.ch/gif-irrad

GIF++ is part of AIDA-2020 TA

Irradiation Bunker

Electronics & Gas Service Areas

Preparation Area
### 10 experimental setups being tested

- mainly detectors for Muon Systems of LHC experiments
- real size detectors and prototypes (several m² active surface each)
- 7 different types of detector technologies (CSC, DT, GEM, GRPC, MM, RPC, TGC)
- test duration varies from few months to years

<table>
<thead>
<tr>
<th>Machine</th>
<th>North Area</th>
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<tbody>
<tr>
<td>T2 - H2</td>
<td>TT20 Setup 16</td>
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<tr>
<td>T2 - H4</td>
<td>TT20 Setup 16</td>
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<td>T4 - H6</td>
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<tr>
<td>T4 - H8</td>
<td>TT20 Setup 16</td>
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<tr>
<td>T4 - K12</td>
<td>TT20 Setup 22</td>
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<tr>
<td>T6 - M2</td>
<td>TT20 Setup 22</td>
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</tbody>
</table>
EA-IRRAD Facility Layout

IRRAD (proton)
CERN-EP & AIDA

T8 beam-line (~$4 \times 10^{11}$ pps of 400ms)

24 GeV/c $p^+$

~$1 \times 10^{16}$ p cm$^{-2}$ 5days$^{-1}$
(12x12 mm$^2$ FWHM)

CHARM (mixed-field)
CERN-EN & R2E

~$10^7 - 10^{11}$ HEH/cm$^2$/h
(0.01-100 Gy/h)

© drawings provided by EN-EA
New IRRAD Proton Facility (EP)

Counting Room

Zones 4/5

Partially shielded

detectors

electronics

Shuttle System

24 GeV/c $p^+$

Cryogenic System

calorimeter samples

Zone 1

Zone 2

Zone 3


© drawing provided by EN-EA
3 tables per IRRAD zone
- 9 irradiation tables operational from Oct. 1st 2015
  - 6x RT irradiation (IRRAD 3, 7, 9, 13, 17, 19)
  - 2x water-cooled cold boxes down to -25°C (IRRAD 5, 11)
  - 1x dedicated to the cryogenic setup (IRRAD 15)

Pre-installed cabling infrastructure
- 4 Patch-panels installed along IRRAD
  - twisted-pairs, coaxial, power HV/LV, ...
- space for custom user-cabling
  - optical fibers, etc..

F. Ravotti (CERN)
4.5k tons of cast iron & 11.5k tons of concrete!

EA-IRRAD Aerial View

IRRAD is part of AIDA-2020 TA

www.cern.ch/ps-irrad

IRRAD (proton)

CHARM (mixed-field)

T8 beam line

F. Ravotti (CERN)
- 23d. beam setup scheduled
  - mostly used for complete the YETS activities
- 201d. for users operation started on April 29th
  - various beam settings
- 1/10 PS cycles to EA-IRRAD (standard)
  - High intensity periods

- 23 groups of samples (SETs) being irradiated
  - 3 active experiments (at RT and -20°C)
  - 20 passive SETs (target $\Phi > 3 \times 10^{16}$ p/cm$^2$)
- 7 other experiments registered until summer

$\sim 4 \times 10^{11}$ p/spill at IRRAD

$\sim 9 \times 10^{13}$ p/h (standard)

$\sim 1.7 \times 10^{14}$ p/h (High Intensity)
CERN Milestones & Deliverables

- CERN Gamma Irradiation Facility (GIF++)
  - Extension / upgrade of GIF++ Gas system
    - New online dose-rate monitor (INRNE)
    - Extension of the cosmic ray tracker on the side walls (INFN)
    - Demonstrator for an augmented reality event display (INFN)

- CERN Proton Facility (IRRAD)
  - Online database on EU irradiation facilities of interest for HEP
  - Improve IRRAD infrastr. / user friendliness
    - equip area to store/handle activated materials
    - sample and user management software system
    - upgrade contactless fluence monitoring
      - Vilnius University
    - high-granularity & fast Beam Profile Monitor
    - test sample holders for extremely-high fluence
    - thermal box to -40ºC for CERN & Birmingham
      - University of Sheffield

D15.10: GIF++ Gas system (all items installed)

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M12

- improved setup for gas chromatographic analysis
- upgrade of the exhaust
  (new pressure regulation system, being tested)

- cosmic trigger gas recirculation modules: August 2016
- other gas recirculation module (or part of it): August 2016

- cooling unit for TGC beam trigger: July 2016

Gas recirculation systems
Under construction

Gas mixture purifier
Under construction

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GIF++ Gas System Upgrade

- M24
  - upgrade of controls (hardware and software)
  - upgrade of pipe insulation
  - additional mixers and/or gas circulation modules (not yet defined in number)

- 10m financial support to students
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M24: D15.6: CERN Proton Facility Upgrade (all items operational)
M12: MS16: specification for management system and online DB ready & documented
M18: MS35: test of various low-cost Si materials concluded

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Unified entry point about irradiation facilities available at CERN, in EU (AIDA-2020) and Worldwide

http://cern.ch/irradiation-facilities

- Specification document ready (MS16)

Portal for CERN facilities operational

DB structure implemented

- data being filled

Automatic (annual) reminders to facility responsible persons being implemented
IRRAD Facility Infrastructure

- Increase storage capability
- Improve testing capabilities of irradiated equipment
- Limit transports of irradiated equipment (Safety)

Counting Room IRRAD1B

Counting Rooms

Storage Area

24GeV/c p+
**IRRAD Storage & Handling Area**

- **Storage Area**
  - 2x shielded zones for **cool-down** and **storage** at **room and low temperature**
  - 1x **workspace** equipped to handle and characterize irradiated equipment
  - dedicated **cabling infrastructure** from workspace to counting room IRRAD1B

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**D15.6 (M24)**

- **Workspace 157/R-062**
  - **Monitoring Temperature and Humidity**
  - **Microscope for inspecting irradiated objects**

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**IRRAD1B**

- **Workspace**
  - **RP Buffer Zone**
  - **IRRAD Storage Low Activity (LSA)**
  - **Non Radioactive IRRAD Storage 25m2**

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**Extech Micro-Thermometer**

- Temperature: **6.19°C**
- Humidity: **76.2%**

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**F. Ravotti (CERN)**

*AIDA-2020 Annual Meeting, DESY – 14.06.2016*
Sample & User Management

- **Motivation**
  - Increased number of irradiation systems
  - Renewing the existing tool (15y old)

- **Specifications Ready (MS16)**
  - Modelling irradiation process
  - Use cases defined

- **Link with Traceability System (TREC) for radioactive materials established**
  - Specific ID for IRRAD defined:
    - SET-NNNNNNN
    - DOS-NNNNNNN
    - BOX-NNNNNNN
  - Implemented already for run 2016

- **Software development is now starting**
CERN Milestones & Deliverables

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High-Granularity & Fast BPM

- **Beam Profile Monitors**
  - Metal-foil detectors
  - Specifically developed for high-intensity beams (> $10^{11}$/burst)
  - Current version is optimized for “slow-extracted” beam

- **New requirements**
  - Patterns for special beam conditions / tables alignment
  - Qualification as a “small-area” particle counter
  - Qualification with a “continuous” beam

D15.7 (M44)

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- **Mini-BPM device** for precise alignment of irradiation equipment
  - up to 4 mini-BPMs and 4 single-PADs readout with one “standard” electronics through adapter PCB

- **Single-PAD device** used as « particle counter »

First Prototype of Mini-BPM produced and tested

![Mini-BPM profiles used to align IRRAD3 table (May 2016)](image)
Sample holders for extremely-high fluence proton irradiation

- Irradiation of small sensors in IRRAD
- Replace “paperboard” holders at $\Phi > 10^{17} \text{ p/cm}^2$
- Evaluate new materials
  - Low activation (ALARA)
  - High availability, low cost, etc.

Irradiation tests scheduled later in the project