7th Beam Telescope and Test Beam Workshop
14.01.2019, CERN

The CERN Gamma Irradiation Facility
operation during the CERN Long Shutdown 2
and planned upgrades to the facility

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Outline

- Introduction
- Key features of the facility
- Practical information & application for beam time
- Operation in 2018 - summary
- Operation in 2019/20 - outlook
- Upcoming improvements
Joint facility, operated by EP-DT and EN-EA

Unique place, combining a high energy muon beam with a 14 TBq\(^{\ast}\) \(^{137}\)Cs gamma source

Designed for testing real size detectors, of up to several m\(^2\), as well as a broad range of smaller prototype detectors and electronic / optical components.

100 m\(^2\) irradiation bunker with 2 independent irradiation zones, separated attenuation systems

All year operation from Cs-Irradiator

Muon beam at H4 beam line - 7 weeks dedicated beam in 2018 (shared with RD51)

Central Control System, recording all relevant parameters and provides interlocks

Wide range of available gases (+ custom gases) in bunker & service zone


\(^{\ast}\) As of 2014
GIF++ Main R&D

- Ageing tests under radiation
- Detector validation tests in presence of high radiation background + muon beam

Annual User Meeting:
- Goal of measurement
- Results obtained so far
- Plans for LS2

Facility designed / optimised for Muon gas detectors for the LHC experiments upgrade projects, but also hosts a large variety of other users (e.g. BLMs for beam instrumentation)
GIF++ Facility Layout

Bunker area contains:
- Gas panels
- Electricity outlets
- Network sockets
- Environmental monitoring
- Gas/smoke detection
- Radiation monitoring
- Air conditioning

- Irradiation Area
- Preparation Area
- Material Access
- People Access
- Removable Roof
- Service Area (Gas)
- Service Area (Electronics)
- Small Material Access

Raised floor throughout the facility (pipes, cable trays)
Current GIF++ Irradiation Bunker

- **Moveable beam dump**
- **Removable roof**
- **Large material access door**
- **People access**
- **H4 beam line**
- **γ-field 1**
- **γ-field 2**
- **upstream field**
- **downstream field**

± 37 degree downstream field
± 37 degree upstream field
GIF++ Irradiator & Attenuation Filters

One $^{137}\text{Cs}$ source, two identical attenuation systems, each consisting of one angular correction filter (Fe) and 6 absorption filters - a total of 14 custom shaped filters

14 TBq $^{137}\text{Cs}$
(as of 2014)

Angular correction filter provides uniform photon distribution for large area detectors

Filter System:

<table>
<thead>
<tr>
<th>Absorption factor</th>
<th>0</th>
<th>0</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 1.47 2.15 4.64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 100 4.64</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

24 possible attenuation factors:

<table>
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<tr>
<th>factor</th>
<th>1</th>
<th>1.47</th>
<th>2.15</th>
<th>3.16</th>
<th>4.64</th>
<th>6.81</th>
<th>10</th>
<th>14.68</th>
</tr>
</thead>
<tbody>
<tr>
<td>value</td>
<td>21.54</td>
<td>31.62</td>
<td>46.42</td>
<td>68.12</td>
<td>100</td>
<td>146.8</td>
<td>215.4</td>
<td>316.2</td>
</tr>
</tbody>
</table>

(calculated values for un-scattered gammas)
GIF++ Available Infrastructure

Central Control System (PVSS)

Gas System

- Central Database
- CompactRIO
- Gas System
- Humidity
- PVSS Project (CCC)

DAQ System

- Beam Trigger (2 pairs of scintillators)
- Cosmic Trigger
- DAQ System
- DCS System
- Gas System
- Beam Trigger (to be completed)

DCS System

- Beam Trigger
- Cosmic Trigger
- Counting Room
- Mainframe
- OPC
- Branch Controllers
- HV/LV Boards
- Service Area

Beam Trigger (to be completed)

- Box Frame
- Tungsten Mats
- Supply Cables

Cables are guided under the false floor

Fine trackers:
- Y-Z readout
- Y only readout
- Y-Z readout
- Y only readout

Concrete

- 40 cm
- 100 cm
- 30 cm
- 50 cm

Iron shielding

Fine tracker Y-Z readout
Central Gas System

The gas system infrastructure is a key element of the successful R&D programs performed at the GIF++

Mixing units, gas recirculation systems and gas analysis module are used for detector R&D studies

Wide range of available gases available
Possibility to use pre-mixed bottles (local gas point)

Gas mixing unit
Monitoring of pressure, O2/H2O, temperature, atmospheric pressure
Additional software controlled pressure regulation for very low flow regimes

Gas chromatographic analysis: allows monitoring gas mixture composition and presence of impurities on return from detectors under test

For latest update, please see “Updates from completed tasks and Deliverables within WP15” from this morning AIDA2020 satellite meeting (https://indico.cern.ch/event/780067/)

Partial funding of the gas system equipment and two CERN technical students
Central Control System

- Central archiving of essential parameters (CERN Oracle DB)
- Web interface for retrieving values
- 12 RADMON channels
- Display in control room
- Integration of two Berthold Geiger probes (almost finished)

Accessible in control room + via DIP

Accessible with SSO + e-group membership
Radiation Monitoring

- 12 x RADMON sensors, that can be distributed throughout the facility
- 2 independent REMUS detectors, accessible via DIP & TIMBER
- 3.2m translation stage, remote controlled, that can be equipped with dosemeter / counter
- 2 Berthold counter GM LB6500 (P.laydijev et al)

Carsten Heidemann, Hans Reithler with support from Domenico Dattola, Ekaterina Kuznetsova, Giuseppe Pezzullo, Dorothea Pfeiffer, Martin Jäkel (GIF User meeting 2018)

The Radiation Field in the New Gamma Irradiation Facility (GIF++) at CERN
Operation Web Page

https://gif-irrad.web.cern.ch/gif-irrad/

Irradiation requests handled by IMPACT (impact.cern.ch)

+ SPS beam request after LS2

Gamma Irradiation Facility - Operation Page

- **Main Page**
- **Logbook**
- **Meetings**
- **Schedule**
- **GIF Control System**
- **Irradiation Request**
- **Contacts**
- **User List**
- **Documents & Plans**
- **Publications**
- **RADMON Status**
- **Subscribe to e-group GIF-active-users**
- **Secondary Beam & Areas (SBA)**

**Irradiation Request**

**Contacts & Notifications**

**News (Twiki)**

**Procedures Safety & Access**

**User List**

**Documentation & Plans**

**Publications**

Reference publications...

- A GIF++ Gamma Irradiation Facility at the SPS-H4 Beam Line
  M. Capone, R. Foresti, L. Lissoni, M. Moli, C. Reniuter
  CERN-SPSC-2009-020 / SPSC-F-336, 2009

- CERN GIF++ : A new irradiation facility to test large-area particle detectors for the high-intensity LPC program
  2004. INS/TFP20041102 [PDF]

- The Radiation Field in the New Gamma Irradiation Facility GIF++ at CERN
  Mirko Fomferra, Giorgio Gatti, Anna Fantoni, M.R. Jakel, Mattia Avanzinelli,
  Nuclear Inst. and Methods in Physics Research, A 666 (2013) 91-100 [PDF]
Very successful run in 2018 with 9 - 11 different setups simultaneous in the muon beam during 7 weeks of shared beam time with RD51.

Extensive gamma-irradiation program throughout 2018 with 22 large setups competing for irradiation.

Challenging optimisation between high- and low-field irradiation.

Up to 11 (!) detector set-ups in beam....

... often with multiple chambers per setup
LS2 Operation

- **Irradiator fully operational throughout LS2**
  - ≈ 1 week of Irradiator maintenance
  - Possibly several short stops due to EHN1 infrastructure maintenance & consolidation

- **Most long term irradiation test will continue**
  - Continuous conflict between High γ-irradiation campaigns (max. collective dose) vs. low radiation ageing tests
  - Bunker space occupied to a large extend

- **Addition challenge**
  - several mass production test campaigns to happen in the coming months in parallel to long term irradiation
2019 Mass-Production Test Campaigns

- **ATLAS MicroMegas (NSW)**

- **ATLAS sTGC (NSW)**
  First chambers tested. 5-6 chambers should arrive beginning of mid January. Expected to continue throughout 2019 (2-4 chambers per week).

- **ATLAS RPC - gas gap**
  100 gaps (5mm x 1.80m x1.20m) to be installed for burn-in test, 10 qualified gas gaps per week, for a total of 10 weeks. 2/3 access per week.

- **ALICE TPC chambers**
  6 chambers per week of production chambers to identify faulty chambers. 20-30 chambers in total. Full gamma field / unshadowed. Finishing end of Jan’19.

Mass production tests will have a significant impact on the irradiation program. Multiple access needed per week (to swap chambers) in addition to frequent absorption filter change and source ON/OFF intervals.
Cosmic Trigger for LS2 Operation

Installation of 4 roof chambers for cosmic tracker (floor chambers already operational)

- Additional 2 trigger chambers to be installed outside GIF bunker (downstream)
- 2 additional chambers planned for upstream (currently on hold)
- Possible extension of cosmic trigger on rooftop, based on muon chambers recuperated from LHC experiments. Discussion started.

For latest update, please see “WP15.5 - Cosmic-rays tracker improvements & augmented reality event-display for GIF++ Facility (D15.11)” from this morning (https://indico.cern.ch/event/780067/)
Outlook LS2 (and beyond)

- Continuous strong demand for the foreseeable future (until LS3)
- Space inside the irradiation bunker became one of the limiting factors
- Need for more space along the beam line to ensure proper access to detectors
- Need for a dedicated low-irradiation zone, further away from the Cs source
Extended Irradiation Bunker

Extension of irradiation bunker by \( \approx 45 \text{ m}^2 \) in the upstream direction. Will increase the space available during beam time and help us to better cope with different gamma intensity requirements throughout the year.

 ERC written
 Project approved
 Funding agreed
 Bunker layout frozen
 Final iterations with RP, HSE…

Current schedule: Mid - 2019
Will require a \( \approx 4 \text{ week} \) stop of facility!
Looking forward to an exciting year 2019!
Backup
DAQ system

Requirements

• Create a trigger from beam tracker (TGC) and/or cosmic tracker (RPC)
• Distribute the trigger to different Detectors Under Test (currently up to 5 DUTs)
• Synchronize the events from the TGC/RPC with the DUTs for tracking/efficiency purpose

Implementation

• Based on a **Trigger Logic Unit** module provided by EUDET community and intensively used in test beams (DESY, CERN, FERMILAB, ...)
• Unit provides **trigger signal** and **trigger number** to all detector DAQs
• Requires busy signal from detectors DAQs
• This module synchronizes the different DAQ systems
Detector Control System + sensors

- Use PVSS/WinCC OA (as in LHC experiments)
- CAEN Easy Power System [1 mainframe, 1 Power Generator, 1-2 crates + with HV and LV boards and 1 ADC A-3801 board for monitoring (128 channels), also for ENV and gas monitoring]
- Mainframe and PC in proximity of the control room (radiation-free area) along with DAQ PCs and equipment
- EASY crates and other equipment closer to detector area

Radiation sensors

Basic configuration: 4 + 4 dosimeters, (controlled by a PC→RS485→µCU)

Gas and Environmental sensors

Monitoring (for both atmospheric and gases): p, T, rH
Baseline: 4 gas and 6 atmospheric sampling points
H4 Muon Beam Simulation

- Beam line simulation for muons, with effect of upstream magnet use (GOLIATH)
- Additional set of scintillators (beam trigger) available.
- Mobile supports, can be used placed according to deflected beam

Mainly useful for large detectors, where muon beam stay within detector area (+ 1m) and negative polarity

Muon Beam Studies in the H4 beam line and the Gamma Irradiation Facility (GIF++)
R. Margraf, N. Charitonidis; http://cds.cern.ch/record/2310593