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CERN PROTON IRRADIATION FACILITY (IRRAD) DATA MANAGEMENT, CONTROL AND MONITORING SYSTEM INFRASTRUCTURE FOR POST-LS2 EXPERIMENTS

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Blerina Gkotse^{1,2}, Pierre Jouvelot², Giuseppe Pezzullo¹, Federico Ravotti¹

¹ Experimental Physics Department, CERN, Geneva, Switzerland

² Mines Paris, PSL University, Paris, France

ABSTRACT

Since upgrades of the CERN Large Hadron Collider are planned and design studies for a post-LHC particle accelerator are ongoing, it is key to ensure that the detectors and electronic components used in the CERN experiments and accelerators can withstand the high amount of radiation produced during particle collisions. To comply with this requirement, scientists perform radiation testing experiments, which consist in exposing these components to high levels of particle radiation to simulate the real operational conditions. The CERN Proton Irradiation Facility (IRRAD) is a well-established reference facility for conducting such experiments. Over the years, the IRRAD facility has developed a dedicated software infrastructure to support the

control and monitoring systems used to manage these experiments, as well as to handle other important aspects such as dosimetry, spectrometry, and material traceability. In this paper, new developments and upgrades to the IRRAD software infrastructure are presented. These advances are crucial to ensure that the facility remains up-to-date and able to cope with the increasing (and always more complex) user needs. These software upgrades (some of them carried out within the EU-funded project AIDAInnova and EURO-LABS) will help to improve the efficiency and accuracy of the experiments performed at IRRAD and enhance the capabilities of this facility.

PROTON IRRADIATION FACILITY IRRAD

- **Qualification of radiation hardness** of materials, detectors, and electronic systems for High-Energy Physics experiments
- **Proton beam of 24 GeV/c**
- Beam of Gaussian shape with typical size of 12x12 mm² FWHM
- 5x10¹¹ p/spill, 8x10¹¹ p/spill from 2024!
- Spills of 400 ms every ~10 s
- Fluence of ~1.4 x 10¹⁶ p/cm² in a week
- Scanning also in dimensions of 10x10 cm²
- Low-temperature irradiation (-25°C)
- Irradiation down to 4.2 K using Cryostat with LHe
- 8 IRRAD Tables, 1 Shuttle, 2 cold-boxes

cern.ch/ps-irrad

DATA MANAGEMENT

IRRAD Data Manager – IDM: A unified data management tool for Irradiation Experiments follow-up: <http://cern.ch/idm>

IDM screenshots with the main functionalities:

- Registration
- Planning
- Operation
- Dosimetry
- Traceability
- History

Key features:

- Users
- Experiments
- Samples
- Schedule
- Beam interaction quantities
- Capacity
- Documenter/sample assignment
- Irradiation status
- Control system
- Beam Instrumentation
- Gamma spectrometry
- Proton fluence calculations
- Logistics/Infrastructure
- Transport
- Reproducibility
- Dissemination
- Reporting

Additional features:

- RFID test deployment for GIF++
- IDM test deployment for ENEA-FNG
- Deployment at FERMILAB
- Deployment at FERMILAB T1A ongoing
- Testing CAEN RadHAND device and API to be integrated with IDM
- RFID tags being tested for sample tagging
- Fluence results calculated and displayed in IDM

BEAM DATA MONITORING AND LOGGING

Fixed-BPM for beam alignment purpose
39 pads of 4x4 mm²

Mini-BPM (9 pads of 4x4 mm²) and single-pad BPM (1 pad of 4x4 mm²) for aligning IRRAD tables to the beam

System Architecture:

- IRRAD facility area (Zones 1, 2, 3)
- BPM1 device (4 mini & 4 single-pad BPMs)
- BPM2 device (4 mini & 4 single-pad BPMs)
- BPM3 device (4 mini & 4 single-pad BPMs)
- BPM4 device (4 mini & 4 single-pad BPMs)
- Proton Synchrotron (PS)
- BPM DAQ1-8
- BPM & CMW SERVER
- ORACLE DATABASE
- NXCALS

Outputs:

- Beam Profile display <https://cern.ch/opwt/irrad/>
- Beam Profile logging display in Timber

VIRTUALIZATION

Using CERN OpenStack for servers' deployment:

- BPM & CMW Server (Production and Test)
- Dose monitoring
- Apex Gamma Server (Canberra Genie 2000)
- Apex Gamma MS SQL Server

Advantages:

- Minimizing hardware computer failures
- Minimising additional costs
- Improving resilience
- Redundancy

OpenStack project components:

- Apex Server
- MSSQL DB 2019
- Windows Server 2019 Openstack VM
- 3 spectrometers IRRAD Lab
- Spectrometer IRRAD Facility
- Client 1 – Windows 10
- Client 2 – Windows 10

CONTROL AND MONITORING SYSTEMS

Brainboxes (Ethernet to Serial)

Motor Control Unit

IRRAD Table

Graphical User Interface (GUI)

Redesign and redeployment of IRRAD Table Control GUI interface

New IRRAD Table Control GUI compatible with Linux and with database in the backend

New lightweight shuttle Control GUI interface compatible with Linux

Monitoring IRRAD positions and temperatures

SUMMARY AND FUTURE WORK

Summary

- IRRAD is a reference facility in HEP, handling several experiments and samples
- IRRAD Data Manager (IDM) was built and deployed to facilitate the data handling of the irradiation experiments, currently being deployed also in other facilities
- New functionalities were developed in IDM to cover users' requirements and be compliant with the CERN IT infrastructure and security
- New BPM Controls Middleware (CMW) server was put in production to publish data in NXCALS, making data available in Timber
- New BPM sensors were installed in IRRAD
- Virtual Machines were deployed for running IRRAD servers
- New developments for the IRRAD control system GUIs and upgrades of the old ones
- Monitoring of Temperatures, dose rates and humidity

Future Work

- Aiming to complete the IDM generalization for other facilities
- Testing RFID tags and CAEN RadHAND for possible use in IRRAD
- A new IRRAD-BPM DAQ (scalable system) is developed and will be installed in IRRAD for the run 2024
- A new classifier of beam quality is foreseen

