Optical Fibre Dosimetry

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With support from EN-EL-FC,

R2E Annual Meeting – 2-3 February 2021
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Optical Fibre Dosimetry
Work Package
Optical Fibre Dosimetry Work Package

WP holder
EN-EL-FC

Mandate and main objectives

The mandate of the Optical Fibre Dosimetry Work Package (OFD WP) is to develop, deploy, operate and maintain the optical fibre radiation sensors that are employed in the monitoring of the radiation dose levels in CERN’s accelerators and transfer lines.

As of today, the main deployed system is the Distributed Optical Fibre Radiation and temperature Sensor (DOFRS).

The OFD WP is instrumental to the Monitoring & Calculation Working Group (MCWG) as it contributes to its main tasks: addressing specific requests from equipment groups; the general reporting activities; the comparison and cross-validation of radiation field simulations; the comparison and cross-validation of radiation measurements from other monitors and detectors.
Distributed Optical Fibre Radiation Sensors
Distributed Optical Fibre Radiation Sensors

DOFRS is based on:

- **Radiation Induced Attenuation** (RIA) in suitable specialty OFs (*not any optical fibre*)
- **Optical Time Domain Reflectometry**

Distributed Optical Fibre Radiation Sensors

Key Features of DOFRS

- Well adapted for large facilities - several hundreds of meters up to 1 km
- Distributed 1D maps of the radiation dose - spatial resolution down to 1 m
- Online monitoring - temporal resolution of a few minutes
- All electronics installed in remote and radiation-free locations – measurement can be deported over km distances
- One cable -> multiple OFs -> multiple radiation sensitivities
- Information of the cumulated dose stored in the OF itself
- Cost Efficient
- Need to replace the OF sensors: cable blowing

Possibility to reset and reuse some OF dosimeters by photobleaching (R&D phase)
DOFRS installations
Evolution of DOFRS at CERN

2013-2016: 1st prototype installed in the PSB

DOFRS project KT-Funded

2017: 1st prototype installed in the PSB

2018: A new version of DOFRS implemented in the PS

2019-2020: DOFRS installed in SPS, TT20 and LHC

ORION project KT-Funded

Run 3 operation

I. Toccafondo’s PhD thesis
Most important LS2 activities

- Large procurement of OFs (sensors and auxiliary OFs)
- Qualification and testing of the OF sensors
- Procurement of optical interrogators and control units
- Installations of rack and mini-racks
- Installations of the OF infrastructure
- Software upgrade
- Commissioning of the systems

Data acquisition started in the PSB
Example of DOFRS systems

➢ **Hardware Architecture:**
  - Radiation Sensitive **Optical fibers (OFs)** in the accelerator
  - OTDR instrument connected to the OFs
  - PXI RT System connected to the OTDR and to the Technical Network (TN) through Ethernet interfaces.

➢ **Software Architecture:**
  - **A Real Time (RT) LabView Application** running on the RT PXI system acquiring
    - Object Oriented Programming (OOP).
    - Use of CERN libraries for data logging and server communication.
    - Acquire, process and publish autonomously the OF data
  - **Expert User Interface**
    - Can be accessed from any computer on the TN
    - Allows to visualize and change on the fly the acquisition and publication parameters.

Collaboration with BE-CEM-EPR
Example from PS in 2018
Some numbers about DOFRS

Four DOFRS systems installed:

- PSB, PS, SPS + TT20, 6 DS regions of Large Hadron collider
- More than 9 km of monitored area
- 4 control units (+1 spare)
- 8 optical interrogators (+1 spare)
- 48*2 optical links (probed in both direction)
- About 97 km of total OF length for the full DOFRS infrastructure
- OFs procured from three different OF manufacturers
O&M and R&D activities
Operation and maintenance during RUN 3

- Monitoring of regular data acquisition from all DOFRS systems
- Development of the tools for the automatic data analysis with SY-STI-BMI
- Full exploitation of results in MCWG context
- Preparation of all maintenance activities to be carried out at the end of the year in the coming years
- Preparation of further installations (if any request is received)
- Improvement of the systems
R&D activities and collaborations

• Development and characterization of new OF sensors which are of interest for future use of DOFRS

• Investigation of techniques to reset and reuse of OF dosimeters¹

• Characterization of radio-luminescent OFs to carry out dose measurements with higher temporal resolution²

R&D activities: regeneration of the OF Dosimeter

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• Injection of light of suitable wavelength allows the recovery of the RIA.
• The initial calibration of the sensor is maintained
• In our tests, the regeneration has been applied three consecutive times on the same sample successfully.

The possibility to implement a prototype of such system in the PSB is under evaluation.

In the last two years SPS+TT20 and six DS regions of LHC were instrumented with DOFRS systems. DOFRS in PSB and PS were consolidated.

Total size of DOFRS systems increased by a factor 15 during LS2.

Monitoring started in the PSB in December 2020 ready to start acquisitions in other accelerators.

Planning and execution of maintenance activities.

Ongoing R&D to extend the capabilities and applicability and to reduce costs.
Thank you for your attention!