

# The Monitoring and Calculation Working Group: mandate and activities

G. Lerner (SY-STI-BMI) on behalf of the R2E-MCWG team

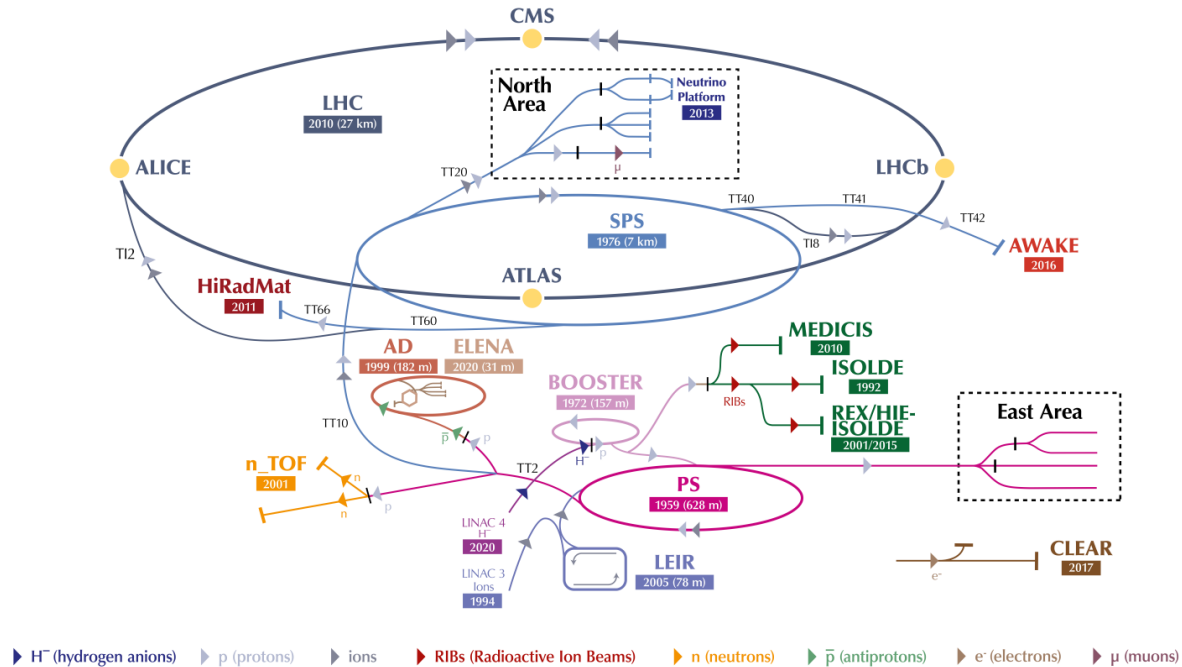
*R2E annual meeting 2022*

1<sup>st</sup> March 2022 - <https://indico.cern.ch/event/1116677>



# Introduction

The CERN accelerator complex  
Complexe des accélérateurs du CERN



LHC - Large Hadron Collider // SPS - Super Proton Synchrotron // PS - Proton Synchrotron // AD - Antiproton Decelerator // CLEAR - CERN Linear Electron Accelerator for Research // AWAKE - Advanced WAKEfield Experiment // ISOLDE - Isotope Separator OnLine // REX/HIE-ISOLDE - Radioactive Experiment/High Intensity and Energy ISOLDE // MEDICIS // LEIR - Low Energy Ion Ring // LINAC - LINear ACcelerator // n\_TOF - Neutrons Time Of Flight // HiRadMat - High-Radiation to Materials // Neutrino Platform

- The CERN accelerator complex includes a large number of **accelerators** and **facilities** where equipment and electronics are affected by radiation
- To achieve a reliable operation of the equipment, it is essential to **characterize the radiation environment** in the areas of interest

- The characterization of the radiation environment is the key ‘mission’ of the **Monitoring and Calculation Working Group (MCWG)** of the R2E project

## MANDATE

- Monitoring and analysis of the distribution and evolution of the radiation fields along CERN’s accelerator complex
- Assessment of potential radiation risks resulting in requirements for handling existing equipment and future installations
- Working on dedicated requests and reporting the results to the users

# MCWG organization

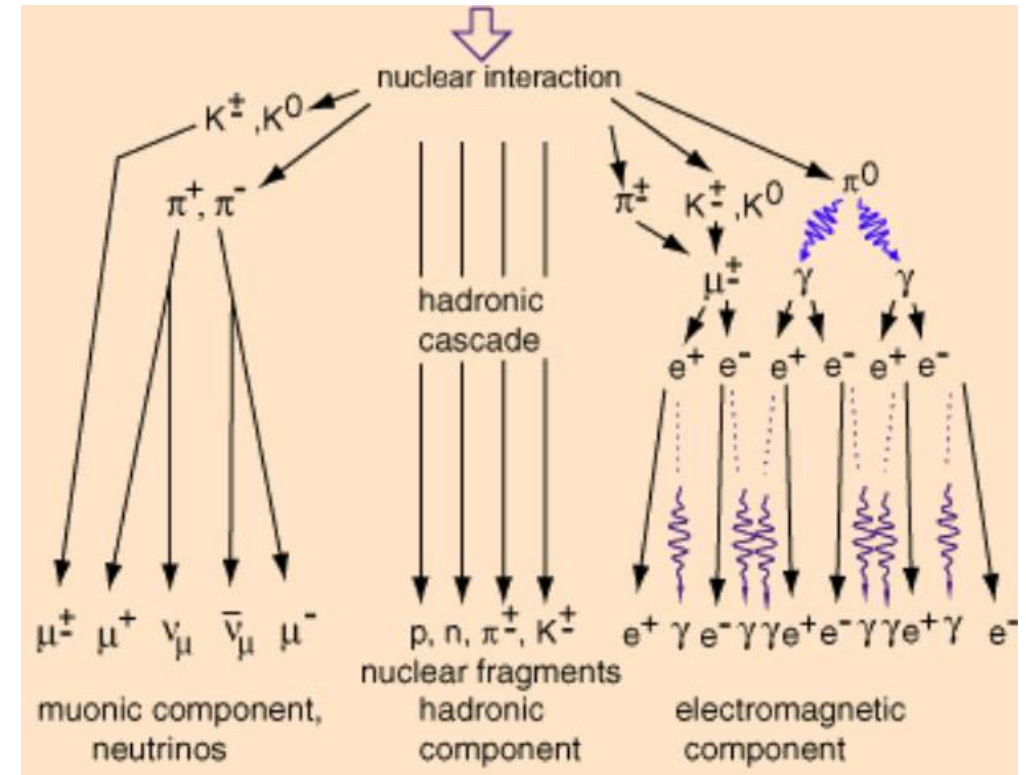
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- The MCWG includes ~10 active members (not necessarily full-time) from SY-STI-BMI, EN-EL-FO and BE-CEM-EPR, meeting regularly each week
- Key information and links:
  - [indico category](#) of the official MCWG meetings taking place every 2 months ([50th meeting](#) just last week!)
  - [info-r2e-mcwg](#) (63 members as of today, mostly users): egroup for all info and communications

# Radiation environment characterization

- Characterizing a mixed-field radiation environment, as the one of the LHC, requires to control:
  - particles types and relative abundance
  - energy spectra
- ...and importantly, for R2E:
  - Quantifying the radiation field using **quantities proportional to the radiation damage to electronics**

## TYPICAL LHC RADIATION CASCADE



### CUMULATIVE EFFECTS

Total Ionising Dose (TID),  
Silicon 1-MeV neutron  
equivalent fluence

### SINGLE EVENT EFFECTS

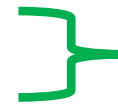
High Energy Hadron  
(HEH) and thermal  
neutron equivalent fluence

# MCWG tools

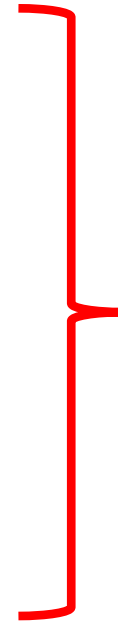
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- The main ‘ingredients’ of the MCWG analyses are **simulations** and **data**:

- **FLUKA Monte Carlo** code for radiation environment simulations (<http://fluka.cern/>)
- **Beam Loss Monitors** for Total Ionising Dose (TID)
- **RadMons** for TID and High Energy Hadron Equivalent, thermal neutron equivalent and Silicon 1-MeV neutron equivalent fluences ([talk by A. Amodio, S. Danzeca](#))
- **Optical Fibre Dosimeters** for full 1D maps of TID ([talk by D. Di Francesca](#))
- **High Level Dosimeters** for passive TID measurements – see next slide



**CALCULATION**  
([talk by D. Prelipcean](#))



**MONITORING**  
([talk by K. Bilko](#))

# High Level Dosimetry activity in the MCWG

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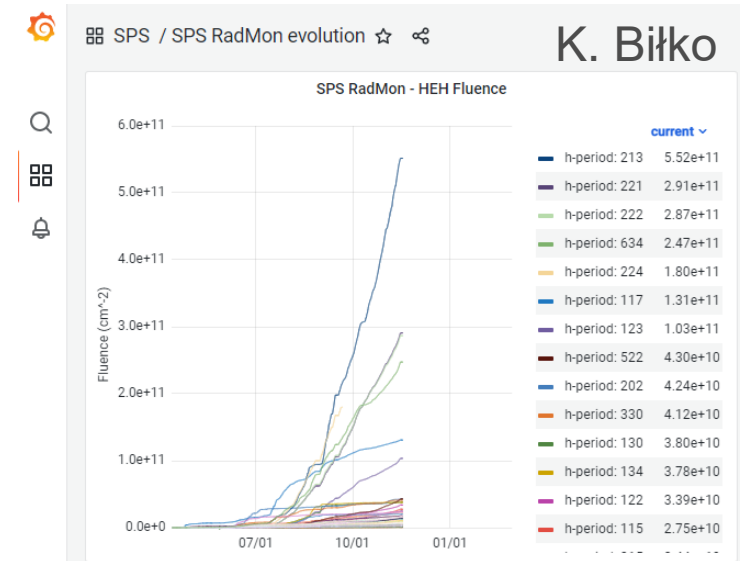
- **Passive dosimeters for TID measurements** have been used at CERN for several decades:
  - Polymer Alanine Dosimeters (PADs)
  - Radio-Photo-Luminescence Dosimeters (RPLs)
- Since ~1 year, the responsibility has been transferred from HSE-RP to the MCWG
- Important activity with several users, involving measurement campaigns both at CERN and in external facilities
- See [talk by Y. Aguiar](#) for a detailed discussion





# Core MCWG analyses and activities

- A key part of the MCWG mandate is the **monitoring**:
  - Automatized analysis framework covering most CERN accelerators and radiation monitors ([talk by K. Biłko](#))
  - Online dashboard: <https://r2e-monitoring.web.cern.ch/>
  - Updates on recent radiation level measurements at the official MCWG meetings
- Relevant documents:
  - Run 2 BLM levels at the LHC ([CERN-ACC-NOTE-2019-0040](#)), 2019
  - HL-LHC radiation level specification document ([EDMS 2302154](#)), 2020
  - SPS radiation levels in 2015-2018 ([EDMS 2471368](#)), 2021

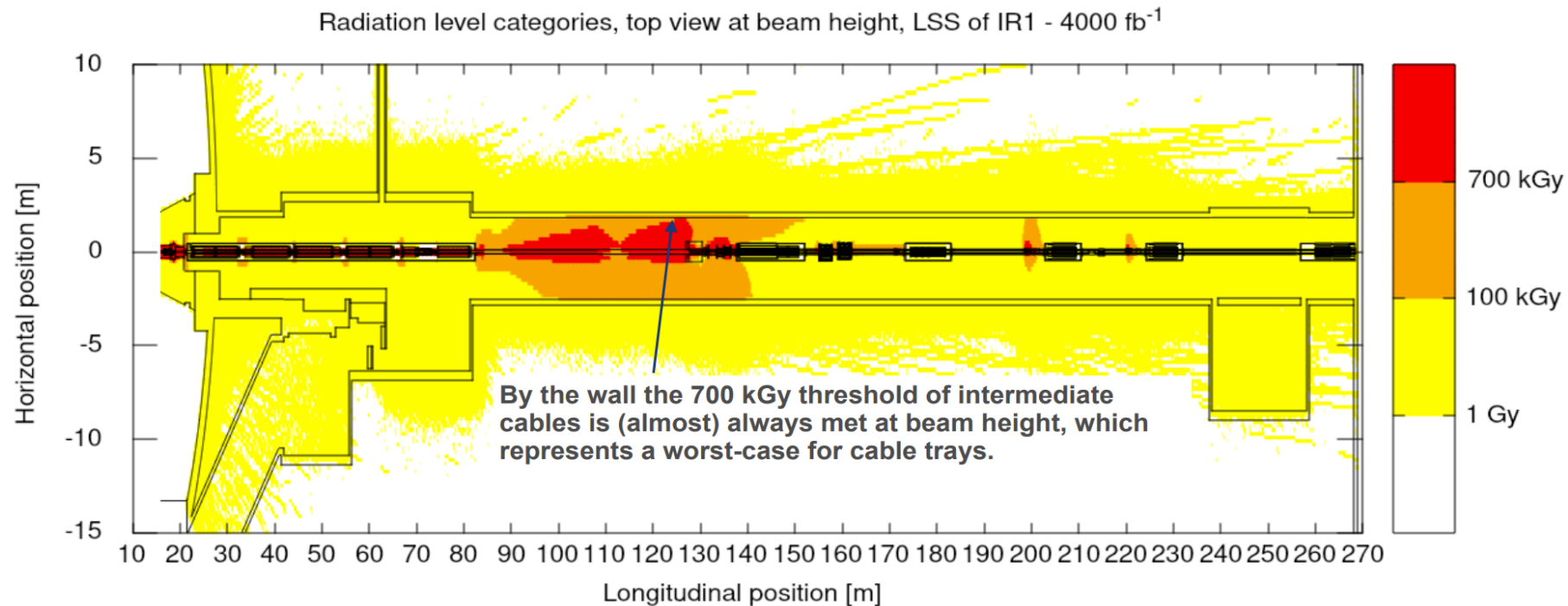


The image shows the cover page of a document titled "RADIATION LEVEL SPECIFICATIONS FOR HL-LHC". It features the CERN and HiLumi logos at the top left. The document reference is "EDMS NO. 2302154 v1.0" and "Reference: LHC-N-ES-0001" with the contact "giuseppe.lerner@cern.ch". The title "RADIATION LEVEL SPECIFICATIONS FOR HL-LHC" is centered. Below it is an "ABSTRACT" section. The abstract text reads: "We present a comprehensive overview of the radiation level specifications for the electronic equipment at the LHC during the High-Luminosity upgrade. The specifications are derived from a combination of Run 2 measurements from BLM and RadMon systems, FLUKA simulations and considerations on the expected evolution of the performance of the LHC accelerator. Four R2E-relevant quantities are considered for the specifications, namely Total Ionising Dose and High Energy Hadron, thermal neutron and 1-MeV neutron equivalent fluences. The results are presented for each relevant location hosting systems based on commercial electronics, and should serve as reference for their development and qualification." The keywords are "HL-LHC, R2E, radiation, specifications, electronics."



# Core MCWG analyses: R2E specifications on cables (new)

- Example of core MCWG activity: support for the definition of HL-LHC radiation level specifications on cables (see [talk at HL-LHC WP15 meeting](#))
- Outcome: proposed strategy for cable procurement, based on the definition of 3 radiation level categories



# User requests for radiation levels

- A key part of the MCWG mandate is to **address radiation level requests by users**
- Since June 2021 we implemented a standard **radiation level request workflow**:
  - Users shall fill a Word request form ([EDMS 2574855](#)) including answers to standard questions, sending it by email to [mcwg-request@cern.ch](mailto:mcwg-request@cern.ch) → we may soon move to a SNOW ticket
  - The request form and the results of the analysis are uploaded to EDMS
- We collected **>20 requests in 2021** (not counting the first months) and already **>10 in 2022**

CERN  
CH-1211 Geneva 23  
Switzerland

EDMS NO. **000000** | REV. **0.0** | VALIDITY **DRAFT**

REFERENCE  
**XXXXXXXX**

Radiation to Electronics  
R2E

Date: 20XX-XX-XX

Request Form

**Radiation Level Request Form**  
R2E Monitoring and Calculation Working Group (MCWG)  
To be sent to [mcwg-request@cern.ch](mailto:mcwg-request@cern.ch)

ABSTRACT:  
This form is intended to collect all the necessary input to address requests for radiation levels in the CERN accelerator complex (LHC, its injector chains and experimental areas) as well as CERN irradiation facilities and external facilities exploited by CERN users. The scope of this type of request includes a broad variety of environments and applications, e.g. different facilities, present/future operation, existing/new installations, with the exclusion of all subjects that are under the responsibility of Radiation Protection (dose to personnel, activation, radiation wastes). Users are encouraged to provide as much information as possible related to it. The form is provided in Word format to facilitate the inclusion of graphic material (e.g. drawings/layouts/tables), which however can also be included as attachments in the request email.

DOCUMENT PREPARED BY: [Author 1 Name] [Author 2 Name]	DOCUMENT TO BE CHECKED BY: <b>TBD</b>	DOCUMENT TO BE APPROVED BY: <b>TBD</b> <b>** Red information to be filled out by MCWG team</b>
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DOCUMENT SENT FOR INFORMATION TO:  
[List of persons to whom the document is sent]

This document is uncontrolled when printed. Check the EDMS to verify that this is the correct version before use.

# Radiation level requests: 2021

- Many done, others still in progress
- Some requests (e.g., those involving RPLs) require a long time to complete

Id	Title	Files	Status	Created on ▲	Author
2599434 v.1.0 ★	Shielding of Access Control rack in bld. 912 level U0 (PP851)	2	Released	2021-06-21	Tomasz Ladzinski
2599441 v.3.5 ★	HLD dosimeters for the 2021 irradiation campaign at n_TOF NEAR	2	Released	2021-06-21	Dominika Senajova, Matteo Ferrari
2599444 v.1.0 ★	Definition of the absorbed dose for equipment located in UPR13/17/53/57 and UA13/17/53/57	3	Released	2021-06-21	Yannic BODY
2599445 v.0.5 ★	Use of high radiation dosimeters to measure irradiated optical materials at the HIFR gamma facility	1	In Work	2021-06-21	Willem Blokland
2599447 v.1.0 ★	Simulation of TID in function of distance for 3 positions in LHC tunnel (LSS1/LSS5 left & right) for ...	2	Released	2021-06-21	Jérémy Blanc
2599448 v.0.5 ★	Alanine pellets for Neutrons dosimetry at UCL on May 2021	1	In Work	2021-06-21	Stéphane DETRAZ
2606649 v.0.5 ★	Radiation level request for 20-08 Cable irradiation test to derive Cable Ageing	2	In Work	2021-07-12	Artem Danyliuk
2606740 v.0.5 ★	Beam Loss Monitor upgrade for SPS	1	In Work	2021-07-12	Kacper Bilko
2642570 v.1.0 ★	n_TOF NEAR dose on Rabbit 3 samples for R2M	2	Released	2021-08-01	MATTEO CECCHETTO
2621774 v.0.5 ★	CHARM environment analysis for DOFRS measurements	1	In Work	2021-09-06	Diego DI FRANCESCA
2621775 v.1.0 ★	ALPS BPM Frontend in TT2 & TT10	2	Released	2021-09-06	Thierry BOGEY
2599450 v.1.0 ★	BTV radiation survey (RPL dosimeters) run 2018	4	Released	2021-09-22	Stephane Burger
2636143 v.1.0 ★	Radiation levels on ODH sensors for HL-LHC	5	Released	2021-09-27	Andrea Lippiello, Melania Averna, Nicolas Broca
2645750 v.1.0 ★	FLUKA simulations of radiation levels in TI18 (SND) from beam-gas interactions	1	Released	2021-10-13	GIUSEPPE LERNER
2647945 v.0.5 ★	Dosimetry cross-check with EBT3-HD films for medical applications - CLEAR	1	In Work	2021-10-20	Wilfrid Farabolini
2651888 v.0.5 ★	Readout of RPL dosimeters for radiofrequency equipment in PS - Run 2018	3	In Work	2021-11-04	Valentin Daniel Desquiens, Cristiano Gagliardi
2655812 v.0.5 ★	Measurement of RPL dosimeters for BTV radiation survey for 2021 run.	1	In Work	2021-11-10	Stephane Burger
2663182 v.0.5 ★	Radiation levels on the BY01 racks in UA23-27 and UA83-87 for HL-LHC	1	In Work	2021-11-15	MICHAL KRUPA
2650150 v.1.0 ★	AWAKE-TAG41	1	Released	2021-11-23	MATTEO CECCHETTO
2669644 v.0.5 ★	Radiation levels in the SPS for ODH sensor installation for future operation (HL-LHC period)	2	In Work	2021-12-06	ANDREA LIPPIELLO
2708292 v.1.0 ★	Radiation to Electronics (R2E) CLEAR test campaign in 2021	1	In Work	2022-02-26	Giuseppe Lerner, Ygor Aguiar

# Radiation level requests: 2022

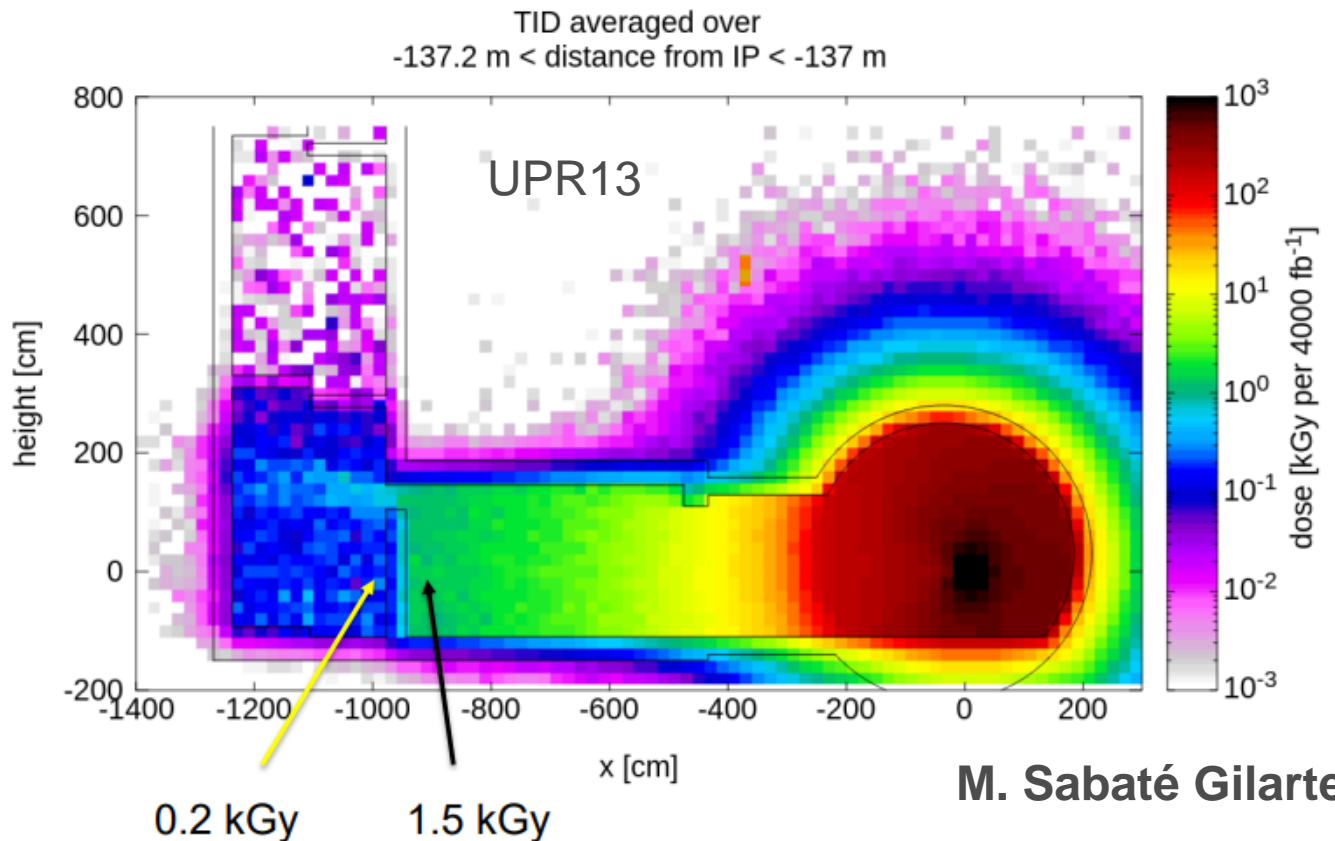
- Multiple requests have already been received for 2022
- Many of them involve the deployment of RPL dosimeters (see talk by Y. Aguiar) for 2022 radiation level measurements → we expect these to remain in work for long periods
- SPS access system request to be discussed in detail in [M. Cecchetto's talk](#)

Id	Title	Files	Status	Created on ▲	Author
2648761 v.0.5 ★ !	RPL measurements around the LUCID detector in ATLAS	🗂 1	🔴 In Work	2021-10-12	Vincent Hedberg
2655780 v.0.5 ★ !	Request for 200 RPL dosimeters for BTV radiation survey for 2022 run.	🗂 2	🔴 In Work	2021-10-25	Stephane Burger
2651162 v.0.5 ★ !	RPL dosimeters for radiofrequency equipment in LINAC4 and PS - Run 2022	🗂 1	🔴 In Work	2021-11-03	Valentin Daniel Desquiens, Cristiano Gagliardi
2659976 v.0.5 ★ !	Monitoring of TT2 and TT10 using RPLs in the BLM and BPM positions.		🔴 In Work	2021-11-12	Ygor Quadros de Aguiar, Kacper Bilko
2683546 v.0.5 ★ !	Monitoring the radiation levels in the Beam Intercepting Devices (TED, TBSE and TCSC)	🗂 1	🔴 In Work	2022-01-21	Jean-Louis GRENARD
2688187 v.0.5 ★ !	ISOLDE target area visualisation cameras and robots	🗂 2	🔴 In Work	2022-01-25	Jean-Louis Grenard, Joachim Voltaire
2686584 v.0.5 ★ !	SPS residual gas analyser installation in LSS6	🗂 3	🔴 In Work	2022-02-01	Chiara Pasquino
2688094 v.0.5 ★ !	RPL for the Beam Dump in TT2 - F16.TDU394	🗂 2	🔴 In Work	2022-02-02	Jean-Louis Grenard
2694868 v.1.0 ★ !	T10 skid shielding in TA851	🗂 3	🟢 Released	2022-02-11	Sylvain Girod
2698775 v.0.1 ★ !	HLD dosimeters for the 2022 irradiation campaigns at n_TOF NEAR	🗂 1	🔴 In Work	2022-02-15	Dominika Senajova
2705941 v.1.0 ★ !	R2E Assessment of the failures in the SPS Access System in 2021	🗂 2	🔴 In Work	2022-02-22	Ygor Aguiar, Matteo Cecchetto, Giuseppe Lerner and Rubé

# Example of radiation level request

- Title: “Definition of the absorbed dose for equipment in UPRs”, [EDMS 2599444](#)
- Request placed by Y. Body, addressed by M. Sabaté Gilarte with FLUKA simulations

- Goal: specify the TID to be received by **fire damper equipment** in the new UPR galleries over the full **HL-LHC** lifetime
- Dedicated calculations performed taking into account the exact position foreseen for the equipment



# Summary and conclusions

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- This talk was aimed at presenting the scope and mandate of the R2E **Monitoring and Calculation Working Group (MCWG)**
- The activities of the MCWG cover an essential portion of the R2E project, i.e., the characterization (and quantification) of the radiation environment where the electronics and equipment are operated
- Important synergies and collaboration are present with users (e.g., electronic equipment owners) and accelerator operation teams
- More details about various aspects of the MCWG activities will be provided in many presentations during this workshop, as linked throughout my slides