HSE

Occupational Health & Safety
and Environmental Protection unit

Radiation Protection at CERN

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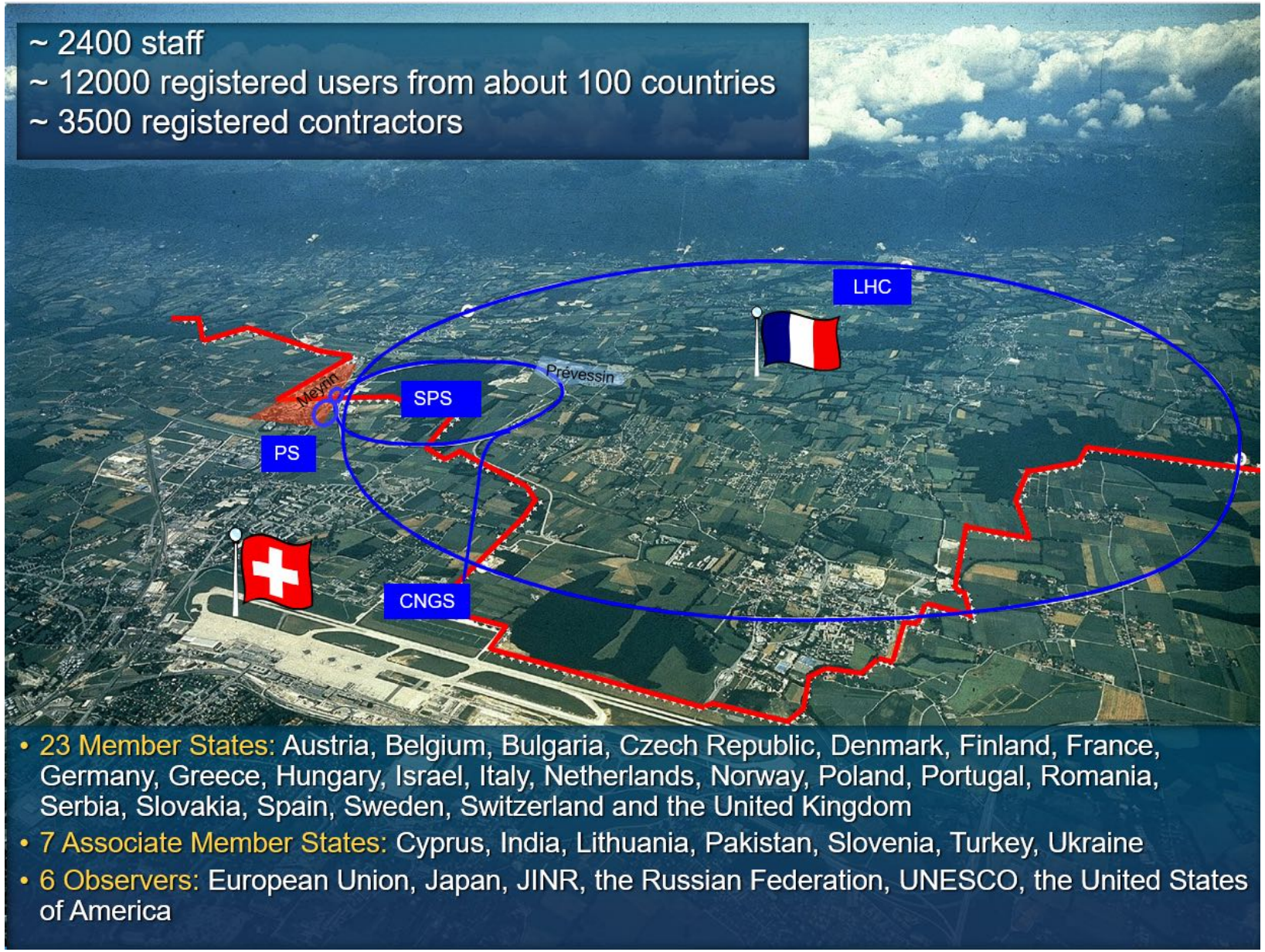
Occupational Health & Safety Department

Radiation Protection Group

Many of the slides prepared by and based on the work of members of the RP Group

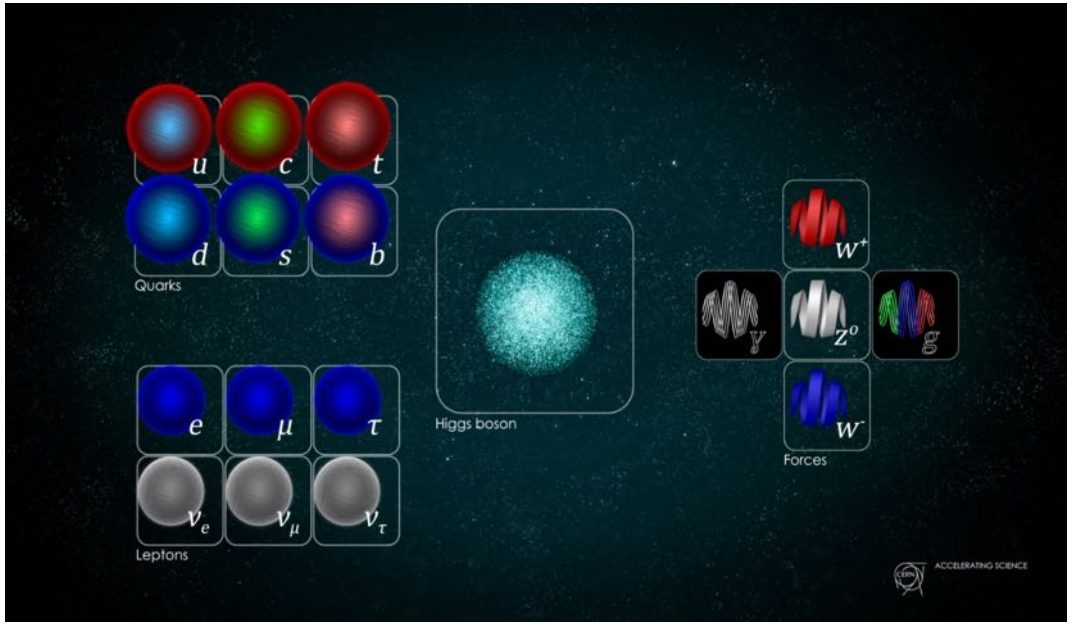
Overview

- Regulatory landscape of Radiation Protection at CERN
- Mandate and responsibilities of the Radiation Protection Group
- RPE scheme for experiments / RSSO scheme
- General principles of Radiation Protection and their implementation at CERN
- Radiation monitoring at CERN
- CERN Radiation Protection Objectives for LS2 and 1 example
- Radiation protection studies for future projects


~ 2400 staff
~ 12000 registered users from about 100 countries
~ 3500 registered contractors
LHC
SPS
PS
CNGS
Meyrin
Prévessin
• 23 Member States: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Spain, Sweden, Switzerland and the United Kingdom
• 7 Associate Member States: Cyprus, India, Lithuania, Pakistan, Slovenia, Turkey, Ukraine
• 6 Observers: European Union, Japan, JINR, the Russian Federation, UNESCO, the United States of America

Mission of CERN

The research performed at CERN helps to uncover what the universe is made of and how it works.



CERN

- provides a unique range of particle accelerator facilities that enable research at the forefront of human knowledge,
- performs world-class research in fundamental physics,
- unites people from all over the world to push the frontiers of science and technology, for the benefit of all,
- has been established in 1954 and has become a prime example of international collaboration.

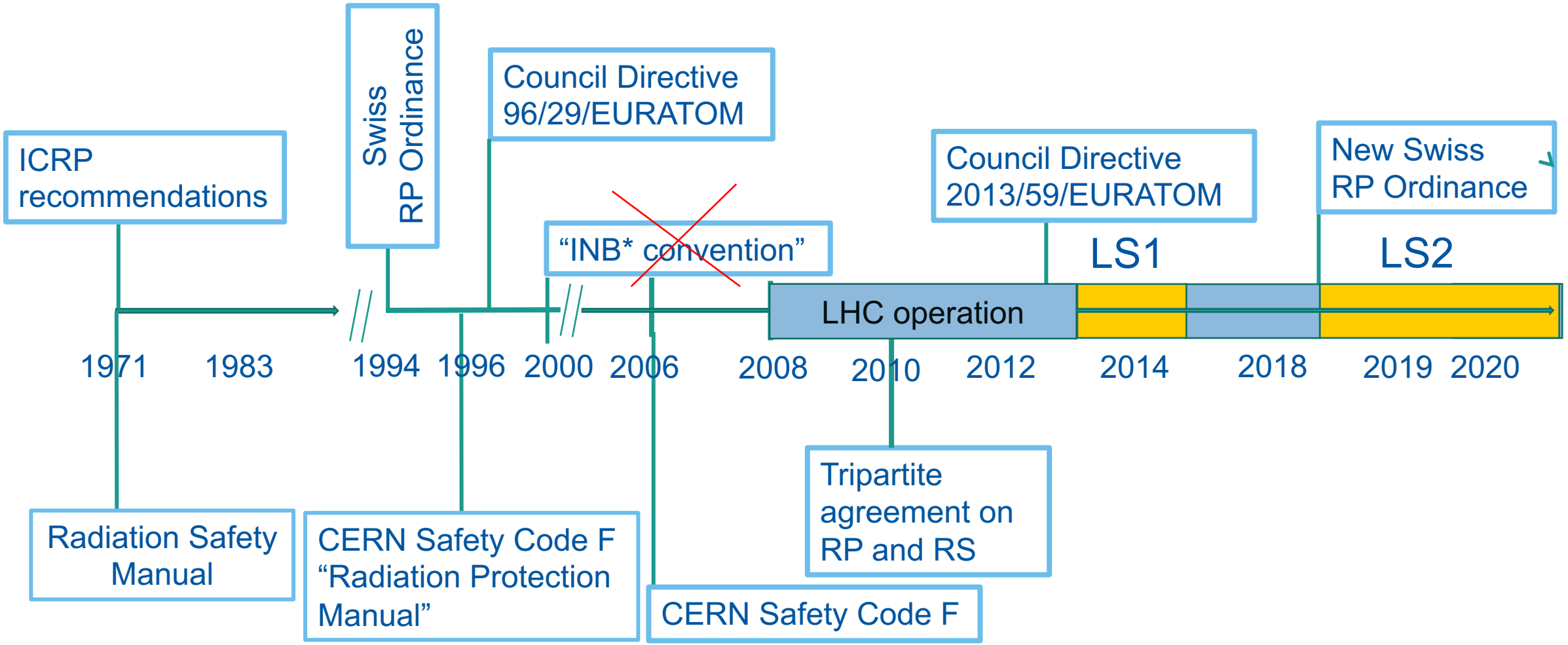
Research. Innovation. Collaboration. Inspiration. Education.

CERN's International Status

- CERN is an intergovernmental Organization subject not to national but international law.
- CERN's status has been recognized by its host states, France and Switzerland, through the seat agreement with Switzerland and the status agreement with France and by the other member states in a Protocol on privileges and immunities.
- Right to establish rules as necessary for the proper functioning of the Organization: CERN Staff Rules and Regulations and the CERN Safety Rules.
- CERN must ensure safety and security of its host states and the proper administration of justice.

⟹ Close collaboration with host states Switzerland and France in matters of Radiation Protection and Radiation Safety

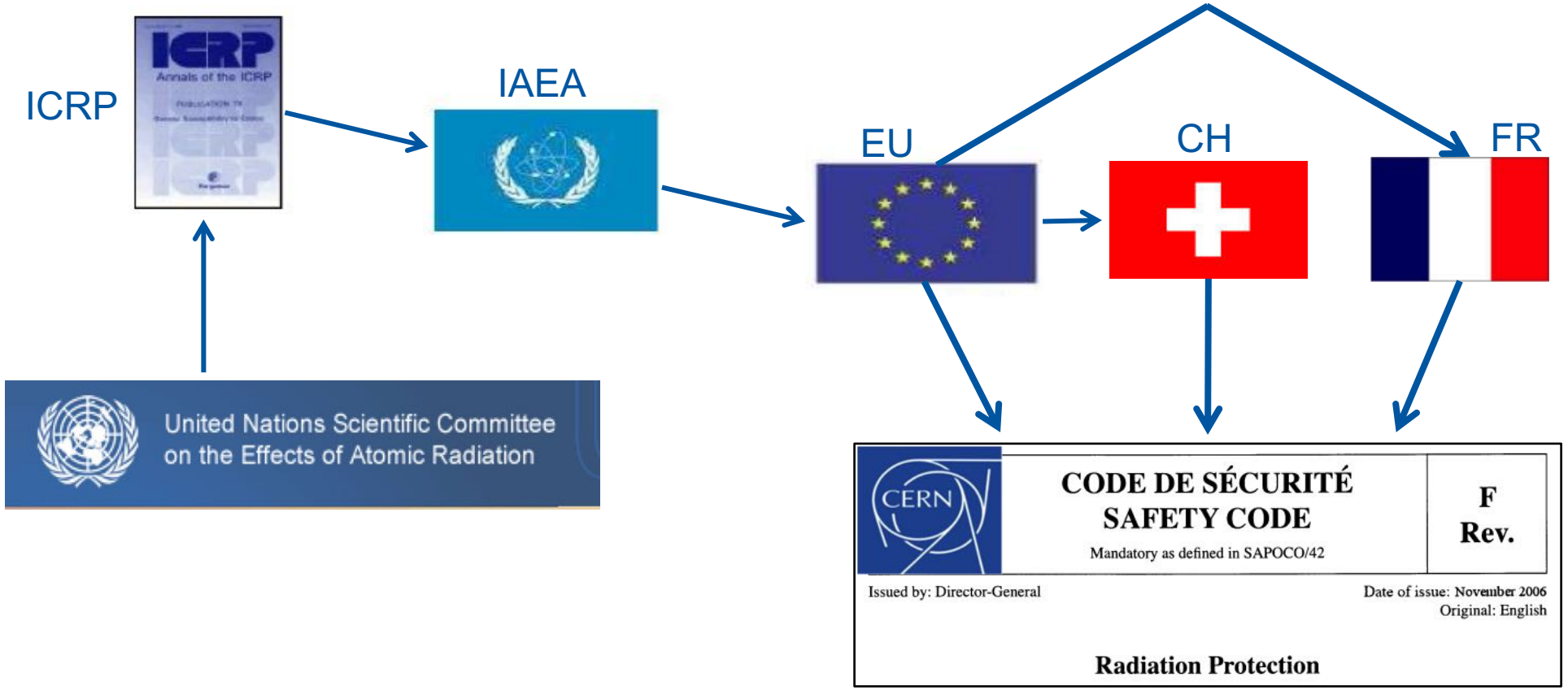
Regulatory Landscape - *History*



*INB = installation nucléaire de base

CERN's Radiation Protection Rules

CERN agrees to follow best practices in matters of radiation protection and radiation safety taking into account the legislation of its host states, as well European and international standards.



The Tripartite Agreement

Signed in 2010, the tripartite agreement on Radiation Protection and Radiation Safety between CERN and its host states (the "Tripartite Agreement"*) provides a legal framework to discuss CERN wide radiation safety and radiation protection issues in a transparent and collaborative way with the host states authorities, ASN (F) and OFSP (CH).

Matters covered:

- Radioactive Waste
- Transport of radioactive materials
- Incident declaration
- Export/import and handling of radioactive materials
- Dosimetry
- Environmental monitoring

ACCORD

ENTRE

L'ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE,

LE CONSEIL FEDERAL SUISSE,

ET

LE GOUVERNEMENT DE LA REPUBLIQUE FRANÇAISE

relatif à la Protection contre les rayonnements ionisants et à la Sûreté des Installations de l'Organisation européenne pour la Recherche nucléaire

Pour l'Organisation — Rolf Heuer — Directeur général

Pour le Conseil fédéral suisse — Pascal Strupler — Directeur de l'Office fédéral de santé publique

Pour le Gouvernement français — André-Claude Lacoste — Président de l'Autorité de sûreté nucléaire

- Environmental subjects are discussed in the « Comite Tripartite de l'environnement (CTE) »
  Rescue service subjects are covered by the « accord tripartite portant sur l'assistance mutuelle des secours »

The Tripartite Agreement

The implementation of best practices and standards in Radiation Protection and Radiation Safety at CERN are discussed between the three parties in the framework of the Tripartite Agreement.

In the framework of the tripartite agreement CERN submits to ASN and OFSP for “homologation”:
Radiation Protection Rules, Radioactive Waste Study, Emergency Plan, Safety Files for new installations

Plenary Meetings

Strategic discussions and decisions in the framework of the Tripartite Agreement

Joint Visits

Verification that CERN complies with host states, EU and international standards in matters of Radiation Protection and Radiation Safety

Working Groups

Discussion of specific subjects and preparation of plenary meetings

Commissaire et Directeur adjoint ASN

Director of Accelerators, Head of HSE Unit, RP Group Leader, Department leaders

Chef de la Division radioprotection

Confédération suisse OFSP

Radiation Protection – Radiation Safety

Radiation Protection

- Responsibility of the Radiation Protection Group (HSE-RP)
- The duties of CERN's Radiation Protection Group include operational radiation protection which comprises assessment of radiological risks, classification of work places in radiation zones, implementation of control measures, monitoring radiation levels for different radiation areas and impact of radiation on the environment, monitoring the implementation of regulations and of specific rulings, approval of ALARA plans, control and characterization of radioactive material and waste

Radiation Safety

- Responsibility of every CERN Department owning radiation sources or using radiation sources put at its disposition.
- These Departments are in charge of implementing the requirements laid down in CERN's Safety rules and documents or specified by HSE-RP in order to ensure the safe operation of their existing and future installations (accelerators, beams, experiments). The Departments are also in charge of training their personnel in matters of Radiation Protection according to the rules specified by HSE-RP.

Radiation Protection Group

Mandate

"The Radiation Protection Group (HSE-RP) of the HSE Unit ensures that personnel on the CERN sites and the public are protected from potentially harmful effects of ionizing radiation linked to CERN activities. The HSE-RP Group fulfils its mandate in collaboration with the CERN departments owning or operating sources of ionizing radiation and having the responsibility for Radiation Safety of these sources."

Operational Radiation Protection

- Risk assessments for personnel and public
- Definition of protective measures, authorization of operation
- Lead in implementation of ALARA principle
- Studies for projects and upgrades
- R&D for tools and methods, operation of shielding benchmark facility

Radioactive Waste Management

- Operation of pre-conditioning and interim storage facility
- Waste disposal towards host states
- Support to departments in radioactive waste minimization and treatment

Individual Dosimetry & Calibration

- Monitoring of external and internal doses and reporting (CERN dosimetry service carries official accreditation in Switzerland)
- Operation of calibration facility

Instrumentation

- Development, installation, operation and maintenance of radiation monitoring systems

Services

- Inter/intra-site radioactive transport
- Shipping (import/export) of radioactive goods
- Radiological characterization of material and waste, operation of analytical laboratory
- Radioactive sources service
- Physics computing support (FLUKA cluster)

RP Mandate

The Radiation Protection Group is responsible for Radiation Protection at CERN including:

- assessing the hazards of ionizing radiation from CERN installations and their associated risks for personnel and members of the public and defines the appropriate protective measures;
- monitoring the implementation and the effectiveness of the protective measures by measuring radiation levels and ambient and personal doses;
- leading the implementation of the ALARA principle in the design, operation and decommissioning of CERN's accelerators and experiments;
- authorizing (suspending) the operation of an equipment, installation or activity generating ionizing radiation in case of compliance (non-compliance) with CERN's radiation protection rules;
- developing and maintaining tools, instruments and methods appropriate for the assessment of radiation hazards and risks particular to the CERN installations;
- providing expert advice and technical support to departments, to the experimental collaborations and to the CERN management in all matters of radiation protection;
- managing the interim storage, treatment and disposal of radioactive waste;
- being in charge of the Organization's regulatory framework in matters of radiation protection;
- contributing to the implementation of the Tripartite agreement on radiation protection and radiation safety.

RP Mandate - *continued*

The Radiation Protection Group specifies, procures, installs and operates on behalf of CERN:

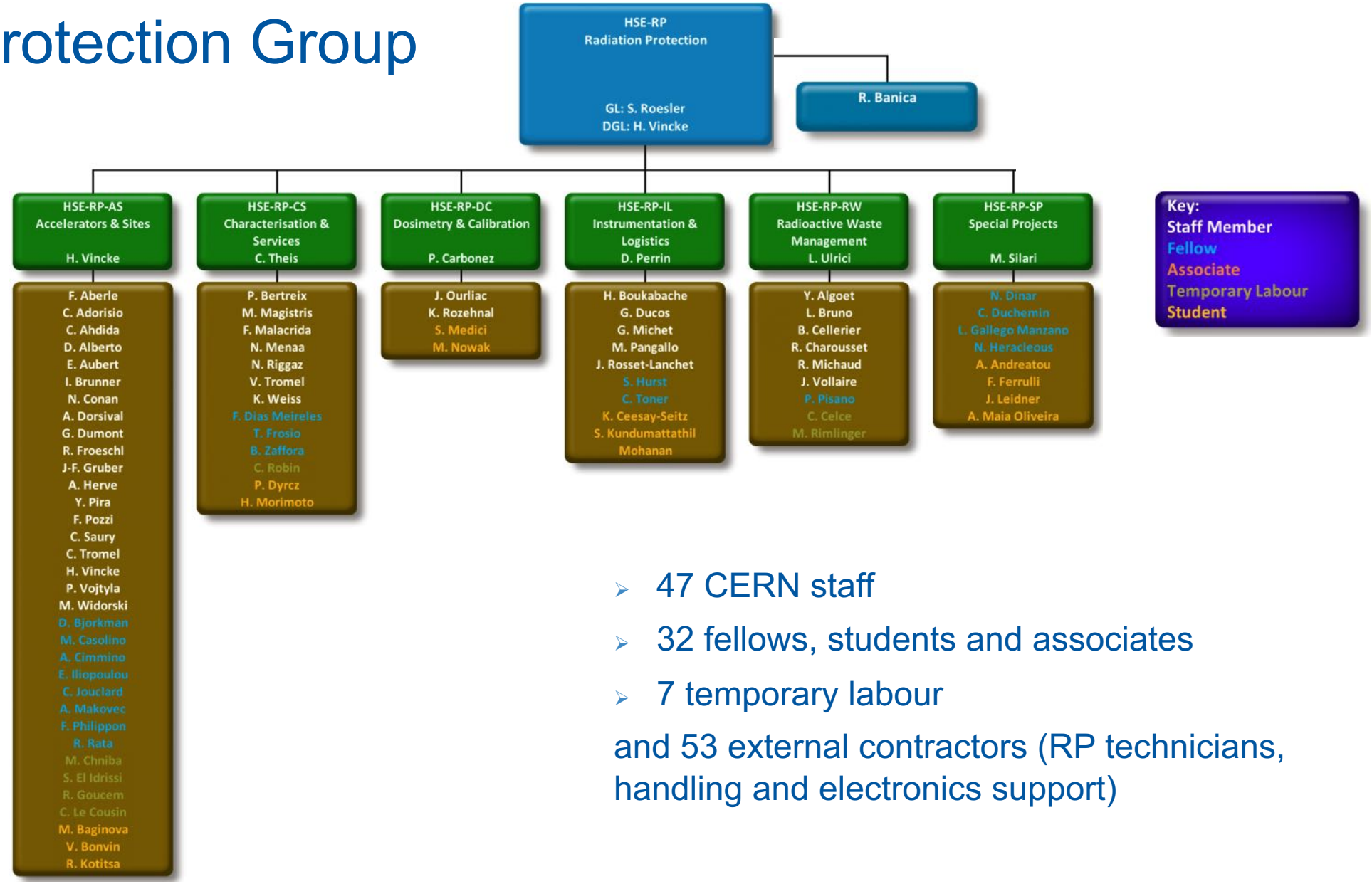
- the radiation monitoring systems for ambient dosimetry;
- an on-call service for assistance in case of urgent interventions;
- the analytical laboratories for operational radiation protection and radioactive waste management;
- the personal dosimetry service to monitor individual doses of radiation workers;
- a radioactive shipping service for the import and export of radioactive material and sources;
- a radioactive sources service for managing and providing radioactive sources;
- the calibration service for radiation protection instruments to ensure the metrological traceability of measurements;
- the pre-conditioning facility for radioactive waste and interim storage facility for radioactive waste.

Key facts related to Radiation Protection

- About 50 km of accelerator infrastructure and over 160 physics experiments, all areas classified as Radiation Areas, 50-60 access points
- Radioactive Ion Beam facility (ISOLDE)
- Spallation Source (n-TOF)
- Several experimental halls for fixed target experiments
- Radioactive laboratories and workshops
- Radioactive Waste Treatment Center and radioactive waste interim storage facility (400 m^3 radioactive waste/year, *s*torage of 7'000 m^3 radioactive waste)

- Over 10'000 Radiation Workers
- Low radiological risks (more than 90% of annual individual doses are lower than 100 µSv, see below)
- External exposure mostly due to gamma irradiation (handling of activated equipment during shutdown periods)
- Most of the accelerator infrastructure is located underground (LHC up to 100m), thus very low external exposure during operation
- Absence of radioactive contamination risks in most accelerator and experimental areas
- Radioactive material and waste mostly with very low activation (French radioactive waste classification: Très Faible Activité TFA, Faible ou Moyenne Activité FMA)

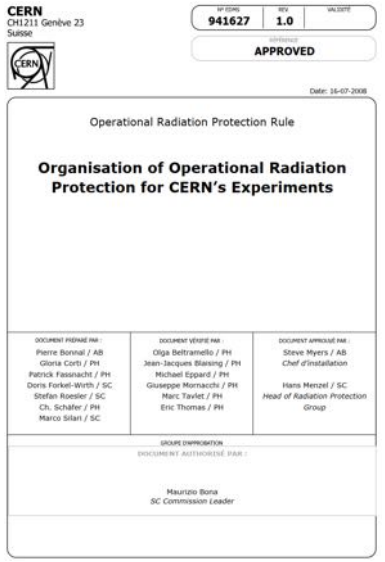
Radiation Protection Group in numbers



- 47 CERN staff
- 32 fellows, students and associates
- 7 temporary labour

and 53 external contractors (RP technicians, handling and electronics support)

Radiation Protection Expert Scheme


CERN
CH1211 Genève 23
Suisse

941627 | 1.0

APPROVED

Operational Radiation Protection Rule

Organisation of Operational Radiation Protection for CERN's Experiments

Motivation

- Introduced with start of the LHC since LHC experiments need considerable RP availability and flexibility
- Need for having RP link persons in experiments with both deeper understanding of RP rules and practices as well as knowledge of the respective experiment who can contribute to RP tasks
- Scheme defined in EDMS 941627 and agreed on with the host states authorities

Requirements

- University degree or technical training
- Good knowledge in working with ionizing radiation or in Radiation Areas
- A certificate received after a successful participation in an RPE course given by a body certified by a national authority. The course includes information on CERN specific radiation protection aspects (CERN specific risks, CERN's RP rules and regulations)
- Successful completion of "on-the-job" training - accompanied by RP
- Joint nomination by the Technical Coordinator and HSE-RP

RPE activities in LHC Experiments today

- Activities are limited to Supervised Radiation Areas
- Monitoring of radiation levels
- Lifting of RP veto
- Radiation surveys in experimental area
- Contribution to implementation of ALARA during interventions
- Radiological control of material from areas without activation risk

HSE-RP delegates tasks but not the responsibility
RPE teams are part of the CERN RP team

The RPE scheme has proven to be very successful thanks to excellent collaboration between RPE and HSE-RP

Radiation Safety Support Officers Scheme

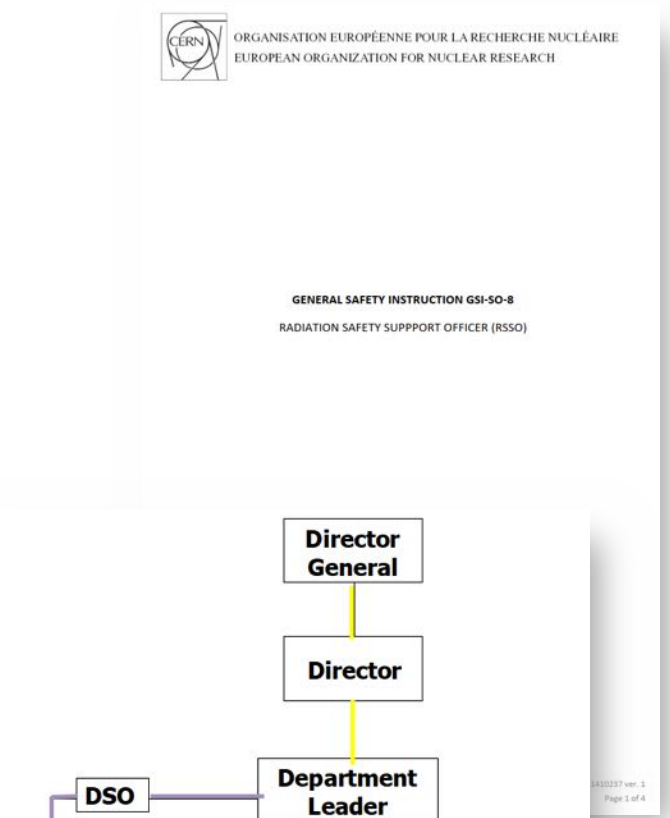
Motivation

- Increasing beam intensities and energies lead to increasing radiation levels and hazards
- Members of equipment groups who never worked before in Radiation Areas and/or with radioactive material will become Radiation Workers

Scope of work

Appointed by his Group Leader to support him with a view to the implementation of the CERN Safety Objectives in the group in matters of Radiation Safety and to execute any other Radiation Safety tasks as may be assigned to him by his Group Leader

- Proposing and monitoring the implementation of appropriate measures for all other persons participating in the activities of the group, to receive information on and comply with the CERN Safety Policy, the CERN Safety Rules, the CERN Safety Objectives and best practices in matters of Radiation Safety;
- Participation in risk assessments prior to the introduction or modification of Radiation Sources by the group as well as in the ALARA process
- Contribution to the establishment and updating of Safety documentation under the responsibility of the group in matters of Radiation Safety, as required;
- Participation in risk assessments prior to the introduction or modification of Radiation Sources by the group;



Trained in dedicated RSSO training courses

General Principles of Radiation Protection

1. **Justification**
   Any exposure of persons to ionizing radiation has to be justified

2. **Limitation**
   The personal doses have to be kept below the legal limits

3. **Optimization**
   The personal doses and collective doses have to be kept as low as reasonably achievable (ALARA)

Limitation – *Safety Code F*

Occupationally exposed persons (Radiation Workers)

3.2.1 The effective dose received in any consecutive 12-month period by any occupationally exposed person must not exceed 20 mSv.

3.4.1 All occupationally exposed persons are classified in one of two categories:

a) Category A: persons who may be exposed in the exercise of their profession to more than 3/10 of the limit in terms of effective dose in 12 consecutive months.

b) Category B: persons who may be exposed in the exercise of their profession to less than 3/10 of the limit in terms of effective dose in 12 consecutive months.

Category A: **20 mSv / yr (*)**

Category B: **6 mSv / yr (*)**

(*) Apprentices and students (age 16-18): 6 mSv/yr
Pregnant women: 1mSv/yr

Not occupationally exposed persons

3.2.3 The effective dose received in any consecutive 12-month period by persons not occupationally exposed must not exceed 1 mSv.

1 mSv / yr

Environment (Public)

4.2.1 The effective dose resulting from CERN's activities received by any person living or working outside the site boundaries must not exceed 0.3 mSv per year. This limit includes both external and internal exposure, the latter resulting from the intake of radioactive releases.

0.3 mSv / yr

Limitation – *Area Classification (external exposure)*

	Area	Dose limit [year]	Ambient dose equivalent rate		Sign
			Work place	Low occupancy	
	Non-designated	1 mSv	0.5 µSv/h	2.5 µSv/h	
Radiation Area	Supervised	6 mSv	3 µSv/h	15 µSv/h	Dosimeter obligatory Dosimètre obligatoire
Radiation Area	Simple	20 mSv	10 µSv/h	50 µSv/h	Dosimeter obligatory Dosimètre obligatoire
Radiation Area	Limited Stay	20 mSv		2 mSv/h	LIMITED STAY SÉJOUR LIMITÉ Dosimeters obligatory Dosimètres obligatoires
Radiation Area	High Radiation	20 mSv		100 mSv/h	HIGH RADIATION HAUTE RADIATION Dosimeters obligatory Dosimètres obligatoires
Radiation Area	Prohibited	20 mSv		> 100 mSv/h	PROHIBITED AREA ZONE INTERDITE No Entry Défense d'entrer

Controlled Area

Limitation – *Area Classification (internal exposure)*

CS, CA: Nuclide-specific Guidance values from Swiss legislation

Specific airborne radioactivity
1 CA = effective committed dose of 20 mSv for a stay of 2000 hours/year

Specific surface contamination
1 CS = 1/10th of dose limit to skin and/or 0.5 mSv/year for daily ingestion of contamination on 10 cm^2

"No contamination"
< 1 CS for identified isotopes
< 1 Bq/cm^2 for non-identified gamma and beta emitters
< 0.1 Bq/cm^2 for non-identified alpha emitters

	Area	Dose limit [year]	Specific airborne radioactivity	Specific surface contamination
	Non-designated	1 mSv	0.05 CA	1 CS
Radiation Area	Supervised	6 mSv	0.1 CA	1 CS
	Simple	20 mSv	0.1 CA	1 CS
	Limited Stay	20 mSv	100 CA	4000 CS
	High Radiation	20 mSv	1000 CA	40000 CS
	Prohibited	20 mSv	> 1000 CA	> 40000 CS

General Principles of Radiation Protection

1. **Justification**
   Any exposure of persons to ionizing radiation has to be justified

2. **Limitation**
   The personal doses have to be kept below the legal limits

3. **Optimization**
   The personal doses and collective doses have to be kept as low as reasonably achievable (ALARA)

Optimization

Publication ICRP 103 (2007)

The Principle of Optimisation of Protection: The likelihood of incurring exposure, the number of people exposed, and the magnitude of their individual doses should all be kept as low as reasonably achievable, taking into account economic and societal factors.

The revised Recommendations emphasise the key role of the principle of optimisation. This principle should be applied in the same manner in all exposure situations. Restrictions are applied to doses to a nominal individual (the Reference Person), namely dose constraints for planned exposure situations and reference levels for emergency and existing exposure situations.

Directive 2013/59/Euratom

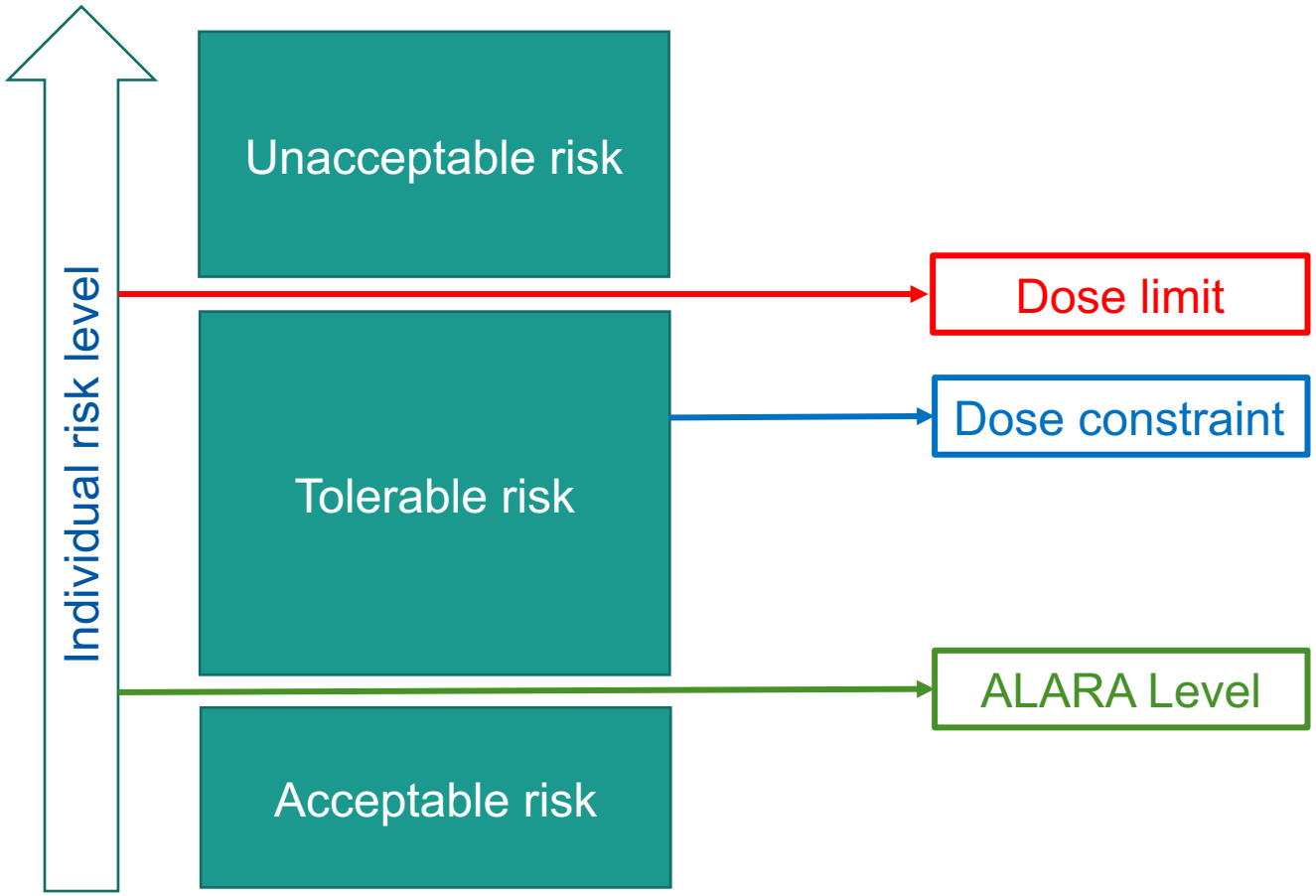
Planned exposure:

> ***"dose constraint"*** means a constraint set as a prospective upper bound of individual doses, used to define the range of options considered in the process of optimisation for a given radiation source in a planned exposure situation;

Emergency / existing exposure:

> ***"reference level"*** means in an emergency exposure situation or in an existing exposure situation, the level of effective dose or equivalent dose or activity concentration above which it is judged inappropriate to allow exposures to occur as a result of that exposure situation, even though it is not a limit that may not be exceeded;

Dose Optimization at CERN



	CERN workers		Population
	Radiation Workers	Other Workers	
Dose limit	20 mSv/yr*	1 mSv/yr	300 µSv/yr
Dose constraint	3 mSv/yr	100 µSv/yr	10 µSv/yr
	Optimization process		
ALARA Level	100 µSv/yr	10 µSv/yr	10 µSv/yr

* Apprentices and students (age 16-18): 6 mSv/yr
Pregnant women: 1mSv/yr

ALARA approach at CERN

A formalized ALARA approach is vital for a successful Radiation Protection of over 10000 Radiation Workers and is supported and enforced by the CERN management.

Optimization at CERN is **consistently implemented from design, operation to dismantling of facilities** at various levels depending on the radiological risks

Group 1 criteria define the ALARA level

ALARA Committee

Individual dose equi.	**Level I**	100 µSv	**Level II**	1 mSv	**Level III**
Collective dose equi.		500 µSv		5 mSv	

Group 2 criteria are the bases of **a radiological risk assessment** (including accidents and incident scenarios) by the RSO and HSE-RP prior to the final ALARA level classification of the intervention.

Ambient dose equivalent rate	**Level I**	50 µSv/hr	**Level II**	2 mSv/hr	**Level III**
Airborne activity in CA		5 CA		200 CA	
Surface contamination in CS		10 CS		100 CS	

Reference: "ALARA Rule applied to interventions at CERN", EDMS 1751123

Optimisation approval process for ALARA Levels 1, 2 & 3

Level		DIMR-1	DIMR-2	DIMR-3
Owner		Applicant (i.e. equipment owner, work coordinator, contract or activity responsible)		
Preparation (iterative)	WDP template	*Optional* Applicant[2]	*Mandatory* Applicant[2]	*Mandatory* Applicant[2,3]
	Provides dose rates	RP	RP	RP
	Sets DIMR level	RP and RSSO	RP and RSSO[3]	RP and RSO
	Documented work optimization process	*Optional* RSSO	*Mandatory* RP and RSSO	*Mandatory* Applicant and RSSO, RP and RSO
Inform PCR (if applicable)		on request	Yes	Yes
Approval		RSSO and RP	Dept. GL and RP[4] and RSO	Complex manager (ALARA-c)
	Veto rights	RP Group leader	Leader of the HSE unit	Director General
Follow up	**Retour d'expérience**	*Optional* RSSO	*Mandatory* RP and RSSO	*Mandatory* RSO and RP and intervention supervisor
	Closure of WDP	*Optional*: RSSO	*Mandatory:* RP	*Mandatory:* RP
	Closure of intervention (DIMR)	RSSO[5]	RSO	ALARA-committee responsible[6]
Controls		*Optional* RSSO	*Mandatory* RSSO[7]	*Mandatory* RP and RSO

ALARA Committee

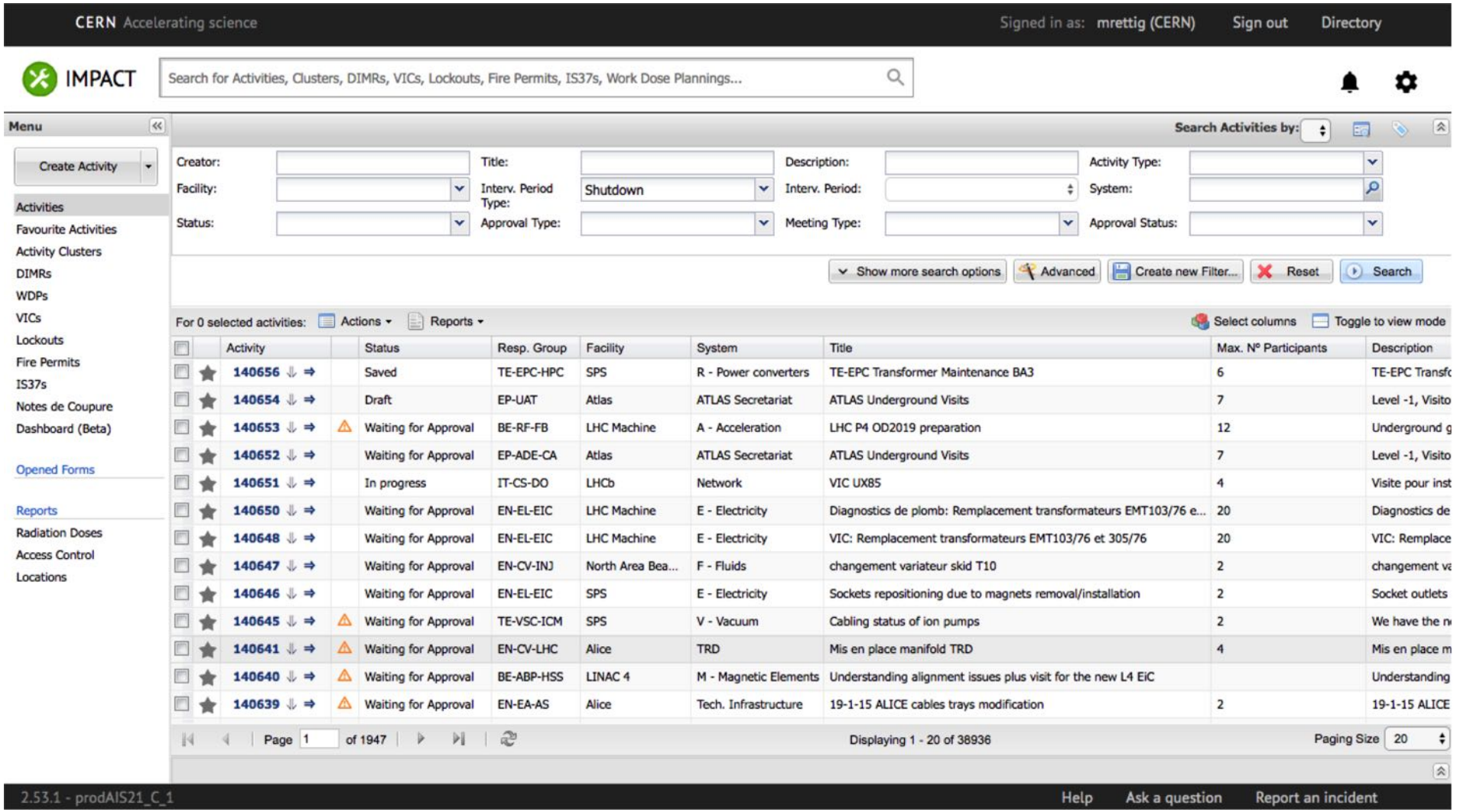
Mandatory:

- Chairperson (The Complex Manager or his deputy).
- Scientific secretary
- Radiation Safety Officer (RSO) of the intervening department.
- Group Leader (or Sub-Detector project leader) responsible for the system or equipment.
- Technical Coordinator (for interventions in an experiment).
- The RP Group Leader.

Optional:

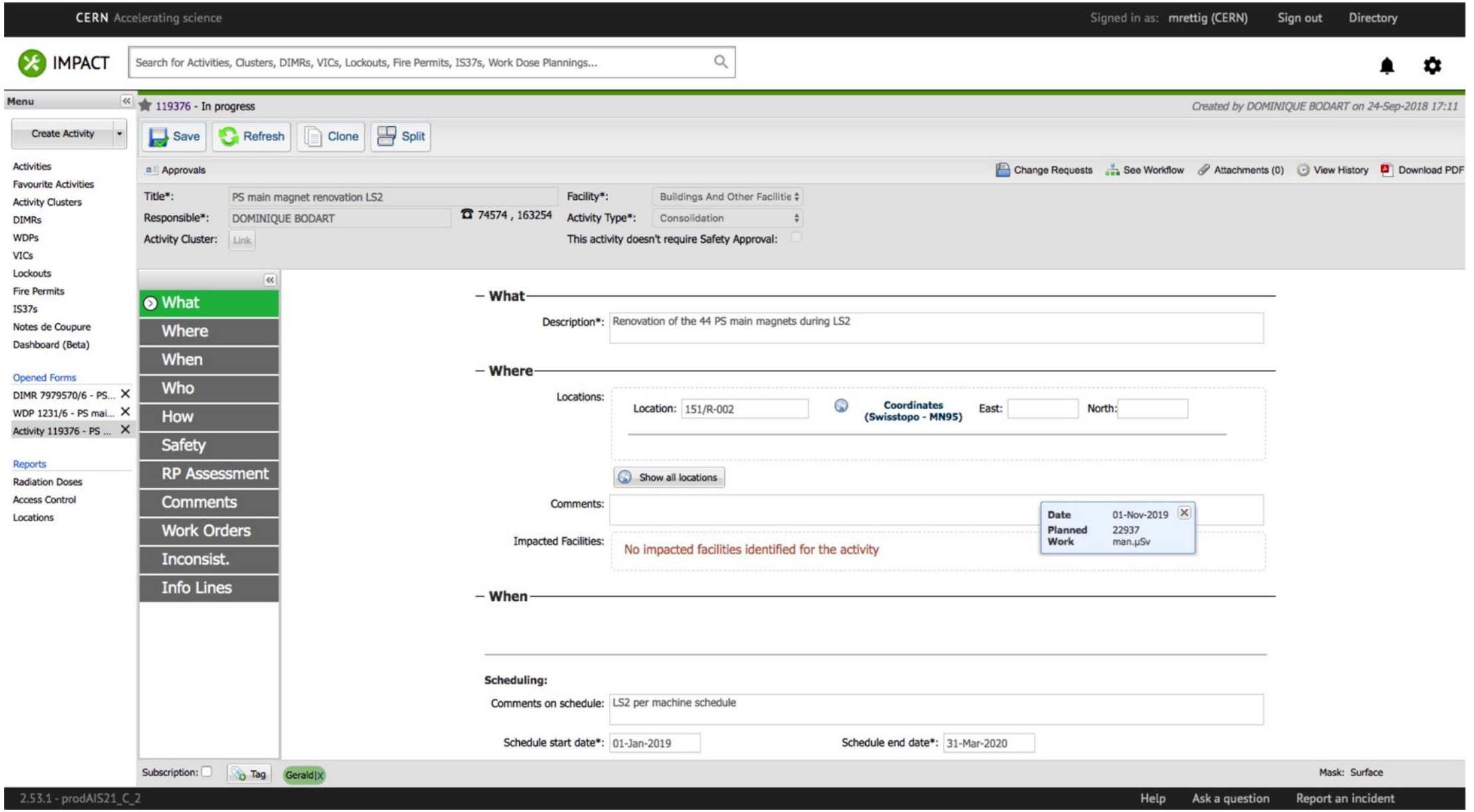
- Department heads.
- equipment experts.
- RPO involved in the DIMR.
- other RSOs/LEXGLIMOSs.
- RP section leaders

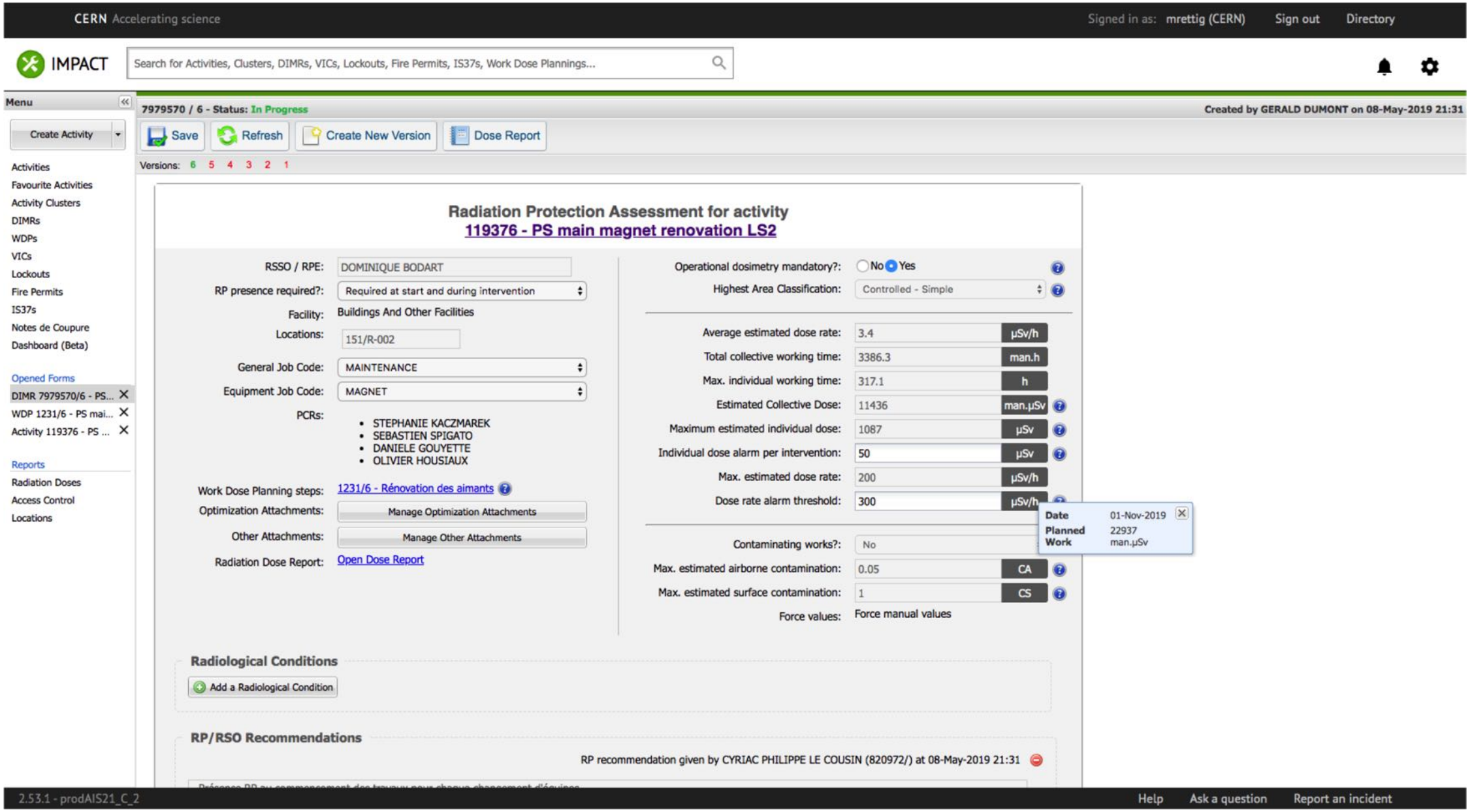
Intervention Management Planning And Coordination Tool



Used for …

- Work declaration
  - Radiography
  - Fire permit
  - Electric lockout
  - Power cut
  - Visits declarations
- Intervention approval
- Access authorisation
- Safety assessment
- Safety approval
- Radiation work permit
- Job dosimetry


CERN Accelerating science
Signed in as: mrettig (CERN)
Sign out
Directory
IMPACT
Search for Activities, Clusters, DIMRs, VICs, Lockouts, Fire Permits, IS37s, Work Dose Plannings...
Menu
Create Activity
Activities
Favourite Activities
Activity Clusters
DIMRs
WDPs
VICs
Lockouts
Fire Permits
IS37s
Notes de Coupure
Dashboard (Beta)
Opened Forms
DIMR 7979570/6 - PS...
WDP 1231/6 - PS mai...
Activity 119376 - PS ...
Reports
Radiation Doses
Access Control
Locations
119376 - In progress
Created by DOMINIQUE BODART on 24-Sep-2018 17:11
Save
Refresh
Clone
Split
Approvals
Change Requests
See Workflow
Attachments (0)
View History
Download PDF
Title*: PS main magnet renovation LS2
Responsible*: DOMINIQUE BODART
☎ 74574 , 163254
Activity Cluster: Link
Facility*: Buildings And Other Facilitie
Activity Type*: Consolidation
This activity doesn't require Safety Approval:
What
Where
When
Who
How
Safety
RP Assessment
Comments
Work Orders
Inconsist.
Info Lines
What
Description*: Renovation of the 44 PS main magnets during LS2
Where
Locations:
Location: 151/R-002
Coordinates (Swisstopo - MN95)
East:
North:
Show all locations
Comments:
Date 01-Nov-2019
Planned Work 22937 man.µSv
Impacted Facilities:
No impacted facilities identified for the activity
When
Scheduling:
Comments on schedule: LS2 per machine schedule
Schedule start date*: 01-Jan-2019
Schedule end date*: 31-Mar-2020
Subscription:
Tag
Gerald|X
Mask: Surface
2.53.1 - prodAIS21_C_2
Help
Ask a question
Report an incident


CERN Accelerating science
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IMPACT
Search for Activities, Clusters, DIMRs, VICs, Lockouts, Fire Permits, IS37s, Work Dose Plannings...
Menu
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WDPs
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Lockouts
Fire Permits
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Notes de Coupure
Dashboard (Beta)
Opened Forms
DIMR 7979570/6 - PS...
WDP 1231/6 - PS mai...
Activity 119376 - PS ...
Reports
Radiation Doses
Access Control
Locations
7979570 / 6 - Status: In Progress
Created by GERALD DUMONT on 08-May-2019 21:31
Save
Refresh
Create New Version
Dose Report
Versions: 6 5 4 3 2 1
Radiation Protection Assessment for activity
119376 - PS main magnet renovation LS2
RSSO / RPE: DOMINIQUE BODART
RP presence required?: Required at start and during intervention
Facility: Buildings And Other Facilities
Locations: 151/R-002
General Job Code: MAINTENANCE
Equipment Job Code: MAGNET
PCRs:
STEPHANIE KACZMAREK
SEBASTIEN SPIGATO
DANIELE GOUYETTE
OLIVIER HOUSIAUX
Work Dose Planning steps: 1231/6 - Rénovation des aimants
Optimization Attachments: Manage Optimization Attachments
Other Attachments: Manage Other Attachments
Radiation Dose Report: Open Dose Report
Operational dosimetry mandatory?: No Yes
Highest Area Classification: Controlled - Simple
Average estimated dose rate: 3.4 µSv/h
Total collective working time: 3386.3 man.h
Max. individual working time: 317.1 h
Estimated Collective Dose: 11436 man.µSv
Maximum estimated individual dose: 1087 µSv
Individual dose alarm per intervention: 50 µSv
Max. estimated dose rate: 200 µSv/h
Dose rate alarm threshold: 300 µSv/h
Date 01-Nov-2019
Planned Work 22937 man.µSv
Contaminating works?: No
Max. estimated airborne contamination: 0.05 CA
Max. estimated surface contamination: 1 CS
Force values: Force manual values
Radiological Conditions
Add a Radiological Condition
RP/RSO Recommendations
RP recommendation given by CYRIAC PHILIPPE LE COUSIN (820972/) at 08-May-2019 21:31
2.53.1 - prodAIS21_C_2
Help
Ask a question
Report an incident

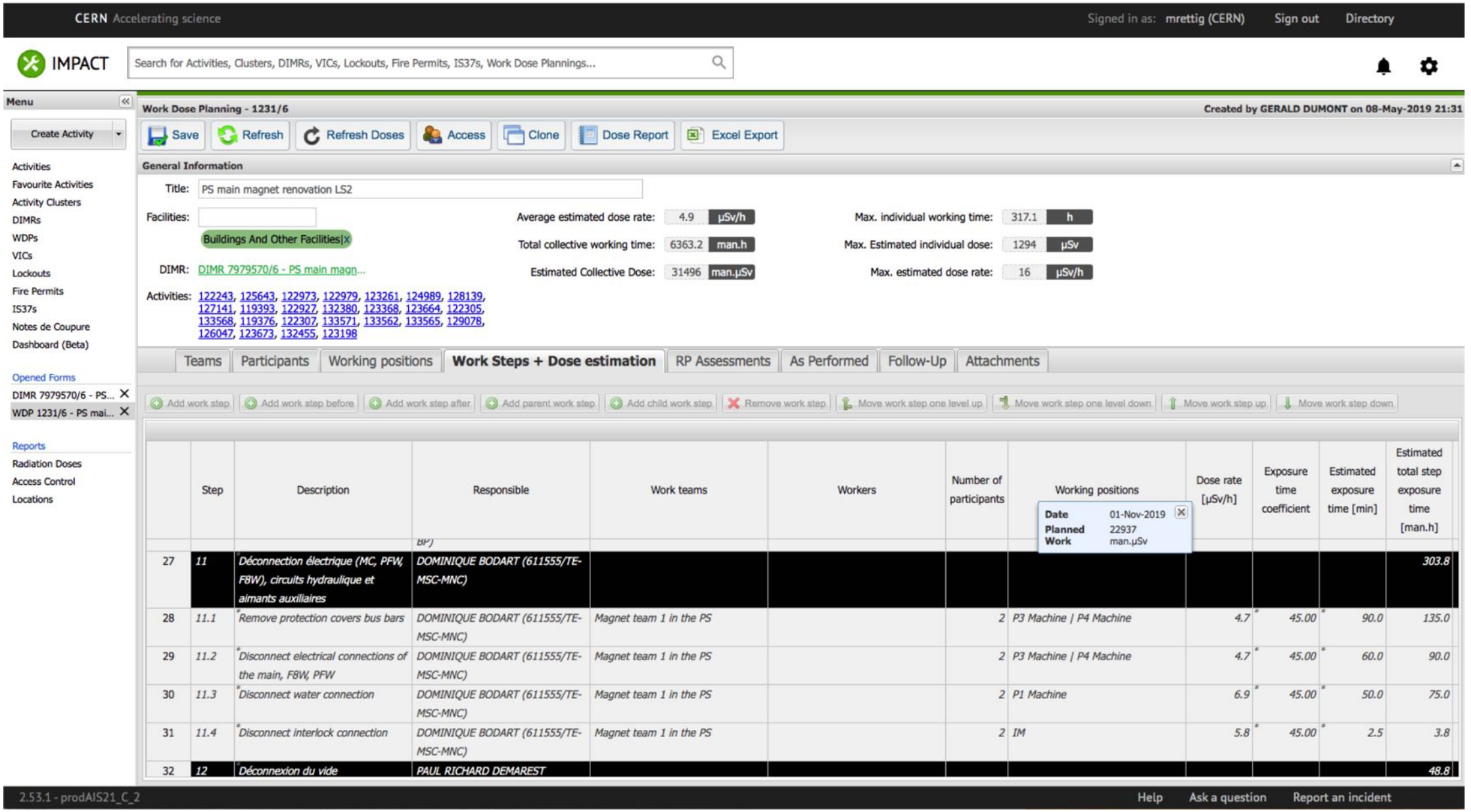
Actors and Objectives of the Work and Dose Planning (WDP)

Actors:

- Requester initiates the WDP (knowledge of location, equipment, required resources and work to be done)
- RSSO (equipment group) and RSO (department) provide support
- RPO (Radiation Protection Officer) contributes RP relevant information (dose rates, level of contamination, experience)
- « Radiation Protection expert » of external company are included, in case contractors are involved in the work

Objective

- Optimise the work procedures and planning such to reduce exposure and overall risks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Directory
IMPACT
Search for Activities, Clusters, DIMRs, VICs, Lockouts, Fire Permits, IS37s, Work Dose Plannings...
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Favourite Activities
Activity Clusters
DIMRs
WDPs
VICs
Lockouts
Fire Permits
IS37s
Notes de Coupure
Dashboard (Beta)
Opened Forms
DIMR 7979570/6 - PS...
WDP 1231/6 - PS mai...
Reports
Radiation Doses
Access Control
Locations
Work Dose Planning - 1231/6
Created by GERALD DUMONT on 08-May-2019 21:31
Save
Refresh
Refresh Doses
Access
Clone
Dose Report
Excel Export
General Information
Title: PS main magnet renovation LS2
Facilities:
Buildings And Other Facilities
DIMR: DIMR 7979570/6 - PS main magn...
Activities: 122243, 125643, 122973, 122979, 123261, 124989, 128139, 127141, 119393, 122927, 132380, 123368, 123664, 122305, 133568, 119376, 122307, 133571, 133562, 133565, 129078, 126047, 123673, 132455, 123198
Average estimated dose rate: 4.9 µSv/h
Total collective working time: 6363.2 man.h
Estimated Collective Dose: 31496 man.µSv
Max. individual working time: 317.1 h
Max. Estimated individual dose: 1294 µSv
Max. estimated dose rate: 16 µSv/h
Teams
Participants
Working positions
Work Steps + Dose estimation
RP Assessments
As Performed
Follow-Up
Attachments
Add work step
Add work step before
Add work step after
Add parent work step
Add child work step
Remove work step
Move work step one level up
Move work step one level down
Move work step up
Move work step down
Step
Description
Responsible
Work teams
Workers
Number of participants
Working positions
Dose rate [µSv/h]
Exposure time coefficient
Estimated exposure time [min]
Estimated total step exposure time [man.h]
Date 01-Nov-2019
Planned Work 22937 man.µSv
27 11 Déconnection électrique (MC, PFW, F8W), circuits hydraulique et aimants auxiliaires DOMINIQUE BODART (611555/TE-MSC-MNC) 303.8
28 11.1 Remove protection covers bus bars DOMINIQUE BODART (611555/TE-MSC-MNC) Magnet team 1 in the PS 2 P3 Machine | P4 Machine 4.7 45.00 90.0 135.0
29 11.2 Disconnect electrical connections of the main, F8W, PFW DOMINIQUE BODART (611555/TE-MSC-MNC) Magnet team 1 in the PS 2 P3 Machine | P4 Machine 4.7 45.00 60.0 90.0
30 11.3 Disconnect water connection DOMINIQUE BODART (611555/TE-MSC-MNC) Magnet team 1 in the PS 2 P1 Machine 6.9 45.00 50.0 75.0
31 11.4 Disconnect interlock connection DOMINIQUE BODART (611555/TE-MSC-MNC) Magnet team 1 in the PS 2 IM 5.8 45.00 2.5 3.8
32 12 Déconnexion du vide PAUL RICHARD DEMAREST 48.8
2.53.1 - prodAIS21_C_2
Help
Ask a question
Report an incident

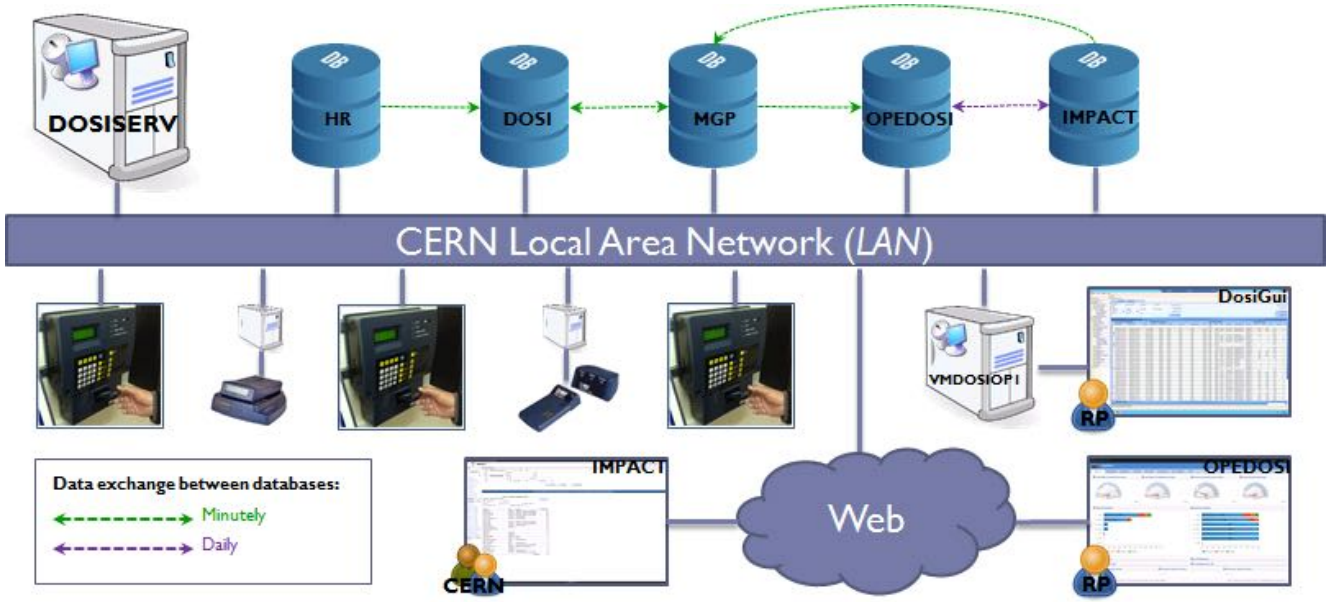
Follow up of Operational Dosimetry

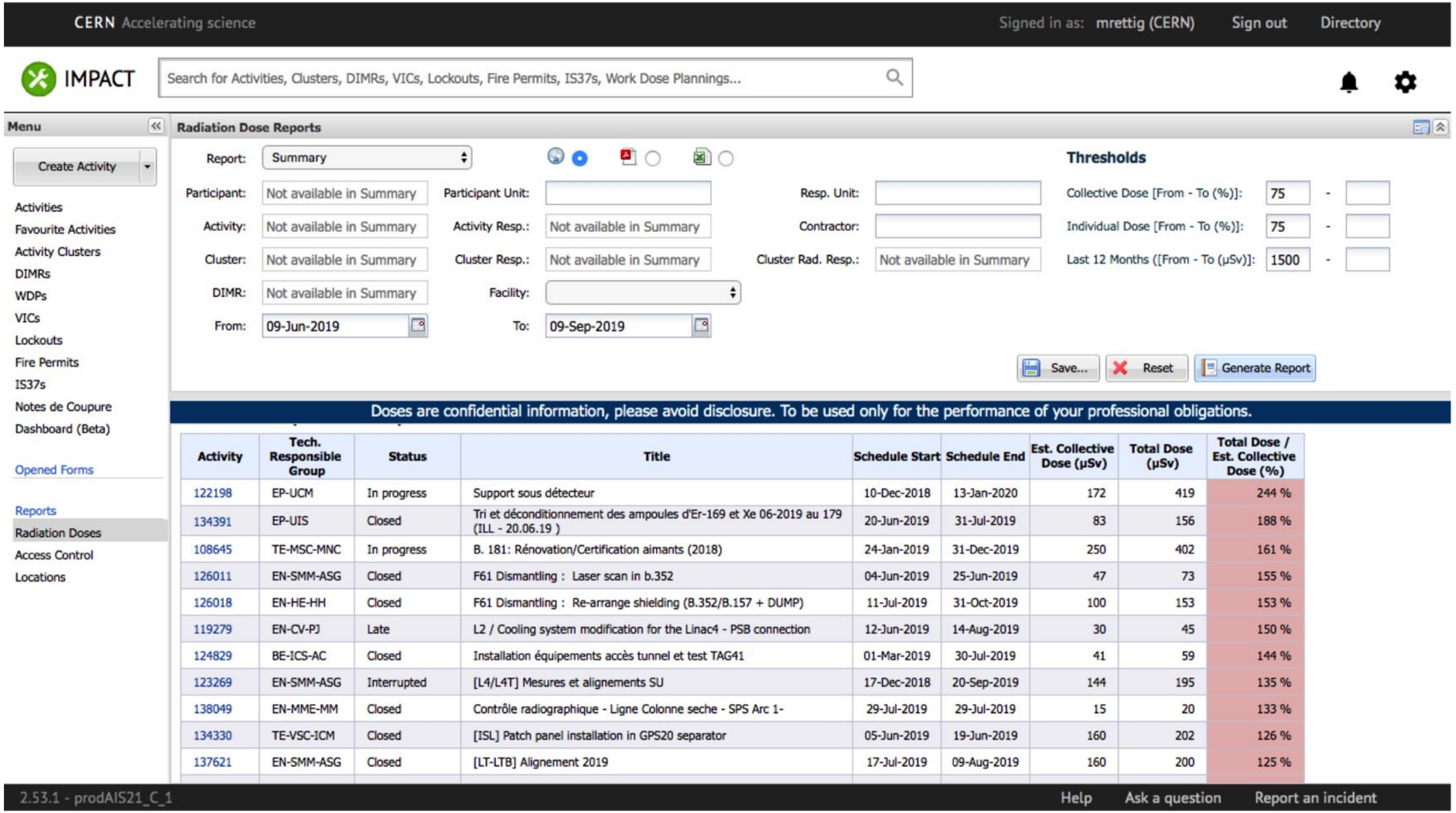
Doses are automatically recorded and assigned to the job code (IMPACT)

Check of operational doses: daily by RPO

If collective dose exceeds the estimate by 50% or the individual dose exceeds by 30%:

- Work on hold and reassessment of situation
- Re-approval required

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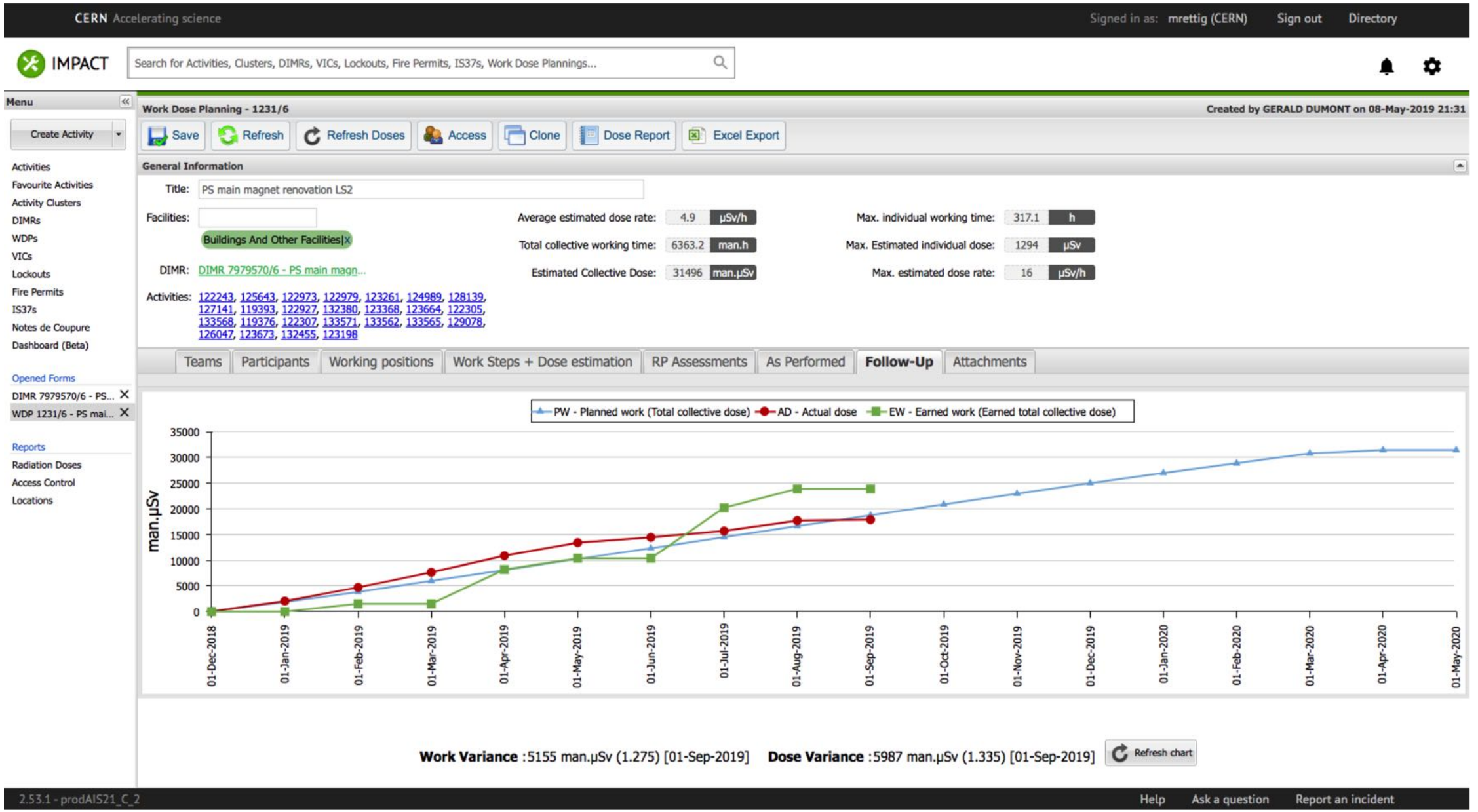
Reports
Radiation Doses
Access Control
Locations
Radiation Dose Reports
Report: Summary
Participant: Not available in Summary
Participant Unit:
Resp. Unit:
Activity: Not available in Summary
Activity Resp.: Not available in Summary
Contractor:
Cluster: Not available in Summary
Cluster Resp.: Not available in Summary
Cluster Rad. Resp.: Not available in Summary
DIMR: Not available in Summary
Facility:
From: 09-Jun-2019
To: 09-Sep-2019
Thresholds
Collective Dose [From - To (%)]: 75 -
Individual Dose [From - To (%)]: 75 -
Last 12 Months ([From - To (µSv)]: 1500 -
Save...
Reset
Generate Report
Doses are confidential information, please avoid disclosure. To be used only for the performance of your professional obligations.
Activity | Tech. Responsible Group | Status | Title | Schedule Start | Schedule End | Est. Collective Dose (µSv) | Total Dose (µSv) | Total Dose / Est. Collective Dose (%)
122198 | EP-UCM | In progress | Support sous détecteur | 10-Dec-2018 | 13-Jan-2020 | 172 | 419 | 244 %
134391 | EP-UIS | Closed | Tri et déconditionnement des ampoules d'Er-169 et Xe 06-2019 au 179 (ILL - 20.06.19) | 20-Jun-2019 | 31-Jul-2019 | 83 | 156 | 188 %
108645 | TE-MSC-MNC | In progress | B. 181: Rénovation/Certification aimants (2018) | 24-Jan-2019 | 31-Dec-2019 | 250 | 402 | 161 %
126011 | EN-SMM-ASG | Closed | F61 Dismantling : Laser scan in b.352 | 04-Jun-2019 | 25-Jun-2019 | 47 | 73 | 155 %
126018 | EN-HE-HH | Closed | F61 Dismantling : Re-arrange shielding (B.352/B.157 + DUMP) | 11-Jul-2019 | 31-Oct-2019 | 100 | 153 | 153 %
119279 | EN-CV-PJ | Late | L2 / Cooling system modification for the Linac4 - PSB connection | 12-Jun-2019 | 14-Aug-2019 | 30 | 45 | 150 %
124829 | BE-ICS-AC | Closed | Installation équipements accès tunnel et test TAG41 | 01-Mar-2019 | 30-Jul-2019 | 41 | 59 | 144 %
123269 | EN-SMM-ASG | Interrupted | [L4/L4T] Mesures et alignements SU | 17-Dec-2018 | 20-Sep-2019 | 144 | 195 | 135 %
138049 | EN-MME-MM | Closed | Contrôle radiographique - Ligne Colonne seche - SPS Arc 1- | 29-Jul-2019 | 29-Jul-2019 | 15 | 20 | 133 %
134330 | TE-VSC-ICM | Closed | [ISL] Patch panel installation in GPS20 separator | 05-Jun-2019 | 19-Jun-2019 | 160 | 202 | 126 %
137621 | EN-SMM-ASG | Closed | [LT-LTB] Alignement 2019 | 17-Jul-2019 | 09-Aug-2019 | 160 | 200 | 125 %
2.53.1 - prodAIS21_C_1
Help
Ask a question
Report an incident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Teams
Participants
Working positions
Work Steps + Dose estimation
RP Assessments
As Performed
Follow-Up
Attachments
PW - Planned work (Total collective dose)
AD - Actual dose
EW - Earned work (Earned total collective dose)
man.µSv
35000
30000
25000
20000
15000
10000
5000
0
01-Dec-2018
01-Jan-2019
01-Feb-2019
01-Mar-2019
01-Apr-2019
01-May-2019
01-Jun-2019
01-Jul-2019
01-Aug-2019
01-Sep-2019
01-Oct-2019
01-Nov-2019
01-Dec-2019
01-Jan-2020
01-Feb-2020
01-Mar-2020
01-Apr-2020
01-May-2020
Work Variance :5155 man.µSv (1.275) [01-Sep-2019]
Dose Variance :5987 man.µSv (1.335) [01-Sep-2019]
Refresh chart
2.53.1 - prodAIS21_C_2
Help
Ask a question
Report an incident

Personal Dosimetry

Distribution of personal doses over different dose intervals

Dose interval (mSv)	Persons Concerned	Persons Concerned	Persons Concerned	Persons Concerned	Persons Concerned	Persons Concerned	Persons Concerned	Persons Concerned	Persons Concerned	Persons Concerned	Persons Concerned	Persons Concerned
years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0.0	5131	5143	5042	5418	5315	6002	6273	7616	8704	8788	9034	9802
0.1-0.9	898	1020	1219	1514	1984	2030	2188	1816	1108	1003	1110	1285
1.0-1.9	33	40	39	31	31	29	82	133	2	11	3	7
2.0-2.9	2	3	13	6	7	0	3	14	0	0	0	0
3.0-3.9	1	1	2	0	0	0	0	1	0	0	0	0
4.0-4.9	1	1	0	0	0	0	0	0	0	0	0	0
5.0-5.9	0	0	0	0	0	0	0	0	0	0	0	0
> 6.0	0	0	0	0	0	0	0	0	0	0	0	0
SUM PERS	6066	6208	6315	6969	7337	8061	8546	9580	9814	9802	10147	11094

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Economic Affairs SECO
Swiss Accreditation Service SAS

Based on the Accreditation and Designation Ordinance dated 17 June 1996 and on the advice of the Federal Accreditation Commission, the Swiss Accreditation Service (SAS) grants to the

Dosimetry Service CERN
385 Route de Meyrin
1217 Meyrin

Period of accreditation:
11.12.2017 until 10.12.2022
(1st accreditation: 11.12.2017)

the accreditation as

Testing laboratory for individual dosimetric monitoring

International standard: ISO/IEC 17025:2005
Swiss standard: SN EN ISO/IEC 17025:2005

3003 Berne, 08.12.2017
Swiss Accreditation Service SAS

Head of SAS
Konrad Flück

SAS is a signatory of the multilateral agreements of the European co-operation for Accreditation (EA) for the fields of testing, calibration, inspection and certification of management systems, certification of personnel and certification of products, processes and services, of the International Accreditation Forum (IAF) for the fields of certification of management systems and certification of products, processes and services and of the International Laboratory Accreditation Cooperation (ILAC) for the fields of testing and calibration.

⇒ The majority of monitored persons at CERN receive a negligible dose

During the last years, only a few persons received doses exceeding 1 mSv

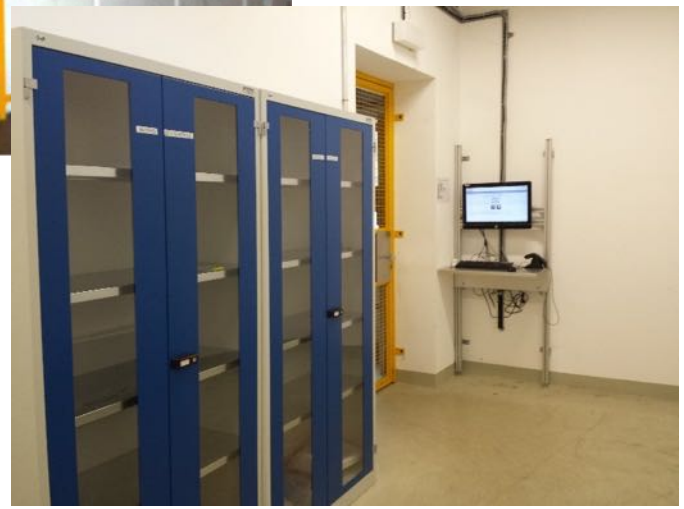
Dosimetry Service accredited according to ISO 17025

Traceability & Buffer zones

- TREC (Traceability of Radioactive Equipment at CERN)
  - Store measurement records
  - Trace the location of all radioactive equipment
- **All material from an activation zone** is considered potentially radioactive and must be controlled by RP.
- Material must be left in a **Buffer Zone** and a measurement request must be registered in the TREC system.
- TREC can generate the electronic documents for the removal of equipment:
  - EDH internal transport
  - EDH stocking/destocking
  - EDH shipping

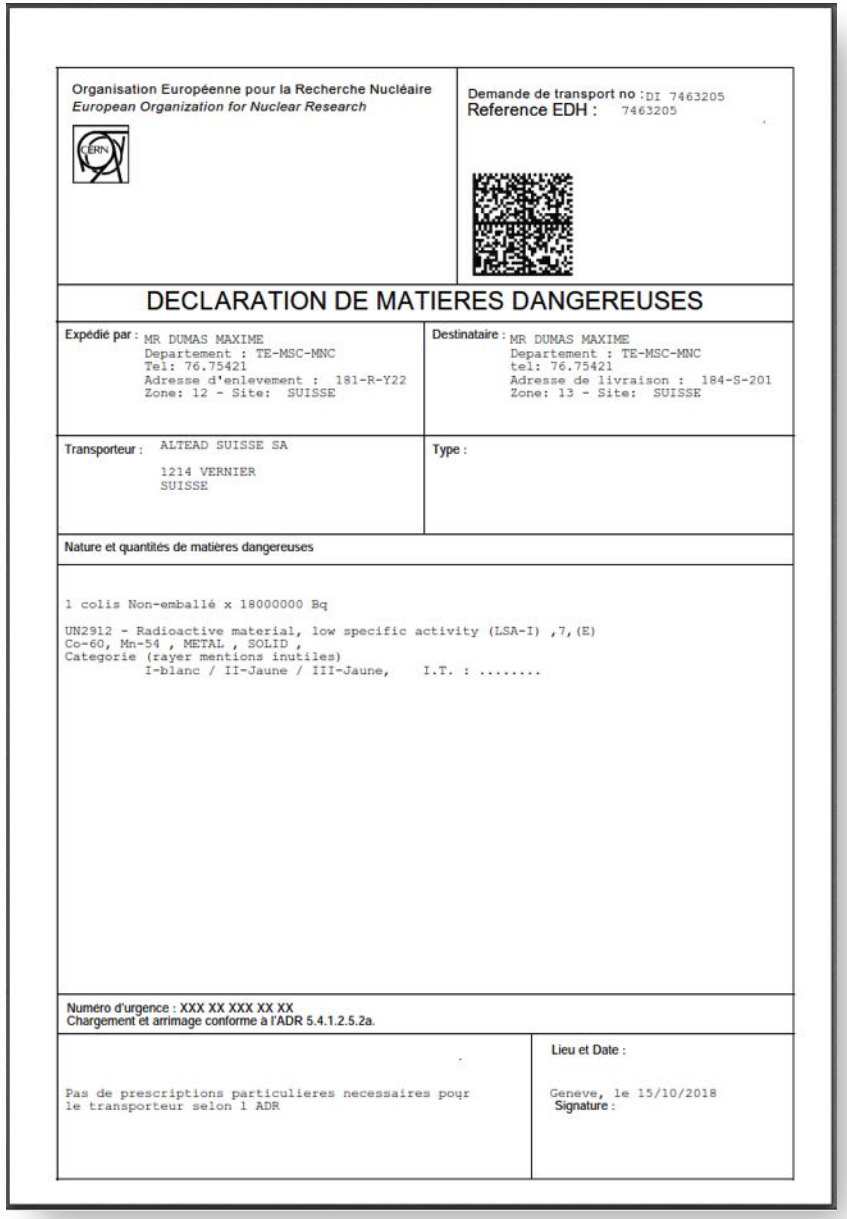
TREC

Welcome to EAM TREC



Internal radioactive transport

- **Before** any internal radioative material transport (intra and intersite) **an EDH request is obligatory**:
  - EDH internal transport request
  - EDH stocking/destocking request
- Internal Transport submitted to ADR European regulation:
- On departure and during the transport: **Dangerous Good Declaration** (DGD) obligatory
- CERN vehicle obligatory
- **Self-Transport authorised** only if classified as exempted by the RP transport service. If not the transport must be done by internal transport services.



Organisation Européenne pour la Recherche Nucléaire
European Organization for Nuclear Research

Demande de transport no : DI 7463205
Reference EDH : 7463205

DECLARATION DE MATIERES DANGEREUSES

Expédié par : MR DUMAS MAXIME
Departement : TE-MSC-MNC
Tel: 76.75421
Adresse d'enlevement : 181-R-Y22
Zone: 12 - Site: SUISSE

Destinataire : MR DUMAS MAXIME
Departement : TE-MSC-MNC
tel: 76.75421
Adresse de livraison : 184-S-201
Zone: 13 - Site: SUISSE

Transporteur : ALTEAD SUISSE SA
1214 VERNIER
SUISSE

Type :

Nature et quantités de matières dangereuses

1 colis Non-emballé x 18000000 Bq

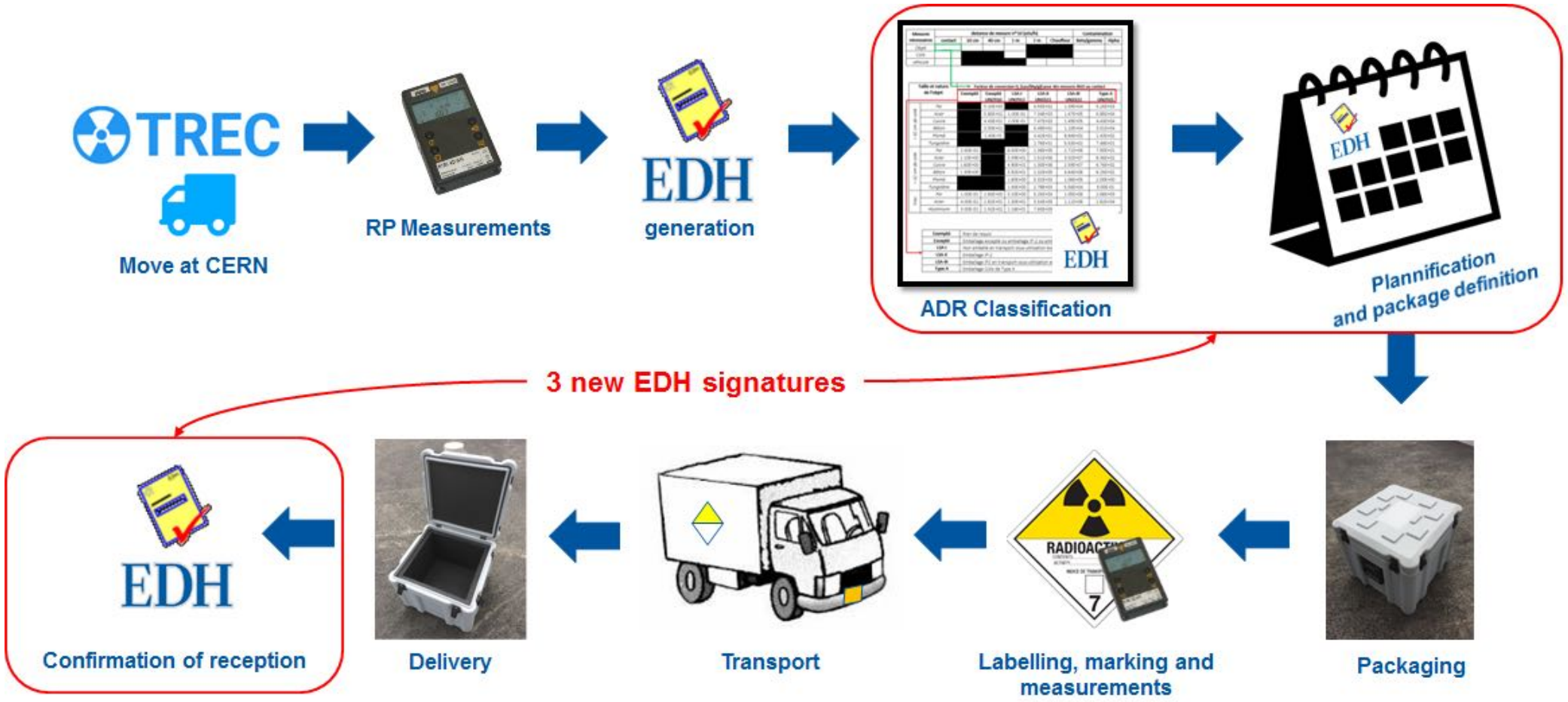
UN2912 - Radioactive material, low specific activity (LSA-I) ,7,(E)
Co-60, Mn-54 , METAL , SOLID ,
Categorie (rayer mentions inutiles)
I-blanc / II-Jaune / III-Jaune, I.T. : .....

Numéro d'urgence : XXX XX XXX XX XX
Chargement et arrimage conforme à l'ADR 5.4.1.2.5.2a.

Pas de prescriptions particulieres necessaires pour le transporteur selon l ADR

Lieu et Date :
Geneve, le 15/10/2018
Signature :

Organization internal radioactive transport



Radioactive workshops

Maintenance (destructive/non-distructive work) on radioactive equipment must be performed in dedicated classified workshops

Radioactive Waste

Tripartite agreement

Elimination through pathways available in France and Switzerland independent of where on the CERN sites the waste was produced.

Fair distribution of waste between the two Host States taking into account quantity, toxicity and total activity of the radioactive waste but also the cost effectiveness of the disposal: “Free release” according to Swiss rules accepted by France.

Example of “Free release” of waste towards Switzerland:

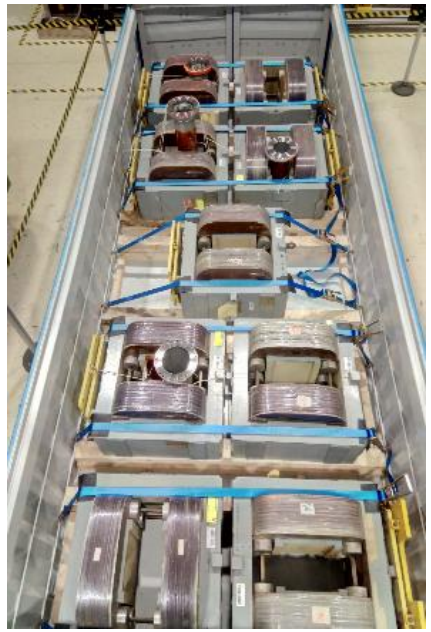
LEP Acceleration RF system

421 tons of waste, corresponding to 1800 m^3 of space in the storage

Example for elimination of radioactive waste (TFA) towards France:

Shredded metallic waste

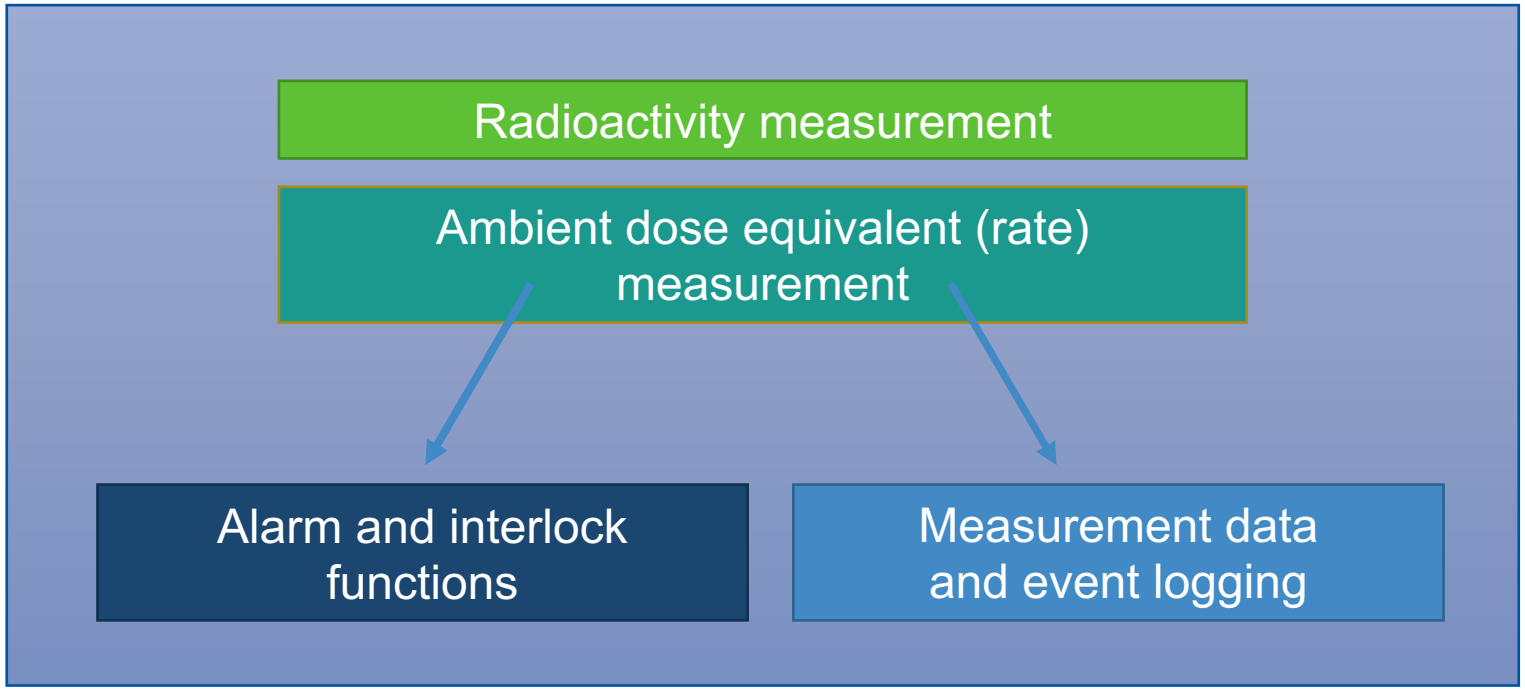
Magnets



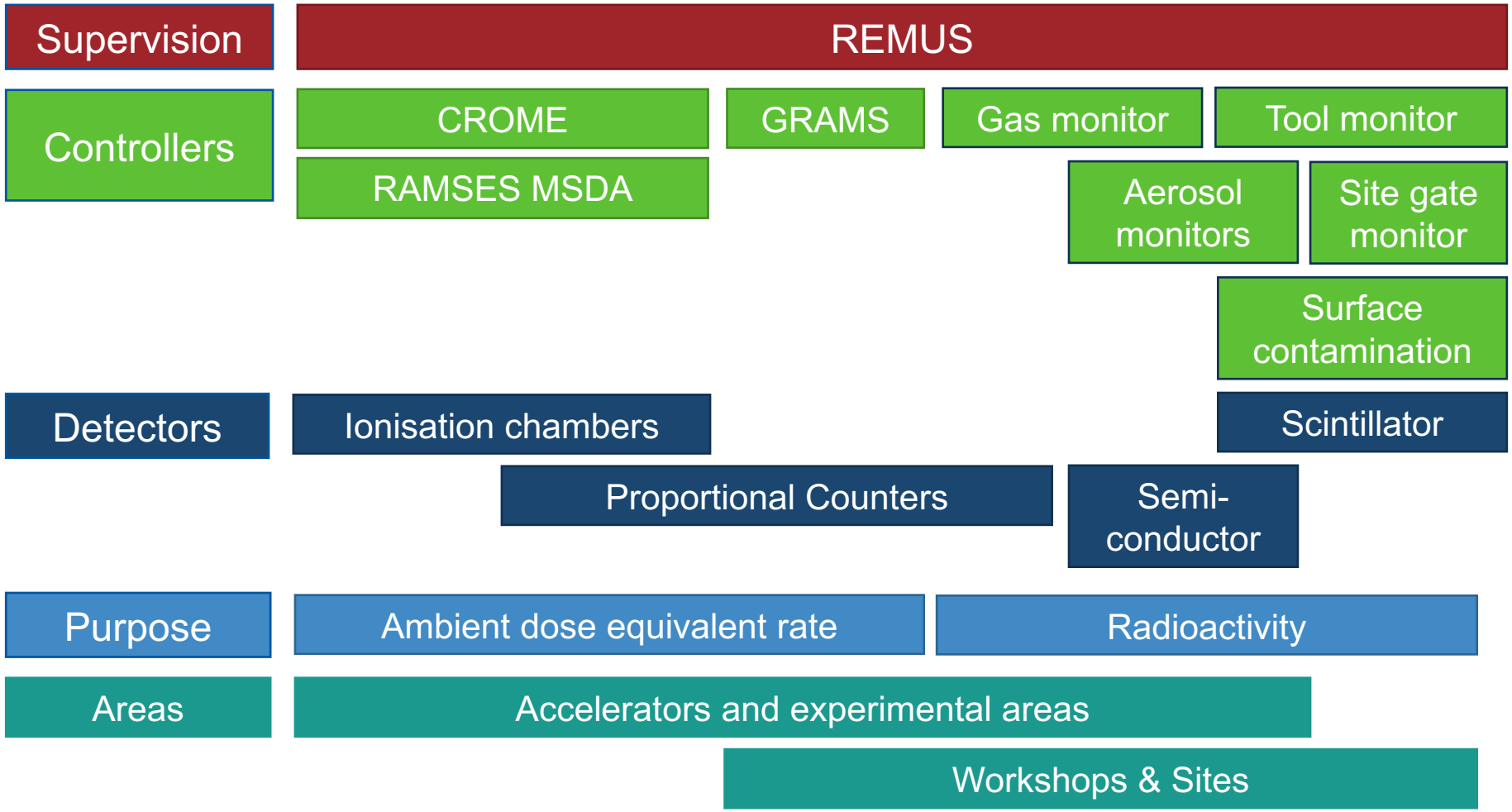
Sorting and packaging of waste

- New packaging should not go into the Radiation Areas.
- All outgoing waste from accelerator and target areas that was exposed to beam is potentially radioactive.
- **CADRA** (Acceptance Criteria for Radioactive waste): waste must be sorted and packaged correctly. Waste management should be considered in the work and activity preparation
- **The cost for containers** must be included in the budget for activities or projects.

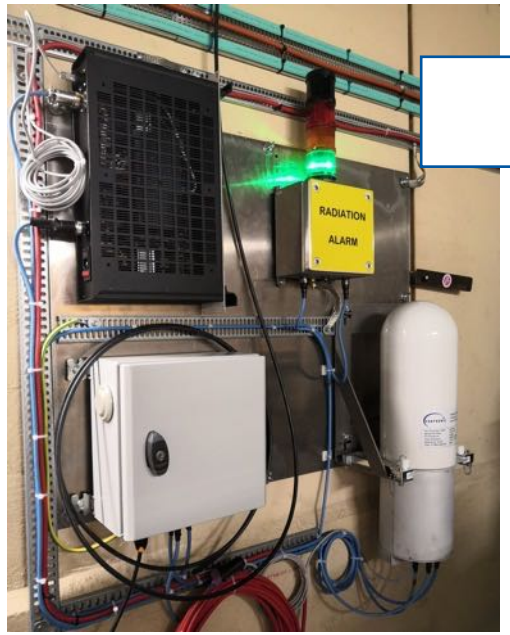
Radiation Monitoring



Area monitoring and detectors – an overview



Radiation Protection instrumentation



AGM/AMF
CERN

AGM/AMF
CERN/SAPHYMO

IAM/XRM
CERN/SAPHYMO

SWENDI
THERMO

SGM
NOVELEC/SAPHYMO

RAMSES MSDA
CERN/SAPHYMO

GRAMS
Berthold Tech
LB112 + probes

Gas monitor
Berthold Tech BAI9109

Aerosol monitor
Mirion ABPM 203M

Hand-Foot-Monitor
SEA H.F.K.

Hand-Foot-Monitor
Berthold Tech LB147

Environmental protection instrumentation

Stray radiation monitoring
EPIC + ERC (CERN/SAPHYMO)

Aerosol monitoring
Canberra iCAM

Aerosol sampler
CERN/SAPHYMO

Reference monitor
GE Reuter-Stokes

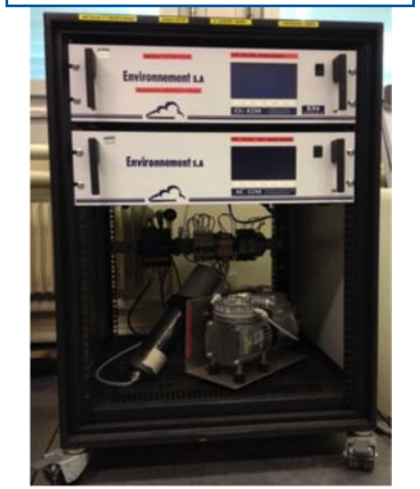
Radon monitoring
RADHOME

Ventilation monitoring
CERN/SAPHYMO

Water monitoring station
WMS – CERN SMART

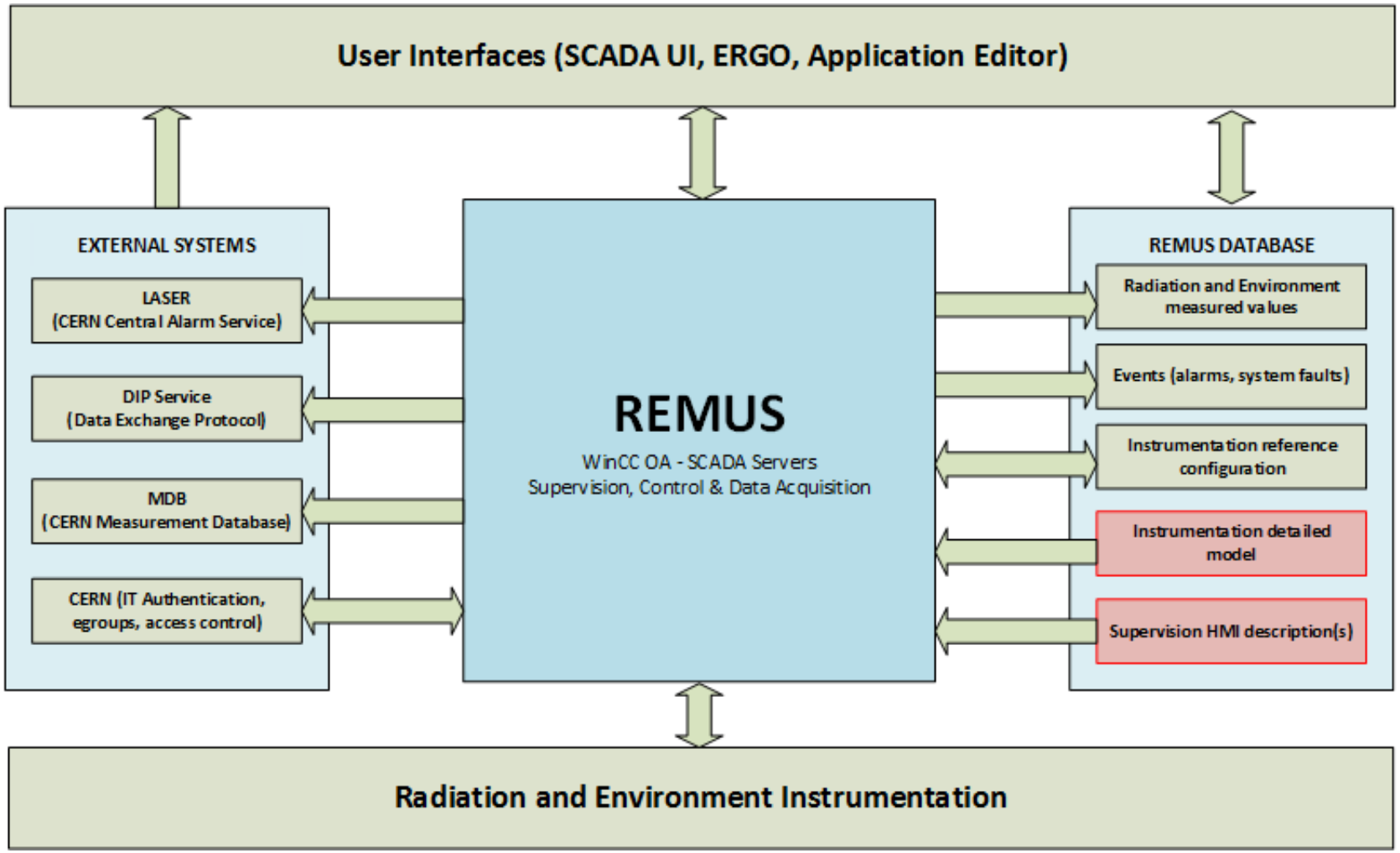
Meteorology Monitoring

Air quality monitoring

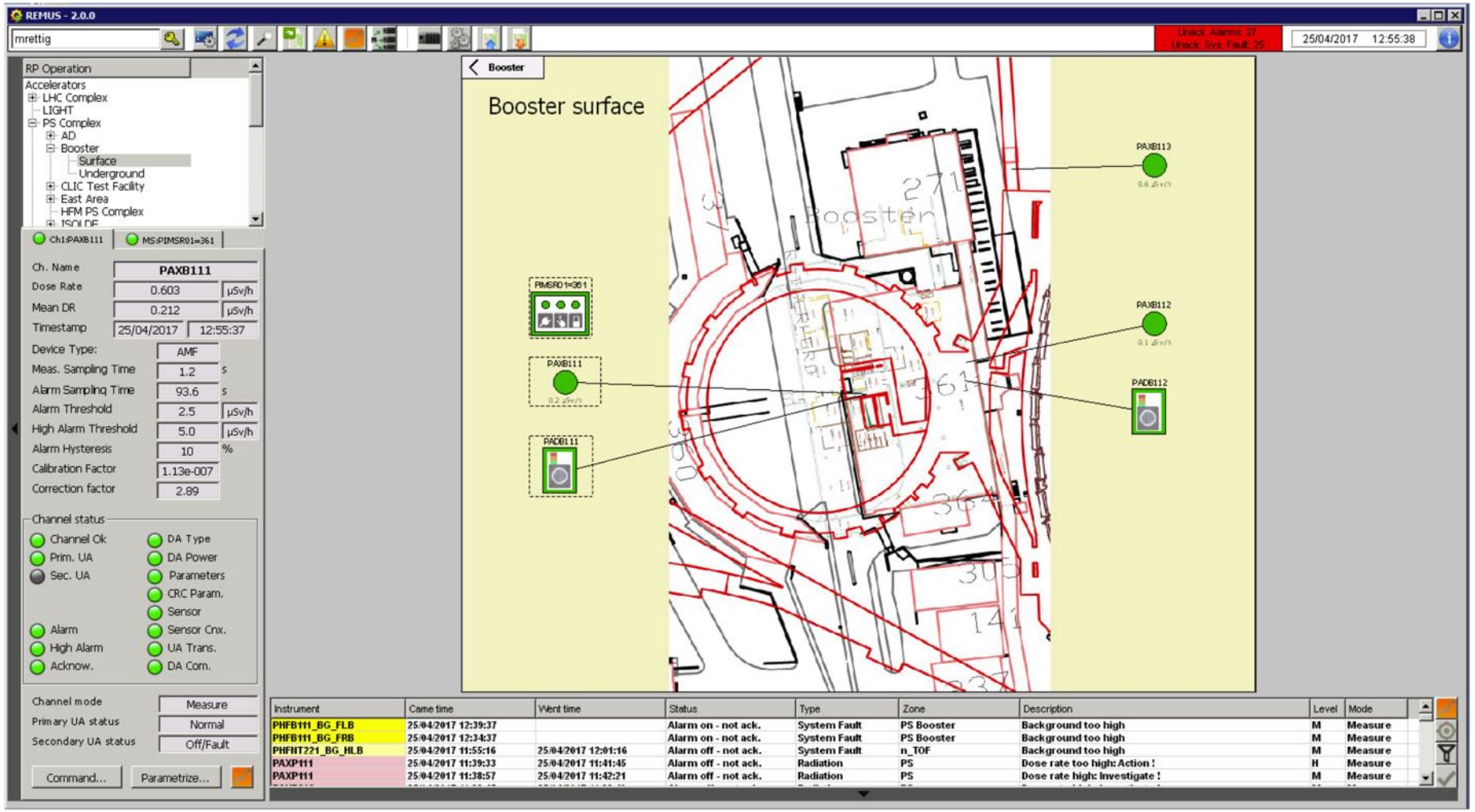


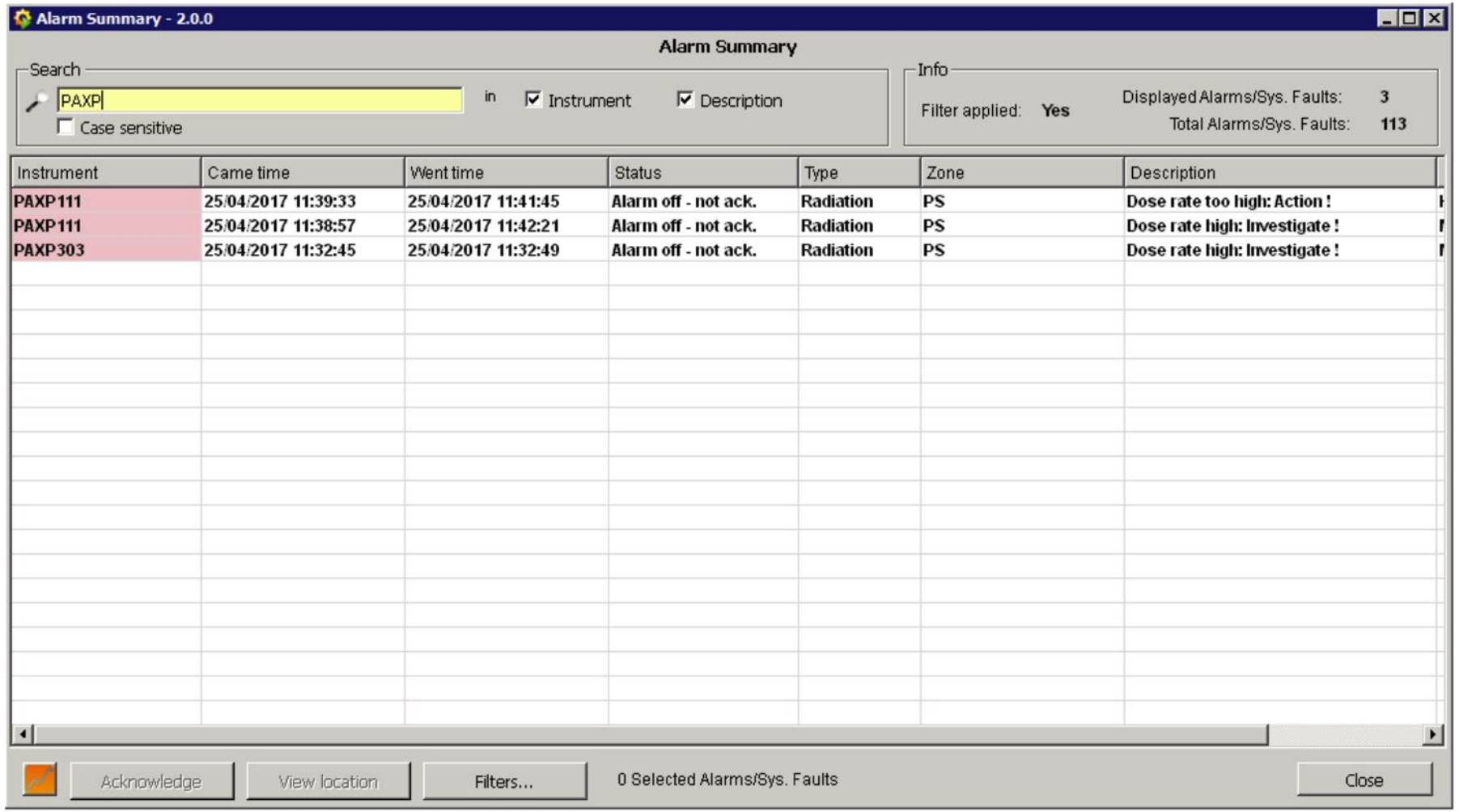
Hydrocarbon detector

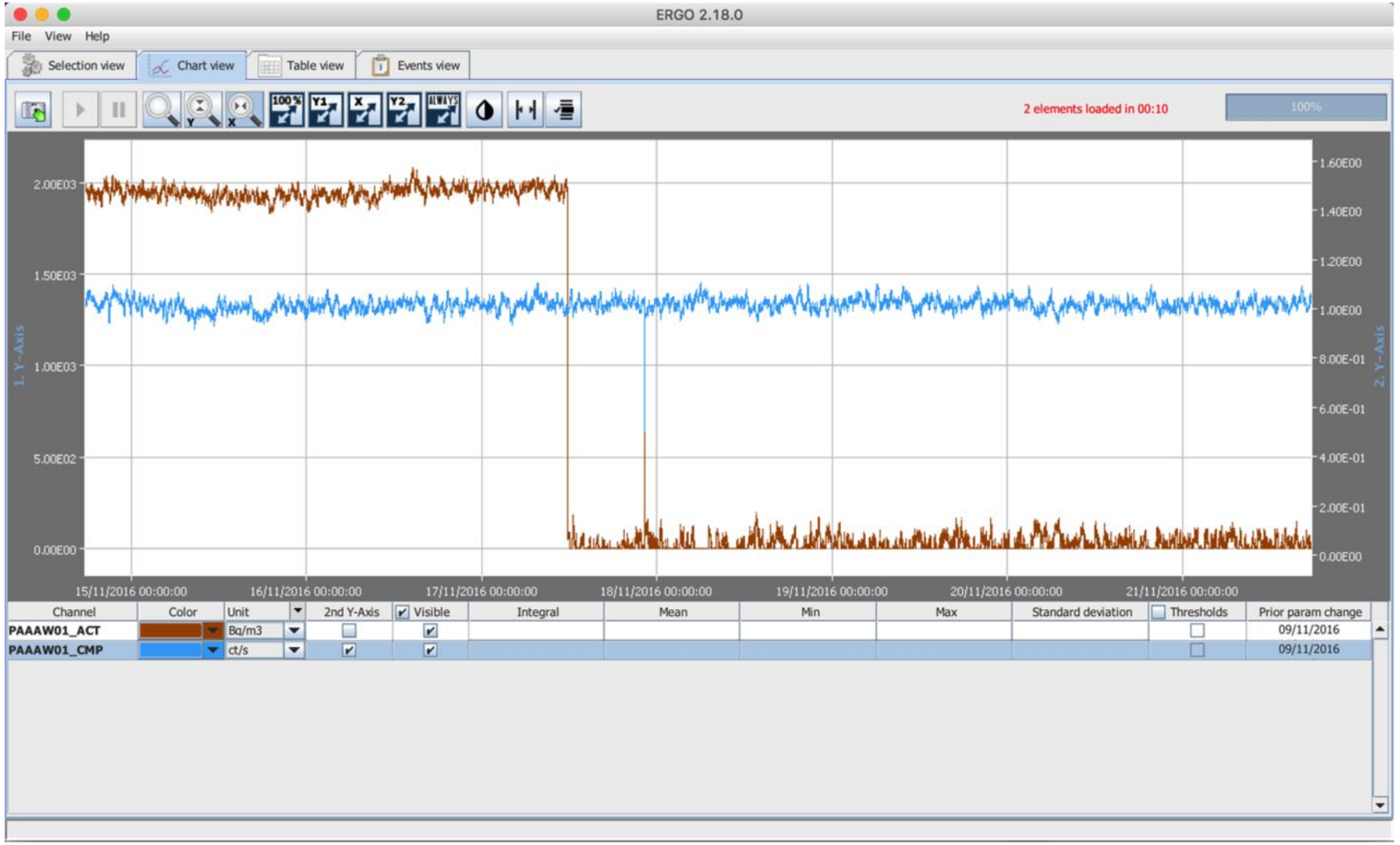
REMUS Functional Architecture



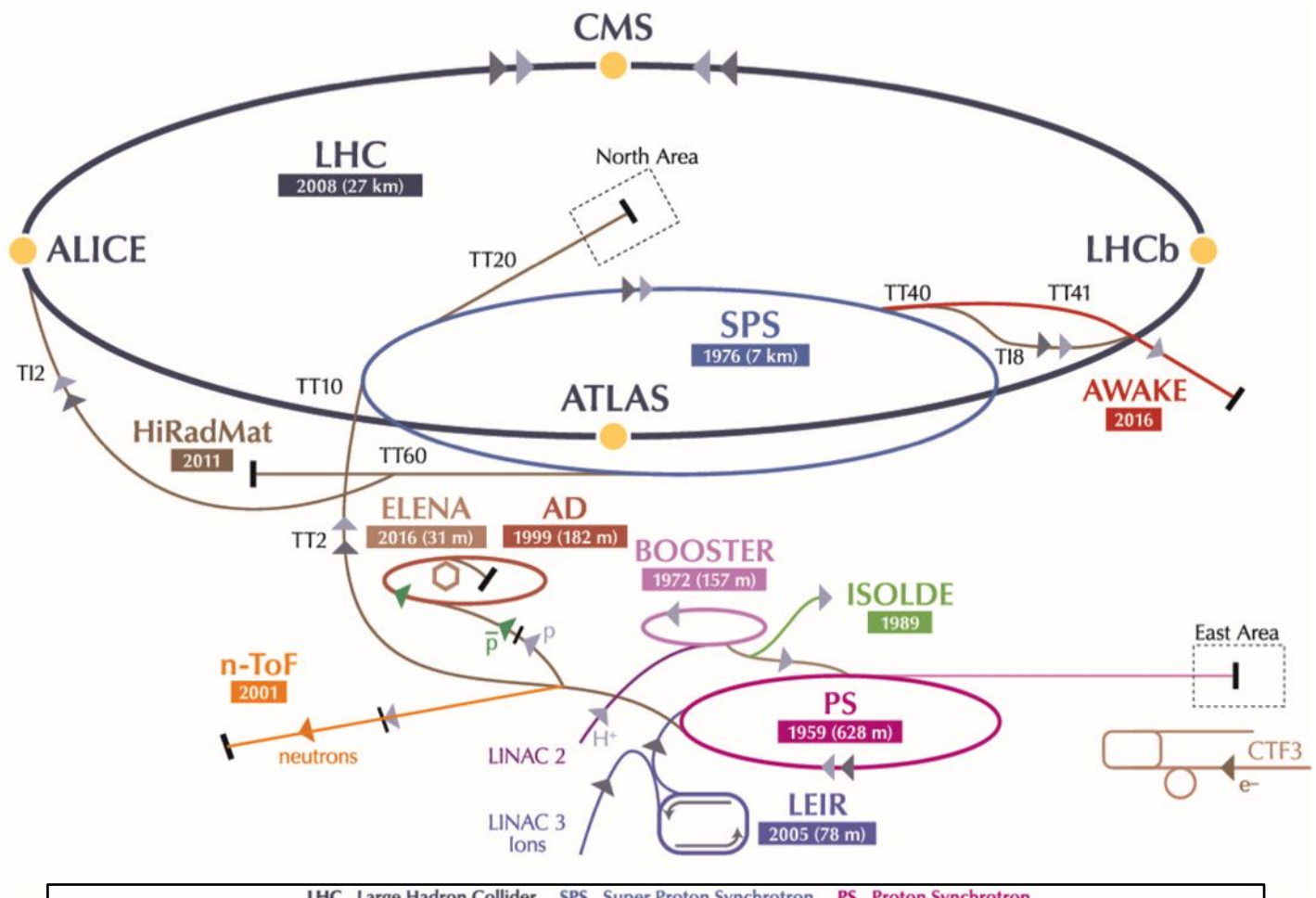
Courtesy A. Ledeul, HSE-SEE


REMUS - 2.0.0
mrettig
Unack Alarms: 27
Unack Sys Fault: 25
25/04/2017 12:55:38
RP Operation
Accelerators
LHC Complex
LIGHT
PS Complex
AD
Booster
Surface
Underground
CLIC Test Facility
East Area
HFM PS Complex
ISOLDE
Ch1:PAXB111
MS:PIMSR01=361
Ch. Name PAXB111
Dose Rate 0.603 µSv/h
Mean DR 0.212 µSv/h
Timestamp 25/04/2017 12:55:37
Device Type: AMF
Meas. Sampling Time 1.2 s
Alarm Sampling Time 93.6 s
Alarm Threshold 2.5 µSv/h
High Alarm Threshold 5.0 µSv/h
Alarm Hysteresis 10 %
Calibration Factor 1.13e-007
Correction factor 2.89
Channel status
Channel Ok
Prim. UA
Sec. UA
Alarm
High Alarm
Acknow.
DA Type
DA Power
Parameters
CRC Param.
Sensor
Sensor Cnx.
UA Trans.
DA Com.
Channel mode Measure
Primary UA status Normal
Secondary UA status Off/Fault
Command...
Parametrize...
Booster
Booster surface
PIMSR01=361
PAXB111
PADB111
PAXB113
PAXB112
PADB112
Instrument | Came time | Went time | Status | Type | Zone | Description | Level | Mode
PHFB111_BG_FLB | 25/04/2017 12:39:37 | | Alarm on - not ack. | System Fault | PS Booster | Background too high | M | Measure
PHFB111_BG_FRB | 25/04/2017 12:34:37 | | Alarm on - not ack. | System Fault | PS Booster | Background too high | M | Measure
PHFNT221_BG_HLB | 25/04/2017 11:55:16 | 25/04/2017 12:01:16 | Alarm off - not ack. | System Fault | n_TOF | Background too high | M | Measure
PAXP111 | 25/04/2017 11:39:33 | 25/04/2017 11:41:45 | Alarm off - not ack. | Radiation | PS | Dose rate too high: Action ! | H | Measure
PAXP111 | 25/04/2017 11:38:57 | 25/04/2017 11:42:21 | Alarm off - not ack. | Radiation | PS | Dose rate high: Investigate ! | M | Measure


Alarm Summary - 2.0.0
Alarm Summary
Search
PAXP
in
Instrument
Description
Case sensitive
Info
Filter applied: Yes
Displayed Alarms/Sys. Faults: 3
Total Alarms/Sys. Faults: 113
Instrument | Came time | Went time | Status | Type | Zone | Description
PAXP111 | 25/04/2017 11:39:33 | 25/04/2017 11:41:45 | Alarm off - not ack. | Radiation | PS | Dose rate too high: Action !
PAXP111 | 25/04/2017 11:38:57 | 25/04/2017 11:42:21 | Alarm off - not ack. | Radiation | PS | Dose rate high: Investigate !
PAXP303 | 25/04/2017 11:32:45 | 25/04/2017 11:32:49 | Alarm off - not ack. | Radiation | PS | Dose rate high: Investigate !
Acknowledge
View location
Filters...
0 Selected Alarms/Sys. Faults
Close


ERGO 2.18.0
File View Help
Selection view
Chart view
Table view
Events view
2 elements loaded in 00:10
100%
2.00E03
1.50E03
1.00E03
5.00E02
0.00E00
1. Y-Axis
1.60E00
1.40E00
1.20E00
1.00E00
8.00E-01
6.00E-01
4.00E-01
2.00E-01
0.00E00
2. Y-Axis
15/11/2016 00:00:00
16/11/2016 00:00:00
17/11/2016 00:00:00
18/11/2016 00:00:00
19/11/2016 00:00:00
20/11/2016 00:00:00
21/11/2016 00:00:00
Channel
Color
Unit
2nd Y-Axis
Visible
Integral
Mean
Min
Max
Standard deviation
Thresholds
Prior param change
PAAAW01_ACT
Bq/m3
09/11/2016
PAAAW01_CMP
ct/s
09/11/2016

The CERN Accelerator Complex



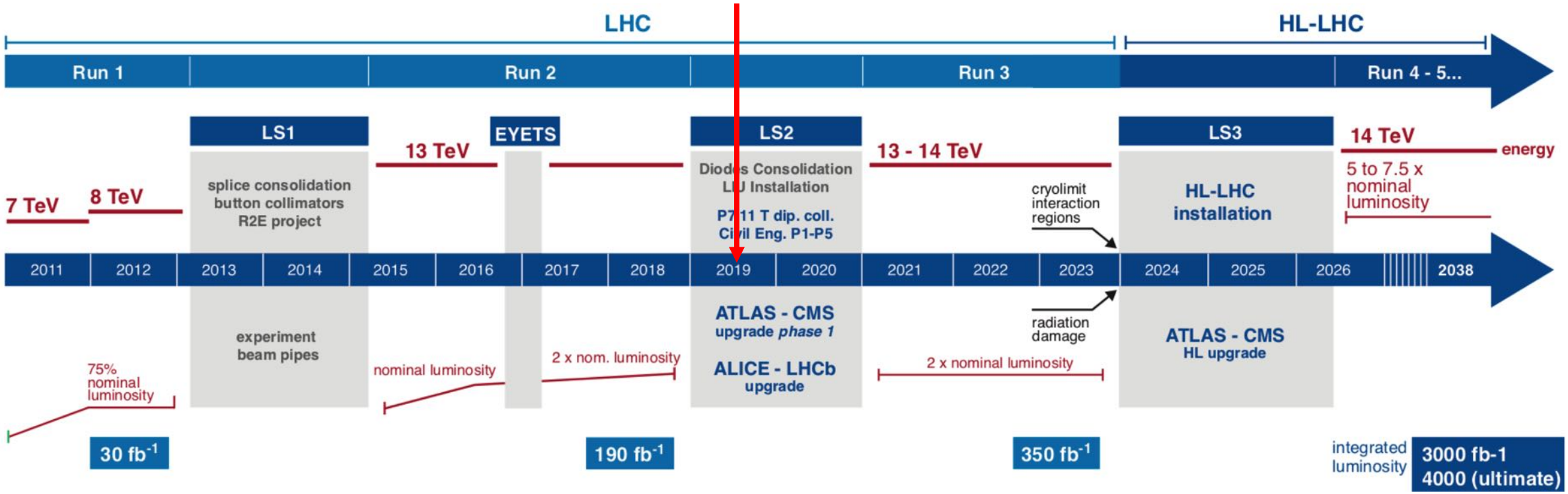
LHC Large Hadron Collider SPS Super Proton Synchrotron PS Proton Synchrotron

AD Antiproton Decelerator CTF3 Clic Test Facility AWAKE Advanced WAKefield Experiment ISOLDE Isotope Separator OnLine DEvice

LEIR Low Energy Ion Ring LINAC LINear ACcelerator n-ToF Neutrons Time Of Flight HiRadMat High-Radiation to Materials

CERN LHC Operation Lifecycle

Five-year cycle: three years of accelerator operation, two years of accelerator shutdown
During operational years: several Technical Stops of few days during the year and a 2-3 months Technical Stop at the end of the year



Long Shutdown 2 (12/2018 – 01/2021)

Currently the main accelerator chain is down for upgrade works:

- New Linac 4 injector
- HL-LHC preparations
- LHC experiments upgrades
- Major maintenance works in in all accelerators

CERN Radiation Protection Objectives for LS2

1. Objective for personal dose: 3 mSv/12 consecutive months

   Close (online) monitoring of personal and operational doses as works proceed. Early warning if objective is approached. Documented decision to exceed objective in well-justified cases (e.g., experts)
   Same objective as in LS1. During LS1 only two persons (experts) received dose exceeding the objective.

2. Number of 'radioactive transports': < 150/month in average (300/month in YETS)

   Limitation in number of transports by grouping

3. Optimisation of radioactive waste production, better waste sorting at the source

   Achieved by optimizing material choice during design, worksite zoning, integration of radioactive waste treatment into work-planning, assistance and enforcement of CADRA

Long Shutdown 2 (LS2) – *ALARA Level 3 works*

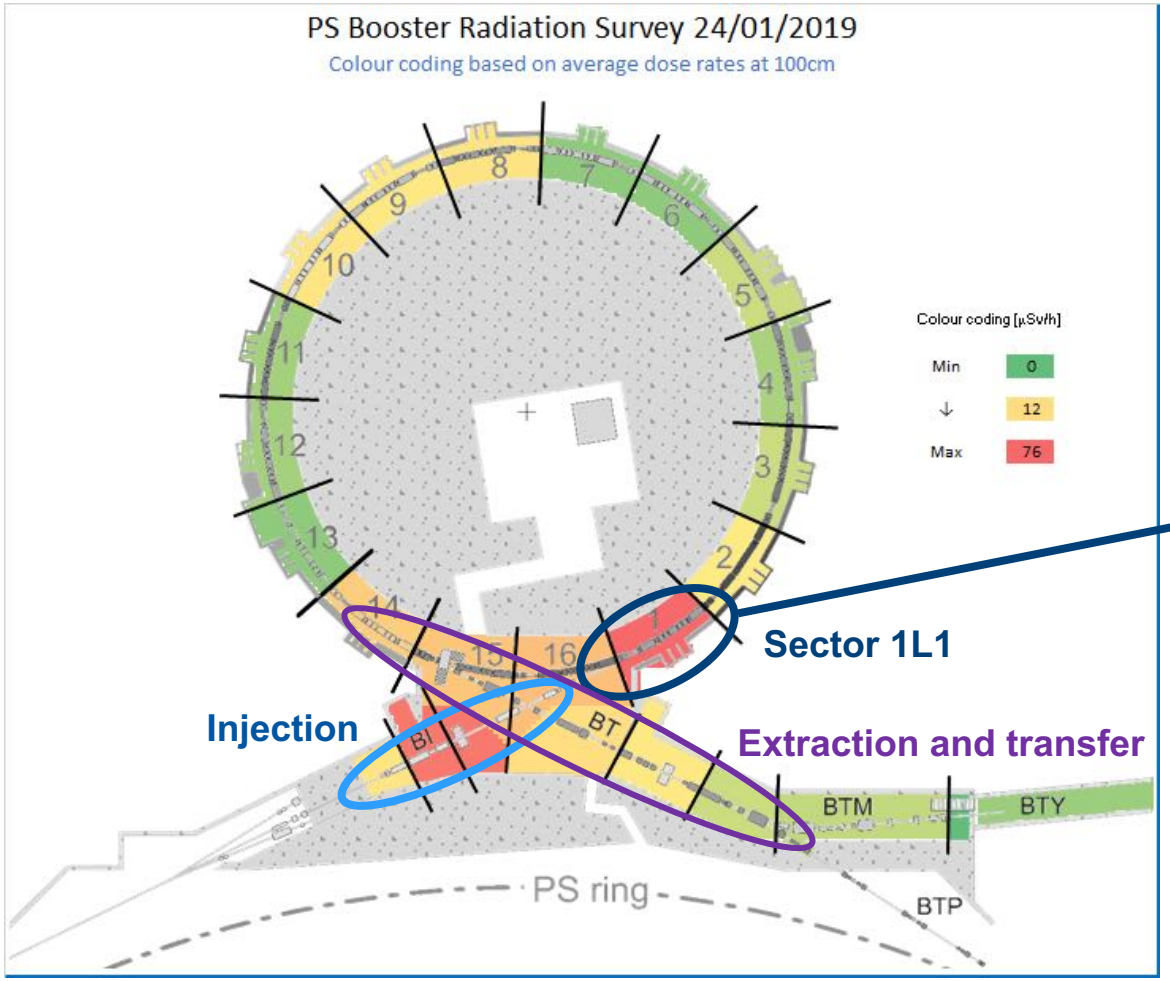
Individual dose equi.	Level I	100 µSv	Level II	1 mSv	Level III
Collective dose equi.		500 µSv		5 mSv	

Location	ALARA Committee Date	Intervention	Collective dose (person mSv)	Max. ind. dose (mSv)
PS	21 Sep 18	Renovation of PS main magnet units	36	1.3
PSB	31 Oct 18	Dismantling of the PSB injection region and the BI and BT transfer lines	5.9	0.4
PS	02 Nov 18	PS Low Voltage distribution system refurbishment	29	1.1
SPS	09 Nov 18	Fire safety system SPS - BA3, 4, 5 and 6	19	2.0
SPS	22 Nov 18	SPS safety lighting infrastructure installation	14	1.1
AD target	25 Jan 19	AD target area dismantling	8.0	0.9
ISOLDE	11 Jan 19	ISOLDE front end exchange *(waived)*	17	1.7
SPS	08 Feb 19	SPS dump removal	8.5	1.0
EA target	01 Mar 19	East area target area renovation	5.4	0.6
SPS	08 Mar 19	SPS electrostatic septum magnet exchange	4.4	0.5
nTof target	03 June 19	nTOF target removal	9.9	1.0
SPS		Fire safety system SPS - BA1 and BA2		
BDF target		Beam Dump Facility test target removal		
AD target		AD target area installation		
NA extraction		TSCS collimator replacement		
SPS		BA1/BA2 cabling		

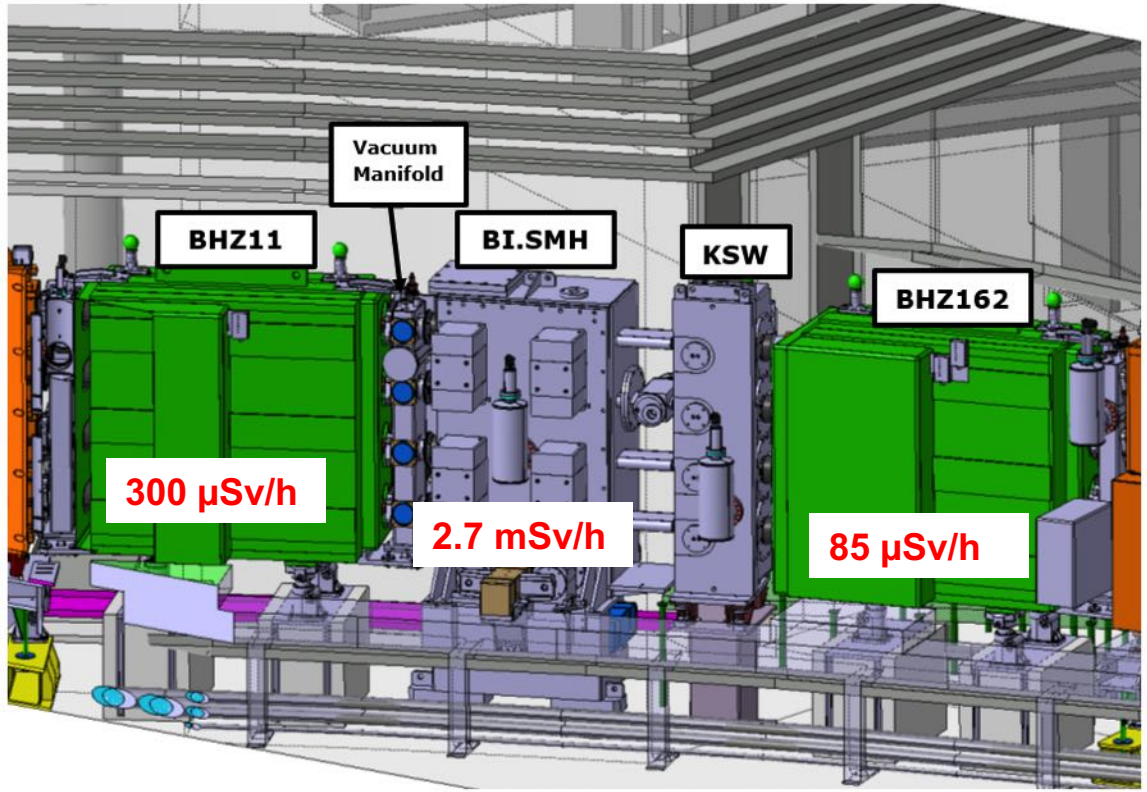
The ALARA committee consists of the following members or their deputies:

- Chairperson: Director of Accelerators
- Scientific Secretary
- Radiation Safety Officer of the owner/creator of the DIMR
- Group Leader responsible for the system or equipment
- Technical Coordinator (for interventions in an experiment)
- RP Group Leader

Long Shutdown 2 (LS2) – *PS Booster*

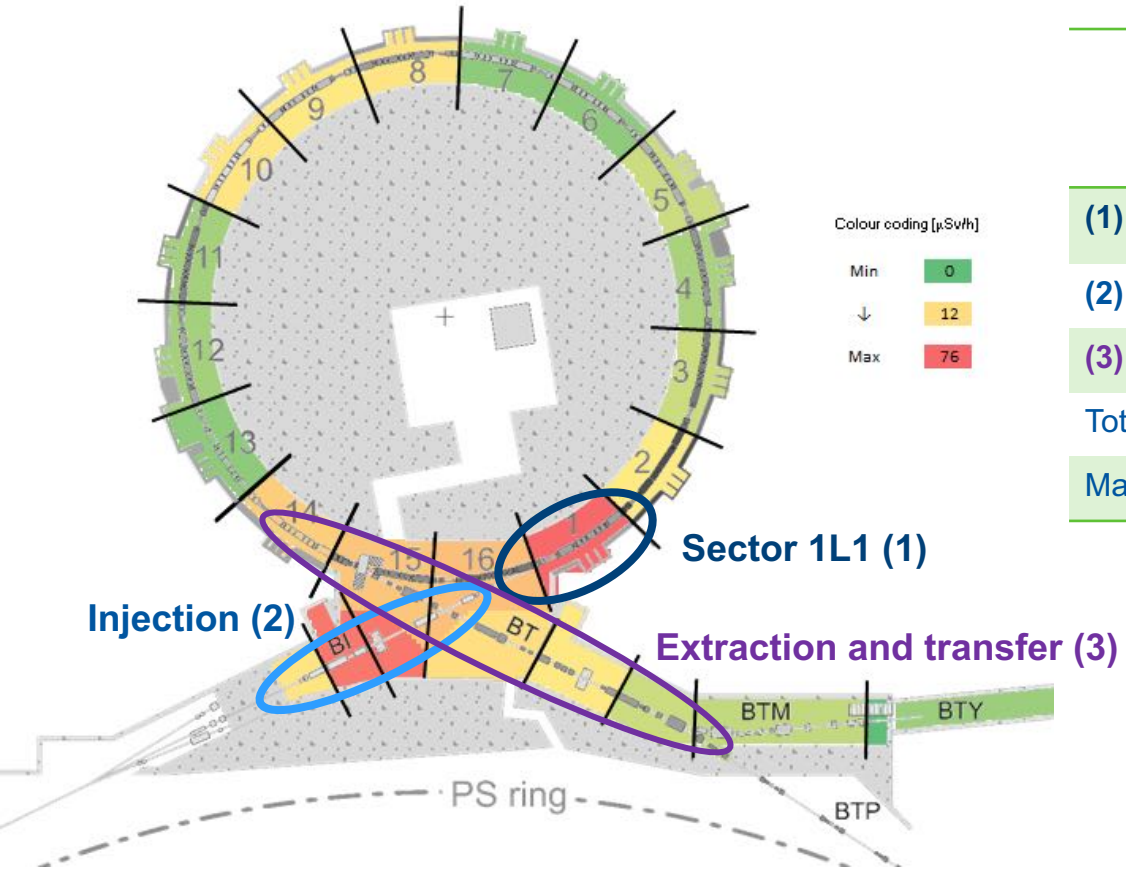


Dismantling of injection / extraction area



Long Shutdown 2 (LS2) – *PS Booster*

Long Shutdown 2 (LS2) – *PS Booster*



	Collective dose **estimated** (person.mSv)	Collective dose **achieved** (person.mSv)	Max. individual dose **estimated** (µSv)	Max. individual dose **achieved** (µSv)
(1)	3.1	**3.2**	400	412
(2)	1.5	**1.25**	252	142
(3)	1.3	**1.0**	137	96
Total	5.9	**5.4**		
Max			400	412

Completion of work within planned doses thanks to detailed preparation and close monitoring of received doses during the works

Challenges

Design of high energy physics accelerators extends over several decades. Radiation Protection studies have to anticipate changes in legislation to avoid later expensive retrofitting.

Already 20 years ago for LHC design studies we used for nuclide-specific activity limits (exemption limits) the most restrictive recommendations by international bodies (IAEA, EC, etc.). Many of them have now (2018) entered the Swiss law.

Keeping high efficiency of Radiation Protection measurements despite decreasing limits is vital for an efficient accelerator operation. Decreasing limits and stricter regulations often require longer or more complex measurements. This must be counter-balanced with innovative methods, processes and tools.

At CERN over 18000 material and waste classification measurements are taken during a single operational year. This huge amount of measurement can only be done efficiently if they are fast. At the same time decreasing clearance limits make fast measurements often impossible. Thus, CERN is now backing up such measurement systematically with software tools based on comprehensive theoretical studies.

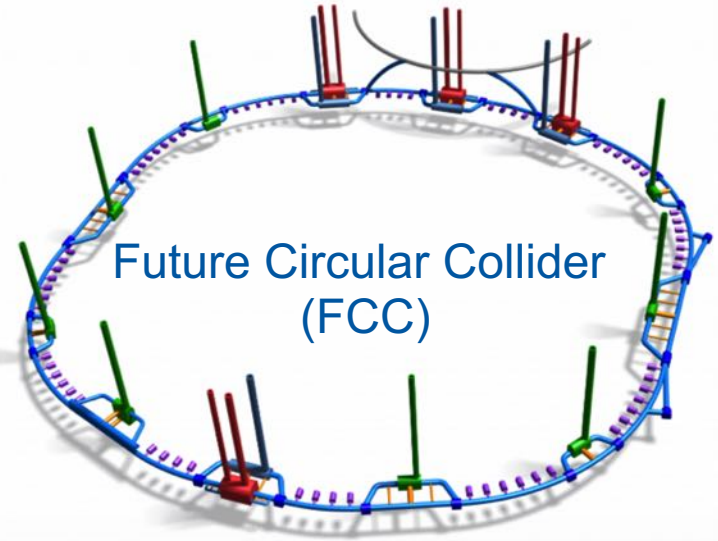
Minimize the production of radioactive waste (and, thus, costs for later disposal) during entire lifecycle of an accelerator.

During design by choosing materials with low activation properties, during operation by minimizing particle losses whenever possible, during dismantling by a timely and accurate radiological characterization and efficient sorting of the waste.

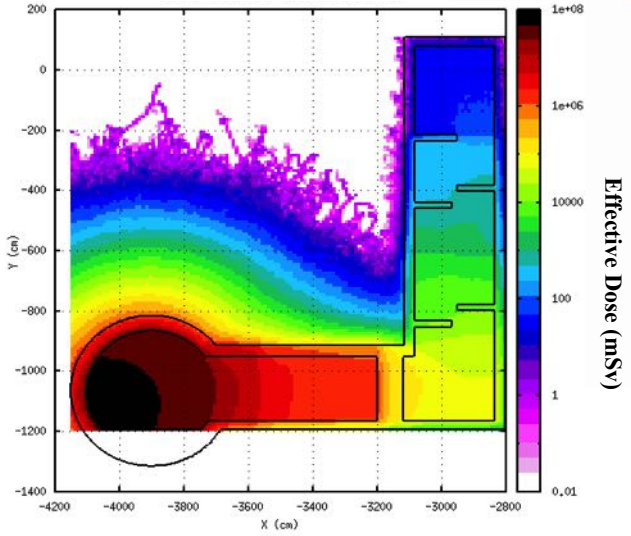
Radiation Protection Studies

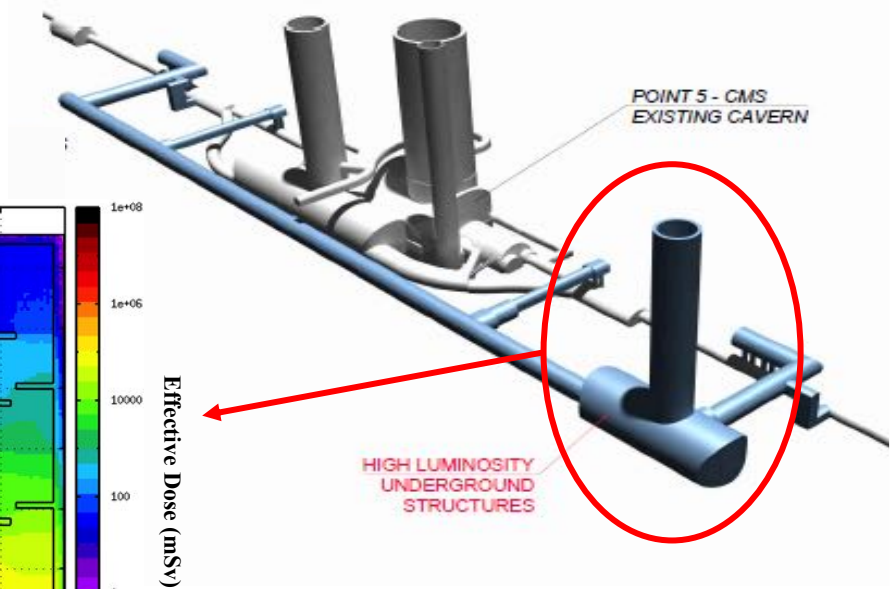
(examples from different study reports and presentations)

from existing to future accelerators

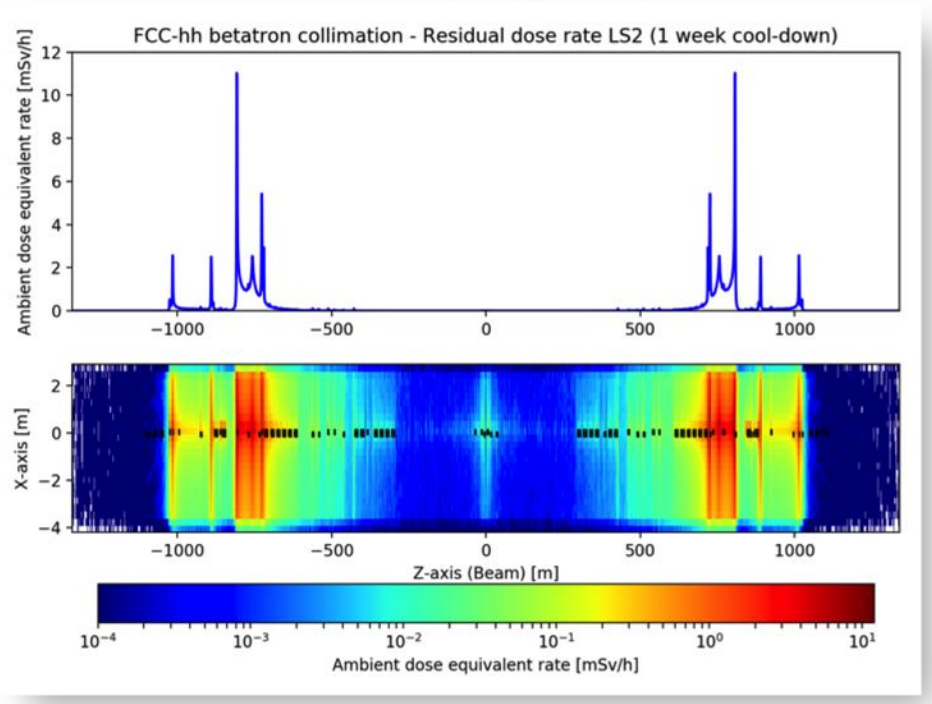


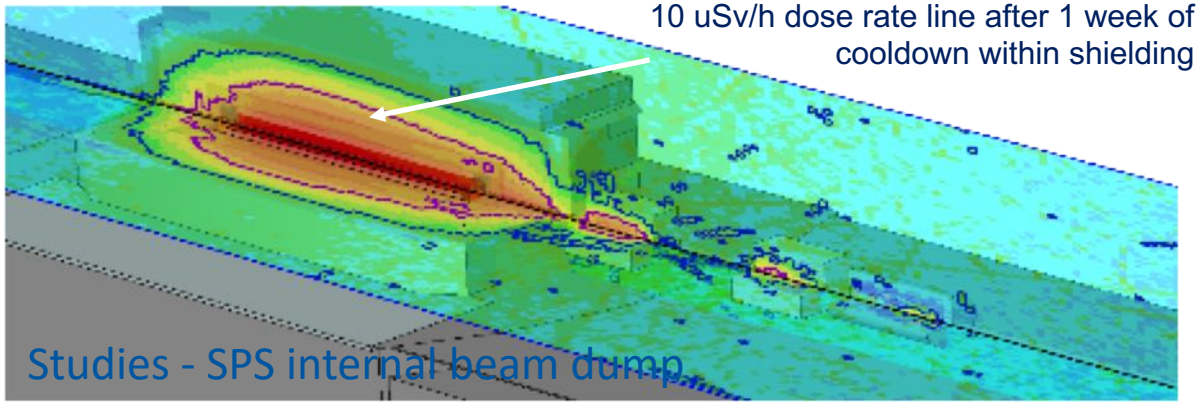
HL-LHC Project (LHC Upgrade)

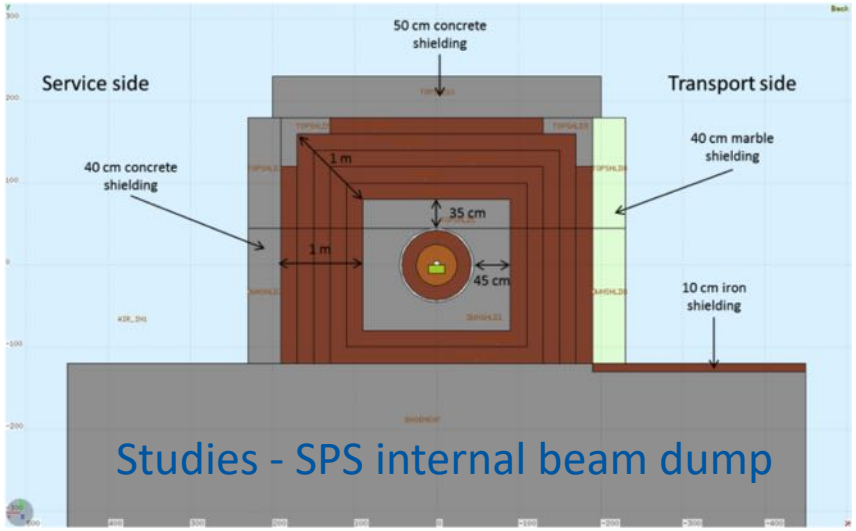




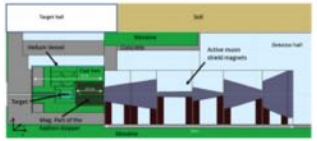
Calculations of shielding and residual dose rates with Monte Carlo radiation transport codes (FLUKA)



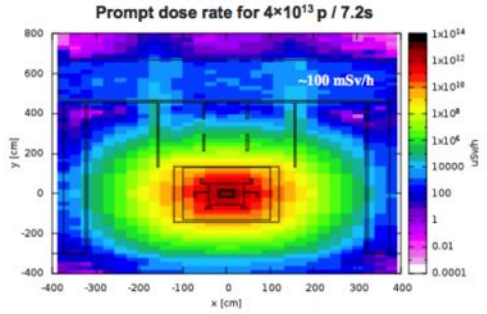




Beam dump facility



- Detailed study of prompt and residual dose rates
- RP evaluation based on FLUKA Monte Carlo simulations
- Activation of air, helium and water + soil activation and radioactive waste
- BDF facility design optimized from RP perspective

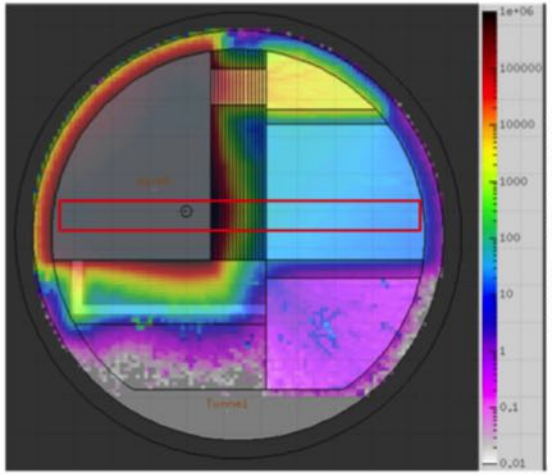


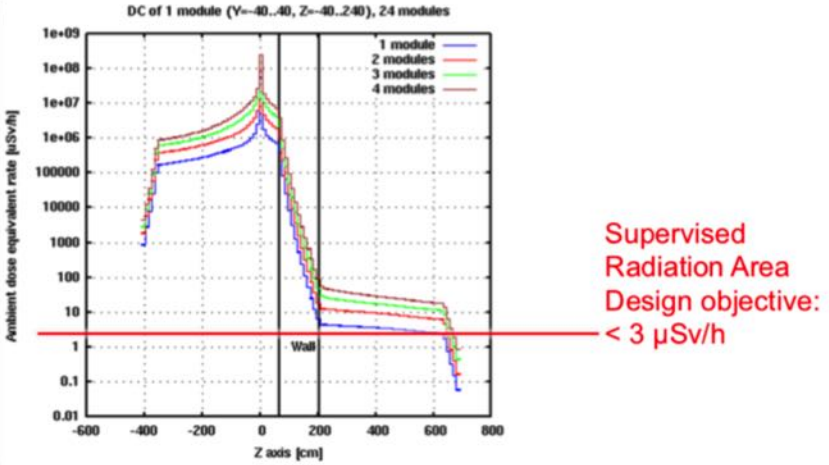
Prompt dose rates reach **~100 mSv/h** above He-vessel and drop down to **< 1 µSv/h** above top concrete shielding

→ Expected classification: **Supervised Radiation Area** (up to 2000h/year) **(< 3 µSv/h)** in the target hall

- **Preliminary RP evaluation showed the general feasibility of the project** in terms of exposure of persons to radiation and radiological impact

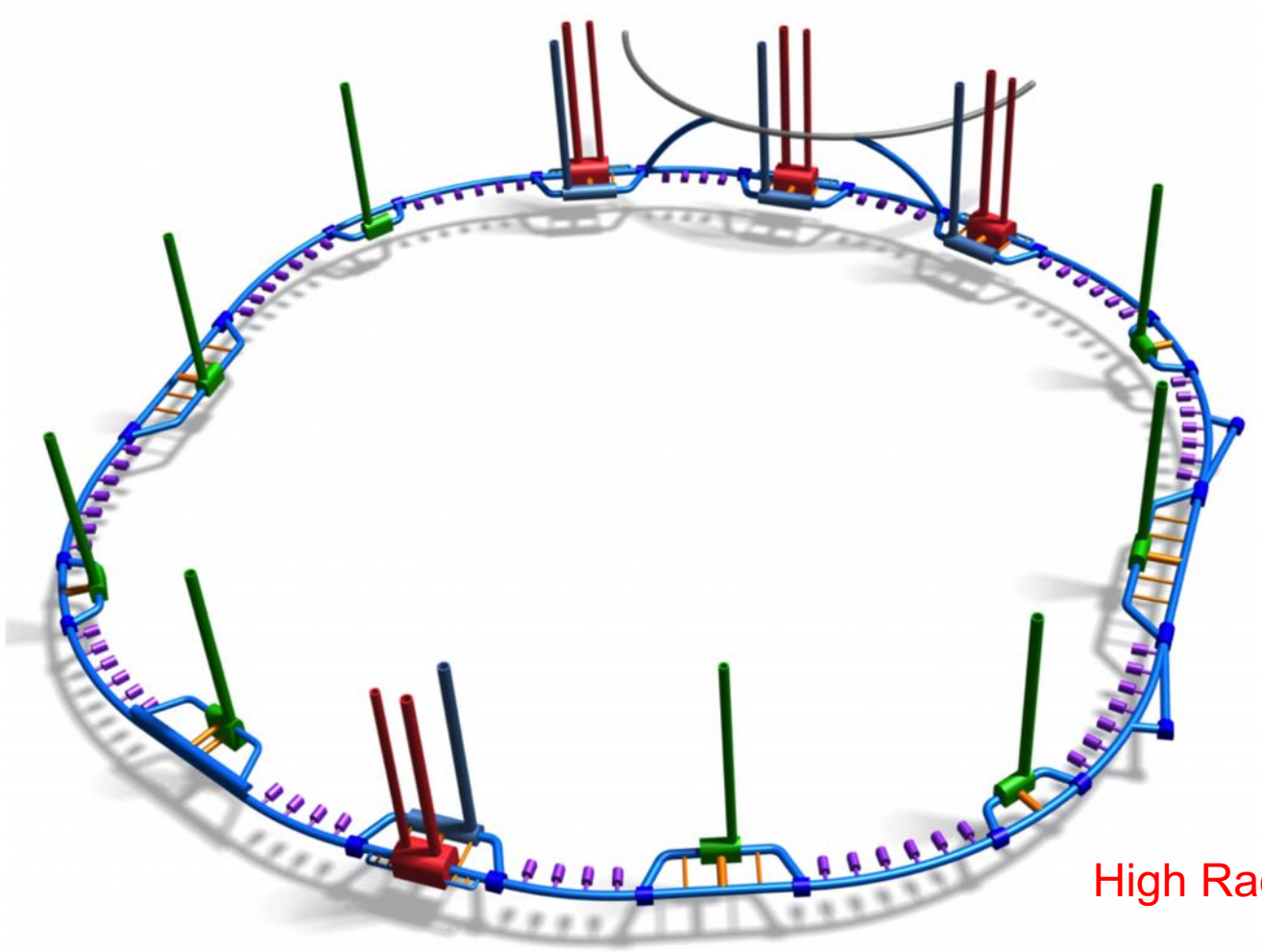
CLIC 380 GeV Klystron option – RF induced parasitic X rays

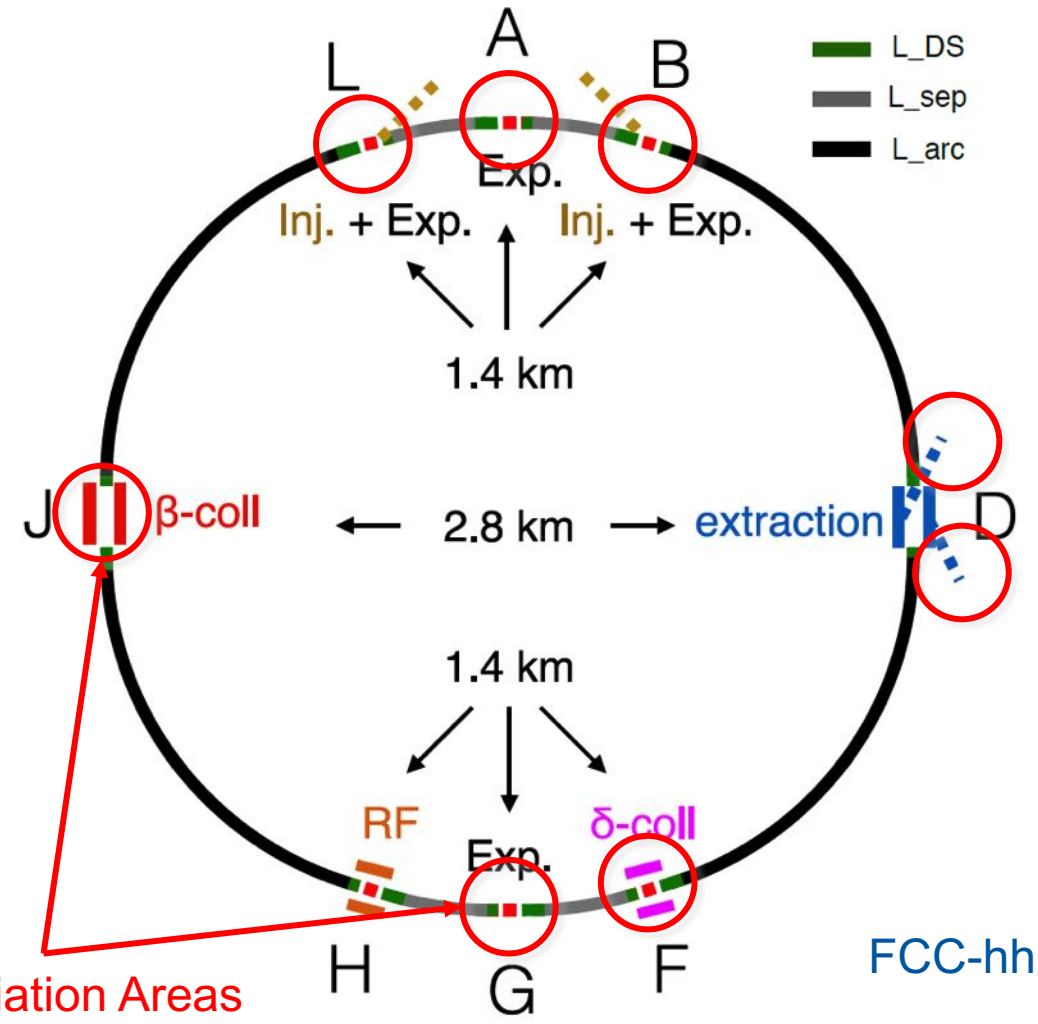




Dose rate levels across klystron tunnel ~ 3 - 50 µSv/h

FCC overview

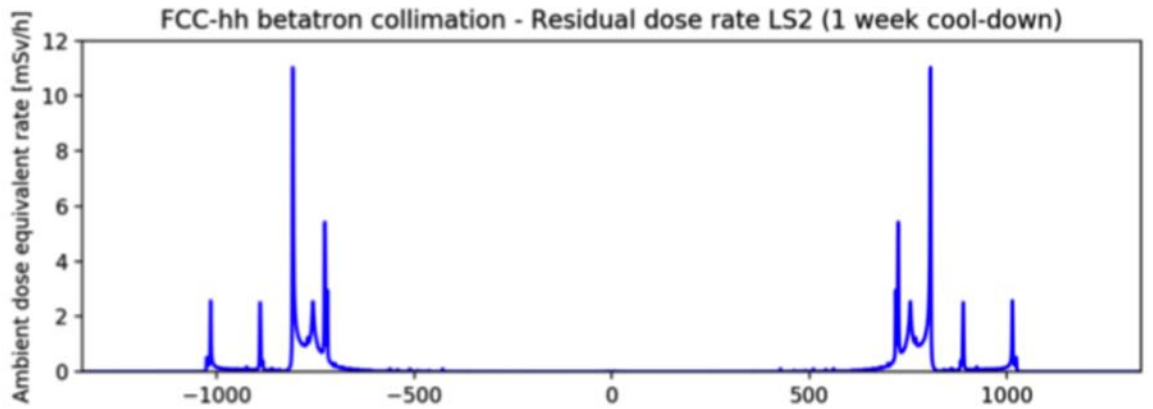


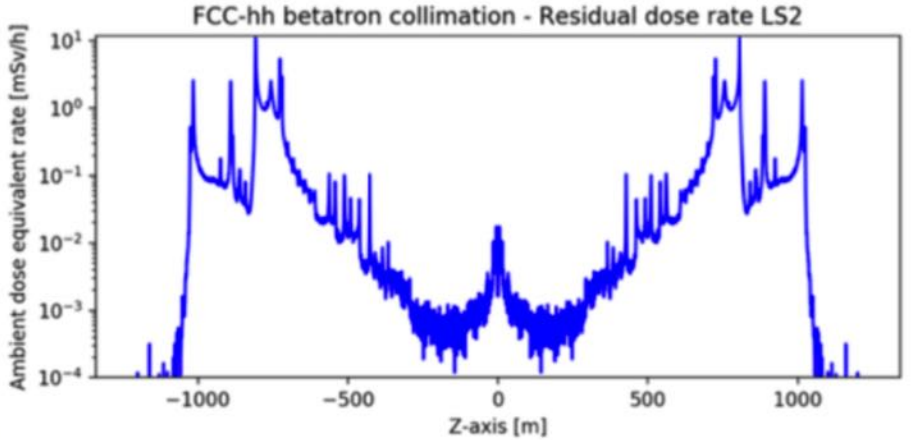


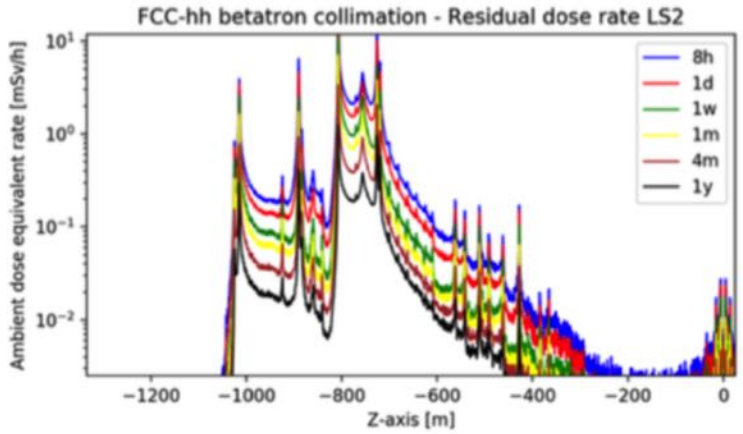
High Radiation Areas

FCC-hh

FCC-hh betatron cleaning: Residual dose rates LS2





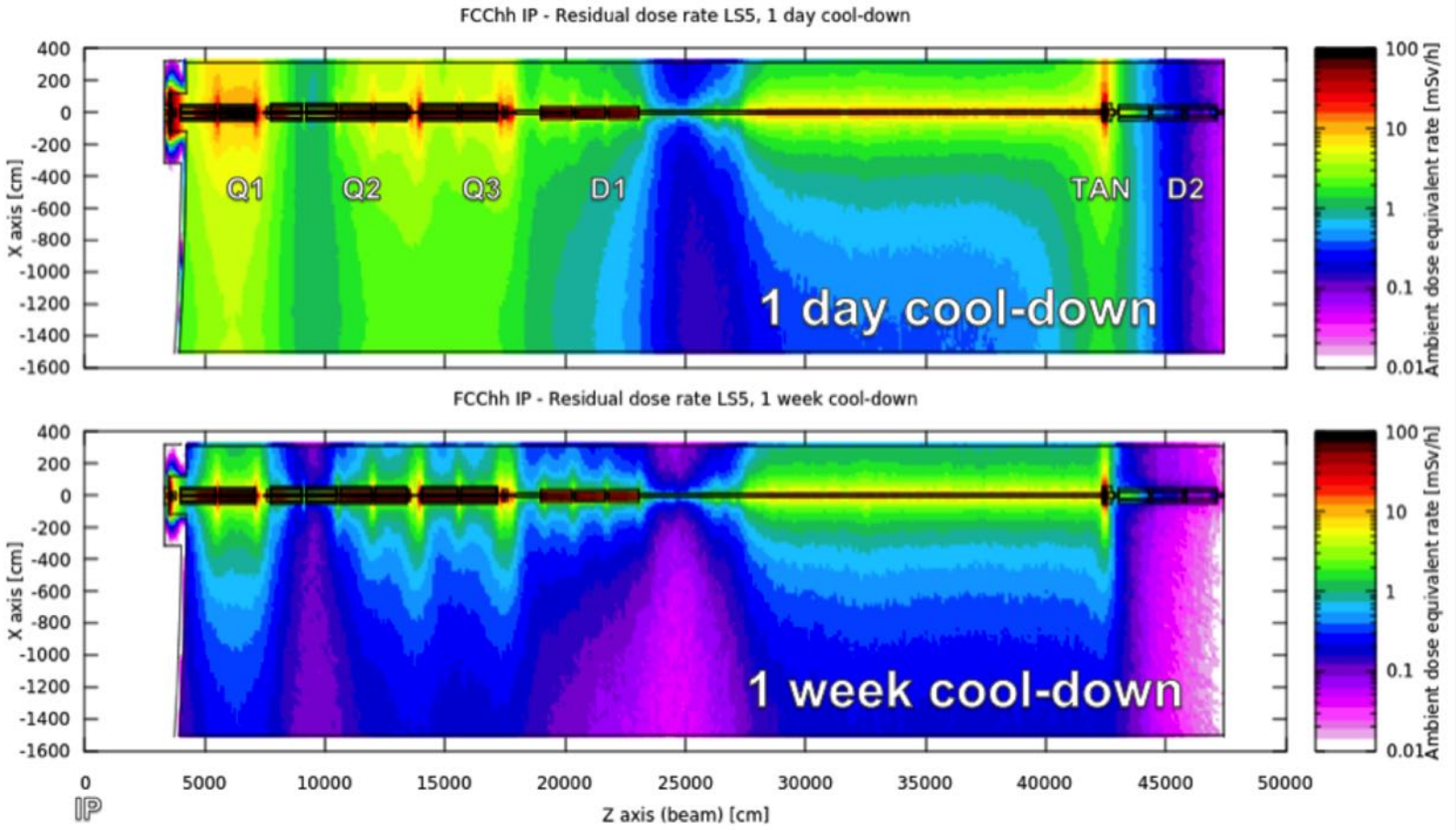


FCC-hh IP: Residual dose rates (LS5)

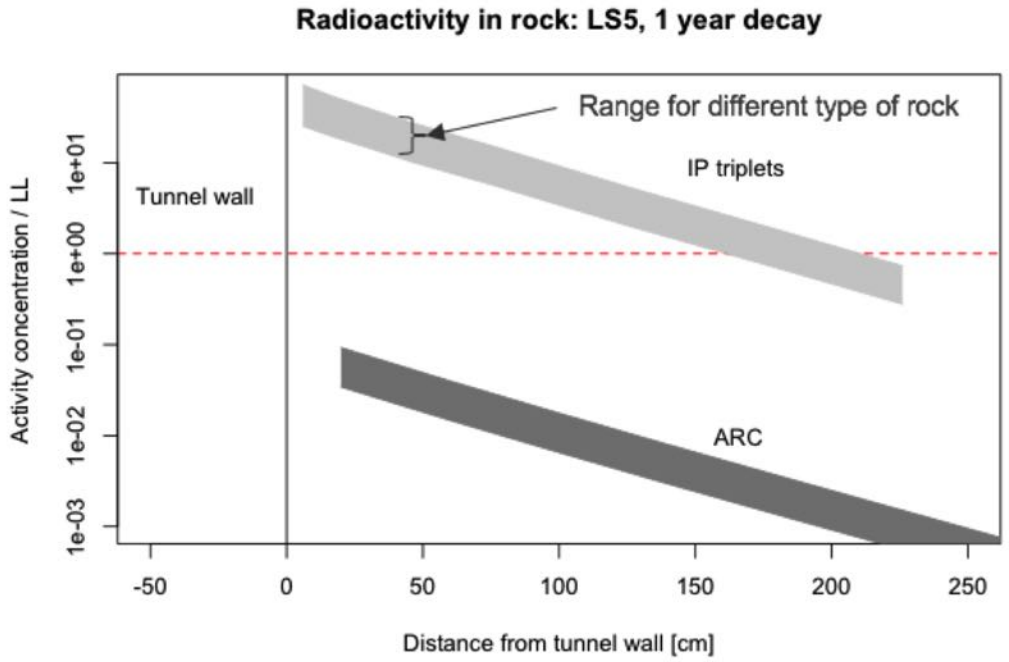
After 25y operation (17500 fb^{-1})

Avg. coll. rate:
5.4e9 p/sec (10y) +
3.2e10 p/sec (15y)

High radiation area requiring remote handling techniques for maintenance interventions



FCC-hh IP & ARC: Ground activation



Comparable to scaled values determined for HL-LHC civil engineering works.

Methodology

- Particle fluence spectra scored in first meters of rock after the tunnel wall (2 material compositions)
- Calculation of isotope production with ActiWiz3Creator for 25 years operation and 1 year cool-down
- Evaluation in fractions of clearance value (LL 2018)

Results

→ In IP sectors, the first 2 m would be above LL limit; in ARCs below limits

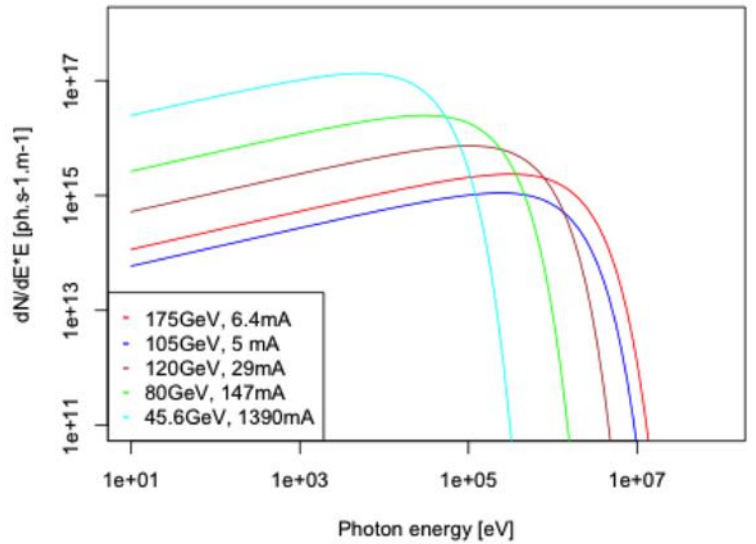
→ LL limit applies to scenarios where the material would be extracted and used/disposed

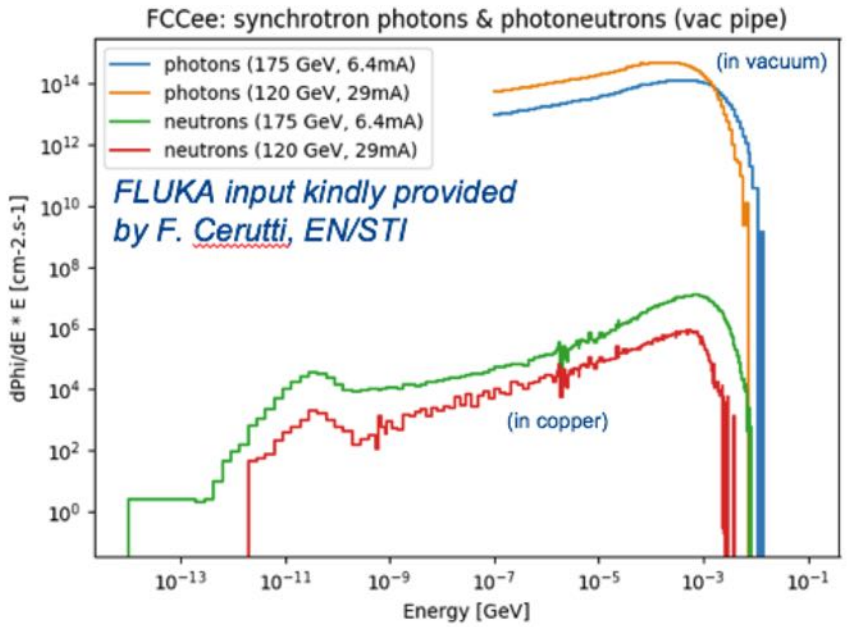
→ Transfer factor to the biosphere is the relevant factor here: not known but usually very small (very low mobility, large dilution)

→ No relevant environmental impact expected

FCC-ee: Synchrotron radiation & activation

At LEP, activation from synchrotron radiation was not a critical issue.
→ FCC-ee at > 175 GeV: synchrotron radiation may significantly contribute to activation in the arcs.

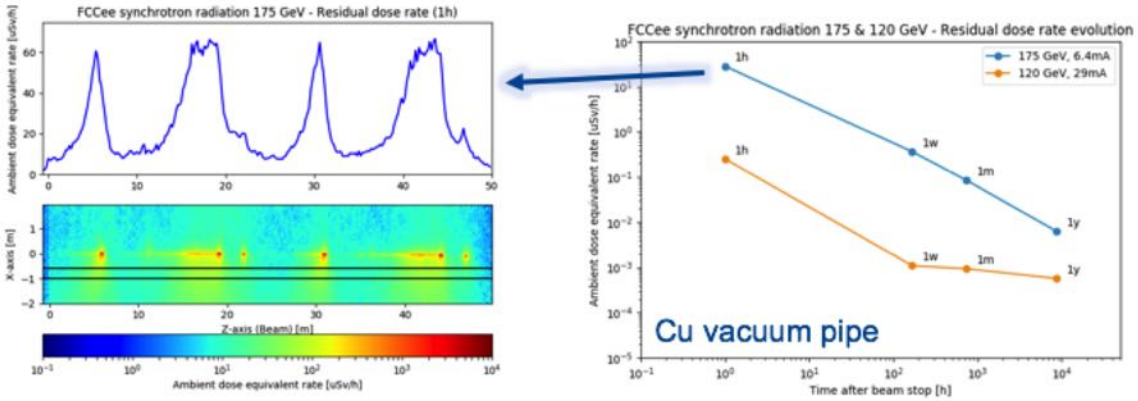




E [GeV]	I [mA]	E_c [keV]	Flux [ph/sec]	~ Fraction > 7 MeV	Flux > 7 MeV [ph/sec]
182.5	5.4	1254	8.0e+20	3.8e-03	3.0e+18
175	6.4	1105	9.0e+20	1.8e-03	1.6e+18
120	29	356	2.8e+21	3.0e-09	8.4e+12
105 (LEP)	5	849	4.2e+20	2.6e-04	1.1e+17
80	147	106	9.5e+21	1.7e-29	1.6e-07
45.6	1390	20	5.1e+22	4.7e-156	2.4e-133

FCC-ee: Synchrotron radiation & activation

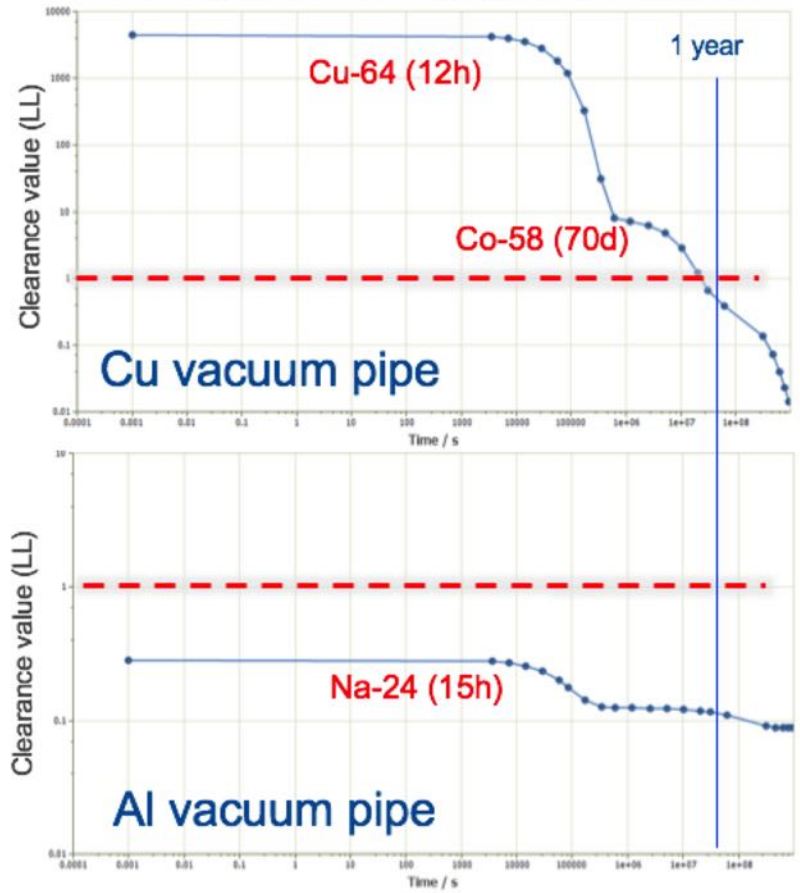
Residual dose rates after 1 op. year of irradiation (175 GeV, 6.4 mA)



Relevant dose rate levels shortly after beam stop, but quick decay to below 1 μSv/h.

Copper vacuum pipe is **disadvantageous** for activation
→ avg. activity level below clearance level after 1 year, but local activation on absorbers will be much higher
→ to be further studied in detail once design is confirmed

Activity level after 1 op. year of irradiation



Welcome

The European Strategy for Particle Physics provides a clear prioritisation of European ambitions in advancing the particle physics science. The Strategy is due to be updated by May 2020 to guide the direction of the field to the mid-2020s and beyond.

To optimally inform all participants in the process, the Secretariat of the European Strategy Group (ESG) called upon the particle physics community across universities, laboratories and national institutes to submit written input by 18 December 2018 to prepare the discussions on the Strategy Update which will take place in 2019.

UPDATES

Open Symposium

In Granada, the European particle physcis community prepares decisions for the future of the field. *Read more*

The detailed **timetable** of the Symposium is available at this link.

Submitted Input

Community proposals submitted to the Strategy Update process are available here.

Update due for May 2020

Among the CERN driven projects …

- HL-LHC / HL-LHeC
- HE-LHC / HE-LHeC
- FCC-hh/ee/eh
- CLIC
- eSPS/LDMX
- SPS BDF/SHiP
- Other PBC projects
- … and many more

Thank you for your invitation to IHEP

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