Overview of Radiation Protection aspects of LS3-WP8 activities

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EDMS 3171642

14th HL-LHC collaboration meeting – 08.10.2024

CERN | HSE Radiation Protection

HiLumi HL-LHC PROJECT

With inputs from:
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Outlook

- HSE-RP contribution to HL-LHC WP8 over many projects/activities
- This talk main focus on:
  - Recall on ALARA at CERN, LS3 dose objective, and more
  - Removal of the TAS in ATLAS/CMS
  - TAN to TAXN conversion
  - WDP, transport and waste aspects

Recall on ALARA at CERN

EDMS 1751123

ALARA Levels at CERN. Airborne activity and surface contamination levels are expressed respectively in CA and CS values, as defined in the Swiss legislation for Radiation Protection (Swiss Federal Council, 2018).

Criteria	ALARA level				
Individual dose [μSv]	Level 1	100	Level 2	1000	Level 3
Collective dose [person μSv]	Level 1	500	Level 2	5000	Level 3
Ambient dose equivalent [μSv/h]	Level 1	50	Level 2	2000	Level 3
Airborne activity in CA	Level 1	5	Level 2	200	Level 3
Surface contamination in CS	Level 1	10	Level 2	100	Level 3

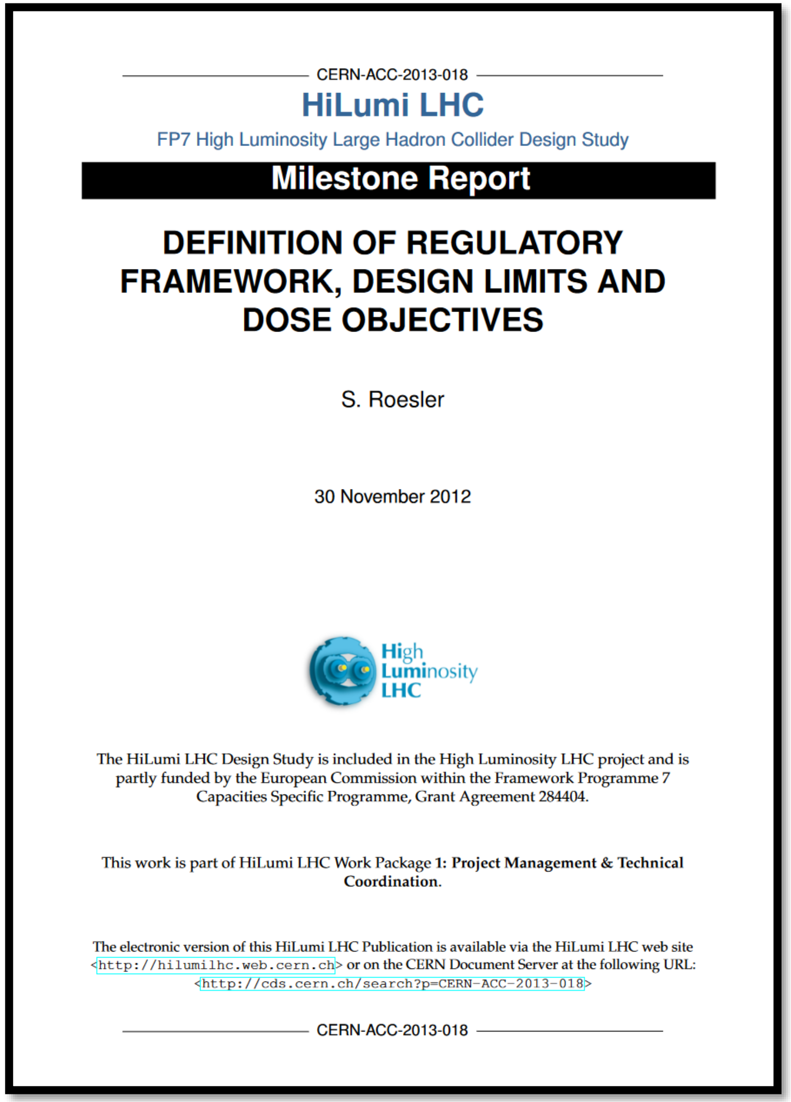
Level		DIMR-1	DIMR-2	DIMR-3
Owner		Applicant (i.e. equipment owner, work coordinator, contract or activity responsible)		
Preparation (iterative)	WDP template	*Optional* Applicant[2]	*Mandatory* Applicant[2]	*Mandatory* Applicant[2,3]
	Provides dose rates	RP	RP	RP
	Sets DIMR level	RP and RSSO	RP and 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 level → Radiological risk assessment based on different criteria
- WDP/optimization mandatory for ALARA II & III
- ALARA III approval by "ALARA committee" (complex manager, GL responsible for the equipment, RSO, RP GL, and more)

Dose objective

- CERN-ACC-2013-018 (EDMS 1509373) summarizes the Radiation Protection regulatory framework as well as the related design constraints and dose objectives to be followed by the HL-LHC project.
- Safety code F, design constraints, ALARA and dose objectives.
- Personal dose objectives apply at CERN:
  - Long Shutdowns -> max 3 mSv
  - The dose is to be counted for any consecutive 12-months period.
  - As it is not a limit it can be exceeded. However, the latter requires the approval by the RP group leader as well as the group leader responsible for the respective person.

- RP objectives from LS2:
  - Dose per person < 3mSv in 12-months period
  - Number of radioactive transports: < 150/month



CERN-ACC-2013-018

HiLumi LHC

FP7 High Luminosity Large Hadron Collider Design Study

Milestone Report

DEFINITION OF REGULATORY FRAMEWORK, DESIGN LIMITS AND DOSE OBJECTIVES

S. Roesler

30 November 2012

The HiLumi LHC Design Study is included in the High Luminosity LHC project and is partly funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404.

This work is part of HiLumi LHC Work Package **1: Project Management & Technical Coordination**.

The electronic version of this HiLumi LHC Publication is available via the HiLumi LHC web site <http://hilumilhc.web.cern.ch> or on the CERN Document Server at the following URL: <http://cds.cern.ch/search?p=CERN-ACC-2013-018>

CERN-ACC-2013-018

DIMR

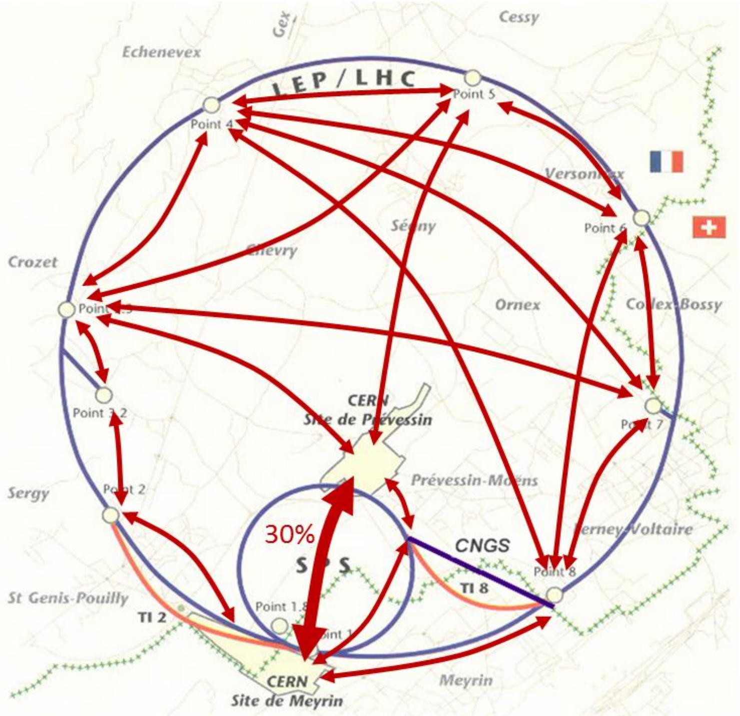
Courtesy A. Pardons and RSOC

Tentative list – ALARA Level to be confirmed by WDP

Area	Project/package	PL/contact	Group	Start of work (T=start LS3)	Work duration
LHC	**HL-LHC**	**Oliver Brüning**	**ATS-DO**		
Pt1+Pt5	Experimental Beam pipe removal (from left-TAS to right-TAS Q1 through IP)	Josef Sestak	TE-VSC	T+2m	2m
Pt1+Pt5	TAN to TAXN conversion (including TAN removal)	Oliver Boettcher	BE-EA	T+4m	7m
Pt1+Pt5	Magnets (warm + SC) deinstallation (all along LSS1 & LSS5) plus DFBX	B. Di Girolamo	TE-MSC	T+4m	1m
Pt1+Pt5	Vacuum sectors and equipment removal all along LSS1 & LSS5 (other)	Eric Page	TE-VSC	T+4m	3m
Pt1+Pt5+Pt7	Collimators deinstallation (LSS1 & LSS5, Point 7)	François-Xavier N.	SY-STI	T+4m	1m
Pt1+Pt5	QRL dismanling (LSS1 & LSS5, work done by CERN)	Andrew John Lees	TE-CRG	T+4m	5m
Pt1+Pt5	Civil Engineering works (LSS1 & LSS5): vertical cores openings and 13 MCEW (Minor Civil Engineering Works)	Christophe Biot	SCE	T+5m	4m
Pt1+Pt5	Removal of CV piping all along LSS1&5	Theodoros Aivaliotis	EN-CV	?	?
Pt1+Pt5	Reinstallation of CV piping all along LSS1&5	Theodoros Aivaliotis	EN-CV	?	?
Pt1+Pt5	Decabling	Georgi Georgiev	EN-EL	T+5m	3m
Pt1+Pt5	Cabling	Gaël Girardot	EN-EL	?	?
Pt1+Pt5	QRL dismanling, refurbishment (in UX65) and re-installation (LSS1 & LSS5), including DSL modifications and re-installation (work done by CERN)	Andrew John Lees	TE-CRG	T+4m	5m
Pt2 + Pt8	Beam Screen Treatment - Triplets of Points 2 et 8	Bernard Henrist	TE-VSC	T+5m	18m
Pt1+Pt5+Pt7	Collimators reinstallation Points 1, 5 et 7	François-Xavier	SY-STI	T+19m	6m
Pt6	Beam dump removal and reinstallation	Nicola Solieri	SY-STI	?	?

- DIMR granularity/ownership discussed and agreed on a dedicated meeting on 09.07.2024 with HL-LHC PSO, RP, RSOs and WP/group representatives.
- Two main activity impacting WP8: TAS removal and TAN/TAXN conversion

Internal transport



Radioactive transport mostly depends on :

- Nuclide inventory / activity (classification)
- External dose rate (labelling)
- Size/mass of the content (packaging)

All the above must be known to guarantee the feasibility of the transport in due time.

Few triggers for “critical” transport:

- *Size/mass of the content exceeding currently available means (590*235*233cm / 20,6t)*
- *Dose rate at contact exceeding 2 mSv/h or/and 100 μSv/h at 2 m*
- *Presence of alpha emitters / “heavy” radionuclides*
- *Total activity > 10^{11} Bq*

Possible issues for transport :

- Certified packaging not available (size / mass too high)
- Dose rate too high – need specific shielding (to be determine and manufactured)
- Activity too high – transport not possible (unless specific derogation from the authorities which can take years to have approved after submission of the dossier and is valid for one specific transport only!)
- Derogation not accepted from authorities.

Radioactive Waste disposal pathways

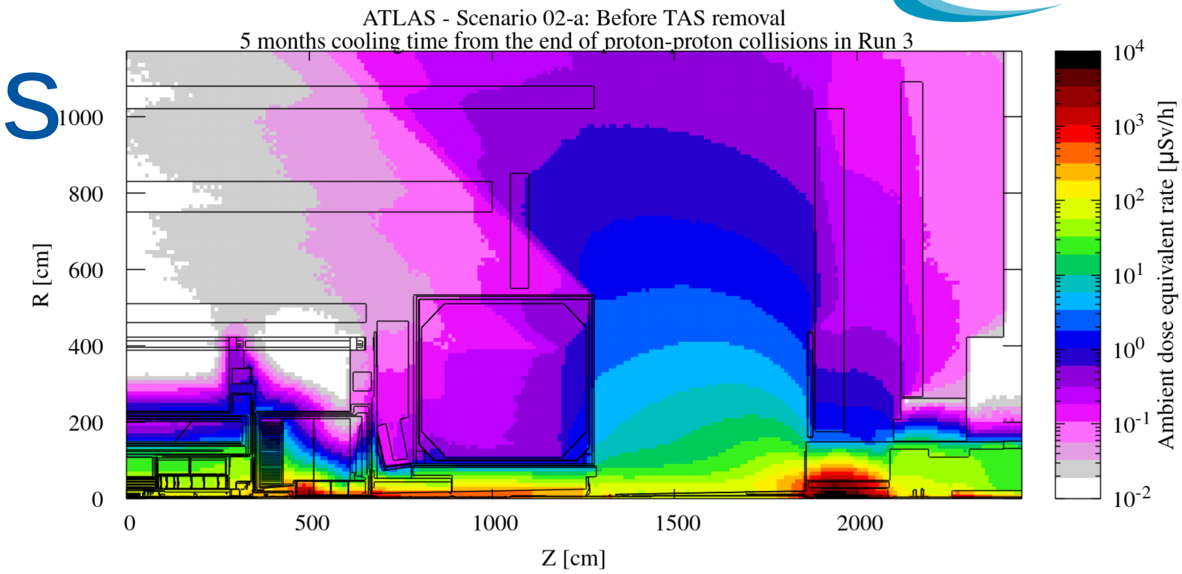
- ✓ From 2010, tripartite agreement between CERN and Host States, represented by Swiss Federal Office of Public Health (OFSP) and the French Nuclear Safety Authority (ASN) -> link
- ✓ "Fair Share" principle revised in March 2022, with three indicators: the volume eliminated, radiotoxicity and elimination costs.
- ✓ With these indicators, it will now be possible to better compare and measure the share between the two Host States

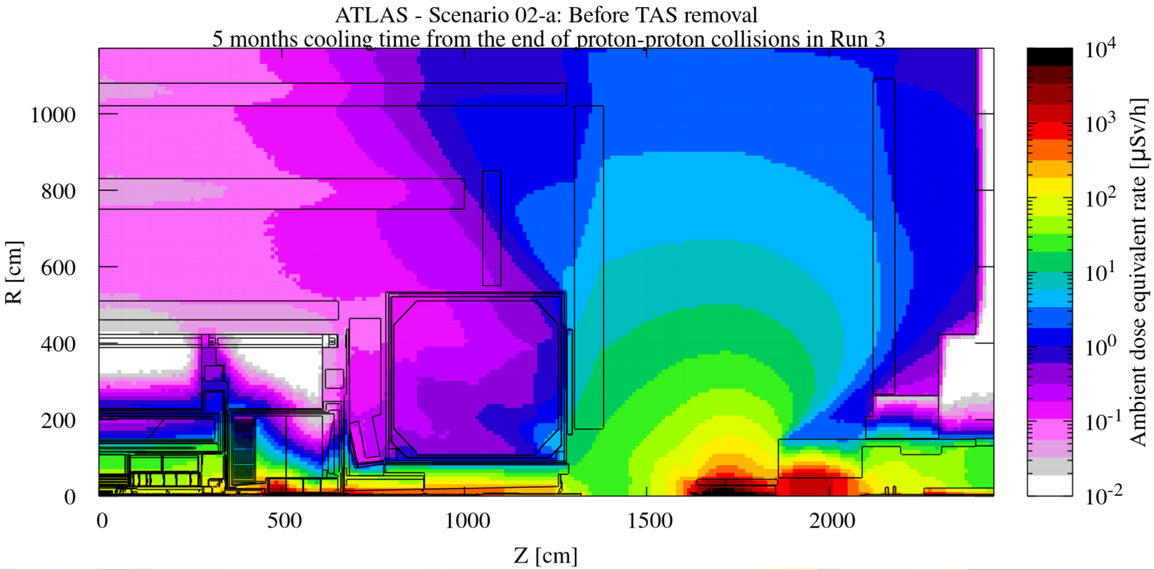
CERN RW classification	Disposal pathway
Clearance candidates – **CL** (Candidats à la Liberation Inconditionelle)	Release from regulatory control in Switzerland (clearance ↔ "free release")
Very Low-Level Waste – **TFA** (Très Faibles Activités)	Surface disposal in France, as defined by the acceptance criteria of the ANDRA CIRES repository.
Intermediate & Low-Level Waste – **FMA-VC** (Faibles et Moyennes Activités a Vies Courtes)	Short-lived intermediate and low level waste, half-life <30 years. Surface disposal in France as defined by acceptance criteria in ANDRA CSA repository.
Intermediate & Low-Level Waste – **FA-MA** (Faibles Activites et Moyennes Activités)	Intermediate and low-level waste which does not fulfil the FMA-VC criteria and disposal in Switzerland (PSI).

Removal of the TAS in ATLAS/CMS

ATLAS open scenarios

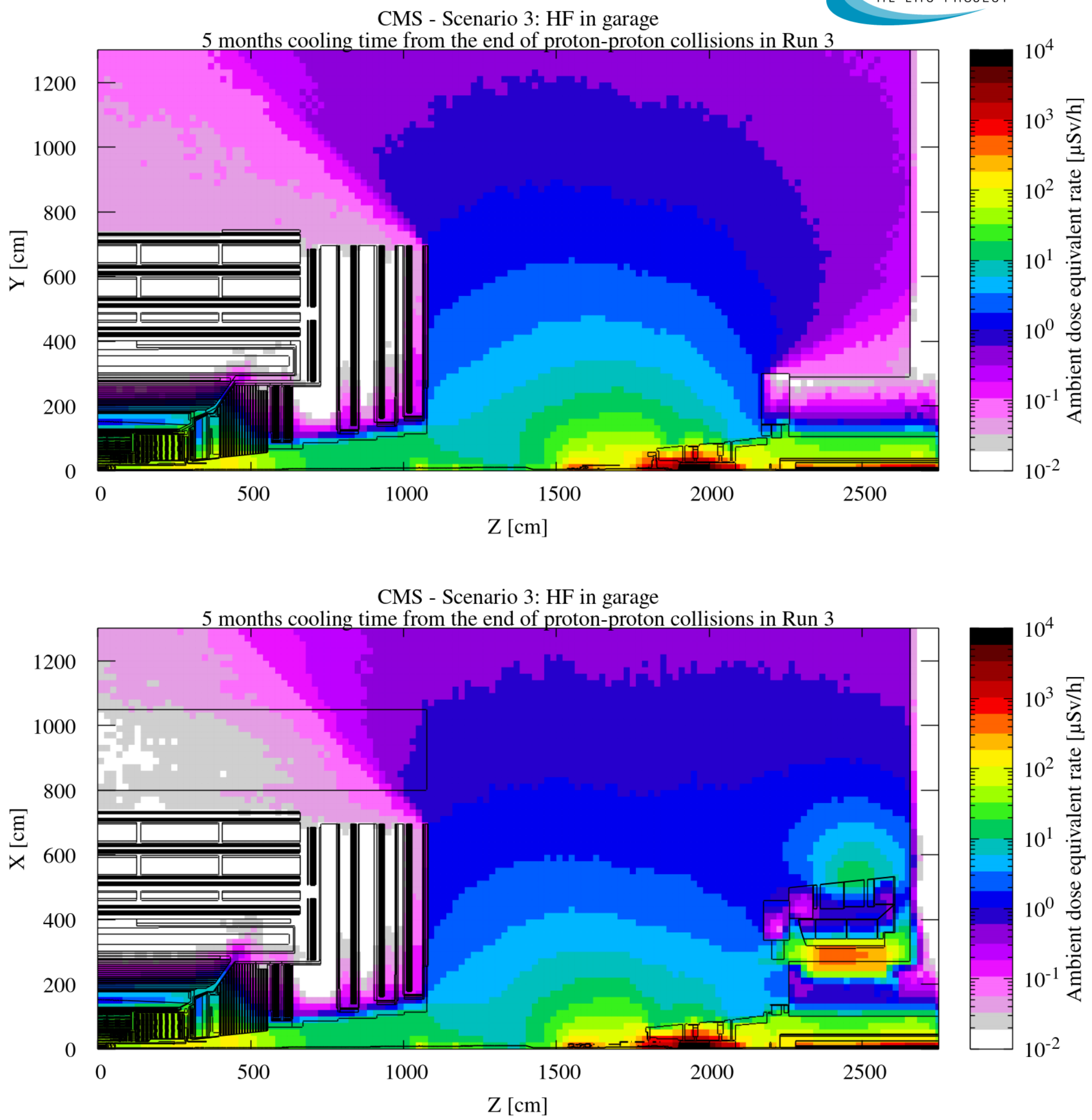
- Several configurations studied and discussed with ATLAS representatives.
  - Results summarized in T. Lorenzon et al., EDMS 3061416
- The most representative configurations for the TAS extraction scenario are the configuration 02-a “Before TAS removal” and configuration 02-b “TAS removal”
- To stay on the conservative side, the cooling time that can be considered is 5 months from the end of proton physics in Run 3 (consistent with TAS dose rate estimates).





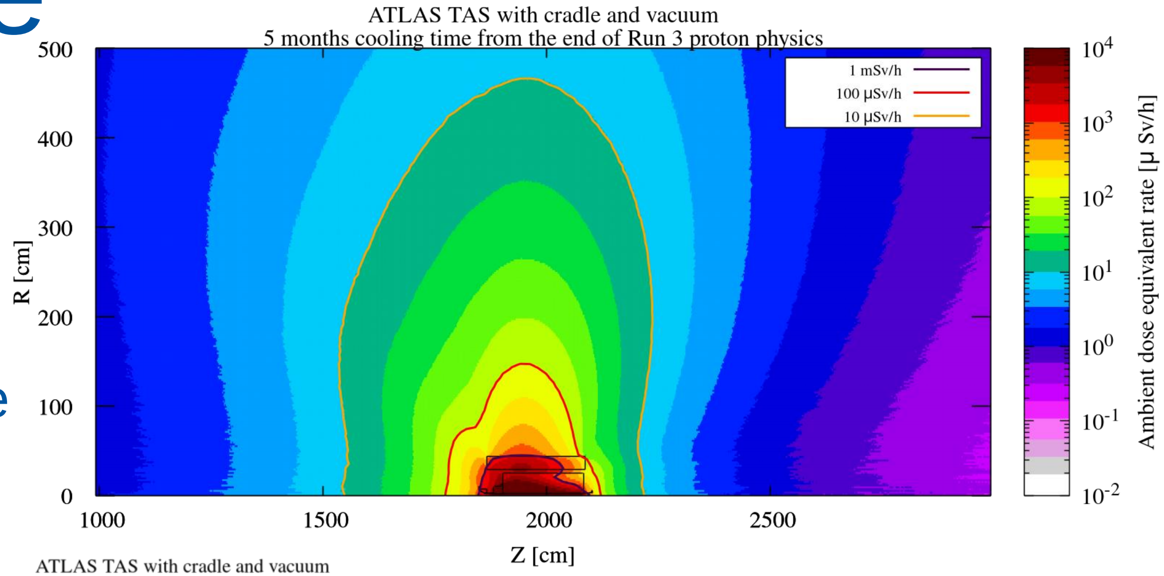
CMS open scenarios

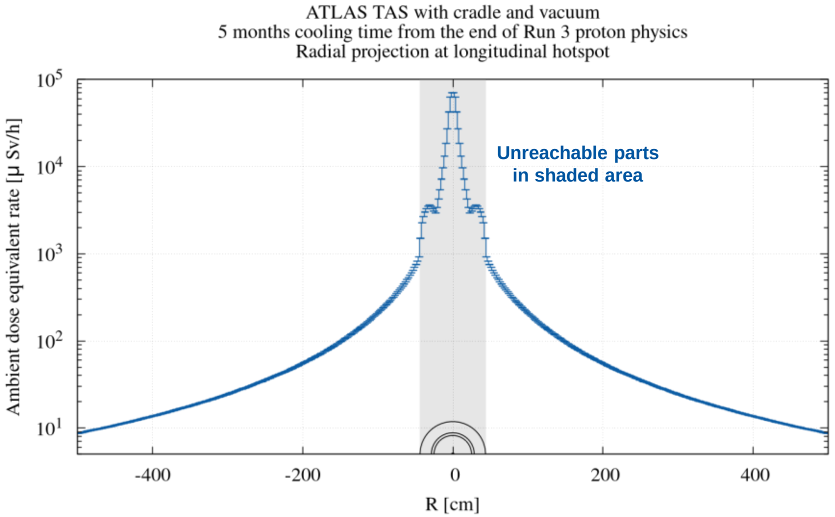
- Several configurations studied and discussed with CMS representatives.
  - Results summarized in T. Lorenzon et al., EDMS 2748870
- The most representative configuration for the TAS extraction scenario is the configuration so-called “HF in garage”:
  - HF detector removed
  - New Forward Shielding removed
  - Rotating shielding open
- To stay on the conservative side, the cooling time that can be considered is 5 months from the end of proton physics in Run 3 (consistent with TAS dose rate estimates).

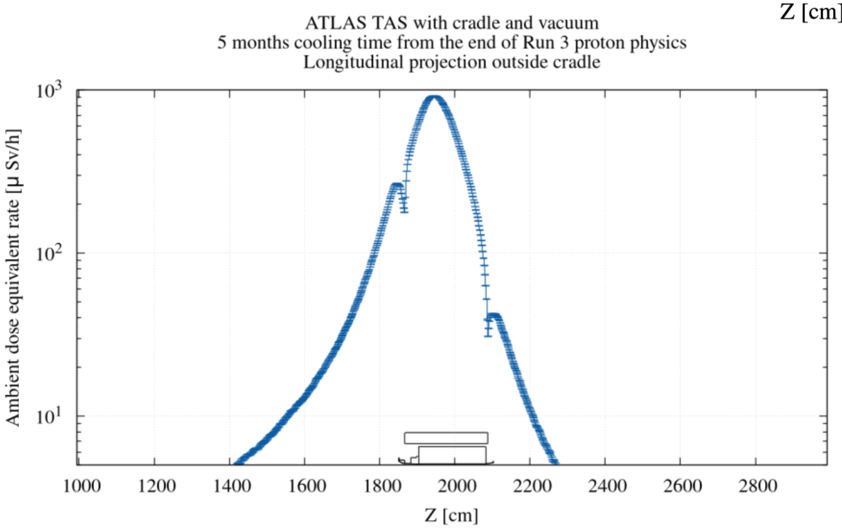


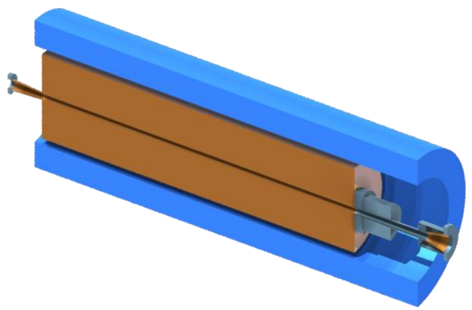
ATLAS TAS and cradle

- Residual dose rates have been estimated and results have been summarized in D. Bozzato et al., EDMS 3129308.
- To stay on the conservative side, the cooling time that can be considered is 5 months from the end of proton physics in Run 3.



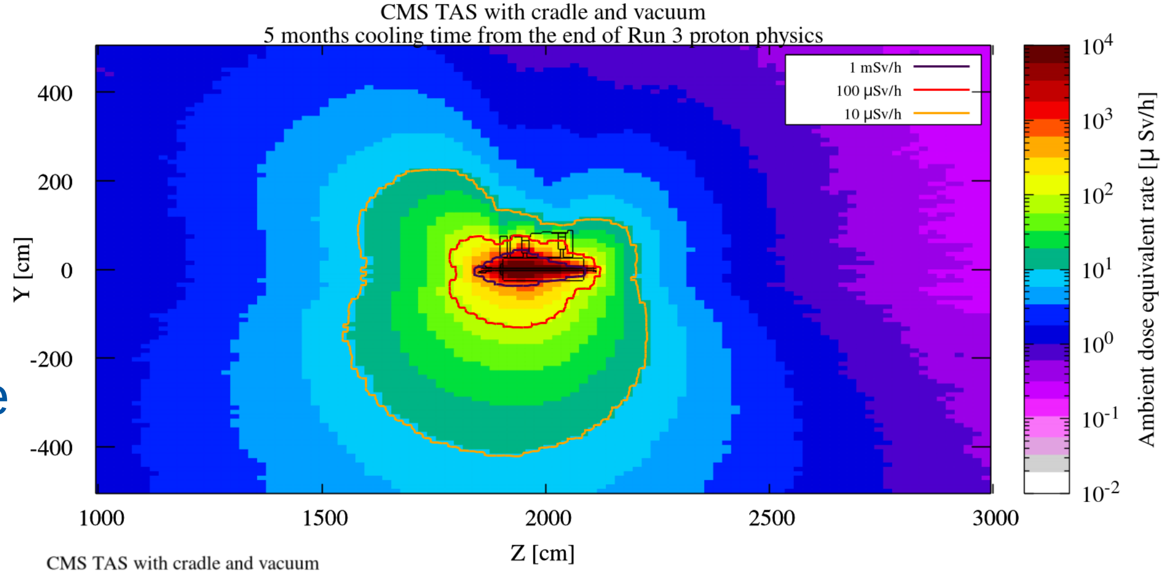


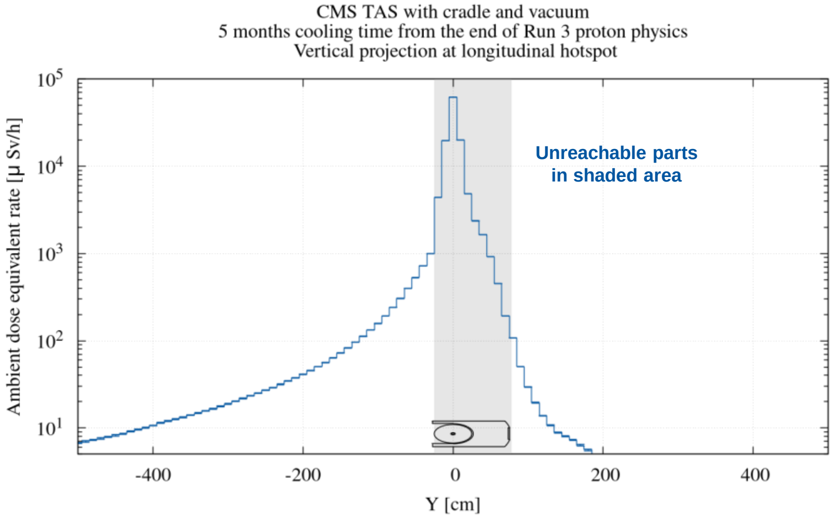


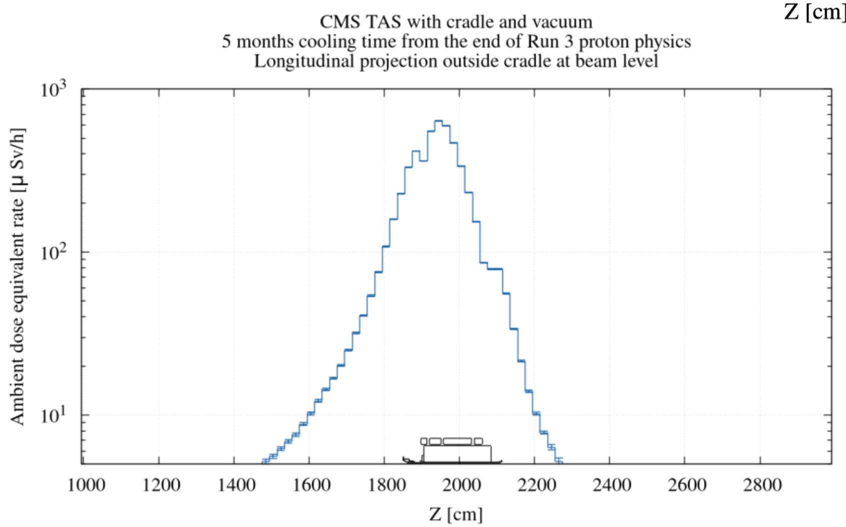


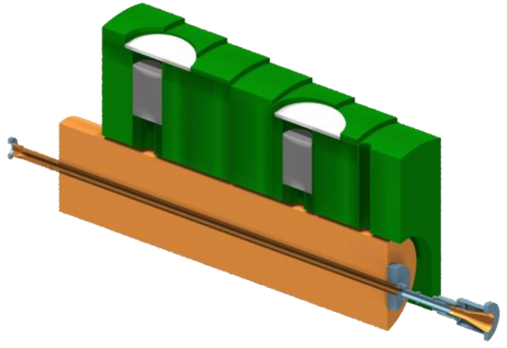
CMS TAS and cradle

- Residual dose rates have been estimated and results have been summarized in D. Bozzato et al., EDMS 3129308.
- To stay on the conservative side, the cooling time that can be considered is 5 months from the end of proton physics in Run 3.









ATLAS JFC3 and JFSU

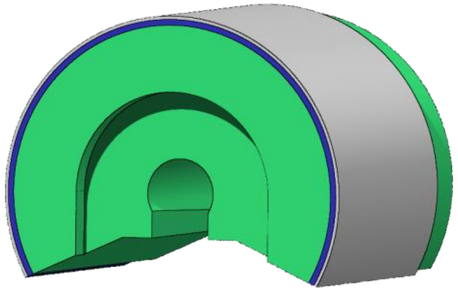
- The radionuclide inventories of the ATLAS JFC3 and JFSU shielding have been estimated and results have been summarized in T. Lorenzon et al., EDMS 2914560
- Results have already been communicated to HSE-RP-CS to define the appropriate transport classification from the ATLAS surface buildings to Building 191 (Meyrin) where they will be machined:
  - The two shieldings would meet the requirements for LSA-1 type transport (input from P. Bertreix)

Isotope	Activity [Bq]
^{55}Fe	4.63E+09 ± 0.17 %
^{60}Co	1.42E+09 ± 0.16 %
^{54}Mn	1.11E+09 ± 0.21 %
^{49}V	2.98E+08 ± 0.25 %
^{3}H	1.61E+08 ± 0.25 %
^{59}Fe	4.03E+07 ± 0.19 %
^{46}Sc	1.79E+07 ± 0.40 %
^{51}Cr	9.79E+06 ± 0.23 %
^{56}Co	7.45E+06 ± 0.52 %
^{22}Na	7.40E+06 ± 0.73 %
^{7}Be	6.42E+06 ± 0.43 %
^{45}Ca	4.96E+06 ± 0.89 %
^{35}S	2.82E+06 ± 0.86 %
^{57}Co	2.81E+06 ± 1.26 %
^{44}Sc	1.02E+06 ± 0.69 %
^{44}Ti	1.02E+06 ± 0.69 %
^{37}Ar	7.88E+05 ± 0.60 %
^{58}Co	5.95E+05 ± 1.61 %
^{39}Ar	2.40E+05 ± 0.61 %
^{33}P	6.38E+04 ± 0.91 %
^{48}V	6.36E+04 ± 0.27 %
^{42}K	2.96E+04 ± 4.46 %
^{42}Ar	2.96E+04 ± 4.46 %
^{32}P	2.21E+04 ± 2.33 %
^{32}Si	2.06E+04 ± 2.50 %
^{63}Ni	1.59E+04 ± 3.59 %
^{14}C	3.25E+03 ± 1.13 %
^{65}Zn	2.47E+03 ± 40.77 %
^{53}Mn	1.37E+03 ± 0.21 %
^{41}Ca	1.28E+03 ± 0.46 %
^{36}Cl	4.30E+02 ± 0.48 %
^{26}Al	8.84E+01 ± 0.45 %
^{10}Be	4.70E+01 ± 0.59 %
^{59}Ni	2.10E+01 ± 3.67 %

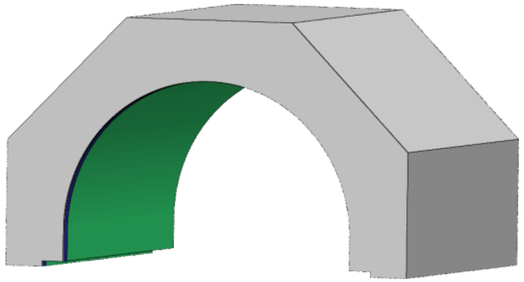
Radionuclide activities for one ATLAS JFC3 for 7 months cooling time from the end of proton physics in Run 3.

Isotope	Activity [Bq]
^{55}Fe	1.32E+08 ± 0.24 %
^{60}Co	4.83E+07 ± 0.27 %
^{54}Mn	2.47E+07 ± 0.53 %
^{59}Fe	8.51E+06 ± 0.68 %
^{49}V	5.12E+06 ± 1.05 %
^{51}Cr	3.19E+06 ± 0.77 %
^{3}H	1.39E+06 ± 1.06 %
^{46}Sc	4.86E+05 ± 3.31 %
^{7}Be	2.62E+05 ± 4.10 %
^{56}Co	1.66E+05 ± 5.72 %
^{48}V	1.49E+05 ± 1.50 %
^{22}Na	8.33E+04 ± 6.62 %
^{45}Ca	6.68E+04 ± 9.52 %
^{57}Co	4.24E+04 ± 11.57 %
^{58}Co	3.43E+04 ± 12.02 %
^{37}Ar	2.10E+04 ± 11.38 %
^{35}S	1.05E+04 ± 24.02 %
^{44}Ti	5.83E+03 ± 8.31 %
^{44}Sc	5.83E+03 ± 8.31 %
^{32}P	2.93E+03 ± 8.34 %
^{33}P	2.66E+03 ± 22.84 %
^{39}Ar	9.11E+02 ± 9.48 %
^{63}Ni	1.46E+02 ± 37.74 %
^{42}K	1.20E+02 ± 70.69 %
^{42}Ar	1.20E+02 ± 70.69 %
^{52}Mn	1.18E+02 ± 1.02 %
^{53}Mn	2.36E+01 ± 0.57 %
^{14}C	9.78E+00 ± 19.54 %
^{41}Ca	5.13E+00 ± 6.38 %
^{26}Al	1.17E+00 ± 3.53 %
^{36}Cl	1.02E+00 ± 8.42 %

Radionuclide activities for one ATLAS JFSU for 3 months cooling time from the end of proton physics in Run 3.



ATLAS JFC3



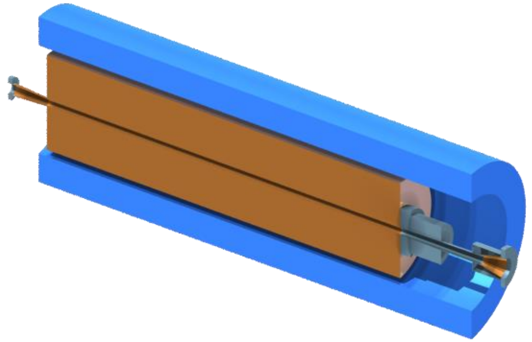
ATLAS JFSU

ATLAS TAS and cradle

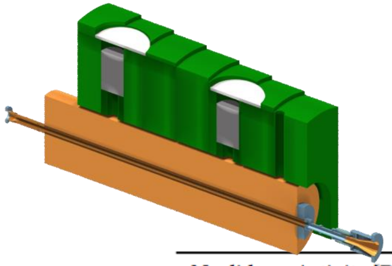
- The radionuclide inventories of the different components have been estimated and results have been summarized in D. Bozzato et al., EDMS 3129308:
  - To stay on the conservative side, the cooling time to be considered is 2 months from the end of proton physics in Run 3.
  - In the table the inventory for the full assembly is summarized.
- Results have already been communicated to HSE-RP-CS to define the appropriate transport classification:
  - The full TAS assembly , or even the TAS alone, would not meet requirements for LSA-1 type transport (input from P. Bertreix): a packed transport in a dedicated container is required (see next slides).

Nuclide	Activity [Bq]	Nuclide	Activity [Bq]	Nuclide	Activity [Bq]
^{55}Fe	2.3733×10^{10}	^{32}P	7.6811×10^{7}	^{71}Ge	1.1301×10^{3}
^{58}Co	1.8084×10^{10}	^{44}Sc	1.3912×10^{7}	^{10}Be	1.1154×10^{3}
^{54}Mn	1.4912×10^{10}	^{44}Ti	1.3912×10^{7}	^{26}Al	7.6039×10^{2}
^{57}Co	1.3027×10^{10}	^{39}Ar	6.3735×10^{6}	^{75}Se	7.3838×10^{2}
^{3}H	7.1789×10^{9}	^{52}Mn	4.2281×10^{6}	^{60m}Co	3.5361×10^{2}
^{60}Co	6.4770×10^{9}	^{42}K	1.2853×10^{6}	^{60}Fe	3.5361×10^{2}
^{51}Cr	5.9177×10^{9}	^{42}Ar	1.2852×10^{6}	^{44m}Sc	9.8146×10^{1}
^{49}V	5.4625×10^{9}	^{32}Si	1.0977×10^{6}	^{72}As	6.0544×10^{1}
^{56}Co	4.7709×10^{9}	^{59}Ni	6.6015×10^{5}	^{72}Se	5.2739×10^{1}
^{59}Fe	1.8680×10^{9}	^{56}Ni	1.7241×10^{5}	^{67}Ga	3.9770×10^{1}
^{46}Sc	1.3007×10^{9}	^{14}C	1.2908×10^{5}	^{40}K	2.9379
^{7}Be	1.1061×10^{9}	^{68}Ga	5.4457×10^{4}	^{67}Cu	3.3024×10^{-1}
^{63}Ni	8.2304×10^{8}	^{68}Ge	5.4448×10^{4}	^{48}Sc	6.1516×10^{-2}
^{48}V	7.2442×10^{8}	^{41}Ca	2.5147×10^{4}	^{66}Cu	8.7986×10^{-3}
^{37}Ar	4.3594×10^{8}	^{47}Sc	1.5123×10^{4}	^{66}Ni	8.7848×10^{-3}
^{35}S	3.3874×10^{8}	^{53}Mn	1.3263×10^{4}	^{71}As	6.5363×10^{-3}
^{65}Zn	3.0255×10^{8}	^{36}Cl	1.1023×10^{4}	^{57}Ni	1.3181×10^{-3}
^{45}Ca	2.4123×10^{8}	^{47}Ca	2.2030×10^{3}	^{69}Ge	1.0285×10^{-6}
^{33}P	1.5497×10^{8}	^{73m}Ge	1.4944×10^{3}		
^{22}Na	1.0620×10^{8}	^{73}As	1.4944×10^{3}		

Radionuclide activities for one full ATLAS TAS assembly (TAS and cradle) for 2 months cooling time from the end of proton physics in Run 3. Only activities above 10-6 Bq are reported.



CMS TAS and cradle



- The radionuclide inventories of the different components have been estimated and results have been summarized in D. Bozzato et al., EDMS 3129308:
  - To stay on the conservative side, the cooling time to be considered is 2 months from the end of proton physics in Run 3.
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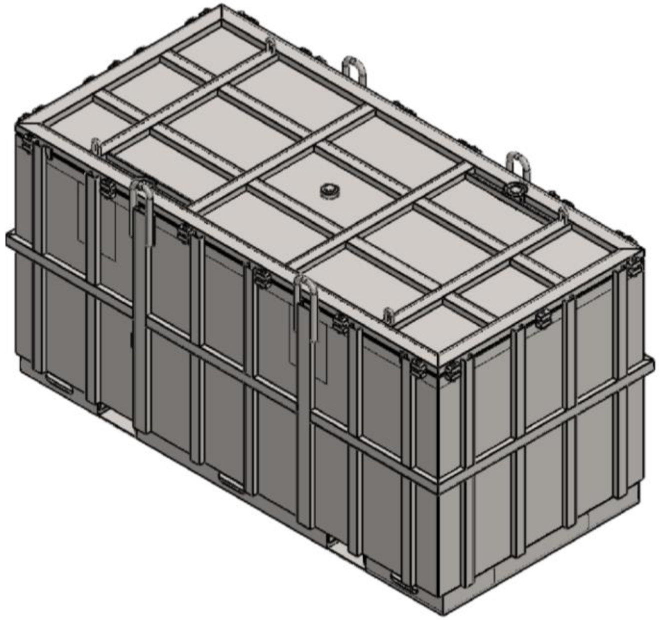
- Results have already been communicated to HSE-RP-CS to define the appropriate transport classification:
  - The full TAS assembly , or even the TAS alone, would not meet requirements for LSA-1 type transport (input from P. Bertreix): a packed transport in a dedicated container is required (see next slides).

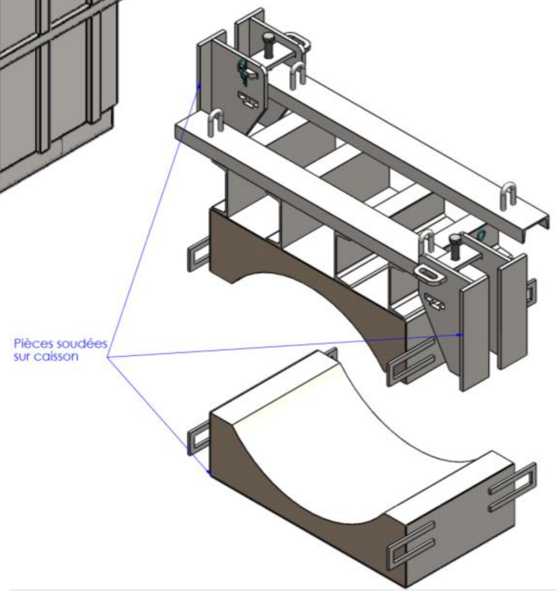
Nuclide	Activity [Bq]	Nuclide	Activity [Bq]	Nuclide	Activity [Bq]
^{55}Fe	2.0987×10^{10}	^{83m}Kr	7.7268×10^{5}	^{95m}Nb	7.1924×10^{2}
^{58}Co	1.9824×10^{10}	^{59}Ni	7.7103×10^{5}	^{90}Y	6.2308×10^{2}
^{57}Co	1.4322×10^{10}	^{75}Se	4.3750×10^{5}	^{90}Sr	6.2288×10^{2}
^{54}Mn	1.3929×10^{10}	^{73m}Ge	3.9246×10^{5}	^{26}Al	4.0336×10^{2}
^{3}H	7.6220×10^{9}	^{73}As	3.9246×10^{5}	^{60m}Co	3.9834×10^{2}
^{51}Cr	5.3794×10^{9}	^{82}Rb	3.2354×10^{5}	^{60}Fe	3.9834×10^{2}
^{56}Co	5.1628×10^{9}	^{82}Sr	3.2353×10^{5}	^{94}Nb	1.7257×10^{2}
^{49}V	5.0006×10^{9}	^{56}Ni	1.7631×10^{5}	^{85}Kr	1.2549×10^{2}
^{60}Co	3.3383×10^{9}	^{68}Ga	1.6098×10^{5}	^{44m}Sc	9.3453×10^{1}
^{59}Fe	1.5239×10^{9}	^{68}Ge	1.6096×10^{5}	^{99}Mo	8.4680×10^{1}
^{46}Sc	1.2385×10^{9}	^{14}C	1.3726×10^{5}	^{99m}Tc	8.2046×10^{1}
^{7}Be	9.9805×10^{8}	^{93m}Nb	1.1477×10^{5}	^{67}Ga	4.5239×10^{1}
^{63}Ni	9.3337×10^{8}	^{95m}Tc	1.1180×10^{5}	^{96}Tc	2.6505×10^{1}
^{48}V	6.6770×10^{8}	^{97m}Tc	7.4130×10^{4}	^{89m}Y	2.3033×10^{1}
^{37}Ar	4.3078×10^{8}	^{95}Zr	6.1512×10^{4}	^{87m}Sr	2.2840×10^{1}
^{35}S	3.4693×10^{8}	^{84}Rb	5.4994×10^{4}	^{89}Zr	2.2071×10^{1}
^{65}Zn	3.4227×10^{8}	^{91}Y	5.3431×10^{4}	^{87}Y	2.2034×10^{1}
^{45}Ca	2.3634×10^{8}	^{92m}Nb	3.6521×10^{4}	^{81}Kr	1.0123×10^{1}
^{33}P	1.5943×10^{8}	^{71}Ge	2.7698×10^{4}	^{40}K	2.8989
^{22}Na	8.0093×10^{7}	^{41}Ca	2.4492×10^{4}	^{67}Cu	3.6718×10^{-1}
^{32}P	8.0028×10^{7}	^{91}Nb	1.9369×10^{4}	^{93}Zr	3.4703×10^{-1}
^{44}Sc	1.3185×10^{7}	^{47}Sc	1.5157×10^{4}	^{71}As	1.5175×10^{-1}
^{44}Ti	1.3185×10^{7}	^{93}Mo	1.4808×10^{4}	^{97}Tc	1.4682×10^{-1}
^{39}Ar	6.4659×10^{6}	^{53}Mn	1.2521×10^{4}	^{92}Nb	6.7753×10^{-2}
^{52}Mn	3.9582×10^{6}	^{74}As	1.1722×10^{4}	^{48}Sc	6.0218×10^{-2}
^{88}Y	2.7804×10^{6}	^{36}Cl	1.1119×10^{4}	^{98}Tc	4.4143×10^{-2}
^{88}Zr	2.2668×10^{6}	^{89}Sr	9.8925×10^{3}	^{79}Se	3.8765×10^{-2}
^{91m}Nb	2.0063×10^{6}	^{95}Tc	4.3979×10^{3}	^{77}Br	3.6581×10^{-2}
^{42}K	1.3425×10^{6}	^{86}Rb	4.3831×10^{3}	^{66}Cu	9.4453×10^{-3}
^{42}Ar	1.3424×10^{6}	^{72}As	3.6680×10^{3}	^{66}Ni	9.4305×10^{-3}
^{85}Sr	1.1534×10^{6}	^{72}Se	3.1951×10^{3}	^{97}Ru	3.1916×10^{-3}
^{32}Si	1.1524×10^{6}	^{47}Ca	2.2809×10^{3}	^{57}Ni	1.3273×10^{-3}
^{83}Rb	1.0293×10^{6}	^{99}Tc	1.4482×10^{3}	^{69}Ge	5.7081×10^{-6}
^{95}Nb	8.9649×10^{5}	^{10}Be	1.0688×10^{3}		

Radionuclide activities for one full CMS TAS assembly (TAS and cradle) for 2 months cooling time from the end of proton physics in Run 3. Only activities above 10-6 Bq are reported.

Transport of the TAS – preliminary solutions

- Solutions for the transport of the TAS and cradle have been investigated (input from C. Celce and G. Dumont).
- The option currently under consideration is a naked 10m^3 container
- The estimated residual dose rates at contact are already close to 2 mSv/h:
  - The bottom part of the container will be the weakest point (generally less shielding provided by the cradle)
  - If the dose rate at contact will be higher than 2 mSv/h, the container will be placed in a 6.05 m x 2.59 m x 2.59 m transport container whose bottom will be lined with an iron slab.

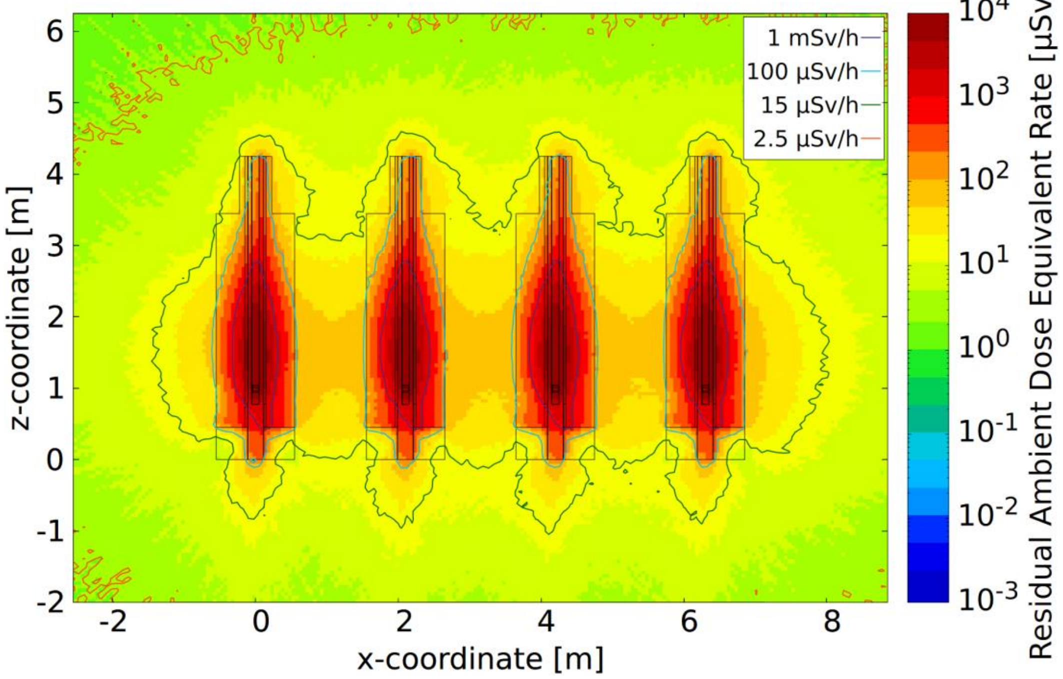


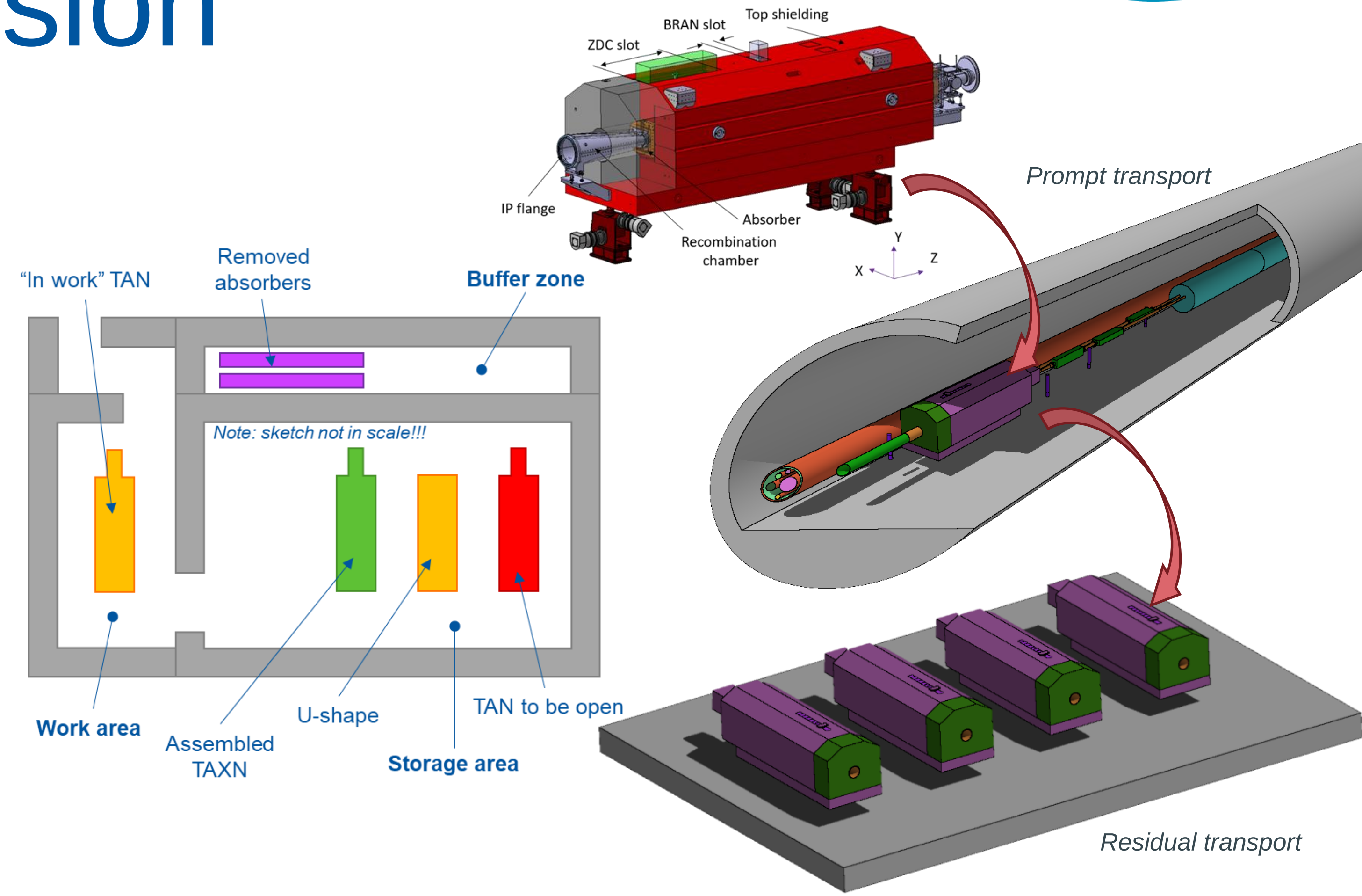


TAN to TAXN conversion

TAN/TAXN conversion

See detailed study by L. Elie in [EDMS 2649832]





- ❑ A number of studies were developed by HSE-RP in the past years on TAXN design and TAN/TAXN conversion.
- ❑ A non-exhaustive list here: EDMS 2467997, 2596841, 2649832, and more.

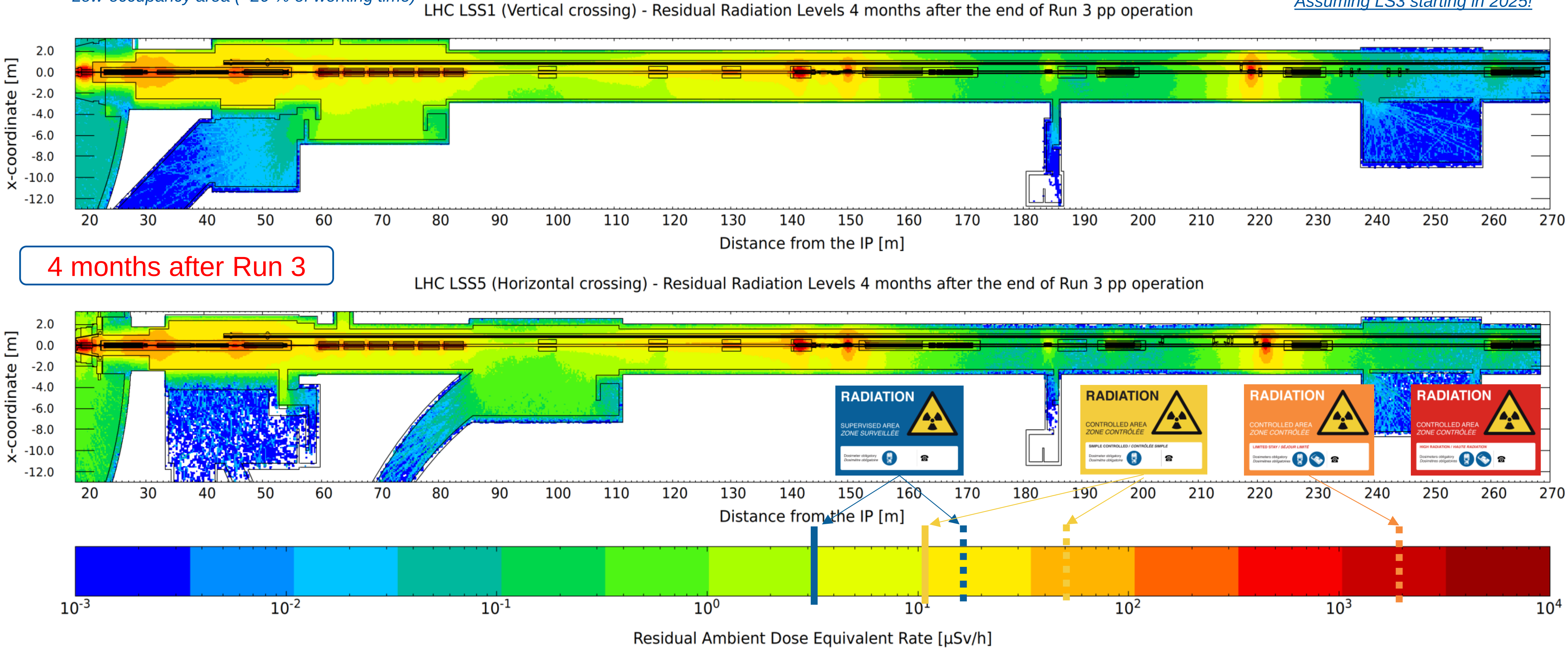
LS3: Residual H*(10) for LSS1/5

Permanent workplace

Low-occupancy area (<20 % of working time)

Assuming LS3 starting in 2025!

4 months after Run 3



TAN/TAXN conversion

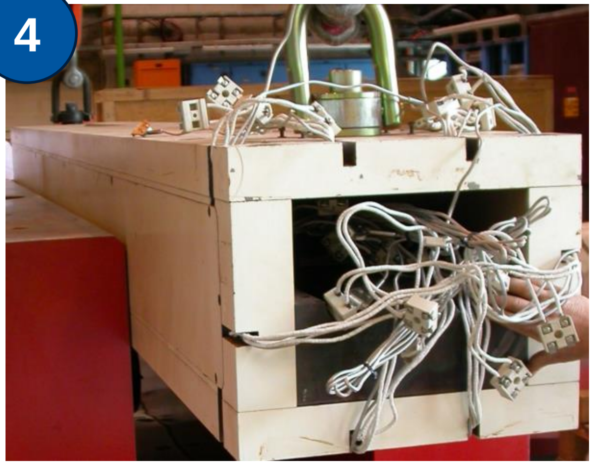
0 Removal of TAN from LHC tunnel + transport

1

2

3

4



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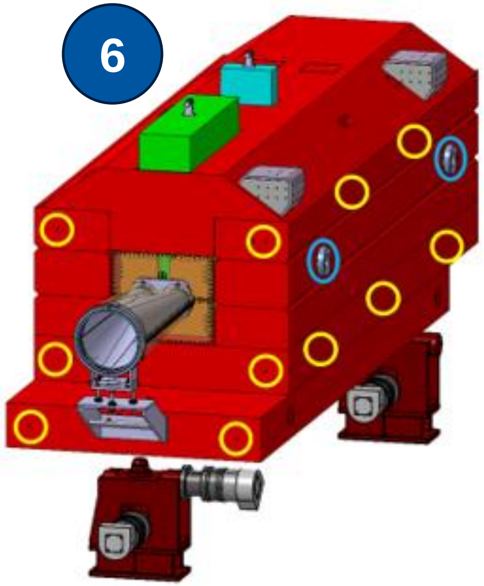


7 Assembly HL-LHC TAXN

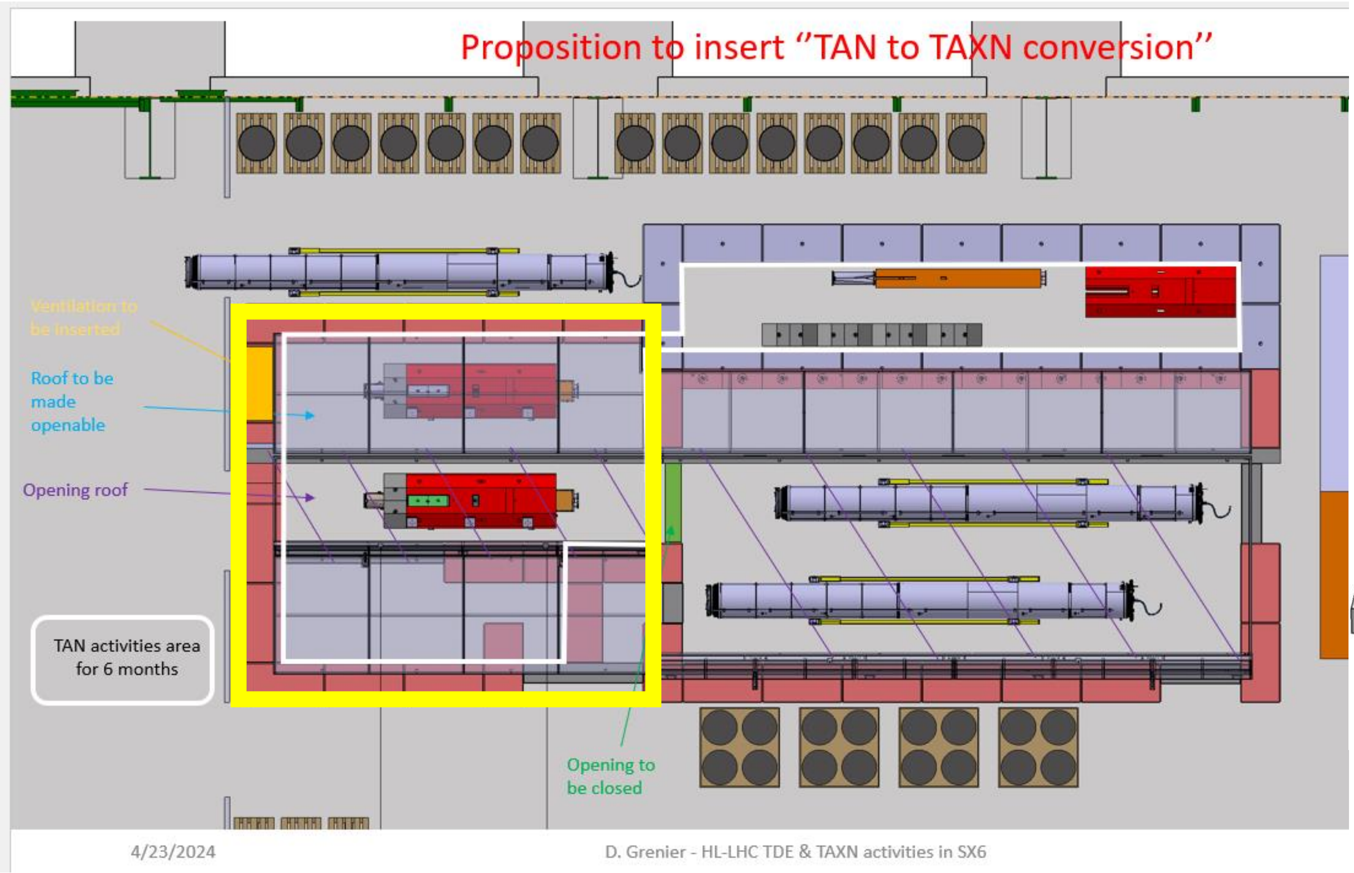
8 Transport/installation in the tunnel

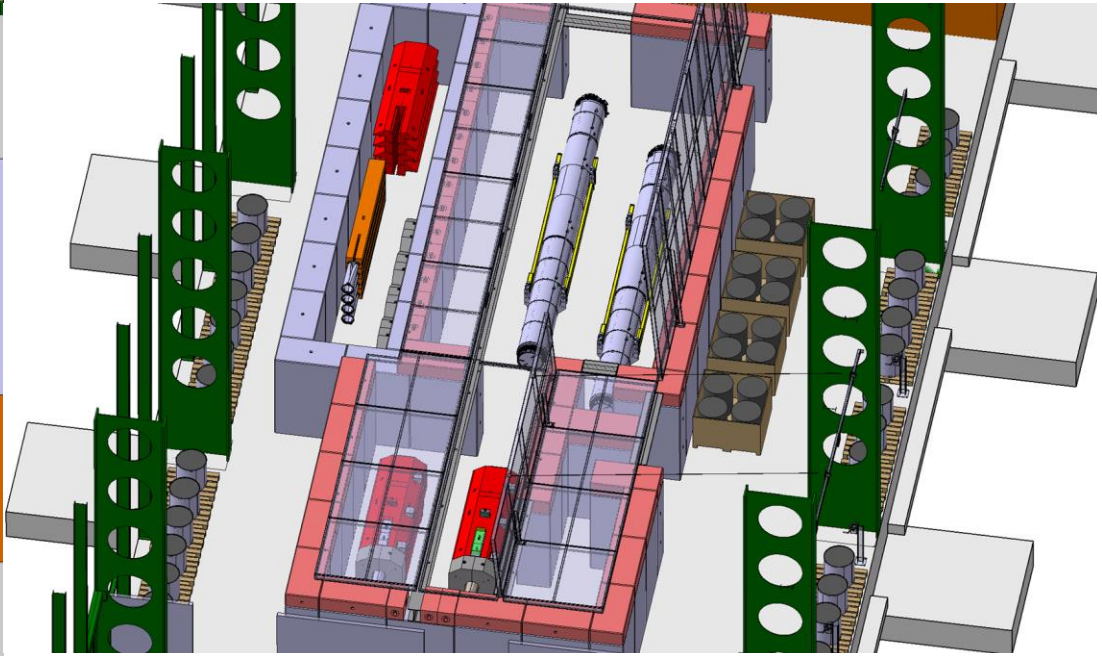
To be repeated 4x!

TAN/TAXN conversion

- Shared worksite (with HL-LHC TDE) in SX6 building
- Dedicated working area for TAN to TAXN conversion (1x TAN at the time)
- Storage of TAN to convert/completed TAXN in UX65

Courtesy O. Boettcher (WP8)



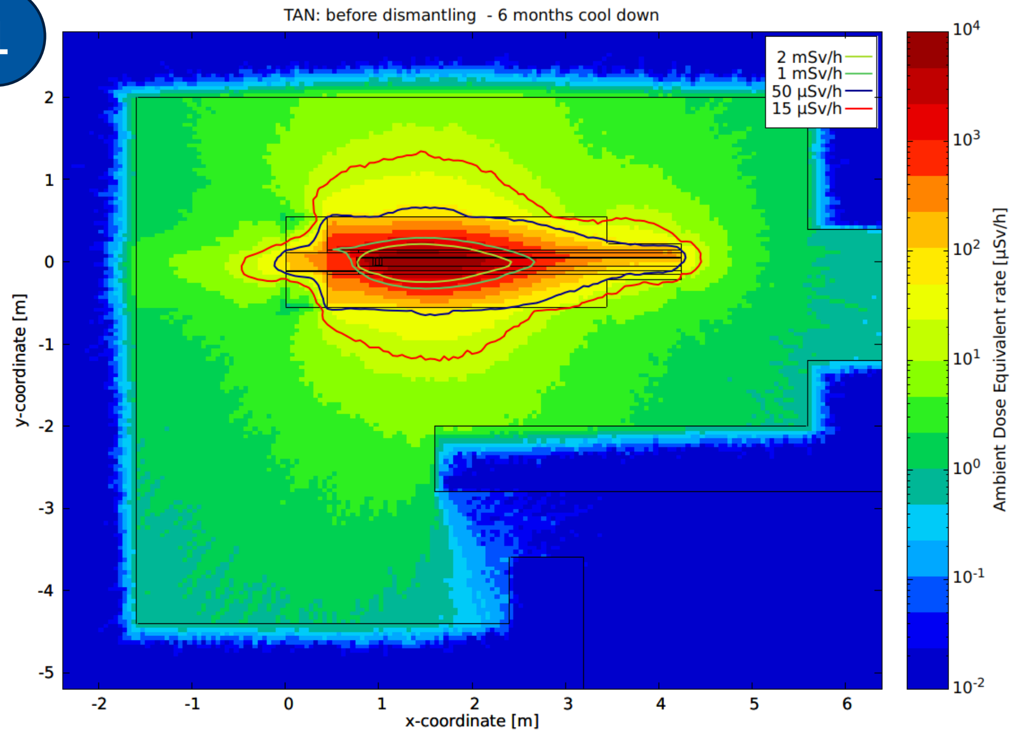


SX6

TAN/TAXN conversion

See detailed study by P. Dyrcz in [EDMS 3088721]

1



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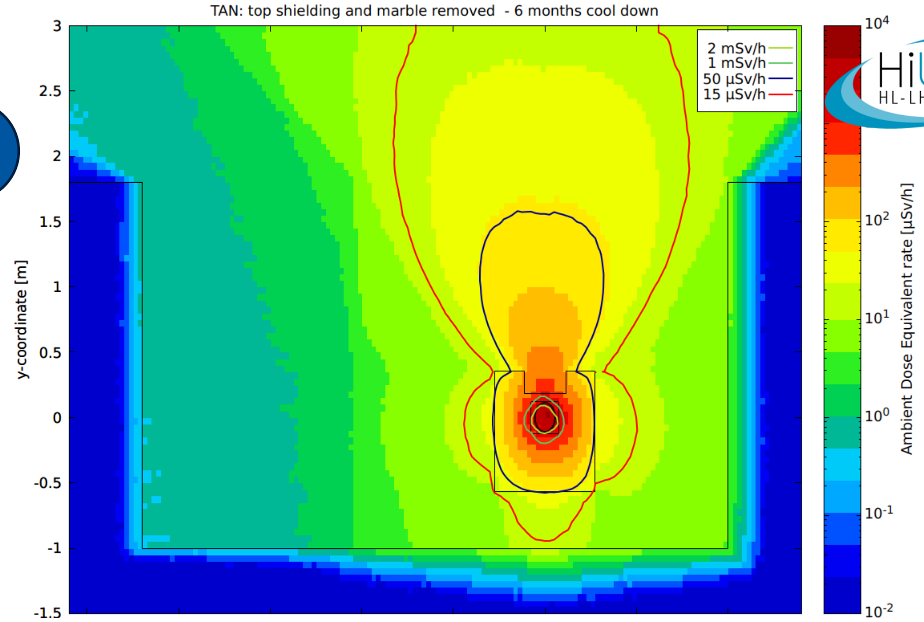
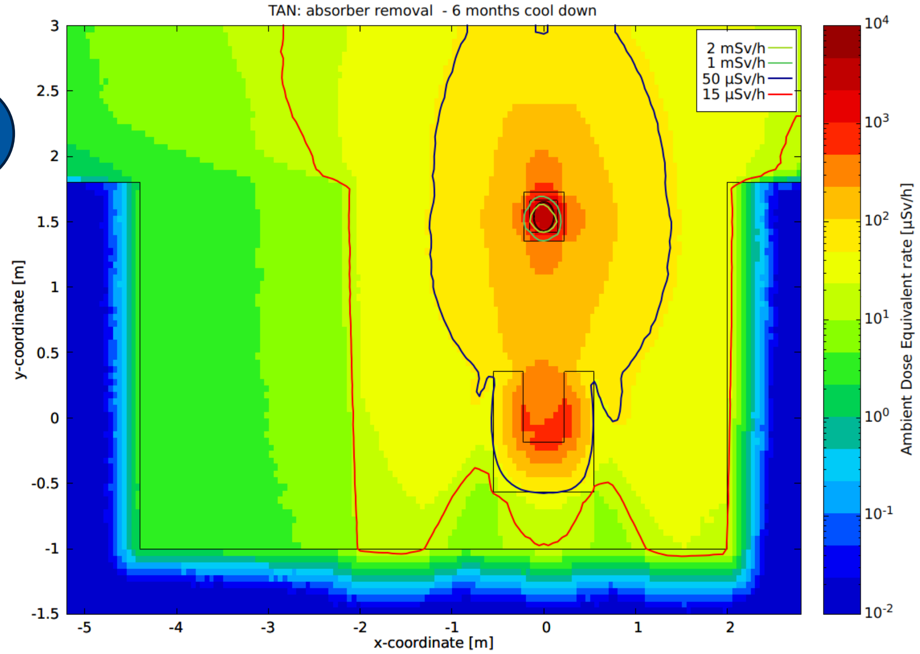


4



- Several configuration studied, in terms of cool down and phases of the conversion.
- Availability (time slot) of the SX6 building took in account.
- Baseline: TAN removal in March/April 2026; conversation as from mid-2026 (~6 months cool down).

TAN/TAXN conversion

No.	Work owner	Task	Location of task (z/x/y)	Work Position (z/x/y)	Time (min)	mSv/h (chest)	Indiv. Dose mSv (chest)	No. Workers	Collect. Dose mSv (chest)	Tools	Parts	Details	Comments
		TAN-to-TAXN conversion (4 TAN)		Total time (h)	18.73	Indiv.	0.93	mSv/h	1.365	mSv/h collective dose		Details	Comments
		TAN-to-TAXN conversion (1 TAN)		Total time (h)	4.68	Indiv.	0.234	mSv/h	0.341	mSv/h collective dose		Details	Comments
I		**Disassembly of TAN and modification of TAN U-shielding**			3.77	h	0.204	Totals	0.301				
		Planned activity start date: 01/05/2026 (6 months cool-down time after pp-run)										Height of sup[illegible]ts tbd, position tbd	
0a	EN-HE	*Preparation: Position TAN in TDE compartement on supports*										He[illegible] tbd, position tbd	
10	BE-EA + EN-HE	**Removal of top shielding**	Scenario B		30		0.018		0.028				
11	BE-EA	Unscrew 2 rods fixing top shielding (downstream side)	3/+-0.4/+-0.5	3/+-1/+-0.5	5	0.020	0.002	2	0.003	wredge tool (size?)			
12	BE-EA	Unscrew 2 rods fixing top shielding (upstream side)	1,5/+-0.4/+-0.5	1,5/+-1/+-0.5	5	0.080	0.007	2	0.013			[illegible]ove	
13	EN-HE	Attach lifting ring + lifting slings (downstream side)	3.5/0/+0.5	3.5/0.6/+0.5	5	0.020	0.002	1	0.002		[illegible] slings (tbd)		
14	EN-HE	Attach lifting ring + lifting slings (upstream side)	1.5/0/+0.5	1.5/0.6/+0.5	5	0.080	0.007	1	0.007				
15	EN-HE	Remove top shielding		at safe distance	10	0.010	0.002	2	0.003				
20	BE-EA + EN-HE	**Removal of 2 marble blocks (upstream side)**	Scenario B		23		0.006		0.012				
21	EN-HE	Attach 2 lifting rings + lifting slings	0.75/+-0.4/+0.5	0.75/+-0.4/+0.5	5	0.020	0.002	2	0.003	wredge tool [illegible])	Lifting ring, slings (tbd)		
22	BE-EA	Unscrew 4 bolts (2 each per block)	0.5/+-0.45/+-0.25	0.1/+-0.45/+-0.25	8	0.020	0.003	2	0.005				
23	EN-HE	Remove 2 marbles blocks		at safe distance	10	0.010	0.002	2	[illegible]				
30	BE-EA + EN-HE	**Removal of 1 absorber box**	Scenario C		21		0.010		[illegible]				
31	BE-EA	Remove insulation sheet (from downstream side)	3.5/0/+0.25	4/0.6/+0.5	1	0.020	0.000	1	0.0[illegible]				
32	EN-HE	Attach 1 lifting ring + lifting slings (downstream side)	4/0/+0.25	4/0.6/+0.5	5	[illegible]	0.002	1	0.002				
33	EN-HE	Attach 1 lifting ring + lifting slings (upstream side)	1.5/0/+0.25	1.5/0.6/+0.5	[illegible]	[illegible]	[illegible]007	1	0.007				
34	EN-HE	Removal of absorber box (to waste compartment - crane operation)		at safe d[illegible]	10	0.010	[illegible]2	2	0.003				
40	BE-EA	**Preparation of 1 TAN U-shielding (for convertion into TAXN U-shielding)**	Scenario C/D		12		[illegible]09						
41	BE-EA	Remove 2 insulation sheets (from downstream side)	[illegible]	4/0.6/+0.5	1	0.0[illegible]	0.000	1	0.000				
42	BE-EA	Unscrew 2 absorber position devices (downst[illegible]	3/+-0.2/-0.25	[illegible].5/0/+0.5	[illegible]	[illegible]	[illegible]002	1	0.002				
43	BE-EA	Unscrew 2 absorber position devices (upstre[illegible]e)	1/+-0.2/-0.25	[illegible].6/+0.5	[illegible]	0.080	[illegible]	1	0.007				
44	BE-EA	Remove bottom insulation sheet (from downs[illegible] side)	3.5/0/+-0.25	[illegible]+0.5	[illegible]	0.010	0.000		0.000				
50	BE-EA	**Modification of 1 TAN U-shielding (convertion to [illegible] U-**	Scenario C/D				0.160		0.240				
51	BE-EA	Drilling of 2 fiducials supports on the side (marked [illegible] blue) - each 15 min.	1+3/0.55/+0.15	1+3[illegible].15	[illegible]	0.060	0.030	1.5	0.045				
52	BE-EA	Drilling of 5 survey target supports on the side (mark[illegible]	1+3/0.55/+-0.35	1+[illegible]0.35	50	0.060	0.050	1.5	0.075				
53	BE-EA	Drilling of 4 survey target supports upper (lateral shielding upstream side - marked in yellow) - each 10	[illegible]5/+-0.5/+-0.35	0[illegible]5/+-0.35	40	0.080	0.053	1.5	0.080				
54	BE-EA	Drilling of 2 survey target supports upper (lower base shielding upstream side - marked in yellow) - each 10	[illegible]	0/+-0.65/-0.6	20	0.080	0.027	1.5	0.040				
II		**Assembly of TAXN**			0.92	h	0.03	Totals	0.04				
0a		*Preparation: TAXN absorber box assembled and tested (Y-chamber installed in absorber clamps, water cooling circuit attached and tested, heating jacket installed and tested)*	*not in presence of radioactivity*									*Height of supports tbd, position tbd*	
60	BE-EA + EN-HE	**Installation absorber positioning devices**	Scenario C/D		55		0.030		0.040				
61	BE-EA	Install 2 absorber positioning devices (downstream side)	3/+-0.2/-0.25	3.5/0/+0.5	10	0.020	0.003	2	0.007			Remove 2 bottom nuts of rods push up the rods to remove them (if blocked, remove the 2 top nuts as well and remove rods after absorber box has been removed).	
62	BE-EA	Install 1 absorber positioning device (upstream side)	1/+-0.2/-0.25	0.5/-0.6/+0.5	15	0.080	0.020	1	0.020			as above	
63	EN-HE	Insertion of new absorber box into U-shielding (crane operation)		at safe distance	10	0.010	0.002	2	0.003				

DRAFT

- Preliminary WDP in work with WP8.
- Residual dose rate, working locations, and potential optimization in work together with HSE-RP.
- Activity potentially ALARA Lev. 3 (to be confirmed).
- More iteration needed on this subject.

TAN/TAXN conversion

TAN shielding: specific activity in Bq/g

RN	6 m	1 y	2 y
Fe-55	**1.07E+03**	**9.45E+02**	**7.33E+02**
Mn-54	4.48E+02	2.98E+02	1.32E+02
V-49	8.68E+01	5.91E+01	2.74E+01
H-3	2.47E+01	2.40E+01	2.27E+01
Co-60	1.82E+01	1.71E+01	1.49E+01

Top shielding (5 months c.d.)

RN	Contribution to LL (%)
Mn-54	93
Co-60	5
Sc-46	1
Sum of LL	3.05E3

Cu-absorber (5 months c.d.)

RN	Contribution to LL (%)
Mn-54	35
Co-60	30
Co-56	16
Sum of LL	1.24E4

NB: Sum of LL>1 means an item need to be treated as radioactive material

- ❑ Radionuclide inventory in the main TAN components have been computed.
- ❑ Next step: transport classification (HSE-RP-CS)
- ❑ RW declared in the HSE-RP-RWM SharePoint (classification to be confirmed).

RW Forecast 2024 ☆

01-My Items | 02-By Group | 02-By-Project | 03-By Facility | 04-By Producer | All Active*

Status	Rad. Waste description	Year	Quarters	RW Pr...	Dep-Grp	Facility	Project	Other haz...	Mass (tons)	Bulky	Volume (...	RP-AS co...	Non-radi...	CL (m3)	TFA (m3)	FMA (m3)	ID
Checked by RW-producer	HL-LHC - WP8 TAN	2026	Q4	Oliver Boettcher	BE-EA	LHC Machine	HL-LHC	None	42	Yes	7	Christophe Tromel	0	0	0	7	16
Checked by RW-producer	HL-LHC - WP8: TAS	2026	Q2, Q3	Oliver Boettcher	BE-EA	LHC Machine	HL-LHC	None	20	Yes	6	Christophe Tromel	0	0	0	6	20

Take away points (I) - TAS

- Residual dose rates for relevant open detector configurations and isolated TAS assemblies have been estimated for both ATLAS and CMS and can be used to provide the necessary input to the WDP preparation.
- The radionuclide inventories for the ATLAS shielding, ATLAS TAS, and CMS TAS have also been estimated and the results have been provided to HSE-RP-CS for the transport classification.
- A possible solution for the transport container for the TAS has been found:
  - In case the dose rate at contact of the container will be greater than 2 mSv/h, additional shielding will be added in the transport container.
- The shift of LS3 to mid-2026 does not change the global picture, provided that the planning is translated accordingly. The transport classification most likely will not change and compensation measures are already being envisaged (i.e. additional shielding in the transport container).

Take away points (II) - TAN

- Close collaboration between WP8 and HSE-RP
- HSEP-RP studies for the TAN to TAXN conversion quite advanced, with several options considered depending on the availability of the SX6 building (presently as from mid-2026).
- The radionuclide inventories for the TAN components have been computed and the results will be soon provided to HSE-RP-CS for the transport classification.
- At present: TAN from Pt.5 will be transported via the tunnel; TAN from Pt.1 need an IP2-container.
- Radioactive Waste: declared in HSE-RP-RWM SharePoint; classification to be confirmed.
- The shift of LS3 to mid-2026 does not change the global picture, provided that an ion run is kept before the end of Run 3 beam operation (assuming 4 weeks ion run) and that the conversion planning is translated by ~7.5 months. If one of the two is not confirmed, the RP impact would need to be re-evaluated.

HSE
Radiation Protection

BACKUP SLIDES

Radiation Area classification

EDMS 810149

Synopsis of the radiological area classification at CERN. Airborne activity and surface contamination levels are expressed respectively in CA and CS values, as defined in the Swiss legislation for Radiation Protection (Swiss Federal Council, 2018). Colors are representative of the signalization in force at CERN, to visually identify different radiation areas.

Area	Annual dose limit	Ambient dose equivalent		Specific airborne radioactivity	Specific surface contamination
		Permanent occupancy	Low occupancy		
Non-designated	1 mSv	0.5 µSv/h	2.5 µSv/h	0.05 CA	1 CS
Supervised	6 mSv	3 µSv/h	15 µSv/h	0.1 CA	1 CS
Simple Controlled	20 mSv	10 µSv/h	50 µSv/h	0.1 CA	1 CS
Limited Stay	20 mSv		2 mSv/h	100 CA	4000 CS
High Radiation	20 mSv		100 mSv/h	1000 CA	40000 CS
Prohibited	20 mSv		>100 mSv/h	>1000 CA	>40000 CS

Low-occupancy: < 20% working time

LS3 preparation (RP): Interventions

Interventions:

- ❑ The optimization of an intervention according to the ALARA principle and its final approval is based on a radiation protection risk assessment.
- ❑ All interventions of ALARA Level 2 and 3 are optimized based on individual RP risk assessments.
- ❑ When the radiological risk associated with an activity is classified as ALARA level 3 it must be reviewed and approved by the ALARA Committee.
- ❑ ALARA 3 preparation: iterative process which may profit form ALARA-like exercise (dry-runs in technical management meetings within departments).
- ❑ Collecting needs possibly through RSOs and presentations in the RSOC meetings.
- ❑ Defying a person coordinating the activity on-site/presenting the activity to the ALARA committee.
- ❑ DIMR: granularity to be defined (split by point? split by macro-activity).
- ❑ IMPACT: grouping to be discussed.

4.1. MEMBERSHIP OF THE ALARA COMMITTEE

The membership of a given ALARA Committee depends on the intervention being discussed. The presence of the following members or their deputies is obligatory:

- Chairperson: The Complex Manager.
- Scientific Secretary of the ALARA Committee.
- Radiation Safety Officer (RSO) of the owner/creator of the DIMR.
- Group Leader (or Sub-Detector Project Leader) responsible for the system or equipment.
- Technical Coordinator (for interventions in an experiment).
- The RP Group Leader.

The following members are optional:

- Department Heads.
- Equipment experts.
- RPO involved in the DIMR.
- Other RSOs/LEXGLIMOSs.
- RP physicist in charge of the installation.

EDMS 1751123