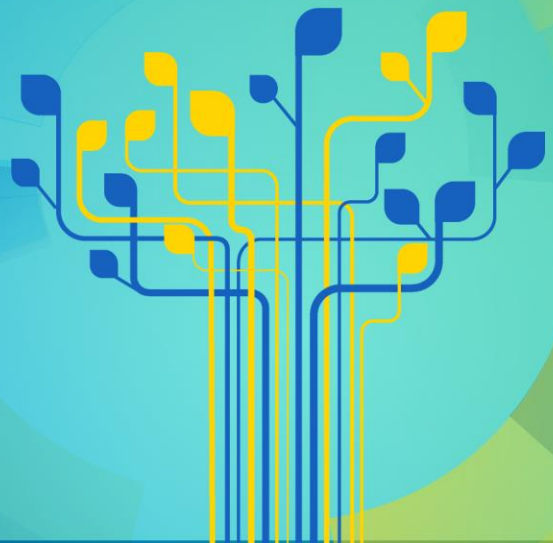
HSE
Radiation Protection

AWAKE Kick-Off – Radiation Protection Work Package



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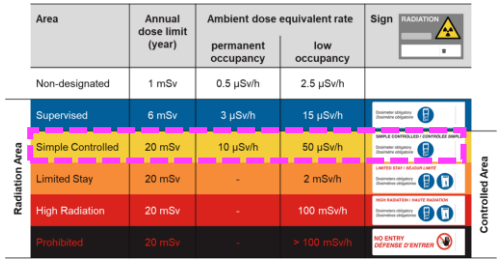
AWAKE Kick-Off 2024
16 July 2024

EDMS 3132880

Outline

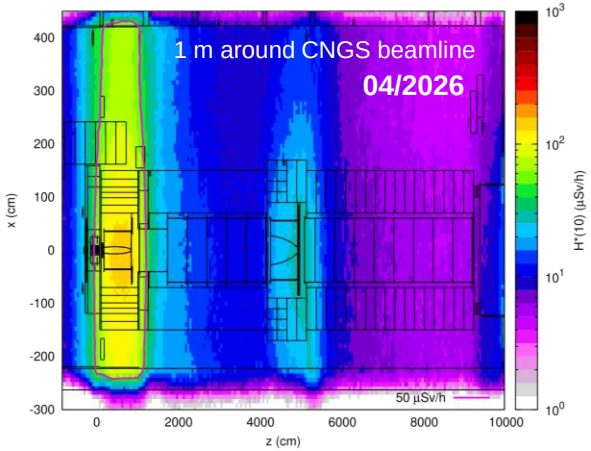
1. Radiological Assessment
2. RP monitoring
3. Operational RP support
4. RP Safety File

RP assessment – Empty TCC4

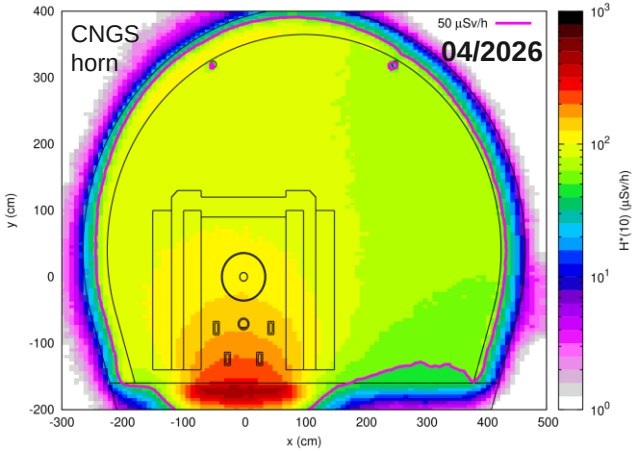


Residual dose rates in the empty TCC4 tunnel

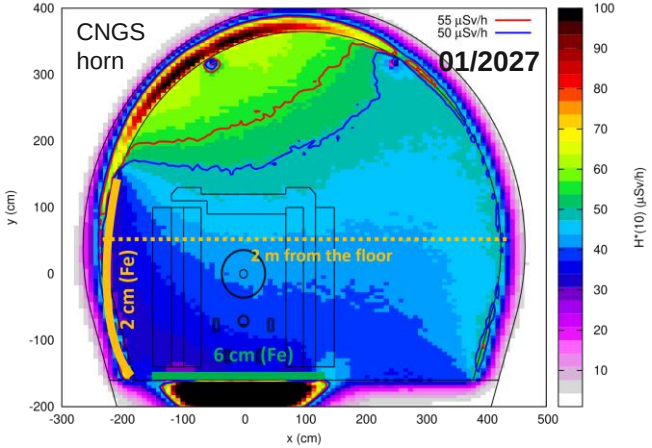
Top view



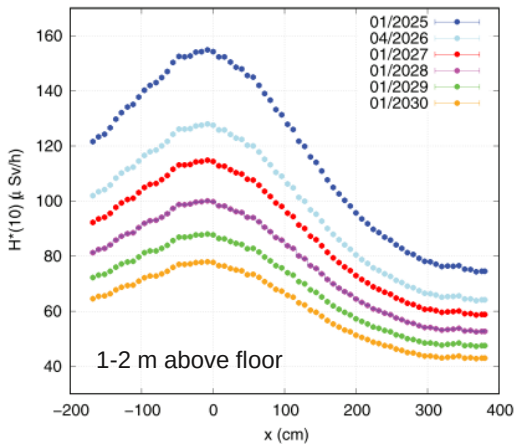
Cross-sect. view



Cross-sect. view + shielding



1d along x at CNGS horn

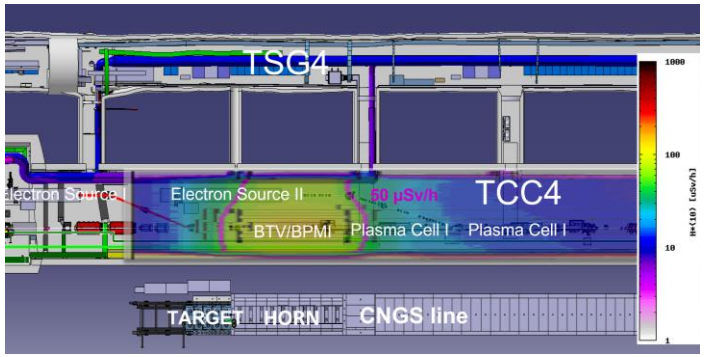


- The TCC4 tunnel will still exhibit elevated radiation levels after the CNGS dismantling due to activation of the tunnel itself
- Additional **shielding** in the most critical area – the CNGS horn location – is needed to bring radiation levels down to a **Simple Controlled Area** (50 uSv/h limit)
- **AWAKE Run 2c/d equipment** will be located **in the critical areas** → works in the tunnel (e.g. installation/maintenance of equipment) will need to take the radiological environment into account (preparation and dose optimization of works in the area)

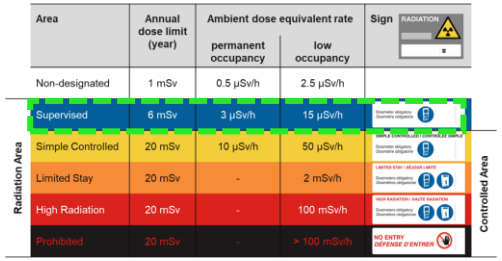
Top view

1-2 m above floor

04/2026



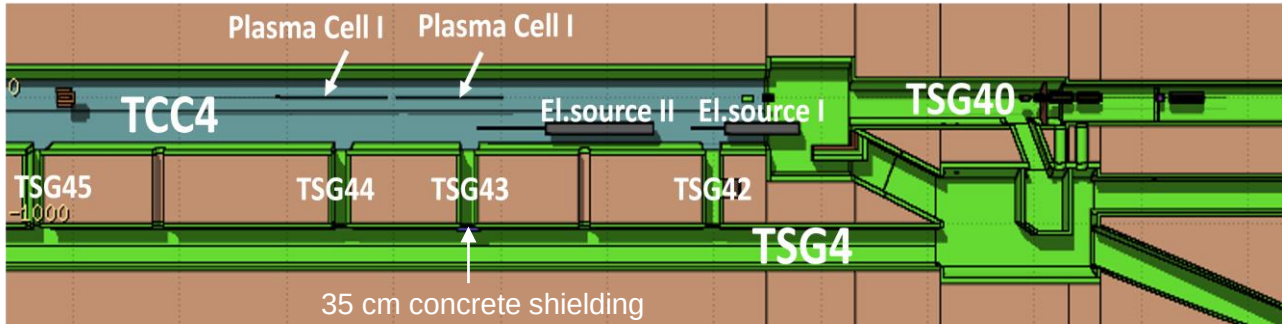
RP assessment – Run 2 c/d



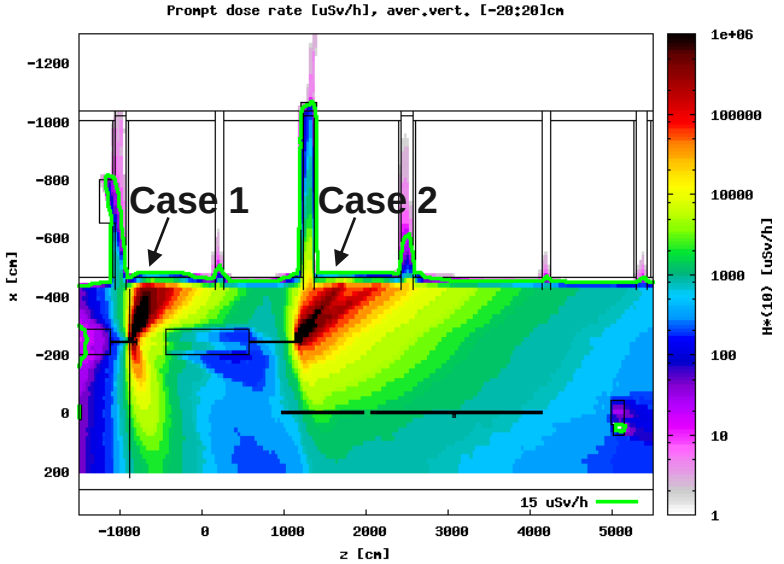
- Electron beam loss scenarios have been studied
- Both e⁻ injectors are in TCC4 tunnel inaccessible during electron (and proton) beam operation
- The closest accessible area is TSG4, which is a Supervised Radiation Area with low occupancy (15 µSv/h limit)
- Two loss scenarios were studied:
  1. e⁻ source I beam losses – dipole polarity failure
     - Electron energy: 20 MeV
     - Beam size : σ_x=135 µm, σ_y=133 µm
     - Beam charge: 600 pC, 10 Hz rate (3.75e10 el/s)
     - Beam diagnostics by means of a 1.2 cm thick Cu Faraday Cup
     - Highest dose rates in TSG4 for dipole polarity failure
  2. e⁻ source II beam losses – dipole polarity failure
     - Electron energy: 150 MeV
     - Beam size : σ_x=135 µm, σ_y=133 µm
     - Beam charge: 150 pC, 10 Hz rate (9.38e9 el/s)
     - Beam diagnostics by means of a 5 cm thick Cu Faraday Cup at worst location (in front of TSG43)
     - Highest dose rates in TSG4 for dipole polarity failure

➢ Additional 35 cm concrete shielding on the TSG4 side next to the TSG43 passage + RP monitor w/ interlock are needed

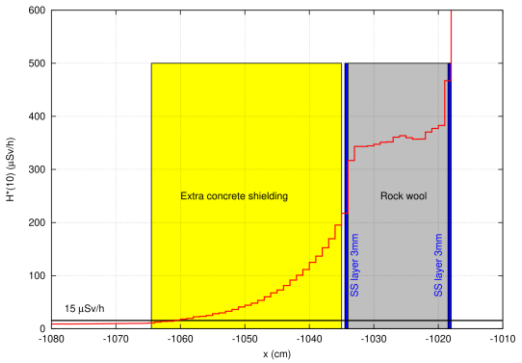
FLUKA model for e⁻ loss verification



H*(10) for convolution of both loss scenarios

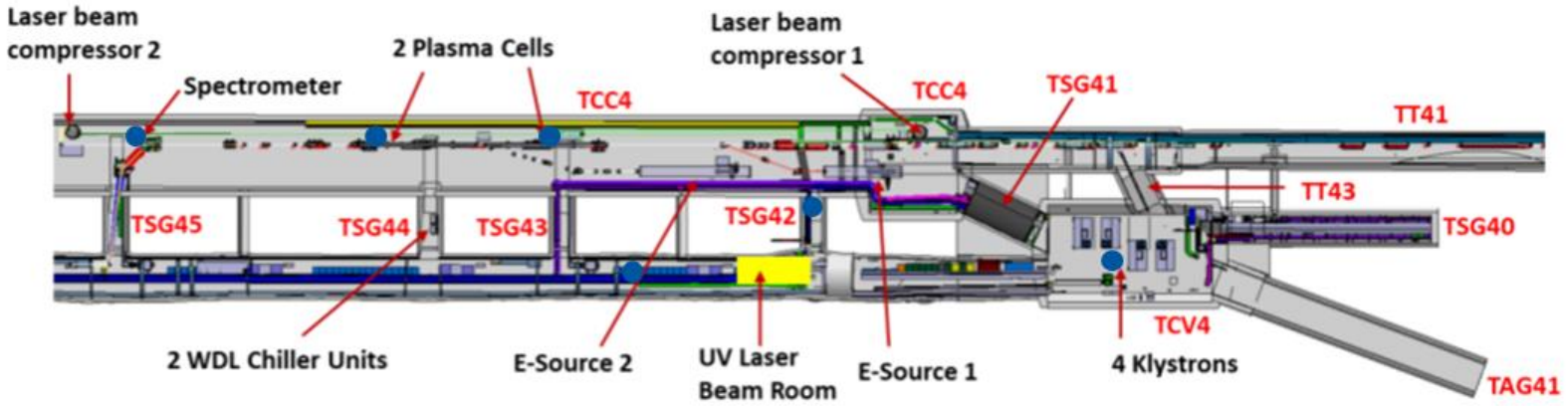


Dose rates along TSG43



RP monitoring for RUN2 c/d operation

Layout for RUN2 c / d



Monitors needed for RUN2 c / d (additional to already existing monitors):

- **3 PMI** monitors placed along the beamline (exact locations to be defined later depending on radiation losses)
- **1 IG-5** Argon chamber (number and exact location depends on shielding, access needs and final area design)
- **1 BAI** air activation monitor (could be omitted in case AWAKE accepts a given waiting time after beam prior to access)
- **1 dedicated X rays radiation detector** system allowing to interlock the **klystrons** (type to be defined, klystrons shielded)
- It shall be noted, that the number of RP monitors might increase depending on the final design of Run 2 c/d

➢ Thanks to the **re-use of existing CNGS equipment** and budget provided by the **HSE Ramses-2-Crome consolidation project**, the majority of budget needed for the **AWAKE run 2c/d monitors** is **already covered**

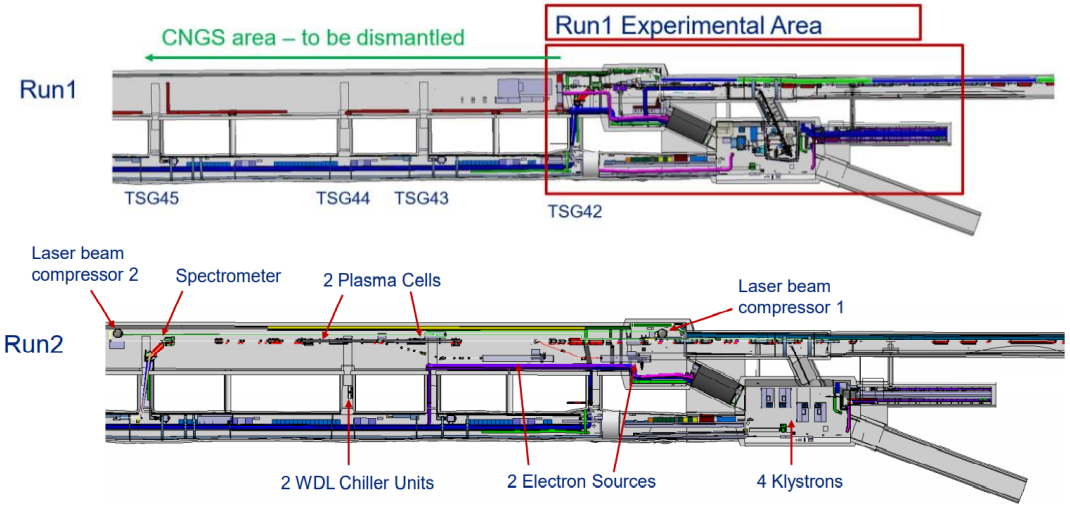
Operational RP aspects

Area	Annual dose limit (year)	Ambient dose equivalent rate: permanent occupancy	Ambient dose equivalent rate: low occupancy	Sign
Non-designated	1 mSv	0.5 µSv/h	2.5 µSv/h	
Supervised	6 mSv	3 µSv/h	15 µSv/h	
Simple Controlled	20 mSv	10 µSv/h	50 µSv/h	
Limited Stay	20 mSv	-	2 mSv/h	
High Radiation	20 mSv	-	100 mSv/h	
Prohibited	20 mSv	-	> 100 mSv/h	

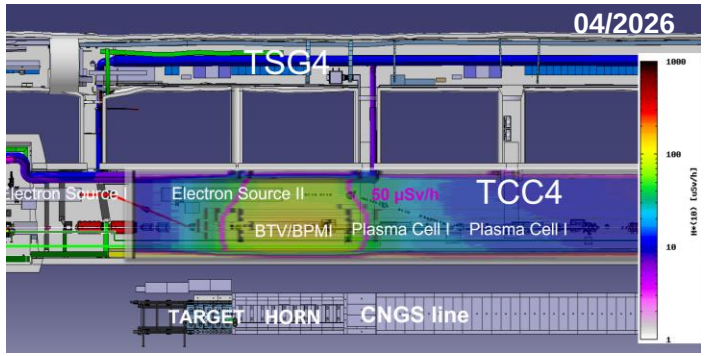
Radiation Area / Controlled Area

- Run 2 c/d will occupy a significantly much **larger area** with **more equipment**
- Next to that the equipment will be in an area with **higher radiological risks** in view of the remaining tunnel activation from CNGS operation
  - **Limited Stay Radiation Area** before shielding installation
  - **Simple Controlled Radiation Area** during equipment installation and operation
- Run 2 c/d will require **more operational RP workforce** in view of higher radiological risks (Limited Stay and Simple Controlled Radiation Area)

→ Works strongly linked to activities in TCC4 and will include planning and dose optimisation, follow-up of dosimetry, RP surveys before/after shielding installations, surveying drillings for installations, etc.



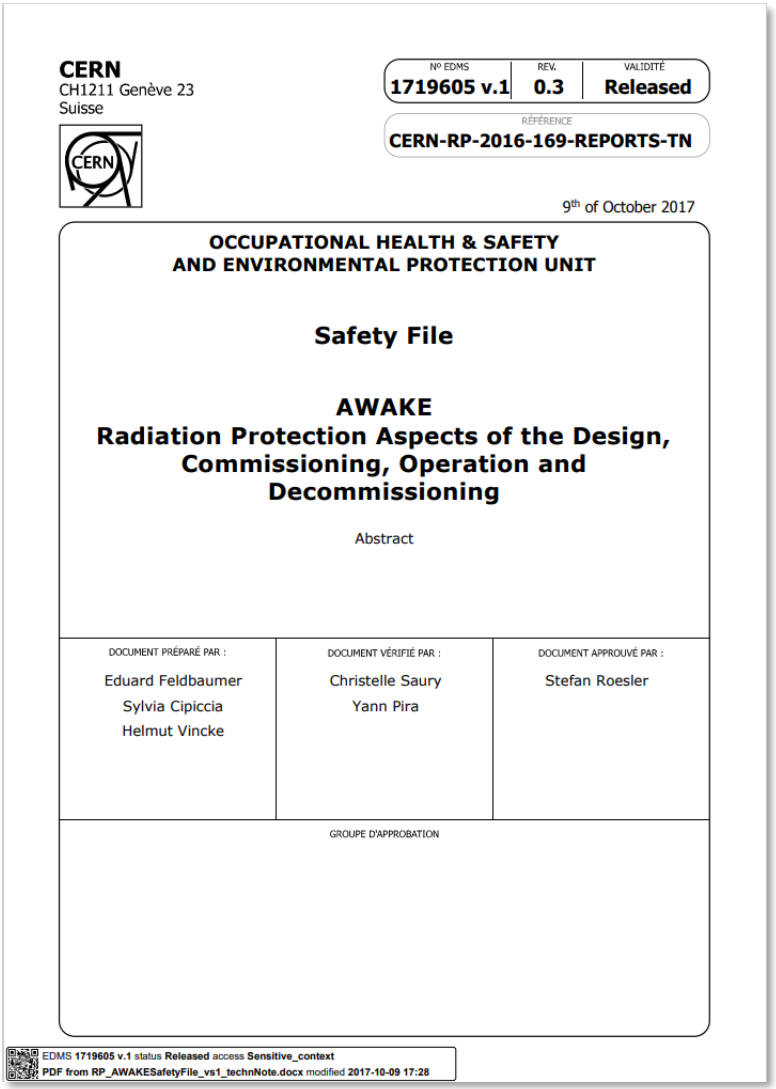
Residual dose rates empty tunnel



RP Safety File

- Similarly to AWAKE Run 1, an **RP Safety File** for **AWAKE Run 2** should be written
- As long as there are **no main differences** in **proton beam parameters** and **beam losses**, many aspects from Run 1 Safety File and operational experience can be included in the Safety File for Run 2
- Some main differences for Run 2 RP Safety File:
  - Empty tunnel studies
  - Accidental electron beam loss scenarios
  - Updated RP monitoring layout
  - In case additional RP studies for Run 2 c/d would be needed, such studies would have to be supported by an additional Fellow (EDMS 3024267)
- The RP Safety File should be finalised before the first beam operation together with the other Project Safety Files (demonstrative, descriptive)

AWAKE Run 1 RP Safety File



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OCCUPATIONAL HEALTH & SAFETY
AND ENVIRONMENTAL PROTECTION UNIT

Safety File

AWAKE
Radiation Protection Aspects of the Design, Commissioning, Operation and Decommissioning

Abstract

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GROUPE D'APPROBATION

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