

HSE Radiation Protection

AWAKE Kick-Off – Radiation Protection Work Package

<u>C. Ahdida</u>, C. Saury AWAKE Kick-Off 2024 16 July 2024





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



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E. Nowak, C. Ahdida, Ambient dose rates and shielding requirements for the TCC4 tunnel after CNGS dismantling, EDMS 2665333 C. Ahdida et al., Radiological Characterization Studies for the CNGS Dismantling, Nuclear Science and Engineering, 198(2), 175–184

RP assessment – Empty TCC4

	Area	Annual dose limit	Ambient dose	equivalent rate		
		(year)	permanent occupancy	low occupancy		
	Non-designated	1 mSv	0.5 µSv/h	2.5 µSv/h		
	Supervised	6 mSv	3 μSv/h	15 μSv/h	Dosimeter abligatory Sosimitive obligatorie	
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Residual dose rates in the empty TCC4 tunnel





1d along x at CNGS horn



Top view





- 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)



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E. Nowak, C. Ahdida, Radiological assessment of the electron beam losses for the preliminary design of AWAKE RUN 2 c/d, EDMS 2667058

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 : $\sigma_x=135 \ \mu m$, $\sigma_y=133 \ \mu m$
 - 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



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C. Ahdida et al, AWAKE CSR - WP26 Radiation Protection Status Report, EDMS 2476597 C. Ahdida, C. Saury, Monitoring needs for AWAKE Run 2, EDMS 2812027 C. Ahdida et al, AWAKE Run 2c/d – Latest RP budget and workforce estimates, EDMS 3024267

RP monitoring for RUN2 c/d operation





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



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Operational RP aspects

	Area	Annual	Ambient dose	equivalent rate	Sign RADIATION
		(year)	permanent occupancy	low occupancy	
	Non-designated	1 mSv	0.5 µSv/h	2.5 µSv/h	
	Supervised	6 mSv	3 µSv/h	15 μSv/h	Dasimeter etilgensy Dasimeter obligative
vrea	Simple Controlled	20 mSv	10 µSv/h	50 µSv/h	SaverLE CONTROLLED / CONTROL EE SaverLE Dosimeter etrigenry Dosimeter etrigenry
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Radi	High Radiation	20 mSv	-	100 mSv/h	Index Adduction / May TE Andre Town Desirvatives obligatory Constructives obligatory
	Prohibited				NO ENTRY DÉFENSE D'ENTRER

- 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)

 \rightarrow 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





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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)

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AWAKE Run 1 RP Safety File

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