



HSE
Occupational Health & Safety
and Environmental Protection unit

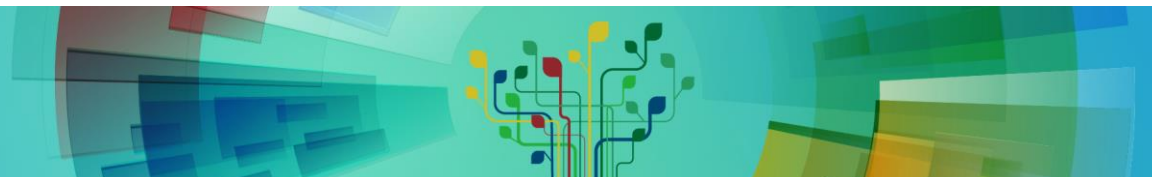


Shielding update for AMBER Drell-Yan at EHN2

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HSE-RP

17/12/2021

[EDMS 2677606](#)

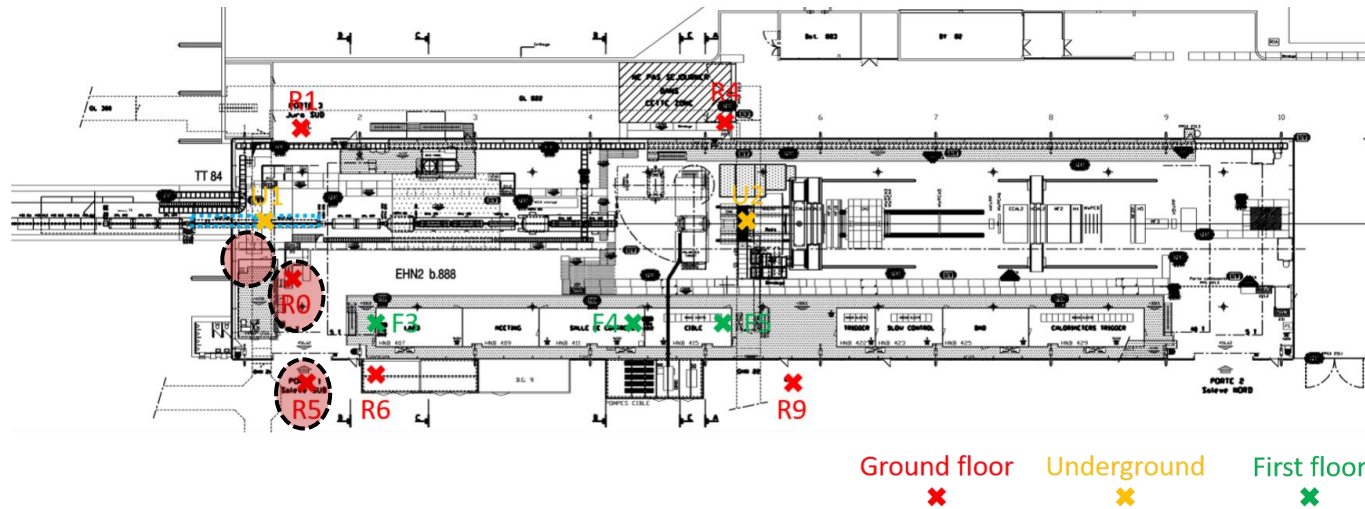


Outline

- Context
- Objective
- Shielding design
- Preliminary results
- Conclusions

Context

- Preliminary studies available for EHN2 with geometry, source term and beam losses [1]
- High prompt dose rates measured in operation at several accessible EHN2 locations [2],[3]
- Optimization of environmental impact at CERN reference points [4]



Objective

- Additional shielding at strategic EHN2 locations to comply with radiation area classification
- Design new shielding bunker for AMBER Drell-Yan
- Air activation assessment
- Skyshine optimization

Area	Annual dose limit (year)	Specific airborne radioactivity	Specific surface contamination
Non-designated	1 mSv	0.05 CA	1 CS
Supervised	6 mSv	0.1 CA	1 CS
Simple Controlled	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

Radiation Area (left side) / Controlled Area (right side)

Area	Annual dose limit (year)	Ambient dose equivalent rate		Sign
		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	
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	

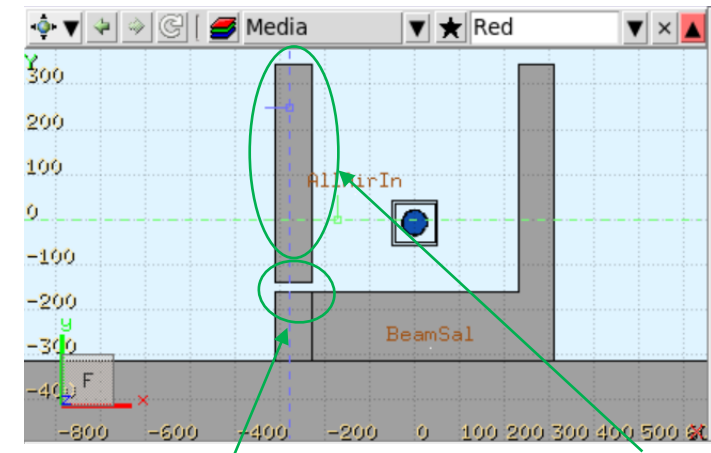
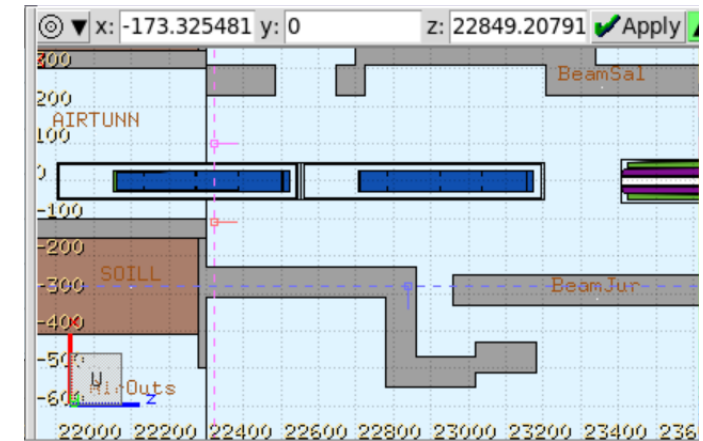
Radiation Area (left side) / Controlled Area (right side)

Shielding design

- Jonction EHN2/TT84 (Proposal BE-EA):

Jonction EHN2/TT84

✓ Implemented in FLUKA model (from V42-56)

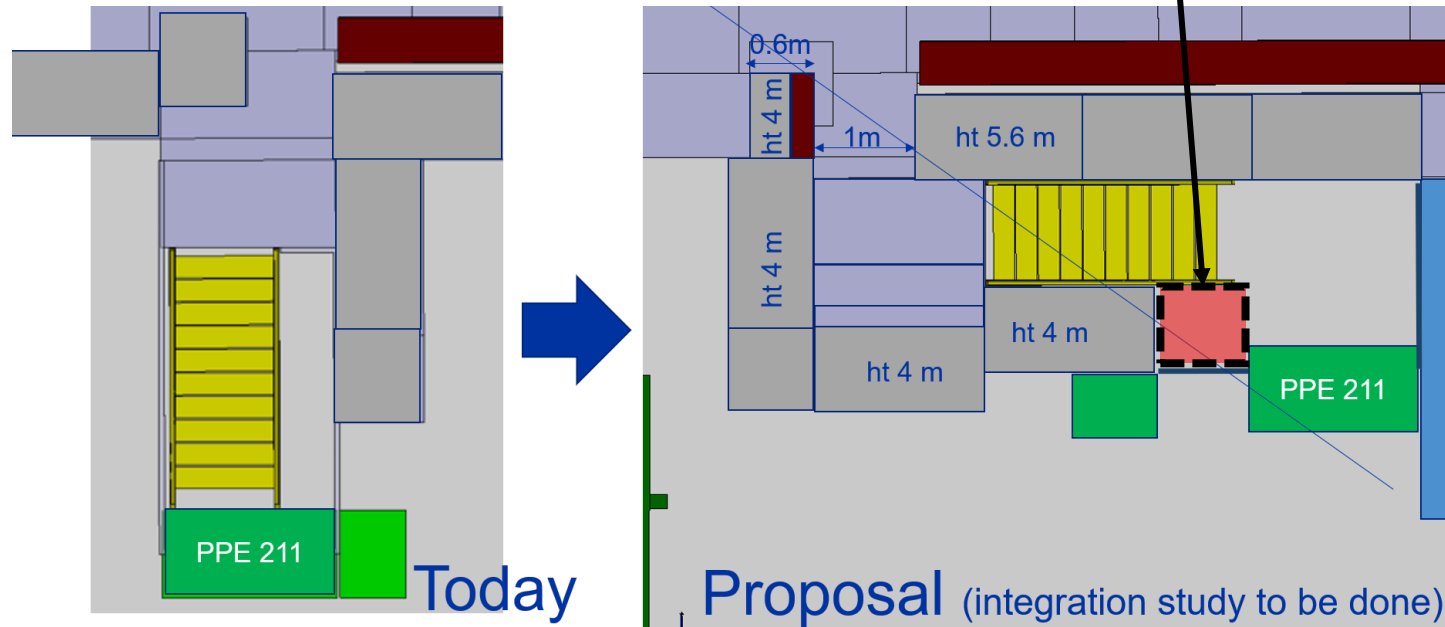


Opening for cables at inside ground level : 40 cm (width) x 20 cm (height)

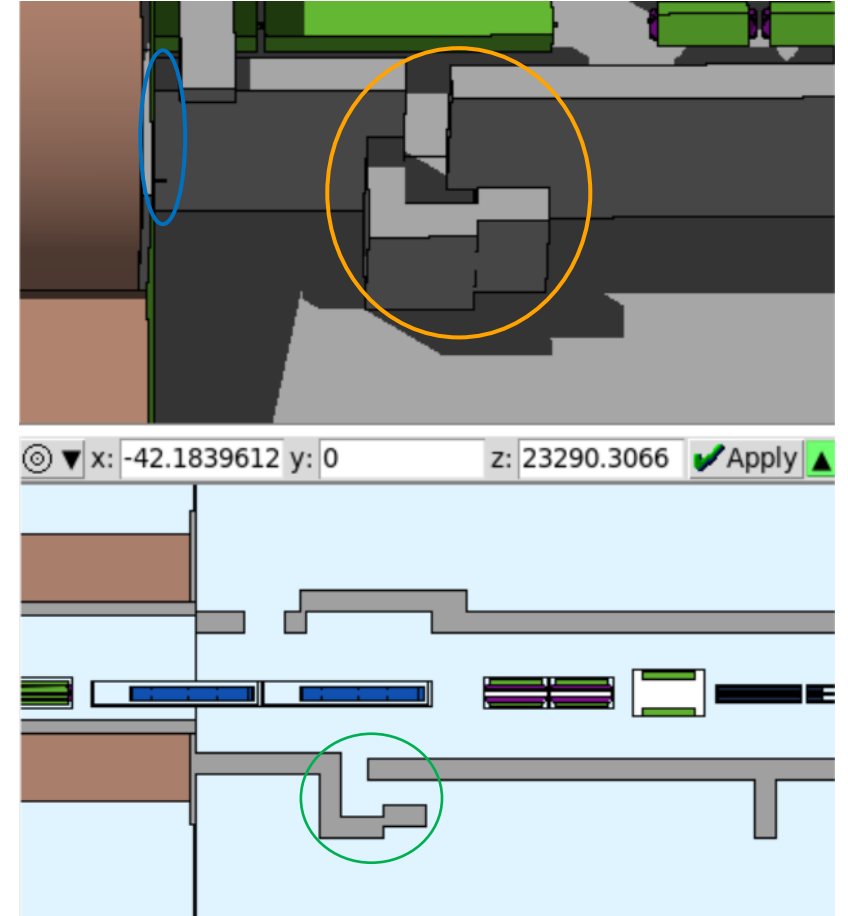
Concrete bricks to fill gap according to proposal

Shielding design

- Chicane PPE211 (Proposal BE-EA)

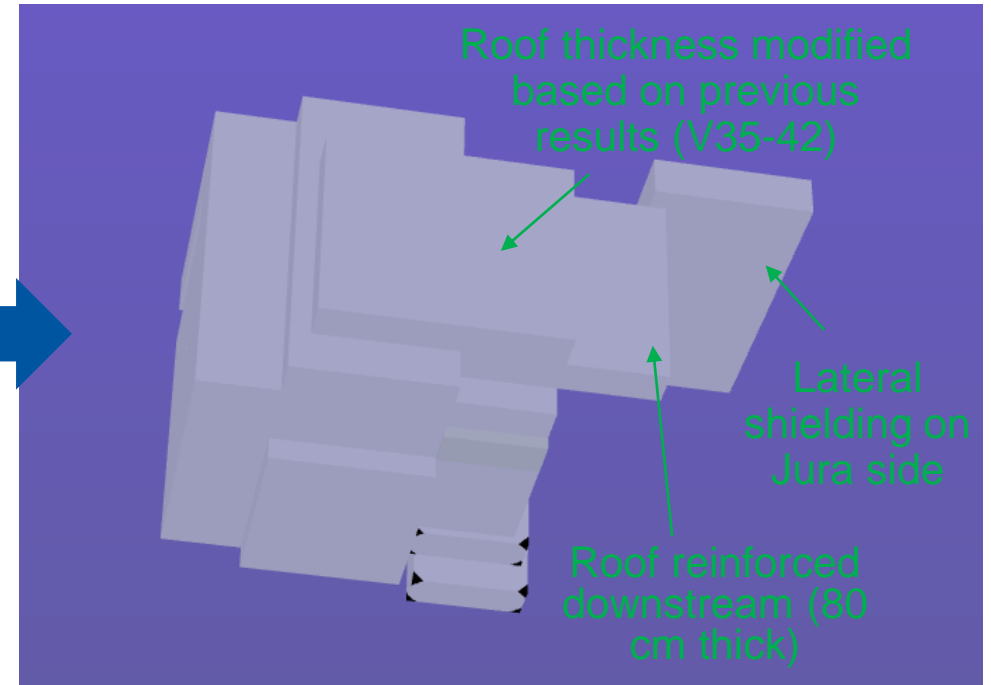
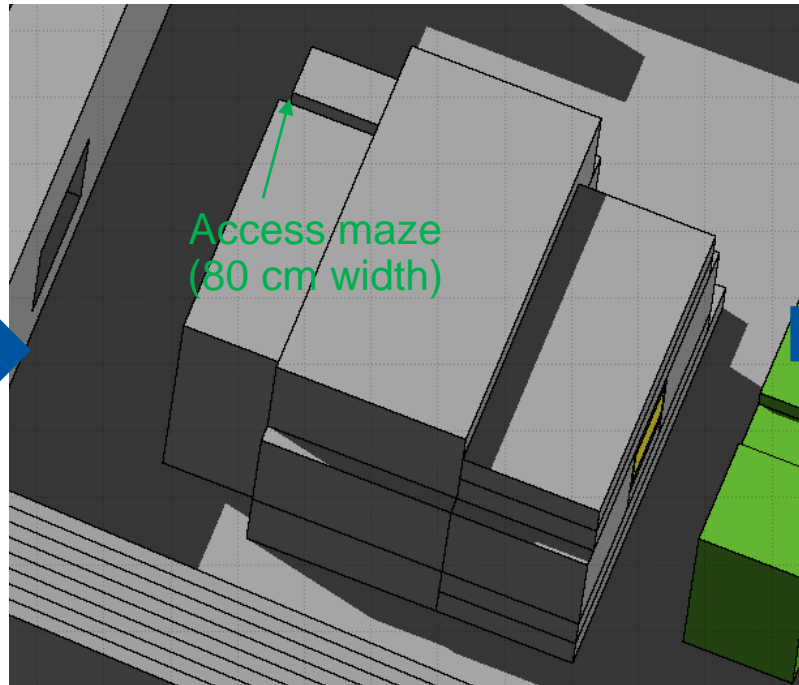


✓ Implemented in FLUKA model (from V42-56)



Shielding design

- Bunker AMBER (*initial proposal vs proposal BE-EA 15.12*)

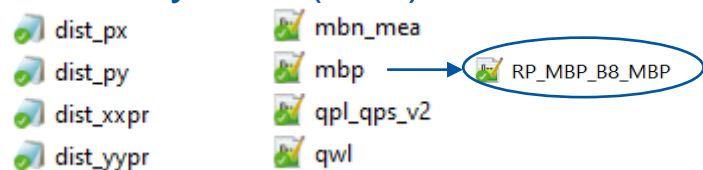


✓ To be implemented in FLUKA model (next iteration) and see effect on Skyshine and Jura side results

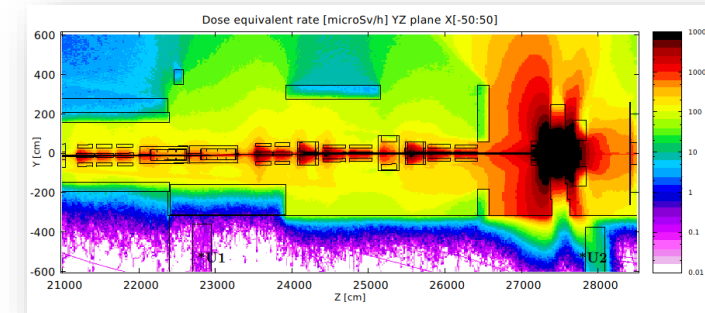
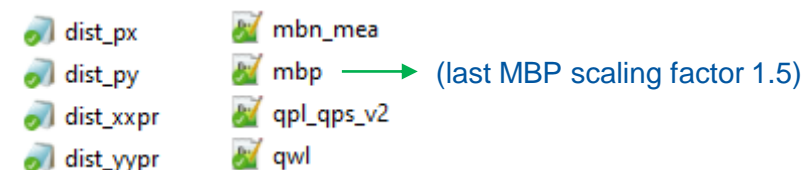
Preliminary results

- Prompt radiation : investigations on beam position

Auxiliary files (V42)

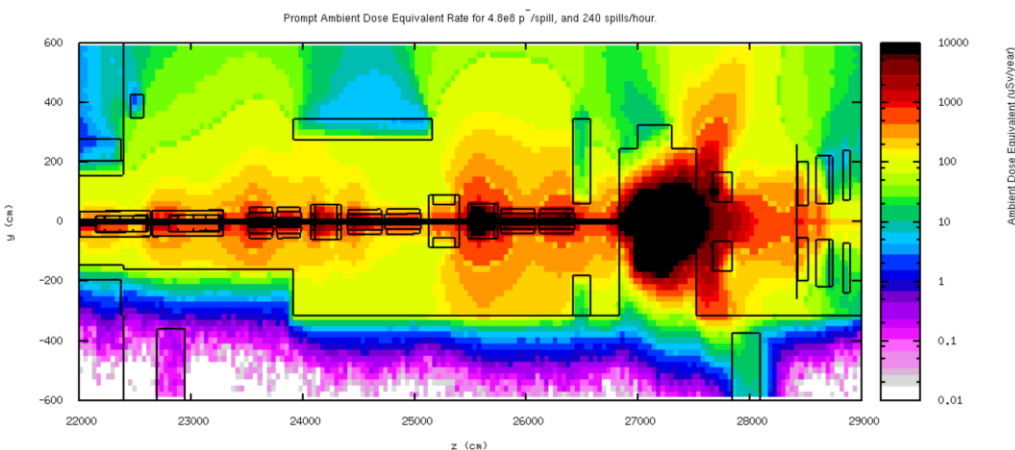


Auxiliary files (V56)

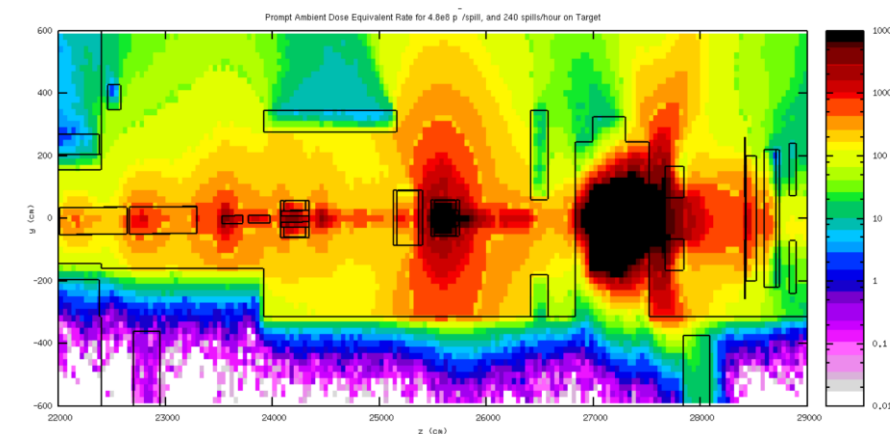


Results from previous study [1]

- ✓ New map file provided by BE-EA on 26.11 for MBP
- ✓ Magnet aperture MBP changed to 14 cm according to Magnet Database









- ✓ Magnet aperture MBP reverted from 14 cm to 11 cm following discussion with BE-EA
→ back to previous situation (V35) with high losses after B8 magnet
- ✓ Original map file mbp.map modified for last MBP magnetic field (+50%) to correct losses and center beam vertically in target **limiting at maximum losses in magnets**

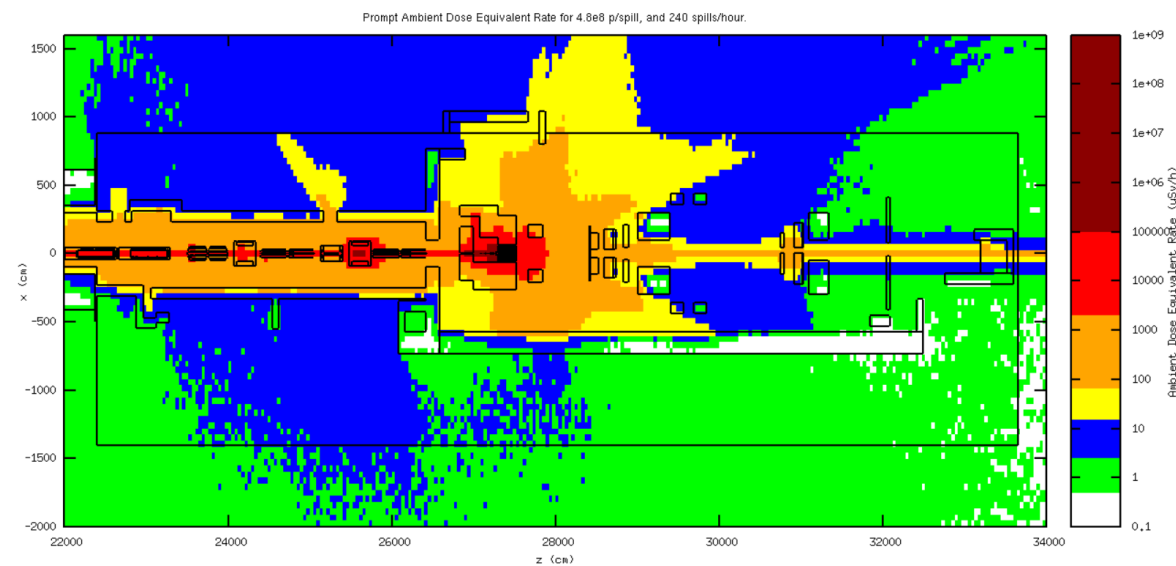
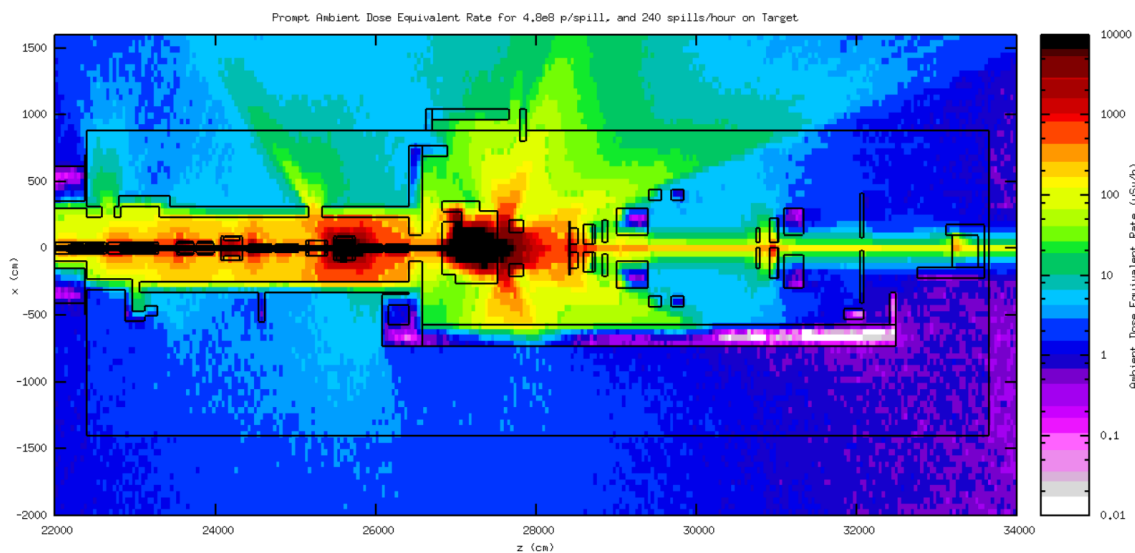


Preliminary results

- Prompt radiation at **beam level Y[-30;30] – V56**

- Source: source.for (190 GeV/c π^- beam from [1])
- Magnetic field: magfld.for (magnets maps from [1] & modified last MBP x1.5)
- Intensity: $4.8 * 10^8 \pi^-$ /spill and 240 spills/h on Target
- Currently 18% losses from COLL5 source to target (10% up to CEDARs and 8% up to target)
- Plots are scaled with **intensity on Target** (factor 1.2 on V56)

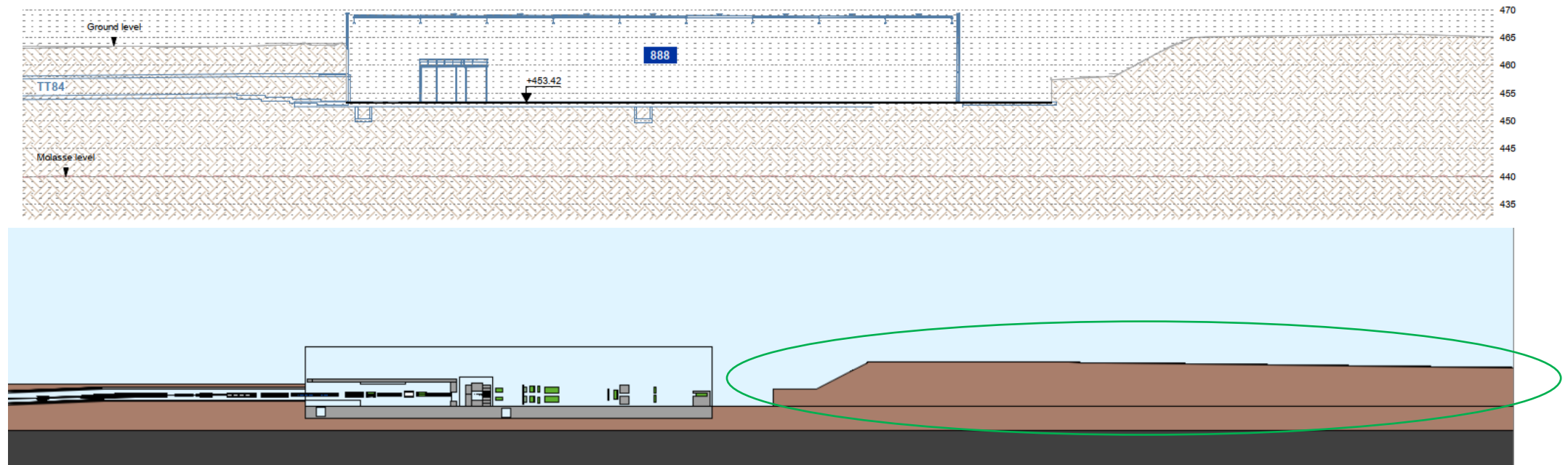
Area	Annual dose limit (year)	Ambient dose equivalent rate		Sign 
		permanent occupancy	low occupancy	
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Simple Controlled	20 mSv	10 μ Sv/h	50 μ Sv/h	
Limited Stay	20 mSv	-	2 mSv/h	
High Radiation	20 mSv	-	100 mSv/h	
Prohibited	20 mSv	-	> 100 mSv/h	



Preliminary results

- Prompt radiation– V56

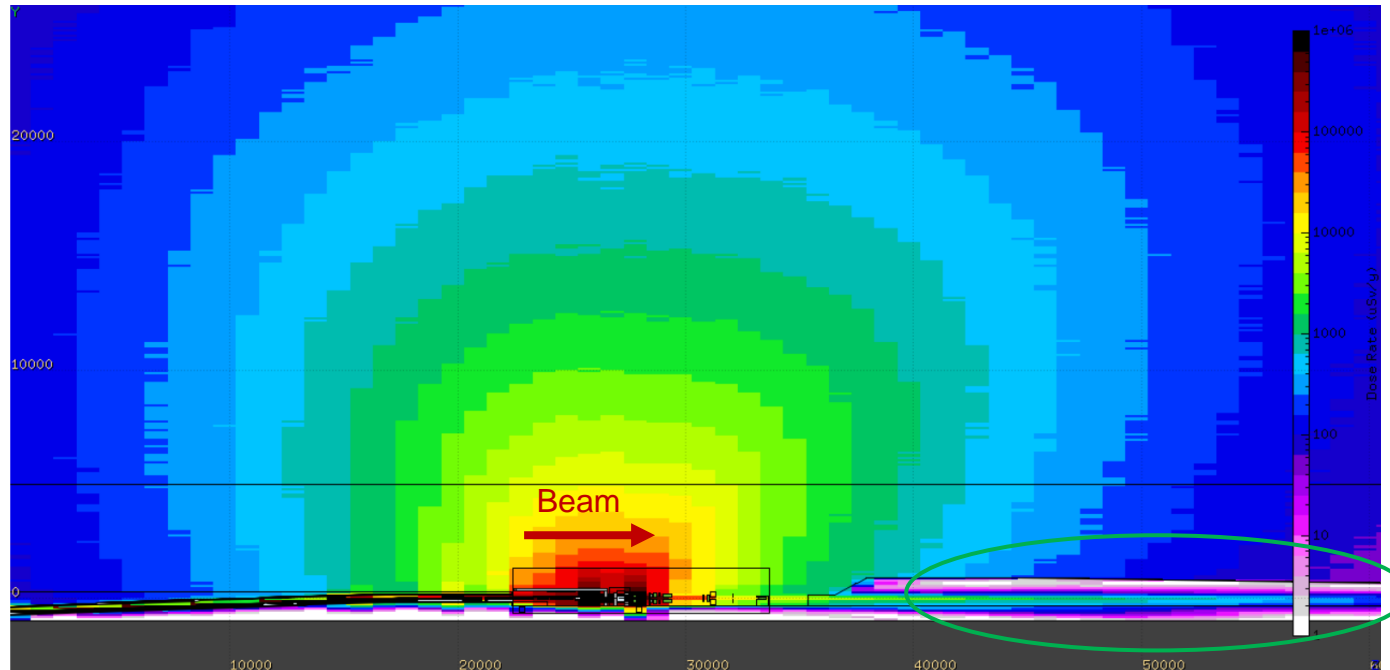
- EHN2 ground profile obtained from SCE-SAM-TG + GIS
- Simplified model with Soil region included for prompt radiation downstream EHN2
- Model completed up to CERN fence for attenuation of straight radiation



Preliminary results

- Prompt radiation – V56

- Annual prompt dose longitudinally to EHN2 with attenuation in soil region downstream:



Annual Ambient Dose Equivalent ($\mu\text{Sv}/\text{year}$). Intensity: $4.8 \times 10^8 \pi^-/\text{spill}$ and 240 spills/h on Target

Preliminary results

- Skyshine – V56

- Monitoring stations (4) and reference group points (2) coordinates from [GIS Environment](#)

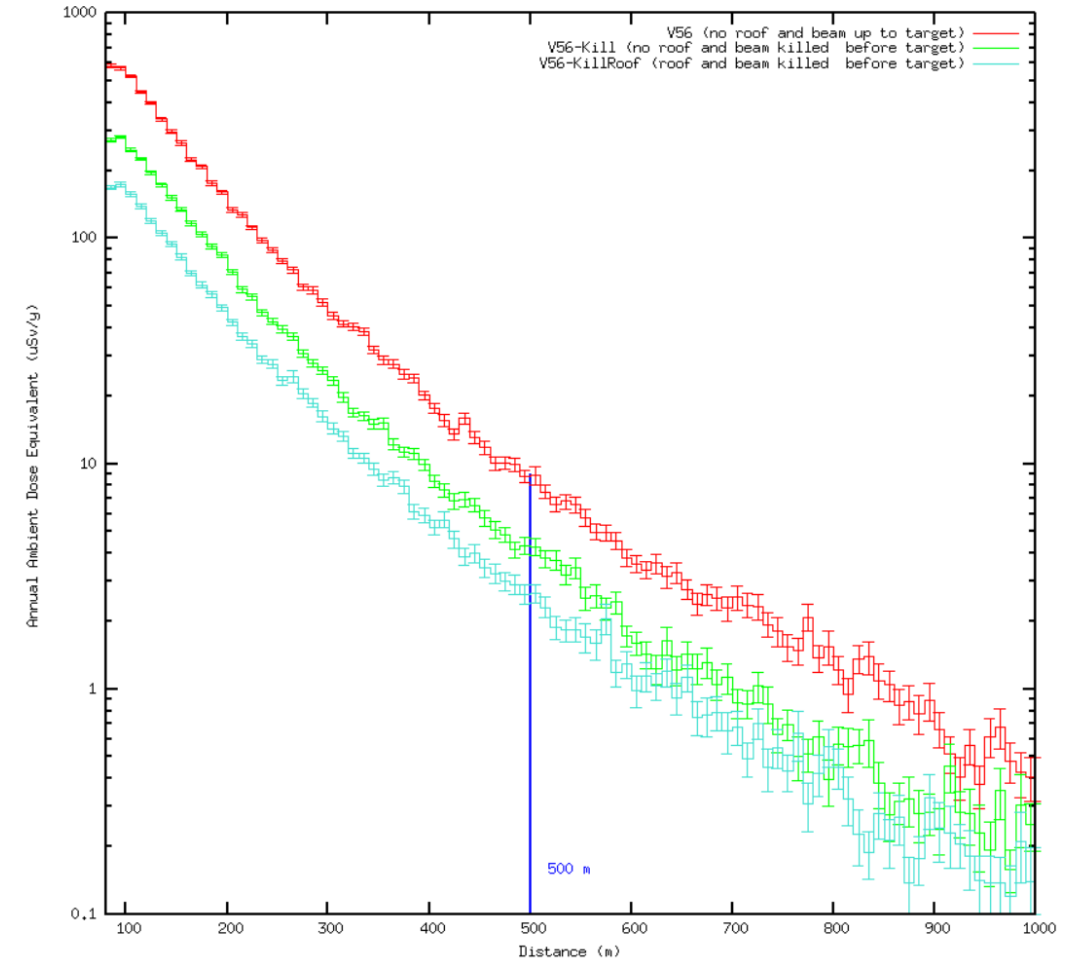


- (0. Target)
- 1. Reference Point S
- 2. Reference Point P
- 3. PMS823
- 4. PMS823
- 5. PMS821
- 6. PMS824

Preliminary results

- Skyshine contribution – V56
 - Intensity: **3.07e14 p/year on target**
 - Objective **10 μ Sv/year** at 500 m distance
 - Limit **1 mSv/year** at 80 m distance
- Upstream losses contributes up to 50%
- 80 cm thick roof would reduce upstream losses by 1.5
- To be re-assessed with final design

Salève side

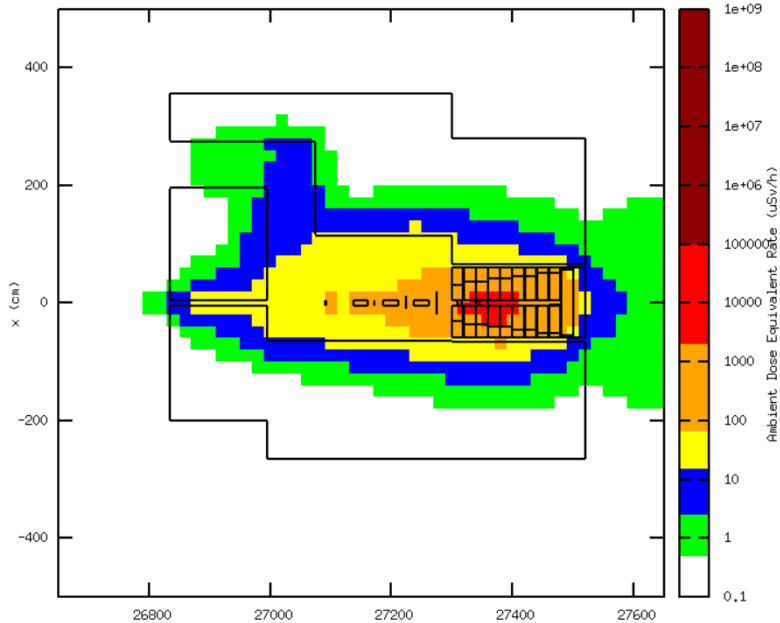


Preliminary results

- Residual radiation – V56

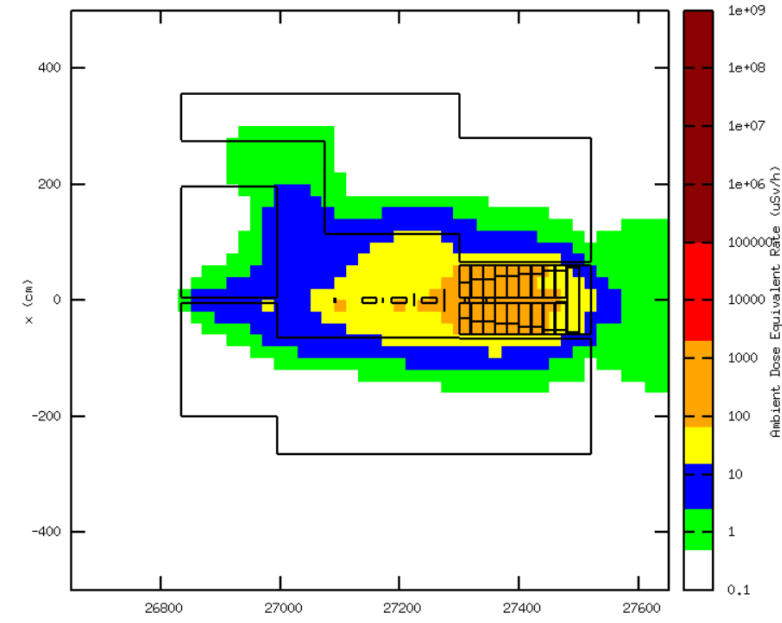
- Decay times: 2mn (*minimum time for access*) / 10 mn (*added*) / 30 mn (*added*) / 1h / 3h / 6h / 1d / 3d / 1w / 1month / 6 month / 1 year

Residual Ambient Dose Equivalent Rate for 4,8e8 p/spill, and 240 spills/hour on Target, 6 month irradiation and 2 mn cool-down time.



2 minutes

Residual Ambient Dose Equivalent Rate for 4,8e8 p/spill, and 240 spills/hour on Target, 6 month irradiation and 30 mn cool-down time.



30 minutes

Preliminary results

Air Activation – V56:

- Air activation for access in AMBER bunker area:
 - ✓ 1 year irradiation, no cool-down time
 - ✓ Results show values **below 0.1 CA**
 - ✓ Main contributors N-13, O-15, C-11, Ar-41
- Air activation for access in EHN2 Hall (**negligeable**)
- Annual activity of the EHN2 air volumes and release to environment (**ongoing**)

Conclusions

- Shielding design for EHN2 – AMBER Drell-Yan should be in agreement with radiation area classification.
- Additional shielding elements and new designs: Junction EHN2/TT84, Chicane PPE211, AMBER Bunker.
- Preliminary results showed for prompt and residual radiation, skyshine contribution and air activation.

Open points:

- *Improve source term (updated source routine)*
 - *Vertical beam offset investigated.*
 - *Pending RP test with source term before CEDAR provided by BE-EA (short term).*
 - *Pending BE-EA get updated maps for MBN magnets from TC (middle term).*
- *Complete study skyshine and air activation*
 - *Skyshine and air activation estimated. Pending final design for accuracy.*
- *Discuss possible mechanical and/or integration constrains*
 - *Proposal for Junction EHN2/TT84, Chicane PPE211 and Bunker. Pending RP results for BE-EA bunker proposal.*
- *Verifications to be done on Jura side shielding.*
- *Documentation: RP Technical Note (EDMS 2670569) and ECR (RP part) started. To be continued.*

References

- [1] Shielding studies for EHN2 with FLUKA, S. Cholak. Internal report (2018)
- [2] COMPASS - 2018 Radiation Protection Survey, C. Ahdida, M. Casolino, H. Morimoto. Survey Note (2019)
- [3] COMPASS - 2018 Radiation Protection Survey 2, C. Ahdida, H. Morimoto (2021)
- [4] Report on Annual Radiation levels calculations for Amber experiment, P. Correia (2020)



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