
Nuclear Waste Zoning and Dose Calculations for the TOTEM Roman Pots

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TOTEM 34th RPTB

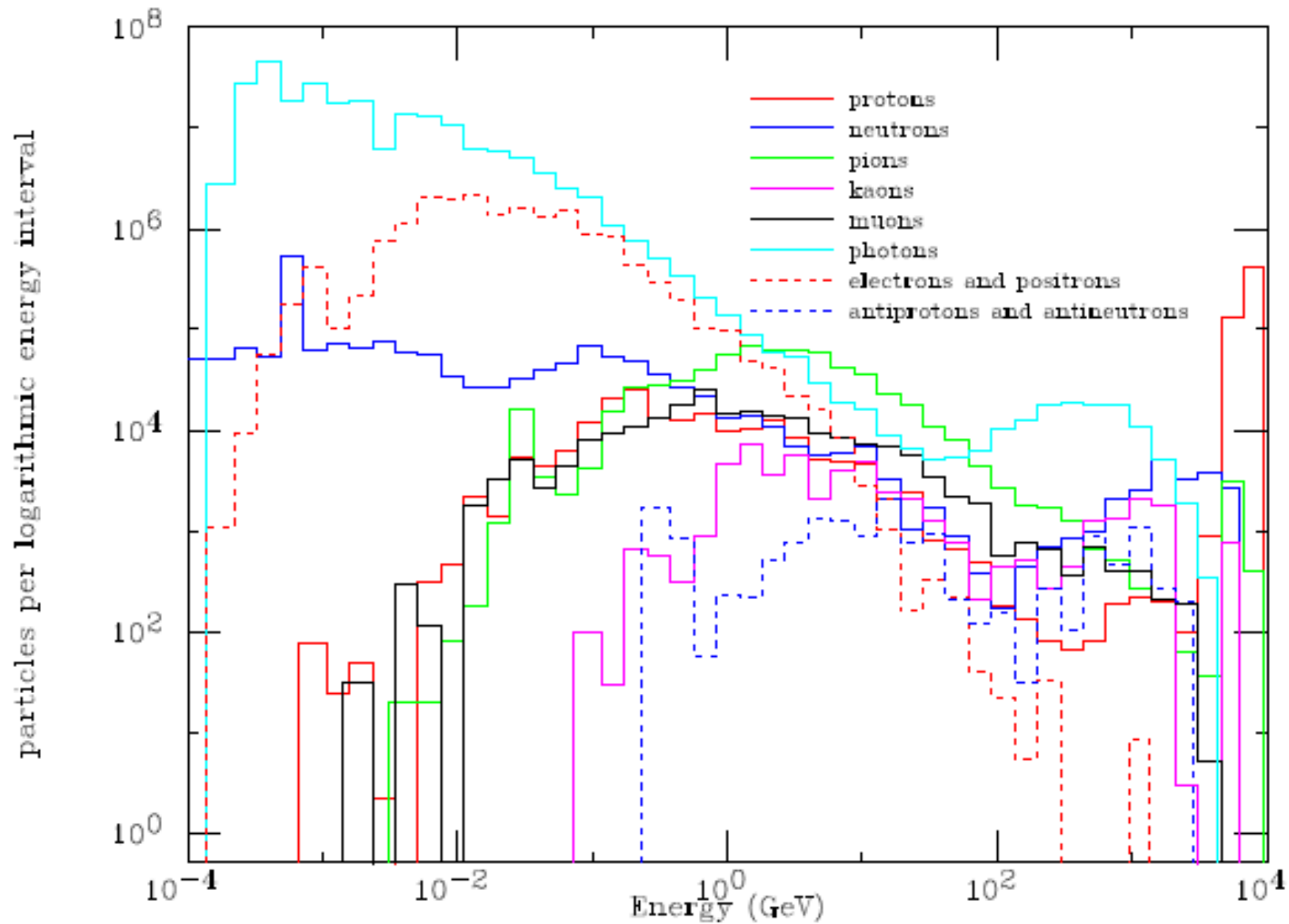
22 November 2006

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- Zoning of the Roman Pots
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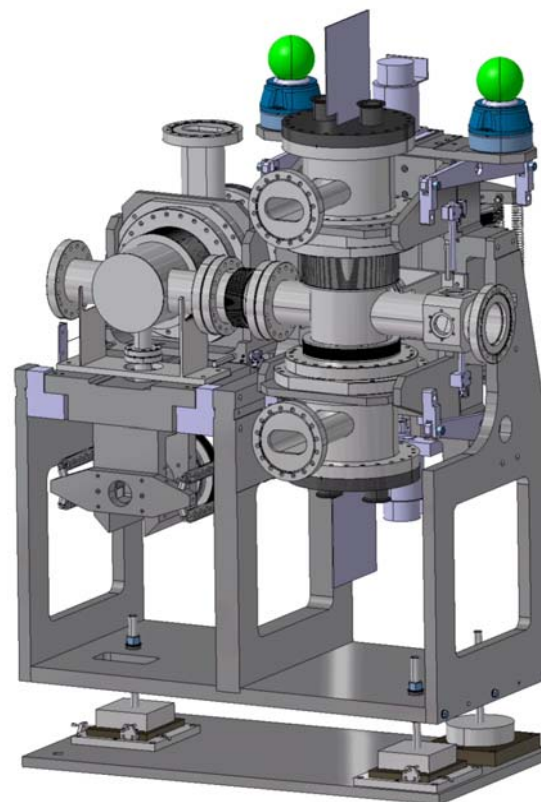
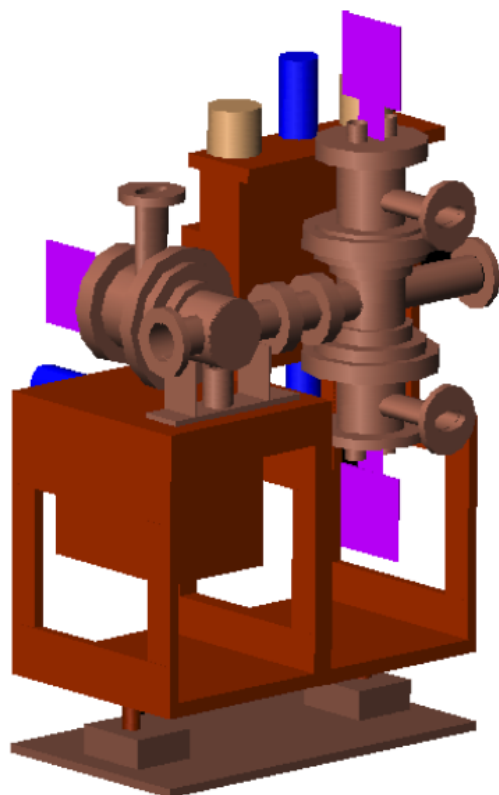
FLUKA Monte Carlo studies

- Detailed description of the experimental set-up, containing one Roman Pot unit (three Roman Pots in total, one horizontal and two vertical), cryostat behind the Roman Pot, cooling pipes, the concrete base and 30 cm of concrete for the tunnel around
- Fluence spectra were provided by Nikolai Mokhov (calculated with the MARS Monte Carlo code at a scoring plane at 214m with radius $R=250$ cm for $\beta^* = 0.55$ m).
- Non- elastic interaction rate taken into account is $8E8$ interactions/sec at the nominal luminosity $L=10^{34}$ $\text{cm}^{-2}\text{s}^{-1}$ (TCL collimator closed).
- Irradiation scenario: 10 full LHC years (365 days x 20 hours x 10)

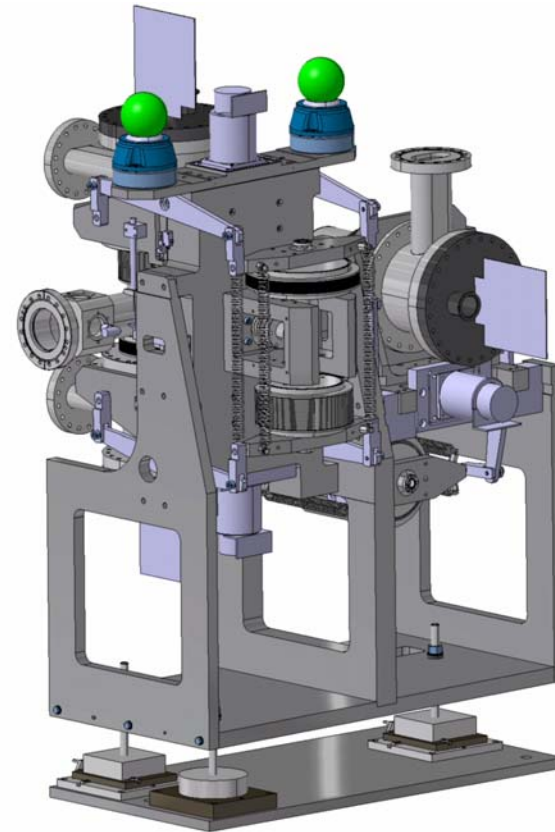
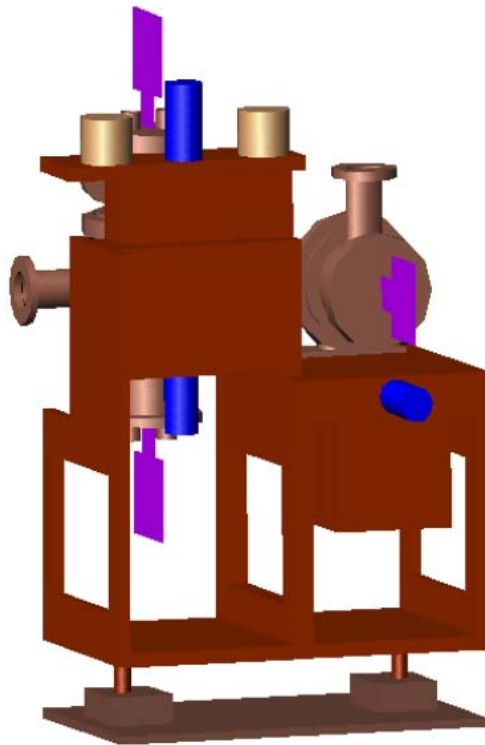


Particle distributions at 214m from the IP5 (TCL closed, $L=10^{34}$ cm $^{-2}$ s $^{-1}$)
calculated with the MARS code by N.Mokhov.

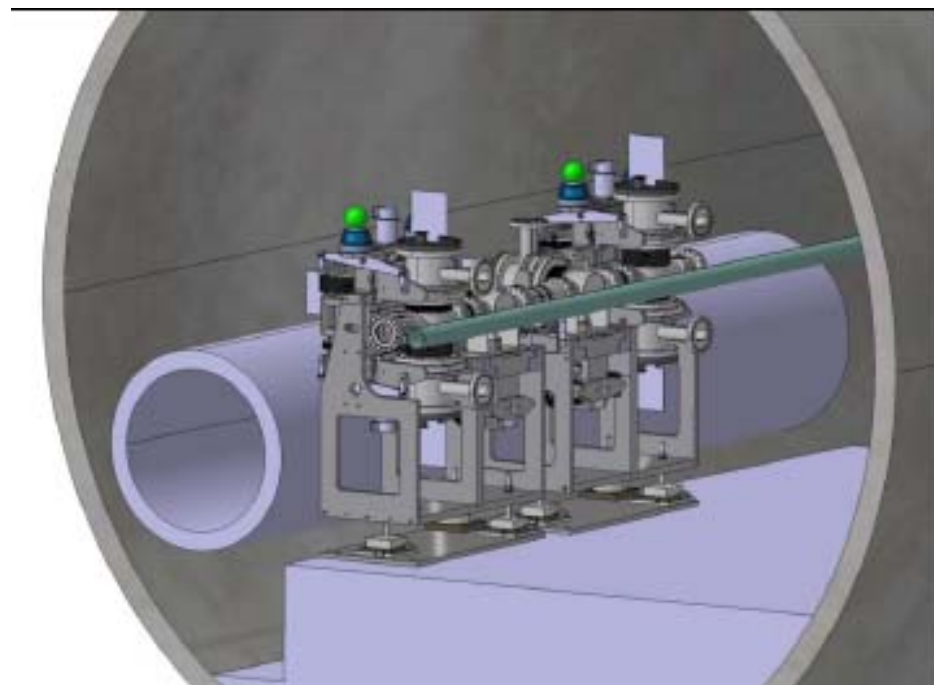
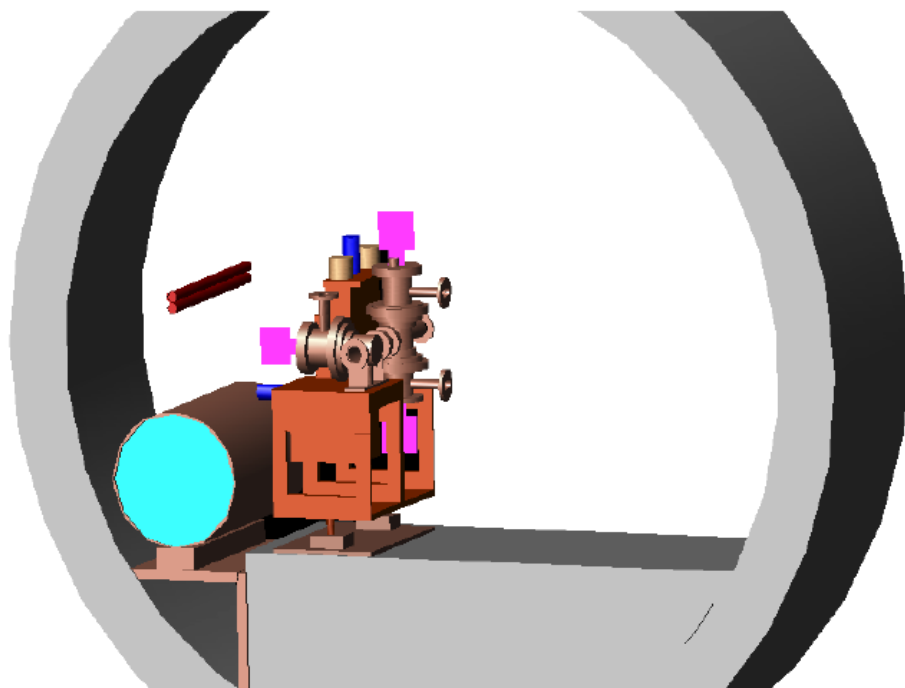
FLUKA model of the Roman Pot geometry (a)



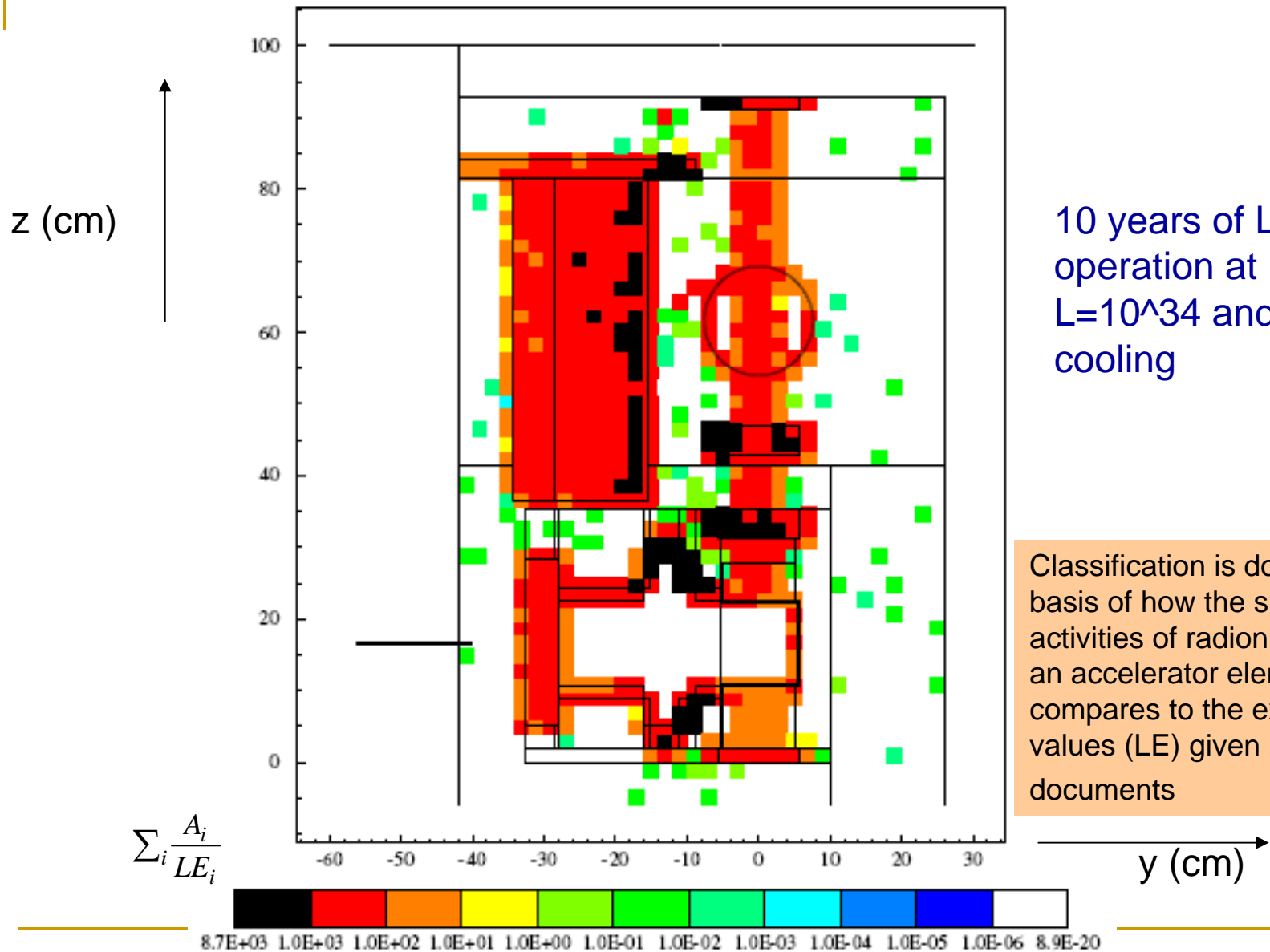
FLUKA model of the Roman Pot geometry (b)



FLUKA model of the Roman Pot geometry (c)

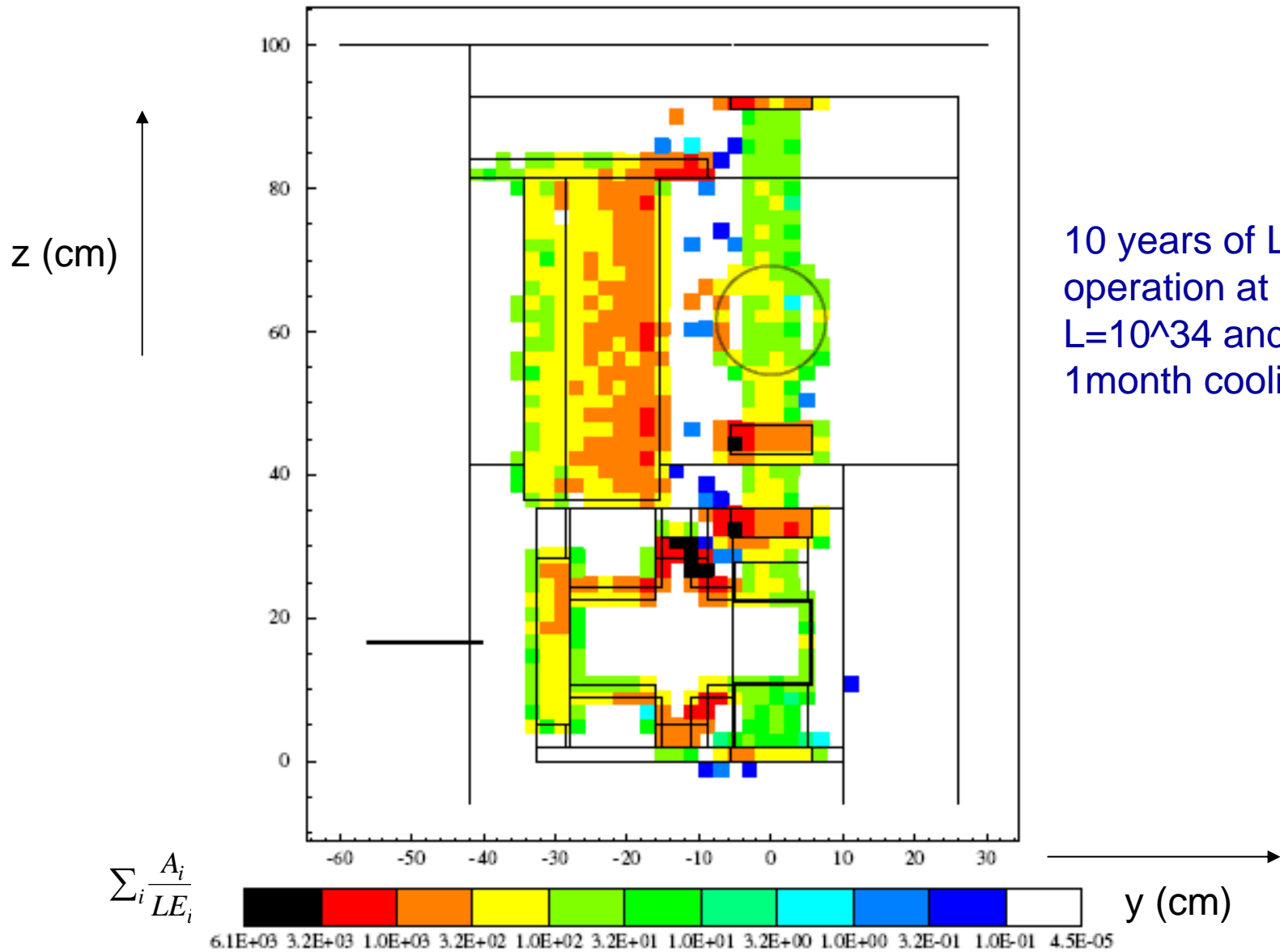


1. ZONING CALCULATIONS

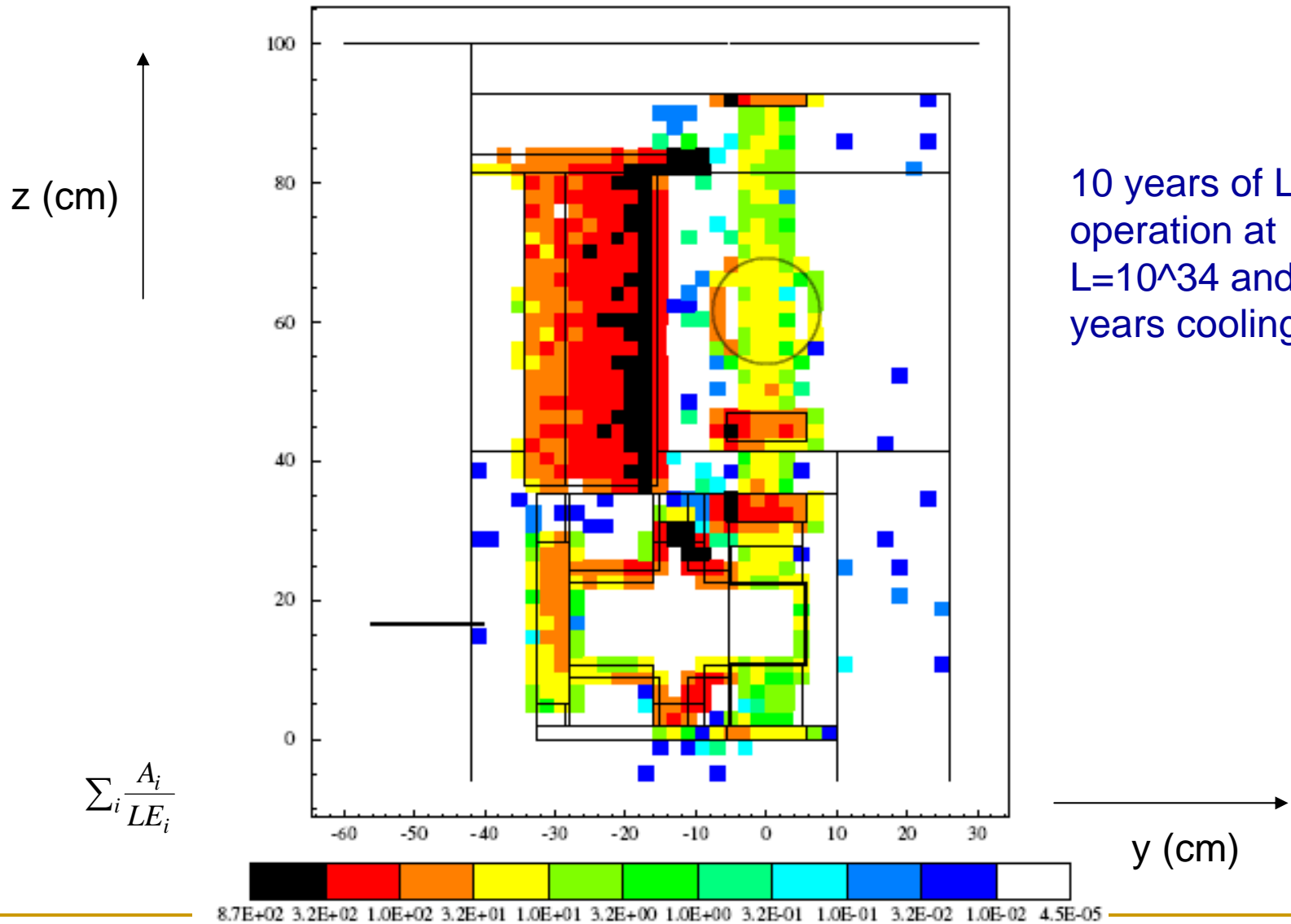


10 years of LHC
operation at
 $L=10^{34}$ and 1 day
cooling

Classification is done on the
basis of how the specific
activities of radionuclides in
an accelerator element
compares to the exemption
values (LE) given by official
documents

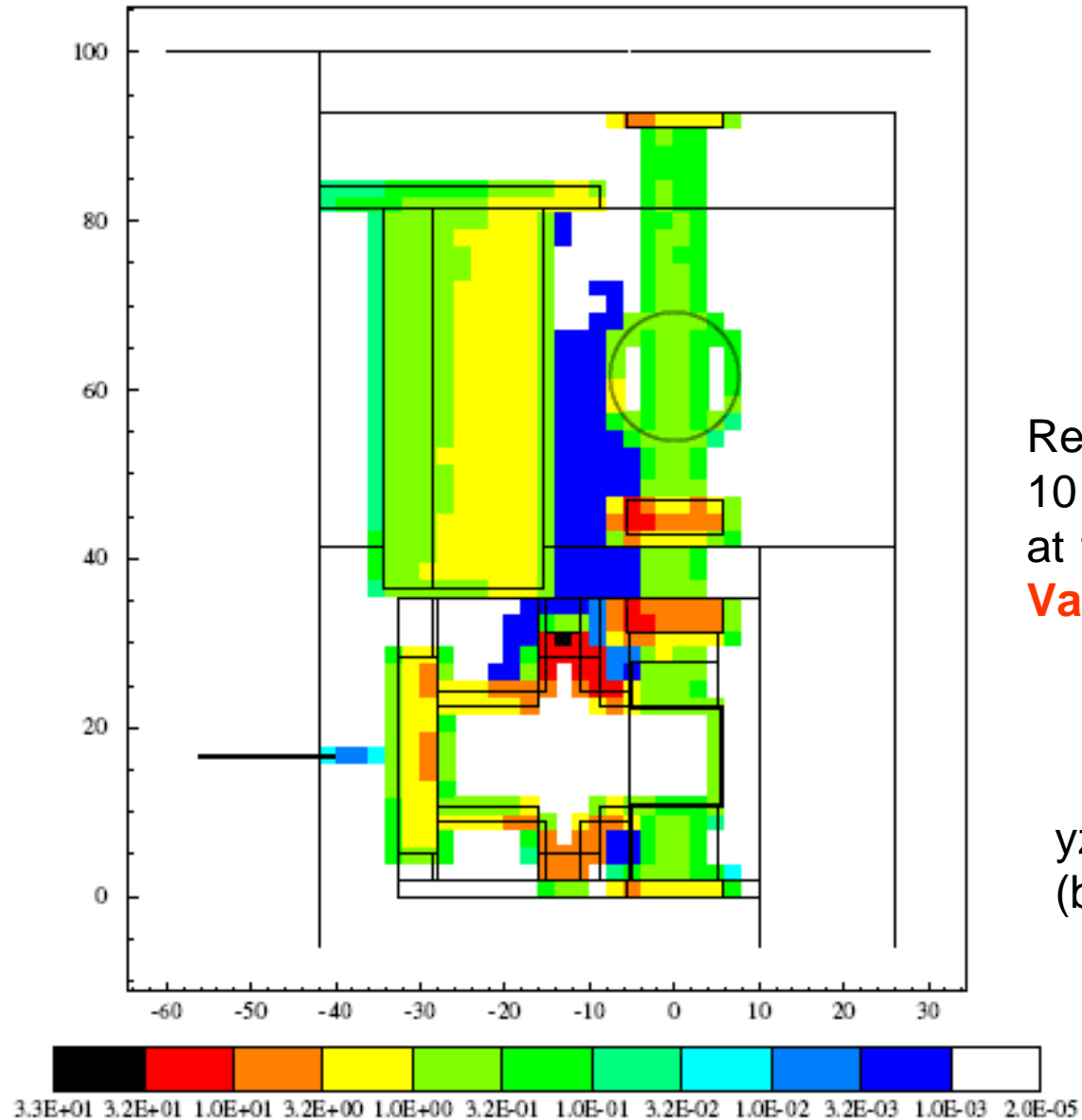


10 years of LHC
operation at
 $L=10^{34}$ and
1 month cooling



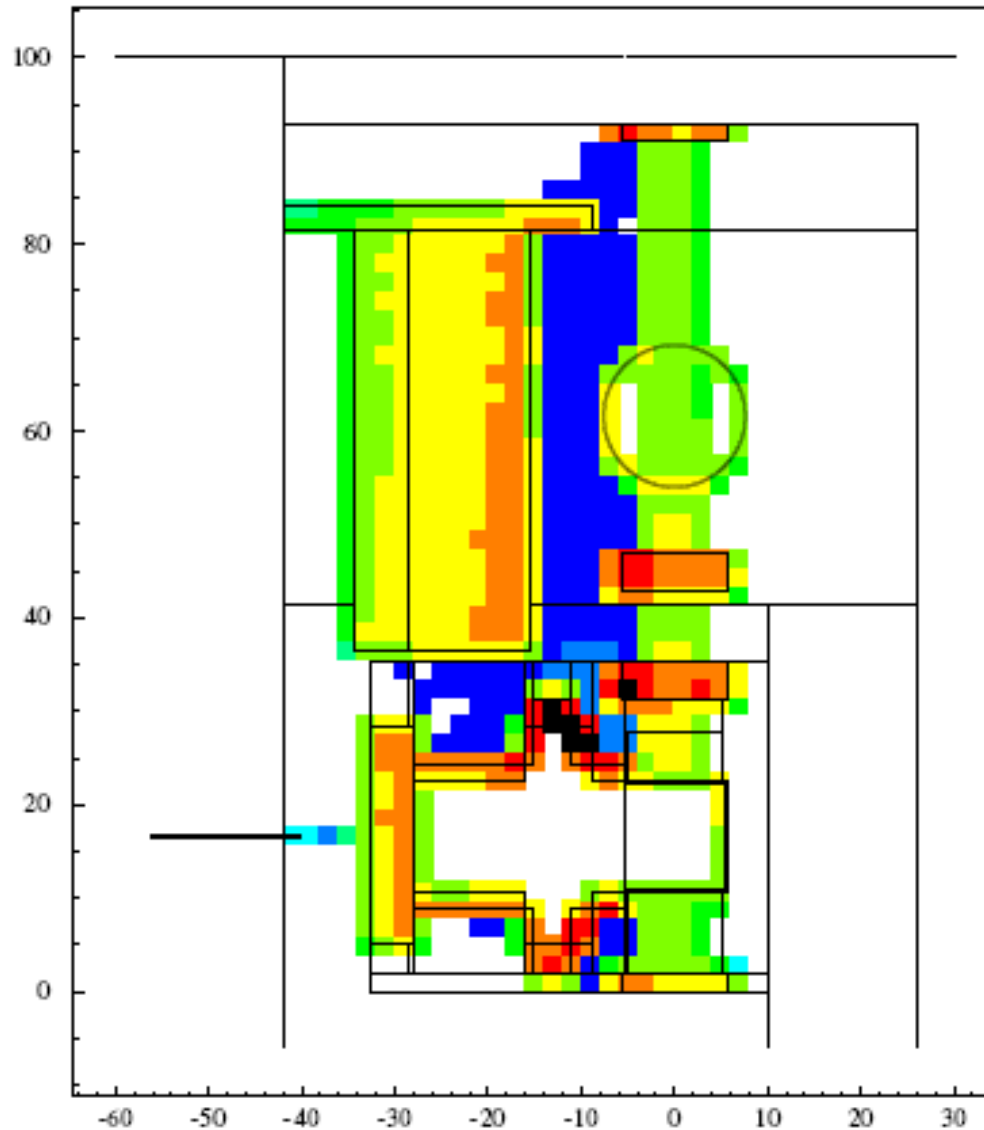
10 years of LHC
operation at
 $L=10^{34}$ and 2
years cooling

2. RESIDUAL CONTACT DOSES



Residual contact dose map,
10 years of LHC operation
at 10^{34} for 1 day cooling,
Values are in mSv/hr

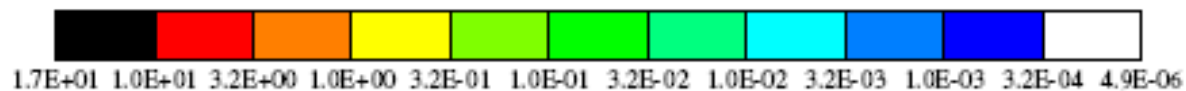
yz projection at $x=1\text{m}$
(beam level).

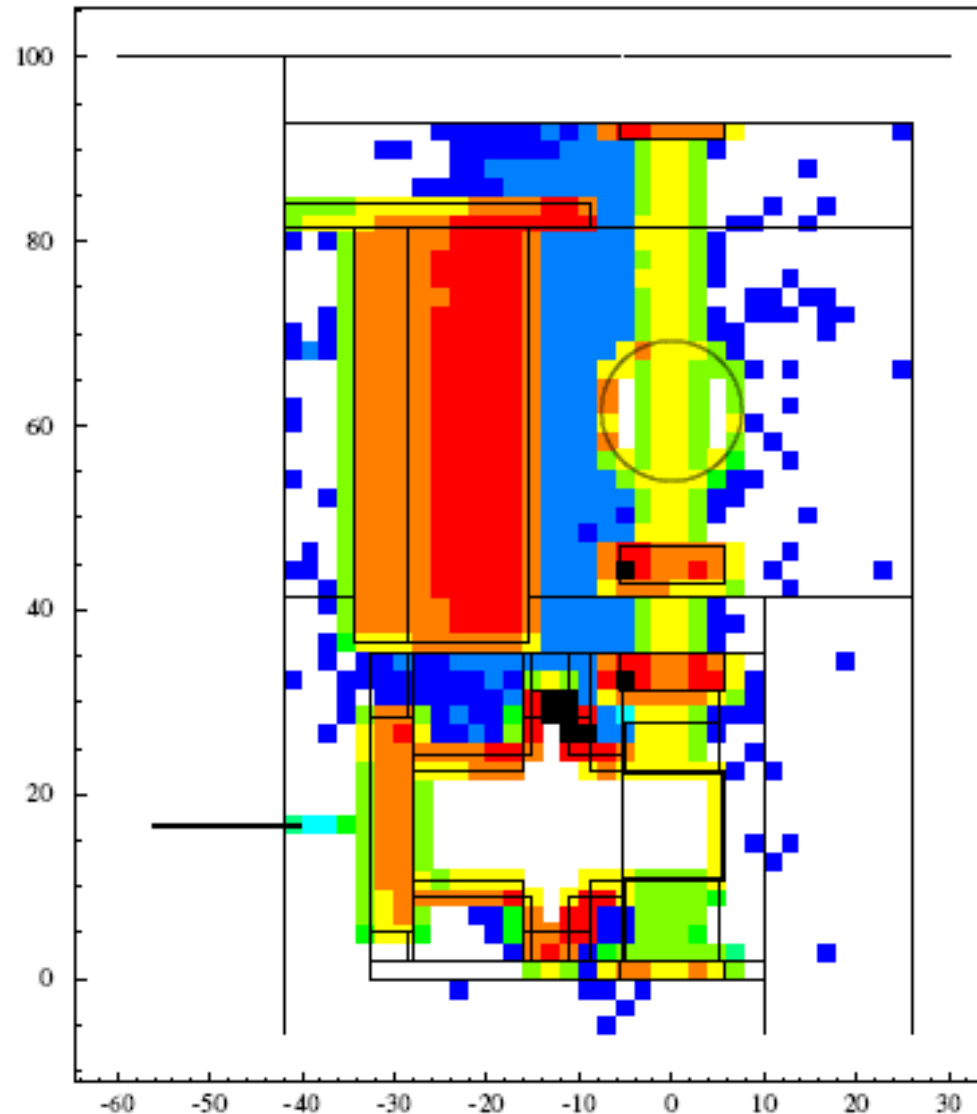


Residual contact dose map,
10 years of LHC operation at
 10^{34} for 1 month cooling.

Values are in mSv/hr

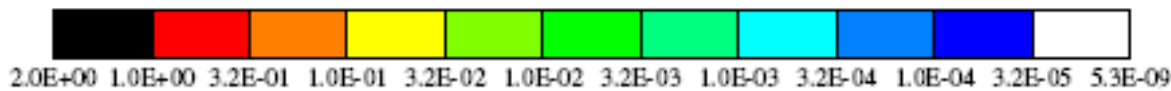
yz projection at $x=1\text{m}$
(beam level).





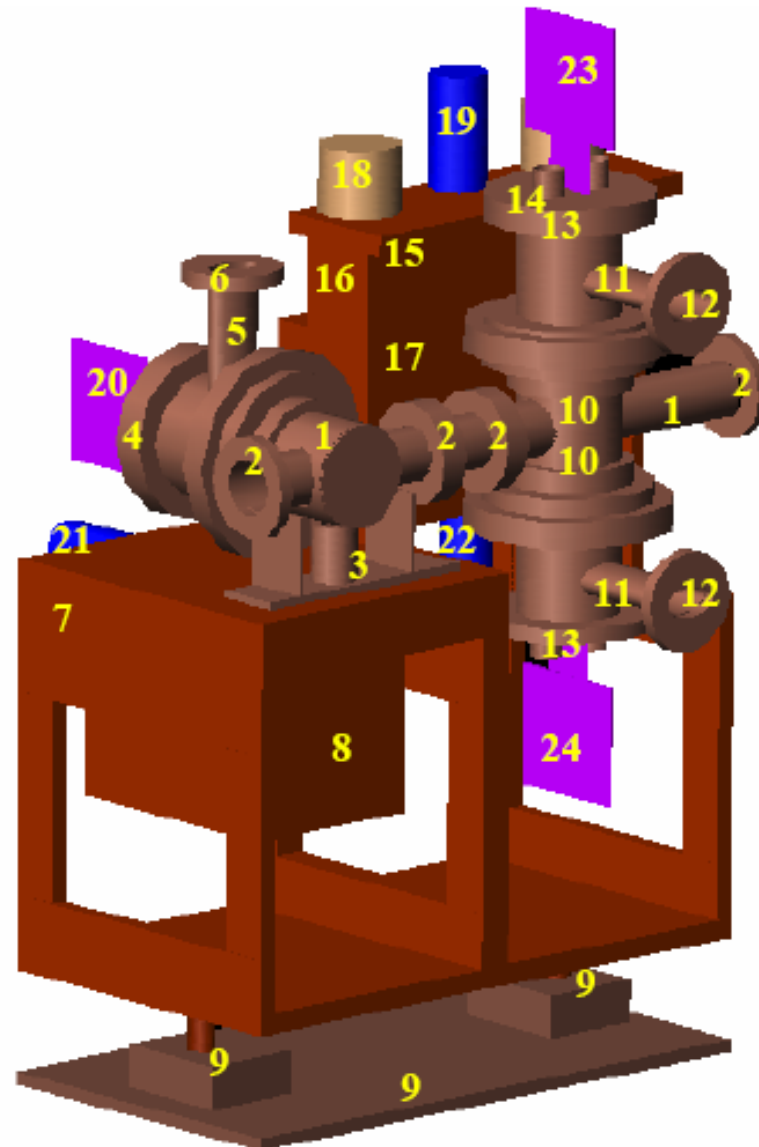
Residual contact dose map, 10 years of LHC operation at 10^{34} for 2 years cooling.
Values are in mSv/hr

yz projection at $x=1\text{m}$
 (beam level).



3. PROMPT DOSES (absorbed doses)

DOSES AVERAGED
OVER THE WHOLE
REGION OF INTEREST!



Element of Roman Pot	Prompt dose [Gy/hr]	Total dose in 1 LHC year [Gy]
1. Horizontal pipe + horizontal pot	2.18E+00	4.89E+03
2. Flanges on horizontal pipe	1.42E+00	3.18E+03
4. Thick disks	1.75E-01	3.91E+02
5. XEC	6.11E+00	1.37E+04
7. Big support	2.22E+01	4.97E+04
8. Big metallic piece	3.79E-02	8.48E+01
9. Small bases and big lower base	1.43E-02	3.21E+01
10. Vertical Roman Pots	4.83E-01	1.08E+03
13. Thick disks up and down	2.15E-01	4.81E+02
15. Horiz. base for fiducials	2.40E-01	5.38E+02
16. Block below horiz. base	1.33E+00	2.98E+03
19. Motor up	6.19E-02	1.39E+02
20. Motherboard at the back	3.45E-02	7.74E+01
21. Motor at the back	7.42E-02	1.66E+02
22. Motor below	2.51E-01	5.63E+02
23. Motherboard at upper RP	8.12E-02	1.82E+02
24. Motherboard at lower RP	4.98E-01	1.11E+03

Element	Prompt dose [Gy/hr]	Total dose in 1 LHC year [Gy]
QRL	1.32E-02	2.97E+01
Support of QRL	4.67E-03	1.05E+01
L-shaped base of QRL	1.33E-03	2.97E+00
Helium inside QRL	1.09E+02	2.44E+05
Cooling pipe 1	1.46E-02	3.28E+01
Cooling pipe 2	1.78E-02	4.00E+01
Coolant inside pipe 1	1.99E-02	4.45E+01
Coolant inside pipe 2	2.68E-02	6.00E+01

Conclusions

- Calculation of zoning and of other parameters of radiological interest for TOTEM Roman Pots → completed
- Results are overestimated because an extreme running scenario for LHC was used
- Agreement between FLUKA and MARS results for prompt dose calculations
- A technical note is under preparation
- Apart from MC simulations for normal operating conditions of the RPs, other **accidental** scenarios should be studied (?)

Acknowledgements

MANY THANKS TO:

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...and to you for your ATTENTION