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MARS15 residual dose analysis

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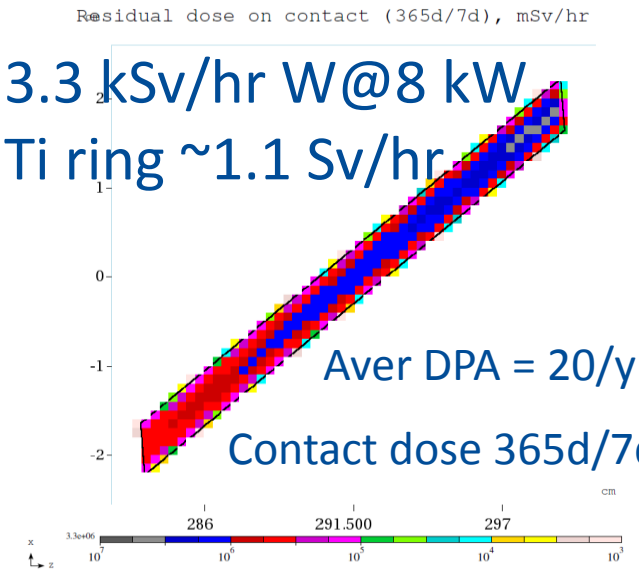
Mu2e Remote Handling Review

3 March 2015

Outline

- Residual dose from the target
- Target cask thickness estimation
- End cap residual activation
- Cryostat residual activation
- Residual doses in the Remote Handling Room
- PS Hall doses on contact with surfaces
- Summary

Residual dose from the target calculation



3.3 kSv/hr W@8 kW

Ti ring ~1.1 Sv/hr

Aver DPA = 20/yr

Contact dose 365d/7d

1) Size scaling factor

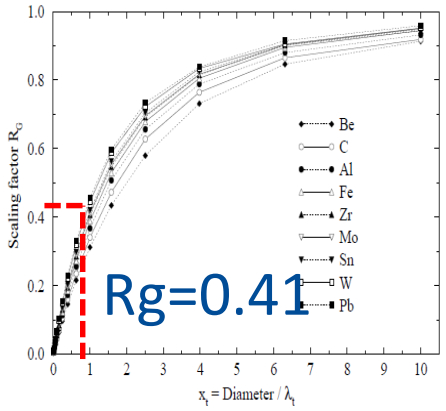


Figure 5: The calculated dose scaling factors, R_G, for solid cylinders of various materials *vs.* the normalized diameter. The lines are drawn to guide the eye.

2) Distance scaling factor

$$D(x,y,z) = k_d \emptyset(x,y,z)$$

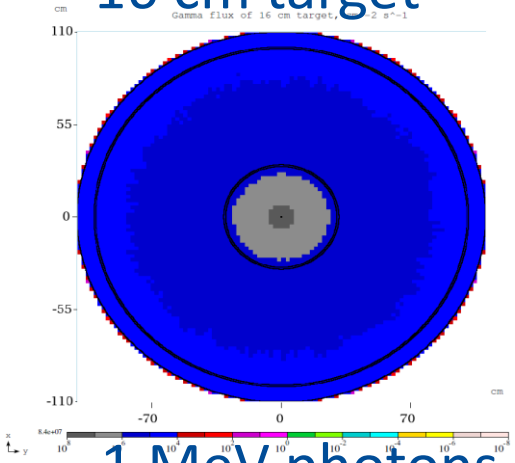
$$= k_d \int dS \frac{A_s}{2\pi\rho^2}$$

$$f(r-R) \equiv \frac{D(r)}{D_0}$$

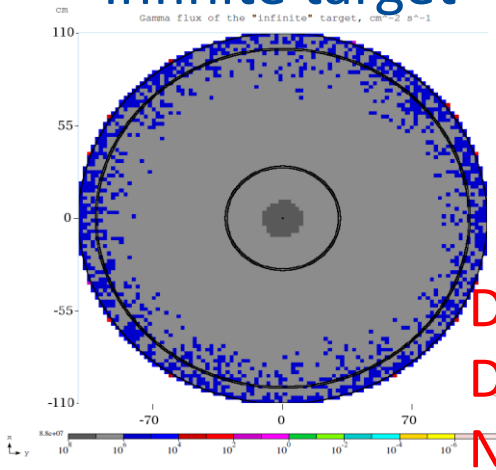
f(100) = 0.0023

f(30)=0.0078

16 cm target



Infinite target



1 MeV photons

3) The finite length correction factors $f^{fs} = \frac{\emptyset^{short}}{\emptyset^{long} * k_{vol}}$,

f^{fs}(100)=0.0611

f^{fs}(30)=0.203

D(100 cm, W, 8 kW) = 0.19 Sv/hr

D(30 cm, W, 8 kW) = 2.1 Sv/hr

Near the end cap ~21 mSv/hr

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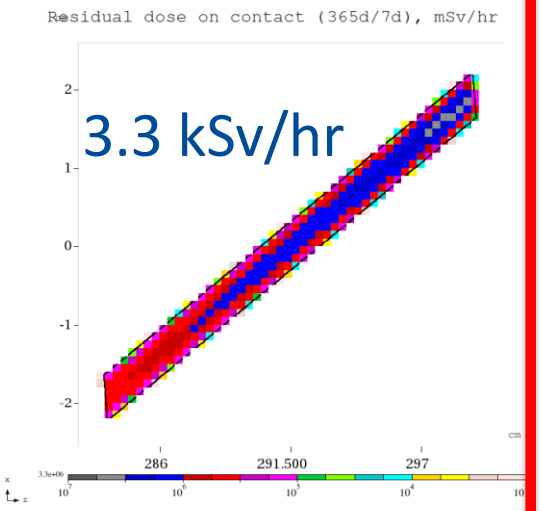
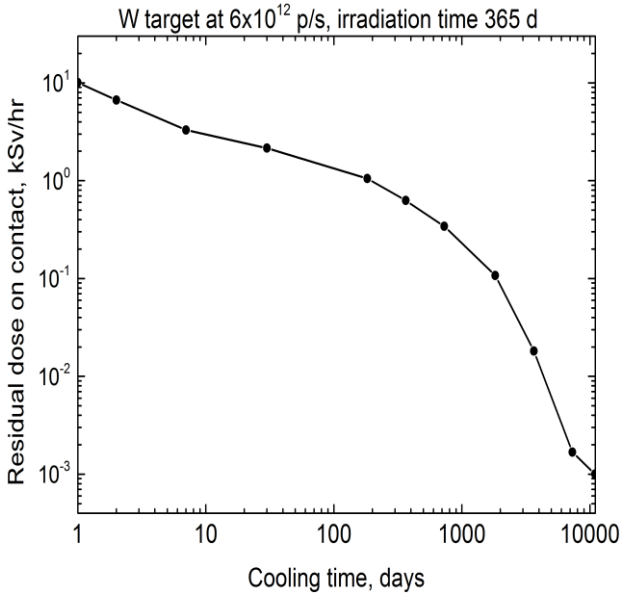
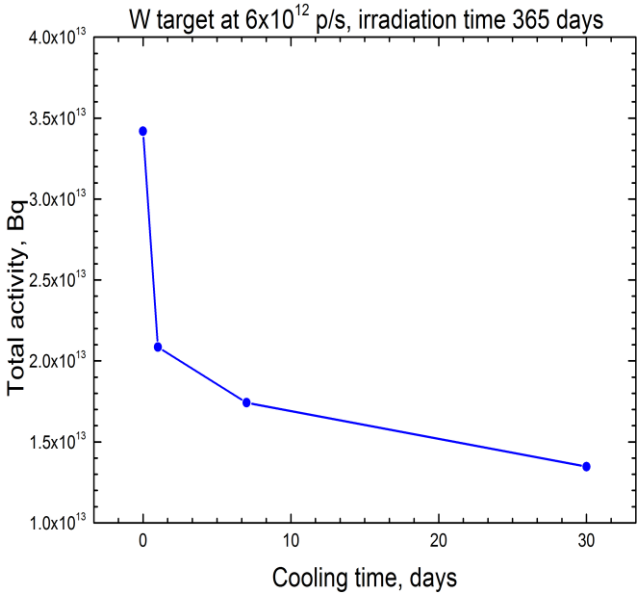
Target cask thickness calculations (1 mSv/hr limit)



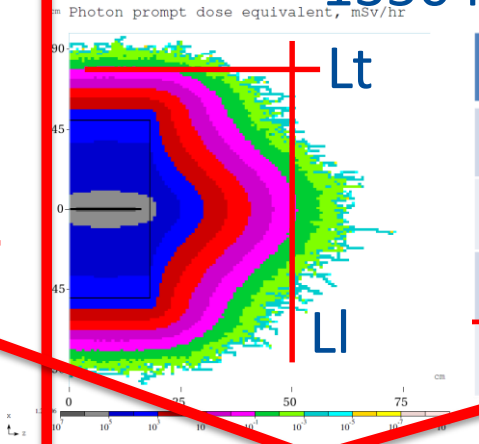




~1350 nuclides,1.7 E13 Bq (365/7), 1 MeV

Steel (in)	DoseRate (mrem/hr)
1	1.06E+06
2	4.61E+05
4	7.00E+04
6	9.09E+03
8	1078
10	120
12	13
14	1.3
16	0.1

1.2mSv/hr



Cooling time	Lt, steel, in	Ll, steel, in
0 d	10.6	11.8
1 d	10.0	11.3
7 d	10.0	11.0
30 d	9.6	11.0

Technique 1

Technique 2

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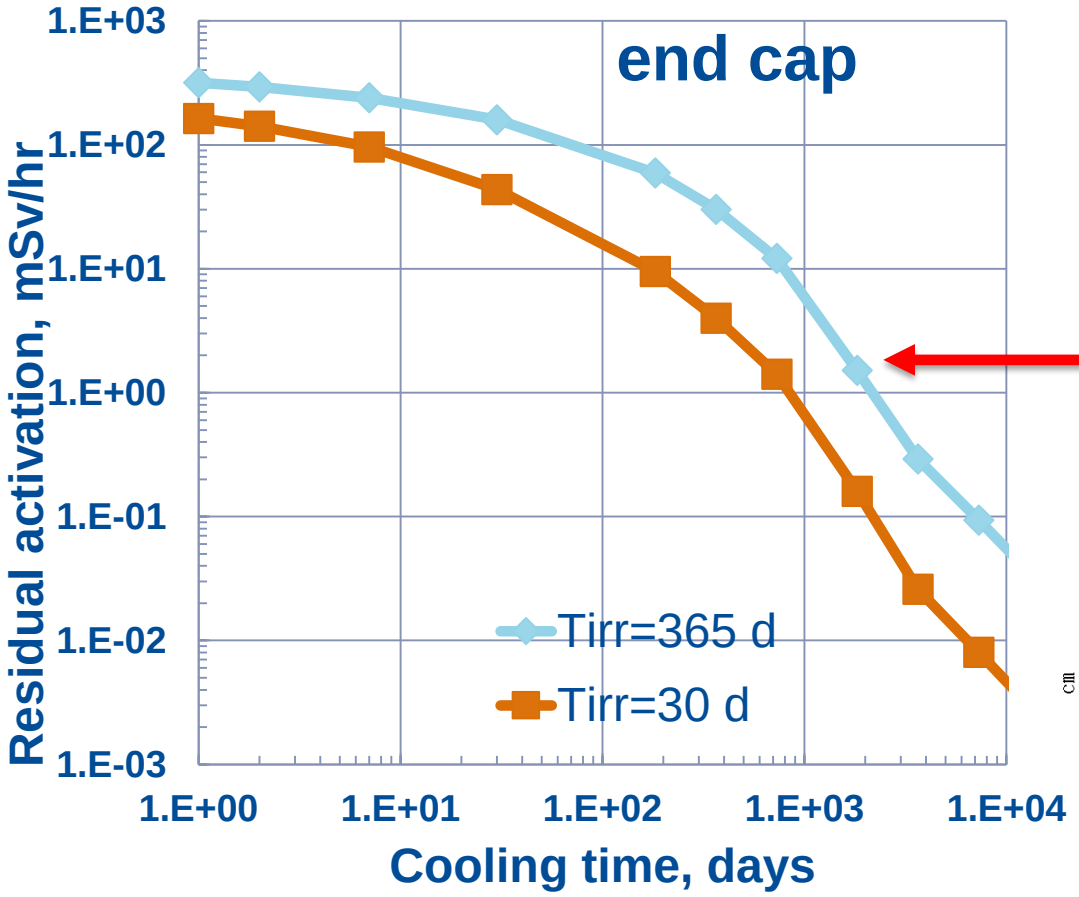
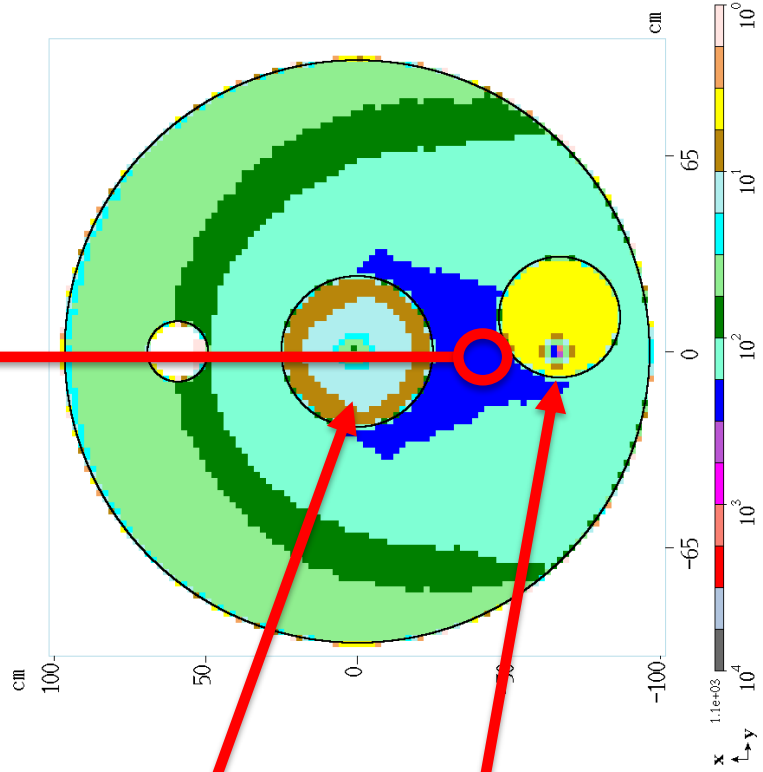
Contact dose on end cap





Proton window

Remote handling window

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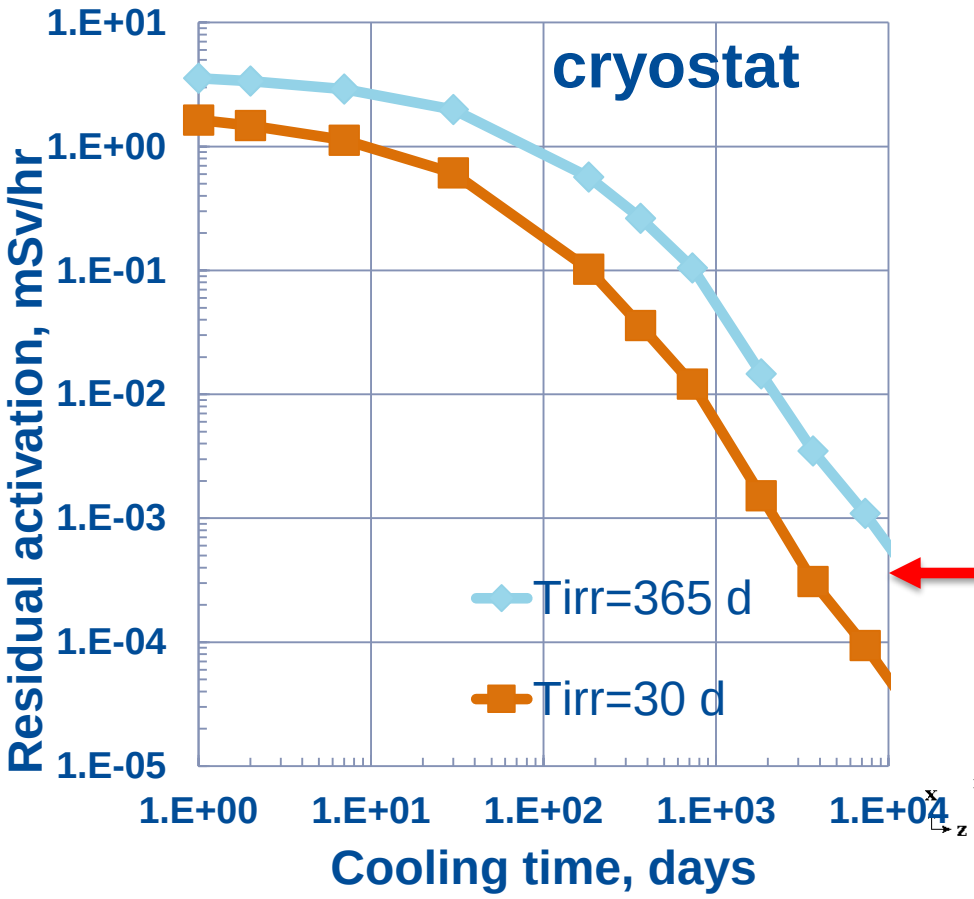
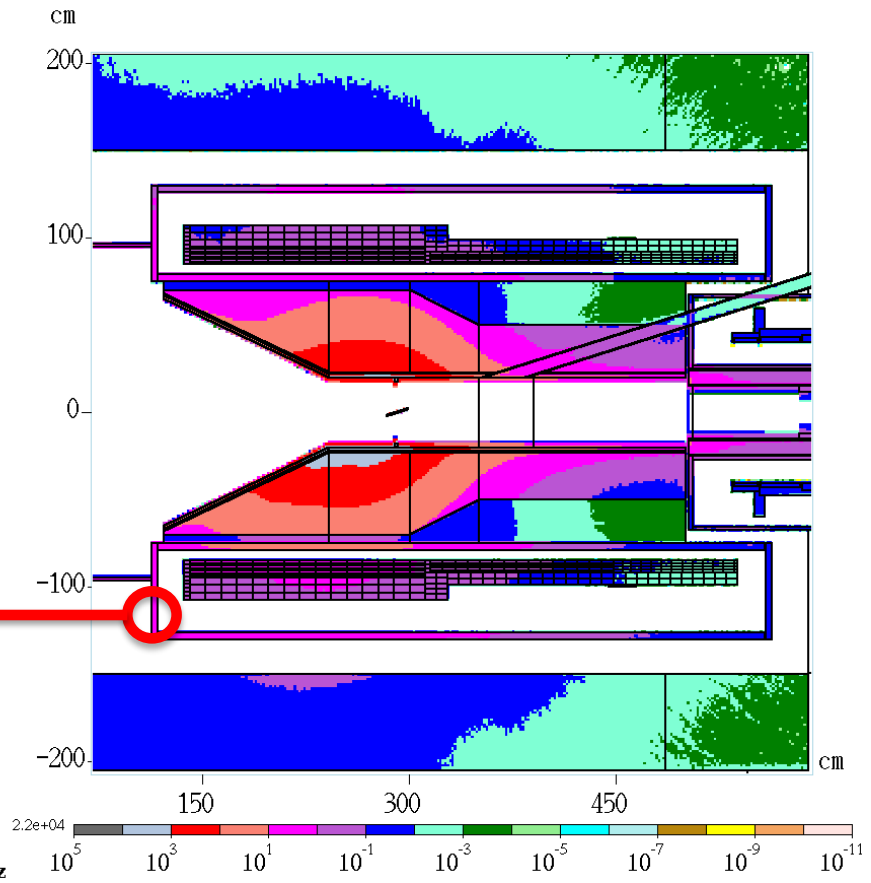
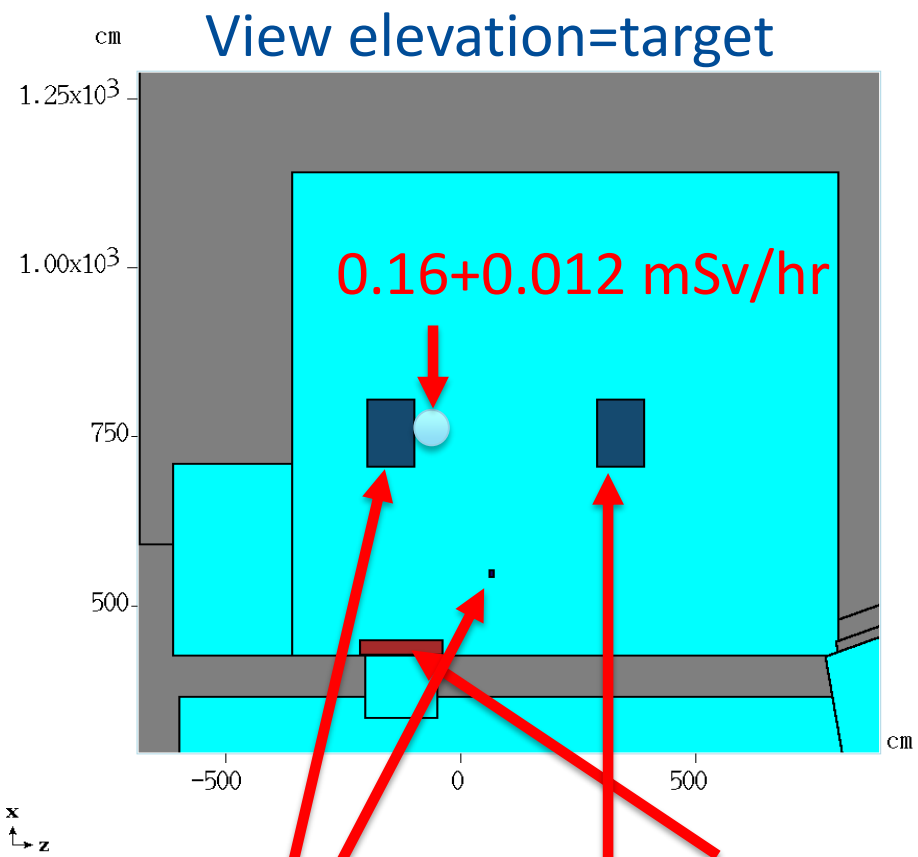
Contact dose on cryostat

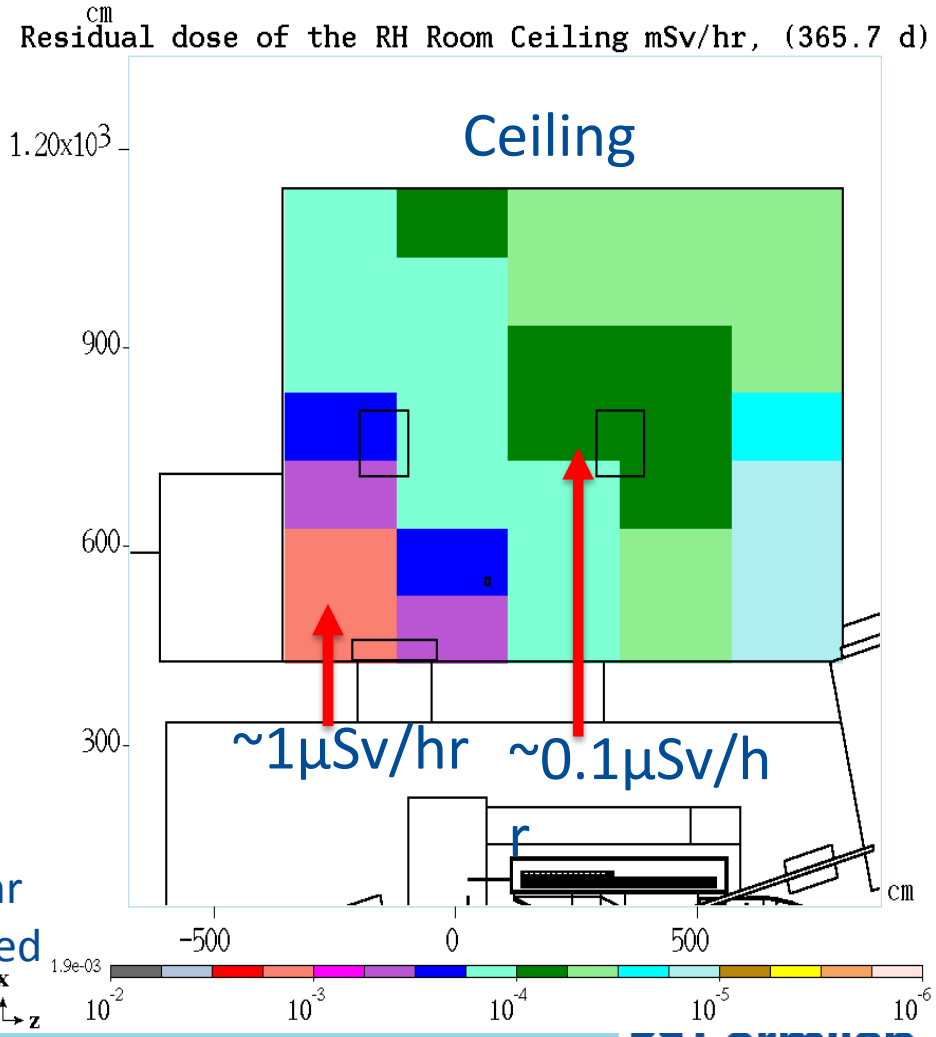




Residual doses in the RHR (1yr/7d), mSv/hr

Walls between PS Hall and RH Room are 2 feet thick, the door is 8 in thick



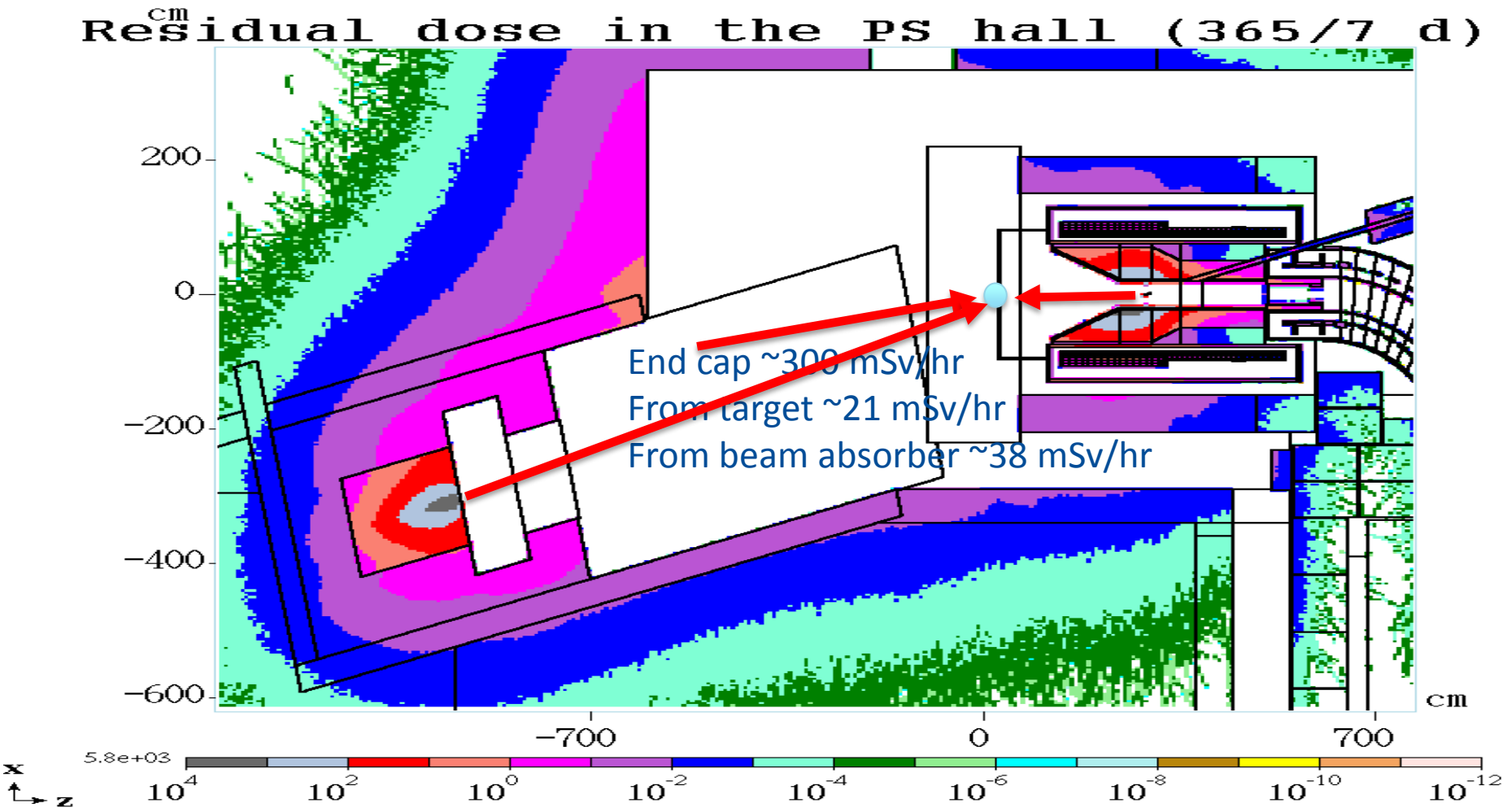


Partial contribution from the door ~ 0.16 mSv/hr

Si samples ~2.3 kGy/yr and ~ 0.6 kGy/yr absorbed

Pump oil ~ 30 kGy/yr absorbed dose

Residual dose in the PS Hall, mSv/hr



- irr\cool,d 1 2 7 30 183
  30 1.00E+00 4.10E-01 9.25E-02 4.69E-02 9.23E-03
  365 1.16E+00 5.68E-01 2.47E-01 8.54E-02 6.48E-02

Summary on relevant doses and quantities

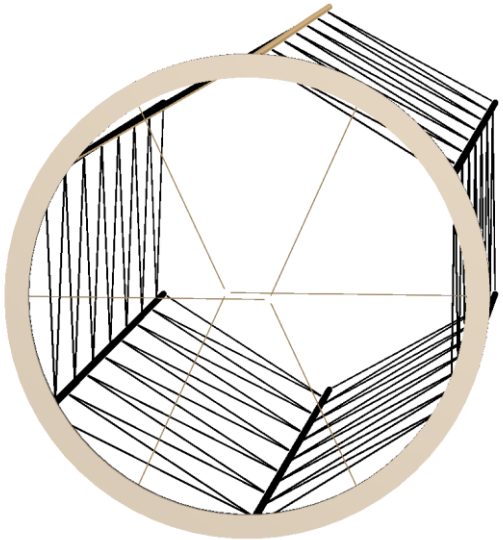
Quantity	Value
Target on contact, 365/7 d	3.3 kSv/hr
At the end cap from target, 365/7 d	21 mSv/hr
Ring on contact, 365/7 d	2.3 Sv/hr
End cap on contact, 365/7 d	300 mSv/hr
PS cryostat on contact, 365/7 d	4 mSv/hr
Absorbed dose in RHR Si samples	2.3 kGy/yr
Dose at the RHR center (door closed, 7 d)	0.181 mSv/hr
Beam absorber on contact (7 d)	300 mSv/hr

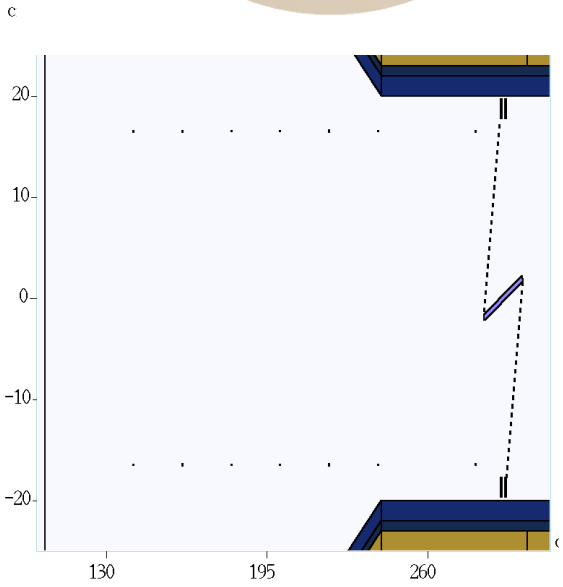
For implications for the occupancy see A. Leveling's talk.

For MARS15 histograms and model see Mu2e-doc-5235

Spare slides

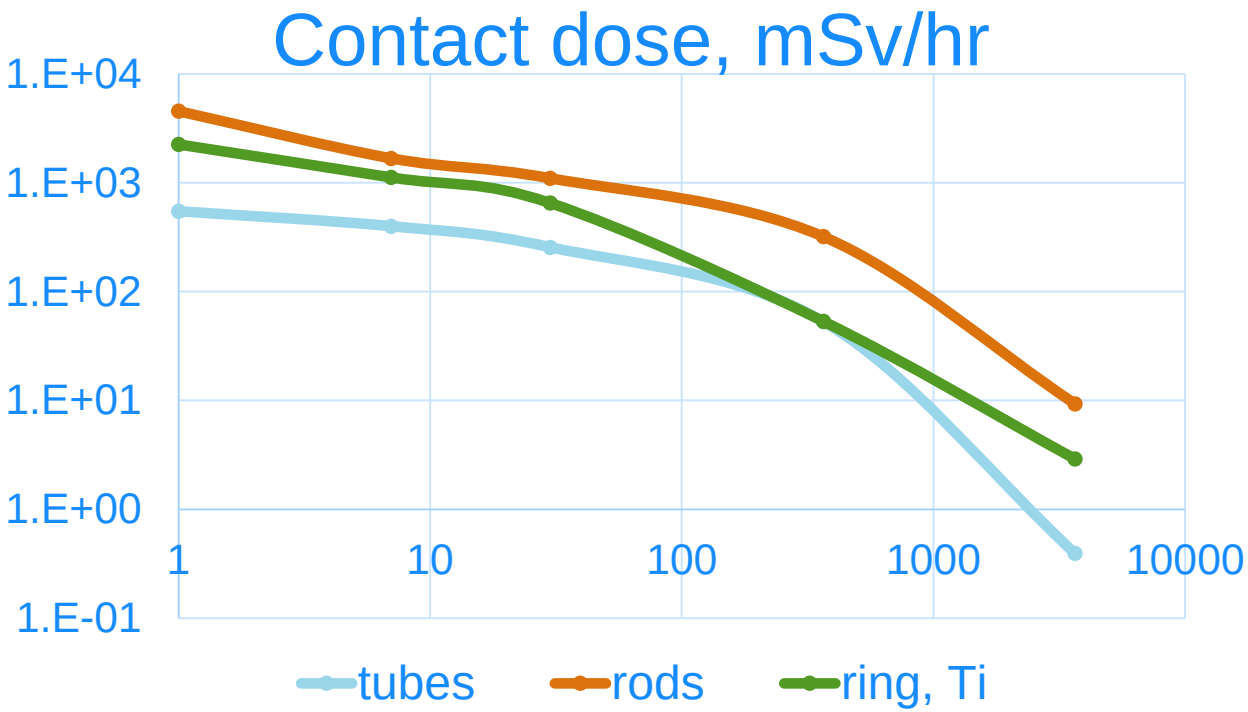
Space frame residual activation





Stainless steel tubes, Ti ring, W (rods)

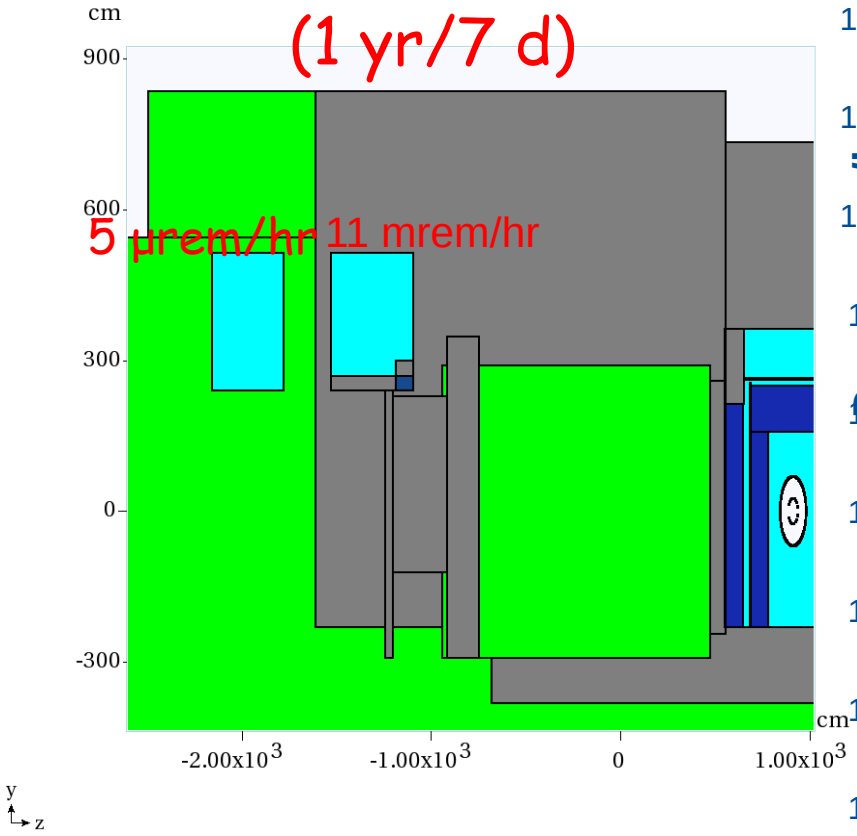
Slow dose decrease (x5 for 100 days)

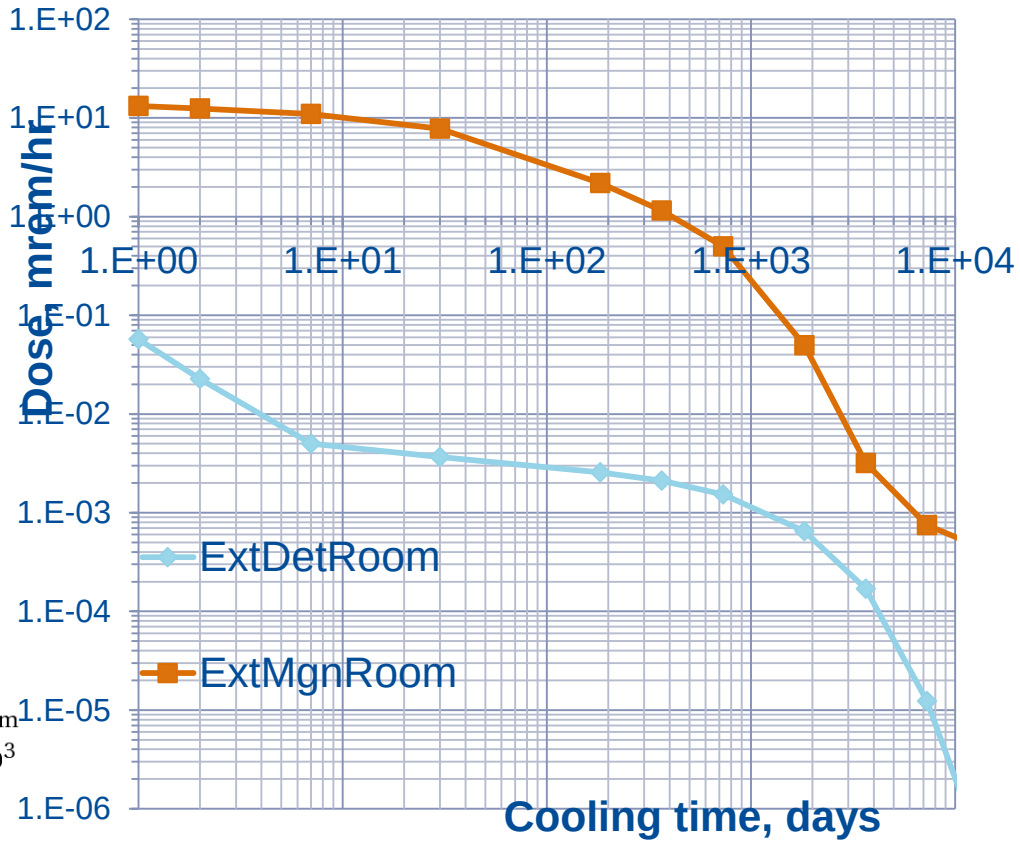


Summary

- The dose from the target is 3.3 kSv (~ 190 mSv/hr (100 cm))
- The cask should be at least 10 in thick
- Dose on contact with the space frame ring 4.8 Sv/hr
- End cap is activated at 240 mSv/hr on contact
- PS cryostat is at 3 mSv/hr
- Dose at the center of the RHR is 0.12 mSv/hr (dominated by the door, which is 0.11 mSv/hr)
- For the point at 3 m from the end cap, the beam absorber contributes 38 mSv/hr, and the end cap ~170 mSv/hr (20%).
- The beam absorber dose will cool down to ~1 mSv/hr after ~ 7 yr.
- For implications on the occupancy see A. Leveling's talk.

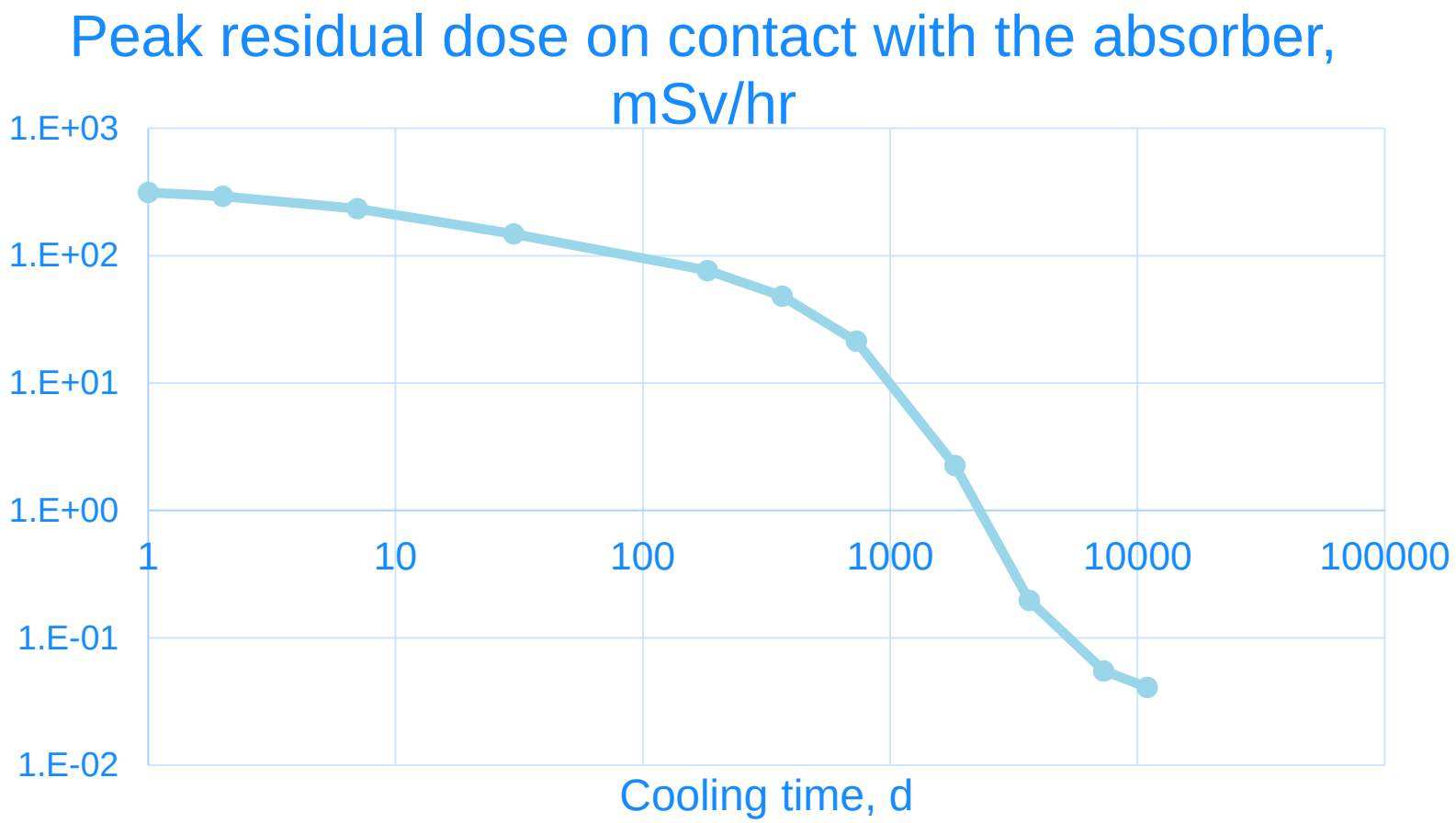
Residual doses in the extinction rooms





For 1 yr/ 4 hr the dose is 17 mrem/hr and 0.14 mrem/hr.
The doses are given at the centers of the rooms.

Beam Absorber cooling curve (average dose)



100 mSv/hr after 100 days of cooling