

Mikhail Kostin

Radiation Activation on Beam Pipes

Fermilab

December 9, 2004

Motivation

- $H^- \rightarrow H^0$ stripping due to black body radiation
- Losses 0.2 W/m, this corresponds to $1.56 \times 10^8 H^0/m$
- p and e^- are loosely coupled in H^0 , γ are similar
- $E_p \approx 8 \text{ GeV}$, $E_{e^-} \approx 0.0043 \text{ GeV}$. Activation is driven by protons.

Model

Beamline: B2 magnets (from the Main Ring),
quadrupoles (not from the Main Ring),
round drift tubes.

- B2: rectangle aperture $9.91 \text{ cm} \times 4.83 \text{ cm}$
- Quadrupole: oval aperture with semi-axes 5.0 cm and 2.6 cm
- Drifts: $R = 5 \text{ cm}$
- Horizontal apertures of all the elements are similar to avoid local losses

Model

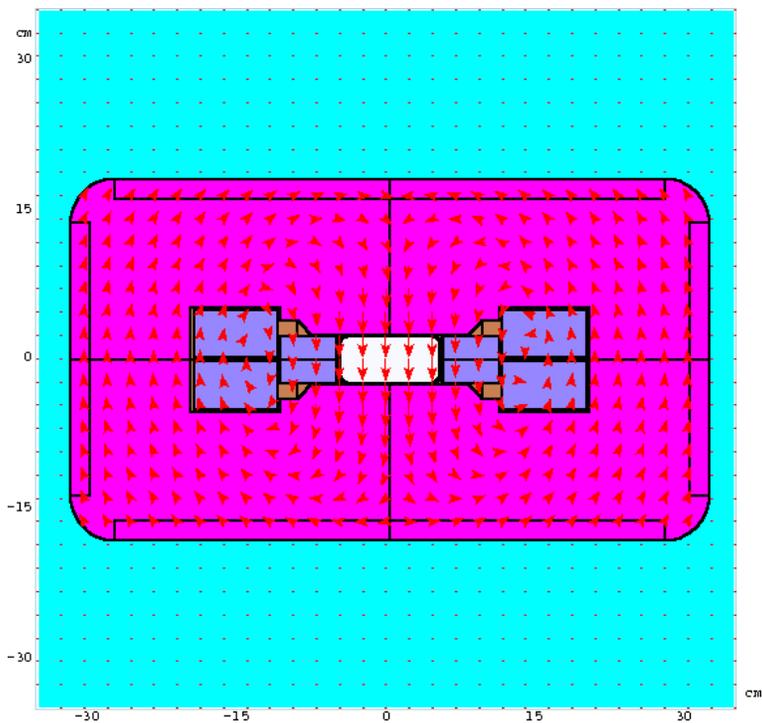


Figure 1: B2.

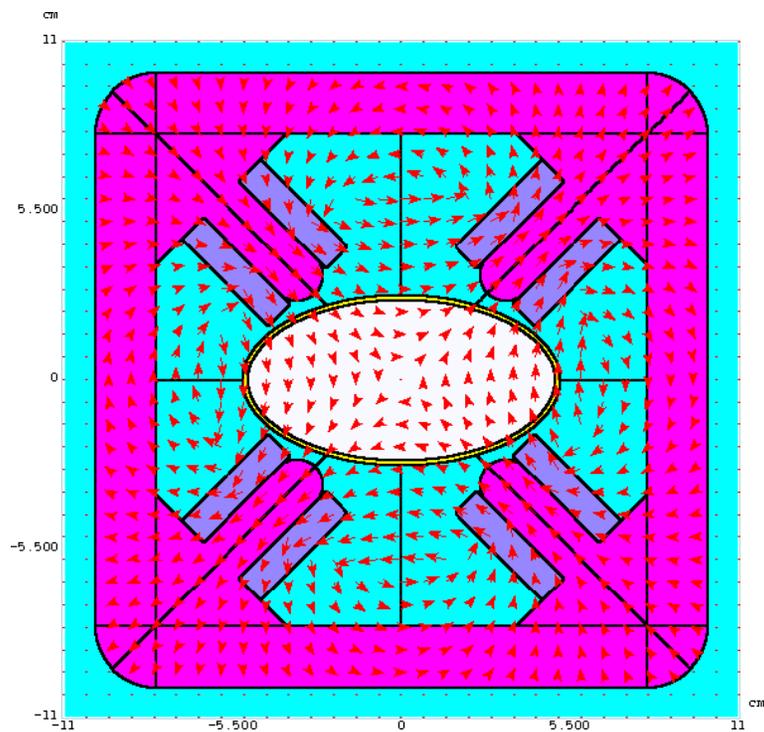


Figure 2: Quadrupole.

Model

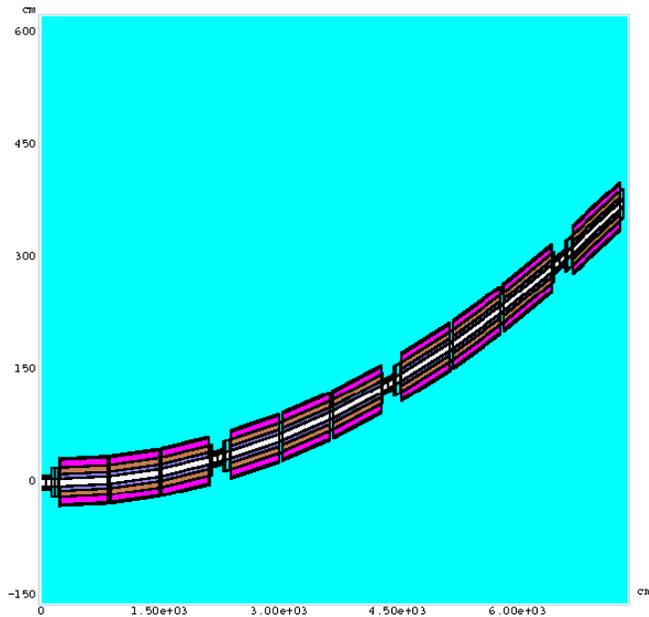


Figure 3: Beam line view.

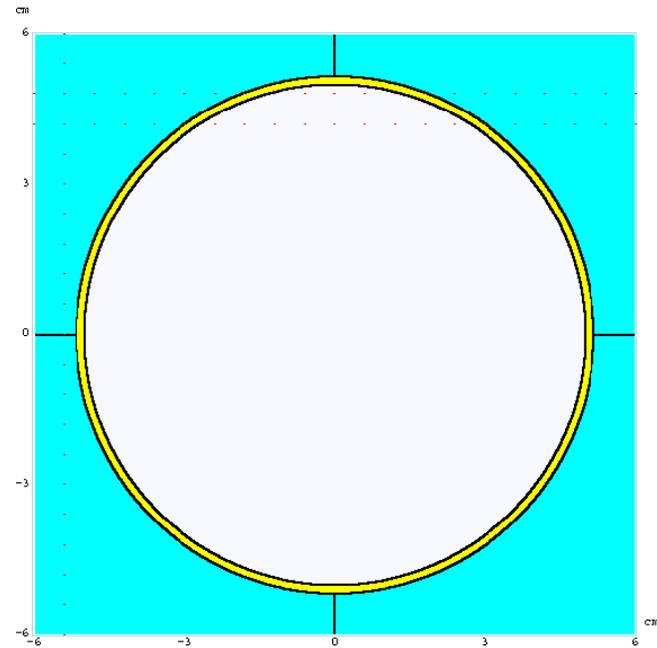


Figure 4: Drift.

- Idea: feed lost H^0 from STRUCT to MARS model
- Problem: MARS does not recognize H^0 , H^- (to be fixed soon)
- Can not track proton as H^0 , tracks are different in field

Model

- Remove the field.
- The protons enter the pipe wall from inside at 2 mrad.
- Vertical Gaussian distribution with $\sigma=1$ mm.
- Uniformly distributed along the z-axis.

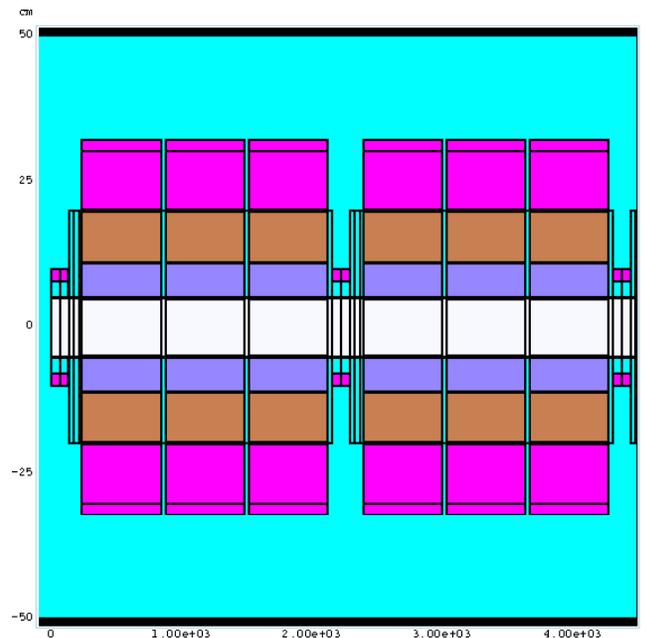


Figure 5: Simplified beam line.

Activation of Beam Pipe

Drifts in the middle of model.

RD > 1 rem/hr.

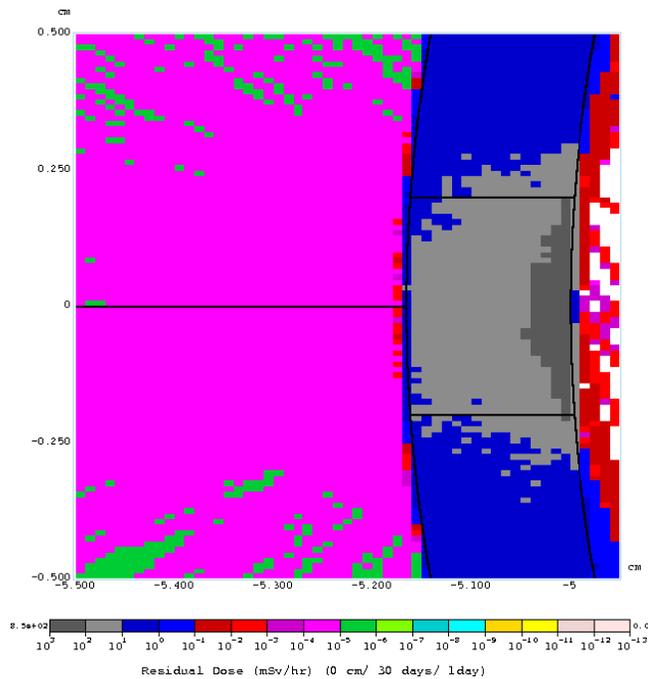


Figure 6: Residual dose in beam pipe wall.

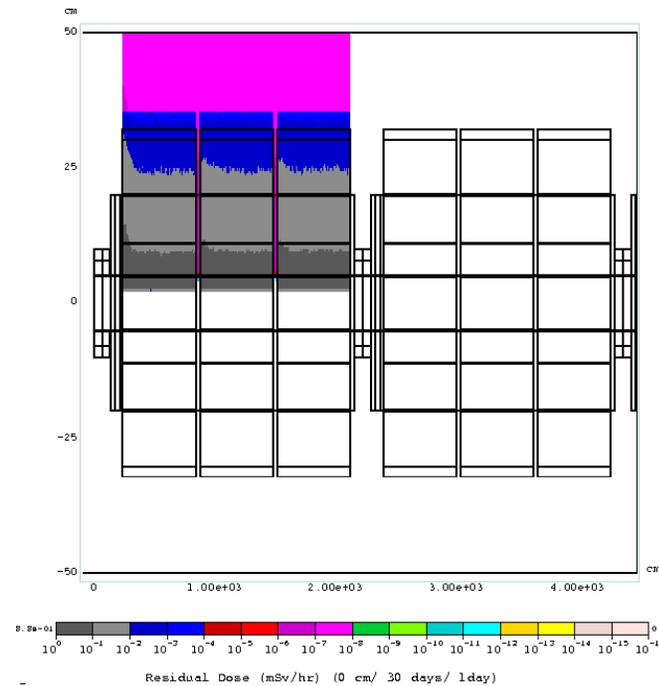


Figure 7: Residual dose profile (R-Z histogram).

Activation of Beam Pipe, Jaws

Jaws: copper, 25 cm, 2 m from end of B2.

Dose on pipe ≈ 100 mrem/hr.

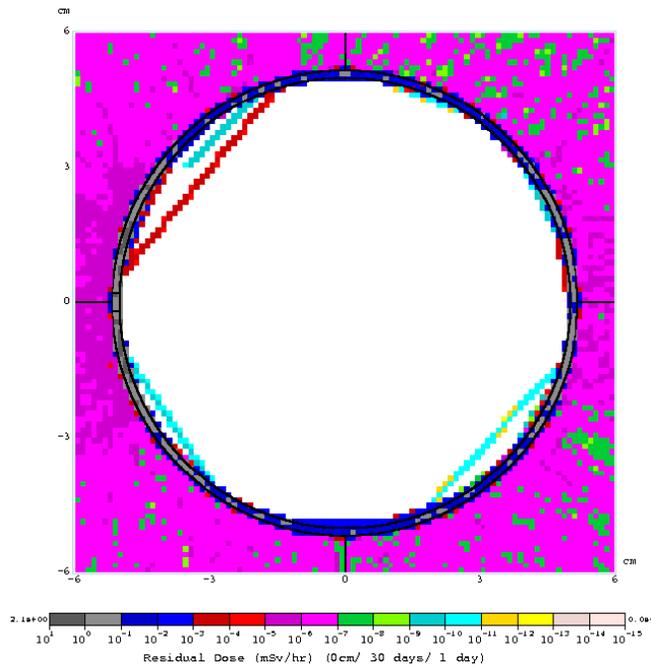


Figure 8: Residual dose in beam pipe wall.

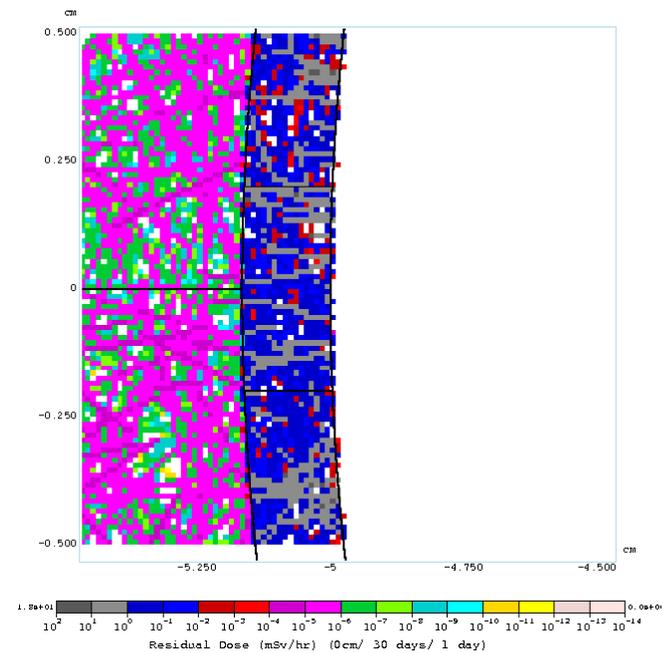


Figure 9: Residual dose in beam pipe wall.

Activation of Beam Pipe, Jaws

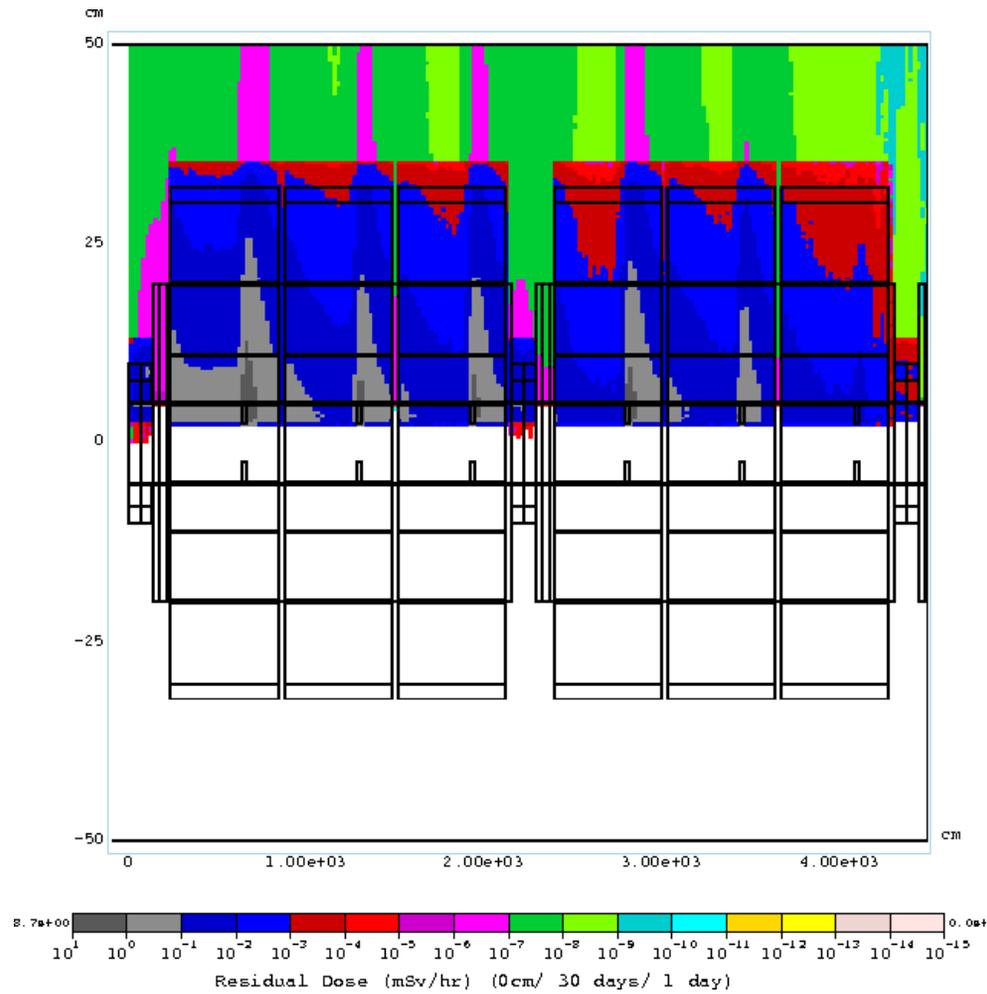


Figure 10: Residual dose profile.

Activation of Beam Pipe, Jaws

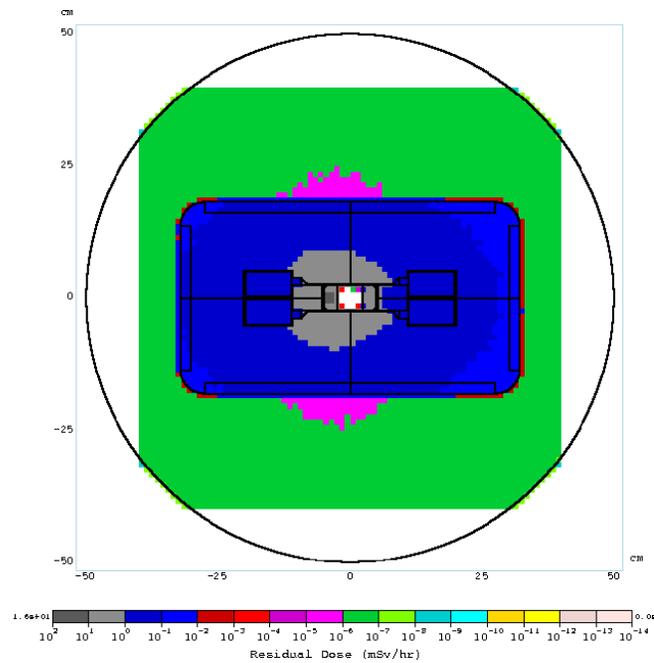


Figure 11: Residual dose.

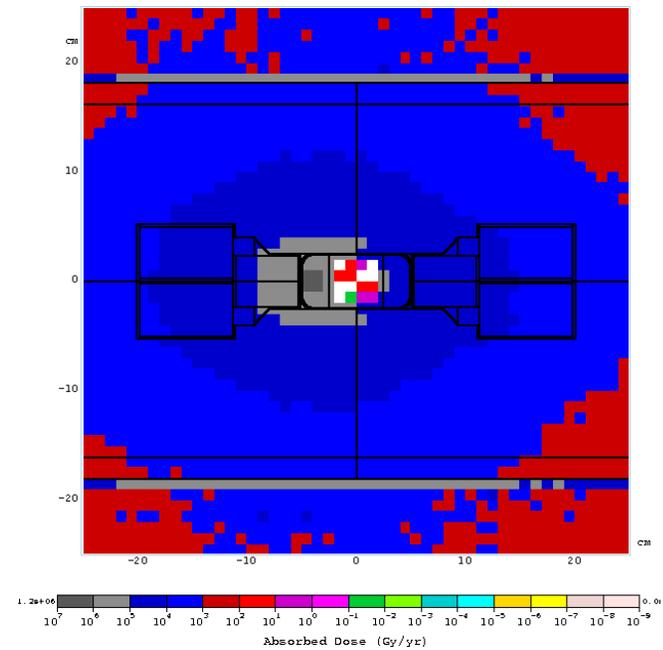


Figure 12: Absorbed dose.

Life time 'limit' = 400 Mrad = 4 MGy

Conclusions

- Need to add H^0 and H^- to MARS to combine simulations with beam transport codes (STRUCT).
- Jaws could work. Possible problem with residual dose on magnet surfaces.
- Possible problem with radiation damage to coils in magnets with jaws.

Backup Slides

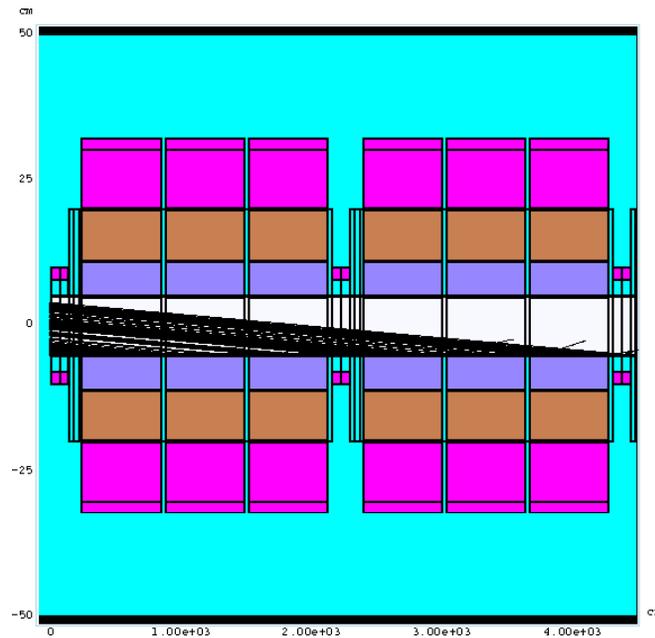


Figure 13: Simplified beam line with proton tracks shown.