Updates on the simulations of physics background in Super c-tau factory detector

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Outline:

- **Background tracks in TPC version of the IT**
- **Effect of increasing the VP diameter**
- **Shielding around the VP**

How many background tracks will be detected in TPC?

Primary processes:

1. Two-photon processes $e^+e^- \rightarrow \gamma^*\gamma^* \rightarrow e^+e^-e^+e^-$ ($E_{e^+e^-}$>2MeV) - 2.9mb (at 3 GeV per beam), DIAG36

However at 1.5 T field radius of electron trajectory with p_t = 1 MeV/c will be ~2 mm
For p_t = 15 MeV/c trajectory radius will be ~3 cm (inner radius of TPC)
For $E_{e^+e^-}$ >30 MeV cross-section for $e^+e^- \rightarrow \gamma^*\gamma^* \rightarrow e^+e^-e^+e^-$ is equal to 5.5 μb (3 GeV per beam), that gives 2.8×10^{-3} particles/bunch crossing ($L=10^{35}$ cm^{-2} s^{-1})

2. Radiative Bha-Bha $e^+e^- \rightarrow e^+e^-\gamma(n\gamma)$ (θ>5mrad), $E\gamma$>1MeV) - 1.2mb (at 3 GeV per beam), BHWIDE

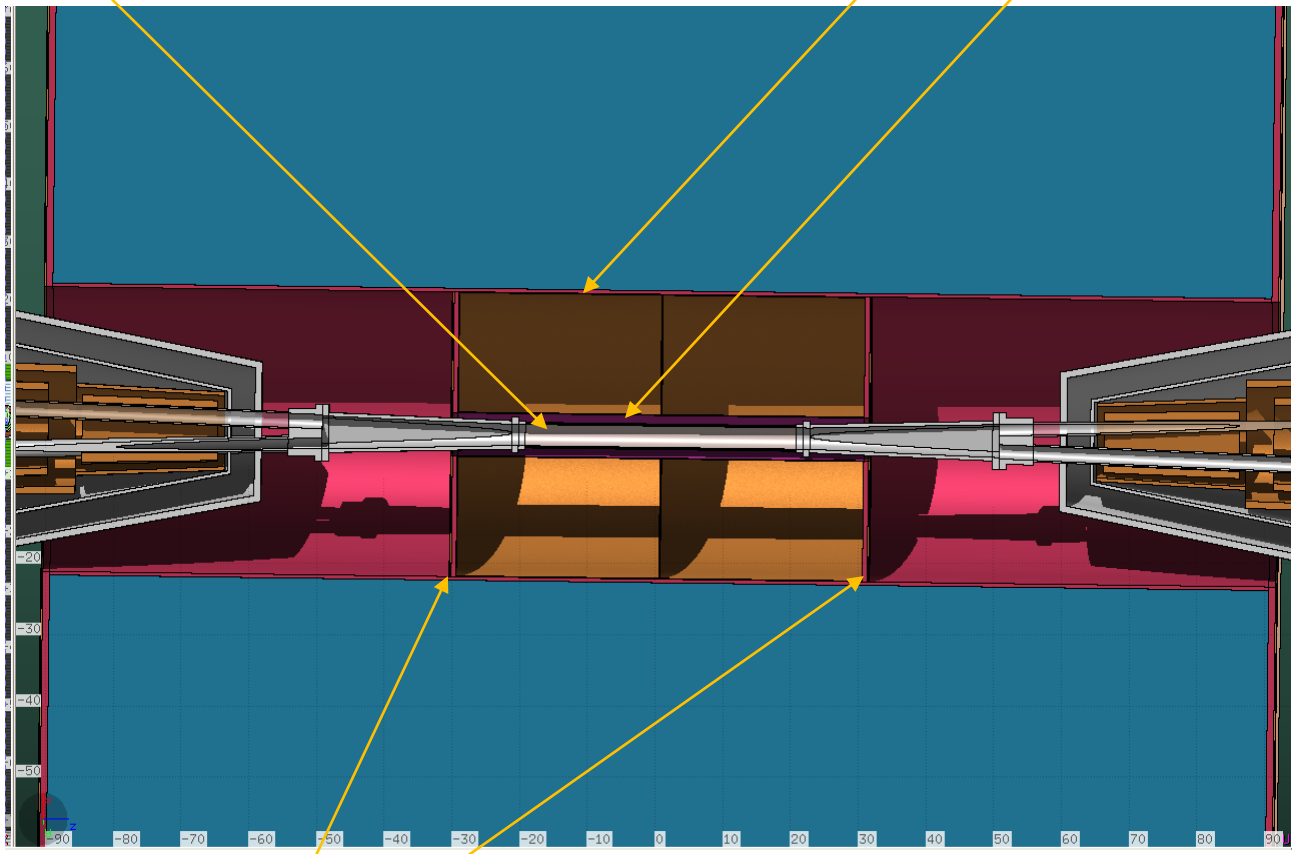
Particles with θ=5mrad will interact with vacuum pipe wall at Z=3m (VP radius is equal to 15 mm). Acceptance of TPC is 0.1 rad < θ < π/2.
For θ>100 mrad, $E\gamma$>1MeV cross-section of $e^+e^- \rightarrow e^+e^-\gamma(n\gamma)$ process is equal to ~2.8 μb (3 GeV per beam), that gives ~1.4×10^{-3} particles/bunch crossing

TPC as Inner Tracker

Outer radius 20 cm

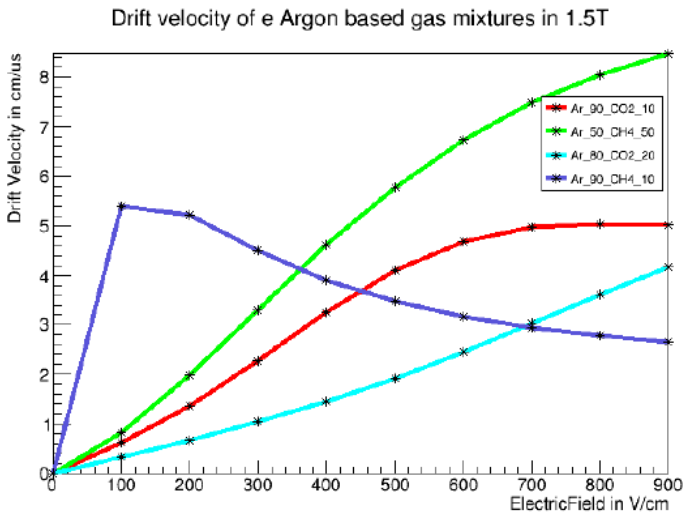
Beam pipe, inner radius 1.5 cm

Inner radius 3 cm



-30 cm < Z < 30 cm

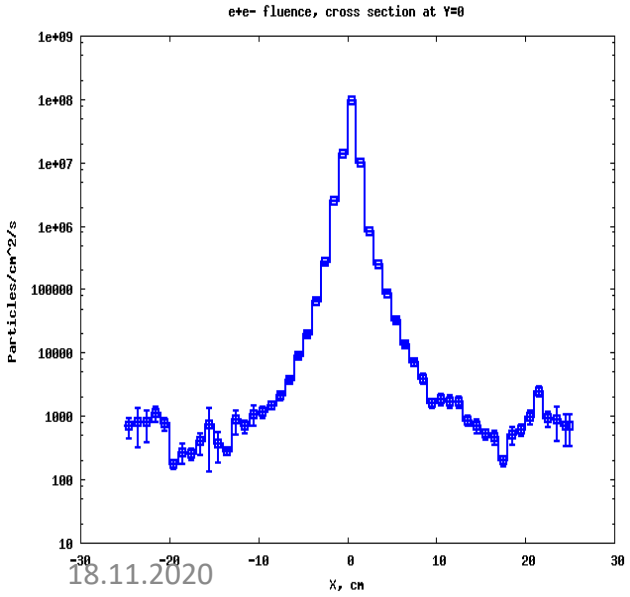
How many background tracks will be detected in TPC?



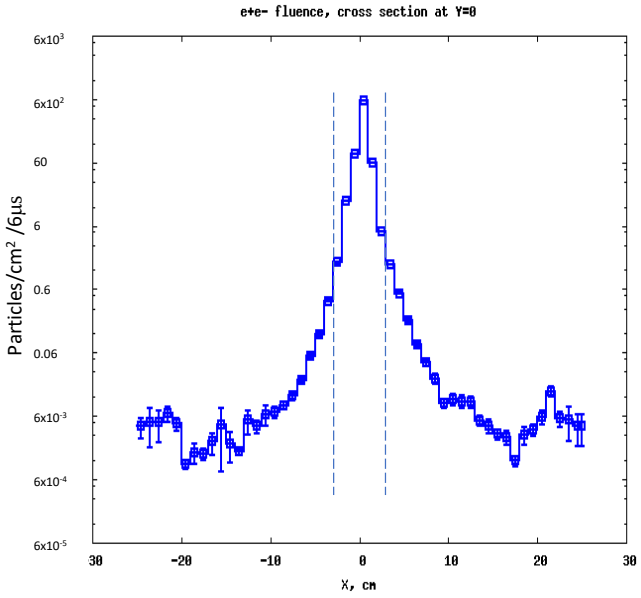
Drift velocity in 1.5 T B-field for one of the most popular TPC mixtures Ar+10%CH_4 is 5 cm/μs for electric field of 100-200 V/cm.

Electrons drift time is 6 μs -> 1200 bunch crossings -> ~5 primary background tracks

How many secondaries?

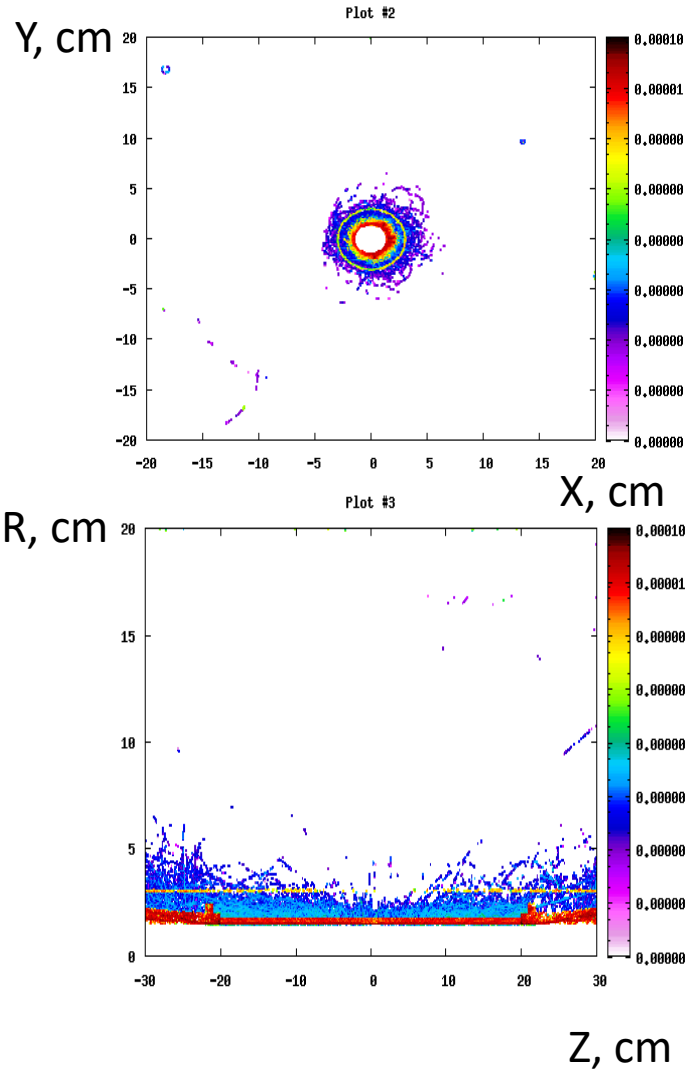


per 6 μs

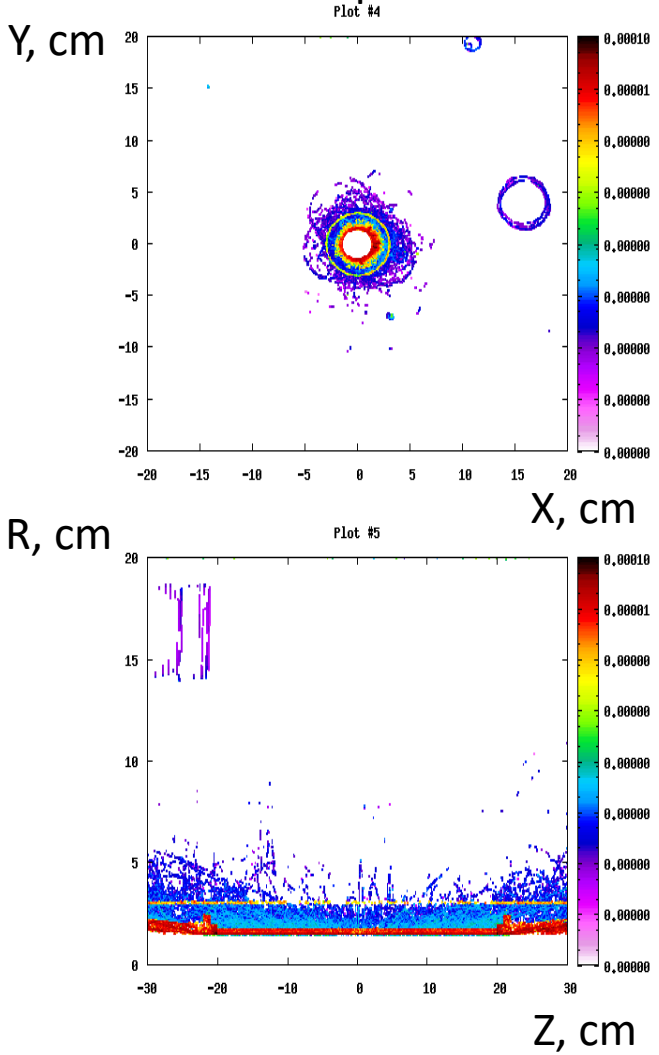


Examples of TPC occupancy (energy depositions) within 6 μs

Sample 1

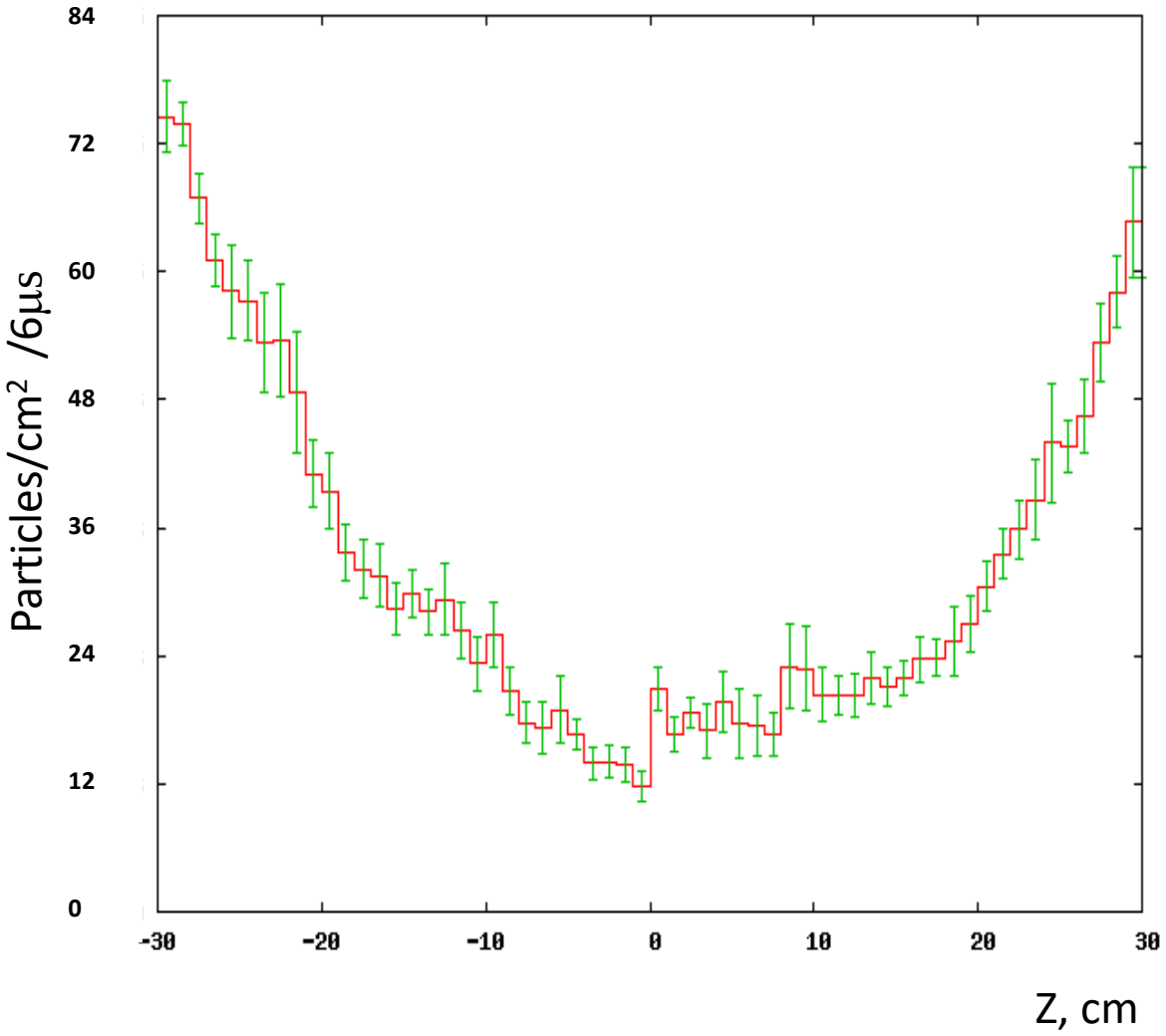


Sample 2



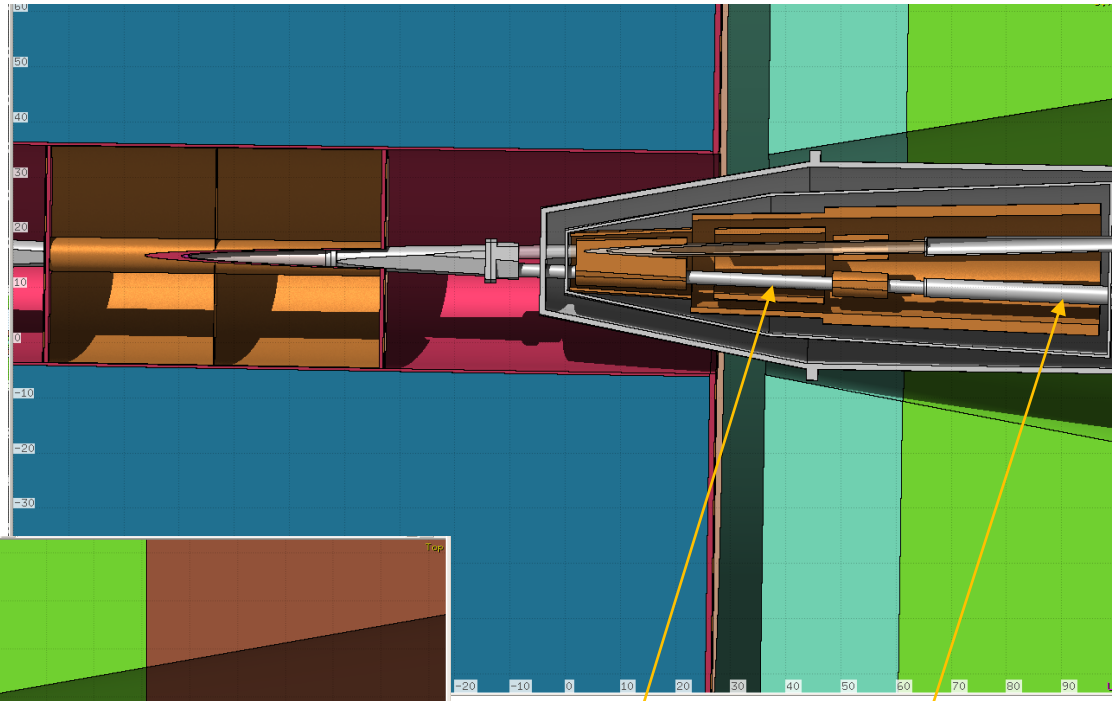
How many background tracks will be detected in TPC?

Number of charge particle tracks per TPC cross-section within 6 μs

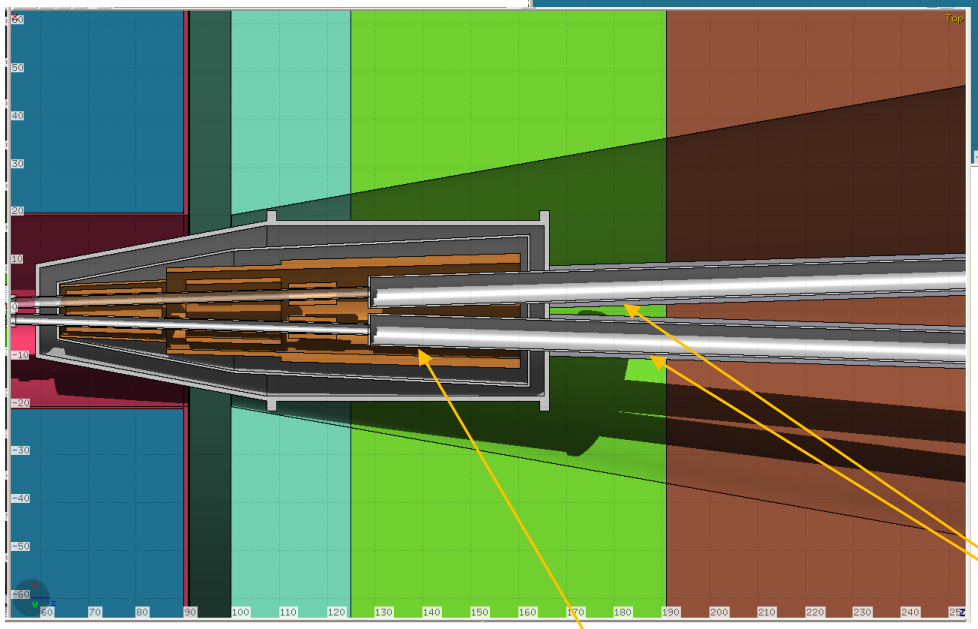


Dependence of background particle flux and dose on beam pipe diameter and shielding

Initial model



Wider BP with shielding



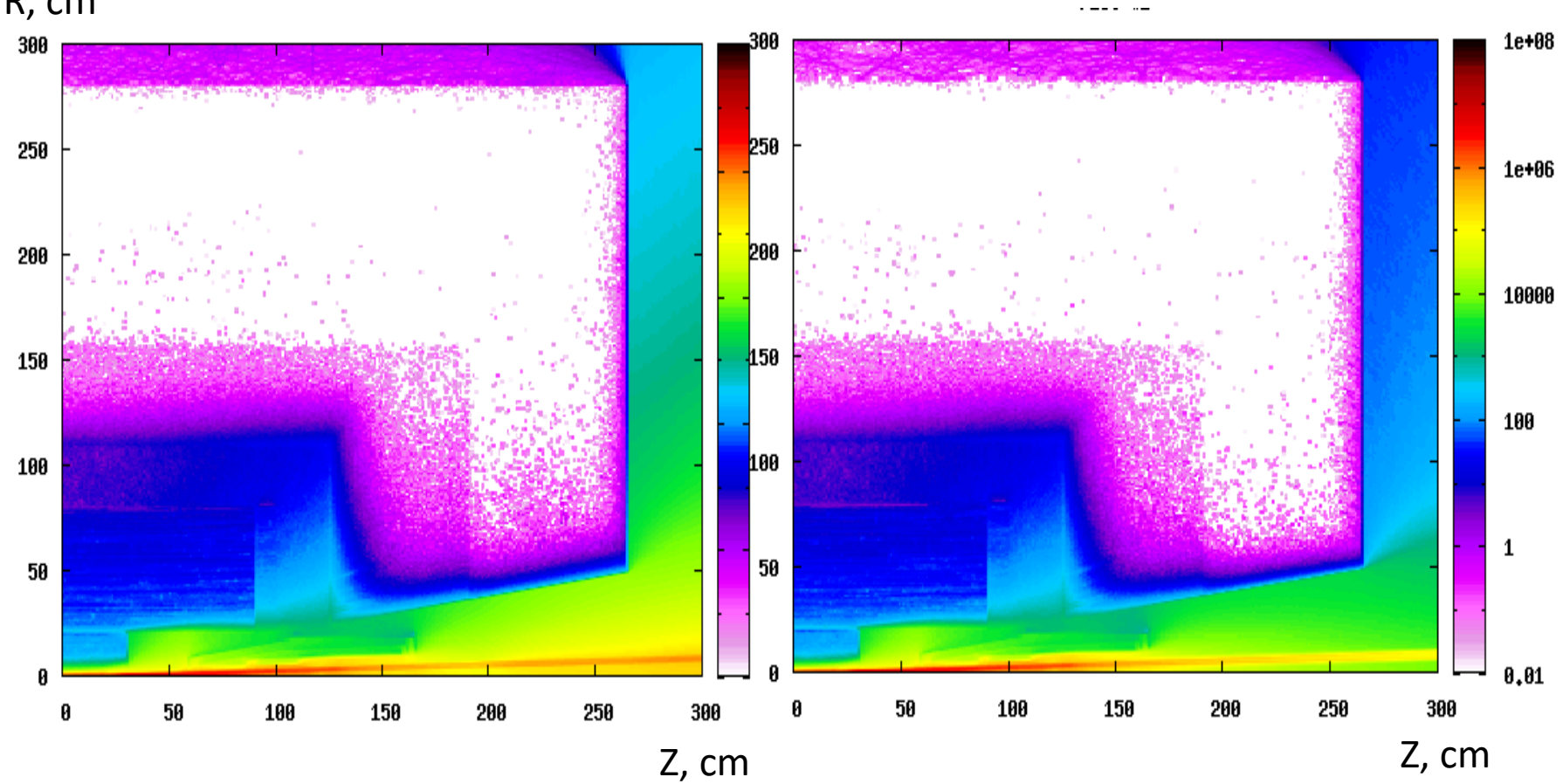
2cm inner diameter BP

3cm inner diameter BP

6cm inner diameter BP

1cm thick lead shielding

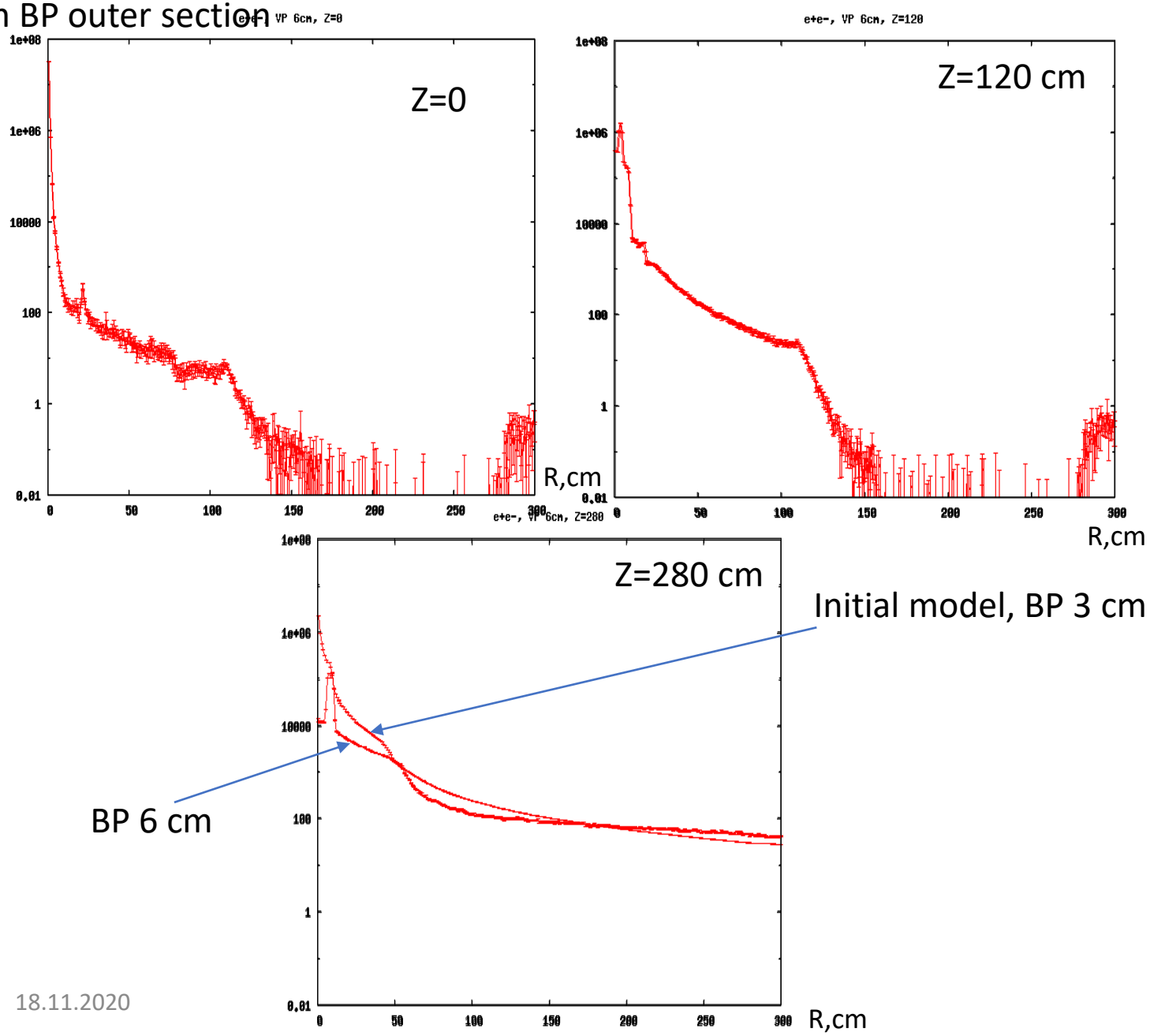
Comparison of e+e- fluence RZ maps for initial model and model with 6cm BP outer section



Initial model

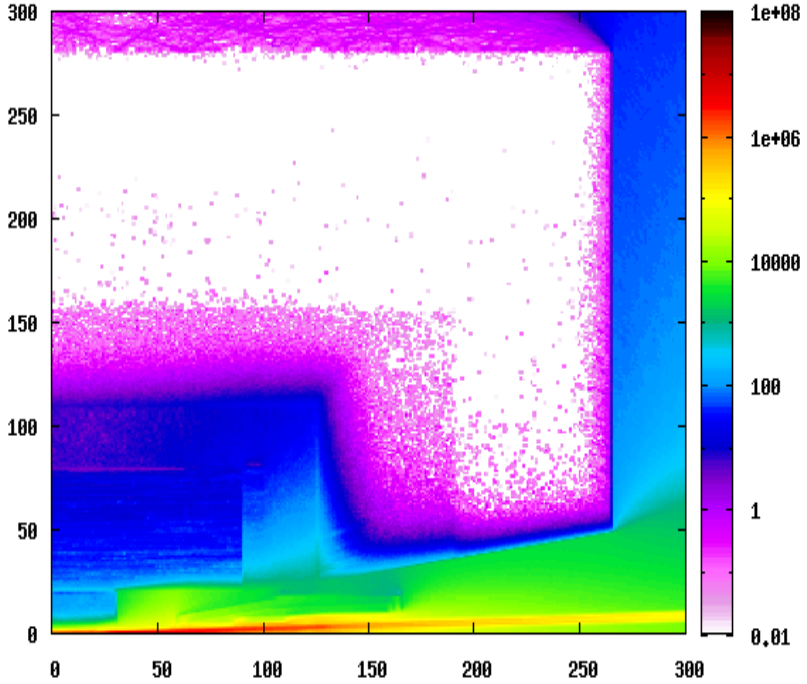
BP 6 cm

Comparison of cross-sections of e+e- fluence RZ maps for initial model and the model with 6cm BP outer section



Comparison of e+e- fluence RZ maps for the model with 6cm BP outer section and the model with 1 cm thick lead shielding

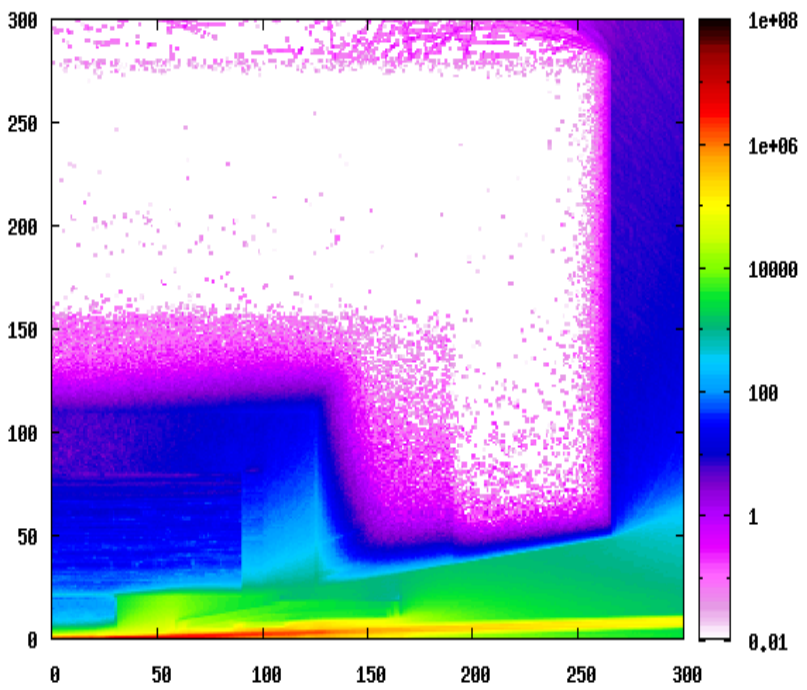
R, cm



Z, cm

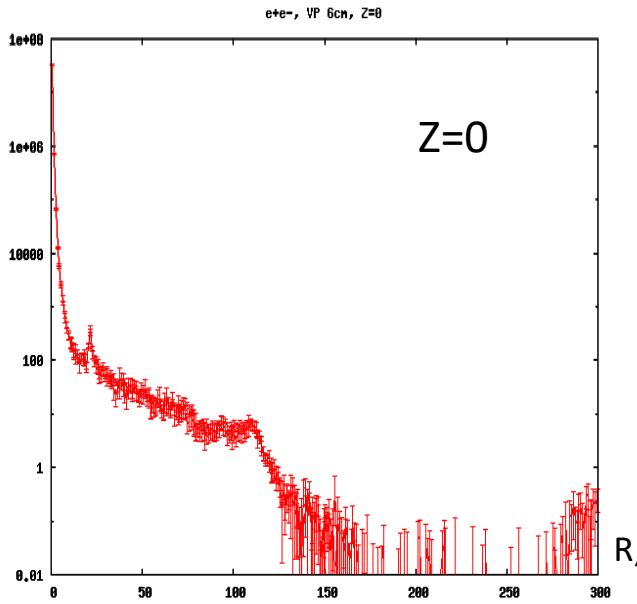
6 cm BP

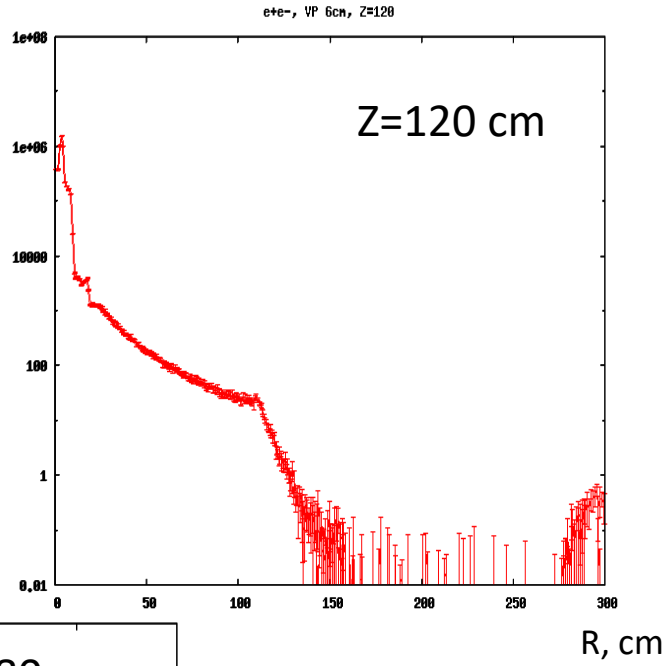
R, cm

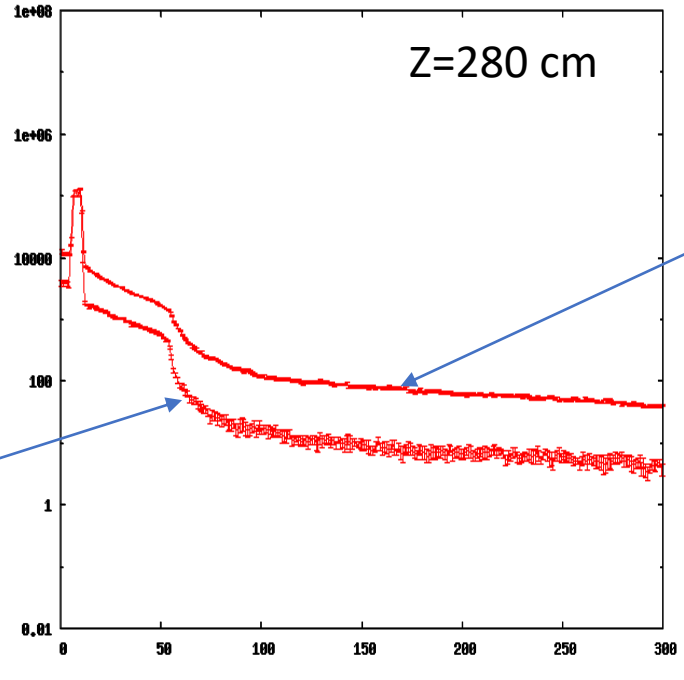


6 cm BP + 1 cm lead shielding

Comparison of cross-sections of e+e- fluence RZ maps for initial model and the model with 6cm BP outer section



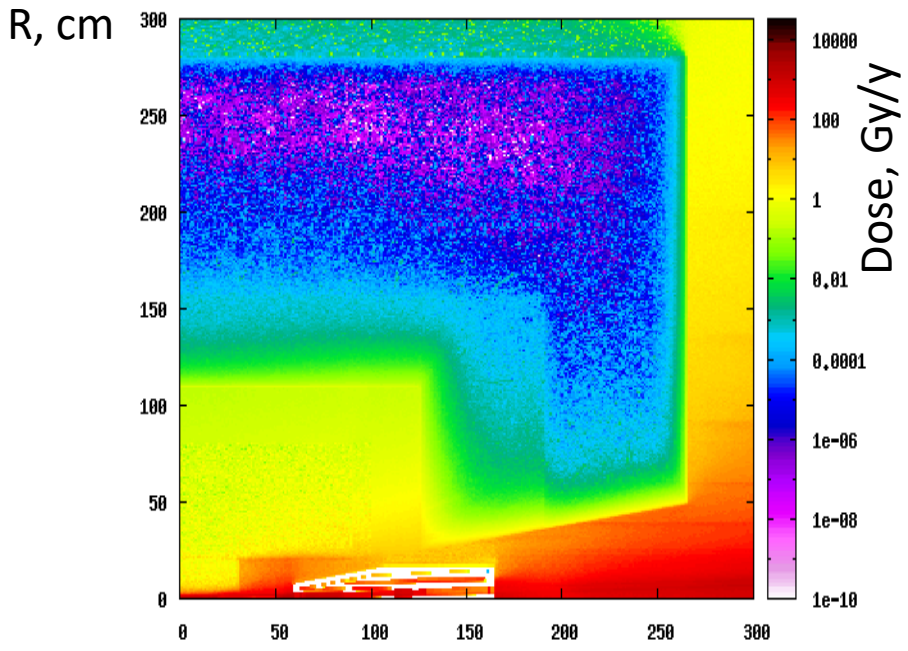


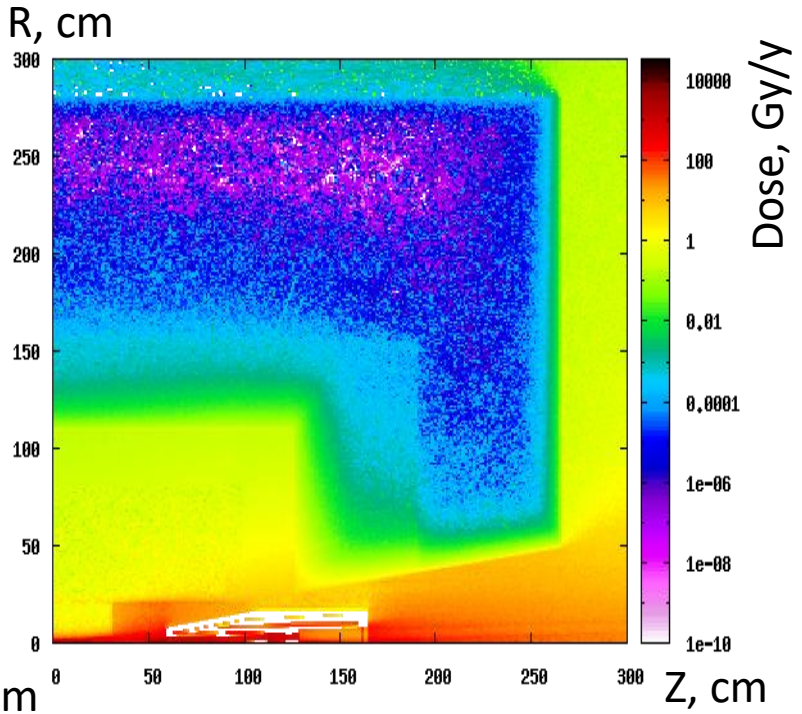


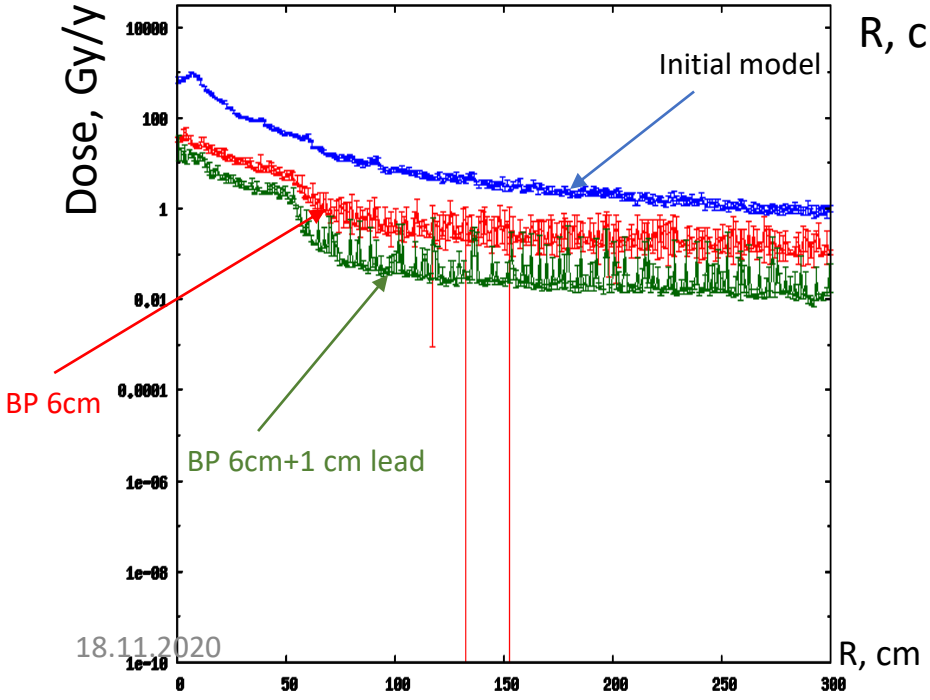
BP 6 cm

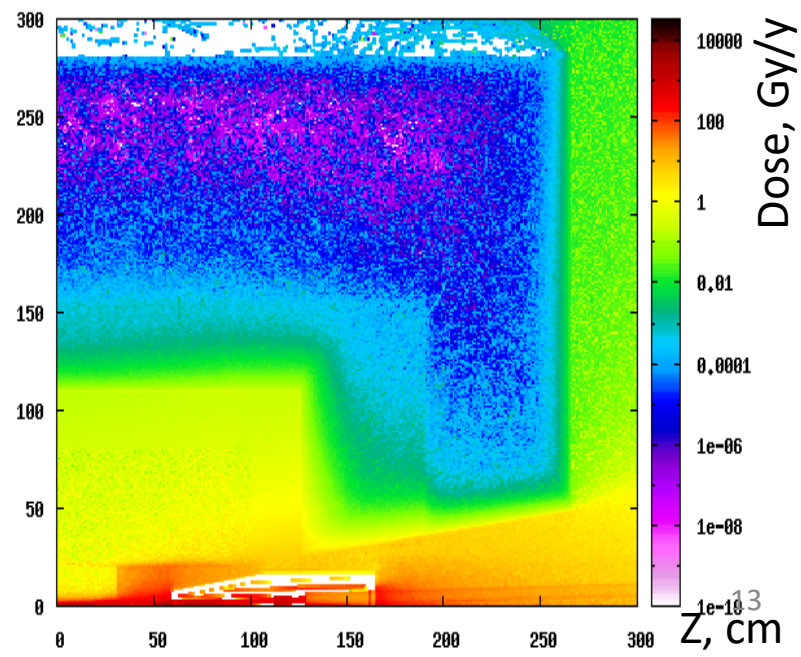
BP 6 cm+ 1cm lead

Comparison of dose maps for different models









Conclusions

- Average number of tracks in TPC volume is below 100. Most of them are secondary particles originating in the flanges and walls of the final focus assembly

- Inner diameter of the beam pipe significantly affects particle flux and radiation dose. Increase of the diameter from 3 cm to 6 cm in the outer section of the beam pipe reduces the particle flux in the region around the detector by a factor 3-5.

- Lead shielding around the beam pipe significantly reduces particle flux and radiation dose in the region around the detector. Combination of two factors: increase of the diameter and 1 cm lead shielding produces dose reduction by a factor more than 10.

- More efforts will be done to find the ways to reduce particle flux and dose rate in the central region of the detector by introducing extra shielding and modifying geometry of critical parts.