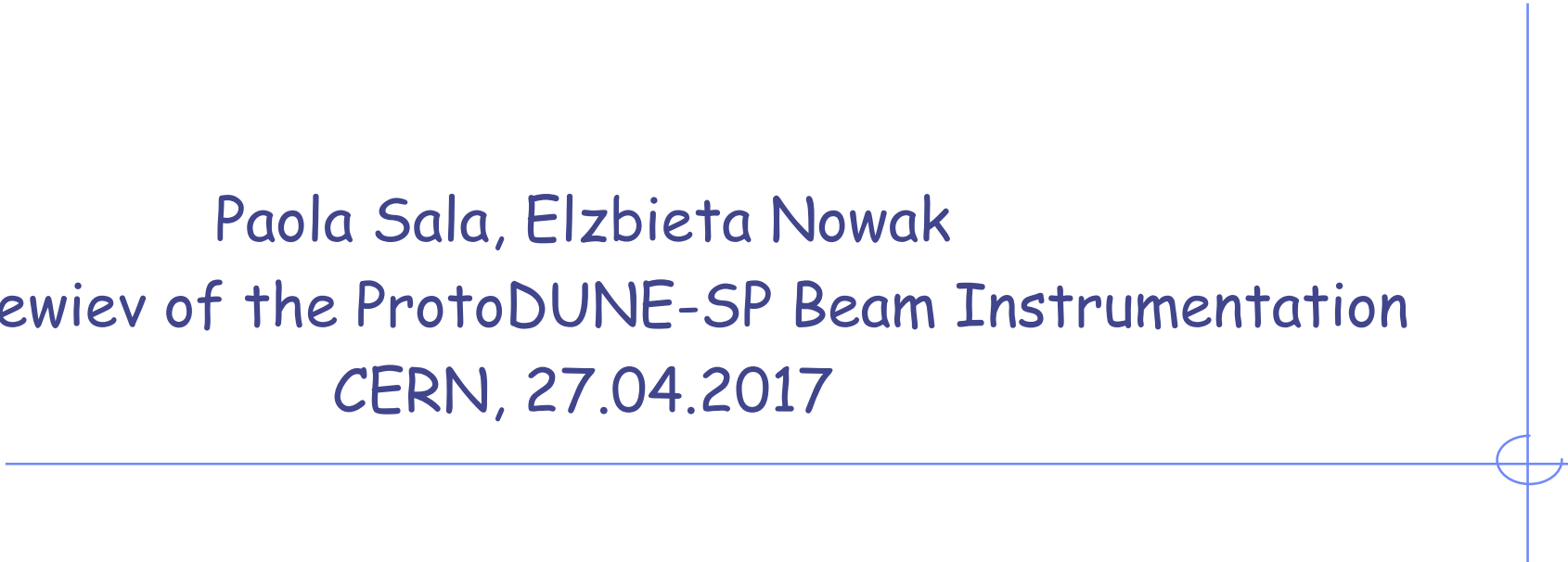


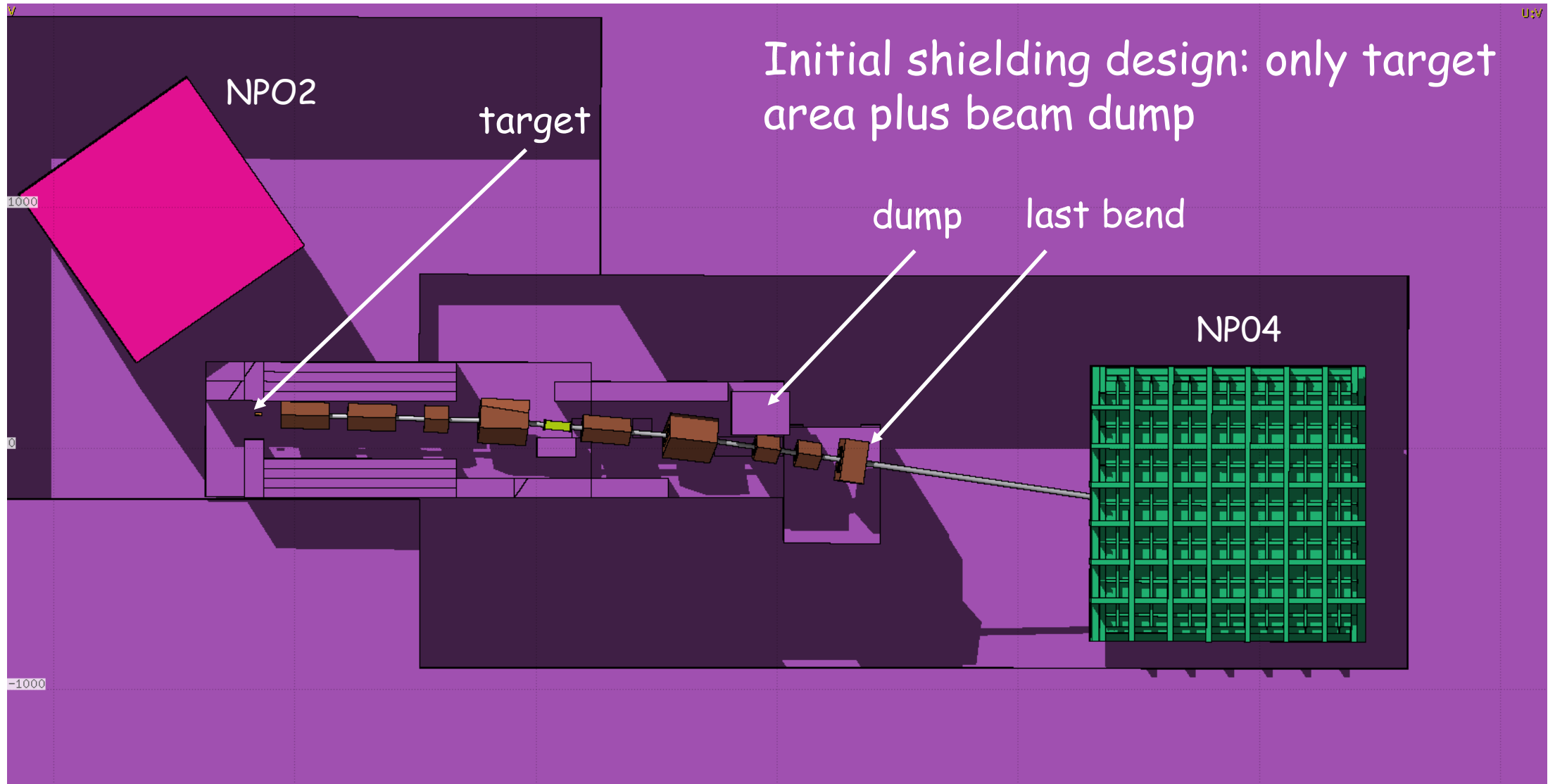


# Background and shielding

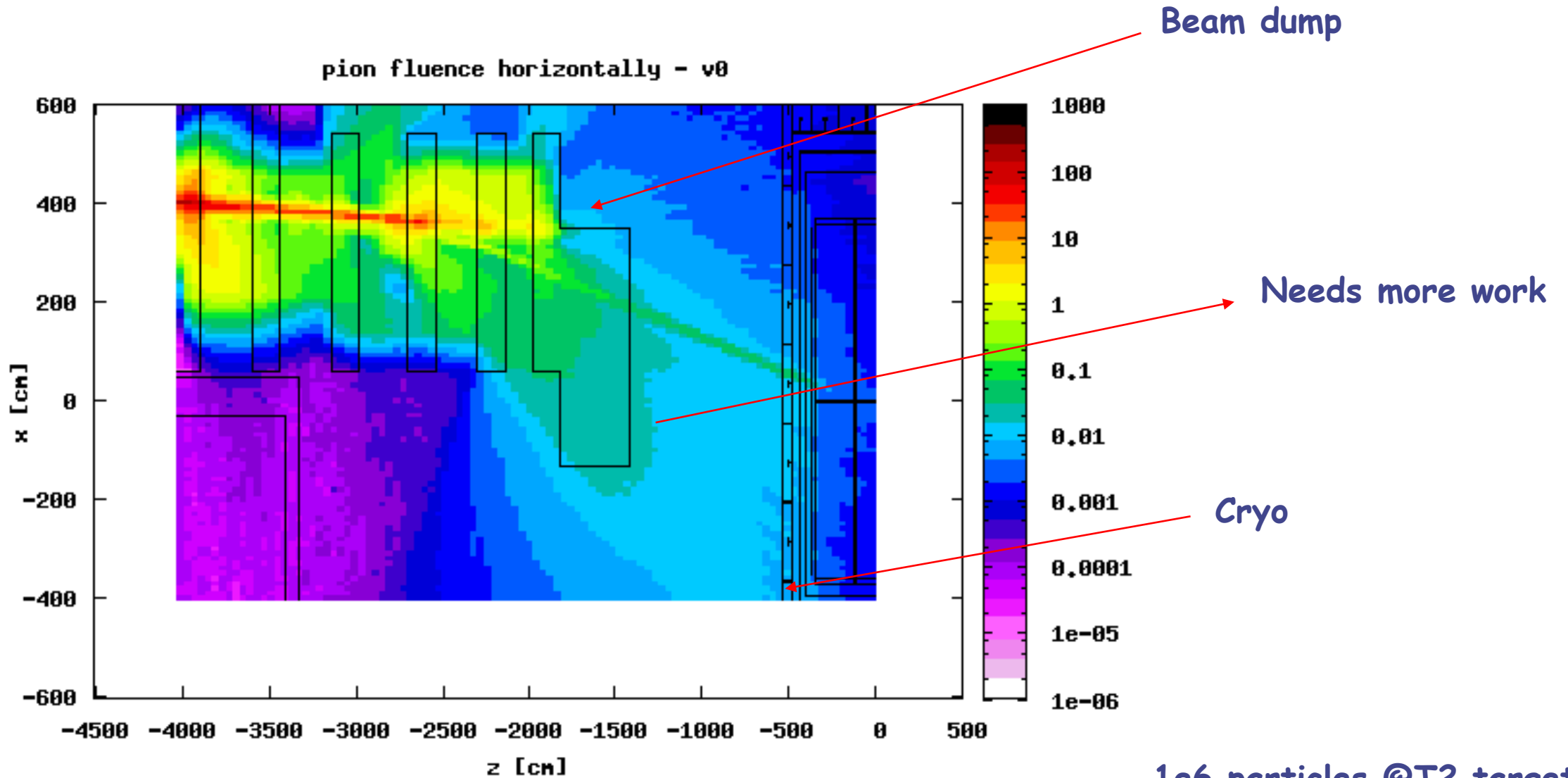
Paola Sala, Elzbieta Nowak  
Design Review of the ProtoDUNE-SP Beam Instrumentation  
CERN, 27.04.2017



# Top view, shield v0



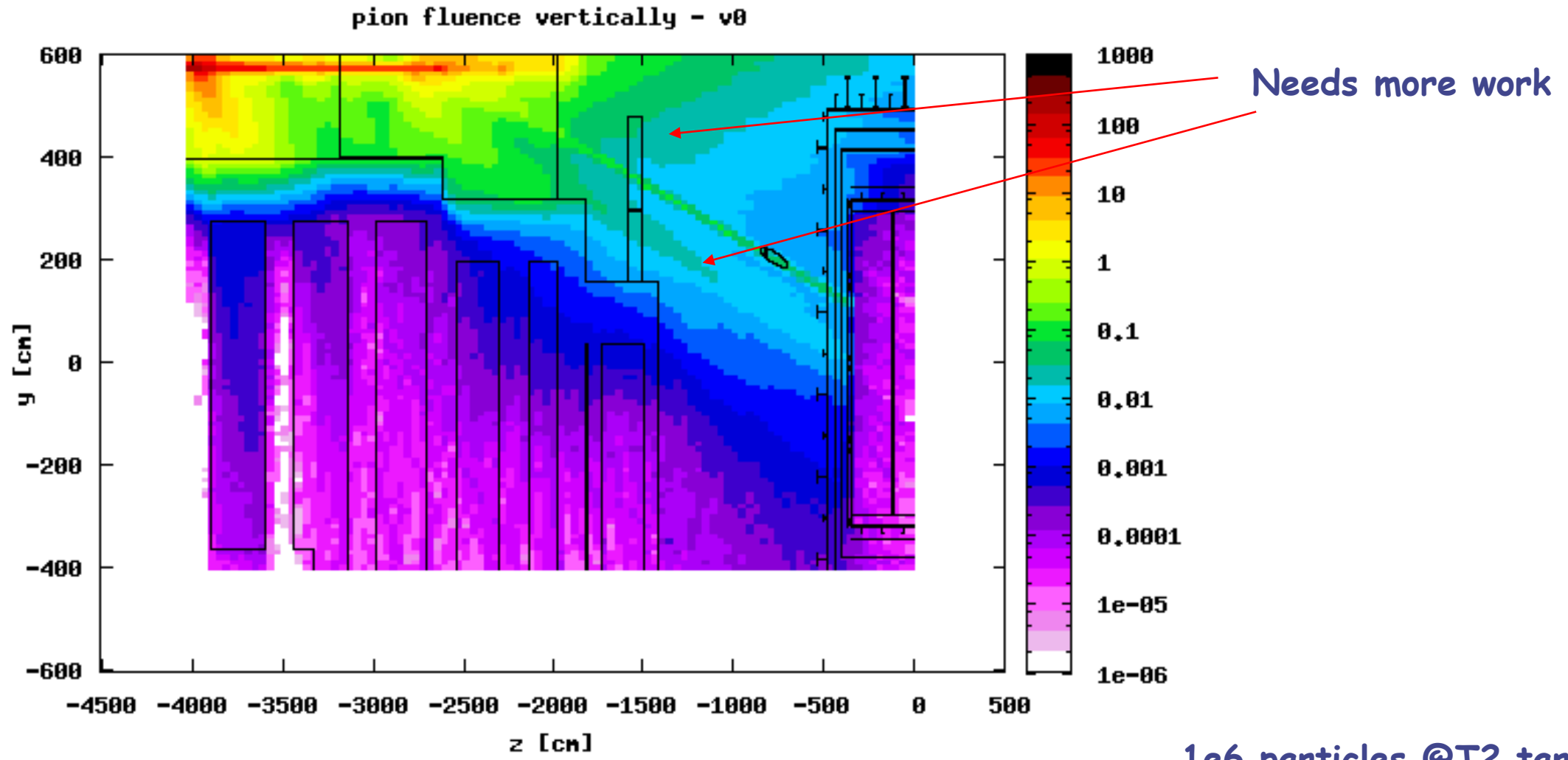
# Particle fluence - v0



1e6 particles @T2 target

Seen from the top

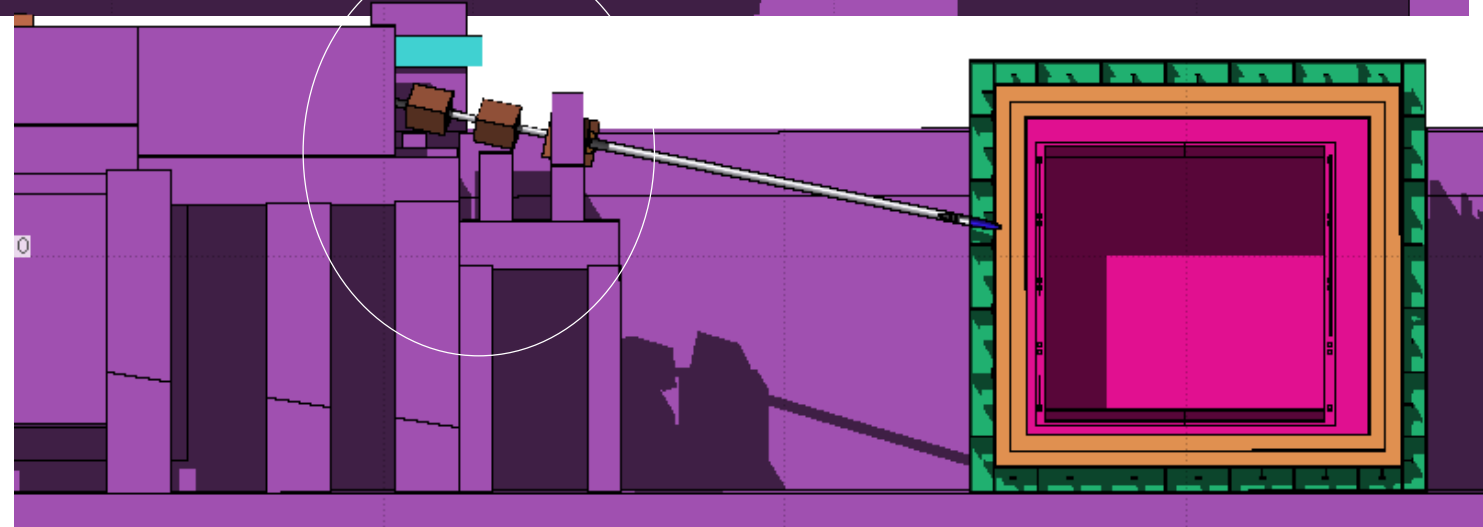
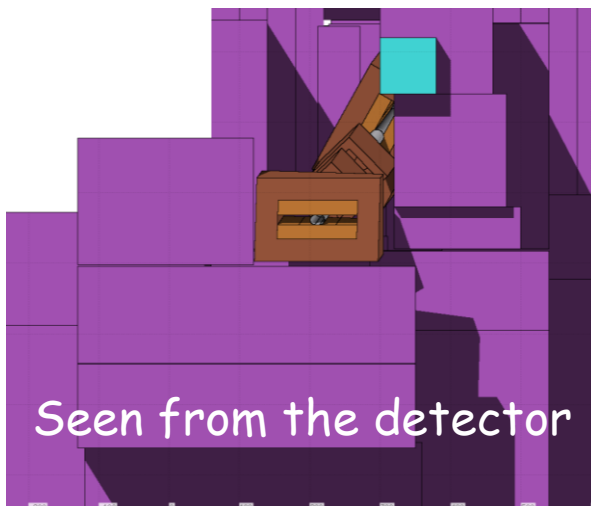
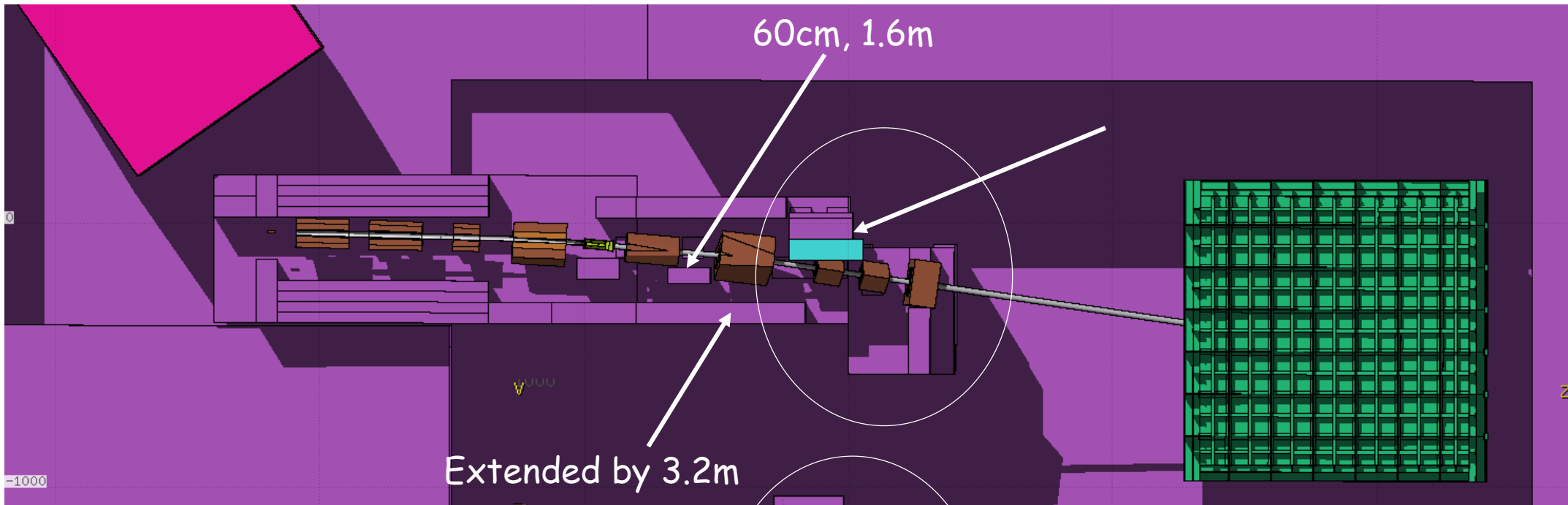
# Particle fluence - v0



Seen from the side

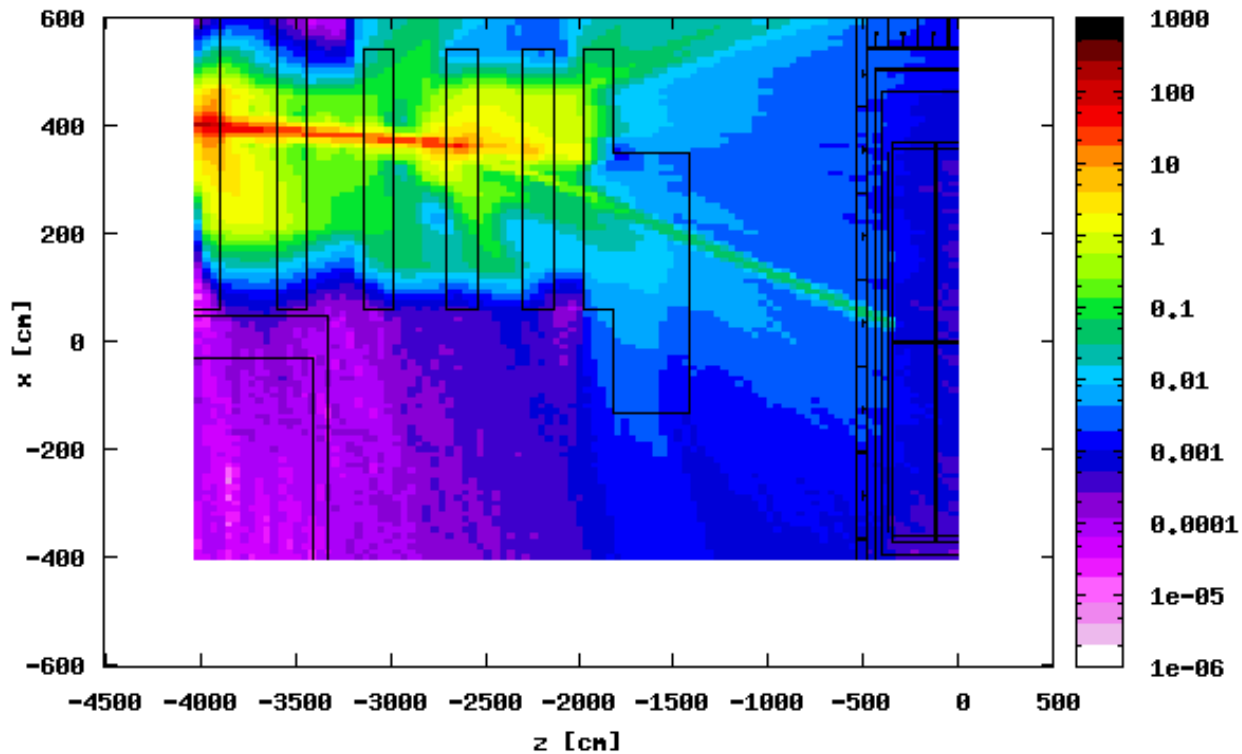


# New shielding proposal

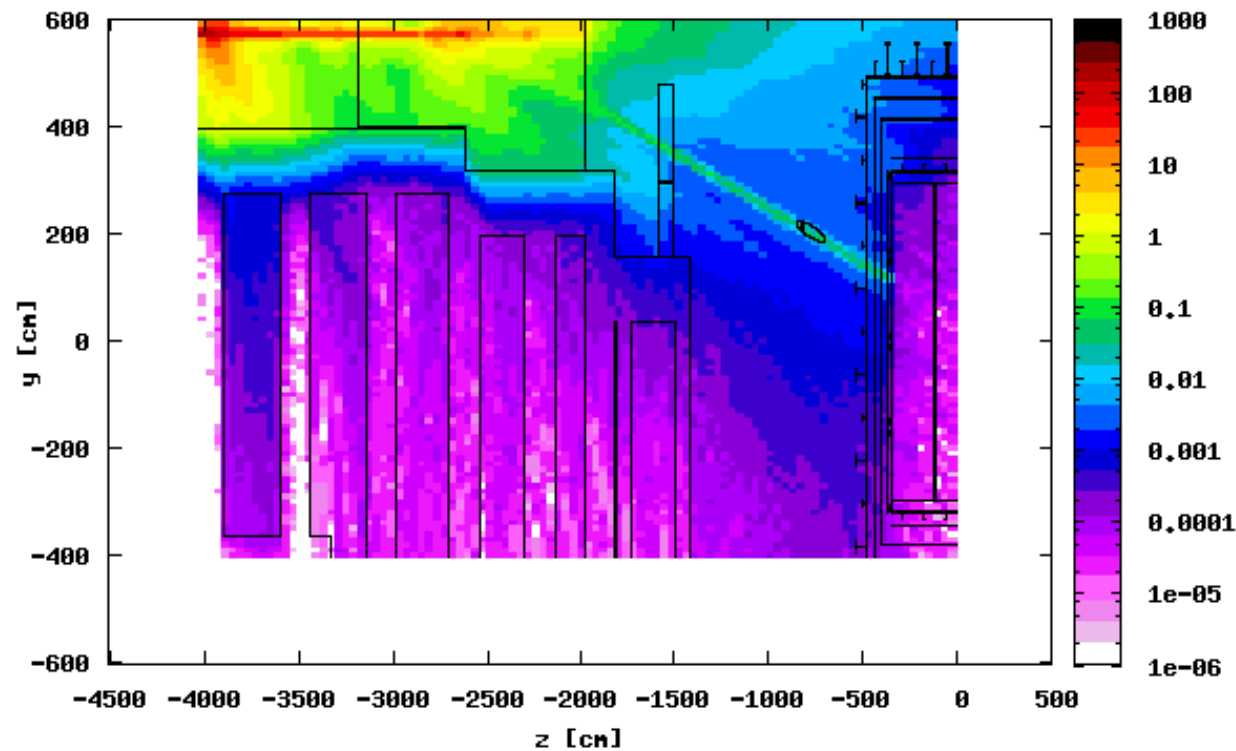


# Shielding proposal: results (maps)

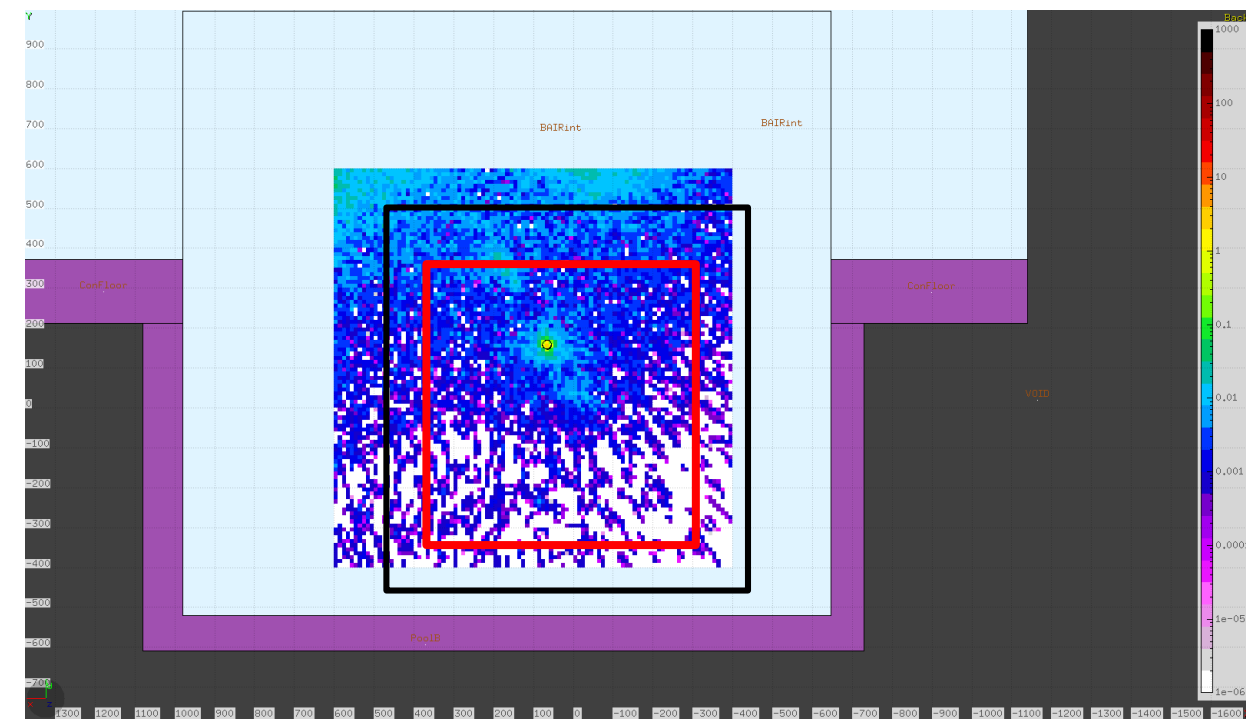
pion fluence horizontally - NEW SHIELDING, NEW DUMP



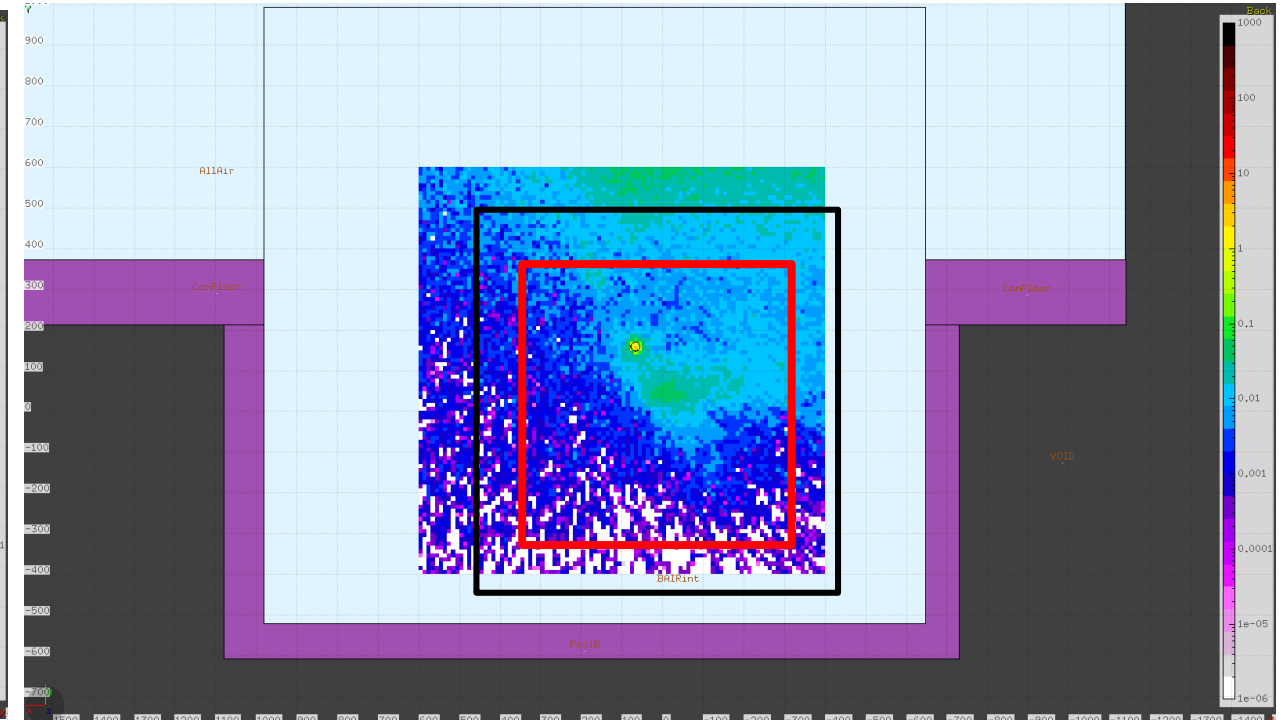
pion fluence vertically - NEW SHIELDING, NEW DUMP



# Pions at the cryostat



New shielding



v0

Active LAr surface: 7.2m x 5.9m  
Cryostat surface: 10m x 9.7m



# Shielding proposal: results

- Assuming  $10^6$  particles/spill from the primary target, 4.8 s spill
- Calculate total rate of particles at cryostat face and entering LAr active volume - excluding muons from secondary H4 beam - :

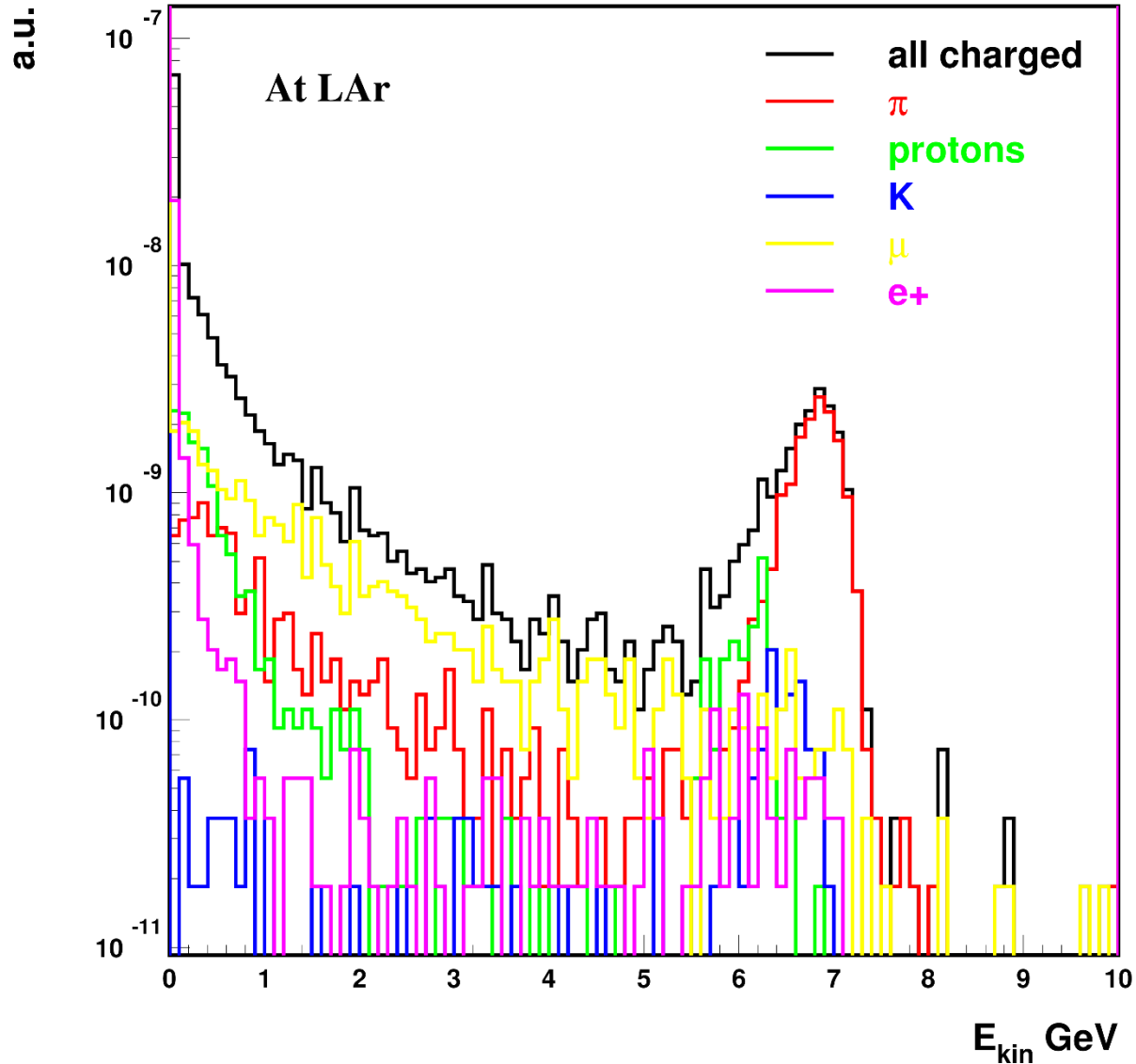
**NOTE:** these are backgrounds from secondary target+tertiary beam line

**Muon halo** from secondary beam line is not included (see last slide)

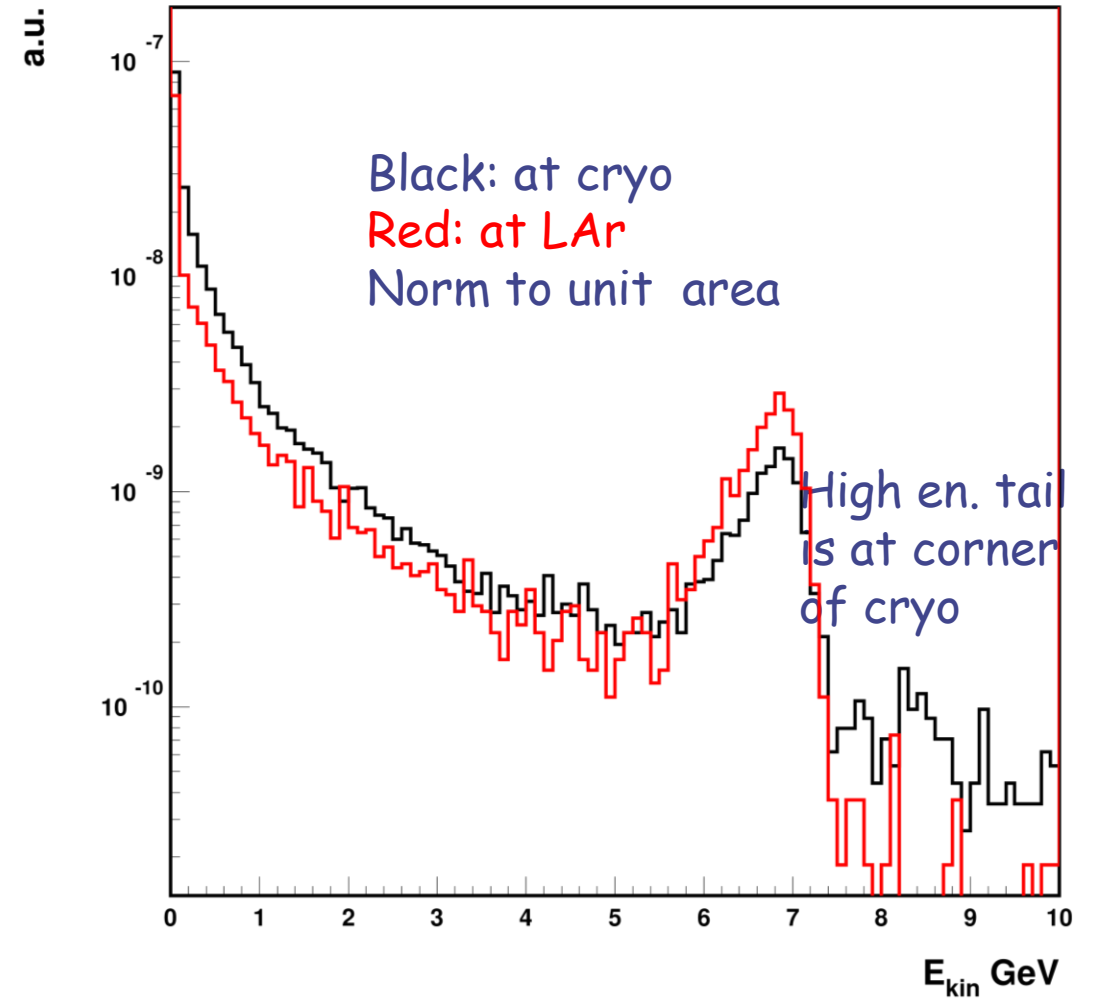
**NOTE:** This shielding proposal is still pending validation by the integration team

Work done in collaboration with CERN Radiation Protection

# Charged particles, 7 GeV focus

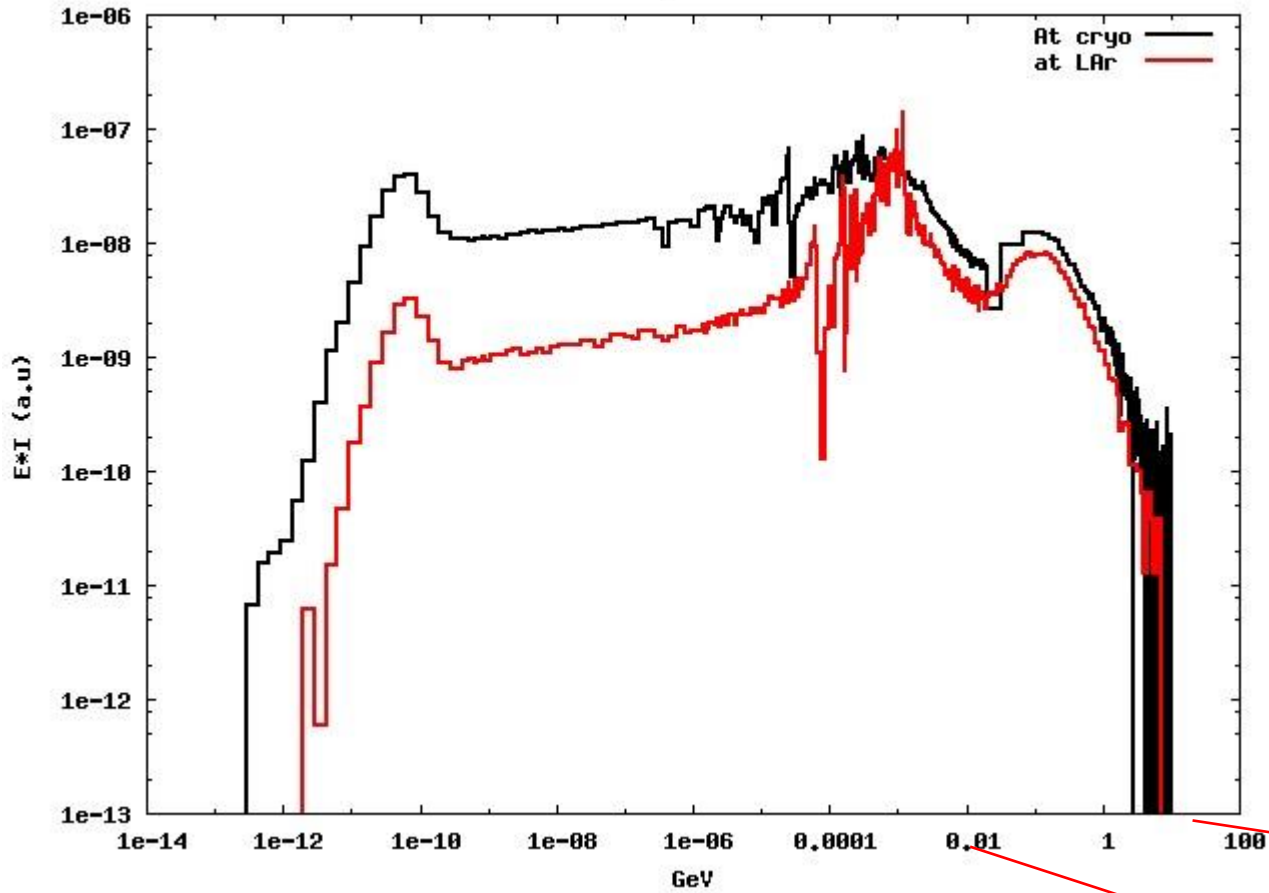


Background is mostly at  $p < p_{\text{beam}}$   
50% below 100 MeV kinetic!



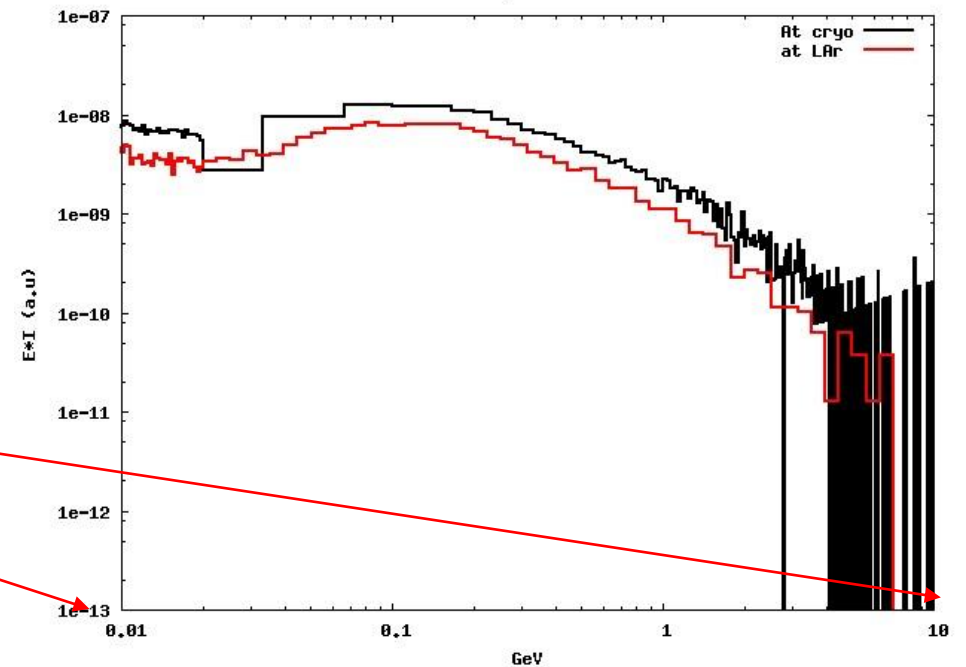
# Neutrons, 7GeV

Neutrons, 7 GeV focus



Neutrons: mostly low energy  
Insulation is a good neutron shield!

Neutrons, 7 GeV focus



Note extended E-range!

# Background: particle rates

At 7 GeV/c focus:

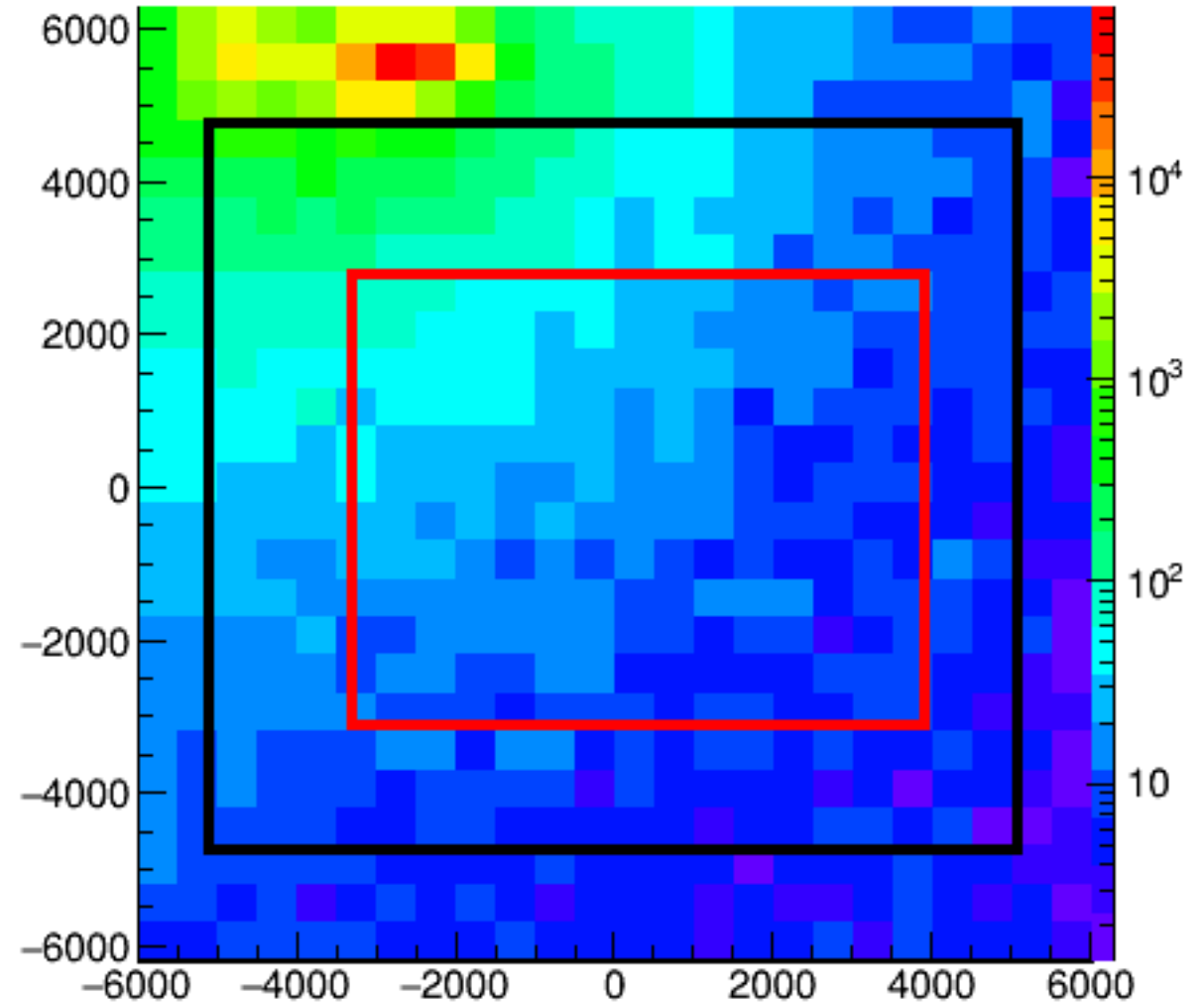
- 1kHz of all charged particles (background) at the LAr detector - reduction by a factor of 2.4 wrt base layout (v0)
  - 0.5kHz charged background > 100 MeV kinetic
  - 3.38 kHz of all charged particles at the cryostat (reduction by a factor of 2.2 wrt v0)
- 5kHz neutrons at the LAr (reduction by a factor of 2.2 wrt v0), of which 0.8 kHz above 20 MeV
- Photons:
  - very soft spectrum at the cryo,
  - Re-generated by charged in the cryo layers
  - At LAR: 0.5kHz above 100 MeV
- Software and reco group will provide feedback

- At 1 GeV focus:
- Charged particles: 180Hz at LAr, 1kHz at cryo
- Neutrons > 20 MeV at LAr 200Hz
- Photons > 100 MeV at LAr 8Hz

Larger reduction wrt  $v_0$ , up to a factor of  $\sim 4$  for charged particles and neutrons

# High energy Muon halo

- Nikos' simulations include high energy beam halo from secondary H4
- Here: high energy ( $>4$  GeV/c) muon halo in NPO4 according to latest G4 beam ntuples
- Units are muons/m<sup>2</sup>/spill
- Black : cryo
- Red: active LAr  $\rightarrow$   $\odot$  200 Hz
- PRELIMINARY
- Muon detectors will be installed on the cryo front face



**Thank you for your attention**

**Questions?**

# Starting point V0:

- Minimal shielding: target area plus beam dump
- Total rate of particles entering LAr active volume - excluding muons from secondary H4 beam - :

Charged particles : 0.8-2.4 kHz (depending on focused momentum)

Neutrons : 7-10 kHz BUT: very low energy

Neutrons  $E > 20$  MeV : 1-1.5 kHz

**NOTE:** these are backgrounds from secondary target+tertiary beam line

**Muon halo** from secondary beam line is not included (see last slide)