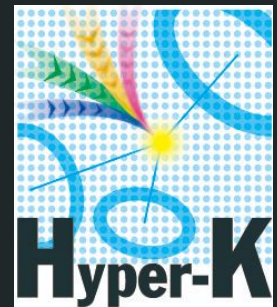


WCTE Beam studies

Matej Pavin,

March 4, 2020

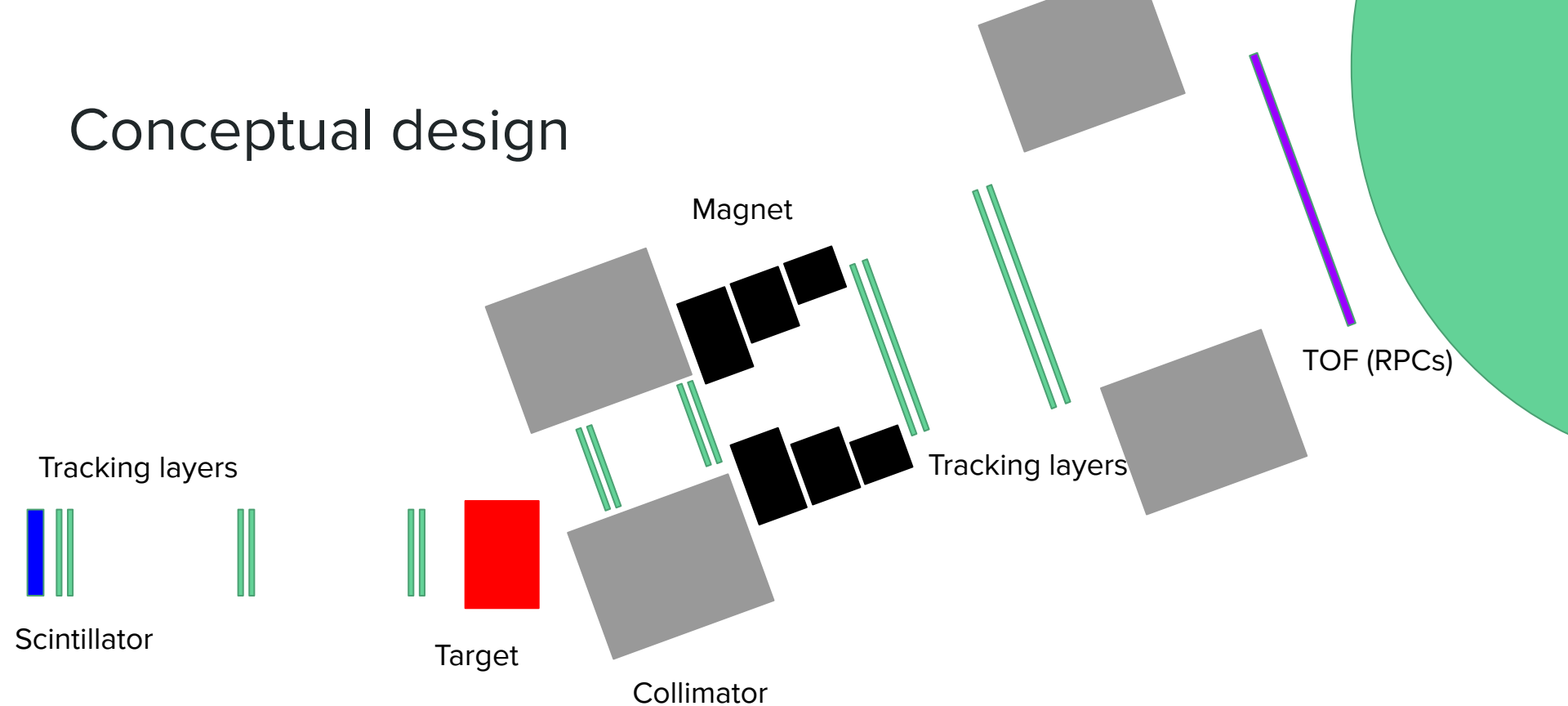
EMPHAT!C



Motivation

- Low momentum tertiary beamline for Water Cherenkov Test Experiment (WCTE)
- Momentum range: 0.2 - 1.2 GeV/c
- Pions, muons, electrons, protons
- The beamline will be part of the experiment

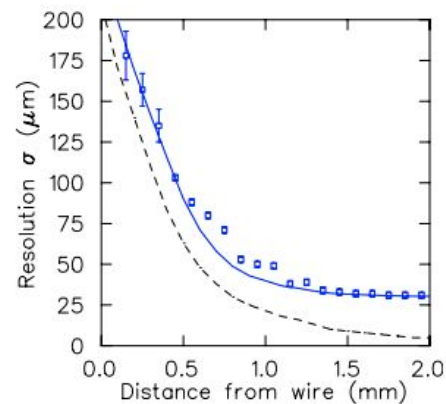
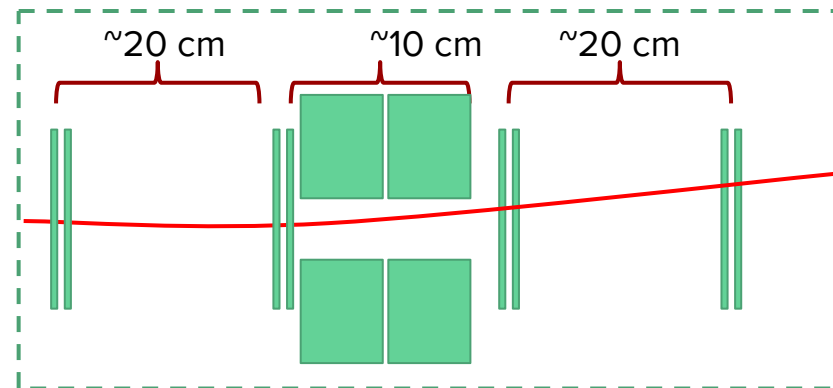
Conceptual design



*distances not to scale

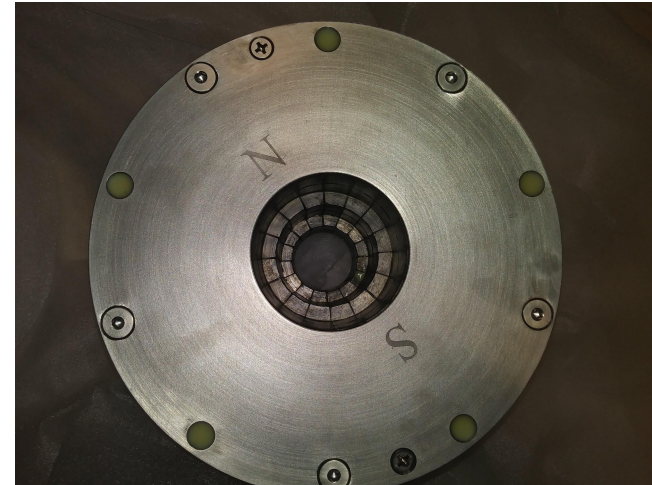
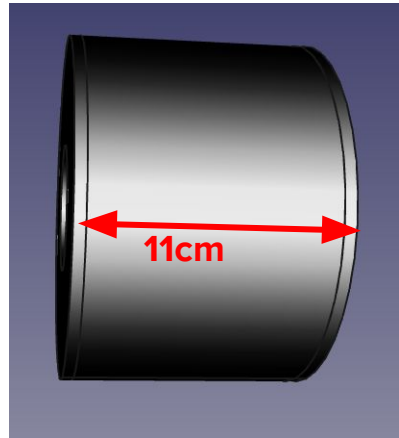
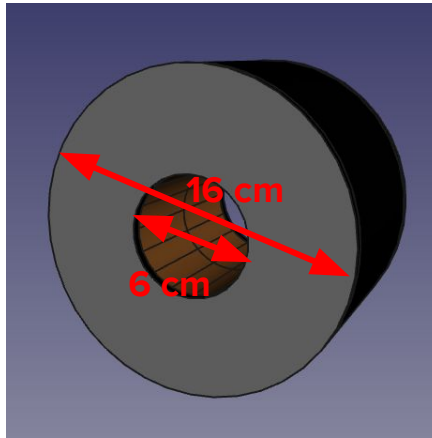
Spectrometer design

- Compact spectrometer: < 1 m in size
- Small permanent magnet + drift chambers
 - Reusing TWIST chambers
- RPC for time of flight in front of the water tank



Magnet design

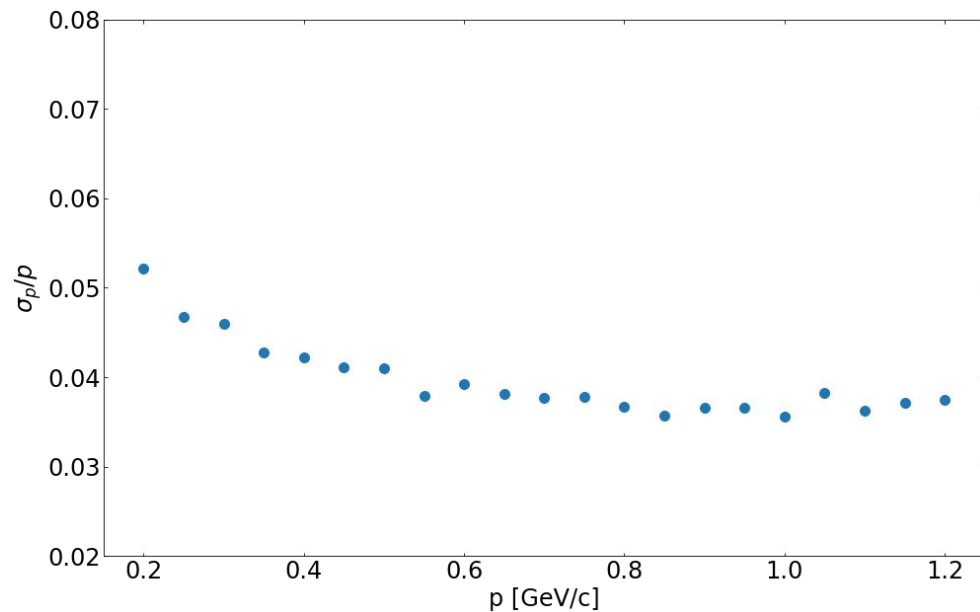
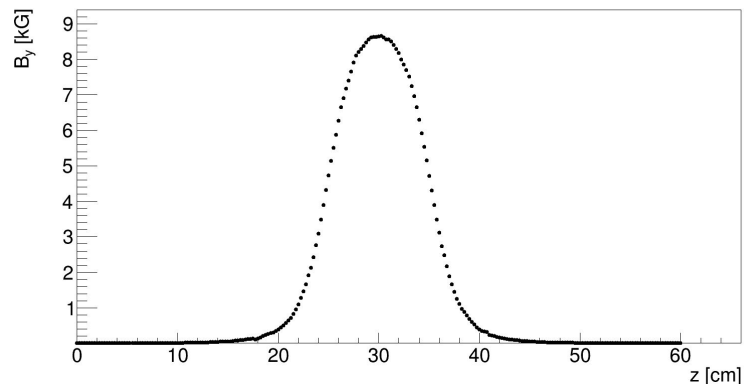
- Small Halbach array ~ 0.05 Tm
- 10 - 20 kg
- Quick design of the magnet in FreeCAD and Comsol 5.4



Existing EMPHATIC magnet
 ~ 0.2 Tm

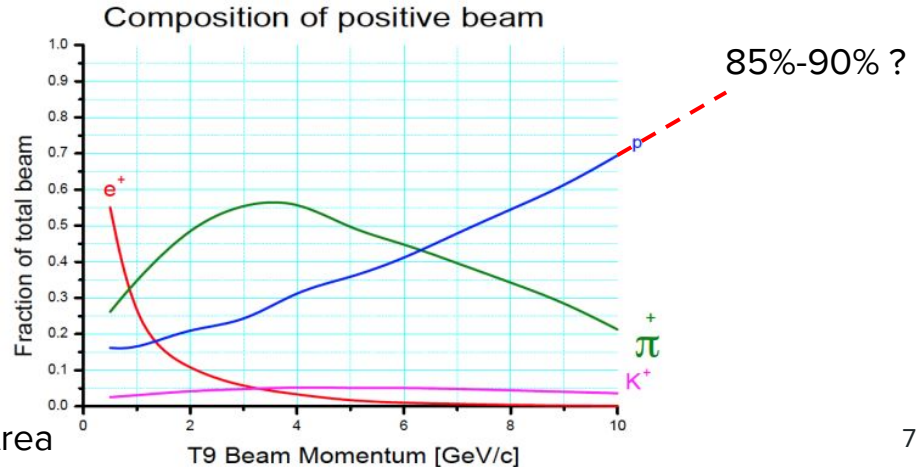
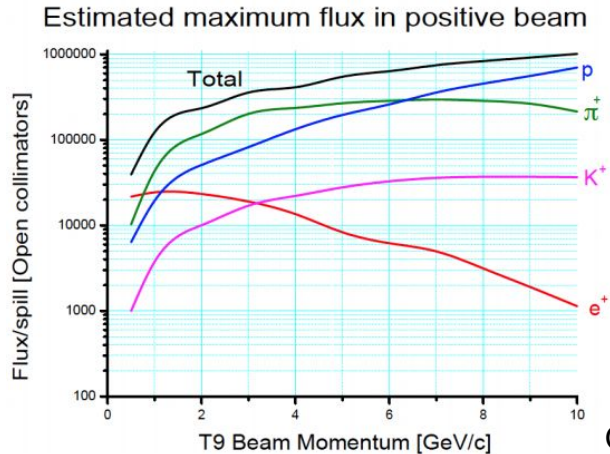
New magnet design

- Total bending power: 0.075 Tm
- Momentum resolution study:
 - Position resolution: 150 μm (TWIST chambers)
 - Separation between planes: 20 cm
 - Assumed 0.0005 X_0 per plane

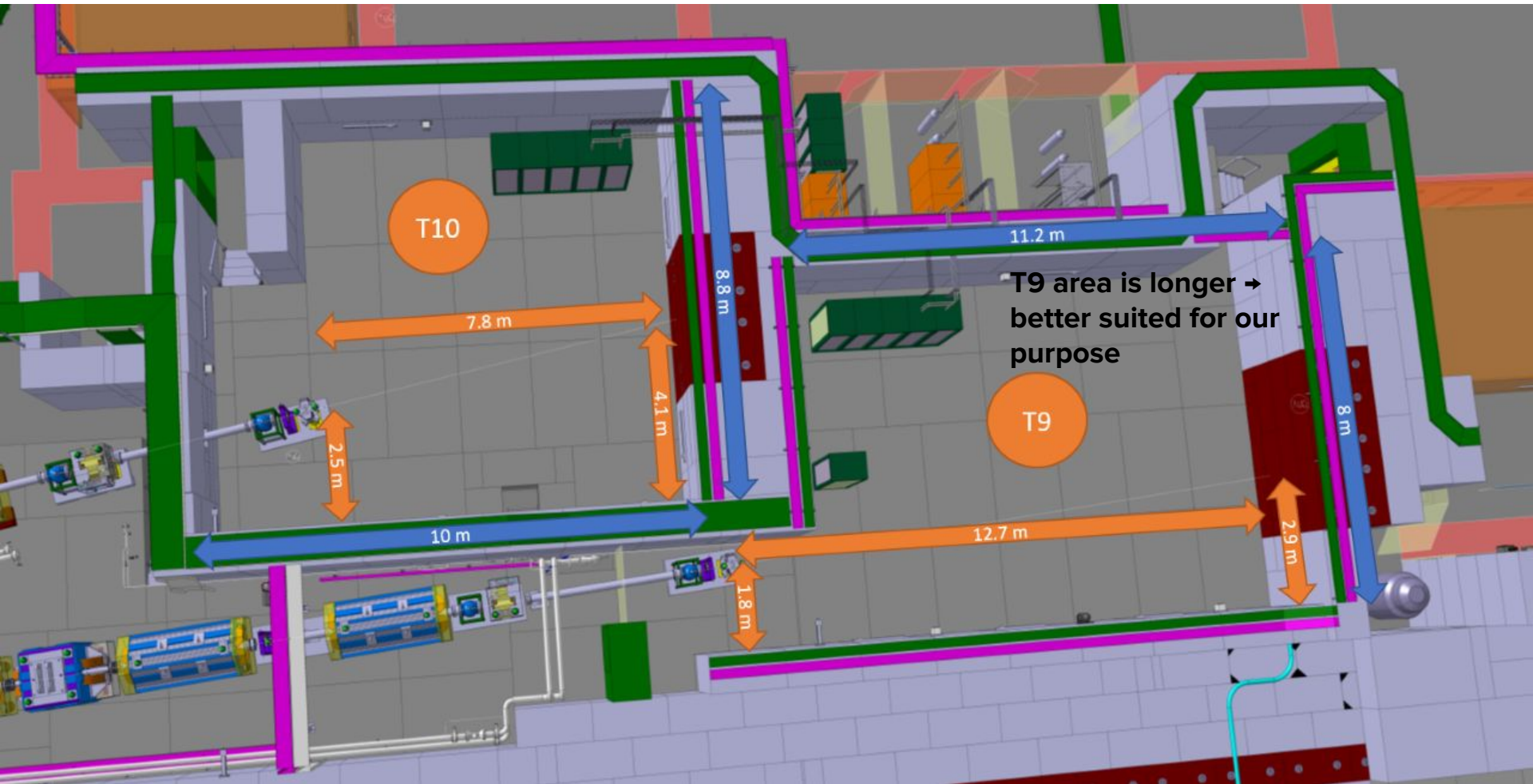


East area

- Momentum range: 0.4 – 15 (12) GeV/c
- Momentum resolution: 0.7%
- Max. momentum band: 15%
- Max. intensity: 10^6 particles per 0.4s extraction, max. 3 times per 40s PS supercycle



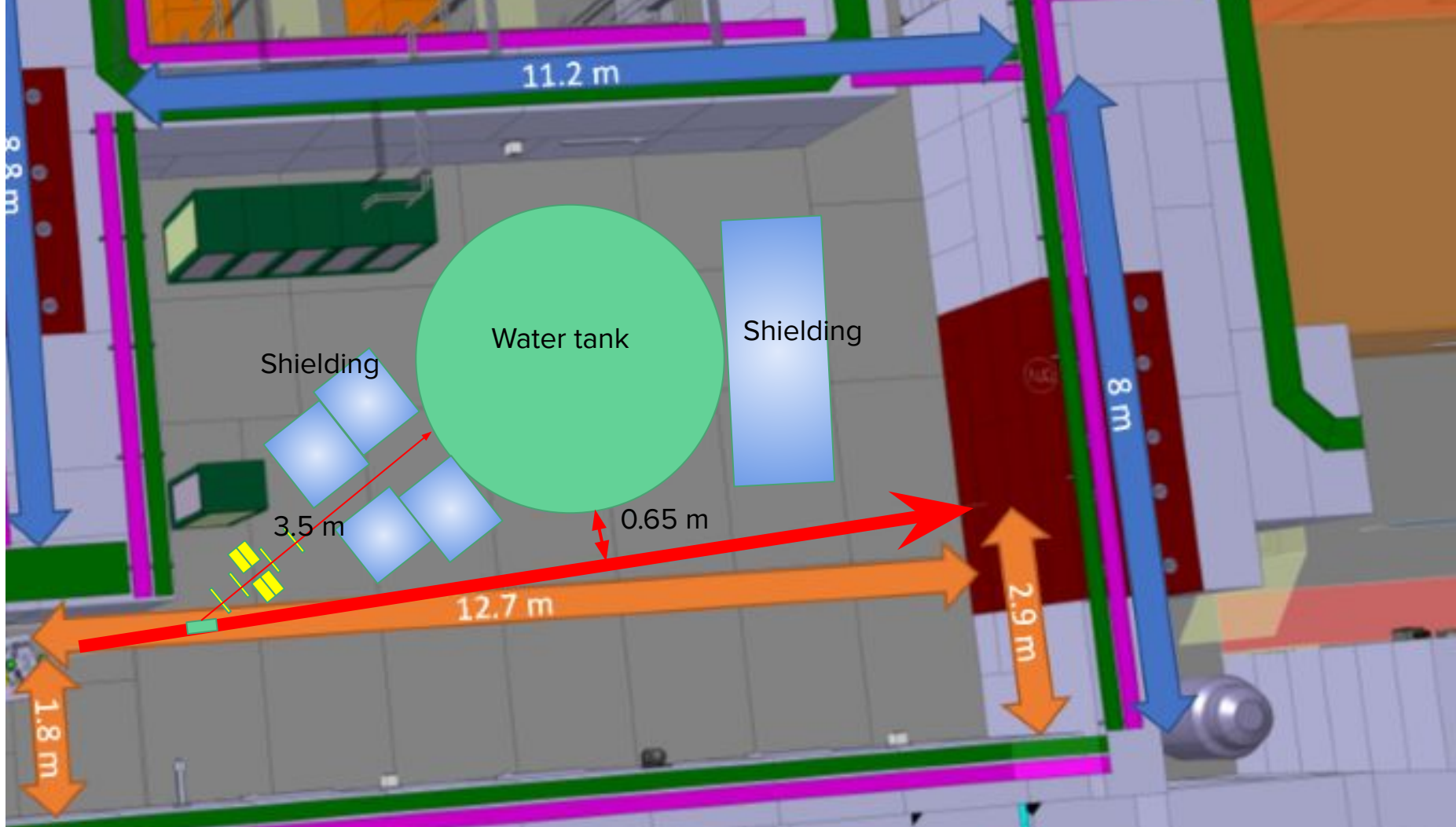
Old East Area



T10

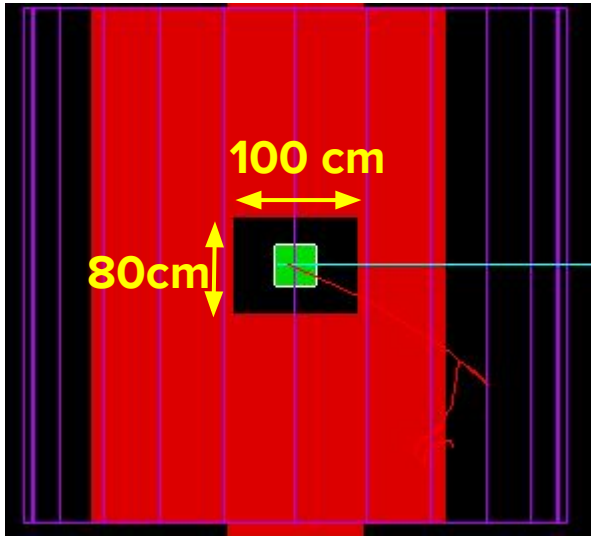
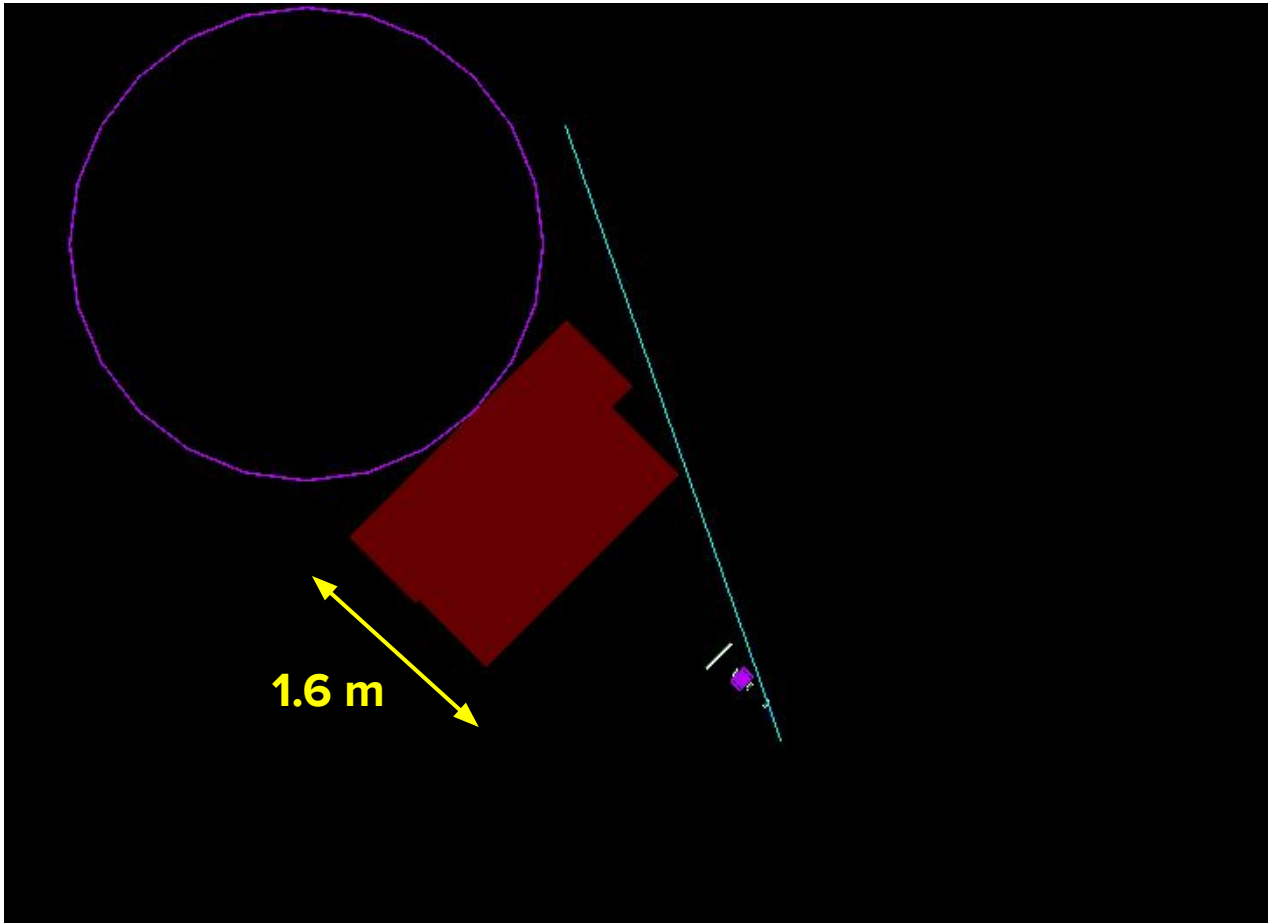
T9 area is longer →
better suited for our
purpose

T9

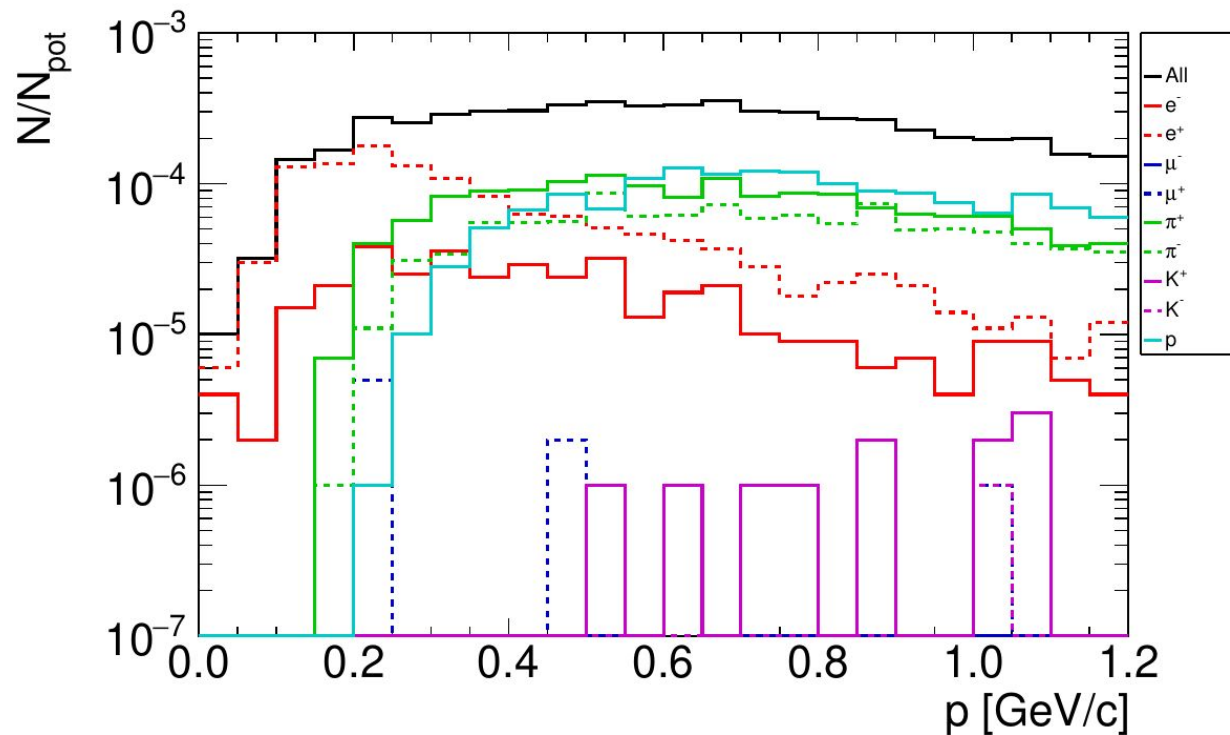


MC simulation

- 12 GeV/c protons
- 15 cm thick carbon target + 3 mm tungsten
- GEANT4.10.05.p01 FTFP_BERT
- 450 mrad tilt between the beam direction and the spectrometer
 - Surviving beam does not hit the water tank

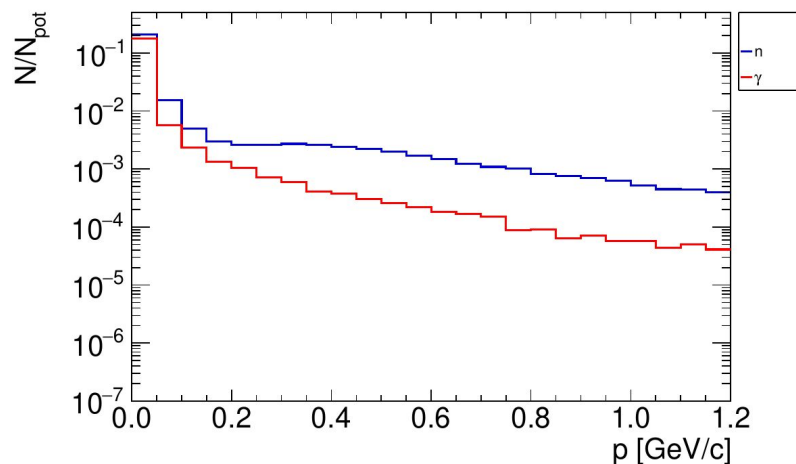


Particle rates

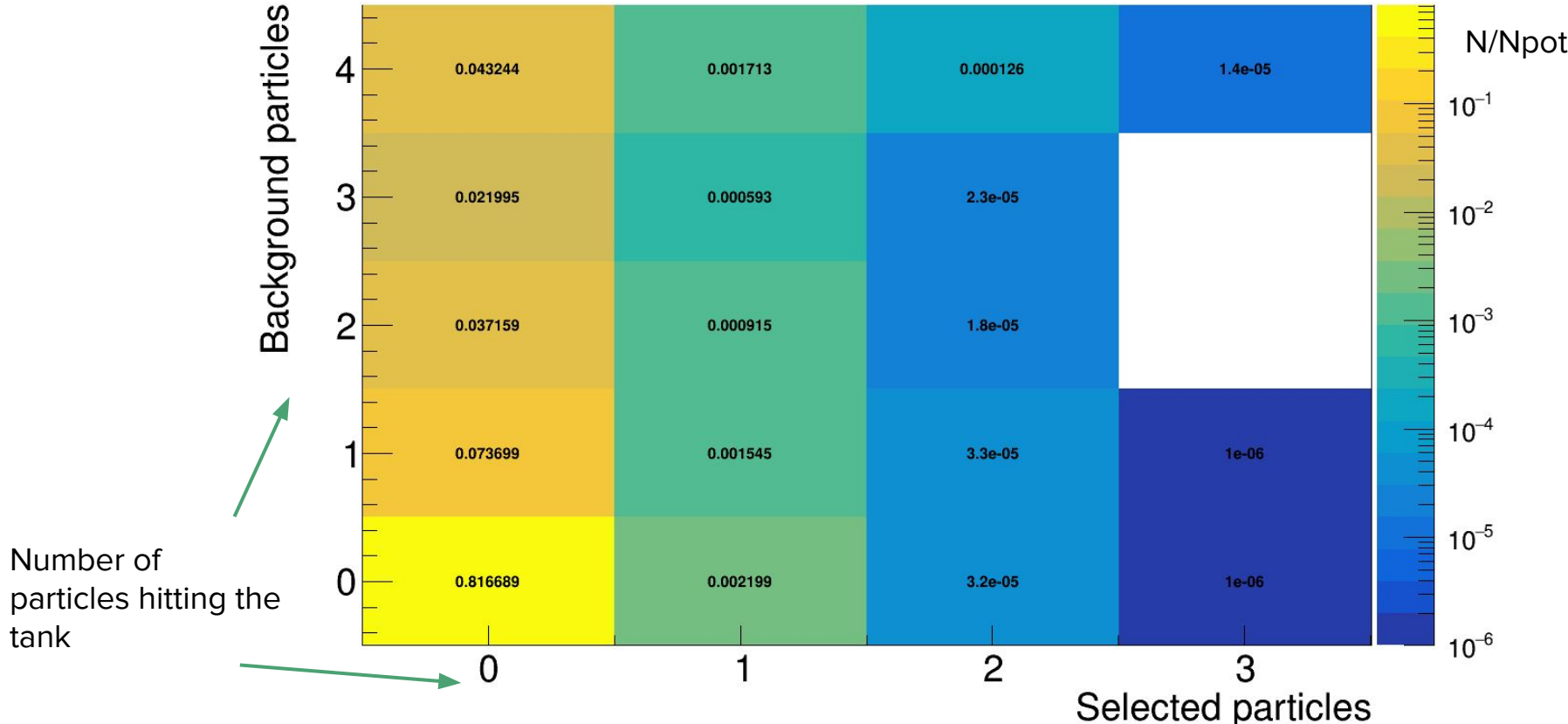


Background

- Significant background are gammas and neutrons (> 85% of the background)
- Additional background (gammas, e+/-, ...) from interactions in the water tank wall (not considered here)
- Generated in the target, magnet and the shielding

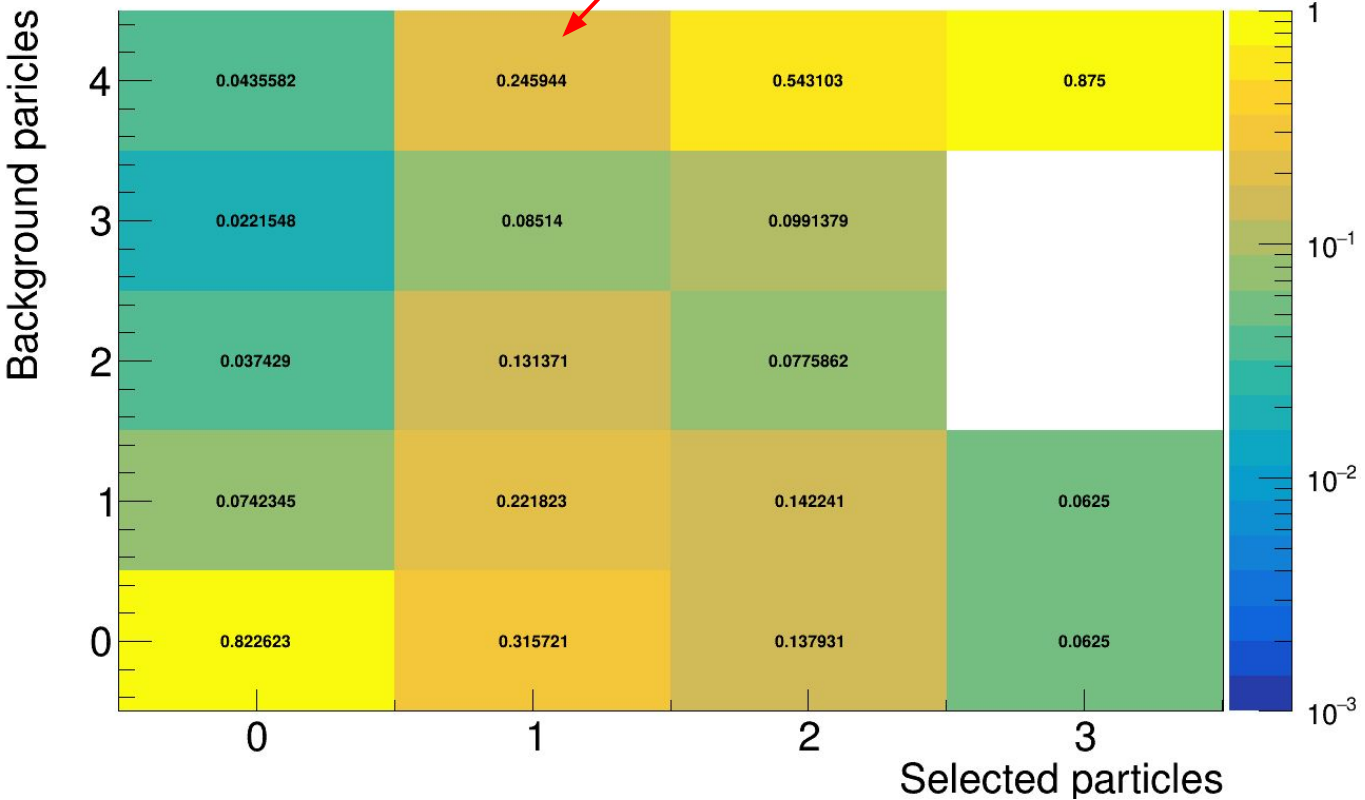


Background

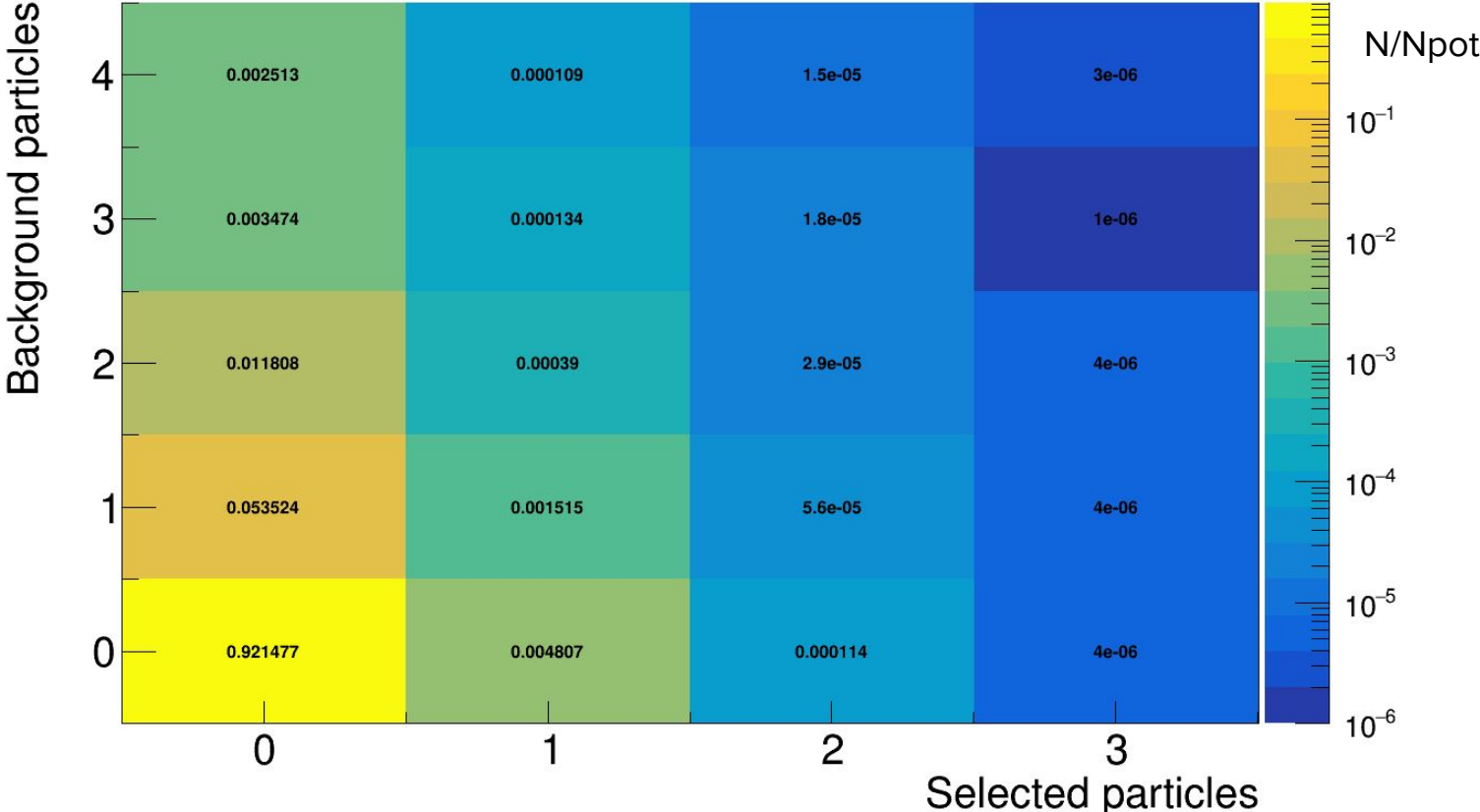


Background

Columns normalized to 1

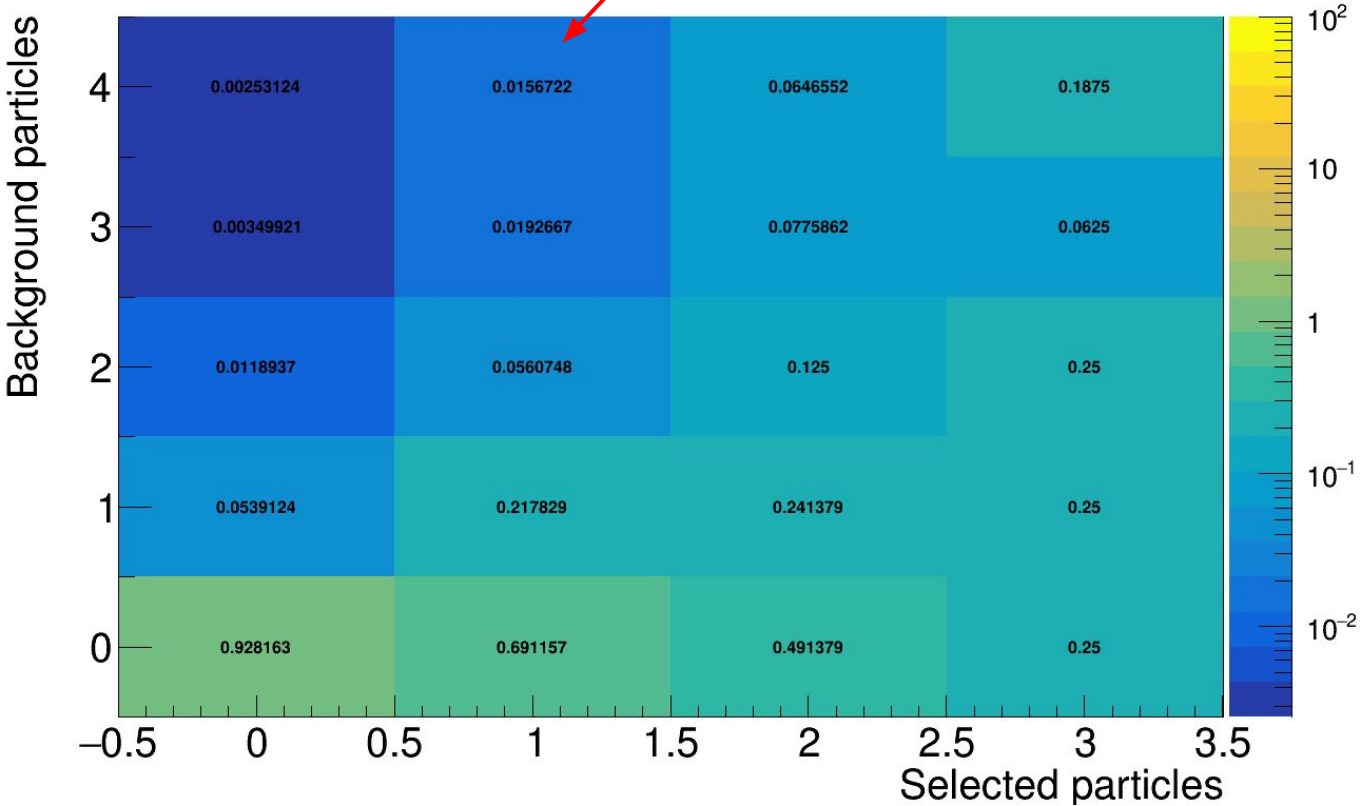


Background ($p > 50 \text{ MeV}/c$)



Background ($p > 50 \text{ MeV}/c$)

Columns normalized to 1



Conclusion

- WCTE needs a low momentum tertiary beamline
- Secondary target and compact spectrometer as a part of the experiment
- East Area is the obvious candidate for the experiment
- Estimated rate 4 - 8 k particles per 10^6 protons on target
- Significant background → neutrons and gammas