SIMULATION OF THE LArTPC+GArTPC ND CONCEPT

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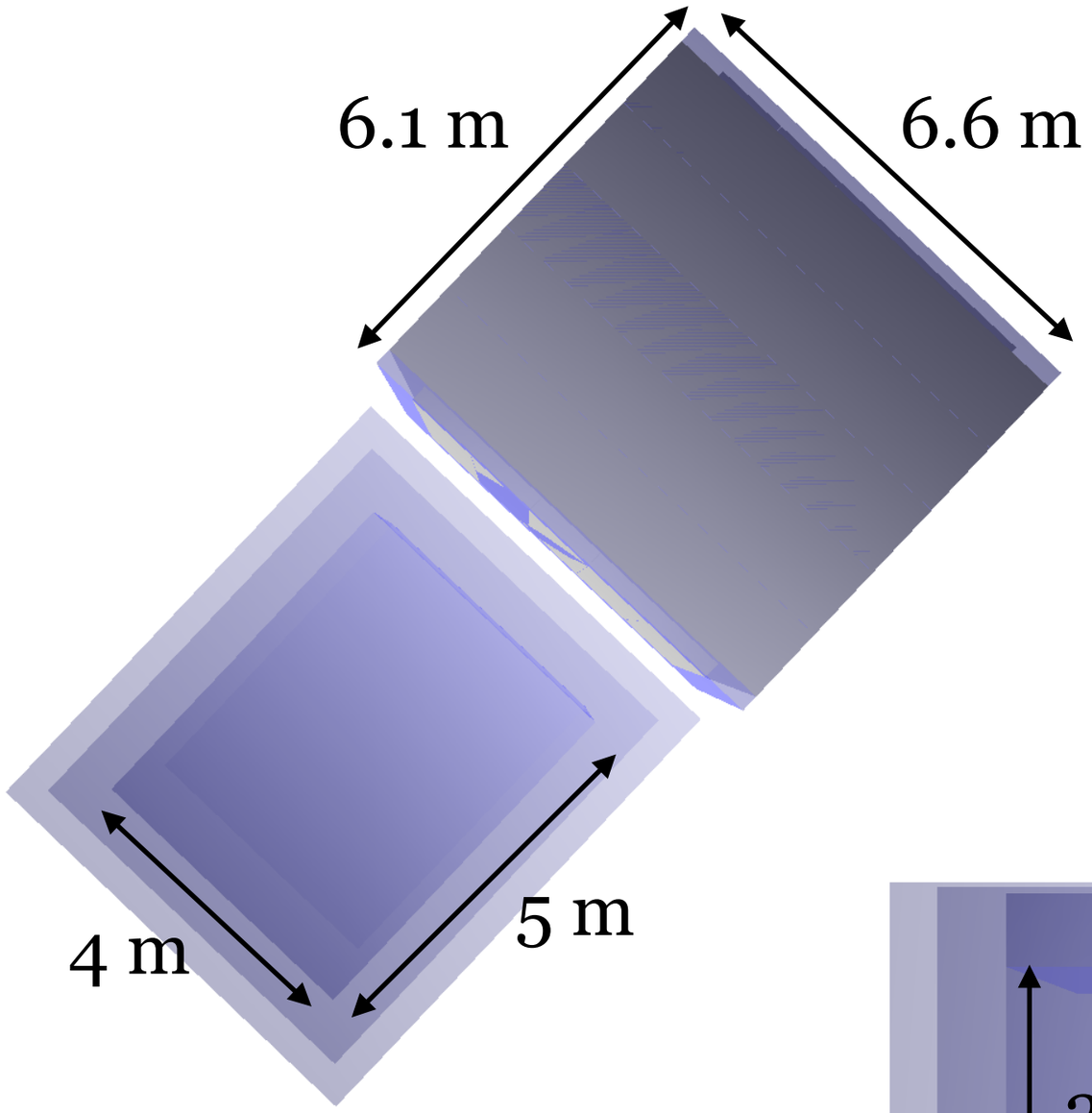
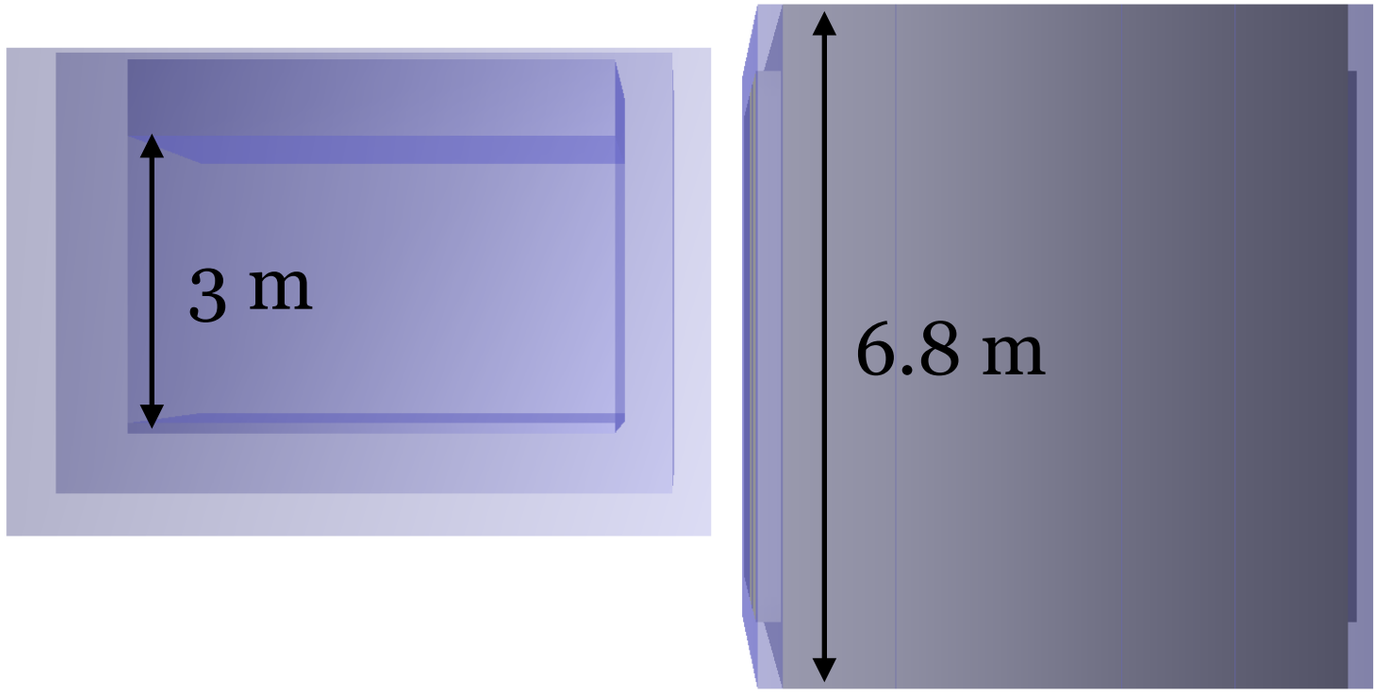
GEOMETRY



Coded by Mike Kordosky, José Palomino and Guang Yang



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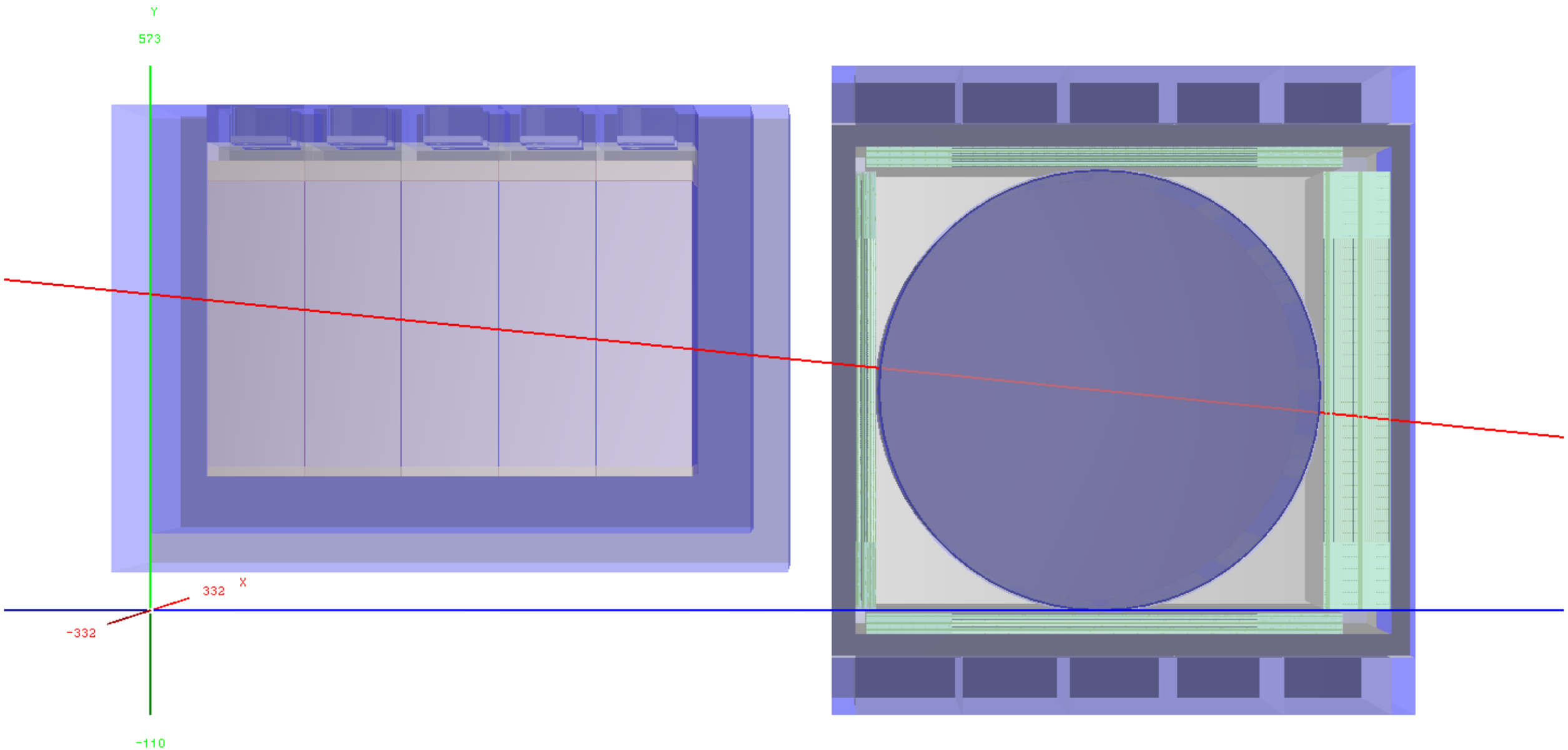
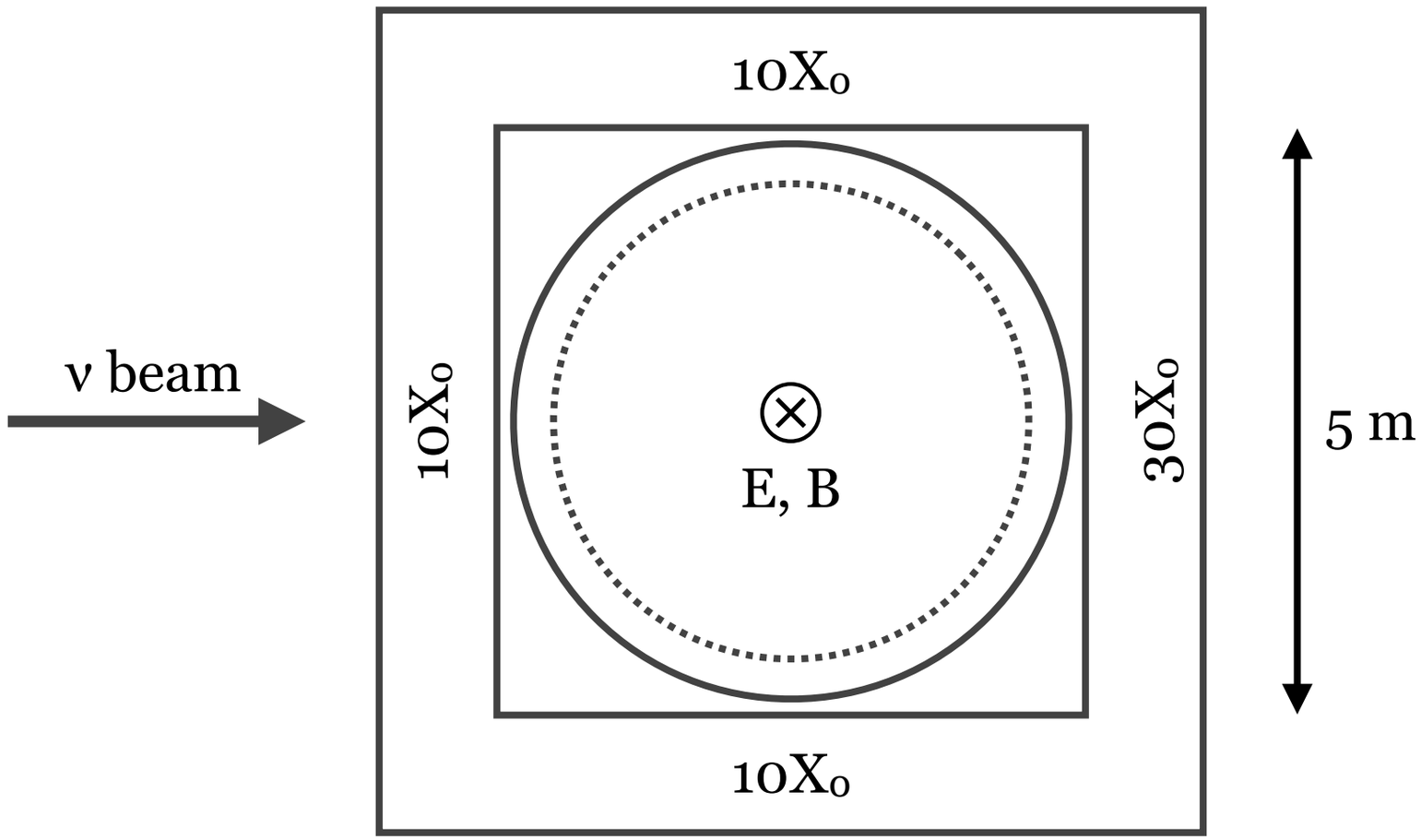
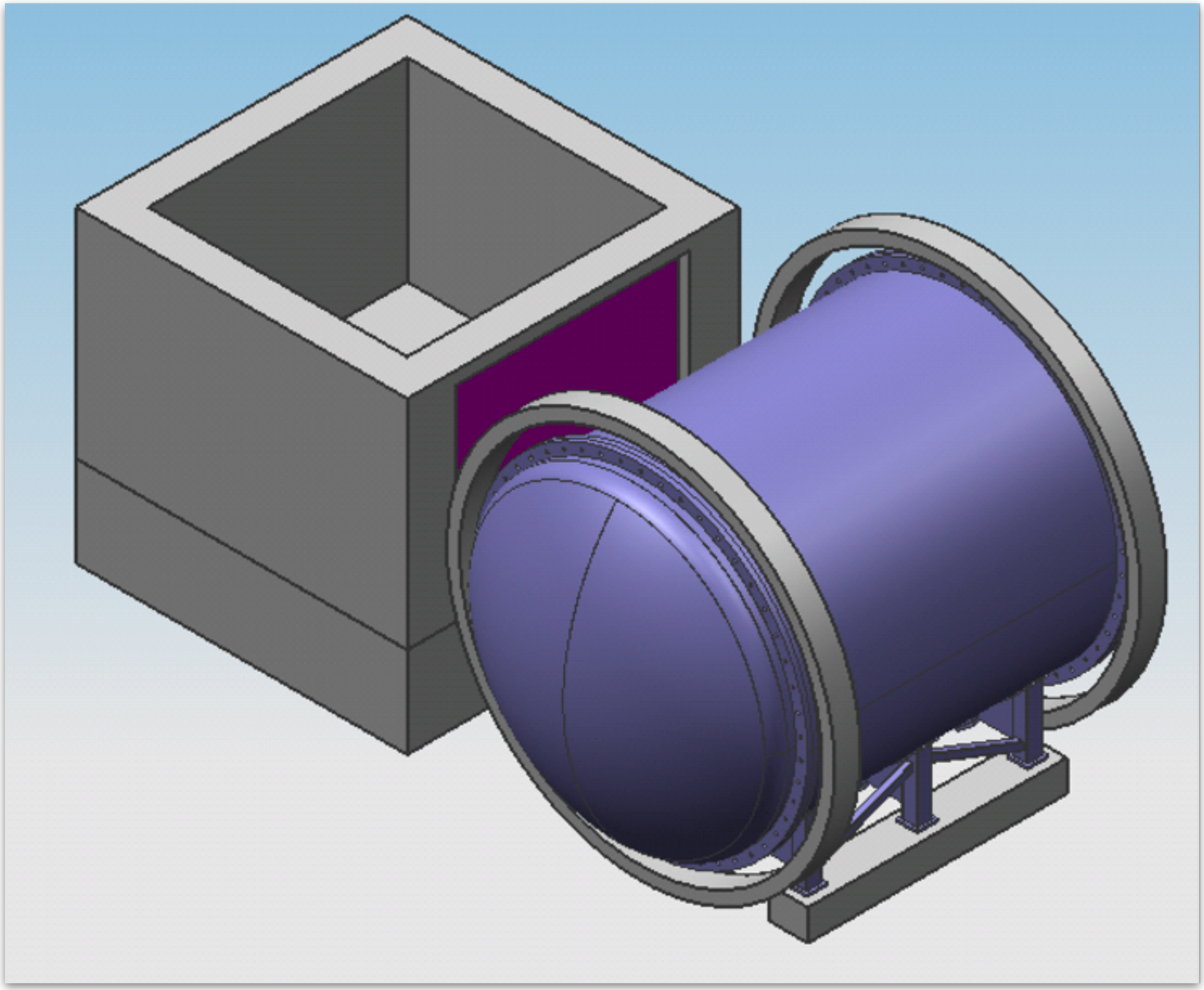


The two detectors are aligned so that the center of their active volumes is on axis.

GEOMETRY



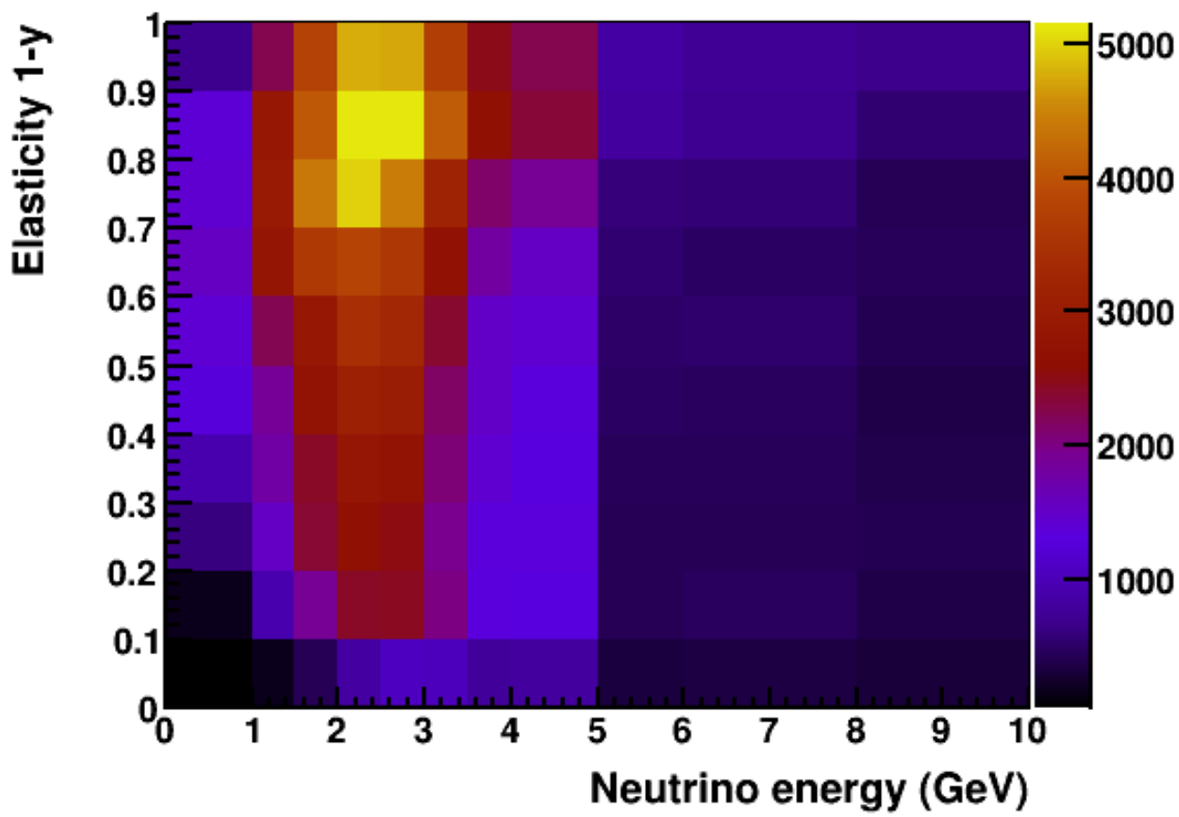
GEOMETRY

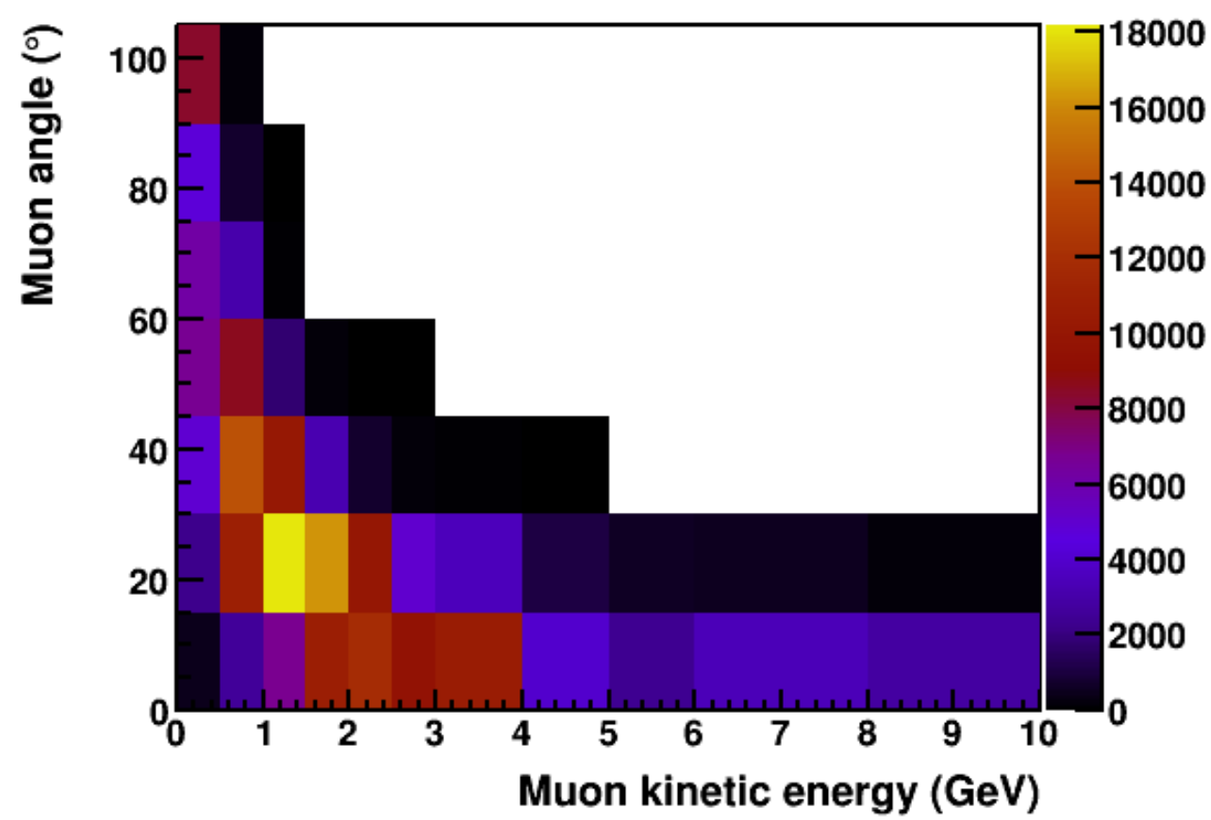


SOFTWARE

- Geometries coded using GeGeDe.
- Neutrino interactions generated using GENIE v2.12.8 (with MEC models enabled).
- Particles propagated through geometry using EDep-Sim and Geant4 10.3.

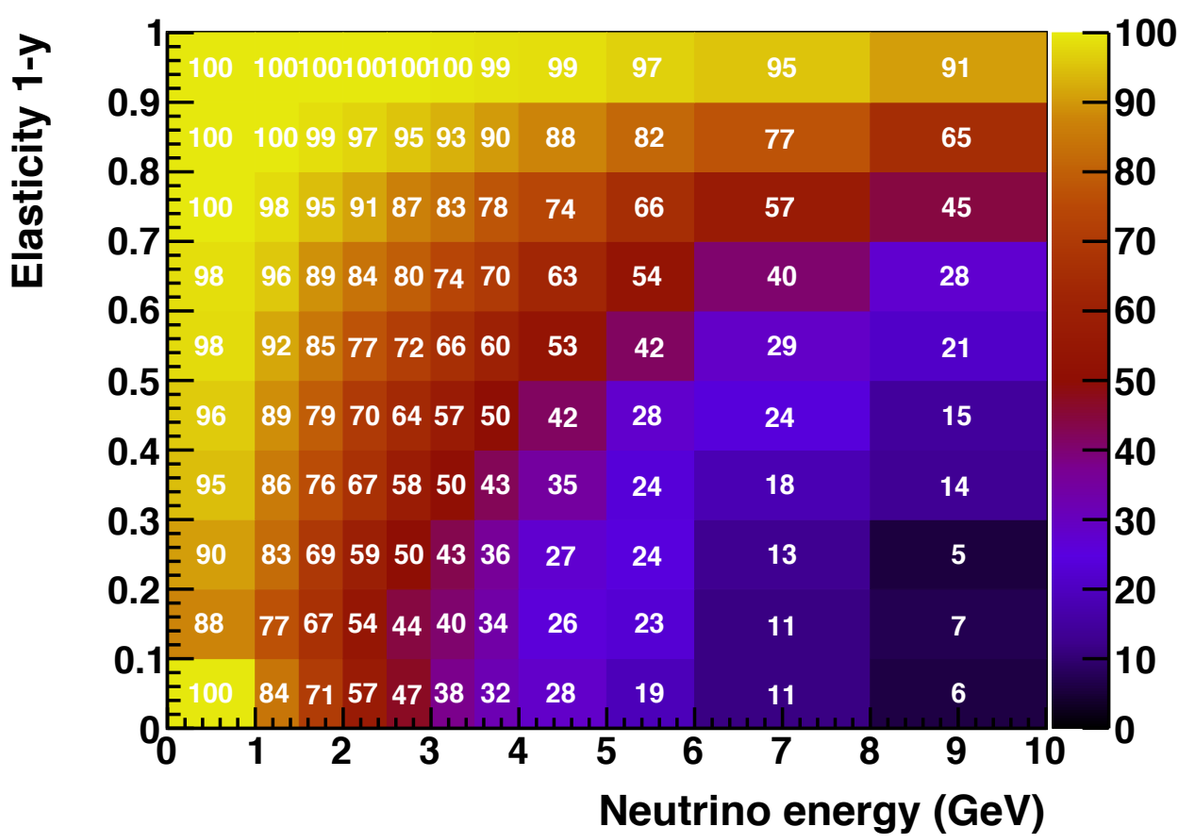
GArTPC ACCEPTANCE

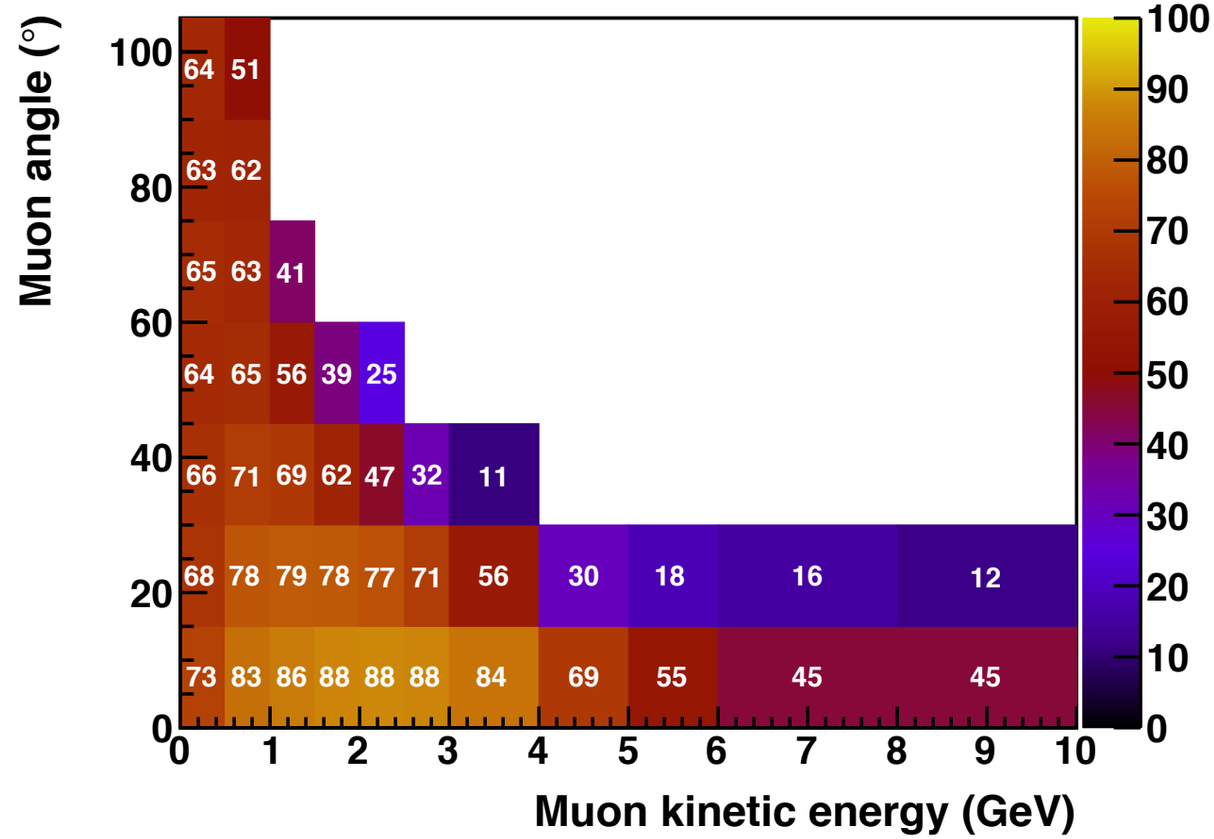




Charged-current neutrino interactions generated in the active volume of the LArTPC and propagated through the ND geometry.

GArTPC ACCEPTANCE

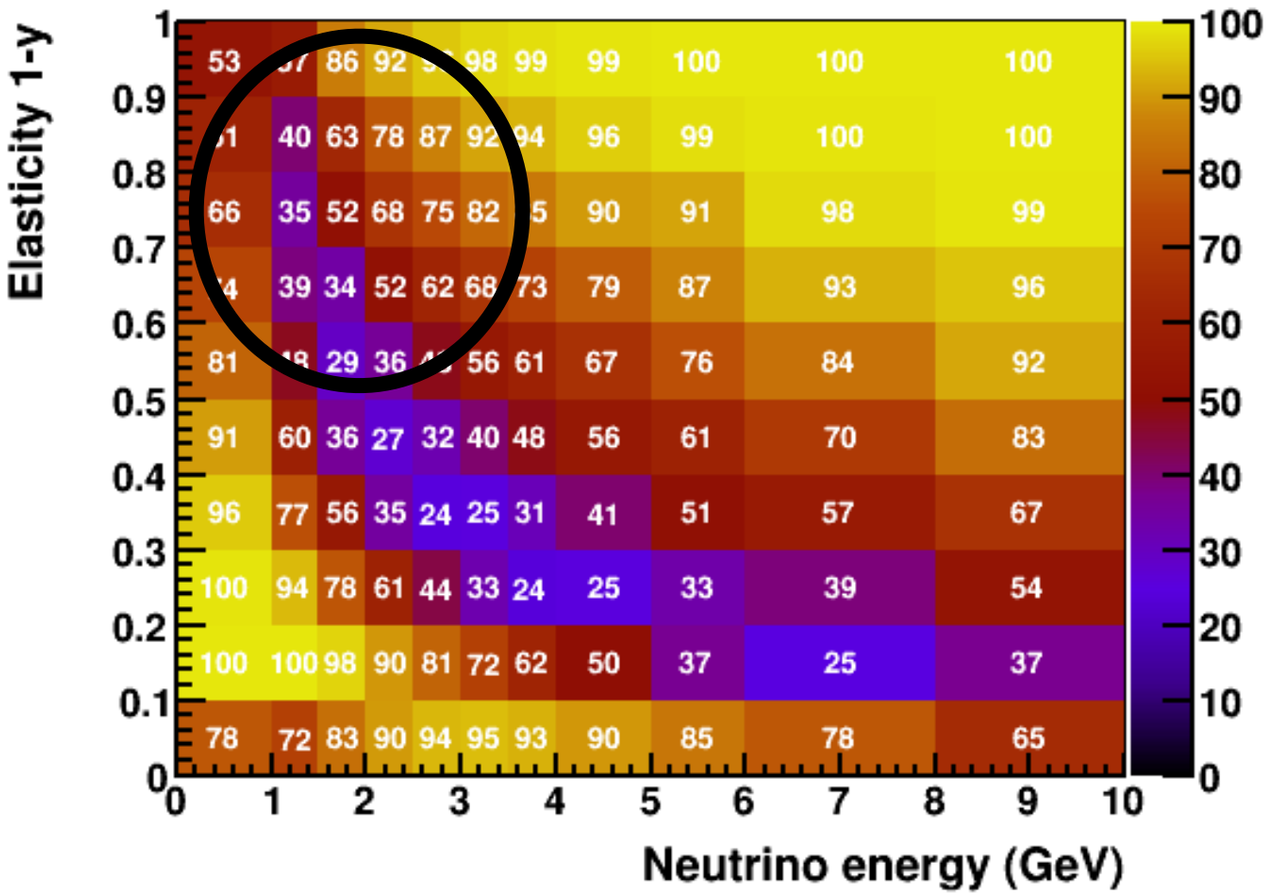




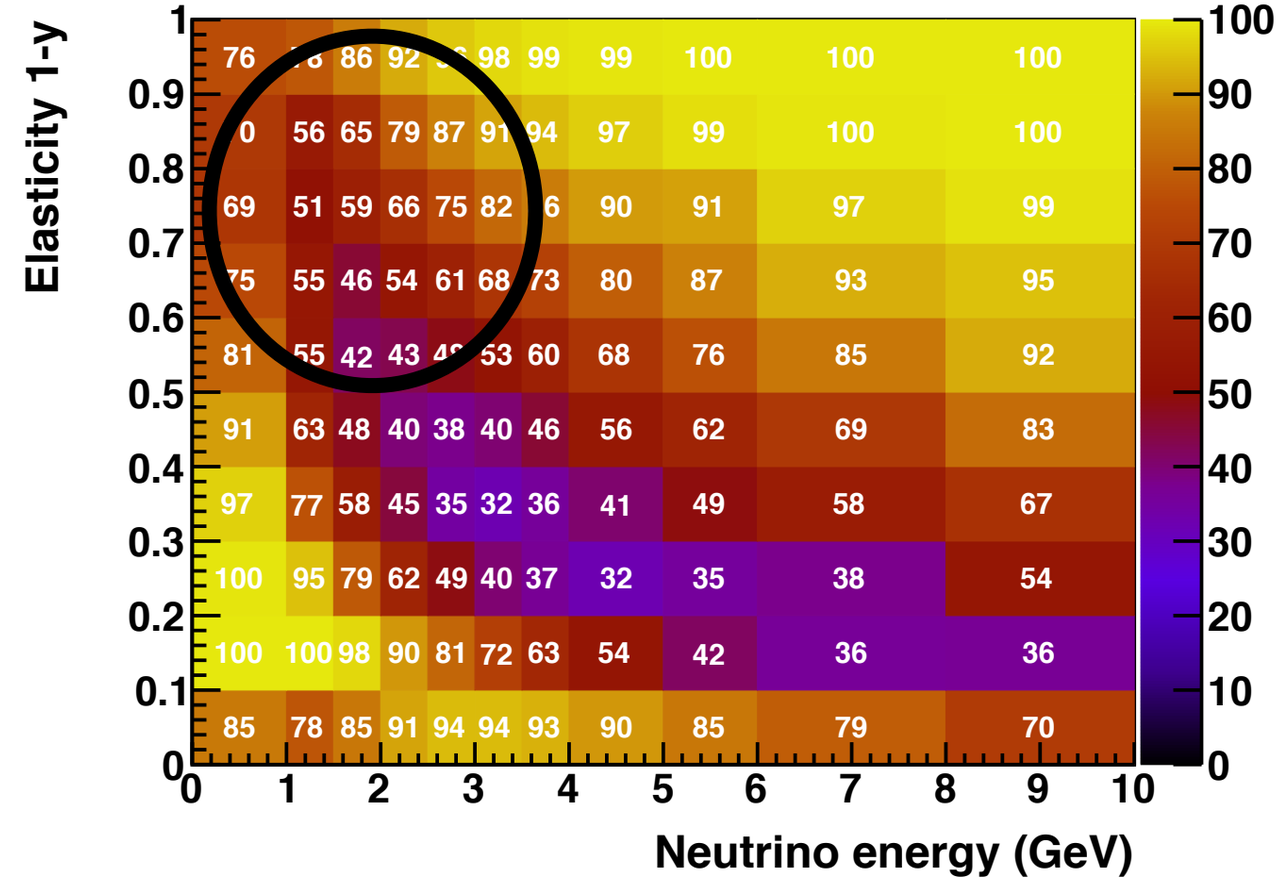
Fiducial cut (50 cm all around and 150 cm downstream) to take into account the containment of hadrons in the LArTPC.

GArTPC ACCEPTANCE

Dipole

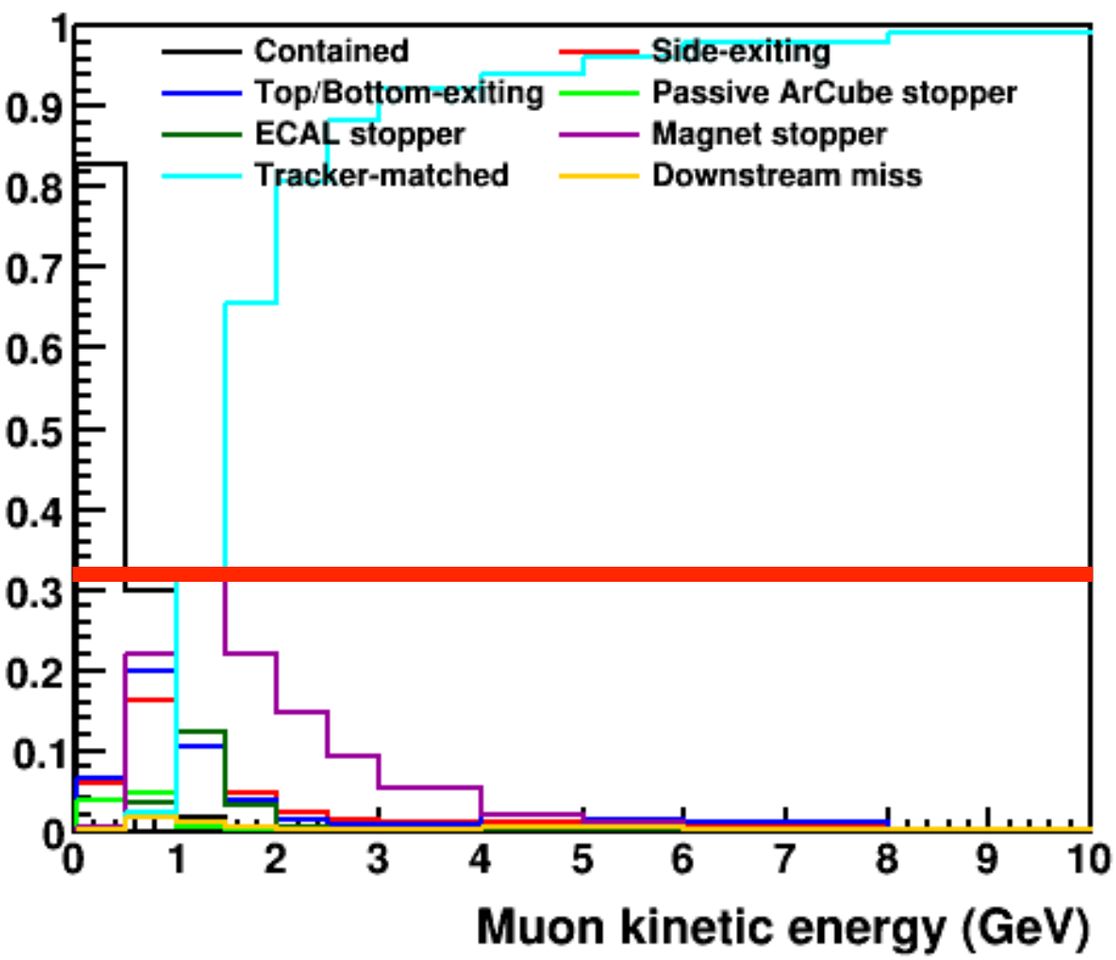


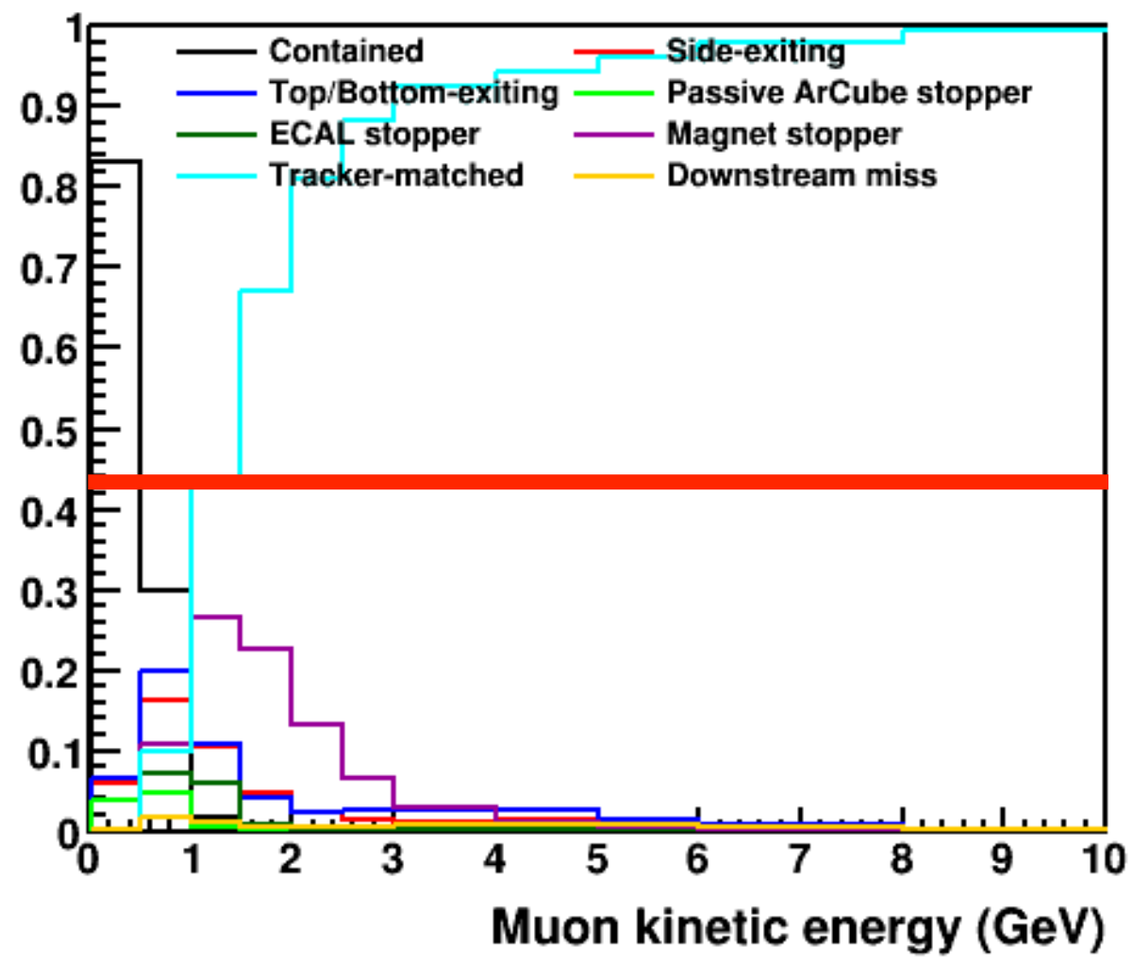
No coils



Acceptance for muons contained in LArTPC or tracked in ECAL or GArTPC for the standard dipole magnet vs the coil-less magnet.

GArTPC ACCEPTANCE



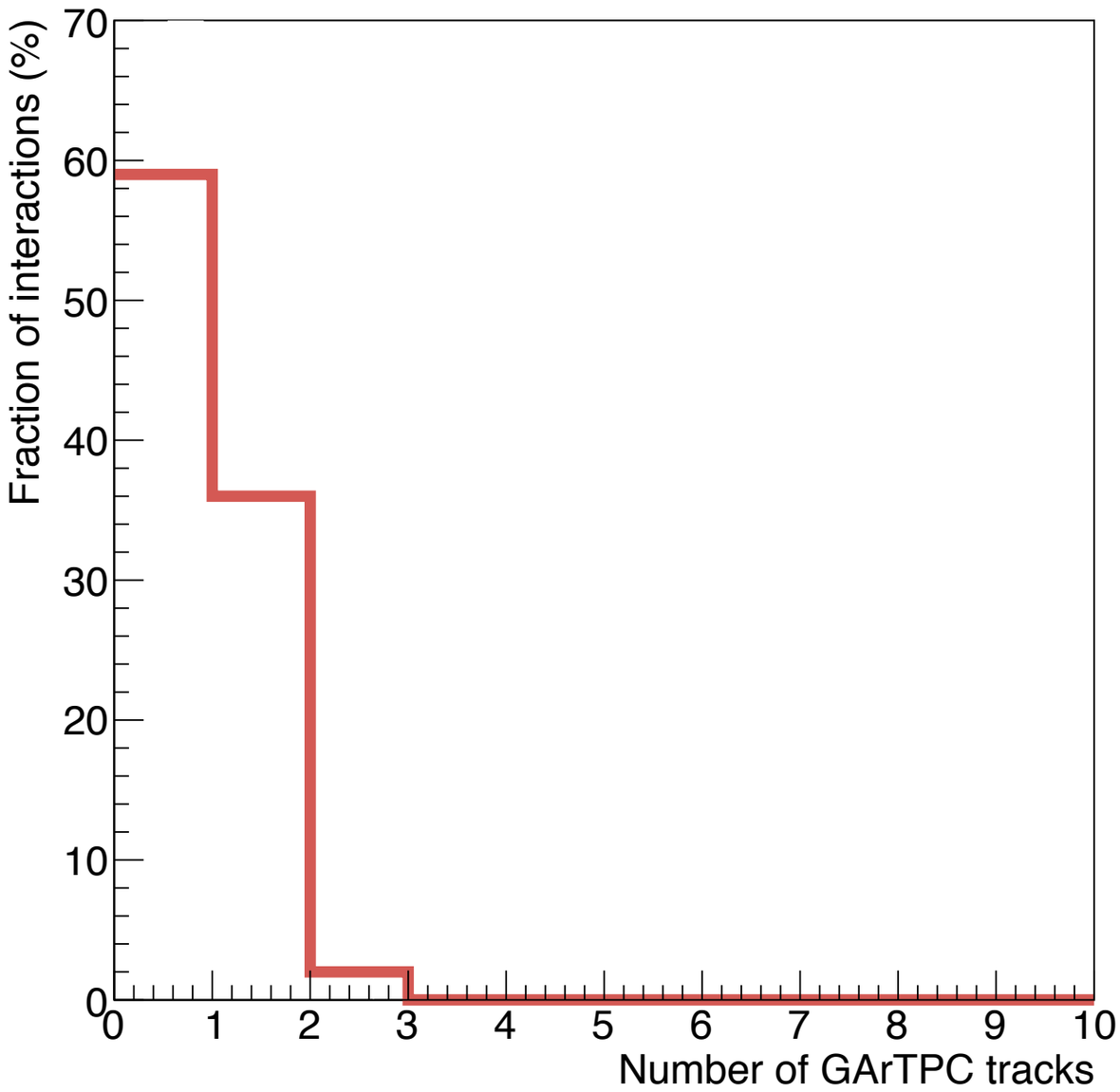


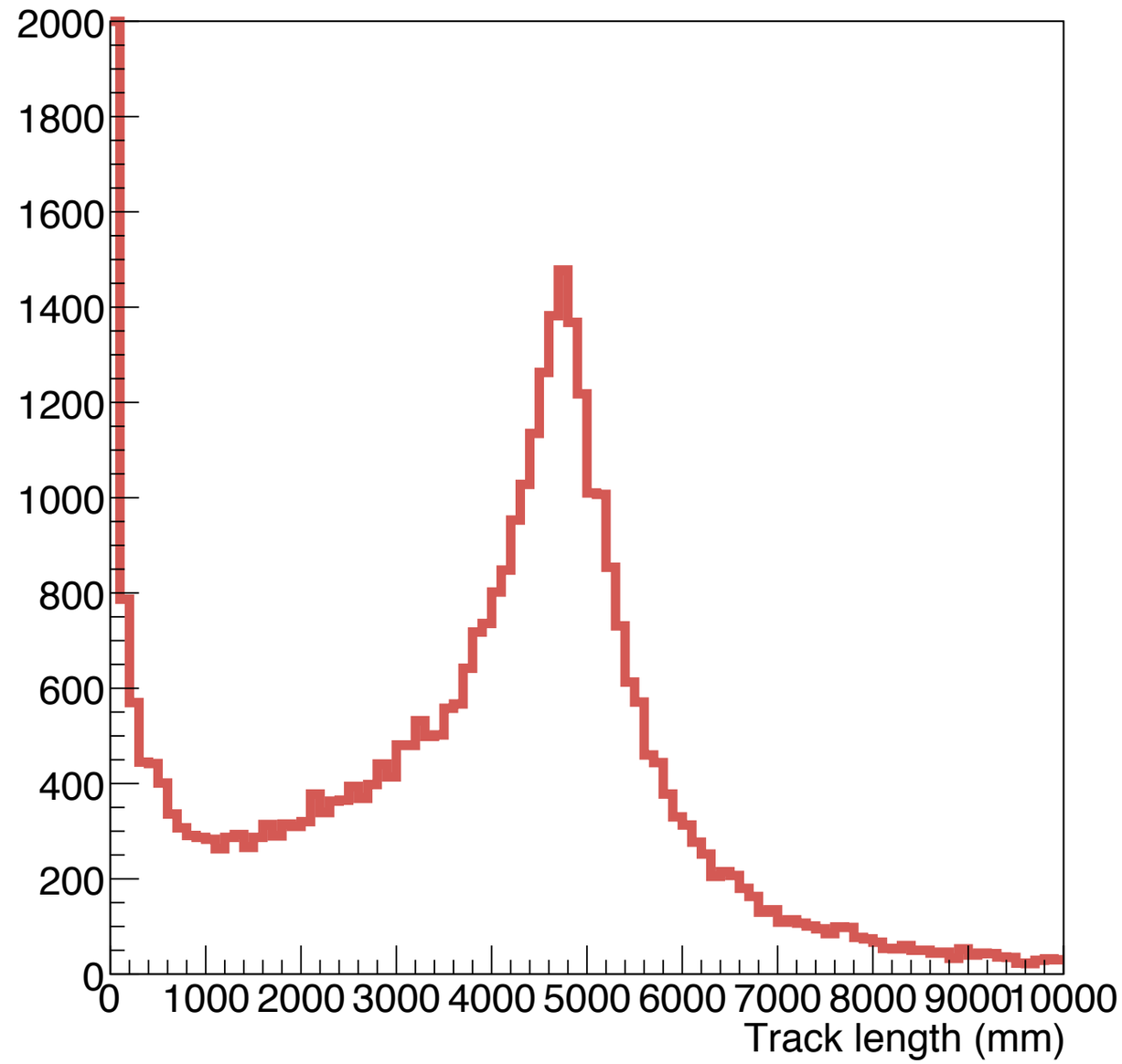
Acceptance as a function of muon kinetic energy for the standard dipole magnet vs the coil-less magnet.

INTERACTION RATES IN LArTPC

- Average rate in the whole detector (predicted by GENIE):
  - 0.105 interactions / ton / spill
- Interactions in the active volume of the LArTPC (~90 tons)
  - 9.5 interactions / spill
- Background interactions in cryostat:
  - Upstream and side walls (~22 tons): 2.3 interactions / spill
  - Bottom (~33 tons): 3.5 interactions / spill
  - Downstream wall (~11 tons): 1.2 interactions / spill
- Order ~**20** interactions / spill in LArTPC detector.

LArTPC INTERACTIONS





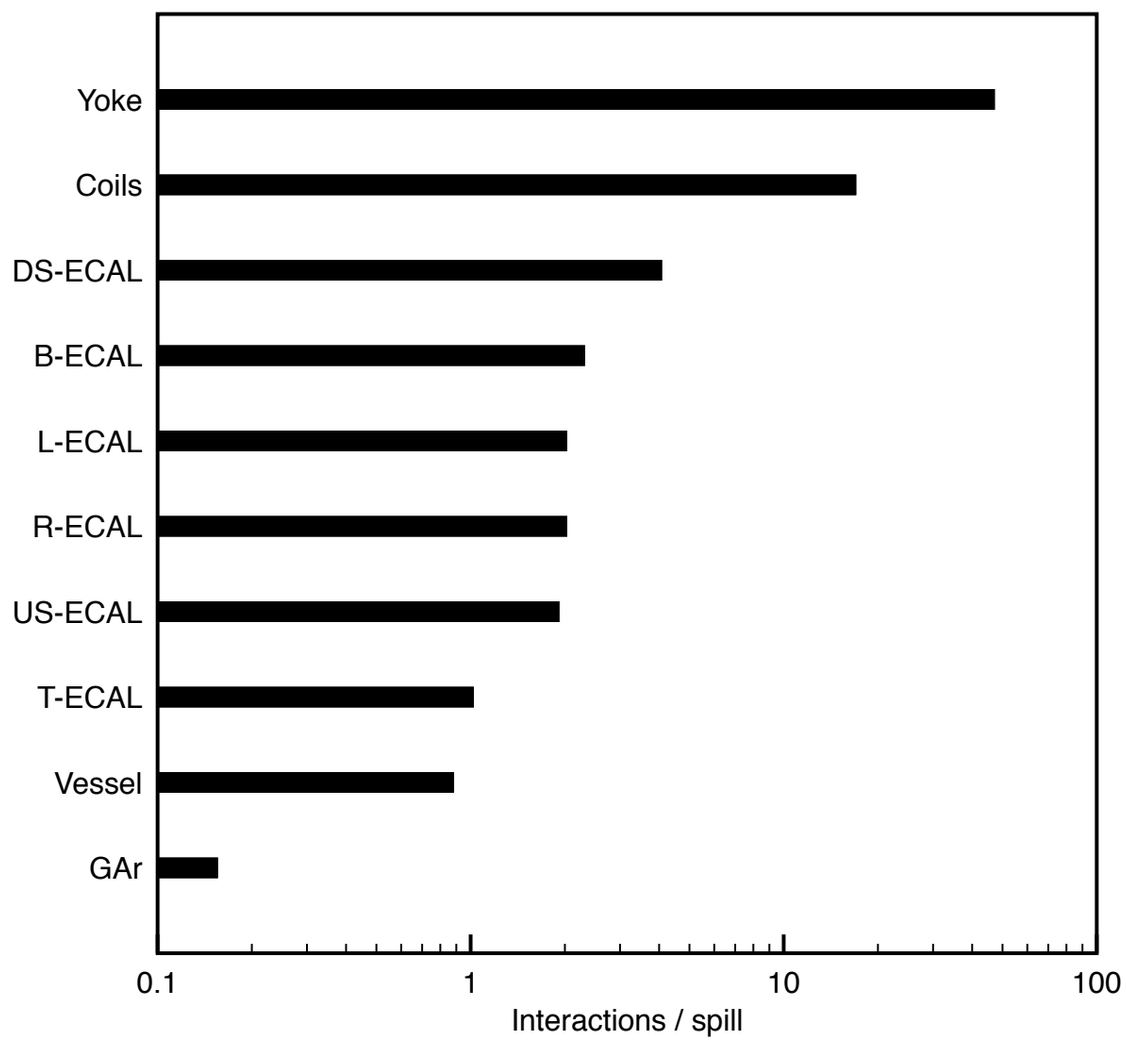
Number of GArTPC tracks and their length for interactions in the active volume of the LArTPC.

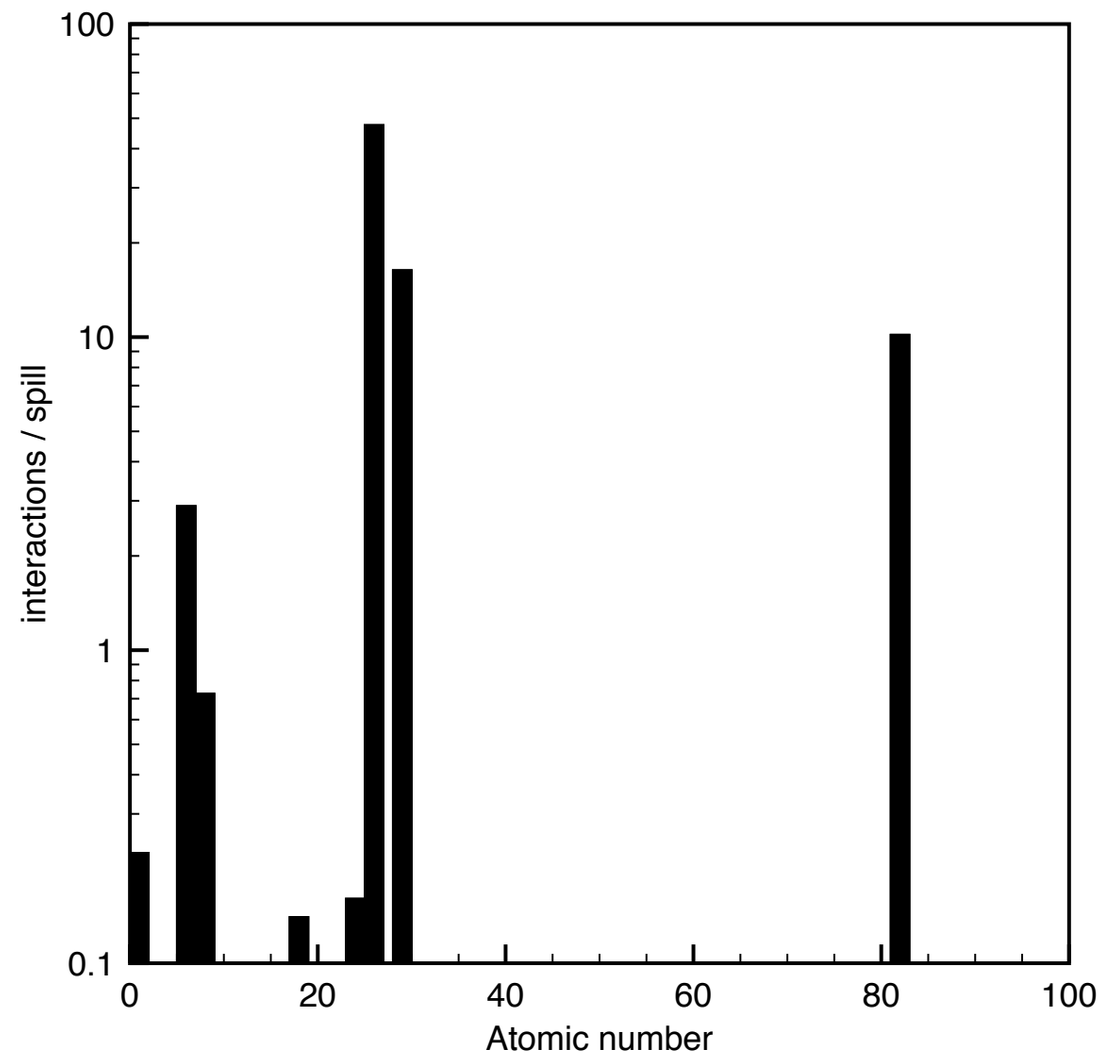
LArTPC INTERACTIONS

Muons	77 %
Charged pions	7 %
Neutrons	7 %
Protons	3 %
Gammas (mostly from neutral pions)	3 %
Other (kaons, electrons...)	3 %

Particle identity of GArTPC tracks for ν interactions in LArTPC.

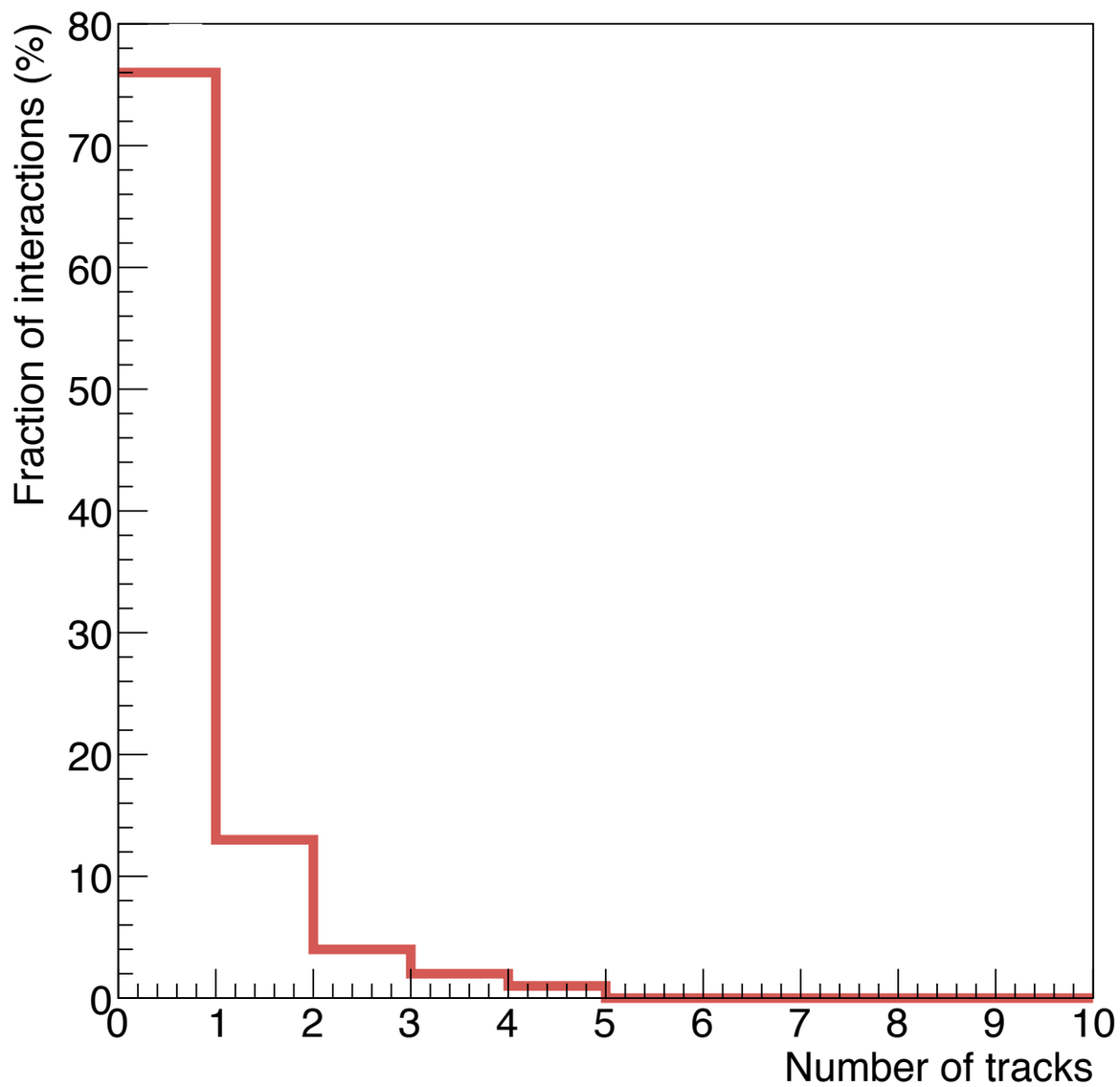
INTERACTION RATES IN SPECTROMETER

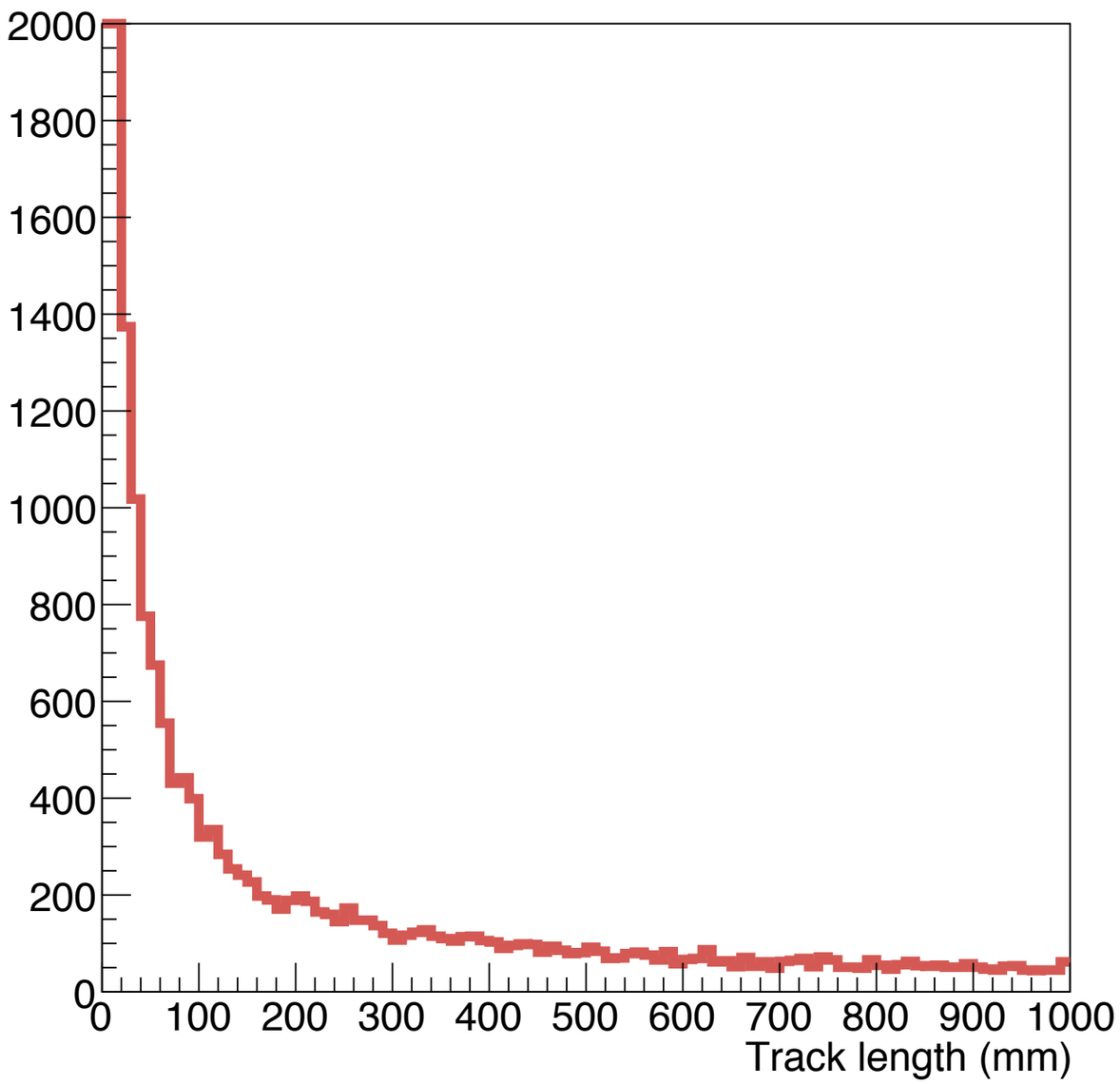




An average of 75 interactions / spill in the spectrometer;
0.15 interactions / spill on average in the GAr.

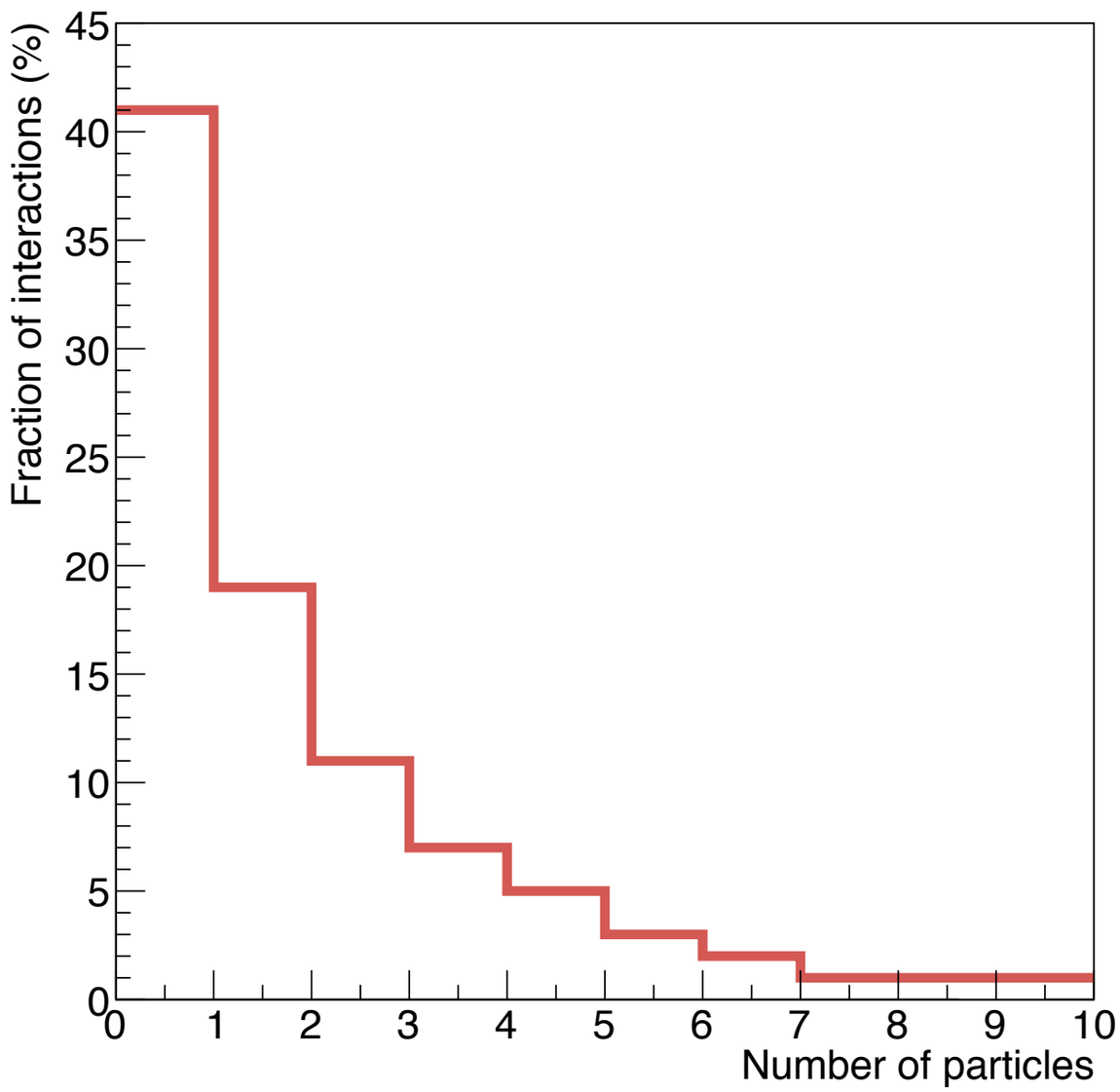
INTERACTIONS IN SPECTROMETER — GArTPC

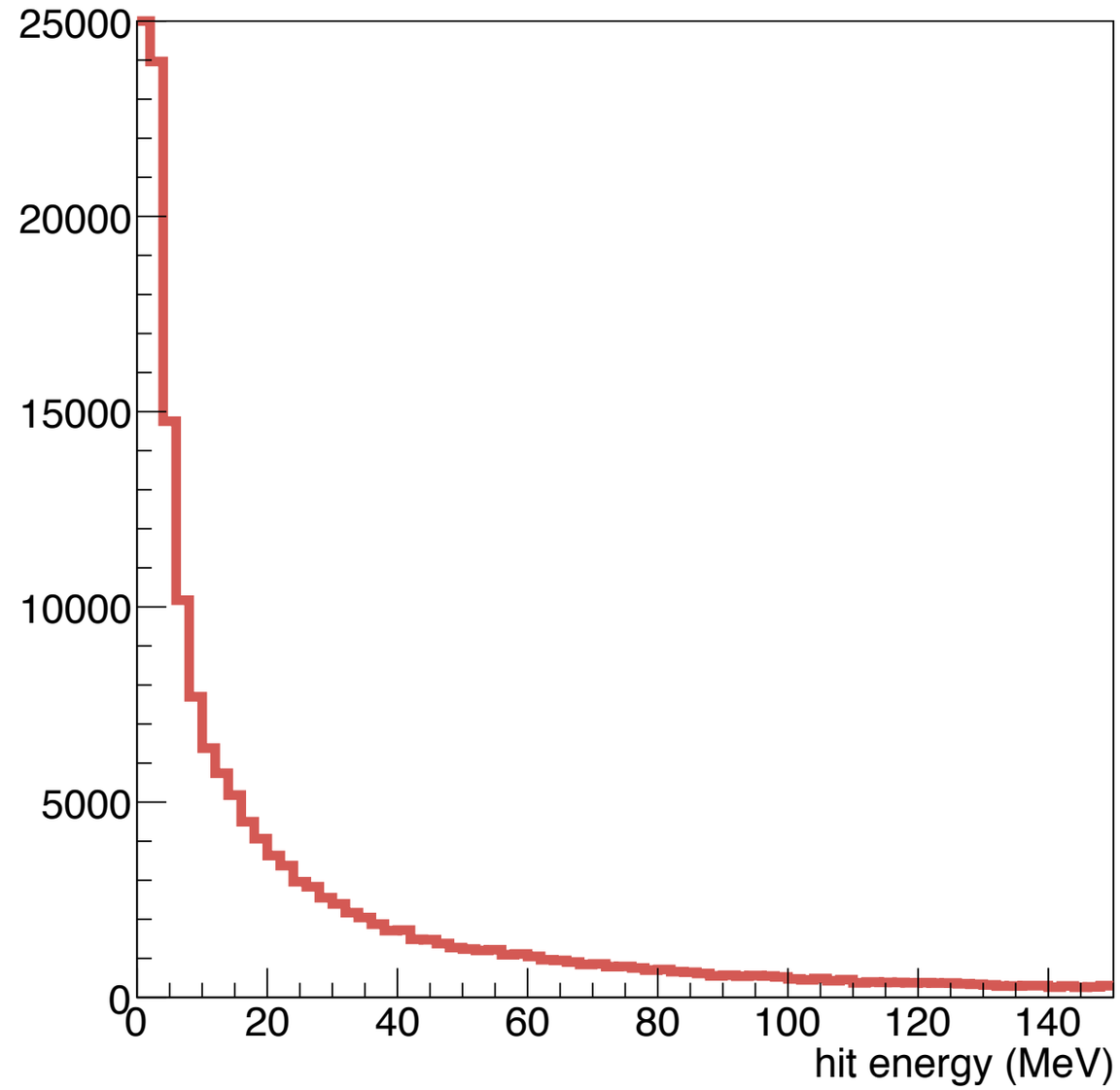




Number of GArTPC tracks and their length for interactions in the whole spectrometer.

INTERACTIONS IN SPECTROMETER – ECAL



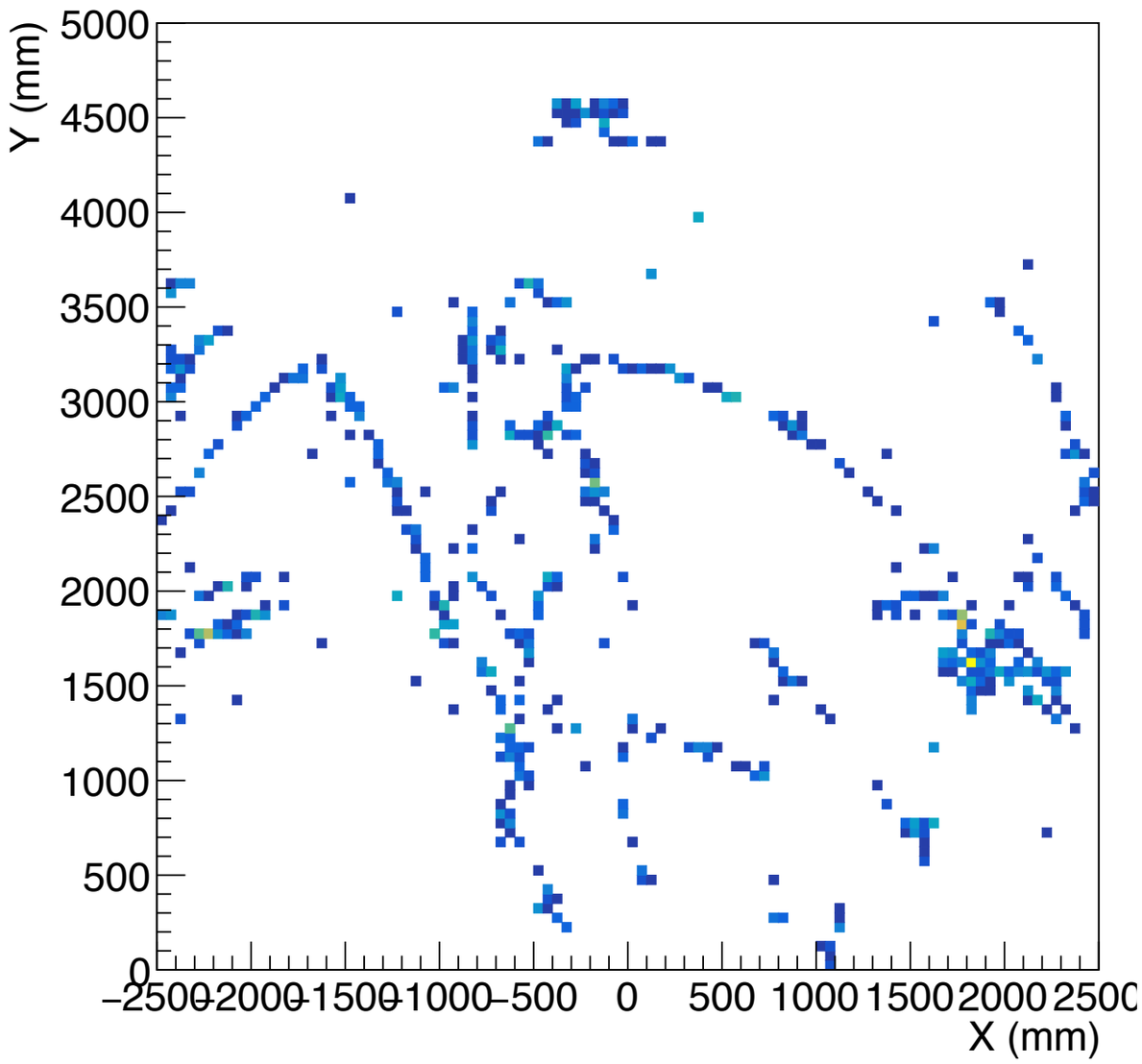


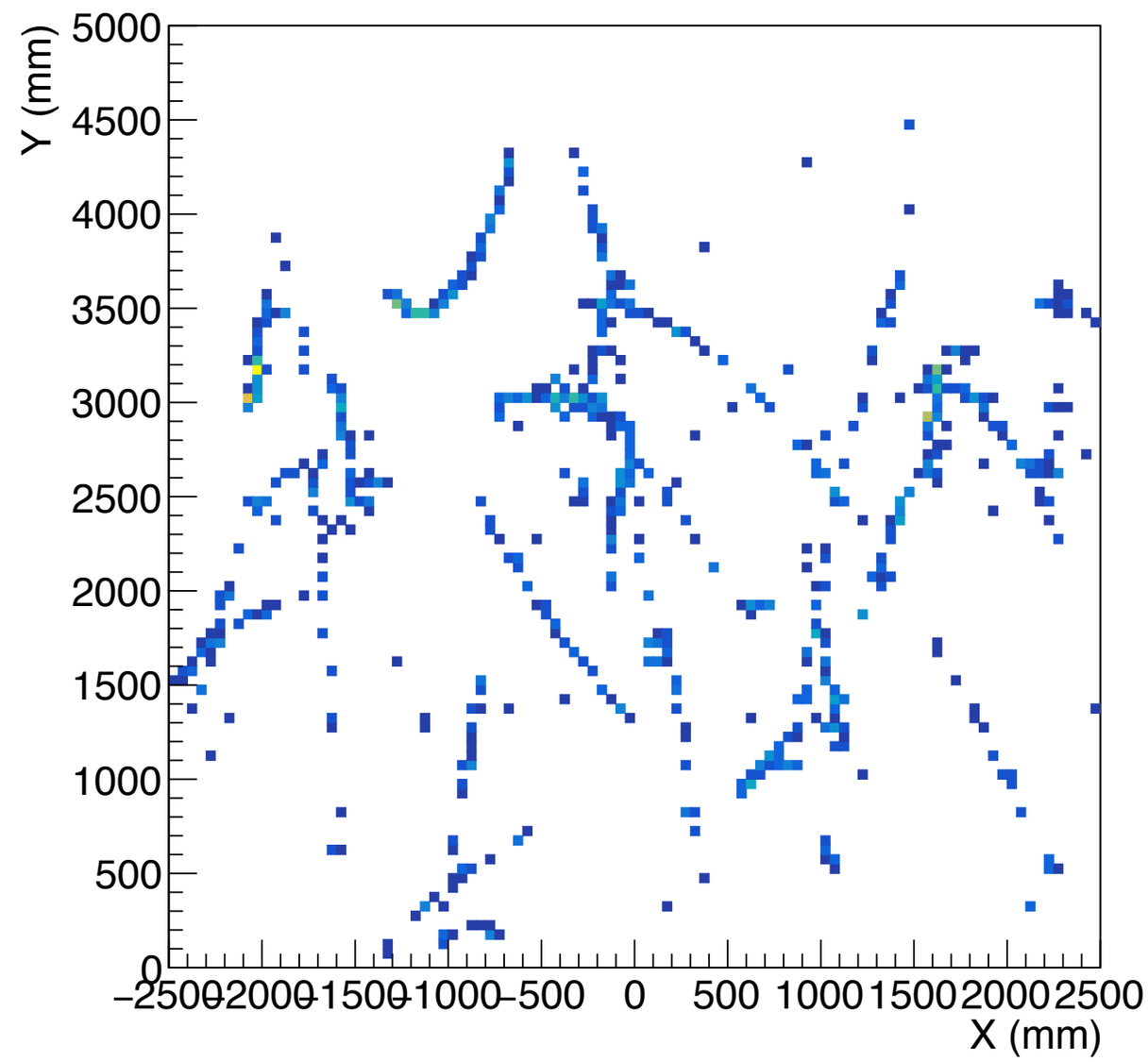
Number of particles interacting in the ECAL and their deposited energy for neutrino interactions in the whole spectrometer.

TIMING INTERACTIONS WITH ECAL

- The detection of neutral pions will make use of the ECAL, since the gammas from the pion decay almost never interact in the GAr.
- For a time resolution of 10 ns (25 ns), about 5% (10%) of the neutrino interactions generate ECAL activity coincident in time with another interaction.
- Interactions in the TPC will be time-stamped using the ECAL or the GAr scintillation signal.
- Reconstruction of the kinematics of the pion decay reduce the background below 1%.

EVENT DISPLAY





SUMMARY

- The GArTPC will see of the order of 25 tracks per spill, with about 10 originating from interactions in the LArTPC.
- Good ECAL time resolution (~10 ns) will be needed for separation of the different interactions in the GArTPC.
- An open/lighter magnet would
  - improve the acceptance of the spectrometer;
  - and reduce the number of background interactions.