Discussion of ν_τ recognition at ~1 TeV

Wenjie Wu, Jianming Bian

University of California, Irvine

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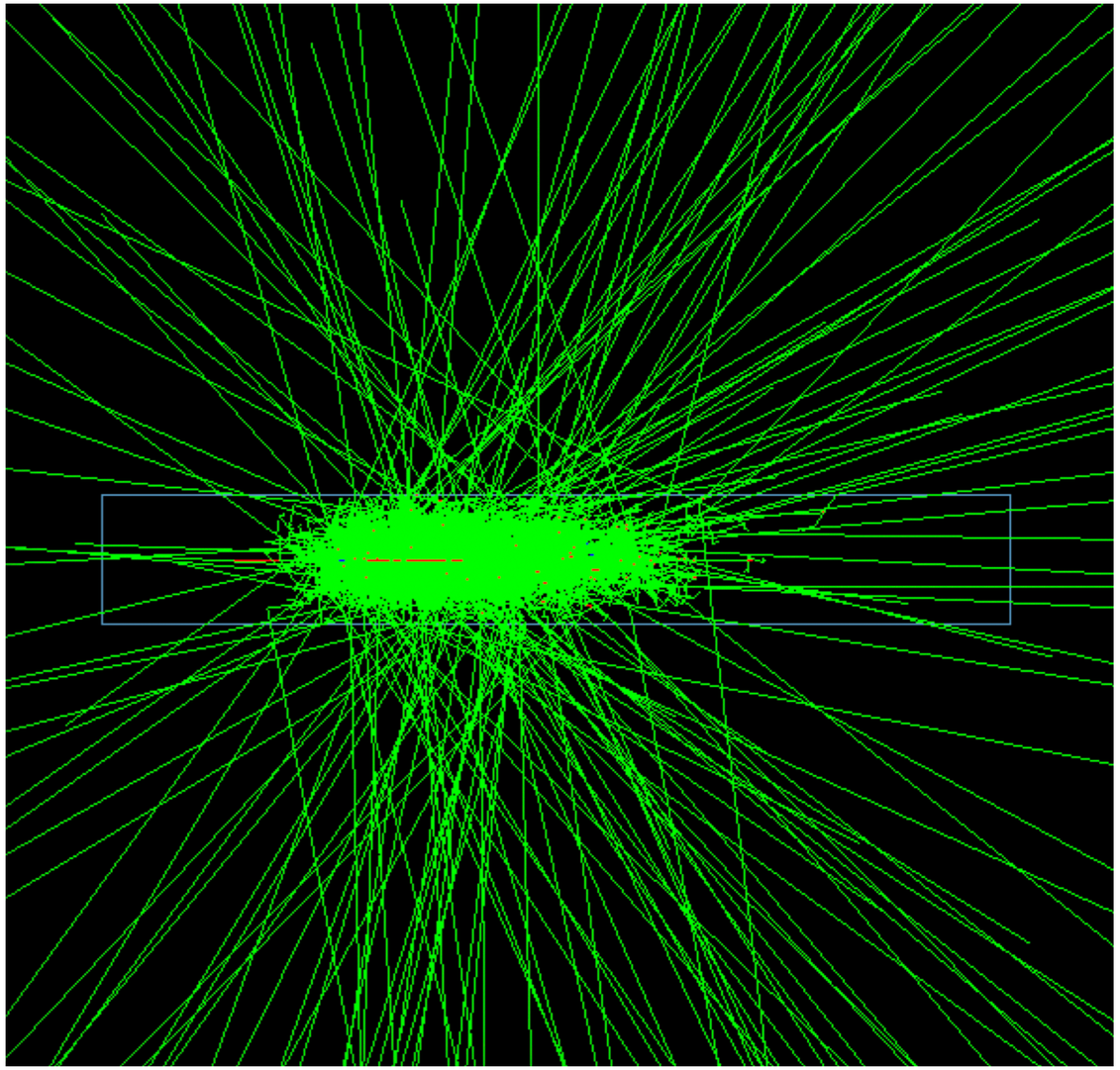
UCIrvine

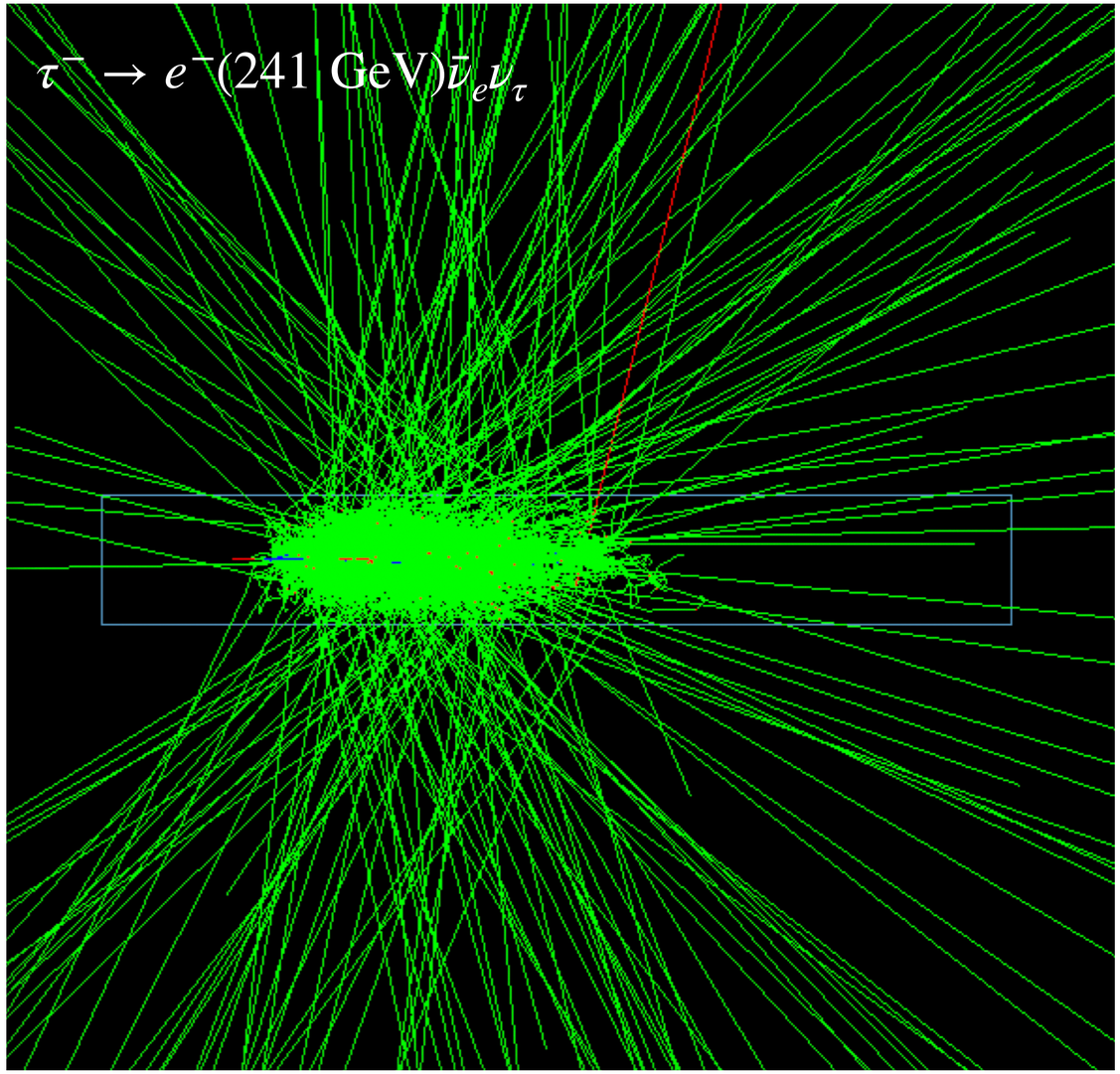
Introduction

- As a start, we now only consider the signatures of τ^- from ν_τ CC
  - The hadronic shower of the final state is also helpful for ν_τ recognition, but need more comprehensive simulations
- Liquid argon
  - LAr radiation length is 14 cm
  - LAr density is 1.4 g/cm^3
- Use Geant4 to simulation tau- in a LAr detector
  - **Detector Size (cuboid)**: 1x1x7
  - Direction: (0, 0, 1). Currently no angle smearing.
  - **Vertex of electron is uniformly distributed along Z-axis** (0, 7000) mm
  - PhysicsList used in the simulation: FTFP_BERT

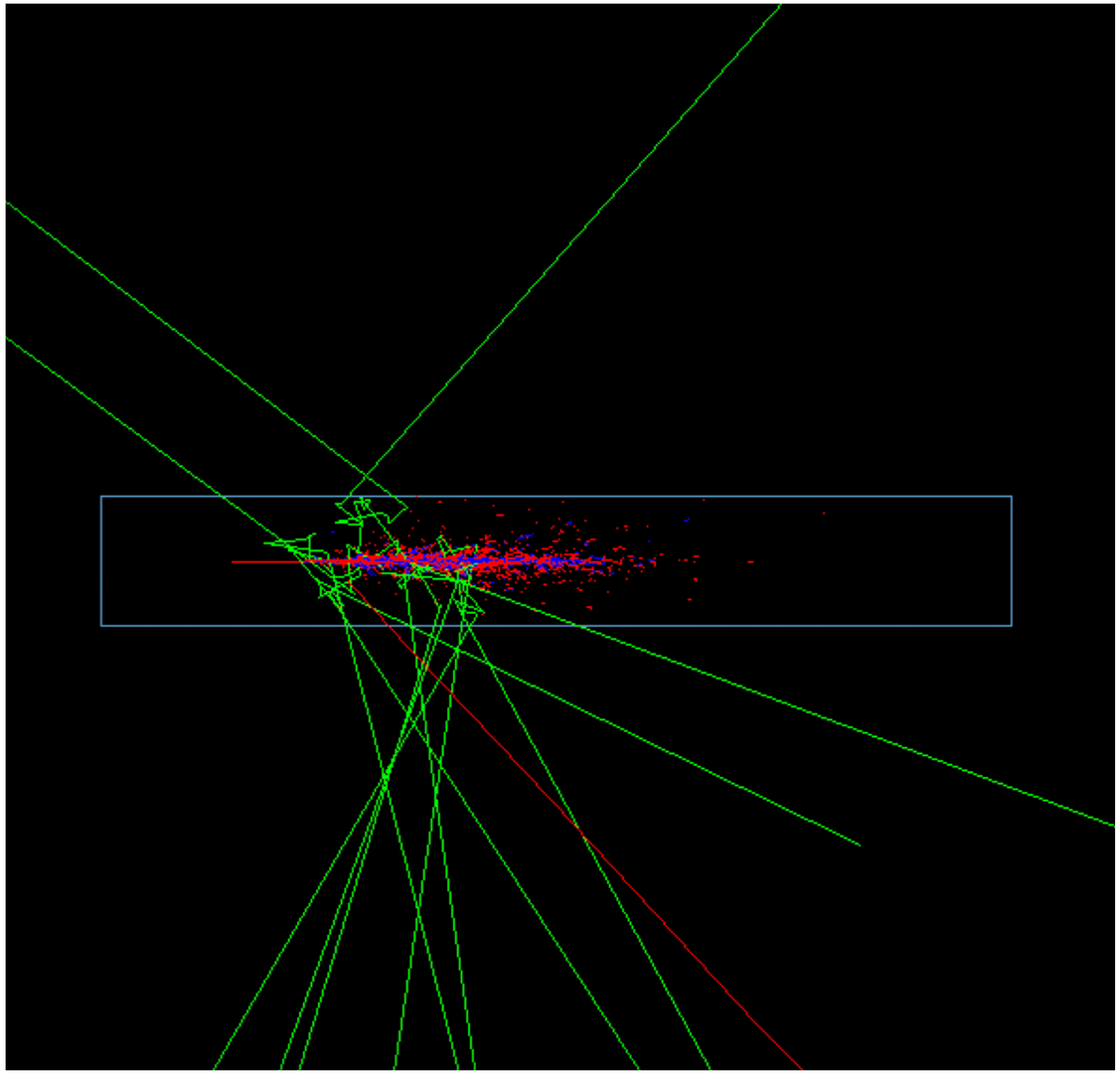
241 GeV e-



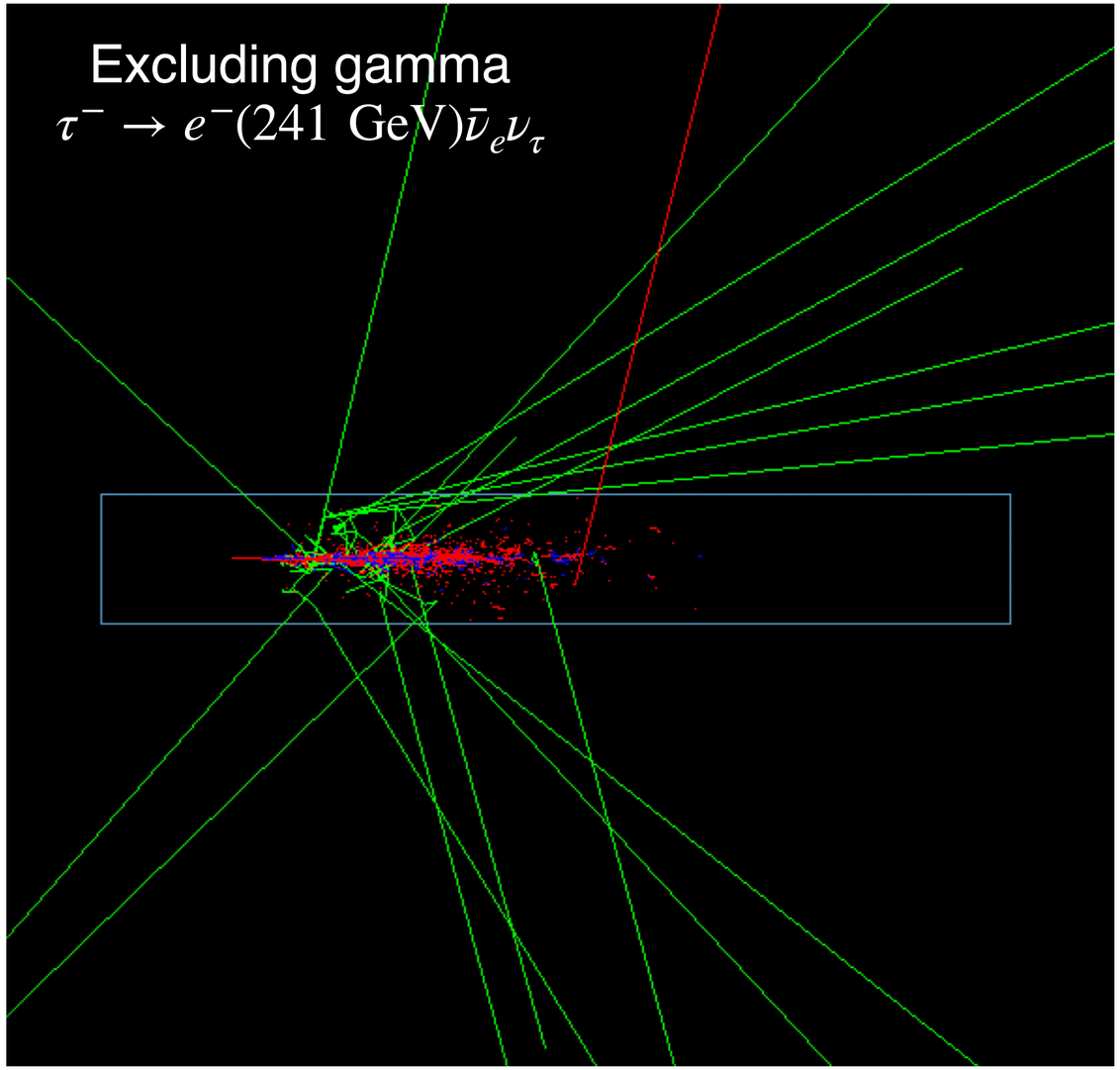
1 TeV tau-



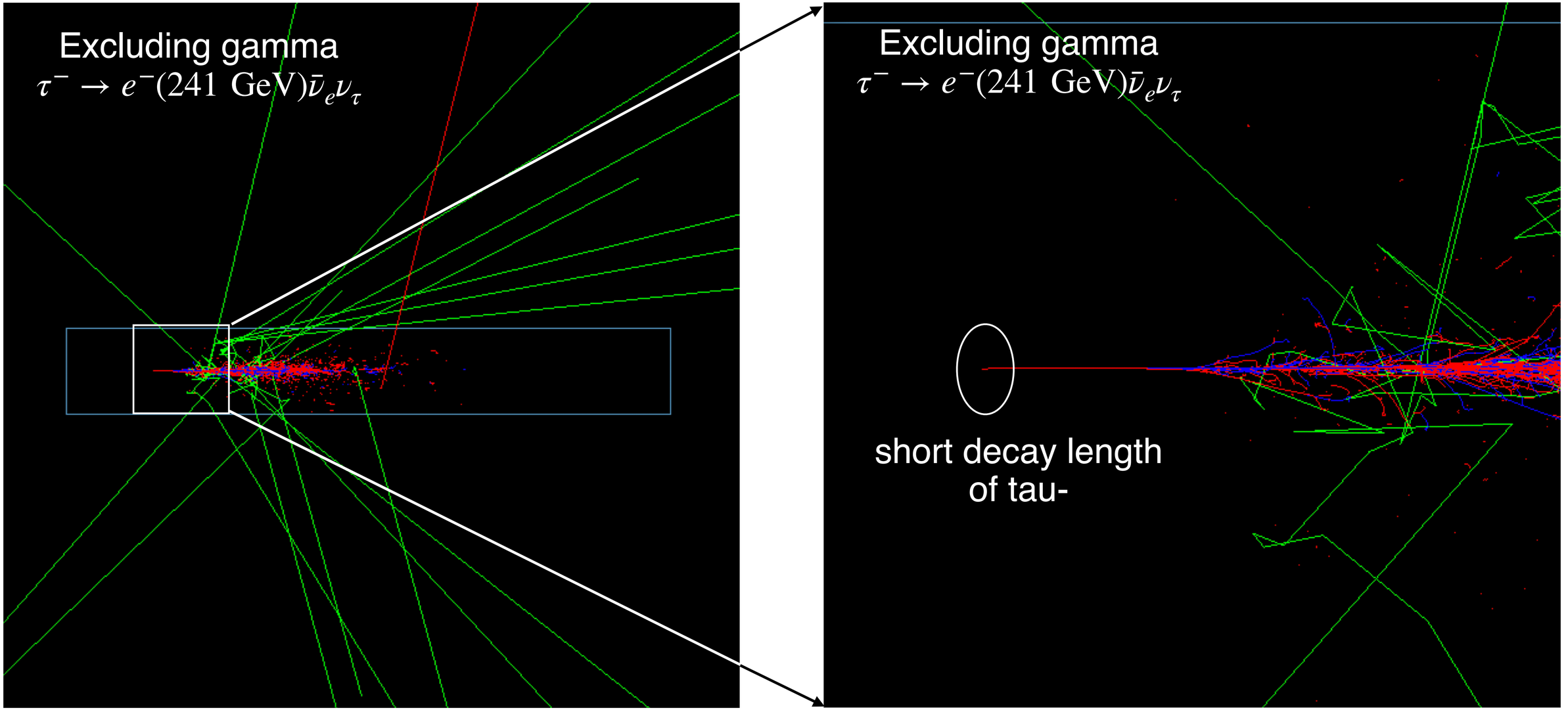
241 GeV e-



1 TeV tau-

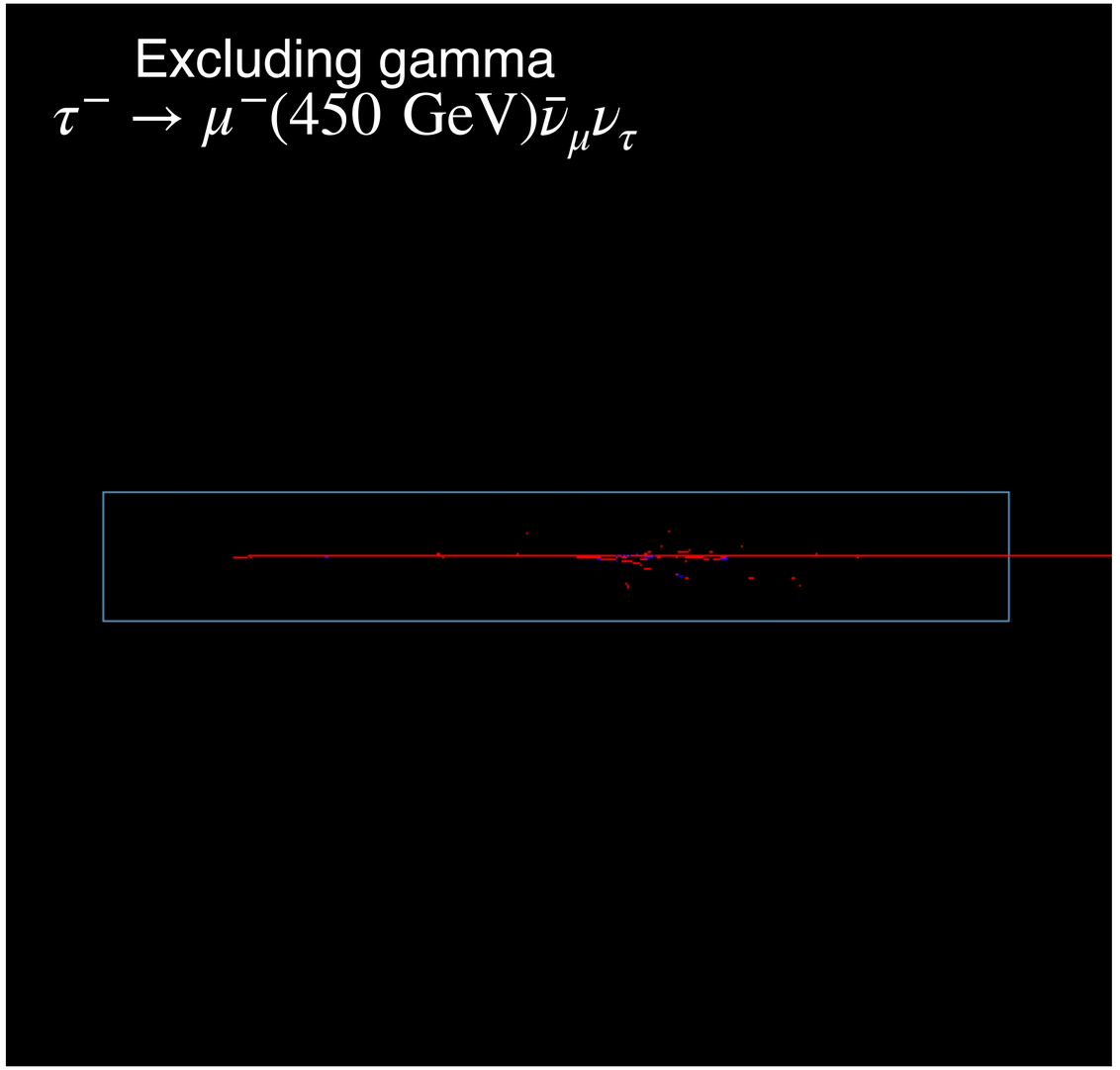


1 TeV tau-

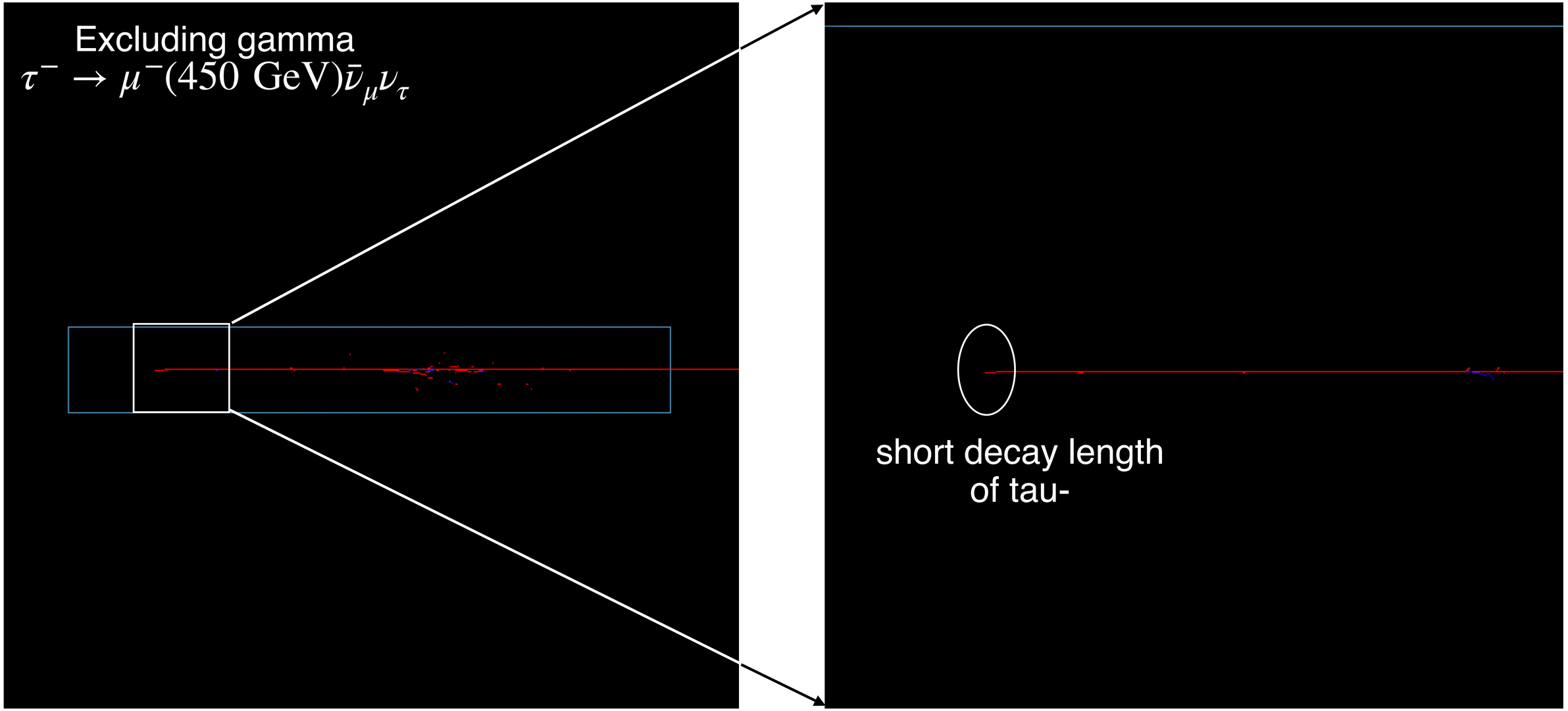

Excluding gamma
$\tau^- \rightarrow e^-(241\ \mathrm{GeV})\bar{\nu}_e\nu_\tau$
Excluding gamma
$\tau^- \rightarrow e^-(241\ \mathrm{GeV})\bar{\nu}_e\nu_\tau$
short decay length
of tau-

450 GeV mu-

1 TeV tau-

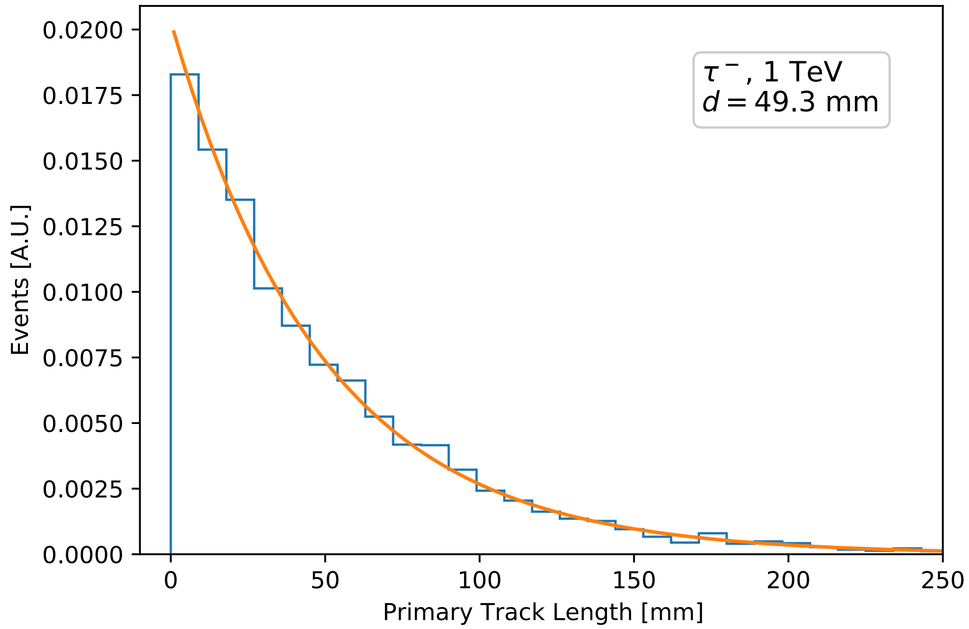


1 TeV tau-

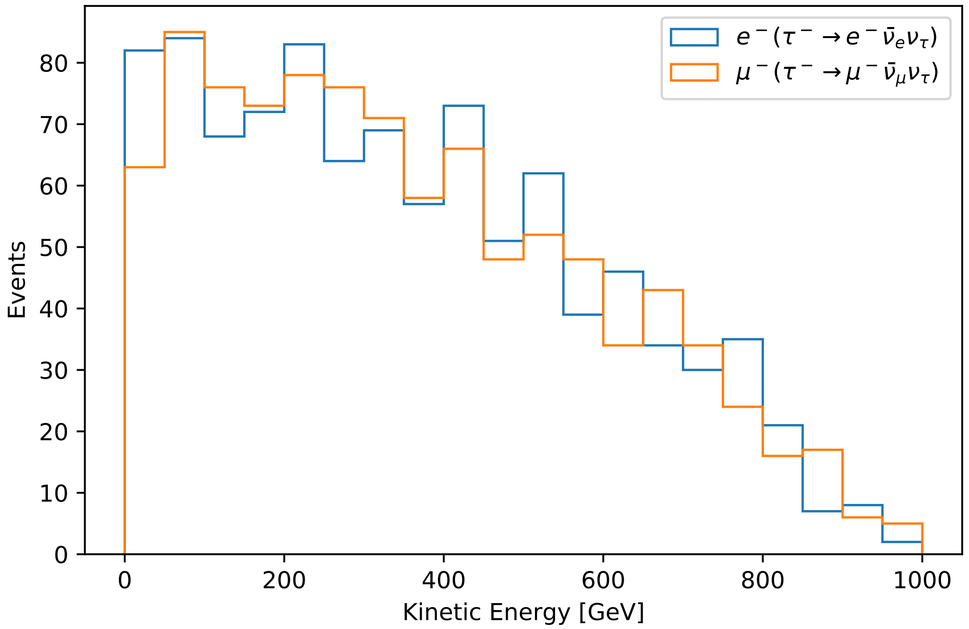

Excluding gamma
$\tau^- \rightarrow \mu^-(450\ \mathrm{GeV})\bar{\nu}_\mu\nu_\tau$
short decay length
of tau-

1 TeV tau-

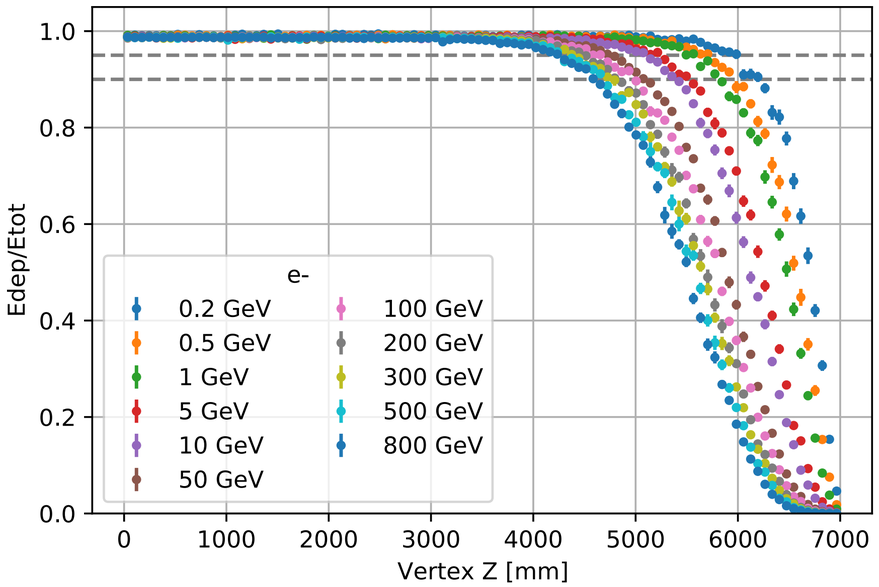
Travel distance of tau- before decay

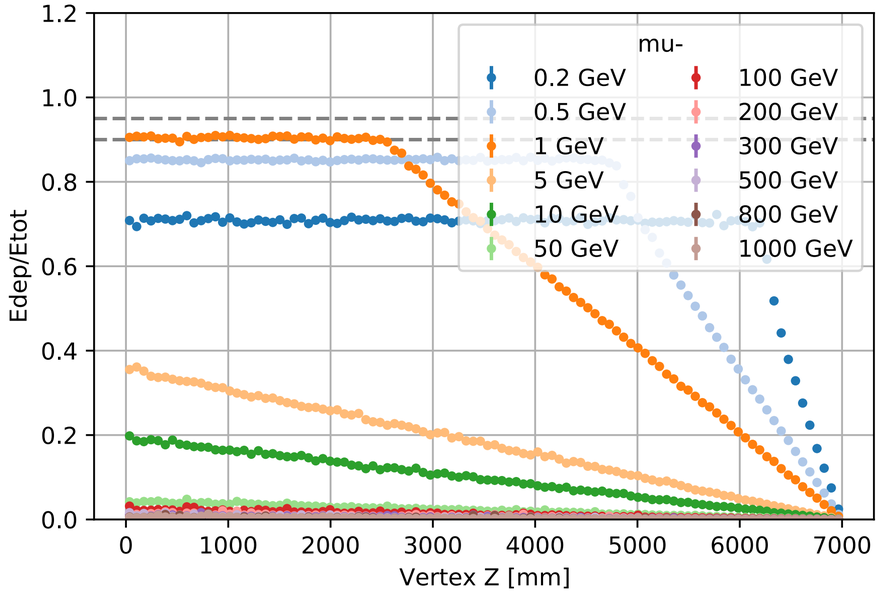


Kinetic energy of the final state lepton from tau- decay

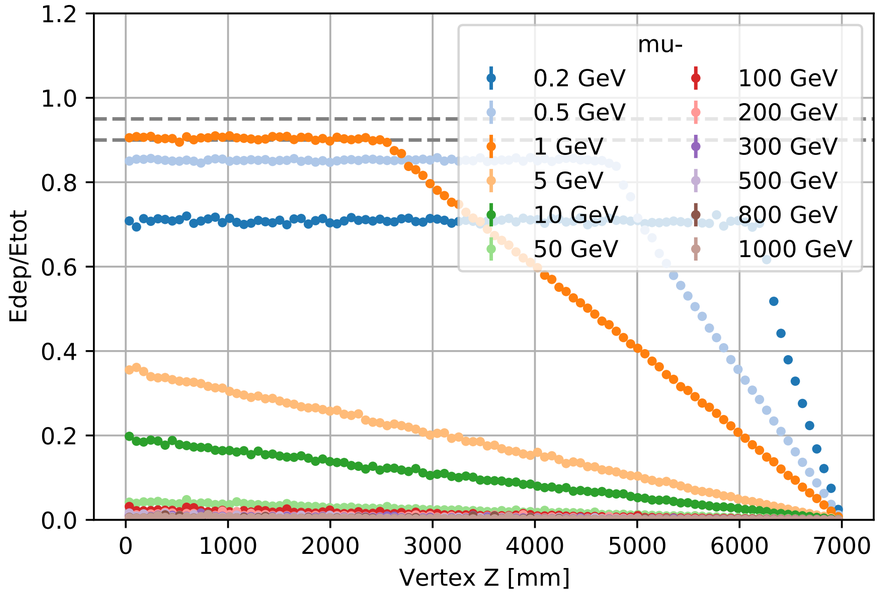


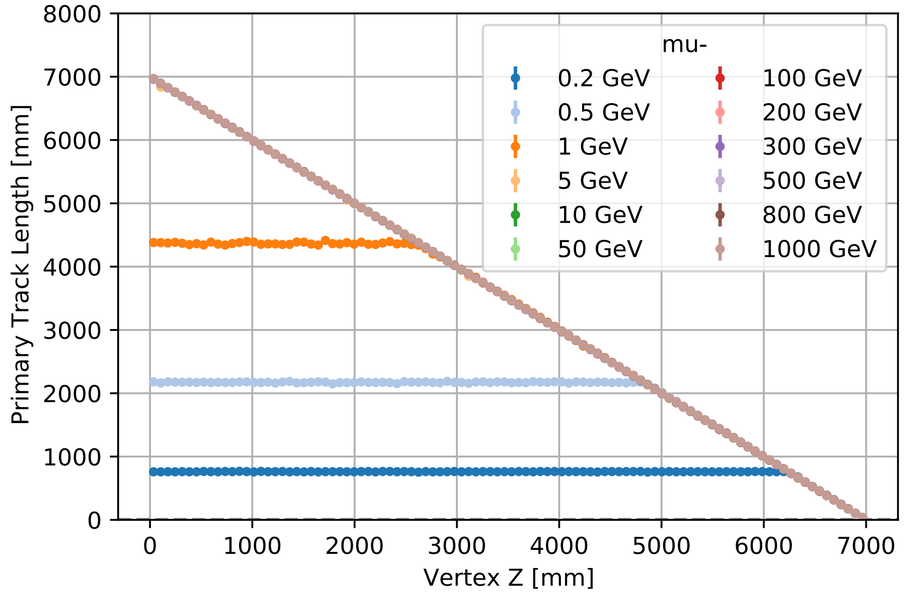
Energy Containment



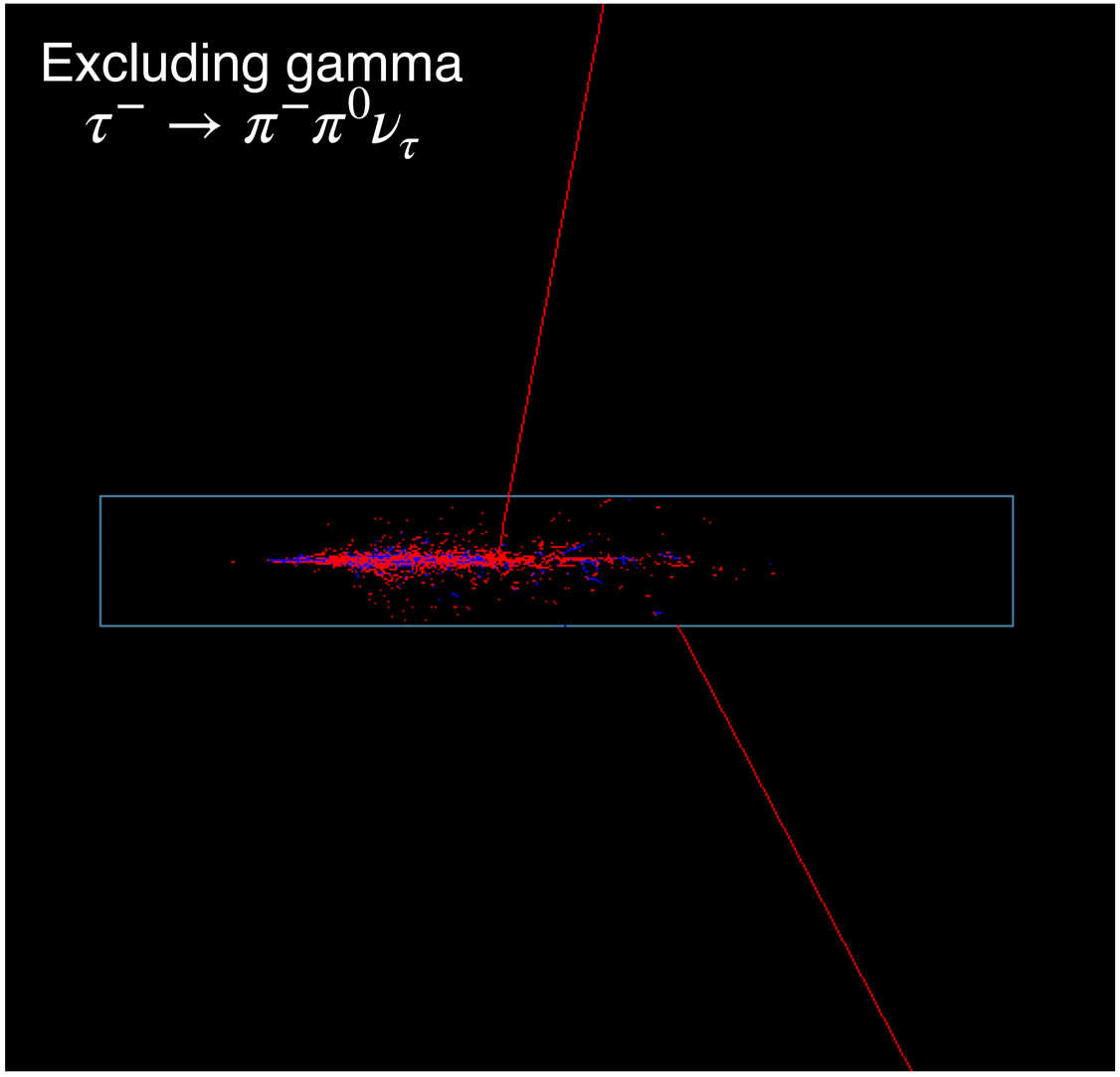


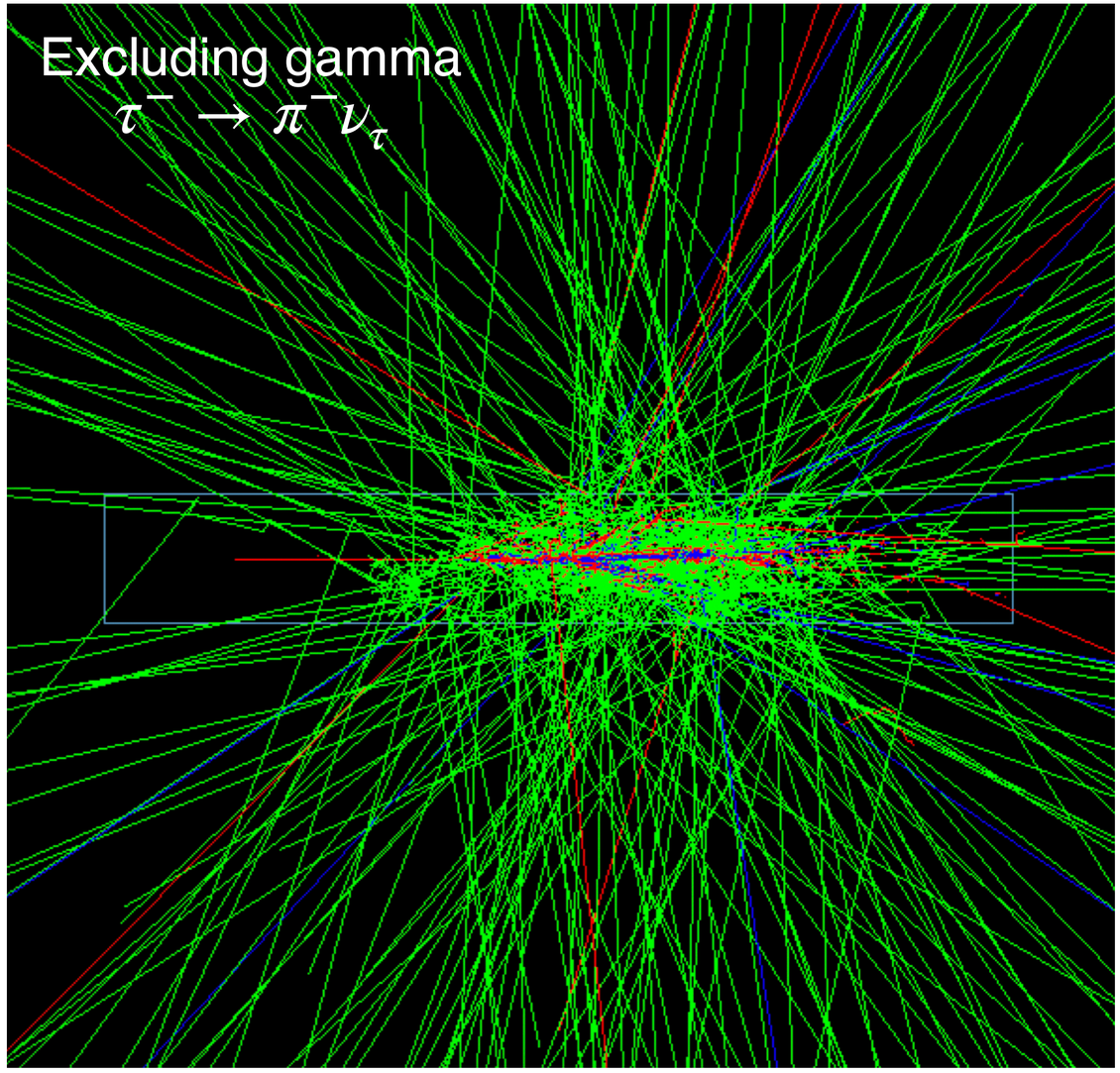
Energy Containment



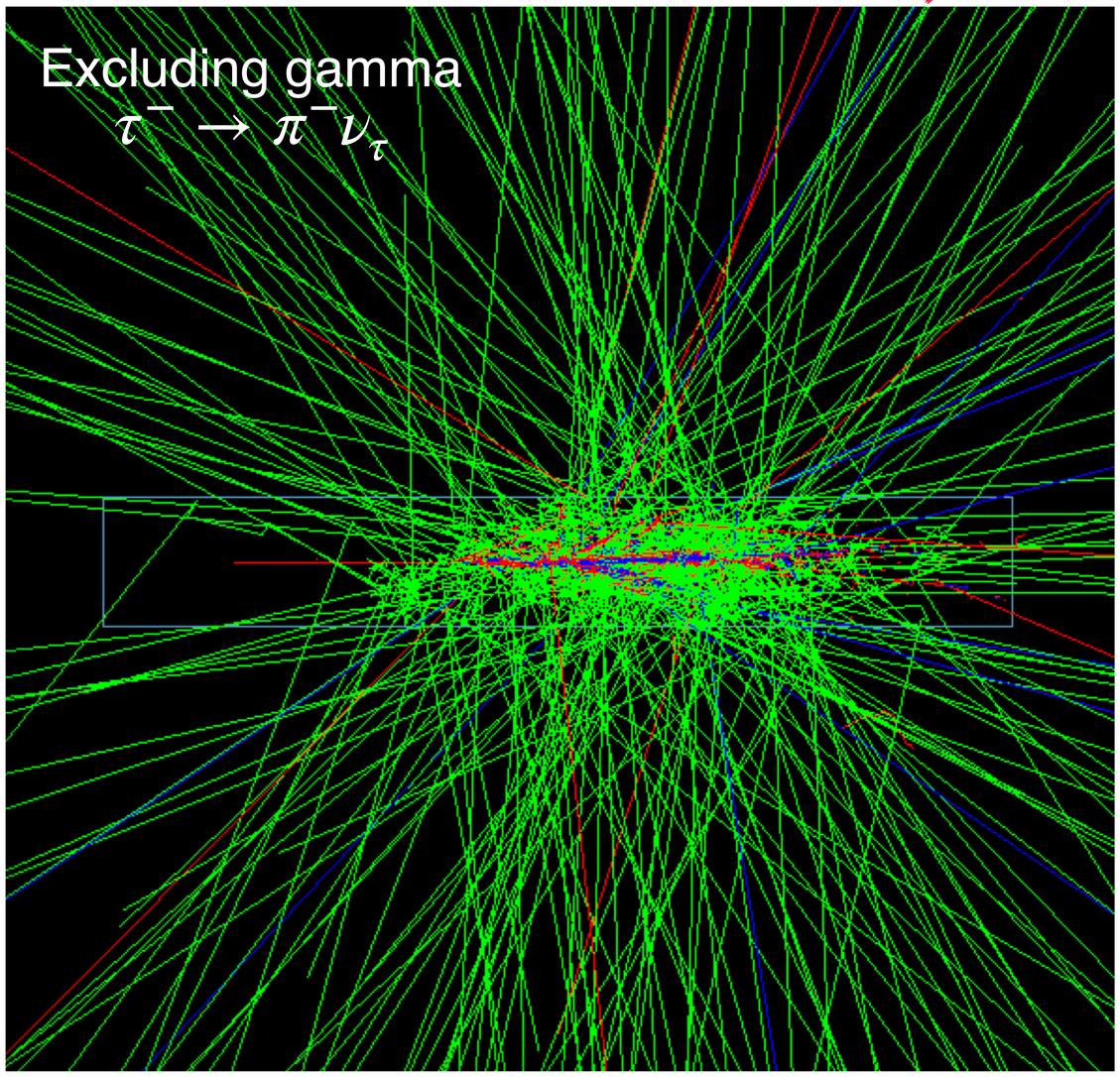


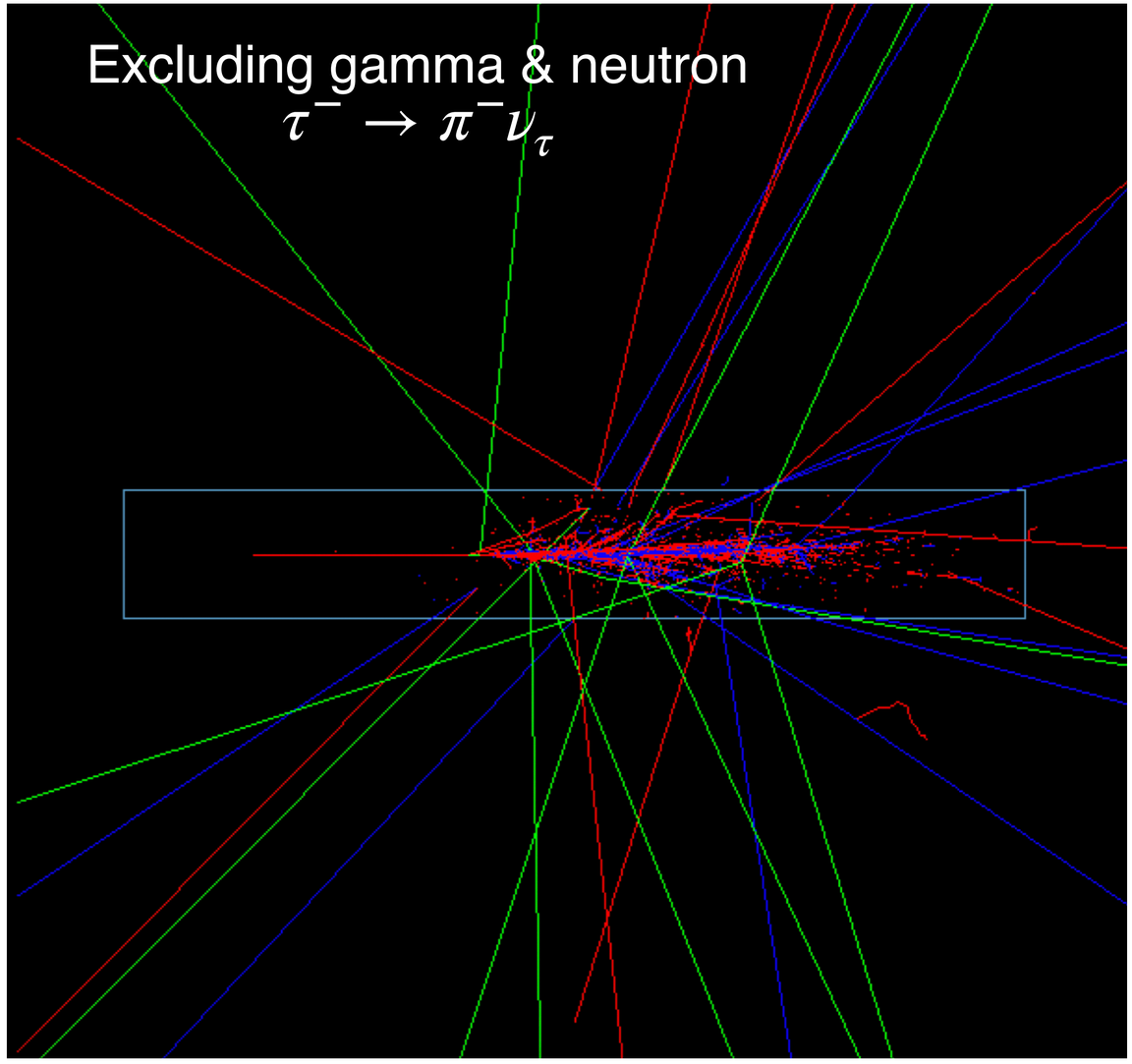
1 TeV tau-


Excluding gamma
$\tau^- \rightarrow \pi^- \pi^0 \nu_\tau$


Excluding gamma
$\tau^- \rightarrow \pi^- \nu_\tau$

1 TeV tau-


Excluding gamma
$\tau^- \to \pi^- \nu_\tau$


Excluding gamma & neutron
$\tau^- \to \pi^- \nu_\tau$

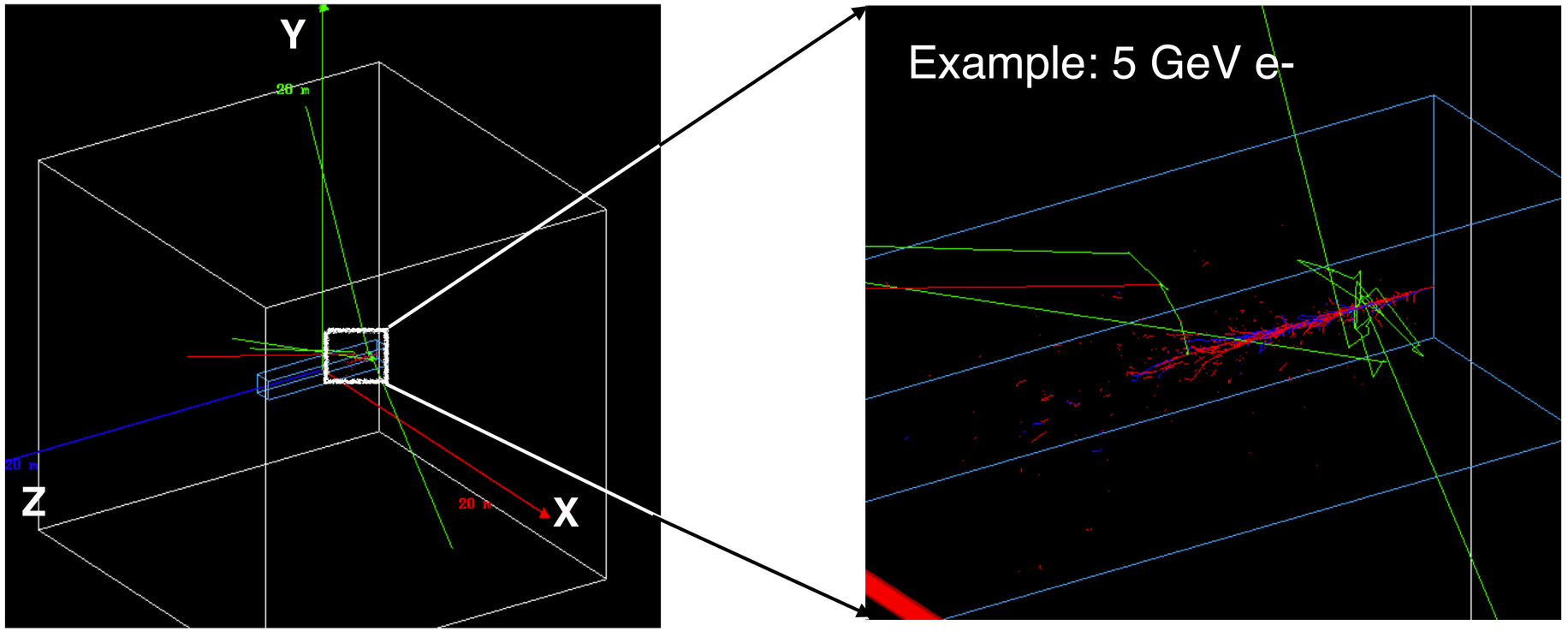
Next steps

- Consider liquid krypton as an alternative option
- Liquid krypton
  - LKr radiation length is 4.7 cm
  - LKr density is 2.41 g/cm^3

Backup

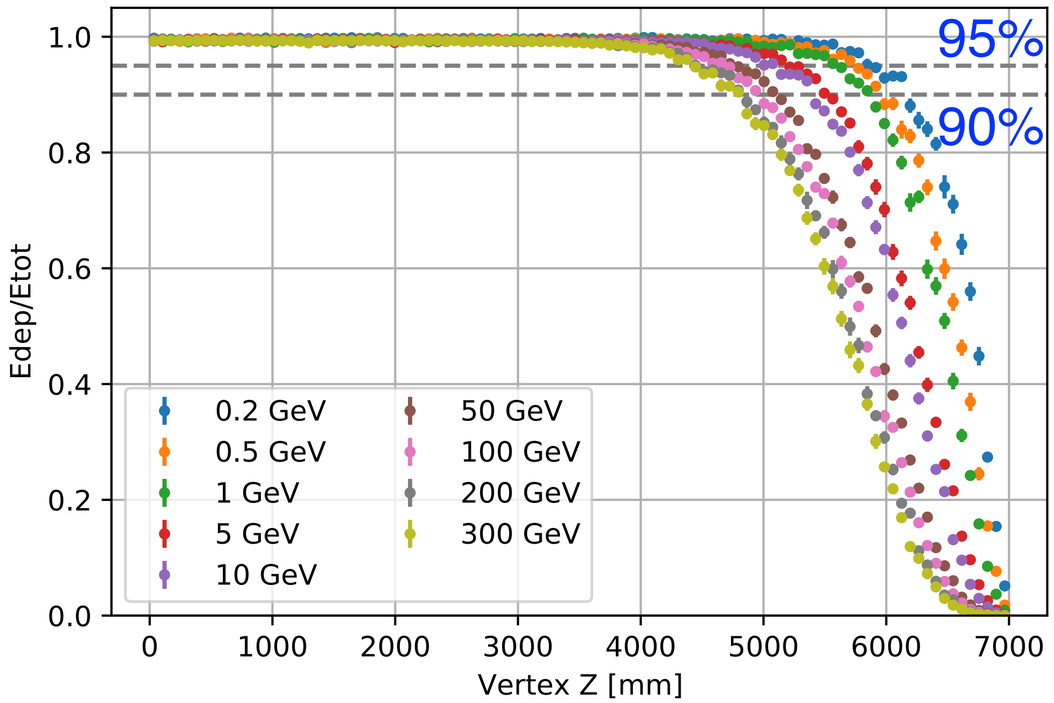
Detector Construction in Geant4

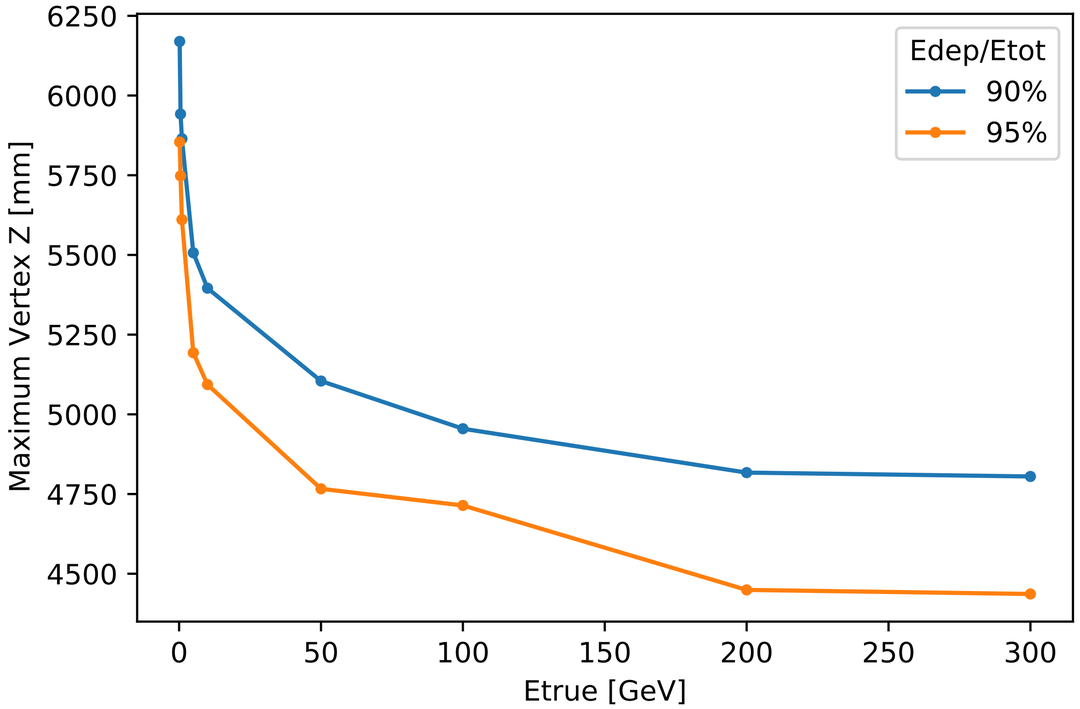
- A simple cuboid detector made up of LAr
  - Size: 1.5x1.5x7 and 1x1x7
  - Electron energy in the simulation: 200 MeV, 500 MeV, 1 GeV, 5 GeV, 10 GeV, 50 GeV, 100 GeV, 200 GeV, 300 GeV



Energy deposition

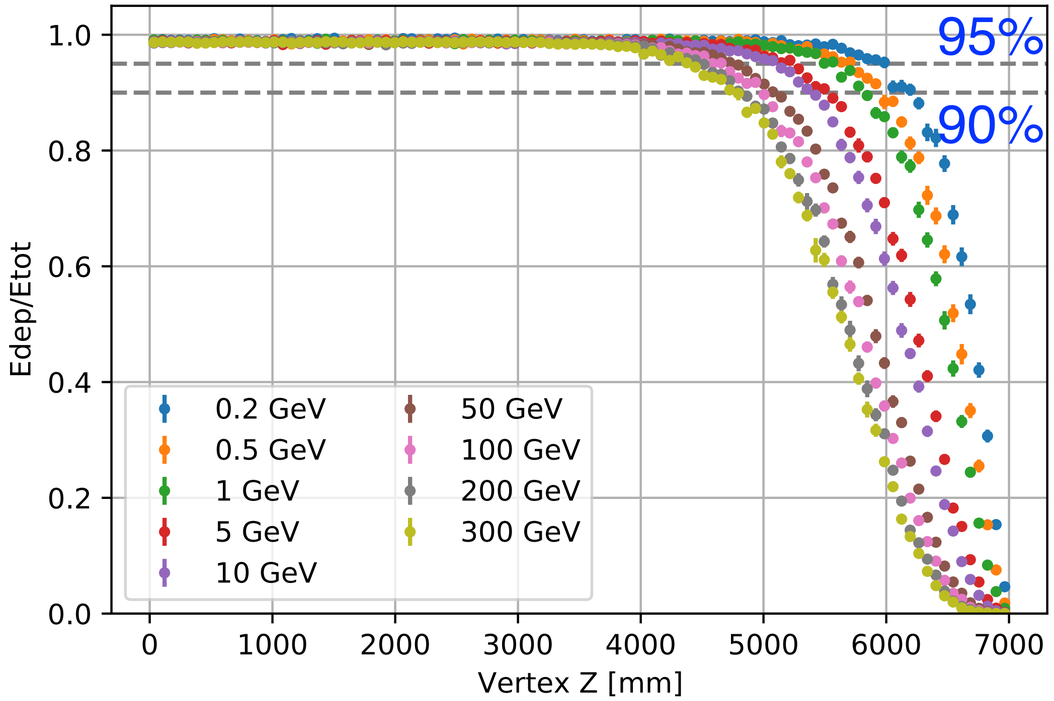
- Size configuration: 1.5x1.5x7 m
  - Left: The fraction of energy deposited inside the LAr region V.S. electron vertex Z
  - Right: Maximum vertex Z that can contain 90% (95%) of the energy V.S. true electron energy

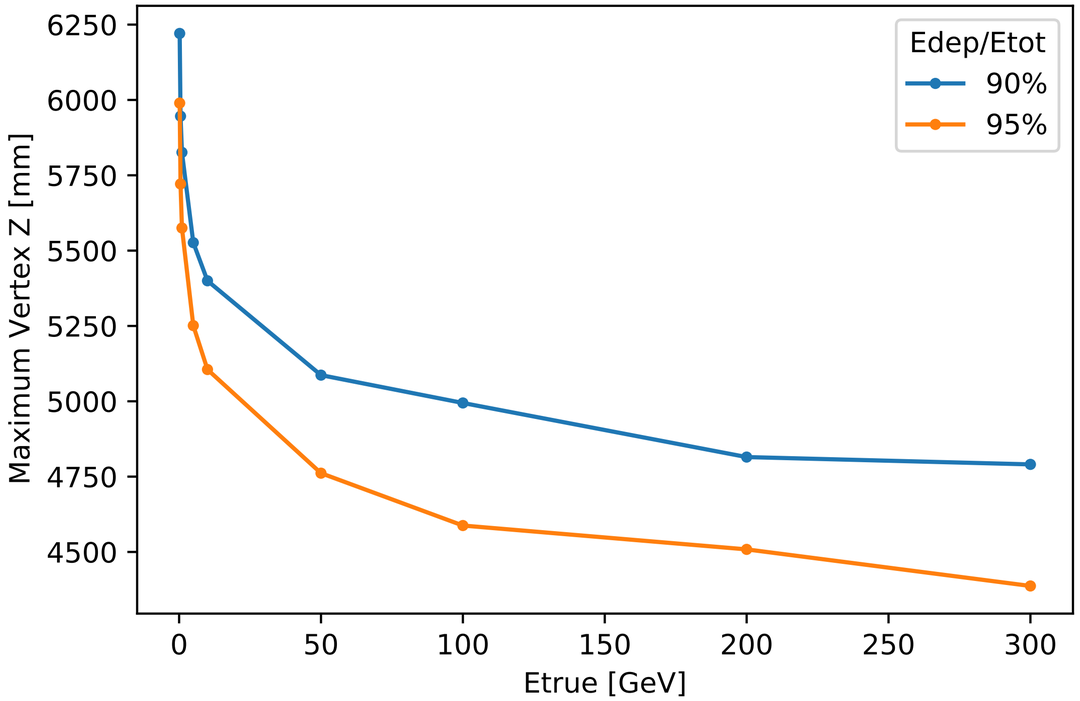




Energy deposition

- Similar plot for the size configuration: 1x1x7 m
  - Left: The fraction of energy deposited inside the LAr region V.S. electron vertex Z
  - Right: Maximum vertex Z that can contain 90% (95%) of the energy V.S. true electron energy





90% and 95% energy containment

- Comparison of two size configurations
  - Two configurations have almost the same acceptance for EM shower up to 300 GeV
  - **300 GeV EM Shower with 95% E containment: z < 4.4 m, 90% E containment: z < 4.8 m**