Particle ID in the 35 ton detector

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Introduction

We are working on particle ID in the 35 ton detector.

Made some event samples.

Made a principal component analysis (PCA) of the reconstructed hits in the events.

Had a first look at some variables that can discriminate between different particles.

Made an initial multivariate analysis (MVA) using those variables as input.

Introduction

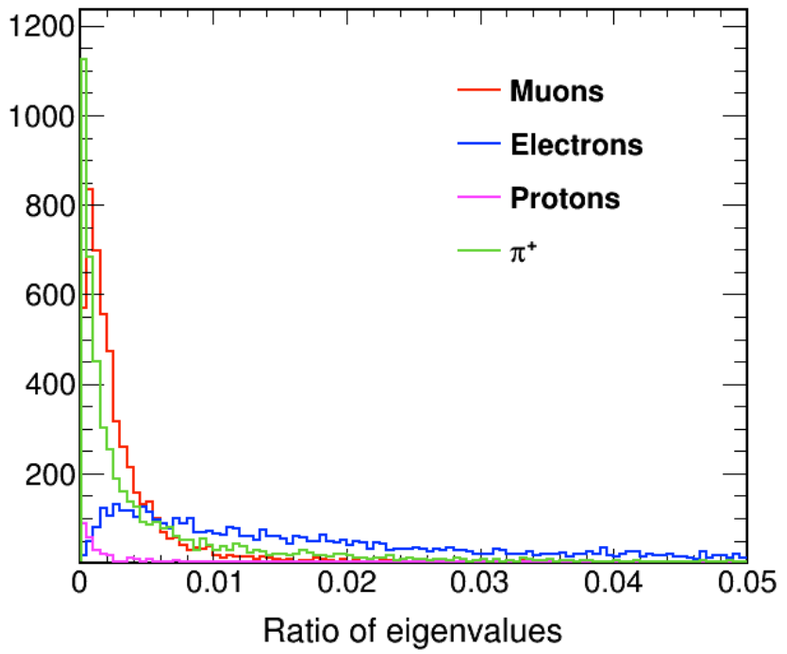
Made some event samples using a particle gun that sends a single particle per event into the 35 ton detector. Particles travel in the +z direction with some smearing of that direction in x and y.

Samples were made with 10000 events for each of muons, electrons, protons and π^+ at each of 5 different values of true momentum: 0.5, 1, 2, 3 and 4 GeV (with some spread in momentum around those central values).

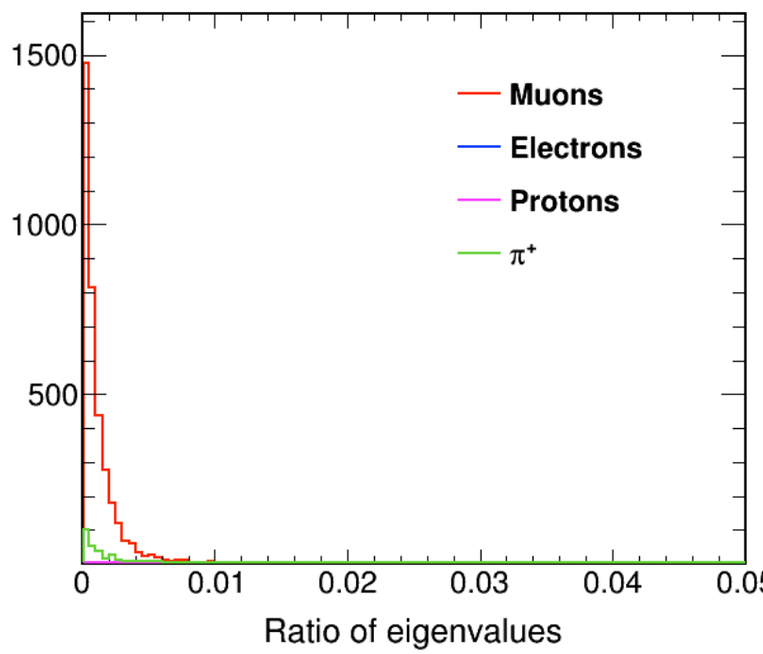
Made a principal component analysis (PCA) of the hit positions from the first reconstructed track in each event. All positions (e.g. radial distance or first or last 20% of track) are computed in the transformed PCA coordinates.

Ratio of eigenvalues

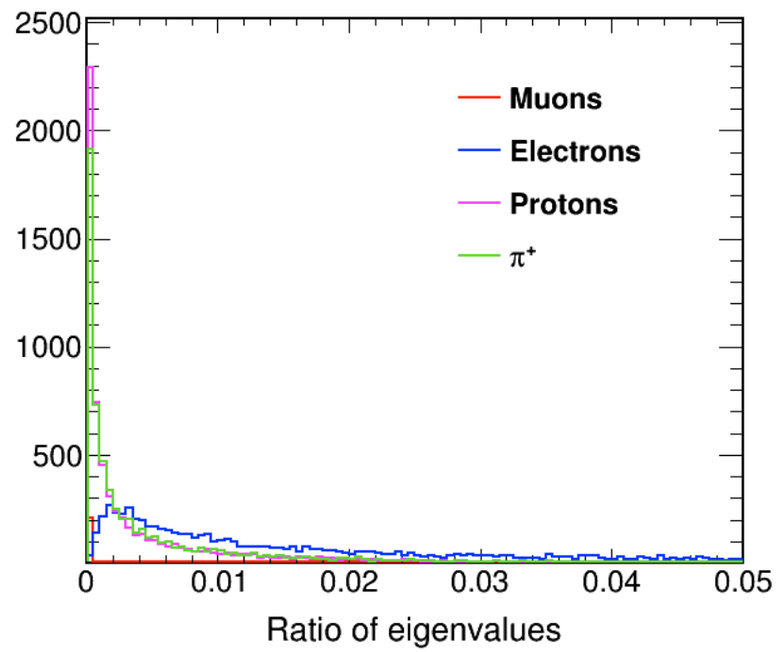
0.5 GeV sample, stopping



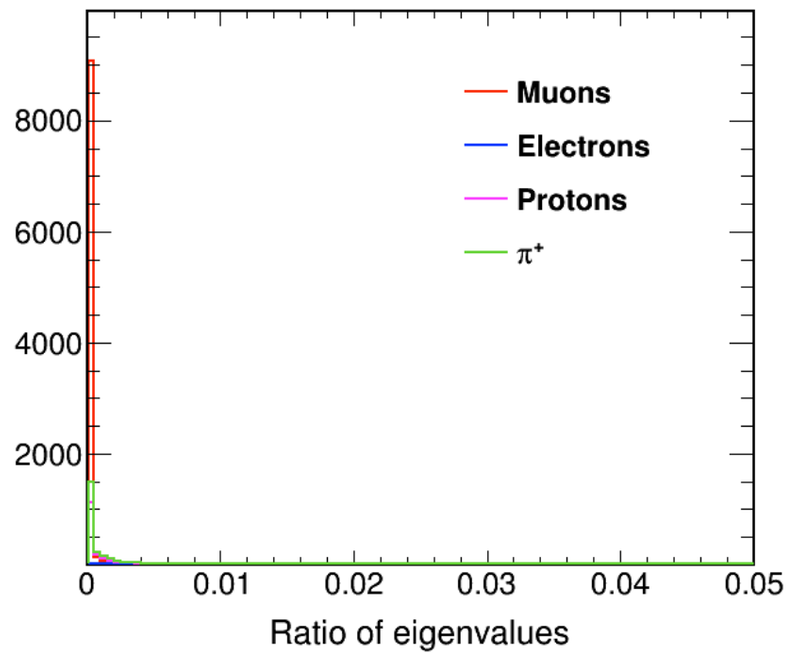
0.5 GeV sample, exiting



2 GeV sample, stopping



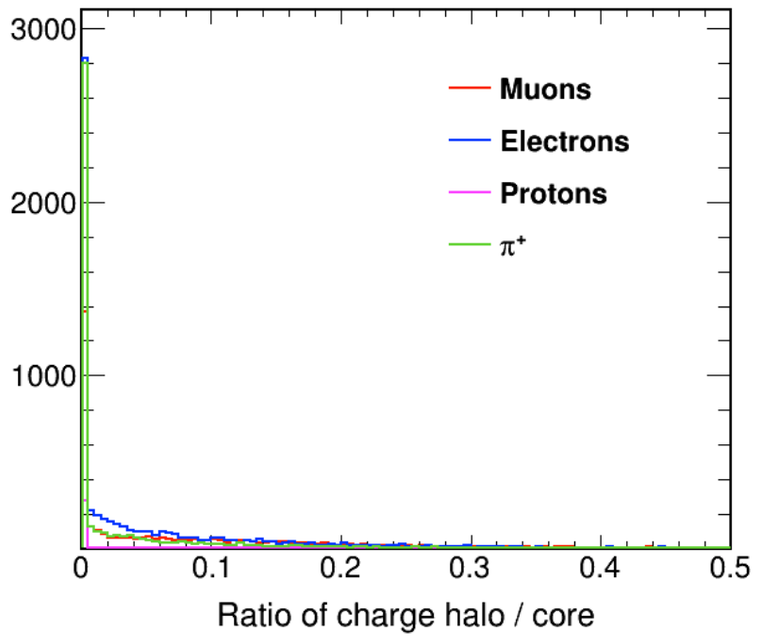
2 GeV sample, exiting



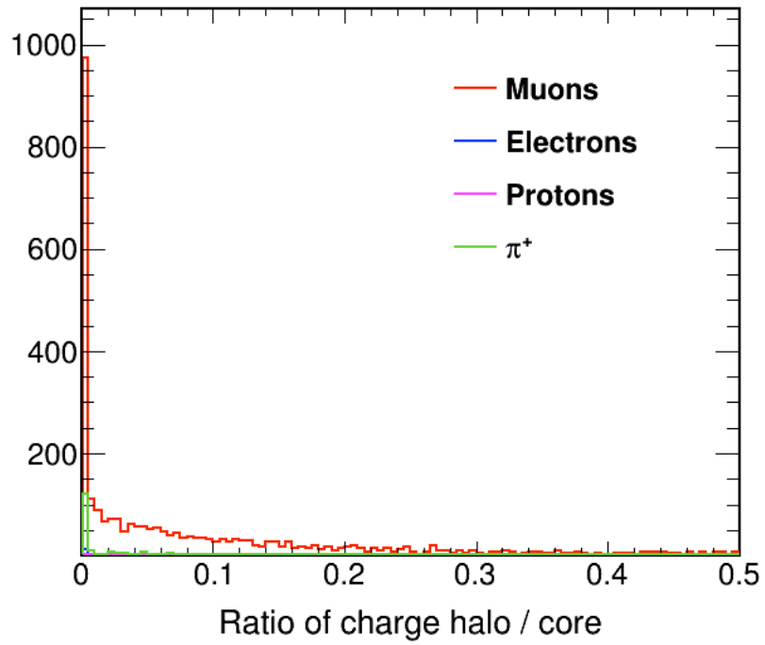
Ratio of second-largest and third-largest eigenvalues added in quadrature to largest eigenvalue (from PCA).

Ratio of charge halo / core

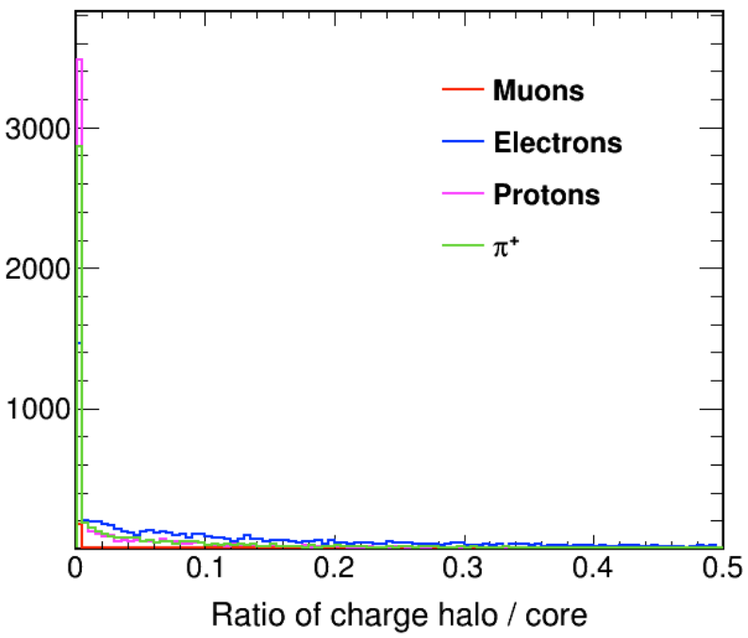
0.5 GeV sample, stopping



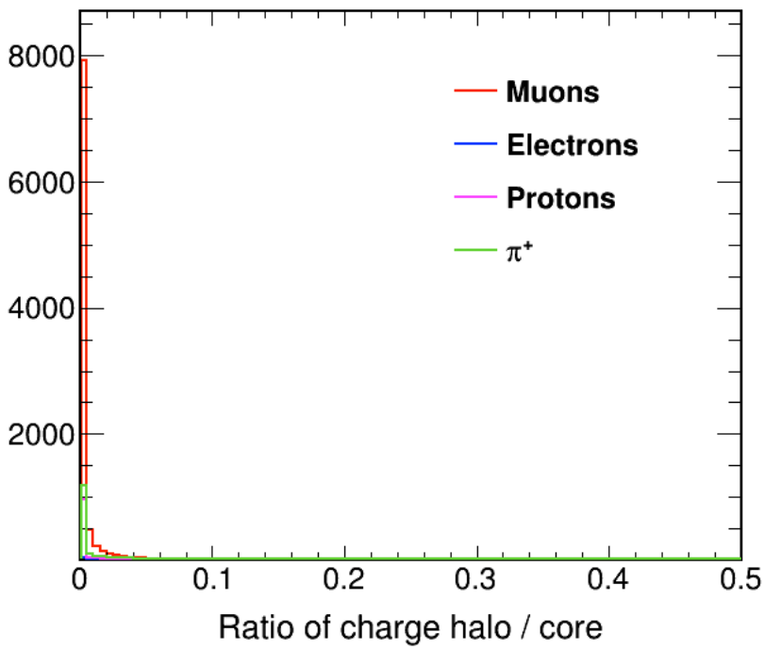
0.5 GeV sample, exiting



2 GeV sample, stopping



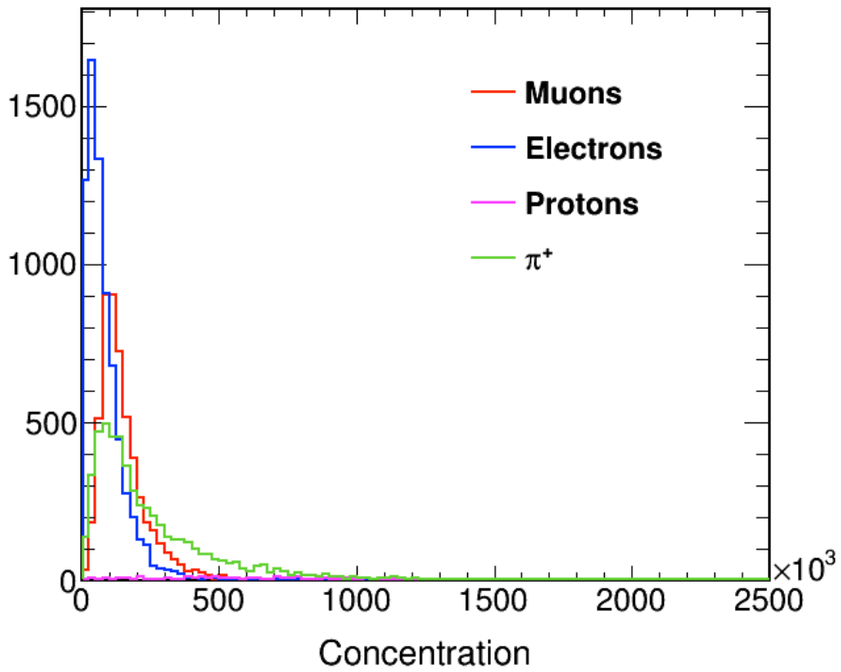
2 GeV sample, exiting



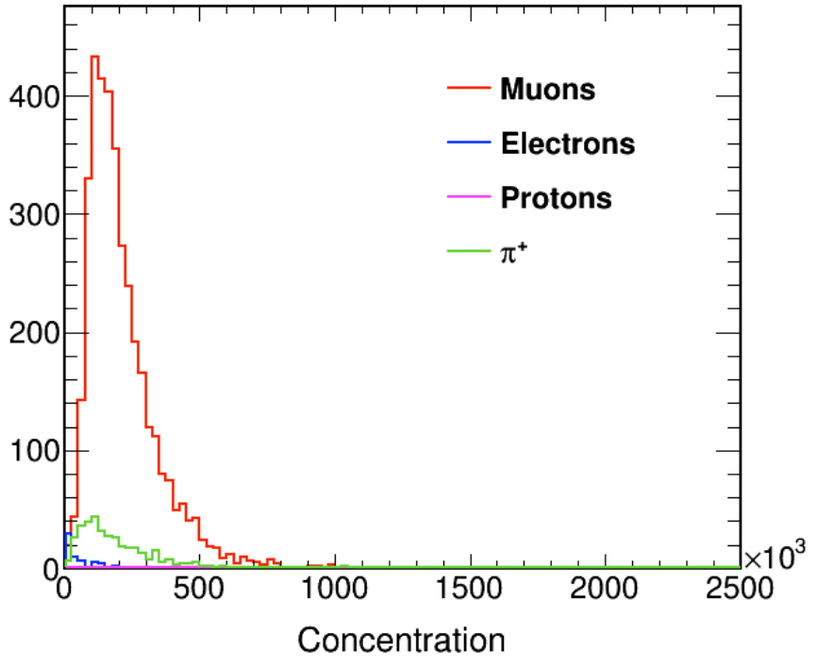
Ratio of charge deposited halo / core:
"core" is < 0.2 Moliere radius from principal axis (PA), "halo" is >= than this value.

Concentration

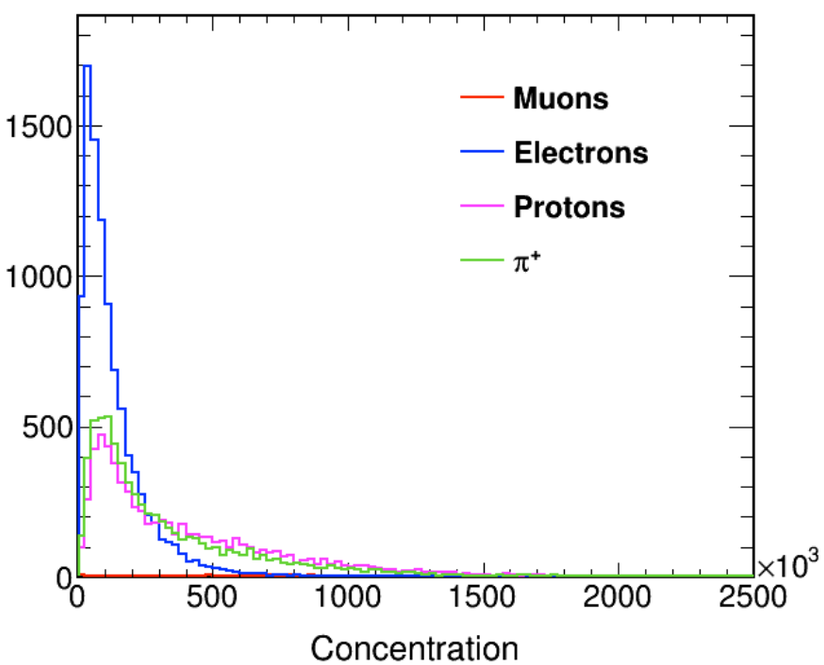
0.5 GeV sample, stopping



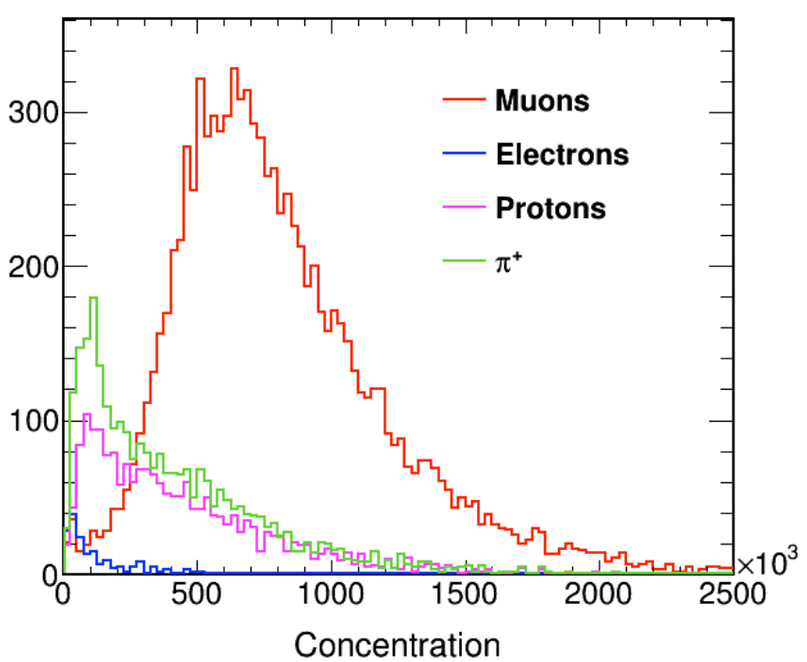
0.5 GeV sample, exiting



2 GeV sample, stopping



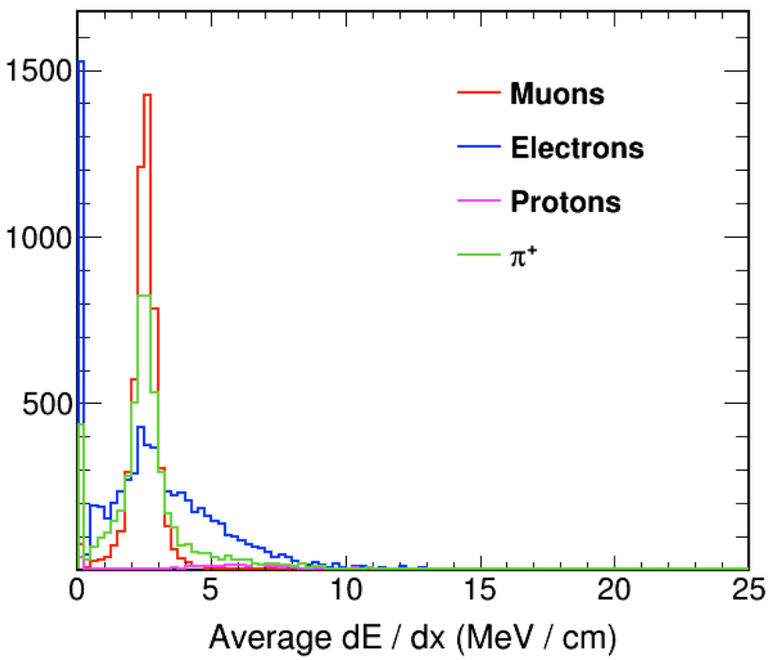
2 GeV sample, exiting



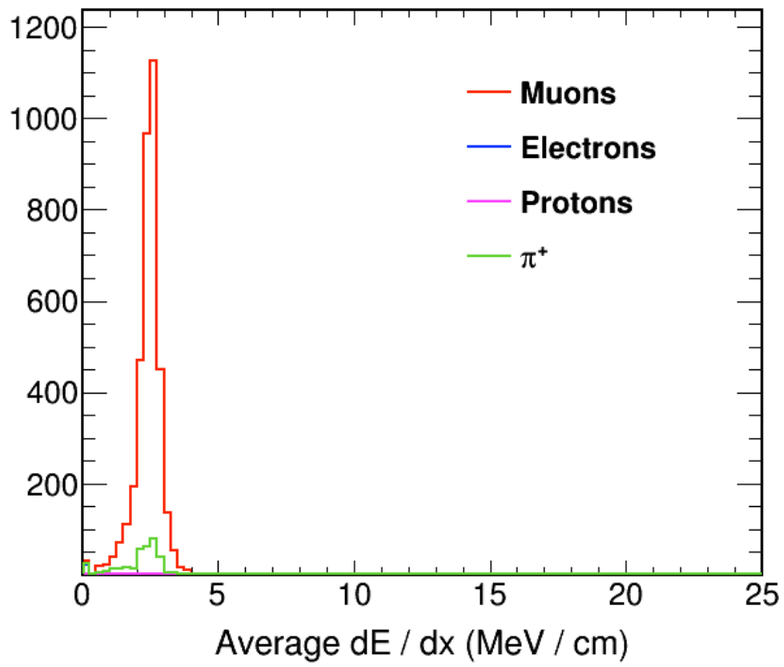
Sum of (charge deposited / radial distance from PA)

Average dE/dx (first 20%)

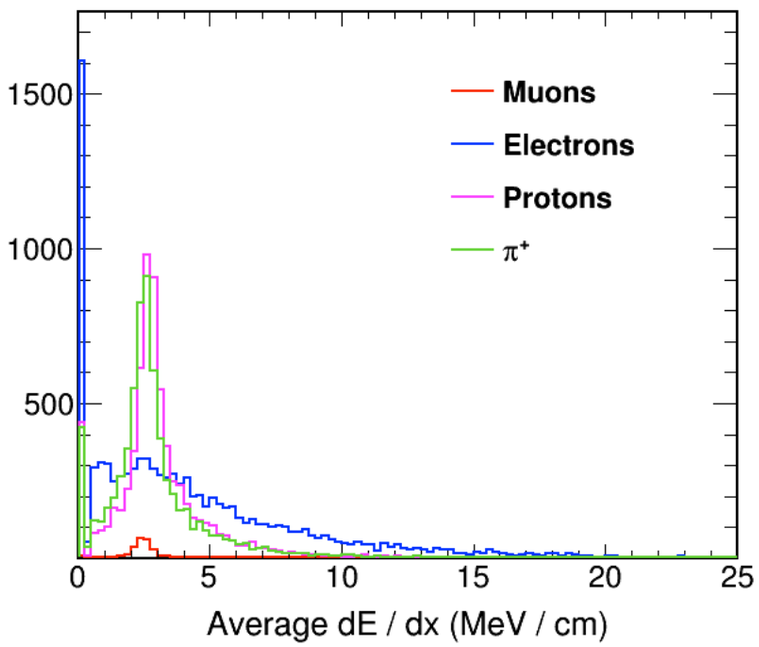
0.5 GeV sample, stopping



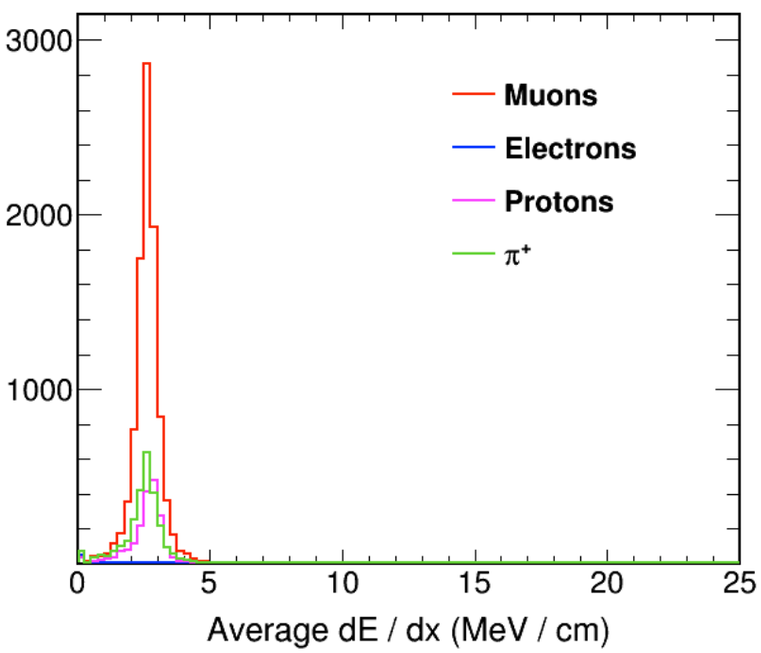
0.5 GeV sample, exiting



2 GeV sample, stopping



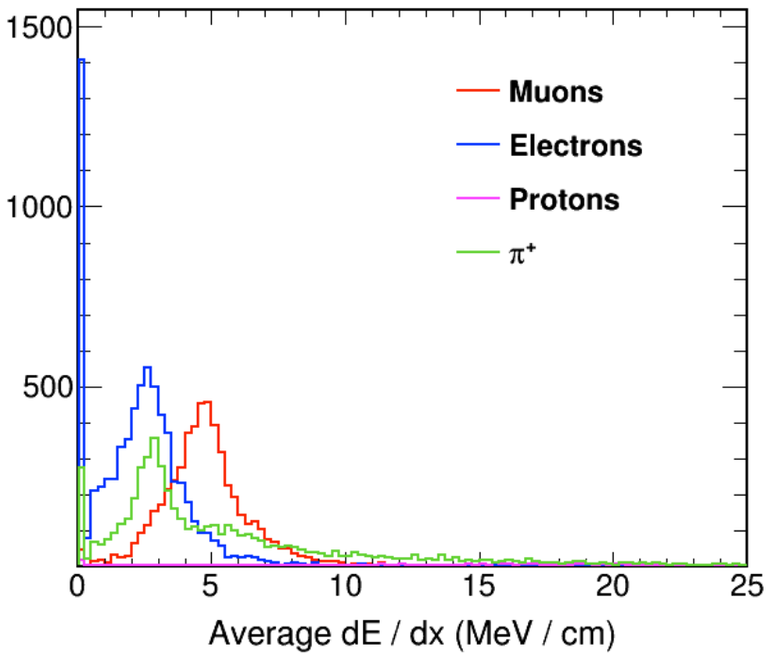
2 GeV sample, exiting



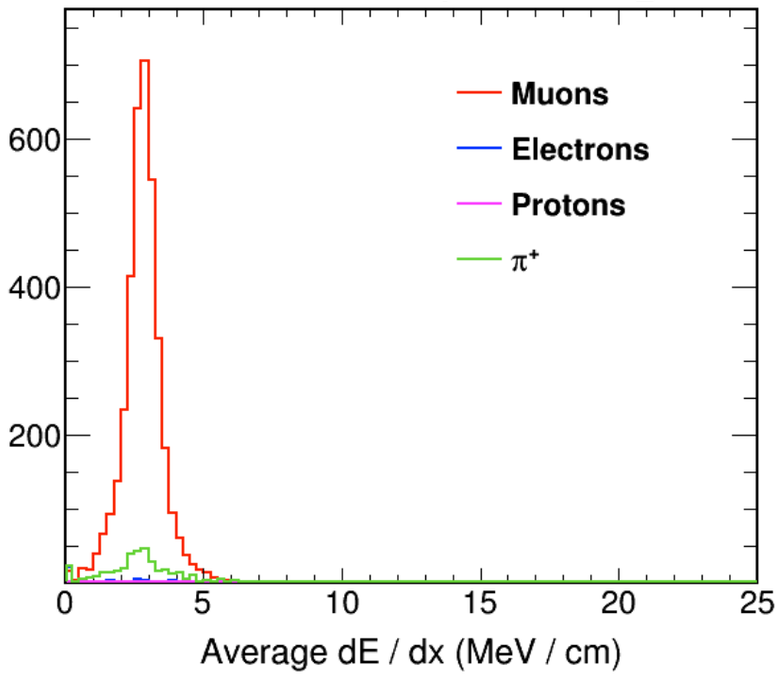
dE/dx is average value from first 20% of track computed using only hits from collection plane.

Average dE/dx (last 20%)

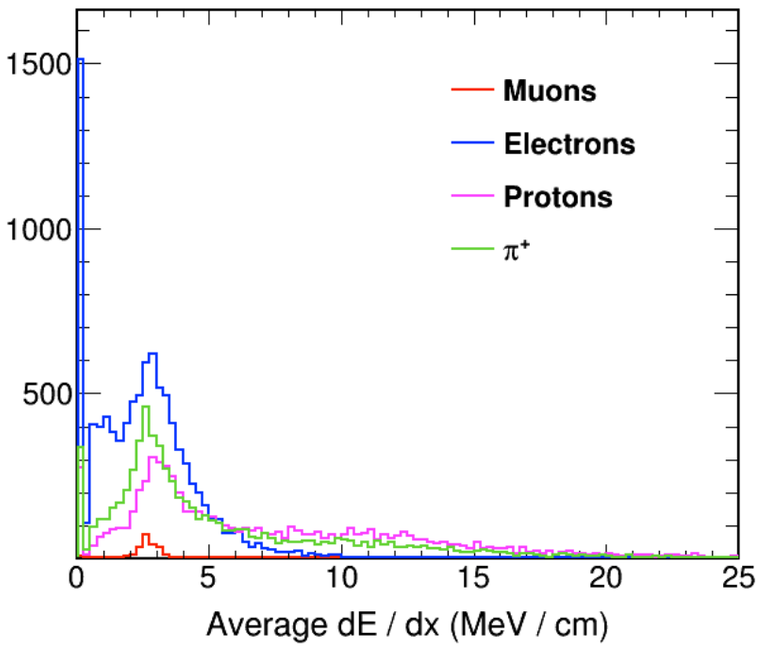
0.5 GeV sample, stopping



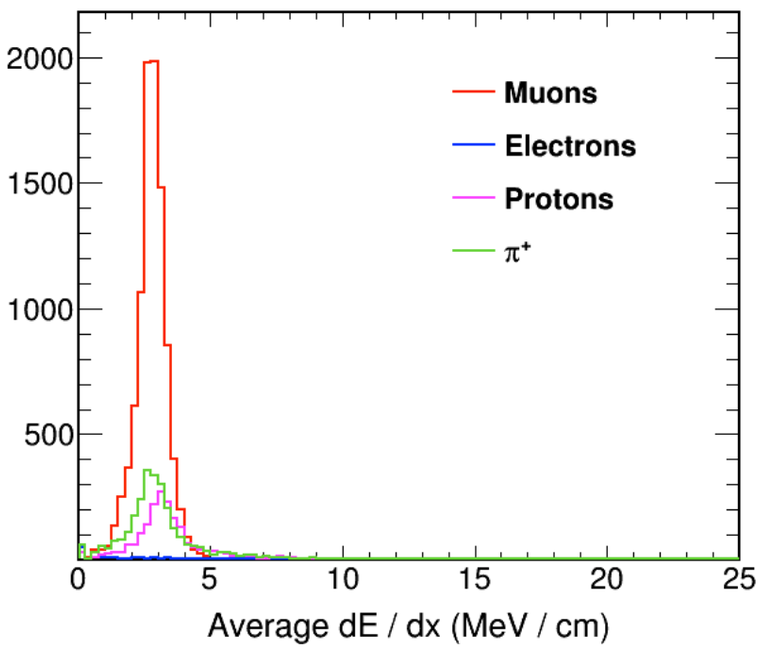
0.5 GeV sample, exiting



2 GeV sample, stopping



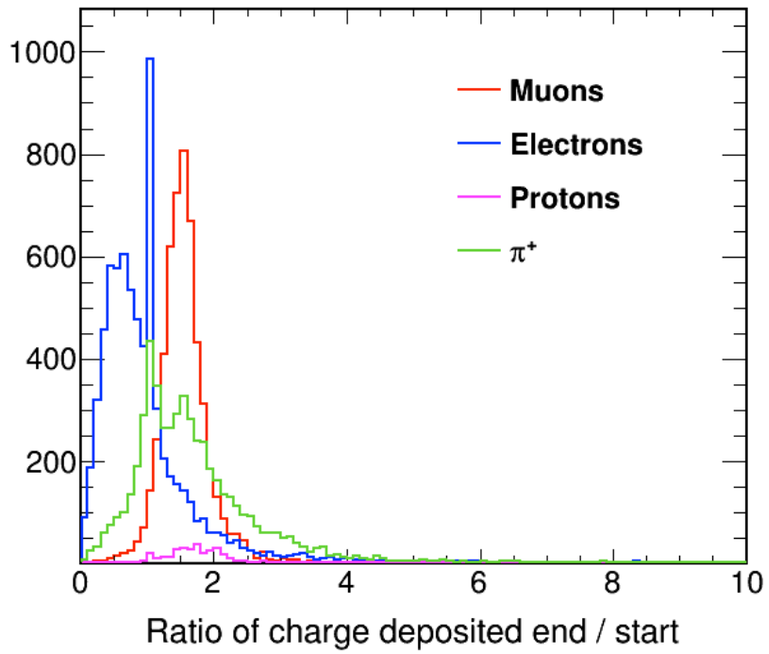
2 GeV sample, exiting



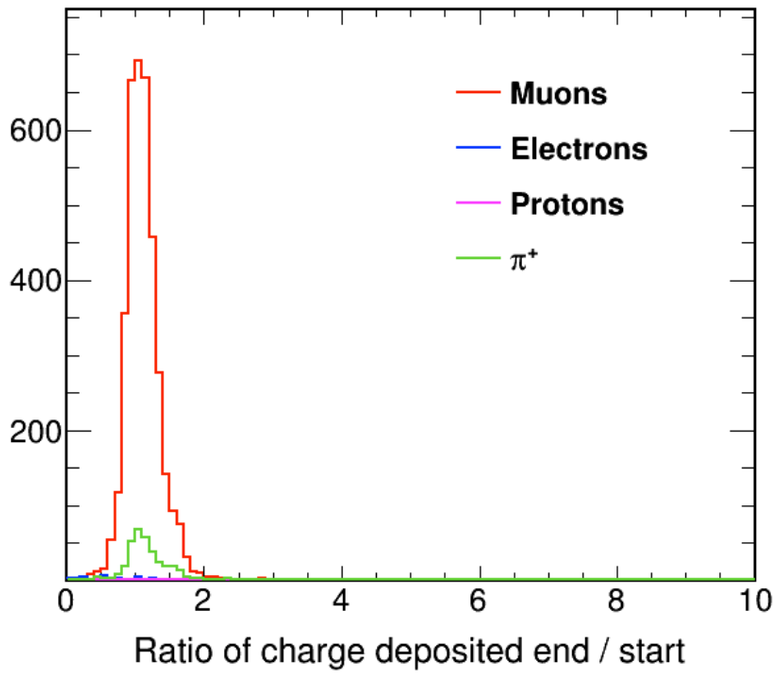
dE/dx is average value from last 20% of track computed using only hits from collection plane.

Longitudinal charge ratio

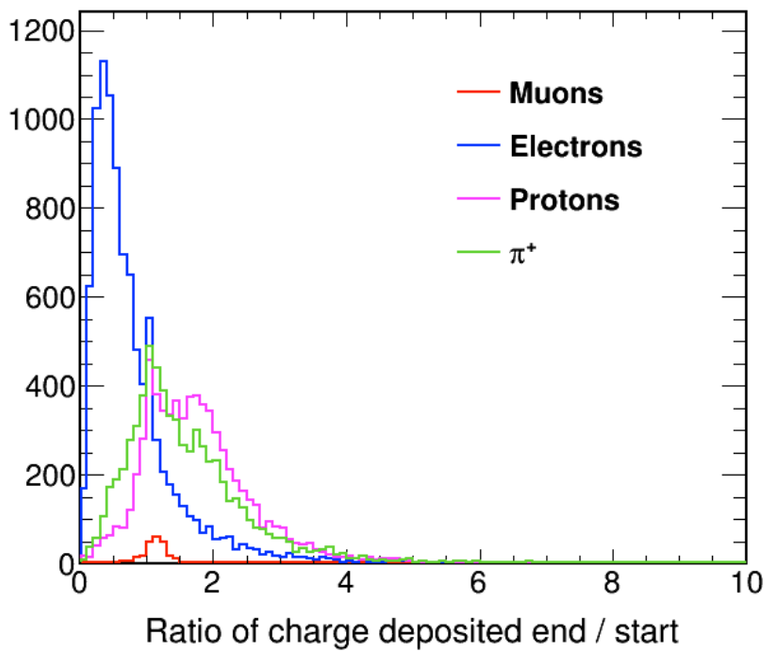
0.5 GeV sample, stopping



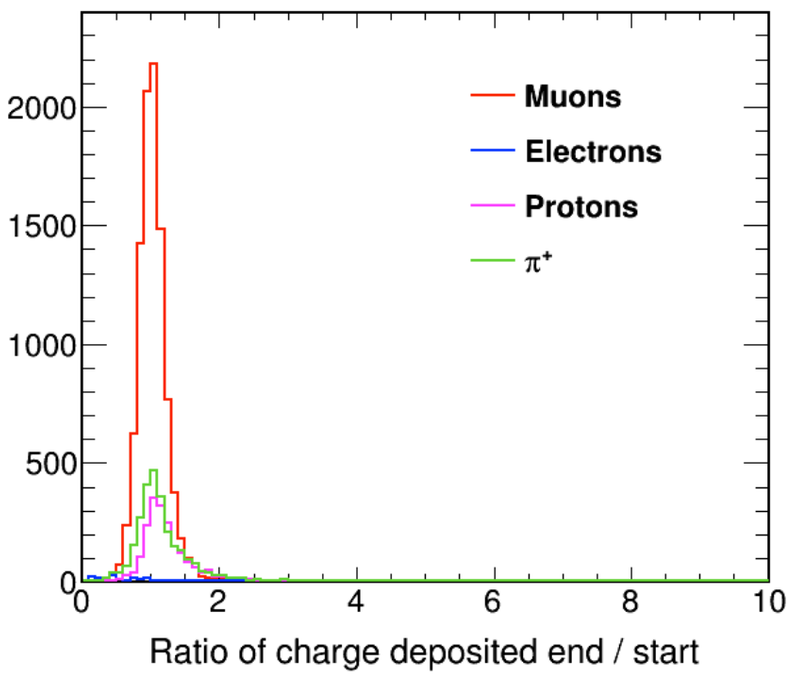
0.5 GeV sample, exiting



2 GeV sample, stopping



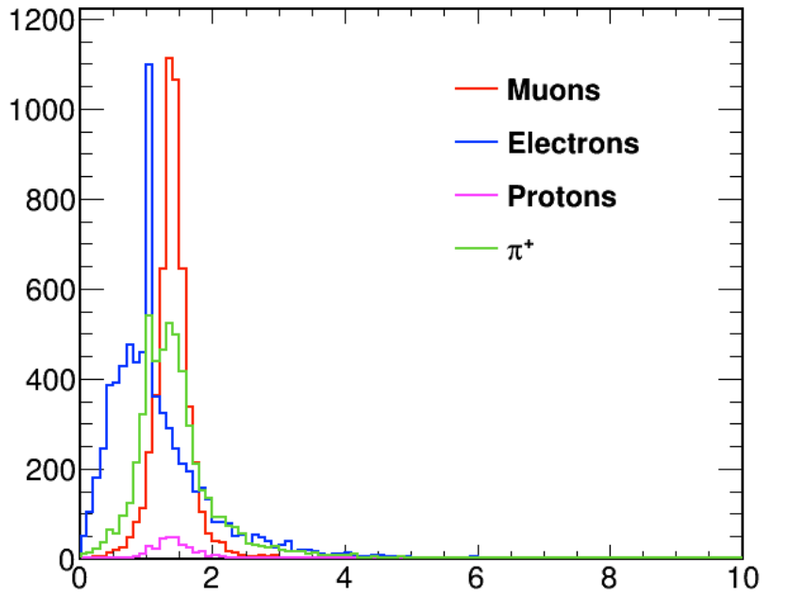
2 GeV sample, exiting



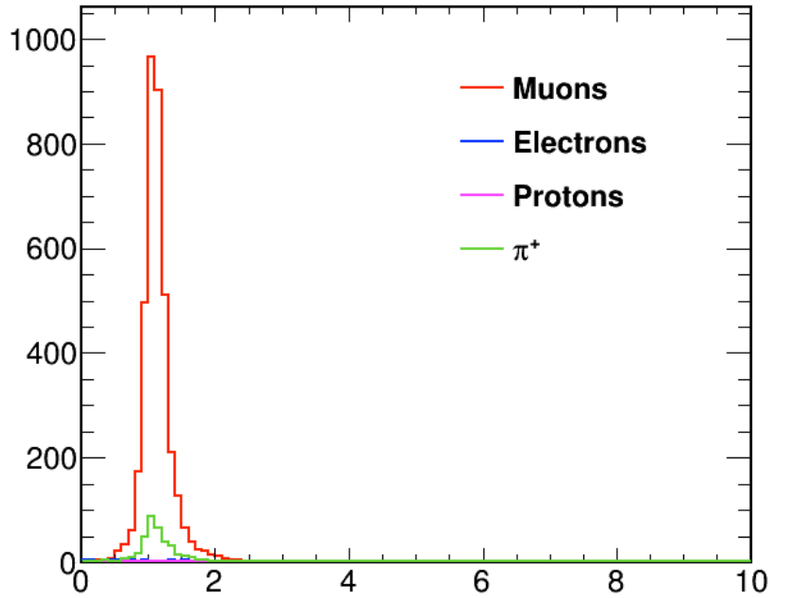
Ratio of charge deposited in last 20% / first 20% of track

End charge ratio

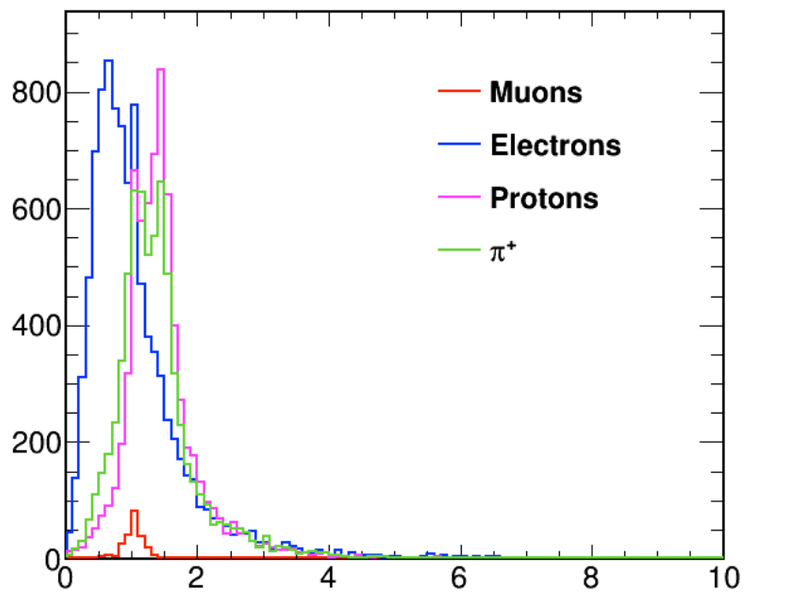
0.5 GeV sample, stopping



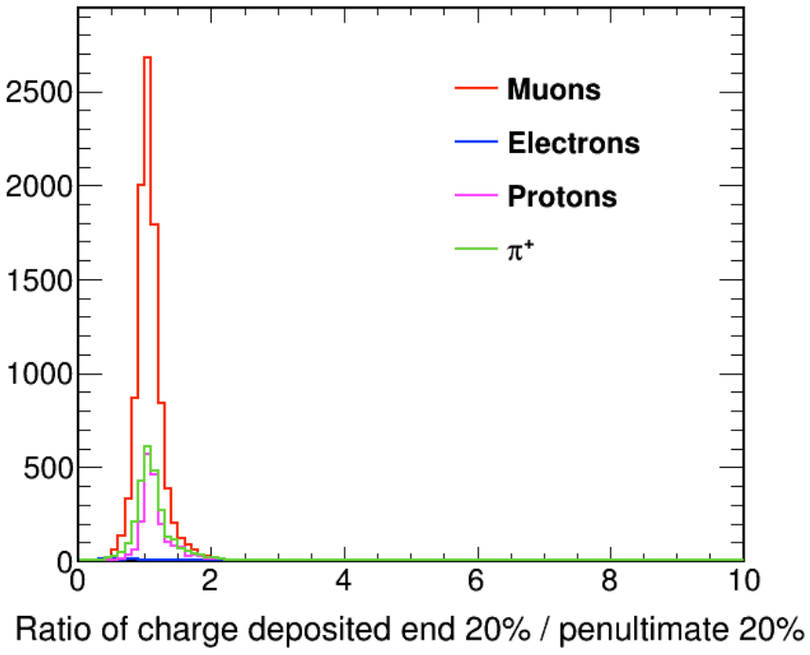
0.5 GeV sample, exiting



2 GeV sample, stopping



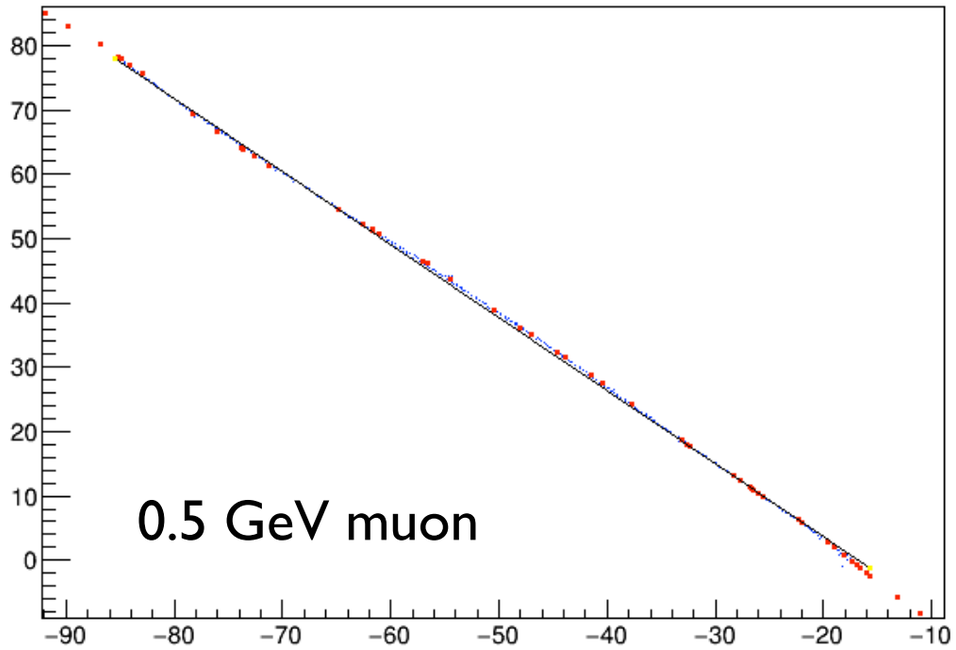
2 GeV sample, exiting

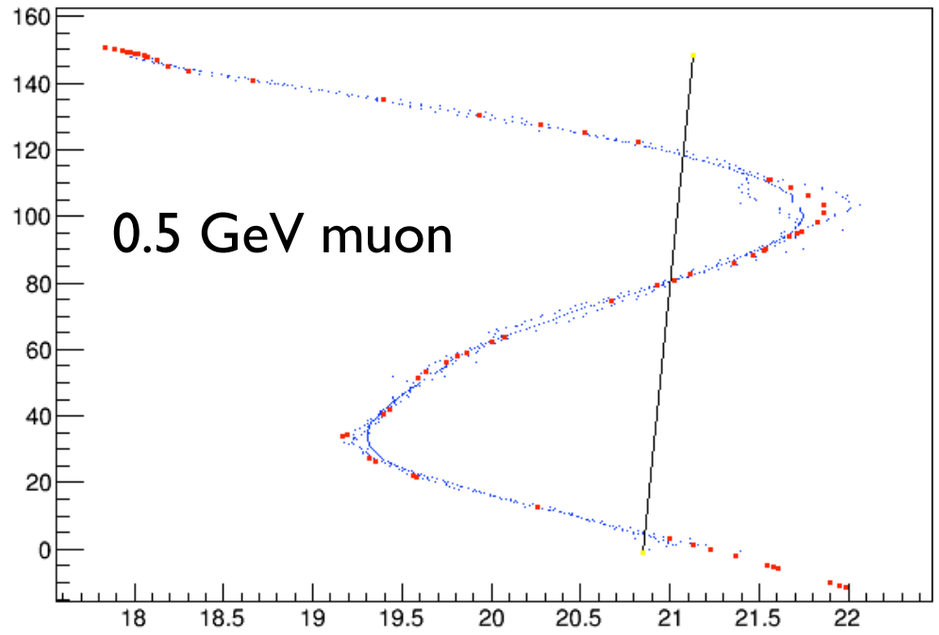


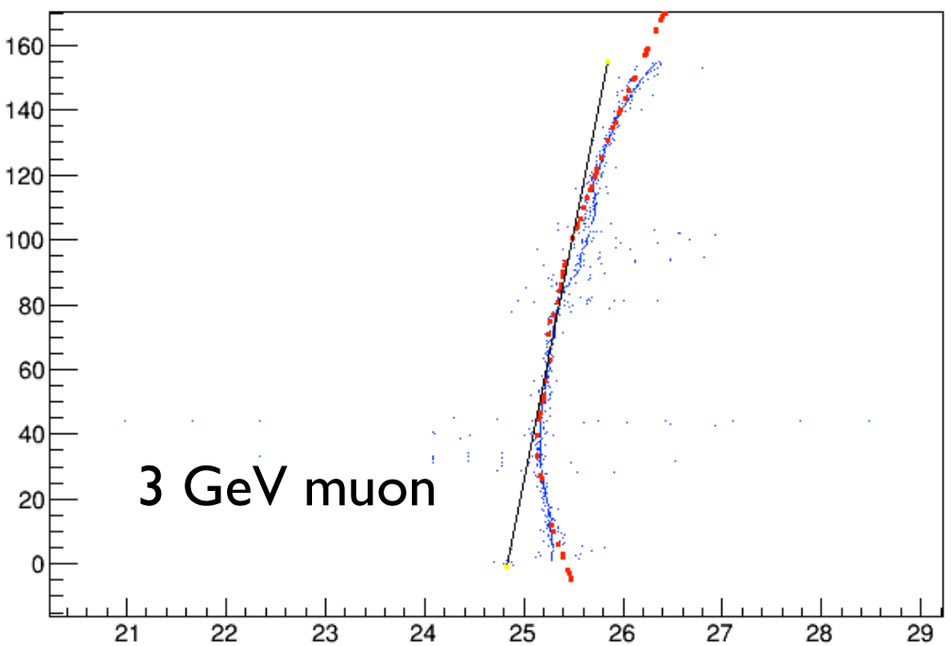
Ratio of charge deposited in last 20% / penultimate 20% of track

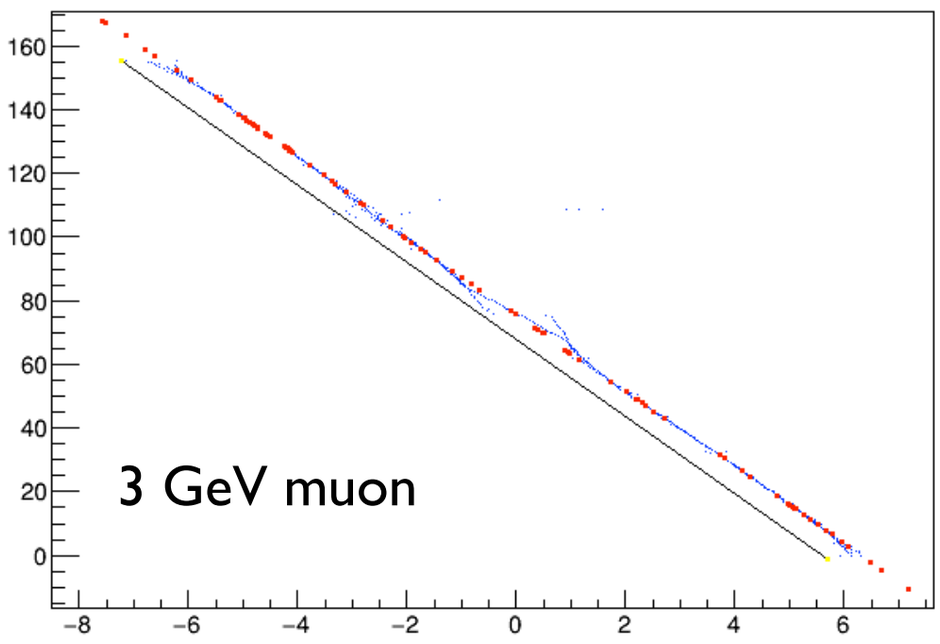
Event displays

Red: true track points Blue: reconstructed hits Black: principal axis









Multivariate analysis

Methods used are MLP (neural net), boosted decision tree and rectangular cuts.

Generated from same event samples as the particle ID variables.

A MVA is done separately for each value of momentum in the event samples.

Particle ID variables used are ratio of eigenvalues, ratio of charge deposited halo/core and dE/dx at start and end of track.

MVA results (1 GeV)

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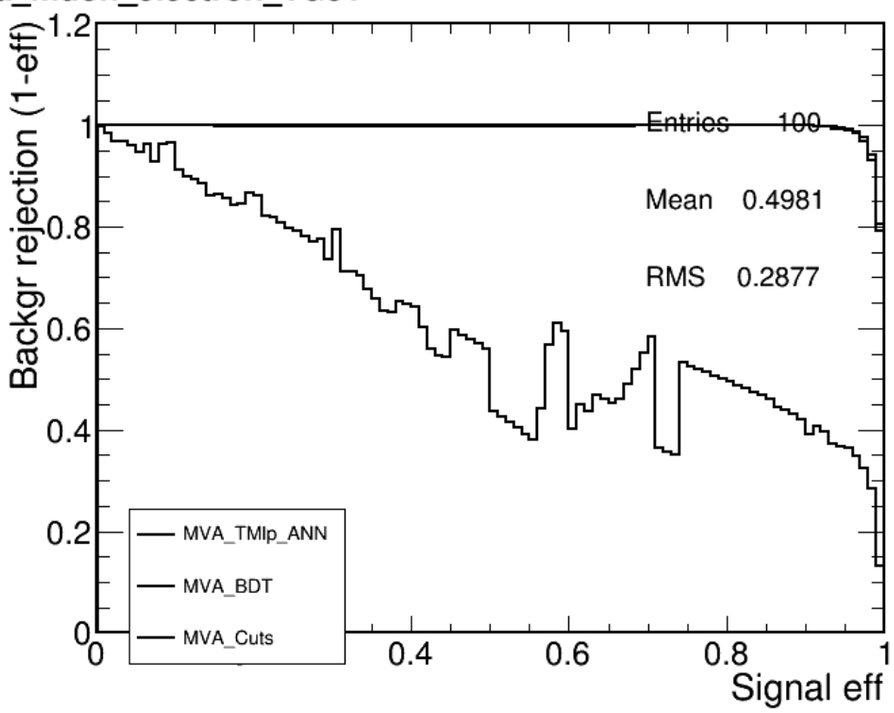
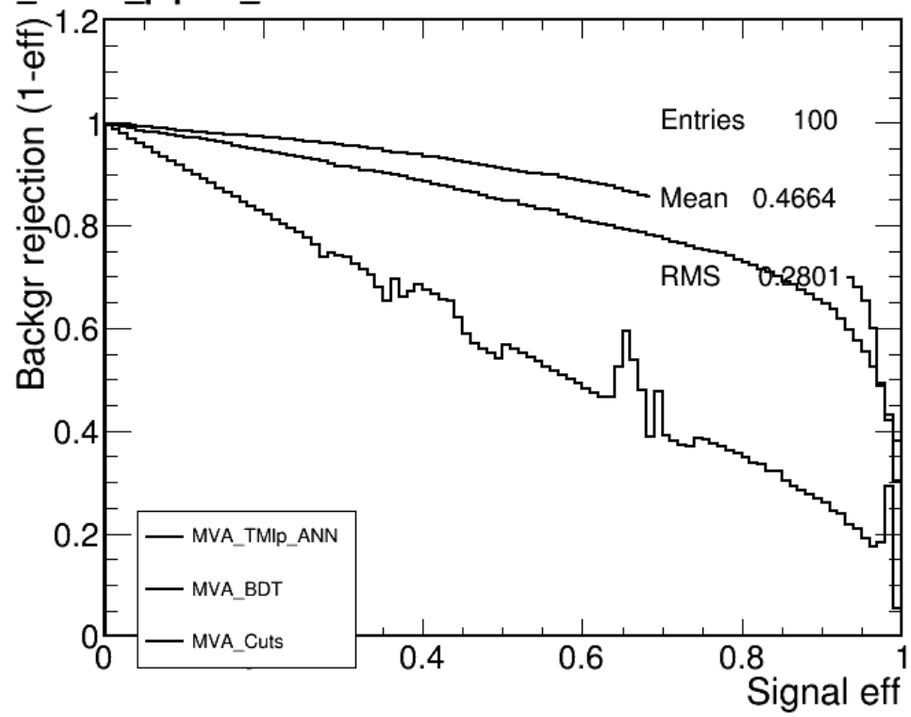
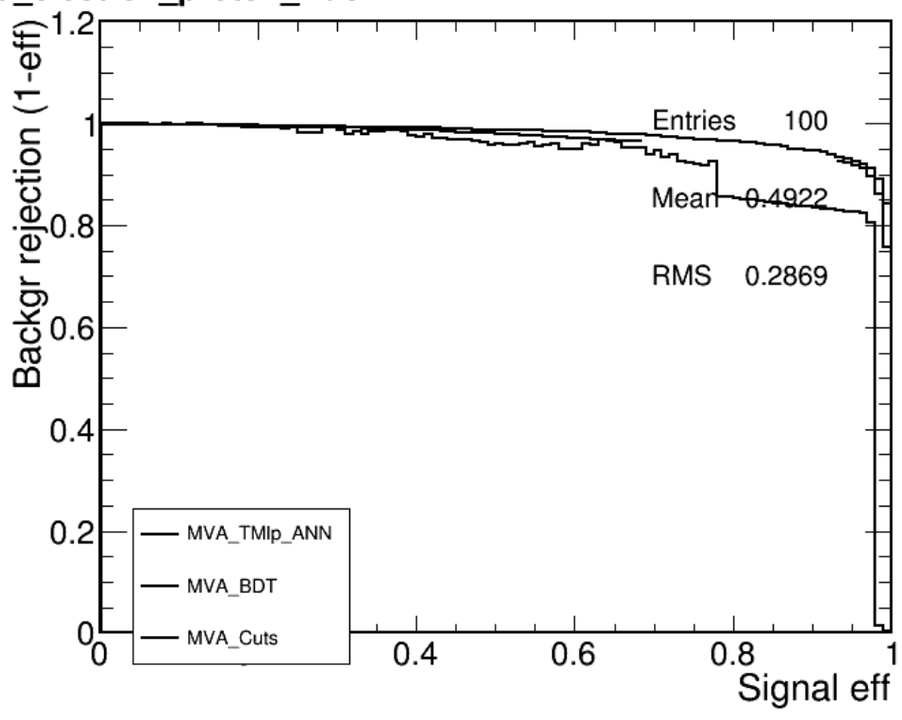
mva_muon_electron_1GeV



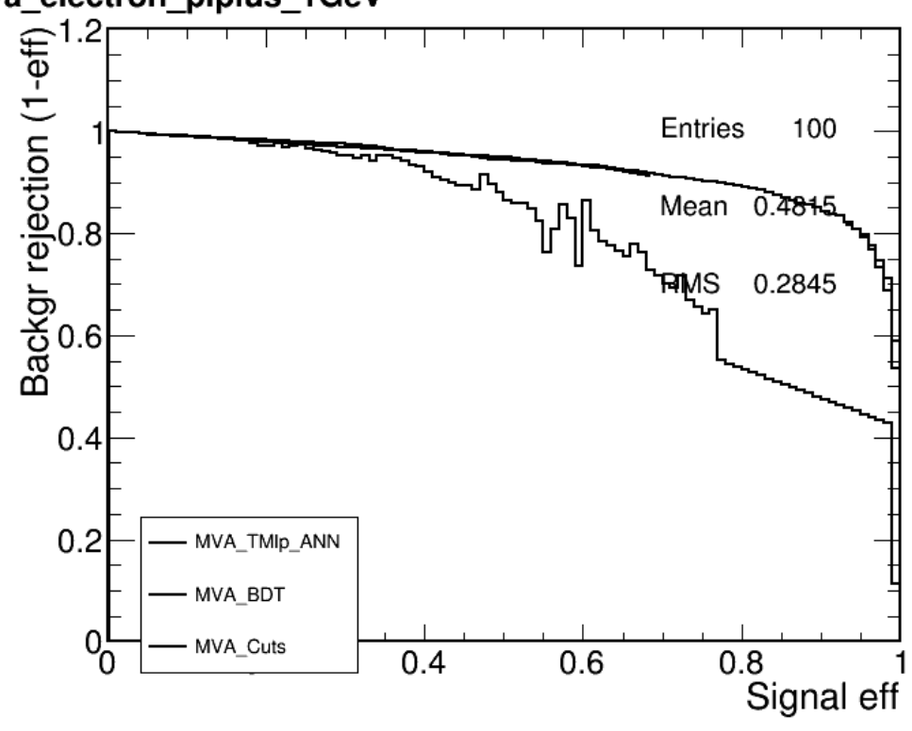
mva_muon_piplus_1GeV



mva_electron_proton_1GeV



mva_electron_piplus_1GeV



MVA results (2 GeV)