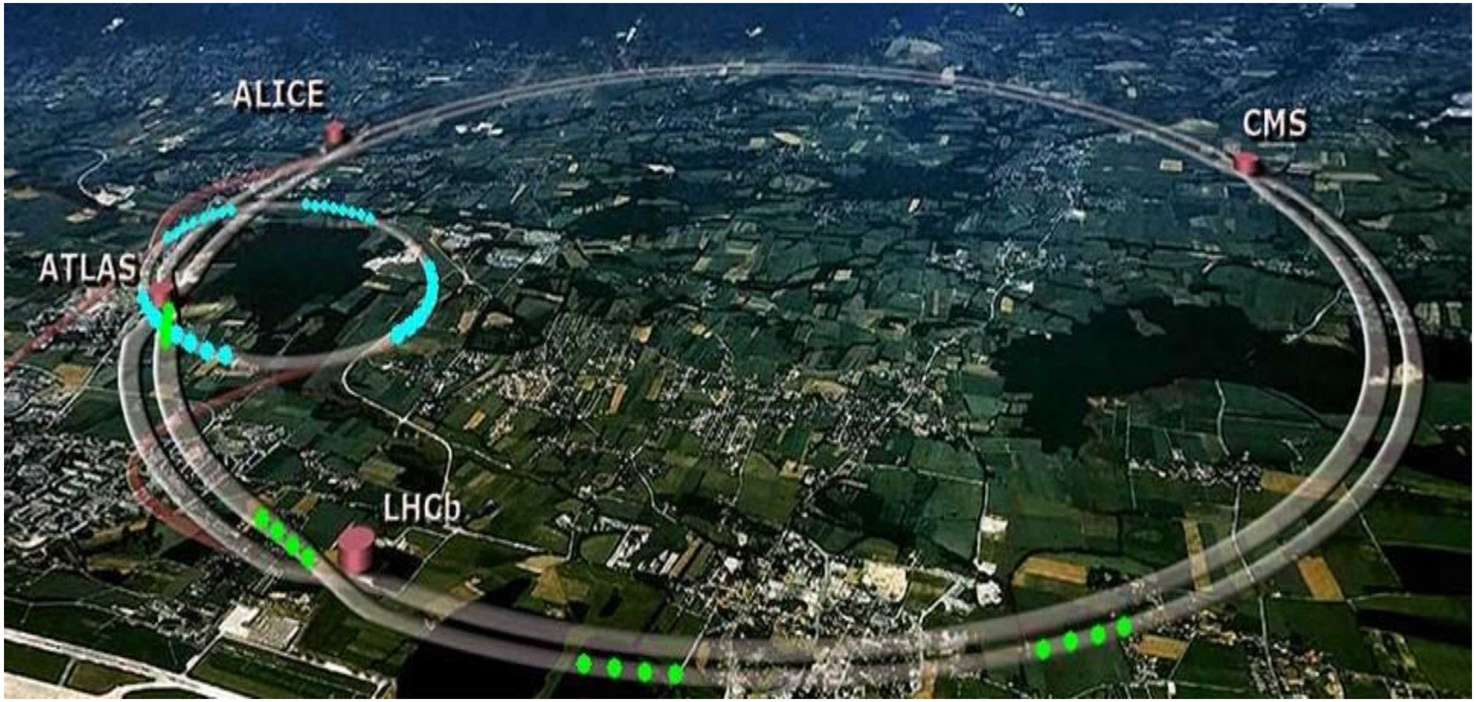
The LHCb detector and the determination of its downstream track efficiency.

Eluned Smith

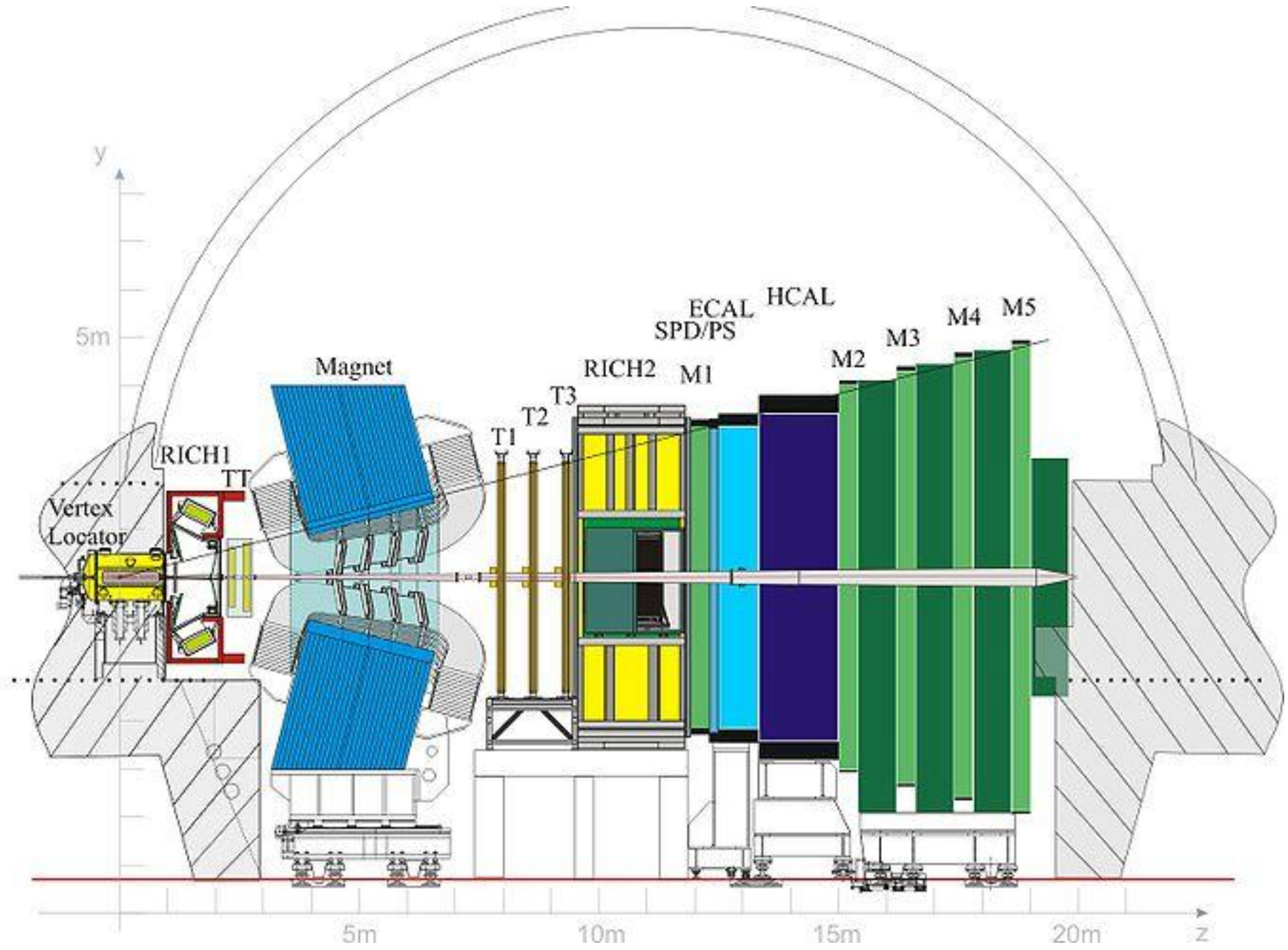
Outline

- Overview of relevant parts of the LHCb detector.
- What are downstream tracks?
- Why do we what to better understand their efficiency?
- Method proposed to determine downstream track efficiency.
- Analysis carried out so far.

The Large Hadron Collider (LHC)

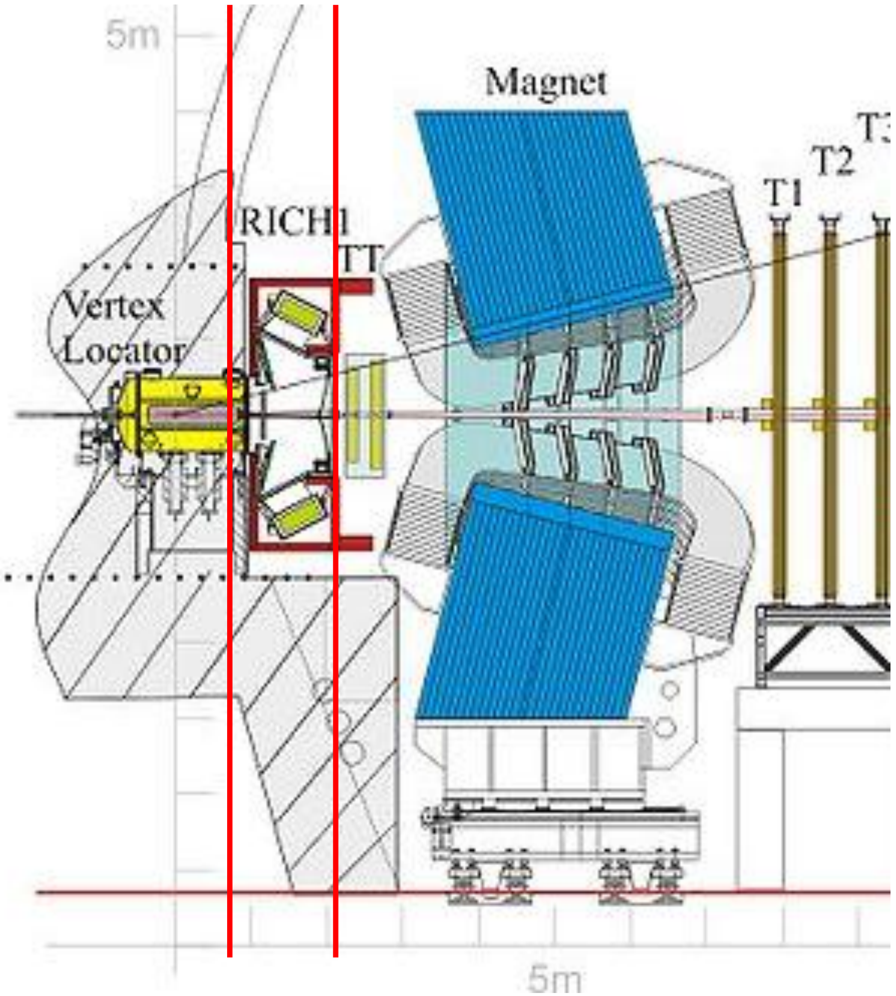


The LHCb detector

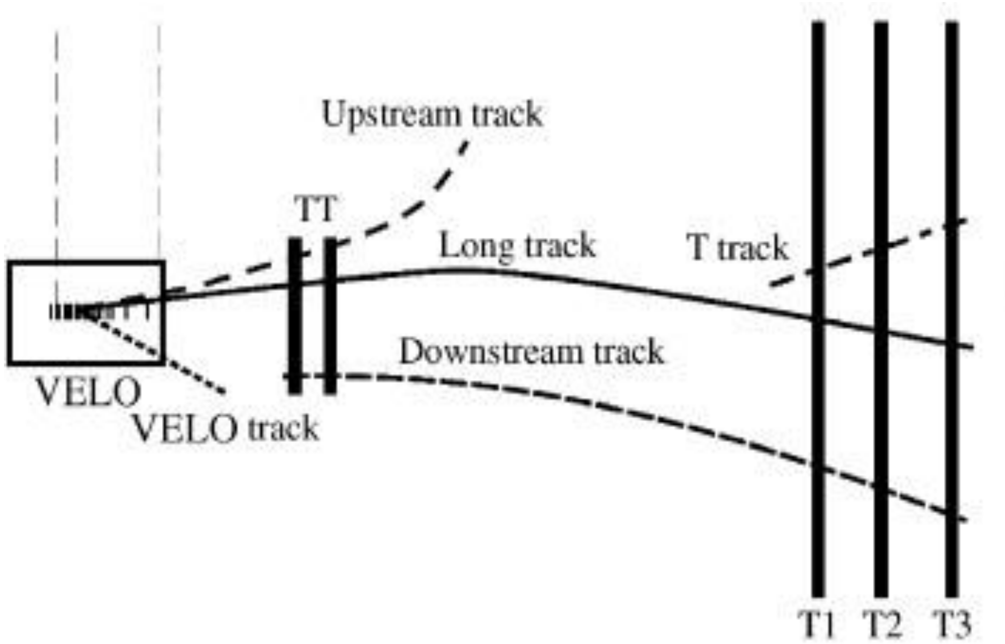


- Vertex locator (VELO) end at ~ 700mm.
- Sensors ~ 7mm from the beam.
- Resolution: $\sigma(x, y, z) =$ (16,15,90)μm.

- TT tracker starts at ~ 2m.
- Track must leave hits in both TT and T1,2,3.



Types of tracks at LHCb.



- Upstream + Downstream = Long
- Events can be registered from just downstream tracks, when displaced vertex is downstream of the VELO.

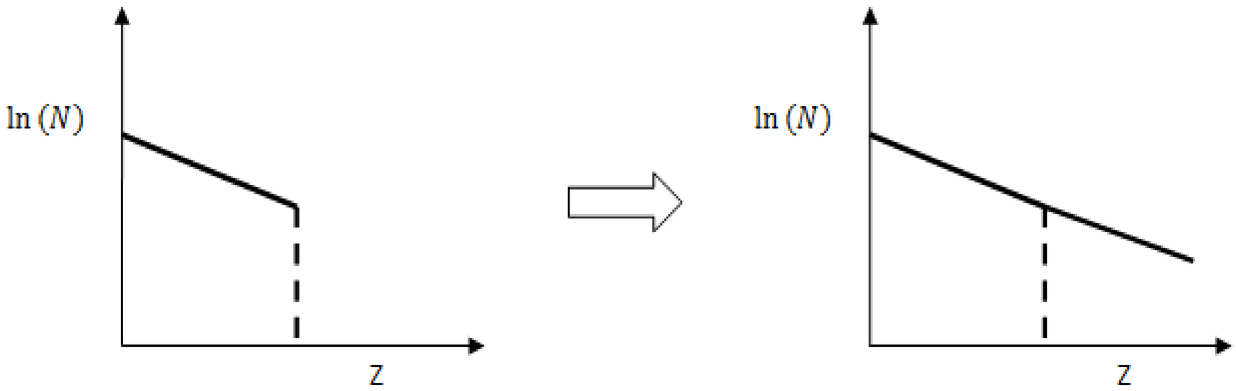
Motivation for improving downstream track efficiency.

- Longstream track efficiency values well studied (2-3 significant figure error depending on bin).
- Downstream track efficiency less well studied and understood.
- Importance: Various hidden sector theories predict long-lived massive particles, which may decay beyond the VELO.

Method to calculate downstream track efficiency.

- Will use data from K_s events (decaying to two pions) as K_s relatively long-lived.
- Relation between observed number (n) and actual (N):
- $n_{long}(z,p,\eta) = \varepsilon_{long}(\eta,p,z)N_{long}(z,p,\eta)$
- $n_{down}(z,p,\eta) = \varepsilon_{down}(\eta,p,z)N_{down}(z,p,\eta)$
- $N_{long}(z,p,\eta) = \frac{n_{long}(z,p)}{\varepsilon_{long}(\eta,p,z)}$

- Use $N_{long}(z, p, \eta)$ to obtain $N_{down}(z, p, \eta)$



- Use observed counts to extract $\varepsilon_{down}(\eta, p, z)$
- $\varepsilon_{down}(\eta, p, z) = \frac{n_{down}(z,p,\eta)}{N_{down}(z,p,\eta)}$

Analysis and progress so far.

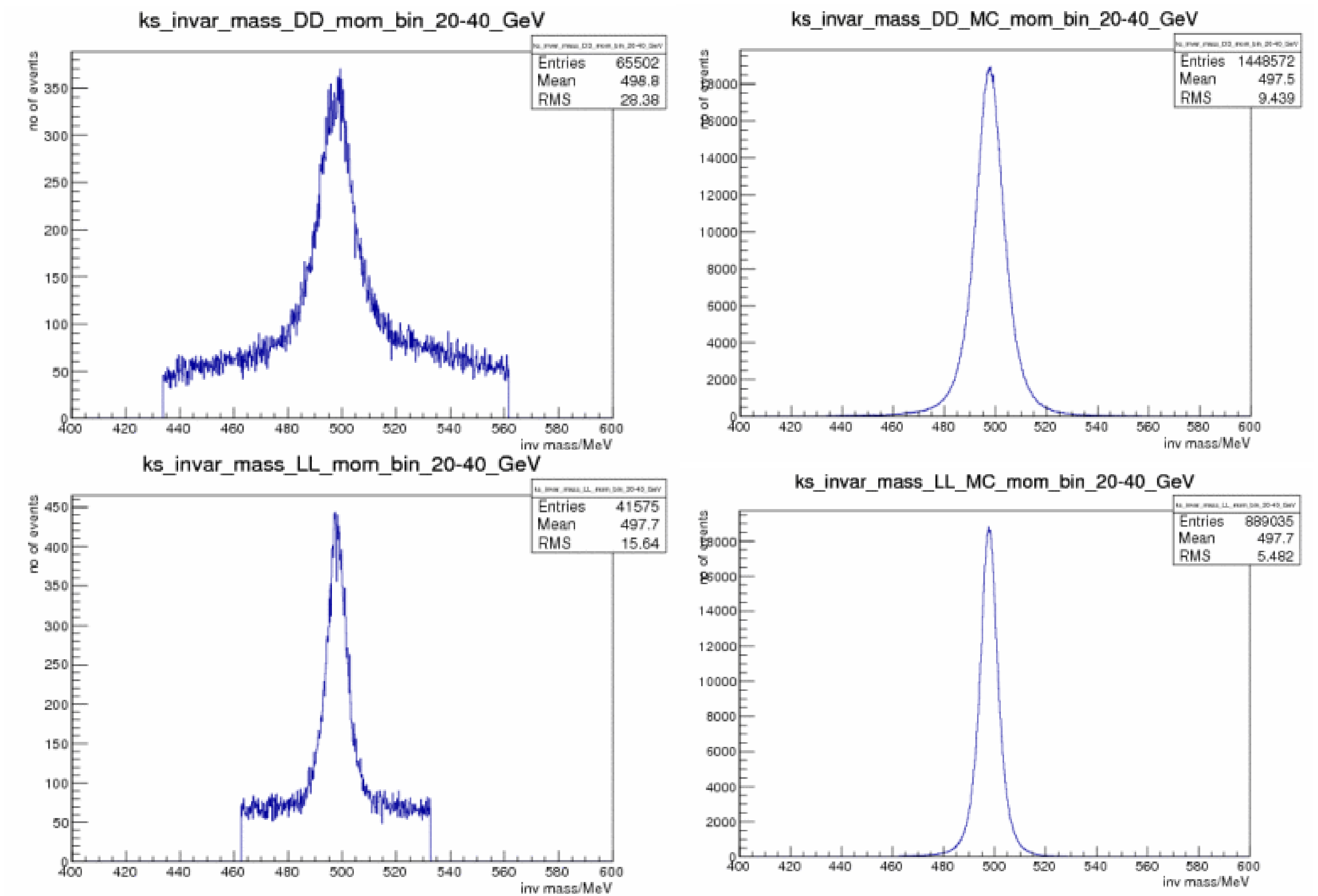
- 1 data sample of ~ 8×10^4 events from 2012 (about 0.2% of total data available).

- 1 Monte Carlo (MC) generated sample of ~ 8×10^6 events.

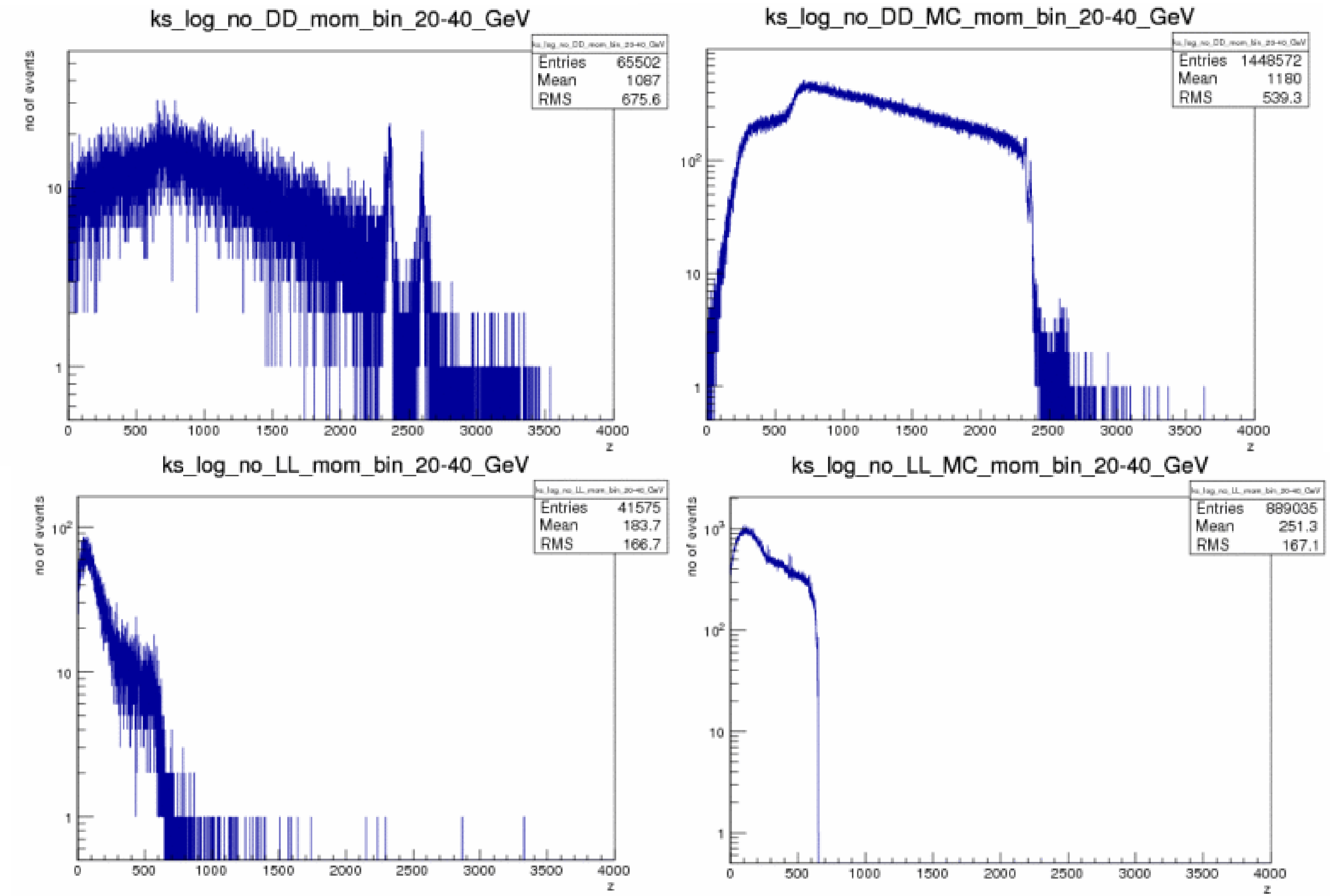
- So far have invariant mass distributions and log of number against z for long/downstream tracks and data/MC (see slide 12) binned in momentum.

K_s selection.

- Data sample: the life time of the K_s was required to be > 1ps.
- Information from RICH particle identification is used to select pions.
- In Monte Carlo only true K_s are selected.
- Tracks already tagged as either long or downstream.



Samples from data (left) and MC (right) for the 20- 40 GeV bin for invariant mass.



Samples from data (left) and MC (right) for the 20- 40 GeV bin for number of K_s against z

Conclusion and future work

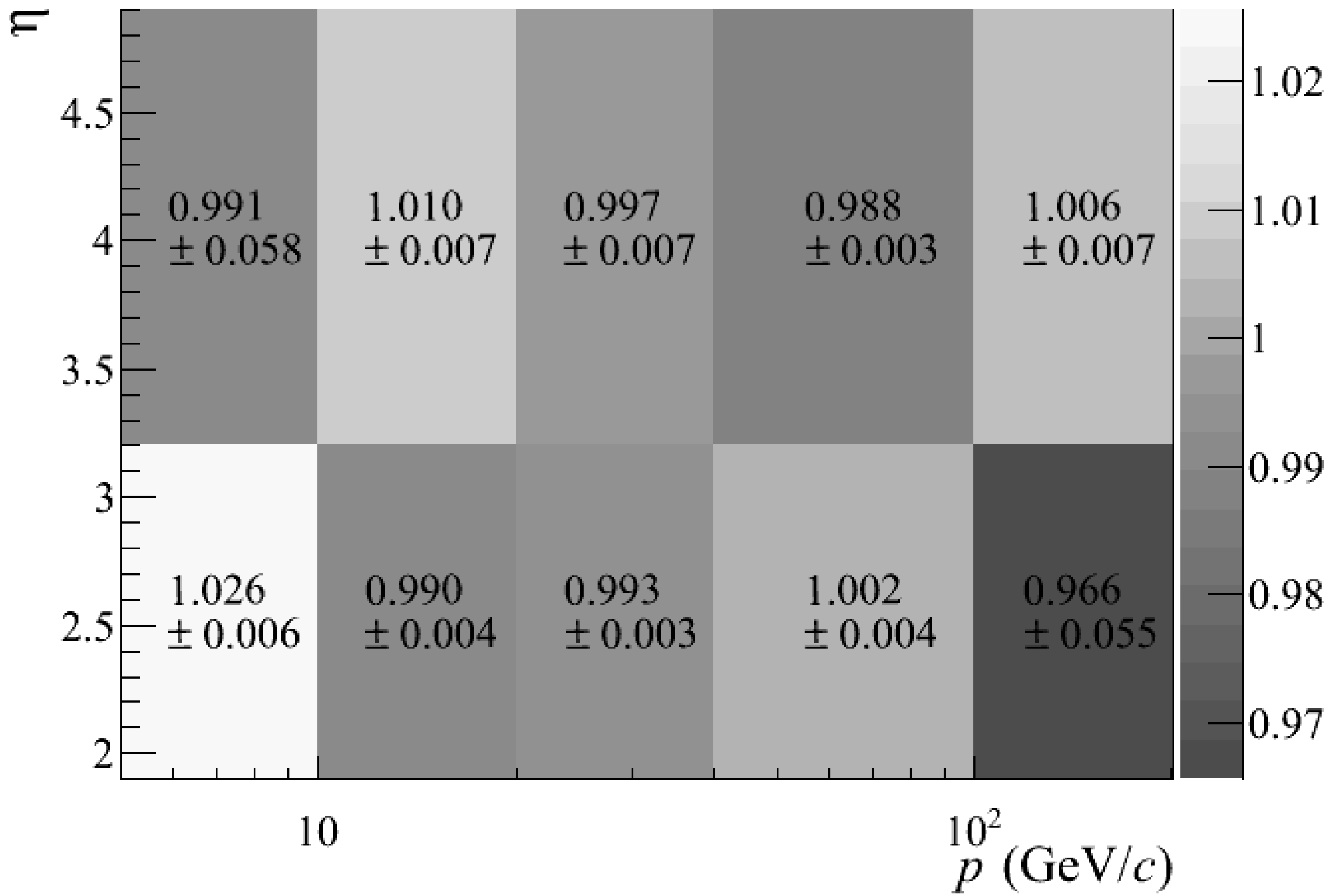
- Downstream track efficiency: important in searches for new long-lived particles.

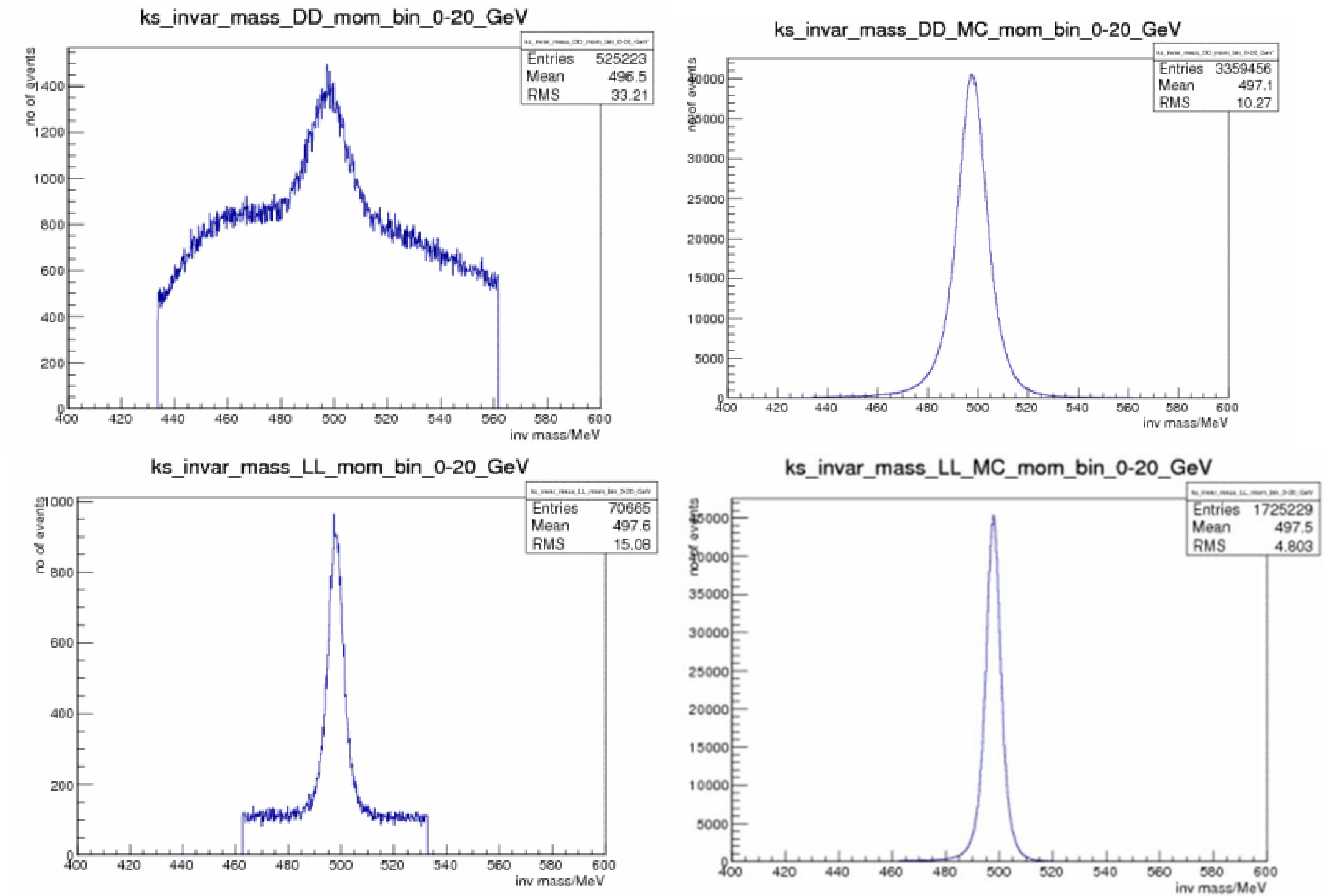
- Efficiency will be determined relative to long track efficiency.

- Next steps:
  - Understand the shape of the invariant mass and z distributions.
  - More cuts?
  - Extrapolate plots to obtain ε_{down}

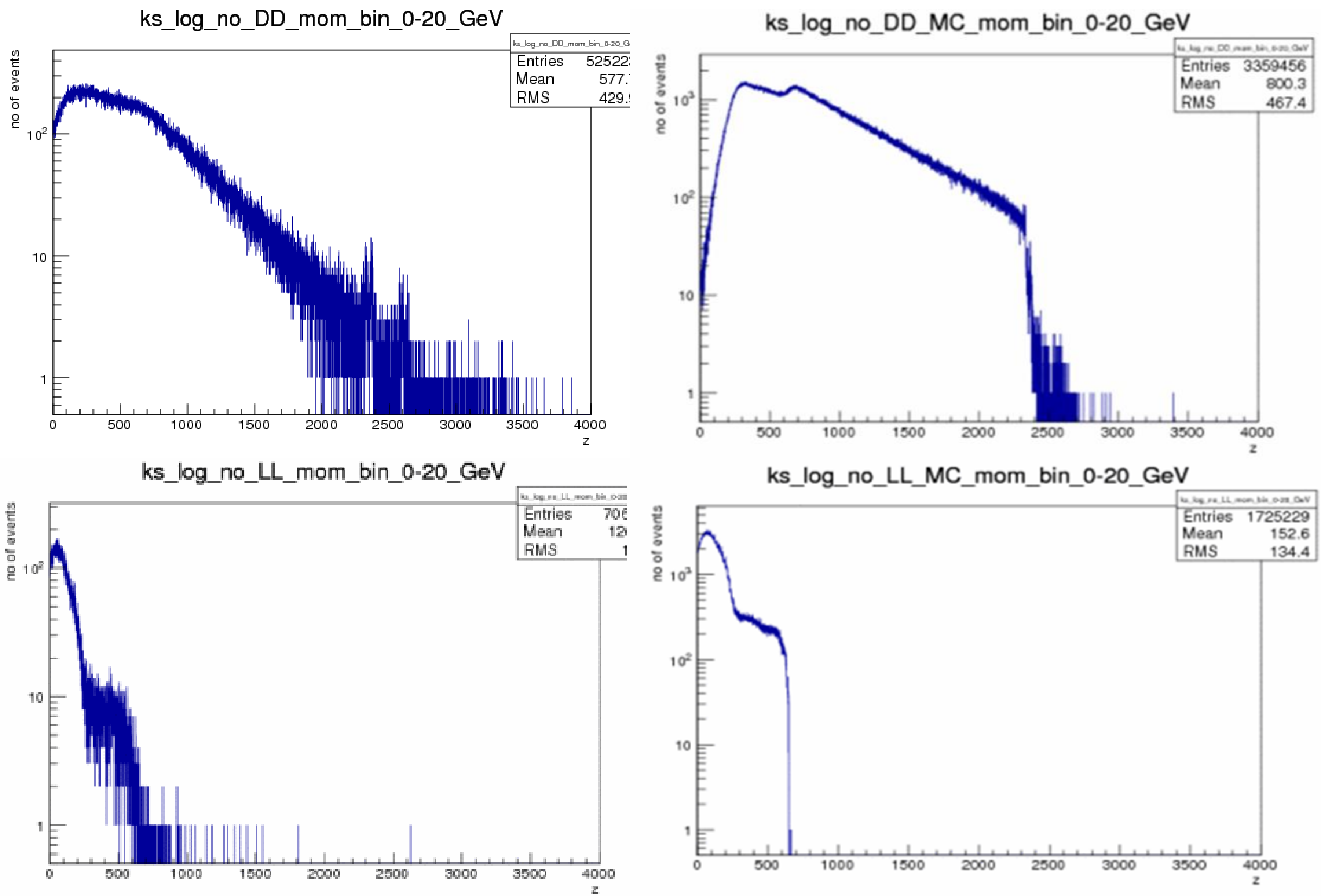
- Plots at http://www.hep.ph.ic.ac.uk/~es708/downstream_track_efficiency

Overall efficiency ratio and its error, 2012





Samples from data for the 0- 20 GeV bin for invariant mass.



Samples from data for the 0- 20 GeV bin for log of the number of particles.