dE/dx from Muons in the LAT Energy Loss vs. Energy Deposition

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LAT Beam test WG EVO

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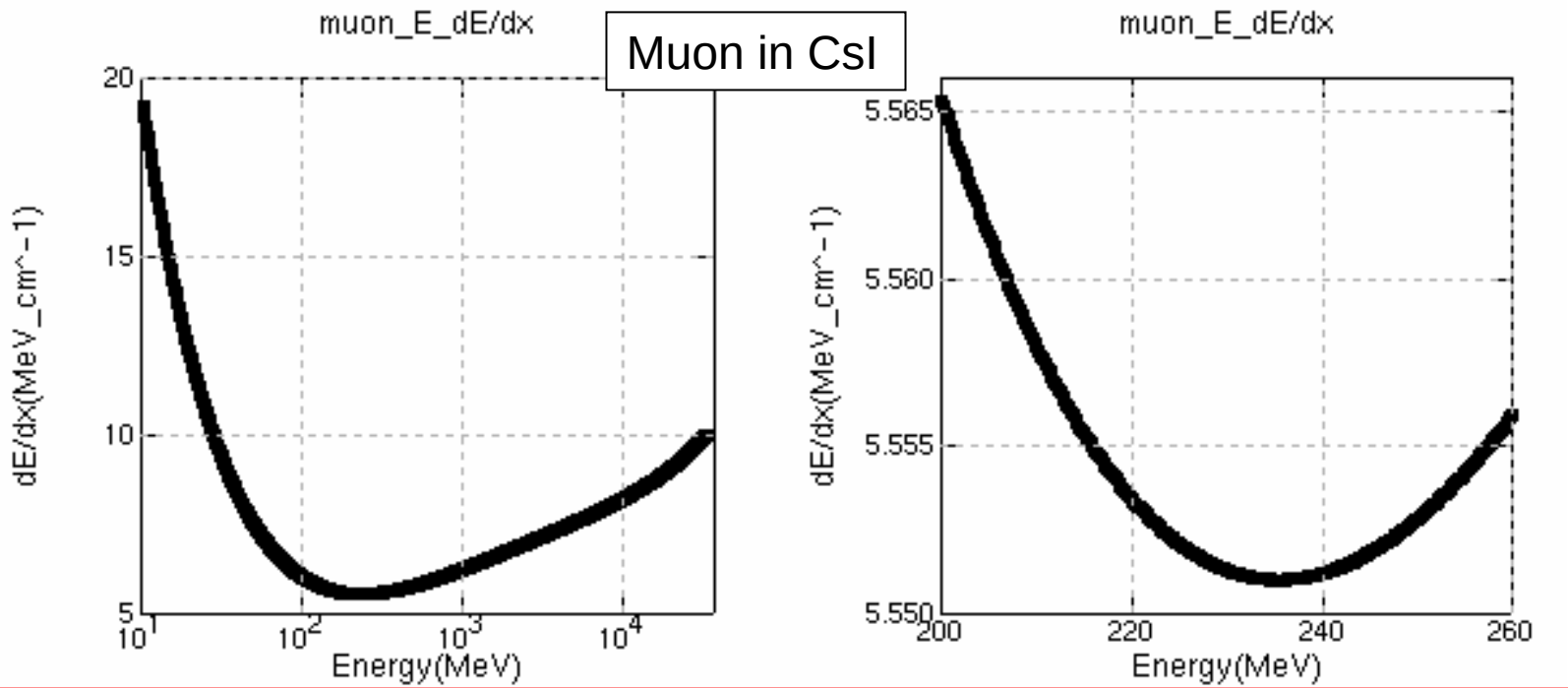
Talk outline

- Use up-to-date dE/dx code to calculate the expected energy deposition of muons using a simple CsI geometry to get deposition in MeV cm^2/g. This code calculates mean energy loss.
- Analyze μ ground data to measure energy deposition in MeV cm^2/g in LAT.
- Compare energy loss from dE/dx code and GLEAM for μ. Also, compare energy deposition.
- Conclusions

Dedx code

- Weaver & Westphal, Nucl. Instrum. Methods Phys. Res. B 187, 285-301 (2002)
- Code is available at http://snfactory.lbl.gov/~weaver/dedx/



MIP: dE_muon / dx = 5.551 MeV / cm

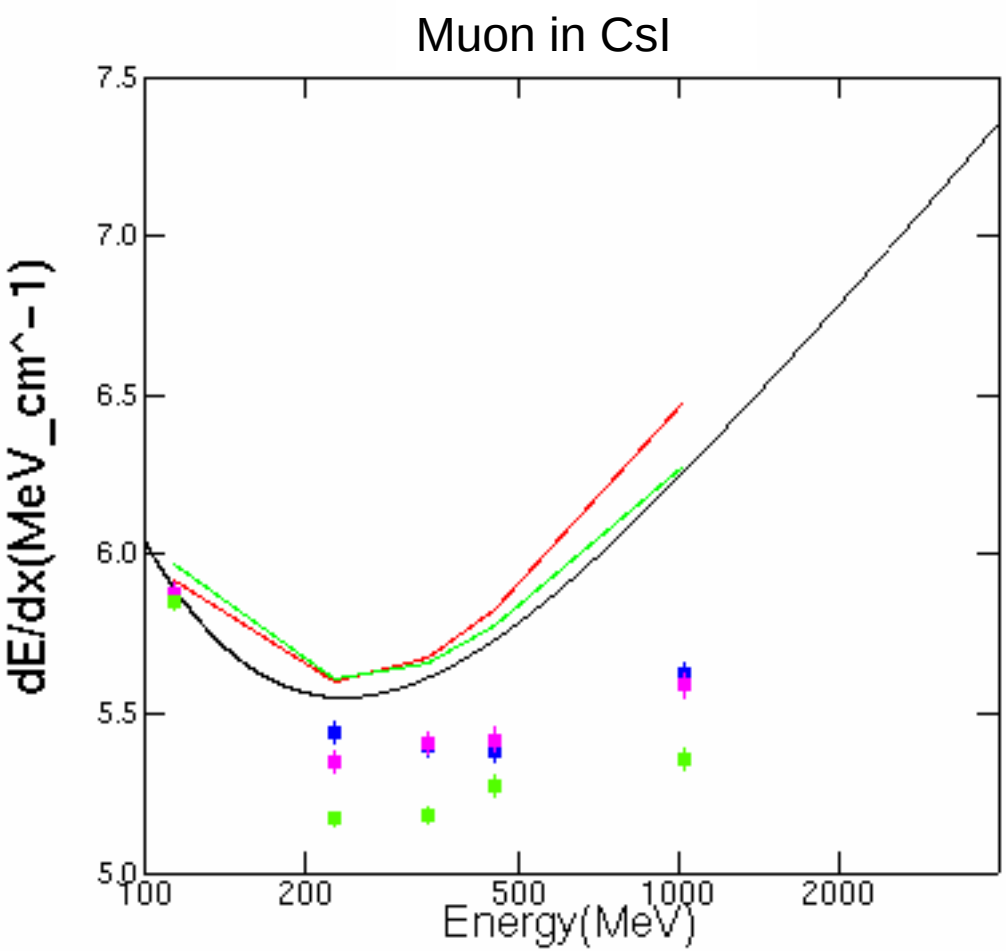
⇒Energy deposit per radiation length = 5.551 * 1.86 = 10.32 MeV / RLn

⇒Energy deposit per layer = 5.551 * 1.99 = 11.05 MeV / layer

For 4 GeV muon, dE_muon / dx = 7.356 MeV / cm

=>Energy deposit per radiation length = 13.68 MeV / RLn

Muon in CsI: Compare with other MC



: dE/dx code WW

: Bethe-Bloch formula

: PDG

: G3 v3.21 Energy Dep.

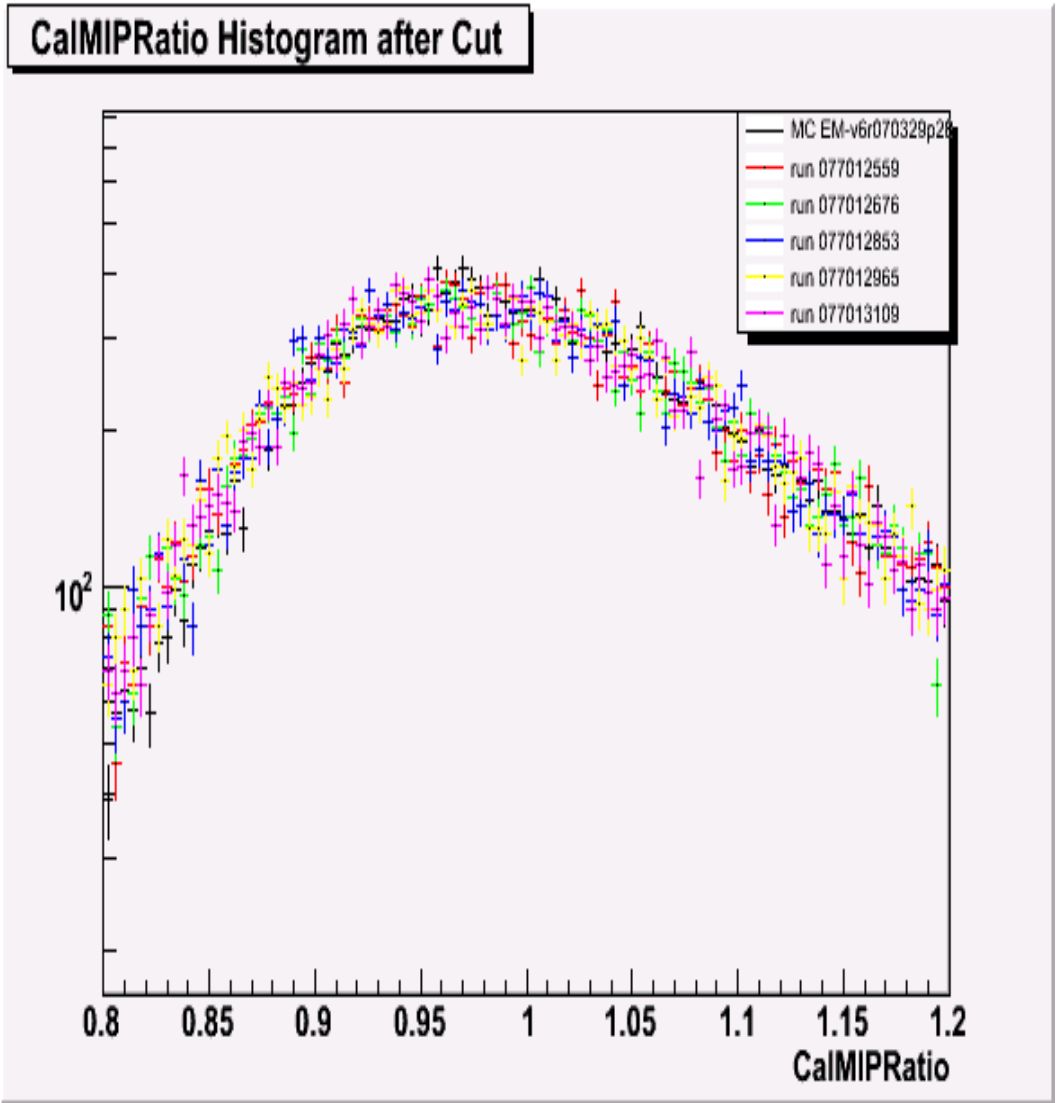
: G4 v5.2 " "

: G4 v6.0 " "

Mean Energy deposit for μ is ~10%smaller for GEANT simulations at 1.021 GeV than energy loss from calculations. (F. Piron et al., note)

ftp://www.cenbg.in2p3.fr/astropart/GlastWWW/reposeur/note-06april2003.pdf

CalMIPRatio After Cuts for LAT Ground Data for Selected Muons and MC Muons



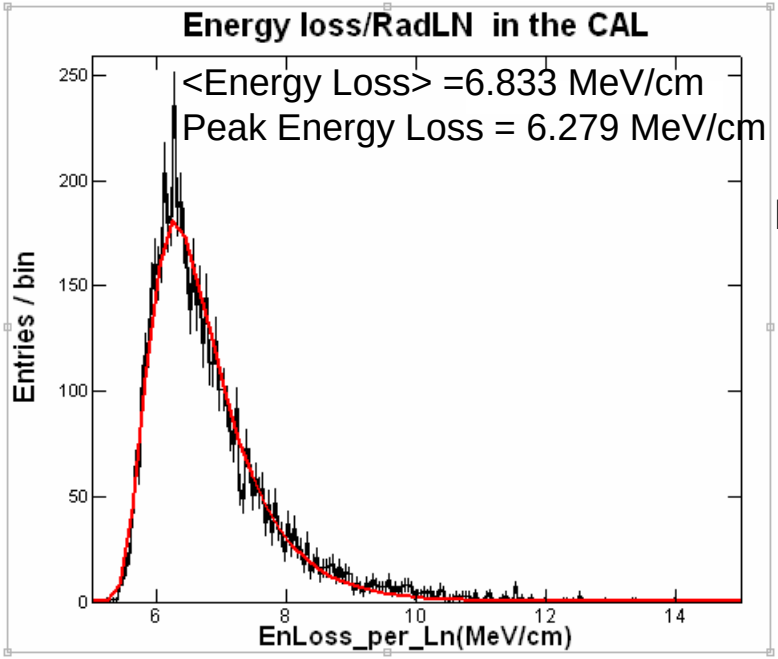
MC and Data E_{peak} for μ Why do they agree?

- CalMIPRatio is calculated in AnalysisNtuple, in the file CalValsTool.cxx.
  - CAL_MIP_Ratio = CAL_EnergyRaw/(12.07*std::max(CAL_CsI_RLn*1., minRadLen));
- Since the mean energy of muons at ground is ~ 4 GeV, WW dE/dx code calculation for a radiation length of CsI gives: 13.68 MeV (~15% higher). But this is energy loss, not deposition.
- It appears that number was put in code to get agreement between MC and ground μ data.

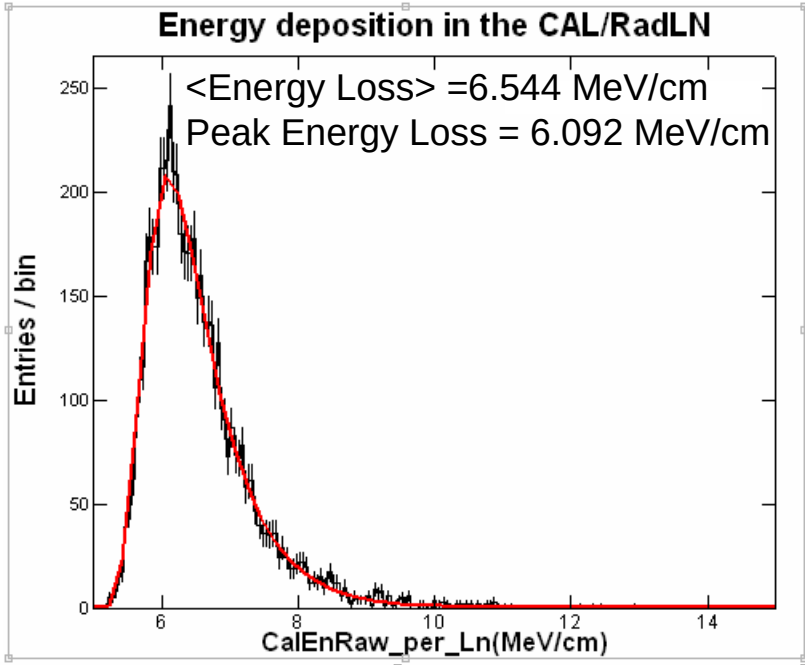
LAT μ MC cuts (Ping)

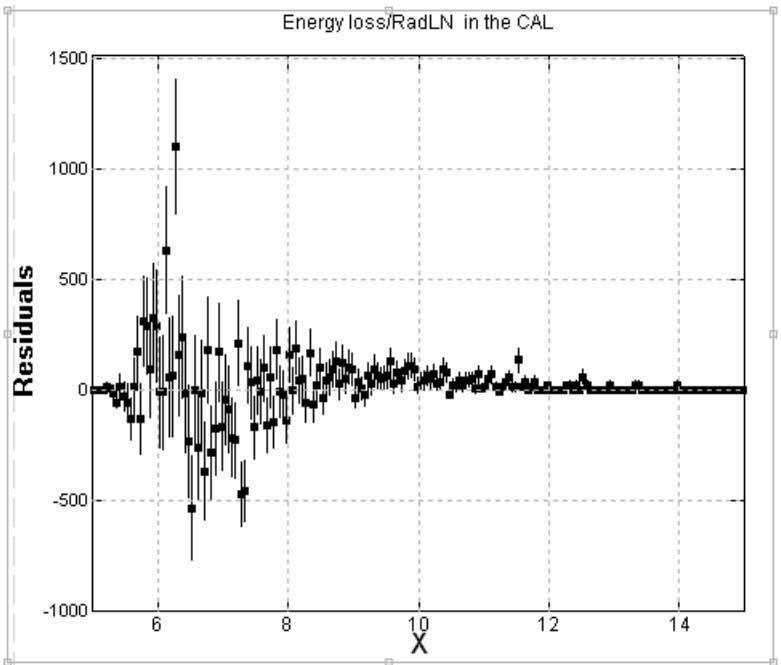
- G4 v6r29p5 MC used.
- Start μ at z=0 – top of GRID
  - Top of CAL crystal is at -4.6 cm according to SVAC Inst. Anal. Primer.
  - Small amount of non-CsI material between z=0 and top of CAL.
- x = y = 20.2 cm (don't start in vacuum-Leon).
- 8 < CalCsIRLn < 9
- CalZDir > 0.98
- For E_μ >= 1 GeV, energy loss in CsI ~ 7 MeV/cm*1.85 cm*8.5 RL ~ 110 MeV. Δ(dE/dx) is small over path length in CsI for μ.

1.021 GeV Vertical Muons – “CAL Only”

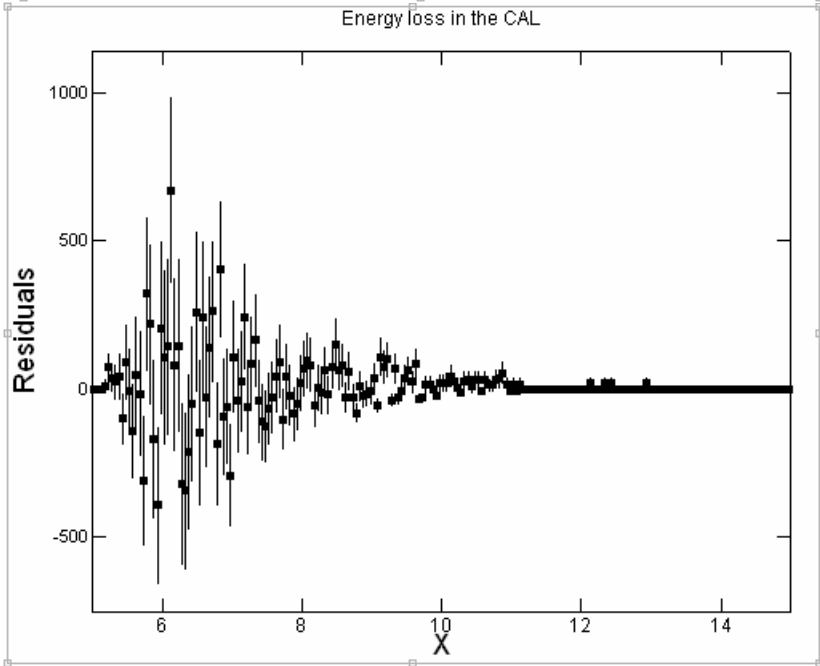


Landau Dist.

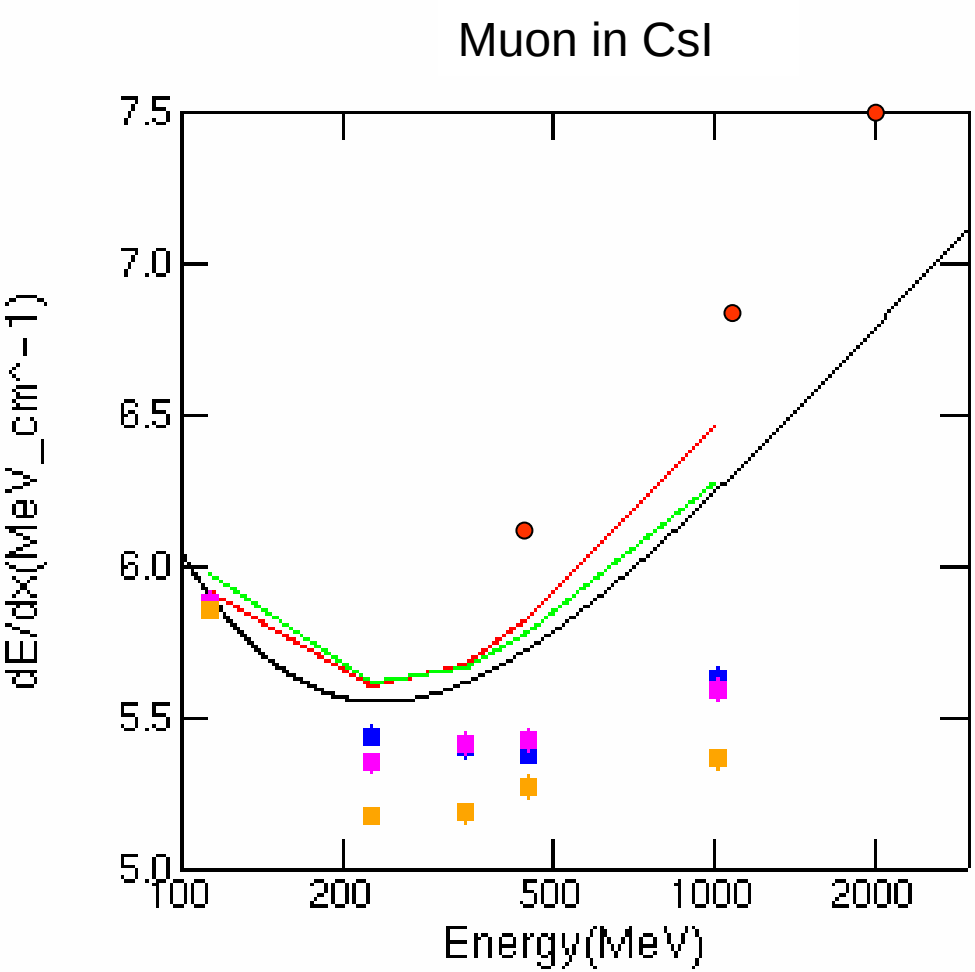




Res/BinWidth



Muon in CsI: Compare with other MC



: WW dE/dx code

: Bethe-Bloch formula

: PDG

: G3 v3.21 Energy Dep.

: G4 v5.2 Energy Dep.

: G4 v6.0 Energy Dep.

: G4 v6r29p5 Energy Loss (LAT) (Ping)

G4 v6r29p5 result is for mean energy loss of muon in LAT CsI CAL (z=0, x= 20.2 cm, y =x is start). Other G3-4 are for energy deposition.

Conclusions

- Ping's current energy loss calculation in GLEAM LAT "CAL only" overshoots the "best" dE/dx theory calculation by about 15%.
- Ping's current energy deposition calculation for "CAL only" also overshoots, but by a bit less. It does not reproduce the Piron G3-4 energy deposition.
- Piron's estimate of energy deposition in simple CsI geometry undershot by about 15% for G4 v6.0.
- Ping will redo her GLEAM calculation of μ energy loss in thin CsI radiator of simple geometry and compare again.
- Continue similar work with protons, C to compare to CERN and GSI beam test data as well as μ ground data (Ping and Yvonne).