Physics Models Update

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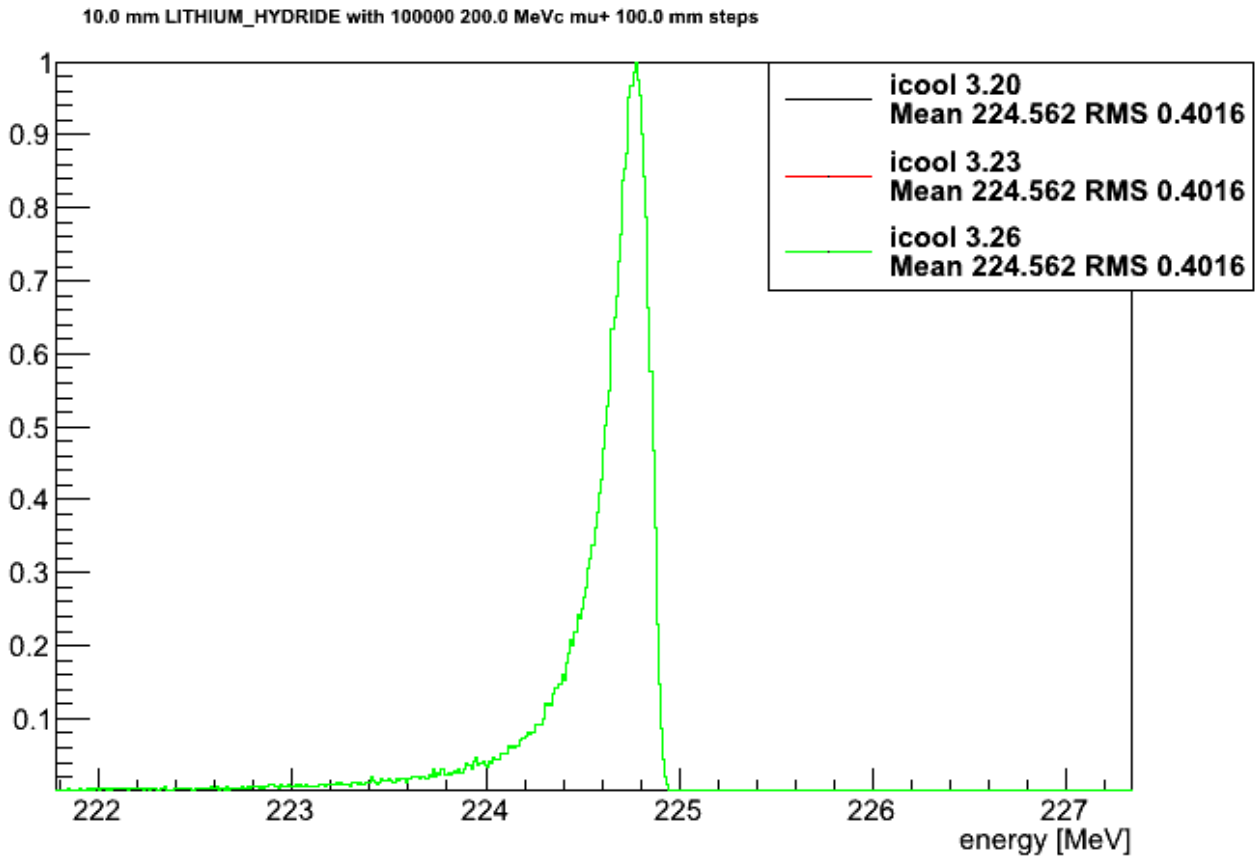
Physics model comparisons

- Last time I looked at physics models
  - G4beamline and ICOOL showed surprisingly wide variation from version to version
  - Using nominally the same physics models
- GEANT4 for latest version GEANT4.9.5 suggest their model has improved (included in G4BL 2.12 as default QGSP model)

LiH - ICOOL

- ICOOL physics model is stable from 3.20 to 3.26
  - delev=2 straglev=5 scatlev=6
- RMS/Mean is calculated for central 99% of the bunch
  - Remove outliers to improve statistical stability



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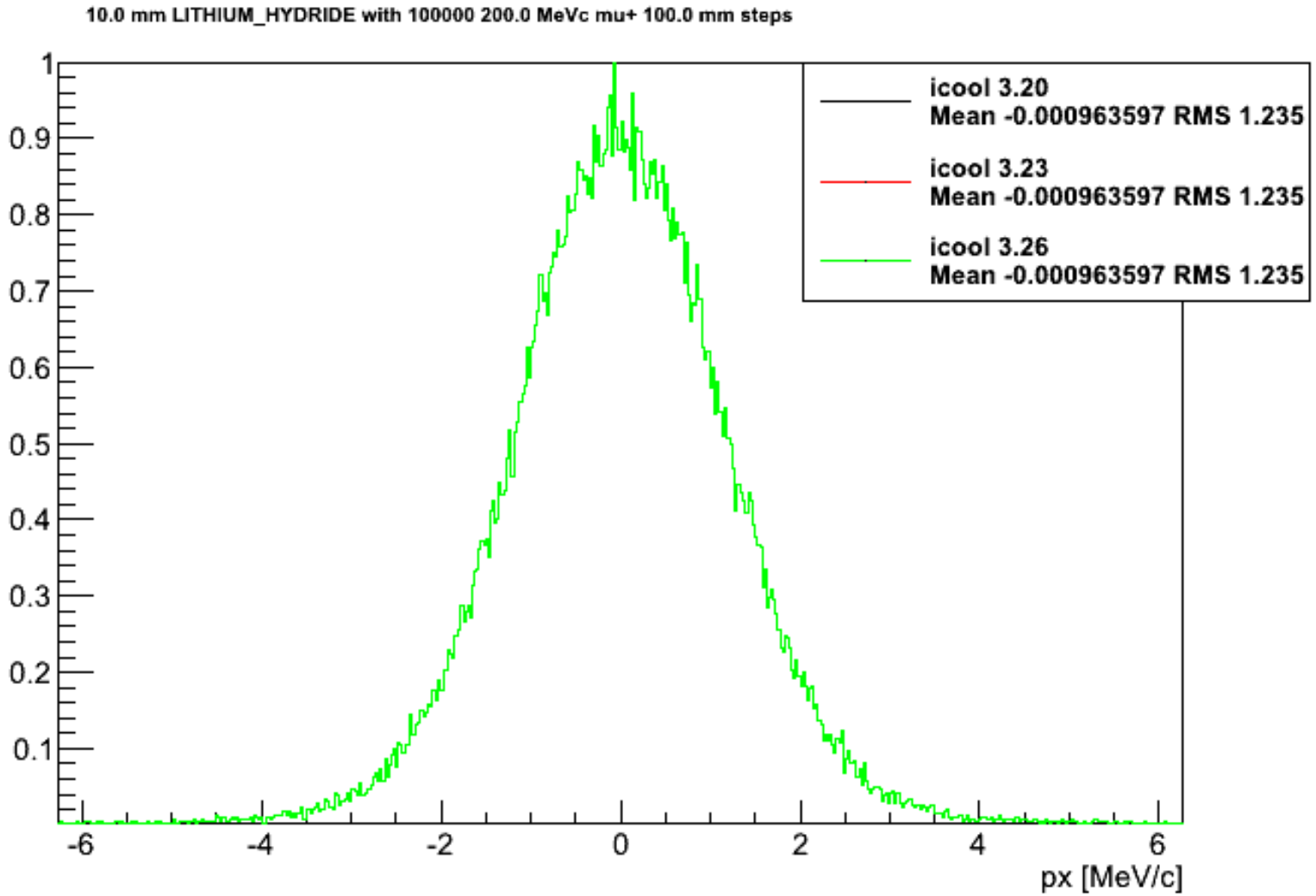
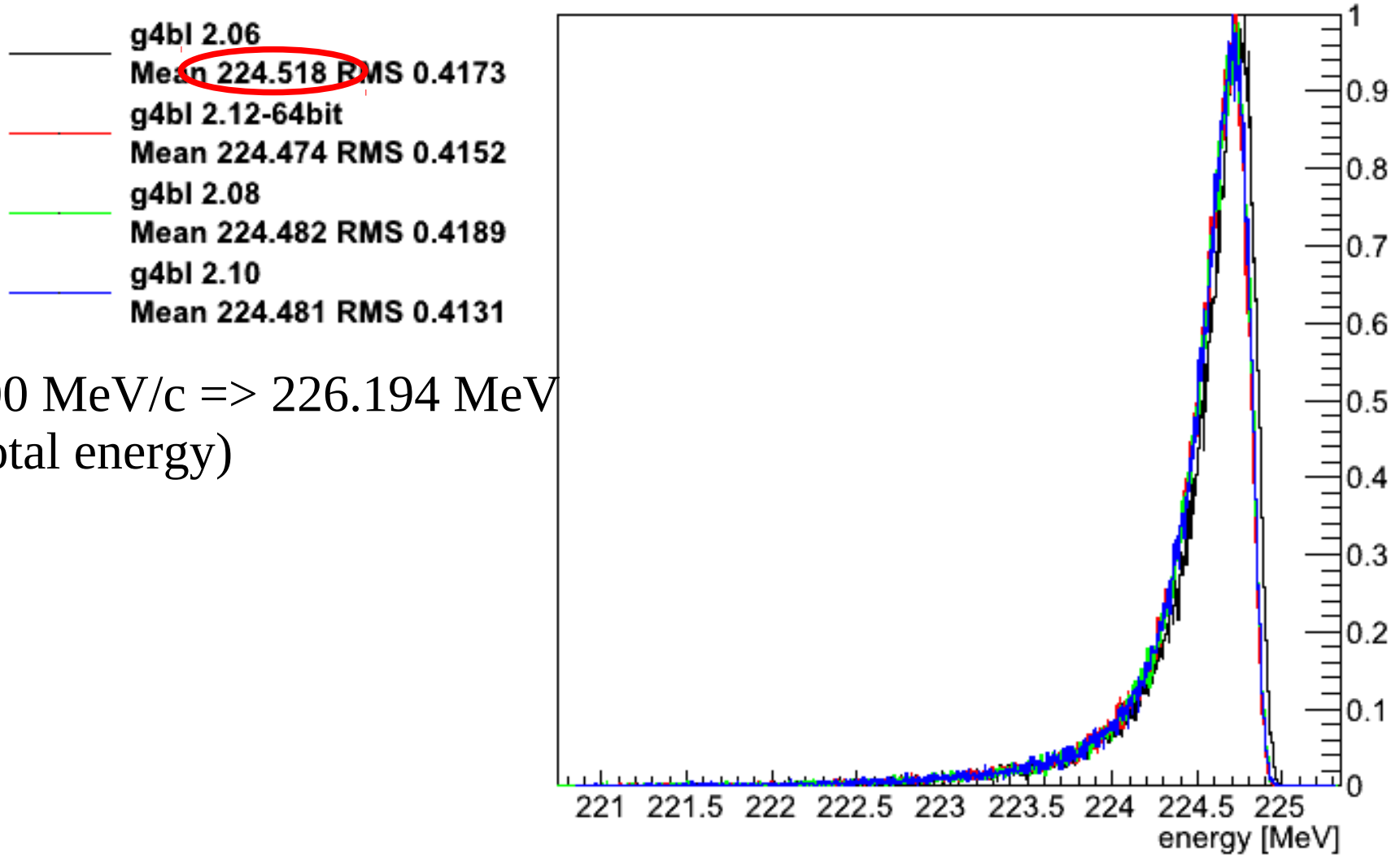


LiH - G4BL

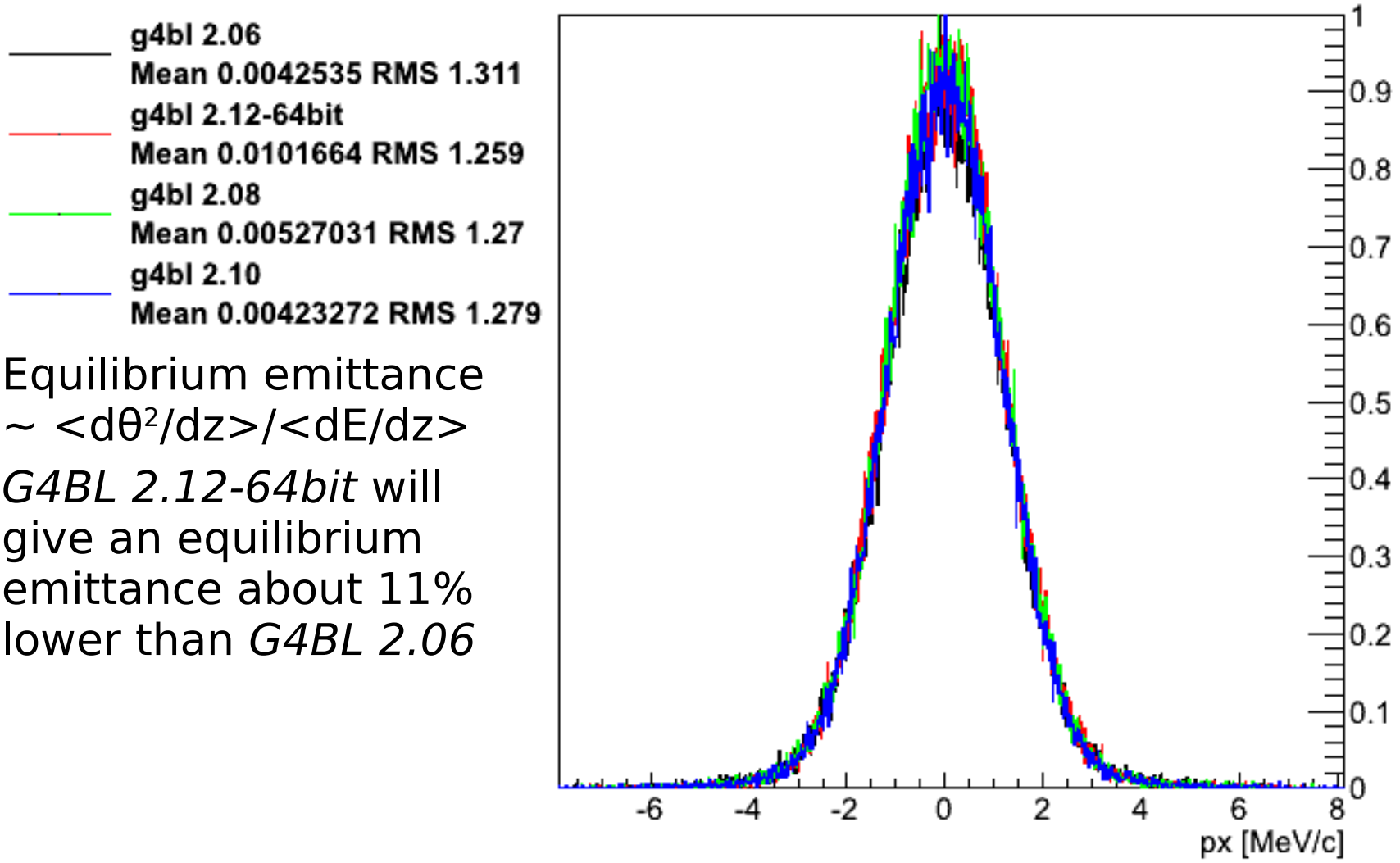
- 10 mm LiH, 100000 200 MeV/c mu+, energy, QGSP_BIC



200 MeV/c => 226.194 MeV (total energy)

LiH - G4BL

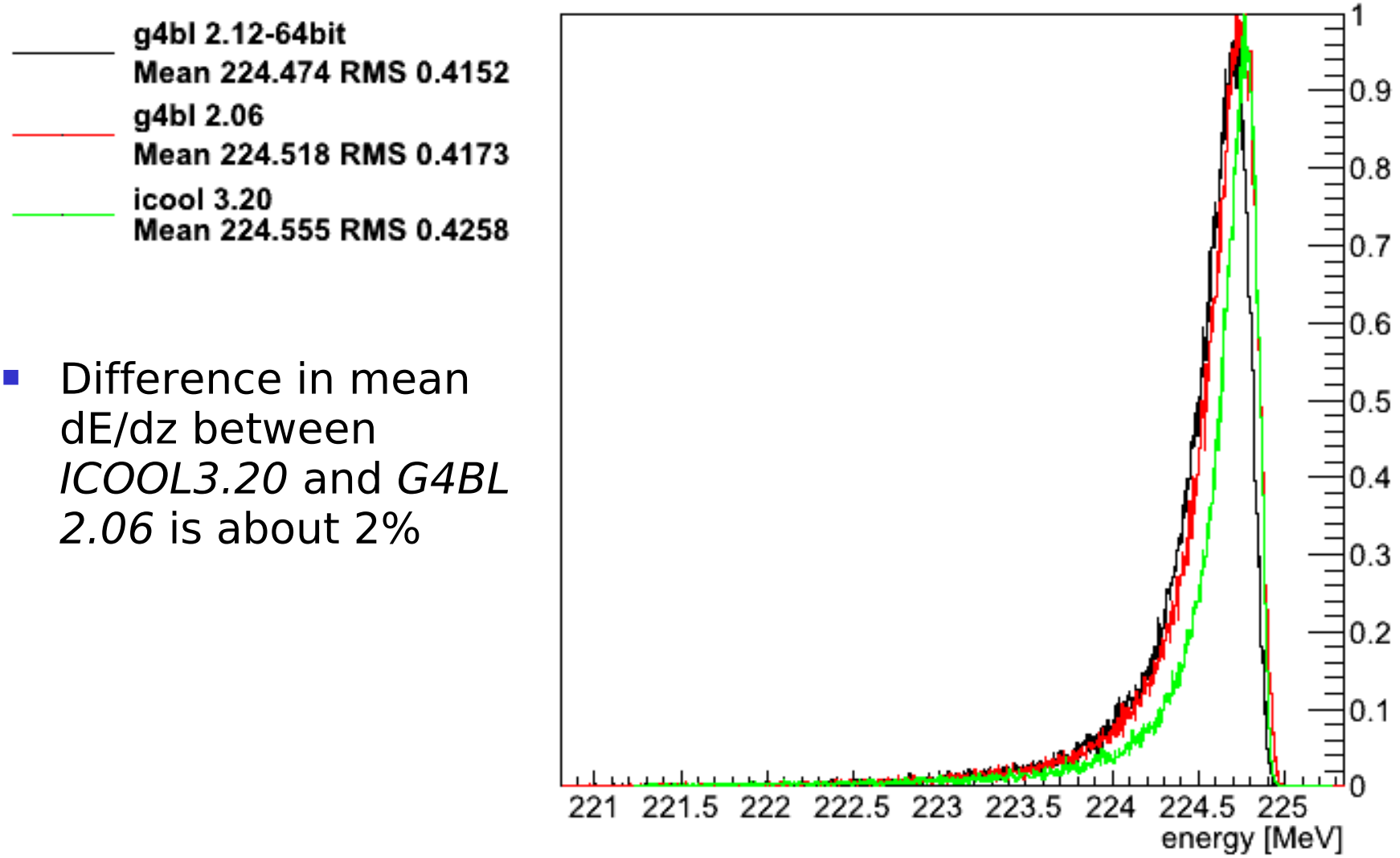
- 10 mm LiH, 100000 200 MeV/c mu+, px, QGSP_BIC



- Equilibrium emittance ~ $\langle d\theta^2/dz \rangle / \langle dE/dz \rangle$
- *G4BL 2.12-64bit* will give an equilibrium emittance about 11% lower than *G4BL 2.06*

LiH – G4BL vs ICOOL

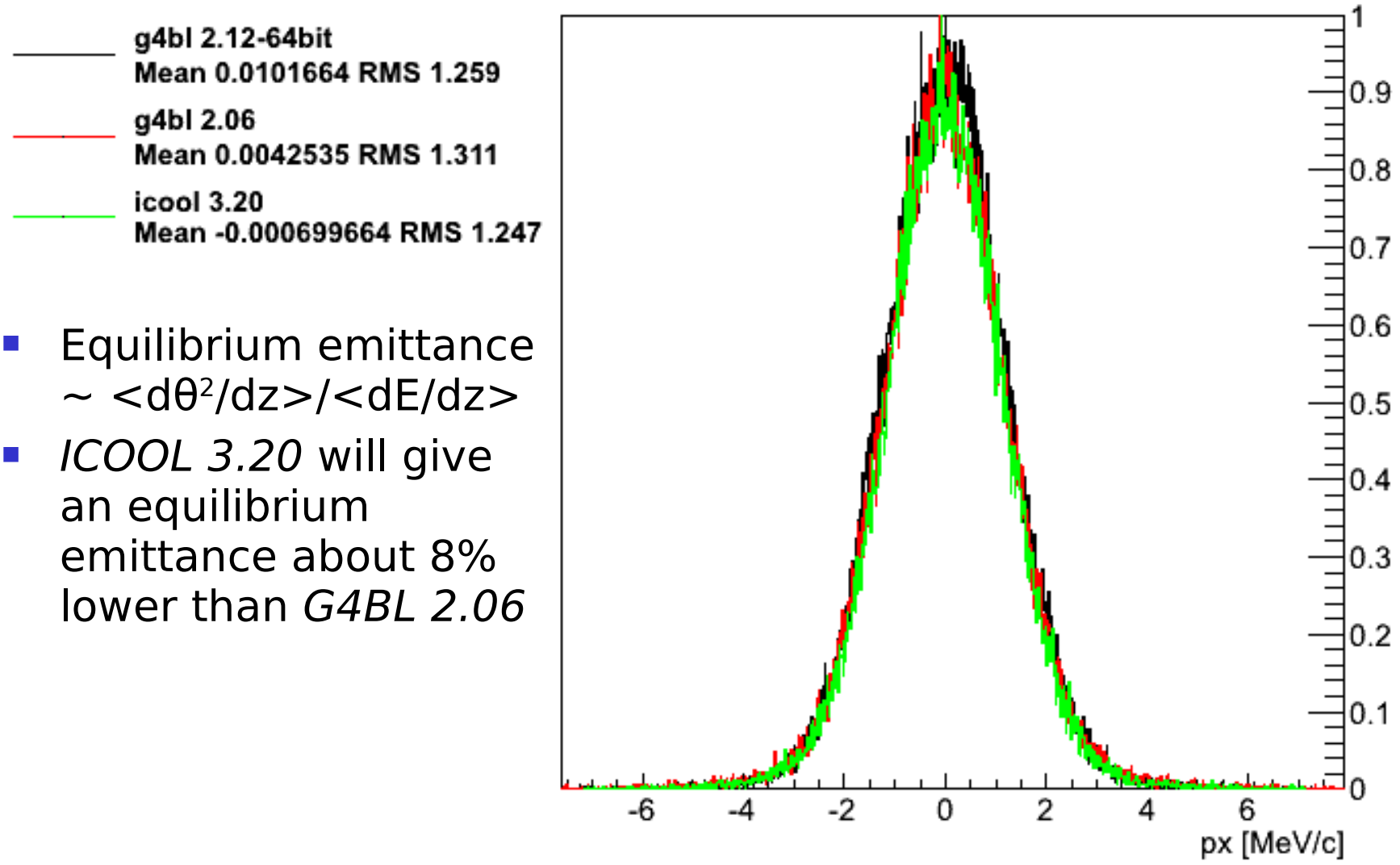
- 10 mm LiH, 100000 200 MeV/c mu+, energy



- Difference in mean dE/dz between *ICOOL3.20* and *G4BL 2.06* is about 2%

LiH – G4BL vs ICOOL

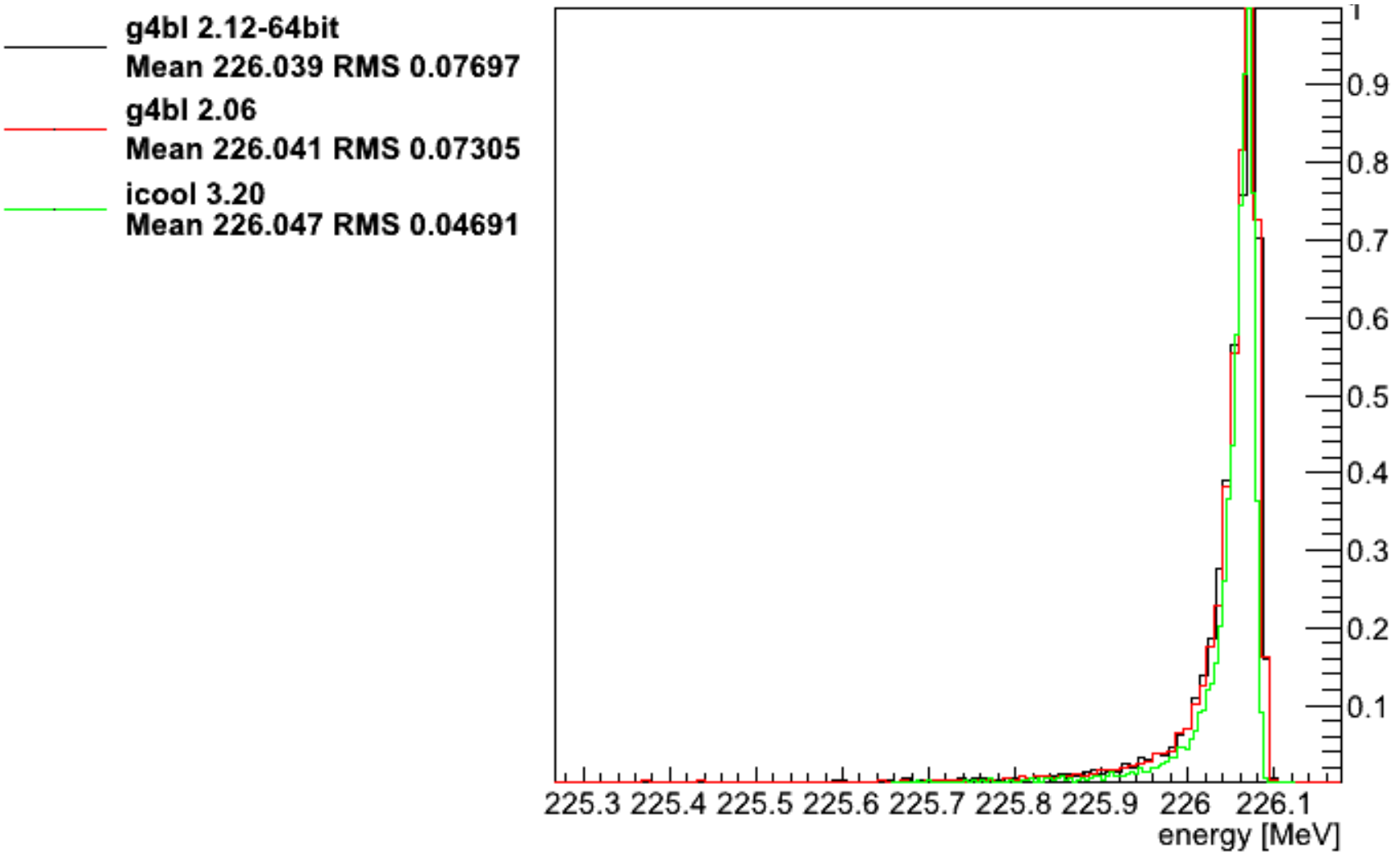
- 10 mm LiH, 100000 200 MeV/c mu+, px



- Equilibrium emittance ~ $\langle d\theta^2/dz \rangle / \langle dE/dz \rangle$
- *ICOOL 3.20* will give an equilibrium emittance about 8% lower than *G4BL 2.06*

Be window – G4BL vs ICOOL

- 0.5 mm Be, 10000 200 MeV/c mu+, energy



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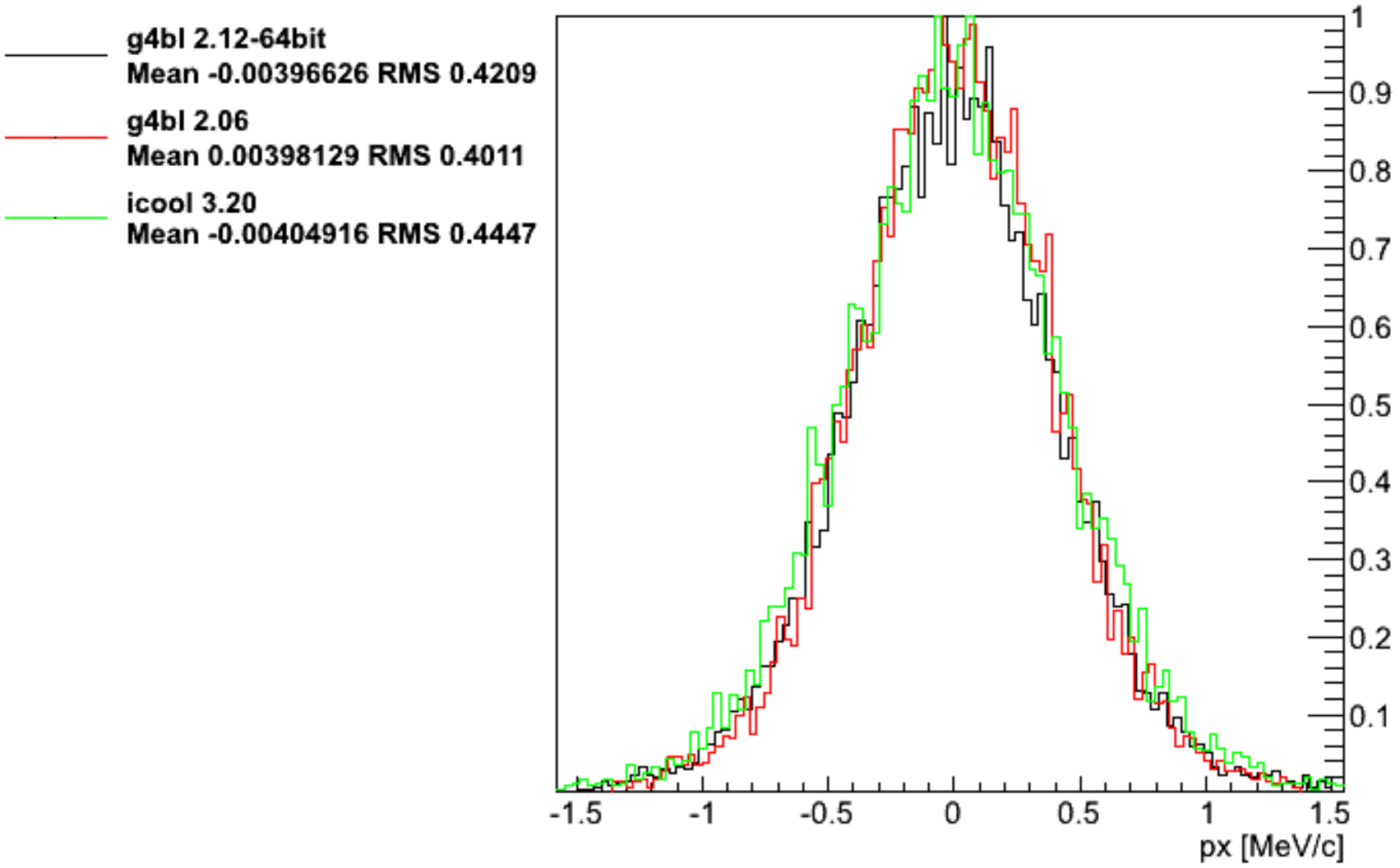

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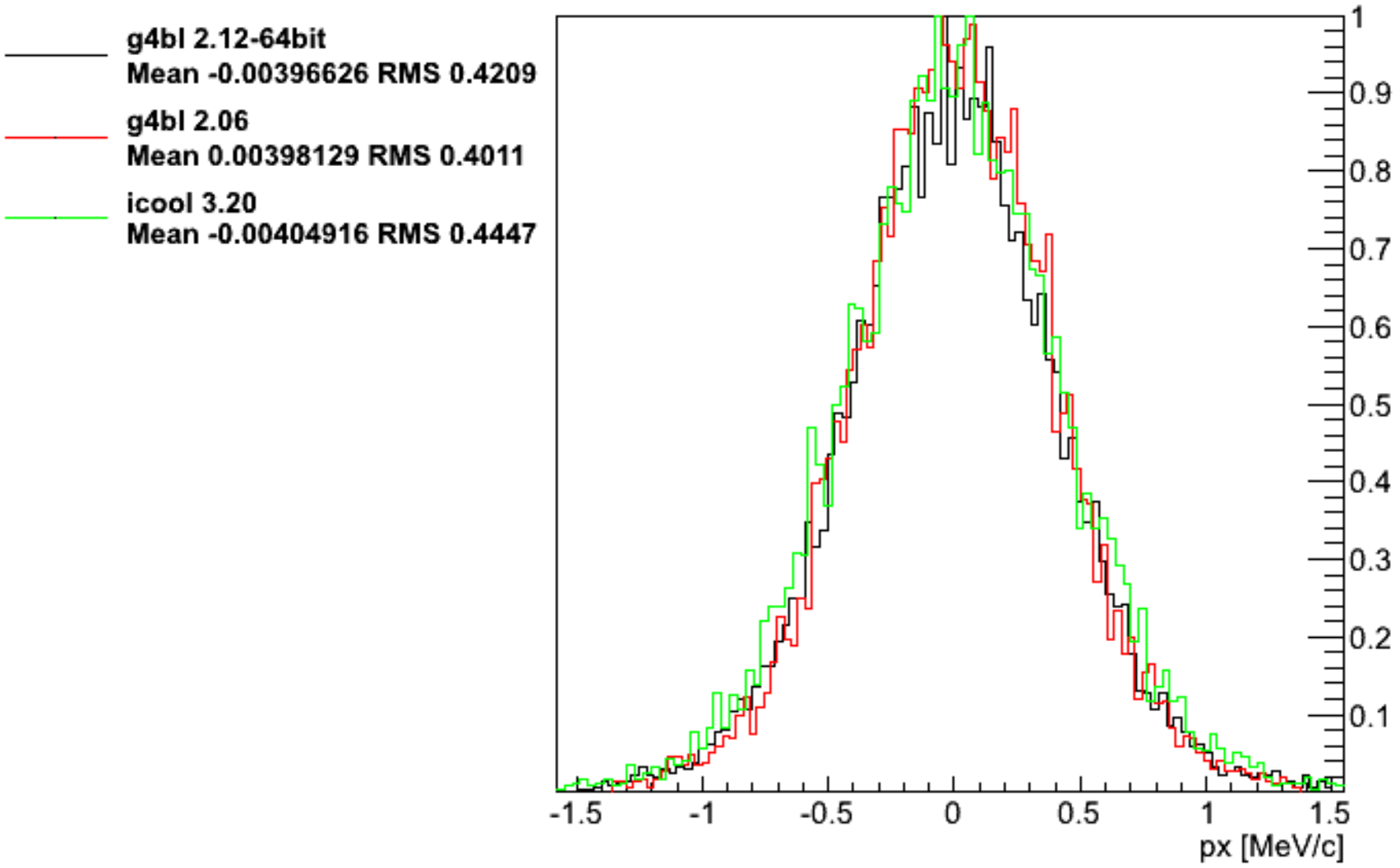
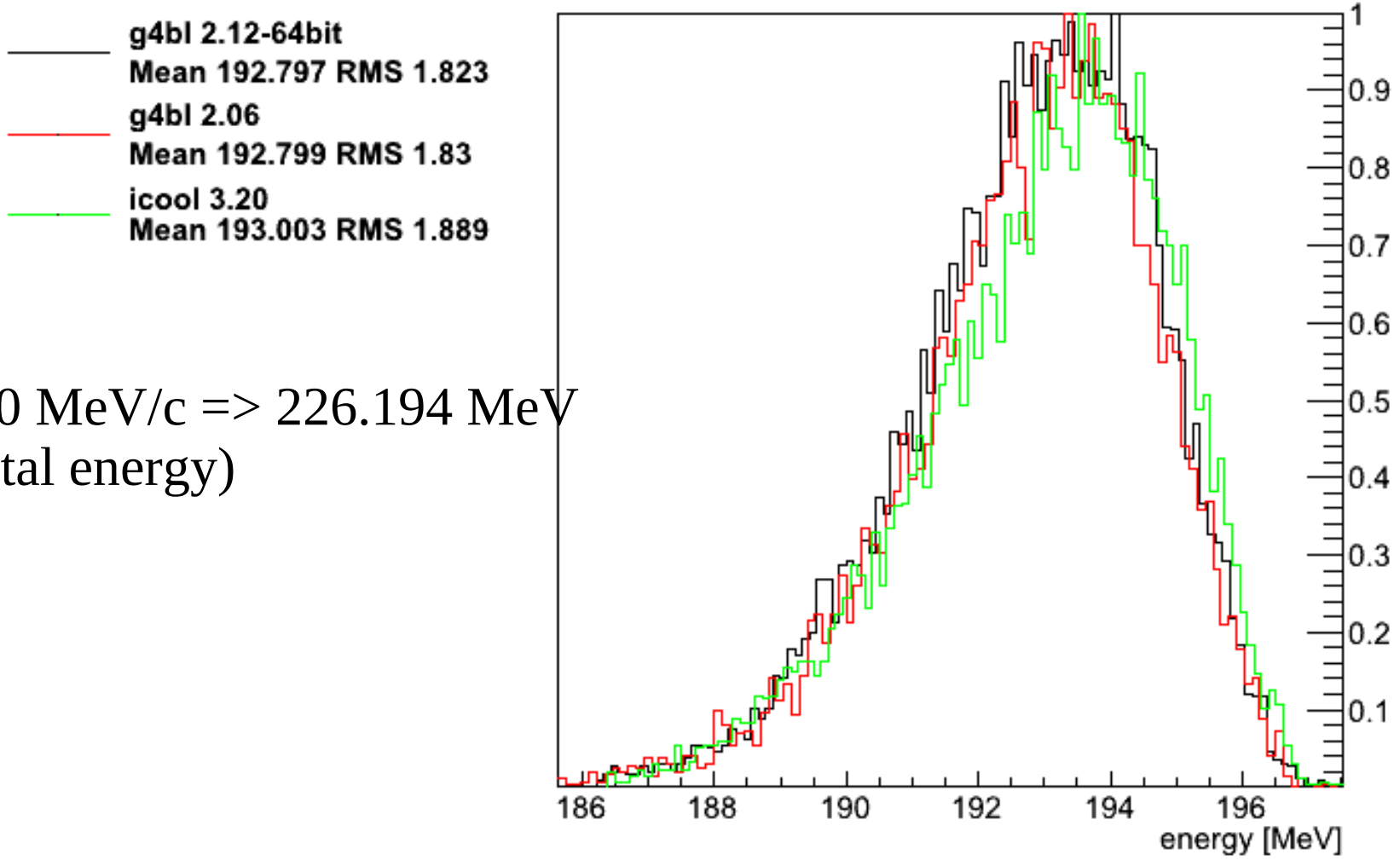


Be plug – G4BL vs ICOOL

- 100 mm Be, 10000 200 MeV/c mu+, energy



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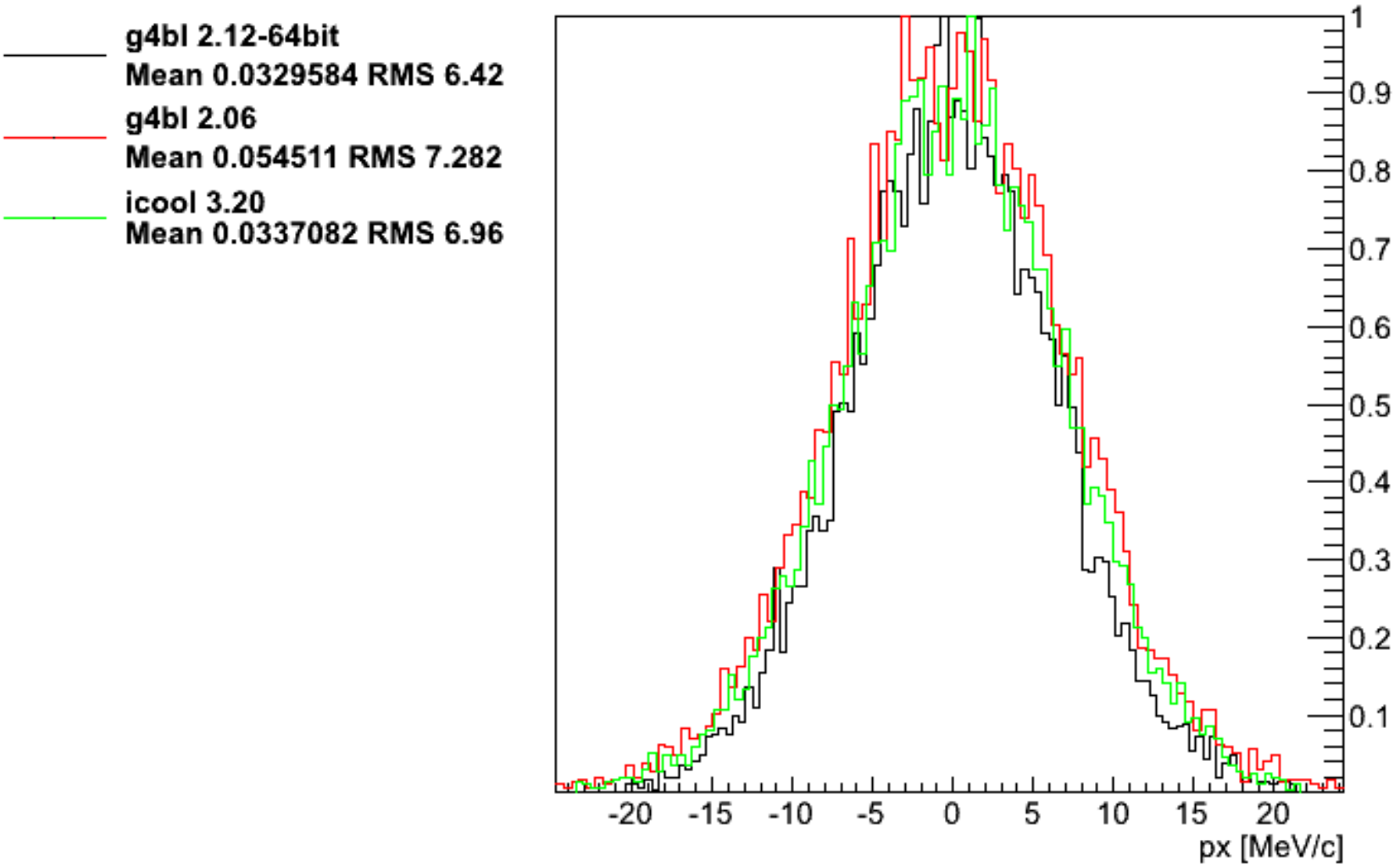
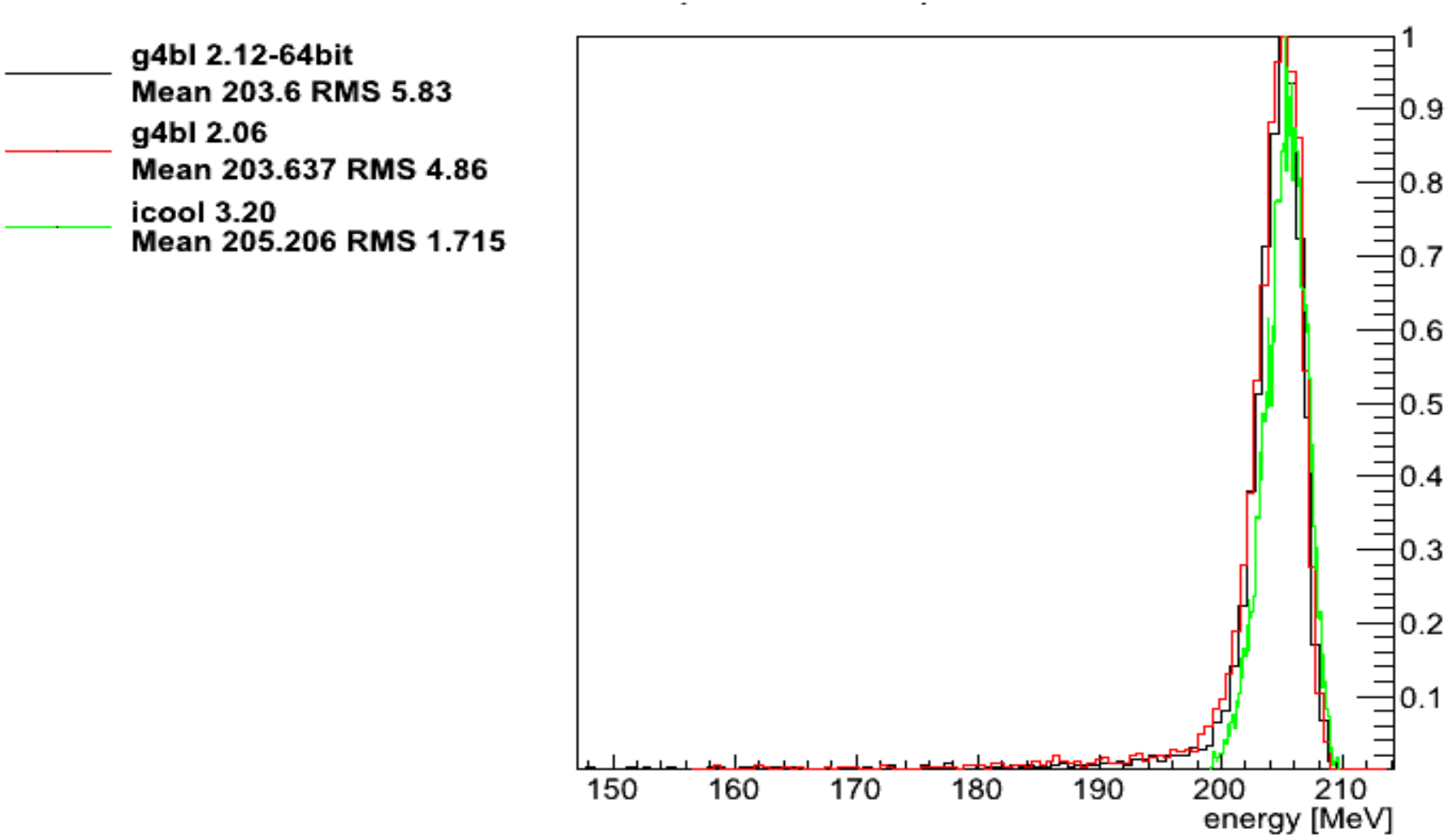
Be plug – G4BL vs ICOOL

- 100 mm Be, 10000 200 MeV/c mu+, px



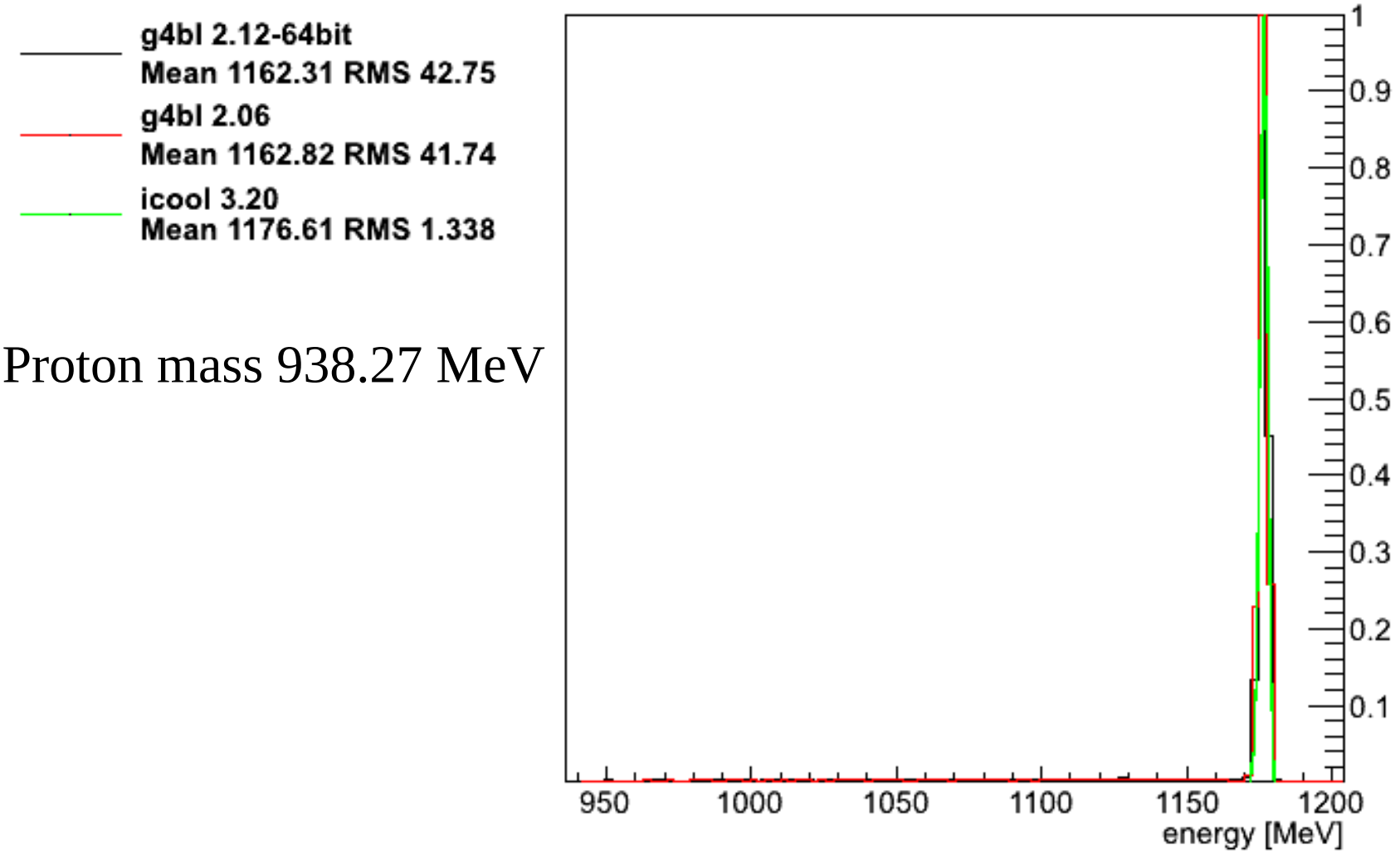
Be plug – G4BL vs ICOOL

- 100 mm Be, 10000 200 MeV/c pi+, energy



Be plug – G4BL vs ICOOL

- 100 mm Be, 10000 800 MeV/c proton, total energy



Proton mass 938.27 MeV

Physics model conclusions

- Within approximations
  - Expect G4BL2.12 and recent ICOOL to give about 10 % lower equilibrium emittance in the cooling channel
  - Energy loss about the same
- Be plug
  - ICOOL fine for muons
  - Less good for pions, protons
    - That's okay, I think we know this (little/no hadronic model)
  - Would be nice to include MARS in comparison
- Nb I have loads of plots for different materials and can make more
  - e.g. lH_2 where I looked at ICOOL ELMS vs Stephen Brooks implementation using ELMS data tables
- Discussion
  - Do we want RDR to use latest version of G4BL (and ICOOL)?