Material Map in GlueX Reconstruction

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Motivation

- Charged particle tracking requires:
  - Errors due to multiple scattering
  - Curvature change due to energy loss (low momentum protons)

History

- Jan. 13, 2009: Simon commits Material/radlen to repository
  - Map is 364k points of fractional radiation lengths in the x/z plane of detector
  - Map is made using MC events
- Feb. 15, 2009: Beni commits DRootGeom class to respository
  - Map uses ROOT's TGeo package. Code is generated from HDDS XML
  - Allows probing of volume and material properties for arbitrary point in space
  - Not thread-safe (immediate seg-fault on first event)
- Feb. 27, 2009: Kalman Fitter switches to DRootGeom
- April 30, 2009: ALT1 fitter adds material using DRootGeom
- June 19, 2009: David commits thread-safe DRootGeom
  - Huge performance hit (50%)
- June 20, 2009: David commits new material map option …

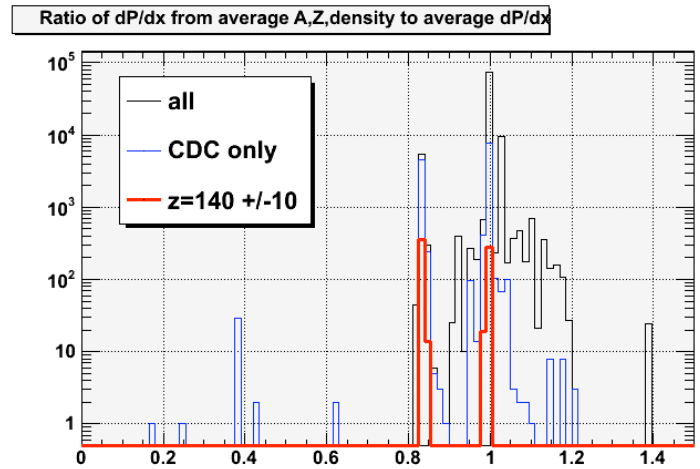
Current Options

- The *FindMat(…)* method in DRootGeom is now a wrapper for either *FindMatLL(…)* or *FindMatTable(…)*
  - Default is *FindMatTable(…)*.
  - "Classic" method is obtained by switching to *FindMatLL(…)* and recompiling.

- *FindMatTable(…)* uses a table filled by one of two methods:
  - Read pre-made map from calibration system (namepath="Material/material_map")
  - Fill it on-the-fly using calls to *FatMatLL(…)*
    - *Material averaged for 80 points in each cell*

Material Maps

- Material map can be generated using: *src/programs/Utils/mkMaterialMap*
  - By default averages 1500 points/cell
  - Averages A,Z,density, radlen
- For energy loss, these are not the appropriate values to average.



$$-\frac{dE}{dx} = Kz^2 \frac{Z}{A} \frac{1}{\beta^2} \left[\frac{1}{2} ln \frac{2m_e c^2 \beta^2 \gamma^2 T_{max}}{I^2} - \beta^2 - \frac{\delta(\beta\gamma)}{2} \right]$$

Bethe-Bloch equation

where: $I = (12Z + 7)eV$

Mean excitation energy

curvature change goes like the momentum loss

$$\frac{dP}{dx} = \frac{\rho}{\beta} \frac{dE}{dx}$$

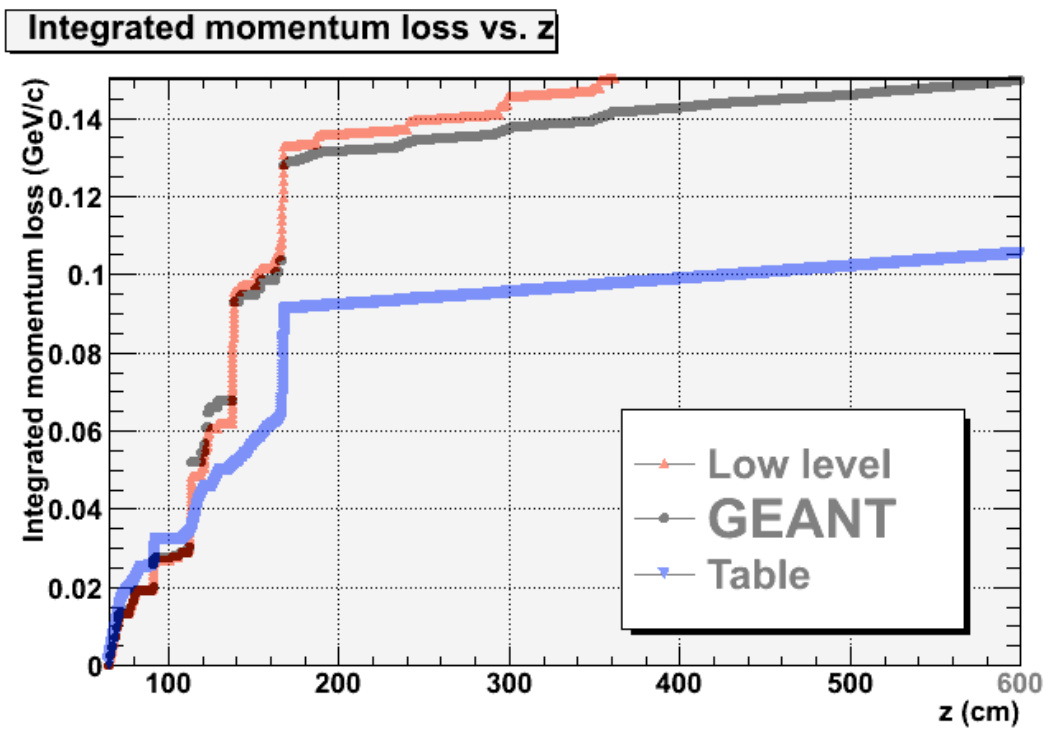
Important quantities to average

$$\rho \frac{Z}{A} \quad \text{and} \quad \rho \frac{Z}{A} lnI$$

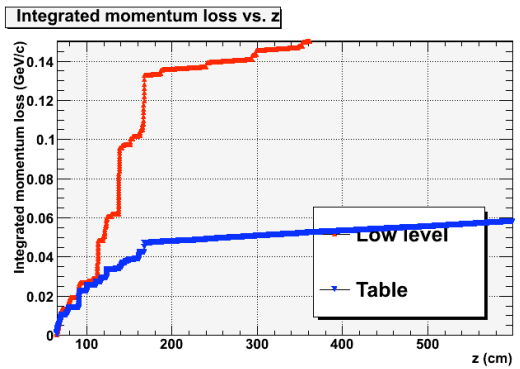
Map sensitivity to sampling and grid densities

Constant B-field (-2T)

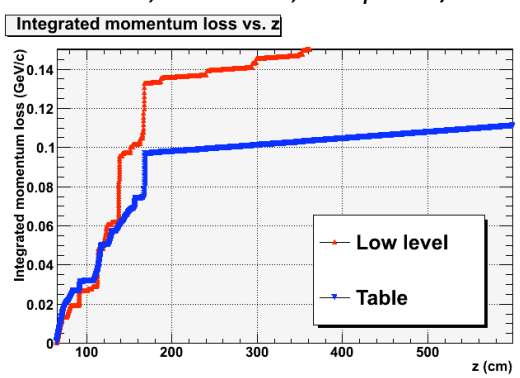
dR=10mm; dz=10mm; 1500 points/cell



dR=1mm; dz=5mm; 40 points/cell

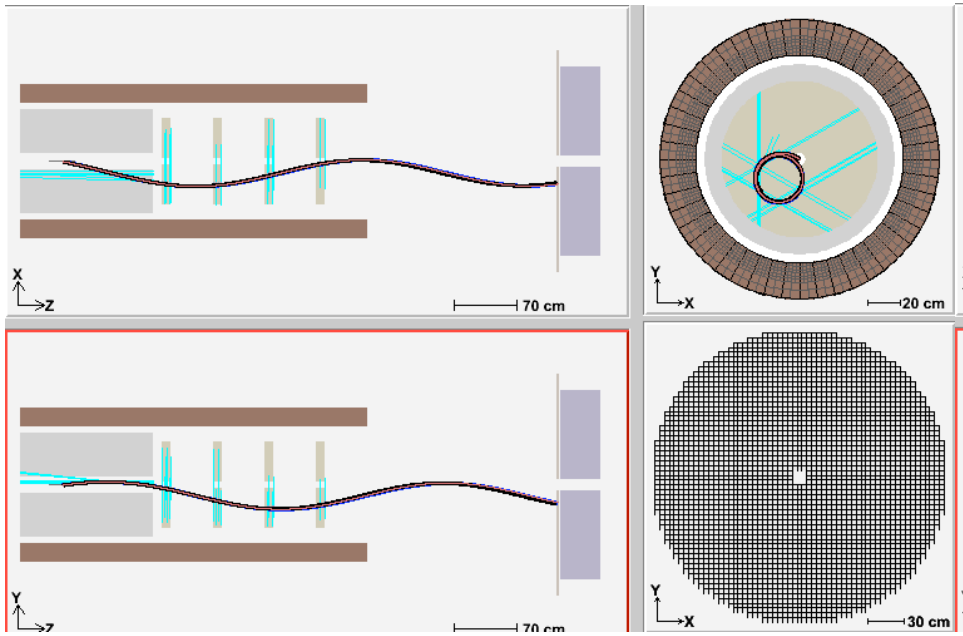


dR=10mm; dz=10mm; 120 points/cell



Momentum loss for 500MeV protons

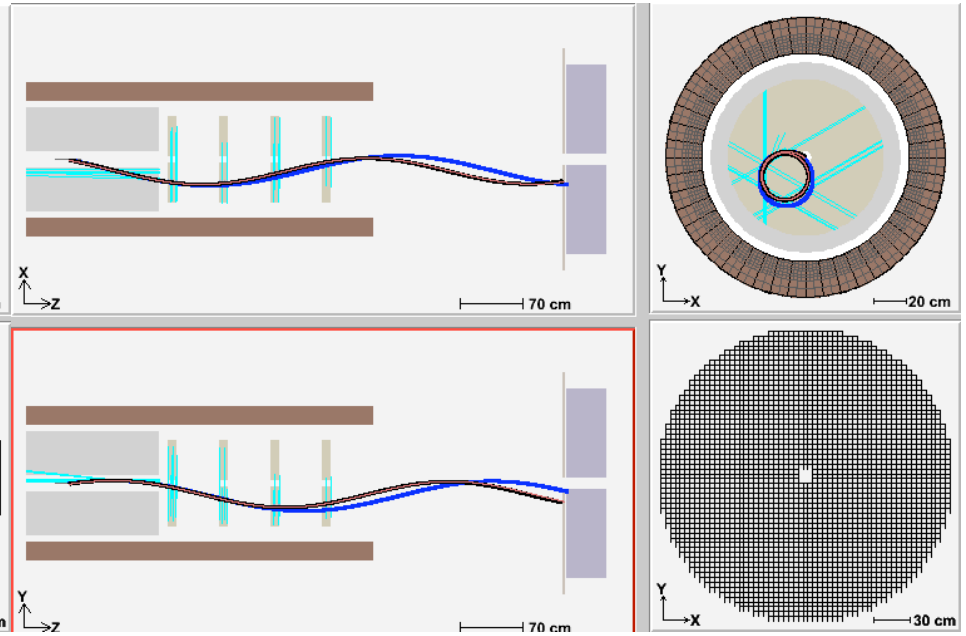
Using *FindMatLL(…)*



Fit result p=499.9 MeV

$\chi^2/N_{dof} = 0.014$

Using *FindMatTable(…)*



Fit result p=436.8 MeV

$\chi^2/N_{dof} = 13.85$

Having the correct material is critical to getting the right fit parameters.

Outlook

- In principle, a map which averages over material should be more accurate than single-point sampling for 1cm steps. More study is needed to understand the discrepancy.
- This will be done between now and the next software meeting.