

Magnetized Detectors in LArSoft

Part II: Aimless (?) Drifting

D.McKee

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Why magnetic fields?

The LBNE near detector will need to measure the beam neutrino composition, which means determining lepton sign, a job that might be done several ways, one of which is applying a magnetic field over the TPC.

(This is basically unfinished business that I want to get checked in so it is not lost.)

What changes?

- Geant4 needs to know **Done and checked in last fall.**
- The MC drift implementation needs to know **Ready to check in**
- The drift direction might be affected (unless $\vec{B} \parallel \vec{\mathcal{E}}$), so the space point reconstruction needs to know. **Ready to check in**
- Track reconstruction needs to know **Not done and no plans**
- Does the Event Display need to know? **Not done and no plans**

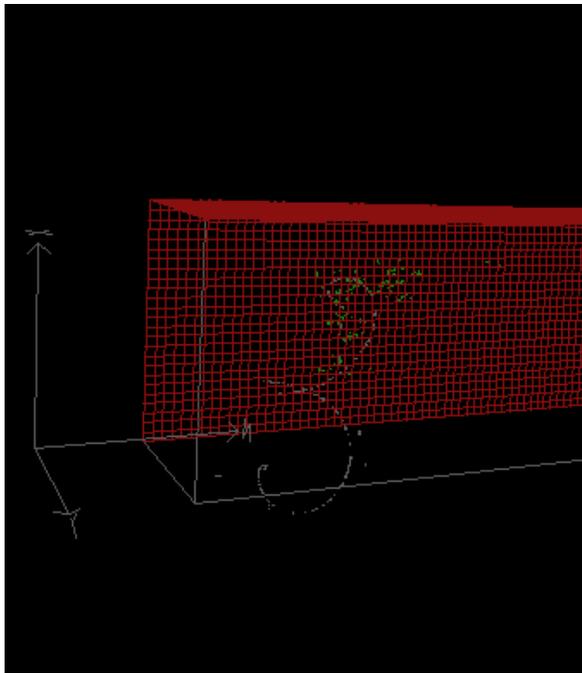
What's already done?

- We have implemented a ART service to support specifying magnetic fields. The module is called `MagneticField` and resides in namespace `mag`.
At this time it supports on a (nonphysical) constant magnetic field on a named `Geant4` volume and its sub-volumes.
- We have made LArG4 aware of `MagneticField` for both `Geant` tracking and electron drift physics.
- We have made the `SpacePoint` module aware of `MagneticField`

Important goal: Minimize the intrusion of this code on experiments not using magnetic fields!

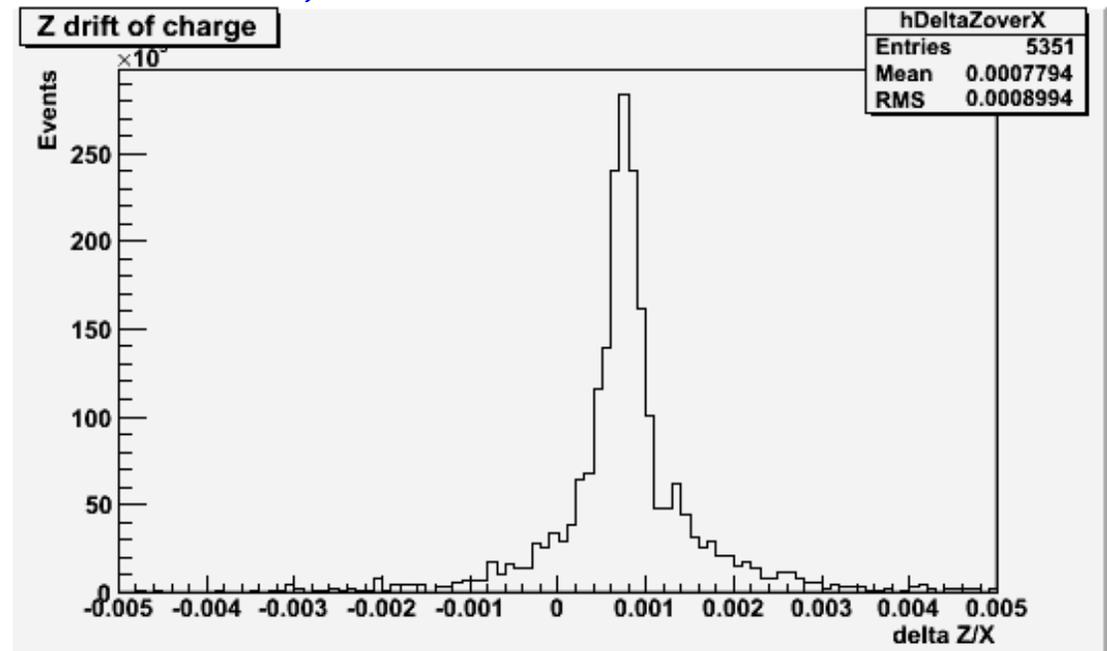
Does it Work? (1)

Geant tracking: Pretty spirals!
 $\mu-\bar{\mu}$ near 0.65 GeV



$$\vec{B} = 1.5\hat{y} \text{ T}$$

Simulate 500 250 MeV protons in magnetized MicroBooNE, then compare Δz (zero without a field) with the initial x position

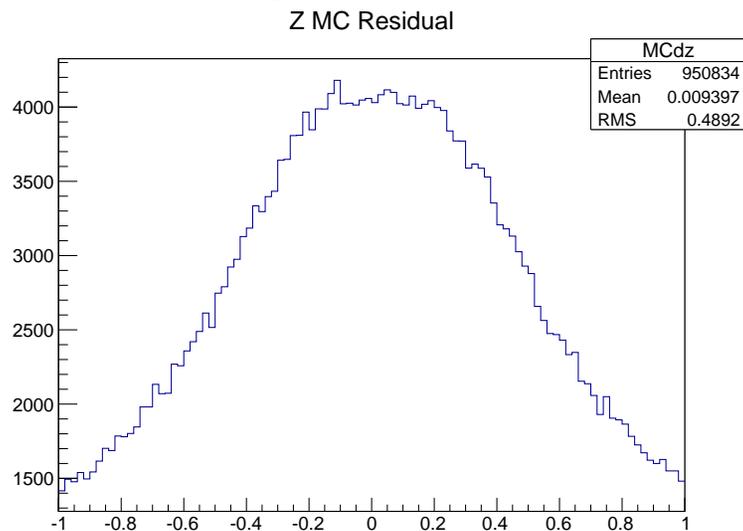


$$\vec{B} = 2.0\hat{y} \text{ T}$$

Does it Work? (2)

Reconstruct the hits (directly, no tracks or clusters) and check the difference between the reconstructed and MC positions

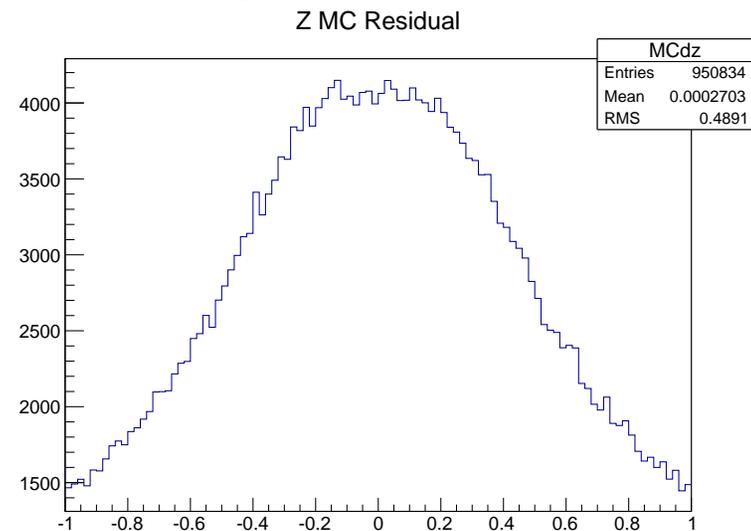
Without magnetic field correction



$$\Delta z = 9.4 \times 10^{-3} \text{ cm}$$

$$\vec{B} = 2.0 \hat{y} \text{ T}$$

With magnetic field correction



$$\Delta z = 2.7 \times 10^{-4} \text{ cm}$$

Getting it to do something...

For the nonce the default is set to no field for Argoneut and microBooNE, and to a 0.4 T field along \hat{y} in LBNE.

```
# Force a magnetic field for testing purposes
services.user.MagneticField.UseField: true
services.user.MagneticField.ConstantField: [0.0, 2.0, 0.0]
services.user.MagneticField.MagnetizedVolume: "volCryostat"

----- charge_drift.fcl (Fundamental)--L87--Bot-----
```

To add modify the magnetic field defaults in lar just add something like

```
services.user.MagneticField.UseField: true
services.user.MagneticField.ConstantField: [0.0, 0.4, 0.0]
services.user.MagneticField.MagnetizedVolume "cryostat"
```

to the bottom of the fickle file use use to run your job.

Still to do...

- Find and additional places where we would need to intervene to correct the back projection. Should we provide a service for this?
- Write some magnetic field aware analysis modules (Helix3DKalman?)
- Finish the documentation
- Event display improvements (Actually even display seems to be handling this pretty well)

and in the long run

- Support a realistic field (presumably read from a file and set by a field map)

Conclusions

- So far if you're not using it, it shouldn't affect you; and we're working to keep it that way
- There is enough there to run casual studies
- There is *no* support of actual analysis in terms of curved track identification, momentum reconstructions, etc.