

Kalman Tracking Status in uBooNE update (early days)

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~~7-April-2011~~ ... 19,20-April-2011.

Kalman Filter



$$\vec{x}_k = \tilde{\vec{x}}_k + K_k \vec{r}_k$$

$$C_k = (I - K_k H_k) \tilde{C}_k$$

where

$$\vec{r}_k = \vec{m}_k - H_k \tilde{\vec{x}}_k$$

\tilde{x}_{k+1} is arrived at using Geant3 based track-following code. Not a transport matrix, as is common elsewhere.

The $\tilde{}$ denotes a predicted quantity. k labels a point on the track. x is the state space and m is the measurement. They are connected by H . The Kalman gain is

$$K_k = \tilde{C}_k H_k^T (H_k \tilde{C}_k H_k^T + V_k)^{-1}$$

Kalman filter



$$\vec{x} = \begin{pmatrix} q \\ |p| \\ \frac{du}{dz} \\ \frac{dv}{dz} \\ u \\ v \end{pmatrix} \quad H = \begin{pmatrix} 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

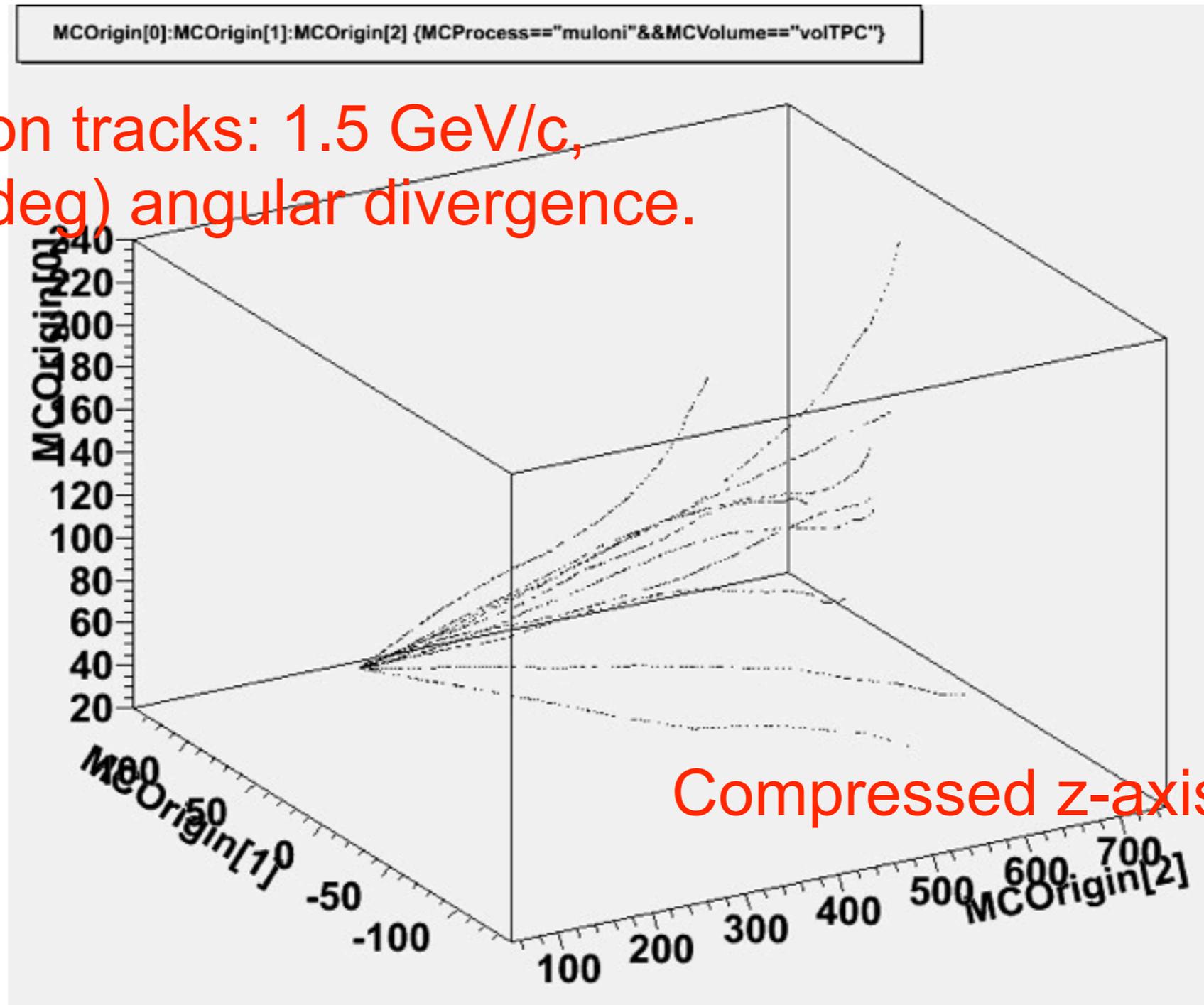
Sum over all points, $k=1, N$. Ndof=2N.

$$\chi^2 = \vec{r}_k^T (V_k - HC_kH^T)^{-1} \vec{r}_k$$

10 MC muons in uBooNE



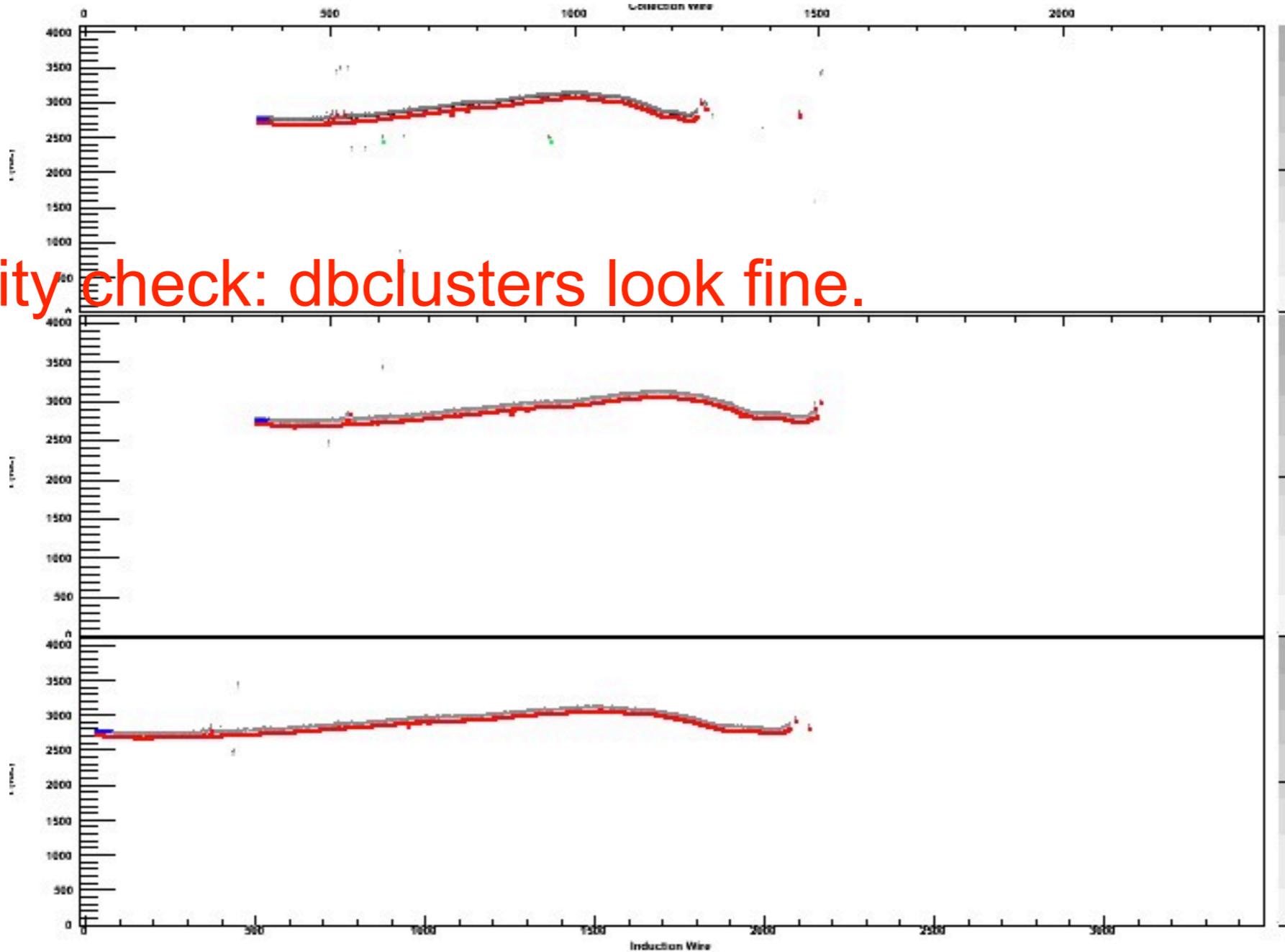
MC true muon tracks: 1.5 GeV/c,
Very low (5 deg) angular divergence.
Looks great.



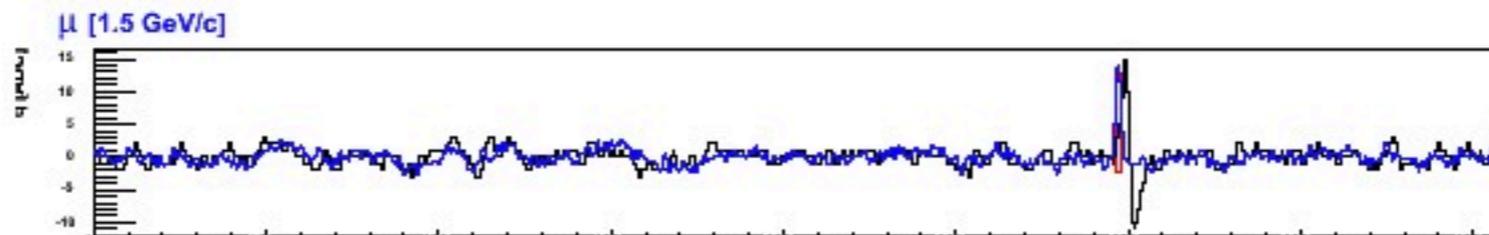
uBooNE MC 1GeV/c muons



Sanity check: dbclusters look fine.



ArSoft
:un: 1/1
:vent: 6
TC Thu Jan 1, 1970
D:00:0.030000000

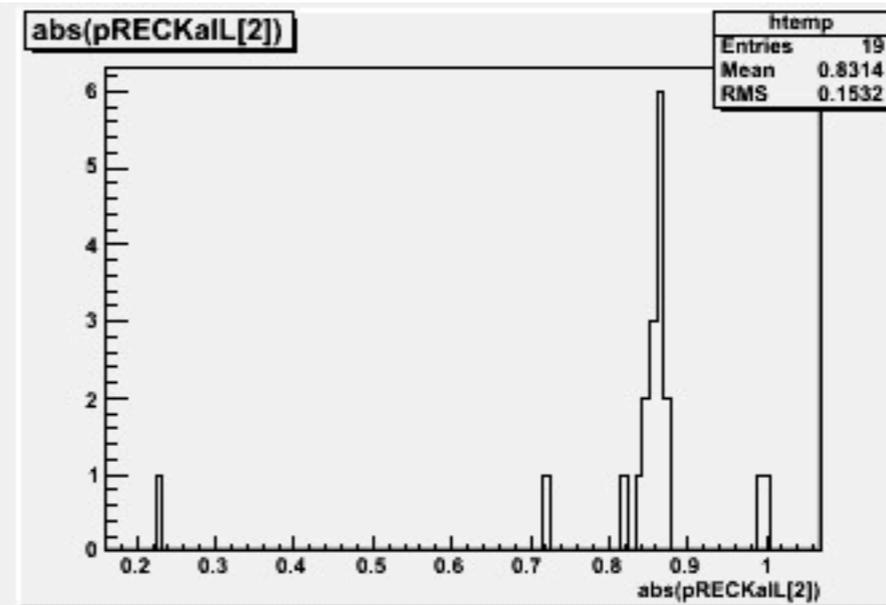
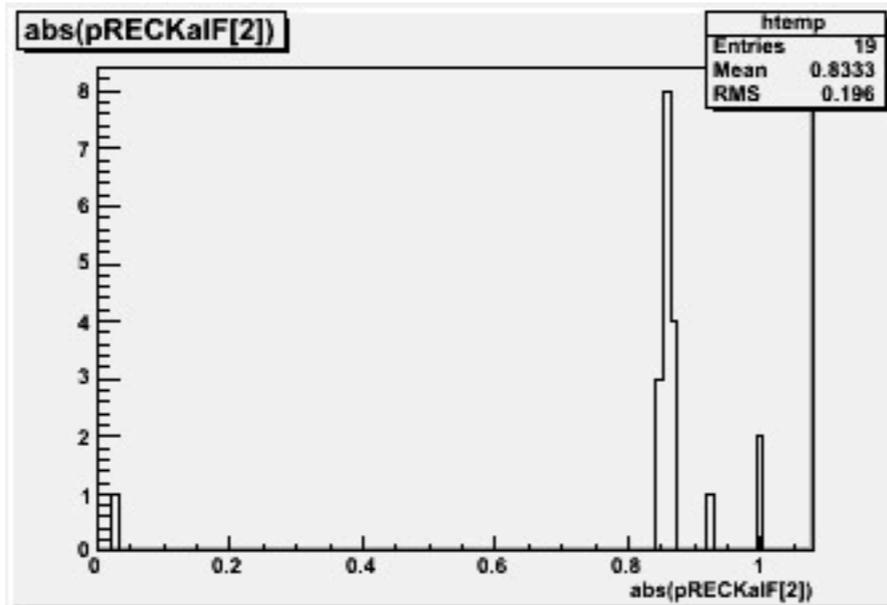


Kalman results on 10 muons



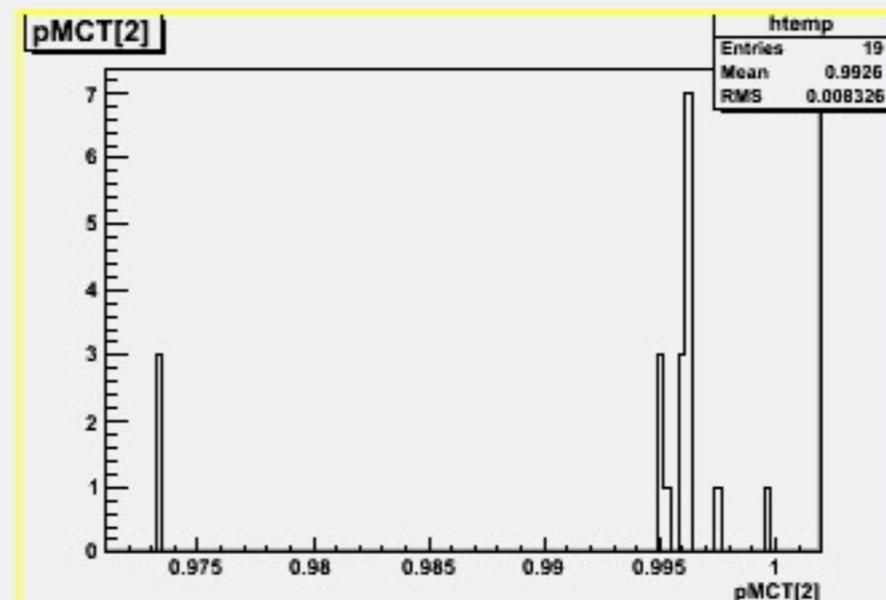
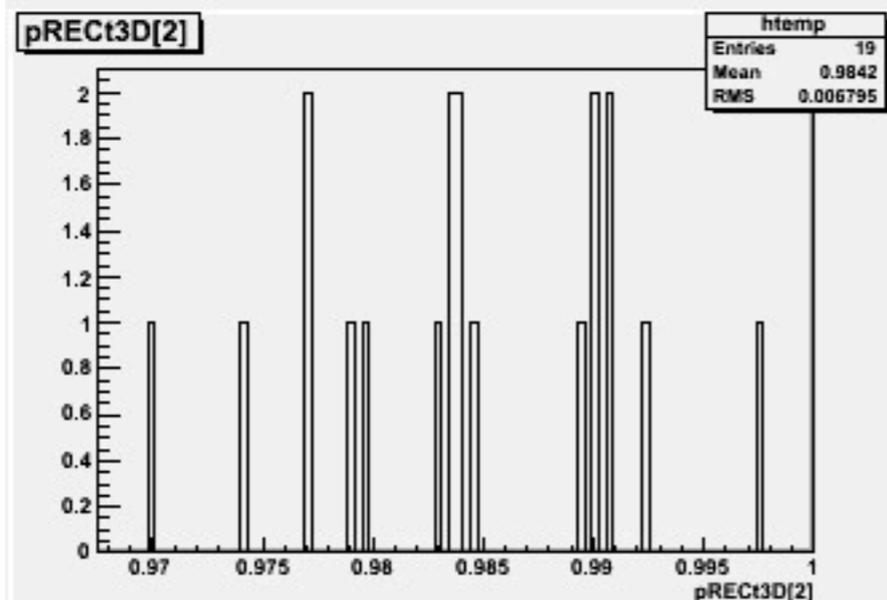
□ Uz

Kalman
First pt



Kalman
Last pt

T3D

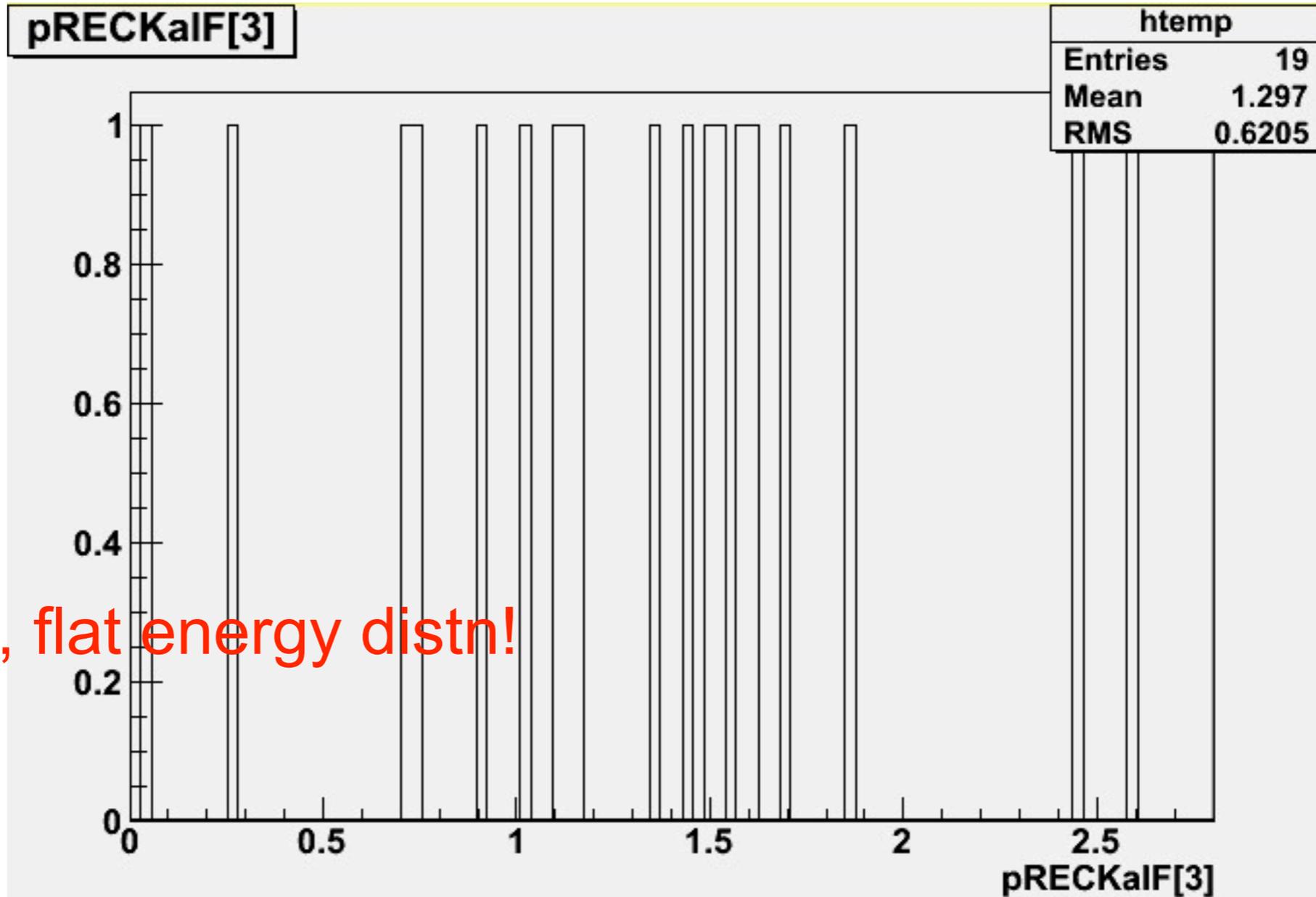


True

Kalman Results on 10 muons



- True 1.5 GeV/c muons

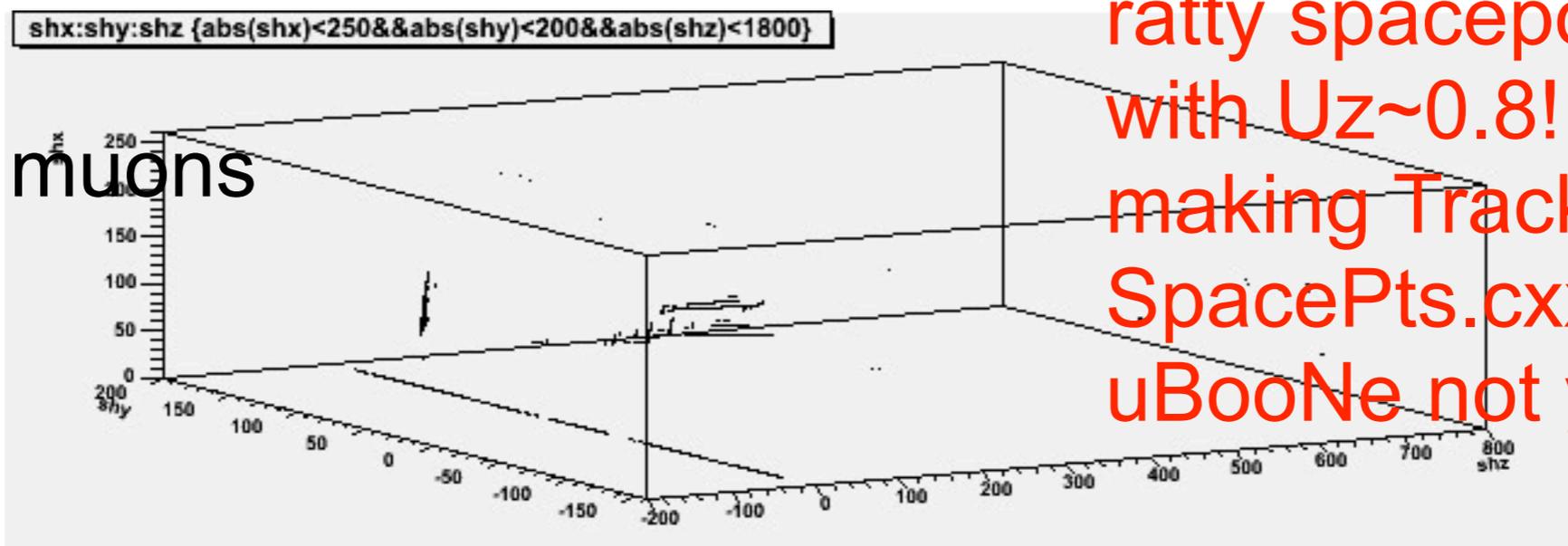


|p|_Kalman

Ah-ha, the SpacePoints are bad

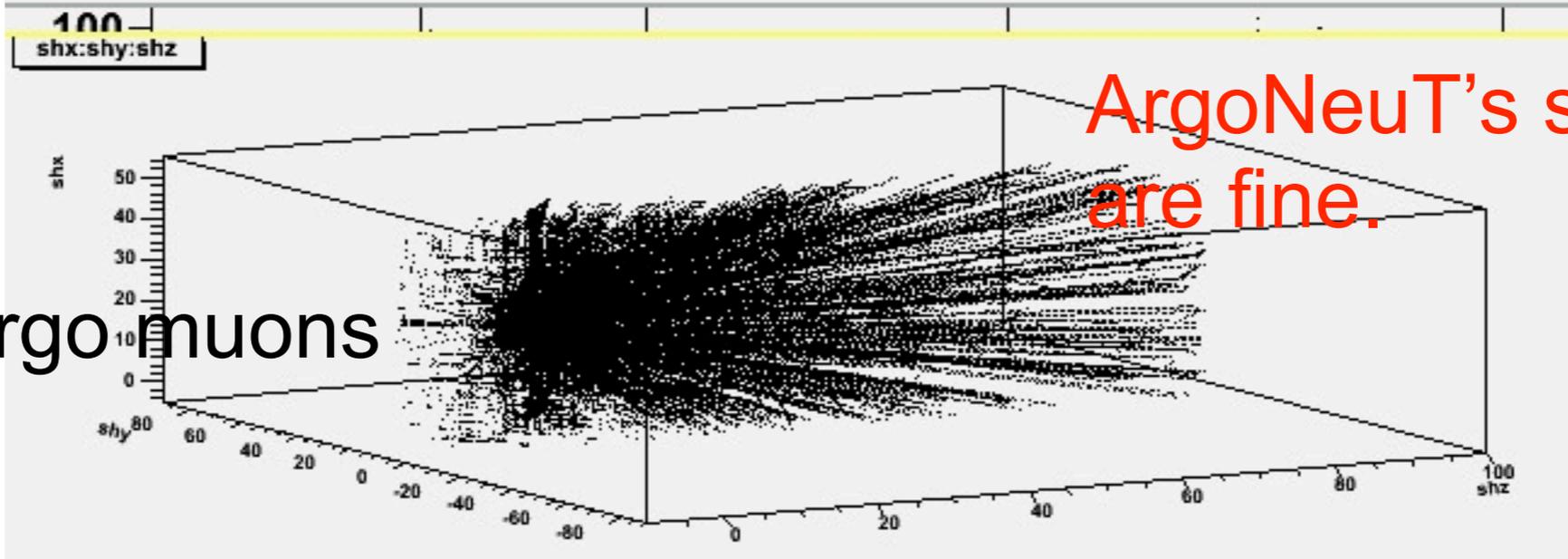


10 uB muons



ratty spacepoints: tracks with $U_z \sim 0.8$! Efforts at making Track3Dreco/SpacePts.cxx work for uBooNE not yet fruitful.

1000 Argo muons

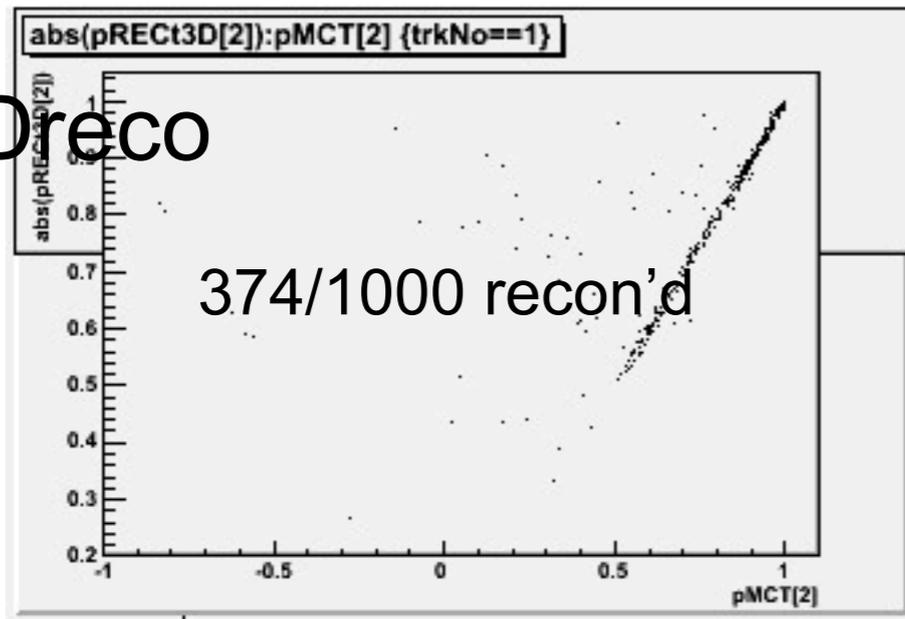


ArgoNeuT's spacePoints are fine.

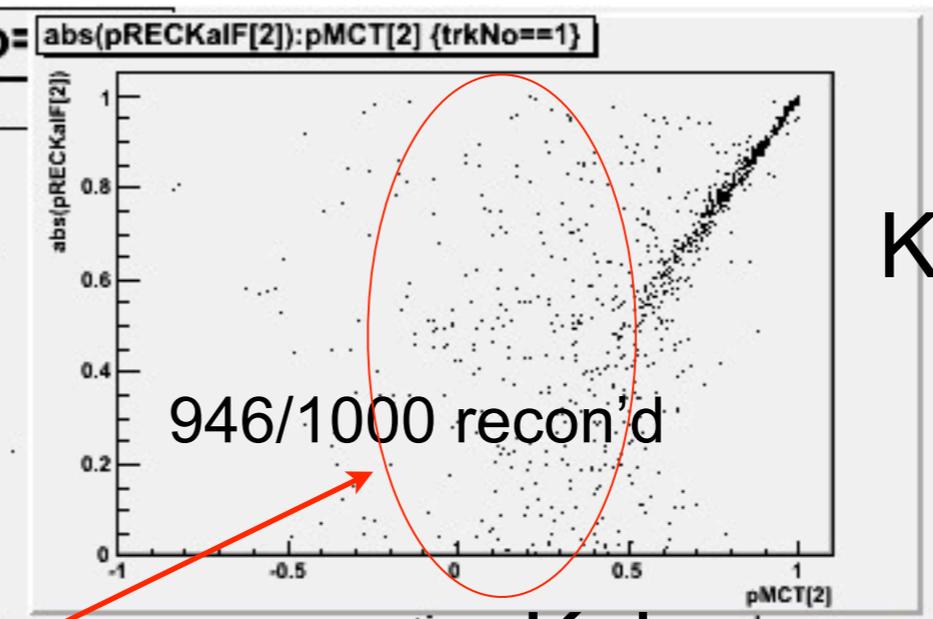
Punt, for now on uBooNE. Use ArgoNeuT. 1000 muons with 45 deg divergence.

Recon Uz vs True. And estimated momentum

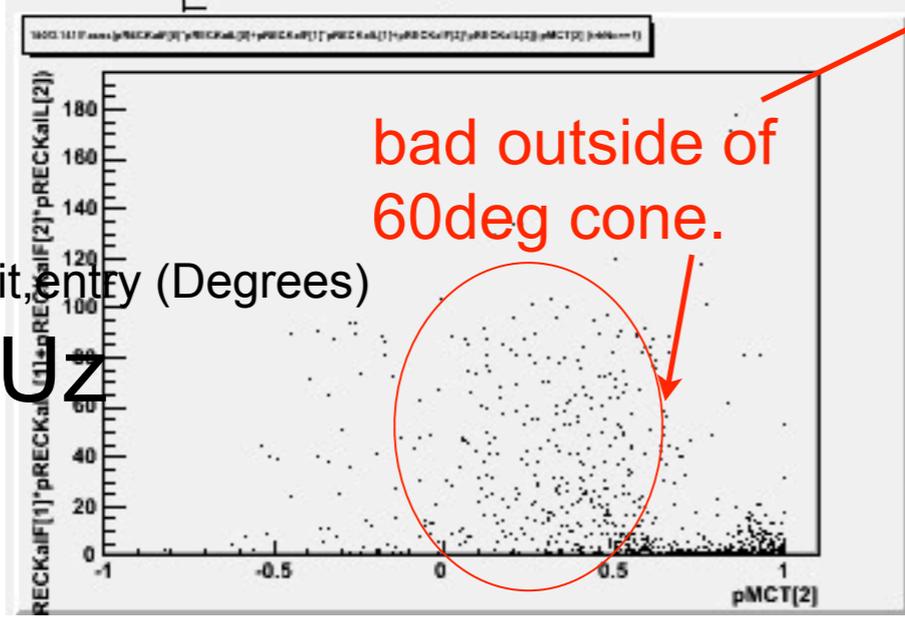
Track3D reco tracks



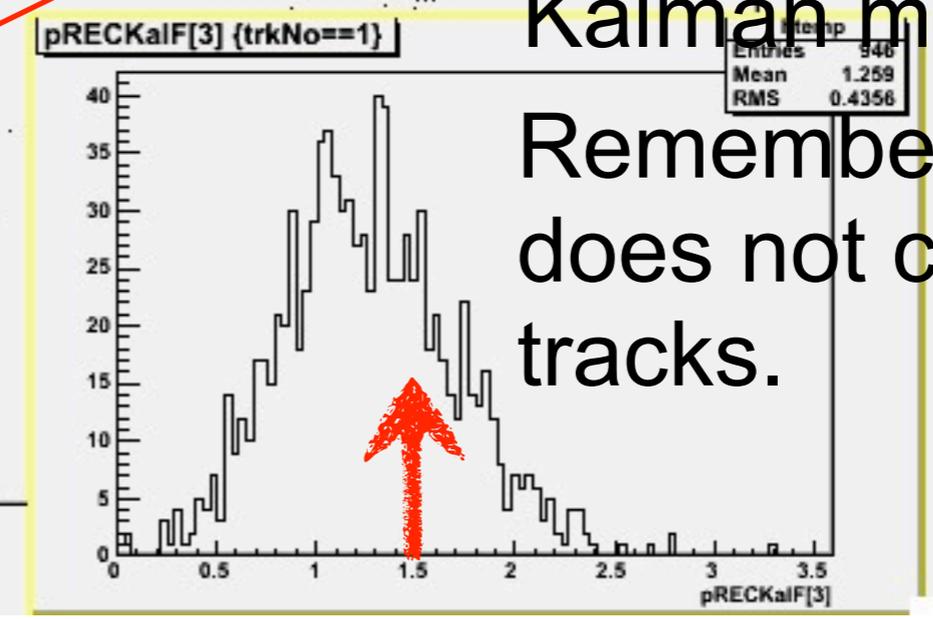
Kalman tracks



Kalman angle_exit,entry vs True Uz



Kalman momentum



Remember: ArgoNeuT does not contain these tracks.

Next Steps



- ❑ Still lots of room to play with input parameters.
- ❑ I'm awaiting Mitch's LArTracker.cxx, which does the SpacePoint finding detector agnostically and without all the built-in "straight line biases" in Track3Dreco.cxx.
- ❑ Can imagine this might be useful for ArgoNeuT too for pointing to MINOS
- ❑ Pointing errors fall out naturally from Kalman fit. Nice for Saima's vertexing.