

Field-on measurement of multiple scattering

MICE CM42

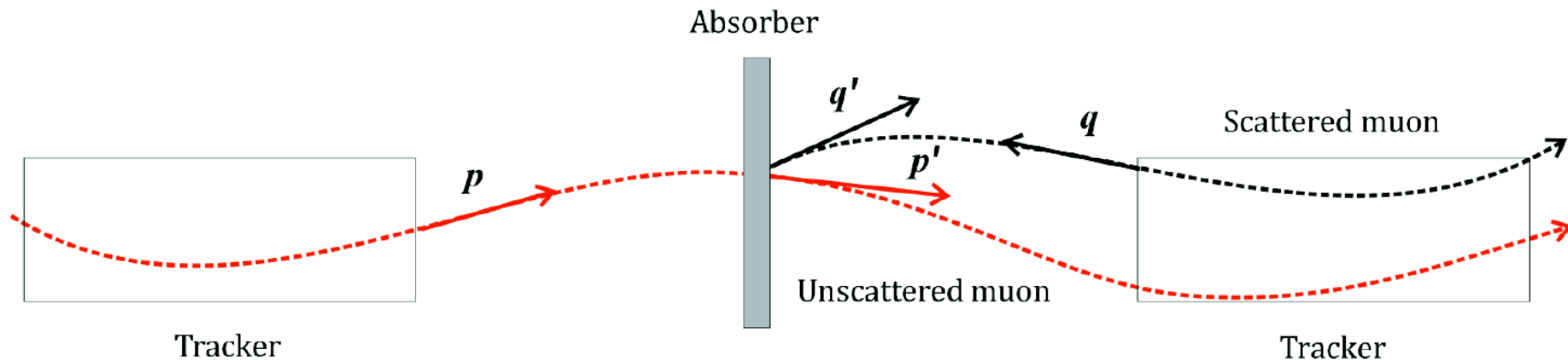
22/06/15

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Introduction

- Preliminary work on measuring the scattering angle at Step IV within magnetic fields has begun.
- Based on the work done by Tim Carlisle, but using tracker reconstruction, as will be used on Step IV data.
- Final aim of this work will be to measure the scattering in LiH.
- However at the MC stage both LiH and LH2 absorbers will be considered.

Method



Outlined in Tim Carlisle's thesis.

- Measure a muon in the US tracker, with momentum \mathbf{p} . Track this forward to the DS face of the absorber, but without scattering, to obtain \mathbf{p}' .
- Measure the same muon in the DS tracker, with momentum \mathbf{q} . Track this back to the absorber to obtain \mathbf{q}' .
- Then calculate the the 3D scattering angle θ , using

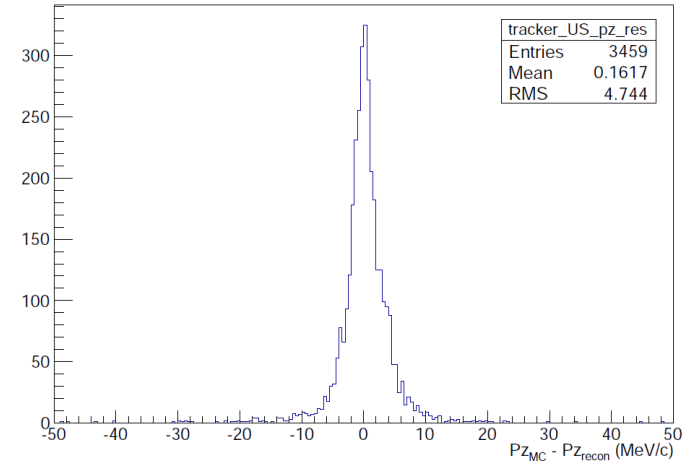
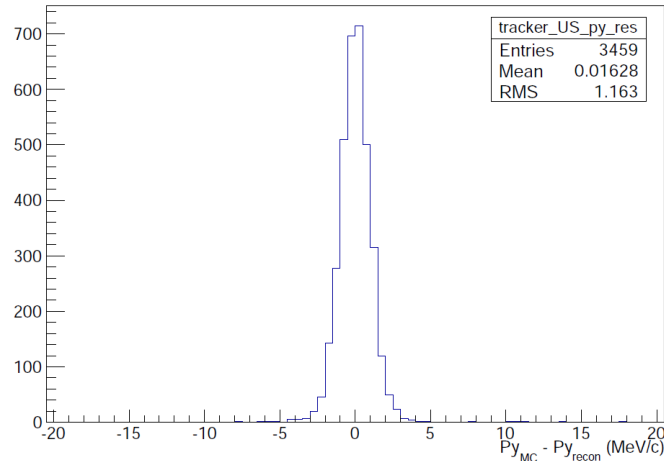
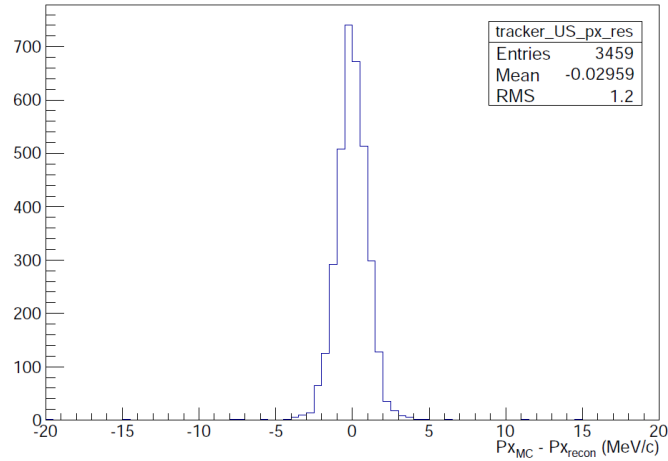
$$\cos \theta = \frac{\vec{p}' \cdot \vec{q}'}{\|\mathbf{p}'\| \|\mathbf{q}'\|}$$

Scattering angle between propagated hits (MC and tracker recon)

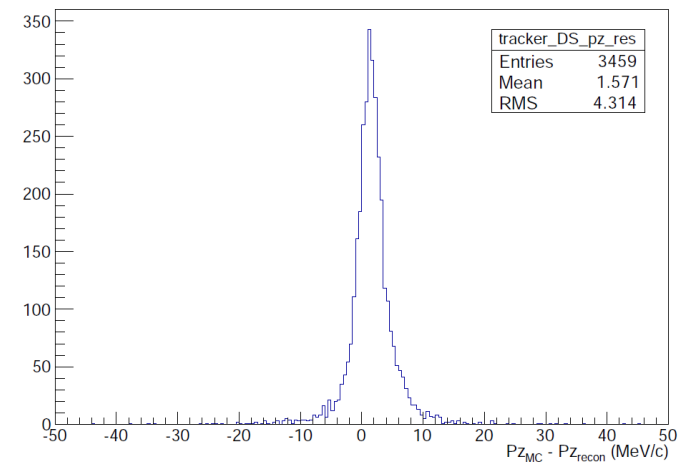
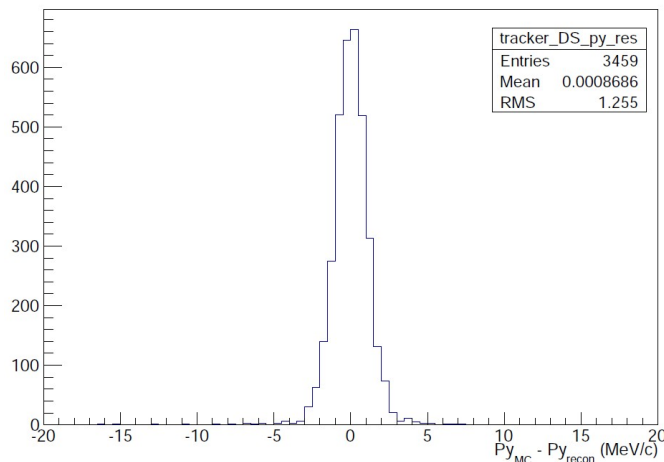
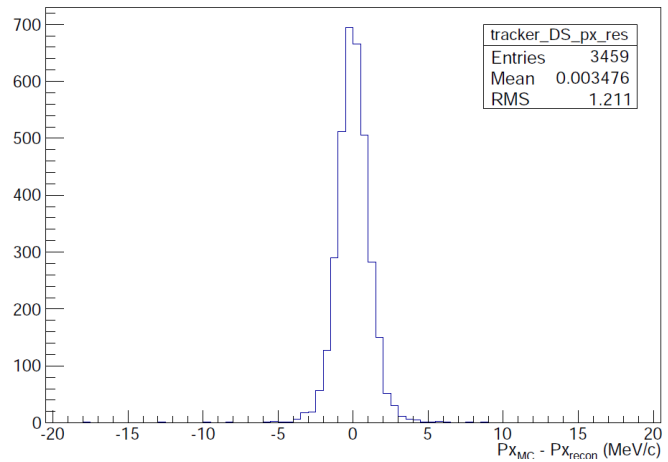
- Simulated a 200MeV/c, 6mm muon beam.
- Followed method from slide 3 first for MC hits in the trackers.
- Then repeated with tracker recon.
- Done for the case of an empty channel, the LiH absorber, AFC + empty hydrogen vessel, and AFC + vessel + LH2.
- Also plotted tracker recon momentum residuals, and residuals of both the MC and recon propagated points at the DS absorber face w.r.t. the MC data at the absorber face.

Tracker recon residuals

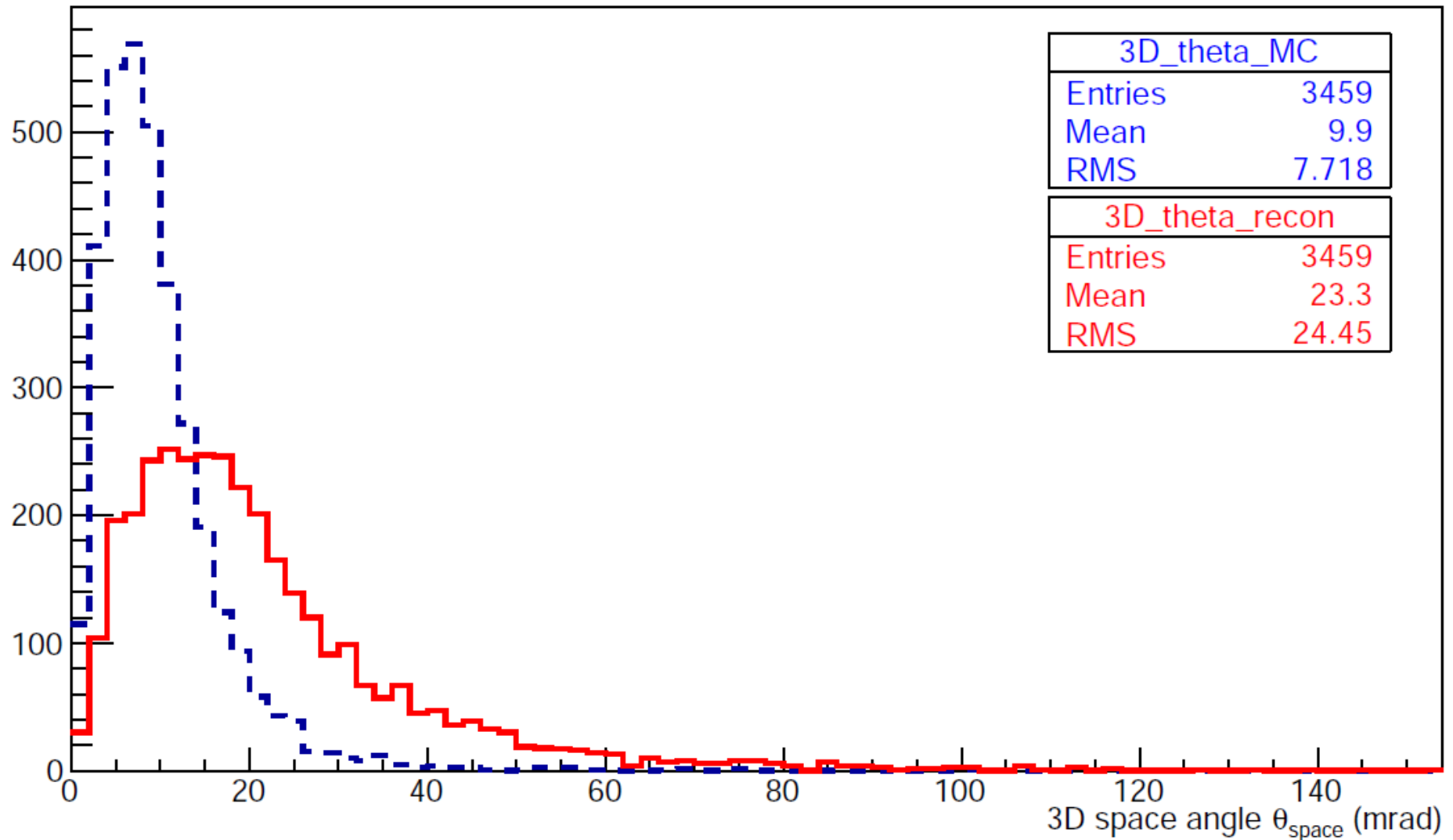
Upstream



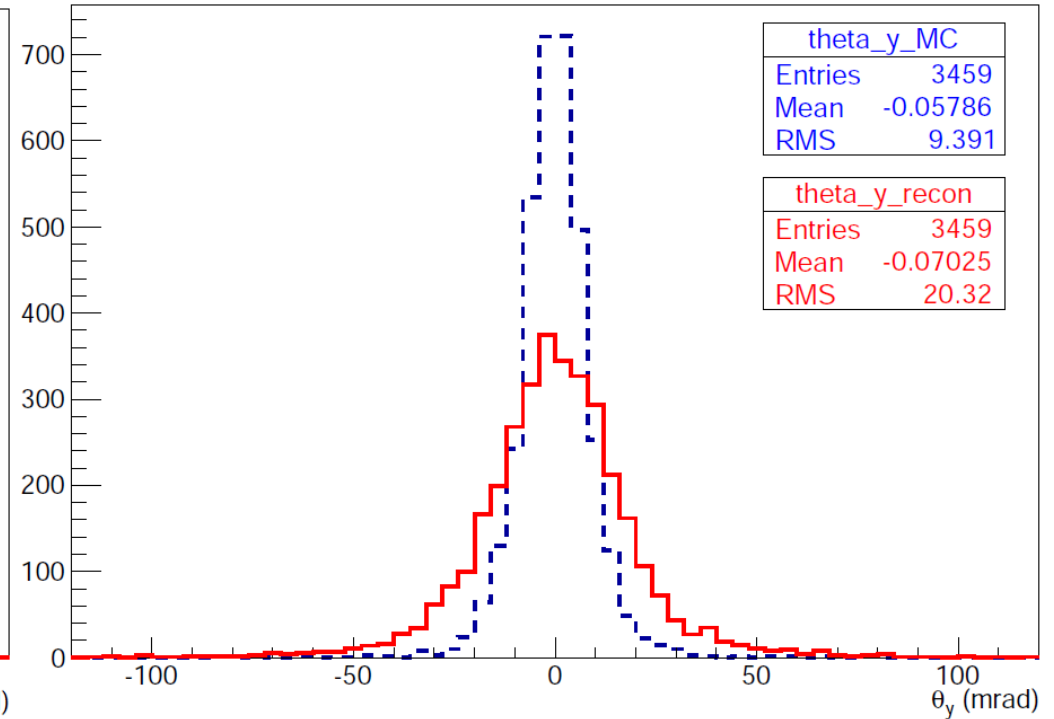
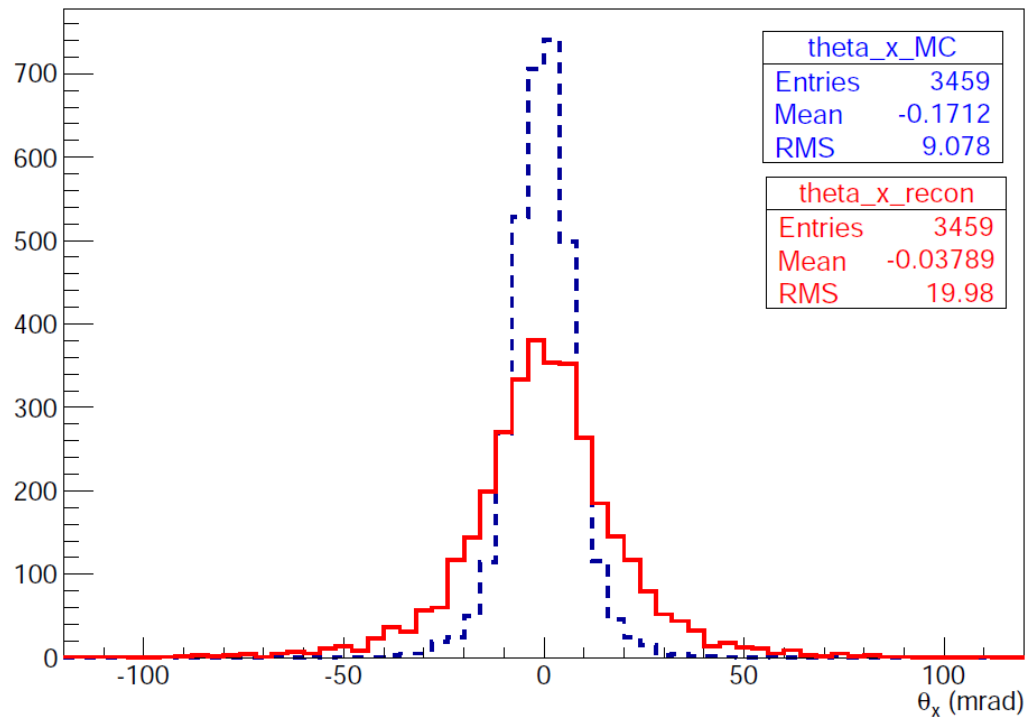
Downstream



Empty channel, scattering angle for propagated MC and reconstructed muons

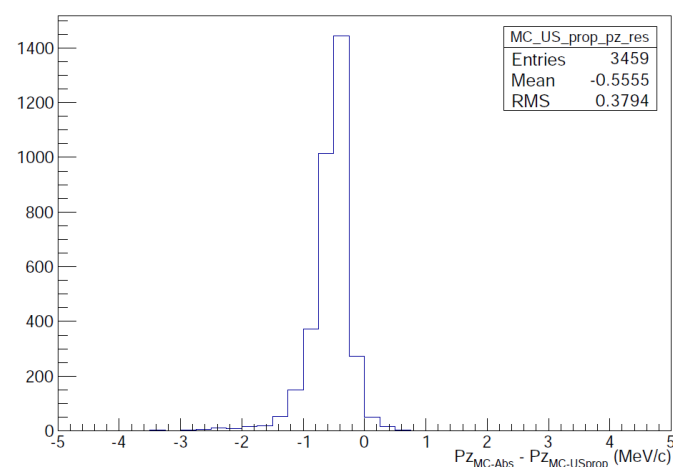
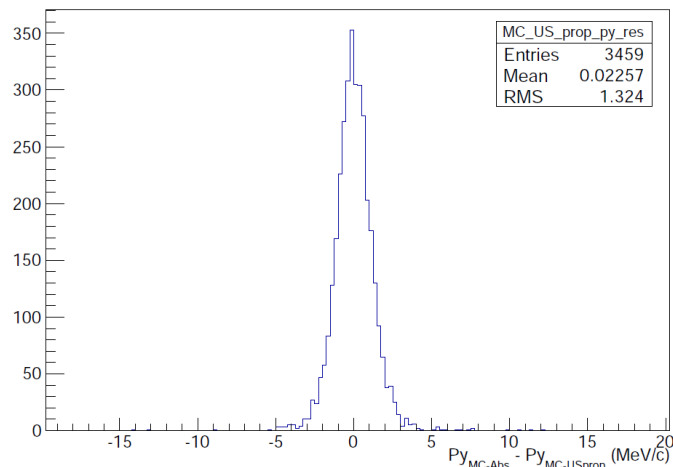
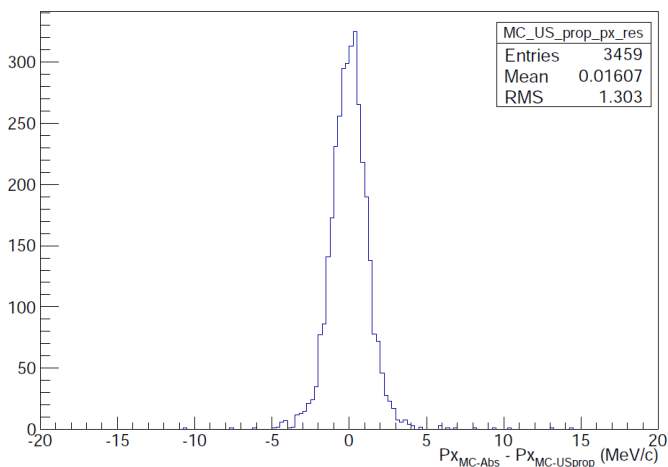


Empty channel, projected scattering angles for propagated MC and reconstructed muons

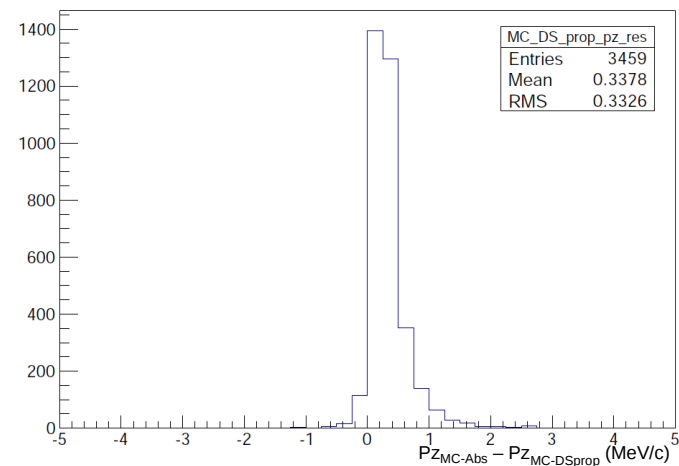
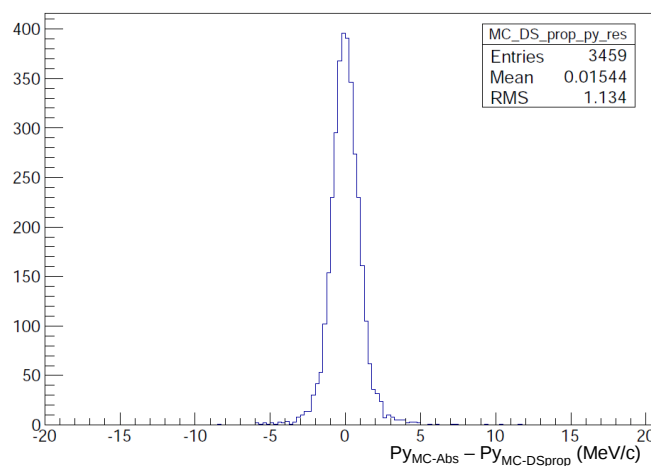
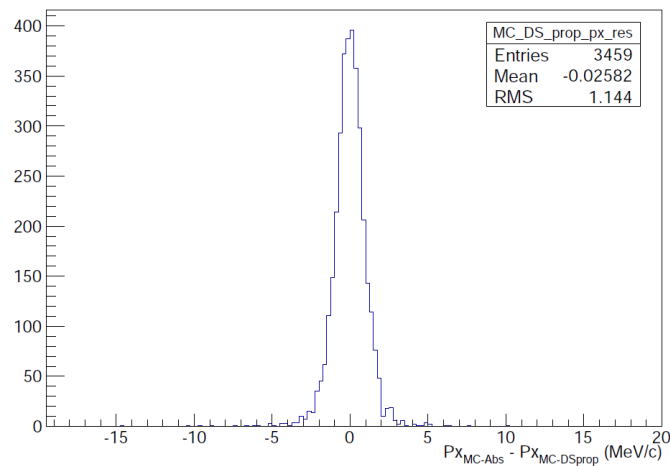


Momentum residuals for propagated MC hits w.r.t. MC truth at (position of) DS absorber face

Upstream

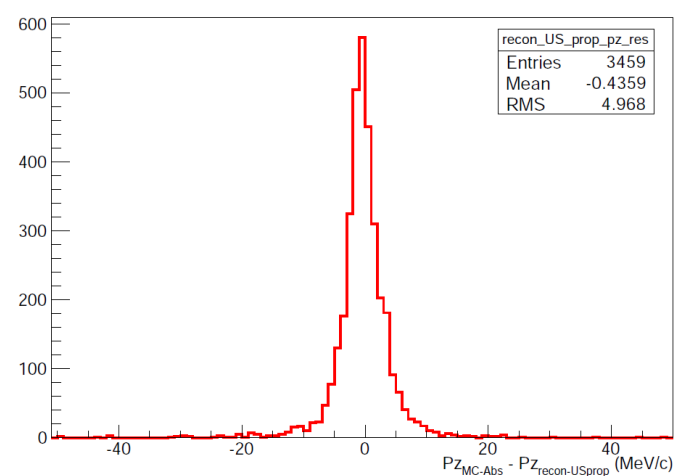
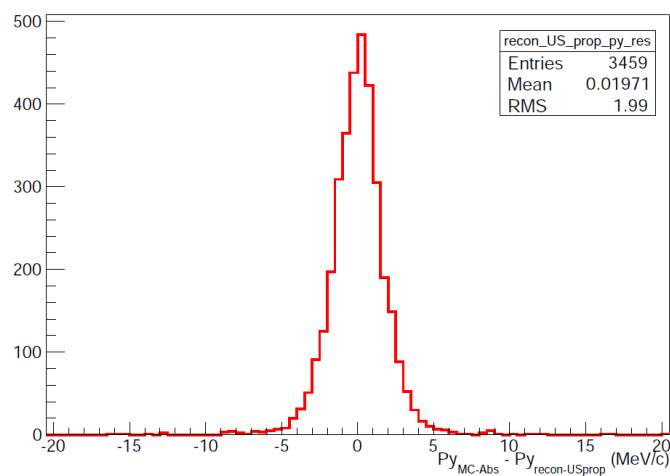
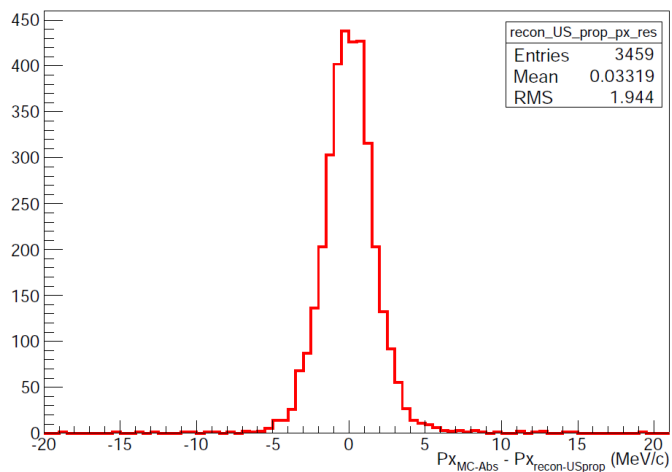


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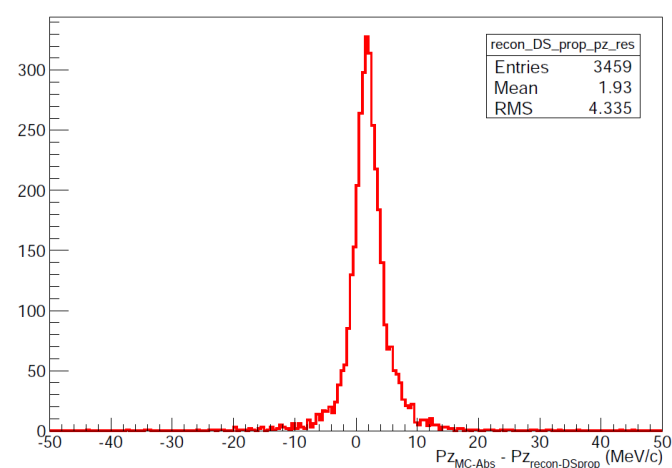
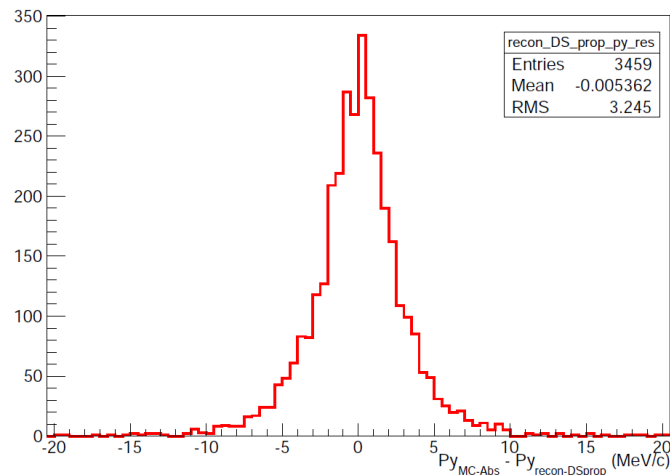
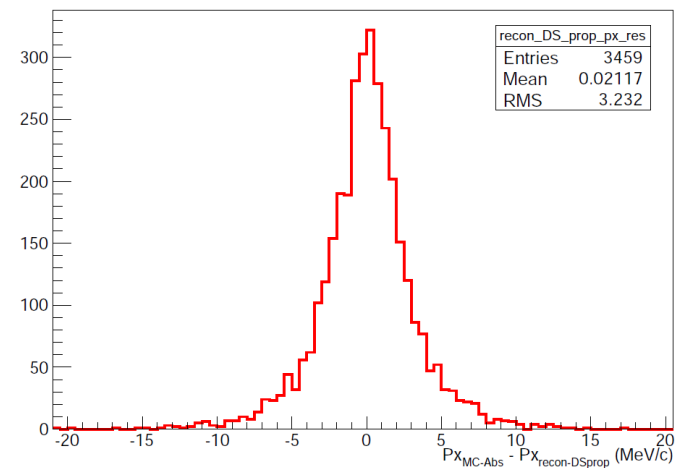


Momentum residuals for propagated recon hits w.r.t. MC truth at DS absorber face

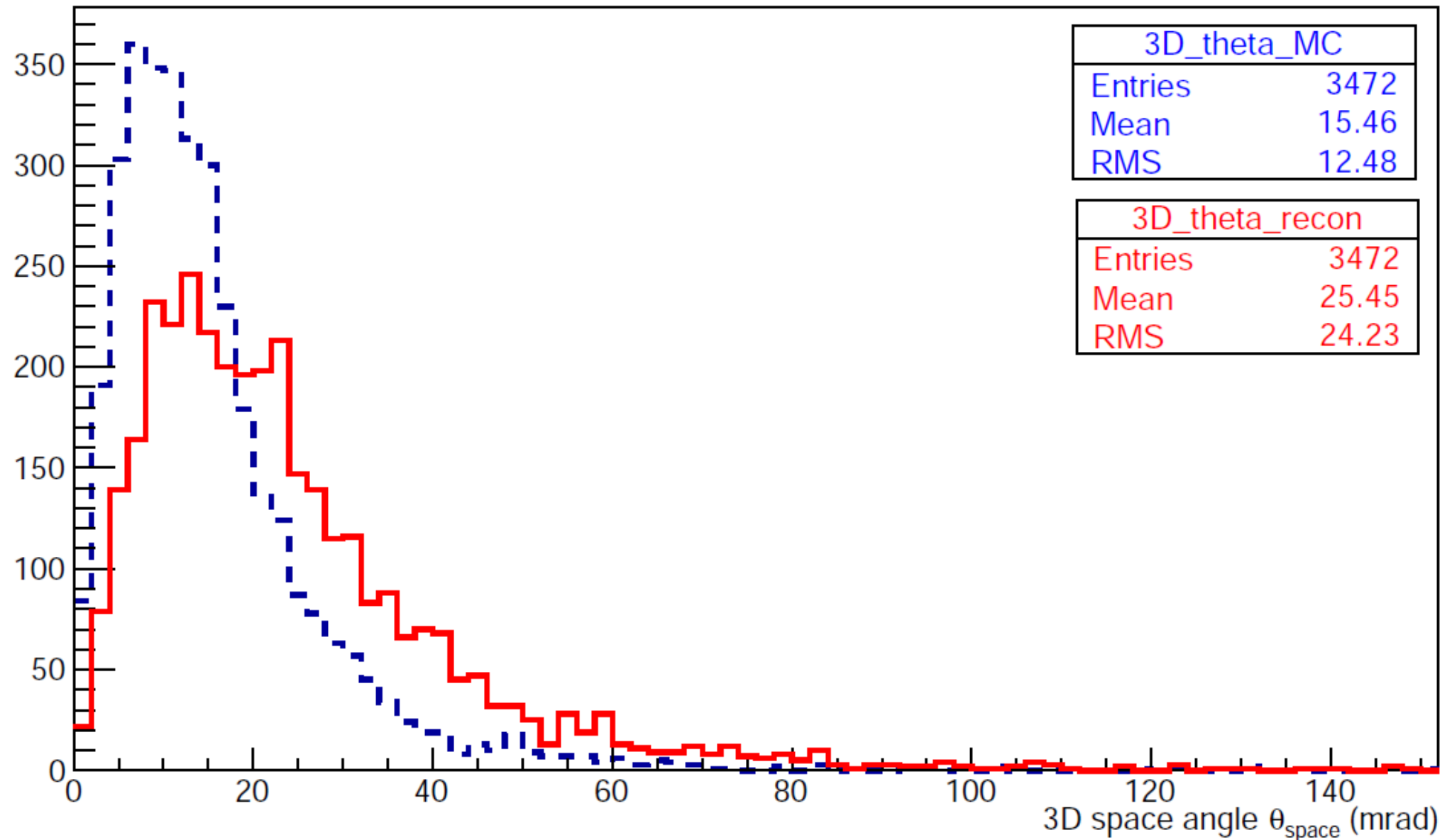
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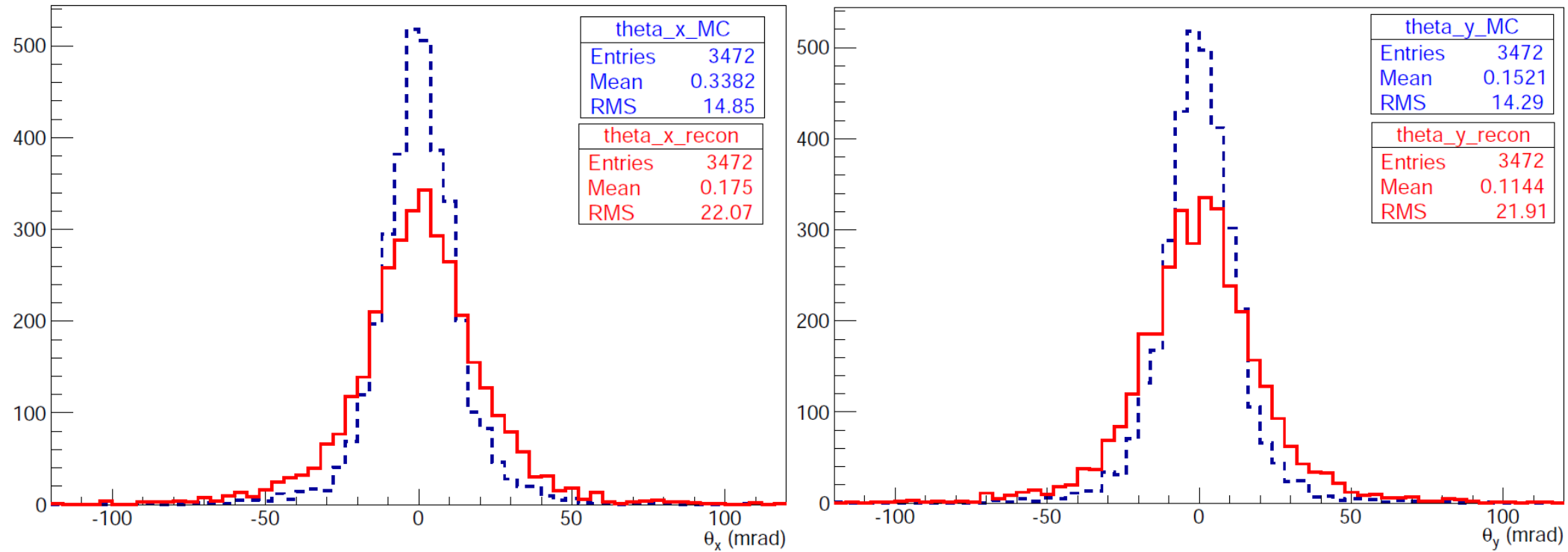
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AFC + empty hydrogen vessel, scattering angle for propagated MC and reconstructed muons

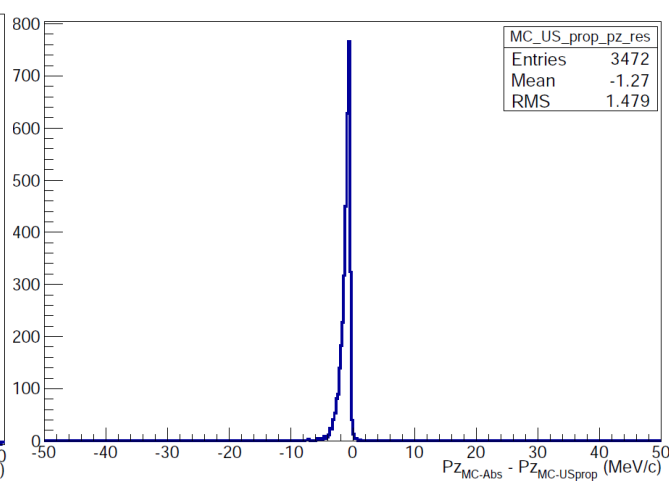
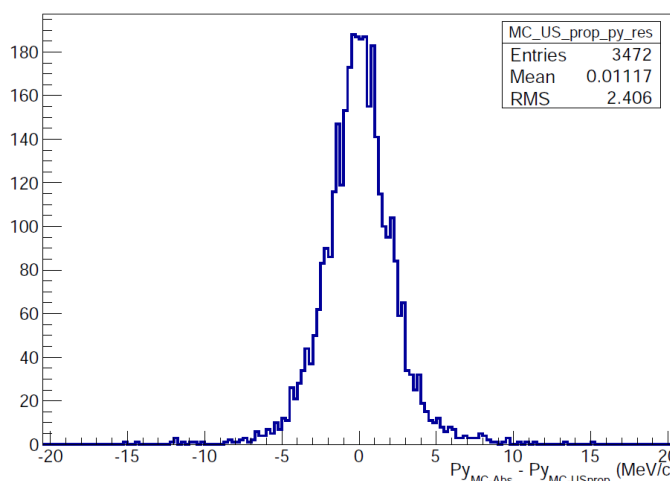
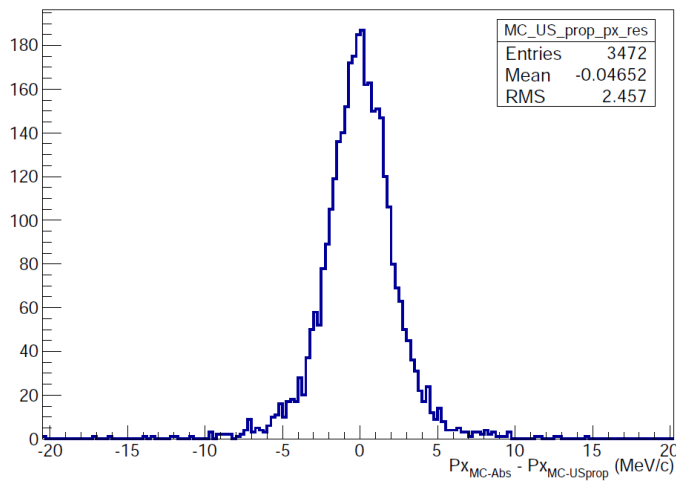


AFC + empty hydrogen vessel, projected scattering angles for propagated MC and reconstructed muons

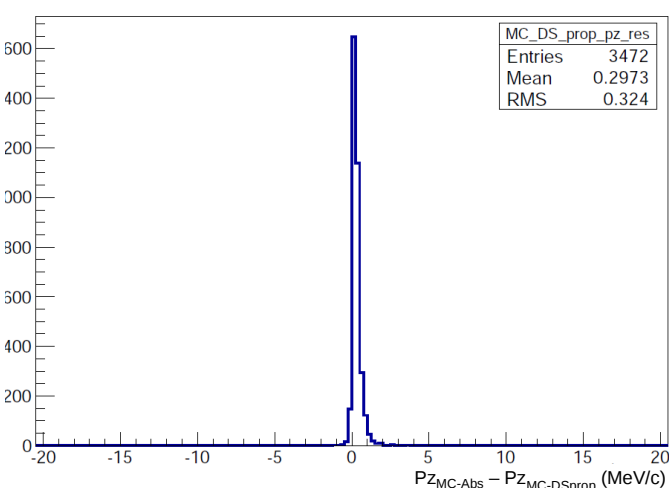
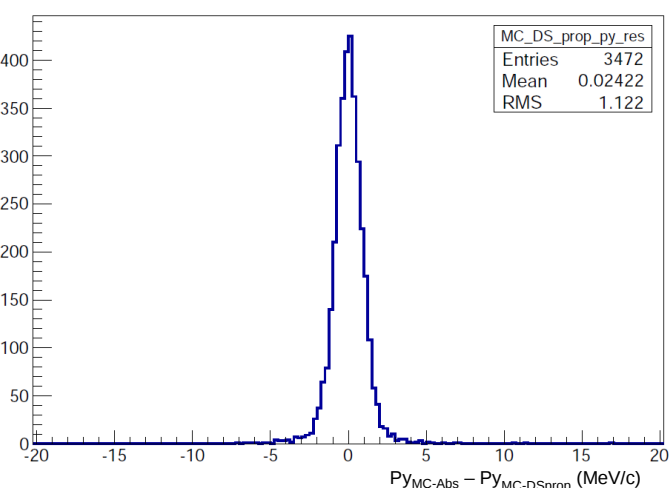
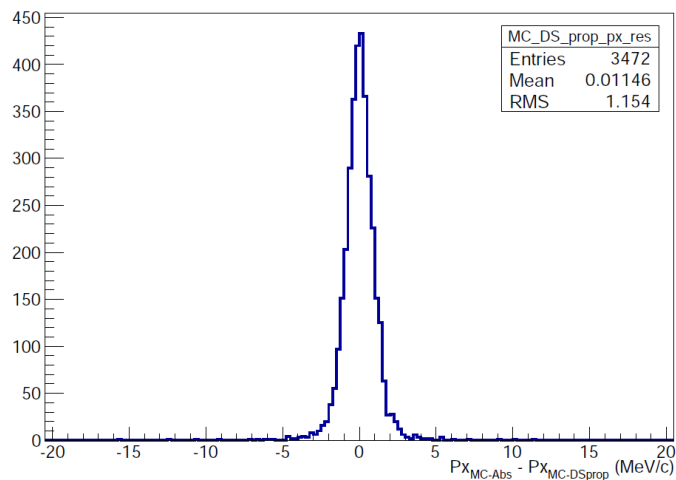


Momentum residuals for propagated MC hits w.r.t. MC truth at DS absorber face

Upstream

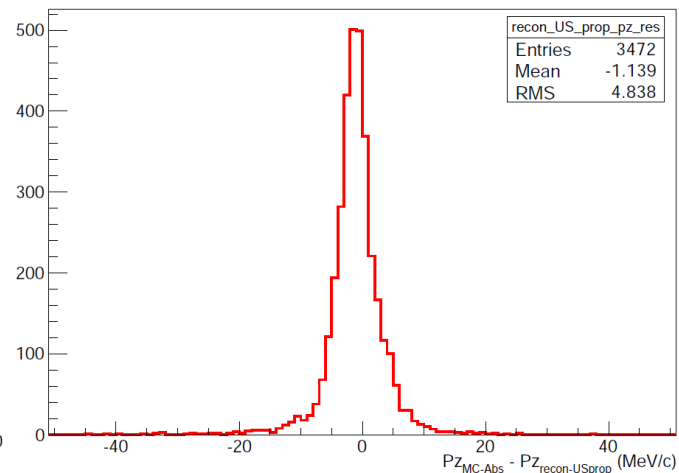
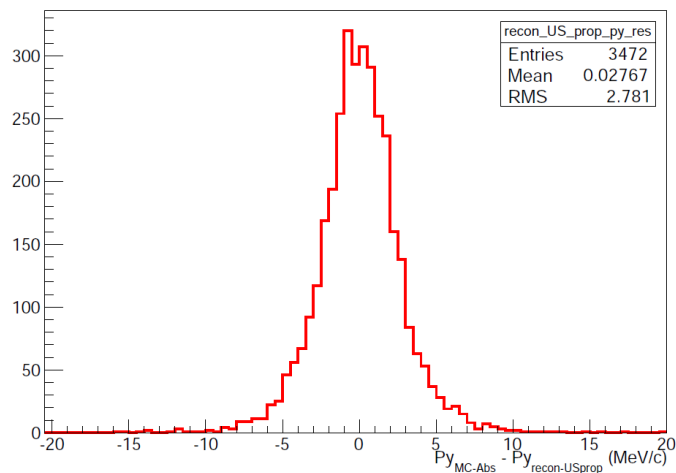
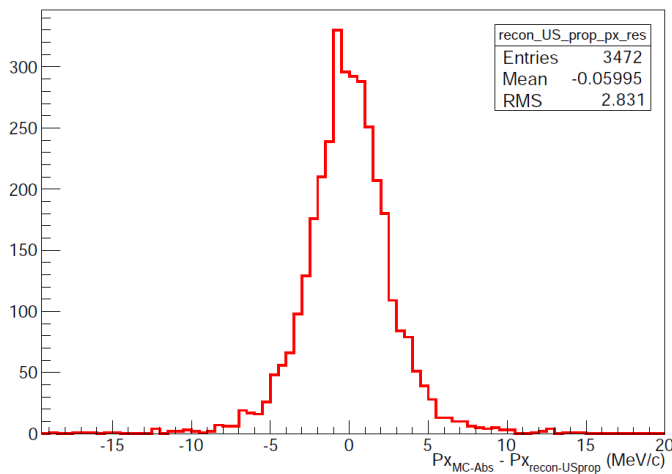


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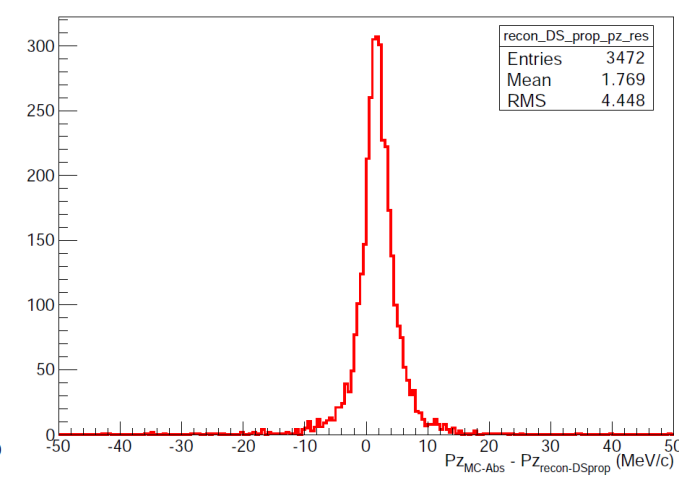
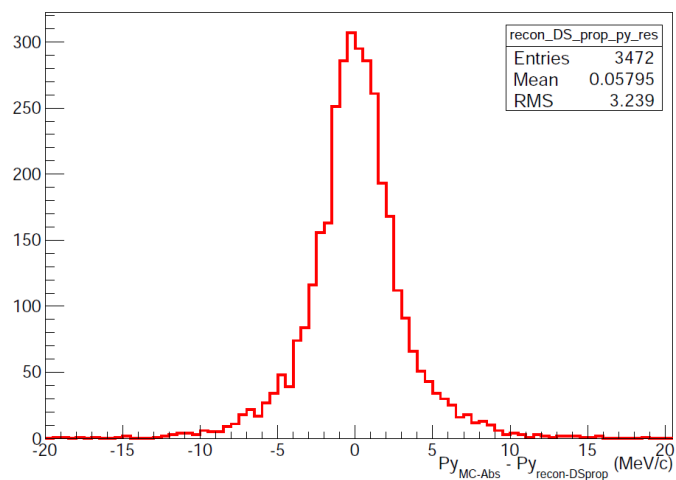
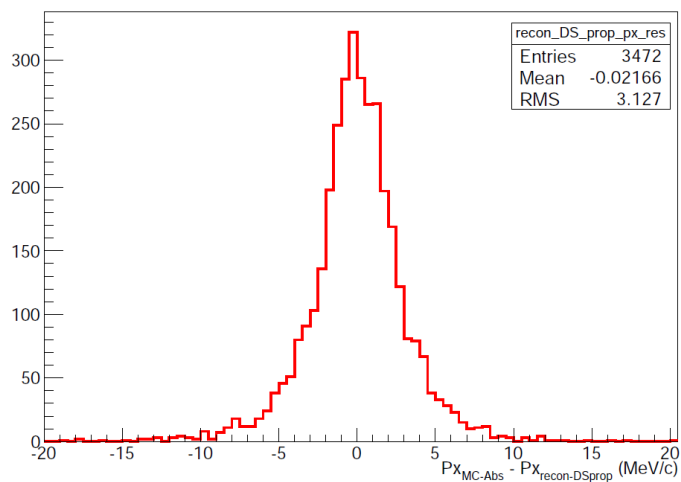


Momentum residuals for propagated recon hits w.r.t. MC truth at DS absorber face

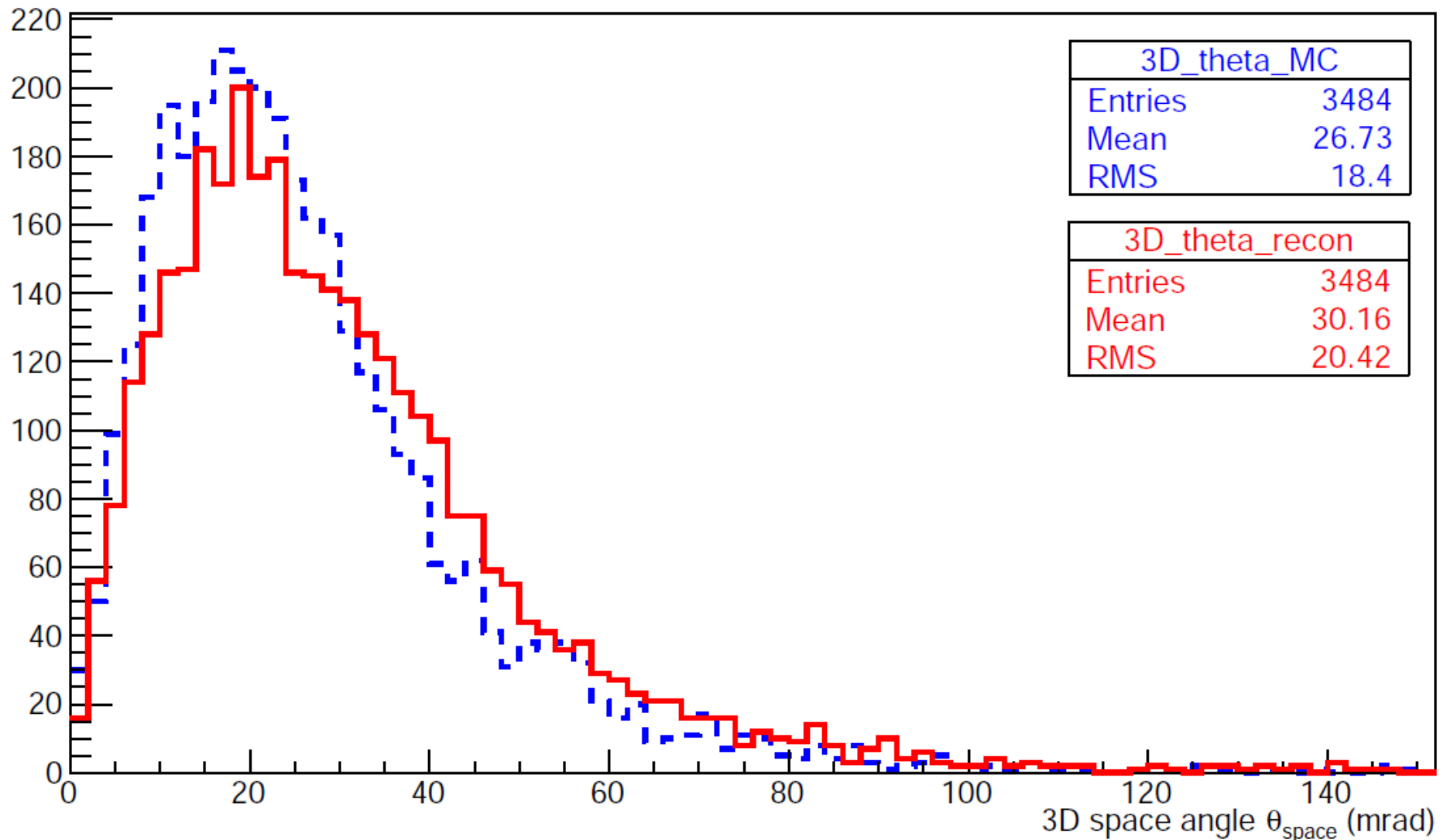
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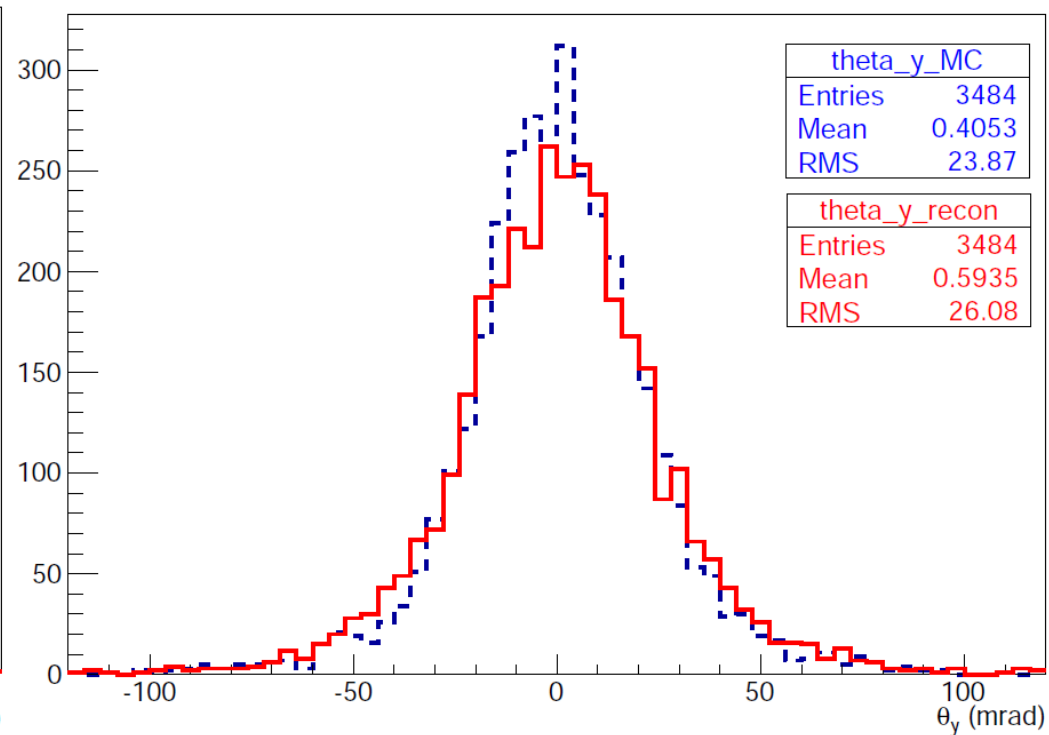
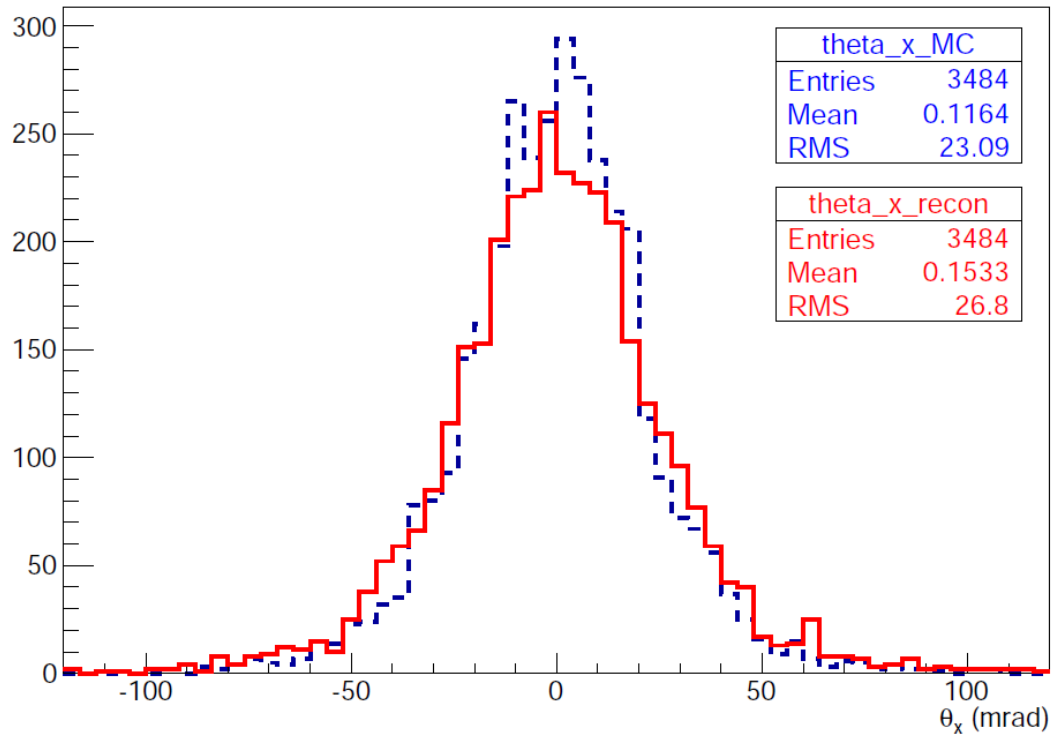
Downstream



AFC + vessel + LH2, scattering angle for propagated MC and reconstructed muons

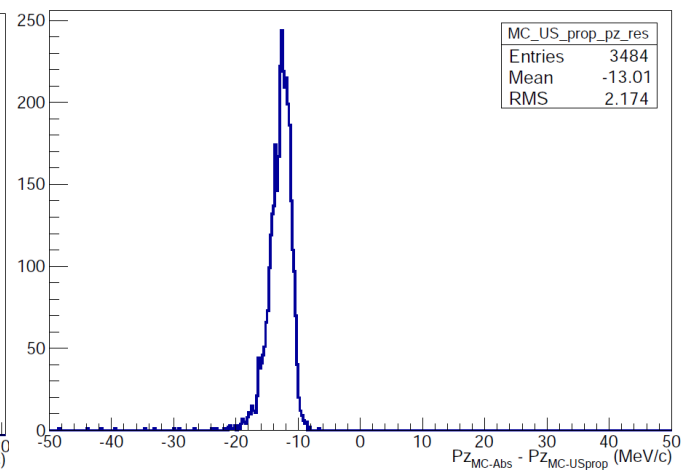
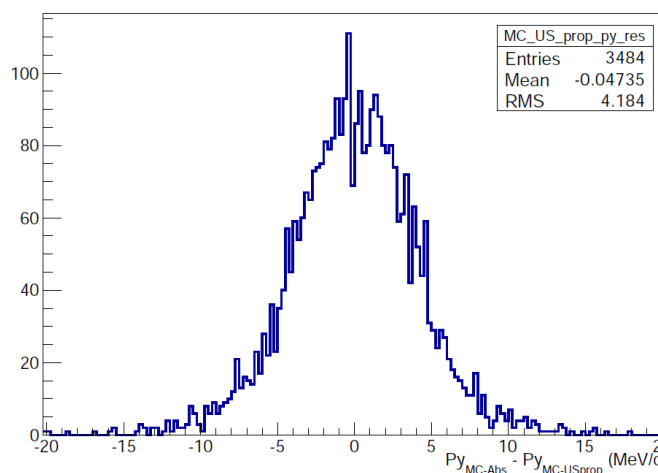
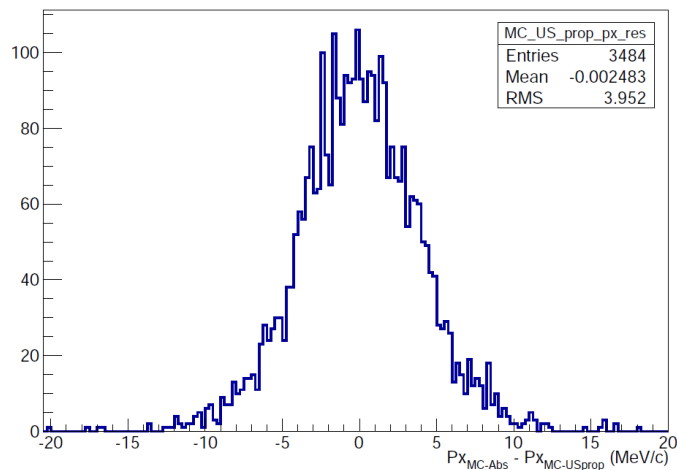


AFC + vessel + LH2, projected scattering angles for propagated MC and reconstructed muons

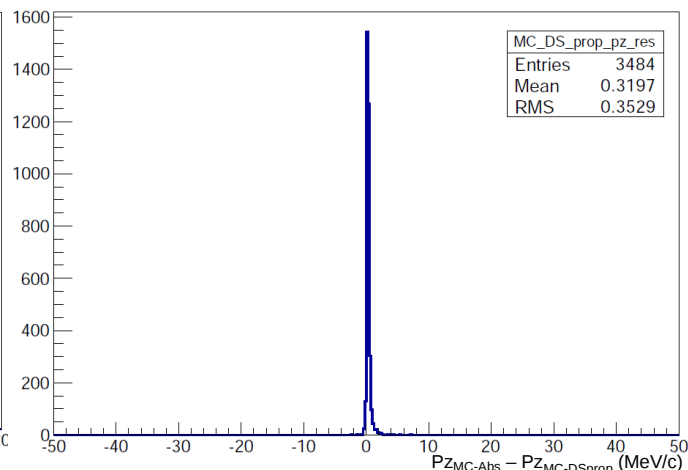
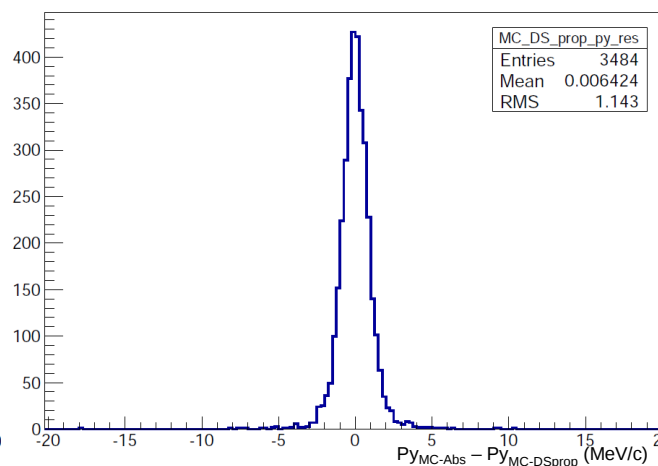
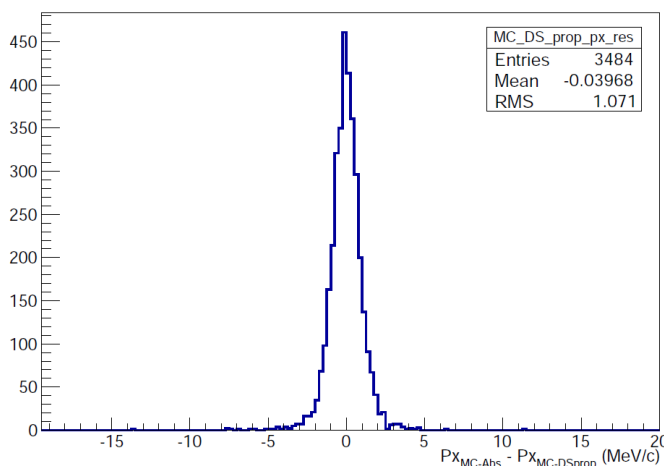


Momentum residuals for propagated MC hits w.r.t. MC truth at DS absorber face

Upstream

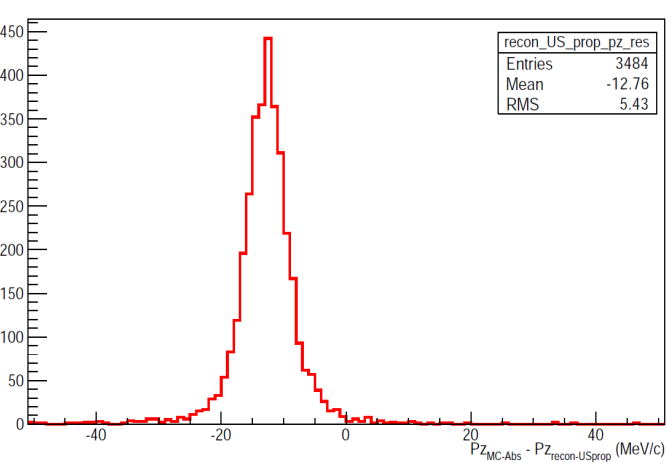
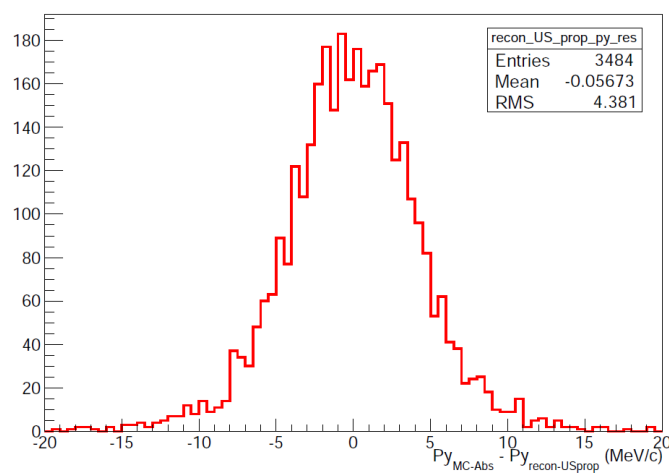
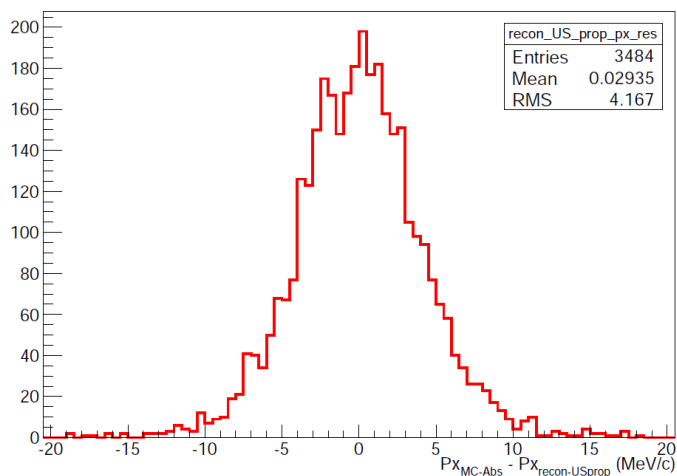


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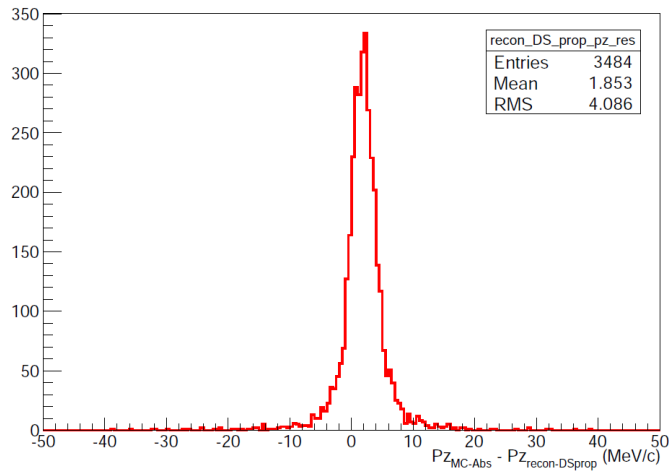
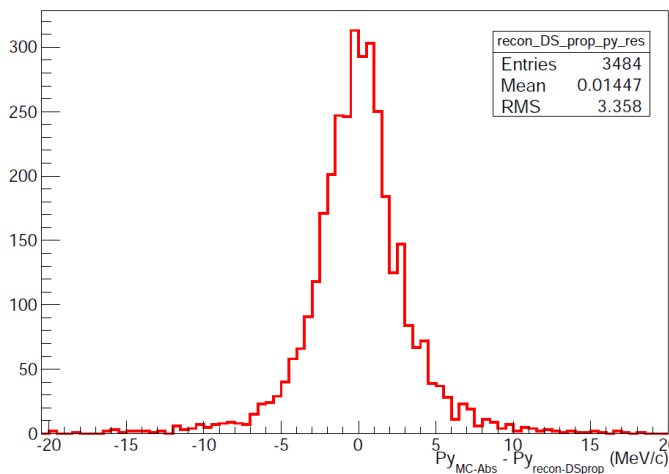
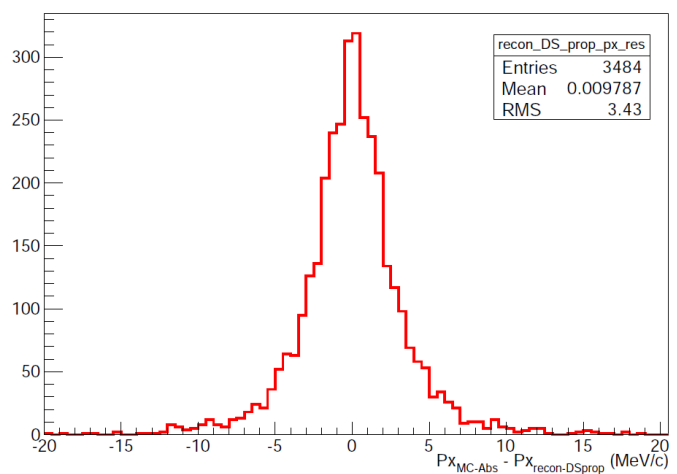


Momentum residuals for propagated recon hits w.r.t. MC truth at DS absorber face

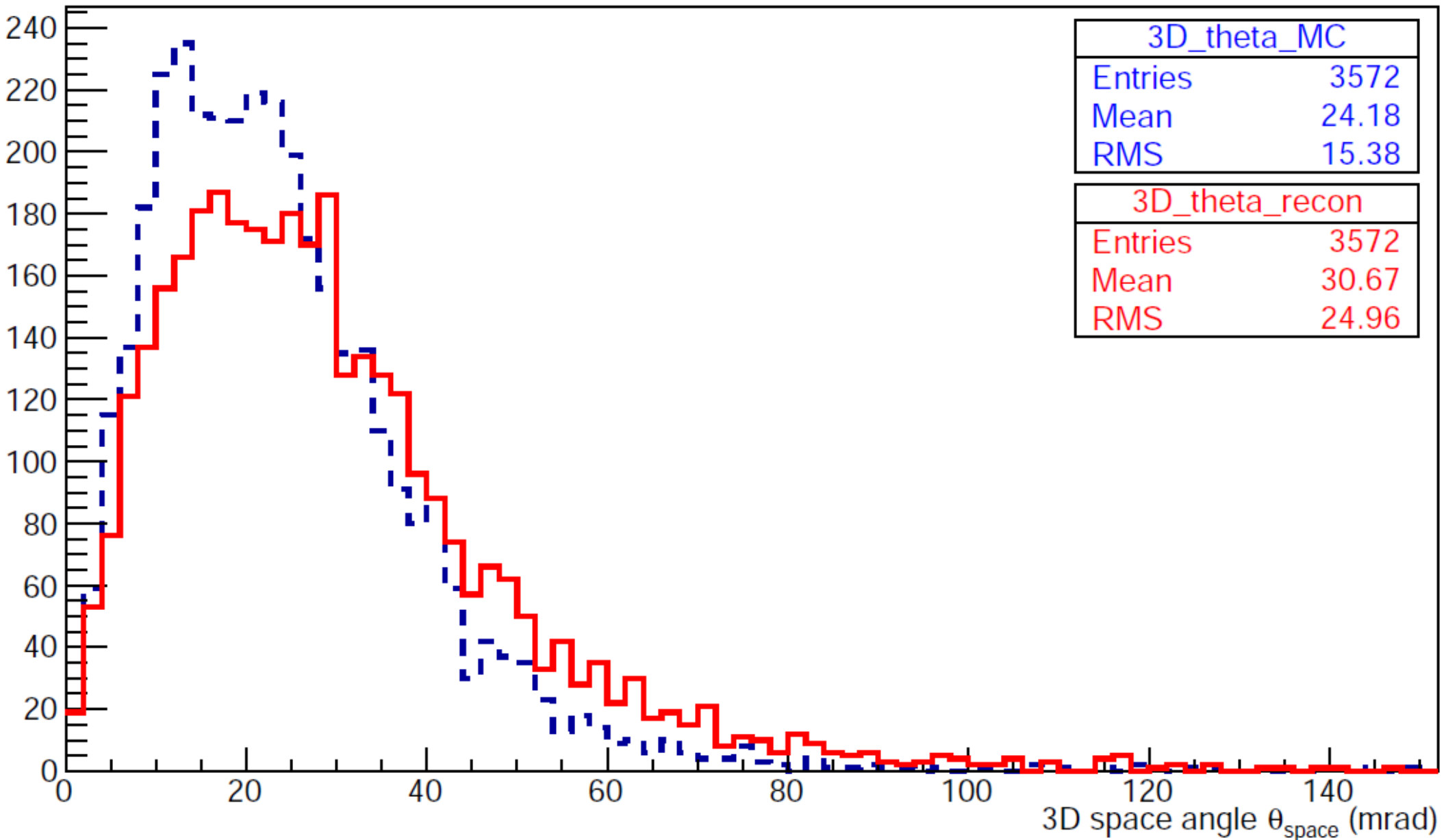
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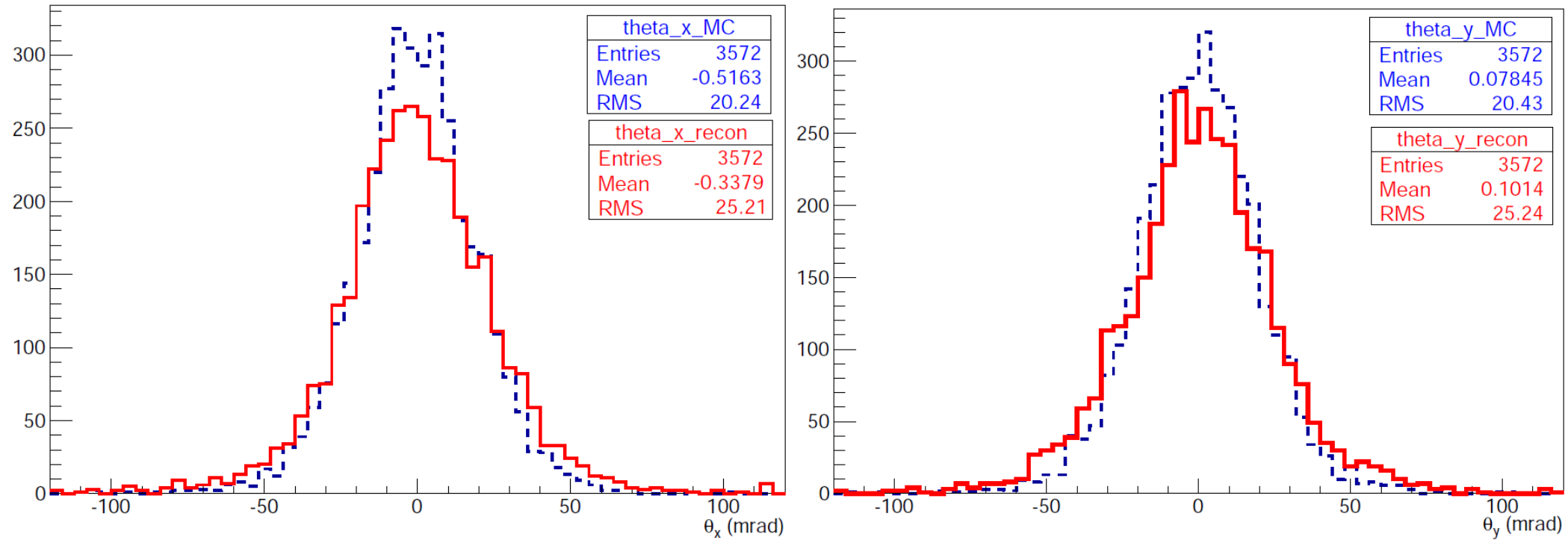
Downstream



LiH, scattering angle for propagated MC and reconstructed muons

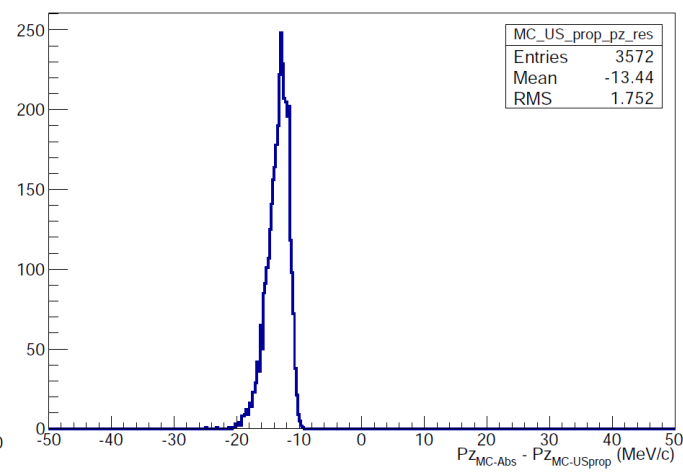
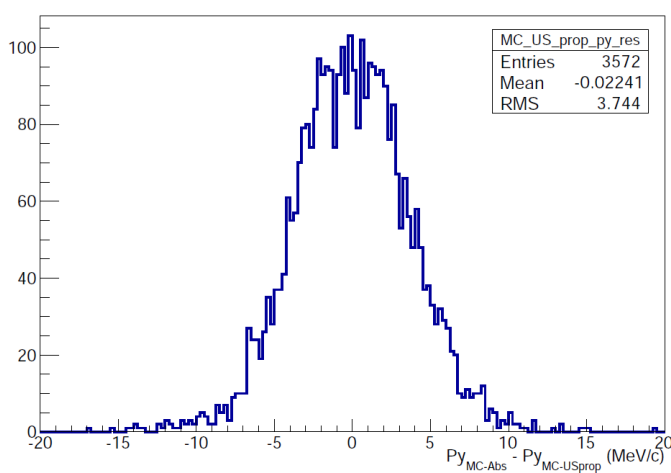
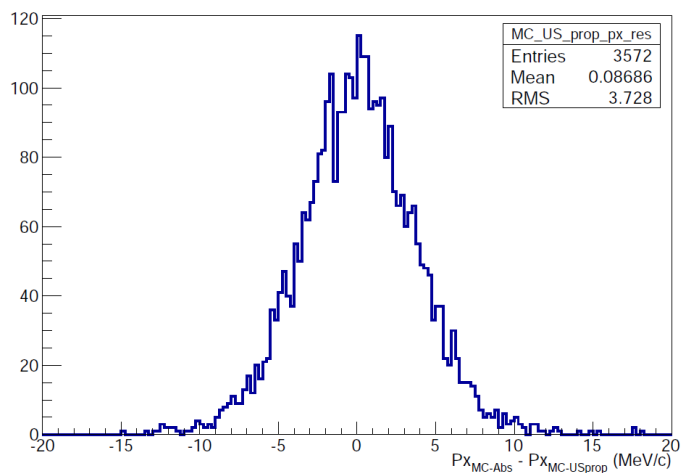


LiH, projected scattering angles for propagated MC and reconstructed muons

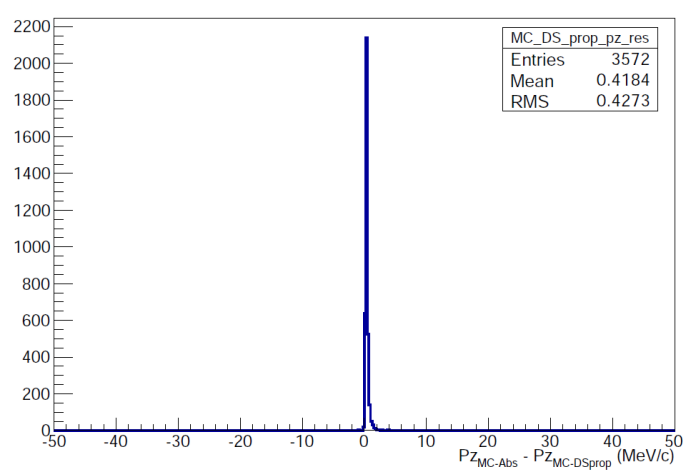
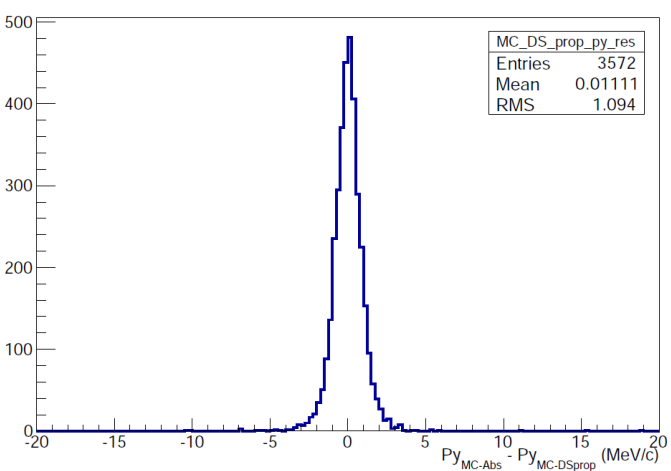
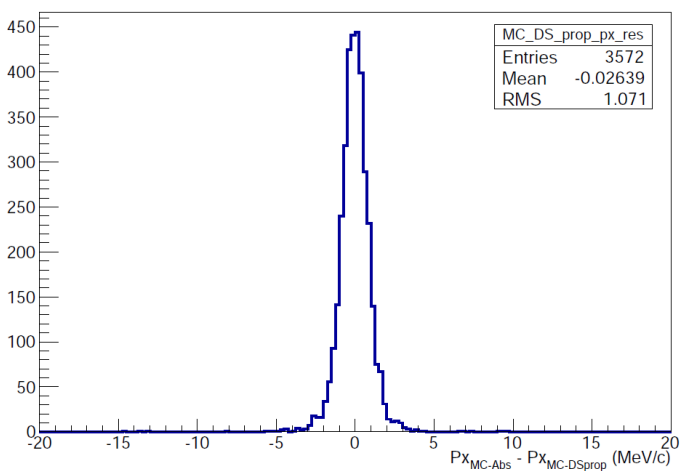


Momentum residuals for propagated MC hits w.r.t. MC truth at DS absorber face

Upstream

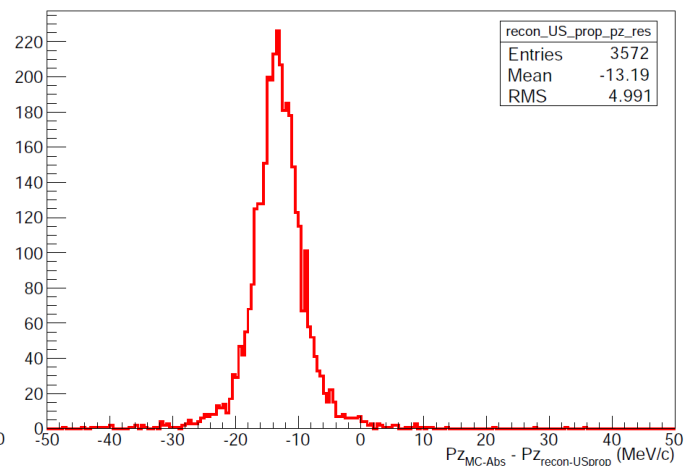
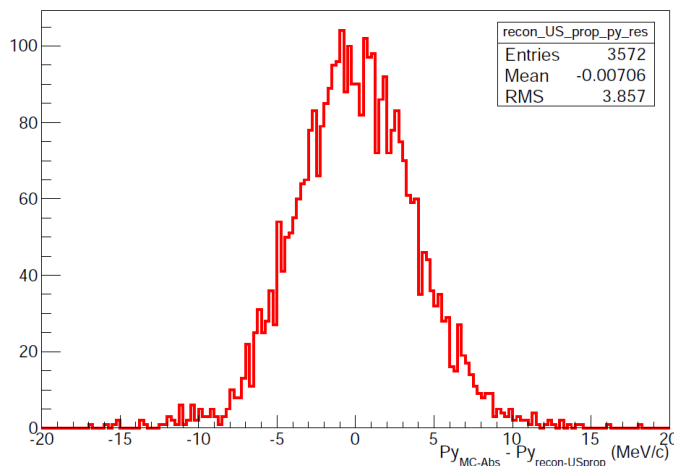
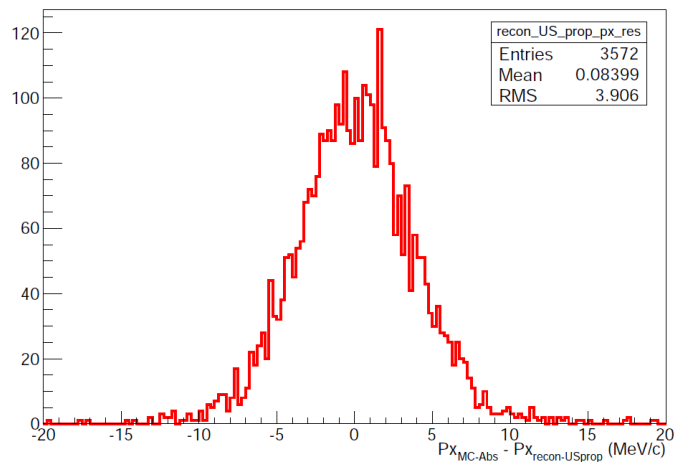


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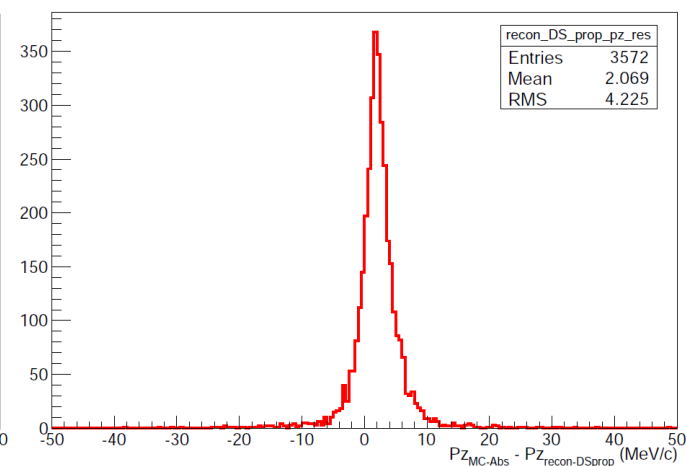
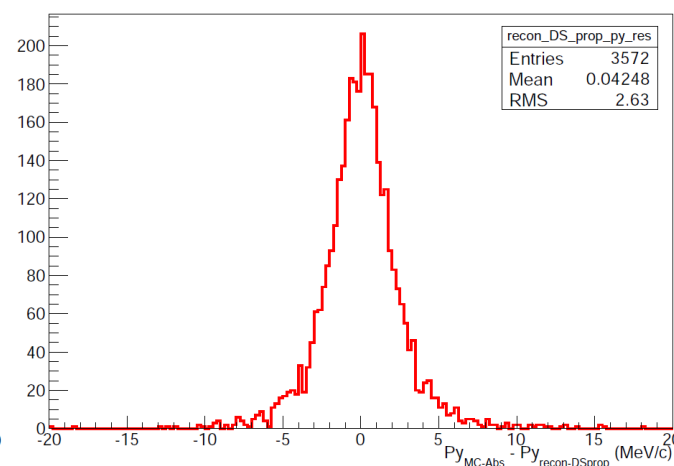
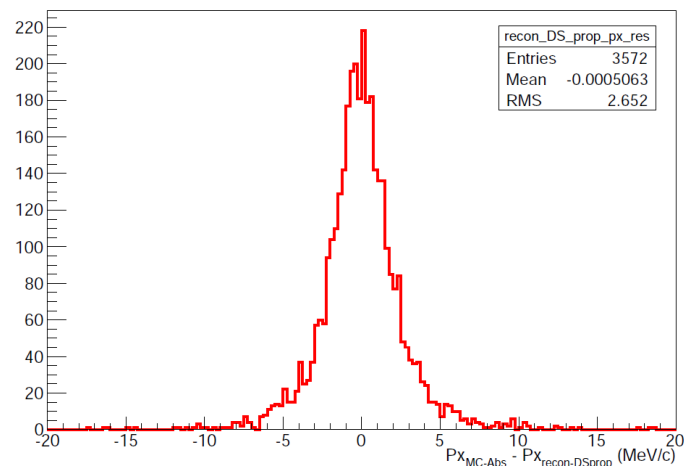


Momentum residuals for propagated recon hits w.r.t. MC truth at DS absorber face

Upstream



Downstream



Next steps

- Investigate offset in pz residuals for propagated particles.
- Run for larger sample sizes.
- Investigate effect of reducing the step size in particle tracking, to see if that improves the residuals of the propagated points.
- Cut on quality of tracker recon tracks, to select samples with better momentum reconstruction.