

# Field-on measurement of multiple scattering

MICE CM43

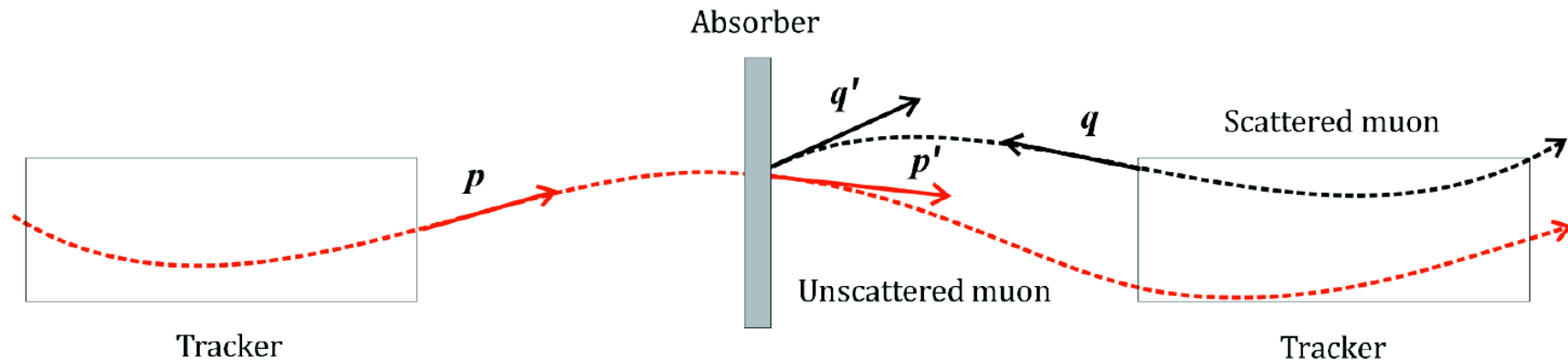
29/10/15

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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 LH2.
- 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  $\theta$ , using

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

# Approach

- 1) Studies of scattering angles obtained from Monte Carlo and Tracker Reconstruction (for legacy geometries).
- 2) Consider sources of error.
- 3) Repeat (1) for up-to-date geometries, and also present scattering distributions as the probability of scatter per angle (in order to be comparable with MuScat results).
- 4) Determine degree of unfolding required based on (3)
- 5) Apply TRUEE unfolding software to simulation output.
- 6) Determine statistics required for measurement.

# Sources of error

- PID

  - Validation of PID routines is underway

- Tracker resolution

  - Unfolding

- Rotations and misalignments of tracker

  - Under investigation by several people

- Other sources of scattering in beamline.

  - Investigated (in legacy simulations so far) by removing elements from beam path

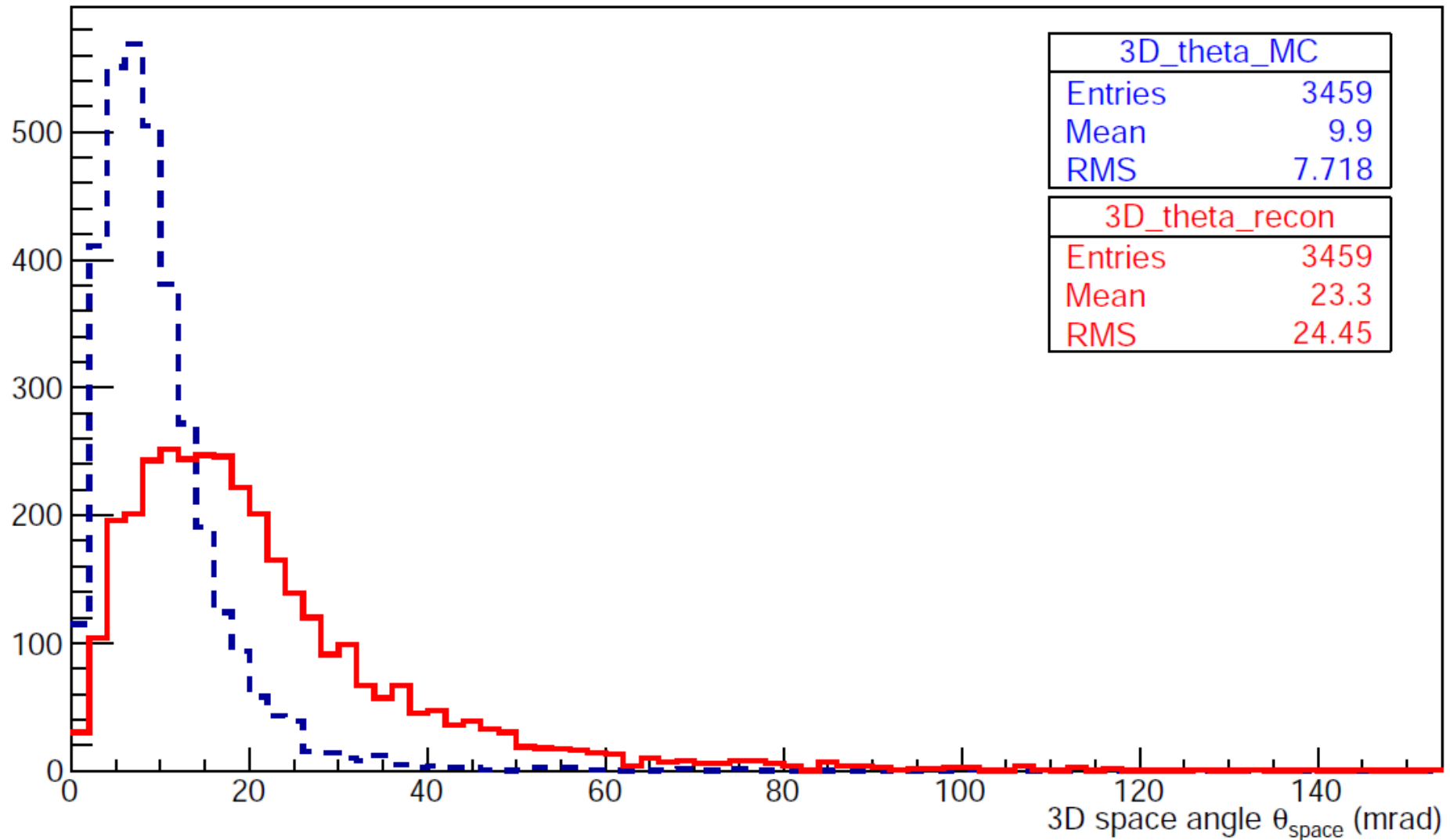
# Approach (revisited)

Next steps are currently held up by issues with the tracker reconstruction/geometries.

- 3) Repeat (1) and (2) for up-to-date geometries, and also present scattering distributions as the probability of scatter per angle (in order to be comparable with MuScat results).
- 4) Determine degree of unfolding required based on (3)
- 5) Apply TRUEE unfolding software to simulation output.
- 6) Determine statistics required for measurement.

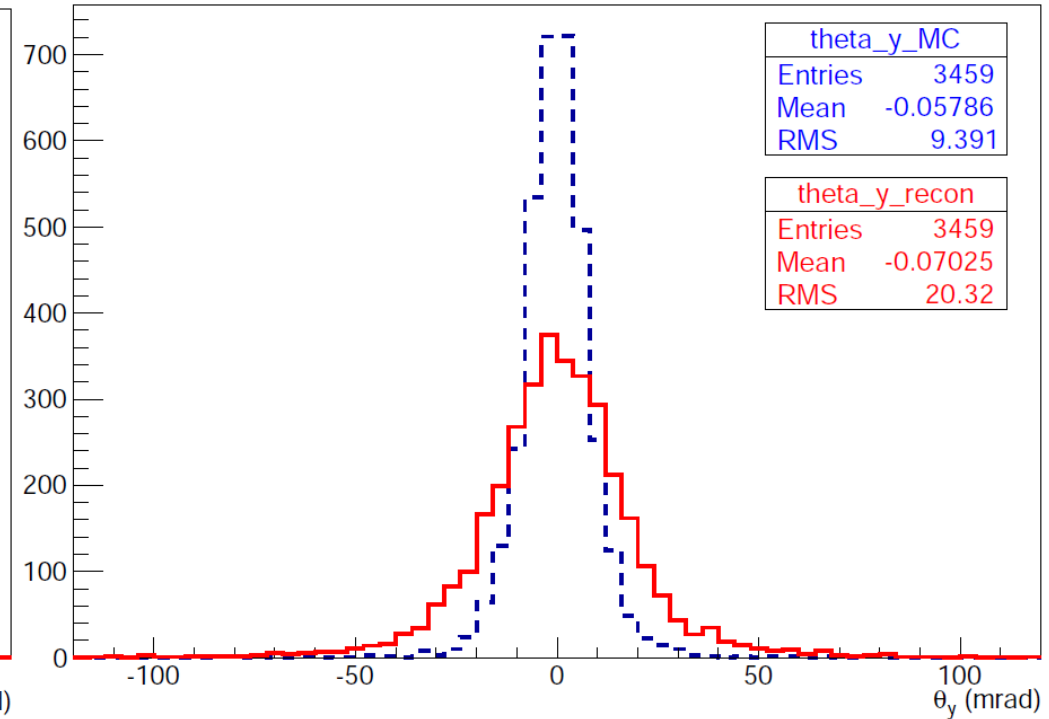
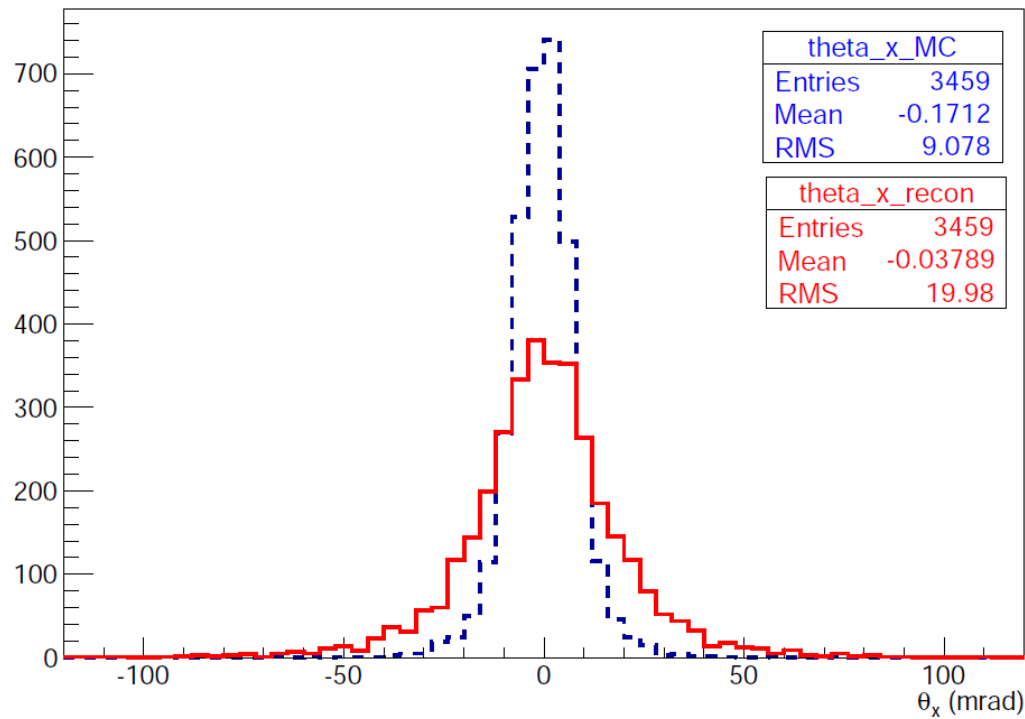
# Additional Slides

# Empty channel, scattering angle for propagated MC and reconstructed muons (legacy geometry)

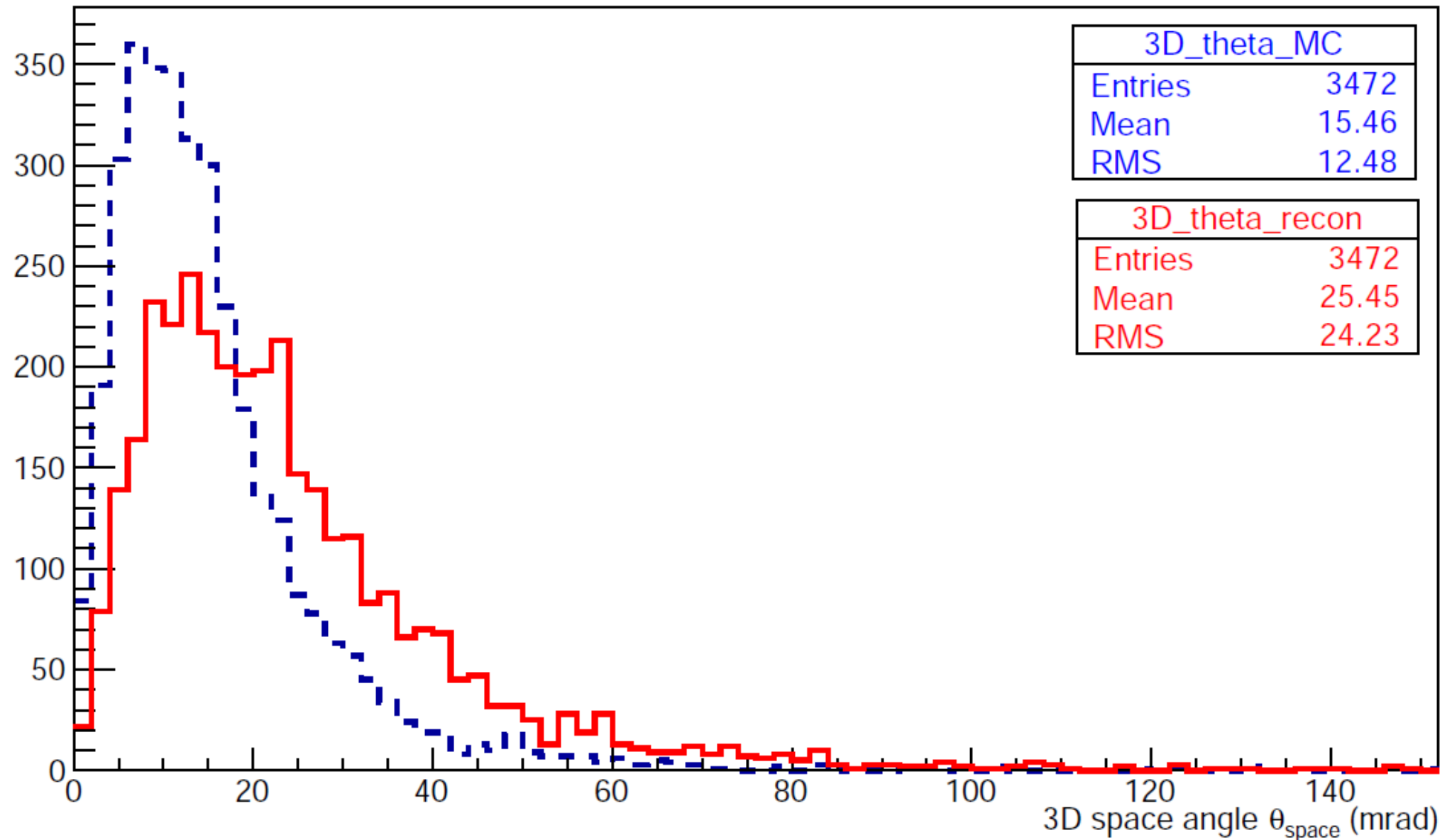




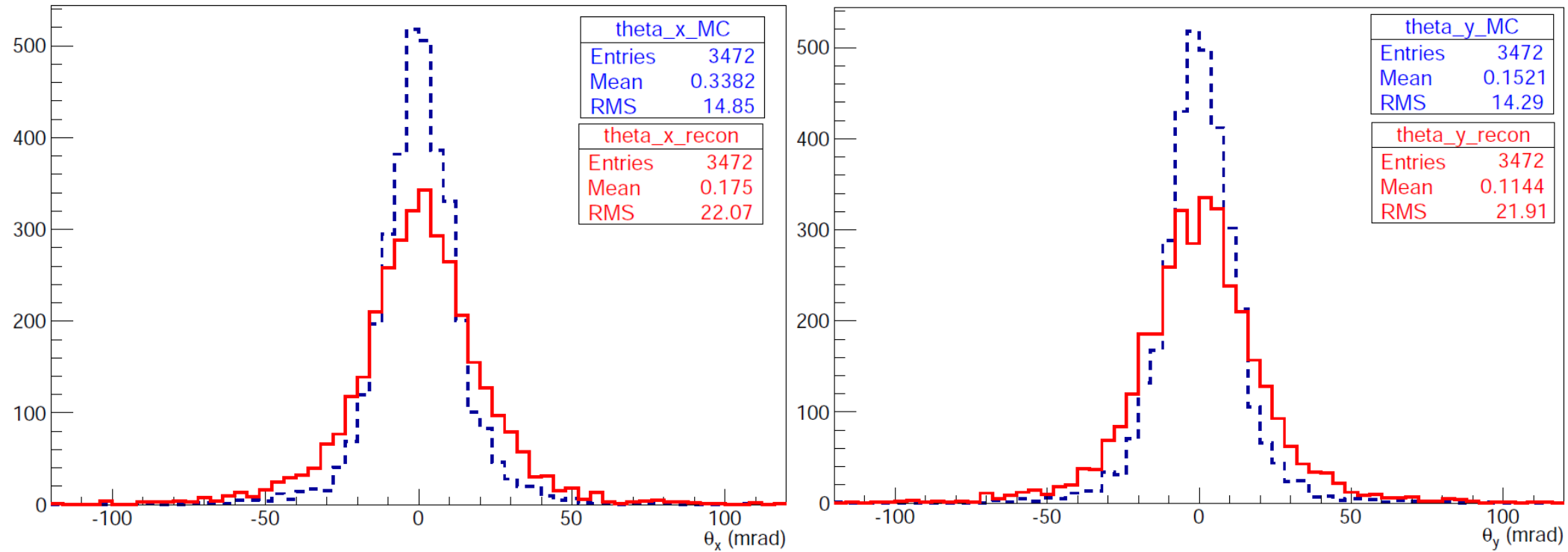
# Empty channel, projected scattering angles for propagated MC and reconstructed muons (legacy geometry)



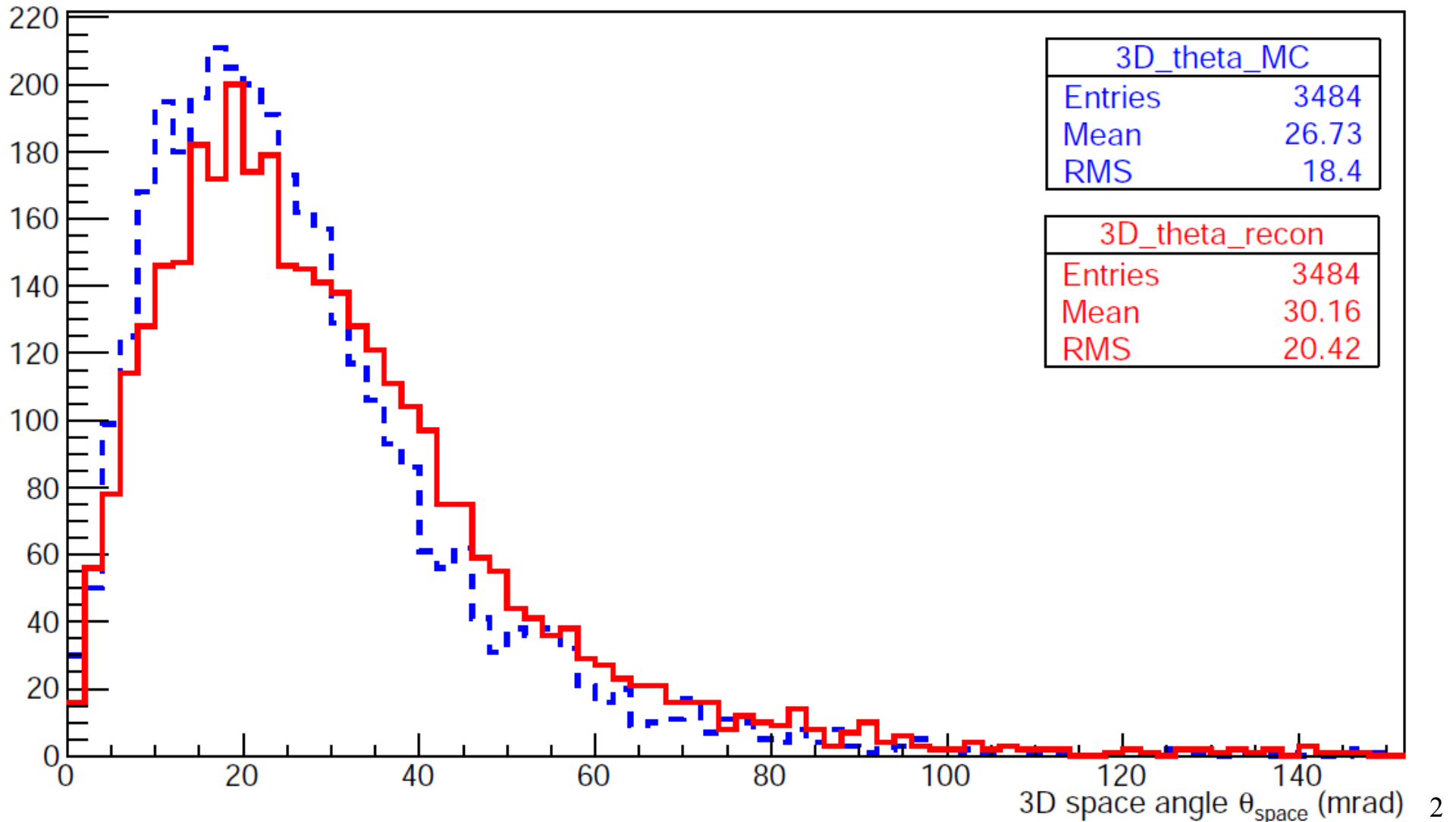
# AFC + empty hydrogen vessel, scattering angle for propagated MC and reconstructed muons (legacy geometry)



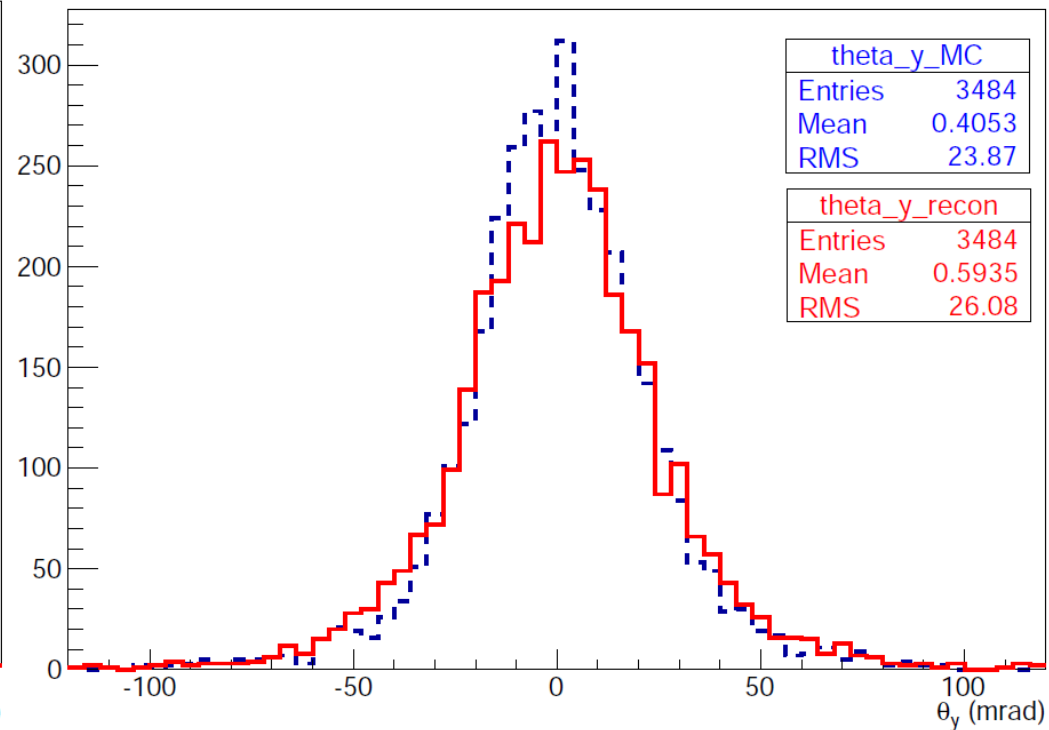
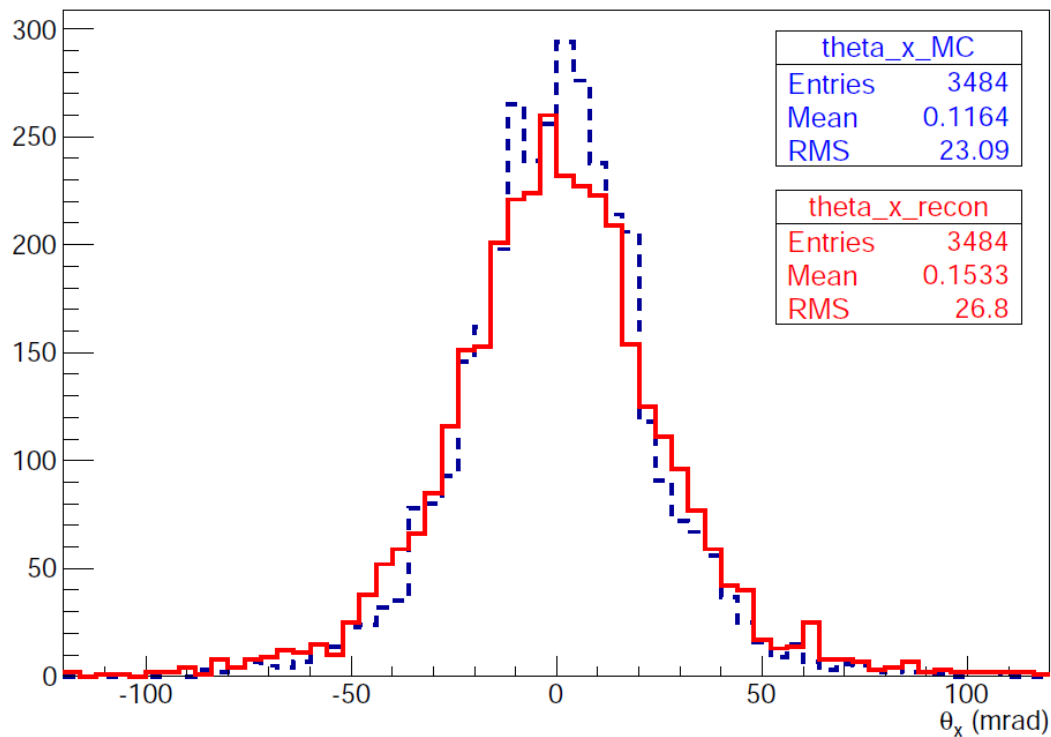
# AFC + empty hydrogen vessel, projected scattering angles for propagated MC and reconstructed muons (legacy geometry)



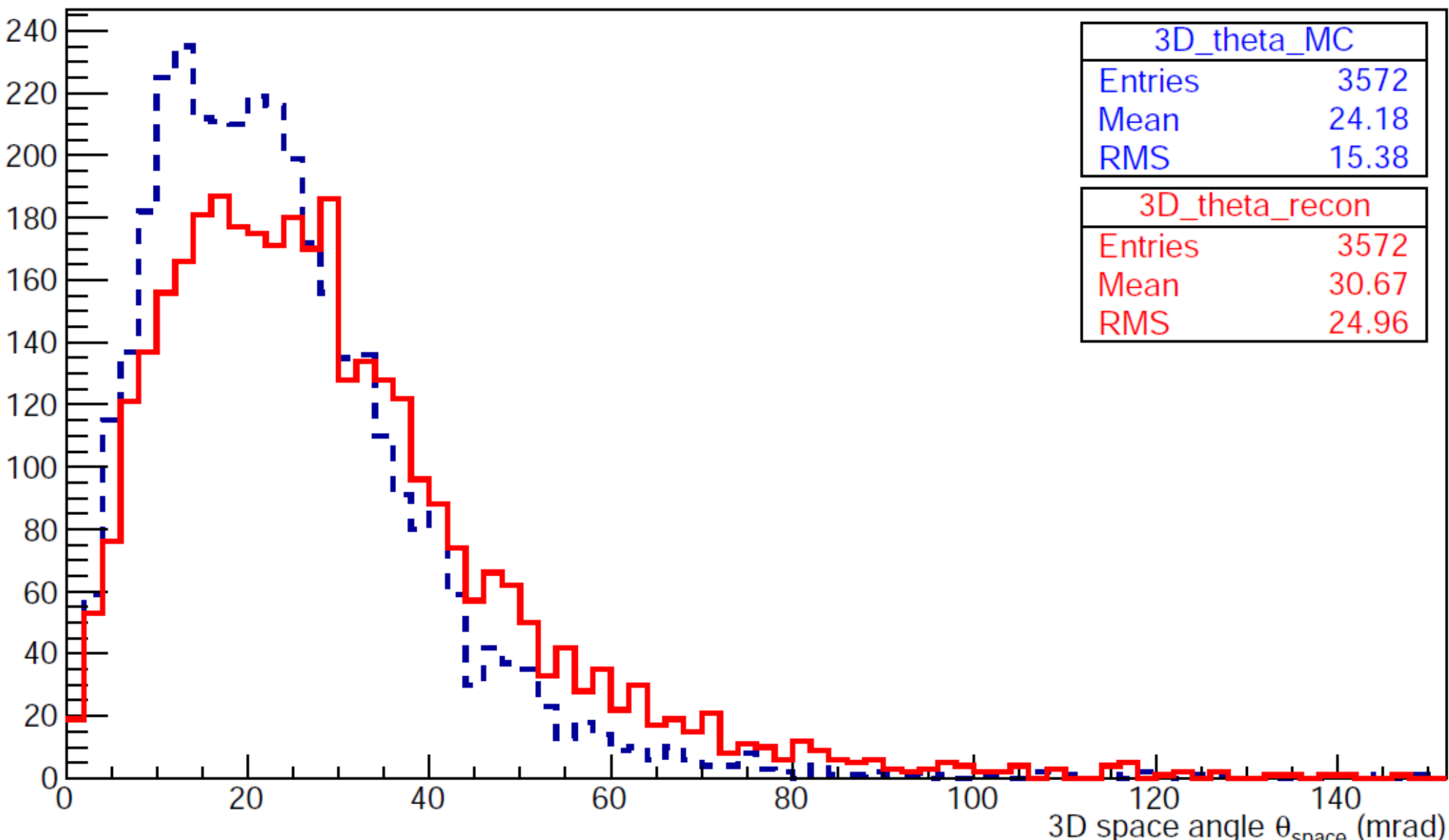
# AFC + vessel + LH2, scattering angle for propagated MC and reconstructed muons (legacy geometry)



# AFC + vessel + LH2, projected scattering angles for propagated MC and reconstructed muons (legacy geometry)



# LiH, scattering angle for propagated MC and reconstructed muons (legacy geometry)



# LiH, projected scattering angles for propagated MC and reconstructed muons (legacy geometry)

