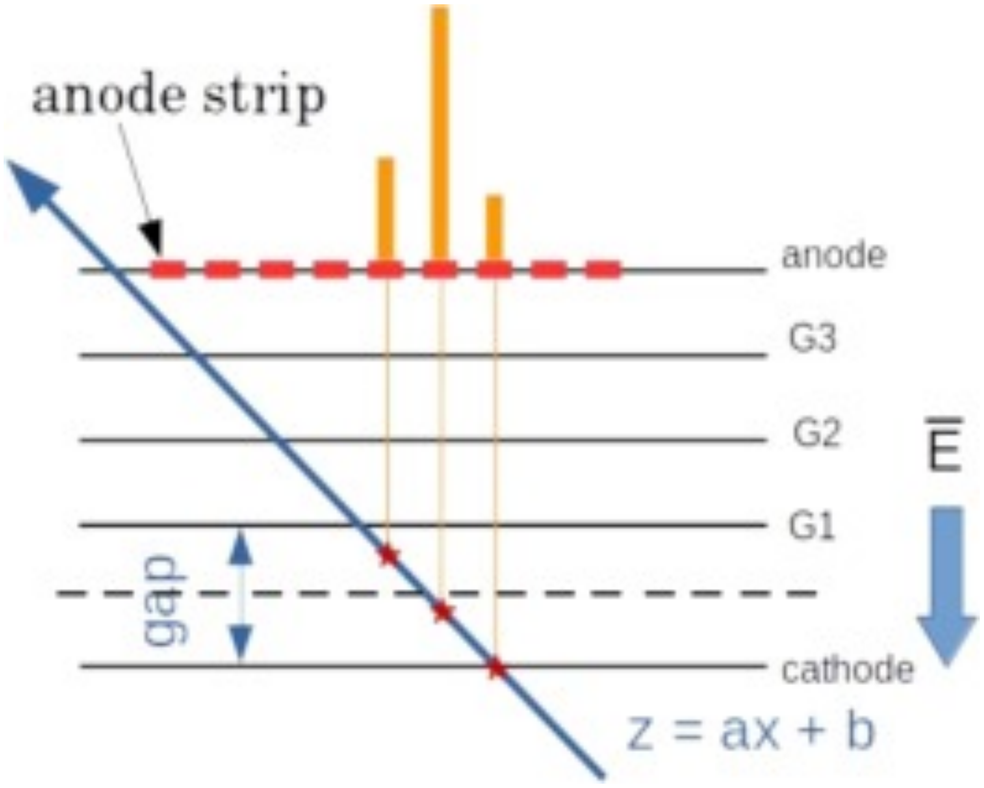
# Cluster Timing

# Using Timing to Resolve Tracking Ambiguity

Use the timing of strips to get a sense of track direction

Ionizations closest to the anode should arrive first

Use timing information to extrapolate a line in direction of travel

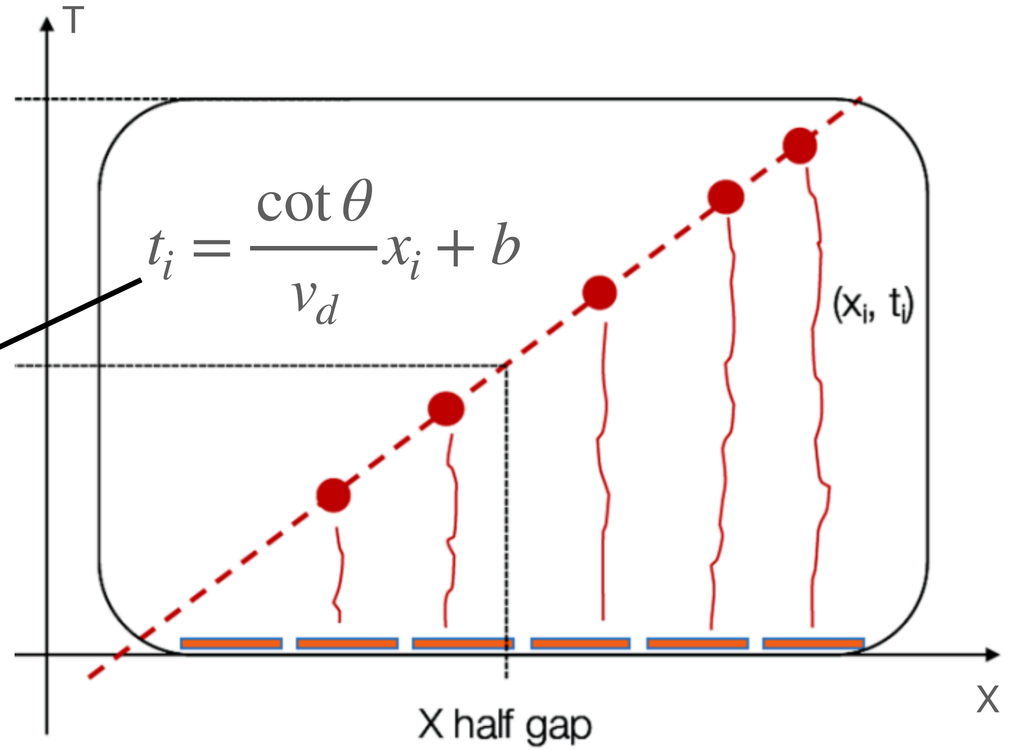


# uTPC Method

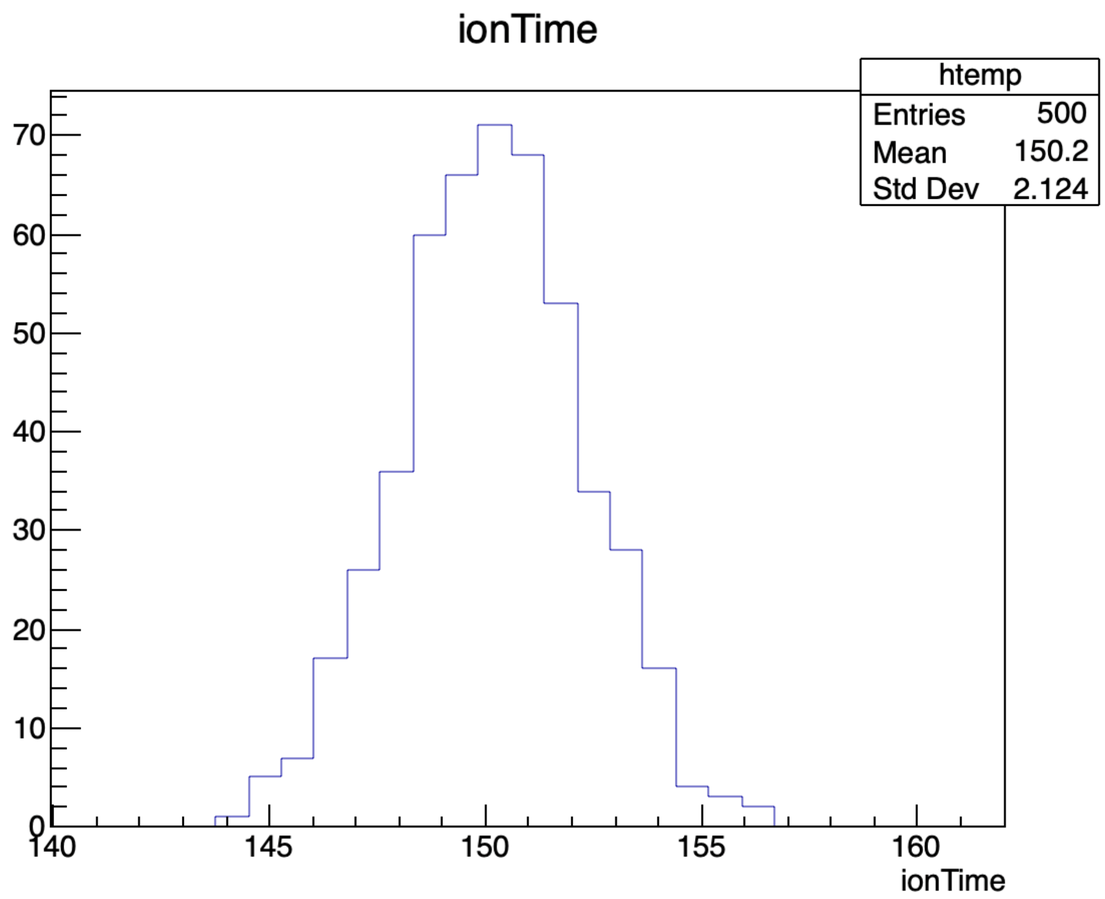
We expect a linear relation between x vs t

Slope indicitive of drift velocity in GEMs

$$z_i = \cot\theta\, x_i + b_z$$

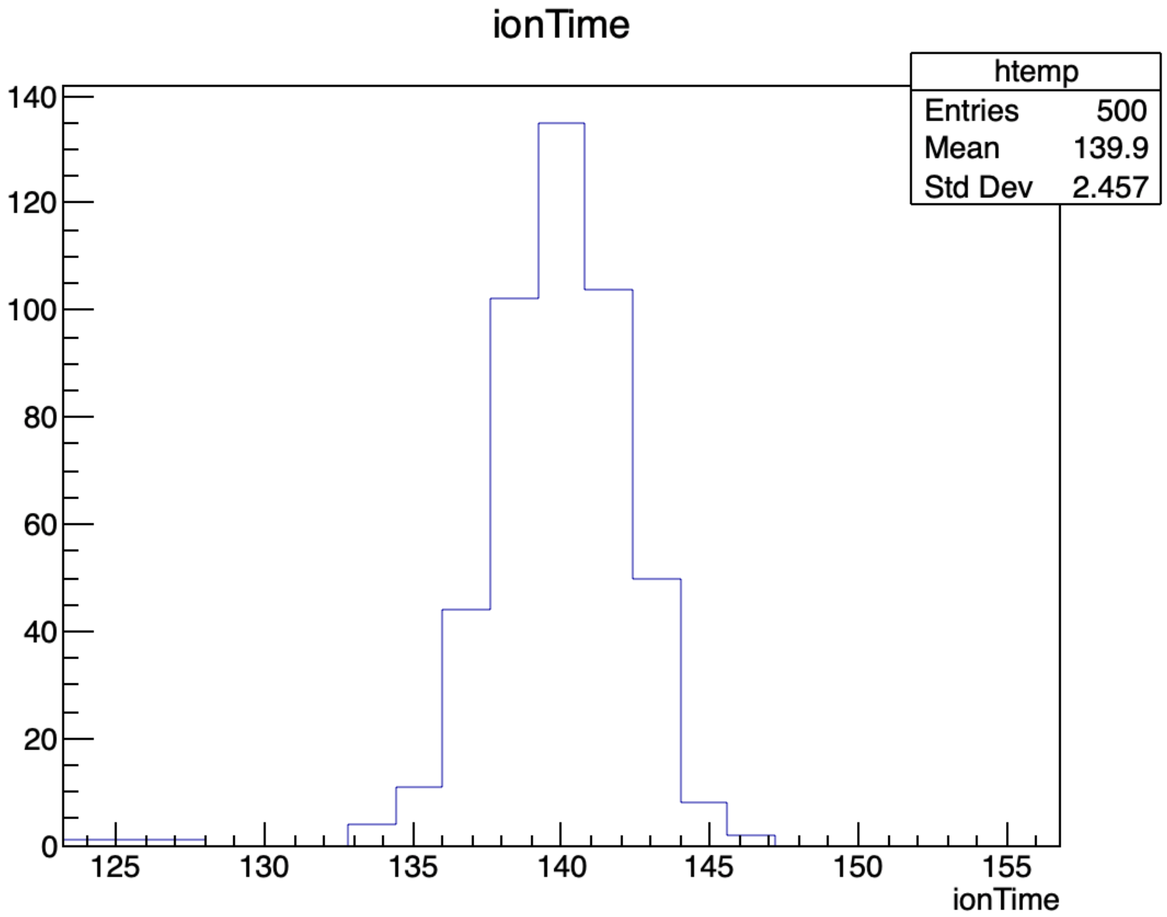


# Drift Time Simulation




2.49 kV/cm

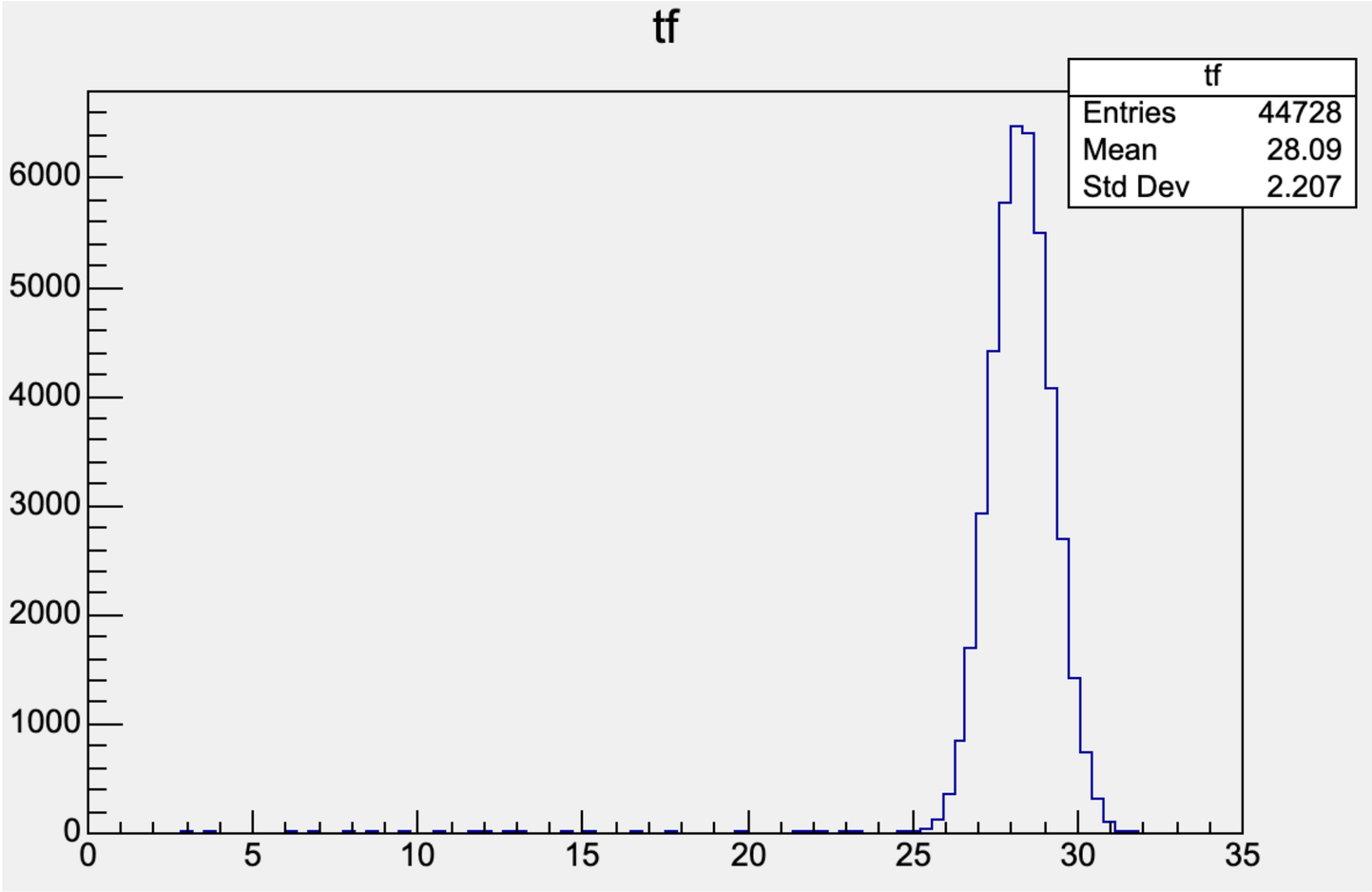
$v_d = 0.0666 \pm 0.001$ mm/ns



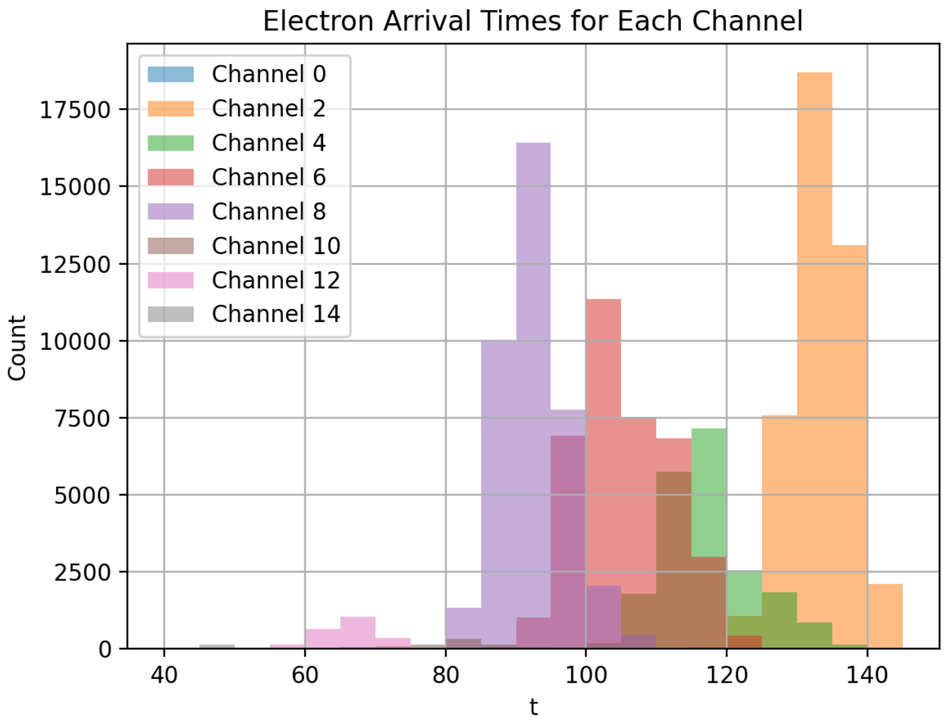

3.73 kV/cm

$v_d = 0.0714 \pm 0.00112$ mm / ns

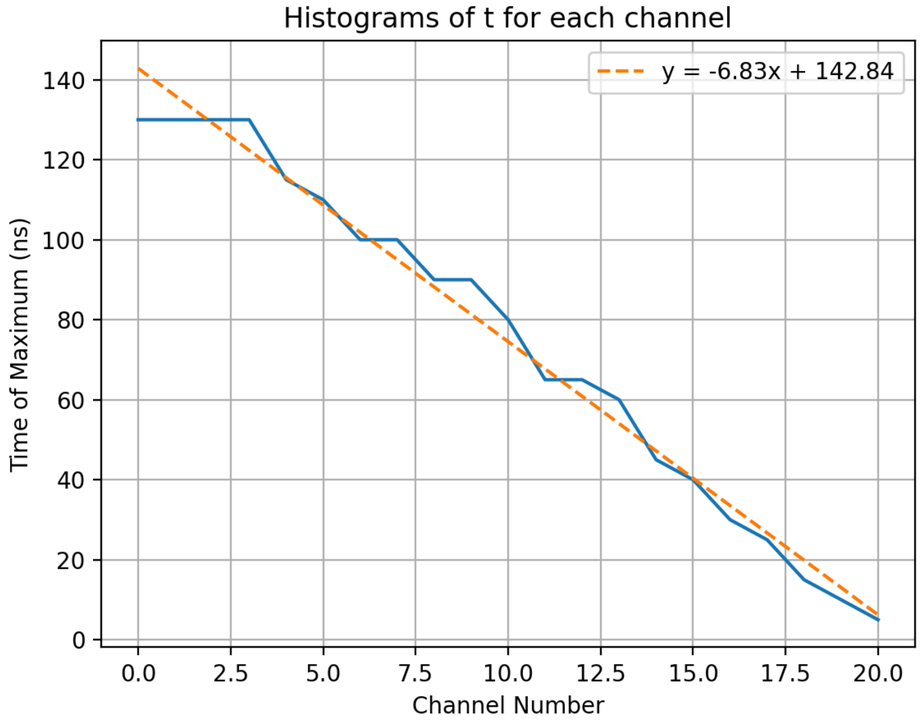
# Temporal Distribution from Single GEM



# Arrival Time vs Channels

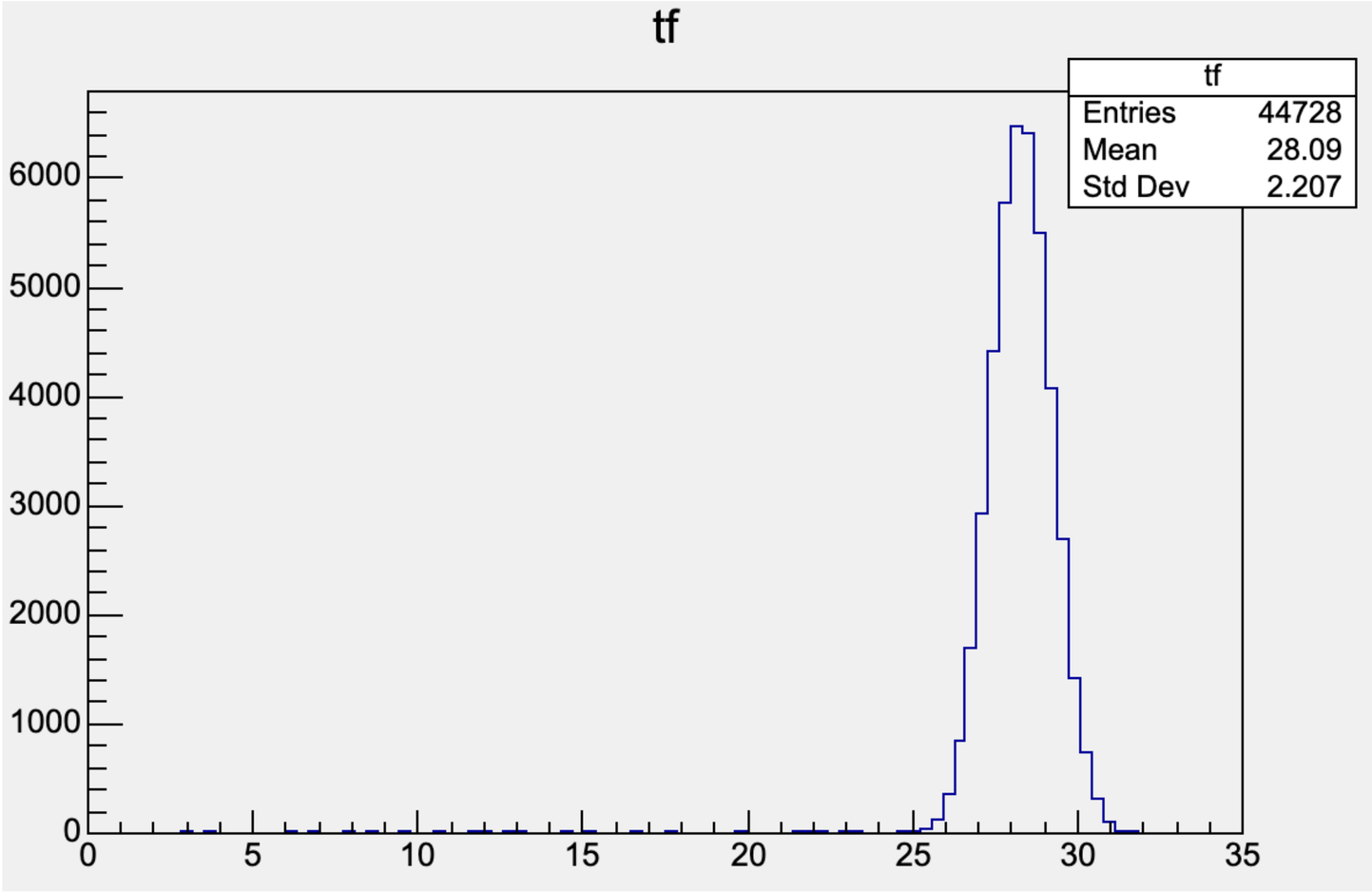



Electron traveling in positive channel number direction,
40deg wrt perpendicular




Supposedly, $|\text{slope}| = (0.4\text{mm}) \cdot \dfrac{\cot\theta}{v_d} \sim 6.9$

# Temporal Distribution from Single GEM



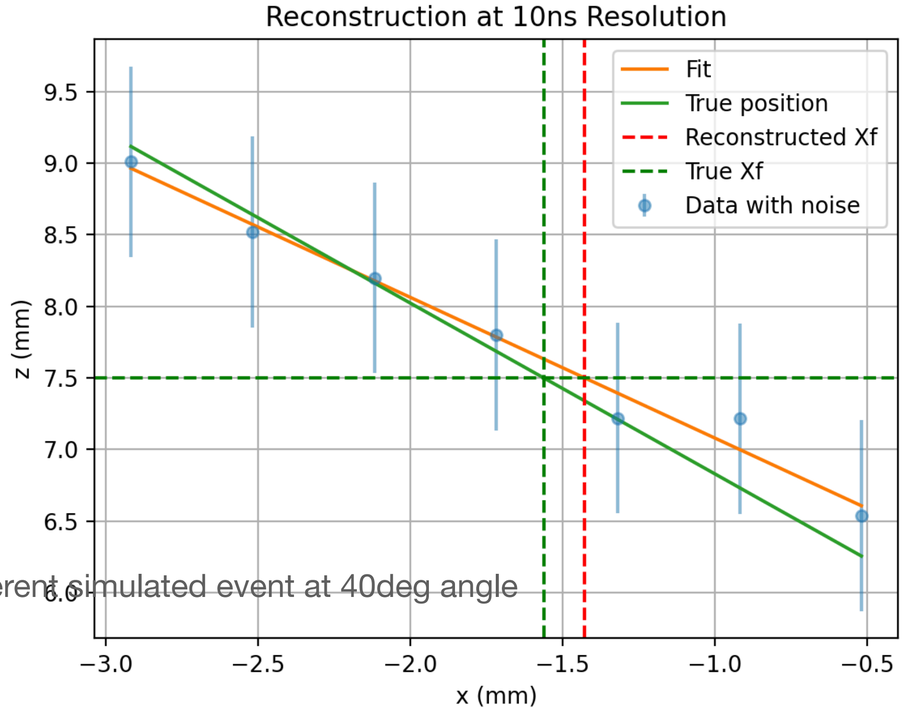
# Required Time Resolution

We would want resolution to be higher than charge centroid method

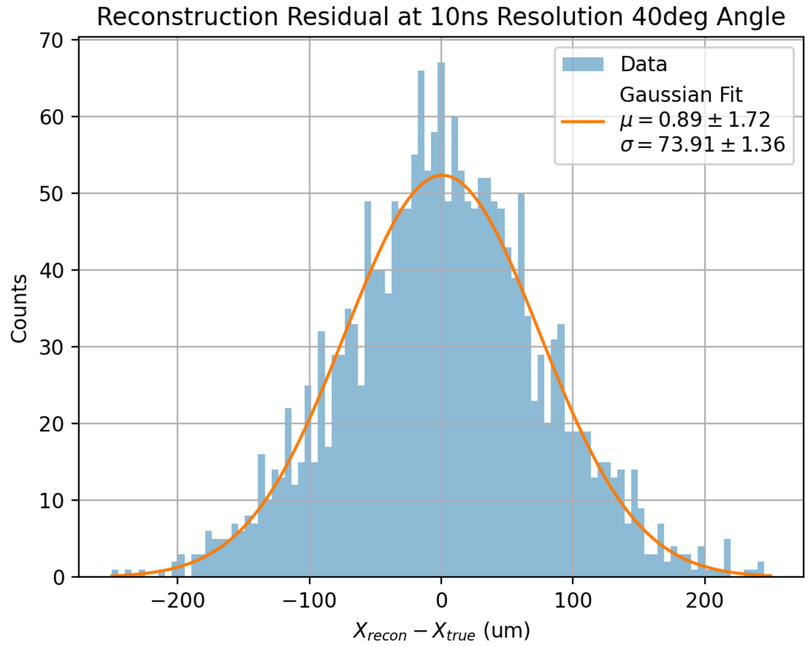
Need resolution <1000um at most

Fit and evaluate residuals for the position at the center of GEM

Need at least 4 points to get decent linear fit and uncertainties




Different simulated event at 40deg angle



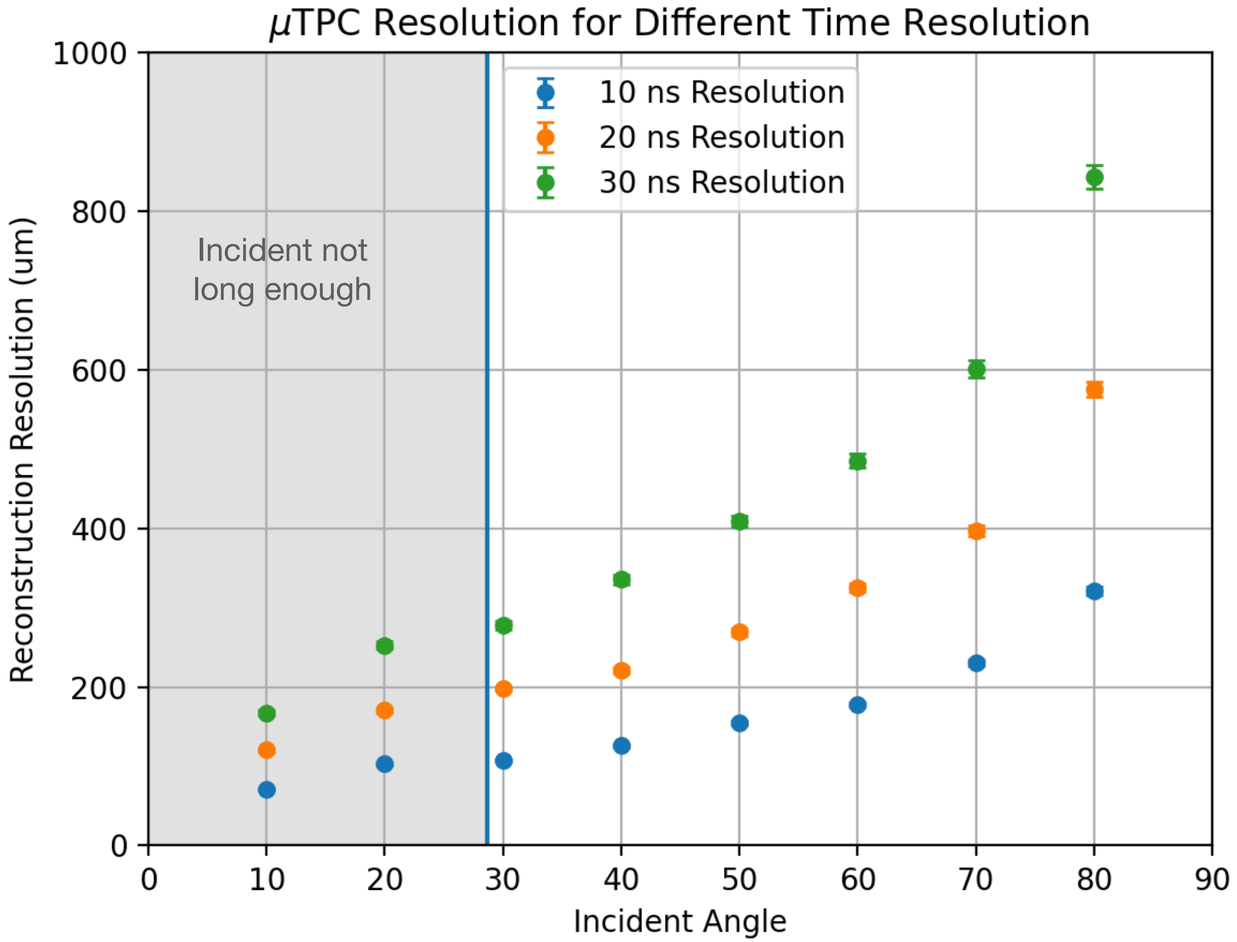
# Required Time Resolution

Process above done over different angles at several noise levels

Shaded region on left does not have long enough track with enough points

Resolution should worsen in region but actually increases (sim needs improvement)

Need timing resolution <30ns




Note: resolution refers to 90% confidence interval