# TMD Studies in $e^+e^-$ Collisions — Week 10 Progress

Shane Sweetman

Simulation study using PYTHIA8, FastJet, ROOT

# Outline

- Definitions and setup
  - $p_T$, $p_z$ and jets
  - How we define the "first pion"
- Graph 1: first pion vs highest-$p_T$ pion
- Graph 2: $p_T$ difference between first pions in the two jets

# Definitions: $p_T$, $p_z$ and jets

**Kinematic picture**

- The beam axis is taken along the $z$–direction:
  - The $e^-$ and $e^+$ collide head-on along $\pm z$.
- Transverse momentum:

$$p_T = \sqrt{p_x^2 + p_y^2}$$

  measures how much momentum a particle has *perpendicular* to the beam.
- Longitudinal momentum:

$$p_z = \text{component of } \vec{p} \text{ along the beam axis.}$$

**Jets in this analysis**

- We cluster all visible final-state particles into jets using a standard jet algorithm.
- We require:
  - Two jets with reasonably large $p_T$,
  - Jets are almost back-to-back in angle,
  - A high thrust value, to select clean two-jet events.

# Definitions: the "first pion"

**Charged pions inside jets**

- For each jet, we look at all the charged pions inside it ($\pi^+$ and $\pi^-$).
- These are the candidates we will use to define our "first pion".

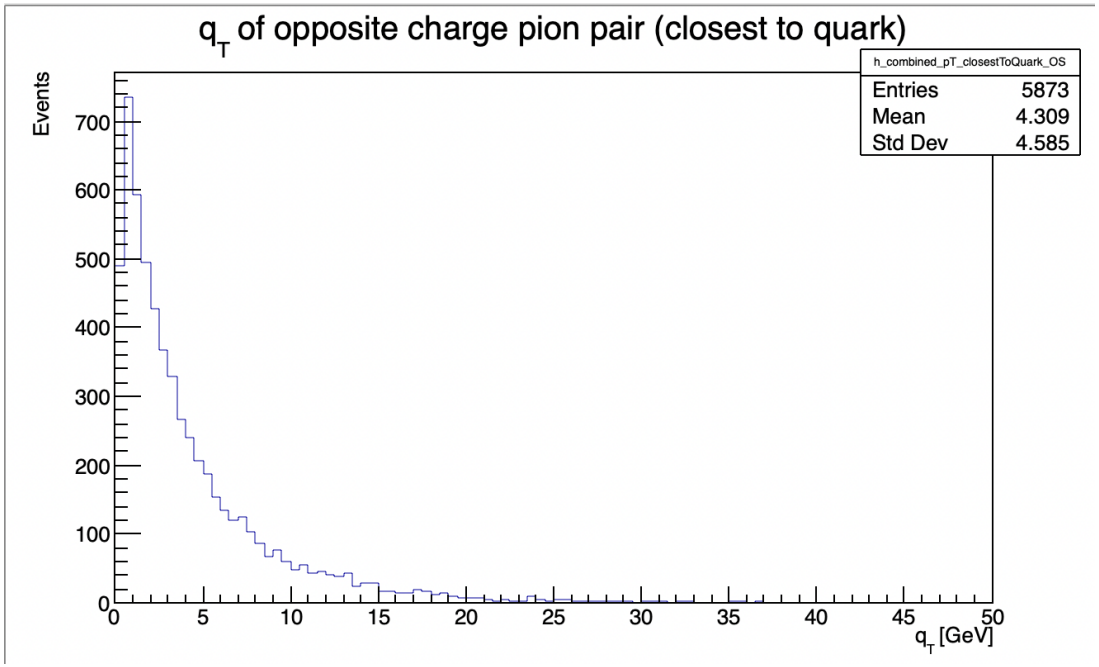
**Tracing back to the quark**

- For every pion, we follow its history backwards through the event:
  - pion $\rightarrow$ parent hadron or resonance $\rightarrow \cdots \rightarrow$ original quark.
- We count how many steps it takes to reach a quark (down, up, strange, charm or bottom).

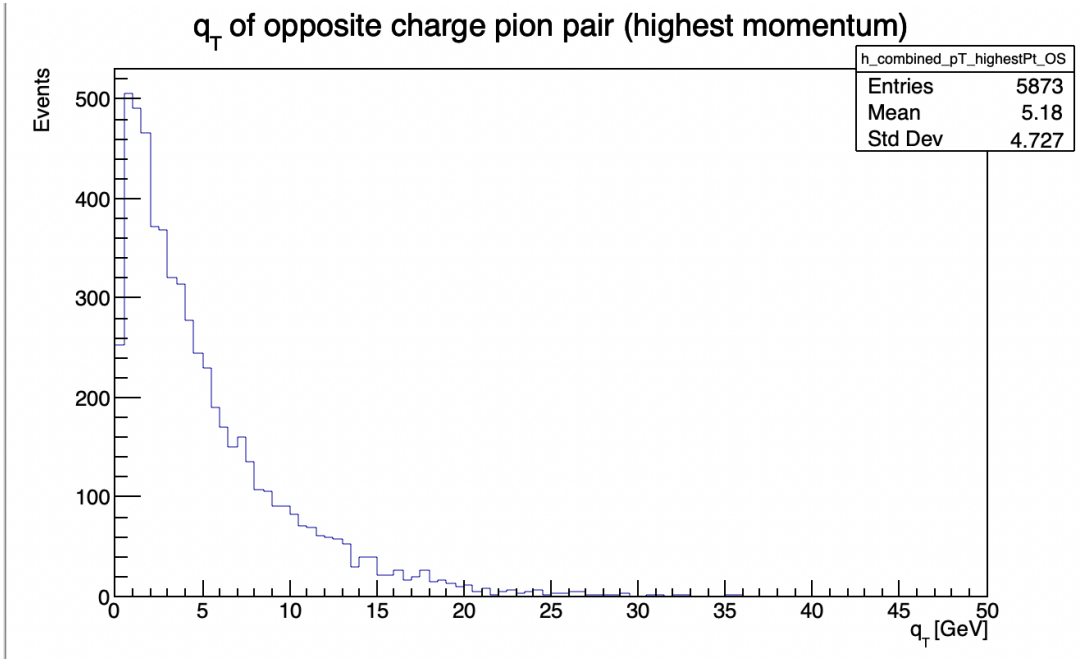
**Working definition for Week 10**

- **First pion** in a jet = the charged pion that is *closest* to the quark in this ancestry sense.
- "Closest" means: the *fewest* number of steps from the quark to the pion.

# Graph 1: first pion -$q_T$ pion



# Graph 2: $p_T$ difference between first pions



# End

Questions?