# Single Electron Simulations for Q² Acceptance of tracker

L. Gonella, P. G. Jones, S. Maple, P. R. Newman
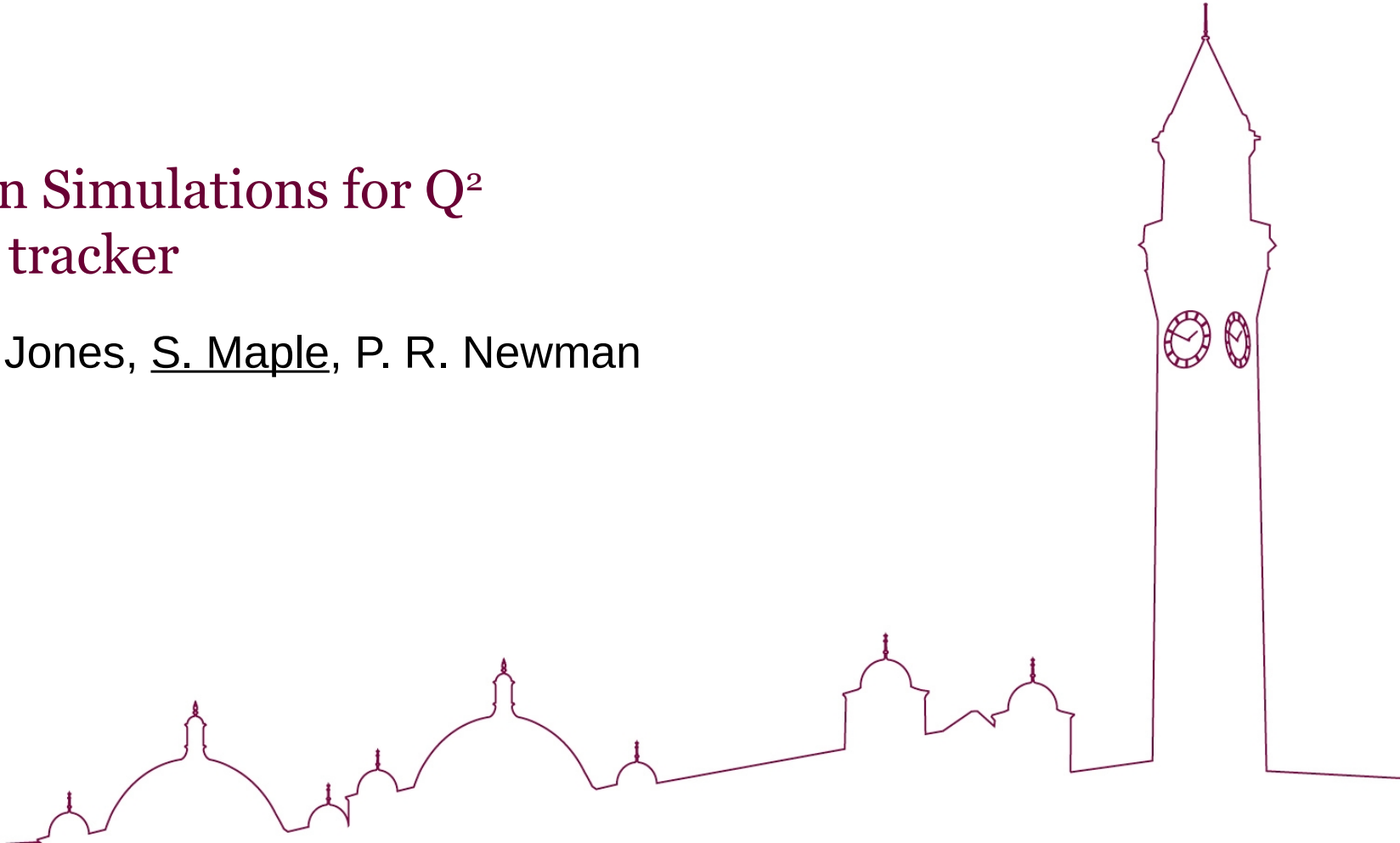
Simulation setup

- Concern that ePIC is developing a hole in its Q^2 coverage:
  - A simplified evaluation of the coverage offered by the tracker alone is performed using single electron events passed through the DD4hep tracking geometry

- 1M electrons generated uniformly in p_T and η for $-4<η<4$ and $0<p_T<0.5$ GeV
  - A further 1M for $0.5<p_T<1.5$ GeV
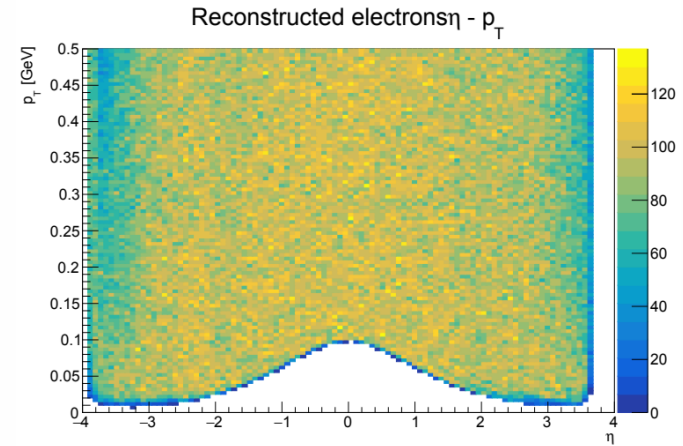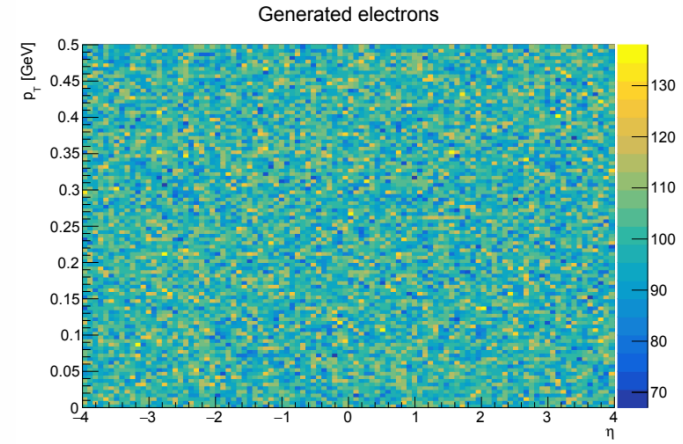- Events passed through geometry and reconstructed with EICrecon
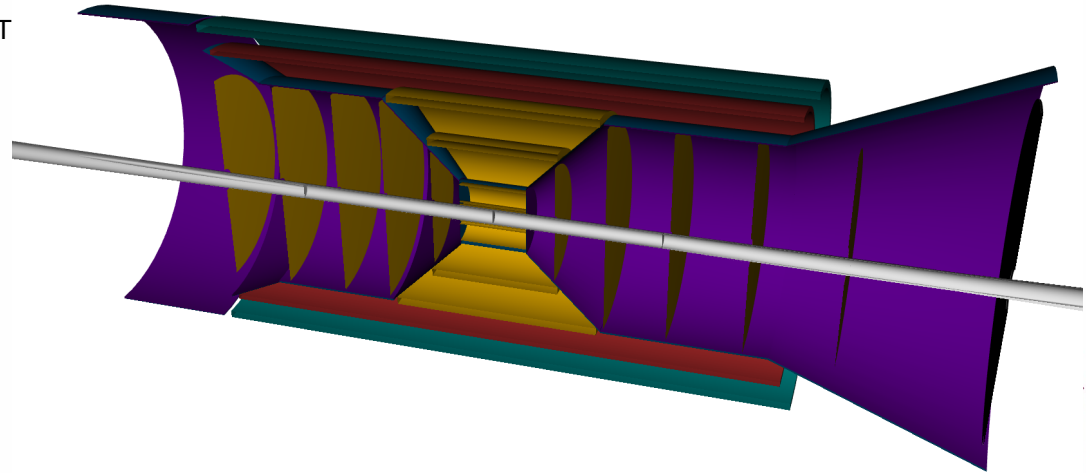
Reconstruction efficiency in p_T vs η

- Efficiency is fraction of tracks in a given η-p_T bin that was successfully matched to a truth track during association → **does not require reconstruction to be in the same bin**
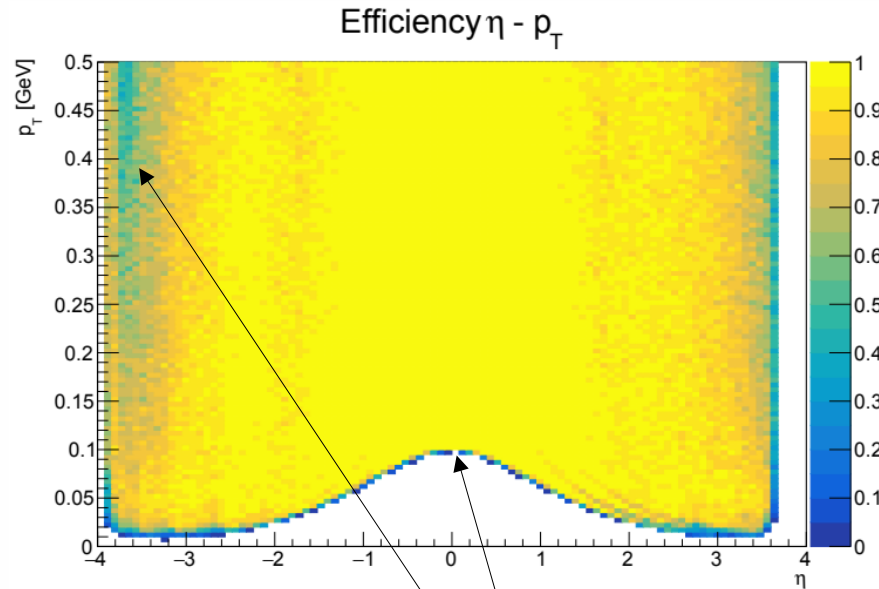

Some interesting features are seen

White region

- White region below peak is a result of minimum momentum allowed by truth seeding
  → p < 0.1 GeV tossed out

src/algorithms/tracking/TrackParamTruthInitConfig.h
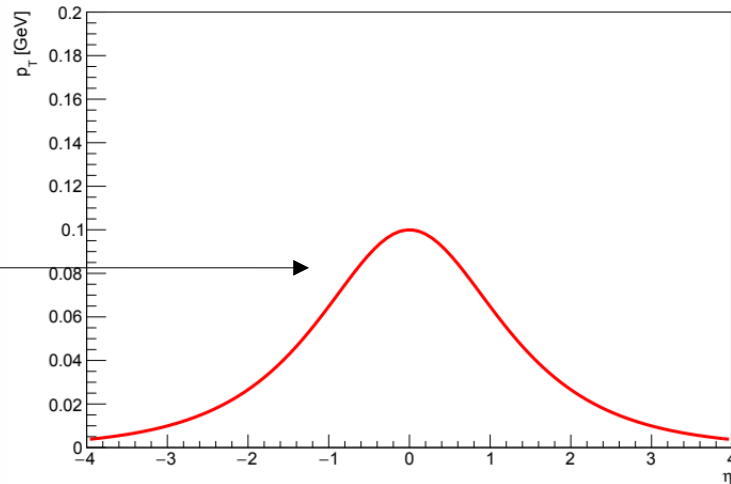
```cpp
13      double m_maxVertexY      = 80  * Acts::UnitConstants::mm;
14      double m_maxVertexZ      = 200 * Acts::UnitConstants::mm;
15      double m_minMomentum     = 100 * Acts::UnitConstants::MeV;
```

● C++   Showing the top match   Last indexed 3 weeks ago
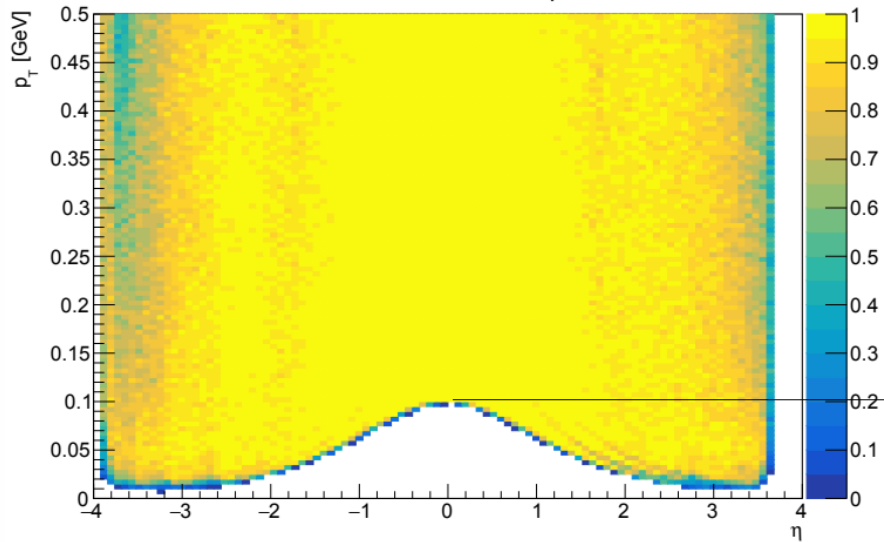
Successful reconstruction at η<-3.5

- Should not be getting 3+ hits for η < -3.5
  - Efficiency is lost after η=-3.5 but increases again towards η=4
  - Band of efficiency still present after restricting to events with within 5% of the true momentum and within 0.1 of true η → any inputs on this are welcome
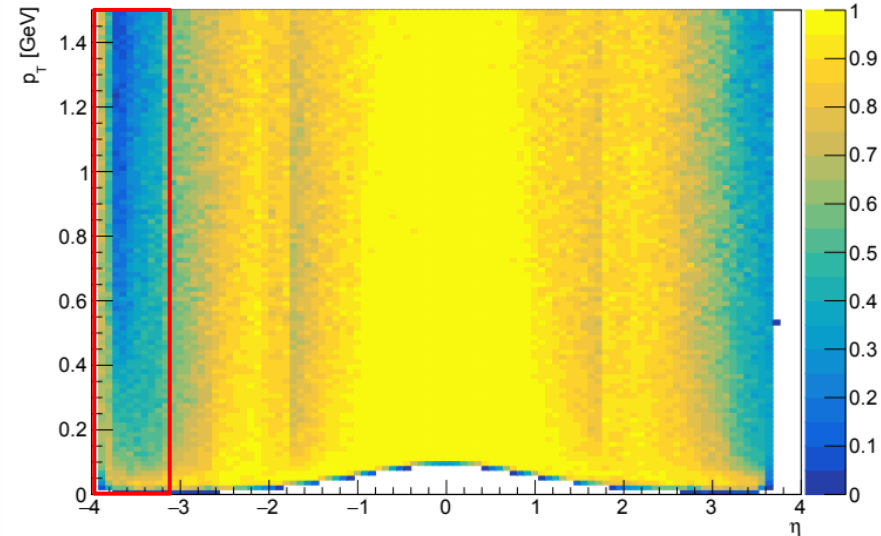

Fraction reconstructed with p within 5% and η within 0.1 of generated
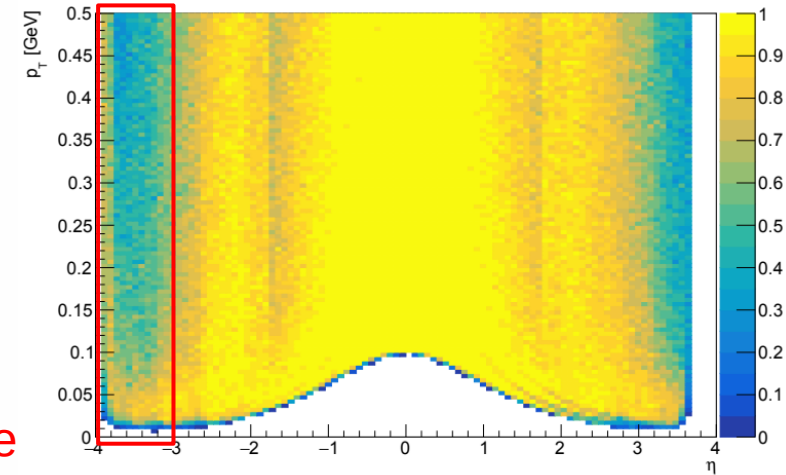
Efficiency η - p_T
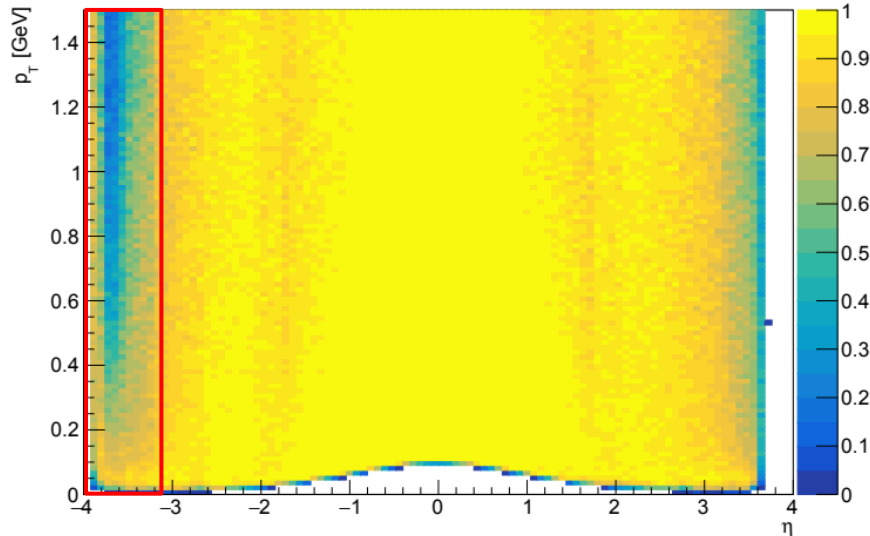
Fraction reconstructed with p within 5% of generated

Electron Kinematics

$$Q_e^2 = 2E_e E_e'(1 + \cos\theta) \qquad y_e = 1 - \frac{E_e'}{E_e}\sin^2\frac{\theta}{2}$$

As $Q^2 \to 0$, $\vartheta \to 180^o$, in kinematic peak $(y \to 0)$ region,

$$Q^2 \to 2E_e^2(1 + \cos\theta)$$

Strong correlation between Q^2 and θ

Weaker correlation between y (or x) and θ

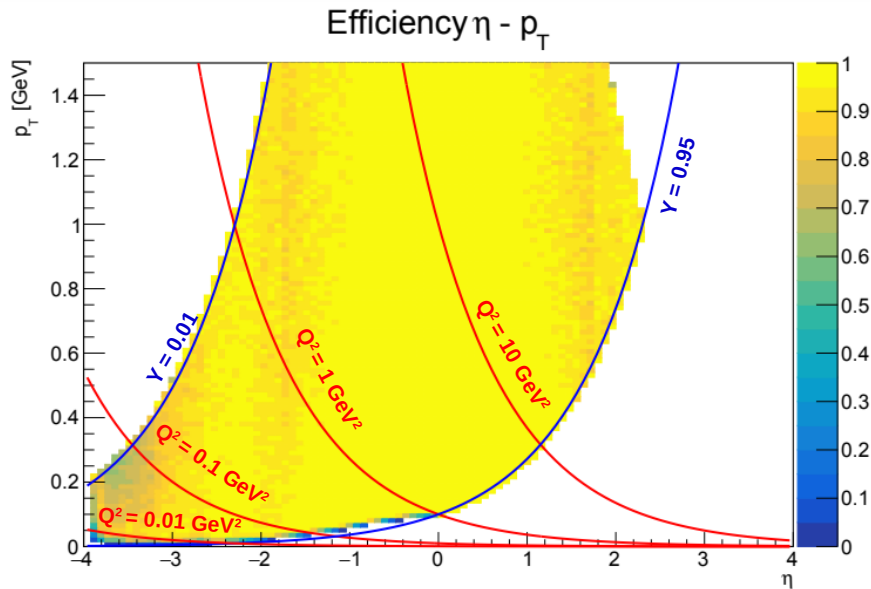Note that these correlations only depend on the electron
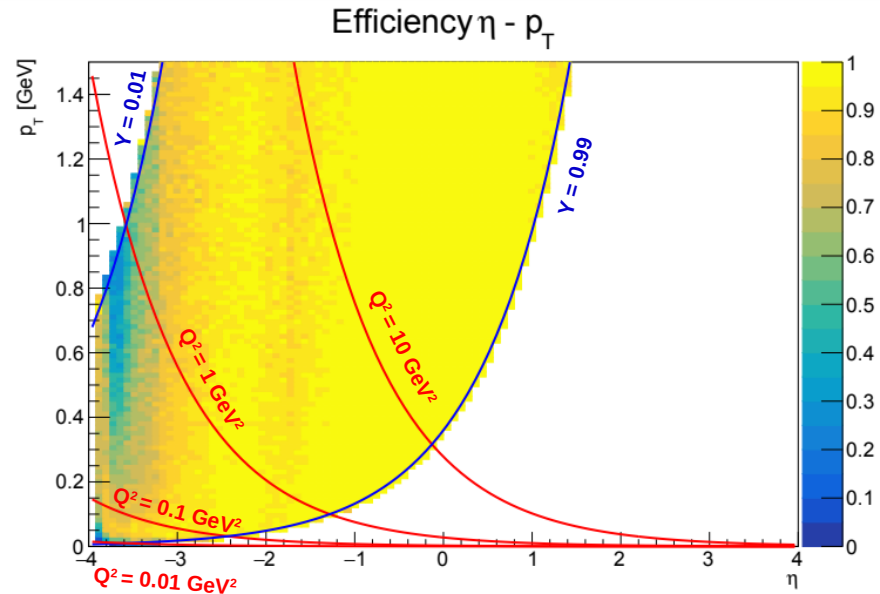beam energy (proton energy is irrelevant)
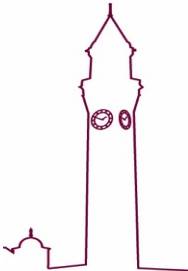
Coverage in Q² and y

- We want as much of the possible events to be in yellow as possible!
  - Mostly the case for $Q^2 > 0.1$ GeV², $y > 0.01$ for 5 GeV beam energy
  - Similarly the case for 18 GeV beam energy for $Q^2 > 1$ GeV²
- Only plot events where energy is less than e-beam energy, and $y < 0.99$

5 GeV electron beam   18 GeV electron beam

Summary

- Performed simulations with single electrons to study Q^2 coverage of tracker
  - Features of η-p_T plot investigated $\rightarrow$ some understood, further investigation required for far backwards reconstruction
- General Q^2 coverage of tracker looks good for $Q^2 > 1\,GeV^2$ and down to $0.1\,GeV^2$ for 5GeV e^- beam energy