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# **Summary of Tracking Analysis**

Joe Price, University of Liverpool MUSE 22<sup>nd</sup> October 2018

### What are the tracker's main physics goals?

- 1. Measure the stored beam profile for:
  - Effective magnetic field seen by muons
  - Beam position & width oscillations
  - Pitch correction to  $\omega_a$  from vertical motion



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- Independently measure e<sup>+</sup> momentum to validate calo algorithms for pile-up & gain corrections
- 3. Look for vertical oscillations for a muon EDM search



# **Tracker Design Overview**

#### Two trackers: each with 8 modules that sit in front of calorimeter





Each module has 128 straws in four layers

Muon's-eye view inside vacuum chamber



# **Track Reconstruction: Finding Tracks in Hits**

#### Select candidates for tracking based on hit times and locations:





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#### Select candidates for tracking based on hit times and locations:



Track fitting is a global  $\chi^2$  algorithm with Geant4 used for track propagation in non-uniform field



## **Track Extrapolation: Decay Point & Calorimeters**

We extrapolate tracks backwards to decay point and forwards to calorimeter:



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# **Tracks: Momentum and Time**

- We see a broad range of e<sup>+</sup> momenta from 350 3100 MeV
- Arrival times show g-2 oscillation, enhanced with mom. cut



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### **Muon Decay Position**



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Extrapolate tracks to where they are tangential to magic radius:



# **Beam Position: Radial & Vertical Projections**

Projections of 2D beam spot from previous slide onto radial and vertical directions:



Beam is not radially centred due to understrength kick.

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Distribution is wide as the beam is oscillating

# **Beam Position: Radial Oscillation**



Beam oscillates radially due to coherent betatron oscillations:





# **Beam Position: Radial Oscillation Amplitude**

Amplitude of radial oscillation decreases as beam spreads out:



Tracker measurements of oscillation frequency and amplitude lifetime are important for calorimeter  $\omega_a$  analysis

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# **Beam Position: Vertical Oscillations**

V Pitch Correction

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Vertical oscillations are smaller and higher frequency, but we can still measure them:



Vertical motion means we need **pitch correction**, which is extracted using this tracker data

### **Example Systematic Study: Kicker Strength Scan**

Observe beam becoming more centred and oscillation amplitude decreasing as we increase kicker strength





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Observe beam becoming more centred and oscillation amplitude decreasing as we increase kicker strength



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### **Calorimeter Comparison: Gain**

Extrapolate tracks to calo for independent cross-checks Compare track momentum and calo energy for gain:





Calo Cross-checks

# **Calorimeter Comparison: Efficiency & Pile-up**

Extrapolate tracks to calo for independent cross-checks



#### Take home messages

- 1. Tracker has many complementary physics goals
- 2. Tracking analysis is working and provides essential information on beam storage
- 3. We now have a new window into beam dynamics & calorimeter performance that wasn't available in E821

