

## TPC Distortion Corrections

- Basic derivation a la R&B, note  $q=-e \Rightarrow \omega$  is negative!

$$F = m \frac{d\vec{u}}{dt} = q\vec{E} + q(\vec{u} \times \vec{B}) - \frac{m}{\tau} \vec{u} \quad (1)$$

$$0 \times \vec{B} = \left[ \vec{E} + (\vec{u} \times \vec{B}) - \frac{m}{q\tau} \vec{u} \right] \times \vec{B} \quad (2)$$

Some useful identities:

$$\vec{u} \times \vec{B} = \frac{m}{q\tau} \vec{u} - \vec{E} \quad (3)$$

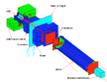
$$\vec{u} \cdot \vec{B} = \frac{q\tau}{m} (\vec{E} \cdot \vec{B}) \quad (4)$$

$$(\vec{u} \times \vec{B}) \times \vec{B} = -\vec{u}(\vec{B} \cdot \vec{b}) + \frac{q\tau}{m} \vec{B}(\vec{E} \cdot \vec{B}) \quad (5)$$

Plug in and collect terms with  $\omega = \frac{q}{m}|B|$ :

$$0 = \vec{u} \left[ \left( \frac{q\tau}{m}|B| \right)^2 + 1 \right] + \left( \frac{q\tau}{m} \right)^2 (\vec{E} \times \vec{B}) + \left( \frac{q\tau}{m} \right)^3 \vec{B}(\vec{E} \cdot \vec{B}) + \frac{q\tau}{m} \vec{E} \quad (6)$$

$$\vec{u} = \frac{|E|}{1 + \omega^2 \tau^2} \frac{q\tau}{m} \left[ \hat{E} + \omega\tau(\hat{E} \times \hat{B}) + \omega^2 \tau^2 \hat{B}(\hat{E} \cdot \hat{B}) \right] \quad (7)$$



## Magnitude and Direction

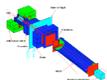
- $E_y, B_y$  are positive,  $B_x, B_z$  are negative (bottom front of TPC)
- $|\omega\tau|$  varies from 1 to 3, and  $B_z$  is  $\sim 50$  times  $B_x$

$$u_x = \frac{\tau|E|}{1 + \omega^2 \tau^2} \left( \frac{-e}{m} \right) \left[ \omega^2 \tau^2 (\hat{E} \cdot \hat{B}) b_x + \left( \frac{-e|B|}{m} \right) \tau b_z \right] \quad (8)$$

$$u_y = \frac{\tau|E|}{1 + \omega^2 \tau^2} \left( \frac{-e}{m} \right) \left[ \omega^2 \tau^2 (\hat{E} \cdot \hat{B}) b_y + \hat{E} \right] \quad (9)$$

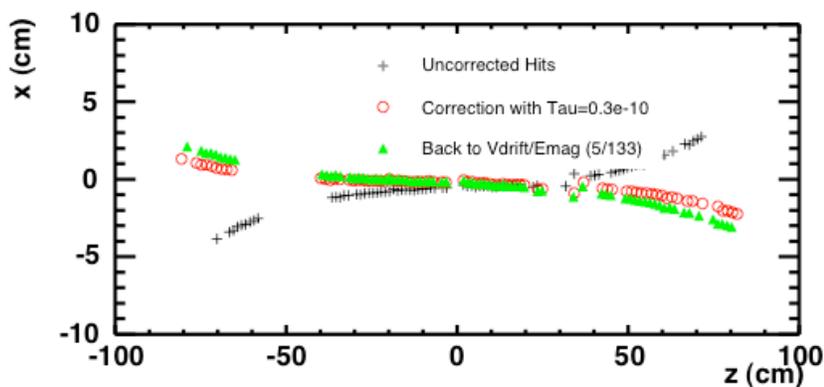
$$u_z = \frac{\tau|E|}{1 + \omega^2 \tau^2} \left( \frac{-e}{m} \right) \left[ \omega^2 \tau^2 (\hat{E} \cdot \hat{B}) b_z - \left( \frac{-e|B|}{m} \right) \tau b_x \right] \quad (10)$$

- Therefore in bottom front of TPC charge drifts
  - down in y
  - forward in z (towards center of TPC)
  - toward negative x
- All signs are now correct!



## Current State of Distortion Corrections

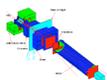
- Implement Modified-midpoint ODE
  - 1st step in Burlisch-Stoer adaptive step method
- Also switched from Tau value to  $V_{\text{drift}}/E_{\text{mag}}$ 
  - reducing  $\omega\tau$  by  $\sim 40\%$ , actually increased overcorrection in x
  - but reduced in z, as expected



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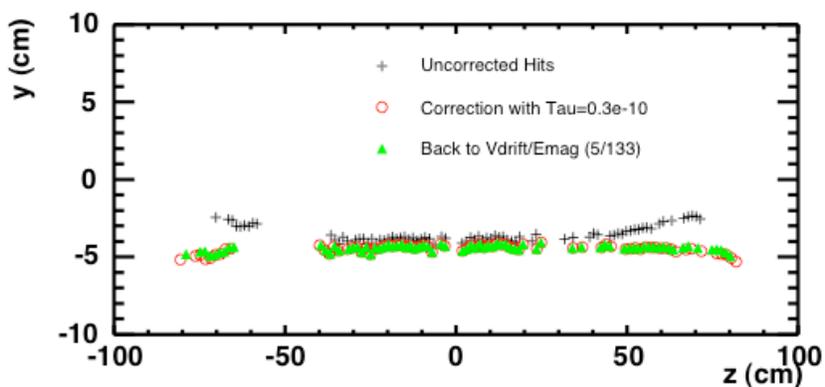
RAS - MIPP Collab - TPC distortions

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## Current State of Distortion Corrections

- Overcorrection also apparent in y



- What's left ? Magboltz, but I suspect :
  - $V_{\text{drift}}/|E|$  (i.e.  $\tau$ ) needs to be a lot smaller, or a little larger...

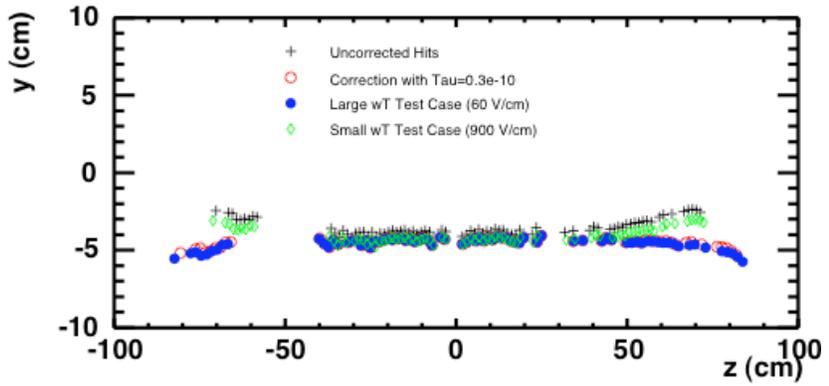
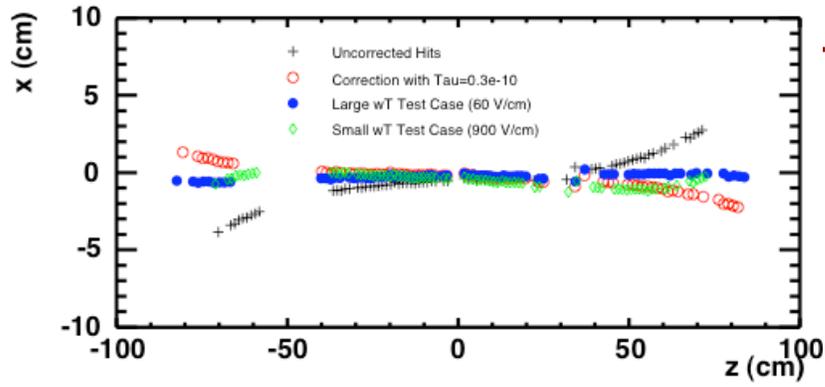
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# Test Cases :



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