B-Field Corrections to Gas Monitor RT Functions

Jason Hindes

Dan Levin

Procedure

- Use the functional form of Oliver Kortner's solution to the drift electron's equation of motion in the MDT environment with a B-Field on
- Compute a scalable correction function based on Garfield
- Assign an average B-Field to every Chamber from AMDB and a static B-Field map
- Compute an RT function for every Chamber

dT_B

- **Equation of Motion for Drift Electrons:**

$$\dot{x} = -\left(\frac{\dot{x}}{\tau}\right)^{1+\epsilon} + \frac{q}{m}[\boldsymbol{E} + \dot{x} \times \boldsymbol{B}] \; ; \quad \tau \equiv \textit{mean free time}$$

$\epsilon \approx .0074$: *experimentally determined*

- **Solution:**

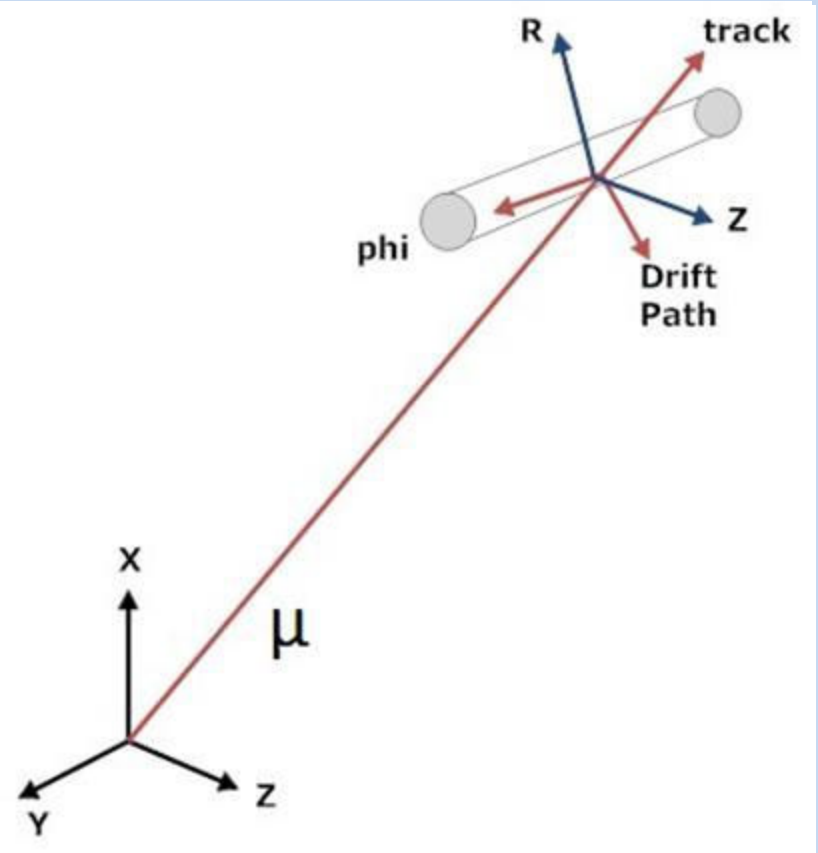
$$t(r, \boldsymbol{B}) = t(r, \boldsymbol{B} = \boldsymbol{0}) + B^{2-\epsilon} \times \int_{r\_wire}^{r} \frac{v_{B=0}^{1+\epsilon}}{E^{2-\epsilon}} dr$$

- **Corrections:**

$$dt(r, B_{obs} - B_{ref}) = (B_{obs}^{2-\epsilon} - B_{ref}^{2-\epsilon}) \times I(E(r), v(r))_{B=0}$$

B_{eff}

- **First Order Corrections**: $B_{v_e^-}^{perp}$
- **Second Order**: $B_{v_e^-}^{||}$
- **Coordinates:**



- **Effective B-Field that requires correction is**

$$|B_{v_e^-}^{perp}| = \sqrt{B_{\mu_{||}}^2 + B_{wire_{||}}^2}$$

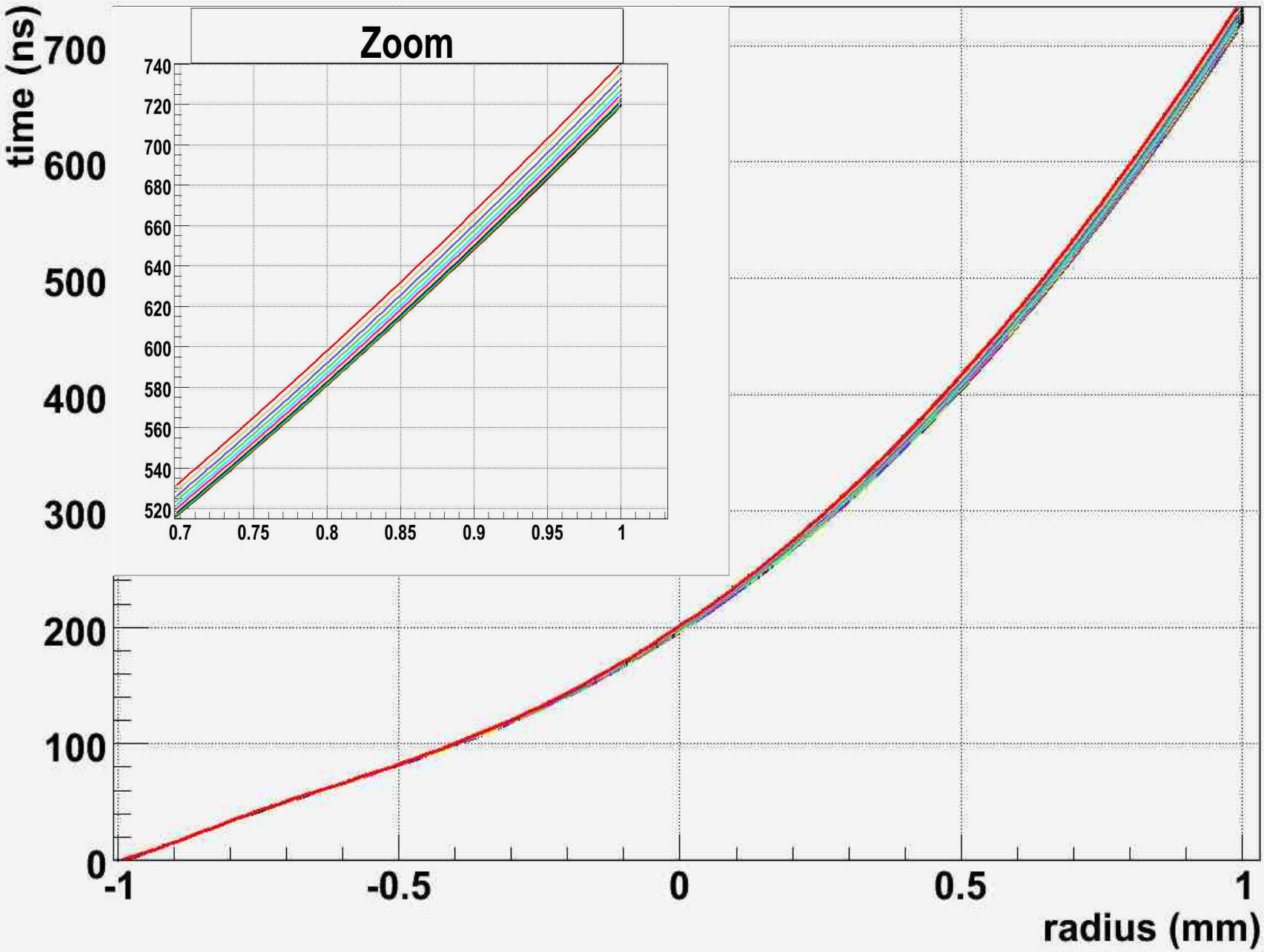
- **Work out the transformations**

$$|B_{v_e^-}^{perp}| = \sqrt{B_\phi^2 + B_r^2(\frac{r}{\rho})^2 + 2B_r B_z\left(\frac{rz}{\rho^2}\right) + B_z^2(\frac{z}{\rho})^2}$$

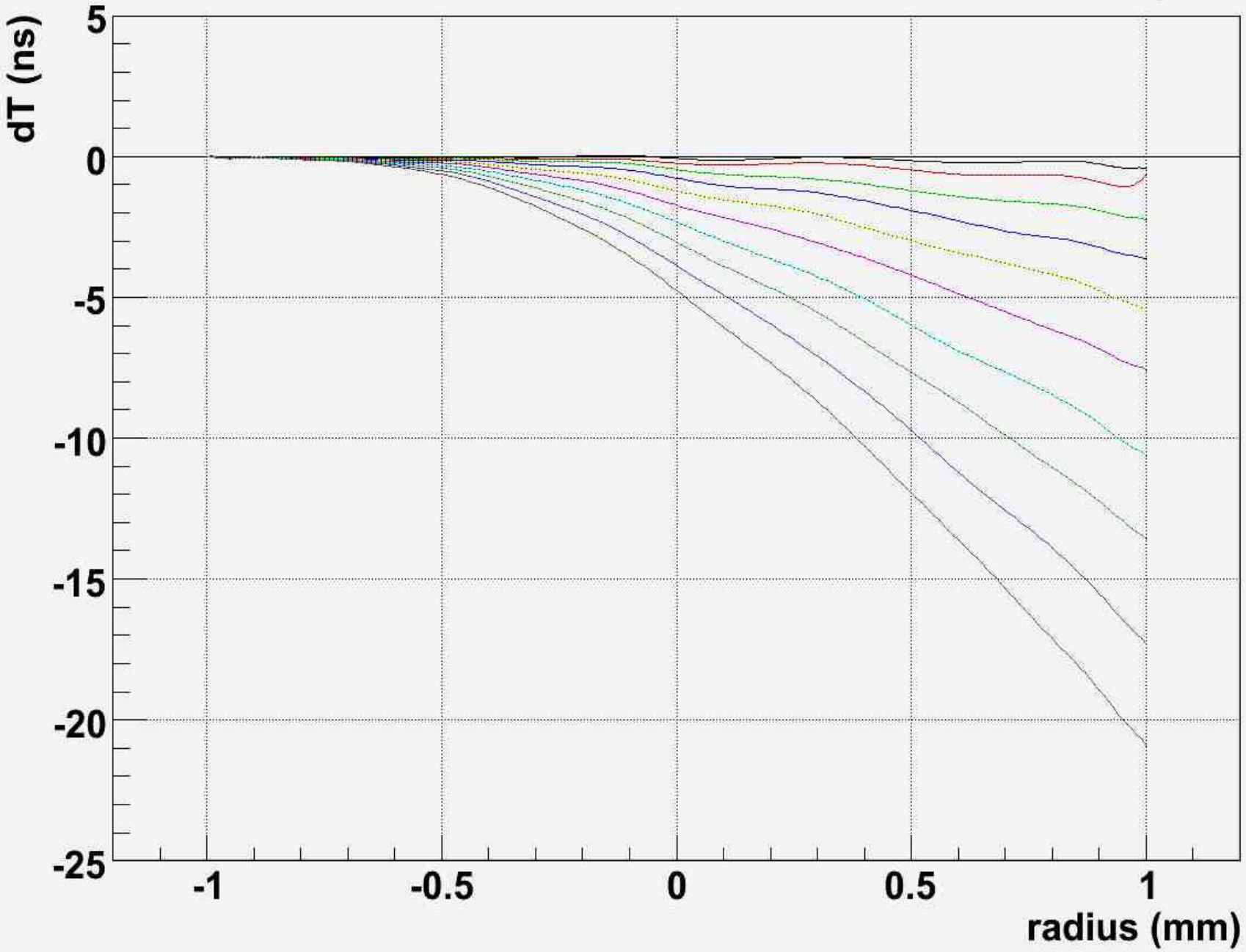
Garfield Simulation Correction Function

- Garfield
- Output TRs in B_{eff} steps of .05T from 0T to1T
- Compute all possible combinations of $dT(r, B_{obs}^{eff} - B_{ref}^{eff})$ and normalize to reference field.
- Use average and cutting procedure to create a scalable correction function from the normalized *dTRs.*

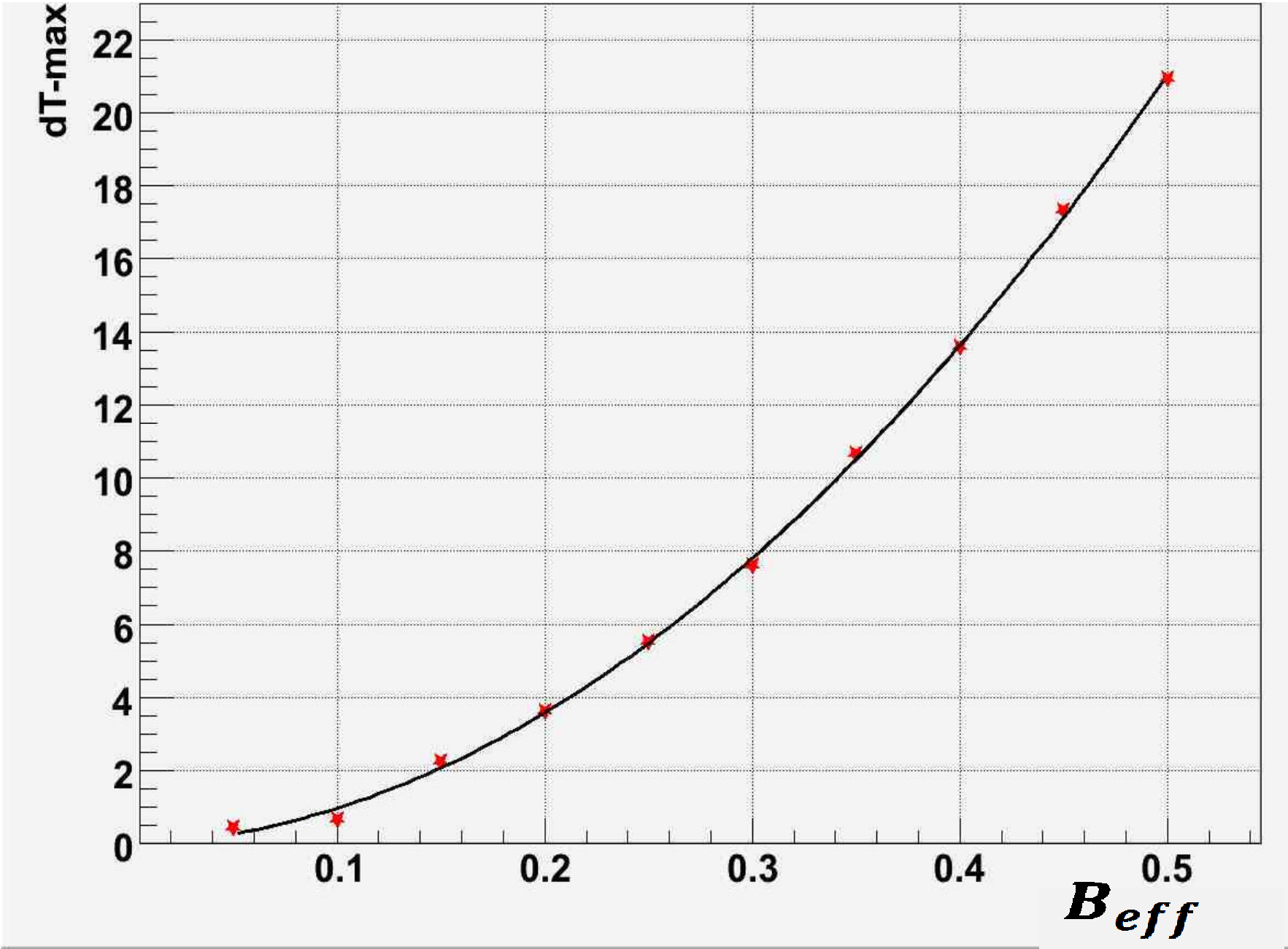
TR functions with B=n*.05T from Garfield Simulations in Chebyshev Space



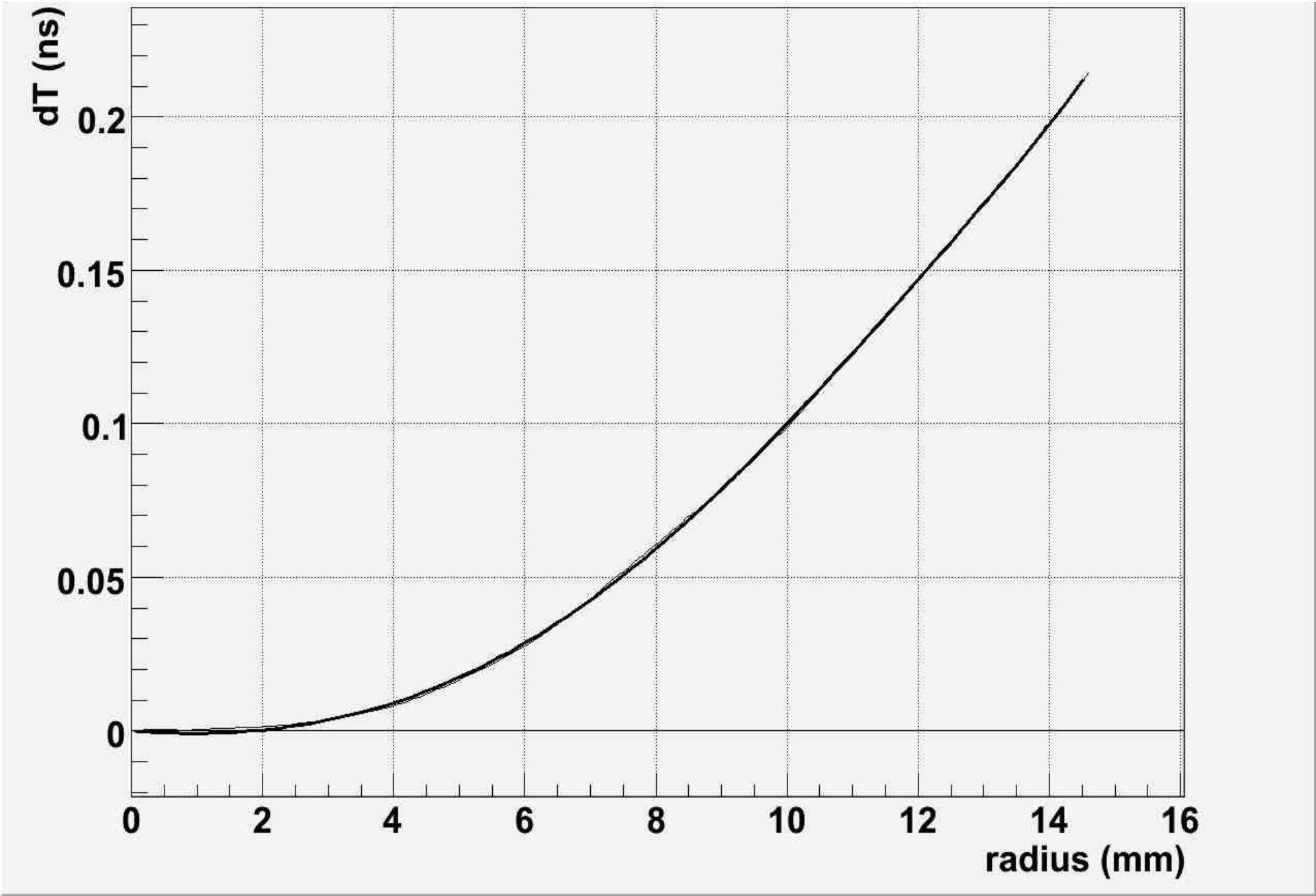
Set of dTR Combinations: .05T steps



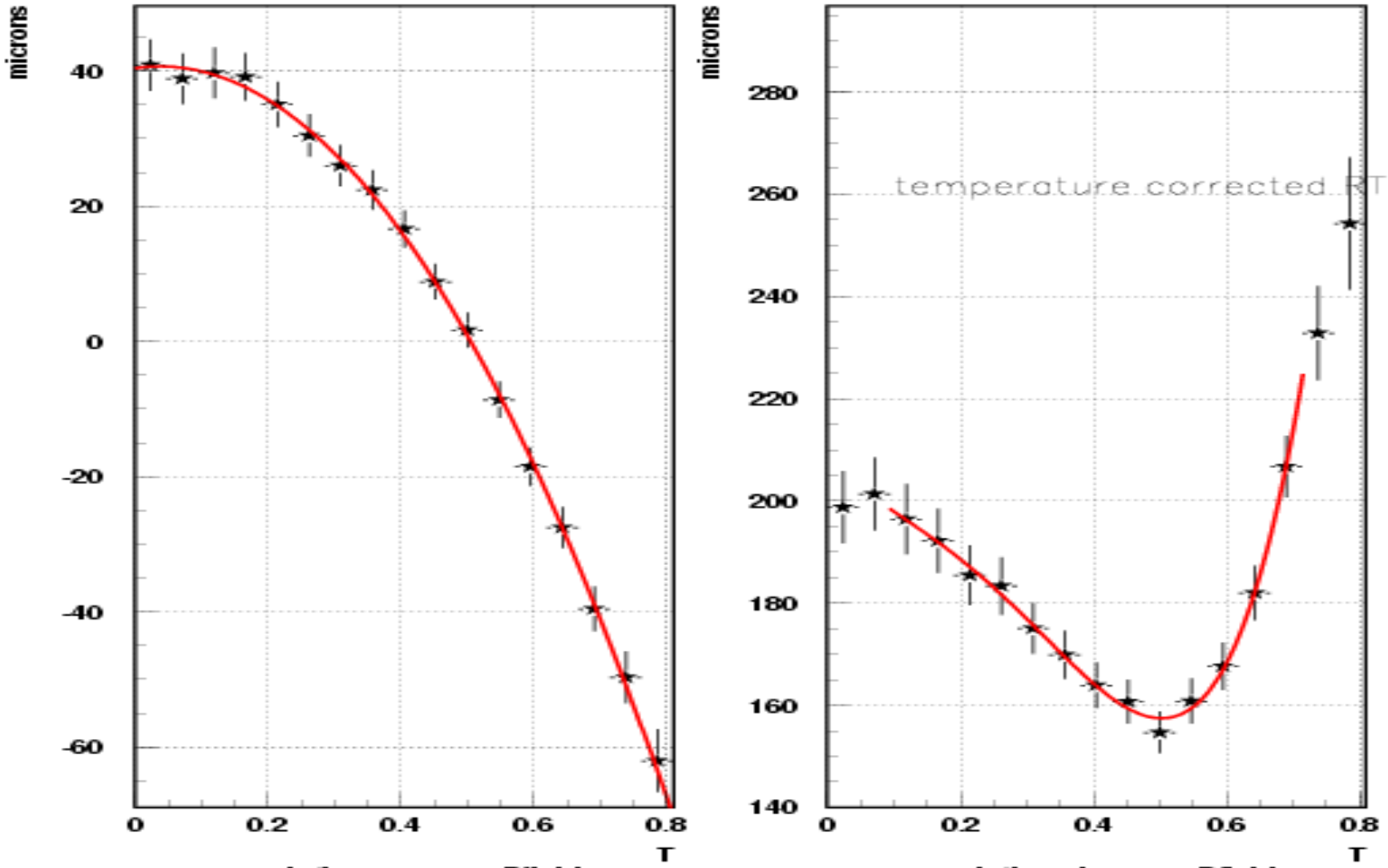
Non Linear Corrections at the Tube Wall: Nearly Quadratic



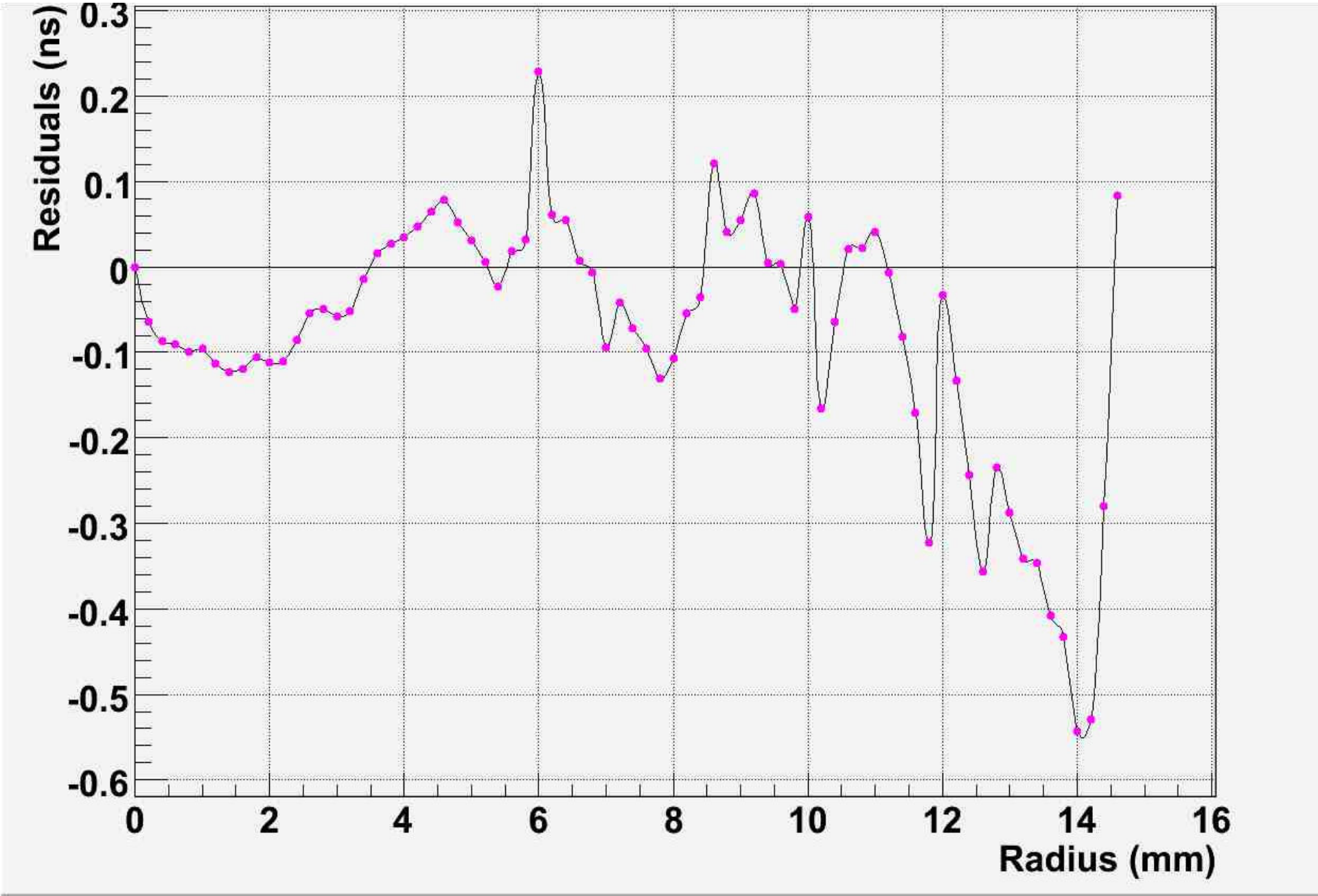
Correction Function Normalized to B_{eff} = .05T



Real Data Comparison Using Track Reconstruction Program MUTRAK



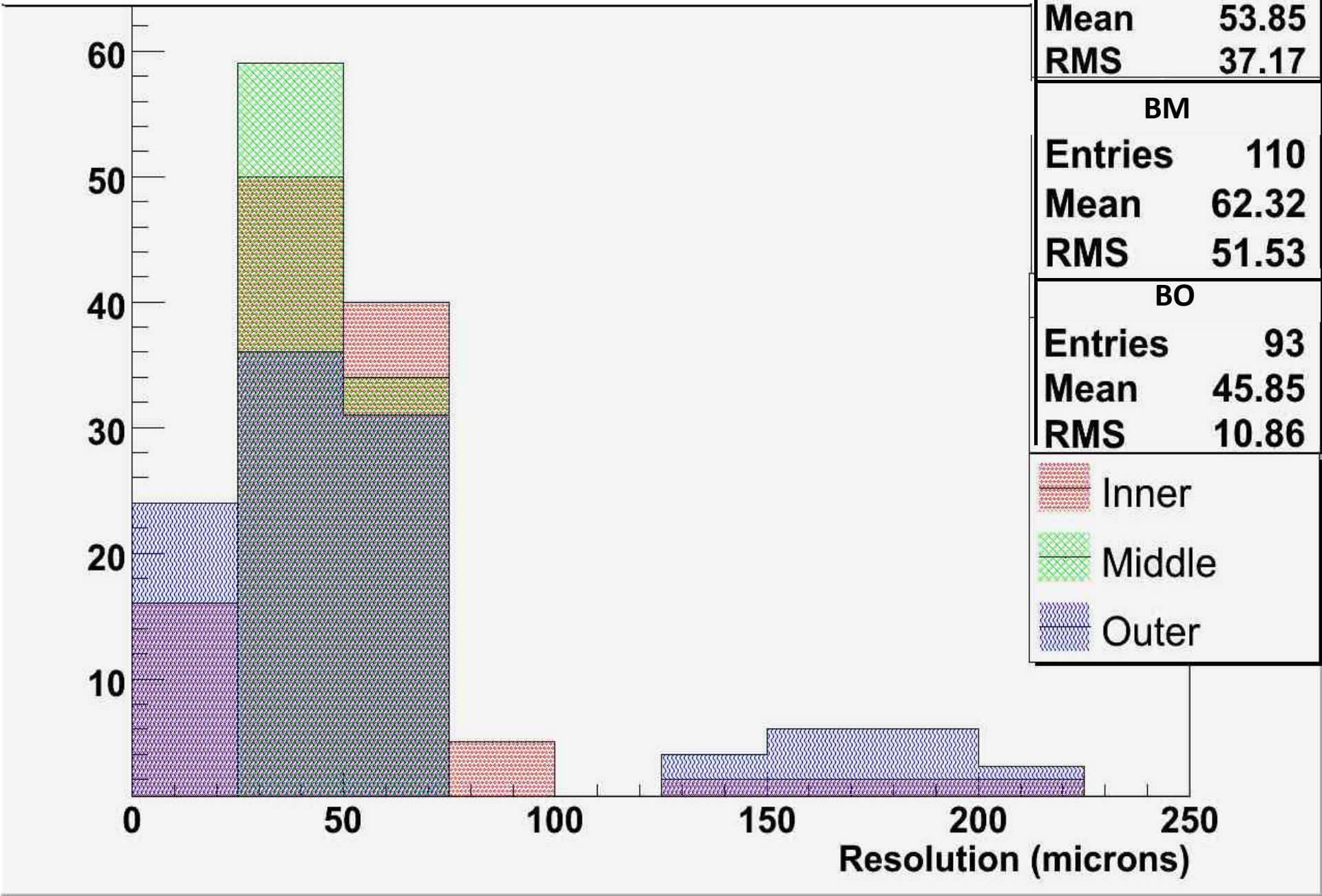
Residuals: RT(B=0) and Correction Function with RT(Bx=.3T,By=.3T,Bz=.3T)



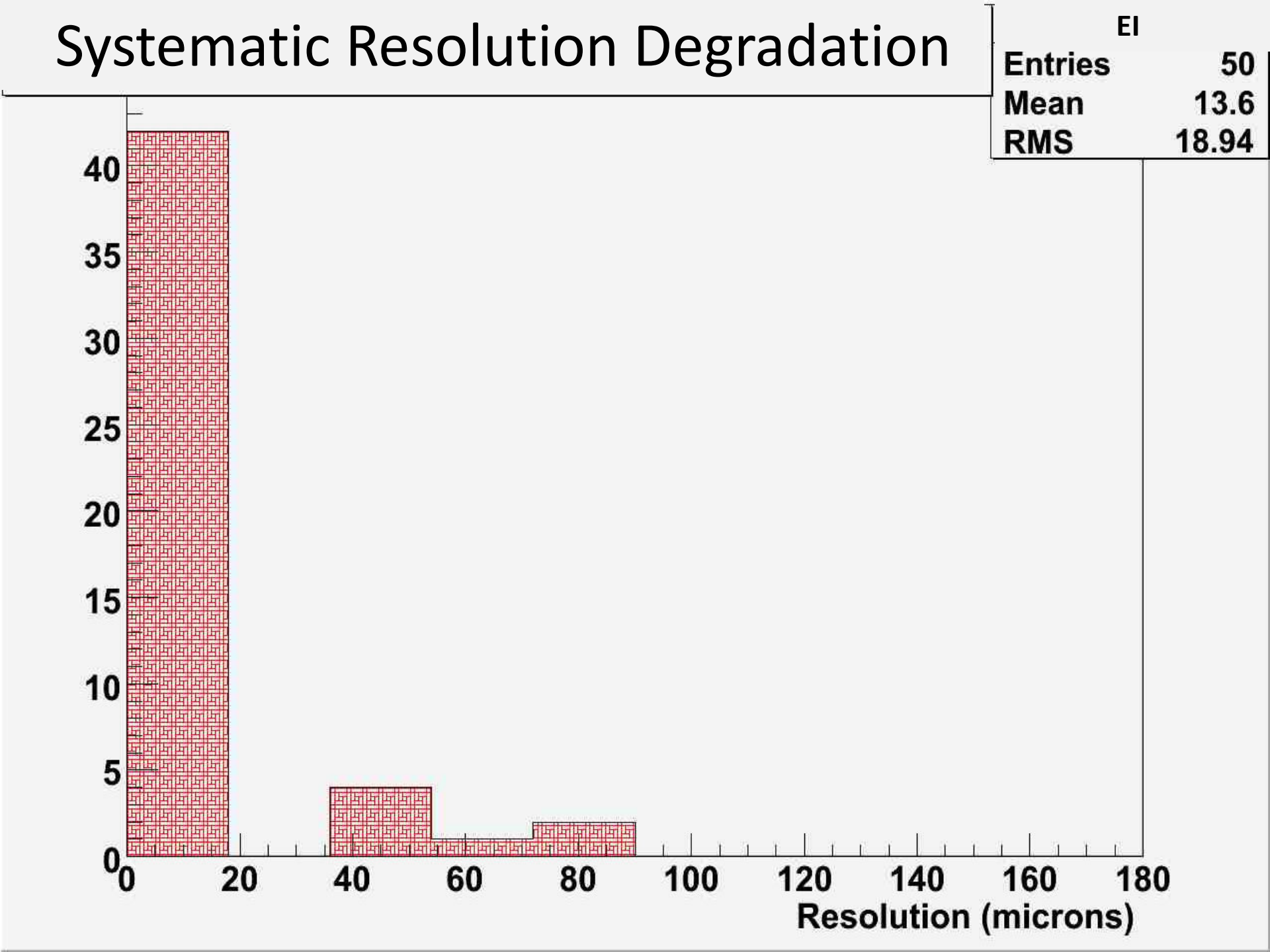
Can We Use A Single B-Field Corrected RT Per Chamber?

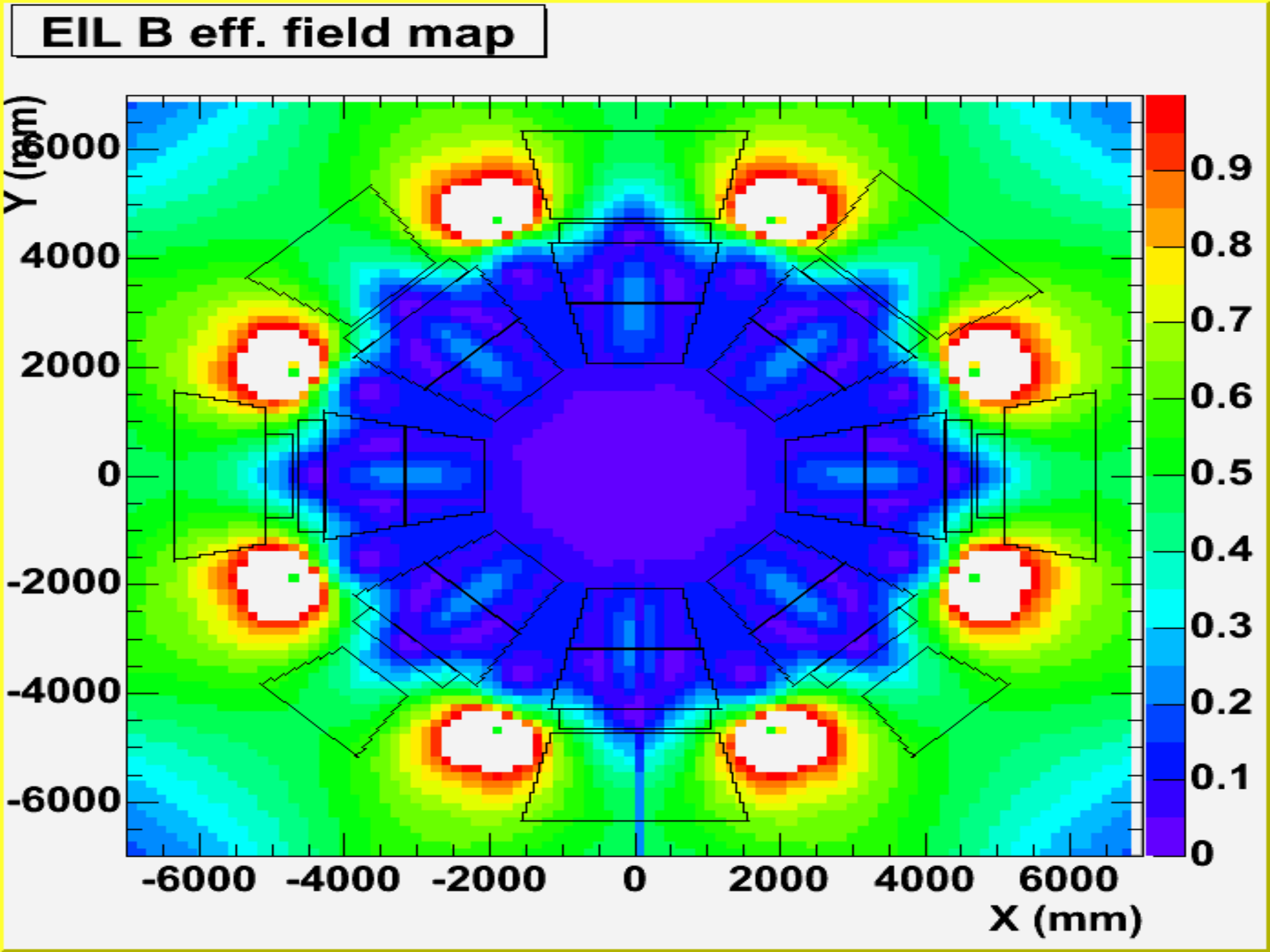
- Assign an average B-Field per Chamber from a line integral along bases with even steps.
- Compute the average drift time correction in an MDT at a particular location from the average B-Field and the actual B-Field.
- Take the difference between these measurements and multiply by the average drift velocity. This will be the local resolution degradation.
- Repeat this process iteratively over the chamber and average the results. This will be the average resolution degradation in a given chamber.
- We want this to be less than 50μm: the overall tube resolution will be 94μm.

Systematic Resolution Degradation

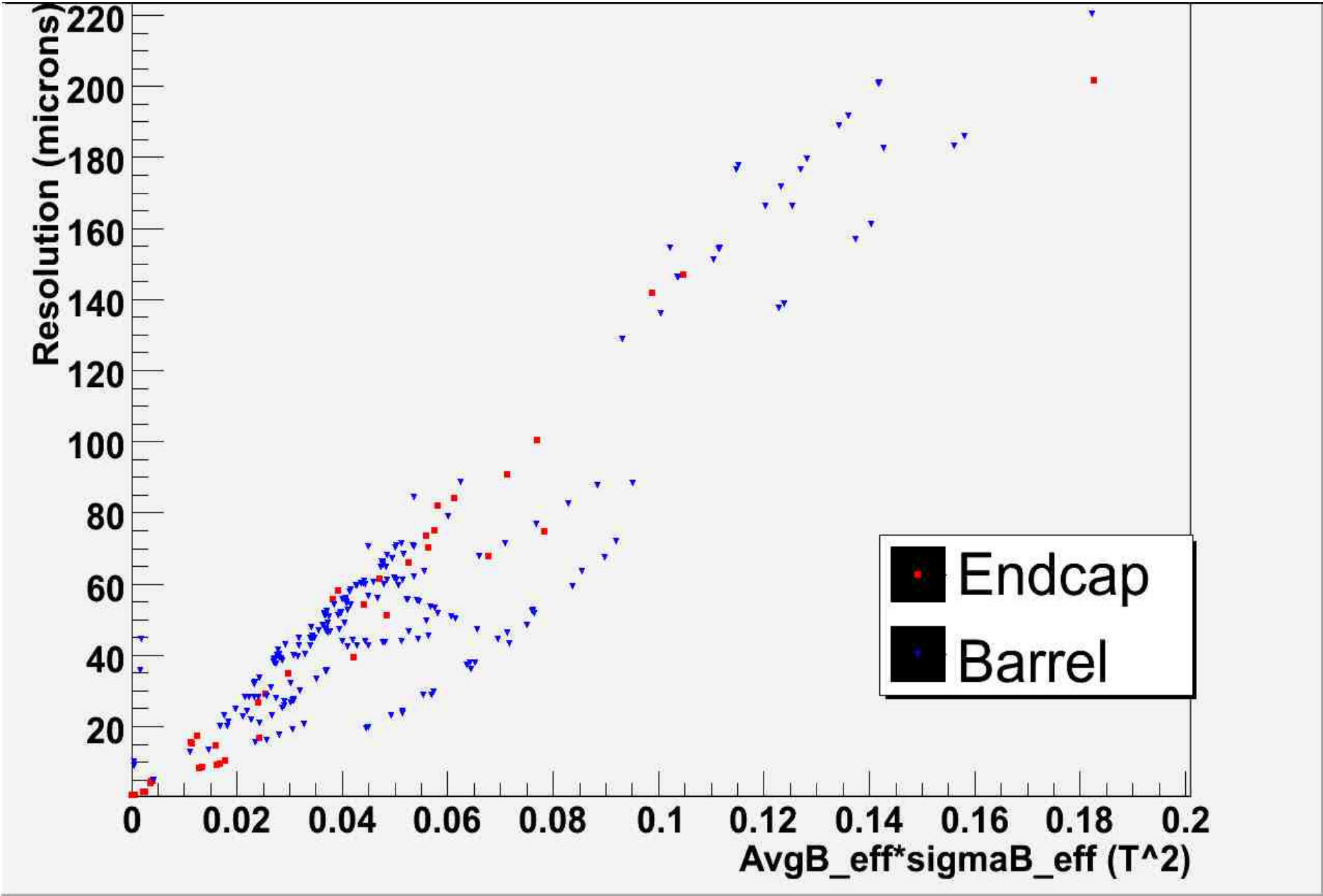


Systematic Resolution Degradation




EIL B eff. field map
Y (mm)
6000
4000
2000
0
-2000
-4000
-6000
-6000
-4000
-2000
0
2000
4000
6000
X (mm)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

Resolution Degradation vs. The Product of B_{eff} and σ_B



Conclusion

- The resolution degradation is less than 50µm, in 69% of the chambers.
- 87% in the Endcap: Exceptions are EIL4, EEL1, EEL2, EES1,EES2.
- 90% in EI, 100% in EM, 100% in EO, and 10% in EE.
- 55% in the Barrel: 54% in BI, 63% in BM, and 55% in BO.
- Corrections in the Barrel will have to be made at the hit-level.
- Endcap corrections could be added to the Automated Temperature Correction Procedure