

# MICE Spectrometer Solenoid Data Analysis

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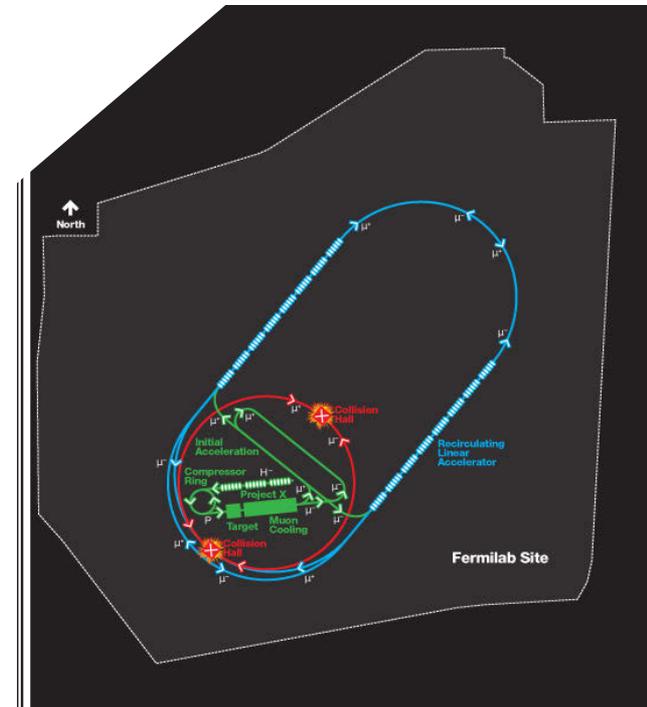
# Muon Collider

## ▶ Pros

- ▶ Muons are fundamental particles.
- ▶ Energy of the interaction is full energy of particle.
- ▶ Precision measurements are possible.
- ▶ Bremsstrahlung from muons is less than for electrons by a large factor.
- ▶ Muon collider consumes less power.
- ▶ Size of muon collider is smaller.
- ▶ Neutrinos from muon decays can be used as a source for a Neutrino Factory.

## ▶ Cons

- ▶ Technically very challenging, since muons have a short lifetime ( $\sim 2.1$  microseconds).
- ▶ Need R&D to prove feasibility of crucial concepts (i.e. muon cooling).



# MICE (Muon Ionization Cooling Experiment)

- ▶ Cooling is a crucial component to build a high intensity Muon Collider.
- ▶ R&D project to demonstrate the “cooling” of muon beams.
- ▶ Reduce the transverse size of the beam and speed of the particles; to produce very bright, focused beams, ready to be accelerated to high energies.

**Spectrometer  
Solenoid #1**



**Spectrometer  
Solenoid #2**

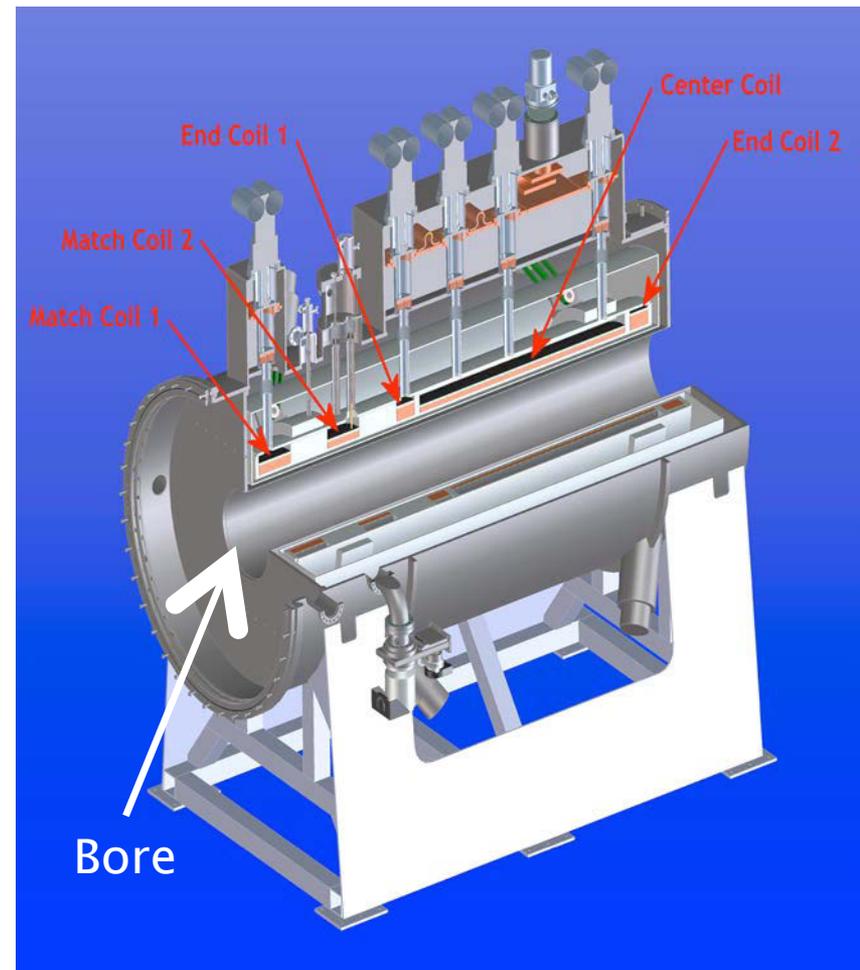
**RF Coupling Coil Modules**

[http://conferences.fnal.gov/cool05/Presentations/Tuesday/T12\\_Kaplan.pdf](http://conferences.fnal.gov/cool05/Presentations/Tuesday/T12_Kaplan.pdf)

# MICE Spectrometer Solenoid

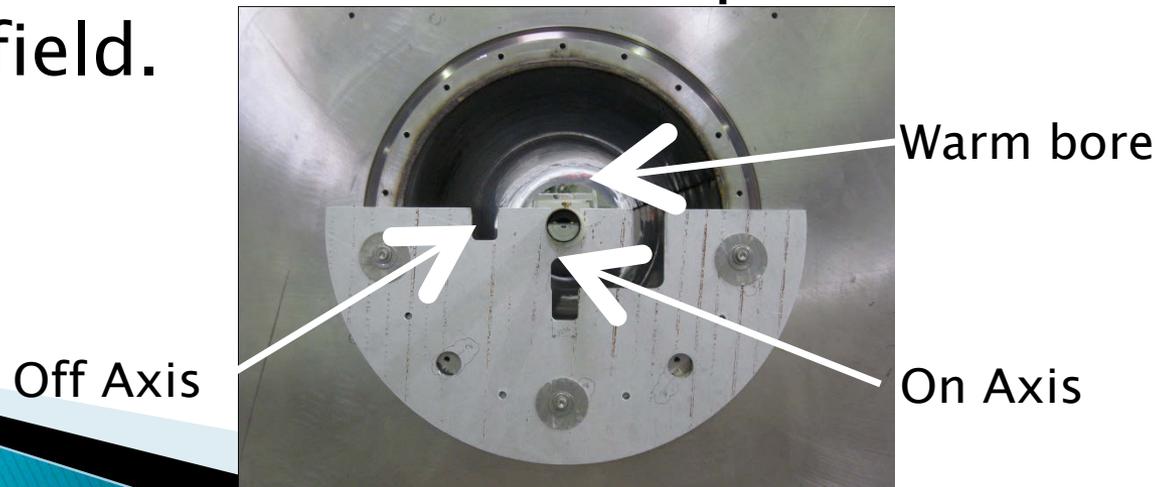
- ▶ Allows for analysis of muon momentum before and after ionization cooling

Magnet	Purpose
M1	Match the magnetic field to cooling channel.
M2	Match the magnetic field to cooling channel.
E1	Fine tuning to magnetic field of center coil.
C	Allows for precise measurement of muon momentum.
E2	Fine tuning to magnetic field of center coil.



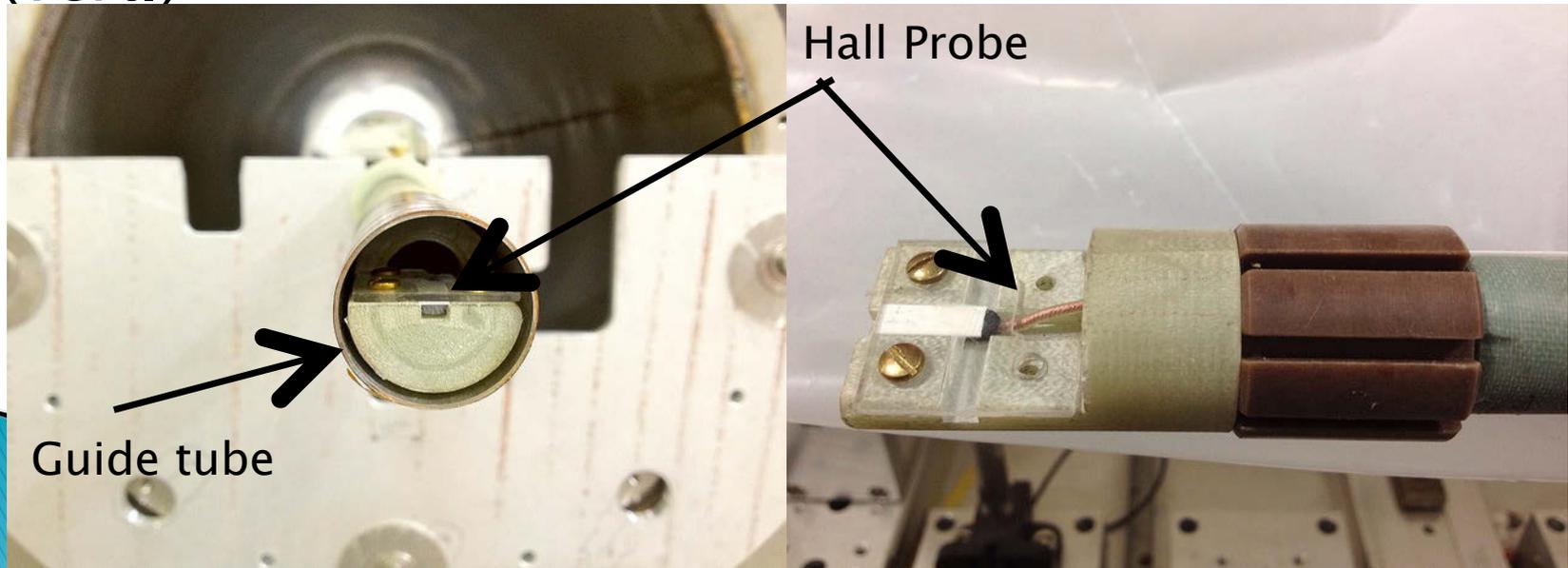
# Spectrometer Solenoid Measurement

- ▶ Data gathered by Marc Buehler and Mike Tartaglia in June 2012 at Wang NMR (private contractor through Lawrence Livermore National Laboratory, CA).
- ▶ Hand driven positioning system within warm bore of the magnet.
- ▶ Measured axial and radial components of magnetic field.



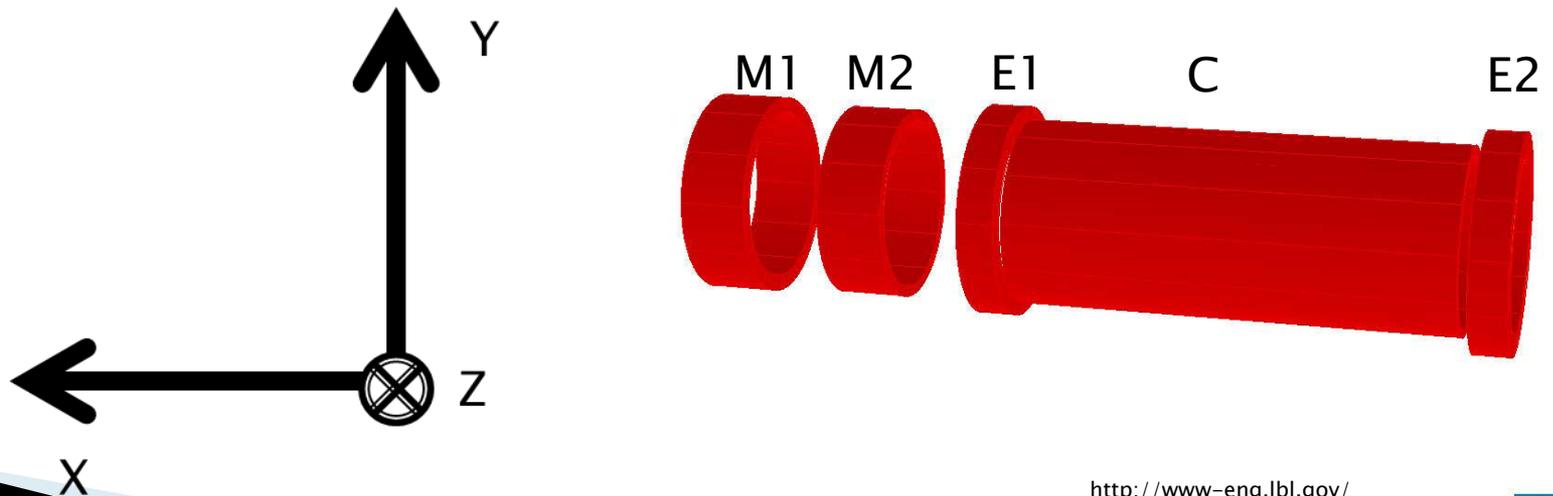
# Spectrometer Solenoid Measurement

- ▶ Support plates on end.
  - Guide tube supports hall probe which can be moved into 3 different positions.
- ▶ M1 at 50A on-axis
- ▶ M2 at 50A on-axis, off-axis (hor.), off-axis (vert.)
- ▶ ECE at 50 A on-axis, off-axis (hor.)
- ▶ All coils at 150A on-axis, off-axis (hor.), off-axis (vert.)

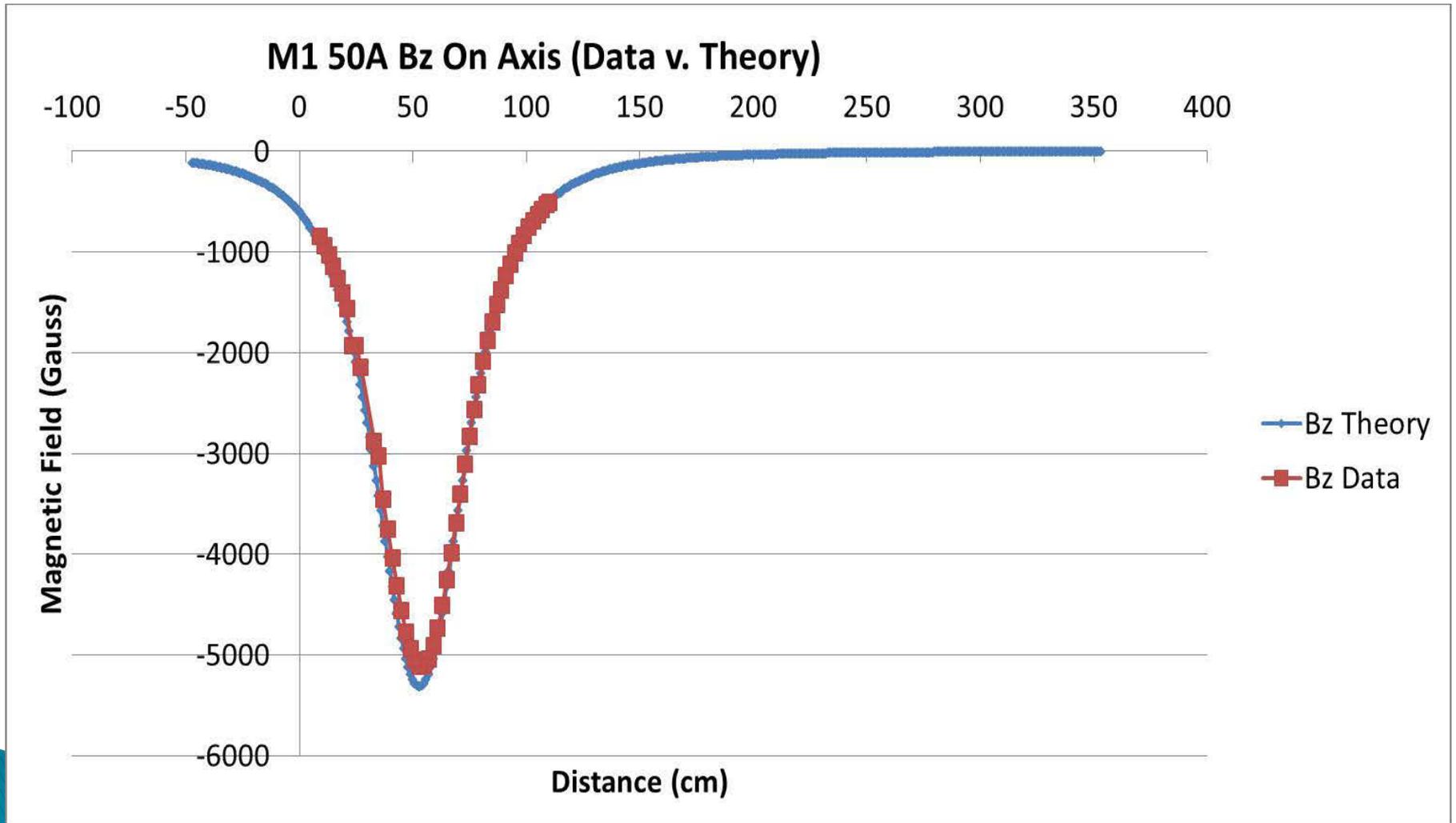


# 50A Measurements

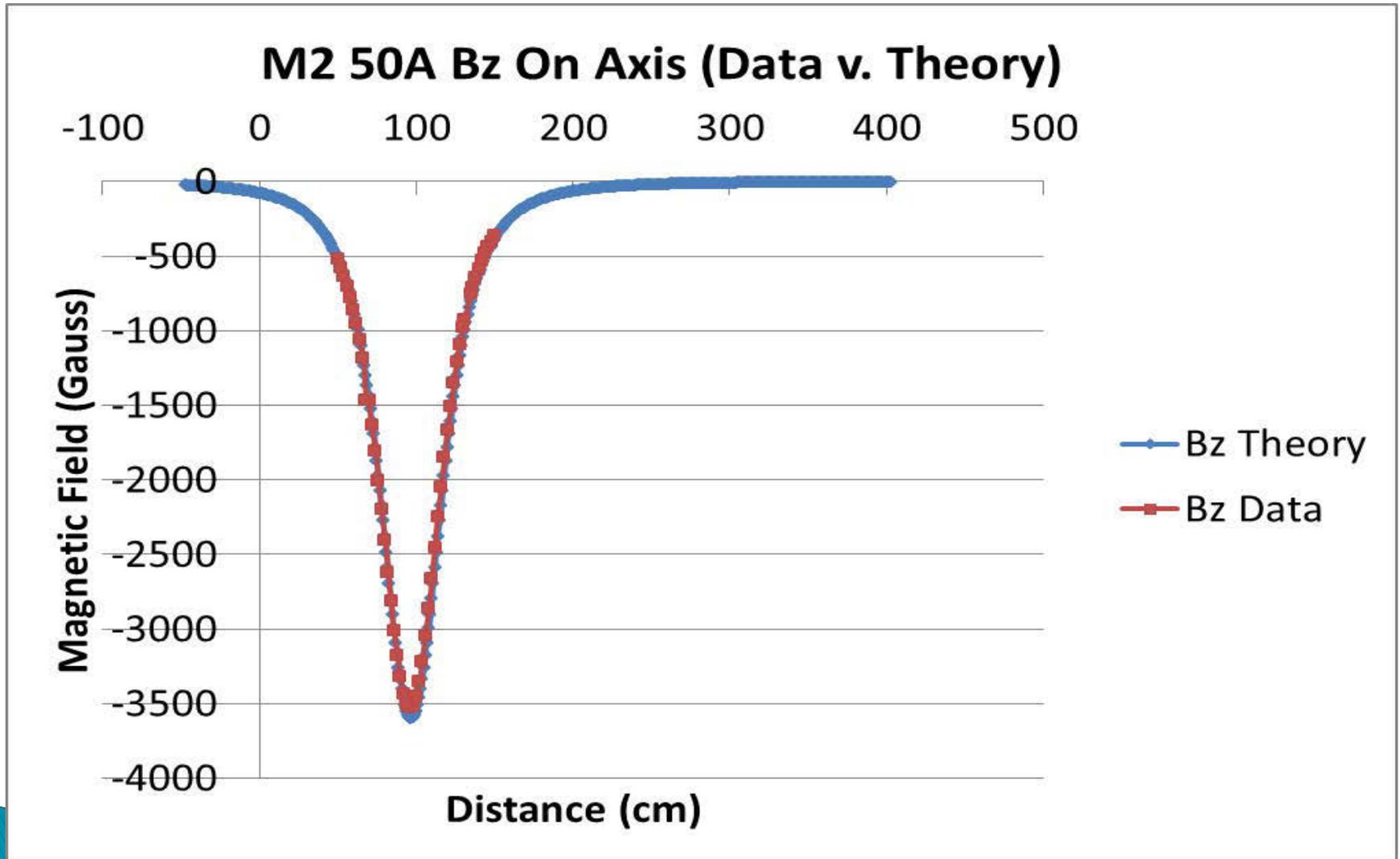
- ▶ Magnetic measurements on a sub-set of coils (M1, M2, ECE).
- ▶ These measurements provided us with more precise geometric positioning information for the coils, which improved our model.



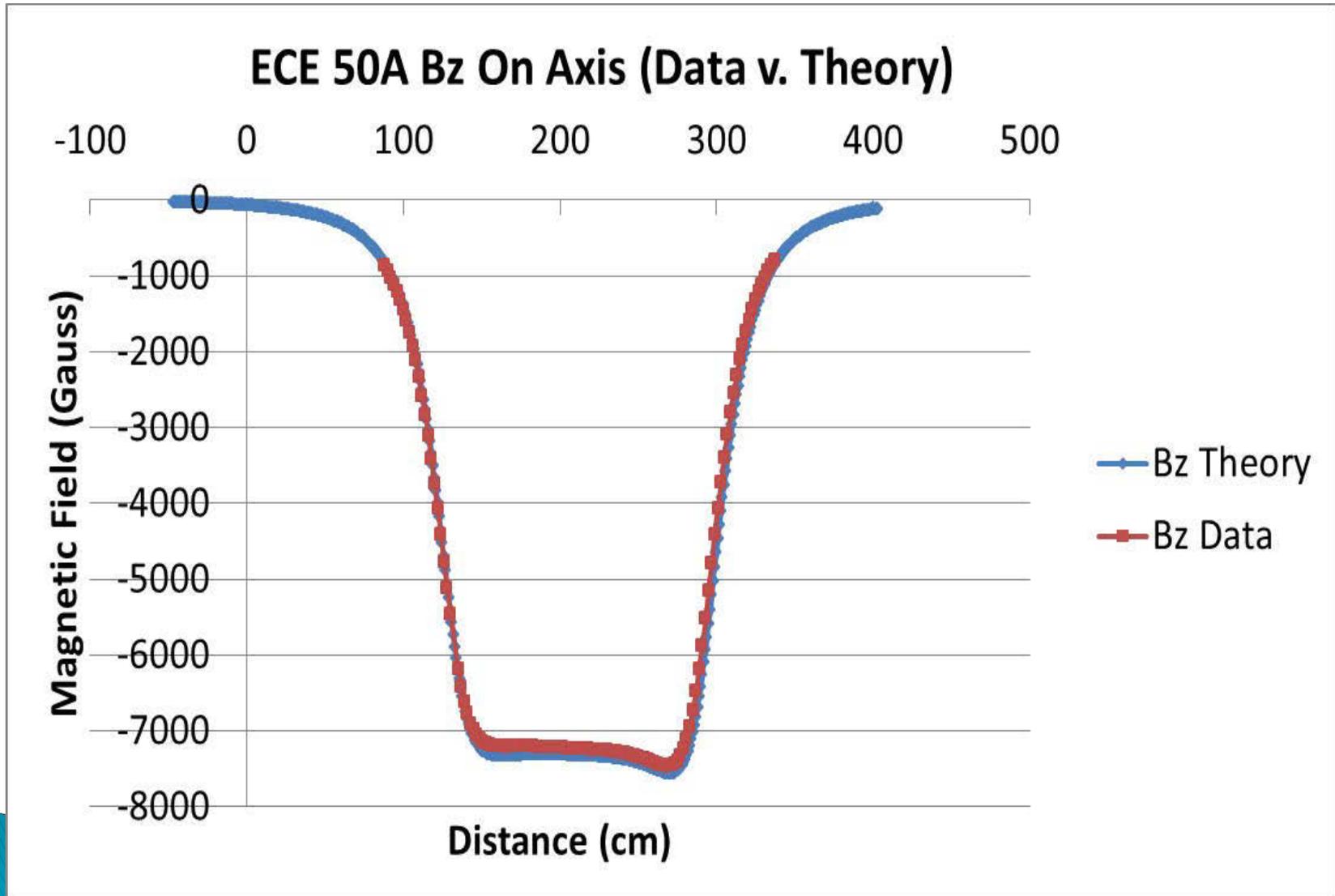
# 50A Measurements



# 50A Measurements

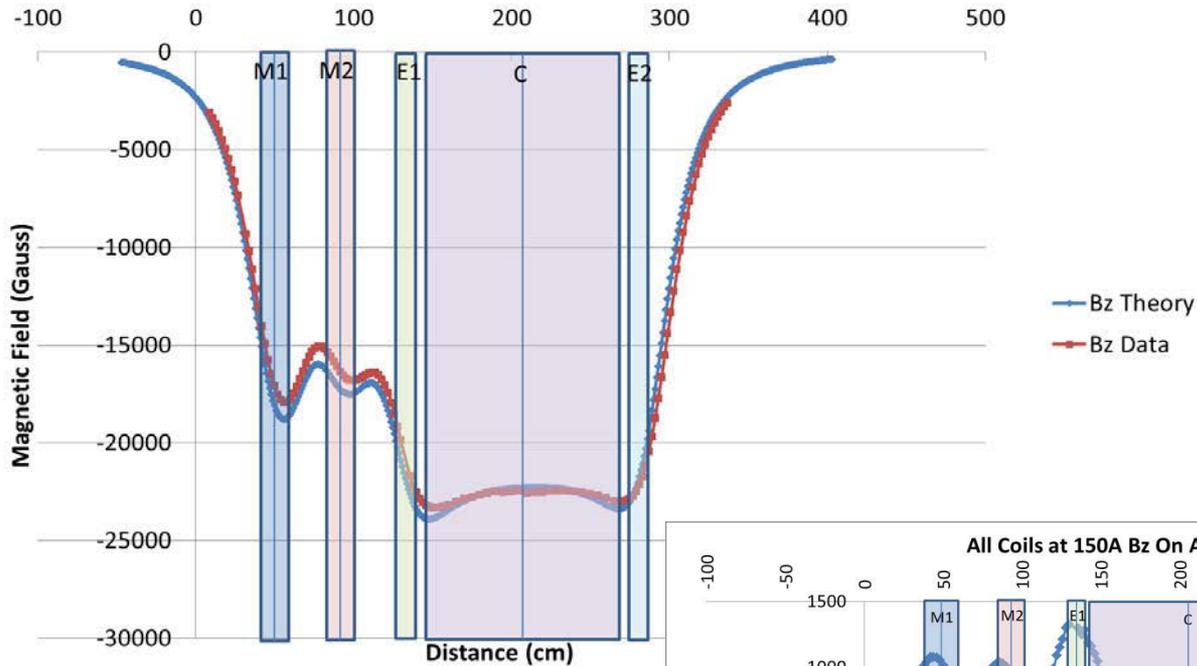


# 50A Measurements

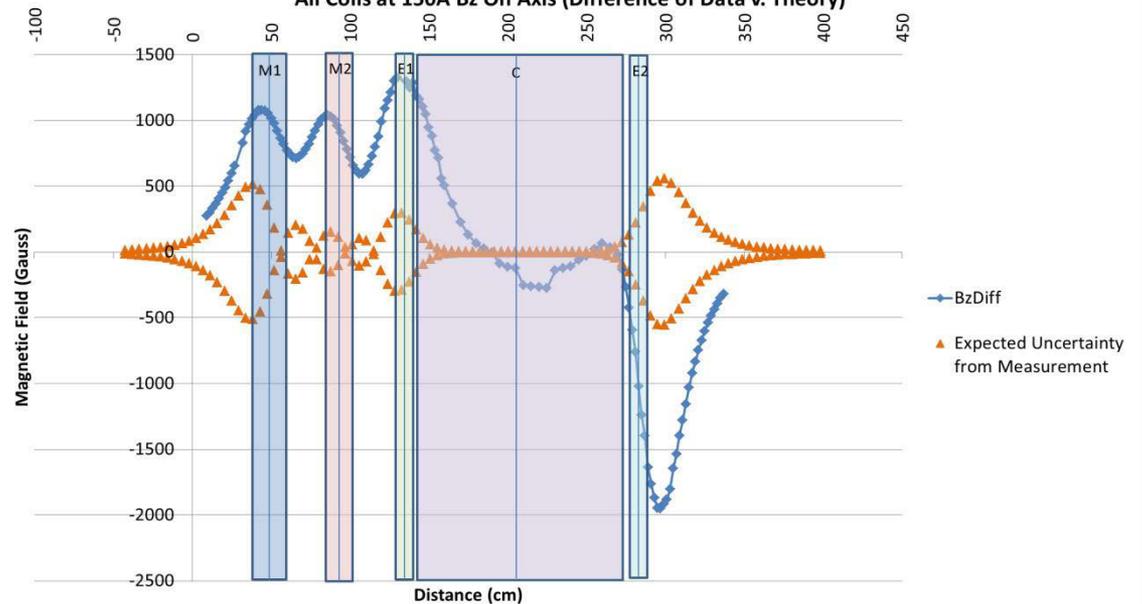


# 150A Measurements

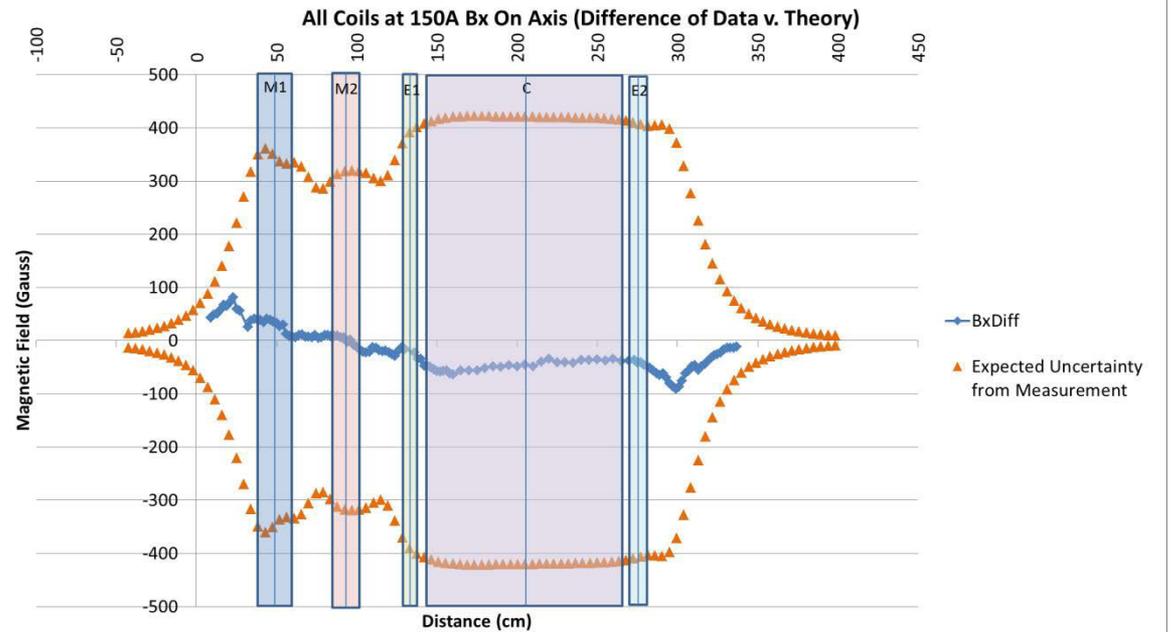
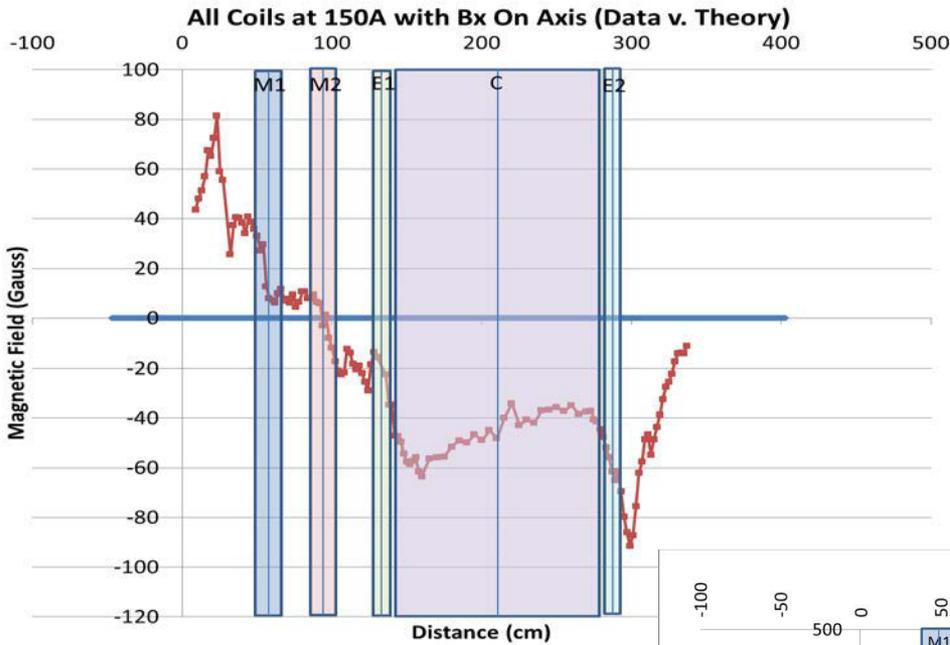
All Coils at 150A with Bz On Axis (Data v. Theory)



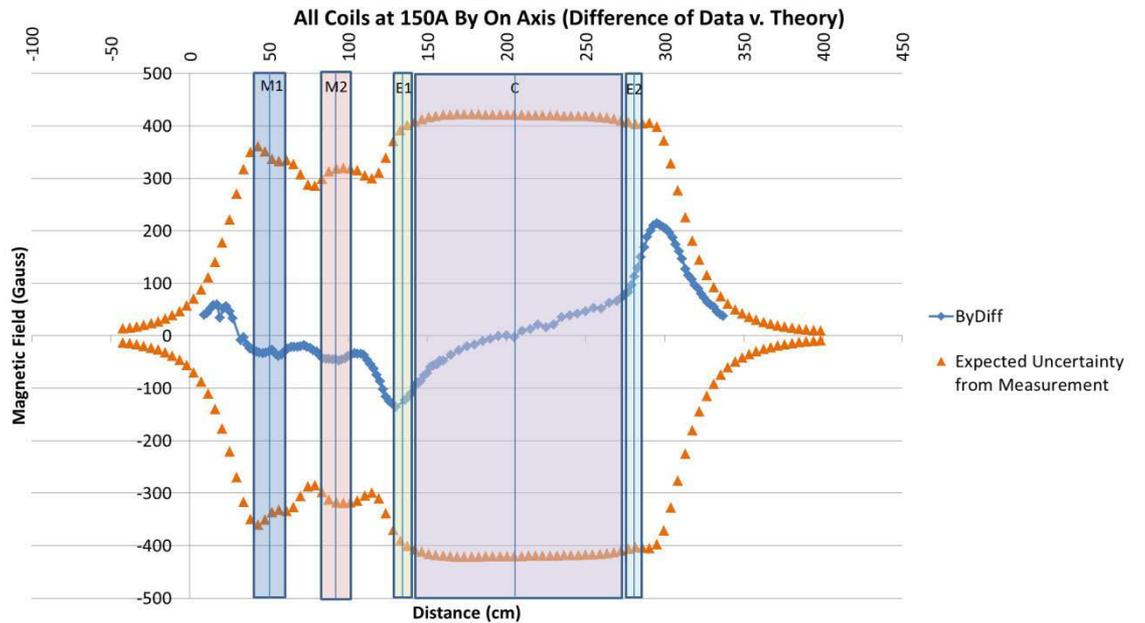
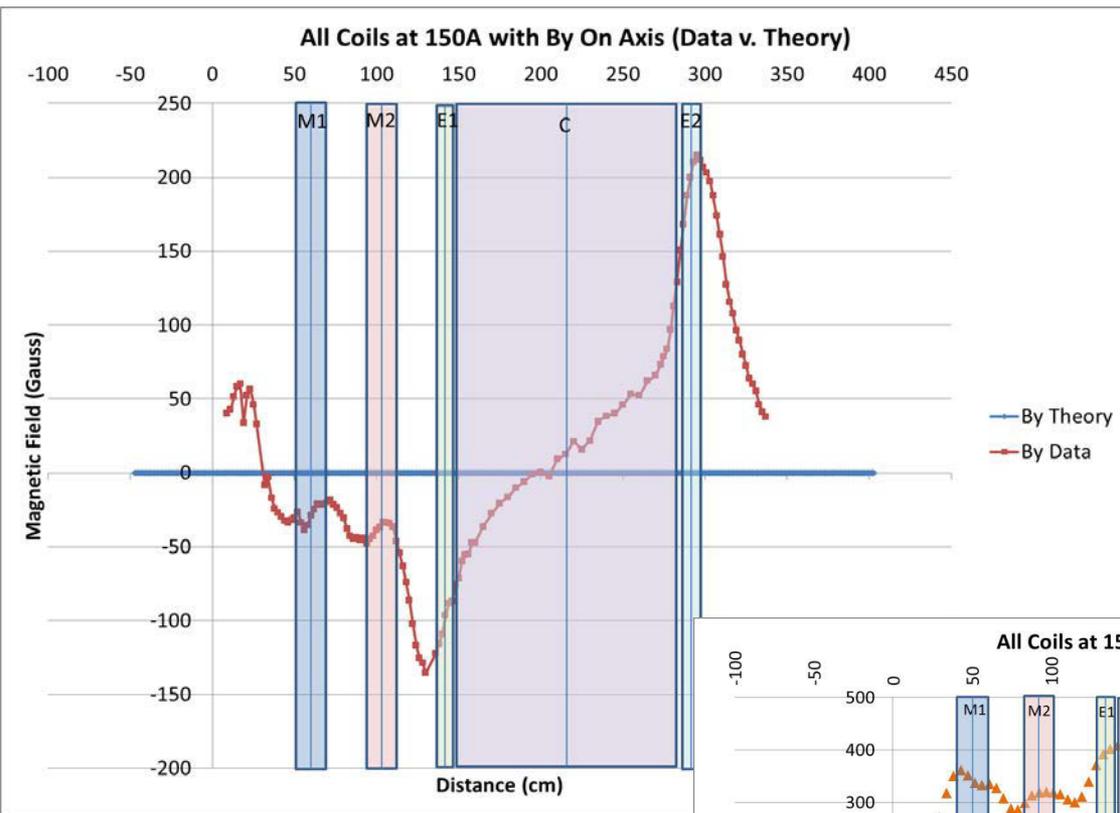
All Coils at 150A Bz On Axis (Difference of Data v. Theory)



# 150A Measurements



# 150A Measurements



# Interpretation of the Data

- ▶ Magnetic field generated by the Matching coils (M1 and M2) and E1 was systematically lower than the prediction from the model.
  - Could indicate problem in power distribution system.
  - Less windings in conductor.
- ▶ Found small discrepancies in the geometric alignment of the coils along the Z axis.

# Summary & Conclusions

- ▶ Generally good agreement between measurement and model.
- ▶ Found no major problems.
- ▶ There is a second, identical Spectrometer Solenoid in the pipe-line that also needs to be verified and measured.
- ▶ Plan is to have the full MICE cooling channel operational at RAL (Rutherford Appleton Laboratory).



# Acknowledgements

- ▶ Marc Buehler
- ▶ Mike Tartaglia
- ▶ Harry Cheung
- ▶ Bjoern Penning
- ▶ TRAC at Fermilab



# Quench!

