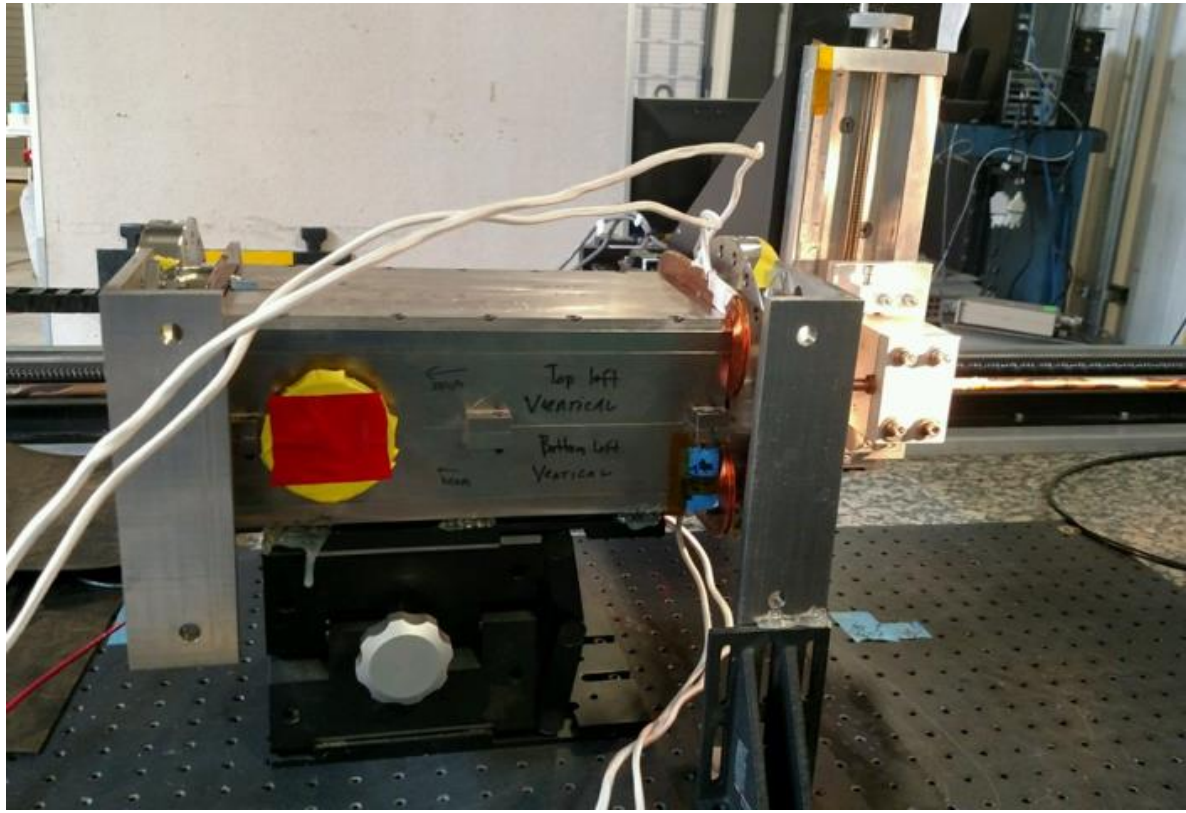
CEBAF Vertical Wien Magnetic Field Map

Results of magnet mapping on November 16, 2020



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Thursday, November 19, 2020

Jefferson Lab

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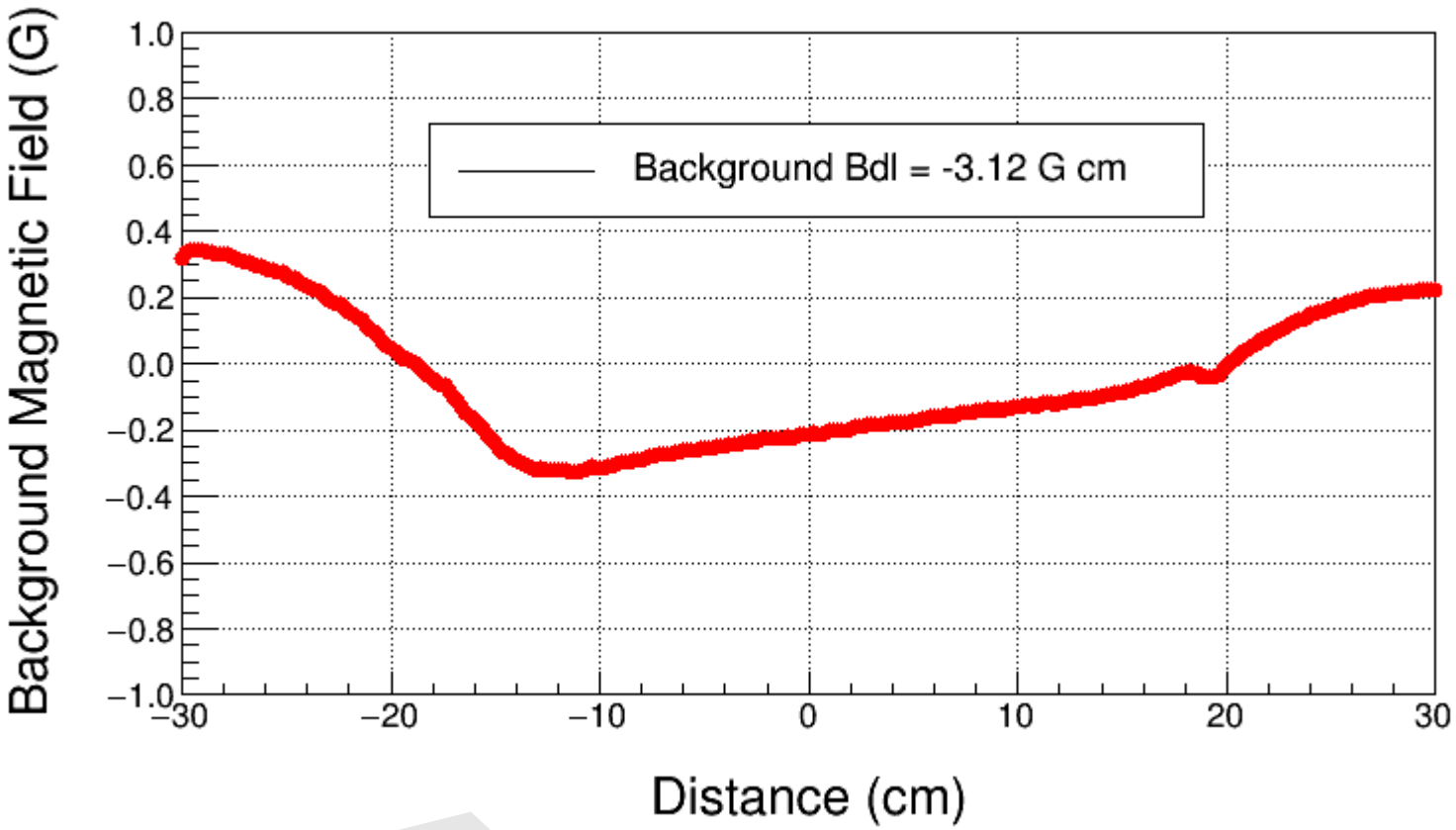
Field Map, No Magnet

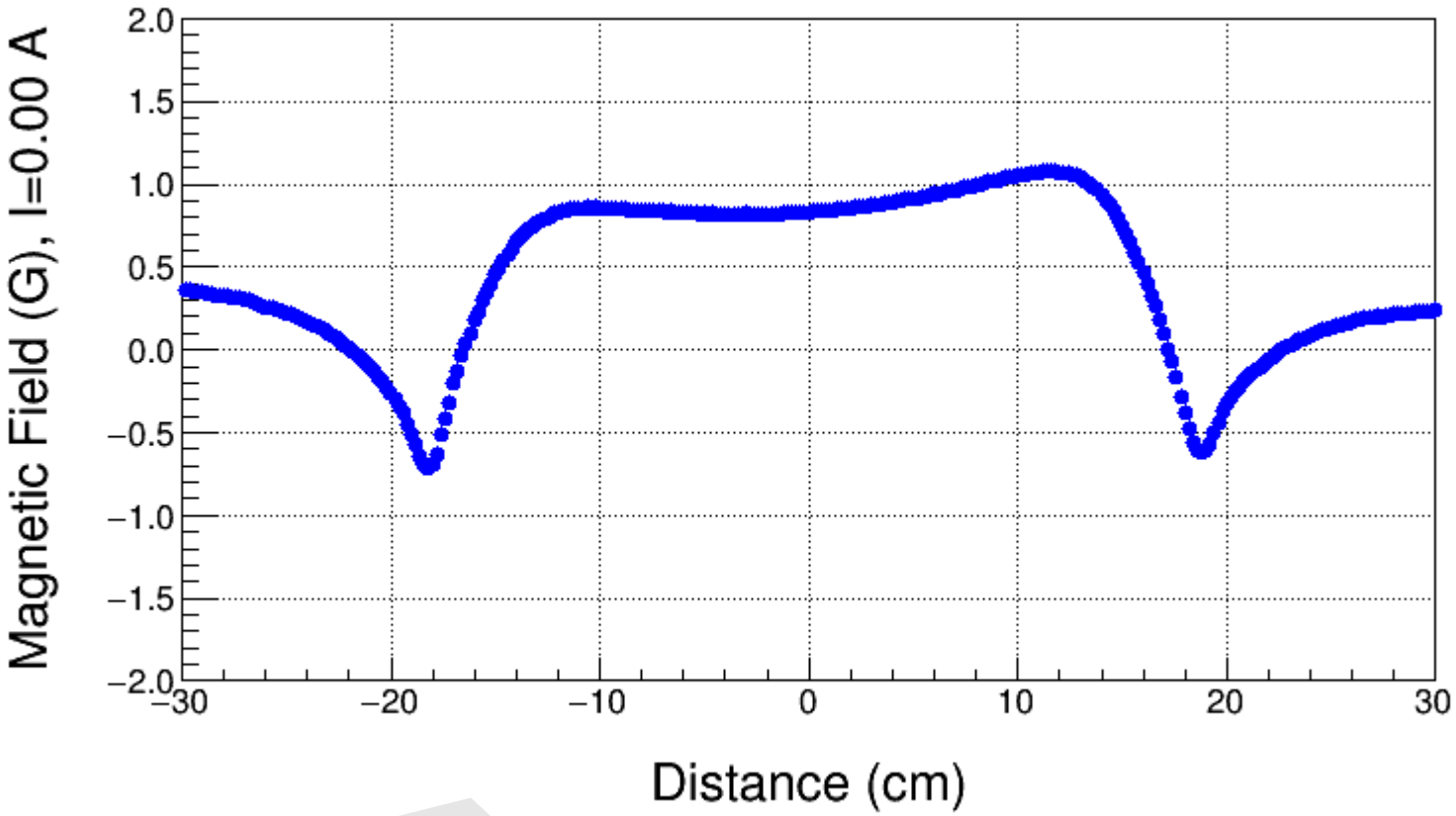
Magnet removed from stand

Field Map, Background



Degaussed, Power Supply OFF

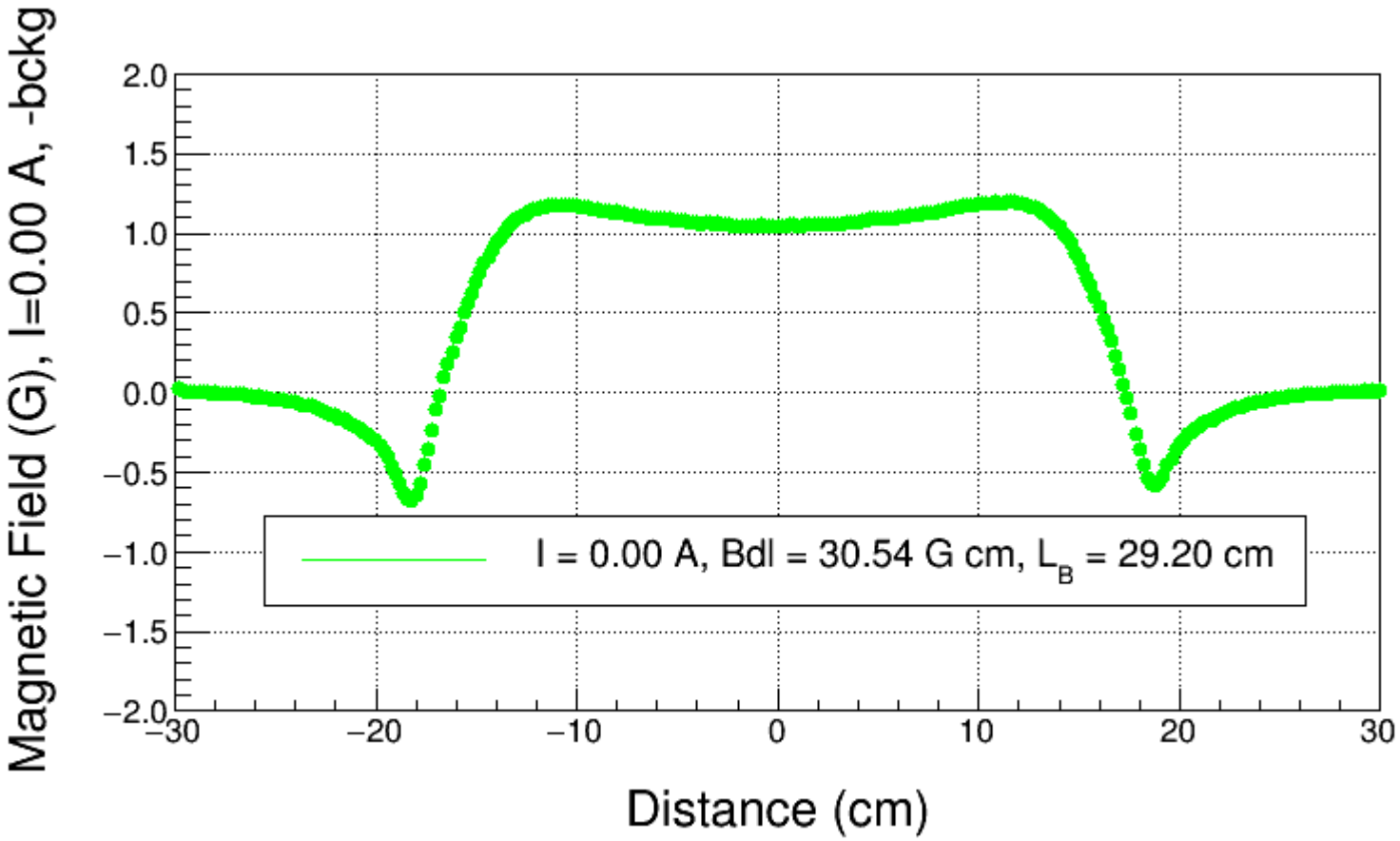
Field Map, I=0.00 A



Hysteresis ±19.9 A

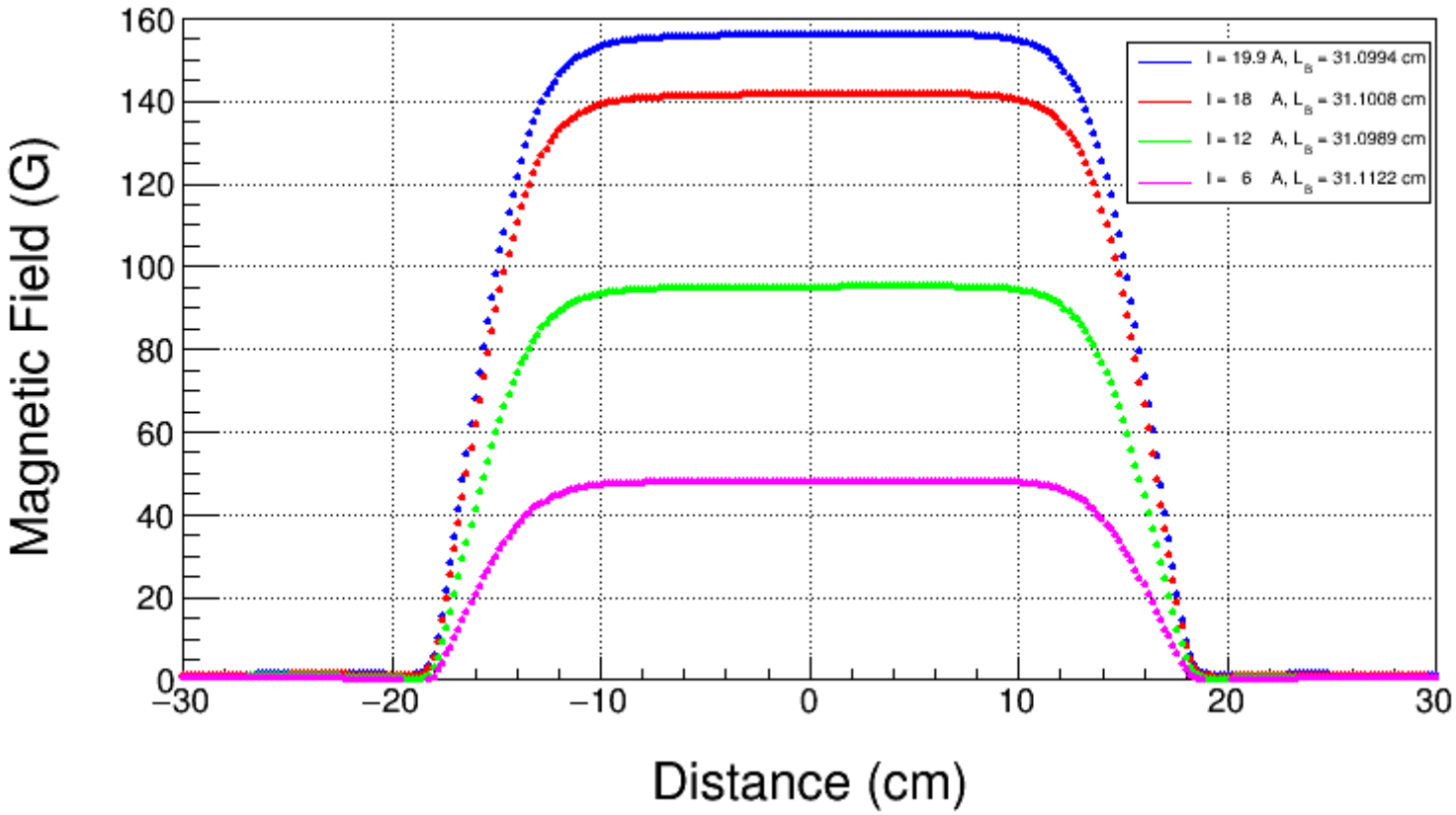
Field Map, I=0.00 A

$$L_B = \frac{\int_{-30\ cm}^{+30\ cm} Bdz}{B_{center}}$$

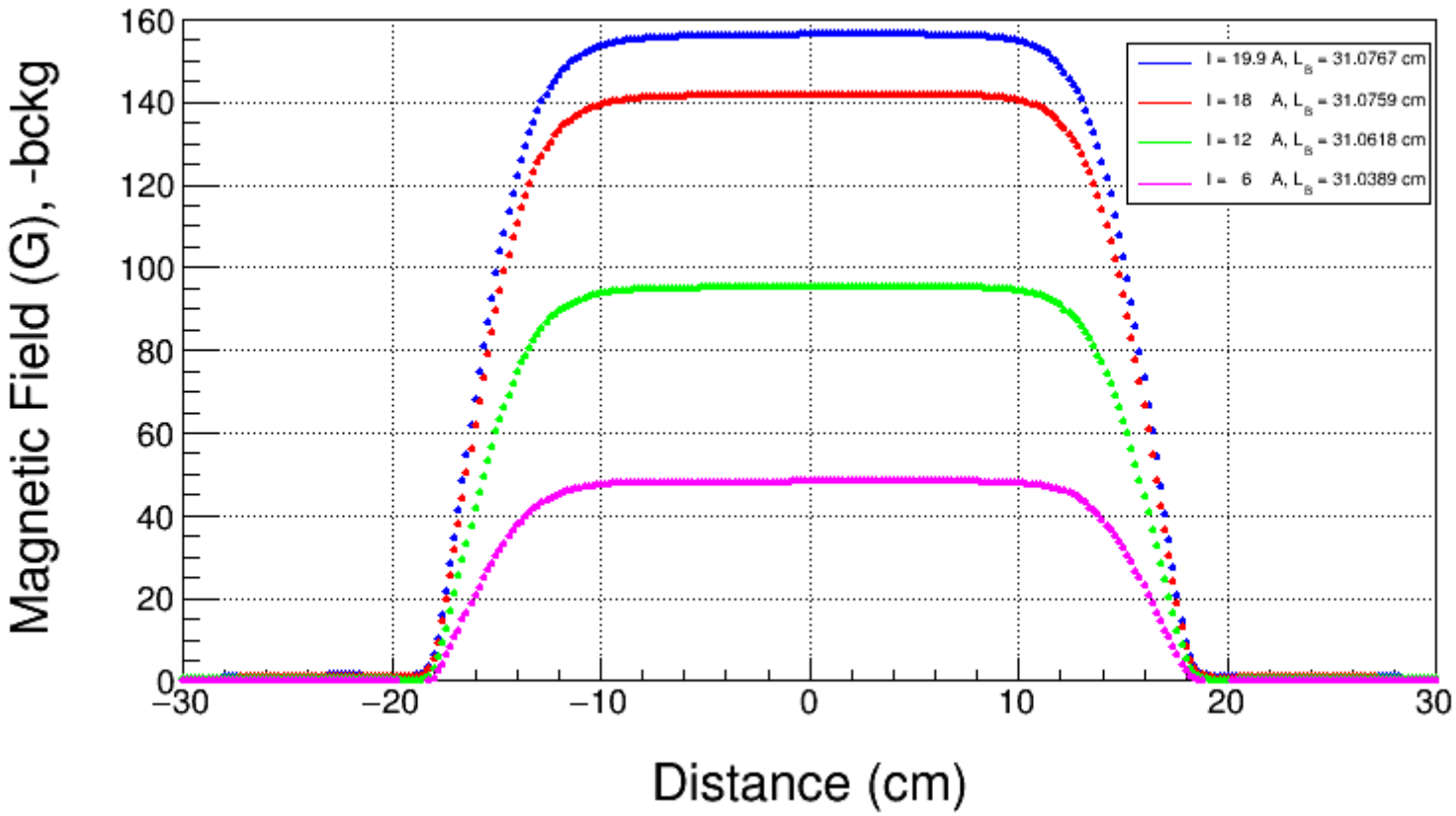


With Background Subtraction

Field Map, No Background Subtraction

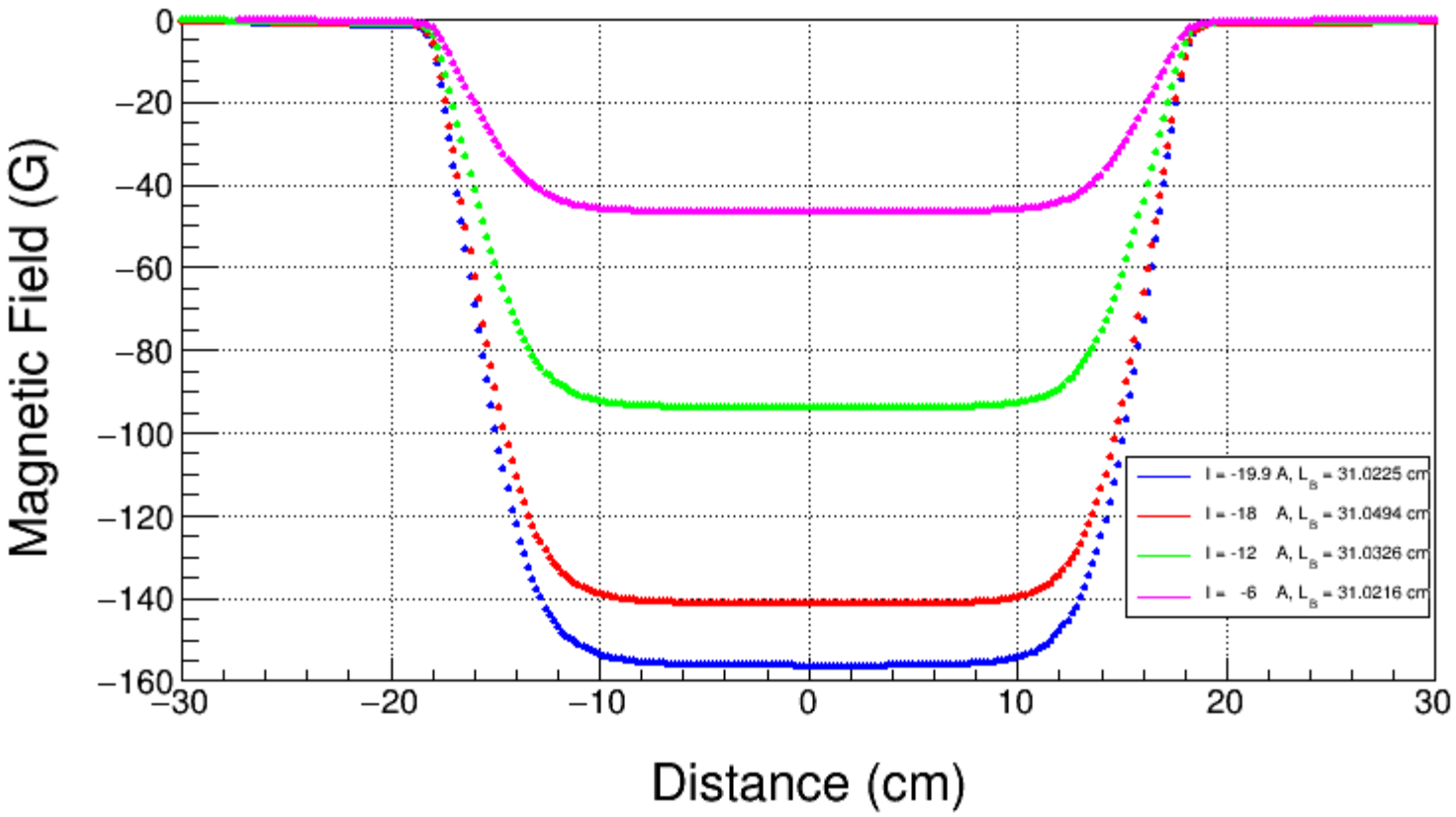


Field Map, with Background Subtraction

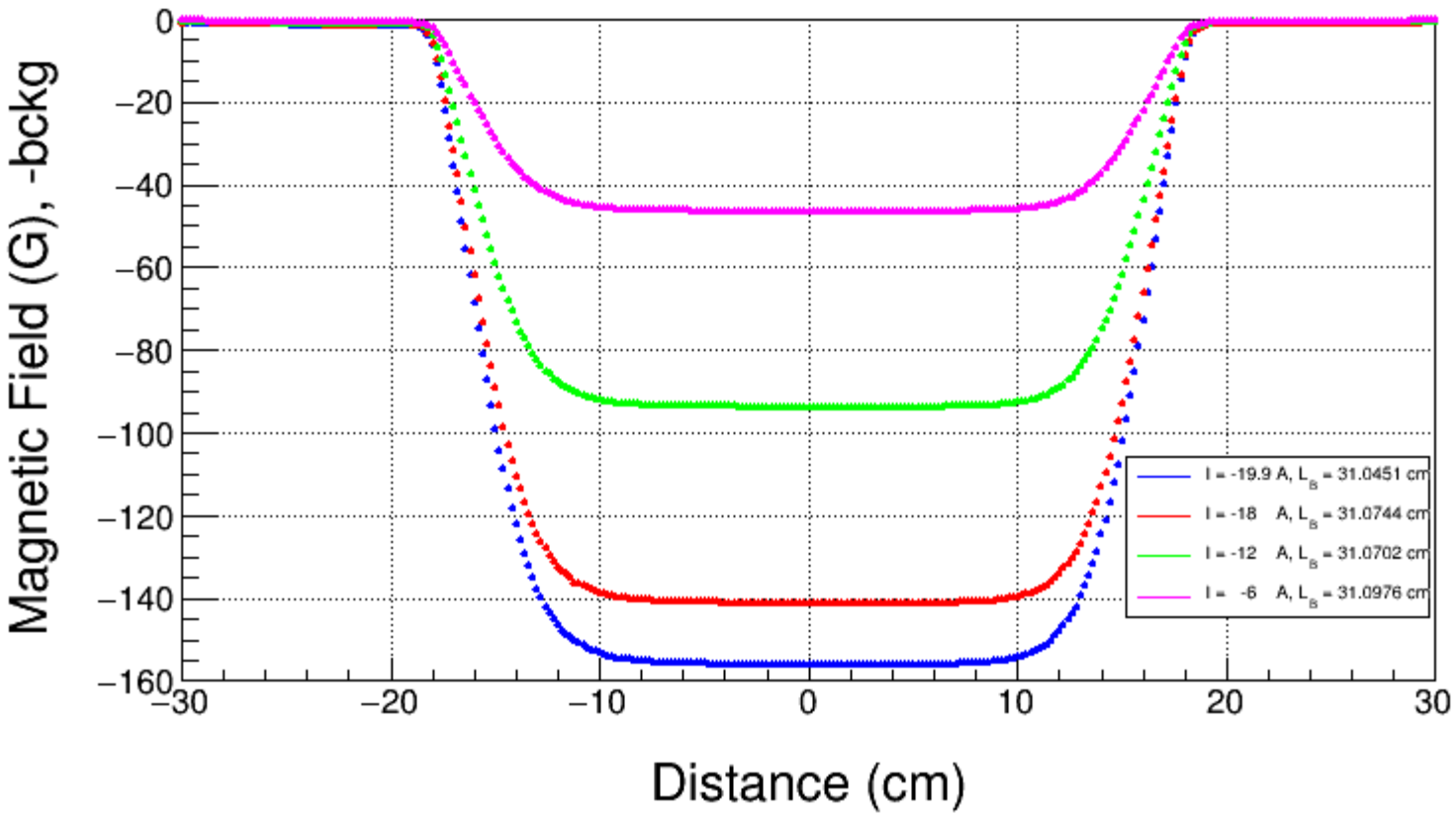


With Background Subtraction

Field Map, No Background Subtraction

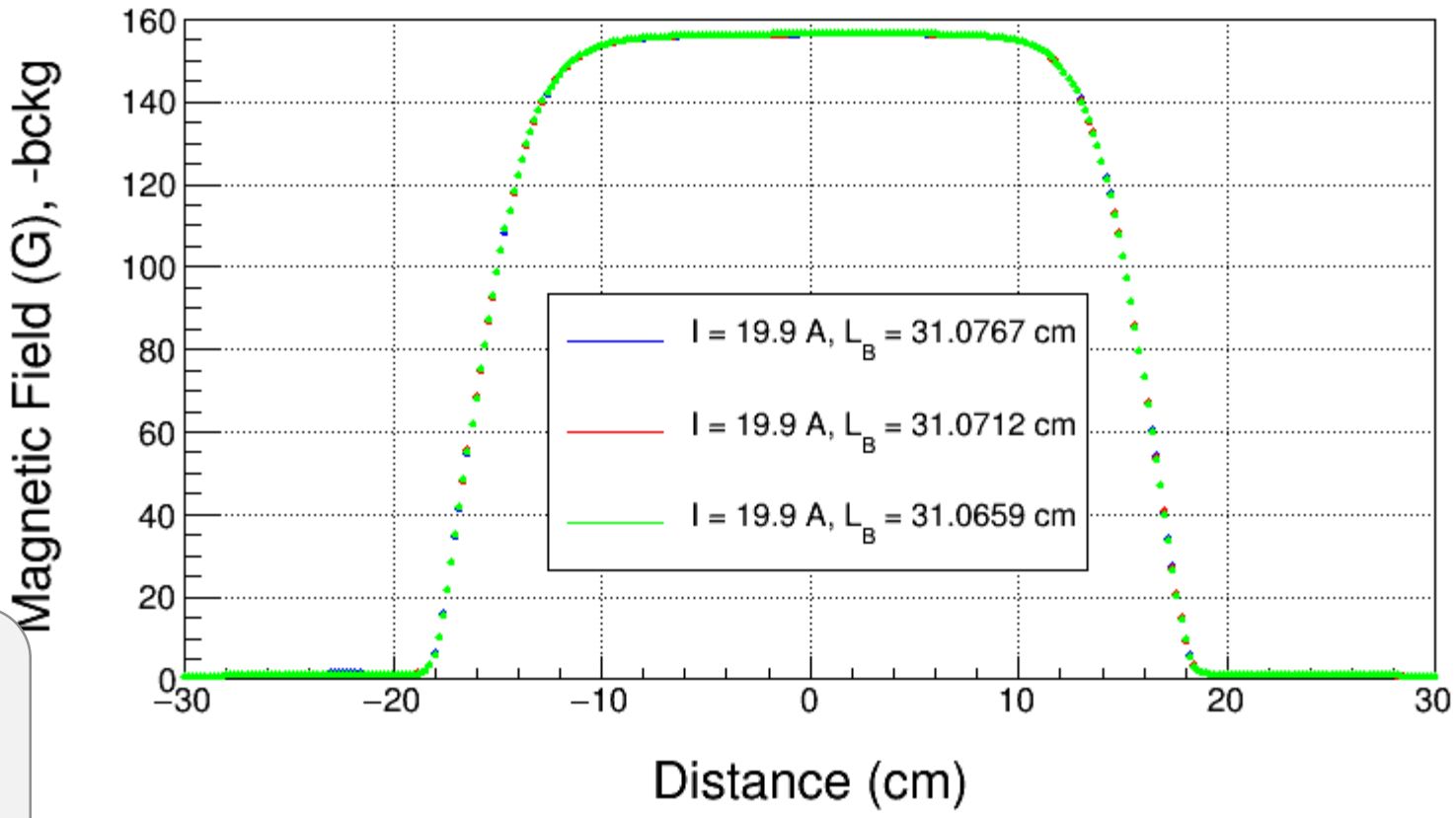


Field Map, with Background Subtraction



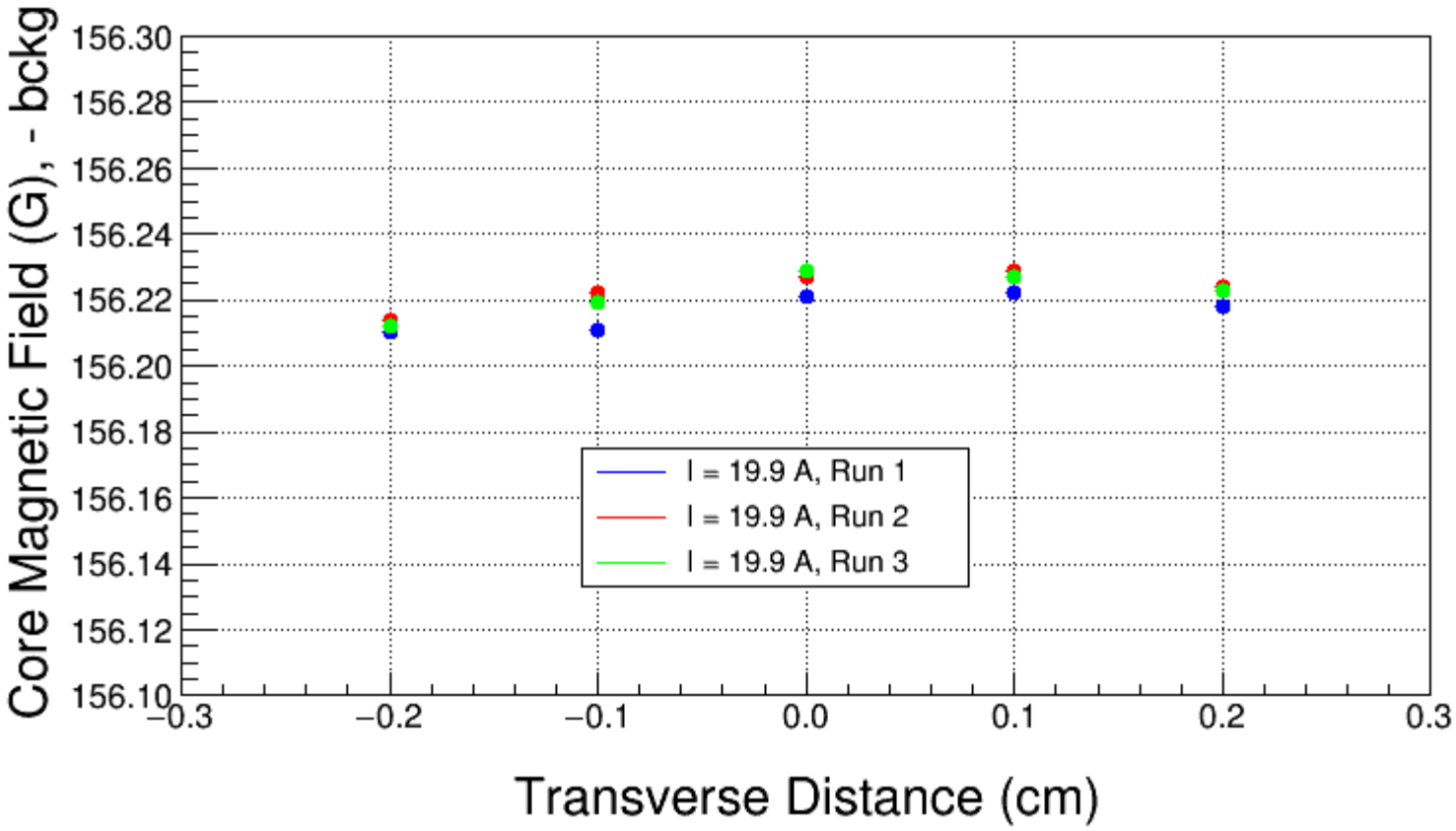
With Background Subtraction

Field Map, 19.9 A, Repeat Measurements



With Background Subtraction

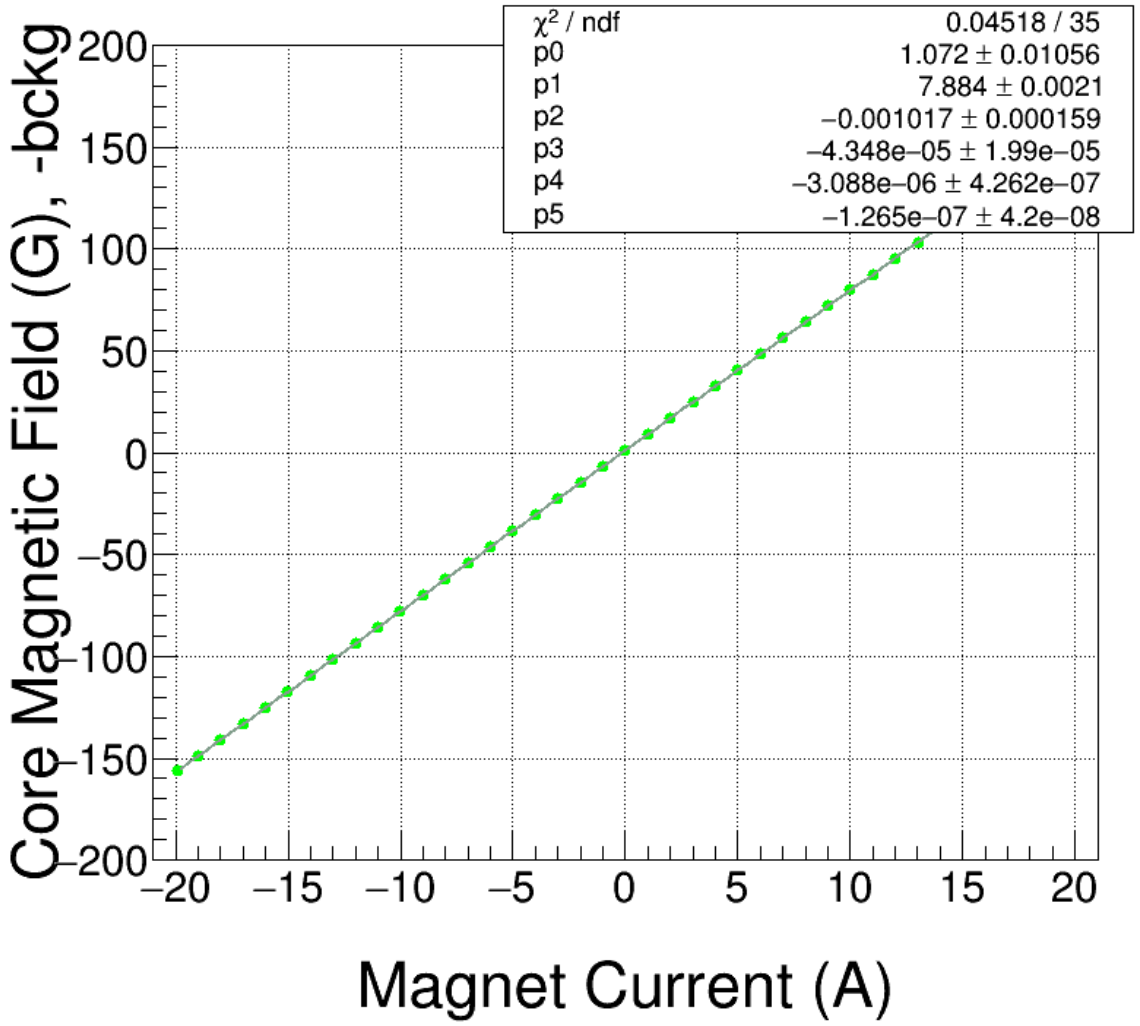
Field Map, 19.9 A, x Transverse



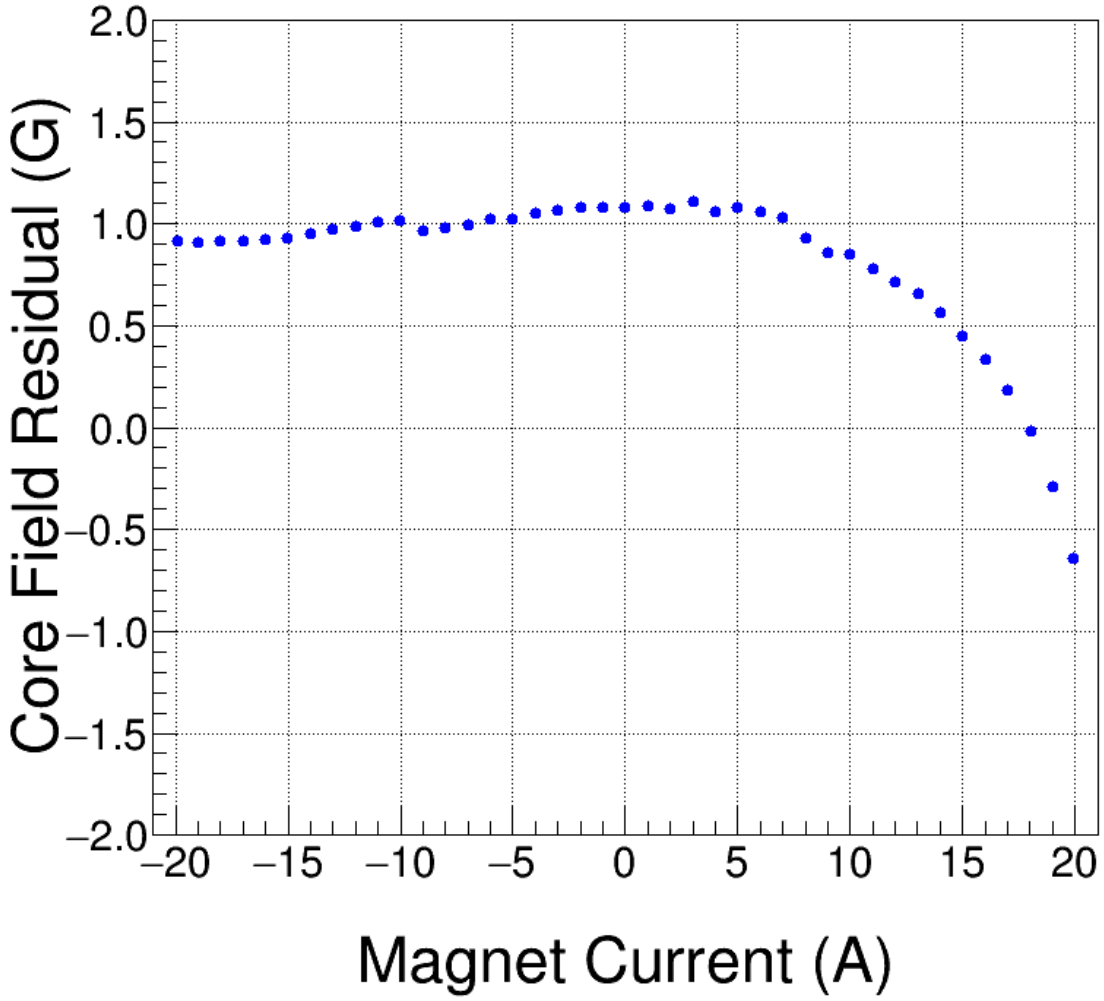
With Background Subtraction

Core (Center) Magnetic Field vs Current

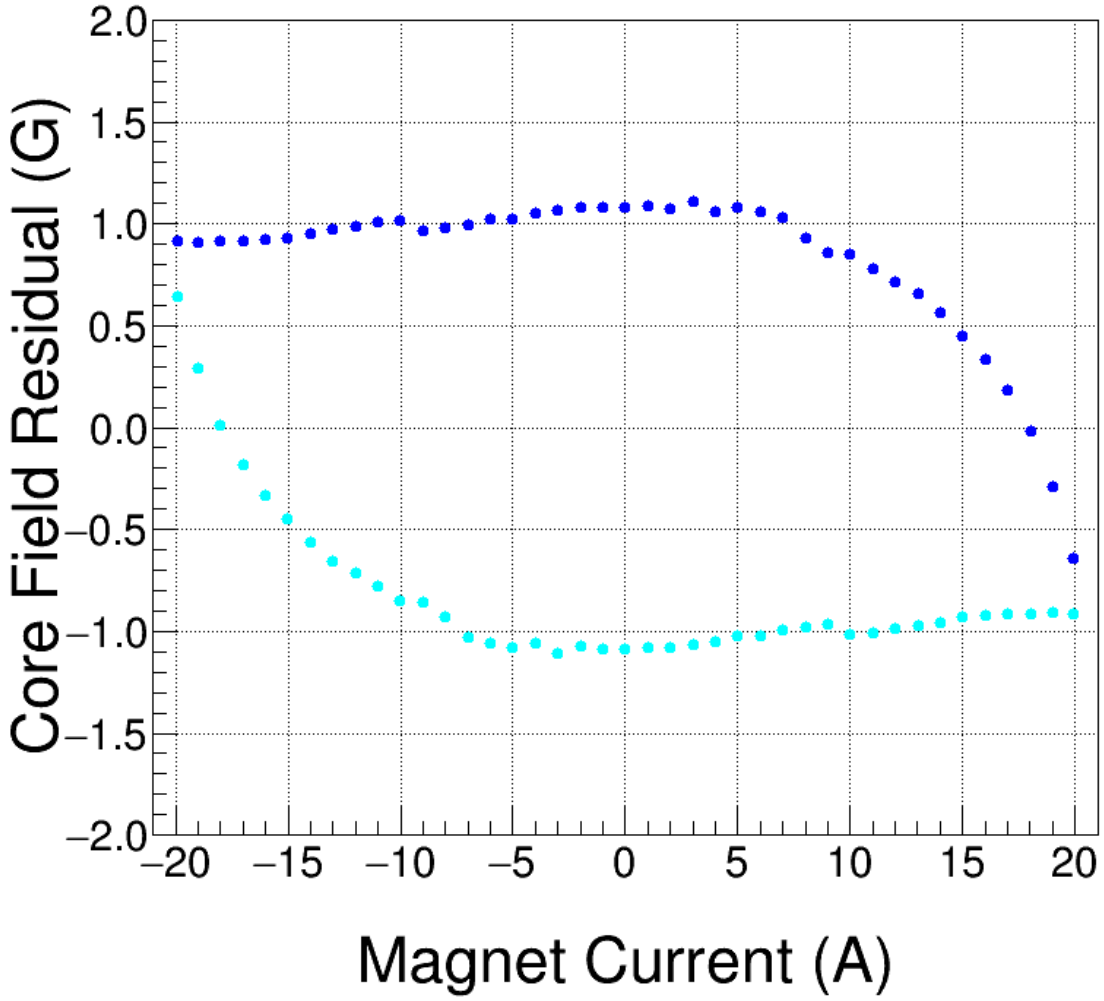
With Background Subtraction



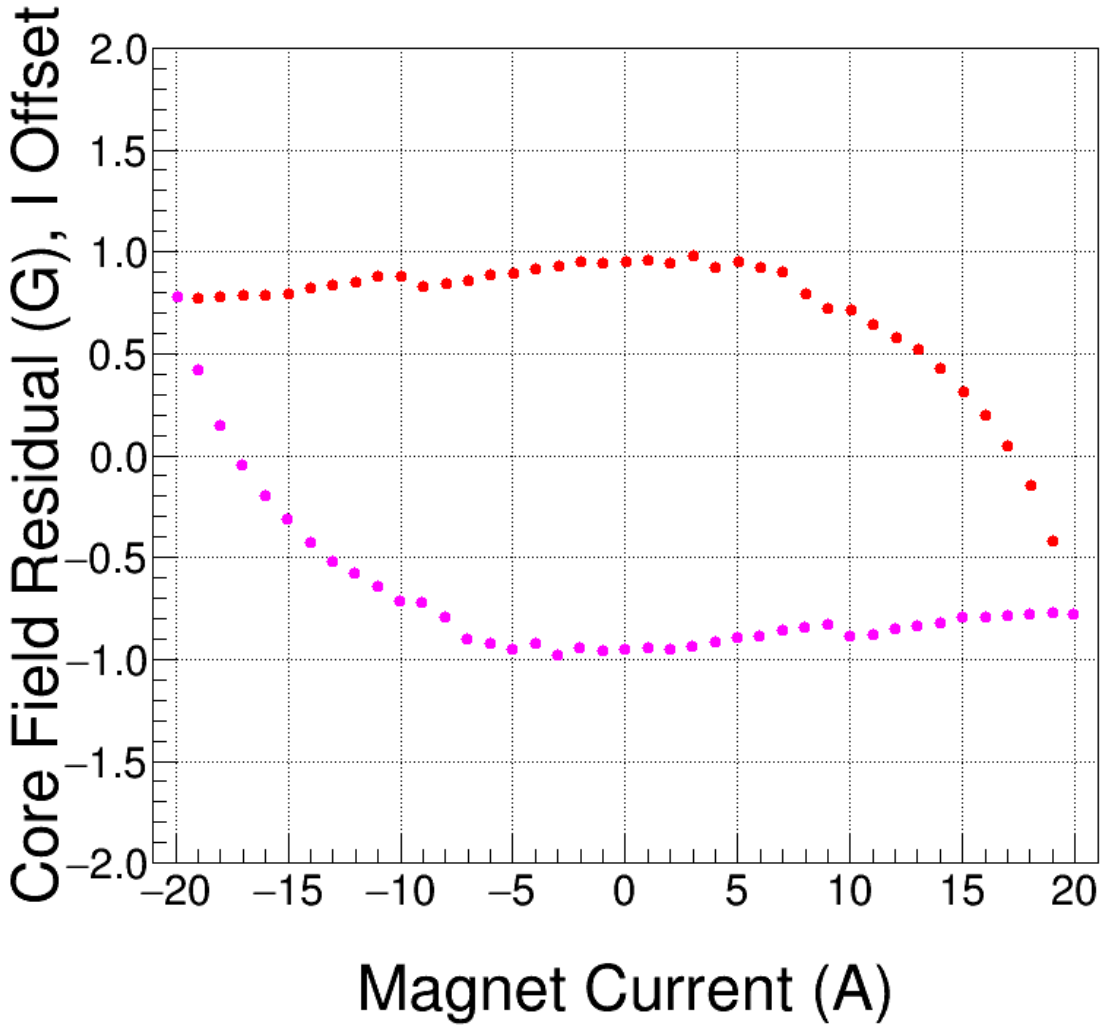
Core Magnetic Field Residuals (B-p1*I)



Hysteresis Loop



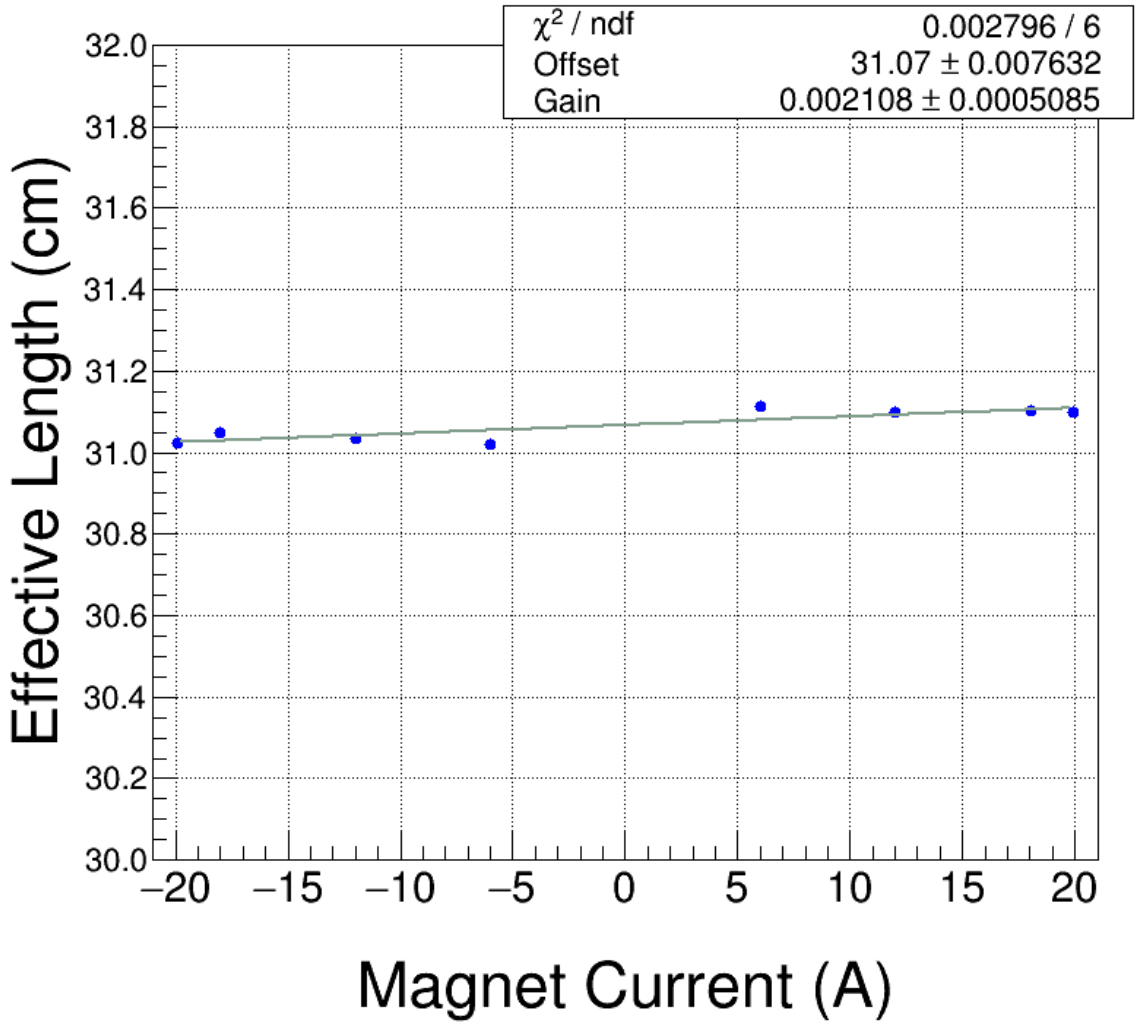
Modified Hysteresis Loop



A second Modification:

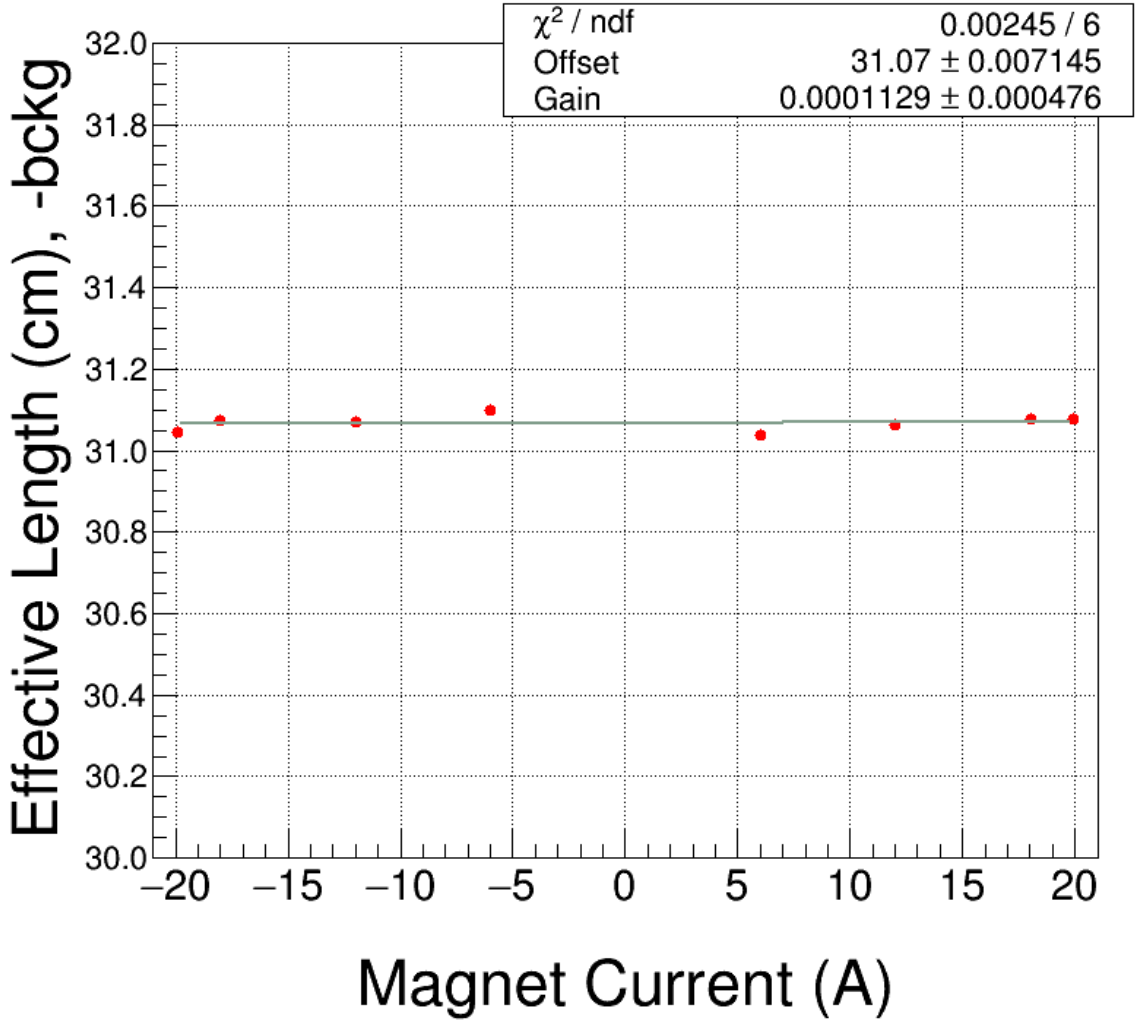
I. subtract -0.017 A offset from Magnet Current

Magnetic Field Effective Length



No Background Subtraction

Magnetic Field Effective Length



With Background Subtraction

Vertical Wien Effective Length = **31.07±0.01 cm**

Vertical Wien Magnetic Field Map

Use B core (center) vs I measurement with these two modifications:

I. Subtract -0.017 A offset from Magnet Current:

$$New\ I = I\ - (-0.017)$$

I. Subtract background core field offset of -0.214 G

II. Use measured effective length to calculate Bdl:

$$New\ Bdl = \left(B\ - (-0.214)\right) \times 31.07$$

Summary

- Vertical Wien field map background of -3.12 G cm is found by mapping degaussed magnet with power supply off
- With background Bdl subtracted, Magnetic Effective Length of 31.07±0.01 cm is now independent of magnet current (Electric Effective Length is 31.20 cm)
- These three measurements are important in understanding field maps:
  I. Magnet at I=0 and on loop
  II. Magnet degaussed with power supply off
  III. Magnet off stand but leaving everything else as is

- Hysteresis loop study of Vertical Wien magnet showed that magnet current during mapping was off by -0.017 A – fix by subtracting this offset from map current
- New Field map was generated

How to calculate power supply current offset

- How to calculate power supply current offset when examining field maps:

1. Start with B (or Bdl) vs I data
2. First, correct first background fields: B = B - bckg
3. Fit with B=a1*I, or B = a0 + a1*I or higher order polynomial (you want the linear coefficient)
4. Calculate hysteresis curve: h= B - a1*I
5. Plot h vs I
6. Calculate opposite hysteresis curve with: neg_h = -h and neg_I = -I
7. Plot neg_h vs neg_I
8. If end-points do not overlap then there is a current offset
9. Guess an offset, re-calculate I as: I = I - CurrentOffset
10. Re-calculate h as: h = B - a1*(I - CurrentOffset)
11. Re-calculate neg_I as: neg_I = -I
12. Re-calculate neg_h as: neg_h =-h
13. Repeat for few values of current offset, till there is overlap at end-point currents