

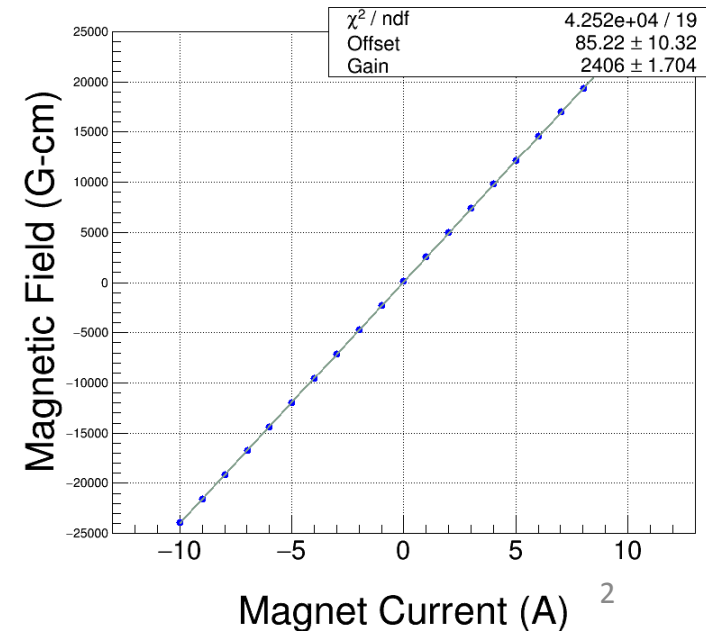
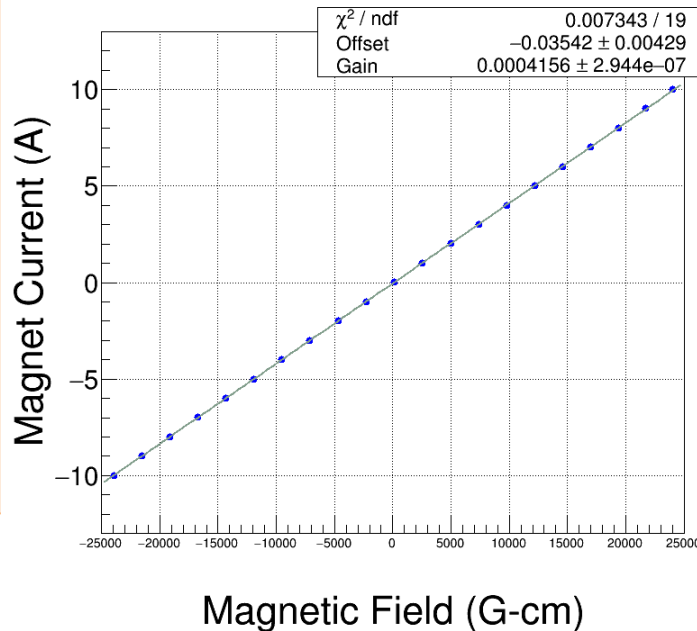
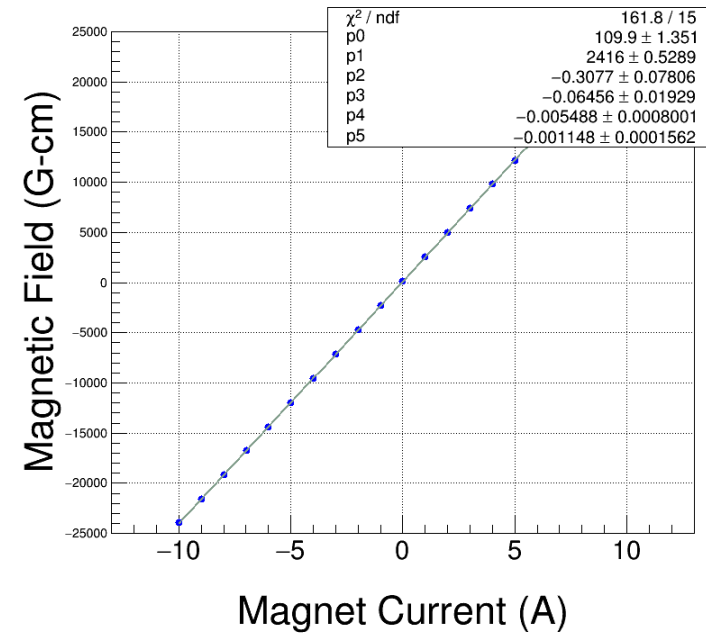
MDL0L02 Dipole Field

July 6, 2016

Field Map

Meas. Date: 8/29/2014
 Coil used: Hall Probe Stepper
 Current (A) Strength (Gauss-cm)

-9.992	-23944.2
-8.996	-21569.6
-7.991	-19169.0
-6.990	-16769.5
-5.990	-14360.7
-4.993	-11954.6
-3.994	-9542.8
-2.989	-7116.1
-1.989	-4698.2
-0.990	-2283.6
0.003	126.0
1.009	2548.4
2.009	4960.8
3.009	7374.6
4.010	9785.8
5.010	12192.0
6.010	14589.8
7.011	16980.4
8.013	19360.4
9.015	21720.5
10.014	24038.1



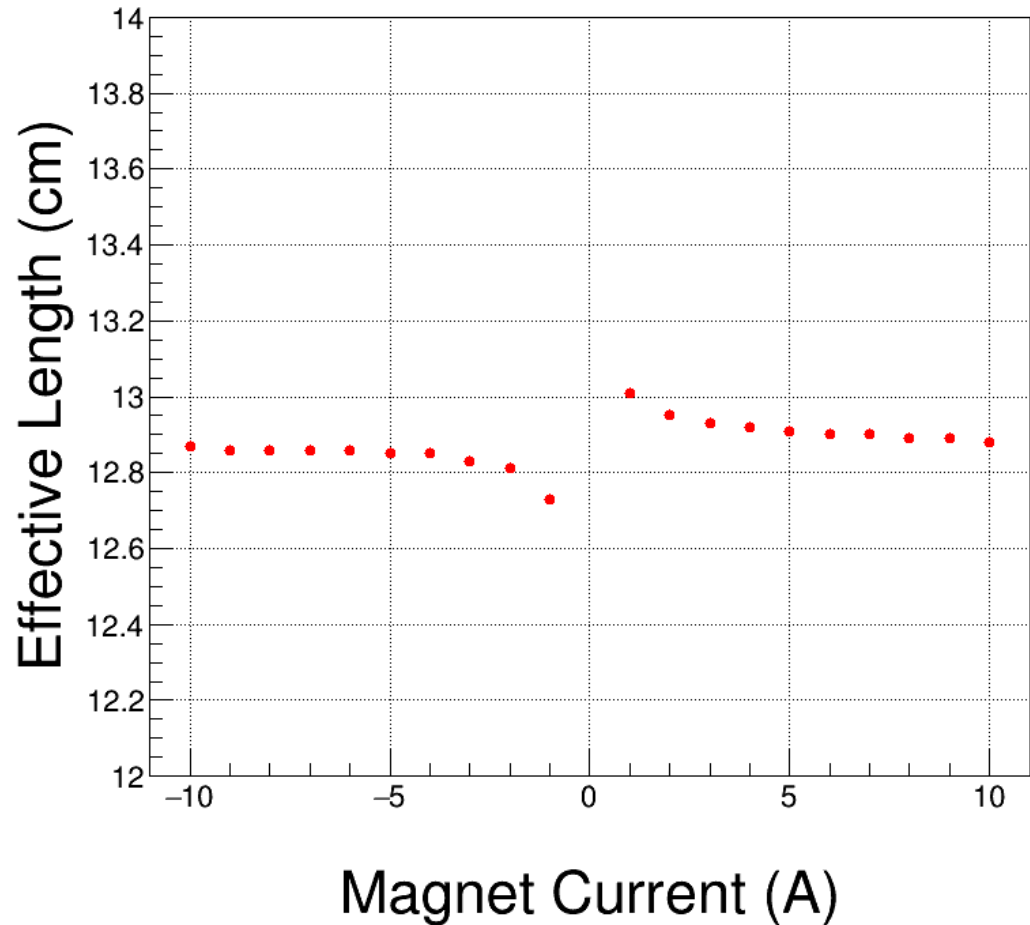
Field Map Effective Length

Meas. Date: 8/29/2014

Coil used: Hall Probe Stepper

Current (A) Eff. L (cm)

10.00	12.88
9.00	12.89
8.00	12.89
7.00	12.90
6.00	12.90
5.00	12.91
4.00	12.92
3.00	12.93
2.00	12.95
1.00	13.01
0.00	16.39
-1.00	12.73
-2.00	12.81
-3.00	12.83
-4.00	12.85
-5.00	12.85
-6.00	12.86
-7.00	12.86
-8.00	12.86
-9.00	12.86
-10.00	12.87



0 BdL

MDL0L02 Dipole Power Supply

5 MeV Dipole (MDL0L02) Global Dipole Field

	Current Mode	amps	BdL Mode	G-cm
1. CEBAF	<input type="checkbox"/>	-0.0489	<input checked="" type="checkbox"/>	0.000
2. 2D	<input type="checkbox"/>	-4.8966	<input type="checkbox"/>	-11721.869
3. 3D	<input type="checkbox"/>	-1.6644	<input type="checkbox"/>	-3962.000
4. 5D	<input type="checkbox"/>	3.7128	<input type="checkbox"/>	9070.000

Trim Expert Rack

Keep Magnet On Loop ON OFF

Degauss Magnet:

MPT-231 Hall Probe **-3.60 G**

Setpoint and Readback

setpoint	-0.0489	amps
readback	-0.0497	amps

Mismatch Assumed Offloop Ramping

Equations Dealing with BdL and Momentum

2 D Line: $\theta = -30^\circ$	$BdL[G - cm] = -1673 \times \rho \left[\frac{MeV}{c} \right]$
3 D Line: $\theta = -12.5^\circ$	$BdL[G - cm] = -722 \times \rho \left[\frac{MeV}{c} \right]$
5 D Line: $\theta = 25^\circ$	$BdL[G - cm] = 1412 \times \rho \left[\frac{MeV}{c} \right]$

DTM 151 Digital Teslameter

MPT-231 Field **-3.59** Gauss MPT-231 Spec

Temperature **21.8** C

Field Mode AC DC DC

AC Peak Field **0.00**

Range Select Gauss

Calibrate (current range)

Zero (current range)

Digital Filtering

Filter Factor (0 - 65534) **0.0**

Window (0 - 65534) **0.0**

Command

Processor

Factory defaults

Dipole Survey (March 20, 2016)

On Hysteresis

$I = -0.0489 \text{ A}$

$BdL = 0.000 \text{ G-cm}$

Hall Probe = -3.98 G^*

Zero is center of dipole and survey was done along 0L Region using a hand-held Hall probe

***Accuracy: $\pm(0.03\%$ of reading $+0.006\%$ of full scale) max**

Hall Probe = $-3.98 \text{ G} \pm 0.18 \text{ G}$

Distance from dipole center (cm)	<By> (G)
(Upstream) -15	0.4
-14	0.4
-13	0.3
-12	0.3
-11	0.2
-10	0.1
-9	0.0
-8	-0.6
-7	-2.2
-6	-3.7
-5	-3.9
-4	-4.1
-3	-3.9
-2	-4.2
-1	-3.9
0	-3.8
1	-3.9
2	-3.9
3	-4.0
4	-3.8
5	-3.9
6	-2.1
7	-0.6
8	0.0
9	0.1
10	0.3
11	0.6
12	0.6
13	0.6
14	0.6
(Downstream) 15	0.6

0 Current

MDL0L02 Dipole Power Supply

5 MeV Dipole (MDL0L02) **Global Dipole Field**

Current Mode BDL Mode

1. **CEBAF** amps G-cm

2. **2D** amps G-cm

3. **3D** amps G-cm

4. **5D** amps G-cm

Trim Expert Rack

Keep Magnet On Loop

DTM 151

Setpoint and Readback

setpoint	0.0000	amps
readback	-0.0006	amps

Mismatch Assumed Offloop Ramping

Degauss Magnet:

MPT-231 Hall Probe G

Equations Dealing with Bdl and Momentum

2 D Line: $\theta = -30^\circ$	$BdL [G - cm] = -1673 \times \rho \left[\frac{MeV}{c} \right]$
3 D Line: $\theta = -12.5^\circ$	$BdL [G - cm] = -722 \times \rho \left[\frac{MeV}{c} \right]$
5 D Line: $\theta = 25^\circ$	$BdL [G - cm] = 1412 \times \rho \left[\frac{MeV}{c} \right]$

DTM 151 Digital Teslameter

MPT-231 Field Gauss MPT-231 Spec

Temperature C

Field Mode AC DC DC

AC Peak Field

Range Select 300 600 1200 3000 Gauss

Calibrate (current range)

Zero (current range)

Digital Filtering Off On

Filter Factor (0 - 65534)

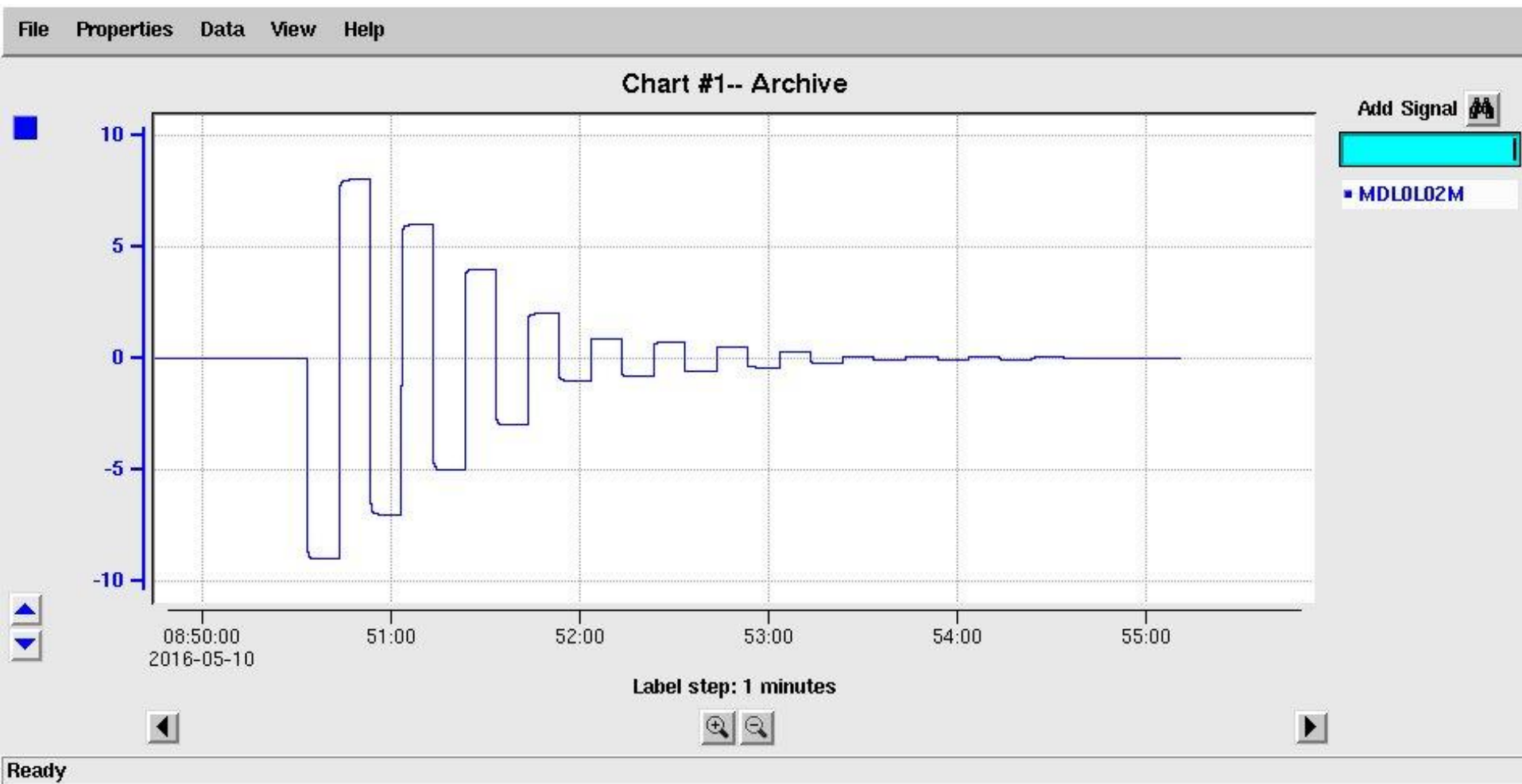
Window (0 - 65534)

Command

Processor

Factory defaults

Degaussed



Degaussed

MDL0L02 Dipole Power Supply

5 MeV Dipole (MDL0L02) **Global Dipole Field**

Current Mode BDL Mode

1. **CEBAF** 0.0000 amps 118.720 G-cm

2. **2D** -4.8966 amps -11721.869 G-cm

3. **3D** -1.6644 amps -3962.000 G-cm

4. **5D** 3.7128 amps 9070.000 G-cm

Trim Expert Rack Keep Magnet On Loop

Setpoint and Readback

setpoint	0.0000	amps
readback	-0.0006	amps

Mismatch Assumed Offloop Ramping

Degauss Magnet: MPT-231 Hall Probe **0.84 G**

Equations Dealing with Bdl and Momentum

2 D Line: $\theta = -30^\circ$	$BdL [G - cm] = -1673 \times \rho \left[\frac{MeV}{c} \right]$
3 D Line: $\theta = -12.5^\circ$	$BdL [G - cm] = -722 \times \rho \left[\frac{MeV}{c} \right]$
5 D Line: $\theta = 25^\circ$	$BdL [G - cm] = 1412 \times \rho \left[\frac{MeV}{c} \right]$

DTM 151 Digital Teslameter

MPT-231 Field **0.84** Gauss MPT-231 Spec

Temperature **21.9** C

Field Mode **AC** **DC** **DC**

AC Peak Field **Get** **0.00** **Reset**

Range Select **300** **600** **1200** **3000** Gauss

Calibrate **0.00** **Erase** (current range)

Zero **Set** **Erase** **0.000** (current range)

Digital Filtering **Off** **On**

Filter Factor **0** (0 - 65534) **Get** **0.0**

Window **0** (0 - 65534) **Get** **0.0**

Command

Processor **Reset**

Factory defaults **Load** DTM-151 Manual

Test at Magnet (March 15, 2016)

- I. With cables from trim card swapped at magnet (after degaussing), Hall Probe = -0.26 G
- II. With current cables disconnected, Hall Probe = -0.06 G
- III. With cables back to normal at magnet (after degaussing), Hall Probe = +0.50 G
- IV. With current set to zero and magnet degaussed, the Hall Probe measures +0.5 G. At this setting, we measured about +1.3 mA of current to magnet using KEITHLEY DMM7510 in series with MDL0L02.

Use KEITHLEY DMM7510
in series with MDL0L02 to
measure current
powering magnet

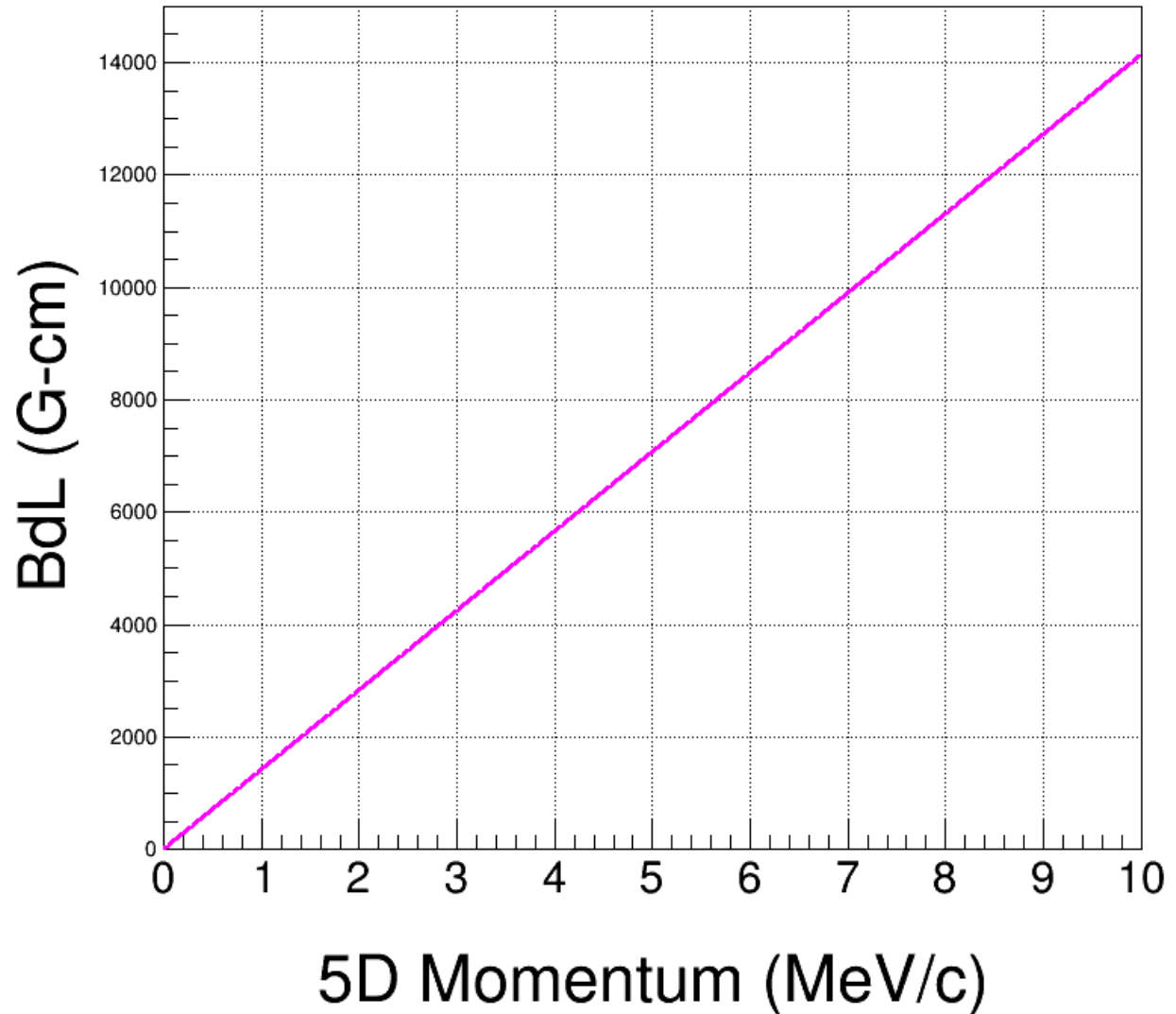
- For Bubble Chamber, we are especially interested in momenta around 5.5 MeV/c (fluorine measurement) and 8.5 MeV/c (oxygen measurement)
- Corresponding magnet currents are 3.2 A and 5.0 A. At these currents, Trim card is good to about 1 to 2 mA.

Trim Card Set Current	DMM Measured Current
0.0	+0.0011
1.0	1.0008
2.0	2.0002
3.0	3.0010
4.0	4.0009
5.0	5.0014
6.0	6.0014
7.0	7.0018
8.0	8.0034
9.0	9.0042
9.0	9.0044
8.0	8.0044
7.0	7.0034
6.0	6.0030
5.0	5.0030
4.0	4.0025
3.0	3.0024
2.0	2.0013
1.0	1.0009
0.0	+0.0016
-1.0	-0.9984
-2.0	-1.9985
-3.0	-2.9992
-4.0	-3.9988
-5.0	-4.9986
-6.0	-5.9982
-7.0	-6.9980
-8.0	-7.9987
-9.0	-8.9986
0.0	+0.0013

Beam Momentum in 5D (opera – Jay)

$$\begin{aligned} \text{BdL} = & -4.811 + \\ & 1416.2 * p - \\ & 1.2399 * p^2 + \\ & 0.1646 * p^3 - \\ & 0.009795 * p^4 + \\ & 0.00021257 * p^5 \end{aligned}$$

Jay's Tech Note TN-15-017, page 9.



March 20, 2016

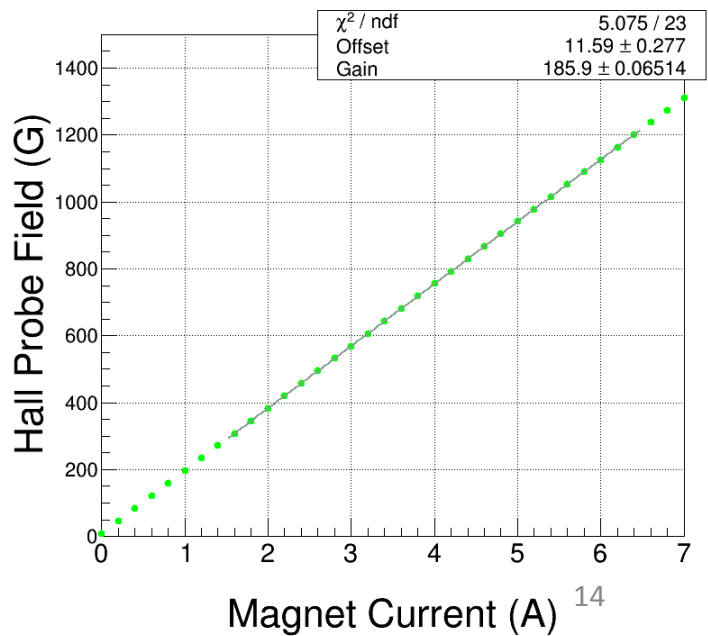
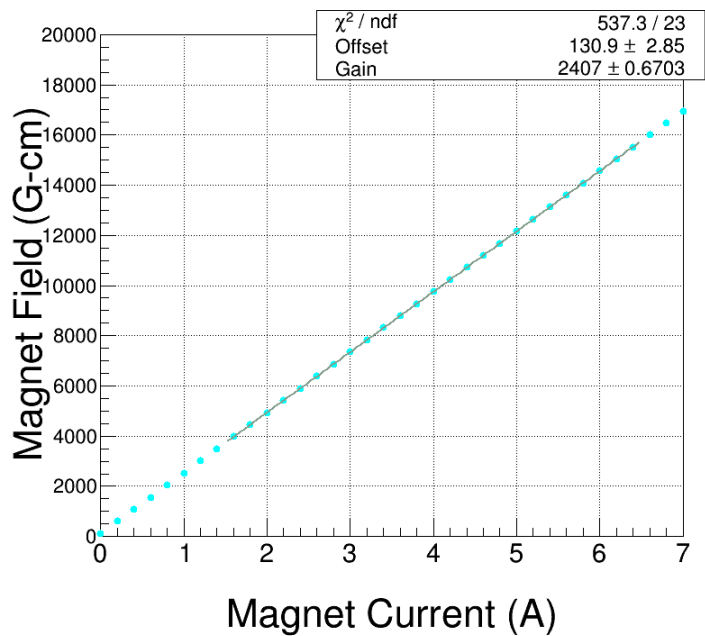
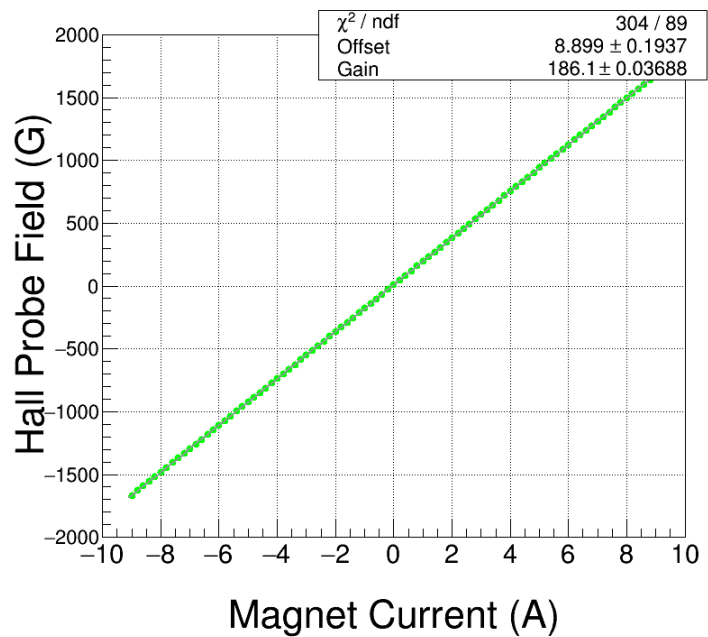
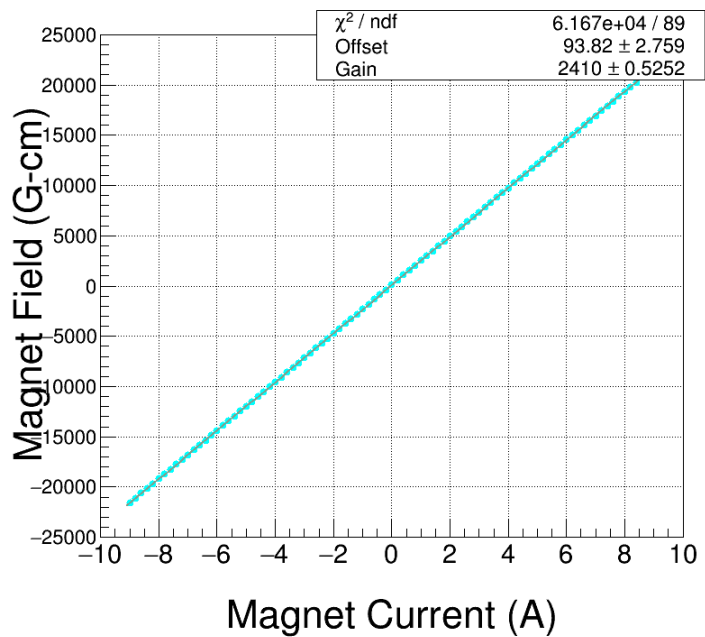
**SCANNED DIPOLE CURRENT FROM
9.0 TO -9.0 A (WITH ON
HYSTERESIS) AND RECORDED BDL
AND HALL PROBE READINGS**

From Field Map

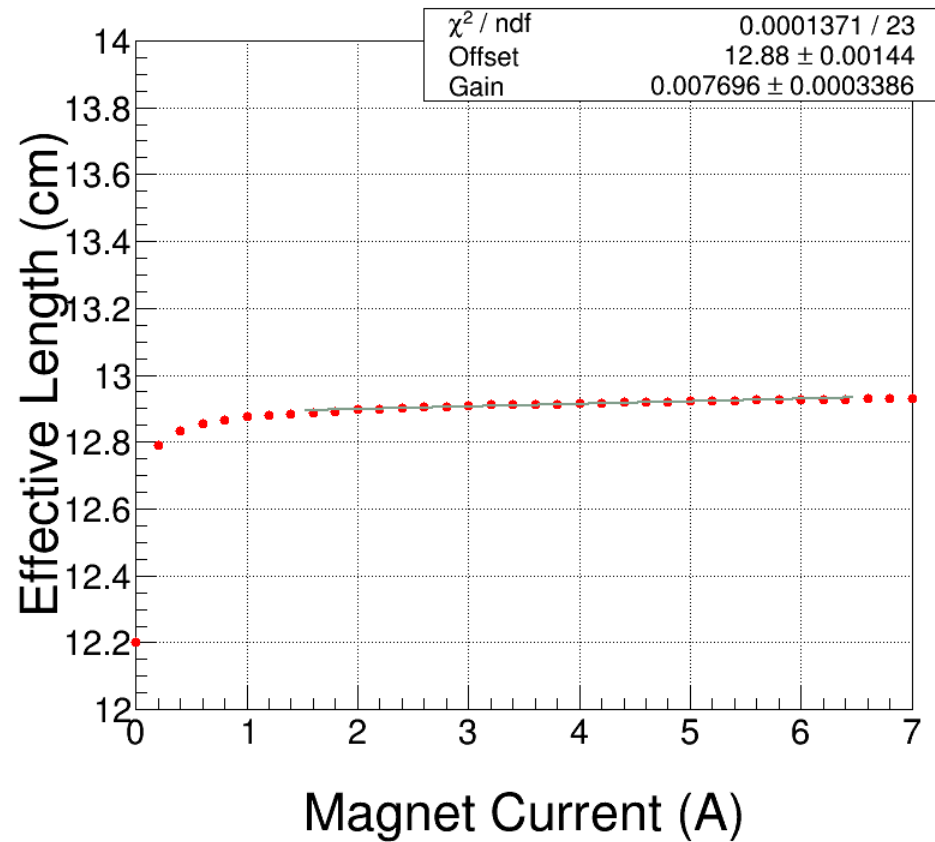
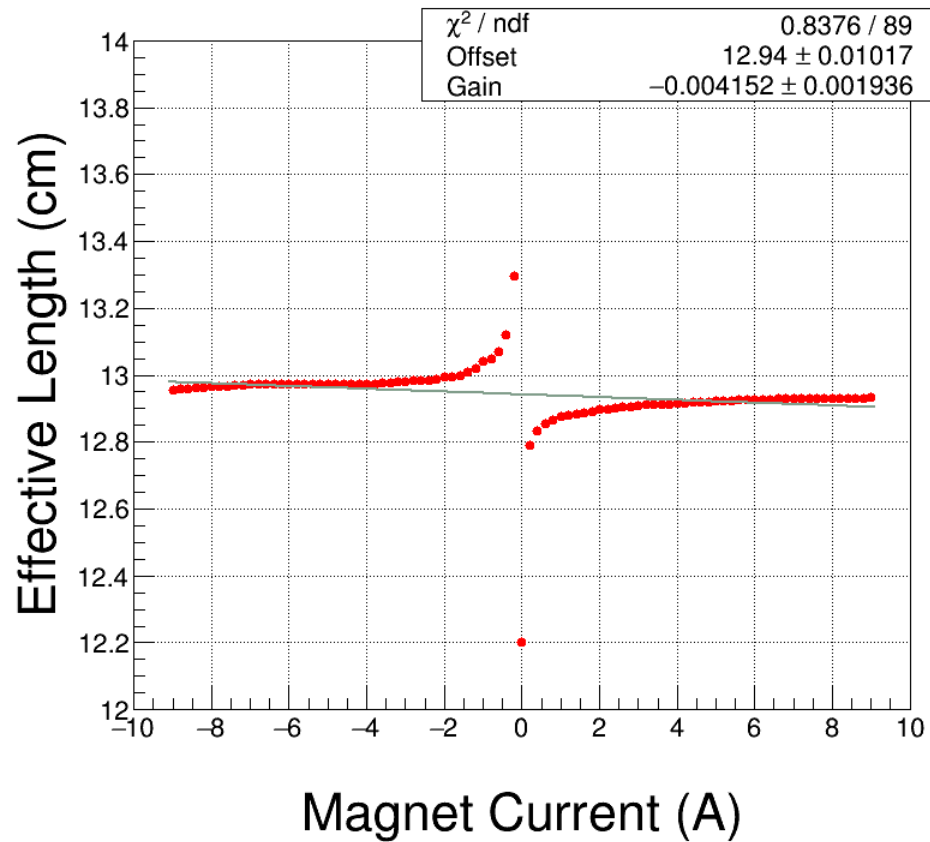
Current (A)	Hall Probe (G)
9.0	1676.84
8.0	1494.811
7.0	1311.098
6.0	1126.72
5.0	941.599
4.0	755.813
3.0	569.625
2.0	382.975
1.0	196.247
0.0	9.73
-1.0	-176.974
-2.0	-363.63
-3.0	-550.311
-4.0	-736.641
-5.0	-922.818
-6.0	-1108.806
-7.0	-1294.494
-8.0	-1480.191
-9.0	-1665.526

From Current Scan

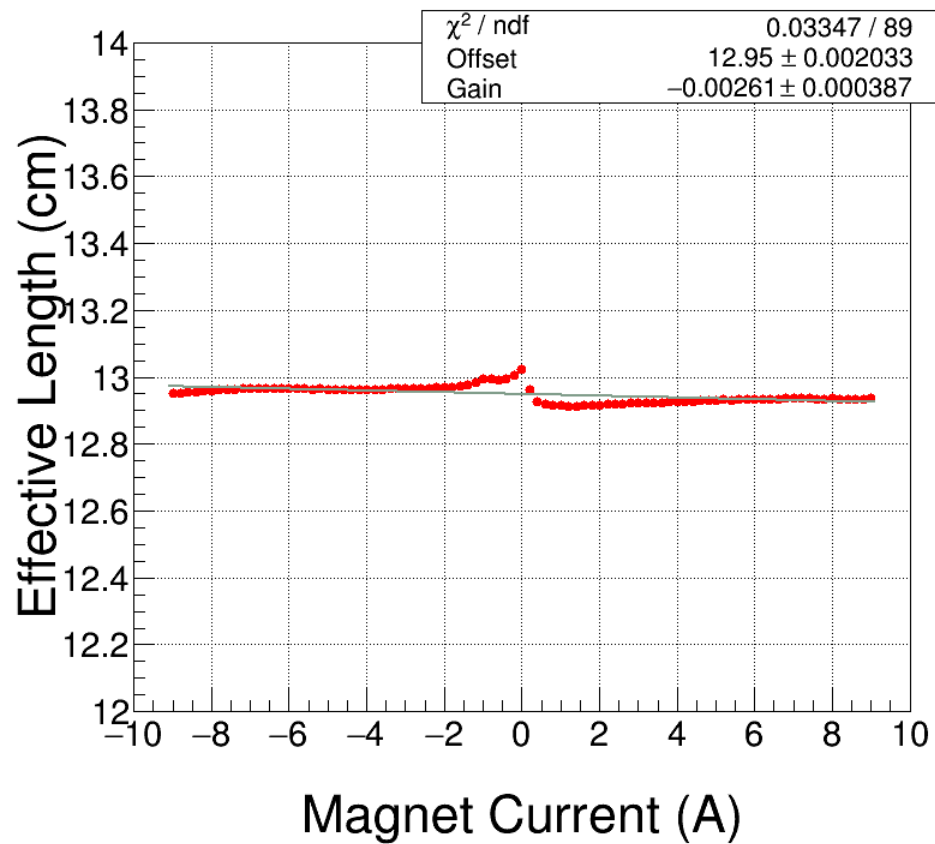
Current (A)	Core Field (G)
10.01	1863.40
9.01	1682.70
8.01	1499.15
7.01	1314.35
6.01	1128.70
5.01	942.75
4.01	756.15
3.01	569.25
2.01	382.25
1.01	195.15
0.00	7.40
-0.99	-179.45
-1.99	-366.65
-2.99	-554.15
-3.99	-742.50
-4.99	-929.65
-5.99	-1116.25
-6.99	-1302.90
-7.99	-1489.25
-9.00	-1675.60
-9.99	-1860.05



Field Ratio



BdL / Hall Probe



(BdL+8.0) / Hall Probe
(i.e., added small offset to
field map)

May 11, 2016

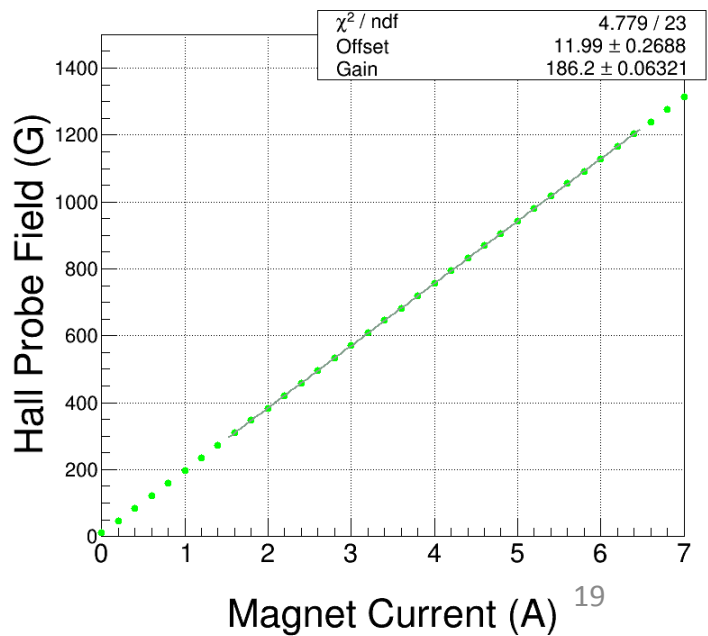
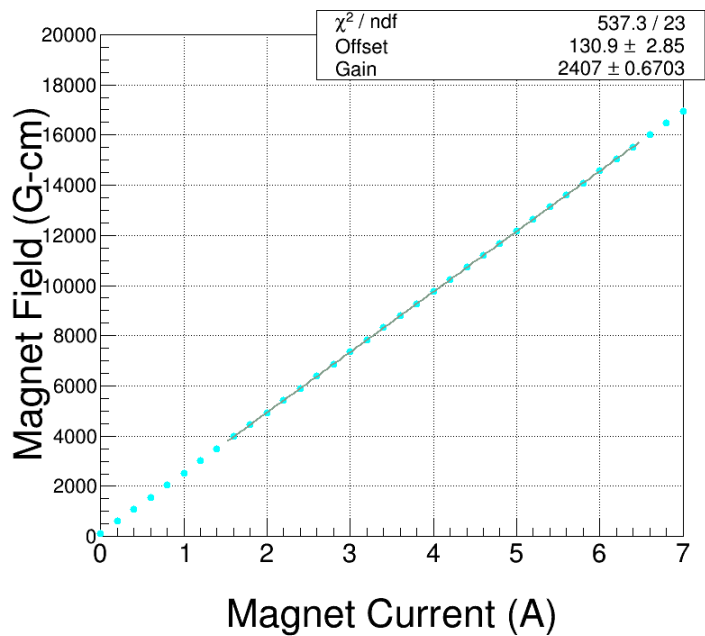
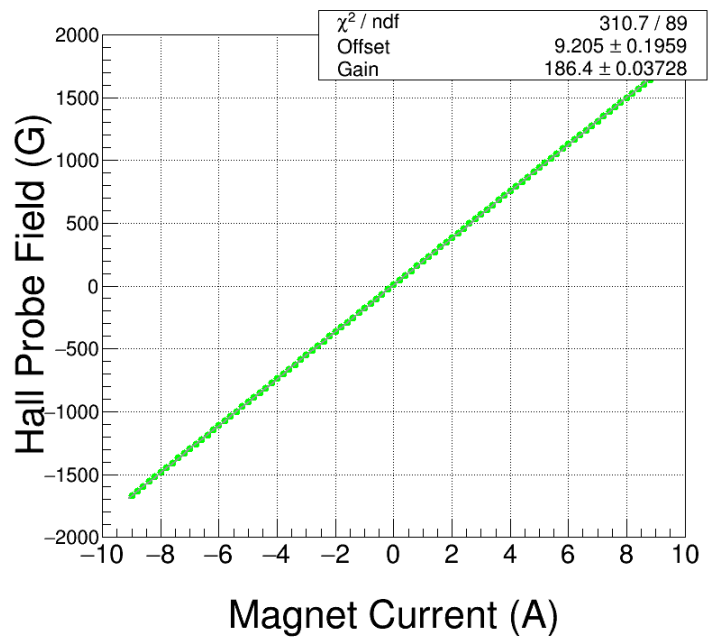
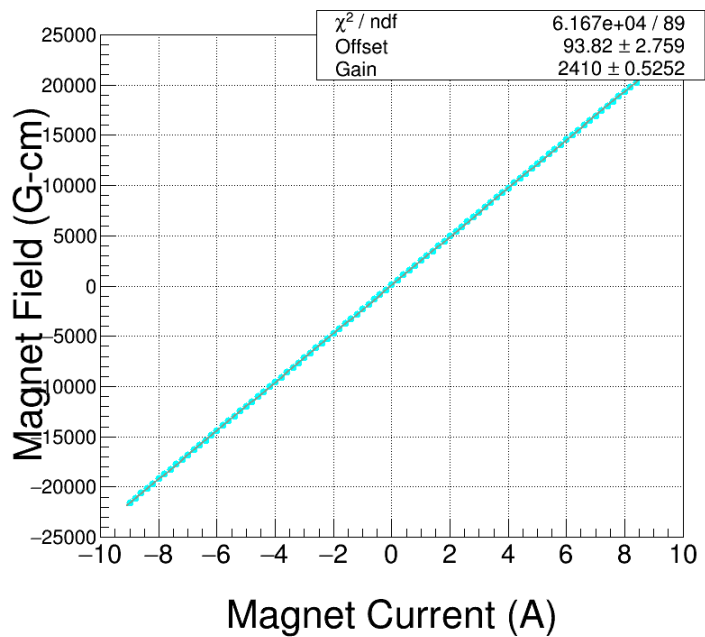
**SCANNED DIPOLE CURRENT FROM
9.0 TO -9.0 A (WITH ON
HYSTERESIS) AND RECORDED BDL
AND HALL PROBE READINGS**

From Field Map

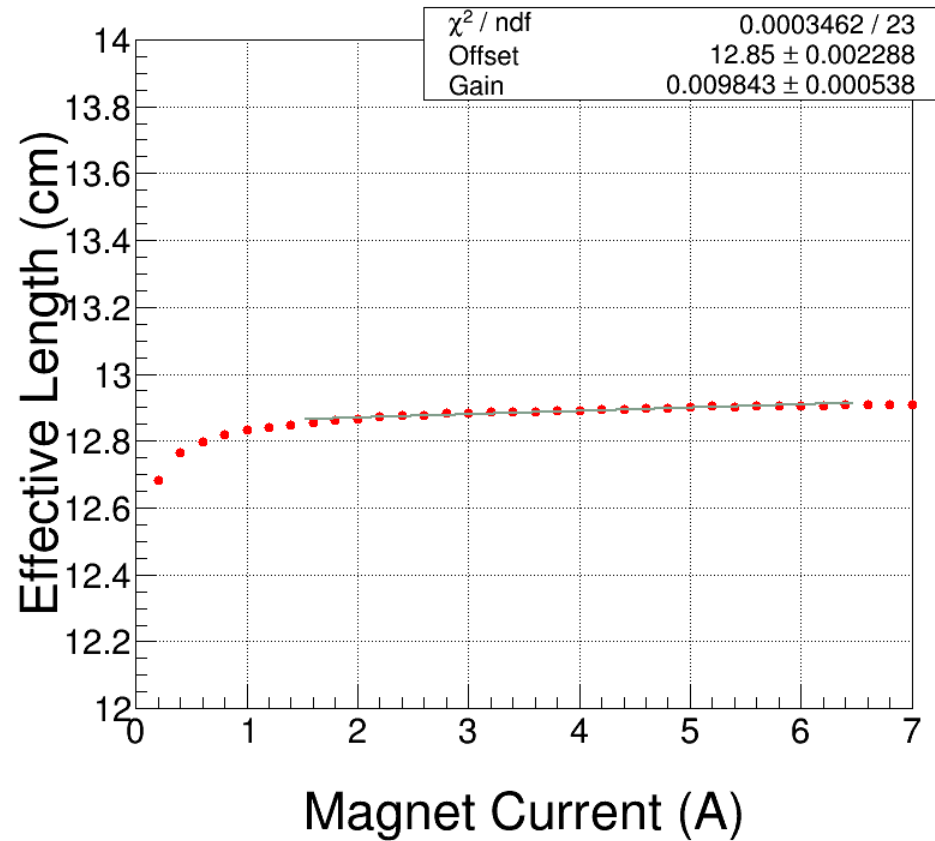
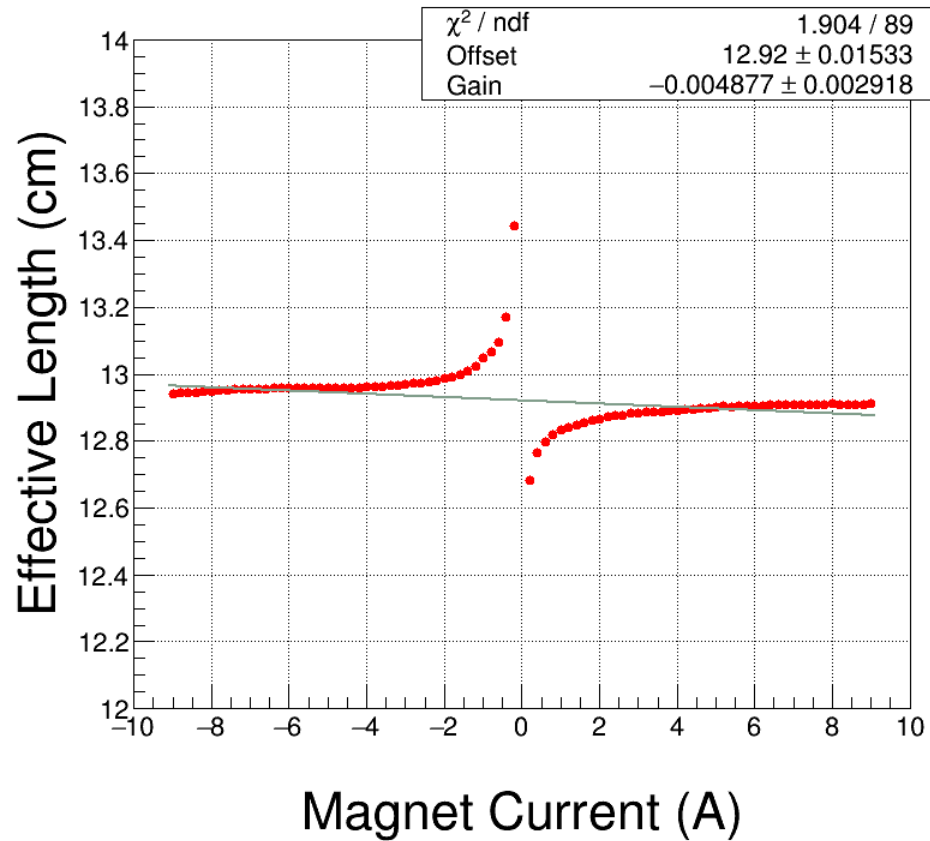
Current (A)	Hall Probe (G)
9.0	1679.413
8.0	1497.175
7.0	1313.228
6.0	1128.575
5.0	943.145
4.0	757.186
3.0	570.716
2.0	383.856
1.0	196.884
0.0	10.084
-1.0	-176.862
-2.0	-363.784
-3.0	-550.767
-4.0	-737.396
-5.0	-923.895
-6.0	-1110.12
-7.0	-1296.09
-8.0	-1481.945
-9.0	-1667.458

From Current Scan

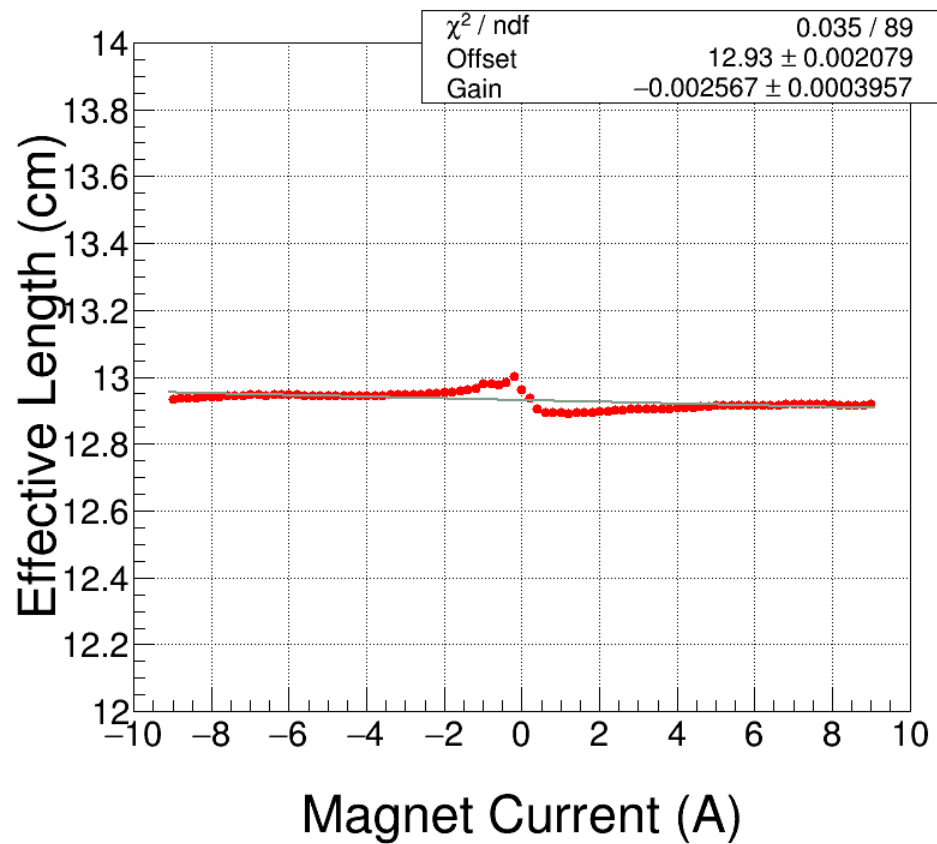
Current (A)	Core Field (G)
10.01	1863.40
9.01	1682.70
8.01	1499.15
7.01	1314.35
6.01	1128.70
5.01	942.75
4.01	756.15
3.01	569.25
2.01	382.25
1.01	195.15
0.00	7.40
-0.99	-179.45
-1.99	-366.65
-2.99	-554.15
-3.99	-742.50
-4.99	-929.65
-5.99	-1116.25
-6.99	-1302.90
-7.99	-1489.25
-9.00	-1675.60
-9.99	-1860.05



Field Ratio



BdL / Hall Probe



(BdL+12.0) / Hall Probe
(i.e., added small offset to
field map)

Summary - I

- I. Hints that there are problems with Field Map:
 1. Measured Hall Probe field in Injector is a bit too large when BdL is set to zero
 2. Effective Length from Field Map depends on magnet current

Either due to errors in current measurement and/or environmental fields

- II. Recommend to use spare magnet to resolve this problem
- III. For magnet currents below 6 A, Trim Card is good to 2 mA
- IV. Is MPT-231 Hall Probe mounted right inside MDL0L02? Should use G10 to hold probe parallel to magnet
- V. Hall Probe MPT-231 measurements at very small fields vary by about 0.2 – 0.3 G, due to exact hysteresis history
- VI. Jay's model is good to 0.1% (see Tech Note TN-15-017)

Summary - II

VII. For Beam Energy Measurement:

1. CEBAF : BdL \neq 0 (due to field map error), instead:
BdL = Hall Probe * Magnetic Length (or use my field survey)
BdL \sim -3.6 G * 12.9 cm = -46 G-cm. Treat as another horizontal corrector.
2. Spectrometer Lines (2D, 3D, 5D): magnet currents between 2 A and 6 A are most relevant. Till we check field map, we will assume a 46 G-cm error on field measurements.

	Error
Trim Power Supply	2 mA
Magnet Model	0.1%
Field Map	46 G-cm

For Mott Energy Measurements