GMW

USER'S MANUAL

MODEL: 5203

PROJECTED VERTICAL FIELD ELECTROMAGNET

Date Sold:_____

Serial number: _____

File No: 5203_C_Proj_Vert_Field_Magnet_May_21_2015.pdf Revision Date: 21 May, 2015

GMW *955 Industrial Road, San Carlos, CA 94070 Tel: (650) 802-8292 Fax: (650) 802-8298*
Email: tom@gmw.com Web site: www.gmw.com

TABLE OF CONTENTS

Section 1

SPECIFICATIONS

Model: 5203 Electromagnet Specifications

Projected Field: (at max current of 100A)	B_Z= ±0.50T (5000G) **(**X,Y,Z = 0, 0, 5mm)
Projected Field Region (for B_z)	X = -6 to +6mm Y = -6 to +6mm Z = 0 to 12mm
Coil:	
Coil resistance (20°C)	173 mΩ
Max. resistance (80°C)	240 mΩ
Max. continuous power*	60A/14.4V (865W)
Max. peak power	2000W
Max. DC current	60A
Max. sinusoidal current	85A
Max. triangle wave current	100A
Self Inductance (Low Field):	Approx. 3500μH at 1 Hz
Self Inductance (High Field):	Approx. 895μH at 1 Hz

(The apparent inductance increases with frequency due to eddy currents in the solid poles)

Cooling: (measured at water I/O manifold)	up to 8.0 Liter/min, 4.0 bar [2.1 USG/min, 60 psid]
Thermal Interlock:	Open circuit above 80° C (176° F)
Dimensions:	Drawing 11907-0224-0_D_S2 74.0 mm W x 74.0 mm D x 123.5 mm H 2.91 inch W x 2.91 inch D x 4.86 inch H
Mass:	2.5 kg (5.5 lb)

***CAUTION - The value of maximum coil power given should not be exceeded.**
At thispower the coils are at maximum safe temperature for continuous operation.

Section 2

WARNINGS

REFER TO WARNINGS BELOW BEFORE OPERATING ELECTROMAGNET SYSTEM

1 Personnel Safety

In operation the magnet fringing field in the vicinity of the pole gap is in excess of 0.5mT (5G). This can cause malfunctioning of sensitive electronic and magnetic components. We recommend that warning signs are posted indicating that a magnetic field may be present.

2 Ferromagnetic Objects

During operation the magnet exerts magnetic attraction towards ferromagnetic objects in the near vicinity of its pole faces. Keep ferromagnetic items clear!

3 Arcing

This magnet stores energy in its field during operation. Do not disconnect any current lead while under load or the magnetic field energy will be discharged across the interruption causing arcing and possible damage to electronic circuits.

4 Coil Hot Resistance

Do not exceed the maximum coil hot resistance given in the specifications or coil overheating and possible damage may occur

5 Watches, Credit Cards, and Magnetic Disks

Do not move magnetically sensitive items into the close vicinity of the magnet pole gap. Even some anti-magnetic watches can be damaged when placed in close proximity to the pole gaps during operation. Credit cards, and magnetic disks are affected by magnetic fields as low as 0.5mT (5G). Depending on the previous operating field and the pole gap, the remanent field in the gap can be in excess of 0.5mT (5G) with the magnet power supply off or disconnected.

6 Power Supply

Refer to the power supply manufacturers manual for additional important safety information.

Section 3

INSTALLATION

Mounting Position

The magnet system can be mounted in any orientation, including being completely inverted. Four M3 clearance holes are provided on the magnet transition plate for mounting the magnet.

Electrical Connections

The magnet system comes with integrated wiring for the magnet. Never connect or remove cables from the magnet system with the DC power energized otherwise damage to the magnet power supply may occur. Follow instruction below for making electrical connections.

Power Supply (Refer to drawings 13907-0025-0-A & 13907-0025-0-A)

1. Firstly ensure the power supply is turned off and the AC power cable is disconnected.
2. Connect the three wires to the output connector block on the rear of the Kepco BOP power supply as detailed below.
    - Red wire to Output
    - Black wire to Common
    - Green wire to Ground

Note: Reconnect AC power cable to power supply . The magnet system is now ready to use. Do not power up the magnet unless the cooling water is turned on and flowing at 8.0 liters/min.

Electrical Interlocks

The Model 5203 has a single thermostat, Selco part no UP62-080C. It is located between the base yoke plate and the lower cooling plate. The thermostat is normally closed, opening when the coil heatsink temperature exceeds 80° C, +/- 5° C. Connect the temperature interlock to the rear of the Kepco supply.

Water Cooling

The Model 5203 can be operated to a cooling plate temperature of 80° C. The coil thermostat will open when the cooling plate temperature exceeds approximately 80° C. If the temperature switch opens then the magnet power supply circuit breaker will trip to the off position. Clean, cool (16° C - 20° C) water at 8.0 l/min at 4.0 bar (60 psid) should be used to cool the 5203 magnet. This can be provided either by house water supply or from a recirculating chiller. The magnet is shipped with the cable junction box connected. Also 10m of hose is provided to give two 5m meter lengths for connetion between the magnet and the recirculating chiller (if ordered), brass fittings on the the chiller are already provided. Note that 4 x hose clamps have also be provided for fitting these water hoses. The power cable that connects the power supply to the magnet (16907-0116-0) is also provided.

Section 4

OPERATION

Electromagnet System (Kepco Power Supply operating in Current Control)

The power supply is a Kepco 20-50GL is optimized for very low ripple and noise. This model does not have a front panel interface and can be computer controlled using either digital or analogue interface. For assistance communicating with this supply please contact Yuqiang Qin at GMW Associates:

Yuqiang Qin
GMW Associates
955 Industiral Road
San Carlos 94070
California
Tel: (650) 802 8292 ext.18
Email: yuqiang@gmw.com

The Kepco 20-50MG may also be used and comes with a front user interface. This unit may also be controlled through either digital or analogue interface.

Section 5

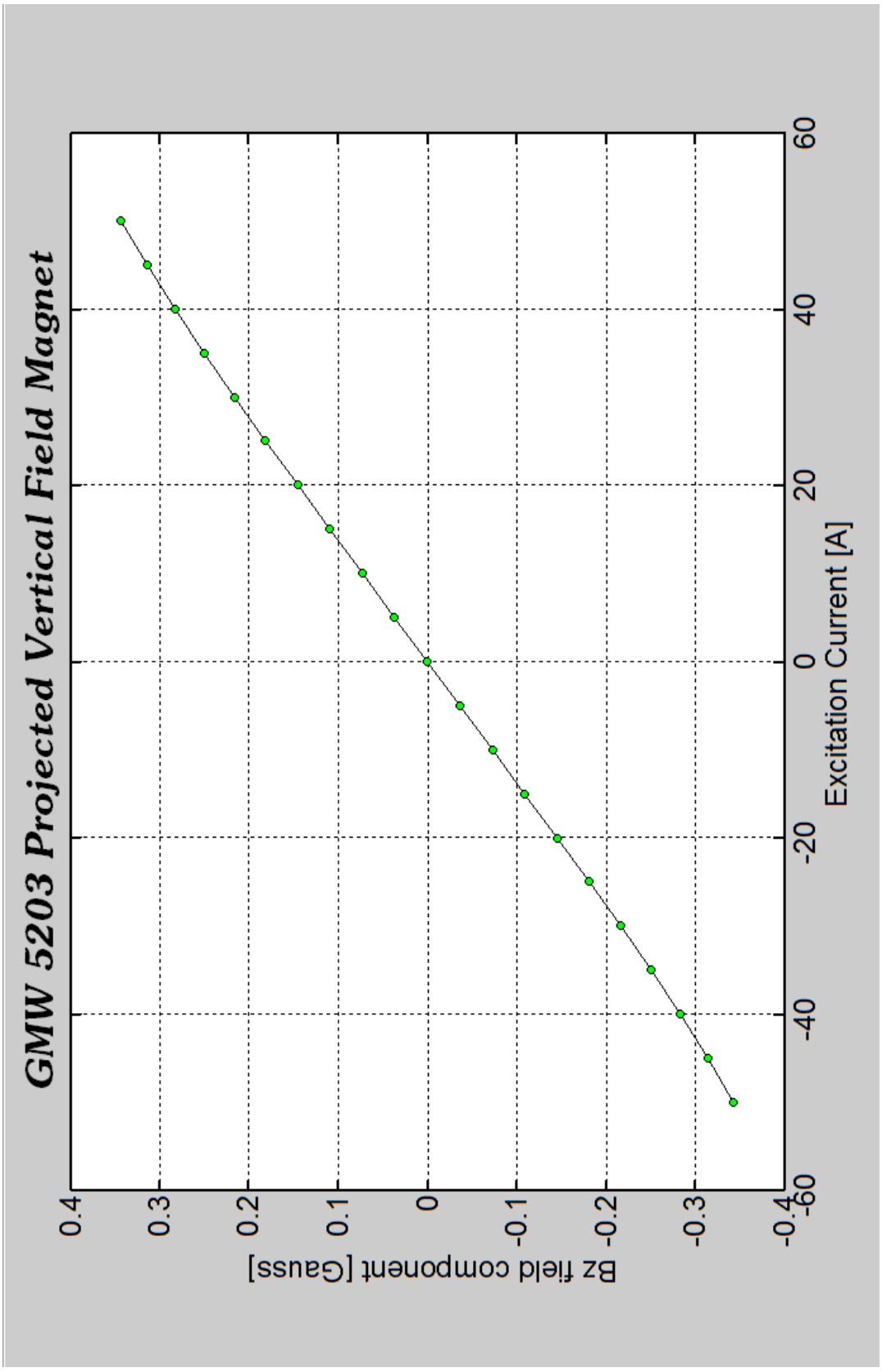
MAINTENANCE

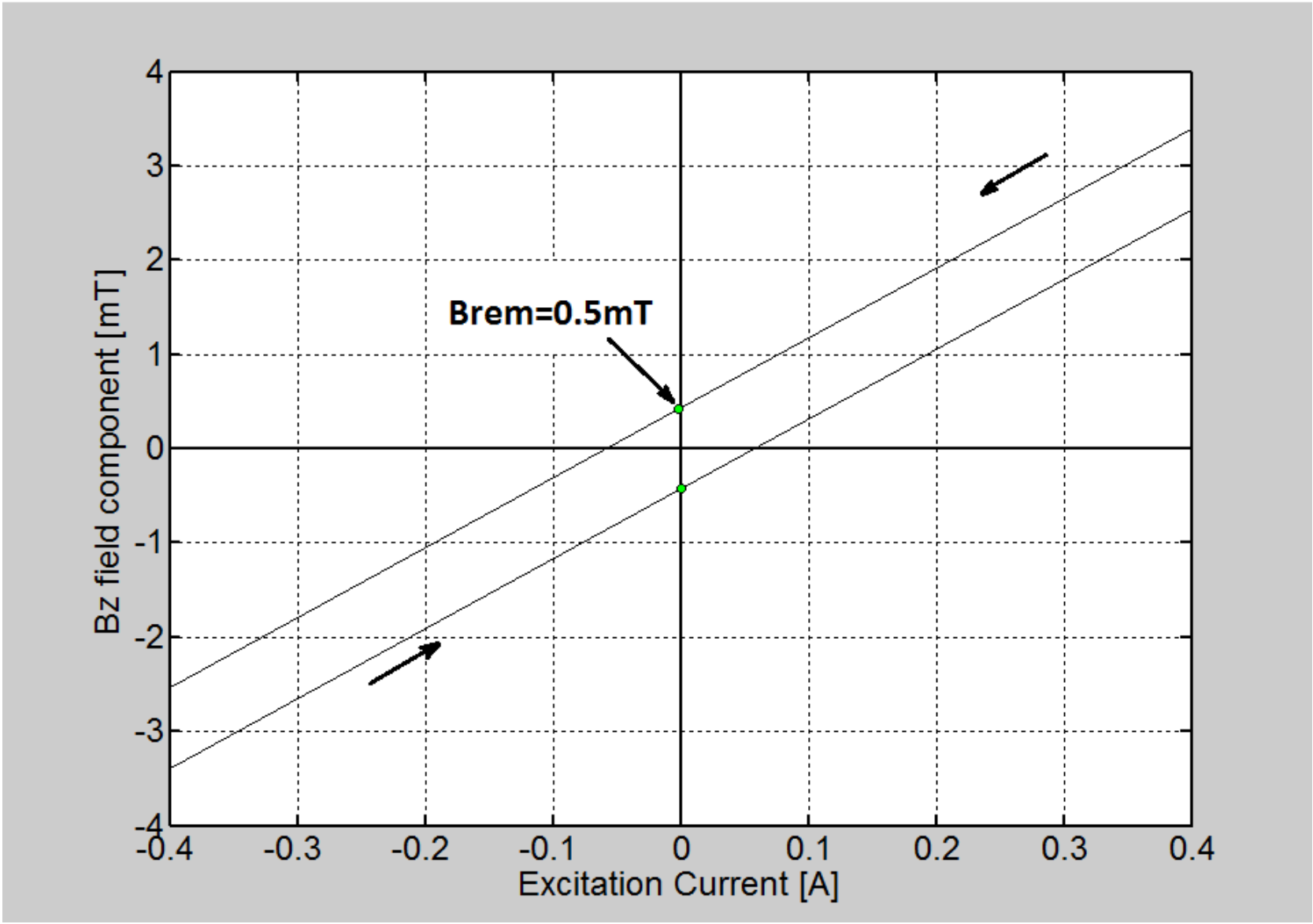
Electrical Connections on the cable junction box and power supply should be checked annually. The electrical connections should be clean and tight. Discoloration is a sign that the connection is overheating and must be rectified before further use of the magnet.

Water Hoses should be checked regularly for water leaks. Any leaks should be rectified before further use of the magnet.

Section 6

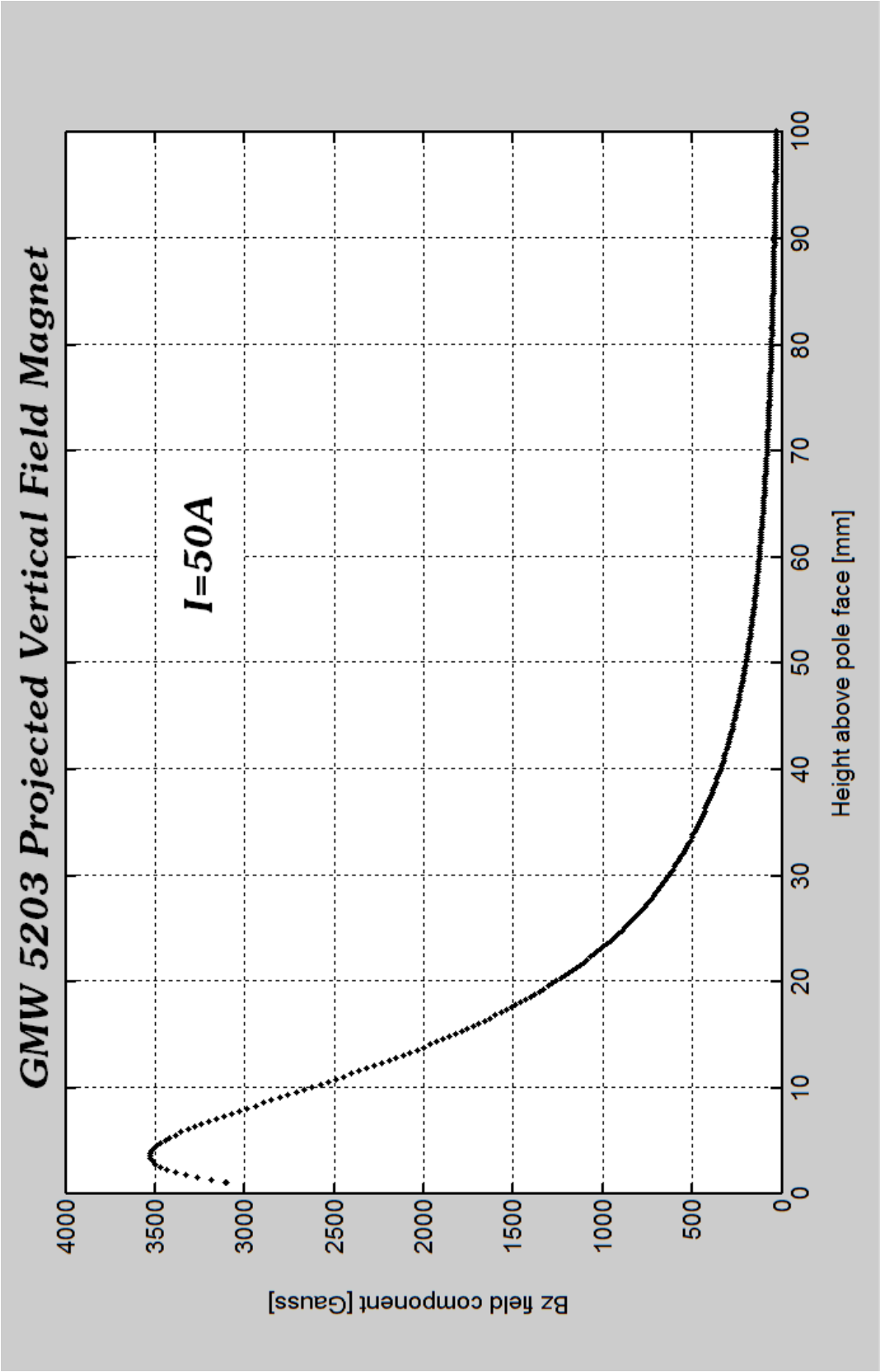
EXCITATION CURVES

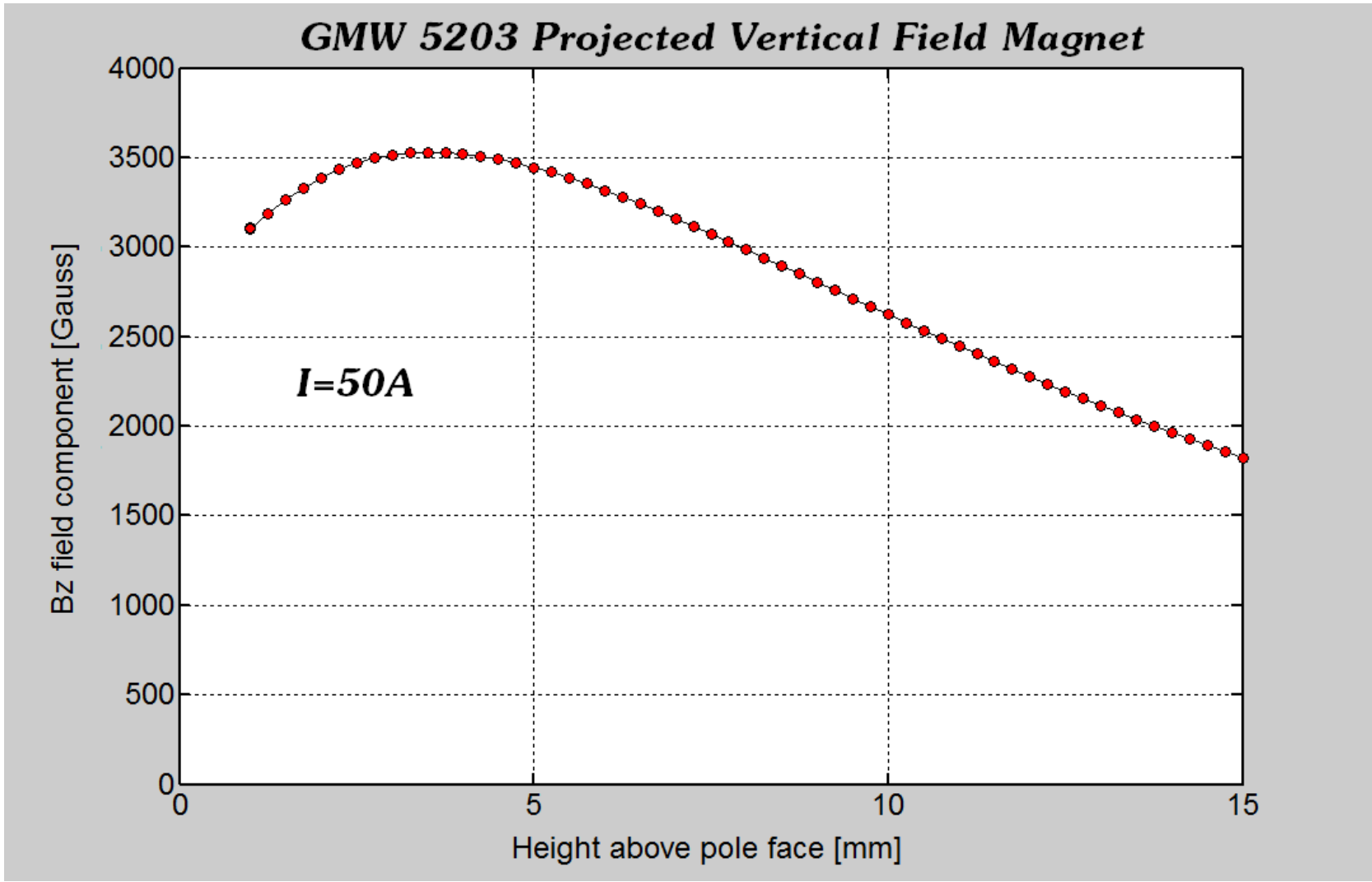


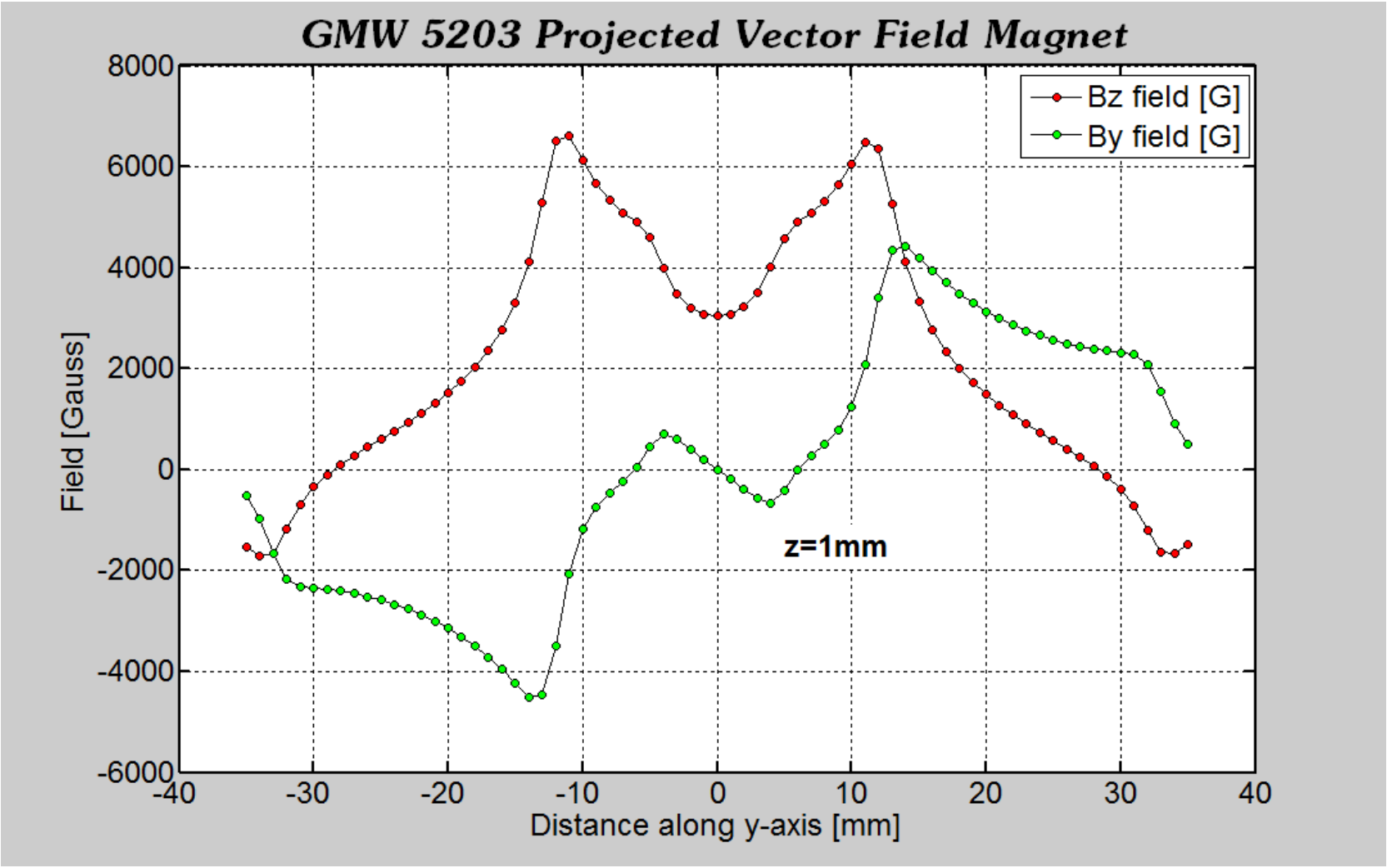

Brem=0.5mT
Bz field component [mT]
Excitation Current [A]
4
3
2
1
0
-1
-2
-3
-4
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4

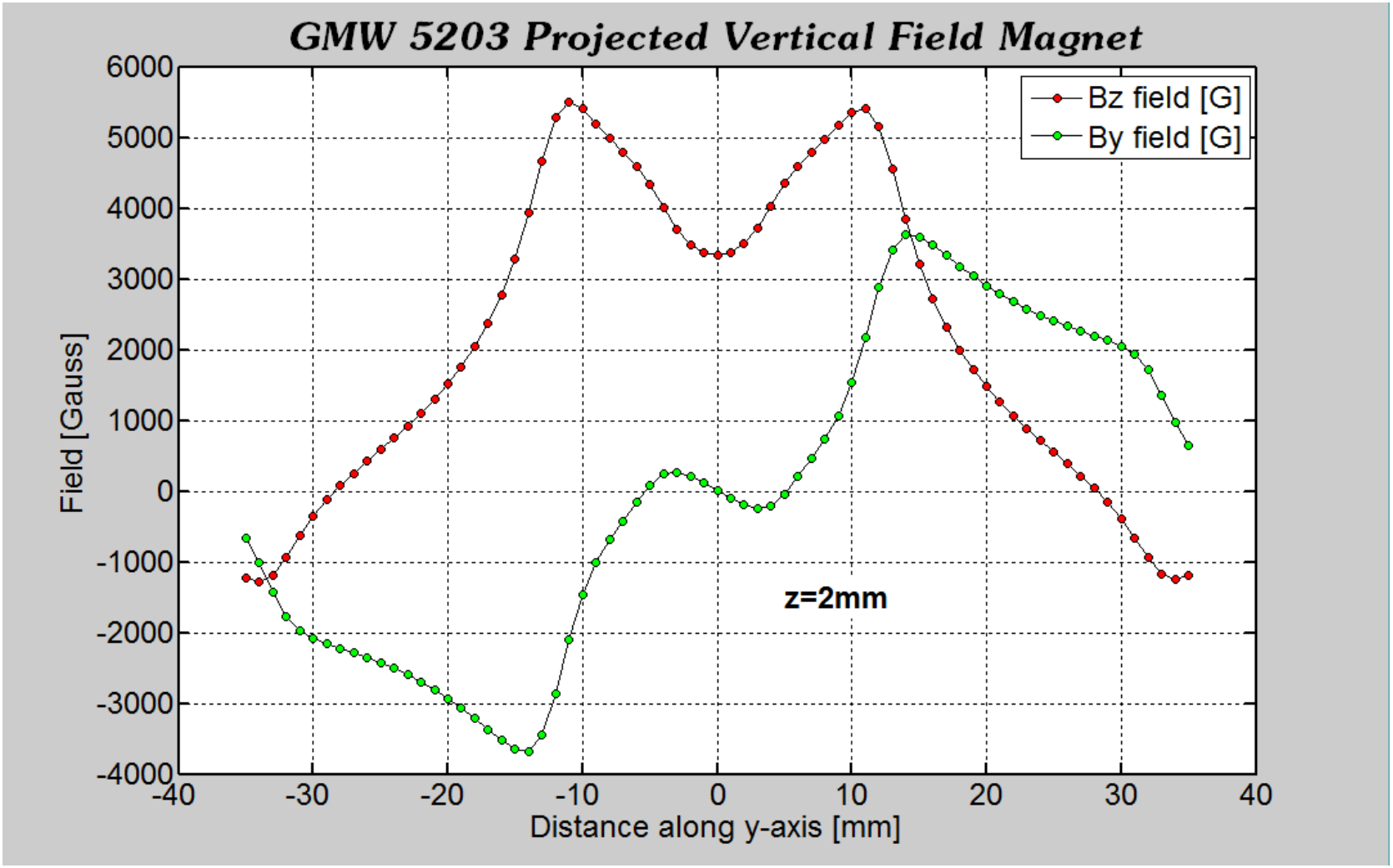
Section 7

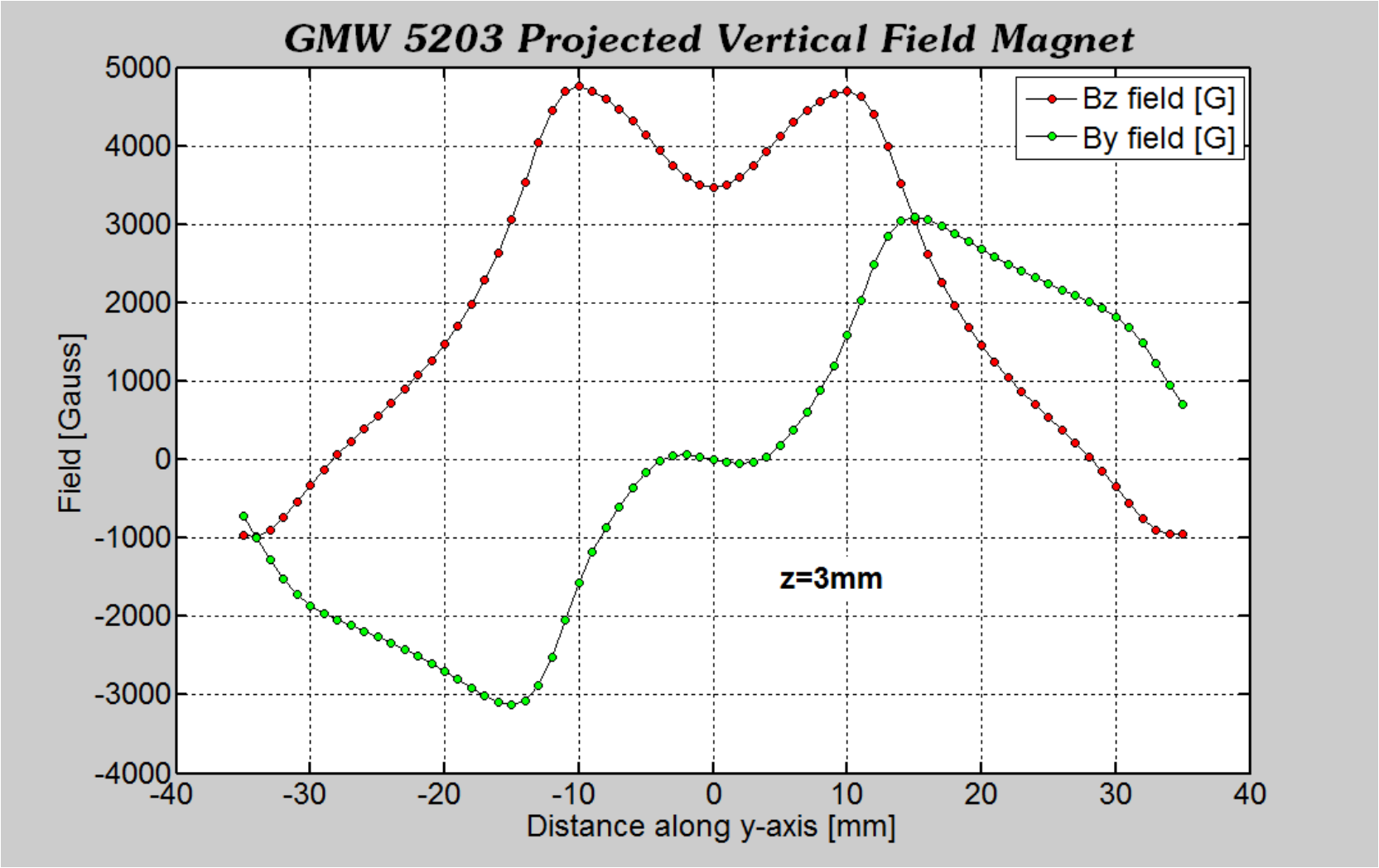
TEST DATA

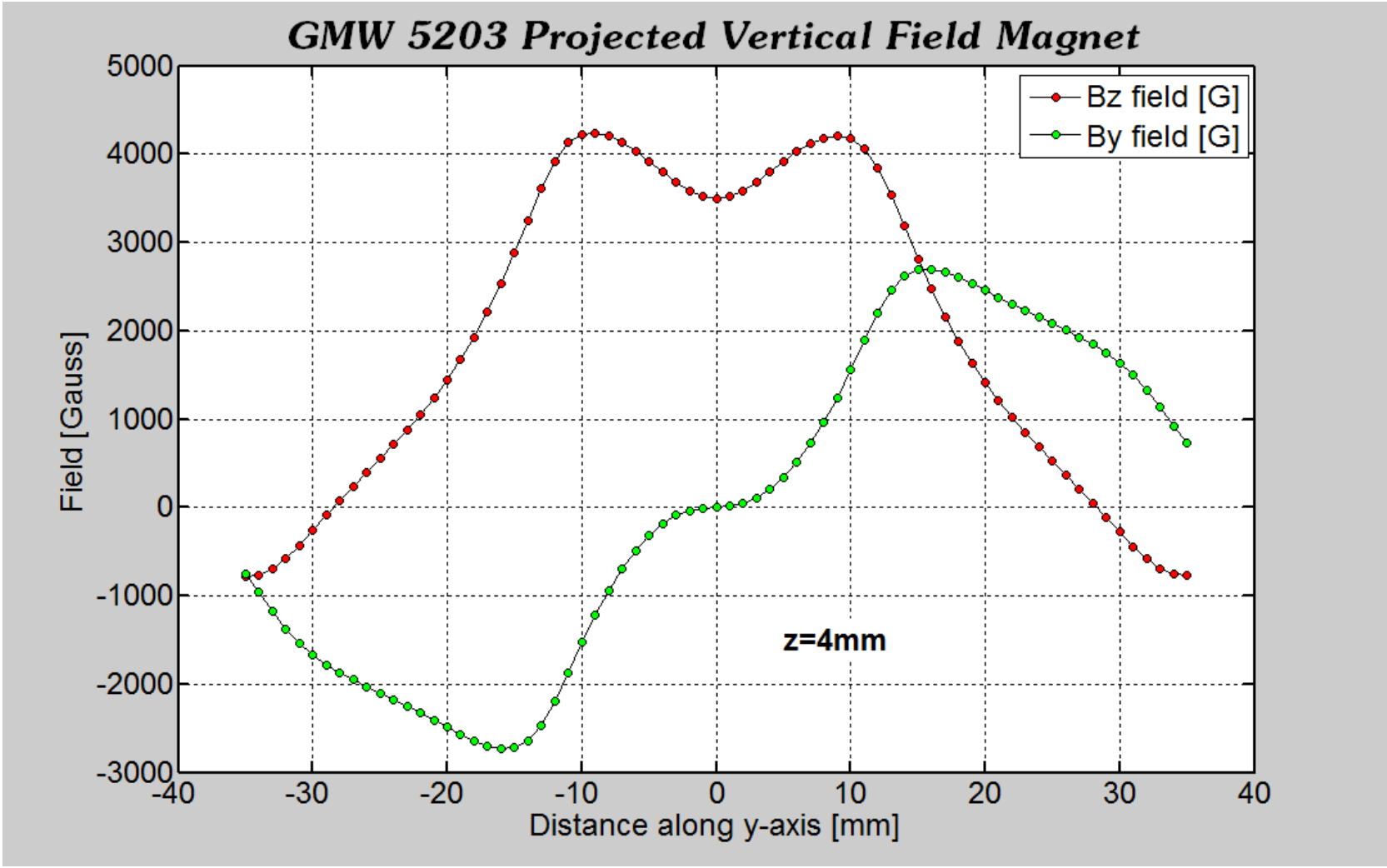


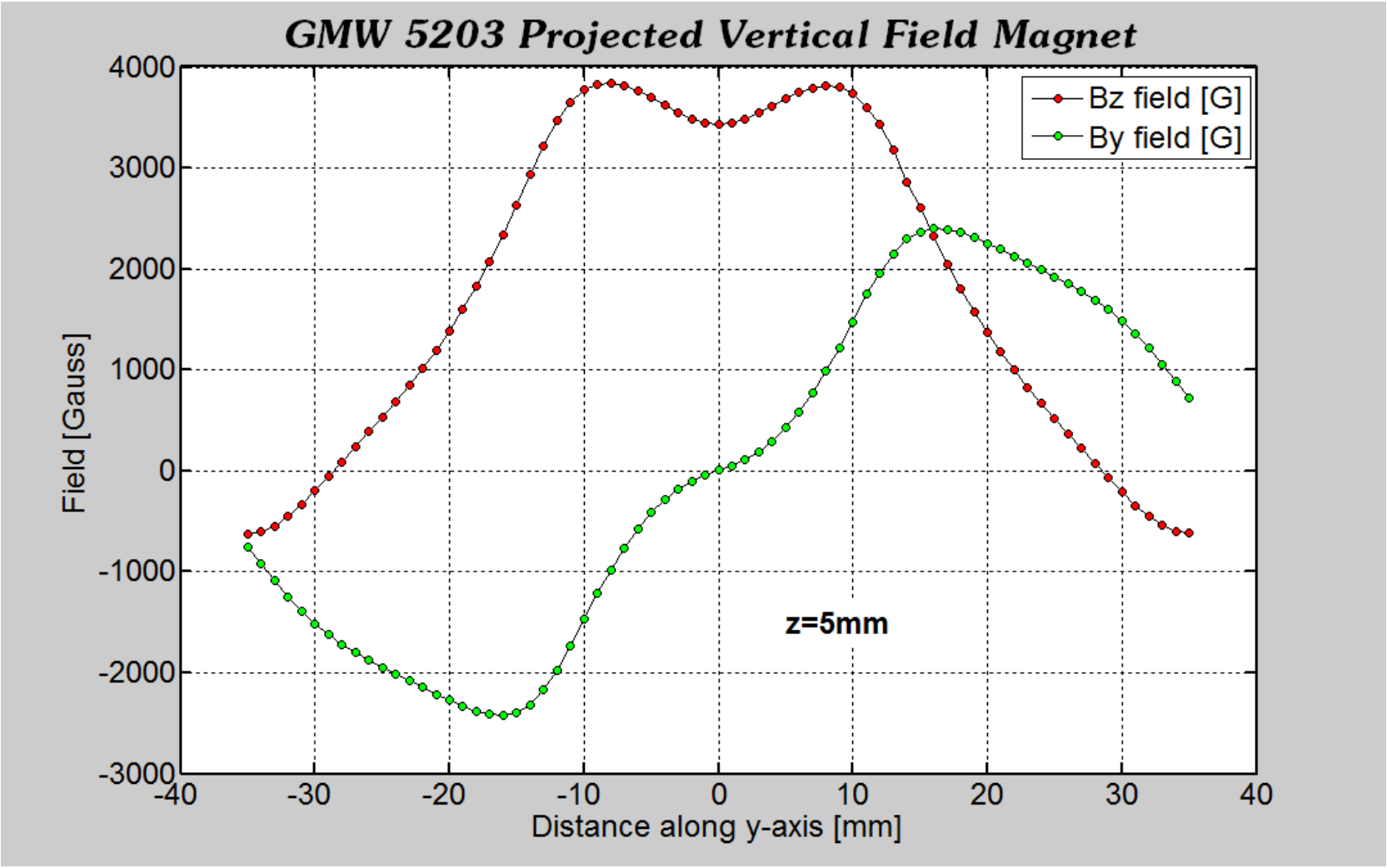

GMW 5203 Projected Vertical Field Magnet
I=50A
Bz field component [Gauss]
Height above pole face [mm]
4000
3500
3000
2500
2000
1500
1000
500
0
0
5
10
15

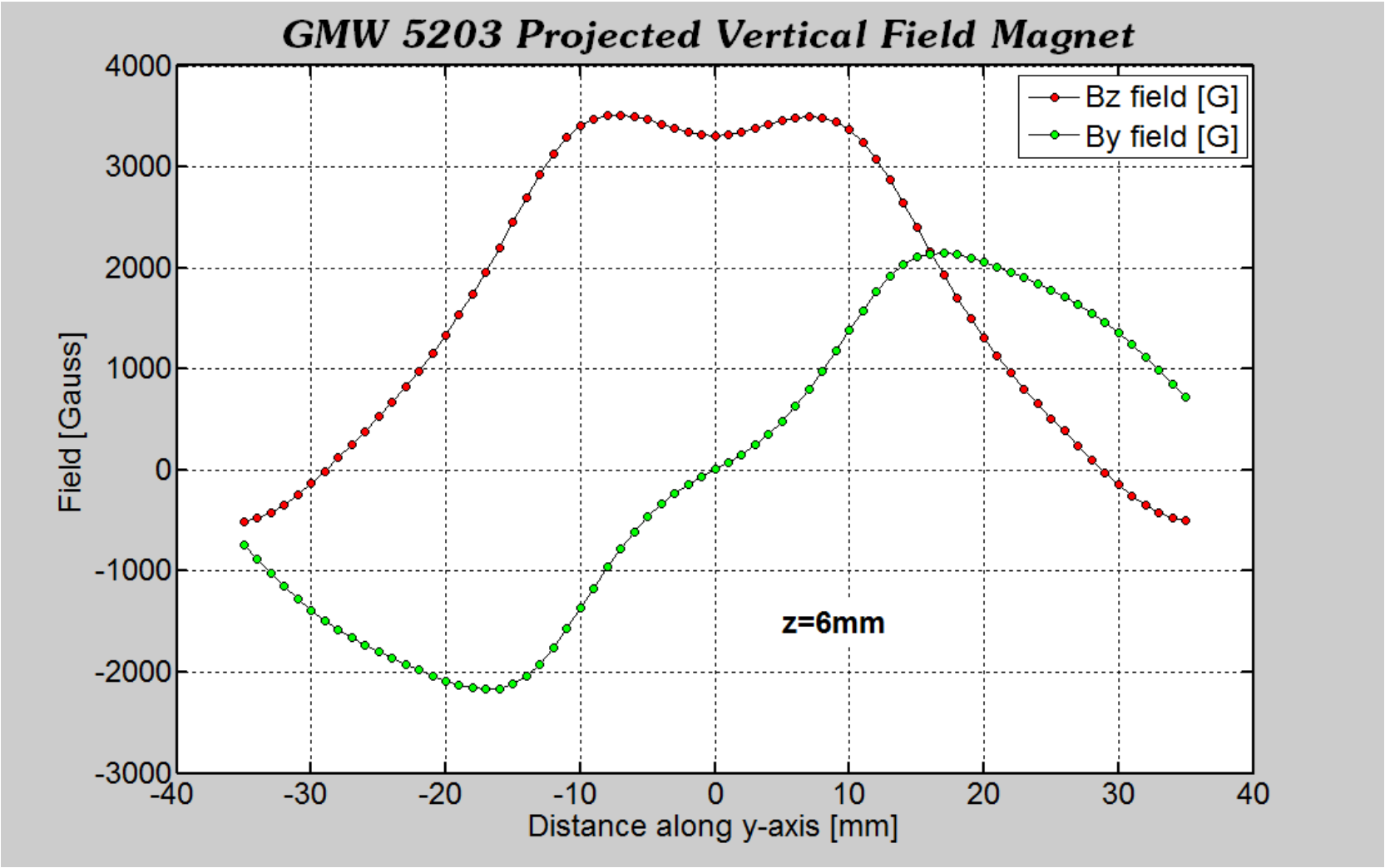

GMW 5203 Projected Vector Field Magnet
Bz field [G]
By field [G]
z=1mm
Field [Gauss]
Distance along y-axis [mm]
8000
6000
4000
2000
0
-2000
-4000
-6000
-40
-30
-20
-10
0
10
20
30
40

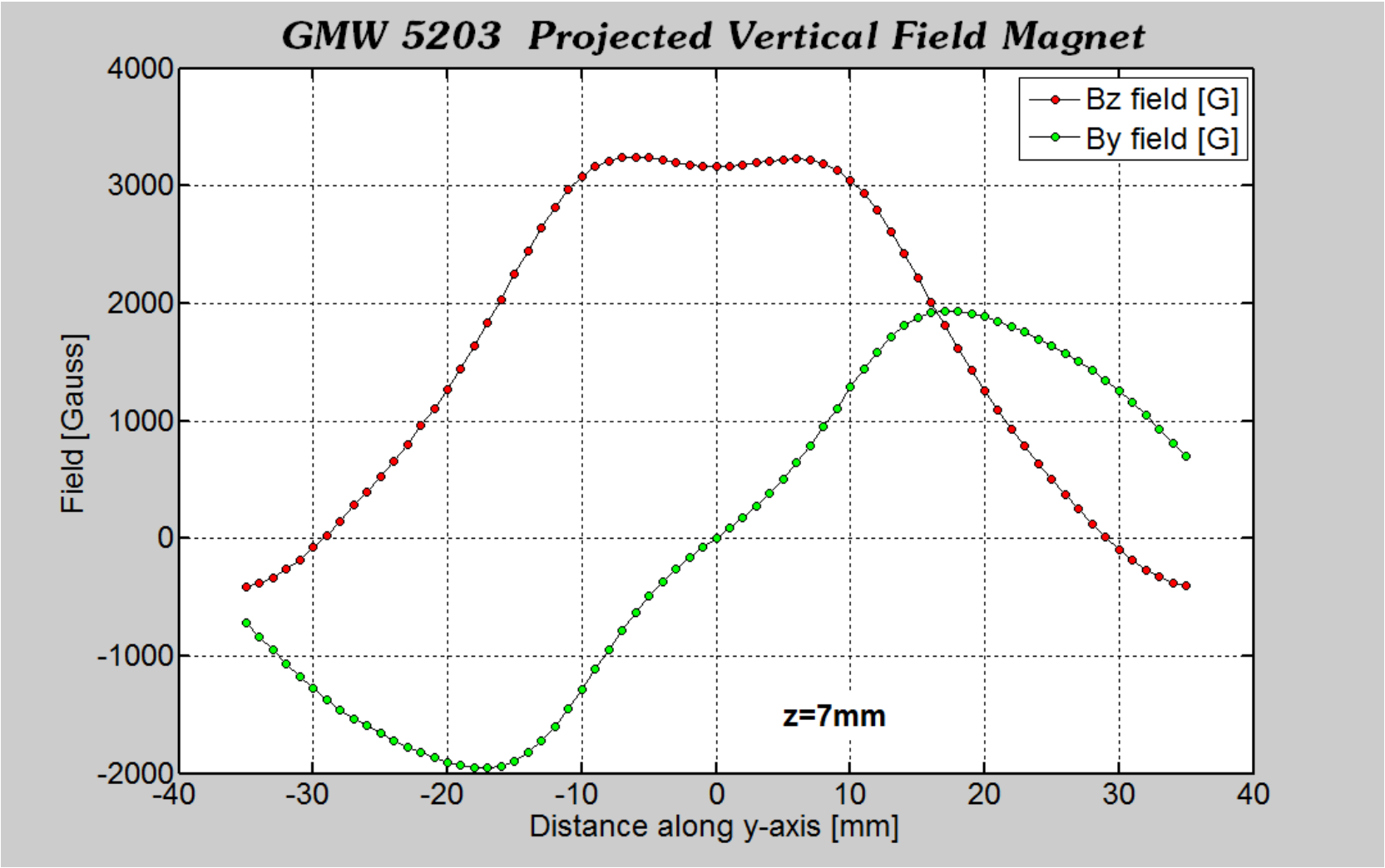

GMW 5203 Projected Vertical Field Magnet
Bz field [G]
By field [G]
z=2mm
Field [Gauss]
Distance along y-axis [mm]
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-40
-30
-20
-10
0
10
20
30
40

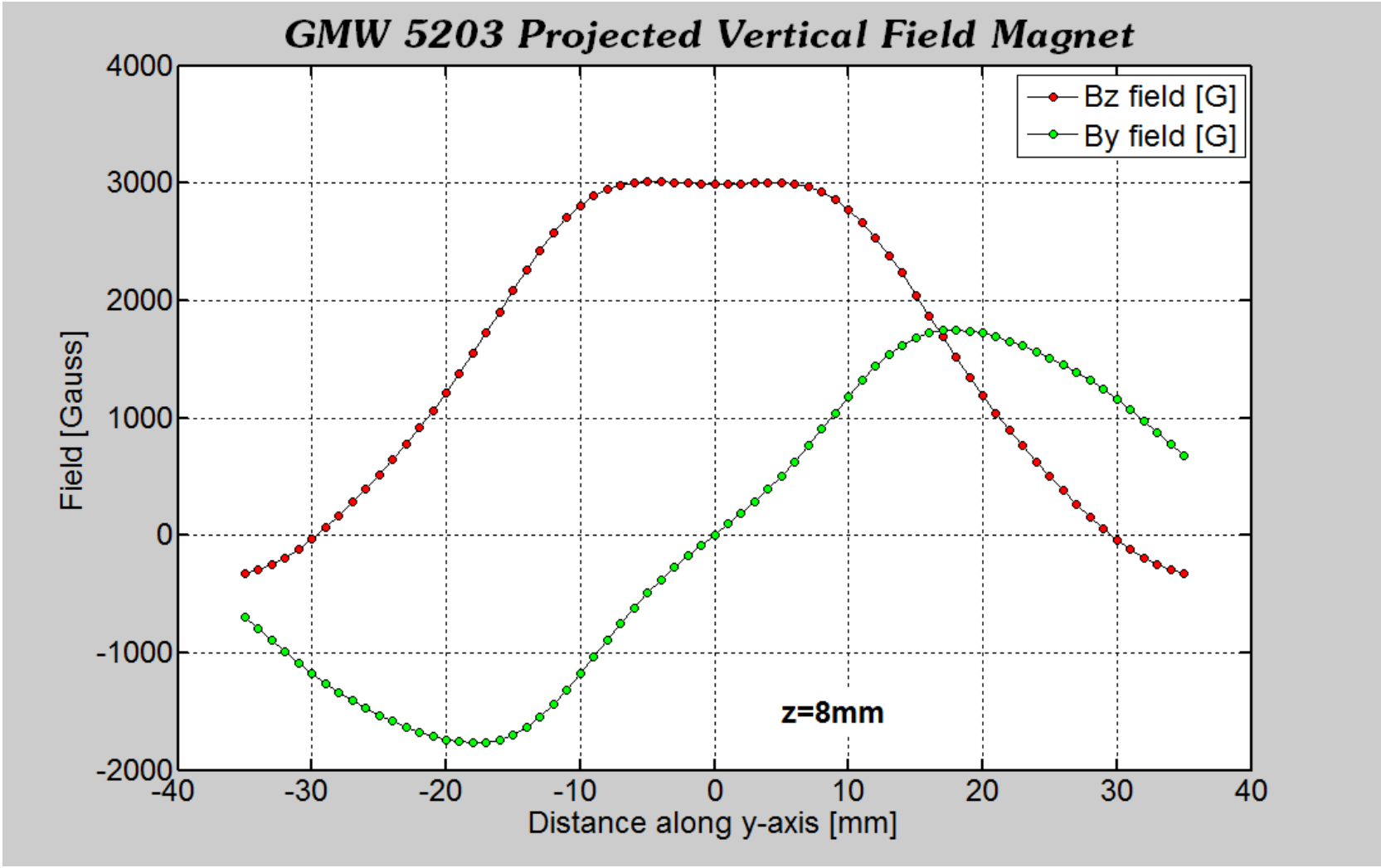

GMW 5203 Projected Vertical Field Magnet
Bz field [G]
By field [G]
z=3mm
Field [Gauss]
Distance along y-axis [mm]
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-40
-30
-20
-10
0
10
20
30
40

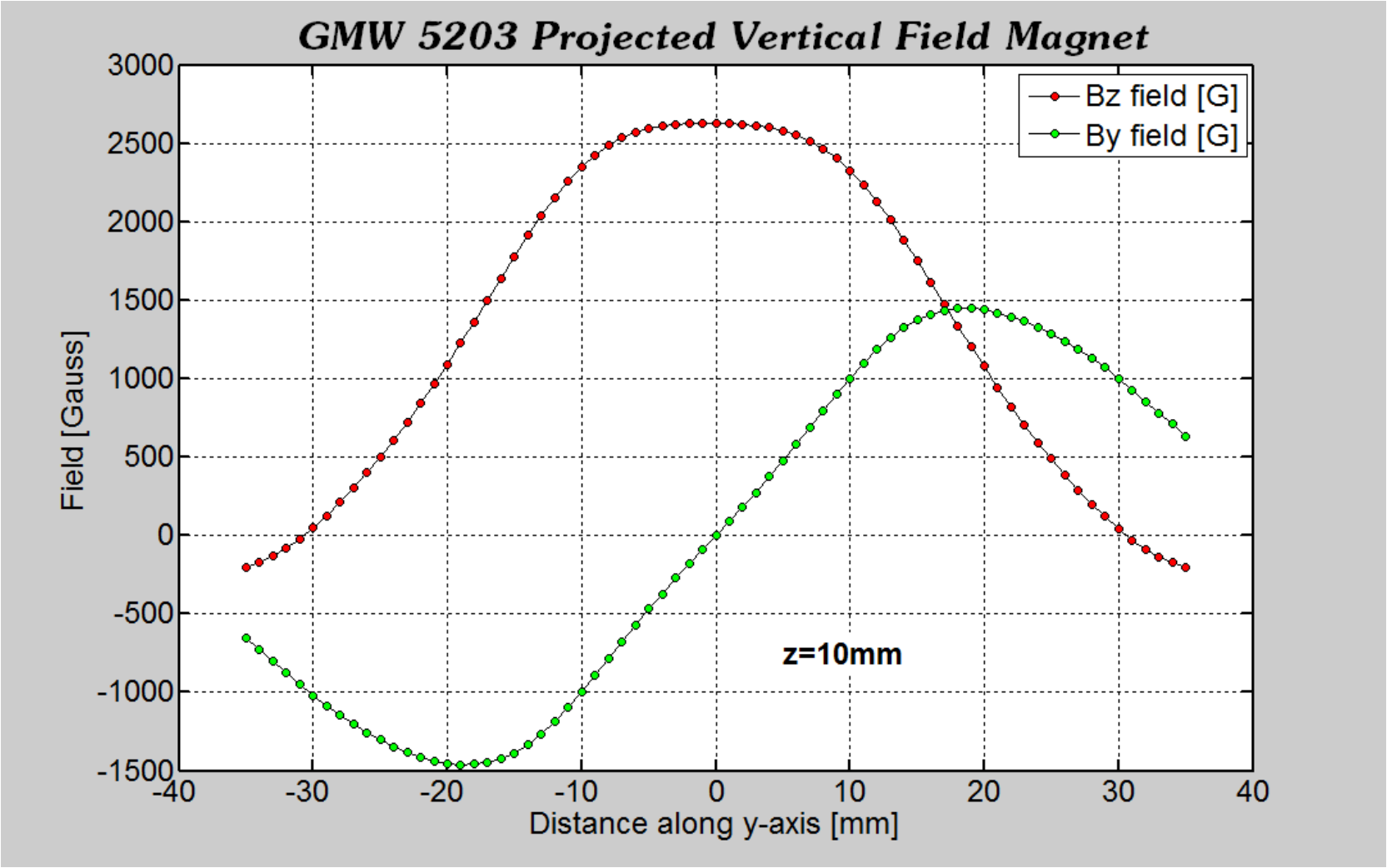

GMW 5203 Projected Vertical Field Magnet
Bz field [G]
By field [G]
z=4mm
Field [Gauss]
Distance along y-axis [mm]
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-40
-30
-20
-10
0
10
20
30
40

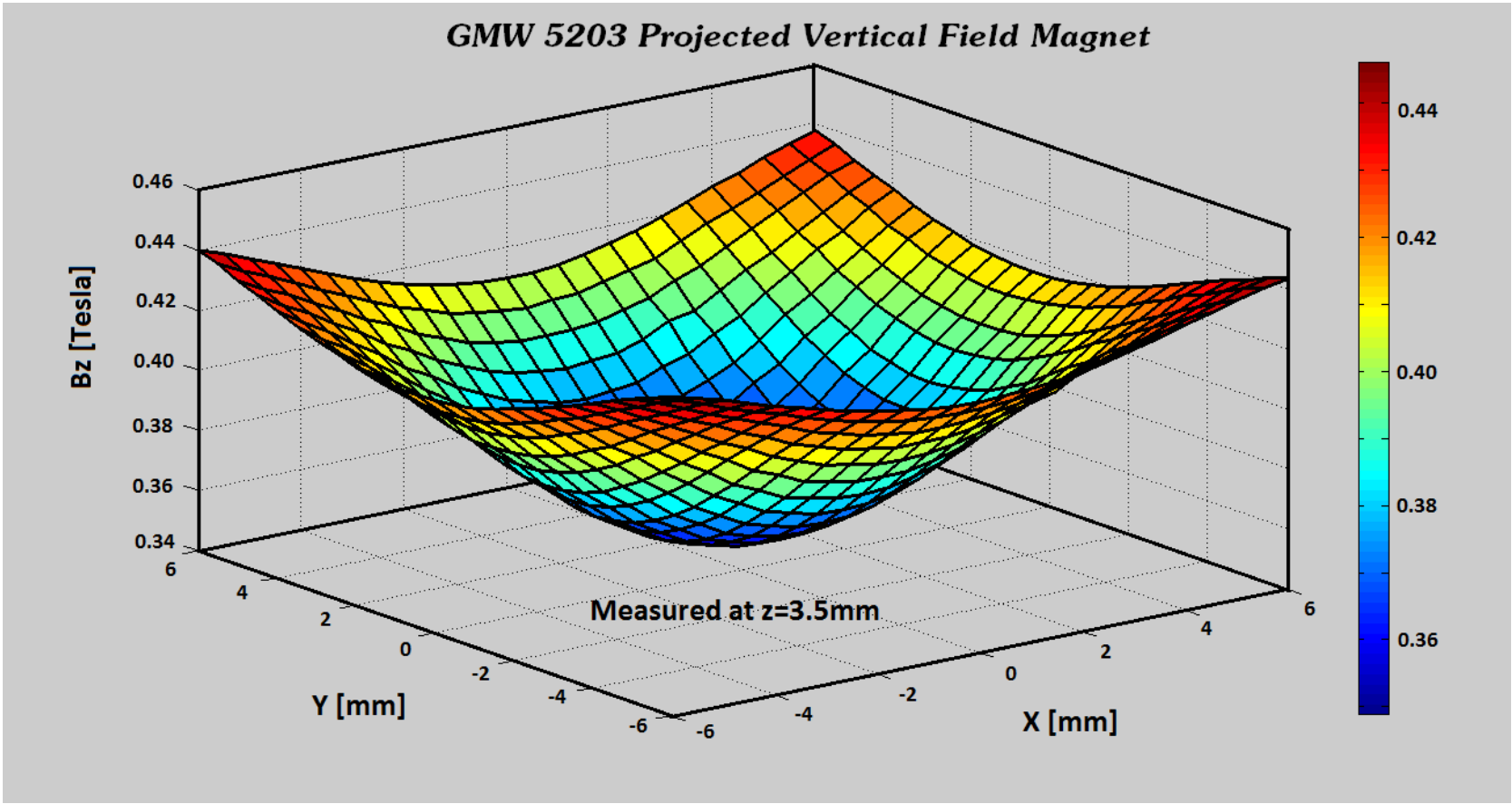

GMW 5203 Projected Vertical Field Magnet
Bz field [G]
By field [G]
z=5mm
Field [Gauss]
Distance along y-axis [mm]
4000
3000
2000
1000
0
-1000
-2000
-3000
-40
-30
-20
-10
0
10
20
30
40

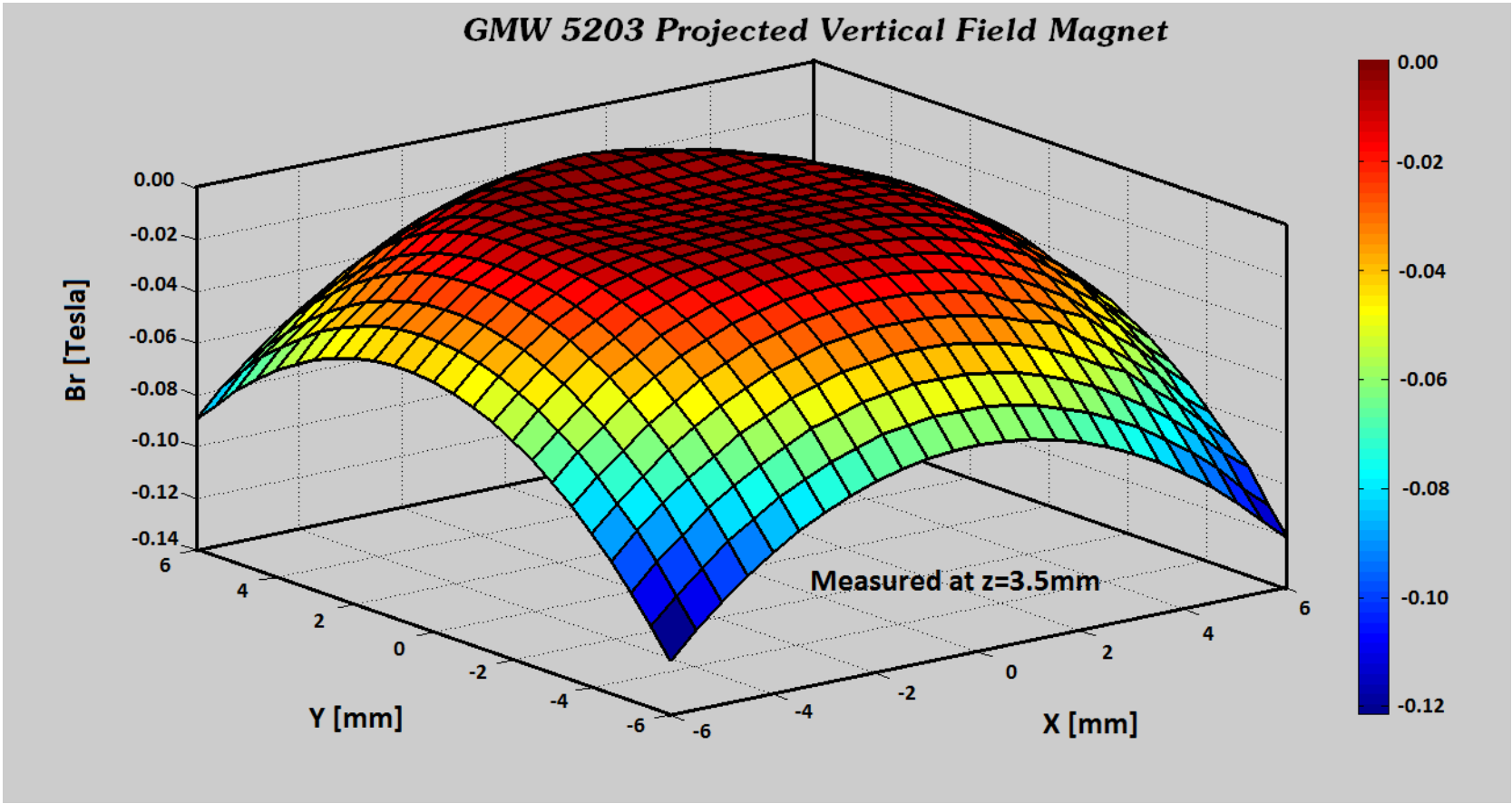

GMW 5203 Projected Vertical Field Magnet
Bz field [G]
By field [G]
z=6mm
Field [Gauss]
Distance along y-axis [mm]
4000
3000
2000
1000
0
-1000
-2000
-3000
-40
-30
-20
-10
0
10
20
30
40

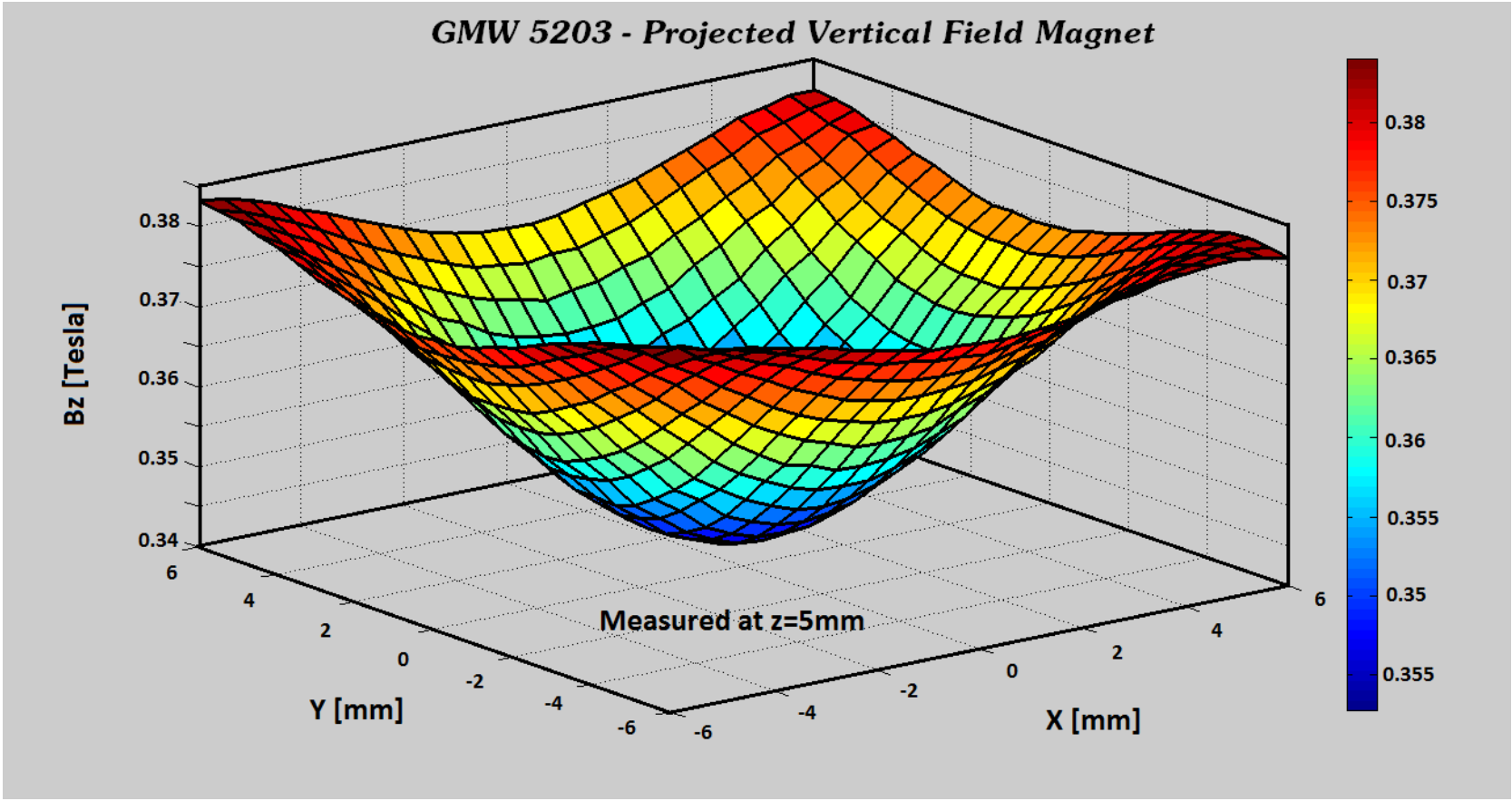

GMW 5203 Projected Vertical Field Magnet
Bz field [G]
By field [G]
Field [Gauss]
Distance along y-axis [mm]
z=7mm
4000
3000
2000
1000
0
-1000
-2000
-40
-30
-20
-10
0
10
20
30
40

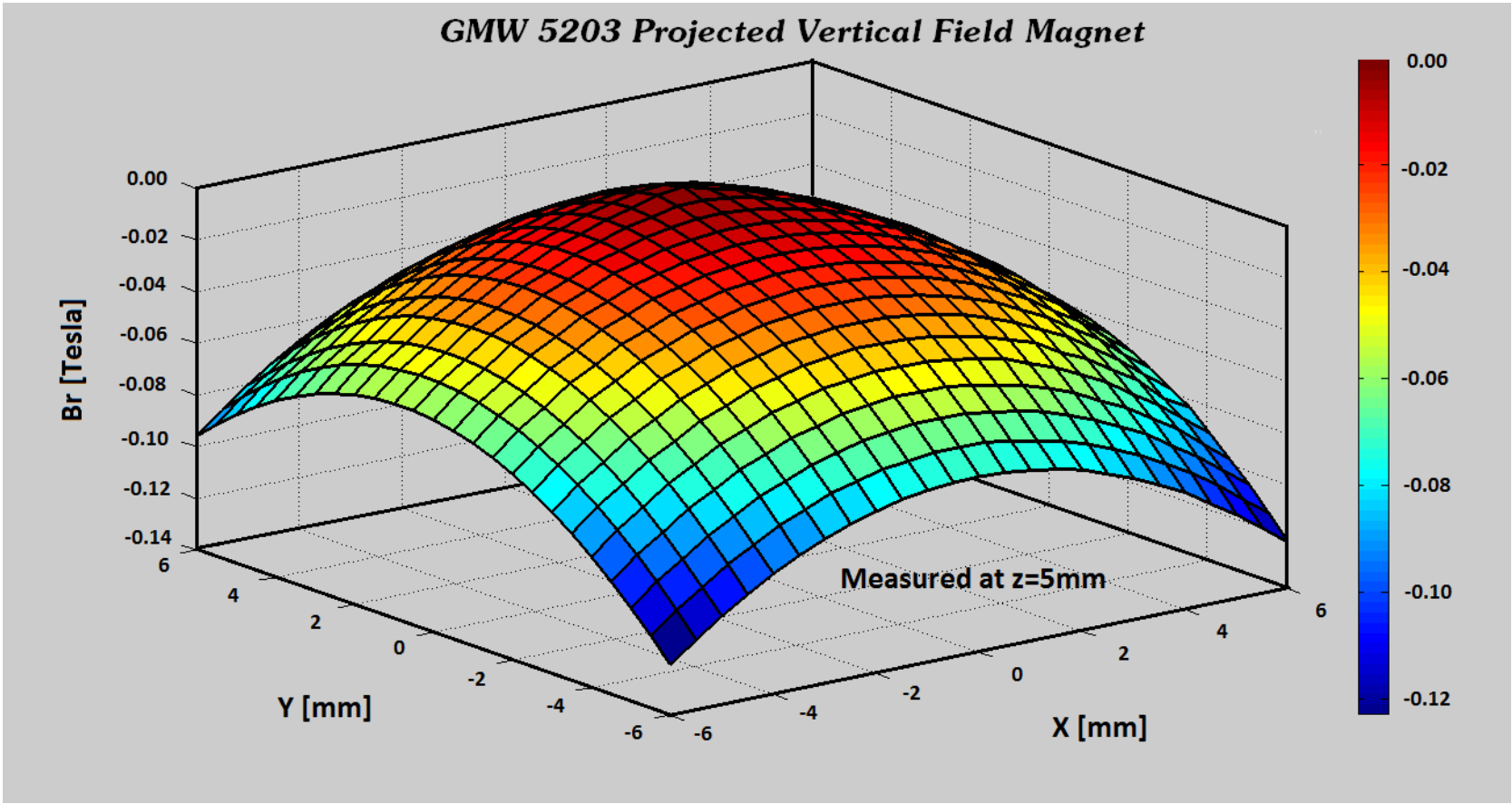

GMW 5203 Projected Vertical Field Magnet
Bz field [G]
By field [G]
z=8mm
Field [Gauss]
Distance along y-axis [mm]
4000
3000
2000
1000
0
-1000
-2000
-40
-30
-20
-10
0
10
20
30
40


GMW 5203 Projected Vertical Field Magnet
Bz field [G]
By field [G]
z=10mm
Field [Gauss]
Distance along y-axis [mm]
3000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-40
-30
-20
-10
0
10
20
30
40


GMW 5203 Projected Vertical Field Magnet
Bz [Tesla]
0.46
0.44
0.42
0.40
0.38
0.36
0.34
Measured at z=3.5mm
Y [mm]
6
4
2
0
-2
-4
-6
X [mm]
-6
-4
-2
0
2
4
6
0.44
0.42
0.40
0.38
0.36


GMW 5203 Projected Vertical Field Magnet
Br [Tesla]
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
Y [mm]
6
4
2
0
-2
-4
-6
X [mm]
-6
-4
-2
0
2
4
6
Measured at z=3.5mm
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12


GMW 5203 - Projected Vertical Field Magnet
Bz [Tesla]
0.38
0.37
0.36
0.35
0.34
Measured at z=5mm
Y [mm]
6
4
2
0
-2
-4
-6
X [mm]
-6
-4
-2
0
2
4
6
0.38
0.375
0.37
0.365
0.36
0.355
0.35
0.355

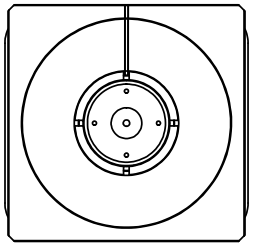

GMW 5203 Projected Vertical Field Magnet
Br [Tesla]
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
Y [mm]
6
4
2
0
-2
-4
-6
X [mm]
-6
-4
-2
0
2
4
6
Measured at z=5mm
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12

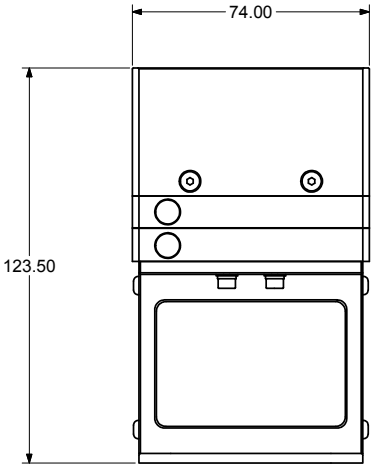
Section 8

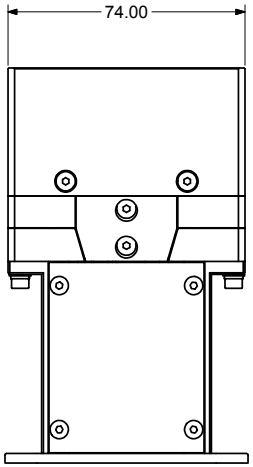
DRAWINGS

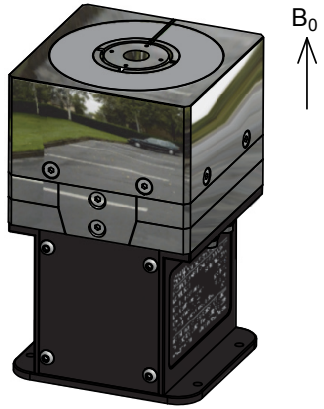
REVISION HISTORY

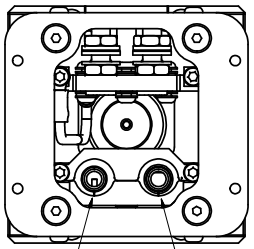
REV	DESCRIPTION	DATE	APPROVED
A	Not Released		
B	Initial Release	10 Sept, 2014	T. King
C	Revision Update	9 Jan, 2015	T. King
D	Update Water Manifold, Coils, Heatsinks, Yoke, and Terminal Block, Add Master Drawing List Sheet	14 May, 2015	T. King







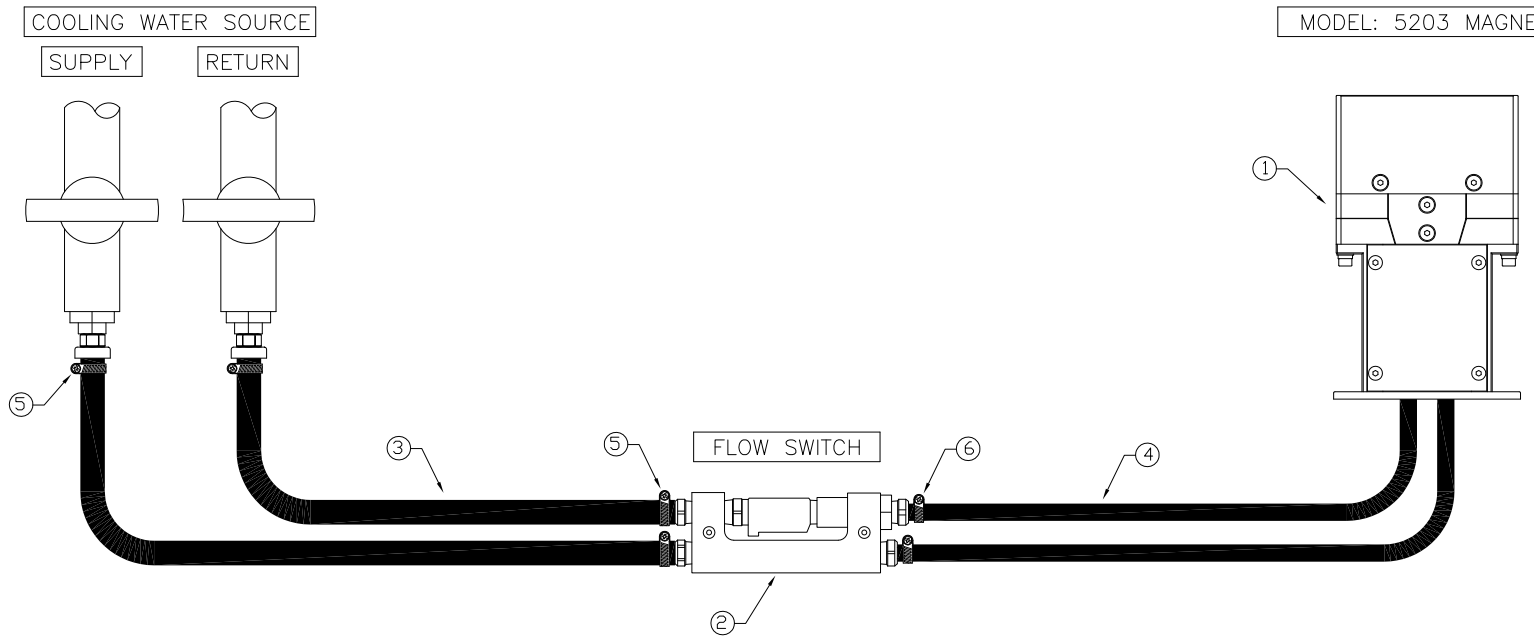




FIELD (Bz max):	0.5T (5.0mm above pole face)
COIL:	
RESISTANCE (20°C):	173mΩ
MAX. RESISTANCE (HOT):	240mΩ
MAX. CONTINUOUS POWER:	60A/14.4V (860W)
WATER COOLING (18°C):	
FLOW:	8 Litre/min
PRESSURE DIFFERENTIAL:	60 psid
MAX PRESSURE:	10 bar (150 psi)
THERMAL INTERLOCK:	Closed below 80°C
MASS:	2.5kg

DRAWN M. Duffy	Date 19 May, 2014	DO NOT SCALE FROM DRAWING	*GMW Associates*
CHECK T. King	Date 8 Sept, 2014	DIMENSIONS & TOLERANCES UNLESS OTHERWISE SPECIFIED	955 Industrial Road, San Carlos, CA 94070
ENGINEERING	Date	LINEAR: INCHES ±.005, mm ±0.03; X.XX ±.01, ±0.1; X.X ±.05, ±0.3; X ±.06, ±1; DEG ±.5, ±0.5; FINISH 63, 1.6	Tel: (650) 802-8292. Fax: (650) 802-8298
		THIRD ANGLE PROJECTION	TITLE: 5203 PVFM General Assembly
			SIZE A2 · DRAWING No. 11907-0224-0 · REV D
			SCALE: 0.9:1 · WT: ~ kg · SHEET: 2 OF: 4

REVISIONS				
REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE		——	–



NOTE:
1: WATER SOURCE MAY BE EITHER FACILITY WATER OR CHILLER
2: IT IS RECOMMENDED THAT THE SOURCE WATER BE FILTERED
3: RECOMMENDED FLOW RATE 8 lpm [2.11 gpm]
4: FLOW SWITCH OPENS BELOW 5.3 lpm [1.4 gpm]

ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE
6	2	6202	Hose Clamp, 1/4 – 5/8", Ideal/Tridon	
5	4	6203	Hose Clamp, 5/16 – 7/8", Ideal/Tridon	
4	A/R	56901406430600	Push On Hose, 1/4", Goodyear Instagrip	
3	A/R	56901412728400	Push On Hose, 1/2", Goodyear Instagrip	
2	2	11907–0288–0	Water Flow Switch Manifold Assembly	
1	1	5203	5203 Electromagnet	

PARTS LIST

DRAWN M. Duffy DATE 4 Dec, 14
CHECK T. King DATE 18 Mar,15
ENGINEERING DATE
5201
NEXT ASSY SYSTEM
SOFTWARE AUTOCAD 2000

DO NOT SCALE FROM DRAWING
DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)

LINEAR	INCHES	mm
X.XXX	±.005	±0.03
X.XX	±.01	±0.1
X.X	±.03	±0.3
X	±.06	±1
DEG.	±.5	±0.5
FINISH	63	1.6

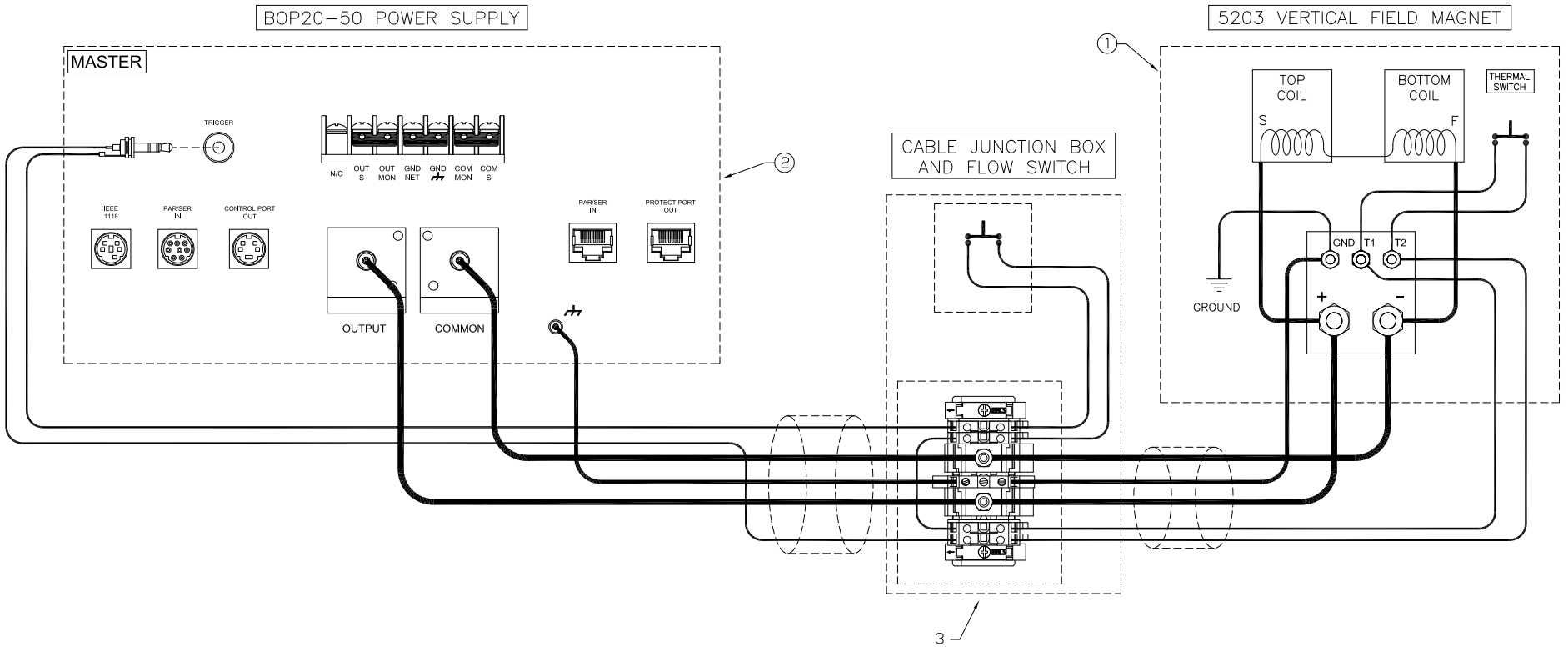
THIRD ANGLE PROJECTION

GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802–8292. Fax: (650)802–8298.

TITLE
5203 VPFM
COOLING SYSTEM

SIZE A1 | DRAWING NO. 11907–0285–0 | REV A
SCALE NTS | WT kg | SHEET 1 OF 1

REVISIONS				
REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE		———	–



NOTE:
1. ITEM 3 – CABLE ASSEMBLY INCLUDES CABLE JUNCTION BOX, FLOW SWITCH, INPUT, AND OUTPUT CABLES

ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE
3	1	16907–0116–0	CABLE, CURRENT AND INTERLOCK, 70A	
2	1	BOP20–50	KEPCOP BIPOLAR POWER SUPPLY	
1	1	5203	PROJECTED VERTICAL FIELD ELECTROMAGNET	

PARTS LIST

DRAWN	M. Duffy	DATE	5 Dec, 14
CHECK	T. King	DATE	18 Mar, 15
ENGINEERING		DATE	
	5203		
NEXT ASSY		SYSTEM	
SOFTWARE	AUTOCAD 2000		

DO NOT SCALE FROM DRAWING
DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)

LINEAR	INCHES	mm
X.XXX	±.005	±0.03
X.XX	±.01	±0.1
X.X	±.03	±0.3
X	±.06	±1
DEG.	±.5	±0.5
FINISH	63	1.6

THIRD ANGLE PROJECTION

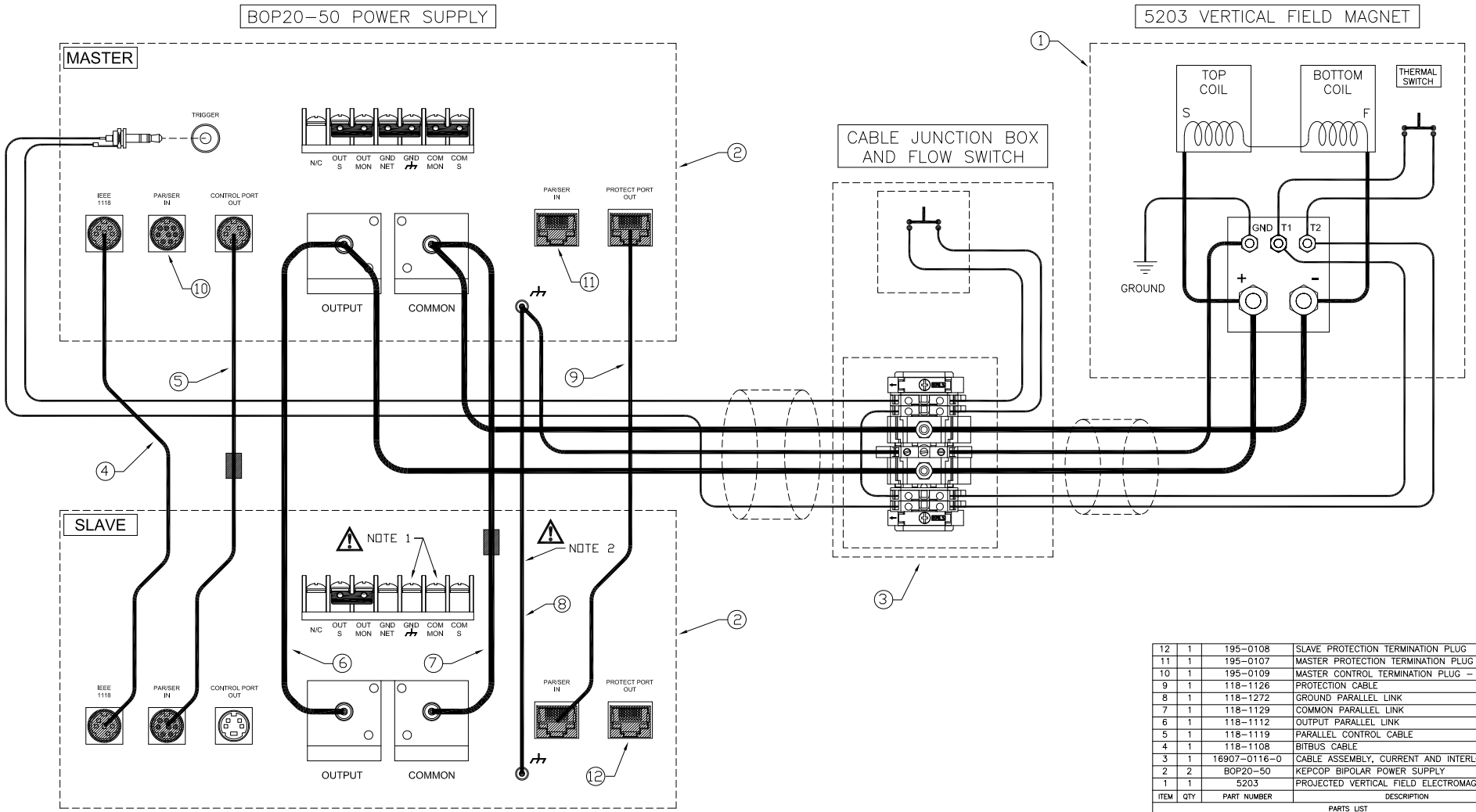
GMW
955 Industrial Rd, San Carlos, CA 94070
Tel: (650)802–8292. Fax: (650)802–8298.

TITLE
ELECTRICAL WIRING
5203 & 1x BOP20–50

SIZE	DRAWING NO.	REV
A1	13907–0025–0	A

SCALE NTS | WT kg | SHEET 1 OF 1

REVISIONS				
REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE		———	–



ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE
12	1	195–0108	SLAVE PROTECTION TERMINATION PLUG	
11	1	195–0107	MASTER PROTECTION TERMINATION PLUG	
10	1	195–0109	MASTER CONTROL TERMINATION PLUG – 'IN'	
9	1	118–1126	PROTECTION CABLE	
8	1	118–1272	GROUND PARALLEL LINK	
7	1	118–1129	COMMON PARALLEL LINK	
6	1	118–1112	OUTPUT PARALLEL LINK	
5	1	118–1119	PARALLEL CONTROL CABLE	
4	1	118–1108	BITBUS CABLE	
3	1	16907–0116–0	CABLE ASSEMBLY, CURRENT AND INTERLOCK, 70A	
2	2	BOP20–50	KEPCOP BIPOLAR POWER SUPPLY	
1	1	5203	PROJECTED VERTICAL FIELD ELECTROMAGNET	

PARTS LIST

NOTE:
1. REMOVE LINKS AS SHOWN – FAILURE TO DO SO MAY RESULT IN DAMAGE THE POWER SUPPLY.
2. FAILURE TO INSTALL GROUND LINK MAY RESULT IN DAMAGE TO THE POWER SUPPLY.
3. ITEM 3 – CABLE ASSEMBLY INCLUDES CABLE JUNCTION BOX, FLOW SWITCH, INPUT, AND OUTPUT CABLES
4. ITEMS 4 – 12 ARE PROVIDED IN KEPCO PARALLEL KIT P/N: 219–0449.

DRAWN	M. Duffy	DATE 5 Dec, 14
CHECK	T. King	DATE 18 Mar, 15
ENGINEERING		DATE
NEXT ASSY	5203	SYSTEM
SOFTWARE	AUTOCAD 2000	

DO NOT SCALE FROM DRAWING
DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED)

	LINEAR INCHES	LINEAR mm
X.XXX	±.005	±0.03
X.XX	±.01	±0.1
X.X	±.03	±0.3
X	±.06	±1
DEG.	±.5	±0.5
FINISH	63 ✓	1.6 ✓

THIRD ANGLE PROJECTION

GMW
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TITLE
ELECTRICAL WIRING
5203 & 2x BOP20–50

SIZE	DRAWING NO.	REV
A1	13907–0026–0	A

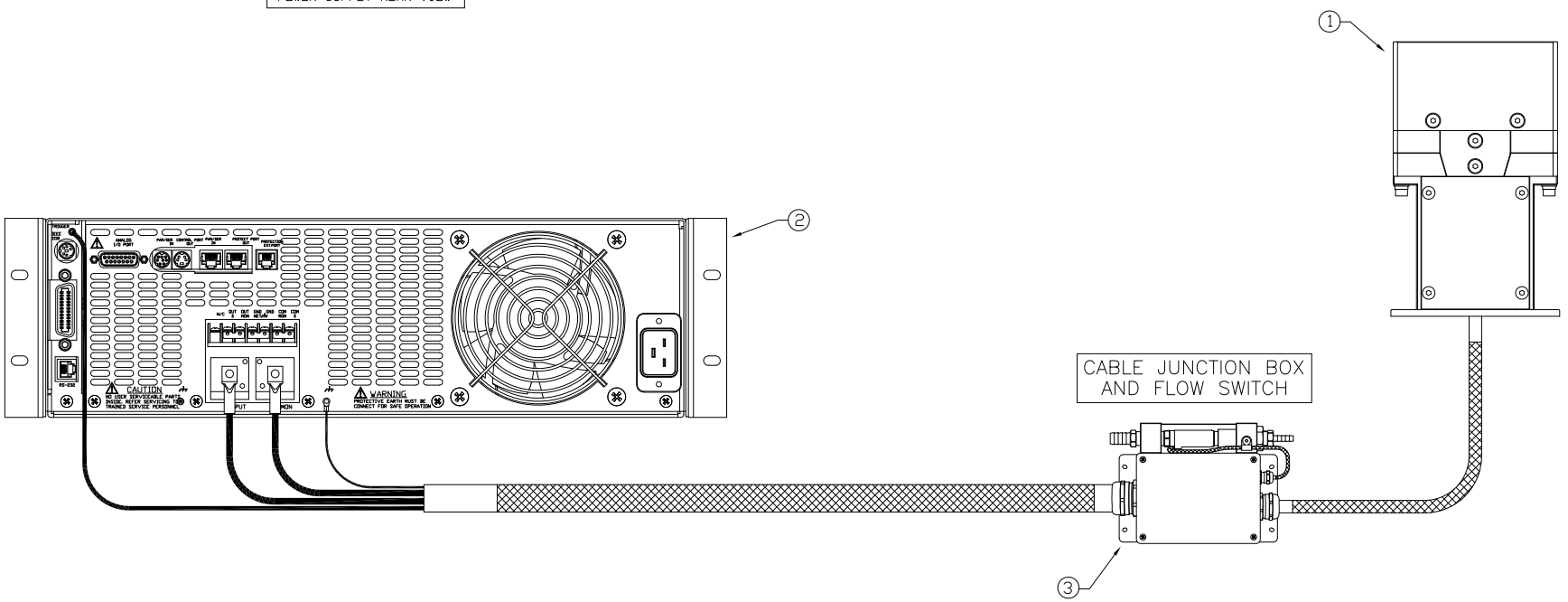
SCALE NTS | WT kg | SHEET 1 OF 1

REVISIONS				
REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE		——	–

BOP20-50 BIPOLAR POWER SUPPLY

POWER SUPPLY REAR VIEW

5203 VERTICAL FIELD MAGNET



NOTE:
1. ITEM 3 – CABLE ASSEMBLY INCLUDES CABLE JUNCTION BOX, FLOW SWITCH, INPUT, AND OUTPUT CABLES

ITEM	QTY	PART NUMBER	DESCRIPTION	NOTE
3	1	16907-0116-0	CABLE, CURRENT AND INTERLOCK, 70A	
2	1	BOP20-50	KEPCOP BIPOLAR POWER SUPPLY	
1	1	5203	PROJECTED VERTICAL FIELD ELECTROMAGNET	

PARTS LIST

DRAWN M. Duffy	DATE 5 Dec, 14	DO NOT SCALE FROM DRAWING (DIMENSIONS & TOLERANCES (UNLESS OTHERWISE SPECIFIED))
CHECK	DATE	
ENGINEERING	DATE	
		5203
NEXT ASSY	SYSTEM	
SOFTWARE AUTOCAD 2000		

LINEAR	INCHES	mm
X.XXX	±.005	±0.03
X.XX	±.01	±0.1
X.X	±.03	±0.3
X	±.06	±1
DEG.	±.5	±0.5
FINISH	63	1.6

THIRD ANGLE PROJECTION

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TITLE
ELECTRICAL ASSY
5203 / BOP20-50

SIZE	DRAWING NO.	REV
A1	11907-0281-0	A

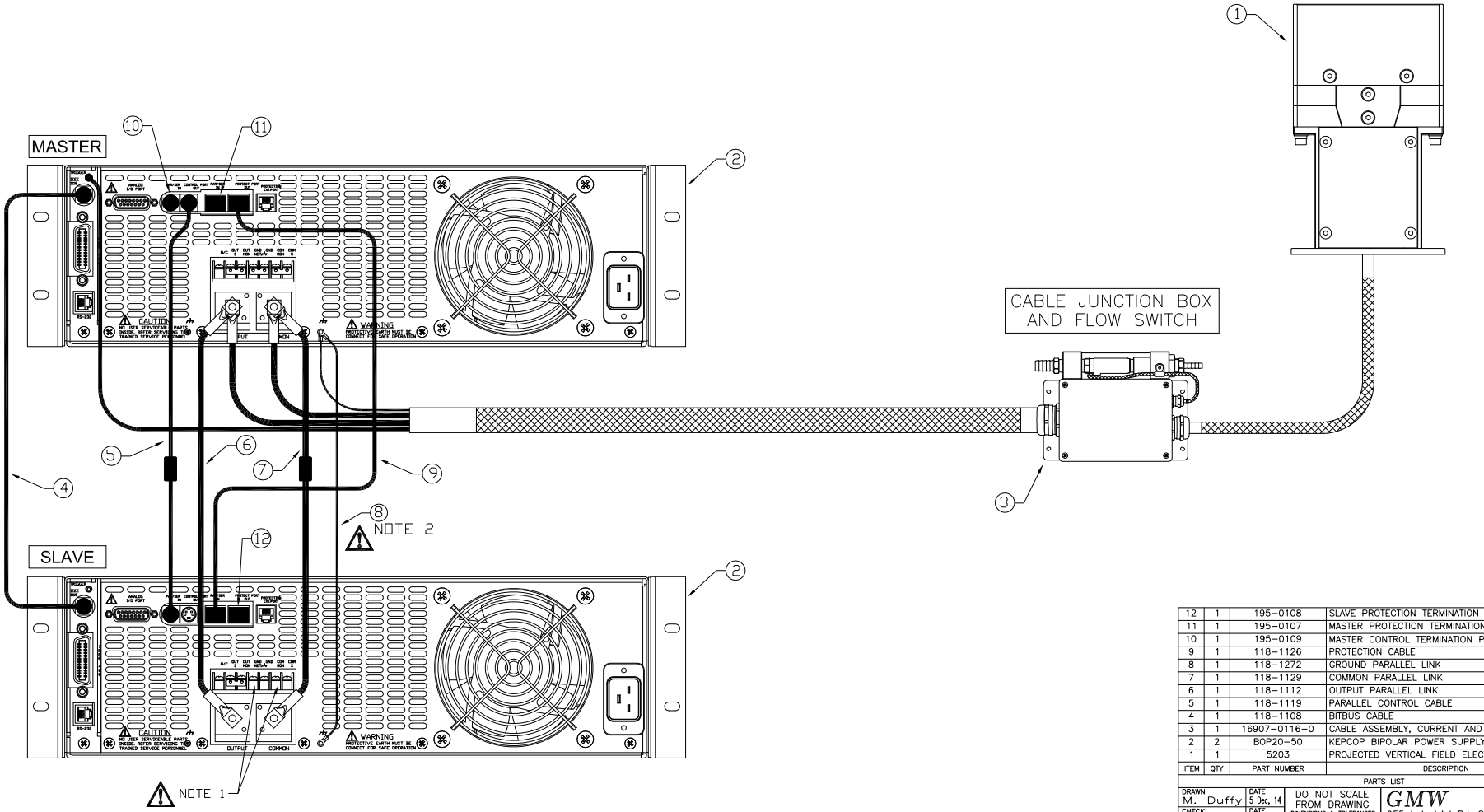
SCALE NTS | WT kg | SHEET 1 OF 1

REVISIONS				
REV	DESCRIPTION	DRAFT	DATE	APPROVED
A	RELEASE			–

BOP20–50 BIPOLAR POWER SUPPLY

POWER SUPPLY REAR VIEW

5203 VERTICAL FIELD MAGNET



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PARTS LIST

DRAWN	M. Duffy	DATE	5 Dec, 14
CHECK		DATE	
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5203 / BOP20–50

SIZE	DRAWING NO.	REV
A1	11907–0282–0	A

SCALE NTS | WT kg | SHEET 1 OF 1