

**Magnetic Measurement Results in
the AGS Cold Snake HSD601
(a.k.a. DSM101)**

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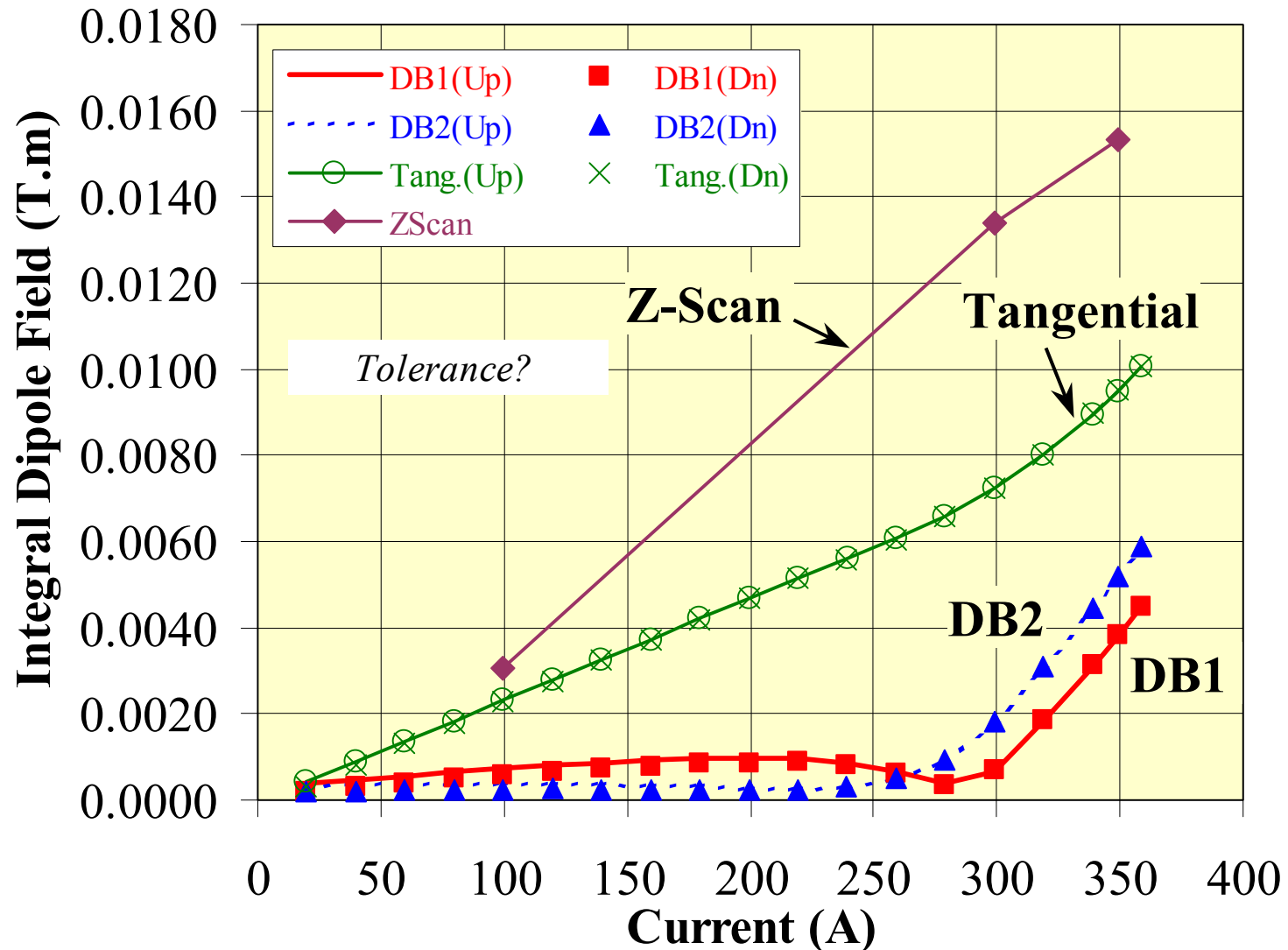
Measurements in the Cold Snake (HSD601)

- Integral dipole field in the main helical magnet:
 - Full excitation curve using a 3.58 m long rotating coil.
 - 3 separate windings (DB1, DB2 and Tangential).
 - Integral from axial scans at 100 A, 300 A and 350 A.
 - Solenoid corrector was off during the measurements.
 - Results are subject to large uncertainties due to impact of measuring coil construction errors in a helical field.
- Integral harmonics in the dipole correctors:
 - Main dipole powered at 350 A; solenoid off.
 - Harmonics measured at 24 mm radius, but scaled to 31 mm reference radius (for consistency).

Measurements in the Cold Snake (Contd.)

- Axial scans using 51 mm long coil:
 - 67 axial positions in 2 inch steps, covering ~3.4 m.
 - Measurements at 100 A, 300 A and 350 A.
 - Harmonics at 31 mm radius (only 30% of coil radius):
 - only a few low order harmonics are significant.
- Excitation curves in the straight section:
 - Using a 51 mm long, 34 mm radius rotating coil.
 - 3 axial positions; roughly at the centers of the three sections with a well defined pitch:
 - axial center and ± 29.5 inch (~ 0.75 m) from center.
 - Solenoid corrector was off during the measurements.
 - Measurements at 20 A to 360 A; both Up & Dn ramps.

Integral Dipole Field in the AGS Cold Snake

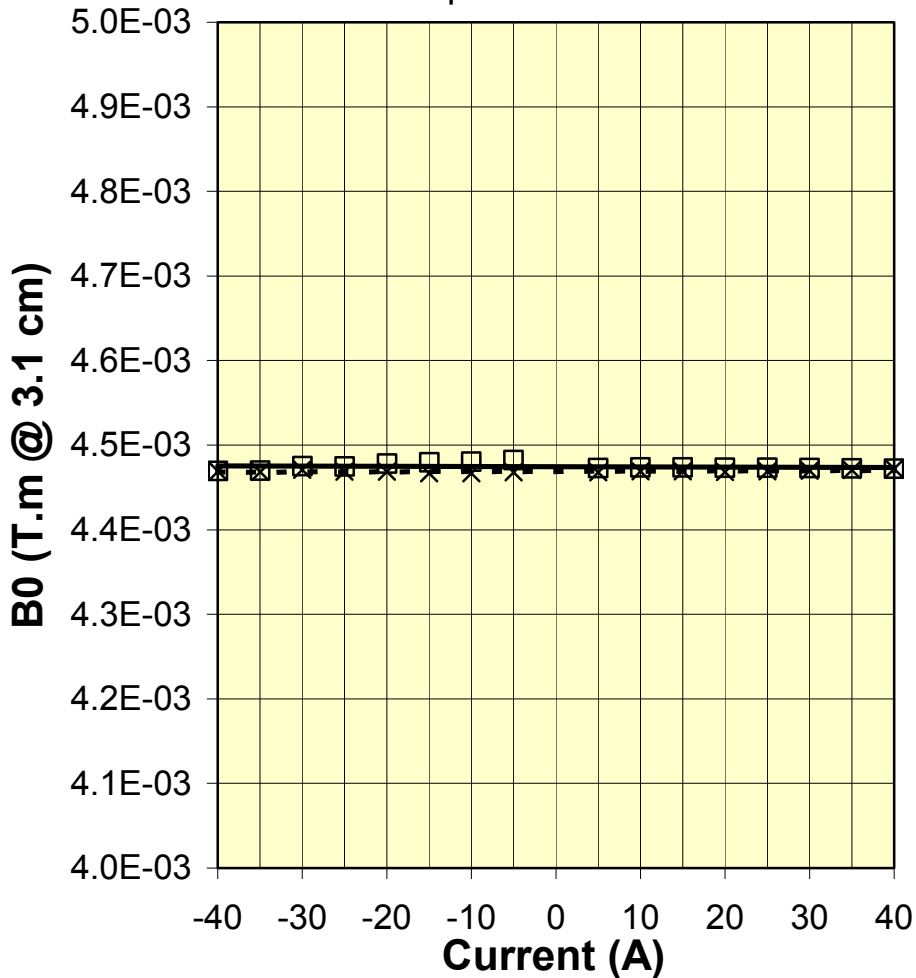


Integral Field: Dipole Correctors

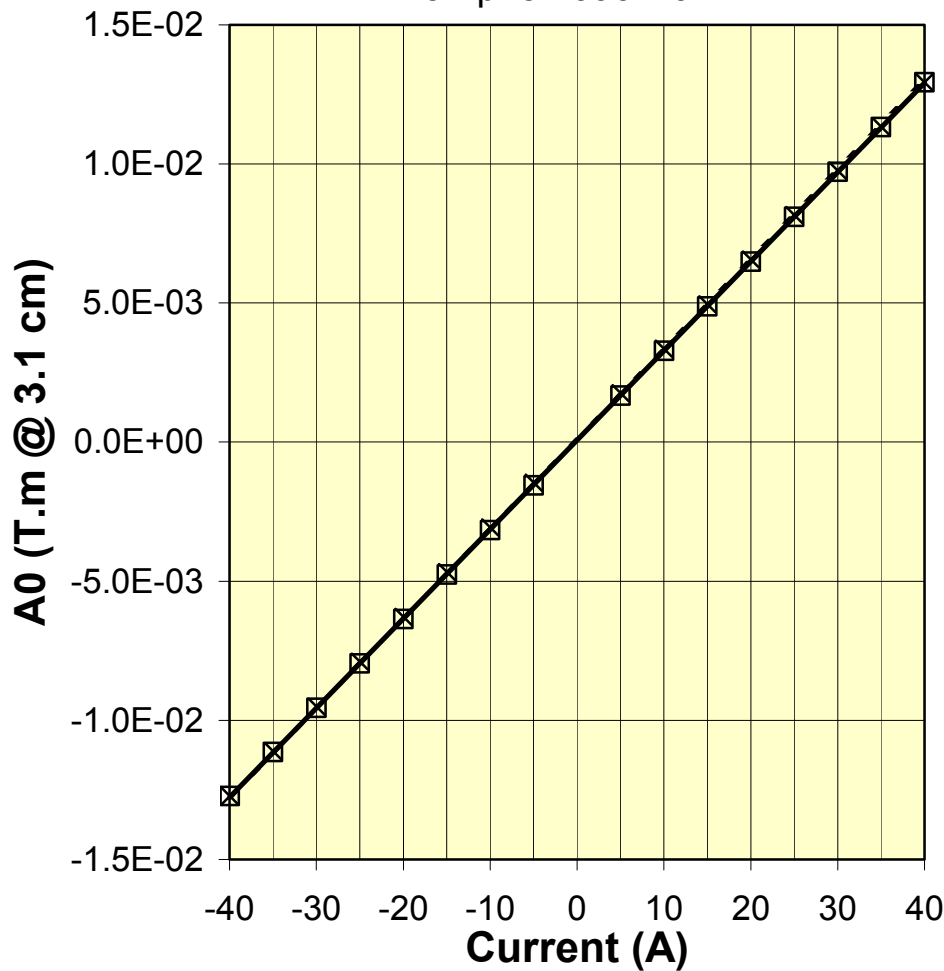
- Two dipole correctors – one on each end.
- Measured with the main dipole powered at 350 A.
- Solenoid is not powered during the measurements.
- Measurements from +5 A to +40 A, and –5 A to –40 A; both up and down ramps.
- Transfer function and harmonics are obtained from the **slope** of a straight line fitted to the normal and skew harmonics as a function of current.
- The **intercept** of the line gives background field from the main dipole.
- **Measurements at 24 mm radius, scaled to 31 mm.**

AGS Cold Snake HSD601 LE Corrector Dipole (Runs 110 through 113)

□ Up Ramp: $-2.3078\text{E-}05$ T.m/kA
× Dn Ramp: $2.2240\text{E-}05$ T.m/kA

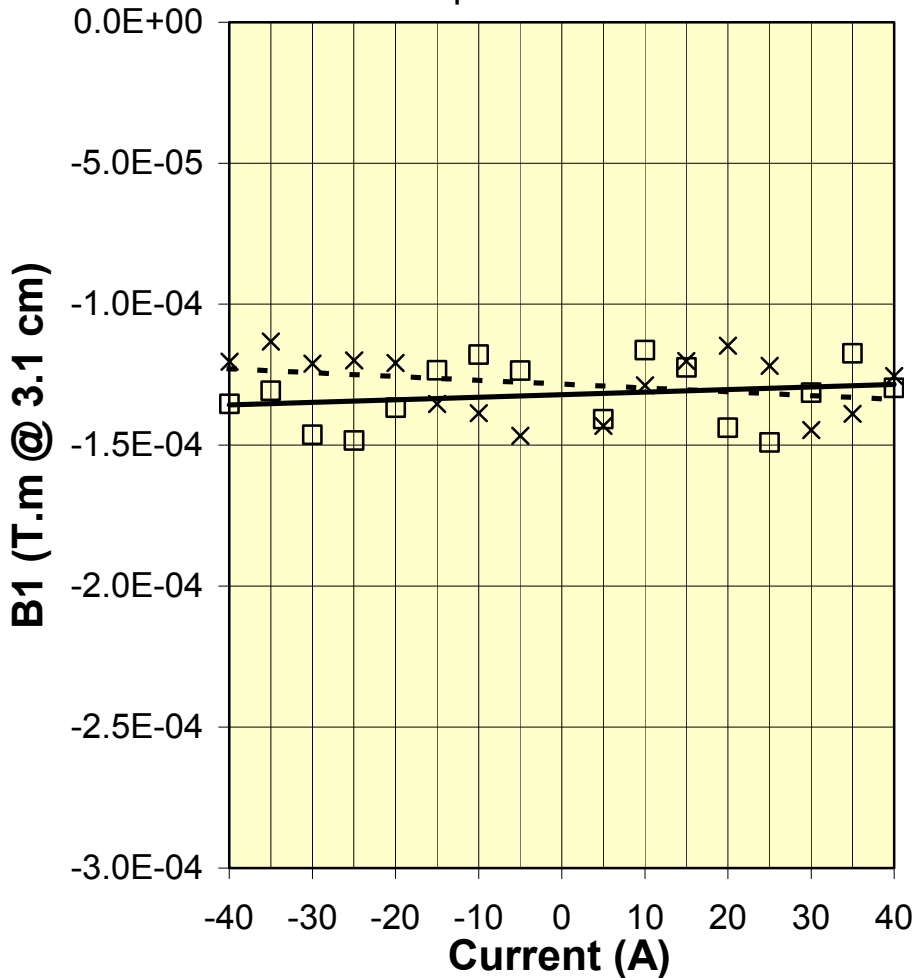


□ Up Ramp: $3.2104\text{E-}01$ T.m/kA
× Dn Ramp: $3.2096\text{E-}01$ T.m/kA

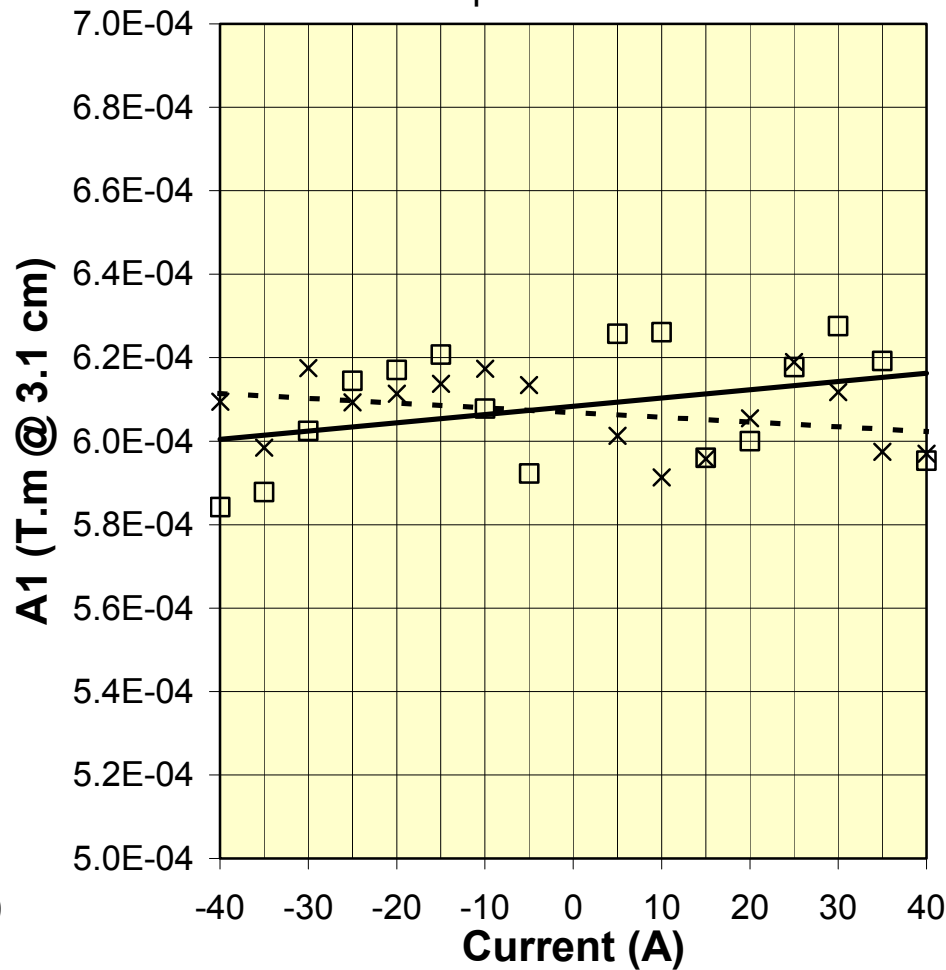


AGS Cold Snake HSD601 LE Corrector Dipole (Runs 110 through 113)

□ Up Ramp: $9.0849\text{E-}05$ T.m/kA
× Dn Ramp: $-1.3594\text{E-}04$ T.m/kA

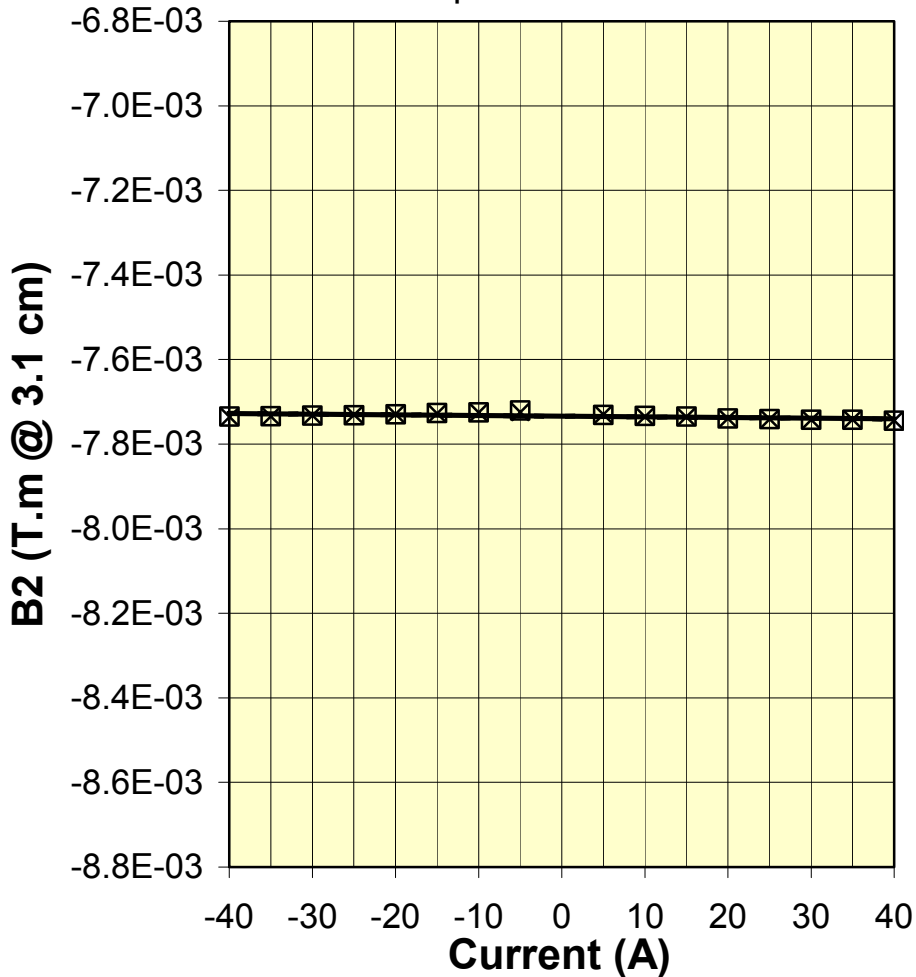


□ Up Ramp: $1.9788\text{E-}04$ T.m/kA
× Dn Ramp: $-1.1542\text{E-}04$ T.m/kA

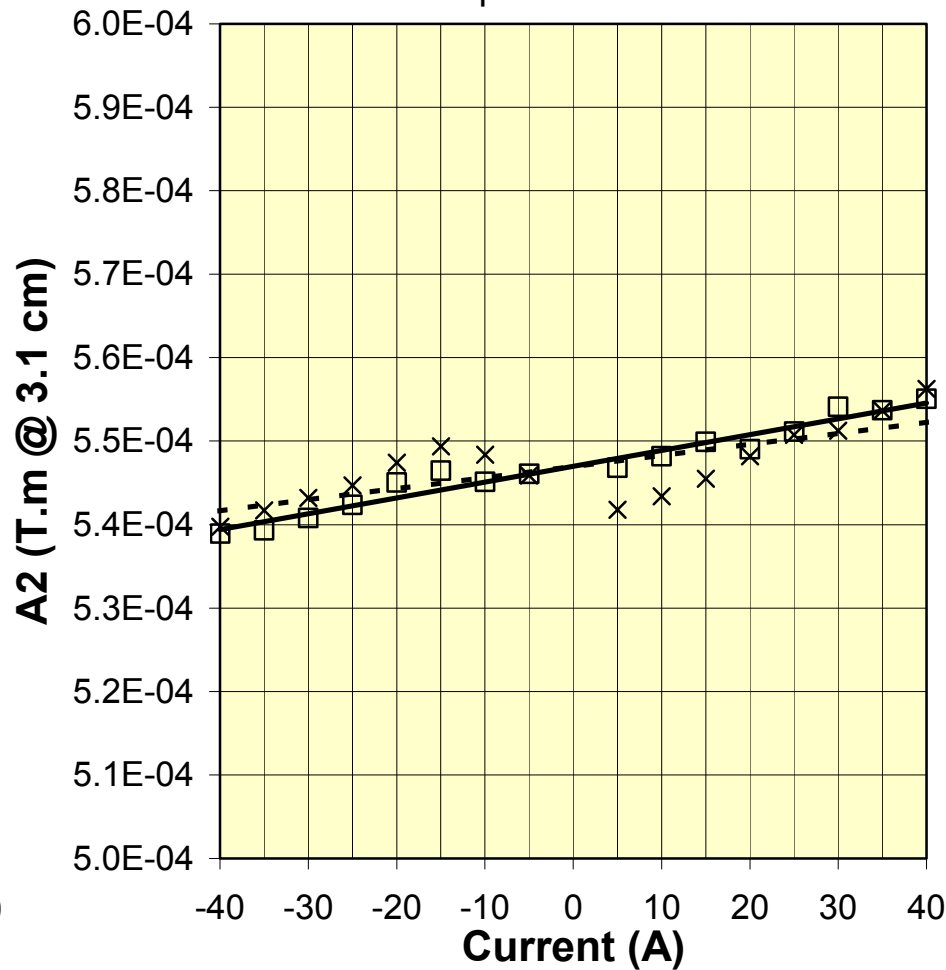


AGS Cold Snake HSD601 LE Corrector Dipole (Runs 110 through 113)

□ Up Ramp: $-1.5919\text{E-}04$ T.m/kA
× Dn Ramp: $-1.6294\text{E-}04$ T.m/kA

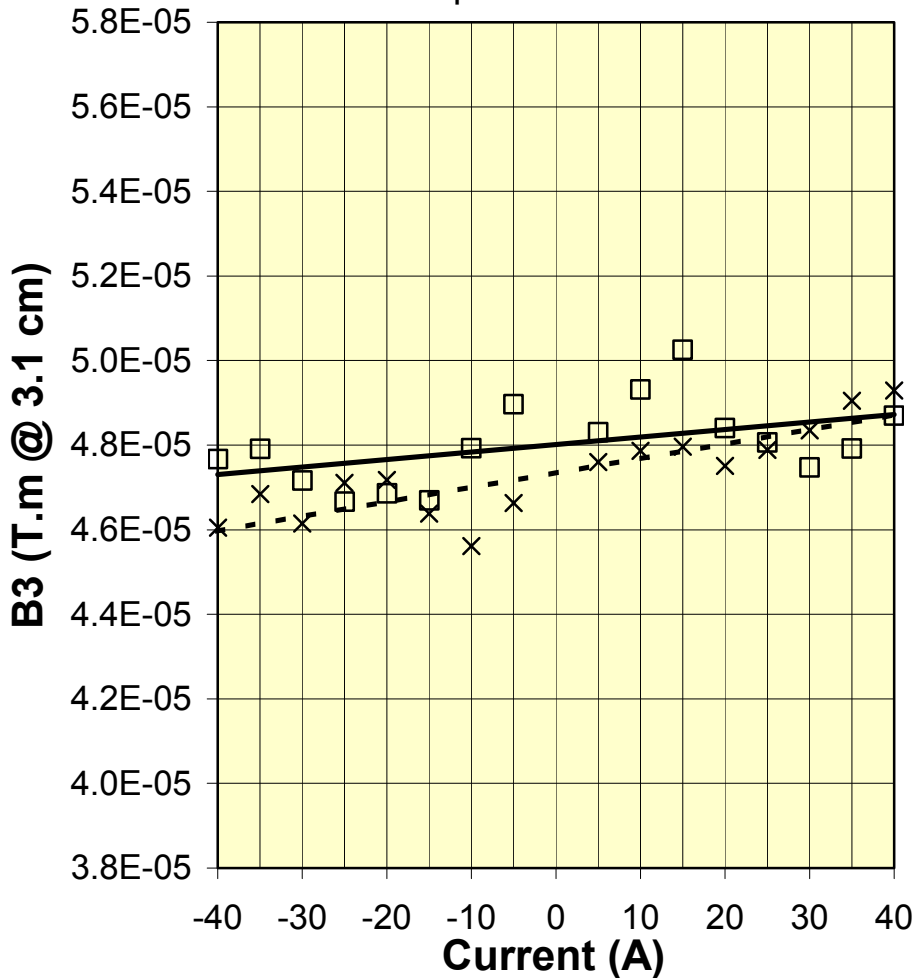


□ Up Ramp: $1.8955\text{E-}04$ T.m/kA
× Dn Ramp: $1.3315\text{E-}04$ T.m/kA

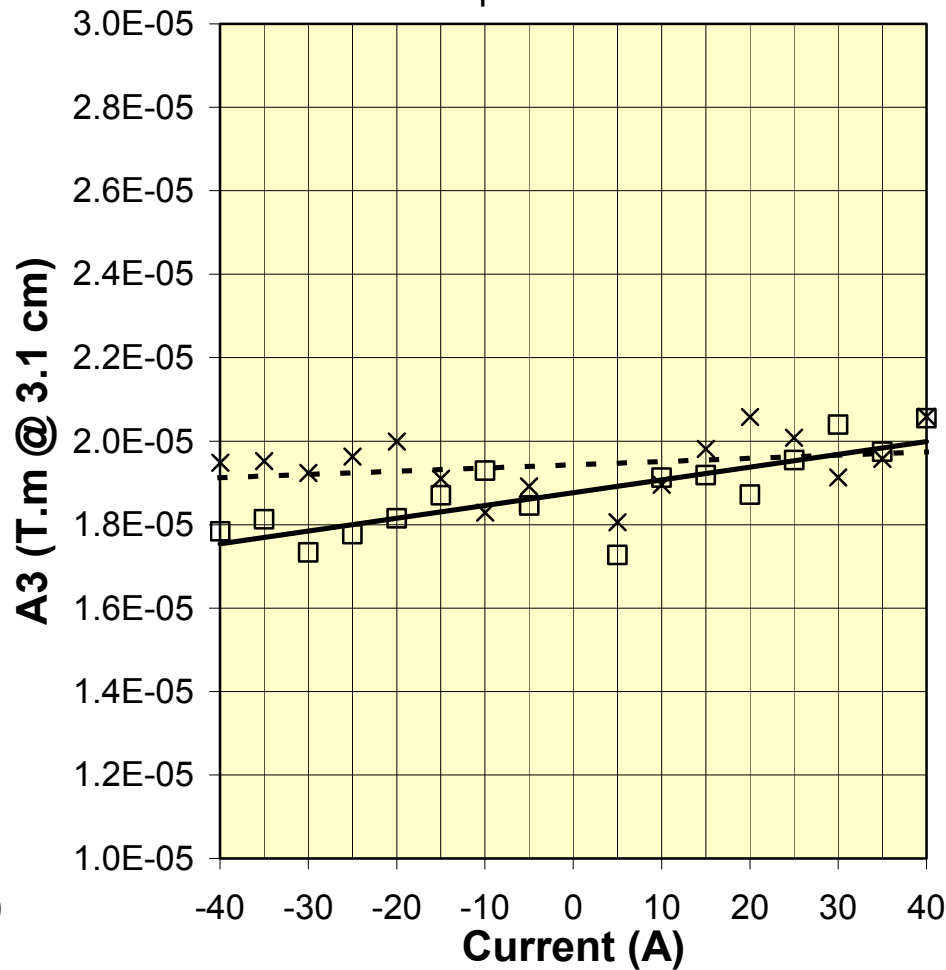


AGS Cold Snake HSD601 LE Corrector Dipole (Runs 110 through 113)

□ Up Ramp: $1.7737\text{E-}05$ T.m/kA
× Dn Ramp: $3.4321\text{E-}05$ T.m/kA

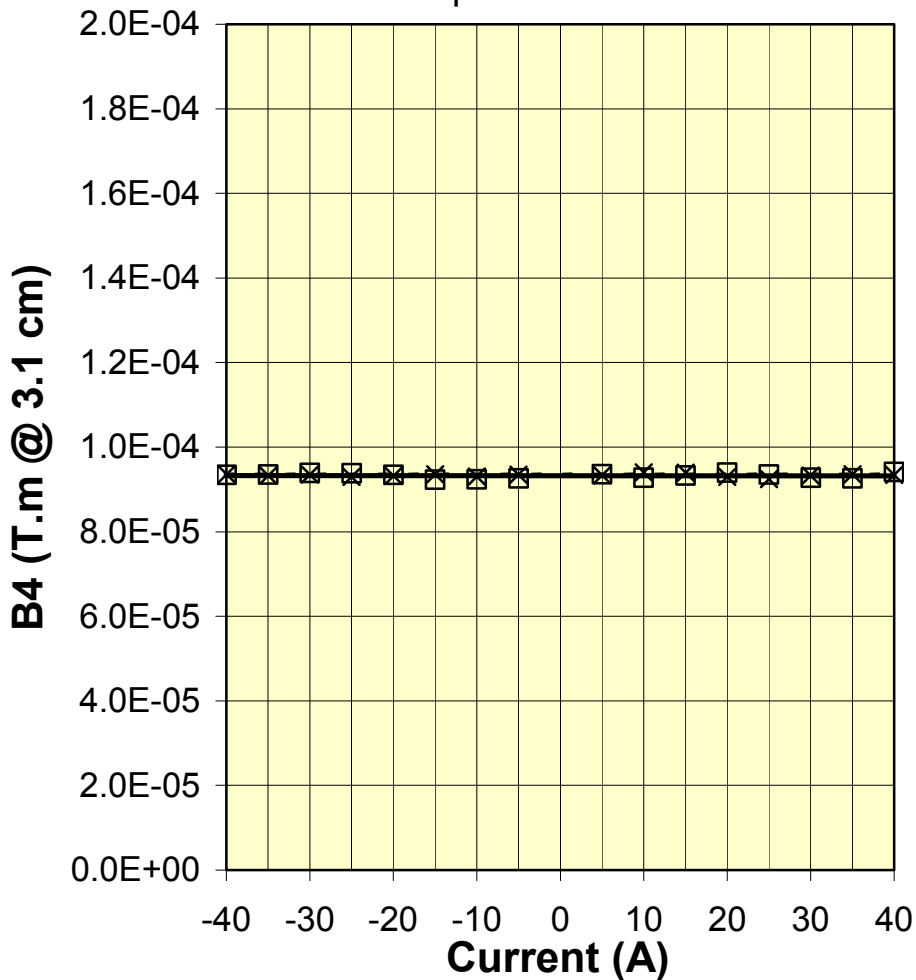


□ Up Ramp: $3.0611\text{E-}05$ T.m/kA
× Dn Ramp: $7.7465\text{E-}06$ T.m/kA

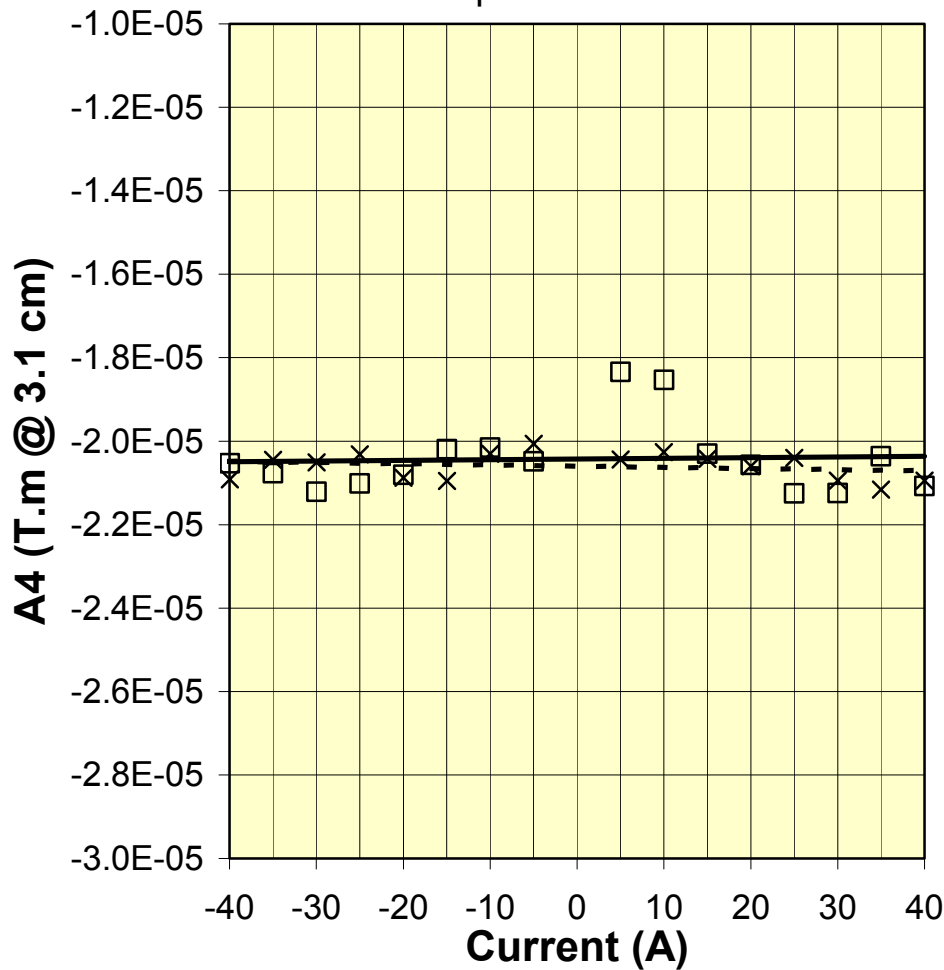


AGS Cold Snake HSD601 LE Corrector Dipole (Runs 110 through 113)

□ Up Ramp: -1.3635×10^{-6} T.m/kA
× Dn Ramp: -5.1201×10^{-7} T.m/kA



□ Up Ramp: 1.5516×10^{-6} T.m/kA
× Dn Ramp: -2.8985×10^{-6} T.m/kA

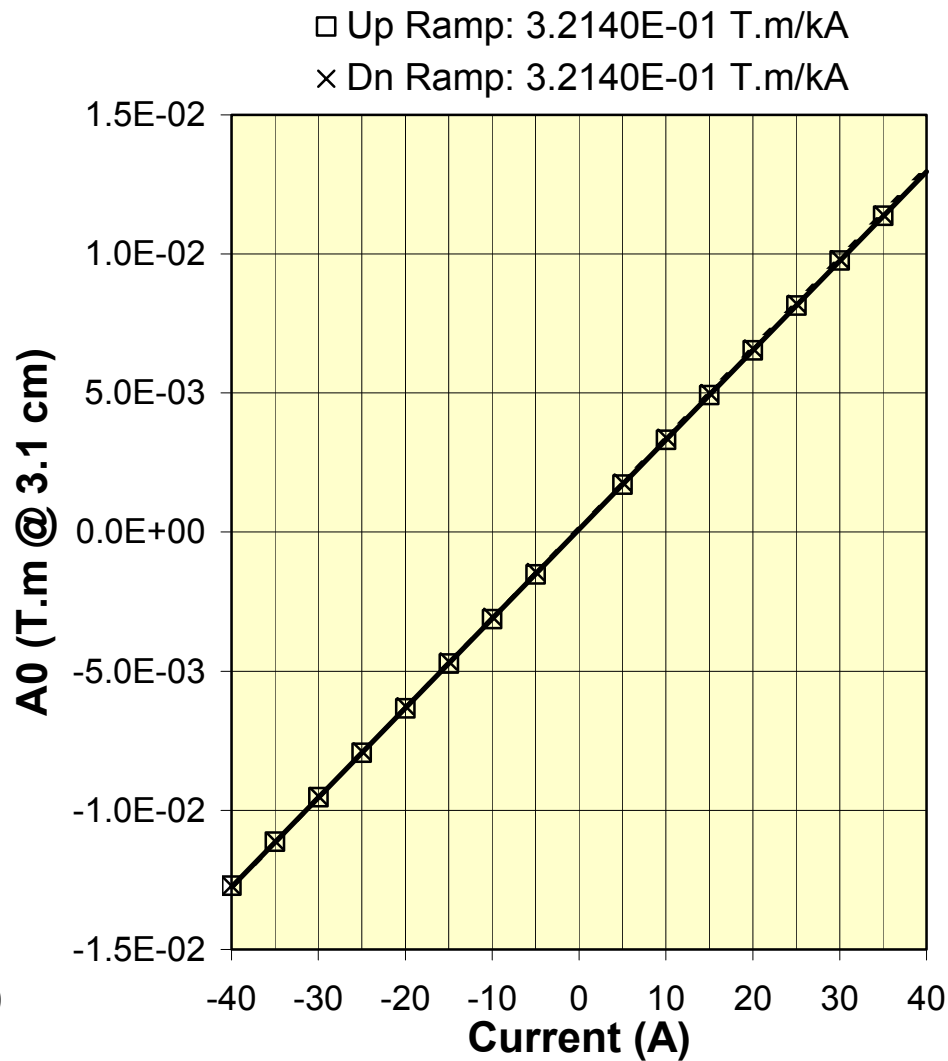
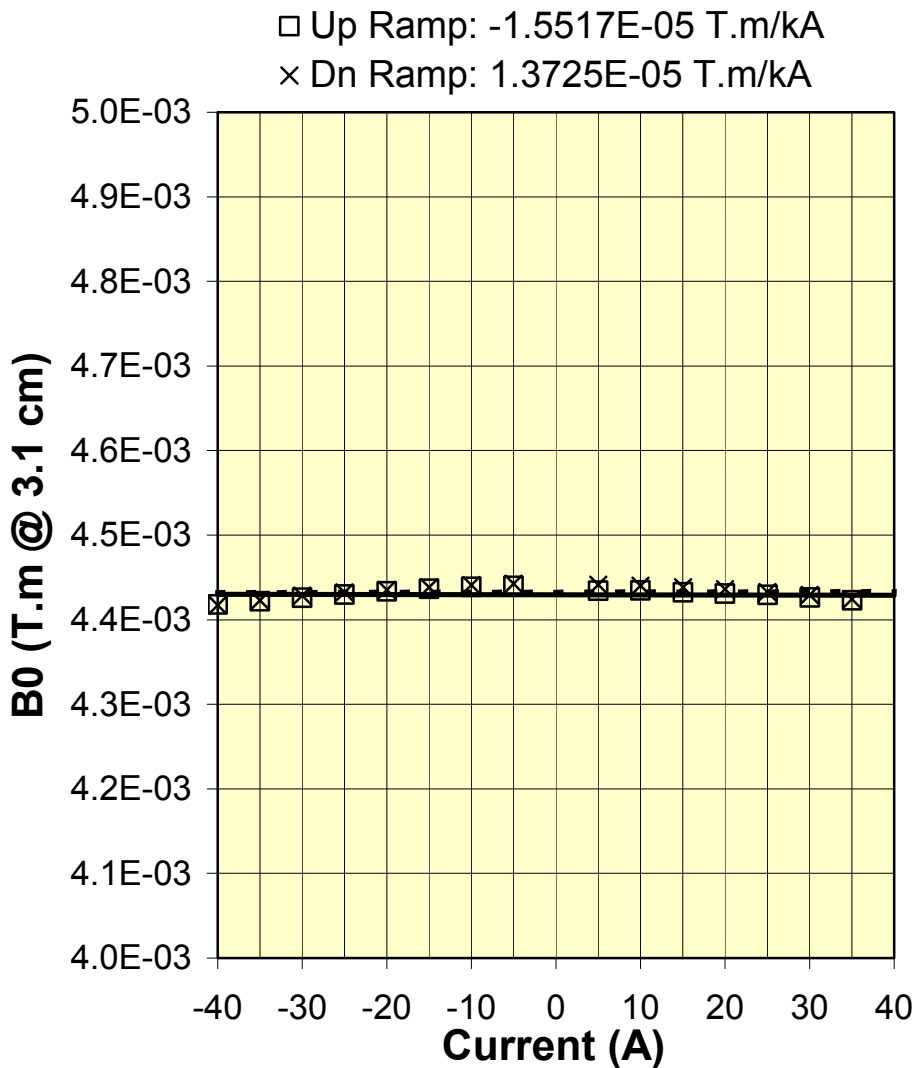


Lead End Corrector: Integral Harmonics

ITF(Up)	ITF(Dn)
0.3210	0.3210
T.m/kA	T.m/kA

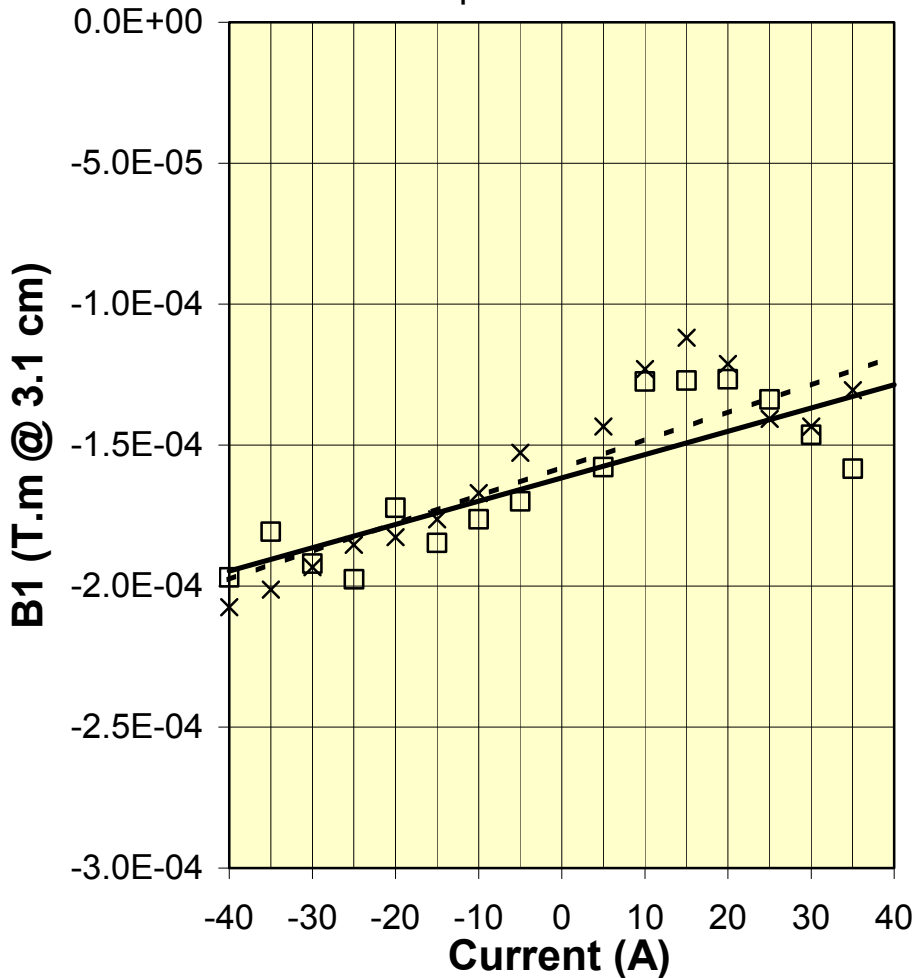
n	"True" Fields ("units" at 3.1cm radius)			
	Bn(Up)	An(Up)	Bn(Dn)	An(Dn)
0	-0.7	10000.0	0.7	10000.0
1	2.8	6.2	-4.2	-3.6
2	-5.0	5.9	-5.1	4.1
3	0.6	1.0	1.1	0.2
4	0.0	0.0	0.0	-0.1
5	-0.3	-0.5	0.4	-0.5
6	-0.1	0.4	0.1	0.3
7	0.2	0.1	-0.1	-0.4
8	0.1	-0.7	-0.2	0.4
9	-0.5	0.3	0.7	0.0
10	1.4	1.2	-0.8	-0.8

AGS Cold Snake HSD601 NLE Corrector Dipole (Runs 105 through 108)

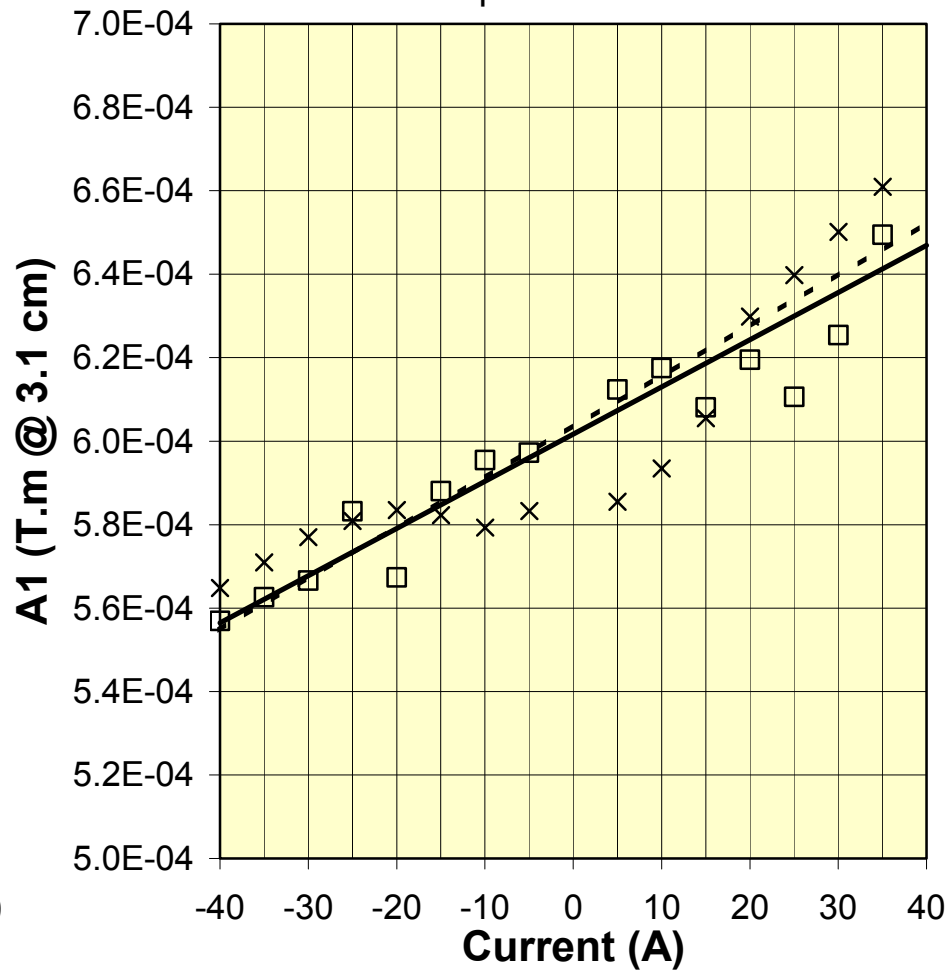


AGS Cold Snake HSD601 NLE Corrector Dipole (Runs 105 through 108)

□ Up Ramp: $8.2649\text{E-}04$ T.m/kA
× Dn Ramp: $9.9217\text{E-}04$ T.m/kA

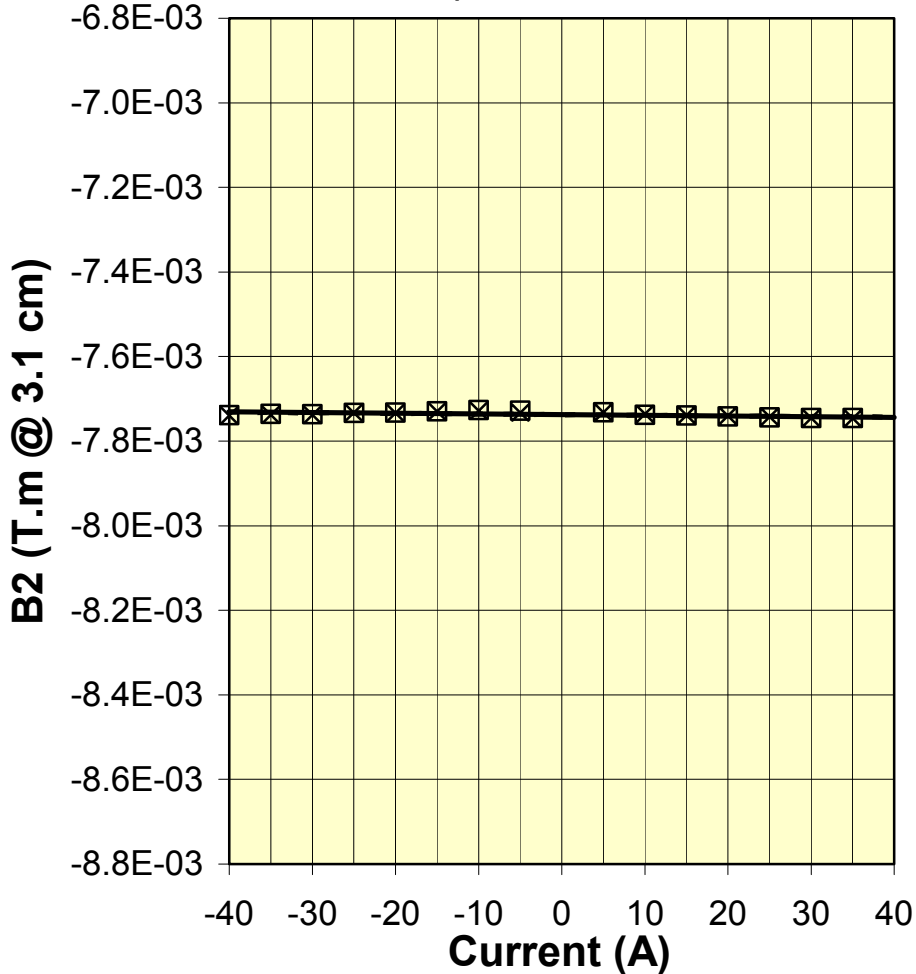


□ Up Ramp: $1.1314\text{E-}03$ T.m/kA
× Dn Ramp: $1.2203\text{E-}03$ T.m/kA

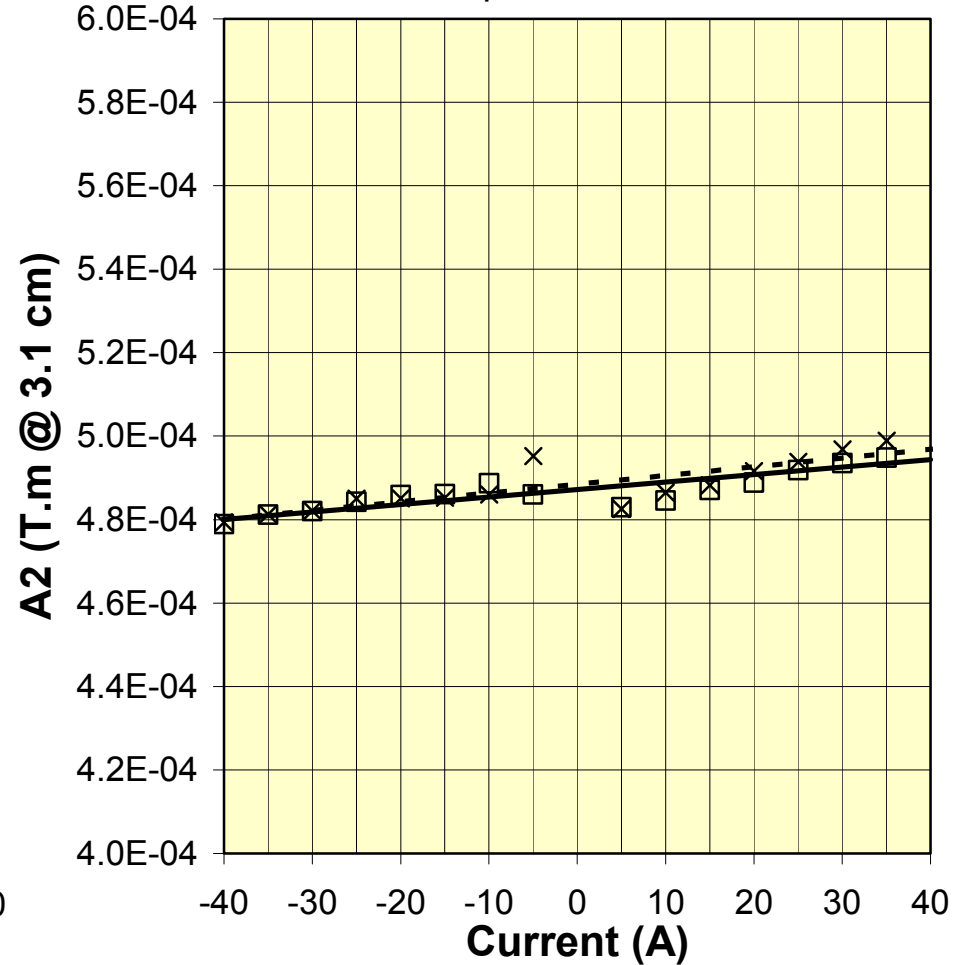


AGS Cold Snake HSD601 NLE Corrector Dipole (Runs 105 through 108)

□ Up Ramp: $-1.6388\text{E-}04$ T.m/kA
× Dn Ramp: $-1.4113\text{E-}04$ T.m/kA

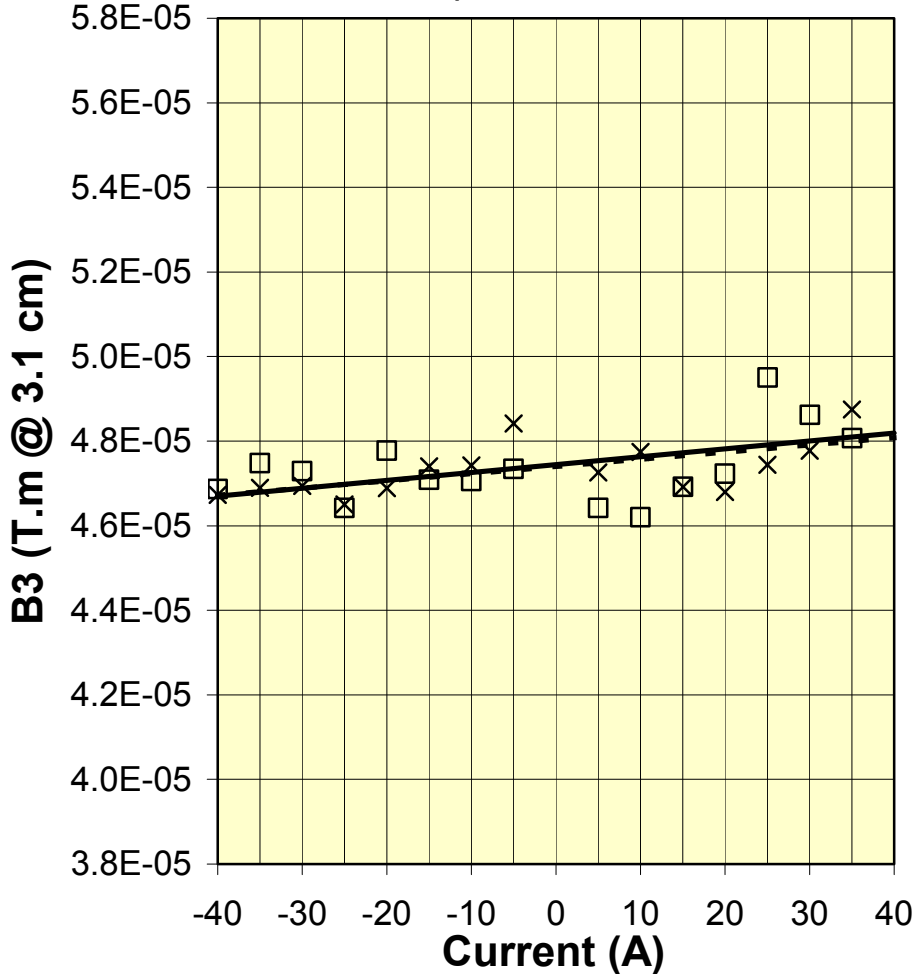


□ Up Ramp: $1.7828\text{E-}04$ T.m/kA
× Dn Ramp: $2.1058\text{E-}04$ T.m/kA

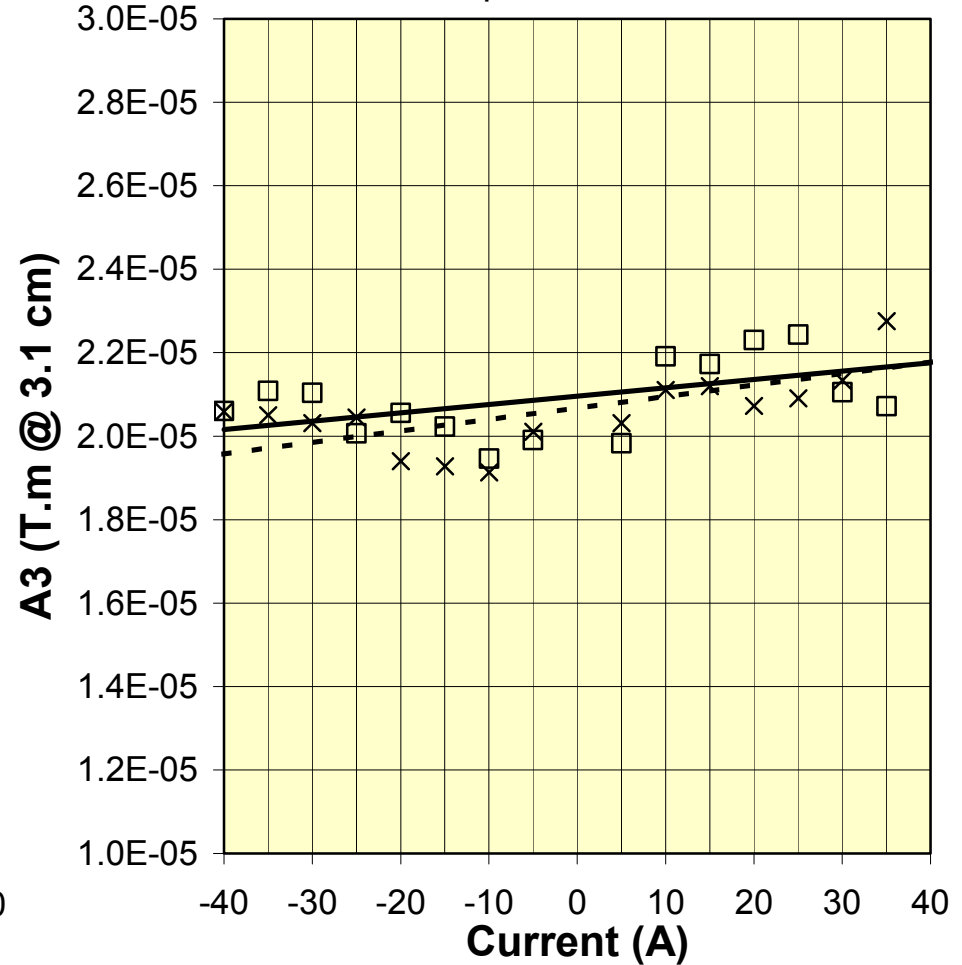


AGS Cold Snake HSD601 NLE Corrector Dipole (Runs 105 through 108)

□ Up Ramp: 1.8690×10^{-5} T.m/kA
× Dn Ramp: 1.7102×10^{-5} T.m/kA



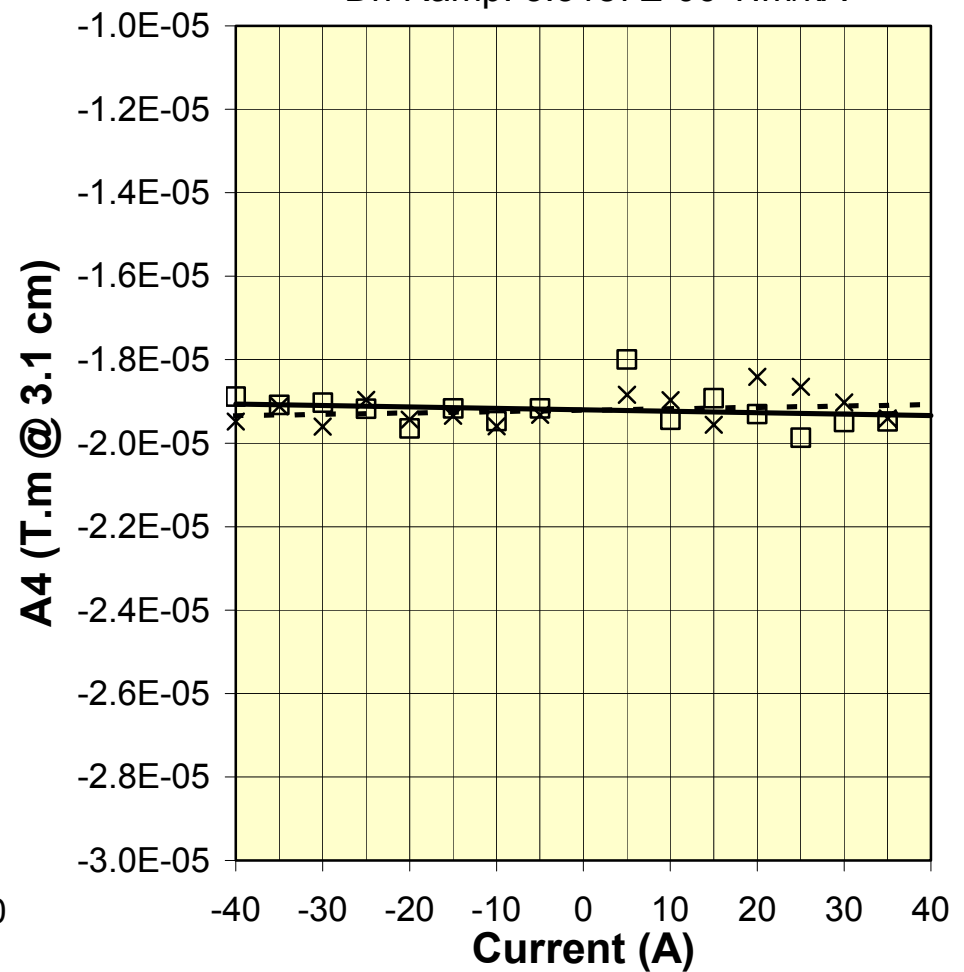
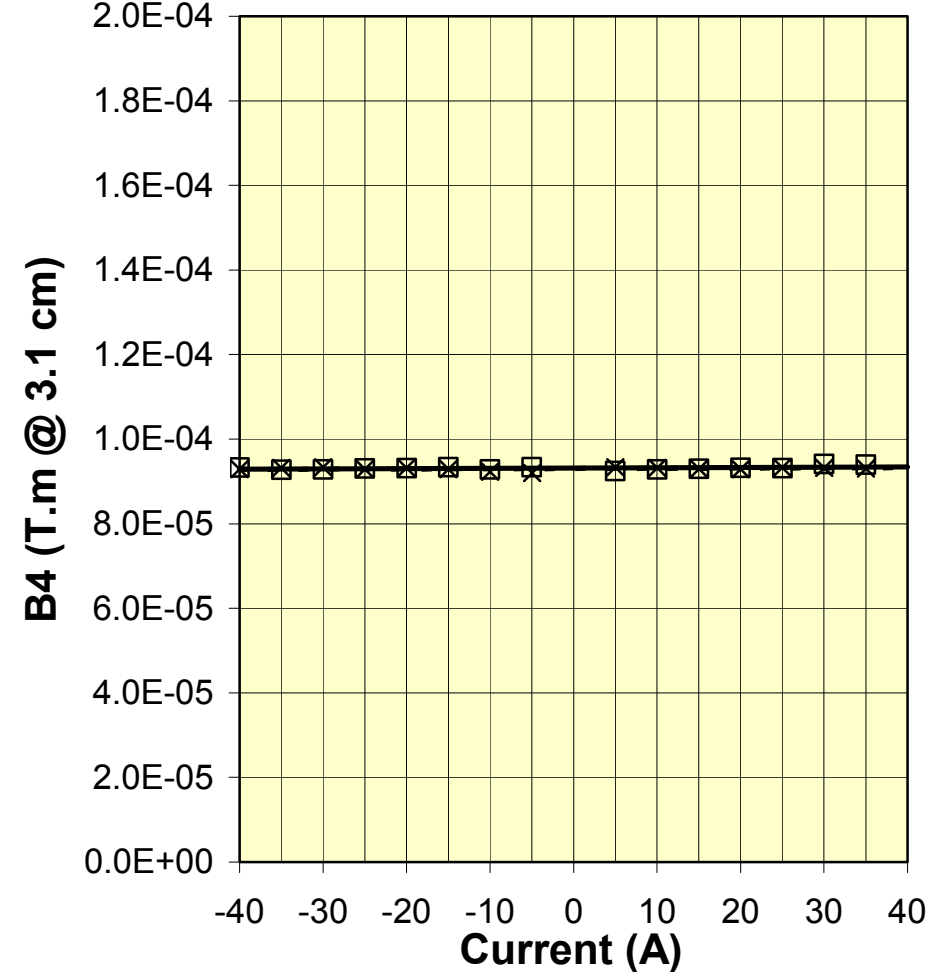
□ Up Ramp: 1.9993×10^{-5} T.m/kA
× Dn Ramp: 2.7623×10^{-5} T.m/kA



AGS Cold Snake HSD601 NLE Corrector Dipole (Runs 105 through 108)

□ Up Ramp: $7.0197\text{E-}06$ T.m/kA
× Dn Ramp: $4.3382\text{E-}06$ T.m/kA

□ Up Ramp: $-3.4785\text{E-}06$ T.m/kA
× Dn Ramp: $3.3187\text{E-}06$ T.m/kA



Non-Lead End Corrector: Integ. Harmonics

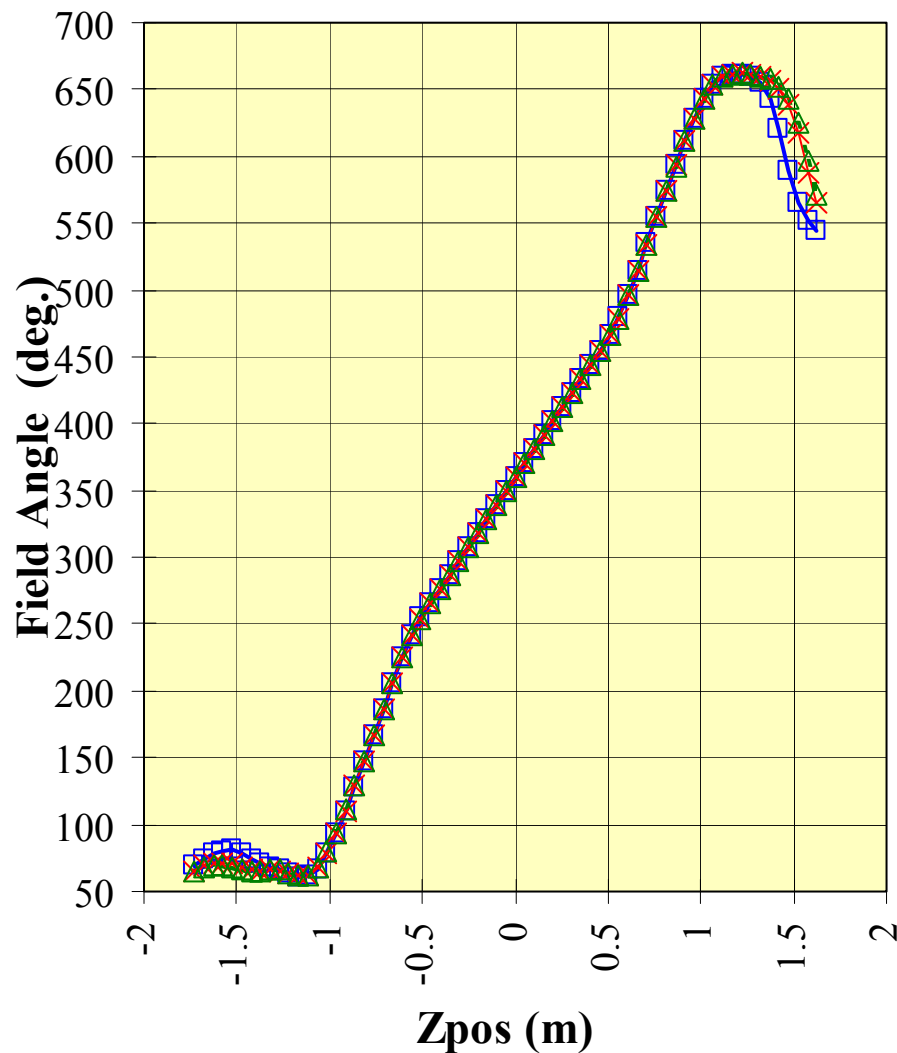
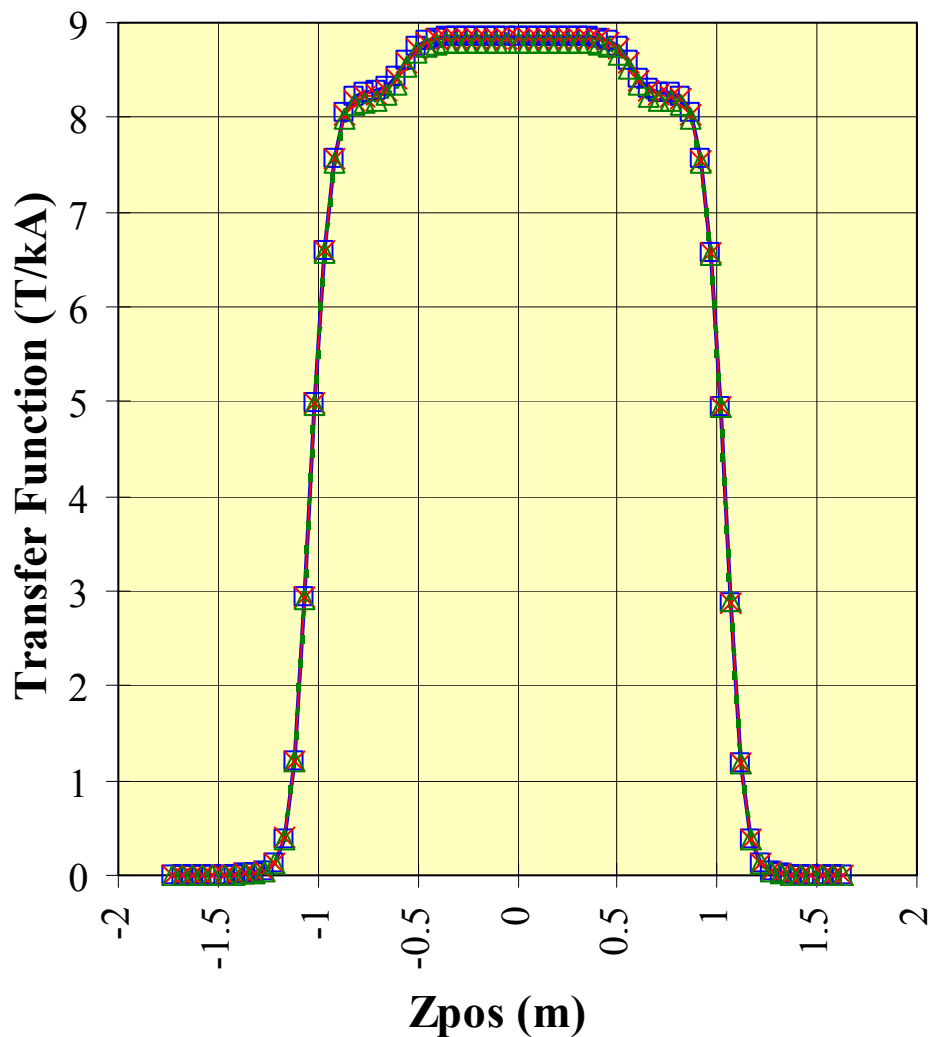
ITF(Up)	ITF(Dn)
0.3214	0.3214
T.m/kA	T.m/kA

n	"True" Fields ("units" at 3.1cm radius)			
	Bn(Up)	An(Up)	Bn(Dn)	An(Dn)
0	-0.5	10000.0	0.4	10000.0
1	25.7	35.2	30.9	38.0
2	-5.1	5.5	-4.4	6.6
3	0.6	0.6	0.5	0.9
4	0.2	-0.1	0.1	0.1
5	0.0	0.0	0.1	-0.6
6	-0.1	0.1	0.1	0.5
7	0.3	0.2	0.5	0.1
8	0.0	0.4	-0.6	0.2
9	-0.1	0.7	0.3	0.3
10	0.4	-0.1	0.9	-2.5

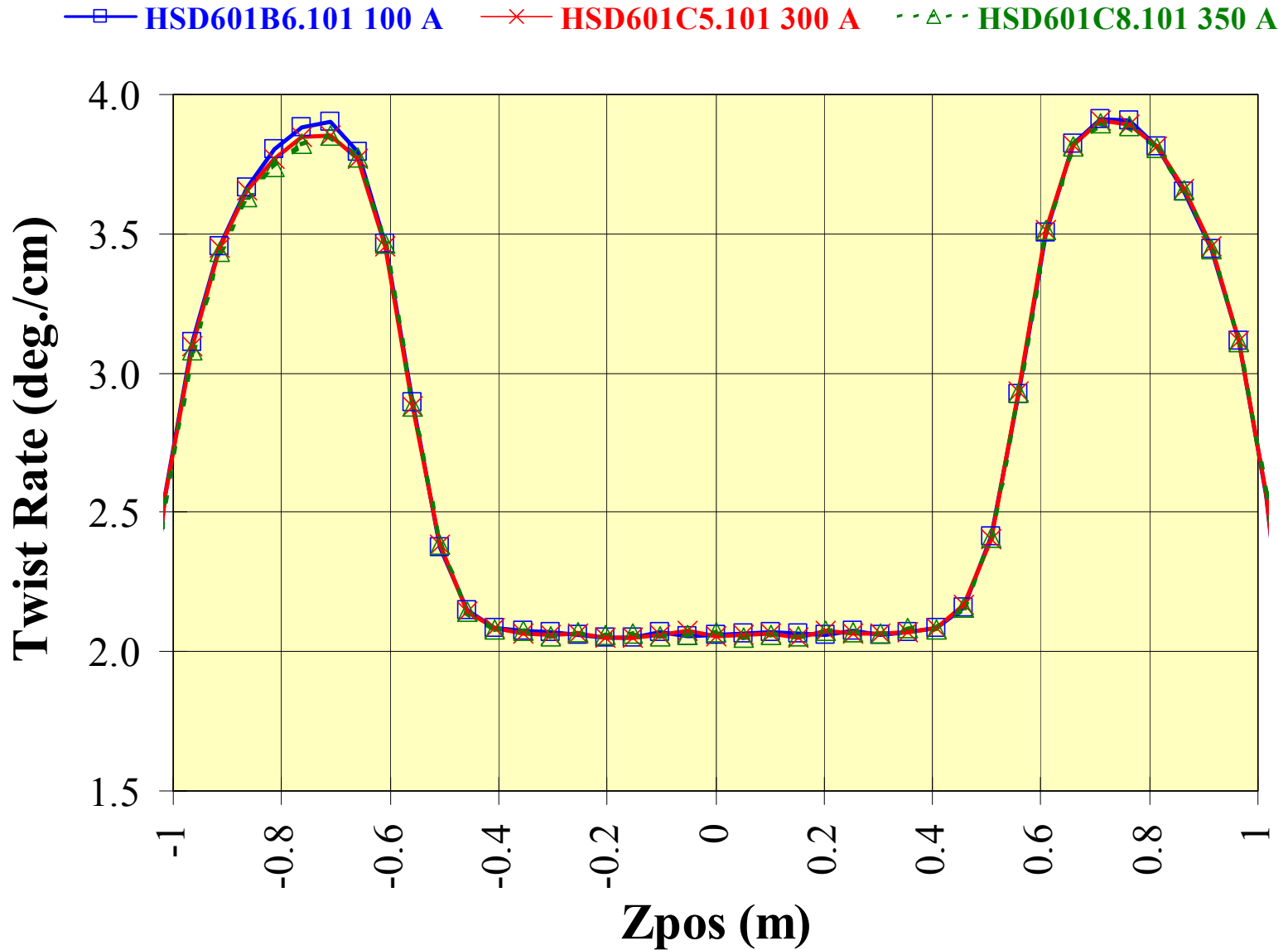
Axial Scans in the Main Dipole: **Harmonics in a** **Space-fixed Reference Frame**

Axial Scans: Trans. Func. & Field Angle

—□— **HSD601B6.101 100 A** —×— **HSD601C5.101 300 A** - -△- - **HSD601C8.101 350 A**

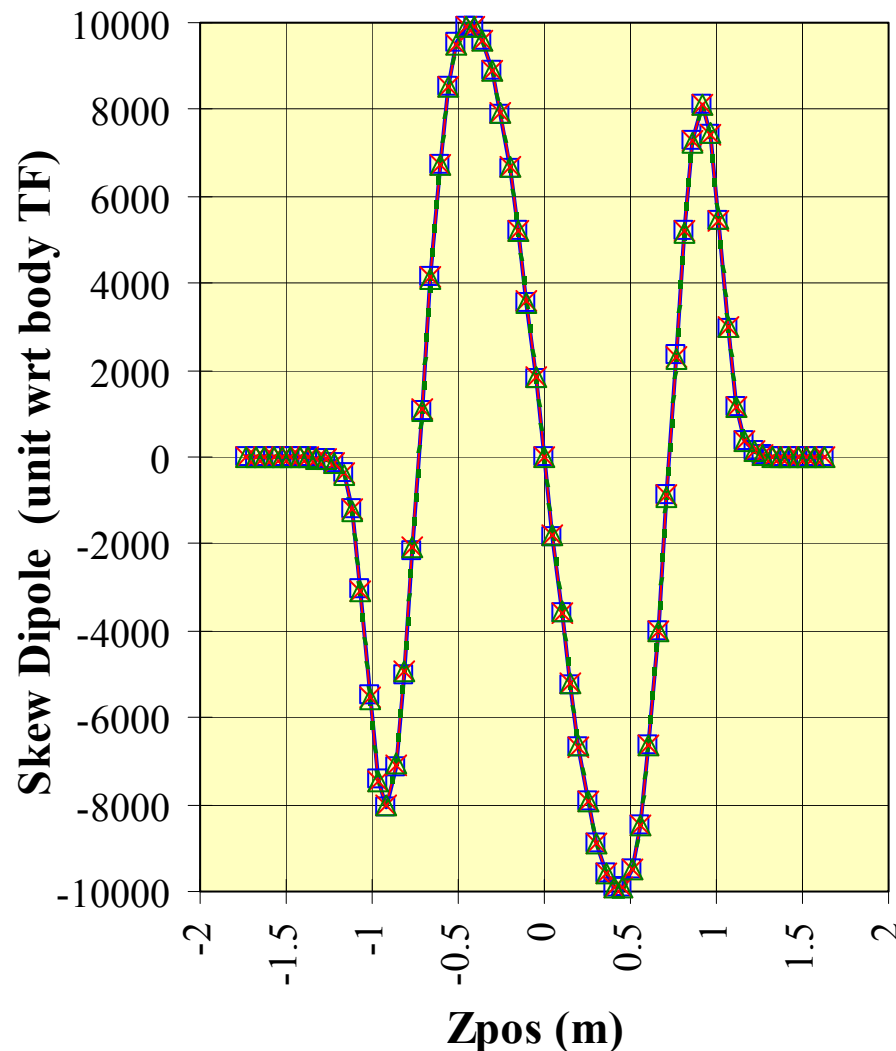
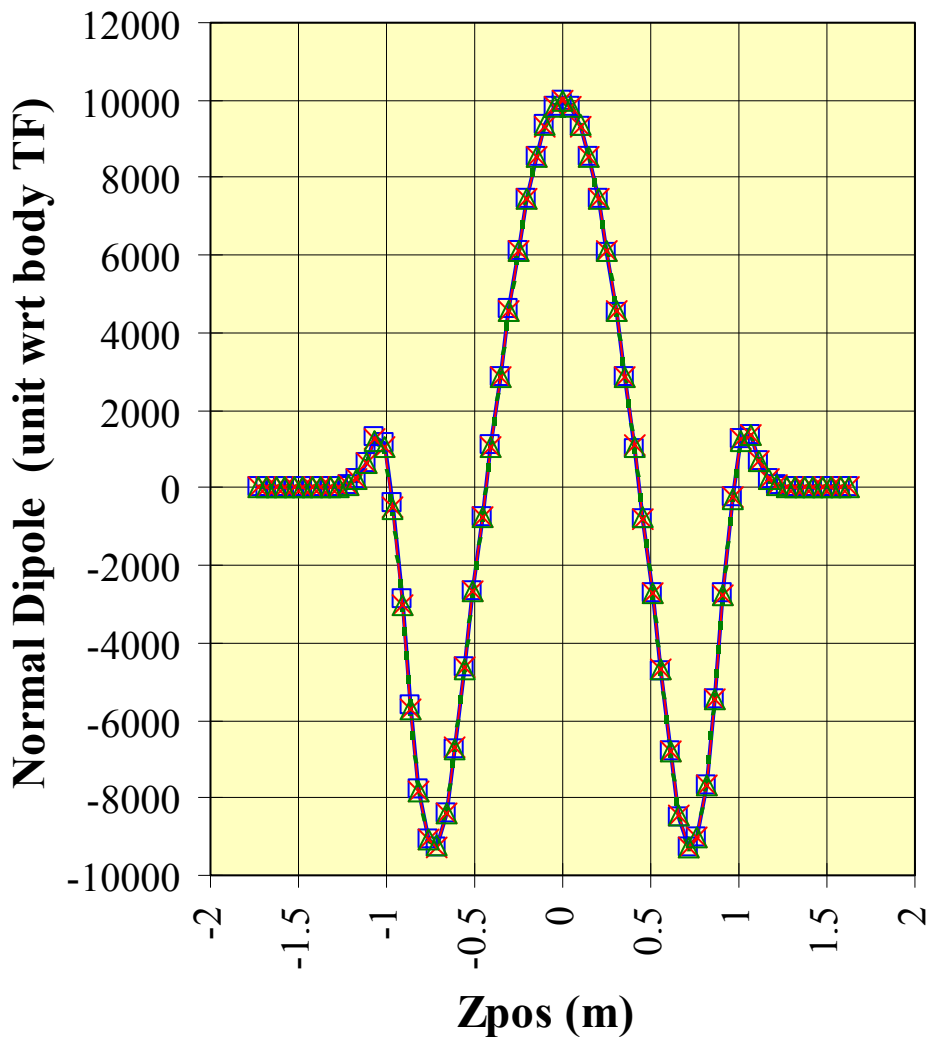


Axial Scans: Twist Rate



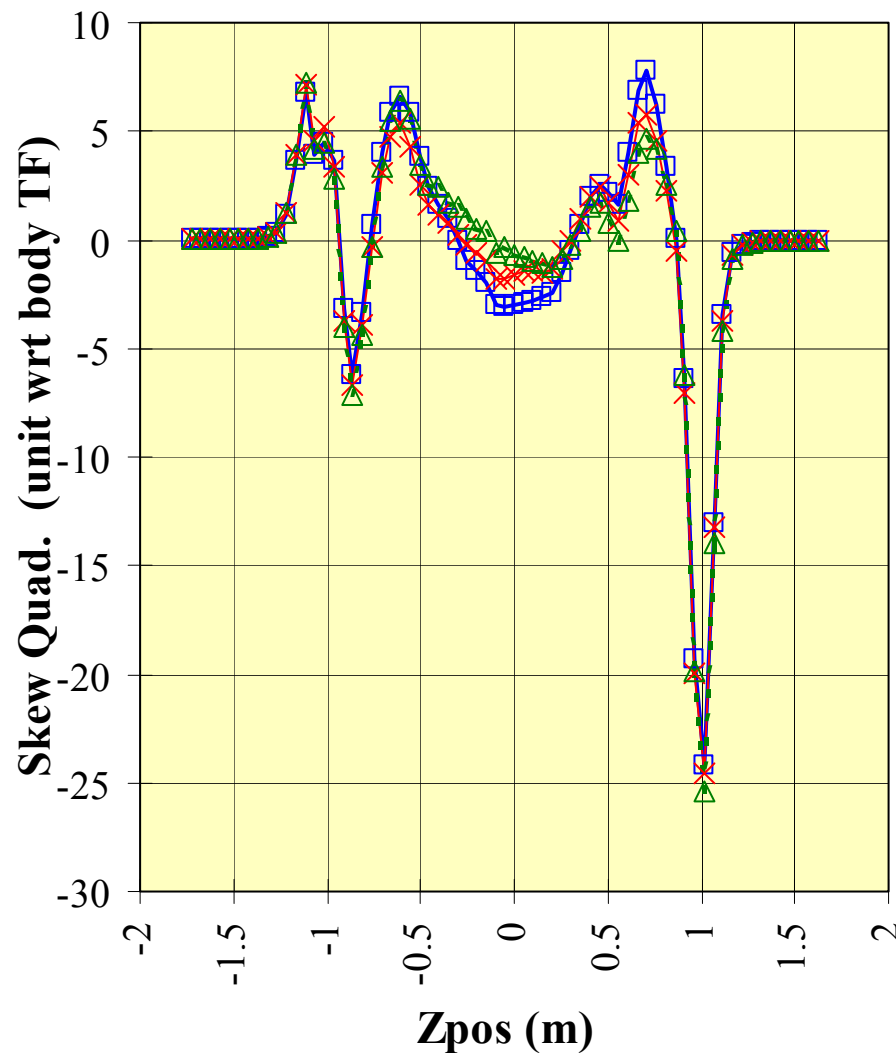
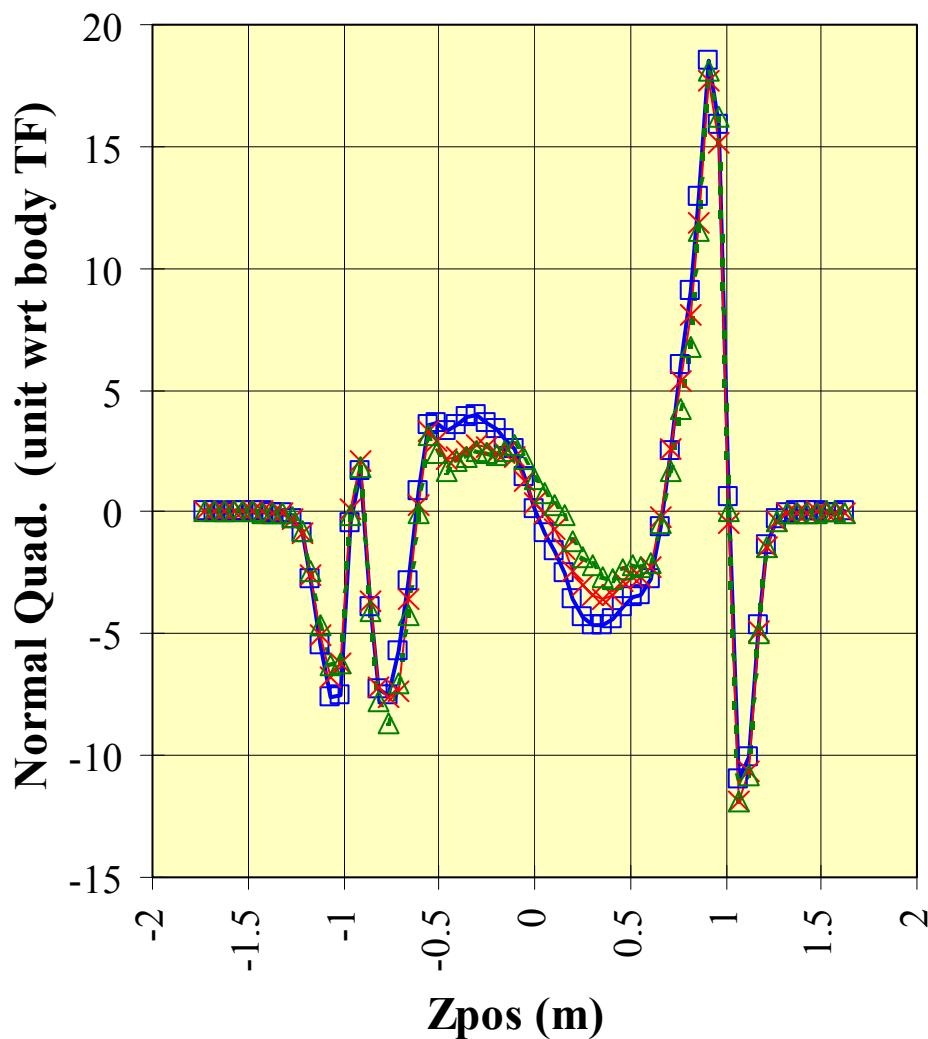
Axial Scans: Dipole Terms

—□— HSD601B6.101 100 A —×— HSD601C5.101 300 A -.-△-.- HSD601C8.101 350 A



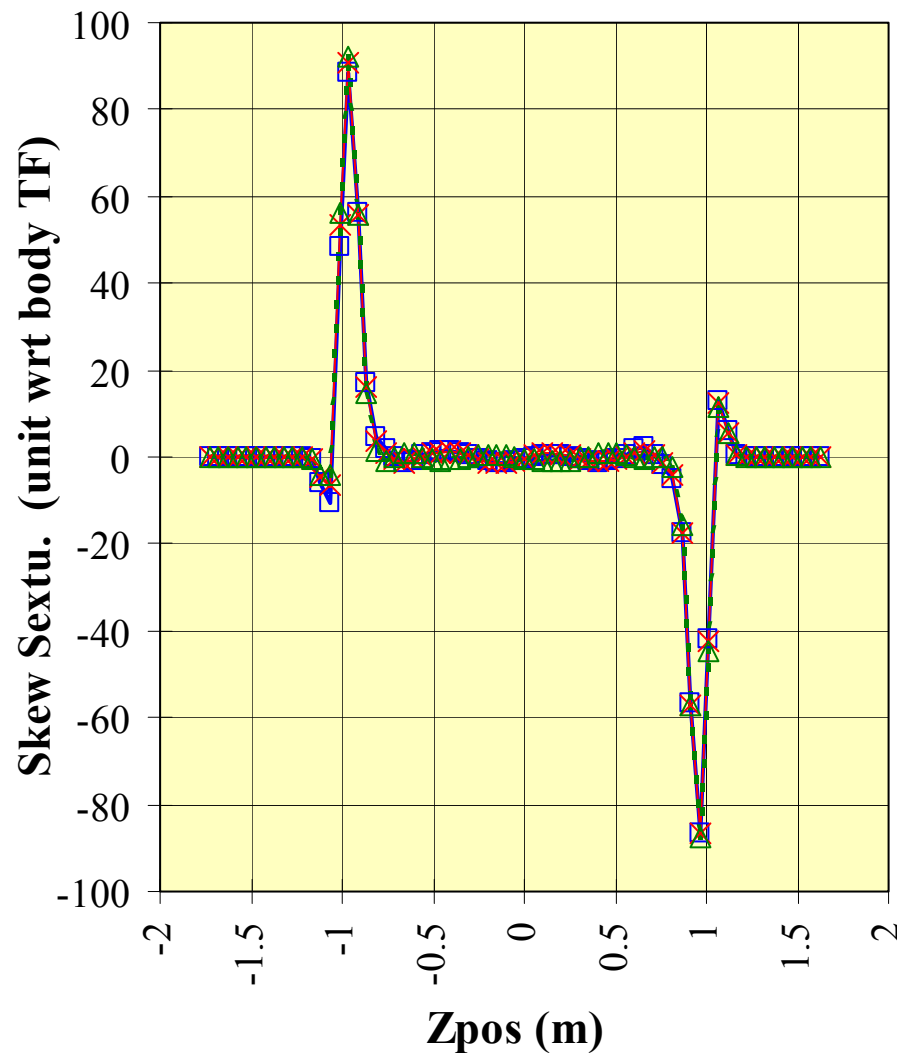
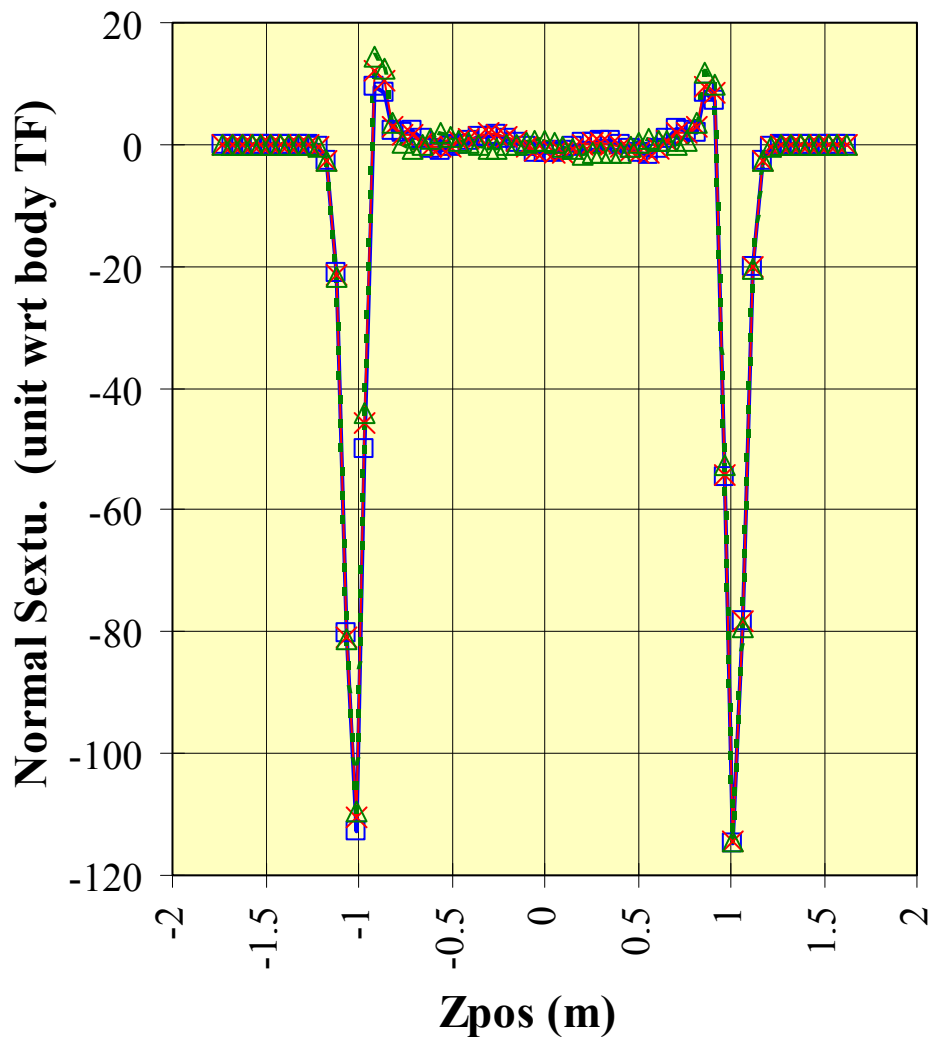
Axial Scans: Quadrupole Terms

—□— HSD601B6.101 100 A —×— HSD601C5.101 300 A -.-△-.- HSD601C8.101 350 A



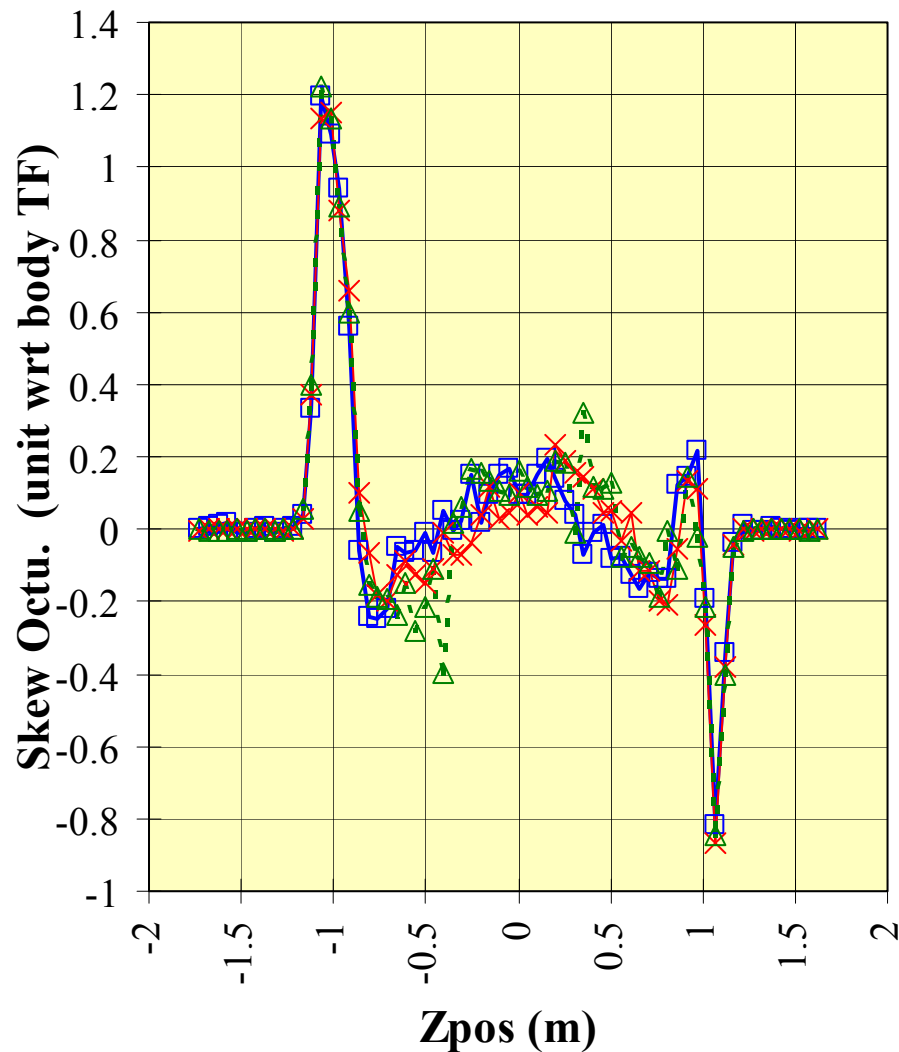
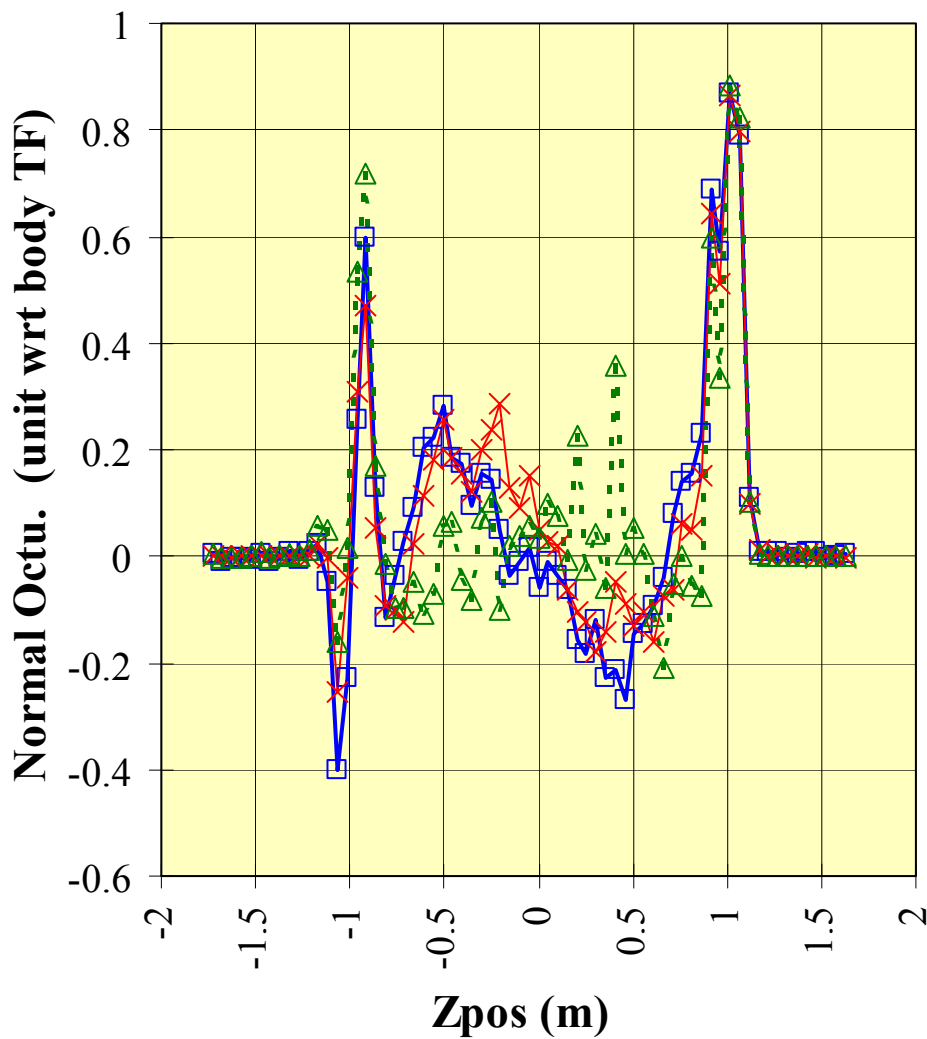
Axial Scans: Sextupole Terms

—□— HSD601B6.101 100 A —×— HSD601C5.101 300 A -.-△-.- HSD601C8.101 350 A



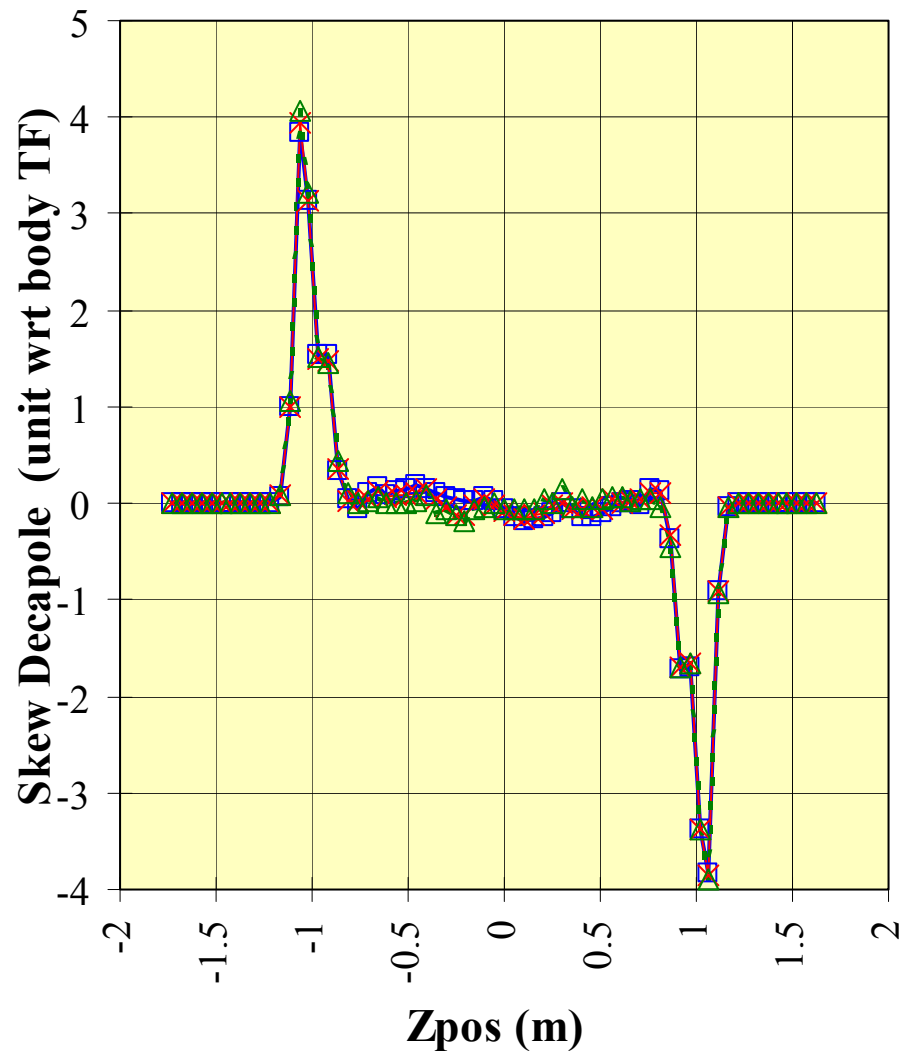
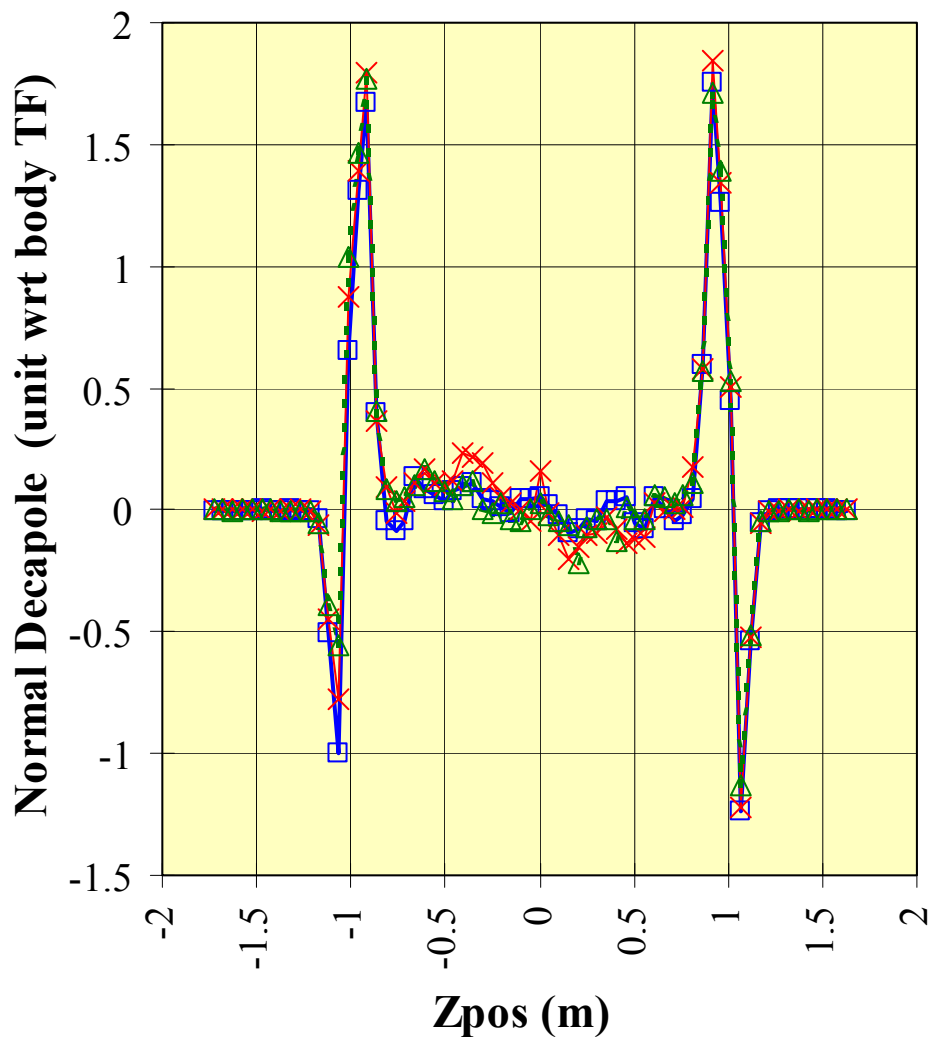
Axial Scans: Octupole Terms

—□— HSD601B6.101 100 A —×— HSD601C5.101 300 A - -△- - HSD601C8.101 350 A



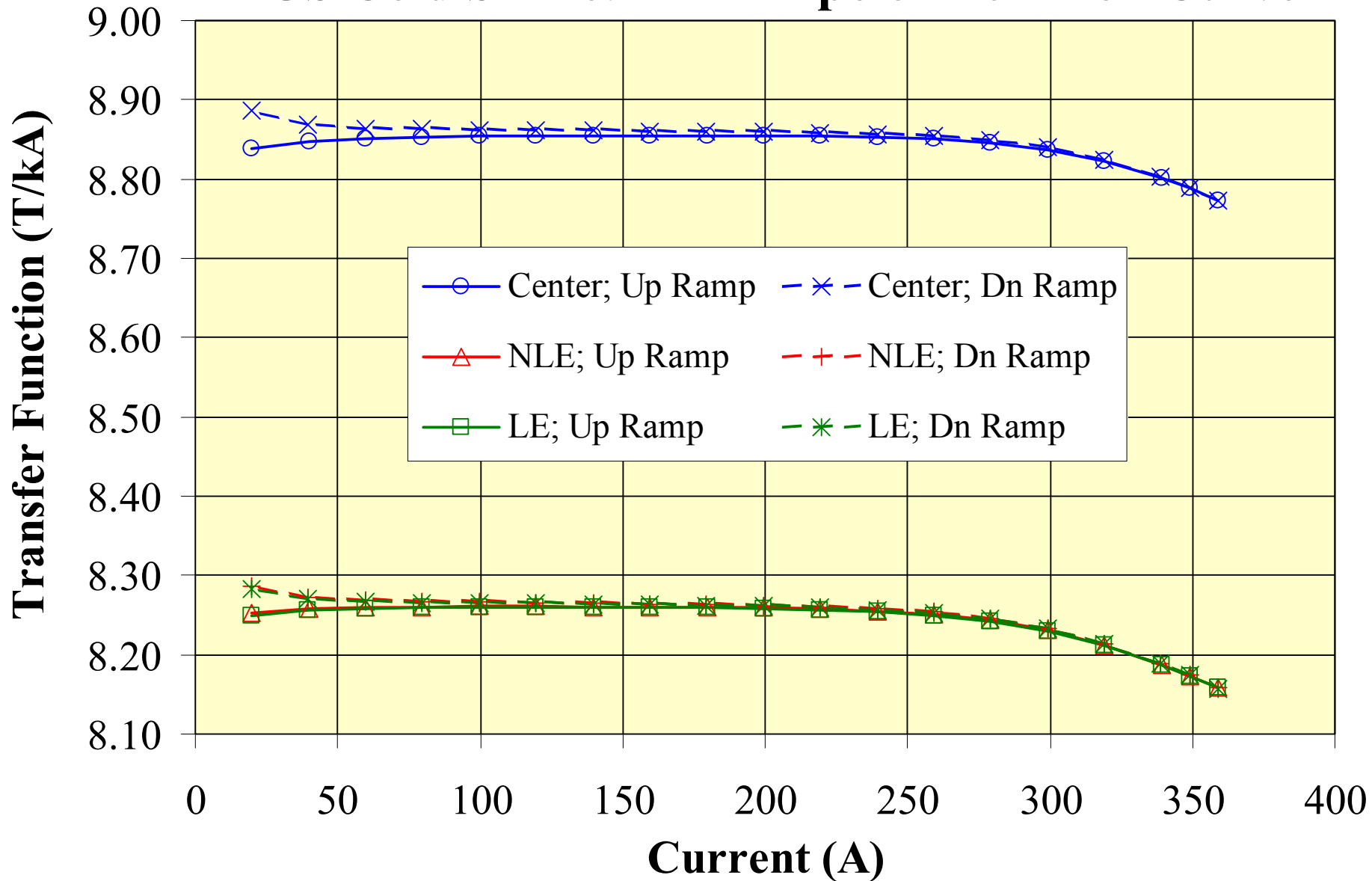
Axial Scans: Decapole Terms

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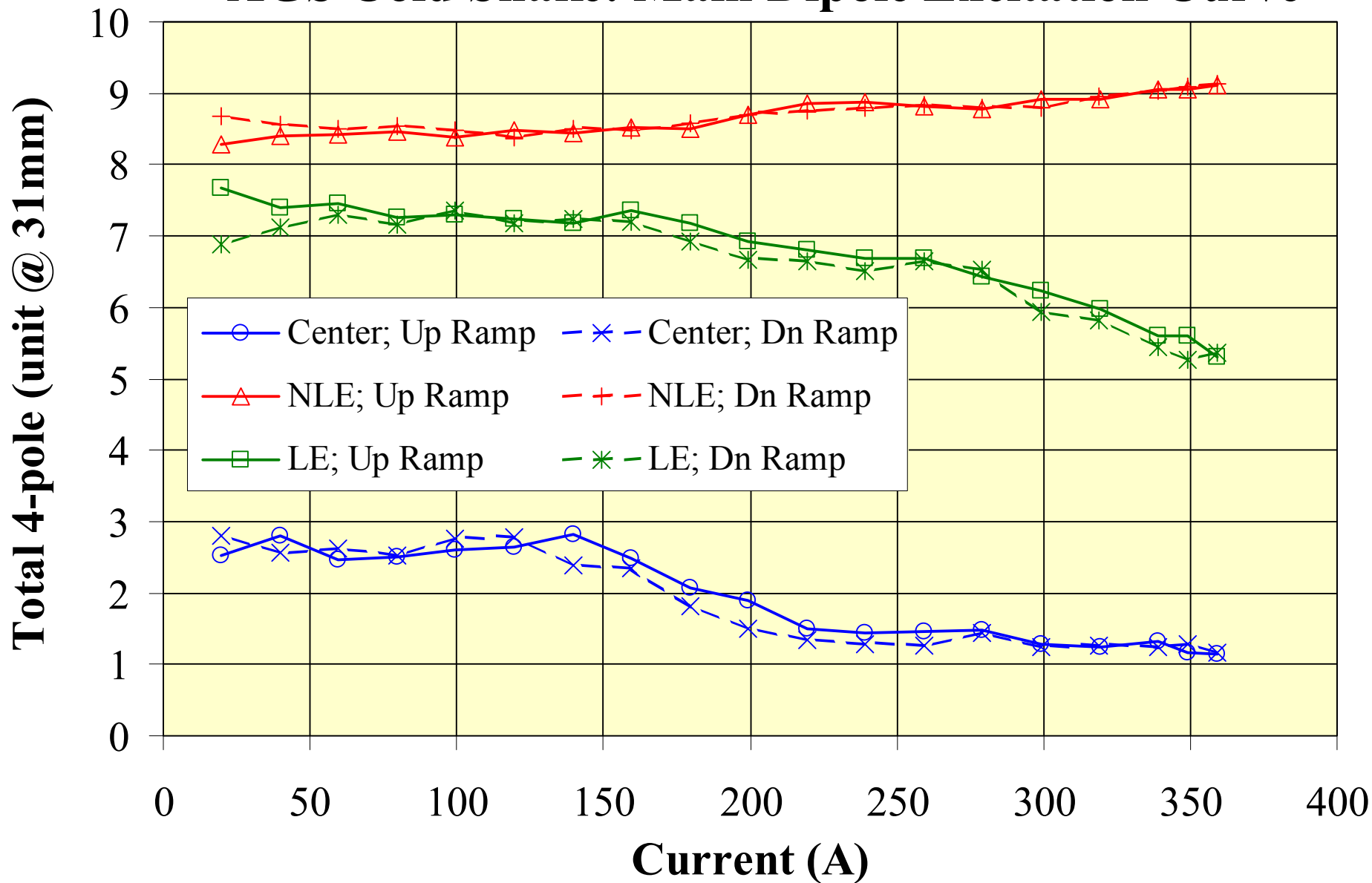


Excitation Curves in the Main Dipole: **Axial Center and ± 0.75 m**

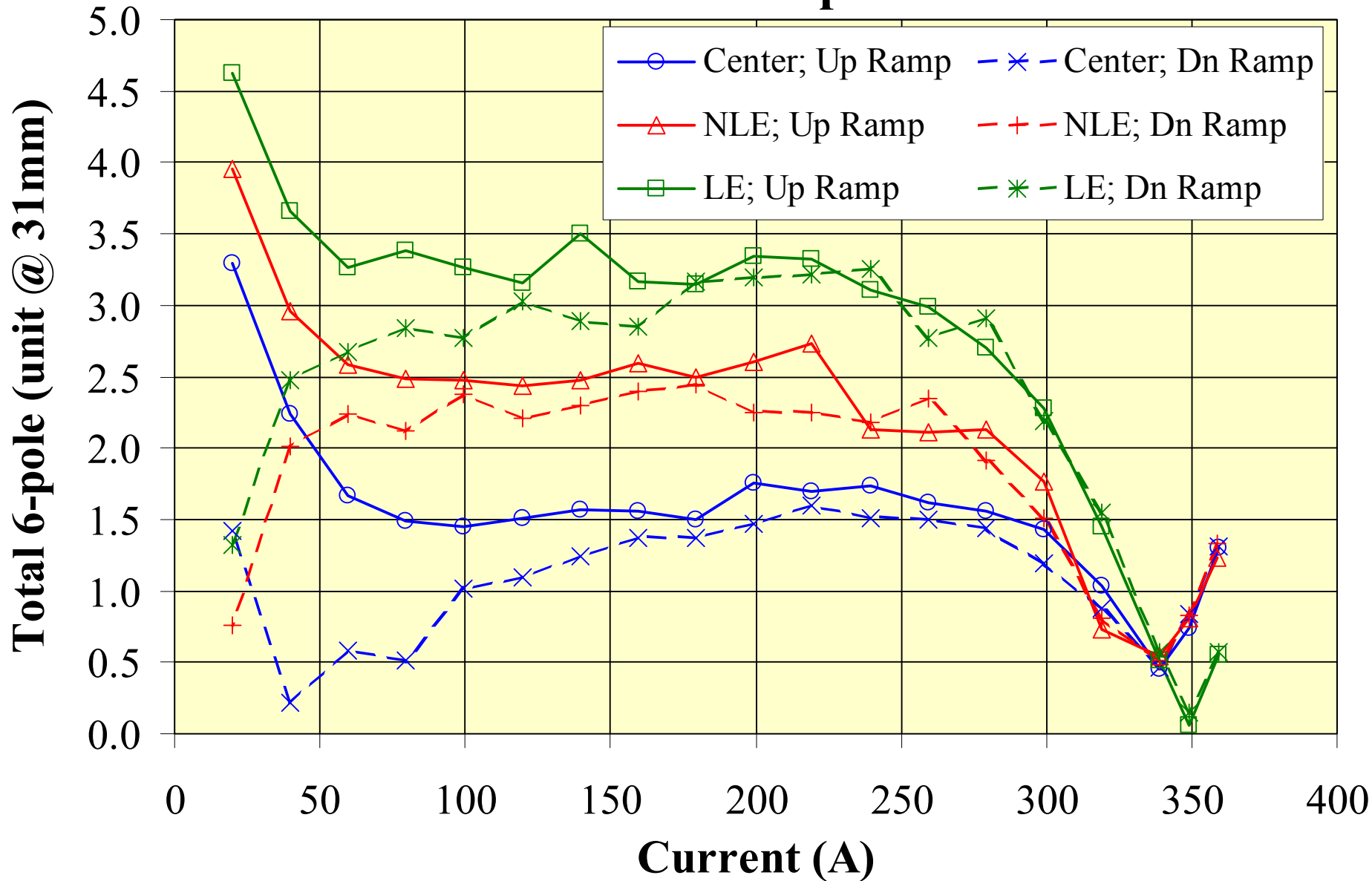
AGS Cold Snake: Main Dipole Excitation Curve



AGS Cold Snake: Main Dipole Excitation Curve



AGS Cold Snake: Main Dipole Excitation Curve



Summary of Field Quality in HSD101

- Cold measurements have been completed in the AGS cold snake (HSD101; a.k.a. DSM101).
- Integral dipole field is below 0.01 T.m at 350 A, with an uncertainty of about a factor of 2.
- Transfer functions of the main dipole and the skew dipole correctors are as expected.
- Only a few low order harmonics could be measured with the available probes.
- Field quality of the main dipole, as well as the two skew dipole correctors, appears satisfactory.