SLAC Traveler for LCLS Gun Spectrometer Quadrupole Magnets

This traveler is intended to cover magnetic measurements for the three 'waterpipe' quadrupole magnets that are used in conjunction with the BXG gun spectrometer dipole magnet.

This technical note describes the details of the magnetic measurements needed to characterize the QG type quadrupole magnets (small green quadrupole magnets located in the gun and gun-spectrometer region) and to characterize the embedded dipole correctors. The 3 magnets (QG01, QG02 and QG03) of this family are to be used only while running beam into the gun spectrometer beamline. For characterizing the beam energy spread for the nominal 1nC standard tuning only QG02 and QG03 are used. For measuring in more details the longitudinal properties of the beam, the three magnets are to be run. The standardization and calibration of these magnets will be done following a procedure similar to that of the ET magnets. However, steering coils are embedded in those magnets, so the calibration should be repeated while the correctors are on. Finally, since QG01 is on the main beamline, the remnant field in QG01 after switching it off and while beam is run in operation mode should not exceed 5Gauss in integrated gradient value.
A magnet of this family (borrowed from the GTF, before the poles were reshaped) had already been studied for determining the degaussing procedure. Results have been reported in
http://www-ssrl.slac.stanford.edu/lcls/technotes/lcls-tn-06-3.pdf
The dipole field will also be characterized. As the beam is ±3mm large (1.24 mm rms) for the nominal tuning, a good field region of ±6mm has been defined for the dipole field. A requirement of $|\Delta B/B| < 10^{-3}$ at $r = 6$ mm for the dipole field is acceptable.

Receiving:

The following information is to be noted upon receipt of the magnets by the SLAC MFD group:

Received by:		← name
Date received:		← mm/dd/yy
SLAC drawing number:	SA-380-313-01	
Vendor serial number from magnet label:	3	
SLAC approved electrical safety covers?		Y/N

Place barcode sticker on magnet and duplicate the barcode sticker here →	SLAC LCLS 001032

Preparation:

The beam direction should be clearly labeled on the quadrupole and the field polarity should be arranged as shown in Fig. 1, with power supply generating positive current ('normal' polarity).

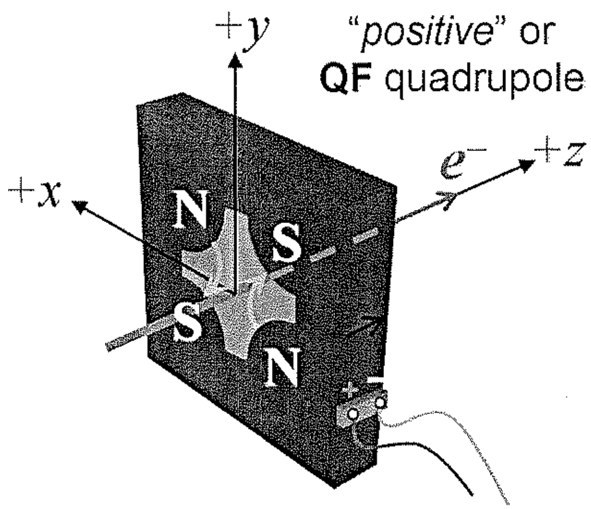


Figure 1. Polarity of quadrupole field with positive power supply output current ('normal' polarity).

Beam direction arrow applied	AD F	← installer initials

Fiducialization:

Fiducialization has already been performed by the CMM group; attach their traveler to this traveler.

Magnetic Measurements:

Upon receipt of the magnet, the following information should be recorded:

Date of arrival to Magnetic Measurements group:	8/2/2006	← mm/dd/yy
Responsible measurement operator name:	SA	← name

URL of Magnetic Measurements Data File:

http:\\www-group.slac.stanford.edu/MET/MagMeas/MagData/LCLS/ quad/ ~~001032~~ QG03

1) Verify that the magnets are complete and undamaged, including wiring connections.

Incoming inspection OK	SJ	← technician initials

Please measure the length-integrated field, $\int Gdl$ over several current settings and the field harmonics as described below.

2) Connect the magnet to a bipolar 12-A power supply, preferably an MCOR12. Use care in turning these supplies on and off to limit current spikes that may occur. Run the magnet up to 8 A for ~30 minutes to warm it up (record temperature).

Ambient temperature	27.5	degrees C
Final magnet temperature	48.7	degrees C

3) Standardize the magnet, starting from 0 to +12 A, then through 3 full cycles from +12 A to −12 A and back up to +12 A, finally ending at −12 A (the MCOR12 ramp rate is not controllable, but a flat-top pause time of ~~5~~ 10 seconds is desired at each maximum and minimum current).

Magnet standardized	SJ	technician name

4) Maintaining the history cycle, measure the length integrated gradient, $\int Gdl$, from −12 A to +12 A in 1-A steps, including zero (25 'up' measurements).

Data filename:	strdat.ru1

5) Still maintaining the history cycle, measure $\int Gdl$ back down from +12 A to −12 A in 1-A steps, including zero (25 'down' measurements).

Data filename:	strdat.ru1

6) Measure field harmonics at quadrupole coil settings of: −12, −6, +1, +6, and +12 A using about a 1-inch diameter probe.

Rotating coil name	DC2_54	name
Rotating coil radius	0.012313	meters
Data filename:	hardat.ru2	

Final data file name & run number for $-I_{max}/2$	——	name and #

Final data file name & run number for $-I_{max}$	——	name and #

Verification of degaussing procedure

The dipole correctors will be turned off during this measurement. We will be reproducing the degaussing curves already studied in
http://www-ssrl.slac.stanford.edu/lcls/technotes/lcls-tn-06-3.pdf
More particularly, we will be using the fraction 0.9 (red curve) from that report, and perform 25 cycles.

17) The quadrupole current will be ramped up to I_n and then back to $-I_{n-1}$ on each cycle at a rate of 10A/s with 2s after each ramp, with
$I_0 = I_{max}$,
$I_1 = - f I_{max}$,
...
$I_n = (-1)^n f^n I_{max}$
with f = 0.90 and for n up to 51
and then down to zero

For this test, run the magnet current to the sequence of current set-points listed in the table below (sequence is from left to right, and then top to bottom - all units are in amperes):

12	-10.80	9.72	-8.75	7.87	-7.09	6.38	-5.74
5.17	-4.65	4.18	-3.77	3.39	-3.05	2.75	-2.47
2.22	-2.00	1.80	-1.62	1.46	-1.31	1.18	-1.06
0.96	-0.86	0.78	-0.70	0.63	-0.57	0.51	-0.46
0.41	-0.37	0.33	-0.30	0.27	-0.24	0.22	-0.197
0.177	-0.160	0.144	-0.129	0.116	-0.105	0.094	-0.085
0.076	-0.069	0.062	-0.056				

A measurement of $\int Gdl$ will then be done. str Dat. run10 $|\int Gdl| =$ 0.13 G
If it exceeds 5 Gauss, then other f coefficient will have to be tried. As presented in the tech note.
http://www-ssrl.slac.stanford.edu/lcls/technotes/lcls-tn-06-3.pdf

18) Finally, the power supply will be tripped off and the $\int Gdl$ remeasured . $|\int Gdl| = 1.6$ G

Final data file name & run number for $\int Gdl$	str dat. run 11	name and #

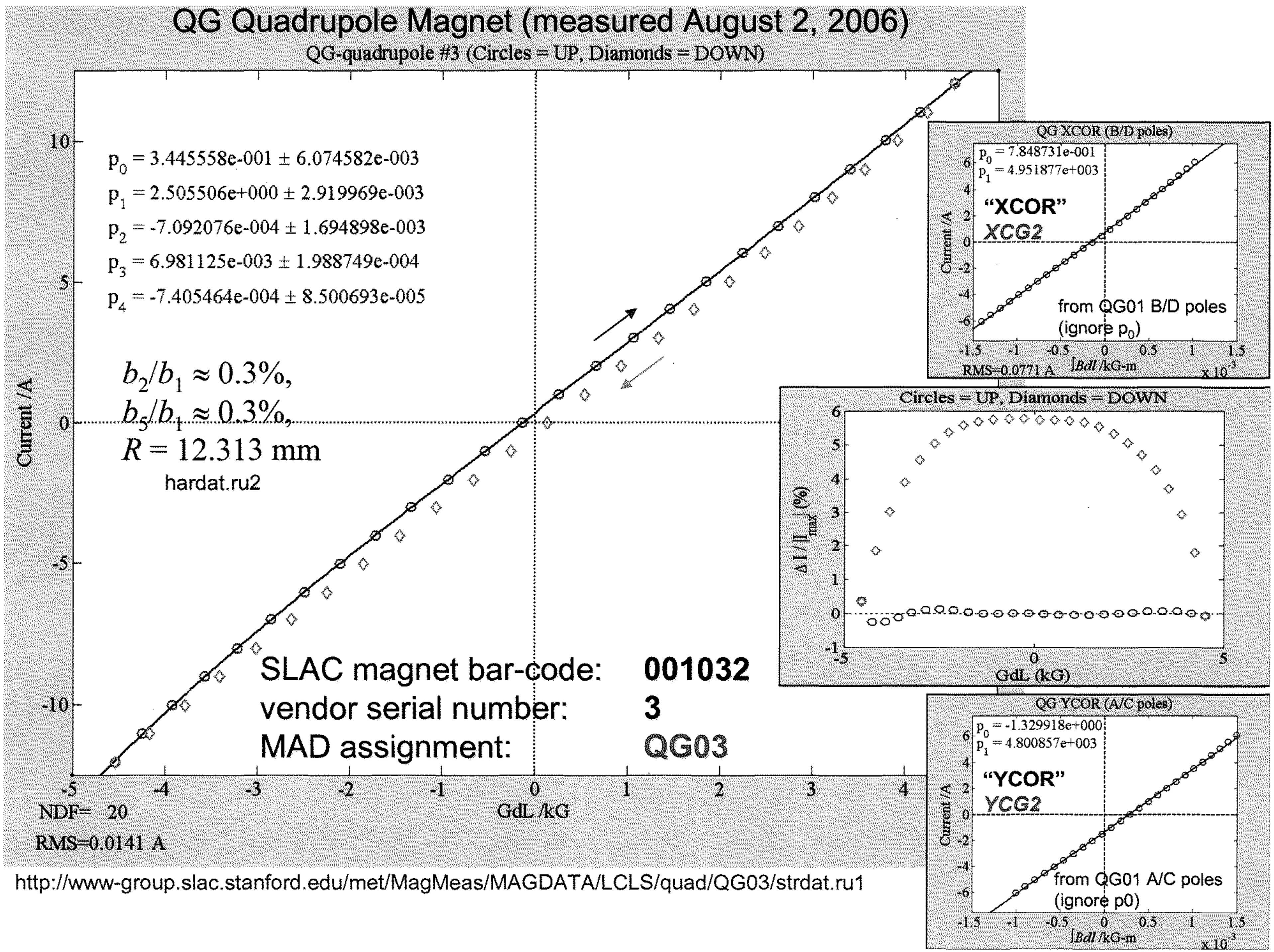
Measurements will be reviewed by C.Limborg. At this point, for the first magnet, the physicists who will decide if additional characterization is required. The basic procedures, not including degaussing, will be repeated for QG02 and QG03.

2) Upon completion of tests, send traveler to Paul Emma (ms 103) who will contact C.Limborg

This section to be completed by system physicist P. Emma).		
Magnet accepted (signed):	~~QGφ3~~ Paul Emma	(Y) N
Assigned name (location):	QGφ3	← Mad Deck Name

Upon full completion, send this traveler to Kathleen Ratcliffe at mailstop 18.

(see QGφ1 for dipole steering coil tests) —PE 8/21/06



http://www-group.slac.stanford.edu/met/MagMeas/MAGDATA/LCLS/quad/QG03/strdat.ru1