## SLAC Magnetic Measurement Plan and Traveler for 200A Unipolar LCLS-II Quadrupoles of Type 1.085Q4.31 (SA-902-675-01)

Revision 3, Initial Release Apr. 17, 2018 (Reviewed Apr. 17, 2018 – P. Emma)

This traveler is intended to cover mechanical fiducialization and magnetic measurements of some of the 1.085Q4.31 quadrupole magnets needed for LCLS-II. There are a total of 21 of these magnets needed for the LCLS-II. The MAD names of the 200A unipolar 1.085Q4.31 quadrupoles are QVB1B, QVB2B, QVB3B, QSP2H, QSP7H, QSP12H, QDL20, QDL21, and QDL22. QVB2B, QSP7H and QDL22 have “positive” polarity and QVB1B, QVB3B, QSP2H, QSP12H, QDL20, QDL21 have “negative” polarity.

**Receiving:**

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

| | |
|---|---|
| Received by (MMG initials): | SDA |
| Date received (dd-mm-yyyy): | 10/11/2018 |
| SLAC barcode number: | 4132 |
| Vendor serial number on the magnet: | E068 |

**Preparation:**

A beam direction arrow, with text “beam direction”, is to be applied to the top and/or connector side of the magnet with a sticker supplied by LCLS-II (J. Amann will determine the direction).

| | |
|---|---|
| Beam-direction arrow in place (initials): | SDA |

**Fiducialization:**

Fiducialization may be done before or after magnetic measurements. The magnet is to be fiducialized by the CMM group. This will require the installation of removable tooling balls, location of the geometric axis of the poles of the magnet, and location of tooling balls with respect to the center of this geometric axis when the poles are aligned precisely horizontal.

| | |
|---|---|
| CMM technician (initials): | KC |

URL of on-line CMM fiducialization data (please modify or correct if necessary):

| |
|---|
| http://www-group.slac.stanford.edu/met/MagMeas/MAGDATA/LCLS-II/Fiducial%20Reports/4132_Fiducial_Report.pdf |

**Magnetic Measurements:**

Enter URL of on-line magnetic measurements data (please modify or correct if necessary):

| |
|---|
| http://www-group.slac.stanford.edu/met/MagMeas/MAGDATA/LCLS-II/Quad/4132 |

1) Determine the connection polarity (with main supply outputting positive current) which produces a "positive" field polarity for QVB2B (below left), but a "negative" field polarity for QVB1B and QVB3B (below right), as shown below:

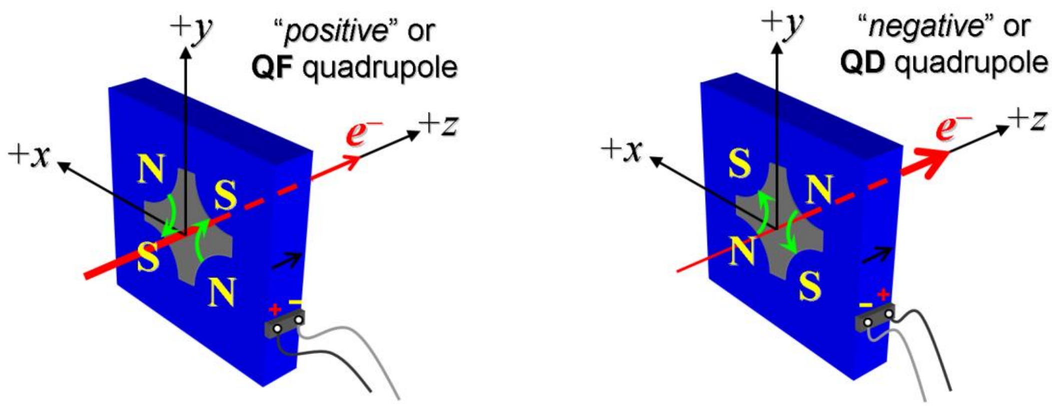


**Figure 1**. The QVB2B magnet is "positive" (left) while QVB1B and QVB3B are "negative" (right).

2) Mark the polarity near the magnet leads with clear "+" and "–" labels as shown above.

| | |
|---|---|
| Magnet polarity chosen from Fig. 1 is (P or N): | P |

3) Connect the magnet to the LCW supply. At a deltaP of 120 psi per circuit, the total magnet flow should be 1.5gpm. Record the actual deltaP required to achieve a total flow rate 1.5gpm below.

| | |
|---|---|
| deltaP (psi) to achieve a total flow rate of 1.5gpm | 1.15 gpm at 113.2 ΔP (psi) |

4) Connect the magnet terminals in the correct polarity as established above, to a unipolar power supply with maximum current $I \geq 200$ A.

5) Run the magnet up to 200 A for ~30 minutes to warm it up (record temperature).

| | |
|---|---|
| Ambient temperature (°C): | 24.6 °C |
| Final magnet temperature (°C): | 27.9 °C |

6) Standardize the magnet, starting from zero to 200 A and back to zero, through three full cycles, finally ending at zero, with a flat-top pause time (at both 0 and 200 A) of 10 seconds. Use a three liner ramp rate of 20 A/sec, if possible, and record the ramp rate used.

| | |
|---|---|
| Standardization complete (initials): | SDA |
| Ramp rate used (A/sec): | 20 A/sec |

7) If the power supply can be run as low as 2 A with <10-mA (0.5%) rms current regulation, then measure $\int Gdl$ from 0 to 20 A in 2-A steps (11 'up' measurements), and then continue monotonically in 20-A steps from 20 A to 200 A (10 more 'up' measurements) and then back down from 200 A to 20 A in –20-A steps (10 'down' measurements), and finally 20 A to 0 in –2-A steps (11 more 'down' measurements).

| | |
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| Filename & run number of $\int Gdl$ up & down data: | Strdat.ru1, strplt.ru1 |

8) Confirm the pole-tip field using a Hall probe at an excitation current of 200 A.

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|---|---|
| Hall probe pole-tip field at 200 A (mean of 4 poles): | 1.068 +/- 0.007 T @ 200.06688 A |

9) For one magnet only, perform a final thermal test. Run the current up to 200 A. Measure the magnet temperature after it stabilizes (2-4 hours?). Record the temperature below.

| | |
|---|---|
| Ambient temperature (°C): | Measurement done on 4111 |
| Final stable magnet temperature at 200 A (°C): | Measurement done on 4111 |

10) Measure the inductance and resistance of the magnet:

| | |
|---|---|
| Inductance of coil (mH): | 5.046 mH |
| Resistance of coil (Ohms): | 0.0798 Ohm |
| Ambient temperature in degrees C | 22.7 ºC |

11) Upon completion of tests, email URL of on-line data to Mark Woodley. Mark Woodley will determine if the magnet is accepted. Upon acceptance of magnet, analysis data will be placed in on-line data folder.

| | |
|---|---|
| Magnet accepted and Analysis file(s) put into on-line data folder (initials): | SDA |
| Assigned beamline location (MAD-deck name): | **QDL22** |

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LCLS-II