SLAC Magnetic Measurement Plan and Traveler for 165 A Unipolar LCLS-II Quadrupoles of Type 2Q10 (SA-344-113-21, SA-344-113-30)

This traveler is intended to cover mechanical fiducialization and magnetic measurements of the 2Q10 quadrupole magnets needed for the Copper-Linac-to-SXR transfer line (CLTS) in the BSY. There are 6 of these magnets needed for the CLTS. There are 2 different configurations for this magnet in the CLTS, SA-344-113-21 and SA-344-113-30. The table below gives the MAD names, model drawing numbers, polarities, and installation directions of the 165 A unipolar 2Q10 quadrupoles.

MAD Name	Eng. Name	Drawing#	Barcode	Polarity	Bus bars
QCUS1	2Q10	SA-344-113-21 (offset bus bar model)	4197	QF	upstream
QCUS2	2Q10	SA-344-113-30	4221	QD	downstream
QCUS3	2Q10	SA-344-113-30	4220	QD	upstream
QCUS8	2Q10	SA-344-113-30	4219	QD	downstream
QCUS9	2Q10	SA-344-113-30	4223	QD	downstream
QCUS10	2Q10	SA-344-113-30	4222	QF	upstream

Receiving:

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

Received by (MMG initials):	SDA
Date received (dd-mm-yyyy):	4/18/2019
SLAC barcode number:	4219
Vendor serial number on the magnet:	15

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.

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/4219_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/4219

1) Determine the connection polarity (with main supply outputting positive current) which produces a "positive" field polarity and "negative" field polarity as shown below:

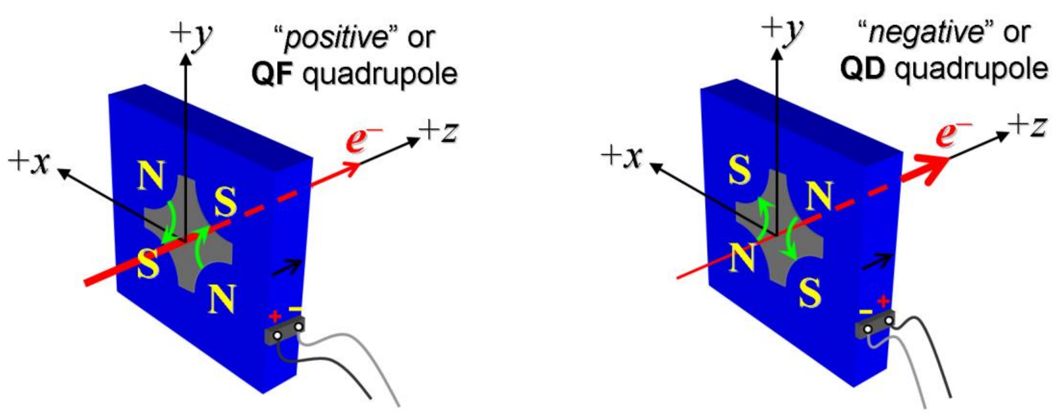

Figure 1. Polarity convention for magnets having "positive" (left) and "negative" (right) polarities.

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):	N

3) Connect the magnet to the LCW supply. The total magnet flow should be gpm. Record the ΔP and flow below.

Record total flow rate and pressure.	0.5 gpm @110 psi

4) Connect the magnet terminals in the correct polarity as established above, to a unipolar power supply with maximum current $I \geq 165$ A.

5) Run the magnet up to 165 A for ~30 minutes to warm it up (record temperature).

LCW delta T (°C)	12.7 °C
Ambient temperature (°C):	20.5 °C
Final magnet steel temperature (°C):	25.7 °C

6) Standardize the magnet, starting from zero to 165 A and back to zero, through three full cycles, finally ending at zero, with a flat-top pause time (at both 0 and 165 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 165 A and from 165 to 0 A following the current range step sizes given in the table below.

Current Range	**Step Size going up**	**Step Size going down**
0 to 20 A	2-A	4-A
20 to 160 A	10-A	20-A
160 to 165 A	5-A	5-A

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

8) For all magnets, with rotating coil, measure the magnet harmonics at 20, 100, and 165 A current setting. Multipole values should be given as a percentage of the quadrupole moment evaluated at the probe radius.

Filename & run number of harmonic data:	hardat.ru1, harplt.ru1
Probe radius used for harmonics (cm):	1.95965
Rotating Coil Designation (Name)	48BC1.6

9) Confirm the pole-tip field using a Hall probe at an excitation current of 165 A.

Hall probe pole-tip field at 165 A (mean of 4 poles):	0.485 +/- 0.01 T @ 165.00103 A

10) For one magnet only, perform a final thermal test. Run the current up to 165 A. Measure the magnet temperature after it stabilizes (2-4 hours?). Record the temperature below.

LCW delta T (°C)	Measurement performed on 4210
Ambient temperature (°C):	Measurement performed on 4210
Final magnet steel temperature (°C):	Measurement performed on 4210

11) Measure the inductance and resistance of the magnet:

Inductance of coil (mH):	9.316 mH
Resistance of coil (Ohms):	0.1051 Ohm
Magnet temperature in degrees C	18.4 °C

12) 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):	QCUS8