SLAC NATIONAL ACCELERATOR LABORATORY

LCLS-II

SLAC Traveler for LCLS-II BLRCUS 0.625SD38.98, SA-375-150-75 HLAM Magnet,

(January 22, 2019)

This traveler is intended to cover mechanical fiducialization, and magnetic measurements of the *BLRCUS* HLAM septum magnet. This magnet is part of the copper to soft X-ray line and is paired with a kicker. The septum has a round field free channel and a rectangular channel whose field will kick the beam up

Receiving:

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

Received by (initials):	SDA
Date placed on test stand (dd-mmm-yyyy):	6/5/2019
SLAC barcode number:	4584
Vendor serial number from magnet label:	2
SLAC approved electrical safety covers? (Y or N):	N
SLAC drawing number (enter number):	SA-375-150-75

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. The terminals shall be oriented down beam.

Beam-direction arrow in place (initials):	SDA

Fiducialization:

Fiducialization will be done before magnetic measurements by the CMM or Alignment 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. The pole gap should also be measured.

CMM technician (initials):	HI,CM

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/4584 BLRCUS Septum SN

02 Fiducialization.xlsx

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/Septum/4584

1) Mark the magnet as BRLCUS. BRLCUS is "negative" horizontal bend in polarity (bending electrons right) which will be rolled CCW 38.61° as you look down beam. Determine the main-coil connection polarity (with main supply outputting positive current) which produces a "negative" horizontal dipole field polarity, as shown below, in the rectangular bending field channel and mark the polarity near the magnet leads with clear "+" and "-" labels.

Magnet marked as (BRLCUS):	SDA
Polarity is marked according to Fig. 1 (initials):	SDA

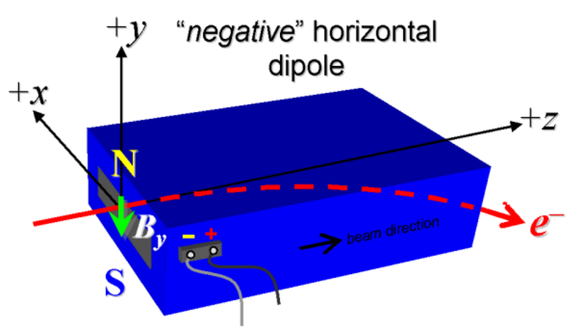

Figure 1. BRLCUS is a **"negative" horizontal polarity dipole (bending electrons to the right).**

2) Mark the **trim** leads with clear "+" and "–" labels such that, with the trim supply outputting positive current, the trim coil *increases* the absolute value of the magnetic field established by the main coil. This will set the trim polarity as "negative" for BRLCUS trim coil.

Trim coil polarity chosen from Fig. 1 is (N):	SDA

3) Measure the inductance and resistance of the **main** and **trim** magnet coils:

Inductance of **main** coil (mH):	0.854 mH
Resistance of **main** coil (Ohms):	0.0385 Ohm
Inductance of **trim** coil (mH):	0.299 mH
Resistance of **trim** coil (Ohms):	0.1132 Ohm

4) Connect the magnet terminals, in the correct polarity as established above, to a unipolar (or bipolar) power supply with maximum current $I \geq 130$ A.

5) Connect magnet to LCW supply. Adjust supply pressure to a delta P of ~51 psi to achieve a flow rate of 0.46 gpm. Run the magnet up to 130 A for ~1 hour to warm it up (record, delta P, flow rate, and magnet coil and steel temperature).

LCW delta P (psi)	117 psi
LCW flow rate (gpm)	0.38 gpm
LCW delta T (°C)	3.5 °C
Ambient temperature (°C):	24.5 °C
Final magnet steel temperature (°C):	26.4 °C

6) Ramp the main of the magnet to 130 A and measure the pole tip field. It should be close to 0.387 Tesla.

Pole Tip Field and Current	0.4545 T at 129.99484 A

7) Ramp the main of the magnet to 0 A and then ramp the trim to +6 A and measure the pole tip field. After measurement turn off trim supply.

Trim Pole Tip Field and Current	0.01129 T at 6.00414 A

8) Standardize the magnet, starting from 0 to 130 A and back to zero, through three full cycles, finally ending at zero, with a flat-top pause time (at both 0 and 130 A) of 10 seconds. Use a three-linear ramp rate of 10 A/sec, record the ramp rate used.

Standardization complete (initials):	SDA
Ramp rate used (A/sec):	10 A/s

9) Align the stretched wire in the rectangular bending field channel. Measure the length-integrated horizontal dipole field, $\int B_y dl$, from 0 to 130 A in the rectangular bending field channel in 10-A steps, including zero (14 'up' measurements). Then, still maintaining the cycle history, measure $\int B_y dl$ back down from 130 A to 0 in 10-A steps, including zero (13 'down' measurements).

Filename & run number of $\int B_y dl$ up & down data:	Wiredat.ru1, wireplt.ru1

10) Still maintaining the cycle history, run the **main** coil up to 130 A, pause at least 10 seconds, and measure $\int B_y dl$ in the rectangular bending field channel as a function of **trim** coil current from 0 to +6 A in 0.5-A steps, including zero (13 'up' measurements), and again from +6 to –6 A in 0.5-A steps (25 'down' measurements). Set the **trim** current back to 0.

Filename & run # of $\int B_y dl$ **trim** data at I_{main} = 130 A:	Wiredat.ru2, wireplt.ru2

11) Set the **main** coil to 0 current after standardizing. Measure $\int B_y dl$ in the rectangular bending field channel as a function of **trim** coil current from 0 to –6 in 0.5-A steps, including zero (13 'down' measurements), and again from –6 to +6 A in 0.5-A steps (25 'up' measurements). Set the **trim** current to 0.

Filename & run # of $\int B_y dl$ **trim** data at I_{main} = 0:	Wiredat.ru3, wireplt.ru3

12) With the main coil at 130 A, measure the length-integrated vertical field at multiple x positions in the rectangular bending field channel. With the wire located at the vertical mid-plane (y = 0), measure the vertical length-integrated field at each 3-mm step of horizontal wire position, from x = –21 mm to +21 mm, with x = 0 centered at the magnet's horizontal center. Record data file name:

Filename of $\int B_y dl$ vs x data at 130 A:	Wirevsx.ru4, wirepltvsx.ru4

13) Align the stretched wire into field free round channel. Standardize the magnet and measure $\int B_y dl$ in the field free channel as a function of **main** coil current at 0, 50, 100 and 130 A steps. Also measure the $\int B_y dl$ in the field free channel with the main power supply off.

Filename of $\int B_y dl$ *vs* main current in field free region:	Wiredat.ru5, wireplt.ru5

14) Standardize the magnet and set the **main** coil to 0 A, then measure $\int B_y dl$ in the field free channel as a function of **trim** coil current from 0 to -6 in -2 A steps, including zero 4 'down' measurements), and again from -6 to 6 A in 2 A steps (5 'up' measurements). Set the **trim** current to 0.

Filename of $\int B_y dl$ in field free region *with Main at 0 A vs* trim current	Wiredat.ru6, wireplt.ru6

15) Standardize the magnet and set the **main** coil to 130 A, then measure $\int B_y dl$ in the field free channel as a function of **trim** coil current from 0 to -6 in -2 A steps, including zero (4 'down' measurements), and again from -6 to 6 A in 2 A steps (6 'up' measurements). Set the **trim** current to 0.

Filename of $\int B_y dl$ in field free region *with Main at 130 A vs* trim current	Wiredat.ru7, wireplt.ru7

16) Standardize the magnet and set the **main** coil to 130 A, then measure $\int B_y dl$ in the field free channel vs X from -6 to + 6 mm in 2 mm steps.

Filename of $\int B_y dl$ *vs X* in field free region *with Main at 130 A*	Wirevsx.ru8, wirepltvsx.ru8

17) Standardize the magnet and measure $\int B_x dl$ in the field free channel as a function of **main** coil current at 0, 50, 100, and 130 A steps. Also measure the $\int B_x dl$ in the field free channel with the main power supply off.

Filename of $\int B_y dl$ *vs* main current in field free region:	Wiredat.ru9, wireplt.ru9

18) Standardize the magnet and set the **main** coil to 0 A, then measure $\int B_x dl$ in the field free channel as a function of **trim** coil current from 0 to -6 in -2 A steps, including zero (4 'down' measurements), and again from -6 to 6 A in 2 A steps (6 'up' measurements). Set the **trim** current to 0.

Filename of $\int B_x dl$ *with Main at 0 A vs* trim current in field free region:	Wiredat.r10, wireplt.r10

19) Standardize the magnet and set the **main** coil to 130 A, then measure $\int B_x dl$ in the field free channel as a function of **trim** coil current from 0 to -6 in -2 A steps, including zero (4 'down' measurements), and again from -6 to 6 A in 2 A steps (6 'up' measurements). Set the **trim** current to 0.

Filename of $\int B_x dl$ *with Main at 130 A vs* trim current in field free region:	Wiredat.r11, wireplt.r11

20) Standardize the magnet and set the **main** coil to 130 A, then measure $\int B_x dl$ in the field free channel vs Y from -6 to + 6 mm in 2 mm steps.

Filename of $\int B_y dl$ *vs X* in field free region *with Main at 130 A*	Wirevsx.r12, wirepltvsx.r12

21) If possible, use a rotating coil to measure the harmonics in the field free channel. Align the rotating coil into field free round channel. Standardize the magnet and measure the harmonics with the **main** coil current at 50, 100 and 130 Amps.

Filename of Rotating Coil Harmonics	Not done

22) Upon completion of tests, send data link to Mark Woodley who will produce a data analysis file. Place data analysis file in magnetic measurements data directory

Magnet data accepted and data analysis file produced	SDA

Enter URL of on-line magnetic measurements analysis data :

http://www-group.slac.stanford.edu/met/MagMeas/MAGDATA/LCLS-II/Septum/4584/BLRCUS_4585.pptx