## SLAC Traveler for LCLS-II 1.0D38.37, Dipole Magnets, BRDAS1 and BRDAS2 for S30XL

**(Nov. 24, 2020)**

This traveler is intended to cover reception, preparation, mechanical fiducialization, and magnetic measurements of the BRDAS1 and BRDAS2 dipole magnets. These magnets are refurbished versions of the 1.0D38.37 (SA-344-100-01) that were previously installed in the PEPII Bypass and are about 1m long.

**Receiving:**

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

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| --- | --- |
| Received by (initials): | SDA |
| Date placed on test stand (dd-mmm-yyyy): | 12/2/2020 |
| SLAC barcode number: | 4587 |
| Vendor serial number from magnet label: | PEP-II HER B3 |
| SLAC approved electrical safety covers? (Y or N): | N |

**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. Mark the MAD names.

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| --- | --- |
| Beam-direction arrow in place (initials): | SDA |
| Magnet marked as (BRDAS1 or BRDAS2): | BRDAS1 |

**Fiducialization:**

Fiducialization must be done before the magnetic measurements. The magnet is to be fiducialized by the CMM or alignment group. This will require the 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 magnet gap at both ends will be recorded.

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| CMM technician (initials): | HI |

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

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| --- |
| <http://www-group.slac.stanford.edu/met/MagMeas/MAGDATA/LCLS-II/Fiducial%20Reports/1.0D38.37> L204587 BRDAS1 12 1 2020.xlsx |

**Magnetic Measurements:**

1. 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/Dipole/4587 |

1. Mark the polarity of each horizontal dipole magnet. BRDAS1 is a “negative” polarity (bending electrons right) and BRDAS2 is a “positive” polarity (bending electrons left). Determine the main-coil connection polarity (with main supply outputting positive current) which produces a “negative” field polarity for BRDAS1 and a “positive” field polarity for BRDAS2, as shown below:



**Figure 1. BRDAS1 is a “negative” polarity (bending electrons right) and BRDAS2 is a “positive” polarity (bending electrons left).**

1. Mark the polarity near the magnet leads with clear “+” and “” labels as shown above

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| --- | --- |
| Polarity of Dipole as marked according to Fig. 1(P or N) : | N[[1]](#footnote-1) |

1. For BRDAS2 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 “positive” for BRDAS2.

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| **Trim** coil polarity chosen from Fig. 1 is (P or N): | N/A |

1. Connect the magnet terminals, in the correct polarity as established above, to a unipolar power supply with maximum current *I* ≥ 200 A.
2. Connect magnet to LCW supply. Adjust supply pressure to a delta P of ~100 psi to achieve a flow rate of 1.7 gpm. Run the magnet up to 200 A for ~1 hour to warm it up (record, delta P, flow rate, and magnet coil and steel temperature).

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| --- | --- |
| LCW delta P (psi) | 113 psi |
| LCW flow rate (gpm) | 1.7 gpm |
| LCW delta T (°C) | 2.52 °C |
| Ambient temperature (°C): | 18.3 °C |
| Final magnet steel temperature (°C): | 25.6 °C |

1. 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 cosine ramp rate of 10 A/sec, if possible, and record the ramp rate used.

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

1. Maintaining this cycle history, measure the length-integrated horizontal dipole field, ∫*Bydl*, from 0 to 200 A in 10-A steps, including zero (21 ‘up’ measurements). Then, measure ∫*Bydl* back down from 200 A to 0 in 10-A steps, including zero (20 ‘down’ measurements).

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| --- | --- |
| Filename & run number of ∫*Bydl* up & down data: | Wiredat.ru1, wireplt.ru1 |

1. With the main coil at 200 A, use a stretched wire to measure the length-integrated vertical field at multiple positions in x. 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* = 30 mm to +30 mm, with *x* = 0 centered at the magnet’s horizontal center. Record data file name:

|  |  |
| --- | --- |
| Filename: | Wirevsx.ru1, wirepltvsx.ru1 |

1. For **BRDAS2**, connect the **trim** coil to a bipolar 6-A (MCOR6) supply with proper trim polarity as determined above. Still maintaining the cycle history, run the **main** coil up to 200 A, pause at least 10 seconds, and measure ∫*Bydl* 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.

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| --- | --- |
| Filename & run # of ∫*Bydl* **trim** data at *I*main = 200 A: | N/A |

1. For **BRDAS2**, set the **main** coil to 0 current by ramping first up to 200 A, then down to zero at the same ramp rate used in the standardization cycle. Measure ∫*Bydl* 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.

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| Filename & run # of ∫*Bydl* **trim** data at *I*main = 0: | N/A |

1. **For one magnet only**, and at a **main** current of 200 A with **trim** at zero, measure the vertical magnetic field component, *By*, at *x* = *y* = 0, as a function of the longitudinal beam-direction coordinate, *z* (from 10 cm to +30 cm in 1-cm steps, where *z* = 0 is defined at the iron edge), at the *upstream* end of this one magnet. Please also measure the background field at *z* = +30 cm with magnet switched off (separate file).

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| Filename of *By* vs. *z* data for exit edge: | Measured on LCLS-II Dipole 4558 |
| Background filename of *By*(*z* = 30 cm), magnet OFF: | Measured on LCLS-II Dipole 4558 |

1. Measure the inductance and resistance of the **main** and **trim** magnet coils:

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| --- | --- |
| Inductance of **main** coil (mH): | 1.689 mH |
| Resistance of **main** coil (Ohms): | 0.0510 Ohm |

1. Measure pole tip field with the main at 200 A and the trim at 0.

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| --- | --- |
| Pole Tip Field and Main Current | 0.693 +/- 0.003 T @ 199.97579 A |

1. Measure pole tip field with the main at 0 A, and the trim at +6 A.

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| Pole Tip Field and Trim Current | N/A |

1. 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

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| Magnet data accepted and data analysis file produced |  |
| Enter name of magnetic measurements analysis data file : |  |

1. LCLS-II Dipole 4587 BRDAS1 was measured as a positive dipole, but after an email communication with Mark Woodley on Jan 25 2021, it was found to be a negative dipole in the MAD deck, so the labels for the power terminals were swapped. The switch can be seen in photo ‘LCLS-II Dipole 4587 BRDAS1 Polarity Change 001.JPG’. Since the Pole Tip Field reaches ~0.7 Tesla at the maximum current, the manget should switch polarity after 10 standarize cycles. –Scott Anderson [↑](#footnote-ref-1)