Revision History

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| Revision | Date Released | Description of Change |
| R0 | July 27, 2021 | Original Release. |

This traveler is intended to cover reception, preparation, mechanical fiducialization, and magnetic measurements of the two sector 20 bunch-compressor (BC20) chicane type 0.906D40.945 dipole magnets to be used as the center dipoles in the reconfiguration of the “W-chicane” to a standard “Double-dog-leg chicane”

The magnet design are copies of the existing B1EL and B1ER dipoles installed at the beginning and end of the existing BC20. The top assembly drawing is SA-257-100-01 and the ESD has document number SLAC-I-070-102-013-00. The dipoles should be assigned names BC20BE and BC20CE.

This traveler has been adapted from the FACET BC14 and BC11 dipole magnet travelers.

**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 received (dd-mmm-yyyy): | 7/27/2021 |
| Vendor serial number from magnet label: | 1 |
| Vendor tests passed on magnet label? (Y or N): | Y |
| SLAC drawing number (enter number): | SA-257-100-01 |

**Preparation:**

A beam direction arrow, with text “beam direction”, is to be applied as shown in Figure 1. Note that this is opposite to what is shown in drawing SA-257-100-01, in order to place the electrical connections away from the walkway.

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| 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. Please measure and record the upstream and downstream gap values.

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| CMM technician (initials): | Hans Imfeld and Francis Gaudreault |

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/FACET\_II/Fiducial%20Reports/2021 07 30 Fiducialize BC20BE.xlsx |

**Magnetic Measurements:**

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

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| Incoming inspection OK (initials): | SDA |
| Date of arrival to mag. meas.(mmm-dd-yyyy): | July-27-2021 |

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

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| http://www-group.slac.stanford.edu/met/MagMeas/MagData/FACET\_II/Dipole/ BC20BE |

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

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| Inductance of **main** coil (mH): |  2.59 mH |
| Resistance of **main** coil (Ohms): | 0.0388 Ohm |
| Inductance of **trim** coil (mH): | 3.36 mH |
| Resistance of **trim** coil (Ohms): | 0.616 Ohm |

1. Determine the main-coil connection polarity (with main supply outputting positive current) which produces a “positive” field polarity for dipoles as shown in Figure 1 below.



Figure 1: As center magnets, the dipoles SA-257-100-01 are “positive” polarity and will bend the electron beam back towards the “wall-side” of the accelerator housing (as opposed to aisle-side). Note that the beam direction is opposite to what is shown in drawing SA-257-100-01.

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

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| **Main** coil polarity set to Positive from Figure 1 is (P): | P |

1. Also 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”, following the same conventions as for LCLS-II[[1]](#footnote-1).

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| **Trim** coil polarity chosen from Fig. 1 is (P): | P |

1. Connect the **main** magnet terminals (not the trims), in the correct polarity as established above, to a unipolar power supply with maximum current *I* ≥ 350 A. Leave the trim coil disconnected for now.
2. Connect magnet to LCW supply. Adjust supply pressure to a delta P of ~150 psi to achieve a flow rate of 3.44 gpm. Run the magnet up to 350 A for ~1 hour to warm it up (record, delta P, flow rate, and temperature).

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| LCW delta P (psi) | 108 psi |
| LCW flow rate (gpm) | 3.15 gpm |
| LCW delta T (°C) | 5.87 °C |
| Ambient temperature (°C): | 28.4 °C |
| Final Top Coil temperature (°C): | 31.5 °C |
| Final Core temperature (°C): | 28.3 °C |

1. Standardize the magnet, starting from zero to 350 A and back to zero, through three full cycles, finally ending at zero, with a flat-top pause time (at both 0 and 350 A) of 30 seconds. Use a Cosine ramp rate of 15 A/sec and record the ramp rate used.

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| Standardization complete (initials): | SDA |
| Ramp rate used (A/sec): | 15 A/sec |

1. Maintaining this cycle history, measure the length-integrated vertical dipole field, ∫*Bydl*, from 0 to 350 A in 25-A steps, including zero (15 ‘up’ measurements). Please record (below) the current necessary to achieve 5.9 kG-m (field to produce 0.023 mrad bend at 10 GeV). Then, still maintaining the cycle history, measure ∫*Bydl* back down from 350 A to 0 in 25-A steps, including zero (15 ‘down’ measurements).

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| Main coil excitation current 5.9 kG-m: | Amps |
| Filename & run number of ∫*Bydl* up & down data: | Wiredat.ru1, wireplt.ru1 |

1. With the **main** coils still hooked up, connect the **trim** coil to a bipolar 12-A (MCOR12) supply with proper trim polarity as determined above.
2. Standardize and then set the **main** coil to 0 amps. Measure ∫*Bydl* as a function of **trim** coil current from 0 to 12 in 1-A steps, including zero (13 ‘down’ measurements), and again from 12 to 12 A in 1-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: | Wiredat.ru2, wireplt.ru2 |

1. Standardize and then set the **main** coil to 221 amps. Measure ∫*Bydl* as a function of **trim** coil current from 0 to 12 in 1-A steps, including zero (13 ‘down’ measurements), and again from 12 to 12 A in 1-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: | Wiredat.ru3, wireplt.ru3 |

1. With stretched wire, measure the vertical length-integrated field component over a horizontal span of ±30 mm at each 3-mm interval, at the following **main** and **trim** coil current settings.
* *I*main = 221 A, and *I*trim = 0
* *I*main = 221 A, and *I*trim = +12 A
* *I*main = 350 A, and *I*trim = 0

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| Filename & run # of ∫*Bydl* vs. *x* data at 221, 0 A: | wirevsx.ru4, wirepltvsx.ru4 |
| Filename & run # of ∫*Bydl* vs. *x* data at 221, +12 A: | wirevsx.ru4, wirepltvsx.ru4 |
| Filename & run # of ∫*Bydl* vs. *x* data at 350, 0 A: | wirevsx.ru4, wirepltvsx.ru4 |

1. **For one of the dipoles only**, and at a **main** current of 221 A, with **trim** current at zero, measure the vertical dipole field By at x,y = 0,0 as function of longitudinal coordinate z from -100 mm to +300 mm in 10 mm steps, where z = 0 is the pole edge. Please also measure the background field at z = +300 mm with the magnet switched off (separate file).

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| Filename of *By* vs. *z* data: | N/A |
| Background filename of *By*(*z* = 30 cm), magnet OFF: | N/A |

1. Perform this final thermal test. Run the **main** current up to 350 A, and with **trim** also set at its maximum operating current of +12 A, measure the magnet temperature after it stabilizes (~1 hour). Record the temperature below.

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| LCW delta P (psi) | 112 psi |
| LCW flow rate (gpm) | 3.15 gpm |
| LCW delta T (°C) | 5.91 °C |
| Ambient temperature (°C): | 23.9 °C |
| Final Top Trim Coil temperature (°C): | 28.8 °C |
| Final Core temperature (°C): | 26.3 °C |

1. Measure Pole Tip Field at the current setting below.

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| PTF with Main at 221, Trim = 0 A: | 0.577 T at 221.05075 Amps |
| PTF with Main at 350, Trim = 0 A: | 0.907 T at 349.99109 Amps |
| PTF with Main at 350, Trim = 12 A: | 0.945 T at 349.99109 & 11.98942 Amps |
| PTF with Main at 0, Trim = 12 A: | 0.034 T at 11.98969 Amps |

1. Upon completion of tests, email URL of on-line data to Glen White (whitegr@slac.stanford.edu) for determination if the magnet is accepted, with Doug Storey (dstorey@slac.stanford.edu) in cc. Upon acceptance of magnet, analysis data will be placed in on-line data folder.

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| Magnet accepted: |  |
| Assigned beamline location (MAD-deck name): | BC20BE |
| Magnet marked with assigned MAD-deck name (initials): | SDA |

1. LCLS-II-2.4-PR-0064, https://docs.slac.stanford.edu/sites/pub/Publications/Polarity.pdf [↑](#footnote-ref-1)