SSRL SPEAR3 septum magnetic measurement plan

This following magnetic measurements program assumes that there are no serious surprises with the measured data. If there is some surprise, the measurement plan will have to be revised.

**Coordinates**: N.B. – everything in this document is stated for the orientation of the septum installed in SPEAR3, which will be as a vertical bending magnet for the injected beam (i.e. horizontal magnetic field). For magnetic measurements, the septum will be on its side, so in x will be in the vertical direction during magnetic measurements.

In the following, x = y = z = 0 is the unkicked stored beam location, which is the mechanical center in y, 17.5 mm in x from the vanadium permendur pole face, and the mechanical center of the eight VP blocks in z (half way between the entrance face of the first block and the exit face of the last block). Negative x is toward the VP “nose”. Positive y is up (in SPEAR, but horizontal in magnetic measurements), and positive z is in the electron beam direction.

**Standardization:** Prior to magnetic measurements, standardize the magnet by ramping from zero to 290 Amps and back to zero three times, then ramp to operating current. Keep current ramp rate below 30 Amp/s and avoid overshoot at the end of each ramp.

1. **Leakage field measurements, stretched wire**:

All leakage field measurements will be at y=0, and with the current standardized to the expected operational value (277 Amps).

* 1. Stretched wire noise characterization: The stretched wire measurements can be made with a single wire, rather than a 10-wire ribbon. We will make up for the larger noise of a single wire with additional measurements to average out the noise. Measure the integral of Bx and By at x = 0 with a motion of the 1 mm, so the wire moves from -0.5 to +0.5 mm in x or y for the By or Bx measurement. Repeat this measurement 10 times and calculate the standard deviation from the mean for the Bx and By integrals. If the standard deviation is below 20 G\*cm, proceed with the following measurements using 1 mm wire motion. If the standard deviation is larger than 20 G\*cm, please contact the SPEAR3 team.
  2. Stretched wire measurements: Because the single wire measurement has higher noise, the measurements will be made for small steps in x, so smoothing of the data can be done in measurement data processing. Measure the integral of Bx and By vs x[mm] = 25, 24, 23, … 1, 0, -0.5, -1, -1.5 -2 … -10, -10.5, -11, then 0.2 mm steps in x from to as close as possible to the nose. Repeat the measurement 4 times at each end (25 mm and as close as possible to the nose). At the other x positions, one measurement is enough. It is OK that the movement of the wire during each measurement (1 mm) is larger than the step size between some of these steps in x; the small steps in x are to provide more data to average out noise, and we’ll de-convolve a 1 mm square function from the measured data.
  3. Trim corrector response, stretched wire measurements: With the main current remaining at 277 Amps, power the trim coil with 4 Amps. Measure the integral of Bx and By vs x. This measurement does not require all the data points of 1a. Just measure every 5th point, i.e. x[mm] = 25, 20, 15, … 0, -2.5 … -10, -11, -12 …
  4. ~~Once we get the data from 1a and 1b, we may decide to adjust the trim to an optimal value and re-measure the data of step 1a~~.

1. **Injected beam field, measurements:** Standardize and set the magnet current to the expected operating value (277 Amps).
   1. Hall probe field integral measurement: Measure Bx, By, and Bz vs. z in 5 mm steps from z = -725 mm to z = +725 mm at x = -20.5 mm and y(z) along the design trajectory for the injected beam. y(z) is the trajectory along the center of the injected beam pole. It is a hard-edged field model with constant radius bend. Here is some MATLAB code defining y(z):

R = 299.527\*0.0254;

theta = 8.792 \* (pi/180);

zexit = R\*tan(theta/2); %z=0 is the vertex; I understand that Martin adjusted the end extender lengths to get this result

zentrance = -2\*R\*sin(theta/2)\*cos(theta/2) + zexit;

ymech = 0\*y;

for n = 1:length(z)

if (z(n) > zexit)

ymech(n) = 0;

elseif (z(n) < zentrance)

ymech(n) = 2\*R\*(sin(theta/2))^2 + (zentrance - z(n))\*tan(theta);

else

ymech(n) = R - sqrt(R^2-(z(n)-zexit)^2);

end

end

The “mouse” holder provided for the Hall probe should automatically follow this curve. Provide the measured data to the SPEAR3 team, and we will determine any current adjustment needed to define the operational value that gives the proper field integral.

* 1. Field integral transverse roll-off measurement: Standardize to the current determined in step 1a. Repeat the Hall probe field integral measurement of step 1a, for y = y(z) + (-10, -6, -2, 0, 2, 6, 10 mm).
  2. Excitation curve: Measure Bx, By, and Bz vs. magnet current at x = -20.5 mm, y(z) along the design trajectory for the injected beam, and z = {center of blocks 1, 3, 4, and 8}. First standardize, then ramp up current, with field measurements for 10 Amp intervals from 0 to 250 Amps, then 5 Amp intervals to 290 Amps.

1. **Leakage field measurements, Hall probe**:

All leakage field measurements will be at y=0, and with the current standardized to the expected operational value (277 Amps). These Hall probe leakage field measurements are now last in the measurement plan, because the stretched wire measurements indicated that the field integrals look very good. If we run out of time, we might skip the leakage field Hall probe measurements.

* 1. Standardize and set main coil to 277 Amps and trim to the value determined from previous measurements. Measure Bx, By, and Bz vs. z in 5 mm steps from z = -725 mm to z = +725 mm, with y = 0, and x = 0 and -13.5 mm.