Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

Strategy to Assure Good Field Quality in the 1st Magnet

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Strategy to Assure Good Field Quality in the 1st Magnet (1)

- Let me put more meat on the magnetic measurements and how our initial thinking is on assuring field quality. We recognize that it is not a standard practice to assure accelerator grade field quality in the first magnet without building one or more prototype(s).

- However, we have done this sort of things before, and our present strategy is the extension of those strategies. They have been mostly published earlier.

- Please see the details of this thinking in the subsequent slides.

Strategy to Assure Good Field Quality in the 1st Magnet (2)

- The target is not only fixing field quality but pre-stress in the coil. For example, in RHIC IR quadrupole we had superconductor from two vendors, and both provided them with the geometric tolerances. However, they were almost at the two ends of the tolerances and therefore we had to accept it. The total difference accumulated over all turns was over 200 microns, which means if we maintain the field quality, we will lose the pre-stress or we make the pre-stress we lose the field quality.
- Since it was known we accommodated by simply changing the wedge thickness. There was only one wedge, but it was at the right place.
- The problem was even bigger in DX dipole magnet which had many more turns. We accommodated by adding extra turn. We know the technique, but we need to evaluate the present designs and need to demonstrate that such large non-conformance can be accommodated without a wholesale redesign which was the case in early SSC and RHIC R&D magnets.

Strategy to Assure Good Field Quality in the 1st Magnet (3)

- Once the above 0th order fix is in place before winding the coil, the design is developed to accommodate three more adjustments. First adjustment will be made after the warm measurements. B1pF already has a thin yoke which provides sufficient yoke for warm measurements. B1ApF is likely to have a small ring around it which may or may not be present during the cold measurements in vertical dewar.
- The correction strategy will depend on the measured values of harmonics. Let's take B1pF as example as this is more developed. If the non-zero harmonics can be adjusted (both allowed and non-allowed) by adjusting iron tuning shims on the inner radius of the iron, it will be done with that only. If that is not sufficient, we will uncollar the magnet and adjust pole and midplane shims.

Strategy to Assure Good Field Quality in the 1st Magnet (4)

- These two shims are not independent parameters, and we have to mindful of the change in pre-stress. On the other side of the coin, this adjustment can be used to get right pre-stress on the coil as well, if needed.
- Please note that these pole and midplane shims can be used to correct non-allowed harmonics also. We have used this to move non-allowed harmonics in RHIC arc quadrupoles. We will readjust the iron tuning shims, if needed, after the second warm measurements to verify the change. No coil midplane and pole shims will be adjusted.

Strategy to Assure Good Field Quality in the 1st Magnet (5)

- The tuning shims mentioned above are very powerful technique and we have demonstrated that to deliver harmonics to deliver first eight harmonics (both allowed and non-allowed) to 10^-5 level, corresponding to the geometric errors of about 10 microns.

- Then the magnet will be tested in vertical dewar. At low current, we will get warm-cold correlation and use that to further correct tuning shims at the yoke id if needed.

Strategy to Assure Good Field Quality in the 1st Magnet (6)

- Then the magnet will be measured in the horizontal stand with full iron. This will not change the harmonics at a low current. However, they will first time provide the measurements at high current.
- If the harmonic changes (created either by iron saturation or the deformation in coil geometry due to Lorentz forces) are beyond the acceptable amount, we will change the iron shim in the rectangular slot.
- No magnetic measurements are planned, and we are planning to rely on calculations only. The error in this adjustment is likely to be much smaller than the specified tolerances.