

## LCLS Undulator Quadrupole Magnet Design Changes After Inspecting And Testing The First Article Magnets

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Below is a list of changes requested after testing the first article magnets:

1. Make the following changes to the drawings:
  - a. All magnet cores shall be made with exactly 123 laminations.
  - b. Hard stops shall be provided for all core stacking tooling so that the lengths of all cores are held constant after epoxy curing.
  - c. Provide extra insulation at the coil leads near the coil to avoid an electrical short with the longer core. ETI also suggested to bend the coil leads outward before potting the coils.
  - d. Modify the magnet shield spacers so the overall length of the magnet remains the same or smaller.
  - e. Longer tie bars shall be designed and used. Do not use the short tie bar design used on the first article magnets.

Once Everson Tesla has been given the approval to start building the magnet with the above conditions they shall submit two new first article magnets. Everson Tesla shall ship these two new first articles to ANL.

Below is a list of questions that need to be answered by ANL before ETI can proceed manufacturing the magnets.

2. Shall ETI continue building the remaining magnets while awaiting approval of the two new first article magnets?
3. Shall ETI send the magnets to England to be magnetically measured before shipping to ANL or LSLC?
4. Isaac Vasserman, of APS, may have a portable method of measuring the magnetic field. This still needs to be determined. If so then someone from APS could go to ETI in Pennsylvania and magnetically measure the magnets before they are shipped to APS or LCLS for final magnetic field measurement.
5. What is the status of the very first two articles?

Below is a question that needs to be answered by ETI before ANL can make the decision whether or not to send the magnets to England to be magnetically measured before shipping to ANL or LSLC.

6. ETI may have a method of crudely measuring the magnetic field and will get back to us. If so they could do this measurement in Pennsylvania before shipping the magnets to APS or LCLS for final magnetic field measurement.

Below is a list of changes requested after inspecting the first article magnets:

7. The hi-pot failed for quad coils to core.
  - a. It was temporarily fixed by applying Kapton tape between the leads and the core.
  - b. Item 6.4 in the traveler shows hi-pot test results less than one ampere. This is too high. Results should be less than  $5 \mu\text{A}$ .
  - c. Better insulation needs to be used.



**Figure 1: Shrink tubing on leads**

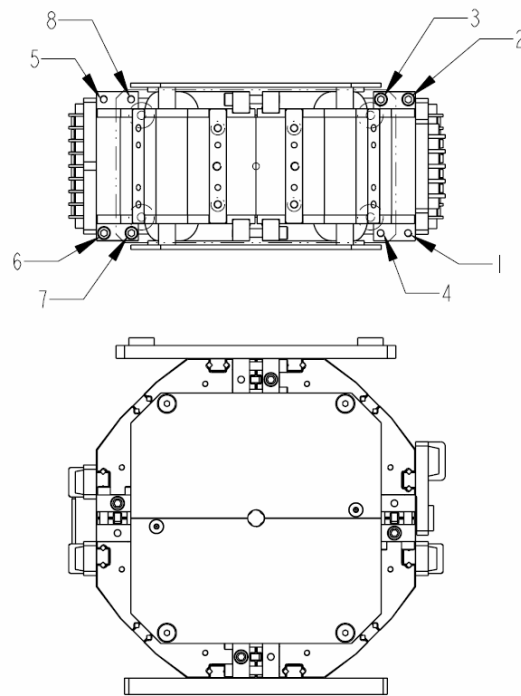
- i. We recommend applying Kapton tape to the leads where the leads nearly touch the clamp blocks. Then cover the leads completely with heat shrink tubing (see Figure 1).
8. Measurements on the inspection sheet for the gaps between the poles have front and back values. The gap diameter has only one measured value. The gap diameter should have both front and back values.
9. It was noticed during the split magnet test that one of the screws was not torqued. They were hand tight. Please use torque procedure (see attached procedure).
10. Use 10 G (not 5 G) Drop Tell Shock indicator in the shipping crate.
11. Magnet #2 thermal switches were rewired like ETI suggested drawing but with the one lead tied to the side. This is how all of the thermal switches shall be wired.
12. The name plate should be bent slightly to conform neatly to the core. I did it using a vice and bent it by hand.
13. Support or shield the leads near the coil so the leads cannot be easily bent near the coil.
14. Keep the leads inside the area bounded by the core (i.e. don't let the leads stick out beyond the core except, of course, at the terminals).

## LCLS Undulator Quadrupole Magnet Torque Requirements after Splitting the Magnet

1. Hand tighten all screws.
2. Apply G-10 blocks with C-clamps to align top and bottom halves (see Figure 2).
3. Torque all screws to 2-3 ft-lbs in the following sequence: 1, 2, 3, 4, 5, 6, 7, and 8. See Figure 3 for screw identification.
4. Remove the C-clamps and G-10 blocks.
5. Torque all screws to 4-5 ft-lbs in the following sequence: 5, 6, 7, 8, 1, 2, 3, and 4.
6. Torque all screws to 7 ft-lbs in the following sequence: 1, 2, 3, 4, 5, 6, 7, and 8.



**Figure 2: Magnet alignment of top and bottom.**



**Figure 3: Torque sequence.**