LCLS-TN-21-3

Tests Of HXR Undulator Covers

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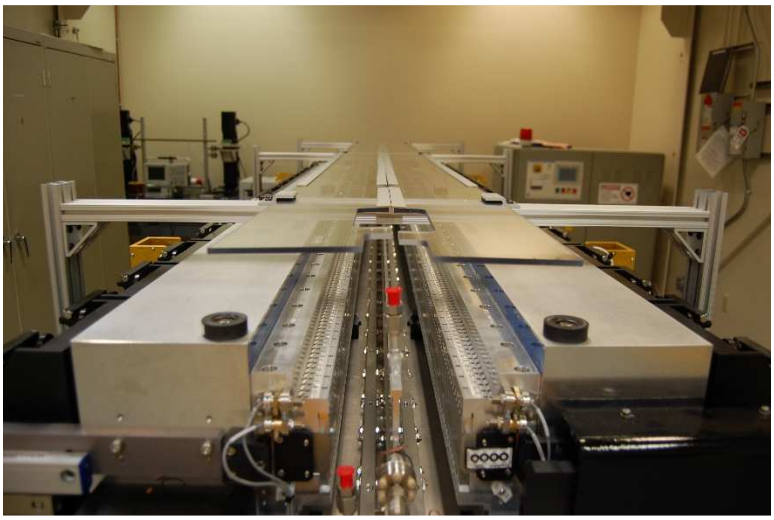
Purpose

Covers were recently purchased to place on top of the HXR undulators to keep debris from falling into the gap when work was done overhead in the tunnel. A photo of a cover is shown below.



Since the undulators are calibrated and have very tight mechanical and thermal tolerances, it seemed prudent to check that the covers do not affect the calibration. Results from two checks are presented below.

Undulator Gap

The effect of the cover on the undulator gap was checked with capacitive sensors. The frame for the cover was installed when the test began. Capacitive sensors were placed in the gap near the middle cover support. A reading was taken. The middle support was loosened, and another reading was taken. The support was re-tightened, and the plexiglass cover was installed and another reading was taken. The results are presented below.

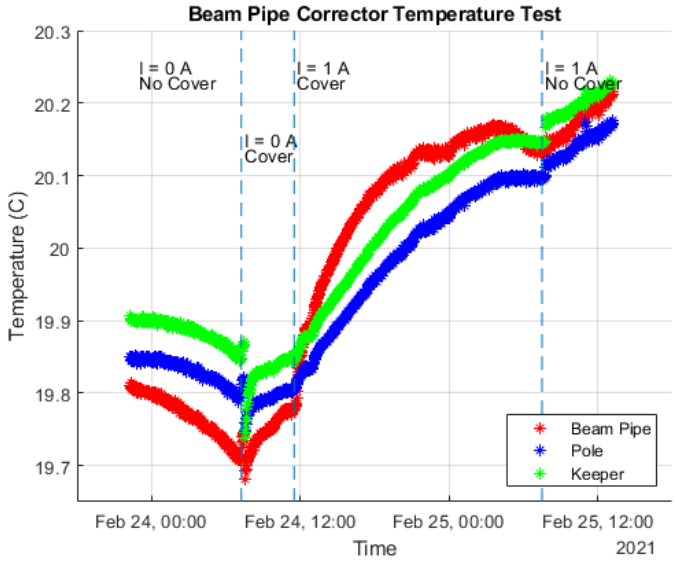
Frame, No Cover	46.5025 mm
Loosen Frame	46.5023 mm
Add Plexiglass Cover	46.5024 mm

The support frames are somewhat stiff and loosening the frame had an immediate effect on the capacitive sensor reading. Although loosening the frame had an effect smaller than the 1 micron gap tolerance, it might be a good idea to keep the frames loose so they don't add stress to the undulator girder. The weight of the plexiglass had minimal effect.

Undulator Temperature

The undulator K value is very sensitive to temperature. A temperature change of the magnets of 0.1 deg C brings the undulators out of tolerance. The beam pipe has corrector windings which produce heat, and the beam itself produces heat. We want to make sure that the cover does not affect the heat flow resulting in changes to the magnet temperatures.

A test of the effect of the cover on undulator temperature was performed. The temperatures of the beam pipe, a magnet pole, and a magnet keeper were measured. First the temperatures were measured overnight. In the morning the technicians installed the undulator cover. Several hours later, the beam pipe corrector power supplies were turned on. A current of 1.0 A was supplied in each of the two corrector windings. The voltage on each winding was 1.7 V. The power heating the beam pipe from the corrector was 3.4 W. The current is at the upper limit of the currents used in the tunnel. (Currents of 0.5 A and below are more typical.) No additional current was added to simulate beam losses. After equilibrium was reached, the next morning, the technicians removed the plexiglass covers. A plot of the temperatures over this time is shown below.



Removing the covers did not make the temperature go down, as might be expected. In fact, the temperature went up slightly because the room temperature was slightly higher than the undulator temperature. It appears that the covers allow adequate ventilation and do not trap heat from the beam pipe.

Note that the beam pipe temperature rose by 0.4 deg C when current was applied. This is near the limit where the magnet temperature is affected at small gap.

This test was performed in the assembly area of the MMF which has modest (±0.5 deg C) temperature control. One can see in the plot that the temperature is rising during the daytime which make precise measurements difficult. The results are adequate, however, to show that the cover has minimal effect on the undulator temperature. The undulator gap for this test was 120 mm. The controller was disconnected, so no additional measurements at different gaps were performed for this test.

Conclusion

Two checks were made to see if the HXR undulator covers affect the calibrations. No problems with the covers were observed.