**Delta Undulator**

**Magnet Assembly, Tuning, and Measurement**

The Magnet Assembly and Testing of the Delta Undulator will take place in the SLAC Magnetic Measurement Facility (MMF). This process will utilize a fixture, specially designed for this purpose that emulates the datum structure of the Delta Undulator Strongbacks. The Fixture is designed to directly interface with the kinematic mounting system used on the devices in the MMF... The devices include the Leitz CMM,Kugler Magnetic Measurement Bench, Undulator Tuning Stand and the Undulator transport Cart. In addition the Lifting Eyes on the Fixture are incorporated in to the mounting system. By using this system the gravitational effects on the Fixture are the same as it sits on each device and while it is being moved from device to device.

**Dimensional Verification of Carriers Installed into Strongback**

The first step in the assembly process is to mount the Guide Rails to the Carrier segments. There are three Carrier segments for each quadrant. Rail/Carrier Assemblies will then be installed into the appropriate quadrant on each of the Strongback halves. This will take place with the Strongback section on the CMM. After the Assemblies for both quadrants of the Strongback half have been installed, the CMM will then measure the reference features on the Carriers to verify their location in reference the Strongback datum system. For this measurement the Strongback section will be positioned and supported on the CMM in the same orientation as when fully assembled and installed on the LCLS Girder. This will ensure that any gravitational effects on the complete assembly are included in the measurements.

This step may seem to be unnecessary. The Carriers and Strongback will have already been inspected to verify conformance to design specifications. But, this will be the last chance to verify the dimensional stack up between components before the magnets are installed and make any corrections if needed. If, it is determined that modifications require machining, this will need to be done before the magnets are installed. To do remove the magnets would be a very time consuming and costly process.

**Install Carrier/Rail Assemblies onto Tuning Fixture**

Next, the Tuning Fixture will be placed on the CMM. On the CMM the Fixture will rest in the same non-adjustable kinematic mounting system used for LCLS I Undulators. The Carrier/Rail Assemblies will then be (transferred from a strongback section to) ~~mounted onto~~ the Tuning Fixture. Once the Assemblies are mounted, and with the fasteners torqued to the correct settings, the CMM will measure the Fixture and the Assemblies to ensure that all components are in the correct position and that they correctly relate to each other. (What does “correctly” mean? May be: the geometrical relations between the components did not change?) This will ensure that the magnets, when installed, will not change their relative positions during the transfer. ~~fixture can be correctly aligned on the Kugler Bench~~. After measurement the Fixture with the Carriers installed will be lifted off of the CMM with the crane and placed on the Undulator Transport Cart were it will be moved to the Tuning stand in the Magnetic Measurement Room.

**Installation of Magnets into the Carriers**

Using the crane in the Magnetic Measurement Room the Tuning Fixture, with the Carrier/Rail Assemblies installed, will be lifted from the Transport Cart onto the Tuning Stand. As on the CMM, here the Tuning Fixture will also rest on a non-adjustable kinematic mounting system.

The individual magnets will now be installed into the slots on the Carriers.

 After the magnets are installed, the complete Tuning Fixture will be returned to the CMM; there the position of each magnet in relation to the Nominal Beam Line will be measured. The data from this measurement will determine how much and in which direction a magnet may ~~need~~ be moved during the Magnetic Tuning process. After this measurement the Tuning Fixture will be moved to the Kugler Bench for Magnetic Measurement and Tuning. Or, it may go back to the Tuning Stand to have the position of some magnets modified before it is moved to the Kugler Bench.

**Magnetic Measurements and Testing on Kugler ~~Kuglar~~ Bench**

The Tuning Fixture Assembly will be lifted with the crane in the Magnetic Measurement Room and positioned on the Kugler Bench. On the Kugler Bench it will rest on the Active Cam Mover kinematic mount system. An optical sensor on the Kugler Bench will traverse over the Carriers measuring the Reference Feature on each Carrier. (How to control roll angle? We’ll need a special reference surface to put a bubble level on.) These measurements will be used to ~~will be used~~ to align the Tuning Fixture/ Carrier Assembly with the ZY and ZX planes of the Kugler Bench using the Adjustable Cam Movers. Once the Assembly is aligned Magnetic Measurements and Tuning will begin.

After Magnetic Measurement and Tuning the Assembly will be moved to the CMM for measurement to verify the position of each magnet

**Magnet Measurement on CMM**

For Magnet Measurement on the CMM the Tuning Fixture assembly will again be placed on the kinematic mount system on the CMM. Using reference features on the Fixture, a coordinate system emulates the virtual beam axis will be created. The quarter circular profile on each magnet will be measured and its X and Y location in relation to the virtual beam axis reported.

The Tuning Fixture Assembly will be move back and forth between the CMM, and Kugler Bench until all of the magnets are correctly positioned and measurements are complete.

**Final Measurement Magnets Installed in Strongback**

After Magnetic Measurement and Tuning is complete the Carrier Assemblies will be removed from the Tuning Fixture and installed into their final location on the Strongback. After all fasteners are in place and torqued to specified settings the magnets will be measured and their location compared to a virtual beam line created from datum features on the Strongback. Should magnets be found out of position the assembly will be return to the Tuning Fixture and the Test and Measurement process will begin again after adjustments are made.