**Delta Undulator**

**Magnet Assembly and Dimensional Verification**

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, ~~Kuglar~~ 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 onto Strongback**

The first step in the assembly process is to mount the Guide Rails to the Carriers. The Rail/Carrier Assemblies will then be installed into the appropriate location on each of the Strongback halves. This will take place with the Strongback halves mounted on the CMM. After the Assemblies (two for each strongback) have been installed, the CMM will then measure the appropriate features on the Carriers to verify their locations (Comment: It would be useful to have the strongbacks set on their feet, so any deflections would be the same as in the real assembly. This step is necessary to check dimensional relations between the strongback’s and the carriers’ references).

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 was determined modifications that require machining are needed after the magnets are installed, they would have to be removed. This 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 non-adjustable kinematic system used for LCLS I Undulators. The Carrier/Rail Assemblies will then be 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. This will ensure that the fixture can be correctly aligned on the Kuglar Bench. (Comment: we’ll need to make sure the shape of the carriers will not change when we transfer them from the tuning fixture to the strongback. I mean, tuning fixture might need shimming to satisfy this requirement.) 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 Carries.

 After the magnets are installed the complete Tuning Fixture may be returned to the CMM to verify the position of the magnets. (Comment: this step is necessary to provide mechanical data for tuning process. I should know which magnet could be moved in which direction to make it close to the center and how much.) Or, it may be moved directly to the ~~Kuglar~~ Kugler Bench for Magnetic Measurement.

**Magnetic Measurements and Testing on Kuglar Bench**

The Tuning Fixture Assembly will be lifted and positioned on the ~~Kuglar~~ Kugler Bench using the crane in the magnetic Measurement Room. On the ~~Kuglar~~ Kugler Bench it will rest on an Active Cam Mover kinematic mount system. An optical sensor on the ~~Kuglar~~ Kugler Bench will traverse over the Carriers measuring the Reference Feature on each Carrier. These measurements will be used to will be used to align the Tuning Fixture/ Carrier Assembly with the ZY and ZX planes of the ~~Kuglar~~ Kugler Bench using the Adjustable Cam Movers. Once the Assembly is aligned Magnetic Measurements and tuning will begin.

~~Yurii uses his magic to make magnetic measurements.~~

After Magnetic Measurement, the Assembly ~~may be moved back to the Tuning Stand to have magnets adjusted, or it may~~ will be moved to the CMM for measurement to verify the magnet positions.

**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 -~~semi-~~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, ~~Tuning Bench,~~ and ~~Kuglar~~ Kugler Bench until all of the magnets are correctly positioned and measurements are complete.

**Final Measurement Magnets Installed in Strongback**

After Magnetic Measurement and Testing 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.