Memo

Date: October 31, 2017
To: IRR Team
From: Toshi Tanabe, NSLS-II Insertion Devices Group Leader
Subject: Modifications to the U42 Undulator at Cell 7 for the SST Beamline

Prior to installation at NSLS-II, modifications were made to the mechanical and controls systems for the U42 Undulator, installed at ring cell 7. These modifications are outlines below:

**Mechanical Modifications**

1. A transport fixture was designed and manufactured to transport the U42 from the building 832 Hi-Bay to the storage building and then through the storage ring tunnel. It was designed as a frame with a set of forklift tubes that double as support outriggers that can accommodate air casters below it. The frame is slid between the bottom of the undulator frame and the floating base plate and clamped in place by the three nuts located on the base height adjusting studs. Once attached, it was very easy to switch between forklift and air caster transport.

2. It was decided that the rotary encoders mounted on the axis of the ball screw shafts were not accurate enough for our purposes. Also, these were only relative and not absolute. So, a new encoder system was designed based on the Danfysik design used on the IXS IVU, but with a different stroke.

3. Due to a lack of ESRF drawings, tooling needed to be designed to manually locate the encoder support plates accurately to the carriage weldments, and then pin and bolt them in-situ instead of beforehand.

4. The old 5-phase gap drive stepping motors and gearboxes needed to be retrofitted and replaced with the newer 3-phase gap drive stepping motors and updated gearboxes. This also required the purchase of 2 new gearboxes and the machining of two new shaft adapters and corresponding adapting hubs.

5. A new control rack was designed and built for the U42 control system.

6. A new motor driver amplifier, a standard NSLS-II Delta Tau controller was installed in the control rack along with power supplies, cabling and other corresponding components.

7. A set of four Magic Finger Holders containing provision for up to 2 rows of pill magnets was installed on each end of both the upper and lower girders to adjust the field integral.

8. A new set of correction coils was designed, along with a set of support stands based on Bosch 90 x 90 extrusion and steel bases that were adjustable in both X, Y, Z, and tilt.
9. A new kill and limit switch system with an integral fine-adjustable trip dog mounting arrangement was designed and manufactured based on the 5-Plunger Version of the Euchner switch that uses the 5-groove trip dog rail.

10. Lead shielding needed to be integrated into the encoder system in order to protect the encoder read heads from radiation.

11. Software was written for the gap drives, motor brakes, encoder feedback, limits, kills, etc.

12. A removable set of polycarbonate guards was designed and manufactured to protect anyone from getting too close to the magnet array.

13. The existing base plate which was not designed for grout needed to be modified in order to be grouted into the straight section.

14. A set of open gap limit switches was installed to trigger the EPS system.

15. A set of upstream and downstream hard stops for both gap open and gap closed was designed and mounted to the welded undulator frame to prevent over travel of gap motion in both open and closed directions.

Controls Modifications

1. Essentially everything related to controls is new on the U42 device. The stepping motors and brakes were replaced with new 3-phase stepping motors with integrated brakes and brake controls in the stepping motor driver. The device had no limit switches, kill switches, e-stops, or encoders, so those were added.

2. There was no control system for the device, so a new control system was designed and built. The design was based on the control system for the Kyma EPU’s on the ESM beamlines.

   a. This control system uses a Delta Tau Brick stepping motor controller and Reer Safety PLC to read the encoders and react to limit, kill, and e-stop switch inputs. The controller, safety PLC, power supplies, circuit breakers, and solid-state relays used for the control system were all new.

3. The software running on the Delta Tau Brick controller and the Reer Safety PLC were adapted from the software from COSYlab used to run the Kyma EPU49. This software was simplified and reconfigured so that it was more compartmentalized, easier to understand, and easier to maintain.

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