THE DEVELOPMENT OF THE UNDULATOR CONTROLS MODULE AT THE LINAC COHERENT LIGHT SOURCE*

A.D. Alarcon†, SNAL, Menlo Park, CA 94025, USA

Abstract

The Linac Coherent Light Source, LCLS, at the SLAC National Accelerator Laboratory, SNAL, is the first hard x-ray Free Electron Laser [1]. The Undulator Controls Module, UCM, controls five cams and two translation stages that regulate the position of each of the 33 permanent undulator magnet segments within 10 microns. The UCM package, hardware and software, was designed and built by the Advanced Photon Source at Argonne. Important lessons were learned throughout the collaborative design, installation, testing, and commissioning periods that could be invaluable to future similar controls projects.

REQUIREMENTS

The requirements for the UCM are not specifically stated in a single document. They exist in a series of documents describing general undulator system requirements, motion requirements, mechanical systems, and thermal stability. From this group of documents, an Engineering Specification Document, ESD, was generated. The ESD serves to describe the engineering design necessary to satisfy the requirements. Requirements for specific UCM software functions were never officially documented, and functions have been added to the UCM package throughout the project.

DEVELOPMENT

A complete and fully functional Long Term Test Stand, LTT, was built by Argonne that was invaluable in the development process of the UCM. The Undulator Controls Module Interface, UCMI, was built to serve as the interface between the devices and the Input Output Controller, IOC. The Undulator Motor Power Interface, UMPI, was developed to provide power and interlocks. Cables and a cable management system, the Electronics Interconnect Assembly, EIA, were all built around the LTT, see Fig. 2 and Fig. 1 to refer to all devices that make up the UCM. Software was created to satisfy all documented requirements. Reviews along the development process improved the quality of the final product, but time constraints prevented the team from learning the intricacies of the UCM in order to further improve it before delivery.

DELIVERY

Argonne delivered 33 sets or mini racks each containing the full set of hardware necessary to run a single undulator. The delivery was on time for installation and the equipment arrived in good condition. All hardware had been tested previous to shipment. The software package was available early as it progressed to a final version. This was crucial as the integration of the UCM software into the LCLS control system was time consuming because of differences in the development environments between LCLS and Argonne.

INSTALLATION AND CHECKOUT

The complex installation of the UCM hardware went smoothly. Cables were well labeled, and the cable distribution system, EIA, proved extremely useful at managing the almost 40 devices that needed control cables. Checkout was hindered by the lack of a proper and tested procedure. Interlock checks and motion calibration procedures had to be learned during valuable checkout time within the tunnel. Mechanical problems in the mover system also presented challenges during the checkout phase.

COMMISSIONING

The commissioning of the UCM can be summarized in one major milestone, LCLS is now the first hard x-ray laser in the world. Repeatable and accurate motion control of the 33 undulators has contributed to a very successful commissioning. Not all physicists desired software functions were available during commissioning because of poor requirements tracking, but most of them have now been added.

CONCLUSION

The Undulator Controls Module has proven itself by the great success of the LCLS. Many easily identified factors can be attributed to this success. Some of them are the quality of the hardware developed by Argonne and its proper and timely delivery, and the swift installation and trouble shooting of the SLAC team. Despite such great success, future similar project can take some advice from hardships experienced during the development of the UCM. A single controls requirement document, summarizing requirements from the mechanical interface to high level functions, can be an invaluable single source to develop the whole control system. The lack of such document delayed the development of some UCM software functions. A timely drafted handout plan that would include drawings, installation and tested checkout procedures must be a requirement during any collaboration.

REFERENCES

[1] SLAC National Accelerator Laboratory Office of Communications (April 21, 2009), "New Era of Research Begins as World's First Hard X-ray Laser Achieves 'First Light'", Press release, `http://home.slac.stanford.edu/pressreleases`.

* Work supported by the US Department of Energy

† alarcon@slac.stanford.edu

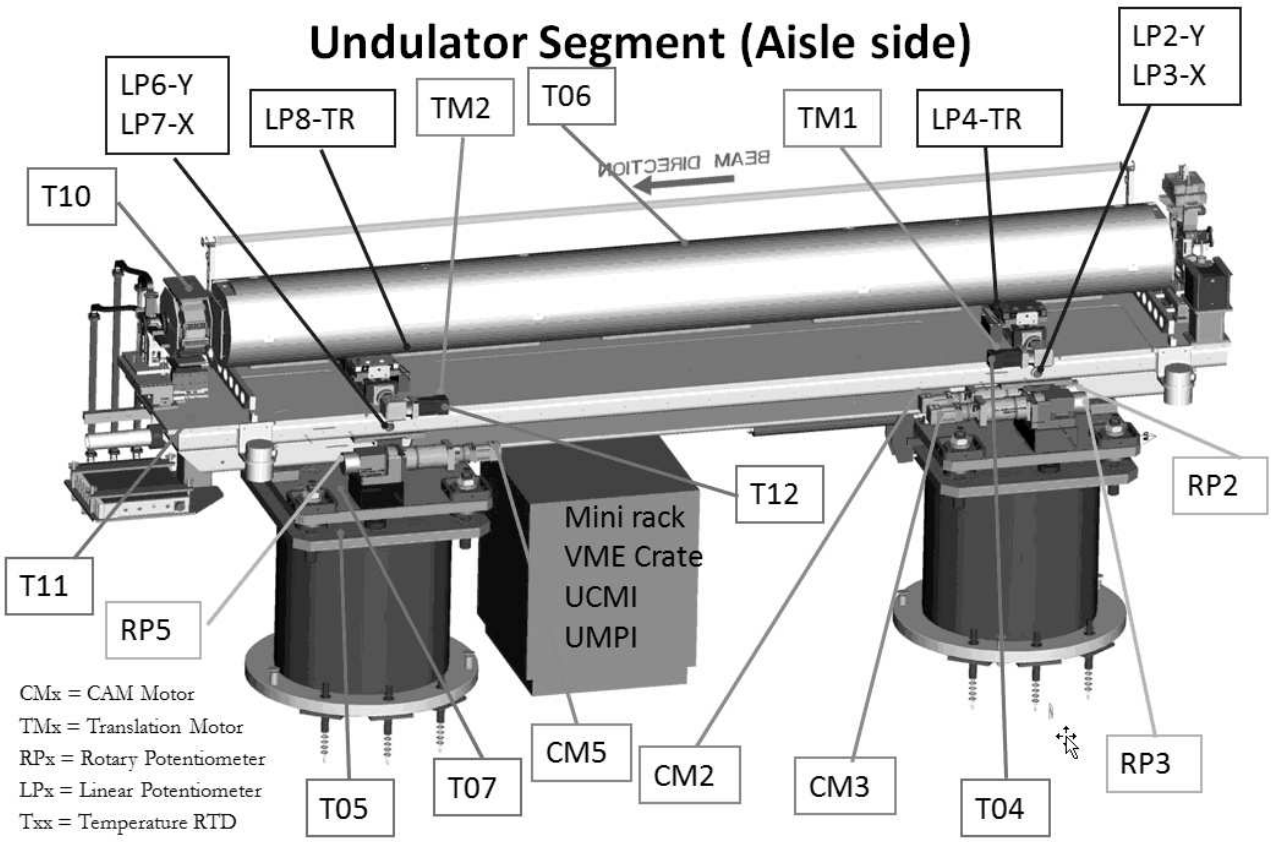

Figure 1: Undulator controls equipment, aisle side.

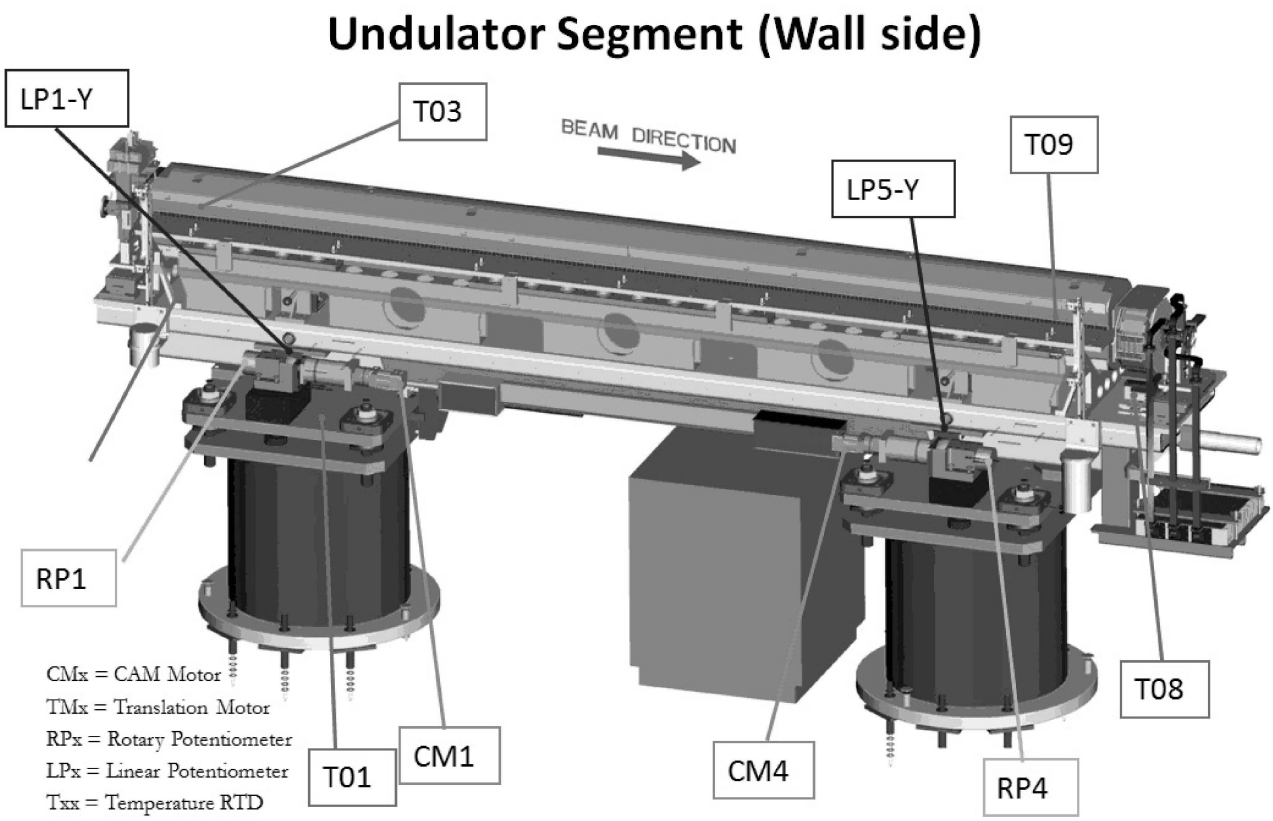

Figure 2: Undulator controls equipment, wall side.