

First Prototype Undulator for the LCLS Project – Mechanical Design and Prototype Lessons

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Abstract

The design of a new hybrid-type undulator with a fixed gap of 6 mm, a period of 30 mm, and a length of 3.4 m is presented. The undulator line, consisting of 33 such units, is a critical part of the LCLS project, which is one step toward the design of a fourth-generation synchrotron radiation source. Magnetic tolerance of all 33 undulators, as well as the corresponding mechanical uniformity, is a major challenge. A ridged C-shape design with a titanium housing of 12" diameter was chosen to provide easy access to the gap area for magnetic measuring and tuning. Lessons learned while working with this prototype are critical for successful project execution. Assembly and tests results, as well as possible design changes, are presented.

Keywords: hybrid undulator, synchrotron radiation, SASE

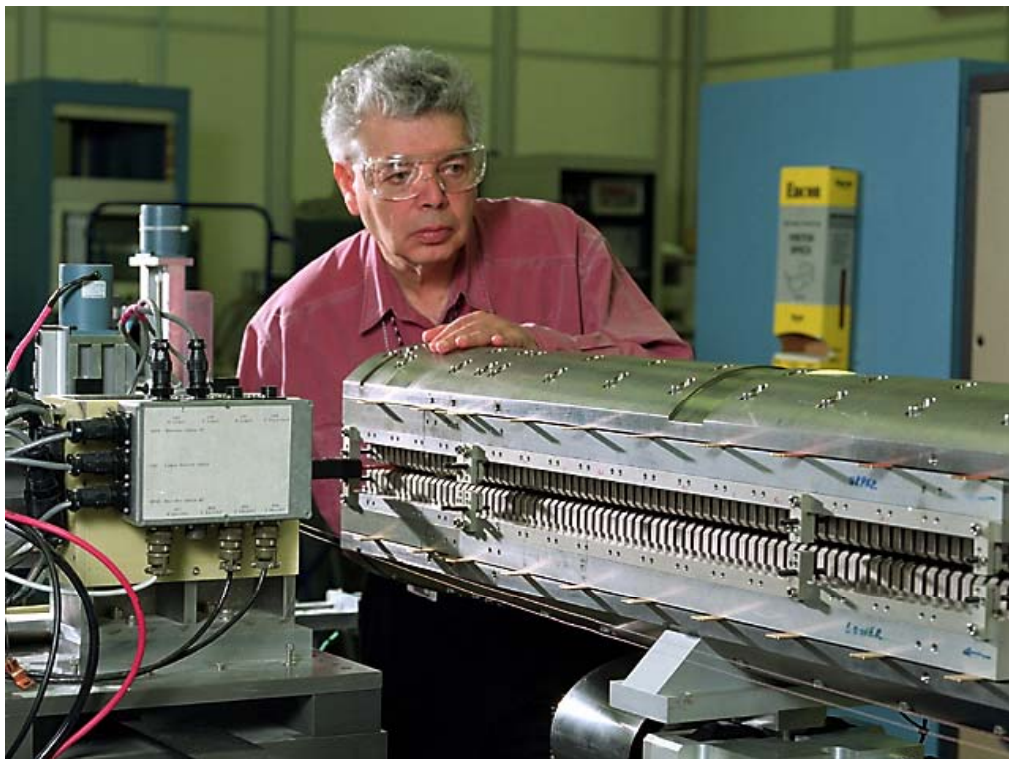


Fig. 1: LCLS prototype undulator on the magnet measuring stand.

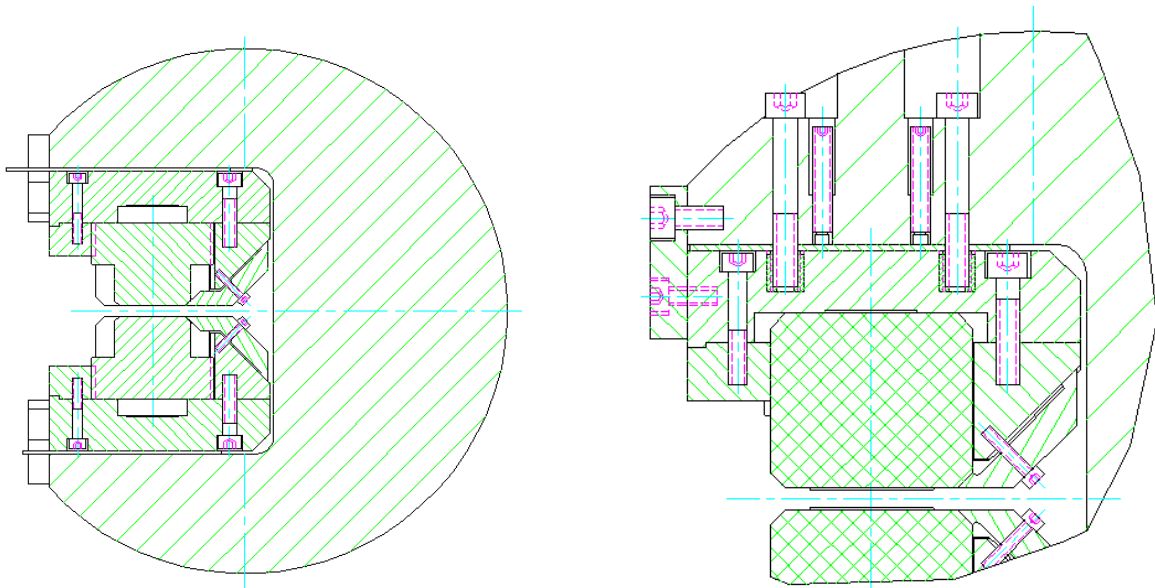


Fig. 2: LCLS prototype undulator cross section and details of the magnet structure.

The first prototype of the LCLS undulator was designed, manufactured and partially tested [1]. In Fig. 1, the undulator is shown on the magnetic measuring stand. The undulator cross section and magnetic structure are shown in Fig. 2. The major design features of this device are listed below:

1. The titanium housing is made from a forged 12” bar.
2. The poles are made of vanadium permendure with so called “wings.”
3. The pole and magnet base is made of aluminum alloy that partially compensates for the changes in pole gap, as well as for the magnetization of the permanent magnets due to temperature change.
4. Only one clamp is used for each pole and magnet. The clamps are made of titanium.
5. Incremental shims and a “push-pull” screw can be used for the undulator gap adjustment.
6. Piezotranslators are used to precisely tune the field strength at both ends of the undulator (two on each end).
7. The outbound area is completely open for the side shim installation, where necessary, in order to tune the field strength along the undulator.
8. Side shims have six bars made of low-carbon steel. Each bar can be individually adjusted and locked in place.
9. Five camshaft movers are used for horizontal and vertical alignment of the undulator as a whole.

