The Advanced Photon Source

A Novel Undulator for Present and Future Light Sources

Over the past four years, APS physicists and engineers have been actively involved in the development of the innovative horizontal gap vertical polarization undulator (HGVPU) for the Linac Coherent Light Source-II (LCLS-II) x-ray free-electron laser (FEL) project at the SLAC National Accelerator Laboratory.

Undulators currently installed at the LCLS have a fixed magnetic gap. The LCLS-II project calls for undulators with an adjustable magnetic gap. Adjustable gap undulators are standard for all storage ring-based synchrotron radiation sources, but the main challenge for x-ray FEL adjustable gap undulators is the requirement for precise control of the magnetic gap in its absolute value and along the electron beam trajectory. Conventional designs lead to quite complicated, bulky, and space-consuming mechanical systems. And although there are no showstoppers in such a design, it does not exploit some advantages that the FEL source brings with its round electron beam and on-axis injection.

The LCLS-II HGVPU in the APS Insertion Device Magnetic Measurement Facility just prior to "hand-off."

The APS engineers and undulator team have developed an innovative design for the magnetic gap drive mechanism of the HGVPU. First, the overall mechanical system was designed to be gravity-neutral, which required a rotation of the magnetic gap 90° from vertical to horizontal. Second, the so-called undulator strongbacks – typically heavy, with large cross-section metal plates that hold undulator magnets and poles – have been replaced by much smaller plates. To maintain precise magnet gap control, specially designed springs, that would exactly match the gap dependence of the magnetic force, were introduced along the backing plate. The capability for highly accurate tuning of the force compensation mechanism leads to precise control of the gap along the device for all gap settings.

Apart from the fact that this novel device represents a very elegant solution for a daunting mechanical problem associated with the conventional type of undulator, there is another very important advantage to using this device at the x-ray FEL or at future x-ray sources. An undulator with a horizontal gap generates vertically polarized x-rays, and that has the potential for improved experimental geometries, because bulky diffractometer systems with long detector arms would not "fight" with gravity because they could be placed in the horizontal plane.

Another very important advantage of this design is its compatibility with the existing infrastructure in the LCLS undulator line. That leads to significant monetary savings for the LCLS-II project. The performance of the prototype and its advantages over the conventional undulator made it a prime choice for the LCLS-II construction project, where it will be used as a baseline device for the hard x-ray source.

On March 17, 2016, the APS undulator team transferred the complete documentation on the HGVPU to Lawrence Berkley National Laboratory, where 34 of the devices will be fabricated for the LCLS-II. This novel device designed and prototyped at the APS has a bright future at the LCLS-II and at the next generation of storage ring light sources. *Contact: Efim Gluskin gluskin@aps.anl.gov*

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Call for APS General-User Proposals

The Advanced Photon Source is open to experimenters who can benefit from the facility's high-brightness hard x-ray beams.

General-user proposals for beam time during Run 2016-3 are due by Friday, July 8, 2016.

Information on access to beam time at the APS is at http://www.aps.anl.gov/Users/apply_for_beamtime.html or contact Dr. Dennis Mills, DMM@aps.anl.gov, 630/252-5680.

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