Superconducting Undulators at the APS: From Planar to Helical and Everything Between

Matthew Kasa

Argonne National Laboratory, USA

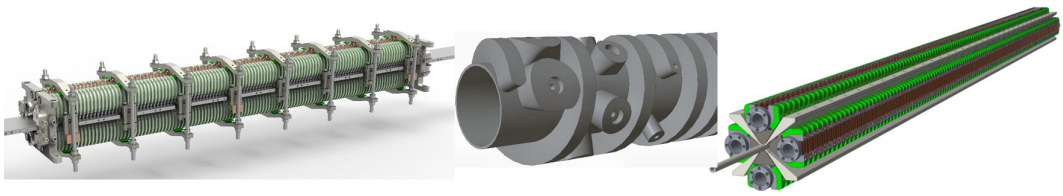
kasa@aps.anl.gov

Efforts to incorporate superconducting undulator (SCU) technology into the storage ring at Argonne National Laboratory's (ANL) Advanced Photon Source (APS) were realized in 2013 with the commissioning of SCU0 [1]. There are currently three SCUs in operation. SCU18-1 [2] was the second SCU installed and has been in operation since May 2015. SCU18-2 replaced SCU0 in September 2016. SCU18-1 and SCU18-2 are both 1.1-meter long planar undulators with an 18-mm period. Third in operation is a 1.2-meter long, 31.5-mm period, helical superconducting undulator (HSCU), which was recently commissioned. The experience and knowledge of designing high quality planar SCUs has evolved at the APS and progressed to include a unique helically-polarizing undulator. The effort to incorporate new SCU technology and topologies is ongoing.

A program is currently underway to develop a universal SCU that is capable of providing planar (horizontal or vertical), elliptical, or helical polarization using two pairs of planar SCU magnets. The horizontal and vertical pairs are offset longitudinally by one-quarter period to provide arbitrary polarization. This topology is referred to as the superconducting arbitrary polarizing emitter (SCAPE) [3]. To further leverage the advantage of SCU technology, other superconductor options are being explored. Prototypes using high temperature superconducting (HTS) tape and Nb_3Sn wire have been constructed and tested.

Along with the magnet design, the cryogenic system has also continued to evolve from the original design adapted from the Budker Institute. The second generation cryostat is more compact and uses standard components [4]. A 4.7-meter long version of the cryostat is being developed for the APS upgrade, which will house two SCUs in either a phased or canted configuration.

Work supported by the U.S. Department of Energy, Office of Science, under Contract No. DE-AC02-06CH11357.



Renderings of the 1.1-meter long planar SCU (left), the end of the HSCU (center), and the SCAPE assembly (right).

References

[1] Y. Ivanyushenkov *et al.,*"Development and operating experience of a short-period superconducting undulator at the Advanced Photon Source," *Phys. Rev. ST Accel. Beams,* no. 18, p. 040703, 2015.

[2] Y. Ivanyushenkov *et al.,* "Development and operating experience of a 1.1-m-long superconducting undulator at the Advanced Photon Source," *Phys. Rev. Accel. Beams,* no. 20, p. 100701, 2017.

[3] Y. Ivanyushenkov *et al.*, "Conceptual Design of a Novel SCAPE Undulator," in *Proc. 8th Int. Particle Accelerator Conf. (IPAC'17)*, Copenhagen, Denmark, May 2017, paper TUPAB117, pp. 1596-1598.

[4] J. Fuerst et al., "A second-generation superconducting undulator cryostat for the APS," IOP Conf. Ser.: Mater. Sci. Eng. 278 012176, 2017.