

# THE UPGRADED ADVANCED PHOTON SOURCE

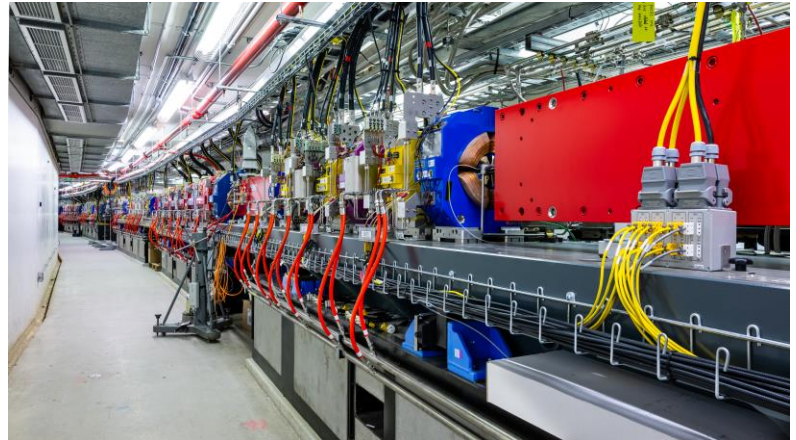
## ADVANCED PHOTON SOURCE ACHIEVES WORLD-RECORD ELECTRON BEAM EMITTANCE

A new set of electron beam measurements puts the upgraded Advanced Photon Source (APS) at the top of the list of the world's synchrotron X-ray research facilities.

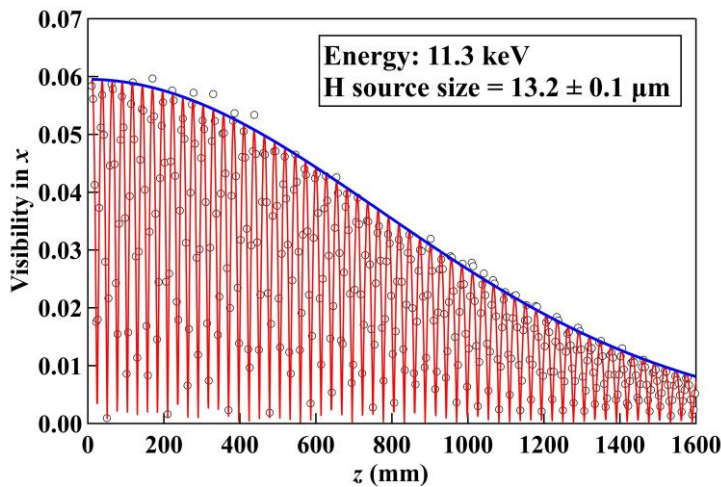
The APS, a U.S. Department of Energy (DOE) Office of Science user facility at DOE's Argonne National Laboratory, is one of the most productive X-ray light sources in the world. Since April 2023, the more than 5,000 scientists who make use of its ultrabright X-ray beams for research each year have waited patiently as the APS underwent a comprehensive upgrade. Central to that upgrade was replacing the over 25-year-old electron storage ring that is used to generate those X-ray beams. A brand new one now sits at the heart of the facility.

Emittance is a measurement of the size and angular spread of the electron beam, and a lower-emittance beam essentially means that the particles are packed into a smaller space. The more electrons you can pack in a smaller region, the brighter the X-ray beams you can generate with those electrons.

The new APS electron storage ring was designed to deliver the lowest possible emittance for a facility of this size. It relies on several novel ideas: reverse-bending magnets and a new method of replenishing electrons in the ring.



The new storage ring at the heart of the upgraded Advanced Photon Source. The electron beam emittance has been measured at 45 pm.rad, confirmed to be the lowest among the world's synchrotron X-ray facilities.



Measurement of the size of the upgraded APS electron beam, using grating interferometry at beamline 3-ID-B.

The design and implementation of the new ring has resulted in a horizontal emittance measurement that is comfortably the lowest in the world for synchrotron X-ray facilities. The previous record, held by the Extremely Brilliant Source (EBS) at the European Synchrotron Radiation Facility (ESRF), is 134 picometers radians (pm.rad).

The APS measurement, conducted at 50 milliamps of beam current, leads to a horizontal emittance of **45 pm.rad**. For certain configurations of the APS, such as round beam mode, the emittance is as low as **28 pm.rad**.

With electron source sizes this small it can be challenging to directly measure the beam emittance. Two separate measurements were performed at beamlines 29-ID and 3-ID-B to determine the electron beam emittance by using sophisticated equipment to measure the characteristics of the X-ray beam. These measurements were performed during normal beam operations at the APS.

The APS team is in the process of bringing beamlines into operation after the year-long shutdown and has already hosted its first experiments by outside users. Research is expected to resume in force later this year, and the new storage ring will continue to be ramped up to its full design current.

Read more about the upgraded APS at [aps.anl.gov](https://aps.anl.gov)

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