LIGHTING THE WAY FOR TOMORROW

Significant scientific progress is increasingly the result of national or international collaboration. A particular strength of the University of Science and Technology of China (USTC) is its powerful facilities designed specifically to cater for large-scale science, which will help form the bedrock of China's second Comprehensive National Science Center, based in Hefei.

Accelerating research with the Hefei Light Source

USTC has proven expertise in major national projects. With USTC's support, China's synchrotron radiation accelerator was officially launched in 1983, becoming the country's first dedicated VUV and soft X-ray synchrotron radiation facility — the Hefei Light Source (HLS).

To better serve growing demand, phase II of the HLS (HLS-II) was launched in 2010. In this phase a linear accelerator, an 800MeV storage ring and five beamline stations were built, all of which, plus the top-off operation mode, have significantly improved the stability, brightness and service life of the light source.

Opened for use in 2016, HLS-II has been used in 889 projects, leading to 700-plus journal publications. The facility drives international collaborations and quality research in material science, condensed matter physics, chemistry, energy, environmental science and life sciences.

Now under the R&D plan is the Hefei Advanced Light Source, proposed by Lu Yalin, who heads the National Synchrotron Radiation Laboratory. This new effort will integrate advanced measurement technology, leading to one of the most advanced synchrotron radiation light sources in the world, with ultrahigh temporal, spatial and energy resolution.

Nuclear fusion energy: The Experimental Advanced Superconducting Tokamak

Providing safe and clean nuclear fusion energy to ward off future energy crises is a global challenge. Led by the CAS Institute of Plasma Physics(IPP), USTC and IPP have built the world's first fully superconducting tokamak, a doughnut-shaped, magnetic confinement device, designed to better harness fusion energy.

An experimental machine designed to explore the physics and engineering of nuclear fusion reactions, the Experimental Advanced Superconducting Tokamak (EAST) uses superconducting magnets to confine hot plasma. Its maximum repeatable plasma current can reach 1MA, currently the highest in the world, while its diverted plasma discharge is the world's longest.

In 2017, EAST achieved more than 100 seconds of steady-state, high-confinement mode (H-mode) operation, a world record. This has implications for the International Thermonuclear Experimental Reactor (ITER), a huge international effort, in which China is a participant, aiming to build the infrastructure to provide clean nuclear fusion power.

International collaborations through EAST have already included a joint experiment on steady-state operation with the DIII-D team of defence contractor General Atomics in the United States, joint conferences and projects on plasma-wall interactions with Germany, and joint efforts with Russia to translate research results.

More fusion power: Keda Torus eXperiment

Another device harnessing fusion power is USTC's Keda Torus eXperiment (KTX), a medium-sized reversed field pinch (RFP) that is smaller and more economical than a tokamak, producing a magnetic field through currents flowing inside plasma.

Completed in 2015, KTX supports three-dimensional toroidal physics research and improves plasma control technologies. It pioneered the eddy current diagnostics to measure plasma displacement, and used novel design to cut down the cost of vacuum vessel maintenance. With a maximum plasma discharge time of 22ms, KTX has been widely utilized, winning acclaim from 30-plus leading interactional experts on magnetic confinement configuration.

Steady High Magnetic Field Facilities

The Steady High Magnetic Field Facility (SHMFF) that USTC participated in building includes a hybrid magnet, five water-cooled magnets and four superconducting magnets, enabling extreme low-temperature and high-pressure experiments for cutting-edge research in a range of fields. It features the world's first three-in-one microscope system, combining scanning tunnelling, magnetic force and atomic force microscopes. Three of its water-cooled magnets have set world records in performance and the 40-tesla-level hybrid magnet has the world's second highest magnetic field. SHMFF has so far been used by 120-plus institutions and for more than 1,100 papers. ■