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Southwest Jiaotong University hosts the world's first quasi-axisymmetric stellarator experiment

As a follow-onto the article "NIFS-SWJTU Joint Project (NSJP) for CFQS" by Prof. Shoichi Okamura in Issue 169 of *Stellarator News*, we present a discussion of the research environment at the Southwest Jiaotong University (SWJTU) and in Chengdu City in China (Fig. 1), and note the vigorous support from our local and national governments for the Chinese First Quasi-axisymmetric Stellarator (CFQS) project and related research activities.

SWJTU was founded in 1896, one of the earliest universities in the modern history of China. It is also the cradle of higher education in civil engineering, traffic engineering, and mining and metallurgical engineering in China. After several historic moves, it is presently located in Chengdu, the capital city of Sichuan province in China.

Fig. 1. A view of Chengdu City.

As it begins its second century of effort, SWJTU has made great progress and taken a leading role in railway transport techniques throughout the world. In 2017, SWJTU was selected by the Chinese government to become a world-class university with world-class construction projects to support this. In recent years, SWJTU has focused on promoting the development of science, in addition to its historic advances in technology. Meanwhile, the School of Physical Science and Technology of SWJTU has become an integrated teaching-research college. In accordance with the national energy development strategy, SWJTU is emphasizing the area of magnetic confinement fusion research and the Institute of Fusion Science in the School is actively working on theoretical simulations and experimental studies over a wide range of fusion research subjects.

Fig. 2. The entrance to SWJTU.

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To further promote magnetic fusion research at SWJTU, the university leadership decided to pursue stellarator physics since this unique configuration is of significance for fusion science even though at present, the major line of fusion development in China is the tokamak configuration only! Such a broader understanding is strongly supported by top-level fusion scientists in China. At the beginning in year 2015, for learning and gaining research experience in stellarator devices, SWJTU made plans to acquire the Compact Helical System (CHS) device from the National Institute for Fusion Science (NIFS) in Japan. Later on, after further discussions with the NIFS staff, SWJTU decided to team with NIFS to construct a new stellarator with an advanced configuration design, the Chinese First Quasi-axisymmetric Stellarator (CFQS). In July 2017, SWJTU and NIFS signed a memorandum of understanding, outlining the roles of both institutions. SWJTU is responsible for the construction of the CFQS and experimental facilities, jointly designing the device and executing experiments with NIFS and other international researchers. NIFS is leading the design work and associated research programs, and contributing heating equipment and diagnostics to the experiment.

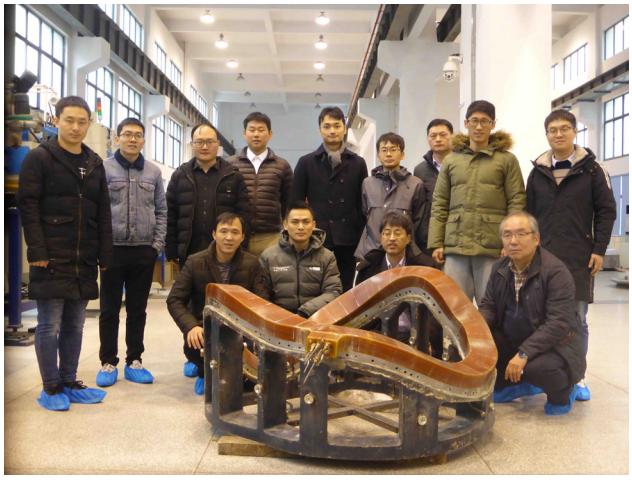

Fig. 3. A mock-up of the MC4 coil surrounded by the team from Keye that manufactured it together with researchers from SWJTU and NIFS.

At present, the physical design of CFQS has been finished. A mock-up modular coil MC4, which has the most complicated 3D structure, has been successfully manufactured (Fig. 3). The mock-up coil has been subjected to many tests to assure that it meets all criteria. This mock-up coil was fabricated by the Keye Electro Physical Equipment Manufacturing Co., Ltd, in Hefei, China. Keye has emerged from the machine shop in the Institute of Plasma Physics Chinese Academy of Science (ASIPP), one of leading fusion institutes in China, where the Chinese superconducting tokamak EAST is in operation. Keye has become one of the highest technology companies in China, producing various types of components and facilities for advanced physics research fields such as high energy physics and fusion sciences. Keye's engineers are eager to tackle challenging problems led by the General Manager, Ms. Xinlian Wu. For the next step, Keye will start to manufacture all of 16 modular coils of the CFQS device.

Also, the engineering design for the vacuum vessel and support structures of the CFQS is progressing. In 2019, the fusion laboratory in charge of the CFQS project has been approved as one of the Key International Collaborative Laboratories in Sichuan province. Meanwhile, SWJTU has been nominated as a Chinese representative in the framework of the IEA agreement of the Stellarator/Heliotron Technology Collaboration Program (IEA SH-TCP). In addition, the CFQS project has received vigorous national and international support from many fusion institutions, including ASIPP and the Southwestern Institute of Physics located in Chengdu City in China, PPPL and the University of Wisconsin in the US, IPP-Greifswald in Germany, IAE, Kyoto University in Japan, etc. It is expected that the operation of CFQS will be the first quasi-axisymmetric stellarator experiment to operate in the world.

Chengdu is the capital city of China's southwest Sichuan province. The city is located in the west of Sichuan Basin and in the center of Chengdu Plain. It is famed for being the home of cute giant pandas. The city covers about a total area of 14.3 thousand square kilometers with a population of over 16 million. Because of the advantageous Dujiangyan irrigation system constructed in 256 B.C.E., it has rich natural resources and a mild climate, and hence, is known as the Heavenly State (Tian Fu Zhi Guo in Chinese). While the economy of Chengdu City is rapidly growing, people in the city have strong interest in the development of cultural and scientific activities. In recent years, Chengdu has made plans to build a new academic zone (park) to expedite development in science and technology. The CFQS project of SWJTU has been selected as one of main scientific programs there.

As a major transport hub in southwest China, Chengdu is easily approached by both air and railway routes. The city bus and metro continue to develop, providing residents and visitors with transportation convenience. Domestic and international fusion researchers are warmly welcomed to visit Chengdu and also to participate in CFQS experiments in the near future.

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