Contribution ID: **50** Type: **Invited Oral**

Sun-Mo-Spe1-04: [Invited] Development of the Wuhan National High Magnetic Field Center and the new Design Principles for High Field Pulsed Magnet

Sunday 6 July 2025 09:10 (25 minutes)

The Wuhan National High Magnetic Field Center at Huazhong University of Science and Technology China is one of the premier facilities worldwide for conducting experiments at pulsed high magnetic fields. The Center has been operational for 13 years. Currently, a 28 MJ capacitor bank consisting of 22 modules of 1.2 MJ each and 2 modules of 800 kJ each as well as a 100 MJ/100 MVA flywheel-generator power supply have been developed to generate peak magnetic fields in the range from 50 T to 94.8 T with pulse duration from 8 ms to 2000 ms. In 2023, a $300M budget is approved to upgrade the facilities that will include new buildings, new magnets, and new energy sources. Three buildings with a total area of 47,000 m2 will be built, providing more experimental stations to meet the demands from users. The pulsed magnet aiming at a peak value up to 110 T in a 10 mm diameter and 70 T with 10 ms flat-top in 14 mm diameter, a 9.5 T magnetic resonance imaging (MRI) superconducting magnet with bore of 800 mm will be built. The energy of the capacitor bank power supply will increase to 167 MJ from 28 MJ for generating higher magnetic field. In addition to the existing experimental stations for electrical transport, magnetic properties, magneto optics, and electron spin resonance studies, more than a dozen new stations will be constructed to host new research capabilities in ultra-high magnetic fields, including magnetic heat measurements, scanning tunneling microscopy (STM), solid nuclear magnetic resonance (NMR) spectroscopy, biological MRI, and high-power terahertz spectroscopy.

Regarding the new pulsed magnets, new design principles will be implemented. High field pulsed magnets have traditionally been constructed in the form of cylindrical solenoids, with each conductor winding reinforced by interlayer composite materials in the hoop direction. For high magnetic fields, the pulsed magnet normally consists of multiple concentric coils, which can result in significant challenges from both electromagnetic and structural perspectives. The highest field magnets use multiple power sources to energize different coils, typically with longer pulses in the outer coils. From an electromagnetic perspective, when the inner coil is quickly pulsed in a background field of a larger coil, the fast rise of the field in the inner coil induces a magnetic field drop in the outer coil. Thus, at peak field, the magnetic field contributions of most coils fall below their maximum potential, limiting the overall performance of the magnet. From a structural mechanics perspective, the reinforcement efficiency of the fiber-wound solenoids decreases with increasing winding radius and thickness of the fiber layers, which in turn reduces the conductor filling factor. To address these challenges, we propose an innovative structure for a multi-coil pulsed magnet featuring radial and circumferential reinforcement with axially stacked stages. The axial stacking reduces the electromagnetic coupling between the coils, allowing each coil to achieve its full potential. Compared to traditional circumferential winding, the radial and circumferential bi-directional winding approach significantly enhances the reinforcement efficiency and conductor filling factor of the magnet. This paper.

The presentation will discuss the status of the present magnets, the plans for the new facilities, and the new magnet technology being developed including demonstrating the advanced nature and effectiveness of this innovation through both theoretical analysis and experimental validation.

Author: LI, Liang (Wuhan National High Magnetic Field Center)

Co-authors: PENG, Tao (Wuhan National High Magnetic Field Center); HAN, Xiaotao (Wuhan National High Magnetic Field Center); DING, Hongfa (Wuhan National High Magnetic Field Center, Huazhong University of Science and Technology); WANG, Qiuliang (Chinese Academy of Sciences (CN))

Presenter: LI, Liang (Wuhan National High Magnetic Field Center)

Session Classification: Sun-Mo-Spe1 - [Special Session] Towards Exceptionally High Magnetic Fields