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Development of the “Demo4” 1.5m-scale spherical tokamak HTS magnet demonstrator at Tokamak Energy

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Tokamak Energy Ltd is a UK company developing spherical tokamaks incorporating HTS magnets in the pursuit of fusion energy production.

A series of demonstration projects has been conducted on a rapid development cycle to generate stable and robust magnet structures, experimental test capabilities, and simulation tools sufficient for the design and construction of a major HTS magnet system demonstrator – “Demo4”.

The system will comprise 14 toroidal field (TF) limbs and a pair of poloidal field (PF) coils, and will be operated at a fusion-relevant temperature of 20 K. Each TF limb is 1m in linear dimension, containing an HTS double pancake coil wound with non-twisted stacked tape cable and a novel partially insulated construction – a tuned turn-to-turn resistivity. The PF coil pair is 1.5m in diameter and has a fully insulated construction, enabling operation in a fusion-relevant DC + AC modulated condition. The magnet makes use of 56 km of full-width REBCO coated conductor (CC) procured from four key manufacturers.

The system’s objectives are to achieve a peak field on conductor of 20 T and stored energy of ~18 MJ; to reach transverse compressive stresses on-tape in excess of 250 MPa; to simulate pulsed neutronic heating of HTS coils; to measure AC loss in large-scale HTS coil structures; to further explore the dynamic behaviour of complex mutually coupled coil arrays and compare with simulation; and to develop scalable coil manufacturing methodologies. The system will raise the technology readiness level of HTS magnets for fusion and other applications considerably.

This talk will present a technical overview of the magnet system, key simulation results, the status of the system and test facility (under construction now and due to be completed in 2021), and preliminary test results where available.

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