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Thu-Mo-Po.04-04: Zethus: a prototype HTS planar shaping coil for the Eos stellarator

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To generate the twisted magnetic fields necessary for fusion plasma confinement, stellarators have historically required complex and precise modular coils, which are difficult to manufacture and maintain. In mitigating this challenge, Thea Energy, Inc. is actively developing “Eos”, a planar coil stellarator that can shape the needed magnetic fields using arrays of hundreds of smaller, optimized planar coils. As the first step to Eos, we launched the “Zethus” program to demonstrate a prototype high-temperature superconducting (HTS) shaping coil. During the project, we rapidly iterated through design versions as well as research and development trials, leading to the manufacturing of a 3.7 T (peak field, on conductor), soldered, metal-insulated HTS shaping coil. Furthermore, we developed and commissioned a custom cryogenic test and measurement system to operate this prototype coil. We installed the coil into a cryostat, conductively cooled it to 20 K, and validated it through a test campaign. Testing consisted of a coil characterization phase, a thermal cycling phase, and finally a quench characterization phase. By the end of all test stages, this HTS shaping coil prototype maintained robust and consistent performance, thus opening the path to the “Canis” 3x3 array of HTS planar coils and to the Eos stellarator.

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