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M4PL-01: SPARC: The High-field Path to Fusion Energy

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The production of high-temperature superconductors (HTS), specifically REBCO coated conductors, has recently reached commercial maturity at the scale and performance required to build large bore, high-field magnets which would enable a breakthrough opportunity to accelerate fusion energy. The key performance metrics in a tokamak, the leading fusion energy concept, scale as the strength of the magnetic field available to confine the plasma to the third or fourth power times the volume of the device. One of the most important consequences of these scalings is that increasing the magnetic field in a tokamak enables a dramatically smaller device to demonstrate net-energy production. A reduction in size is accompanied by important reductions in cost, timeline, and organization complexity required to construct and operate the device, enabling a net-energy fusion device to be constructed at university or private company scale through innovative private funding models. MIT and Commonwealth Fusion Systems (CFS), a new startup company focused on the rapid commercialization of fusion, are jointly pursuing a privately-funded, accelerated approach to demonstrate the feasibility of fusion energy. The approach relies on starting at the scale and speed required to rapidly demonstrate a new generation of high-field, large-bore, REBCO-based superconducting magnets and then incorporating those magnets into a compact net-energy tokamak called SPARC that will demonstrate net fusion energy gain. This talk will present the advantages of high magnetic field fusion physics and engineering and the approach to its technological foundation built on the design and demonstration of large-bore, REBCO-based superconducting magnets, as well as highlight the cryogenic materials challenges and opportunities of this new approach to fusion energy.

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