An overview of the HIT research program and its implications for magnetic fusion energy

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The HIT research group reports evidence of pressure confinement in sustained spheromak configurations, quantitative agreement with Hall-MHD simulations, and a possible new pathway towards economical magnetic fusion energy. In HIT-SI (R_o = 0.34 m, a = 0.2 m), two inductive helicity injectors oscillating 90^o out of phase, continually drive edge currents and impose magnetic perturbations that provide sustainment via imposed-dynamo current drive (IDCD).[1] Experimental results[2] indicate the sustainment of a spheromak configuration without gross confinement-degrading instabilities that have plagued spheromaks previously;[3] an example derivation of the IDCD mechanism is provided.[4] The level of quantitative agreement between the experiment and Hall-MHD simulations with NIMROD and PSI-TET is presented, along with suggestions of next steps to improve agreement. Lastly, an IDCD-driven spheromak reactor concept (the dynomak) is presented that indicates cost-competitiveness with conventional energy sources.[5] The dynomak utilizes a molten salt (FLiBe) blanket system for first wall cooling, neutron moderation and tritium breeding. A tritium breeding ratio (TBR) of greater than 1.1 has been calculated using a Monte Carlo N-Particle (MCNP5) neutron transport simulation. High temperature superconducting tapes (YBCO) are used for the equilibrium coil set, though more conventional low-temperature superconductors could also be used. The limiting equilibrium coil set lifetime is at least thirty full-power years. The primary FLiBe loop is coupled to a supercritical carbon dioxide Brayton cycle due to attractive economics and high thermal efficiencies. With these advancements, an electrical output of 1000 MW is produced from a thermal output of 2486 MW, yielding an overall plant efficiency of approximately 40%. The overnight capital cost of this 1 GWe power plant is estimated to be $2.7 billion in 2013 USD.

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[2] B.S. Victor, et al., *Phys. Plasmas* **21** (2014) 082504.
[3] B. Hudson, et al., *Phys. Plasmas* **15** (2008) 056112.
[4] T.R. Jarboe, et al., *Phys. Plasmas* **22** (2015) 072503.
[5] D.A. Sutherland, el al., *Fus. Eng. Des.* **89** (2014) 4, 412-425