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Can high fields save the tokamak? The challenge of steady-state operation for low cost compact reactors JEFFREY FREIDBERG, MIT Plasma Science and Fusion Center, AKSHUNNA DOGRA, WILLIAM REDMAN, ANTOINE CERFON, Courant Institute NYU — The development of high field, high temperature superconductors is thought to be a game changer for the development of fusion power based on the tokamak concept. We test the validity of this assertion for pilot plant scale reactors (Q $\sim$ 10) for two different but related missions: pulsed operation and steady-state operation. Specifically, we derive a set of analytic criteria that determines the basic design parameters of a given fusion reactor mission. As expected there are far more constraints than degrees of freedom in any given design application. However, by defining the mission of the reactor under consideration, we have been able to determine the subset of constraints that drive the design, and calculate the values for the key parameters characterizing the tokamak. Our conclusions are as follows: 1) for pulsed reactors, high field leads to more compact designs and thus cheaper reactors – high B is the way to go; 2) steady-state reactors with H-mode like transport are large, even with high fields. The steady-state constraint is hard to satisfy in compact designs – high B helps but is not enough; 3) I-mode like transport, when combined with high fields, yields relatively compact steady-state reactors – why is there not more research on this favorable transport regime?

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