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Physics Basis for Optimizing 3D Field Coils in Tokamaks[1] NIKOLAS LOGAN, CAOXIANG ZHU, JONG-KYU PARK, SEONGMOO YANG, QIMING HU, Princeton Plasma Physics Laboratory — The multimodal, non-axisymmetric plasma response to 3D fields in tokamaks can be predicted and the corresponding 3D fields can be optimized for maximum plasma performance. In this presentation, matrices relating external fields to the resonant response and torque response throughout the plasma are compared and contrasted across a wide variety of plasma scenarios. The fields required to localize the resonant response or torque in the edge or core (minimizing the effects elsewhere) are shown to be distinct from the fields that produce the largest global responses, providing insight for the design of distinct ELM control and EFC coils. The robust features of dominant eigenmodes are used together with stellarator design tools to optimize the geometry of 3D coils, increasing the efficient coupling of these coils to the physics of interest without undesired secondary effects. Importantly, efficient coupling can be maintained even when enforcing large distances between coils and the plasma during the geometric optimization of coil designs. The physics-driven optimization presented here thus provides a practical path to utilizing exterior coils in future reactors to obtain the powerful 3D field benefits demonstrated on current machines with internal coils.

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