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Force optimization for novel stellarator-tokamak hybrid coils

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The novel perturbed tokamak concept seeks to leverage the strengths of both tokamaks and stellarators in a hybrid machine for magnetic confinement fusion. In recent work, S. Henneberg and G. Plunk (2024), as well as T. Schuett and S. Henneberg (2024) introduced a quasi-axisymmetric (QA) design that offers several advantages, including a low aspect ratio for a large plasma volume, fast particle confinement, and simple coil geometry. As a proof of principle, they developed an initial coil set using conventional poloidal and toroidal tokamak coils along with on single type of nonplanar stellarator coils. However, engineering constraints beyond simple geometrical measures were not considered in their design. This study focuses on optimizing the coils for different candidate configurations to closely match the plasma boundary and maintain the desired QA properties, while incorporating practical buildability limitations. To achieve this, we successfully employed a two-stage optimization process, utilizing a new method by S. Hurwitz et al. (2024) to calculate the forces acting on the coils.

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