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Optimization and Mechanical Characteristics Analysis of the Self-Supporting Scheme of Barrel Yoke for CEPC Detector

This study addresses the design challenges of the barrel yoke, a key detector component in the large-scale Circular Electron Positron Collider (CEPC) scientific facility. Given the detector's unprecedented size and extreme demands for structural strength and precision, a conventional barrel yoke design would fail to meet the requirements. Consequently, an self-supporting scheme of barrel yoke design has been proposed as a solution.

To validate the effectiveness of this new structure, a finite element analysis (FEA) methodology was employed. A comprehensive comparative analysis was conducted between the conventional barrel yoke (without end flanges) and the new self-supporting barrel yoke (with end flanges). The analysis encompassed three key mechanical aspects: static analysis (assessing structural strength and deformation under load), modal analysis (determining natural vibration characteristics), and seismic analysis (examining response under seismic loads). The results demonstrate that the self-supporting barrel yoke with end flanges outperforms the conventional design without end flanges across all analysis criteria. Its superior strength, stiffness, and dynamic stability better satisfy the stringent design requirements of the CEPC detector, proving the effectiveness and superiority of the proposed self-supporting design.

In conclusion, the self-supporting barrel yoke not only meets all mechanical design requirements but also, due to its integrated end flanges, enables a more streamlined and efficient installation process, making the assembly considerably more convenient. This research provides a critical foundation and a valuable reference for the final design and installation of the CEPC detector barrel yoke.

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