Optimization of Compact Stellarator Configuration as Fusion Devices

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Optimization of the stellarator configuration requires trade-offs among a large number of physics parameters and engineering constraints. An integrated study of compact stellarator power plants, ARIES-CS, aims at examining these trade-offs and defining key R&D areas. We developed configurations with A≲6 and excellent QA (both 2 and 3 field periods) while reducing α losses to ~10% (still higher than desirable). Stability to the linear ideal MHD modes was attained but at the expense of reduced QA (and increased α losses) and increased complexity of the plasma shape. Recent experimental results indicate, however, linear MHD stability limits may not be applicable to stellarators. It appears that the plasma/coil stand-off distance is not as an important as envisioned previously. By utilizing a highly efficient shield-only region in strategic areas, we reduced the minimum stand-off by ~20%-30%. This allows a comparable reduction in the machine size. The device configuration, assembly, and maintenance procedures appear to impose severe constraints. A cost-optimization system code has been developed and is utilized to guide the optimization process.