



## Design of optimized stellarators with simple coils

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Stellarators are three-dimensional magnetic confinement devices that rely mainly on coils currents to generate rotational transform of confining magnetic field. Recent studies in stellarator optimization have shown that the properties of stellarator such as rotation transform, neoclassical confinement, and ideal MHD stability can be improved significantly. However, magnetic field coils of optimized stellarators are usually quite complex and are difficult to be built. Thus, optimization of stellarators with simple coils is important. The goal of our work is to design a small stellarator with simple coils. Towards this goal we have developed a code suite for calculating vacuum flux surfaces directly from magnetic coils, evaluating ideal MHD stability as well as calculating neoclassical transport. In contrast with traditional “two-steps” method of optimizing flux surfaces firstly and generating coils secondly, our code suite has been used to design simple stellarators by direct optimization from coils.

We choose the Columbia Nonneutral Torus (CNT) <sup>[1]</sup>, a four-coil stellarator configuration (two circular interlocking coils and two circular poloidal field coils), as the starting point of our optimization. By using grid search and random search algorithms, a few interesting configurations with good neoclassical confinement and stable ideal MHD are found. The Zhejiang University Compact Stellarator (ZCS) <sup>[2]</sup> is obtained by targeting only neoclassical transport in optimization. The results show that, by just changing the shape of the interlocking coils from circular to elliptical, the effective helical ripple amplitude of CNT is reduced by an order of magnitude. Furthermore, by targeting neoclassical transport and MHD stability simultaneously, a compact stellarator with simple coils (CSSC) <sup>[3]</sup> is obtained. CSSC has favorable properties of magnetic well and a low helical ripple amplitude comparable to that of W7-X<sup>[4]</sup>. Meanwhile, CSSC’s interlocking coils are much simpler than those of W7-X.

### References

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