

Flexible and Fast Stellarator Optimization with DESC Suite

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Stellarator Fusion reactor design require expensive numerical optimization to ensure good confinement and achievable engineering tolerances. DESC software package couples equilibrium and optimization codes together to efficiently solve the numerical optimization problems. Unlike finite differences or adjoint methods, automatic differentiation provides access to exact derivatives of any objective function and allows the inclusion of more physics constraints, such as metrics for particle confinement and stability. This reduces the computation time by three orders of magnitude in tests compared to STELLOPT, and enables exploration over a higher-dimensional parameter space. DESC also allows novel boundary conditions by fixing the Poincare section or near-axis modes instead of the last closed flux surface, which yields better optimization results. This approach to stellarator optimization is valid for finite- β solutions throughout the full plasma volume and has been extended to free-boundary equilibria. Examples of these computational advances are demonstrated along with a discussion of the new physics insights they provide.

References

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