# Improving the Constructability of Stellarators

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The U.S. stellarator community is currently planning a new program to determine the benefits and limitations of quasi-axisymmetry for magnetic fusion in the ITER era and beyond. A next step experiment will be needed in order to have significant international impact. However, we must first answer questions about the practicality and costs of stellarator construction that have been raised by the problems encountered on NCSX and W7-X. Opportunities for simplification of stellarator designs have been identified and the community is developing a plan to follow up with more in-depth engineering and physics studies.

**Near-term plan to address stellarator construction feasibility issues**

The work will make use of the detailed knowledge and staff expertise developed via the NCSX program to extract the lessons-learned. It will take advantage of international collaboration in both physics and engineering. Near-term goals are to:

- Understand the underlying technical causes which drove cost and schedule growth in NCSX and W7-X and possibilities for improvement. Explore alternatives for simplification, for example, in the assembly approach, in metrology, and in the use of trim coils to reduce tolerance requirements.
- Test the importance of key physics constraints via collaboration on experiments.
- Explore QS configuration space to test sensitivity to physics and engineering requirements.
- Explore coil topology alternatives (modular, helical, saddle, hybrids)

**Much progress has been made**

Since the conversion of the Model C stellarator into the ST tokamak in 1970, twenty-eight stellarators have built successfully to high tolerances (~1 part in 1000 in major radius) , and have produced a large volume of results in the archival literature. University groups, national laboratories, and industry in various combinations have executed these projects. Device sizes range from R = 0.3 m up to R = 3.6 m fields from 0.3 to 3.5 T, and powers from kW to nearly 20 MW. Plasmas in these devices had $T_e$, $T_i$ ranging up to over 5 keV, betas up to 5%, and pulse durations (at powers < 1 MW) of up to an hour. The largest present US stellarator, the modular, quasi-symmetric HSX at Wisconsin, has Te > 2 keV with 100 kW of ECH.

This success of this long and diverse series of experiments around the world is the reason that stellarators are of intense interest for magnetic fusion. Much has been learned from these experiments. A careful review of that experience will be conducted to document what matters and what doesn't matter in terms of practical details.

In summary, while the feasibility of constructing stellarators is well established, constructing them within attractive cost and schedule targets is an issue that the community will address.