

August 17, 2000

Dr. Charles R. Finfgeld  
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Dear Dr. Finfgeld:

### Report of NCSX Milestone Completion

In this letter we report completion of the milestone, "Compute an updated NCSX reference plasma configuration meeting all requirements," identified in the Program Execution Agreement for the compact stellarator program, to have been completed in June. We have selected as the basis for design development a 3-field-period configuration with aspect ratio  $R/\langle a \rangle = 4.4$ , volume-averaged beta  $\langle \beta \rangle = 4\%$ , a medium value of rotational transform ( $t \approx 0.66$  at the edge), and a ratio of external to total rotational transform of about 0.7 at the edge. The properties of the new plasma configuration are dramatically improved over its predecessor, "C82," as indicated in the table below:

Parameter	C82	New N=3	Comment
Number of periods	3	3	
Aspect ratio	3.4	4.4	Major radius / average plasma radius
Beta (%)	4.0	4.1	
$t_{\text{external}}, t_{\text{total}}$ at edge	0.29, 0.47	0.49, 0.66	
Magnetic surface quality (fixed-boundary)	stochastic for $r/a > 0.75$	good surfaces out to $r/a = 1$ , small internal islands.	further island reductions being studied
Eff. hel. ripple @ $r/a = 0.7$	1.0%	0.6%	
NBI fast ion loss	23%	19%	H beams and plasma, fixed volume and B-field
Coil complexity measure	3.1	2.1	
Relative coil current density measure	1.0	0.5	saddles with 1/R background field

We have selected a representative variant of the new configuration, “LI383,” as the basis for the next step in the design development, namely the comparative evaluation of saddle and modular coil options leading to a selection between them. At the same time, the physics team continues to study configuration variants in the near neighborhood of LI383 that would further improve the physics (e.g., further reduce the internal islands and increase stability margins). These studies may lead to modest modifications of the basic plasma configuration in the future, though much smaller than the change from C82 to LI383 and insignificant in terms of the choice between saddle and modular coil options.

As was reported in my June 30 status update and discussed at the recent NCSX PAC meeting, more than a dozen configurations were evaluated in June before downselecting to two for more extensive evaluation. Besides the selected 3-period option, an interesting 2-period option with a lower aspect ratio was retained at that time. Despite an intense effort over several weeks, we have not found satisfactory coil solutions for the 2-period case. While it merits further study on a longer timescale, it appears that the 2-period case is not an option that is compatible with the NCSX schedule. Since the 3-period configuration does meet our needs, it is appropriate to go forward with it.

As you know, we decided to delay completion of this milestone in order to more fully understand the coil implications of the 2 and 3-period cases before choosing between them. As it turned out, it was indeed the coil implications that most clearly differentiated the two. However, much of the project’s coil-related design and analysis effort since June has been based on the 3-period configuration which was ultimately chosen. The overall delay in the NCSX schedule is thus roughly half the two months’ delay in completing this milestone, or about one month. In an effort to get back on schedule as quickly as possible, we are tightly focusing our efforts on the critical analyses needed to support the next milestone, deciding between saddle and modular coils and picking a reference machine configuration, scheduled for September. If you have any questions, please contact me.

Sincerely,

G. H. Neilson  
NCSX Project Manager