

Modular Coil Design

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Goals

- Find an 18-modular coil design for li383 satisfying physics and engineering criteria.
 - Starting from a solution with acceptable physics properties, attempt to improve engineering parameters.
 - Starting from an initial solution (e.g., conformal winding surface), find a path to an engineering solution.
- Develop a good starting point for a merged stelopt/coilopt analysis.
 - Reduced number of free-parameters.
 - Convergent free-boundary vmec reconstruction.

Coilopt model

- 18 modular coils
 - 3 coil types, no coils on symmetry planes, variable currents.
 - Exponential or linear penalty functions for coil-coil separation, coil-plasma distance, coil curvature, nbi access.
 - Fourier series or spline representations for $u(s)$, $v(s)$.
- 18 TF coils, 3 VF pairs (no solenoid coils).
 - Variable coil currents
 - Linear penalty function for total poloidal current

Summary of coil optimization results

- 0227a1 - best physics performance to date, but some engineering problems
- 0711a1 - 18 modular coil design with good physics properties (1/R tf model)
- 0813a1 – continuation of 0711a1 with improved engineering metrics
- 0918 sequence – 18 modular coils, 18 TF coils, 3 VF coils
- 1011 sequence – attempt to maintain engineering feasibility (in progress)

		M12	M21	M23		M25			
		0227a1	0711a1	0813a1	0918a14	0918a17	0918a18	1011b4	1011a3
Modular Coils per FP		7	6	6	6	6	6	6	6
Avg. Field Error	%	0.48	0.59	0.58	0.58	0.62	0.89	2.66	2.97
Max. Field Error	%	1.95	2.17	2.12	2.21	2.38	3.28	12.29	13.22
Min. Coil-Coil Separation	cm	12.85	11.5	11.1	11	11.9	12.1	14	14
Min. Plasma-Coil Separation	cm	17.46	18.8	19.7	20	19.9	19.2	21	20.9
Min. Radius of Curvature	cm	7.74	8.7	9.2	9	9.4	9.6	11	14
Min. NBI Access	cm		24.6	30.5	30.5	30.9	32.1	38.1	39.2
I-mod,1	kA	-482.18	-556.3	-551.1	-565	-565	-565	-416.5	-420.4
I-mod,2	kA	-497.23	-586.5	-585	-595.1	-595.1	-595.1	-578.4	-587.6
I-mod,3	kA	-512.17	-640.5	-647.2	-625.2	-625.2	-625.2	-801	-804.1
I-mod,4	kA	-464.33							
TF coil model		1/R	1/R	1/R	18 TF	18 TF	18 TF	18 TF	18 TF
TF current (total)	kA	-1615.25	-1200	-1200	-1188	-1188	-1188	-1101	-1007

Summary and plans

- 18-modular coil designs including reference TF and VF coils have been found with field errors, physics properties comparable to previous (M12) 21 coil solutions (L-P. Ku).
- Attempts to make local modifications in bend radius and coil spacing are showing good results (D. Williamson).
- Exploring methods (e.g., spline representation) that allow coilopt to make local corrections to coil geometry and possibly reduce the number of free parameters in the stellopt/coilopt problem.