Coil Design Status

Meeting Magnetic Configuration Requirements during Discharge

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Meeting Magnetic Configuration Requirements during Discharge

- Helical Field Coils along with Axisymmetric Field Coils must have sufficient flexibility to provide the magnetic configuration required at all points during discharge
- Discharge Definition
  - Vacuum (Zero Beta, Zero Current)
  - Zero Beta, Full Current
  - Full Beta, Full Current (C10)
- Reference Coil Configuration
  - Sad185.16 - 16 Saddle contours on 18.5 cm surface

Approach to Date

- Design Coils for One Discharge Point
- Add EF and optionally other PF coils
- Using Neil's Coil Current Optimizing Routine, optimize all Coil Currents to minimize field errors
- Do VMEC Free Boundary Reconstruction and evaluate Free Boundary Surface

Optimizing Coil Currents starting with Coils for Full Beta

Coil Configration	Discharge Point	Field Errors		Free Boundary Offset, mm		VMEC
		Max	Mean	Max	Avg	<M>
Independent Saddle Currents with EF-21& 22 only	Zero Beta	3.23	0.76	56.9	14.9	2.54
	Full Beta	2.16	0.47	13.6	3.2	2.32
	Vacuum	4.54	0.87	140.9	25.6	3.06
Equal Saddle Currents with EF-21& 22 only	Zero Beta	3.24	0.82	65.4	18.7	2.65
	Full Beta	2.20	0.50	16.0	3.3	2.33
	Vacuum	4.86	1.21	158.8	28.3	3.17
Independent Saddle Currents with 8 PF Coil Pairs	Zero Beta	3.25	0.61	33.6	6.9	2.67
	Full Beta	2.16	0.47	13.9	3.2	2.33
	Vacuum	4.53	0.77	38.6	8.1	2.52
Equal Saddle Currents with 8 PF Coil Pairs	Zero Beta	3.32	0.64	45.1	9.3	2.64
	Full Beta	2.17	0.49	17.0	3.7	2.34
	Vacuum	4.76	1.03	57.5	10.4	2.63

Optimizing Coil Currents starting with Coils for Vacuum

Coil Configration	Discharge Point	Field Errors		Free Boundary Offset, mm		VMEC
		Max	Mean	Max	Avg	<M>
Independent Saddle Currents with EF-21& 22 only	Zero Beta	3.52	0.92	66.1	22.1	2.41
	Full Beta	2.57	0.69	36.8	12.1	2.36
	Vacuum	2.94	0.40	17.4	3.6	2.37
Equal Saddle Currents with EF-21& 22 only	Zero Beta	4.02	1.25	74.0	21.6	2.50
	Full Beta	4.63	1.12	39.6	11.8	2.61
	Vacuum	2.94	0.41	17.3	3.7	2.40
Independent Saddle Currents with 8 PF Coil Pairs	Zero Beta	2.95	0.65	37.3	9.1	2.44
	Full Beta	2.65	0.60	28.5	8.0	2.35
	Vacuum	2.81	0.38	17.8	3.4	2.34
Equal Saddle Currents with 8 PF Coil Pairs	Zero Beta	3.45	0.87	26.7	7.3	2.64
	Full Beta	4.39	0.96	52.1	13.5	2.69
	Vacuum	2.85	0.39	17.5	3.5	2.38

Coil Currents for 12 Independent Vacuum Saddles with 8 PF's

		Coil Currents, KA		
Coil #	Type	Vacuum	Zero Beta	Full Beta
1	Saddle	51.7	36.1	30.3
2	Saddle	57.8	52.1	57.1
3	Saddle	43.5	52.5	49.4
4	Saddle	57.6	51.2	66.2
5	Saddle	52.2	51.9	43.6
6	Saddle	47.7	56.0	63.1
7	Saddle	55.4	55.6	53.5
8	Saddle	56.5	51.8	49.1
9	Saddle	49.6	50.5	50.5
10	Saddle	35.5	28.4	37.1
11	Saddle	43.0	41.4	41.1
12	Saddle	59.6	59.5	61.9
13	EF-22	-21.7	-13.3	-45.6
14	EF-21	37.5	-38.7	-54.1
15	DF-5	-18.7	10.9	32.7
16	DF-2	124.6	216.8	173.2
17	DF-1	-187.8	-315.8	-208.6
18	DF-7	96.4	367.8	212.1
19	EF-Sol	-59.9	-211.1	-50.3
20	CF-9	27.2	19.2	29.6

Summary

- Based on what has been examined to date, appears independently power saddle coils will be needed. (may need to limit current in specific coils)
- A Full Set of PF Coils will be needed. Vertical Field coils alone (ie EF21&22) are not sufficient.
- Preferable to start with a Vacuum Coil set and then optimize for other beta.
- May still want to explore use additional helical field “trim” coils