Coilopt Analysis of TF Coil Options

Preliminary results

D. Strickler

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Goals

- Find an 18 modular coil design satisfying physics and engineering criteria
- Evaluate TF coil options with Coilopt
  - 9 TF coil option with coil on v = 0 plane
  - 12 TF option with coils split about v = 1/2 for diagnostic access, no coils on v = 0

Coilopt model

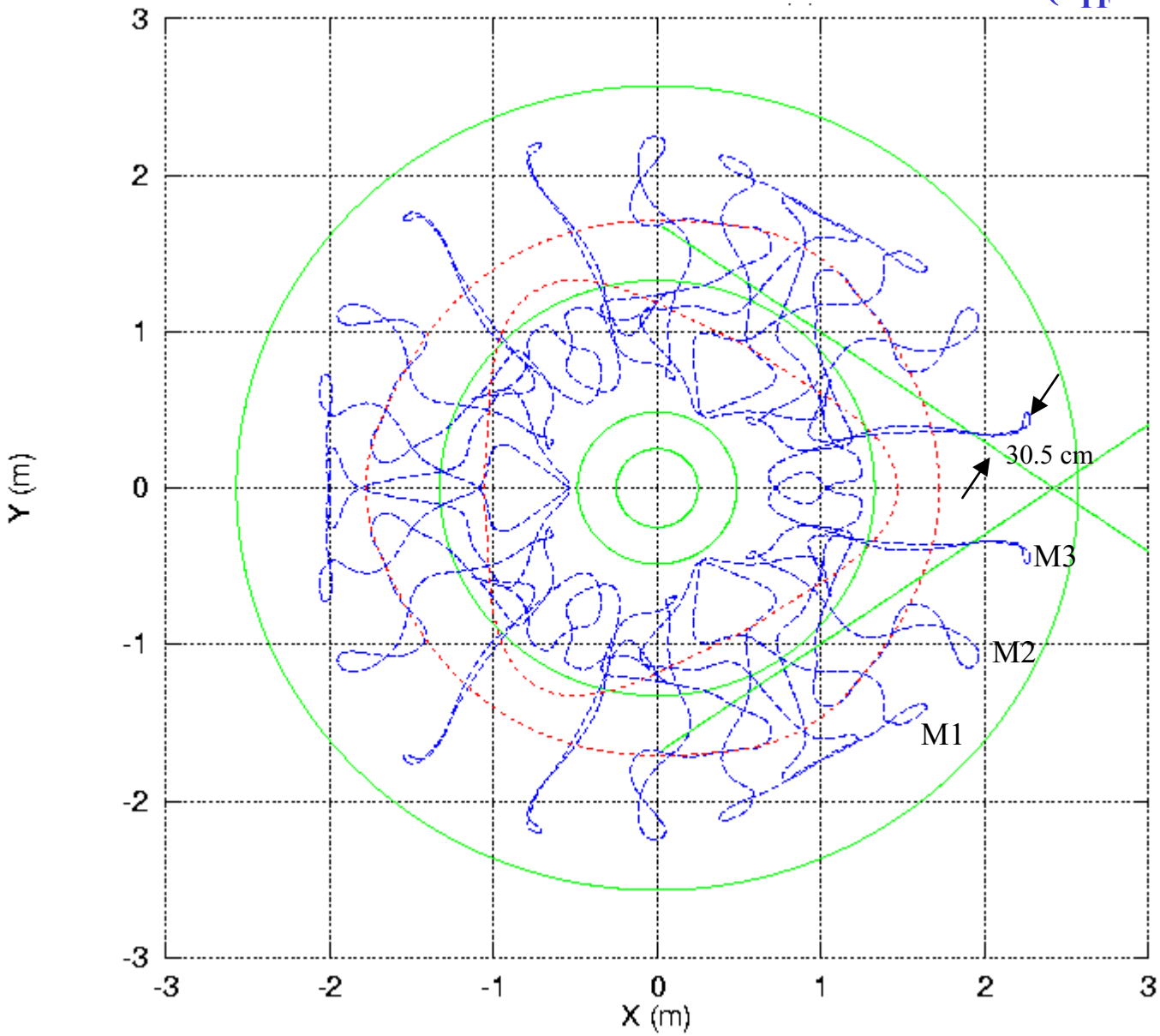
- 18 modular coils
  - 3 coil types, no coils on symmetry planes
  - Variable coil shapes, currents
- 5 PF coil option
  - Fixed locations (modified for new TF coils)
  - Variable currents
- Include background TF coils in optimization
  - Added penalty function for total poloidal current constraint
  - Allows variable currents in TF coils

Some recent coil optimization results

¥0227a1 - best physics performance to date, but some engineering problems
¥0711a1 - first 18 modular coil design to show good physics reconstruction
¥0813a1 — continuation of 0711a1 with improved engineering metrics
¥0823, 0827 — include TF coil model in optimization

		0227a1	0711a1	0813a1	0823a1	0823d4	0827a2
Modular Coils per FP		7	6	6	6	6	6
Avg. Field Error	%	0.48	0.59	0.58	0.58	0.58	0.58
Max. Field Error	%	1.95	2.17	2.12	2.24	2.13	2.17
Min. Coil-Coil Separation	cm	12.85	11.5	11.1	11.1	10.4	10.4
Min. Plasma-Coil Separation	cm	17.46	18.8	19.7	19.8	19.6	19.6
Min. Radius of Curvature	cm	7.74	8.7	9.2	9.2	9	8.8
Min. NBI Access	cm		24.6	30.5	31.2	31.9	31.5
I-mod,1	kA	-482.18	-556.3	-551.1	-546	-531.4	-534.4
I-mod,2	kA	-497.23	-586.5	-585	-583.1	-564.4	-564.7
I-mod,3	kA	-512.17	-640.5	-647.2	-653.1	-629.4	-627.4
I-mod,4	kA	-464.33					
TF coil model		1/R	1/R	1/R	9 TF	9 TF (v)	12 TF (v)
TF current (total)	kA	-1615.25	-1200	-1200	-1200	-1549.5	-1550.5
I-TF1	kA					-163.5	-179.3
I-TF2	kA					-176.5	-79.1

18 Modular Coil Solution 0813a1 with 1/R field (I_{TF} = 1.2 MA)



Field error:
Avg. = 0.58%
Max. = 2.12%

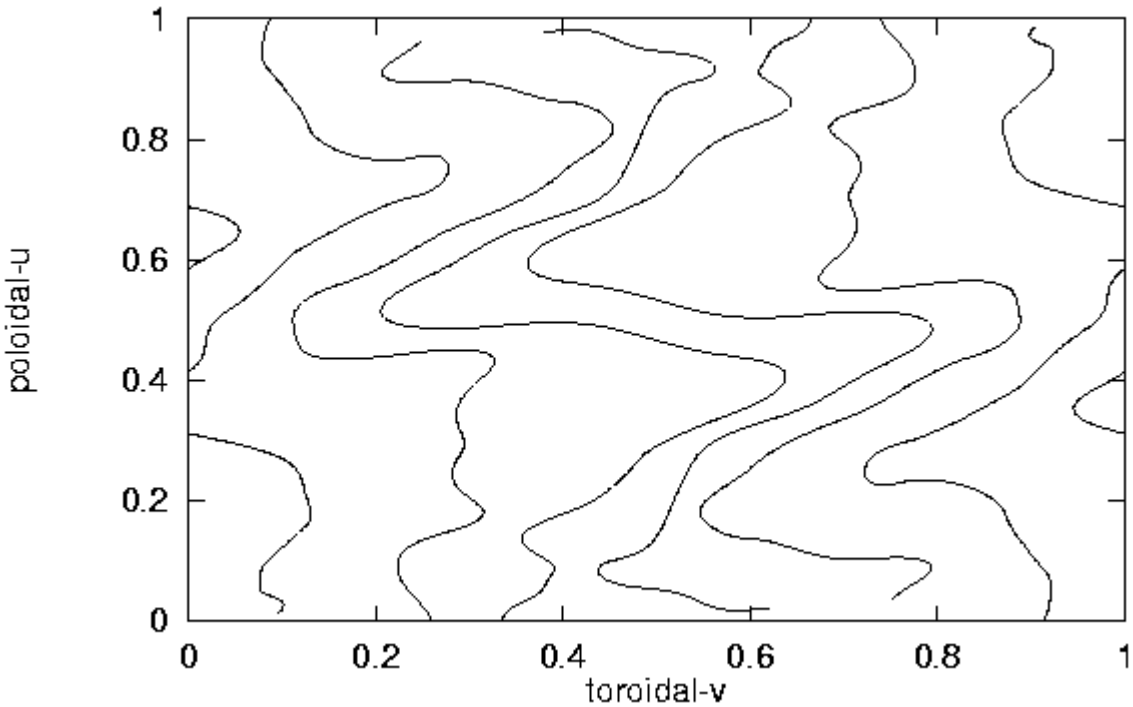
Coil-coil spacing:
1) 11.1 cm
2) 11.1 cm
3) 12.9 cm

Rad. curvature:
1) 9.3 cm
2) 9.2 cm
3) 9.8 cm

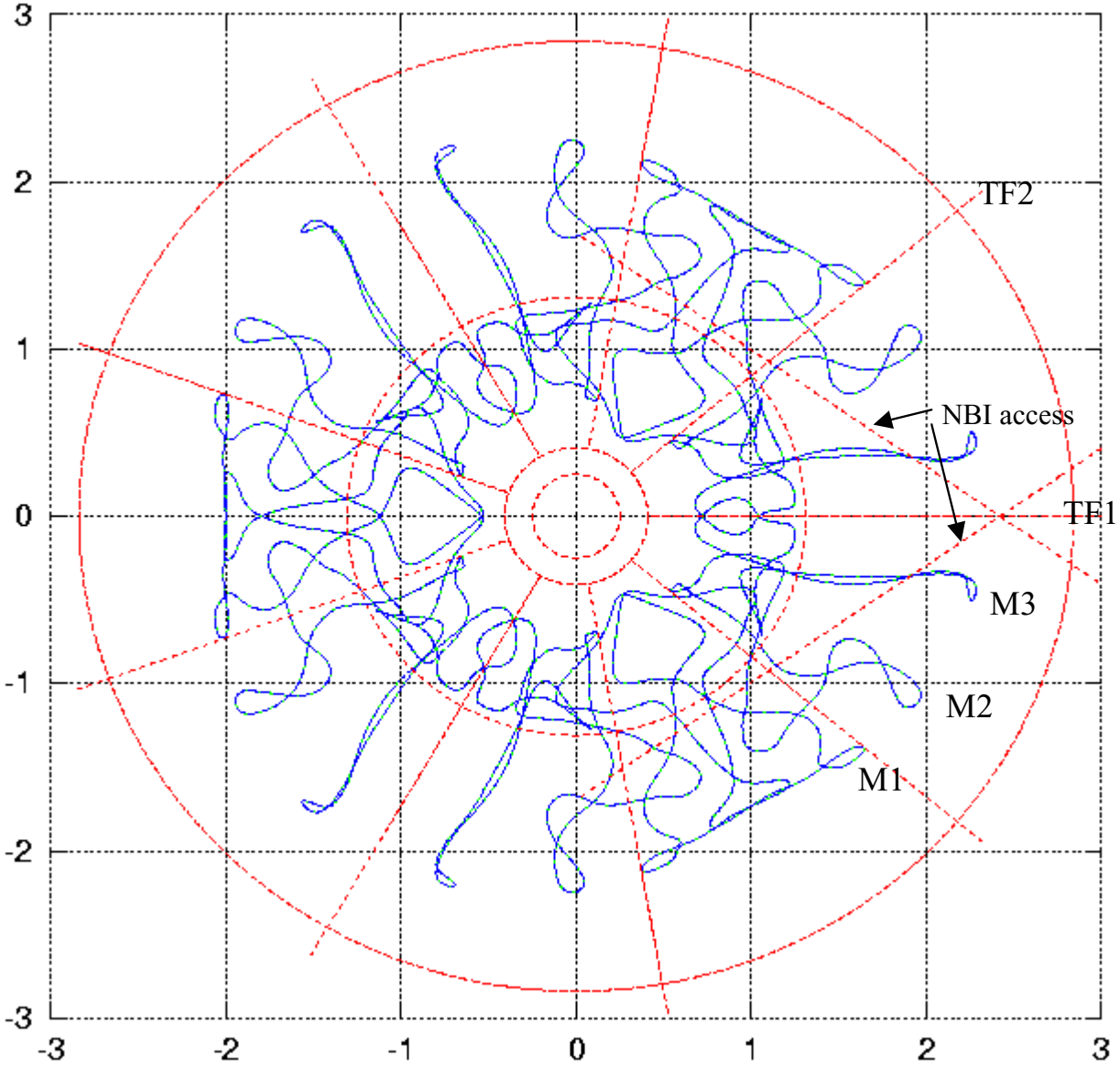
NBI access:
Min. = 30.5 cm

Coil-plasma dist.:
Min. = 19.7 cm

18 Modular Coil Solution 0813a1



Coilopt solution 0823d4 (9 TF coil model)



Field error:
Avg. = 0.58%
Max. = 2.13%

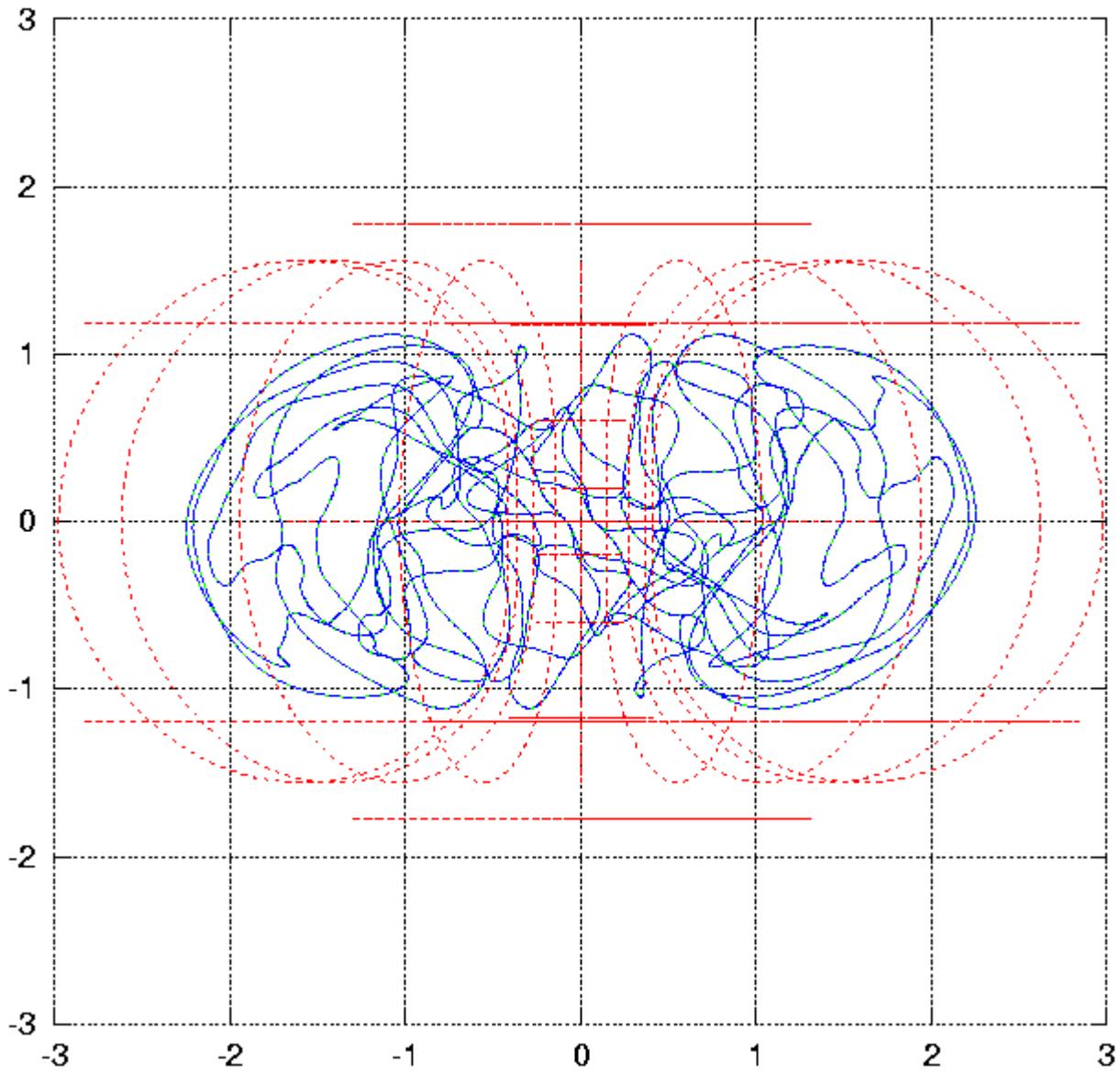
Coil-coil spacing:
1) 10.4 cm
2) 10.4 cm
3) 12.6 cm

Rad. curvature:
1) 9.4 cm
2) 9.0 cm
3) 9.7 cm

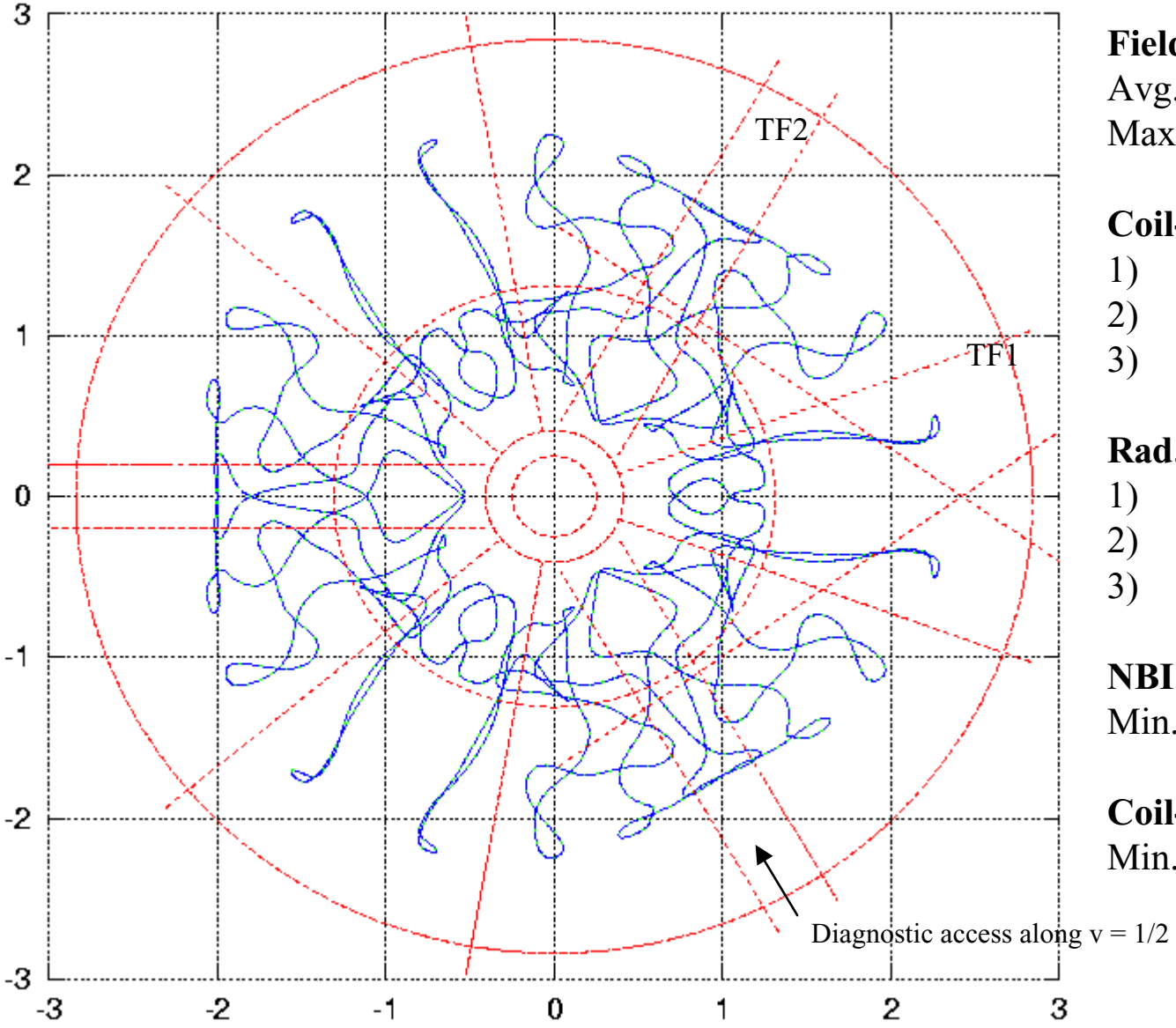
NBI access:
Min. = 31.9 cm

Coil-plasma dist.:
Min. = 19.6 cm

Coilopt solution 0823d4



Coilopt solution 0827a2 (12 TF coil model)



Field error:
Avg. = 0.58%
Max. = 2.17%

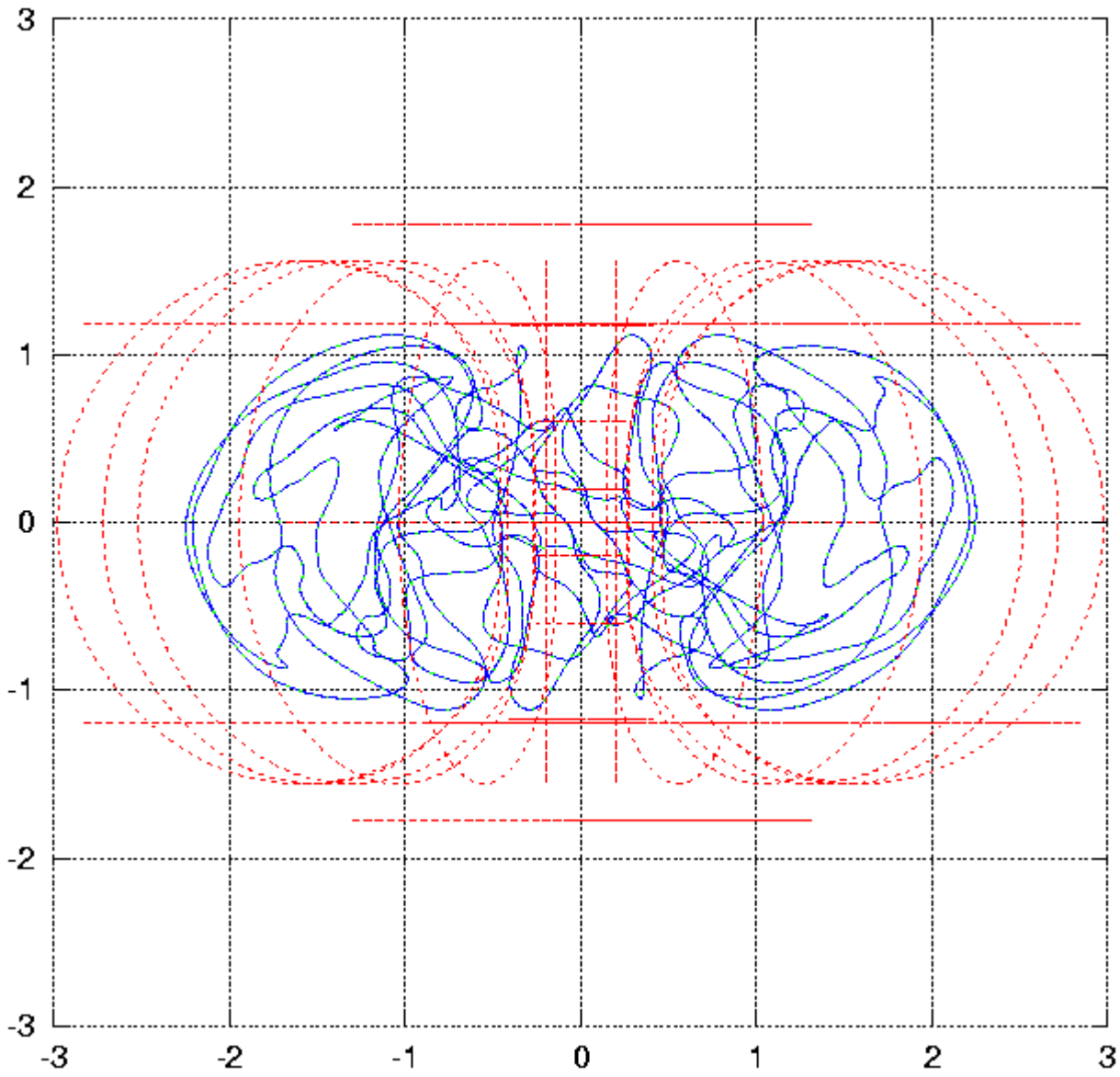
Coil-coil spacing:
1) 10.5 cm
2) 10.5 cm
3) 12.7 cm

Rad. curvature:
1) 9.3 cm
2) 8.8 cm
3) 9.4 cm

NBI access:
Min. = 31.5 cm

Coil-plasma dist.:
Min. = 19.6 cm

Coilopt solution 0827a2



Summary and status of coil design

- 18 modular coil designs are promising
- Assessment of 9, 12-TF coil options is in progress
  - Coilopt results are consistent with 1/R model
  - Need free-boundary reconstruction and Stellopt analysis
- Need to look at 15-TF coil, non-1/R option
- Plan to add design-specific diagnostics/constraints
  - Coil current density estimate
  - Vessel offset penalty