Elongation & Aspect Ratio Studies

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- $X = 3.0$ results indicate that there is only slight improvement over $X = 2.45$ for stability while the B_{mn} magnitudes are larger

  $A = 3.0$ cases look interesting / need more work

- targeting coil complexity and jmax in the optimizer has led to reduction in "cut-coil" current densities by factor of 1.5 – 3.0

- examination of coil complexity / jmax indicate the kink is the driver, and that these must be targeted in optimizer or values are not guaranteed to be minimum

- future work will include continued examination of coil measures and influences on magnetic surface quality for $i < 0.5$ configurations

Various Aspect Ratios, $\kappa = 3.0$, Bootstrap Enforced

A	I (kA)	β (%)	λ_K	balloon stability	$\lvert B_{mn}^{max} \rvert$	coil comp. (j_{max})	$i(a)$	$i(0)$
3.5 (τ_i^{GTC} = 20.0 ms at 4% β)	275	5.25	$-.64 \times 10^{-4}$	stable	1.96%	3.19 (1.68)	.485	.272
3.5	298	5.75	-1.1×10^{-4}	stable	2.53%	3.25 (1.88)	.485	.285
3.5	321	6.25	-1.3×10^{-4}	stable	3.03%	3.55 (5.0)	.486	.292
4.0 (τ_i^{GTC} = 21.3 ms at 4% β)	252	5.15	$-.48 \times 10^{-4}$	stable	1.3%	3.13 (1.25)	.480	.276
4.0	285	5.70	-6.0×10^{-4}	1 surface	1.3%	3.11 (1.60)	.480	.297
			-3.0×10^{-4} (Terpsicore failure)	stable	1.47%	4.45 (>24)	.49	.290
4.5 (τ_i^{GTC} = 24.6 ms at 4% β)	212	4.20	$-.66 \times 10^{-4}$	stable	0.73%	2.81 (0.79)	.483	.248
4.5	230	4.70	-2.0×10^{-4} (Terpsicore failure)	stable	0.57%	2.79 (0.73)	0.50	.276
3.0 (τ_i^{GTC} = 17.5 ms at 4% β)	241	4.75	$+.56 \times 10^{-4}$	stable	3.9%		.475	.239
3.0	270	5.50	$+.68 \times 10^{-4}$	stable	3.9%		.490	.262
3.0	295	6.25	$+.61 \times 10^{-5}$	stable	3.8%		.50	.279

* A = 3.0 cases require further optimization

** L.P. Ku ran GTC for above cases

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Targeting Coil Complexity & Coil Jmax in the Optimizer

- by targeting coil complexity and coil jmax in current sheet solutions, the "cut-coil" current densities have been lowered significantly

current sheet:	coil complexity	coil jmax
A3k2.45b5.0	3.06 → 2.74	1.55 → 0.95
A3k2.45b5.5	3.04 → 2.79	1.36 → 1.07
A4k2.45b5.0	3.02 → 2.70	1.00 → 0.66

"cut-coil" solution*:

A3k2.45b5.0	54.1 →	18-21 kA/cm²
A3k2.45b5.5	34.9 →	21
A4k2.45b5.0	42.0 →	16.4

* A. Brooks examined cut-coil solutions to obtain ~ 1% mean field error

Examination of Coil Complexity

- although targeting coil complexity & jmax reduced these quantities somewhat, why is the coil complexity $\gtrsim 2.70$ for the class of configurations

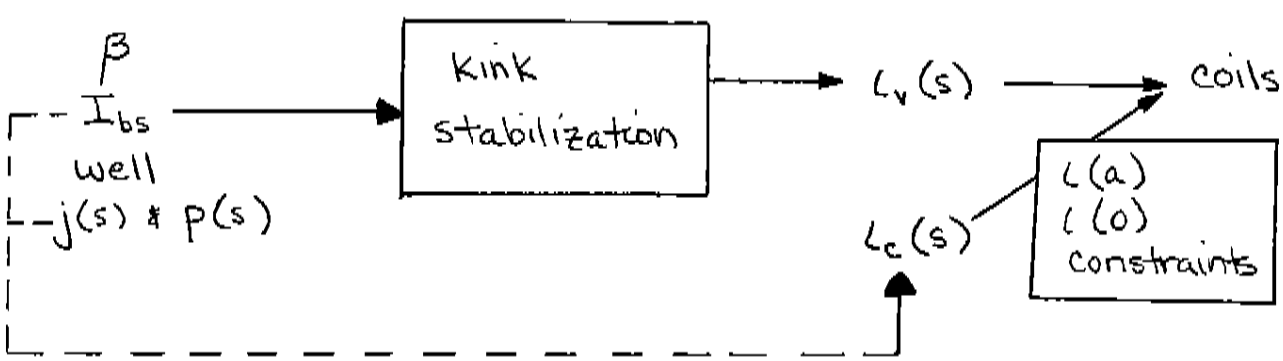
- using the $A = 4.0$, $\kappa = 2.45$, $\beta = 5\%$ ($I_{bs} = 244$ kA) case, allowed the kink growth rate to increase

$\lambda_K = -.35 \times 10^{-4}$ — coil complexity = 2.70, jmax = 0.66

$\lambda_K = -1.0 \times 10^{-3}$ — coil complexity = 2.30, jmax = 0.50

$\lambda_K = -1.2 \times 10^{-3}$ — coil complexity = 2.18, jmax = 0.48

→ it appears that the kink is the main driver for coil difficulties (however, the $\iota(a)$ constraint was also weakened in the above cases)



Examination of Coil Complexity, cont'd

- using the $A = 4.0$, $x = 2.45$, $\beta = 5\%$ ($I_{bs} = 244$ kA) case, lower current at fixed β ($i(a)$ constraint weakened)

$I_{bs} = 244$ kA	coil complexity = 2.70 $j_{max} = 0.66$	$i(0) = .308$ $i(a) = .484$
$I_{bs} = 200$ kA	coil complexity = 2.65 $j_{max} = 0.64$	$i(0) = .246$ $i(a) = .438$
$I_{bs} = 150$ kA	coil complexity = 2.48 $j_{max} = 0.52$	$i(0) = .17$ $i(a) = .385$

- the coil measures must be targeted in the optimizer otherwise there is no guarantee one has obtained the lowest values

for example	C10 (kink unstable)	coil complexity = 3.0 $j_{max} = .95$
	C82 (kink stabilized)	coil complexity = 3.1 $j_{max} = 1.2$

→ targeting coil measures in C10 should drive them much lower (unless $i(a) \sim .47$ constraint keeps them higher ??)