Promising results in the effort to use new nescoil tools to reduce maximum surface current density

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Talk presented at PPPL, April 15, 1999

Goal of this effort (starting point in coil design)

Improve the quality of nescoil surface current solution for c82, i.e.,

reduce maximum surface current density and complexity of current contours

without significantly reducing the accuracy of plasma reconstruction

Get “acceptable” accuracy with “better” surface currents

What is new?

Using a new coilsurface that satisfies the 18 cm constraint.

Remember that the original c82 (and c10) surfaces that we (and Wayne) were using had sharp curvatures and a plasma-separation distance as low as 14.2 cm.

The concern about current density on new smooth surface

Old coilsurface was nearer to plasma in some places than the new smooth one.

It may require even bigger current densities!

Attack using two new tools recently added to nescoil

SVD quick-scan with Berr, Jmax, Complexity… at each svd point

Targeting $|J|^2$ in addition to $|B \bullet n|^2$ in nescoil svdscan

Recent Promising Results for c82

Mf,nf	Nsvd	<Berr>	MaxBerr	Jmax	Complex	Comments
10,10	STD	0.11	1.65	0.88	2.96	C10 with old surface
10,10	STD	0.22	1.758	1.170	3.242	C82 New surf, no SVD
10,10	194	0.22	1.689	0.9356	3.139	Good. Better than STD
10,10	185	0.26	1.999	0.9240	3.244	Better than Case 2?
10,10 J	201	0.28	2.087	0.9116	3.210	Targeting J, a bit better?
8,8	121	0.60	6.714	0.8316	3.119	Great, but Berr too high?
20,20	286	0.22	2.643	1.384	3.942	Can't beat 10x10. Why?
32,32	300	0.19	2.429	1.346	4.535	No better. Why?

Do not understand why lower mf,nf do better, but won't complain.

The c10 case was with old surface which is closer to plasma in some places.

Extra capabilities added to nescoil in the past week

Target Surface Current $\int ds\,|\bar{B}\cdot\hat{n}|^2 + \alpha\int ds\,|\bar{J}|^2$ with any α.

Error calculation on a grid finer than the target grid.

Reminder: other capabilities added to nescoil in the past 4 weeks

Svd scan: do rapid scan over all svd weights

Berr, Xerr, Jmax, Jcurvature, Complexity at each point in svdscan.

Targeting Xerror within nescoil is now extended to svd scan.

Xerror postcalculator within nescoil for any minimization target.

Weighted optimization to target selected plasma areas for err reduction.

All new codes were tested against old cases/codes by Art and Prashant.

Summary

Recent additions made to Nescoil are yielding good results:

C82 surface current density has been significantly reduced (close to c10!)

Jmax brought down from 1.17 for standard nescoil to 0.91

while the Berror and complexity are still kept low enough at

<Berr> = 0.28%, Berr_max = 2.1%, Complexity = 3.2

We expect it will be easier to fit coils to the new smooth surface.

What seems to have worked:

SVD fast-scan with low (m,n)

Next: Do these reconstruct to a physically acceptable plasma?