COIL CONCEPTS AND TOOLS

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NCSX Project Meeting, ORNL, May 5-6, 1999

CONTROL OF C82 PLASMA SHAPE USING THE C82.D18.3.16 (16 EQUAL CONTOUR) SADDLE COIL SET

4/29 Status: Reconstructions were KINK UNSTABLE

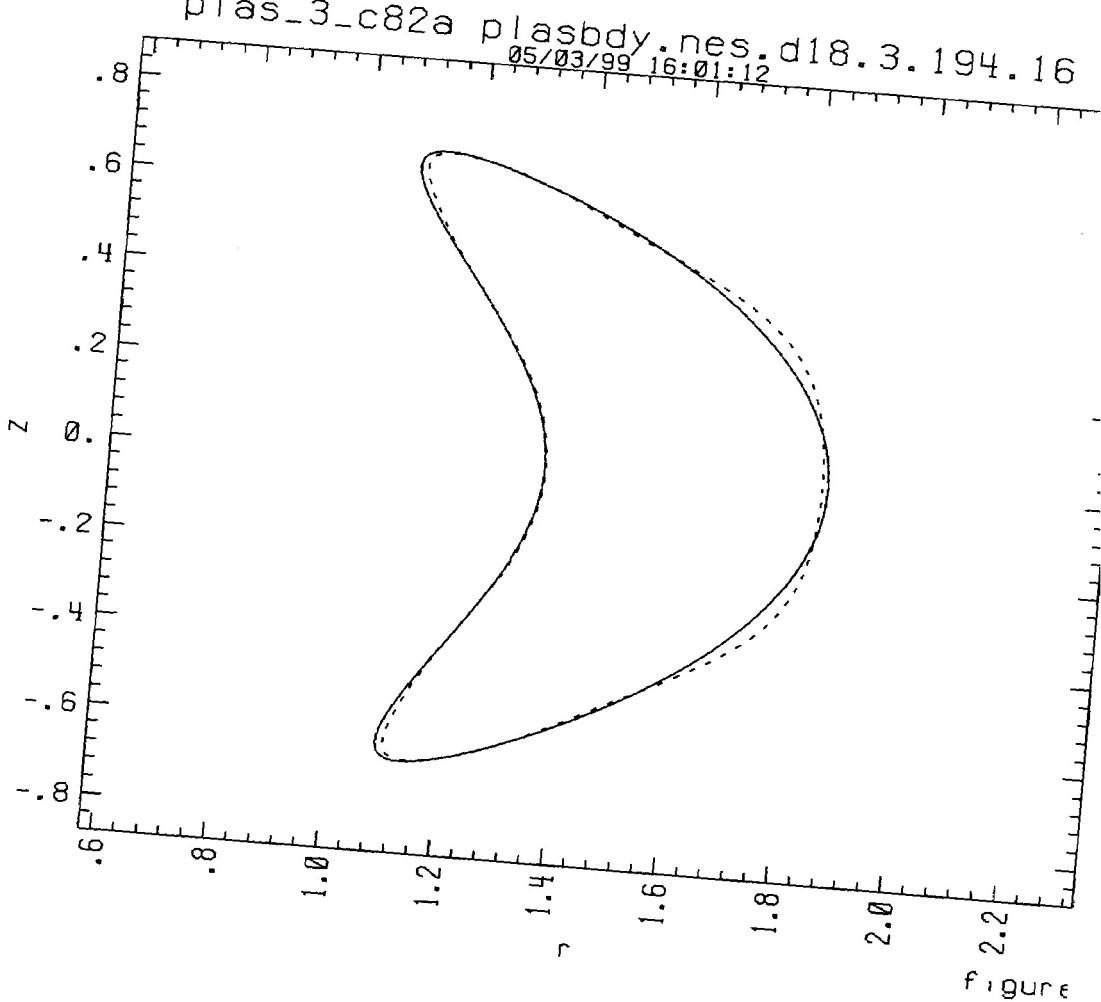
- Attributed to inadequate outboard indentation (length of field lines on outboard side) seen at $v = 0.5$ toroidal cross section. (Note: focus on the top/bottom ears, not on the midplane!!)

5/6 Status: WE HAVE STABILIZED THE KINK using the same coil set

- 2 "groups" of saddle coils have been identified as efficient controllers of outboard indentation.
- By appropriately adjusting these 2 currents we have been able to regain this "lost" indentation and re-stabilized the kink.
- Reversing the sign of the change in the 2 currents DESTABILIZES the kink, which shows that we have

a useful knob for stabilization experiments.

Although reverse engineering the coils makes sense for determining the basic coil configuration, the true flexibility of the coil system can only be explored by "forward" shape influence calculations such as explored here (just as we would do if we were designing a tokamak!) PLEASE PLEASE PLEASE PLEASE do not get hung up on the DETAILS of what will be presented. The results represent a PROOF OF PRINCIPLE and can be applied to any coil set. The C82.D18.3.16 coil set is not the final story. We are confident that the GA algorithm (see later) will provide us with the final coil system AND THAT THE NUMBER OF COILS WILL BE SUBSTANTIALLY FEWER THAN AT PRESENT.



gure 1: Reconstructed plasma at v=0 plane. Reference plasma is solid,

iginal reconstruction is dashed

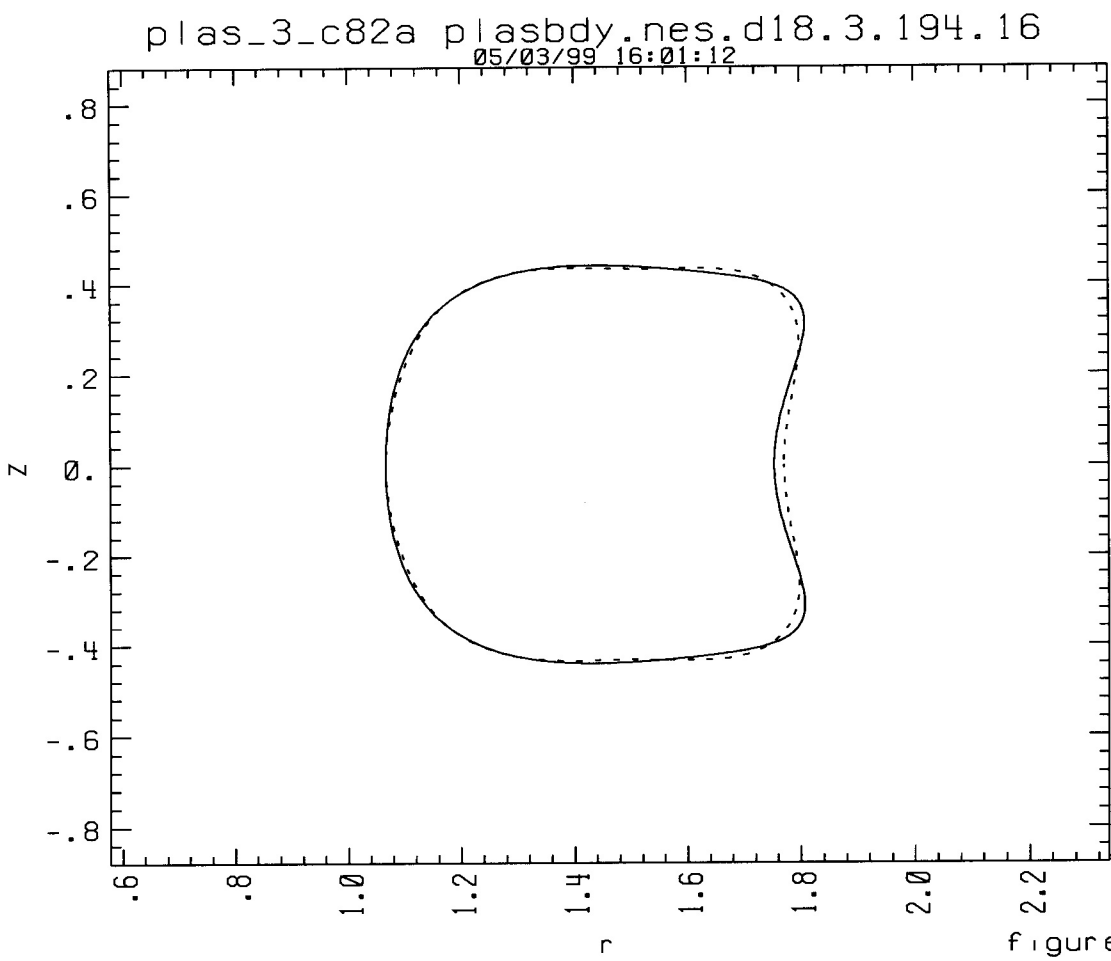


Figure 2: Reconstructed plasma at v=0.5 plane. Note the loss of indentation on the outboard region. Particularly note that the ears are less pronounced.

The kink eigenvalue is 6.3 e-4

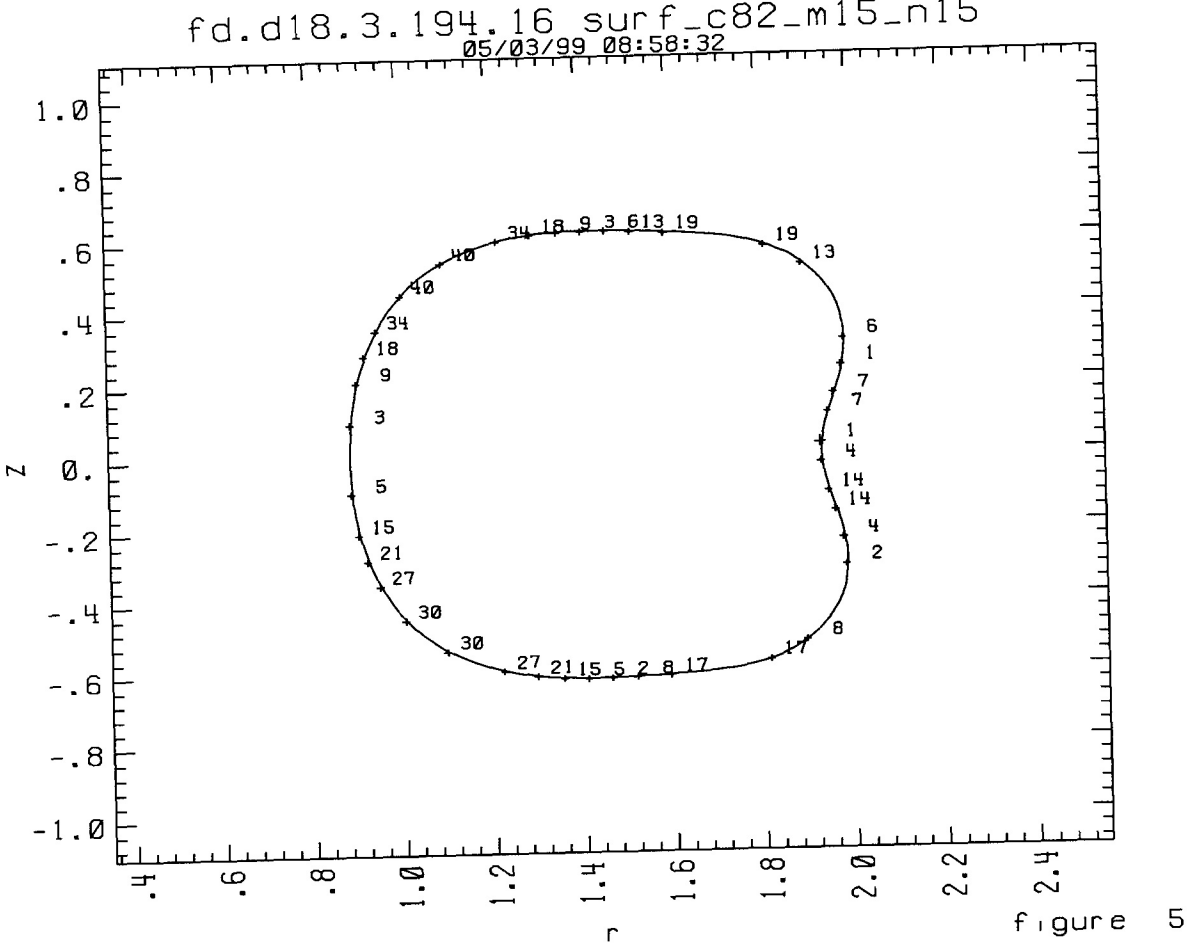


figure 5

Figure 3: Location of saddle coils (crosses) as they intersect the v=0.5 plane. Relative signs of coil currents are (clockwise from outboard midplane + + - - - - + + + + + + + + - - - - -. From this plot we can identify which coils can control the indentation:(1,2,3):(4,5,6) and (13,14,15):(7,8,9).

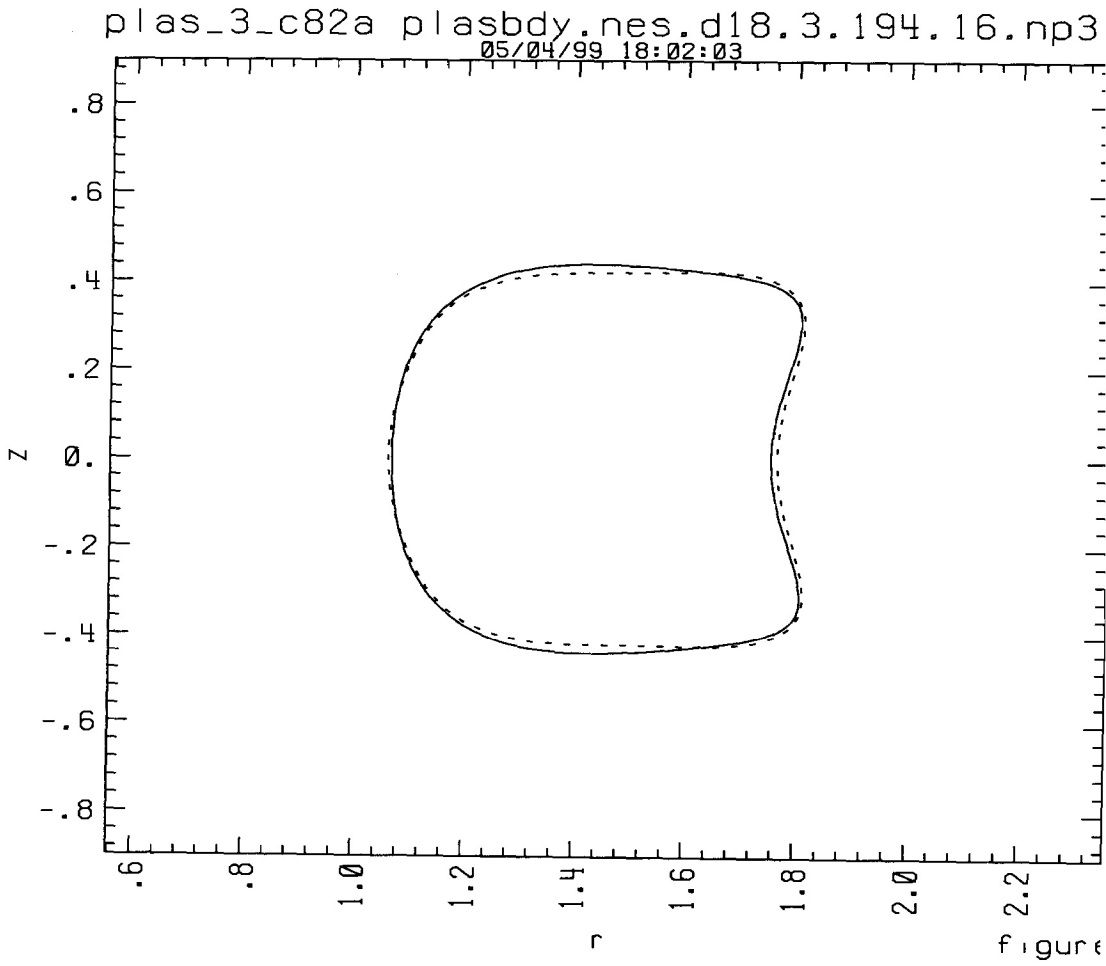


Figure 4: Shows effect of making a +10% change in the 2 group coil currents.

The indentation is regained, leading to a reduced kink eigenvalue of 4.5 e-5

(same as target C82)

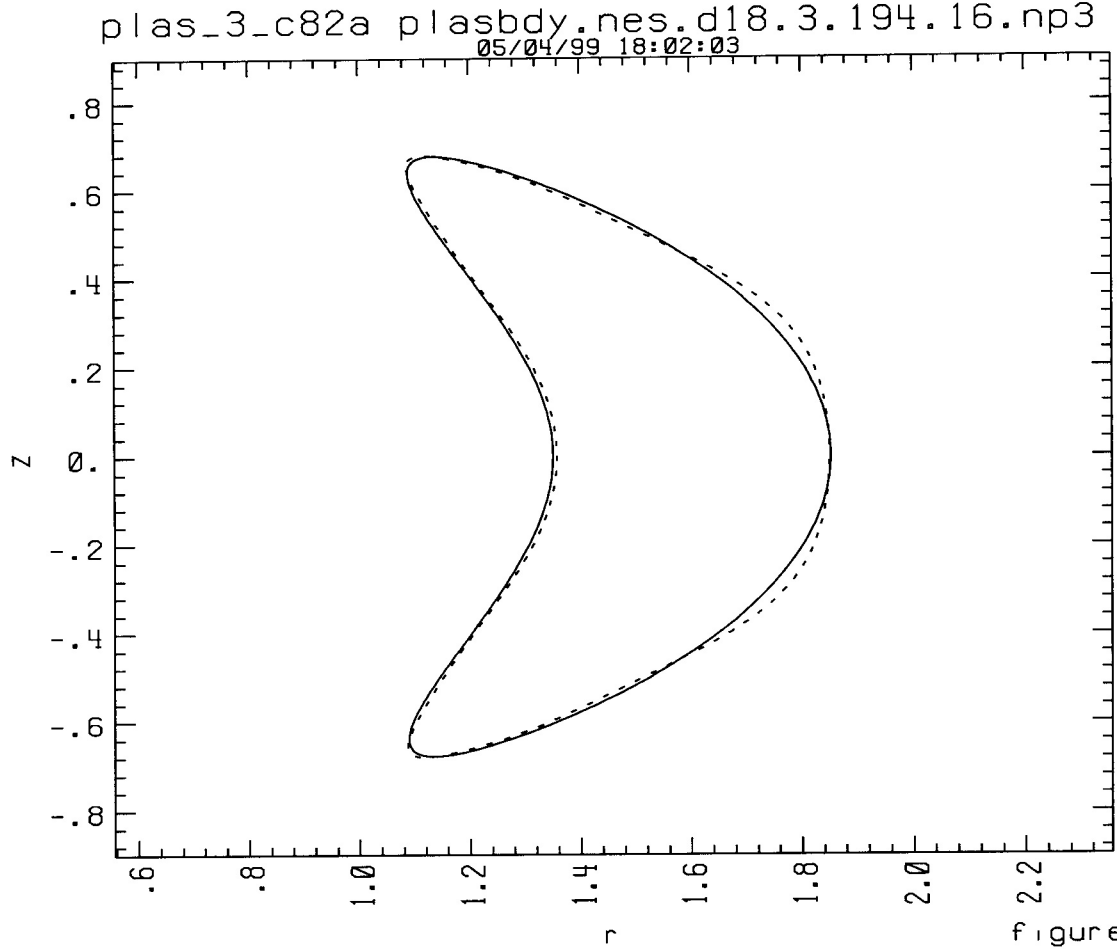


Figure 5: Same reconstruction as previous figure except shows v=0 plane

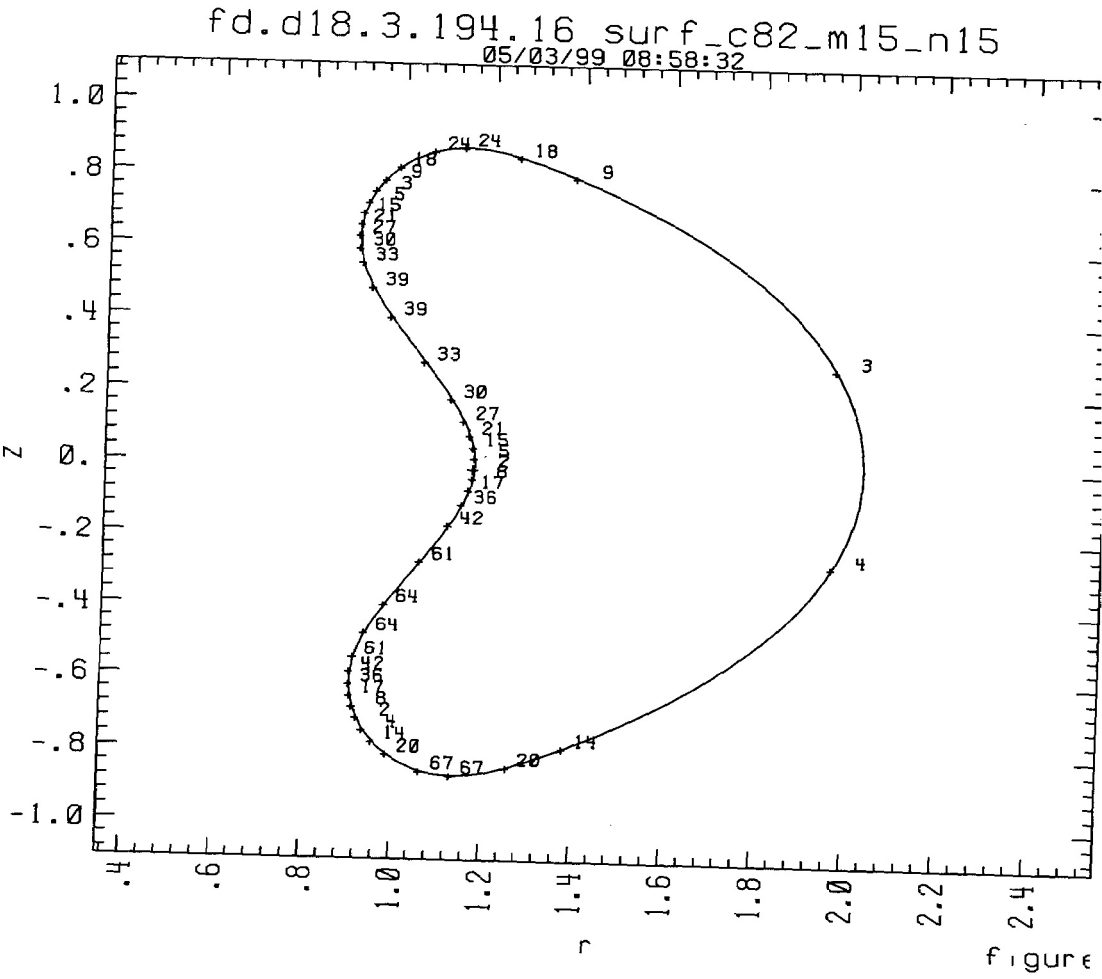


Figure 6: Note the distribution of coils on the v=0 surface. We can move the coil surface away locally where the reconstructed bulge is without affecting the coils themselves. (The conformal shape of the coil surface was arbitrary)

SUMMARY OF NEW RECONSTRUCTED PLASMA PARAMETERS FOR D18.3.194.16.NP3

$\beta = 3.78\%$

$\lambda_{kink} = 4.0 \times 10^{-5}$ **(same as target C82)**

$\chi^2(B_{mn})$ S	C82	.NP3
0.3	4.32e-5	1.41e-4
0.5	1.83e-4	2.46e-4
0.7	7.69e-4	8.09e-4

χ^2(Ripple Wells) S	C82	.NP3
0.3	4.78e-3	6.97e-3
0.5	1.95e-2	1.66e-2
0.7	3.85e-2	2.62e-2

PROGRESS IN GA/SIMPLEX CODES

The GA is now showing its superiority over the SIMPLEX in obtaining more accurate solutions, particularly when we fix the number of coils (rather than fixing the number of contours). As an example for the C82 configuration with 10 coils per period,

SIMPLEX $\Rightarrow$ Avg Berr = 1.20% Max Berr = 5.41%

GA $\Rightarrow$ Avg Berr = 0.75% Max Berr = 4.07%

Using the same current sheet that Art Brooks used to cut his 16 contour (approx 30 coil per period) coil set, the GA has explored how small B_n errors can be driven when 8, 10, and 12 coils per period are retained WITHOUT ENGINEERING CONSTRAINTS ON MINIMUM COIL-to-COIL SEPARATIONS AND ON COIL CURRENT DENSITY. It is very interesting that average B-filed errors of less than 0.9% can be obtained even for the 8 coil solution (see Figure).

The calculation of minimum coil-to-coil separation

and minimization of Jmax is currently being installed in the GA and will be available for use shortly. The necessary modules have already been installed and tested in the SIMPLEX code.

3_c82a.sad18g - 8X8 - 121 weights - 60 contours