Coil Configuration

Status of Winding Surface Improvements

Stellarator Working Group

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Problems identified with present surfaces

- Radii of curvature reported by Engineering from ProE (~ 10 cm for c82) much less than anticipated from an 18 cm offset from plasma:
  - Reduces available width for conductor and hence increase conductor current density
- Offset from plasma not as uniform as desired:
  - Encroaches on envelope required for vacuum vessel and first wall
- Problems arise from
  - Generating surfaces at fixed offset in radial planes
  - Limitation of Fourier fitting data points

Tools developed to diagnose existing surface and calculate improved ones

- Surfcurv - routine to evaluate true surface curvatures
  - Calculates two principal curvatures on mesh of points in surface
  - Searches for minimum positive and minimum negative (reverse) curvatures
- Surfsep - routine to evaluate true 3-D offset from
  - Calculates closest point to plasma from a mesh of points in coil surface
- Offsur - routine to calculate a true conformal coil surface
  - Calculates offsets from plasma along true 3-D surface normal
  - Evaluates fourier coefficients for data points

Having Difficulty
Fourier Representing Surface

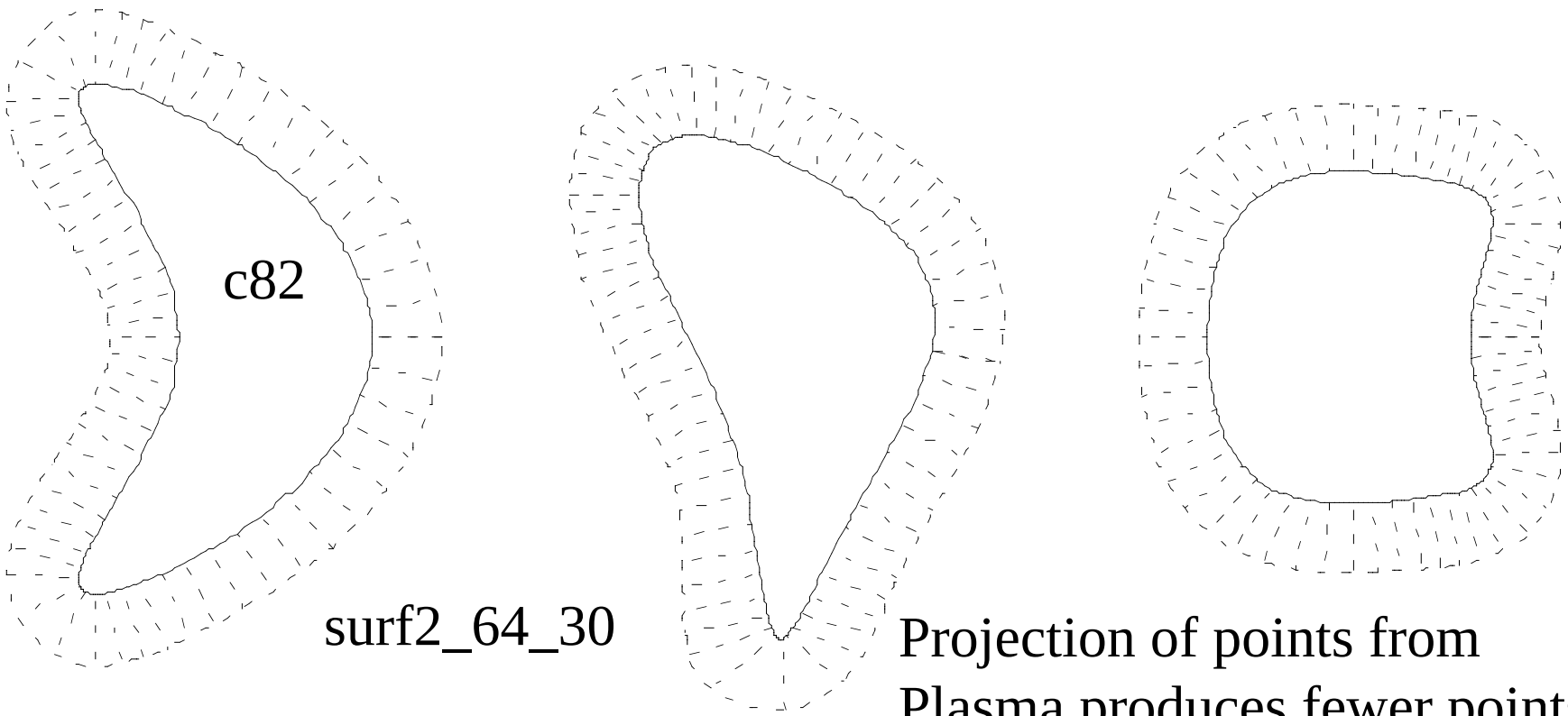
Large number of harmonics needed for good fit causing dimpling in surface

Surface ID	Modes m	Modes n	Offset from Plasma, m dmax	dmin	dmean	Radii of Curv, m rc+	rc-
surf18 (ref)	10	10	18.3	14.2	17.6	11.4	21.7
surf2_64_30	30	30	18.4	17.5	18.0	9.9 *	12.1
surf1_m6n20	6	20	31.1	16.1	18.0	7.1	13.8
surf1_m7n15	7	15	18.9	15.9	18.0	6.8	17.8

Last 2 surfaces remaps (in u) of second surface with fewer harmonics

*Low radii of curvature driven by local surface dimpling

New offset surface looks good
(from a distance)

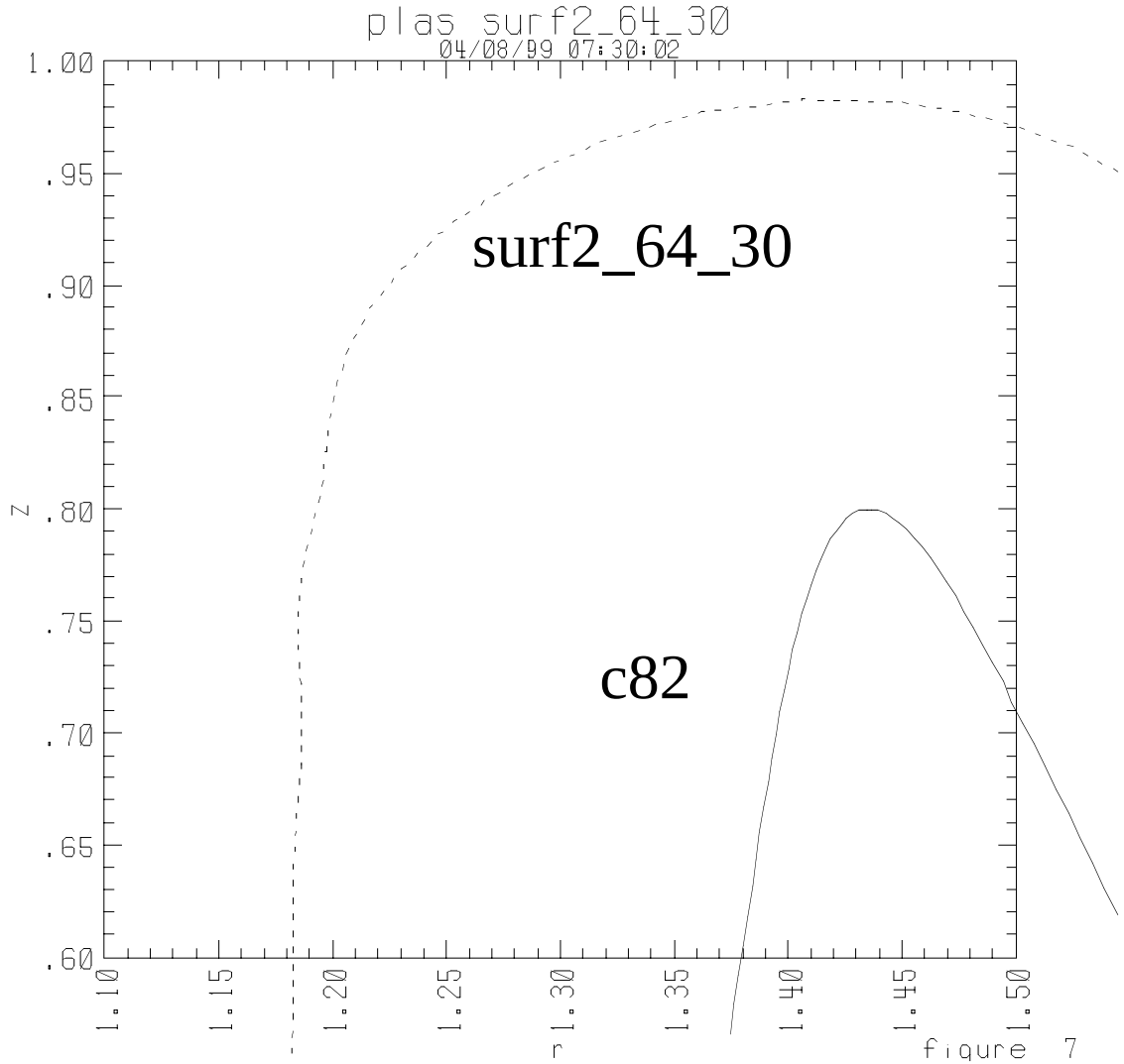


surf2_64_30

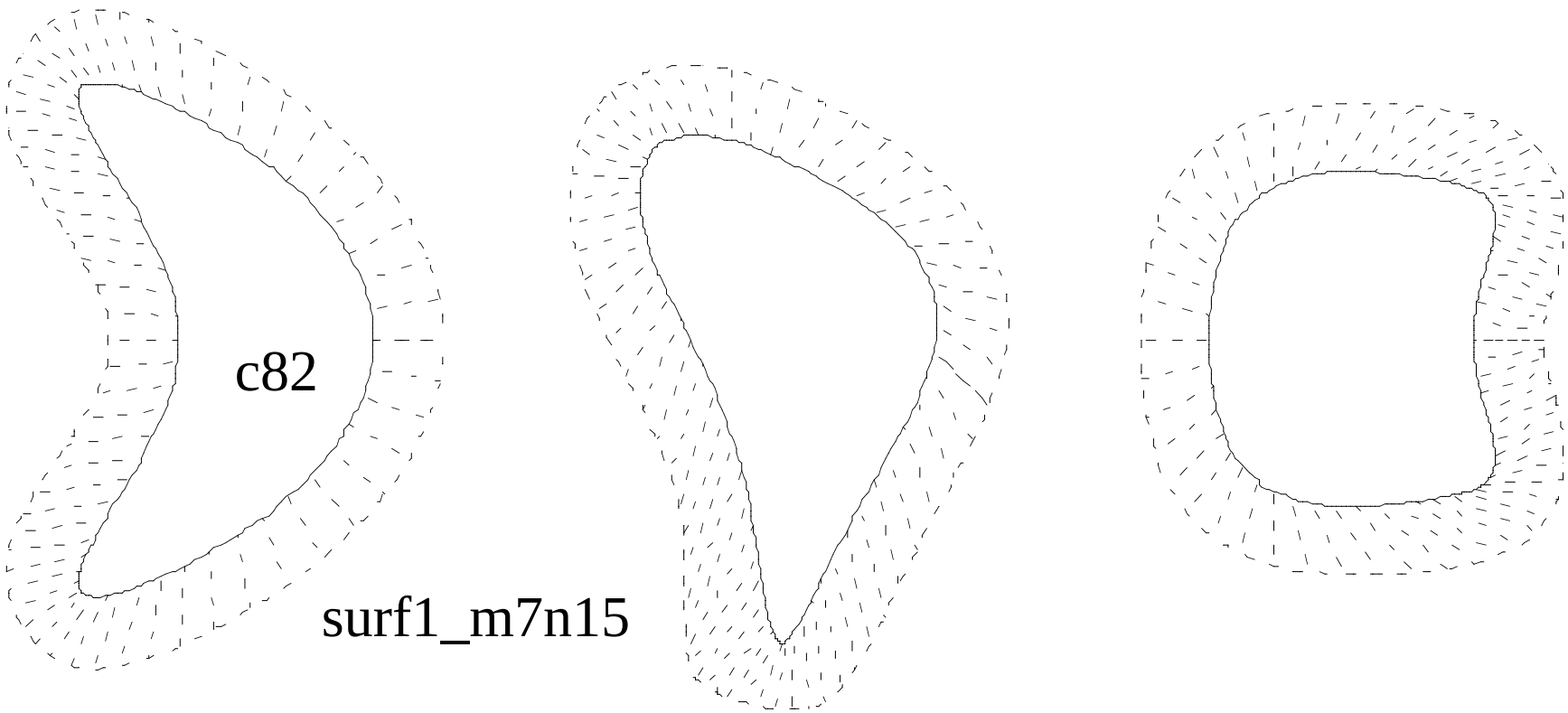
Projection of points from
Plasma produces fewer points
in regions of highest curvature

“Dimpling” or Wavy-ness of offset surface

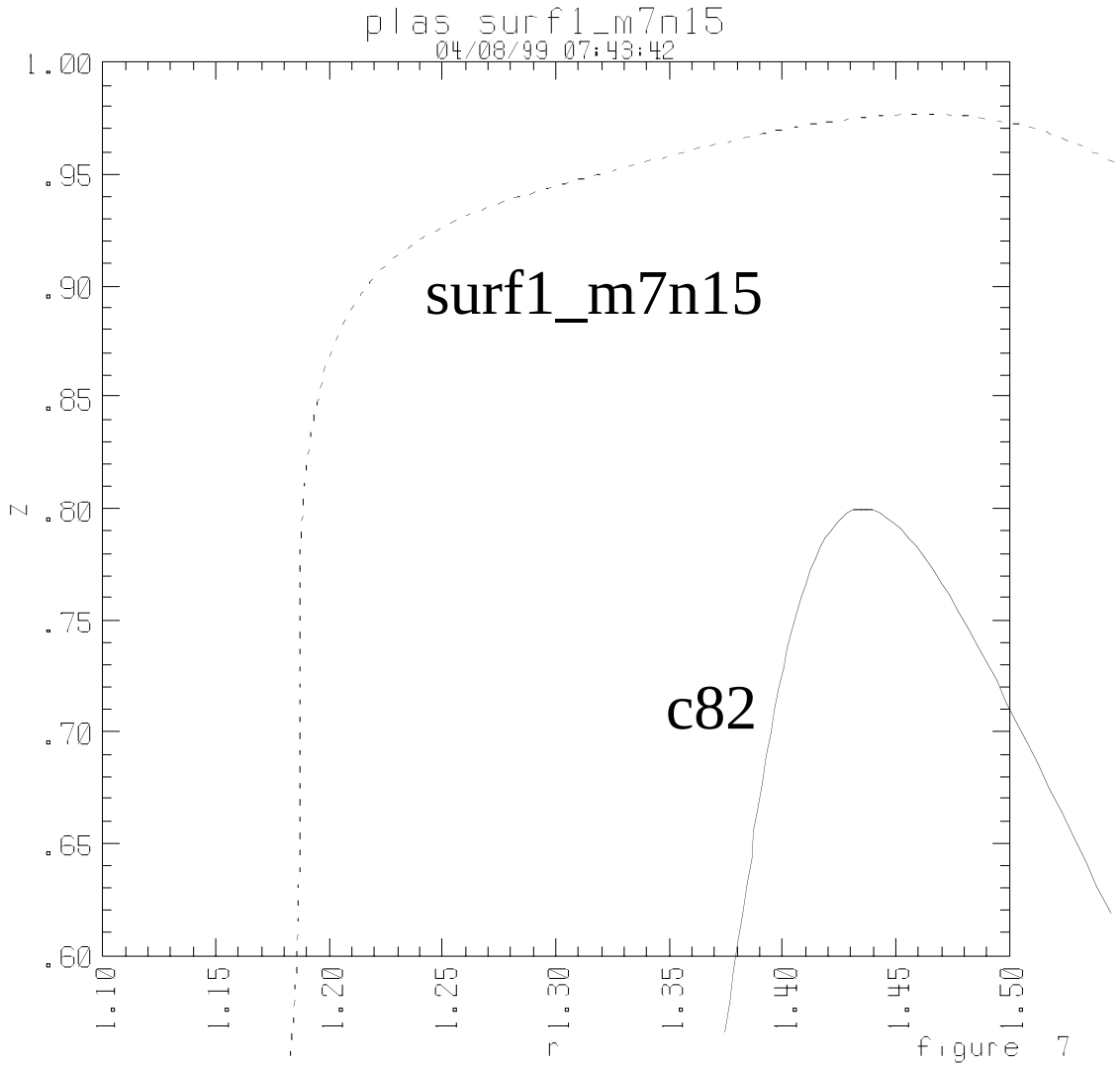
due to large number of modes required to fit data points



Remapping produces more points on surface in regions of high curvature



Reducing harmonics while remapping improves surface wavy-ness



NESCOIL Current Sheet Comparisons

Surface ID	Max Error %	Mean Error %	Jmax/Ipol
surf18 (ref)	0.18	2.23	1.08
surf2_64_30	0.20	4.30	1.08
surf1_m6n20	0.16	1.74	6.90
surf1_m7n15	0.16	2.06	2.95

Good fit, but high mode solution retains low current density but loses on max error and reconstruction.

Low mode solution causes unexplained increase in jmax

Summary

- Coil Surface can be created to within +/- 5 mm
- Remapping can improve surface wavy-ness and recover NESCOIL errors
- Need to understand what drove current density up during remapping
- May need to fall back to old methods and just move surface out until it meets minimum clearance needed