

Surface Quality of High Iota Configurations
-- Preliminary PIES Results --

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Outline

- PIES calculations --assumptions and approach
- Flux surface quality for II75_286
- Comparison of flux surfaces for LI65_136 and its variant

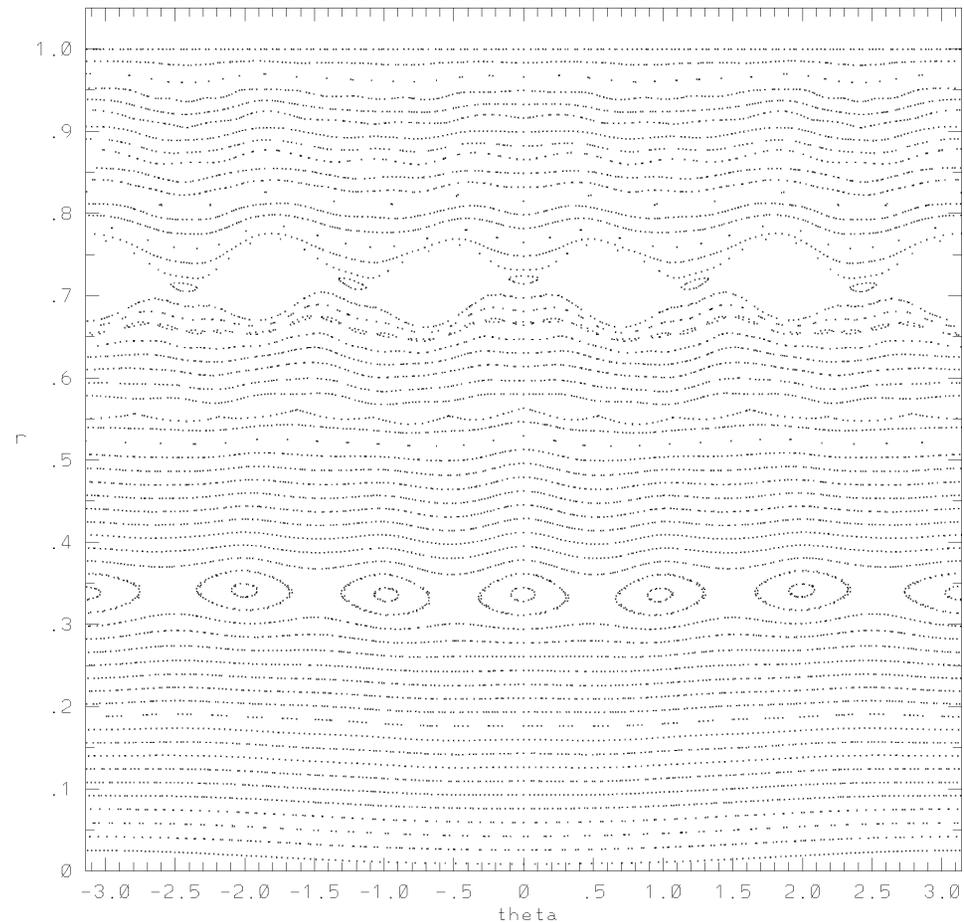
PIES Calculations, Assumption and Approach

- For all calculations:
 - 60 surfaces
 - 20 poloidal and 10 toroidal modes (may not be adequate)
- Using B fields from VMEC to start. Neoclassical effects of bootstrap current ignored.
- Iteration terminates if
 - Force residue < 0.01 , Maximum correction in B, ι , x, y $< 10^{-5}$
 - Poincare plot does not change significantly when blending is turned off for the next iteration

Surface Quality for II75_286

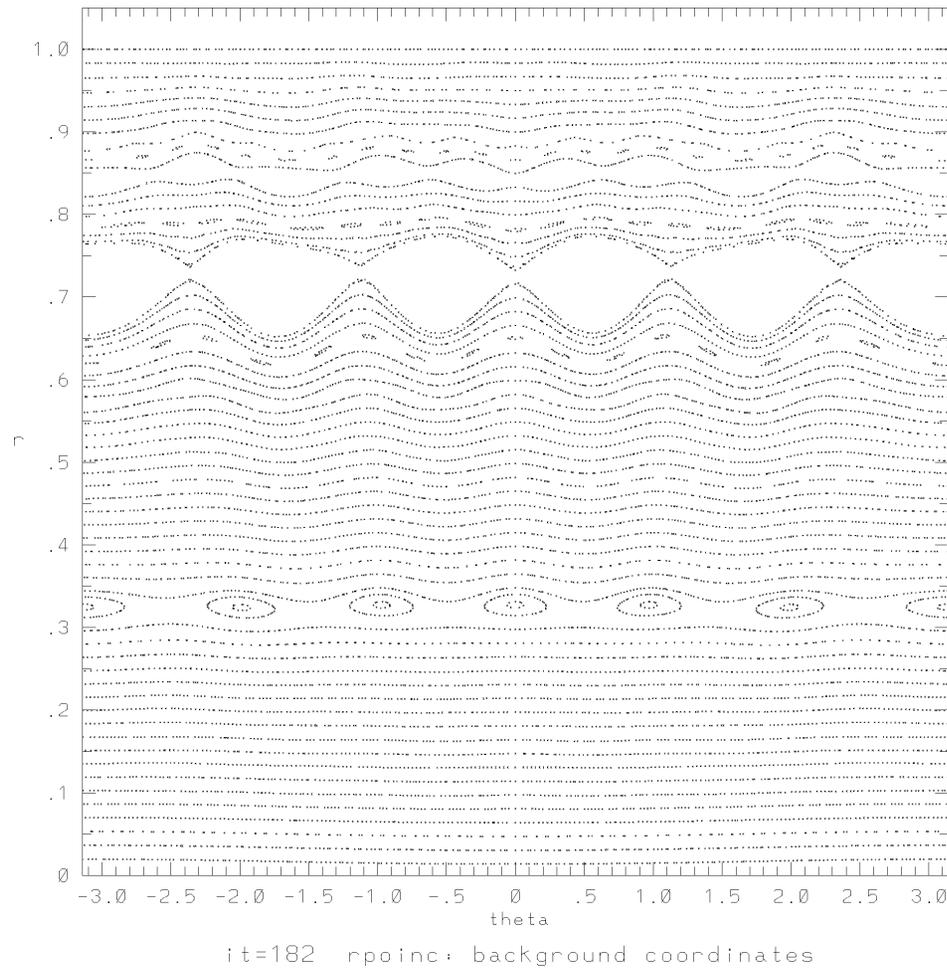
- II75_286 has been chosen to do detailed coil design studies:
 - Low coil complexity and current density in current sheet solution
 - MHD stable up to $I_p=120$ kA and $\beta=4\%$ (C82 volume).
 - Good QA; neoclassical τ_E for D ~ 26 ms (C82 volume).
 - Vacuum transform 0.5-0.61
 - $0.464 < \iota < 0.747$ @ $I_p=120$ kA and 4% β
 - $0.475 < \iota < 0.725$ @ $I_p=100$ kA and 4% β

Configuration II75_286 appears to maintain surface integrity at 4% beta. The islands are large, however, particularly near $\iota=0.6$ resonance. The total island width may occupy as much as 20% of the plasma.



it=181 rpoinc: background coordinates

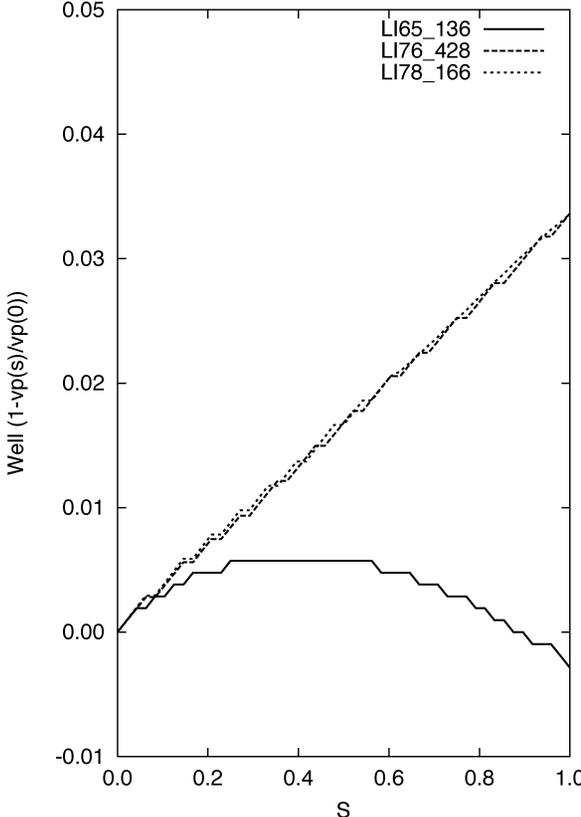
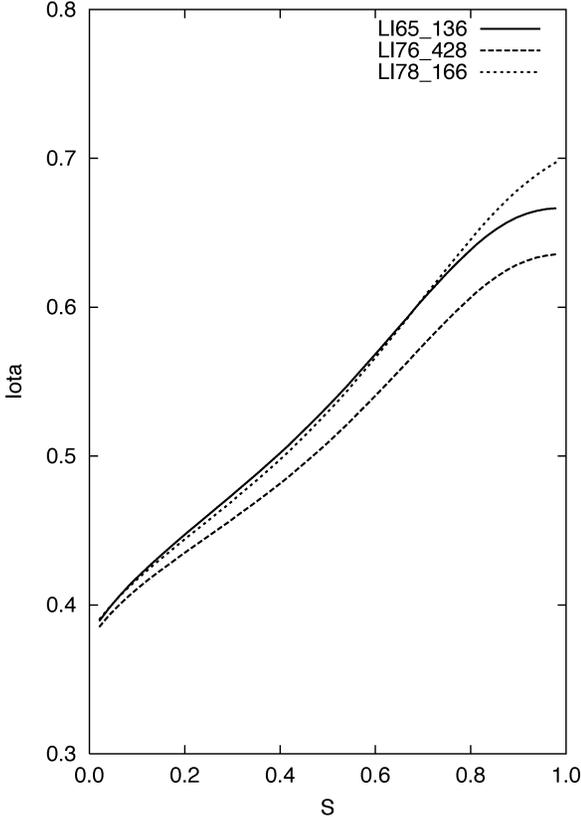
The large islands do not appear to be driven by the pressure effects, as seen below with $I_p=100$ kA but $\beta=0\%$



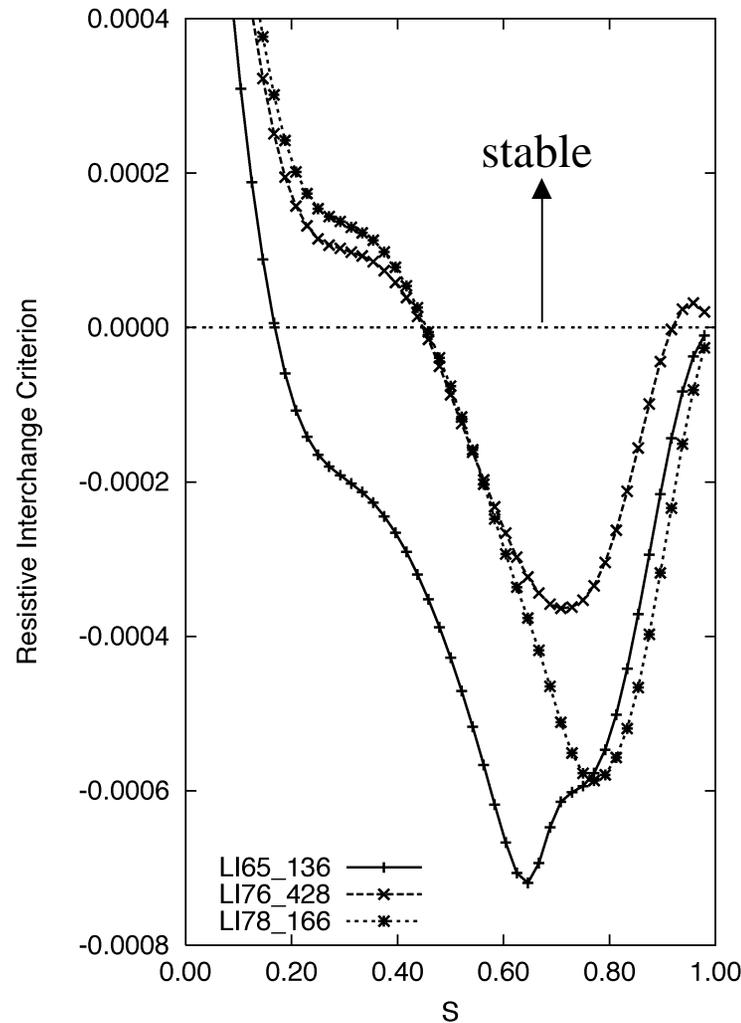
Surface Quality of LI65_136 and Its Variant

- A sequence of optimized configurations, starting from LI65_136, has been generated to study D_r and surface quality
 - Progressively deeper vacuum magnetic well from 0 to 4.5%
 - Worsening of quasi-symmetry, but still with $\max\{|B|\}$ @ $s=0.5 < 1.1\%$. Ballooning β limit also degraded.
 - If realized, configurations with a deeper well tend to be more robust to pressure driven instability.
- Three configurations were selected for PIES analysis, all at 4% β .

The three configurations have similar iota, but different characteristics of vacuum magnetic well and magnetic shear.

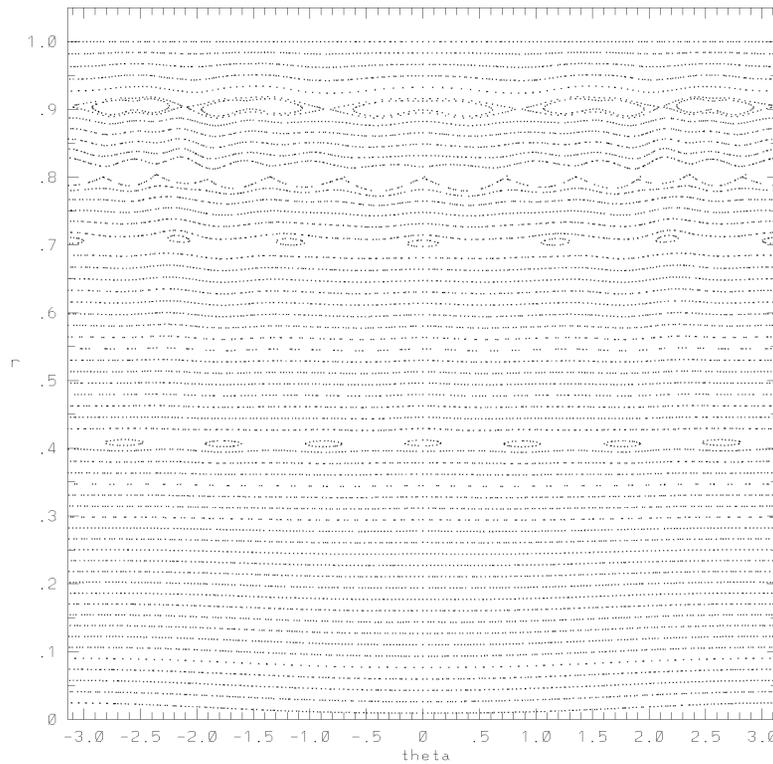


Vacuum magnetic well tends to improve stability to interchange modes, making a configuration more robust.

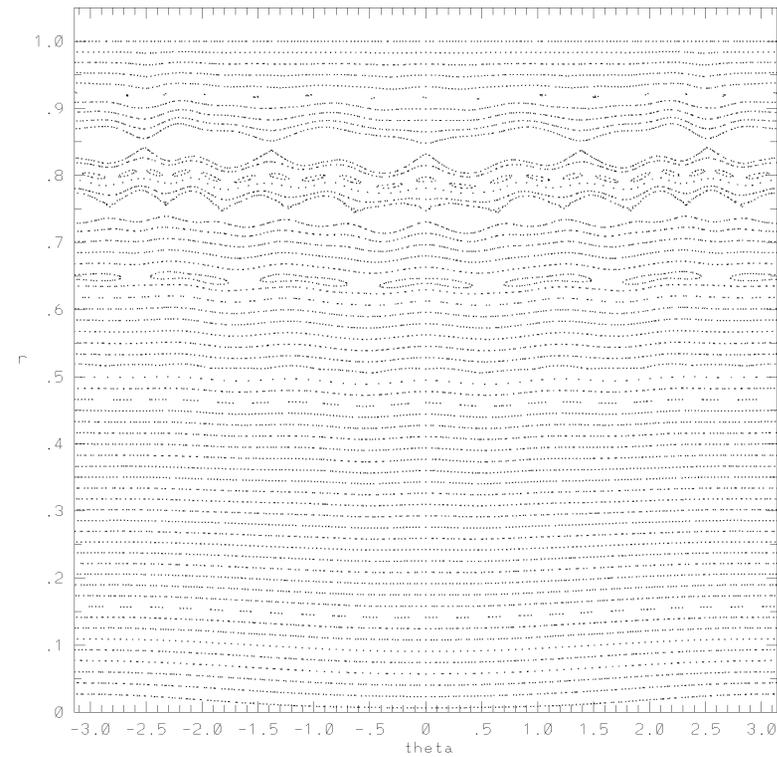


Local resonance has been detuned.

Comparison of PIES results seems to show LI76, which has better resistive interchange characteristic, has better surface quality than LI65, but

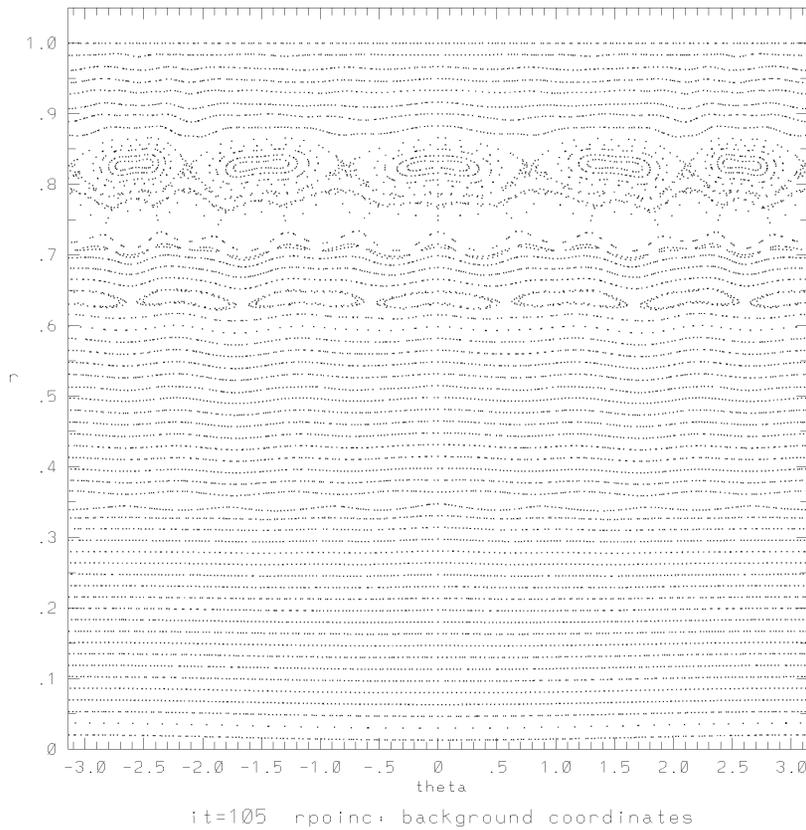


LI76_428

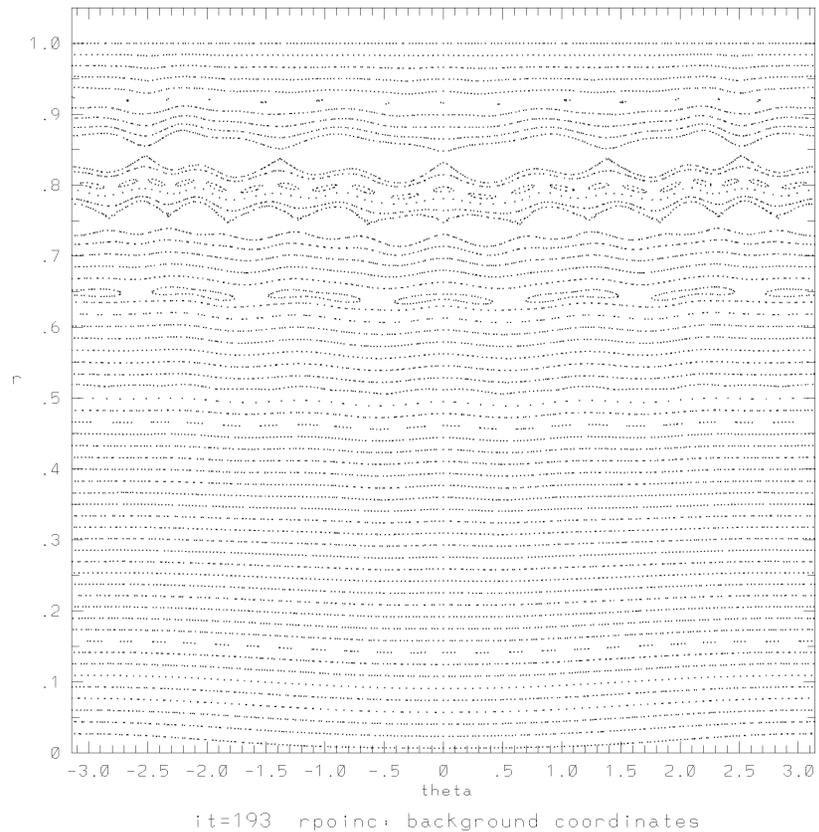


LI65_136

LI78 has better resistive interchange than LI65 and better shear than LI76, yet the region near $\iota=0.6$ appears to be stochastic.

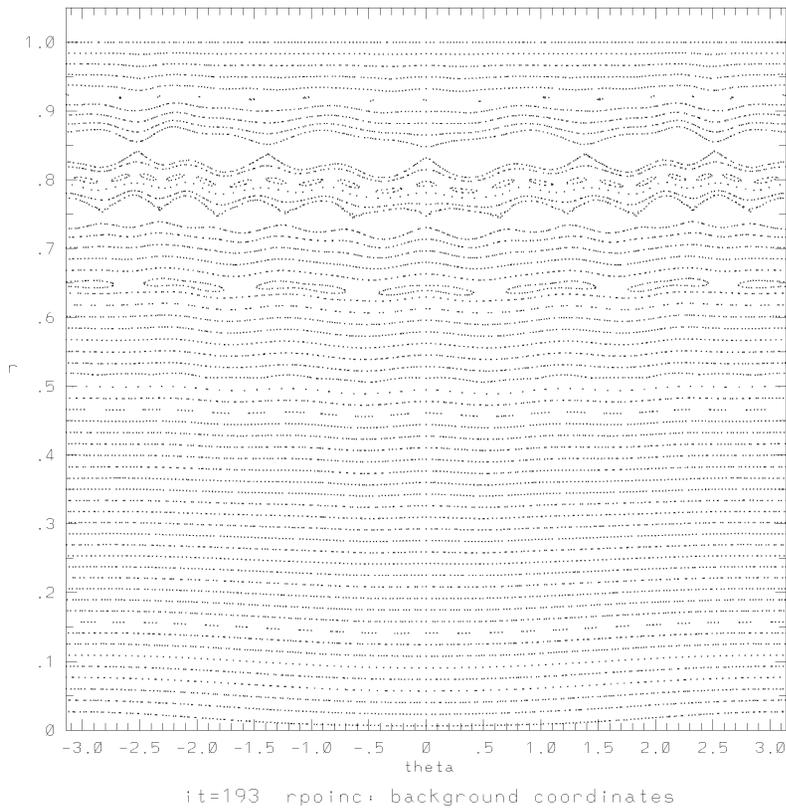


LI76_428

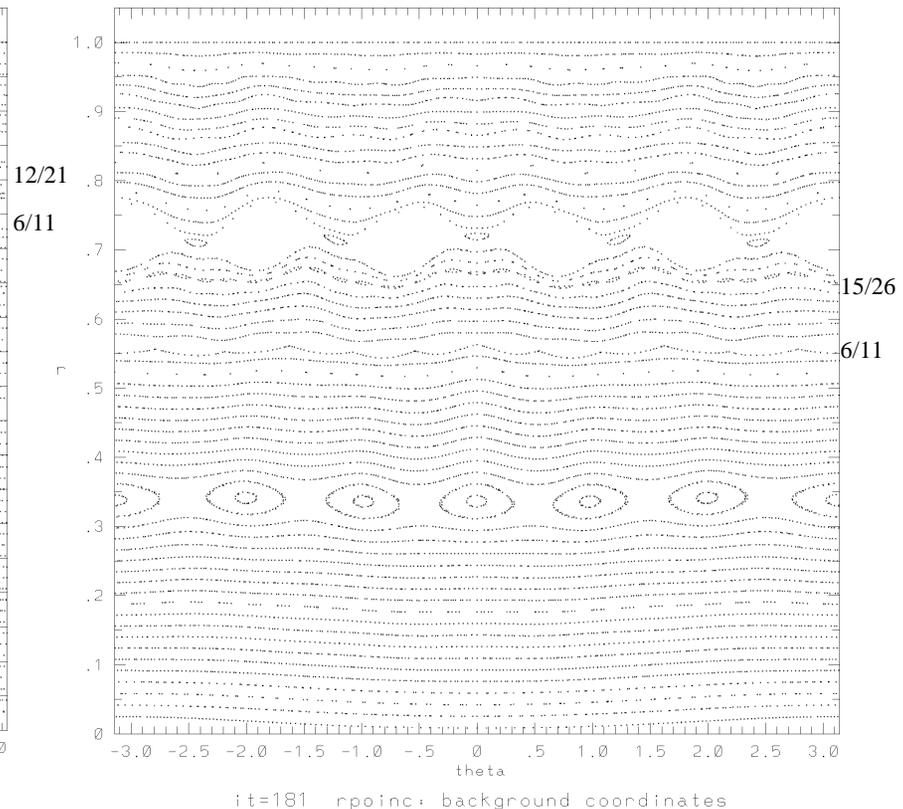


LI65_136

Why the island size of LI65/LI76 is much smaller than that of II75? How can we avoid having high order islands? What would happen if current and current profile are different?



LI65_136



II75_286

Work in Progress

- Improve PIES convergence with more modes and radial grids with the present configurations. Correlate island width to analytic estimates to understand what are important.
- Iota profile modification, e. g., push $\iota=0.6$ as much in or as much out as possible.
 - Can we achieve $0.53 < \iota < 0.73$?
 - Or is it better if $0.43 < \iota < 0.58$?
- Configurations having different aspect ratios and number of field periods.