Island Fixing Explorations

NCSX Project Meeting

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Island Fixing Explorations
Problem separated in two groups

- Repair Islands introduced by less than perfect coil set designed to match a fixed boundary plasma with good surfaces
  - Repaired plasma should retain good physics properties of initial plasma
- Grow a plasma (i.e. increase volume or number of good surfaces) generated by a coil set design to match a fixed boundary with inherently poor interior surfaces (i.e. c82)
  - By definition, a different plasma is formed with no control over properties

Methods being Explored

- Adjust currents in existing coil design (saddles, pf) to target resonance
  - Using existing Curropt code for current optimization which minimizes total field error
  - Develop a new code (or modify an existing one) to target field error Bmn-s directly, appropriately weighting resonant harmonics
- Design Trim Coils to target a specific radial field harmonic on the surface which it is resonant (i.e. where islands have formed)
  - Using existing suite of coils design tools (NESCOIL, etc)

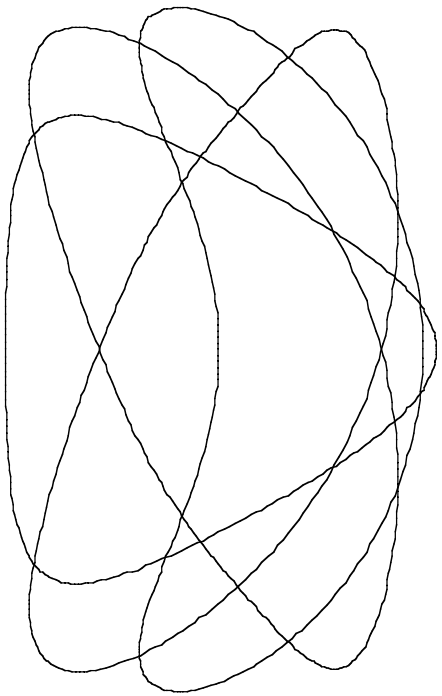
Methods being Explored, cont'd

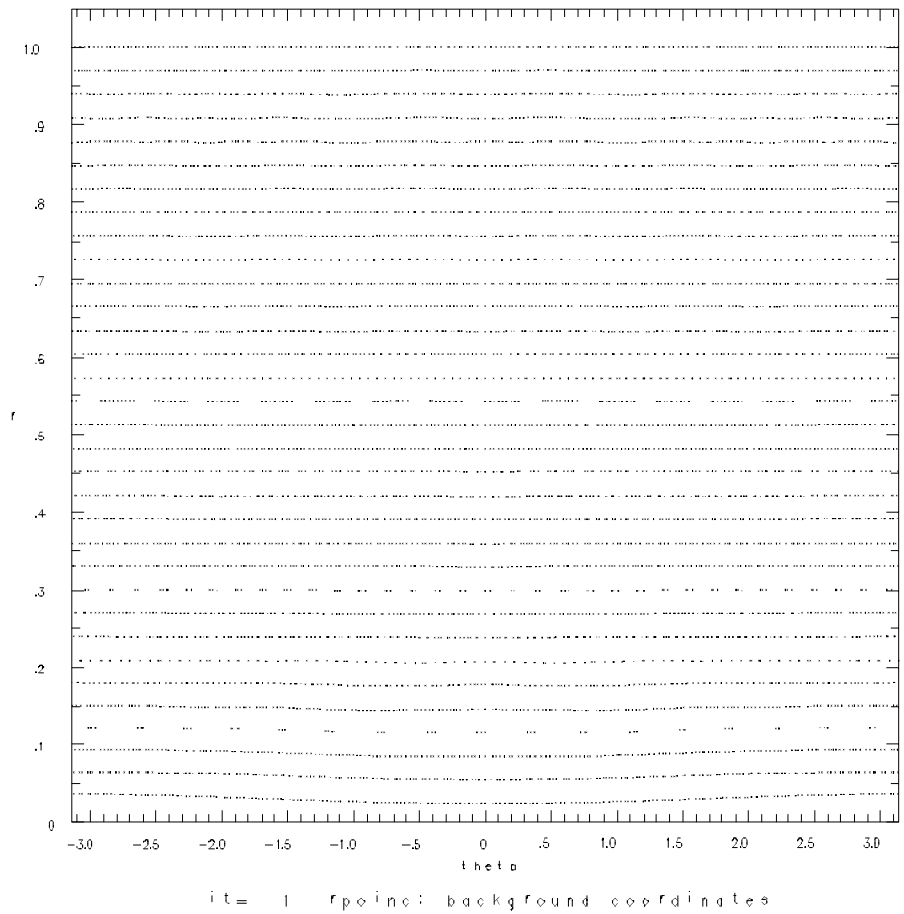
- For each method,
  - Use PIES to do the field line tracing and transform calculation
  - Extract the last closed flux surface (in straight line coordinates) to use as target surface (from PIES or VMEC if appropriate)
  - Apply method to suppress resonant harmonics in the error field on the target surface
- Process would be applicable for both Vacuum and Full Beta Plasmas

Early Failure

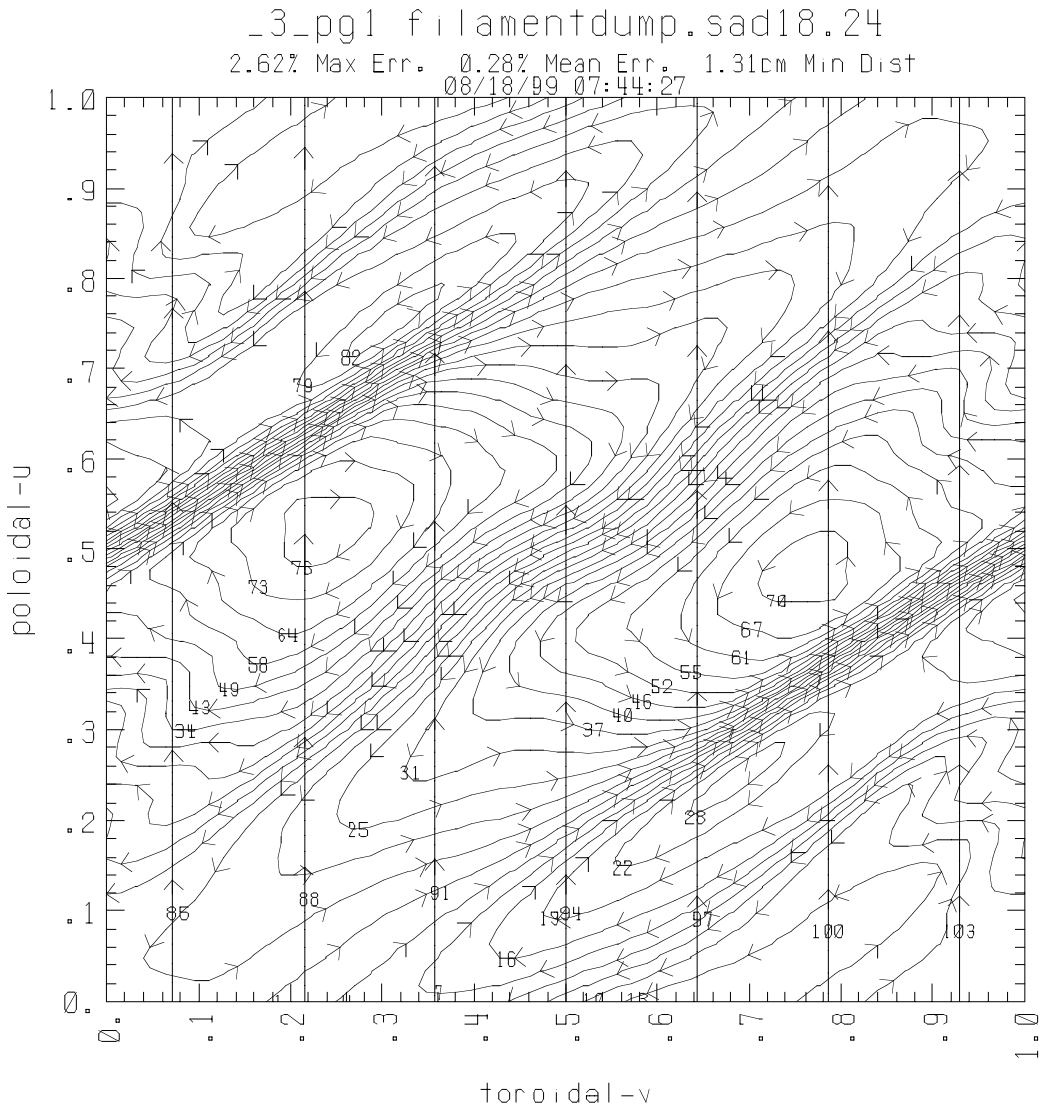
- Initial explorations for c82 not sucessful
  - Tried to grow c82 vacuum surfaces
  - Not enough independent flexibility found in existing coils (ie c82 reference configuration d121.16) to target resonant harmonics alone without significantly impacting other terms.
- Since c82 fixed boundary has poor surfaces in vacuum, a test case plasma was used for method verification.
  - PG1 (Paul Garabedian), obtained from Long-Poe, was optimized for vacuum and the fixed boundary PIES solution shows very good surfaces throughout the plasma volume.

Test Plasma PG1 with Good Vacuum Fixed Boundary Surfaces

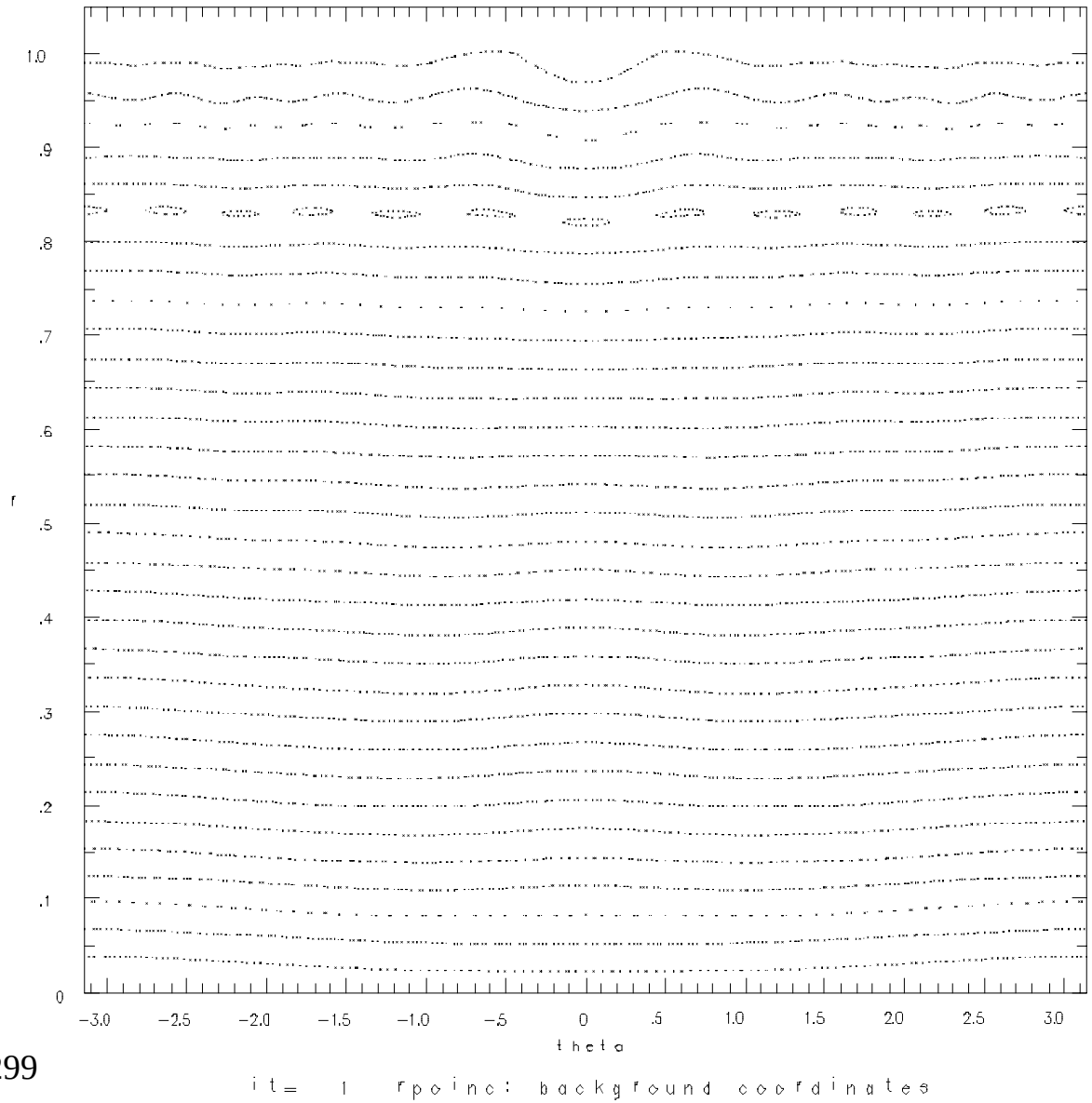




Coil Set Used to Explore PG1

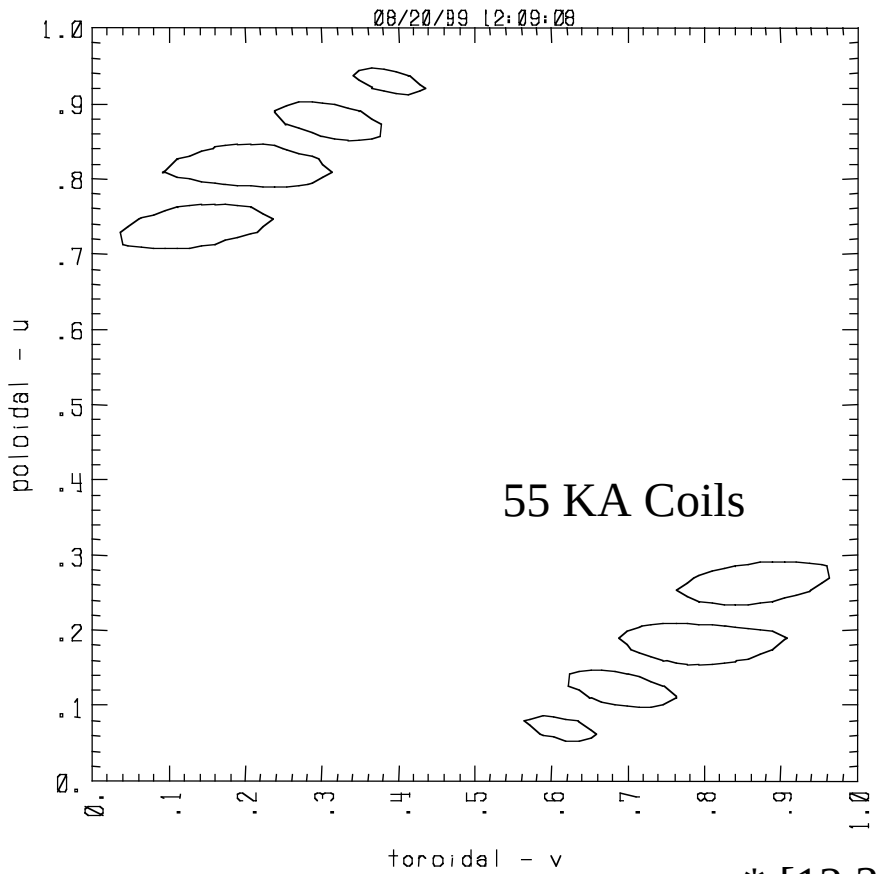


Pies Surfaces with initial coil set



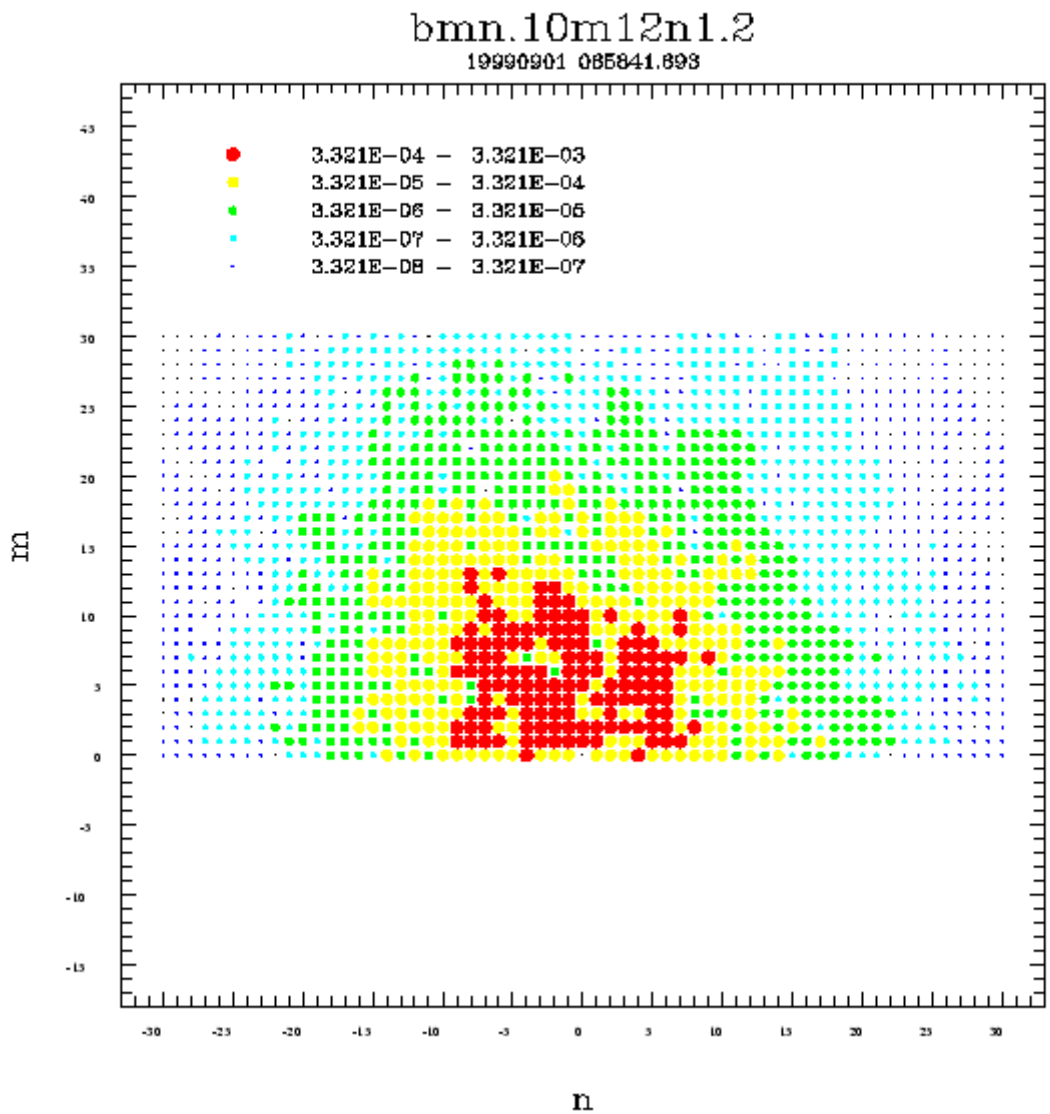
[12,3] Island at iota=.25

Trim Coils Generated to target [12,3]* mode on iota=.25 surface



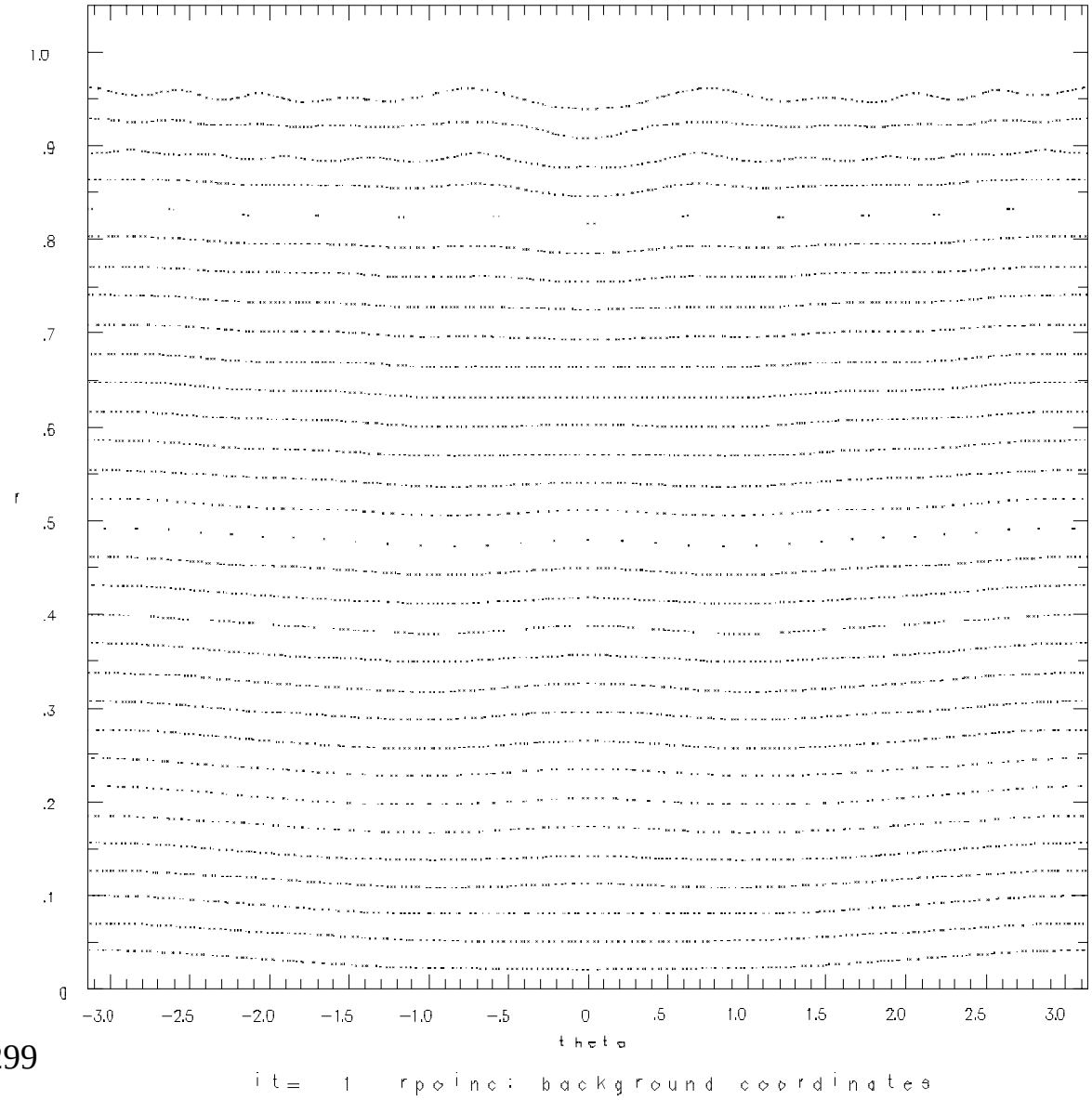
* [12,3] is NESCOIL's [12,-1]

Harmonic content of trim coils



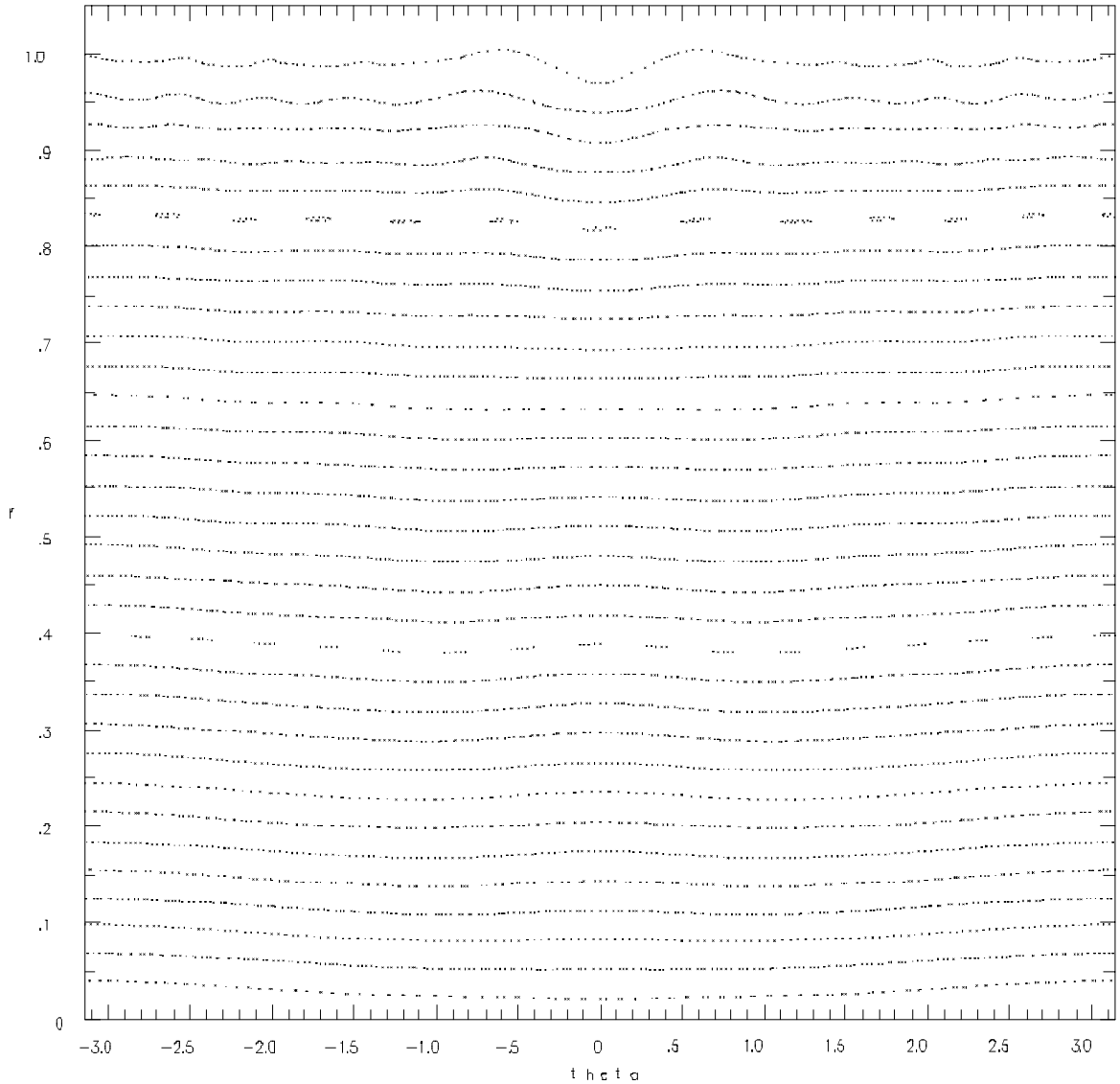
Targeted [12,-1]
Mode = 2.65e-4

Surfaces with trim coils targeting [12,3] mode

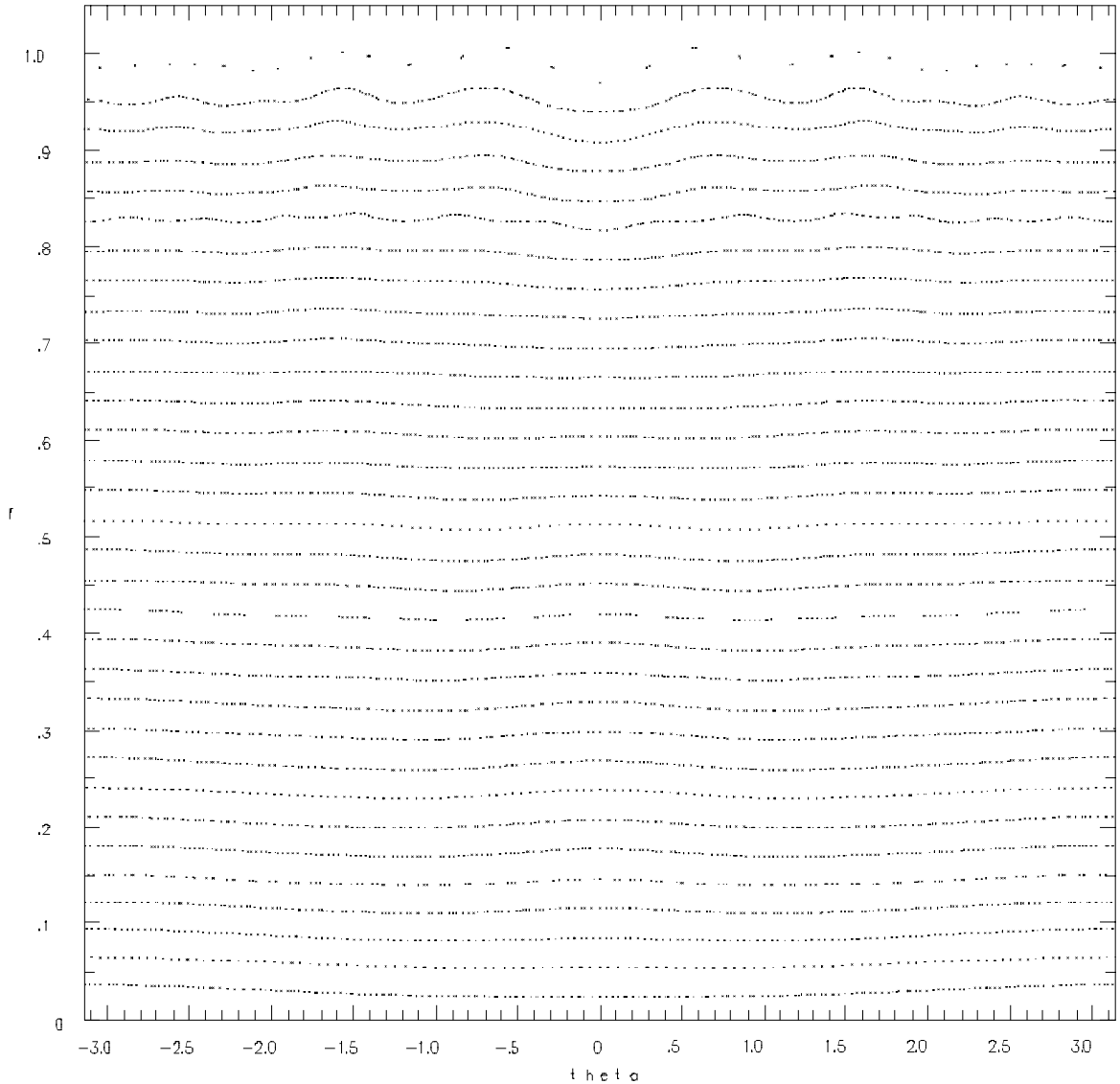


[12,3] Island at iota=.25 suppressed

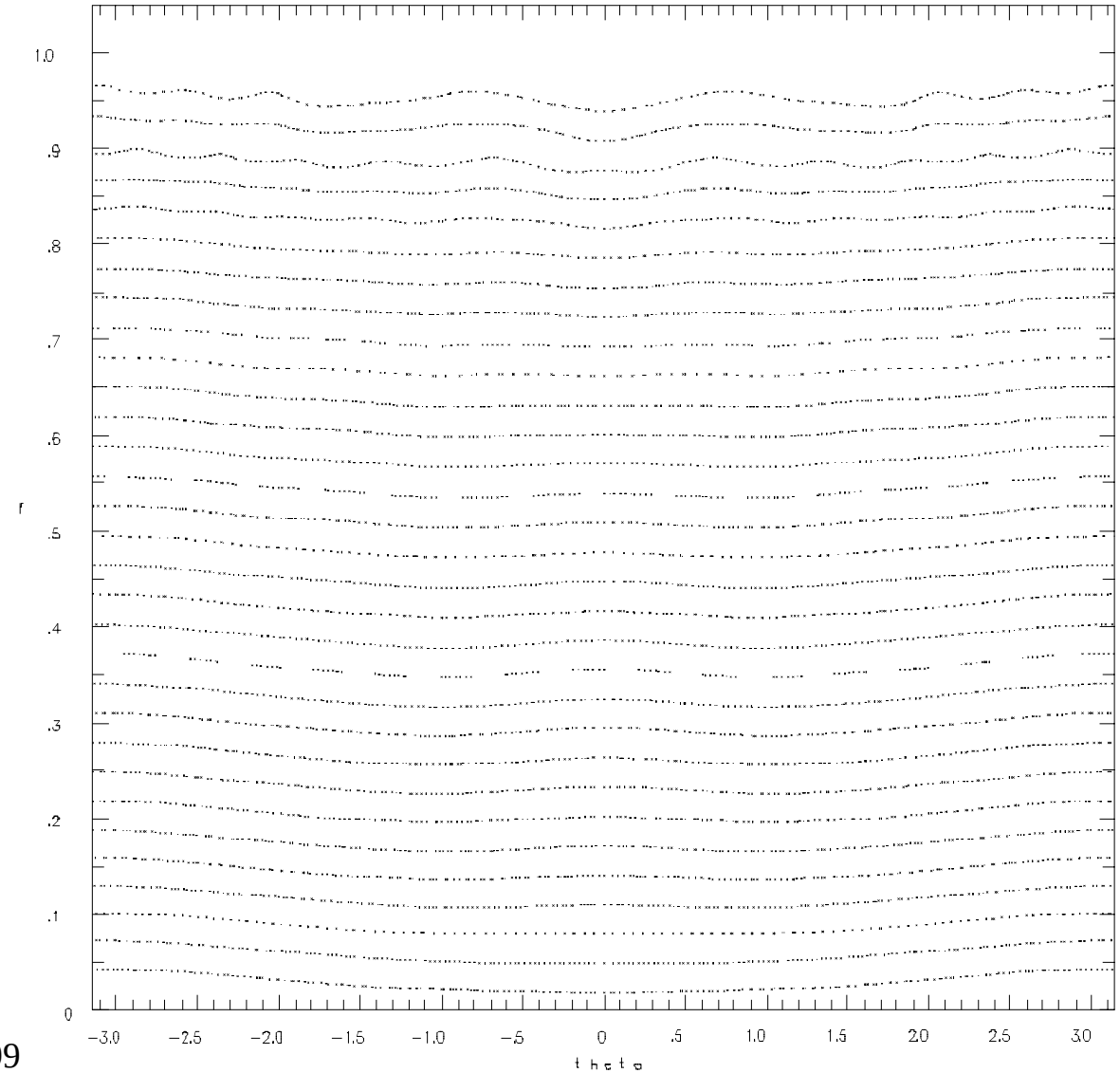
Trims coils with half current
[12,3] Islands only partially suppressed



Trims coils with reverse current
(PIES resolution not sufficient to capture Island)



Trims coils with current doubled
[12,3] Islands over compensated (Phase change)



[12,3] Island
Phase change
O-points
are now
X-points

(look real close)

Summary

- Resonance Suppression Demonstrated in at least one case (trim coils on PG1) to successfully control Islands. May not be practical for fixing large numbers of surfaces over a range of iota profiles
- Adjusting currents in existing design coils was not successful do lack of independent flexibility in controlling harmonics. Have not yet tried weighing important harmonics while targeting Bmn directly.
- Solution will probably require both approaches