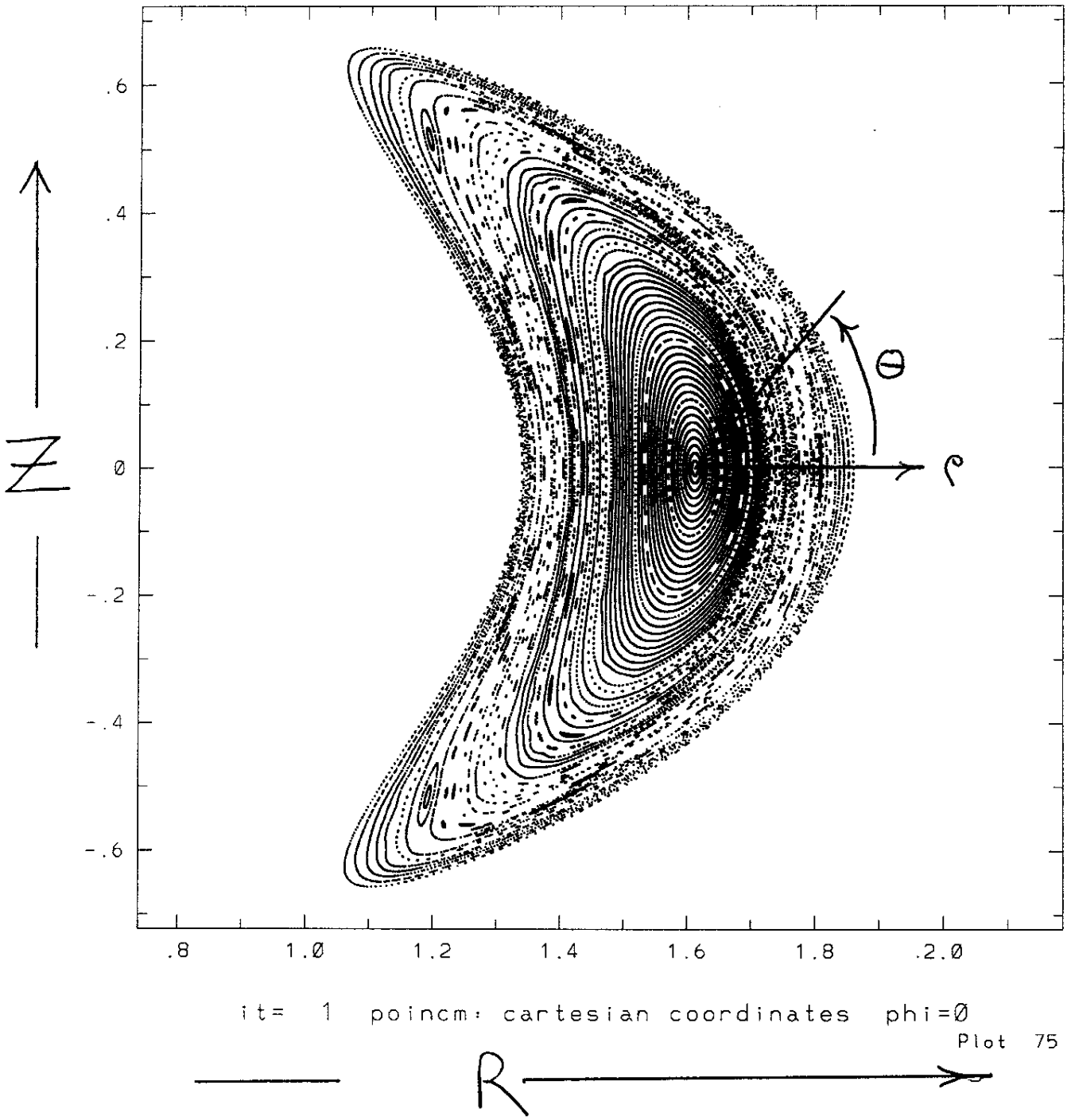
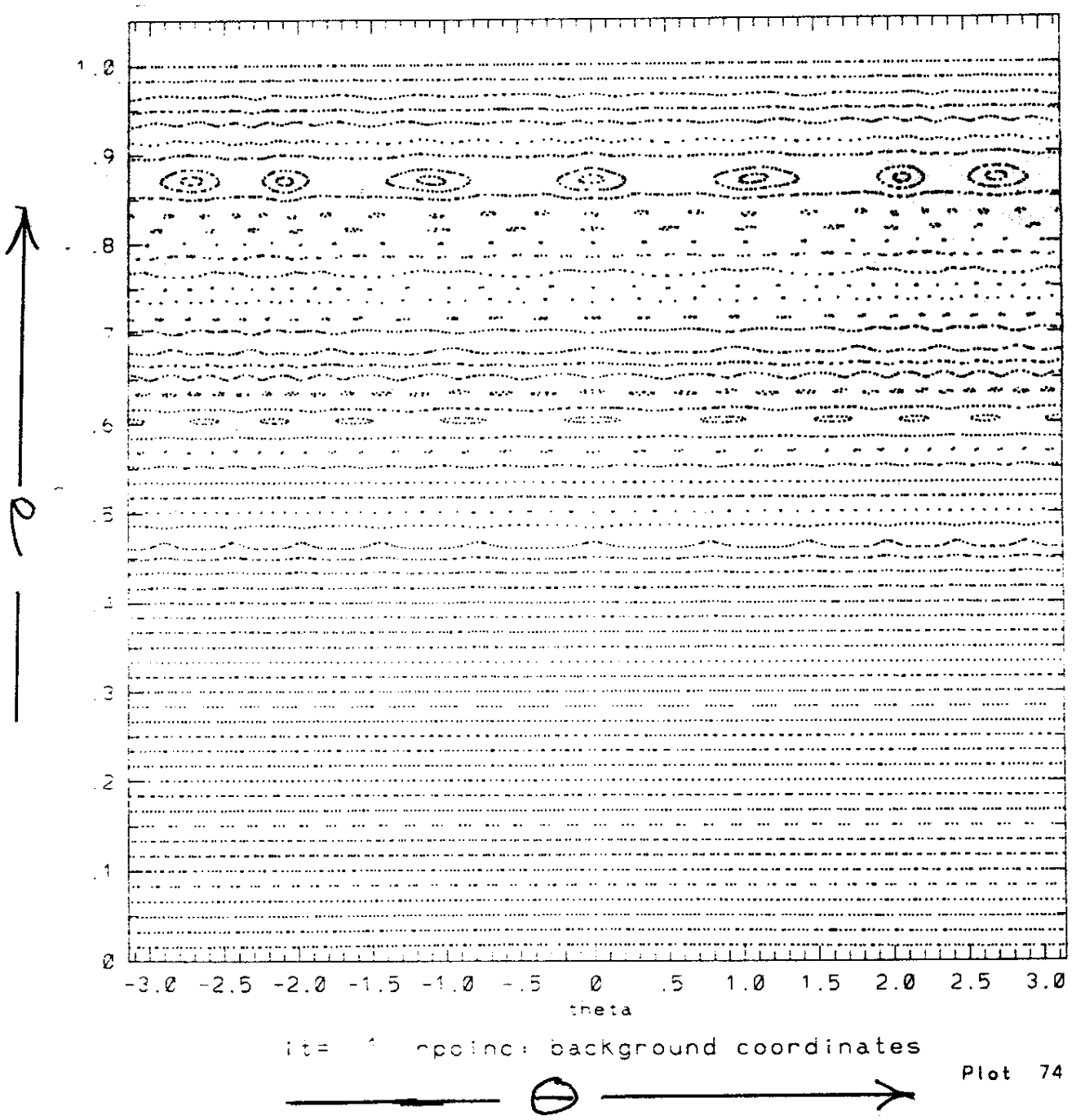
Equilibrium Quality/PIES

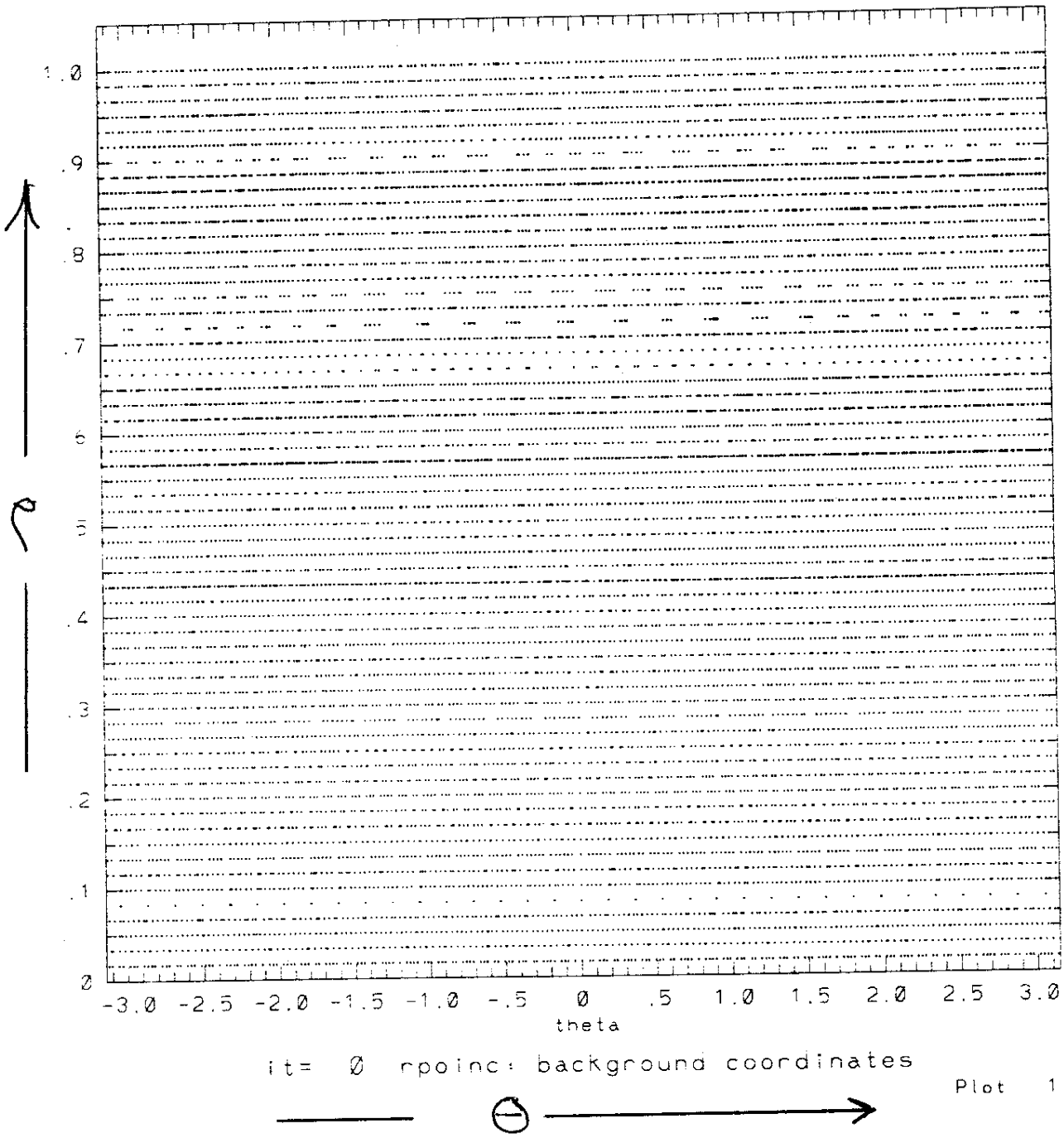
Don Monticello, Allan Reiman, and Neil Pomphrey

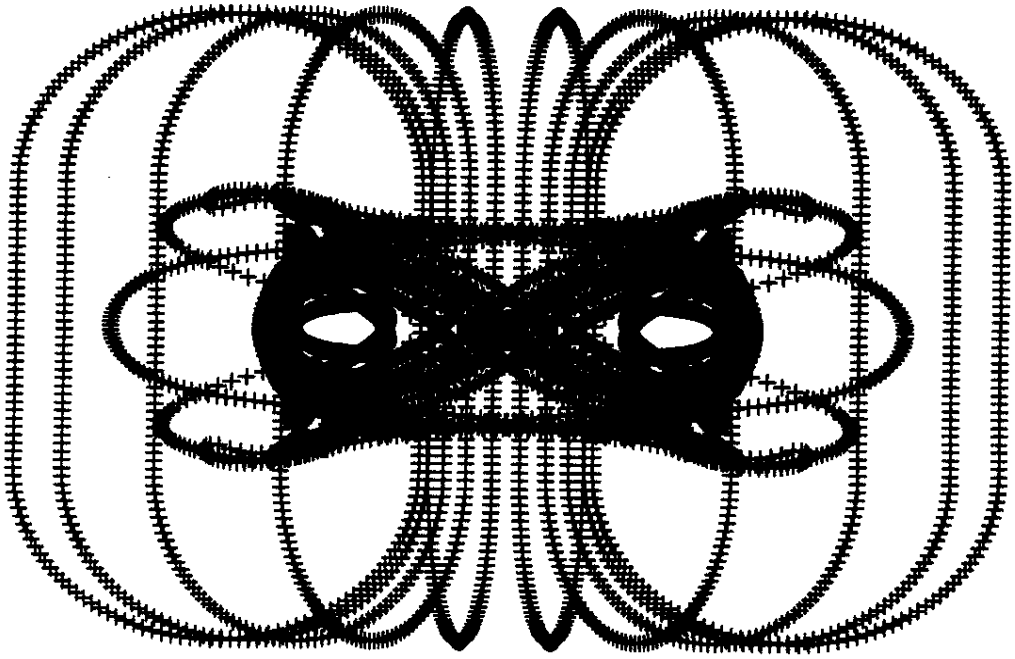
- **Outline**

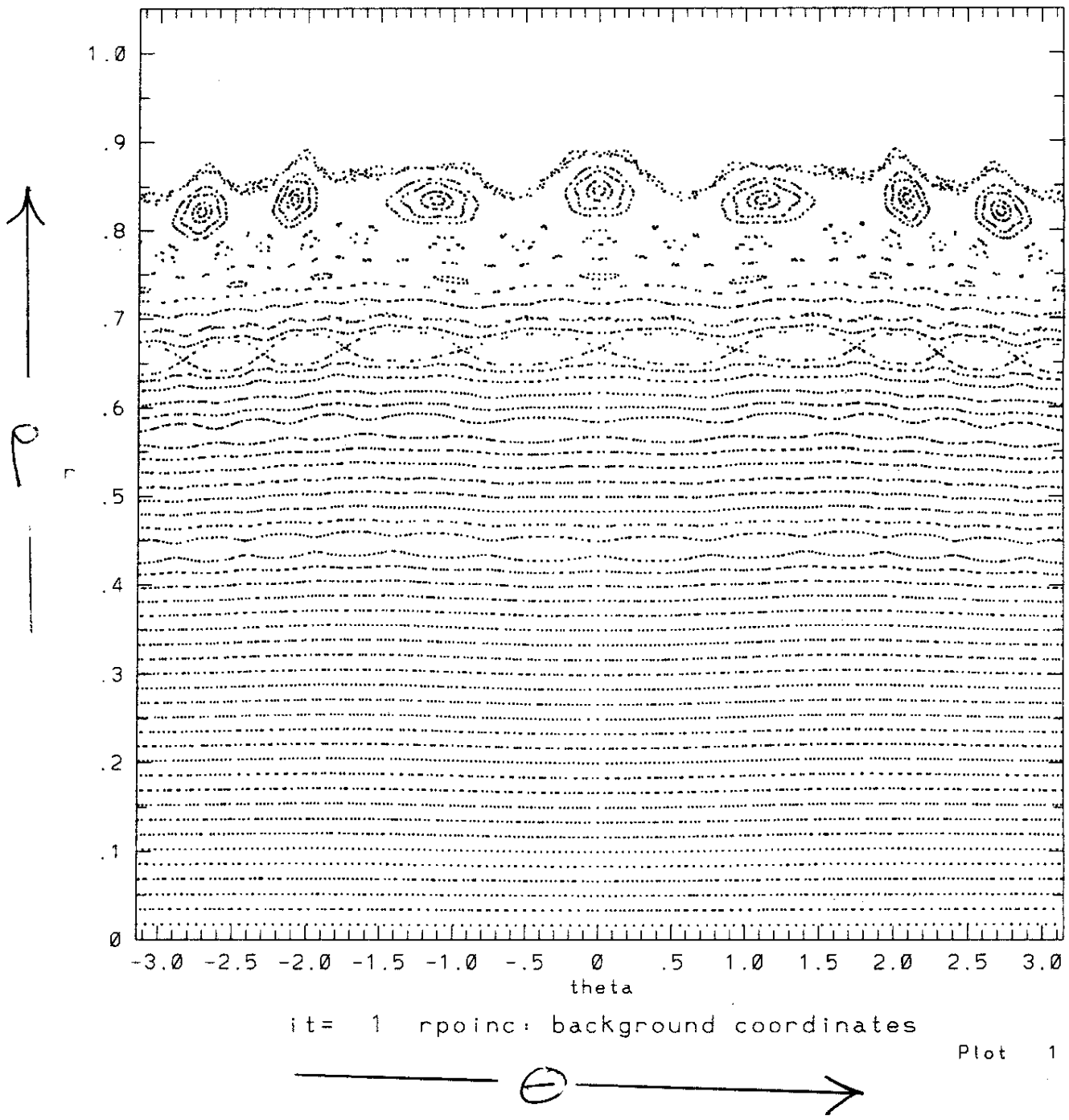
  - **Flux surface integrity problem - Inconsistency of VMEC solution**
  - **Results of using VMEC currents in PIES**
  - **Outline of a new coil design procedure**

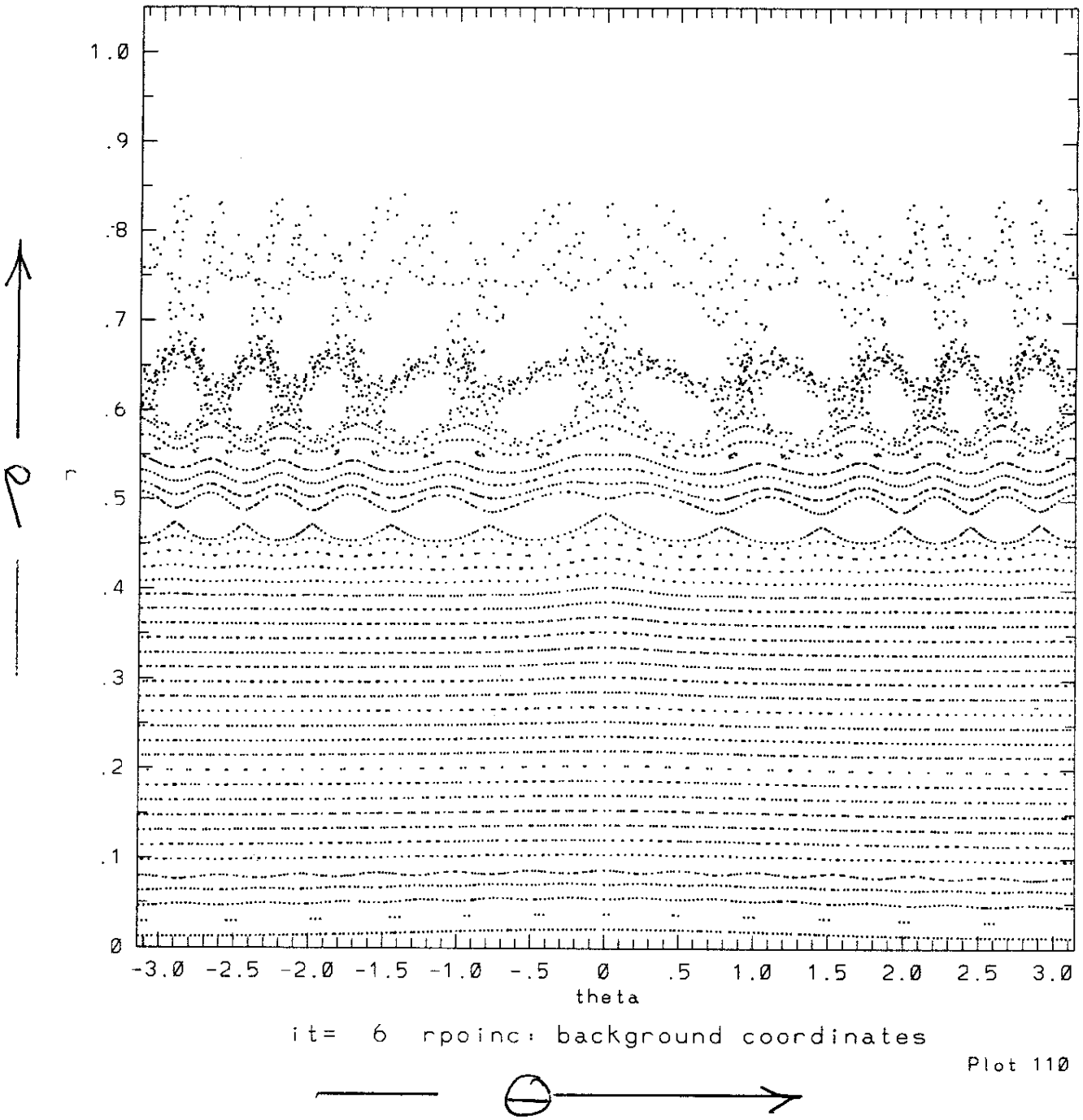

.6
.4
.2
0
-.2
-.4
-.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
Z
R
θ
ρ
it= 1 poincm: cartesian coordinates phi=0
Plot 75


1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
-3.0 -2.5 -2.0 -1.5 -1.0 -.5 0 .5 1.0 1.5 2.0 2.5 3.0
theta
it= 1 rpcinc: background coordinates
Plot 74


1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
-3.0 -2.5 -2.0 -1.5 -1.0 -.5 0 .5 1.0 1.5 2.0 2.5 3.0
theta
it= 0 rpoinc: background coordinates
Plot 1




1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
r
-3.0 -2.5 -2.0 -1.5 -1.0 -.5 0 .5 1.0 1.5 2.0 2.5 3.0
theta
it= 1 rpoinc: background coordinates
Plot 1
ρ
θ


1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
r
-3.0 -2.5 -2.0 -1.5 -1.0 -.5 0 .5 1.0 1.5 2.0 2.5 3.0
theta
it= 6 rpoinc: background coordinates
Plot 110

- **Outline of coil design procedure**

The present method to select coil currents uses

$B \cdot \hat{n}(\rho = 1)_{m,n} = M_{m,n,k} I_k + B_p \cdot \hat{n}(\rho = 1)_{m,n}$

here,

I_k **is the current in the** k_{th} **coil and** $B_p \cdot \hat{n}$ **is the normal component of the field due to plasma current and is calculated from VMEC output by a code provided by Peter Merkel.**

We determine the coil currents,

I_k**, by minimizing**

$\sum_{m,n} [B \cdot \hat{n}(\rho = 1)_{m,n}]^2$

using SVD techniques.

We propose the following modification to effect a Cary-Hanson like minimization of islands

Choose coil currents, I_k, by minimizing

$$\sum_{m,n} [B \cdot \hat{n}(\rho = 1)_{m,n} \omega_{m,n}]^2 +$$

$$\sum_i [(\frac{B \cdot \nabla \rho}{B \cdot \nabla \phi}(\rho = \rho_i))_{m(i),n(i)} \omega_{m(i),n(i)}]^2$$

Where i is an index targeting a particular surface, ρ_i, and Fourier modes, $m(i), n(i)$. $\omega_{m,n}$ is a weight function.

The calculation of the part of the field,

$$B \cdot \hat{n}(\rho = \rho_i)_{m(i),n(i)}$$

that is due to the plasma currents is to be calculated by the PIES code.

Bootstrap Current

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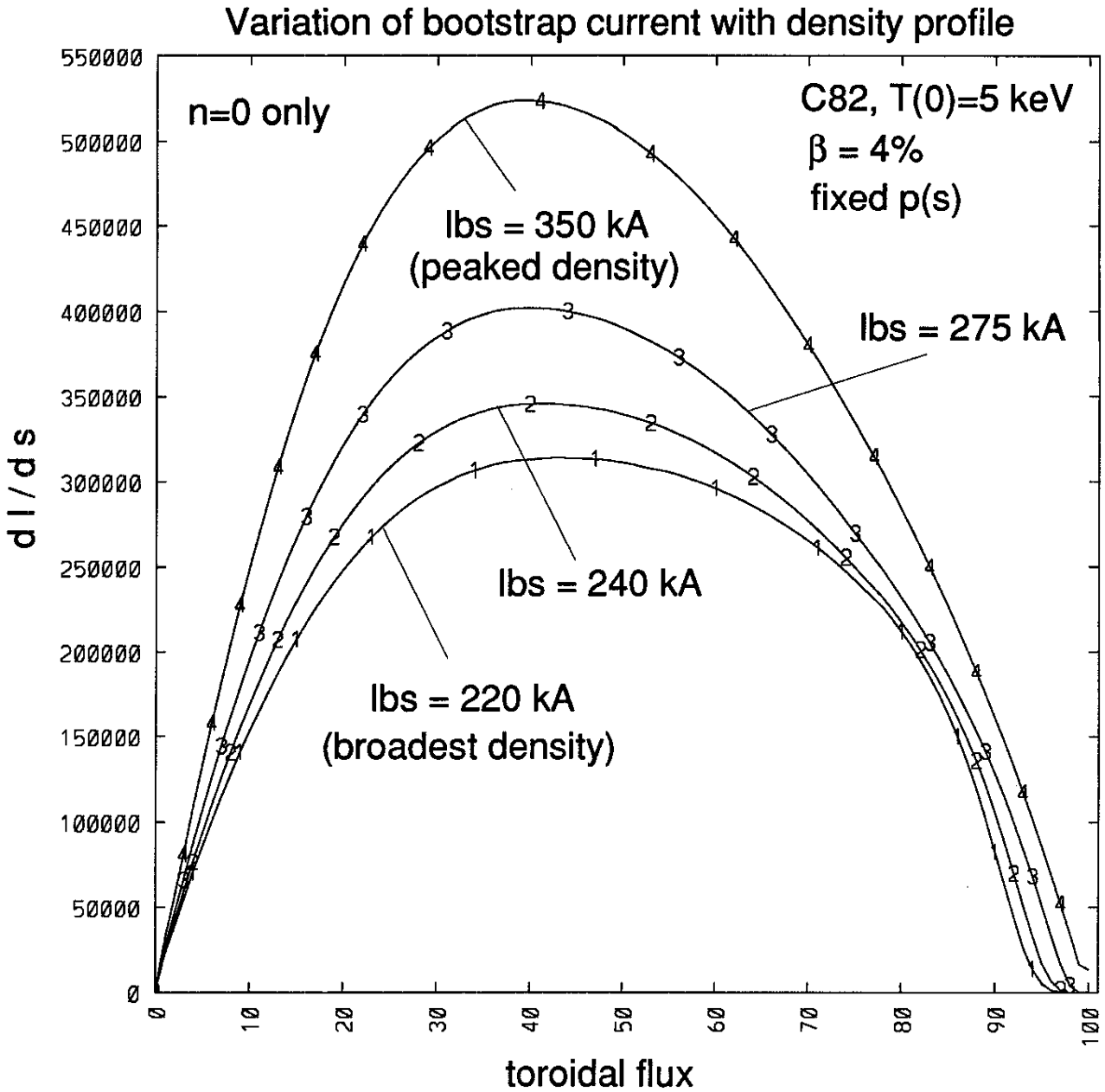
Allan Reiman, Don Spong, Roscoe White,
and Mike Zarnstorff

- Outline

  - Update of Benchmarking of Bootstrap Codes
    - QOS
  - Density profile control of bootstrap current for C82
  - Status and plans


Variation of bootstrap current with density profile
n=0 only
C82, T(0)=5 keV
β = 4%
fixed p(s)
Ibs = 350 kA
(peaked density)
Ibs = 275 kA
Ibs = 240 kA
Ibs = 220 kA
(broadest density)
d I / d s
toroidal flux
550000
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
80
90
100