ENERGETIC PARTICLE TRANSPORT CALCULATIONS FOR NCSX CONFIGURATION QAS3C10 UPDATE

M. H. Redi
Stellarator Group Meeting
January 28, 1999

OUTLINE

1) Single particle orbits, no pitch angle scattering

2) Effect of hydrogen and B scaling

3) Increase R=1.45 to 1.61, change of injection angle

4) Poloidal distribution of lost ions

1) Single Particle Orbit Loss

* Simulated individual ions
  which had left plasma from $\nu_{\perp}=0$ ensemble simulation

* Prompt loss appears due to orbit wobble and closeness of
  wall to initial ionization location

* Delayed $\nu_{\perp}=0$ stochastic loss of passing beam ions

  - occurs for example, after 260,00 time steps at $\sim\tau_E/3$

  - occurs only when energy slowing down is included
    with and without pitch angle scattering

  - independent of timestep size (check Δt=>1/10 Δt)

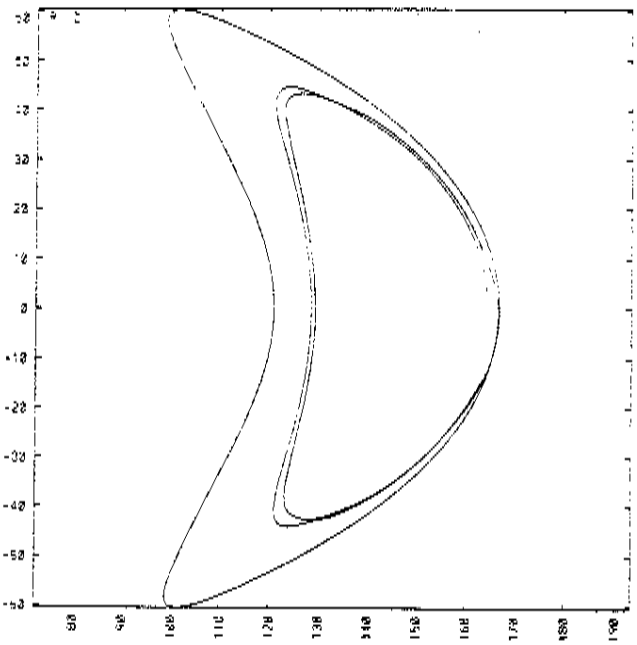
  - ν_{ε} =0, particle does not leave in 400,000 timestps

  - single particle orbits shown
    are projected onto flux surfaces at ϕ=0

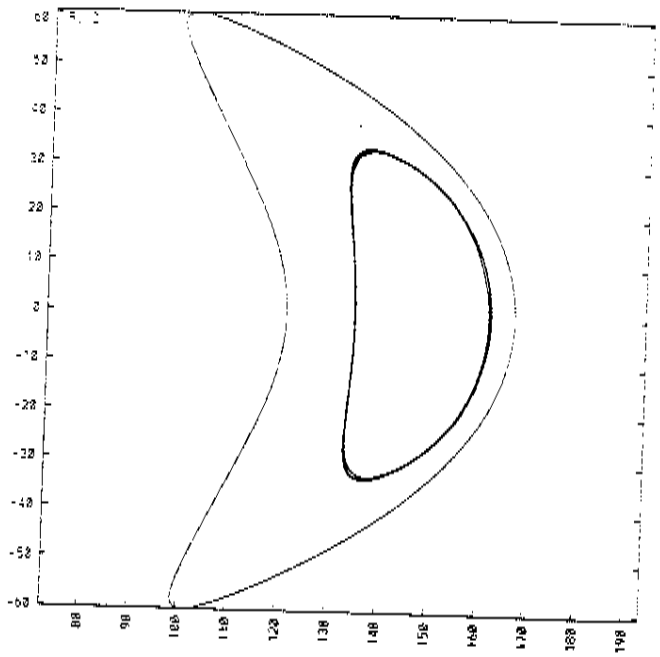
  - 3-space orbits also interesting

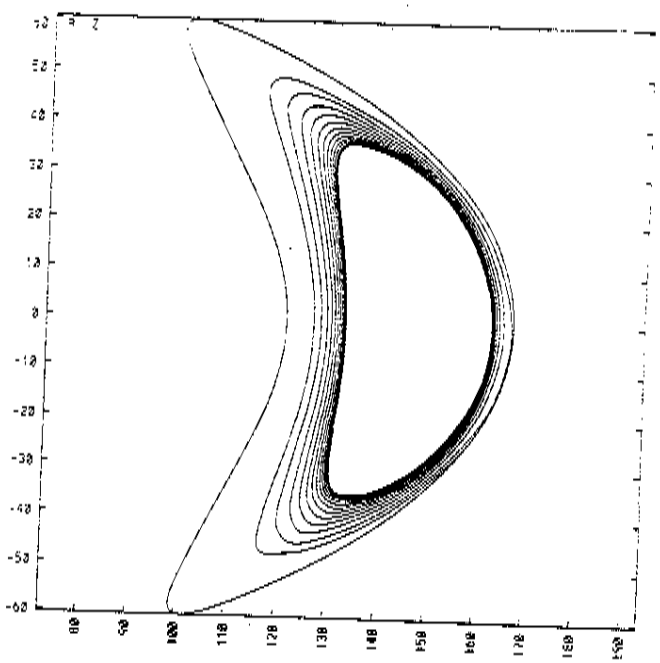
  - Passing ion stochastic loss
    H. E. Mynick, Phys. Plas. **5**, 1471 (1993).
    and Phys. Plas. **5**, 2460 (1993).

• PROMPT LOSS BEAM ION; ORBIT WOBBLE

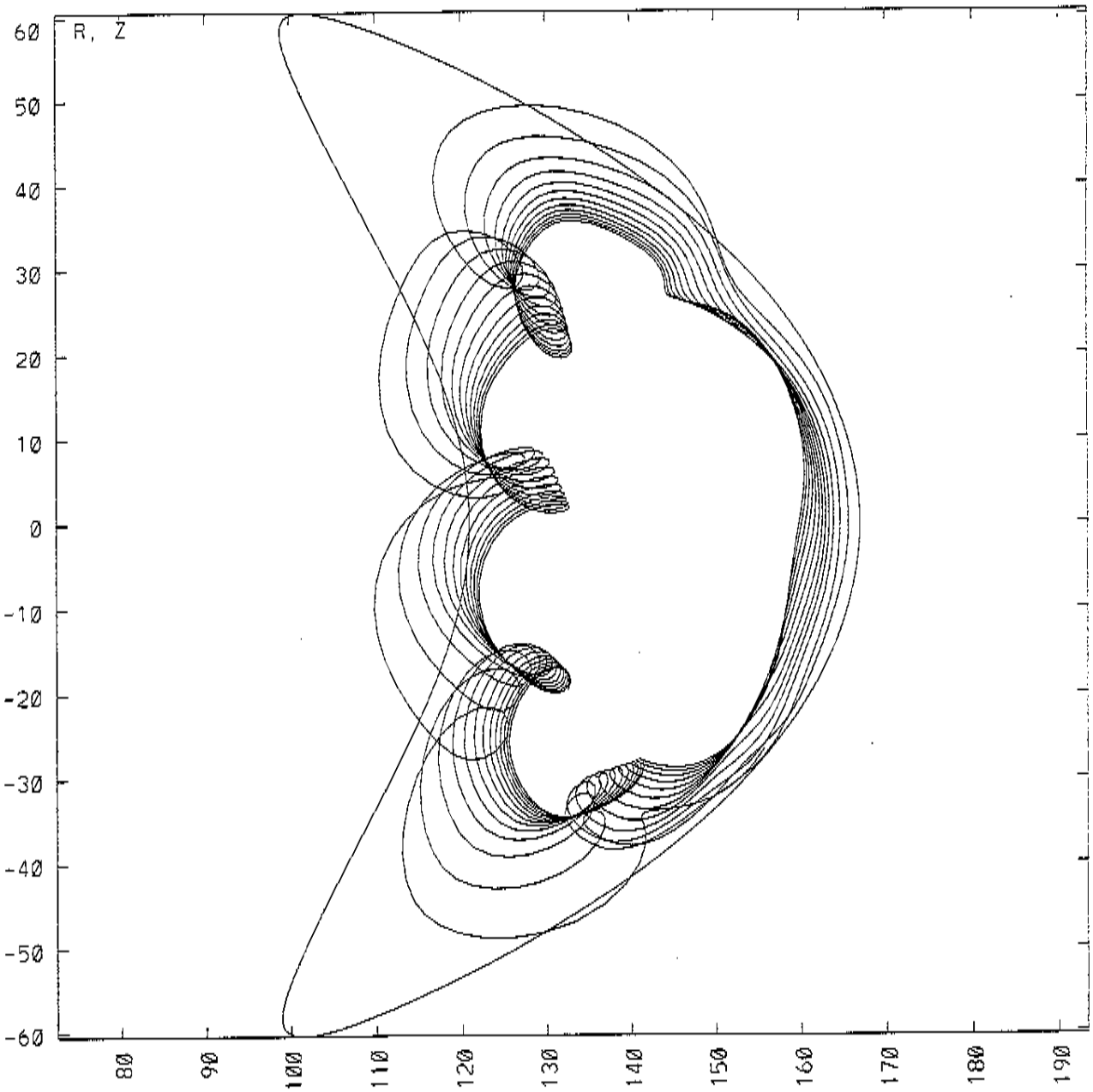


• DELAYED STOCHASTIC LOSS OF PASSING BEAM ION
- FIRST 9000 TS
- at 250,000 begins to exit plasma.
- 260,000 TO 268,000 TS



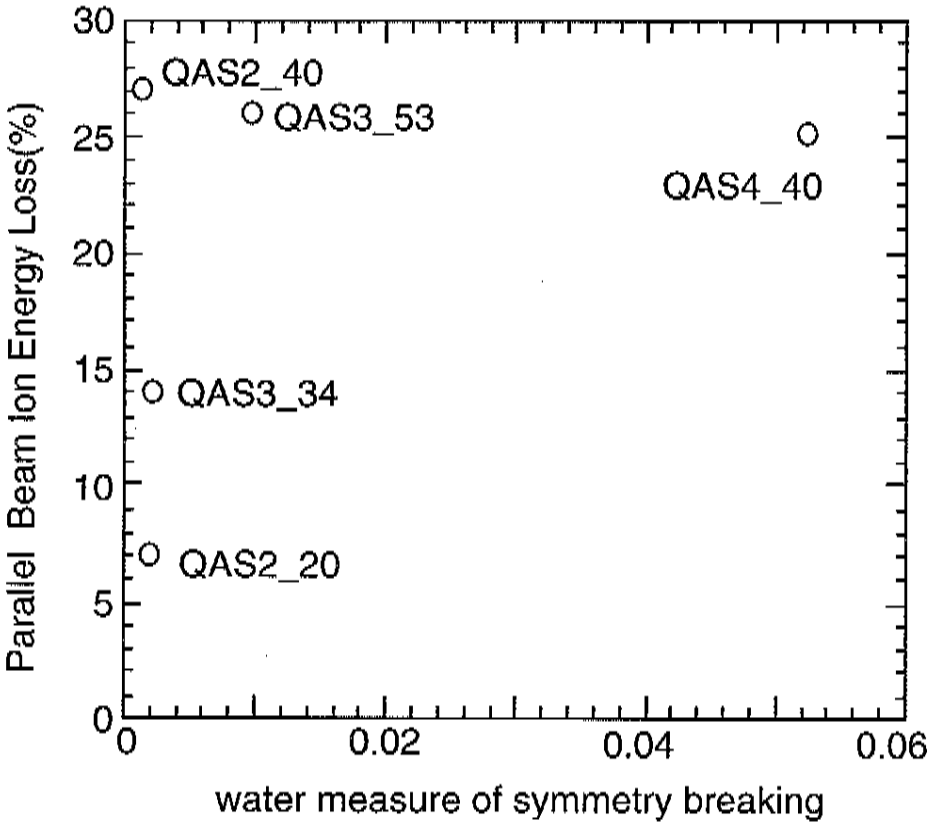


the [same passing ion's] Stochastic transport in 3-space
260,000 to 268,000 TS



- Delayed loss not due to ripple wells.
  Water measure will not diagnose it.

  - Isaev Water has shown no correlation
    with beam ion loss from several qas designs



3) HYDROGEN BEAMS, B SCALING

Loss in τ_{sl} with $\nu_{\perp}(0) = \nu_{\varepsilon}$= 35/sec,

	Prompt loss	Energy Loss	Particle Loss
D beams, 1 T	7	41	65
D beams, 1.4 T		39	
D beams, 4 T	4	21	35
H beams, 1 T	9	29	39

- Threshold phenomenon,
  e.g. Goldston, White Boozer ripple criterion:
  $\delta \sim 1/\rho$, $\rho \sim m^{0.5}/B$

- If ν_{ε}=0 delayed losses are suppressed.

3) INCREASE RAXIS=1.45 TO 1.61,

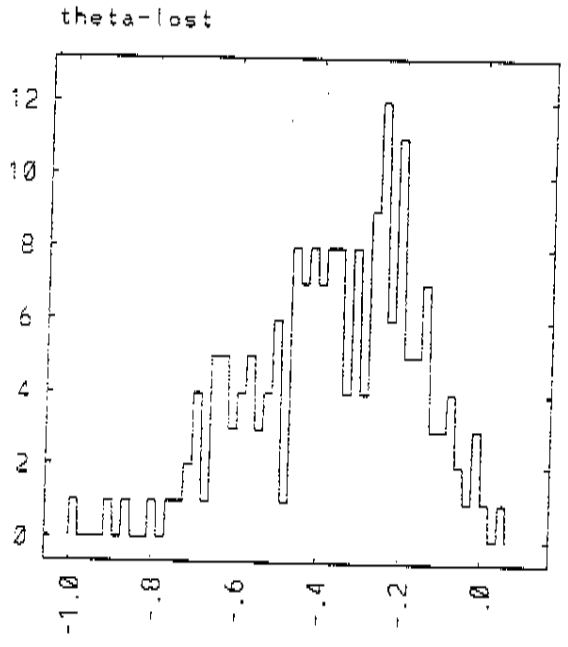
- Energy loss increases from 41% to 47% in τ_E

- Change injection angle:
  If change tangency radius of beam
  from R= 130 cm to R=161 cm

  Loss decreases to 39% in τ_E

4)

LOST BEAM ION POLOIDAL DISTRIBUTION



-1. RADIANS 0

- distribution crossing last closed flux surface
- Peaked below midplane within 60°

Poloidal distribution @ last closed flux surface for beam ions at low current on TFTR

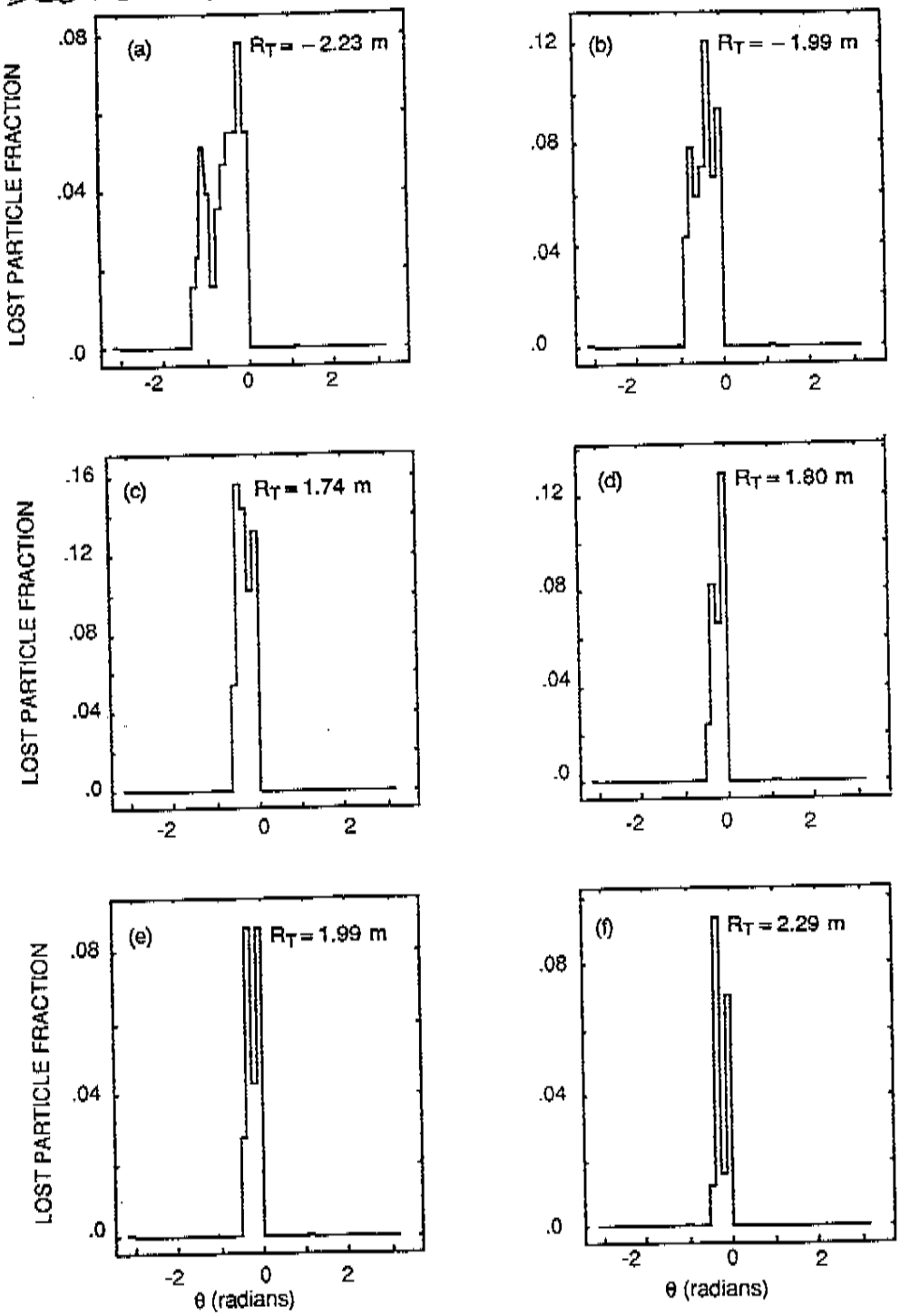


FIG. 6. Poloidal distributions of neutral beam ion loss fractions over $\tau_s^{nb}/2$ at 0.9 MA, 2.6 m for different values of R_T: (a) −2.23 m, (b) −1.99 m, (c) −1.74 m, (d) 1.80 m, (e) 1.99 m and (f) 2.29 m for poloidal angle in units of radians.

Rodrigues et al

SUMMARY

1) Loss with no pitch angle scattering:
   - prompt loss, stochastic passing orbits
   - collisional loss not correlated with Water, "ripple wells"

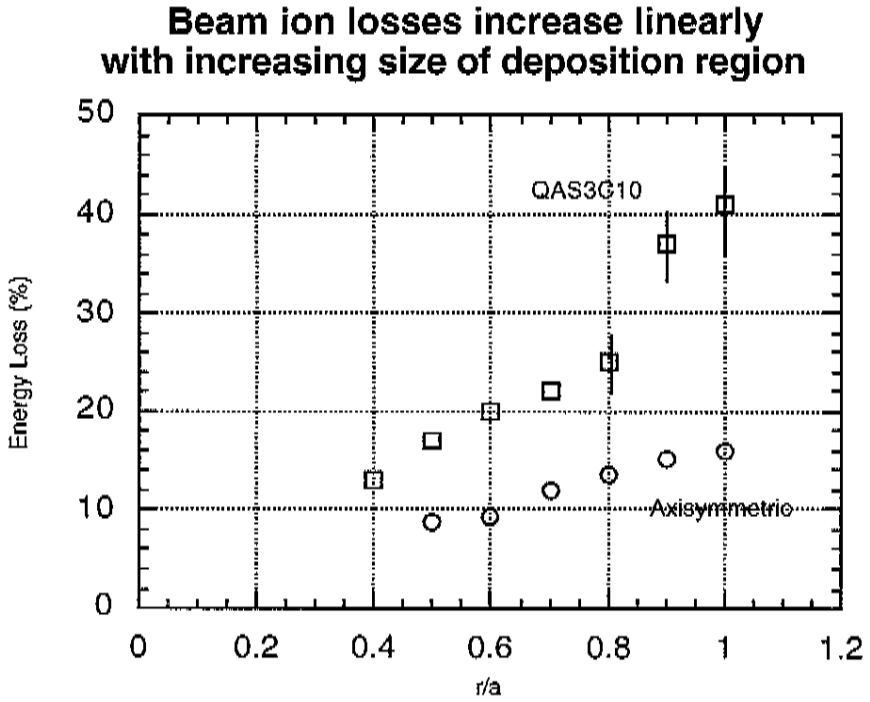
2) Reduced losses with hydrogen and with increased B
   - Not understood, does not scale with ρ

4) Increase R=1.45 to 1.61, change of injection angle, makes only small change in loss fraction

5) Poloidal distribution of lost beam ions at last closed flux surface
   - peaked below the midplane, within 60°
   - similar to predicted loss pattern for TFTR beam ions

CORRECTION:

Horizontal axis of deposition profile truncation losses shown last week was r/a, not edge normalized toroidal flux.



DRAFT postscript manuscript in /u/ftp/pub/redi/

Comments by 2/7/99