ENERGETIC PARTICLE TRANSPORT CALCULATIONS FOR NCSX CONFIGURATION QAS3C10 UPDATE

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Stellarator Group Meeting
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OUTLINE

1) Effect of hydrogen and B scaling

2) New equilibrium, R= 1.61

3) Pitch distribution of lost ions

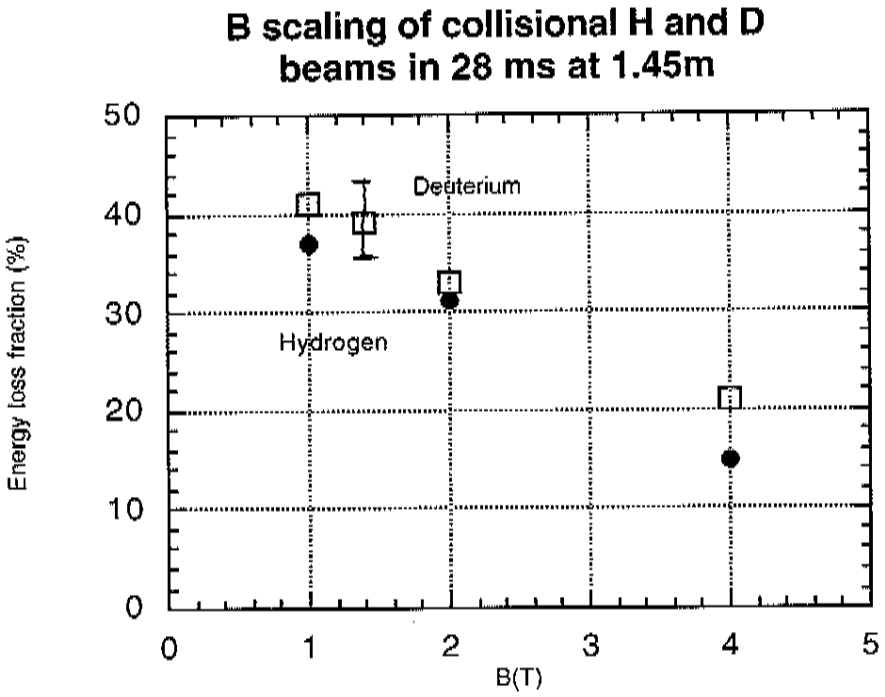
1) Effect of hydrogen and B scaling

- Correction: D/H scaling results from 1/28/99 were not for losses over same time interval

- Find $m^{0.5}/B$ scaling of collisional losses (include pitch angle scattering)

Strong B scaling,
little difference between H and D

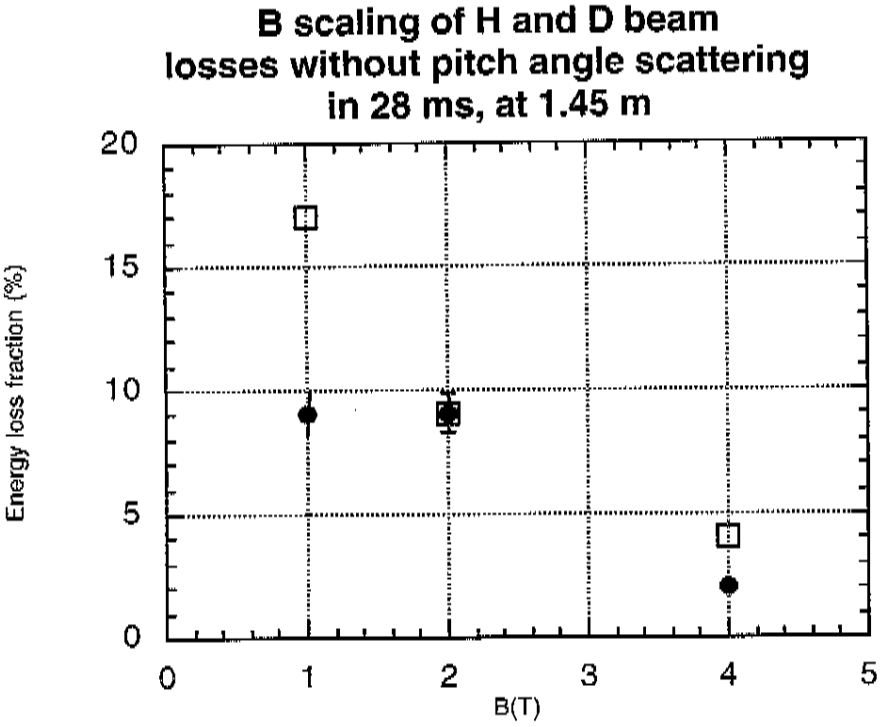
28 ms = τ_{SL} for D



Redi 2a

Simulations without pitch angle scattering also show strong B scaling

Collisionless losses at low field include delayed stochastic passing loss as well as prompt losses



$\rho_{//} \sim m^{0.5}/B$

Redi,2b

2) SIMULATIONS WITH RAXIS = 1.61M

*** Results are similar to those at 1.45 m**

*** Single particle orbits examined so far are very similar:**

- prompt : orbit wobble

- delayed, no pitch angle scattering:
  stochastic passing

* Correction:

Previous results for change of Raxis
were not for losses over same time interval

- Collisional energy loss: E lost = 44% in τ_{sl}

- with no pitch angle scattering E lost = 18%

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

  Energy loss = 36% in τ_{sl}

Redi,3

3) Exit times and pitch distributions of lost ions, R= 161cm

* Collisionless and prompt losses are passing, (Redi,4a) as expected since that is the injection pitch

* Collisional losses (Redi, 4b) show

  - Some spreading of stochastic passing ions, and a new population, twice as large, which is trapped.
  - Likely both banana drift and ripple well as the FWHM is ~.4 in pitch.
  - Time scale 5400 toroidal transits = 28msec, or one slowing down time

* Collisional losses plotted to show major radius at exit (Redi,4c)

  - Suggests that ripple trapped fraction is small, by analogy to tokamaks: R_exit < R_axis would be only ripple well trapped ions.

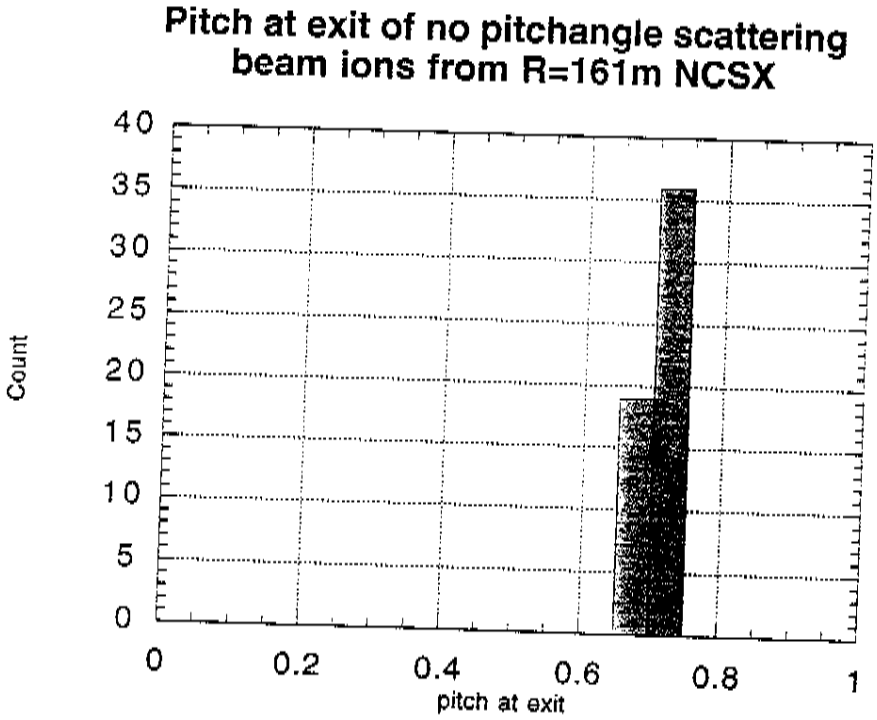
* If increase pitch of initial ions by 15% (Redi, 4d)

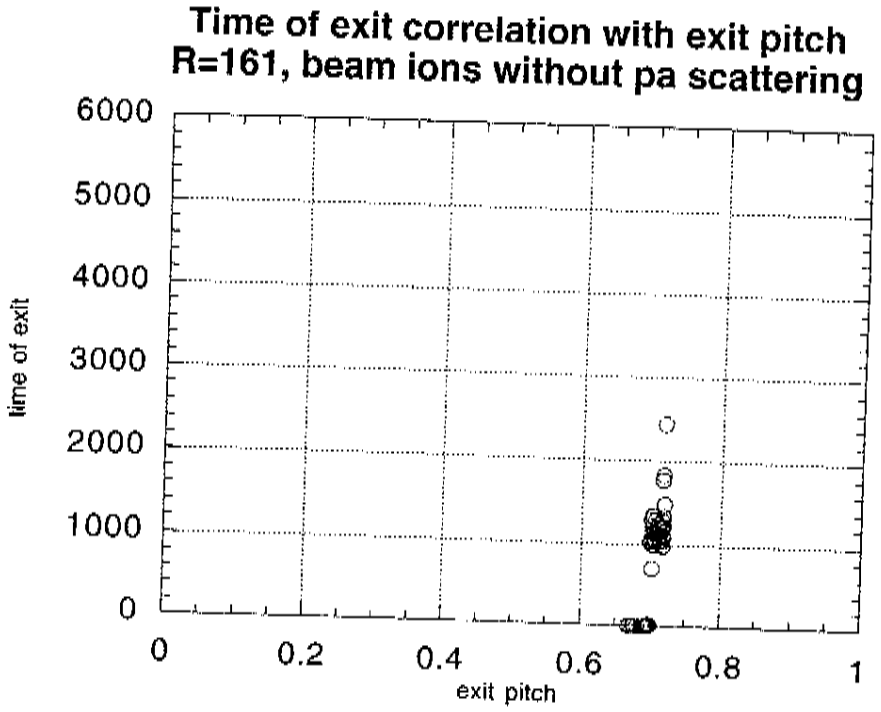
  - collisionless losses occur much more rapidly

* If launch beam ions with random pitches (Redi, 4e)

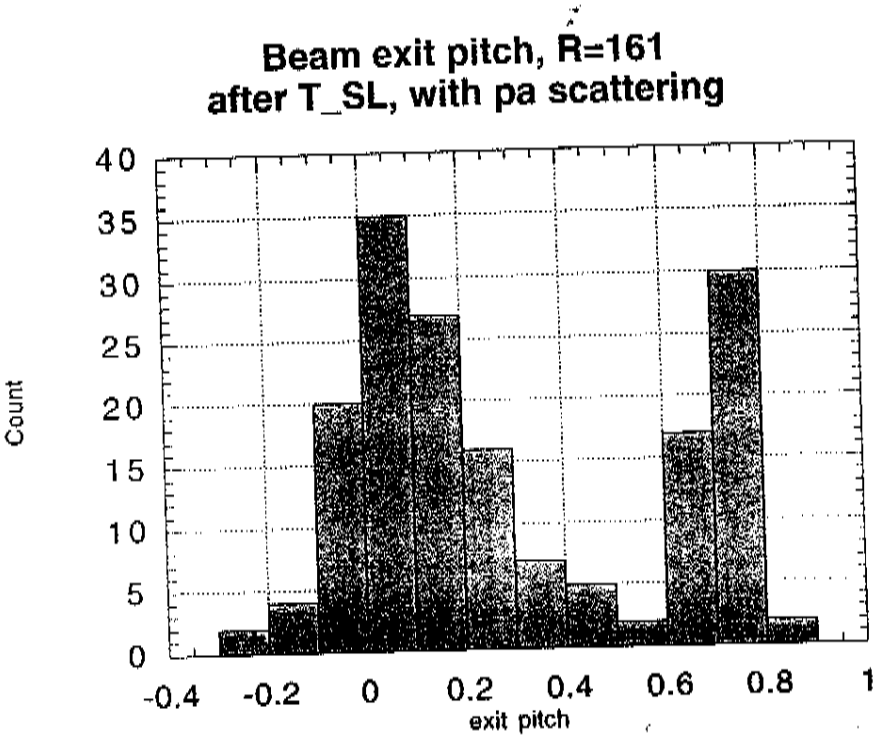
  - stochastic passing losses pitch 0.6-1.
  - prompt losses at all negative pitches
  - large trapped ion losses pitch -0.1-to 0.5 at later times.

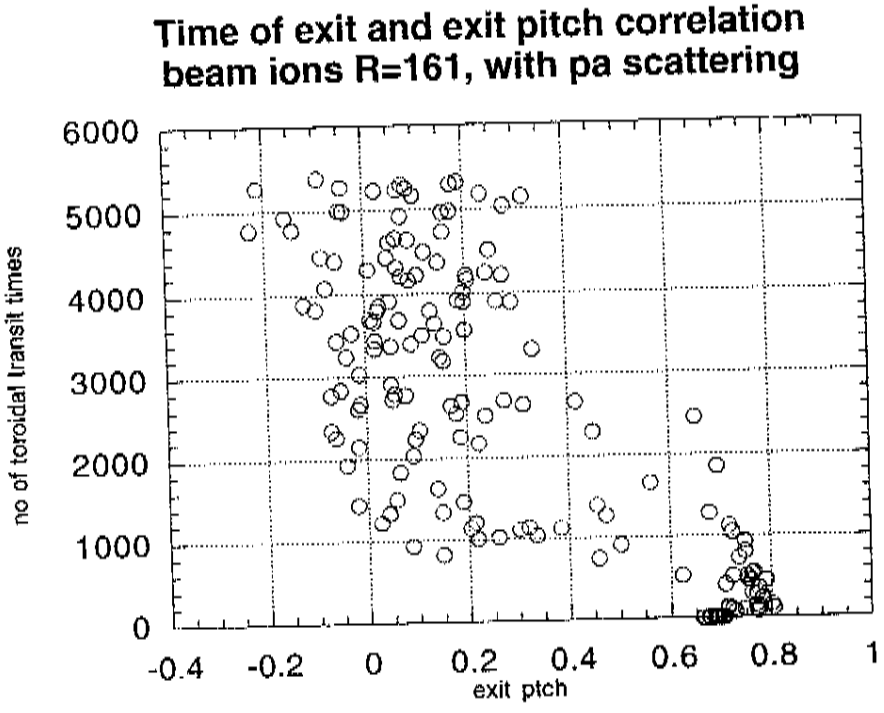
Redi, 4


Pitch at exit of no pitchangle scattering
beam ions from R=161m NCSX
Count
pitch at exit
0
5
10
15
20
25
30
35
40
0
0.2
0.4
0.6
0.8
1


Time of exit correlation with exit pitch
R=161, beam ions without pa scattering
time of exit
exit pitch
0
1000
2000
3000
4000
5000
6000
0
0.2
0.4
0.6
0.8
1

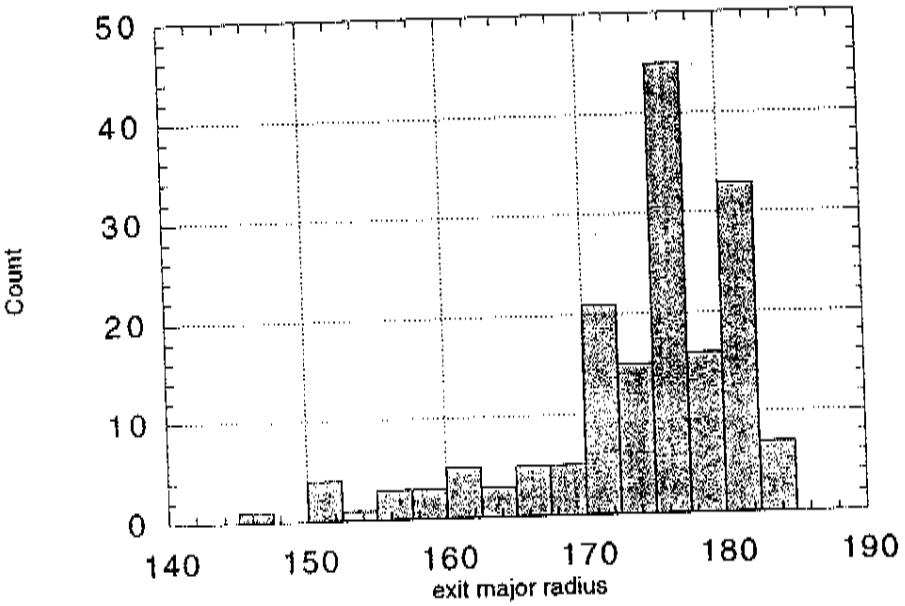
Redi 4a


Beam exit pitch, R=161
after T_SL, with pa scattering
Count
exit pitch
40
35
30
25
20
15
10
5
0
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1

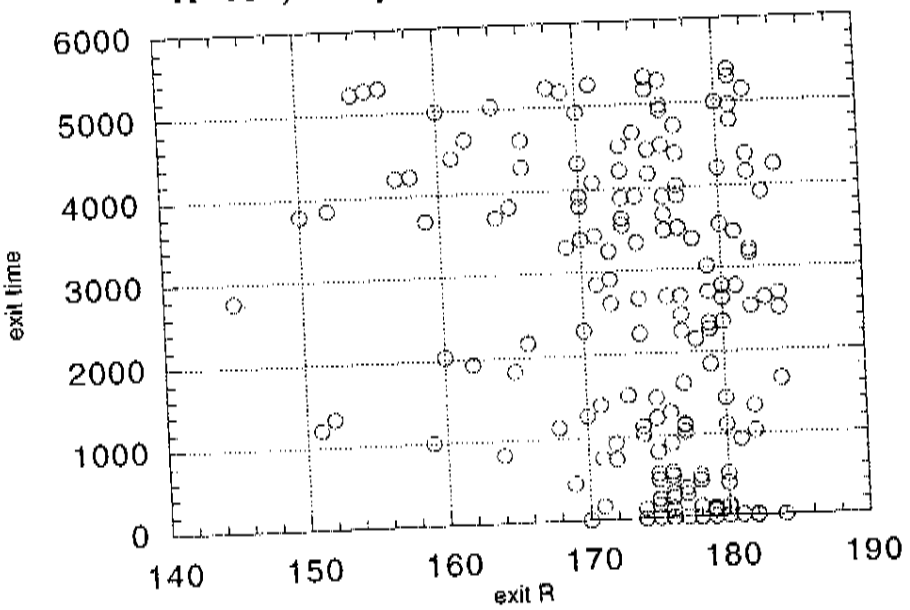

Time of exit and exit pitch correlation
beam ions R=161, with pa scattering
no of toroidal transit times
exit ptch
6000
5000
4000
3000
2000
1000
0
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1

Redi, 46

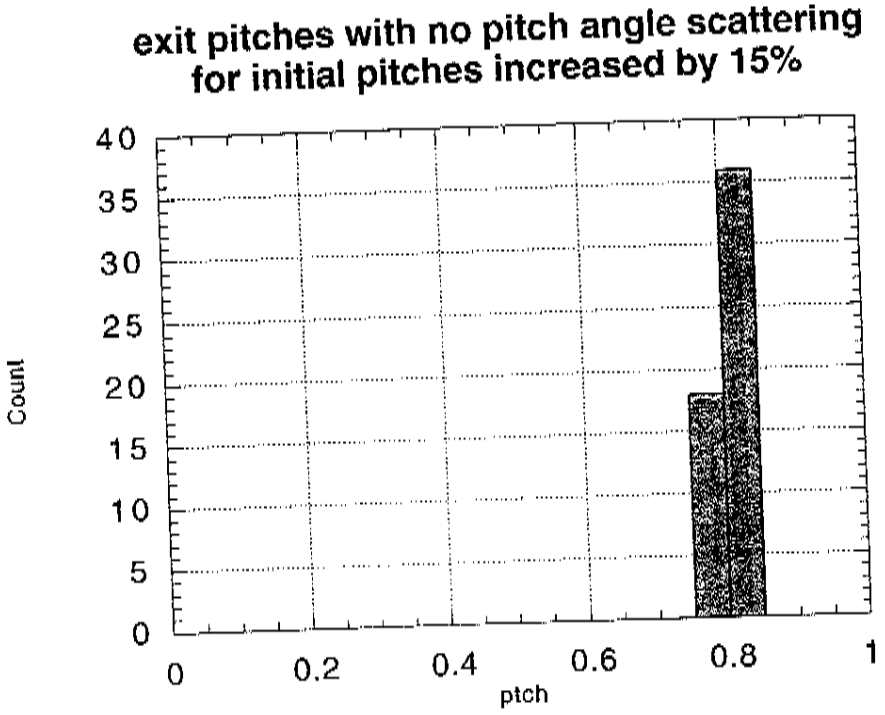
Exit major radii of beam ions from R=161, with pitch angle scattering

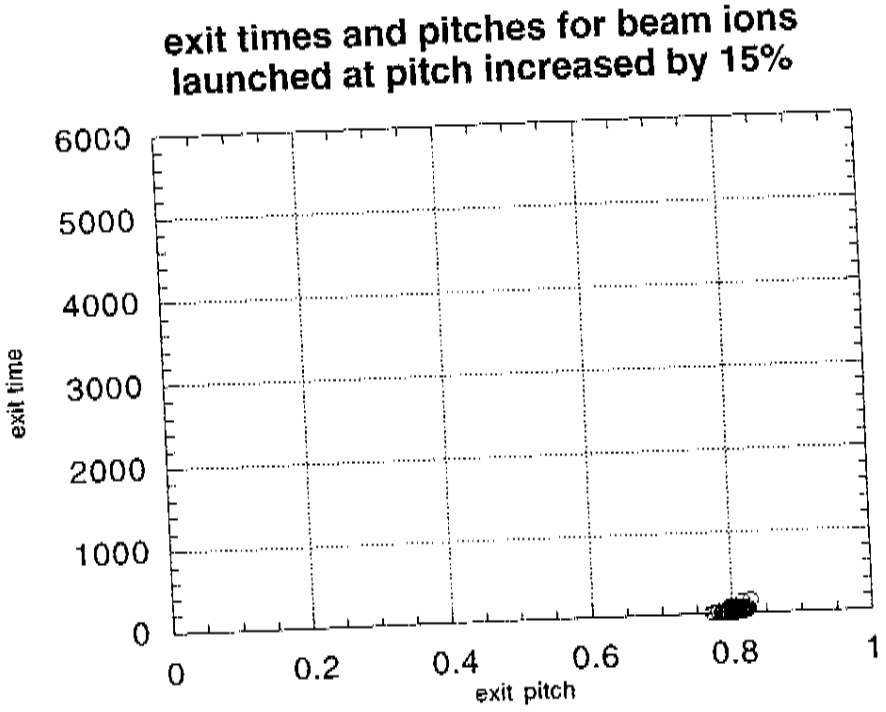


Exit time and major radius at exit R=161,with pitch angle scattering

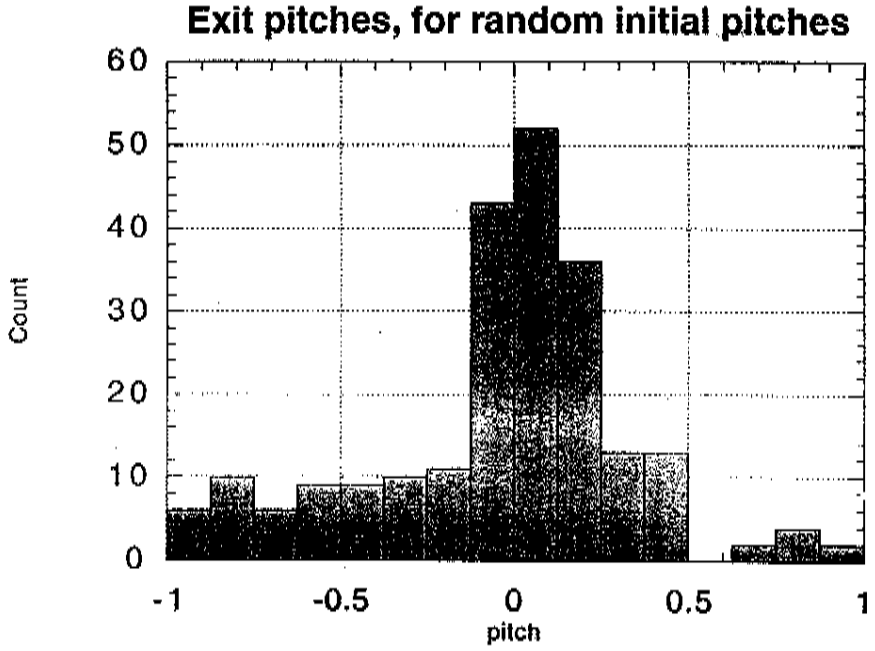


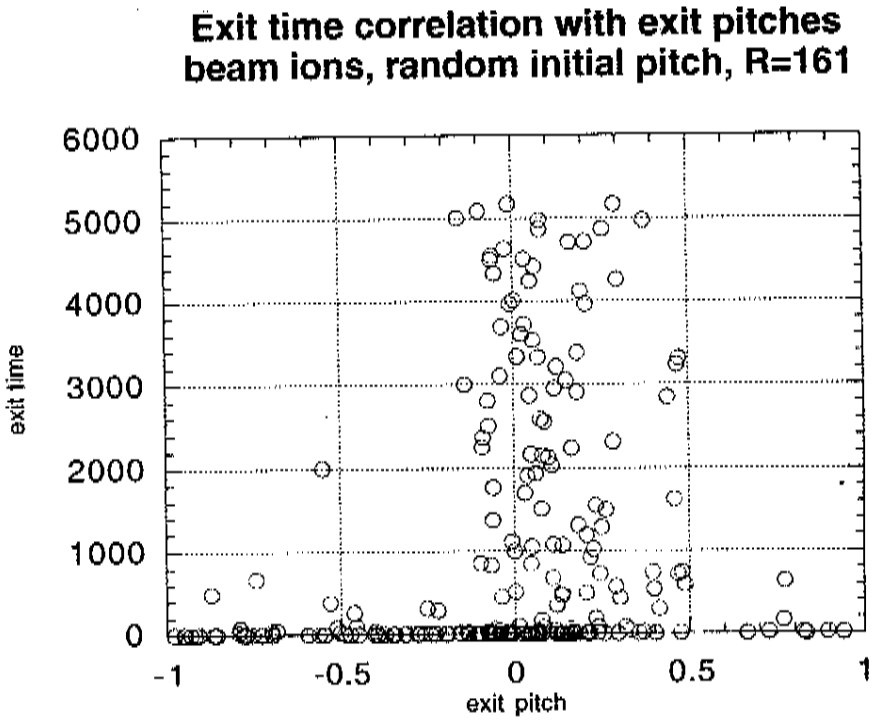
Redi, 4c


exit pitches with no pitch angle scattering
for initial pitches increased by 15%
Count
40
35
30
25
20
15
10
5
0
0
0.2
0.4
0.6
0.8
1
ptch


exit times and pitches for beam ions
launched at pitch increased by 15%
exit time
6000
5000
4000
3000
2000
1000
0
0
0.2
0.4
0.6
0.8
1
exit pitch

Redi, Ed


Exit pitches, for random initial pitches
Count
pitch
60
50
40
30
20
10
0
-1
-0.5
0
0.5
1


Exit time correlation with exit pitches
beam ions, random initial pitch, R=161
exit time
exit pitch
6000
5000
4000
3000
2000
1000
0
-1
-0.5
0
0.5
1

Redi, 4e

SUMMARY

1) Find $m^{0.5}/B$ scaling of losses for collisional losses;
little difference between H and D.

2) Simulations without pitch angle scattering at 1T
show 8% more losses for D (delayed stochastic passing)
than H.

3) Collisionless and prompt loss pitches are passing,
as expected

4) Collisional loss pitches show

- Some spreading of stochastic passing ion pitches,
and a new population, twice as large, which is trapped.

- Likely both banana drift and ripple well
as the FWHM is ~.4 in pitch.

- Plots of R_exit suggest ripple trapping loss is small

Redi, 5