Energetic Particle Confinement

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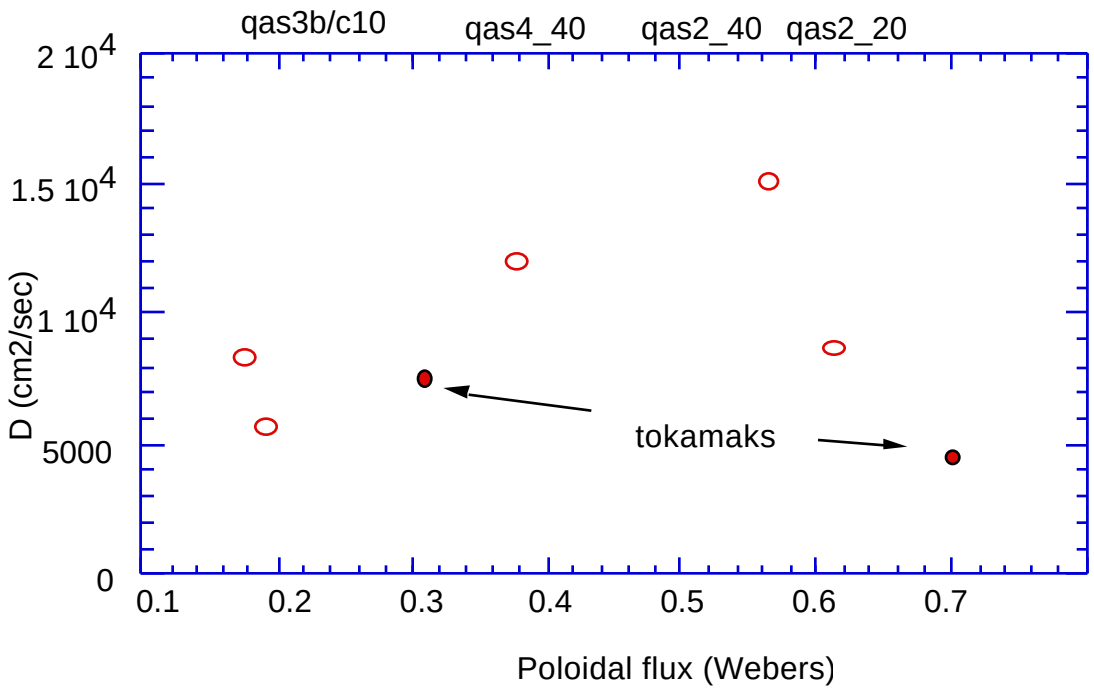
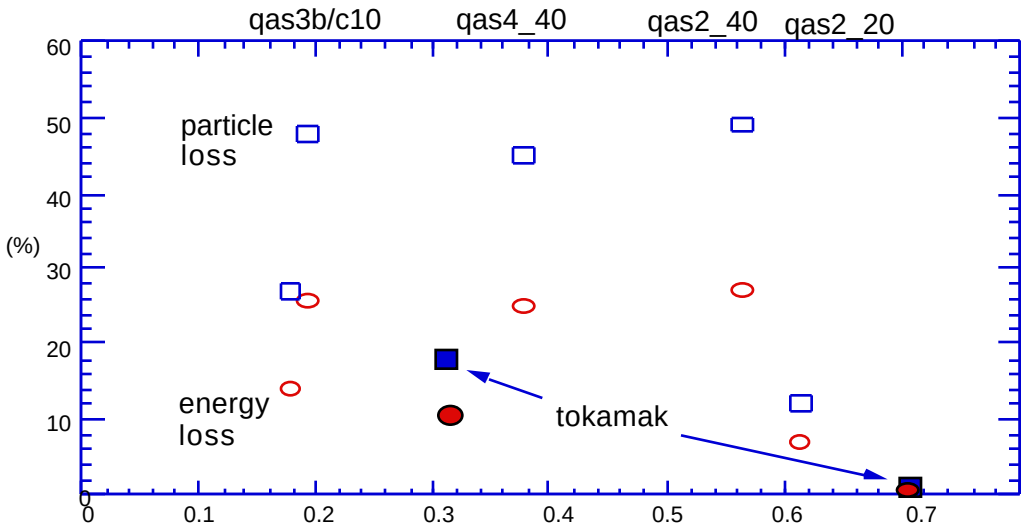
Diffusion Coefficient Decreases with Poloidal Flux for Tokamaks, Not for QAS Stellarators



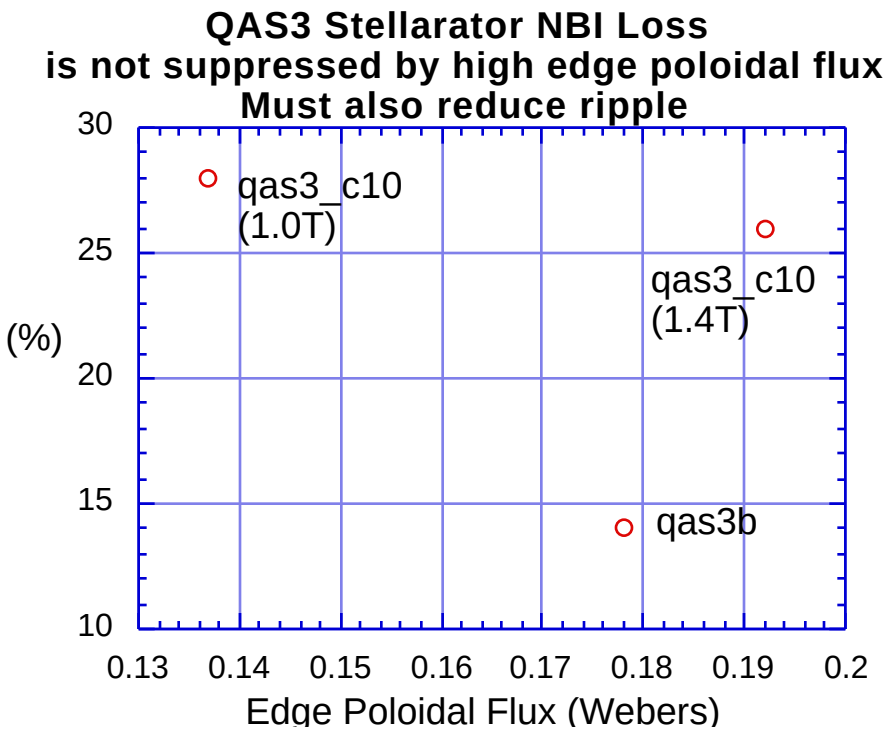
Stellarators scaled to R=145cm, B= 1.4 T

Parallel Injected Neutral Beam Ion Loss in QAS Stellarator
Shows Little Dependence on Poloidal Flu

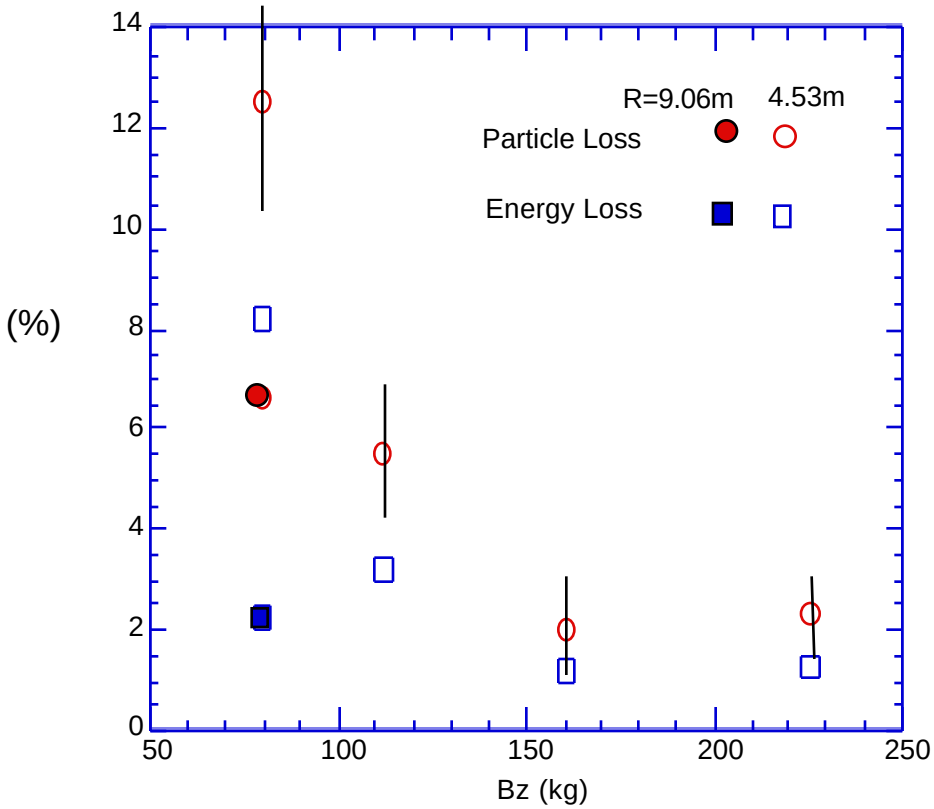


Equivalent tokamaks show loss fraction reduced for increased poloidal flux
Stellarator particle loss results mainly from ripple wells, not controlled by poloidal flux
qas3 have higher aspect ratio (~3.5) than other cases (2.2) $\nu_{perp}/\nu_e = 1$, E=40kev

Stellarators and tokamaks scaled to R=145cm, B= 1.4 T


QAS3 Stellarator NBI Loss
is not suppressed by high edge poloidal flux
Must also reduce ripple
30
25
20
15
10
(%)
qas3_c10
(1.0T)
qas3_c10
(1.4T)
qas3b
0.13
0.14
0.15
0.16
0.17
0.18
0.19
0.2
Edge Poloidal Flux (Webers)

Control of Energetic Ion Loss in QA Stellarator
Alpha loss in qas2_20
dependence on R weaker than on B



* For tokamak:
  - Expect passing ion loss ~ 1/ Poloidal flux = $1/BR^2$
  - Expect trapped ion loss ~δ/δ_S

    Since stochastic threshold δ_S ~ $1/\rho q'$ ~ BR

    expect trapped ion loss ~ 1/BR

* Find qas2_20 stellarator alpha loss ~ $1/B^2R$

* Increasing B improves confinement much more than increasing R

Conclusions- Energetic Particle Confinement

*** Loss of parallel injected beam from qas3_c10 (R=145cm, B=1T) is 28% beam energy, 51% beam ions**

* Energetic Particle Loss behavior is similar to diffusion coefficient dependence on Ψ:
- Better for lower thermal ion diffusion coefficients.

* Effect of pitch angle scattering
- makes even parallel injection survival dependent on ripple wells,
- not primarily on edge poloidal flux.

* Transport can be reduced
- for lower q, reduced ripple wells and (less than for tokamaks) by higher edge poloidal flux.
- with low Zeff, for low ν/ν_ε, high Ne for short τ_{sl}

* Simulations of qas2_20 reactor
- with increased R and B show that increased B gives less loss than expected:
- due to complex geometry of stellarator stochastic regions