NSTX

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Dependence of momentum and particle pinch on collisionality

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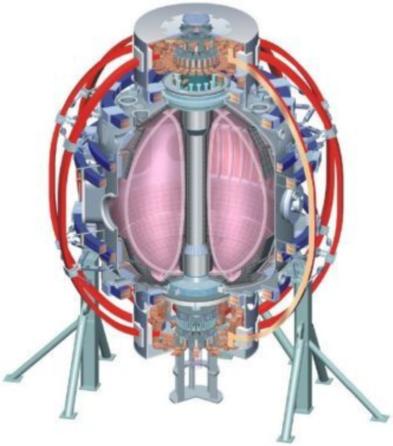
With S.M. Kaye, L.F. Delgado-Aparicio, V. Soukhanovskii …

and the NSTX Research Team

XP908 Final Review
April 9, 2009



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Dependence of momentum and particle pinch on collisionality

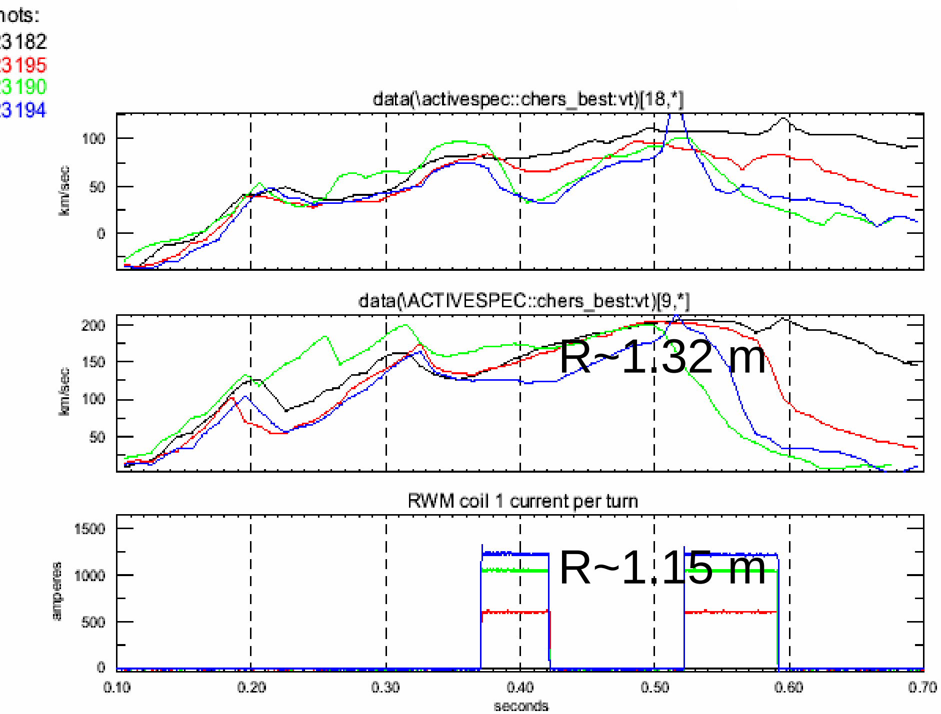
- Aims:
  - Compare dependence of momentum pinch velocity on collisionality with analytic theory and/or gyrokinetic predictions
  - Compare momentum pinch velocity with particle pinch velocity
  - Repeat with different q to begin to investigate q-dependence

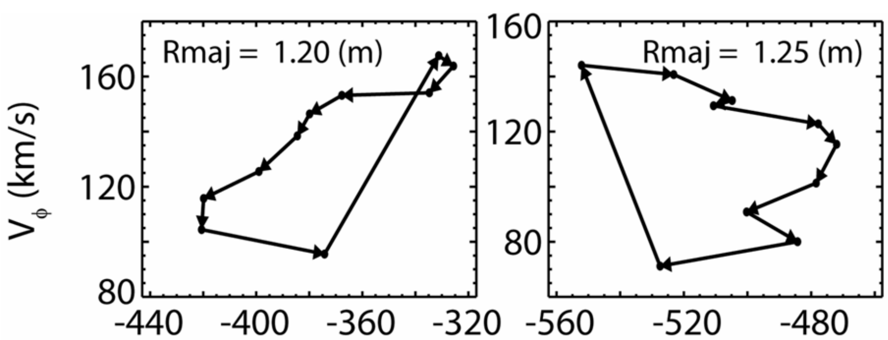
- Technique:
  - Use n=3 non-resonant magnetic perturbations to distort the rotation profile, allowing for separation of the roles of momentum diffusion vs convection (pinch).
  - Scan collisionality by varying Ip, Bt at fixed q
    - As reported by Kaye et al, IAEA 2006
  - Use Ne puffing and/or supersonic gas injection to perturb edge density and measure particle transport properties

Motivation

- Rotation widely acknowledged as playing critical and beneficial role in the performance of fusion plasmas
  - Stabilization of resistive wall modes and neoclassical tearing modes
  - Confinement improvement through turbulence suppression (E x B shear)
- Understanding momentum transport key to obtaining predictive knowledge of rotation for future devices
  - Momentum pinch physics important part of problem
- Size of momentum pinch will determine how peaked rotation will be in future devices
  - ITPA JEX TC-15

Perturbative τ_ϕ, χ_ϕ Can be Obtained from Transient Application of nRMP

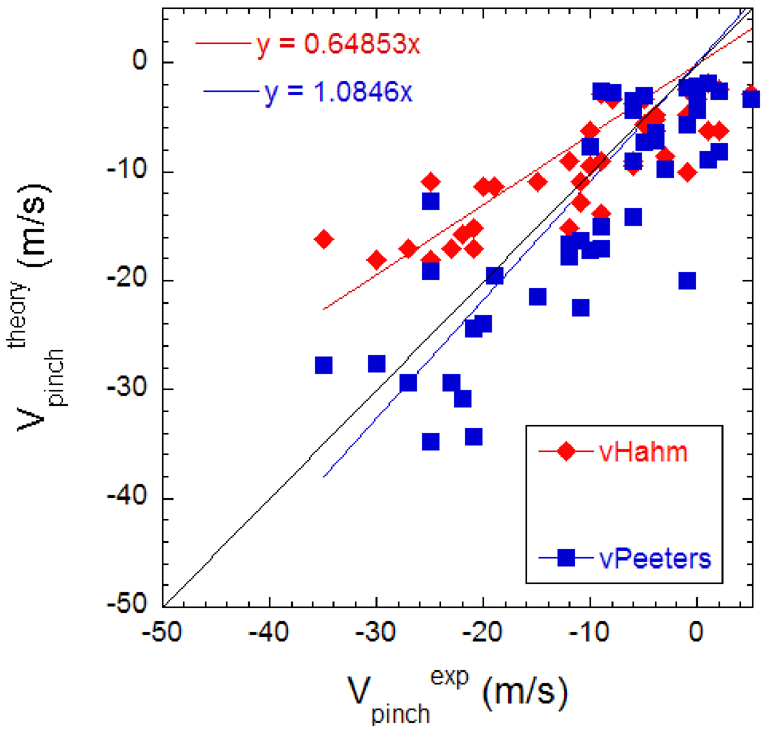


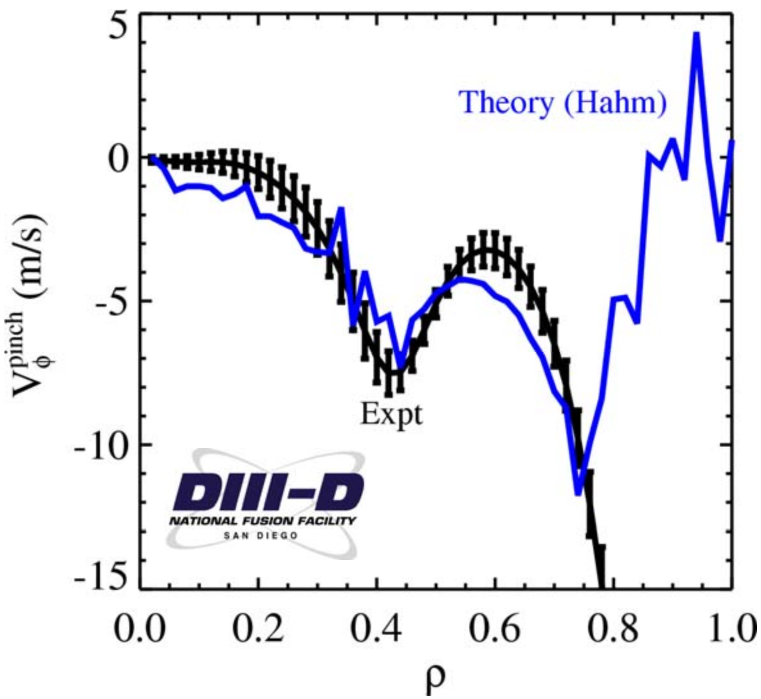


- Braking should be
  - long enough to have measurable affect on rotation
  - Not so long as to affect underlying plasma (ie shorter than momentum confinement time)
- If apply second pulse, need to wait for plasma to “recover”
- Must change V_ϕ independently of dV_ϕ/dr
  - can unravel relative contribution of χ_ϕ and V_ϕ^{pinch}

Reasonably Good Agreement Between Theory and Experiment on both NSTX and DIII-D

- Theory predicts drive of pinch through low-*k* turbulence
  - Coriolis drift, Peeters *et al.* PRL (2007)
  - ∇B, curvature drifts, Hahm *et al*. PoP (2007)





Experimental plan

Establish MHD quiescent H-mode (3+4 shots)
Similar to #129922, Bt ~ 0.55 T, Ip ~ 1.1 MA

Fail → Defer

Success ↓

Complete 3-point "collisionality" scan
by varying Bt, Ip at fixed q (4+2 shots)
(Bt, Ip) = (0.45, 0.9), (0.35, 0.7)

Fail → If lowest Bt produces MHD, try (0.4, 0.8), or skip

Success ↓

Repeat scan, using edge
density perturbations +NRMP (6+4 shots)

→

Repeat without NRMP (3+1 shots)
(compare edge particle
transport with/without NRMP)

↑

Establish suitable companion L-mode reference, and repeat Steps I-III (7+5 shots)

↑

23 good shots