

XP-1041 Joint NSTX/DIII-D poloidal rotation experiment

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Overview of planned experiment:

The goal of this experiment is to investigate the carbon poloidal rotation in matched NSTX and D III-D plasmas to determine whether the differences between the measured poloidal rotation and the neoclassical predictions are affected by aspect ratio.

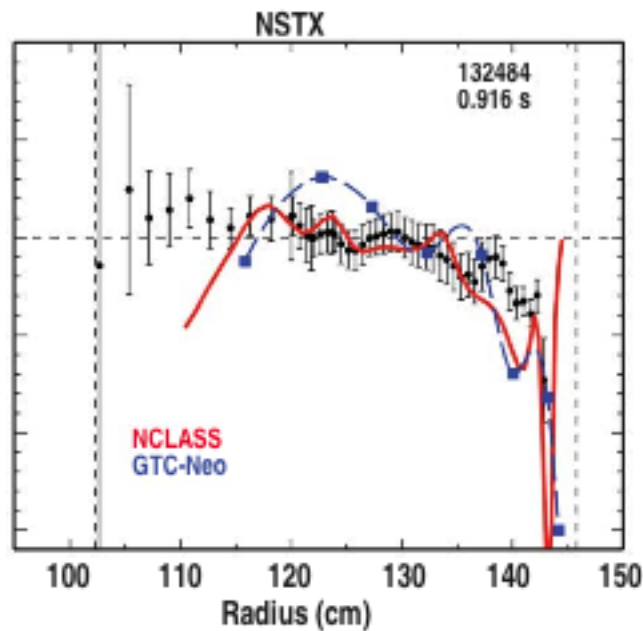
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Theoretical/ empirical justification

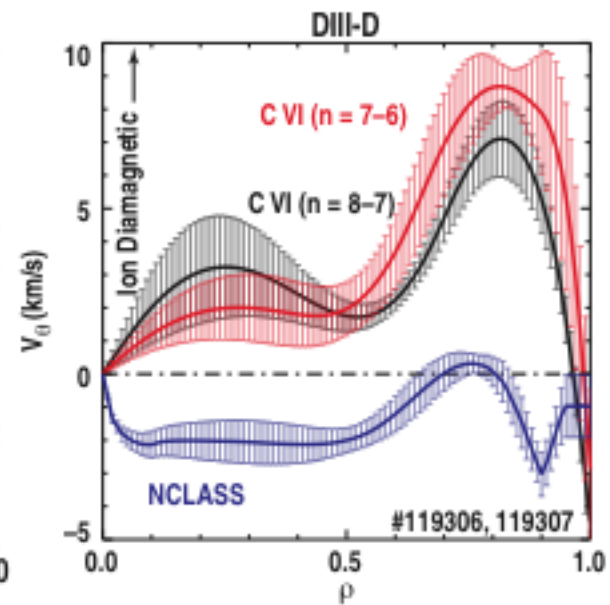
- Measured poloidal velocities on various machines is inconsistent with respect to expectations for poloidal velocity from neoclassical theory.
- DIII-D: QH-mode plasmas had sign and magnitude of measured poloidal velocity differing from neoclassical theory.
- NSTX: H-mode plasmas with measured poloidal velocity at or below neoclassical expectation.
- JET: Measured poloidal velocity in ITB an order of magnitude larger than neoclassical.
- JT-60: Measured poloidal flow is consistent with neoclassical in ITB.
- MAST: Measured poloidal flow is consistent with neoclassical in L and H mode plasmas.
- A comparison between DIII-D and NSTX for similar H-mode at low magnetic field would provide a unique comparison at distinctly different aspect ratios.
- Comparisons with modest ion temperature and low magnetic field would eliminate a potentially serious systematic error due to gyro orbit and finite lifetime effects.

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Bell, et al. APS 2009



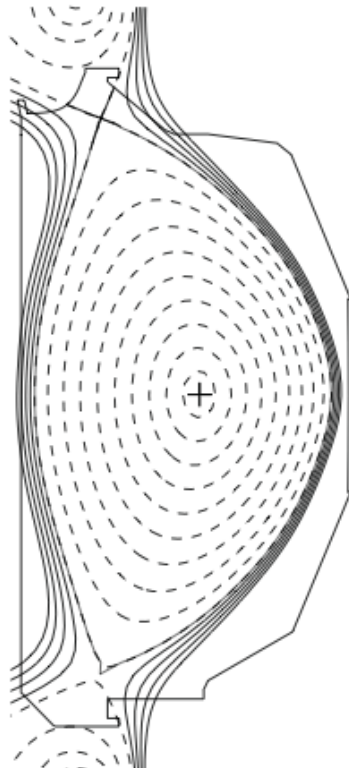
Solomon et al. APS 2005

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Matched discharges from D III-D and NSTX

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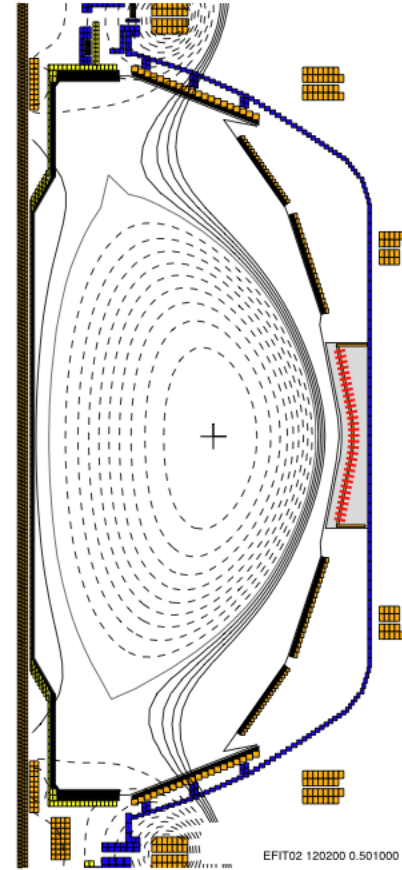
shot      140996
time     3800.00
chi**2   16.031
Rout(m)  1.683
Zout(m)  -0.002
a(m)     0.611
elong   1.873
utri     0.559
ltri     0.000
indent   0.000
V (m**3) 19.330
A (m**2)  1.889
W (MJ)    0.235
betaT(%) 5.898
betaP     0.935
betaN     3.277
In        1.800
LI        0.828
LI3       0.828
error(e-4) 5.489
q1        4.924
d95       2.657
dsep(m)   0.056
Rm(m)     1.751
Zm(m)     0.004
Rc(m)     1.711
Zc(m)     -0.006
betaPd    0.922
betaTd    5.817
Wdia(MJ) 0.232
Ipmeas(MA) 0.637
BT(O)T    -0.584
Ipilt(MA) 0.847
Rmidin(m) 1.072
Rmidout(m) 2.294
gapin(m)  0.056
gapout(m) 0.071
gapbot(m) 0.141
gapbd(m)  0.107
Zis(m)    0.745
Rvsin(m)  1.205
Zvsin(m)  1.199
Rvsout(m) 1.400
Zvsout(m) 1.269
Rsep1(m)  1.341
Zsep1(m)  -1.147
Rsep2(m)  1.345
Zsep2(m)  1.142
psib(Vs/R) -0.131
elongm    1.432
qm        1.016
nev1(e19) 4.705
nev2(e19) 4.769
nev3(e19) 4.578
ner0(e19) 4.775
n/hc     -0.368
dRsep     0.001
qmin      1.016
rhoqmin   0.000
    
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MDSplus, shot = 140996, run = EFT01, time = 3800.00

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shot      120200
time     0.501000
chi**2   56.846
Rout(m)  0.857
Zout(m)  -0.007
a(m)     0.606
elong   1.960
utri     0.555
ltri     0.532
indent   0.000
V (m**3) 10.080
A (m**2)  2.013
W (MJ)    0.179
betaT(%) 12.146
betaP     1.142
betaN     4.978
In        2.440
LI        0.799
error(e-4) 10000.000
q1        16.927
d95       7.950
dsep(m)   0.066
Rm(m)     1.000
Zm(m)     1.000
Rc(m)     0.974
Zc(m)     -0.009
betaPd    1.162
betaTd    12.358
Wdia(MJ) 0.182
Ipmeas(MA) 0.739
BT(O)T    -0.493
Ipilt(MA) 0.729
Rmidin(m) 0.251
Rmidout(m) 1.460
gapin(m)  0.066
gapout(m) 0.107
gapbot(m) 0.424
gapbd(m)  0.409
Zis(m)    100.000
Rvsin(m)  0.279
Zvsin(m)  -1.351
Rvsout(m) 0.813
Zvsout(m) -1.551
Rsep1(m)  0.535
Zsep1(m)  -1.194
Rsep2(m)  0.521
Zsep2(m)  1.180
psib(Vs/R) -0.012
elongm    2.140
qm        1.000
nev1(e19) 0.000
nev2(e19) 0.000
nev3(e19) 0.000
ner0(e19) 0.000
n/hc     0.036
dRsep     0.002
qmin      2.387
rhoqmin   0.678
    
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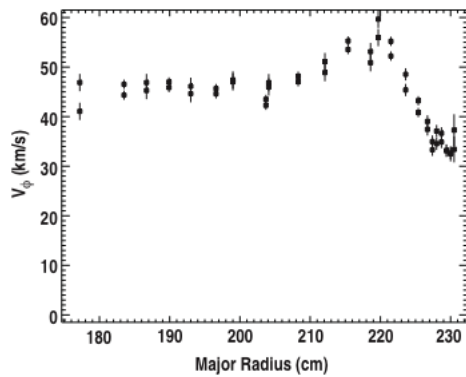
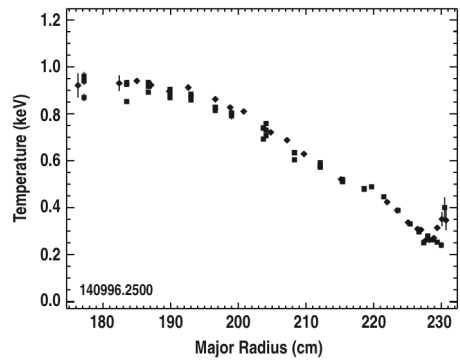


EFT02 120200 0.501000 s

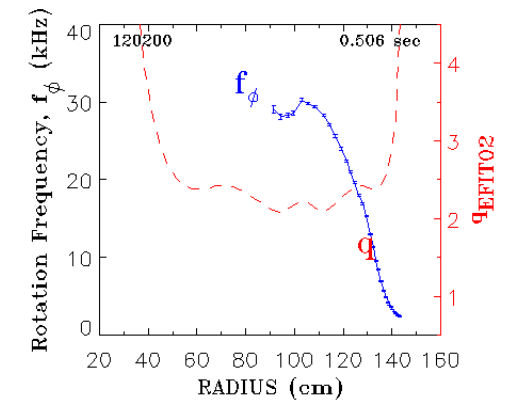
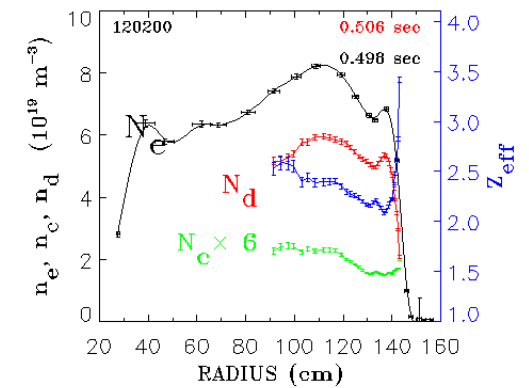
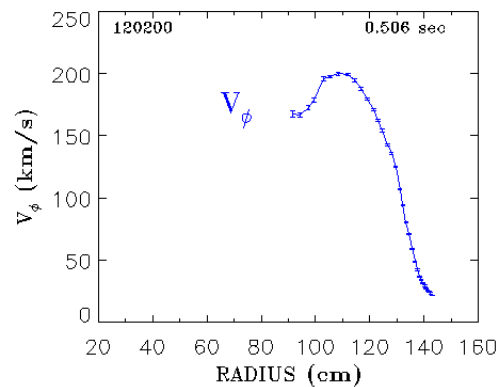
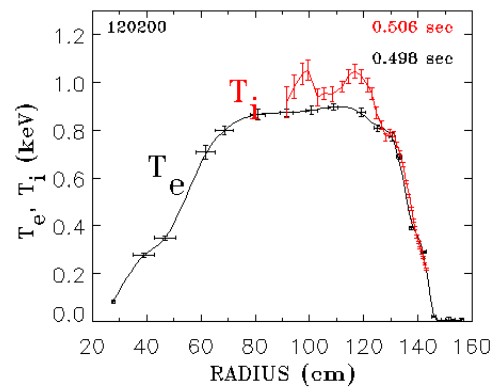
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- NSTX V_ϕ larger than DIII-D V_ϕ by factor of 3-4.
- Use magnetic braking with EFC coils to reduce NSTX V_ϕ

D III-D



NSTX



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Experimental run plan

1. Establish the DN target plasma, using reference shot 120200, matching shape, $I_p=0.73$ MA, $B_t=0.495$ T.
2. Increase B_t from 0.495 T to 0.55 T to match D III-D discharges.
3. Decrease I_p from 0.73 MA to 0.6-0.64 MA range. (Steps 2 and 3 can be done simultaneously.)
4. Add $n=3$ error field in steps to reduce toroidal velocity to about 50 - 60 km/s. This should require EFC currents from 0 - 800 kA.

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Diagnostic Needs

- Poloidal and toroidal CHERS are necessary.
- Turbulence measurements desired, since turbulence is offered as a reason for the disparity between measured and neoclassical values of poloidal velocity.
 - Even with the non-optimal viewing geometry, BES is desired. The pitch angle ($I_p/B_t = 1.1 \text{ MA/T}$) for these plasmas is far from optimal for the new BES diagnostic, which is aligned with field lines when $I_p/B_t \sim 2 \text{ MA/T}$.
 - High-k scattering is also desired, to be configured with a radial location around 140 cm radius.
 - UCLA reflectometer

Planned Analysis

EFIT, TRANSP, NCLASS, GTC-Neo, NEO