Transport scaling experiments

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Proposed XPs

XP1 **Transport scaling with configuration and plasma shape**
(early run - 1 1/2 days)

XP2 **Intra-machine A-scaling of perturbative impurity/electron transport**
(mid run - 1 day)

XP3 **Dimensionless transport scaling (beta and rho-star) in H-mode discharges**
(late run - 2 days)

XP1 Transport scaling with configuration and plasma shape

- **Confinement scaling in high triangularity DND plasma shows unusual characteristics (XP 223) :**

- up to ≈ 2.5 times L-mode scaling and steadily increasing

- weak or no I_p scaling

- decrease with n_e, then sudden increase (electrons) at low n_e

- fast degradation with P_{in} at 4.5 kG and no degradation (to a threshold) at 6 kG

- only small confinement increase at L-H transition

- peripheral (ion) turbulence depends strongly on B_t

- **L-mode scaling:** $\tau_E \approx 0.025\ I^1\ B^0\ P^{-3/4}\ n^{0.4}\ R^2\ (1/A)^0\ k^{3/5}$

- **Proposed XP will explore κ, δ and configuration dependence (LSN vs. DND)**

- **Neon injection will be used as an independent probe of ion transport**

- **LSN may allow longer discharges and access to higher τ_E**

XP1 - proposed scans

- **DND:** I_p scan at fixed B_t and n_e (restore XP 223 conditions)
  power scan with Neon injection at fixed I_p and maximum field
  elongation scan at fixed B_t, I_p, and n_e
  triangularity scan at fixed B_t, I_p, and n_e

- **LSN:** I_p scan at fixed B_t and n_e
  n_e scan at fixed I_p, and B_t
  power scan at fixed I_p, and two B_t values

- **CSL: repeat LSN scans time permitting**

- **Estimated run time: 1 1/2 days**

XP2 Intra-machine A-scaling of impurity/electron transport

- Results from previous runs consistently hint that electron transport is dominant in NSTX
- Looks like we traded electron confinement for improved ion confinement at low A and low field
- Is this a low aspect-ratio effect, or a low B effect ?
- Proposed XP will probe perturbative impurity transport (Ne puff or C pellet injection) and perturbative electron transport (‘cold-pulse’ with impurity pellet), at two extreme aspect ratio and field values
- The XP will use discharges developed in the intra-machine A-scaling XP225 (S. Kaye) and early experience with pellet injection
- Estimated run time: 1 day

XP3 Dimensionless transport scaling - beta and rho-star

- **High confinement at high beta is major NSTX milestone**

- **XP 223 suggests that beta scaling cannot be very strong**

$$\tau_E \approx \tau_B \, \rho^{*\,x\rho} \, \beta^{x\beta} \, \nu^{*\,x\nu} \, q_{cyl}^{xq}$$

- **Dimensionless scaling experiments required to separate eventual rho-star/beta scaling**

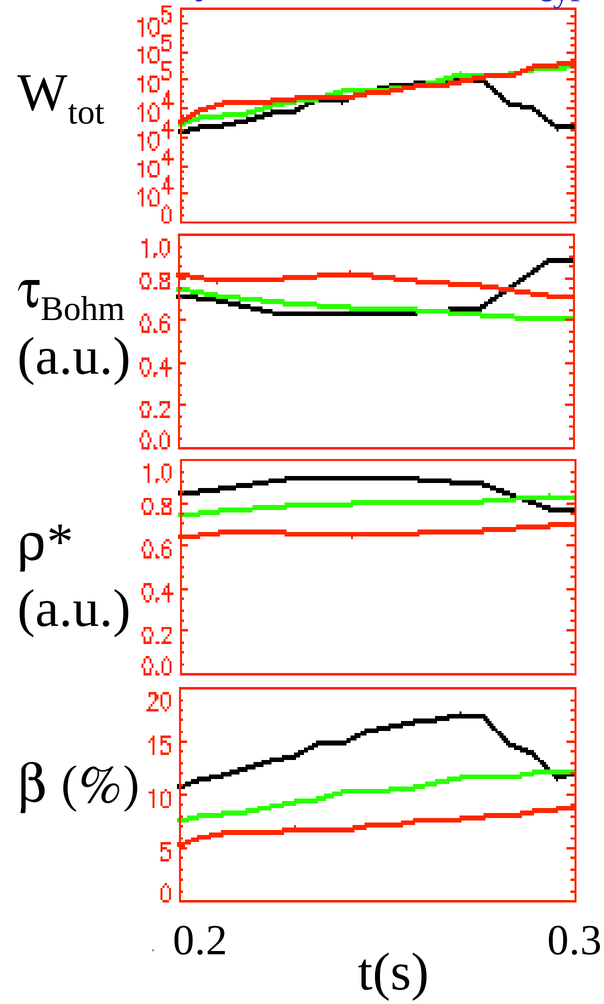
- **Scaling in H-mode first priority**

- **Rho-star scaling using B_t:**
  β, ν^*, q=const. -> n ~ $B^{4/3}$, T~$B^{2/3}$
- **Beta scaling using B_t:**
  ρ^*, ν^*, q=const. -> n ~ B^4, T~B^2

- **Will assume weak ν^* dependence**

- **RF needed to control T, possibly also density control**

B_t scan at fixed q_{cyl}



Parameters of DIII-D rho-star and beta scans

TABLE II. Engineering parameters for H-mode dimensionally charges on DIII-D and projection to ITER.

	DIII-D	
B_T(T)	0.95	1.9
a(m)	0.62	0.62
I_p(MA)	0.66	1.33
$\bar{n}(10^{19}\ m^{-3})$	2.8	5.5
Z_{eff}	1.6	1.4
W_{th}(MJ)	0.24	0.91
P_{tot}(MW)	3.4	6.1
τ_{th}(s)	0.069	0.148
H	2.0	2.2

- **Estimated run time - 2 days**

Table II. Engineering and Dimensionless Parameters for the H Mode Beta Scaling Experiment

Parameter	Discharge	
	90117	90108
B (T)	1.62	1.93
R (m)	1.67	1.68
a (m)	0.61	0.61
I (MA)	1.13	1.35
$\bar{n}$ (10^{19} m^{-3})	3.60	7.39
W_{th} (kJ)	274	847
P (MW)	1.73	6.26
τ_{th} (s)	0.158	0.135
R/a	2.76	2.76
κ	1.81	1.84
δ	0.23	0.24
ℓ_i	1.22	1.16
q_{95}	3.76	3.88
$\bar{n}/B^4$	0.53	0.53
W_{th}/B^6	15.4	16.3
β^{th} (%)	0.92	1.97
β_N^{th}	0.80	1.71
$B\tau_{th}$	0.255	0.262