Momentum database for T&C Gr

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Outline

1. Aims and Approach
2. Experimental conditions (how the db was put together, who contributed)
3. Parameter regimes
4. Relation among χ_ϕ, χ_i and V_{pinch} at r/a=0.6 (preliminary analysis)
5. Parameter dependences of χ_ϕ, V_{pinch}, χ_ϕ/χ_i, RV_{pinch}/χ_ϕ at r/a=0.6
6. Summary
7. Plans for future analysis / Discussion

Aims and Approach

Outline and aims

The purpose of this study is to understand the characteristics of momentum transport coefficients including diffusive and non-diffusive terms by multi-machine experiments over a wide range of magnetic configurations.

A database of multi-machine analysis from plasma and engineering parameters scans (I_p, n_e, V_t, heating power, B_t) will be constructed.

We expand on the data set with different values of non-dimensional parameters (ρ^*, ν^*, β, η_i, T_i/T_e,,,) so as to establish a modeling/scaling and to predict V_t profile in ITER.

Approach (~2009) <-plan at the last ITPA meeting at Naka

(i) To investigate the parameter dependences of χ_ϕ, V_{pinch}, χ_ϕ/χ_i, RV_{pinch}/χ_ϕ from the data which had already been reported. Scalar database at r/a=0.3, 0.4, 0.5, 0.6, 0.7 in H-mode.

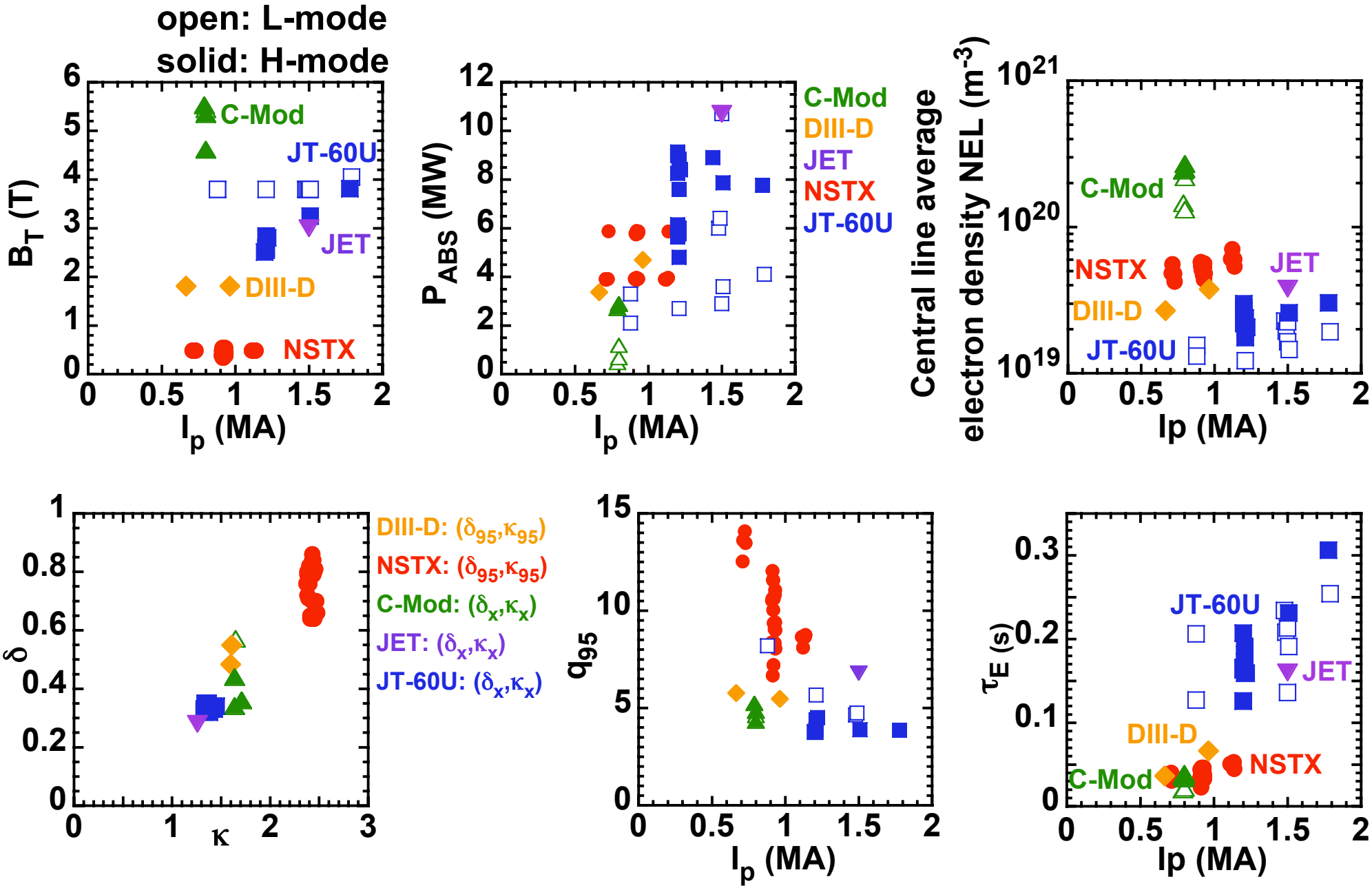
(ii) To understand the experimental regime of each machine.

(iii) To plan what kind of parameters should be scanned for the database construction.

Experimental conditions

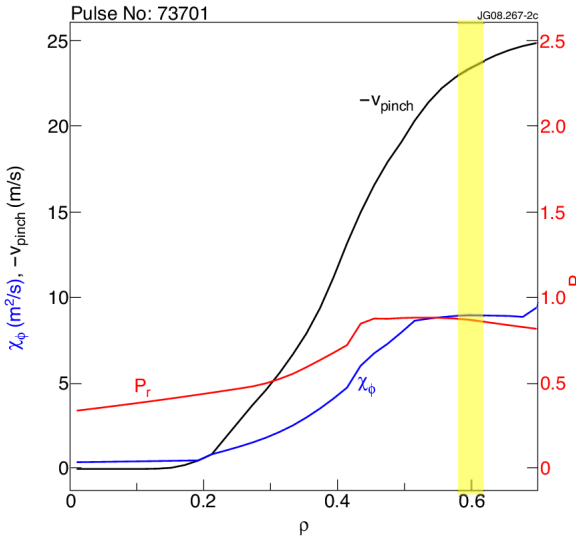
Device	shots / data	radius	IP [MA]	BT [T]	Ion gradB drift	NEL [10^{19} m^{-3}]	PABS [MW]
C-Mod (J. Rice)	6 shots / 18 data (3H, 3L)	0, 0.3, 0.6	0.79-0.8 (CW)	4.6-5.5 (CW)	Toward (LSN) / Away from (USN)	13.1-26.8	0.47-2.89 (OH, ICRF)
DIII-D (W. Solomon)	2 shots/ 14 data (H-mode)	0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8	0.7-1 (CCW)	1.8 (CW)	Toward X-point	2.7-3.8	3.4-4.7 (NB)
JET (T. Tala)	1 shots / 5 data (Type III)	0.3, 0.4, 0.5, 0.6, 0.7	1.5 (CCW)	3 (CCW)	Toward X-point	3.8	10.7 (NB, ICRF)
NSTX (S. Kaye)	26 shots / 69 data (H-mode)	0, 0.1, 0.2, 0.5, 0.6, 0.7, 0.8	0.7-1.1 (CCW)	0.34-0.54 (CW)	Toward X-point	4.2-7.1	3.9-5.9 (NB)
JT-60U (M. Yoshida)	23 shots / 92 data (15H, 9L)	0.3, 0.4, 0.5, 0.6,	0.9-1.8 (CW)	2.8-4.0 (CW)	Toward X-point	1.2-2.5	2.1-10.7 (NB)

Parameter regimes

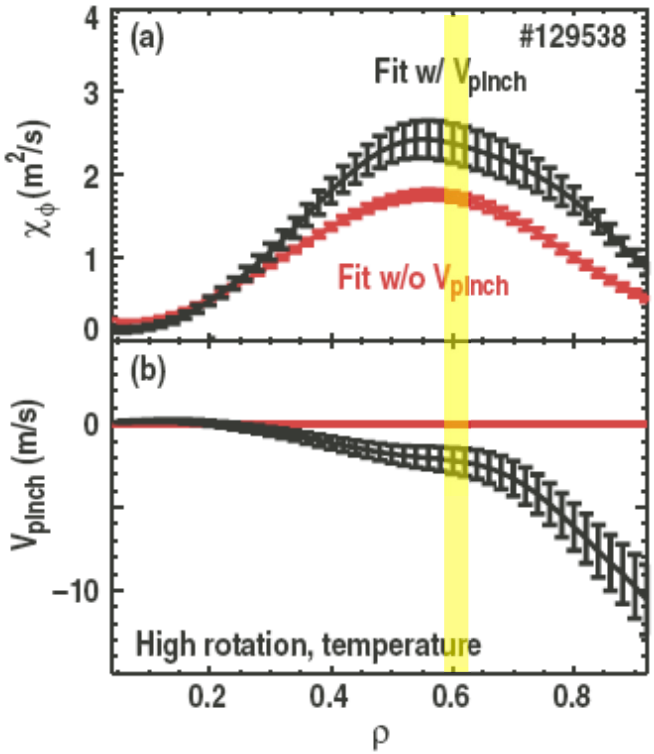


Profiles

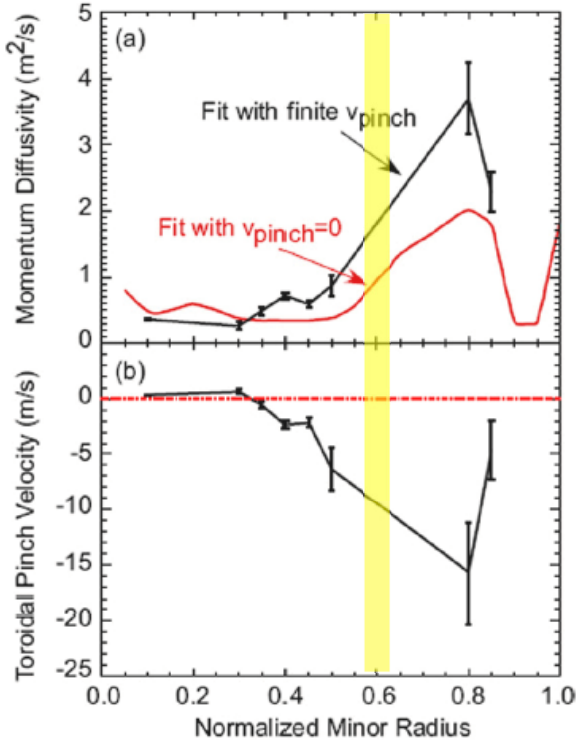
JET, IAEA2008



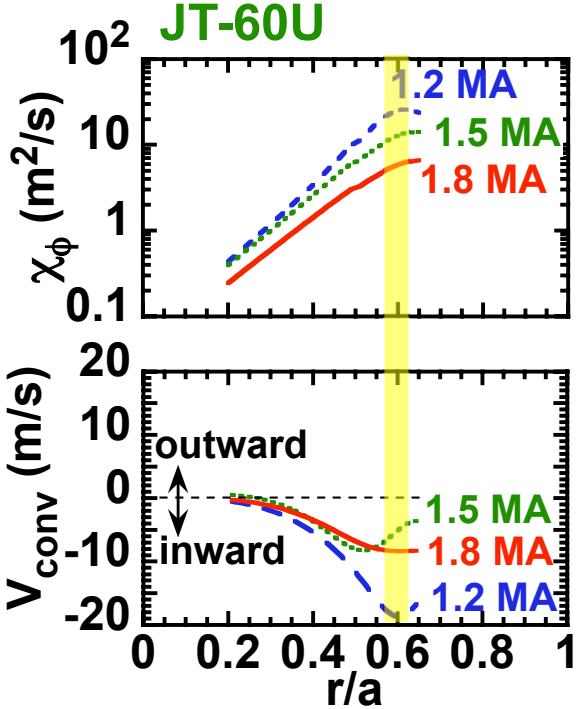
DIII-D, NF2009



NSTX NF(2009)



JT-60U

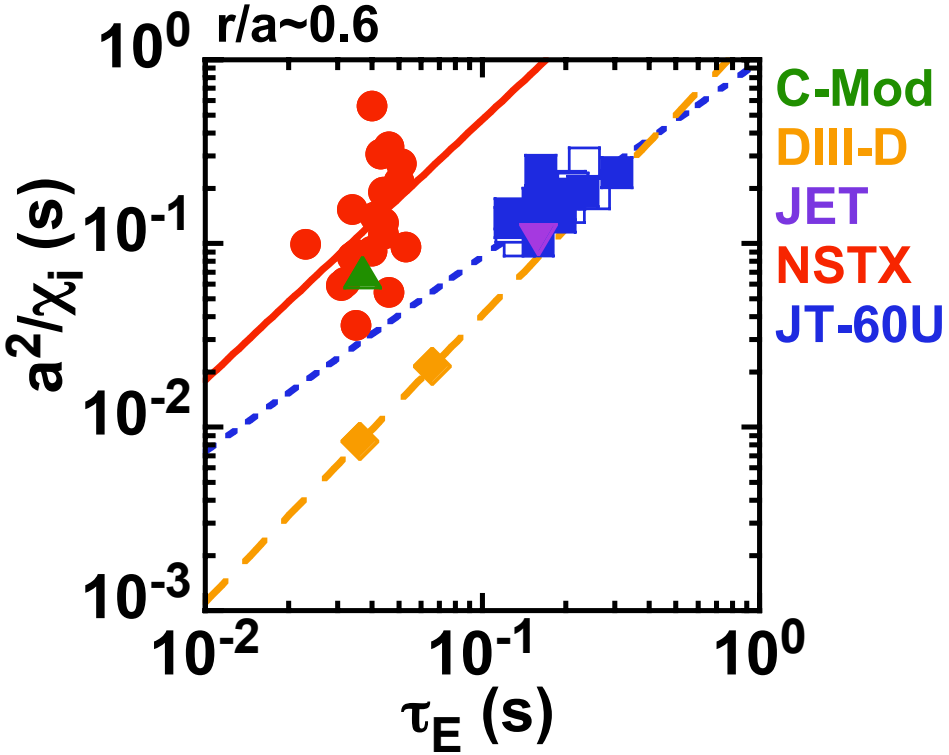


Profiles of χ_ϕ are similar: χ_ϕ becomes larger in the outer region of plasma and has a maximum around r/a~0.6-0.8.

Profiles of V_{pinch} (inward) are also similar.

For a discussion of χ_ϕ and V_{pinch}, the data at r/a =0.6 is selected in this talk.

Correlation between χ_i at r/a=0.6 and τ_E

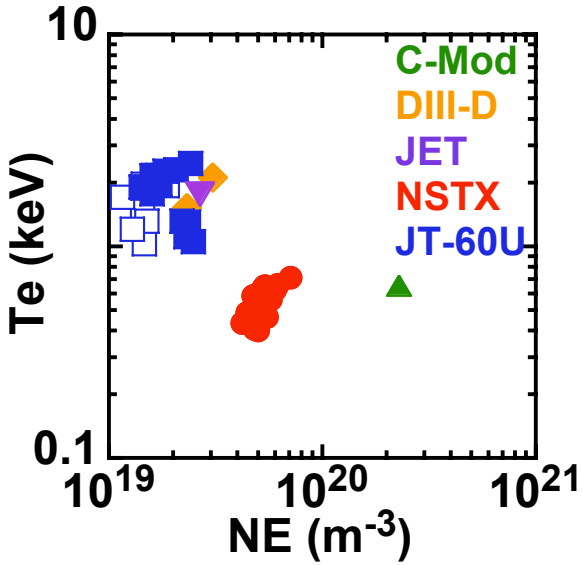


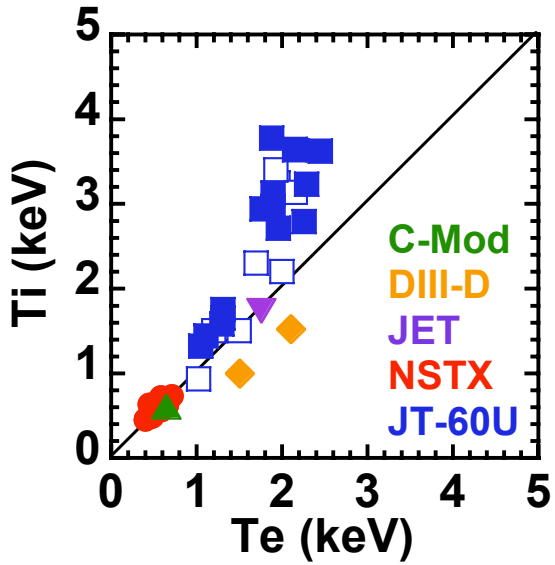
The diffusivity χ_i at *r/a*~0.6 roughly represents the quality of global confinement because a good correlation between χ_i and τ_E is observed.

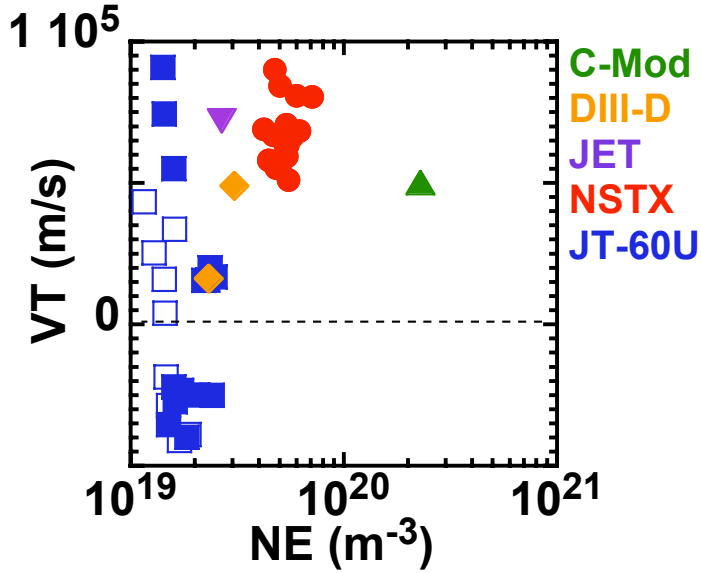
The data at r/a=0.6 is though to be relevant for primitive analysis.

Parameter regimes (r/a~0.6)

Dimensional

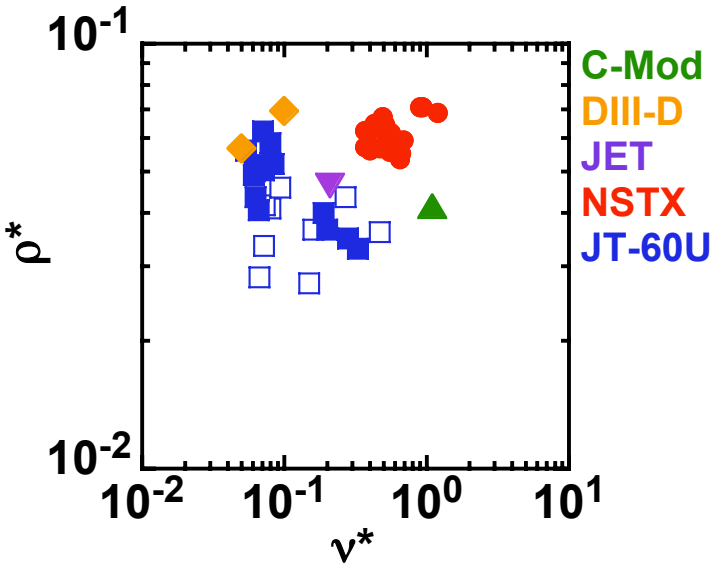


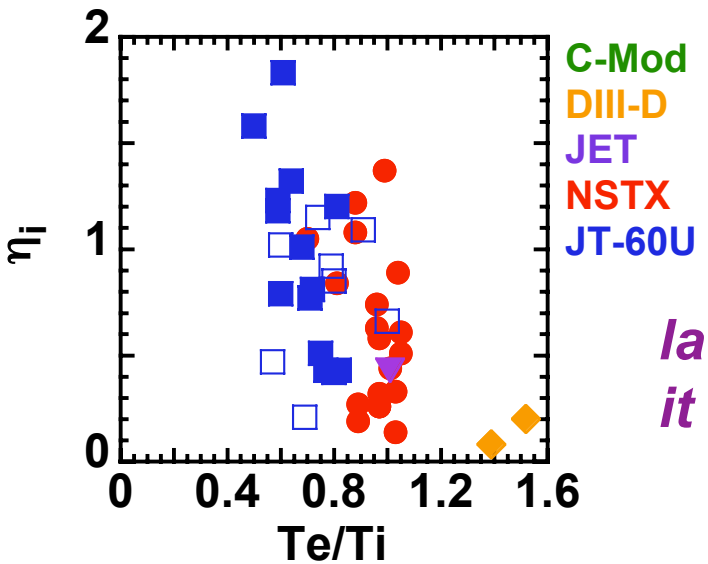




Non-dimensional

ρ_{pol}* is the ion poloidal Larmor radius normalized to the minor radius,
ν* is the effective electron collision frequency normalized to the bounce frequency.

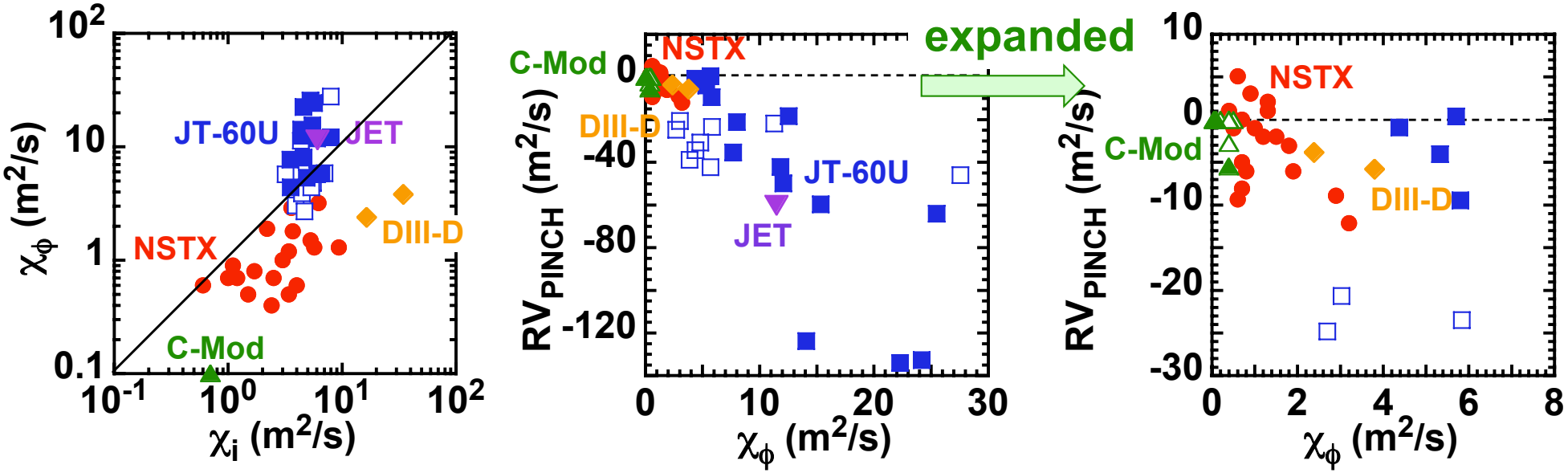




$$\eta_i = \frac{L_{Ti}}{L_{ne}}$$

lack of β_N
it should be collected.

Relations among χ_ϕ, χ_i and V_{pinch} (r/a~0.6)



Similarity among devices

χ_ϕ increases with increasing χ_i.

V_{pinch} increases with increasing χ_ϕ.

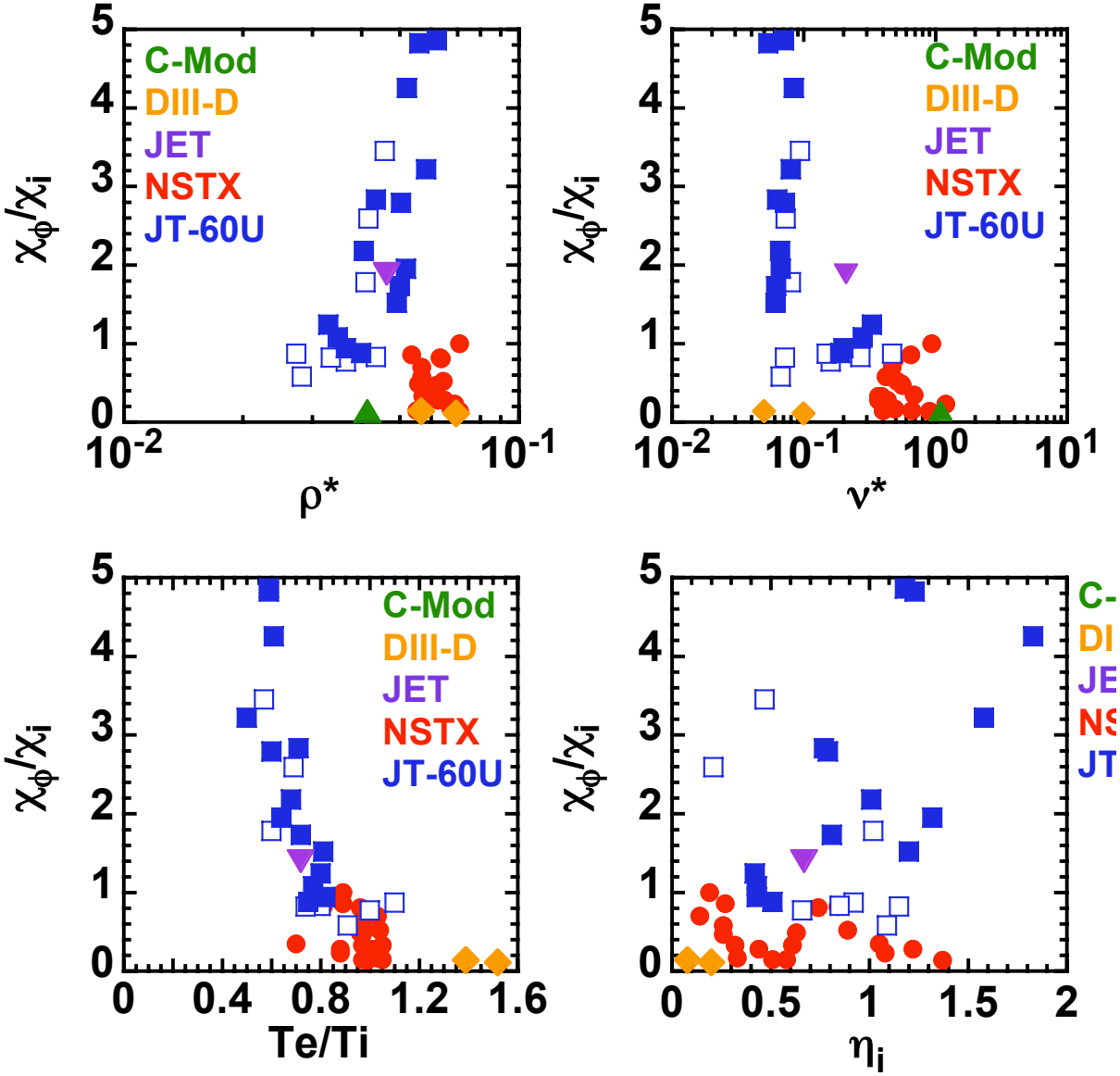
Difference

$\chi_\phi < \chi_i$ or $\chi_\phi \sim \chi_i$ in NSTX, C-Mod and JT-60U(low power).

$\chi_\phi > \chi_i$ in JET and JT-60U at higher heating power

Question is on what parameter the ratio of χ_ϕ/χ_i depends.

Attempt to find χ_ϕ/χ_i dependence (r/a~0.6)



In primitive database and analysis, clear dependence of χ_ϕ/χ_i on ρ_i^*, ν^*, η_i was not observed.

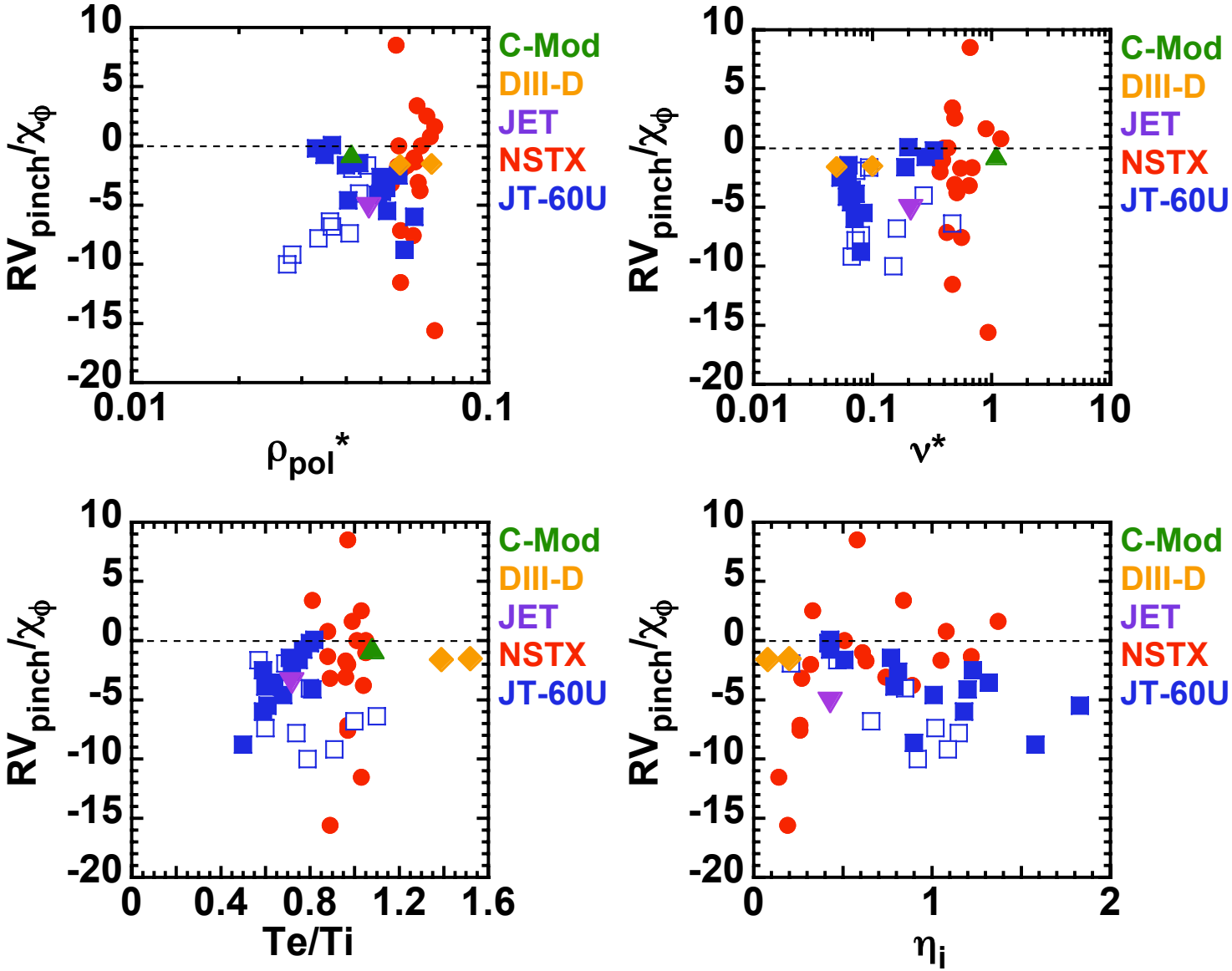
T_e/T_i might be correlated with χ_ϕ/χ_i.

Careful analysis is required to find these dependences.

Scan a parameter with fixed other parameters.

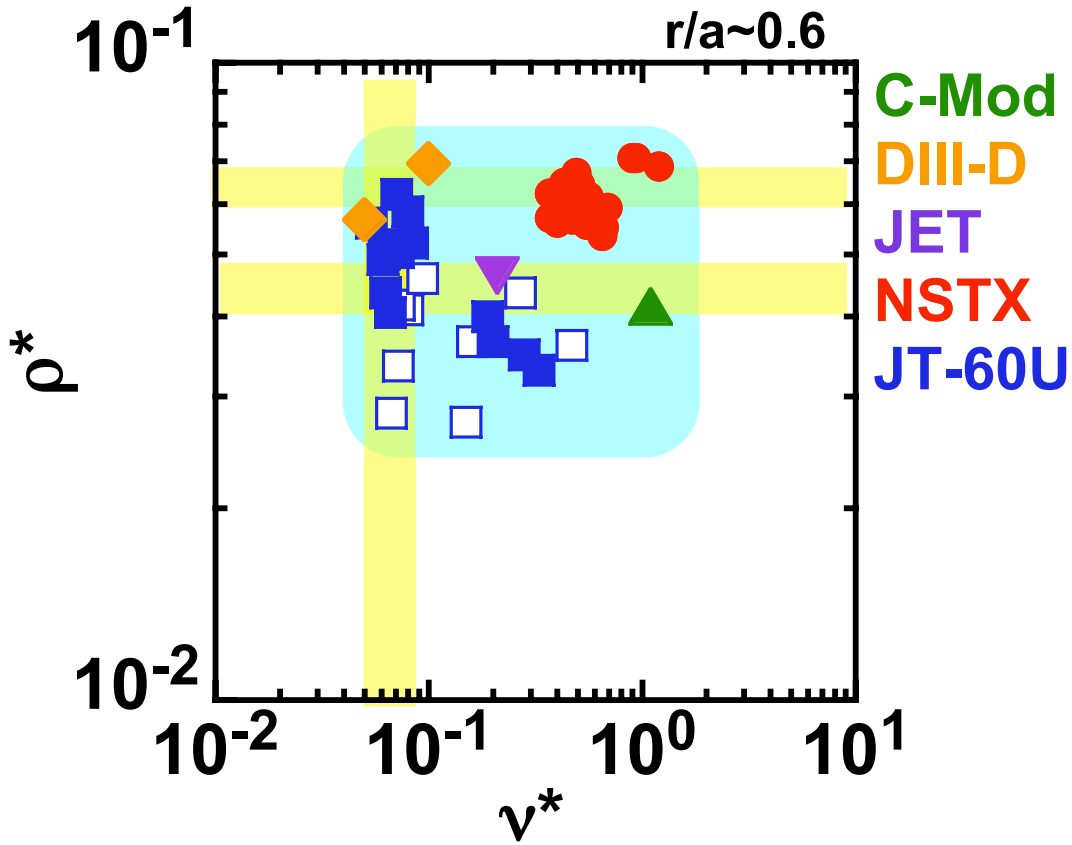
Dependence on β_N should be investigated.

Attempt to find RV_{pinch}/χ_ϕ dependence (r/a~0.6)



Also clear dependence of - RV_{pinch}/χ_ϕ on ρ_i^*, ν^*, η_i, and T_e/T_i was not observed. Careful analysis is required.

Target regimes for scaling



To compare the data and establish a scaling/modeling in multi-machine, parameter regime should be selected to overlap each other.

Summary

Status of the momentum database was reported.

Experimental conditions and Parameter regimes are shown.

Relations among χ_ϕ, χ_i and V_{pinch} at r/a=0.6 are investigated.

χ_ϕ increases with increasing χ_i.

$\chi_\phi < \chi_i$ or $\chi_\phi \sim \chi_i$ in NSTX, C-Mod and JT-60U(low power).

$\chi_\phi > \chi_i$ in JET and JT-60U at higher heating power.

V_{pinch} increases with increasing χ_ϕ.

Parameter dependences of χ_ϕ, χ_ϕ/χ_i, RV_{pinch}/χ_ϕ at r/a=0.6 are investigated.

Thanks to the data from each machine, the data from each machine can be plotted on the same graph, and we can start discussion of momentum transport coefficients in multi-machine.

In primitive analysis, clear dependence of χ_ϕ/χ_i and RV_{pinch}/χ_ϕ on ρ_i^*, ν^*, η_i and Te/Ti was not observed.

To compare the data and establish a scaling/modeling in multi-machine, parameter regime should be selected to overlap each other.

Issues and Future plans

Future plans

(i) Continue to investigate parameter dependences of χ_i, V_{pinch}, χ_ϕ/χ_i, RV_{pinch}/χ_ϕ using the present database.

(ii) Especially, more careful analysis is needed for parameter dependences of χ_ϕ/χ_i, RV_{pinch}/χ_ϕ using non-dimensional parameters.

(iii) β_N should be collected.

(iv) Other radial positions should be investigated.

(v) New data from each machine will be added to the database.

(vi) Useful (easy to compare) database for various theoretical models should be established. We need requirements from the theoretical viewpoint.