

Pedestal Particle Transport Study using Perturbation Method in HL-2A and KSTAR

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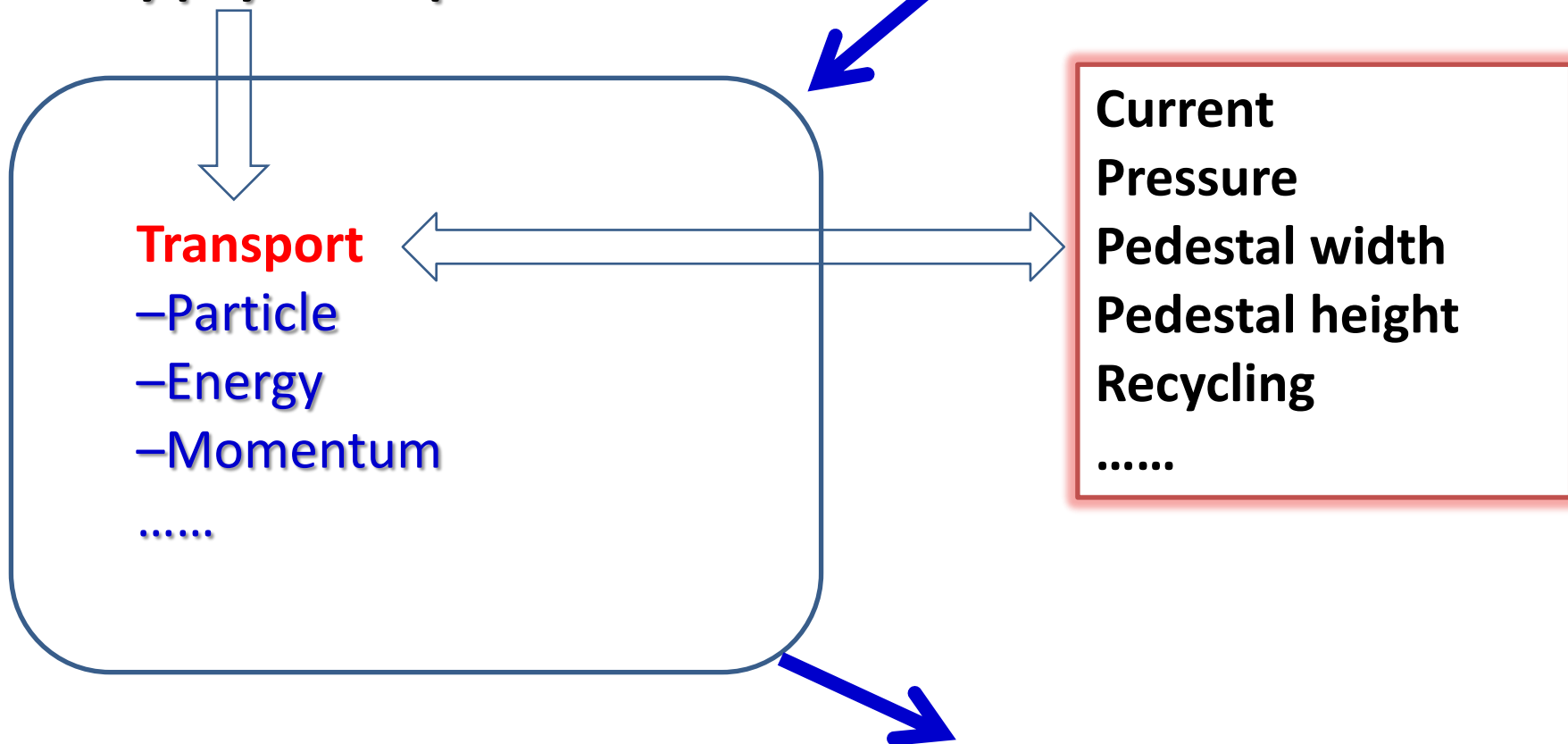
HL-2A team and KSTAR team

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- **Motivation**
- **Experimental results in HL-2A and in KSTAR**
 - Edge density profile
 - Particle source location
 - Perturbation experiments → **ELM mitigation by SMBI**
 - Edge particle flux spectrum
- **Comparison of transport study**
 - Comparisons with/without SMBI
 - Particle flux analysis
 - Toroidal rotation analysis
 - Energy transport analysis
- **Summary**

We try to understand procedures

Many physical topics



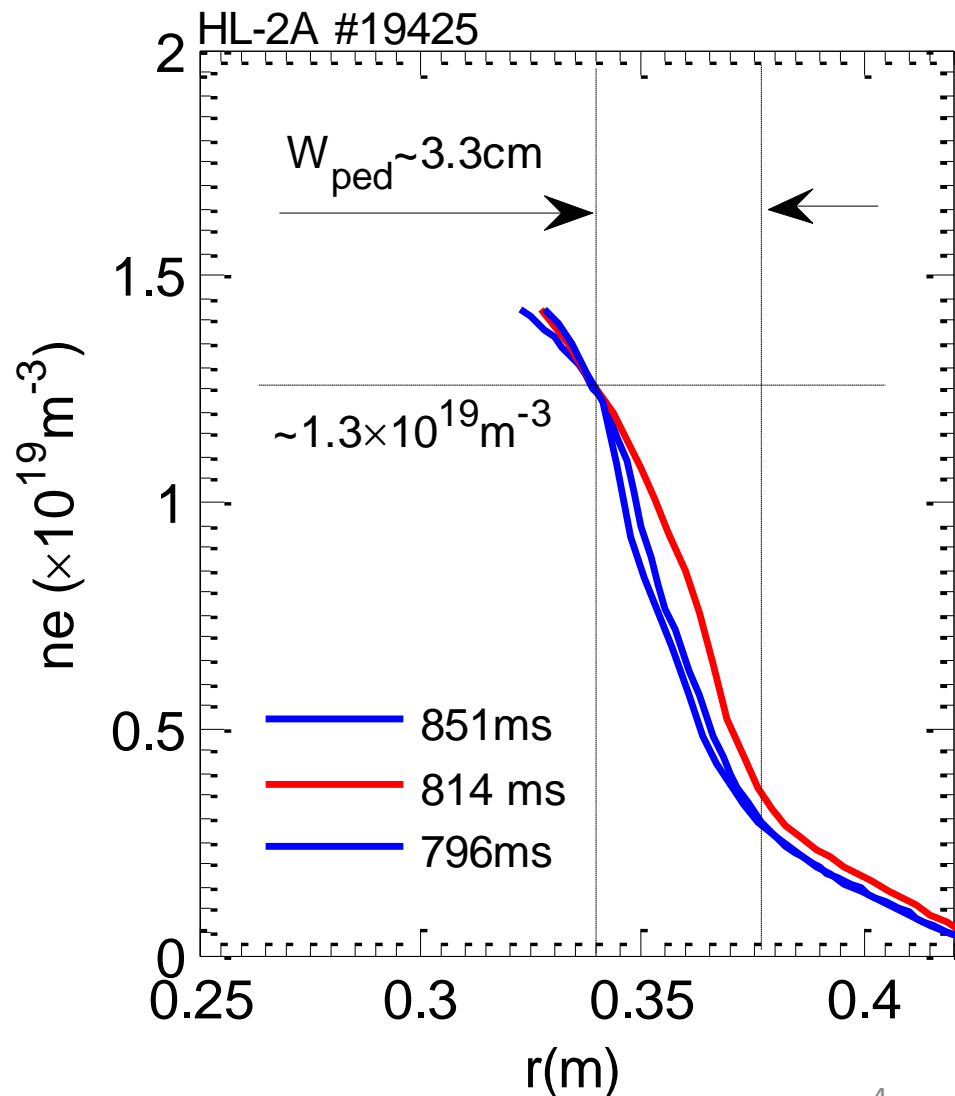
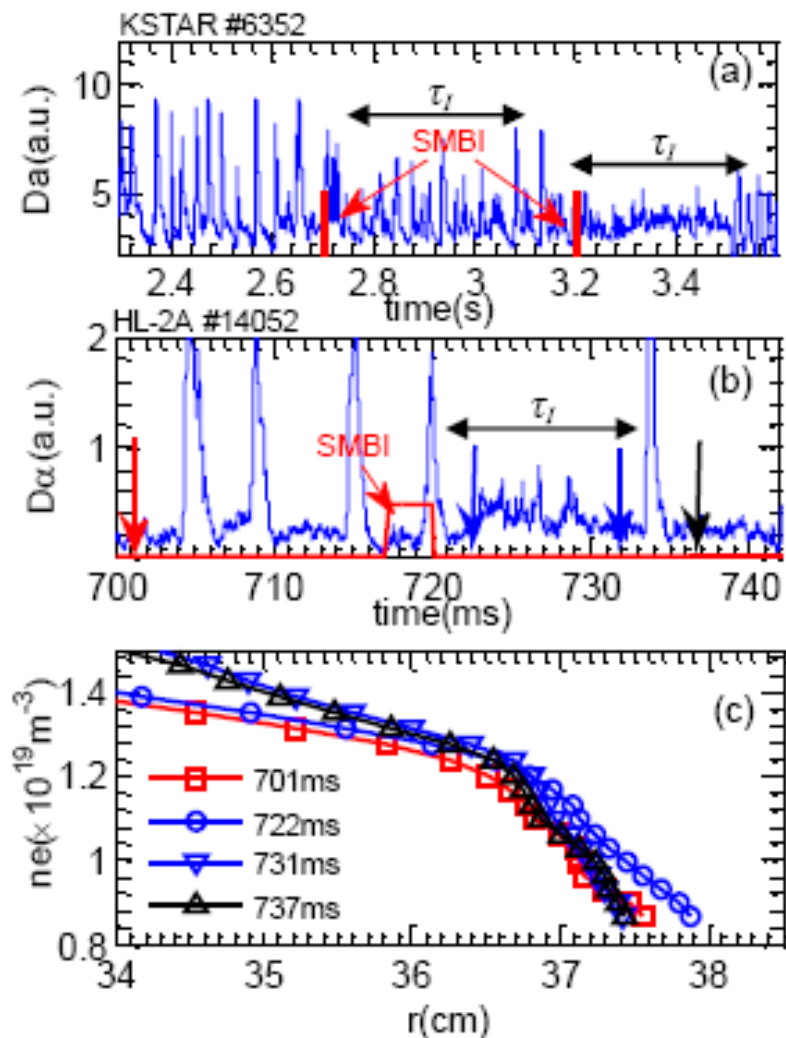
Transport
 -Particle
 -Energy
 -Momentum

Current
 Pressure
 Pedestal width
 Pedestal height
 Recycling

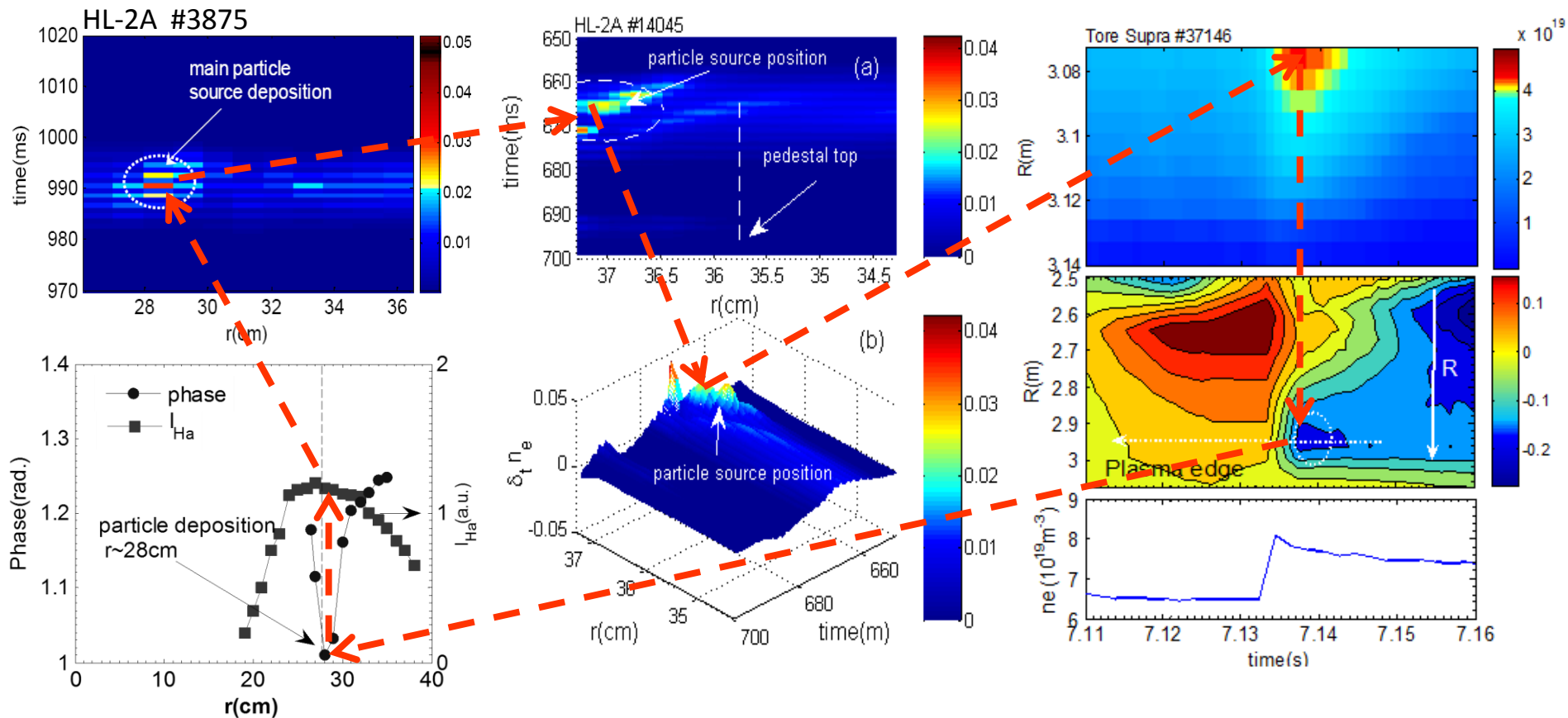
H-mode Stability operation → ELM physics ...

This talk will focus on particle transport with and without SMBI to mitigate ELMs.

Edge density profile and pedestal construction in pedestal in concept and experiment.



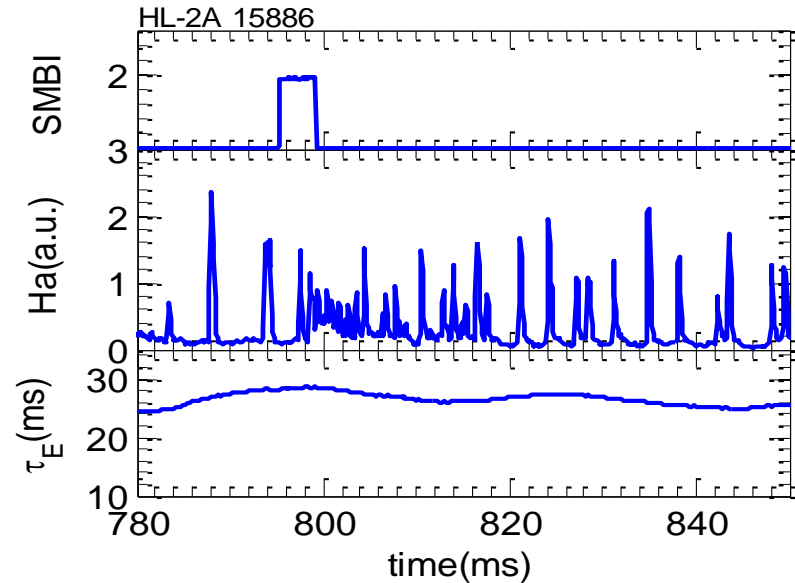
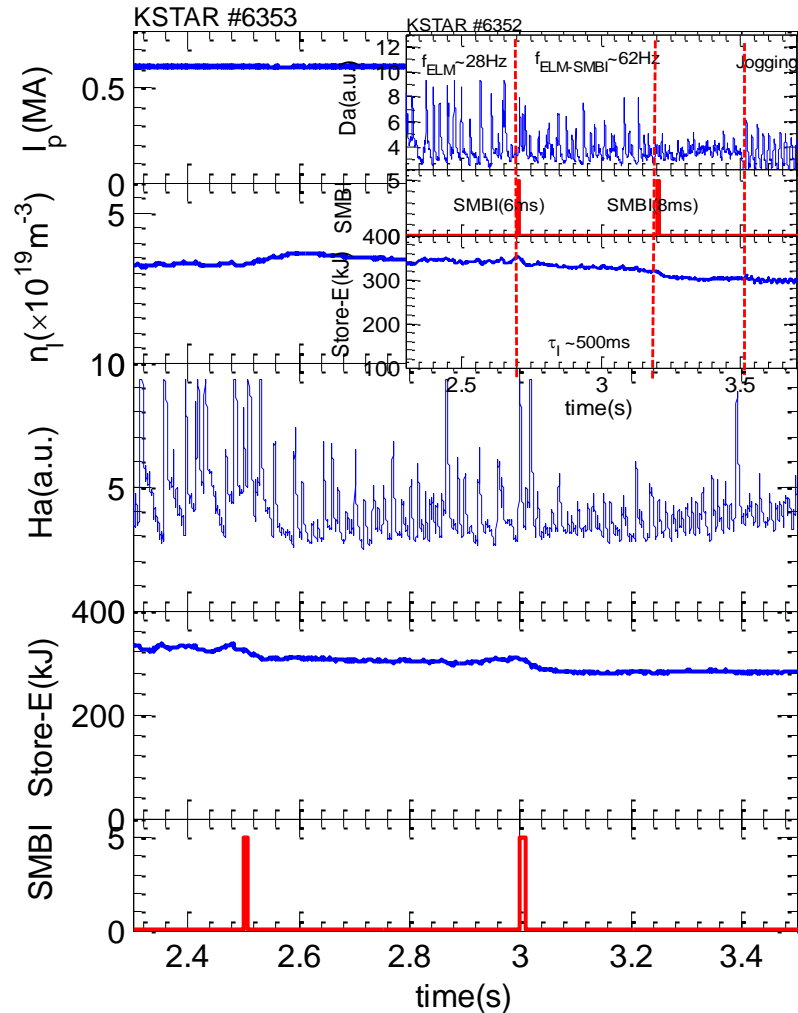
→ Particle source



- | | |
|---------------------------------------|--------------------------|
| 1 → Phase of the density perturbation | 2 → Peak of Ha intensity |
| 3 → Density increase ratio | 4 → Temperature decrease |

W.W. Xiao, RSI 2010

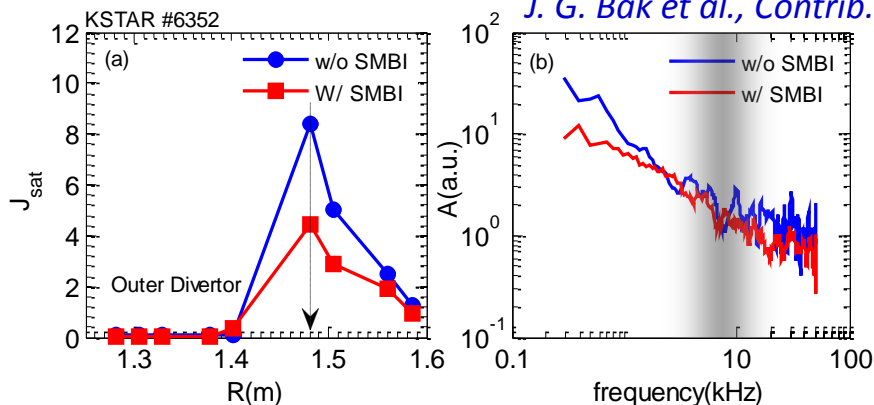
→ Store energy in ELM mitigation by SMBI in HL-2A and KSTAR



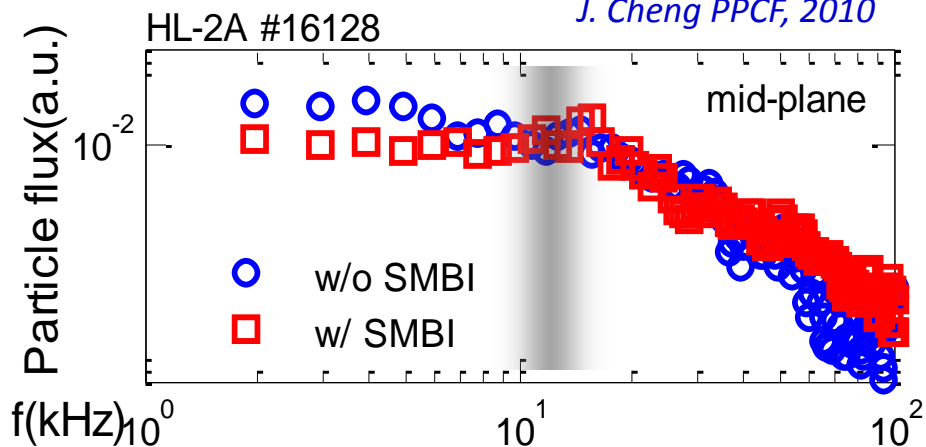
These observations mean that the pedestal particle confinement is degraded by SMBI injection. Point: SMBI deposition in the pedestal inhibits the formation of extended transport events which span the full width of the pedestal. This comes at the expense of an increase in the population of smaller fluctuations and avalanches.

[\[I. Gruzinov, P. H. Diamond and M. N. Rosenbluth, PRL, 2002\]](#)

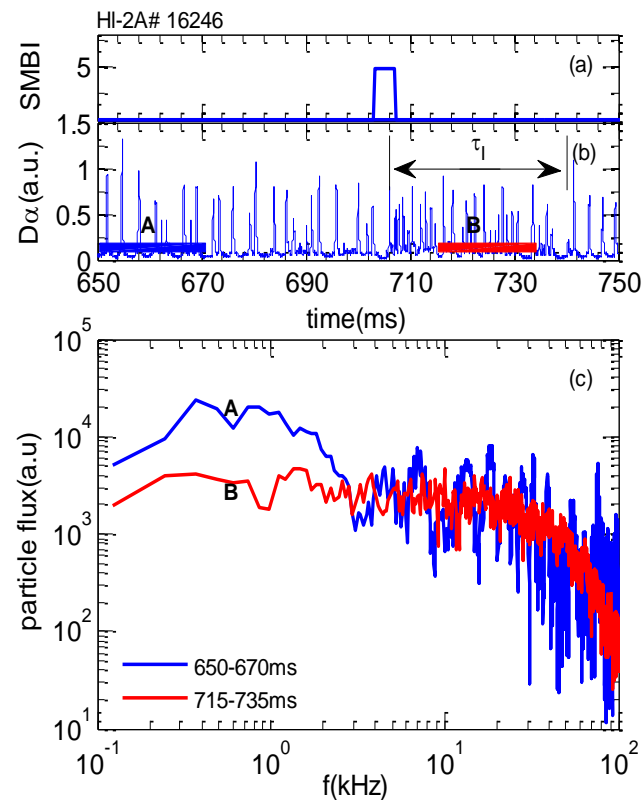
Particle flux analysis →



J. G. Bak et al., Contrib. PP 2010



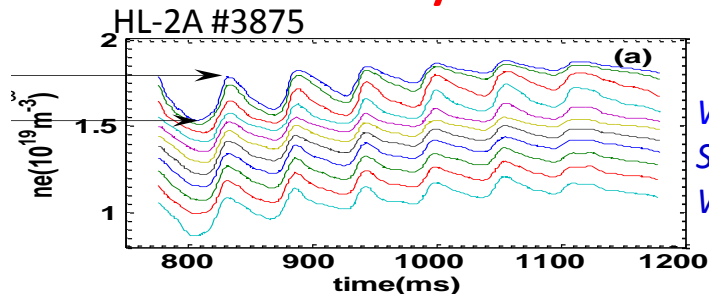
J. Cheng PPCF, 2010



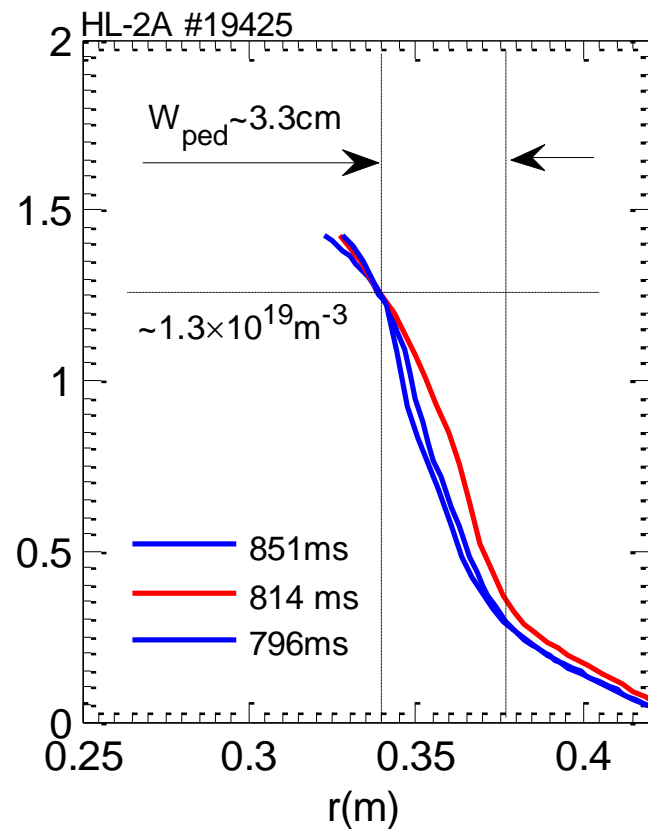
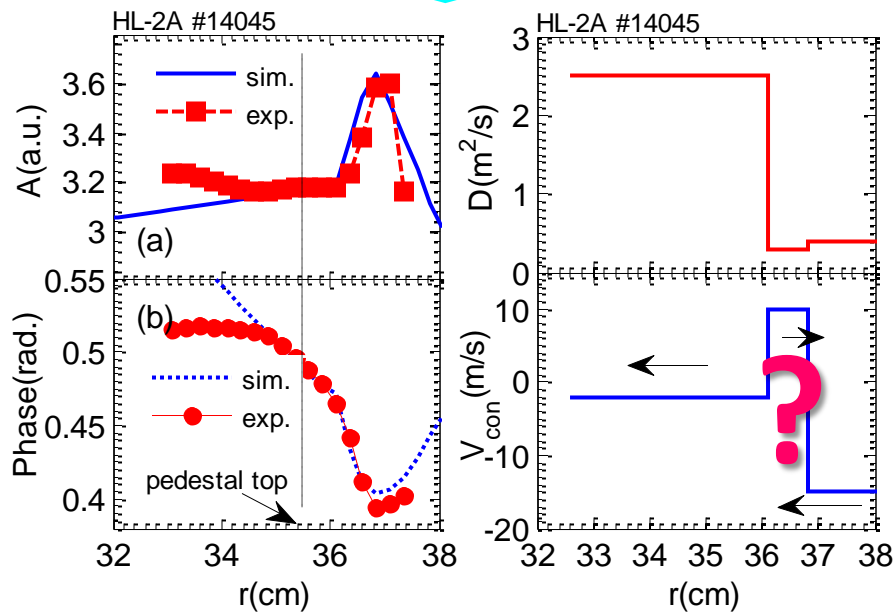
I. Gruzinov, P. H. Diamond and M. N. Rosenbluth, PRL, 2002
T. Rhee, J.M. Kwon, H. Diamond, W.W. Xiao., PoP, 2012
W.W. Xiao, P.H. Diamond, X.L. Zou, et al., NF, 2012

Key point → SMBI deposition in the pedestal inhibits the formation of extended transport events

Particle flux analysis →



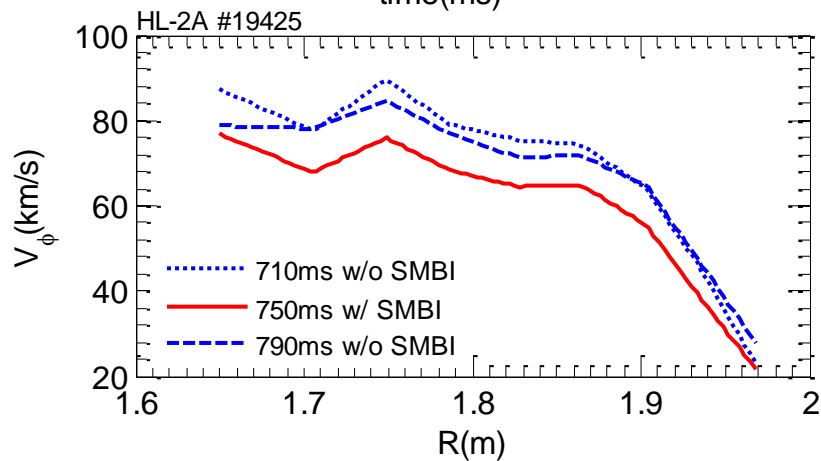
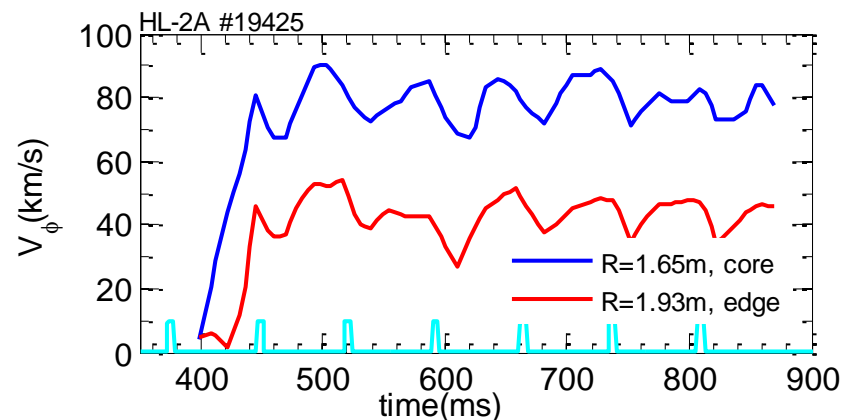
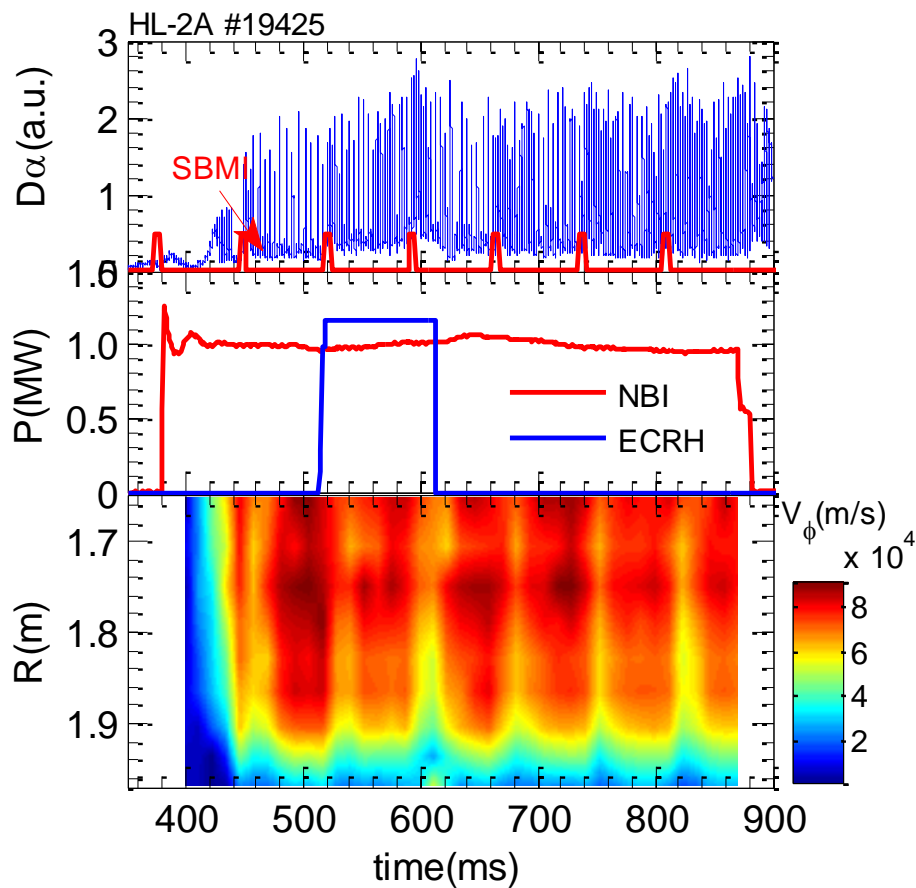
W.W. Xiao, RSI 2010
S. P. Eury, PoP 2005
W.W. Xiao, PRL 2010



L. Wang and P.H. Diamond, NF, 2011

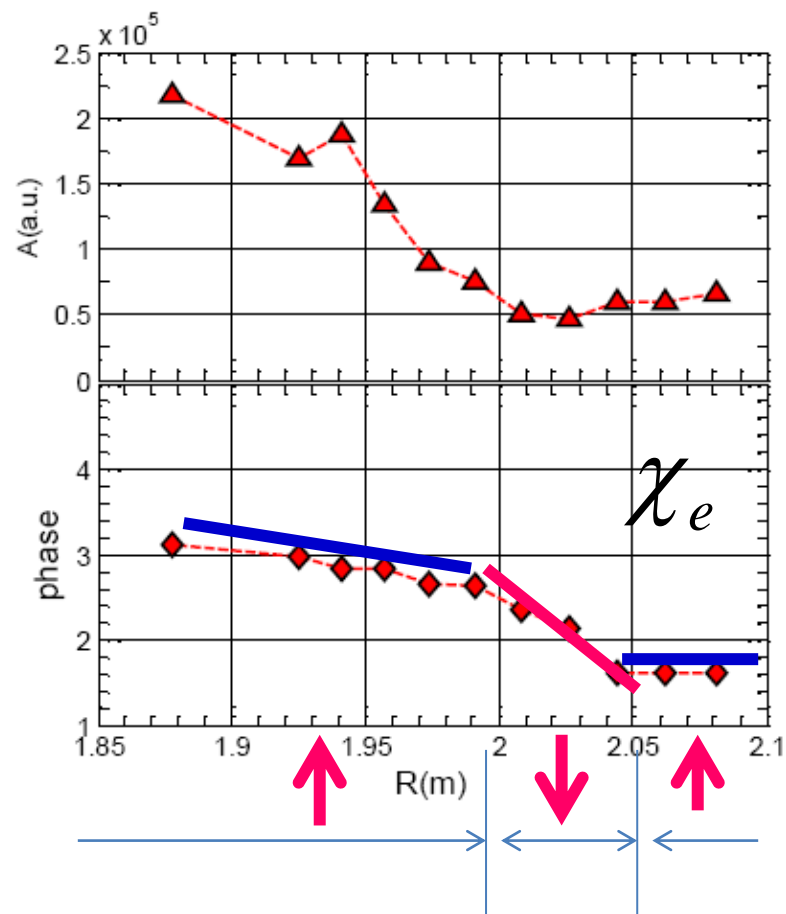
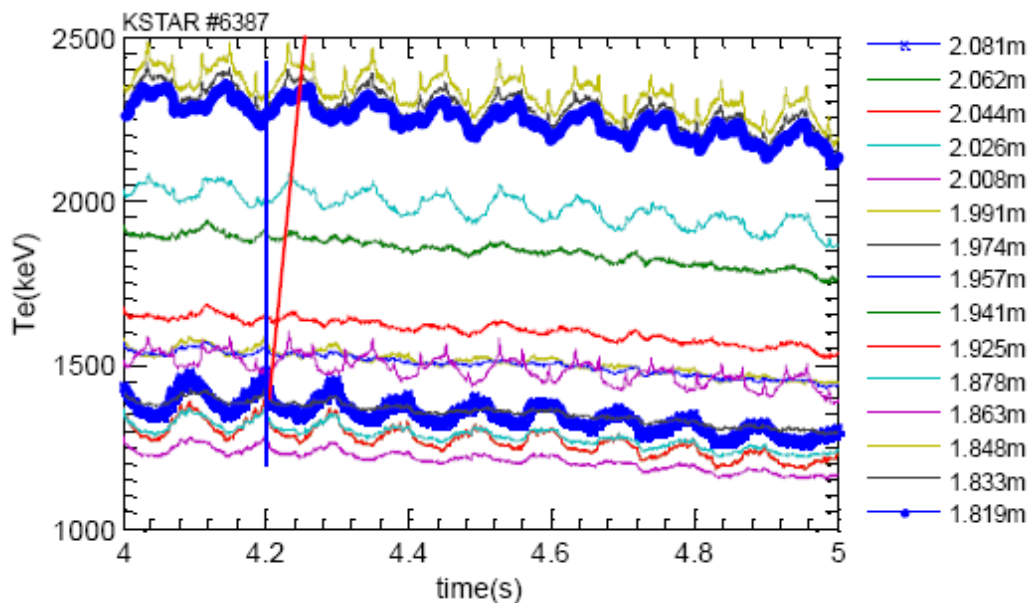
Issues: How to remove the influence from ELM burst and the extra particle source?

Toroidal rotation analysis →



Poloidal rotation analysis is ongoing...

Energy transport analysis →



Modulation ECRH heating in pedestal region

- ELM mitigation by SMBI appears successful and some promising results have been obtained on HL-2A and KSTAR.
 - How to understand the physics of the ELM mitigation?
 - Global plasma confinement is small changed during SMBI.
 - Plasma rotation was modulated during SMBI.
- Long time ELM mitigation has been obtained by multi-SMBI pulses, ~ 400ms. More than confinement time.
- How to remove the influence from ELM burst and the extra particle source?
- Balance transport analysis is necessary and to understand the complex edge transport → explore the relation of particle, energy and momentum.