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

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Outline

• 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
Motivation

We try to understand procedures ....

Many physical topics ....

Transport
- Particle
- Energy
- Momentum

Current
Pressure
Pedestal width
Pedestal height
Recycling

H-mode Stability operation \rightarrow ELM physics ...

This talk will focus on particle transport with and without SMBI to mitigate ELMs.
Experiments in HL-2A and KSTAR

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

KSTAR #6352

HL-2A #14052

HL-2A #19425

W_{ped} \sim 3.3\text{cm}

\sim 1.3 \times 10^{19}\text{m}^{-3}

R_{m}

V_{\phi}(m/s) \sim 1.3 \times 10^{19}\text{m}^{-3}

W_{ped} \sim 3.3\text{cm}
Experiments in HL-2A

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
Experiments in HL-2A and KSTAR

→ 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.

Particle transport

Particle flux analysis ➔

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

J. Cheng PPCF, 2010


Key point ➔ SMBI deposition in the pedestal inhibits the formation of extended transport events
Particle flux analysis →

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

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

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

Poloidal rotation analysis is ongoing...
Energy transport

Energy transport analysis →

Modulation  ECRH heating in pedestal region
Summary

- 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.