

## §25. Development of Cluster Beam for Fueling

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### INTRODUCTION

As an alternative method for fueling, we consider hydrogen cluster beams. Major parameters of the cluster beams proposed are;

	LHD	Reactor
Fueling rate (Pa·m <sup>3</sup> /s)	6	100
Mean cluster size (atoms/cluster)	1,000	10,000
Beam energy (MeV/cluster)	0.1	1
Number of nozzles	1	15

Here we consider cluster beams are injected into the region just inside of the outermost flux surface of the target plasmas, not injected into the core region of the plasmas directly. The fueling rate is variable by changing the number of the energized nozzles and the pulse rate. The parameters of the target plasma will not be influenced significantly by the injection of clusters as pellet injections, because each cluster particle is small and can be injected in a high repetition rate.

Gas clusters can be obtained by adiabatic expansion from nozzles. It is known that about 5% of the total gas flow from a nozzle can be clusters from the researches in the middle of 1970's, where they tried to develop the cluster beams to heat reactor plasmas.<sup>1)</sup> By taking this gas efficiency, 114 (LHD) or 1,900 (Reactor) Pa·m<sup>3</sup>/s must be pumped away and reused. Since the diameter of cluster beams is small (in millimeter range), differed from neutral beams for heating, effective differential pumping is possible.

### KEY ISSUES

The key issues to realize the cluster fueling systems are;

- a) to develop high gas-rate pulsed nozzle with low beam divergence
- b) to develop ionizer to match high gas-rate nozzle
- c) to develop accelerator to match high-gas rate nozzle
- d) to understand the behavior of the clusters after deposited

in a target plasma.

Apart from know-hows accumulated in the development of cluster heating systems in 1970's,<sup>1)</sup> we may adopt recent technologies of cluster beam systems for surface treatment.<sup>2)</sup>

### EXPERIMENTAL APPROACH

We fabricated a movable nozzle to measure the profile of a gas jet from the nozzle in FY 1997.<sup>3)</sup> In FY1998, we developed a direct ionization method of clusters, where a dc discharge is produced between a pulse nozzle and a skimmer.<sup>4)</sup> In FY 1999, we measured the extracted (cluster) ion beam profiles.<sup>5)</sup> For most of the experiments so far, we used argon gas as a working gas because argon clusters are produced in a room temperature and can be handled easily.

Recently we prepared a new nozzle which should have a low beam divergence, a nozzle cooling system using Peltier element, and a compact mass analyzer. The corresponding experimental results would be obtained in the coming fiscal year.

### Reference

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