§27. Transport Analysis System for LHD Plasma Using Pellet Injection

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We are now developing a new system, which is useful to understand plasma transport in LHD using pellet injection. This system consists of diagnostic technique, diagnostic measurement and analysis method, which will be widely available for transport analysis. This program will cover two kinds of areas. One is particle fueling for steady state plasma, particle balance including wall recycling and wall pumping, and temporal changes of their performance. The other is non-local effect of local perturbation given by pellet and gas puffing, time and spatial scales to affect the plasma global performance, and mechanisms for relaxation process of local perturbations.

<Wall effects on density control>

Density control study is one of the most challenging areas in steady state operation of tokamaks and helical devices. In long pulse and relatively high density operation wall pumping effects should be taken into account for steady particle control. Especially, the temporary evolution of wall pumping effects is found to affect plasma density evolution. Without low Z materials coating on the first wall, saturation and refreshment of the wall surface are repeated during a single shot. This has been discovered in TRIAM-1M long pulse operation. Moreover, particle fluxes with relatively low energy contribute to the wall pumping. Knowledge for this subject will help steady state operation in LHD and comparison between two devices will be useful from a wall material point of view.

<H_α signal analysis in plasmas with energetic electrons>

H_α signal is usually used to monitor the particle influx into the plasma. When a pellet is injected, H_α from the pellet cloud is also useful to evaluate the cloud density from Stark broadening. As is well known, however, fast energetic electrons play an important role to ablate the pellet. There are several kinds of energetic electrons when RF waves drive steady current in tokamak and RF waves initiate currentless plasma in helical devices. In order to understand the velocity distribution of the energetic electrons, mainly exist near the plasma boundary and first meet the pellet at the edge, a polarization measurement of H_α emission is done in TRIAM-1M. The Zeeman splitting of the H_α emission is clearly seen at B=6~7T and under some conditions the intensity ratio of π and σ components is found very below the normal value predicted in a Maxwellian plasma. Using a simple model for the velocity distribution function we can evaluate the distortion from the Maxwellian one.

<Curved guide tube for high field side injection>

In the steady state long pulse operation, the fueling efficiency should be improved. The high field side (HFS) pellet injection is one of the most promising fueling methods for fusion plasma, because its fueling efficiency is higher than that of normal pellet injection or gas fueling. From a technological point of view, HFS pellet injection system becomes complicated, because the curved guide tube is required and total length of the pellet path becomes longer compared with the outside- injection system. A pellet is broken when the pellet velocity is too high and the curvature of the guide-tube is small. Therefore, we must optimize the pellet velocity and the curvature of the guide-tube in order to inject a complete pellet with sufficient velocity. Figure 1 shows the experimental set up to study the deceleration effects of the curved guide tube.

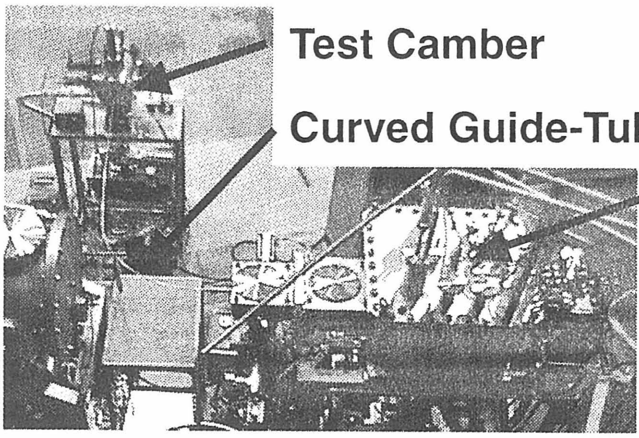

Fig. 1 Photograph of experimental set up. The curvature of the guide-tube is ~ 450 mm.