§30. HCN Laser Scattering Measurement on CHS

Iio-Tsuji, S., Shimada, R., Tsutsui, H. (Tokyo Tech.)
Akiyama, T., Okamura, S., Kawahata, K., Tanaka, K. (NIFS)
Okajima, S. (Chubu Univ.)

Anomalous transport plays a dominant role in the confinement in helical systems. Hence it is indispensable to understand microturbulences to improve confinement since they are supposed to be a cause of the anomalous transport. Two types of improved confinement with a neoclassical internal transport barrier (N-ITB) or an edge transport barrier (ETB) have been observed in CHS. The relationship between transport and microturbulences can be made clear in these plasmas with transitions to improved modes. In this research we develop a HCN laser scattering measurement system to examine the correlations between electron density fluctuations and confinement.

A multichannel HCN laser interferometer started to be developed on CHS in 2003. We plan to utilize the plasma center chord and slightly modify the optics for heterodyne detection to measure the scattered light. A collective heterodyne scattering measurement was adopted because it can distinguish the directions in which electron density fluctuations propagate. We examine some theoretical models by evaluating characteristics of fluctuations such as the wave number and frequency spectra. In order to reveal the relation of transport barriers with fluctuations we investigate changes in features of turbulences before and after a transition to an improved mode.

This interferometric and scattering measurement system is equiped with a Super Rotating Grating (SRG) [1] instead of a usual rotating grating. The grating is attached to the upper part of a rotor in a normal turbo molecular pump, so that it can rotate at higher speed than that of a usual rotating grating. While the frequency of beat signal for heterodyne detection is limited up to several tens kHz with the use of a usual one, the SRG increases it up to maximum of 1.4 MHz. Consequently the SRG enables us to measure fluctuations at high frequencies (~MHz), which are observed in some tokamak devices. Twin lasers are usually utilized to obtain beat frequencies on the order of MHz. The SRG makes it possible to realize high-frequency beat signal at rather lower cost and with shorter time to develop.

Figure 1 shows an elevation view of the whole interferometric and scattering measurement system installed on CHS in 2004 and Fig. 2 is the photograph of the upper part of optical flame. Mechanical vibrations should be suppressed for interferometric measurement, while the floor of around CHS is not so robust. The optical flame thus had to be fastened to the concrete floor of basement. For that reason the height of the flame become about 6 m. The flame was installed without touching CHS or any equipment. The beam path length is about 15 m from the laser to CHS and the beam transmission was designed to be common with interferometric measurement. The optical design was completed.

Detectors are Schottky-barrier diodes (SBDs) because they have high sensitivity in the FIR range. Putting detectors on the designed position on the plate where all optics for detection are placed, we carried out a test to generate the beat signal. As a result, beat signal of 1 MHz was acquired without serious noises. In addition, there was almost no effect of mechanical vibrations even during plasma experiments. The SBD was found to be sensitive to stray microwave power of ECH from the vacuum vessel and the amplitude was much larger than that of the beat signal. Then, by placing detectors inside a shield box made of 5 mm-thick aluminum board with metal mesh for the window for HCN laser light, the microwave noises could be completely eliminated.

Reference
1) Maekawa, T. *et. al.*, Rev. Sci. Instrum. **62**, 304 (1991).

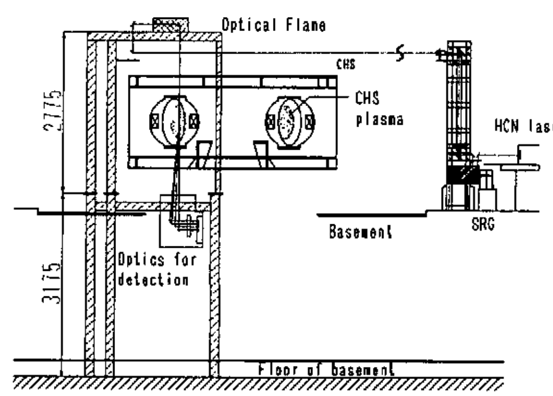

Fig. 1. Schematic View of HCN laser scattering measurement system.

Fig. 2. Installed upper part of optical flame