(TG3) Spectroscopy group report

Date: Jan. 18, 2022 Jan. 19, 2022 (T. Kawate)
Time: 9:40 – 16:43
Shot#: 176501 – 176624 (124 shots)
Prior wall conditioning: Yes
Divertor pump: OFF
Gas puff: H_2, N_2, Ar, Ne

NBI#(1, 2, 3, 4, 5)=gas(H, H, H, H, H)=P(3.8, 4.1, 4.1, 5.1, 4.8)MW
ECH(77GHz)=ant(5.5-U, 2-OUR)=P(0.703, 0.792)MW
ECH(154GHz)=ant(2-OLL, 2-OUL, 2-OLR)=P(0.979, 0.930, 0.986)MW
ICH(3.5U, 3.5L, 4.5U, 4.5L)=P(0, 0, 0, 0)MW
Neutron yield integrated over the experiment = 2.5×10^{12}

Topics

1. Temperature hole (M. Goto)
2. Experimental identification of spectral lines from highly charged heavy ions (C. Suzuki)
3. Study of deuterium/hydrogen molecular band emission in LHD
   (S. Brezinsek, M. Goto, M. Kobayashi)
4. Doppler free spectroscopy for the neutral penetration profile measurement
   (M. Goto, S. Nishiyama)

Study of thermal transport for the plasma with a temperature hole (Goto, Oishi, Murakami)

Experimental conditions:

(R_{ax}, Polarity, B_t, γ, B_q) = (3.75 m, CW, 2.64 T, 1.2538, 100%)

Objective and method:

- Thermal transport for plasmas with a temperature hole produced by tungsten pellet is investigated.
- Temperature hole has been mainly observed for R_{ax}=3.6 m configuration and R_{ax}=3.75 m is attempted.
- n_e is adjusted so that T_i measurement by CXS is possible.

Results:

- Plasma sustainment is difficult with R_{ax}=3.75 m and formation of a clear temperature hole always leads to a collapse (Fig. 1).
- A small size pellet requires higher n_e for having impurity accumulation which is necessary for a temperature hole formation.
- A clear n_e hole has been observed with R_{ax}=3.6 m (Fig. 2), but that is not the case with R_{ax}=3.75 m (Fig. 3).

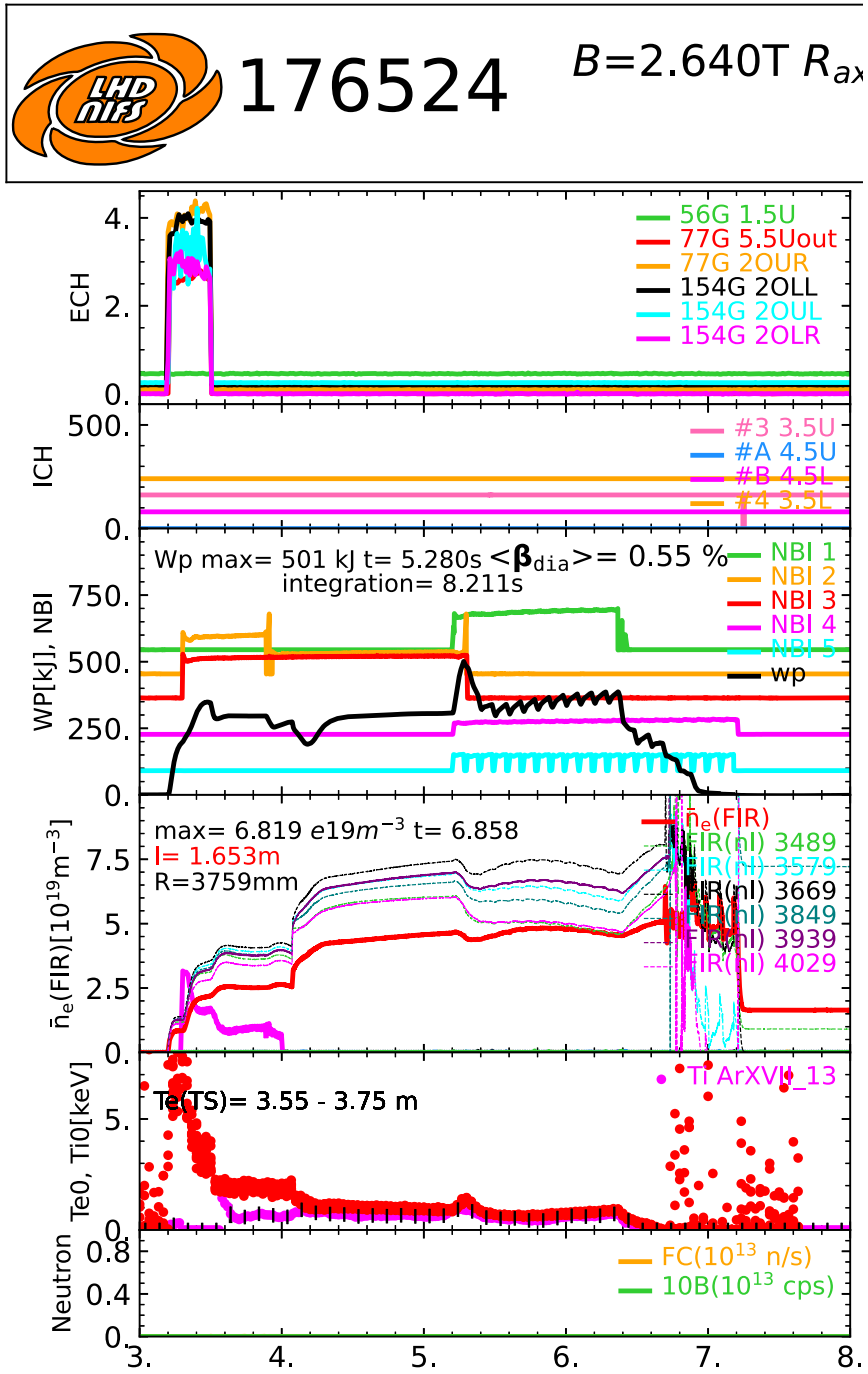


Fig. 1

#172260 (3.6 m)

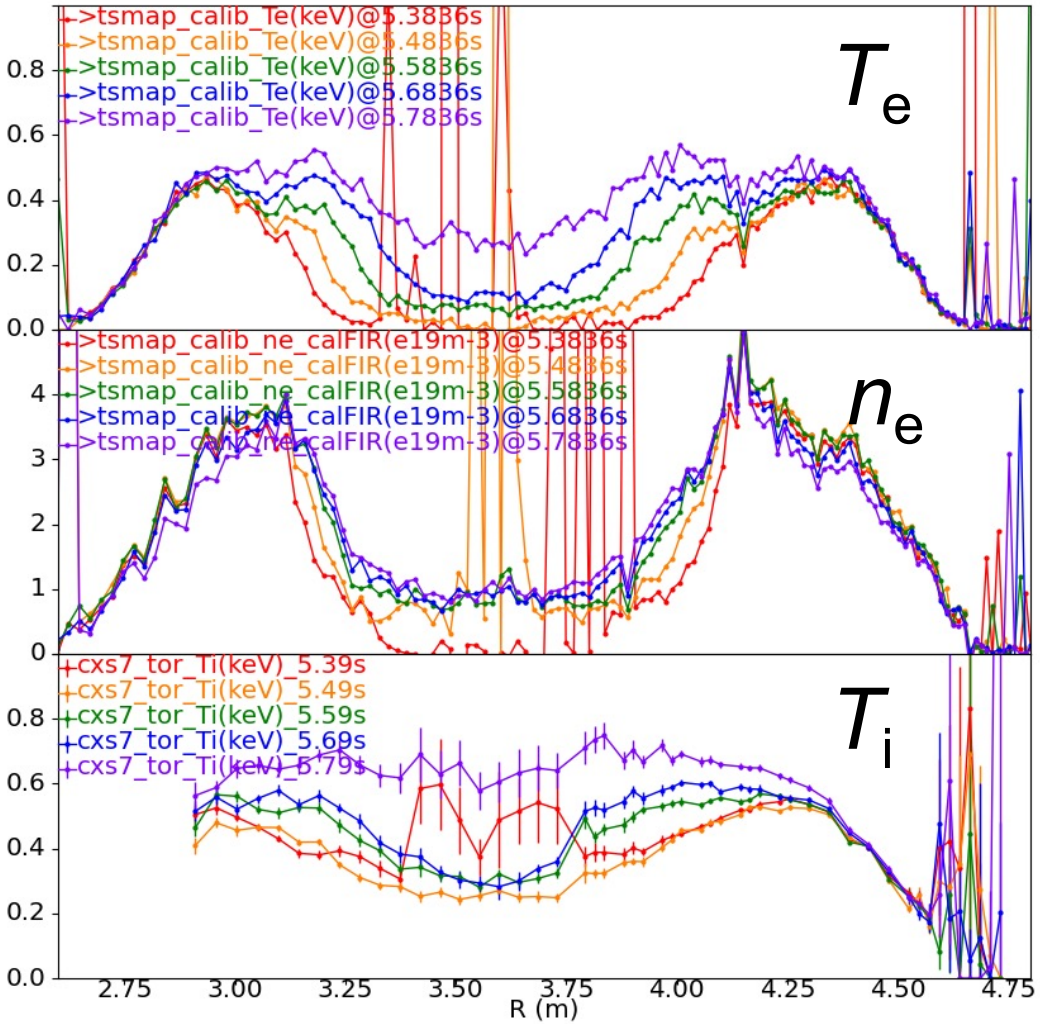


Fig. 2

#176524 (3.75 m)

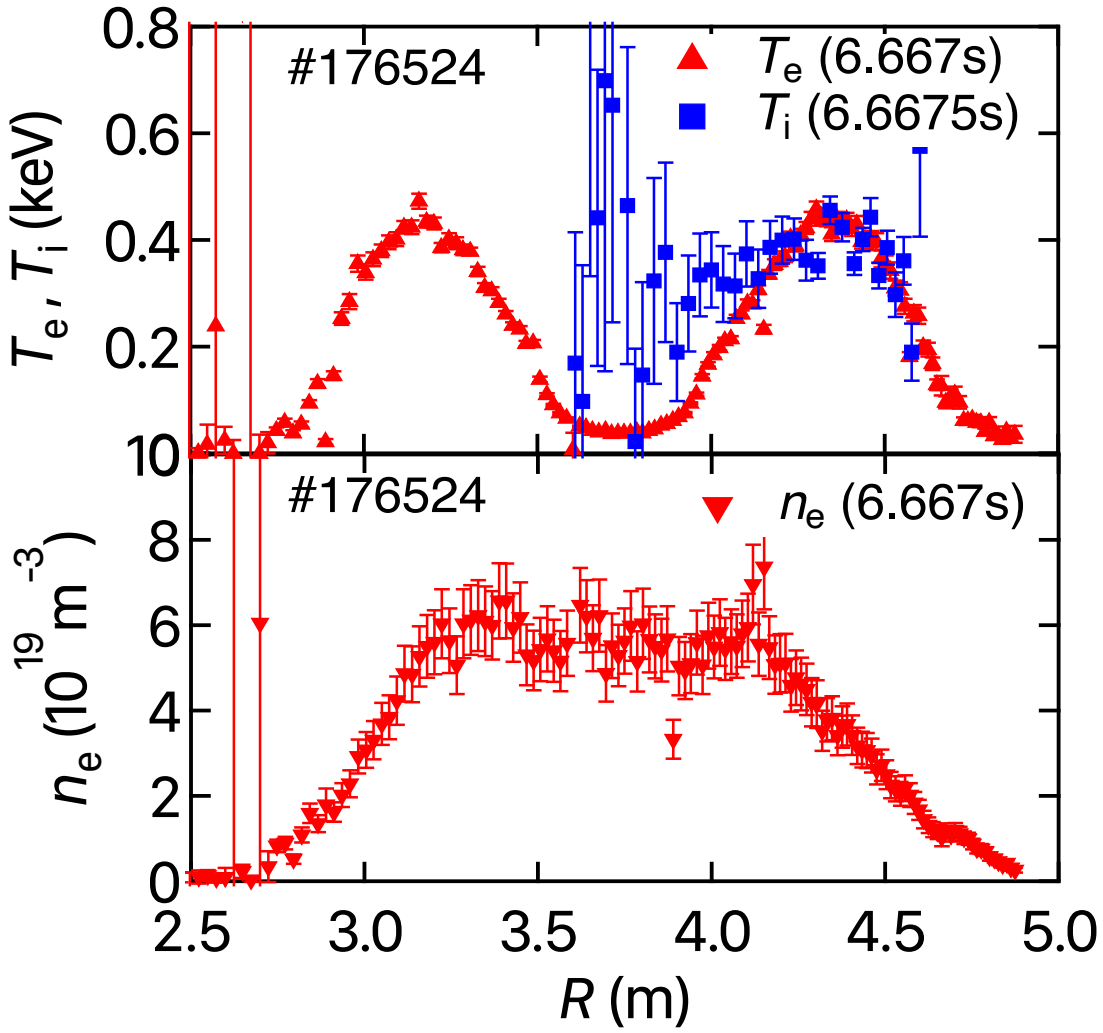


Fig. 3

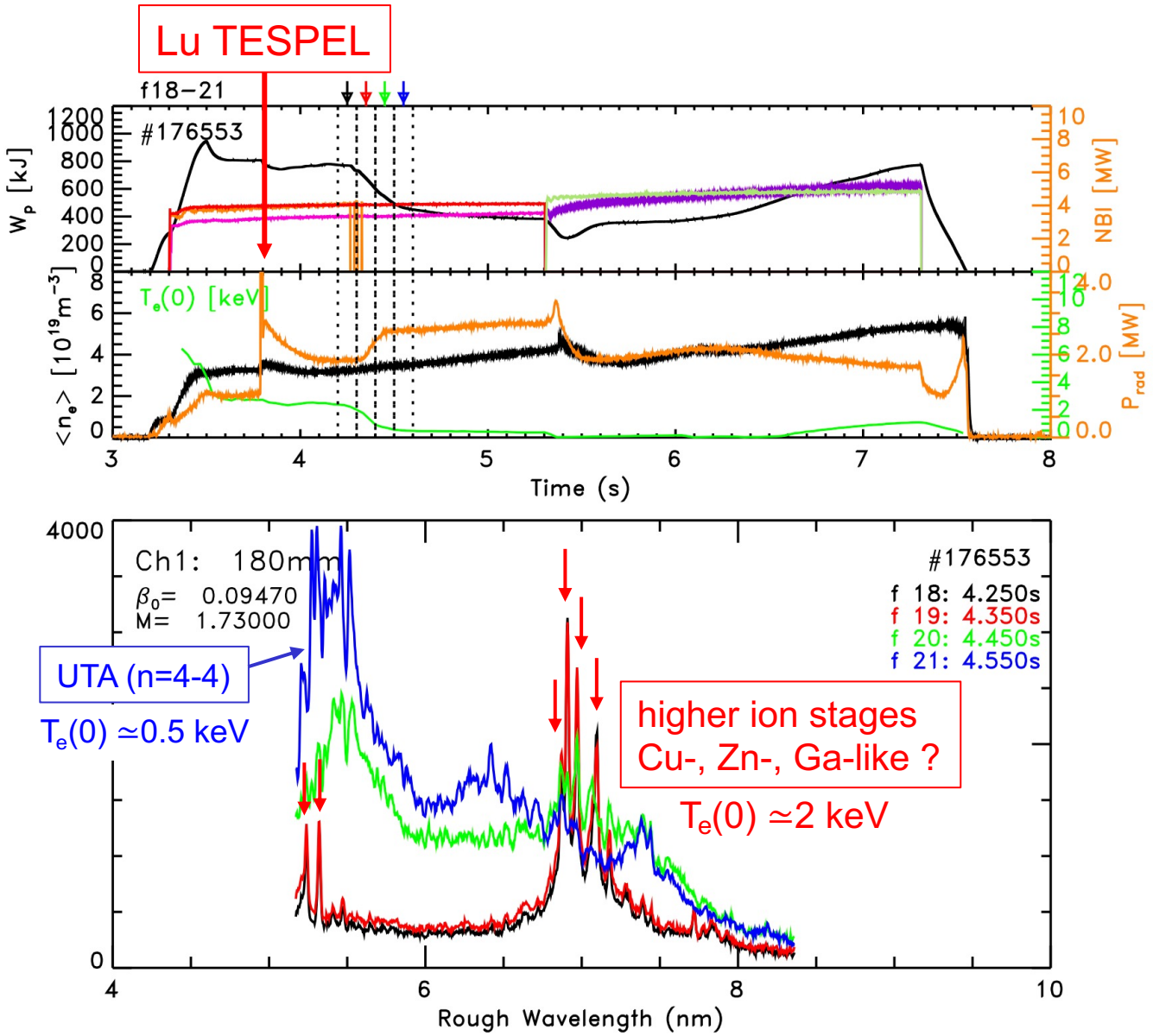
Identification of spectral lines from highly charged heavy ions (C. Suzuki)

Objective: In order to extend the spectral database of heavy ions to various elements and different wavelength ranges, we try to measure soft X-ray/EUV spectra of La, Tm, Yb, and Lu injected by TESPEL.

Experimental conditions:
(R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CW, 2.75 T, 1.2538, 100.0%) #176532–176562

Experiment:
The four heavy elements were injected into NBI plasmas with electron density of (2–5)x10^{19} m^{-3} and electron temperature of about 2 keV. Spectra in the wavelength range of approximately 1–30 nm were measured by SOXMOS and EUV spectrometers.

Results:
Temporal evolutions of the spectra were successfully observed for a wide range of electron temperature. In particular, high temperature spectra of Lu were clearly observed for the first time as shown in the figure.



Study of deuterium molecular band emission in LHD: excited and ground state population as function of divertor conditions (S. Brezinsek, M. Goto, M. Kobayashi et al.) 18 Jan. 2022.

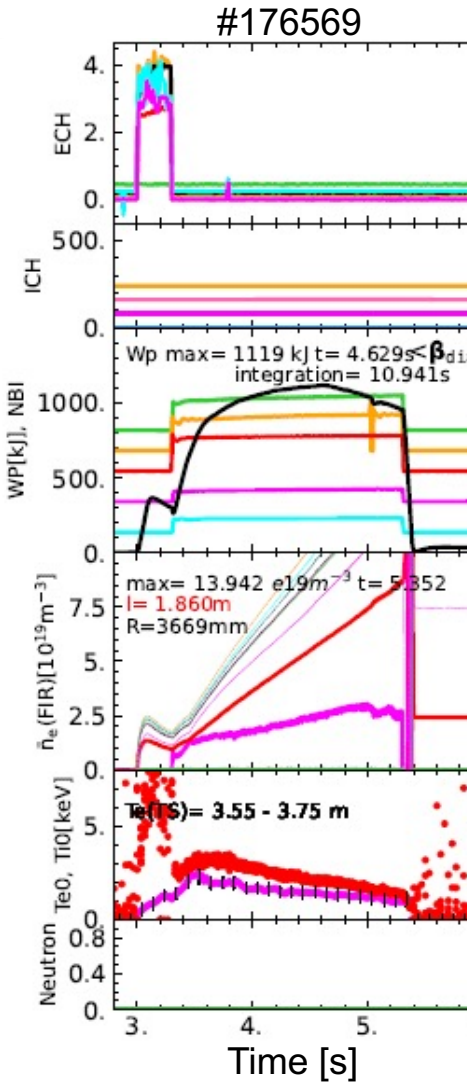
Background & Objectives:
Hydrogen molecule plays an important role in the divertor detachment through their rotational & vibrational states. The present experiment has been conducted to obtain database of the molecular spectra to evaluate rotational & vibrational temperature in various divertor plasma conditions.

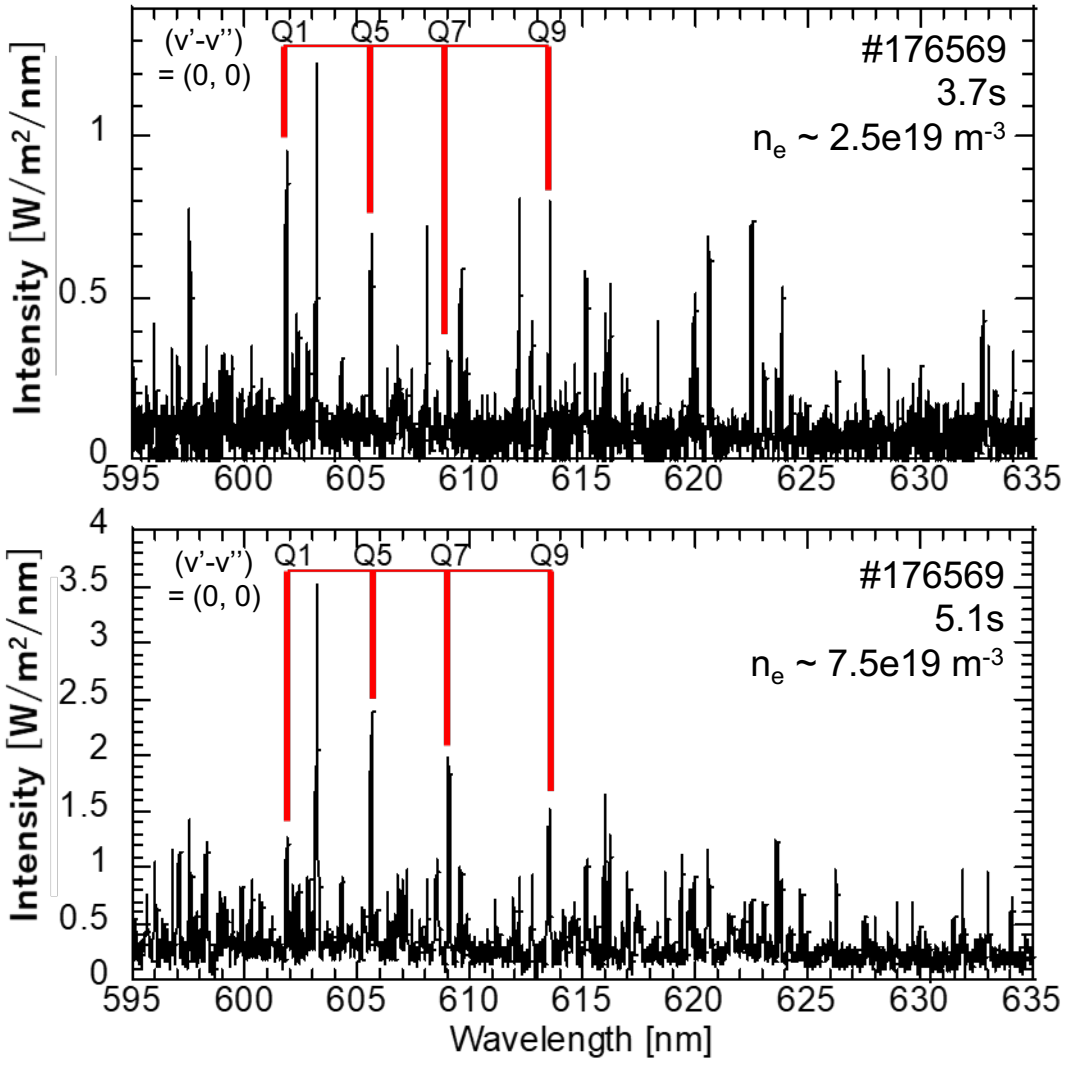
Results: R_{ax}=3.60m, B=2.75T, CW. Dataset of NBI & density scan was extended in addition to the experiments on 21 Dec. 2021.

The molecular spectra were measured with several spectrometers in visible and VUV range. Figures show an example of **density ramp-up discharges** obtained by the Echelle spectrometer viewing the divertor region.

Q-branch lines of (v'-v'') = (0, 0) are identified. **The line intensity ratio of the Q=1, 5, 7, and 9 are clearly different between the low and high density regime**. The result indicates **change of rotational temperature of the hydrogen molecules** for the different divertor plasma parameters.

The detailed analysis will be conducted later.





Doppler-free spectroscopy for Hα

M. Goto and S. Nishiyama

Experimental conditions:
(R_{ax}, Polarity, B_t, γ, B_q) = (3.9 m, CW, 1.375 T, 1.2538, 100.0%)

Motivation and method:

- Doppler free spectroscopy is a technique to eliminate the Doppler broadening from an emission line profile which enables us a measurement of detailed line profile structures.
- We have been trying this technique for the hydrogen H-alpha line.
- Laser is guided by an optical fiber and is injected from 7.5-U port, and the light reflected on a mirror placed at 7.5-L port is received by the same optical fiber (Fig. 1).
- The wavelength is scanned and the absorption spectrum over the entire line profile is measured.

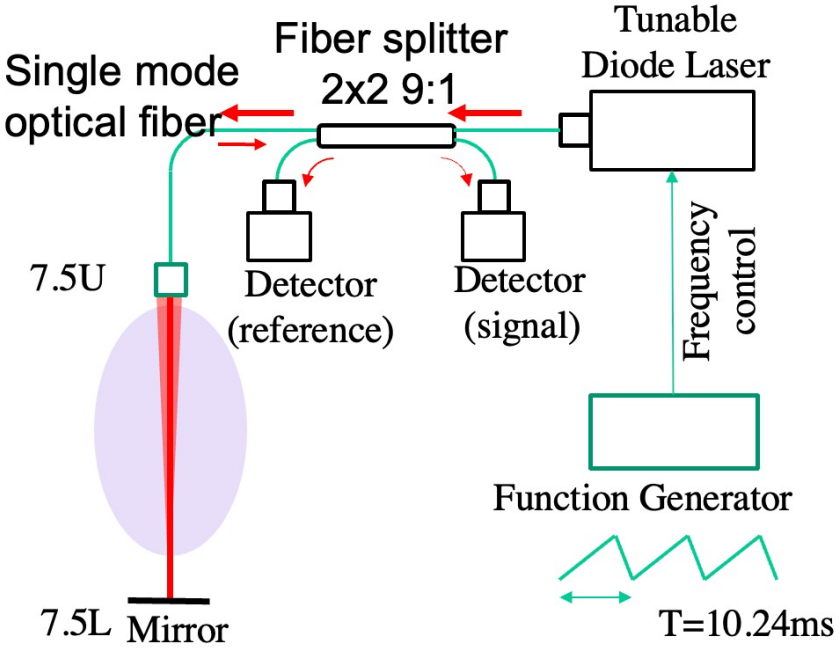


Fig. 1

Results:

- The reflected light has been clearly detected and some difference is seen with and without a plasma (Fig. 2).
- Further investigation is necessary to confirm that the obtained data is really a Doppler-free signal.

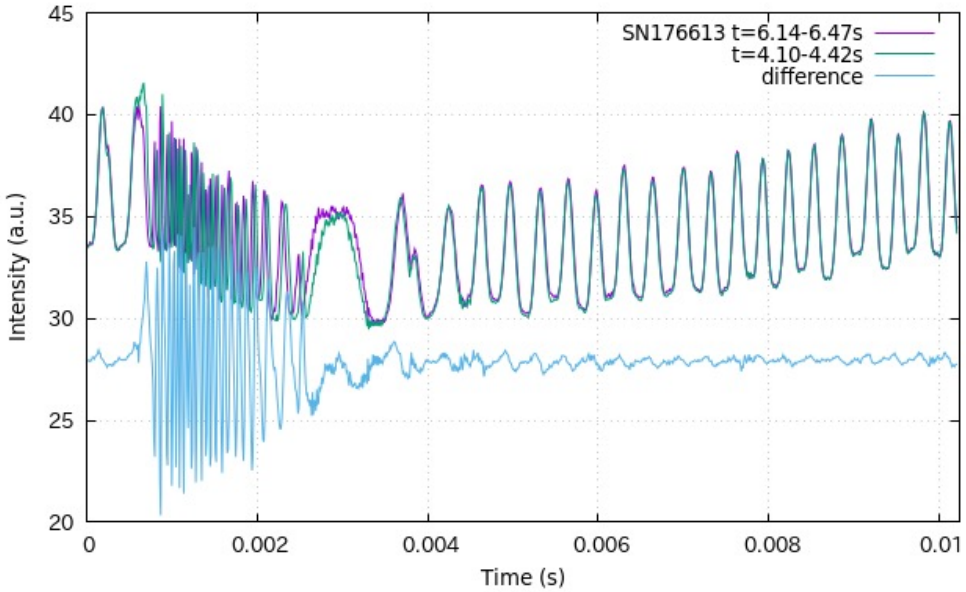


Fig. 2