# (TG3) Spectroscopy group report



Oct. 20, 2021 (T. Oishi)

Date: Oct. 19, 2021 Time: 12:28 – 16:09 Shot#: 170342 – 170412 (71 shots) Prior wall conditioning: No Divertor pump: OFF Gas puff: H<sub>2</sub>, He, Ne, Ar, N<sub>2</sub> Pellet: W, Fe, Ni (Impurity pellet), Ce, LaH<sub>x</sub>, Ho (TESPEL)

NBI#(1, 2, 3, 4, 5)=gas(H, H, H, H, H)=P(3.7, 4.4, 3.8, 4.9, 5.1)MW ECH(77GHz)=ant(5.5-U, 2-OUR)=P(0.45, 0.56)MW ECH(154GHz)=ant(2-OLL, 2-OUL, 2-OLR)=P(0.40, 0.48, 0.48)MW ICH(3.5U, 3.5L, 4.5U, 4.5L)=P(0, 0, 0, 0)MW Neutron yield integrated over the experiment =  $1.5 \times 10^{12}$ 

Topics

- 1. Simultaneous multi-wavelength spectroscopies for validation on atomic data and spectroscopic modelings for highly-charged ions (I. Murakami)
- 2. Observation of visible forbidden lines from tungsten highly charged ions (D. Kato)
- 3. Spectroscopy of highly charged rare-earth ions (F. Koike (Sophia Univ.), C. Suzuki)

### TG3: "Simultaneous multi-wavelength spectroscopies for validation on atomic data and spectroscopic modellings for highly-charged ions"

I. Murakami, D. Kato, T. Oishi, Y. Kawamoto, T. Kawate, H. A. Sakaue, M. Goto

- Conditions: #170342-#170375. NBI #1-#5. ECH. H2 gas.
  (*R*<sub>ax</sub>, Polarity, *B*<sub>t</sub>, γ, *B*<sub>q</sub>) = (3.6 m, CW, 2.75 T, 1.2538, 100.0%)
- **Objectives:** Spectroscopic model (Collisional-radiative (CR) model) of tungsten ions is to be validated with the measured spectra using LHD, especially for low charged ions.
- Experiments: A tungsten impurity pellet was injected at 4.0s. NBO #1-3 were injected at 3.3-5.3s and NBI#4-5 were injected at 5.3-7.3s. EUV spectra at 2.0-7.7nm and 10-30nm were measured.
- **Results:** Strong radiation power of accumulated tungsten at core caused temperature hole. W<sup>6+</sup> and W<sup>7+</sup> lines were observed when the cold hole was producing. Modulating NBI#4 and #5 could sustain plasma when the tungsten accumulation was mild. We first measured ion temperature distribution using CXS7 when electron temperature hole was producing.



## TG3: Observation of visible forbidden lines from tungsten highly charged ions

Proponent: D. Kato

Co-authors: M. Goto, T. Oishi, Y. Kawamoto, N. Tamura, H. Funaba, H.A. Sakaue, I. Murakami, T. Kawate, N. Nakamura (UEC)

#### Experimental conditions:

 $(R_{ax}, Polarity, B_{t}, \gamma, B_{q}) = (3.6 \text{ m}, CW, 2.75 \text{ T}, 1.2538, 100.0\%), #170342 - #170375, NBI#1-5, ECH, H2 gas$ 

### **Objectives**

Observations of UV-visible lines of W highly charged ions in LHD core plasmas, and identification of the M1 transitions.

#### **Experiments**

A tungsten impurity pellet was injected at 4.0s. NBI#1-3 were injected at 3.3-5.3s and NBI#4-5 were injected at 5.3-7.3s.

#### **Preliminary results**

Temperature hole was observed at 5.2 - 5.3s. Low Te (< 200eV) plasmas with W content were successfully created. Visible forbidden lines of low charge state W ions will be identified.





## Spectroscopy of highly charged rare earth ions (F. Koike, C. Suzuki)

**Objective:** In order to extend the spectral database of rare earth ions to various elements and different wavelength ranges, we try to measure EUV spectra of La, Ce, and Ho  $\overline{\mathbf{z}}$  injected by TESPEL.

## **Experimental conditions:**

 $(R_{ax}, Polarity, B_t, \gamma, B_q) = (3.6 \text{ m}, CW, 2.75 \text{ T}, 1.2538, 100.0\%)$ #170376–170409

## **Experiment:**

The three lanthanide elements were injected into NBI plasmas with electron density around  $(3-5)x10^{19}$  m<sup>-3</sup>. Extreme ultraviolet spectra in several different wavelength ranges were measured by multiple spectrometers.

## **Results:**

EUV spectra including unknown lines were observed in high/low temperature cases. In particular, Ce spectra were clearly observed as shown in the figure.

