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PLASMA ROTATION MEASURED BY H_α EMISSION FROM THE T2R REVERSED FIELD PINCH

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1 Introduction

We reported previously [1] on the flow of hydrogen in the T2R reversed field pinch, determined from the line shape of the Balmer$_\alpha$ hydrogen line, measured along a line of sight in the poloidal plane. This line shape could only be explained by assuming different groups of excited hydrogen atoms, each with its specific velocity. We found a radial movement of about 20 km/s, on which superimposed a rotation of about 2 km/s. We extended now our measurements to investigate the influence of the plasma current on these flows.

2 Experimental Setup

A 1.5 m Czerny-Turner spectrometer, equipped with a 1200 l/mm grating, was used to study the light emitted in the visible and ultra-violet wavelength region. An image-intensifier at the exit plane of the spectrometer was lens-coupled to a linear array CCD camera with 2048 pixels [2].

The observation volume in T2R for this experiment is a cylinder in the poloidal plane with a diameter of 10 mm. The light collected was transported to the spectrometer through a 14 m long fiber and moved between different observation ports (see figure 1) for different plasma discharges. In this way we could use four different impact parameters, observing both from the top and from the bottom of the device.

The line profile of H_α was studied during a time interval of about 1 - 4 ms after the start of the discharge. To fit the profile of the H_α line we needed three Gaussians (see figure 2) as mentioned before [1], shifted in wavelength. A small central component did not shift much in wavelength when changing observation port. This can be explained as originating from H_2, dissociated and excited close to the wall.

The other two components represent a group of H-atoms moving radially. We see light from this group, excited in a limited range of the minor radius, shifted to both longer and shorter wavelengths. Light emitted from atoms closer to the fiber with the velocity component along the line of sight e.g. towards us, leads to a blue shift, while emission from atoms at the other side of the vessel, moving away from us, leads to a red shift. The average splitting between these components is around 13 pixels, corresponding to 20 km/s radial velocity, half the difference in speed between the two groups.

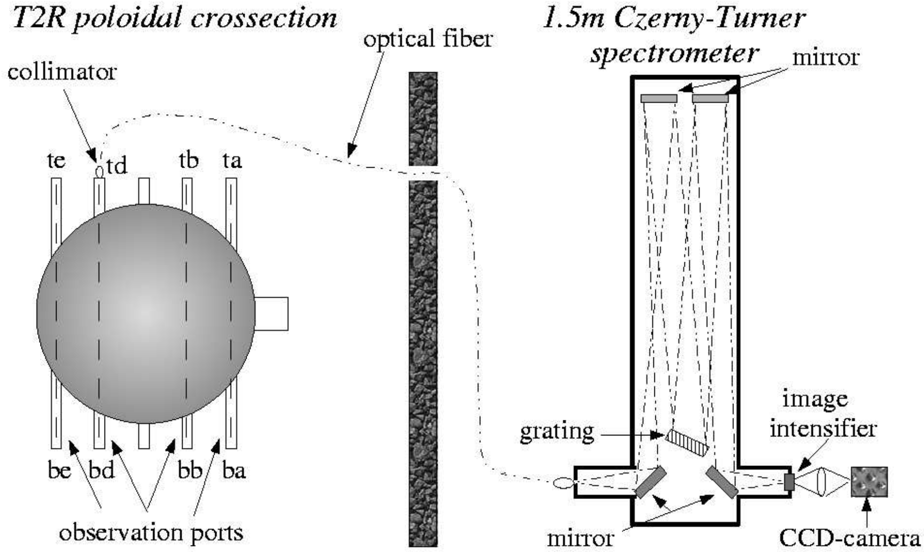

Figure 1: *Light was collected from eight observation ports in a poloidal cross section: four on the top,* **t***, resp. the bottom,* **b***, of the machine, labeled from* **a** *on the outboard side to* **e** *on the inboard side.*

3 Results

We measured the positions of the components of H_α from a series of similar discharges while moving the fiber through all eight possible poloidal ports.We found that the positions (and averages) of the two main components were shifted to longer wavelengths when observed through ports **ta** (top,outboard) and **be** (bottom,inboard) and to shorter wavelengths when observed through **ba** and **te**. This effect is less pronounced for the **b** and **d** positions. This shift is caused by a poloidal, rotational movement of the order of 2 km/s. By repeating a series of discharges at different plasma current we could study if the current influenced the flow and hence the line shifts. The results, calculated from the observations at ports **a** and **e**, are given in figure 3.

The observations at the lowest plasma current were repeated using the newly installed gas puff device, which allows to maintain a higher density during the discharge. This caused an increase in the rotation, but the error is also increased, see figure 3. This resulted from larger variations in the positions of the two main components between different time frames in the same discharge, an indication of an increase in turbulence. As mentioned above, the distance between the two main components allows us to determine the radial velocity of hydrogen. The results are shown in figure 4. In this case we selected

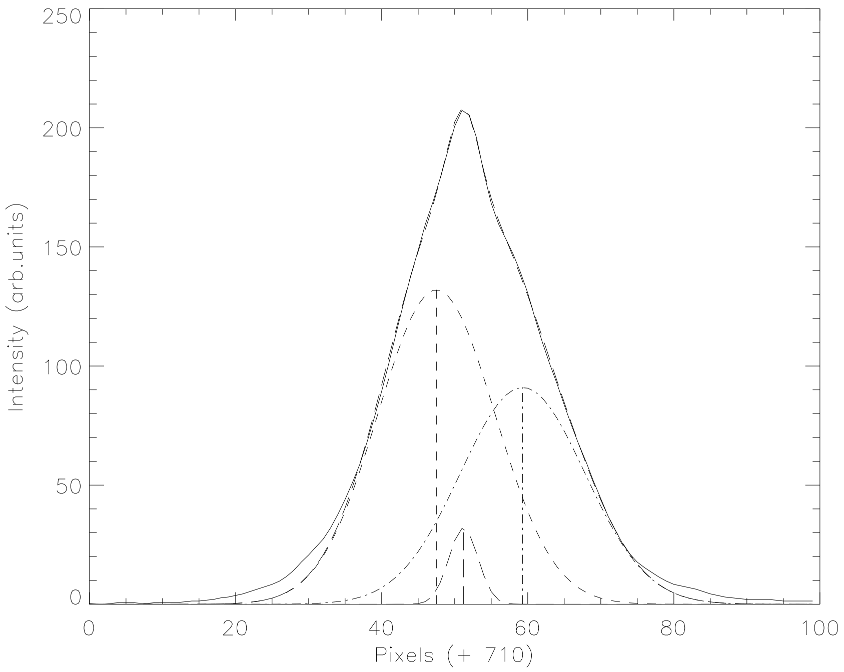

Figure 2: *A typical lineprofile fitted with three Gaussians. The integration time for these profiles was 0.6 ms.*

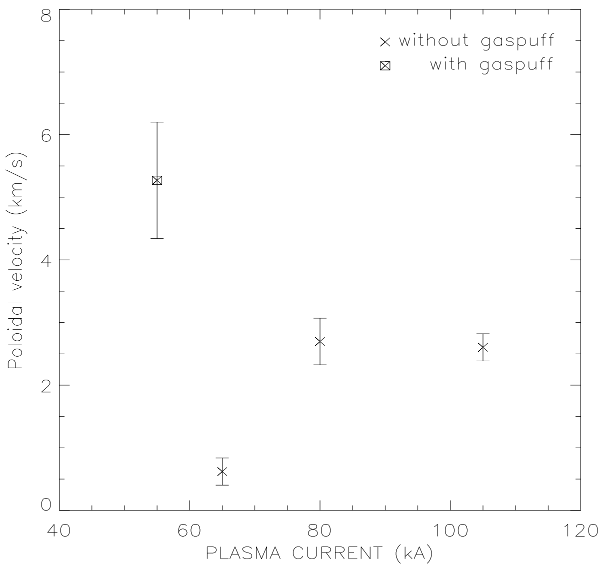

Figure 3: *Poloidal rotation of hydrogen from the observations of H_α through ports* **a** *and* **e**.

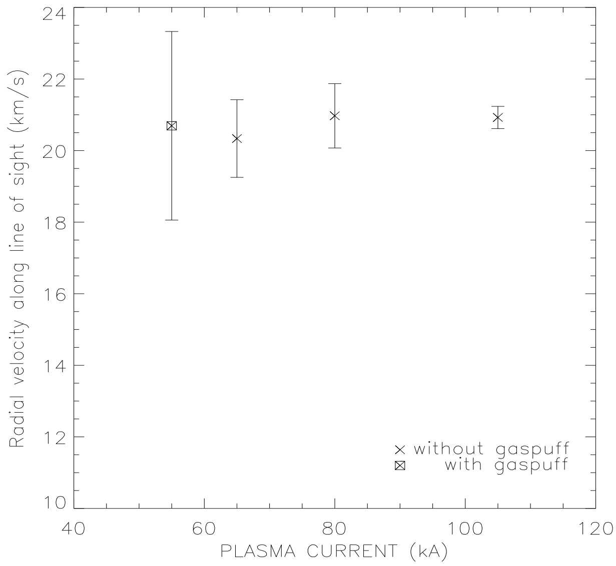

Figure 4: *The radial velocity of hydrogen from the observations of H_α through ports* **b** *and* **d**.

the observations from the ports **b** and **d**, where the direction of the radial movement of hydrogen is less deviating from the line of sight, than if **a** and **e** are used. The plasma current seems to have little or no influence on the radial flow, but the use of the gas puff system increased also here the inaccuracy of the measurement.

4 Conclusions

The line shape of H_α emitted from the reversed field pinch T2R and observed in a poloidal plane, revealed two Doppler shifted components and a small unshifted one. From the main components we could determine a general radial movement of hydrogen atoms of the order of 20 km/s. Superimposed hereupon a rotation was measured. The rotational speed, of a few km/s, depended on the plasma current.

References

[1] F.G. Meijer, R.M. Gravestijn and E. Rachlew, 28th EPS Conference on Controlled Fusion and Plasma Physics, Funchal, 2001.

[2] F.G. Meijer, *A high resolution vacuum ultraviolet spectrometer for plasma spectroscopy*, Meas.Sci.Technol. **10** (1999) 367-373.