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Space and Time Resolved XUV Spectroscopy of C V and O VII Lines

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1 Introduction

The radiation of the light impurities (Carbon and Oxygen) in the CASTOR tokamak (R=0.4 m, a=0.085 m, T_e~200 eV) has been measured in the VUV and USX ranges. The measured spectra have been interpreted by the STRAHL code and by the newly developed IDL based code EVIMP. The impurity transport parameters have been estimated. Also, first measurements with XUV monochromator are noticed.

2 Experimental Setup

The two-channel multilayer-mirror based USX spectrometer [1], constructed in IPP Prague, allows the absolute spectrum measurements in the ranges of 1.4-2.4 nm and 3.1-4.5 nm with the space resolution about 5 mm on plasma and time resolution 100 ìs. This spectrometer can be mechanically tilted by –10°, so that both the time and space resolved spectral lines of the He- and H-like Carbon and Oxygen are measured. Additionally, the time behavior of the lower ionization states is monitored in a visible or VUV range by a photomultiplier with interference filter.

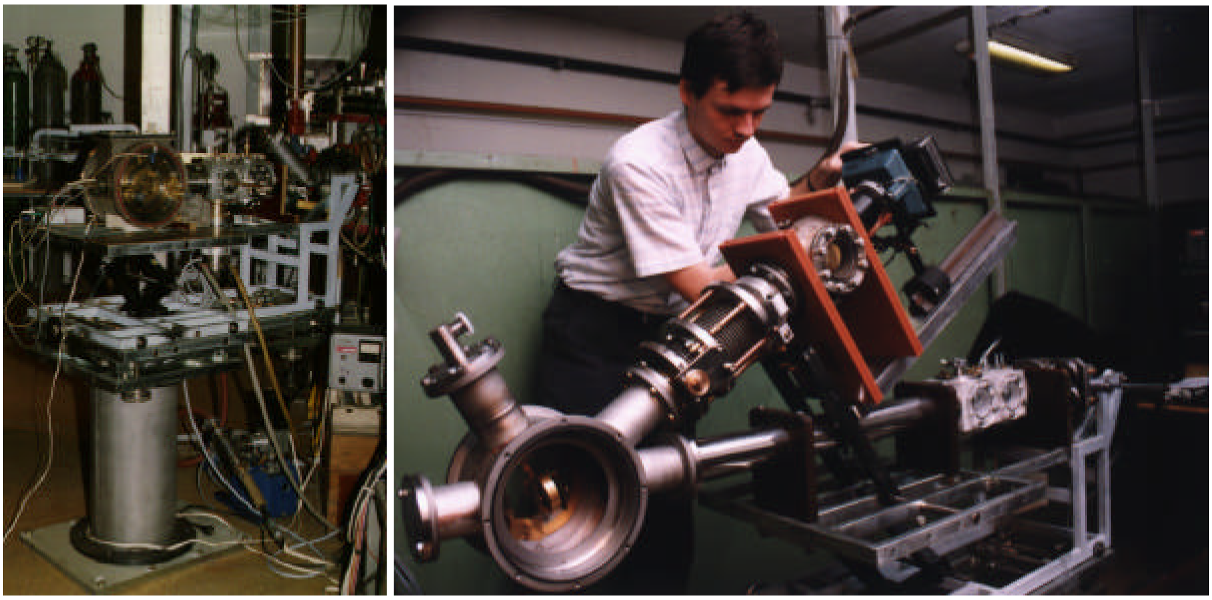

Fig.1. The two-channel MLM based USX spectrometer (left) and the imaging high-throughput XUV monochromator on base of the spherical multilayer mirror (right)

The newly constructed imaging high-throughput XUV monochromator on base of spherical multilayer mirror will allow measurements on Carbon line C V 4.027 nm with spatial resolution better than 1 mm and time resolution 10 ìs.

3 Impurity Evolution Model

The time dependent coronal model with transport phenomena was used to compute the impurity distributions. A new version of the more general STRAHL code [3], programmed in Garching (version 10/1999 by R.Dux), was applied on the discharge data. However, the new EVIMP (EVolution of IMPurities) code under IDL 5.2 was developed especially for a small radius, high temperature tokamak plasmas. The EVIMP allows to include a real plasma parameter behavior, such as $n_e(r,t)$, $T_e(r,t)$, etc.

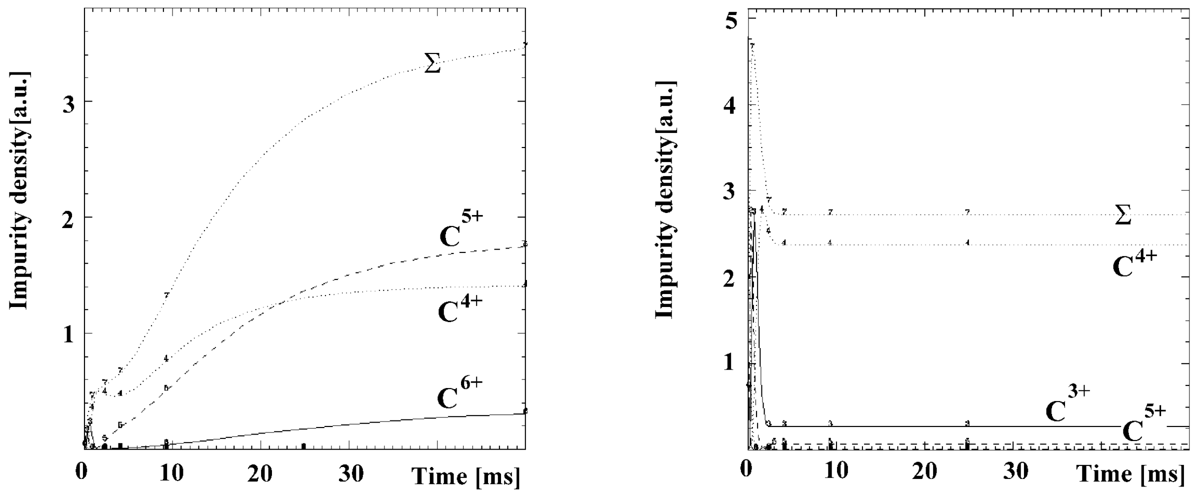

Fig. 2. The temporal behavior of the Carbon ion distribution for two limit situations: low diffusion D=0.1 m^2/s (left), and high diffusion D=5 m^2/s (right).

4 Experimental results

The dominant lines in the USX range, measured by the USX spectrometer on the CASTOR, are following: O VII (2.181 nm, 2.160 nm, 1.863 nm), O VIII (1.897 nm), C V (4.027 nm), C VI (3.374 nm). The temporal behavior of spectrum in the Carbon and Oxygen lines range is shown in Fig. 3. The spatial profiles of the most intensive lines are figured in Fig. 4. In addition, the C III line (464.7 nm) is monitored by a photomultiplier with an interference filter (Fig. 5.). Nowadays, the first measurements with newly constructed XUV monochromator equipped by a MCP with a four-anode collector are realized [2]. In the next months, the monochromator will come with a new detection part, so the presented spatial and temporal resolution will be reached.

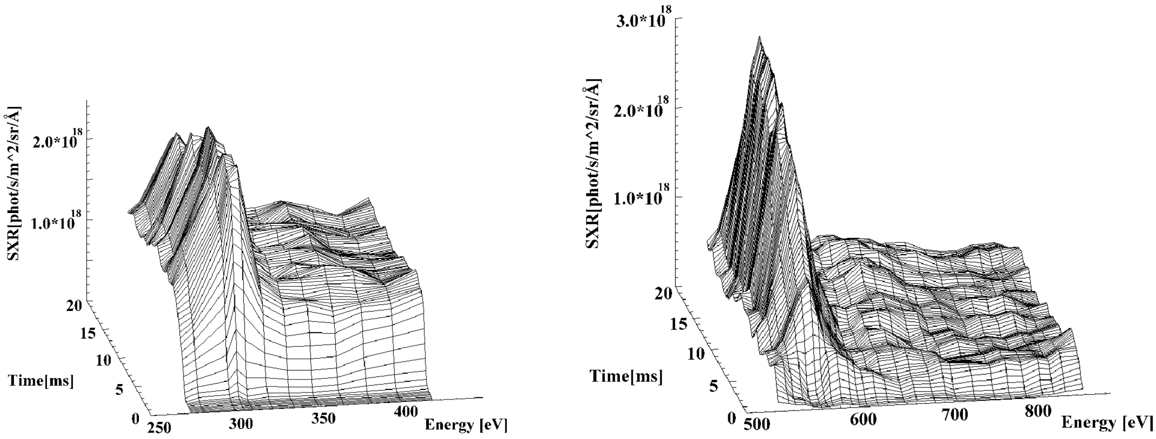

Fig. 3. Spectrum in the Carbon lines (left) and the Oxygen lines (right) range measured shot-by-shot by the USX spectrometer.

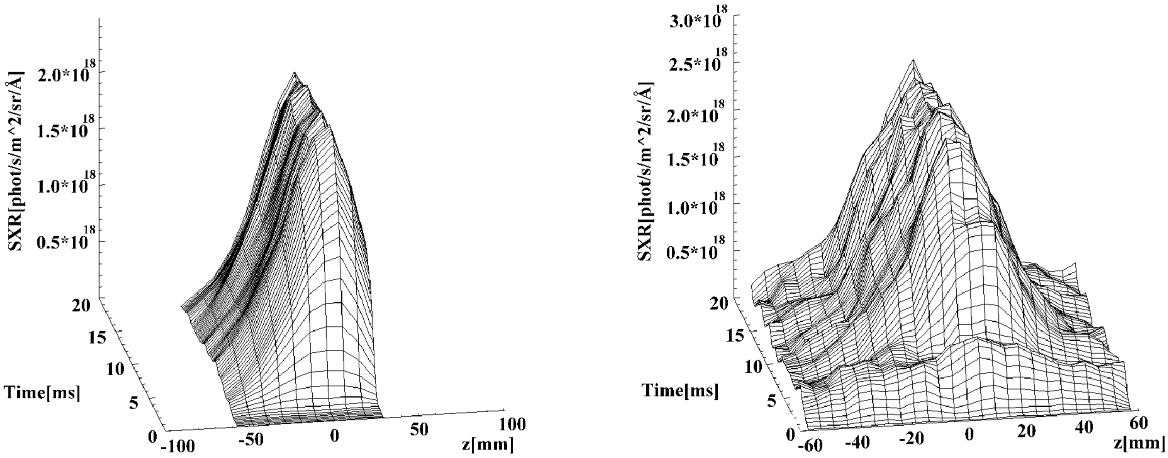

Fig. 4. The line-of-sight measured profile of C V 308 eV (left) and O VII 574 eV (right).

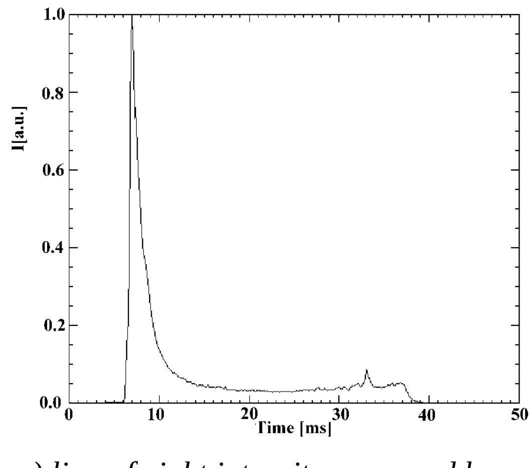

Fig. 5. The C III (464.7 nm) line-of-sight intensity measured by a photomultiplier.

5 Conclusion

The model shows that the ratio between the O VII lines depends strongly on the local plasma temperature T_e, especially for the range 100-300 eV. In our case, due to the space resolution, the experimental data of the above-mentioned lines give the local electron temperature and Oxygen concentration. The time evolution of the O VII lines intensity depends weakly on impurity transport. On the other hand, the space and time profiles of the C V line are very sensitive to the impurity diffusion across magnetic fields, in the plasma conditions of the CASTOR tokamak. Both two transport codes lead to the diffusion estimation typical for tokamaks. The space and time resolved USX spectroscopy of C V and O VII lines is a suitable tool for estimation of the impurity transport in the plasma within T_e=100-300 eV.

6 Acknowledgements

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7 References

[1] V.Piffl, J.Badalec, A.V.Golubev, S.V.Bobashev, IPPCZ-340, IPP Prague, 1994
[2] V.Piffl, J.Badalec, Vl.Weinzettl, Prototype of the Imaging High-throughput XUV Monochromator on Base of Spherical Multilayer Mirror , 26th EPS, Maastricht, 1999
[3] Behringer, K., JET-R(87)08, Culham, 1987