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Mo flux and effective sputtering from the toroidal limiter

Visible spectroscopy is used in FTU to measure the intensity of spectral lines both of hydrogen or deuterium and the impurities present in the plasma [1]. Since the spectrometer can be calibrated in absolute intensity, the impurity flux is derived by the measurements of absolute line intensity.

The radiation in the visible spectral range is principally emitted in the edge regions of the plasma, by the neutral atoms or by ions with low ionisation stages. Thus, the visible spectroscopy is an important diagnostic tool for studing impurity concentrations and transport.

Since FTU is operating with a toroidal limiter in molibdenum, the most careful analysis is done for molibdenum impurity [2]. A visible spectrum, in the range of 3800-7000 A, for a tipical FTU discharge, is shown in fig.1. The identified MoI lines and their corresponding transitions are shown in table 1:

Table 1

wavelenght (A)	transition term
3798.3	$z^7P^o_4$-a^7S_3
3864.1	$z^7P^o_3$-a^7S_3
3903.0	$z^7P^o_2$-a^7S_3
5506.5	$z^5P^o_3$-a^5S_2
5533.0	$z^5P^o_2$-a^5S_2
5570.4	$z^5P^o_1$-a^5S_2

The first three lines correspond to the transition from the level z^7P^o to the fundamental state (a^7S_3) while the last three lines from the level z^5P^o to the metastable state (a^5S_2).

The brightness of these lines can be used to obtain the MoI flux from the limiter, by computing the ratio S/XB, i.e. the number of ionisation per photon emitted (S being the ionisation rate, X the excitation rate and B the branching ratio of the observed line) [3]. Fig.2 shows the MoI flux, computed by the first three lines, as a function of the electron density for discharge at 6 T and 0.6 MA, in configuration of toroidal limiter and H_2 fuel (a) and in configuration of poloidal limiter and D_2 fuel (b). In both cases, the MoI flux decreases with the density until it reaches the detection limit. By comparing the two different configurations, the MoI flux is 10 times less operating with toroidal limiter, as expected by the ratio between the limiter emitted surfaces and by operating with different fuels.

In fig.3 the ratio of MoI flux to the fuel flux is shown. The hydrogen flux is derived by the brightness of H_β line intensity for case (a) and the deuterium flux by D_γ line intensity for case (b). The ratio can be considered as an effective sputtering yield of Mo due to the hydrogen/deuterium ions impinging on the limiter surface and self-sputtering. In toroidal limiter configuration, this ratio is of the same order of magnitude (within a factor 3) of that obtained in poloidal limiter configuration.

REFERENCES

[1] I. Condrea, R. Bartiromo, G. Mazzitelli and D.H. McNeill, Proc. 14th Int. Conf. on Plasma Physics, Innsbruk,1992

[2] M.L. Apicella, G. Apruzzese, G. Bracco, et.al., ENEA Report, RT/ERG/FUS/95/19 (submitted to Nuclear Fusion)

[3] N.R. Badnell, T.W. Gorczyca, M.S. Pindzola and H.P. Summers, J. Phys. B **29**, 3683 (1996)

FIGURE CAPTION

Fig.1-Visible spectrum for a tipical FTU discharge.

Fig.2-Neutral Mo influx , in toroidal limiter configuration (a) and in poloidal limiter configuration (b).

Fig.3-The ratio of MoI flux to the fuel flux, in the same cases of fig.2.

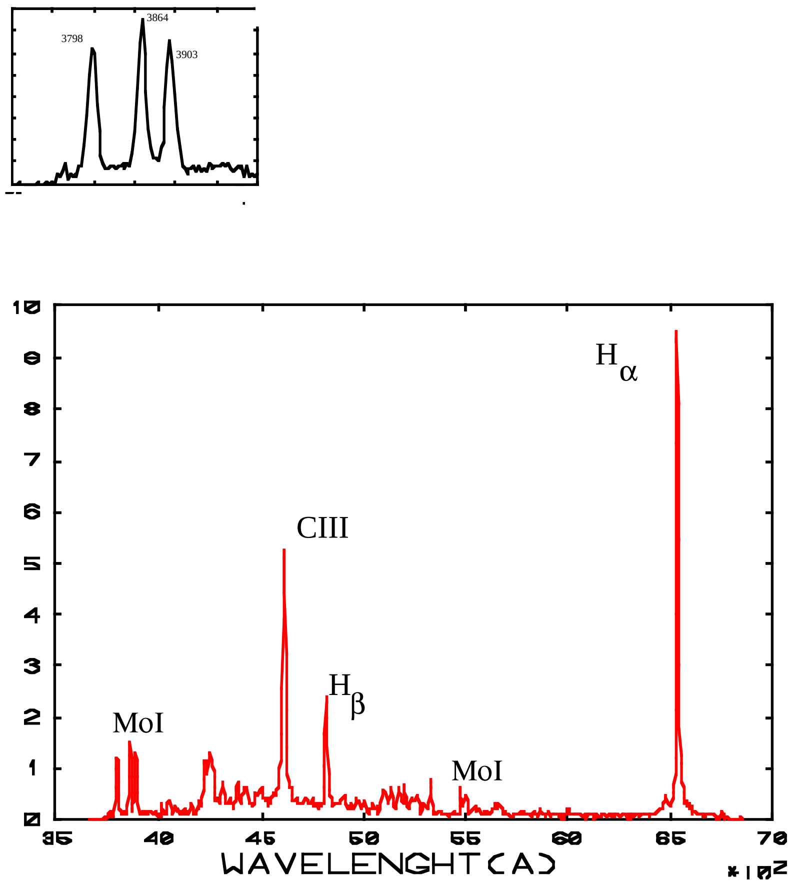
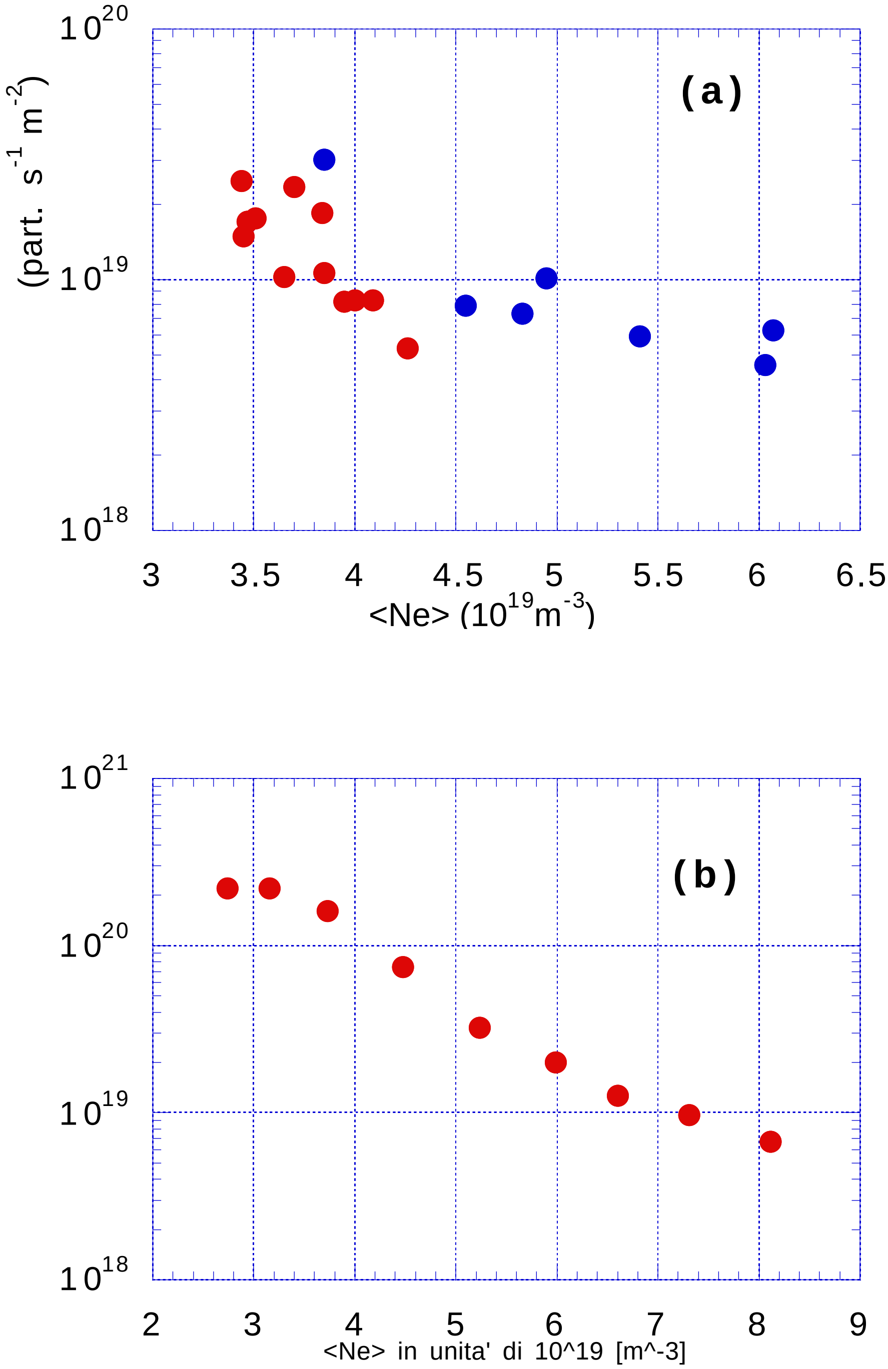
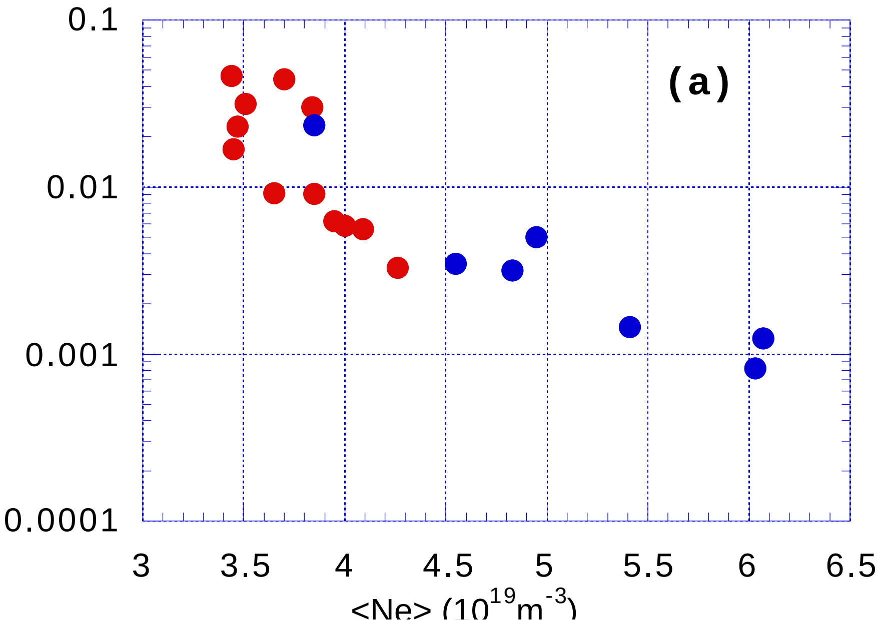

3798
3864
3903
10
9
8
7
6
5
4
3
2
1
0
A U
MoI
CIII
Hβ
MoI
Hα
35
40
45
50
55
60
65
70
WAVELENGHT (A)
*10^2

Fig.1



(a)
(b)
(part. s^-1 m^-2)
10^20
10^19
10^18
10^21
3
3.5
4
4.5
5
5.5
6
6.5
<Ne> (10^19 m^-3)
2
7
8
9
<Ne> in unita' di 10^19 [m^-3]

Fig.2


0.1
0.01
0.001
0.0001
3
3.5
4
4.5
5
5.5
6
6.5
(a)
<Ne> (10^19 m^-3)

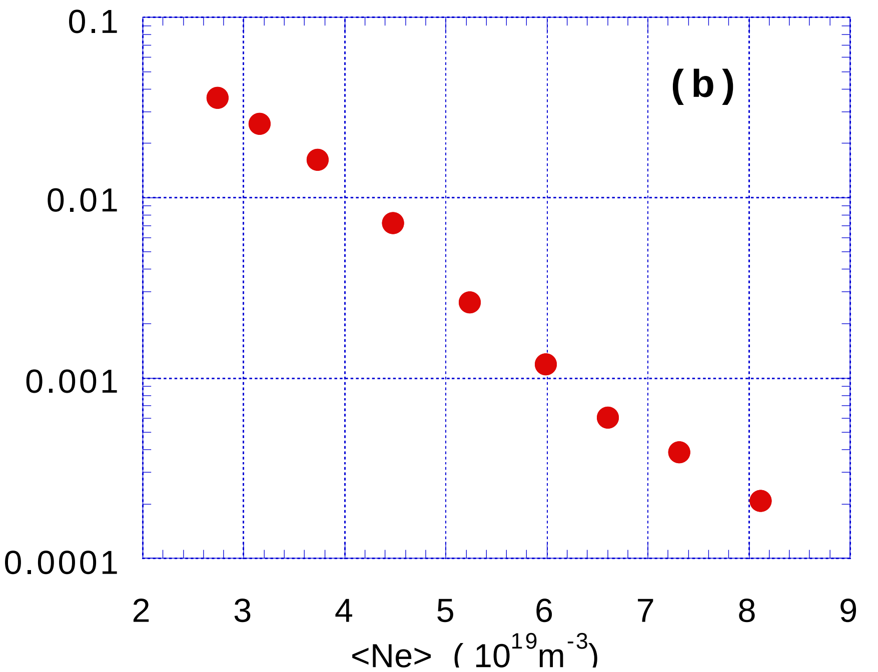

0.1
0.01
0.001
0.0001
2
3
4
5
6
7
8
9
(b)
<Ne> (10^19 m^-3)

Fig.3