# IMPURITY FLUX ONTO THE DIVERTOR PLATES OF ASDEX

A. P. Martinelli, E. Taglauer, and ASDEX Team

Max–Planck–Institut für Plasmaphysik, EURATOM Association,
D–8046 Garching, Federal Republic of Germany.

ABSTRACT

Fluxes of metallic impurities onto the divertor plates of ASDEX with different plasma parameters were collected and resolved in space and time by means of five carbon strips wound parallel on a cylindrical core rotating during the discharge.

Ion beam accelerator analysis (Rutheford Backscattering Spectroscopy (RBS), Proton Induced X-Ray Emission (PIXE) ) of five carbon strips exposed to the plasma show a different distribution of the Fe and Cu atoms across the scrape-off layer (SOL). The Fe fluxes collected in the centre of the SOL are related to the Fe content in the central plasma; the Cu deposition has a maximum value close to the Cu divertor plates, indicating evaporation or sputtering from the plates.

## INTRODUCTION

In earlier measurements prior to the "hardening" process, the Fe fluxes in the ASDEX divertor obtained by means of a collector probe were correlated with the Fe densities measured in the main discharge chamber by using a transport model [**1**]. First measurements with the collector probe differently positioned in the divertor of ASDEX after "hardening"are now reported and discussed, as a basis for establishing again a correlation between probe results in the divertor and plasma parameters in the main chamber, for the new ASDEX configuration after "hardening".

## MEASUREMENT LAYOUT AND METHOD

The cross-section of ASDEX after "hardening", with the time-resolved collector probe positioned in the divertor chamber, is shown in Fig. 1. The collector probe is connected to the NNW window and consists essentially of a cylindrical head, which can be rotated by a stepping motor, and of a manipulator to insert the cylindrical head into the divertor chamber, and extract it.

The collector head consists of a set of five graphite (PAPYEX) strips wound parallel on a cylinder. During the plasma discharge the cylinder is rotated behind the fixed shield, which has five apertures, 4 mm in diameter, 14 mm apart, so that particle fluxes from the plasma can be collected. As a rule, the apertures are perpendicular to the toroidal magnetic field, so that only ionised particles are collected. The aperture diameter defines the local resolution and, together with the rotation speed, the time resolution (a few hundred ms).

After plasma exposure, the cylinder is withdrawn from the divertor chamber and the five strips are taken off and analysed for metallic impurities by PIXE and RBS using a 2.5 MeV van de Graaf accelerator.

The measurement results show coverages (atoms/$cm^2$) on the strips between 1/10 of a monolayer (roughly the detection limit) and a few monolayers.

EXPERIMENTAL RESULTS

Figure 2 shows the Cu and Fe fluxes calculated from the measured coverages on strip 1 (1 cm from the Cu divertor plate), on strip 2 (2.4 cm from the Cu divertor plate), and so on, as a function of time during discharge no. 21007 (NI discharge).

The Cu flux attains a maximum value of $6 \cdot 10^{16}$ atoms/$cm^2$ s, a factor of 10 higher than the correspondent maximum Fe flux.

It is seen in Fig. 2 that after about 1.2 s both the Cu and Fe signals strongly drop. At the corresponding spot on the graphite strip one observes a surface-structure change. This change is a consequence of high-energy deposition during neutral beam injection; the deposited metallic impurities cannot be further observed.

Figure 3 shows the Cu and Fe deposits collected on strip 1, strip 2, and strip 3 (3.8 cm from the plate), as a function of the time during discharge no. 21861.

It is again seen that the Cu coverage (flux) is a factor of 10 larger than the Fe coverage (flux) on strip 1.

It is also observed that the coverage (flux) on strip 2 during NI is strongly reduced. Again, surface examination of the strip shows a substantial structure change. This indicates that strip 2 has reached a high temperature during the NI, higher than strip 1, which shows no surface alteration though closer to the divertor plate than strip 2.

This is explained by the position of strip 2 on the separatrix, where the energy deposition is maximal.

DISCUSSION

Further experimental results support the trend shown by the above reported results obtained with the collector probe in the ASDEX divertor after the "hardening" process. By way of discussion and preliminary conclusion the following can be stated:

- collected Cu and Fe fluxes are very different in value and show different radial dependences.

- collected Fe fluxes correlate with the Fe fluxes measured in the main plasma chamber and do not appear to be directly generated in the divertor chamber. The overall Fe outflux from the plasma can be determined by taking the values of the Fe fluxes over the width of the SOL in the divertor and integrating them over the circumference of the divertor and the four divertor sections (upper, lower, inner, outer). Overall Fe fluxes up to $5 \cdot 10^{18}\ s^{-1}$ are obtained.

- measured Cu fluxes close to the Cu divertor plates are a factor of up to 10 higher than the Fe fluxes; this indicates erosion of the divertor plates.

REFERENCES

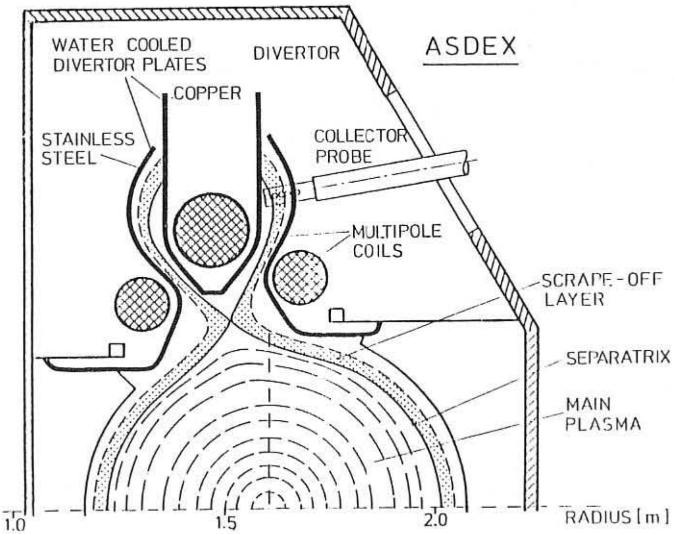
[**1**] Taglauer, E., Nucl. Instr. and Meth. in Phys. Research B13 (1986)218-224

FIGURE CAPTIONS

Fig. 1. Schematic cross-section of the ASDEX Tokamak after "hardening" showing the position of the collector probe in the upper divertor chamber.

Fig. 2. Cu and Fe fluxes on strip 1 (1 cm from the divertor plate), strip 2 (2.4 cm), strip 3 (3.8 cm), strip 4 (5.2 cm) as function of the time in discharge no. 21007.

Fig. 3. Cu and Fe deposits (and fluxes) on strips 1, 2, 3 as functions of the time in discharge no. 21861. The upper part shows the discharge parameters $I_p$ (plasma current), $n_e$ (electron density), and NI (neutral beam injection).

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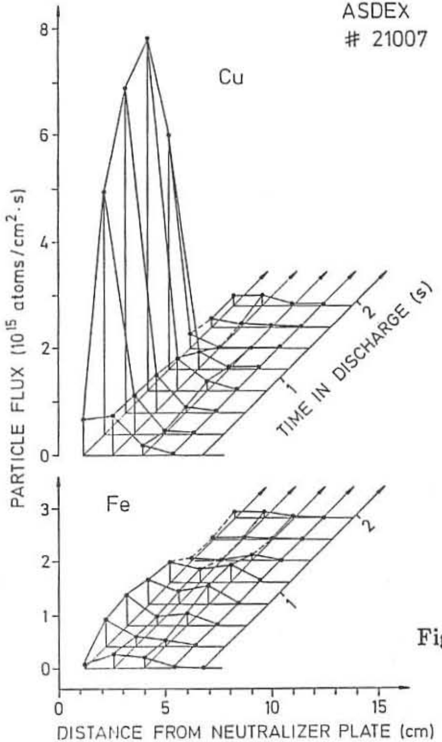
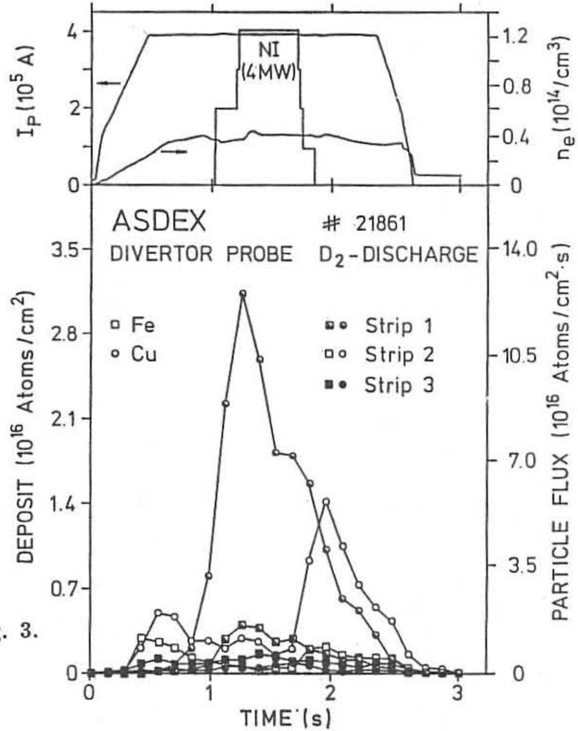



Fig. 2.

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