Measurement of ^{3}H Depth Profiles in Wall Materials of ASDEX Upgrade

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The ultra-pure injector of the accelerator laboratory of LMU and TUM offers the possibility to scan target samples in two lateral directions versus the Cesium sputter beam and enables thus measurements of depth profiles without perturbing crater edge effects. Within a cooperation between the Max Planck Institute of Plasma Physics, Garching and the Institute of Nuclear Physics and Engineering Bucharest ^{3}H depth profiles were measured in wall materials of the fusion experiments ASDEX Upgrade (IPP Garching) and JET (Culham). ASDEX Upgrade is operated with D_2 gas. Fig. 1 shows a cross section through the 16 sections of the torus with the locations of ICRH (ion cyclotron radiofrequency heating in sections 2, 4, 10 and 12) and of neutral beam injection (NBI in sections 7 and 15). ^{3}H is produced by the fusion reaction $^2\text{H} + {}^2\text{H} \rightarrow {}^3\text{H} + {}^1\text{H}$. The ^{3}H ions obtain an initial kinetic energy of about 1 MeV corresponding to a range of 8 μm in carbon which is the sample wall material.

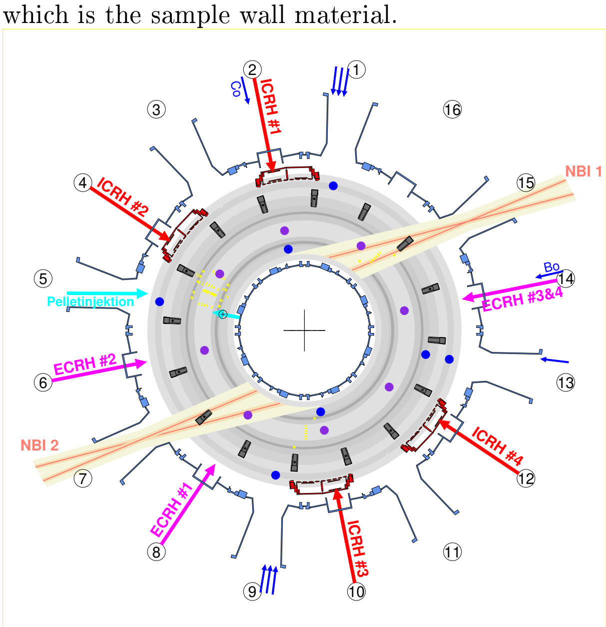

Fig. 1: Cross section through the ASDEX Upgrade torus with the locations for heating, ICRH (ion cyclotron radiofrequency heating) and NBI (neutral beam injection)

^{3}H depth profiles were recorded with a ΔE-E PIN silicon detector at the 40° beam line after the first switching magnet. Two of the measured depth profiles of the sections 3 and 13 are shown in Figs. 2 and 3. At section 3 two components are observed, a surface layer up to about 0.3 μm and a deep layer from about 0.3 μm up to about 2 μm. At section 13 only the deep layer is observed. The surface layer is due to deposition of torus gas in the walls. The deep layer originates from the implantation of energetic ^{3}H ions.

Fig. 4 shows the depth integrated ^{3}H concentrations, the area densities, for the surface layer (+) and for the deep layer (o) of the measured sections. It is seen that the sections 13 - 15 have intense deep layer area densities and have no or weak surface layer area densities. These sections 13 - 15 are dominated by strong implantation of ^{3}H and by erosion. This toroidal ^{3}H distribution can be explained by locked plasma modes and the occurrence of disruptions of plasma currents with subsequent destruction of the plasma. At this location of the occurrence of disruptions around sections 13 - 15 strong implantations and erosion take place.

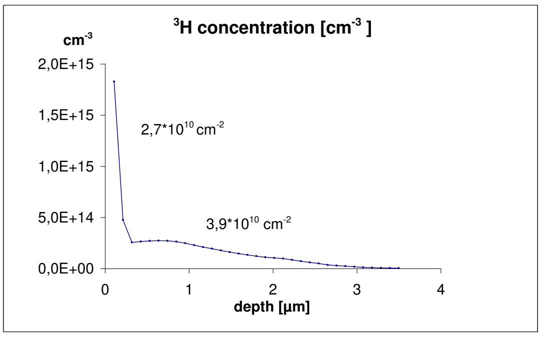

Fig. 2: Measured ^{3}H depth profile for section 3 with a surface and a deep layer

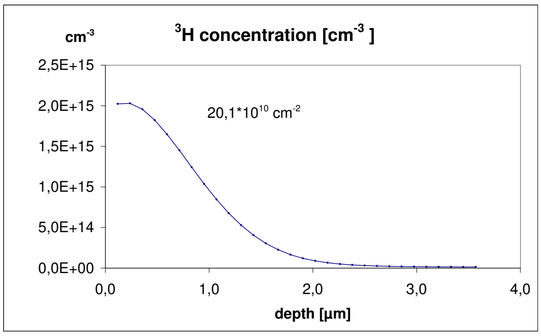

Fig. 3: Measured ^{3}H depth profile for section 13 with a surface and a deep layer only

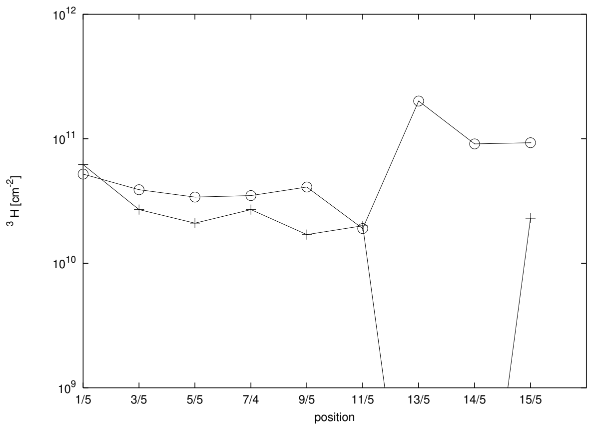

Fig. 4: Area densities of the surface layer (+) and the deep layer (o) for the measured sections of the ASDEX Upgrade torus.