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ABSTRACT.

In the 2001 shutdown of JET the septum, which separates the inner and outer divertor in the JET Mk-II gas box divertor, was removed and replaced by a simple protection plate. This enables a path of the neutrals from the inner to the outer divertor and thus a comparison of a closed and open divertor conguration. It is thought that asymmetries in the detachment process are influenced by the presence of the septum. Following septum removal, an experimental L-mode density limit session has been performed for comparison with a previous identical experiment with septum in place. The fuelling location was varied: inner/outer divertor and main chamber. Complementary experiments have also been performed to investigate the influence of the inner wall clearance on the L-mode density limit. The final density limit can significantly depend on the distance to the last closed flux surface to the inner wall.

1. EFFECT OF SEPTUM REMOVAL.

In figure 1 two density limit pulses with and without septum are shown. The discharge was fuelled from the inner divertor until the disruptive L-mode density limit occured. The onset of the X-point MARFE, which is a precursor to the ultimative density limit (see below), appears for both discharges at the same density. Generally, Z_{eff} is slighly higher (by about $\Delta Z_{eff} \approx 0.2$) in pulses where the septum has been removed. Figure 2 shows the divertor pumping for a discharge pair with main chamber fuelling. No difference in the divertor pumping is observed. The ion saturation current, as measured at the inner divertor strike zone, behaves very similar as function of the plasma density for the case with septum and without septum: The Degree Of Detachment (DoD), which is defined as DoD = $C \times n_e^2 / I_s$ is shown for both cases with and without septum ingure 2. The onset of the detachment appears at similar densities for both cases at $\approx 3.8\times10^{19}$ m^{-3}. The detachment in the case with septum develops a little stronger, but the X-point MARFE develops for both cases at a DoD of larger than 10 in the inner divertor. In the gas box divertor with septum it was found that by dierential gas pung in the divertor the detachment of the divertor (in/out asymmetries) can be in uenced [1, 2]. Pung in the inner divertor leads to a completely detached inner divertor, whilst the outer divertor remains attached until the X-point MARFE forms. Figure 3 shows a comparison of such an inner fuelled density limit discharge with septum (Pulse No: 53080) and without septum (Pulse No: 58718). The DoD is plotted for individual divertor Langmuir probes. Puffing from the inner divertor leads to an early detachment of the inner divertor and late detachment of the outer divertor. The detachment at the inner divertor develops gradually whereas the detachment at the outer divertor suddenly happens. As can be seen in figure 3 the erosion of the ion saturation current profile starts at the separatrix, indicated by the $\text{DoD}^{\text{stike}}$. The onset of the X-point MARFE is determined by a detachment of $\text{DoD}^{\text{peak}} \geq 2$, with DoD^{peak} being determined by the ux tube with the highest (peak) ion current. No difference in the detachment process between discharges with and without septum has been observed. This is surprising, since one would expect a distribution of the neutral in flux from the inner private flux region to the outer divertor. However, the outer divertor remains also without septum attached until the X-point MARFE forms.

This principle behaviour of the detachment is conrmed by tomographic measurements of the D and CIII radiation in the divertor. The radiation distribution of Dα and CIII during the detachment behaves similar for discharges with and without septum.

The experimental results are in relativ good agreement with EDGE2D/NIMBUS modelling results. Also here no signicant dierence in the detachment process with and without septum was observed. A slight difference is observed in the detachment process of the outer divertor: without septum the onset of the detachment happens at ≈15% lower density. Otherwise, the detachment of the inner divertor, the target power fluxes, the deuterium exhaust rate and the target electron density behave very similar, no matter if the plasma is fuelled from the inner or outer divertor.

The above explained results suggest that for ITER a transparent dome might not change the asymmetry in the detachment process. But hopefully the dome in ITER will improve the pumping efficiency.

2. INFLUENCE OF INNER WALL CLEARANCE ON DENSITY LIMIT

It has been found previously [2] that the plasma configuration and with this the distance of the LCFS to the inner wall (limiter) has an influence on the final disruptive density limit. In order to study the influence of the distance to the inner wall more systematical density limit experiments with a high clearance plasma conguration (1.7MA/2.4T, P_{NBI} = 2.4MW) and different gaps to the inner wall have been carried out. Figure 4 shows the critical density for the development of the X-point MARFE and the critical density for occurance of the Wall MARFE. The distance from the LCFS to the inner limiter has been varied between 2 and 12cm (blue symbols). Independent of the wall clearance the X-point MARFE forms always at the same density ($\bar{n}_e \approx 4.1 \times 10^{19}\ \mathrm{m}^{-3}$), whereas the critical density for the occurance of the Wall MARFE is 20-30% higher at distances larger than 9cm. At low distances to the inner wall no dierence between the appearance of the X-point MARFE and Wall MARFE can be idendied. Those results are in line with results obtained at TEXTOR, where the density limit in L-mode discharges was found to depend on the inner wall clearance [3] and is thought to be a result of a recycling instability [4]. One open question with respect to the recycling instability was: Do ion fluxes to the inner limiter or charge exchange losses contribute to the development this recycling instability? To answer this question measurements of the CII emission at the inner bumper limiter and the inner wall have been carried out. This CII emission is derived spectroscopically after a Zeeman-analysis and is thus a local measurement of the emission on the higheld side. Ingure 4 it is shown that the CII emission from the inner wall (and thus the flux from the inner wall) does not depend on the inner wall clearance. On the other hand the CII emission from the inner limiter depends strongly on the distance of the LCFS to the limiter, demonstrating that the ion fluxes are dominant on the higheld side plasma wall interaction in L-mode plasmas.

SUMMARY AND CONCLUSION.

Removing the septum in the Mk-II gas box divertor has not changed the L-mode density limit. The

X-point MARFE occurs at the same density. The detachment behaviour is surprisingly also the same for all fuelling scenarios. When fuelled from the inner divertor the inner divertor can be completely detached, while the outer divertor stays attached. The final, disruptive density limit depends on the inner wall clearance.

ACKNOWLEGEMENTS
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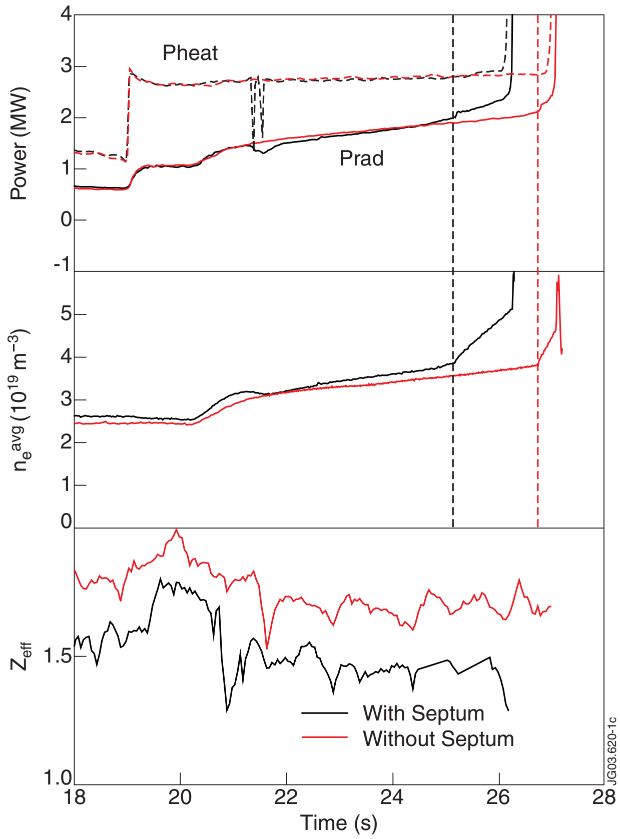

Figure 1: Comparison of L-mode density limit discharges (Pulse No: 53080 with septum, 58718 without septum) 1.7MA/2.4T,P_{NBI} = 2MW

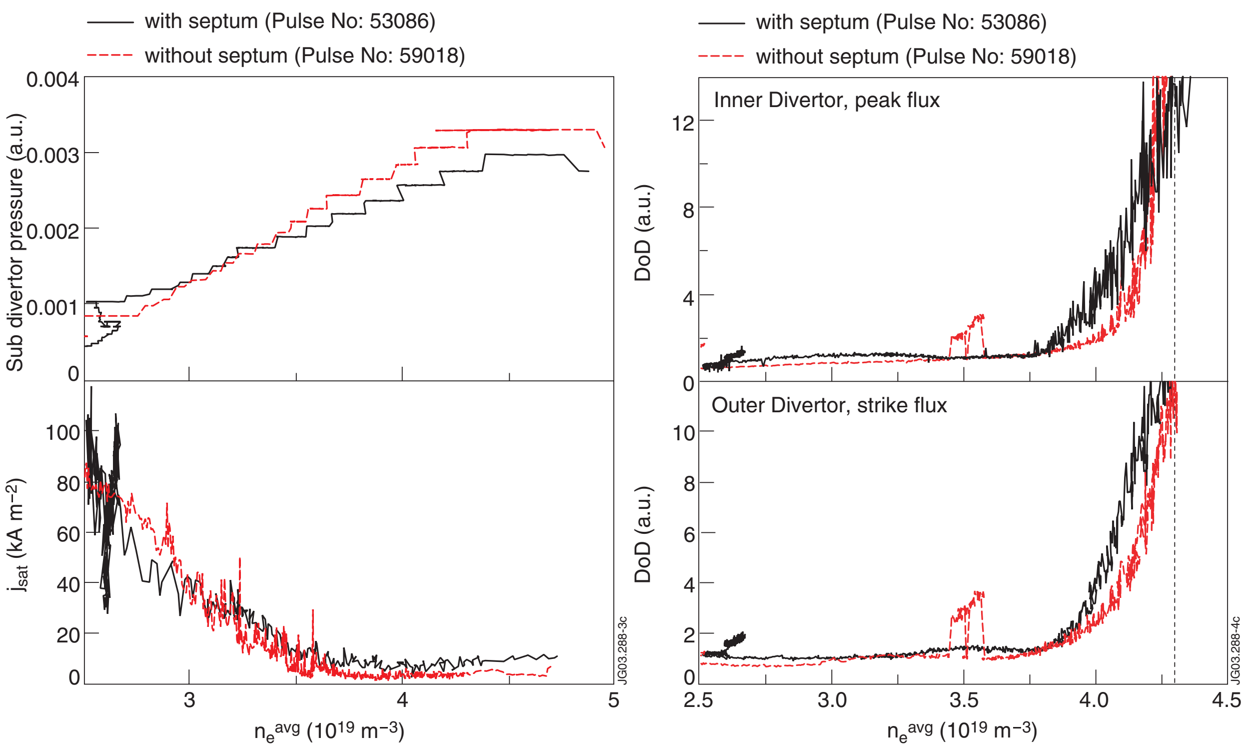

Figure 2: Left: comparison of sub-divertor pressure and ion saturation current at inner strike zone, with and without septum, main chamber fuelling; Right: comparison of DoD with and without septum, main chamber fuelling.

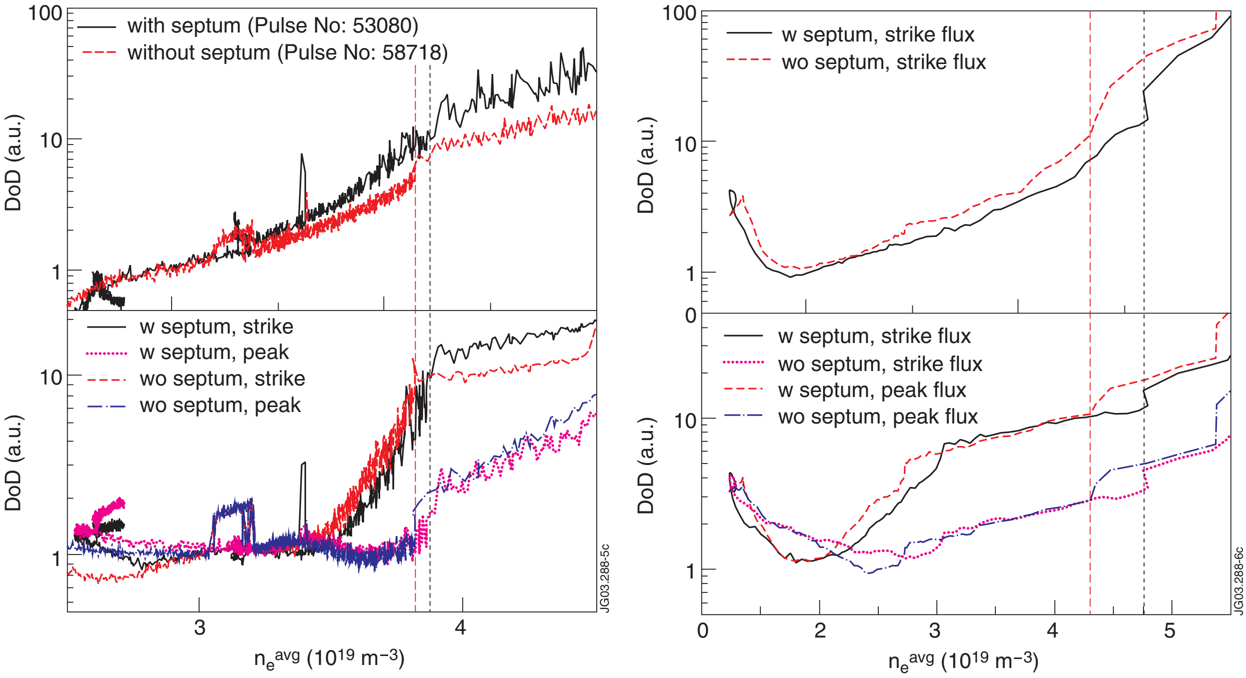

Figure 3: Left: DoD for inner divertor with septum (Pulse No: 53080) and outer without septum (Pulse No: 58718); Right: Simulation of detachment (DoD) in density limit discharges with EDGE2D/NIMBUS; X-point MARFE onset is indicated by the dashed line.

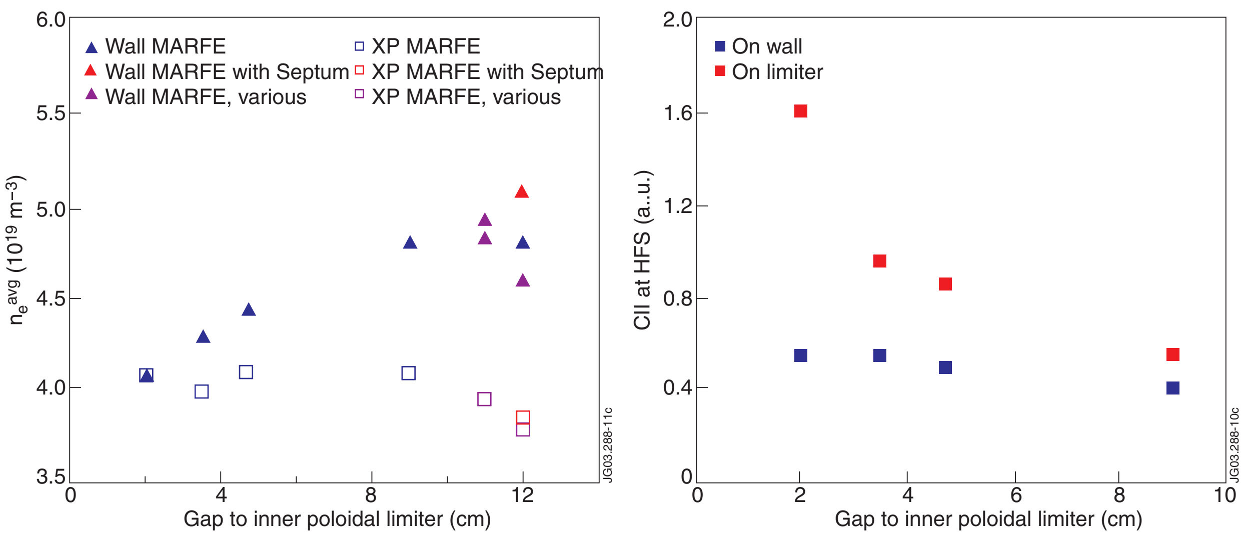

Figure 4: Radial inner gap scan in Mk-II SRP. Left: critical densities for onset of X-point MARFE and onset of Wall MARFE, various means: dierent divertor pumping conditions; Right: CII line emission on the inner wall and on inner limiter at $\overline{n}_e = 4 \times 10^{19}$ m^{-3}.