LETTER TO THE EDITOR

Formation of a three-dimensional plasma boundary after decay of the plasma response to resonant magnetic perturbation fields

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Abstract. The formation of a three-dimensional particle and heat flux pattern during suppression of type-I edge localized modes (ELMs) by resonant magnetic perturbations (RMP) was reported for DIII-D and in RMP ELM control experiments on other devices. However, no direct link between this three-dimensional shape of the outer plasma boundary and the plasma response to the external RMP fields has yet been shown. In this paper, for the first time direct experimental evidence is shown for a direct link between the decay of an $n = 3$ plasma response and the formation of a 3D plasma boundary. We inspect a lower single-null L-mode plasma which first reacts at sufficiently high rotation with an ideal resonant screening response to an external toroidal mode number n=3 RMP field. Decay of this response due to reduced bulk plasma rotation changes the plasma state considerably. Signatures such as density pump out and a spin up of the edge rotation – which are usually connected to formation of a stochastic boundary – are detected. Coincident, striation of the divertor single ionized carbon ($CII@\lambda = 514\,\mathrm{nm}$) emission and a 3D emission structure in double ionized carbon ($CIII@\lambda = 465\,\mathrm{nm}$) at the separatrix is seen. The striated CII pattern follows in this stage the perturbed magnetic footprint modeled without a plasma response (vacuum approach). This provides for the first time substantial experimental

evidence, that a 3D plasma boundary is formed as soon as the internal plasma response decays and that the resulting boundary structure follows the vacuum modeled magnetic field topology. However, the inward extension of the perturbed boundary layer can still not directly be determined from these measurements.