# First experimental confirmation of island SOL geometry effects on detachment in Wendelstein 7-X

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The Wendelstein 7-X (W7-X) stellarator, utilizing the island divertor concept, has shown experimentally that stable detachment is easily achieved in the "standard" magnetic field configuration. However, previous work has predicted that the geometry of the island scrape-off layer (SOL), in particular the internal island field line pitch Θ plays a decisive role in divertor detachment [1]. This work provides the first experimental confirmation of this prediction in W7-X. Detachment experiments were performed in the "low iota" configuration, which has a significantly smaller Θ in comparison to the "standard" configuration ($\Theta_{max}\approx0.002$ vs $\Theta_{max}\approx0.0036$). From the stellarator 2 point model [1], such a reduction of Θ would substantially increase the weight of perpendicular transport in the SOL.

Tomographic reconstructions of the radiated power distribution [2] show remarkably different radiation patterns in the "low iota" configuration as compared to "standard". In particular, radiation condensation at the X-point, typical in "standard" configuration [2], is shifted to a location between the X-points in "low iota" (loosely termed "O-point radiation"). Additionally, the total radiated power in the "low iota" configuration exhibited strong oscillations; hence, no stable detachment scenario was achieved, although Neon-seeded detachment provided greater controllability over a larger range of radiated power. EMC3-Eirene modeling of these two configurations qualitatively reproduces the differences in the radiation pattern. The modeling results also reveal that the main driver for these differences is the increased weight of perpendicular heat transport arising from the change in island geometry. The radiation condensation near the island "O-point" is not present in all islands. Rather, this radiation occurs only in islands that are in close magnetic connection to the divertor target plates. This observation implies that the radiation condensation arises from local impurity and/or main ion sources arising from recycling on the divertor target plates.

[1] Y. Feng et al, *PPCF* **53** (2011) 024009

[2] D. Zhang et al, *Nucl. Fusion* **61** (2021) 116043