The He/Ne beam diagnostic for active emission spectroscopy in the island divertor of Wendelstein 7-X

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A dedicated line-ratio spectroscopy system on thermal helium (He) and neon (Ne) was implemented at Wendelstein 7-X to measure radial profiles of electron density $n_e(r)$ and temperature $T_e(r)$ in front of the horizontal target in the graphite island divertor of W7-X.

The injection system consists of two boxes with 5 fast piezo valves each, mounted directly behind the divertor plates in one upper and one lower divertor module, which are magnetically connected in the 5/5 island configuration [1]. The new observation system includes 54 horizontal lines-of-sight which are channelled to a 19cm and a 32cm focal length Czerny-Turner spectrometer allowing observation of the He and Ne lines as well as impurities and hydrogen (H) lines with high spectral resolution (dispersion down to 1.3 nm/mm).

In the first divertor campaign of W7-X solely He has been used to measure T_e and n_e profiles for the full radial width of the scrape-off layer in the divertor, across the 5/5 island in the standard magnetic configuration. The spatial resolution of the diagnostic is 3 mm and the time resolution is 25 ms. Edge parameter measurements with the He-beam have been carried out during different physics experiments, such as radiative edge cooling and detachment studies through H fuelling. Preliminary results show clear impact of the seeded impurities (N_2 and Ne) and H fuelling on the measured T_e and n_e, in agreement with other edge diagnostics.

Ne has been tested in order to extend the applicability of the diagnostic to the detached divertor regime at very low T_e ($\ll$10eV) to be achieved in the next campaigns. Results from Ne injection and the status of the development of a dedicated collisional-radiative model for Ne are here presented.

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References

[1] M. Griener *et al* 2017 *Review of Scientific Instruments* **88** 033509