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12.3 Wisconsin In-Situ Penning (WISP) Gauge – An in-situ gauge to measure partial neutral pressures of hydrogen and impurities

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A new type of in-vessel Penning gauge, the Wisconsin In-Situ Penning (WISP) gauge, has been developed and successfully implemented in the Wendelstein 7-X island divertor baffle and vacuum vessel. The capacity of the quantitative measurements of the neutral household for light impurities, in particular helium, is important for tokamaks as well as stellarator divertors in order to avoid fuel dilution and radiation energy loss. Penning gauges assisted by spectroscopy are a powerful tool to obtain the total neutral pressure as well as fractional neutral pressures of specific impurities. The WISP gauge is a miniaturized Penning gauge arrangement, which exploits the ambient magnetic field of magnetic confinement fusion experiments to establish the Penning discharge. Then, in-situ spectroscopy is conducted to separate the fractional neutral pressures of hydrogen, helium and possibly also other impurities. The WISP probe head was qualified at UW Madison at 240 mT as well as at the PAX magnet at IPP Greifswald, Germany at 3 T. A power law scaling between current and pressure: I = C*Pn with n = 1.0 – 1.2 for the 240 mT case and 2.3 – 2.8 for the 3 T case was shown. Pressure measurements between several 10-2 mbar and down to 10-6 mbar were achieved, demonstrating a reliable operation range for relevant divertor and main plasma vessel pressure levels with time resolution of up to 1MHz.

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