**Wisconsin In Situ Penning (WISP) neutral partial pressure gauges in view of the quasi steady-state operation at Wendelstein 7-X**

S. Sereda1, B. Elward1, J. Hoffman1, D. Naujoks2, D. Pilopp2, G. Schlisio2, O. Schmitz1 and the W7-X team\*

*1 Department of Engineering Physics, University of Wisconsin - Madison, Madison, USA*

*2 Max-Planck-Institut für Plasmaphysik, Greifswald, Germany*

Helium exhaust is one of the key problems for future magnetic fusion confinement devices in the case of deuterium-tritium fuel mixture. Helium ash, originating from deuterium-tritium fusion in the main plasma, must be effectively exhausted. Otherwise, it causes fuel dilution and cooling of the main plasma. Thus, neutral helium gas must be effectively removed from a device through the corresponding pumping ducts.

The Wisconsin In Situ (WISP) neutral partial pressure gauges were developed [1] to measure neutral partial pressures of different species in the ambient magnetic field of magnetic fusion devices. The Penning gauges are equipped with spectroscopy to measure line emission of different species (mainly hydrogen and helium), allowing neutral partial pressure studies. During the first operational phase (OP1.2) of Wendelstein 7-X the first set of WISP gauges was commissioned.

This contribution focuses on the recent updates of the WISP system at Wendelstein 7-X in the view of the quasi steady-state operation. Water cooling was added in order to withstand the heat flux from the plasma, allowing the gauges to operate continuously at the 10 MW heating power of the main plasma. In addition, a new compact line emission detector system was implemented. Moreover, 4 additional gauges will be installed at the high-iota part and pumping gap of the divertor target. Line emission measurements in these locations will allow a better understanding of helium exhaust at Wendelstein 7-X, including up-down asymmetry effects and exhaust in the high-iota part of the pumping system.

Results from the ongoing puff/pump experimental studies of the OP2.1 campaign at Wendelstein 7-X will be presented along with supporting calculations of the effective helium confinement time and helium enrichment parameter.

[1] T. Kremeyer et al., Rev. Sci. Instrum. 91, 043504 (2020)

\* The full list of W7-X team members is given in T. Sunn Pedersen et al 2022 Nucl. Fusion 62 042022