First results and upgrade of the ICRH antenna system for W7-X

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To simulate in W7-X the behaviour of alpha particles in a future stellarator reactor, a population of fast ions with energies ranging from 80-100keV is required in the core of high-density plasmas ($n_e > 10^{20}m^{-3}$). Ion Cyclotron Resonance Heating (ICRH) can deliver this, with minority heating of H in ^{4}He plasmas and the ^{4}He-(^{3}He)-H 3-ion scenario, where ^{4}He can also be replaced by D. The shape of the two strap ICRH antenna for W7-X consists of two poloidal straps, is matched to the 3D shape of the Last Closed Magnetic Surface (LCMS) of the standard magnetic field configuration on W7-X [1]. This antenna without Faraday Screen [2], was commissioned on W7-X plasmas in February and March of 2023 with only one strap energized, because of a faulty pre-matching capacitor (and vacuum feedthrough), leading to operation with $k_{\parallel} \sim 0$. Two main goals were reached: (i) operation at power levels up to 700kW, with clear increase of the plasma stored energy and (ii) plasma breakdown using ICRH only at magnetic fields of 1.7T for the full duration of the ICRH pulse with about 300kW RF power. After removal of the antenna from the W7-X plasma vessel only a slight discoloration of the antenna straps and box was observed. The antenna system and RF Generators have been repaired and upgraded in recent months for operation with both straps simultaneously. Zero and pi-phasing of the antenna straps will now be possible, both at 25 and 38 MHz. The paper will include past results from the operations with one strap and present an overview of the plans for the next experimental campaigns on W7-X with the upgraded antenna system. [1] J.Ongena et al., Physics of Plasmas 21, 061514 (2014) ; [2] R. Van Nieuwenhove et al., Nucl. Fusion 32 (1992) 1913