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P2.1066 MHD activity during the recent divertor campaign at the Wendelstein 7-X stellarator

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During the past operational phase OP1.2b at Wendelstein 7-X (W7-X), wall conditioning via repeated boronization led to enhanced plasma performance. To further support safe W7-X operation, an additional plasma heating interlock system, based on the measured diamagnetic energy (Wdia), has been successfully operated during the whole campaign. For the first time at W7-X in addition to the electron cyclotron heating system a neutral beam injection system (NBI) was put into operation, which acted as a source of fast ions and provoked MHD activity under certain conditions. Based on measurements from a total of 125 Mirnov probes, the effect of the NBI on the underlying MHD mode structure in selected plasma scenarios is studied. Preliminary mode number analysis results are presented, complemented by Soft X-Ray, electron cyclotron emission and phase contrast imaging diagnostic measurements. The developed analysis techniques have been proven useful for ongoing investigations of sudden energy crashes, such as observed in transient high plasma energy phases (Wdia ~ 1.2 MJ) or in the presence of external electron cyclotron current drive, where they even led to a total collapse of the plasma. Observed decay times of the plasma energy and currents of the order of about 1-10 ms are up to 100 times faster compared to assumptions previously made in calculations concerning engineering layout and mechanical stresses on diagnostic components installed in the vacuum vessel. High induced currents and the resulting forces represent a potential threat to the structural integrity of these components and to a safe W7-X operation. It is essential to understand the mechanisms of the observed energy crashes and plasma collapses to develop strategies to stabilize high performance plasmas and to minimize the risk of machine damage in future operational phases.

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Presenter: RAHBARNIA, K. (EPS 2019)

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