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Conceptual Design of Halo Machine

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Over the past three decades, extensive research has been conducted on halo currents to assess the thermal [1] and electromagnetic stresses [2] imposed on the ITER wall during plasma disruptions. However, the contribution of these currents to the generation of sideways forces on the tokamak vacuum vessel still remains poorly understood, which raises concerns [3, 4]. In order to address this critical priority for ITER, the ITPA community initiated a dedicated joint experiment in 2018. While significant progress has been made [4], it has become apparent that for reproducible studies of halo-kink-wall physics a specialized linear plasma device is needed.

Figure 1: The Halo Machine is designed for reproducible studies of kink-wall interaction and related currents.

We propose to study halo- and kink-related wall currents, plasma propulsion [5], and magnetic reconnection [6] in one machine to exploit the synergy between these closely interconnected research topics. Plasma guns generate two plasma current channels embedded in a background magnetic guide field Bz < 0.1 T, with electron temperature Te=5–20 eV, plasma density n=1–3x10ˆ18m-3, column diameter a=5 cm and one-meter length. The diagnostics include fast cameras, electrostatic and magnetic sensors, and electron/ion energy analyzers. Moreover, the currents in hexagonal plasma facing components (PFCs) are measured with recently developed probes [7]. The design of PFC arrangement is supported by SPICE3 and BIT3 modelling.

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Primary author: YANOVSKIY, Vadim

Co-authors: PODOLNIK, Ales (IPP Prague); MOMO, Barbara (Consorzio RFX); TSKHAKAYA, David (nstitute of Plasma Physics of the Czech Academy of Sciences); MARTINES, Emilio (Università degli Studi di Milano –Bicocca); VILLONE, Fabio (Consorzio CREATE); ZUIN, Matteo (Consorzio RFX); CAVAZZANA, Roberto (Consorzio RFX)

Presenter: YANOVSKIY, Vadim

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