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Recent advancements and hydrogen plasma experiments in RF based two driver negative ion source (Twin source) at IPR

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TWo-driver Indigenous Negative ion source, popularly known as TWIN source, at IPR has been operational for the last few years. The TWIN source is ¼th of the ITER DNB source in size. It has been developed to support the Indian Test Facility, INTF operation (testing of ITER DNB source). Hydrogen plasma is generated in both the drivers (diameter ~ 280 mm, length 150 mm, each) of the TWIN source by coupling RF power (from 180 kW, 1 MHz RF generator) inductively and then allowed to expand into a rectangular expansion chamber of volume ~ 1000 (L) × 500 (B) × 200 (H) mm3. The RF power is fed into two water-cooled RF coils of 6.5 turns each simultaneously via a motorized variable capacitor-based matching network and a 3:1 ferrite-based isolation transformer. More design details of the Twin source can be found in [1-4].
The TWIN source is designed to be operated in both "air mode"and "vacuum immersed mode"(air mode: RF coils are in air; vacuum mode: RF coils are immersed in vacuum). Presently, the air mode operation of the TWIN source is ongoing. RF input power of 75 kW is coupled successfully, for the first time, with a power factor of more than 0.8 to generate hydrogen plasma. Langmuir probes and optical emission spectroscopy diagnostics are implemented to study TWIN plasma dynamics. In addition, for safe operation, H-alpha based interlocks, RF coil currents and voltage monitors, water calorimeter, etc., are also integrated with the TWIN data acquisition and control system (DACS). The hydrogen plasma density of the order of 10^17 m-3 has been achieved and is expected to be 10^18 m-3 at higher RF power in vacuum mode. TWIN source has also been successfully operated at a low pressure of 0.35 Pa, for the first time. The H-ion beam extractor-accelerator system is not yet coupled to the ion source. The paper will give an overview of the TWIN source progress, together with the recent experimental data and the challenges faced during plasma operation.

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