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Beam current performance in the ITER negative ion source prototype SPIDER

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SPIDER is the full-sized ion source prototype for the ITER Heating Neutral Beams (HNB). Hosted by Consorzio RFX in Padova, Italy, it forms part of the ITER Neutral Beam Test Facility (NBTF). SPIDER has for the first time operated with fully opened beam segments, up to ¼ of the designed beam extraction area. With an increase in the maximum achieved RF power and acceleration voltage, this has enabled SPIDER to take a substantial step towards the ITER HNB requirements of 60 A extracted current at 100 keV.
As the first negative ion beam source fully enclosed in a single vacuum, SPIDER has presented some unique challenges for high power operation. RF induced breakdowns at the rear of the source drove the initial decision to reduce the number of open beam apertures, so to reduce the pressure at the back of the source while keeping the same filling pressure in the plasma chamber. The recent increase in the number of open apertures from 28 to 300 has resulted in an increase in the beam-generated plasma downstream of the accelerator. Due to the enclosed nature of the vacuum and the electromagnetic field generated by the source, the high voltage power supplies collect some of these additional charges, complicating the measurement of the beam current. This contribution describes the assessment of the SPIDER beam current for three different source configurations, and the impact of steps taken to remediate the issue. Source parameter dependences are discussed, for both the beam and the additional current.

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