

Lessons learned after three years of SPIDER operation and recent MITICA activities

Diego Marcuzzi^{1,*}, and the NBTF Team
¹ Consorzio RFX, corso Stati Uniti, 4, Padova, Italy

*corresponding author: diego.marcuzzi@igi.cnr.it

ITER requires 2 neutral beam injectors (NBIs), with possibility for a third one, providing 16.5 MW power each, as part of the auxiliary heating and current drive to reach fusion conditions.

As the requirements of ITER NBIs have never been simultaneously attained, a Neutral Beam Test Facility (NBTF) was established at Consorzio RFX (Italy), aimed at the operation of the full-scale ITER NBI prototype (MITICA) up to full performances, anticipated by the exploitation of the full-scale prototype of the ion source of ITER NBIs with 100keV particle energy (SPIDER).

SPIDER is the largest Radio Frequency (RF) based negative ion source. The inclusion of constraints related to ITER environment led to explore new conditions with non-negligible uncertainties and risks, justifying the need to establish a dedicated facility.

Full immersion of source and accelerator in the same vacuum where the beam propagates is a constraint that impacted design and operation, occurring in a domain with dynamic variation of pressure close to critical values of the Paschen curve. Moreover, the target ion current required a number and dimension of RF antennas never used, with risks of electromagnetic interferences and geometrical non-uniformities.

Due to these constraints, discharges induced by RF power on the rear side of the source, linked to the residual pressure, limited the performances since early operation.

Temporary solutions allowed to operate safely, even though at reduced performances: a mask was installed to mitigate the discharge risk, reducing the number of beamlet apertures and then the residual pressure outside of the source.

After three years of operation, SPIDER entered a major shutdown, in which the modifications not yet implemented will be introduced. This contribution provides a summary of the main scientific results and the solutions currently under installation.

Moreover, most important milestones reached and issues faced during recent MITICA activities are reported.