

Achievement at the ITER Neutral Beam Test Facility and prospects for the R&D activities within the ITER research plan

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ABSTRACT

- A Neutral Beam Test Facility (NBTF) was set up in Padova, Italy, to ensure the reach of ITER Neutral Beam Injector (HNB) target parameters on a dedicated 1:1 prototype, MITICA, anticipated by the SPIDER experiment devoted to the optimization of the ITER-size ion source.
- While MITICA is progressing towards the first operation, but already obtaining results on specific tests, recent SPIDER campaign confirmed the correct path towards the goal.

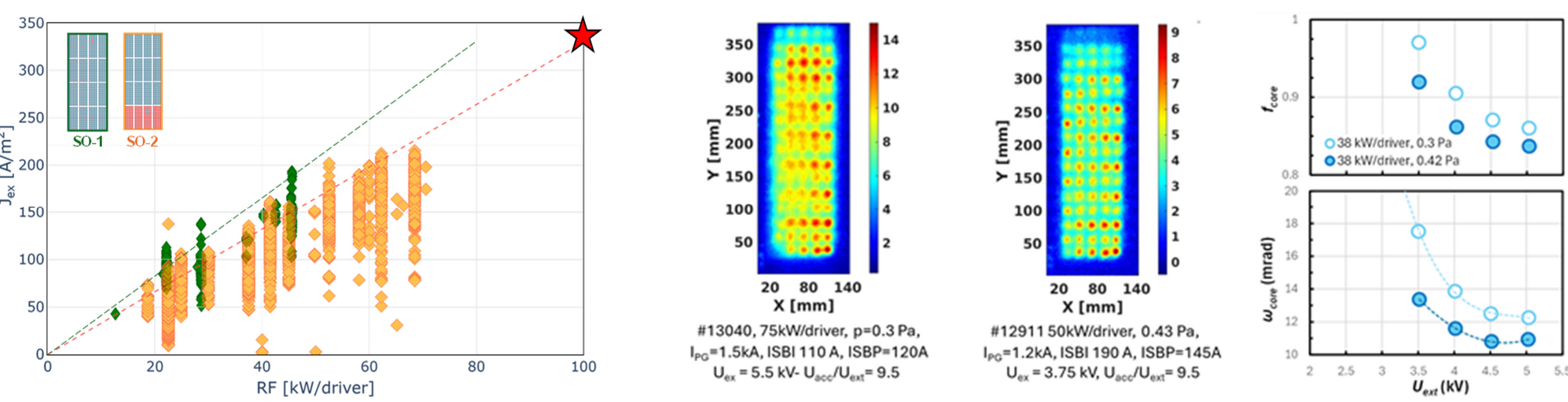
BACKGROUND

- The plan of the R&D on ITER Neutral Beam Injectors has been revised to meet the needs of the new ITER Research Plan (IRP)
- The overall NBTF plan of activities with the relevant time schedule is now fully integrated with the ITER research plan, emphasizing milestones, links with the inputs expected by the HNB development
- Fully integrated and essential part of this approach, the NB community is significantly involved in this challenging project, supporting directly the NBTF with dedicated experiments: main examples are ELISE at IPP on negative ion generation and experiments at QST on high voltage holding and accelerator optics

SPIDER

RECENT RESULTS

SPIDER recent operation was primarily aimed at the characterization of the bottom segment of the source, by operating most of the 320 beamlets simultaneously for the first time. Results are in line with expectations from the half-size source test facility ELISE and with ITER targets. Investigations were carried out also on beam uniformity and divergence.



Recent SPIDER results: ion current density, beam uniformity and divergence

CURRENT SHUTDOWN AND NEXT CAMPAIGN

Occurrence of RF-driven discharges during the first SPIDER campaign and identification of inefficiency in the original RF oscillators led to modifications, currently under installation to refurbish and complete the configuration.

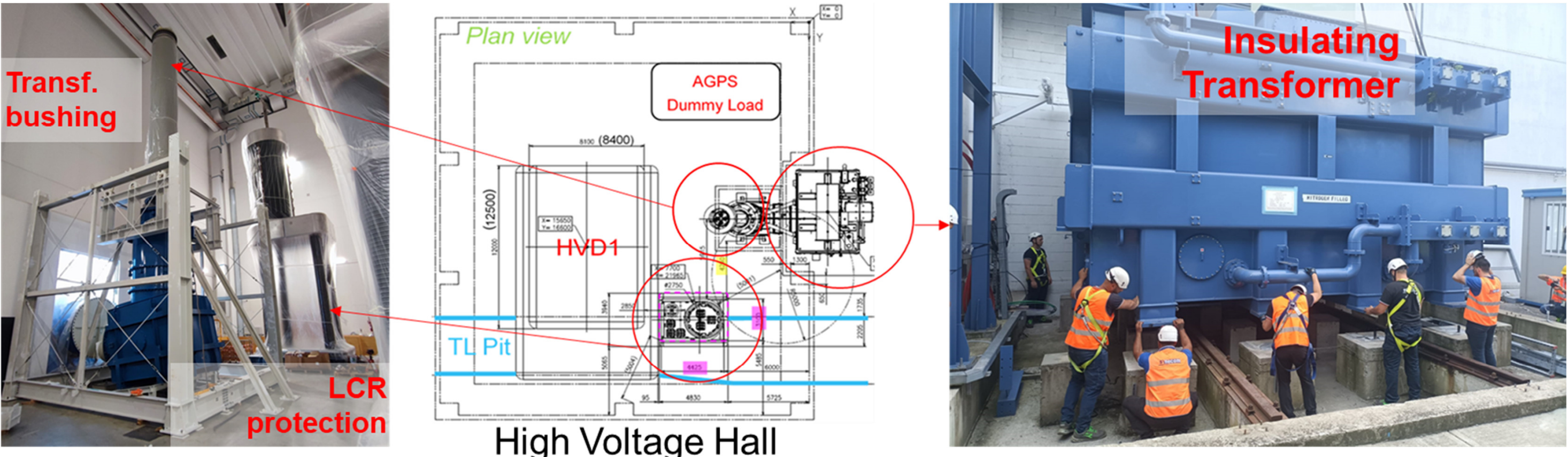


Completing SPIDER configuration: ongoing installation of new vessel module with NEG pumps and new RF solid-state amplifiers

MITICA

HIGH VOLTAGE POWER SUPPLY RESTORATION

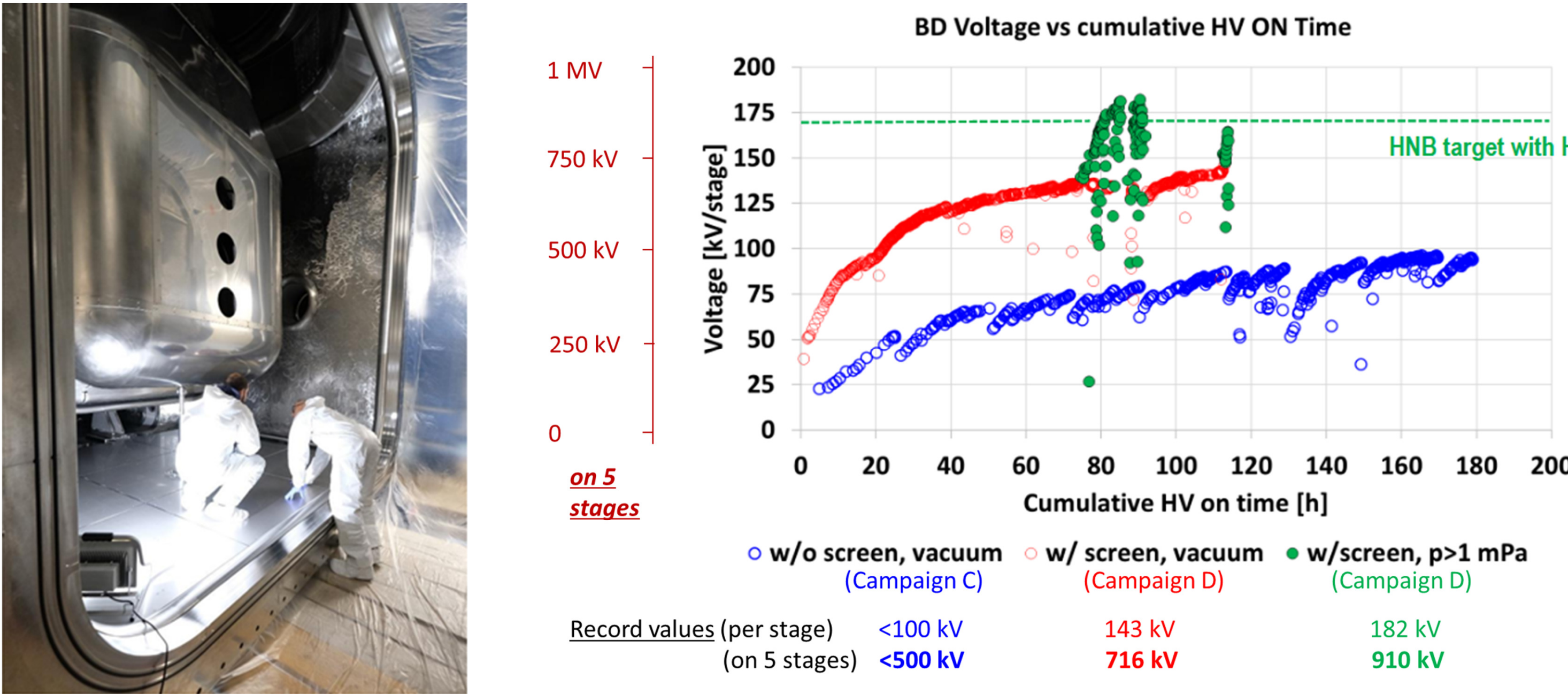
In 2021, during the first MITICA power supply integrated tests, a pair of events occurred involving unexpected breakdowns and overvoltage, which led to the damage of a few components. Solutions were identified and procured, currently under installation and test.



Power supply restoration: additional protection and new component installed

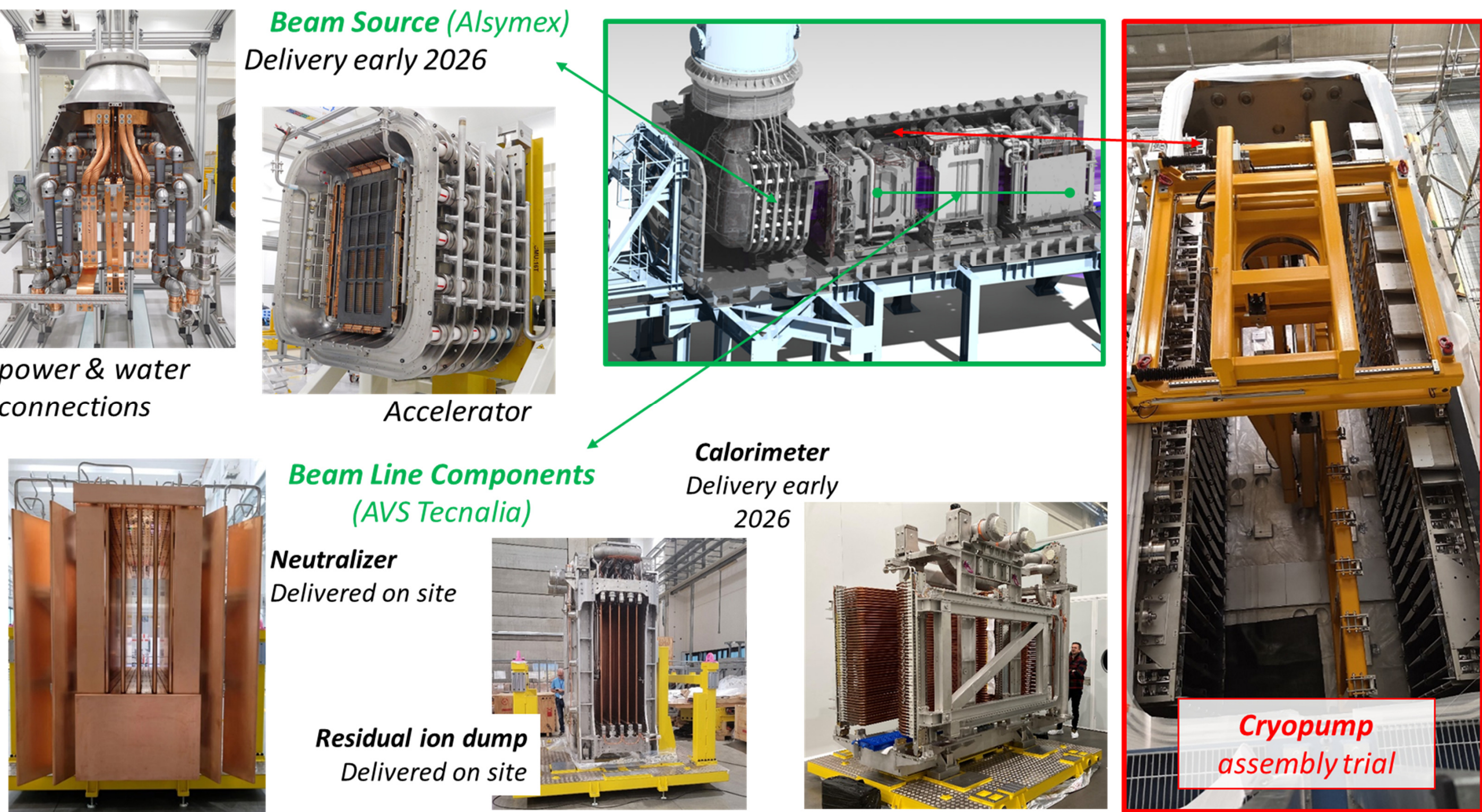
HIGH VOLTAGE TESTS IN VACUUM

Voltage holding in vacuum at 1 MV level, with electrodes of the MITICA beam source dimensions and complexity is a challenge in a fully uncharted territory. Anticipating the investigation of this issue is a strong and strategic risk mitigation in the path towards the first MITICA operation. The completed experiments reached very promising results, relevant with respect to the corresponding target for MITICA and ITER campaigns, both in high vacuum and with injection of gas at a filling pressure coherent with future operation in hydrogen.



Recent HV insulation tests in vacuum: setup and main results

TOWARDS FIRST MITICA OPERATION



F4E procurement for in-vessel components and cryopump assembly trial

CONCLUSIONS

- SPIDER source performance demonstrated the scaling to the ITER target, in terms of extracted negative ion current, other important parameters were effectively investigated. Next campaign is aimed at target parameters.
- Preparation for the first MITICA operation are in full swing, in particular with restoration of power supply under completion.
- HV holding insulation tests in vacuum were carried out, with results relevant to the future MITICA operation in hydrogen.