Contribution ID: **172** Type: **Poster**

Development and First Results from SupRISE: An RF-Driven Ion Source for Neutral Beam Injection

Monday, 8 September 2025 16:30 (1h 30m)

Neutral Beam Injection (NBI) is widely used for non-inductive heating, current drive, fueling, and diagnostics in most major magnetic confinement fusion devices. The DIII-D tokamak operates with eight NBI ion sources based on the U.S. Common Long Pulse Source (CLPS) design, delivering a total output power of up to 20 MW. Over the years, the DIII-D NBI system has undergone significant evolution, incorporating various enhancements that have endowed it with unique features and capabilities. These include beamlines capable of both on- and off-axis injection, co- and counter-current injection, as well as pre-programmed and feedback-controlled variable power and energy injection.

In recent years, however, system reliability has declined due to aging ion source components and fatigued power supplies. In response, the DIII-D NBI team has launched a program to renew and modernize key NBI technologies. Central to this effort is the development of a radiofrequency (RF)-driven, inductively coupled plasma (ICP) ion source that is compatible with the existing DIII-D infrastructure. The objective is to develop a large-area ion source with high plasma uniformity and a favorable species mix, suitable for extraction of up to 70 A of ion current with a target divergence of less than 20 mRad vertically and 5 mRad horizontally.

To this end, a full-scale test device—**the Superior Radiofrequency Ion Source Experiment (SupRISE)**—has been constructed. The primary aim is to investigate how power coupling to the plasma is influenced by drive frequency, antenna design, and chamber geometry. SupRISE uses a four-turn copper antenna to couple up to 50 kW of RF power into a racetrack-shaped (~70 × 30 × 30 cm) quartz vessel, operating at frequencies between 4–8 MHz. Also central to the study are the properties and performance of the RF power supply and impedance-matching unit.

Presented is an overview of the SupRISE source engineering and design, along with initial experimental results. Systematic scans of power, frequency, pressure, and matching conditions are performed to explore the plasma response using Langmuir probe and optical emission spectroscopy diagnostics. Results are compared to both analytical and computational models.

This work is supported by US DOE under DE-SC0024523 and DE-FC02-04ER54698

Primary author: Dr CROWLEY, Brendan (General Atomics)

Co-authors: Mr KALLENBERG, Evan (General Atomics/NCSU); Mr VAN LAKWIJK, Kurt (Eindhoven University of Technology); Dr DAVDA, Kirtan. M (North Carolina State University); Mr HOSSAIN, Md Sazzad (North Carolina State University); Mr MAZZEO, Arthur. G (North Carolina State University); Dr SHAH, Miral (North Carolina State University); Mr AMMONS, Keanu J (North Carolina State University); Prof. LIETZ, Amanda (North Carolina State University); Prof. SHANNON, Steven C (North Carolina State University); Prof. LAGGNER, Florian (North Carolina State University); Mr SCOVILLE, J. Timothy (General Atomics)

Presenter: Dr CROWLEY, Brendan (General Atomics)

Session Classification: Poster Session

Track Classification: Negative ion sources and sources for fusion facilities