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Plasma ignition schemes for the SNS radio-frequency driven H^- source

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The H^- ion source for the Spallation Neutron Source is a radio-frequency driven (2 MHz) multicusp volume source which operates at a duty cycle of 6% (1 ms pulses and 60 Hz) [1]. In pulsed RF driven plasma sources, ignition of the plasma is an important issue that affects the stability of source operation and the antenna lifetime. Four different modes of source operation in regard of plasma ignition have been investigated. The schemes are:

a) Self ignition (ignited by the high power ~40 kW, 2 MHz RF pulse).
b) Filament (a Ta or W filament is run continuously, and thermionic emission of electrons aids ignition of the pulsed plasma).
c) UV light (pulses from a UV flash lamp are synchronized with the starting flank of the pulsed 2 MHz RF power, and photoelectrons aid ignition).
d) A low-density plasma is continuously maintained by low power (~20 W), 13.56 MHz, RF and aids the ignition of the high density pulsed plasma. This dual frequency mode can be implemented both with two antennas and two matching circuits for 2 MHz and 13.56 MHz RF as well as in a single antenna mode with a single matching network [2].

We will present studies of plasma ignition delays for all operation modes, compare working ranges of H_2 pressure in the plasma chamber, and point out how lifetime, reliability and ease of operation are affected by these modes.

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References

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Poster session

Cath: 43