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Ion Sources for the Multi-Isotope Single-Pass RF Driver

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The Front Ends of the Single-Pass RF Driver (SPRFD) produce a timed sequence of many different isotopes: 10 with mass ~Xe for the Compression pulse and 6 with mass ~Pb for Fast Ignition and implosion of the pellets' cylindrical end caps. The16 isotopes require practical, existing ion source technology. Practical considerations include compatibility with the requirements for vacuum and support (e.g., electric power and cooling) that can be provided to the sources in the ~1.5MV terminal, and compactness for produce-ability of the electrodes and ceramics of the HVDC column.

The ion sources needed for the SPRFD are within the state of the art in terms of brightness, current, and engineering features. Xenon isotopes, for example, use the technology Hughes Research Laboratories derived from ion thrusters for the demonstration at Argonne National Laboratory (1977-80) of over 60 mA at low-emittance, 1.5MeV Xe+. At that time, the primary issue for scaling to ≥100 mA was the ability to transport the space charge-dominated beams after their emission from the high-gradient accelerating column in the 1.5 MV Dynamitron®.

Demonstration of the radiofrequency quadrupole accelerator (RFQ) by the Los Alamos National Laboratory, also in the late 1970s, provided the means to handle ≥100mA beams of 1.5 MeV heavy ions. Numerous RFQ applications have exploited the convenience of starting RF acceleration at low ion speeds while circumventing the practical issues of MV preaccelerators. For HIF drivers, however, the contribu-tion of high gradient d.c. acceleration to generating beams with ≥100mA needs to be exploited by combining the RFQ with MV+ pre-acceleration.

To hold voltage in the high-gradient HV column, the gas load emanating at 1.5 MV needs to be evacuated with pumps located at electrical ground. With many ion sources, and gas load tending to increase with beam current, minimizing the gas load from each source is a first priority.

The ~20 μsec on-time for each isotopic pulse allows pulsing the gas for the sources. At SPRFD's 10 pps repetition rate, the duty factor for each source is ~0.0005, ~0.005 for the array of 10 sources ~Xe and less for the 6 sources ~Pb. Means to provide gas puffs include fast valves and laser heating, with or without laser ionization of the material. Very high brightness source technology using field emission from hollow needles containing liquid also may be appropriate for Hg, Bi, Pb, and other readily liquefied materials. Capitalizing on the pulsed nature and low duty factor of the sources also is an effective path to minimizing the power needed to run the sources in the 1.5 MV terminals.

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