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Reimagining FEBIAD Ion Sources: From Design Innovation to Performance Optimization

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Radioactive ion beam production at Isotope Separation On-Line (ISOL) facilities depends on ion sources that offer high selectivity, stability, and efficiency. At TRIUMF, recent developments in FEBIAD ion source technology have focused on two complementary avenues: operational optimization and component redesign enabled by modern manufacturing. Systematic tuning of source parameters, combined with mass spectrometric diagnostics, led to a significant enhancement in the selectivity of the uranium fluoride molecular ion (UF^+), increasing its ratio relative to the isobaric contaminant WOF_3^+ from 4% to over 97% without reducing overall ion yield. In parallel, the electron accelerator grid—a critical element influencing electron transport and ionization efficiency—was redesigned using generative design techniques. The resulting geometry, not manufacturable by conventional methods, was successfully produced in collaboration with ISOLDE using additive manufacturing with tantalum. Upcoming tests will evaluate the predicted gains in electron transport efficiency and thermal management with the redesigned grid. These advances support the implementation of more robust and selective FEBIAD ion sources for future ISOL facilities, including TRIUMF's Advance Rare IsotopE Laboratory (ARIEL).

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