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Beam Switching at CERN-ISOLDE

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ISOLDE is a world-leading facility for radioactive ion beam (RIB) research using the Isotope Separation Online (ISOL) method, capable of producing over 1300 isotopes of more than 70 elements. It supports a diverse range of experiments in nuclear physics, nuclear astrophysics, laser physics, solid-state physics, and medical applications, with beam energies from 30 keV to 10 MeV/u. Serving approximately 1500 academic researchers, ISOLDE conducts around 50 experiments annually; however, the demand for beam time consistently exceeds supply, resulting in a backlog of 1,155 shifts awaiting scheduling.

To address this issue, ISOLDE investigates to transition from a single-user to a multi-user facility, enabling parallel experiments. Currently, about 50% of proton pulses from CERN's PS Booster are allocated to ISOLDE, which operates two target stations (frontends) located at the General Purpose Separator (GPS) and the High Resolution Separator (HRS). These produce mass-separated radioactive ion beams delivered to various experimental setups for nuclear spectroscopy, laser spectroscopy, mass measurements, and solid-state research. At present, the switch-over between separators is performed manually by the beam operator and occurs only when a user requests beam from a different separator.

The beam switch project aims to enhance operational efficiency by introducing an automated beam allotment system, allowing automatic switching between separators. This "alternating mode" is expected to increase operational days by 20 to 30 per year, providing up to four additional experiment slots and facilitating test experiments. With the new beam-switching system, ISOLDE could significantly boost total activity and beam time, enabling two experiments to run simultaneously.

Recent studies have investigated beam sharing options at ISOLDE. The primary bottleneck is the CA0 beamline, which merges and switches beams from the two separators to different experiments. While the CERN PS Booster allows pulse-to-pulse switching between the two separators, most experimental installations at ISOLDE receive beams through a single central beamline (CA0). When the HRS beam occupies CA0, the GPS can only deliver beams to upstream beamlines. Similarly, when the GPS beam uses CA0, the HRS cannot run at all.

To resolve this, the proposed solution is to pulse the CA0 beamline. Implementing this solution would require developing a switching system for the electrostatic power supplies, along with new timing hardware and synchronized beam gates. The system would alternate the entire CA0 beamline between inputs from the GPS and HRS separators, directing output to the LA0, CB0, or RA0 beamlines.

Tests at the ISOLDE offline facilities using high-voltage solid-state switches confirmed that switching times were well below the required limits, demonstrating feasibility for integration with existing equipment and infrastructure. Furthermore, ISOLDE features a beam gate system composed of electrostatic plates positioned after the separator magnets. These plates control the passage of secondary RIB beams by managing the enabling and disabling of beam injection into the HRS or GPS. Recent advancements in the beam gates have paved the way for the beam switch project, which focused on upgrading the beam gate control system. This involved implementing an interim solution that improved the control logic and helped understanding the existing limitations.

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