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Thermalized and ReAccelerated beam diagnostics at NSCL

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The National Superconducting Cyclotron Laboratory at Michigan State University produces rare isotope beams using the fast fragmentation technique. A recent expansion of the facility enables low energy (< 60 keV) and post-accelerated (< 3 MeV/A) beams to be delivered to experiments. The first stage is thermalization in a helium-filled linear gas cell. Depending on the chemistry of the beam species being extracted, the beam may be singly or doubly charged atomic or molecular ions. In order to select the correct mass the low energy beam transport (LEBT) dipole magnet follows the gas cell. The beam can be further transported to the electron-beam ion trap (EBIT) charge breeder and the ReA superconducting linac to provide post-accelerated beams around the Coulomb barrier. Energies up to 3 MeV/A are currently available and a future expansion is planned to provide up to 12 MeV/A for 238U.

Both the gas cell and the EBIT can produce stable backgrounds orders of magnitude higher in intensity than the isotope of interest. Scanning the fields in the LEBT magnet and the charge-over-mass (Q/A) separator following the EBIT provides selectivity, but the diagnostics giving feedback to this process must be able to provide information on the intensity and species of the isotopes on the single-ion-counting level.

NSCL has installed a wide array of beam diagnostics devices, both traditional and detector-based. These devices include Faraday cups for measuring current in the low 10s of pA, with dedicated setups capable of 100s of fA, microchannel plate (MCP) detectors for imaging the beam profile, with observation possible in the low 10s of Hz and decay counters sensitive only to the radioactive portion of the beam. The decay counters give information on the beam species through half-life measurements, with further identification available through the measurement of gamma rays using NaI and germanium detectors. After post-acceleration, the energy of the beam components can be measured with silicon detectors utilizing scattering from gold foils, and in-beam silicon detectors, which allows the beam composition to be measured based on their masses only.

This contribution will discuss the array of traditional and radioactive beam diagnostics available at the laboratory, and show data obtained during the operation and characterization of the gas cell and ReA facilities.

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