Rare isotope beam energy measurements and scintillator developments for ReA3

The ReAccelerator for 3 MeV/u beams (ReA3) is under construction at the National Superconducting Cyclotron Laboratory (NSCL) in Michigan State University. The facility will stop and reaccelerate rare isotope beams produced by in-flight fragmentation from the Facility for Rare Isotope Beams (FRIB). My dissertation project was to develop beam energy diagnostics with good precision and accuracy for the low energy and low intensity of the ion beam at ReA3. Ion beams from ReA3 linac pass through one of the 45° bending magnets which can be used to determine the absolutely beam energy based on the magnetic rigidity. Two methods were developed for the energy calibration of the beam analyzing magnet: nuclear resonant reaction and a time-of-flight (TOF) technique. The gamma ray yields of the $^{27}Al(p,\gamma)^{28}Si$ and $^{58}Ni(p,\gamma)^{59}Cu$ resonance reactions have been measured with the high detector efficiency CAESAR (CAESium iodide ARray) and SuN (Summing NaI(Tl)) detectors to precisely determine the absolute proton beam energy and energy spread. In addition, I have investigated the scintillation degradation for KBr, YAG:Ce, CaF_2:Eu and CsI:Tl scintillator screens under low-intensity H_2^+ irradiation in the range of 600-2150 keV/u and 28-58 keV/u at ReA3. The different scintillation degradation response has been observed on these scintillator materials under low- and high-energy ion bombardments. The development of the two energy calibration techniques for ReA3 and the study of the scintillator screens will be presented.