Abstract

In the scope of this thesis, a digital data acquisition system for the HORUS spectrometer, based on the Digital Gamma Finder (DGF-4C) modules from the company XIA LLC, has been set up. In contrast to the existing analog data acquisition system, it can be easily extended by additional detector channels, which became necessary with the development of the new particle-detector array SONIC. Fully equipped, SONIC houses eight ΔE-E silicon telescope detectors. The digital data acquisition system has been tested extensively with respect to energy and time resolution as well as data throughput. In addition, its performance has been studied in two in-beam experiments, a $\gamma\gamma$ angular correlation and a particle-γ coincidence experiment.

The test of the data acquisition revealed severe differential nonlinearities (DNL) of the built-in ADCs. When operated at high dynamic ranges, double peaks are observed in the γ-ray spectra, hampering the subsequent data analysis. An offline correction algorithm has been developed in this work, which is capable of restoring Gaussian peak shapes and the integral linearity in the measured spectra.

Taking advantage of the new digital data acquisition and the combined setup of SONIC and HORUS, a proton-scattering experiment on the heaviest stable $N = 52$ isotone ^{96}Ru has been performed. The lifetimes of 30 excited states were extracted, using proton-γ coincidence data and applying the Doppler-shift attenuation method. In combination with a second proton-scattering experiment, performed at the Wright Nuclear Structure Laboratory (WNSL) at Yale University, proton-neutron mixed-symmetry states were identified based on absolute $M1$ and $E2$ transition strengths. In particular, the existence of hexadecapole excitations of fully-symmetric and mixed-symmetry character has been investigated in the scope of *sdg*-IBM-2 and shell-model calculations.