BETA DELAYED NEUTRON EMISSION – NEW PERSPECTIVE ON R-PROCESS NUCLEI WITH VERSATILE ARRAY OF NEUTRON DETECTORS AT LOW ENERGY (VANDLE)

R. Grzywacz[1, 2], S.V. Paulauskas[1], M. Madurga[1], W.A. Peters[3], C.J. Gross[2], D. Miller[1], M. Al-Shudifat[1], D.W. Bardayan[2], J.C. Batchelder[3], J. Blackmon[4], N.T. Brewer[5], L. Cartegni[1], J.A. Cizewski[6], P.A. Copp[7], M.E. Howard[6], S. Ilyushkin[8], C. Jost[1], A. Kuźniak[1,9], S. Liu[3], B. Manning[6], C. Matei[3], M. Matos[4], A.J. Mendez II[2], K. Miernik[2,9], P.D. O'Malley[6], S. Padgett[1], C. Rasco[4], D.W. Stracener[2], F. Raiola[8], A. Ratkiewicz[6], K. Rykaczewski[2], F. Sarazin[8], K.T. Schmitt[2], I. Spassova[3], D. Walter[6], E.H. Wang[5], M. Wolińska-Cichocka[2,3], E.F. Zganjar[4]

[1] *Dept. of Phys. and Astr., University of Tennessee, Knoxville, TN 37996, USA*
[2] *Phys. Div., Oak Ridge National Laboratory, Oak Ridge, TN 37830, USA*
[3] *Oak Ridge Associated Universities, Oak Ridge, TN 37831, USA*
[4] *Dept. of Phys. and Astr., Louisiana State University, Baton Rouge, LA 70803, USA*
[5] *Dept. of Phys. and Astr., Vanderbilt University, Nashville, TN 37235, USA*
[6] *Dept. of Phys. and Astr., Rutgers University, Piscataway, NJ 08854-8019 USA*
[7] *Phys. Dept., University of Wisconsin-La Crosse, La Crosse, WI 54601, USA*
[8] *Dept. of Phys., Colorado School of Mines, Golden, CO 80401, USA*
[9] *Faculty of Phys., University of Warsaw, Warsaw PL-00-681, Poland*

Beta-delayed neutron emission (βn) is a prevalent decay channel for a majority of the very neutron-rich nuclei. It is of particular importance in r-process modeling and influences the final isotopic abundance distribution. While many nuclear models predict nuclear lifetimes and branching ratios of the r-process nuclei, very little is known experimentally about the energy spectrum of the neutrons from βn branches that provide direct information about the unbound states populated through beta decay. These measurements constitute a better test of nuclear models than simply using lifetimes and branching ratios.

The new Versatile Array of Neutron Detectors at Low Energy (VANDLE) [1] was commissioned at the Holifield Radioactive Ion Beam Facility (HRIBF). The HRIBF uses proton-induced fission to produce unique, intense and high isotopic purity beams of neutron-rich fission fragments. We have measured neutron energy spectra in key regions of the nuclear chart: near the shell closures at ^{78}Ni and ^{132}Sn, and for the most deformed nuclei at Z=37. Many of these nuclei lie directly on the r-process path [1]. Of the 29 βn emitters studied, only 4 relatively long-lived isotopes were previously measured. For some of the most exotic nuclei, narrow and intense peaks in the neutron energy distribution indicate the presence of resonances, which are most likely signatures of the excitation of deeply bound "core" states. VANDLE has the unique ability, for a time-of-flight scintillator array, to measure neutron energies as low as 100 keV, which is critical for making credible comparisons between experiment and theory. Preliminary results from the most prominent measurements will be presented.

References

[1] C. Matei et al., Proceedings of Science, NIC X, 138 (2008)