PRODUCTION AND STUDY OF EXOTIC NEUTRON-RICH NUCLEI USING THE LICORNE DIRECTIONAL NEUTRON SOURCE

John A. Smith, Institute for Advanced Studies, City, Country

J.N. Wilson[1], M. Lebois[1], L. Qi[1], P. Amador-Celdran[2], D. Bleuel[3], J. Briz[4], R. Carroll[5], W. Catford[5], D. Doherty[6], R. Eloirdi[2], G. Georgiev[7], A. Gottardo[1], K. Hadynske-Klek[8], K. Hauschild[7], V. Ingeberg[8], J. Ljungvall[7], A. Lopez-Martens[7], G. Lorusso[9], R. Lozeva[10], P. Marini[11], I. Matea[1], T. Materna[6], L. Matthieu[11], A. Oberstedt[12], S. Oberstedt[13], S. Panebianco[6], Z. Podolyak[5], A. Porta[4], P. Regan[5,9], K. Rezynkina[7], S.J. Rose[8], E. Sahin[8], R. Shearman[5], S. Siem[8], A.G. Smith[14], G. Tveten[8], D. Verney[1], N. Warr1[5], F. Zesier[8], M. Zielinska[6]

1 Institut de Physique Nucléaire d'Orsay, Bât. 100, 15 rue G. Clémenceau, 91406 Orsay cedex, France
2 JRC-ITU Karlsruhe, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany

3 Lawrence Livermore National Laboratory, 7000 East Ave, Livermore, CA 94550, USA

4 Subatech/Ecole des Mines, 4 rue Alfred Kastler, 44307 Nantes, France

5 Department of Physics, University of Surrey, Guildford, GU2 7XH, United Kingdom

6 CEA Saclay, DSM/Irfu, F-91191 Gif-sur-Yvette Cedex, France

7 CSNSM Orsay, Bât. 104, F- 91405 Orsay, France

8 University of Oslo, Department of Physics, P.O. Box 1048, Blindern 0316 Oslo, Norway

9 National Physical Laboratory, Hampton Road, Teddington, Middlesex TW11 0LW, United Kingdom

10 IPHC, Université de Strasbourg, 23 rue du Loess, BP28 F-67037, Strasbourg, France

11 CENBG Bordeaux, Chemin du Solarium, Le Haut Vigneau, BP 120 F-33175 Gradignan, France

12 Fundamental Fysik, Chalmers Tekniska Högskola, 41296 Göteborg, Sweden

13 IRMM European Commission, Joint Research Centre (IRMM), 2440 Geel, Belgium

14 University of Manchster, Dept. Of Physics, Oxford Road, Manchester, M13 9PL, United Kingdom

15 Institut für Kernphysik, Zülpicher Straße 77, 50937 Köln, Deutschland

We have recently successfully demonstrated a new technique for production and study of many of the most exotic neutron-rich nuclei at moderate spins. LICORNE, a newly developed directional inverse-kinematic fast neutron source at the IPN Orsay, was coupled to the Miniball high resolution gamma ray spectrometer to study nuclei the furthest from stability using the ^{238}U(n,f) reaction. This reaction and ^{232}Th(n,f), are the most neutron-rich fission production mechanisms achievable and can be used to simultaneously populate hundreds of neutron-rich nuclei up to spins of ~16h. High selectivity in the experiment was achieved via triple gamma-ray coincidences and the use of a 400ns period pulsed neutron beam, a technique which is unavailable to other population mechanisms such as ^{235}U(nth,f) and ^{252}Cf(SF) used in the past. The pulsing allows time correlations to be exploited to separate delayed gamma rays from isomeric states in the hundreds of nuclei produced which are then used to cleanly select a particular nucleus and its exotic binary partners. In the recent experiment several physics cases are simultaneously addressed such as shape coexistence, the evolution of shell closures far from stability, and the spectroscopy of nuclei in the r-process path near N=82. Preliminary physics results will be presented on the structure of the ^{138}Te and ^{100}Sr nuclei along with a future project, nu-ball, to couple LICORNE with a hybrid escape-suppressed spectrometer to refine further the technique and achieve a large increase in the observational limit.