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A new technique to produce and study the most exotic neutron-rich nuclei

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We have recently successfully demonstrated a new technique for production and study of many of the most exotic neutron-rich nuclei. 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 238U(n,f) reaction. This reaction is the most neutron-rich fission production mechanism achievable and was employed to simultaneously populate hundreds of neutron-rich nuclei up to spins of ~16h. High selectivity in the experiment was achieved via the use of a 400ns period pulsed neutron beam, a technique which is unavailable to other population mechanisms such as 235U(nth,f) and 252Cf(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. The most interesting cases occur when the isomeric state is in a nucleus close to stability (e.g. 130Te), which guarantees from mass/charge conservation that the binary partners (106,108Zr) are at/beyond the very limit of our present knowledge. In the recent experiment several physics cases are simultaneously addressed such as shape coexistence, the evolution of the shell closures near doubly-magic 78Ni, and the spectroscopy of nuclei in the r-process path near N=82. Preliminary results will be presented.

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