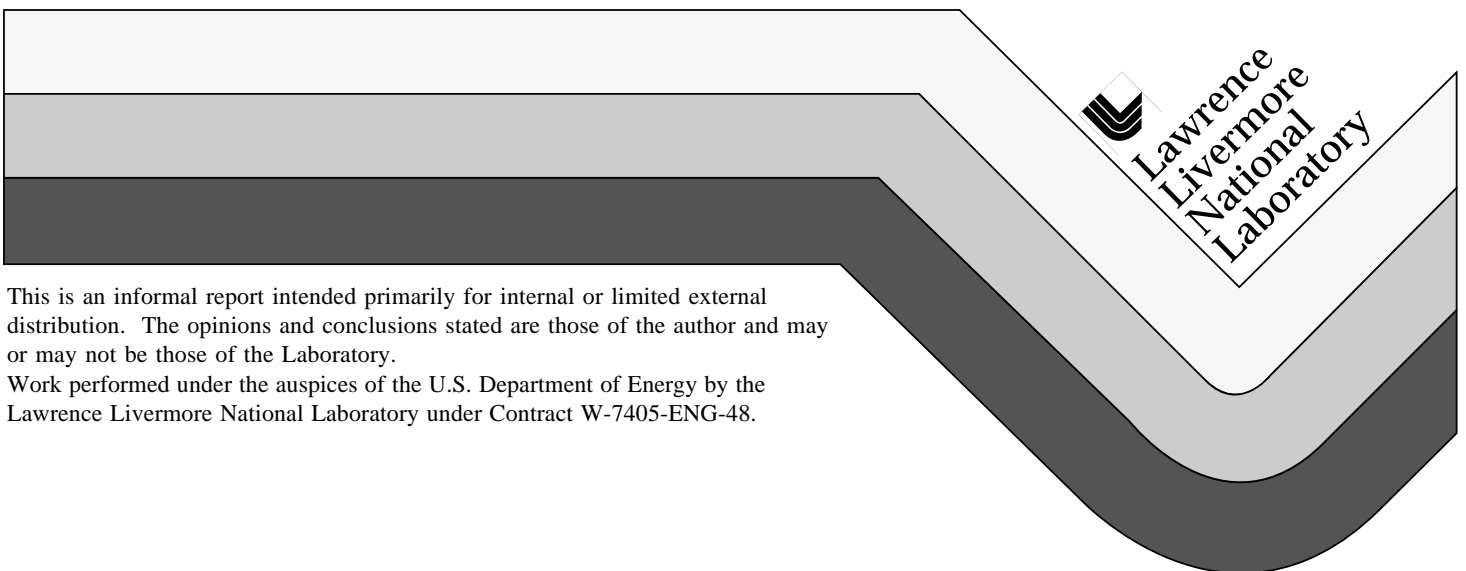


**Studies in the Region of Enhanced Nuclear Stability
Around $N = 162$ and $Z = 108$**

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In FY96, we carefully examined our raw data from the experiment to produce element 110 via the bombardment of ^{244}Pu with ^{34}S ions at the U400 cyclotron at the Joint Institute for Nuclear Research, Dubna, Russia.^{1,2} We did this to assure ourselves that 1) the one Z=110 event we discovered in our data was the only Z=110 event that we could identify with a high degree of surety, and 2) that our claim to the discovery of element 110 could not be denied due to a failure on our part to explain some aspect of our results. With regard to point 2), we also performed collateral bombardments at the Dubna U400 cyclotron to characterize the response of the time-of-flight detectors at the end of the Dubna gas-filled mass separator in order to understand better an unusual signal we incurred in the discovery event. This signal is believed to have arisen from the coincident detection of the alpha particle from the decay of one of the daughter nuclei in the 110 chain and a conversion electron from deexcitation of the subsequently-produced nucleus. Following this, we submitted an article paper on our experiment to the journal Physical Review C, which was published in the August, 1996, issue.

During the year, we also prepared for the next experiment in this collaboration, which was to have been the search for an isotope of element 114, produced via the bombardment of ^{244}Pu with ^{48}Ca ions. Element 114 is believed to be at the center of a region of nuclei (superheavy elements) which is very stable due to the presence of both proton and neutron spherical closed shells, and characterization of the decay properties of these nuclei would be of prime importance to the theoretical understanding of the behavior of nuclear matter. The accompanying figure is a nuclide chart (plot of Z vs. N) showing what types of nuclear reactions are required to produce which transuranium nuclides. The crosses represent the centers of extra-stable regions of nuclei. The Z=110 isotope we discovered is shown as the square just to the upper right of the cross at Z=108, N=162. The region we hoped to attain in the Z=114 experiment is near the cross in the upper right part of the figure. In this region, the rightmost two squares are nuclides we could expect to make via the "hot fusion" reactions $^{244}\text{Pu} + ^{48}\text{Ca}$ and $^{248}\text{Cm} + ^{48}\text{Ca}$, while the leftmost square is the most neutron-rich nuclide the "cold fusion" reaction mechanism could produce. The negative numbers (MeV) are predicted measures of the ground-state stability of these nuclides: the more negative the number, the more stable the nucleus. Every MeV increase in stability represents a factor of about 10^6 increase in half-life, and our target-projectile

combination is expected to land us near the neutron closed shell around $N \sim 178-184$, as well as at $Z=114$. The “hot fusion” reaction is required in order to inject the maximum number of neutrons into the product nucleus for a given number of protons, in order to achieve the highest possible isotopic stability. This experiment is probably an order of magnitude more difficult than the search for element 110, and would require a considerably more efficient detection system than our experiments have had in the past. To this end, since the actual bombardment will likely not begin before the middle of FY97, in FY96 we purchased a suite of surface-barrier detectors for use in the experiment. Our previous experiments in this collaboration have demonstrated the capability for producing high-intensity cyclotron beams to bombard targets capable of withstanding these beams over a long period of time, coupled with a very stable detection and data acquisition system, all necessary to achieve positive results in such an experiment. Our collaboration will not be funded by LDRD in FY97 due to a decision that the category “world-class basic research” is no longer a priority for funded research.

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Presentation

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