Design of a Sample Changer/Transport System to be used for Gammasphere Studies on Electron-capture Delayed Fission

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A sample changer/transport system has been designed to rapidly transport isotopes from high beam intensity irradiations in Cave 0 to the center of Gammasphere to study electron-capture delayed fission (ECDF).

In the Cave 0 target system, recoiling reaction products are captured by KCl aerosols in a flowing stream of He gas. The activity-laden aerosols are transported from the irradiation vault to the Gammasphere cave through a polyvinyl chloride capillary tube. The aerosol is then deposited on a thin polypropylene foil at one of four stations on a sample changer wheel. This wheel sits approximately four feet from the center of the Gammasphere array. After a specified collection time, the wheel is rotated 90˚. A solenoid-operated piston then moves the foil from the wheel to the center of the array. After a specified counting time, the piston returns the foil to its wheel position. After the wheel rotates another 90˚, the counted foil is deposited into a reservoir of used foils. After another 90˚ rotation, an unused foil is dropped from a reservoir of new foils to the open wheel position. This four station process is continuous and simultaneous. For example, when one foil is being counted in Gammasphere; one foil is collecting aerosol from the capillary tube, one foil is being dumped into the used reservoir, and another is being dropped into the open position on the wheel.

A motion controller program controls the stepping motor that turns the wheel and the solenoids that activate the piston and vacuum systems. These programs are written on a PC and downloaded to the motion controller before the experiment.

At the counting station, the activity-bearing polypropylene foil will be placed between two ion-implanted Si detectors at the center of Gammasphere. Fission fragments, alpha particles, K x-rays, and gamma rays will be measured while the sample sits inside the array.

Gammasphere is an ideal detection system for studying the gamma spectroscopy associated with the ECDF process for two primary reasons. First, the small solid angle of each detector prevents summing of the ECDF gamma rays with those from the deexcitation of the fission fragments. Second, a high detector efficiency is desired when dealing with relatively low production rates.

The centerpiece of the Gammasphere measurements will be a search for gamma transitions within the second well of the nuclear potential. Based on results from earlier measurements of the K x-rays in coincidence with delayed fission fragments, we have found that in regions of N and Z where a fission isomer is expected, the delayed fission process is slow enough for the K-vacancies left by the electron capture of the precursor to fill. The most likely explanation for this delay is that the ECDF process is proceeding through the fission shape isomer in the EC daughter. The observation of some common gamma transitions in coincidence with various fission fragments and K x-rays would be indicative of transitions within the second well.

The first experiment to utilize this sample changer/transport system will take place in Spring 1997 with the ECDF study[1,2] of ^{232}Am and ^{234}Am with half-lives: 1.31 $\pm$ 0.04 and 2.32 $\pm$ 0.08 minutes, respectively. The speed at which the sample changer/transport system moves the sample from the target area to Gammasphere could be as low as 10 seconds-- a benefit in studying isotopes with short half-lives.

Footnotes and References

1. H.L. Hall, *et.al*., Phys. Rev. C 41, ,618 (1990).
2. H.L. Hall and D.C. Hoffman, Annual Rev. Nucl. Part. Sci. 42, 147 (1992).