Heavy Element Nuclear Chemistry and Physics Goals

- Use of the BGS for synthesis and identification of new heavy element isotopes.

  The Berkeley Gas-filled Separator (BGS) allows separation and detection of heavy element isotopes produced in compound nucleus reactions. Studies of production and decay of these heaviest isotopes provide important information on nuclear masses, heavy element production reaction mechanisms, and nuclear structure and stability at the high-Z limit. Recent worldwide experimental results have revitalized the heavy element field. The combination of high-intensity heavy-ion beams from the 88-Inch Cyclotron with the high efficiency and selectivity of the BGS has put us into position to make the most important contributions.

- Chemical separations of the transactinide elements.

  Studies of the chemical properties of the elements are the most fundamental goal in chemistry. Our world-leading studies of the chemical properties of the transactinide elements (Z=104-108) are unique within the US. Comparison of heavy element chemical properties with those of periodic table homologues and theoretical predictions provide important insights for a better understanding of chemical properties throughout the periodic table.

- The study of fission, both spontaneous fission and electron capture-delayed fission.

  Spontaneous fission is an extremely sensitive probe of nuclear structure and stability, and delayed fission provides a means for studying the details of fission barriers in a low-background, out-of-beam environment. Electron-capture-delayed fission measurements with Gammasphere provide new experimental information on the structure of fission barriers in the neutron-deficient actinides.

- Student training in ultra-sensitive nuclear physics and chemistry techniques.

  These exotic, frontier studies attract many undergraduate and graduate students to nuclear and radiochemistry. This research provides excellent education and training for future contributions and careers in a variety of applied areas, as well as in frontier research.

- Research in applied areas of nuclear science:
  - Prediction and monitoring of behavior of actinides in the environment
  - Nuclear medicine and isotope production
  - Radiopharmaceutical preparation
  - Nuclear power
  - Nuclear waste isolation and site remediation
  - Treatment, processing, and minimization of wastes
  - Ultra-sensitive instrumentation and analyses
  - Automated and computer-controlled remote processing
  - Surveillance of clandestine nuclear activities

- A world-class heavy element research program for future studies.

  We will maintain a flexible first-rate program which can respond quickly to new research opportunities in heavy element studies and for a broader range of experiments requiring a) high-intensity beams, b) highly efficient or highly specific separations, and/or c) requiring the most extreme detection sensitivity. These fields of expertise will be essential in the development of apparatus and experiments at the proposed Rare Isotope Accelerator facility.