The Joint Institute for Nuclear Astrophysics

^{238}U fission at the NSCL: A step toward producing r-process nuclei

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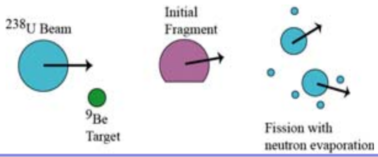
Why do fission at the NSCL?

- Current research has taken a strong interest in exotic neutron rich nuclei that are thought to be significant in stellar processes. It has been predicted that the fissioning of a ^{238}U beam could produce these isotopes in much larger quantities than other available methods.
- Fission remains one of the least understood nuclear processes and although some studies have been done in the past more data is needed to test current fission models.
- In order for next generation rare isotope facilities to be a versatile as possible it is necessary to study fission in greater depth. This will allow for design parameters to be better specified to support future fission experiments.



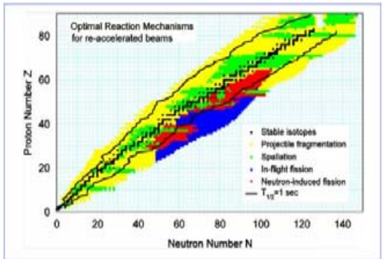
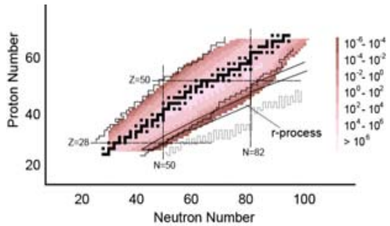
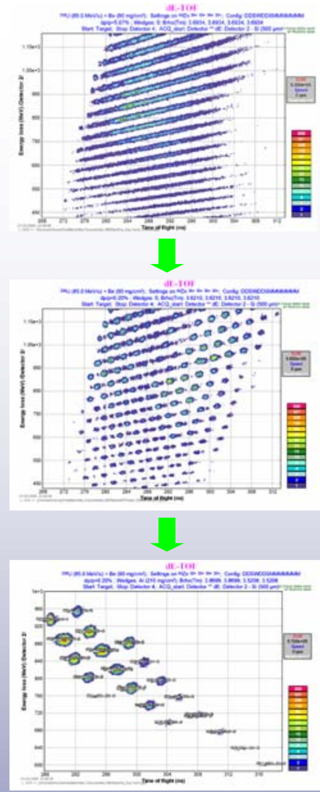
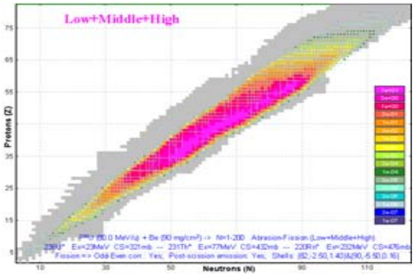


Figure 7.2: Color map of the optimal production method for re-accelerated secondary beams produced at a 400 kW, 400 MeV/nucleon facility. The plot extends to a production of 10^{-4} s^{-1}.



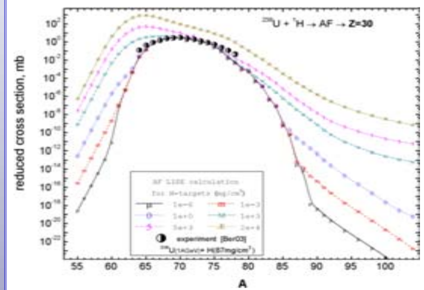




2D fission fragment production cross-section plot for sum of Low, Middle, High EERs for the reaction ^{238}U (1AGeV) + Be

Abrasion-Fission: three excitation energy regions model

- We have designed our experiment using the Abrasion-Fission model developed in the LISE++ code framework. We believe this model to be superior to previous models due to its strong correlation with data accumulated from fission work done previously at GSI.
- Most importantly this model includes prediction for production by secondary reactions of the fission fragments in the target which we believe are the primary means of production for the more exotic neutron rich nuclei.



Reduced production cross-sections of Zinc fission fragments produced in the reaction ^{238}U(10AGeV)+p as a function of the target thickness.

Challenges and opportunities

- The development of the ^{238}U beam at the NSCL will allow for future future fission studies at this facility.
- This experiment will produce a large number of fission products with broad momentum distributions. In order to identify these particle we have created a detector setup that if successful could be used for a number of experiments that involve a wide array of fragments.
- We also plan to observe ^{84}Zn during this experiment making the NSCL the first facility to identify it.
- The results of this experiment will be able to determine the strength of the secondary reaction predictions and allow for a better refinement of future fission models.
- Solving any unforeseen difficulties that may arise may provide essential experience that could be used to design future rare isotope facilities.

The experimental setup

- This experiment will utilize an 85 MeV/u beam of ^{238}U
- This beam will then be fissioned on a light Be target similar to the Li targets proposed for some future rare isotope facilities. Previous work has been done on mostly Pb or p targets.
- The fission fragments will then be analyzed in the A1900 fragment separator using the full momentum acceptance to ensure the largest possible data sample.
- Finally the fragments will be detected at the A1900 focal plane using a silicon detector stack. Since the detectors will be at the end of the A1900 the losses due to transmission between the separator and the detector will be eliminated.

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