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COMPARISON OF 18-GeV AND 60-GeV (Serpukhov) INTERACTIONS IN URANIUM AND COPPER, USING RADIOCHEMICAL METHODS

by

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I. INTRODUCTION

The major part of high-energy interactions in complex nuclei proceeds by two steps:

1) a nucleonic cascade, being essentially two-body interactions;

2) an evaporation step and/or fission.

The distribution of residual nuclei resulting from these interactions can be determined by radiochemical methods. Therefore, a comparison of the distribution of residual nuclei at 18 and 60 GeV will directly show any change in the interactions in the given proton energy interval. Although no great changes are expected this should be tested experimentally. In particular some complex high-energy interaction does seem to be energy sensitive even above 10 GeV[1]. A detailed comparison of the yield distribution for residual nuclei would be very time-consuming, but it is possible to select typical reaction products for high and low deposition energy processes and compare those at the given energies.

2. EXPERIMENTAL METHOD

A target sandwich suitable for irradiation in the internal beam will contain uranium,aluminium and copper foils. After irradiation the target should be transported by air to be at CERN within 10 to 20 hours. Here the uranium target will be analysed in the Nuclear Chemistry Group for iodine, bromine, antimony and possible other elements. The radioactive elements will be separated further by an isotope separator to obtain directly an isotopic distribution.

It is known that neutron-rich isotopes for bromine, iodine and antimony are produced by fission (resulting from low-energy-deposition processes) while neutron-deficient isotopes are produced by another process, probably spallation (but certainly reculting from high-energy-deposition processes)[2,4]. A comparison of these two different reaction products can be made within (± 3%) and within these limits one can determine whether the ratio of low to high energy deposition processes changes between 18 and 60 GeV. See Fig. 1 for an example at 18 GeV[2,4].

The copper target will be analysed for several product nuclei without the use of an isotope separator. The shape of the yield-distribution curve can in this case be compared for the two energies within (± 10%).

Obviously, the 18-GeV exposures will be analysed immediately before and after the 60-GeV exposures in order to make sure that the experimental technique (which is well known today) is identical for the comparison.

3. TIME DEMANDS

One would like to carry out 5 exposures, each with an integrated flux of 3×10^{13} circulating protons. For a repetition rate of 2 sec and a beam intensity of $\sim 10^{11}$ protons per burst, this would mean 5 times 1 hour irradiation. During these irradiations the protons cannot be used for other experiments.(It might be possible to work with less protons.)

4. REFERENCES

1 The cross-section for ternary fission in uranium seems to increase between 18 and 23 GeV proton energy. (Private communication from CERN-Heidelberg-Naples-Warsaw mica collaboration);

2 G. Rudstam, G. Sørensen, J. Inorg. Nucl. Chem. 28, 771 (1966);

3 E. Hagebø, J. Inorg. Nucl. Chem. (to be published);

4 R. Brandt, Atompraxis 13, 15 (1967).

Fig. 1: Cross-section (a) and ranges (b) of iodine isotopes produced at 18 GeV on uranium.