Applicability study of Photofission Rate of Reaction Ratio Method to identify High Enriched Uranium by utilizing the Bremsstrahlung spectrum photon

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The study of applicability of nuclear fuel material isotopic composition measurement method based on photonuclear reaction on identifying HEU was studied in this paper. The principle of PFRR method was validated by Kimura et. al. [1] by assuming a Gaussian photon source while in this paper, Bremsstrahlung induced photon source spectrum was used.
Keywords: Photofission rate of reaction ratio method, photonuclear reaction, high enriched uranium, Bremsstrahlung.

1. Introduction

Photofission Reaction Rate Ratio (PFRR) is one of the latest Non-destructive assay (NDA) methods where it can alleviate several problems: Few self-generated neutron or photoemissions due to shielding; Difficulty of measurement due to intensive gamma ray background; Low measurement reliability because of impurities and unknown information.

2. Methodology

2-1. Photonuclear reaction rate

$$RR = N \int_{E_{min}}^{E_{max}} \sigma(E)\varphi(E)$$

Eq. 1

Eq. 1 shows the photonuclear reaction rate formula used in this study where N is atomic number density, σ is photofission cross section, φ is Bremsstrahlung photon flux.

3. Results

This research involves the simulation of a heavy metal target being hit by an electron beam originates from linear accelerator, the target then releases photon in Bremsstrahlung spectrum which then collides with a uranium target (U235-238 mix), see **Figure 1**. 6 and 11 MeV electron beam energy were studied because the photofission cross section of U^{235} and U^{238} at these two energies vary significantly. The real experiment is expected to be conducted this April. As for simulation, the Bremsstrahlung spectrum photon was generated with PHITS which acts as source spectrum ran by MCNP. The uranium target is a thin parallepiped geometry (0.1cm). The result from MCNP which is shown in **Figure 2** conforms with that of theoretical trend (see Poster), where the ratio of PFRR increases with the rising enrichment. The theoretical trend takes the photofission cross section from library ENDF VII.0 (point wise data converted to group energies).

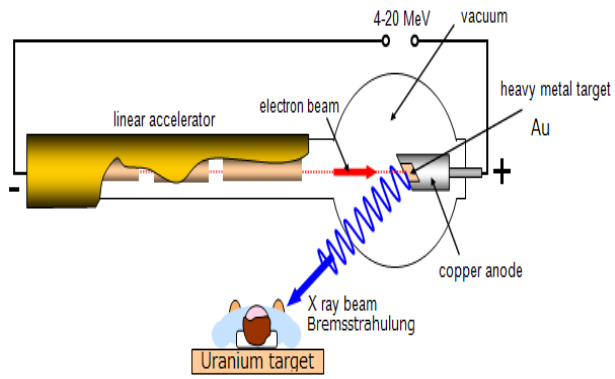

Figure 1 Conceptual experimental setup

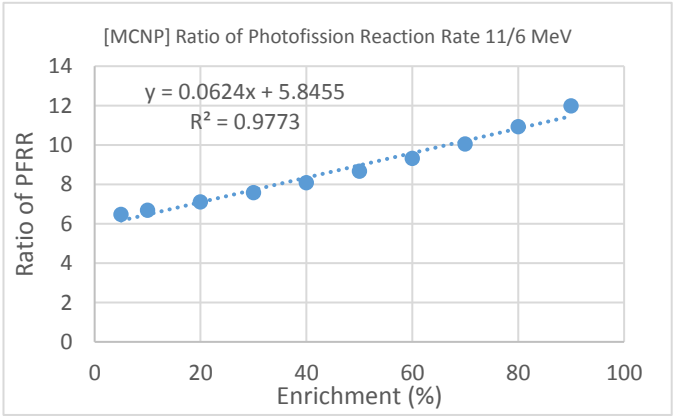

Figure 2 PFRR of incident 11/6MeV from MCNP

References [1] Rei Kimura et.al, 2016, Journal of Nuc. Sci. and Tech., DOI:10.1080/0022313.