# MLF Experimental Report

| 提出日 Date of Report | |
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| 課題番号 Project No.<br>2012A0142 | 装置責任者 Name of responsible person<br>Hideo Harada |
| 実験課題名 Title of experiment<br>$^{62}$Ni(n, γ) reaction measurement | 装置名 Name of Instrument/（BL No.）<br>BL4 |
| 実験責任者名 Name of principal investigator<br>Mariko Segawa | 実施日 Date of Experiment<br>2012/05/20 10:00-2012/5/25 9:00 |
| 所属 Affiliation<br>Japan Atomic Energy Agency | |

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

## 1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

The high purity sample (96 % enriched in $^{62}$Ni) of powder form and $^{197}$Au (metal sheet) were used.

## 2. 実験方法及び結果 （実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

**Introduction:** The construction of stellar models of nucleosynthetic yields of massive stars of various metallicities is quite im portant for finally constructing models for the chemical evolution of galaxies. Although the calculated nucleosynthetic yields of most isotopes from A = 16 to A = 90 are in good agreement with the solar abundances, the isotope $^{62}$Ni is overproduced. The origin of the overproduction is considered to be due to residual uncertainties in the stellar models and/or in the nuclear physics inputs used for the calculation of the nucleosynthetic yields of massive stars. Previously, the MACS at 30 keV was derived as being 37.0 ± 3.2 m barn, about 3 times larger than the value used for the nucleosynthetic yield estimate of massive stars. Here, in order to derive the MACS, we have to know the cross sections below 5.5 keV. Thus, we need to know the contribution of the s-wave resonance at $E_r$=4.54 keV precisely, since its contribution to MACS of $^{62}$Ni could be significant.

**Aim:** In the present study, we aimed to obtain the pulse-height spectrum for $^{62}$Ni(n,γ) reaction with good signal to noise ratio below 5.5 keV and drive the absolute neutron capture cross section for $^{62}$Ni(n,γ) reaction, using Ge-detector system and NaI detector system, respectively.

## 2. 実験方法及び結果（つづき） Experimental method and results (continued)

**Experiments:**

(1) The pulse-height spectrum for $^{62}$Ni(n,γ) reaction taken by Ge-detectors and the resonance at 4.5keV

The pulse-height spectrum for $^{62}$Ni(n,γ) reaction was obtained with good signal to noise ratio below 5.5 keV. Fig.1shows the TOF spectrum for $^{62}$Ni(n,γ) reaction obtained by Ge-detectors at ANNRI of BL04. The resonance clearly seen at the black arrow corresponds to $E_r$= 4.5 keV. We put the gates (gate1 and gate2) on resonance and off-resonance regions on the Fig.1 indicated as blue and green lines. Fig.2 shows the γ-ray spectrum for the gate1 and gate2 of the TOF spectrum. The γ-ray peaks at $E_\gamma$= 6836keV was the γ-ray emitted from the captured state of $^{63}$Ni to that of ground state. We could obtain the sharp peak on the resonance energy region at $E_r$ = 4.5 keV. Now, we estimate net γ-ray yields on careful analytical evaluation in order to obtain the capture cross section.

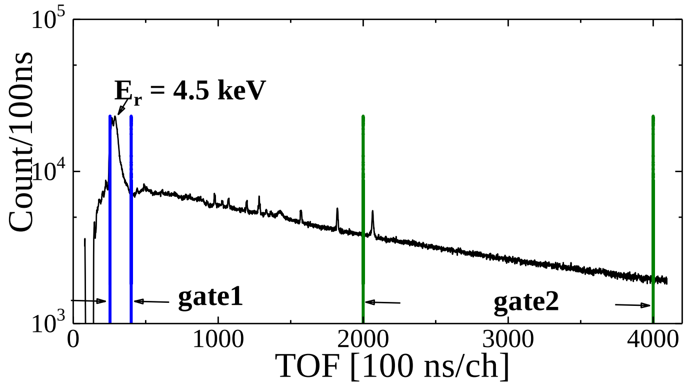


Fig.1 TOF spectrum for $^{62}$Ni(n, γ) reaction obtained by Ge-detector.

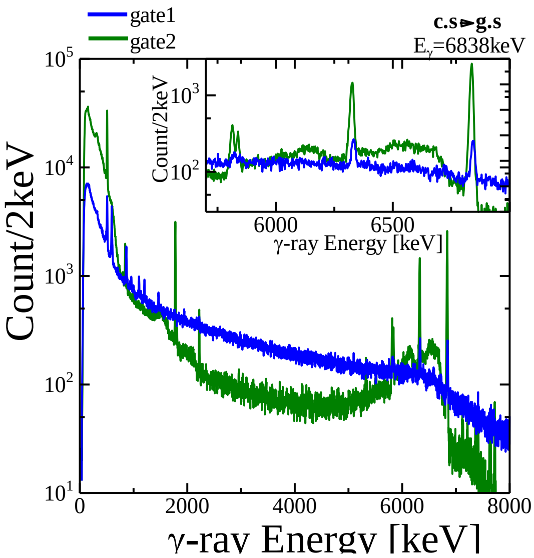


Fig.2 Pulse-height spectrum for $^{62}$Ni(n, γ) reaction obtained by Ge-detector.

(2) The capture cross section for $^{62}$Ni(n,γ) reaction using NaI-detector

As our original plan, the absolute capture cross section would have obtained by NaI detector system. However, in the neutron energy higher than a few keV, the background neutron scattered by the collimator, which was placed between Ge-detectors and the NaI detector system, was found to be severe background. Because such scattered neutron could enter the NaI detector, the γ-ray from $^{127}$I(n, γ) reaction were observed in the TOF spectrum taken by the NaI detector. Since the γ-ray energy of $^{62}$Ni(n, γ) and $^{127}$I(n, γ)reaction are very close, it was difficult to distinguish the true γ-ray of $^{62}$Ni(n, γ) reaction. Hence, in the beam time, the basic background study was performed in order to reduce the scattered neutron. The thickness of the borated polyethylene shield set between the collimator and NaI detector were increased from 0 to 45 cm, and background γ-ray owing to $^{127}$I(n, γ) reaction was studied as shown in Fig. 3. Owing to the result and other results taken by the developing group, the collimator and neutron shield for NaI-detector has been improved.

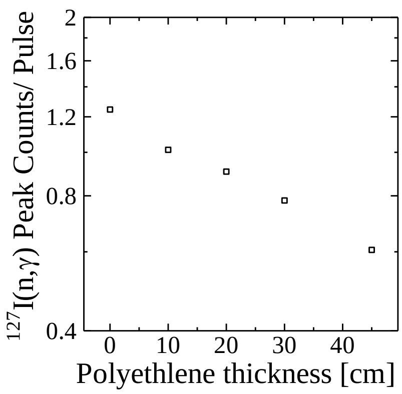


Fig.3 Polyethylene thickness and background count rate