Measurement of differential and double differential cross-section for natural Gallium at 8.0 MeV neutrons

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INTRODUCTION: Gallium has widely been used to make alloys with low melting points and has become a candidate element in Chinese Initiative Accelerator Driven Systems (CIADS) project for liquid–metallic coolant. The neutron cross section of gallium is useful for nuclear device design. The experimental differential cross section data is still rare in fast neutron energy region. The secondary neutron emission differential and double-differential cross sections (DXs and DDXs) of n + ^{nat}Ga have been measured at the neutron energy of 8 MeV using the multi-detector fast Neutron Time-Of-Flight (NTOF) spectrometer in China Institute of Atomic Energy (CIAE) which is shown in Fig. 1. The time-of-flight spectra of the secondary neutrons from about 1 MeV to 9 MeV were measured with 3 BC501A liquid scintillators (with a size of Φ180 mm × 100 mm). The measured DXs and DDXs were obtained at 21 angles within the angular range between 20 and 140 degrees.

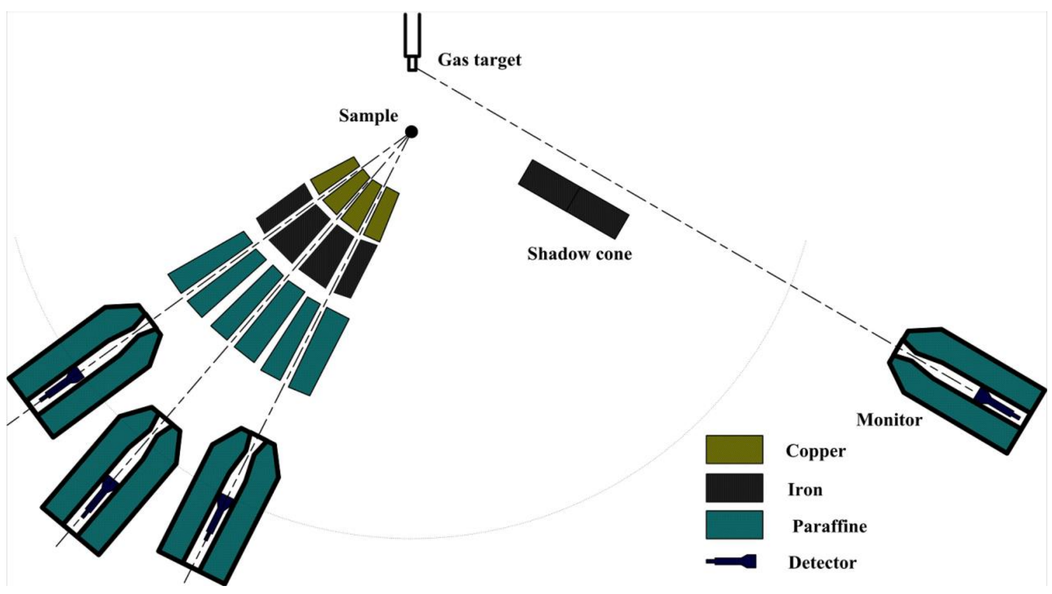

Fig. 1 Diagram of the multi-detector fast NTOF spectrometer

Data Analysis:
Two-dimensional table-cut conditions for n-γ discrimination are applied to project the accumulated list mode data into NTOF spectra. Four runs of measurement with gas in (sample in and out) and gas out (sample in and out) were performed for each angle during the experiment. Other relevant quantities are obtained in addition, such as neutron detection thresholds, monitor count rates, calibration constants of the time-to-amplitude converters (TACs), and photon line positions. The data was derived by comparing the measured NTOF spectra with Monte Carlo simulation, and corrected with n-p scattering cross section in small angles. The corrections due to multiple scattering, fluence attenuation in the sample, and finite geometry effects were performed with Monte-Carlo caculations with the STREUER code. The data analysis basically is an iteration procedure which is demonstrated in Fig. 2.

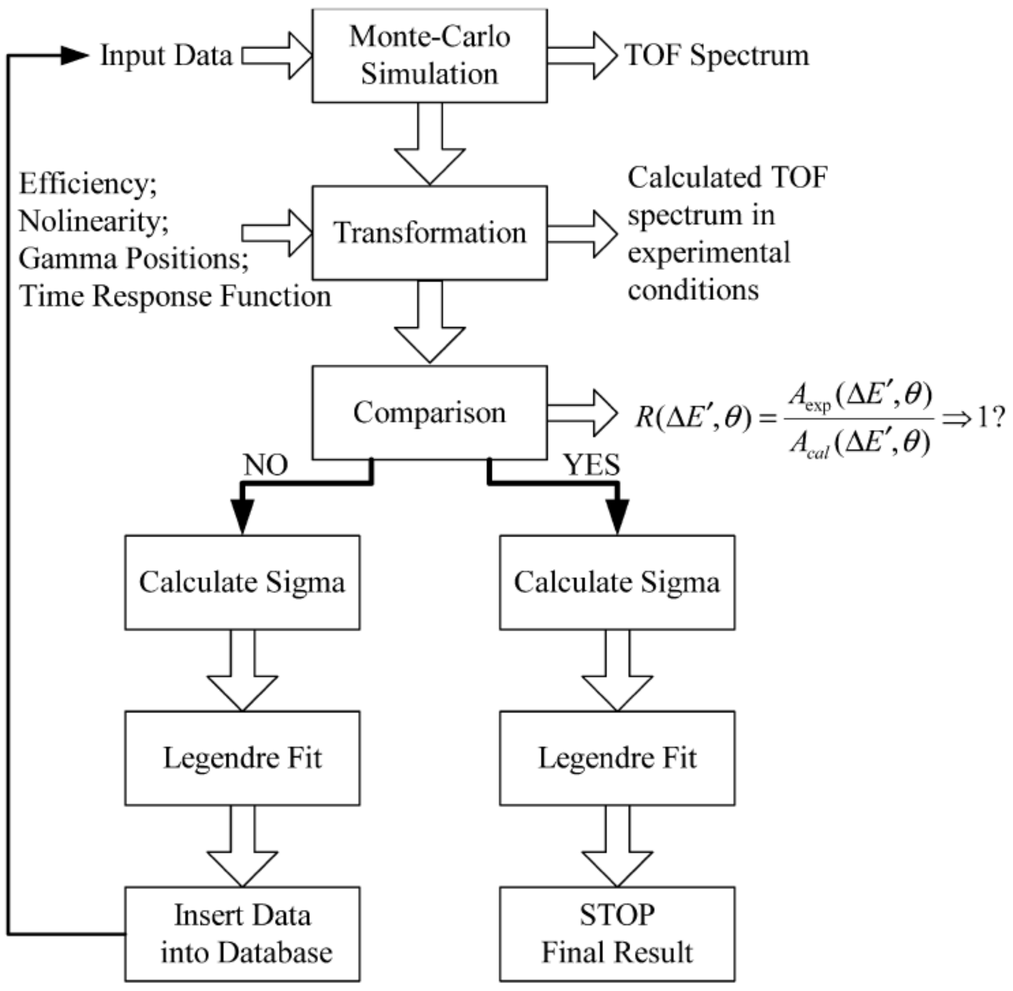

Fig. 2 Diagram of the multi-detector fast NTOF spectrometer

Results:
Fig. 3 is the NTOF spectrum of n+^{nat}Ga at 25 degree. The black line is the experimental result after background subtraction and the green line is the Monte Carlo simulation of the last iteration.

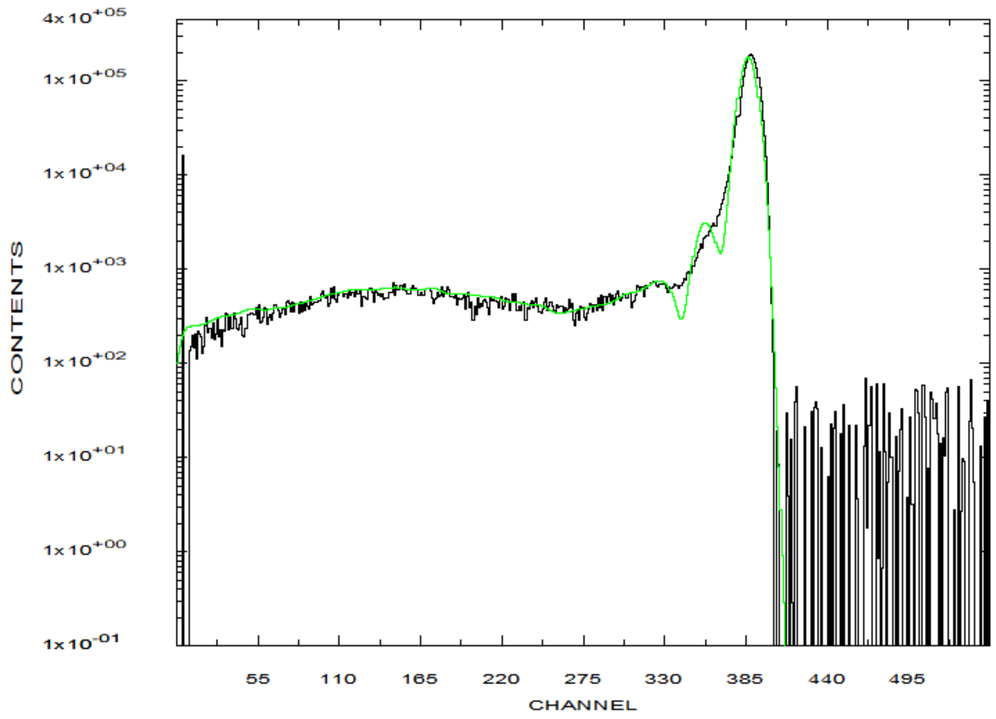

Fig. 3 The NTOF spectrum of n+^{nat}Ga at 25 degree

The measured angular distribution of elastic scattering of n+^{nat}Ga is compared with evaluated data (ENDF, CENDL, etc.) in Fig. 4. It can be seem that all evaluated data results are agree well with our experimental result except for ENDF/B VIII. The error bars of the measured cross section include the statistical uncertainty(~1%), the uncertainty of detection efficiency(3%), the uncertainty of standard n+p cross sections(1%) and the uncertainty of the measurement system(2%).

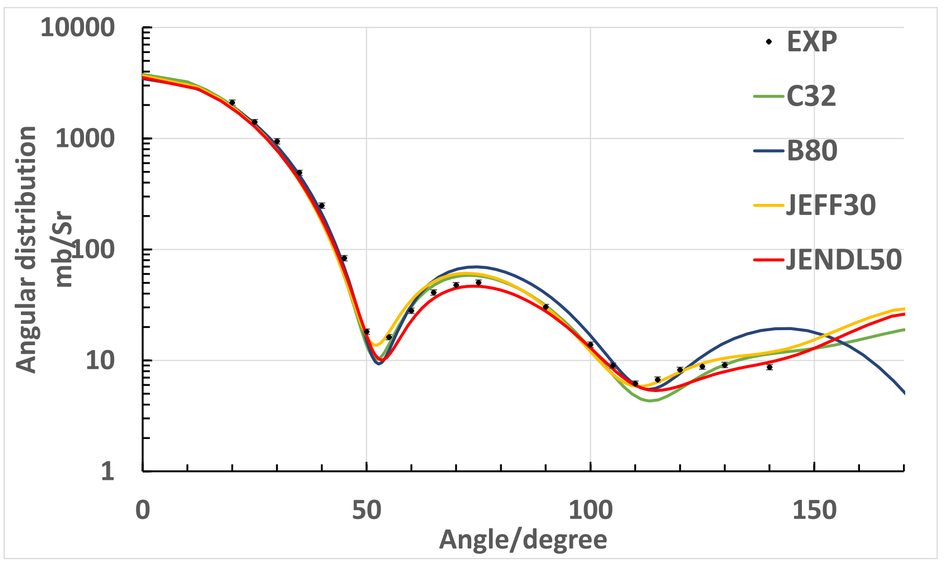

Fig. 4 The angular distribution of elastic scattering for n+^{nat}Ga

Fig. 5 shows the comparison of DDX of n+^{nat}Ga at 70 degree between the evaluated data and the measured ones. It was found that the experimental results were agree with TENDL better than other evaluated data base.

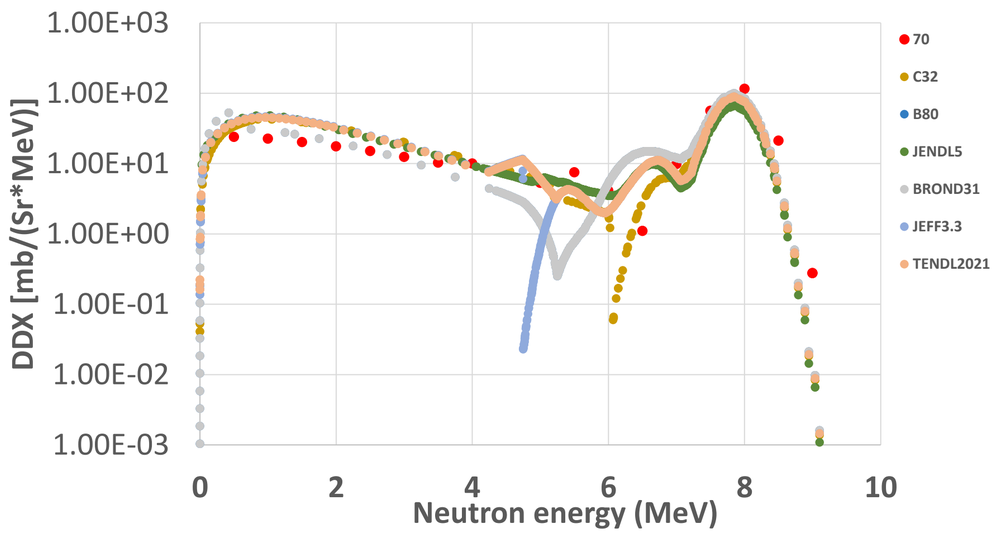

Fig. 5 The DDX of n+^{nat}Ga at 70 degree

Conclusion:
The differential and double-differential cross sections have been measured at 21 angles in the range between 20 deg and 140 deg for n + ^{nat}Ga at the incident neutron energy of 8.0 MeV. The data would be helpful for improvement of the data evaluation.

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