



^{241}Am Neutron Capture Cross Section Measurement and Resonance Analysis

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INTRODUCTION

- Accurate **nuclear data** are required for the design of nuclear transmutation facilities for **nuclear waste** treatment.
- **Accelerator-Driven System (ADS)** is a sub-critical facility aimed at reducing the current amount of **Minor Actinides (MAs)**, the main component of **high-level nuclear waste**.
- **^{241}Am neutron capture cross section** is one of the major contributors to the ADS **criticality uncertainty**
- Area of interest is from **0.454 keV** to **1.35 MeV**
- **JENDL-4.0** evaluated data for ^{241}Am presents uncertainties that are as high as **13%**.
- Current **uncertainty requirements** have been set at **below 5%**

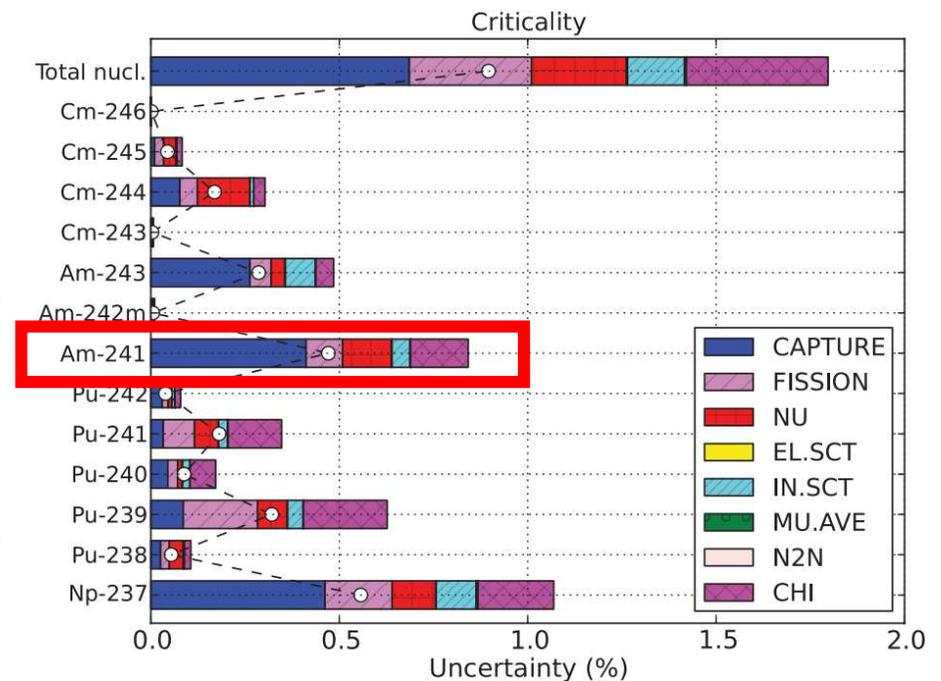


Fig. 1 Uncertainties by reaction and nuclide of criticality*

*H.Iwamoto et al. J. Nucl. Sci. Technol., 2013; 50(8):856-862.

EXPERIMENTAL SETUP

Experiments using the NaI(Tl) spectrometer of the ANNRI beamline of J-PARC. **Time-of-flight (TOF)** experiments and **neutron filter** experiments were performed

- ^{241}Am sample:
 - **7.5 mg**
 - Encapsulated in an Al case
- TOF experiments
 - Measurements with **no neutron filter**
 - Energy range:
 - **10 meV to 100 eV**
 - Minor influence of double-bunch
 - Flight path: **27.9 m**
- Neutron filter experiments
 - Fe filter – 20 cm thickness
 - Energy: **23.5 keV**

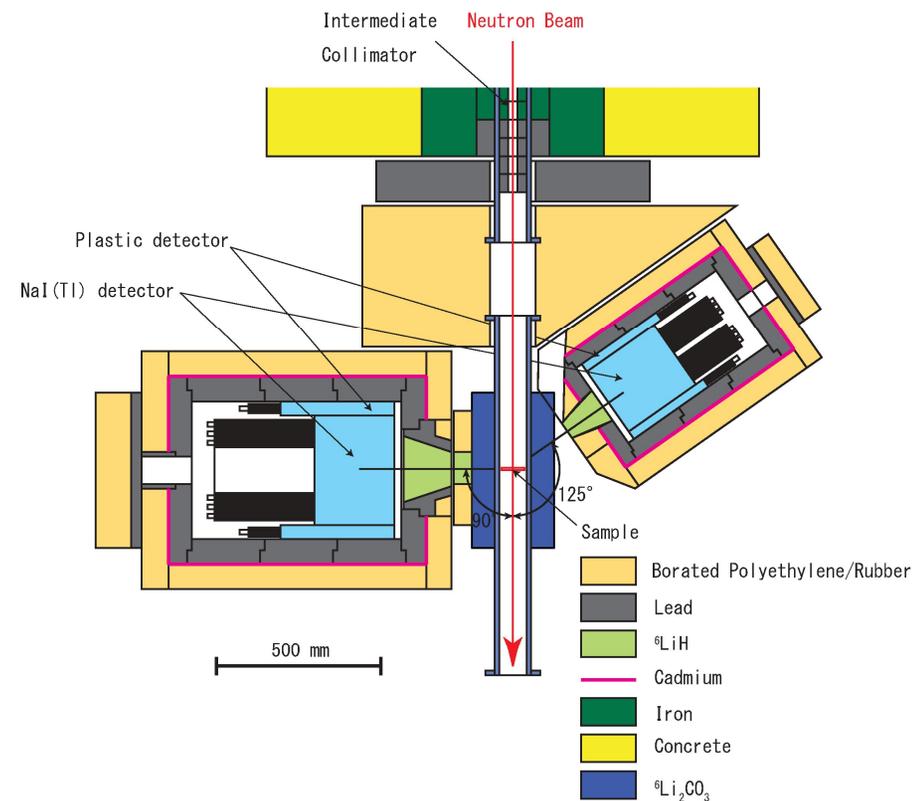


Fig. 2 NaI(Tl) spectrometer of ANNRI*

*G.Rovira et al. J. Nucl Sci. Technol., 2020; 57(1):24-39.

RESONANCE ANALYSIS

The **TOF experiments** results were analyzed using the **REFIT** code. **Resonance parameters** and the **thermal cross section** values were extracted from the analysis.

- Thermal Cross section
 - **704 ± 25 b**
 - Good agreement with:
 - Terada (**707 ± 29 b**)
 - Nakamura (**702 ± 25 b**)

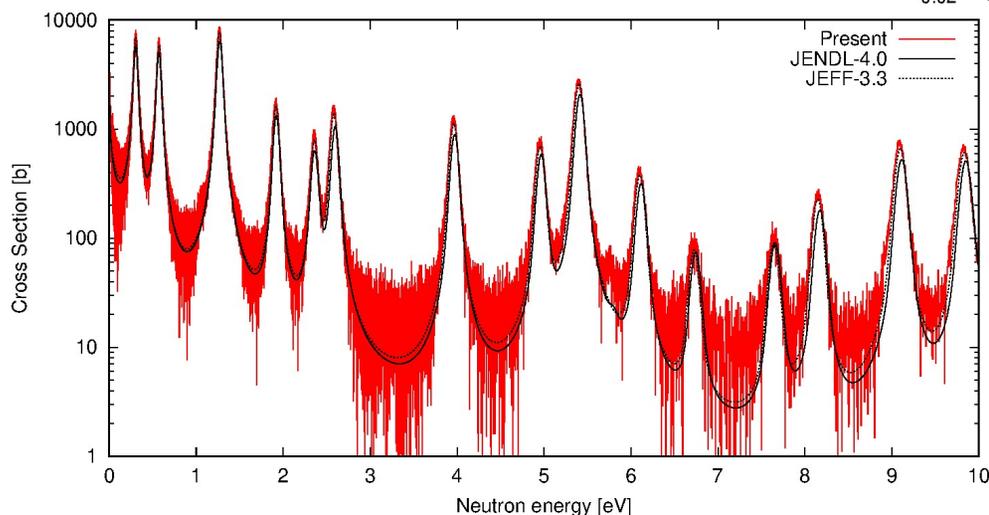


Fig. 3 Experimental results for the ^{241}Am neutron capture cross section compared to JEFF-3.3 and JENDL-4.0

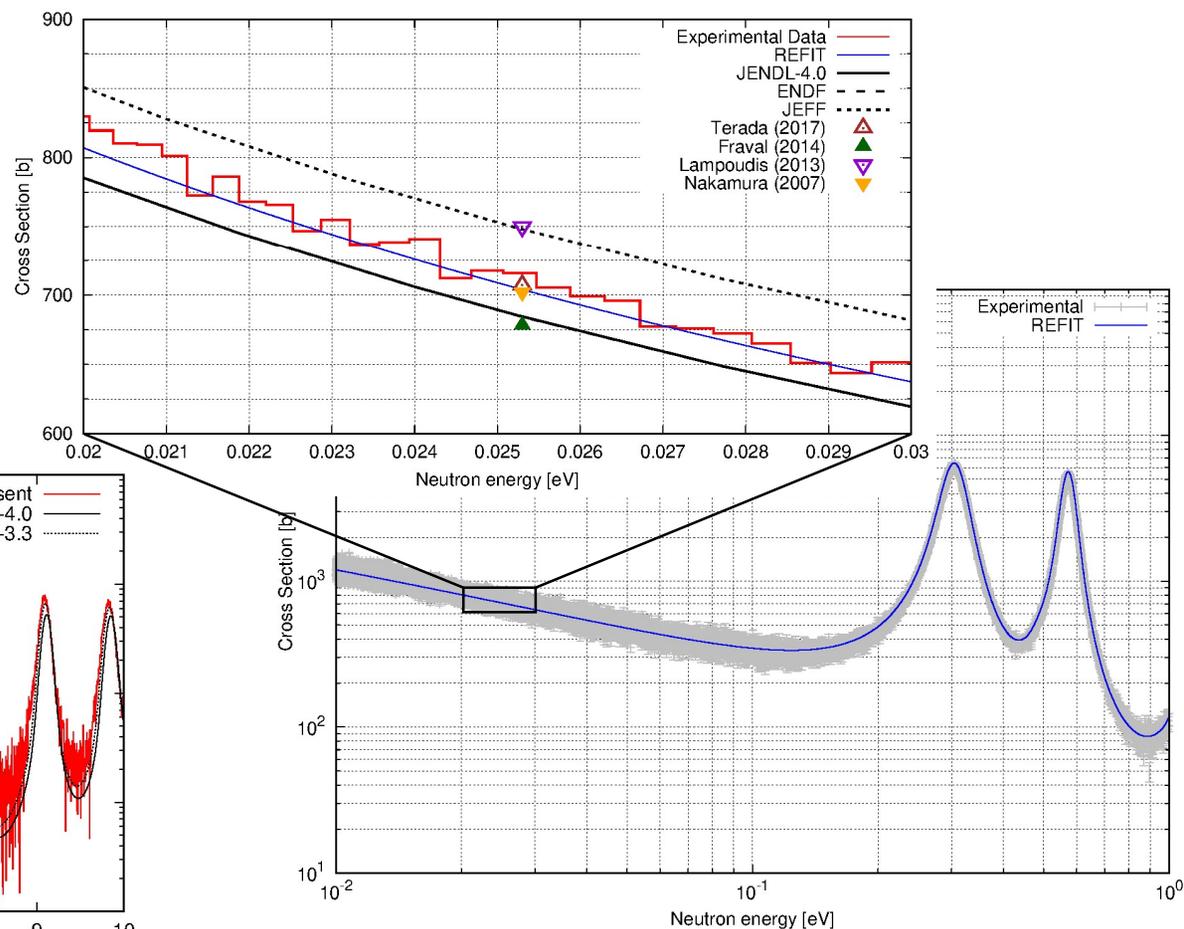


Fig. 4 Experimental results for the ^{241}Am neutron capture cross section in the region below 1 eV fitted with REFIT.

RESONANCE ANALYSIS

Resonances were fitted up to 20 eV with REFIT. The Average radiation width ($\langle \Gamma_{\gamma,0} \rangle$) was extracted from 16 resonances with error < 10% in the fitting.

- $\langle \Gamma_{\gamma,0} \rangle = 44.1 \pm 1.0$ meV
 - Fraval = 43.0 ± 2.0 meV
 - Mendoza = 45.4 ± 1.2 meV
- Resonance energy fitting results agree with data from JEFF-3.3

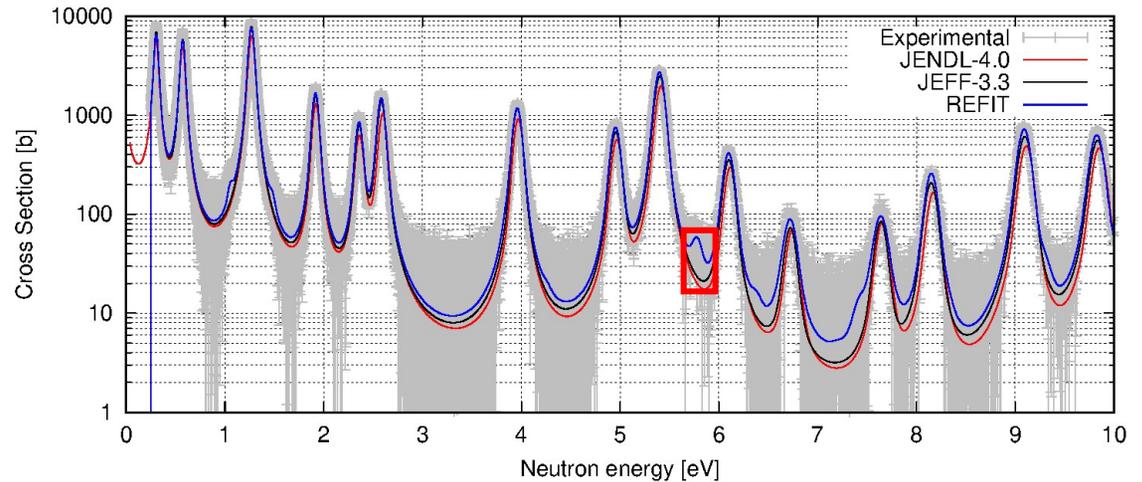


Fig. 5 Fitted results from 0 to 10 eV compared with data from JENDL-4.0 and JEFF-3.3

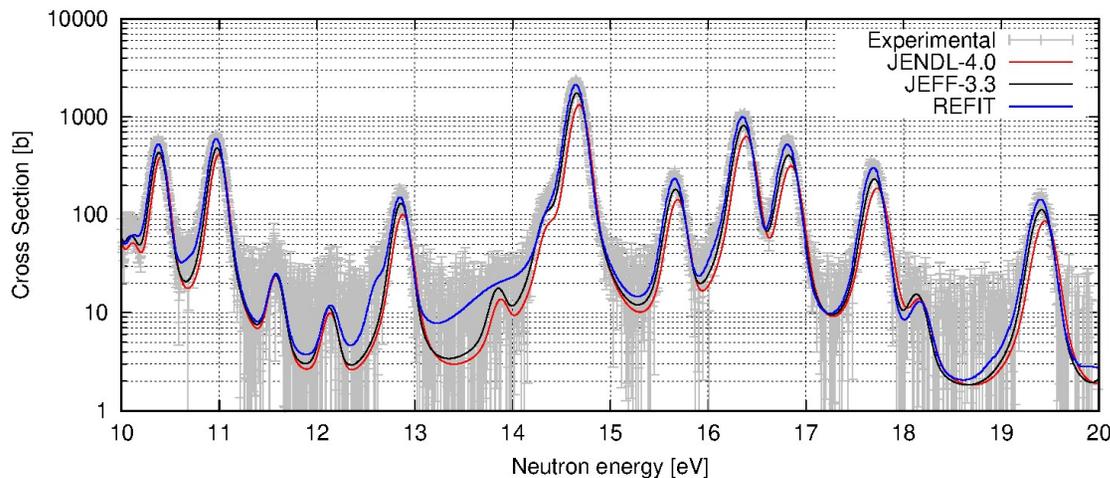


Fig. 6 Fitted results from 10 to 20 eV compared with data from JENDL-4.0 and JEFF-3.3

Misassigned resonance at 5.8 eV due to a 2% ^{237}Np contamination estimation with REFIT.

FILTER CROSS SECTION RESULTS

The ^{241}Am neutron capture cross section was determined relative to the capture yield of gold at the energy of **23.5 keV**. Results agree within uncertainties with evaluated data libraries.

- Cross section determined as:

$$\sigma_{Am} = \frac{Y_{Am}}{Y_{Au}} \cdot \frac{N_{Au}}{N_{Am}} \cdot \frac{P_{Au}}{P_{Am}} \cdot \sigma_{Au}$$

being for the Au and Am samples:

- Y_x = Measurement yield
- N_x = Area density [at/b]
- P_x = Proton shots during experiment
- σ_{Au} = JENDL-4.0 ^{197}Au capture cross section [b]
- σ_{Am} = Exp. ^{241}Am capture cross section [b]

Total uncertainty $\sim 11.9\%$ mainly due to the statistical uncertainty (11.8%)

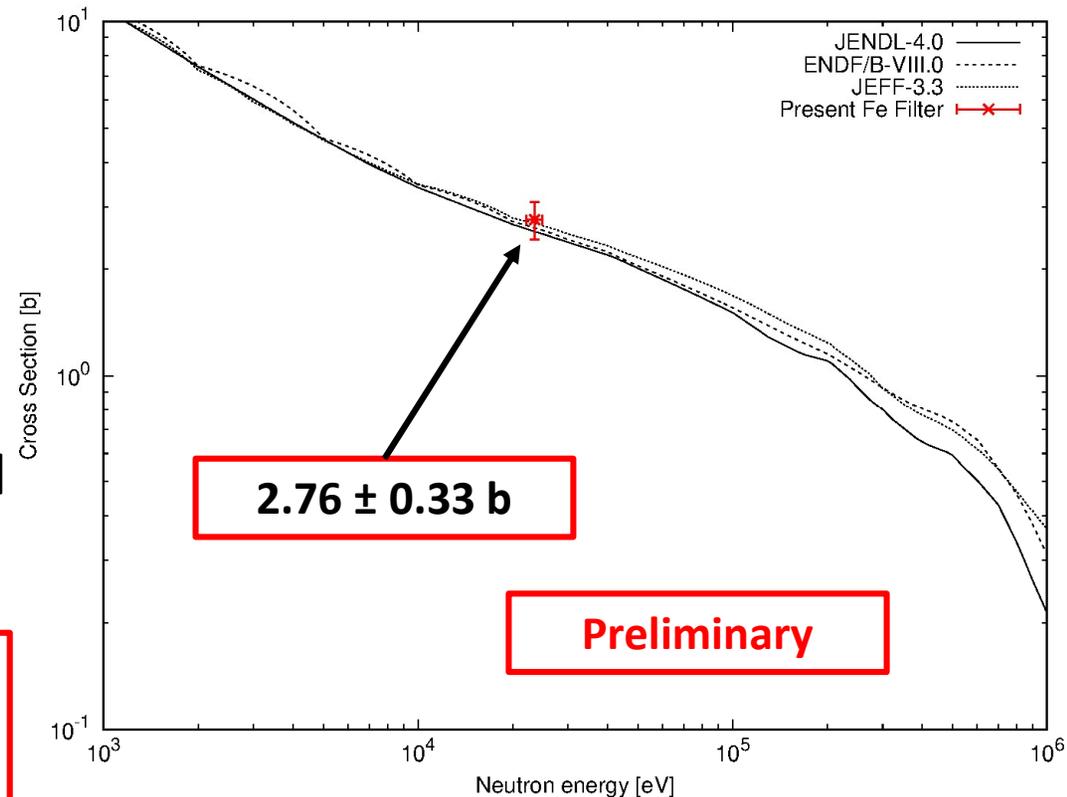


Fig. 7 Preliminary cross section results for ^{241}Am at **23.5 keV** with the **Fe** filter compared with evaluated data libraries

CONCLUSIONS

- **^{241}Am neutron capture cross section** was measured in **TOF** and **filter** experiments from **10 meV** to **100 eV** and at **23.5 keV**
- **Thermal** cross section was found to be **704 ± 25 b**
- **Av. Radiation width** from resonance analysis with REFIT was determined as **$\langle \Gamma_{\gamma,0} \rangle = 44.1 \pm 1.0$ meV**
- A **misassigned** resonance was found in JENDL-4.0 at 5.8 eV
- The neutron capture cross section for **^{241}Am at 23.5 keV** was measured as **2.76 ± 0.33 b**
- This value **agrees within uncertainties** with evaluated data libraries but is higher (11.9%) than the current requirements (<5%) for ADS