



Neutron Capture Cross Section Measurement and Resonance Analysis of ^{107}Pd Using ANNRI at MLF/J-PARC

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Introduction

Nuclear waste

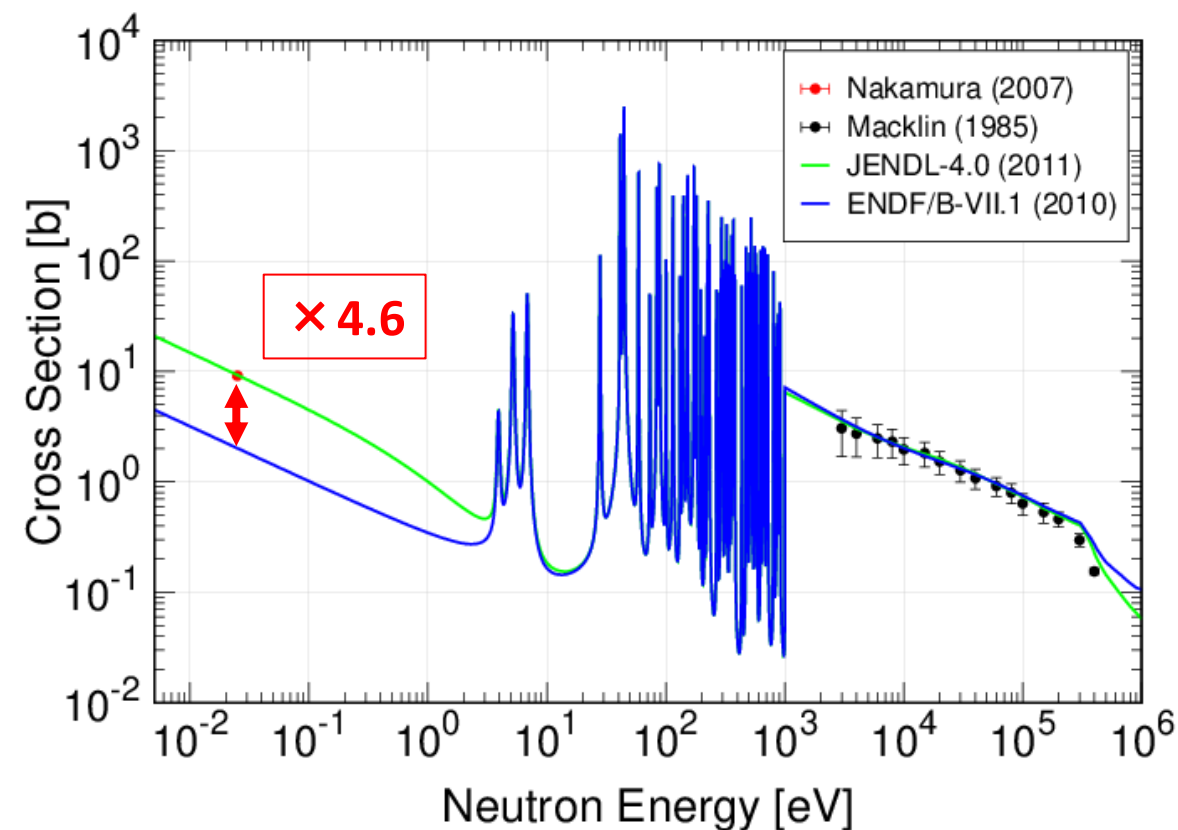
- Nuclear reactors generate Long-Lived Fission Products (LLFPs)
- LLFPs' long half-life cause a significant issue in nuclear industry
- Nuclear transmutation of LLFPs into short-lived or stable nuclides is expected as a solution
- Highly accurate nuclear data for the neutron-induced nuclear reactions are necessary in order to design LLFPs nuclear transmutation systems
- However, neutron cross section data of LLFPs are limited
- Improvement of the data accuracy is important issue

Introduction

➤ Pd-107

- Half life: 6.5 million years
- Pure beta emission nuclei
- $^{107}\text{Pd}(n,\gamma)^{108}\text{Pd}$
- Activation method cannot be used

Author	year	Neutron energy	Reaction
Nakamura	2007	25.3 meV	(n,γ)
Macklin	1985	Resonance region	$(n,\gamma), (n,\text{tot})$
Sighn	1978		$(n,\gamma), (n,\text{tot})$
Anufriev	1980		(n,tot)
Macklin	1985		(n,γ)

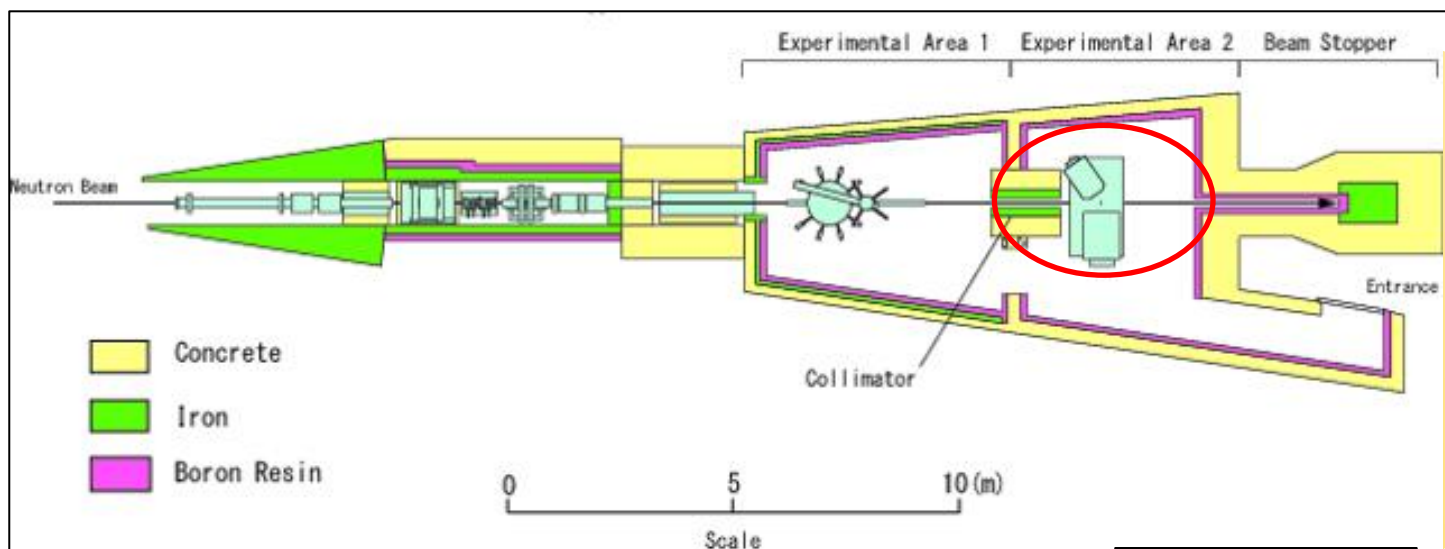


- High-precision neutron capture cross-section measurement required

Experimental setup

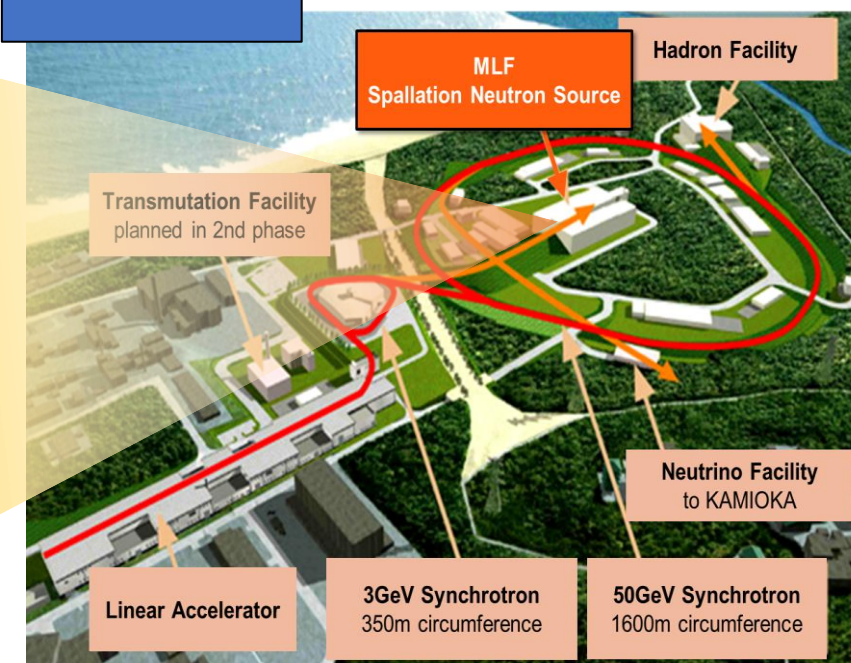
J-PARC/MLF

Accurate Neutron-Nucleus Reaction Measurement Instrument - (ANNRI)

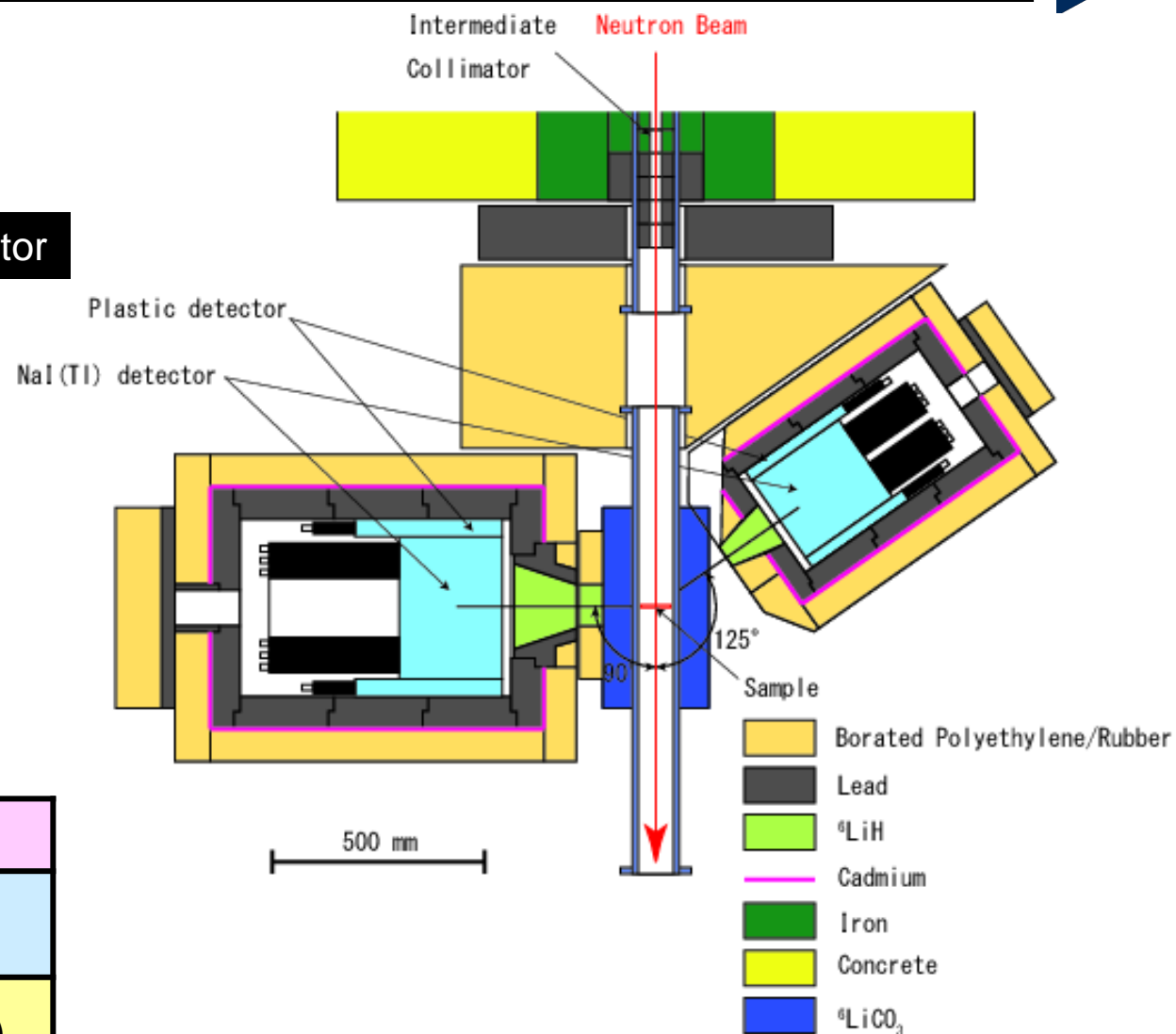
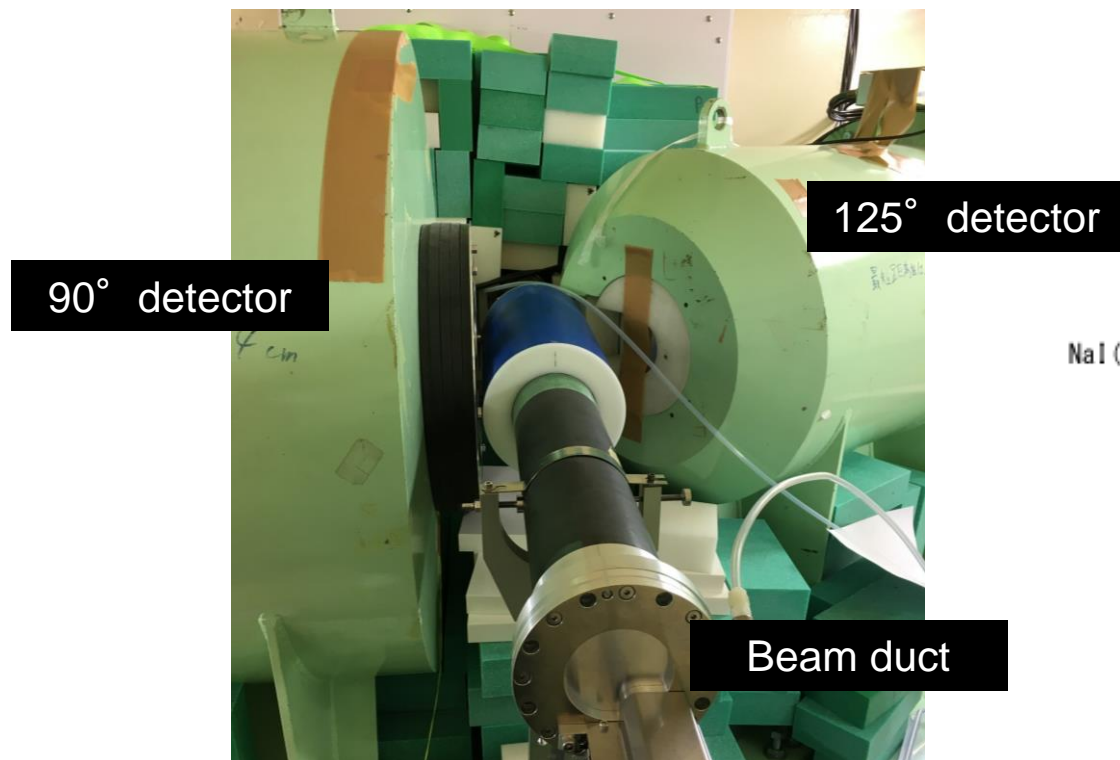


BL04 ANNRI

J-PARC/MLF



Experimental setup



	diameter	length
90°	13 inch (330 mm)	8 inch (203mm)
125°	8 inch (203 mm)	8 inch (203 mm)

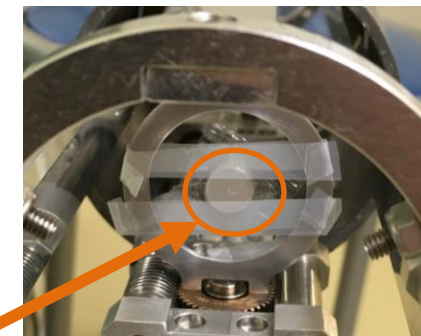
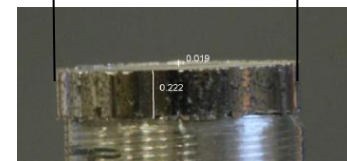
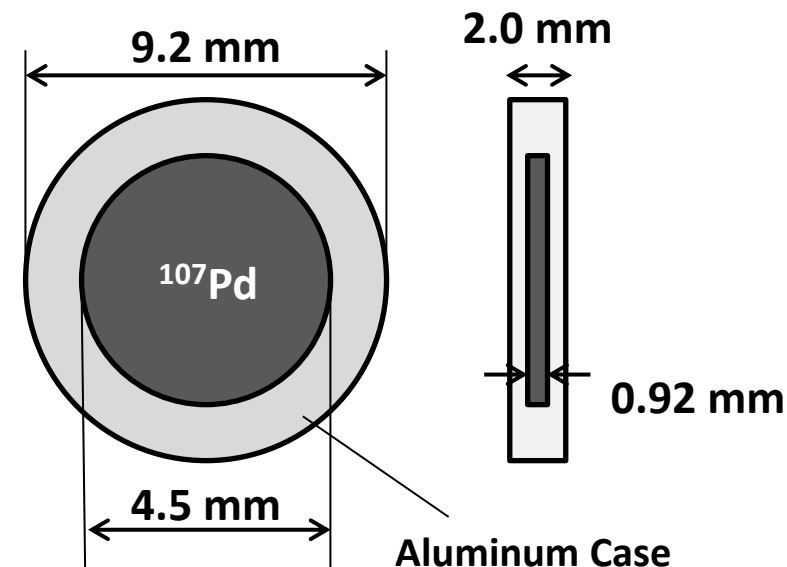
Experimental setup

Pd sample and measurement condition

- ^{107}Pd sample
 - Weight total : 137.4 mg / net(^{107}Pd) : 21.0 mg
 - Size diameter : 4.5 mm / thickness 0.92 mm
- J-PARC operation condition
 - Beam power : 730 kW
 - 25 Hz, double bunch
- Other samples for background evaluation
 - Dummy : aluminum case
 - Carbon : scattering
 - Blank : no sample
 - ^{105}Pd , ^{106}Pd , ^{108}Pd : isotope impurities
 - Au, $^{10}\text{B}_4\text{C}$: neutron spectrum

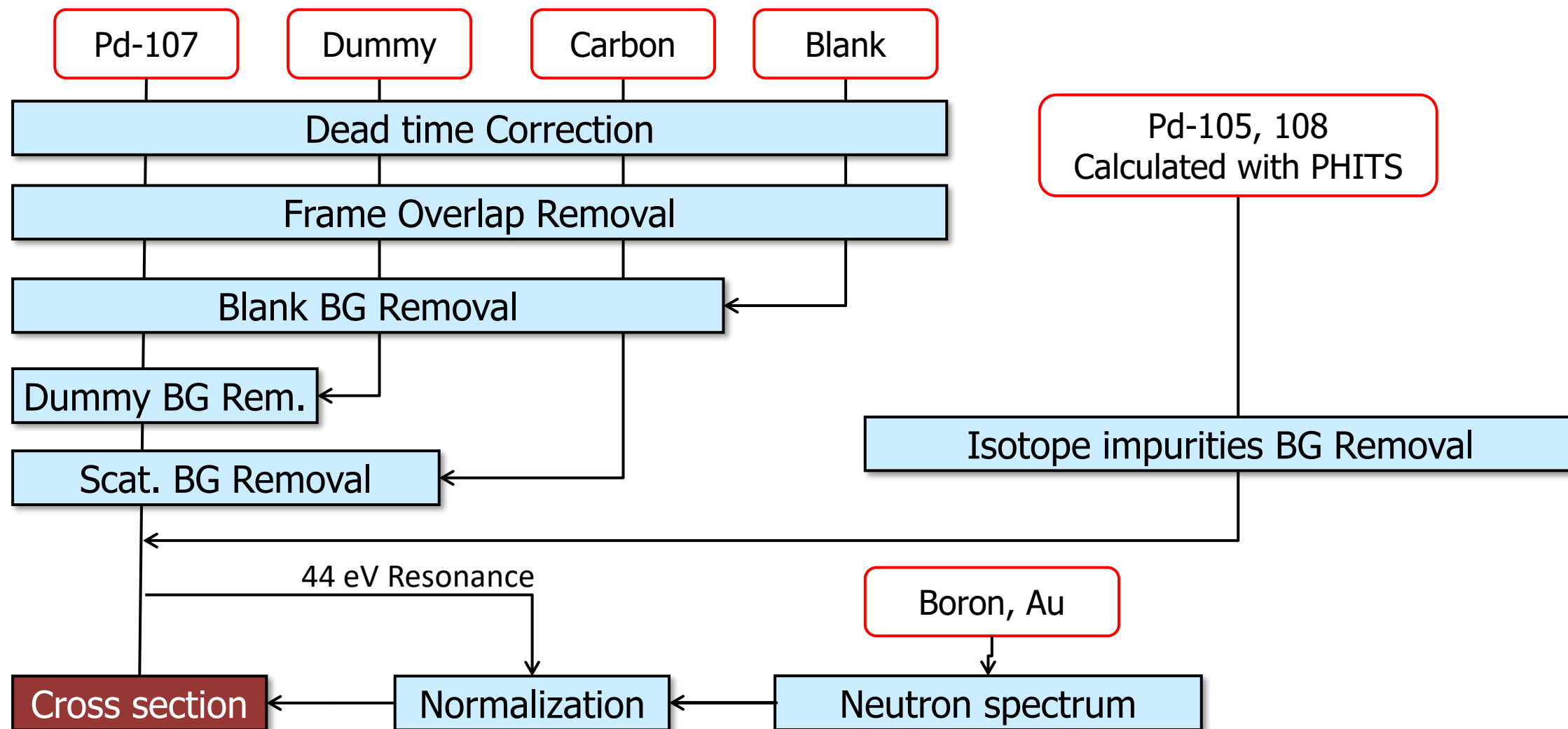
isotope	ratio (%)
104	2
105	48
106	23
107	15
108	9
110	3

^{107}Pd sample

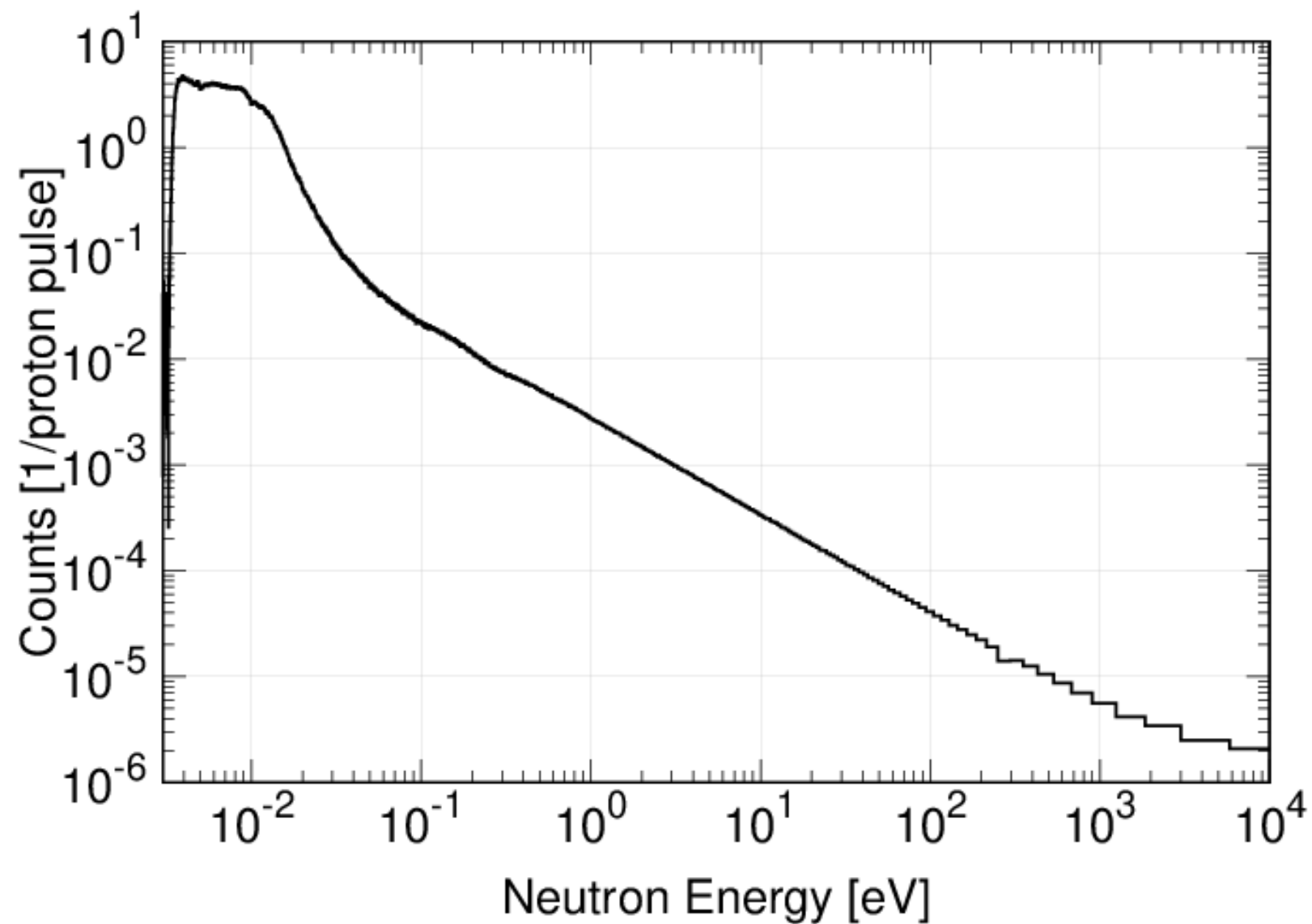


^{107}Pd sample

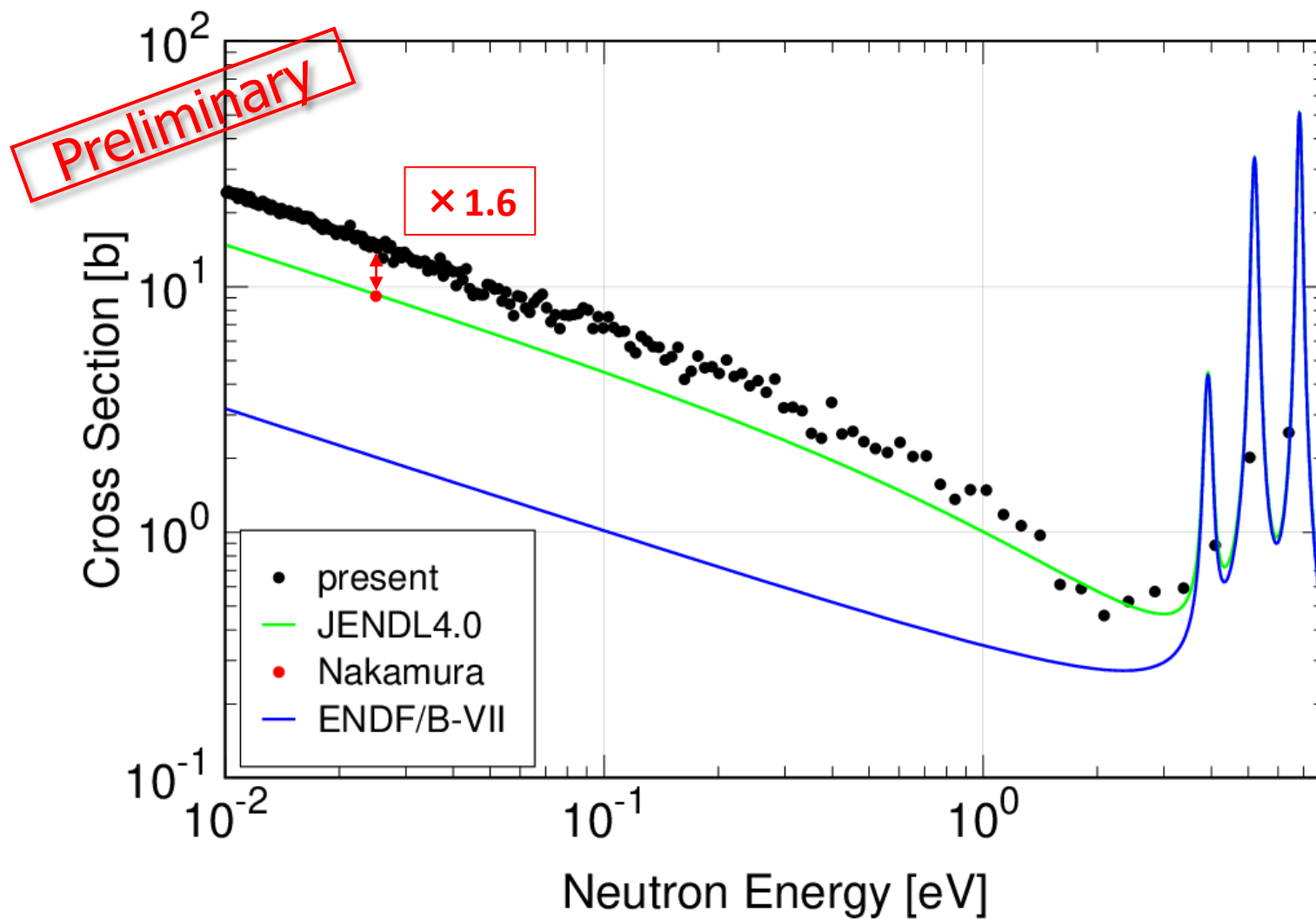
Data Analysis



Results Neutron spectrum



Results Thermal cross section

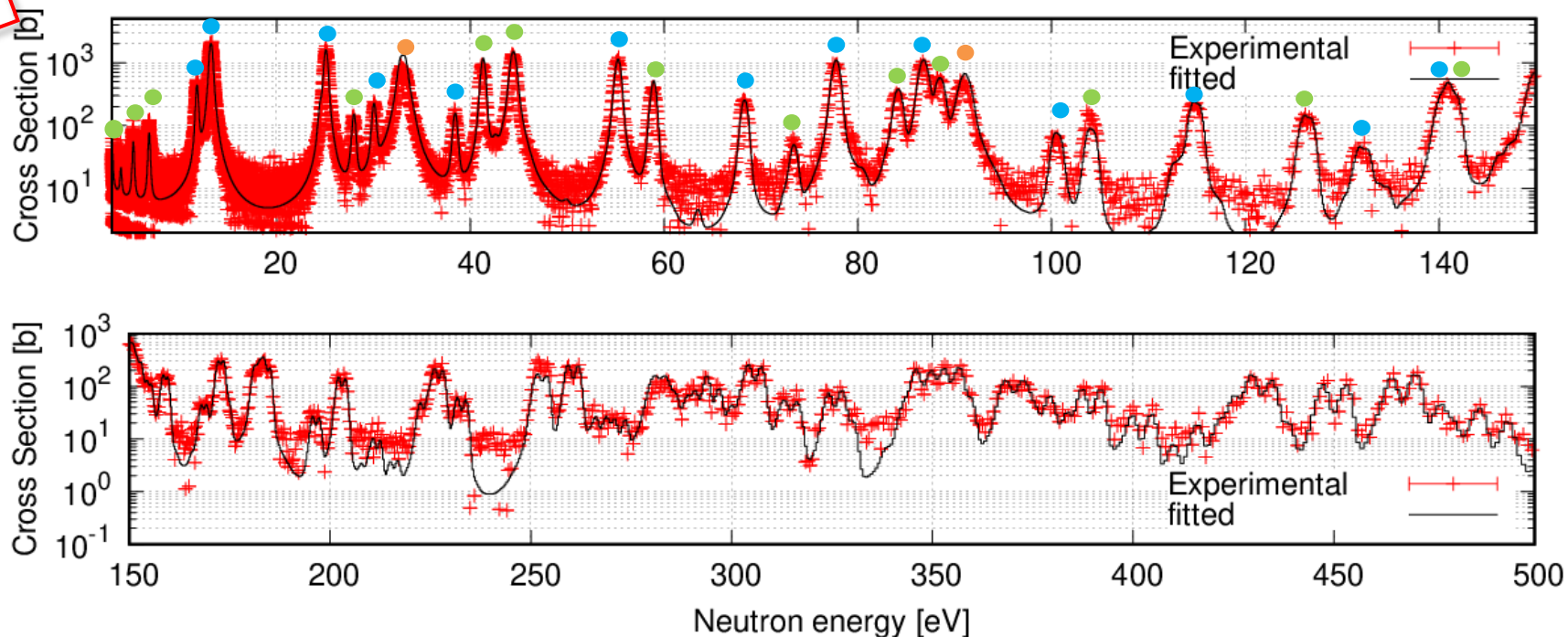


- Present value : 14.7 ± 0.8 b
- JENDL-4.0 (Nakamura's data) value : 9.16 ± 0.27 b
- The method of Nakamura's measurement : Ground state transition method
- Ground state transition method gives a lower limit of cross section

Results Resonance region

- Resonance analysis using REFIT
- Energy region : 3.9 – 500 eV
- Number of observed resonance : 40
- Number of fitted resonance : 16
- New resonance : none
- Resonance parameter : Close to the value of JENDL-4.0
- $\langle \Gamma_\gamma \rangle = 0.154$ eV (JENDL : 0.151)

Preliminary



Pd-107

Pd-105

Pd-108

Summary

Summary

- Measure neutron capture reaction of Pd-107 at J-PARC ANNRI
- Thermal cross section 14.7 b was bigger than the values of JENDL-4.0 9.2 b.
- Resonance parameter was close to the values of JENDL-4.0.

Future work

- Some correction factors and uncertainty will be scrutinized and improved.
- High energy region analysis

