



WPEC 2004  
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# Present Status of JENDL Project

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## Organization of Japanese Nuclear Data Committee (JNDC)

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- Subcommittee on Nuclear Data
  - High Energy Nuclear Data Evaluation,
  - Evaluation and Calculation System WG,
  - FP Nuclear Data Evaluation WG,
  - Evaluation WG on Astrophysics.
- Subcommittee on Reactor Constants
  - Reactor Integral Test WG,
  - Shielding Integral Test WG,
  - Standard Group Constants WG,
  - Medium and High Energy Nuclear Data Integral Test WG.



## Organization of JNDC (2)

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- Subcommittee on Nuclear Fuel Cycle
  - Decay Heat Evaluation WG,
  - WG on Nuclide Generation and Depletion,
  - Fission Yield Evaluation WG.
- Standing Groups
  - ENSDF Group,
  - JENDL Compilation Group,
  - CINDA Group,
  - Group on Atomic, Molecular and Nuclear Data for Medical Use,
  - Editorial Group of “Nuclear Data News”,
  - High Priority Request List Group



## General Purpose File (JENDL-4)

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- Scope:
  - High burn-up,
  - MOX utilization,
  - ADS system,
  - Medical Use such as BNCT (Boron Neutron Capture Therapy),



# JENDL-4

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- Incident particles and maximum energy
  - Mainly neutron,
  - Proton, Charged particle and Photon,
  - Standard maximum energy: 20 MeV,
    - To be extended when needed.
- Contents
  - More accurate MA and FP data,
  - More covariance data,
  - More secondary gamma production data,
  - Number of nuclides included is similar to that of JENDL-3.3.
- Completion year: 2008-2009



# JENDL-4

Nuclear Database for Next Generation Nuclear Energy

## JENDL-4

Expansion of  
Application Fields



R & D of  
Inovative Nuclear Reactor

### Compilation of Nuclear Data

- ★ **Nuclear Data Evaluation**  
MA and FP  
Uncertainties and secondary  $\gamma$ 's  
Charged particle and photon-induced reactions
- ★ **Integral Test**  
Benchmark calculation

Integrated  
Computer  
System

### Utilization of Nuclear Data

- ★ **Group Constants**  
Multigroup transport  
Continuous Monte Carlo  
Burnup calc.
- ★ **Quality Assurance**  
Confirmation of Accuracy

Japanese Standard Nuclear Data Library

**JAERI/NDC**



# JENDL Special Purpose Files

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- High Energy File
- Photonuclear Data File
- PKA/KERMA File
- ( $\alpha$ ,n) Reaction Data File
- Actinide File
- Others:
  - Fusion File, Activation Cross Section File, Dosimetry File and FP Decay Data File



## High Energy File

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- Neutron & Proton File up to 3 GeV.  
(Total: 122 nuclides)
- To be used for the design of high energy proton accelerator and R & D of ADS system.
- A part of the data file was released in March 2004 as High Energy File 2004. (66 nuclides)
- The file for IFMIF will be produced from this file. (Up to 50 MeV)



# High Energy File

Total: 122 Nuclides

1 <sup>st</sup> priority (40 nuclides)	H-1, C-12, N-14, O-16, Al-27, Cr-50,52,53,54, Fe-54,56,57,58, Ni-58,60,61,62,64, Cu-63,65, W-180,182,183,184,186, Au-197, Hg-196,198,199,200,201,202,204, Pb-204,206,207,208, Bi-209, U-235,238
2 <sup>nd</sup> priority (45 nuclides)	H-2, Be-9, B-10,11, Mg-24,25,26, Si-28,29,30, K-39,41, Ca-40,42,43,44,46,48, Ti-46,47,48,49,50, V-51, Mn-55, Co-59, Zr-90,91,92,94,96, Nb-93, Mo-92,94,95,96,97,98,100, Ta-181, Pu-238,239,240,241,242
3 <sup>rd</sup> priority (37 nuclides)	Li-6,7, C-13, F-19, Na-23, Cl-35,37, Ar-35,38,40, Zn-64,66,67,68,70, Ga-69,71, Ge-70,72,73,74,76, As-75, Y-89, Th-232, U-233,234,236, Np-237, Am-241,242,242m,243, Cm-243,244,245,246

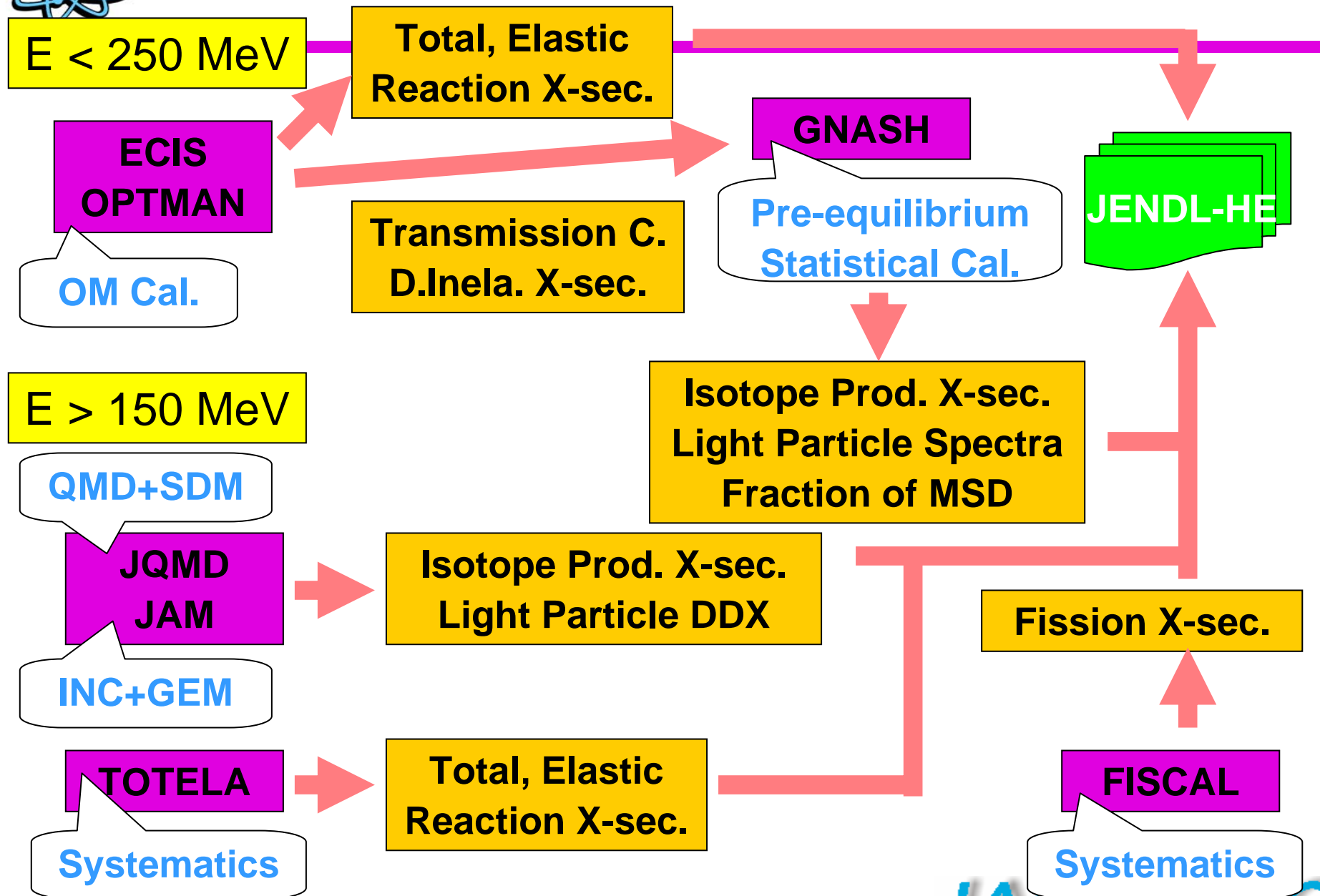
Red: released in March 2004 (66 Nuclides)

Green: under compilation,

Black: under evaluation

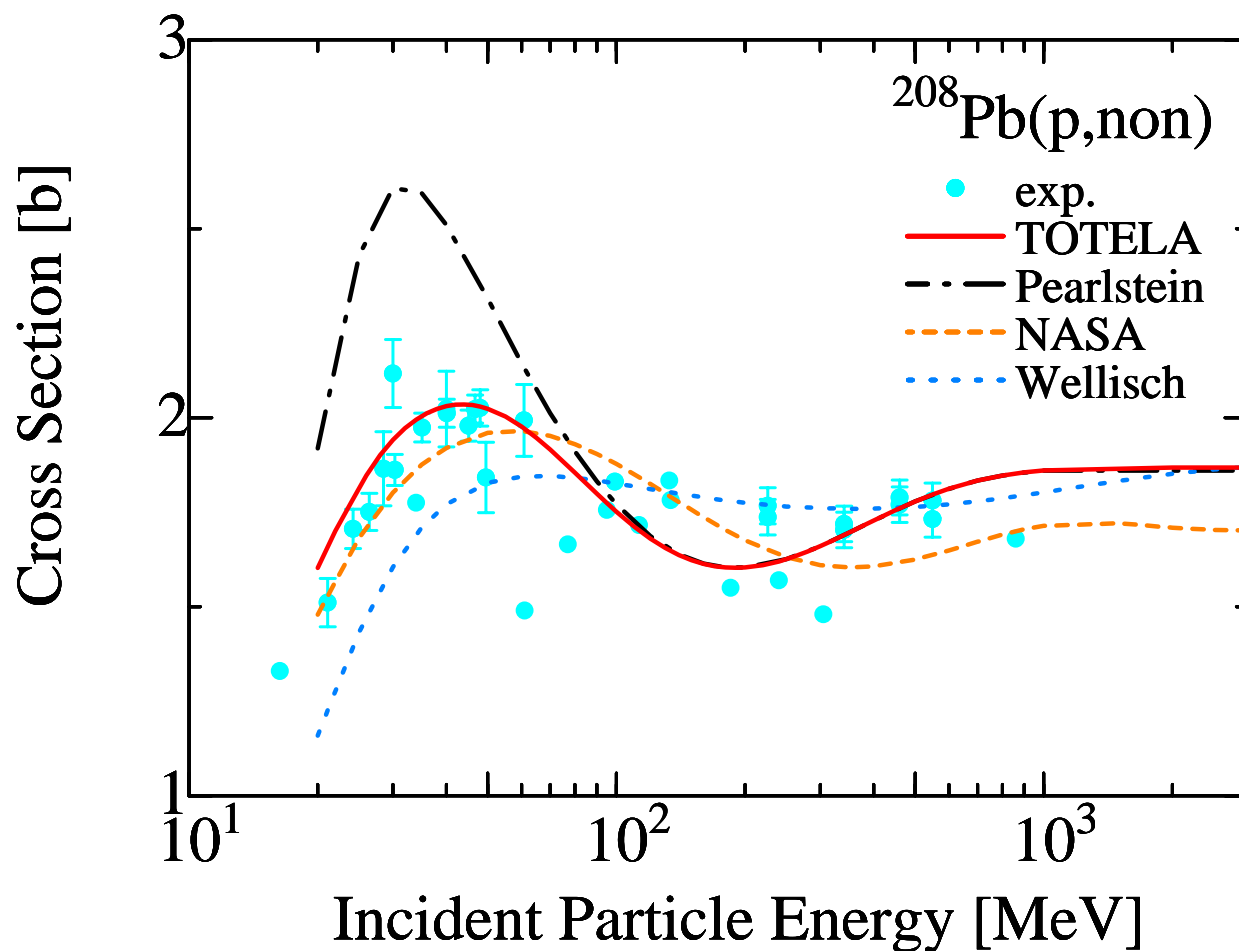


# Evaluation Methods and Tools





# TOTELA Calculation





# Photonuclear Data File

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- Released in March 2004.
- Maximum energy: 140 MeV.
- Photo reaction data for 68 nuclides:
  - ▶  $^2\text{H}$ ,  $^3\text{He}$ ,  $^{6,7}\text{Li}$ ,  $^9\text{Be}$ ,  $^{10,11}\text{B}$ ,  $^{12}\text{C}$ ,  $^{14}\text{N}$ ,  $^{16}\text{O}$ ,  $^{19}\text{F}$ ,  $^{23}\text{Na}$ ,  
 $^{24,25,26}\text{Mg}$ ,  $^{27}\text{Al}$ ,  $^{28,29,30}\text{Si}$ ,  $^{31}\text{P}$ ,  $^{40,48}\text{Ca}$ ,  $^{46}\text{Ti}$ ,  $^{51}\text{V}$ ,  $^{52}\text{Cr}$ ,  
 $^{55}\text{Mn}$ ,  $^{54,56}\text{Fe}$ ,  $^{59}\text{Co}$ ,  $^{58,60}\text{Ni}$ ,  $^{63,65}\text{Cu}$ ,  $^{64}\text{Zn}$ ,  $^{90}\text{Zr}$ ,  $^{93}\text{Nb}$ ,  
 $^{92,94,96,98,100}\text{Mo}$ ,  $^{133}\text{Cs}$ ,  $^{152,154,155,156,157,158,160}\text{Gd}$ ,  $^{181}\text{Ta}$ ,  
 $^{182,184,186}\text{W}$ ,  $^{197}\text{Au}$ ,  $^{196,198,199,200,201,202,204}\text{Hg}$ ,  $^{206,207,208}\text{Pb}$ ,  
 $^{209}\text{Bi}$ ,  $^{235,238}\text{U}$ ,  $^{237}\text{Np}$ .
- Data of other nuclides will be taken from KAERI's evaluated data.



## PKA/KERMA File & ( $\alpha$ ,n) File

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- PKA/KERMA
  - Not yet compiled.
  - After the compilation of the file for IFMIF, the data will be created from the file.
- ( $\alpha$ ,n) File
  - Released in February 2003 for 13 nuclides.
  - ${}^6,7\text{Li}$ ,  ${}^9\text{Be}$ ,  ${}^{10,11}\text{B}$ ,  ${}^{12,13}\text{C}$ ,  ${}^{14,15}\text{N}$ ,  ${}^{17,18}\text{O}$ ,  ${}^{19}\text{F}$ ,  ${}^{23}\text{Na}$ .
  - Total of 32 nuclides were expected but it is rather difficult to complete the whole evaluation.



## Actinide File

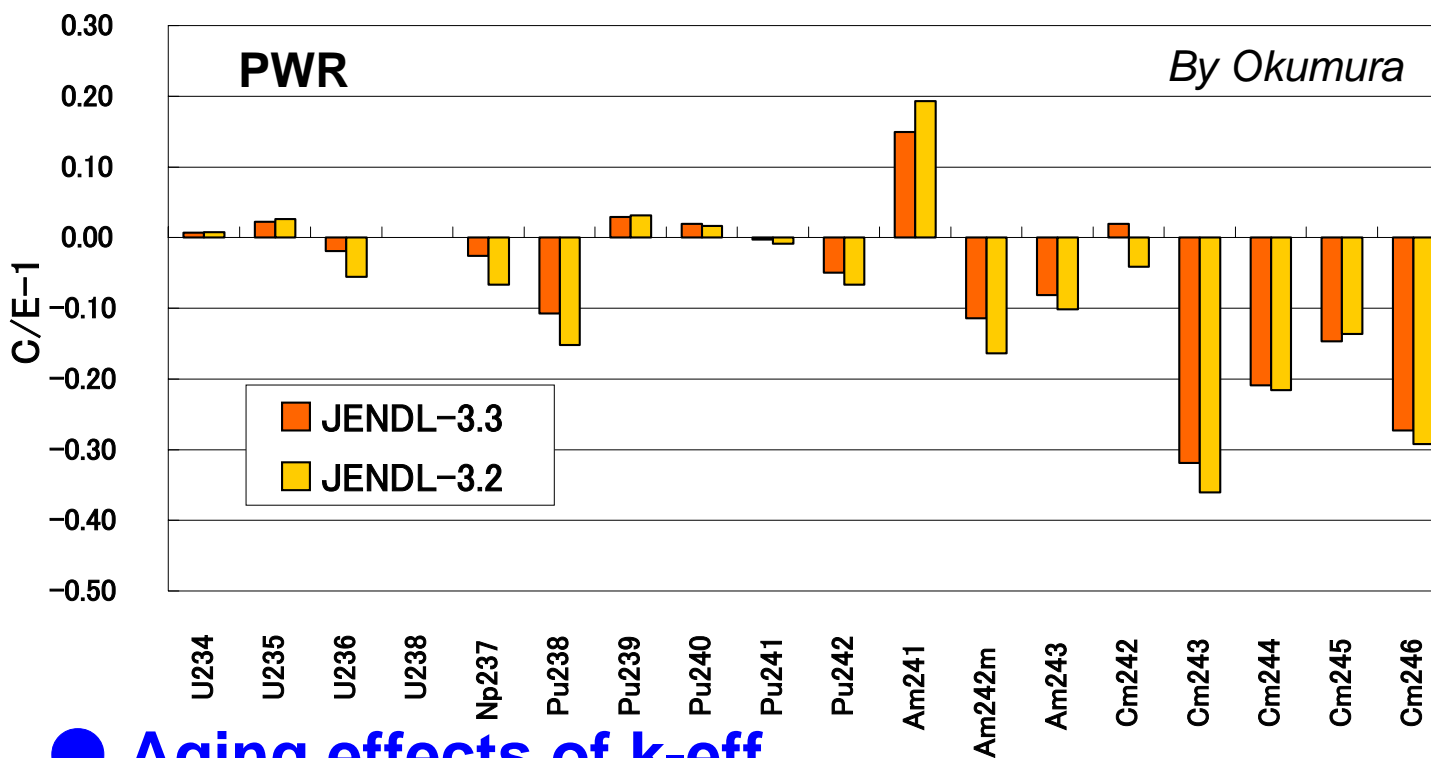
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- The data in JENDL-3.3 are being re-evaluated.
- Problem of JENDL-3.3
  - Inconsistency with PIE data,
  - Inconsistency with recent measurement.
- Only actinides data are included.  
(62 nuclides at present)



# Problems of Current Actinide Data

## ● Discrepancies in Post Irradiation Experiments



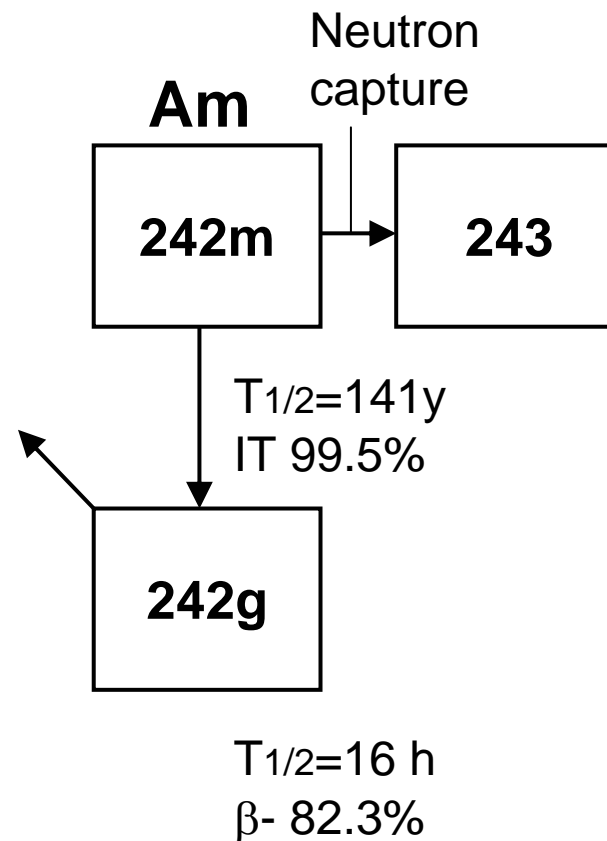
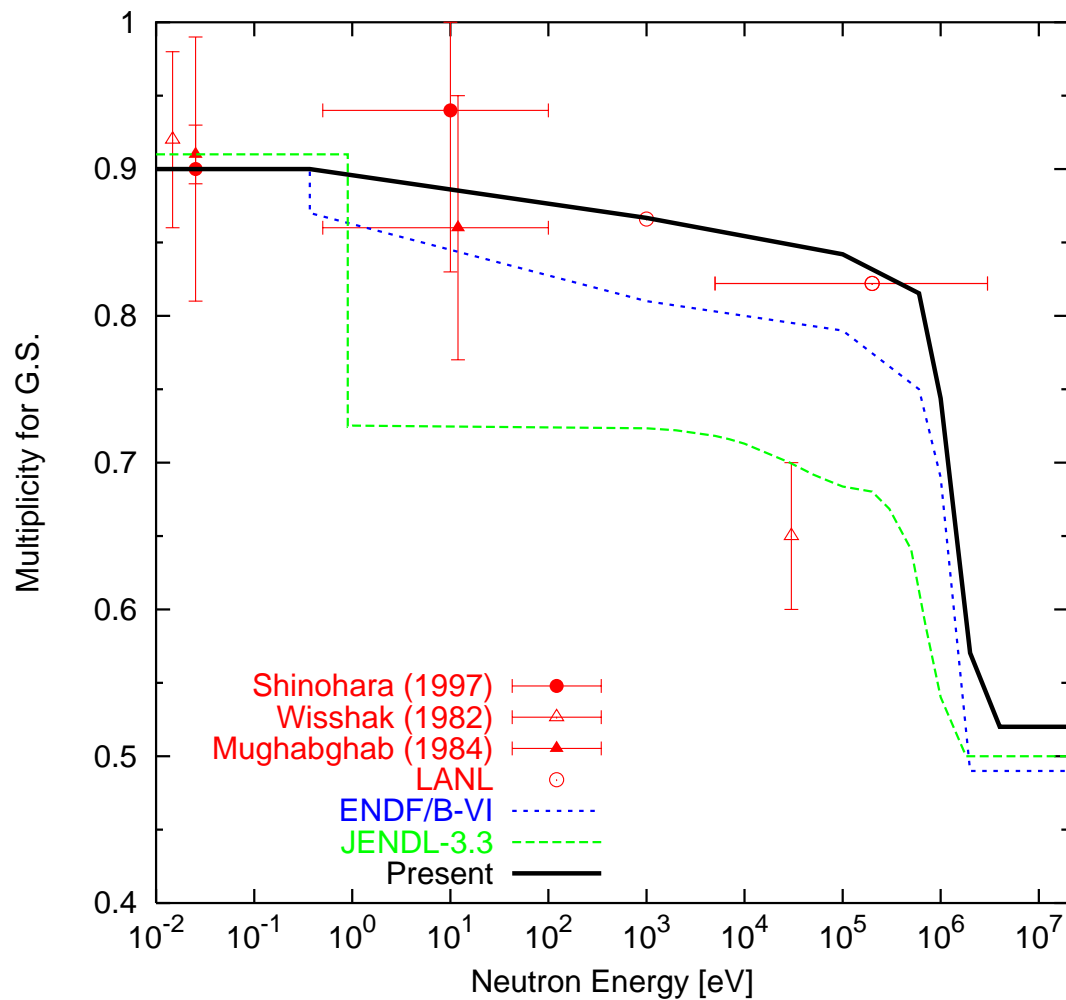
## ● Aging effects of k-eff

Larger amount of Am241 → Larger C/E of k-eff



# Isomeric Ratio of Am241 Capture

By Kawano (LANL)





## Cross Sections in the Thermal and Resonance Region

Nuclides	s-fis	s-cap	Reson. Params.	<i>By Nakagawa</i>
Np237	$\Delta^1$	$\Delta^2$	500 eV	1) not agree with KULS 2) discrepancies
Pu238	$\Delta$	$\Delta^1$	500 eV	1) old exp.
Pu242	$\times$	$\bigcirc$	1900 eV	
Am241	$\bigcirc$	$\Delta^1$	150 eV	1) discrepancies
Am242m	$\Delta^1$	$\times$	43 eV	1) discrepancies
Am243	$\Delta^1$	$\Delta^2$	250 eV	1) discrepancies, 2) old
Cm242	$\times$	$\Delta^1$	275 eV	1) old exp (absorption)
Cm243	$\Delta$	$\Delta$	100 eV	old exp.
Cm244	$\Delta$	$\Delta$	1000 eV	old exp.
Cm245	$\bigcirc$	$\Delta$	100 eV	old exp.
Cm246	$\Delta$	$\Delta$	400 eV	old exp.

$\bigcirc$ : good,  $\Delta$ : not enough,  $\times$ : no experimental data



## Cross Sections above Resonance Region

Nuclides	s-fis	s-cap	<i>By Nakagawa</i>
Np237	$\Delta^1$	$\Delta^2$	1) discrepancies: E<100keV. 2) not enough: E> 100keV
Pu238	$\Delta^1$	$\Delta^2$	1) discrepancies. 2) old exp, no data: E>100keV
Pu242	$\bigcirc^1$	$\Delta^2$	1) no exp.: E<100keV. 2) no exp.: E>100keV
Am241	$\bigcirc$	$\Delta^1$	1) no exp.: E>100keV
Am242m	$\Delta^1$	$\times$	1) discrepancies
Am243	$\Delta^1$	$\Delta$	1) discrepancies
Cm242	$\Delta^1$	$\times$	1) no exp. in MeV region
Cm243	$\Delta^1$	$\times$	1) no exp.: E<100keV
Cm244	$\Delta^1$	$\times^2$	1) discrepancies. 2) no exp.: E>10 keV
Cm245	$\bigcirc$	$\times$	
Cm246	$\bigcirc$	$\times$	

$\bigcirc$ : good,  $\Delta$ : not enough,  $\times$ : no experimental data



# 2003 Symposium of Nuclear Data

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- Date: 27th and 28th Nov. 2003.
- Place: JAERI, Tokai
- Topics:
  - Nuclear data for ADS system.
  - Data needs for next generation reactors and future JENDL plan.
  - Frontier of Nuclear Physics Study, Advanced Science Study and so on.
- Attendee: Total 121
- Presentation:
  - Oral: 18 papers.
  - Poster: 26 papers.



## Tutorial for Nuclear Data

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- First tutorial for nuclear data.
- Date: 26th Nov. 2003.  
The day before the 2003 symposium.
- Participants: 48 persons.
- Topics: Evaluation and Processing of Nuclear Data.
- Most of the participants had good feeling and wanted to have a tutorial in next year.



## Development of CONDUCT System

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- CONDUCT: Combined System for Nuclear Data Utilization, Calculation and Transfer.
- A part of a project on MA nuclear data measurements for advanced nuclear reactor.
- Special fund by Ministry of Education, Culture, Sports, Science and Technology (MEXT)
- Five year project from 2002-2006.



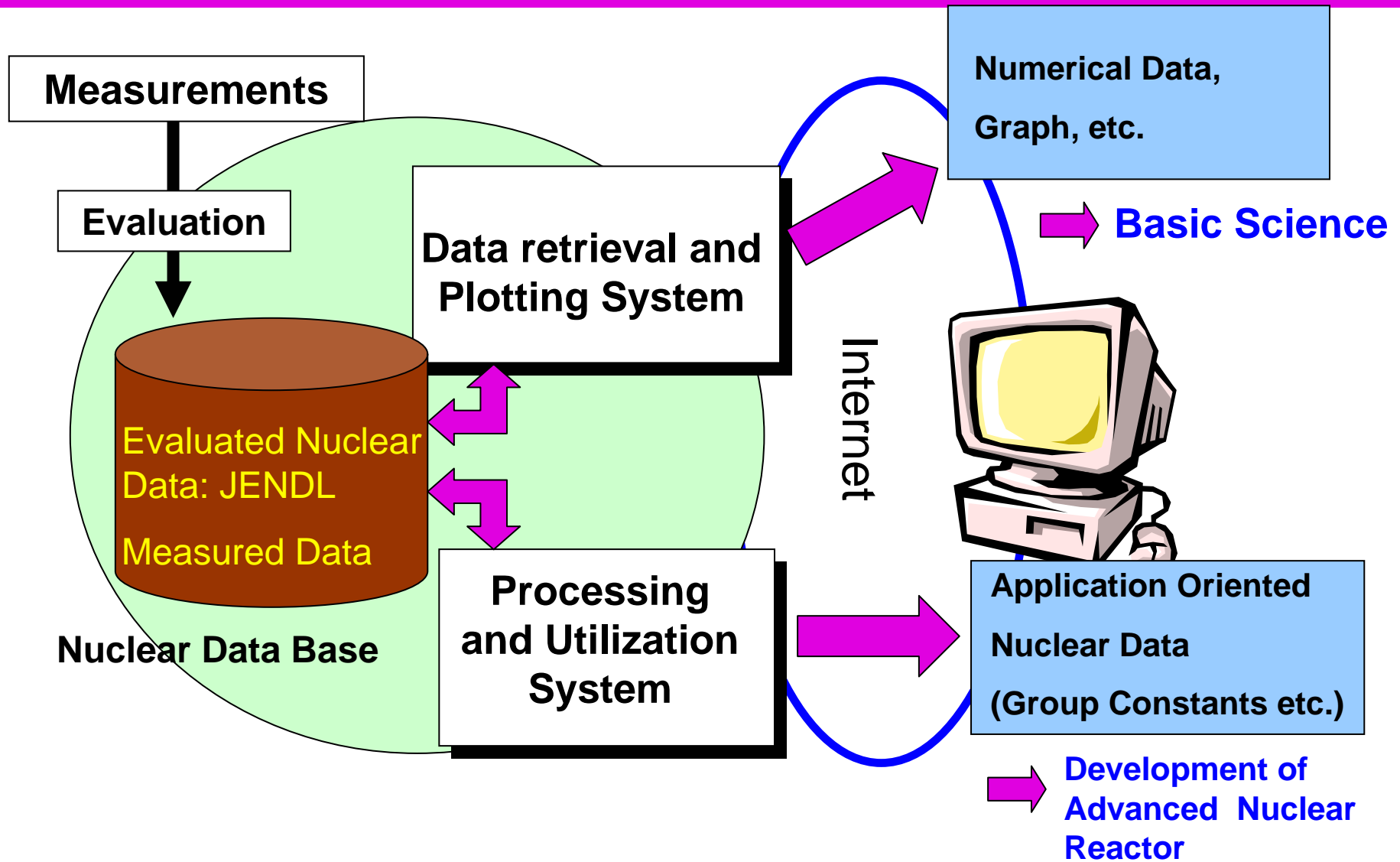
# Project Members

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- Development of Detectors:
  - JAERI, JNC, Tokyo Institute of Technology, Osaka University, Kyoto University, Chiba Institute of Technology
- Cross Section Measurement:
  - Tokyo Institute of Technology, JAERI, JNC, Osaka University, Kyoto University, Tohoku University
- Evaluation & Development of Data Utilization System:
  - JAERI, Hokkaido University, Tokyo Institute of Technology



# CONDUCT



# CONDUCT (2)

Hardware : PC Cluster

Research for Utilization:

Retrieval, Plotting, Providing results

Managing system

Retrieval and plotting system

Measured data

Evaluated data

Processing and utilization system

Group Constants

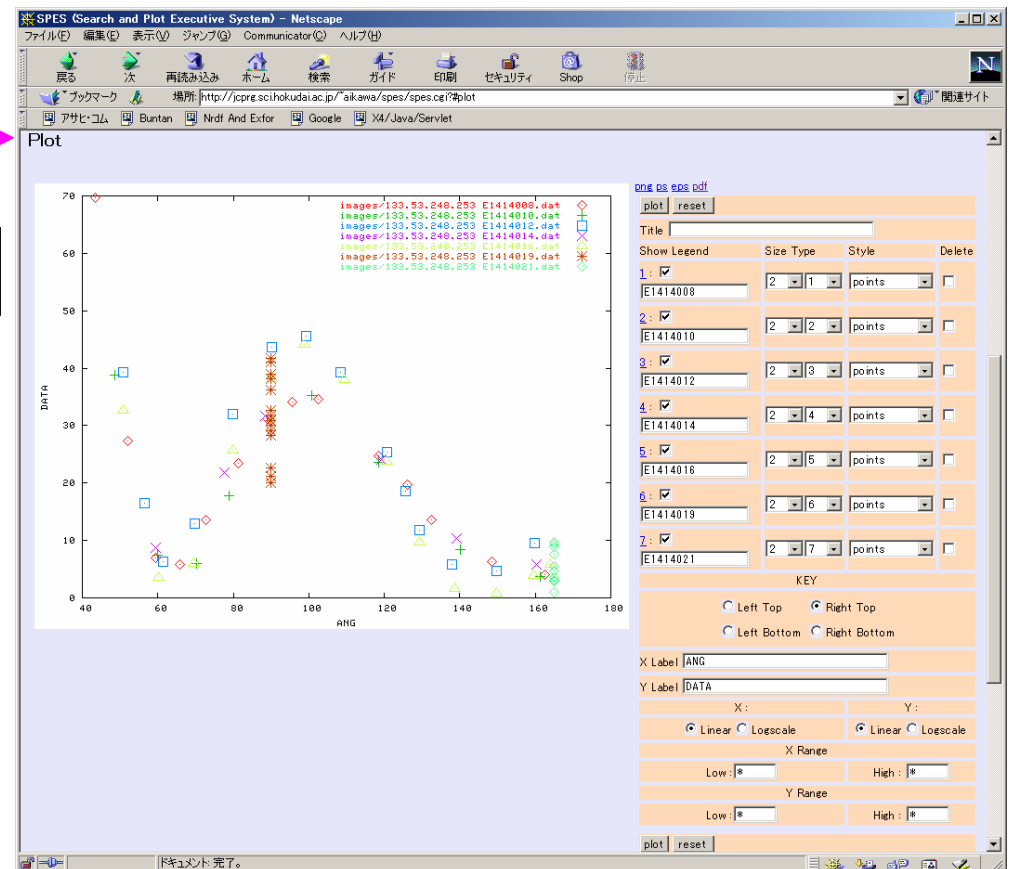
Benchmark Test

Completed

Prototype

Discussing

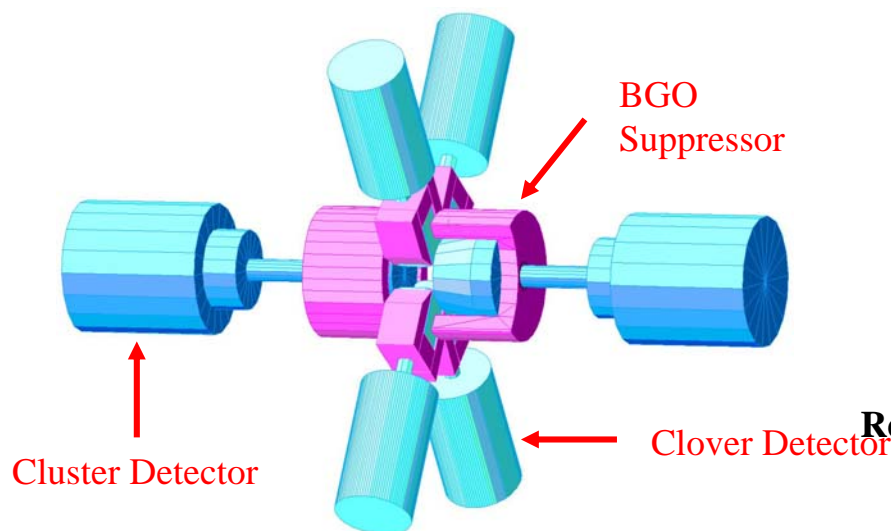
## Retrieval and Plotting





# Development of Detector System

## Newly developed Detector



Cluster Detectors: 2

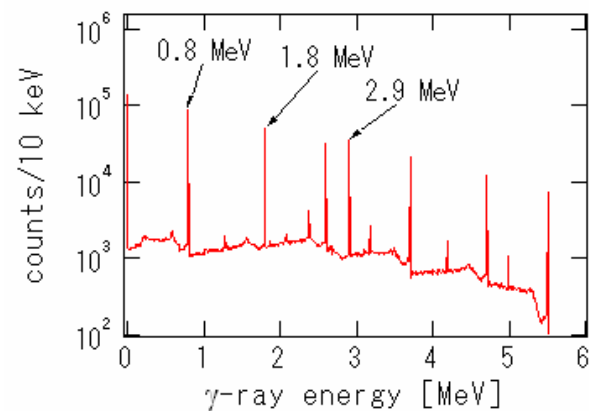
- 6 segments: 1
- Surrounding detectors: 6

Clover Detectors: 4

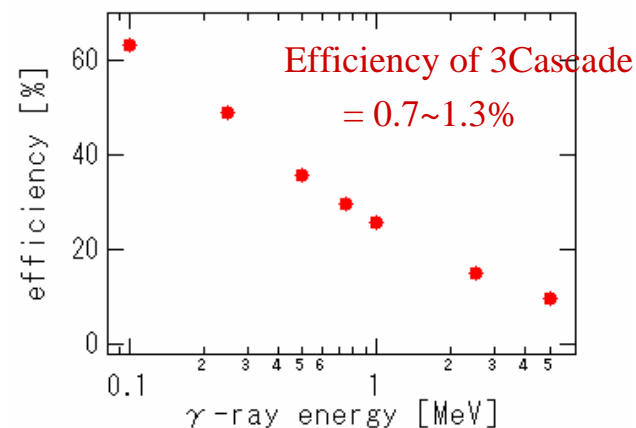
- 4 Crystal Cube Detectors: 4

BGO Compton Suppressor

## Results of Simulation



## Response functions for 3 Cascade $\gamma$ rays (0.8-1.8-2.9 MeV)



## Energy Dependence of Absolute Efficiency



## Summary

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- Organization of Japanese Nuclear Data Committee
- JENDL General Purpose File (JENDL-4)
- JENDL Special Purpose Files
  - High Energy File
  - Photonuclear Data File
  - PKA/KERMA and ( $\alpha, n$ ) Reaction Data Files
  - Actinide File
- 2003 Symposium on Nuclear Data
- Development of CONDUCT System