Preliminary Evaluation Including Covariance for ^{237}Np and ^{240}Pu above resonance region

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Summary

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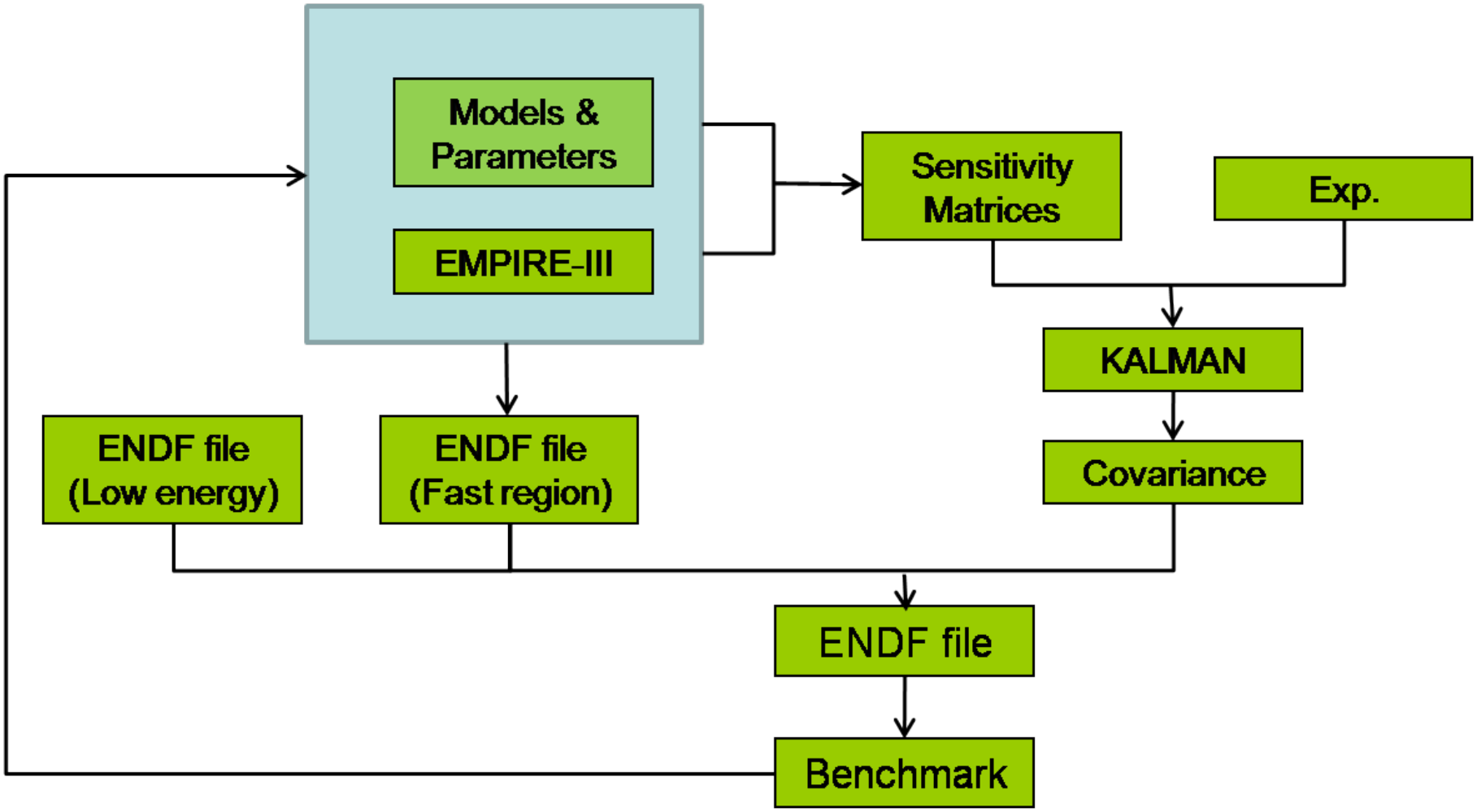
Introduction

- ✓ The evaluated nuclear data with covariance matrices of Minor Actinides need for future applications
  - ➢ Advance Fuel Cycle (AFC), Safeguards, Fast reactor, etc
- ✓ A KAERI-ORNL collaborative work under International Nuclear Energy Research Initiative (INERI) program
  - ➢ Nuclides: ^{237}Np, ^{240}Pu, and $^{240\text{-}250}$Cm
  - ➢ ORNL: Low energy region
  - ➢ KAERI: Fast region
- ✓ Producing the evaluation files with covariance data, and then testing them through sensitivity/uncertainty calculations for some benchmark problems

Evaluation & Covariance Procedure



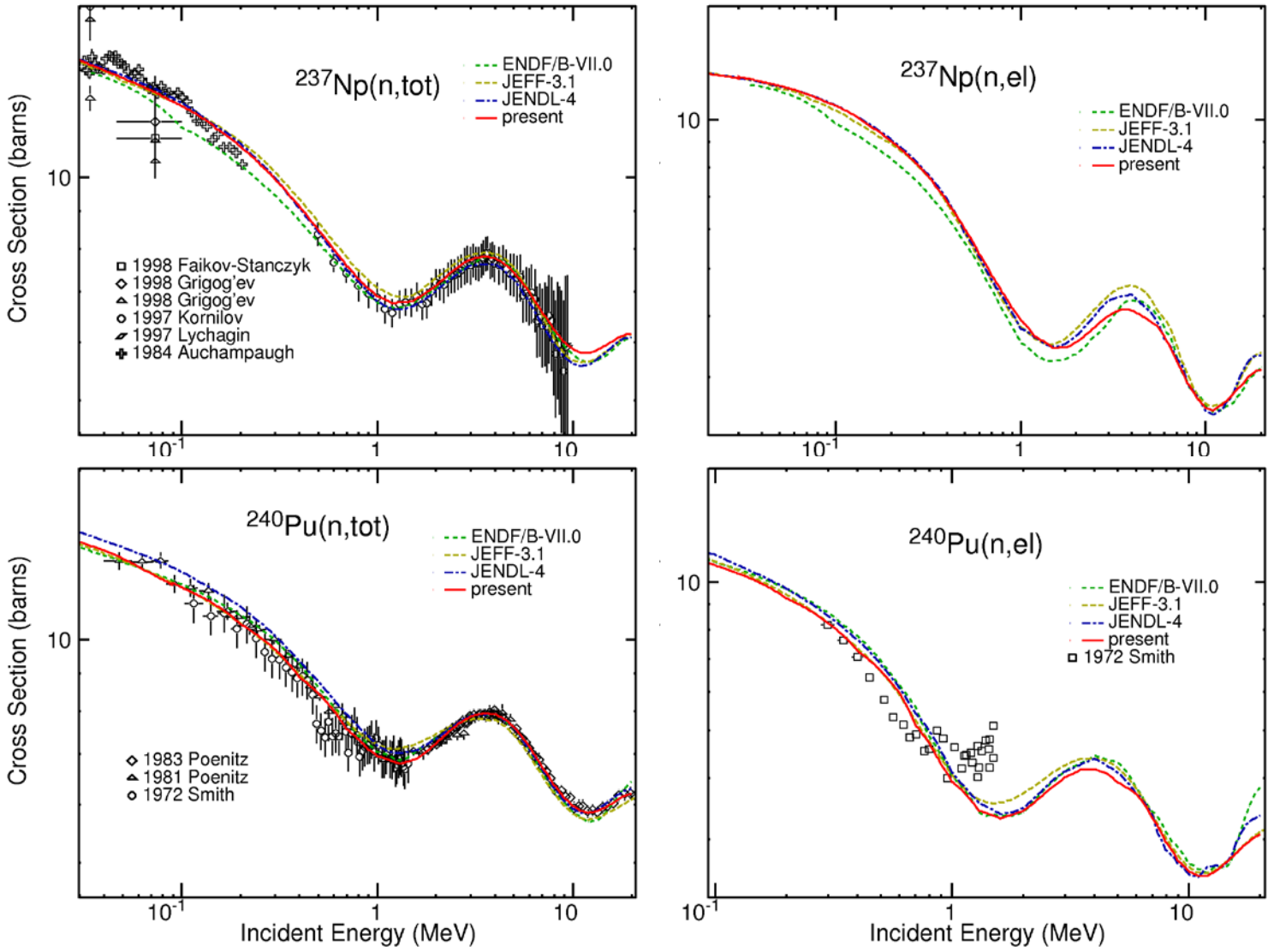
EMPIRE-3 calculation

- ✓ OMP
  - ➢ An isospin-dependent coupled-channels optical model potential containing the dispersive term (DCCOMP) suggested by Capote et al.. (RIPL # 2408)
- ✓ Hauser-Feshbach with HRTW
- ✓ DEGAS for gamma and PCROSS for others in pre-equilibrium
- ✓ Empire specific level densities
- ✓ Gamma strength function by plujiko(MLO1)
- ✓ Double-humped fission barrier
  - ➢ OMPs for fission suggested are modified in order to reproduce the measurements of fission cross section

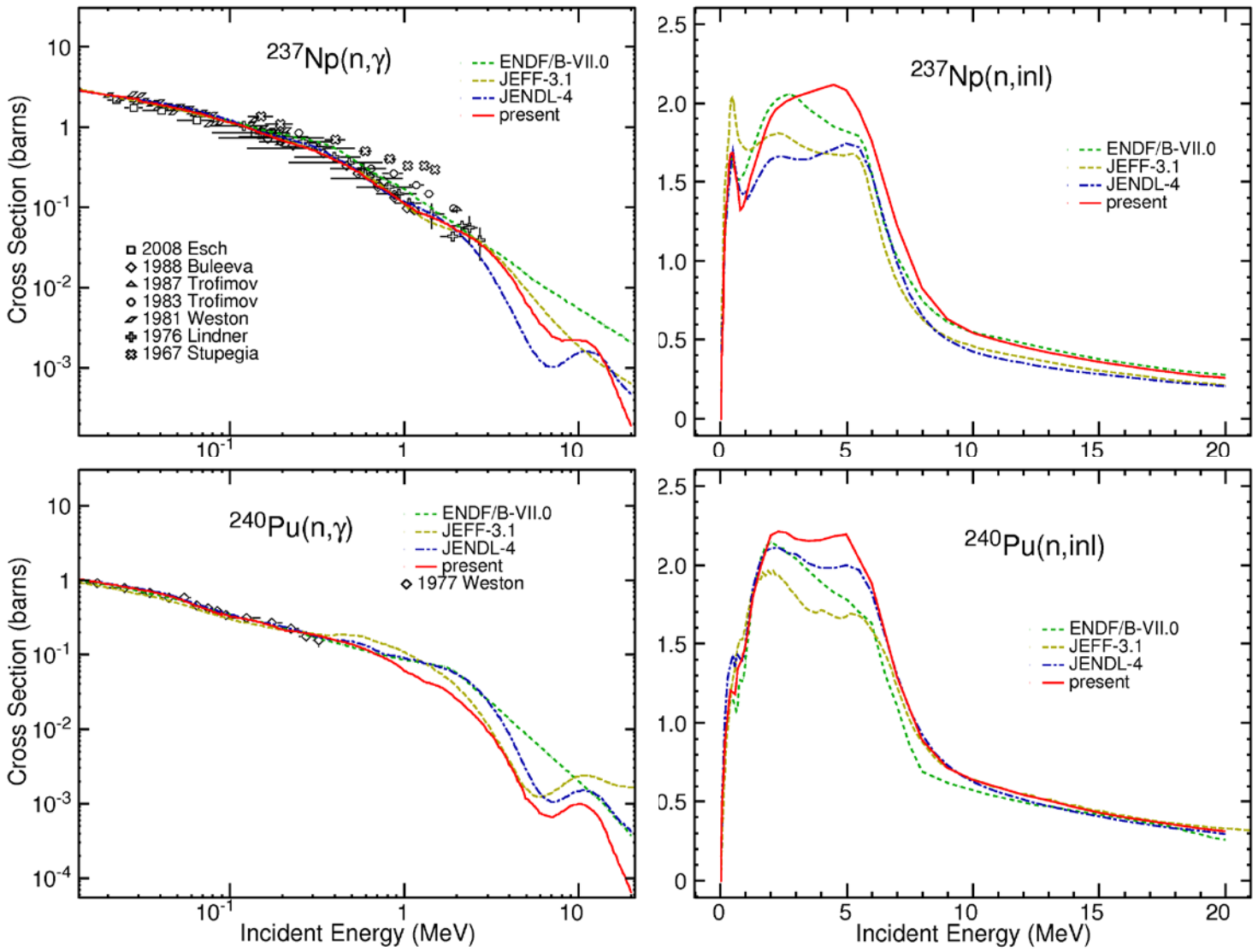
Covariances

- ✓ EMPIRE-KALMAN
- ✓ Covariances above resonances
  - ➢ Sensitivity matrices from 3 ~ 5 % variations of model parameters around optimal value
  - ➢ Using uncertainties of measurements if available
  - ➢ Using pseudo data with 10% uncertainty for the cross section of model calculation if no measurement is available
- ✓ Preliminary file
  - ➢ Present list of covariance data generated:
    - MT=1,2,4,16,17,18,22,24,(51-91),102,103,107
  - ➢ MF=32 from ORNL for (^{237}Np, ^{240}Pu, ^{244}Cm)
  - ➢ Getting from JENDL-4 (nu-bar, fission neutron spectra, MF 31)

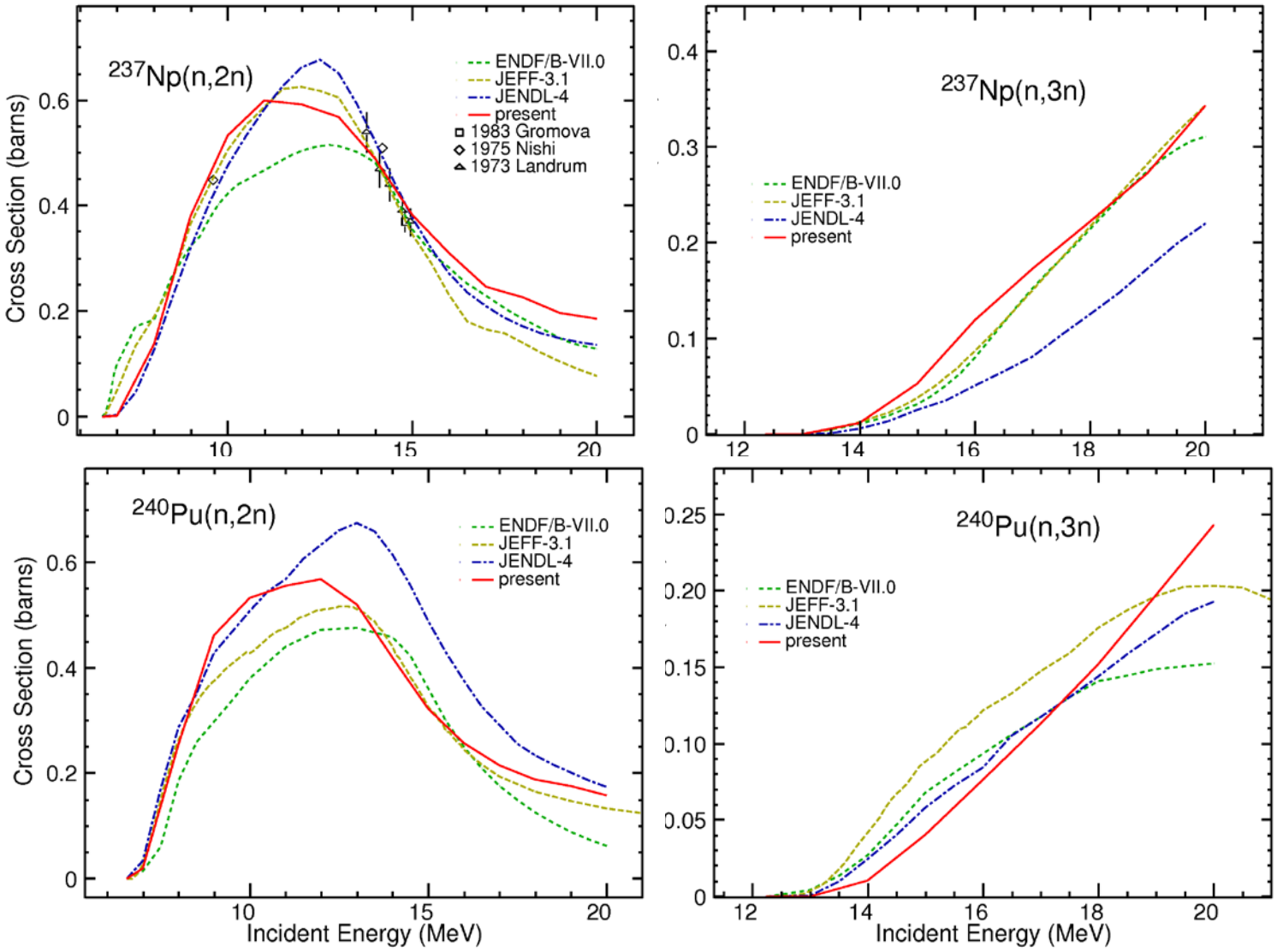
Total & Elastic Cross sections



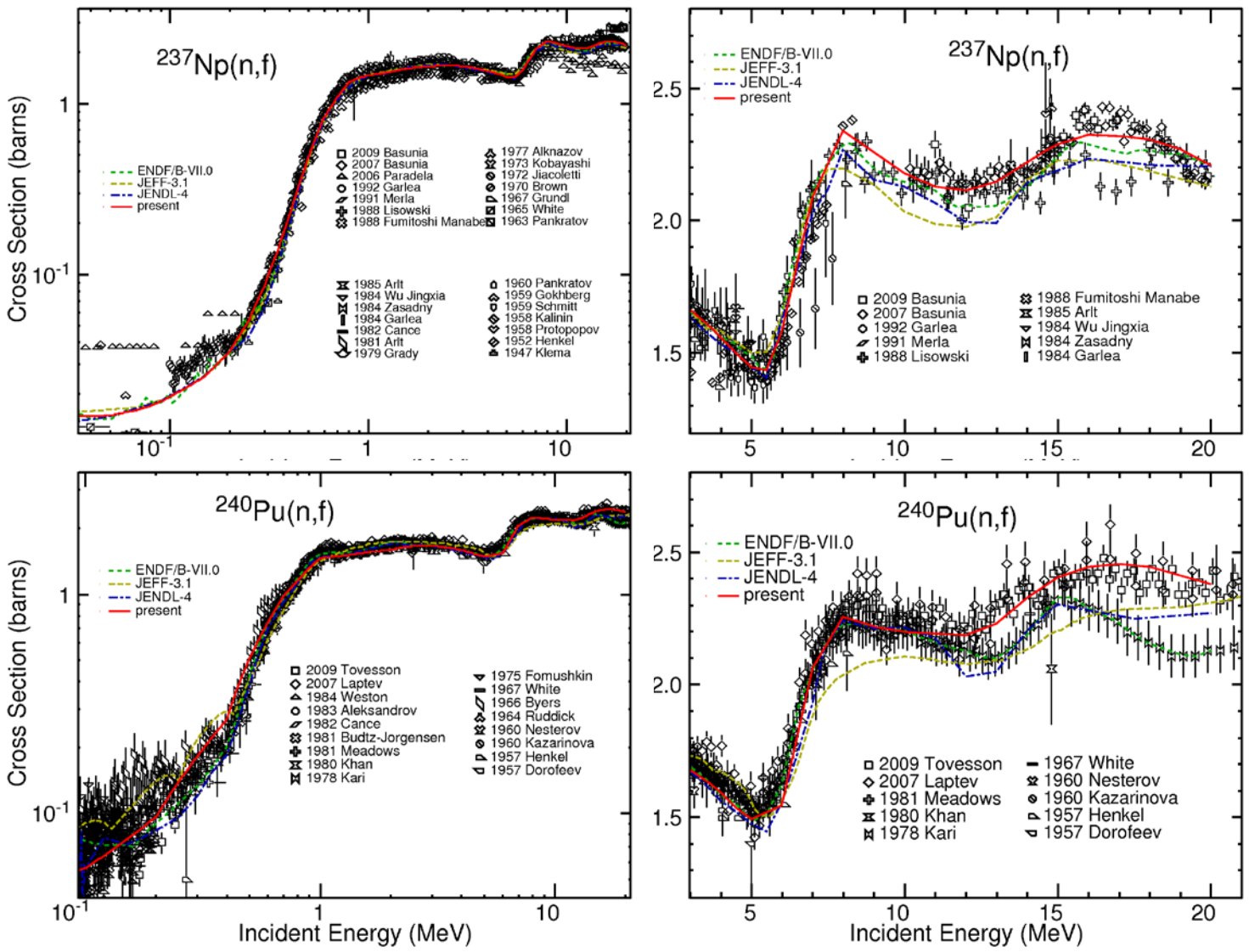
Capture & Inelastic Cross sections



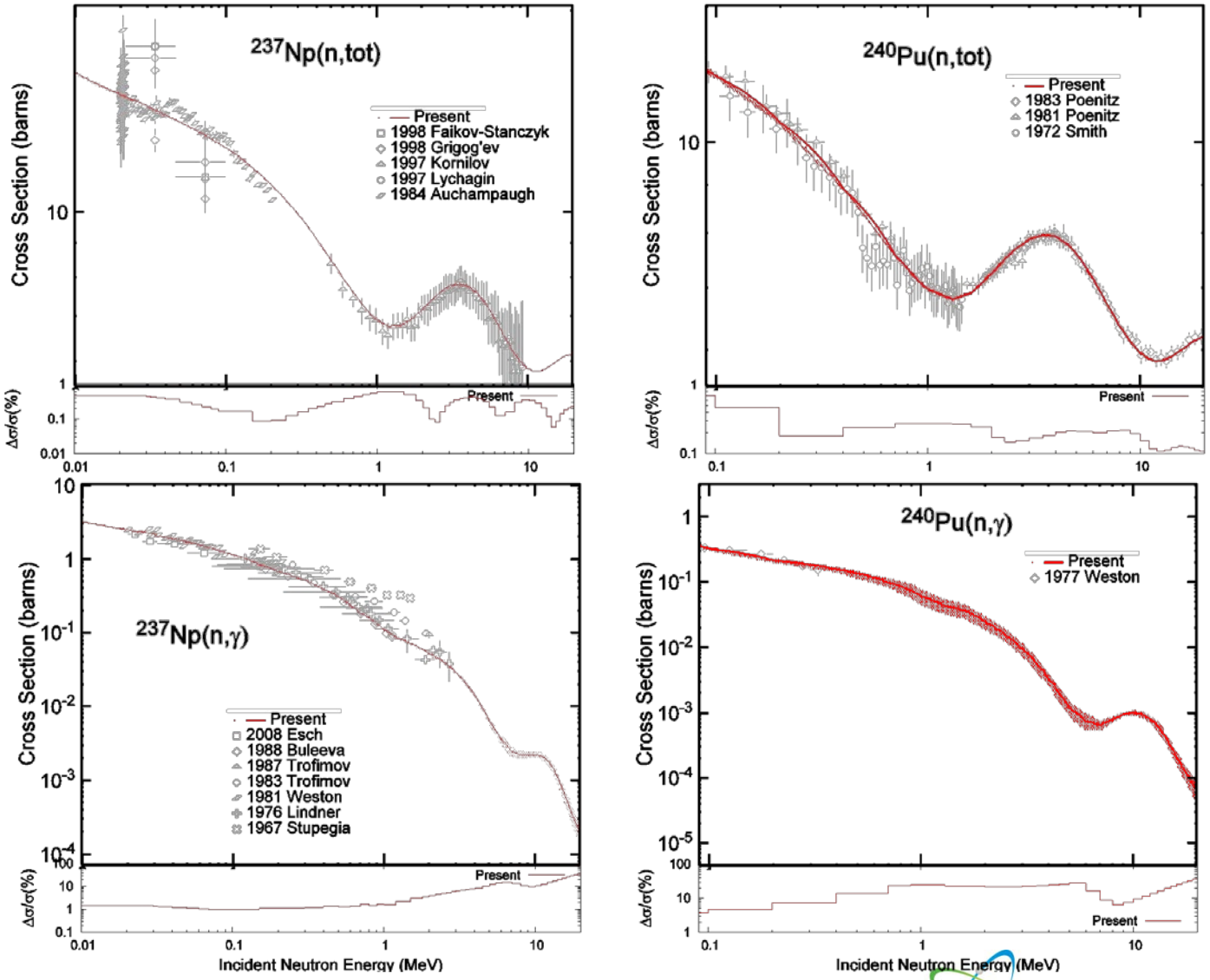
(n,2n) & (n,3n) Cross sections



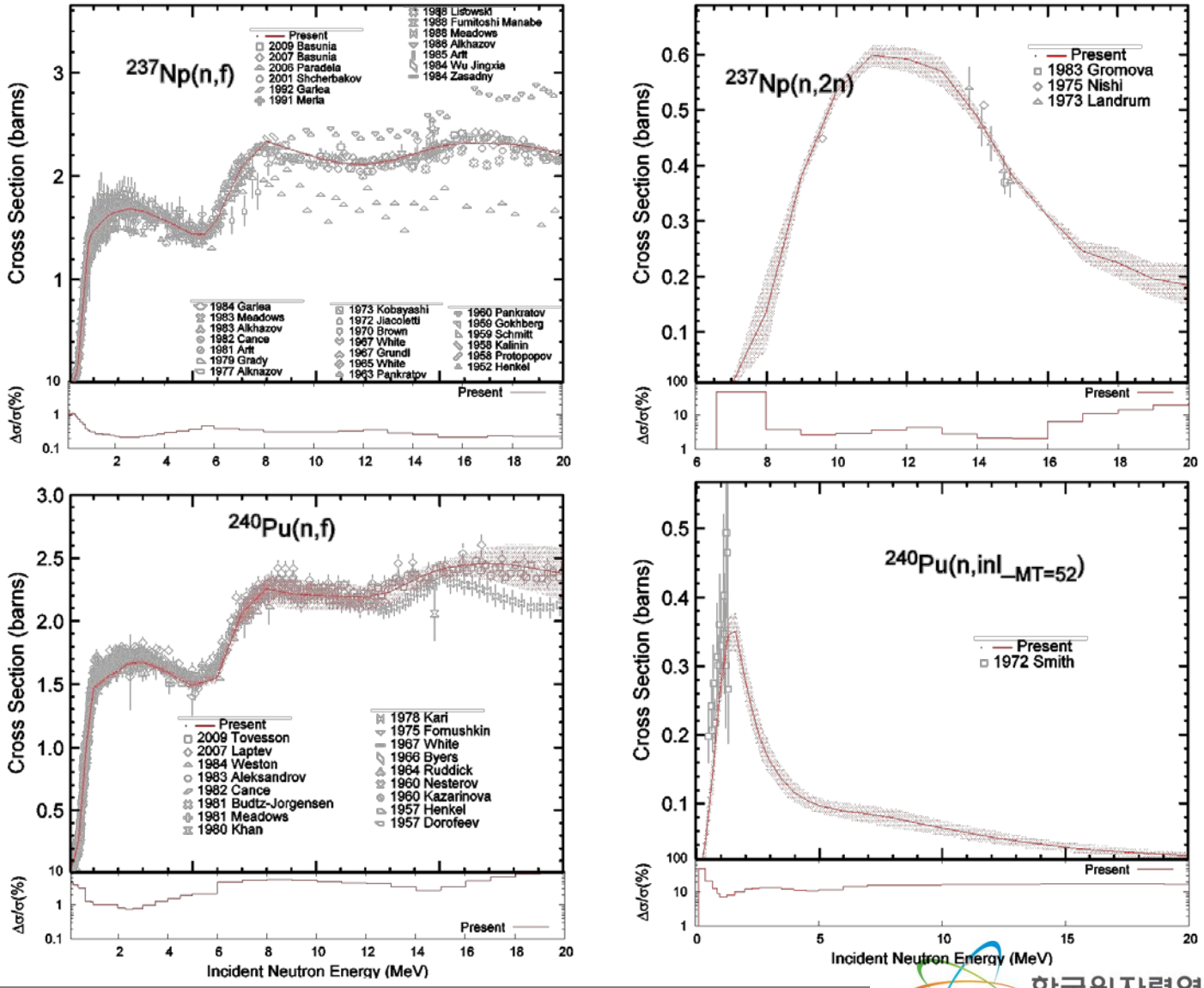
Fission Cross sections



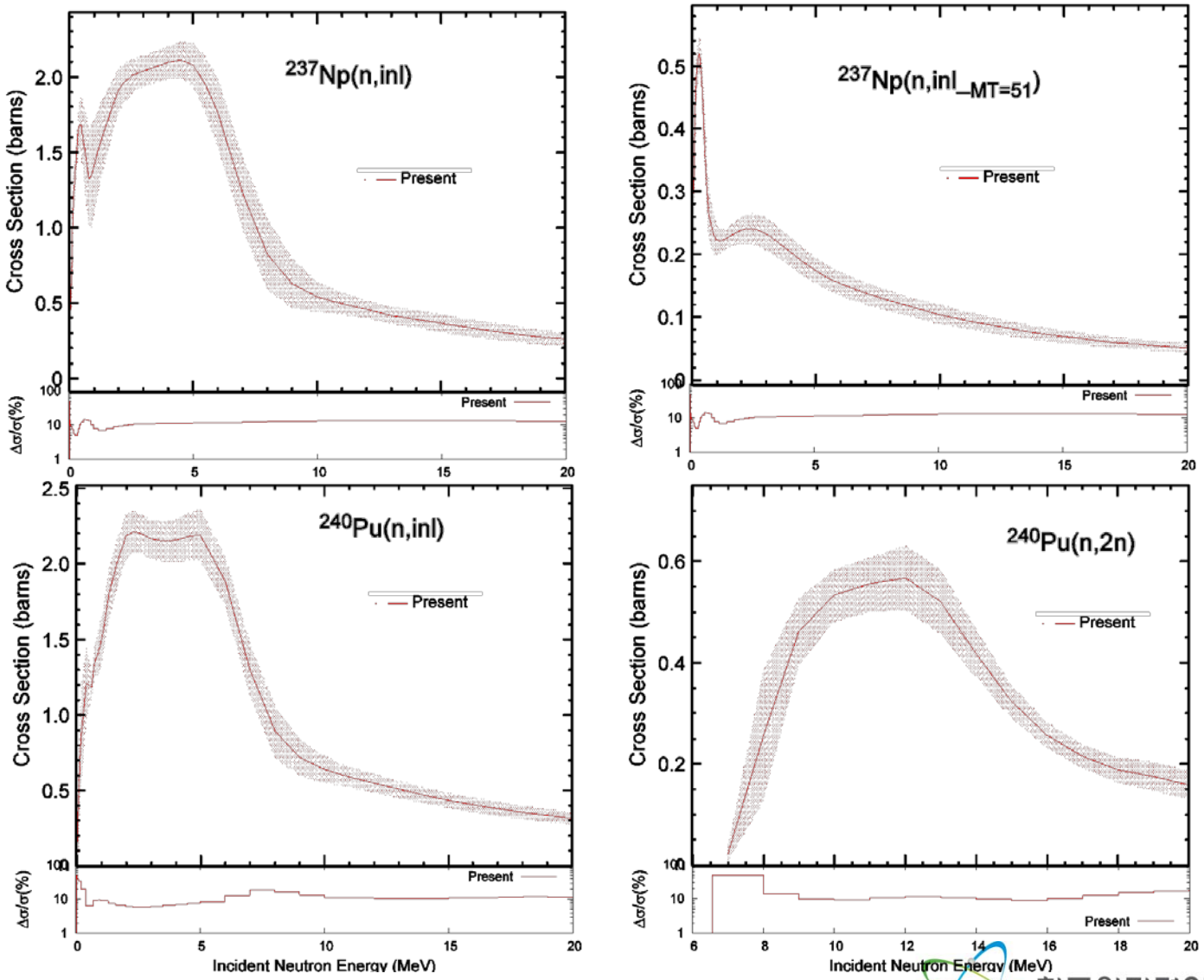
Uncertainties for cross sections with measurements



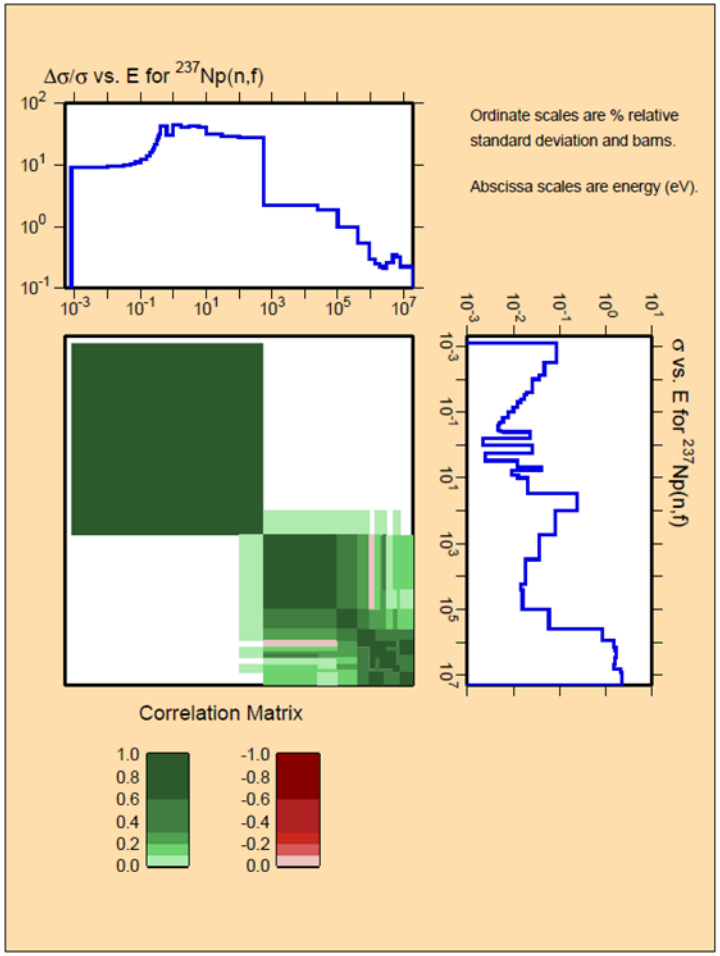
Uncertainties for cross sections with measurements

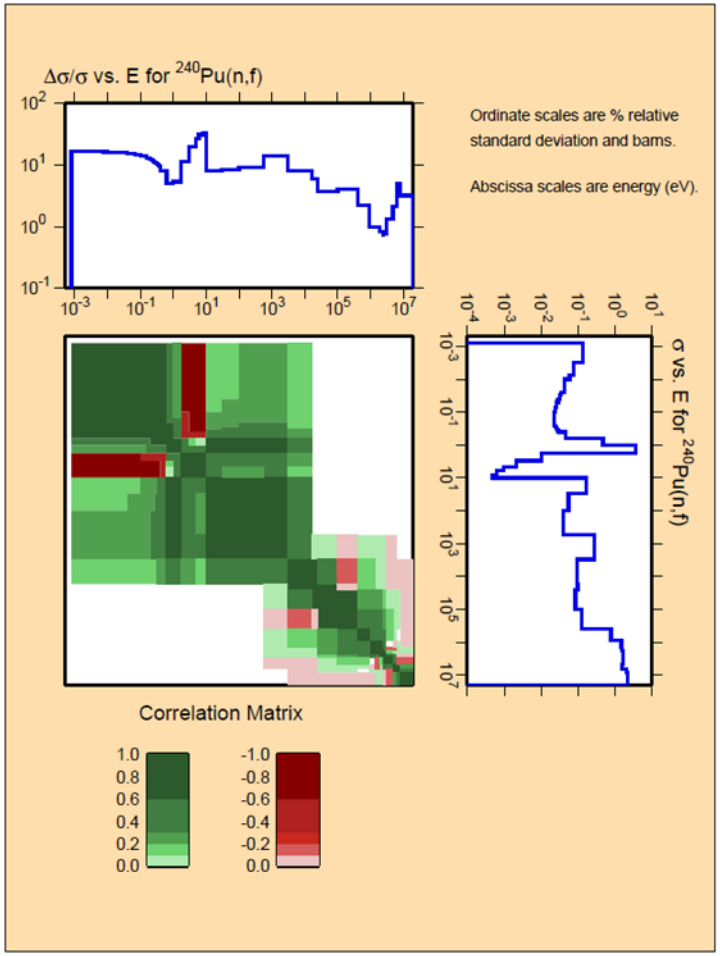


Uncertainties for cross sections with no measurement



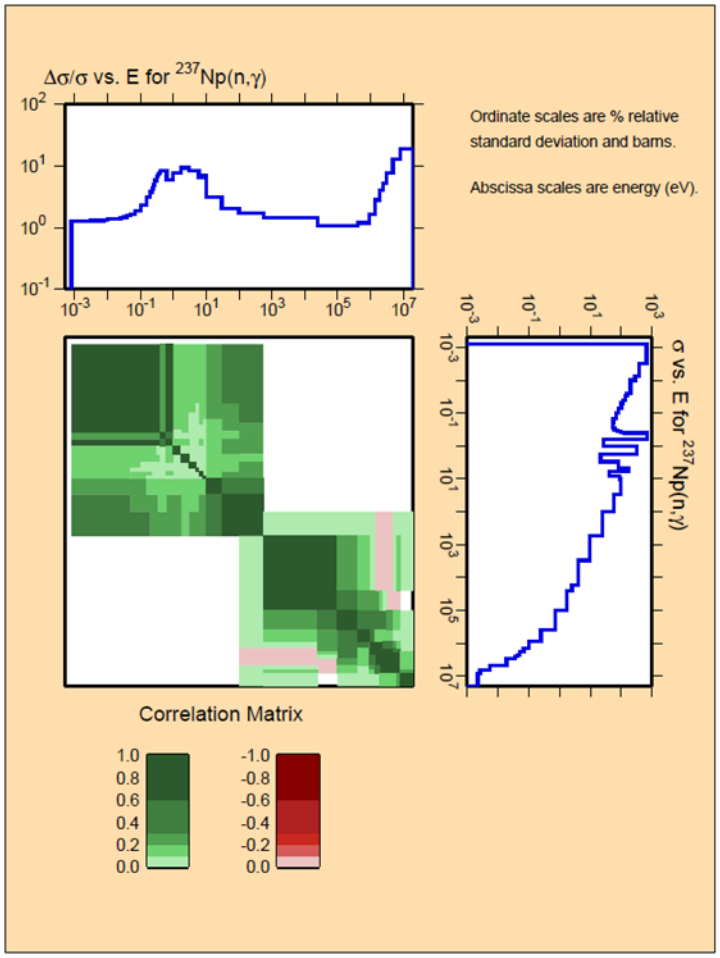
Correlation

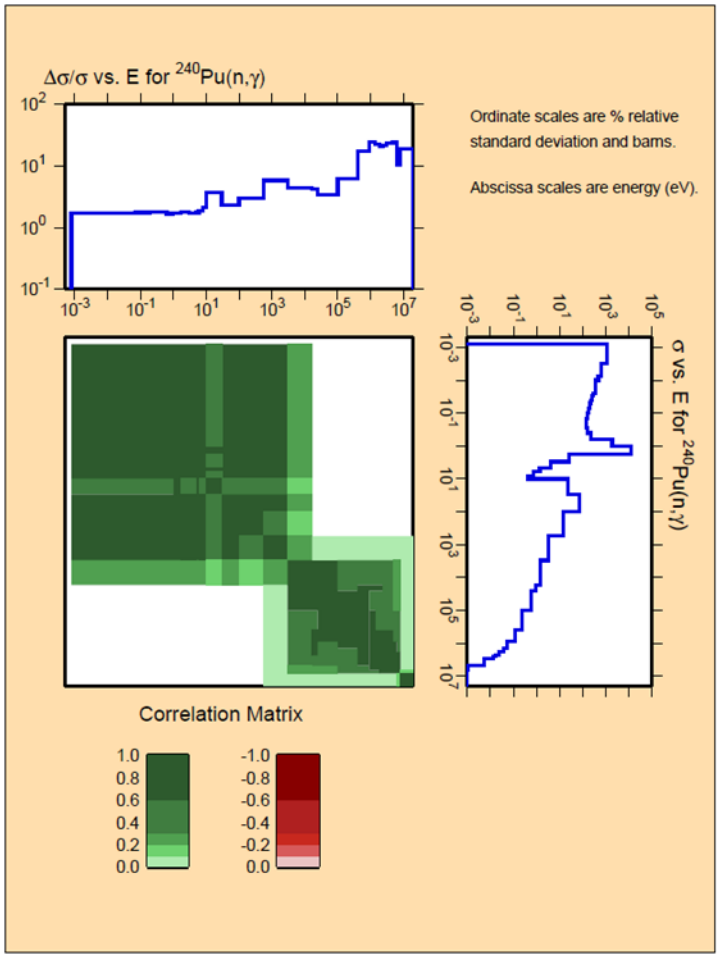




Covariance data of (n,f) for ^{237}Np and ^{240}Pu

Correlation

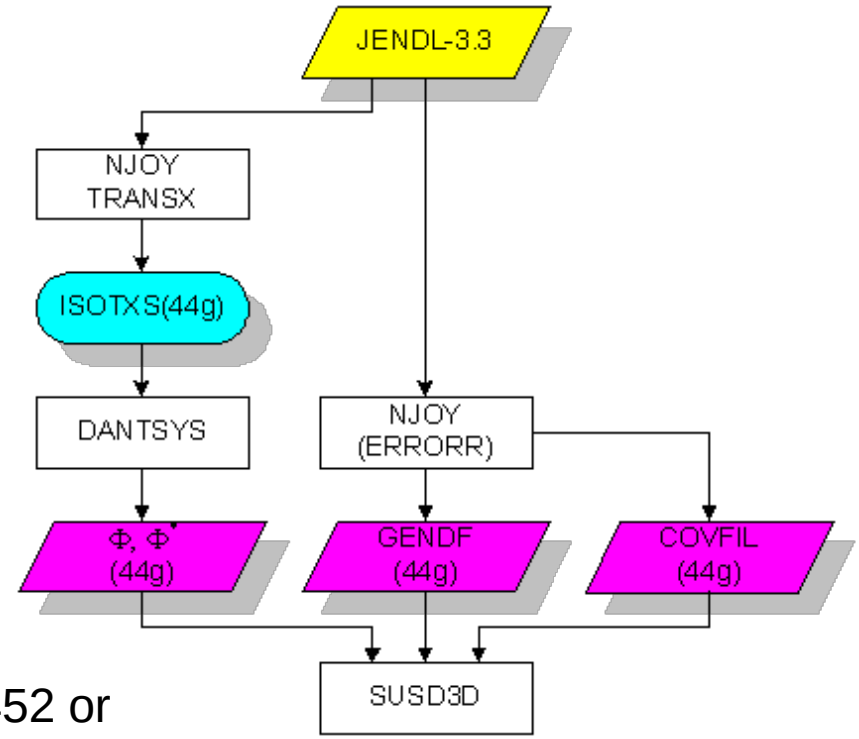




Covariance data of (n,g) for ^{237}Np and ^{240}Pu

Sensitivity and Uncertainty Analysis of k_{eff}

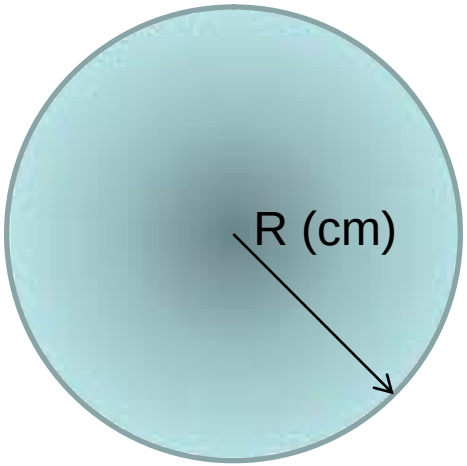
- ✓ Data preparation
  - NJOY99/TRANSX
  - Reference data: JENDL-3.3
  - Energy group: SCALE 44-group
- ✓ Forward/adjoint flux distribution
  - DANTSYS
  - P_3-S_{16} approximation
- ✓ S&U analysis of k_{eff}
  - SUSD3D
  - Total fission (MT=18) and total ν (MT=452 or MT=455+456) covariance data
  - Covariance data: JENDL-3.3, Low-fidelity, New covariance data

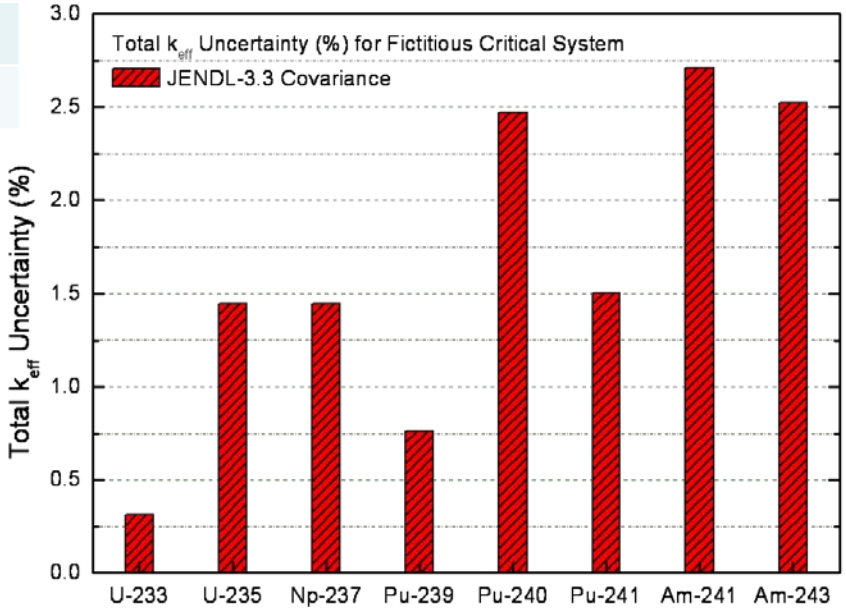


➢Very useful for assessing the new covariance data through inter-comparison of uncertainty by constituting nuclides and by nuclear reactions for a specified nuclides of interest

Fictitious critical system searched by JENDL-3.3-based DANTSYS calculation

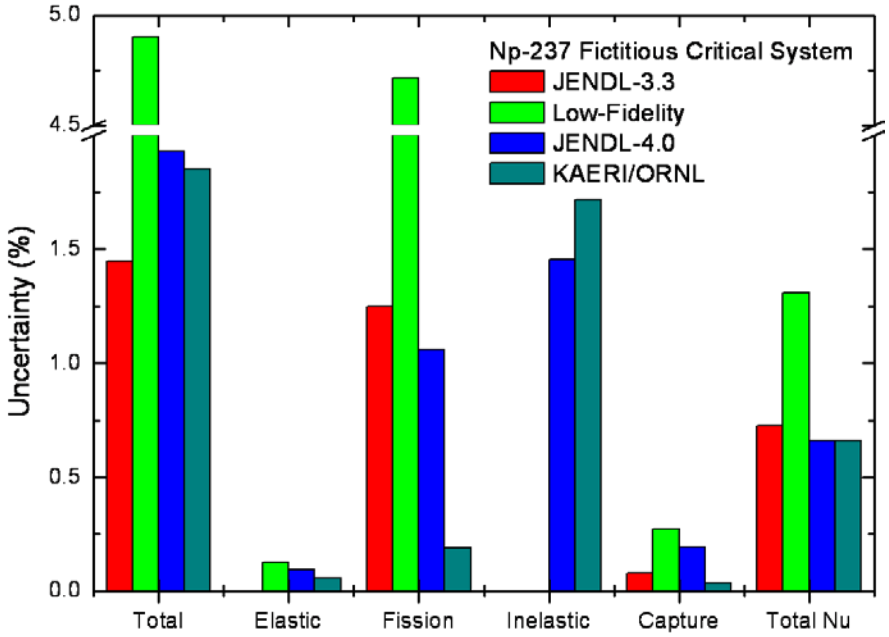
No.	Actinide	Critical Radius (cm)
1	92-U-233	5.72
2	92-U-235	8.25
3	93-Np-237	9.20
4	94-Pu-239	4.95
5	94-Pu-240	7.24
6	94-Pu-241	5.20
7	95-Am-241	11.33
8	95-Am-243	15.54

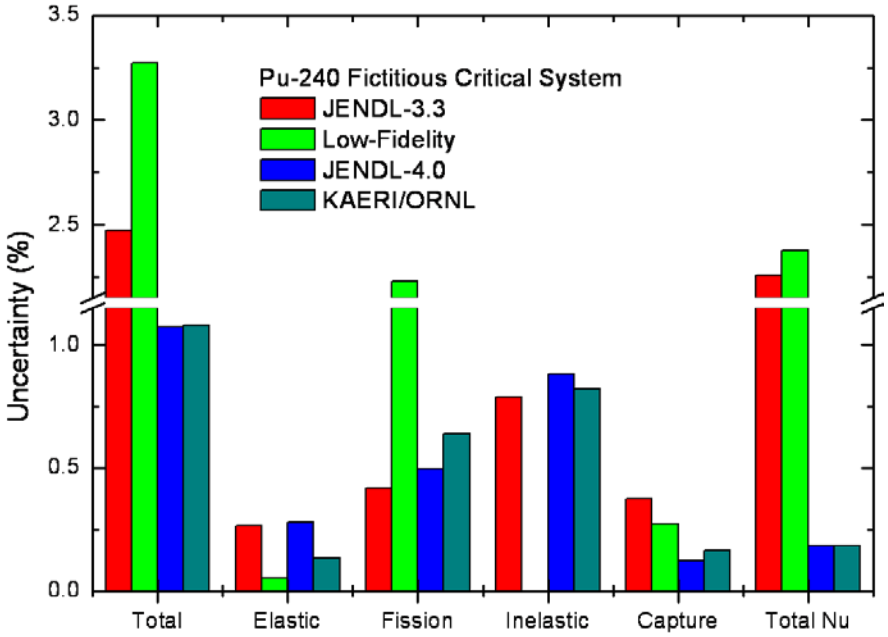




✓ Total uncertainties(~2.5%) for ^{240}Pu-, ^{241}Am-, and ^{243}Am-fictitious cores are due to large uncertainties in total nu-bar, total fission, and capture covariance data

Total k_{eff} uncertainties





- ✓ Total k_{eff} uncertainty for Lo-Fi ^{237}Np became extremely large caused by large fission covariance data.
- ✓ KAERI/ORNL covariance brings about nearly the same total k_{eff} uncertainty estimation as JENDL-4.0.
  - ✓ underestimate total fission
  - ✓ overestimate inelastic scattering

- ✓ Total k_{eff} uncertainty for Lo-Fi ^{240}Pu became extremely large caused by large fission and total nu covariance data.
- ✓ Total uncertainty with KAERI/ORNL covariance is comparable to those with JENDL-4.0.
  - ✓ slight increase of total fission

Summary

- ✓ We produced neutron cross section files of ^{237}Np and ^{240}Pu.
- ✓ Covariance matrices for ^{237}Np and ^{240}Pu were generated by the EMPIRE-KALMAN approach considering sensitivity matrices of model calculations and uncertainties of experimental data
- ✓ A Fictitious system was constructed for testing of our covariance data

- ✓ Further works
  - ➢ Covariances for angular distributions and nu-bar would be added.
  - ➢ Too small uncertainties will be rectified through analyzing measurements more carefully.
  - ➢ Since then, covariance files for all curium isotopes will be generated.