# Covariances for the LANL <sup>239</sup> Pu cross section evaluation



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LOS ALAMOS NATIONAL LABORATORY CAVEAT

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## **METHODOLOGY**

We are in the process of updating the <sup>239</sup>Pu cross sections in the fast energy range (complementing the work of IAEA / INDEN / ORNL / LLNL)

#### Covariances constructed with NEXUS KALMAN code

Method: Combine model variation with experimental uncertainties

Bayesian inference used to estimate covariances

Posterior covariances for parameters take the form:

 $P = (X^{-1} + C^T V^{-1} C)^{-1}$ 

And the final covariance matrix (function of energy) is:

$$F = CPC^T$$

Where:

X = prior model parameter cov. matrix, V = experimental data cov. matrix, C = model sensitivity matrix

Rising et al. Nuclear Science and Engineering 175 81 (2013)

### **TOTAL CROSS SECTION**



Model: Soukhovitskii (2005) optical model [deformation ~0.21]

Uncertainties generated from variation of 7 optical model parameters and 25+ experimental datasets

### **TOTAL: ENERGY CORRELATION MATRIX**



#### Generally positive correlation as a function of energy

### **TOTAL: RELATIVE UNCERTAINTY**



LANL result is consistently higher than ENDF/B-VIII.0

Reason for differences are under analysis

### **CAPTURE CROSS SECTION**



Model: CoH statistical Hauser Feshbach with M1 of Mumpower et al. PRC 96 024612 (2017)

Uncertainties generated from 20+ model parameters and 10+ experimental datasets

### **CAPTURE: ENERGY CORRELATION MATRIX**



#### Diagonal or near diagonal positive correlation; off-diagonal negative as a function of energy

### **CAPTURE: RELATIVE UNCERTAINTY**



LANL result is consistently higher at higher energies than ENDF/B-VIII.0

New Mosby (2018) data is most impactful to new uncertainties

# (N,2N) CROSS SECTION



#### Model: CoH with new collective enhancement of Mumpower et al. submitted PRC (2022)

Uncertainties generated from variation of 20+ model parameters and 4 experimental datasets

# (N,2N): ENERGY CORRELATION MATRIX



#### Generally positive correlation as a function of energy

# (N,2N): RELATIVE UNCERTAINTY



LANL result is consistently similar order as ENDF/B-VIII.0

Differences arises from new collective enhancement and Méot et al. PRC 103 054609 (2021) data near threshold

# (N,INEL) CROSS SECTION



Model: CoH statistical model

Uncertainties generated from variation of 20+ model parameters and 1 experimental dataset

# (N,INEL): ENERGY CORRELATION MATRIX



#### Generally positive correlation as a function of energy

### (N,INEL): RELATIVE UNCERTAINTY



LANL result is consistently similar order as ENDF/B-VIII.0

Cross section near threshold is very uncertain and model dependent

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