



CSEWG Meeting, BNL, November 3-5, 2009

Status of ENDF/B-VII.1 Covariances

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CSEWG, Nov 2008: Release ENDF/B-VII.1 in 2010

Include covariances of interest to GNEP

Goal - create a library that is broad enough, and complete enough, for users to adopt it, with the understanding that the quality varies from high to low - about 100+ nuclides - with expectation that over time the overall quality will be improved

Approach - Start with the *existing* suite of 108 that comprises:

- ~ 5 Actinide hi-fi, 14 medium
- ~ Light nuclei from LANL (~10); H, ⁶Li, ⁷Li, ¹⁰B of good quality
- ~ Remaining structure, heavy, FPs came from BNL

Upgrade Work in coming 1-2 years:

- Add ORNL results for ¹⁹F, ^{33,35}Cl, ⁵⁵Mn and Ni, Ti, V as available
- Add planned LANL upgr. Ti, V, ²⁴⁰Pu, ²⁴¹Am, ¹⁶O, ²³⁷Np med/high quality
- LANL add fiss spectra for big 3 if we have resources
- Add ang dist for ²³⁹Pu, ^{5,8}U, ⁵⁶Fe, ²³Na, ¹⁶O if we have resources
- BNL improve ~65 low-fi materials (add mf32 from Atlas, upgrade fast region)
- BNL improve minor actinides (Empire modelling, more rigorous use of data)

This is a challenging but realistic goal, that does not need extensive resources beyond what we think could be available. Significant work needed to pull together though.

Current Covariance Activities in US

Laboratories

ANL, INL	testing & validation
BNL	eval in full energy range - structural materials and FPs
LANL	eval in full range - light nuclei; URR & fast region - actinides
ORNL	eval in RRR & URR - priority materials including actinides
LLNL	???

Covariance libraries

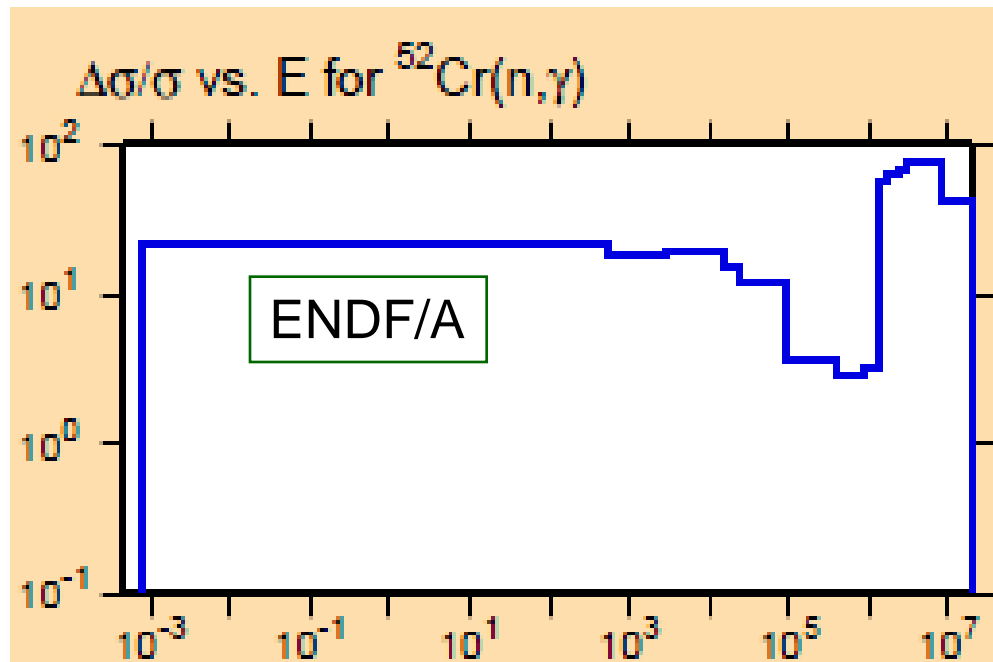
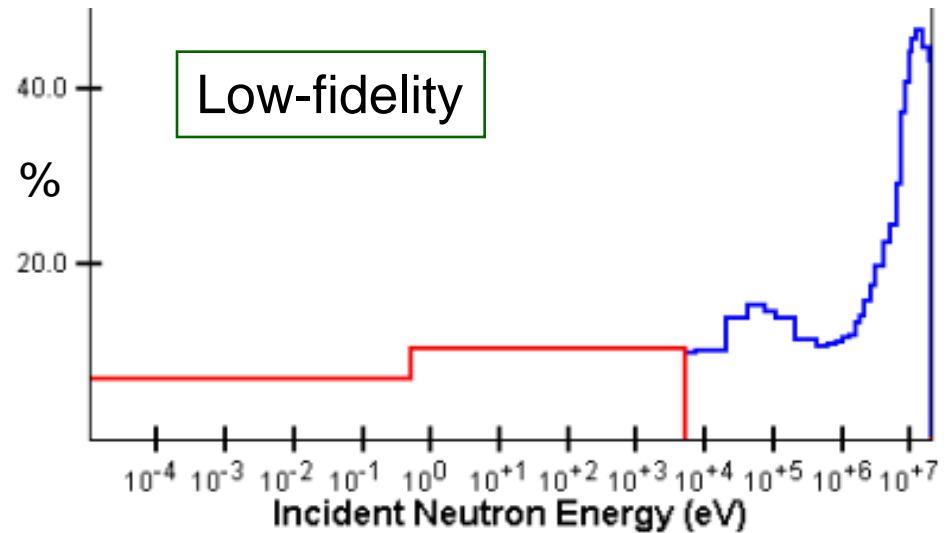
1. Low-fidelity 387 materials, released 2008, ANL-BNL-LANL-ORNL
2. SCALE-6 255 materials, 200 lowfi, released 2008, ORNL
3. AFCI-1.2 110 materials, multigroup, Aug 2009, BNL-LANL-INL/ANL
4. VII.0 14 materials complete
5. ENDF/A 9 materials complete, 7 materials partial
8 materials submitted last week (5 complete, 3 partial)

1. Low-fidelity covariances, 387 materials

Useful, but cannot be adopted by VII.1

To get plots and files go to
www.nndc.bnl.gov/lowfi

Low-fi library provides useful basic guidance particularly for capture, but it has not been developed for ENDF/B-VII.1.



2. SCALE-6 covariance library

Instructive, but not suitable for VII.1

Selected by ORNL from various sources, 255 materials.
Example of what people do if official library not available.

TABLE I: Sources of covariance data in the SCALE-6 covariance library.

Source	Materials
ENDF/B-VII	Gd ^{152–158,160} , Th ²³² , Tc ⁹⁹ , Ir ^{191,193}
(Pre-release) ENDF/B-VII	U ^{233,235,238} , Pu ²³⁹
ENDF/B-VI	Na ²³ , Si ^{28–29} , Sc ⁴⁵ , V ⁵¹ , Cr ^{50,52–54} , Mn ⁵⁵ , Fe ^{54,56–58} , Ni ^{58,60–62,64} , Cu ^{63,65} , Y ⁸⁹ , Nb ⁹³ , In ^(nat) , Re ^{185,187} , Au ¹⁹⁷ , Pb ^{206–208} , Bi ²⁰⁹ , Am ²⁴¹
JENDL	Pu ^{240–241}
LANL Hi-Fi	H ¹ , Li ⁶ , B ¹⁰
Lo-Fi	~200 materials (mostly fission products and minor actinides)

3. AFCI covariance library

It should serve as basis for VII.1

110 materials

- 20 actinides, 12 light nuclei (LANL)
- 78 structural materials and fission products (BNL)

Covariances requested for main reaction channels

- elastic, capture, inelastic, n2n, fission
- for light nuclei all neutron-removal channels (“capture”)
- nubars for actinides

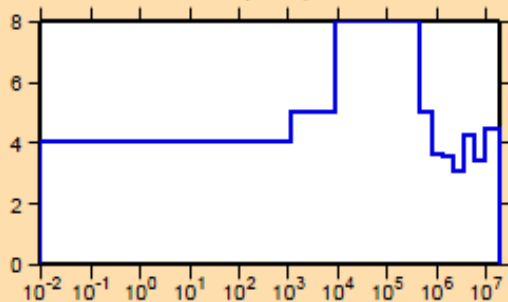
Strong interaction between evaluators and users

- Users at INL and ANL are directly involved in the project
- Produced data are almost instantly used and tested

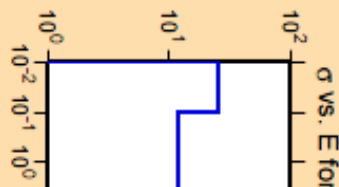
Status (more by C. Mattoon on Thursday)

- AFCI-1.2 library (33-groups) released to users in August 2009
- AFCI-2 expected in FY2010

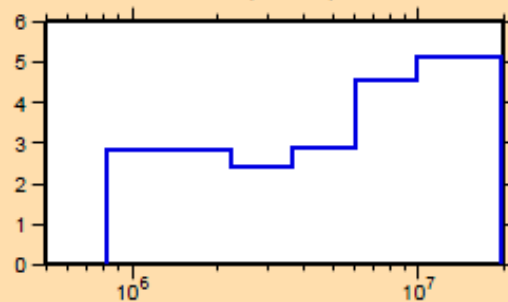
$\Delta\sigma/\sigma$ vs. E for $^{56}\text{Fe}(n,\text{el.})$



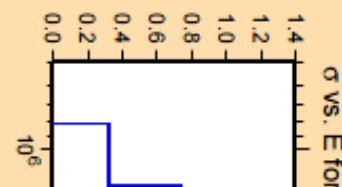
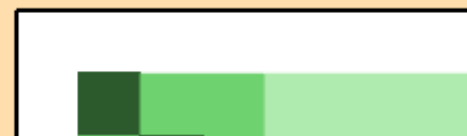
Ordinate scales are % relative standard deviation and barns.
Abscissa scales are energy (eV).



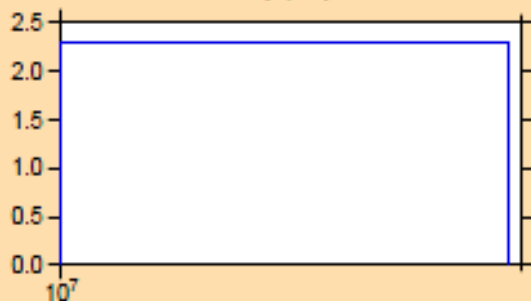
$\Delta\sigma/\sigma$ vs. E for $^{56}\text{Fe}(n,\text{inel.})$



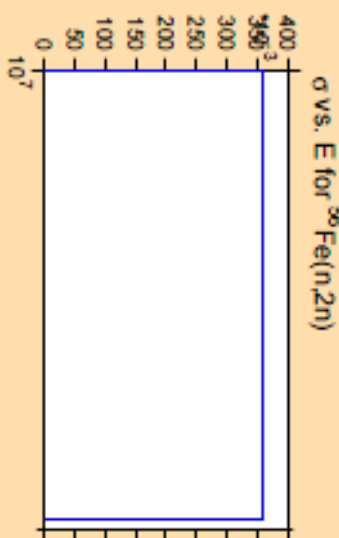
Ordinate scales are % relative standard deviation and barns.
Abscissa scales are energy (eV).



$\Delta\sigma/\sigma$ vs. E for $^{56}\text{Fe}(n,2n)$

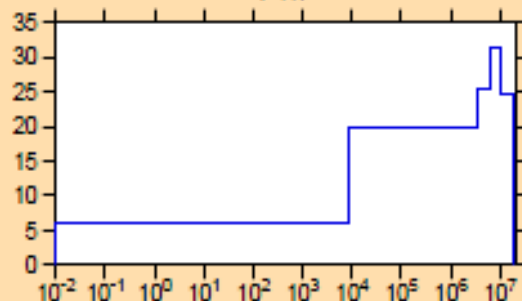


Ordinate scales are % relative standard deviation and barns.
Abscissa scales are energy (eV).

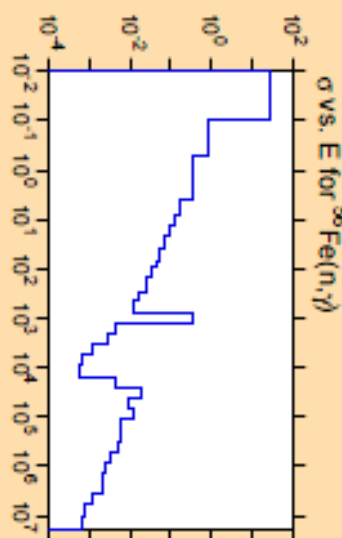
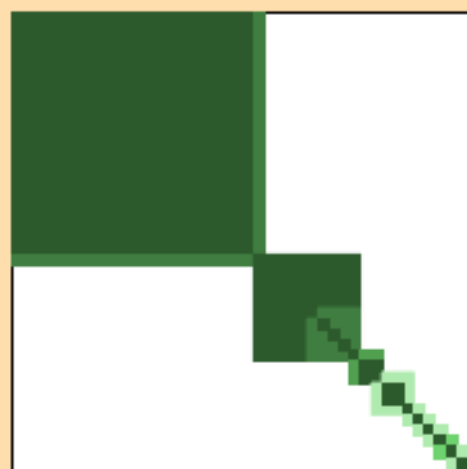


Correlation Matrix

$\Delta\sigma/\sigma$ vs. E for $^{56}\text{Fe}(n,\gamma)$



Ordinate scales are % relative standard deviation and barns.
Abscissa scales are energy (eV).



Correlation Matrix

4. Covariances in ENDF/B-VII.0

Each file must be carefully reviewed

14 materials with complete covariances

- ^7Li taken from ENDF/B-VI.8
- ^{89}Y , ^{99}Tc , $^{191,193}\text{Ir}$ new, all data in MF33 (cs)
- $^{152-155,156-158,160}\text{Gd}$ new, MF32 (res par), MF33
- ^{232}Th new, MF31 (nubars), MF32,33

Covariances reviewed by NNDC

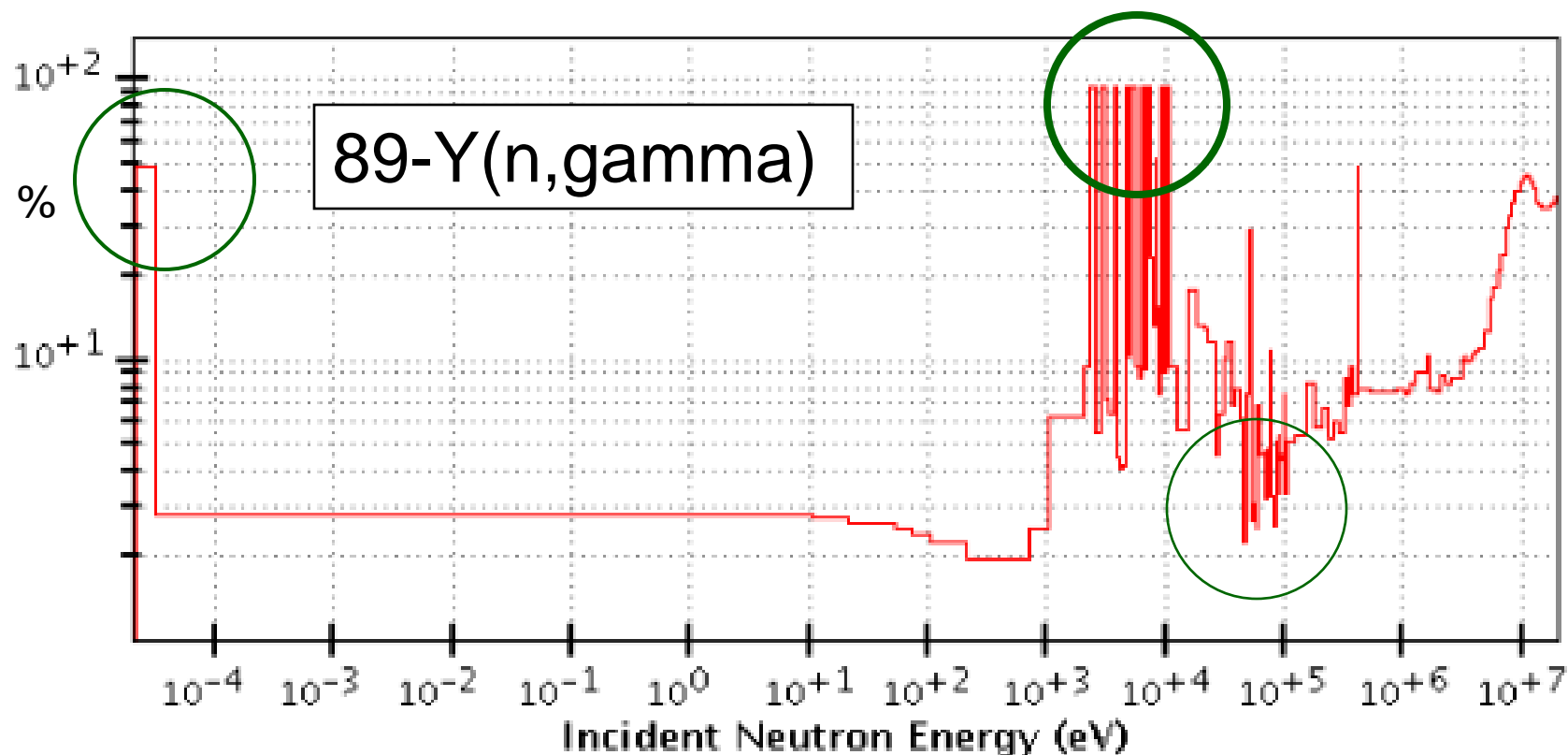
1. Processed by NJOY, PUFF – R. Arcilla, talk on Thursday
 - Discrepancies in 2 materials (^{156}Gd , ^{232}Th)
2. Review of data – PO, talk on Thursday
 - Deficiencies in 6 materials, some of them considerable

Covariances in ENDF/B-VII.0

Probably the worst case: 89-Y

All data in MF33, directly viewed by Sigma, RRR < 410 keV

Biggest issue: huge RRR uncertainty peaks - generated artificially



5. Covariances in ENDF/A

Each file must be carefully reviewed

9 materials with complete covariances

- $^{233,235,238}\text{U}$ MF31,32,33 (MF32 converted to MF33)
- ^{239}Pu MF31,32,33 (MF32 converted to MF33)
- $^{180,182-184,186}\text{W}$ MF 32,33 (^{180}W fast only)

7 materials with partial covariances

- ^{19}F MF32, MF33 partial from VII.0
- $^{35,37}\text{Cl}$ MF32 only
- $^{39,41}\text{K}$ MF32 only
- ^{55}Mn MF32 only
- ^{240}Pu MF33 only (fast region)

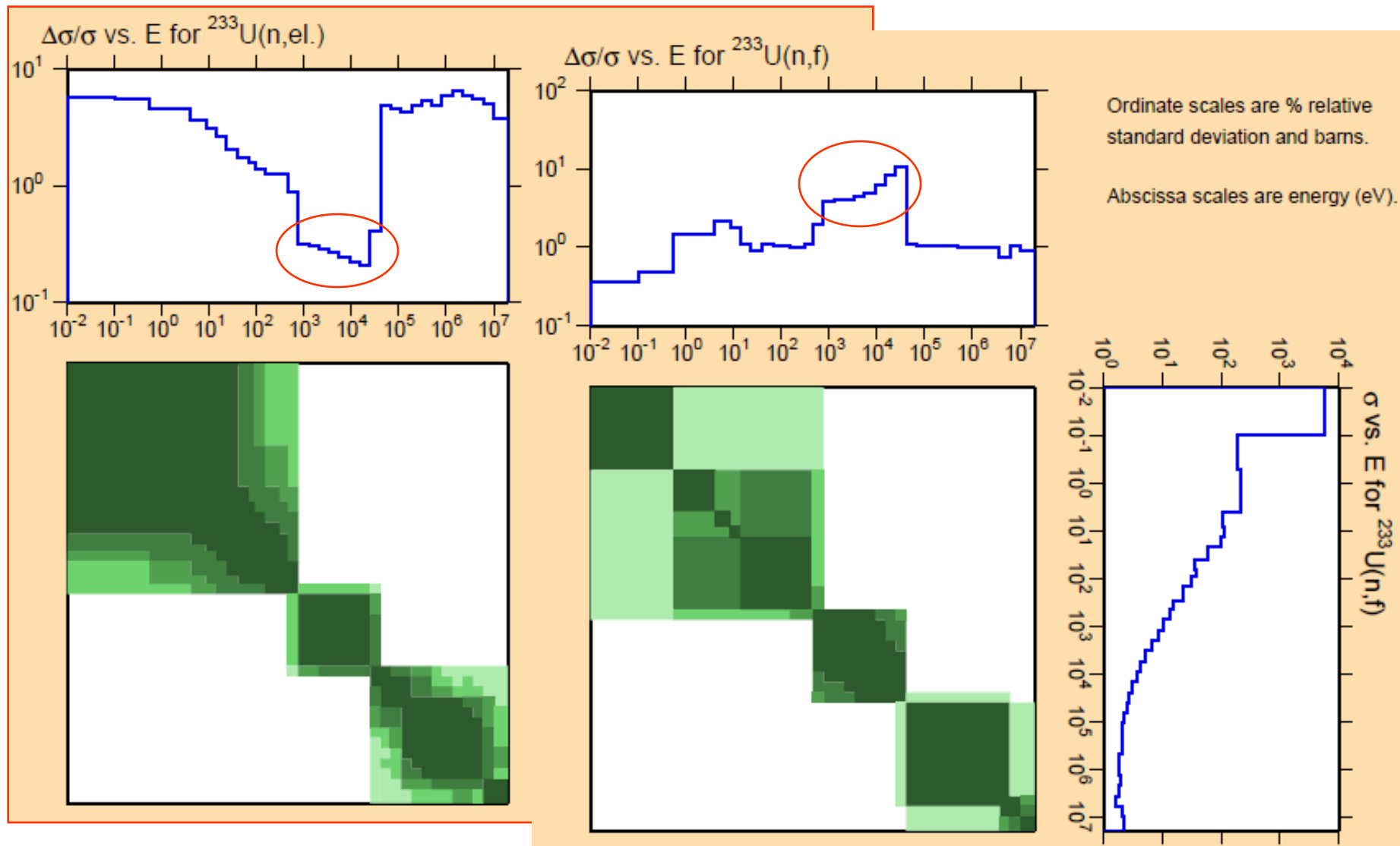
Covariances reviewed by NNDC – numerous issues

1. Processing – R. Arcilla, talk on Thursday
2. Review of data - PO, talk on Thursday

Covariances in ENDF/A

Careful review needed

U-233: URR region 0.6-40 keV, (n,el) and (n,f) uncertainties?



Conclusions 1

Covariances in ENDF/B-VII.1 library

- It should contain ~125 materials with covariances
- 110 materials produced for AFCI + about 15 others

Status of work

- Final version of AFCI library should serve as the basis for VII.1, **conversion** to ENDF-6 format needed
- ENDF/B-VII.0 and ENDF/A should be used as much as possible, but deficiencies **must** be addressed
- ~10 additional priority materials by **sophisticated** methods
- ~85 materials by **medium-quality** methods

Conclusions 2

Processing

- NJOY x PUFF differences represent continuing headache
- Fixes are urgently needed

Quality Assurance

- Topic of key importance
- Uncomfortable news: **numerous** deficiencies in VII.0 and ENDF/A

Can we do it?

- To produce VII.1 with decent covariances is huge challenge
- I believe it is possible, but strong commitment is needed