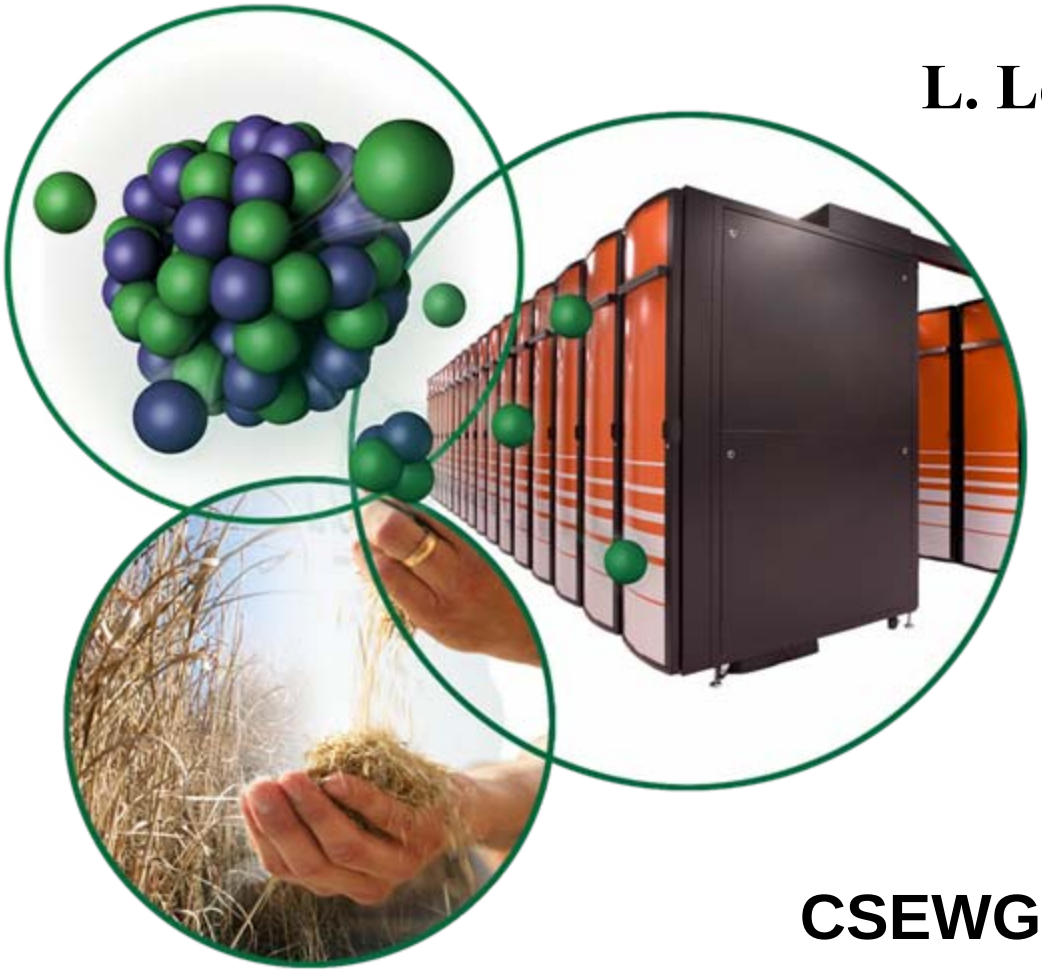
Resonance Evaluations at ORNL



L. Leal, R. Sayer, and H. Derrien

Nuclear Data Group

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Resonance Evaluations Including Covariance Complete at ORNL

Isotopes	Resonance Parameters	Covariance
W isotopes (^{182}W, ^{183}W, ^{184}W, ^{186}W)	Conversion of MLBW into RM	SAMMY Retroactive
^{19}F	Data Evaluation with SAMMY (LRF=7)	Obtained with the RR evaluation
^{55}Mn	Data Evaluation with SAMMY (resolved and unresolved)	Obtained with the RR evaluation

Resonance Evaluations Including Covariance Complete at ORNL

Isotopes	Resonance Parameters	Covariance
Cl isotopes (^{35}Cl, ^{37}Cl)	Data Evaluation with SAMMY (LRF=7)	Obtained with the RR evaluation
K isotopes (^{39}K, ^{41}K)	Data Evaluation with SAMMY	Obtained with the RR evaluation
^{48}Ti isotopes	Conversion of MLBW into RM	SAMMY Retroactive

Resonance Evaluations in Progress at ORNL

Isotopes	ORELA measurements	SAMMY evaluation
Cr isotopes	Transmission and Capture measurements for ^{53}Cr and natural Cr;	Resonance parameters and covariance for ^{50}Cr, ^{52}Cr, ^{53}Cr, ^{54}Cr
Ni isotopes	Capture measurements for ^{58}Ni and ^{60}Ni	Resonance parameters and covariance for ^{58}Ni, ^{60}Ni
^{48}Ti isotopes	Transmission and Capture measurements	Resonance parameters and covariance

Resonance Parameter Covariance Evaluation at ORNL

L. Leal, R. Sayer, H. Derrien, G. Arbanas, and D. Wiarda

Nuclear Data Group

Oak Ridge National Laboratory

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Covariance Evaluations Complete at ORNL

Isotopes	Resonance Parameters	Covariance
U isotopes (^{233}U, ^{235}U, ^{238}U)	Done at ORNL	SAMMY retroactive ^{233}U, ^{235}U
^{239}Pu	Done at ORNL	Obtained with the RR evaluation
^{48}Ti isotopes	Conversion of RP into RM	SAMMY Retroactive

Covariance Evaluations Complete at ORNL

Isotopes	Measurements	Covariance
W isotopes (^{182}W, ^{183}W, ^{184}W, ^{186}W)	Measurements at ORNL	SAMMY retroactive
^{35}Cl and ^{37}Cl	Done at ORNL	Obtained with the RR evaluation
^{39}K and ^{41}K	Done at ORNL	Obtained with the RR evaluation
^{19}F isotopes	Conversion of RP into RM	SAMMY Retroactive

^{19}F Resonance Evaluation at ORNL

L. Leal, D. Wiarda, K. Guber, and H. Derrien

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^{19}F Evaluation

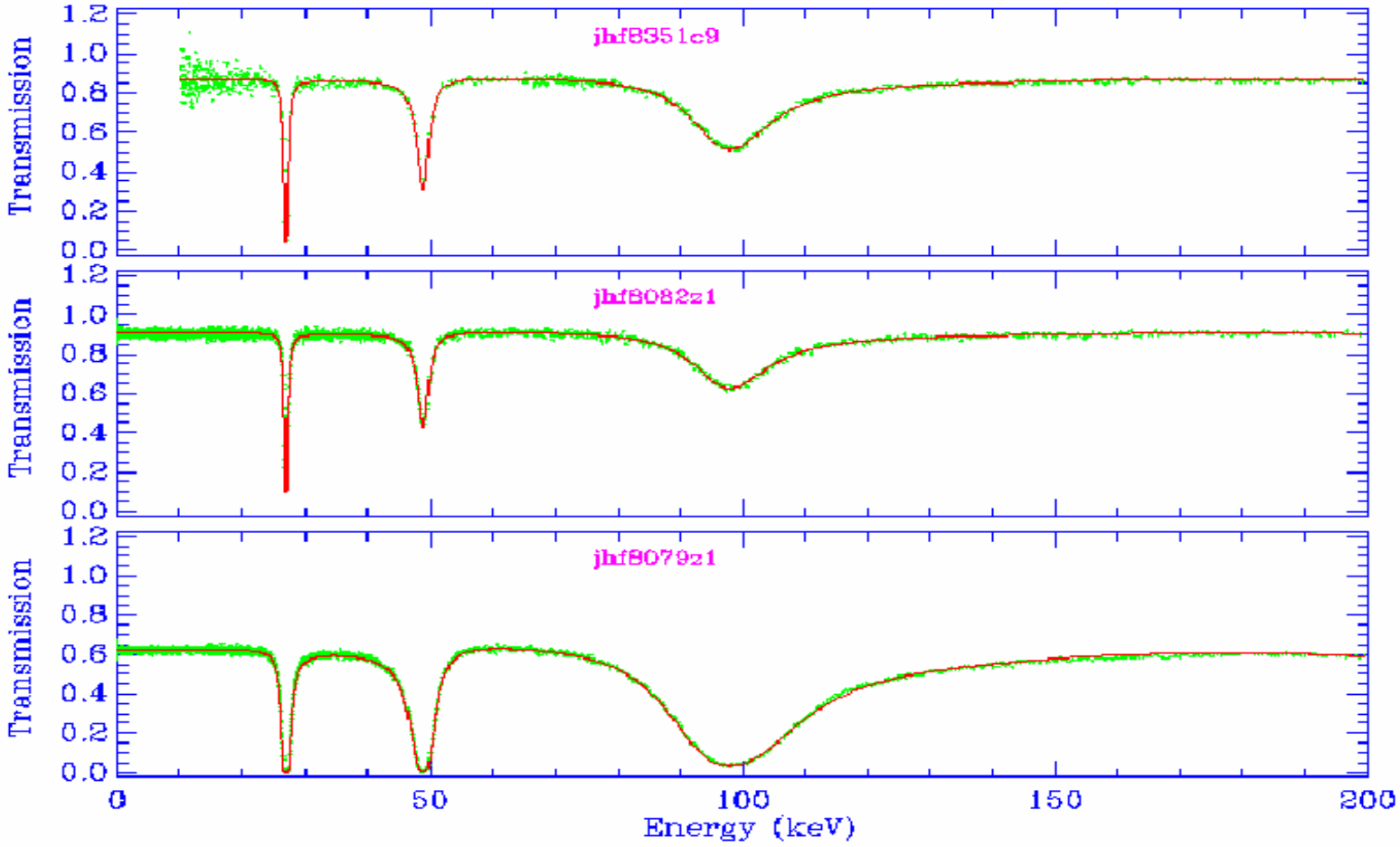
Features:

- **Evaluation performed up to 1 MeV with 2 s-wave, 5 p-wave, 17 d-wave, and 7 f-wave resonance for a total of 31 resonance.**
- **Inelastic Channels: 109.9 ($1/2^-$) keV and 197.2 ($5/2^{+)}$ keV**
- **Reich-Moore formalism was used.**
- **LRF=7 ENDF format used for resonance parameters representation**
- **AMPX (POLIDENT) used to process RM with inelastic channels**
- **Resonance Parameter Covariance generated**

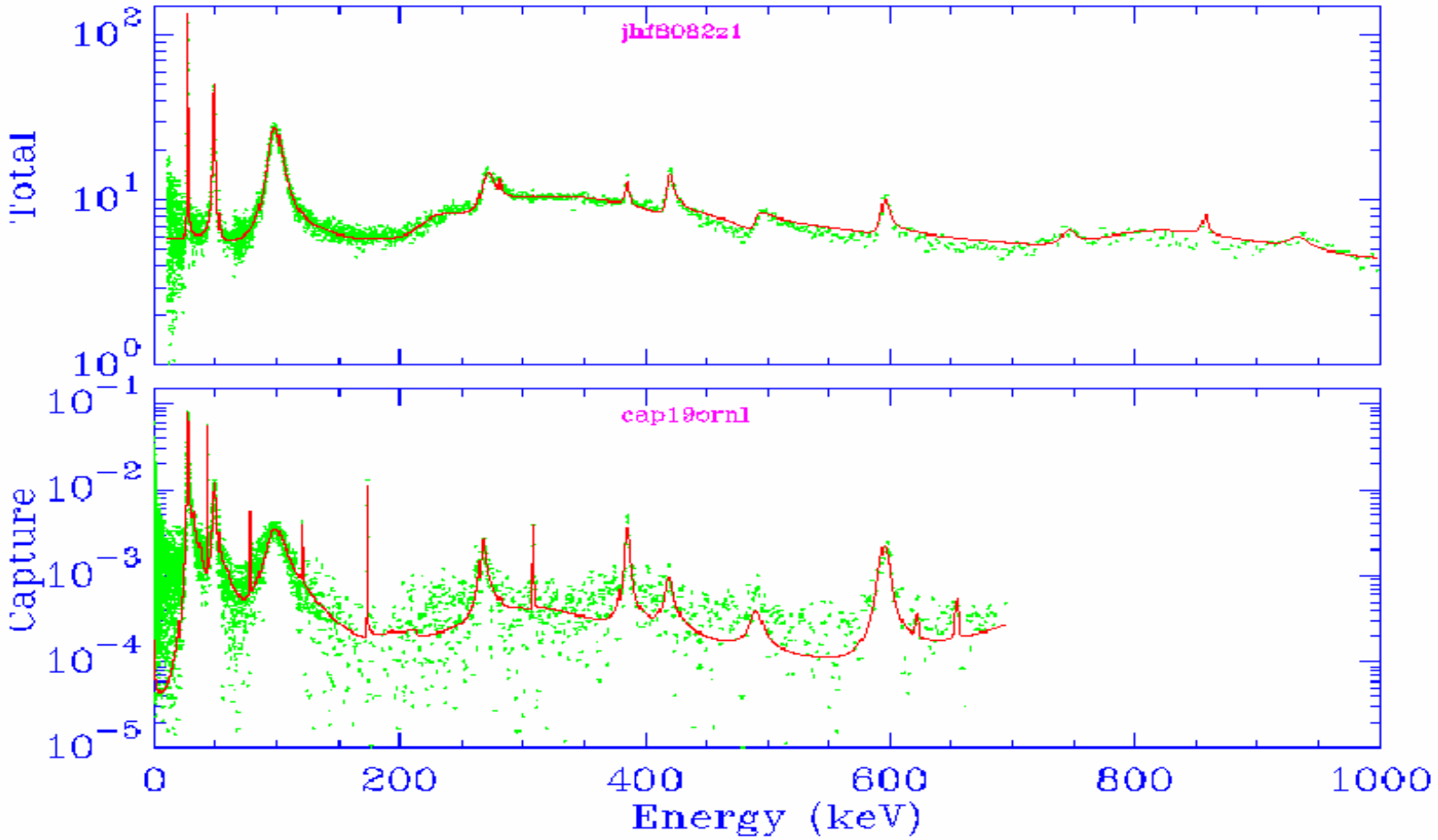
Experimental Data Bank

- **Three Transmission Data Measurements of Larson *et al.* made at ORELA 80 meters flight path with sample thicknesses 0.13093 at/b, 0.016886 at/b, and 0.024184 at/b, respectively in the energy range 5 ev to 20 MeV**
- **One Capture measurement done at ORELA 40 meters flight path performed by Guber *et al.* up to 700 KeV**
- **Inelastic Cross Section Measurements Performed by Broder *et al.* at Obninsk up to 1 MeV**

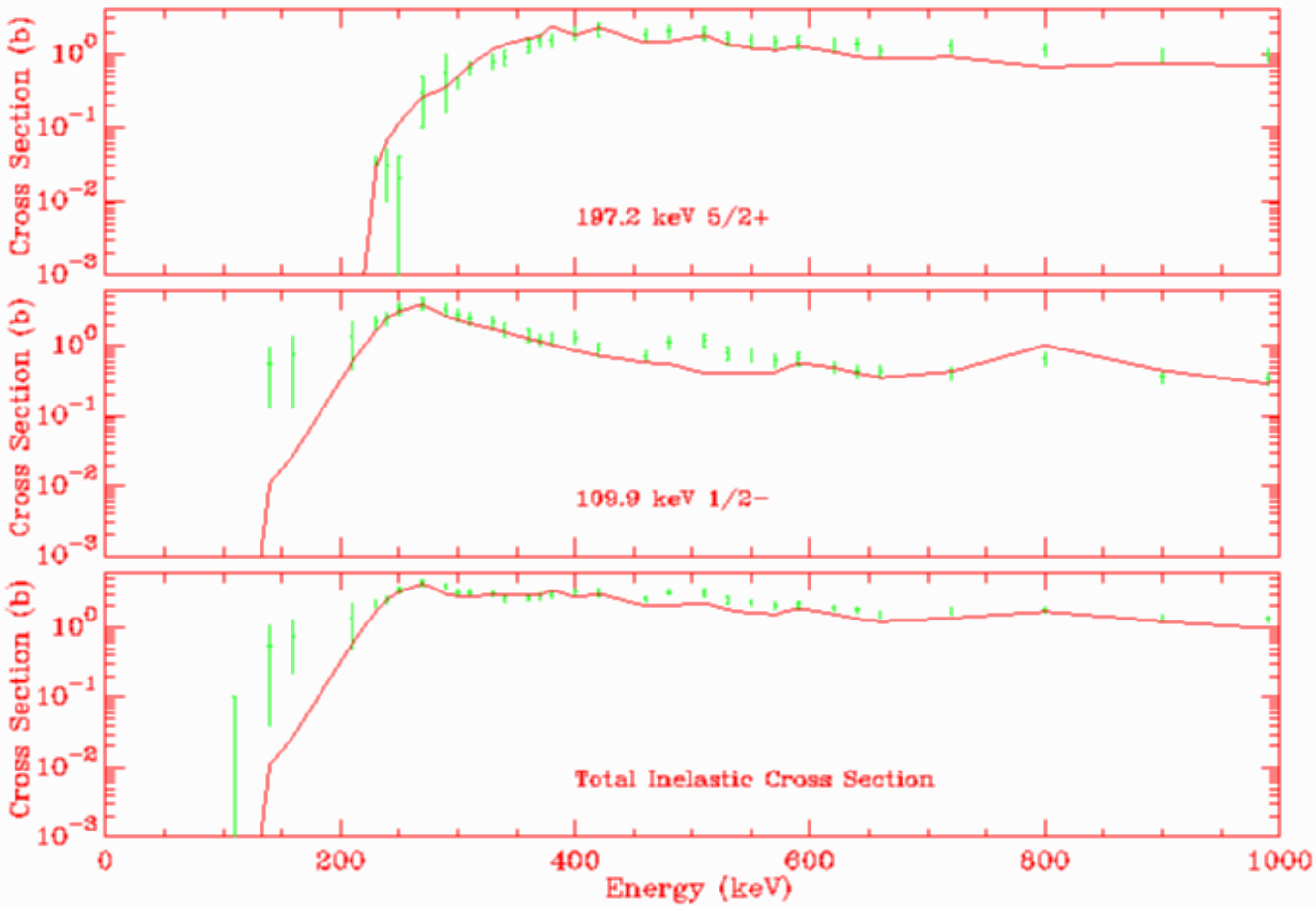
Transmission



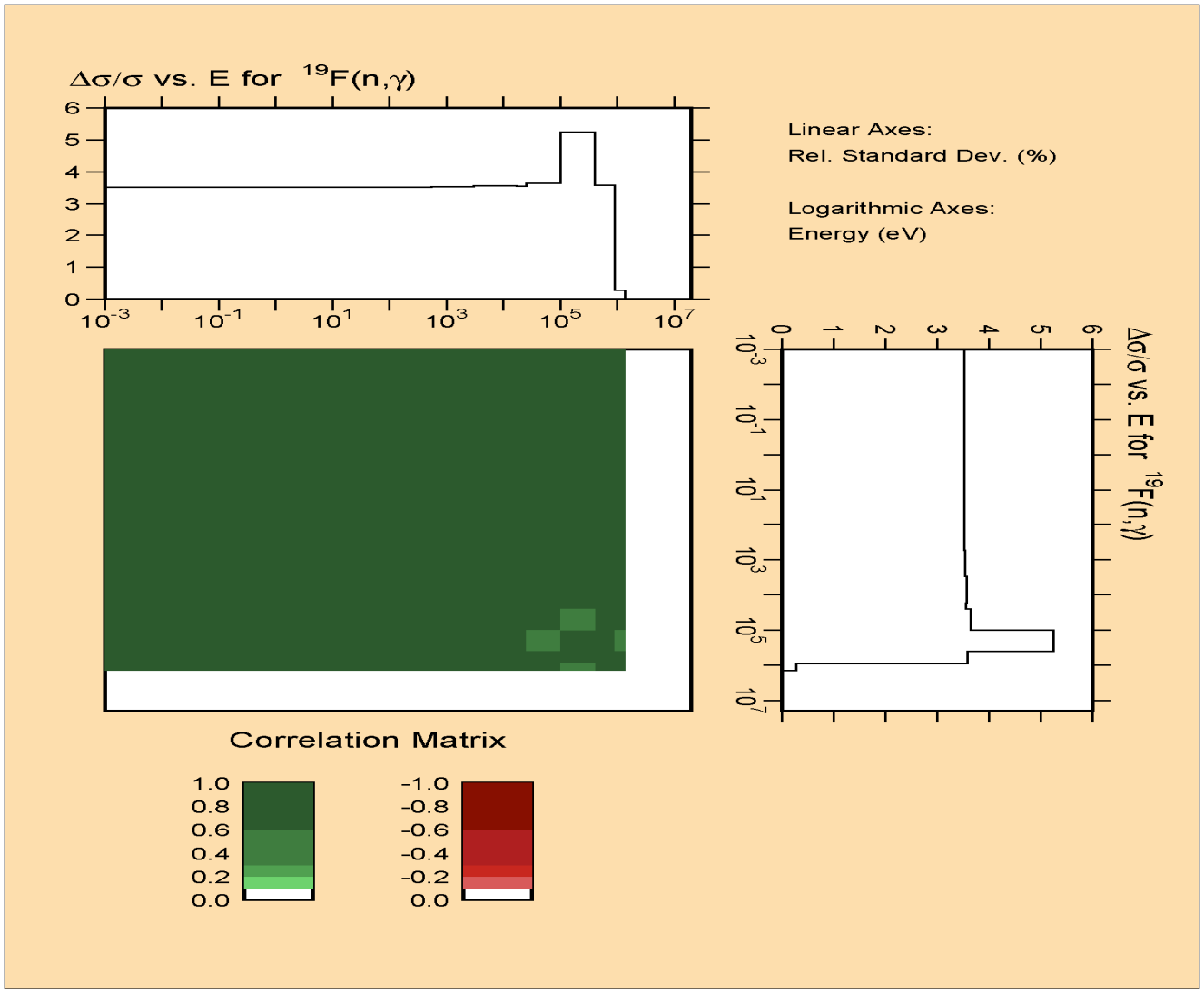
Total and Capture Cross Sections



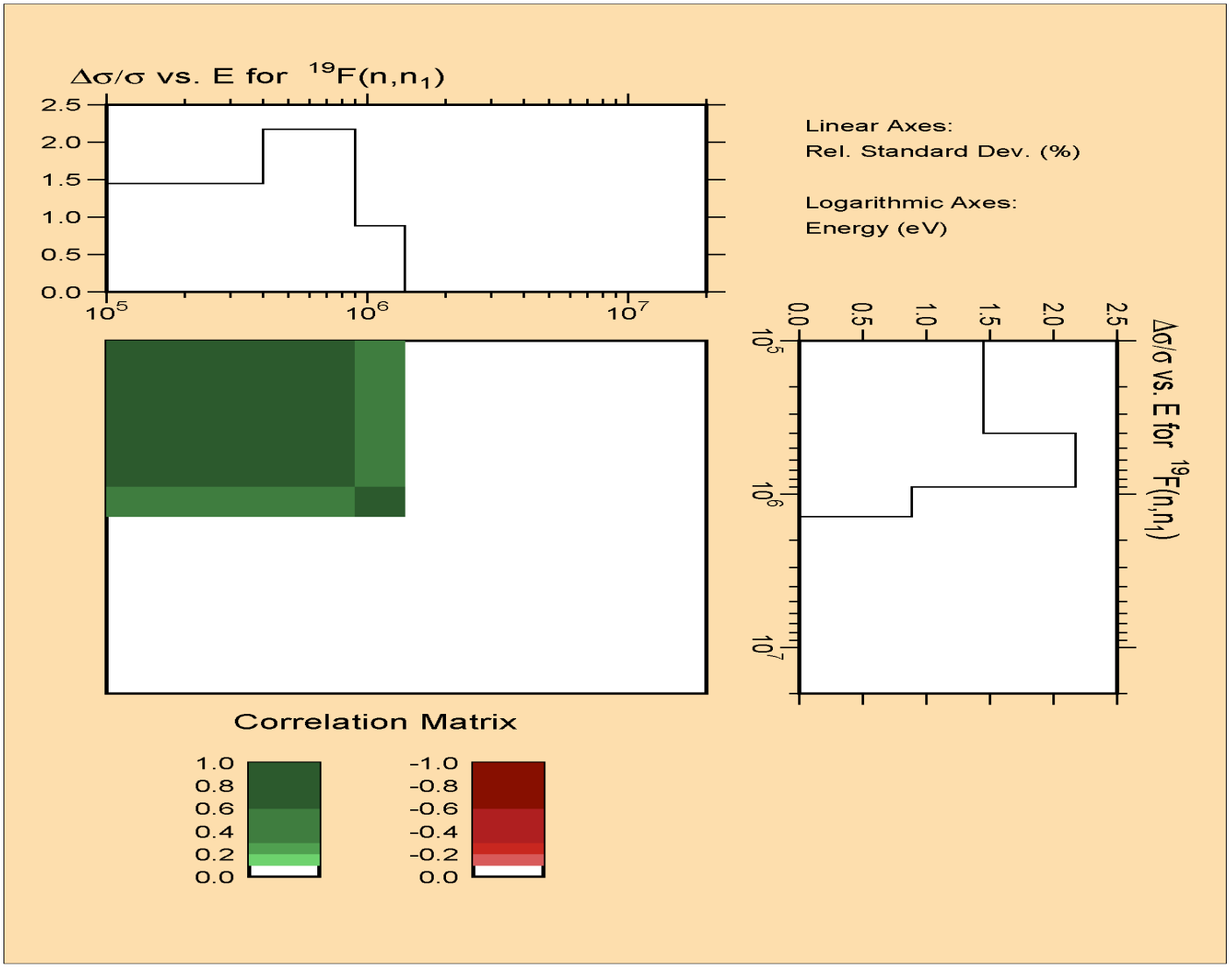
Inelastic Cross Sections



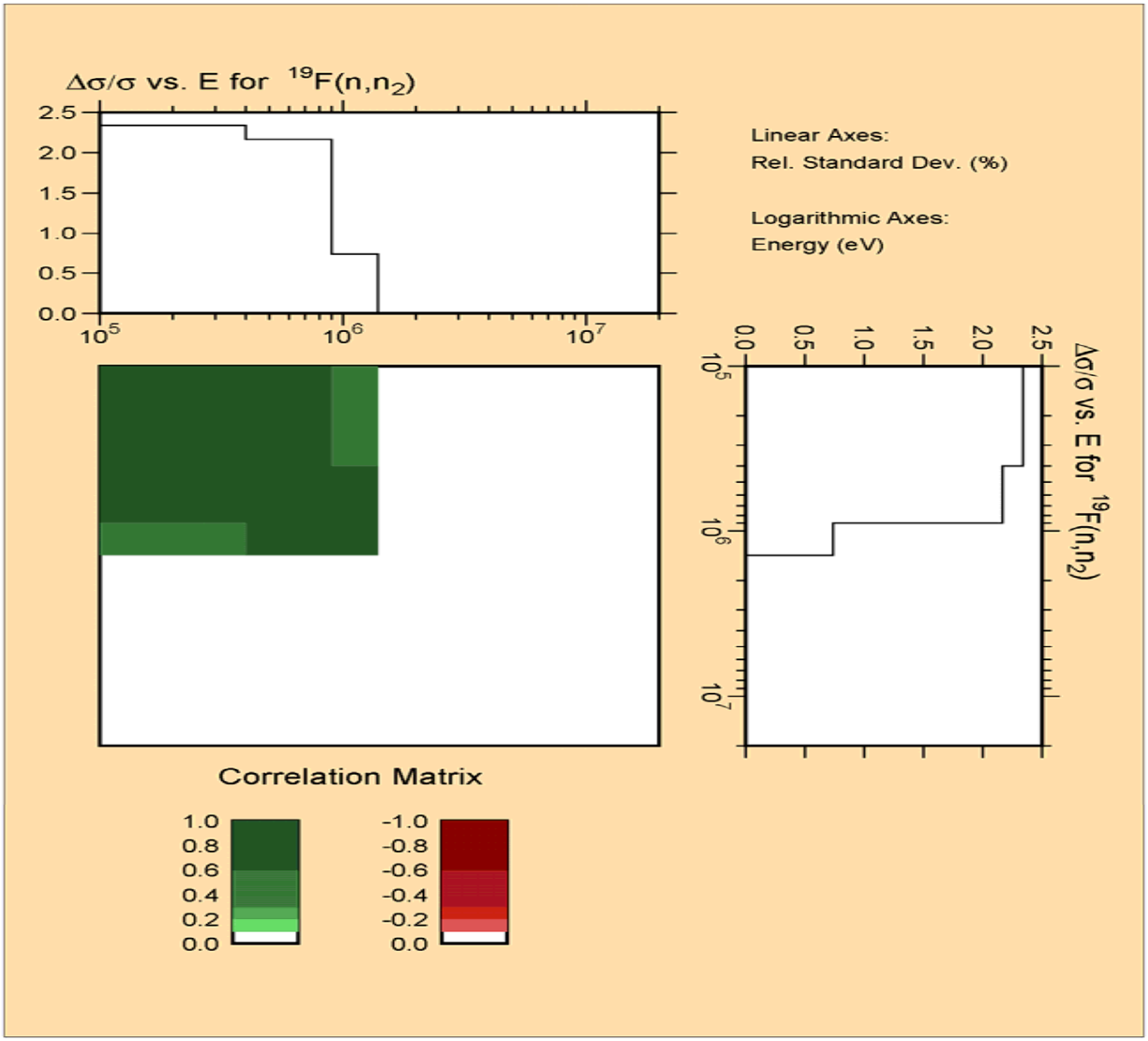
^{19}F Covariance Evaluation



^{19}F Covariance Evaluation



^{19}F Covariance Evaluation



^{48}Ti *Resonance Evaluation at ORNL*

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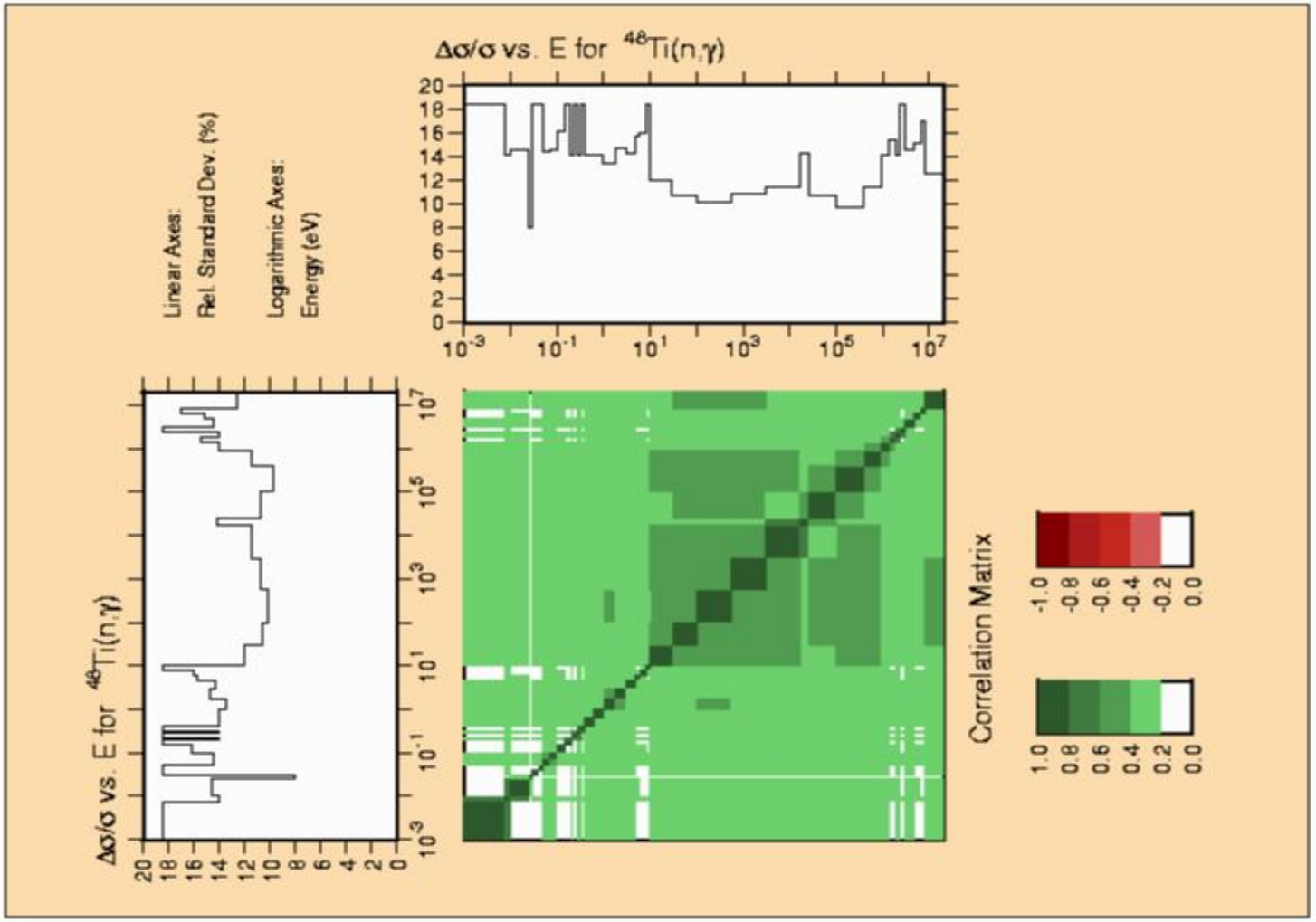
CSEWG, Nov 4-6, 2008

^{48}Ti evaluation

- Address criticality safety of the Actinide Removal Process (ARP) facility at the Savannah River Site
- Monosodium Titanate (MST, $NaHTi_2O_2$) is added to the diluted salt solution to adsorb soluble radionuclides including uranium and plutonium
- Existing ENDF/B-VII.0 Titanium cross sections and uncertainties used in the ARP criticality calculations were investigated
- New uncertainty evaluations were done for Titanium using the ORNL computer code SAMMY

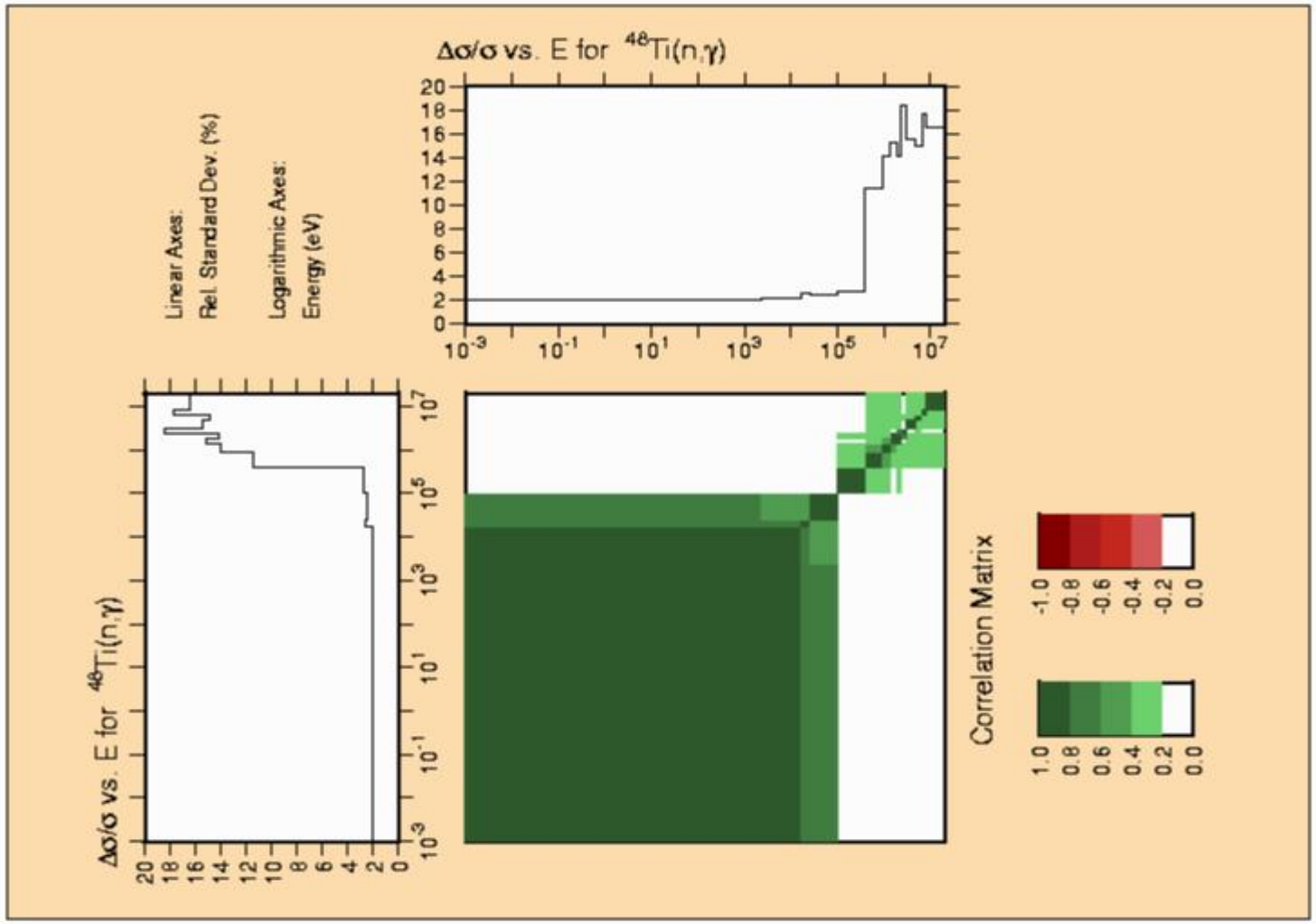
ENDF/B-VII capture covariance data processed with ERRORJ



Titanium Data

Isotope Name	Abundance (%)	σ_γ (thermal)	$\delta\sigma_\gamma / \sigma_\gamma$ (%)
^{46}Ti	8.25	0.59 ± 0.18	30.5
^{47}Ti	7.44	1.63 ± 0.04	2.4
^{48}Ti	73.72	8.32 ± 0.16	1.9
^{49}Ti	5.41	1.87 ± 0.04	2.2
^{50}Ti	5.18	0.18 ± 0.03	16.7

^{48}Ti Covariance Matrix Generated with SAMMY Processed with ERRORJ



^{55}Mn *Resonance Evaluation at ORNL*

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Nuclear Data Group

Oak Ridge National Laboratory

CSEWG, Nov 4-6, 2008

^{55}Mn Resonance Evaluation
Status of the analysis of recent neutron transmission and capture cross sections in the energy range below 120 keV

- **Experimental data base**

  New Data:

  ORELA neutron transmission, Harvey et al. 1988

  GELINA neutron capture, Shillebeeckx et al. 2006

  ORELA neutron capture, Guber et al. 2007

  Old data for evaluation in thermal range:

  Total cross section, Rainwater et al. 1947

  Total cross sections, Cote et al. 1964

  Capture cross section, Widder et al. 1975

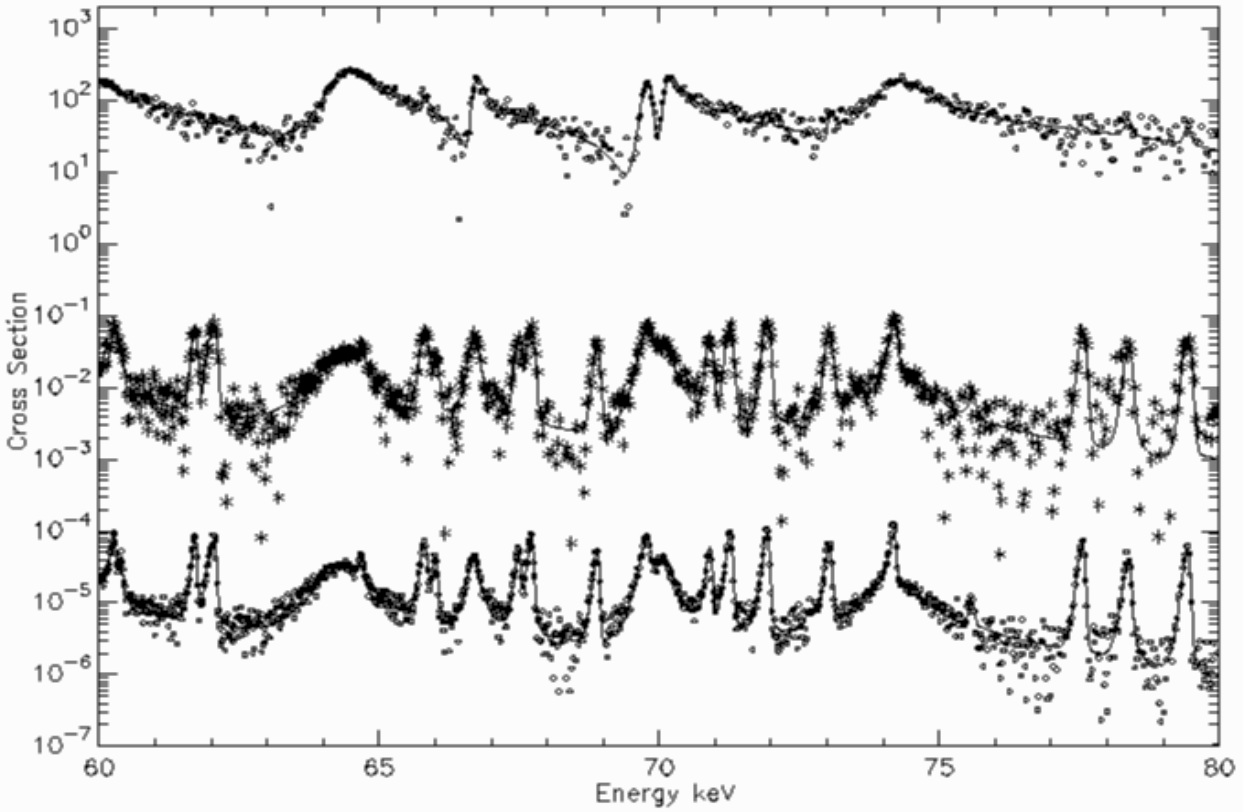
  Correction applied to the data from preliminary SAMMY analysis:

  Residual background between resonances in ORELA and GELINA capture data

  Part could be due to d-wave contribution and to direct capture

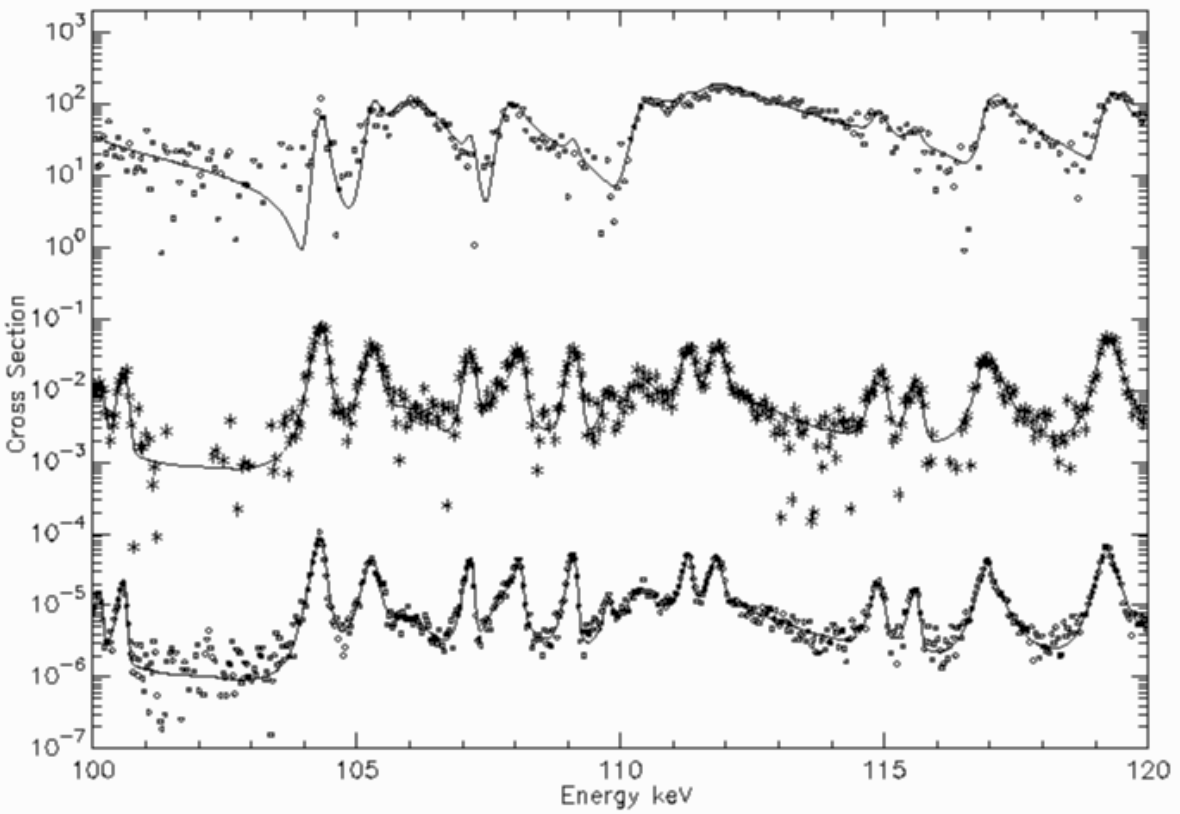
  Under investigation

SAMMY fit of ORELA total (upper), ORELA capture (middle) and GELINA capture (lower) cross section from 60 keV to 80 keV

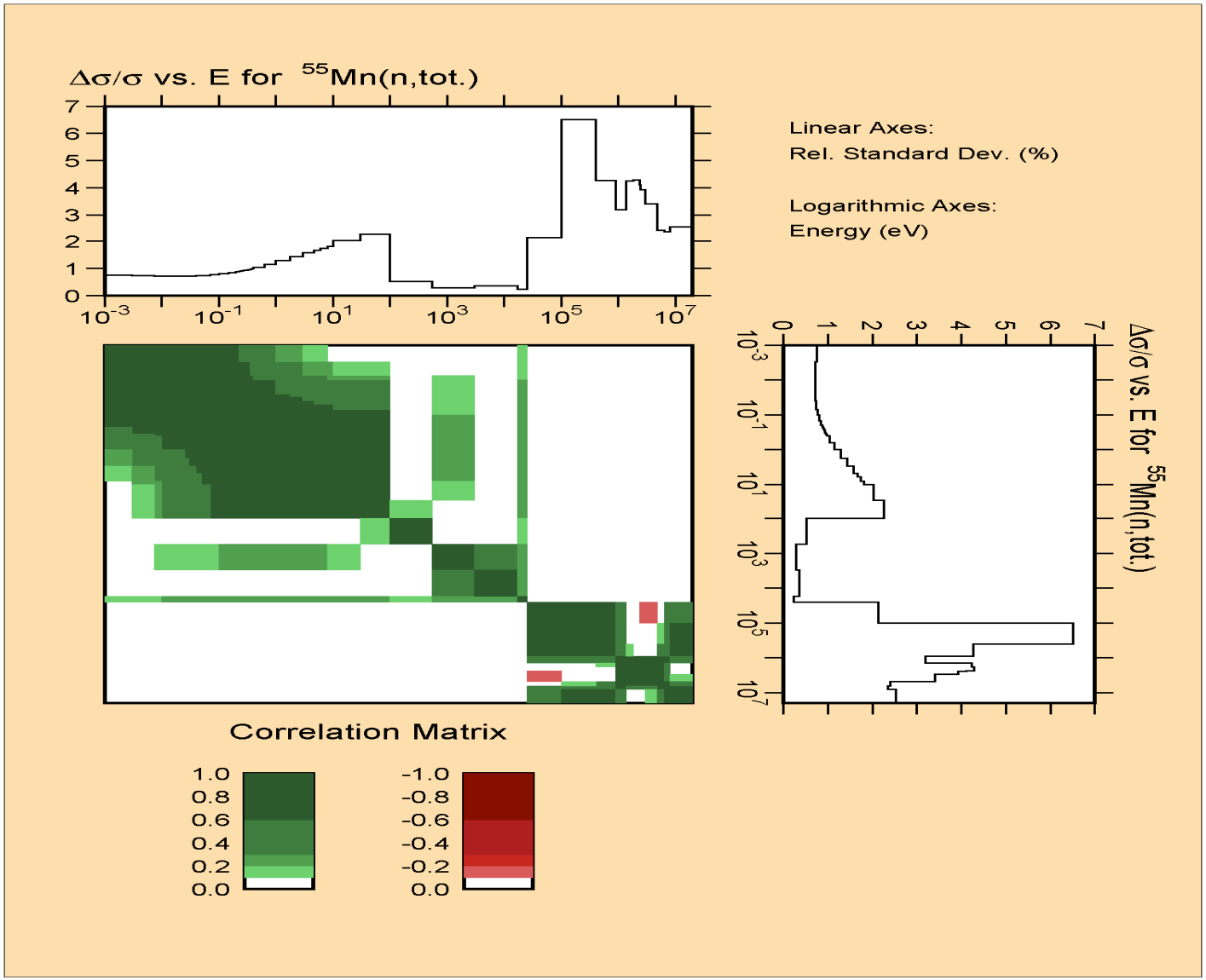


paradigm shift

SAMMY fit of ORELA total (upper), ORELA capture (middle) and GELINA capture (lower) cross section from 100 keV to 120 keV



44-group covariance processed with PUFF-IV for the total



^{35,37}Cl Resonance Evaluation at ORNL

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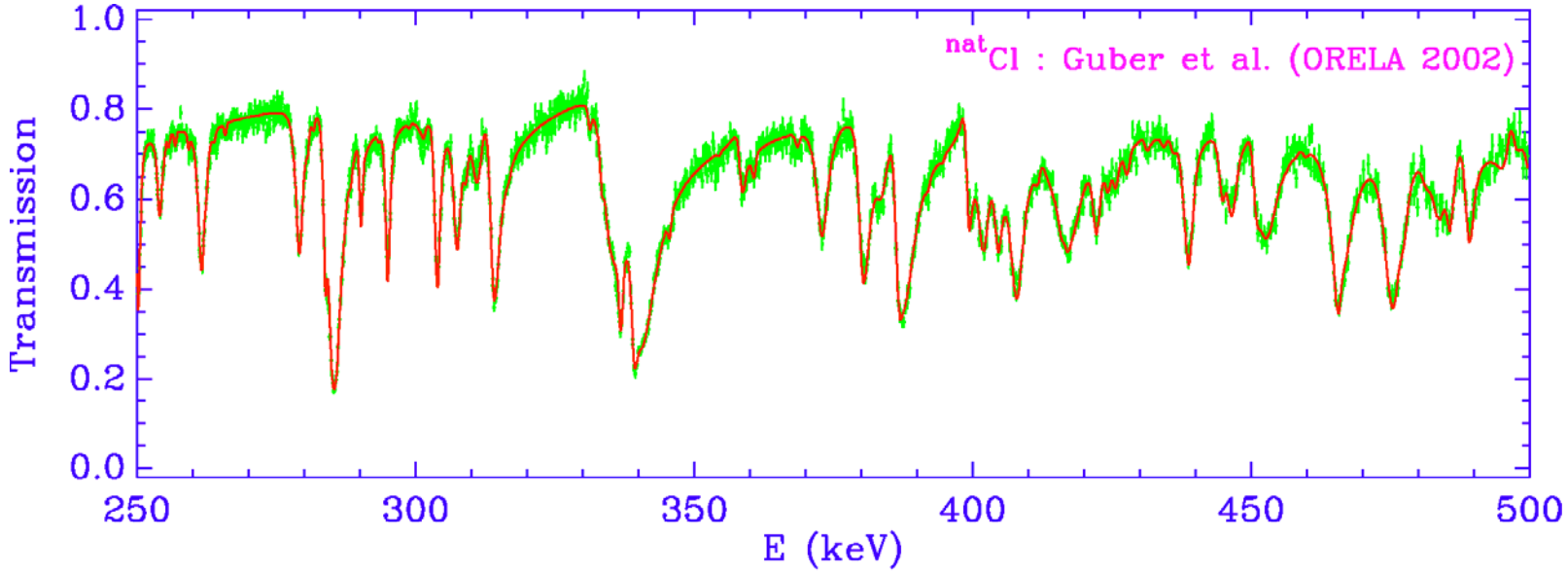
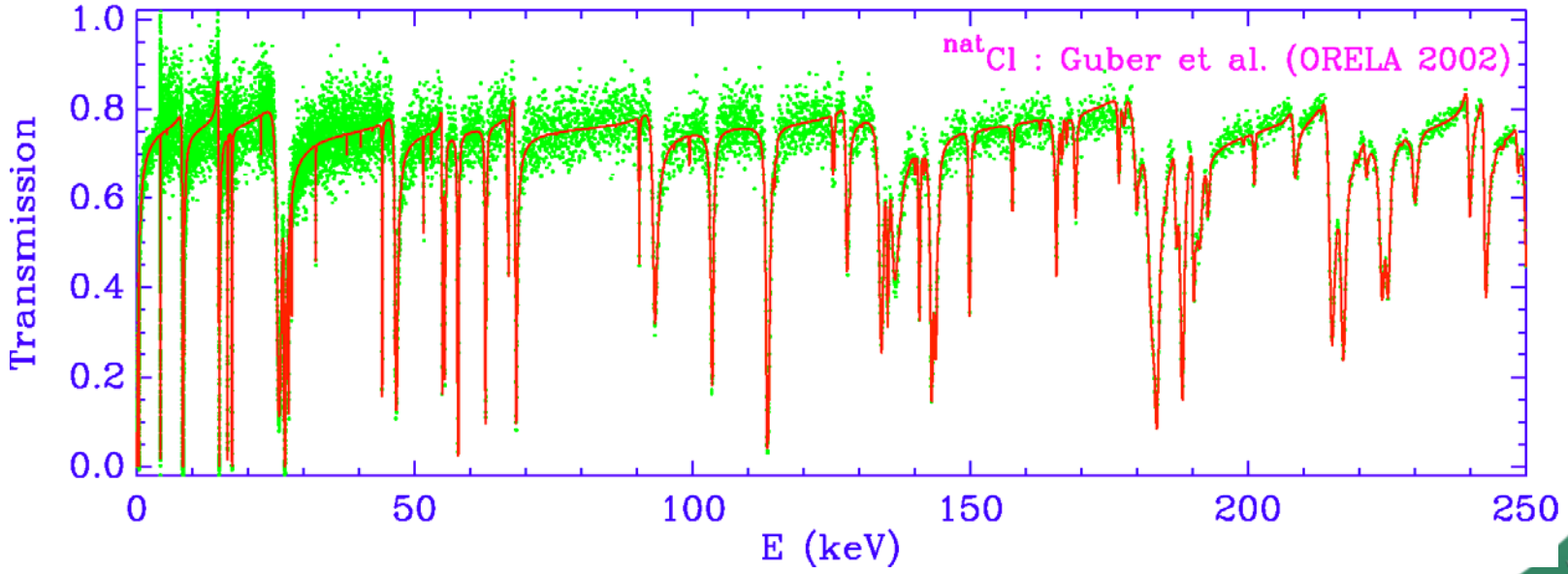
CSEWG, Nov 4-6, 2008

^{35,37}Cl Resonance Parameter and Covariances

- File 32 generated for 10^{-5} eV to 1.2 MeV. (RADCOP code)
- ^{35}Cl : Proton exit channel taken into account: LRF = 7
- ^{37}Cl : LRF = 3, LCOMP = 1 (expanded format).
- Uncertainties and correlations verified against master SAMMY covariance (binary) file.
- 44- and 238-group uncertainties from PUFF-IV and SAMMY agree.
- Complete ENDF files submitted to NNDC.

SAMMY fit of the ORNL Transmission data for Natural Cl





^{50,52,53,54}Cr Resonance Evaluation at ORNL

L. Leal and H. Derrien

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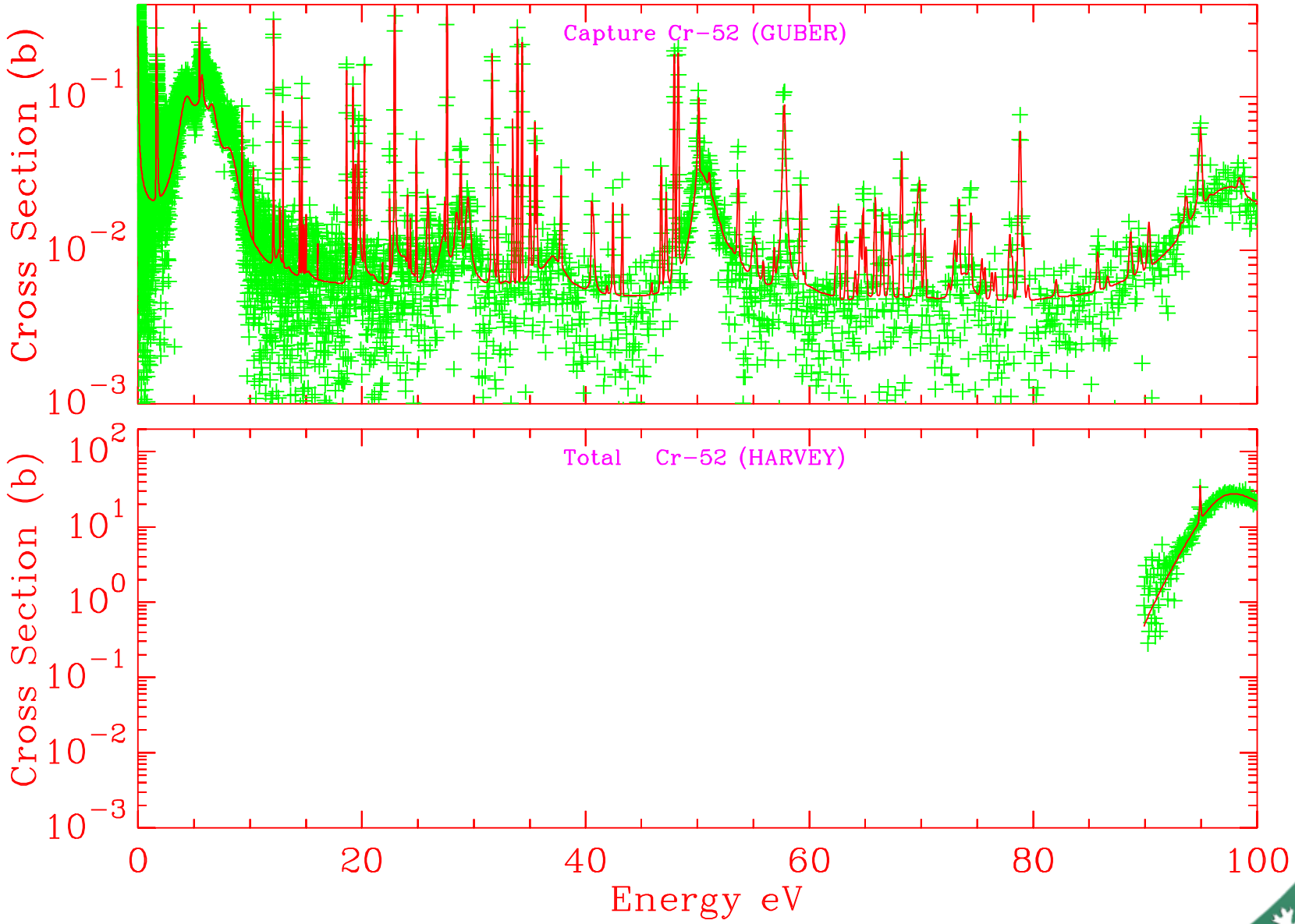
Oak Ridge National Laboratory

CSEWG, Nov 4-6, 2008

Cr isotope evaluation

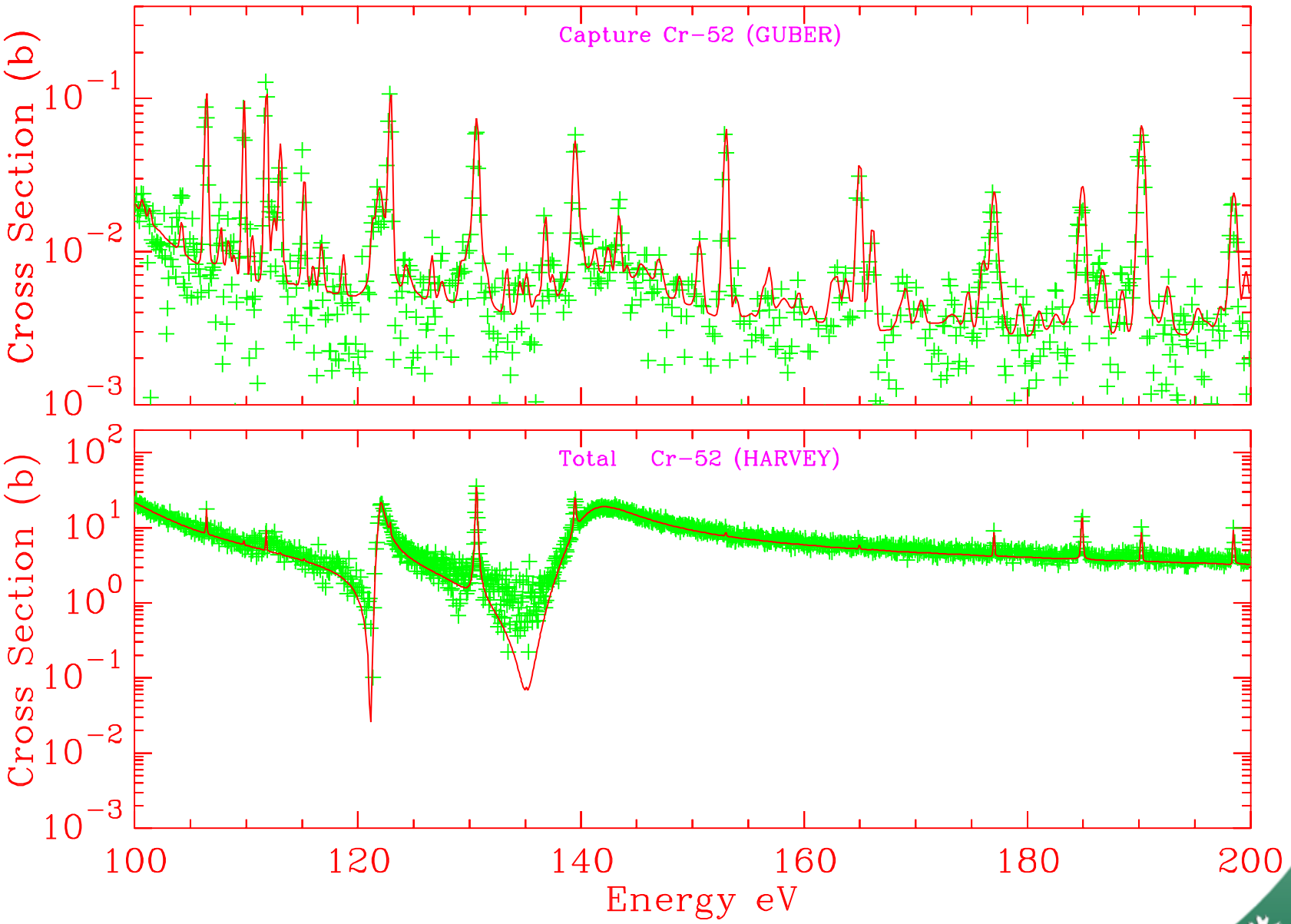
- Transmission and capture cross section measurements done at ORELA for ^{53}Cr and natural Cr for energy below 500 keV (Guber);
- Early high resolution transmission measurements done by Harvey at ORELA above 100 keV for all Cr isotopes;
- Evaluation performed with SAMMY;
- Preliminary resolved resonance parameters determined for all Cr isotopes;

^{52}Cr Resonance Evaluation



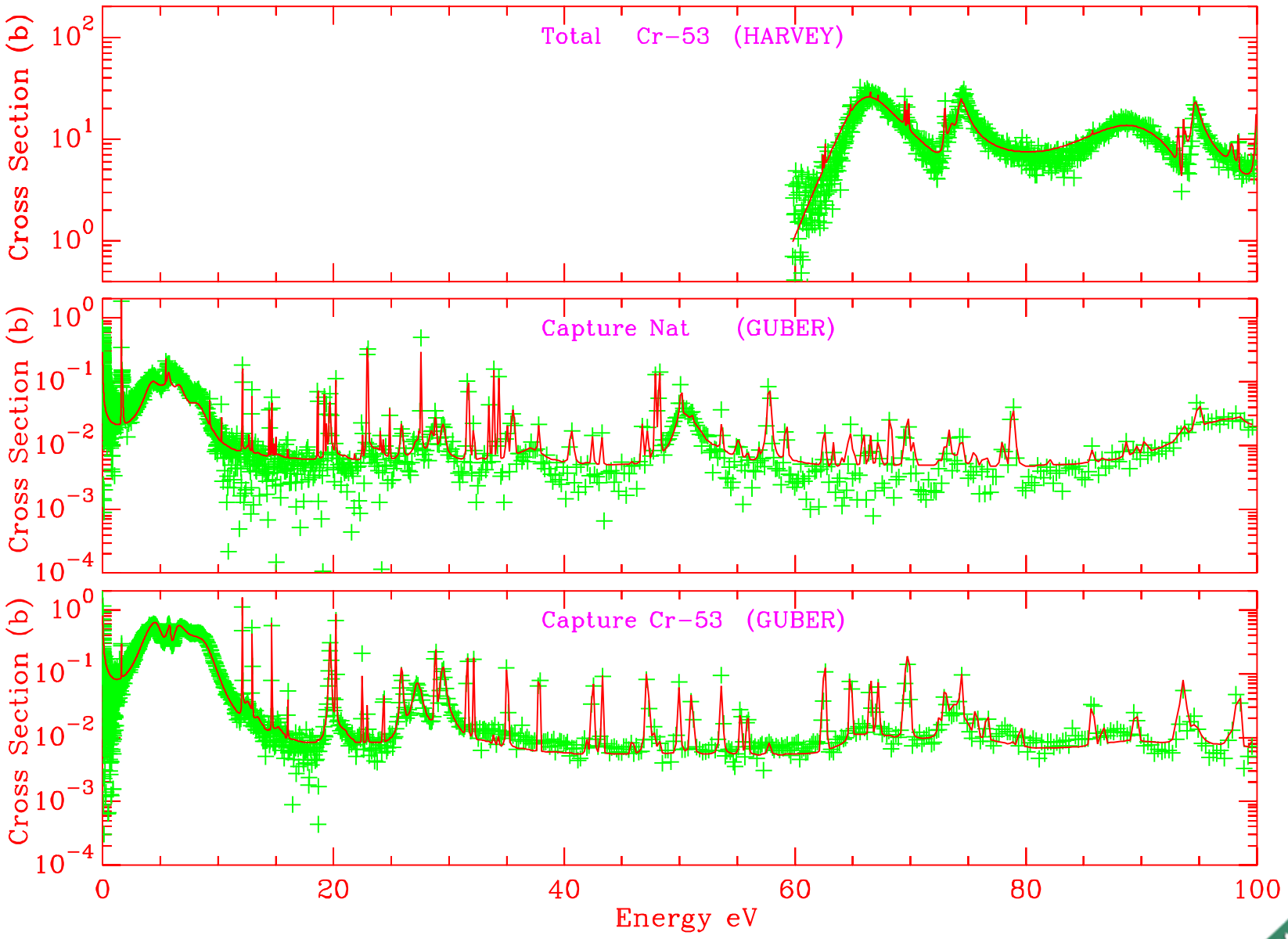
paradigm shift

^{52}Cr Resonance Evaluation

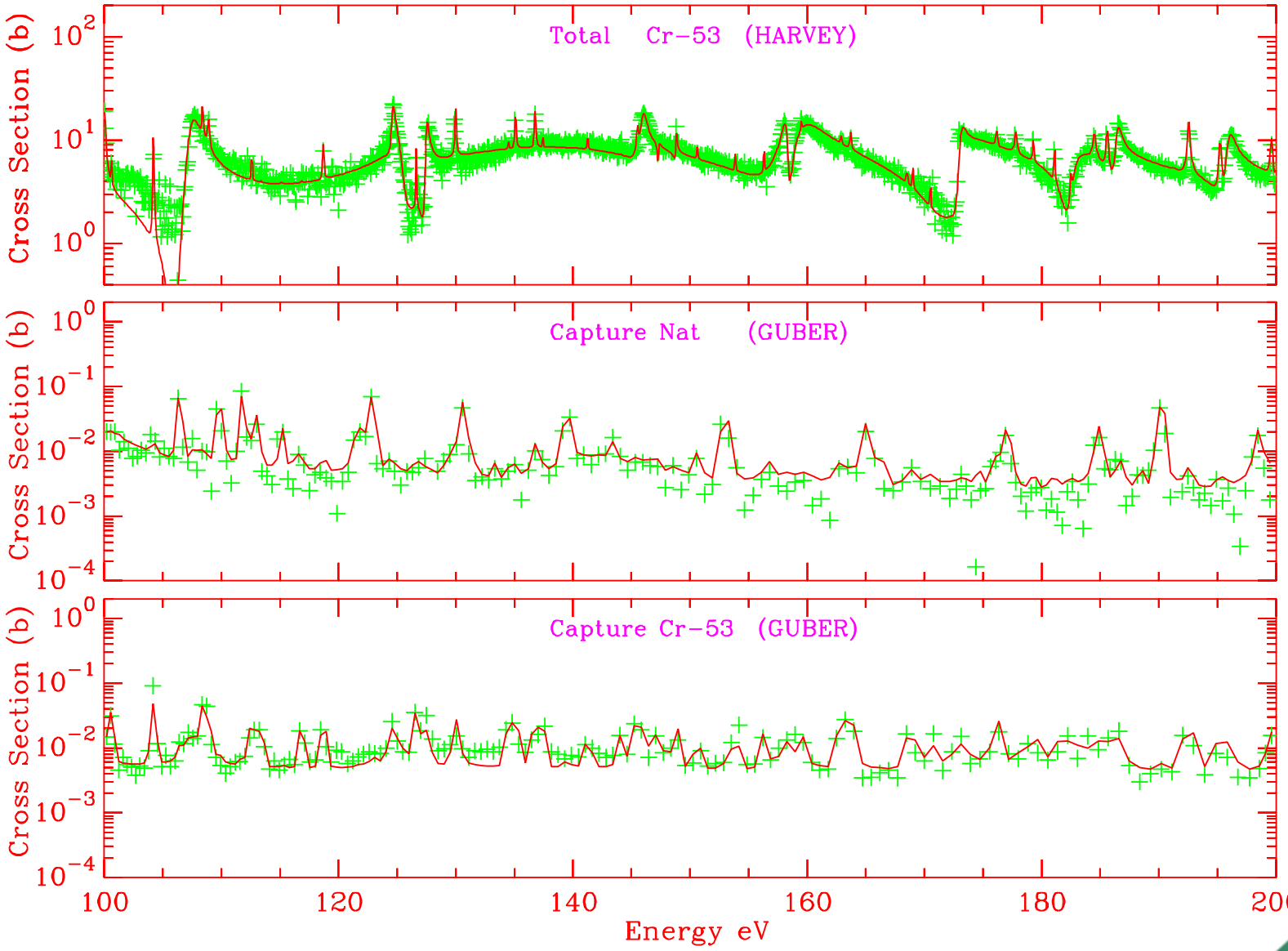


paradigm shift

^{53}Cr Resonance Evaluation



^{53}Cr Resonance Evaluation



^{60}Ni Resonance Evaluation at ORNL

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Oak Ridge National Laboratory

CSEWG, Nov 4-6, 2008

Motivation for a New Evaluation

- New capture measurements available from ORELA;
- Possibility of extending the resolved energy range up to 800 keV from the analysis of Brusegan very resolution transmission measurement;
- Need for cross section accuracy improvement for criticality safety purpose;
- Inclusion of parameter covariance

paradigm shift

EXPERIMENTAL DATA BASE

- New ORELA capture cross section measurement in the neutron energy range 10 eV to 700 keV by Guber et al.(2008). TOF at 40 m;
- GELINA very high resolution transmission measurement in the neutron energy range from 500 keV by Brusegan et al.(1994); results of REFIT analysis published by Brusegan et al. at Gatlinburg Conference. TOF at 350 m;
- ORELA high resolution transmission measurements by Harvey et al.(1975-1980) analyzed by Perey et al.(1982); resonance parameters used for ENDF/B-VI in the energy range up to 450 keV. TOF at 80 m; Li-glass detector and NE-110 detector;
- New value of the thermal capture cross section measured by Raman et al. and published in 2004 (Phys. Rev. C 70, 044318)

SAMMY ANALYSIS OF THE EXPERIMENTAL DATA

- Bayes sequential fit of:
  - Harvey et al. transmission, n=0.0293 at/b, 10 eV to 150 keV
  - Harvey et al. transmission, n=0.0837 at/b, 10 eV t0 150 keV
  - Harvey et al. transmission, n=0.0744 at/b, 20 keV to 800 keV
  - Brusegan et al. transmission, n=0.0744 at/b, 500 keV to 800 keV
  - Guber et al. capture, 5 eV to 700 keV.
- About 150000 experimental data points
  Preliminary results: global χ^2 1.22

paradigm shift

SOME PRELIMINARY RESULTS

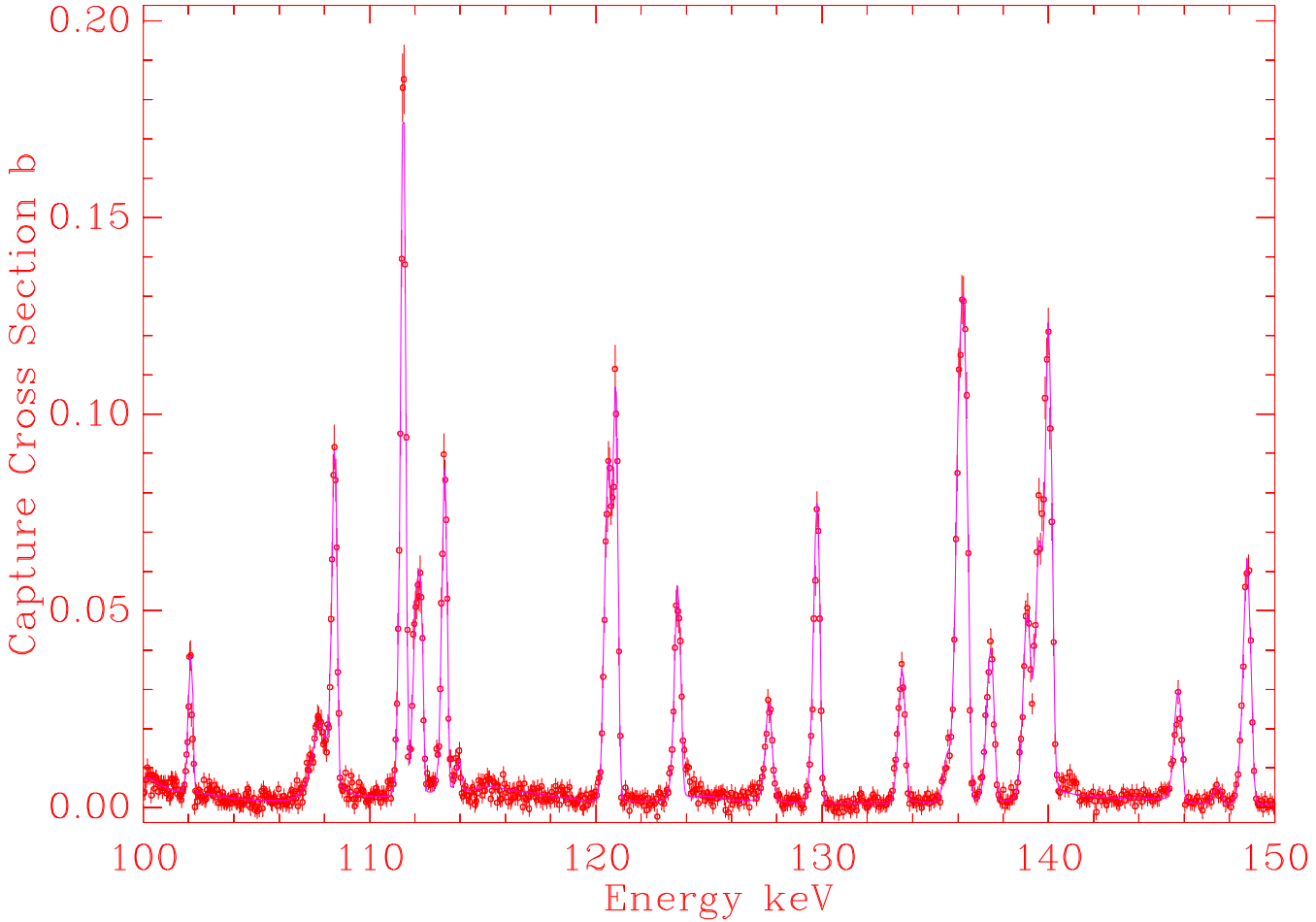
- 456 resonances in the energy range 0 to 800 keV
  - 60 s-wave resonances
  - 396 p- and d- wave resonances
- Tentative of identification the p- and d-wave resonances in the energy range 0 to 450 keV:
  - s-wave 30 resonances S0 = 2.42x10-4 $\langle\Gamma\gamma\rangle$ = 1118 meV
  - p-wave 118 resonances S1 = 0.632x10-4 $\langle\Gamma\gamma\rangle$ = 679 meV
  - d-wave 113 resonances S2 = 0.889x10-4 $\langle\Gamma\gamma\rangle$ = 586 meV

Comparison between the average capture cross sections calculated from the present resonance parameters and those from ENDF/B-VII. A decrease of the cross section is observed.

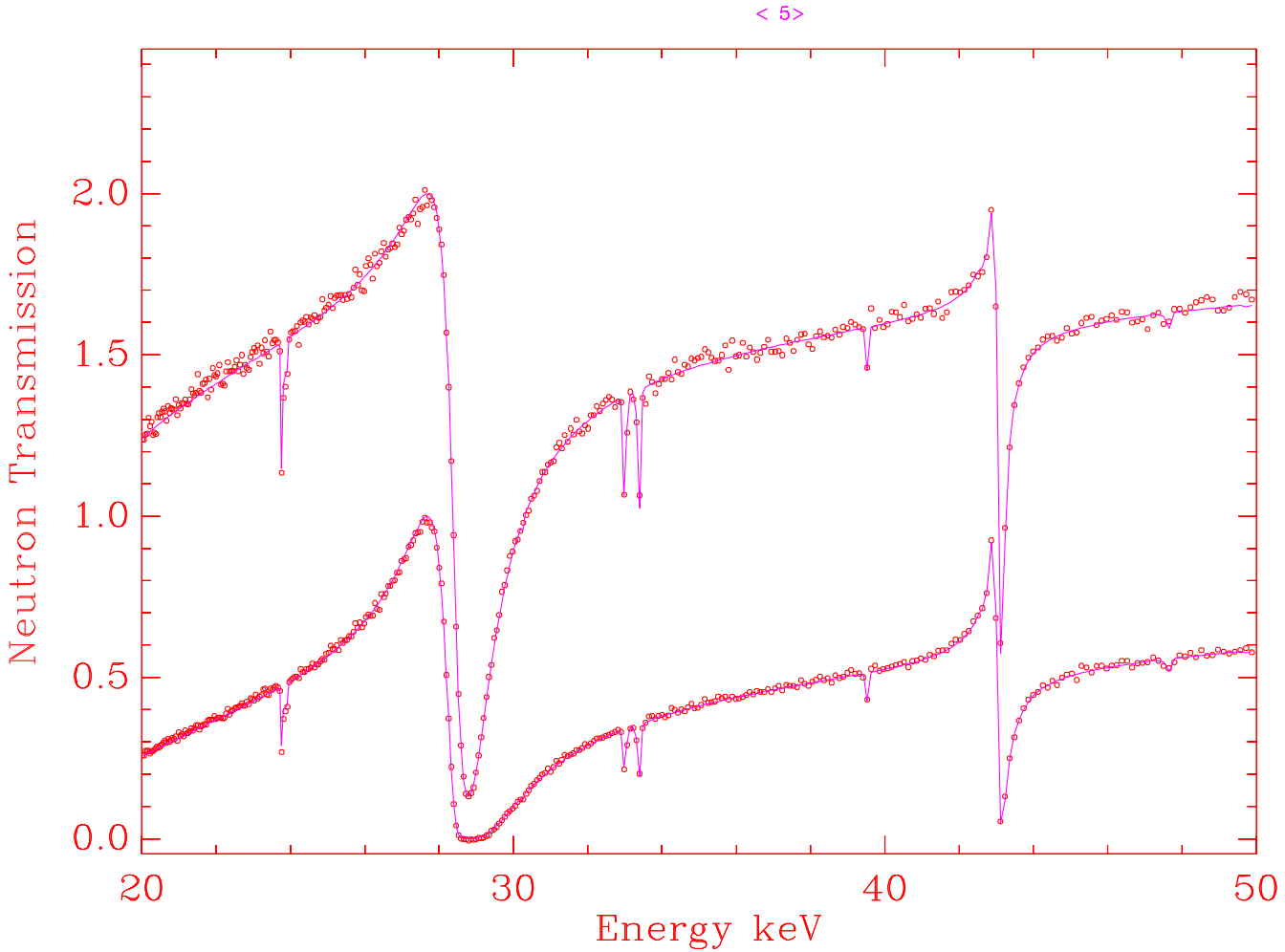
Average Capture Cross Sections from B7 and from the ORNL evaluation (Preliminary results)

Enegy Range (keV)	ENDF/B-VII.0 (mb)	ORNL (mb)	Deviation (%)
0.010 – 0.10	61.07	52.22	17
0.1 – 1.00	17.62	14.65	20
1.00 – 5.0	34.79	33.53	4
5.0 – 20.0	68.33	70.40	-3
20.0 – 27.0	23.71	22.56	5
27.0 – 38.0	26.76	21.56	24
38.0 – 47.0	17.08	15.75	9
47.0 – 70.0	17.17	14.98	15
70.0 – 100.0	15.47	13.31	16
100.0 – 150.0	14.23	12.45	14
150.0 – 200.0	11.58	8.62	34
200.0 – 250.0	9.58	8.02	20
250.0 – 300.0	9.56	8.65	10
300.0 – 350.0	11.28	9.83	15
350.0 – 400.0	10.37	8.28	25
400.0 – 450.0	8.84	8.07	9

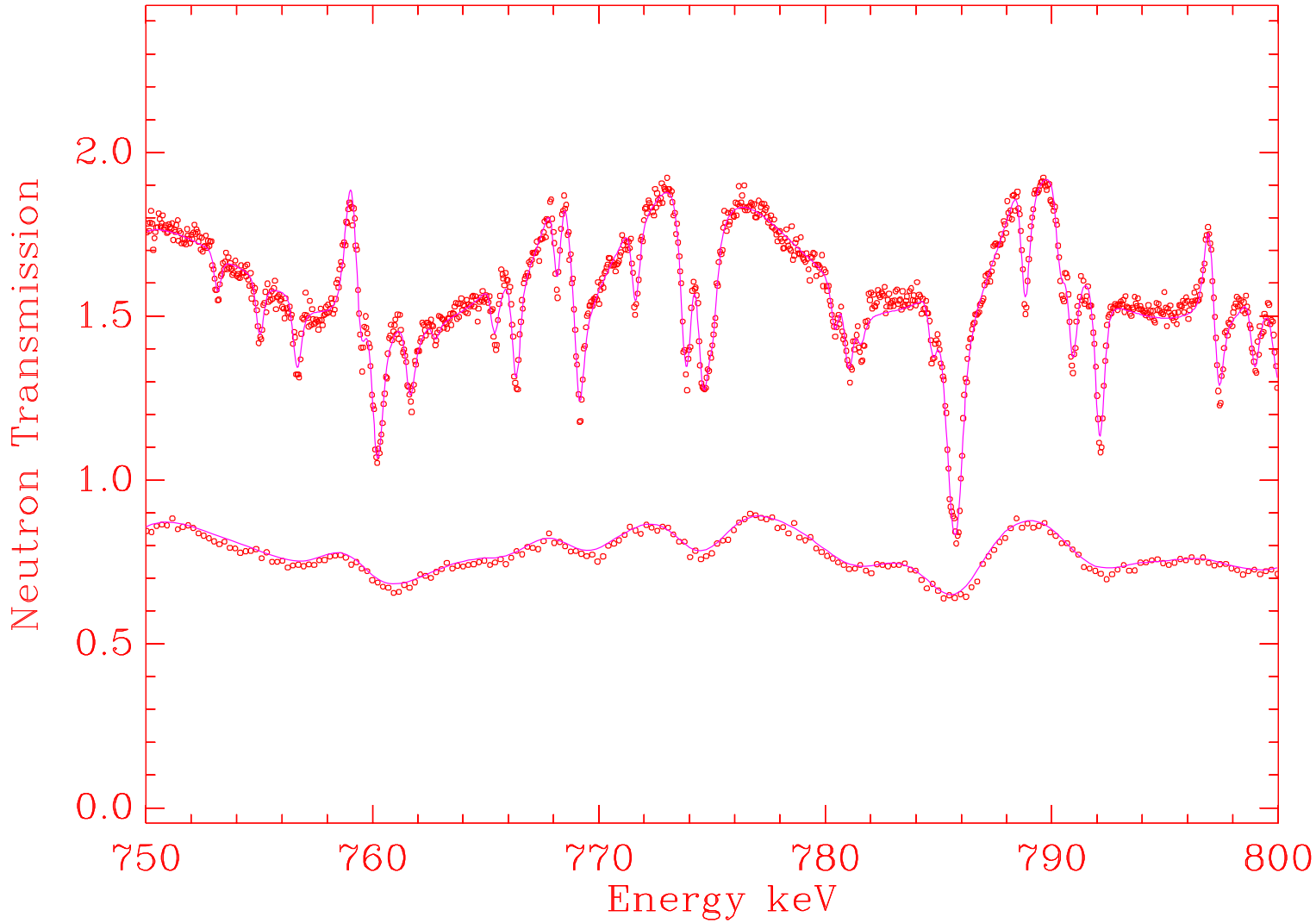
^{60}Ni Resonance Evaluation



^{60}Ni Resonance Evaluation



^{60}Ni Resonance Evaluation



paradigm shift

Tungsten "Resonance Evaluation"

Luiz Leal
Herve Derrien
Roberto Capote
Ivo Kodeli
Andre Trkov

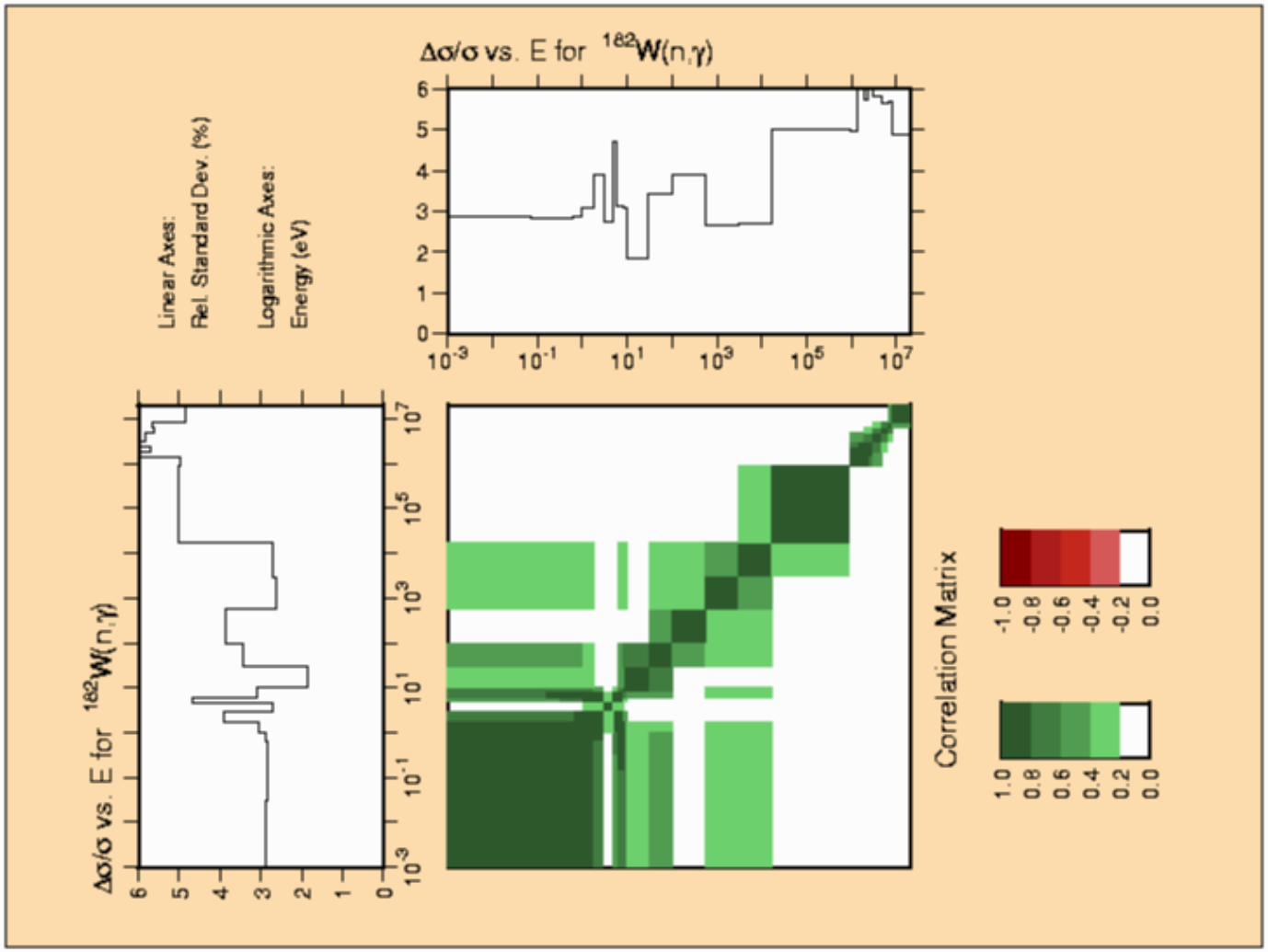
Oak Ridge National Laboratory

CSEWG, Nov 4-6, 2008

^{182}W

	ENDF	NEW	Mughabghab
RRR	$10^{-5} – 4.5 \times 10^{3}$ (MLBW)	$10^{-5} – 1.2 \times 10^{4}$ (RM)	-
σ_0	20.55	20.71	19.9 ± 0.3
I_γ	597.16	628.33	600 ± 60

^{182}W Covariance

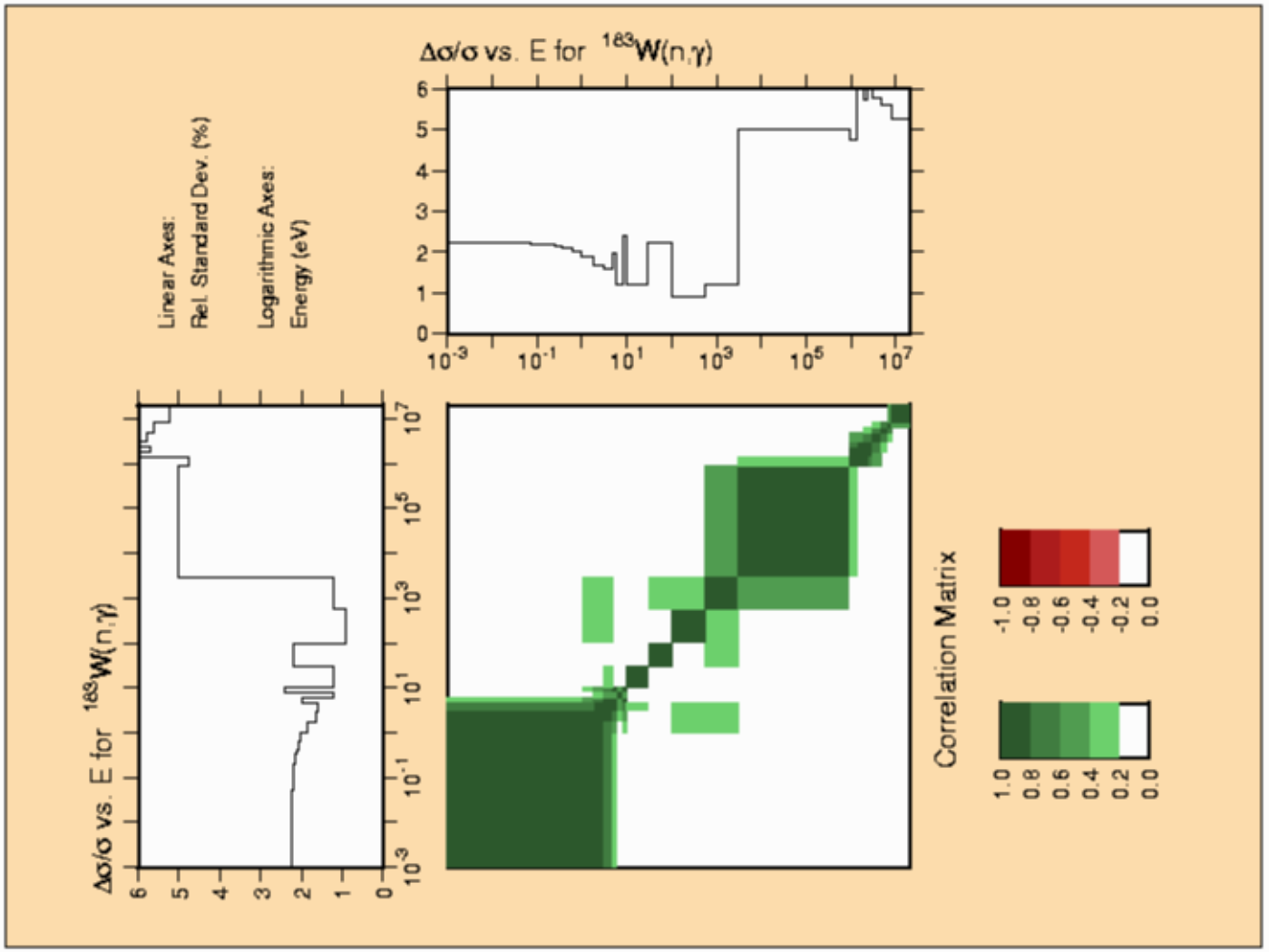


^{183}W

	ENDF	NEW	Mughabghab
RRR	$10^{-5} – 7.65 \times 10^{2}$ (MLBW)	$10^{-5} – 2.2 \times 10^{3}$ (RM)	-
σ_0	10.01	10.11	10.4 ± 0.2
I_γ	356.32	334.73	355 ± 30

paradigm shift

^{183}W Covariance

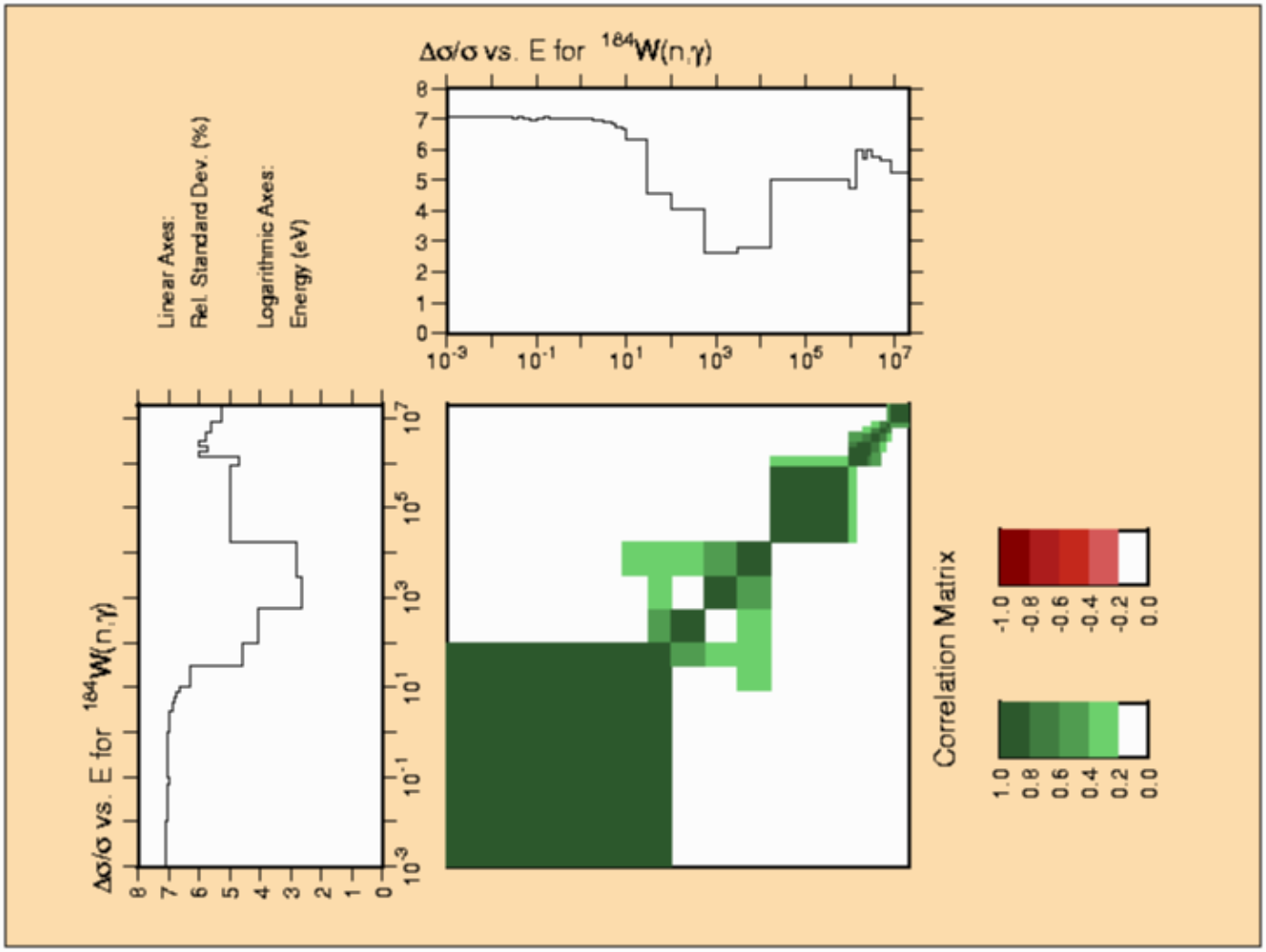


^{184}W

	ENDF	NEW	Mughabghab
RRR	$10^{-5} – 2.65 \times 10^{3}$ (MLBW)	$10^{-5} – 1.5 \times 10^{4}$ (RM)	-
σ_0	1.75	1.70	1.7 ± 0.1
I_γ	16.56	16.22	14.7 ± 1.5

paradigm shift

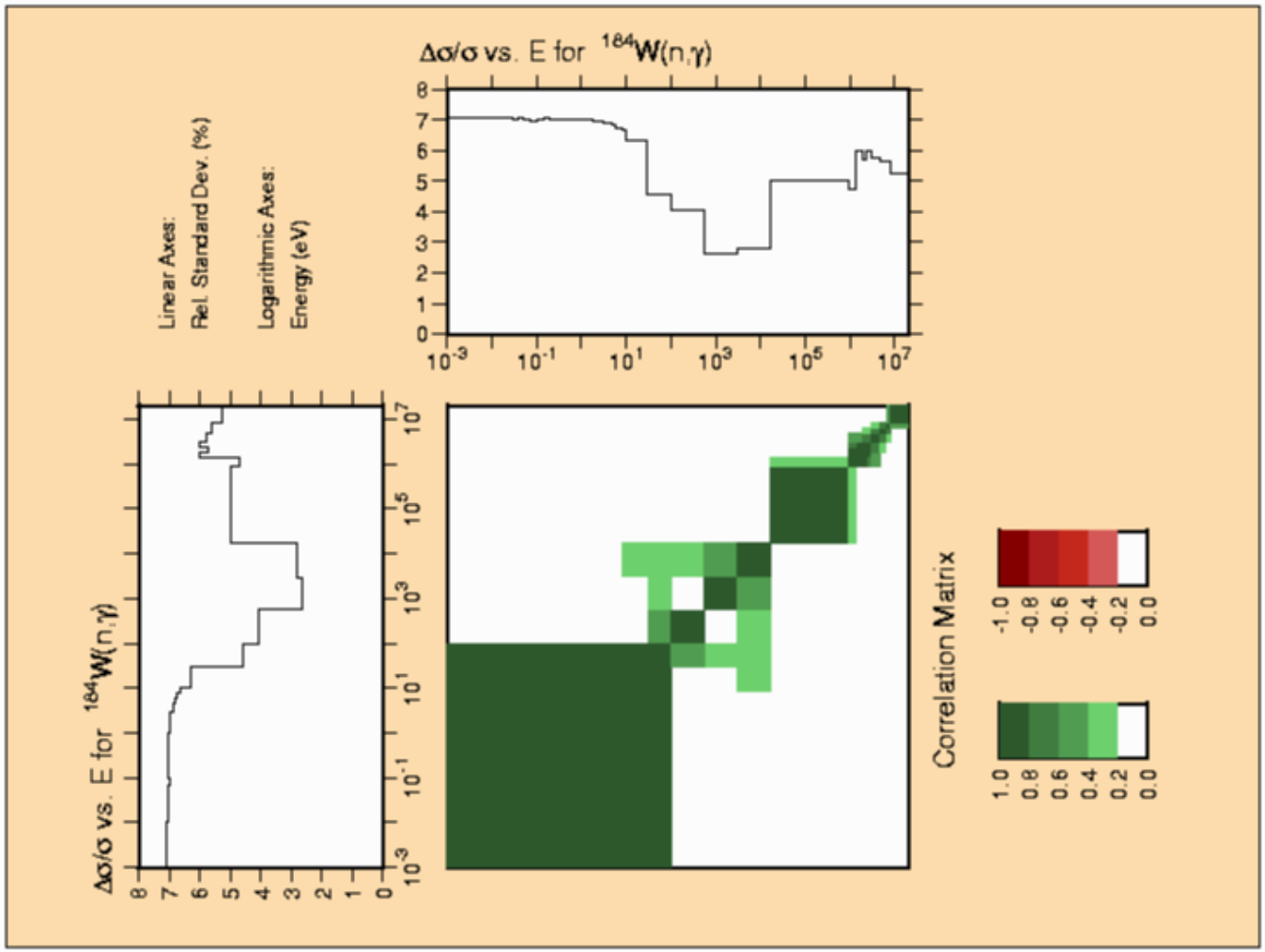
^{184}W Covariance



^{186}W

	ENDF	NEW	Mughabghab
RRR	$10^{-5} – 3.2 \times 10^{3}$ (MLBW)	$10^{-5} – 1.5 \times 10^{4}$ (RM)	-
σ_0	38.1	38.06	38.1 ± 0.5
I_γ	518.92	481.74	480 ± 15
$K_0 = I_\gamma / \sigma_0$ (measurements)			
12.59 ± 0.23			

^{186}W Covariance



^{239}Pu Resonance Evaluation at ORNL

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Oak Ridge National Laboratory

CSEWG, Nov 4-6, 2008

Motivation for a New Evaluation

- Existing resonance evaluation is divided into three disjoint resonance parameter set as 1.0×10-5 eV to 1 keV, 1 keV to 2 keV, 2 keV to 2.5 keV;
- Cross section mismatch at the energy boundaries;
- Not easy to generate uncertainty for the whole energy region (zero correlation);
- Solve long standing problem for thermal benchmark (use of the TSURFER cross section adjustment code)

paradigm shift

EXPERIMENTAL DATA

Reference	Energy Range (eV)	Facility	Measurement
Bollinger et al. (1956)	0.01 – 1.0		Total Cross Section
Gwin et al. (1971)	0.01 – 0.5	ORELA	Fission and Absorption at 25.6 m
Gwin et al. (1976)	1.0 – 100.0	ORELA	Fission and Absorption at 40.0 m
Gwin et al. (1984)	0.01 – 20.0	ORELA	Fission at 8 m
Weston et al. (1984)	9.0 – 2500.0	ORELA	Fission at 18.9 m
Weston et al. (1988)	100.0 – 2500.0	ORELA	Fission at 86 m
Weston et al. (1993)	0.02 – 40.0	ORELA	Fission at 18.9 m
Wagemans et al. (1988)	0.002 – 20.0	GELINA	Fission at 8 m
Wagemans et al. (1993)	0.01 – 1000.0	GELINA	Fission at 8 m
Harvey et al. (1985)	0.7 – 30.0	ORELA	Transmission at 18 m
Harvey et al. (1985)	30.0 – 2500.0	ORELA	Transmission at 80 m

^{239}Pu Resonance Evaluation