

Perspective on CIELO

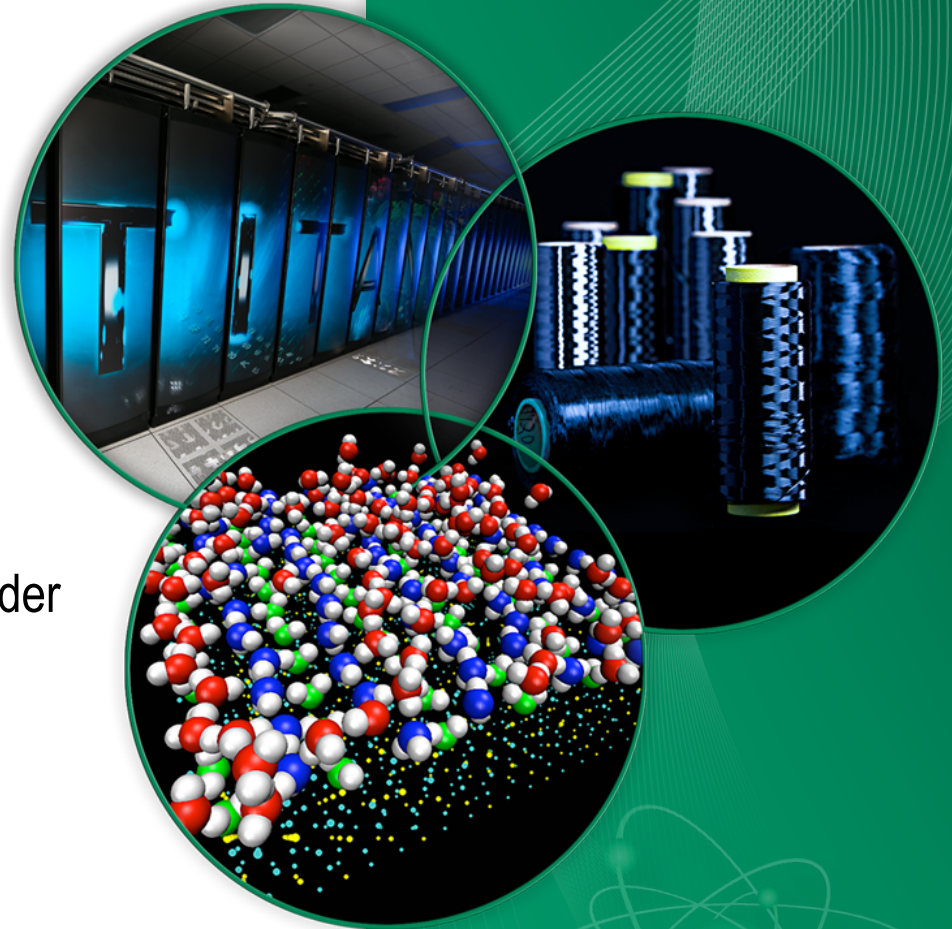
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NEMEA-7 / CIELO Workshop

Geel, Belgium

November 5-8, 2013



Introductory Comments

- Perspective from multiple view points
 - ORNL performing nuclear data work for US Nuclear Criticality Safety Program (NCSP)
 - Beginning in FY2013, ORNL named lead US laboratory responsible for supporting NNSA in management and execution of entire NCSP in the US
 - Includes oversight responsibilities for work areas relevant to CIELO: Nuclear Data, Analytical Methods, Integral Experiments (new critical experiments)
 - Relevant NCSP work performed at ANL, BNL, LANL, LLNL, ORNL, RPI, and SNL
- US NCSP nuclear data work plans align with CIELO goals and schedule—planned work on the following:
 - ^{235}U , ^{238}U , ^{239}Pu , ^{16}O , and ^{56}Fe
 - US work on ^1H funded by other US nuclear data programs

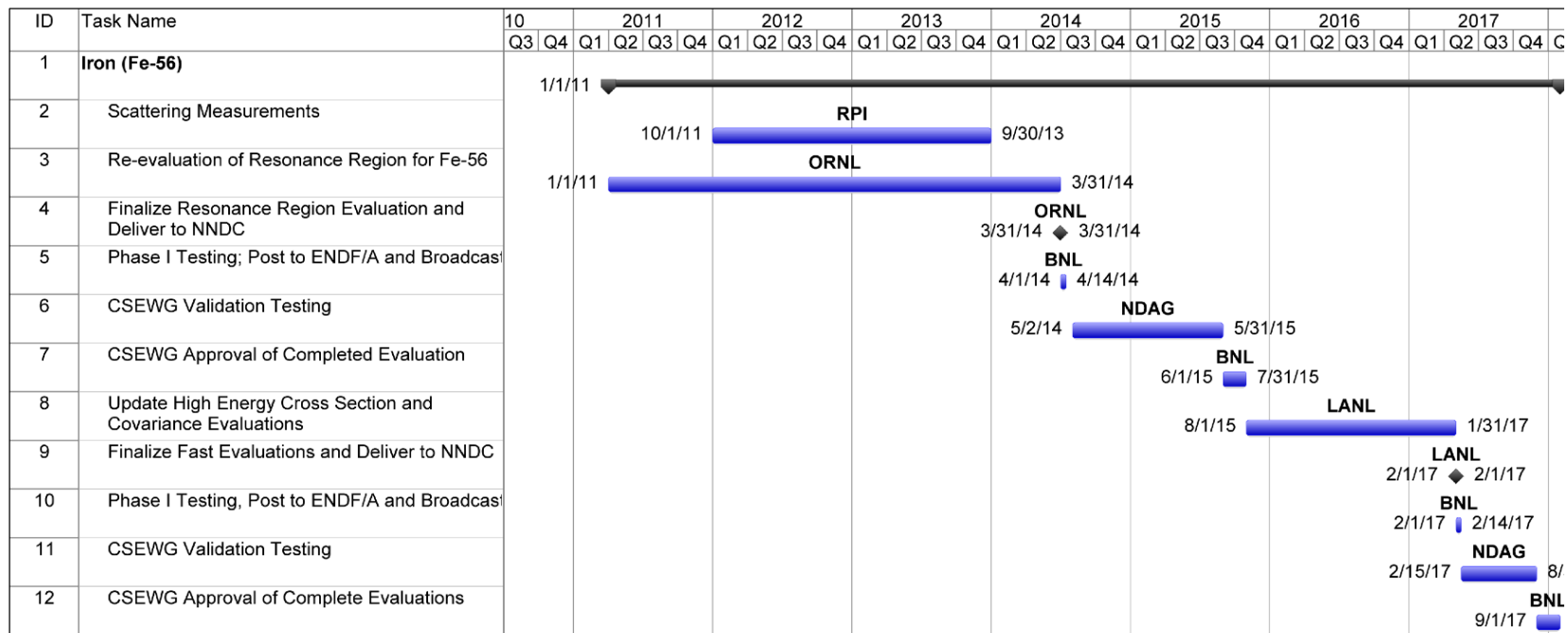
NCSP 5 Year Plan for Nuclear Data

Appendix B Nuclear Data

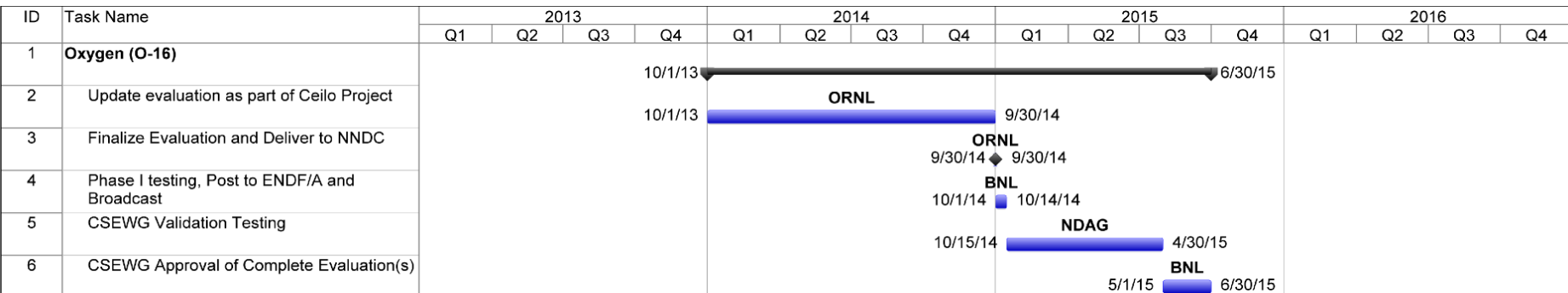
Priority Needs / Additional Needs		Thermal scattering (BeO, HF, D ₂ O, SiO ₂ , CH ₂ , C ₂ F ₆ , C ₃ O ₂ H ₈ , etc.), ²³⁹ Pu, Cr, ²³⁷ Np, Pb, W, ⁵⁵ Mn, Ti, ²⁴⁰ Pu, Fe, ⁵⁸ Ni, ⁶⁰ Ni, ⁶³ Cu, ⁶⁵ Cu / ²³³ U, Th, Be, ⁵¹ V, Zr, F, K, Ca, Mo, Na, La								
Completed Evaluations		Minor Actinides, SiO ₂ , ⁵⁵ Mn, ^{180,120,183,184,186} W, ²³⁹ Pu, ^{50,52,53,54} Cr, ^{58,60} Ni, ⁵⁵ Mn, ^{39,41} K, ¹⁹ F								
	Materials	Pre-FY2013	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	Post-FY2019
Measurements	Calcium (Ca)									
	Cerium (Ce)									
	Copper (Cu)									
	Dysprosium (Dy)									
	Gadolinium (Gd)									
	Iron (Fe)									
	Strontium (Sr)									
	Tungsten (W)									
	Vanadium (V)									
	Zirconium (Zr)									
	Polyethylene (CH ₂)									
		Materials	Pre-FY2013	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019
Complete Evaluations	Calcium (Ca)									
	Cerium (Ce)									
	Cobalt (Co)									
	Copper (Cu)									
	Dysprosium (Dy)									
	Gadolinium (Gd)									
	Iron (Fe)									
	Lead (Pb)									
	Nickel (Ni)									
	Oxygen (O)									
	Plutonium-239									
	Strontium (Sr)									
	Tungsten (W)									
	Uranium-235									
	Uranium-238									
Vanadium (V)										
Zirconium (Zr)										
Polyethylene (CH ₂)										
		ORNL		RPI		LANL				

- Requests for additional IE measurements: Ni, Mo, Cr (Fe-Cr alloys), Mn in intermediate energy range (VNIITF, NCERC).
- Request for measurements and evaluation of angular distributions at high energy for Cu.
- Continuing need for thermal scattering data.

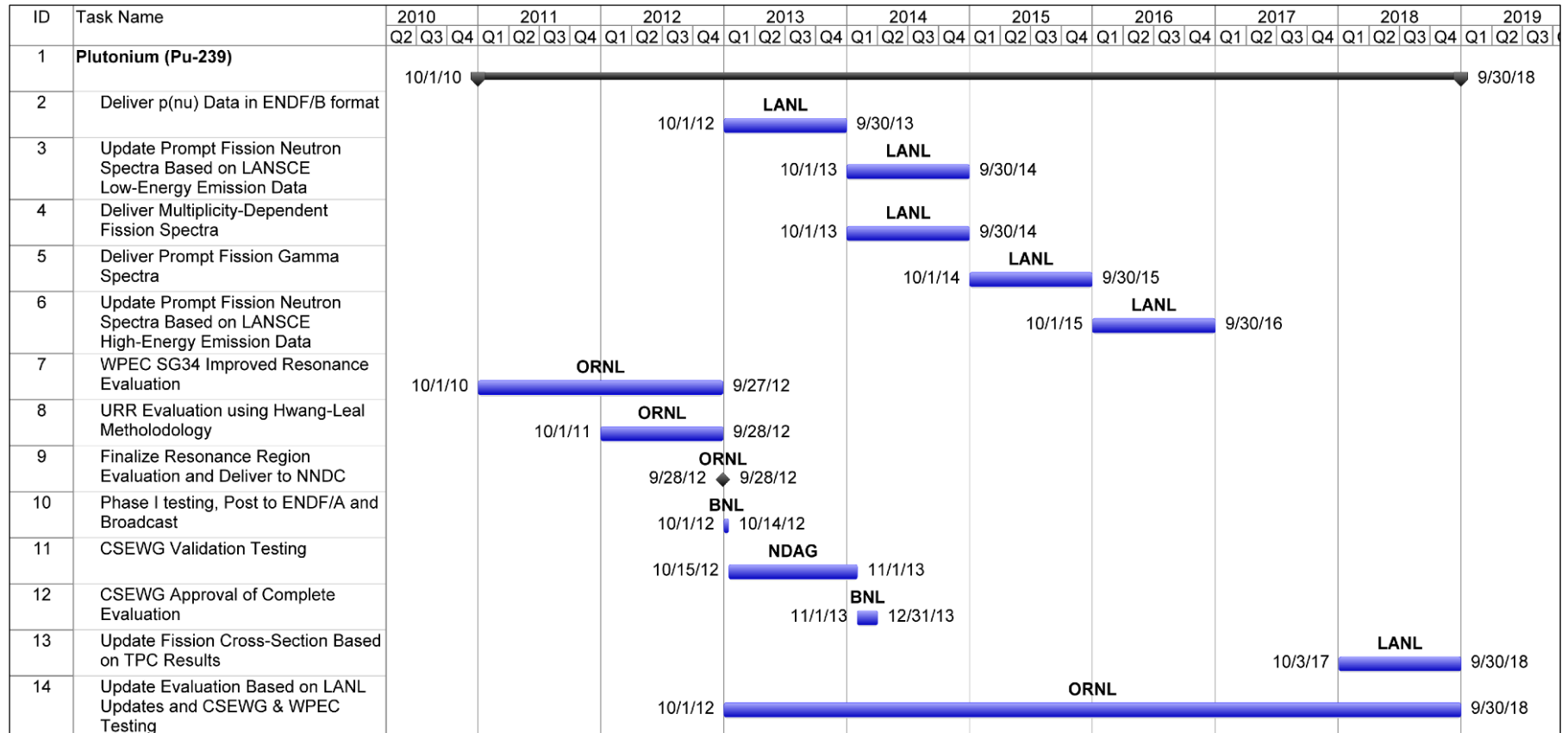
US NCSP ⁵⁶Fe Work Plan



US NCSP ¹⁶O Work Plan



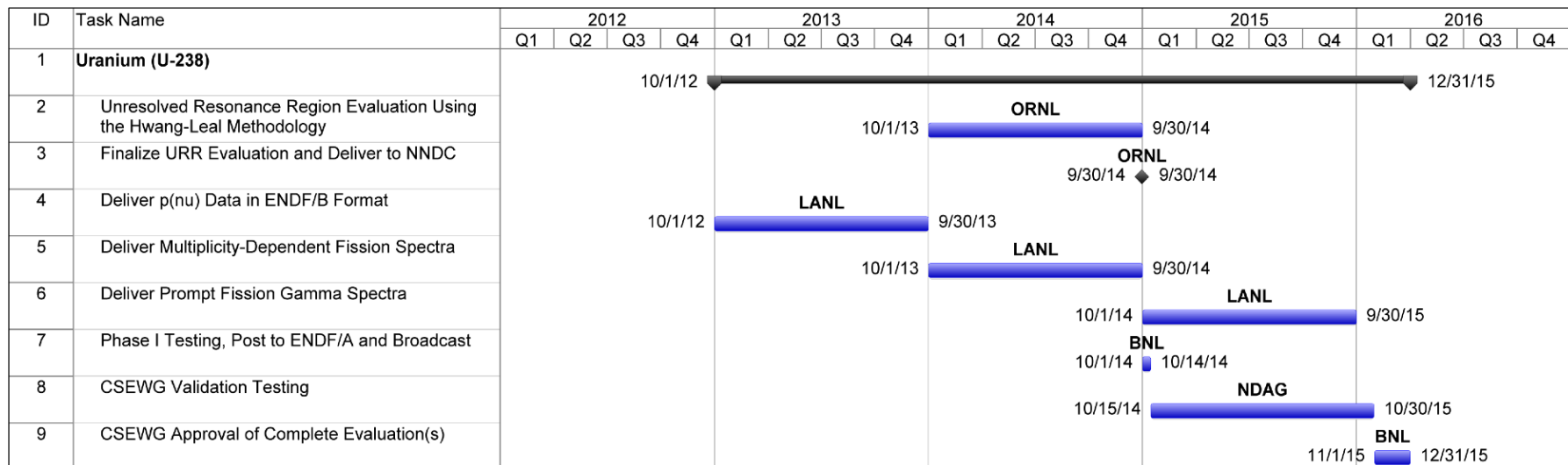
US NCSP ²³⁹Pu Work Plan



US NCSP ²³⁵U Work Plan

ID	Task Name	2011				2012				2013				2014				2015				2016				2017				2018			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	Uranium (U-235)	10/1/11 ————— 9/30/17																															
2	Deliver p(nu) Data in ENDF/B Format	10/2/12 — LANL — 9/30/13																															
3	Deliver Multiplicity-Dependent Fission Spectra	10/2/13 — LANL — 9/30/14																															
4	Deliver Prompt Fission Gamma Spectra	10/1/14 — LANL — 9/29/15																															
5	Review the evaluation of U-235 capture and fission cross sections based on new measurements at LANSCE	10/3/16 — LANL — 9/30/17																															
6	Resolved Resonance Capture Evaluation Per WPEC SG29 Recommendations	10/1/11 — ORNL — 3/31/14																															
7	CSEWG Validation Testing	4/1/14 — NDAG — 3/31/15																															
8	CSEWG Approval of Complete Evaluation(s)	4/2/15 — BNL — 5/31/15																															
9	Unresolved Resonance Region Evaluation	10/1/11 — ORNL — 3/31/14																															
10	Finalize Resonance Regional Evaluations and Deliver to NNDC	3/31/14 — ORNL — 3/31/14																															
11	Phase I testing, Post to ENDF/A and Broadcast	4/1/14 — BNL — 4/14/14																															
12	CSEWG Validation Testing	4/15/14 — NDAG — 4/30/14																															
13	CSEWG Approval of Complete Evaluation(s)	5/1/14 — BNL — 6/30/14																															

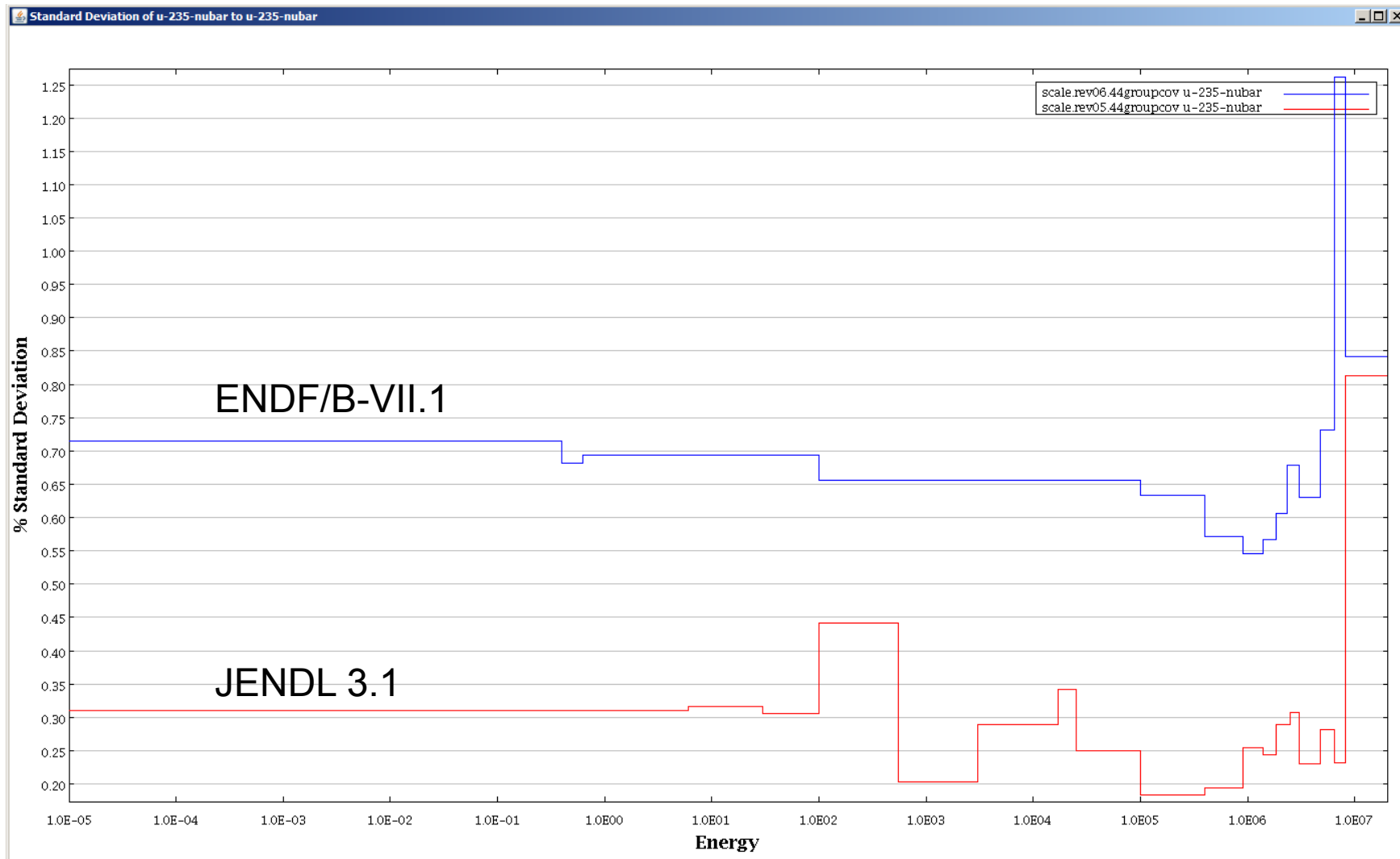
US NCSP ²³⁸U Work Plan



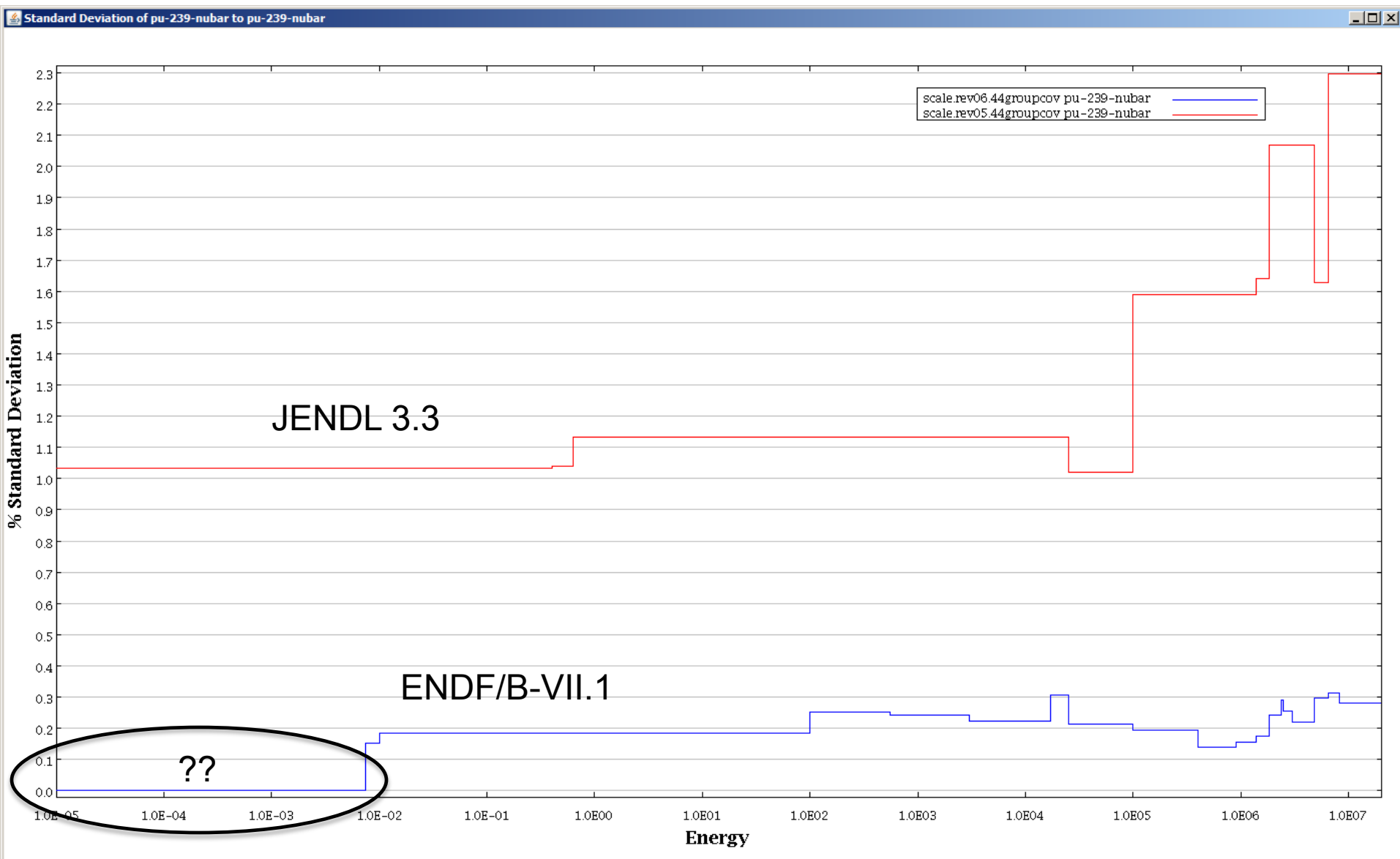
Some Brief Technical Comments

- Much has been said at workshop about integral benchmark performance of key CIELO isotopes
- Also need concerted effort to assess performance of covariance data
- ORNL has initiated effort of testing latest ENDF/B-VII.1 covariance data for impact on sensitivity/uncertainty (S/U) analyses for thermal, intermediate, and fast critical benchmarks--more details to be presented by Mark Williams at next CSEWG meeting November 20-22 at BNL
- Some questions about ENDF/B-VII.1 uncertainty data for ^{239}Pu , ^{235}U and ^1H :
 - ^{235}U : thermal & intermediate energy nu-bar increased from 0.3% to 0.7% with ENDF/B-VII.1 (i.e., relative to ENDF/B-V and JENDL 3.1)
 - ^{239}Pu : thermal & intermediate nu-bar is 0.2%--also VII.1 evaluation has 0% uncertainty below 0.01 eV (do not understand)—JENDL 3.3 uncertainty ~1%
 - ^1H : thermal elastic scattering uncertainty is 0.3%—JENDL 3.3 uncertainty ~0.1%
 - Noted JENDL covariance data released with SCALE 6.1 prior to ENDF/B-VII.1 release
 - ENDF/B-VII.1 uncertainty values will have significant impact on previous S/U analyses used to provide NRC technical regulatory guidance to licensees in the US
- More detailed studies needed to understand covariance data to ensure CIELO provides highest quality covariance data.

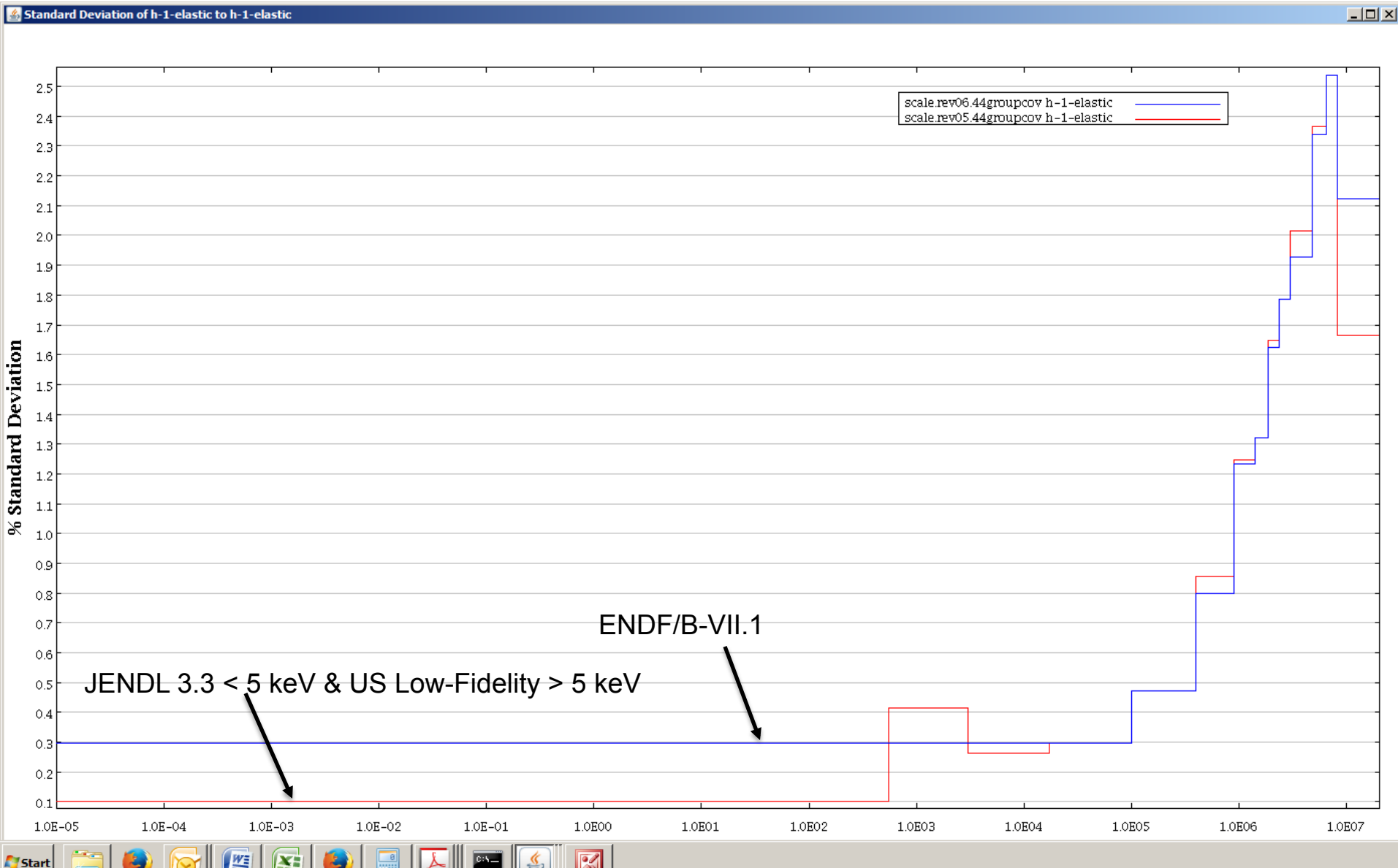
^{235}U Nu-bar Uncertainty



^{239}Pu Nu-bar Uncertainty



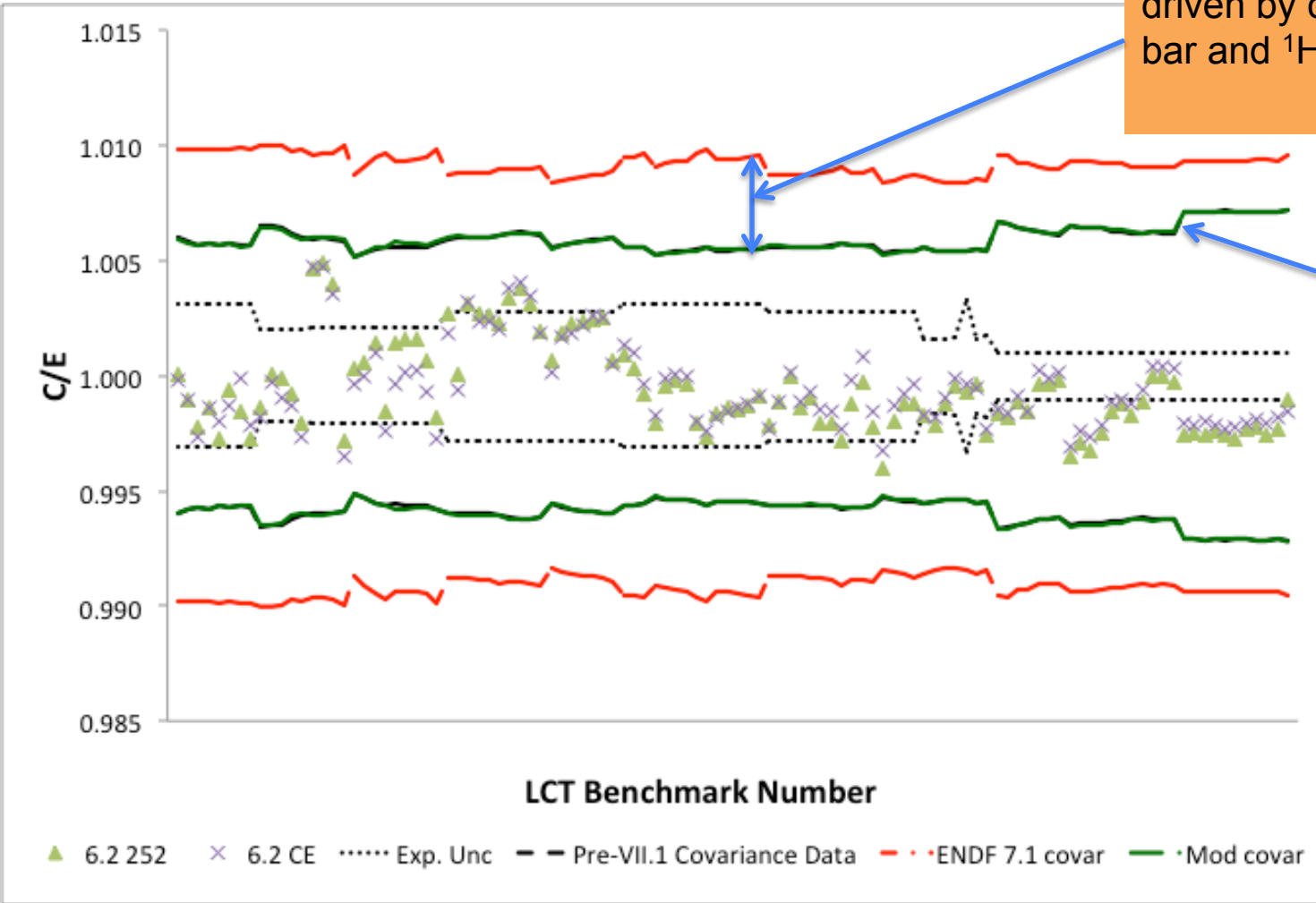
^1H Elastic Uncertainty



Example SCALE S/U Results Using ENDF/B-VII.1 Covariance Data for LEU Thermal Benchmarks

Uncertainty in k_{eff} due to nuclear data for ICSBEP LEU-COMP-THERM series of benchmarks

B-VII.1 Uncertainty Impact driven by changes to ^{235}U nu-bar and ^1H scattering

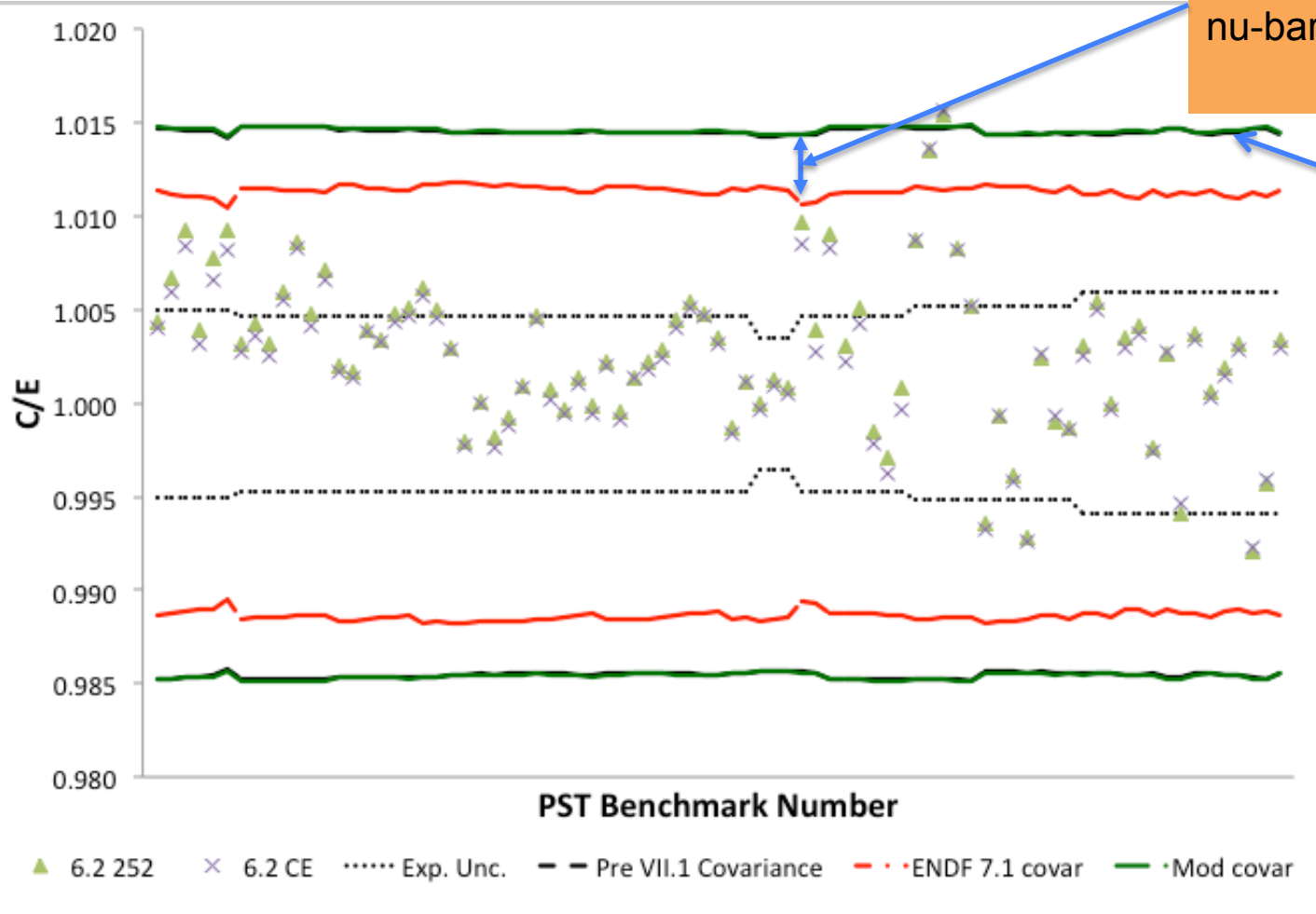


Mod covariance: ENDF/B-VII.1 with ^{235}U nu-bar and ^1H scatter covariance changed back to values consistent with ENDF/B-V and JENDL 3.X

Example SCALE S/U Results Using ENDF/B-VII.1 Covariance Data for Pu Solution Benchmarks

Uncertainty in k_{eff} due to nuclear data for ICSBEP PU-SOL-THERM series of benchmarks

B-VII.1 Uncertainty Impact driven by changes to ^{239}Pu nu-bar and ^1H scattering



Mod covariance: ENDF/B-VII.1 with ^{239}Pu nu-bar and ^1H scatter covariance changed back to values consistent with ENDF/B-V and JENDL 3.X

Summary

- US NCSP nuclear data work plans align with CIELO goals and interests—BNL, LANL, ORNL and RPI
- CIELO evaluation contributions have been presented by US laboratories at workshop—tremendous progress has been made but work still to be done
- Integral testing should continue to be focus with CIELO effort but also need to have more detailed studies and investigations for evaluated covariance data
 - Have questions about ENDF/B-VII.1 covariance data for thermal and intermediate neutron systems—will need to continue investigation with end-users and evaluators