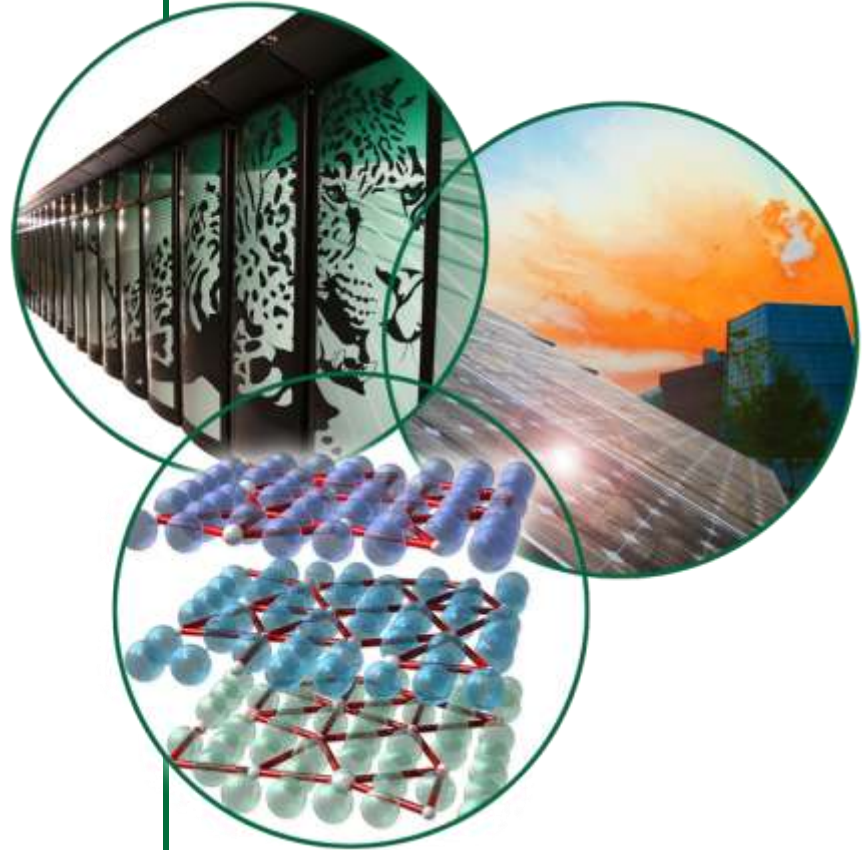# Criticality Safety Validation of SCALE 6.2 Beta 1 With ENDF/B-VII.0 Libraries

W.J. Marshall, D. Wiarda, C. Celik,
B.T. Rearden, and D.R. Wentz

U.S. DEPARTMENT OF **ENERGY**

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Outline

1. Introduction

2. VALID procedure and library contents

3. Validation methods

4. Results

5. Conclusions

6. Future work

Managed by UT-Battelle
for the U.S. Department of Energy   NCS Validation of SCALE 6.2B1 with ENDF/B-VII.0 Libraries

Introduction

- Through the support of the DOE Nuclear Criticality Safety Program, the performance of SCALE 6.1 was assessed for hundreds of critical benchmarks

  – Intended as a demonstration of SCALE performance across a wide range of systems

- Benchmarks are all from IHECSBE and included in the VALID library maintained at ORNL

  – Several cases have added since the SCALE 6.1 validation report

- This effort has been repeated for SCALE 6.2 Beta 1

- Models are executed using 238-group, 252-group, and continuous energy libraries based on ENDF/B-VII.0

VALID procedure and library contents

- Verified, Archived Library of Inputs and Data procedure is a SCALE project computational procedure at ORNL

- Similar to 10CFR50 Appendix B QA program:
  - Independent preparation and review of models and documentation
  - Individuals must be certified as qualified for task assigned
  - Version control maintained on data
  - Data and documentation backed up and retrievable

- Described more fully in paper on VALID
  - Presentation was Tuesday morning, I hope you enjoyed it

VALID procedure and library contents

- Critical experiments currently in library and used in validation effort

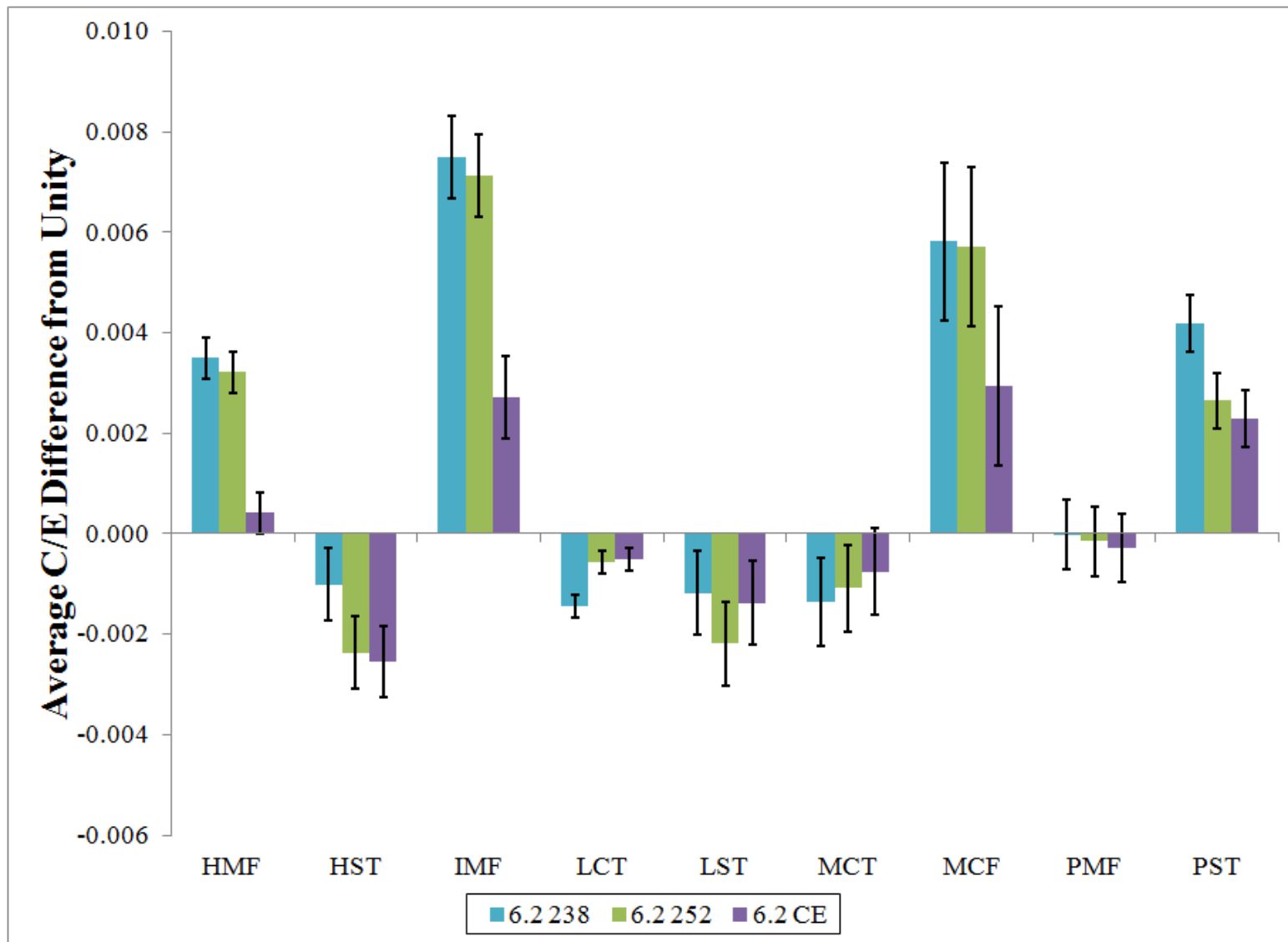| Sequence	Experiment class	IHECSBE case numbers	Number of configurations
CSAS5/KENO V.a	HEU-MET-FAST	15, 16, 17, 18, 19, 20, 21, 25, 30, 38, 40, 65	18/22[a]
	HEU-SOL-THERM	1, 13, 14, 16, 28, 29, 30	52
	IEU-MET-FAST	2, 3, 4, 5, 6, 7, 8, 9	8/11[a]
	LEU-COMP-THERM	1, 2, 10, 17, 42, 50, 80	108
	LEU-SOL-THERM	2, 3, 4	19
	MIX-MET-FAST	5, 6	2
	MIX-COMP-THERM	1, 2, 4	21
	PU-MET-FAST	1, 2, 5, 6, 8, 10, 18, 22, 23, 24	10
	PU-SOL-THERM	1, 2, 3, 4, 5, 6, 7, 11, 20	81
CSAS6/KENO-VI	HEU-MET-FAST	5, 8, 9, 10, 11, 13, 24, 80, 86, 92	24
	IEU-MET-FAST	19	2
	MIX-COMP-THERM	8	28

[a]The larger number includes simplified cases that are duplicate cases for which detailed models are also available in the library.

- 326 cases with KENO V.a
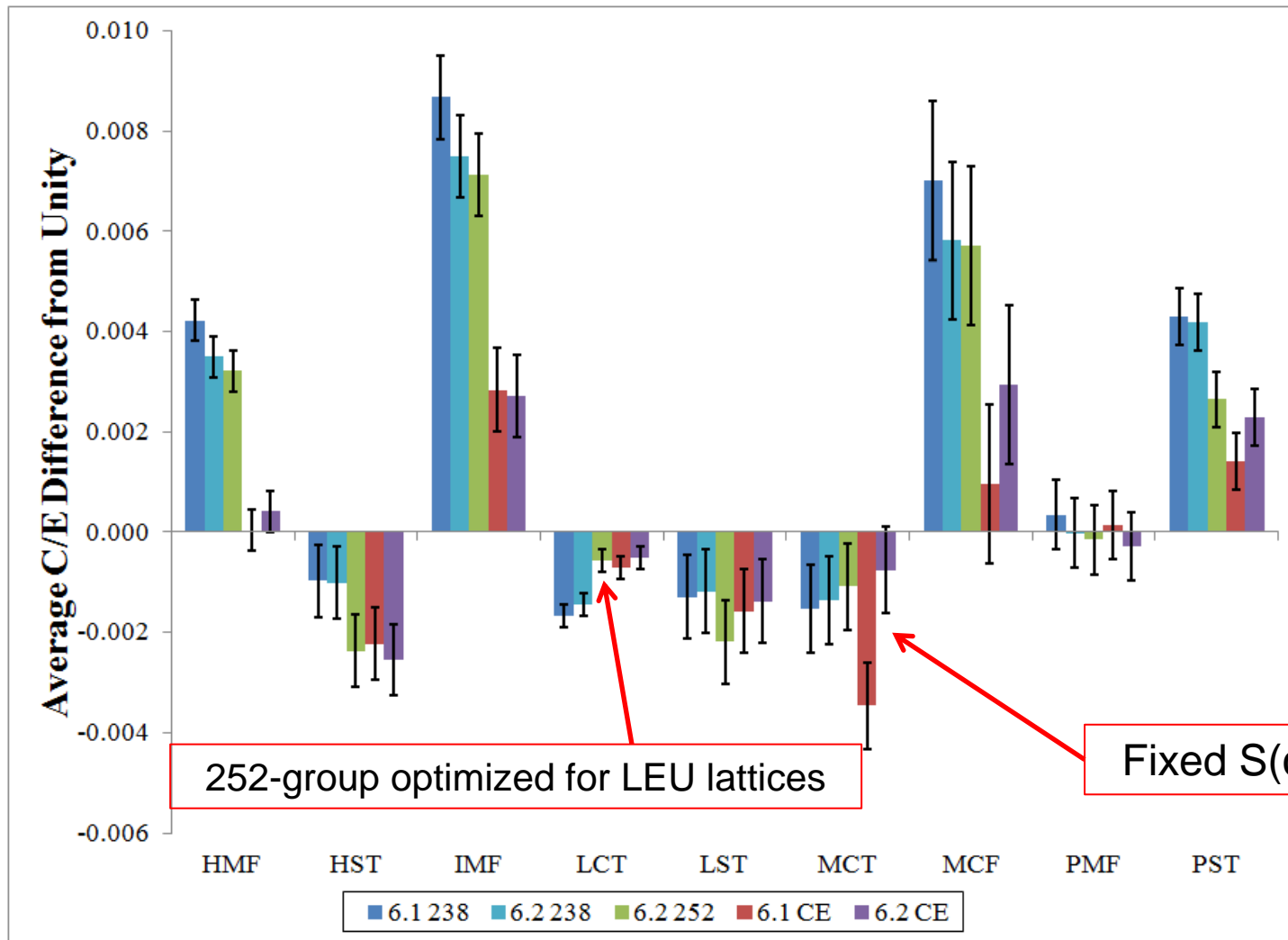- 54 cases with KENO-VI

Validation methods

- Performance reported in terms of calculated-to-experiment ratio (C/E)

- Expected (experiment) value is determined in the IHECSBE evaluation for each experiment

- Uncertainty in C/E is propagated uncertainty in expected k_{eff} value and calculational uncertainty from KENO

  - Uncertainty in expected k_{eff} 10 to 50 times larger than KENO uncertainty

- Linear average C/E value and its uncertainty determined for each category of experiments
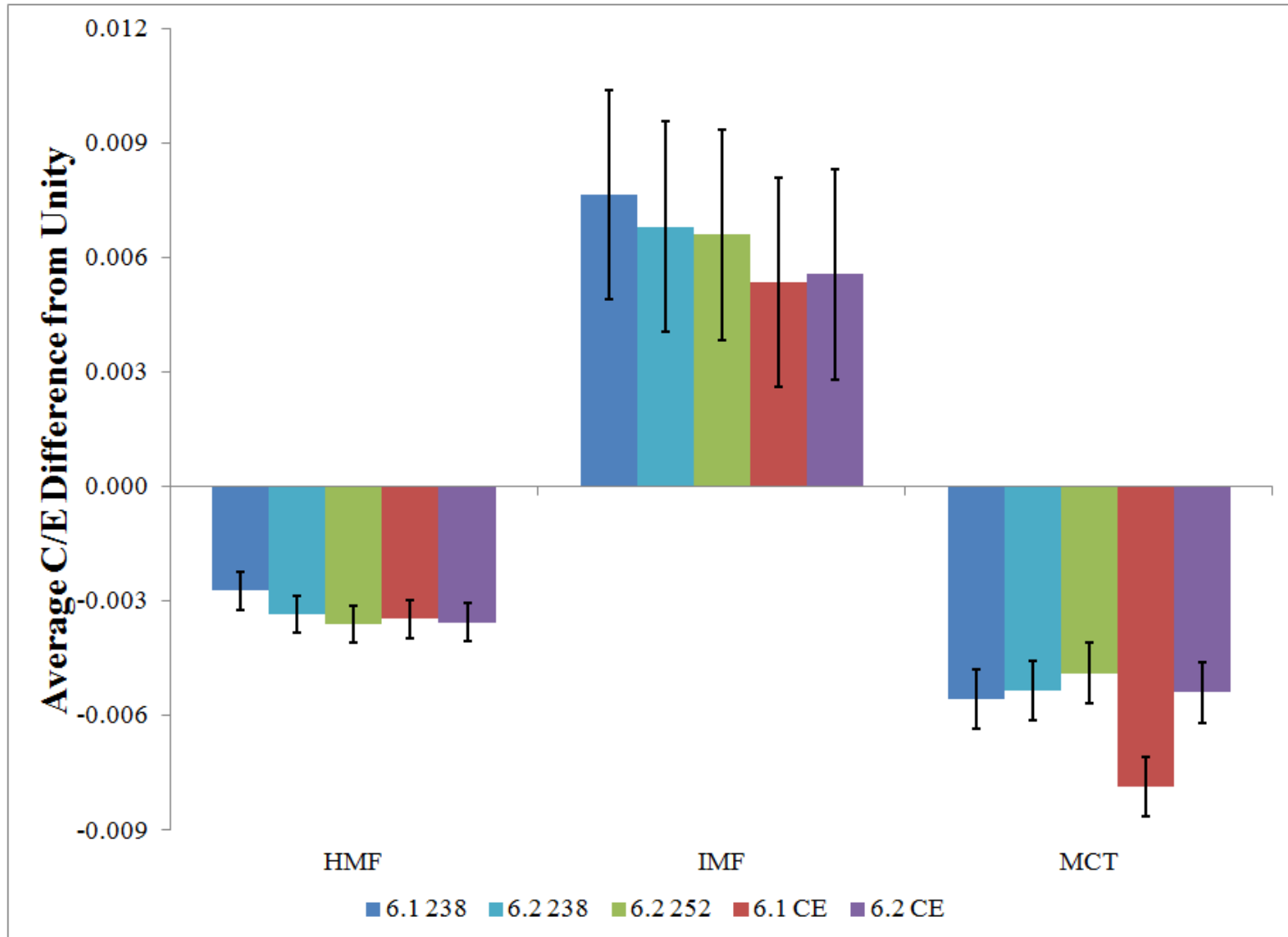
NCS Validation of SCALE 6.2B1 with ENDF/B-VII.0 Libraries

OAK RIDGE National Laboratory

Results for three libraries in 6.2B1

NCS Validation of SCALE 6.2B1 with ENDF/B-VII.0 Libraries

Now compared to results from 6.1
(Same experiments in all categories)

Managed by UT-Battelle
for the U.S. Department of Energy   NCS Validation of SCALE 6.2B1 with ENDF/B-VII.0 Libraries
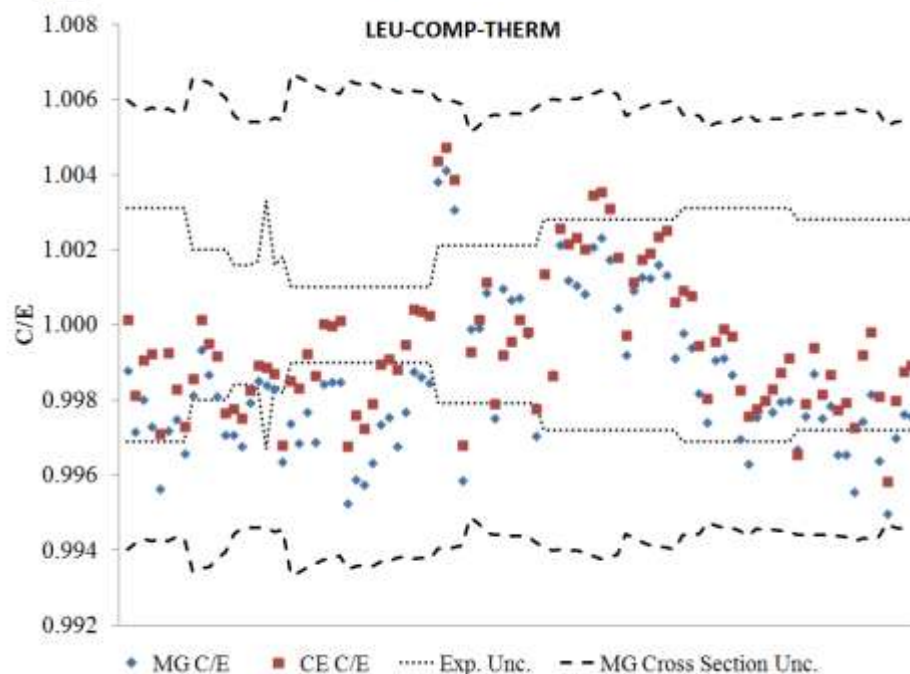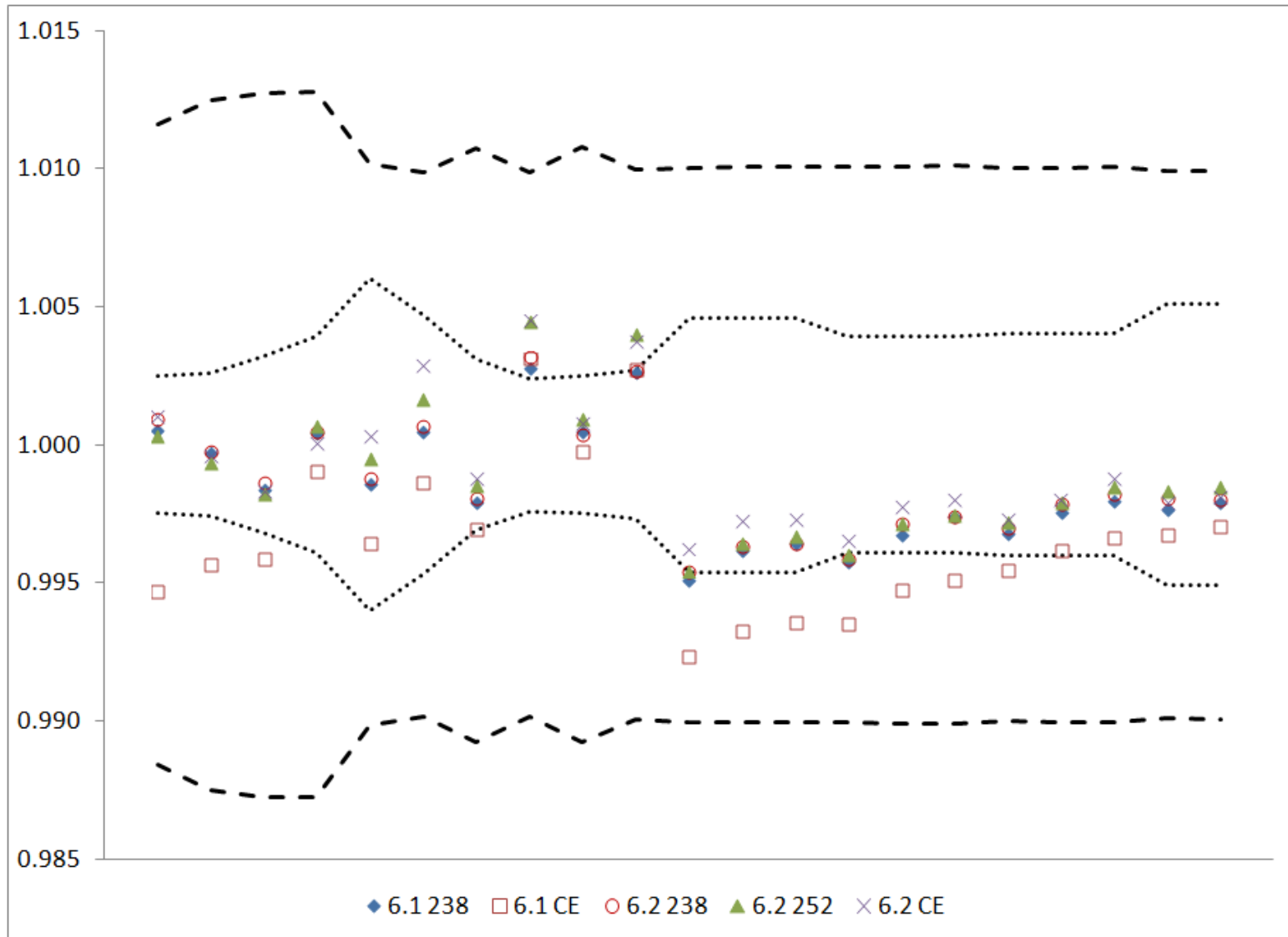
KENO-VI Results

Results

- Plots generated for C/E values with experimental and cross section uncertainties

- Experimental uncertainties from IHECSBE

- Cross section uncertainties from TSUNAMI-3D (SCALE 6.1)

10   Managed by UT-Battelle
     for the U.S. Department of Energy
                              NCS Validation of SCALE 6.2B1 with ENDF/B-VII.0 Libraries

Results – KENO V.a MCT C/E values

Managed by UT-Battelle
for the U.S. Department of Energy   NCS Validation of SCALE 6.2B1 with ENDF/B-VII.0 Libraries

Results – KENO V.a and VI

- Used C5toC6 utility within SCALE to convert KENO V.a models to KENO-VI models for all experiments in some categories

- Only simple geometries used, 238-group ENDF/B-VII.0 library

- Used SCALE 6.1, similar results expected for SCALE 6.2 and other libraries

Category	KENO V.a Avg. k_{eff}	KENO-VI Avg. k_{eff}	Difference	Cases Within 2σ
HMF	1.00385 ± 0.00002	1.00386 ± 0.00002	-0.00001 ± 0.00005	22/22
LST	0.99884 ± 0.00006	0.99878 ± 0.00006	0.00006 ± 0.00009	17/19
PST	1.00430 ± 0.00001	1.00432 ± 0.00001	-0.00002 ± 0.00002	80/81

Conclusions

- KENO Monte Carlo codes perform well predicting k_{eff} for a broad range of systems in SCALE 6.2B1 with ENDF/B-VII.0 cross sections

- CE typically has smaller deviations from expected k_{eff} values than 238-group or 252-group calculations
  - $S(\alpha, \beta)$ data fix improves CE performance in SCALE 6.2
  - 252-group does particularly well for LCT systems

- KENO-VI and KENO V.a appear to provide equivalent results on identical systems

- KENO appears to run 15% or more slower in 6.2B1 than 6.1

Future work

- Currently testing CE and multigroup ENDF/B-VII.1 libraries

- Finish work replicating KENO V.a benchmarks in KENO-VI to provide solid basis for comparison, update to SCALE 6.2

- Working with the SCALE nuclear data team to evaluate ENDF/B-VII.1 covariance data and development of recommended covariance library for SCALE 6.2

- Add more experiments from the IHECSBE to the VALID library
  - SDF for each case in VALID distributed with IHECSBE