GNDS implementation update: results of TNSL and heated URRPT testing

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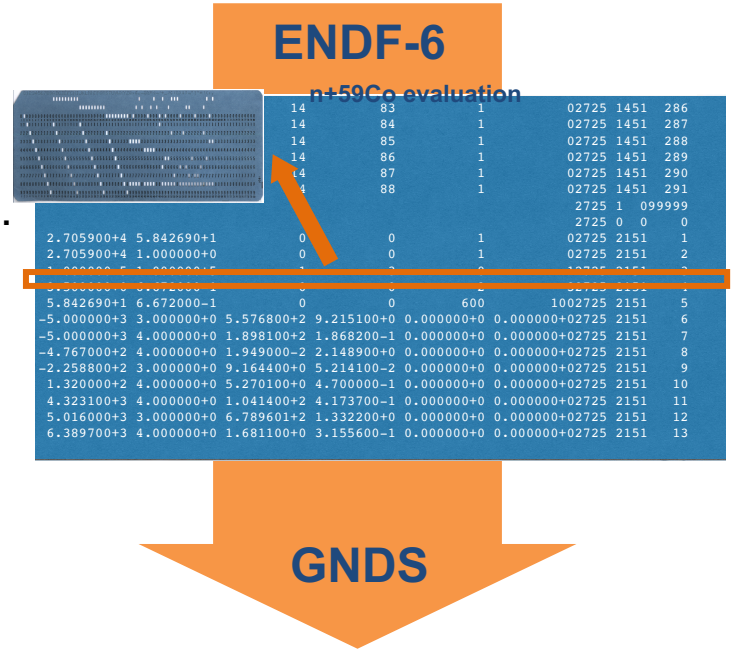
From ENDF-6 to GNDS

- GNDS is hierarchical
- It defines a structure not a format
  - Data can be stored in a file using XML, HDF5, etc.
- Structure follows physics
- Stores data for one PROTARE (PROjectile, TARget, Evaluation)
  - e.g., n+^{56}Fe , γ+Fe for ENDF/B-VIII.0
- Supports <u>simultaneous storage</u> of
  - Evaluated, and processed Monte Carlo and multi-group data
  - Multi-temperature data
  - Enabled via styles and component/forms
- GNDS international effort under OECD/NEA/WPEC
  - SG38, SG43 (2017-2020) and EG-GNDS

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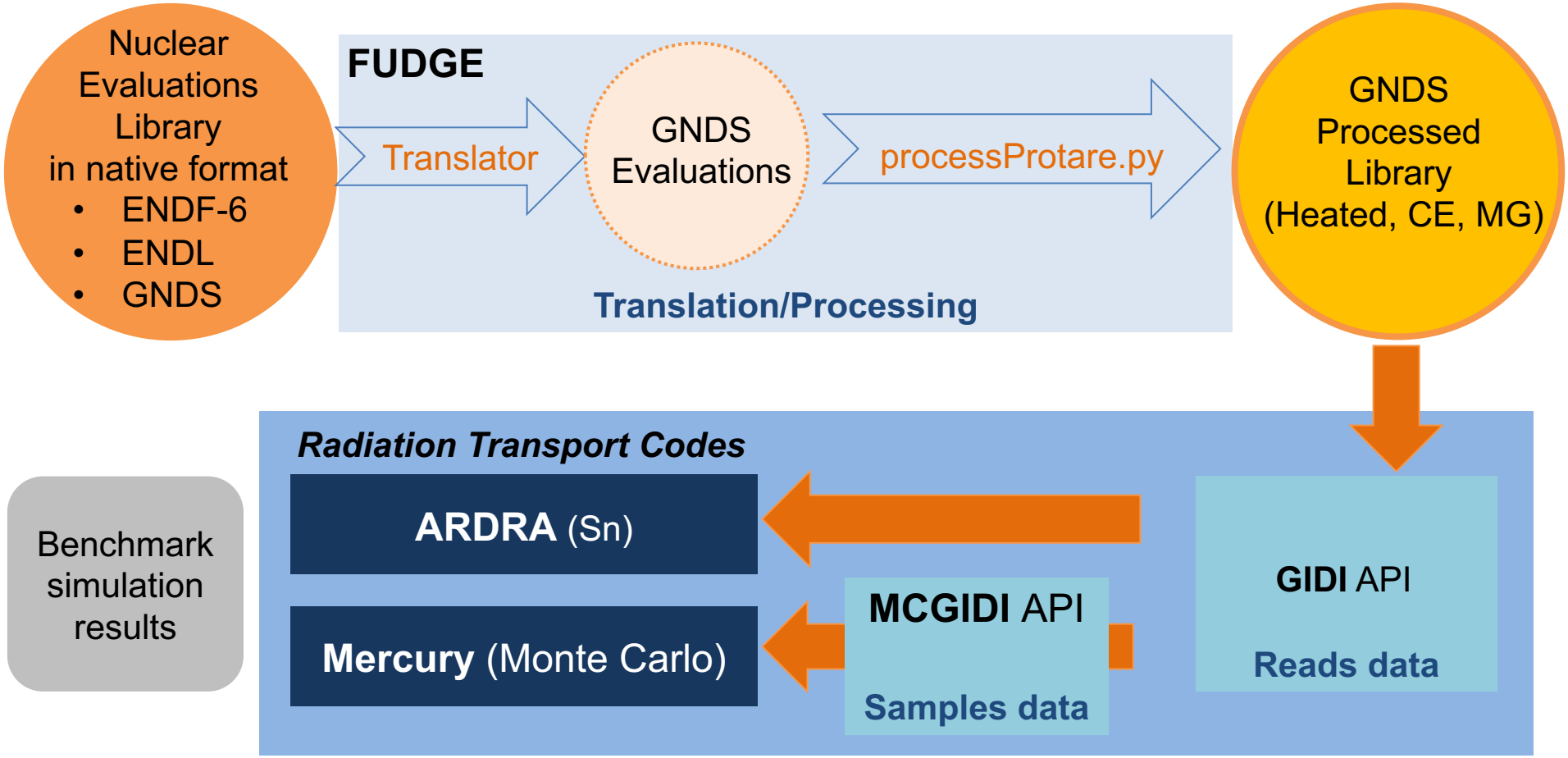
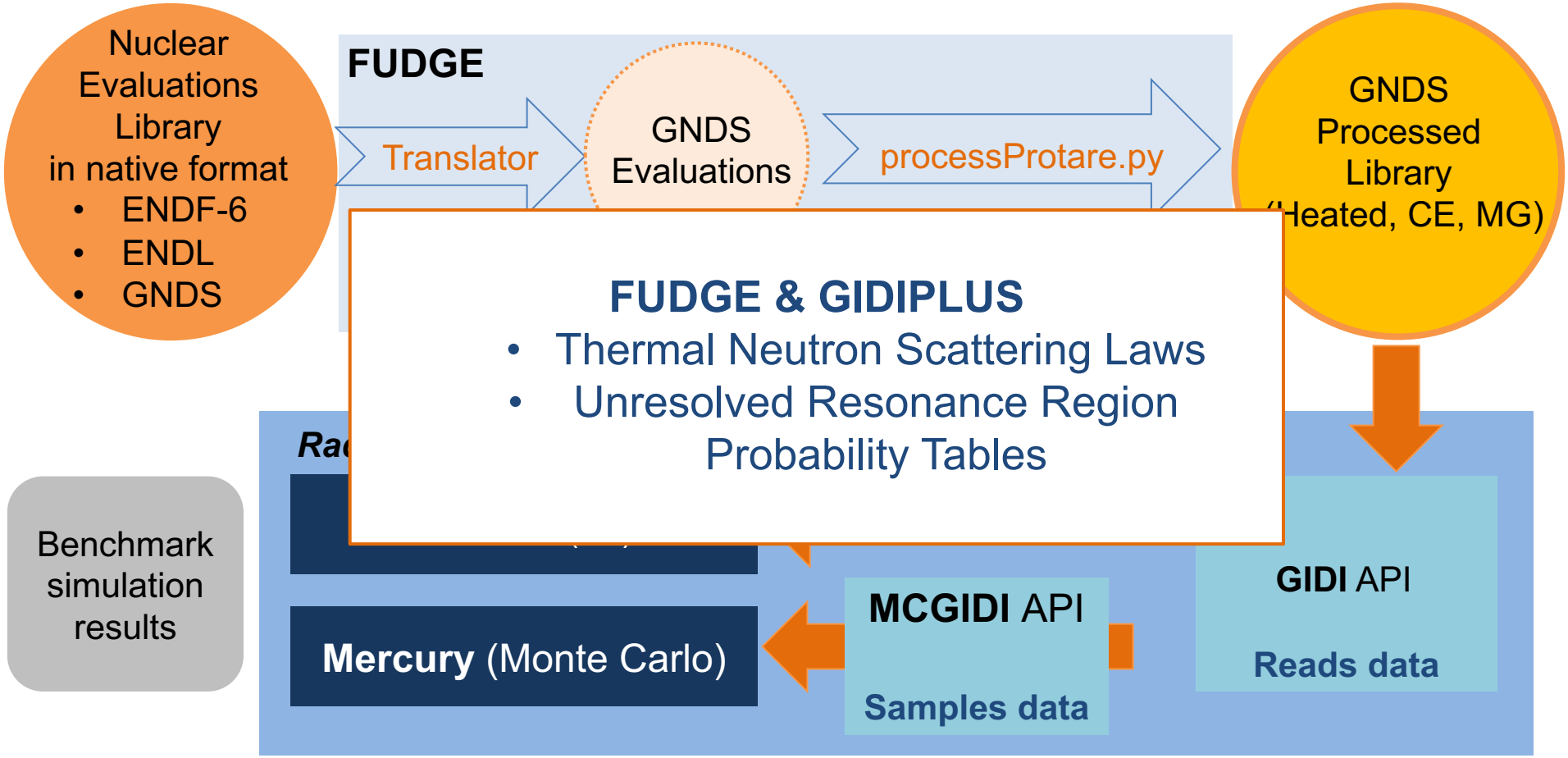
GNDS support at LLNL

- FUDGE
  - LLNL's nuclear data management package.
- GIDIPLUS: LLNL transport APIs
  - GIDI: low-level C++ API for accessing GNDS data.
  - MCGIDI: low-level C++ API for Monte Carlo sampling of nuclear reaction data.
- LLNL transport codes
  - Ardra: Deterministic transport code
  - Mercury: Monte Carlo transport code
- LLNL's V&V test suite

GNDS Implementation



GNDS Implementation



Testing of new low energy capabilities

- V&V with LLNL Codes

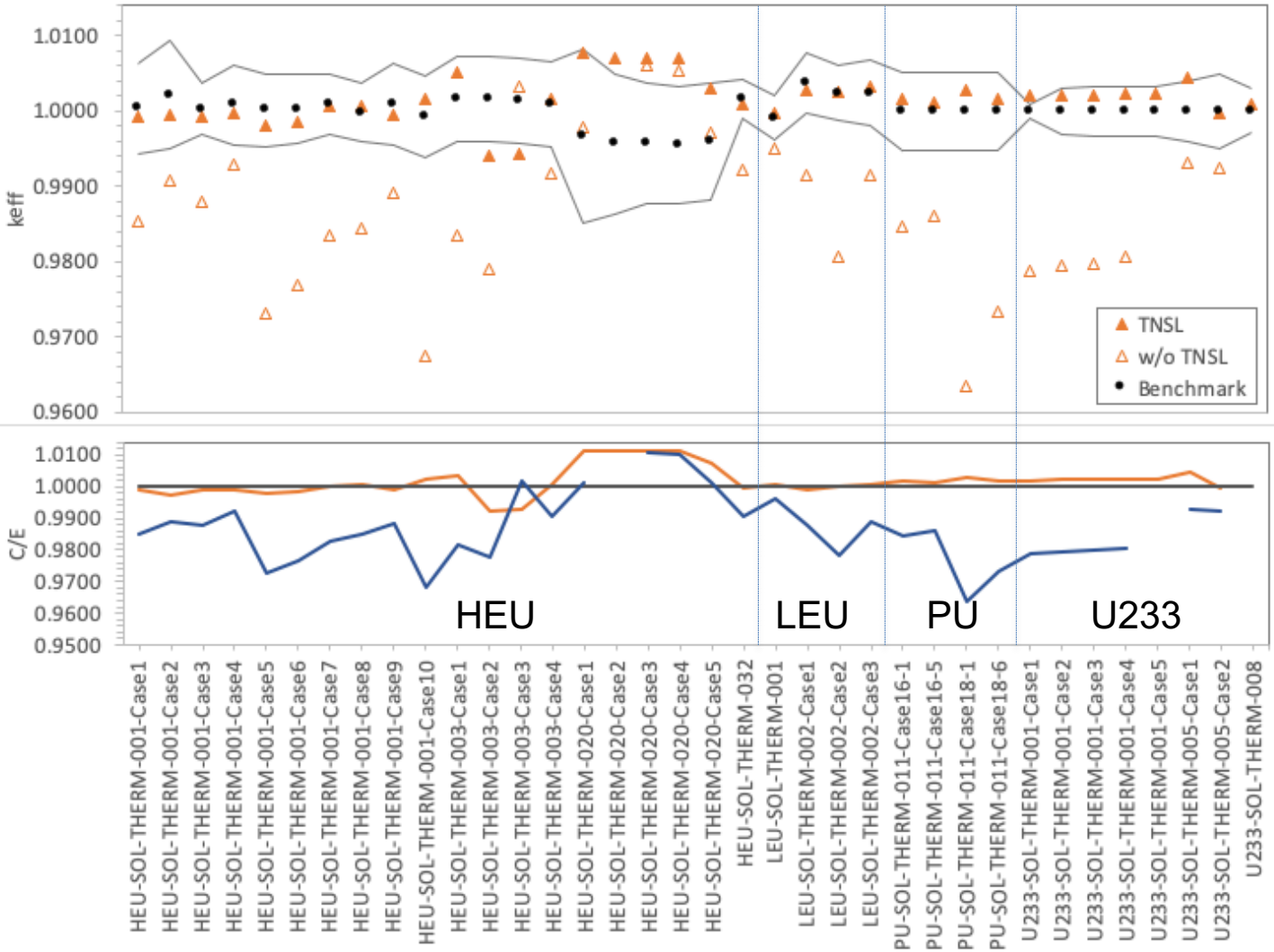
Code	Code Type	Run mode	Data Format/ API	Benchmark tests	Cross-sections	New Capabilities
Mercury	Monte Carlo	Batch	GNDS/ GIDI/ MCGIDI	Criticality: 123 fast assemblies + 36 thermal +15 fast Reaction ratios: 3 assemblies 16 Pulsed spheres	Continuous Energy	TNSL URR
Ardra	Sn	Interactive	GNDS/ GIDI	Criticality:79 assemblies +12 thermal	Multigroup: 230 groups +616 groups	TNSL

- ENDF/B-VIII.0 library was translated and processed with FUDGE into GNDS format
- Results were compared to MCNP6 - ENDF/B-VIII.0 results

Brown et al, NDS, 148 1-142, 2018

Thermal neutron scattering laws

- Implemented in LLNL Monte Carlo code



35 thermal assemblies

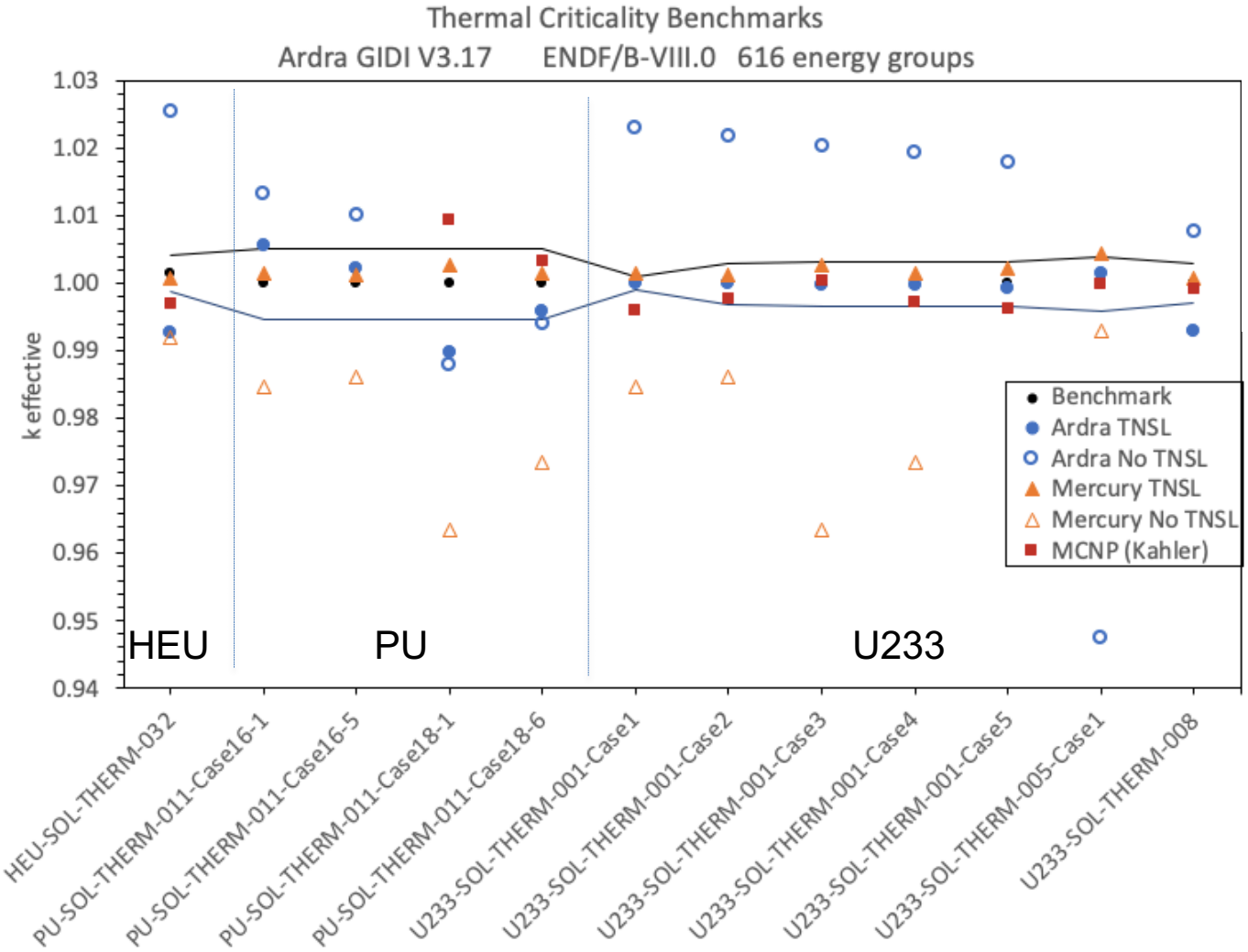
Mercury ENDF/B-VIII.0 CE XS

Significant improvement with TNSL ON

HST20 cases: keff are high but within 2σ.

Thermal neutron scattering laws

- Implemented in LLNL deterministic code

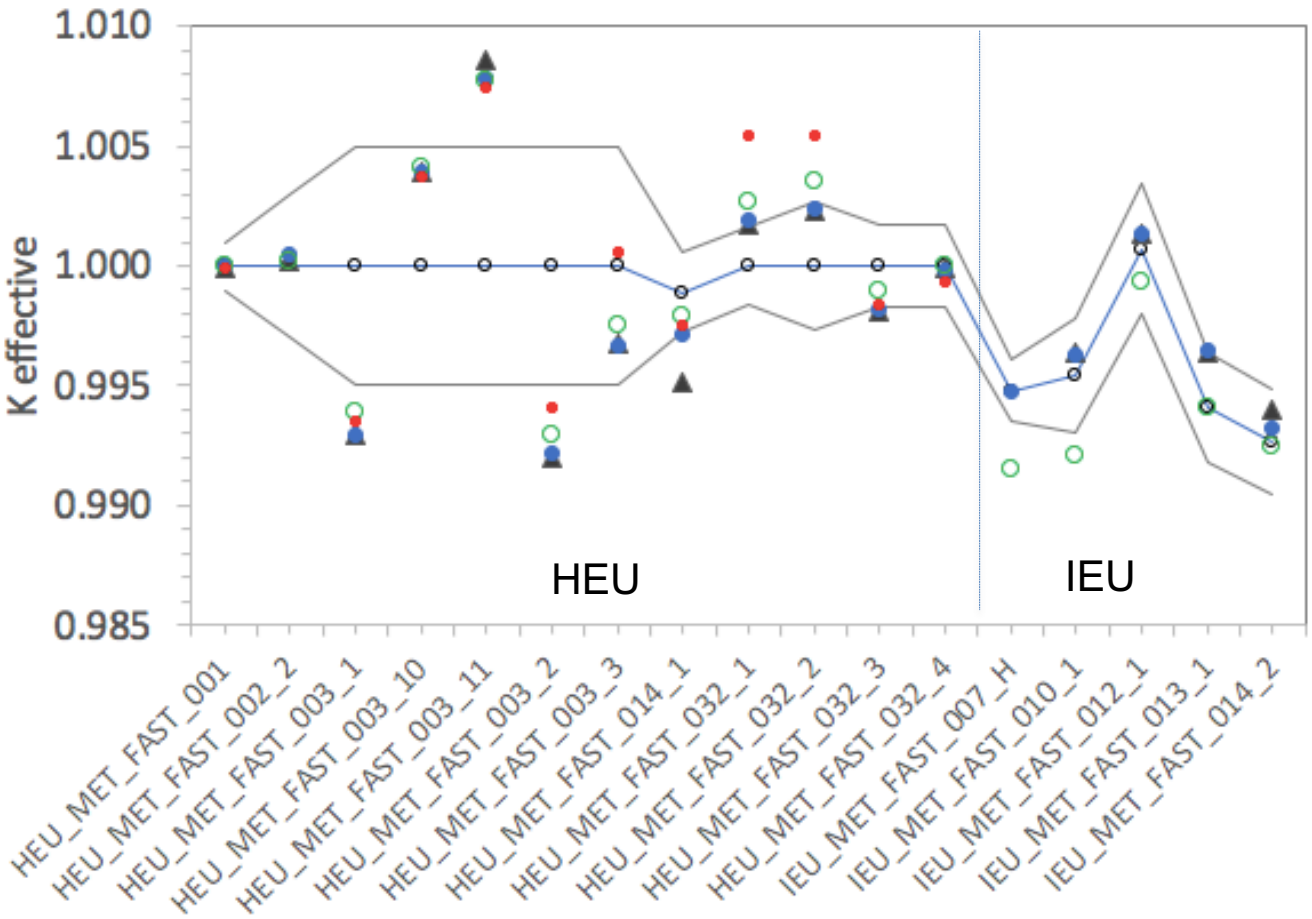


12 1D-thermal assemblies
Ardra
ENDF/B-VIII.0
MG XS 616 gp

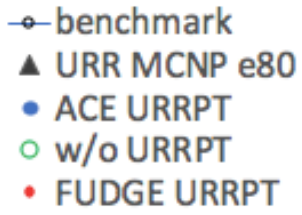
Significant improvement with TNSL ON. Results within 2σ of benchmark

URRPT for ^{235}U and ^{238}U

- 18 Tests from IAEA benchmark suite for processing codes [A. Trkov]

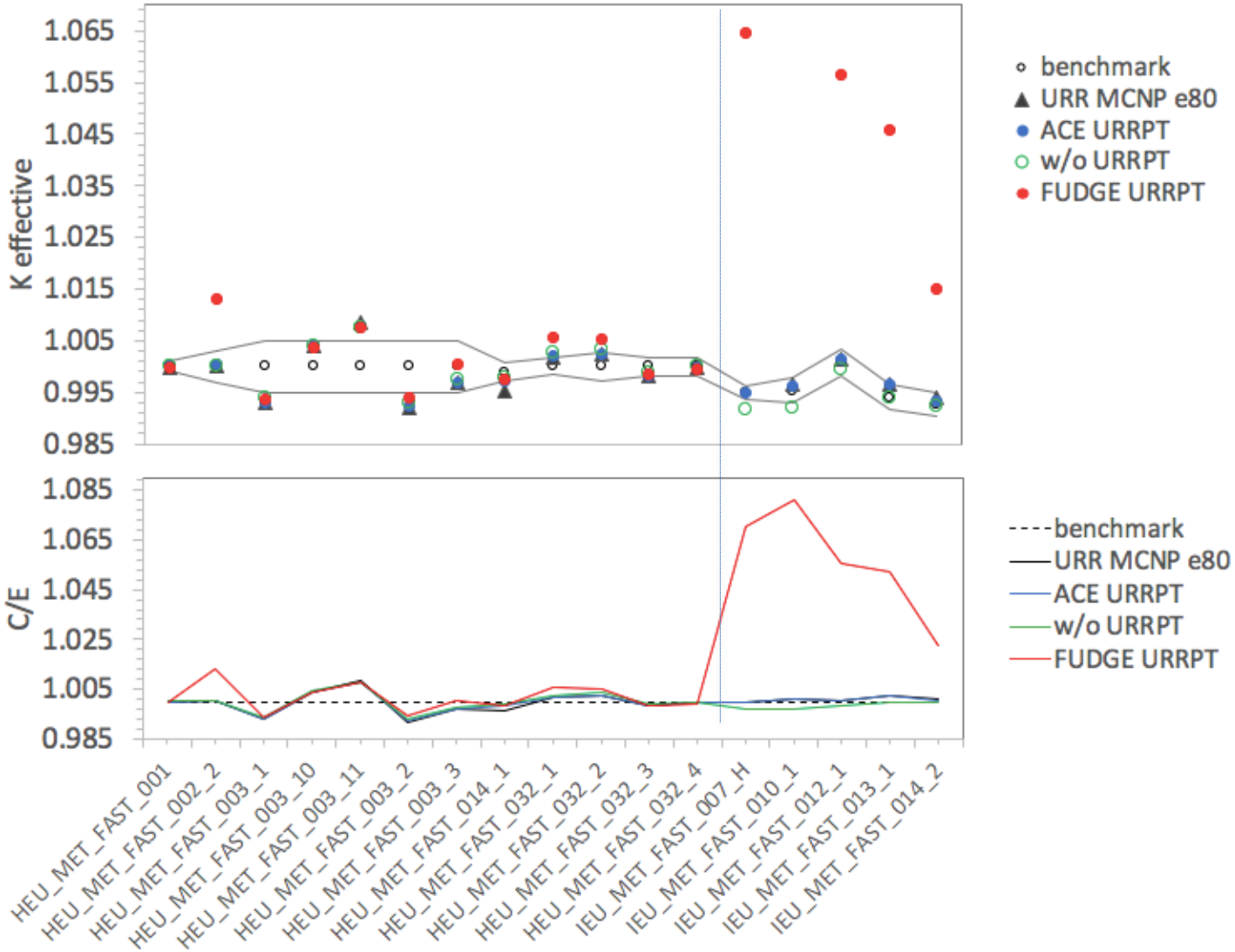


Code: Mercury
ENDF/B-VIII.0
Continuous Energy



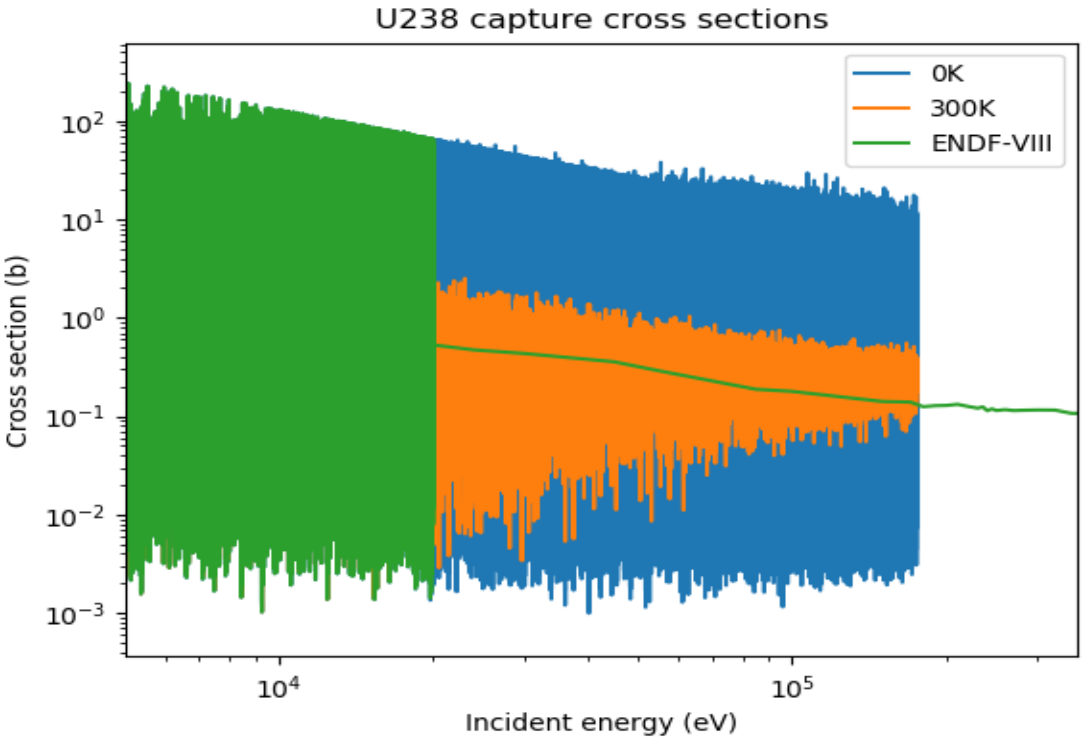
MCNP and Mercury in good agreement when using ACE URRPT.
Overall Fudge URRPT for HEU cases are consistent with ACE URRPT while IEU cases are off scale (see next slide)

URRPT for ^{235}U and ^{238}U – no heating



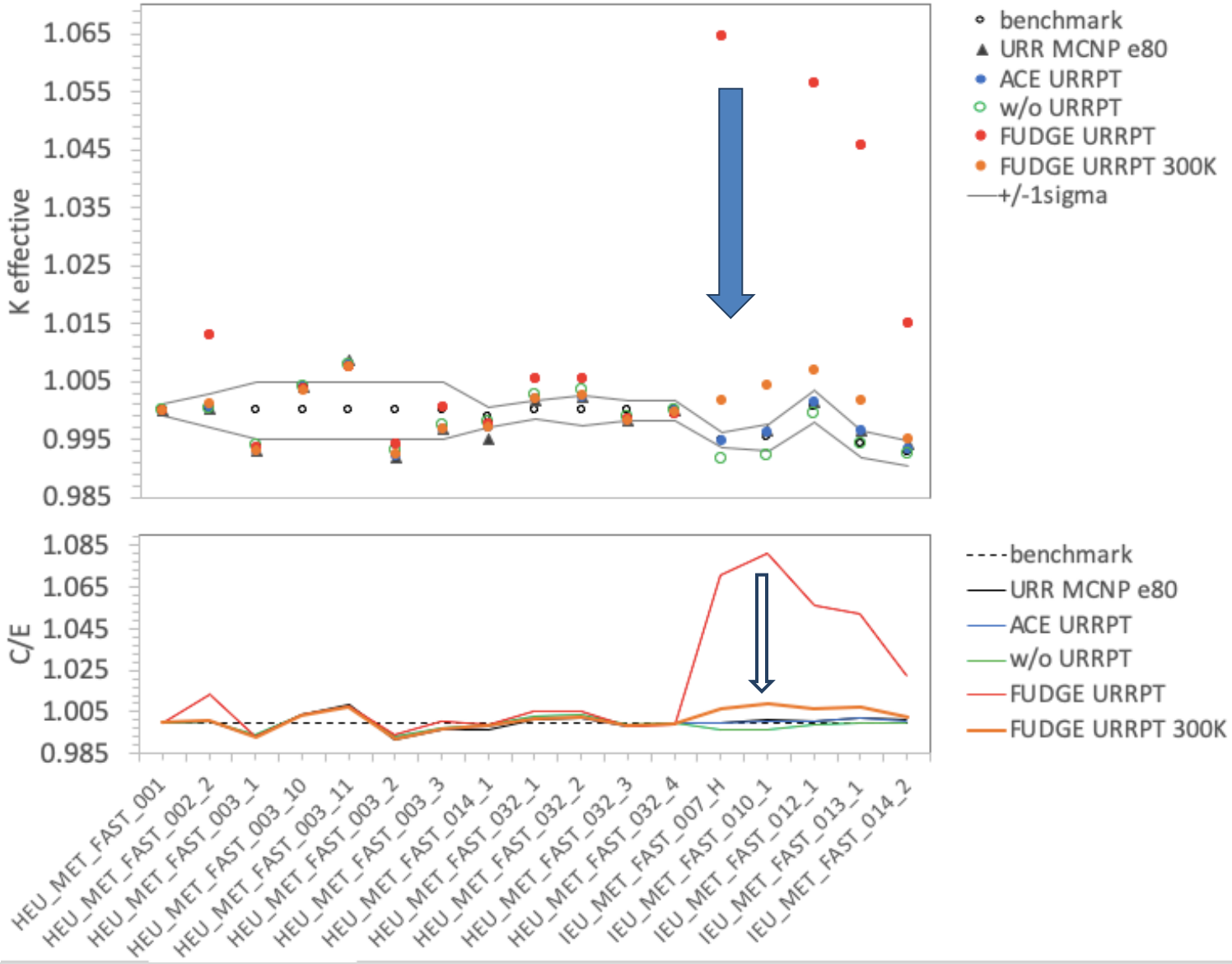
Effect of Doppler broadening must be included in probability tables

- Doppler broadening reduces the spread of possible cross sections as peaks/troughs are smoothed out.
  - Higher level density in heavy targets = bigger effect

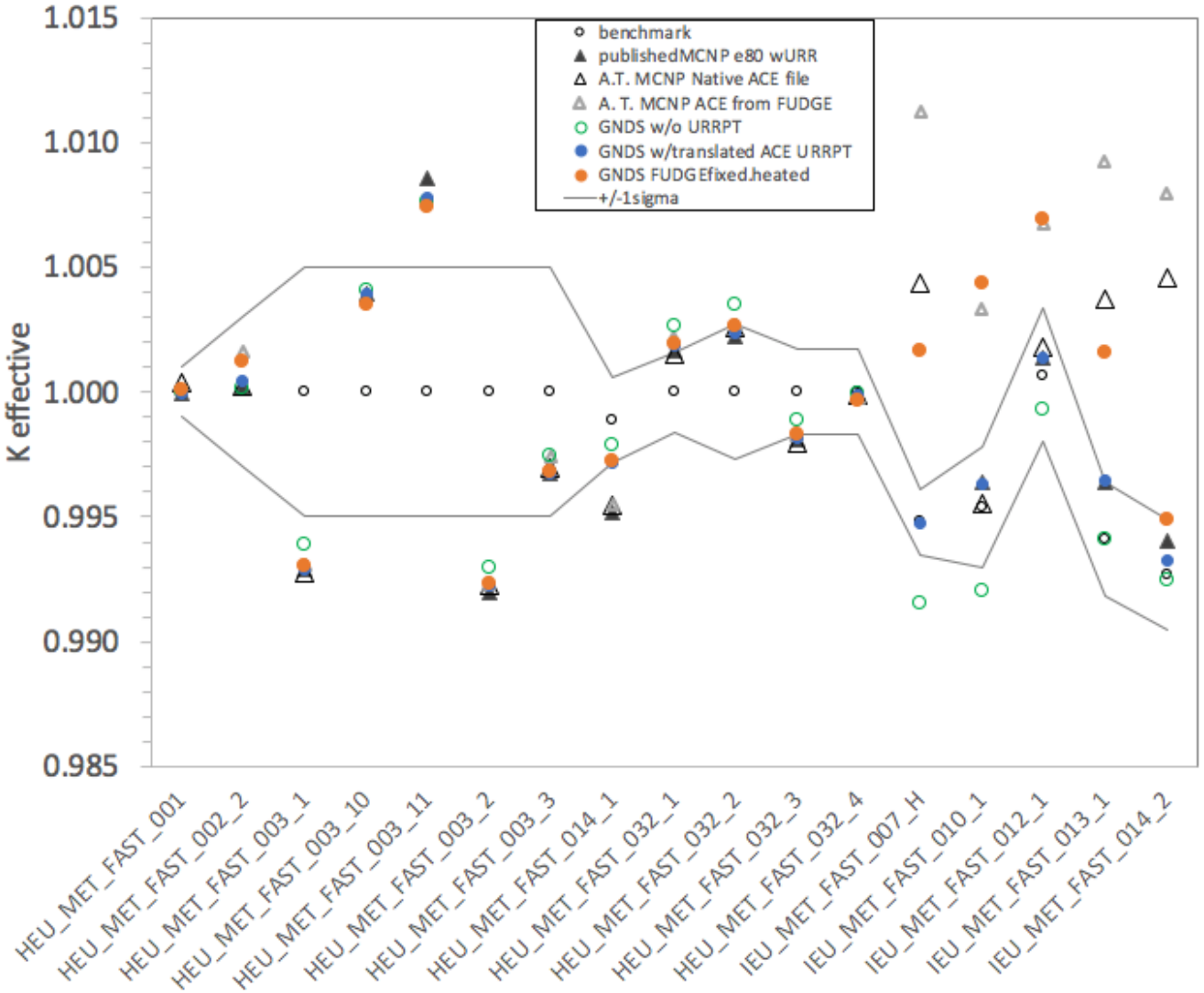


See presentation Beck, Mattoon

Poor initial results for ZPRs and BigTen now much improved



FUDGE can translate GNDS URRPT to ACE format



Summary

- Implemented and validated new low energy capabilities in the GNDS format
  - FUDGE Processing: URRPT
  - GIDI/MCGIDI APIs: URRPT, TNSL
- Addition of integral benchmarks to LLNL test suite probing thermal to epithermal region
- GNDS to ACE translator (n sub-library, outgoing n) including URRPT

- Future work:
  - Automate generation of URRPT in FUDGE
  - Expand GNDS to ACE translation capability (e.g. TNSL, photons)
  - Develop photon transport validation suite