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Update on the International Reactor Physics Evaluation Project (IRPhEP) for EGPRS

February 2023

Mark D DeHart, Patrick Blaise, Ian Hill

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Nuclear Energy Agency

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NUCLEAR ENERGY AGENCY

Update on the International Reactor Physics Evaluation Project (IRPhEP) for EGPRS

Chair: Mark D. DeHart
(Idaho National Laboratory, USA)

Vice-Chair: Patrick Blaise
(Commissariat a l'Energie Atomique et aux Energies Alternatives, France)

Secretariat: Ian Hill
(OECD/NEA, France)

Presented to the Expert Group on Physics of Reactor Systems (EGPRS)

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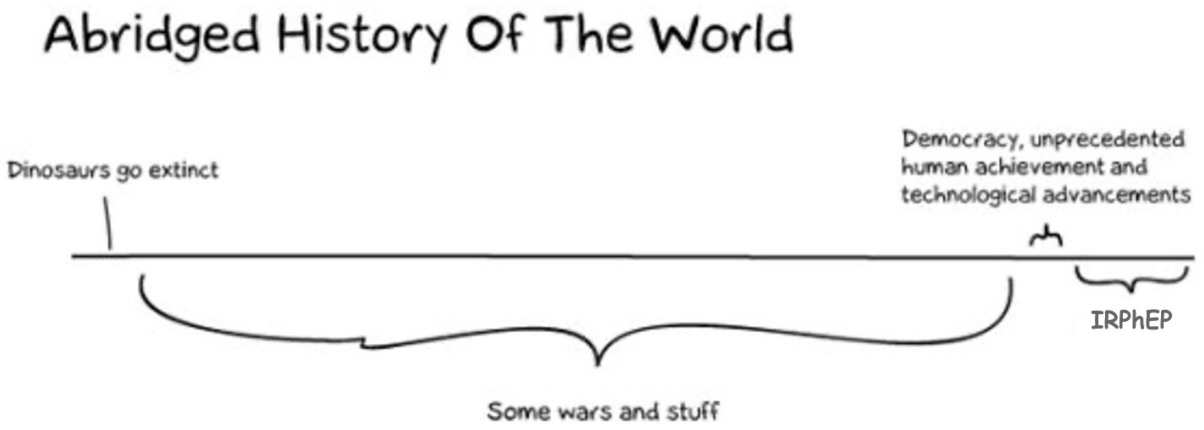
Idaho National Laboratory

Overview

- Recent changes in organization of IRPhE
- Current Status
  - 2021 Handbook
  - 2022 Handbook
    - New evaluation
    - Revisions
- Upcoming meetings
- Closing Comments



Reorganization of IRPhEP and the International Criticality Safety Benchmark Evaluation Project (ICSBEP)

- John Bess left Idaho National Laboratory in November 2021.
- NEA decided to restructure the organization of IRPhEP and ICSBEP
  - Prior to 2022, both projects were managed by a single individual
    - Blair Briggs, inception – 2014
    - John Bess, 2014 – 2021
  - As of 2022, the projects are to be managed separately, with a chair and vice-chair for each
  - NEA solicited nominations for each role, announcing IRPhE Chair and ICSBEP Chair and Vice-Chair in May 2022, then the IRPhE Vice Chair in Sept.
- IRPhEP: Mark DeHart, Chair – Patrick Blaise, Vice Chair – Ian Hill, Secretariat for WPRS
- ICSBEP: Catherine Percher (LANL) Chair – B. J. Marshall (ORNL), Vice Chair – Julie-Fiona Martin, Secretariat for WPNCS

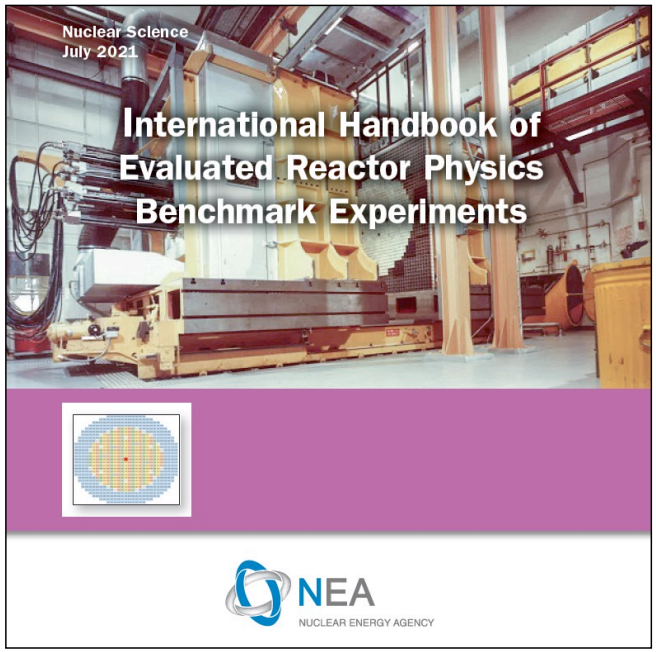
Latest Handbook Contributions

- 2021 edition
  - Technical Review Group gathered virtually in October 2020
  - 6 Minor Revisions
  - 2 New Evaluations
- 2022 edition
  - Technical Review Group gathered virtually in December 2021
  - 4 Minor Revisions
  - 1 New Evaluation

International Handbook of Evaluated Reactor Physics Benchmark Experiments

2021 Edition

- 25 Participating Countries
- 57 Reactor Facilities
- Data from 169 Experimental Series
  - 165 Approved Benchmarks
  - 4 DRAFT Benchmarks
- Available November 2022



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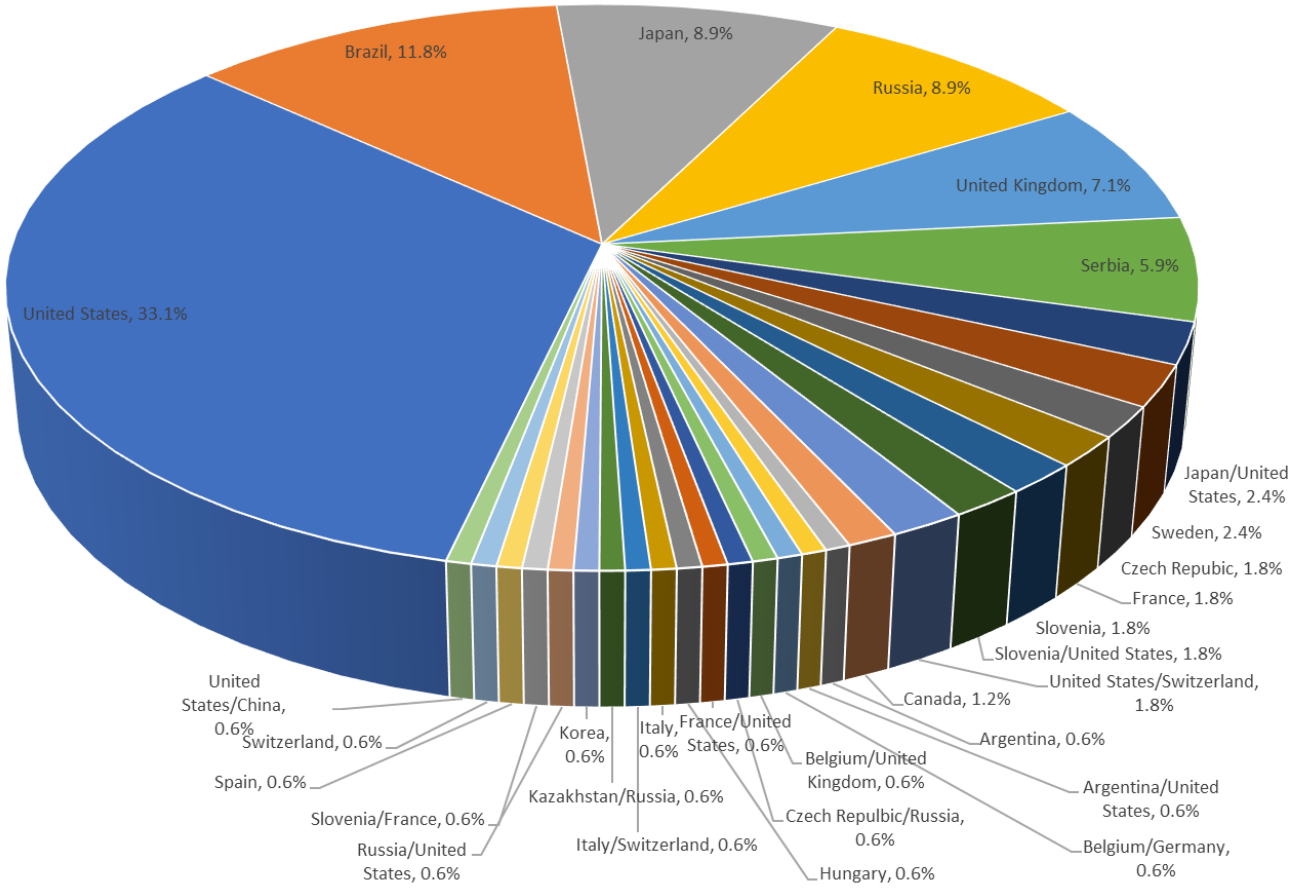
Breakdown of Current Reactor Facilities in IRPhEP Handbook

- **7 Pressurized Water Reactor (PWR)**
  - BEAVRS, DIMPLE, DUKE, EOLE, OTTOHAHN, SSCR, VENUS
- **3 Vodo-Vodynaoi Energetichesky Reactor (VVER)**
  - LR-0, P-Facility, ZR-6
- **0 Boiling Water Reactor (BWR)**
- **10 Liquid Metal Fast Reactor (LMFR)**
  - BFS-1, BFS-2, BR2, EBR-II, FFTF, JOYO, SNEAK, ZEBRA, ZPPR, ZPR
- **5 Gas Cooled (Thermal) Reactor (GCR)**
  - ASTRA, HTR10, HTTR, PROTEUS, VHTRC
- **2 Gas Cooled Fast Reactor (GCFR)**
  - PROTEUS, ZPR
- **5 Light Water Reactor (LWR)**
  - CROCUS, DIMPLE, IPEN(MB01), KRITZ, TCA
- **3 Heavy Water Reactor (HWR)`**
  - DCA, ETA, ZED2
- **1 Molten Salt Reactor (MSR)**
  - MSRE
- **1 Reaktor Bolshoy Moshchnosti Kanalniy (RBMK)**
  - RBMK(CF)
- **7 Space Reactor (SPACE)**
  - ORCEF, KRUSTY, SCCA, TOPAZ, UKS1M, ZPPR, ZPR
- **23 Fundamental Physics Reactor Measurements (FUND)**
  - ATR, BFS-1, BFS-2, CORAL(1), FCA, FR0, HECTOR, IGR, KUCA, LAMPRE, LR-0, MINERVE, NRAD, ORCEF, ORSPHERE, PBF, RA-6, RB, RHF, TREAT, TRIGA, ZEBRA, ZPR

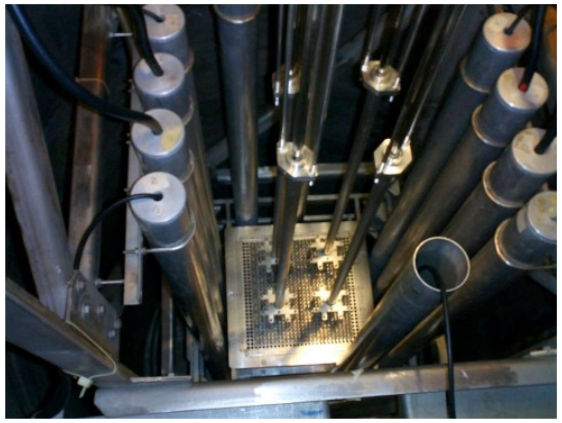
Handbook Contributions by Country

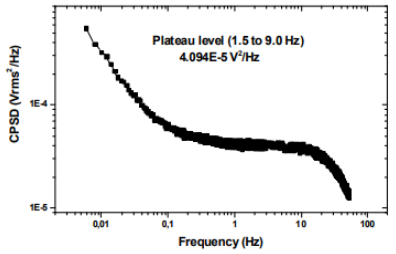


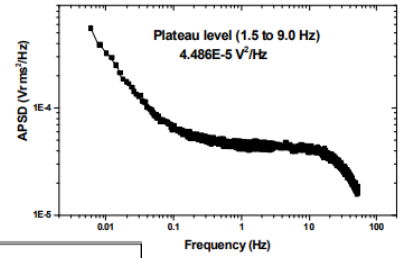
New Approved Handbook Evaluation

IPEN(MB01)-LWR-RESR-021

- Benchmark of Reactivity Determination to Support Validation of Evaluated Delayed Neutron Data
- Auto Power Spectral Density (APSD) and Cross Power Spectral Density (CPSD) methods used for kinetics parameters and reactivity worth assessments
- Two excellent papers on this work:
  - Diogo Feliciano dos Santos, Adimir dos Santos, Ricardo Diniz, “APSD up to 100 kHz dataset measured in the IPEN/MB-01 research reactor facility,” *Data in Brief*, **33**, 2020.
  - Diogo Feliciano dos Santos, Adimir dos Santos, “Zero-power noise up to 100 kHz in the IPEN/MB-01 research reactor facility,” Annals of Nuclear Energy, **152**, 2021





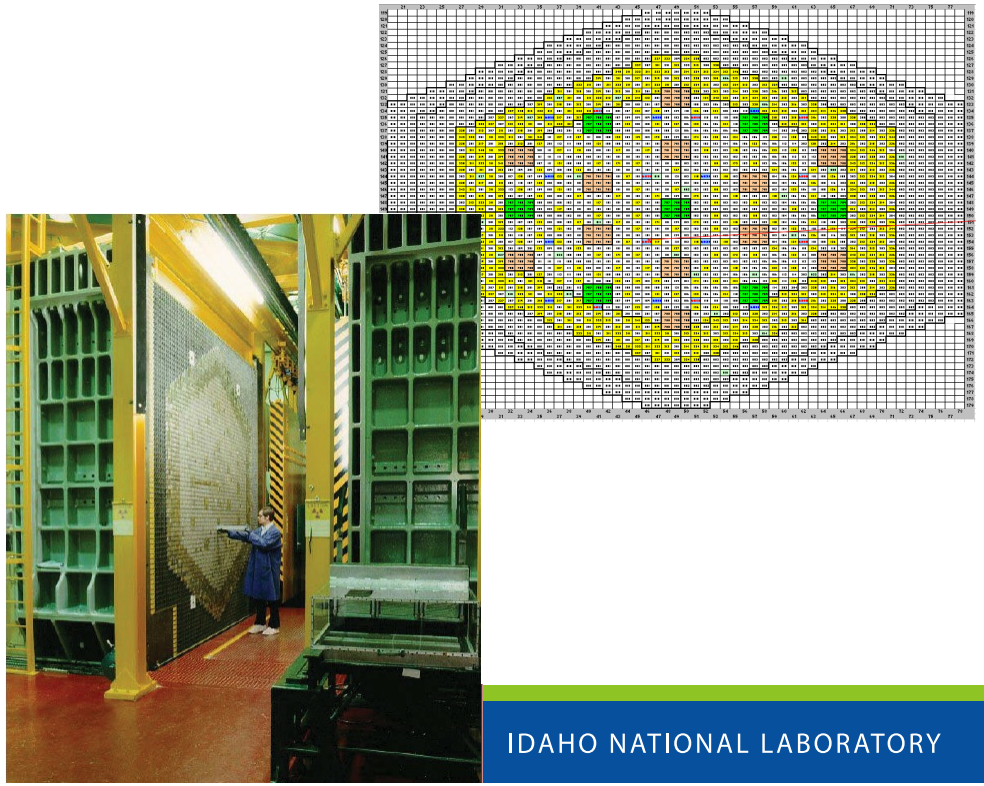


Delayed Neutron Group	β_i	$\sigma_{\beta_i}^{corr}$	$\sigma_{\beta_i}^{uncorr}$
1	2.805E-04	5.25E-06	1.87E-06
2	1.439E-03	5.85E-05	9.60E-06
3	1.379E-03	9.90E-05	9.20E-06
4	3.051E-03	9.90E-05	2.03E-05
5	8.603E-04	4.95E-05	5.74E-06
6	4.905E-04	2.25E-05	3.27E-06

Revised Handbook Evaluations (4/4)

ZPPR-LMFR-EXP-001, -002, -005, & -006

- Fix ambiguities in drawer orientation



Additional Items from 2021 meeting:

- Updates given on TVA-WB and MPCMIV Benchmarks
- JOYO IRPhE package reinstated
- IDAT Update

Recent and Upcoming meetings

- The 2022 IRPhE/ICSBEP TRG meetings planned for an in-person meeting in Paris in November 2022, but was postponed to allow completion of some benchmarks delayed due to COVID.
- The 2022/2023 IRPhE/ICSBEP meeting will be held in Paris, April 3-7, at NEA HQ along with a SINBAD meeting. IRPhE will meet on Monday, April 3.
- It is anticipated that both benchmark projects will continue to meet in tandem as many TRG members support both projects.
- SINBAD is more independent but may choose to co-locate with the other benchmark projects
- Date for the 2024 meeting will be set in April; anticipated to be scheduled for spring 2024 at NEA HQ.

Closing Comments

- IRPhE and ICSBEP Chairs and Vice-Chairs are currently coming up to speed with management of the projects – “on the job training”
- John Bess will join the April meetings in person to help with leadership transition.
- The IRPhEP continues to provide high-quality integral benchmark data
- Valuable for nuclear data testing, uncertainty reduction, criticality safety, reactor physics, advanced modeling and simulation
- Data and expertise contributed from 25 countries

- This Handbook enables current and future activities supported by experimental validation

Questions?