

PAUL SCHERRER INSTITUT



eurad

European Joint Programme
on Radioactive Waste Management



D. Rochman

EURAD WP8/Subtask 2.1: Status



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EURAD WP8 annual meeting, Oct 31 – Nov 2, 2023, Wetztingen,
Switzerland



Status: All done ! Thank you very much

- Papers/report

RESEARCH REPORT

Sensitivity and uncertainty analysis of Gundremmingen-A assembly B23 sample I2680 depletion calculation with Serpent 2

Authors: Sijja Häkkinen, Petteri Schillebeeckx, Marcus Seidl

Confidentiality: Public

VTT

RESEARCH REPORT

Gundremmingen-A assembly B23 sample I2680 depletion calculation with Serpent 2

Authors: Sijja Häkkinen, Petteri Schillebeeckx, Marcus Seidl

Confidentiality: Public

VTT

NENE 2019
28th International Conference Nuclear Energy for New Europe

Determination of the NPP Krško spent fuel characteristics with the Serpent and SCALE code systems

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Bojan Kurinčić

Validation of spent nuclear fuel decay heat calculations using Polaris, ORIGEN and CASMO5

EPJ Nuclear Sci. Technol. 7, 18 (2021)

© D. Rochman et al., Published by EDP Sciences, 2021
<https://doi.org/10.1051/epjn/2021017>

Available online at: <https://www.epj-n.org>

Nuclear Engineering and Technology

Contents lists available at ScienceDirect

Nuclear Engineering and Technology

journal homepage: www.elsevier.com/locate/nucengtec

Original Article

Uncertainty analyses of spent nuclear fuel decay heat calculations using SCALE modules

Ahmed Shama^{a,b,*}, Dimitri Rochman^b, Susanne Pudollek^c, Stefano Caruso^d, Andreas Pautz^{a,b}

frontiers | Frontiers in Energy Research

Original Research

published: 09 April 2022
doi: 10.3389/fenrg.2022.101076

Analyses of the bias and uncertainty of SNF decay heat calculations using Polaris and ORIGEN

OPEN ACCESS

EDITED BY: Gerit Van den Eynde, Belgian Nuclear Research Centre, Belgium

REVIEWED BY: Jurek Wlo, Massachusetts Institute of Technology, United States

REGULAR ARTICLE

OPEN ACCESS

EPJ Nuclear Sci. Technol. 8, 9 (2022)

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<https://doi.org/10.1051/epjn/2022007>

REGULAR ARTICLE

OPEN ACCESS

Validation of spent nuclear fuel decay heat calculations using Polaris, ORIGEN and CASMO5

EPJ Nuclear Sci. Technol. 7, 18 (2021)

© D. Rochman et al., Published by EDP Sciences, 2021
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REGULAR ARTICLE

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REGULAR ARTICLE

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Validation of spent nuclear fuel decay heat calculations using Polaris, ORIGEN and CASMO5

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REGULAR ARTICLE

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Spent fuel characterization analysis using various nuclear data libraries

Dušan Čalič^a, Marjan Kromar^b
Jožef Stefan Institute (JSI), Slovenia

Validation of spent nuclear fuel decay heat calculations using Polaris, ORIGEN and CASMO5

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Available online at: <https://www.epj-n.org>

30th International Conference Nuclear Energy for New Europe

M3 sam

Comparing Different Approaches to Calculating Decay Heat Power of a Spent Fuel Dry Storage Cask for Krško NPP

Chiehu Hursin

REGULAR ARTICLE

On the estimation of nuclide inventory and decay heat from the EURAD European project

Dimitri Alexandre Rochman^{1,*}, Francisco Álvarez-Velarde², Ron Dagan³, Luca Fiorito⁴, Sijja Häkkinen⁵, Petteri Schillebeeckx⁶, Marcus Seidl⁸

<https://doi.org/10.1051/epjconf/202124712008>

Spent fuel characterization analysis using various nuclear data libraries

Dušan Čalič^a, Marjan Kromar^b
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Available online at: <https://www.epj-n.org>

EPJ Web of Conferences 247, 12008 (2021)

PHYSOR2020

BOUNDARY CONDITION MODEL CHARACTERIZATION AND FINAL ASSESSMENT OF A PWR ASSEMBLY

Augusto Hernandez-Solis¹, Klemen Ambrožič², Marjan Kromar³, Peter Schillebeeckx³, Aleksander Žerovnik⁴

Annals of Nuclear Energy 161 (2021) 108415

Contents lists available at ScienceDirect

Annals of Nuclear Energy

journal homepage: www.elsevier.com/locate/anucene

On the use of criticality and depletion benchmarks for verification of nuclear data

L. Fiorito^{a,*}, P. Romojaró^b, O. Cabellos^b, M. García-Hormigos^c, A. Hernandez-Solis^d, S. Sánchez-Fernández^e, A. Stankovskiy^f, G. Van den Eynde^g, G. Žerovnik^{h,*}

FORMATO PFI-PN-04.1

Ciemat DIVISION DE FUSION NUCLEAR	INFORME	DFN/IN-01/II-21	HOJA 1 DE 28
	REF. EXTERNA		REVISION 0

TITLE: Contribution of CIEMAT to EURAD WPS Task 2.1 on uncertainty propagation in depletion analyses.

AUTHORS: F. Álvarez-Velarde, S. Panizo Prieto

- Students: EPFL (A. Shama), CIEMAT (S. Prieto), UPM, JSI (G. Letnar), SCK-CEN (D. Houben, A. Bengoechea, F. Gimaldi)
- Presentations, training courses, meetings: ...

Subtask 2.1: conclusion

- More work is needed, but we have achieved a number of agreed conclusions:

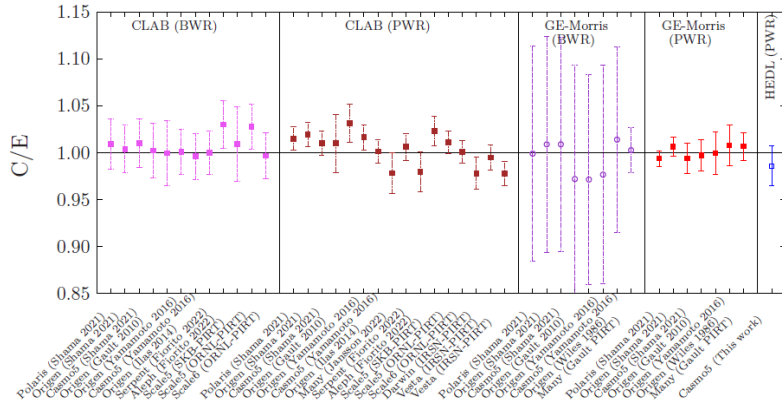


Fig. 7. Plots of the average C/E values for the decay heat

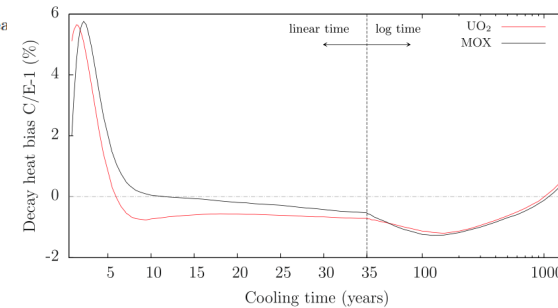
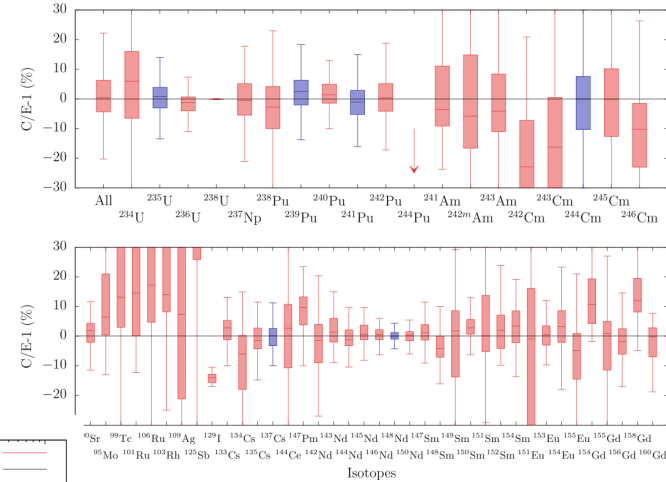


Fig. 9. Decay heat biases obtained from the mean biases on nuclide inventory.

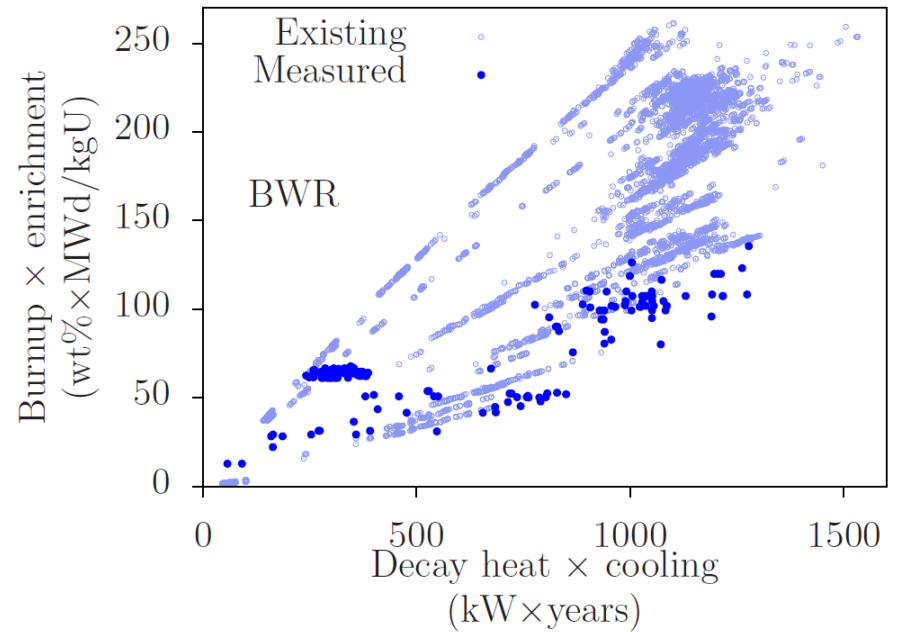
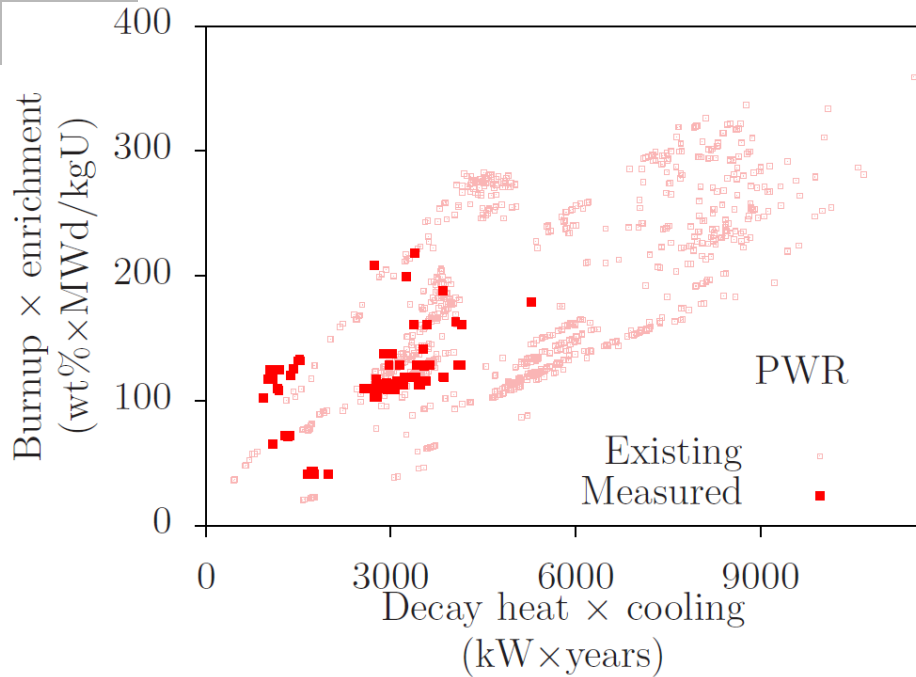
Table 6. Summary of the recommendations concerning some SNF calculated nuclide concentrations and decay heat, for the cooling period between 1 and 1000 years

	^{148}Nd	^{137}Cs	^{235}U	^{239}Pu	Average burnup	Decay heat
Uncertainty	4%	5%	4%	4%	5%	> 4%
Bias	-0.1%	-0.4%	+0.2%	+2.5%	-	See Figure 9

The uncertainty represents one standard deviation (1σ).

Subtask 2.1: conclusion

- More work is needed, but we have achieved a number of agreed conclusions:

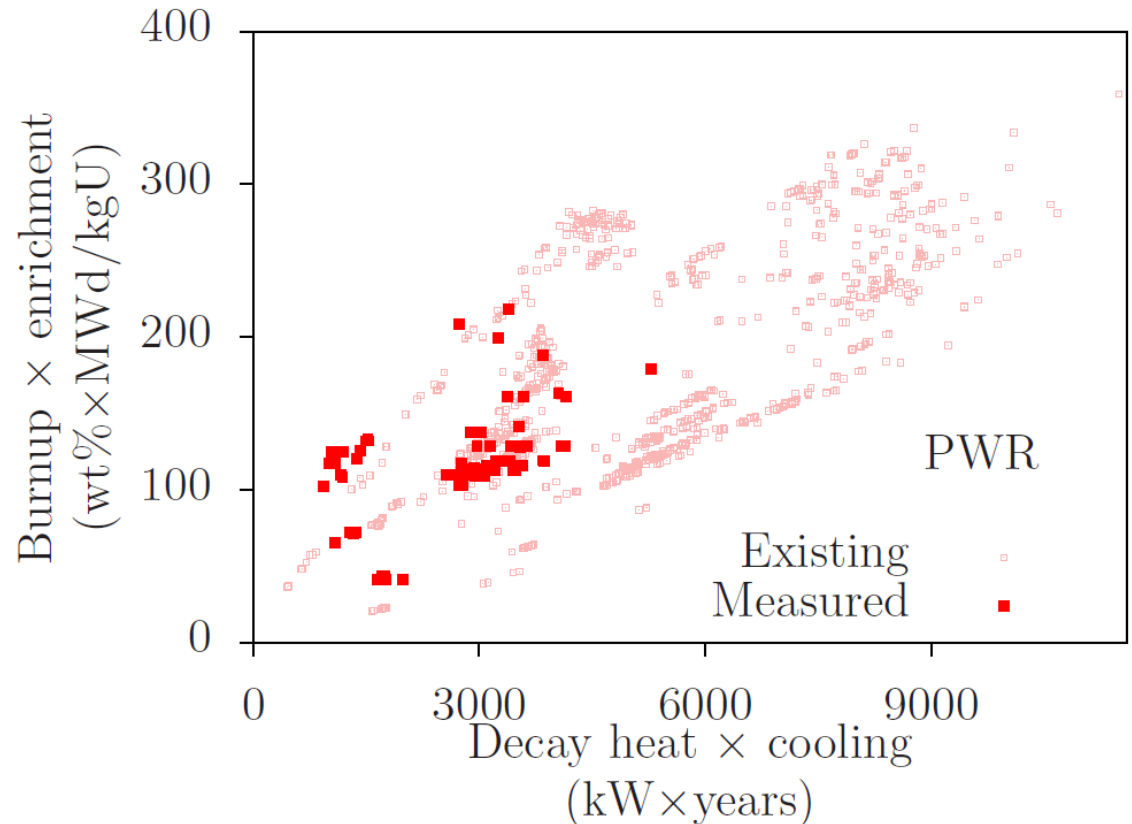


Experimental needs

- Limited overlap between measured SNF decay heat and SNF currently in storage

- Current SNF:

- high enrichment,
- high burnup,
- long cooling,
- high decay heat

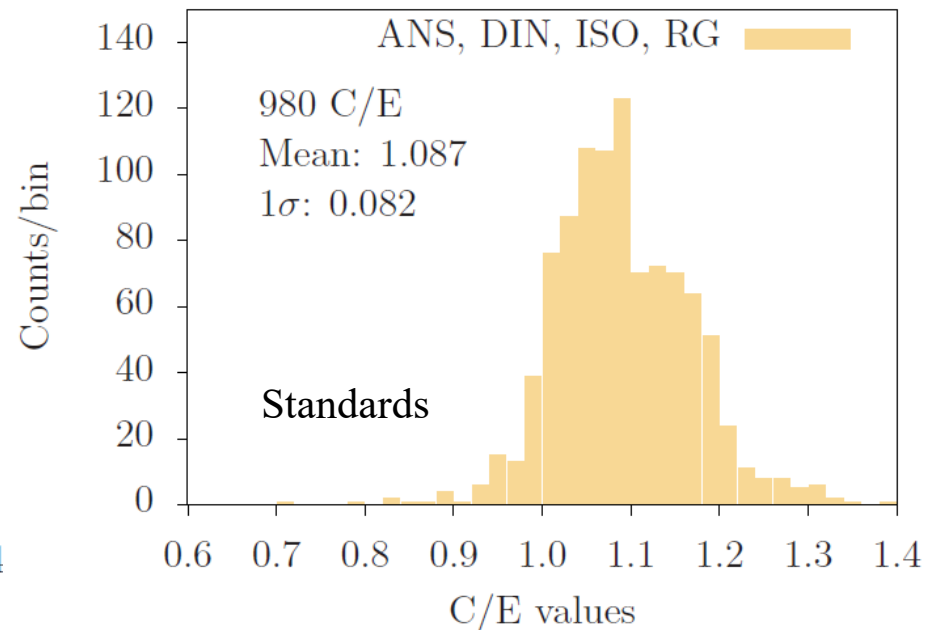
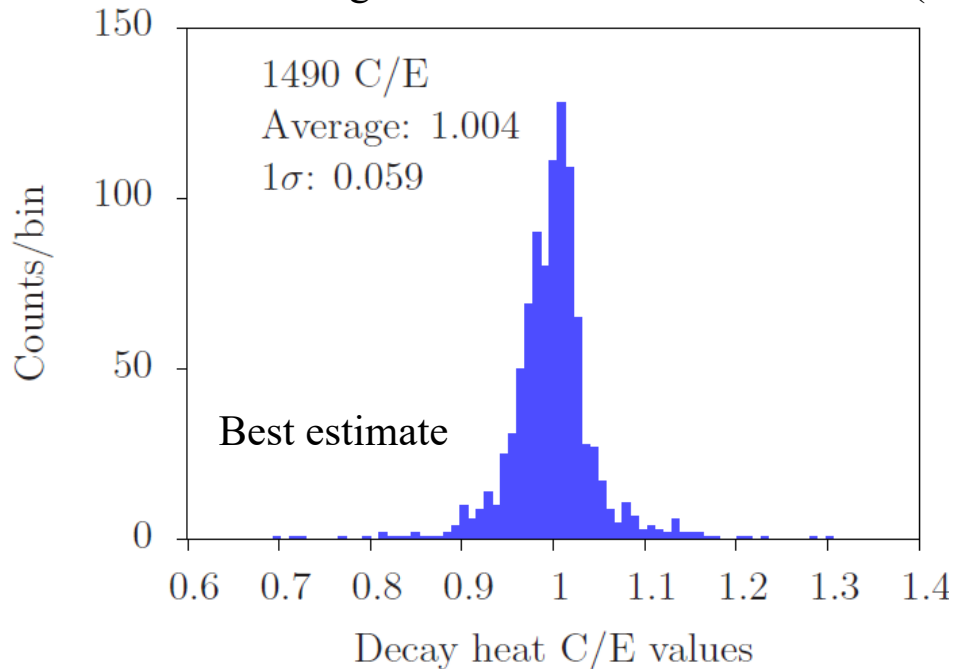


- No measurements for MOX, and for VVER or CANDU fuels
- Only one (currently in Sweden) existing calorimeter (two additional in design/plan phase, France and Switzerland)

Decay heat estimation

- How well can we estimate SNF decay heat ?

Histograms of the ratios of calculated (C) over experimental (E) decay heat values



- Best-estimate calculations provide good average C/E, but large 1σ
- Standard calculations provide on average over-estimated values (but not systematically)

- Current experimental uncertainties: between 1 and 5 %



European Joint Programme
on Radioactive Waste Management

Newsletter 14
September 2023

EURAD's final annual event!
TAKE A LOOK AT THE DRAFT AGENDA



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 - [EURAD-PREDIS Summer School](#)



Newsletter 14
September 2023

INTERVIEW WITH ANDERS SJÖLAND (SFC WP LEADER)

In a nutshell, could you describe how SFC contributes to a safer disposal of spent nuclear fuel?

The spent nuclear fuel has a number of very dangerous properties, which make us go to such length to safely dispose of it, literally forever. These properties are the radiation, the ability to become critical, the decay power giving heat, and the nuclide inventory giving radiation on release (as well as, in some cases, being chemically toxic). In order to safely handle the spent fuel, these properties must be accurately known in all steps of the back-end of the nuclear fuel cycle. There are limits on how many of these can be accepted in the various parts of the cycle

information on the composite nuclides. For the operational situation, it is not possible to routinely destroy the fuel in order to analyse it.



Simply put, a one sigma uncertainty of 2 % is a realistic aim for a well characterised fuel. For other fuels, it has been shown in a number of prominent SFC journal papers that the uncertainties in nuclear data (cross sections etc.) can be up to 10 % on the calculated decay power. The question on the number of sigma's to apply is a complicated one because of the complicated statistics of the spent fuels, and is the focus of an intense international debate in various organisations. The result

P. 3

Recommendations 2/3

- Current experimental uncertainties: between 1 and 5 %
- Current calculated uncertainties: between 2 and 10 %
 - Nuclear data
 - Operating conditions & Modeling impact
 - Manufacturing tolerances
 - Burnup induced changes
- Need for new measurements (burnup, enrichment, cooling time, fuel type) and facilities
- Need for improved theoretical understanding and nuclear data
 - For different cooling periods
 - For different fuel types
- Recommendations are needed for the use of standards, calculation methods, code improvement

Recommendations 3/3

- Redundancy
 - Experimental (multi measurements of same SNF, and multi facility)
 - Simulation (double check, different codes)

- Comparisons of code implementation
 - Module
 - Solvers, inputs, assumed values

- Use of blind benchmarks
 - Based on experimental values
 - Or computational benchmark

- User effect due to
 - Interpretation of the same information
 - Ambiguity of definition
 - Different options
 - Mistakes

Subtask 2.1: into the future

- See the update of the SOTA report
- How to continue (what did we miss, adapt our work with respect to the new needs)

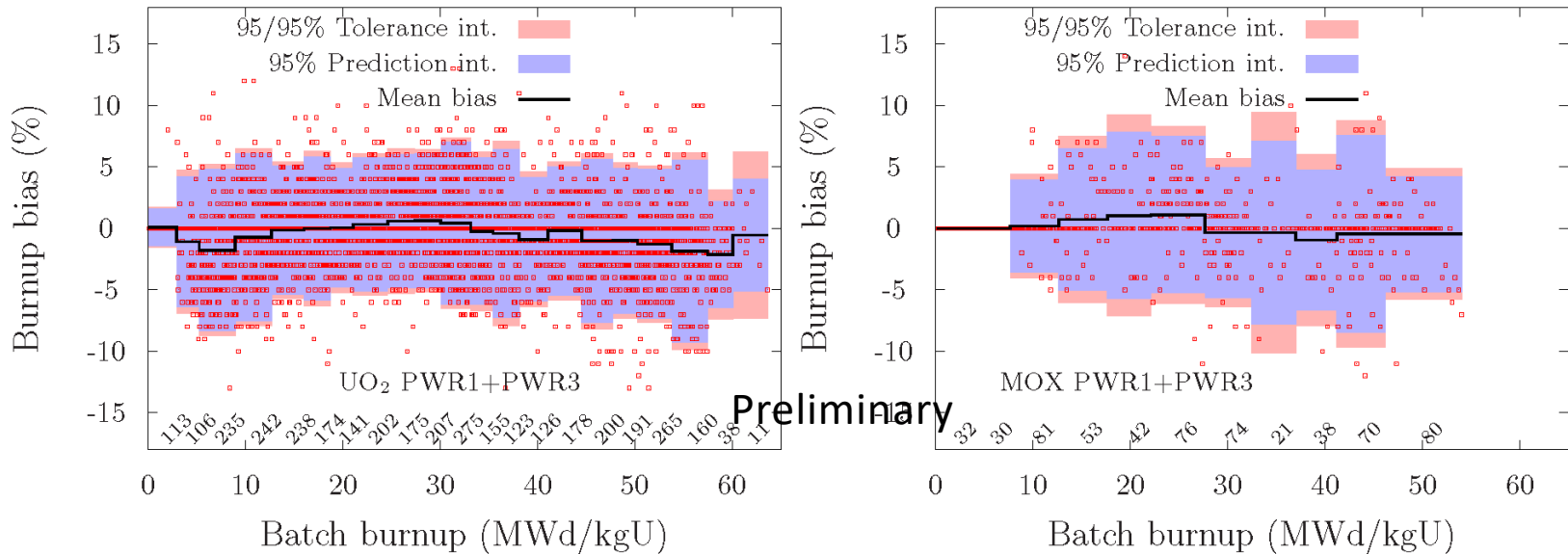


Fig. 4. Burnup biases considering only UO₂ (left) or MOX (right) batch of assemblies. Numbers in italics indicate the number of batches in each bins.

Wir schaffen Wissen – heute für morgen

