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European Joint Programme on Radioactive Waste Management

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EURAD WP8/Subtask 2.1: Status

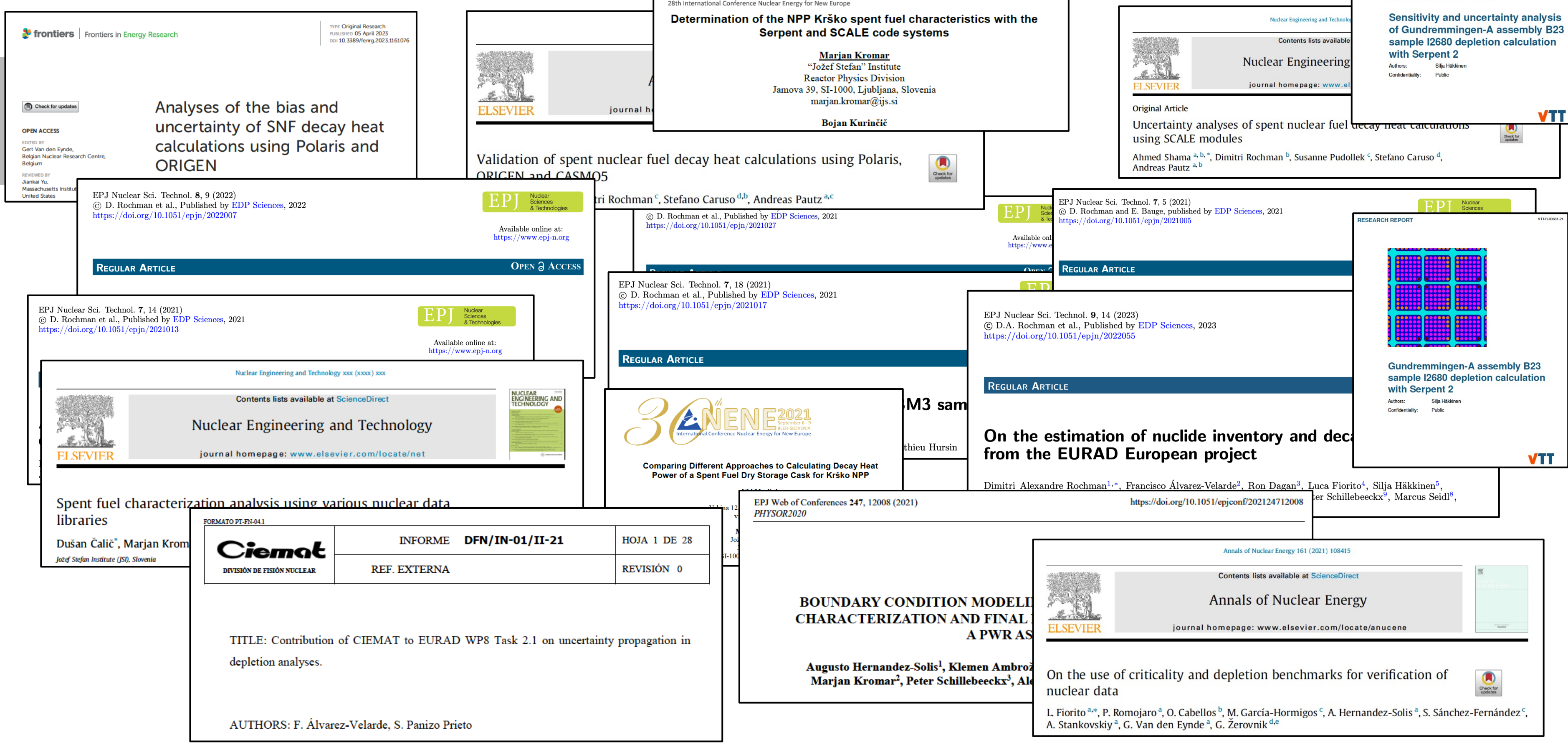
The project leading to this presentation has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 847593.

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

Zertifiziertes Managementsystem STARS ISO 9001

Status: All done ! Thank you very much

- Papers/report



- 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 achived a number of agreed conclusions:

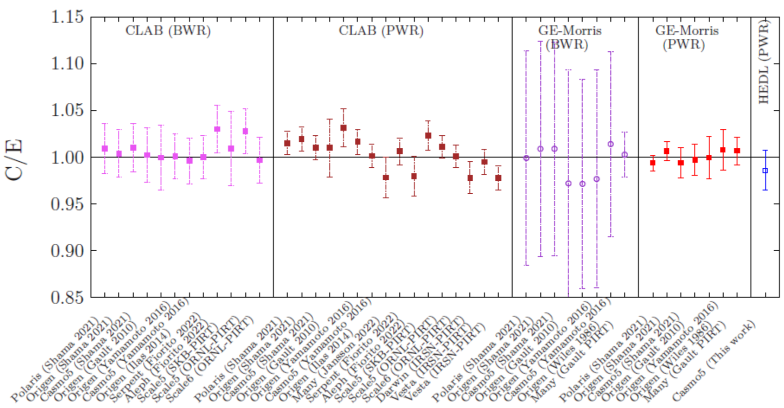
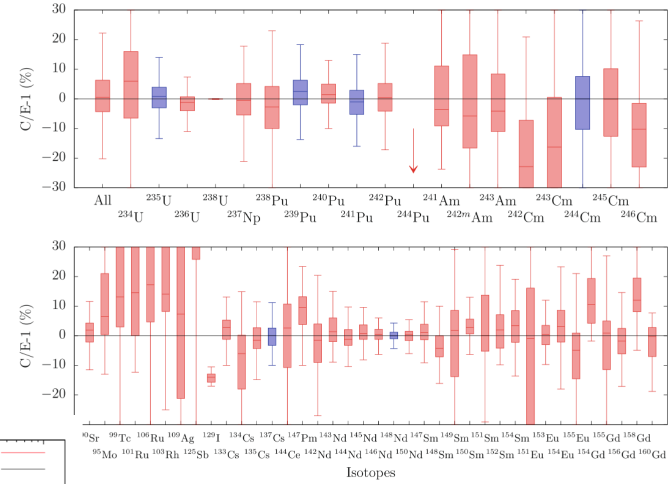


Fig. 7. Plots of the average C/E values for the decay hea



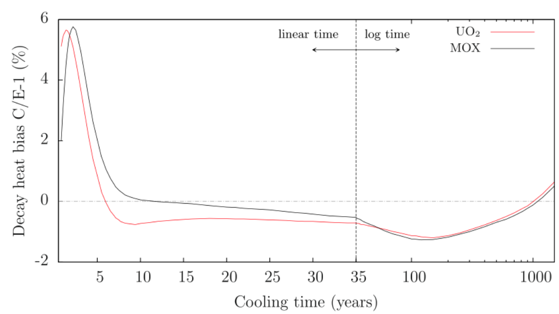


Fig. 9. Decay heat biases obtained from the mean biases on nuclide inventory.

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

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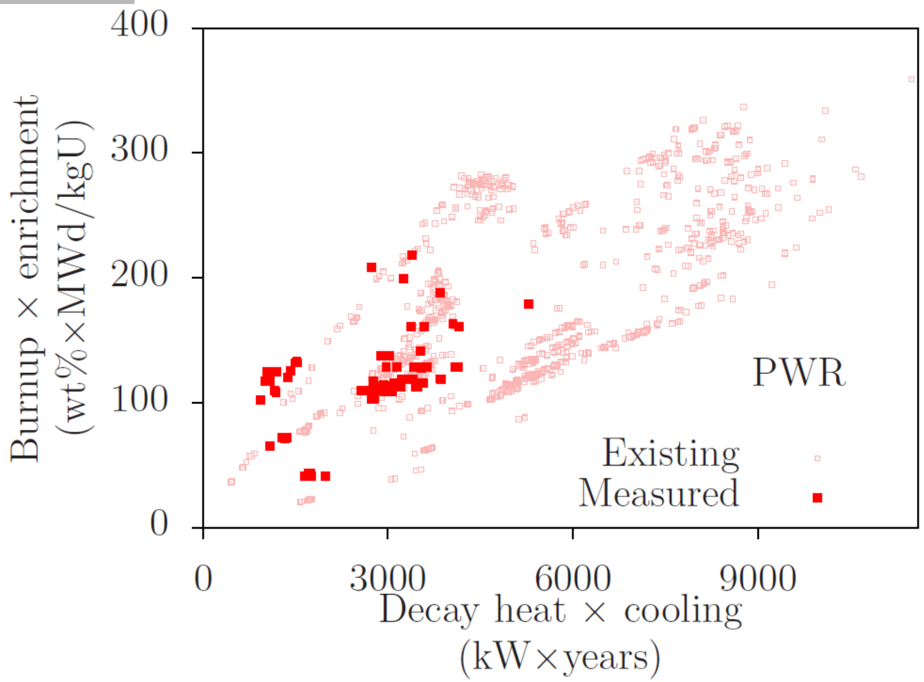
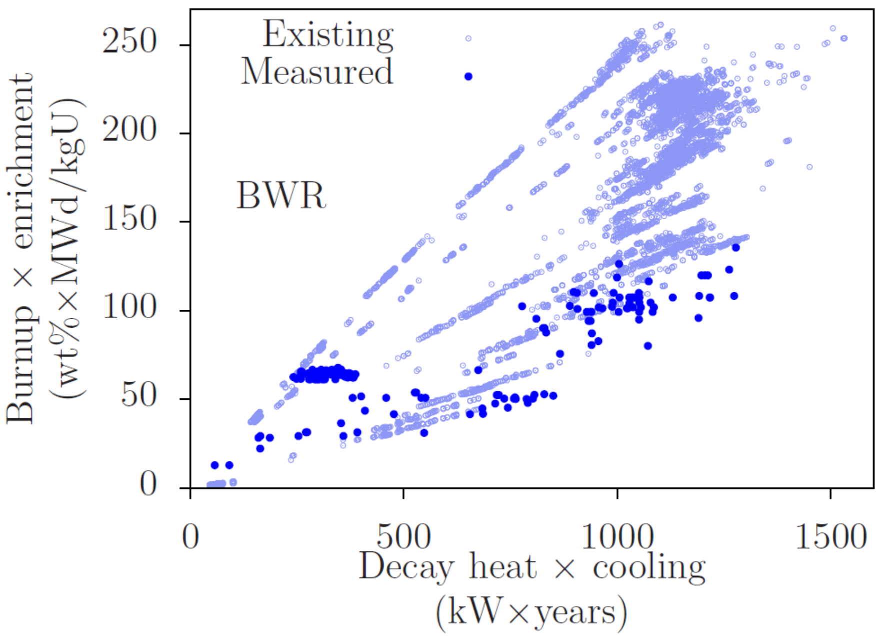
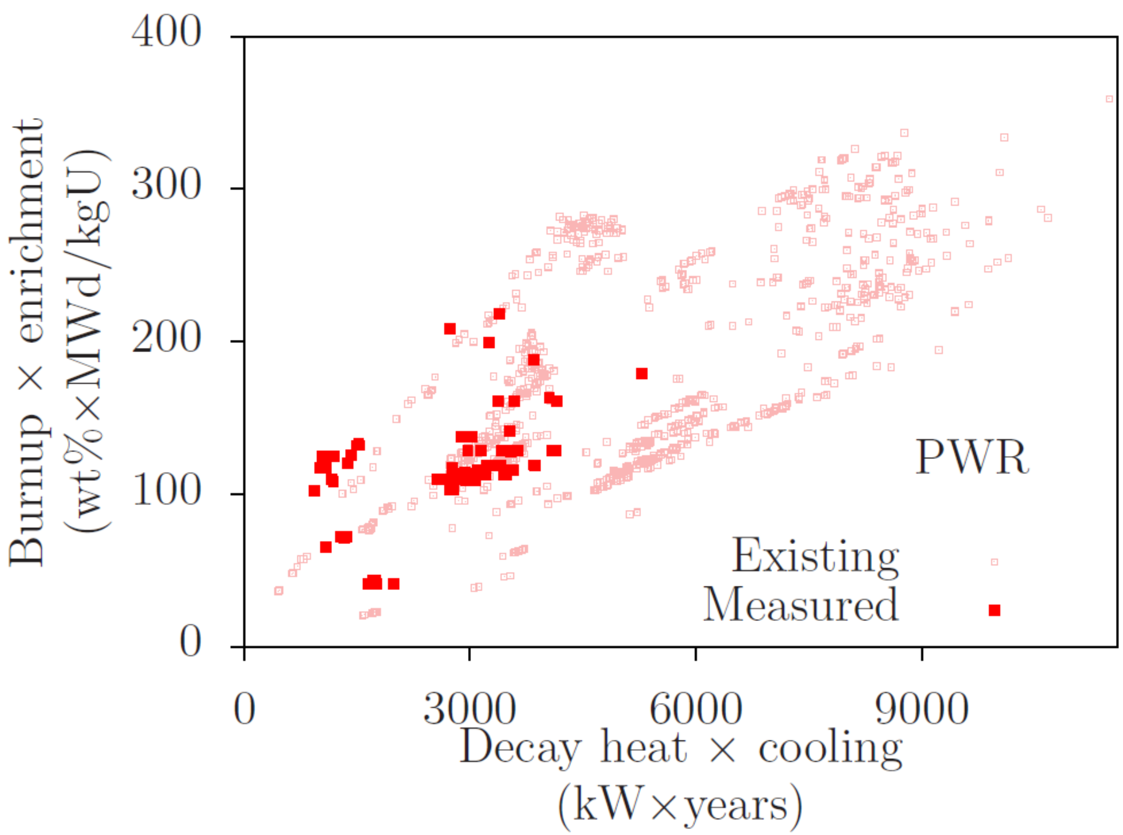




Experimental needs

- Limited overlap between measured SNF decay heat and SNF currently in storage
- Current SNF:
  - high enrichment,
  - high burnup,
  - long cooling,
  - high decay heat

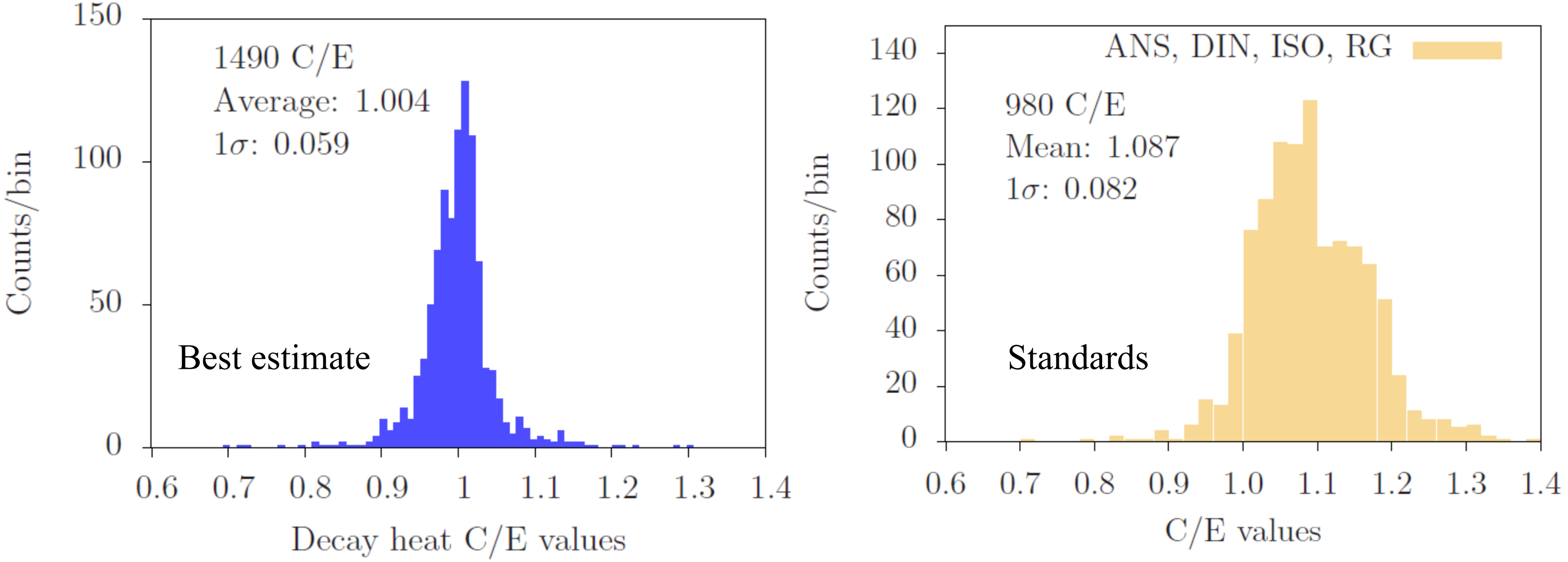


- No measurements for MOX, and for VVER or CANDU fuels
- Only one (currently in Sweden) existing calorimeter (two additional in design/plan phase, France and Switzerland)

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 1**σ**
- Standard calculations provide on average over-estimated values (but not systematically)

Recommendations 1/3

- Current experimental uncertainties: between 1 and 5 %

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Newsletter 14
September 2023

EURAD's final annual event!

TAKE A LOOK AT THE DRAFT AGENDA

Table of contents

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Newsletter 14
September 202

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

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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)

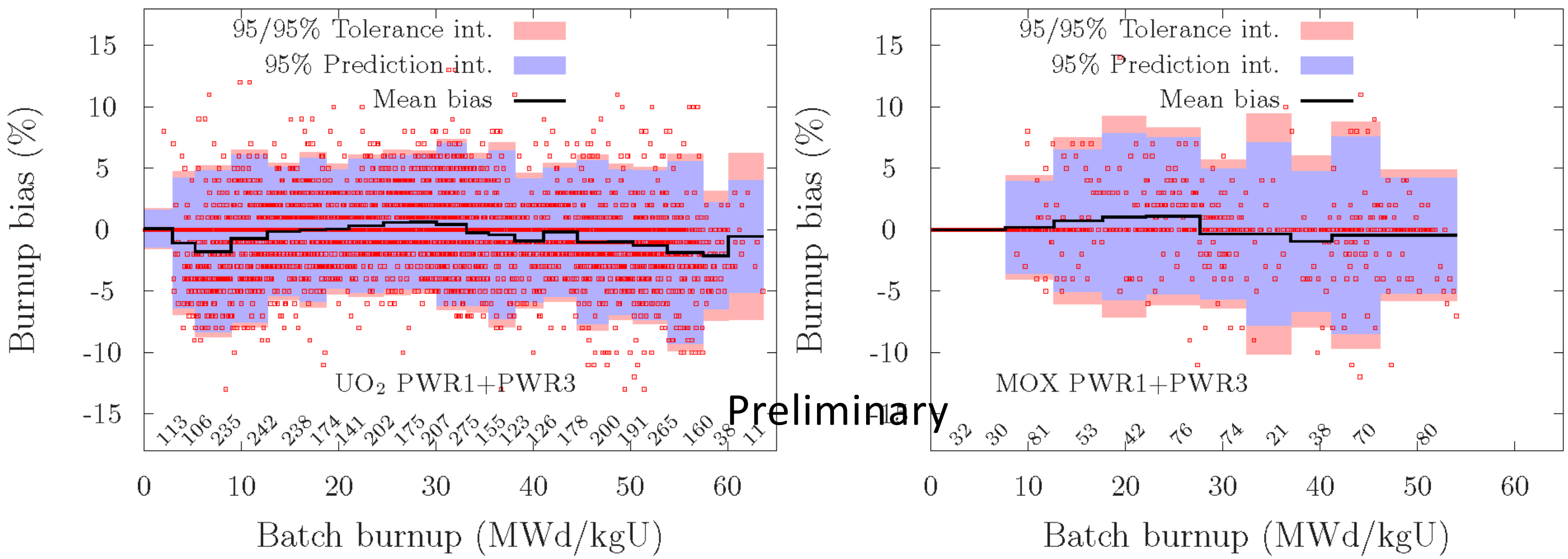

Fig. 4. Burnup biases considering only UO$_2$ (left) or MOX (right) batch of assemblies. Numbers in italics indicate the number of batches in each bins.

Wir schaffen Wissen – heute für morgen