PAUL SCHERRER INSTITUT

PSI

D. Rochman

SG12: Decay heat for existing SNF
Short report of the 2nd meeting

27th WPNCS, July 1th, 2022, OECD Headquarters, Paris, France

Zertifiziertes Managementsystem STARS ISO 9001

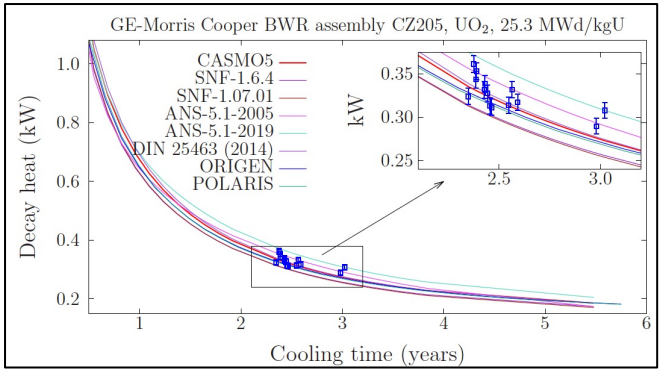
Subgroup general goal

- Goal: Provide users with reliable estimations of SNF-DH
  - Spent fuel from existing power plants
  - Decay heat for specific cooling periods (to be determined (*e.g.* < 3days, >months, years, decades, more))

- Intermediary steps:
  - Knowledge exchange, discussion, presentations
  - Report SOTA (state of the art)

- Preparation:
  - New benchmark
  - Measurement needs and possibilities

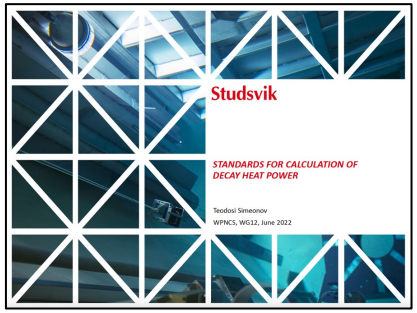
- Links:
  - NEA (WPEC, RW)
  - IAEA (NE, NA)
  - EU, national, international activities

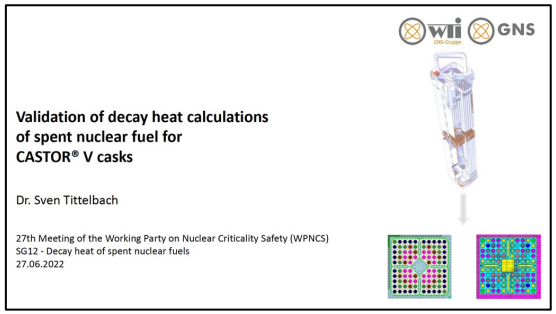


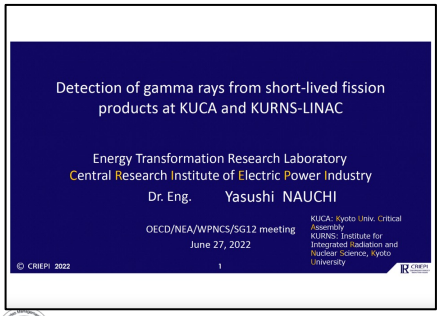
Main outcome of meeting

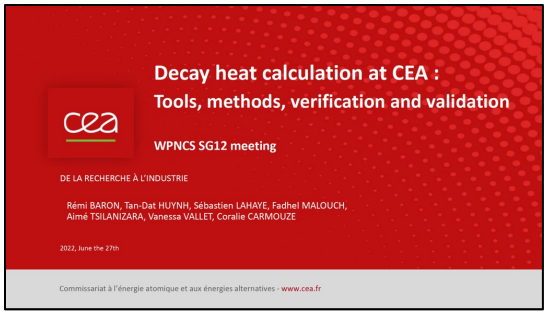
- 62 participants, 21 in person
- 7 technical presentations, 2 overview presentations (1 RWMC, 1 WPNCS)
- Discussion on the SG12 report

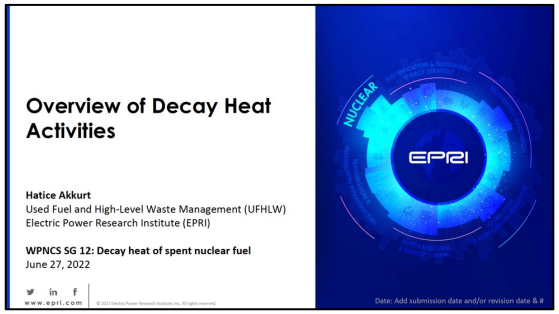
- Decision on future computational benchmark
- Letter of support for the KKG calorimeter, interest in a joint project
- Need of new measurements









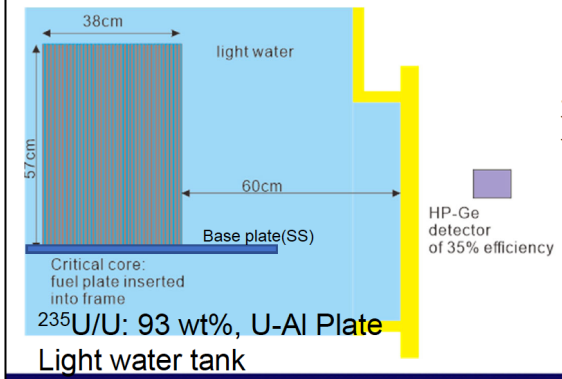


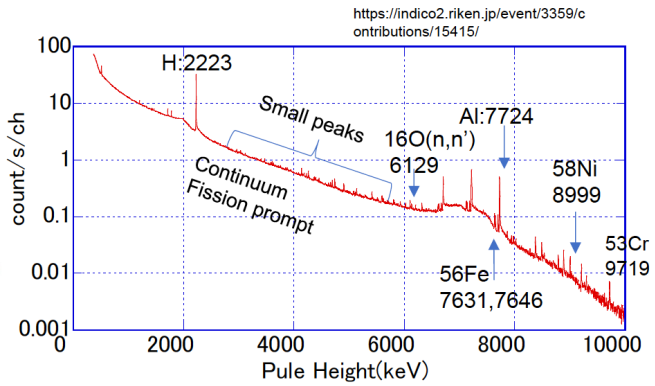
Y. Nauchi - 2 presentations (CRIEPI, Japan)

- Measurements of g-rays from short lived fission products (< 4sec)
  - Validation of JENDL FY and decay data
  - Critical facility & nTOF
- Need to simulate bremsstrahlung ray for Sr90 to Y90
  - Sr90 emits very few gamma-ray
  - Signs at Fukushima NPP of high dose on Sr filter -> bremsstrahlung

Critical Experiments

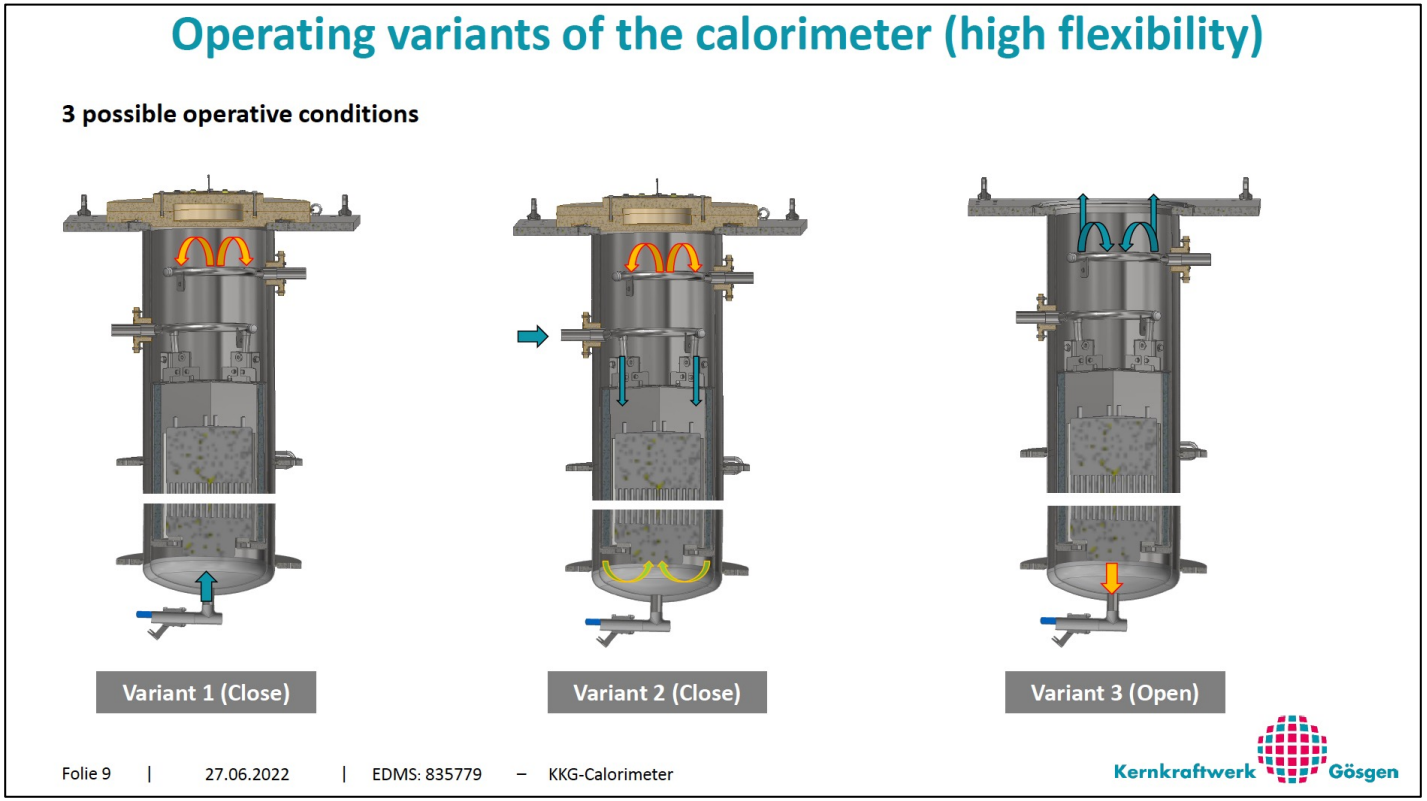
- γ ray spectroscopy for KUCA to establish a technique to identify and quantify reactions occurring in a critical core.
- Spectrum with good resolution & high count rate (13kcps)





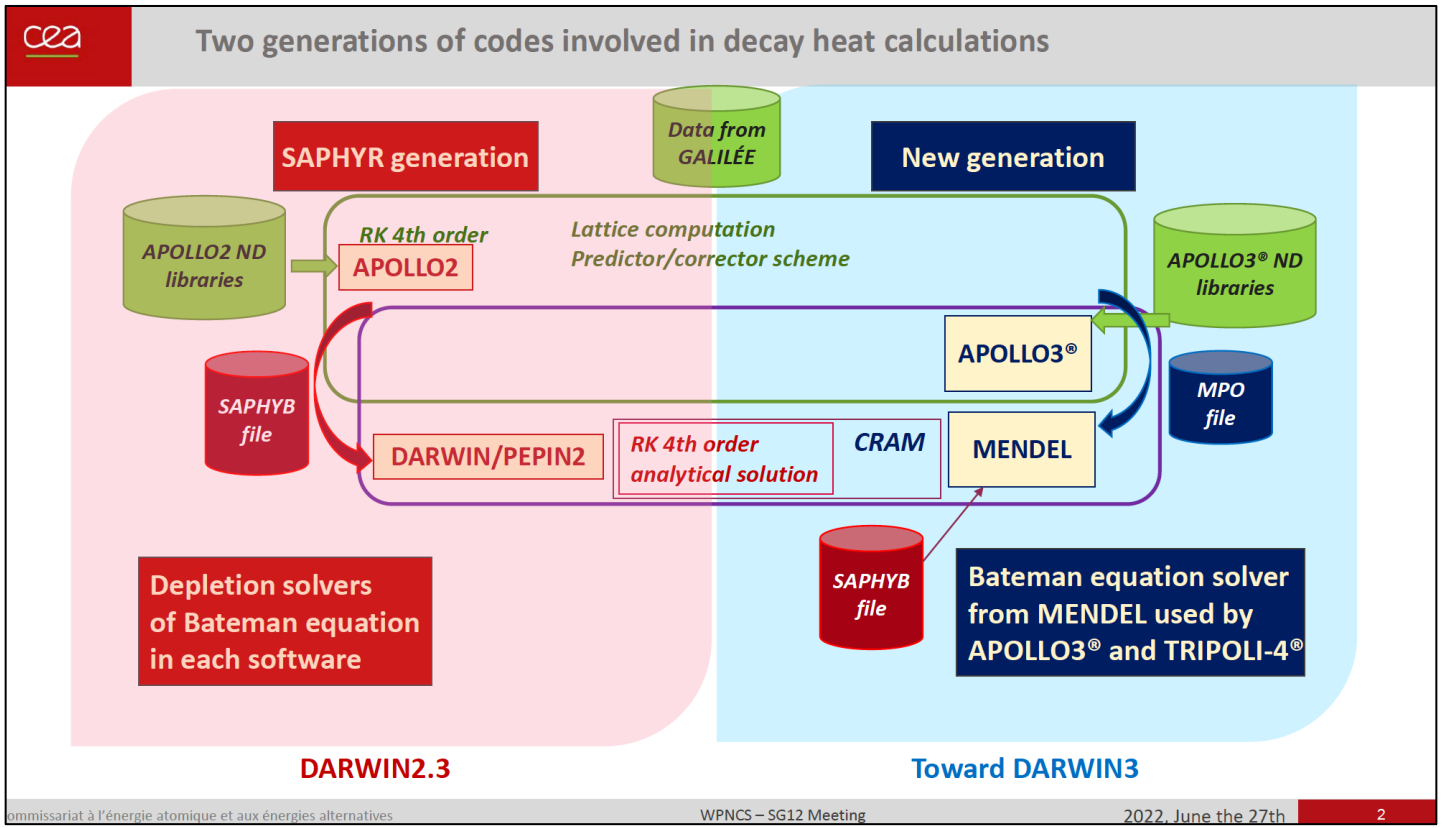
S. Caruso - presentation (KKG, Switzerland)

- Project of a new calorimeter at the KKG wet storage pool
  - Need of DH measurement for high burn-up SNF, high enrichment, MOX
  - Need of more precise data (1-3%) for transport, storage, optimization
  - Soon submitted to the Swiss regulator
  - Define SNF of interest with NAGRA



S. Lahaye - presentation (CEA, France)

- Calculation and validation (decay heat and PIE nuclides)
  - DARWIN2.3 (now), DARWIN3 with MENDEL development (later)
  - PIE nuclide concentration, CLAB, HEDL, GE-Morris, MERCI
  - DH: C<E
  - Interest in new DH measurements & benchmark

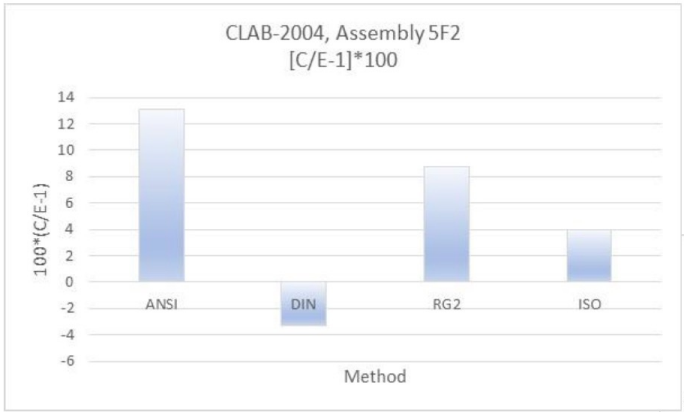


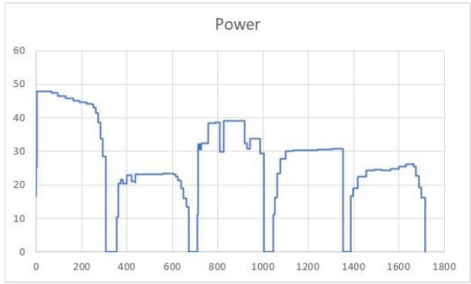
T. Simeonov - presentation (Studsvik, USA)

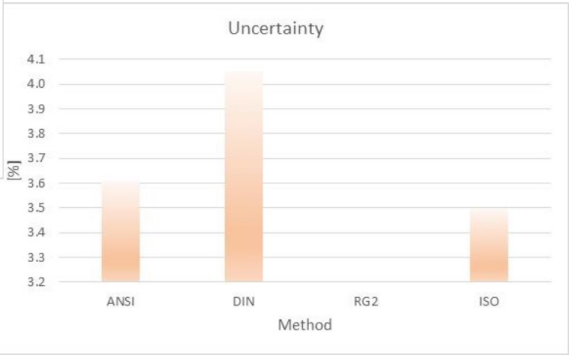
- Review of DH “standards”:
  - ANSI, DIN, NUREG, ISO comparison
  - Proposal to make a code available for DH standards
  - “section 6”

SNF CODE, ILLUSTRATION

- Burnup 47.4 MWd/kgU
- Decay time 4724 days



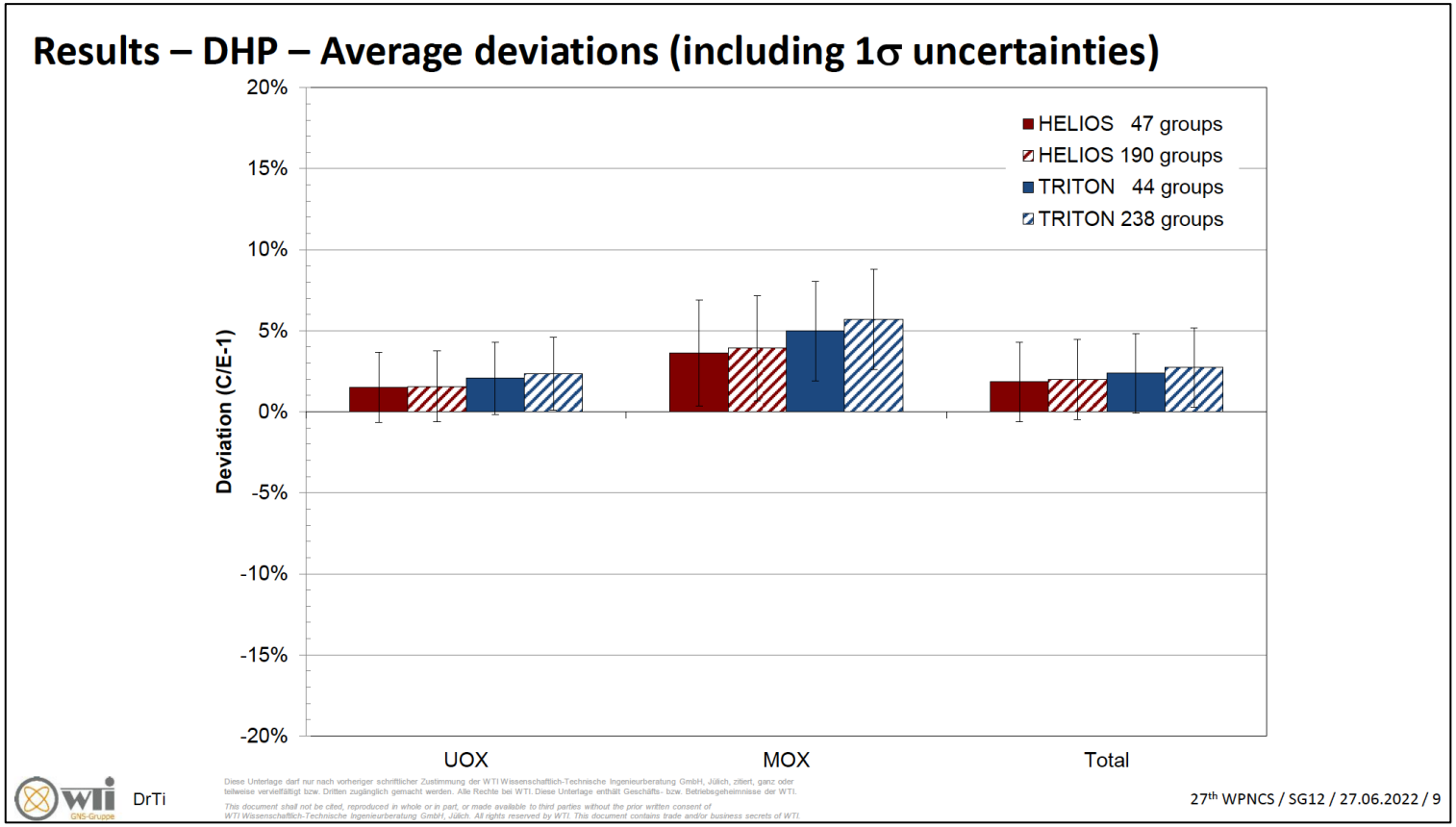




Studsvik

S. Tittlebach- presentation (WTI, Germany)

- DH validation for CASTOR V casks:
  - Based on PIE nuclide concentration LWR-PROTEUS and ARIANE
  - SCALE/TRITON and HELIOS , C>E
  - Derivation of correction factors



H. Akkurt - presentation (EPRI, USA)

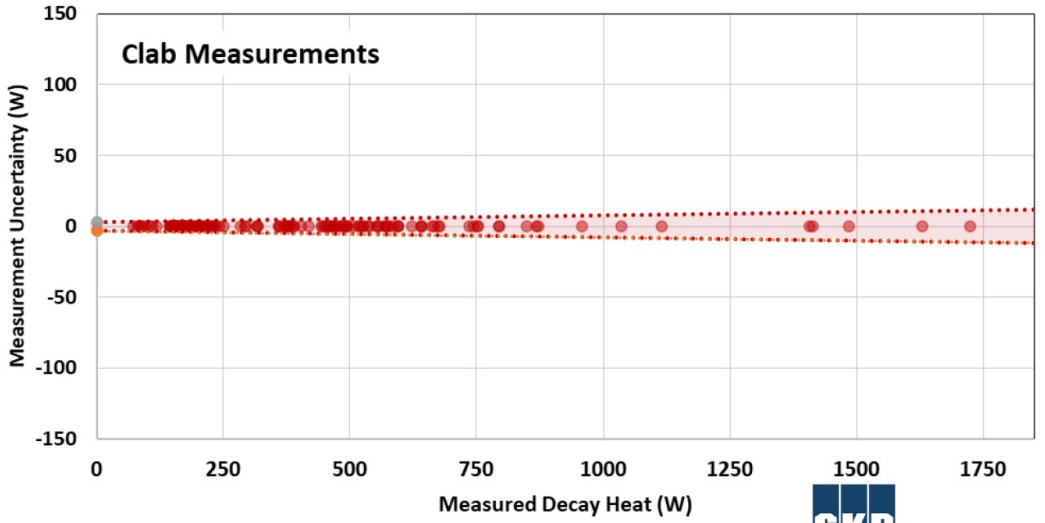
- PIRT Report
- EPRI-SKB collaboration
- Extended Storage Collaboration Program

Extending Validation Range for Decay Heat

	Clab-1*	Clab-2**	Clab-3***
Measurement interval	2003-2004	2005-2010	2017-2021
Number of Measurements	109	95	51
Enrichment range (%)	2.1-3.4	2.1-3.7	2.1-4.1
Burnup range (GWd/MTU)	15-51	20-50	20-55
Cooling time range (Years)	11-27	11-27	**1.5-35**
Decay heat range (W)	57-712	91-850	**71-1724**

Recent measurement campaign (2017-2021), significantly extended decay heat validation ranges for cooling time and decay heat

*Published in SKB Report R-05-62 in 2006
**Some validation results published (journal articles) without full specifications
***Not yet published



Uncertainty analysis is still ongoing but preliminary analysis indicate that measurement uncertainty is less than 1% for high decay heat

22

SKB EPRI

Reporting

- Main goal of the SG12: SOTA report (available on Overleaf)

Contents

Executive Summary . . . vi
List of terms . . . vii
1 Introduction [All] . . . 1
2 Motivation [All] . . . 2
2.1 Decay heat for short cooling times . . . 2
2.2 Decay heat for intermediate cooling times . . .
2.3 Decay heat for long cooling times . . .
3 Definition . . .
3.1 Spent Nuclear Fuel [K. Govers, V. Leger] . . .
3.2 General Spent Nuclear Fuel Characterization . .
3.3 Decay heat [A. Sjöland] . . .
3.3.1 Definition by DOE [P. Petkov] . . .
3.3.2 Definition from standards . . .
3.4 Burn up [K. Govers, P. Alvarez] . . .
3.4.1 Calculated burnup . . .
3.4.2 Measured burnup . . .
4 Physical origin of decay heat, key contributors [R. Da
4.1 Overview . . .
4.2 Delayed fission . . .
4.3 Actinides . . .
4.4 Fission products . . .
4.5 Activation products . . .
5 Measurements . . .
5.1 Calorimetric measurements . . .
5.1.1 General information . . .
5.1.2 Details . . .
5.2 Gamma and beta measurements . . .
5.2.1 Ion chamber measurements . . .
5.2.2 Detection of gamma rays from short-lived
5.3 Differential measurements . . .
5.3.1 Pulse measurements . . .
6 Calculation methods . . . 26
6.1 Simple formula [R. Dagan] . . . 26
6.2 Delayed fission [V. Vallet, O. Bremnes, F. Laugier] . . . 27
6.3 Standards [T. Simeonov, V. Hannstein] . . . 28
6.3.1 DIN 25463-1 and -2 standards, 2014 . . . 30
6.3.2 US NRC RG 3.54, revision 2, 2018 . . . 33
6.3.3 JAEA standard, JAERI-M 91-034, 1991 . . . 36
6.3.4 ANS standards . . . 37
6.3.5 ISO 10645 (2022) . . . 41
6.4 Summation and best estimate methods [D. Rochman, L. Giot, A. Algora, M. Fallot] . . . 42
6.4.1 Summation method . . . 42
6.4.2 Case specific approximations . . . 43
6.4.3 Nuclear data . . . 46
6.4.4 TAGS data [L. Giot, A. Algora, M. Fallot] . . . 47
6.4.5 GRS best estimate method uncertainty analysis [Pl. Petkov] . . . 50
6.5 Methods for depletion solvers . . . 51
6.6 Uncertainties [P. Petkov] . . . 54
6.6.1 Safety factor definition . . . 54
6.6.2 initial geometry and density uncertainty . . . 54
6.6.3 fuel mass uncertainty . . . 55
6.6.4 enrichment uncertainty . . . 55
6.6.5 power operation uncertainty . . . 55
6.6.6 uncertainty due to nuclear reactions . . . 55
6.6.7 variations in moderator density (coolant pressure, temperature) . . . 55
6.6.8 burnable absorber . . .
6.6.9 activation of construction mate
7 Computer codes and nuclear data libraries .
7.1 CEA [F. Malouch, S. Lahaye, A. Tsil
7.2 ORNL [G. Ilas] . . .
7.3 SNF [T. Simeonov] . . . 57
7.4 FISPIN [R. Mills] . . . 58
7.5 EVOLCODE [P. Alvarez] . . . 58
7.6 VESTA [R. Ichou] . . . 59
7.7 Nuclear data libraries . . . 59
7.7.1 Library processing-CEA [T.-D. Huynh] . . . 59
7.7.2 JENDL-5 [F. Minato] . . . 59
8 Validation [G. Ilas, D. Rochman, S. Lahaye, R. Mills, V. Vallet, R. Ichou] . . . 61
8.1 Code validation . . . 61
8.2 Validation with measurements . . . 61
8.2.1 Validation of ALEPH2 . . . 61
8.2.2 Validation of VESTA 2.2 . . . 61
9 Recommendations . . . 62
10 Conclusion . . . 63
A Details on decay heat formula . . . 76
A.1 Borst-Wheeler function, circa 1946 . . . 76
A.2 Untermyer-Weills function, 1952 . . . 76
A.3 Patterson-Schlitz function, 1955 . . . 76
A.4 Glasstone function, 1963 . . . 77
A.5 El-Wakil function, 1971 . . . 77
A.6 Glasstone function, 1981 . . . 77
A.7 Todreas-Kazimi function, 1990 . . . 78
B A Numerical simulation on Bremsstrahlung Ray Measurement for β-decay in Spent Nuclear Fuel: a Japanese example 79

Future DH computational benchmark

- 2D simulations: assembly and pincell
- CLAB-2006 measurement: PWR 17x17 assembly 0E2, 3.1 %, 41.6 MWd/kgU
- Multiple measurements

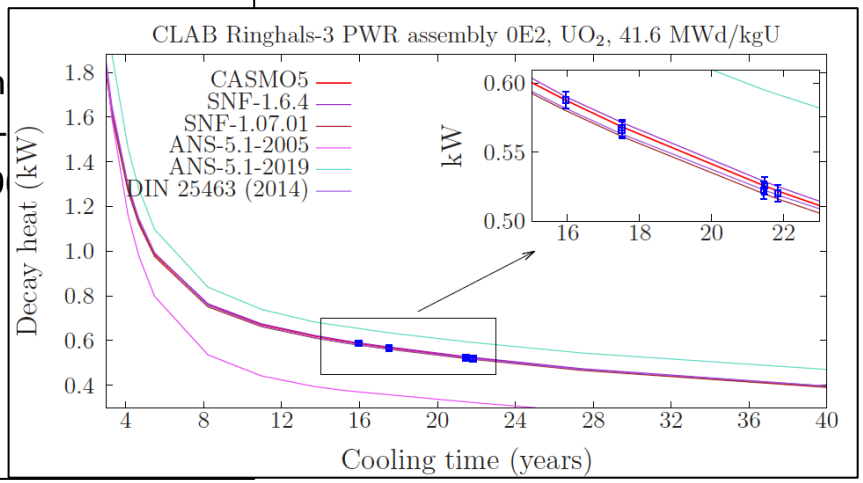
Required input/output

- Input details provided by the SG12

- Irradiation steps and cooling steps for the pincell and assembly
- Code, important methods, libraries

- Calculated DH + standard DH values
- Calculated neutron/gamma emission, activity
- k_{inf} during irradiation
- Nuclide concentrations during irradiation + cooling tim
  - U-234,235,236,238, Pu238-242, Am241-243, Cm242-
  - Nd146-148, Rh103,106, Cs133,134,137, Ba137m, Sr9
- fission rates (separate between 4 main actinides)
- Delayed fission

- Sensitivity ?
- Gaps ?



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Wir schaffen Wissen – heute für morgen