SAREC SUBTASK 6.2 - SOURCE TERM AND FGR MODELLING

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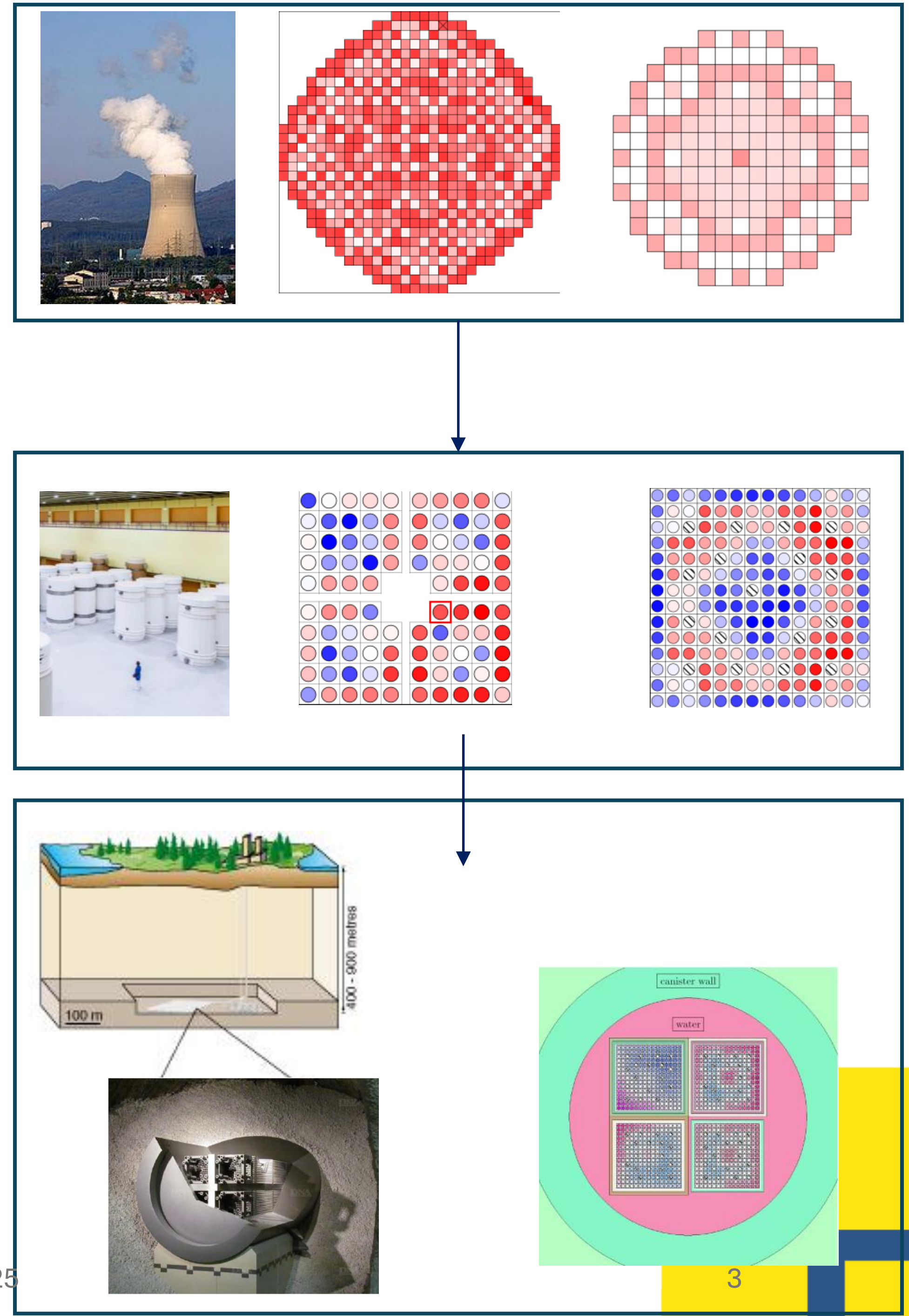
Contribution from PSI to subtask 6.2

- Source term (radionuclide inventory) calculations will be performed for UO2 and MOX supporting the evaluation of IRF and matrix dissolution studies

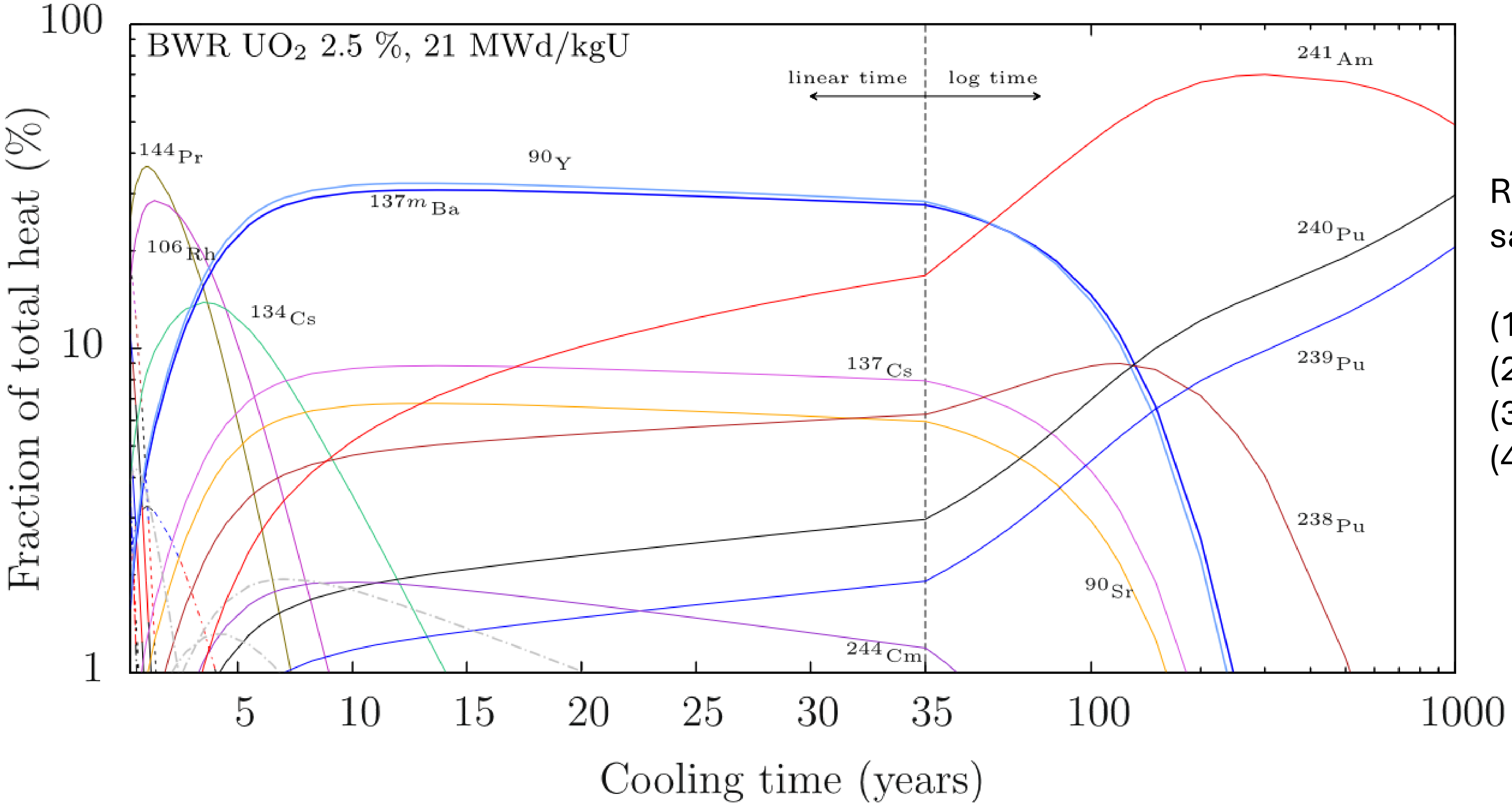
- Neutronic calculations and source term estimations for
  - Cooling time from the end of irradiation up to million years
  - UO_2 and MOX fuel types from PWR and BWR
  - Different burnup and initial enrichments with uncertainties for selected cases
  - If useful: provide other quantities such as decay heat or radiotoxicity

WHY, what ?

- We are dealing with nuclear materials: Spent Nuclear Fuel
- 1st main question: What is in the spent Fuel ?
- Safety first for transport, storage, and long-term repository
  - Over 100 000s years
  - Criticality-safety, dose, decay heat
  - Risk, uncertainties, consequences
- All SFC start from the knowledge of source terms: nuclide concentrations
  - Knowledge: experimental or theoretical
  - Includes safeguard needs
- 2nd main question: What is the required degree of knowledge ?
  - 5 %, 10 %, 50 % ?
- Need for measurements, calculations, uncertainties & validations, prior to any other studies



Which nuclides constitute the spent fuel ?



Relevance depends on safety parameters

(1) Decay heat
(2) Neutron source
(3) Gamma source
(4) Environmental factors

How well do we know the nuclide composition ?

- Nuclide vector at end of irradiation is usually determined with reactor simulation tools like CASMO/SIMULATE, SCALE, etc,

- These “tools” are based on experimental data: cross sections, fission yields, decay constants.

- Two types of validation:
  - Integral test: measurements of decay heat, neutron and gamma dose
  - Single effects tests: PIE measurements of nuclide concentrations

- In the time window which allows the observation of source terms, codes can be fine-tuned to match observations. This is not possible for the large time frames for long term storage

eurad

Experience from EURAD (-1)

- The proposed work builds on
  - Experience from EURAD-1 (WP8)
  - PSI full core models for Swiss plants
  - Extensive validation with measurements

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REGULAR ARTICLE — OPEN ACCESS

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

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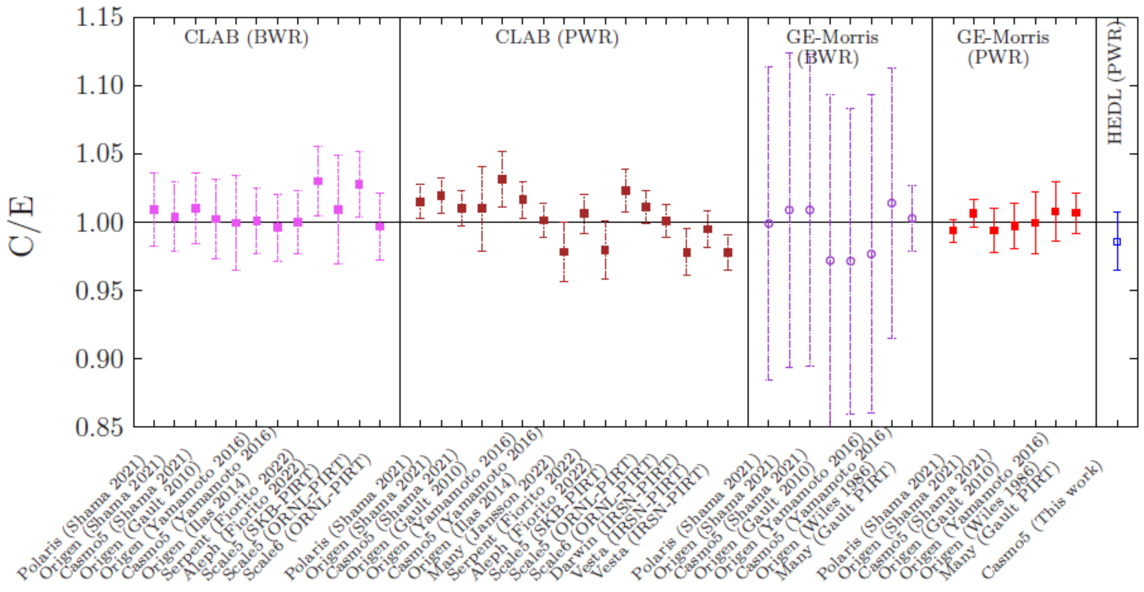

Fig. 7. Plots of the average C/E values for the decay heat from various references.

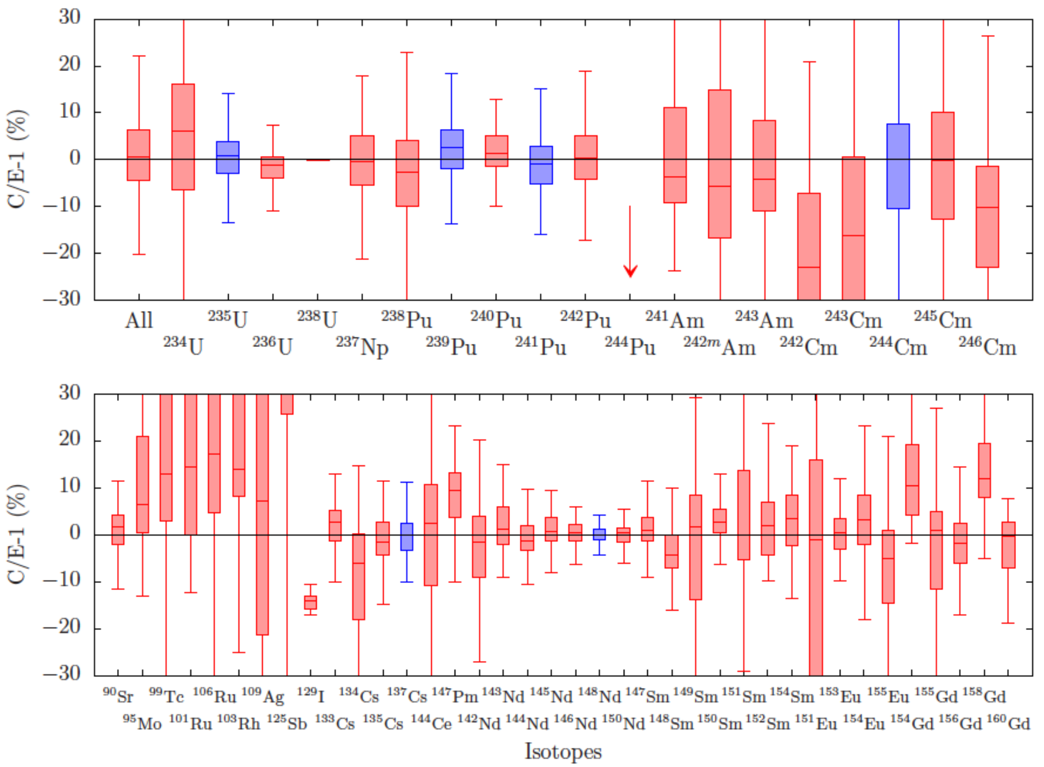

Fig. 4. Interquartile ranges for the $C/E-1$ isotopic concentrations, considering a total of more than 12 000 measured concentrations. The blue color is given to important isotopes. See Tables 3 and 4 for numerical values.

Proposed quantities

- Nuclide vector (actinides and fission products of interest), e.g. U-235, Pu-239, Cs-137, in g/tHM
- Evolution as a function of cooling time: e.g. from 1 year to 10^6 years
- Different types of fuel (UO_2, MOX): to be defined within the subtask
- Different types of reactors: PWR or BWR: to be defined within the subtask
- Different burnup values: to be defined within the subtask
- Other quantities ?