

EMPLOYMENT OF RELATIVE TIME SCALE IN THE U&S ANALYSIS OF THE MBLOCA SCENARIO IN A GENERIC KONVOI NPP

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Previous work - MBLOCA with SAM - described in:

- A. Stakhanova et al., “Uncertainty and Sensitivity Analysis of the ASTEC Source Term Results of a MBLOCA Scenario with the Activation of Severe Accident Management Actions in a Generic KONVOI Plant,” Proc. ERMSAR2024, Paper001, p. 695, Stockholm, Sweden, May 13–16, 2024
- B. Stakhanova, A., Gabrielli, F., Sanchez Espinoza, V.H., Pauli, E.M. and Hoefer, A., 2025. Uncertainty and Sensitivity Analysis of the ASTEC Source Term Results of a MBLOCA Scenario with the Activation of Severe Accident Management Actions in a Generic Konvoi Plant. *Nuclear Technology*, pp.1-18.
<https://doi.org/10.1080/00295450.2025.2544372>

A:

- Set of 300 MBLOCA simulations (with 48 simulations where FCVS was activated) analyzed as a whole – ERMSAR-2024 conference
- Results between MBLOCA and MBLOCA+FCVS activation were compared

B:

- Relative time scale is introduced
- Relative time scale is applied to the FP release in environment and containment results
- Results between MBLOCA and MBLOCA+FCVS activation were compared

Computational framework

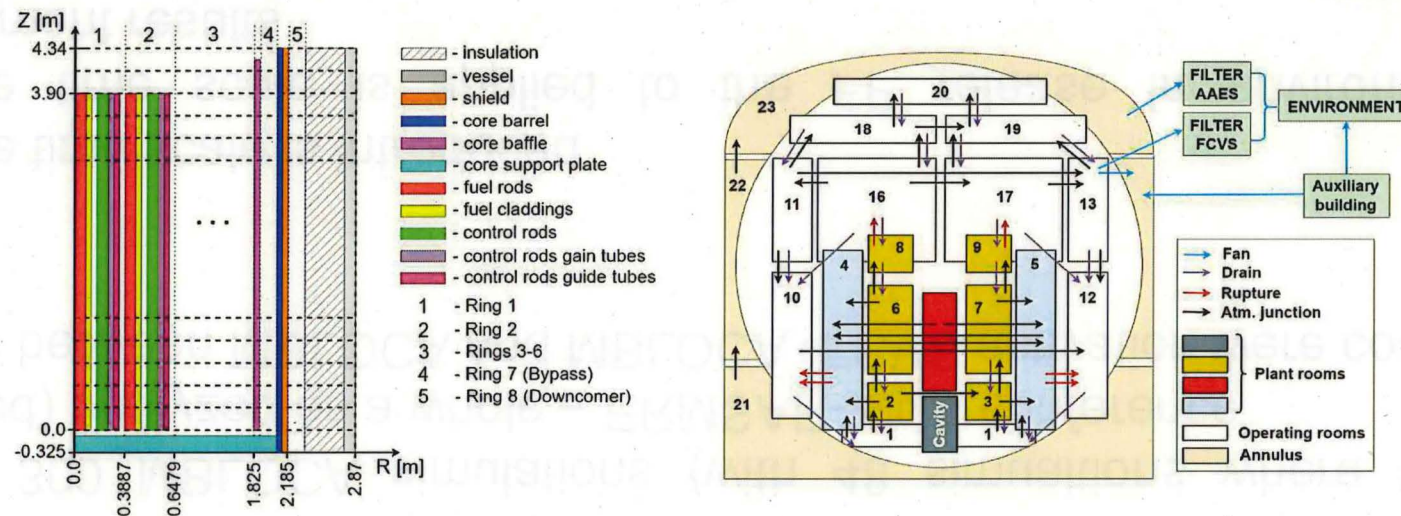


Figure 1. Core (left) and containment (right) nodalization of the ASTEC model of a generic KONVOI NPP

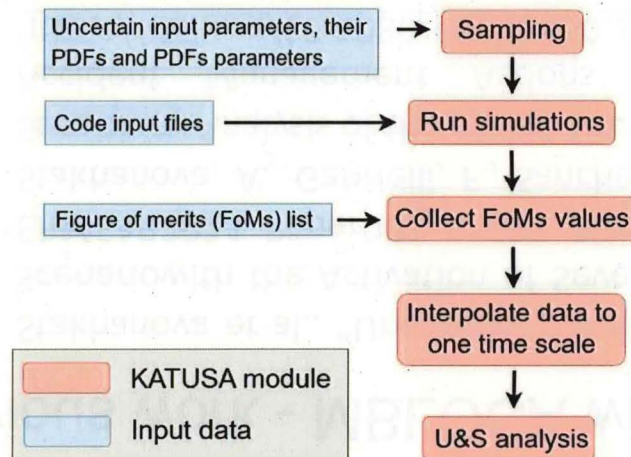


Figure 2. KATUSA tool scheme

- ASTEC code
- KATUSA tool for U&S analysis
- KONVOI-1300
- MBLOCA scenario
- 600 simulation in total -> 97 with FCVS activation are analyzed
- 18 uncertain input parameters, some of them are correlated

Problem description

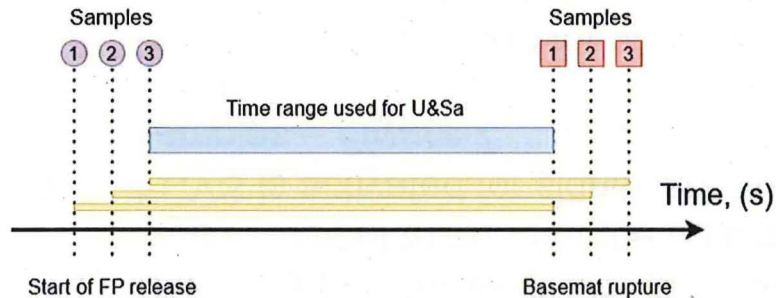


Figure 3. Approach for data extraction used in previous works

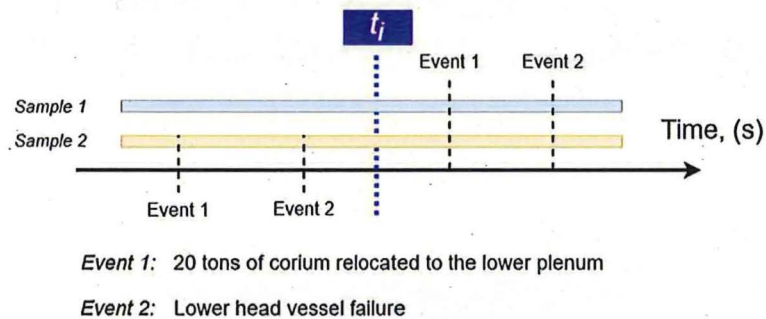


Figure 4. Samples with the different SA progression used in U&Sa

- In the previous works the U&S analysis was made on the absolute time scale.
- Between two considered events the data analysed as it is shown on the **Figure 3**.
- For any time point different realisations of the SA scenario could be at the different stages of the SA progression – **Figure 4**.

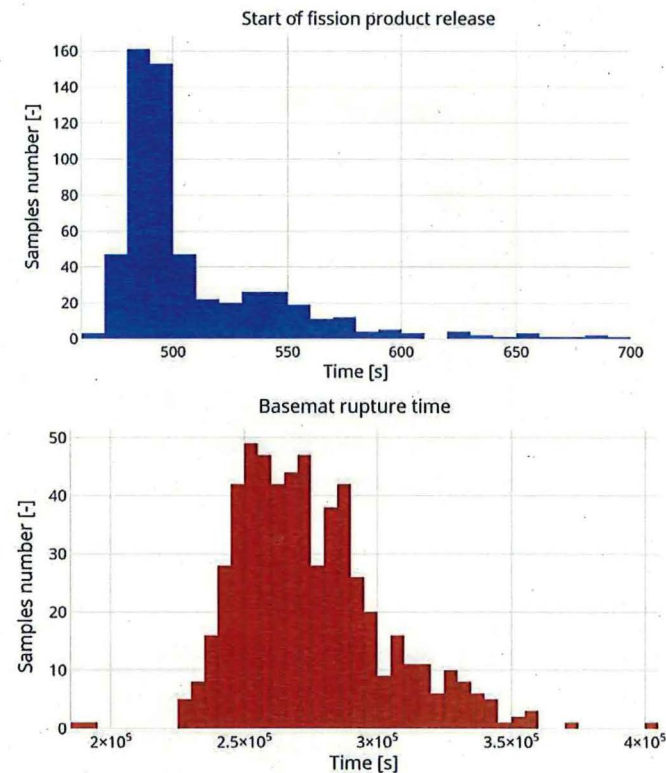


Figure 5. Distribution of the characteristic events in time

- The range between the earliest and the latest start of FP release – usually in our simulations [400, 700] s
- The range for the time of basemat rupture is much broader – **Figure 5**.

Problem description

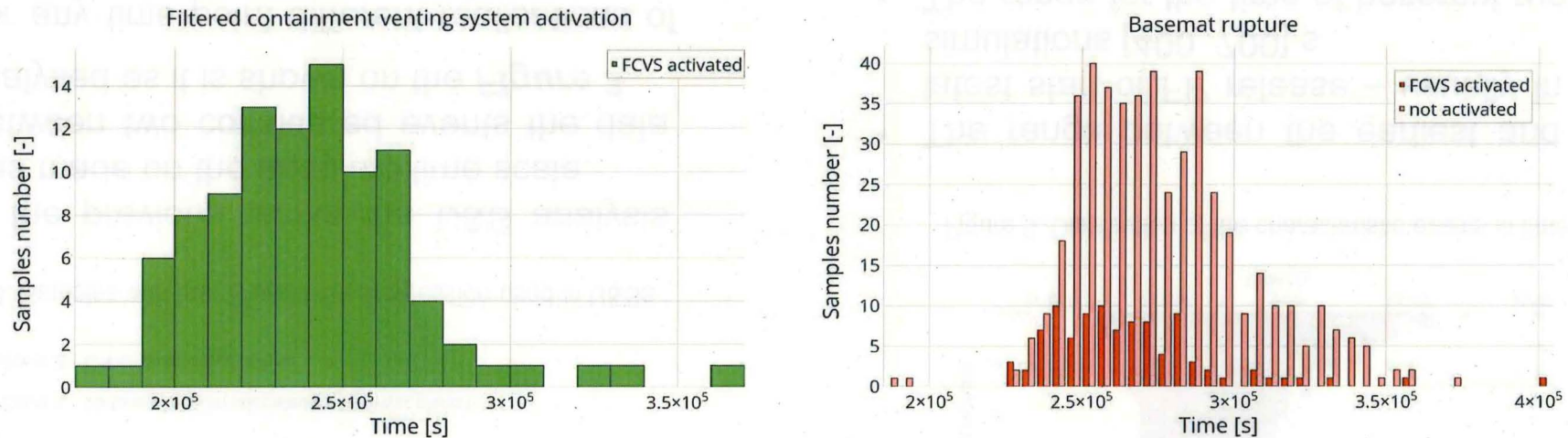


Figure 6. Distribution of the characteristic events in time

Due to the late activation of the filtered containment venting system (FCVS) – **Figure 6**:

- 1) Stop analysis, for example, at $\sim 250\,000$ s – it will lead to loss of the part of the time scale, where FCVS is activated for significant number of samples – **Figure 7**
- 2) Extend the time range for analysis – exclude a lot of sample (including ones with FCVS activation)

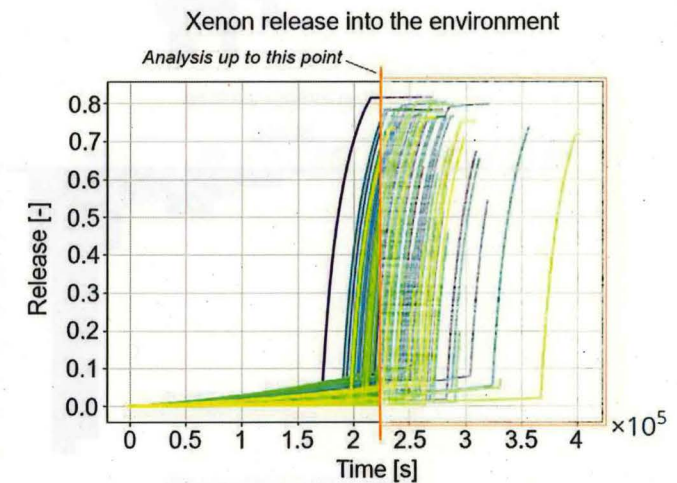


Figure 7. Data lost in the U&Sa with the absolute time scale for set of simulations with the FCVS activated.

Proposed solution

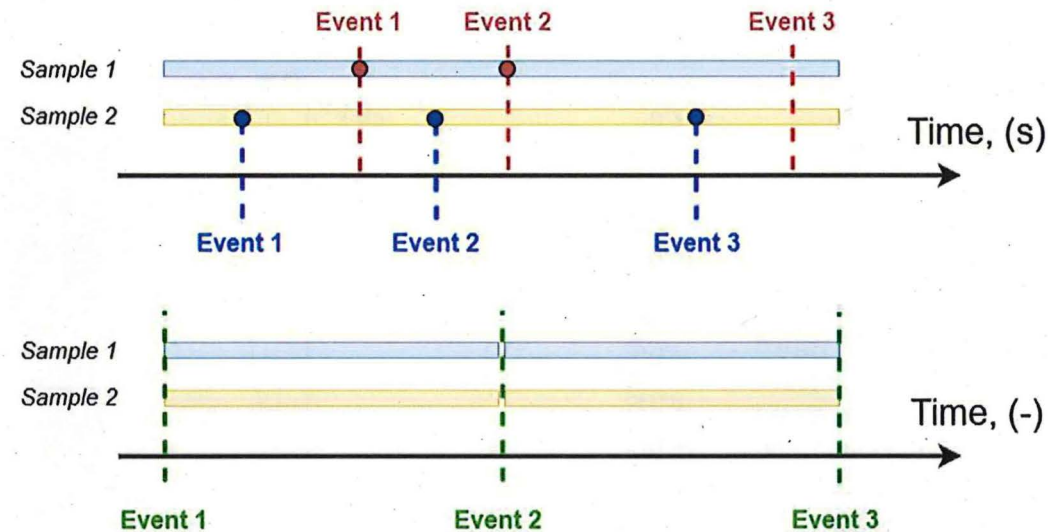


Figure 8. Absolute and relative time scales schemes

Proposed solution is to align all simulated SA progressions to the common relative time scale – **Figure 8**.

- Take start of FP release as time point „0“ and basemat rupture as time point „1“
- Divide time scale into parts. For example, analyze first the part between start of FP release and lower head vessel failure (LHVF), then between LHVF and basemat rupture

Results of U&S analysis

- In total 600 MBLOCA simulations were performed to collect enough cases with FCVS activation
- 97 cases with FCVS
- 8 cases (from 97) were excluded due to the FCVS activation happened right before the basemat rupture - **Figure 9**
- Spearman correlation coefficients were calculated on the absolute time scale to check the effect from excluded samples - **Figure 10**

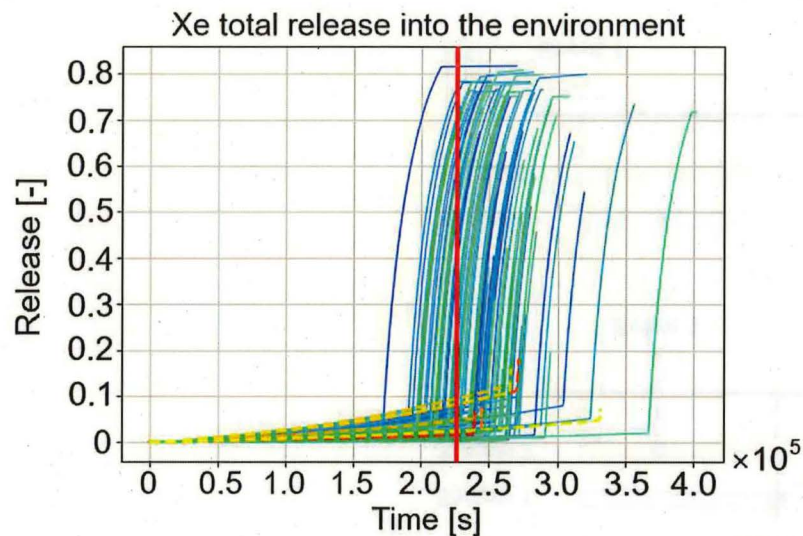


Figure 9. Xe release into the containment in time. Analyzed and excluded samples.

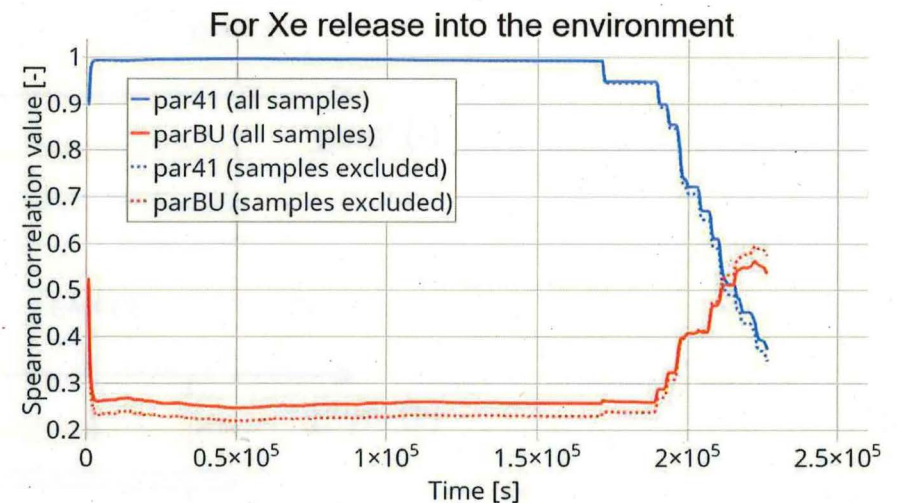


Figure 10. The Spearman correlation values in time for Xe, release. With and without samples exclusion.

Results of U&S analysis

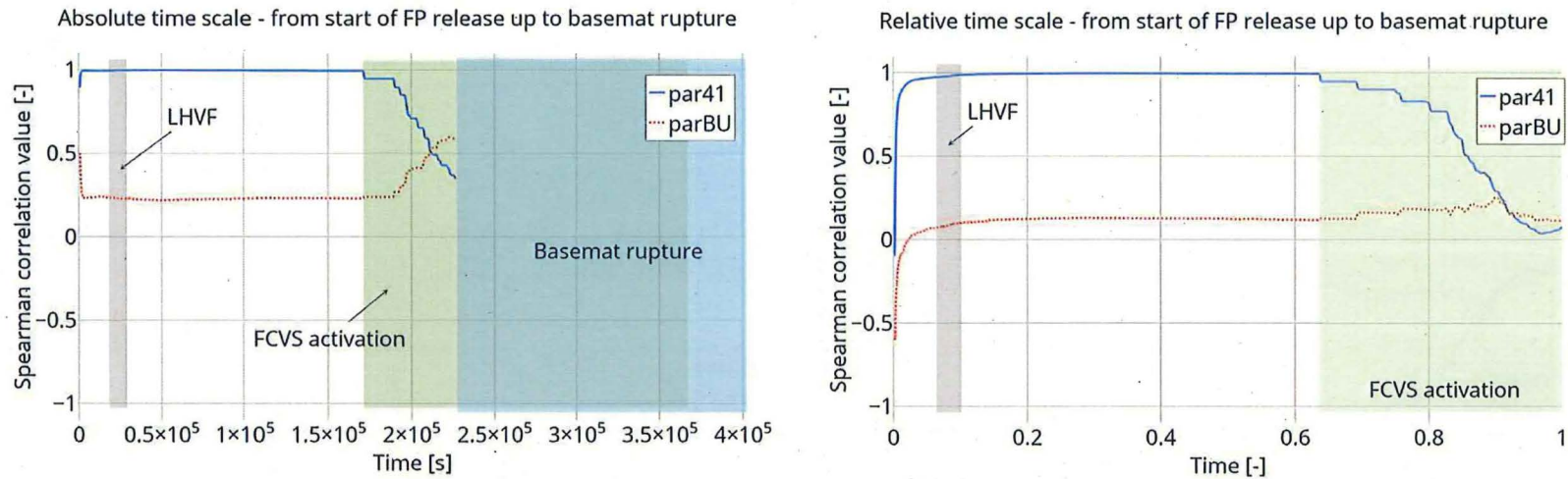


Figure 11. Spearman correlation values for the Xe release into the environment on the absolute and relative time scales.

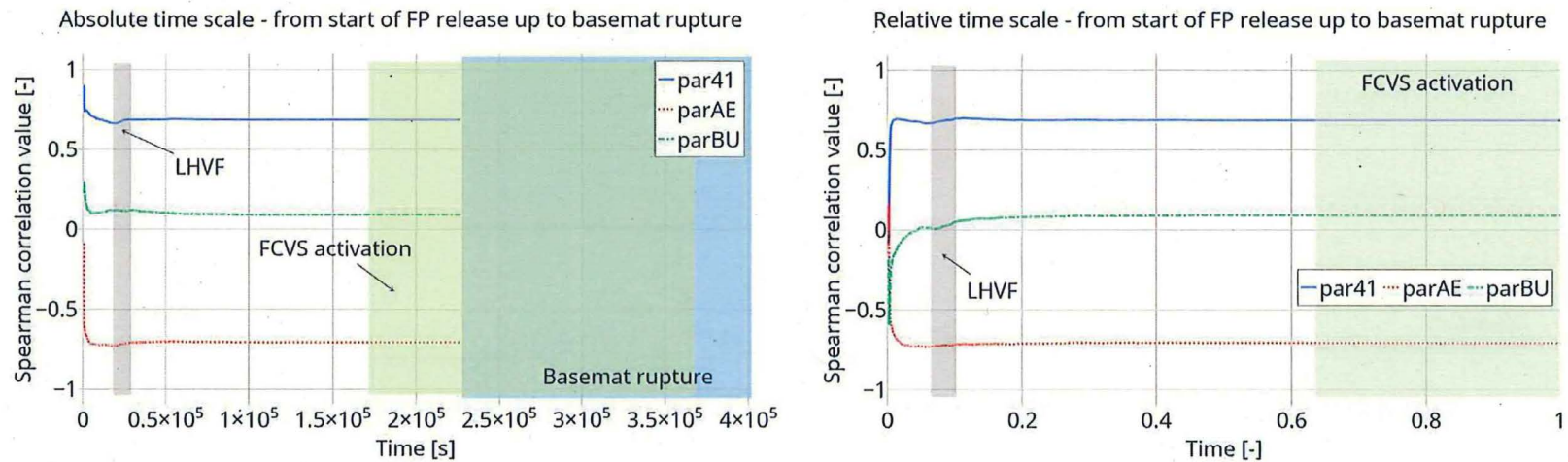


Figure 12. Spearman correlation values for the Cs release into the environment on the absolute and relative time scales.

Results of U&S analysis

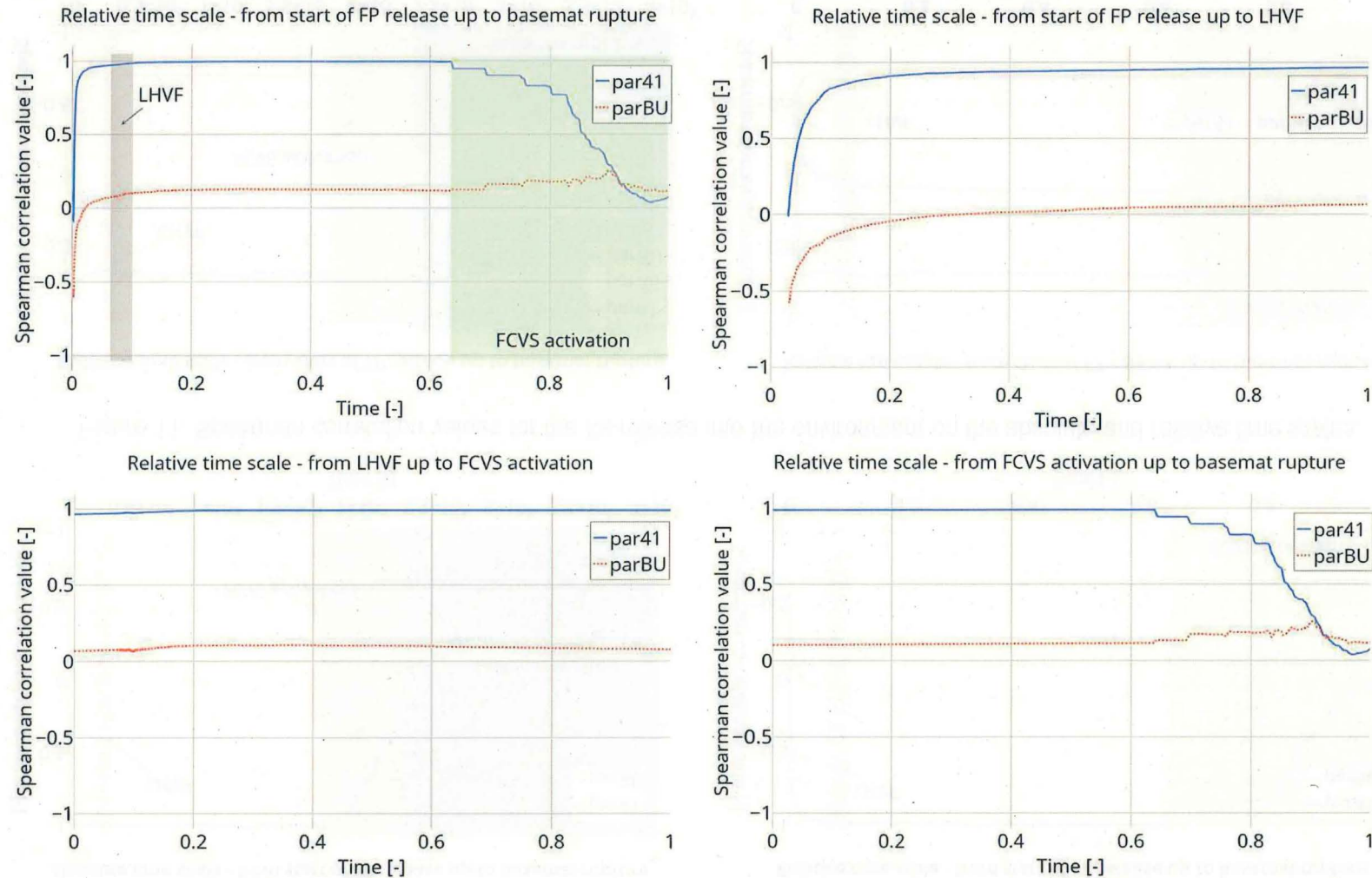


Figure 13. Spearman correlation values for the Xe release into the environment on the relative time scale. Example of dividing time scale into parts between characteristic events

Conclusions and outlook

- Previous work of analyzing results of MBLOCA SA scenario with FCVS activation is continued
 - Relative time scale option is used to perform U&S analysis
 - Focus on the simulations where FCVS was activated to show the need of the relative time scale option
 - Time scale could be divided into zones between characteristic events
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- ❖ Relative time scale option could be further tested
 - ❖ Other options of time scales alignment could be considered

Thank you for your attention!

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