Insights on an SBO accident in BWR

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CIEMAT

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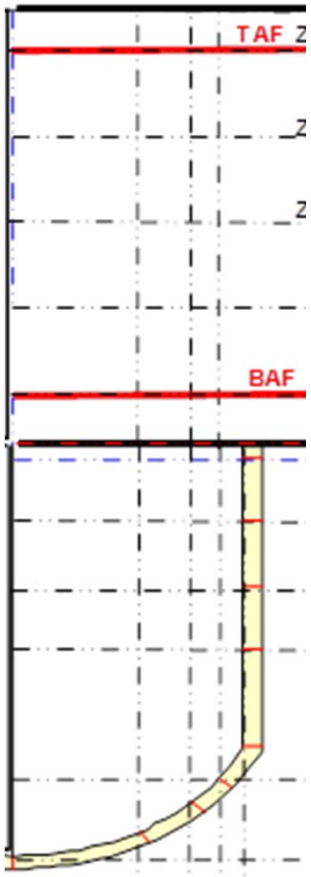
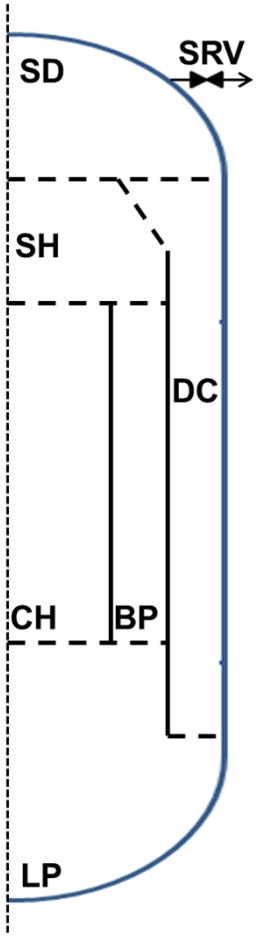
  - *To find a conservative scenario for FP release and source term*
- ***Scope***
  - *MELCOR v2.1 analysis of a BWR3-Mark1 plant*

II. Plant modelling

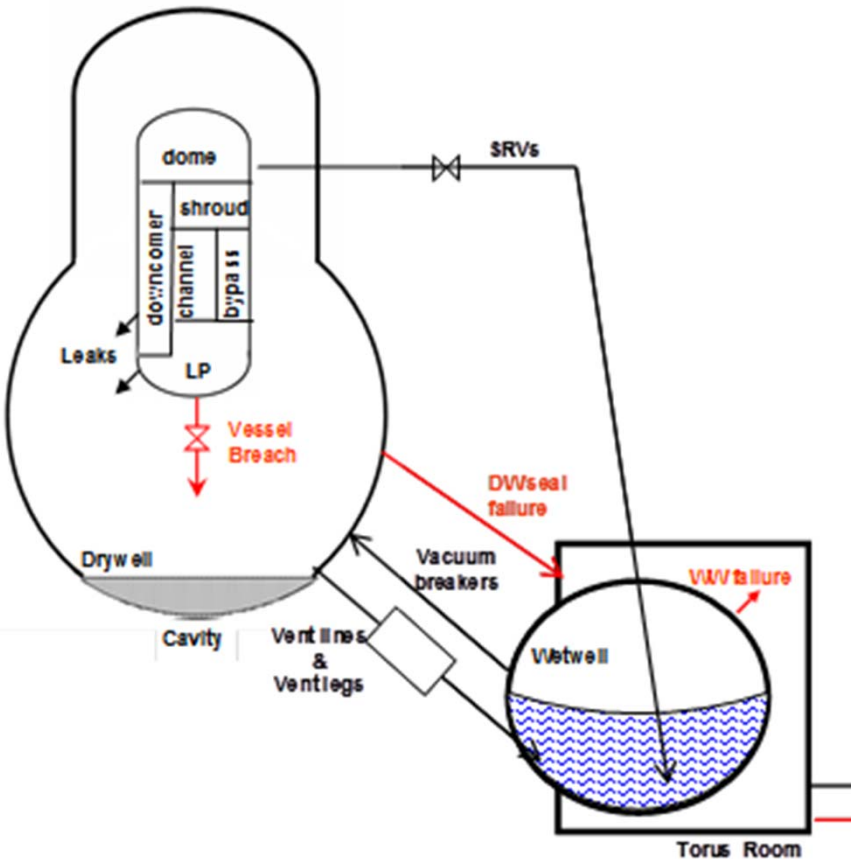
Core & LP



RPV

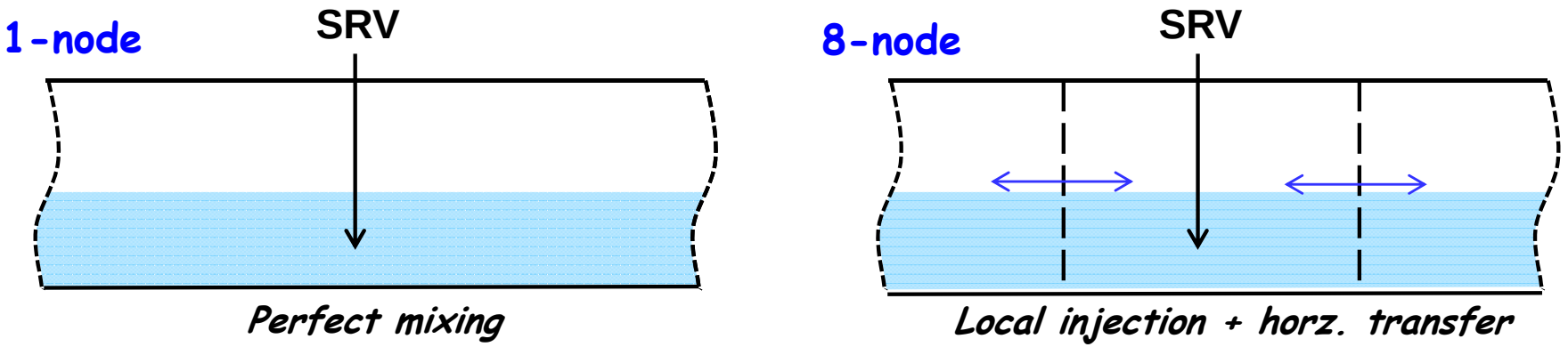


PCV

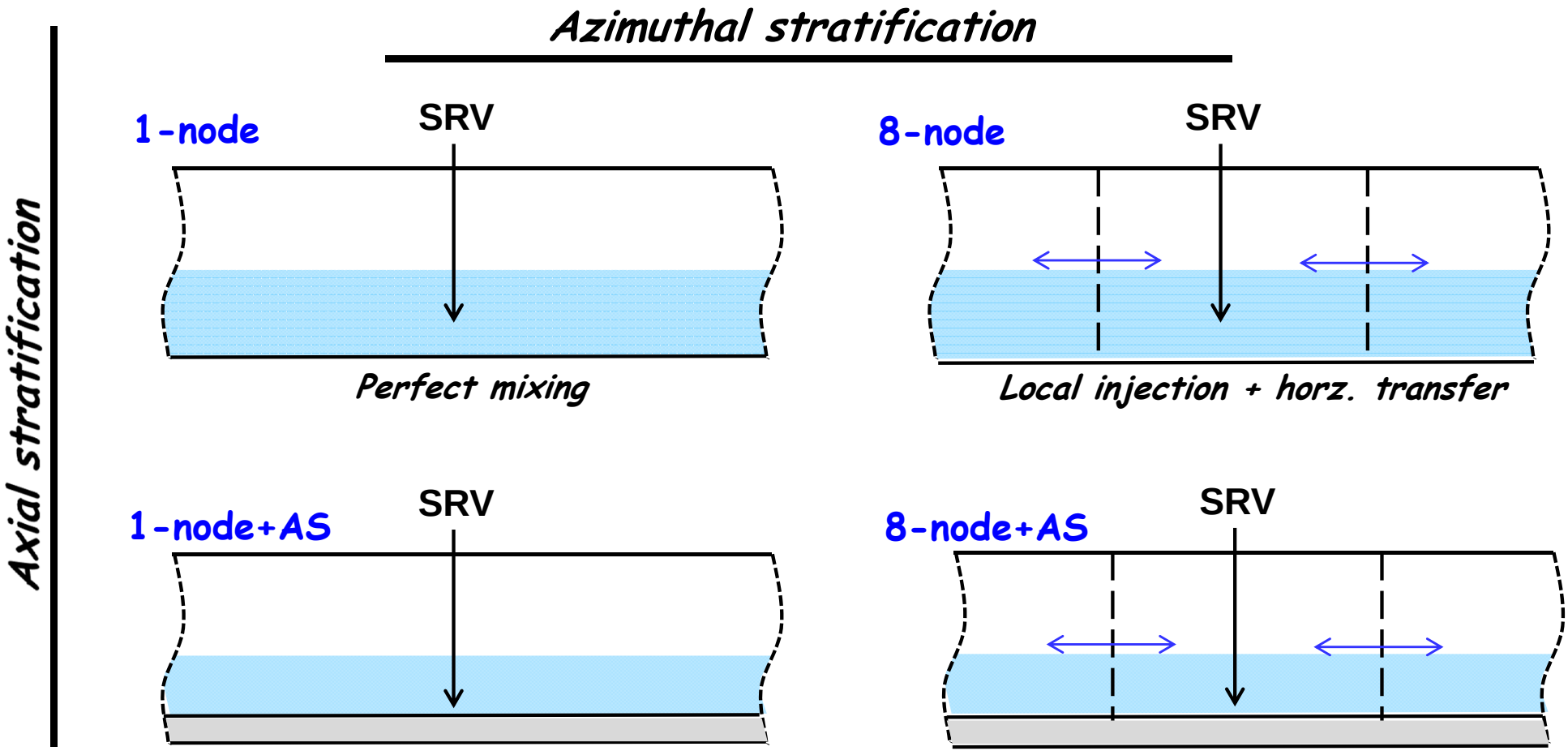


II. Plant modelling (wetwell)

Azimuthal stratification



II. Plant modelling (wetwell)

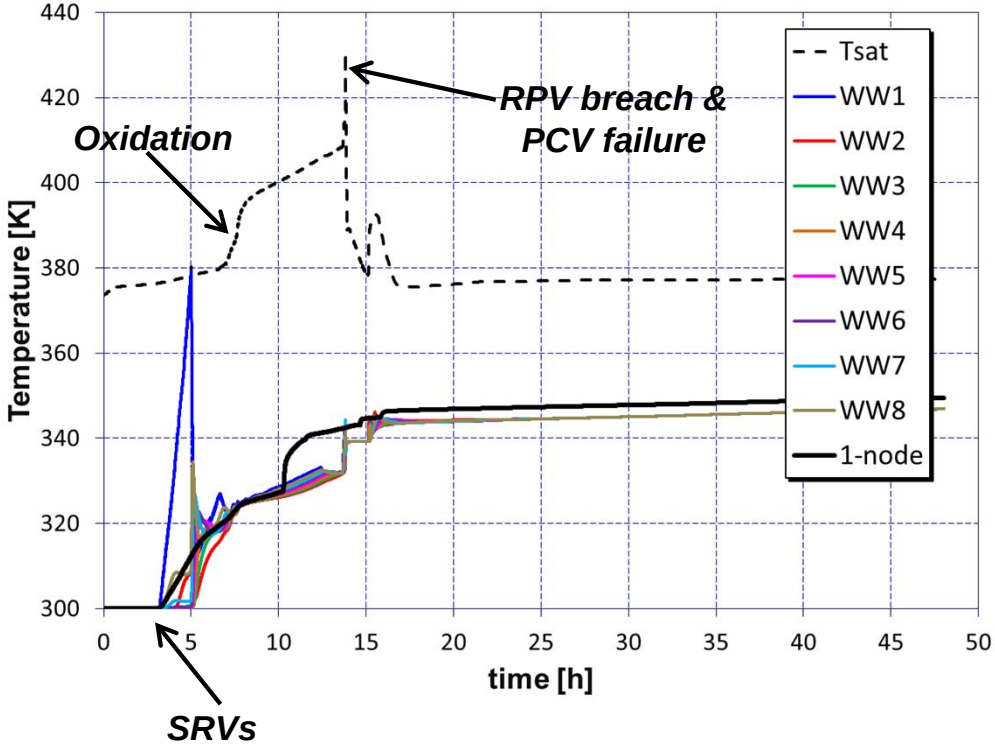


"perfect vertical stratification" (water below injection point does not play any role)

III. Results: Thermal-hydraulics

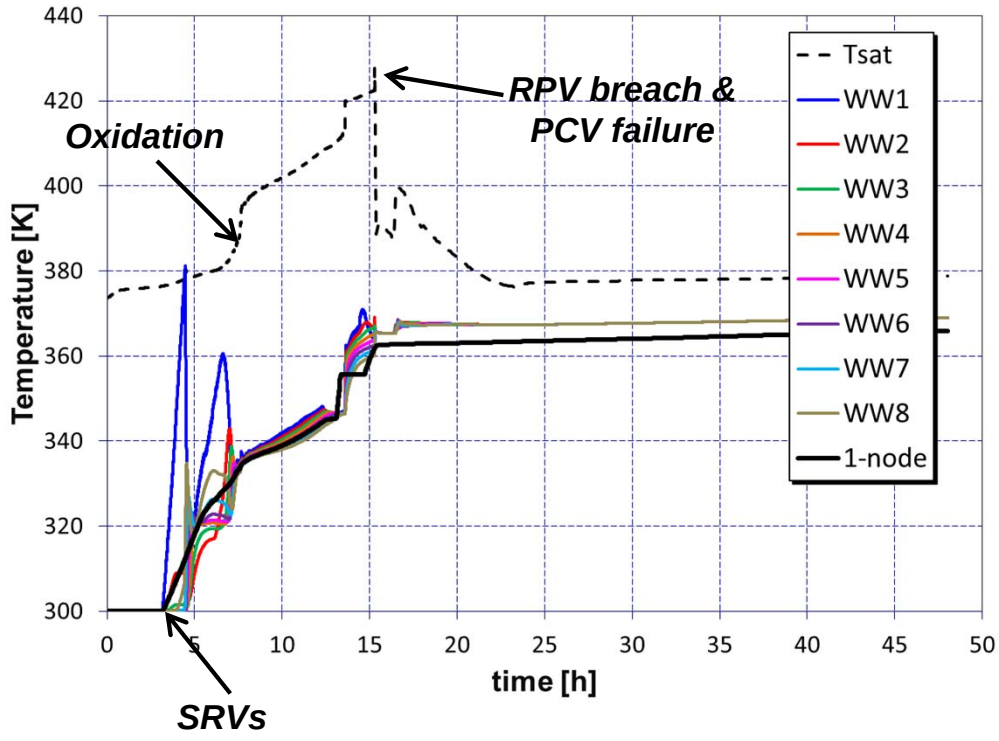
SP temperature

(without axial stratification)



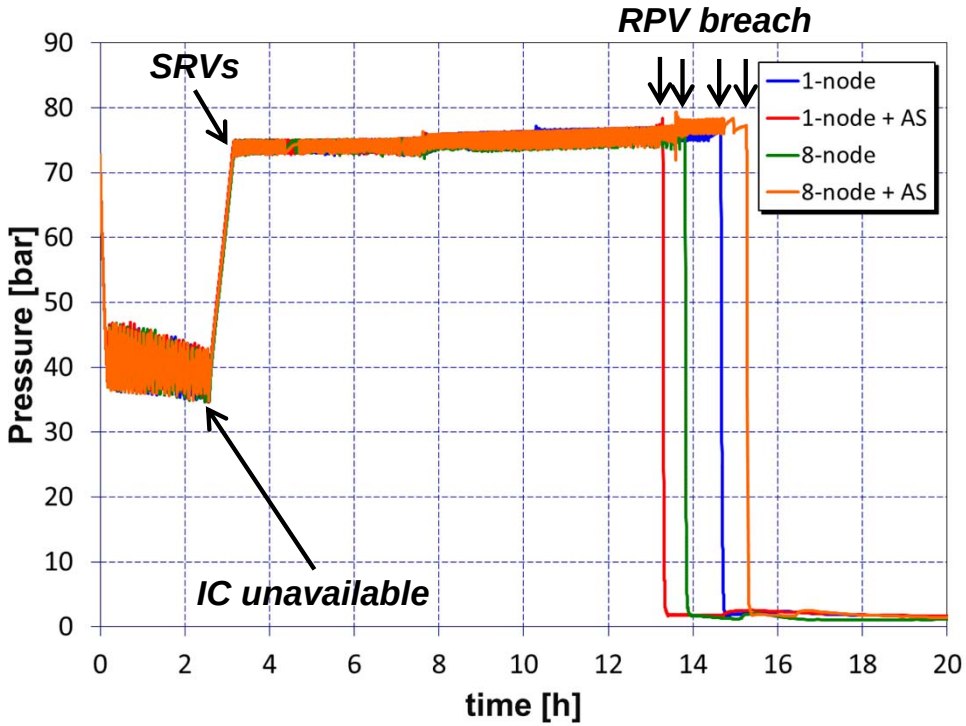
SP temperature

(with axial stratification)

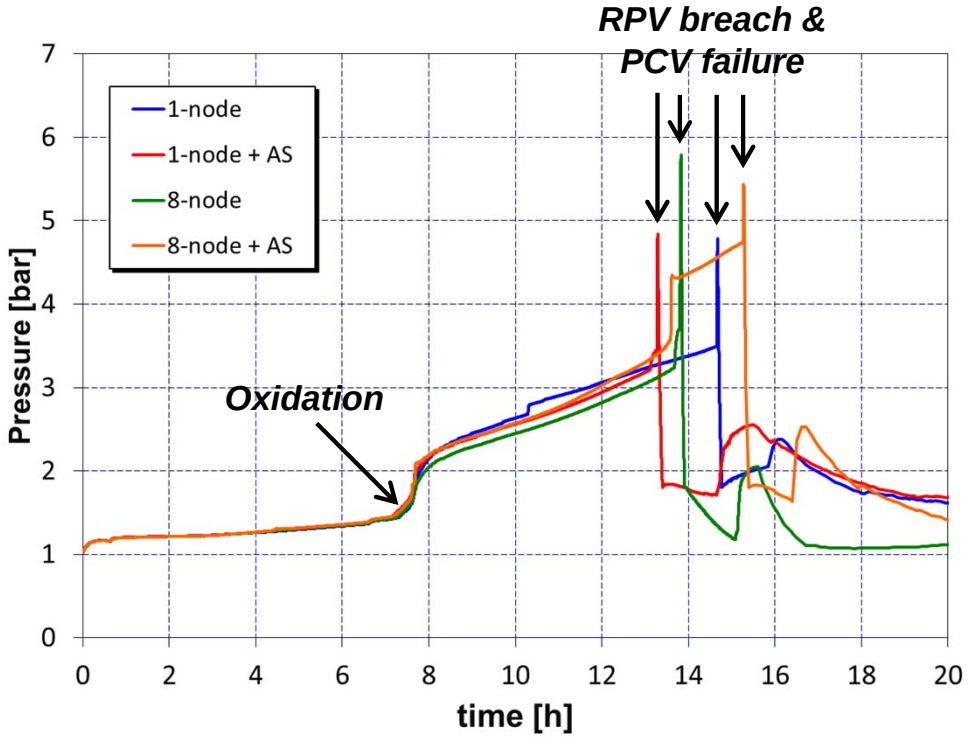


III. Results: Thermal-hydraulics

RPV pressure



PCV pressure

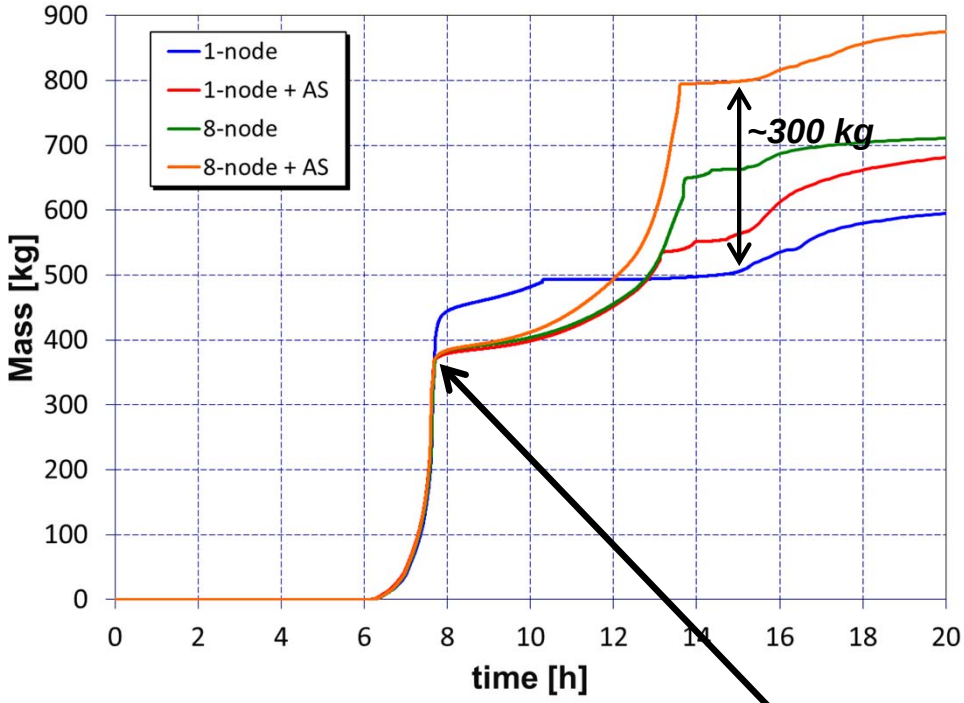


III. Results: Key event chronology

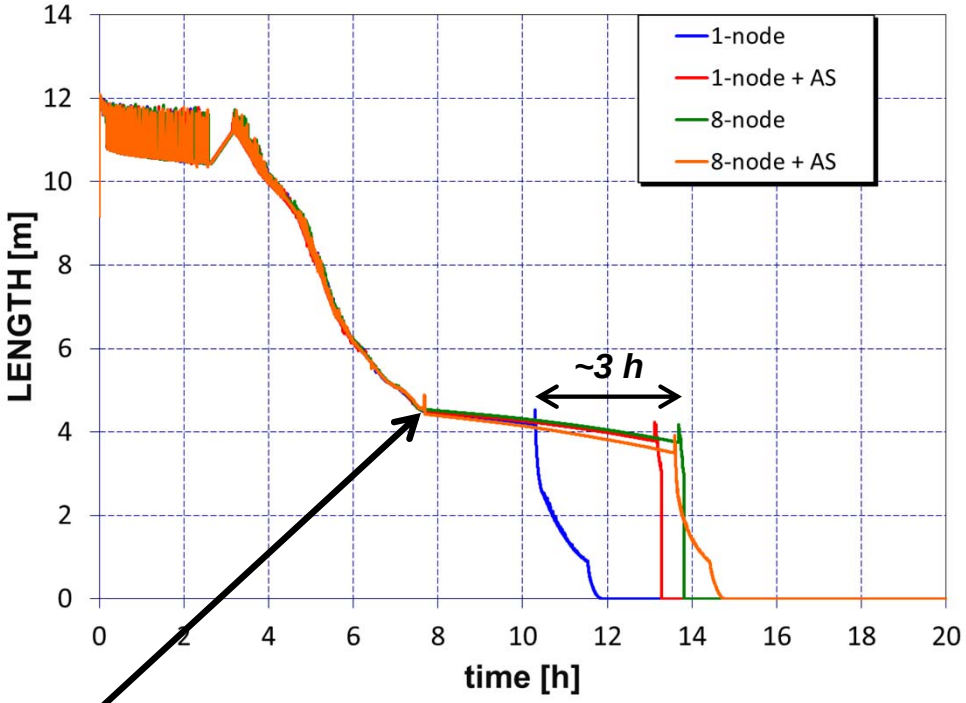
Key event	1n	1n AS	8n	8n AS
IC operation (h)	0-2.6	0-2.6	0-2.5	0-2.6
SRV operation (h)	3.2-14.2	3.2-13.3	3.2-13.8	3.2-14.7
Core uncovery (h)	5.2-6.8	5.2-6.8	5.2-6.8	5.2-6.8
Fuel in LP (h)	10.3	13.1	13.6	13.5
Dry RPV (h)	11.9	13.3	13.8	14.7
RPV failure (h)	14.7	13.3	13.8	15.3
PCV failure (h)	14.7	13.3	13.8	15.3

III. Results: In-vessel evolution

H_2 production



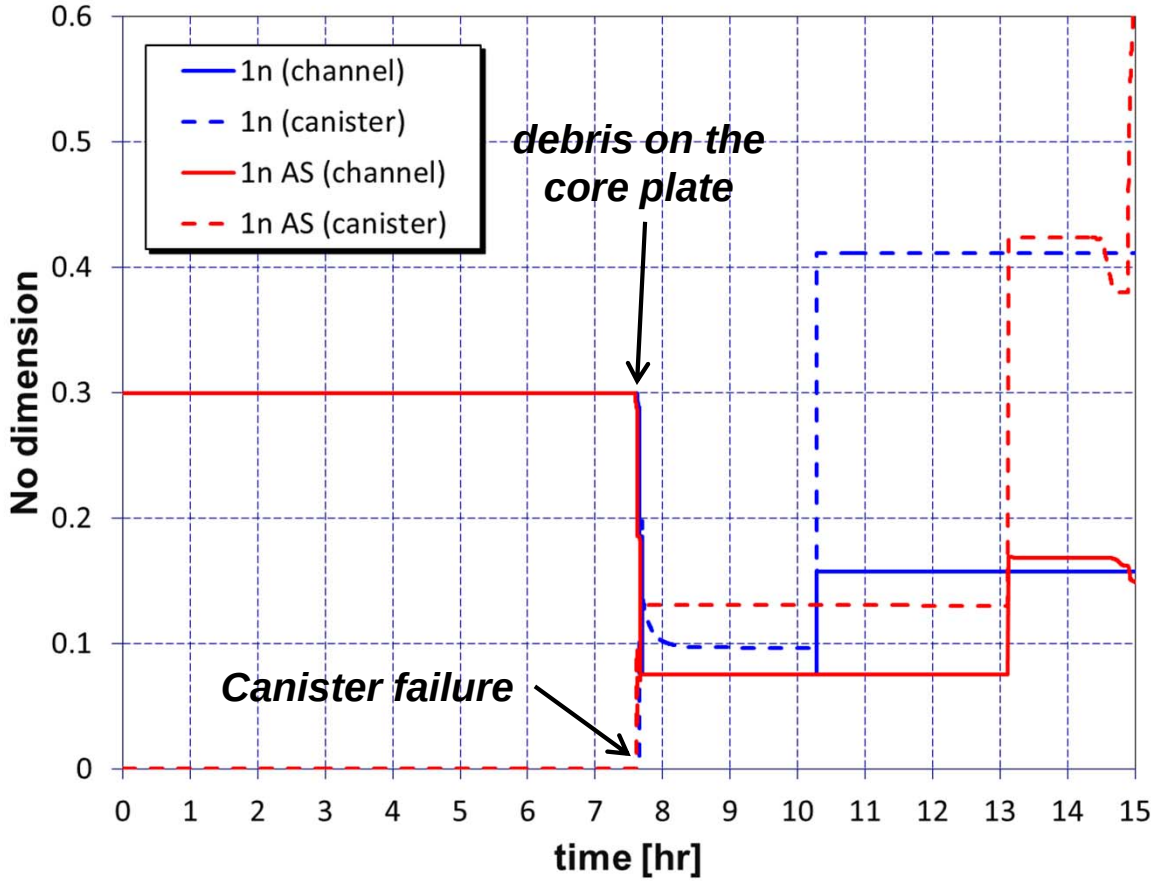
Water level



Differences originated at ~ 7.6 h

IV. In-vessel insights

Open fraction of flow paths



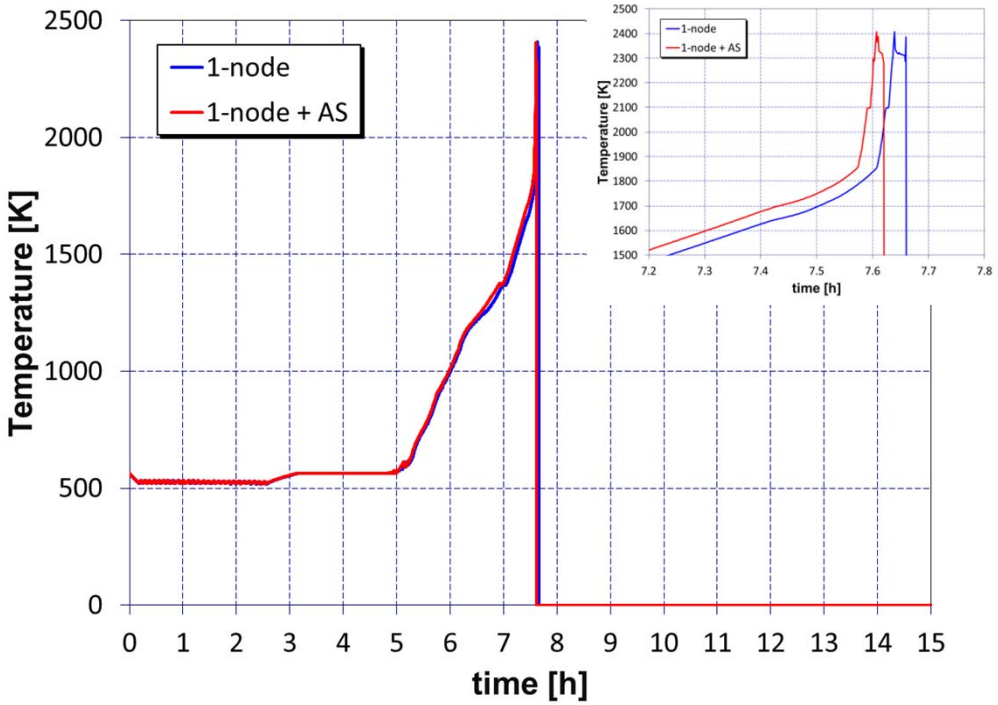
Comparison of cases

1-node* vs *1-node + AS

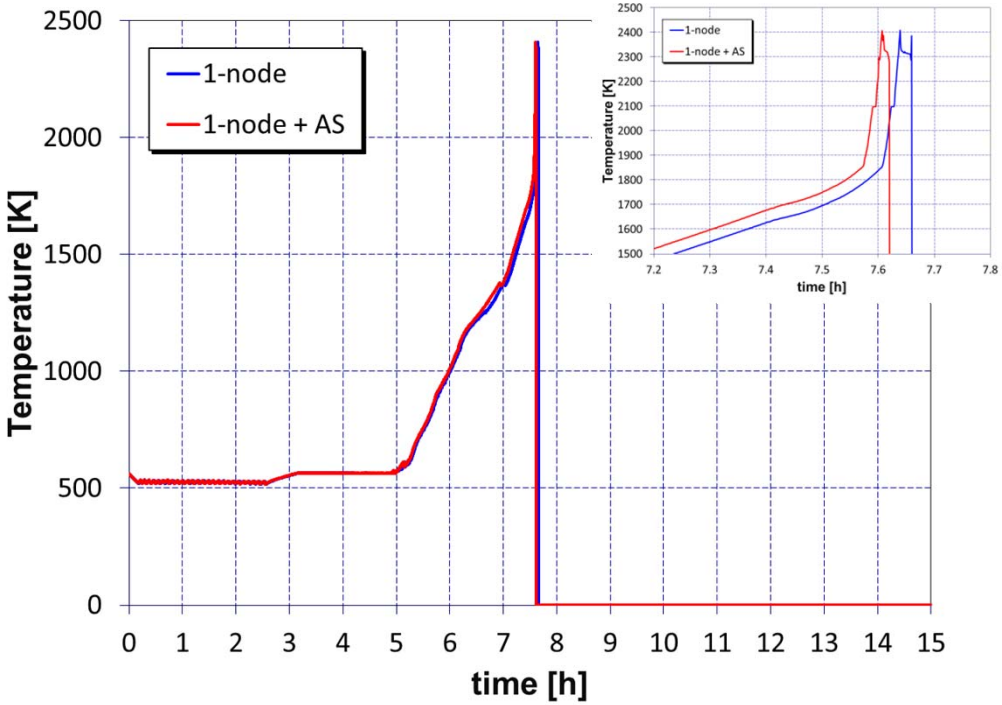
- Failure cross section of canister has a difference ~25%

IV. In-vessel insights

Cladding temperature
(central ring)

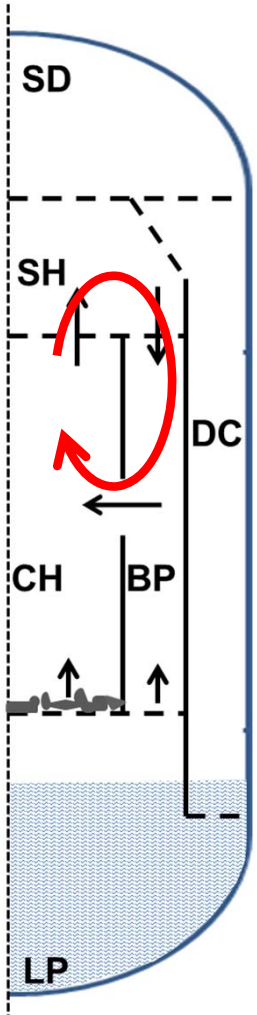


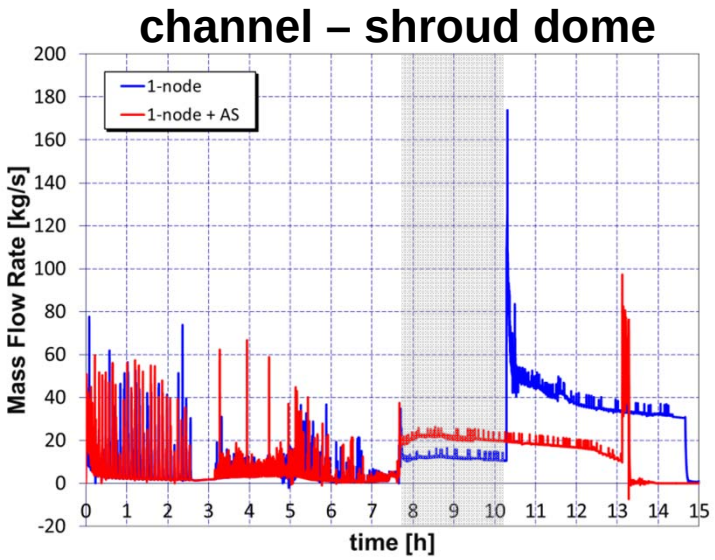
Canister temperature
(central ring)

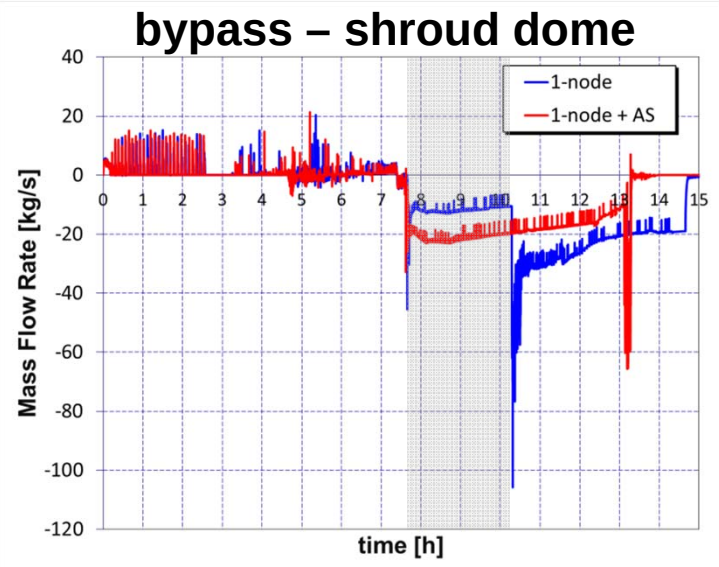


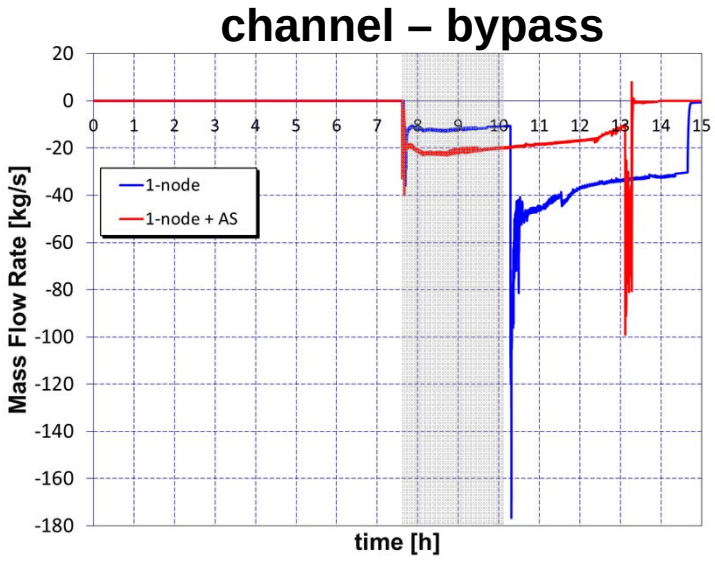
Insignificant differences in clad and canister temperature (~5 K and ~ 3 min)

IV. In-vessel insights



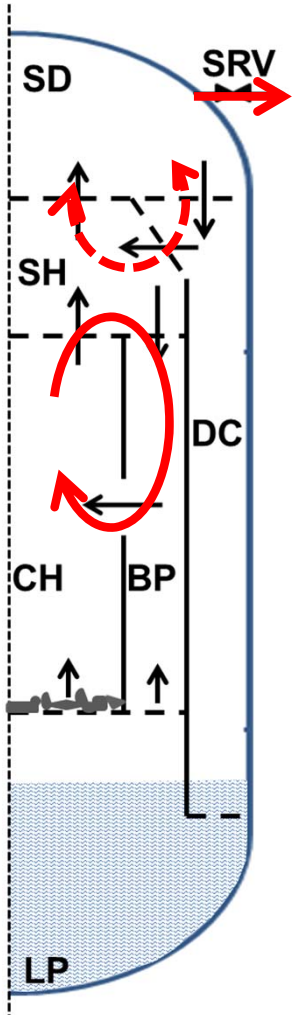


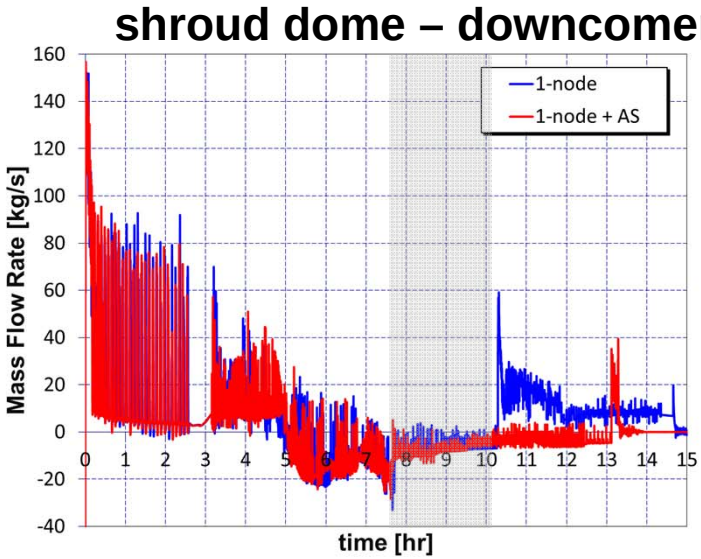


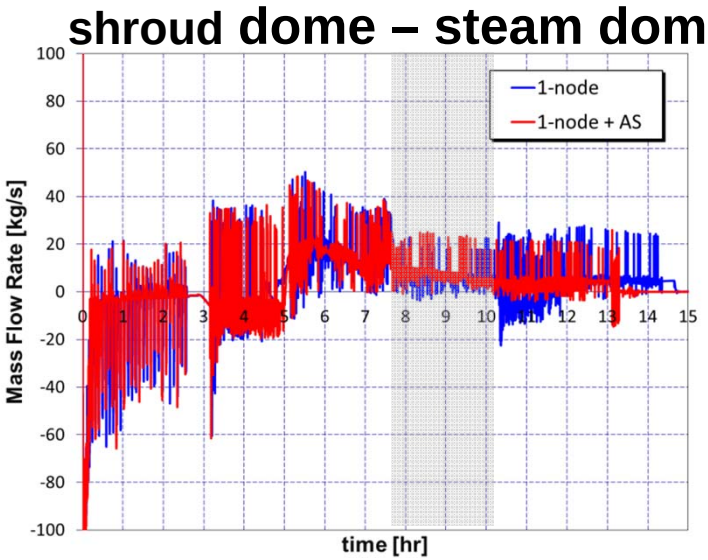


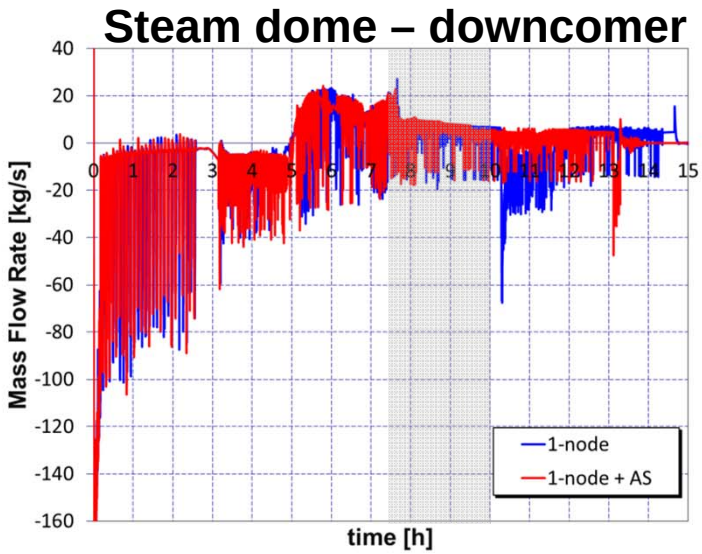
- A convective flow loop is developed in the core region when canister fails
- Case '1-node' has lower mass flow rate through the channel *(lower CH-CP cross section)*

IV. In-vessel insights





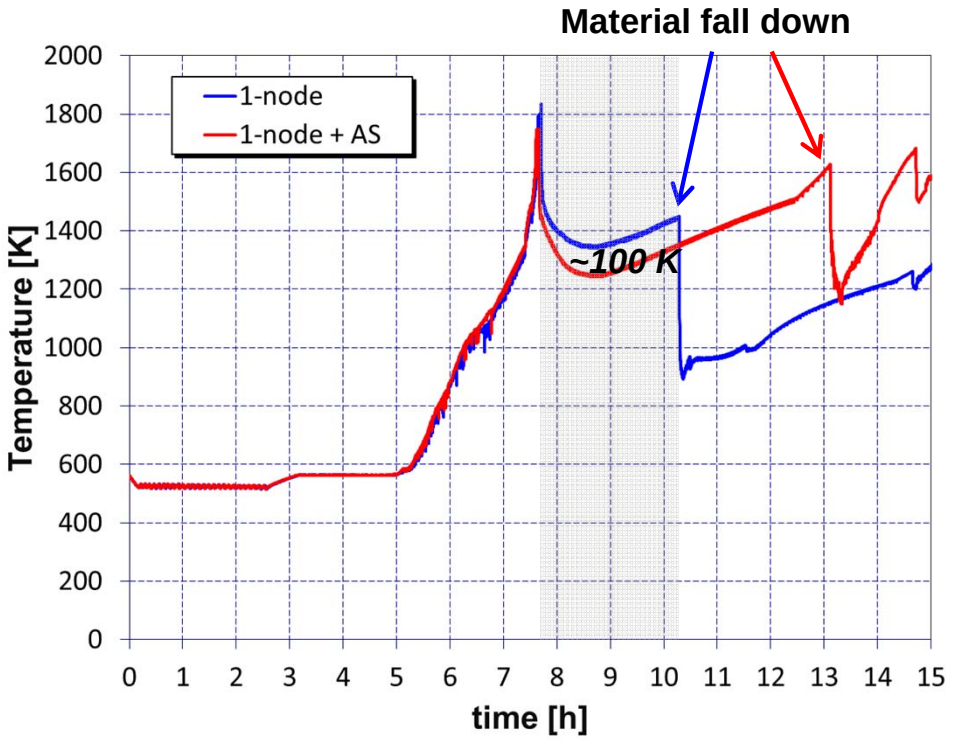




- A second flow loop is developed in the upper plenum
- This loop is broken when SRVs open
- Occasionally this loop can change the direction

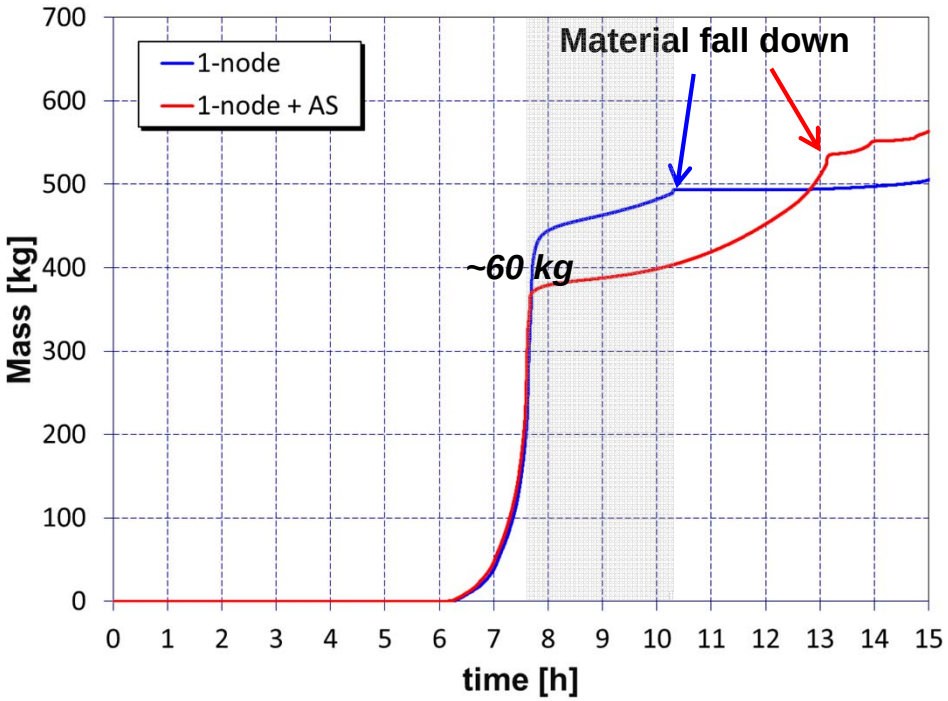
IV. In-vessel insights

Channel temperature



Lower flows leads to higher temperature

Hydrogen generation

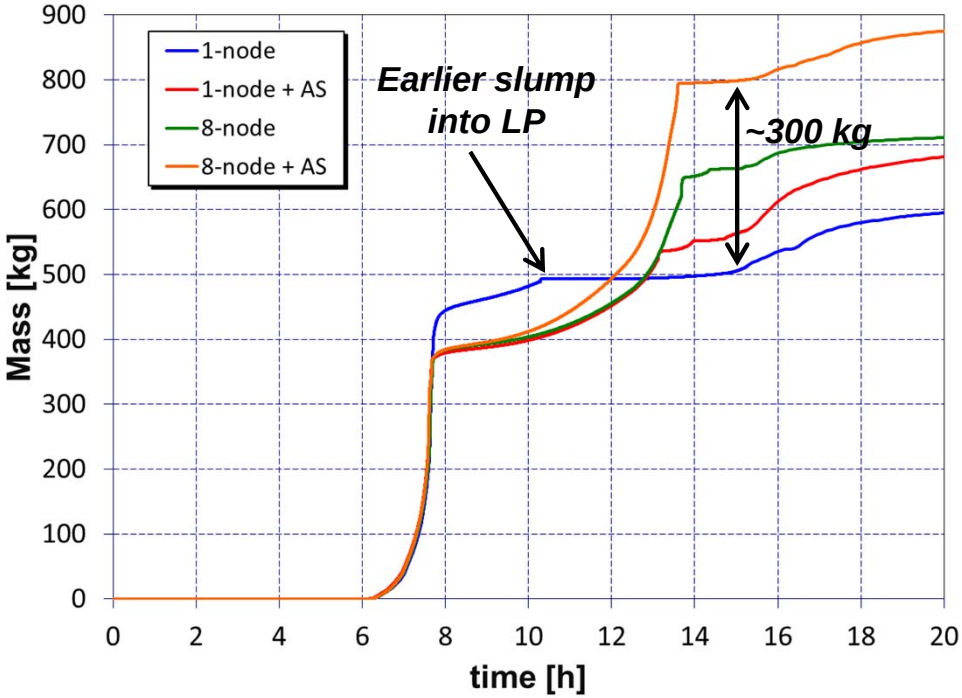


Higher temper. leads to higher oxidation

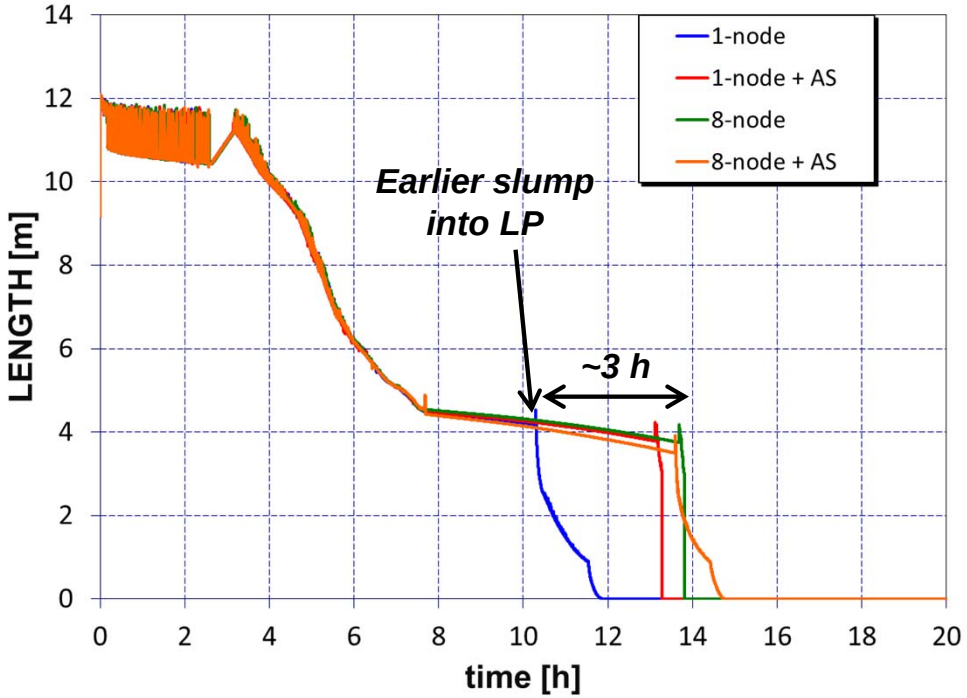
Advanced degradation

IV. In-vessel insights

H_2 production



Water level



Advanced degradation, leads to lower in-vessel oxidation and earlier RPV dry-out

V. Final remarks

- RPV modeling introduces significant user effect on core degradation evolution.
- Canister failure leads to the development of convective loops inside the RPV.
- Small differences in estimated degradation can lead to significant differences in key parameters, e.g. generated H_2, PCV failure time, etc.
- **Results must be taken with caution when supporting accident management.**

Acknowledgements

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