Fast Transients and Critical heat flux for experimental reactors applications

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FAST TRANSIENTS AND CRITICAL HEAT FLUX FOR EXPERIMENTAL REACTORS APPLICATIONS

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THE CONTEXT : BORAX TYPE ACCIDENTS IN RESEARCH REACTORS

- Explosive transients induced by a reactivity insertion for :
  pool type research reactors;
  compact cores with aluminium plate fuel
  liquid water coolant. Generally

atmospheric pressure to some bars, 20-50°C, some m/s circulation.

- Exponential rise of the power, with a low period (as short as a few ms).

- The dominant reactivity feedback is induced by the production of void.

- The thermal heat flux from fuel to coolant is the only mechanism to prevent fuel plates melting and steam explosion.

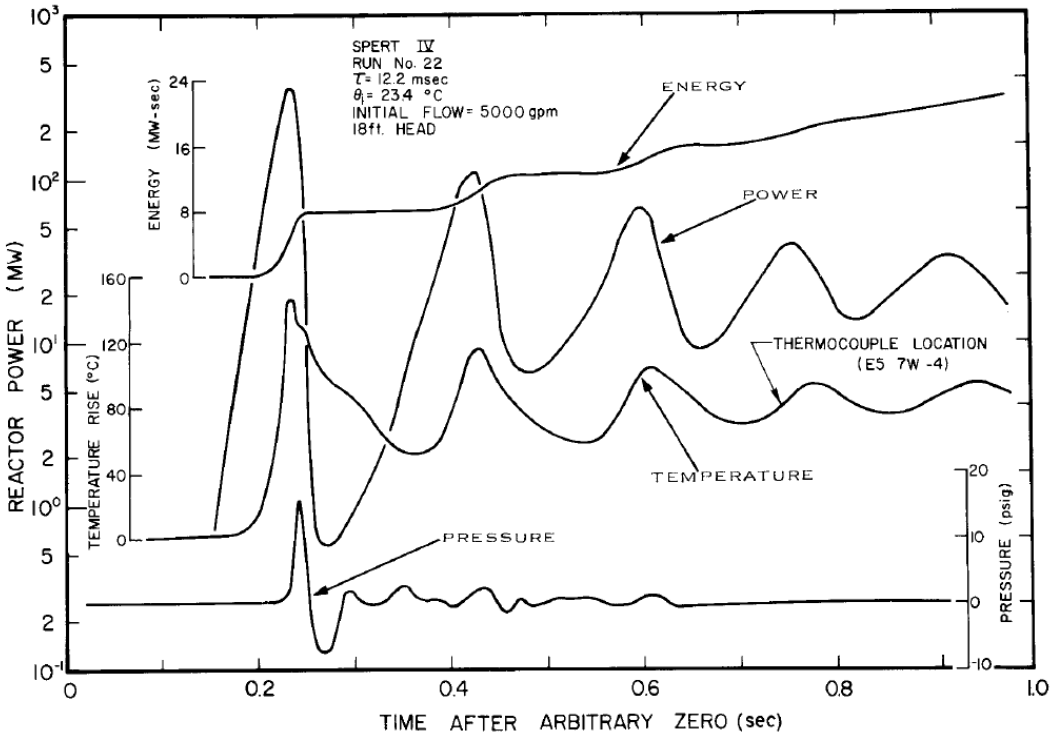


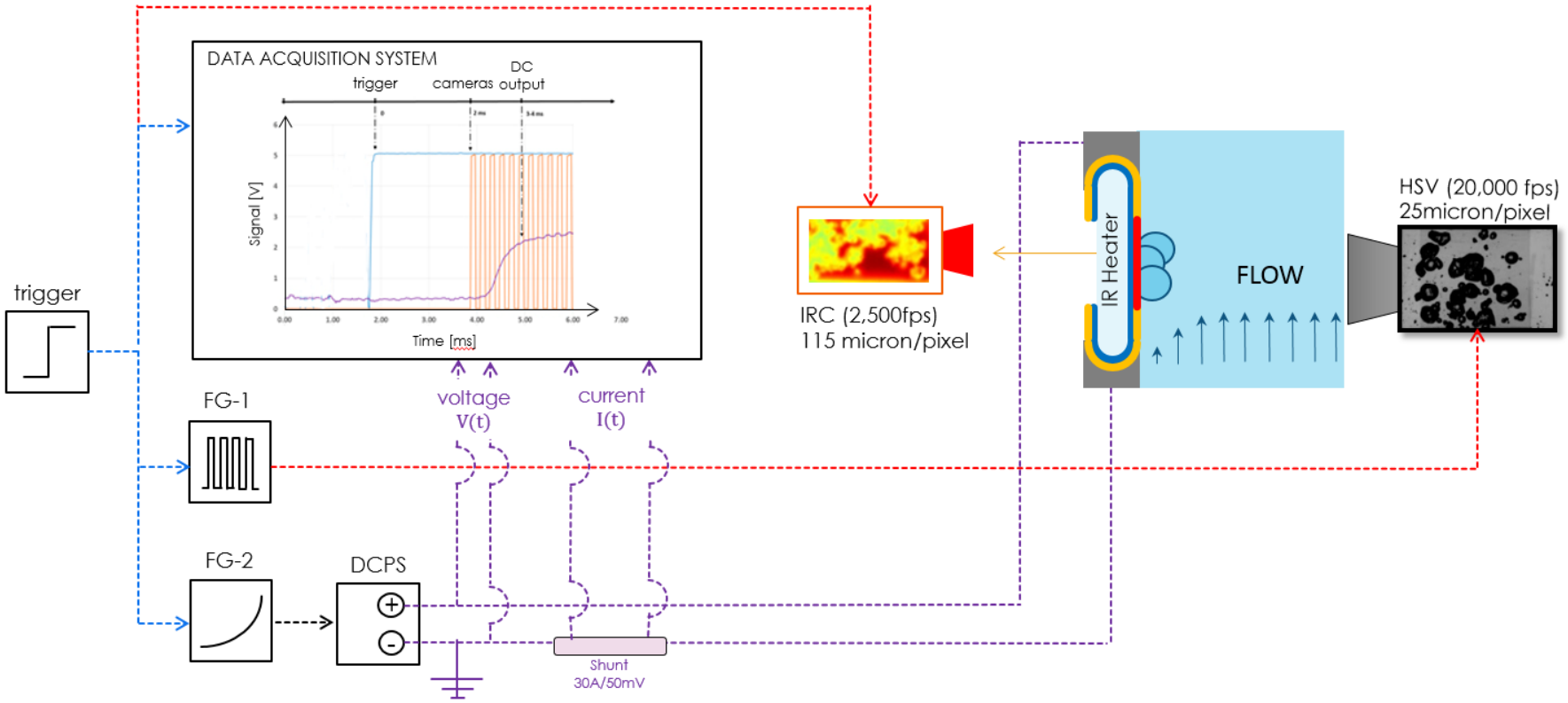
Fig. B-38 Test 22, 12.2-msec period.

Studying boiling in these conditions is of prime interest to be able to predict the behavior of the core.

- **The onset of boiling is highly desirable as it permits to enhance heat transfer from fuel to coolant and introduces reactivity feedbacks that can slow down the rise of power and stabilize it.**
- **Film boiling, on the contrary, impairs the vaporization of the coolant and leads to thermal isolation of the fuel and finally to its burnout.**

EXPERIMENTAL STUDIES

- Experimental studies at MIT (M Bucci/A Kossopalov et al)
- High speed video (20 000 fps) + IR videos (2500 fps) for flux and temperature computation



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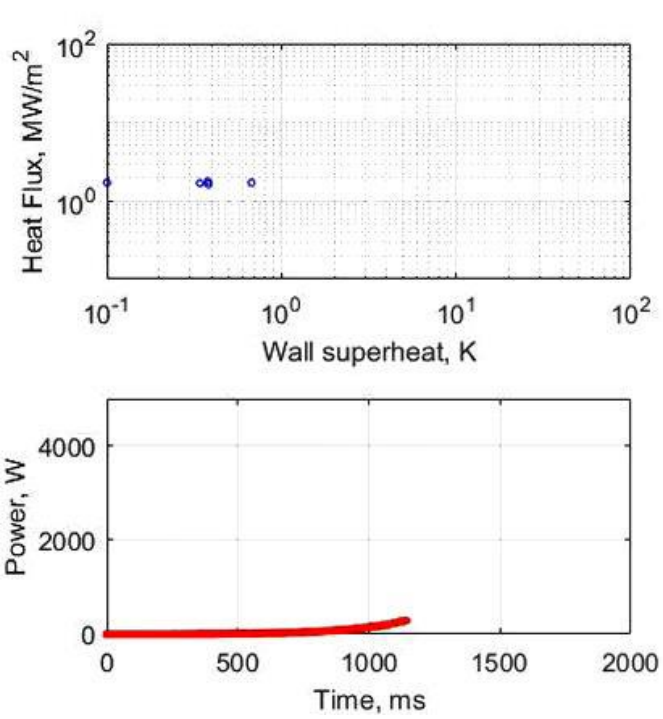

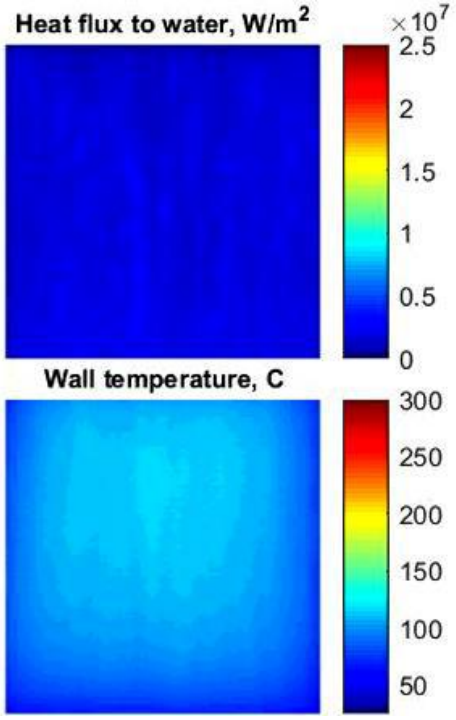

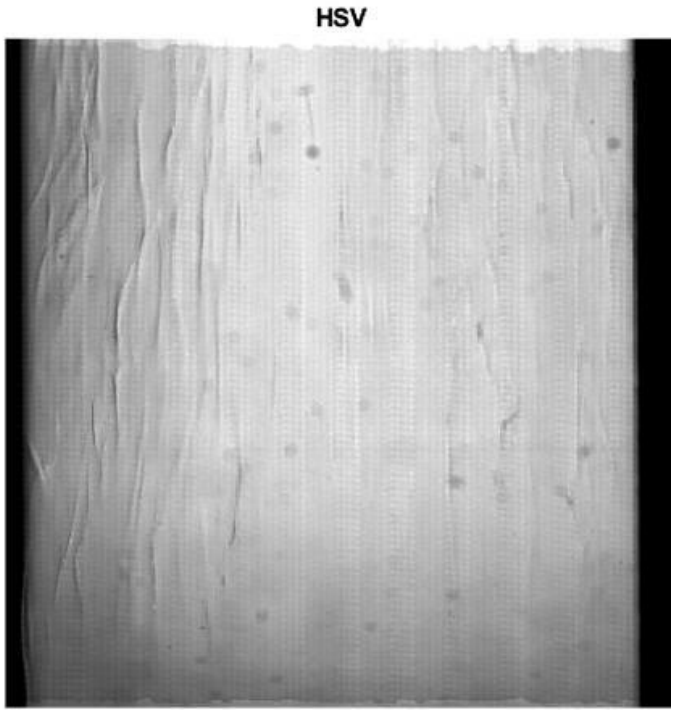

Boiling under exponential power input. 75 K subcooling, Re=35000, 200 ms period

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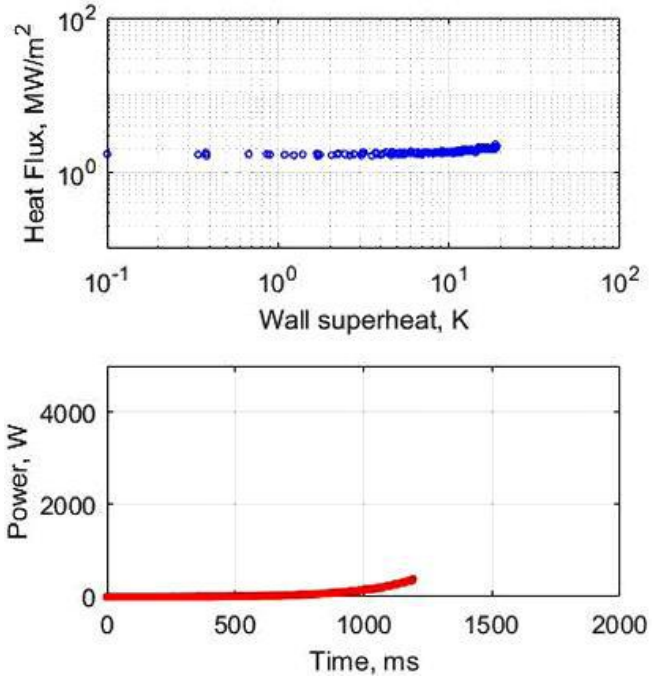

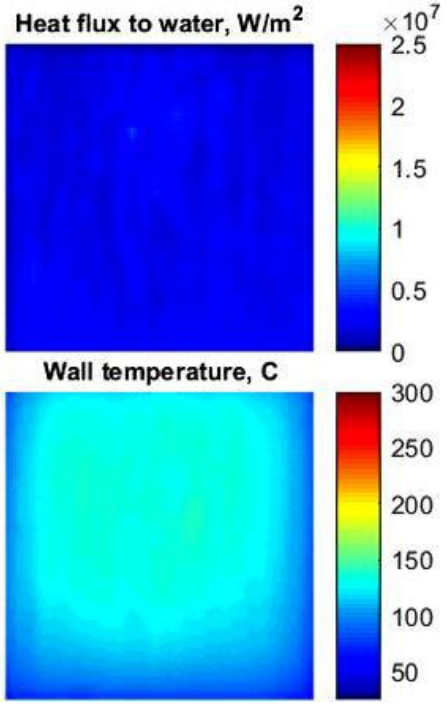

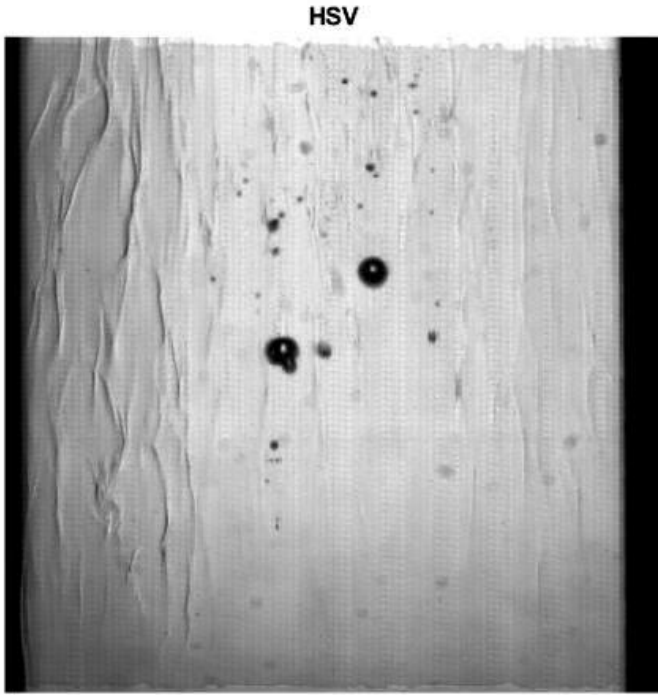

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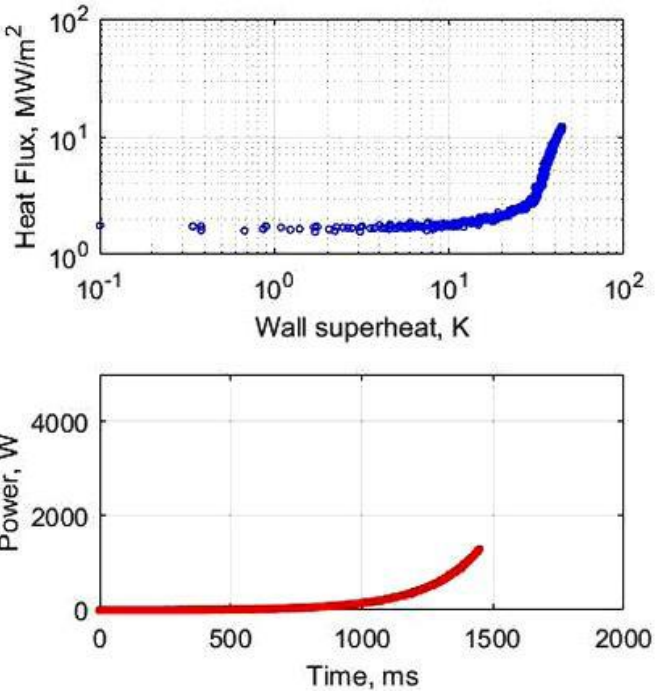

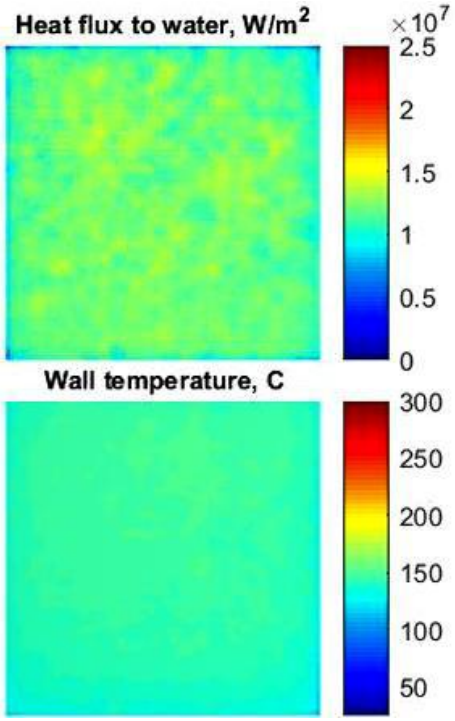

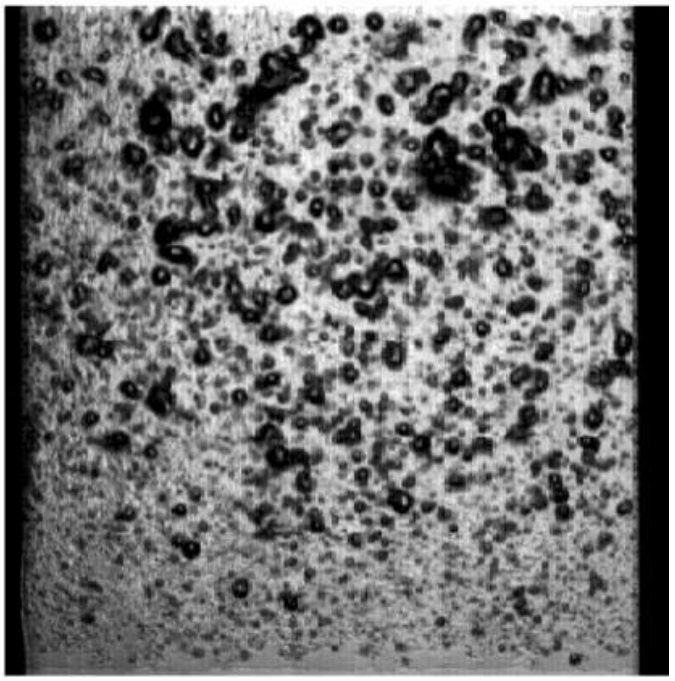

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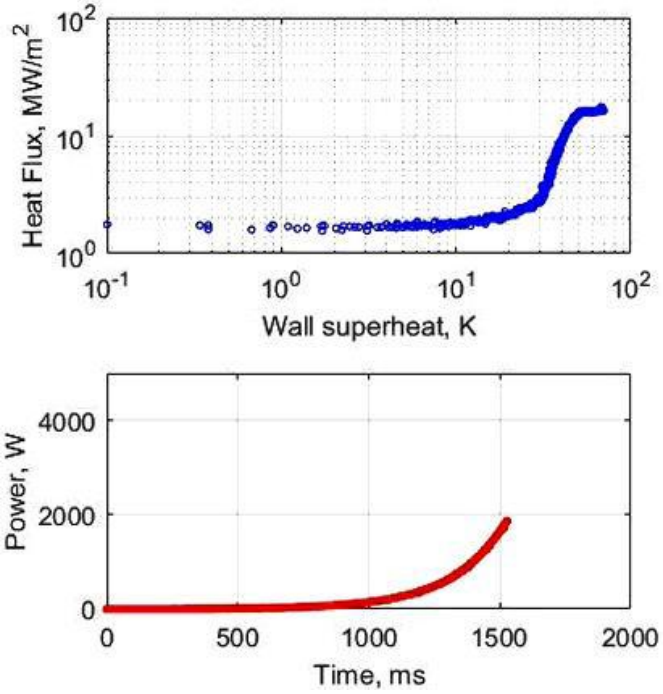

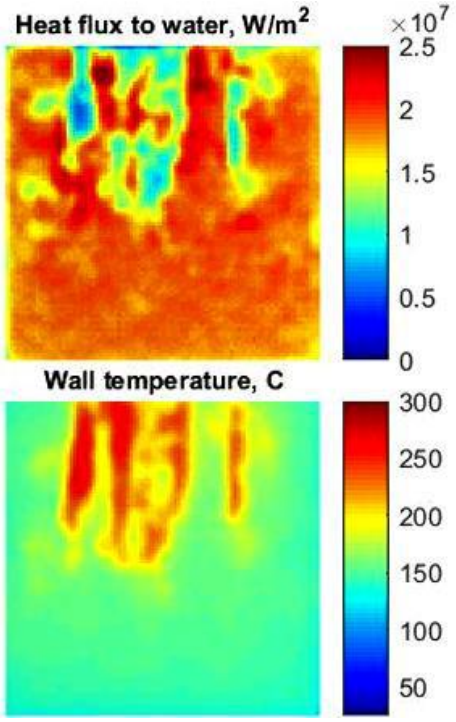

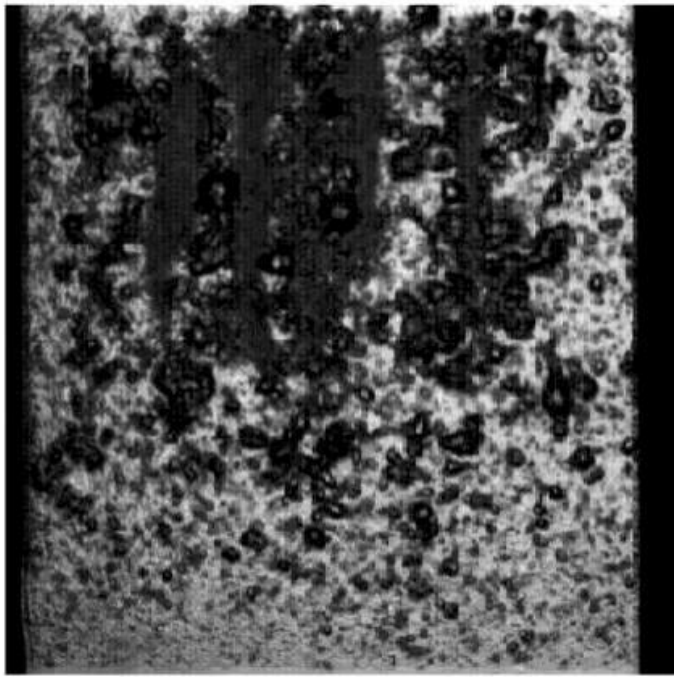

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QUESTIONS

- Physics of transition to film boiling in such « unusual » conditions ?
- Effects of the parameters of interest (Subsaturation, flow, pressure, exponential period of the transients) ?
- How to enhance the transient (for reasonable reactivity insertions) CHF in experimental reactors (surface state / operation conditions, …) ?
- Far from CFD applications now, but could be a challenge for the future.
- At term : CFD/neutronics coupling approach for the transient calculation.

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Thank you for your attention

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