

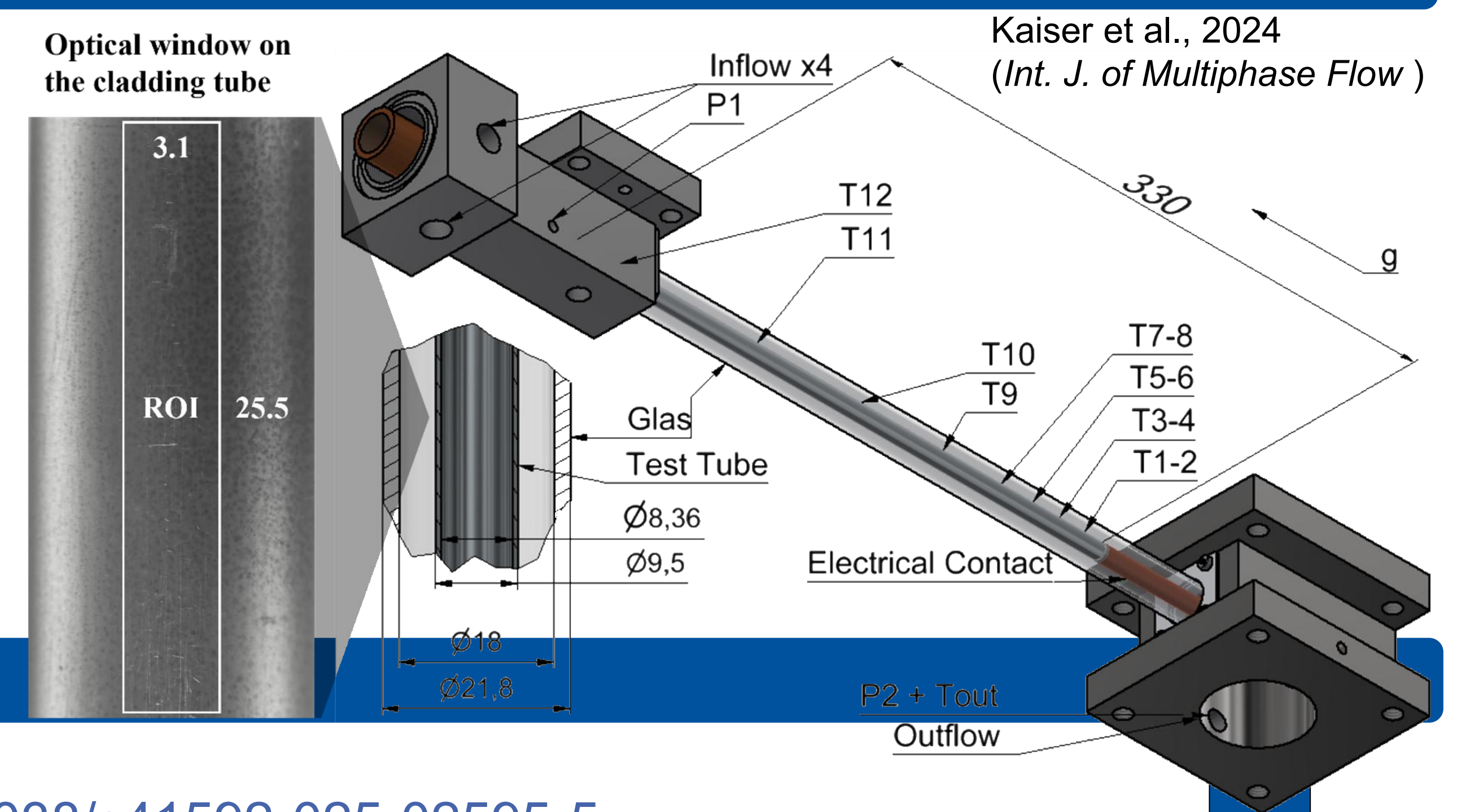
High-Speed Imaging and Bubble Segmentation on Nuclear Fuel Claddings

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Abstract and Experimental Setup

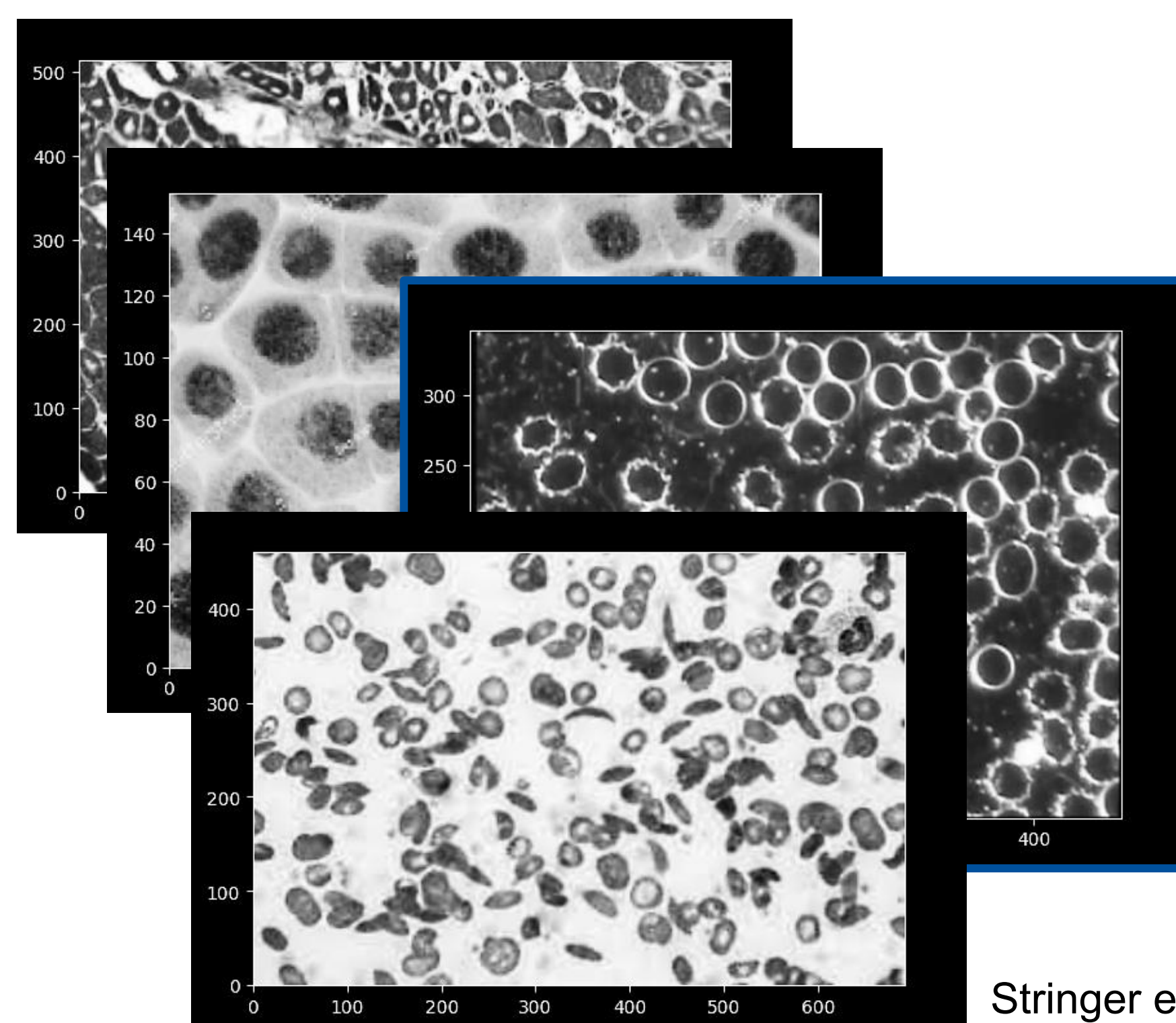
This poster presents a feasibility study on the direct measurement of bubbles on heated cladding tubes. Bubble dynamics are detected and their size determined using high-speed imaging in combination with an AI-based segmentation approach. The experimental setup, the method and initial observations regarding the suitability of deriving modeling parameters from the experiments are presented.



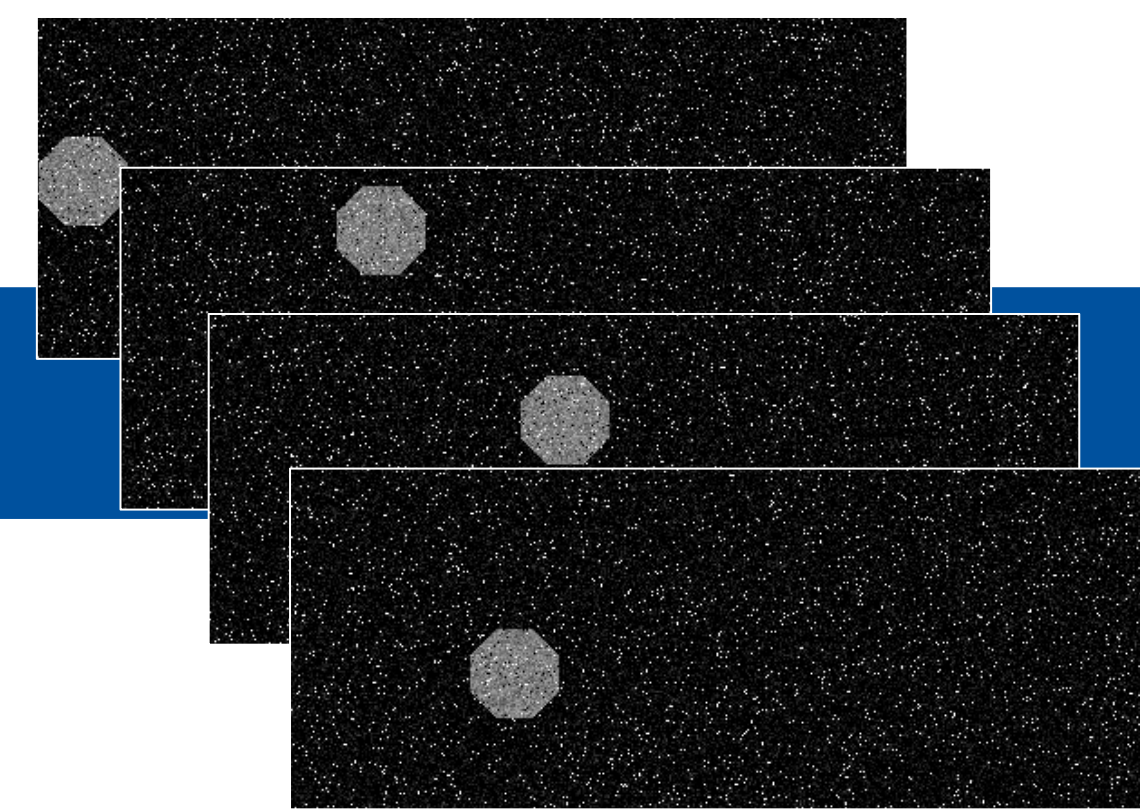
Method and Setup for the Video Post-Processing

The **Cellpose 3** model is used (type: CNN/ U-Net) from <https://doi.org/10.1038/s41592-025-02595-5>. Special Feature: Prediction of flow fields (vector flows) for separation of (bio-) cells.

Selection of labeled “basic datasets”
E.g.: medical databases

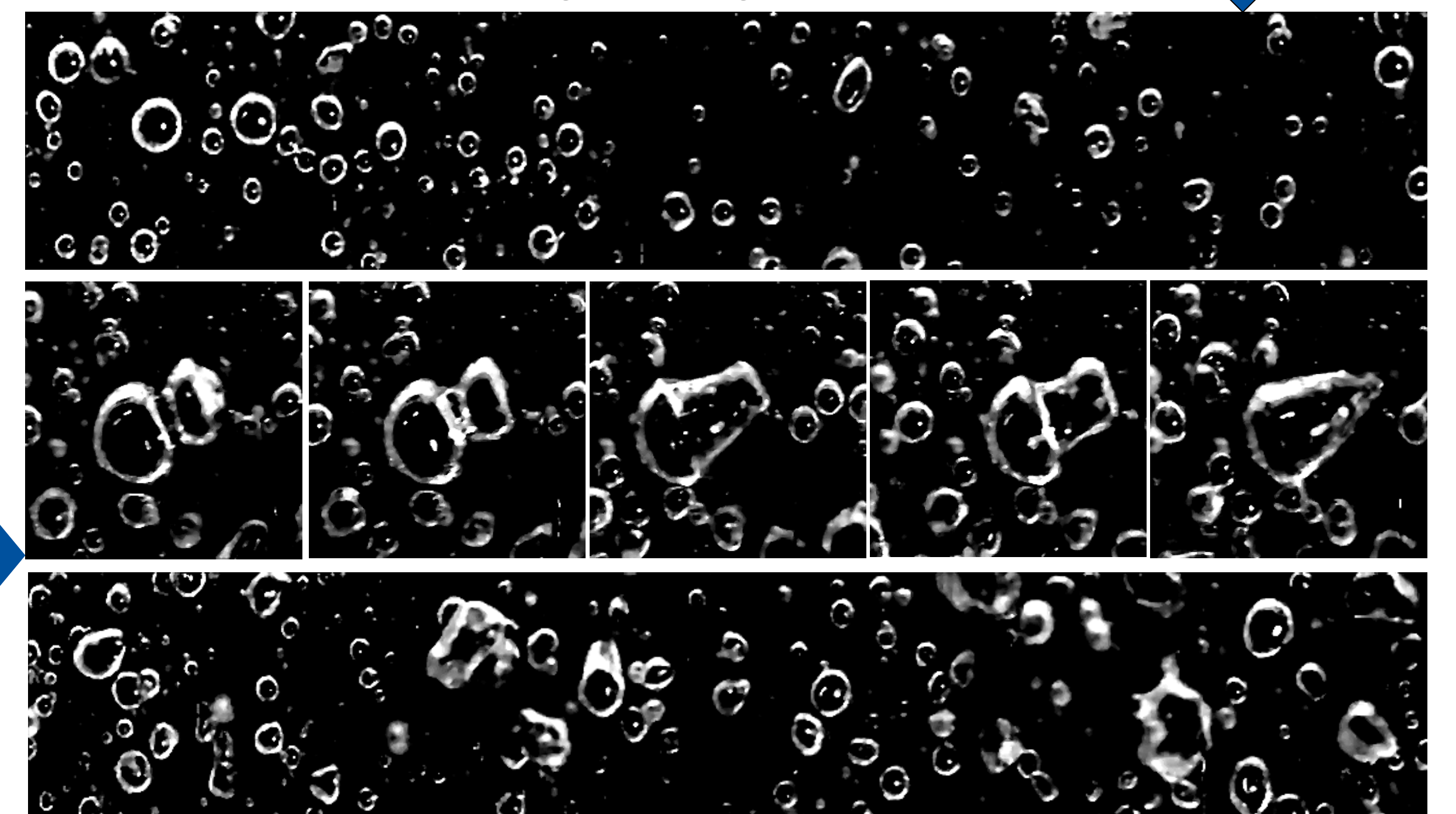


Automatic transfer learning with random shapes and Gaussian noise (15 cases)



Stringer et al., 2025 (Nature Methods)

Model inference using boiling video data

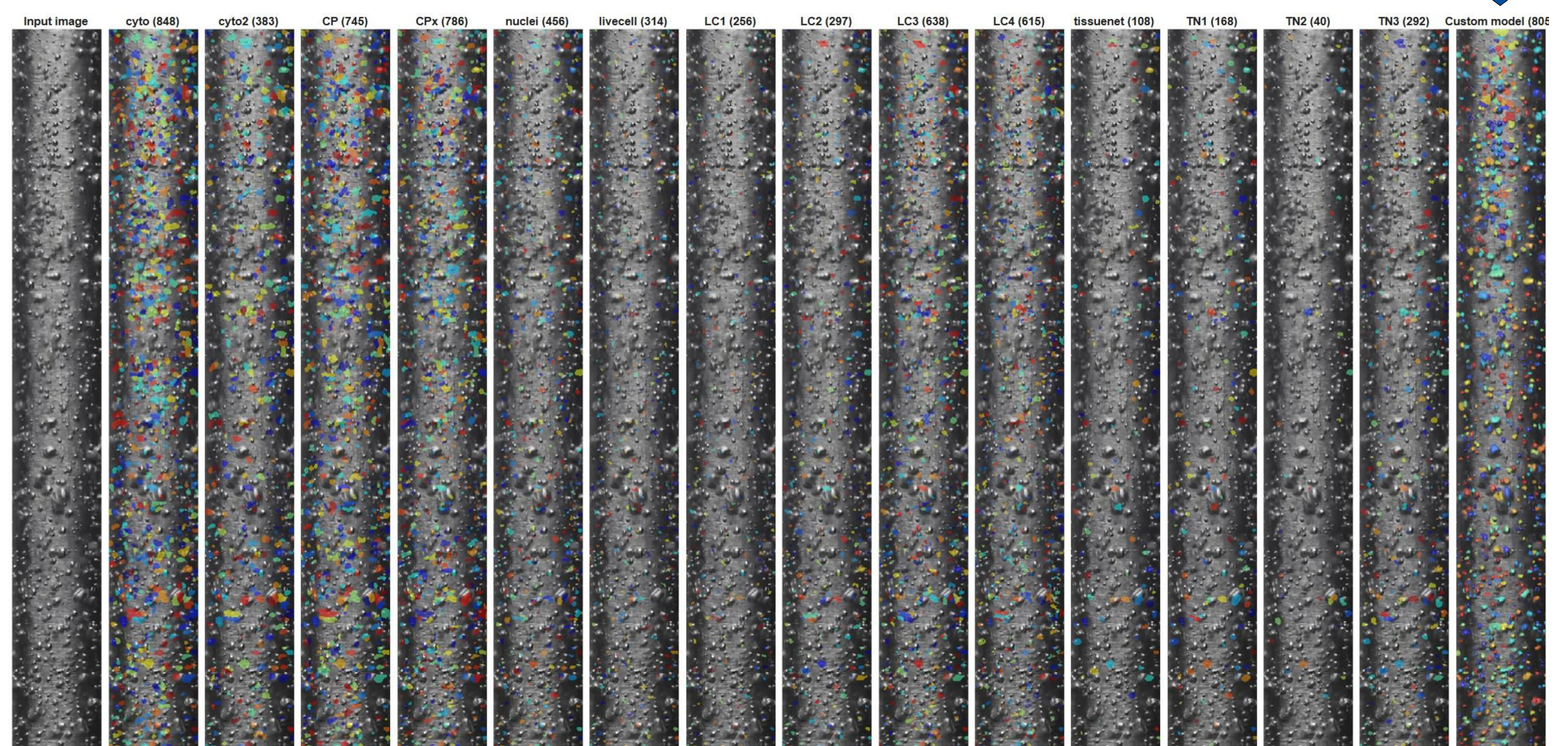


Wefers et al., 2025 (Proceedings of NURETH-21)

Experience and lessons learned

Sample test case: $\dot{q}_{wall}$: 1 MWm⁻², G: 481.6 Kg m⁻²s⁻¹, Re_D : 19545, T_{sub} : 47 K, p_{static} : 3 bar(a)

- Medical databases provide a good foundation.
- Manual intervention is limited to the initial basic selection (first impression).
- Transfer learning using universal shapes achieves acceptable results.
- Performance is largely case-independent.
- “Overly realistic transfer learning” and large sample sizes is counterproductive.



Key Takeaways

- Automatic segmentation without case-specific labeling can be comparable to fine-tuned traditional methods
- Medical databases are often suitable for clustering boiling phenomena

Future Work

- More detailed bubble size & departure analysis.
- Extracted bubble parameters are to be used for wall boiling models: Benchmark against established correlations.