**Faraway, so close: high resolution investigations of boiling heat transfer, from cryogenic fluids to high-pressure water.**

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**ABSTRACT**

In every field of science, the possibility of discovering and understanding new phenomena or testing new hypotheses is strongly related to and limited by the capability of observation. Here, we will discuss recent advances in experimental boiling heat transfer research made possible by unique experimental facilities and non-intrusive high-resolution optical diagnostics. We will analyze the capabilities and limitations of these techniques in supporting the understanding of fundamental two-phase heat transfer problems, with a focus on extreme boiling conditions such as the boiling of water at high pressure and temperature, close to nuclear reactor conditions, the boiling of dielectric fluids for electronic cooling applications, or the boiling of cryogenic fluids relevant to space propulsion and energy storage. The use of these diagnostics has been instrumental in providing answers to long-standing fundamental questions on the fluid dynamics and heat transfer nature of these processes.