*Proceedings of the 10th World Congress on Mechanical, Chemical, and Material Engineering (MCM'24)*
*Barcelona, Spain –August 22-24, 2024*
*Paper No. HTFF 231*
*DOI: 10.11159/htff24.231*

# Investigating the Use of Interferometry to Measure Temperature in Experimental Fluid Mechanics

**Xinyang Ge[1], Joanna A. Zielinska[2], Sergio Maldonado[1]**
[1]Faculty of Engineering and Physical Sciences, University of Southampton, Southampton,
SO16 7QF, UK.
xg2y21@soton.ac.uk; s.maldonado@soton.ac.uk
[2]Photonics Laboratory, ETH Zurich,
Zurich, CH-8093, Switzerland.
jzielinska@ethz.ch

## Extended Abstract

Precise temperature measurement in fluids is essential across a wide array of applications, from operational aspects of industrial facilities like power stations and heat exchangers to essential research in basic sciences [1-3]. Conventionally, fluid temperatures have been measured using intrusive tools such as thermocouples, thermistors, and resistance temperature detectors (RTDs), which require the insertion of a device directly into the fluid. While these instruments provide adequate estimates for most purposes, their use can be impractical and may disrupt fluid dynamics within precision-engineered systems, thereby compromising the accuracy of data in scientific analyses. Alternative non-intrusive methods, including laser-induced fluorescence (LIF) and thermochromic liquid crystals (TLCs), are utilized when contact-based sensors are unsuitable; however, these techniques often necessitate the addition of substances that could alter the fluid's inherent properties.

In this research, we investigate the use of a conventional interferometer to measure line-of-sight-averaged temperature fluctuations in water within experimental fluid dynamics. This approach is applied to two distinct scenarios: monitoring slow temperature changes in static water and fast temperature variation in convective flow heated by a horizontal rod—a novel application for standard interferometry. The exceptional precision of our measurements stems from the interferometer's rapid responsiveness and heightened sensitivity to the subtle variations in the refractive index of water that temperature shifts induce. Using the interferometer, we can detect extremely small temperature changes with millikelvin precision in a non-intrusive way, allowing for the observation of subtle fluid dynamics such as the asynchronous arrival of counter-rotating vortices at the test site. The validity and reliability of our approach are corroborated through comparative analyses with established experimental and numerical methodologies, including RTD sensors, Particle Image Velocimetry (PIV), and Large Eddy Simulations (LES).

Despite the inherent limitations due to its line-of-sight averaging aspect, the non-intrusive nature and robustness of this technique, along with its capability to deliver real-time, highly precise measurements, make it exceedingly valuable for various experimental fluid dynamics applications.

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