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Review

Technical Report on the TSTOF Measurement Method: Technical Basics, Historical Development, and Comparison with Other Laser-Based Measurement Methods

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Abstract

The TSTOF stands for the time-shift time-of-flight measurement method, which is used to characterize individual dynamic particles—such as droplets in droplet clouds or particles in flows—in various industrial applications. Over the past 15 years, this method has become increasingly important and is valued in particular for its ease of use and compact design. So far, however, there is no technical report that deals exclusively and systematically with TSTOF technology. In the scientific literature, the method is usually only treated in connection with specific applications—theoretical or experimental—but is rarely presented in its entirety. Often the citations are incomplete or do not refer to scientifically validated sources. Current technical developments are usually not adequately considered, while non-scientific publications often take up technical aspects uncritically without referring to verifiable data. This report describes the technical foundations of the TSTOF measurement method, presents its historical development, and systematically compares it with established laser-based methods.

Keywords: metrology; laser; particles; droplets; paint spray

1. Introduction

The characterization of particles, such as droplets or particles that are suspended in a flow or a droplet cloud, is of central importance for numerous industrial processes. This includes spray drying, coating, combustion, and pharmaceutical aerosol applications. In addition to capturing size and speed, the measurement of particle composition is gaining in importance, particularly for complex multiphase systems, such as emulsions and suspensions. Conventional laser-based measurement techniques, such as laser diffraction (LDT) [1] or the phase Doppler technique (PDT) [2–4], are well established in many areas. However, they reach methodical limits, particularly for single-particle analysis in dense, dynamical, or optically challenging measurement environments. In such cases, the precise registration of individual particles is often only possible in a restricted way.

The time-shift time-of-flight technique (TSTOF) [5–7] provides an alternative and powerful approach for such cases. Through a combination of temporally shifted light-scattering signals with a precise time-of-flight measurement, the TSTOF method enables the

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