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LIGHT SCATTERING FROM A DROP WITH AN EMBEDDED SPHERICAL PARTICLE FOR THE TIME-SHIFT TECHNIQUE

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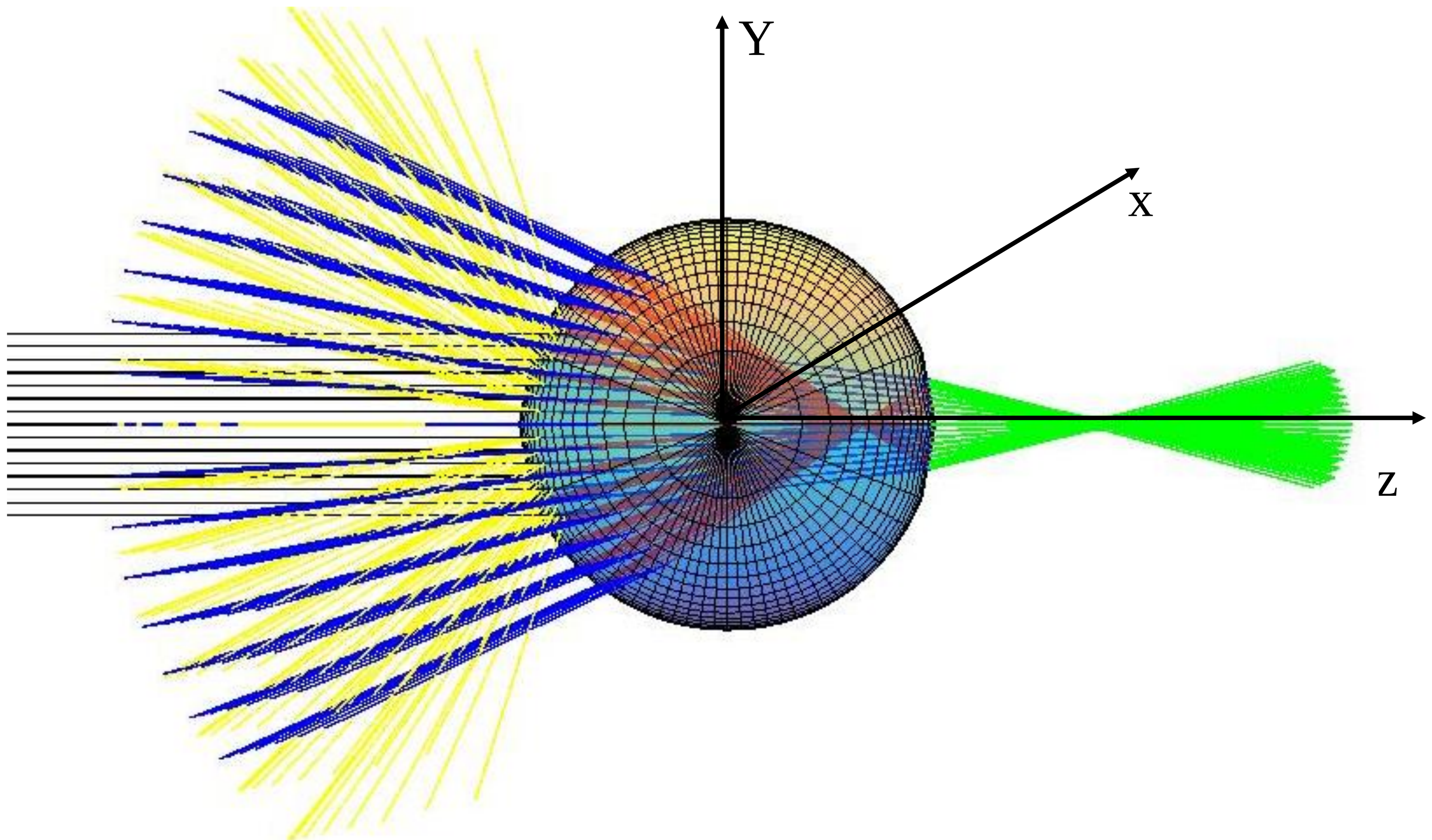
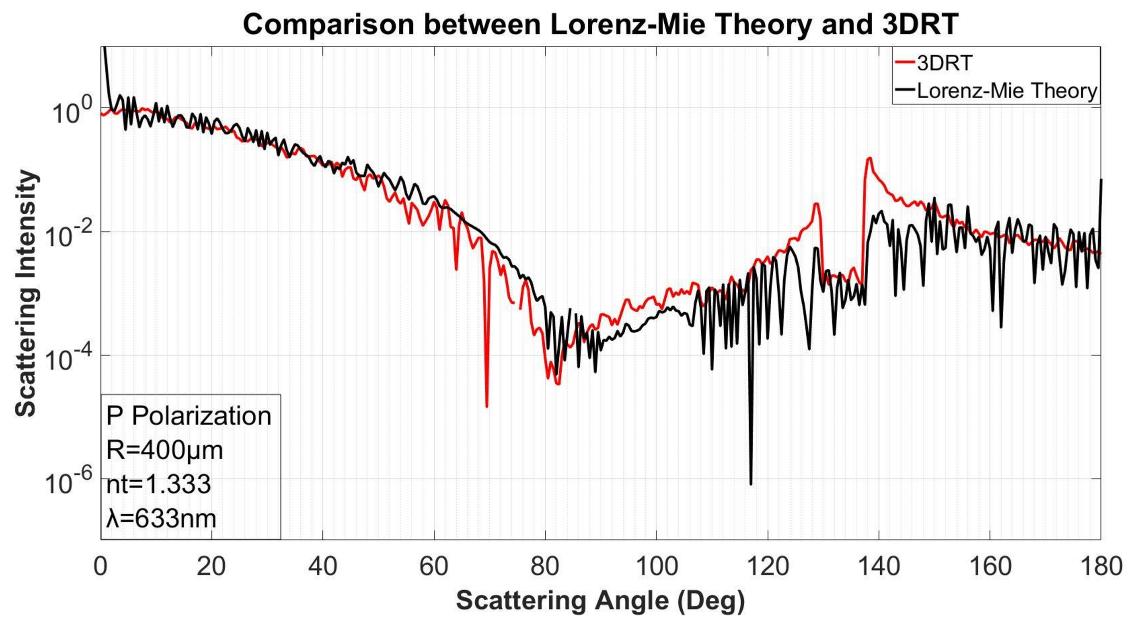
TECHNISCHE UNIVERSITÄT DARMSTADT

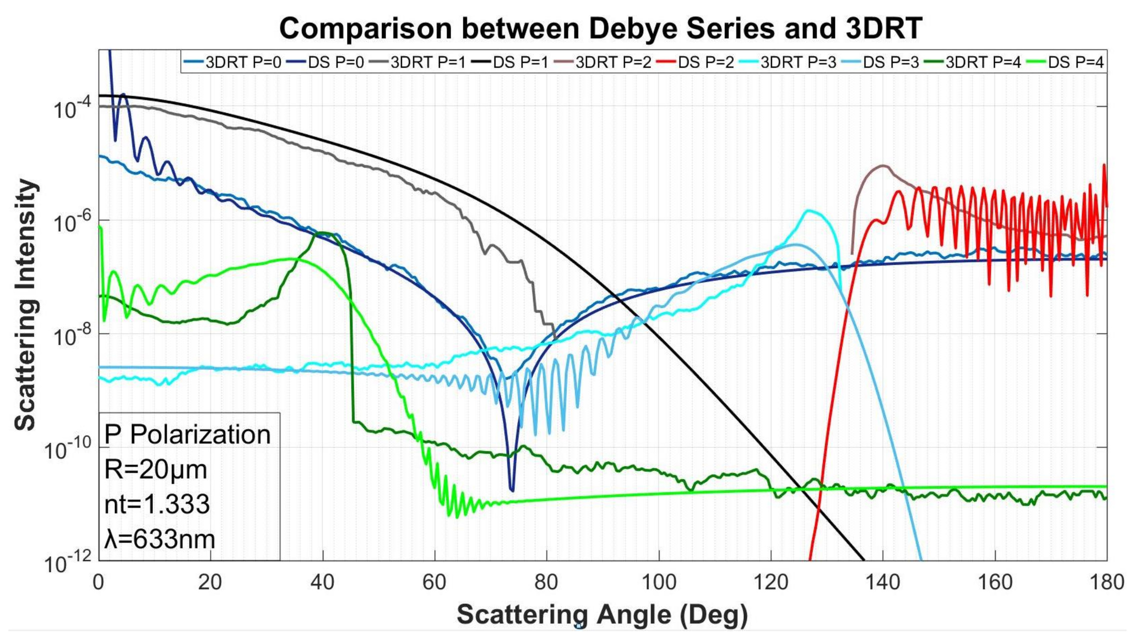
Advanced Optical Measurement Systems

Three-Dimensional Ray Tracing Technique (3DRT)

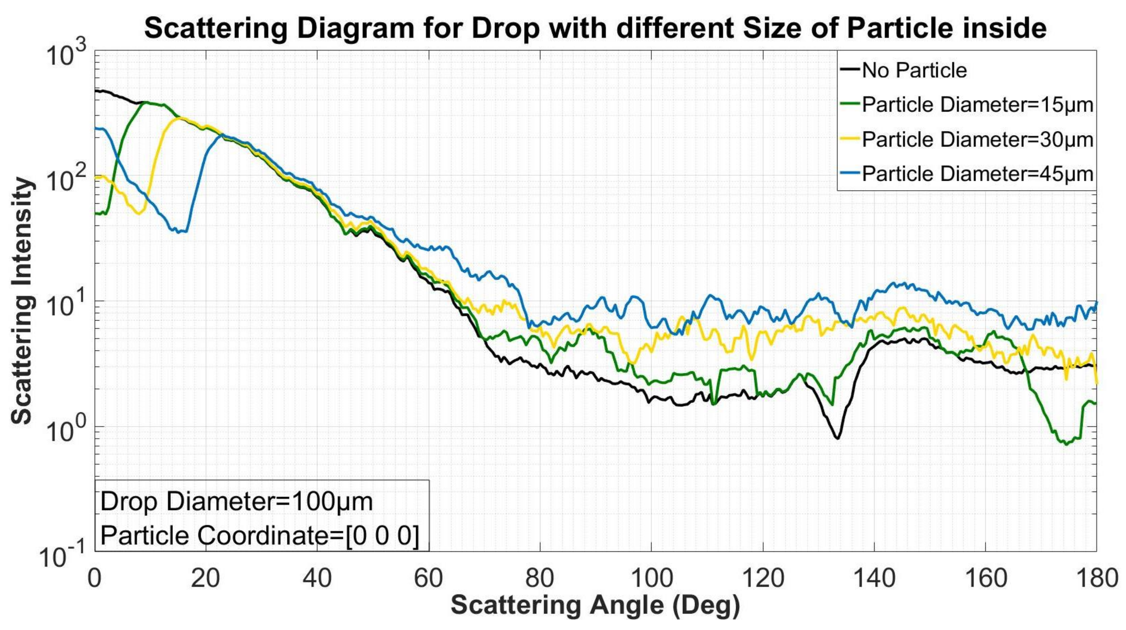
This study is devoted to light scattering from drops with an embedded, reflecting particle, as would be expected in an encapsulation / coating process or with spraying of metallic paints. The present study falls within a broader effort to explore the possibility of utilizing the time-shift technique for such characterization tasks. Ray tracing is used, computing the trajectories of a large number of incident rays defined by an incident plane wave and superimposing all rays scattered in a given direction to result in a scattering diagram. Rays up to p=10 are used to compute the scattered light intensity field. Verification of the simulations is performed through comparison with selected, known solutions.

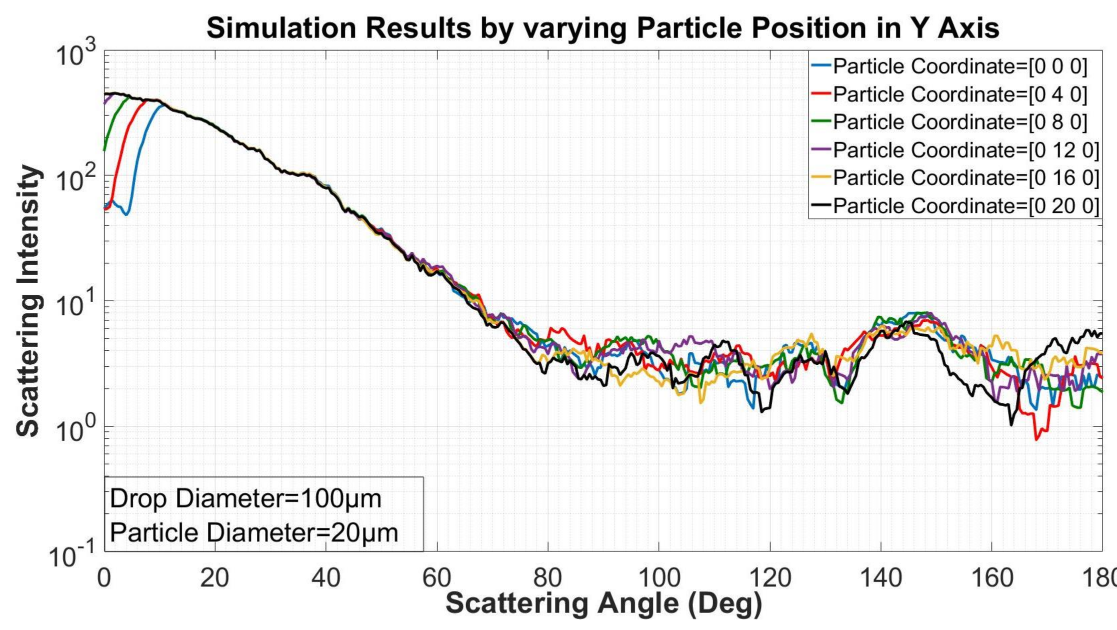


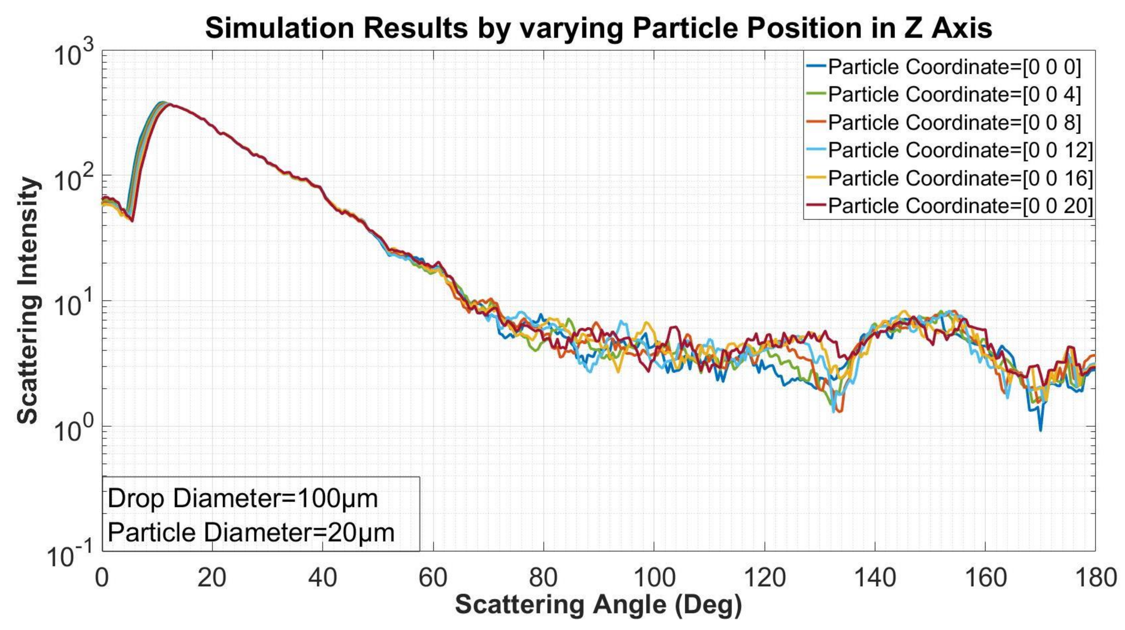




Light Scattering Diagram for Drop with an Embedded Particle

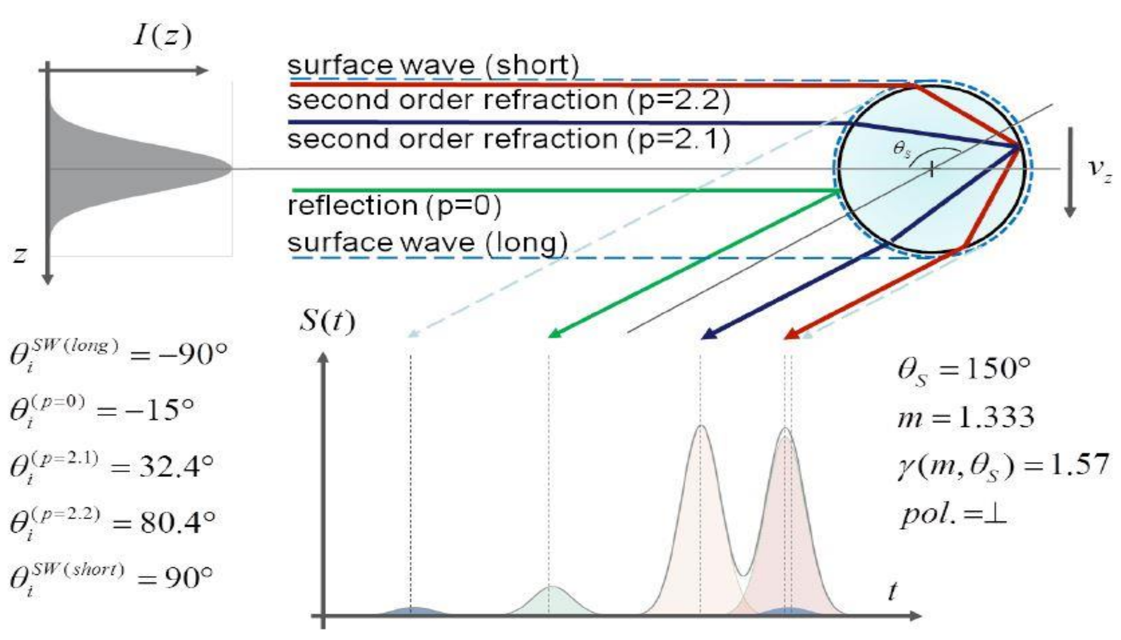


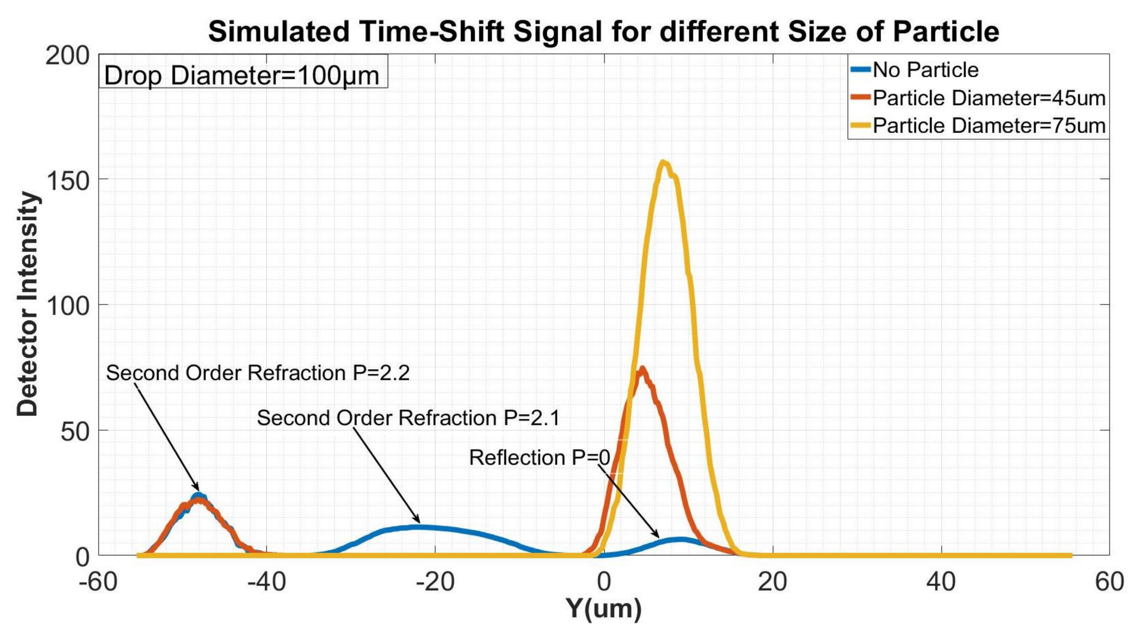




The position of the particle can be varied in x, y and z directions. The calculation results show that forward scattering is less sensitivity to changes of particle position in the z direction. The size of embedded particle has a significant influence on the forward scattering intensity.

Light Scattering Simulation for the Time-Shift Technique





The ray tracing program can simulate the time-shift signal for a droplet passing through the measurement volume. In this case the incident wave is a highly focused Gauss beam (w=10µm). In this example, when the diameter of the particle is 45µm, the signal of the scattering order p=2.1 vanishes. When the diameter of the particle is above 75µm, both of the second order refraction p=2.1 and p=2.2 vanish, because the particle blocks the internal transmission of the light.

1. Philip Laven, "Simulation of rainbows, coronas, and glories by use of Mie theory," Appl. Opt. 42, 436-444 (2003)
2. Walter Schäfer and Cameron Tropea, "Time-shift technique for simultaneous measurement of size, velocity, and relative refractive index of transparent droplets or particles in a flow," Appl. Opt. 53, 588-597 (2014)