# Temporal Integrated Detection and Applications of FS-Pulse Scattering

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In recent years the scattering from particles illuminated with short pulse lasers was investigated in a number of publications. A number of these papers deal with the theoretical and numerical description of the scattering process [1], whereas the applications mainly focus on the inelastic scattering after stimulation with laser light. Up to now, the special characteristics of short pulse elastic scattering, with pulse lengths shorter than the object's extent, are used only in a limited number of applications [2],[3]. The main characteristic of femtosecond pulse scattering on small particles is the temporal separation of the pulses, because of the different optical path lengths through the particle. Therefore the particle converts the incident pulse in a train of pulses, with the pulse heights and temporal separation depending on particle size, refractive index and observation angle. Because the temporal separation is given by the travel time the light needs to cross the particle, the arrival times between different scattered pulses are extremely small. In the paper detection schemes and possible applications will be presented, which use the special characteristics of scattered femtosecond pulses but do not need the high temporal resolution. Because of the temporal pulse separation, signal parts from different scattering orders are no longer coherent. Therefore interference structures, which are in the case of continuous illumination the cause of scattering lobes, disappear. The interference inside a single scattering order, as for the rainbow, exists as long as the pulses from different paths overlap. This offers the possibility to improve or extend techniques which are disturbed by additional scattering orders, as the rainbow technique for small particles. Fig. 1 shows the calculated and measured intensity distributions in the rainbow region of a 94μm water droplet for continuous and pulse illumination (tp = 200fs) and for a temporal integrating receiver.

The suppression of the ripple structure in the rainbow, which normally limits the precise determination of the rainbow angle and therefore the refractive index of the droplet [4], is clearly observable for pulse illumination. One part of the paper presents numerical and experimental investigations for the extensions of the rainbow technique to small particles and compares the accuracy of the refractive index determination for continuous and pulse illumination. The second part of the paper deals with the suppression of morphology dependent resonances through the broad electromagnetic spectrum of the femtosecond pulse.

## References

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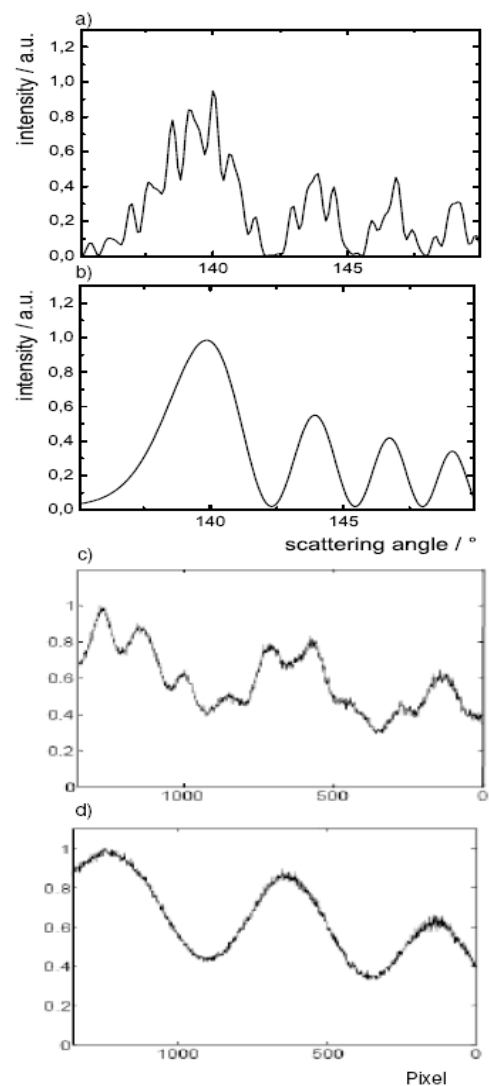
Fig. 1. a,b) Numerically obtained angular intensity distribution in the far field of a 94μm droplet illuminated by a continuous source and 200fs laser pulses. Pulsed illumination suppresses the ripple-structure. c,d) The corresponding measured angular intensity distribution confirms previous calculations.