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Detection of Objects Hidden in Highly Scattering Media Using Time-Gated Imaging Methods

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ABSTRACT

Non-intrusive and non-invasive optical imaging techniques has generated great interest among researchers for their potential applications to biological study, device characterization, surface defect detection, and jet fuel dynamics. Non-linear optical parametric amplification gate (NLOPG) has been used to detect back-scattered images of objects hidden in diluted Intralipid solutions. To directly detect objects hidden in highly scattering media, the diffusive component of light needs to be sorted out from early arrived ballistic and snake photons. In an optical imaging system, images are collected in transmission or back-scattered geometry. The early arrival photons in the transmission approach always carry the direct information of the hidden object embedded in the turbid medium. In the back-scattered approach, the result is not so forth coming. In the presence of a scattering host, the first arrival photons in back-scattered approach will be directly photons from the host material.

In the presentation, NLOPG was applied to acquire time resolved back-scattered images under the phase matching condition. A time-gated amplified signal was obtained through this NLOPG process. The system's gain was ~ 100 times. The time-gate was achieved through phase matching condition where only coherent photons retain their phase. As a result, the diffusive photons, which were the primary contributor to the background, were removed.

With a large dynamic range and high resolution, time-gated early light imaging has the potential for improving rocket/aircraft design by determining jets shape and particle sizes. Refinements to these techniques may enable drop size measurements in the highly scattering, optically dense region of multi-element rocket injectors. These types of measurements should greatly enhance the design of stable, and higher performing rocket engines.

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