# Study of Raman-Nath Diffraction Experiments on OSL and NIF*

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The study of laser beams crossing in plasma has long been of interest in Inertial Confinement Fusion application, where the Cross-Beam Energy Transfer (CBET) can redistribute laser energy around the fusion capsule/holhraum. One common assumption for CBET is that the diffraction from the plasma grating occurs in the Bragg regime, with no diffracted orders present besides the first order. This ignores the possibility of diffraction phenomena associated with the Raman-Nath diffraction regime.

Early experiments conducted on the National Ignition Facility [1,2] showed that plasma gratings generated by the interference of two laser beams crossing at a small angle on the surface of a planar target could lead to 60% of the diffracted light scattered into non-zero orders. Recently, additional experiments were performed on the Optical Sciences Laser, showing high normalized energy of approximately 10% and 3% at the first and second diffracted orders locations, respectively. The existence of the higher-orders is characteristic of diffraction from gratings in the Raman-Nath as opposed to the Bragg regime.

We propose a theoretical approach to model the Raman-Nath diffraction in these experiments. The laser-plasma interaction is described using a novel laser propagation model where the laser refraction is described by sampling the field with geometrical optics and the laser intensity is reconstructed using field estimators and interpolators based on Delaunay triangulations [3,4]. The amplitude of plasma waves generated by the overlap of the various laser wavefields is computed using a model similar to those commonly developed for CBET. The scattered laser power in each diffracted order is then computed along the wave trajectory using Raman-Nath diffraction theory. We identify several mechanisms that contribute to the difference in diffraction efficiency observed between the two experiments despite these being conducted at similar laser intensities.

**References**

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