Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Tomographic PIV using pulsed, high power LED illumination
CHRISTIAN WILLERT, Institute of Propulsion Technology, German Aerospace Center (DLR), 51170 Koeln, NICOLAS BUCHMANN, JULIO SORIA, Department of Mechanical and Aerospace Engineering, Monash University, Melbourne, VIC 3800, Australia — High-power light emitting diode (LED) illumination is investigated as an alternative to traditional laser-based Nd:YAG illumination for Tomographic Particle Image Velocimetry (TPIV). Light pulses of significant intensity (1-10 mJ) are obtained by briefly operating the LED at high drive currents and short pulse durations (I_f = 24A, $\tau_p = 150\mu$s). Two LEDs of different wavelengths (green, 525nm; red, 623nm) are investigated with both LEDs providing sufficient pulse energy and image quality to perform reliable TPIV measurements. Volumetric illumination is achieved by direct projection of the LED into the flow, which yields a measurement volume of approximately 8 x 8 x 14 mm^3. The feasibility of this illumination approach is assessed by performing TPIV measurements in homogenous, grid-generated turbulence. in comparison to Nd:YAG laser illumination the absence of laser speckle and excellent pulse-to-pulse stability of the LEDs yield particle image data of high quality with a 3-D displacement measurement uncertainty on the order of 0.2-0.3 pixel. Using an array of LEDs the illuminated volume can be further increased. For instance six high power LEDs are sufficient to illuminate a volume of about 50 x 50 x 10 mm^3.

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Date submitted: 03 Aug 2012 Electronic form version 1.4