LaVision
FOCUS ON IMAGING

In Application

Digital Light Sheet Correction

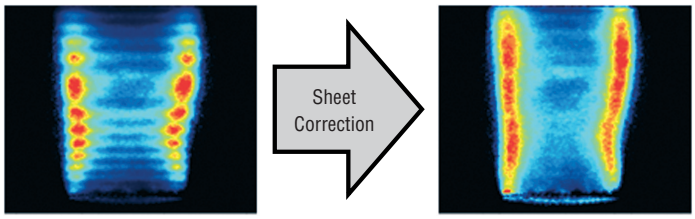
Laser imaging on homogeneous light sheets

Introduction

In planar laser light sheet experiments the LIF and Rayleigh signal **S** is directly proportional to the density of molecules **n** and the local laser energy **E**, i. e. **S** = **c E n** with the calibration constant **c**. Therefore, for signal calibration the energy profile across the light sheet height together with the individual laser pulse energy has to be known.

Integral part of LaVision's laser imaging systems is an on-line energy monitor to measure the pulse-to-pulse energy fluctuation. According to the detected pulse energy values our **DaVis** software automatically corrects the signal intensities. For the correction of a non-uniform but stable light sheet energy profile a measurement in a homogeneous scattering medium (**n** = constant) is carried out. From this so called light sheet image the energy profile is extracted and used for light sheet correction.

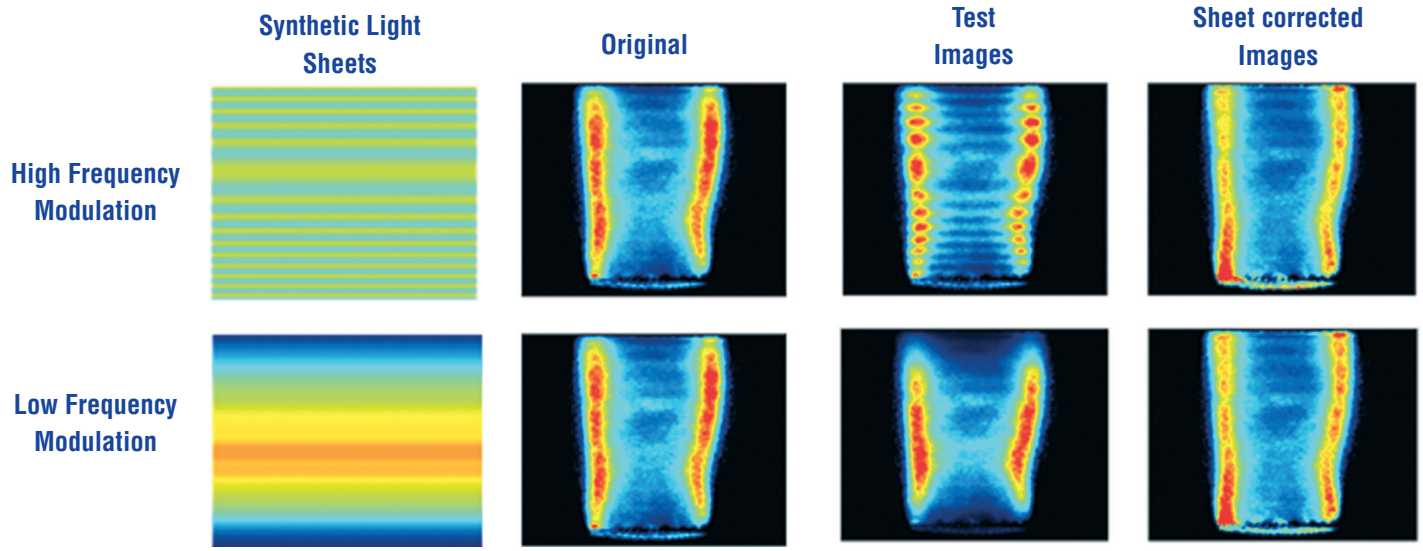
Light sheet recording for sheet correction is not always possible due to imperfect reference conditions like inhomogeneous scattering samples and/or optical distortions going from the reference to the real test conditions, like e. g. dust or oil films on the entrance window of a measurement chamber. Furthermore, such obstacles in the beam delivery path can change over time making an effective light sheet correction nearly impossible.



OH-LIF image before and after digital light sheet correction

Digital light sheet correction

LIF and Rayleigh images carry intrinsic information about the underlying energy profile of the laser light sheet used for excitation. Based on advanced image processing routines the digital light sheet correction filter in **DaVis** can - to a certain extent - correct for such unwanted beam profile artefacts present in the original LIF (Rayleigh) images. This is even possible for single shot images when the detected signal covers most of the light sheet area. In other cases image averaging is necessary to collect signal over the whole light sheet before the digital sheet correction filter can be applied.



Original OH-LIF image is modulated with two different synthetic light sheets to create two test images. Digital light sheet correction is then applied to these test images to nearly restore the original OH-LIF image.

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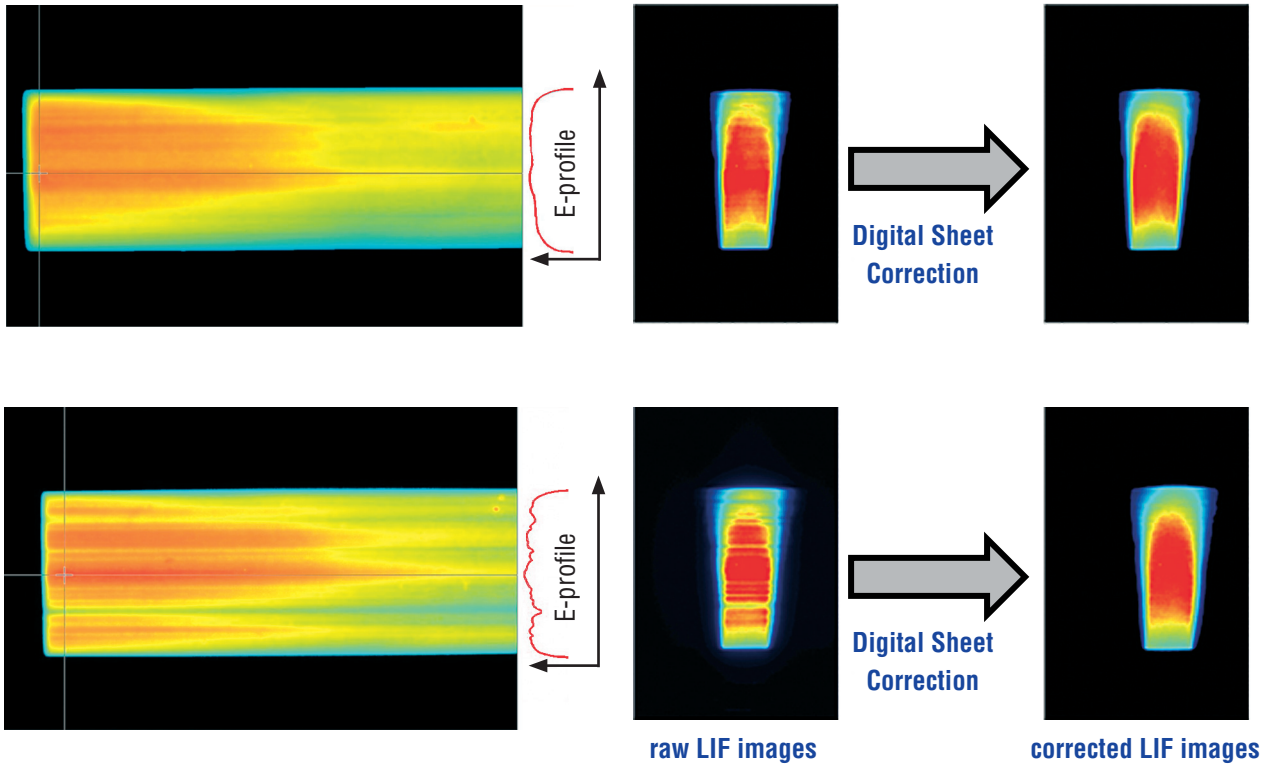
Quality of digital light sheet correction

For validation purposes a measured (original) OH-LIF image was modulated with synthetically generated light sheets. In the bottom figure of the front page two artificial light sheets with high and low modulation profiles are superimposed with the original OH-LIF image generating two test images. Then the digital sheet correction filter is applied to both test images to reconstruct the original image. The comparison of these two sheet corrected images with the original image shows impressively the power of the digital light sheet correction filter which is implemented as a standard feature in our **DaVis** LIF and Rayleigh software packages, respectively.

The quality of digital light sheet correction was also tested using experimental data. Two laser light sheets with different energy profiles were used for anisole LIF imaging in a stable gas jet. As shown in the bottom figure the upper light sheet shows a nearly perfect top hat energy profile, while the profile of the lower light sheet is much more modulated. As a result, the corresponding LIF images of the same gas jet are different, although both should be equal. Finally, digital light sheet correction transfers successfully both raw LIF images into the same “true” LIF image of the gas jet. In conclusion, digital light sheet correction enables LIF and Rayleigh imaging on homogeneous light sheets without artefacts.



Experimental validation of digital light sheet correction: two laser sheets with different energy profiles are used to generate LIF images in a stable anisole seeded gas jet. Digital light sheet correction is applied as a post processing step to recover in both cases the same original LIF intensity distribution in the gas jet.

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