



ALPHALAS GMBH  
 BERTHA-VON-SUTTNER-STR. 5  
 D-37085 GÖTTINGEN  
 GERMANY

TEL +49 - (0)551 - 77 06 147  
 FAX +49 - (0)551 - 77 06 146  
 E-MAIL [INFO@ALPHALAS.COM](mailto:INFO@ALPHALAS.COM)  
 WEB [WWW.ALPHALAS.COM](http://WWW.ALPHALAS.COM)



*LASERS, OPTICS, ELECTRONICS. MADE IN GERMANY.*

## CCD-S3600-D(-UV) APPLICATION EXAMPLE

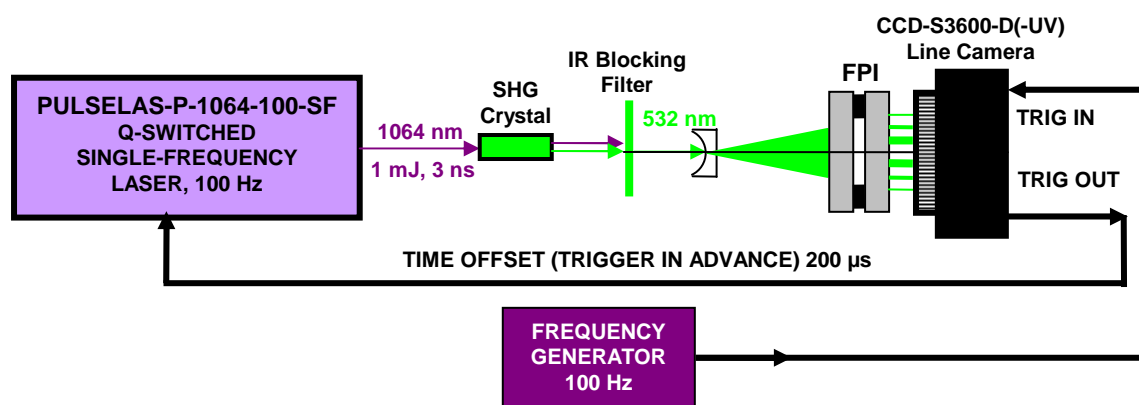
### Long-Term Frequency Stability Analysis of a Pulsed Laser

Rev. 2012-06-07, Copyright © 2012 ALPHALAS GmbH. All rights reserved.

In this example, the frequency stability and the longitudinal mode content of a single-frequency diode-pumped Q-switched laser was conveniently monitored and analyzed by means of a combination of a Fabry-Perot interferometer and the CCD-S3600-D line camera. The laser used in this experiment was the PULSELAS-P-1064-100-SF (manufactured by ALPHALAS GmbH) delivering 1 mJ pulses with 3 ns pulse duration (FWHM) in single-frequency mode and operating at a repetition rate of 100 Hz.

The laser output was frequency-doubled to 532 nm, not only for the convenience to work with visible light, but also to allow high-sensitivity detection of weaker additional longitudinal modes [1]. The Fabry-Perot interferometer (FPI) had a free spectral range of 50 GHz ( $\sim 47$  pm at 532 nm).

The experimental setup is shown in Figure 1.



**Figure 1: Experimental Setup for Long-Term Frequency Stability Analysis of a Pulsed Laser**

The CCD camera was set to “single-shot” operating mode. It was triggered from a frequency generator at 100 Hz. Its trigger output in turn was used to trigger the pulsed laser. This resulted in the same repetition rate of 100 Hz, but the laser could be triggered always exactly at the moment when integration begins in the CCD. Thus, the shortest possible integration times could be used and noise was reduced to a minimum.

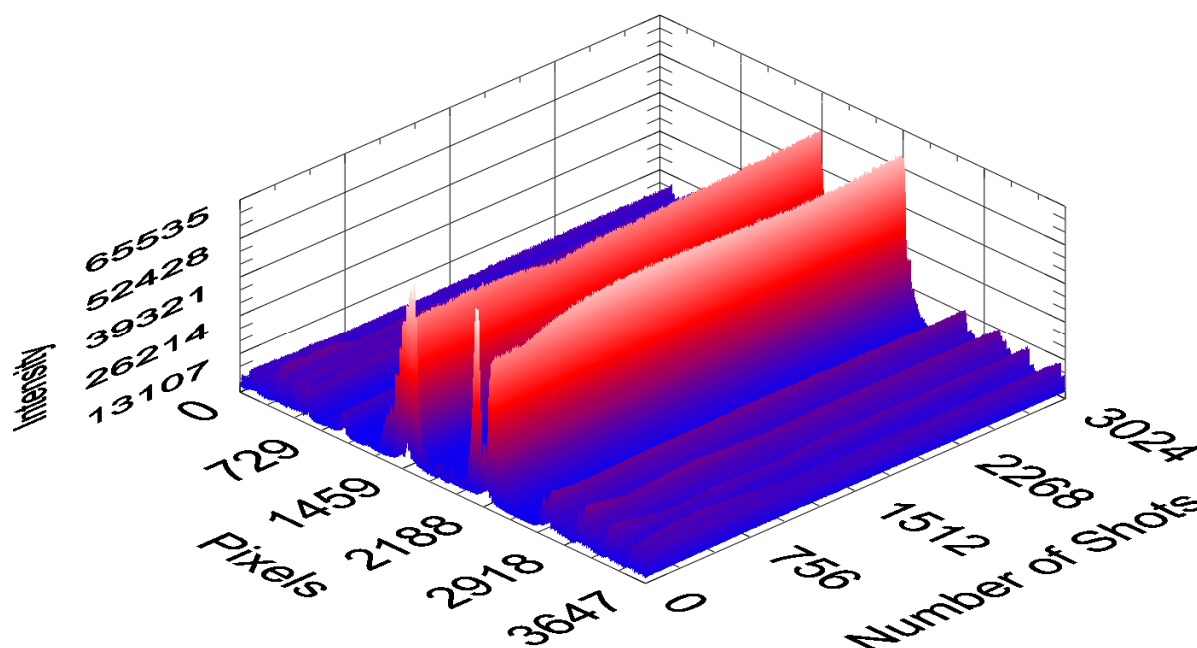
Because this particular laser fires with a delay of approximately 200  $\mu$ s after having received a trigger signal, another unique feature of the CCD-S3600-D line camera to generate trigger in advance was also used.

In addition, because a jitter of about 30  $\mu\text{s}$  was typical for this particular laser, a slightly increased integration time of 50  $\mu\text{s}$  was set. Thus, the shots could be captured in spite of the jitter. Without jitter, one could have set the shortest possible integration time of 10  $\mu\text{s}$ .

The following CCD camera settings were used:

- **CCD operating mode:** “Single-shot, clean & ready with external hardware trigger”
- **Integration Time:** 50  $\mu\text{s}$  (because of the jitter specific for that laser)
- **Trig Out before Integration:** 200  $\mu\text{s}$  (this is the pre-integration start offset for the trigger output to trigger the laser in advance, also specific for that laser)
- **Scans per Acquisition:** 3024 (this is the number of captured frames required by the user). It is worth mentioning that CCD-S3600-D(-UV) line cameras allow to capture up to 4599 shots in standard onboard data storage mode. In the advanced streaming mode, the number of captured frames can be much higher and is only limited by the capacity of the hard drive of the user’s computer.

The line camera was able to capture the Fabry-Perot interference pattern for each laser shot. In Figure 2 below, 3024 shots were recorded. Clearly visible is the transition feature at the beginning of the recording after turning on the laser, where the laser frequency is still unstable. All recorded data was captured and conveniently visualized in a LabVIEW 3-D plot. Please refer to the LabVIEW example applications included with the CCD camera.



**Figure 2: Record of the Fabry-Perot Interference Pattern Evolution**



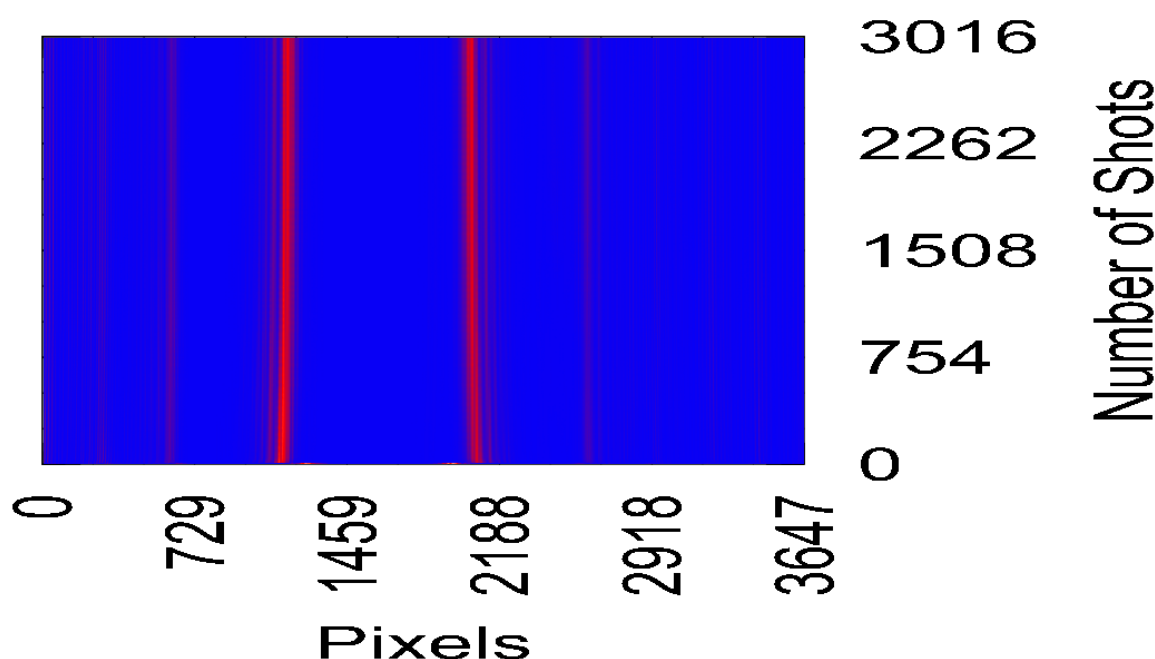
ALPHALAS GMBH  
BERTHA-VON-SUTTNER-STR. 5  
D-37085 GÖTTINGEN  
GERMANY

TEL +49 - (0)551 - 77 06 147  
FAX +49 - (0)551 - 77 06 146  
E-MAIL [INFO@ALPHALAS.COM](mailto:INFO@ALPHALAS.COM)  
WEB [WWW.ALPHALAS.COM](http://WWW.ALPHALAS.COM)



*LASERS, OPTICS, ELECTRONICS. MADE IN GERMANY.*

Another recorded data set is shown in a second run that clearly demonstrates the slight change of the laser frequency (best visible through the spacing change for the most inner maxima of the interference pattern) during the warm-up stage (see Figure 3).



**Figure 3: Laser Frequency Drift as Function of Time (Number of Shots)**

Reference:

[1]. K. A. Stankov and I.Y.Milev, **Use of a vacuum-planar photodiode to drive an electro-optic Q-switch directly**, APPLIED OPTICS, Vol. 30, No. 36 , (1991) p. 5250

Copyright © 2012 ALPHALAS GmbH. All rights reserved. Do not copy, share or reproduce without permission.

Please note: Specifications are subject to change without notice. No responsibility for typing or printing errors. ALPHALAS GmbH reserves the right to make changes without further notice to any products herein. ALPHALAS GmbH makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ALPHALAS GmbH assume any liability arising out of the application or use of any product, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters that may be provided in ALPHALAS GmbH data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals", must be validated for each customer application by customer's technical experts. ALPHALAS GmbH products are intended for expert users only. ALPHALAS GmbH products are not designed, intended, or authorized for use in medical, surgical or any other human in vivo applications, or for any other application in which the failure of the ALPHALAS GmbH product could create a situation where personal injury or death may occur. Therefore, ALPHALAS GmbH products must not be used in such applications. Furthermore, ALPHALAS GmbH products must not be used in critical applications (e.g. in life support systems, in aviation, in nuclear facilities, in weapon systems, in safety or security systems, etc.). ALPHALAS GmbH products must not be used where damage to property may occur.

Trademark notice: LabVIEW is a trademark of National Instruments Corporation. Windows is a trademark of Microsoft Corporation. Mac and Mac OS are trademarks of Apple Inc. Linux is a trademark of Linus Torvalds. All other trademarks and copyrights are the property of their respective owners.