LaVision
FOCUS ON IMAGING

IN APPLICATION

High-Speed Stereo-DIC Measurement on a Rifle during Firing

Introduction

The deformation of the gun barrel during the firing of a shot is an important parameter that significantly influences the accuracy of the weapon. To illustrate how such a measurement can be realized and which deformations can be recorded, the measurements on a rifle barrel with muzzle brake and suppressor are shown here as an example.

Experimental setup

The experiment was conducted on a shooting range. The weapon was recorded by three high-speed cameras (Phantom T4040) during the firing of the shot. An LED 300, which emits light in the blue spectrum and is synchronized with the recording of the cameras, serves as the lighting.

In order to achieve optimum contrast of the speckle pattern applied to the weapon, the principle of Photogenic Patterning was used. A fluorescent colour is used for patterning and only this part of the light spectrum is imaged onto the camera sensor using suitable filters.

The outer two cameras are fitted with a filter that blocks the direct light from the illumination source and only allows the light from the photogenic speckle to pass through. The centre camera has no filter and therefore not only sees the speckle pattern, but also the weapon.

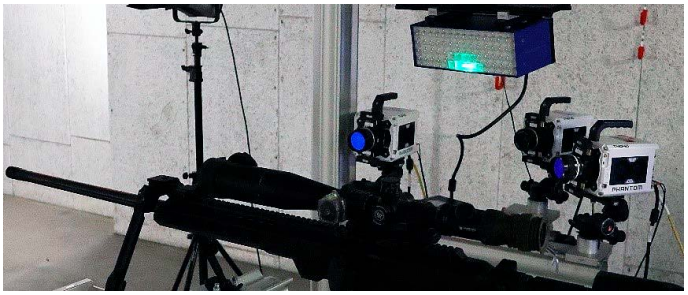

Figure 1: *Setup of the 3 camera high-speed DIC system and rifle at the shooting range*

Principle

The measurements were carried out with a reduced ROI (2560 x 768 px) at a recording frequency of 20 Khz. The exposure time was 6.1 µs and all three cameras were calibrated in a common coordinate system.

The trigger for the shots was activated manually and the image sequence was downloaded with the shot. As the barrel length with muzzle brake and suppressor are not the same length, the time of bullet ignition was selected to synchronize the measurements. This was defined as the time at which the first displacement in the direction of the shot was measured.

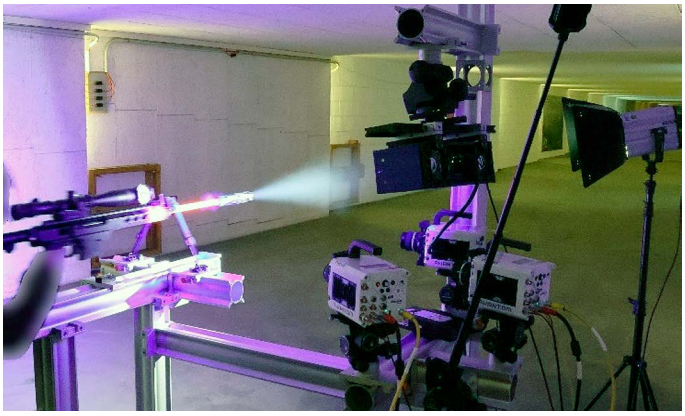

Figure 2: *Image of the rifle during the shot*

As the weapon undergoes a whole-body movement in addition to the deformation, a part of the housing was measured alongside the weapon barrel and its movement subtracted.

Results

For the evaluation, four areas along the gun barrel and one area on the housing were marked and their vertical deformation was plotted over time (see Fig. 3). It can be seen that approx. 6.5 ms after ignition (t = 0) there is a deformation in the rear area of the barrel, which moves forwards at a later time. When the bullet leaves the barrel, it has deformed by less than 0.1mm at the end and 0.3 mm at rear area.

LaVisionUK Ltd
2 Minton Place / Victoria Road
Bicester, Oxon / OX26 6QB / United Kingdom
E-Mail: sales@lavision.com / www.lavisionuk.com
Phone: +44-(0)-870-997-6532 / Fax: +44-(0)-870-762-6252

LaVision GmbH
Anna-Vandenhoeck-Ring 19
37081 Göttingen / Germany
E-Mail: info@lavision.com / www.lavision.com
Tel. +49-(0)551-9004-0 / Fax +49-(0)551-9004-100

LaVision Inc.
211 W. Michigan Ave. / Suite 100
Ypsilanti, MI 48197 / USA
E-mail: sales@lavisioninc.com / www.lavisioninc.com
Phone: (734) 485 - 0913 / Fax: (240) 465 - 4306

LaVision
FOCUS ON IMAGING

High-Speed Stereo-DIC Measurement on a Rifle during Firing

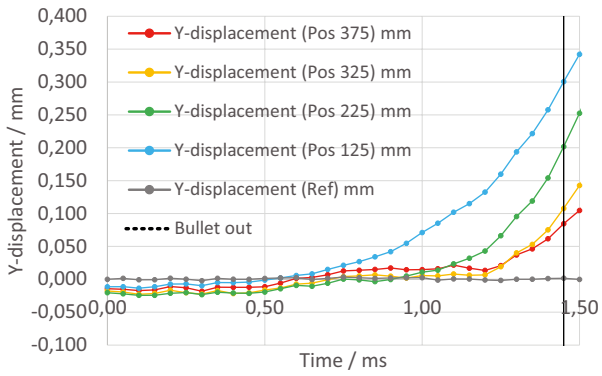

Figure 3: *Vertical deformation of selected areas along the barrel over time*

When comparing the deformation behaviour of the gun with muzzle brake and suppressor, no significant differences can be identified up to the exit of the bullet. However, the behaviour after the bullet has exited differs significantly. The barrel with muzzle brake (Fig 5) deforms much less at the tip directly after the bullet emerges, but then oscillates much more strongly.

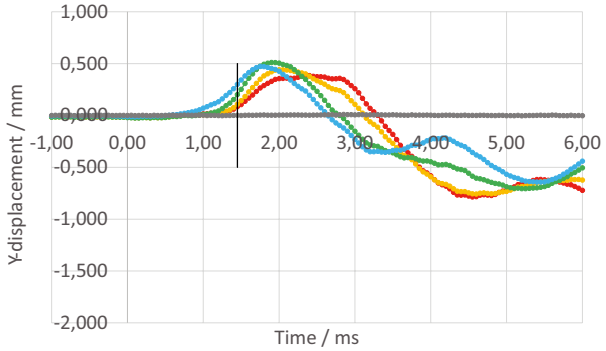

Figure 4: *Vertical deformation of selected areas along the barrel with suppressor over time*

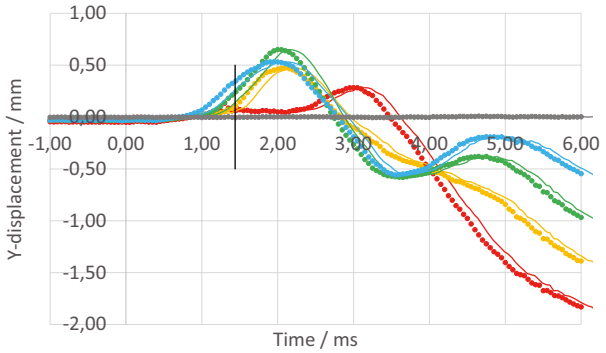

Figure 5: *Vertical deformation of selected areas along the barrel with muzzle brake over time*

The following figures 6 and 7 show a direct comparison of the vertical deformations of the weapon with muzzle brake (top) and with suppressor (bottom) at two points in time.

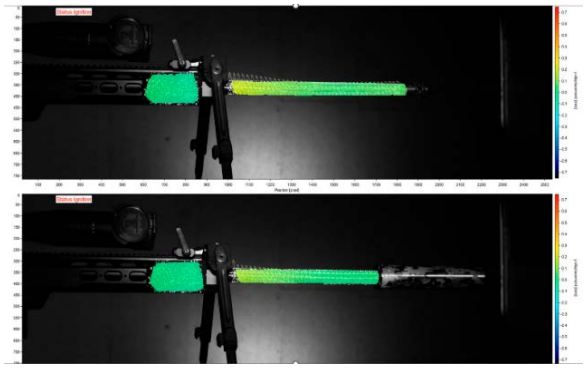

Figure 6: *Vertical deformation of barrel with muzzle brake (top) and with suppressor (bottom) before the bullet left*

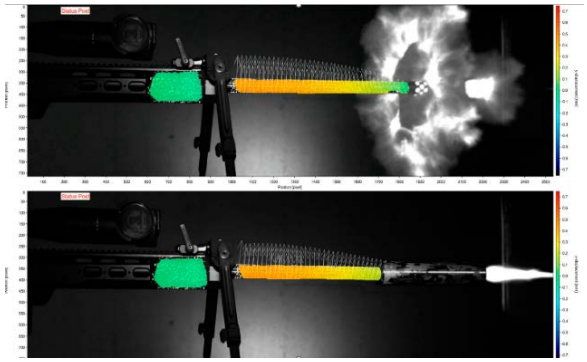

Figure 7: *Vertical deformation of barrel with muzzle brake (top) and with suppressor (bottom) just after bullet left*

In addition to the vertical deformation, the deformation in the direction of observation was also measured, but no significant deformations were found here. Therefore, only the vertical deformations are discussed.

Conclusion

The tests show that a high-speed DIC system can be used to measure small deformations superimposed by whole-body movements with high temporal and spatial resolution.

The combination of high-speed and photogenic patterning also achieves a very high image quality and can therefore achieve excellent measurement resolutions.

The results show that the differences between the muzzle brake and the suppressor in this configuration are only visible after the bullet has left the barrel.

02/24

LaVisionUK Ltd
2 Minton Place / Victoria Road
Bicester, Oxon / OX26 6QB / United Kingdom
E-Mail: sales@lavision.com / www.lavisionuk.com
Phone: +44-(0)-870-997-6532 / Fax: +44-(0)-870-762-6252

LaVision GmbH
Anna-Vandenhoeck-Ring 19
37081 Göttingen / Germany
E-Mail: info@lavision.com / www.lavision.com
Tel. +49-(0)551-9004-0 / Fax +49-(0)551-9004-100

LaVision Inc.
211 W. Michigan Ave. / Suite 100
Ypsilanti, MI 48197 / USA
E-mail: sales@lavisioninc.com / www.lavisioninc.com
Phone: (734) 485 - 0913 / Fax: (240) 465 - 4306