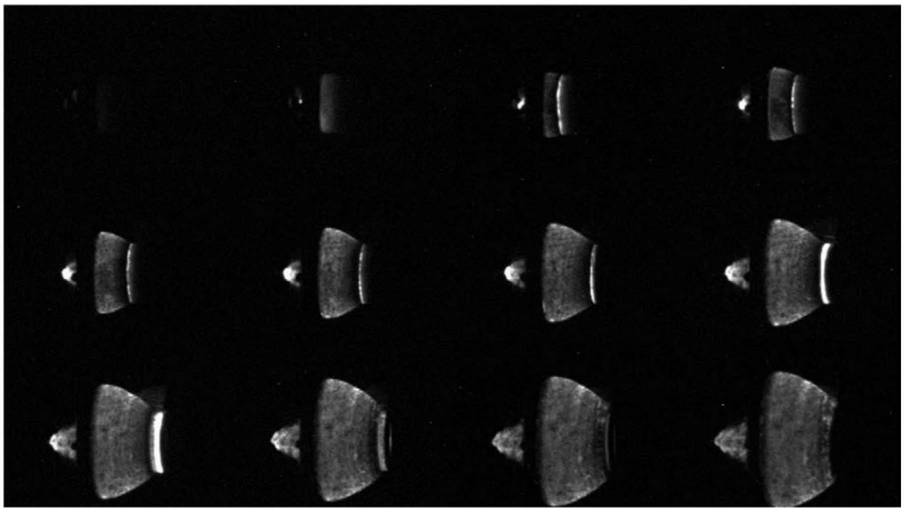
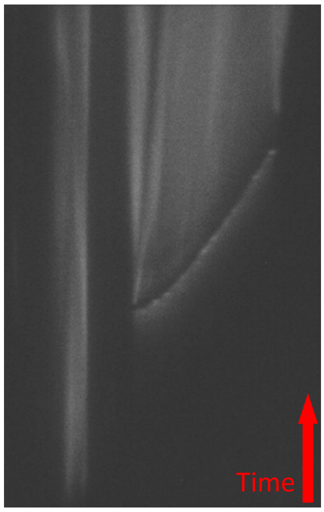
Application note

No. 13

Ultra-high speed framing and Streak camera imaging of C4 Explosive





Images Courtesy of University of Rhode Island

EXPERIMENT OVERVIEW

The **purpose of the test was to quantify the shock speed and qualify the axisymmetric detonation development of a C4 booster test piece**. To achieve these objectives both image resolution and temporal accuracy are crucial. Such tests require unique and costly laboratory test chambers, so where possible multiple measurements are made to reduce the overall number of tests. Traditional instrumentation uses a framing camera to capture high resolution 2D images of the explosive expansion and axisymmetric development. However, the temporal resolution of a framing camera is limited by the number of frames available – typically up to 32 images capturing at interframe times between 50nS and 1μS. To provide images suitable for accurate shock movement measurement, finer time resolution is required. This second experimental aim is achieved by a Streak (1D) camera with a “slit” view of a small area of the event and “sweeping” this across a 2D sensor. The resulting image shown above has a 50nS temporal resolution along the “sweep/time” axis.

Traditional experimental configurations use these two cameras separately, which creates a perspective difference and more complex triggering set up. The solution offered by Specialised Imaging uses two cameras connected together via the SIM auxiliary camera port allowing use of the same optical path (example set up shown here). This second camera can be a high-speed video camera for longer record durations or, as in this case an Optronis streak camera which can also be controlled using the same control software.

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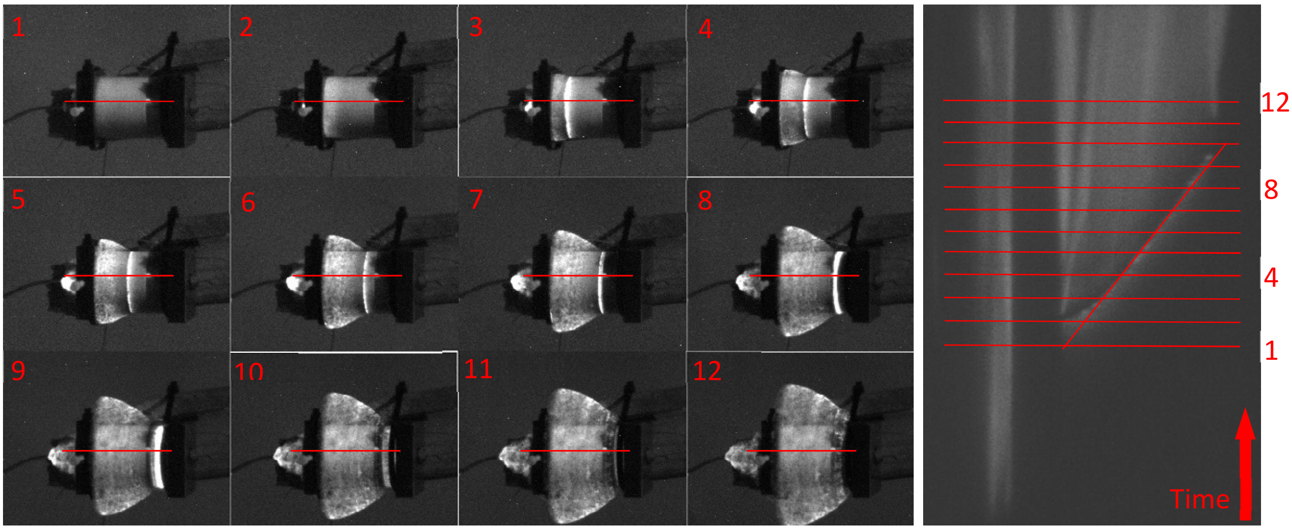
EXPERIMENTAL SET UP

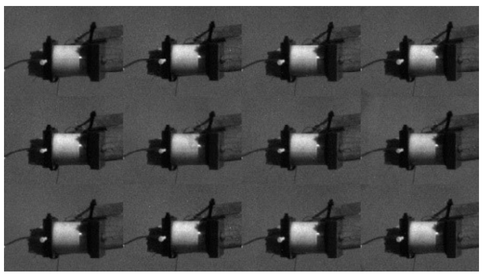
<u>Illumination</u>
The event was self illuminating so no additional illumination was necessary.

<u>Cameras</u>
The cameras were placed outside the chamber behind protective armoured glass. The front objective was an **80-200 mm** focal length lens providing an approx. **30 cm x 22 cm** field of view. The SIMD framing camera was set to 567nS interframe time (~ 1,764,000fps), 70nS exposure time and captured 16 images providing a total recording duration of 9.1µS. Twelve of the sixteen images captured are shown here. The Optronis Streak camera used a 100µm slit width and image "sweep speed" of 500ns/mm providing a total record time of 10µS, giving 50nS temporal resolution with 200 temporal points along the "sweep/time" axis**.**



RESULTS

The SIM camera control software allows sequences to be combined. The above sequence is a combination of the dynamic and static images taken prior to the test (shown right). The red lines on the SIM results show the approximate location of the streak camera slit image.



The red lines on the corresponding Streak camera result show the approximate times when the Framing camera images were taken.

<u>The Specialised Imaging SIM-D framing camera</u>
These images clearly show the axis symmetrical nature of the detonation shock as it progresses through the test piece.

<u>The Optronis streak camera</u>
This image clearly shows a consistent detonation shock velocity through the explosive, as indicated by the red diagonal line. In addition, the finer temporal resolution of the Streak results show there was little variation in shock velocity between the larger timesteps of the Framing camera images.

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