EXAMPLE APPLICATIONS OF

OPTIMEX-8 and OPTIMEX-64

OPTICAL ANALYZERS OF EXPLOSIVE PROCESSES

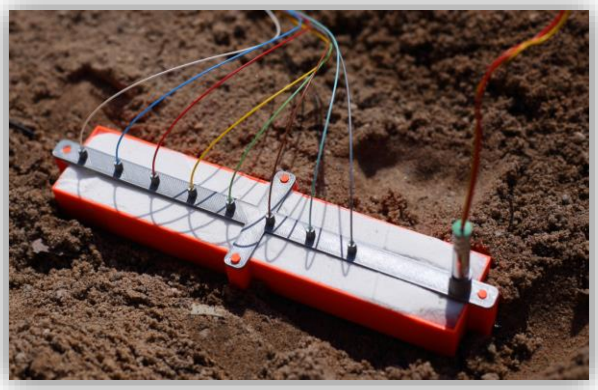
The OPTIMEX-8 and OPTIMEX-64 are advanced instruments which utilize multiple optical fibers as probes to record light intensity signals generated by explosions. The instruments are useful for determination of various detonation parameters of all kinds of explosive materials. The instruments may be equipped with either glass or plastic fiber optic probes or a combination of both for signal transport according to the customer's preference. The data acquisition system and evaluation features are based on extensive research of explosives light output.

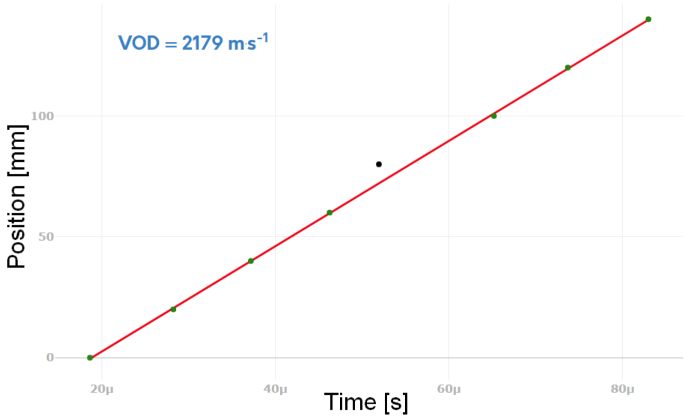
The OPTIMEX-8 is battery powered and it has 8 input channels.

The OPTIMEX-64 is a tabletop instrument with user defined number of channels from 8 up to 64.

OPTIMEX-8/64 is able to cover the same tasks as the VOD-815 plus several others. All the graphs below show real experimental data obtained with the instrument.

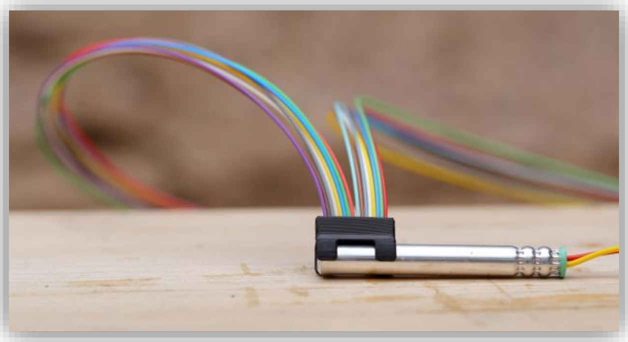
1. Detonation velocity - using series of optical probes

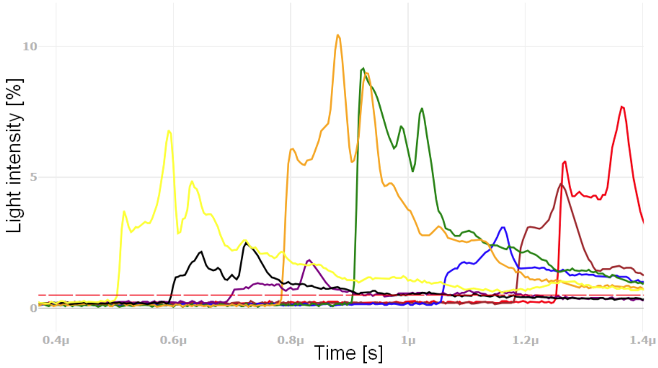




The classical discontinuous measurement of detonation velocity is performed using 8 optical probes placed in different locations perpendicular to the charge axis. The light signals obtained from these probes are then checked. Depending of the signal shapes, the best evaluation method is selected and applied to obtain detonation velocity value. **The possibility to check the actual light profiles greatly improves reliability of the OPTIMEX-8/64**. In the example above, the detonation velocity of a powdered explosive Semtex S25 was measured. The result of automatic evaluation by linear regression of the time-distance data is shown.

2. Detonation velocity - the smallest scale

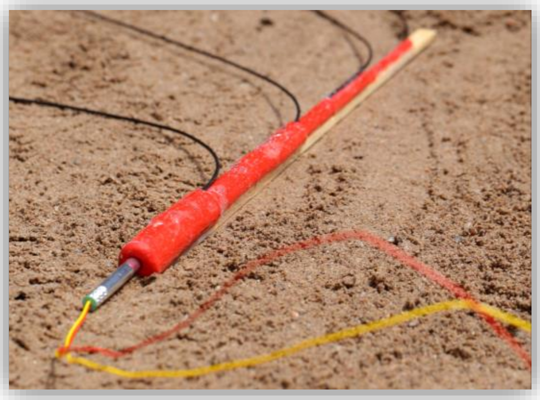


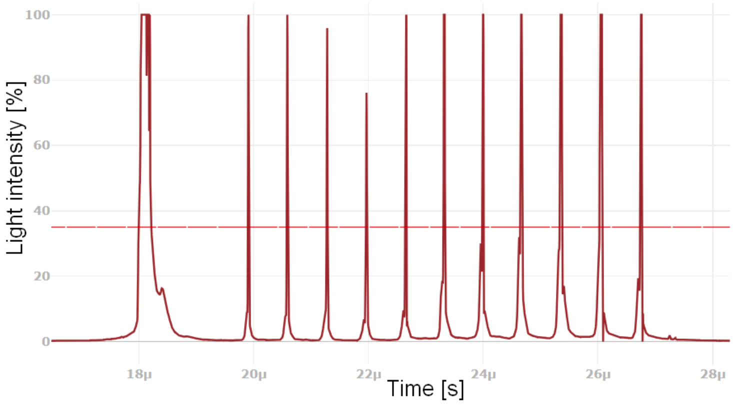


When the glass optical fibers are used as probes, **minimum length of the charge is very small thank to a small diameter of the fibers**. Therefore, the OPTIMEX-8/64 is able to determine detonation velocity even for a secondary explosive filling of an industrial detonator. The distance between the probes can be as small as 1 mm and the overal measurement path may be shorter than 10 mm. As can be seen from the graph, the risetime of the signals is not always the same so a possibility of signal inspection is crucial to get a correct result. This type of experiment would not be possible to evaluate without the possibility of close inspection of light signal shapes.

OZM Research s.r.o.
Blížňovice 32, 538 62 Hrochův Týnec, Czech Republic
Tel: +420 608 742 777 • Fax: +420 469 692 882 • E-mail: ozm@ozm.cz • www.ozm.cz

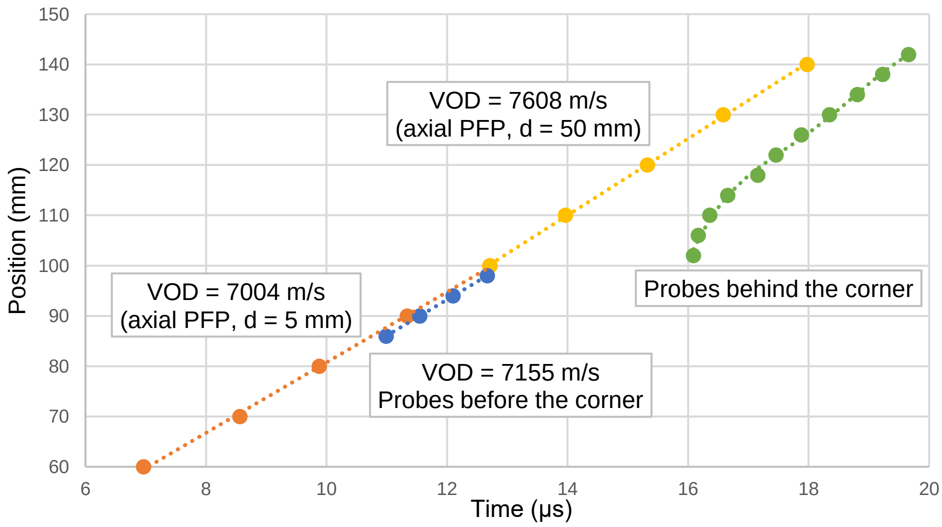
3. Detonation velocity - using Perforated Fiber Probe





The Perforated Fiber Probe (PFP) provides an alternative approach for VOD measurement. The PFP consist of a plastic optical fiber with small holes drilled in its core. The number of holes in the PFP determines the number of light peaks. This arrangement is especially useful for plastic, emulsion or powdered explosives and it is also beneficial in case of heavily confined or in-hole charges because the probe is inserted parallel to the charge axis. With a large number of holes, the PFP is able to provide semi-continuous detonation velocity data. In the example above, light intensity record was obtained using the OPTIMEX-8 from the PFP inserted in Semtex 1A.

4. Corner Turning of detonation waves



When a small diameter explosive charge is connected to a large diameter section, various detonation wave behavior can be observed. In ideal explosives, the detonation wave should turn around the edge and run to the periphery with its characteristic velocity. In the case of non-ideal explosives, some portion of the explosive is usually left unreacted and the detonation fully catches up at a certain distance from the edge. In our test, the explosive behaved ideally. **The OPTIMEX-64 with its high number of channels is an ideal instrument for detonation wave tracking in a complex explosive charges.**

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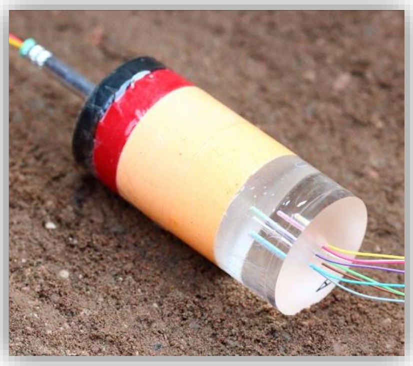
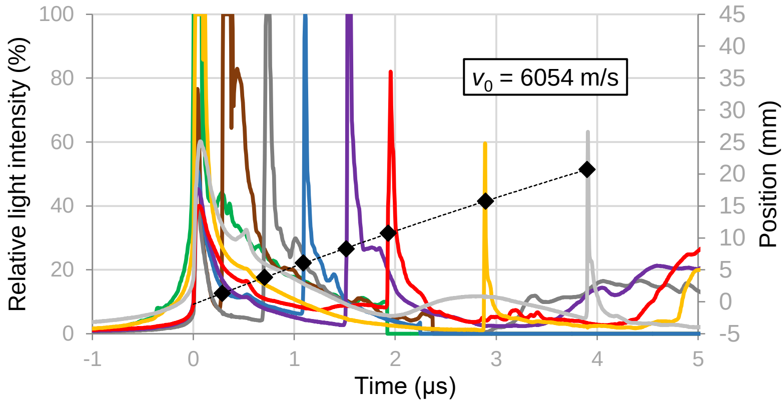
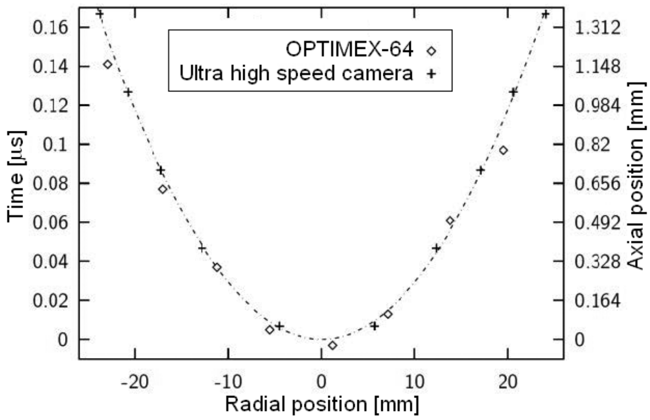
5. Shock velocity in inert material





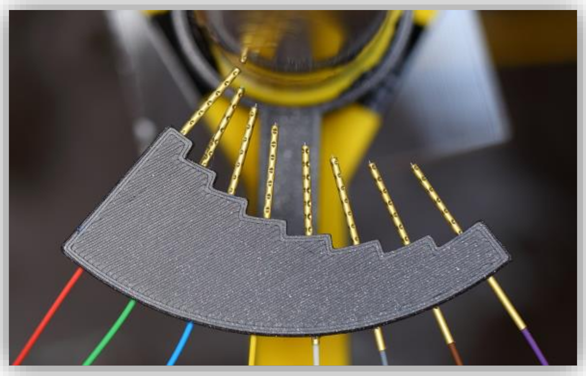
An intense light flash is generated when a strong shockwave hits a solid object. This effect can be used to track shock progress through a block of inert material. In the above image, the shock wave travelled through a block of plexiglass attached to the explosive charge using 8 glass optic probes connected to the OPTIMEX-8. The resulting shock velocity curve (black) was then extrapolated to zero thickness where it corresponds to the initial shock pressure transmitted to the inert material. **The Chapman-Jouguet (CJ) detonation pressure of the explosive can be determined this way.**

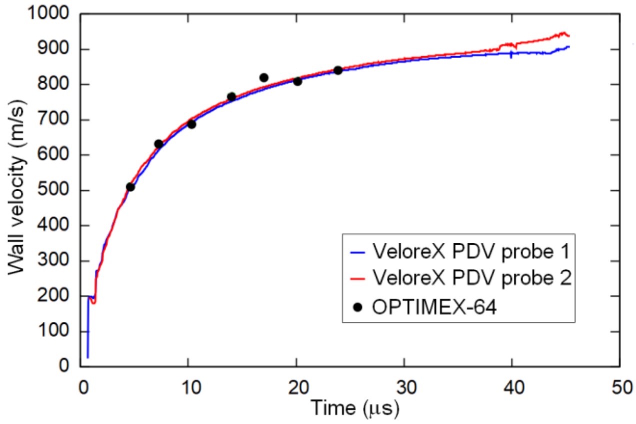
6. Radius of detonation wave curvature



In case of ideal detonation of infinite cylindrical charge the detonation wave front is flat. However, side expansion of gases causes gradual loss of shock energy in the radial direction and therefore stabilizes a curved shock front. The radius of detonation wave curvature is an important parameter which quantifies ideality of detonation. In the example above, an explosive charge of pressed RDX with an effective length to diameter ratio of 4 was tested. **The curvature measured using a series of 8 glass optical probes connected to the OPTIMEX-8 is in perfect agreement with the ultra high speed imaging data.**

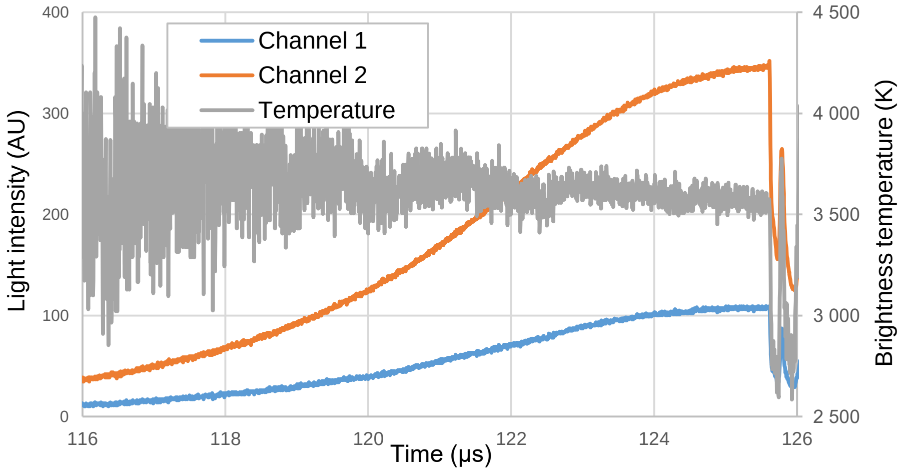
7. Cylinder expansion tracking





Cylinder expansion test is used to characterize the pressure profile of detonation products. The tested explosive is confined in a copper cylinder and initiated at one end. **The expanding cylinder wall can be tracked by fiber optic probes the same way as with piezo pin or electric contact probes.** Light signals are generated once the wall hits the fiber tip at a velocity of a few hundred meters per second. The graph shows wall velocity profiles obtained in cylinder expansion test of emulsion explosive using 8 probes of OPTIMEX-64 compared to continuous velocity records from the laser interferometric VeloreX PDV system.

8. Temperature in the detonation reaction zone



Pyrometric measurement of brightness temperature is the only practical way of detonation temperature measurement. **With the optional pyrometric set, the OPTIMEX-64 is able to record brightness temperature of detonation reaction zone.** In this case, the probe is positioned in the axial direction, i.e. perpendicular to the approaching detonation wave. Blackbody calibration or a reference sample is necessary for correct temperature reading. The graph shows temperature record of sensitized nitromethane.

9. Further uses

There are several other uses of the OPTIMEX-8/64 such as:

- Projectile velocity measurements using optical screens,
- deflagration to detonation transition studies,
- detonation pressure measurement using a stack of polymer foils
- combined detonation velocity & curvature measurements using inclined PFP,
- delay measurement of multiple electric and non-electric detonators,
- and many others…

For technical advices regarding OPTIMEX-8/64, consulting your specific needs or optimizing system configurations for any applications, please contact

Mr. Martin Künzel

+420604132074

kunzel@ozm.cz