Prescale Measurements in Water

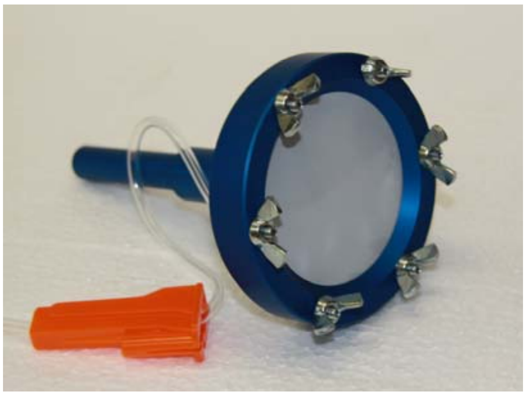
Application Example: Measuring Shock Waves

The measurement of shock waves in water is a difficult process because there are hardly any suitable sensors. Although our own pressure sensors (needle probe and sensors M) are able to measure these waves. If you want to record the entire pressure distribution, e.g. in the focus of a kidney stone lithotripter, you have to determine the pressure point by point.

With the use of the pressure indicating films Prescale, on the other hand, the entire pressure distribution can be recorded with only one measurement.

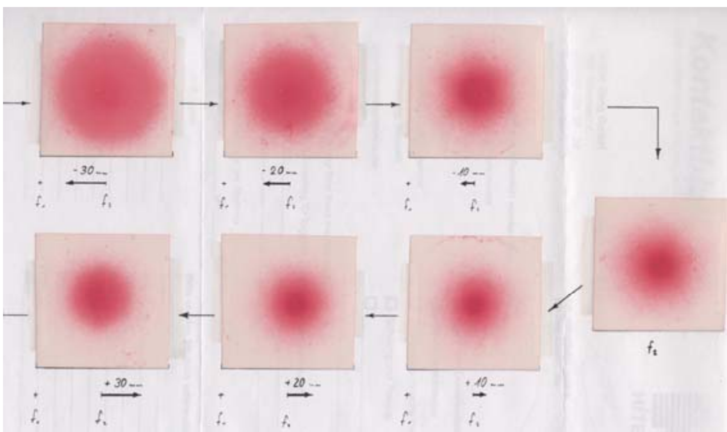
That this actually works with the pressure measurement films has surprised us, because the rise time of such a shock wave is about 1 ns and the total duration of the pressure pulse is only a few microseconds. Nevertheless it is possible, with the right tools, to make a clear representation of the shock waves.

We used an underwater holder that we had developed especially for this application. It is important that the pressure measurement film lie cleanly on a hard background. As the glossy smooth PET side of the film is waterproof, the matt side was placed on the back wall and sealed against water penetration. The air under the film was sucked out by mouth through a small hose with a shut-off valve.



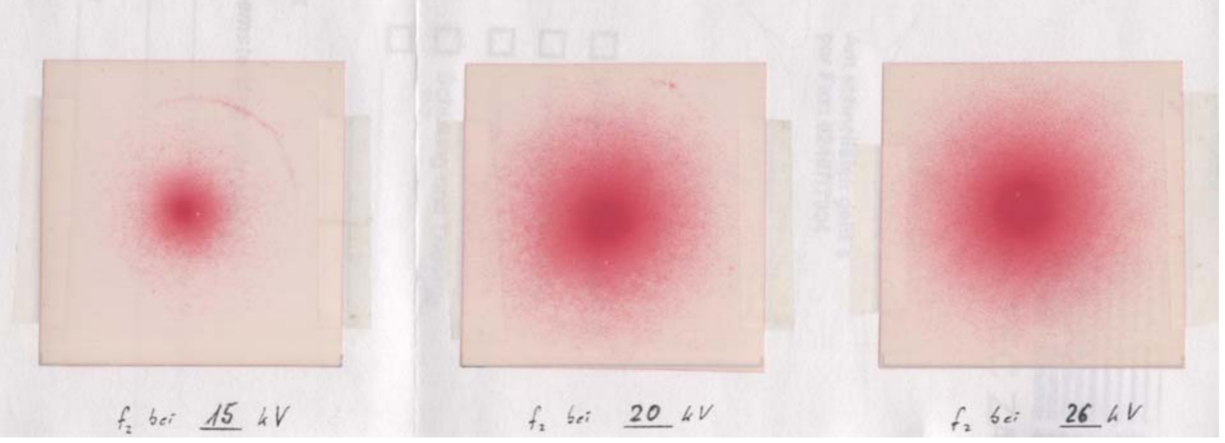
Prescale film holder for under water

The holder was placed in the water in such a way that the shock wave hits the film frontally. You can see the results in the focusing field along the axis of the focusing ellipsoid.



The focusing process is clearly visible. The pressure distribution is clearly shown. The film used here was type HS. It can also be clearly seen that the true shock wave focus lies behind the geometric one. This effect and also the only slight divergent pressure distribution behind the focus is due to the non-linear behaviour of the shock waves, where the speed of propagation in water increases with increasing pressure.

In general, it can be expected that the red colouration is weaker at such short loads than at a load of 10 seconds. This is also the case, but in other industrial applications this is not such a major influence. Here, however, the weakening compared to longer loads is about 50%. Since in our example the shock wave is reflected by the sound-reflected wall and thus the pressure on the wall is doubled, the results of the red colouration of the film match the measurements with the needle probe very well. Only the central area of the middle 5 mm goes into saturation and thus reaches 130 MPa. In the focus the pressure is still a bit higher, but could not be represented by the film.



In the second example we also have measured in focus and varied the output energy. At first glance, you can see the widening of the pressure in the focal area. As the film in the centre goes into saturation, it would have been even better to have placed two films on top of each other, namely the HS and the HHS film, to get the true peak pressure in the focus. This would have required perforating the rear foil with a needle to suck out the air not only behind the foils but also between the foils. This would also apply to measurements in lower pressure ranges where the two-layer films are used.

As an alternative to the above measuring foil holder, the foils can also be laminated between plastic foils, depending on the application. However, it is also important to pay attention to the hard background for measurement.