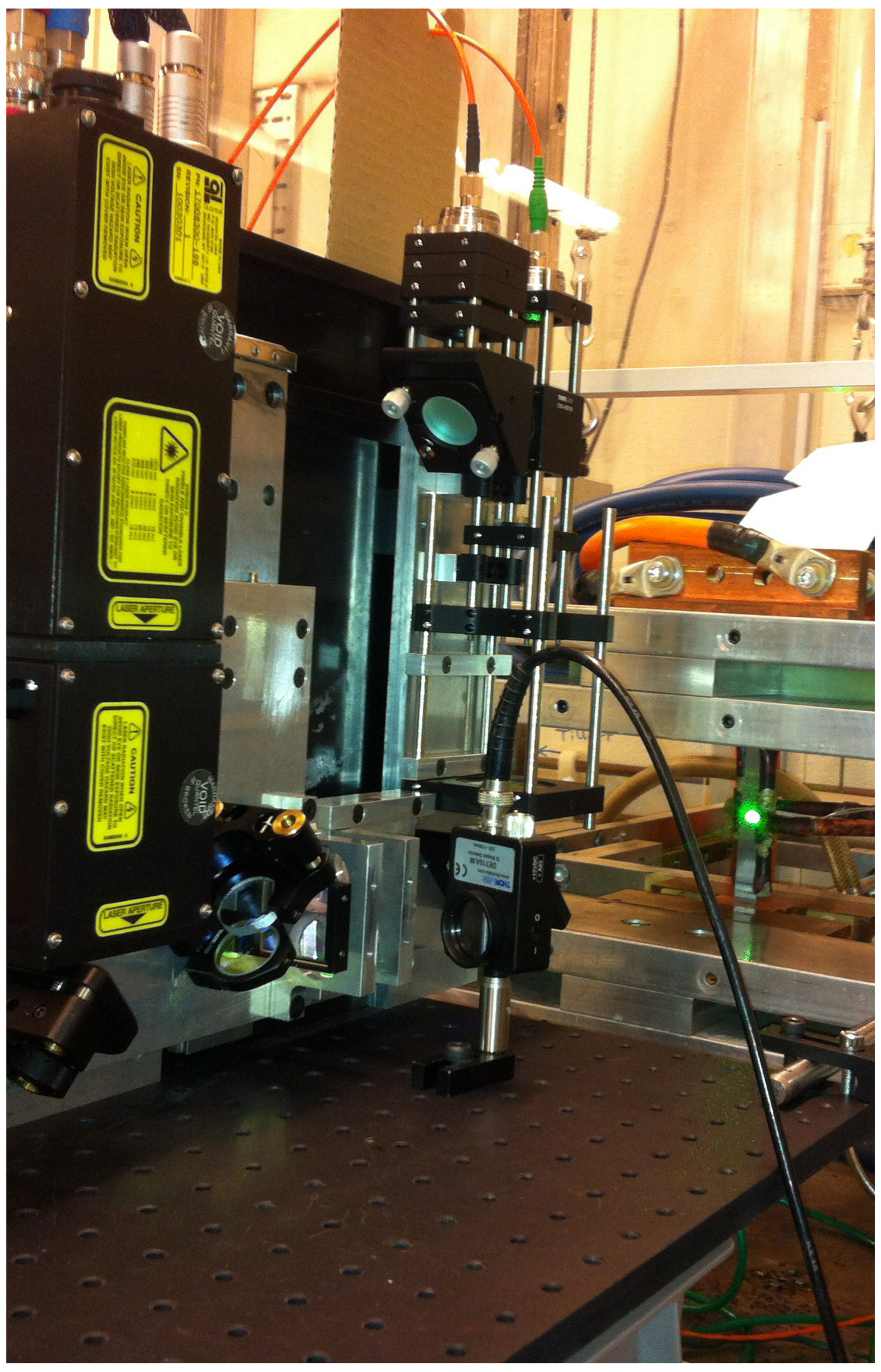

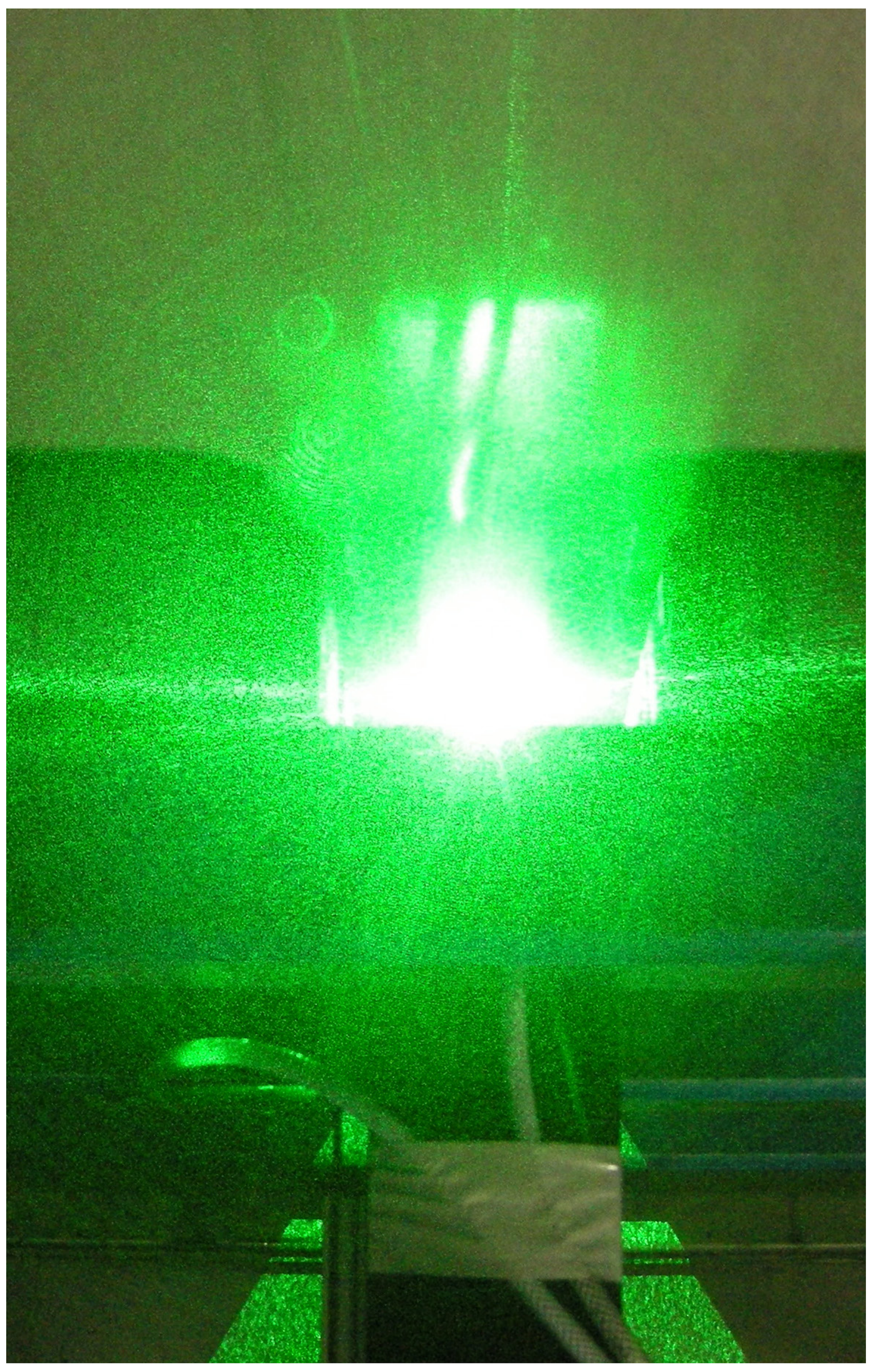

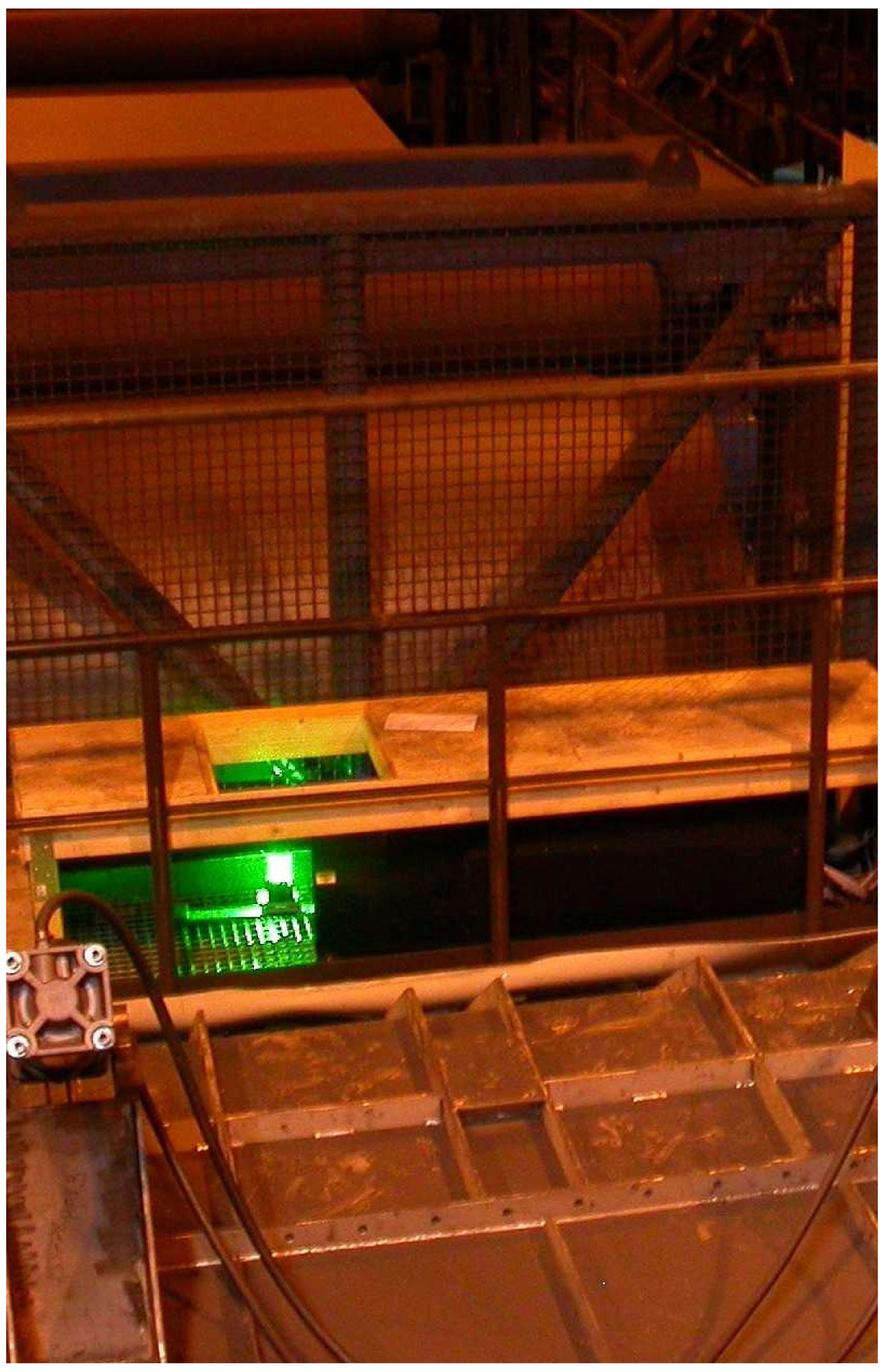

Laser Ultrasonics

Contact free testing

With laser ultrasonics the ultrasound is both generated and detected with a laser source, see figure 1. The technique is completely contact free and the working distance between the instrument and the sample can be altered simply by the choice of optics. The measuring speed for each measurement can become very high depending on the sort of interferometer which is used and the measuring frequency depends on the frequency of the generation laser, 20Hz is normal. The technique can be completely non-destructive if the energy in the generation laser is low enough to only temper the surface. For many application where a stronger ultrasonic signal is needed, ablation of the top atom layers is preferable but by doing this the method becomes by definition destructive but very close to nondestructive.

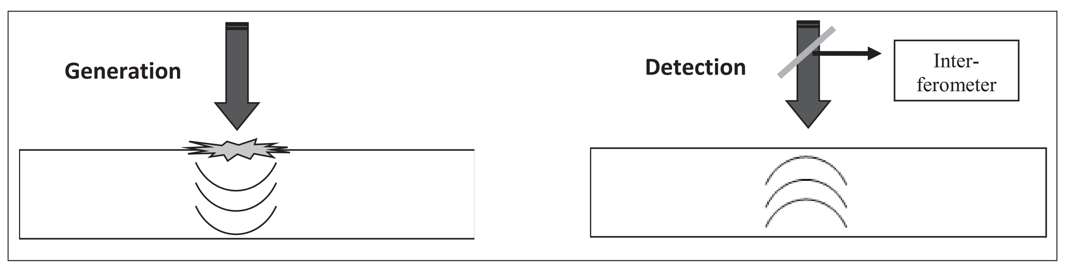

Figure 1. Left: The ultrasound is generated through focusing a pulsed laser beam on a sample. Right: The ultrasound is detected through focusing a continuous laser light on the sample from which the reflected light is guided into an interferometer which measures the vibration on the surface.

Defect detection

The ultrasound which is traveling through a material is affected by all kind of obstacles which is in its path. In the presence of cracks and pores the ultrasound will to some extent be attenuated since the elastic conditions are changed so the signal from a sample with the presence of defects will often become weaker than expected from a defect-free sample. Another affect in the ultrasonic signal is the appearance of echoes coming from the reflection and diffraction on defects which would not be present in a defect free signal, see figure 2.

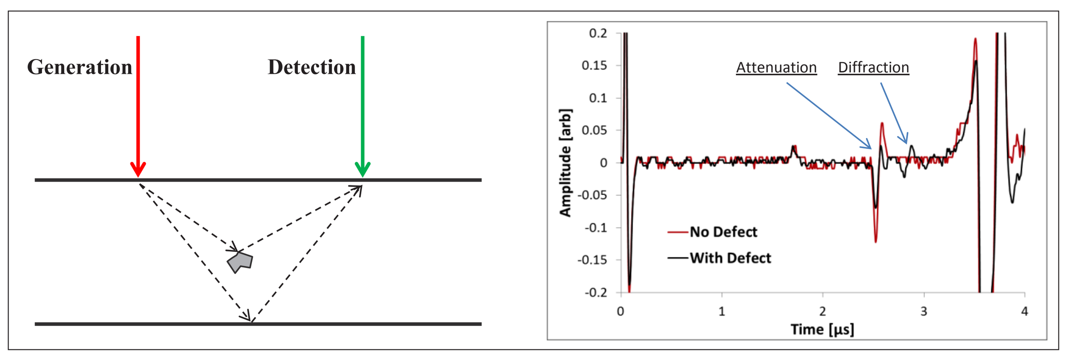

Figure 2. Left: Illustration of the interaction of the ultrasonic wave and a defect in a sample. Right: Two ultrasonic signals, one with and one without a defect present. The effect of the defect to the ultrasonic signal is an attenuation of the first longitudinal wave and the appearance of an additional wave due to reflection on the defect.

Material characterization

Apart from anomalies in the material also the differences in microstructure will affect the ultrasonic signal traveling through it. The overall elastic properties of the material will affect the attenuation and the velocity of the ultrasound. Grain size, phase constitution and crystallographic texture are some of the parameters which potentially can be measured with laser ultrasonic's. Mechanical properties such as yield strength and hardness can often be measured indirectly through looking at the different LUS parameters.

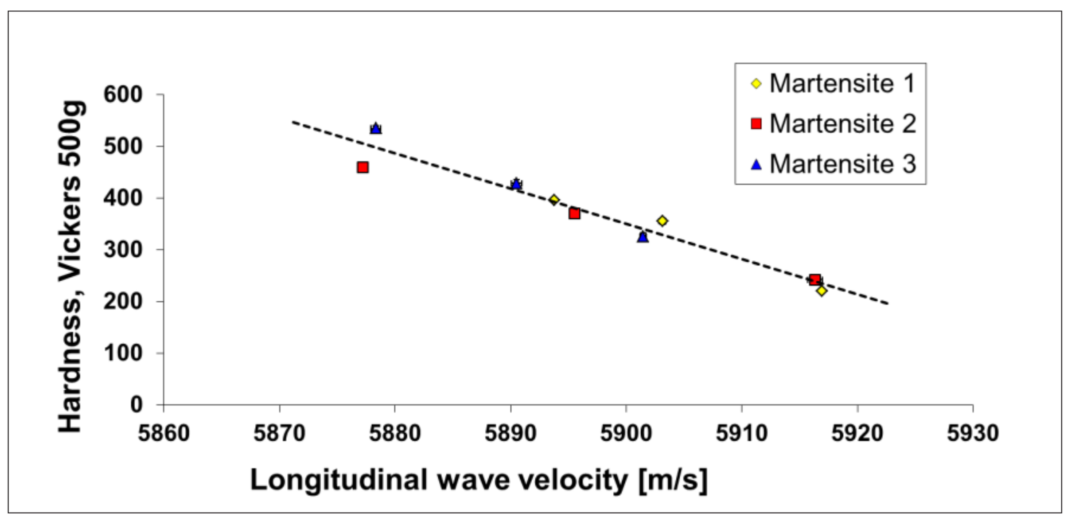

Figure 3. Hardness in heat treated martensitic steel related to longitudinal wave velocity.

Thickness gauging

One of the few applications of laser ultrasound which is being used in industry is the one of thickness gauging of profiles where only one side of the material is available, e.g. extruded seamless tubes. The thickness is measured in the same way as traditional ultrasound where the specific velocity for the examined material is known at a specific temperature. Swerea KIMAB has developed a method which can measure the thickness independently of the velocity and consequently also estimate the ultrasonic velocity. Figure 4 shows the result of thickness and velocity measurements during heating of a sample.

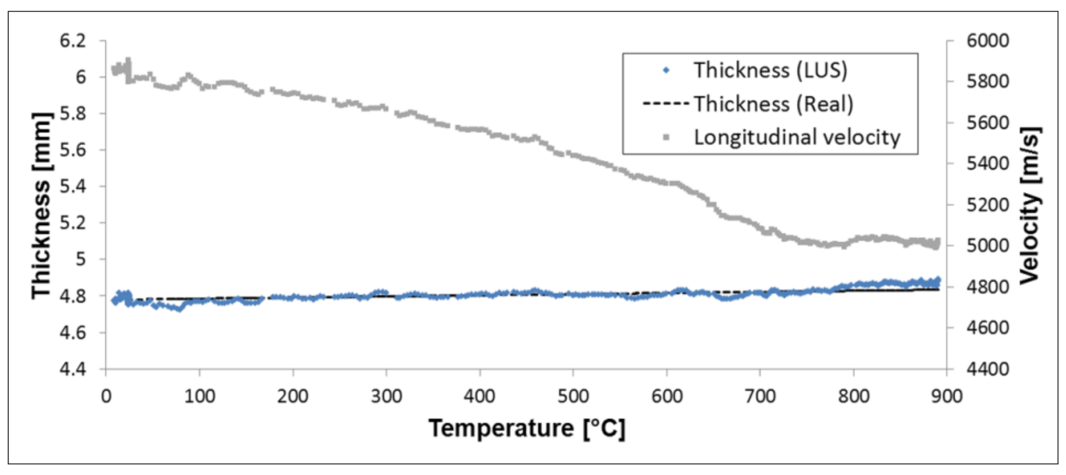

Figure 4. Wave velocity and thickness measured independently during heat treatment of bainitic steel.

CONTACT:
Peter Lundin | *peter.lundin@swerea.se*

Swerea KIMAB | Box 7047, SE-164 07 Kista, Sweden | Phone: +46 8 440 48 00 | www.swereakimab.se

swerea | KIMAB