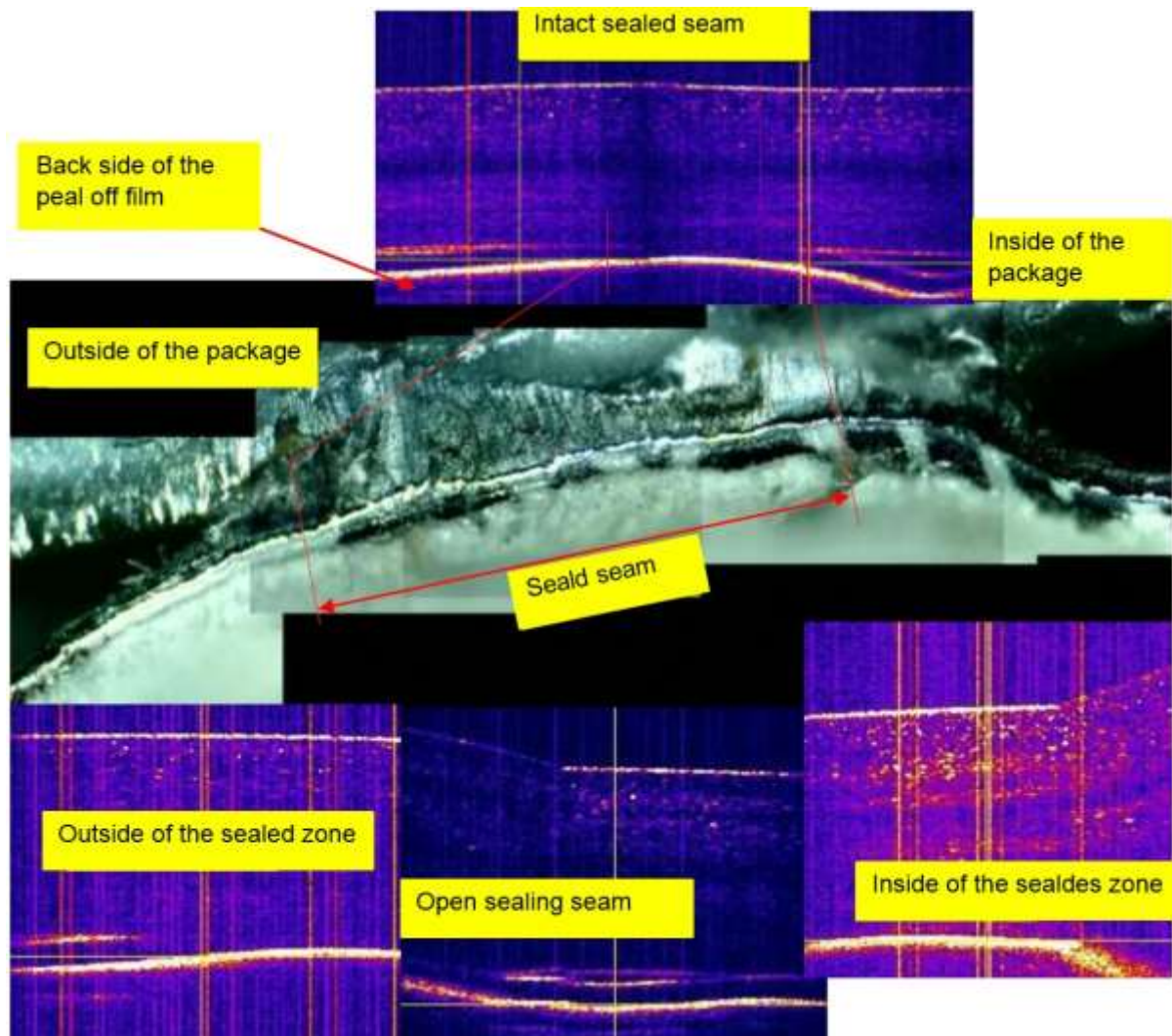


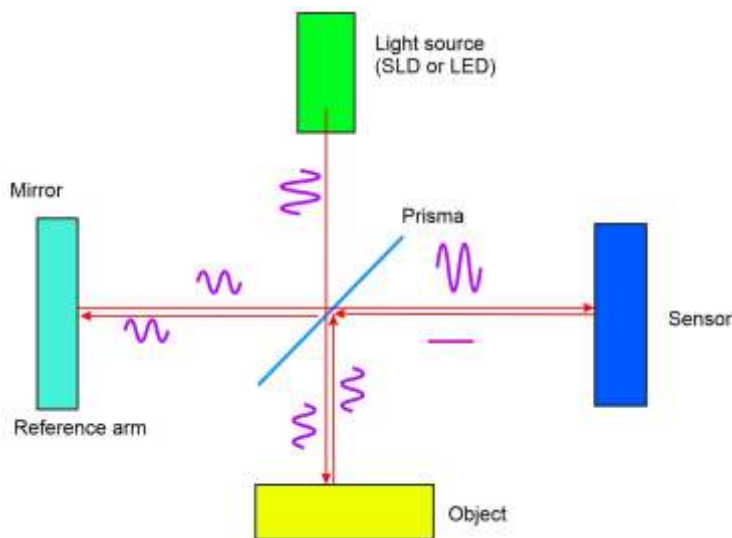
We introduce: “Optical coherence tomography, a new robust method for the industry”



With our new but simple technology, we qualify a sealed seam, distinguish between a crack, a scratch or a discoloration, and also locate micro holes in large areas at high speed.

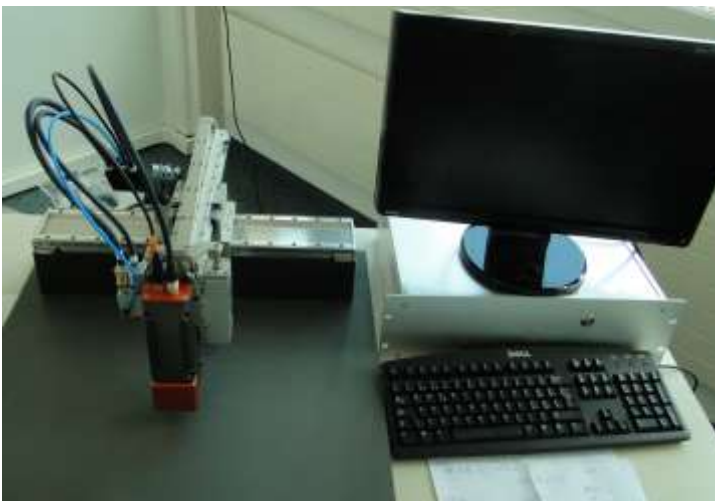
Measuring with light

The OCT System (optical coherence tomography system) is based on interferometry. A light source emits short - coherent light pulses. This light is splitted by a beam splitter into two beams. One of the beams is reflected in the "reference arm" at a known distance, the other beam is directed in the "Sample arm" onto the surface of the object. From the object the light is back scattered as a function of the flight time of the light to the beam splitter. The two beams from the reference arm and the sample arm are recombined in the beam splitter and directed to the detector. Is the difference in optical path length of the two beams less than the coherence length, then the high speed ASP Array (Active sensor pixel Array) with $300 * 300$ interferometers register the signals as an interferogram.



The interferogram produced by the two arms result in a linear pattern of structures with different degrees of intensities, from which the relative optical distance can be represented as an axial depth profile.

With an scanning process the light beam is directed - transversely - in one or two directions, thus an two- dimensional picture or a three- dimensional volume (tomogram) can be recorded. Contrary to the conventional optical microscopy the OCT-method decouples the transverse resolution and the longitudinal resolution. The transverse resolution is determined by the numerical aperture of the optical system which is used. The longitudinal vertical resolution depends on the spectral bandwidth of the light waves, which are used. The ASP array (**A**ctive **S**ensor **P**ixel array) consist of 300×300 single "interferometers". Each pixel on the chip is equipped with a own lens and with the own signal preprocessing.



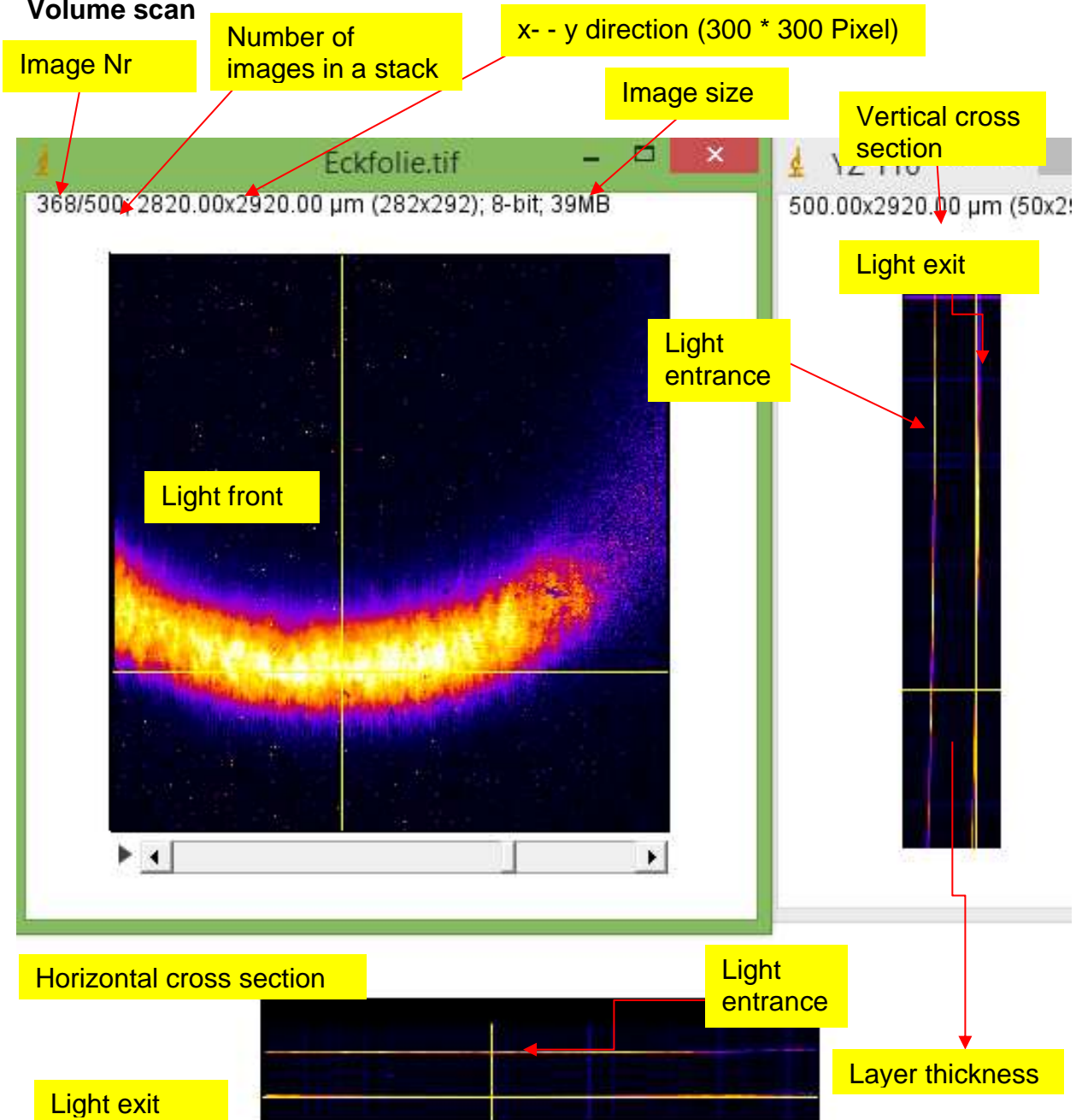
OCT measuring head

A system for measuring the time of flight consists of the sensor, on the optical bench the control electronics as well as the software for evaluating the interferences.

To read OCT- images and to understand the information in the pictures:

OCT datasets are data images representing the time of flight of photons in the xy plane and in the z direction. The data can be used to derive characteristic features of a considered object.

Volume scan



In the picture above, two light fronts are shown in one picture.

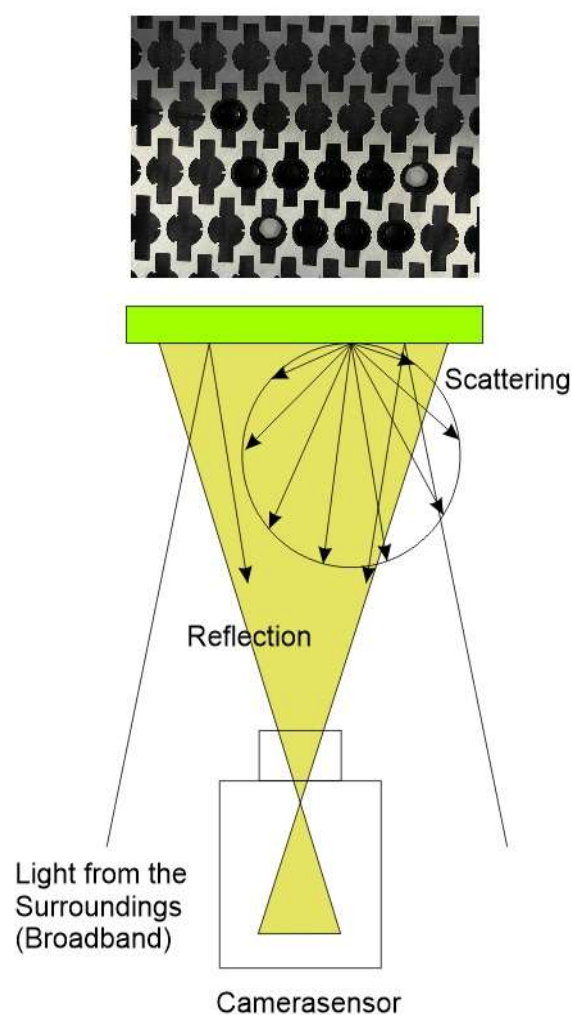
Technical information to the measuring equipment:

The following technical requirements apply to measurements in ongoing production:

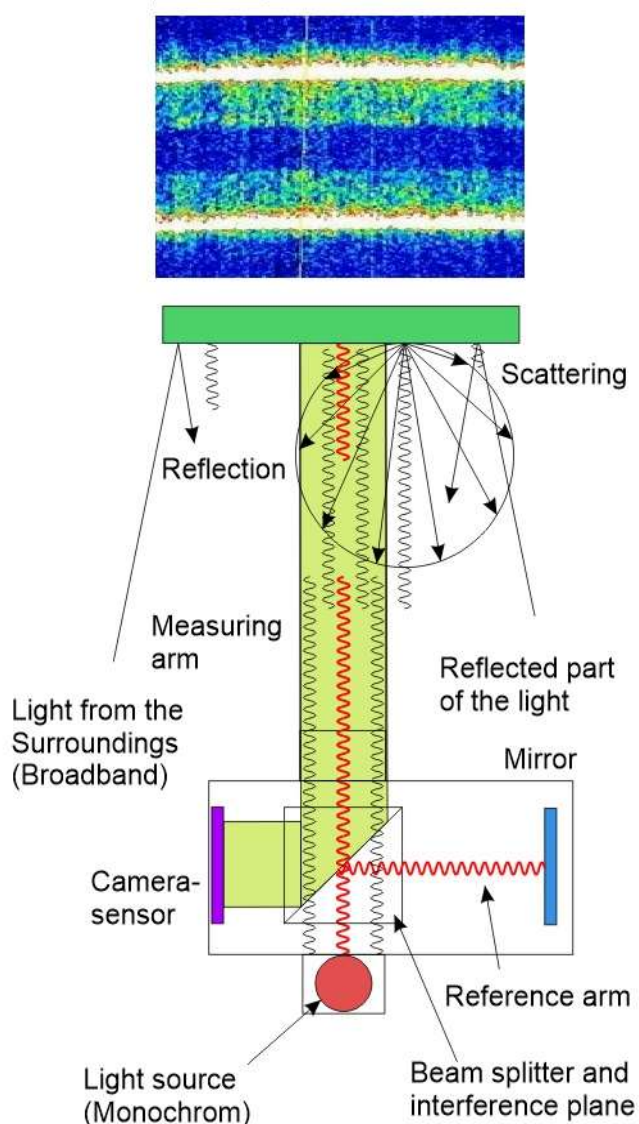
Scanning length	up to 1200 mm
Standard element scan width	300 mm
Time to measure	2 seconds and longer
Scanning area in the test time	full surface scan
Number of measuring points in one line (guide value)	300
Number of measurement points in a column (guide value)	50
Pixel size	(Geometric) 100 microns
Maximum sampling rate	1'000'000 two-dimensional images of 90'000 each readings per second
Demodulation frequency (guide value)	5 kHz
Minimum feature resolution (guide value)	50 microns

OCT method compared to conventional camera systems:

Conventional camera systems



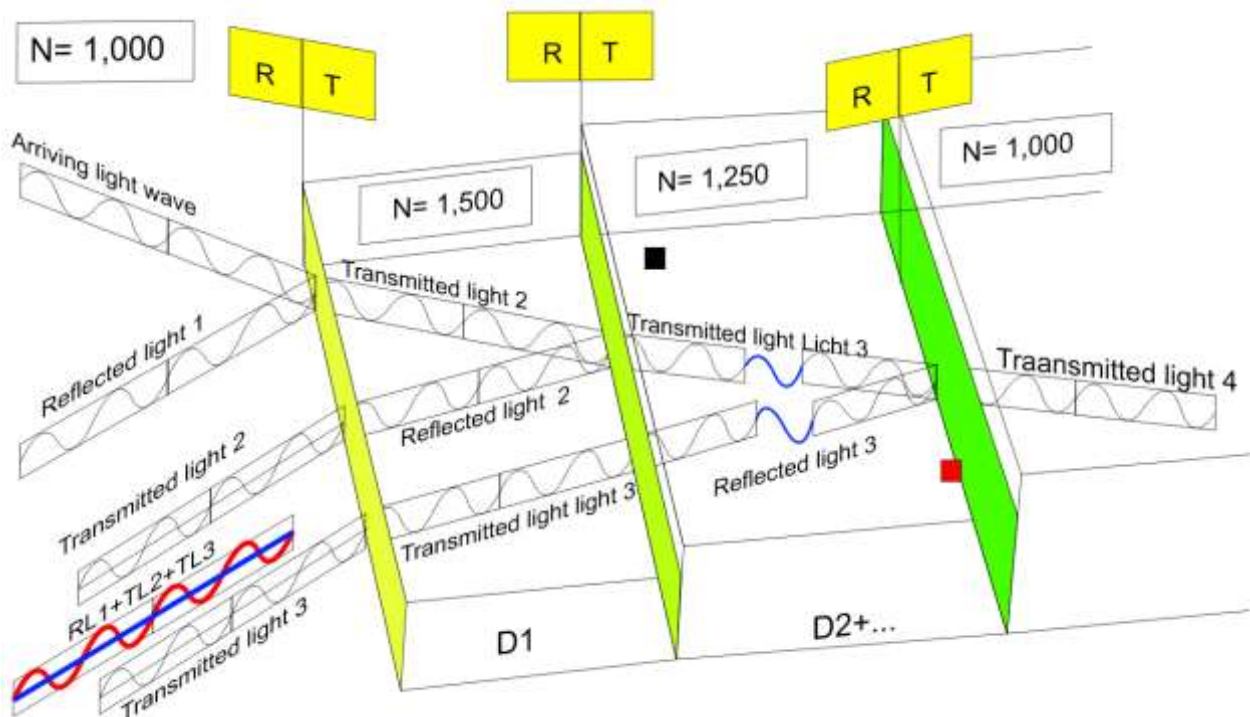
pOCT- Systems



Normal image systems capture the reflection and scattering of an object surface. They are dependent on the light from the environment and the radiation from the object itself. In contrast, OCT systems only measure interference from surfaces or from the interior of a component. The interferences arise only if the photons originate from the same light source. The OCT method is not dependent on the color of an object or the light from the environment and basically only compares the influence of the measured light by the object under consideration.

Technical connections

When interpreting the measured values, the following basic model is available. The individual layers show the entrance of the light into the first layer and the reflected as well as the transmitted portion of the measuring light. At each transition, the light passing through the object is visually influenced and thus allows characterization of a feature. R stands for reflection in the graphic, T for transmission and N specifies the optical property of the material.



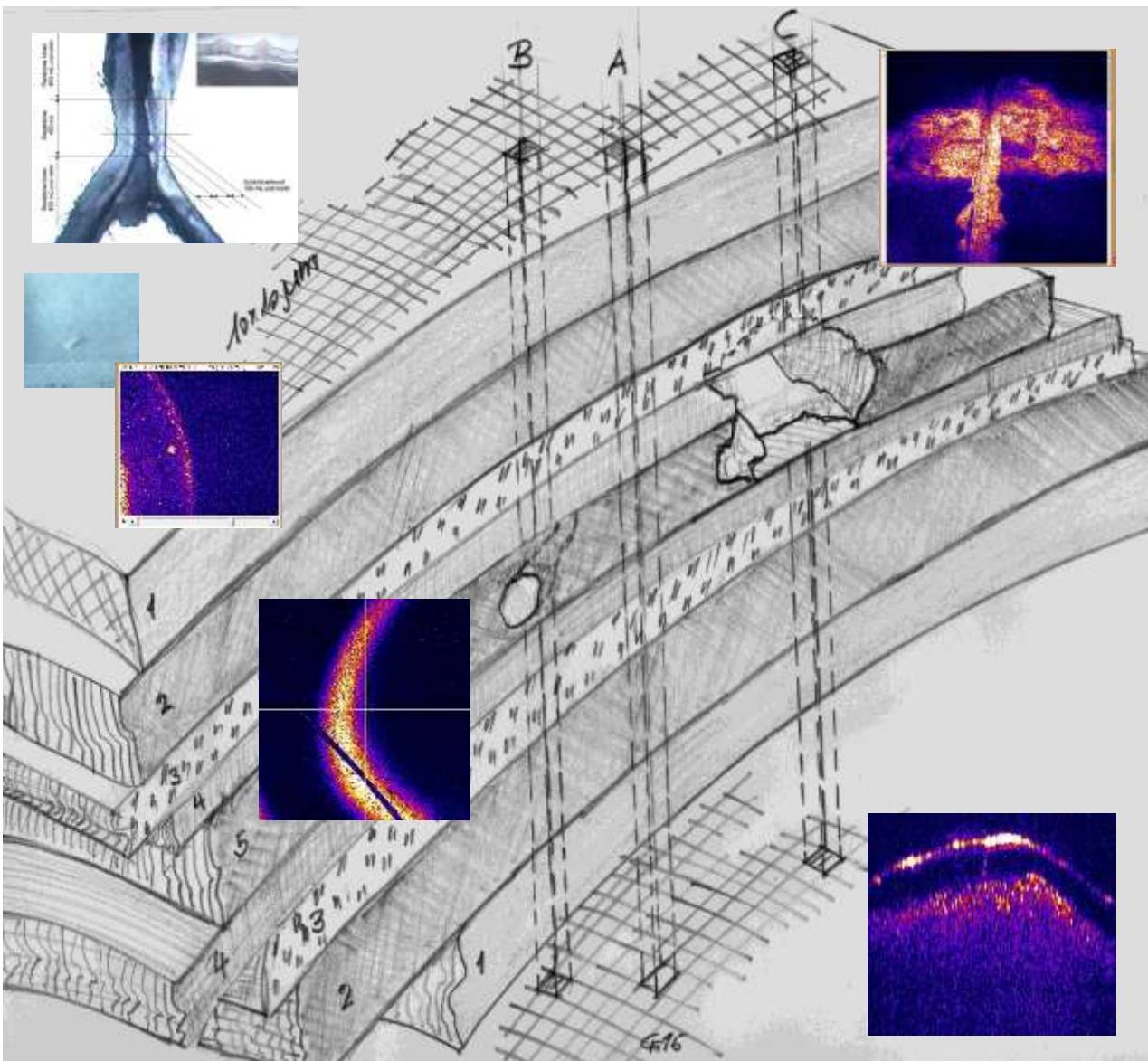
The incoming light experiences the first difference in airspeed on the first surface (fold or normal surface) because the light traverses a material more slowly than air. The difference is expressed by the refractive index. (Air = 1, cover foil = 1.5). The light passes through the cover foil and arrives at the next layer whose characteristic can be measured during operation with the OCT method. If particles are welded in (black mark in the picture) the light experiences a change in the speed, because a difference in the refractive index exists. If the zone has a thickness difference between two layers (marked in blue), the speed of the light does not change, it just stays in this layer for a longer time, which is measured.

If there is a detachment of a layer (red mark), the light experiences a change in speed, because the difference in the refractive index between the material for sealing (adhesive) and the separation (air) is clear again.

The three examples show that light and the behavior of interfered light can be modeled and characterized. The measured phenomena can be matched to defined quality characteristics. If light from air enters a material, the refractive index difference is always large! ($n_{\text{Luft}} = 1$; $n_{\text{Material}} = 1,5$).

The first transition indicates the top level in the layer composite of a seal zone. From there, the light first penetrates the cover film before the light hits the surface of the adhesive in the sealing plane and passes through the adhesive layer of the sealing zone. Subsequently, the light front meets the back of the seal zone or on the surface of the food tray.

The sealing seam inspection with the OCT method achieved laterally a geometric resolution of 1 μm to 100 μm and in the depth less than 1 μm . It is advantageous to measure a product from both sides, because function layers or thickness differences can change the signal characteristics. Barrier layers or certain functional layers exert their influence. A sealing zone is illustrated in the following sketch, using the example of a film, consisting of 4 layers. In the middle is the sealing layer (5). In the OCT image are detected all the photons which comes back to the sensor, regardless of the shape and the nature of the sealing seam.

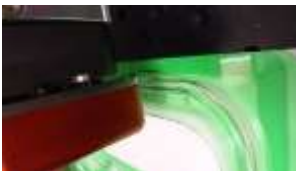
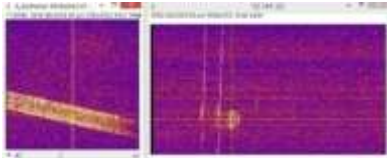
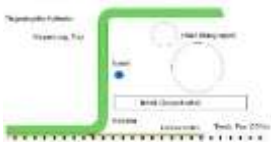
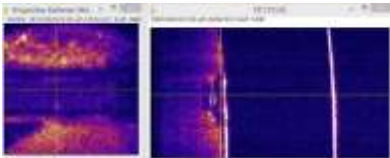

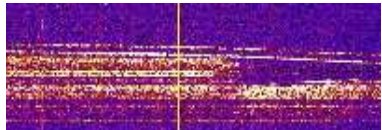

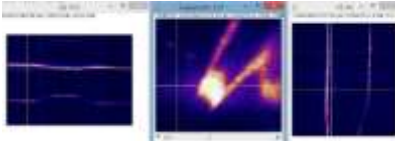
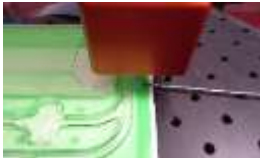
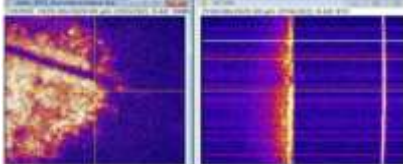
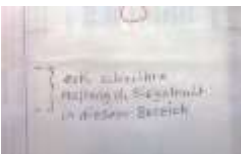
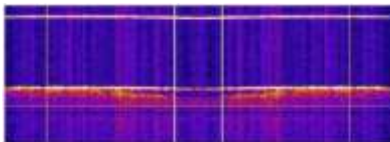
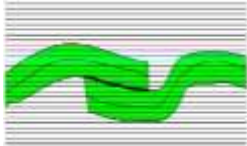

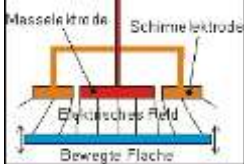


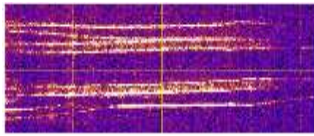



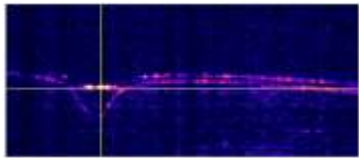

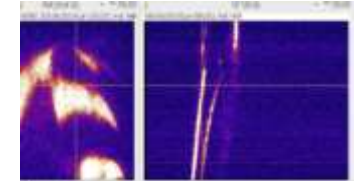

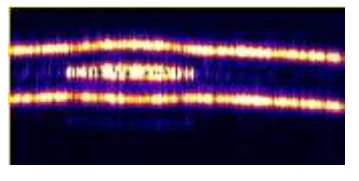

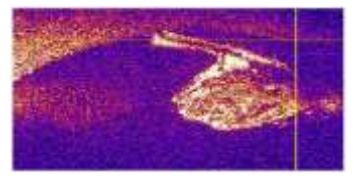

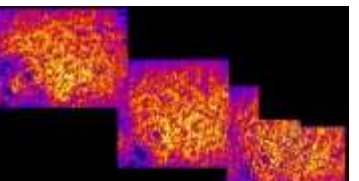

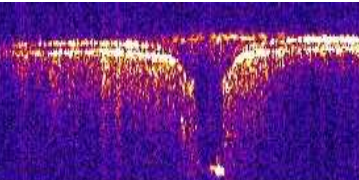

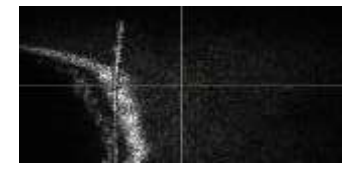

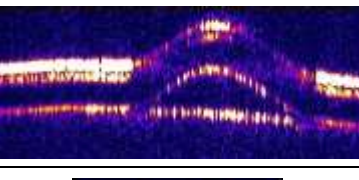


With the OCT system, particles, fibers breaks or liability failures are detected in their spatial position, that is, the expansion of a sealing defect and its depth.


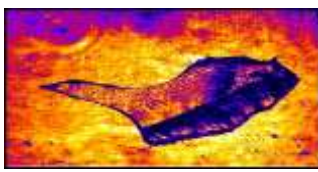



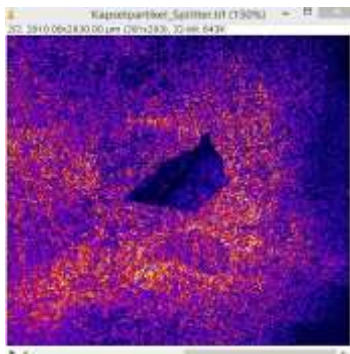


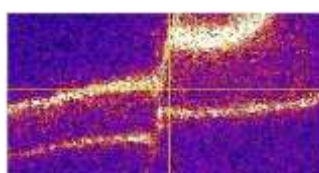
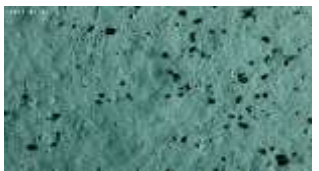
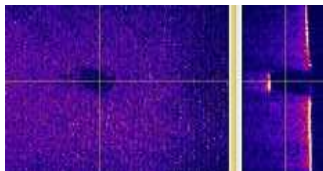
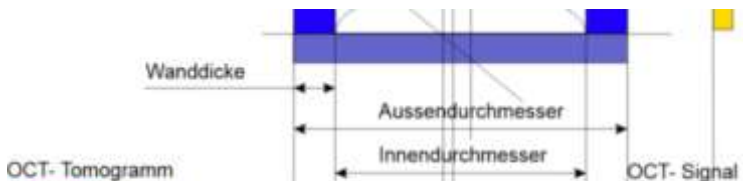
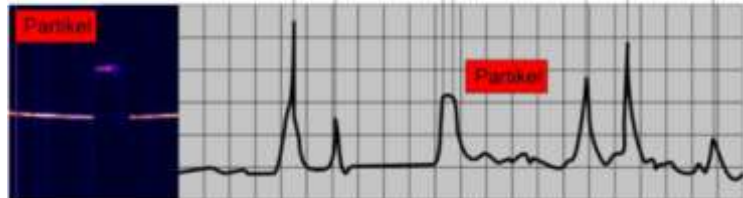

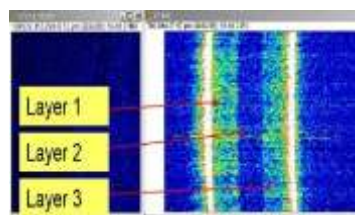
With the OCT method to qualify sealing seams there are less uncertainties in comparison with optional methods. (Visualization systems or phase contrast x- ray method). Unlike conventional systems, spatial resolution and controlling speed are much higher.


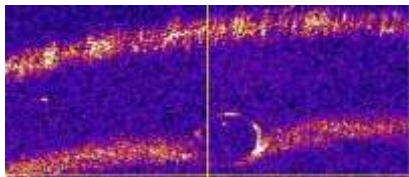

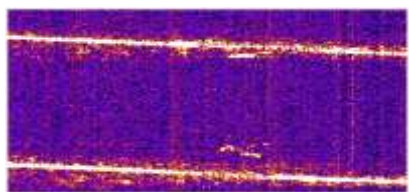

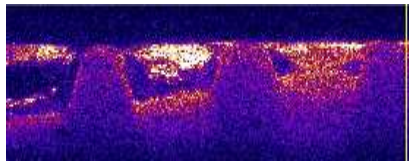

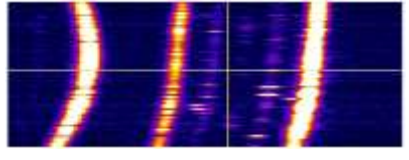

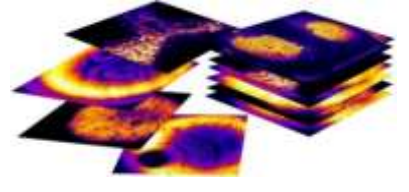

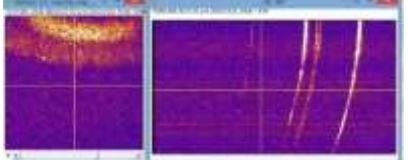

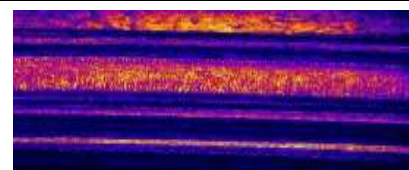
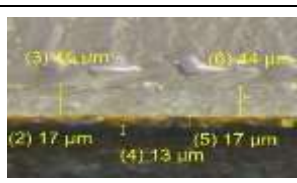
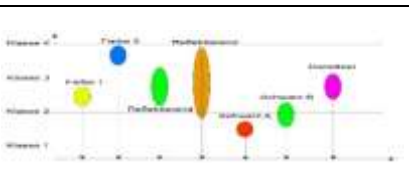

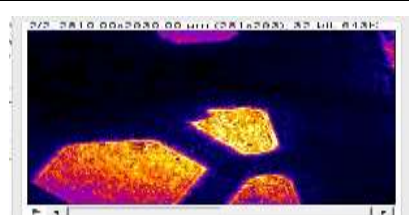
Previously examined with the OCT method errors on packaging:


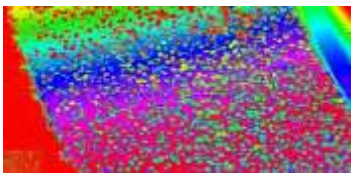

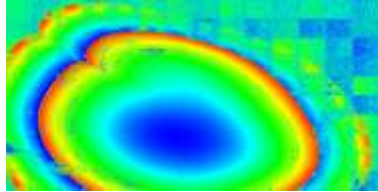

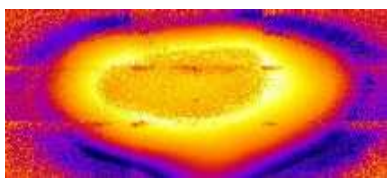

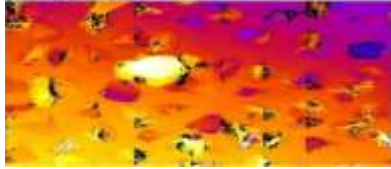

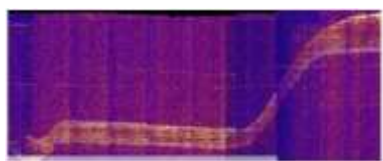

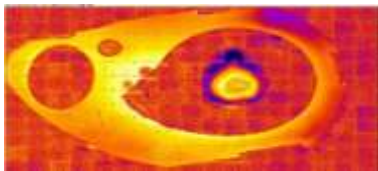

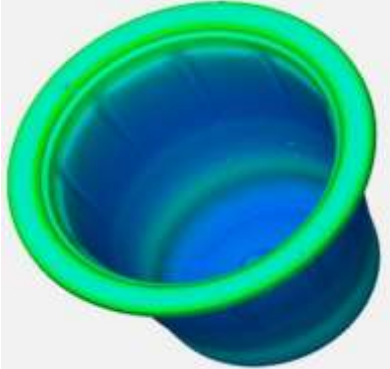

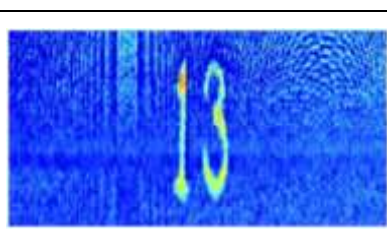

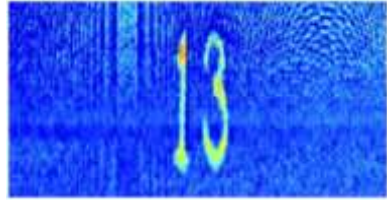
For the preparation of the entire measuring device, many types of defects in packaging and fault samples have been investigated and proven.


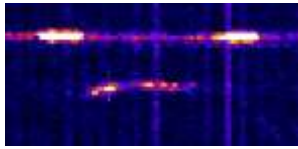

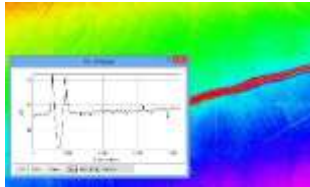

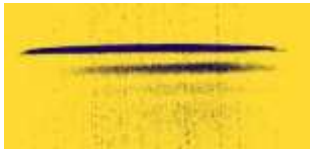

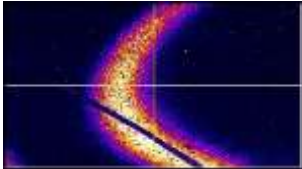
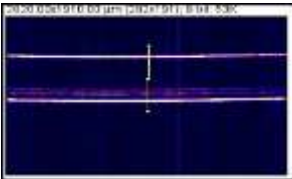

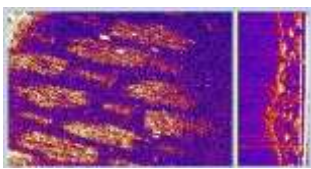
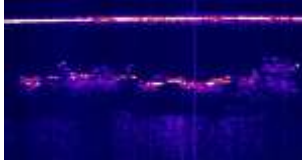
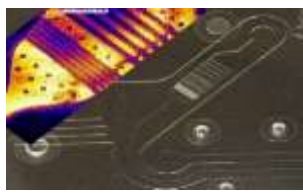
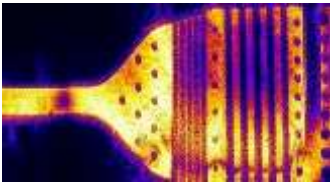

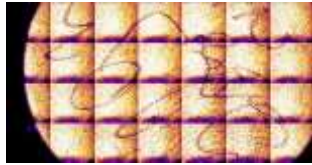

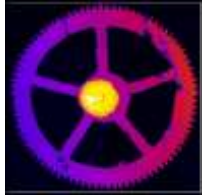
Designation	Description	Picture	Failures types
		Photo	Measured data
Inlaid catheter	The catheter lies on the bonding agent, it is trapped.		
Welded catheter type 2	The catheter is clearly embedded in the adhesion promoter.		
In the seal zone Wrapped product (hair, paper)	Foreign part (paper, fiber) in the sealed seam.		
Width of the sealing seam	Is the minimum width of the 6 mm sealed seam guaranteed?		
Broken seal	No glue, inclusion or scratches in the seal area.		
Loose Peel Off Film	The film does not stick, it is loose.		
No bonding agent	Glue not applied, incomplete application of the adhesion promoter.		
Packed Needle	Is e.g. the needle is present in the packaging?		
Other characteristics	As needed and result, e.g. is a tool in the packaging?		

Designation	Description	Picture	Failures types
		Photo	Measured data
Micro hole	Are there micro-holes or is the arrangement of the perforation correct?		
Defect	Is the film damaged, does it have a hole or is it torn?		
Delamination	Are individual films separated from each other?		
Inclusions	Are residual particles between the film layers?		
High end film	Passing pull strips in the foil?		
Damage	Are micro holes or foil injuries?		
Parts in the seal	Is a crumb or food particle in the sealed seam?		
Faults in the sealed seam	Is the seal completely or partially detached?		
Scratch, Crack or dirt	Are the phenomena cracks, discoloration or scratches?		

Designation	Description	Picture	Failures types
		Photo	Measured data
Broken glass	Are there any broken glass in the product?		
Plastic particle	Are there any plastic particles in the product?		
Crumb or other inclusions	Are there any soils in a Vail or Tray?		
Dirt	Are residual particles between the film layers?		
Defect	Is there a hole, a scratch or a crack in the product?		
Micro perforation	How deep is the perforation? Is the QR code correct?		
OCT measurements through a tray	The light signals show the outside and the thickness of the wall.		
Sealing seam defects	The signals also show particles, cracks or other disturbances.		
Layer thickness	What is the thickness of the individual layers in multilayer films?		

Designation	Description	Picture	Failures types
		Photo	Measured data
Blister	Is there a hole in the blister?		
Blister	Is the blister seal tight?		
Tube closure	Is the tubes tightly closed?		
Gas barrier layer	Is the gas barrier layer included?		
Food tray	How thick are the individual layers in the formed container?		
Plastic bottles	The film does not stick, it is loose.		
Injection molded parts	What is the shaped geometry?		
Plastic coating	How thick are the individual layers? (up to 4 layers)		
Injection molded parts	Are brows or "angel hair" on the molded part?		

Designation	Description	Picture	Failures types
		Photo	Measured data
Mechanical defect	Existence of mechanical damage (impression, hole, crack).		
Defect shell	Is there a defect on the component (geometry, contour)?		
No product in the package	Is there a product in the packaging and / or is the filling level correct?		
Wrong placed product	Is the component in the tray as planned or not?		
Thickness differences	Is the product homogeneous or are there differences in thickness?		
Position failure	Is the component in the right place or not?		
Final check	Are all parts included in the tray? (Liquid, syringe, content).		
Lasercode	Is the laser code on the component correct and readable?		
Tool number	Has the tool-number been read? (Integration in SPC)		

Designation	Description	Picture	Failures types
		Photo	Measured data
Coating thickness	How thick is the coating on the stent?		
Surface	Does the surface show scratches or cracks?		
Micro pores	How deep is the blockage of the micropores?		
Sealing seam	Is a fiber or a hair in the sealed seam?		
Thickness differences	Do thickness differences exist in one component?		
Embedded tissue	Is the tissue properly embedded and not on the support?		
Volume	What is the volume in the channels? (nl accuracy)		
Topography	What is the topography in a micro channel?		
Geometry	What is the geometry of the component or the microstructure?		

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