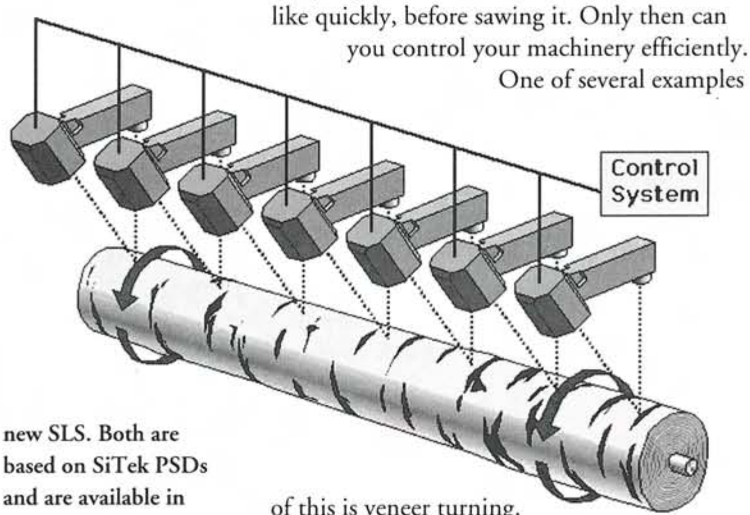
SiTek® ELECTRO OPTICS
Non-Contact
1/96
PEOPLE, PRODUCTS & NEWS

Get 2-15% more from every log!

Selcom AB makes non-contact distance measurement systems. There are now two different ranges of measurement probes in the product programme. The Optocator and the new SLS. Both are based on SiTek PSDs and are available in several different versions to cover most measure-ment needs. All of Selcom's measurement probes are designed for industrial environ-ments, where reliability is important.

High yield and high productivity are important competitive factors for the wood processing industry. In times of high raw material prices and small margins, it is important to get as much as possible from every log and from every minute.

One important thing needed to optimise production is to get a true picture of what every log, block or half finished board looks like quickly, before sawing it. Only then can you control your machinery efficiently.



One of several examples of this is veneer turning. When the logs are put into the veneer lathe, centering has a great influence on the result.

Firstly, more continuous single slices of veneer can be obtained. This means less finishing work, since you otherwise have to join smaller pieces together to make a larger piece.

Secondly, the surface wood is of the highest quality. If you can extract more of the wood nearest the surface of the log, it is worth more than the increase in percentage yield.

This requires a true picture of the outer envelope of the log, beneath the bark and splinters. Any cracks must also be quickly and correctly identified.

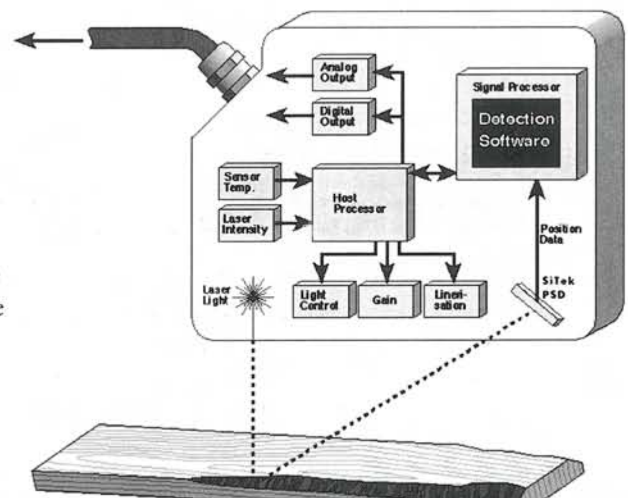
Raute Oy in Finland is a manufacturer of complete peeling lines for plywood mills. One important component is the LASER XY-infeeder, which ensures that the log is centred in the veneer lathe.

The LASER XY-infeeder contains seven Optocators. The Optocator is a non-contact laser probe, based on the principle of triangulation, designed around the SiTek PSD and made by Selcom AB. These detectors measure the true envelope of the log whilst it rotates. Each Optocator does 16,000 measurements a second, which makes it possible to calculate the profile of the log, without erroneous values caused by cracks, pieces of bark etc. affecting the results. The computer in the system calculates how to locate the log in the lathe, to obtain the best yield in terms of value. The final position is calculated with a positioning error of 0.005 mm. After this, the log is adjusted to the calculated position and transferred to the lathe.

The final result is 10-15% more single veneer and it is also the best grade - the surface wood.

Since 1988, Selcom has delivered more than 350 Optocators for installation in XY-infeeders, for use in plywood production all over the world.

This is one of many examples of how a saw mill has successfully managed to increase its yield, and thus save money and raw material by making use of modern non-contact measurement. Someother examples are correct centring of logs in board edgers and resawing mills, more efficient edge moulders and trimmers.



SiTek 20th Anniversary .... grows and grows!

SiTek Electro Optics AB was founded in 1976 as a so-called seed company, which budded off from the Institution for Solid State Electronics at Chalmers Technical University in Göteborg. During the first years, activities were carried out on campus. SiTek acquired its own premises in Partille, a suburb of Göteborg in 1984, containing a well-run clean room and all the necessary equipment for making Position Sensing Detectors (PSD).

The second half of the eighties was however a difficult time, since the market was not quite ready for the product. At the same time, it was found that the venture needed considerably more marketing, customer training and customer collaboration than had been thought. Despite this, technical development has continued and collaboration with our loyal customers has been developed.

The beginning of the nineties brought a stabilisation of activities. This stabilisation together with the fact that the market began to discover the product forms the basis for the growth of the company which we have now started. 1995 was a record year for SiTek in most respects: earnings, profit, number of units made. The big challenge for the next few years is to increase production volumes even more, at the same time as retaining the flexibility and speed which has always been important and which has been appreciated by our customers.

We intend to celebrate our 20th anniversary with a number of activities spread over the year. These will include a few seminars with both lighter and more serious content. Keep your eyes open for more information.

Maria Siverbo

Klas Rudenström

One very important component in the growth and development SiTek is now enjoying is our new personnel. During November, we welcomed two new colleagues who introduce themselves below. They have already walked the tightrope in production, and are very important cogs in our work of growing and increasing production volumes.

Maria Siverbo is my name and I am 19 years old. I did a humanities major at the Angered College last spring. During the nearly 4 months I have been at SiTek, I have learned a lot about making PSDs and pleasant colleagues and interesting job tasks make the job very stimulating.

In my spare time, I train and compete in orienteering, which is a fantastic, entertaining sport. In winter, I mostly do gymnastics and running, and occasionally go swimming. Another of my major interests is slalom skiing. It is so nice to swish down the slopes.

My name is Klas Rudenström and I am 23 years old. I have done a 4-year technical major at College, plus one year of industrial computing science, and have previously worked on assembling hearing aids.

Here at SiTek, I work in production, and look forward to participating in SiTek's forthcoming ascendancy in export markets.

My leisure time is mostly spent playing handball, where I represent Redbergslids IK in the elite league. During the season, I spend at least five evenings a week on handball, for both training and matches. In summer, I play a bit of golf, and have recently joined the Öjared golf club. I am also interested in sports in general, and keep up with the scene.

At present, I live in a one-room flat, am a bachelor who likes going out to bars and amusing myself with my friends.

Technical Fair, Stockholm - 95

SiTek's participation in the Technical Fair -95 in October was a great success. Our stand received a large amount of attention, and during the 5 days of the fair, we made contact with 250 people who showed interest in our products in one way or another. Add to this the 200 who took part in our small competition, and thus gained the chance of winning a camera.

Our new, patented PSD with built-in stray light protection which we introduced at one of the product presentations arranged by the Institute for Optical Research, aroused great interest. Several customers have started to use it, which has resulted in better systems performance.

SiTek´s PSD-school

Chapter 5 by Lars Stenberg, ESDE AB

In section 2 of Sitek's PSD school, we looked at the design parameters for a triangulation probe and derived the 11 formulae which can be used to design the geometry of a triangulation probe. In section 3, these formulae were used to make a closer study of how the geometry of such a probe is designed, and also calculated the focal length of the main lens. In section 4, we went through the selection of the light source and how to generate a so-called quasi-collimated light beam. The focal length of the condenser lenses was calculated in section 4. In this section and subsequent sections, we will discuss how to calculate and select suitable optical components for making a triangulation probe.

What type of light source should I select?

The calculations in section 4 directly affect the choice of a light source. In these calculations, the Gaussian[1] magnification is 4 times in our case. If the light source has a maximum geometric extent of 1 mm, the illuminated image of the light source on the measurement object will have a dimension of 4 mm. In practice, this eliminates all kinds of bulbs. What remains to choose from are light emitting diodes and laser diodes.

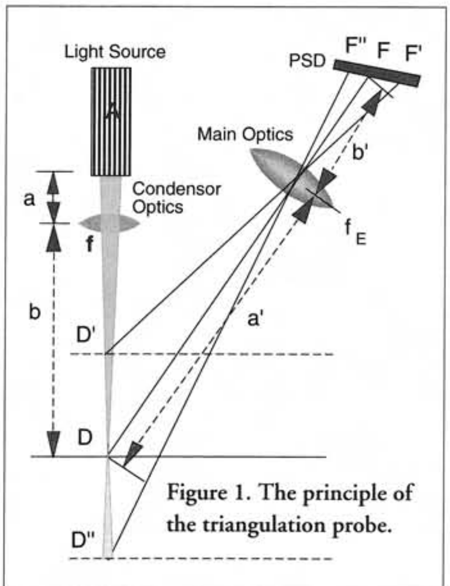


Figure 1. The principle of the triangulation probe.

Light emitting diodes generally have a larger light emitting area than laser diodes and are also frequently provided with a cast epoxy lens whose purpose is to focus the light. It is frequently necessary to dimension an LED in this way because the light which leaves the emitting surface is spread over a hemisphere. Unfortunately, the cast epoxy lens has poor optical properties, with all known optical aberrations[2], which makes it very difficult to add further lenses to produce a well-focused, sharp, circular spot of light. If we select an LED without an epoxy lens, we can only make use of the light which passes through our condenser lens. This means that if we select an LED whose light emitting surface is 0,3 x 0,3 mm, the image will be 1,2 x 1,2 mm, and the generated light spot will also be quite weak. A spot of light which only extends 1,2 x 1,2 mm is not sufficiently one-pointed if you want to measure the threads on an M6 screw, for example.


Lars Stenberg

We are forced slowly but surely in the direction of a laser diode, which is unfortunately both more expensive and more complicated to make the electrical connections to, than an LED or light bulb. But the big advantage of the laser diode is that it is a more or less perfect point source of light, from an opening which frequently has dimensions of about 5 x 1 mm. This means that with 4 times Gaussian or geometric magnification, the dimensions of the light spot will be 20 x 4 mm. Since we are now beginning to use dimensions which approach the wavelength of light, we must check how the diffraction of the light affects the dimensions of the light spot.

Because the wavelength of light is not zero, the light waves emanating from different parts of an object will sometimes reinforce each other and sometimes impair each other. This means that a lower limit occurs on the size of objects which can be studied in detail when light of a certain wavelength is used. The formula which specifies the limit to resolution when you use imaging optics in a circular mount is:

$$\sin \Theta = 1{,}22\ \lambda/A$$

in which Θ is the angular resolution in degrees, λ is the wavelength in mm and A is the aperture or diameter of the imaging optics in mm. If we calculate the resolution for the human eye at a wavelength of 555 nm (maximum intensity of solar radiation), when the diameter of the pupil is 2,4 mm, we get

$$\Theta = \arcsin\ (1{,}22 \times 555 \times 10\text{-}6/2{,}4) = 0{,}016$$

Since 0,016 is expressed in degrees, we get the angular resolution of the eye in seconds of arc if we multiply 0,016 by 3600, which gives 58,19 seconds, or 0,97 minutes of arc. This is why the angular resolution of a healthy eye is normally specified as being 1 minute of arc. The above formula shows that you can see smaller objects if you either choose light of a shorter wavelength or use imaging optics of greater aperture.

It can be derived[3] from the definition of resolution, that the image diameter, measured in mm, D, when a point source of light is imaged, is[4]

$$D = s \times (2{,}44 \times \lambda/A)$$

in which s is the distance from the imaging optics to the image in mm, λ is the wavelength in mm

1. From the German mathematician, Carl Fredrich Gauss, 1777 - 1855.
2. The five so-called monochromatic aberrations, according to the so-called third order Seidel theory, consist of spherical aberration, astigmatism, coma, image field curvature and distortion. These faults will be discussed in subsequent issues.
3. Not evident without further explanation.
4. It is assumed that Θ is a small angle, measured in radians, so that $\sin \Theta = \Theta$ to a good approximation.

and A is the aperture, or diameter of the imaging optics in mm. Note that D will be small if s and λ are small and/or A is large.

We know that s in our example is about 120 mm and there are laser diodes which lase at a frequency which provides red light at a wavelength of 635 nm. Let us calculate D when A = 2,5 mm. Put into the formula above, this gives D = 0,074 mm. Note that even if the light source itself is a point, the image will still be 0,074 mm in diameter since the wavelength of light is not zero. (On the other hand, the image can be much larger if the condenser optics which form the light image are not sufficiently well corrected, but this is a problem which has to be solved by adjusting the geometry of the optics.)

Because of the geometric or Gaussian magnification, in combination with the diffraction effect, the dimensions of the light spot become

$$(0,02 + 0,074) \times (0,004 \times 0,074) \text{ mm} =$$
$$= 0,094 \times 0,078 \text{ mm.}$$

If we do the corresponding calculation for A = 1 mm, we get D = 0,186 mm. In other words, we get a smaller point of light by choosing a larger aperture for the imaging condenser optics.

What aperture should the condenser optics have?

Should we select 2,5 mm? Before I answer that question, we are going to study the beam which leaves the laser diode more closely. The data sheets for various laser diodes which lase at 635 nm specify that the portion of the beam which is at right angles to the lengthways direction of the emitting surface (app 5 x 1 mm) is spread through an angle of 35° whereas the portion of the beam which is parallel to the lengthways direction of the emitting surface is only spread through about 7°. Please refer to illustration 2. This is caused by the fact that the dimensions of the emitting surface begin to approach those of one wavelength of light, and this is thus a diffraction effect.

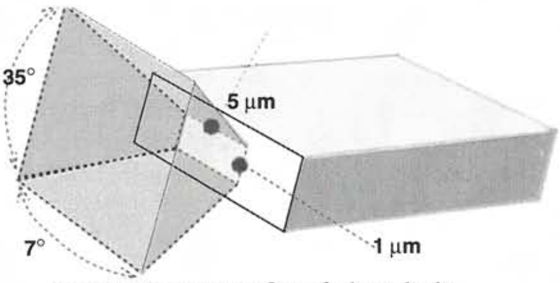


Figure 2. Emitting surface of a laser diode.

(The reader can use the formula to check the calculations for resolution shown above, but since we are now using a slit-shaped opening, the constant 1,22 in the formula, which applies to circular openings, should be replaced by a constant of 1,00, i.e. the formula should be reduced to the wavelength divided by the opening.)

In order to make use of as much light as possible from the laser diode and obtain a circular beam at the same time, we should select an aperture for the condenser optics which makes the light from the laser diode fill the entire aperture of the condenser lenses. Since the beam angle was 7° at its narrowest, this gives half the aperture a_k, for the condenser lens, using the designations in figure 3, as tan 3,5 = a_k/30, i.e. a_k = 1,83 mm. (In section 4, the distance from the light source to the condenser lens, designated as a in figure 1 and in figure 3, section 4, was calculated to be 30 mm.)

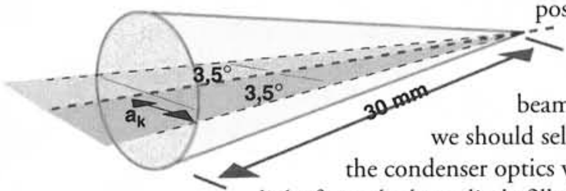


Figure 3. Circular beam.

But this means that we get a circular beam of diameter 3,67 mm, which admittedly means that the diffraction will be 1,5 times less than we had recently calculated, but the beam from the condenser lens will be as depicted in figure 4, which means that the diameter of the light spot will vary unnecessarily throughout the measurement range of the triangulation probe. If we want a beam of 2,5 mm diameter, the distance a in figure 1 should be 1,5 times smaller, i.e. about 20 mm.

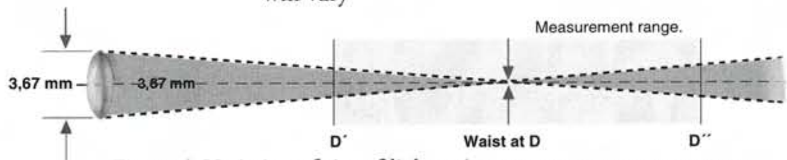


Figure 4. Variation of size of light point across measurement range.

Waist at D ??

This means that if we put in a = 20 and b = 120 in the lens formula, the aperture of the condenser lens becomes 17,1 mm instead.

What optical properties should a suitable condenser lens of aperture 17.1 mm have?

Well, that is a question I will attempt to answer in sections 6 and 7, and we will also investigate the difference in optical quality between an optical system which consists of a single lens and an optical system which contains several lenses. We will also analyze various optical systems which can be purchased ready made and discuss the question of ordering a special design.

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