EN

White paper

Projection lasers for area marking

In co-operation with

HSE

Simply Precise

THE AUTHORS

CHRISTOPH KÄHLER
is product manager for line lasers at the international laser technology firm LAP GmbH Laser Applikationen. Christoph Kähler is also a certified laser safety officer and sought-after speaker.

JENNIFER KATHARINA ZAHNEN
is the owner of HSE Engineering Consulting. As an experienced HSE engineer, she advises companies in all matters of environmental protection, work safety, and fire safety.

WHY USE PROJECTION LASERS FOR FLOOR MARKING?

Projection lasers mark spaces like paths or storage areas clearly and visibly with colored laser lines. In high-wear industrial environments, lasers are an effective and cost-efficient alternative to conventional floor-marking methods. Taped or painted markings wear off and need to be replaced regularly, giving rise to considerable costs. Projected laser lines can avoid these costs.

For lasers to work in practice, a few important aspects need to be considered.

What applications is laser marking suitable for? What is the correct way to mark areas with lasers? What is the right kind of laser? What ambient conditions as well as safety and legal aspects need to be considered?

This white paper is intended to help companies correctly evaluate the use of line lasers for area marking, and choose the best lasers for the job. The white paper explains the basics in a readily understandable way and answers key questions to help you make a decision.

Our checklist will help you better evaluate feasibility upfront.

Line lasers generate colored marking lines that are always visible, even in heavily stressed areas.

1. THE TASK

For indoor traffic safety in production facilities and logistics centers, rules of accident prevention call for the visible marking of paths, storage areas, and hazard areas. But conventional marking methods like tape or paint quickly deteriorate due to mechanical wear. Forklift traffic and sliding pallets create abrasions on markings. As a result, markings wear off and are often hard to see after just a few weeks (Fig. 1).

Dirt and dust in production environments can also affect visibility. This is especially true in steel works, foundries, and refractory industry plants. Dirt sticking to conventional markings can leave them unrecognizable. Replacing the markings is only a temporary fix. Even high-quality marking paint with sealant coating does not solve the problem permanently.

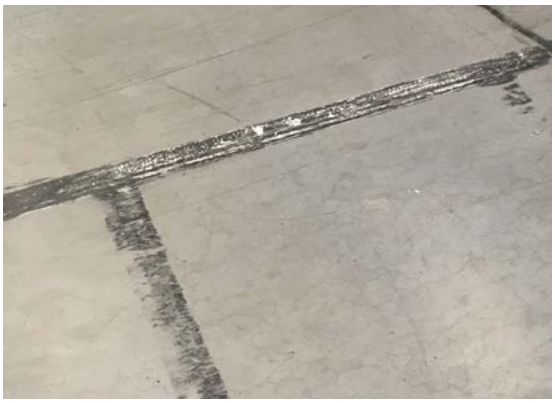


Fig. 1: Abrasion on floor markings

Projection lasers offer an alternative for both scenarios by projecting lines onto the floor. This provides the desired markings without anything having to be applied to the floor. Advantages: laser projection is immune to wear, and the markings are always visible, even in heavily stressed areas. As simple as the solution sounds, the details require some attention. In addition to employee safety considerations, the laws of physics can sometimes get in the way. We will explain in the following the basic properties of lasers and their projection behavior.

2. SELECTING THE RIGHT LASER

Only industrial lasers should be used for area marking. Today, industrial projection lasers are commonly used around the world in demanding production environments such as the aircraft and automotive industries, mechanical engineering, and the steel and aluminum industries. Through advances in technology, laser diodes are now small enough to permit various applications. However, this has also resulted in many international vendors offering projection lasers via online platforms at very low prices. Be careful here because not all lasers are the same! There are major differences in build quality, projection quality, lifetime, and reliability.

LAP has spent 35 years making projection lasers that meet most demanding industrial standards.
All "XtrAlign" family lasers from LAP have at least 30,000-hour service life and 100 percent tested quality. A rugged stainless steel housing to IK10 and IP67 standards protects the sensitive laser source from dust, water, vibration, and shock. In hard industrial use, a stainless steel housing has clear advantages over cheaper aluminum housings.

→ ***Summary:*** *Quickly purchasing a cheap off-the-shelf product seldom delivers good results. Industrial environments require industrial lasers designed for the task. If you are planning to use lasers for marking the floor, first carefully define your requirements together with knowledgeable experts.*

PROJECTION BEHAVIOR OF DIFFERENT KINDS OF LASERS

In addition to quality and lifetime, the projection behavior of the laser is an important selection criterion. There are two types of lasers to choose from for the best results. In the following they will be termed “standard beam expansion” and “alternative beam expansion.” In both, the line projection is generated by a cylindrical lens that shapes the point laser source into a line. However, the different expansion methods have different effects on the line. Each has its particular advantages for a given Installation.

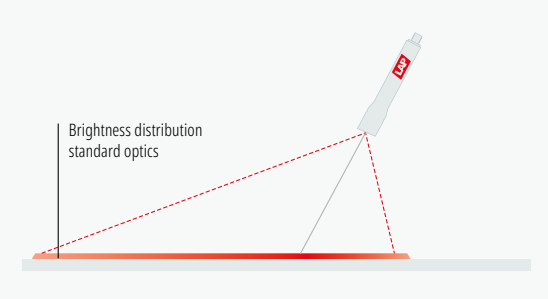


Fig. 2:
Standard Expansion of the laser beam in a cylinder rod lens

In the standard version of the laser, beam expansion is by means of a cylindrical rod lens (Fig. 2). The beams on the edges travel farther than the ones in the center. The energy density is highest in the center of the beam, and with it the visibility of the projection. Energy, and visibility with it, decay at the ends.

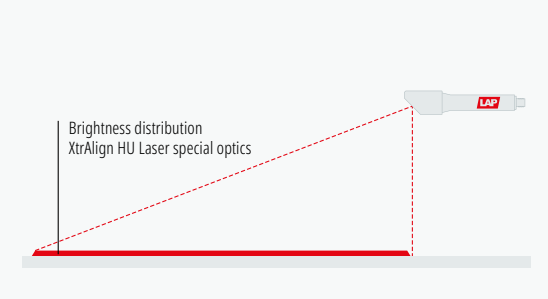


Fig. 3:
Alternative Expansion of the laser beam in a cylinder tube lens

Lasers with **"standard beam expansion"** have the advantage of very high line straightness, and can be freely focused to the right projection distance. The "XtrAlign HD and HY" lasers from LAP have a line straightness of +/- 0.05 mm/m, which clearly indicates the quality. This is especially important when multiple projection lines are combined into one long line. For example, projecting a 50-meter path takes several lasers (*see chapter “Installing lasers”*).

In **“alternative beam expansion,”** the beam is not directly expanded, but optically refracted by a cylindrical tube lens (Fig. 3). Lasers of this type give very even brightness distribution throughout the length of the line. The "XtrAlign HU" lasers from LAP have special optics that allow them to project an unbroken line that keeps brightness over a length of 20 meters.

→ ***Summary:*** *There are benefits to both projection types. Which laser is best for the specific application will depend on other factors, which are discussed in the following chapters.*

→ ***What you need to know:*** *Due to the point nature of the laser source, the projected line will be narrow. A broad line like with painted markings is not possible with projected lines.*

Fig. 4:
Floor sealed with resin, slight reflection

Fig. 5:
Metal floor, high reflection

FLOOR FEATURES

Rough floor

How visible the laser line is for viewers depends on the floor the line is projected onto. A rough, gray concrete floor, as is often found in factory buildings, is ideal for laser marking. Lasers with standard beam expansion give very good results here. The laser line is easy to see from all directions.

Reflective floor

If the floor is painted and sealed, it can be reflective (Fig. 4). In some cases the floor might even be metal (Fig.5). With these floors, area marking by laser projection will have its complications. Since the laser beam is reflected based on the angle of projection, lines made by lasers with standard beam expansion are easily visible only from one direction. Viewers looking from another direction will hardly be able to see the line (Fig. 6).

On reflective floors, alternative beam expansion lasers give the best projection results because the reflected laser beam is likewise visible from many directions (Fig. 7). This visibility from all sides improves safety.

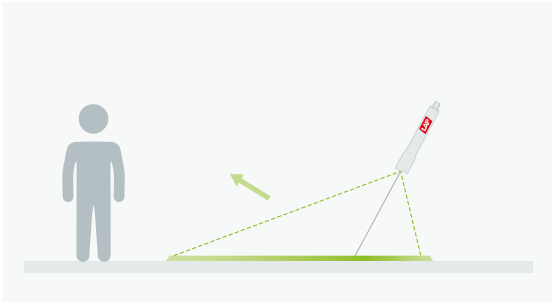


Fig. 6:
Reflection with standard expansion: With reflective floors, the viewer must be looking against the direction of projection to see the line

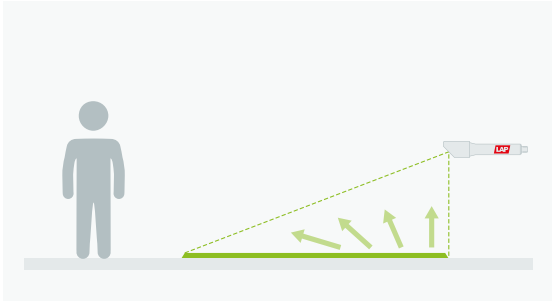
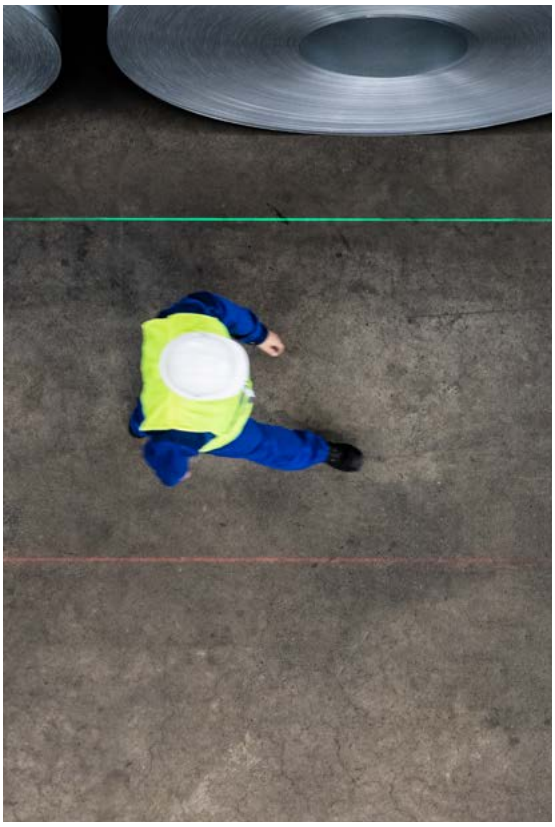


Fig. 7:
Reflection with alternative expansion



INFLUENCE OF AMBIENT CONDITIONS

Lighting conditions

Ambient light has the greatest effect on the visibility of projected lines for viewers. Well-lit working areas appear very bright to the human eye, but artificial lighting has little effect on laser projections. Natural light has much greater influence. Sunlight coming in through skylights or windows and hitting the projection can make the line almost invisible. This is because sunlight covers the entire wavelength spectrum and is intense. It blankets any laser projection.

Dust and dirt accumulation

Dark and dusty environments offer the ideal operating conditions. In large metalworking and metal fabrication buildings, lights and windows are often covered by dust, abraded material, and aerosols. Conventional floor markings with paint or tape can also be limited in their visibility by dust and dirt accumulations. Such areas are perfect for projecting lasers, since the marking is visible regardless of how dirty or dusty things are.

→ ***What you need to know:*** *Lasers can be used for outdoor area marking only when it is dark. For indoor use, lasers should not be used in areas exposed to permanent sunlight. For temporary sunlight, such as next to roll-up doors or other entryways, each application should be examined as to whether laser makes sense for marking areas.*

INFORMATION

RED OR GREEN LASER LINES?

The most commonly used colors for line projections are red, green, and blue. Other colors are possible, but are used only in very specific applications.
A red projection might be used to mark hazard or off-limits areas. The human eye fundamentally sees green better than red. Under the same conditions, a green projection will therefore always be easier to see than a red one.
So, combining the two colors cannot be recommended.

INSTALLING LASERS

Before deciding on a laser, the first question is: Where and how can it be installed? If the lines need to cover a large area, the laser should be installed as high as possible right under the ceiling. Ceiling beams are ideal for mounting. If the ceiling height is over ten meters, the laser should be very powerful (max. 40 mW) to ensure that it gives good visibility.

If it is mounted low down (one to three meters), for example over a door or on a shelf, it can have lower power (e.g. 15 mW). Bear in mind that the laser can be damaged by forklifts or cranes, so it should have a rugged housing. LAP's XtrAlign family lasers offer the highest impact resistance class, IK10. That means that they remain functional even after hard collisions.

LAP offers many different mounting brackets for lasers, some of which have fine adjustment capability. This fine adjustment is important if multiple lasers will project along a single line. The number of lasers can vary between three and eight, depending on the environment, ambient conditions, mounting height, and floor. For the projected lines to be perceived as one line, the lasers have to be precisely aligned.
A bracket with fine adjustment like the LAP's "B5-HD" is ideal.

→ ***Summary:*** *Before choosing lasers, check the installation positions and mounting brackets. If the lasers will be mounted low, they will need to have a rugged housing.*

REAL-WORLD USE

MARKING STORAGE AREAS

Repeatedly placing and removing palettes in and from the same place is rough on floor markings. Laser marking offers many advantages. The green line is easy to see, and the marking never needs to be replaced. If the storage area is moved, there are no marking remnants on the floor that need to be scraped off.

REAL-WORLD USE

MARKING PATHWAYS

For operational reasons, it is often not possible to have completely separate pedestrian and vehicle paths. To ensure that the marking is visible regardless of how dirty the floor gets, a pedestrian path at one of the foundry furnaces was clearly marked with the LAP lasers.

Nominated for the BG RCI Förderpreis 2017 Sicherheitstechnik

3. OPERATIONAL SAFETY

IT ALL DEPENDS ON THE LASER CLASS

For safe use of positioning lasers, it is necessary to know what their laser class is and what the laser classes mean. The DIN EN/IEC 60825-1:2015 standard categorizes lasers by classes. The classification (Fig. 9) is based on the wavelength (visible or invisible spectrum) and power. The maximum permitted power is measured at a distance of 70 or 100 millimeters along the laser line. The point on the line with the highest power density is determined.

Class 1 lasers are non-hazardous and can be used without protective measures. However, their power is so low that the line they project is hard to see, even under favorable conditions.

Class 2 and 2M lasers are described in the standard as "potentially hazardous," but contact lasting less than 0.25 seconds does not cause harm per the standard. Thus, if class 2 and 2M lasers are used in such a way that they do not shine directly at persons, their use is non-hazardous.

Class 3R and higher laser classes require special safety precautions. This includes notification that the area they are used in is a laser area, and there must be a designated laser safety officer in the plant.

→ ***What you need to know:*** *The entire laser power is distributed along the line. Therefore, lasers with very high internal power can still be classified in a lower laser class in use.*

Fig. 8:
Sample laser warning sign per EN 60825-1.
The laser class must also be clearly marked on the laser.

LASER CLASS	MAX. PERMITTED POWER AT 70 mm	MAX. PERMITTED POWER AT 100 mm
1	1.18 mW	
2	3.0 mW	
2M		3.0 W
3R	15.0 mW	
3B	500 mW	
4	> 500 mW	

Fig. 9:
Laser classes per EN/IEC 60825-1

HAZARD ASSESSMENT

To ensure safety in operation, the owner must perform a hazard assessment per the "Technical Rules for Stationary Radiation Sources" (TROS) and comply with the "Work Safety Regulation on Artificial Optical Radiation" (OStrV). That means that if you are planning to install lasers, you need to check whether persons can be dazzled by the lasers. The movements of path users in the plant play an important role (Fig. 10 and 11).

The example given here (Fig. 11) shows the marking of paths. Pedestrian and vehicle paths should be clearly separated by laser markings. Typical movements of pedestrians, forklifts and on-site traffic like trucks and the resulting natural direction of view of the path users were examined.

It can be seen that in normal traffic movements in the plant, it is almost certain that people will not look into the laser beam by accident (Fig. 10).

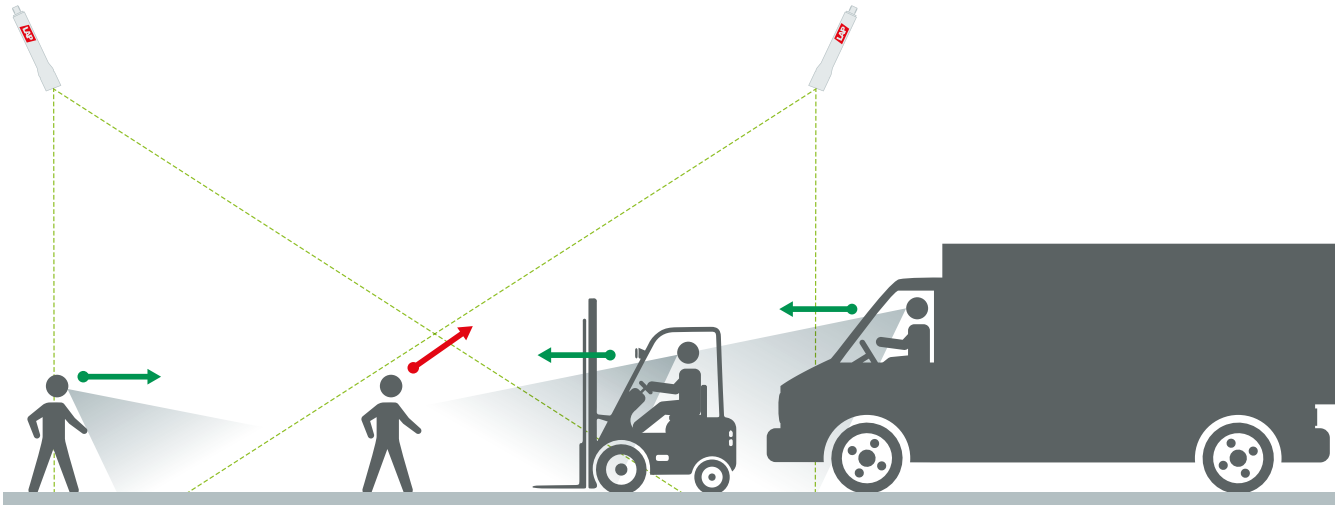


Fig. 10:
During normal movements at the site, the directions of view of path users are risk-free.

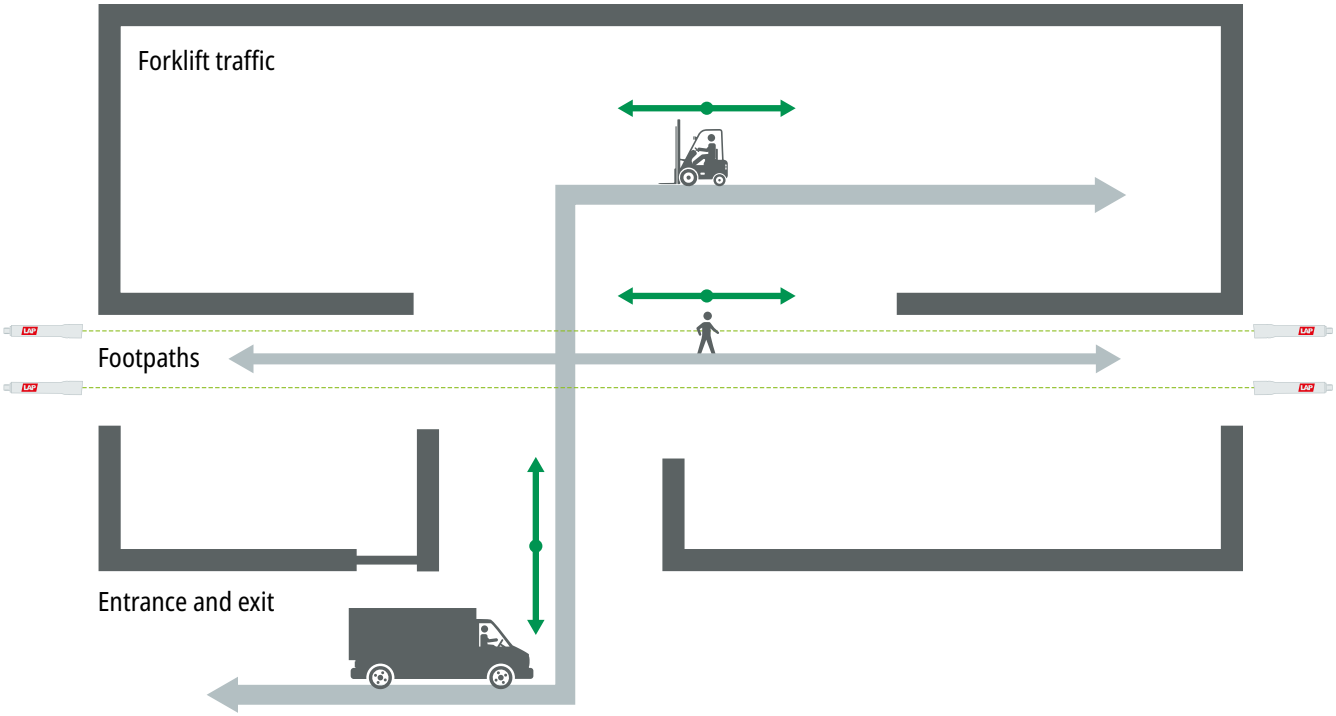
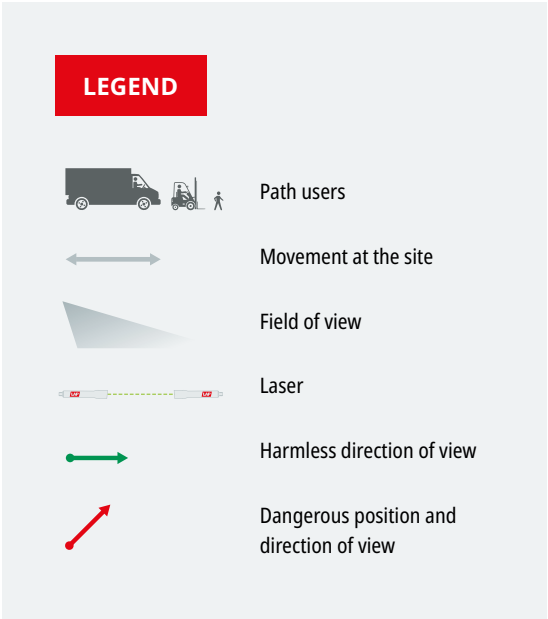


Fig. 11:
The graphic shows an example of the directions of movement of pedestrians and drivers on the site.

If, contrary to expectation, dazzling is possible, the severity of exposure needs to be determined. The exposure severity is derived from the energy that actually impacts the retina. The exact calculation and limit values are contained in the TROS. Since the beams of area-marking lasers are expanded, and the laser sources are typically mounted high above eye level, the actual energy impacting the retina is very low and therefore not hazardous.

→ ***What you need to know:*** *If class 3R or 3B lasers are used, a closer examination of the overall installation might result in a reclassification to laser class 2 based on the exposure values. Only a certified laser safety officer can perform this examination.*



LEGAL NOTES

Laser marking can be used in high-risk areas only in conjunction with further safety measures. According to the Technology Organization Personnel (TOP) principle, laser marking is an organizational measure and acts as a system in combination with other measures. If your hazard assessment identifies other hazards that require protective separation such as barriers, protective grating, photoelectric barriers, or railings, then marking by laser alone is insufficient.
This also applies to any colored marking, as it offers no protection from falls or mechanical hazards.

The hazard assessment must carefully consider the possibility that the projected line may not be recognizable or a laser has a technical defect. Additional measures should be considered, appropriate to the hazards for path users.

→ ***Summary:*** *Laser marking of high-risk areas should always be based on a hazard assessment performed with the assistance of a safety engineer or work safety specialist.*

4. SUMMARY

The use of lasers for marking areas in plants offers many advantages. It is a cost-effective alternative to conventional marking methods. It eliminates the need for costly remarking, whether with tape or paint. The line projections are visible at all times. Laser marking is an effective way to ensure that markings are visible, particularly in production plants where dust and dirt accumulation can make conventional floor markings invisible.

Installing marking lasers is not a trivial matter. Work safety, technical and legal aspects need to be considered. To get the best results and avoid wasting money, it is advisable to check the feasibility beforehand. This white paper and the checklist on page 15 can help you decide if laser marking is suitable for your specific situation.

5. DO THE REAL-WORLD CHECK!

IS LASER MARKING RIGHT FOR YOUR SITUATION?

	YES	NO
NO DIRECT SUNLIGHT?		
LOW-REFLECTIVITY FLOOR?		
INSTALLATION ON CEILING OR OTHER SUITABLE LOCATIONS POSSIBLE WITHOUT SHADING?		
NOT THE ONLY PROTECTIVE MEASURE?		

WAS EVERYTHING ANSWERED WITH YES? YOU'RE GOOD TO GO!

CONTACT US!

Jennifer Katharina Zahnen, proprietor of HSE Engineering Consulting, can provide further expert assistance in matters of work safety. For technical questions and assistance in choosing the right lasers, contact LAP experts Caren Lüdemann (Sales) and Christoph Kähler (Product Management).

CONTACTS

Caren Lüdemann
linelaser@lap-laser.com

Christoph Kähler
C.Kaehler@lap-laser.com

Jennifer Katharina Zahnen
jenna.zahnen@hse-nrw.de

ABOUT LAP

LAP is one of the world's leading suppliers of systems that increase quality and efficiency through laser projection, laser measurement, and other processes. Every year, LAP supplies 15,000 units to customers in industries as diverse as radiation therapy, steel production, and composite processing. LAP has 350 employees at locations in Europe, America, and Asia.

www.lap-laser.com

ABOUT HSE

HSE Engineering Consulting advises companies in matters of work safety, plant safety, and environment and fire protection. HSE also offers safety instruction and training tailored to the needs of client companies.

www.hse-nrw.de

made in Germany

LAP GmbH
Laser Applikationen
Zeppelinstr. 23
21337 Lüneburg
Germany
Phone +49 4131 95 11-95
Email info@lap-laser.com
www.lap-laser.com