# EXTRACT Manual

# LaseTPC (Truck Position Crane)

## LASE project no.:

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# 1 General

This document specifies the functionality of the LaseTPC (Truck Position Crane) and gives technical information about the system.

The LaseTPC is designed for the ports application with the background to positioning the truck trailer to the right position under the crane.

This document gives information about following topics:

- **General overview**
- **Hardware components**
- **Mechanical installation**
- **Electrical installation**
- **Handling and Set-up**
- **System software**
- **Interfaces/telegrams**
- **System calibration**
- **Maintenance**

The specification is part of the project documentation. For further notes regarding the laser scanner or other hardware devices please see also the respective manufacturer's documentation, which will be delivered with the project documentation.





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## 1.1 Target group

This document is directed to persons performing following activities:

### 1.1.1 Mounting, electrical Installation, Maintenance and device changing

Industrial electrician and Service engineers

### 1.1.2 Commissioning, handling and set-up

Technicians and Engineers

## 1.2 Used symbols

The book symbol shows, that in the text is referred to additional documents or documentations of the respective manufacturer of the component


**ATTENTION! -** This symbol with the yellow triangle indicates in the document to hazards. With this symbol marked text parts should accurately be read and observed to avoid accidents!


The „**I**“ symbol indicates text passages, in which special notes/information are contained which are to be observed. This text passages are to be read accurately.

## 1.3 Used abbreviations

| | |
|---|---|
| LaseTPC | LASE Truck Position Crane system |
| LSP | LASE Servo platform |
| 3000D Laser scanner | LASE Servo platform (LSP + 2D-Laser scanner as complete unit) |
| 2000D Laser scanner | Individual laser scanner without swivel platform |
| 2D | 2-dimensonal |
| 3D | 3-dimensional |
| LMS | 2D-Laser Measuring system |
| CAN | Controller Area Network (standardized Fieldbus system with communications orientated data exchange protocol) |
| TCP/IP | Transmission Control Protocol/Internet Protocol – network protocol |
| IPC | Industrial PC |
| LCU | LASE Control Unit = IPC |
| WS | Water side |
| LS | Land side |
| PS | Portside |
| SB | Starboard side |
| TL | Traffic Light |

# 2 General overview

While working, the ship to shore (STS) crane driver has to aim the spreader for loading and unloading from tens of meters high. The loading/unloading speed (cycle time) of STS crane is of great significance for the port efficiency. During the operation the crane is aligned to the bay of the container ship. The crane shall not be moved along the birth while one bay is operated. For this reason it is important that the trucks carrying containers to the crane respectively carrying them away are positioned under the crane in a way the crane driver can lower the container/spreader without any gantry movements. In order to increase speed, LASE therefore developed the LaseTPC system which guides the truck drivers to the right stop position under the crane.


**Figure 1: STS Crane in operation**

Traditionally the truck drivers are guided by an instructor which positions the truck manually. The goal of the LaseTPC is to take over the dangerous job by keep the instructor out of the danger area (underneath the spreader) as long as possible.

Another advantage of the system is that it can provide the exact position of the trailer/container to the PLC system (control system). The control system can use that information as input/feedback for automation.

## 2.1 Procedure

- The crane control system (PLC) provides the information such as active lane(s), drive in direction, slot on the trailer, operation mode (twin, double-hoist or loading/unloading) as initial parameters for the LaseTPC system. The system starts initialization according those parameters (e.g. Scanner will be swivelled to the used lane).
- The traffic light gives “green” signal and the truck is allowed to drive in. A display under the traffic light shows for which lane the traffic light is meant. As the truck travels under the crane, the truck profile can be detected by the laser system. From this profile information, the software determines the length of the truck with trailer and calculates the stop position automatically.
- The laser system keeps on tracking and the software compares the current truck position to the stop position continuously. At the same time, the software generates traffic light signals to guide the truck driver to stop on the right position (nominal position).
- According to the traffic light signal the truck driver performances actions such as “slowing down”, “stop the truck” or “drive back”, until he reaches the stop position. Approx. 2m before nominal position is reached the traffic light starts to blink. If nominal position is reached the red light is shown. If the truck has driven too far the green light (arrow downwards) is shown,
- After loading/unloading operation, the crane PLC sends a “operation finish” telegram. The truck can leave its stop position. The traffic light gives “green” signal for the next truck.

## 2.2 Laser scanning system

The laser scanning system consists of 2 LASE3000D, which are mounted under the 2 cross girders of the STS Crane. The Lasers are scanning downward onto trucks from a height of about 15 meters high to the ground (1 x PS, 1 x SB). By swivelling, the LASE 3000D can adjusting the scanning plane to be able to cover more than one lane. The swivelling angle is controlled by the telegram from the PLC (active lane and move-in direction).

Usually just one 3D-laser is used. The system can reach the best results when the scan is detecting the truck trailer profile from the back. Thus mostly the scanner which is located closest to the incoming truck is in operation.

Of course if necessary the LASE software application can handle 2 lanes and at the same time by using both 3D-Scanners together.

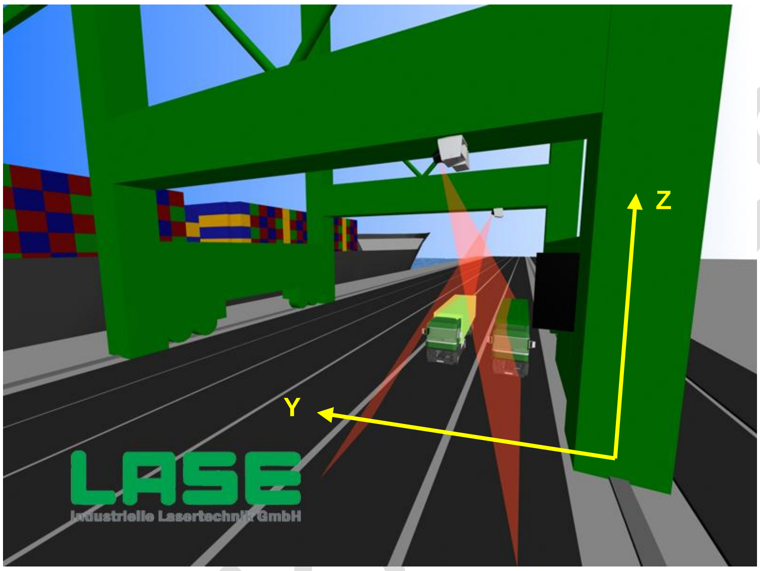



**Figure 2: Y / Z axis view**

When trucks approach, the laser scanners can be adjusted to swivel towards the relevant lane in advance with the information provided by STS operation system (as shown in Figure 2).

While a truck is being driven into the lane, the LASE 3000D scans the truck. The scan is collected by the application software. The application converts the profile data into truck position information (along X-axis). The calculated position information is used to control the traffic lights. The traffic lights guide the truck driver to stop at the right position along STS central axis (nominal position) (As shown in Figure 3).

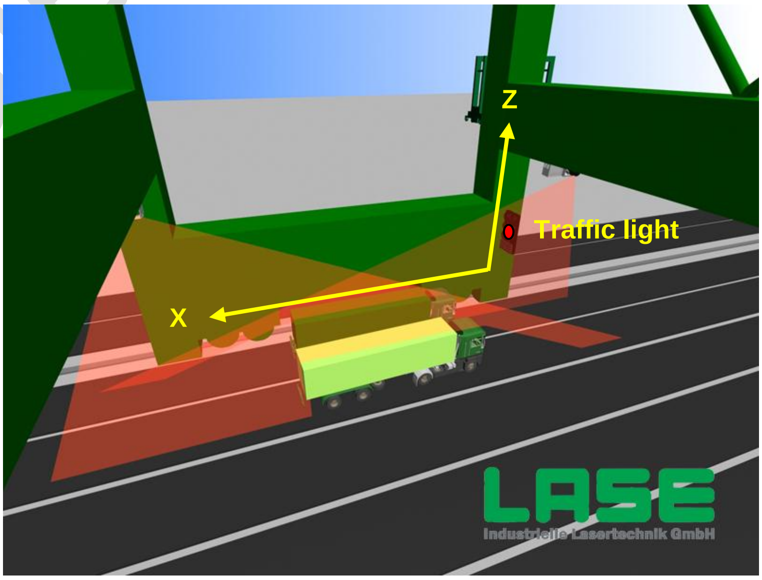



**Figure 3: X / Z axis view**

# 3 Hardware

Per crane the system consist of 2 x LASE3000D laser scanners, 4 x traffic light including display, 1 x IPC and 1 x Switch cabinet. The traffic lights the IPC and the switch cabinet will be provided by  Customer.

The laser scanners are the main important part of the entire system. From the scan data of the laser scanners the LASE software application calculates the current position of the truck trailer combination.

## 3.1 System overview

The picture below shows the hardware configuration for the truck positioning system. The system is divided in four parts:

- LASE 3000D - Laser scanners
- Traffic light system including 7-segment displays
- Field switch cabinet
- Main switch cabinet with IPC/LCU

INFO

**To avoid influences from high voltage cables respectively from the drives to the data wiring the connections between filed switch cabinet and LCU (e-house) should be realized with fiber optical lines.**

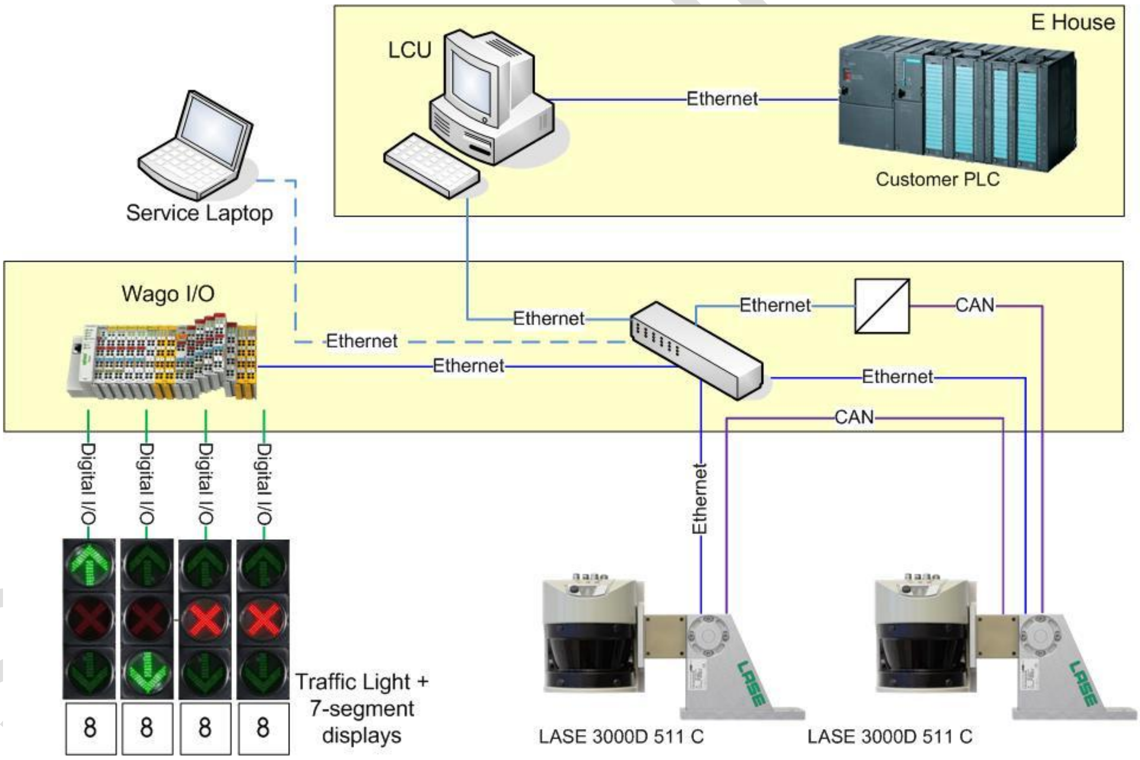



**Figure 4: System overview**

## 3.2 Laser scanner (LASE 3000D – 511 C 10100)

The high performance 3D-Laser scanner from LASE is based on a 2D laser scanner and a swiveling platform. The swiveling platform is driven by a servo-drive. A high resolution encoder in the servo-drive measures the rotation angle of the platform. By the linkage of the 2D-Laser data with the encoder data high precise 3D measurement profiles can be created.

A 3D-image of the scenario under the crane is not used for this project. Here the servo drive is used to swivel the laser scanner to the lane where the next truck coming.


**Figure 5: 3D Laser scanner LASE 3000D -511 C**

The LASE 3D-Scanner is designed for outdoor use. The scanner is equipped with 2 cables for the connection to the switch cabinet. The cables are approximately 1.5 meter long and having Harting plugs at the end. One cable is for the power connection the other is for the data connection. Information to the used type of Harting plugs and the pin order will be given chapter: **Fehler! Verweisquelle konnte nicht gefunden werden. Fehler! Verweisquelle konnte nicht gefunden werden.**.

The following table shows the technical data.

| **LASE 3000D – 511C 10100** | |
|---|---|
| Typ. Measurement range (10% remission) | 40m |
| Max. measurement range | 80m |
| Scan angle laser scanner | 190° |
| Angular resolution | 0,166° …. 1° |
| Scanning frequency | 25Hz …. 100Hz |
| Swivel range platform | +-90° |
| Protection class | IP 65 (Scanner IP67) |
| Voltage servo (motor) | 24VDC +- <2V / nom. 4A, max. 8A |
| Voltage Servo (logic) | 24VDC +-3% / max. 1A |
| Voltage servo (heating) | 24VDC +-6V / |
| Voltage scanner (logic) | 24VDC +-5% / nom. 0,9A, max.2A (start-up) |
| Voltage scanner (heating) | 24VDC +-4V / max. 2,5A |
| Shock and vibration | IEC 68 |
| Temperature | With heating -25°C …. +50°C |
| Weight | Approx.. 7,5Kg |

**Table 1: technical data 3D-Laser scanner**

### 3.2.1 Laser radiation

The in the Lase TPC included LASE 3000D Laser scanner is working with one infrared light laser of the class 1 (eye safe). The laser beam is not visible for the human eye.

- **The laser protection regulations according to DIN EN 60825-1 (latest version) are to be observed!**
- **In no case the housing of the 2D scanner may be opened.**

### 3.2.2 Laser output

The laser is working with a wave length of $\lambda$ = 905 nm (invisible infrared light). During the standard operation (when the protection housing and the pane is not damaged) the out coming radiation is not dangerous for the human eye and the human skin.

### 3.2.3 Laser warning sign

The relevant laser warning signs, the triangular laser warning symbol and the 3-speaking laser warning note in black-yellow design (see figure below) are outside the housing of the 2D laser scanner.

.


**Figure 1: Laser warning signs**

INFO

If the LASE 3000D-laser scanner is integrated in a housing or if additional coverings (sun protection, dust protection etc.) are mounted around the LASE 3000D Laser scanner, so that the warning signs are covered, further warning signs (not included in the scope of delivery!) are to be fixed beside the outlet of the laser beam.

## 3.3 Traffic light system + 7-segment displays

The traffic lights including the 7-segment displays will be provided by Customer. This chapter shall give an overview about how the lights will be controlled by the LASE system.

For this project with 4 lanes per crane 4 traffic lights will be used. Each traffic light is equipped with 3 single lights and one 7-segment display. The light at the top is a green arrow showing upwards, in the center is a red cross and at the bottom position is green arrow showing downwards.

The 4 traffic lights will be mounted at all 4 vertical legs of the STS Crane. For each move-in direction only 2 lights are in operation. The other 2 are showing the red cross which means “No entry”. Due to more lanes than mounted traffic lights (two per move-in direction) under each of the traffic lights a 7-segment display is mounted. The display indicates for which lane the traffic lights signals are currently for.

The following figure shows the traffic lights with the possible symbols:

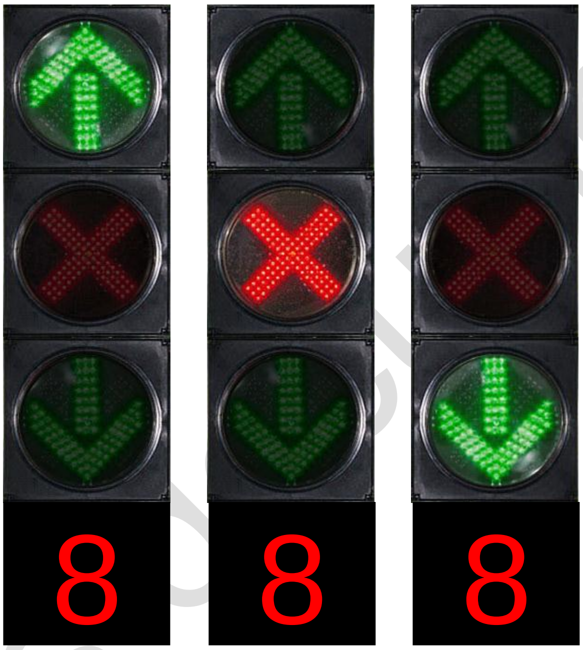



**Figure 6: Traffic lights**

### 3.3.1 Traffic light logic

The following table shows the traffic light system logic:

| **Truck position** | **Traffic light action** | **Driver action** |
|---|---|---|
| Distance between truck and nominal position: -15...-3m | ↑ light on (green arrow upwards) | Keep moving on |
| Distance between truck and nominal position: -2...0.5m | ↑ light blinking (green arrow upwards) | Slowing down |
| Distance between truck and nominal position: -0,5...-0.05m | ↑ light blinking (green arrow upwards)<br>X light blinking (red cross) | Prepare to stop |
| Truck parking at the nominal position along STS central axis (error ca.: +/- 50mm) | X light on (red cross) | Stop the truck |
| Distance between truck and nominal position: 0,05...0.5m | ↓ light blinking (green arrow downwards)<br>X light blinking (red cross) | Prepare to stop |
| Distance between truck and STS central axis: 0.5...2m | ↓ light blinking (green arrow downwards) | Slowing down back |

| | | |
|---|---|---|
| Distance between truck and STS central axis: 2...4m | 🡇 light on (green arrow downwards) | Driving back slowly |
| Distance between truck and STS central axis: > 4m | 🡇 light on (green arrow downwards) | Driving back |

**Table 2: Traffic Light logic**

Like already mentioned above only two of the 4 installed traffic light systems are used to guide the driver. Which traffic lights are used depends on the move-in direction. For the opposite side the traffic lights are showing the red cross. The 7-segment displays will be switched off.

| **Traffic light** | **Move-In direction**<br>**Portside ➔ Starbord** | **Move-In direction**<br>**Starbord ➔ Portside** |
|---|---|---|
| WS-PS | **X** light on (red cross)<br>Display = off | Lights are active according table traffic light logic<br>Display shows number of used lane |
| LS-PS | **X** light on (red cross)<br>Display = off | Lights are active according table traffic light logic<br>Display shows number of used lane |
| WS-SB | Lights are active according table traffic light logic<br>Display shows number of used lane | **X** light on (red cross)<br>Display = off |
| LS-SB | Lights are active according table traffic light logic<br>Display shows number of used lane | **X** light on (red cross)<br>Display = off |

**Table 3: Traffic Light logic – move-in direction**

## 3.4 LASE Control Unit (LCU) – (Option)

For this project the IPC will be provided by  Customer. The IPC should be a state of the art IPC (intel core5/7 or similar) with a WINDOWS 7 32Bit operating system and a SSD.

The IPC will be mounted in the e-house of the STS Crane.

On the IPC the LASE measurement application (Truck Position Crane) will be installed. The drivers and settings for the CAN-Ethernet converter must be installed and adjusted.

## 3.5 Switch cabinet – (Option)

For this project the field switch cabinet, which is located on the cross girders starboard side, will be provided by  Customer as well.

The switch cabinet includes the power supplies for all the hardware components as well as necessary clamps and fuses. The logic power and the power for the servo drive respectively the heating should be driven by separated power supplies.

Additionally the switch cabinet includes the Wago modules which are controlling the traffic lights. The used Pin-order is shown in the next chapter.

The switch cabinet should also include a free power socket (220VAC) for a laptop.

# 4 Mechanical installation

## 4.1 Installation position overview

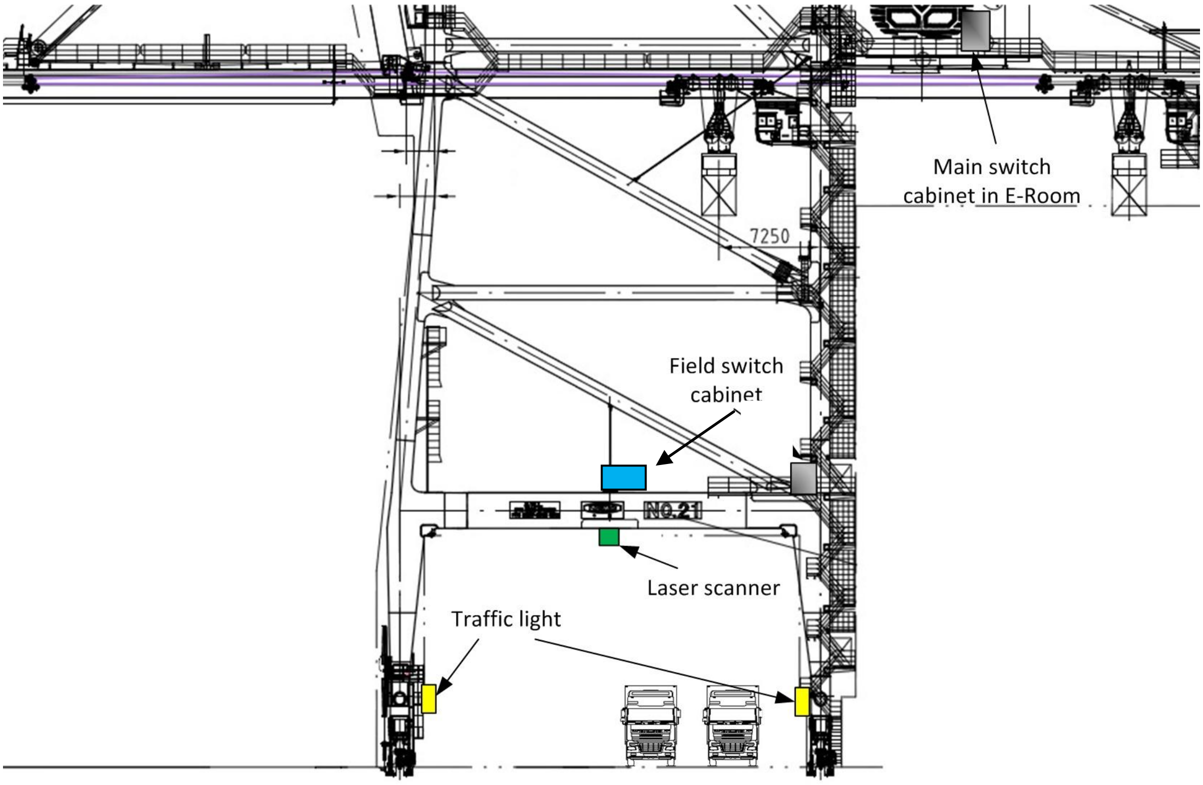



**Figure 7: Installation positions (front view)[1]**

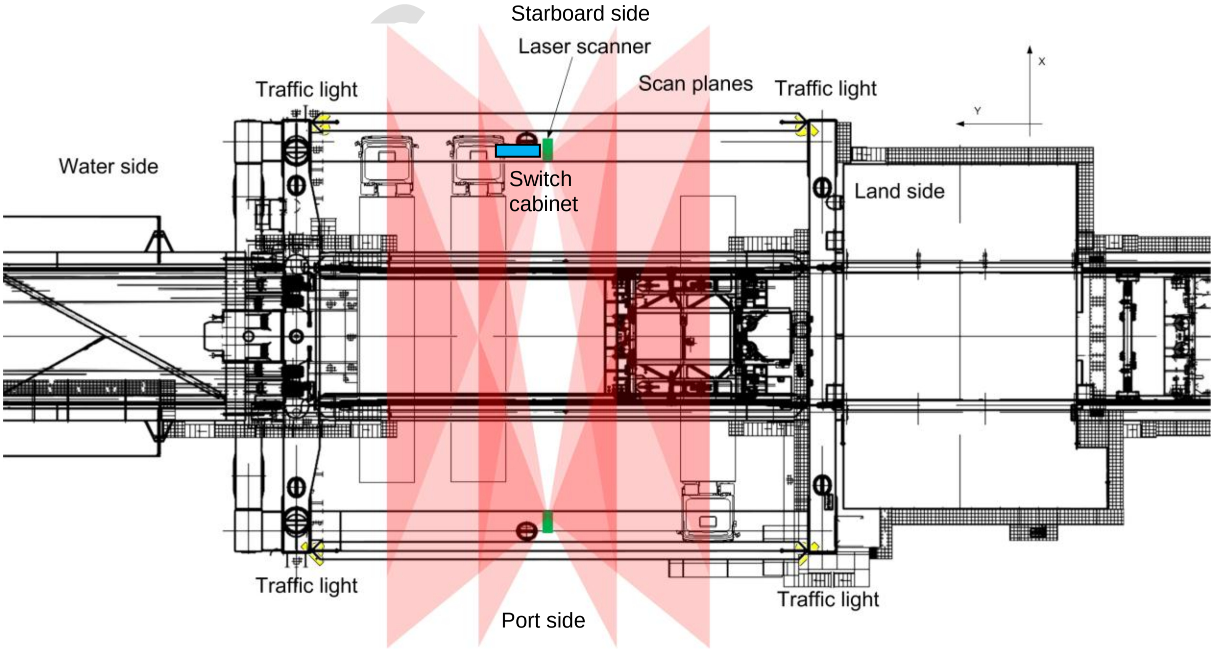



**Figure 8: Installation positions (top view)**

The two laser scanners will be installed under the portal cross girder. The cranes are working on 4 lanes. To allow the LASE system to cover all 4 lanes with both scanner systems the scanners have to be mounted upright above the Y-center of the 4 lanes (between lane 2 and lane 3).

In this project 4 traffic lights are installed at each vertical leg. This configuration ensures that the truck driver is able to see the traffic light from his cabinet all the time.

The field switch cabinet is installed on the top of the portal cross girder Starboard close to the laser scanners.

The main switch cabinet including IPC/LCU is placed in E-Room. The communication between both cabinets is realized via fibre optics.

# 5 System software

The system software consist of the following modules

- LASE CEWS Basic – Application Framework
- LASE CEWS Application Core – Truck position crane

The LASE CEWS Basic - Application Framework is responsible for the communication with the laser scanner and the PLC. It also provides a 2D- and 3D-Visualisaton and the 3D-processing with the transformation of the 3D- laser scanner data regarding the position information provided by the PLC (instruction set). The 3D-function is an option and not used in this project.

**The LASE CEWS Application Core – Truck position crane is the individual software with the project specific programming.**

The software of the measurement system is been developed and tested in C++ with help of the development environment Visual Studio 2008 for WIN XP/WIN 7.

## 5.1 LASE CEWS Basic

The LASE CEWS Basic Module is the Frame Software for the LASE CEWS Application core and consists of following modules:

- Communication module Laser
  Parameterization and data handling for following laser types (LMS, LD OEM, LRS, HD P, ODS, O2DS etc.). Following interfaces are – depending on the laser types – adaptable: Ethernet TCP/IP, Profibus, RS 422, RS 232, analogue.
- Communication module Input/Output
  Parameterization and data handling for following input- output modules PLC, Level 2 and Level 3 (more on request) following interfaces are supported – Ethernet TCP/IP, RS 422, RS 232, (Profibus, analogue)
- Communication LASE CEWS
  Application core
  Measurement data editing and transfer to the application core
- Data recorder feature: All measuring data and process data are logged continuously and completely. For analysis and simulation purposes the data can be written back to the application.
- Graphical user menu display for the safe und intuitive handling of the measurement system, inclusive status messages, result displays, controlling
- 2D- and 3D visualization
  for the visualization and evaluation of the measuring data. Scan pictures in 2D and 3D- displays, zoom function, free selectable outlook.
- Application parameters
  Dialogue based input of the process parameters for hardware and software
- Error and event reports
  Report and display of errors and events for quick diagnostics purposes

## 5.2 LASE CEWS application core – truck position crane

LASE CEWS application core is one of the most important parts of system. This part of the software collects the scan data, performs all necessary internal transformations and all calculations. The software includes filter and validation algorithms to ensure reliable measurement results as well as the needed telegram messages for the communication with the crane PLC

## 5.3 Software GUI

Several views for showing measuring data are available for the user as well as dialog boxes for configuration and determination of parameter.

### 5.3.1 Main displays

In the main displays the measuring data are visually and graphically displayed. Errors and events can be displayed additionally.

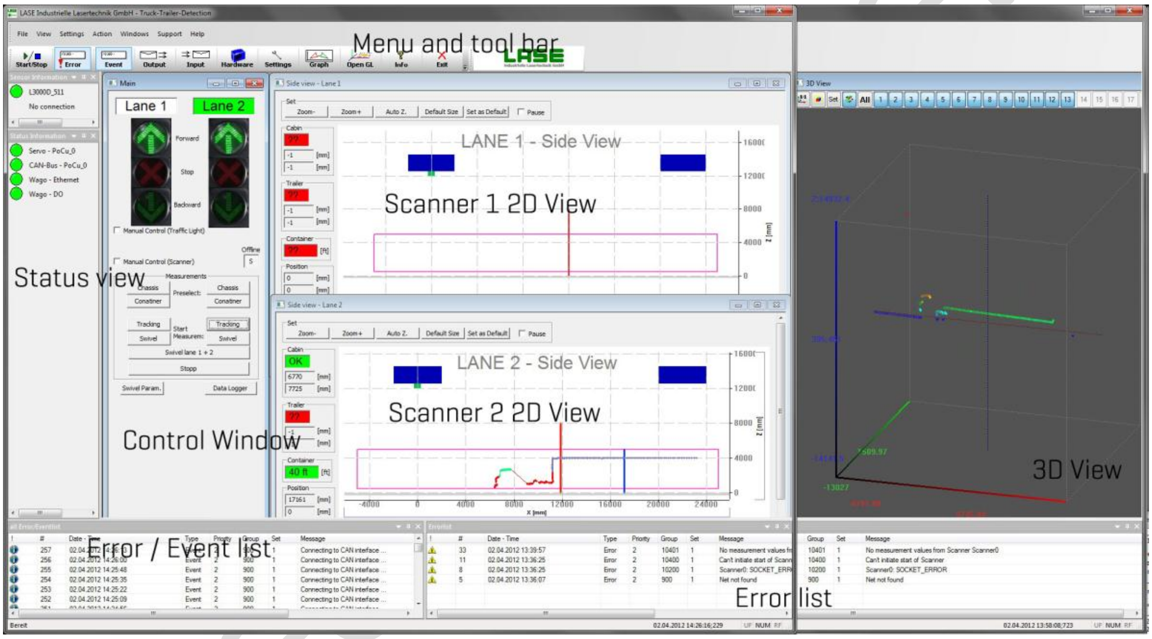



**Figure 9: LaseTPC software**

### 5.3.2 Status view

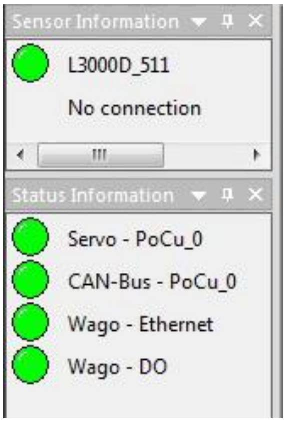



**Figure 10: State view**

In this view all status of the connected hardware are displayed. The status LEDs turn green if the appropriate function runs successfully.

- **Sensor Information**: indicates if the 2D laser scanner operates or which error occurred.
- **Status Information:**
  - **Servo** indicates the status of Servo motor from the LASE 3000D
  - **CAN-Bus** indicates the status of CAN bus communication
  - **Wago – Ethernet** indicates the status Ethernet communication between the Wago module and LASE Software
  - **Wago – DO** indicates the status of Wago digital outputs.

### 5.3.3 Main window

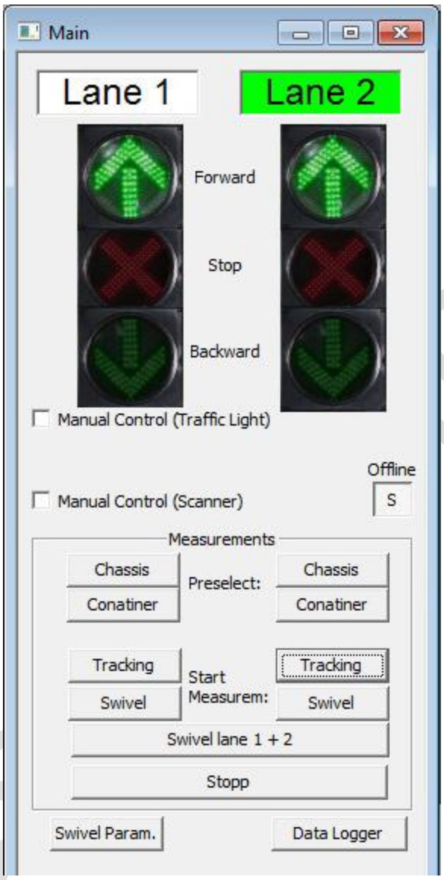



**Figure 11: Main window**

This window shows which lane is active and it shows the current status of the traffic lights. The view also provides the possibility to manual control the traffic lights and the LASE 3000D laser scanner. This function can be used during commissioning or maintenance.

### 5.3.4 Scan profile 2D view

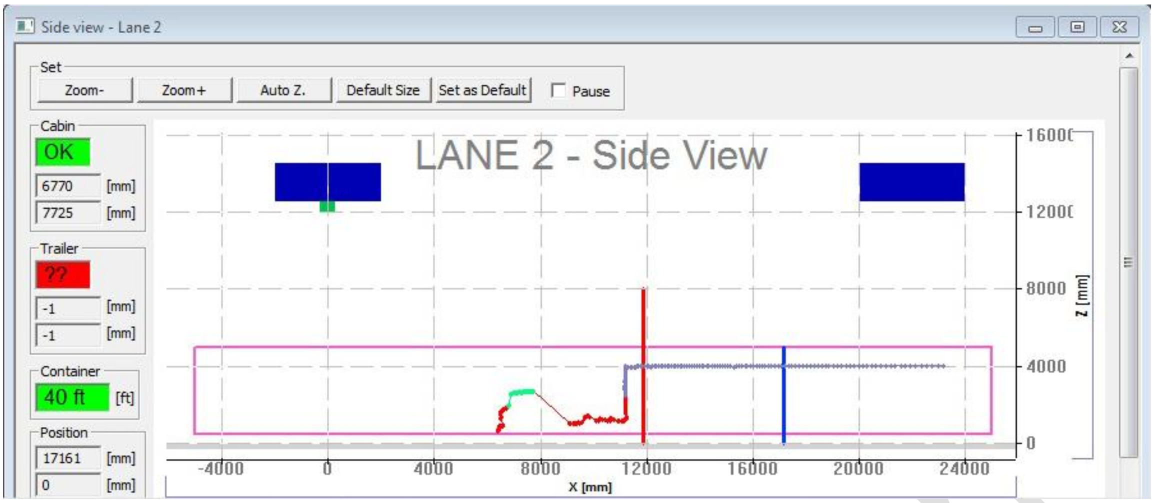



**Figure 12: Scan profile 2D view**

On this view, you can see all import information about the LaseTPC algorithm and get a little feeling about how it works.

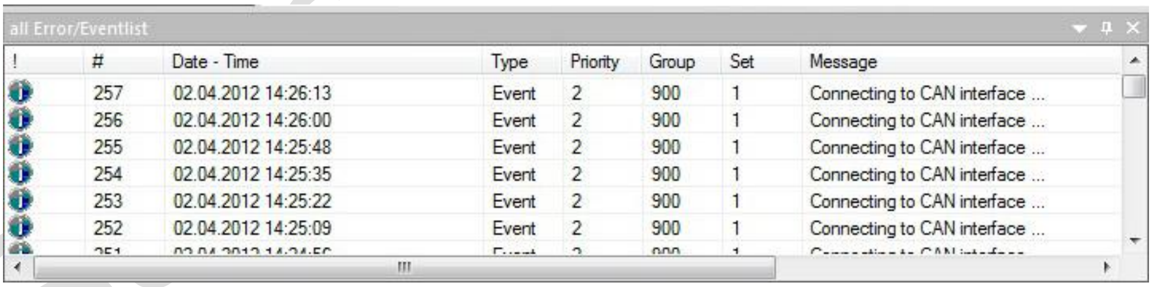
As shown in figure 15, a truck with 40 feet container is approaching from the right. The pink rectangle represents the Area of interest. Only scan data inside this rectangle will be used by the calculation algorithms. The picture above shows a profile of a loaded truck. The small green line on the left represents the roof of the truck cabin. The violet line on the right represents a 40' container on the trailer.

The red vertical line indicates the target position (nominal position) for the STS Crane. The blue vertical line indicates the current center position of the container. When both lines are matching the truck has to stop. The distance between this both lines is used to control the traffic lights.

The system now gives the truck driver a visual signal, and the goal is to guide him stop at the target position, which means the red line and blue line fit each other exactly.

The fields on the left hand side are providing some more information like position of cabin and trailer, container length etc.

### 5.3.5 Error / Event list




| ! | # | Date - Time | Type | Priority | Group | Set | Message |
|---|---|---|---|---|---|---|---|
| | 257 | 02.04.2012 14:26:13 | Event | 2 | 900 | 1 | Connecting to CAN interface ... |
| | 256 | 02.04.2012 14:26:00 | Event | 2 | 900 | 1 | Connecting to CAN interface ... |
| | 255 | 02.04.2012 14:25:48 | Event | 2 | 900 | 1 | Connecting to CAN interface ... |
| | 254 | 02.04.2012 14:25:35 | Event | 2 | 900 | 1 | Connecting to CAN interface ... |
| | 253 | 02.04.2012 14:25:22 | Event | 2 | 900 | 1 | Connecting to CAN interface ... |
| | 252 | 02.04.2012 14:25:09 | Event | 2 | 900 | 1 | Connecting to CAN interface ... |

**Figure 13: Error / Event list**

In the Error / Event list all events and errors are listed. The latest entry is on first position of the table.
The table contains following columns:

- **Time**: In this column date and time of the event is shown.
- **Incoming/Outgoing: Events** and -> **ERRORs** are marked. Outgoing of an errors is acknowledged with -> **OK**.
- **Group:** This number only serves for recognizability of events that belong together and has no further relevance for control of events.
- **Message:** In this column the event is described.

### 5.3.6 Error list

Errorlist

| ! | # | Date - Time | Type | Priority | Group | Set | Message |
|---|---|---|---|---|---|---|---|
| ⚠ | 33 | 02.04.2012 13:39:57 | Error | 2 | 10401 | 1 | No measurement values fr |
| ⚠ | 11 | 02.04.2012 13:36:25 | Error | 2 | 10400 | 1 | Can't initiate start of Scann |
| ⚠ | 8 | 02.04.2012 13:36:25 | Error | 2 | 10200 | 1 | Scanner0: SOCKET_ERR |
| ⚠ | 5 | 02.04.2012 13:36:07 | Error | 2 | 900 | 1 | Net not found |

**Figure 14: Error list**

In the error list only the currently present errors are listed. After outgoing of an error this one is deleted from the list (for description of columns see above: 7.3.5 Event list; the column Incoming/Outgoing is not necessary here).

### 5.3.7 Scan profile 3D view (option)

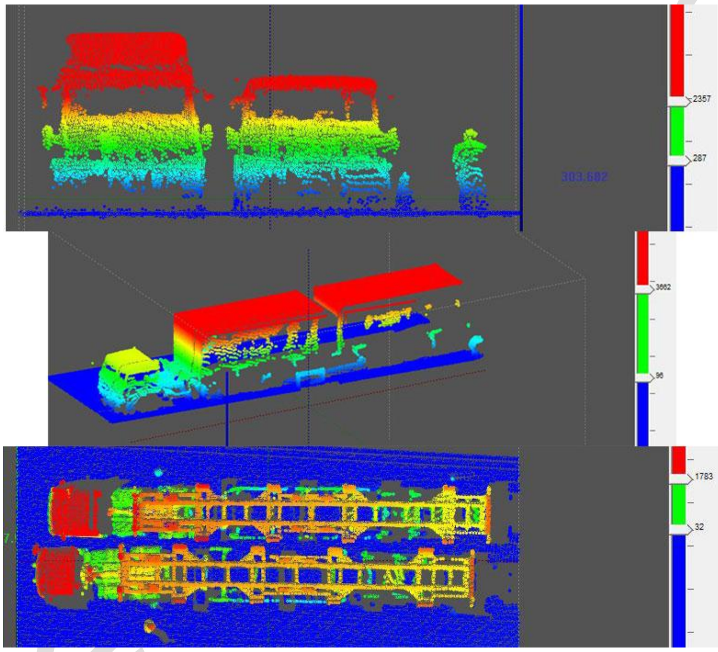


**Figure 15: Scan profile 3D view**

INFO

Optionally a 3D-view can be provided. The view can present a 3D-image of the 3D laser scanner measurement data. This optional function of the LaseTPC system can be a big advantage for further application such like container / trailer positioning for the automatic loading / unloading process.