DYNAMIC POSITIONING CONFERENCE
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WORK BOATS

Lasers: Position Reference Sensors for DP

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Lasers:
Position Reference Sensors for DP

The workboat is the backbone of the oil services industry in the Gulf of Mexico. Oil rigs and vessels depend on workboats to supply them with personnel, supplies and needed equipment so that they can do the jobs they are intended to do.

Approaching and positioning near rigs or vessels is a critical operation workboats perform 24 hours a day in all sea conditions. Various tools are available for the boats to use enabling them to on-load and offload in the safest and most efficient way possible. Today, workboats fitted with dynamic positioning systems have an array of sensor inputs available for them to choose from including DGPS, acoustics, Artemis, taut wire, wind sensors, microwave systems, gyros and laser systems.

Laser systems have been used for positioning since the mid 70's in one form or another and scanning laser systems have been used in marine applications since around 1988. Originally these scanning laser systems were developed to track gun arrays towed behind seismic vessels. These lasers swept back and forth in fixed sector scans and recorded range and bearing information that was incorporated with the information acquired from the seismic guns.

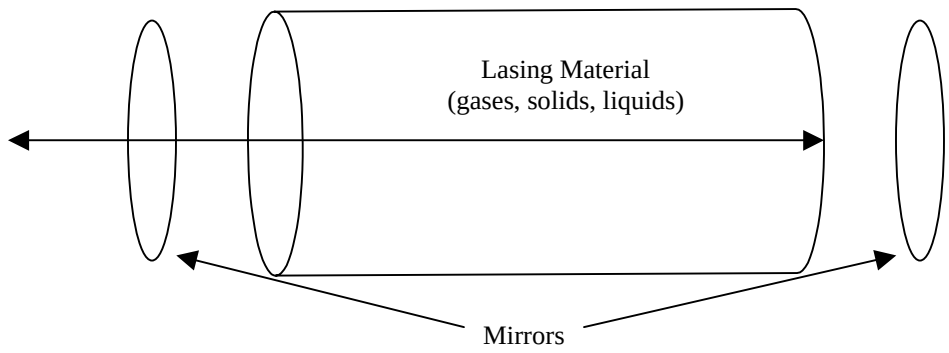
The introduction of scanning lasers allowed for vessel movement in the water by incorporating a vertical fan shaped laser beam which kept the target in sight better than single point laser beams could. This beam design made returns from the targets viable in adverse weather conditions and let the unit operate without the need for personnel to point and fire the laser to obtain returns. The result was a laser that could provide repeatable, high accuracy positioning information from multiple targets.

Further software development allowed the laser to go a step further. Autotracking of a single target or multiple targets has made the laser a viable tool for dynamic positioning, collision avoidance, docking control and other marine positioning applications.

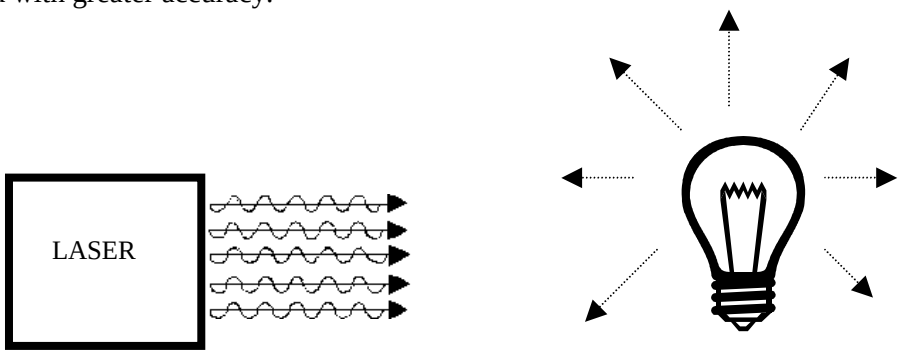
What is a laser?

- The word LASER is an acronym that stands for Light Amplification by Stimulated Emission of Radiation.
- A laser is an optical device with mirrors at the ends which is filled with a material such as gas, liquid, crystals, dye or glass
- Lasers produce a beam of light with unique properties of coherence (electromagnetic waves which are in phase in both space and time), collimation and monochromaticity

Laser Design



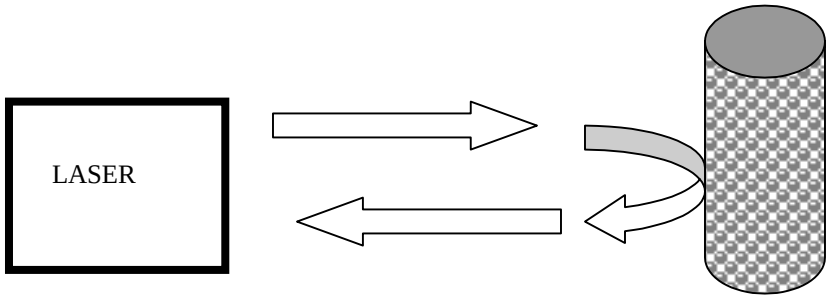
Light from incoherent sources (such as a light bulb) are composed of many different wavelengths traveling in all directions causing the light to spread as it travels so it cannot be focused with precision. Light waves from a laser are in phase with each other. This enables the light from the laser to travel for long distances with little diffusion. This unique coherence property allows the light to be concentrated so it can be focused with greater accuracy.



Coherent light versus incoherent light

How Lasers Measure Range

The coherent beams from the laser travel at the speed of light (186,300 miles/sec). Distance (range) is calculated by measuring the time it takes the beam of light to be sent from the laser, arrive at the target and reflect back to the laser.



Measurement of range to a target

There are four safety classifications for lasers:

- Class 1- Considered harmless when laser used in intended manner.
- Class 2- Low powered laser only hazardous if the beam is intentionally stared into
- Class 3a- Medium powered laser which can be an eye hazard if the light is collected and focused into the eye
- Class 3b- Medium powered laser which can be an eye hazard if the beam is viewed directly
- Class 4- High powered laser that can be an eye hazard not only in viewing the beam but also from diffused light from the laser. Considered hazardous to eyes, skin and can be a fire hazard

All lasers used for dynamic positioning applications are semiconductor diode lasers and are considered eye safe.

Common uses of lasers include:

- Missile guidance
- Surgical Procedures including birthmark, wrinkle and tattoo removal, destroying kidney stones and alleviating snoring
- Bar Code Readers
- Silicon wafer manufacturing
- Laser printers
- Laser speed guns
- Transmission of huge amounts of information through fiber optic bundles that enable telephone and internet transmission
- Laser light shows, CD players, laser pointers for sale presentations
- Accurate vessel and target positioning in marine applications

Lasers in the Marine Industry

Lasers have been used in the marine environment for many years. As discussed earlier, they are commonly used in seismic gun array tracking, FSPO operations, docking control and dynamic positioning applications.

Laser Use for Dynamic Positioning

In the oil industry safety is paramount. Workboats and supply vessels offload and on-load 24 hours a day in close proximity to other vessels and offshore structures. The DP vessel needs constant, reliable position information in order to make decisions to ensure the vessel is positioned safely during these operations. Lasers can be an effective solution for positioning vessels by providing a tool which can deliver a constant stream of high accuracy, almost real time range and bearing information that the DP operator requires.

Why are Lasers Useful for Dynamic Positioning?

Lasers have the ability to operate with centimetric accuracy without returns being affected by the close proximity of tall structures such as platforms. Lasers function in most weather conditions and can operate 24 hours a day. All the equipment needed to operate a laser system is located on board the vessel and platform. Lasers can act as stand alone units to add an additional safety feature or quality control check or they can be interfaced with any DP console system. Only inexpensive, passive targets are required eliminating the need for electricity at the site to be tracked. These prisms or tube targets are inexpensive and can be permanently mounted thus saving set up time in future DP operations. Laser systems are very simple to set up and can be operated by vessel personnel with a minimum amount of training. They are also eye safe and pose no threat to personnel on the vessel or the sites that are being tracked.

Areas Where Lasers are Effective

From port to platform, most vessels take advantage of DGPS information to reach their desired location. Once the vessel is within sight of the platform, the laser system can locate the desired target and start to obtain range and bearing information. Typical range for a laser system is 5 meters to 2000 meters maximum from the target to be tracked.

A Laser System Typically Consists of:

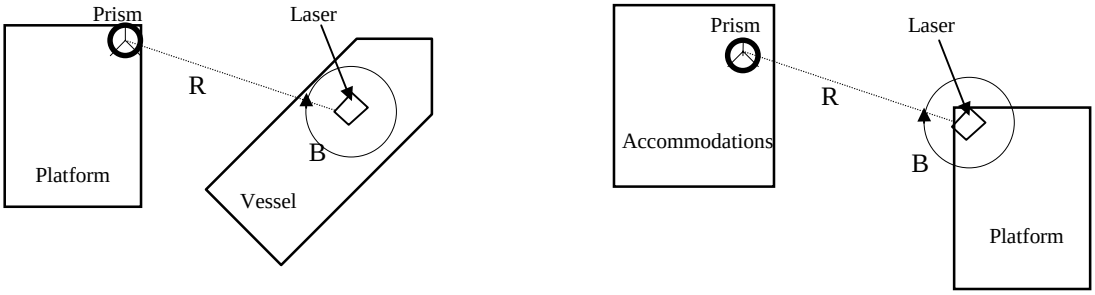
- The laser module
- A power source
- A control unit with software
- Cabling
- Targets to range to

In most instances the only items located on the site to be tracked are passive targets such as retro prisms or tubes covered with reflective tape. All the other system parts are located on board the vessel which simplifies installation, operation and troubleshooting.

Installation

The laser unit is permanently mounted on the vessel in the area where it can best view its intended target. Lasers are visual instruments so they must be able to see the target that the operator wants to obtain range and bearing information from. The unit should be able to rotate 360° unobstructed. Depending on the vessel size, the laser can be installed on a helideck, mast, rail, wheelhouse or other location where the conditions offer the best view of the target. This site should be in an area free of high vibration, smoke, structures that may obscure views and the unit should be mounted where personnel are not in line of sight of the unit. Targets are mounted on the structure or vessel to be tracked preferably in an area that is unobstructed and easy for the laser to see. In order for the laser to give viable readings, one end of the system must be stationary as would be the case with a vessel positioning to a platform.

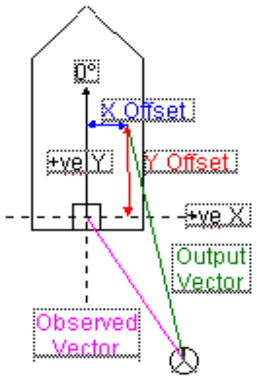
Where Lasers can be Installed



Whether the laser is located on the vessel or on the platform, the laser system operates in the same manner. In dynamic positioning, the laser is located on the vessel in most instances but it can be located on board platforms to track other closely situated structures such as accommodation modules.

Laser Referencing

The bearing of the target is usually referenced to the centerline of the ship but other structures on the vessel can be entered as this reference point, such as a GPS antenna. The displayed ranges and bearings are still relative to the laser, but the adjusted range and bearings are used in the data output. Assuming that the laser is mounted so that it's 0º points to the bow of the vessel, the following schematic applies:



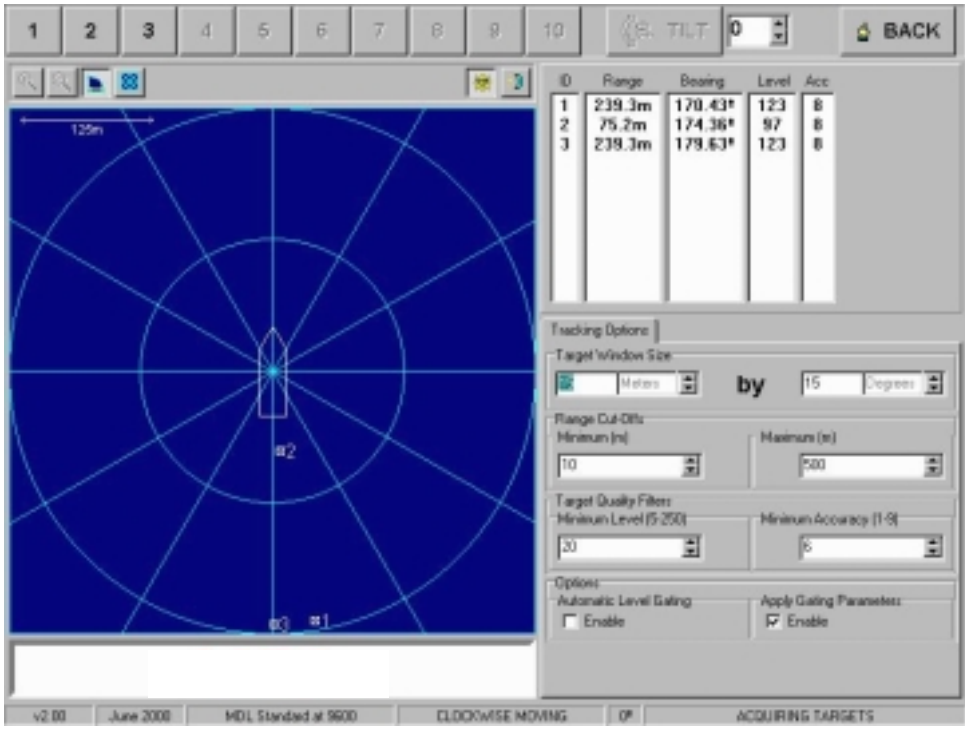
System Operation

Lasers can be operated as stand-alone units or as primary or secondary sensors for DP consoles. If acting as a stand-alone unit, the operator can enter various parameters into the software that allow for target level, range or angles to be gated to exclude returns from unwanted targets. Alarms can also be incorporated which sound if the parameters chosen by the operator are exceeded. If acting as a sensor for a DP console, the unit relays range and bearing information to the console and all other functions are controlled through the DP system.

Lasers provide a short range, local reference system that relies on intrinsically safe, passive targets (set up on the platform) that the vessel positions itself from. The laser acquires targets by performing a 360° initial sweep and displaying all targets found during this sweep on a display.

The DP operator then chooses a target to "auto track" from the displayed targets and the laser will spin around, acquire the chosen target and "lock on" to it. In auto track mode, the selected target is followed by the laser, regardless of vessel movement and the range and bearing information is recorded approximately once per second. The laser can track the target in the full range of 360° as long as nothing obstructs its view. If the target is lost, the system will try to reacquire it and if this is not possible, visual or audio alarms alert the operator so the lost target can be relocated or a more suitable target can be chosen to track. Multiple targets should be located on the structure to be tracked to ensure flexibility in target choice. When the sun is low on the horizon or situated behind a particular target being tracked, the sun may interfere with the lasers ability to give valid returns. If the structure has targets in several key locations, the laser can be redirected to track one of the other targets that is not in the direct path of the sun. This allows for continuous, reliable range and bearing positions throughout the DP process. The laser continues to track until it is told by the operator to stop operation. Alternately, the operator could also instruct the laser to continuously scan the full 360° arc and return data from all targets seen although this may be not be the best tracking option for dynamic positioning applications.

This diagram shows a typical target acquisition. From this screen the operator can choose the target desired by pressing the corresponding numeric key or choose to continue to scan all the targets by selecting a 360° sweep.



Factors Which Affect Signal Returns

There are several factors that can affect the lasers ability to give valid, repeatable returns. If the distance from the laser to the chosen target exceeds the overall ranging ability of the laser, the unit will not be able to lock on the target or, in some cases, even acquire it. Lasers are optical instruments so heavy rain, snow or fog may impair returns received from the laser since the unit may not be able to see its target. The actual quality of the target being used, the movement of the target or the vessel in the water can impair signal returns during rough sea conditions. The Sun, during sunrise or sunset, may be behind the chosen target and cause the laser to loose lock. As discussed, switching to another target, away from the direct sunlight will solve the problem of impaired return.

Gating the Targets

Various parameters can be chosen through the software which allow targets that are closely situated to the desired target to be gated out and ignored by the laser. These gates allow for vessel movement and can be instructed to gate using range, angle or the signal level from the target as determining factors.

Laser Pluses and Minuses

- Lasers can be effected by fog, snow or heavy rain
- Targets can be affected by sunlight when in line with an intended target
- Lasers are limited by range-they have to see the target to give a return.
- Lasers used in positioning and survey are eye safe
- Reflections off the water are ignored
- 24 hour a day operation
- Structure height does not hinder the ability to receive centimetric positioning data
- Work to passive targets such as prisms or reflective tape
- Easy to operate, don't require excessive set up or training
- Low maintenance systems
- Data is almost real time and the system is local

Conclusion

The ability to provide a constant stream of accurate range and bearing information (particularly in close-to situations) and the ability to be used in conjunction with DP consoles or as stand alone units, make lasers a valuable tool that can be tailored to individual vessel requirements. Laser technology has proven its ability in the field as a highly reliable, low maintenance position reference system and should be considered as a viable solution for many different dynamic positioning applications.