# “Compact“ Laser Beam Stabilization
# Optional functions and components

## 1. Introduction

In this overview, we present the optional functions and components of the *Compact* laser beam stabilization system so that you can decide whether they are of interest for your application.

To stabilize a laser in its position and direction against fast fluctuations and slow drifts, the laser beam stabilization consists of the controller, two position detectors and two piezo-driven mirror mounts. The standard system uses the controller with no other options, *Si-4QD* position detectors for visible light and the *P2S30* mirror mounts. Beyond this standard, the following overview shows various optional functions and components, each with a keyword. Most customers choose the "high-end" *P4S30* piezo mirror mounts and a controller with USB interface with associated software.

### Standard system


Detector Si-4QD

Controller

Mirror mount P2S30

### Options

- **WID** – wide intensity
  dynamic power factor >1000
- **PSD**
  free target position
- **UV**
  190 nm – 1000 nm
- **IR**
  800 nm – 3000 µm
- **Software interface**
  USB/RS232/Ethernet
- **Sample&Hold**
  bridge laser off times
- **Adjust-in**
  move your target
- **Set&Hold**
  hold the current position
- **P4S30**
  “gold standard“
- **Different mirrors**
  0.5 – 4 inch
- **Clean room**
  avoid contaminations
- **Vacuum models**
  down to $10^{-11}$ mbar

You can find further options and detailed information under “System descriptions” on our website, the respective data sheets and the user manual.

## 2. Serial interface (USB, RS-232 or Ethernet) with software

The *Compact* system can be equipped with a serial or TCP/IP interface. The optional interface allows to read out, visualize and save signals. In addition, it can also be used to make some settings. For connection to a single computer, we recommend the USB or RS-232 interface. If you want to integrate the system into a network, you can choose the Ethernet port.

With the interface you will also receive our communication and visualization software. For integration into your own programs, you can find the communication protocol for download on our website.

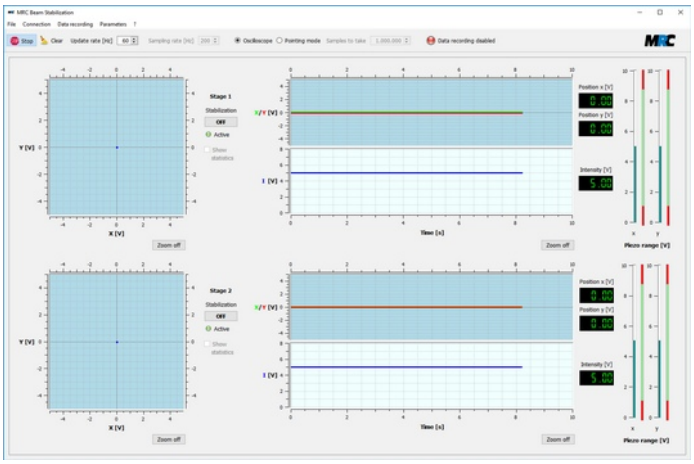

*Figure 1: Main window of the communication and visualization software*

### Main functions of the software

- Read-out of positions, intensities and piezo voltages
- Conversion of signal voltages into position values in µm/mm
- External activation: switching on/off of the two control stages
- *Set&Hold* function of the current positions. Here, a position currently measured on the detectors is stored and used as the target position for further stabilization. This function is used in particular in combination with the *PSD* detectors.
- Setting and reading parameters such as the P-factor for adjusting the control bandwidth, the offsets for *Adjust-in* target positions, etc.
- Parameterization of the data streams
- Reading out the status

For some of the mentioned functions special hardware options are required.

The system works as a standalone device even without the interface. It does not require any programming or parameter settings for operation, which makes the setup quick and easy.

## 3. Sample&Hold circuit (”*ADDA*“)

With the *Sample&Hold* circuit, the piezo actuated mirrors remain in their last stabilized position during periods without laser power. For this purpose, the system stores the controlled positions and holds them as long as no new position signals are sent from the detectors. As soon as the laser hits the detectors again, the closed-loop controller continues to stabilize in real time. This ensures the stability of the beam even for lasers with low repetition rates or laser on/off times. This optional function is helpful for various applications, e.g.:

a) in systems where the laser has to be turned on and off during a process, e.g. in processing machines,
b) for lasers with low repetition rates (<1 kHz) or with irregular pulses or pulse trains,
c) in setups with a very large distance between the actuated mirror and the detectors. In these cases, after temporarily switching off the laser, drifts may affect the alignment to such an extent that the laser beam no longer hits the detector in the uncontrolled state.

Depending on the laser parameters, the *Sample&Hold* circuit can be operated in two ways. Firstly, through automatic control, in which the system itself responds to the laser's on and off cycles. Secondly, it can be controlled by external triggering, using signals to operate the system synchronously with the laser pulses.

For more information see our description “Sample&Hold circuit (“*ADDA*”)”.

## 4. Moving the target position on PSDs (”*Adjust-in*“)

The measuring principle of a *PSD* allows to move the target position on the detector by a voltage offset. For this purpose, we offer the optional *Adjust-in* function. The desired target position can be set via the serial interface or software (see section 2). With the *Set&Hold* function in the software, it is also possible to set the current beam position on the detector as the target position. *Adjust-in* thus enables electronic fine adjustment of the stabilized target position. This can be helpful, for example, in cases where the components are not accessible for manual adjustment or the target position has to be varied.

As an alternative to control the function via the serial interface, the target positions can also be adjusted via analog voltages between -5V and +5V. For this purpose, the controller can additionally be equipped with analog inputs for the x and y positions (option "Supplement for *Adjust-in*").

For more information see our description “PSD detectors and the Adjust-in function”.

## 5. Piezo mirror mounts

We offer various models of highly dynamic mirror mounts. They cover the entire tilting range via piezos. The following table shows the main features of the *P2S30* and *P4S30* models. In addition to these, we also offer 4'' mirror mounts that can be controlled with the *Compact* system. The two older models *PKS* and *PSH* are also still available on request.

| | P2S30 (standard) | P4S30 |
|---|---|---|
| Highlights | Large tilting range<br>High bandwidth<br>Transmission possible | Very large tilting range<br>Highest bandwidth |
| Mirror diameter | 1‘‘ | 1‘‘ to 3‘‘ |
| Piezo tilting range | 2 mrad mechanical<br>4 mrad optical | 4 mrad mechanical<br>8 mrad optical |
| Manual tilting range | ±4.5° | ±4.5° |
| |  |  |

## 6. Detectors

For most applications, the *Si-4QDs* of the standard system are best. Due to the measuring principle of quadrants, they achieve an extremely high positional accuracy in the sub-micrometer range. They cover a wavelength range of 320-1100 nm. For special applications and other wavelengths we offer further detectors.

### 6.1. ”Wide-Intensity“ 4QD (*WID*)

The special characteristic of this 4-quadrant detector is that it covers a very large dynamic range of laser power/intensity over a factor >1000. This means that the laser intensity can be varied or modulated over three decades without changing the gain or replacing filters. For this purpose, the *WID* detector uses a special logarithmic amplifier that provides a constant signal-to-noise ratio over the entire intensity range. Thus, it can be used wherever laser powers are strongly varied. These are, for example, applications in laser machines with high-power lasers that are prealigned with low power, or applications in spectroscopy with varying wavelengths and powers.


*Figure 2: Detector with LEDs for position and intensity and connectors*

| | WID | UV-WID |
|---|---|---|
| Wavelengths | 320-1100 nm | 190-1000 nm |
| Sensor area | 10x10 $mm^2$ | 3x3 $mm^2$ |

## 6.2. UV and-IR detectors

| | UV-4QD 3x3 | IR 4QD (InGaAs) | IR 4QD (Ge) |
|---|---|---|---|
| Wavelengths | 190-1000 nm | 900-1700 nm | 800-2000 nm |
| Sensor area | 3x3 $mm^2$ | Ø = 3 mm | 5x5 $mm^2$ |

## 6.3. PSD

In contrast to the 4QDs, the *PSD* has a continuous sensor area. While the laser beam stabilization system with 4QDs always stabilizes the laser onto the center of the sensor, it is possible with a *PSD* to select the target position anywhere on the sensor area.

| | PSD |
|---|---|
| Wavelengths | 320-1100 nm |
| Sensor area | 9x9 $mm^2$ |

Note: For setting the target position, the "*Adjust-in*" option is used (see section 4).

# 7. Further options and adaptions

## 7.1. Direct control of the piezo actuators (”*Drive Actuator*“)

Direct control of the piezo actuators (i.e. without feedback from the detectors) is possible via the serial interface. However, this function can only be controlled via commands, not via the software. As an option we can add additional inputs to the controller. This makes it possible to control the actuators directly via external voltage signals.

## 7.2. External activation

If you do not want to use the serial interface to switch on and off the control stages, we can install analog inputs for TTL signals. In both cases, the two control stages can be switched separately.

## 7.3. Vacuum and clean room adaptions

Both, the detectors and the piezo actuators can be adapted for use in vacuum or in clean rooms. Please also refer to our description of vacuum and clean room solutions or contact us.

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Subject to change.