# Comparison of SHSInspect RL MODULE and SHSInspect RL GAUGE

## 1 Introduction

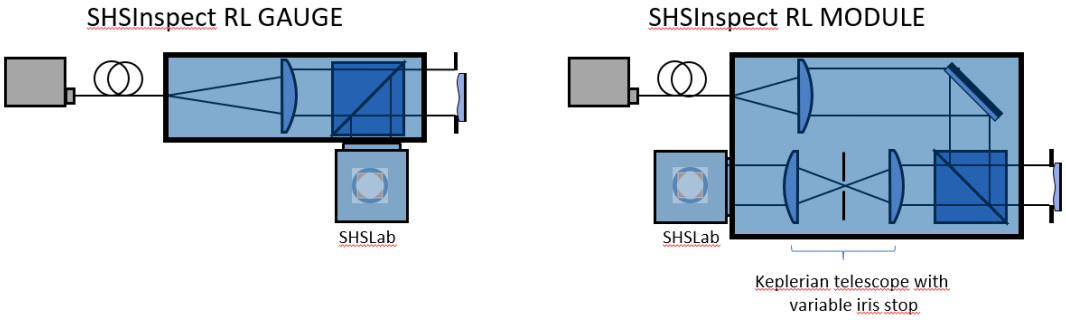
This Application Note compares the measurement capabilities of the SHSInspect RL MODULE and SHSInspect RL GAUGE. For the example of the measurement of the surface shape of plano mirrors, the difference between the two RL products is discussed.

## 2 Optical layout

The SHSInspect RL MODULE uses a Keplerian relay telescope to conjugate the planes between the SHSCam wavefront sensor and the measurement plane on the exit of the RL MODULE. The Keplerian telescope has a variable iris stop in its focus. This can efficiently be used to block ghost reflexes which come from optical surfaces in the measurement setup outside the SHSInspect RL MODULE.

The SHSInspect RL GAUGE applies a more compact setup without internal relay telescope. Thus, the RL GAUGE has no Keplerian telescope with internal iris stop for blocking ghost reflexes.

In this study, both systems use the same SHSLab HR3 wavefront sensor and the same light source with 530nm central wavelength, however, both can also be used with light sources with other wavelengths.



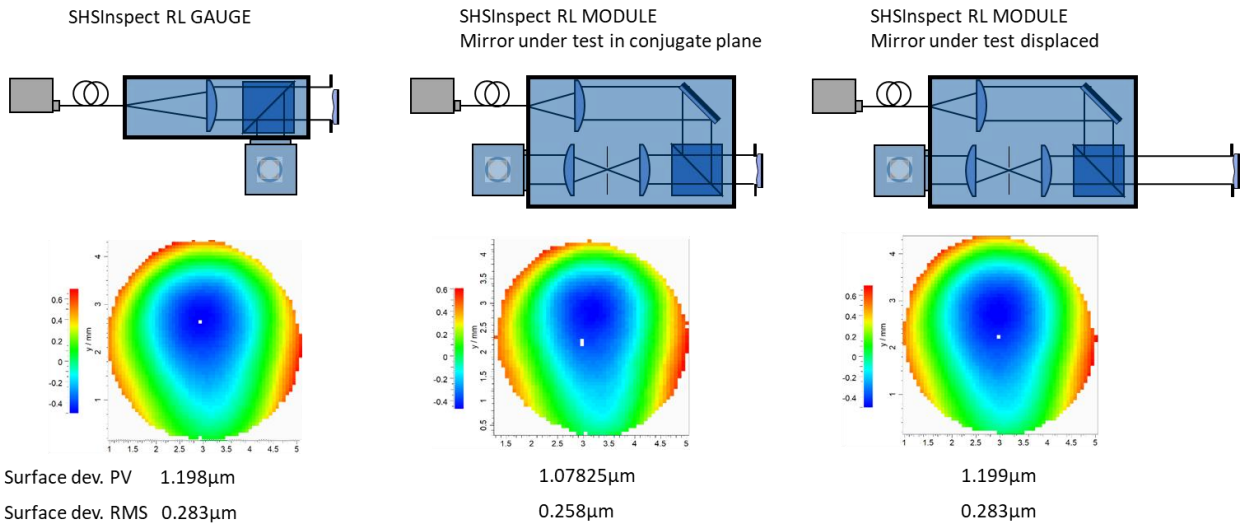

## 3 Measurement of surface shape

In this measurement example, we want to measure the surface shape of a plano mirror. The mirror is place at the conjugate plane of the SHSInspect RL MODULE, which is located 17mm from the module's front flange. An aperture with 4mm diameter is fixed directly on top of the mirror and the reflected wavefront is recorded. After that the mirror under test incl. aperture is attached to the SHSInspect RL GAUGE front flange and the reflected wavefront is recorded, too. The aperture ensures that both modules measure the mirror's surface shape aberrations on the same area of interest.

The measurement results show a clear difference in the PV- and RMS-values of the obtained surface shape deviation. The reason is wavefront propagation: in case of the SHSInspect RL GAUGE, the wavefront reflected at the mirror surface propagates by a distance of 105mm until it is measured by the SHSLab HR3 wavefront sensor. For the SHSInspect RL MODULE, the reflected wavefront does not suffer from a modification due to propagation because the mirror under test was placed at the conjugate plane of the Kepler telescope.

To confirm this explanation, the same mirror is placed at a distance of 105mm away from the SHSInspect RL MODULE measurement plane. That way, the reflected wavefont propagates the same distance from the mirror to the measurement plane as in case of the measurement done with the SHSInspect RL GAUGE (see schematic below). The results of these measurement agree well with the results obtained with the SHSInspect RL GAUGE, confirming the above explanation.

# Comparison of SHSInspect RL MODULE and SHSInspect RL GAUGE




## 4 Application-oriented comparison

The above results demonstrate the technical difference between the SHSInspect RL MODULE and the SHSInspect RL GAUGE. In case no external telescope is used with the SHSInspect RL GAUGE the loss of measurement accuracy resulting from propagation of the wavefront is clearly visible.

However, there are more technical topics how the SHSInspect RL MODULE and the SHSInspect RL GAUGE can be differentiated, the trade-off is very clear:

| | SHSInspect RL GAUGE | SHSInspect RL MODULE |
|---|---|---|
| Ghost reflex blocking | - | + |
| Measurement accuracy | - | + |
| Acceptance angle | + | - |
| Weight and dimension | + | - |

In summary, whenever an accurate absolute measurement is needed, the SHSInspect RL MODULE is often the better choice. Still, for certain applications also the SHSInspect RL GAUGE is well suited:

| | SHSInspect RL GAUGE | SHSInspect RL MODULE |
|---|---|---|
| Alignment of mirrors | + | + |
| Alignment of optical systems for minimal aberrations | + | + |
| Measurement relative to a Golden Master Sample | + | + |
| Quantitative measurement of wave aberrations of objective lenses | -* | + |
| Quantitative measurement of plano mirrors, windows and afocal optics | -* | + |
| Testing of micro-optics <1mm diameter | - | + |

* Only with suitable external imaging and ghost reflex blocking