Know the wavelength scale your interferometer is actually using

Continuous diode-laser monitoring with a Coher Sense KISA sensor in a dual-wavelength interferometer

A nominal laser wavelength is not a measurement.

In this 17.24 h test, a diode laser sold and operated as a nominal 640 nm source moved enough to change the calculated synthetic wavelength by more than 1.4 µm on the 1-minute trend. Continuous wavelength monitoring turns that hidden scale-factor change into a measured quantity.

Why dual-wavelength interferometry needs wavelength information

Dual-wavelength interferometry combines two optical wavelengths to create a much larger synthetic wavelength. This extends the non-ambiguity range and is attractive for dimensional metrology, surface and step-height measurements, precision positioning, and optical or semiconductor manufacturing.

The advantage comes from the small difference between the two laser wavelengths. The same small difference also makes the synthetic wavelength sensitive to drift of either source. A stabilized He-Ne laser can provide a robust reference, while a compact diode laser may still move with temperature, drive current, warm-up conditions or operating state.

Synthetic wavelength: $\Lambda = \lambda_1 \lambda_2 / |\lambda_1 - \lambda_2|$

For the present setup, the second source is a nominal 640 nm diode laser and the reference is a stabilized 632.816 nm He-Ne laser. Around this operating point, a 1 pm change of the diode wavelength changes the synthetic wavelength by approximately 8.3 nm.

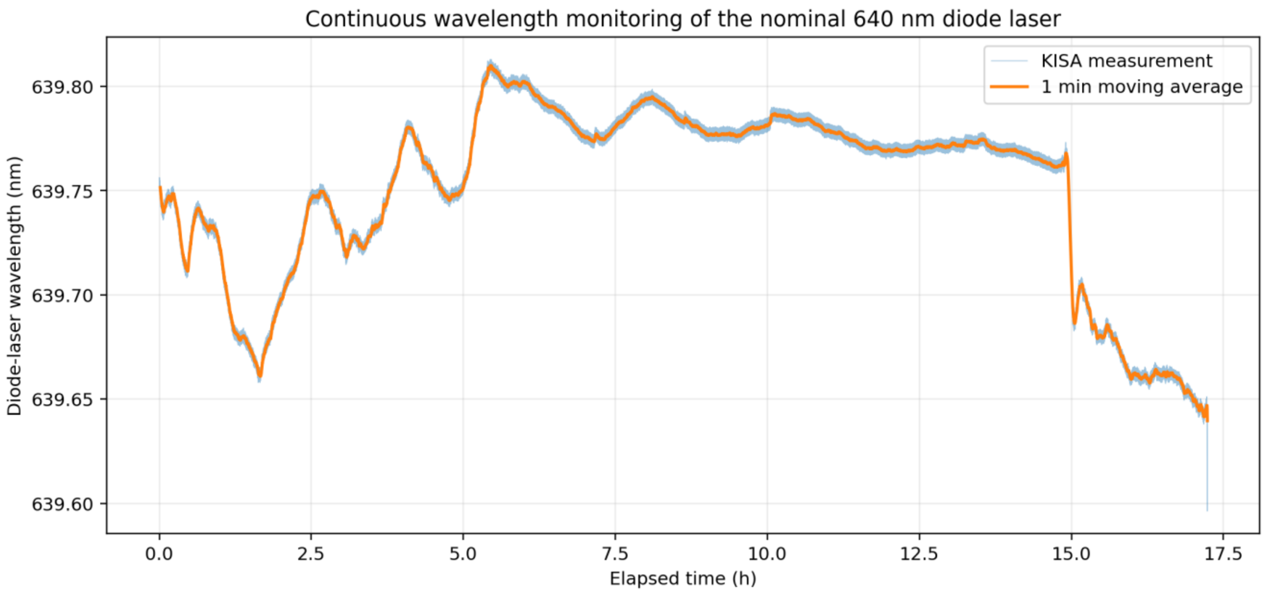

Figure 1. Continuous KISA measurement of the nominal 640 nm diode laser. The 1-minute moving average follows the raw data closely while revealing the long-term wavelength behaviour.

The consequence: the synthetic wavelength moves with the diode laser

The measurement contains 41,006 samples acquired over 17.24 hours at a typical interval of 1.51 s. The raw diode-laser wavelength spans 216.6 pm; the 1-minute averaged trend still covers 170.3 pm. This is not a small effect once the two wavelengths are combined.

170 pm	1.43 µm	1.6-3.4 µm
1 min averaged diode excursion	1 min averaged synthetic-wavelength span	difference vs nominal synthetic wavelength

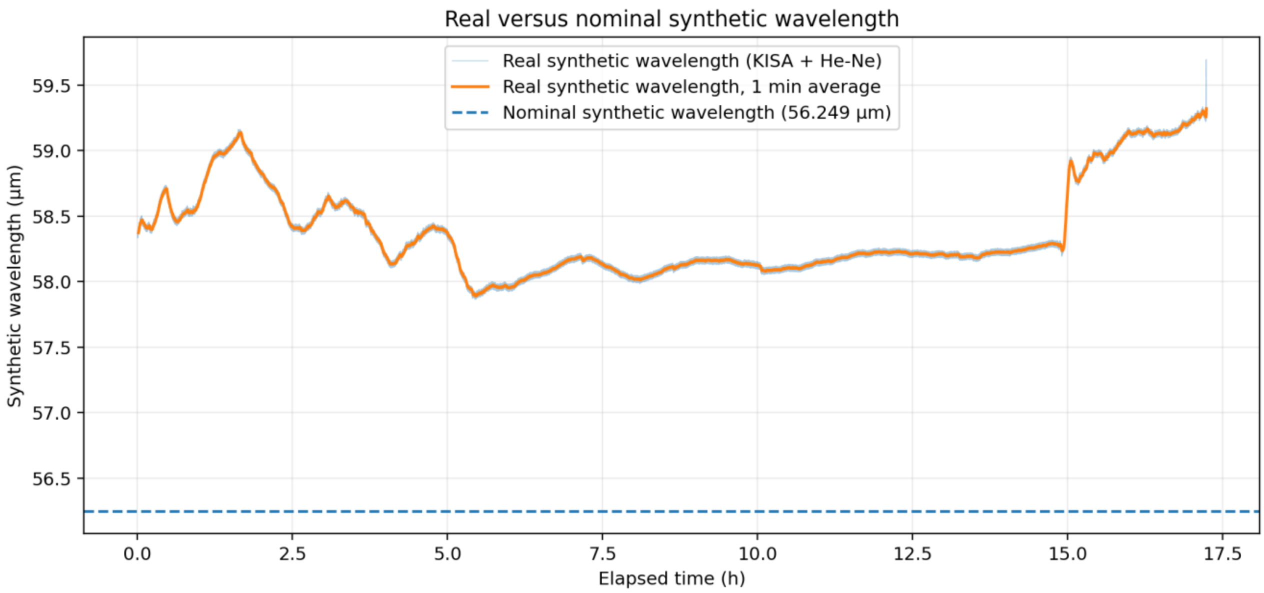

Figure 2. Synthetic wavelength calculated from the KISA-measured diode wavelength and the stabilized He-Ne reference compared with a nominal value calculated from 640.0 nm and 632.8 nm.

Nominal versus real: two different sources of error

If the interferometer assumes 640.0 nm for the diode laser and 632.8 nm for the He-Ne laser, the nominal synthetic wavelength is 56.249 µm. The measured system instead operates around 58.4 µm and changes over time.

This comparison exposes two distinct effects. First, the actual diode wavelength is not exactly its nominal 640.0 nm value, creating a static offset in the synthetic wavelength. Second, the diode continues to drift, creating a dynamic scale-factor change during operation.

In this dataset, the nominal assumption is 1.6-3.4 µm away from the calculated synthetic wavelength.

If the synthetic wavelength is used directly as the phase-to-distance scale, using the nominal value would correspond to an approximately 2.8-5.8% scale-factor difference over this measurement. The resulting dimensional error depends on the interferometer geometry and reconstruction, but the wavelength uncertainty itself is clearly large enough to matter.

The practical implication is straightforward: for precision work, “640 nm” should be treated as a nominal product description, not as a continuously valid metrology input. A wavelength monitor can provide the actual operating value instead.

KISA turns wavelength drift into a trackable system parameter

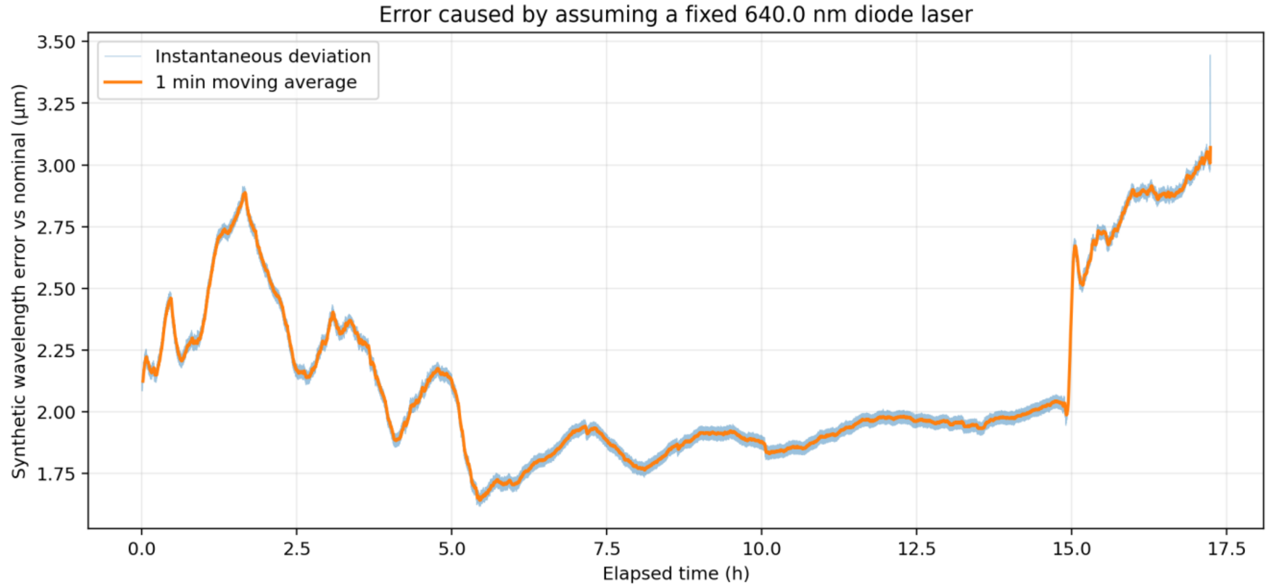

Figure 3. Deviation of the calculated synthetic wavelength from the nominal 56.249 µm value. The 1-minute trend makes the evolving scale-factor error visible without hiding the underlying measurement.

A Coher Sense KISA sensor in the ~1 GHz / 1 pm configuration complements the stabilized reference laser by monitoring the less stable source continuously. Once the operating point is referenced or calibrated as required by the application, the KISA data can be recorded alongside the interferometer signal or used to update the synthetic wavelength in software.

Where this helps

For the measurement system	Relevant applications
Track the actual diode wavelength instead of relying on its nominal label.	Optical surface and form metrology
Update the synthetic wavelength during long measurements or thermal changes.	Step-height and dimensional measurements
Separate laser-source drift from true motion or sample-related changes.	Wafer, substrate and mask inspection
Log the wavelength state for traceability and process diagnostics.	Precision positioning and stage metrology
Detect abrupt changes in the laser operating state before they become unexplained measurement shifts.	Integrated industrial and OEM interferometers

The value of monitoring

The purpose of KISA in this setup is not to replace the stabilized He-Ne reference. It is to make the second laser transparent to the metrology system. Instead of assuming that the diode wavelength is stable enough, the interferometer can know when it changes - and by how much.

KISA helps ensure that the synthetic wavelength is not just assumed - it is known.

For dual-wavelength interferometry, continuous source monitoring can turn an otherwise hidden source of scale-factor uncertainty into a measurable, loggable and potentially correctable parameter.

Coher Sense KISA | Compact wavelength and power monitoring for laser-based systems

Configuration shown: approximately 1 GHz / 1 pm wavelength precision for narrowband laser monitoring.