Low Noise-to-Signal Ratio

The advantages of achieving a low noise-to-signal ratio in reflectance measurements are:

- Certainty in the quality of the reflectance data;
- Leads to greater accuracy in the calculation of:
  - Film growth rate
  - Film thickness
  - Real and imaginary refractive index
  - Surface roughness
- Confidence in monitoring even the most complex of structures, e.g. VCSEL, edge emitting lasers and quantum cascade lasers;
- Explanation of noise-to-signal ratio in reflectance measurements.

We define the noise-to-signal ratio as the ratio of the standard deviation in a measured signal to the average intensity of that signal in a standard test. ORS-Ltd's standard test involves operating the instrument over a clean silicon wafer under laboratory conditions and lasts for 15 hours. We typically observe noise-to-signal ratios of better than 0.1% and we have developed one instrument that is as low as 0.02%.

The important things to consider are the types and sources of noise. These fall into three classes:

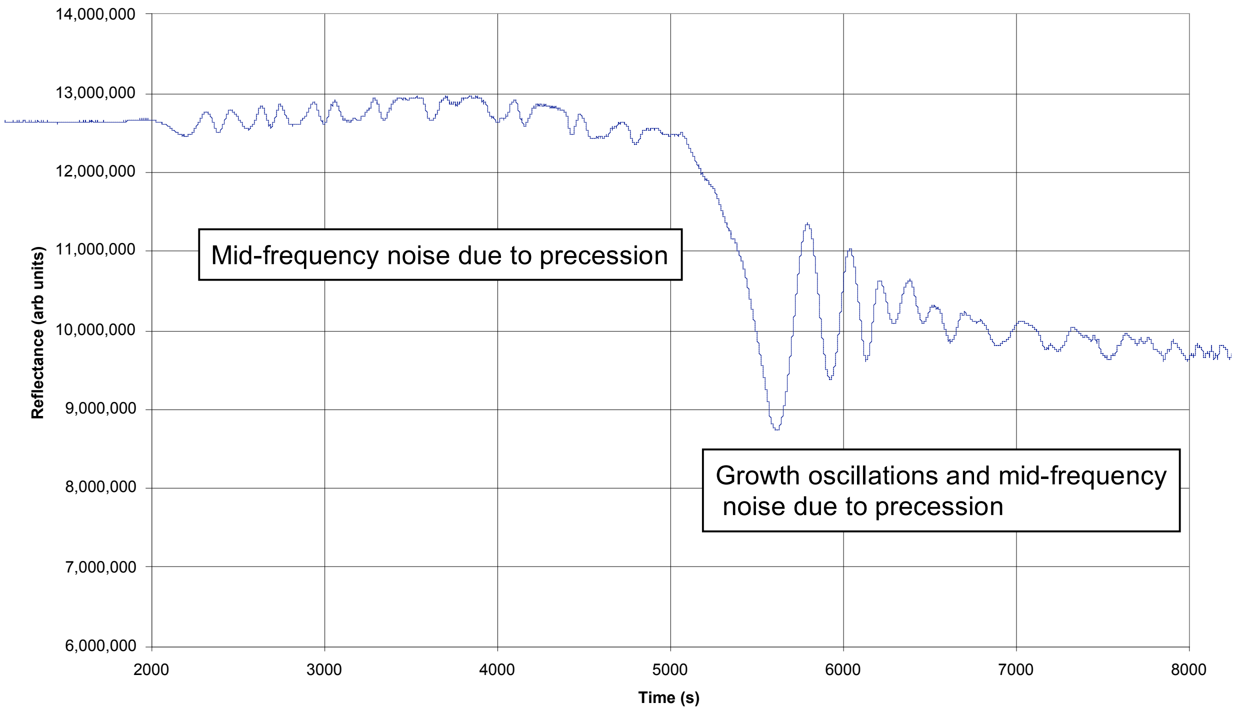
1. Low-frequency noise or drift due to temperature and/or inherent fluctuations found in current stabilised lasers and white light sources.

   - Low-frequency noise can be minimised by controlling the temperature of a laser-based instrument and ensuring it runs in a state of equilibrium at all times.

2. High-frequency noise due to vibrations from pumps etc., and the electronics' Schott noise.

   - High-frequency noise is rare and can be negated by operating the instrument well within its design specification.

3. Mid-frequency noise is almost always due to precession or fringing in the return signal. This is the most difficult source of noise to eliminate as you can still monitor the growth oscillations, but will not be able to achieve a reproducible, accurate fit.



Mid-frequency noise needs special attention. It is a result of either precession in the reflected beam or fringing in the optics.

- Precession of the reflected beam means that its optical path varies in a cyclical fashion with the platen rotation. The measured intensity is a function of the optical path, so to eliminate precessional noise it is important to ensure the reflected optical path is consistent. We achieve this by synchronising the reflectance measurement to the platen rotation.
- Fringing is due to very small variations in the thickness of the lenses and windows that the transmitted and reflected beams pass through due to temperature variations. We eliminate these effects by supplying specialist optical view-ports and removing all optics from within the instrument.