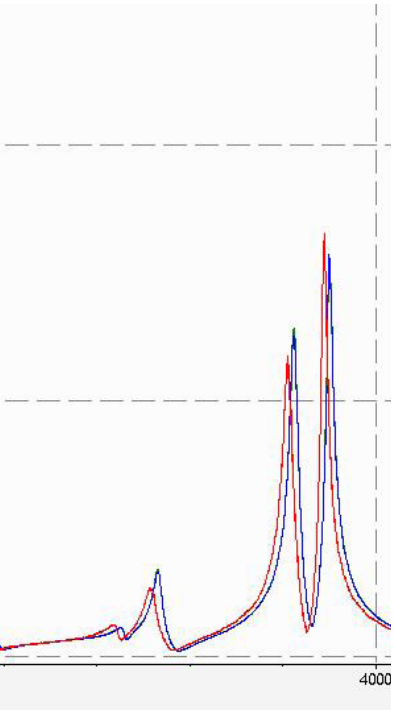


Precise vibration measurements in climate chambers

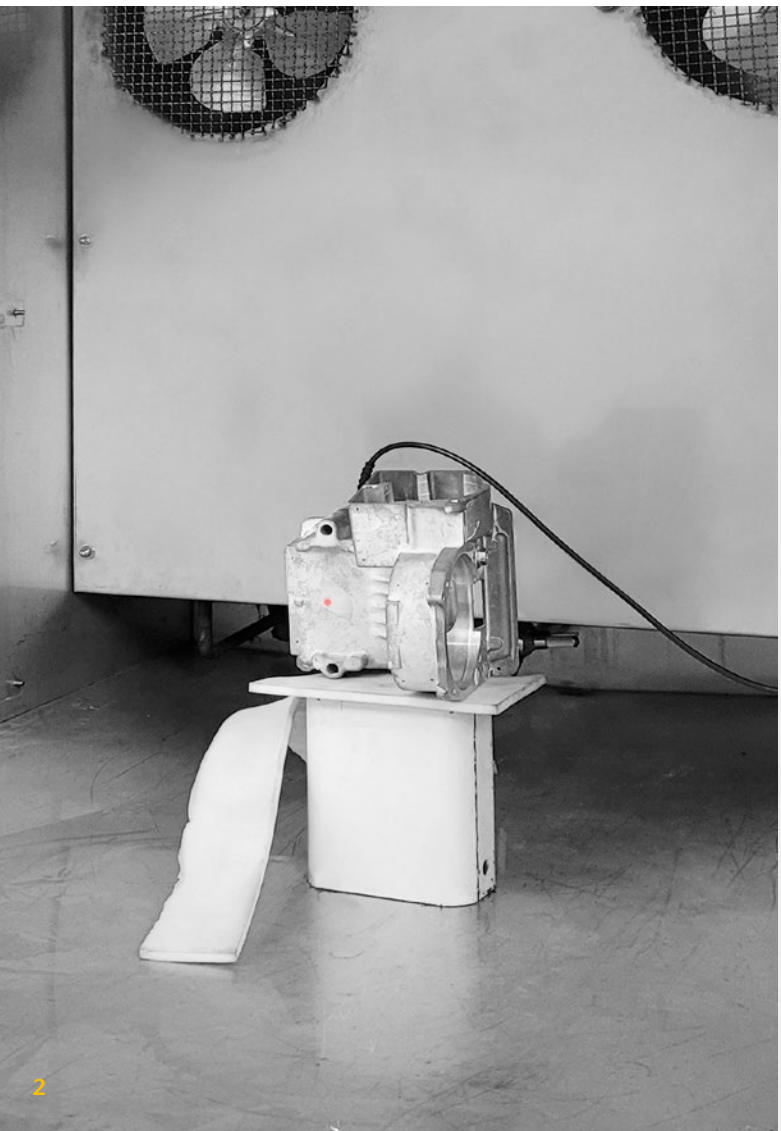
New standards with laser Doppler vibrometry

Application note

Innovation needs control – challenges in the climate chamber

Modern products have to withstand extreme environmental conditions. To test this resilience, components are exposed to a wide range of temperatures and humidity levels in climate chambers – but how can the vibration behavior be measured precisely when solid glass panes and high temperatures are involved and challenge the measurement technology?

This application note addresses precisely this issue. It shows how modern laser Doppler vibrometers (LDV) from Polytec enable reliable and high-precision vibration measurements in climatic chambers even under the most demanding conditions.



Smart measurement setup – high-tech meets everyday practice

The measurement setup was specifically chosen to reflect the typical challenges of industrial applications:

- **Climate chamber**
  Industrial design, temperature range up to 80°C, equipped with quintuple glazing – an extreme test for any optical measuring system.
- **Measurement object**
  A bell housing whose vibrations are specifically stimulated by integrated Visaton mini shakers.
- **Measurement technology**
  Two LDV models – the high-resolution QTec Scanning Vibrometer and the compact VibroGo as phase reference are used for non-contact recording of vibrations.
- **Excitation**
  Shakers ensure precise and reproducible vibration excitation.
- **Glazing**
  The five layers of special glass in the chamber are a deliberately chosen "stress test" for the optical measurement technology.

1 *Measurement on gearbox bell housing inside a climate chamber with the door open using a QTec Scanning Vibrometer and a VibroGo*

Systematic measurement strategy – step by step to the result

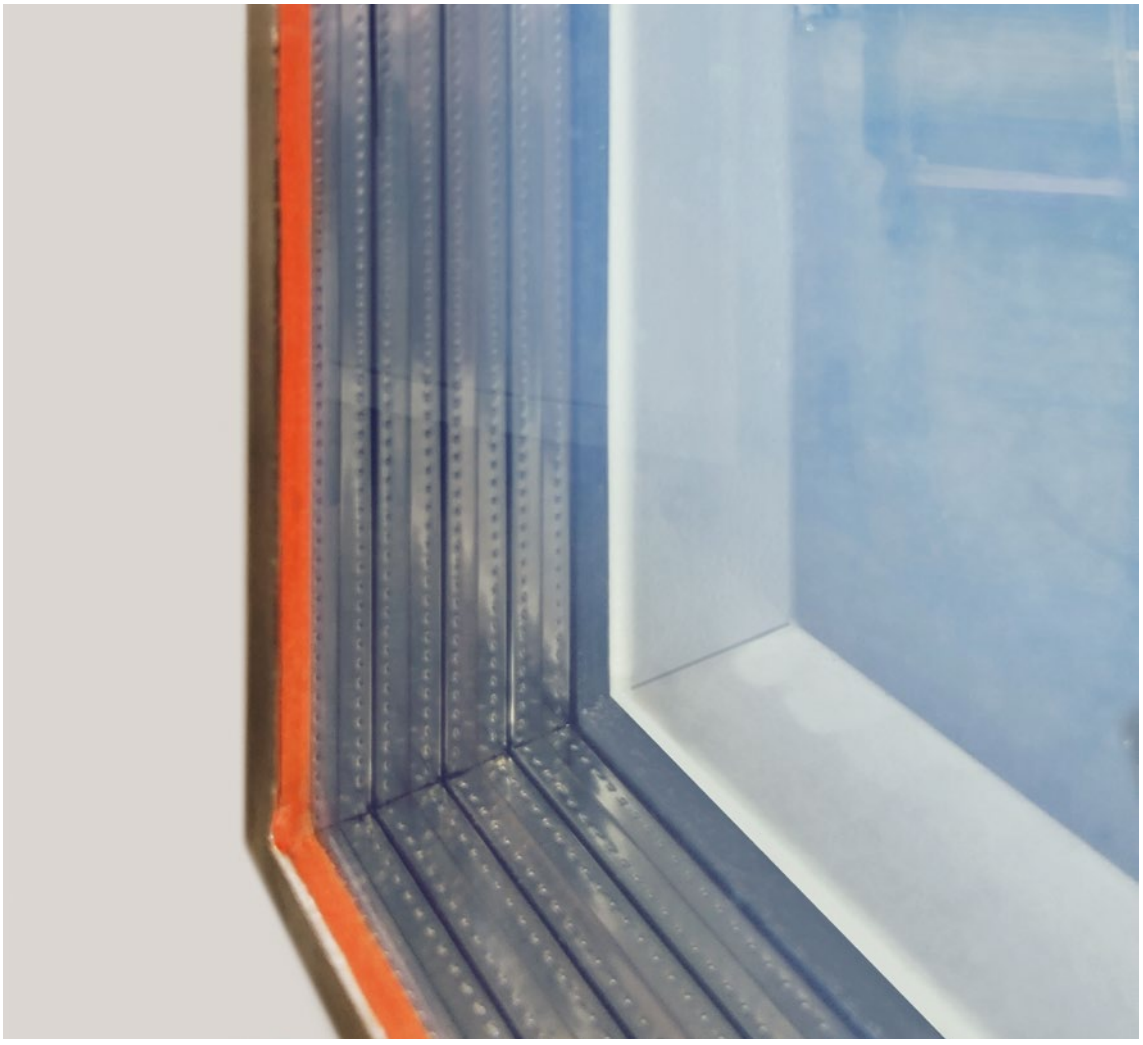
In order to obtain reproducible and meaningful data, the measurement campaign followed a structured procedure:

- **Baseline**
  Climate chamber off, door open, no excitation – as reference condition.
- **Direct measurement**
  Door open, shaker excitement – ideal conditions for the LDV.
- **Glazed measurement**
  Door closed, shaker excitation – signal attenuation through glass becomes measurable for the first time.
- **Extreme test**
  Climate chamber at 80°C, door closed, shaker excitation.
- **Measuring modes**
  In all scenarios, single-shot readout and 10x and 100x averaging were used to maximize signal quality and minimize random noise.

Impressive results – reliable signals despite glass and heat

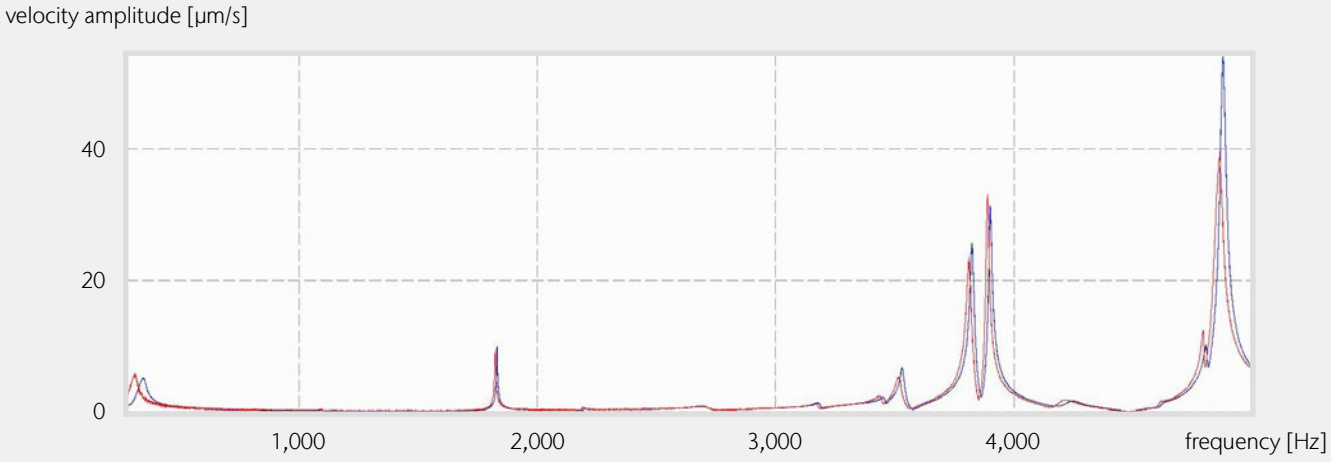
The results were surprisingly positive: even under difficult conditions – fivefold glazing and an internal chamber temperature of 80°C - the QTec Scanning Vibrometer and VibroGo delivered constant, robust signal levels. The differences in the signal-to-noise ratio compared to the ideal measurement conditions (open door) are minimal.

The QTec Scanning Vibrometer was particularly impressive thanks to its multi-channel interferometry: precise vibration mapping, even with maximum heat input and a damping glass barrier. An additional comparison of different types of glazing provides practical recommendations on how to further minimize signal losses in climate chamber glazing.

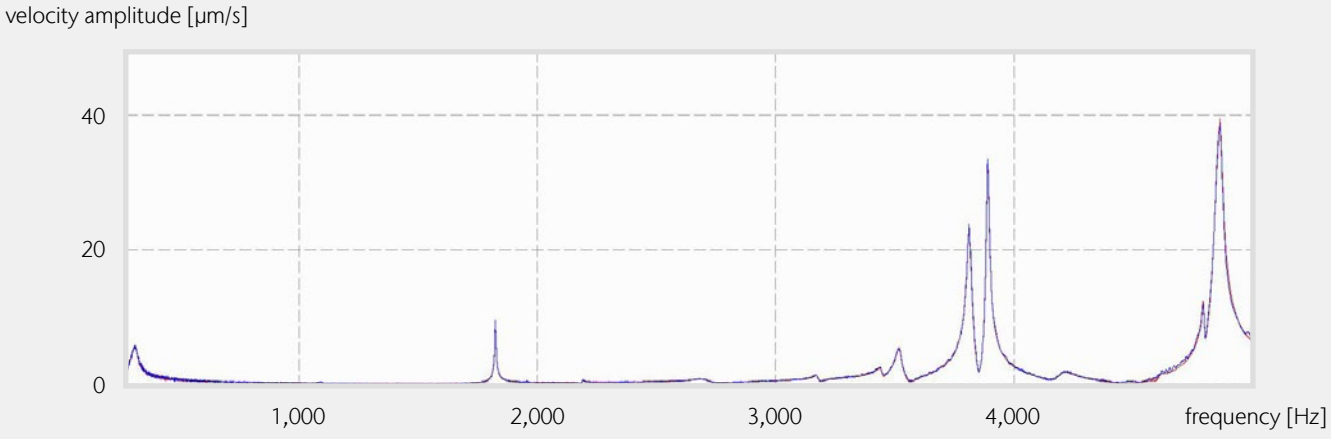


2 *five-pane glazing of the climate chamber through which the measurements were taken*

"Stress test" for the optical measurement technology



3 QTec measurement results under different boundary conditions. Green: Door open; Blue: Door closed; Red: Climate chamber 80°C



4 *Comparison of QTec (red) and VibroGo (blue) at climate chamber 80°C*

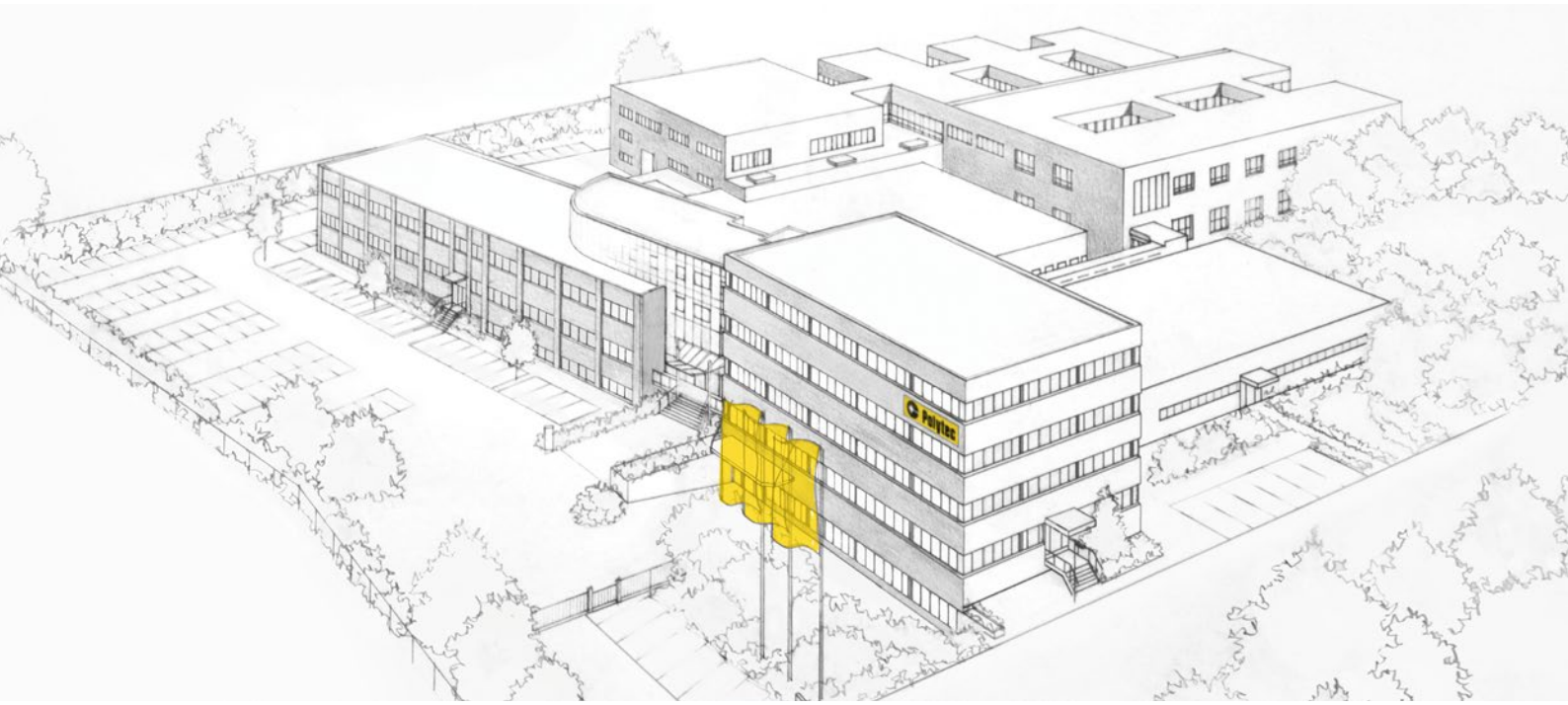
Industrial companies benefit twice: For the first time, you can seamlessly combine environmental simulations and vibration analyses without compromising on data quality.

5 *Deflection shape of the bell housing at 1102 Hz*

6 *Deflection shape of the bell housing at 1829 Hz*

Conclusion and outlook – LDV as a key technology for environmental tests

The new generation of laser Doppler vibrometers takes vibration analysis in climate chambers to a new level. Thanks to non-contact measurement, high precision and insensitivity to multiple glazing, they are ideally suited for demanding test scenarios. The QTec Scanning Vibrometer and the VibroGo as a phase reference have proven to be versatile solutions – even under extreme conditions.



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