Computer support of analysis optical spectra measurements

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Introduction

The purpose of our research was to find a way to check the accuracy of measurements performed with a Fabry-Perot interferometer.

Why the measurements carried out with a Fabry-Perot interferometer?

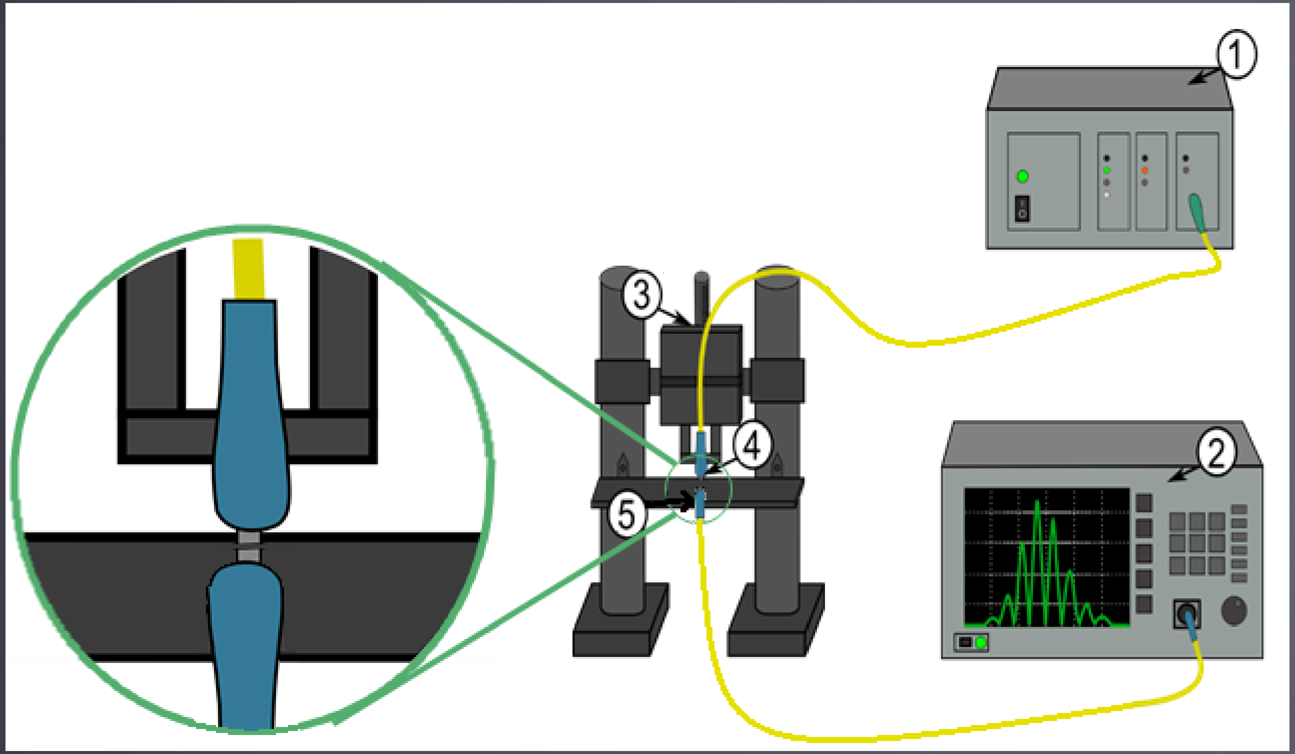
- precise and reliable results
- potentially low cost
- easily installed in hard to reach places

Why do we check the accuracy of measurements?

- to evaluate measurement errors
- to determine exact values of the refractive index and/or the width of the resonant cavity

Measurement set-up

The measurements were performed with a Fabry-Perot interferometer working in the transmission mode.

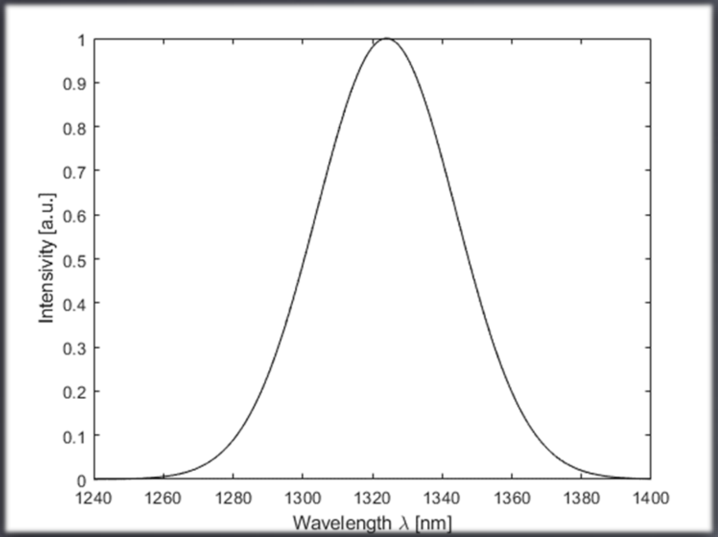


1. A superluminescent diode operating at a central wavelength of 1310 nm
2. An optical spectrum analyser
3. A micromechanical setup that allows changing the distance between the optical fibers
4. Two single-mode optical fibers.

We invastigated the influence of resonating cavity length and refractive index on the envelope of the registered interferogram.

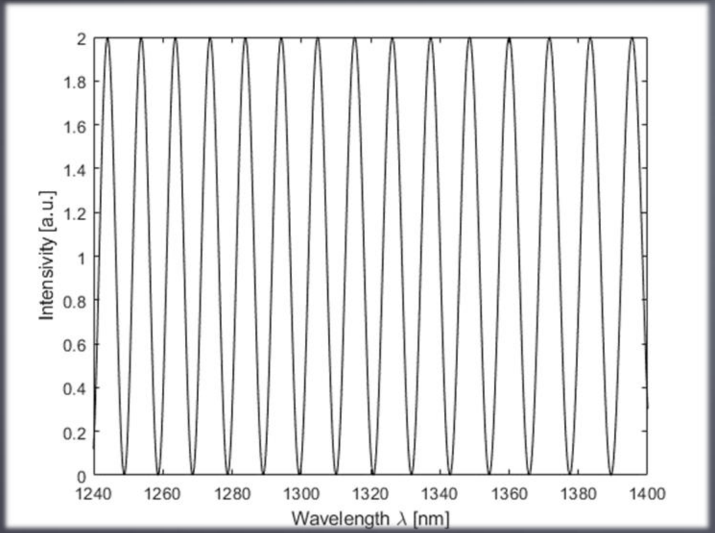
Theoretical model of the interferogram

Input signal
$S(\lambda)$

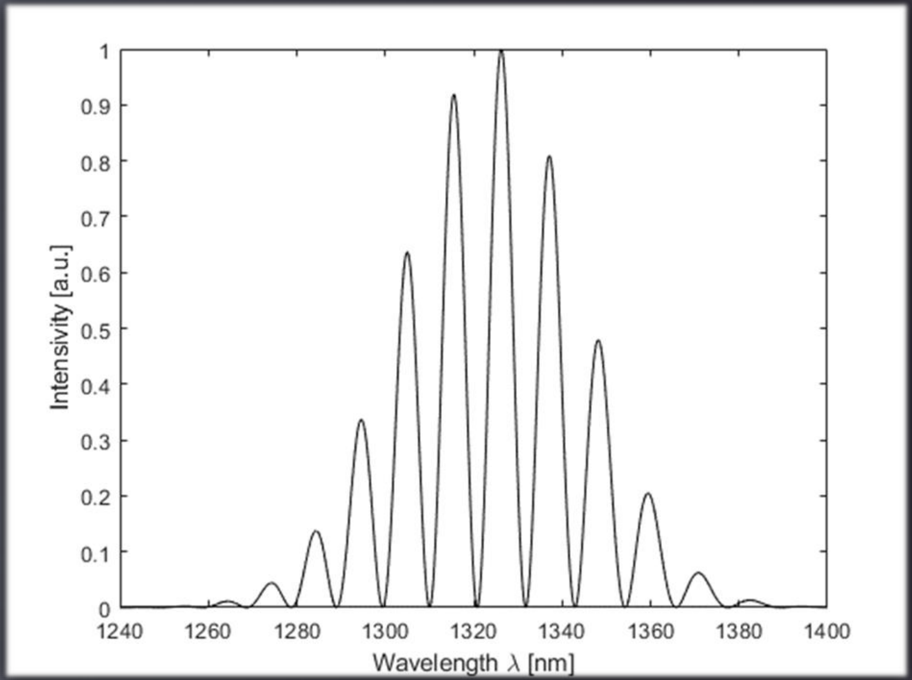


Interferometer transmission

$$T = 1 + \cos\frac{4\pi \times n \times l}{\lambda}$$



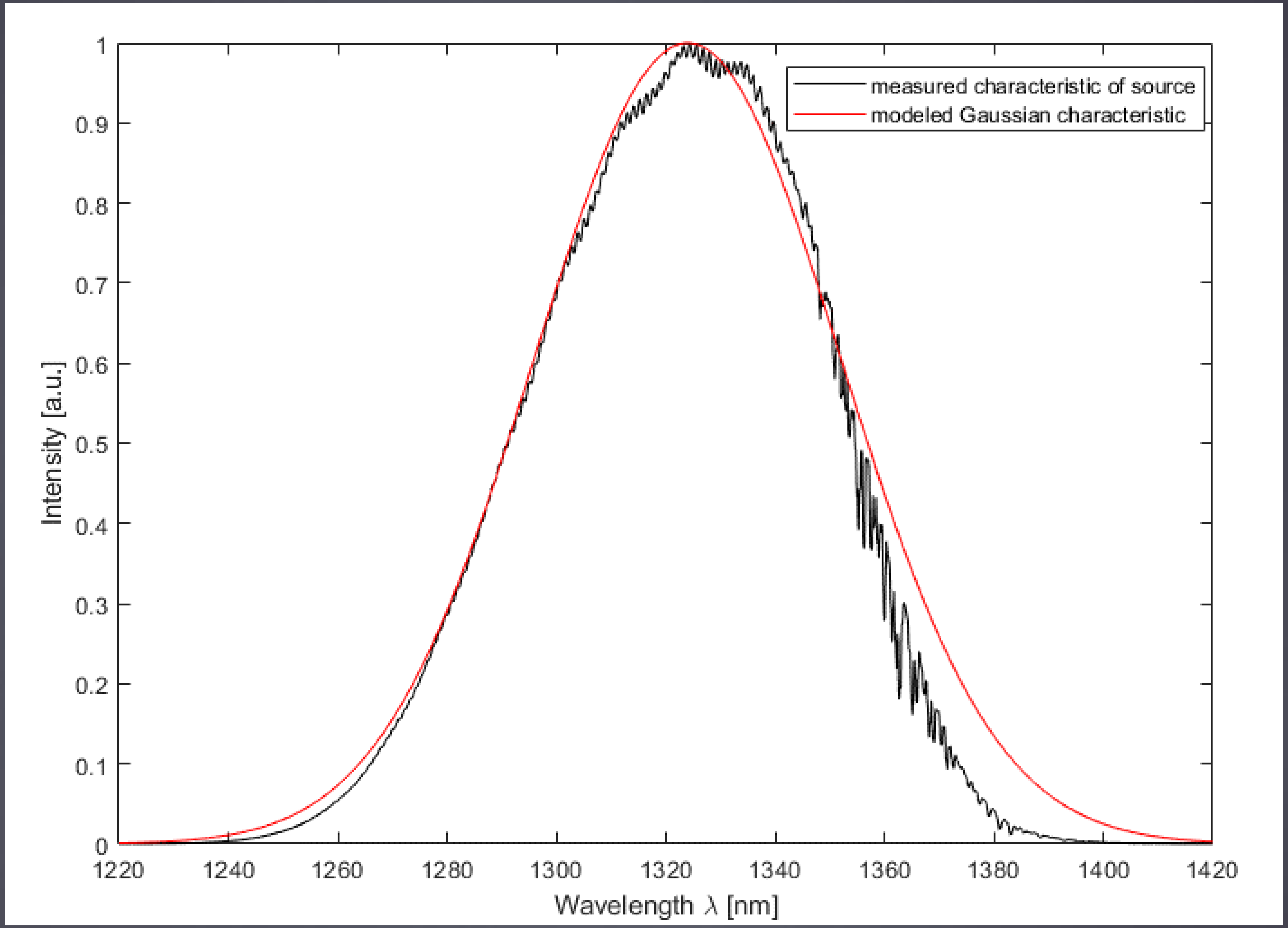
Output signal $I(\lambda)$



$$I(\lambda) = S(\lambda) \times \left(1 + \cos\frac{4\pi \times n \times l}{\lambda}\right)$$

Where n is the refractive index, l is the cavity length of the physical path and λ is the wavelenght.

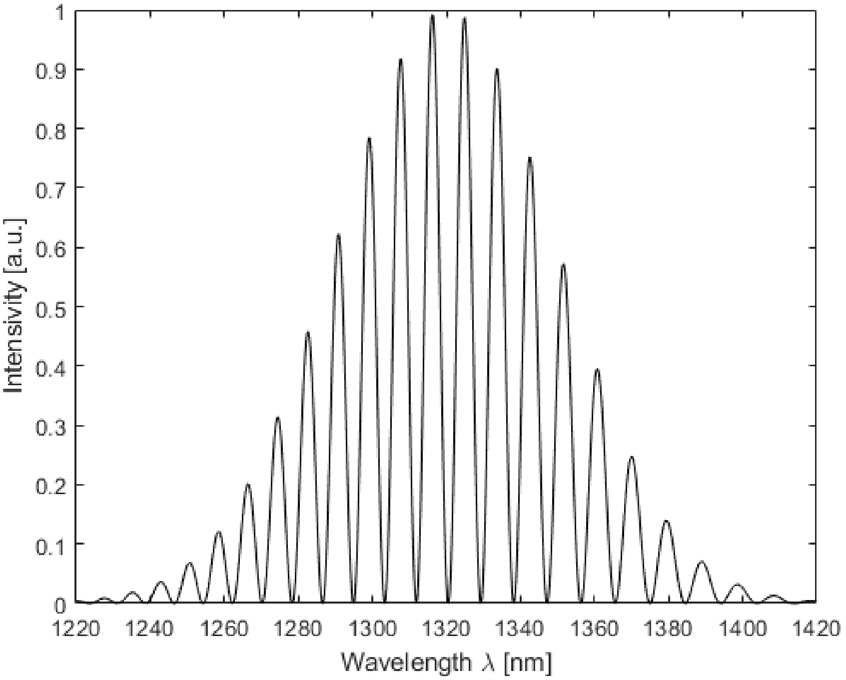
Modelling the light source characteristics

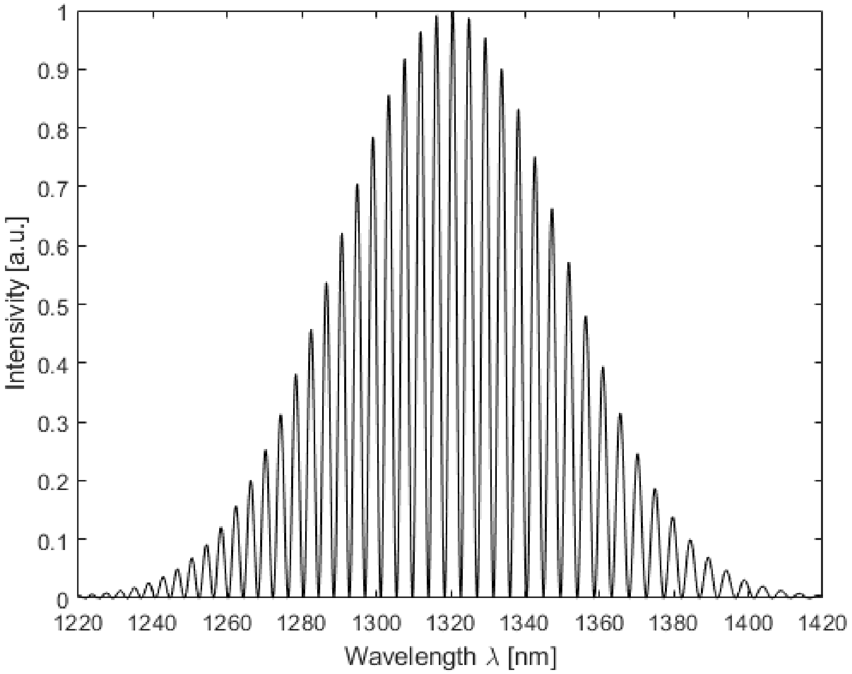


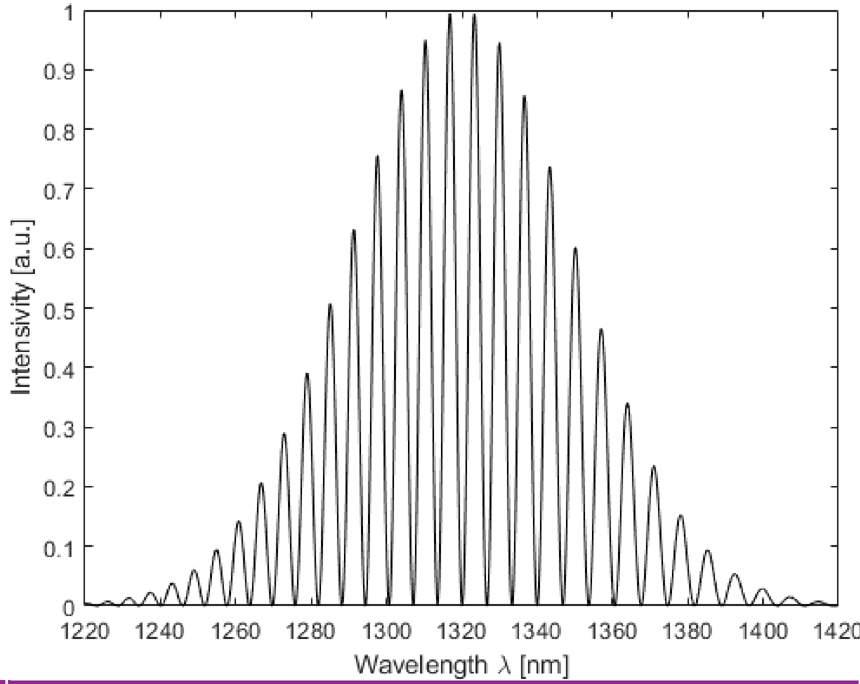
To achieve better results, the interferogram of the light source was assumed to have an ideal shape of a Gaussian distribution.

Changing the parameters – preparing models of the interferograms

• Refractive index 1.0003 (air) • Length of cavity 100μm	• Refractive index 1.0003 (air) • Length of cavity 200μm	• Refractive index 1.33 (water) • Length of cavity 100μm

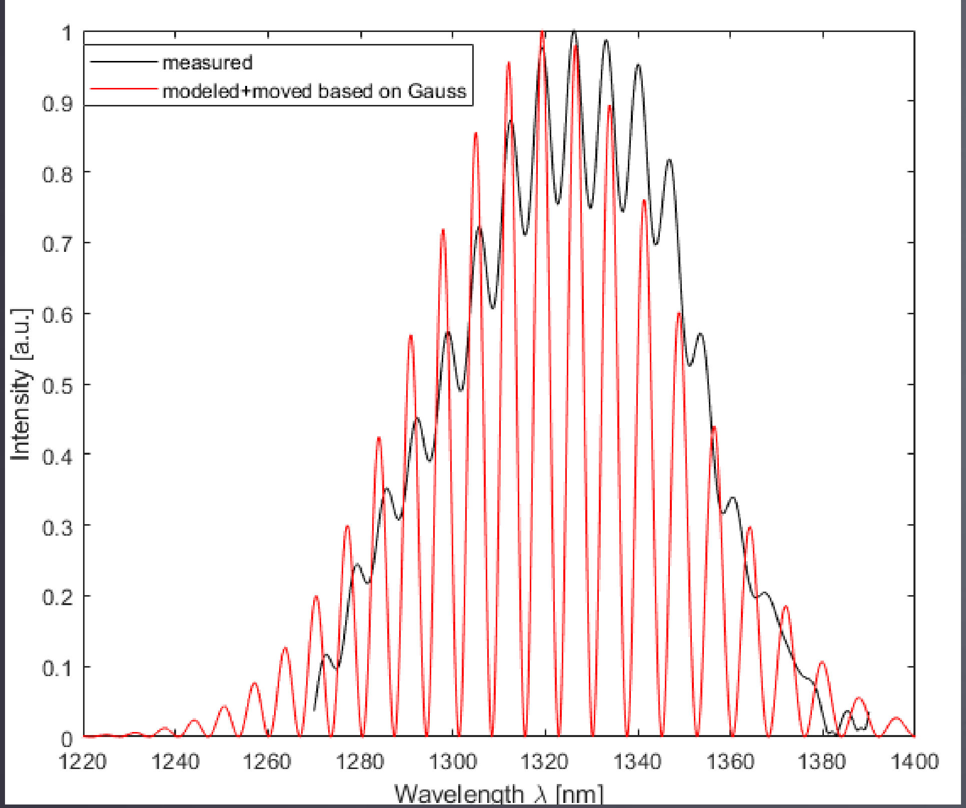


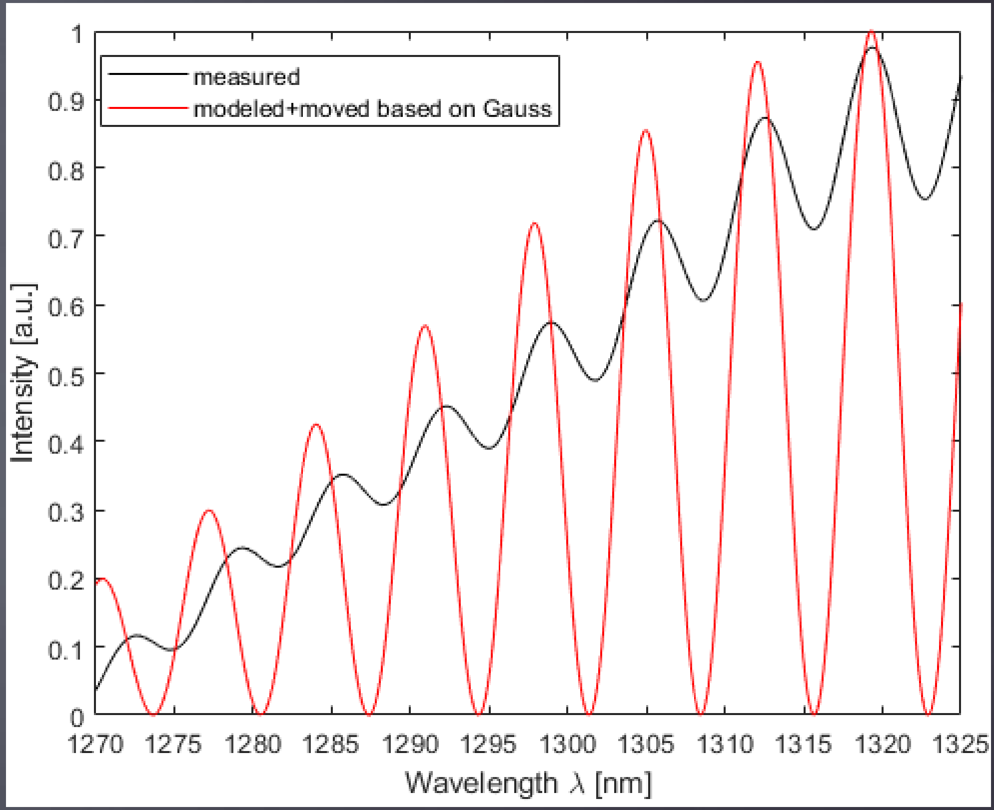




The comparison of simulated and measured interferograms

To fit the simulated and measured interferograms we shifted the position of the simulated interferogram in such a way as to have minima in the same position on the y- axis.





We obtained a good fit of interferograms, especially for peaks on the left side of the central wavelength (what is shown in the picture on the right).

Summary

- The comparison of simulated and measured interferograms allows verifiying measurement errors or determining exact values for the refractive index and/or the width of the resonant cavity.
- There are two ways to perform model fitting: by adjusting the position of the central peaks or minimums next to the central peak. It was observed that the second solution was more optimal and implemented in the program.

Thank you for your attention!

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