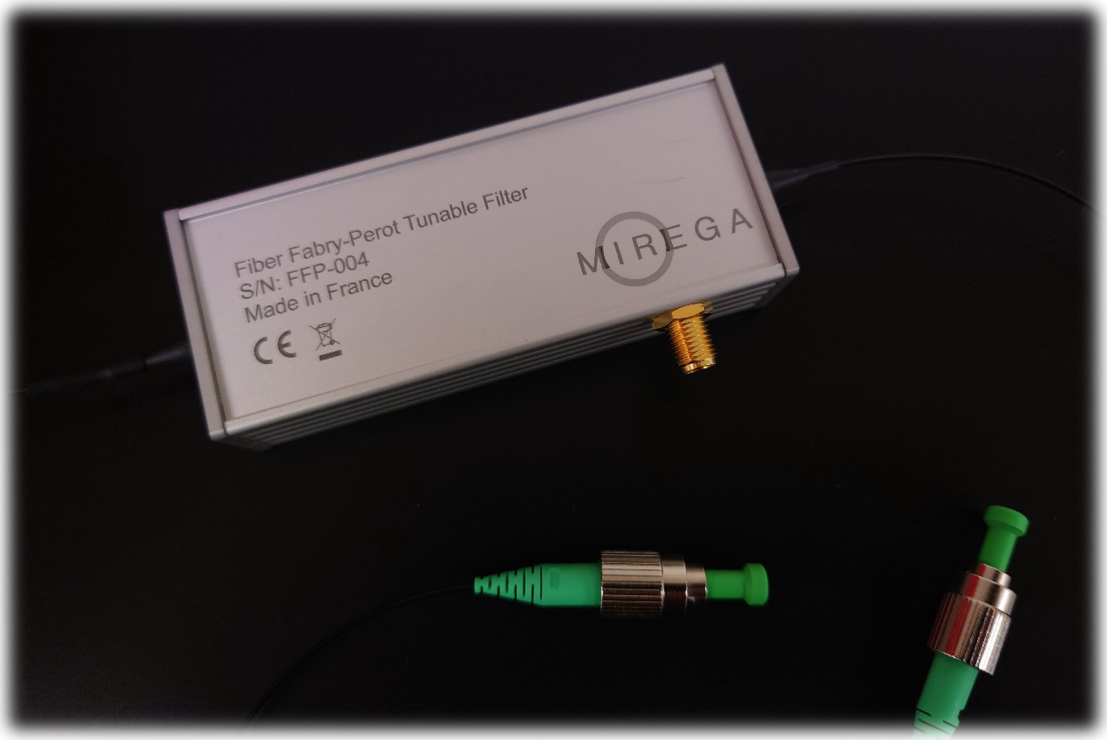
MIREGA
COMPACT GAS ANALYZER

FFP TEST REPORT

FFP-004

Date :	2024/07/16
Specifications :	FSR : 10 THz
Operator :	Pierre Mahiou
Options :	-
Archive name :	FFP-004

This document reports the performances of your delivered Fiber Fabry Perot tunable filter. It starts with a compliance matrix, showing your device's compliance with its specifications and Mirega's high quality standards. On the next pages, we invite you to discover how your cavity was tested in our lab and how it performed.



Picture of your FFP-004

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Compliance matrix

The table hereafter summarizes the compliance test results of your FFP-004:

Property	Spec.	Result	Unit	Pass / Fail
FSR	10 (+/-15%)	8.87	THz	**Pass**
Finesse at 1580nm	> 15 000	18 474	-	**Pass**
Filter bandwidth @1580nm	< 660	480	MHz	**Pass**
Lowest mechanical resonance frequency	> 10	51	kHz	**Pass**
Required voltage per FSR	-	280	Vpp	**NC**

The following items are compliant by design:

Property	Spec.	Unit
Maximum tuning voltage	+/- 320	V
Maximum optical input power	5	mW
Single-mode fibers with FC/APC connectors	-	-
Capacitance	< 10	nF

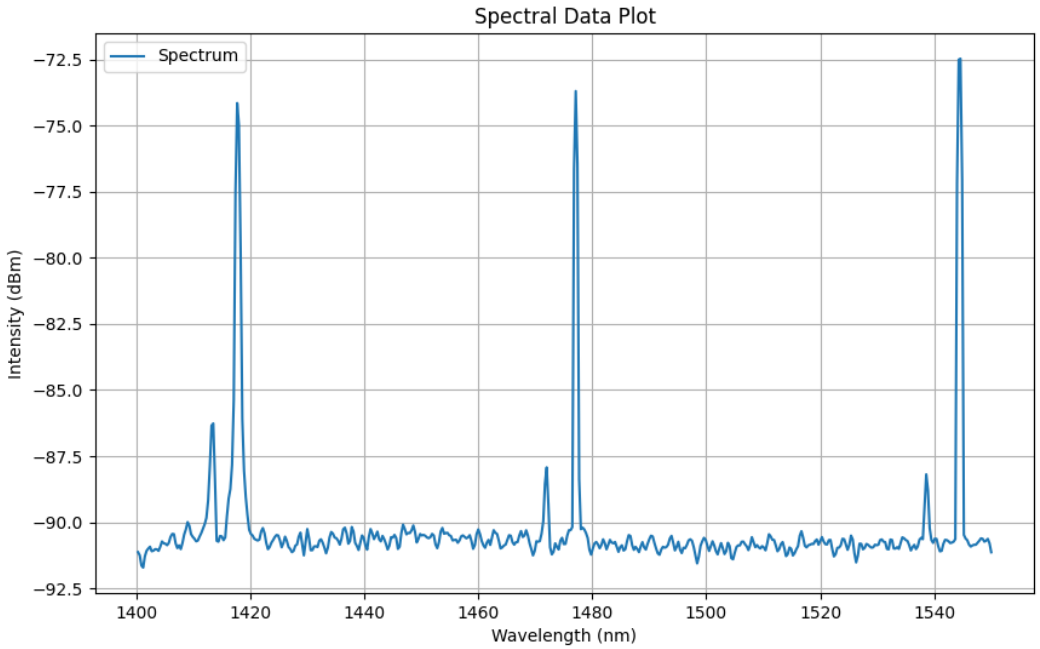
For information, additional tests have been performed on your FFP-004:

Property	Result	Unit
Center wavelength	1545	nm
Insertion loss	10.1	dB
Minimum extinction ratio for second order mode	19	dB

Free Spectral Range

The full Free Spectral Range (FSR) of the cavity has been measured using a white light source and a spectrum analyzer around 1550nm to scan a full FSR and detect the resonance peaks wavelength. The optical length of the cavity is then calculated from the full FSR.

Please not that this measurement is noise limited, from the spectrometer. Position and relative amplitude of the peaks are correct but amplitudes may not be fully accurate.

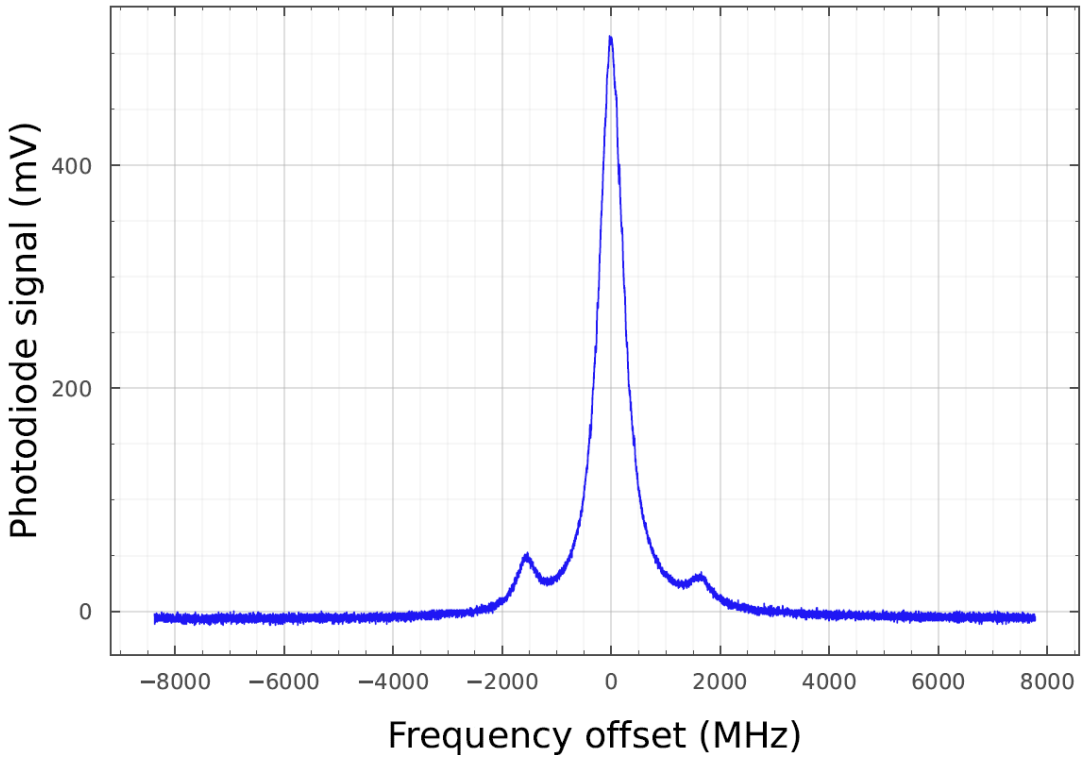


2 FSR measurement with spectrometer

FSR = 8.87THz (67.5nm @1510nm)
Cavity length : 16.9µm

Finesse and bandwidth

Finesse is calculated by first measuring the bandwidth of the filter using a tunable laser with modulation sidebands serving as frequency reference. We then calculate the Finesse as *F = FSR / bandwidth*.
Characterization was done using a 1580nm laser. As the reflectivity of the coating is similar at 1580nm and 1550nm, the filter bandwidth is identical.



Resonance peak @1580nm with 1600MHz sidebands

Bandwidth: 480 MHz
Finesse: F = 8.87e12 / 480e6 = 18 479

First mechanical resonance frequency

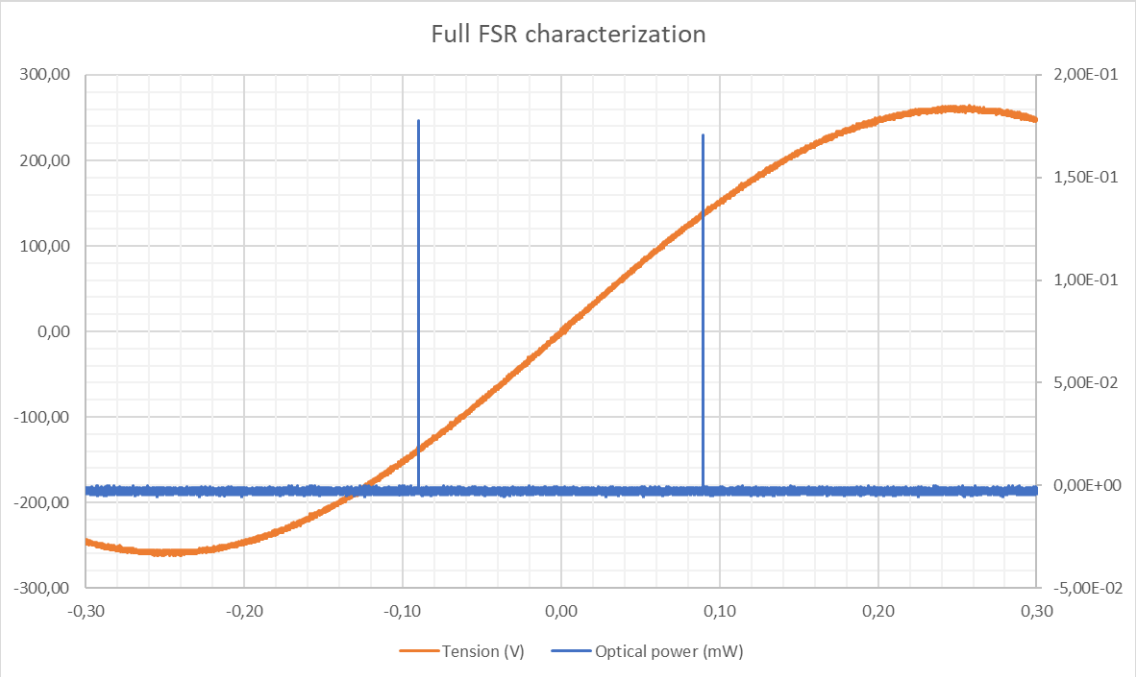
The first mechanical resonance frequency is measured by applying a small sinusoidal control voltage (<10mVpp) to the cavity piezo actuators. The amplitude of the response is measured and the first resonance therefore determined.

First measured resonance frequency: 51 kHz

The mechanical resonance frequency is measured for small amplitude variation. (<10mVpp)
However, when driving at high amplitude (full FSR) other mechanical aspects have to be considered.
Please contact us if you need more information.

Tuning voltage per FSR

An entire Free Spectral Range is scanned to measure the required voltage necessary to scan this complete FSR. The laser wavelength is tuned so that the full scan is roughly centered around 0V.
Please note that the difference of the peaks heights is due to the sample rate of the oscilloscope and linked to any actual power fluctuation.



Full FSR characterization scanning the piezoelectric actuator

Required voltage span: 280Vpp

Due to the non-linearity and specific behavior of the piezoelectric actuators, higher voltage might be necessary depending on the sweep frequency and voltage offset. Do not hesitate to contact us for additional information.

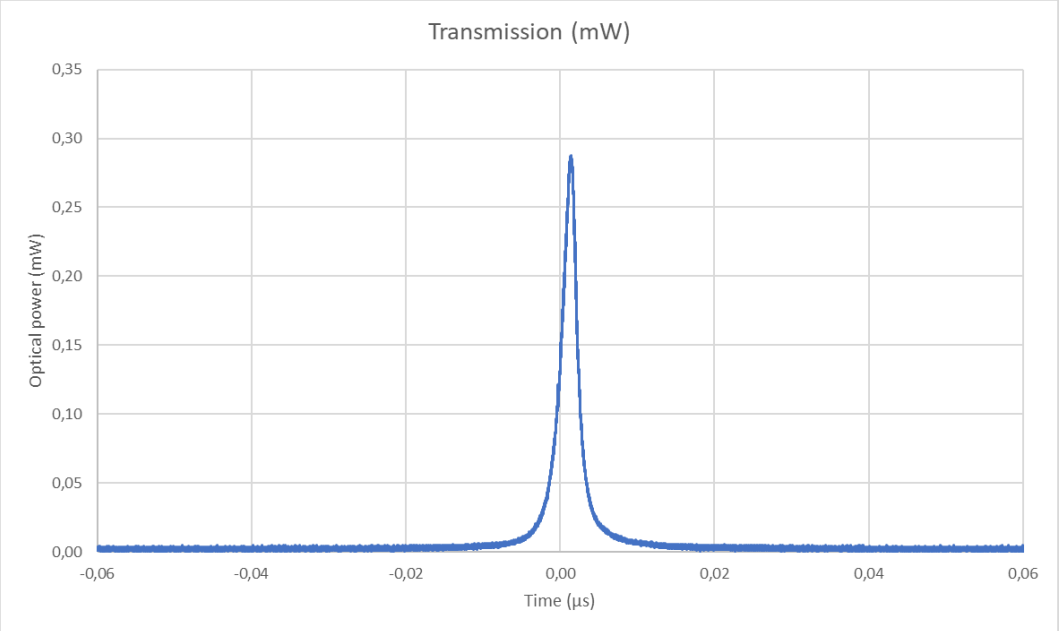
Maximum input power

Input power is limited by design to 5 mW.

When scanning the cavity at slow speed and the transmission peak with maximal input power, a thermal effect may occur which can affect the symmetry of the resonance peak. Please contact us for more information on this subject.

Additional tests: Insertion loss

Insertion loss is measured by comparing the peak transmission and the reflected signal as reference for the optical power.



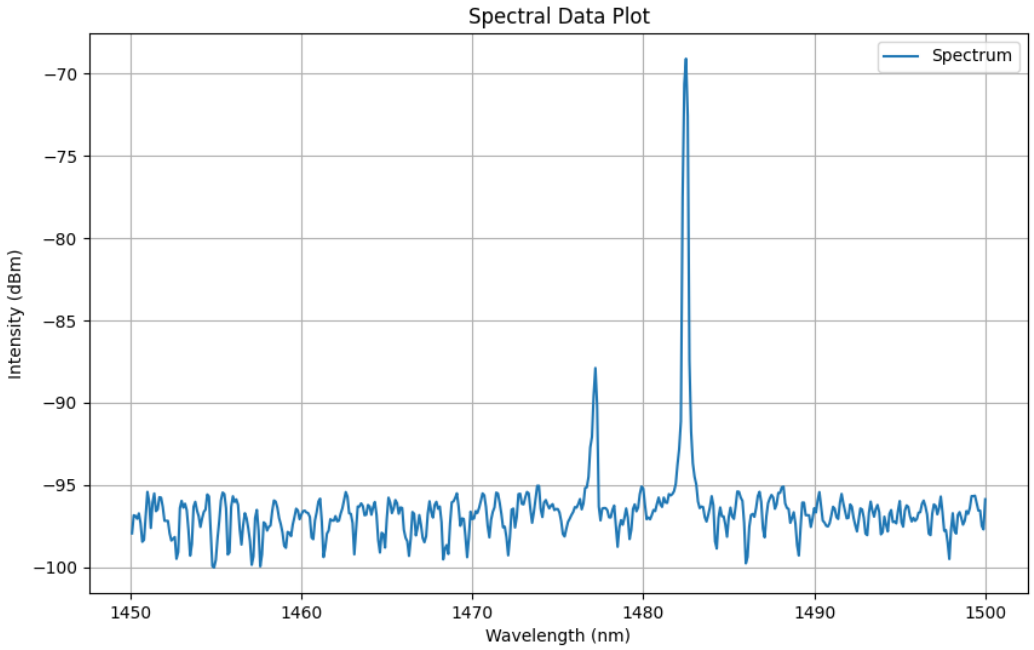
Transmission signal of the filter swept around 1580nm

Input signal power (from laser): 2.85mW
Transmission peak: 0.28mW

Transmission ratio: 0.28/2.85 = 9.82 %
Insertion loss: -10.1 dB

Additional tests: Secondary mode

As with any optical cavity, secondary modes can appear due to slight fluctuation in the assembly. While we try to minimize those to a bare minimum, we cannot always fully suppress every mode. The main resonance peak is known as the TEM_{00} mode and has the largest amplitude (several order of magnitude above any secondary mode).
In this section we try to characterize the largest visible TEM_{pl} mode and it's position and amplitude relative to the TEM_{00} mode.



Transmission of the cavity around the main resonance peak

Main resonance peak: -69dBm
Second order mode: -88dBm

Minimum extinction ratio: -19 dB

We also locate the secondary mode using sidebands as a frequency reference.

Offset to TEM00 is 821 GHz
(As a reminder, bandwidth is 480MHz)