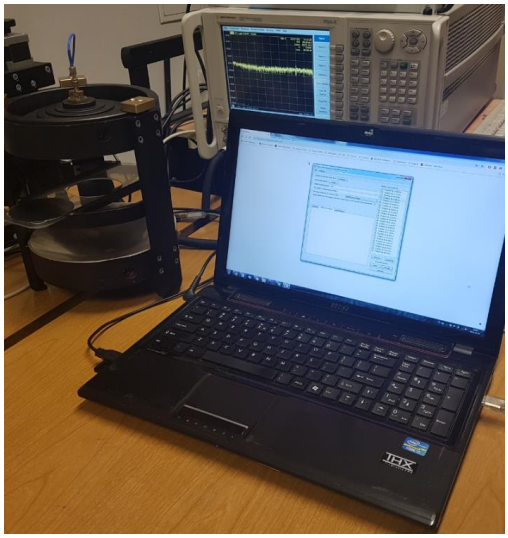
FABRY-PEROT OPEN RESONATOR 20-110 GHz

EMArges offers a novel type of a **Fabry-Perot open resonator** (FPOR) with Gaussian mirrors for automated broadband and precise resonant measurements of electromagnetic properties of low-loss dielectric sheets in the **20-110 GHz** frequency range. The FPOR system is equipped with a specialized **software** controlling the measurement process and extracting complex permittivity of the material under test from the measured frequency and quality factor.

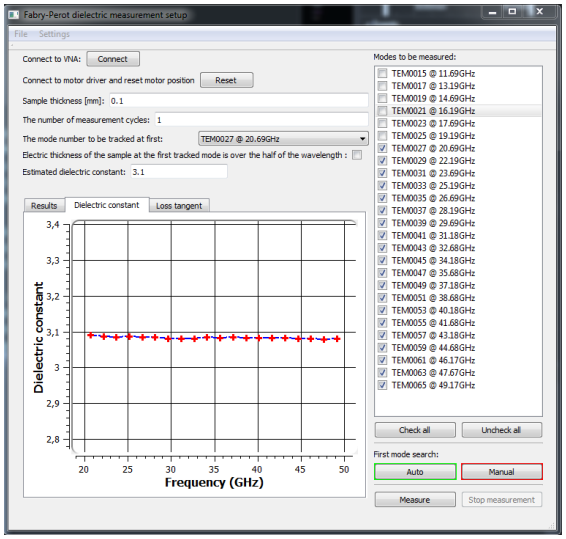
The whole measurement setup consists of a computer, where the aforementioned control software is installed, connected to the FPOR and to measurement equipment (either VNA or **scalar Q-Meter**). The FPOR operates at consecutive $TEM_{0,0,q}$ Gaussian odd modes spaced every **1.5 GHz**.

Due to a sophisticated adaptive algorithm implemented in the control software dedicated to precise and robust tracking of the modes during the measurement, total measurement time usually does not exceed **15 minutes** in the 20-50 GHz range.

Fabry-Perot Open Resonator



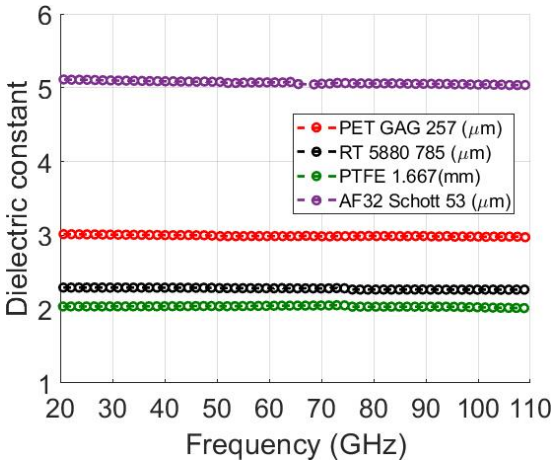
Measurement setup

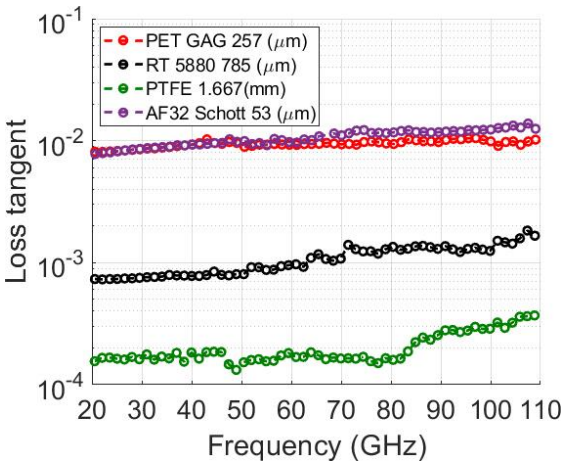


Measurement results (PET, t = 100 µm)

The system allows measuring samples with the following properties:

1. **dielectric constant**: $\varepsilon' = 1 \ldots 15$ (accuracy: $\Delta\varepsilon'/\varepsilon' < 0.5\%$)
2. **loss tangent**: $\tan\delta < 10^{-2}$ (accuracy: $\Delta\tan\delta/\tan\delta < 2\%$), and for $\tan\delta < 10^{-5}$ only dielectric constant can be measured.
3. **thickness**: 15µm – 3mm
4. **diameter**: >75mm





Exemplary measurement results

EMArges Sp. z o.o. ul. Bieszczadzka 7 45-427 Opole Poland www.emarges.com info@emarges.com

FABRY-PEROT OPEN RESONATOR 20-110 GHz

Parameters of a Fabry-Perot Open Resonator (FPOR)

Application	FPOR is intended for the measurements of the complex permittivity of low-loss laminar dielectric materials.
Accuracy of measurements	$\Delta\varepsilon/\varepsilon$ = ±0.5% for ε = 1…15 $\Delta\tan\delta/\tan\delta$ = ±2% for $\tan\delta \leq 2\%$
Operational frequency range	20-110 GHz The upper frequency depends on the network analyzer, so it is usually one of the following: 50 GHz, 67 GHz or 110 GHz.
Operational temperature range	Room temperature
Additional equipment needed to perform measurement	Vector Network Analyser (e.g. Keysight, N5245A, Rohde&Schwarz ZNA67) National Instruments 488.2 GPIB controller or LAN Scalar Q-Meter
Measurement procedure	The whole measurement is automated and controlled via dedicated software installed on a PC computer. At first, resonant frequencies and Q-factors of $TEM_{0,0,q}$ odd modes of the empty resonator are measured. Afterwards, sample is inserted onto the holder and all the modes of interest are adaptively sought for and the changed resonant frequencies and Q-factors are measured in order to extract dielectric constant and loss tangent by comparing the results with a look-up table computed with a dedicated FPOR electromagnetic model.
Additional information	The thickness of the sample should be in the 15μm – 3mm range, while the diameter should exceed 75 mm.

Limitations

Due to coupling with spurious modes that slightly alter resonant frequencies of the measured modes, the thickness of the sample of known dielectric constant is limited as shown in the Figure.