Breathalyzer-based Prompt Coronavirus Screening Test using THz Spectroscopy of Viruses in LC-Resonant Metamaterial Nano-Antenna Array

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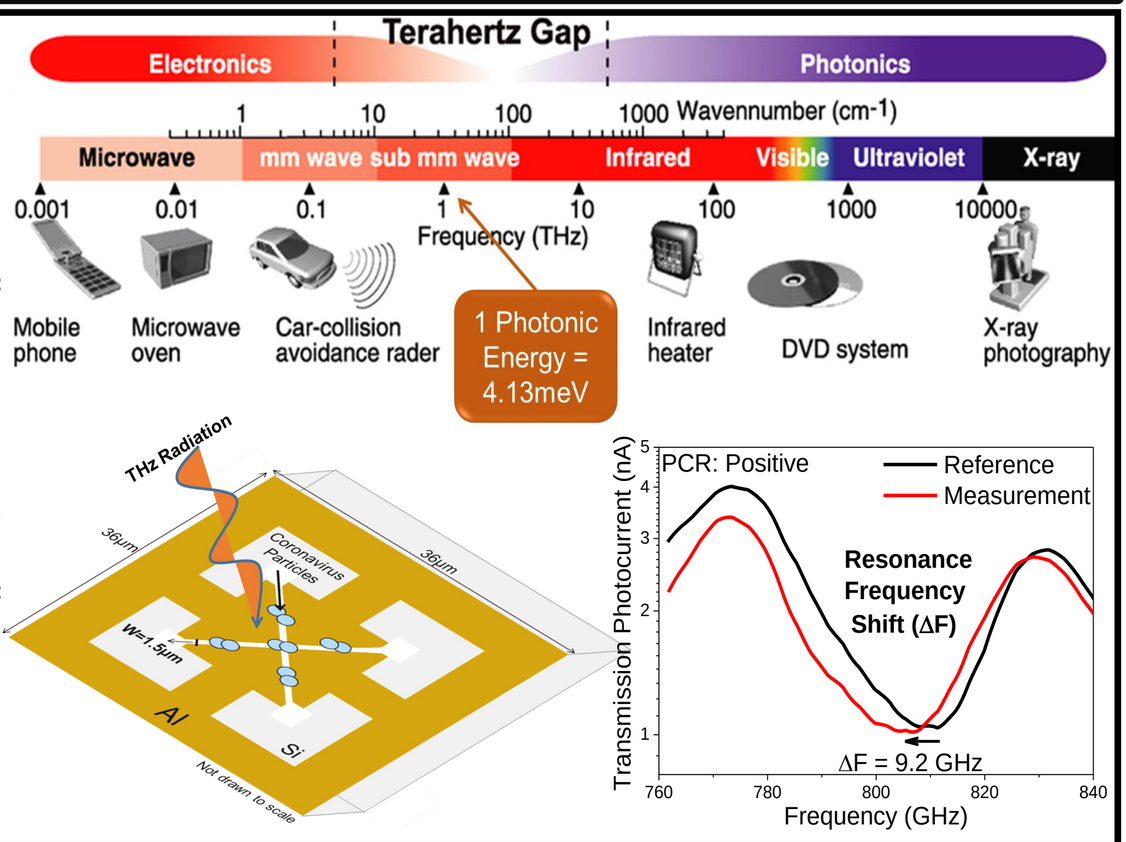
ABSTRACT

We propose a tested, sensitive and prompt COVID-19 breath screening method that takes less than one minute. The method is non-biological, and is based on the detection of shift in resonance frequency of a nano-engineered LC-resonant metamaterial chip, caused by viruses and mainly related exhaled particles, when performing a Terahertz spectroscopy. The chip consists of thousands of micro-antennas arranged in an array, and enclosed in a plastic breathalyzer-like disposable capsule kit. Low scale clinical trials were conducted with asymptomatic, symptomatic coronavirus patients and healthy individuals. It is shown that coronavirus positive individuals are effectively screened upon observing a shift in the transmission resonance frequency of about 1.5-9GHz, which is diagnostically different from the resonance shift of healthy individuals that display a 0-1.5GHz shift. Initial results of screening coronavirus patients yielded 88% agreement with the RT-qPCR results.



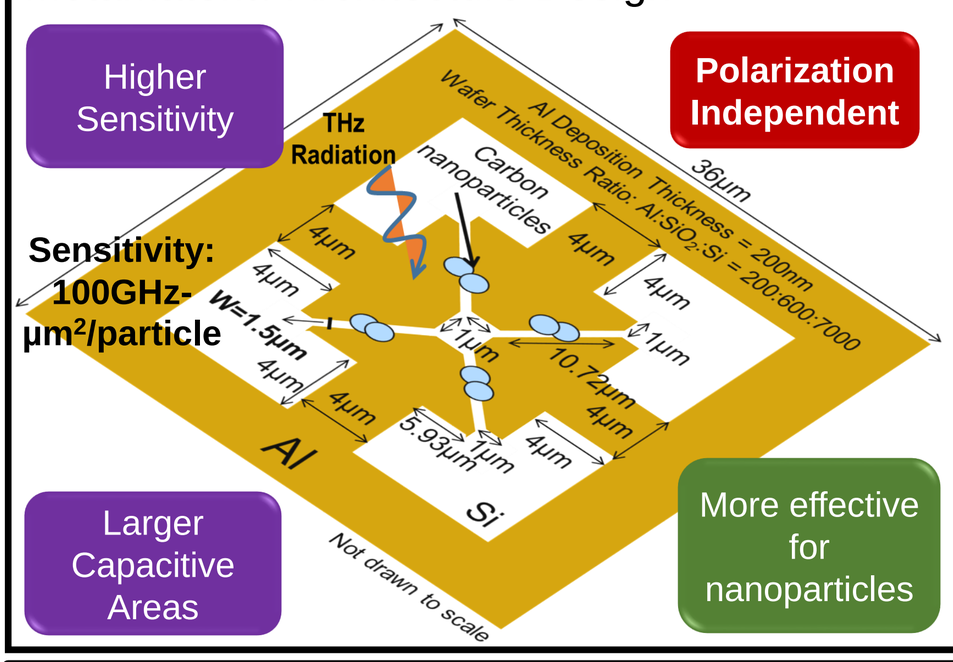
CORONAVIRUS SCREENING TEST

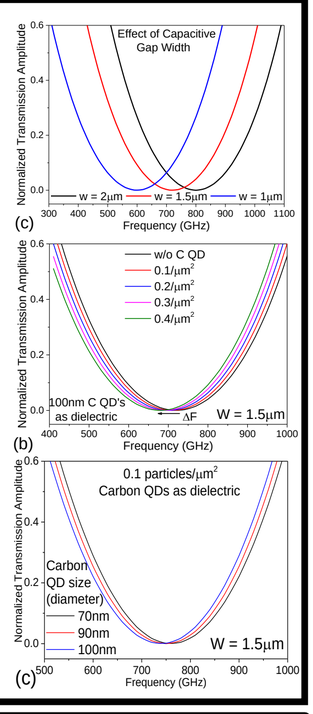
WORKING PRINCIPLE

- **Dielectric response of polarization independent M.M structure is captured at resonance by THz impedance spectroscopy.**
- **The dielectric is a combination of all exhaled particles specific to a coronavirus infected patient, which is different from a healthy person.**
- **The screening is done via a breath-test where the patient blows directly onto our arrowhead M.M chip, with the help of a breathalyzer kit, designed to be transparent to THz.**

DETECTOR STRUCTURE – NOVEL DESIGN

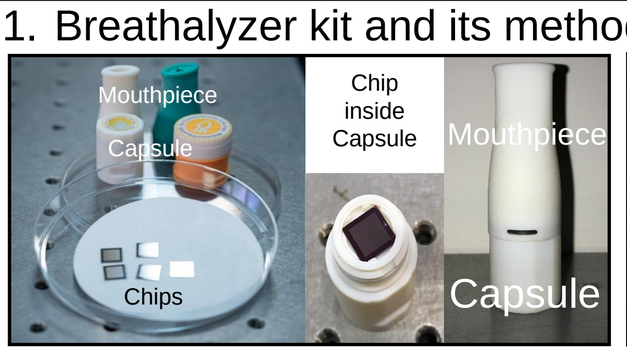
Metamaterial Architecture Design

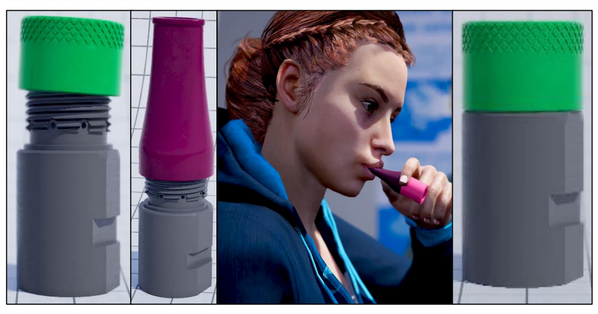




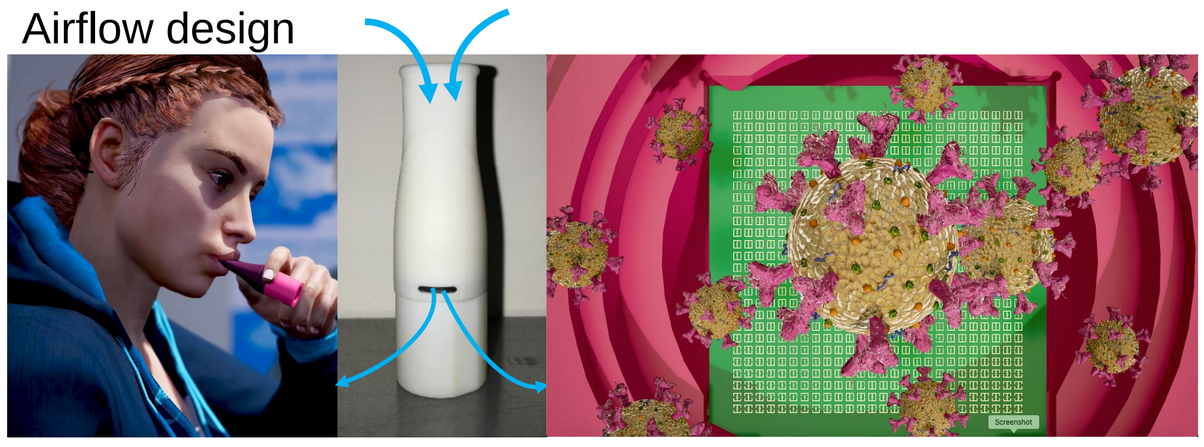
BUILDING BLOCKS of SCREENING TEST

1. Breathalyzer kit and its method of use

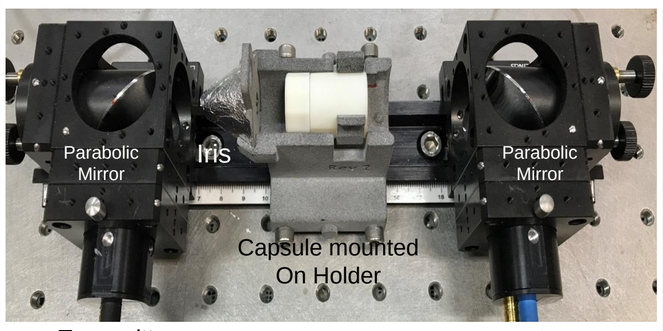




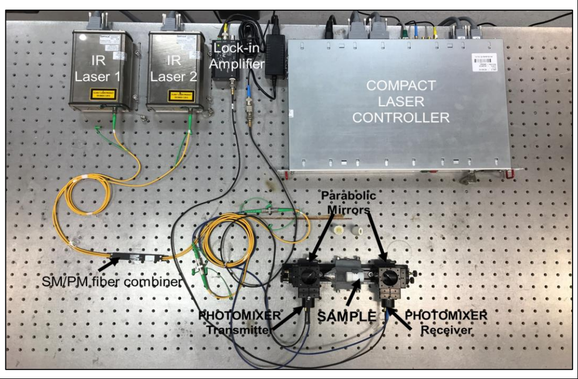
Airflow design



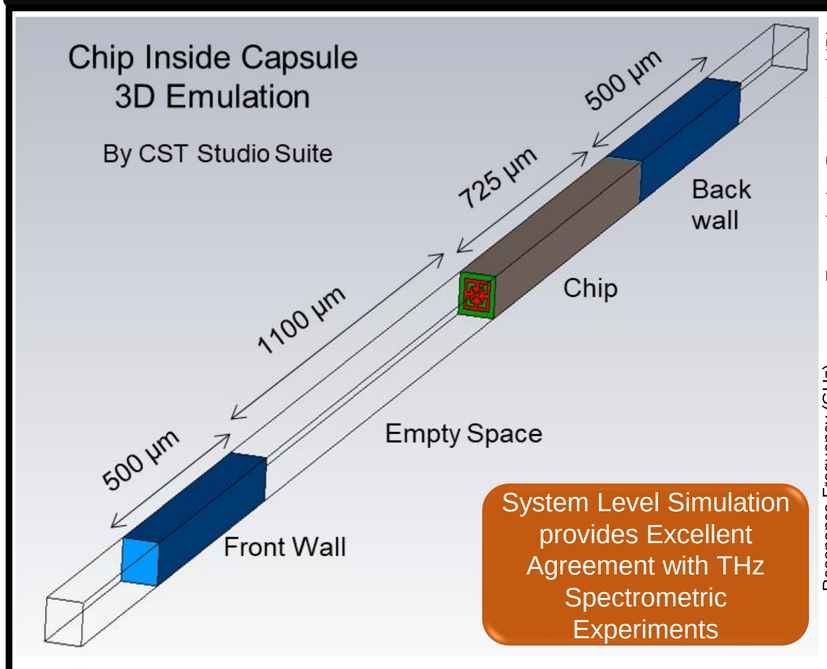
2. Terahertz spectrometer (Linearly Polarized)

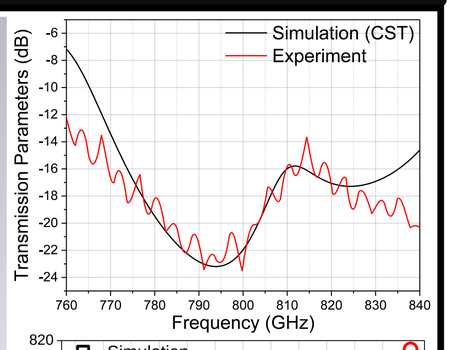


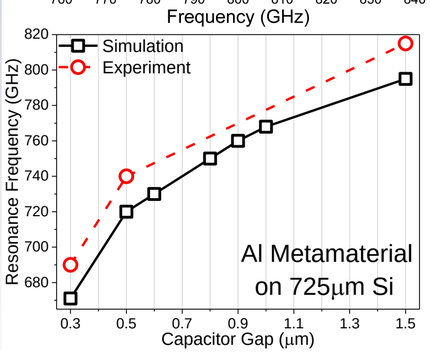
Transmitter Receiver

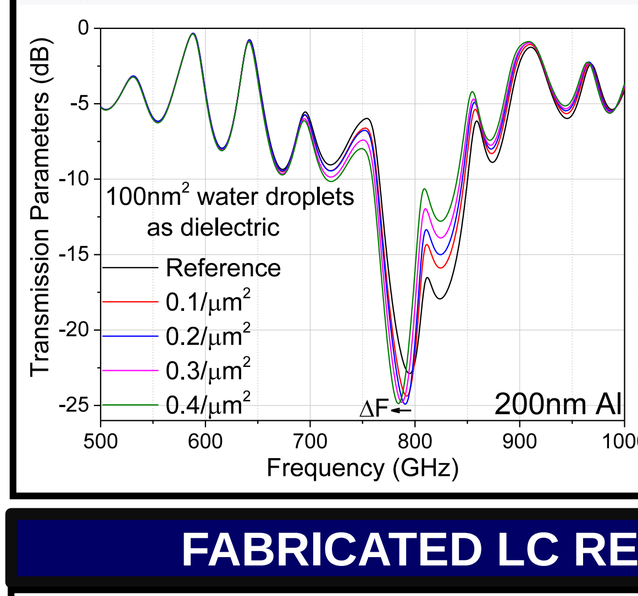


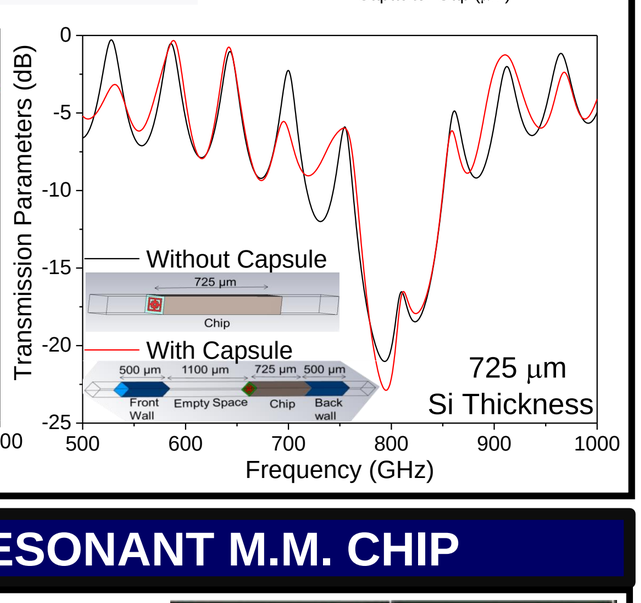
SYSTEM LEVEL M.M SIMULATIONS



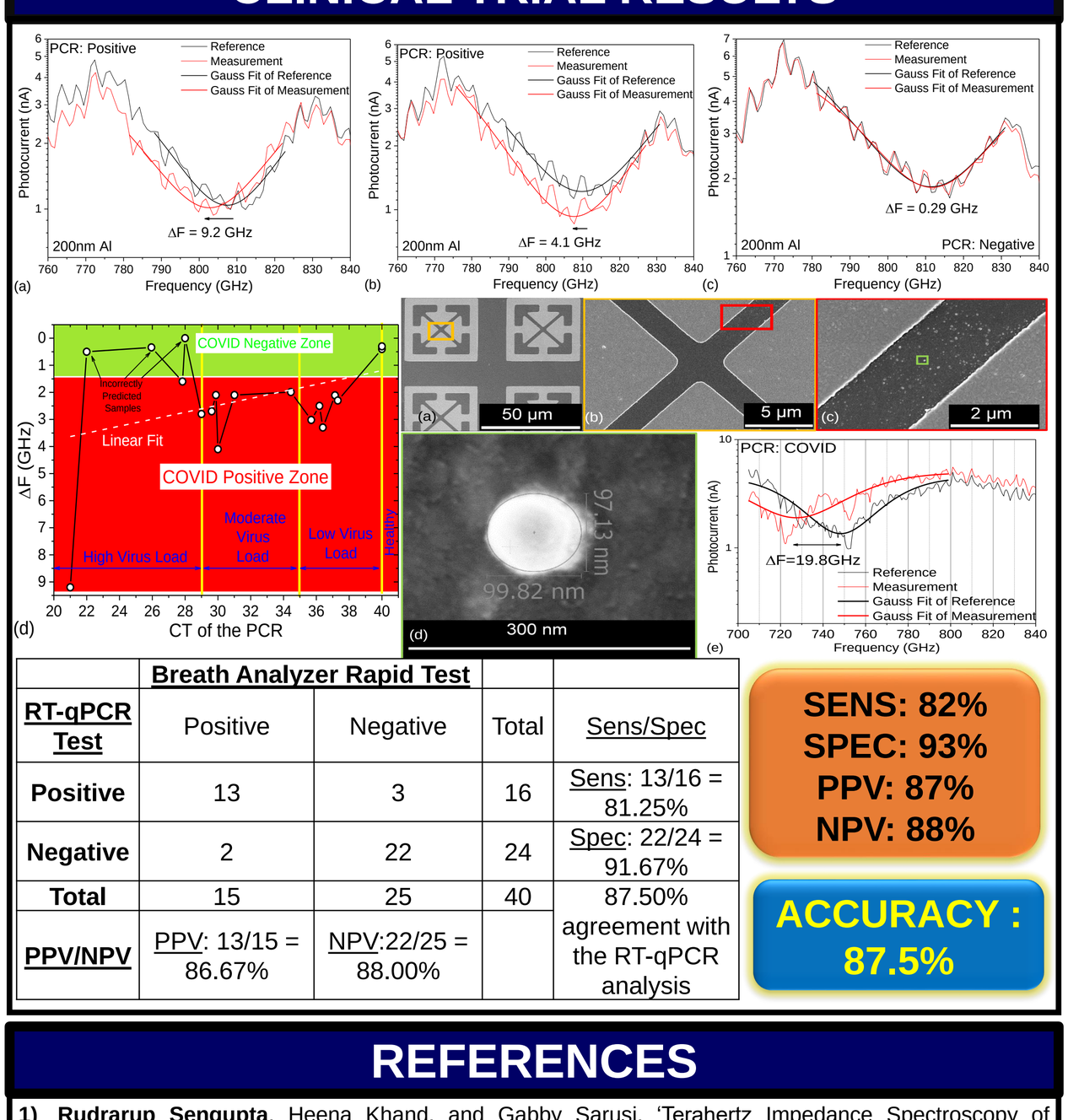








CLINICAL TRIAL RESULTS

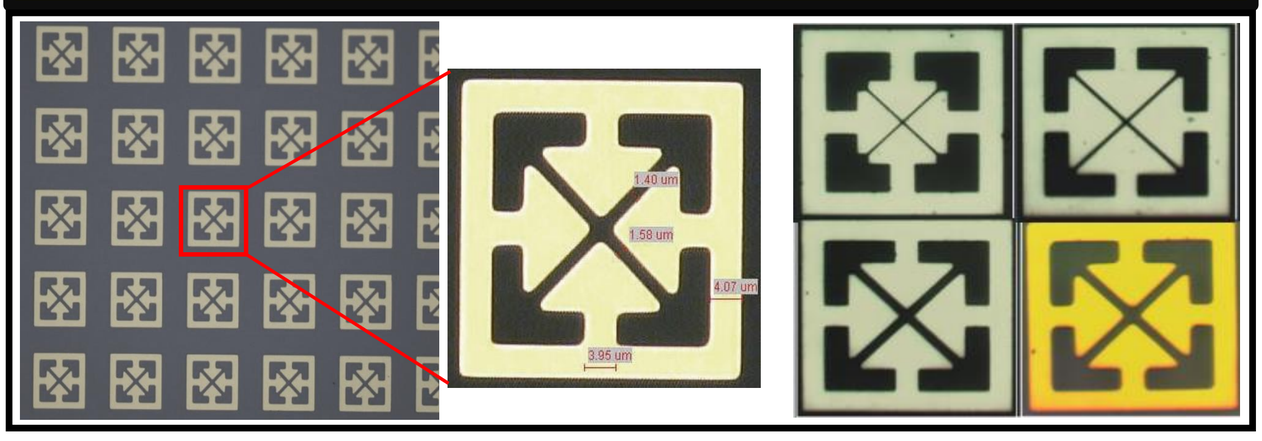


	Breath Analyzer Rapid Test			
RT-qPCR Test	Positive	Negative	Total	Sens/Spec
Positive	13	3	16	Sens: 13/16 = 81.25%
Negative	2	22	24	Spec: 22/24 = 91.67%
Total	15	25	40	87.50% agreement with the RT-qPCR analysis
PPV/NPV	PPV: 13/15 = 86.67%	NPV:22/25 = 88.00%		

SENS: 82%
SPEC: 93%
PPV: 87%
NPV: 88%

ACCURACY : 87.5%

FABRICATED LC RESONANT M.M. CHIP



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