COMSOL CONFERENCE
2015 GRENOBLE

EMPIRe Laboratory

جامعة الملك عبدالله للعلوم والتقنية
King Abdullah University of Science and Technology

Radio Frequency Resonator For Continuous Monitoring Of Parallel Droplet Microfluidic Systems

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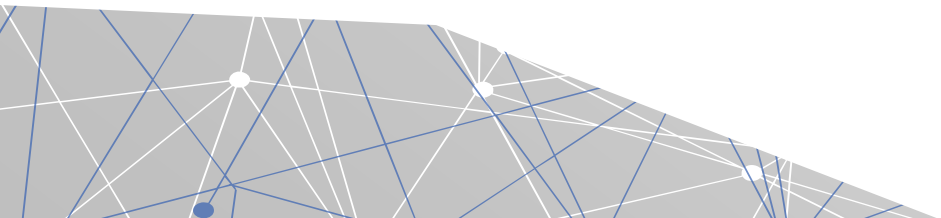

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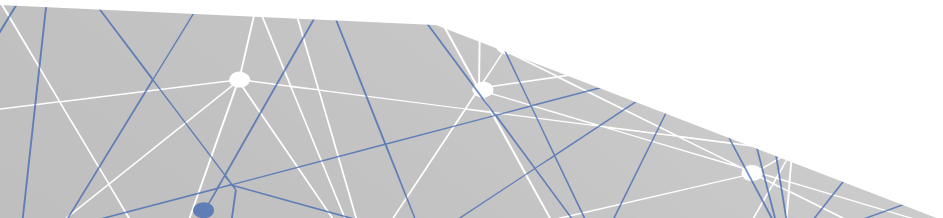
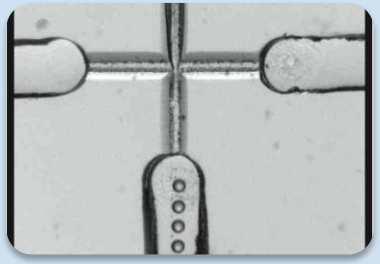
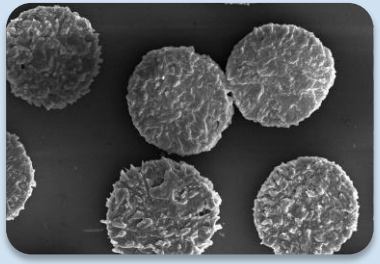


Introduction



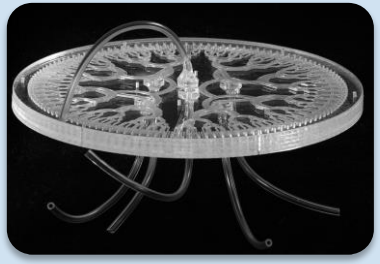
Micro Droplets

- Droplets as micro-Reactors
- Droplets as detection systems
- Greater Surface : Volume



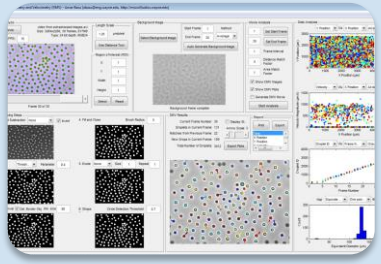
Applications for this technology

- Quantum dots
- Micro & nano particles
- Active Pharmaceutical Ingredients
- Nano crystals



Scaling up

- Parallelization
- Very challenging
- Flow are highly coupled
- Must to retain uniformity in hundreds of generators

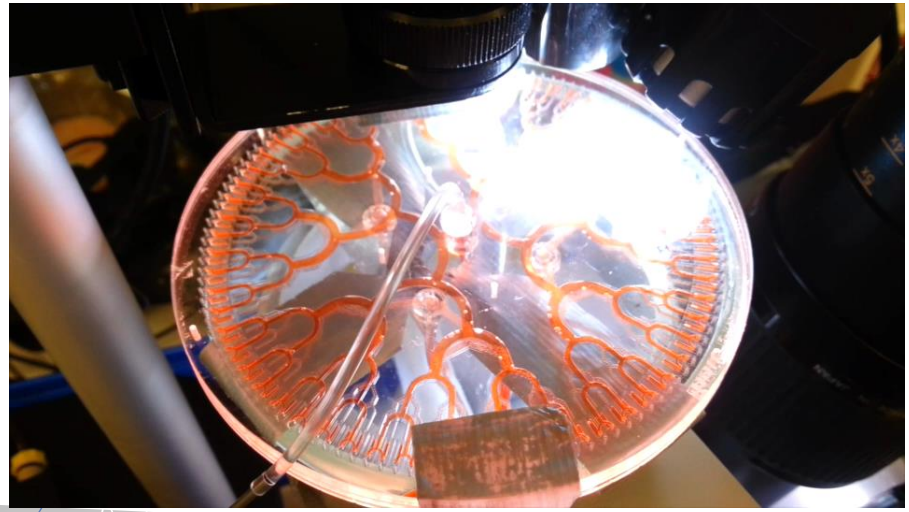


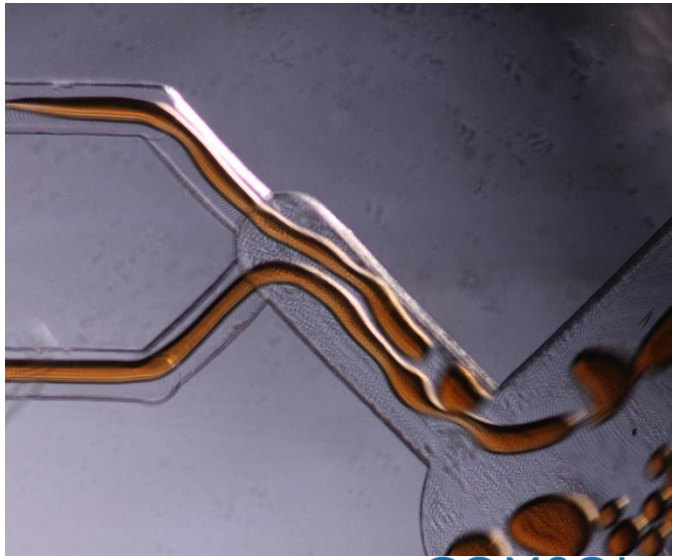
Monitoring systems

- Optical (Image processing)
- Electrical sensing
  - Impedance Measurement
  - Radio Frequency resonator

(Conchouso, 2013)

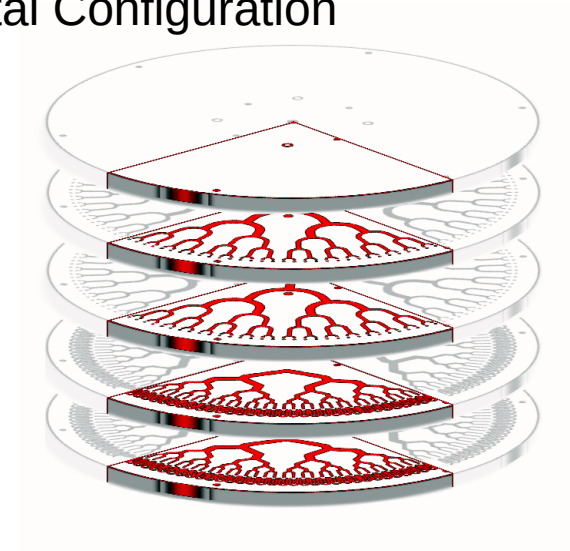
Introduction

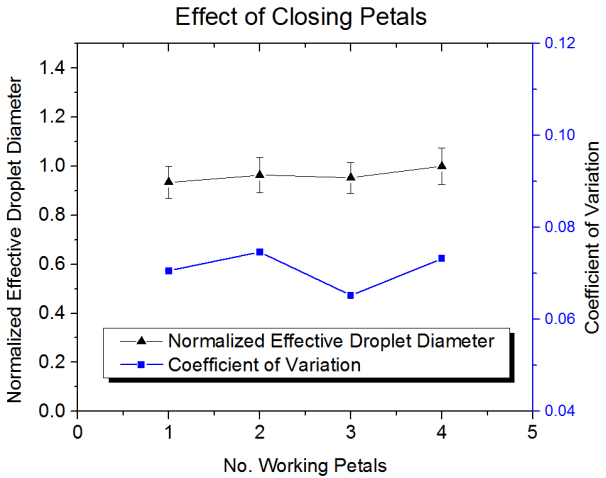




Introduction

Petal Configuration



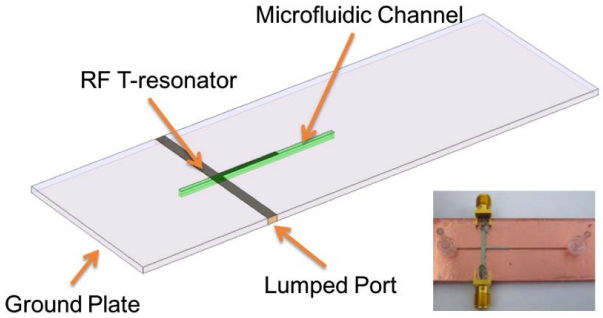


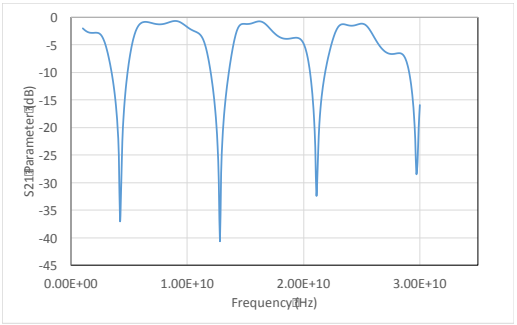
(Conchouso, 2013)

Device Description

- A radio frequency T-resonator is comprised of an open-end transmission stub and feed lines
- The system resonates at odd integer multiplies of its quarter wavelength
- Its response depend on:
  - Stub length
  - Effective Permittivity of the materials

$$L = \frac{nc}{4f\sqrt{\varepsilon_{eff}}}$$





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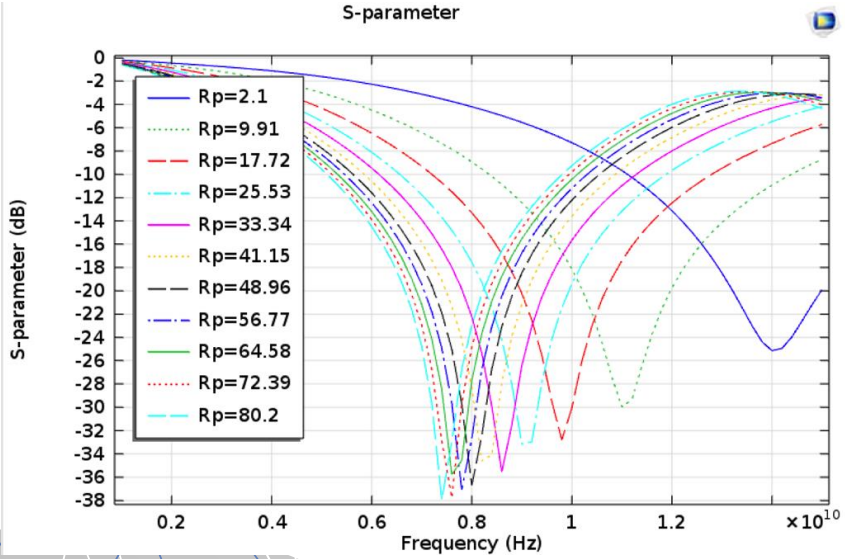
Device Description



Material	Property	Value
PMMA	ε_r	2.7
Water	ε_r	80.4
Mineral Oil	ε_r	2.1
Copper (Cu)	$\kappa(S/m)$	$5.8x10^7$
Silver (Ag)	$\kappa(S/m)$	$2.5x10^6$

Table 1: Material properties used on the simulation

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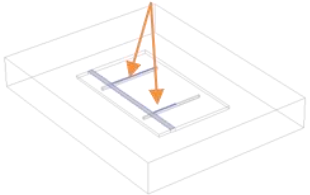
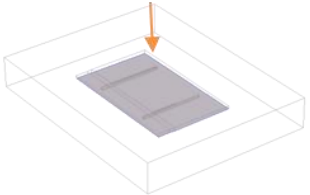
Use of COMSOL Multiphysics

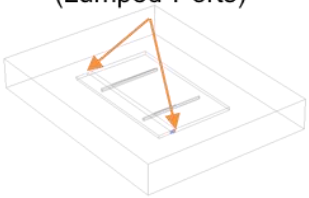
T-Resonators
(Perfect Conductor 1)



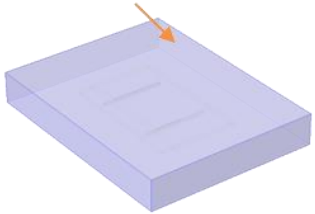
Ground
(Perfect Conductor 2)



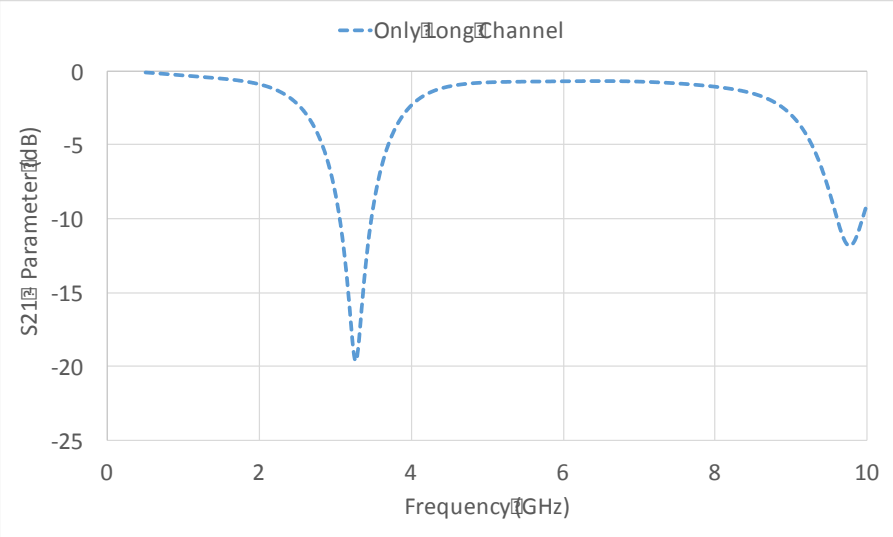
Port 1,2
(Lumped Ports)

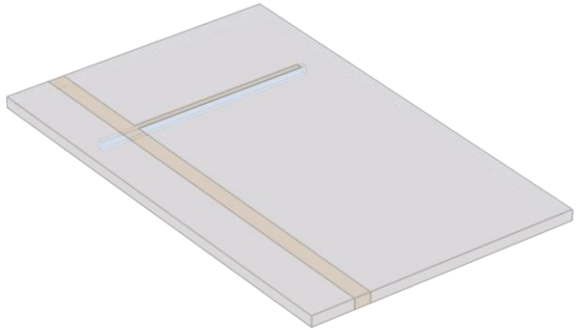


Air Box



Simulation Results & Discussion





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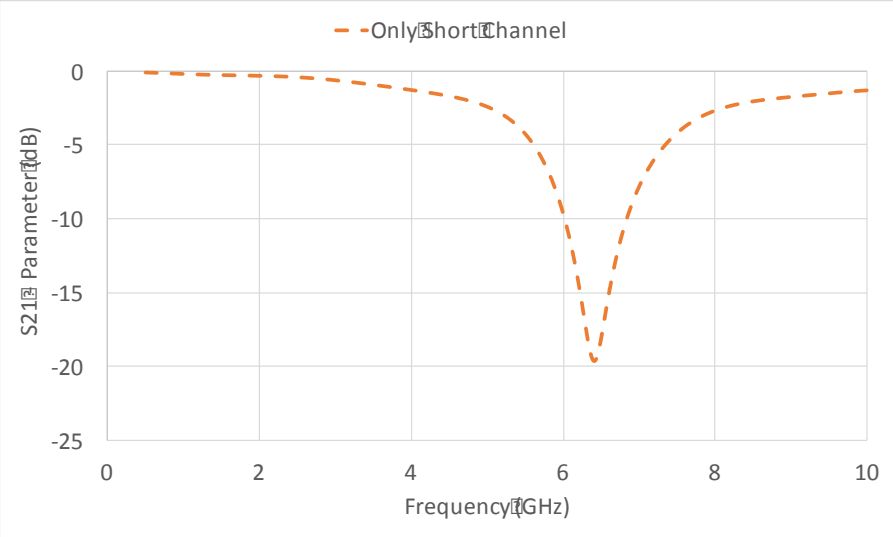

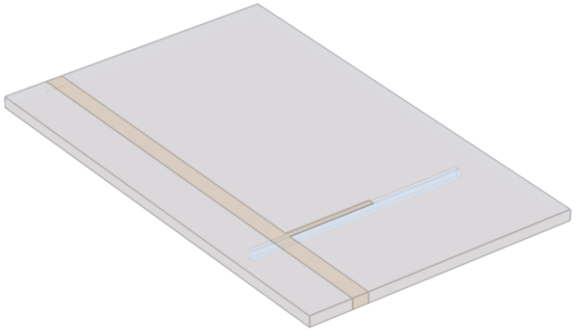

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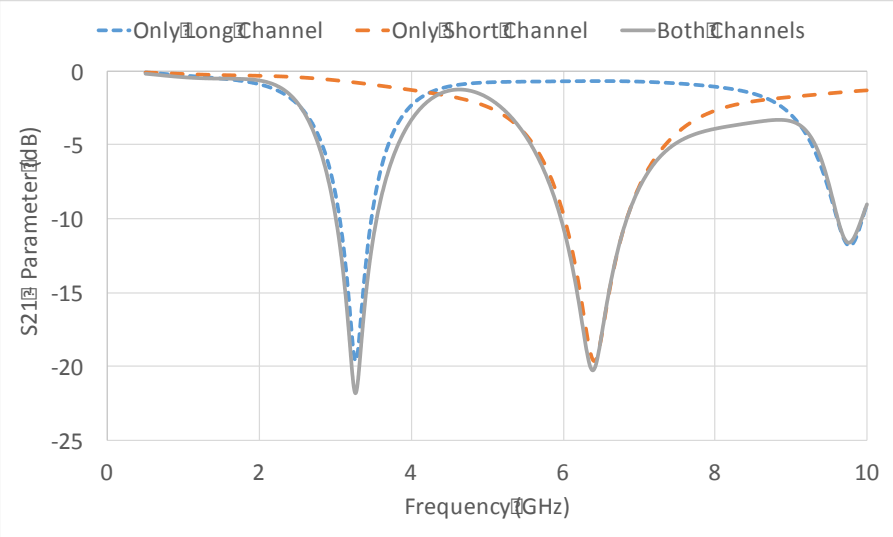

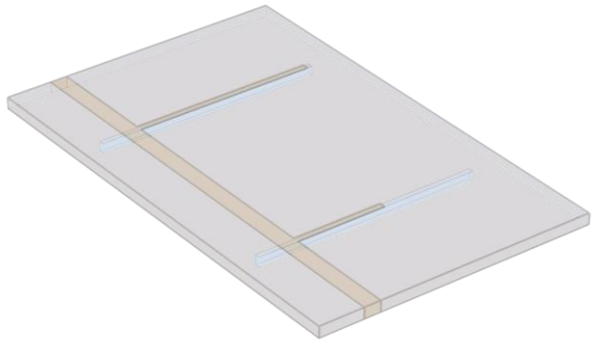

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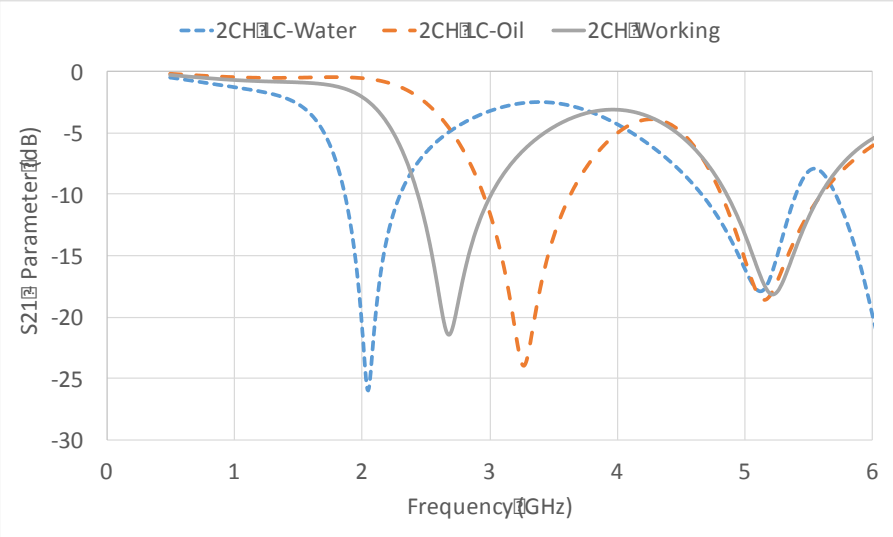

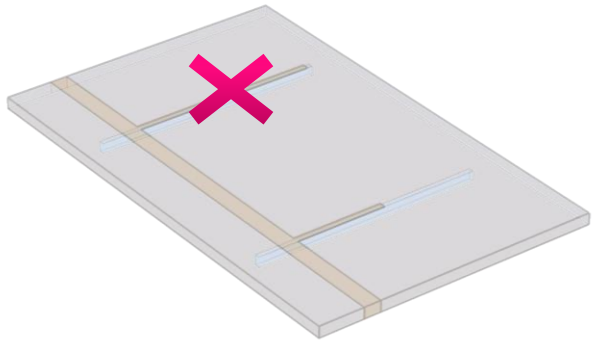

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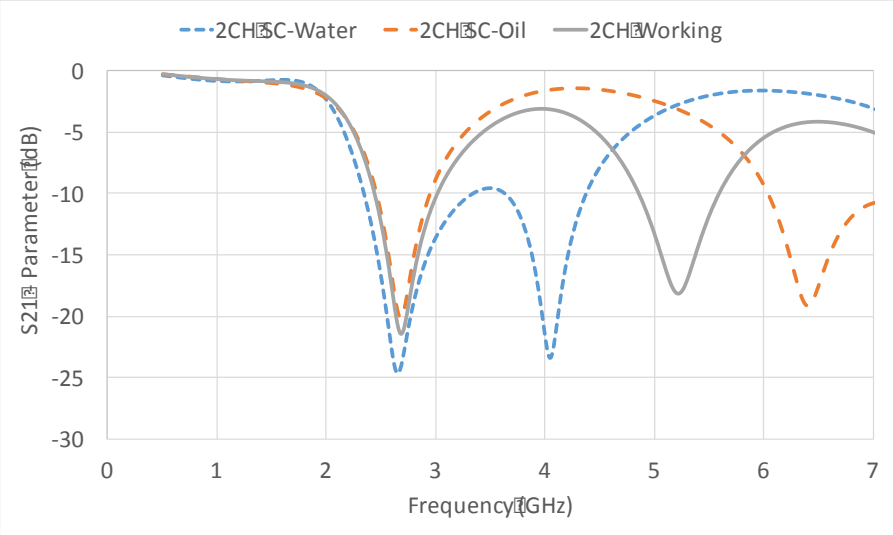

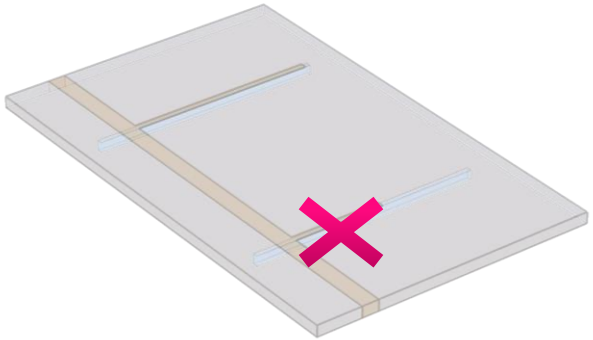

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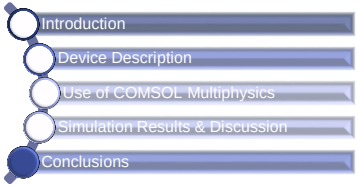
Conclusions



- RF sensing is a promising approach for monitoring parallel droplet generation
- The proposed sensor shows frequencies shifts of 50MHz for only a 5% change in water in oil content
- This technology can be integrated to current microfluidic chips and requires of fewer number of probes
- The number of resonators cannot be expanded to several because each needs a finite bandwidth to operate independently.
- COMSOL allowed us to quickly vary design parameters for optimization and design

Merci Beaucoup!!
Happy to take any questions.