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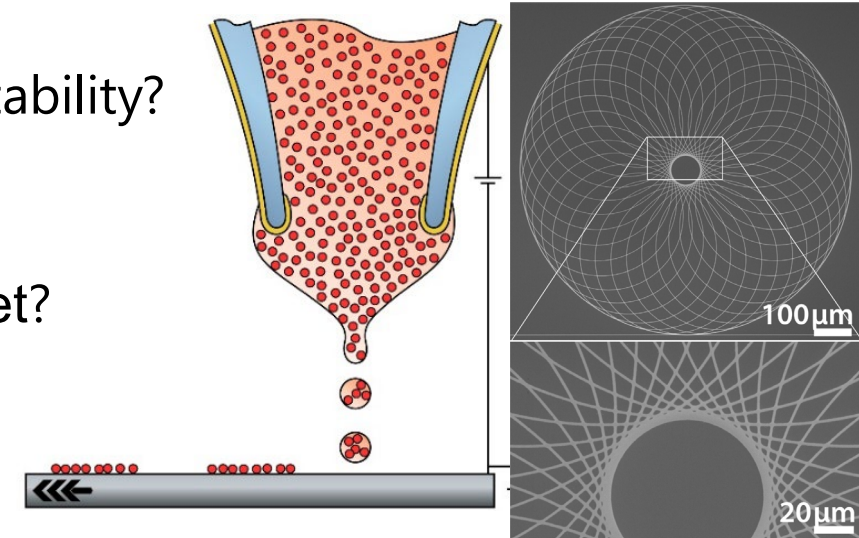
■ Problematic:

- What is the effect of nozzle voltage on the jet shape and stability?
 - Methodology: Numerical Simulation ( COMSOL)

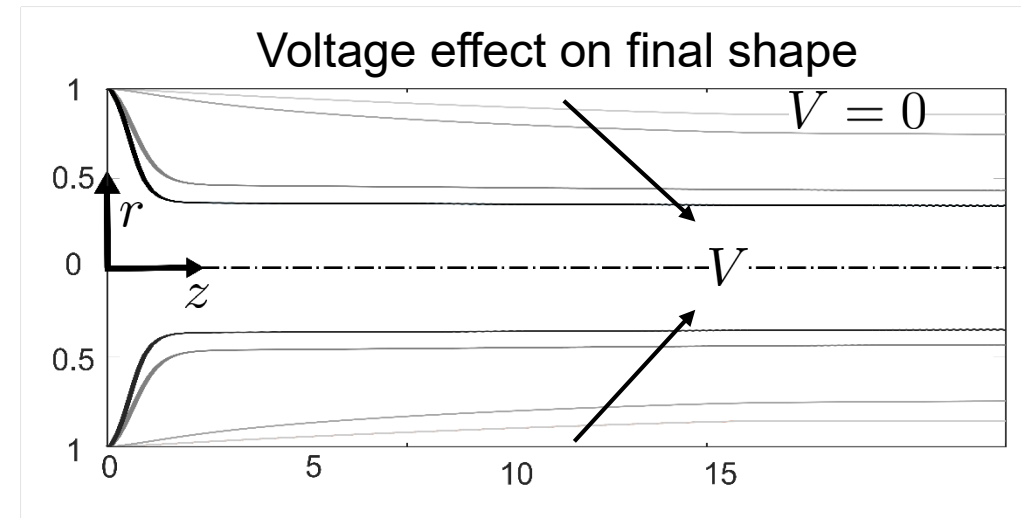
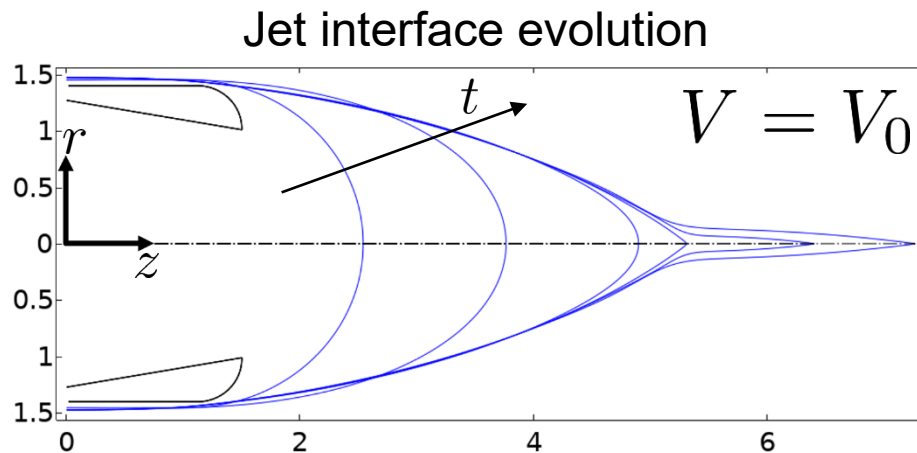
■ Achievements: Validated non-linear modeling of EHD jetting

■ Outlook: How to control the output of particulate electrified jet?

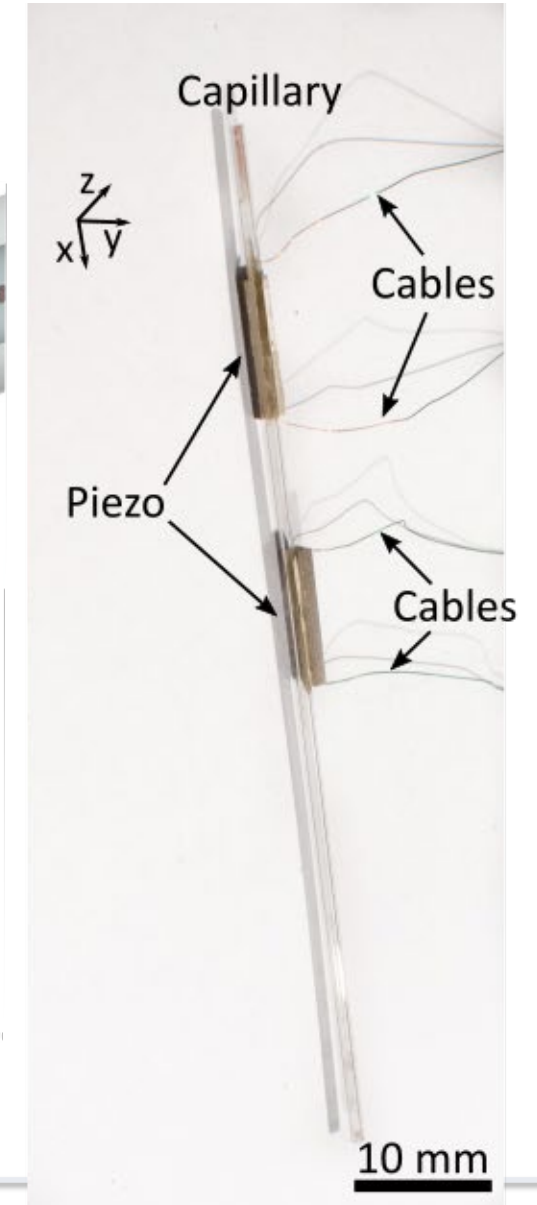
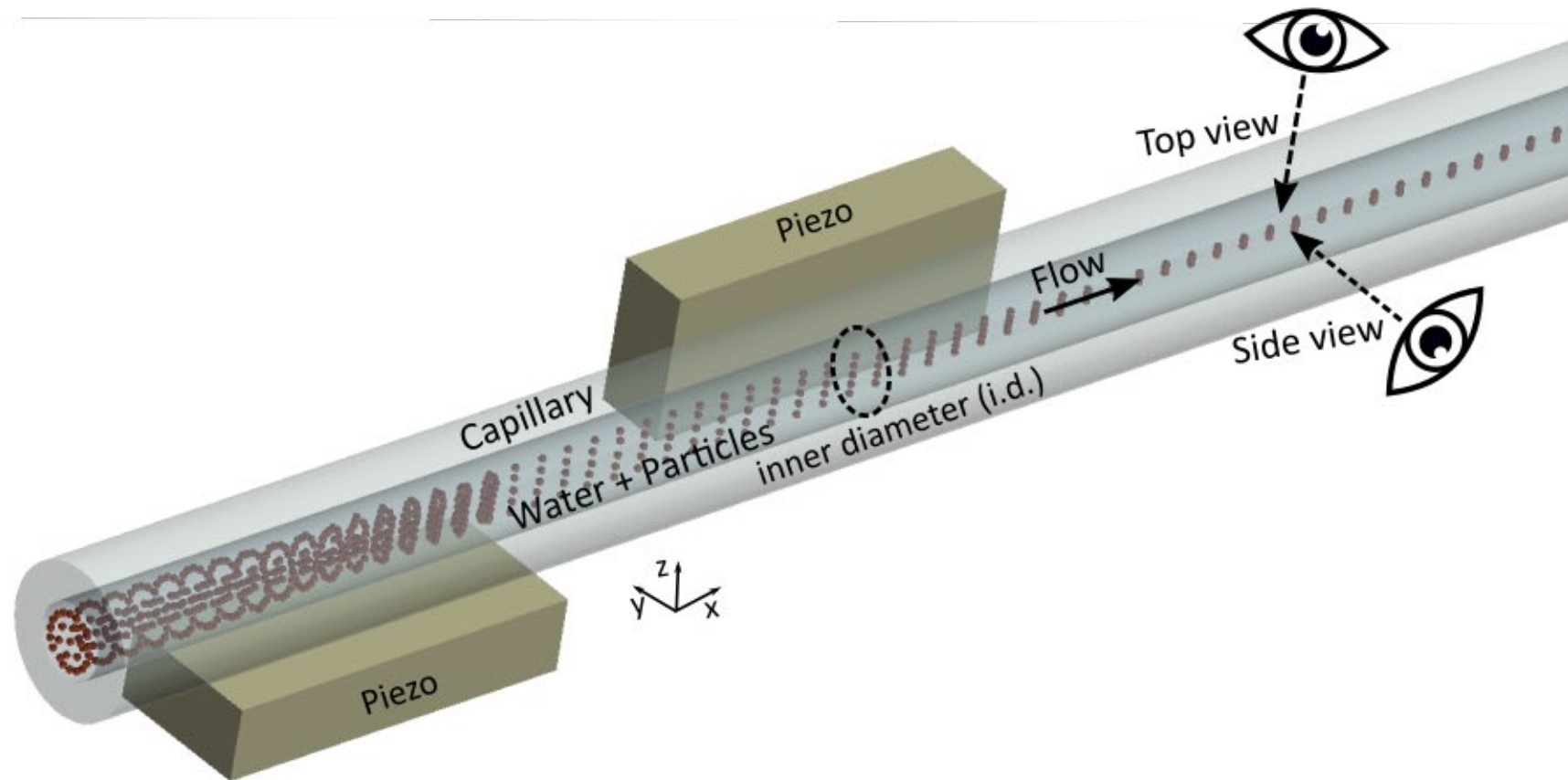
- Drawing flow diagram: jet vs cone-jet
- Stability of the jet: droplet size



Dimensionless simulations



Operating Principle



Polystyrene Particle Focusing

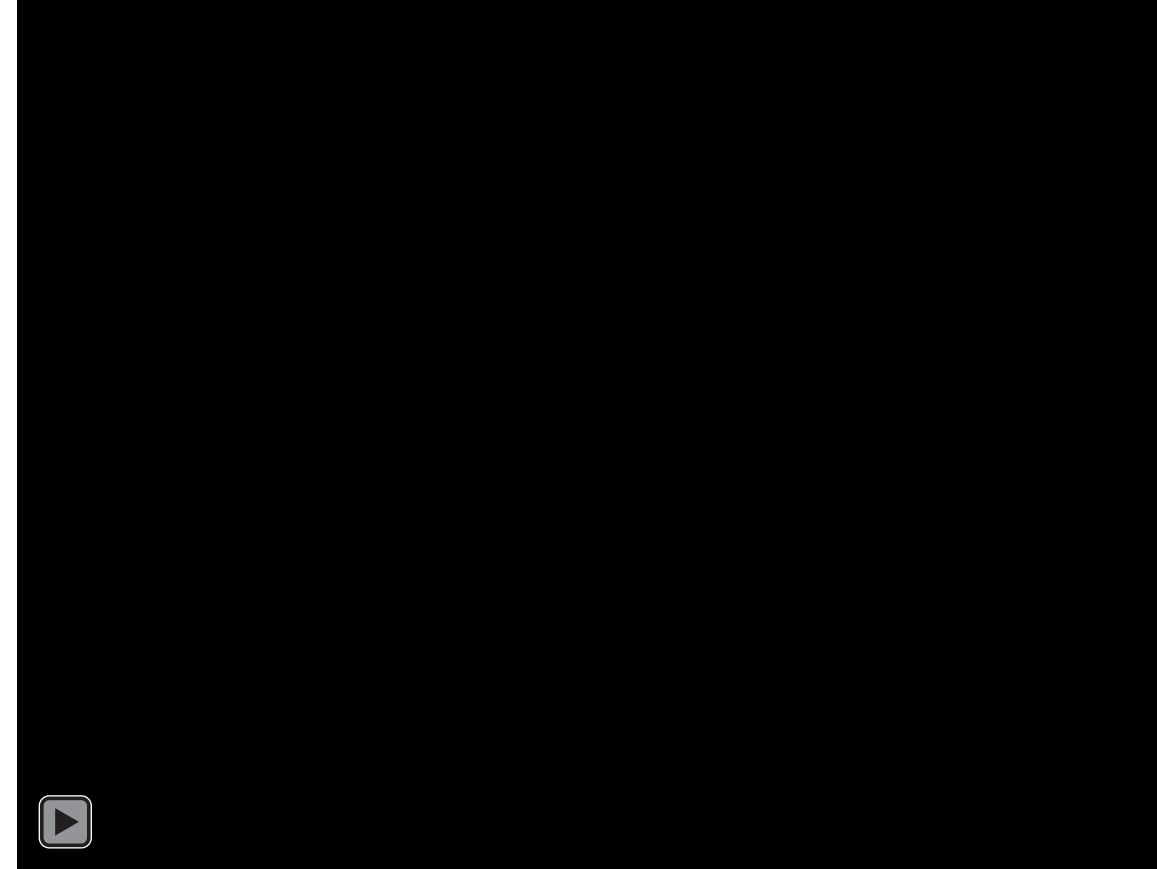
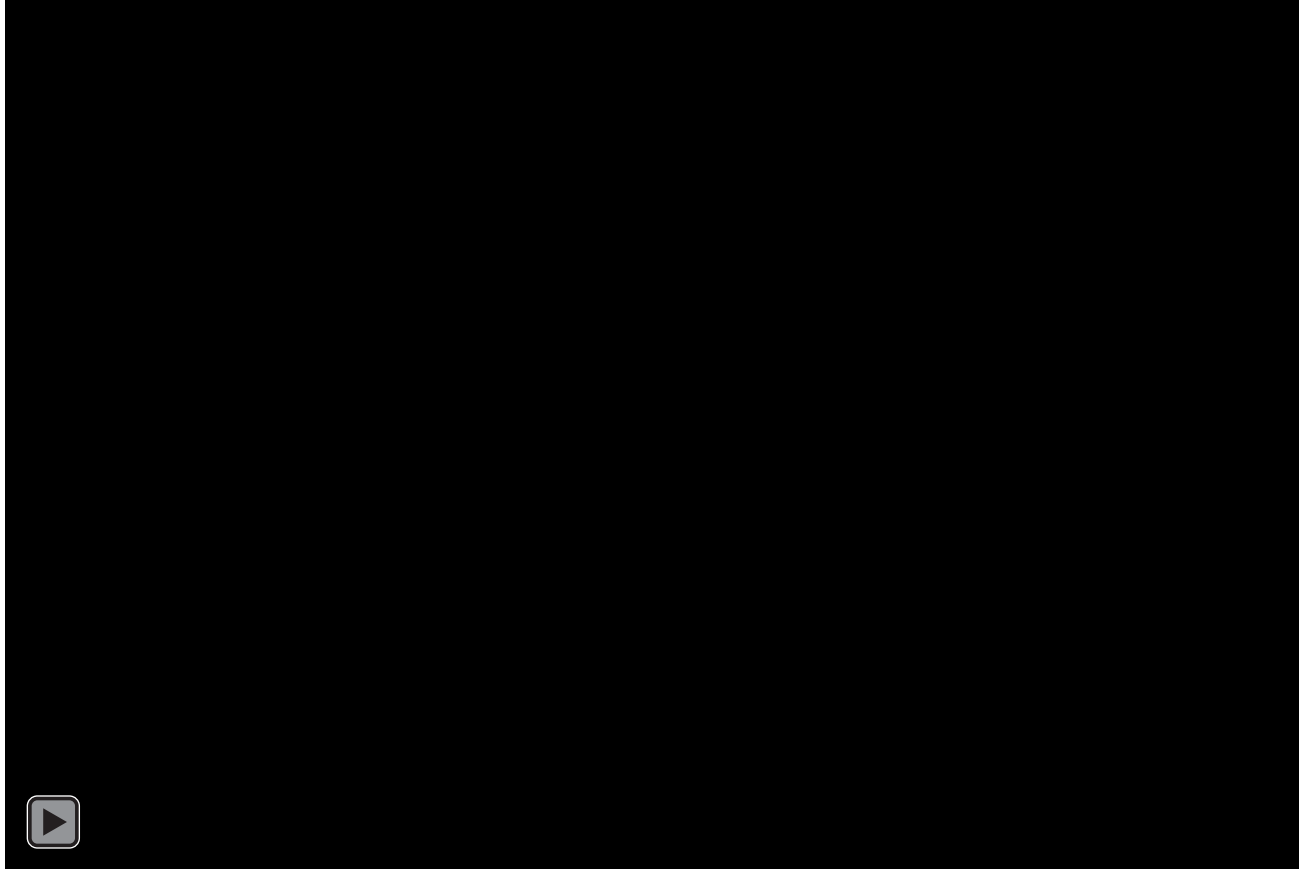
5 μm PS Particle5 μm PS Particle

Top View

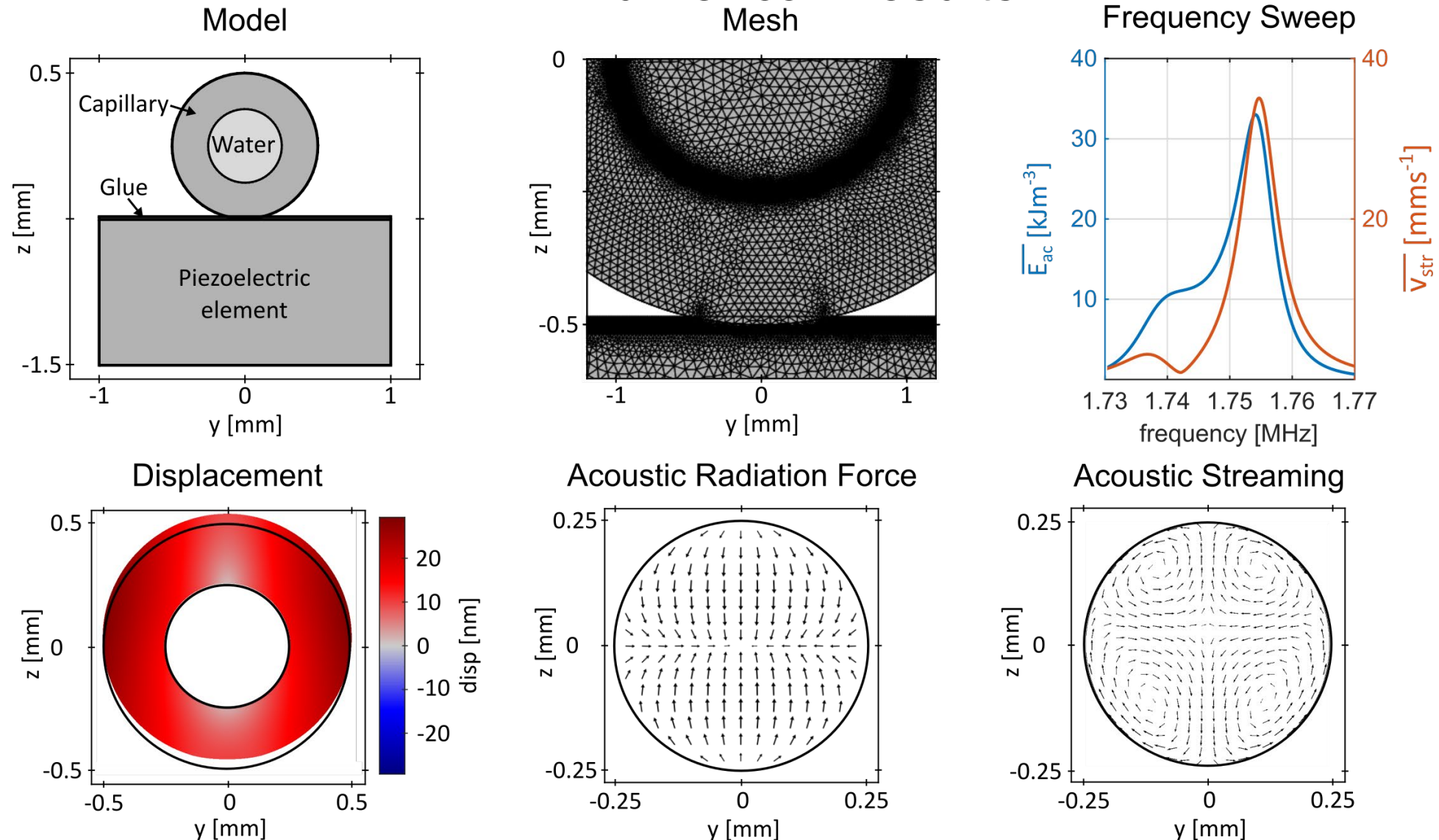
Side View

Top View

Side View

 $Q = 100 \mu\text{L min}^{-1}$ $V = 15 V_{PP}$
 $f = 1.74 \text{ MHz}$
 $C = 0.05\% \text{ v/v}$ $Q = 5 \mu\text{L min}^{-1}$

Numerical Results



1 μm Copper Particle Focusing

Top View

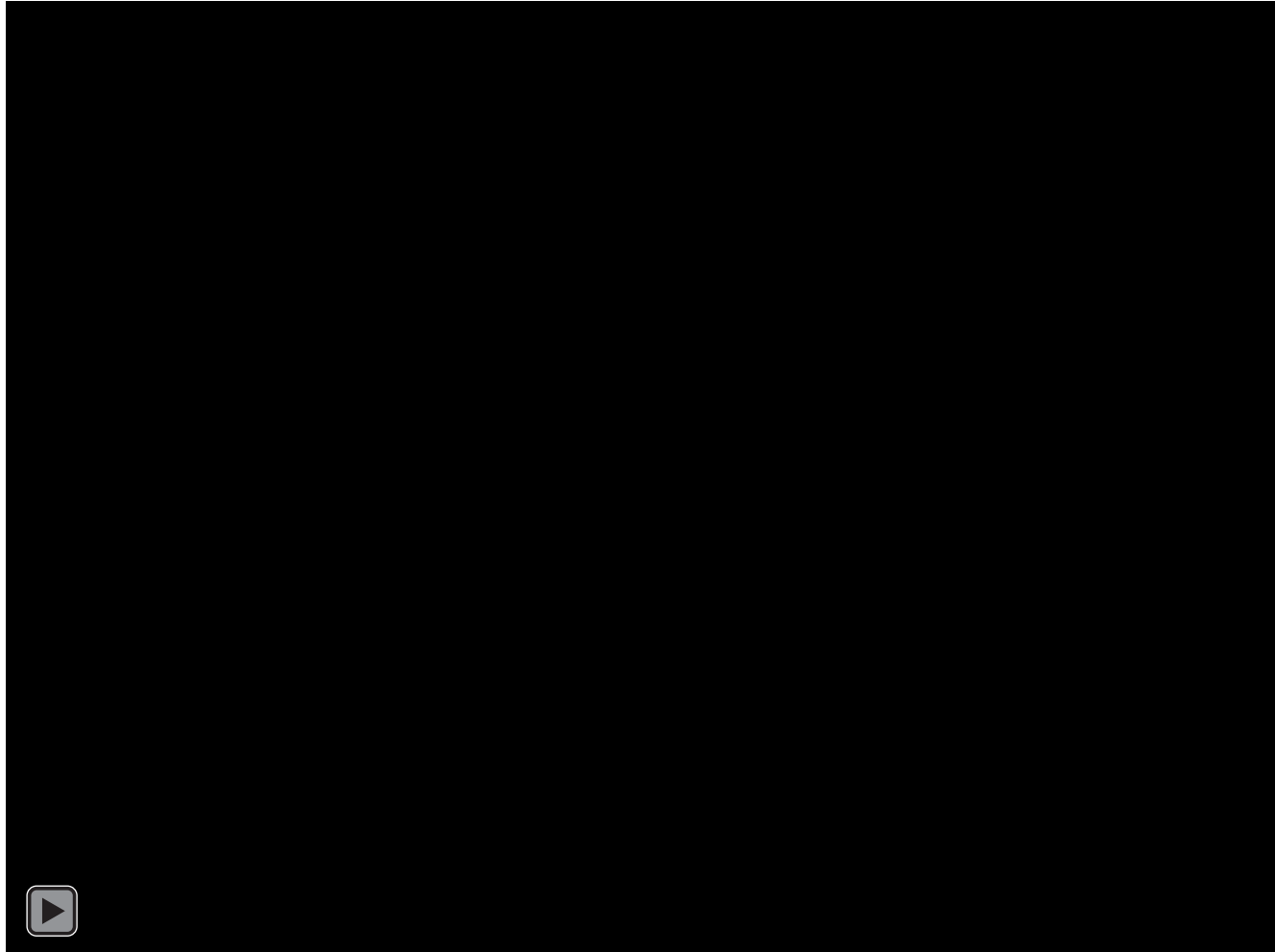
Side View

$$Q = 100 \mu\text{L min}^{-1}$$

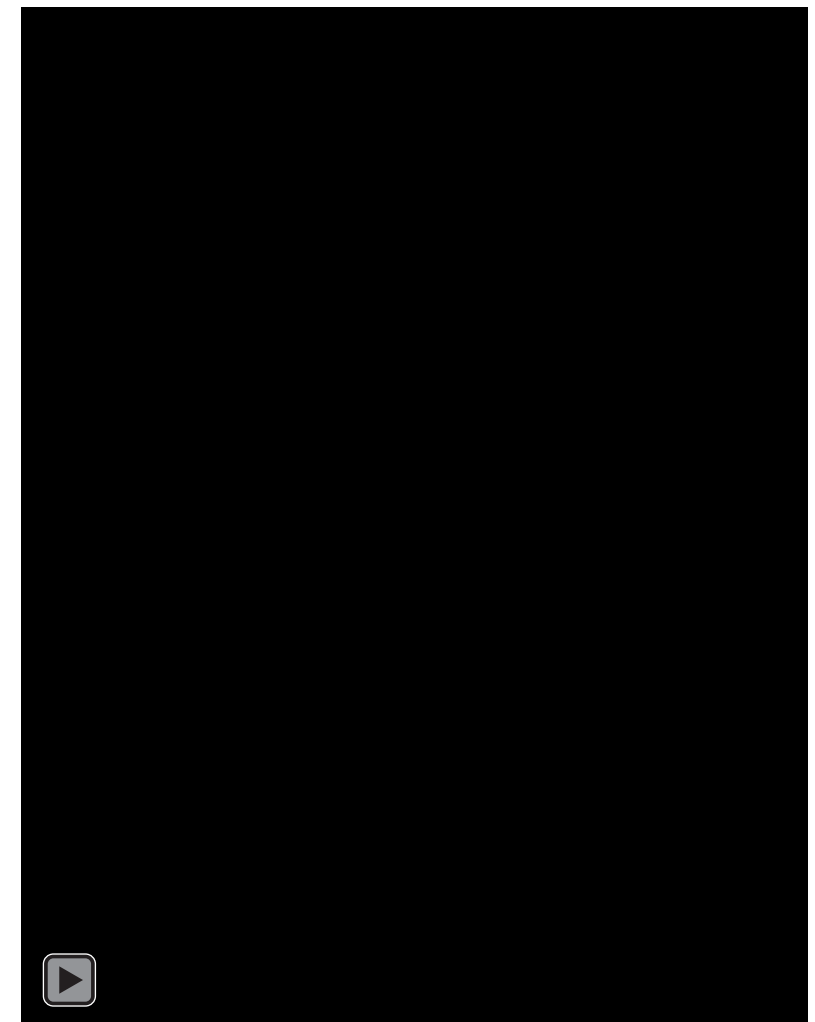
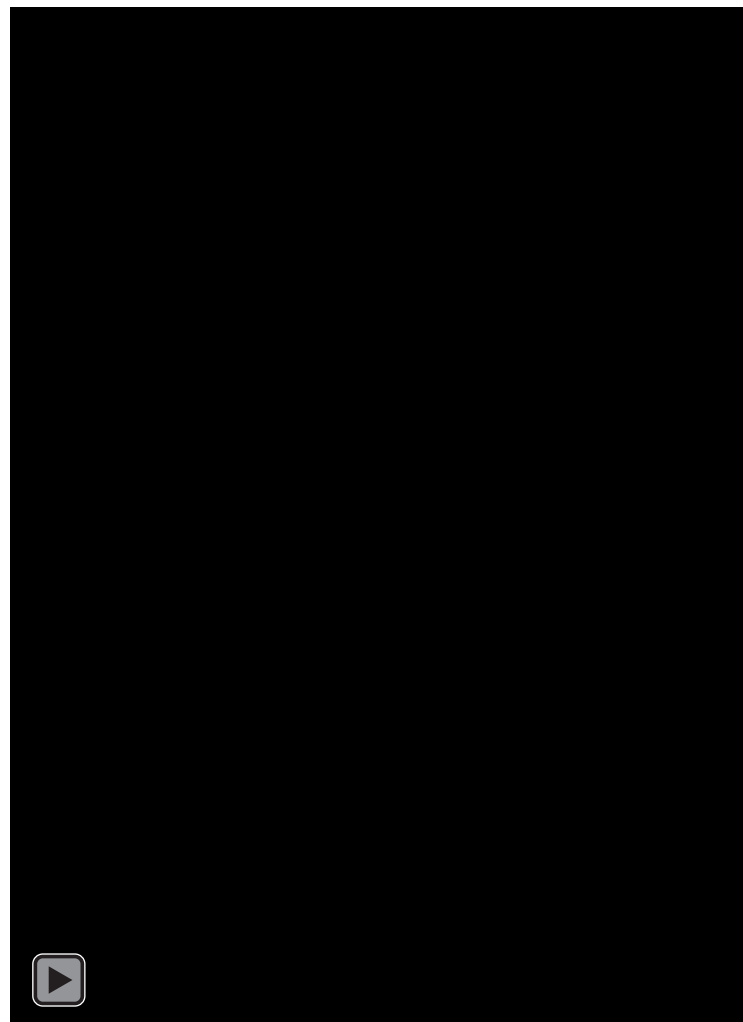
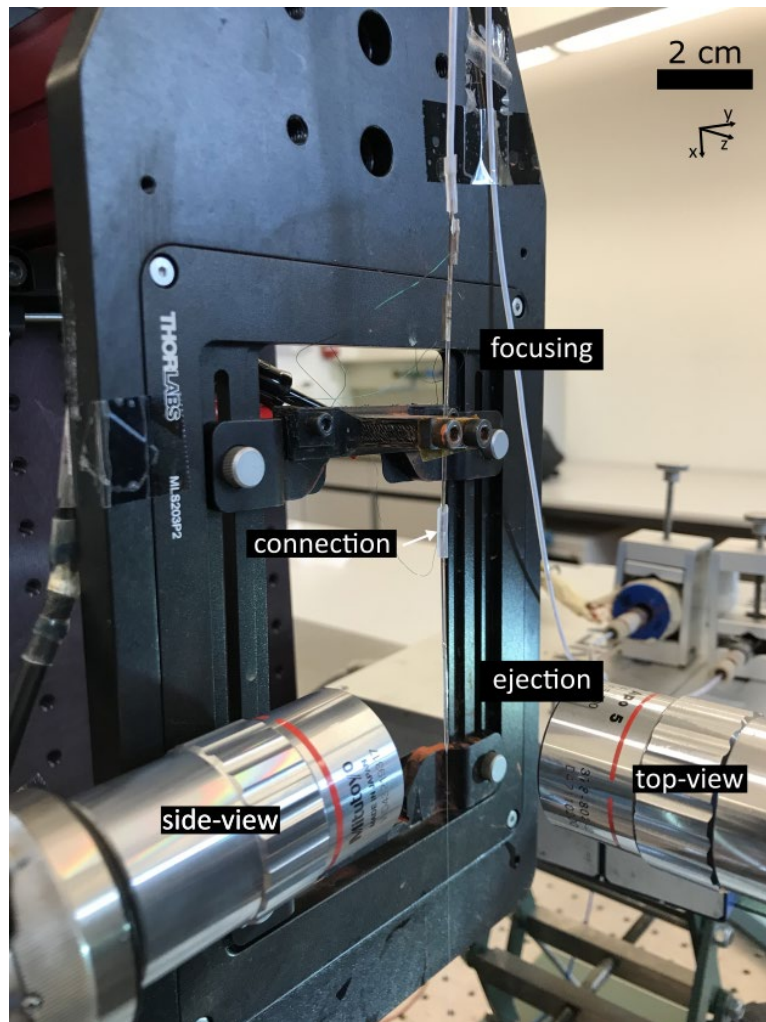
$$V = 15 V_{\text{PP}}$$

$$f = 1.74 \text{ MHz}$$

$$C = 0.5\% \text{ v/v}$$

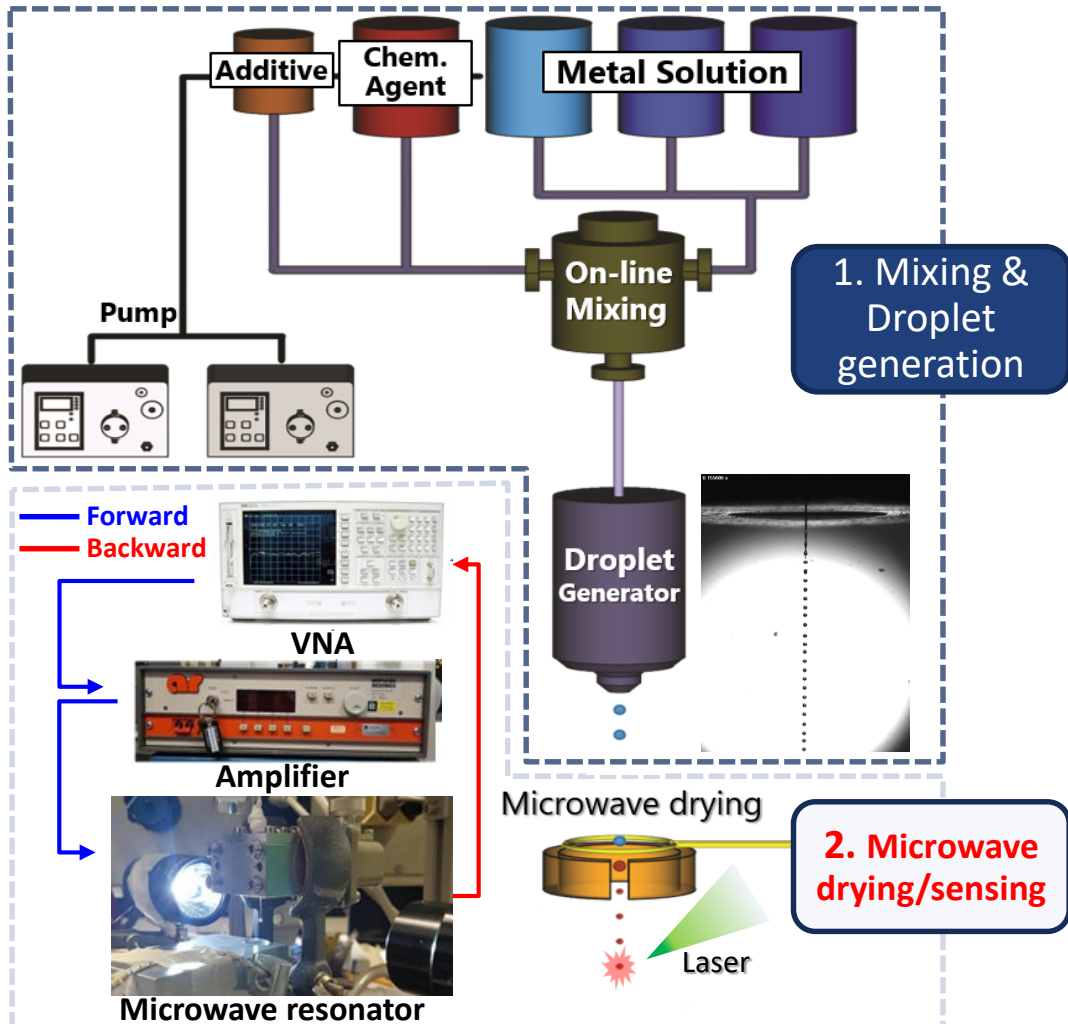


Experimental Setup Metal Particle Ejection

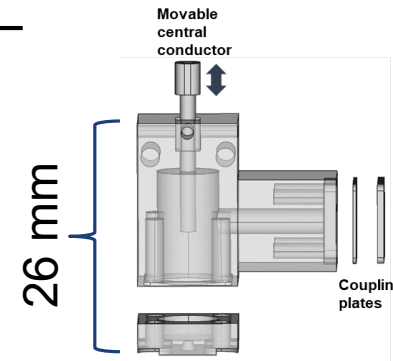
 $Q = 200 \mu\text{L min}^{-1}$ $C = 2\% \text{ v/v}$ $f = 1.74 \text{ MHz}$ $V = 15 \text{ V}_{\text{pp}}$

High-throughput droplet generation and microwave resonator

Concept

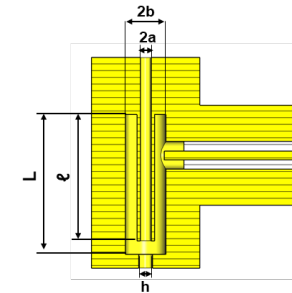


Cylindrical resonator microwave drying

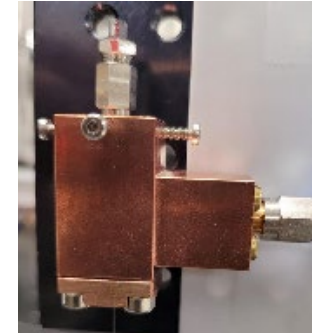


<Design>

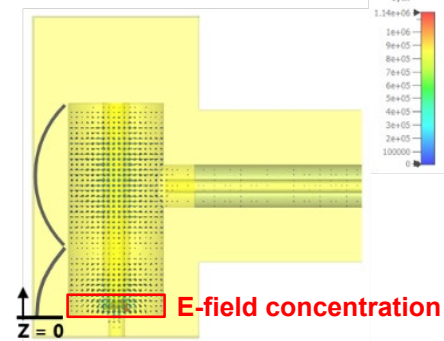
A new miniaturized resonator is developed not only for heating but also for sensing



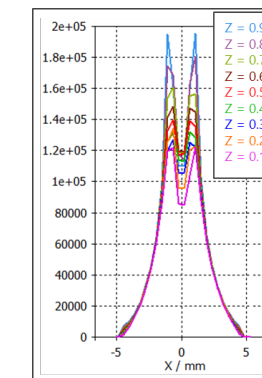
<Model>



<Real part>

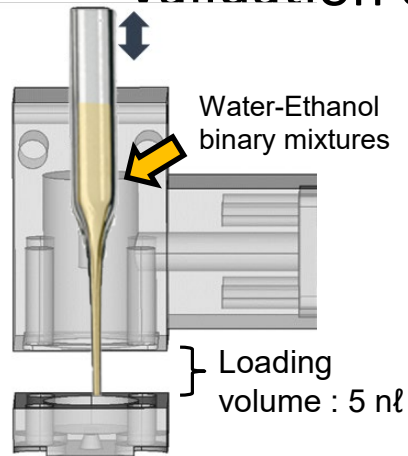


<Electric field distribution>



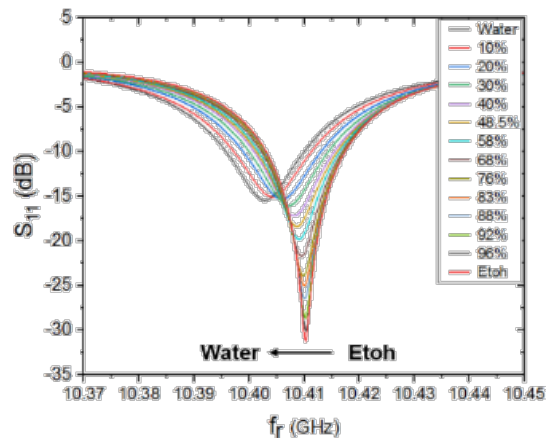
The electrical field is concentrated in the gap between a central conductor and an outer wall.

Validation of new developed MW resonator for sensing in nano-liters range

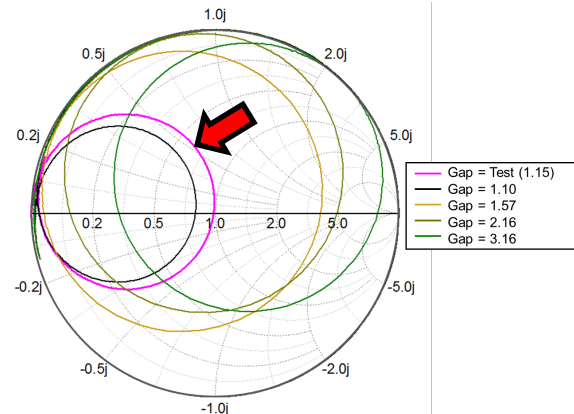


<Set up for static sensing>

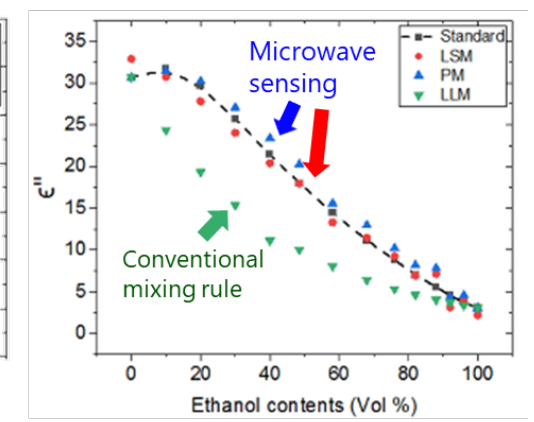
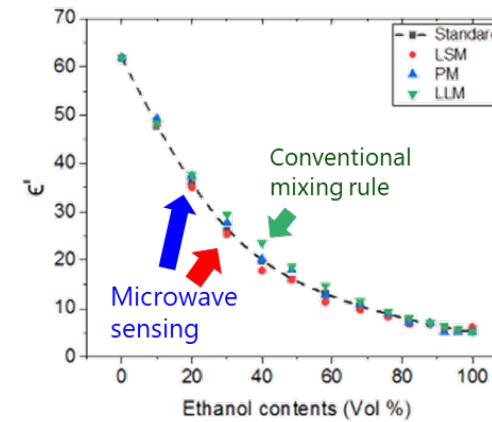
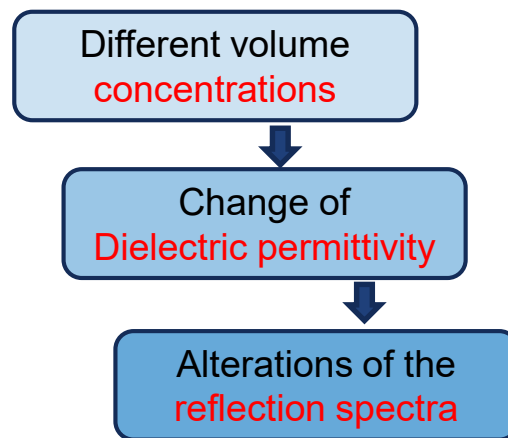
Various concentrations of water-ethanol mixtures were loaded through a \varnothing 80 μ m capillary in a critically coupled system. (Loading volume: 5 nL)



<Reflection spectra>

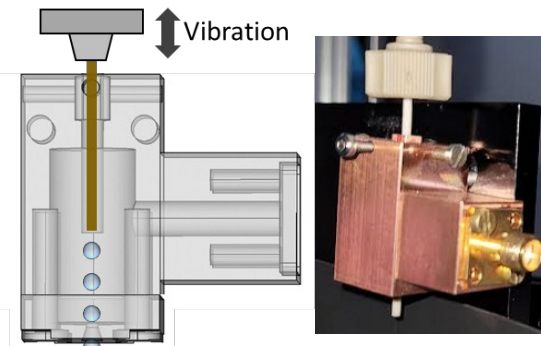


<Smith chart>

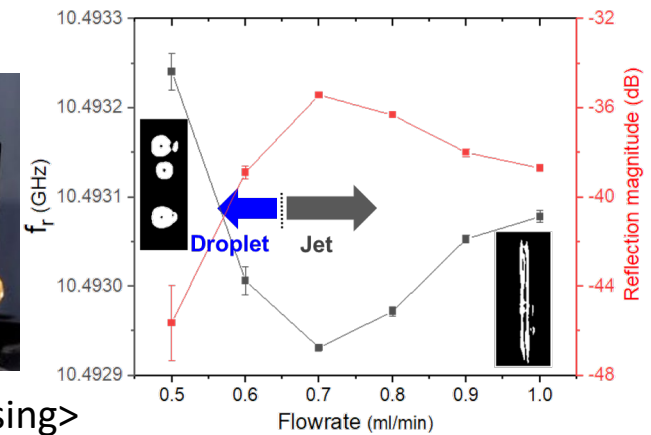


<Complex permittivity>

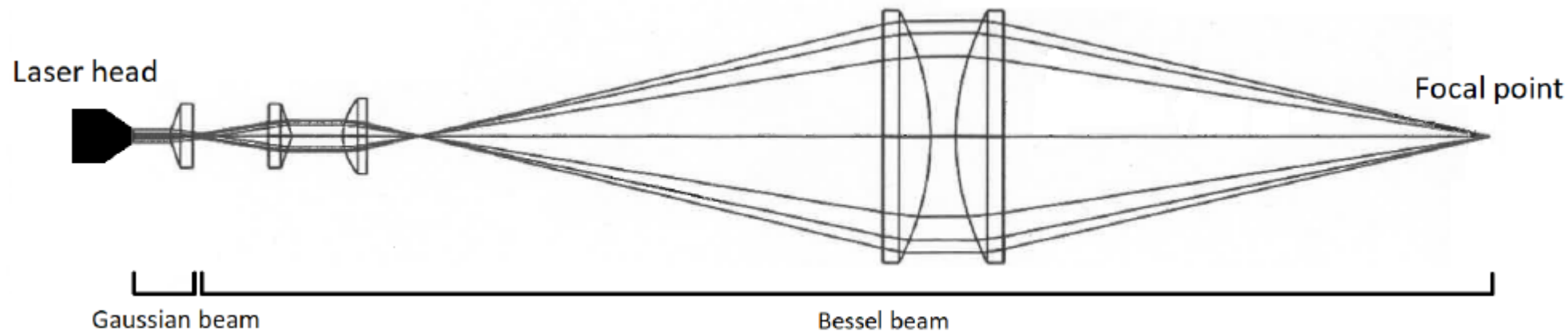
The complex dielectric permittivity (ϵ' , ϵ'') is successfully extracted from the resonance behavior based on the resonance frequency and quality factor (Max. error: 12 %)



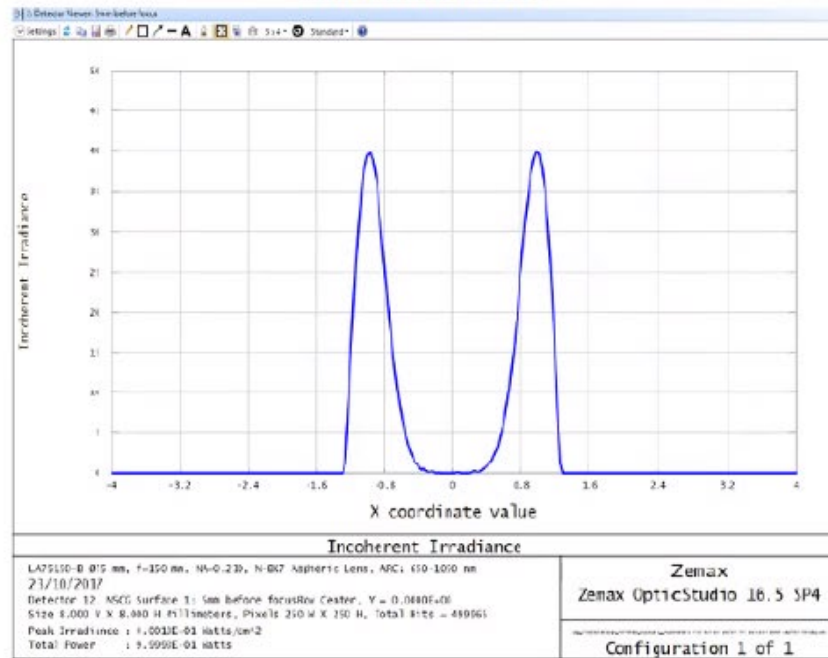
<Set up for dynamic sensing>



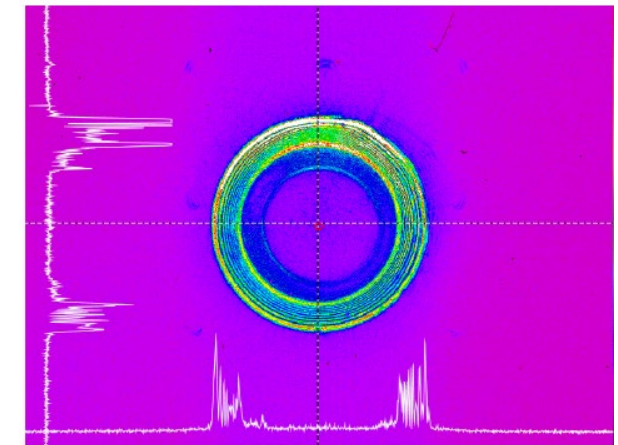
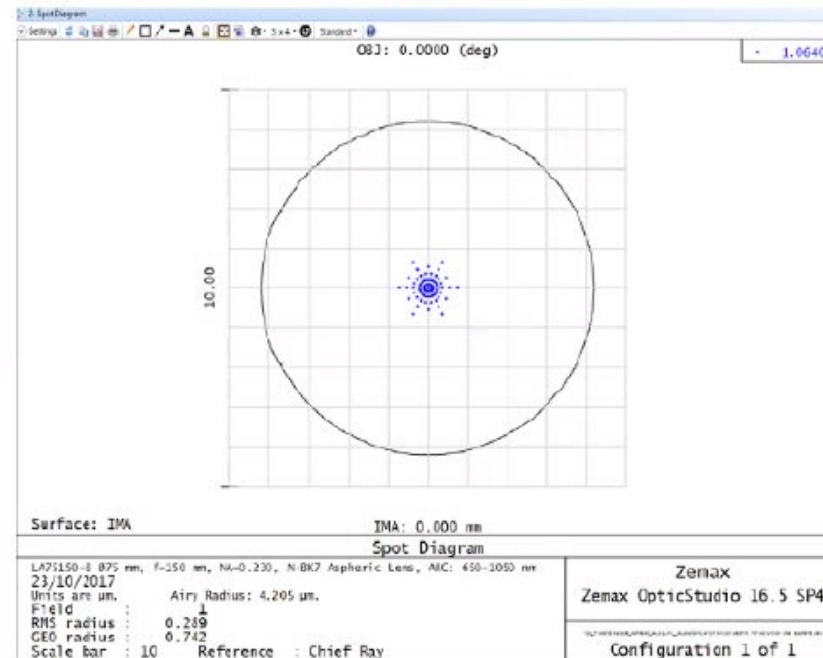
A sensor can distinguish a jet and a droplet flow by the resonance deviation



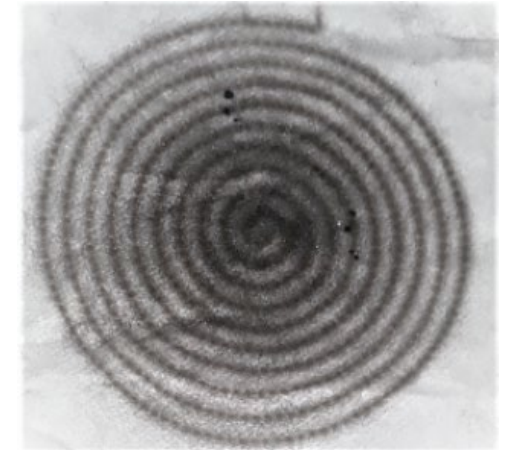
5mm before focus



at focus

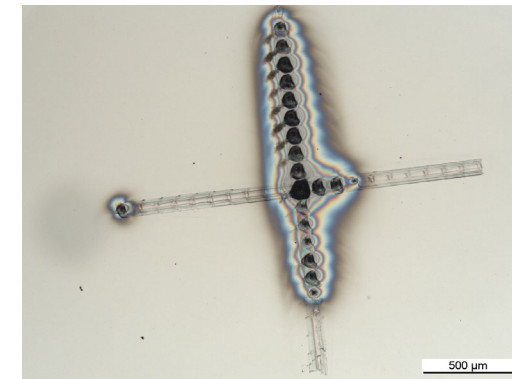
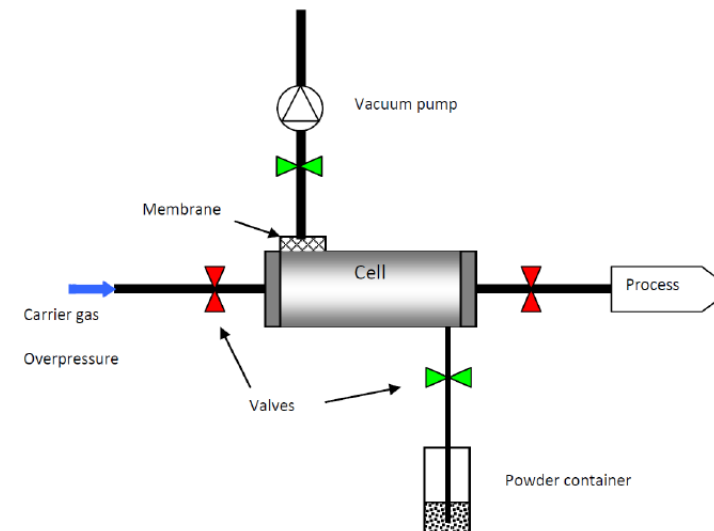


Powder feed 3-D printer @ Empa



Si powder (1 μm diameter)
printed on paper 100 μm line width

Dr. Sébastien Vaucher
Dr. Briac Lanfant
Master thesis: Anurag Singhania
Master thesis internship: Maxime Kaczmarek
Arnaud Mader
Christian Affolter
Christoph Amsler



Conclusions – interesting structures but no spring!

Output:

Several publications

3 PhD thesis (1 accomplished, 2 ongoing)

Several master thesis (4 – 6)

Several students projects – educational

Increased understanding of processes

Research - Serendipity – Innovation – Engineering

Thank you !

