# ADVANCES ON MODELLING THE ATOMIZATION OF ELECTROHYDRODYNAMIC JETS

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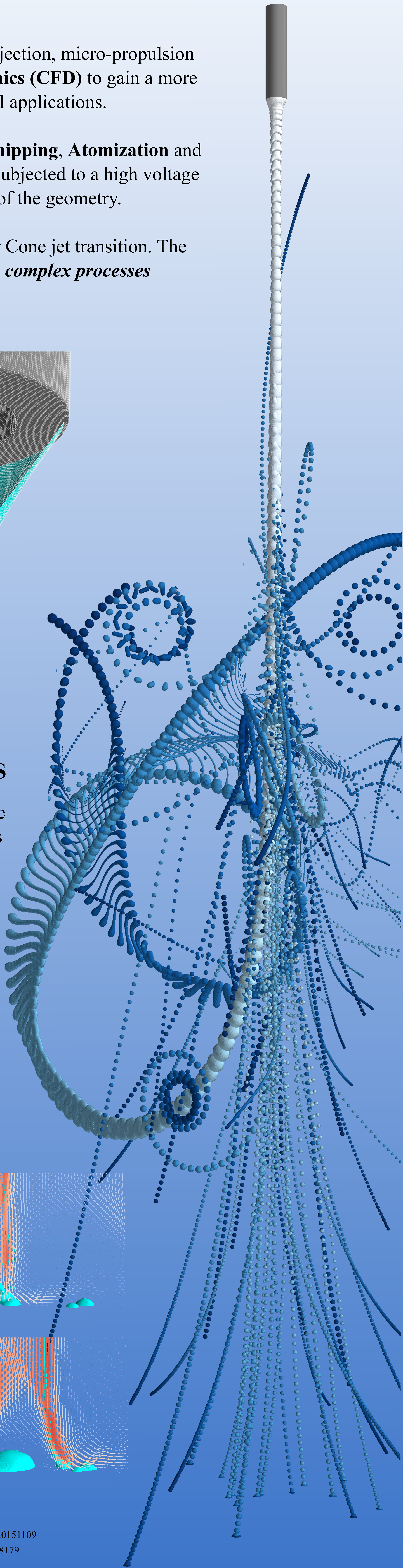
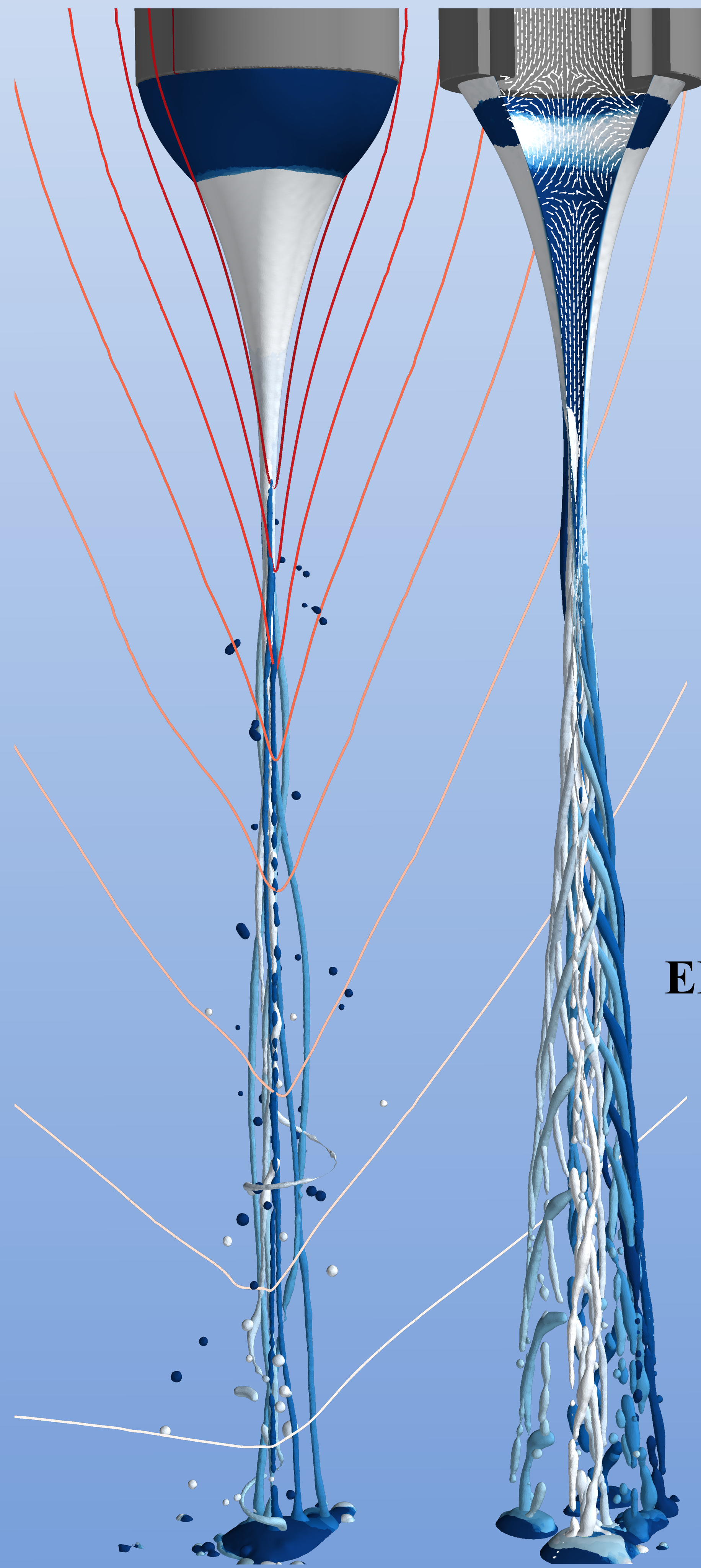
## TRANSIENT ELECTROHYDRODYNAMIC NUMERICAL SIMULATIONS

**Electrohydrodynamic (EHD) jets** are widely utilized in a variety of applications, including drug delivery, fuel injection, micro-propulsion and spray coating. This study endeavors to integrate **fully three dimensional (3D) computational fluid dynamics (CFD)** to gain a more profound understanding of the atomization of electrohydrodynamic jets and their implications for various industrial applications.

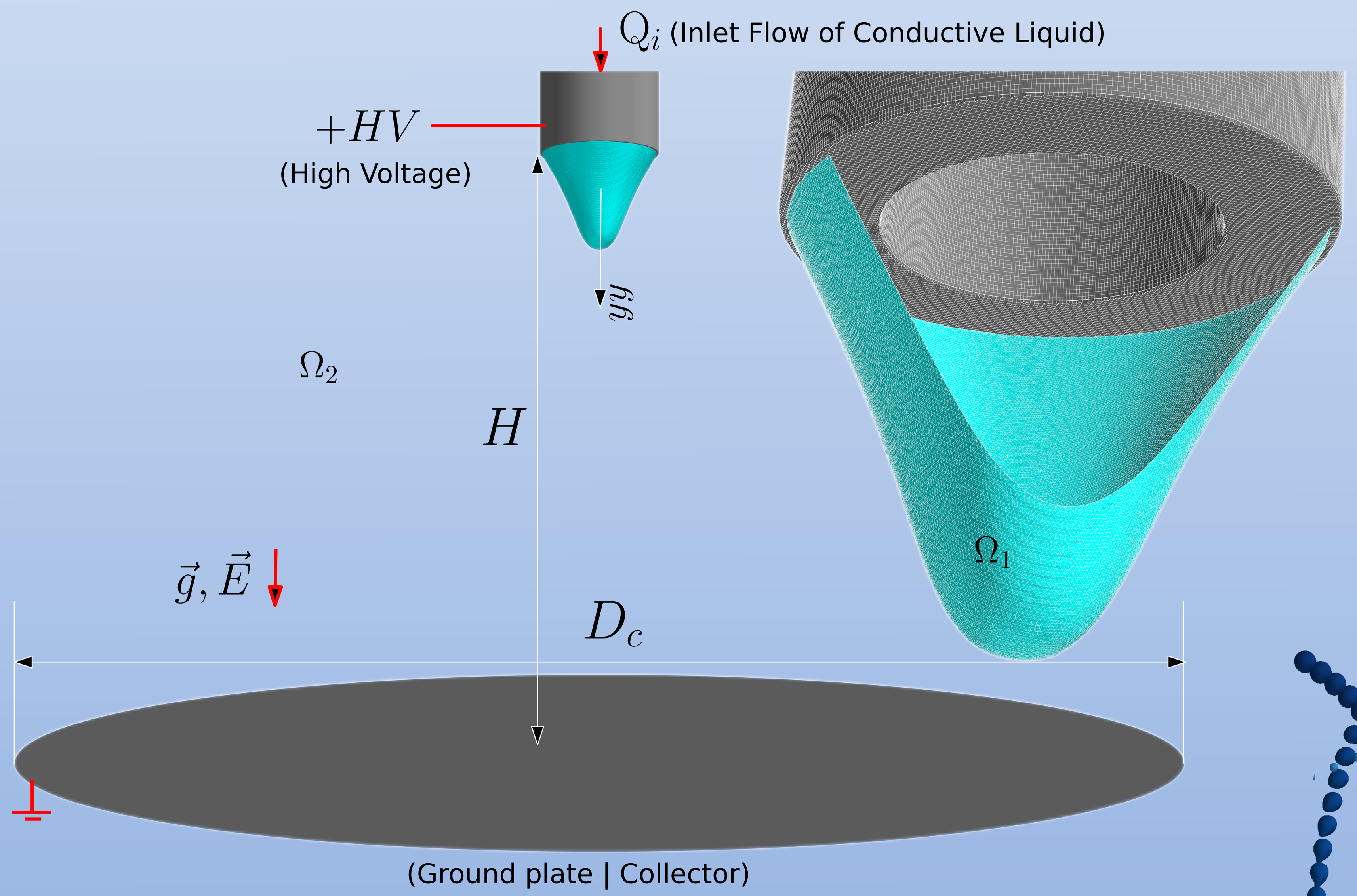
The atomization process is complex, involving numerous variables. To comprehend the fundamentals of **Jet whipping**, **Atomization** and **Liquid Depoition** a single **Taylor Cone Jet** is employed. A Taylor Cone jet is generated using a capillary nozzle subjected to a high voltage and connected to a ground plate that can function as either a collector or an extractor, as depicted in the schematic of the geometry.

This work highlights the complex three-dimensional nature of electrohydrodynamic jets, formed through the Taylor Cone jet transition. The simulations conducted have proven that ***3D simulations are indispensable in deepening our understanding of the complex processes involved in jet deposition and spray atomization*** (Cândido & Páscoa, 2023).





*blues: Liquid free-surface (colored by time)*
*reds: Field isolines of electric potential*




## ELECTROHYDRODYNAMIC GOVERNING EQUATIONS

Electrohydrodynamics relates the dynamics of fluid flows in the presence of electric fields. In this study, we coupled the **Navier-Stokes equations** for hydrodynamics with the **Maxwell's equations** for electrostatics.

$$\nabla \cdot \vec{u} = 0,$$

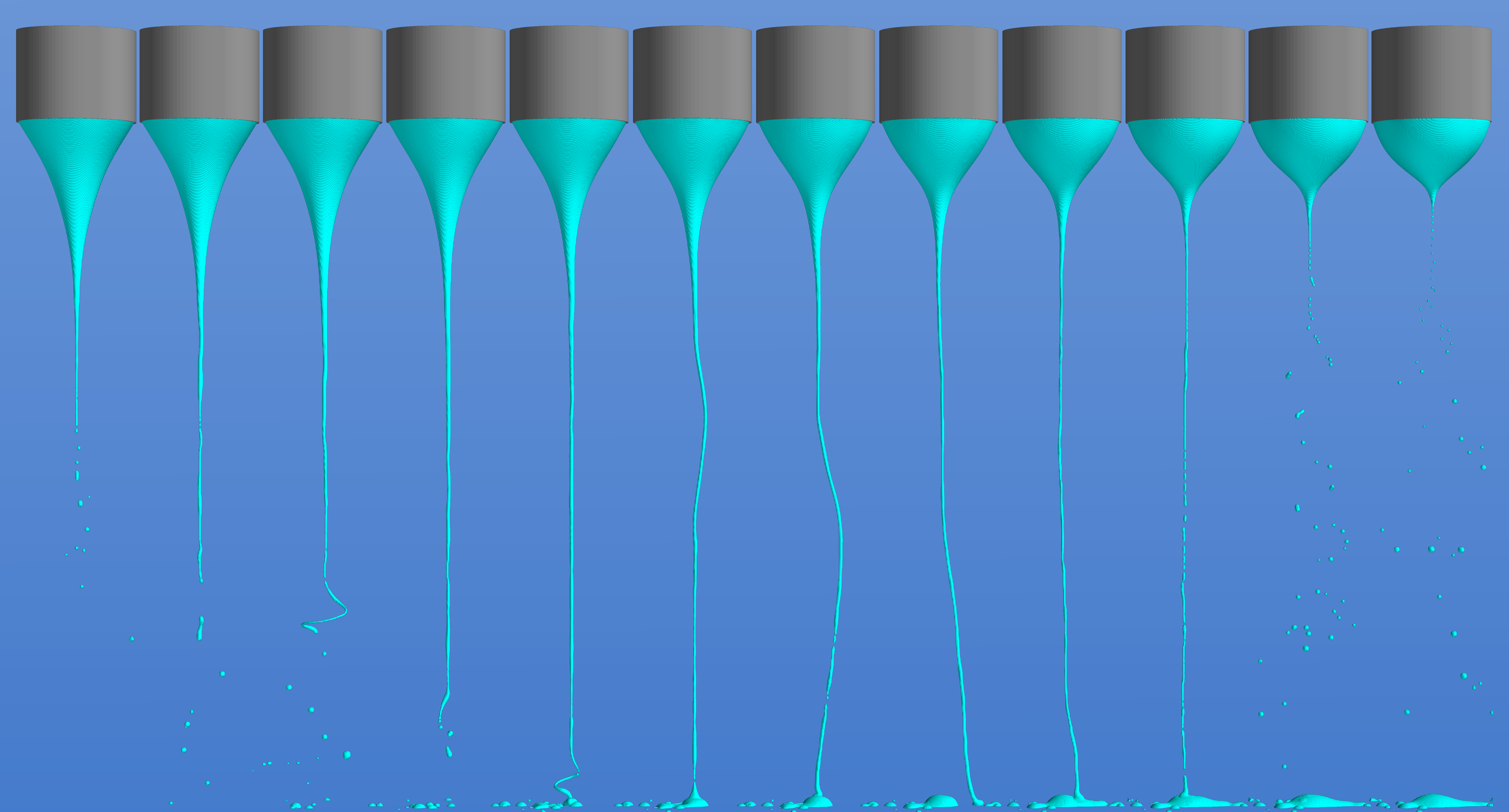
$$\frac{\partial}{\partial t}(\rho \vec{u}) + \nabla \cdot (\rho \vec{u} \vec{u}) = -\nabla p + \nabla \cdot \vec{\tau} + \rho \vec{g} + \vec{F}_\sigma + \vec{F}_e$$

$$\nabla \cdot \left(\varepsilon \vec{E}\right) = \rho_e,$$

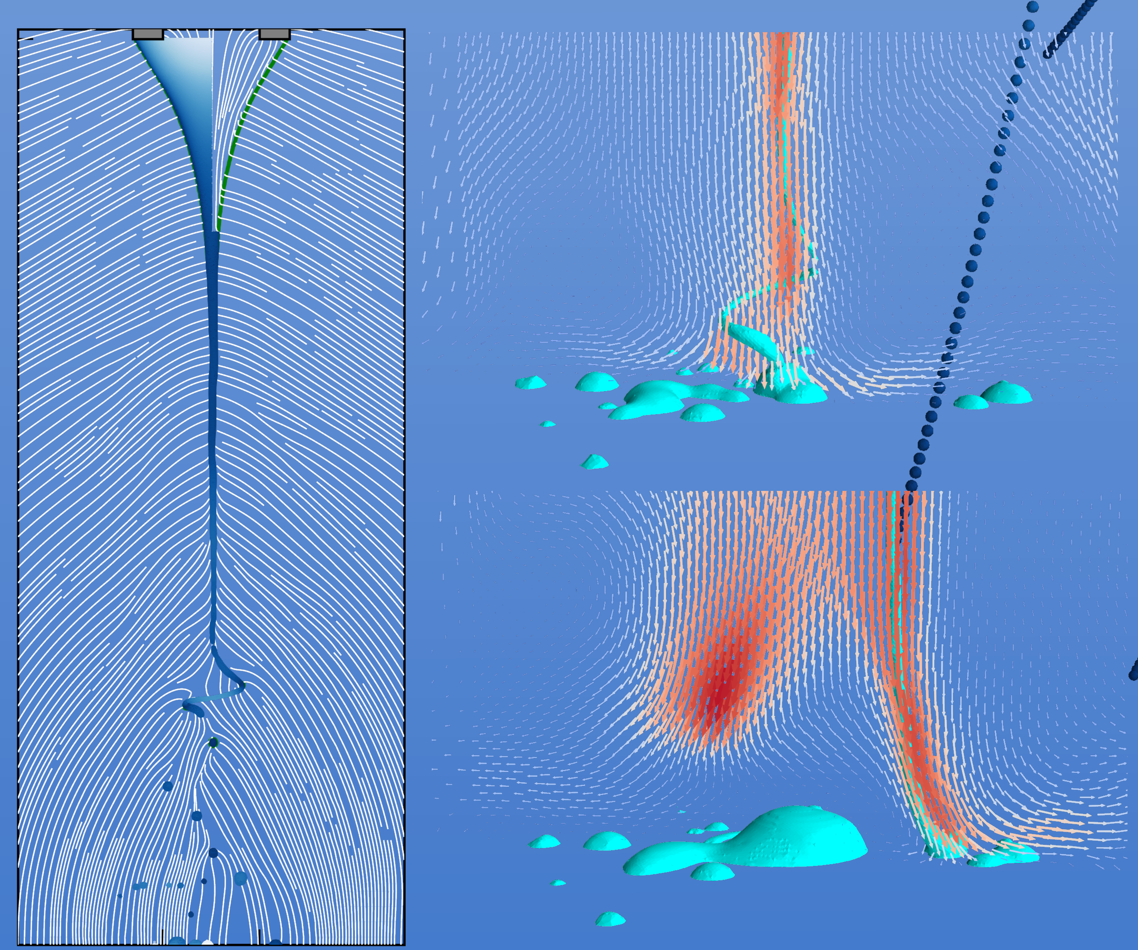
$$\frac{\partial}{\partial t}\rho_e + \nabla \cdot (\rho_e \vec{u}) + \nabla \cdot (\sigma \vec{E}) = 0$$

## EJECTION CONTROL*

** aqua: Liquid phase free-surface & arrows: 2D velocity vector field of the medium (air)*



## LIQUID DEPOSITION*



**References**

**Cândido, S.**, & Páscoa, JC., "Dynamics of three-dimensional electrohydrodynamic instabilities on Taylor cone jets using a numerical approach". Physics of Fluids 1 May 2023; 35 (5): 052110. https://doi.org/10.1063/5.0151109

**Cândido, S**, & Páscoa, JC., "Numerical Simulation of Electrified Liquid Jets Using a Geometrical VoF Method." Proceedings of the ASME 2021 IMECE. November 1–5, 2021. https://doi.org/10.1115/IMECE2021-698179

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C-MAST

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