FACULTAD DE FÍSICA
PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE

Study of interactions in laboratory plasma jets

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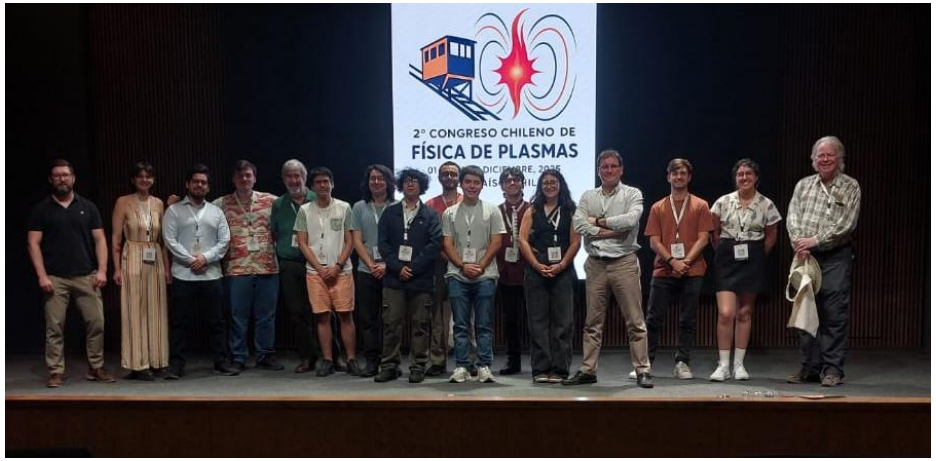
Where I am from

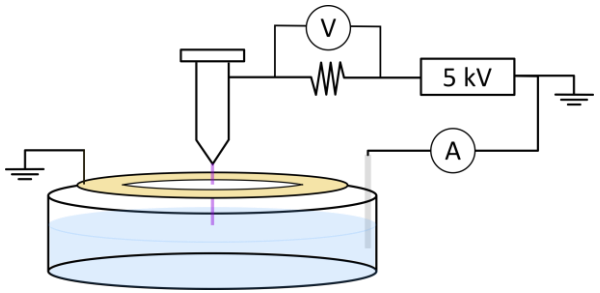
Santiago, Chile

Pontificia Universidad Católica de Chile

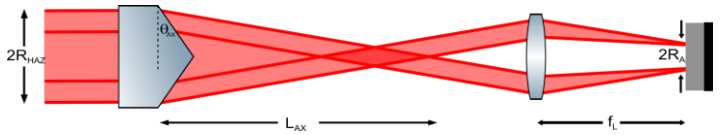


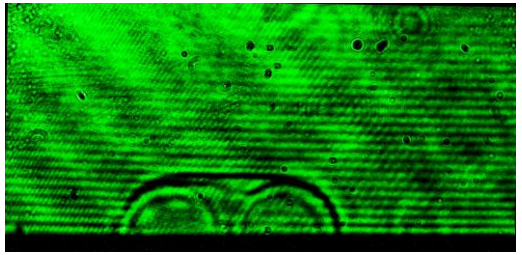
Experimental plasmas at PUC

Cold plasmas

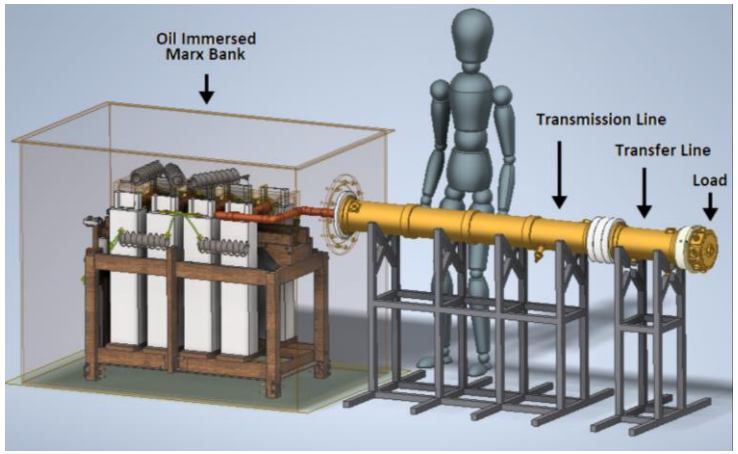


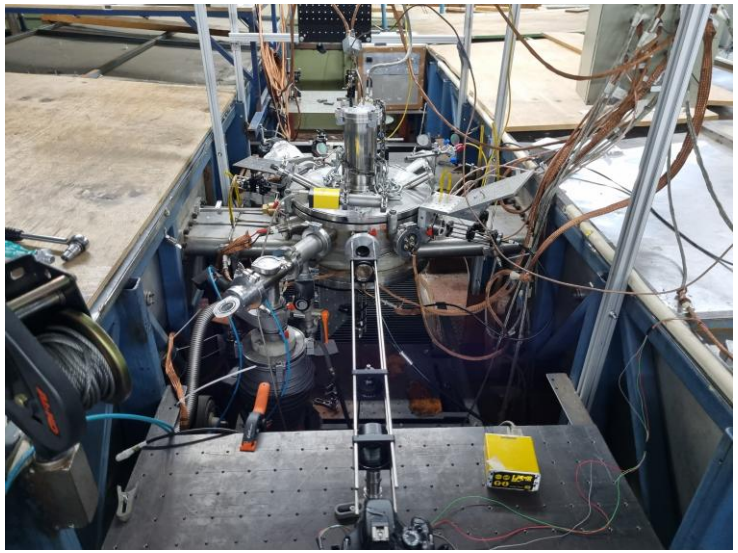
Laser produced plasma





Pulsed-power generators



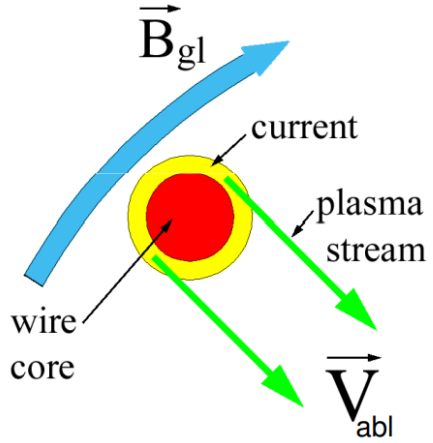


Motivation

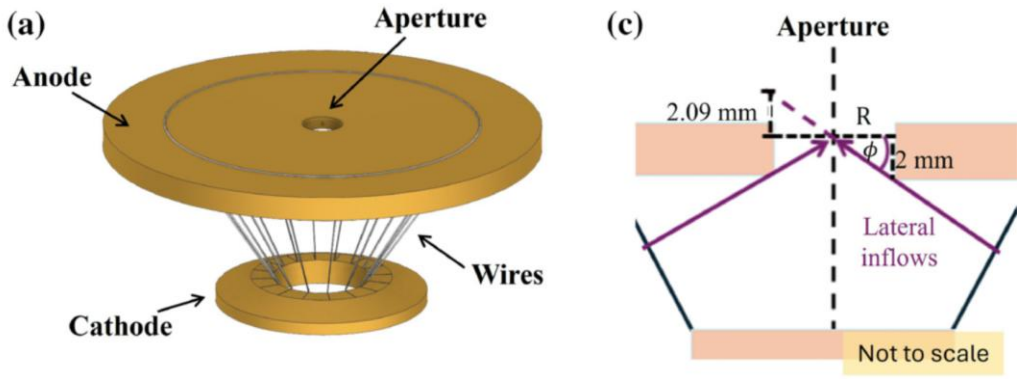
- Laboratory HED experiments provide a platform where we can study the equations of radiation hydrodynamics and MHD in regimes relevant to astrophysical flows, implementing experimental diagnostics obtaining results that are reproducible.
- Pulsed-power-driven conical wire arrays are an atractive platform for laboratory astrophysics.

Conical wire-arrays

- When a fast current pulse is driven through a conical arrangement of thin metallic wires, the wires' surface converts to plasma, and the resulting ablation flows are accelerated and redirected by the global Lorentz force.
- For suitable geometries, the streams converge towards the array axis and form a tightly collimated supersonic jet above the anode.



S. Ledebev et. al., Phys Plasmas, 10.1063/1.1385373 (2001)



L. Izquierdo et. al., Phys. Rev. E, 10.1103/pvcm-kgvw (2026)

Astrophysical jets

- Collimated outflows are observed over a large range of scales and energies, from protoestellar jets and Herbig-Haro objects to microquasars.
- These have in common that are narrow, collimated beams emerging from an accreting source and interactions regions and bow shocks due to the interaction with the medium.

Hubble telescope image of Herbig-Haro object HH 110

Interactions

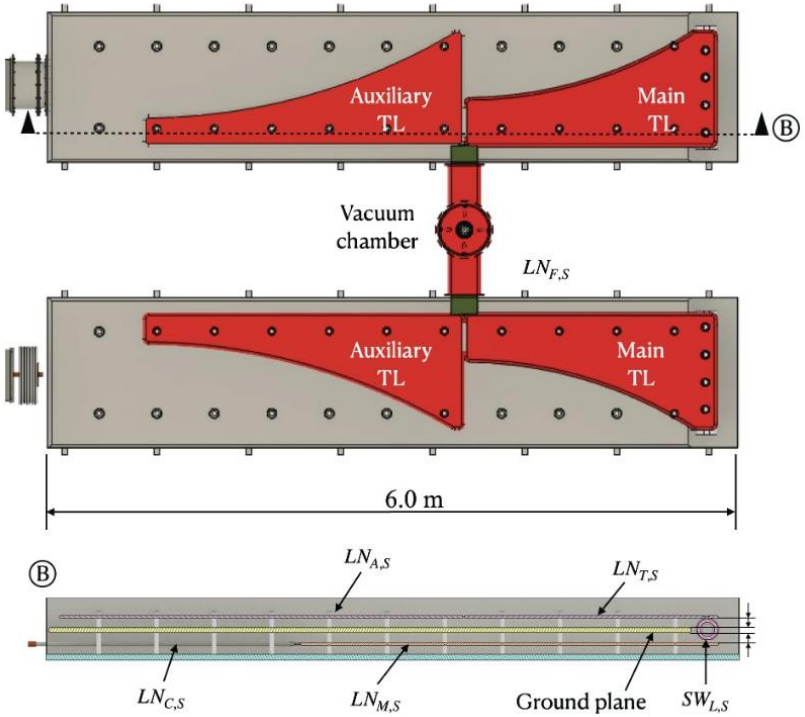
- A long–standing challenge is to understand the structure of the interaction region where a supersonic, often radiatively cooled jet encounters the ambient plasma. Astrophysical observations reveal bow shocks, and evidence of multiple type of shocks coexisting in the same system.
- By achieving adimensional parameters closely enough so that the laboratory plasma flows evolve in an analogous dynamical regime to collimated jets, they can serve as “scaled analogues” to astrophysical dynamics, in order to study these fenomena.

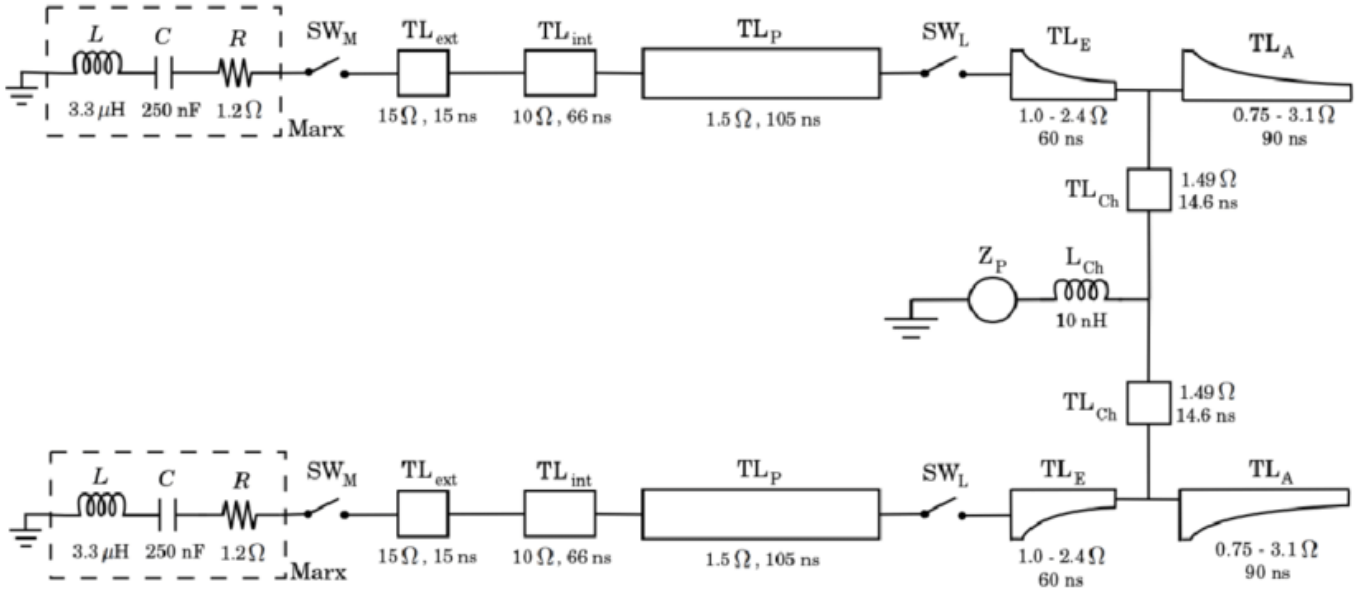
Llampüdkeñ

- Marx-type pulsed-power generator located at the Pontificia Universidad Católica de Chile
- 2 Marx capacitor banks + spark gaps
- Current pulses: ~ 450 kA
- Characteristic rise time:

~ 300 ns

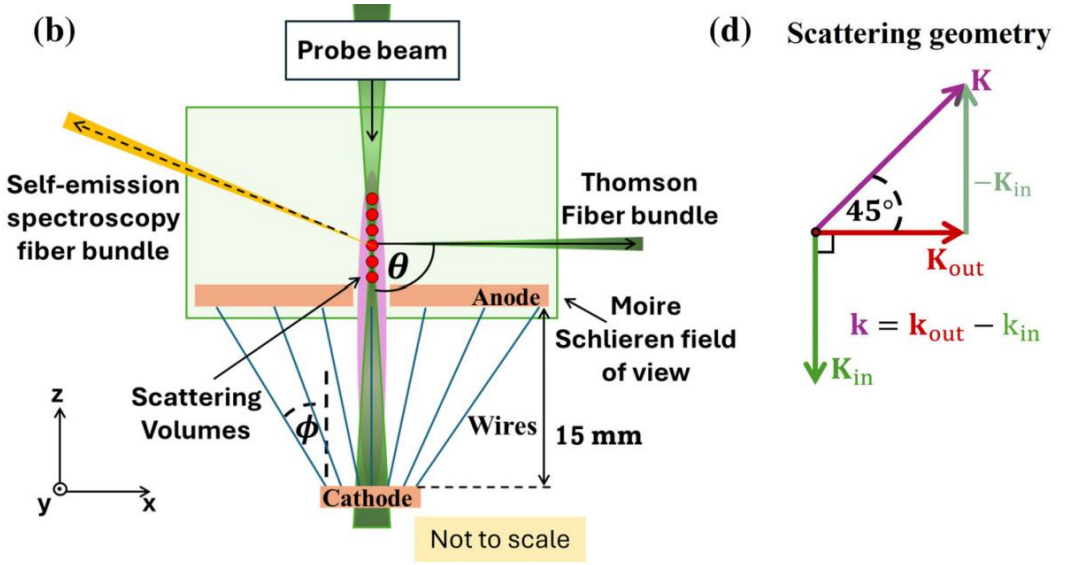
- Upgrade: 1 MA





Plasma diagnostics

- Thomson scattering
- Spectroscopy
- Interferometry/Moiré-schlieren
- B-dots



L. Izquierdo et. al., Phys. Rev. E, 10.1103/pvcm-kgvw (2026)

scientific reports

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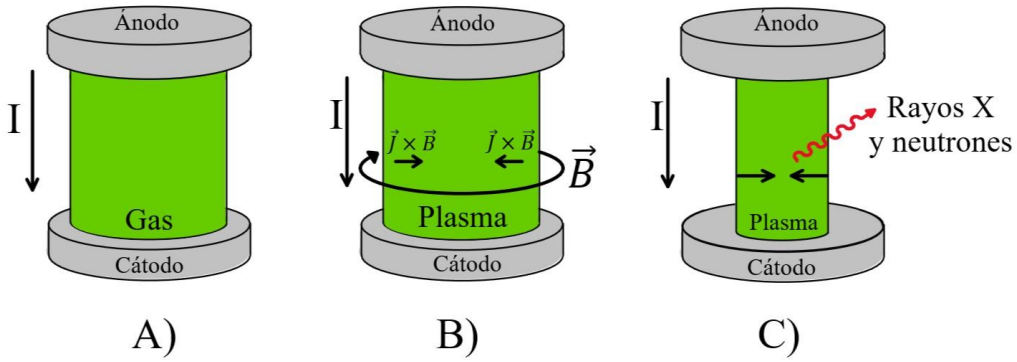
OPEN

Bayesian inference of plasma parameters from collective Thomson scattering technique on a gas-puff near stagnation

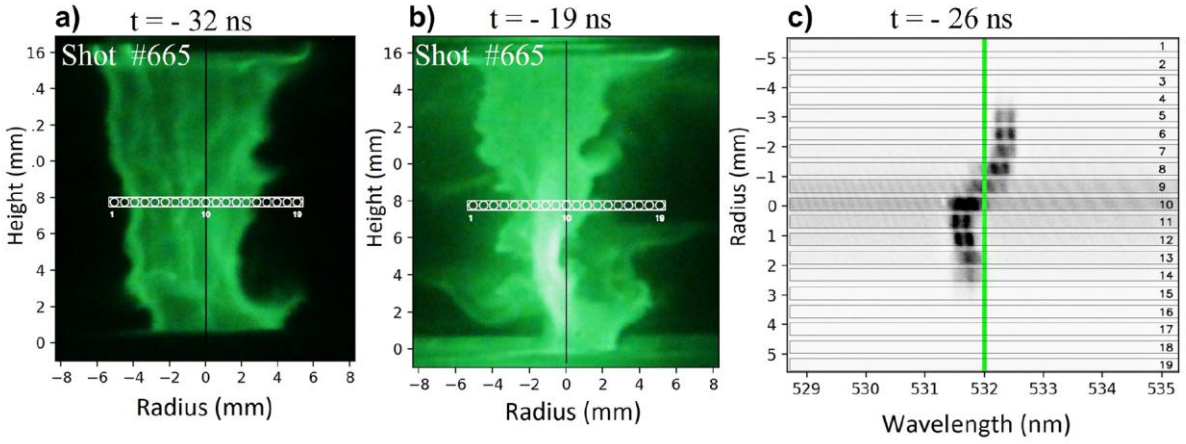
M. Escalona[1], J. C. Valenzuela[1✉], G. Avaria[2], F. Veloso[1] & E. S. Wyndham[1]

Llampüdkeñ

- Provide consitions necessary to ablate, accelerate and compress matter in a controlled laboratory



P. Phillips



M. Escalona et. al., Scientific Reports. 10.1038/s41598-023-40014-x (2023)

Llampüdkeñ

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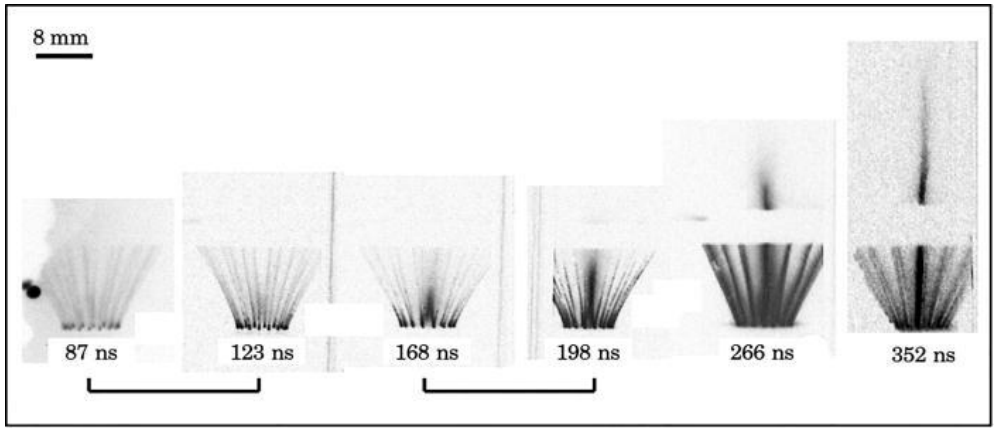
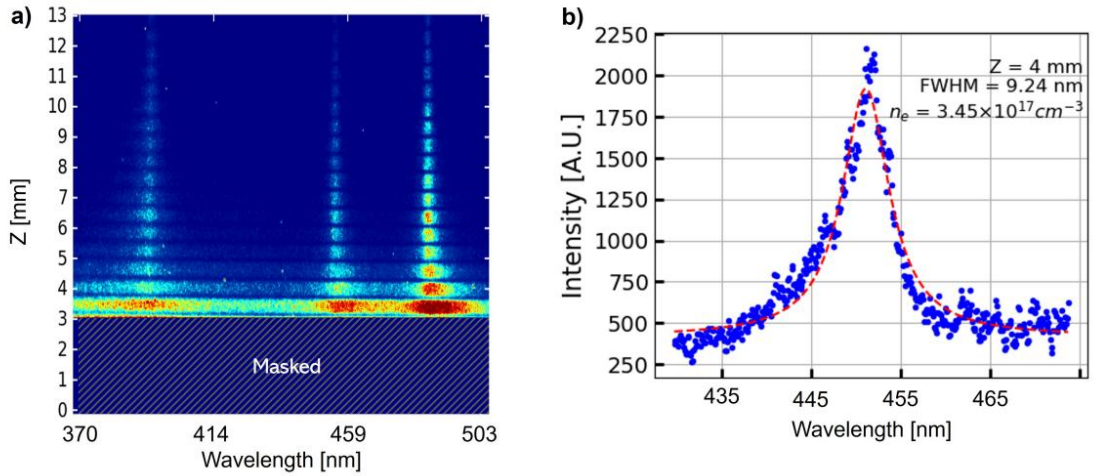


G. Muñoz et. al., Phys. Plasmas, 10.1063/1.5045215 (2018)



L. Izquierdo et. al., Phys. Rev. E, 10.1103/pvcm-kgvw (2026)

The plan?

- Plasma jets driven by pulsed-power conical-wire arrays interactions:
  - Jet-Jet
  - Jet-LPP
  - Jet-background plasma
- Searching for different collisions regimes by changing experimental configuration