This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.

WP 6.3: Multi-scale Innovative targets for laser-plasma accelerators

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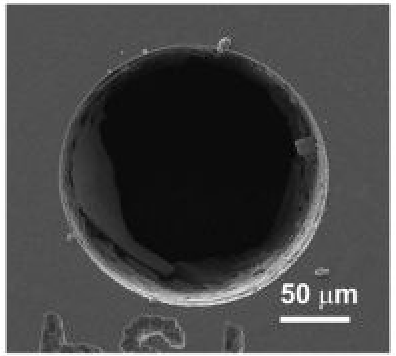
- **Problematic:** the inferior beam quality and stability of laser-plasma accelerators is partly due to a poor control of the target properties.

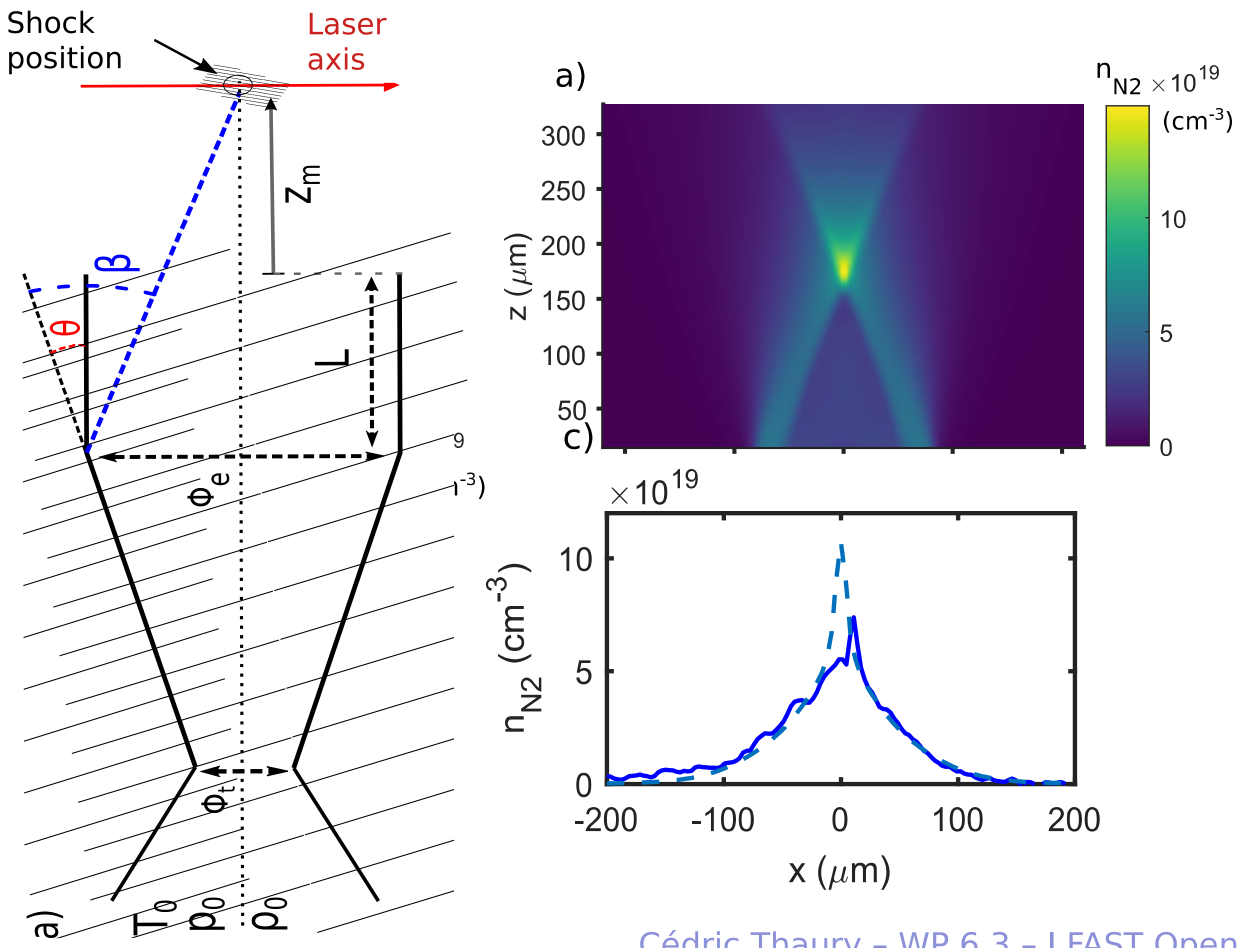
- **Objective:** developing innovative targets for improving the performances of laser-plasma accelerators.

- Use an innovative 3D laser machining technique (FLICE) to control the plasma density on the sub-100 micron scale

- Test the developped targets on various facilities, from kHz low energies (~3 MeV), to multi-GeV accelerators.



Micrometer-scale shocked nozzles for laser-plasma interaction



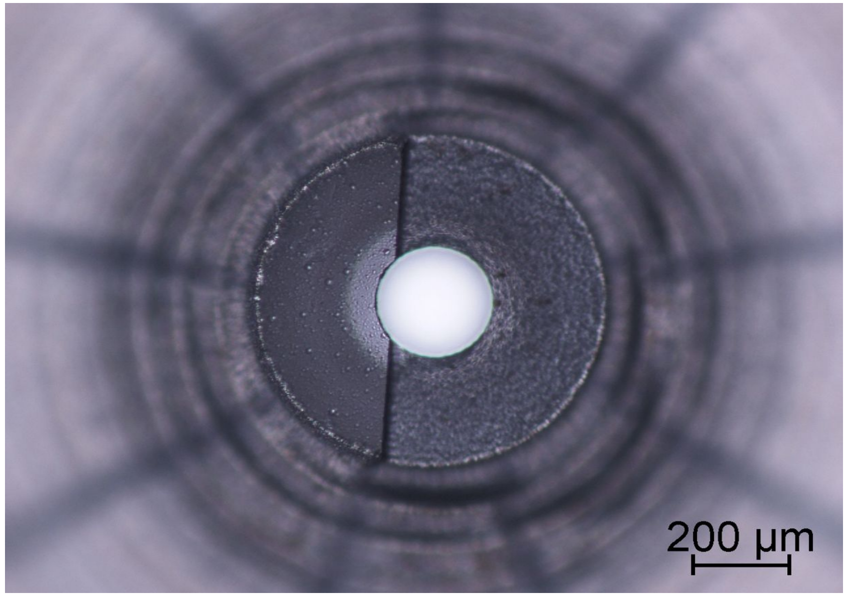
Principle

- Supersonic flow followed by a straight section
- Straight section interrupts the supersonic flow: creates a shock

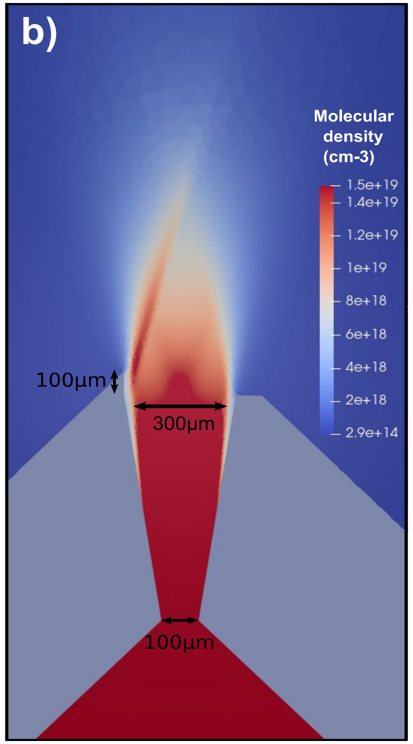
Objective

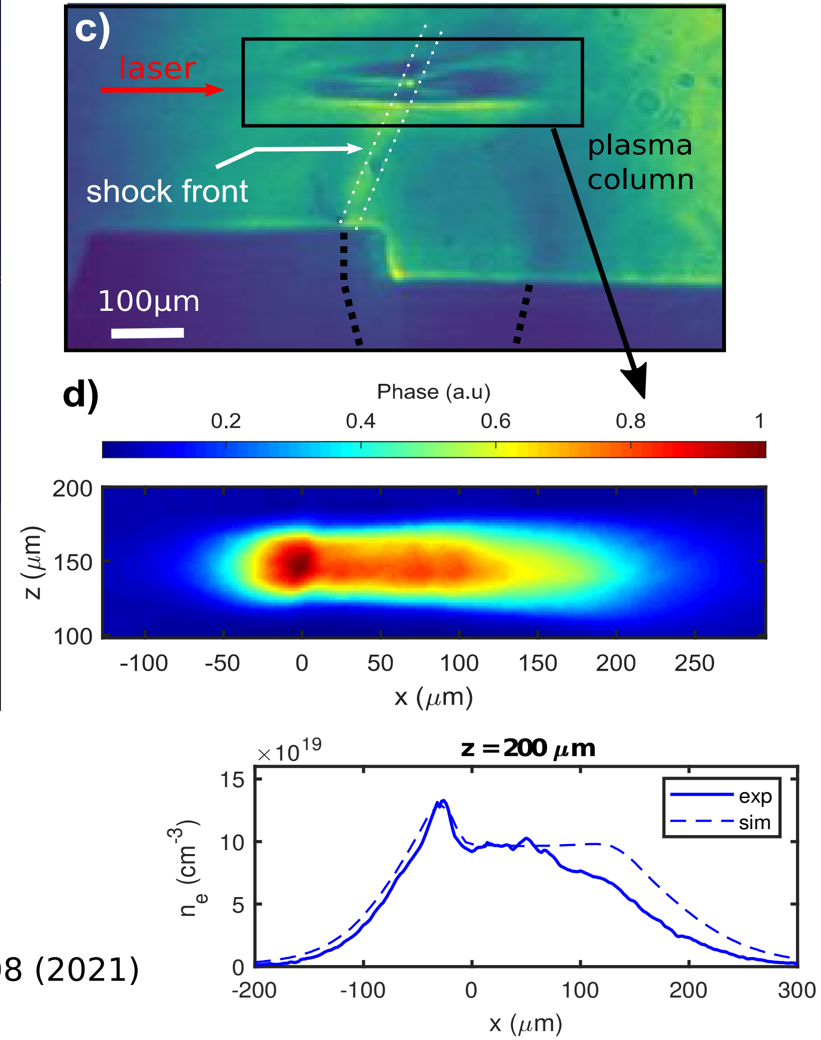
- Producing density transition on the 10 µm scale for density downramp injection in LWFA

Asymmetric microjets



Femtosecond Laser and
Chemical Etching in dielectrics

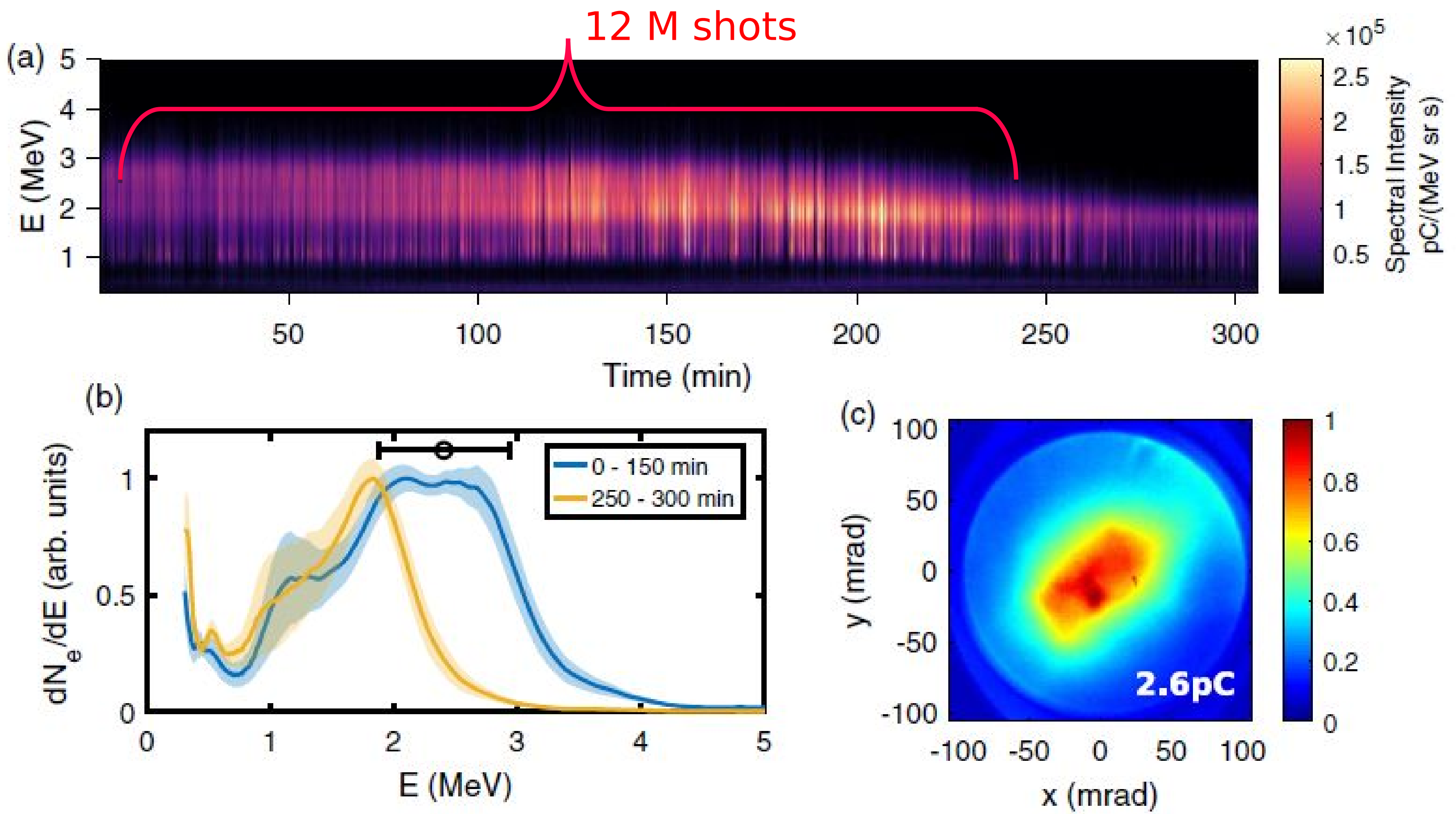




25 % drop in density in < 10 µm

* V. Tomkus et al. Opt. Express **26,** 27965 (2018), L. Rovige et al.arXiv preprint arXiv:2103.12408 (2021)

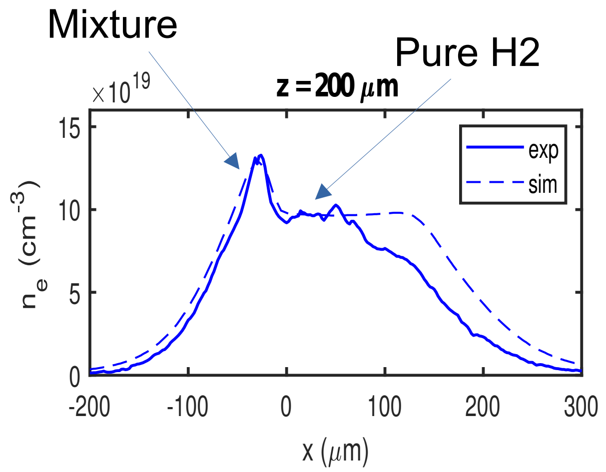
5-Hour Hands-Off Operation, at 1 kHz



L. Rovige et al., PRAB **23**, 093401 (2020)

First designs of micro nozzles with 2 inlets

Goals:
1) ionization injection in first high-Z gas section
2) Optimized and adjustable shock injection



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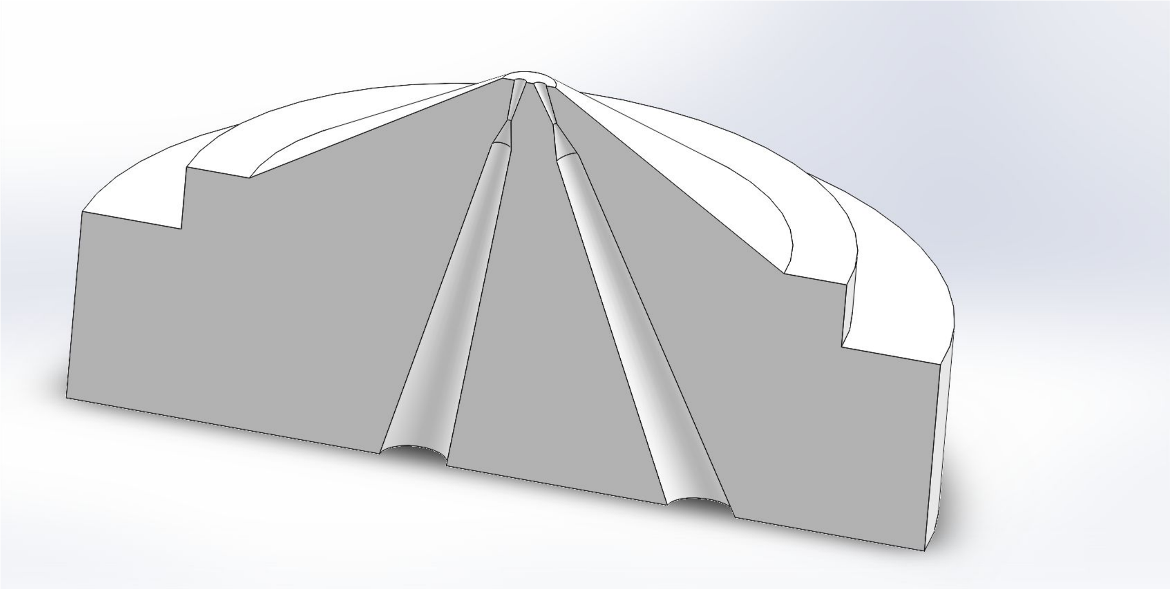

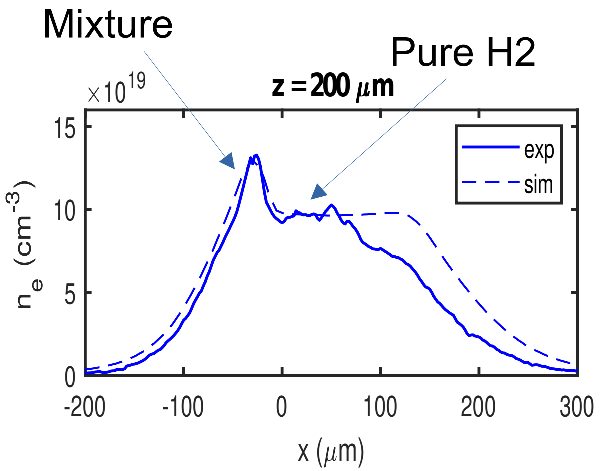

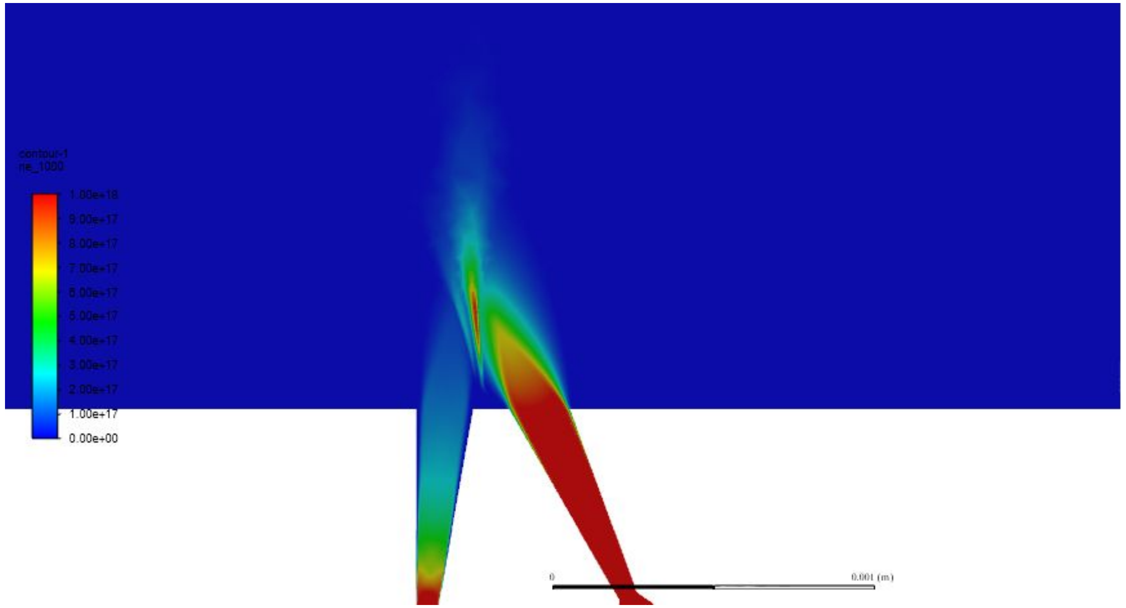

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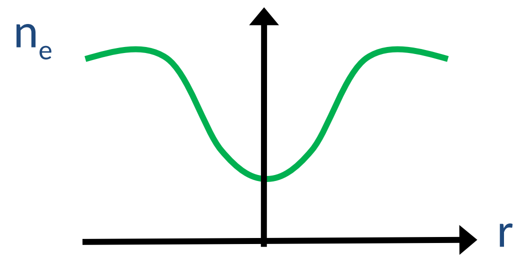
High energy laser-plasma accelerators

- Laser-plasma accelerators generate fields **> 100 GV/m**

- Reaching **GeV-energies** requires to sustain this field over a long distance (>cm)

  → **plasma guiding**

Plasma wave-guide

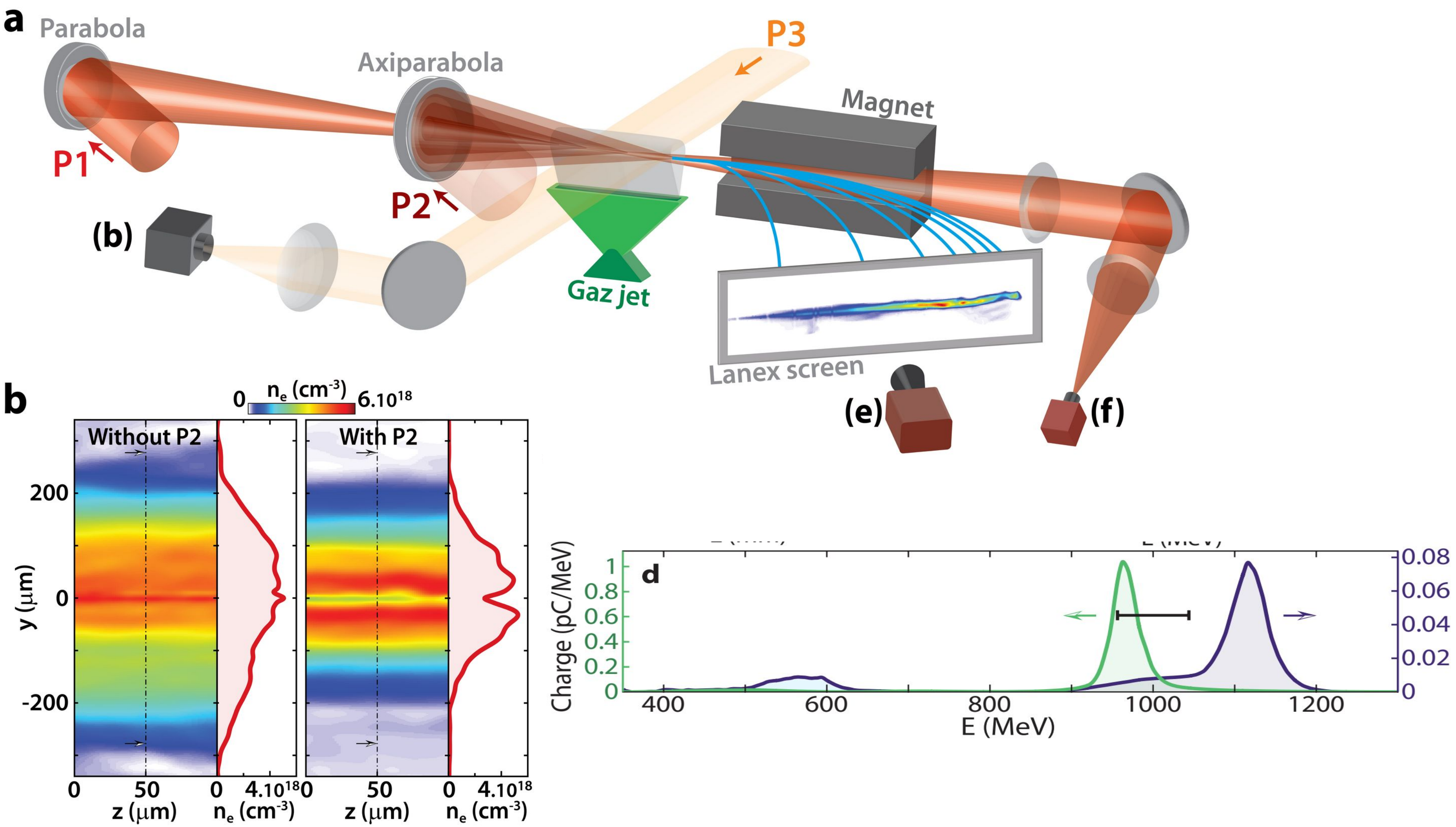


Refractive index $\eta = \sqrt{1 - n_e / n_c}$

➨ acts as a lens

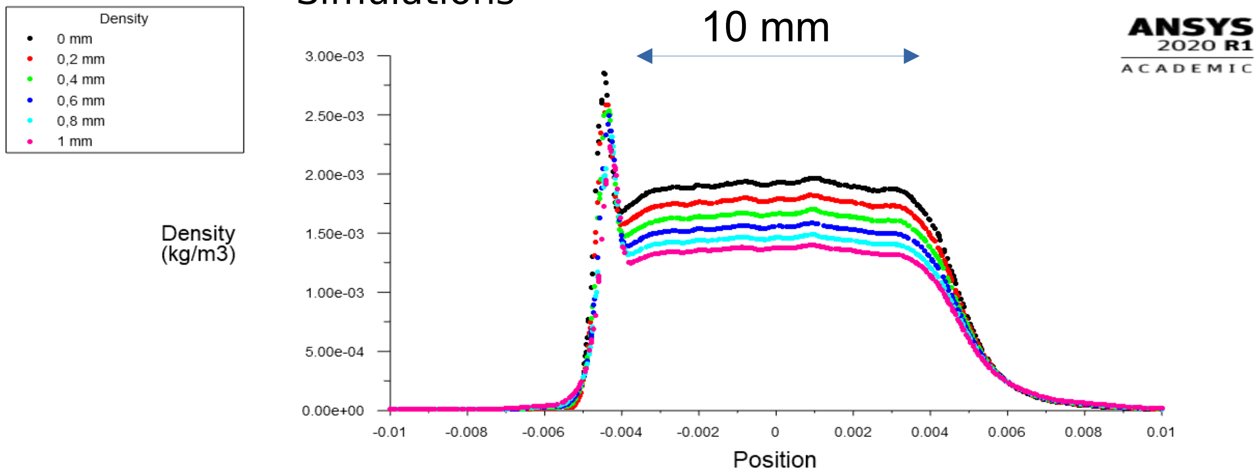
High energy laser-plasma accelerators

- **Two laser beams**
- A low energy beam (P2) generates the waveguide
- The driver beam generates the wakefield

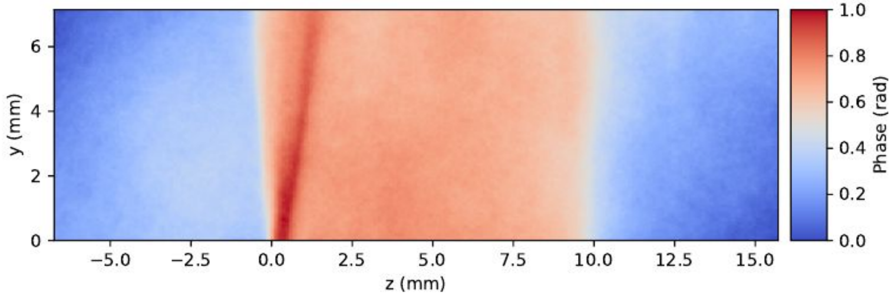


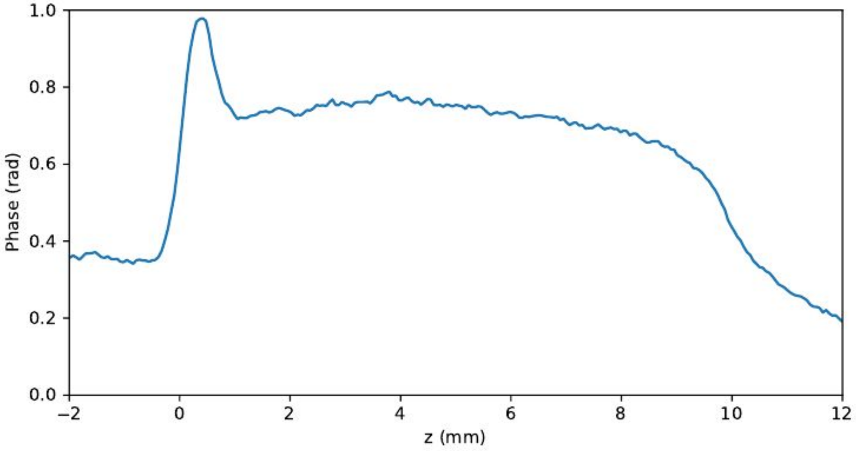
Shock nozzle for laser-plasma accelerators

Simulations



Experiment





Work plan

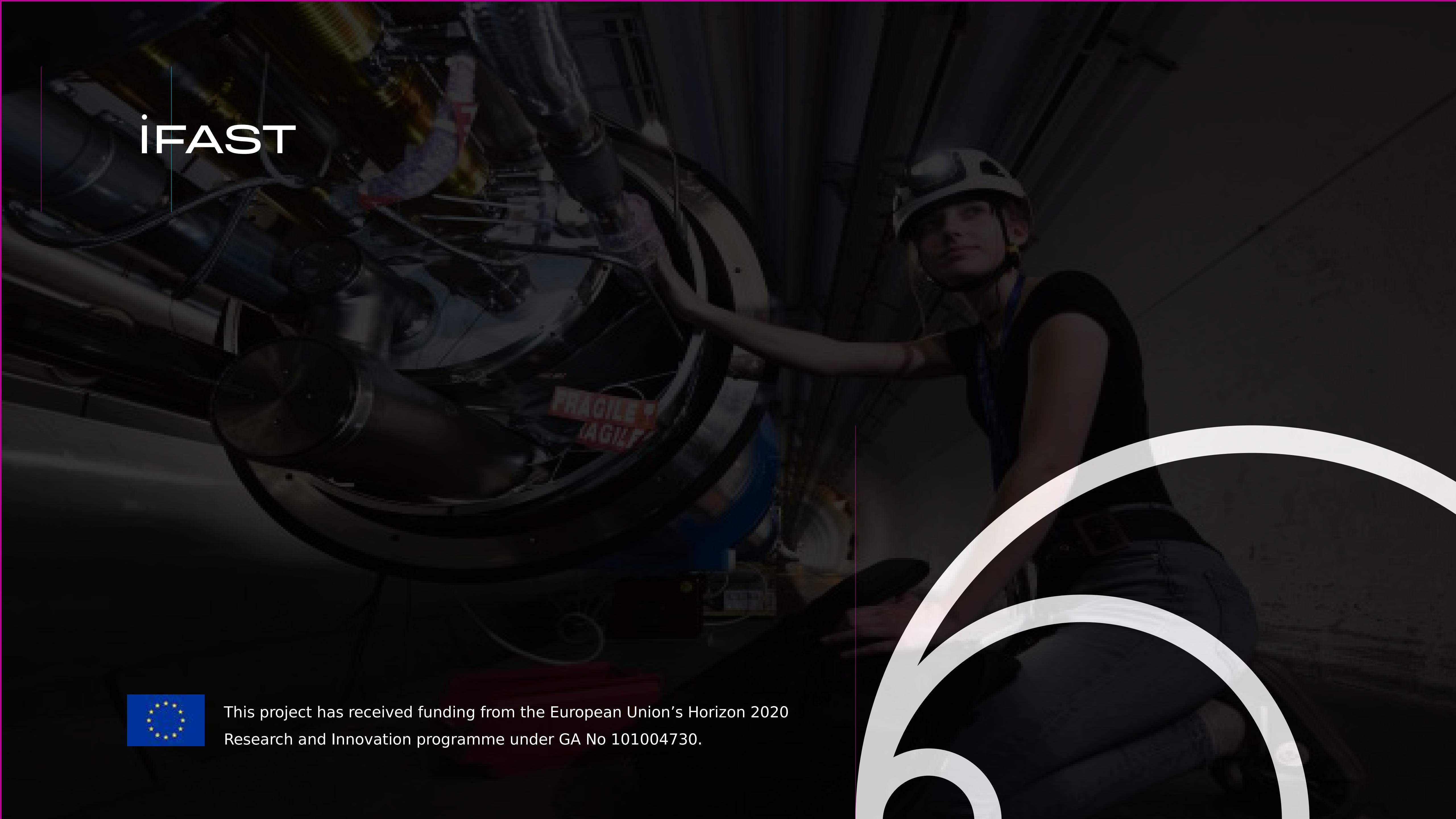
Year 1:

- *Comprehensive study of shock nozzles.*
- *Design of micro-gas-jets with 2 gas inlets*
  → higher charge and better beam quality.
- *Experimental characterization and test of the 10 mm nozzle.*

Year 2:

- Test of gas-jets with 2 gas inlets
- Design and test of >6 cm gas jets
- Test of optimized shock nozzles

D6.3 – M24 - Report on electron acceleration with micro-scale target at a kHz repetition rate, and with long targets at the multi-Joule level.



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