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

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

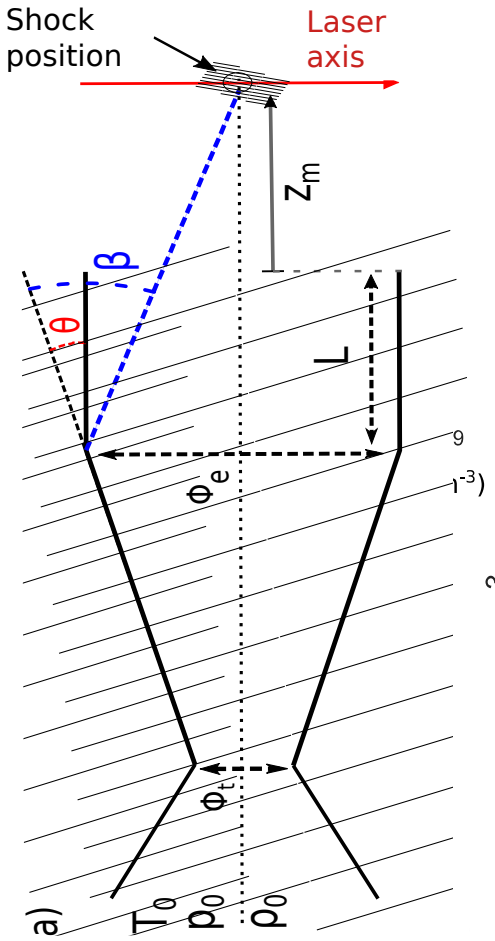
C. Thaury[1], J. Faure[1], V. Tomkus[2], G. Raciukaitis[2]

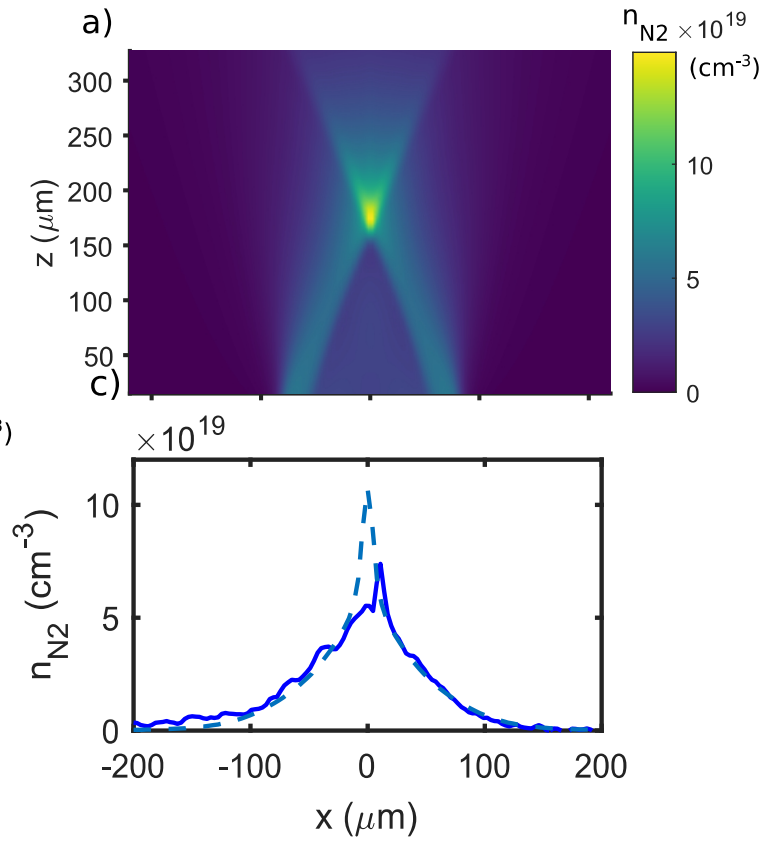
1. LOA, CNRS-ENSTA-Ecole Polytecnique (France)
2. FTMC (Lithuania)

iFAST

- **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 acelerarors.

Micrometer-scale shocked nozzles for laser-plasma interaction





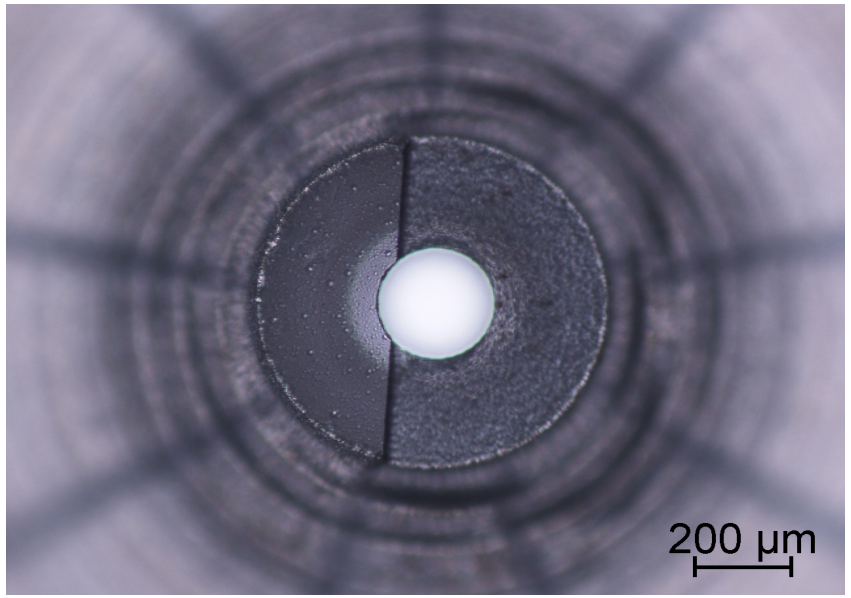
Principle

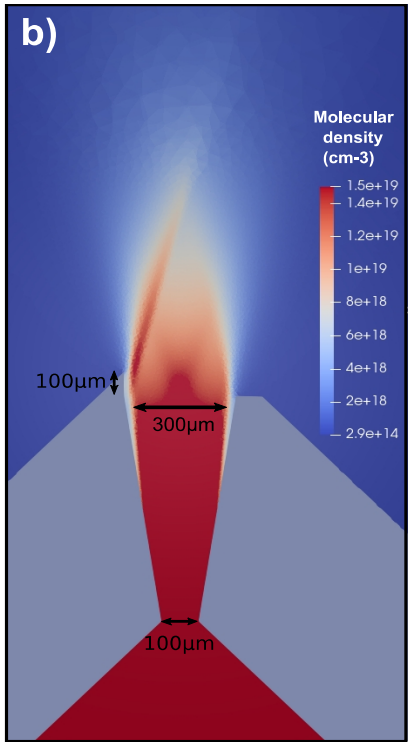
- Supersonic flow followed by a straight section
- Straight section interrupts the supersonic flow: creates a shock

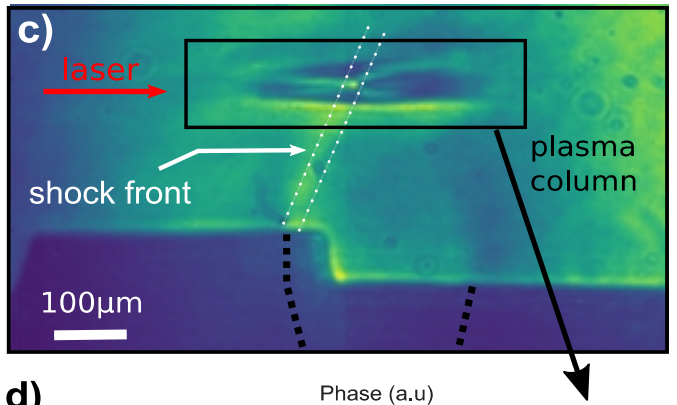
Goal

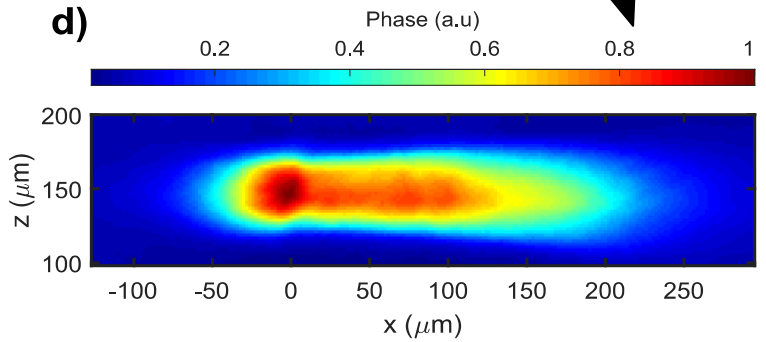
- Producing density transition on the 10 µm scale for density downramp injection in LWFA

Asymmetric microjets



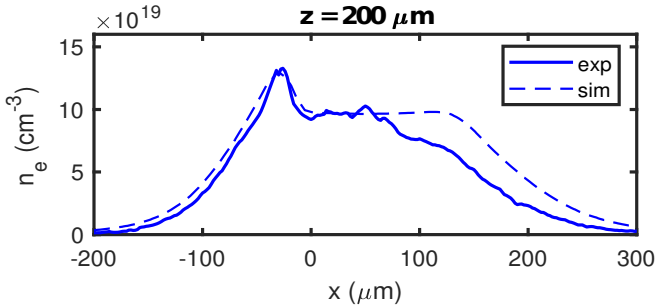






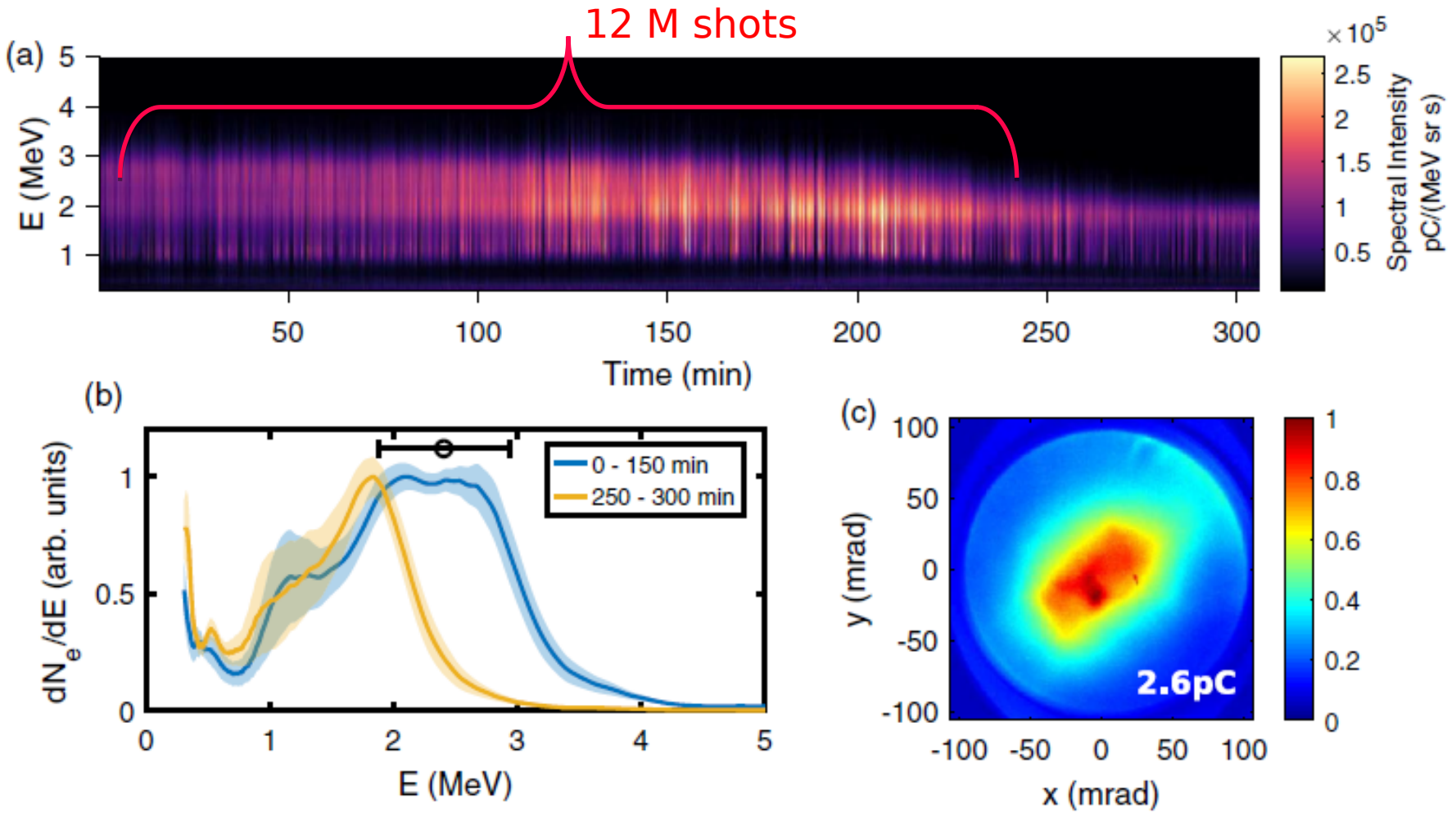
Femtosecond Laser and
Chemical Etching in dielectrics

25 % drop in density in < 10 µm



* V. Tomkus et al. Opt. Express **26,** 27965 (2018), L. Rovige et al., submitted

5-Hour Hands-Off Operation, at 1 kHz



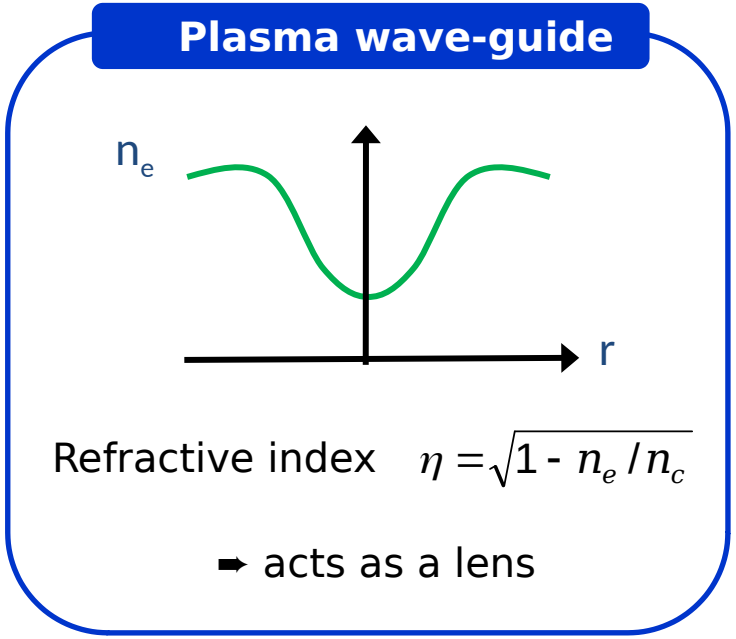
L. Rovige et al., PRAB **23**, 093401 (2020)

High energy laser-plasma accelerators

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

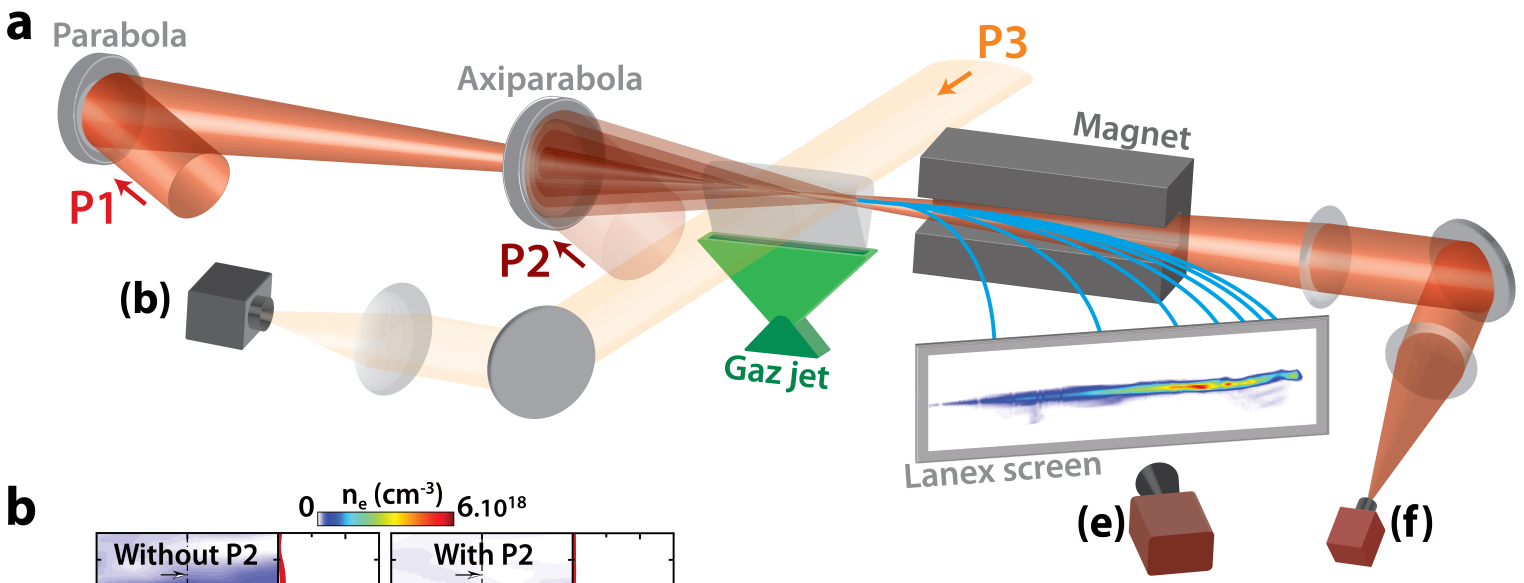
- Reaching **GeV-energies** requires to sustain this field over a long distance (>cm)

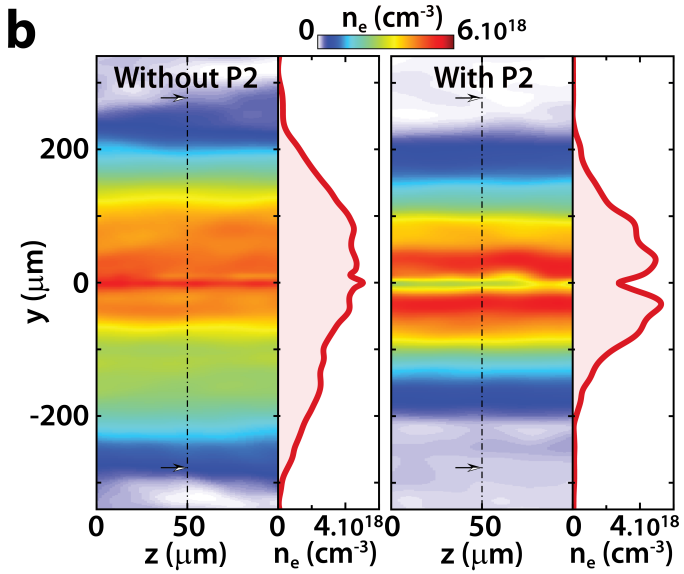
  ~ **→ plasma guiding**

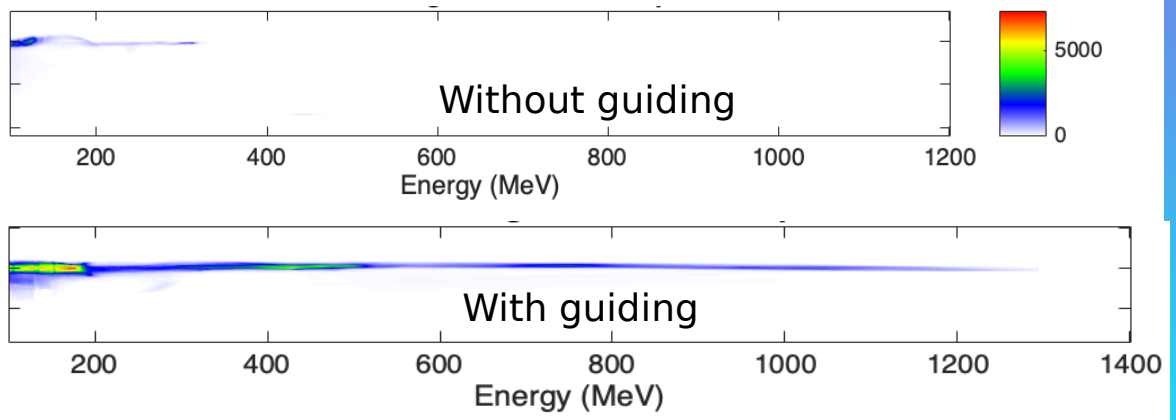


High energy laser-plasma accelerators

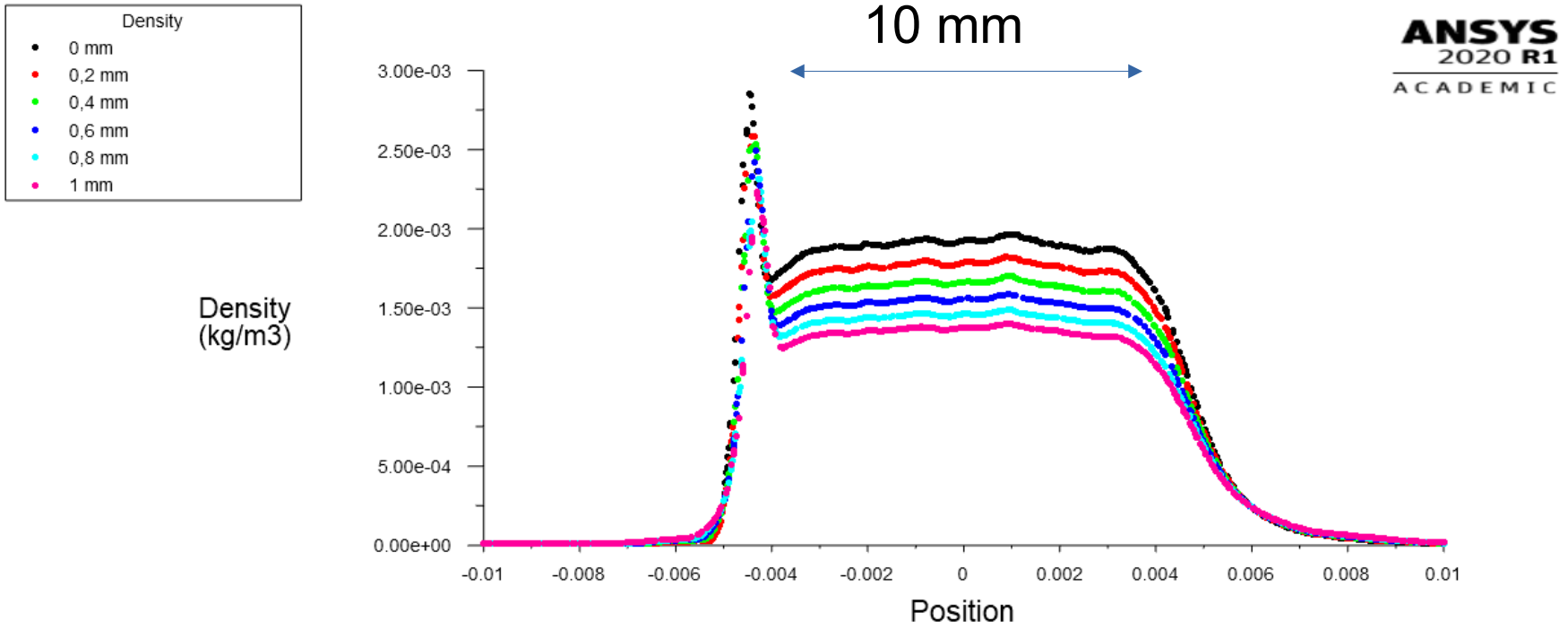
- **Two laser beams**
- A low energy beam (P2) generates the waveguide
- The driver beam generates the wakefield







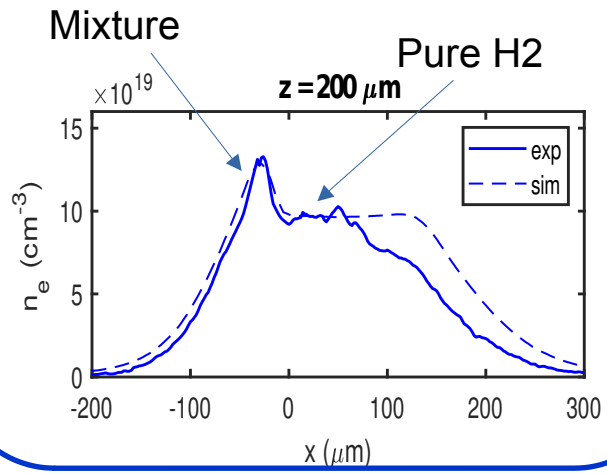
Shock nozzle for laser-plasma accelerators

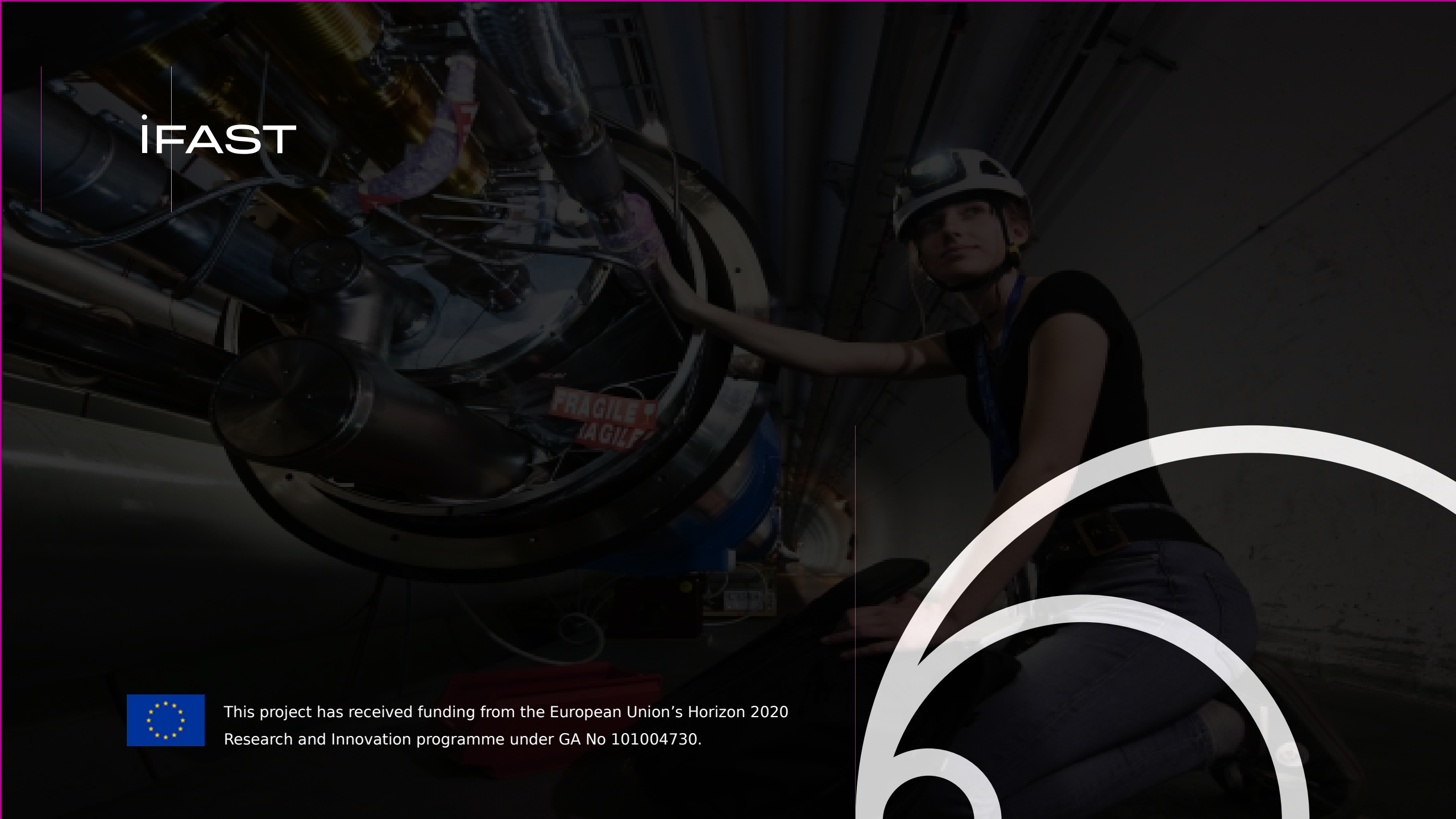


Work plan

- **Year 1:**
  - Comprehensive numerical 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, with and without guiding.
- **Year 2:**
  - Test of gas-jets with 2 gas inlets
  - Design and test of optimized nozzles

Jet with 2 gas inlets





iFAST

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