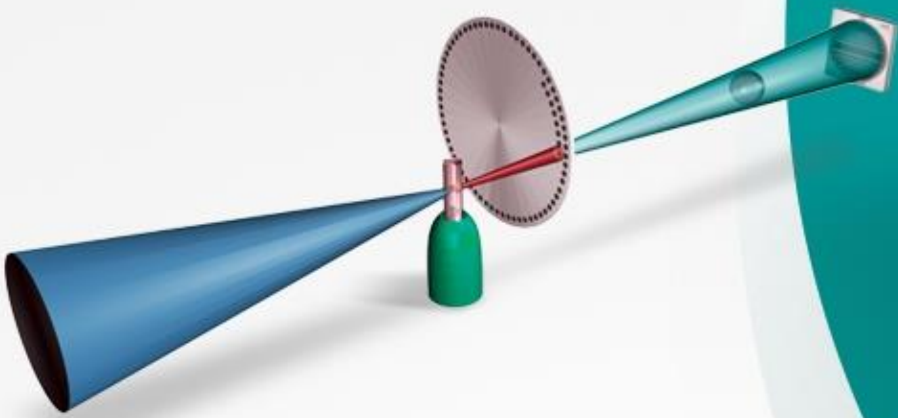


SourceLAB

Laser Plasma Technologies

Laser Plasma Targetry

Smallscale gas jets at a near-critical level

MAP Workshop
Munich, 11/10/2013

François Sylla

SourceLAB : Overview

Origin

- Spin-off of the **Laboratoire d'Optique Appliquée** (LOA) - 2013

Value offer

- Precision **targetry** for laser-plasma interaction
- Secondary sources of **particles and radiations**
- Temporal laser **contrast cleaning** devices

Skills and Expertise

- Laser-plasma targetry **first specialized supplier**
- **Innovative design** for reliable performances
- Broad expertise on **all main components** of the laser-plasma accelerator (intense laser, beam transport, interaction, detection)

Organization

Quicker access to your physics and applications

SourceLAB

Founders

CEO
Dr. **François Sylla**

Technical Director
Dr. **Aurélien Ricci**

Business Developer
Guillaume Bouchon

Scientific committee

Prof. **Victor Malka**
Dr. **Rodrigo Lopez-Martens**
Prof. **Antoine Rousse**, LOA Director
…

Strategic committee

Dr. **Michel Mariton**, CEO Horiba Jobin-Yvon
Séverine Redon, CEO Jacobacci Partners Paris
Prof. **Jacques Lewiner**, ESPCI-ParisTech Scientific Director
…

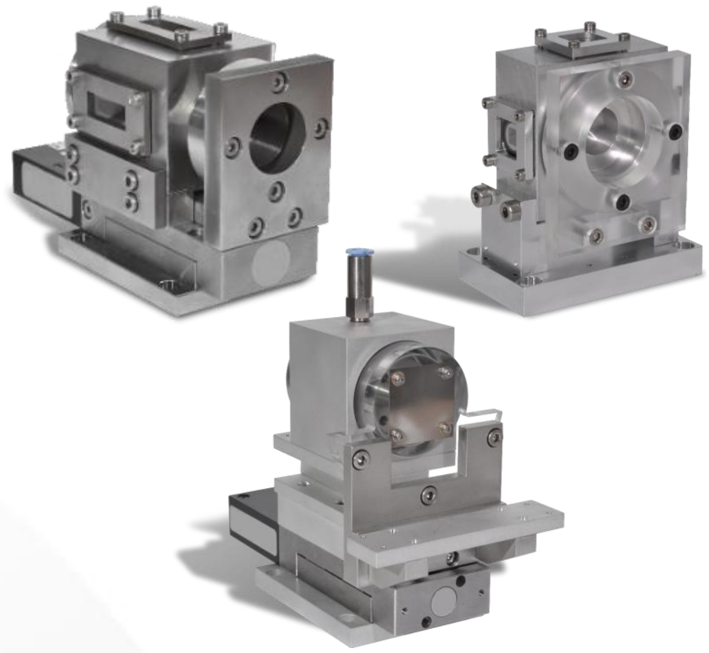
Partners

loa, École Polytechnique ParisTech, CNRS, ENSTA ParisTech, erc, oséo, GSR Ventiltechnik, PHASICS the phase control company, AREVA

Product line (1/4)

Adjustable Gas Cells

- SL-ALC



Performances

- On-line adjustable plasma length
- Micrometric precison
- Suitable for optical diagnostics

Examples of Applications

- High energy electron acceleration
- Fine control of the injection

Reference

- Corde et al, **Nat. Com.**, 4 1501 (2013)

Product line (2/4)

High Precision Positioner

- SL-ST-1000

Performances

- kHz repetition rate
- Micrometric passive stability
- Nanometric active stability

Examples of Applications

- Attosecond science
- kHz plasma mirror

References

- Wheeler et al, **Nat. Phot**, 6 (2012)
- Veltcheva et al, **PRL**, 108, 075004 (2012)
- Borot et al, **Nat. Phys**, 8 (2012)

Product line (3/4)

XPW Contrast Filter

- SL-XPW

Performances

- Contrast enhancement ratio of 10^3
- Excellent spatial profile by hollow core fiber filtering
- Easy-to-align and robust

Examples of Applications

- fs-pulse contrast enhancement (>three order)
- fs-pulse post compression (>two-fold)
- Generation of high contrast few-cycle pulses

References

- Ricci et al, **RSI**, 84, 043106 (2013)
- Ricci et al, **Opt. Exp**, 21 9711 (2013)

Product line (4/4)

Gas Jet Systems

- SL-GT-10

Performances

- Overcritical densities
- Submillimetric plasma size
- Fast-switching valves

Examples of Applications

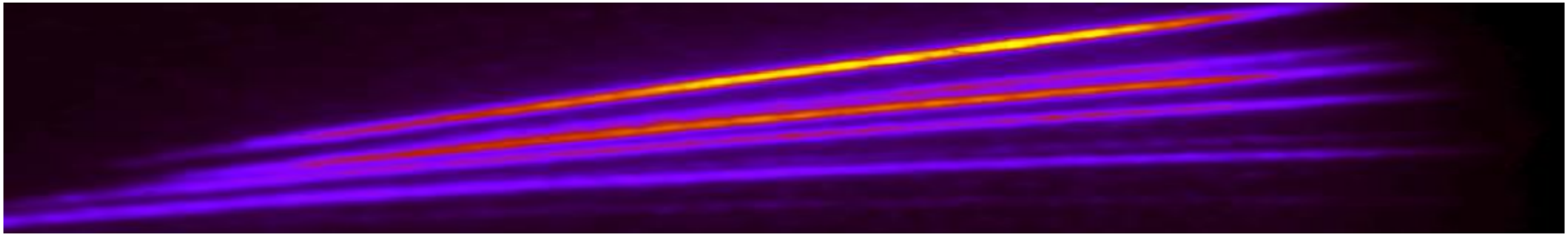
- High energy ion acceleration
- Plasma microscopy

References

- Sylla et al, **PRL**, 110, 085001 (2013)
- Sylla et al, **PRL**, 108, 115003 (2012)
- Sylla et al, **RSI**, 83, 033507 (2012)

Motivations

- Laser-Ion acceleration in a controllable way



- What is the plasma gradient scale length ?
- What does happen to the laser pulse in this gradient ?
- How is laser energy deposited to fast electrons ?
- What does happen to the fast electrons as they propagate ?
- How do the fast electrons transfer their energy to the ions ?
- How is ion acceleration sustained ?

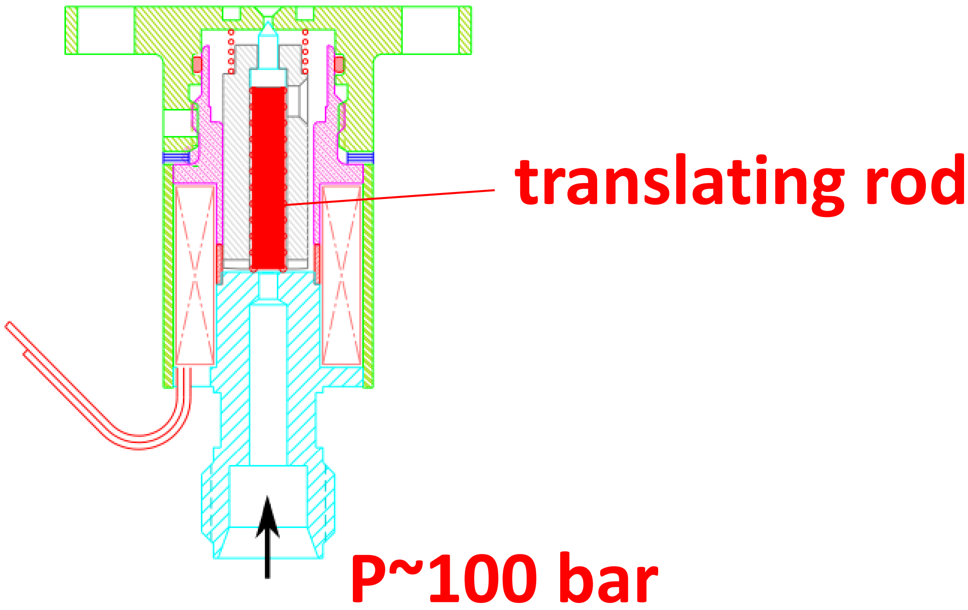
Possible strategy: high-density smallscale gas jets

- **Gas jet**: reproducible object, potentially high repetition rate
- **Density**: very efficient coupling between laser and electrons close de n_c
- **Smallscale (< 1mm)** : access to plasma microscopy with visible fs-light (2ω shadow-interferometry)

?

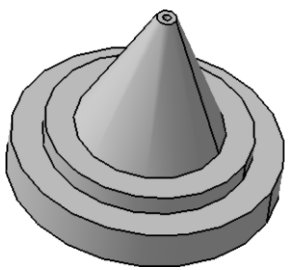
State-of-the-art

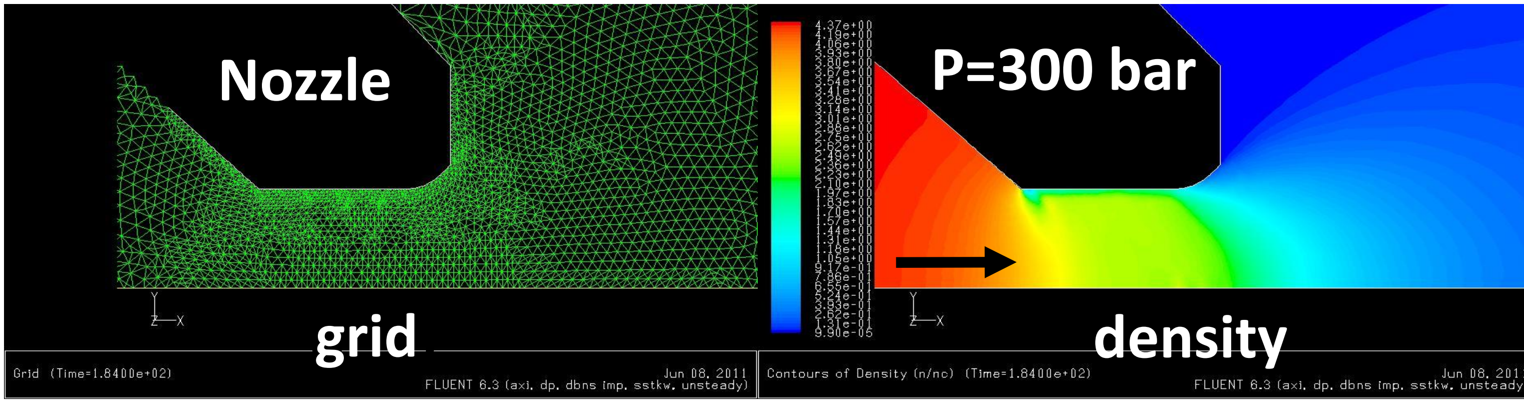
- Low density (few percent of n_c), millimeter scale, low repetition rate

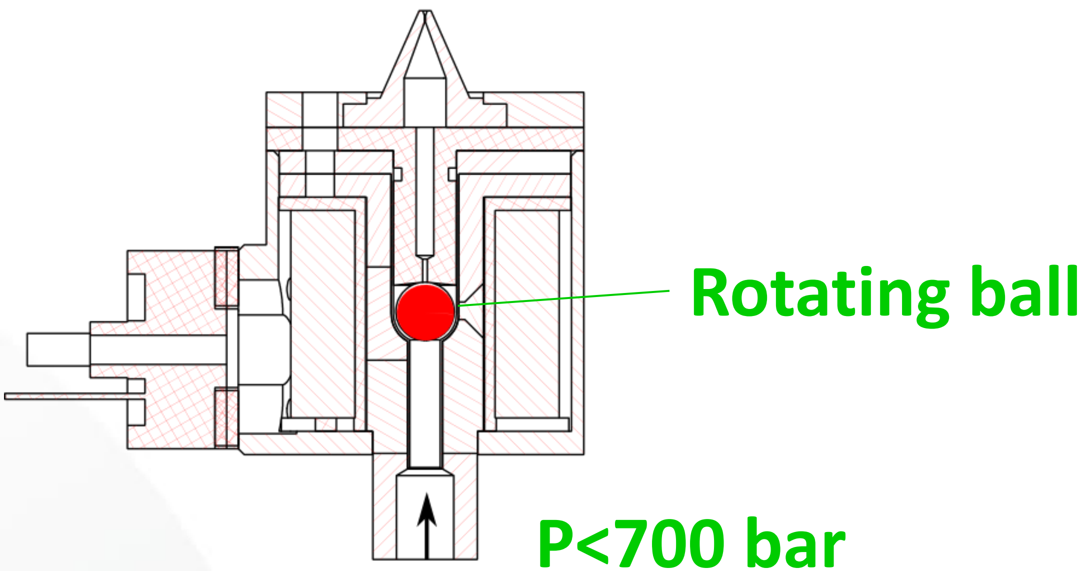


Innovation process

Ø 400 µm

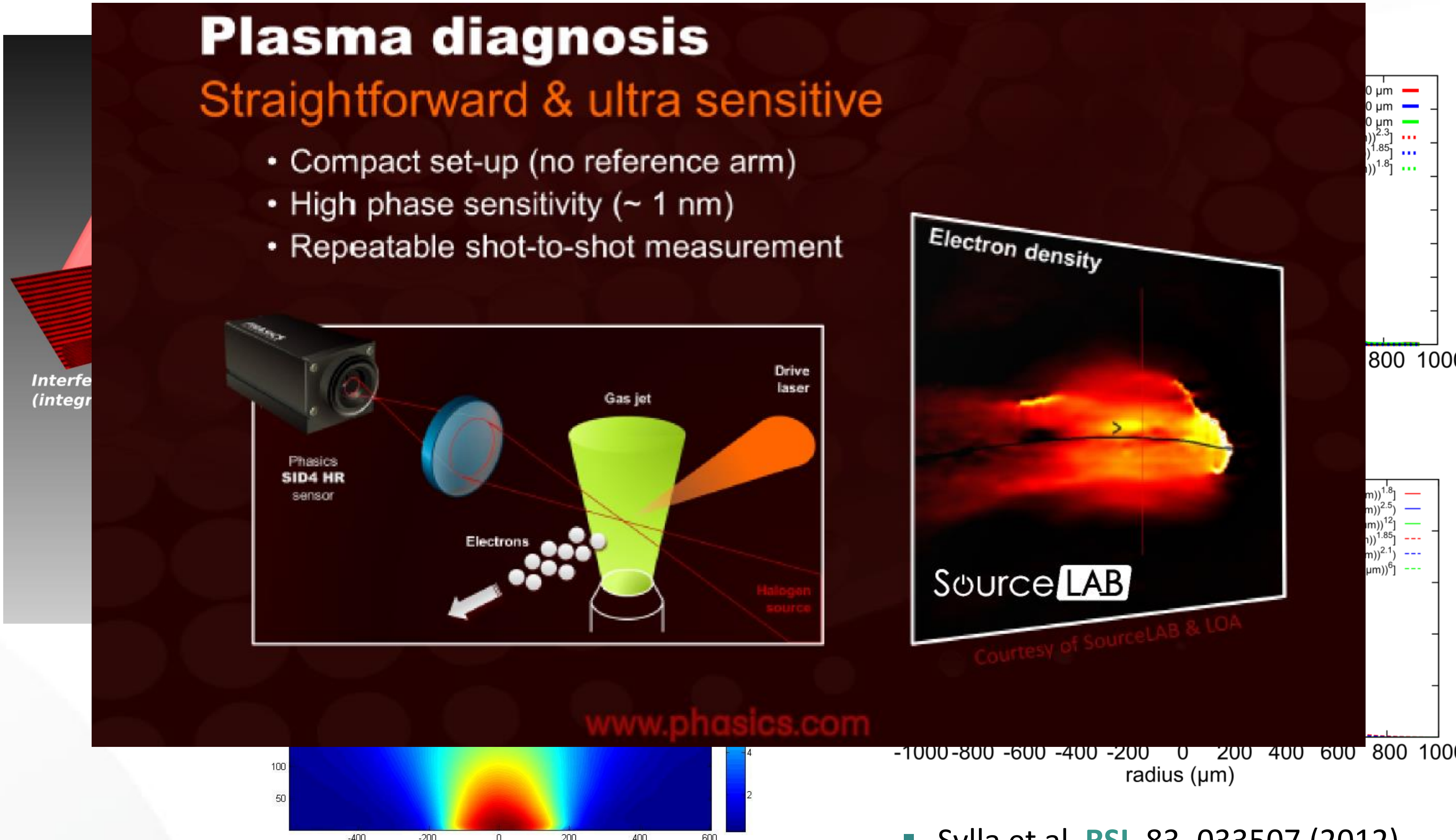






Typical performances

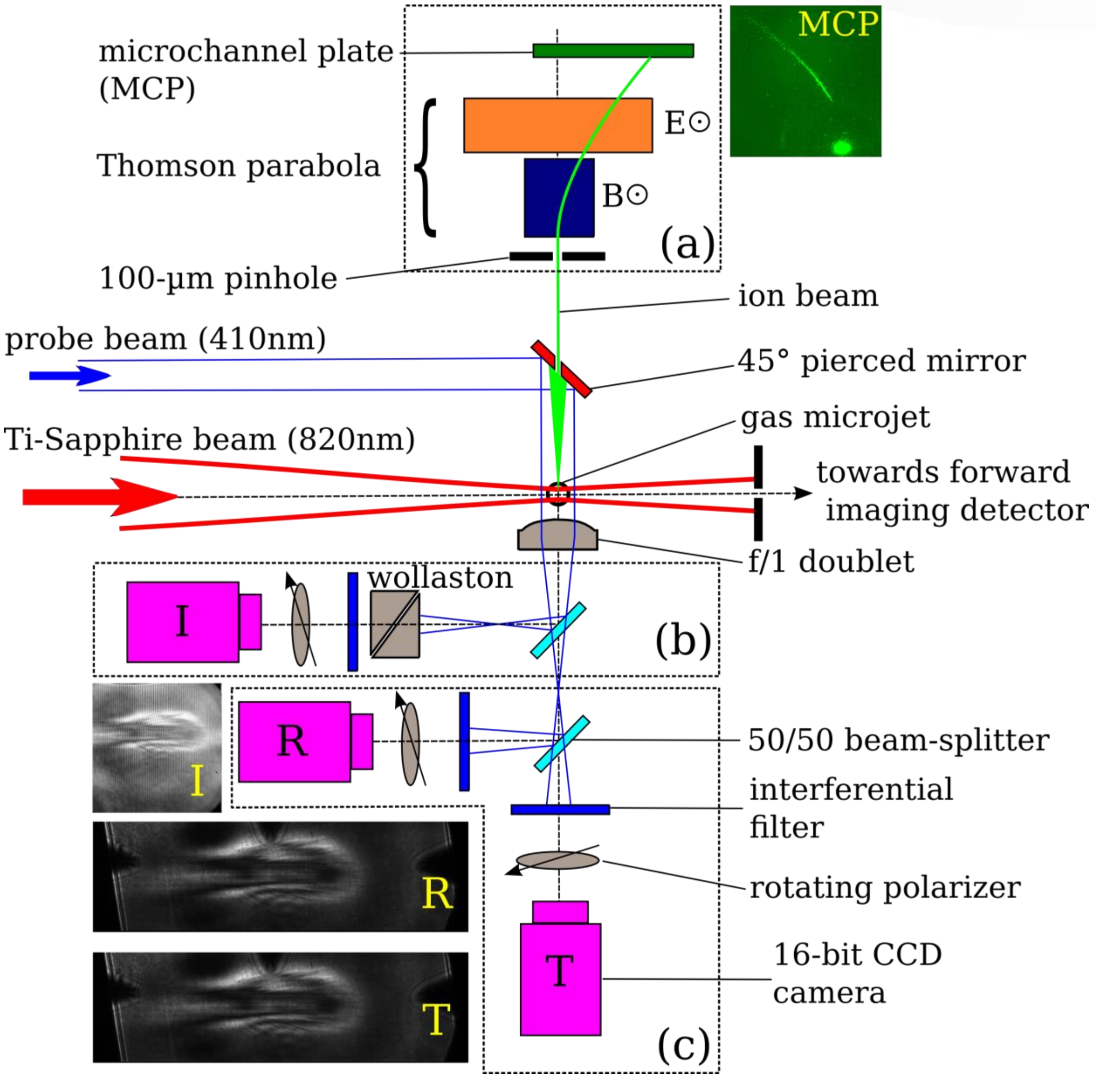
Quicker access to your physics and applications



- Sylla et al, **RSI**, 83, 033507 (2012)

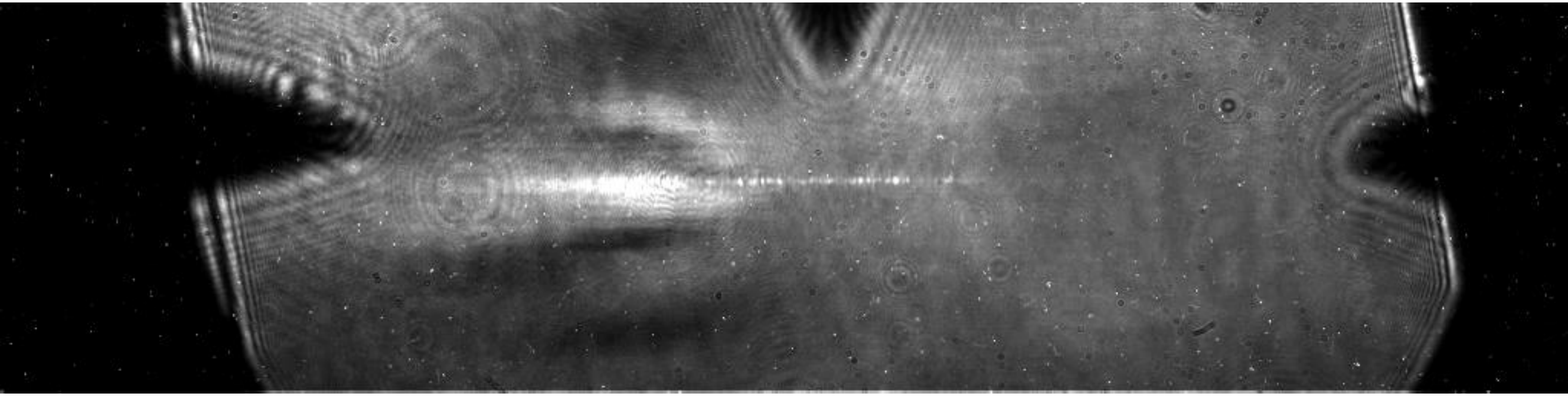
Laser plasma experiment setup

- E=800 mJ, τ=30 fs, a_0~2.5
- **spatial resolution**: better than 1.5 µm
- **temporal resolution**: ~30 fs (integrated)



Laser propagation in underdense plasma

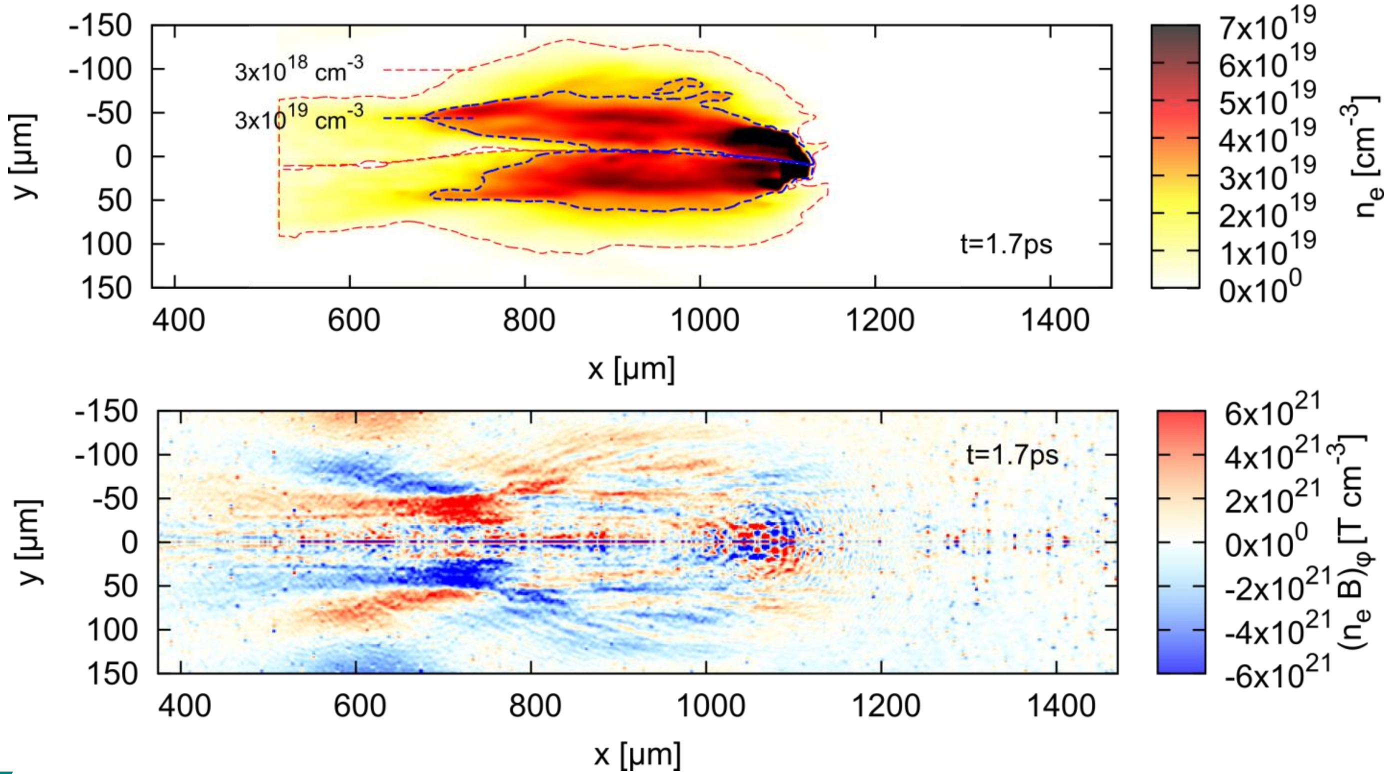
- $n_e \sim 2\text{-}3\%\ n_c$



- T=0.3-100 ps

Plasma magnetization

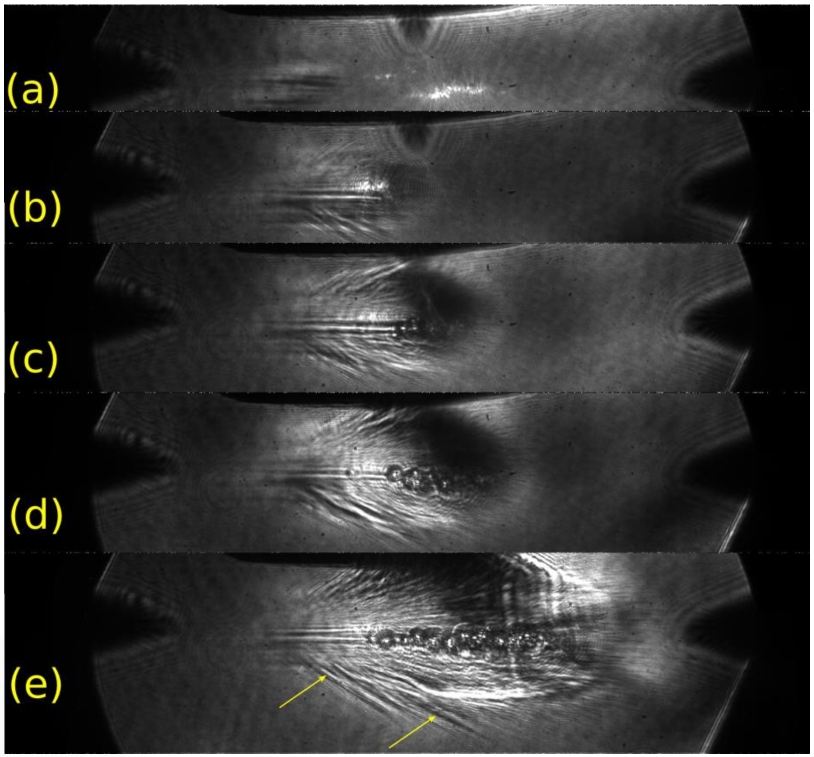
- n_e~2-3% n_c

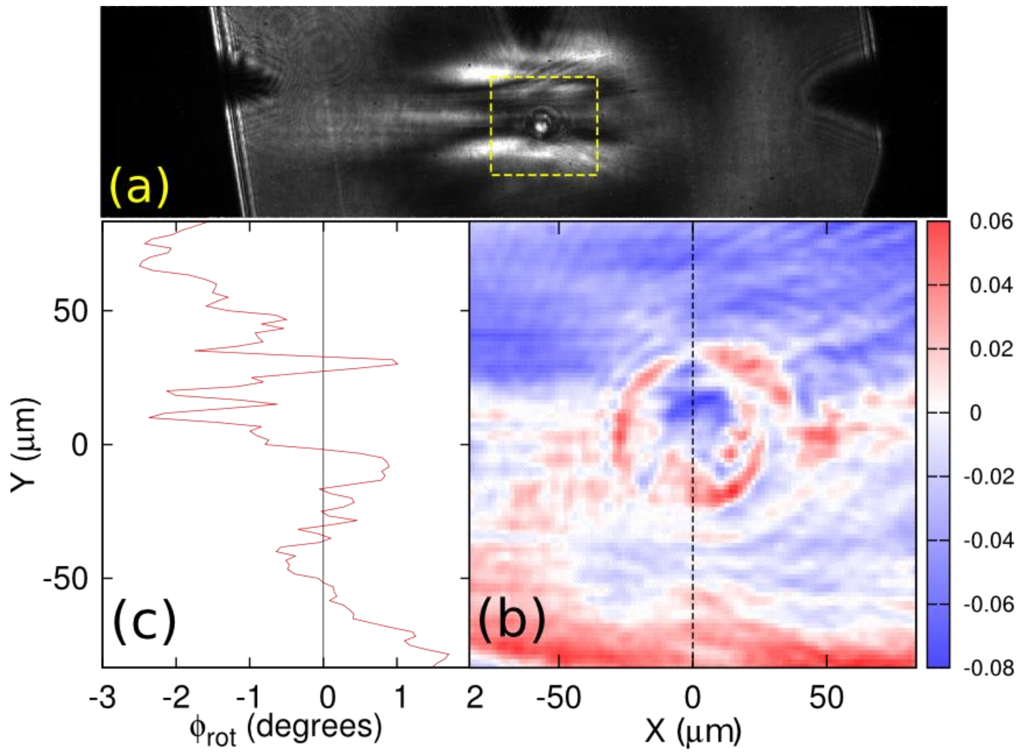


- T=0.3-2.7 ps

Electromagnetic soliton/vortex excitation

- $n_e \sim 10\% \ n_c$

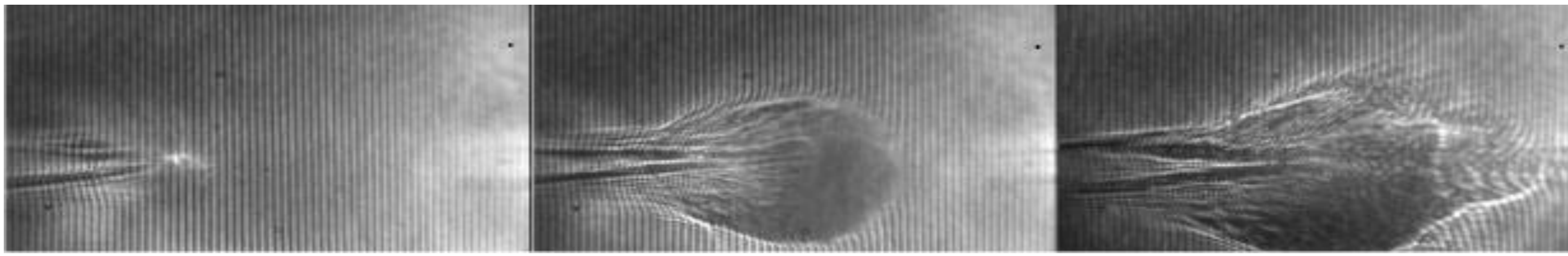


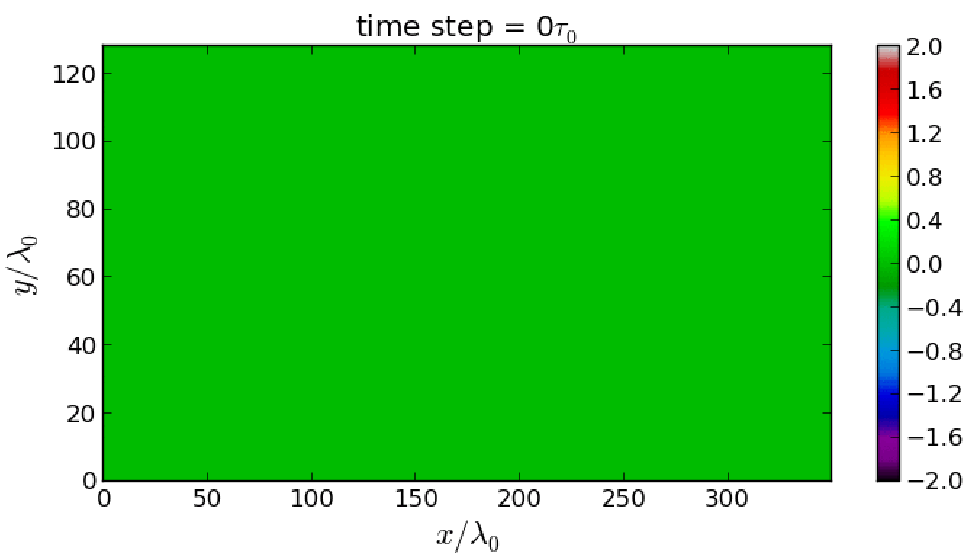


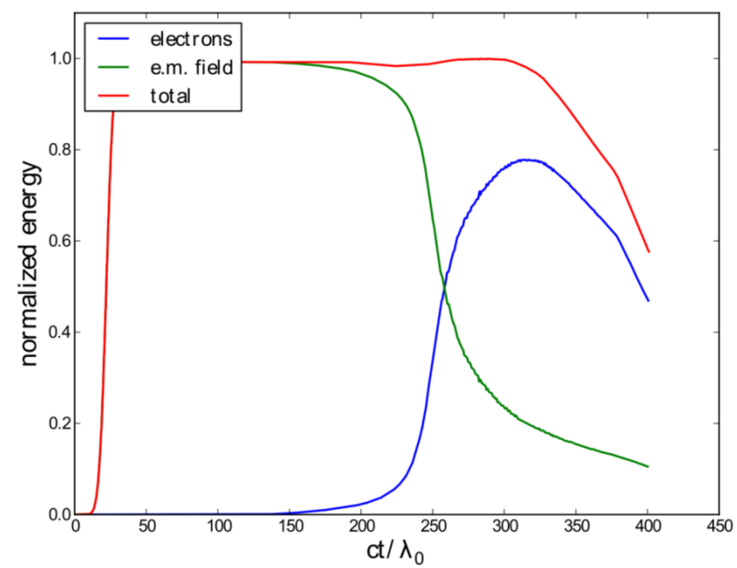
- Sylla et al, **PRL**, 108, 115003 (2012)

Laser collapse

- $n_e \sim n_c$

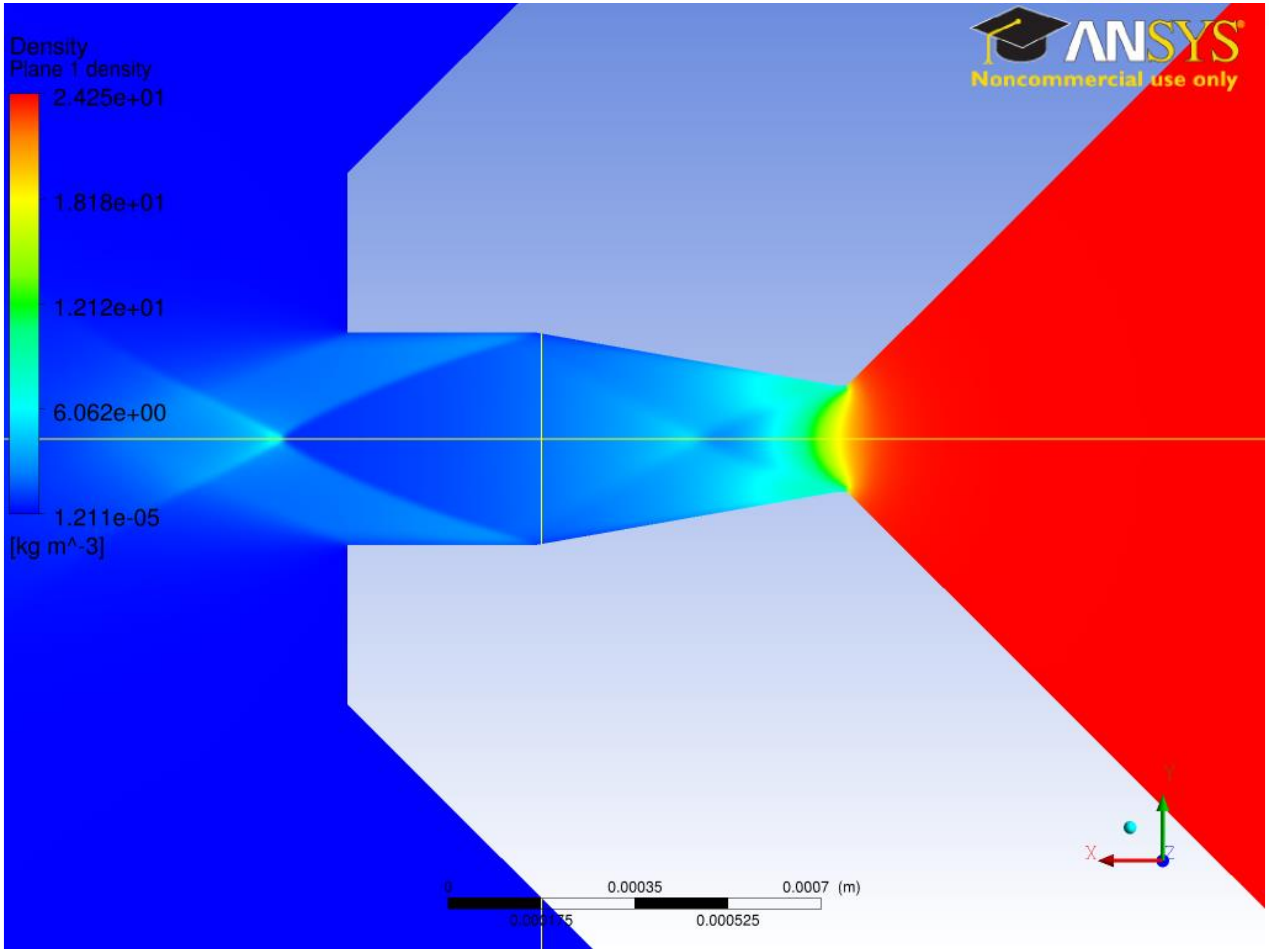






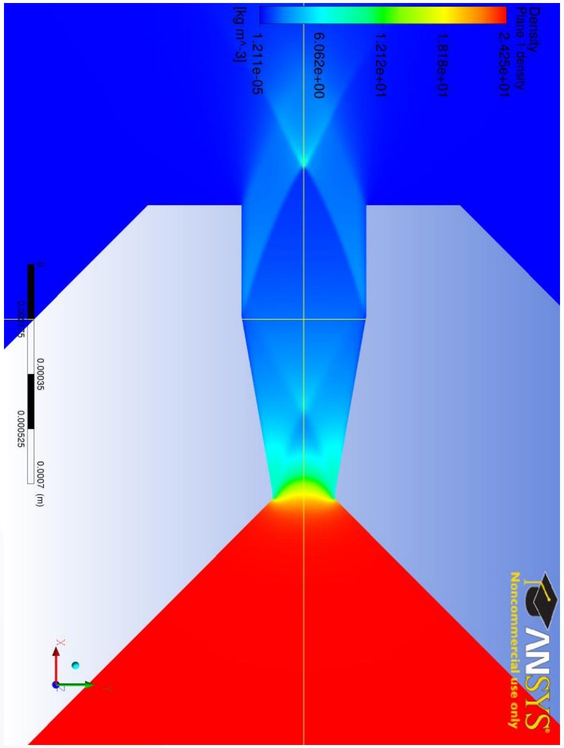
- Sylla et al, **PRL**, 110, 085001 (2013)

How to reduce the plasma size ?



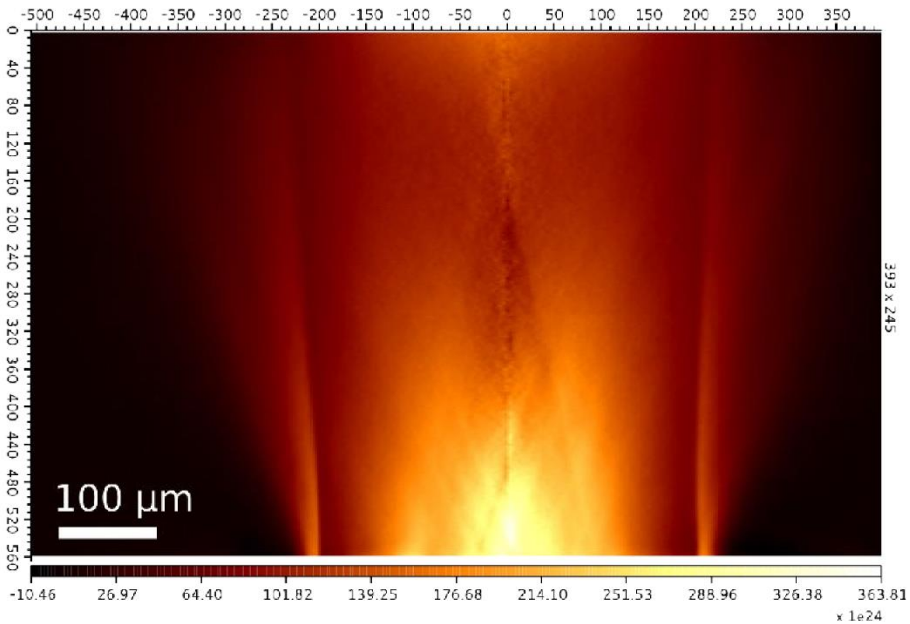
Simulation vs experiment

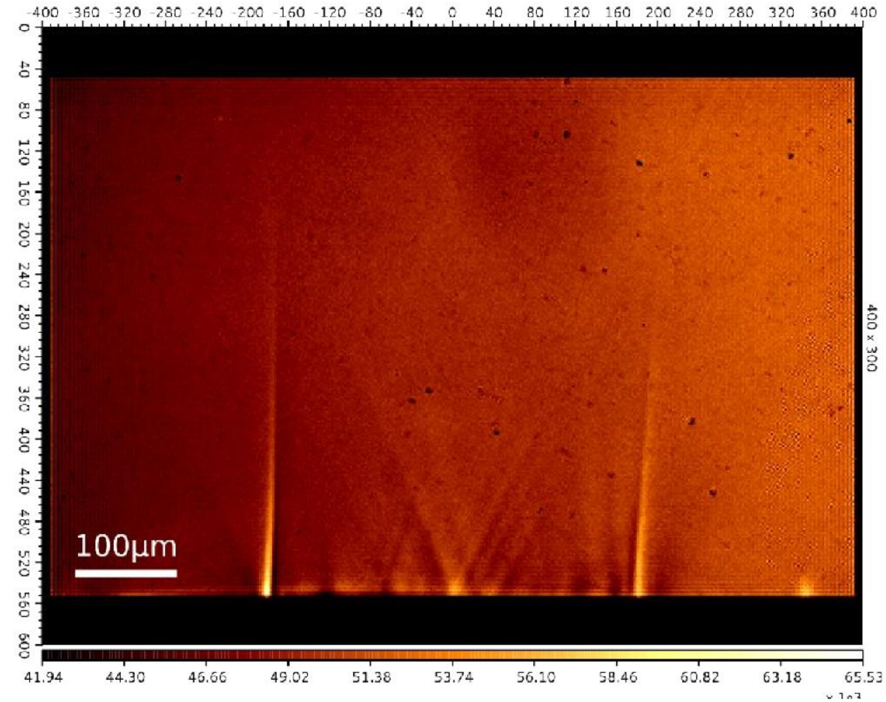
- Density 200µm-400 µm (Phasics) 300 bar Argon, 50 µs exposure



- Density 200µm-400 µm (ANSYS) 300 bar Argon

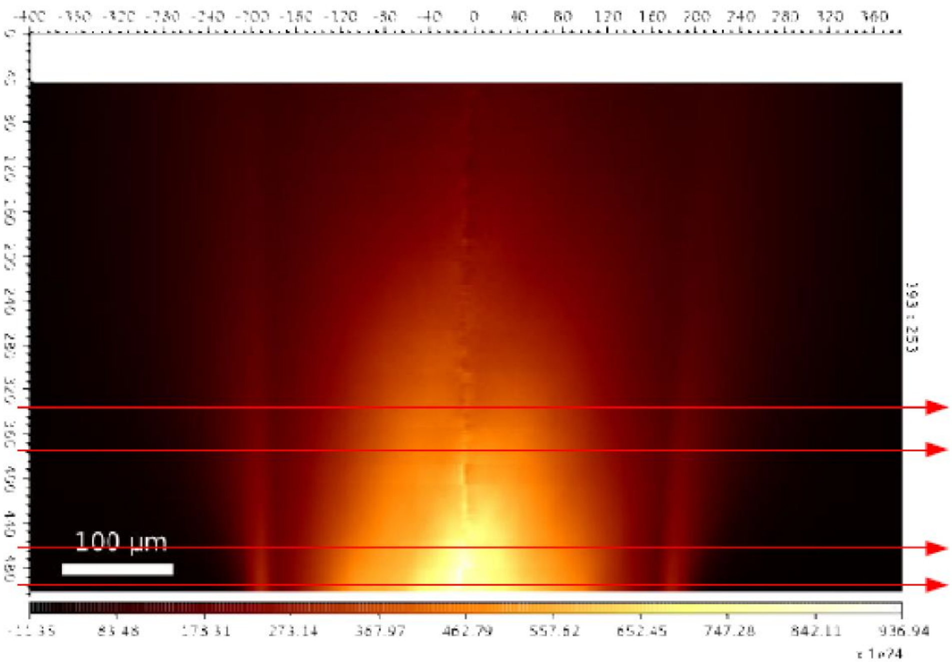
Interesting feature ? (1/3)

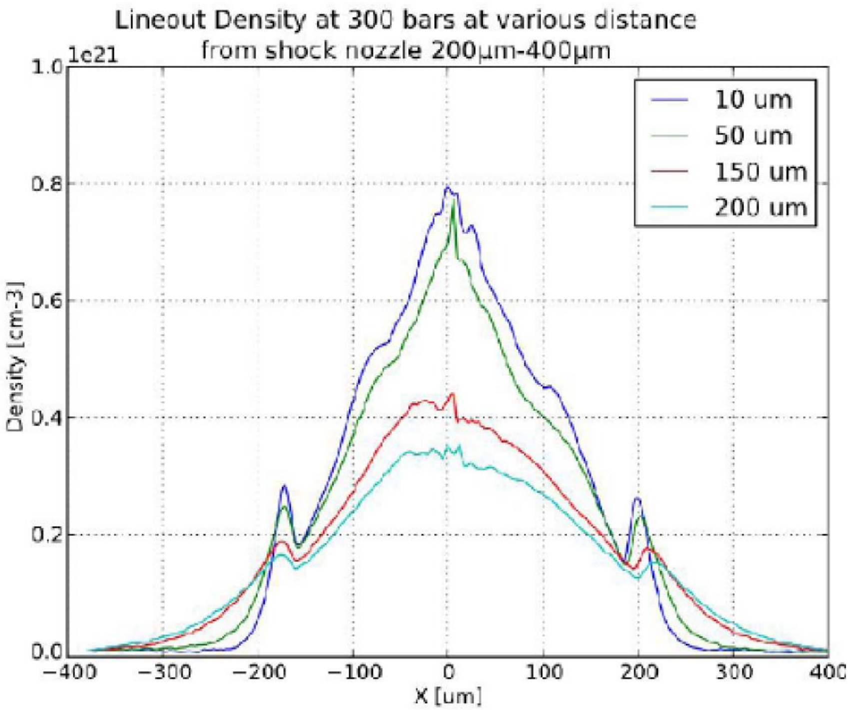




- Density 200µm-400 µm (Phasics) 300 bar Argon, 50 µs exposure
- Shadowgraphy 200µm-400 µm (Phasics) 300 bar Argon, 50 µs exposure

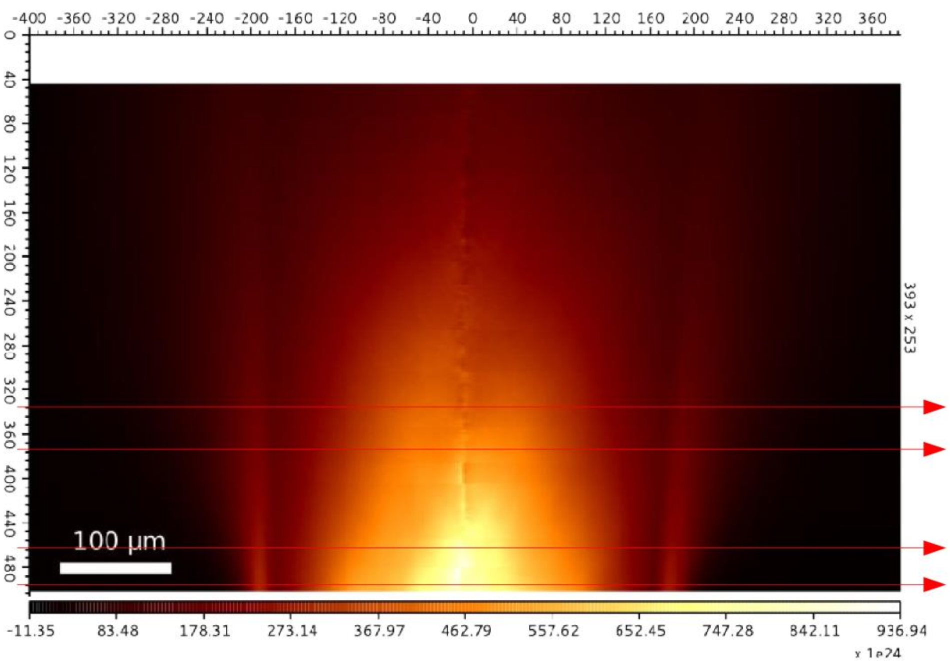
Interesting feature ? (2/3)

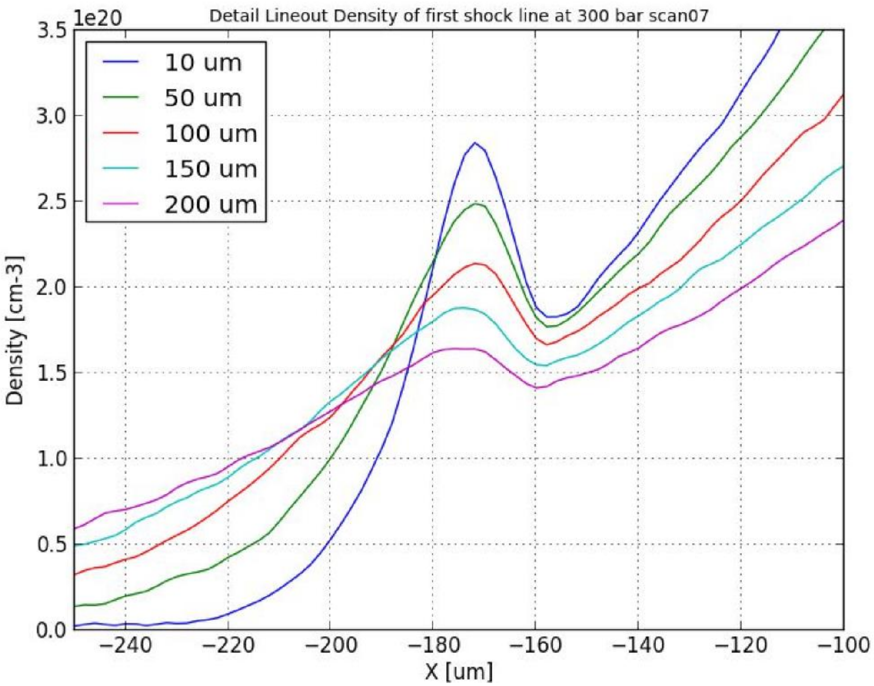




- Density 200µm-400 µm (Phasics) 300 bar Argon, 50 µs exposure

Interesting feature ? (3/3)





- Density 200µm-400 µm (Phasics) 300 bar Argon, 50 µs exposure

Conclusions

- High-density smallscale gas jets are suitable tools for the exploration of the near-criticical regime.
- Robust and well characterized and understood (SL-GT-10 item).
- Ion acceleration (as a beam) is to be demonstrated: length, gradient issues.
- Shock nozzles should be investigated in depth in the near-future.

SourceLAB

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