Measuring the temporal evolution of a laser induced plasma

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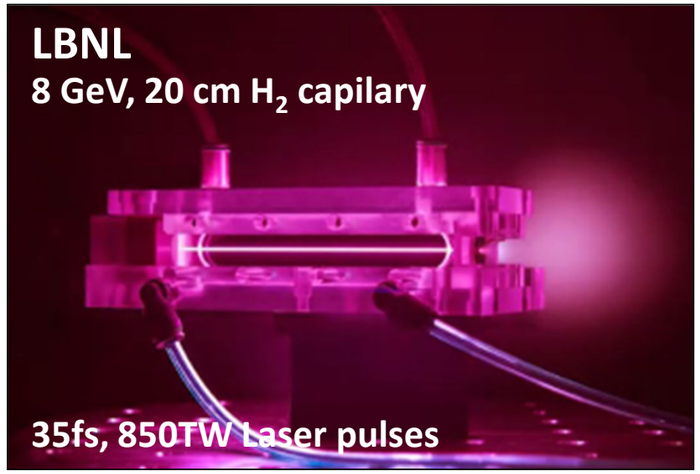
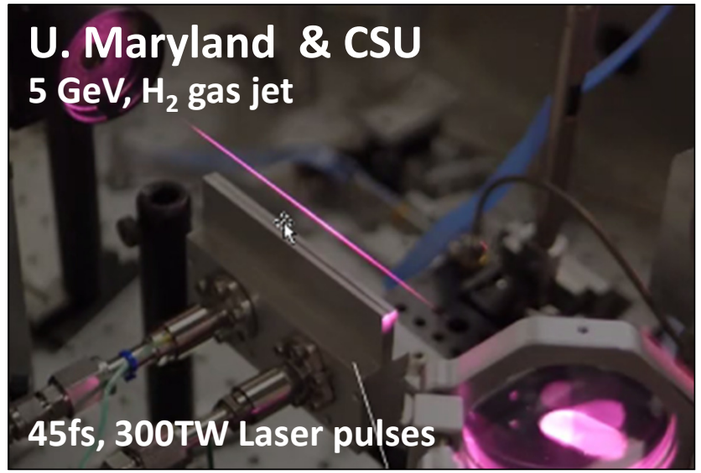
Why laser induced plasmas??

Motivation: Laser Particle Accelerators

Conventional Accelerators

Laser Plasma Accelerators

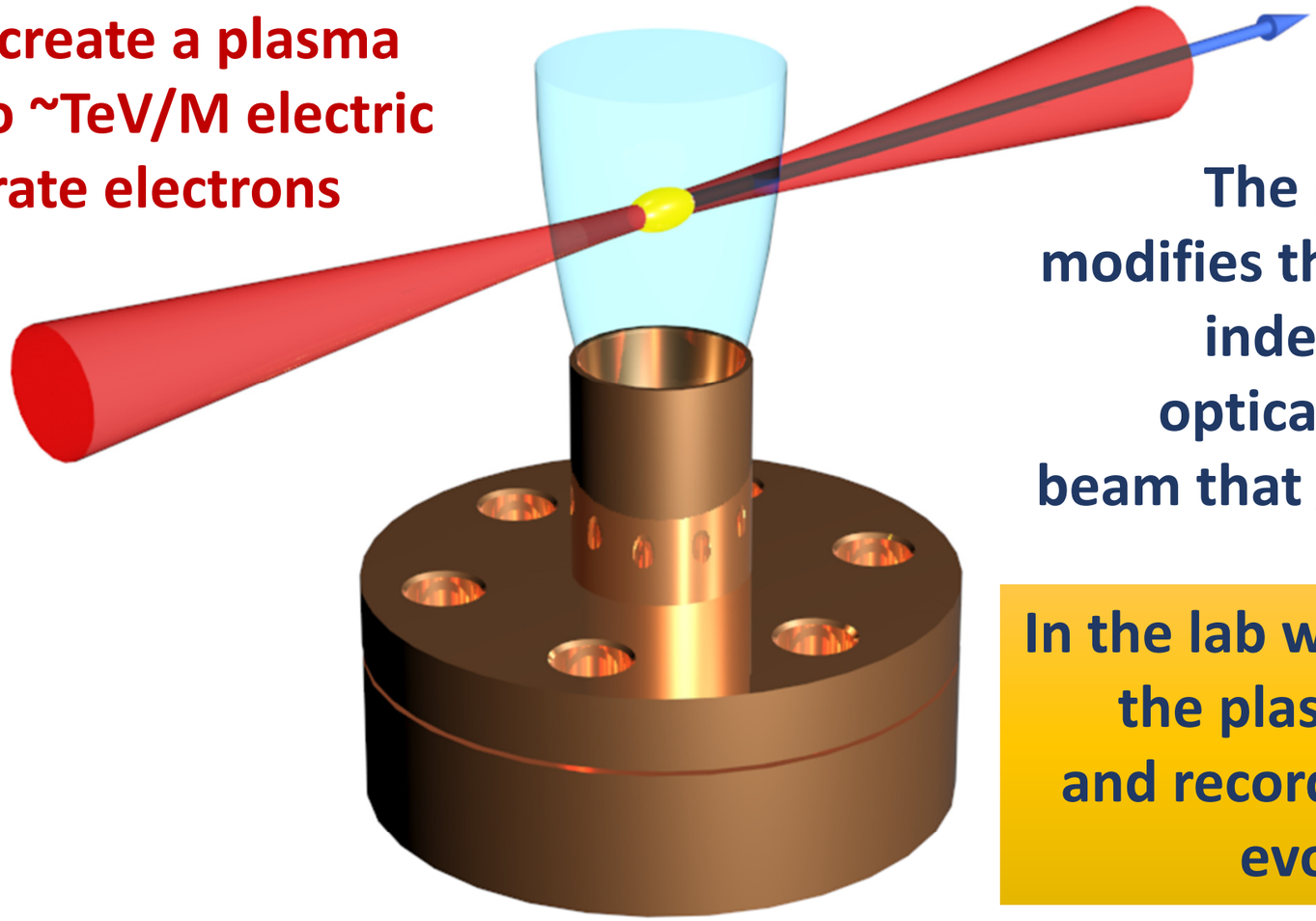




- New technology 😐
- Low repetition rates ☹
- Irregular beams ☹
- Shot-to-shot variation ☹
- Small dimensions ☺
- Less complexity ☺
- Moderate costs ☺
- Small shielding ☺
- Potential to increase beam energy ☺

Laser Driven Particle Acceleration

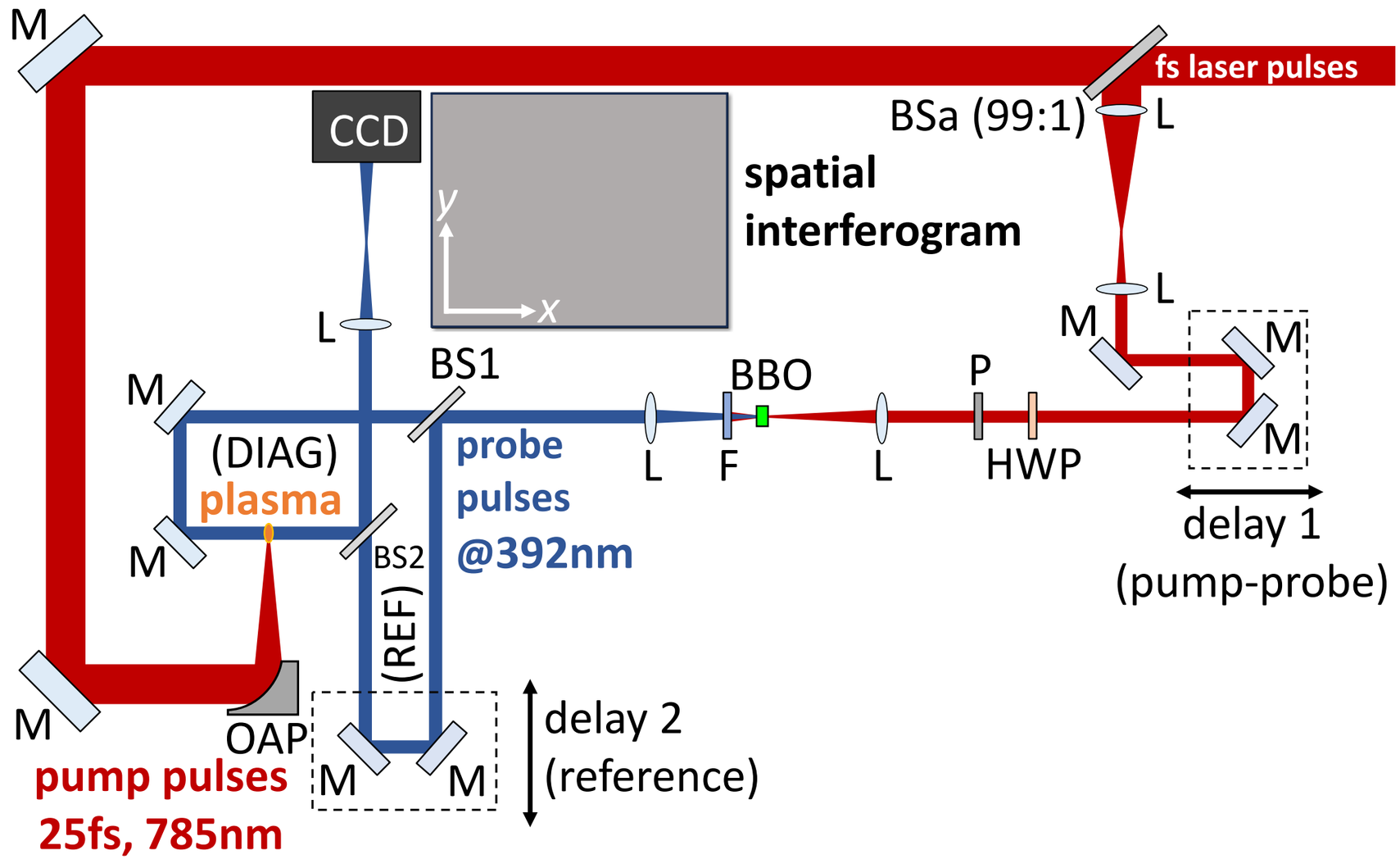
Ultrashort Laser pulses focused in a gas jet in vacuum create a plasma that sustains up to ~TeV/M electric fields that accelerate electrons



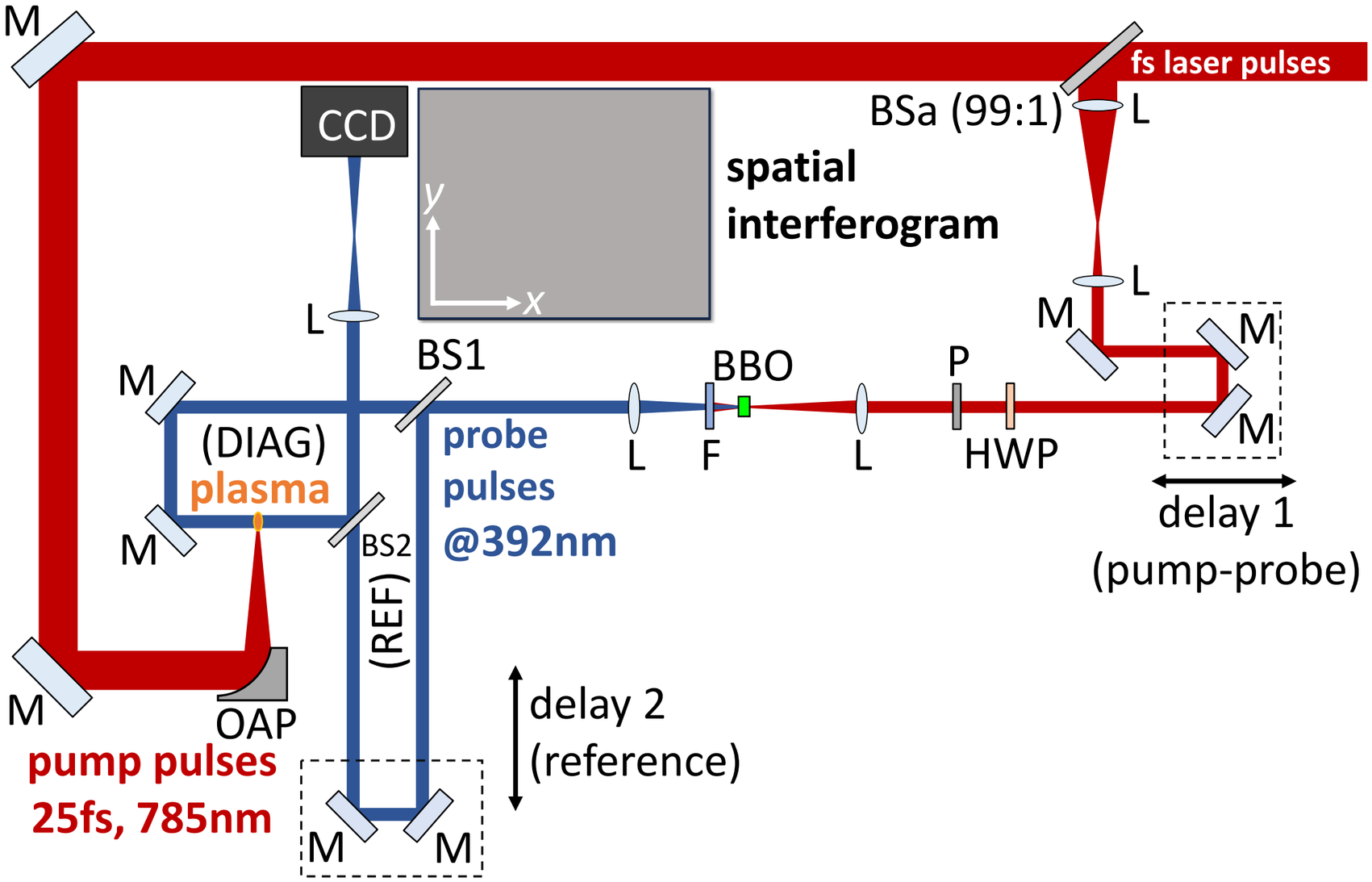
The plasma volume modifies the air refractive index, changing the optical path of a light beam that goes through it

In the lab we will measure the plasma density and record its temporal evolution

Time-Resolved Mach-Zehnder Like Interferometer

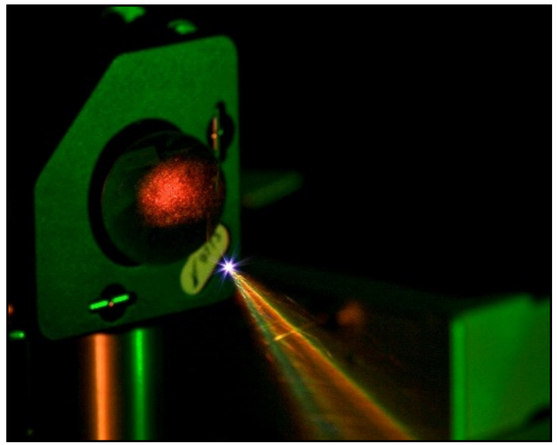


Time-Resolved Mach-Zehnder Like Interferometer

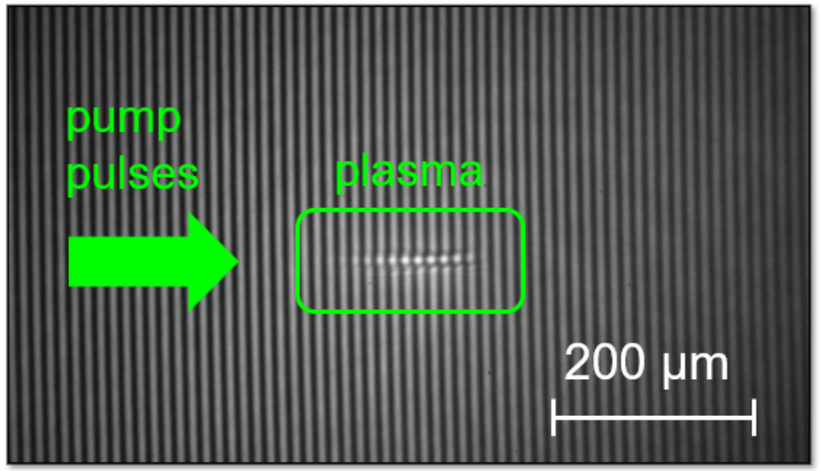


Laser-induced Plasma Characterization

25fs laser pulses, ~100μJ, focused in **air** by a parabolic mirror to **10^{16} W/cm^2**



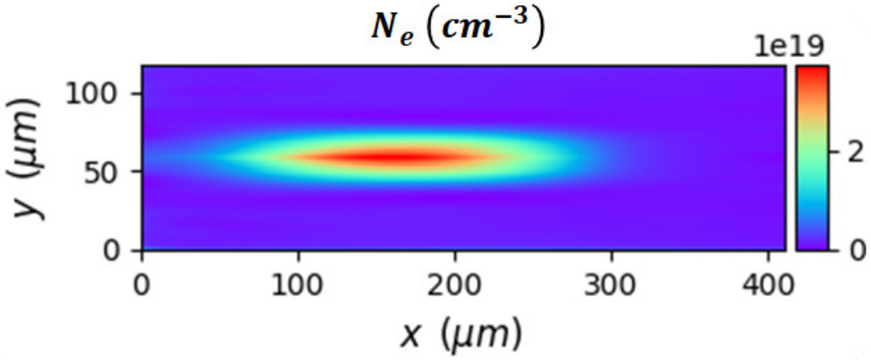
Laser-induced plasma interferogram



Plasma (electronic) density

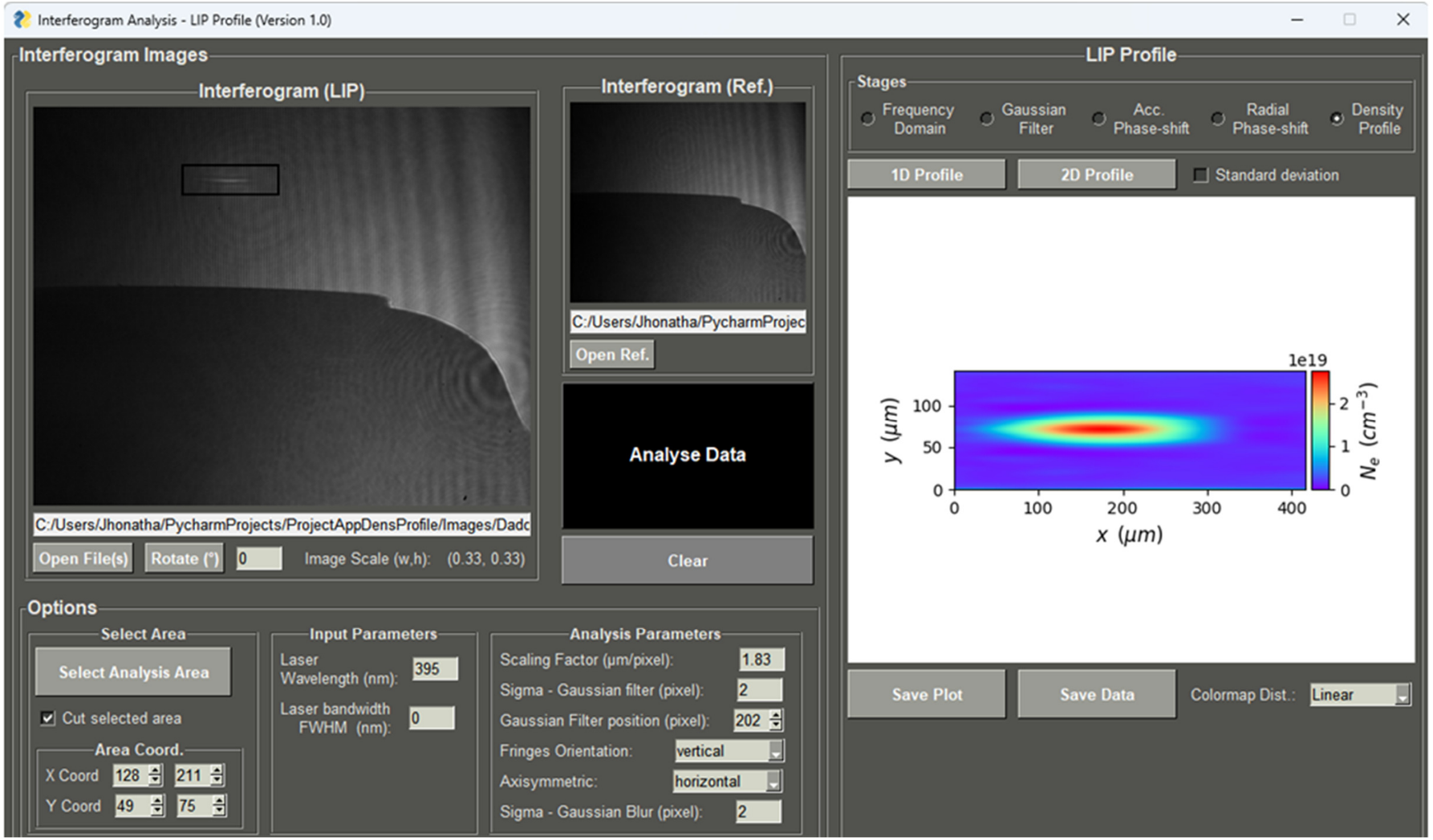
$$n_e(x,y) = \frac{4\pi^2 c^2 \varepsilon_0 m_e}{e^2 \lambda^2}\left\{1 - \left[1 + \frac{\Delta\phi(x,y)\lambda}{2\pi l}\right]^2\right\}$$

Laser-induced plasma density map

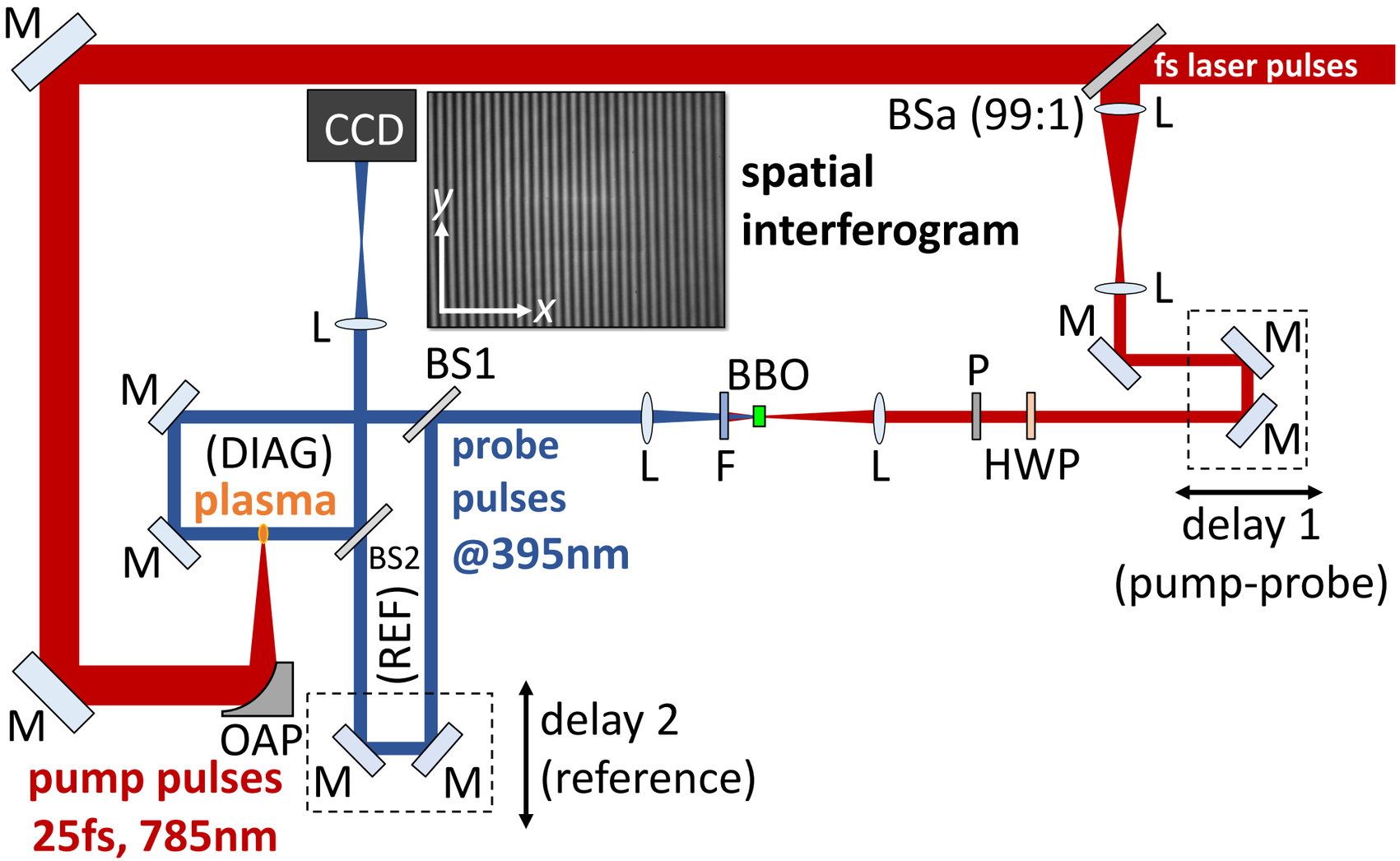


Plasma Density Retrieval

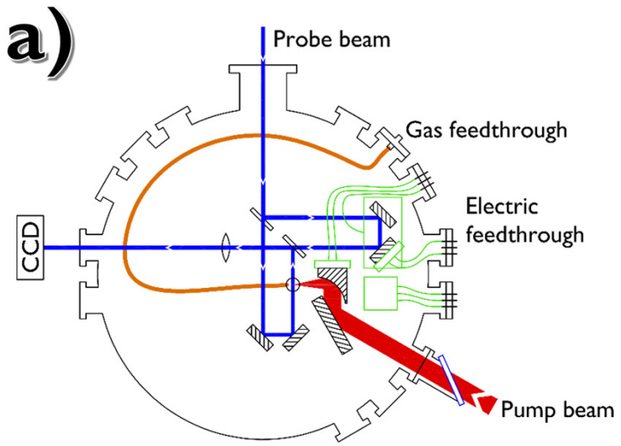
- Interferograms analysis by Fourier Transforms and Abel Transforms

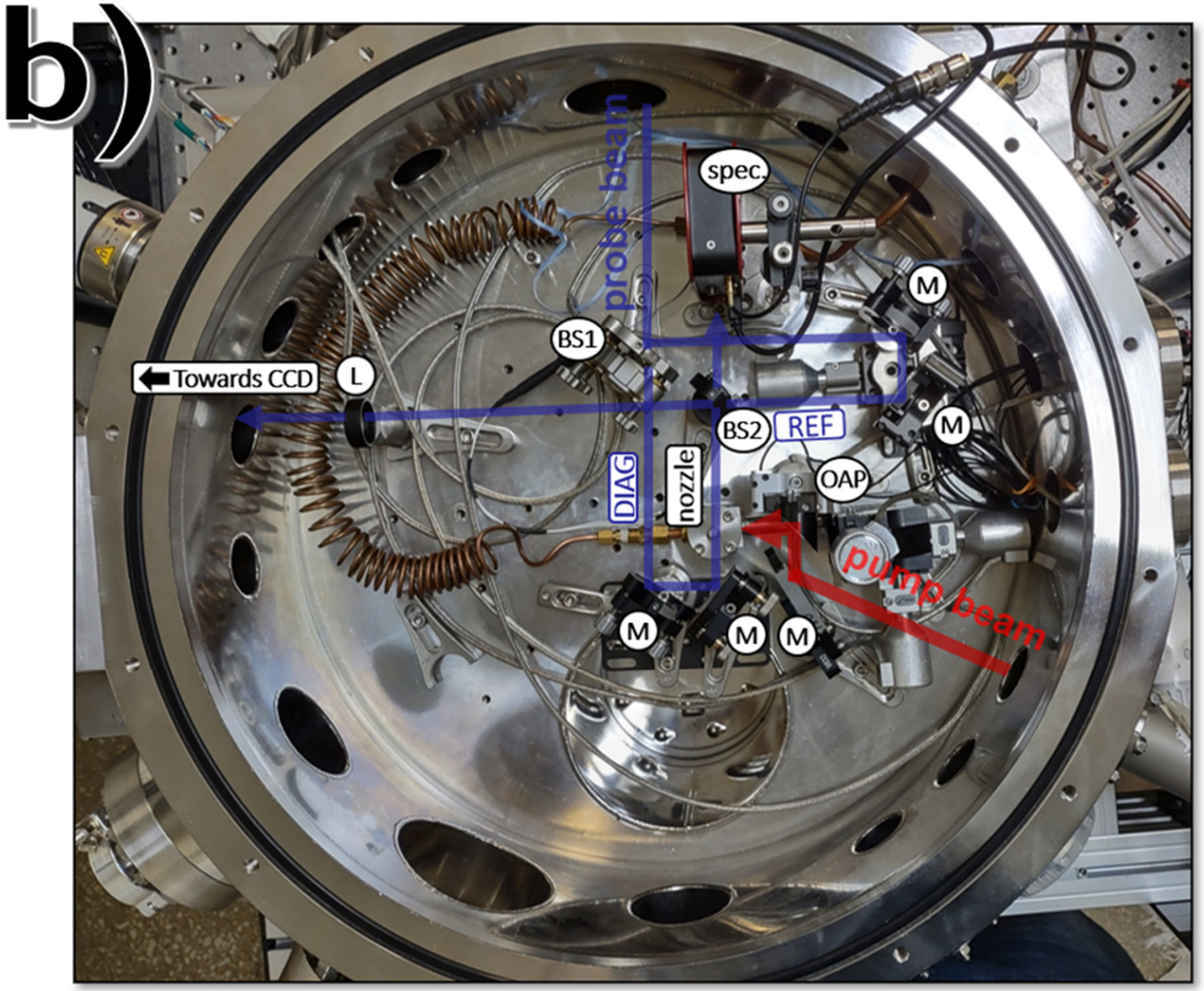


Time-Resolved Mach-Zehnder Like Interferometer

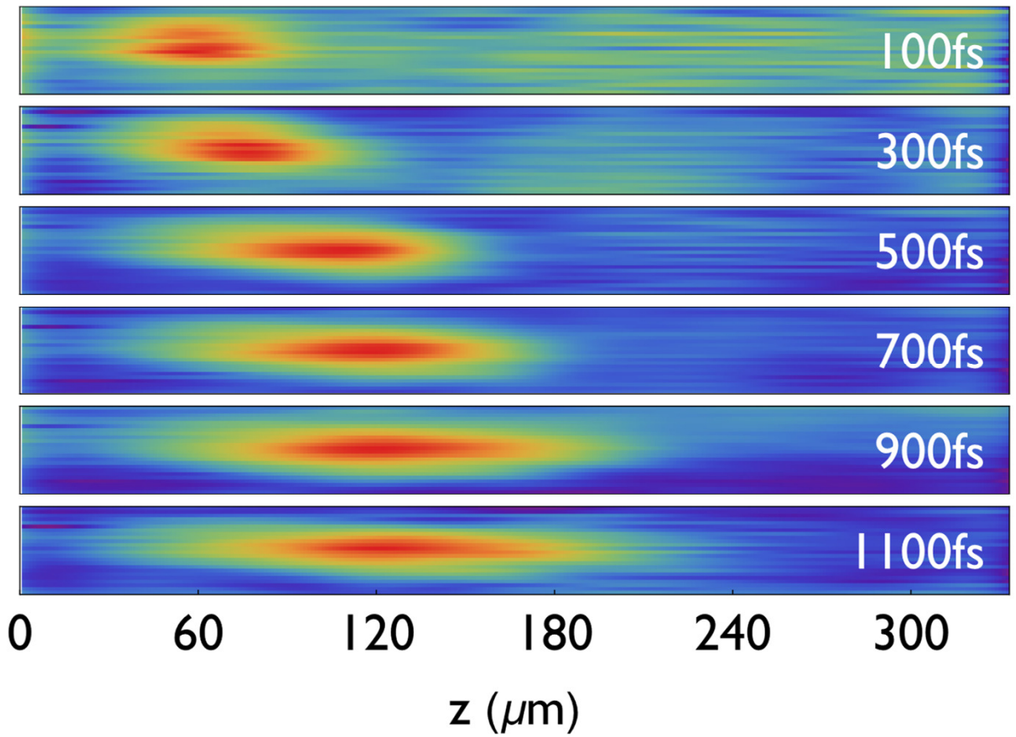


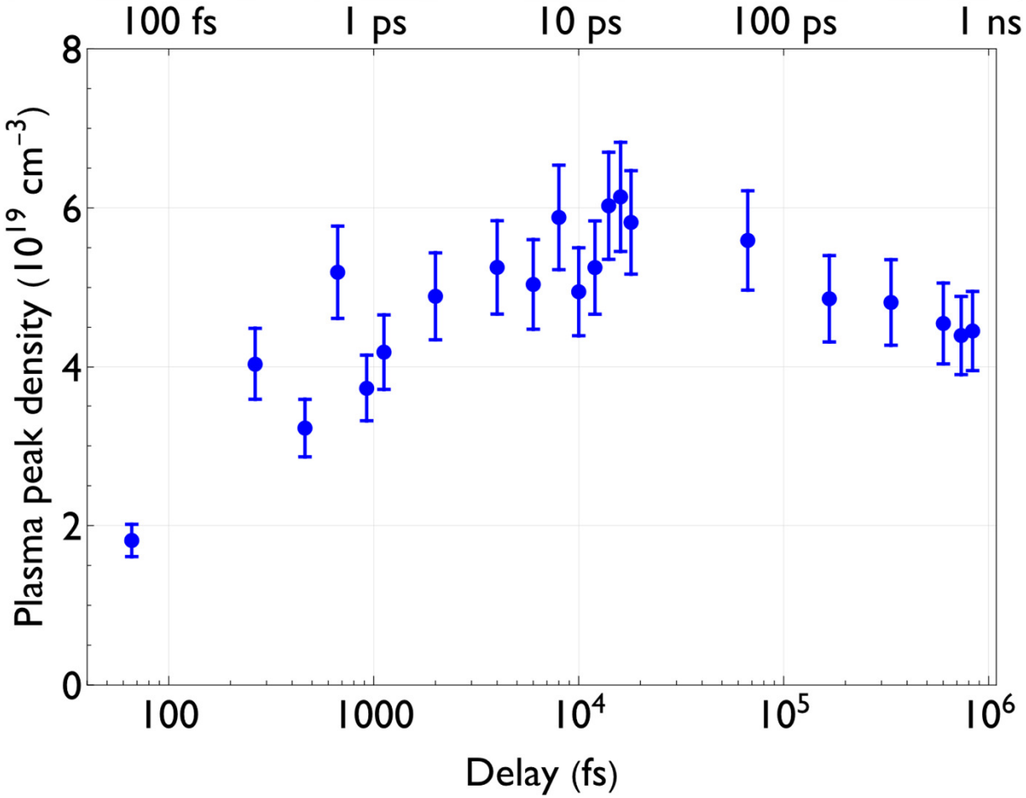
Experimental Setup





Plasma Temporal Evolution



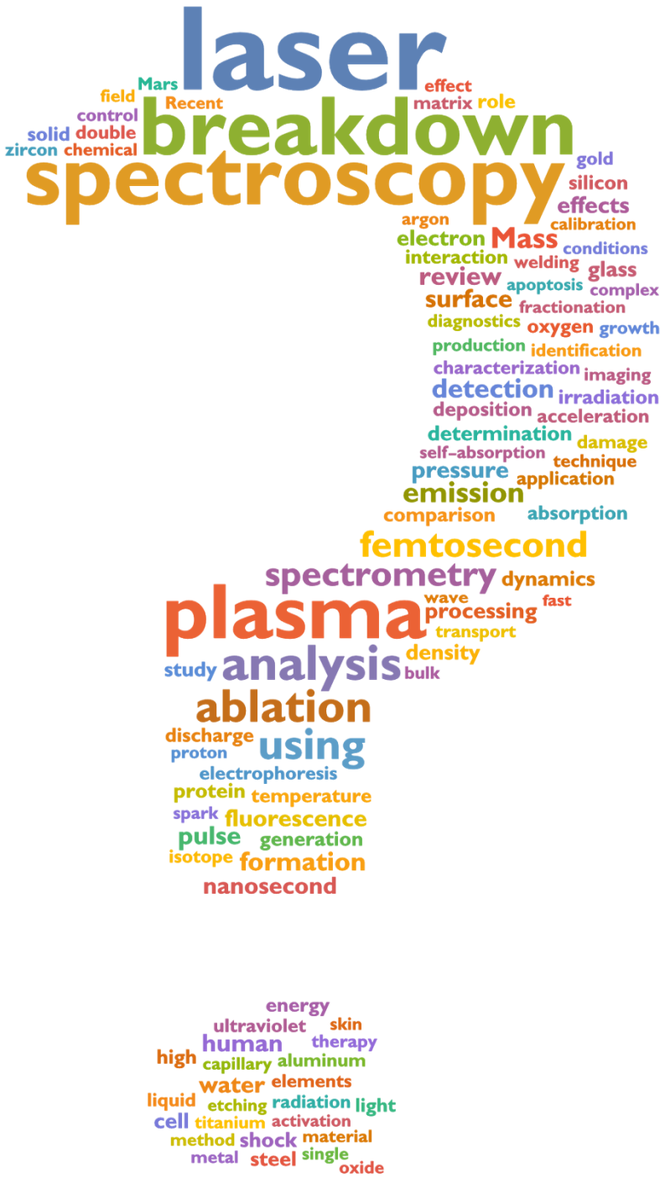


Possible Measurements:

- Laser Intensity
- Plasma spatial profile
- Plasma spatial Density distribution
- Plasma refractive index
- Plasma maximum density
- Plasma density temporal evolution
- Plasma lifetime
- Estimate plasma temperature
- Estimate plasma temperature temporal evolution

Thank you for your attention

See you at the Lab!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