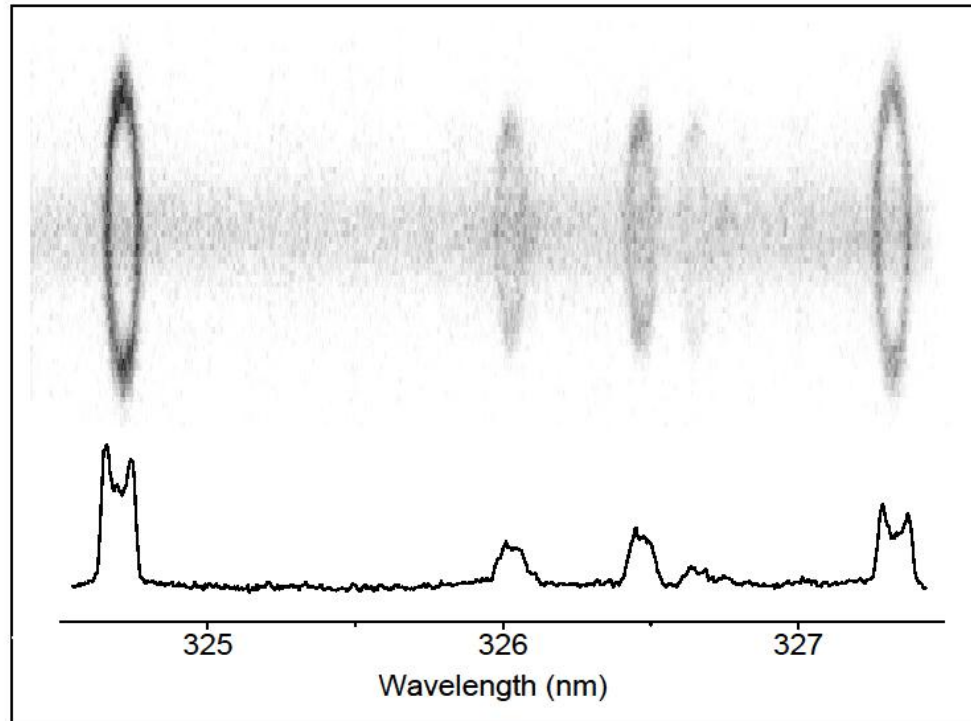


UNCOMMON LINE SHAPES OF Cu I LINES IN LASER INDUCED PLASMA



M. Skocic, D. Dojic, S. Bukvic
University of Belgrade, Faculty of Physics

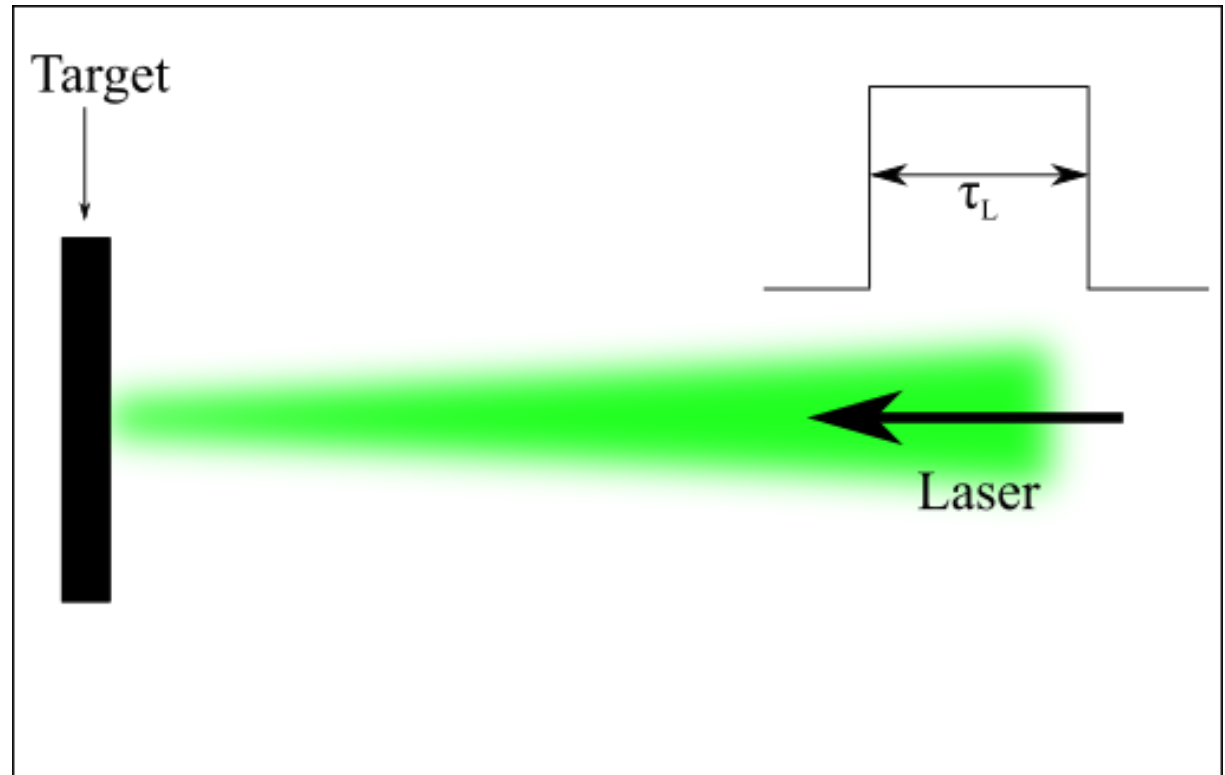
Laser induced plasma – general characteristics

$t < \tau_L$

- **Absorption of laser radiation on the metal target**
- **Heating and melting of the metal target**
- Target evaporation
- Absorption in the plasma plume

$t > \tau_L$

- Fast plasma plume expansion
- Plasma cooling
- Shock wave formation



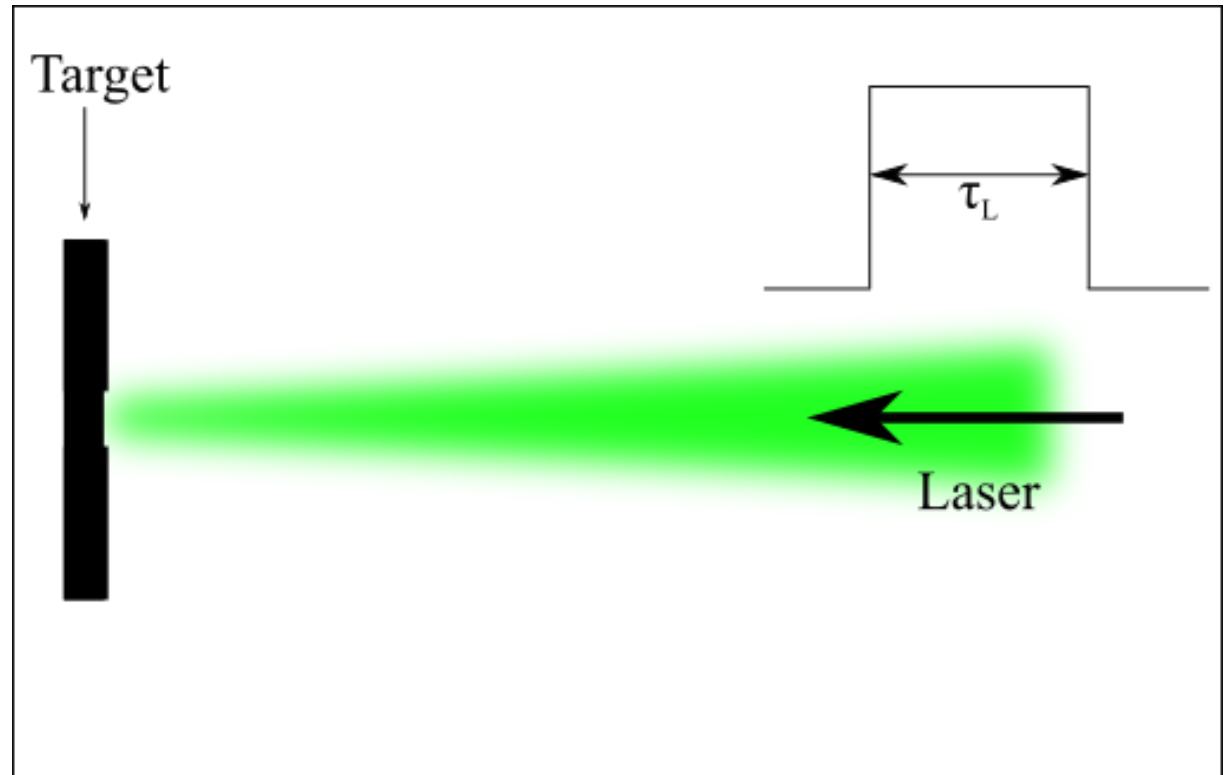
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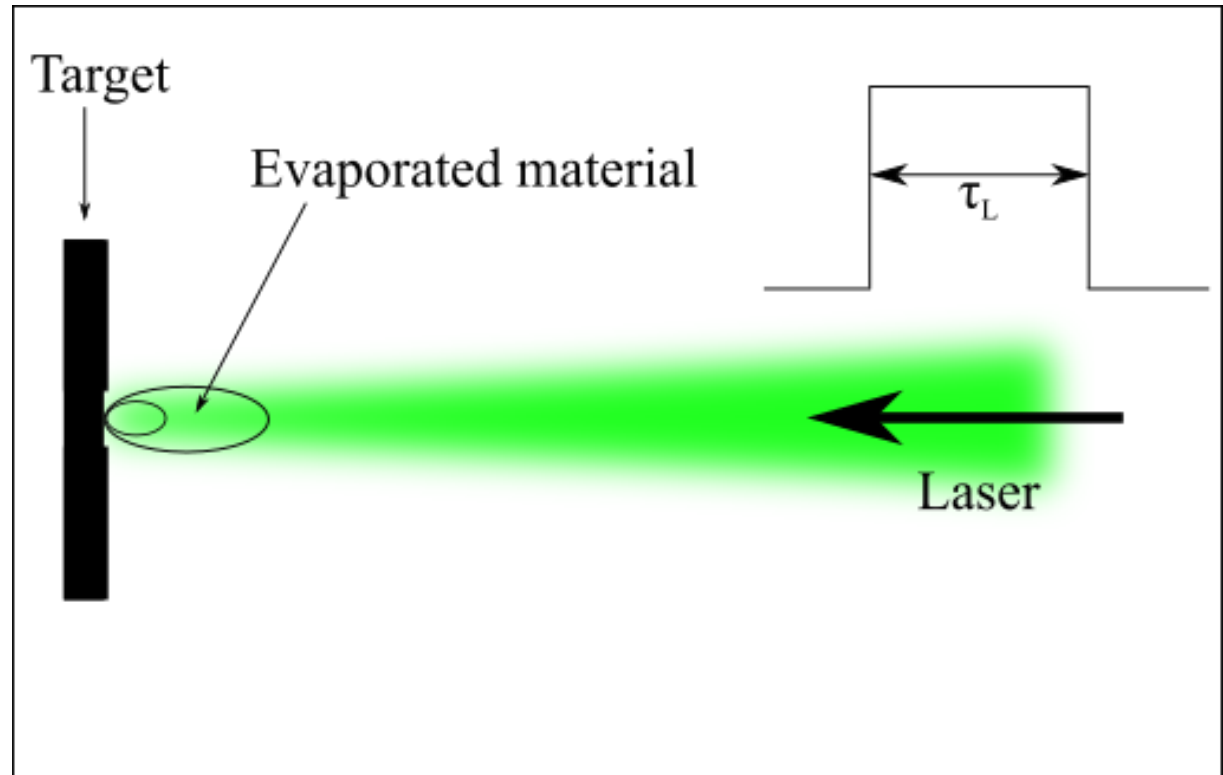
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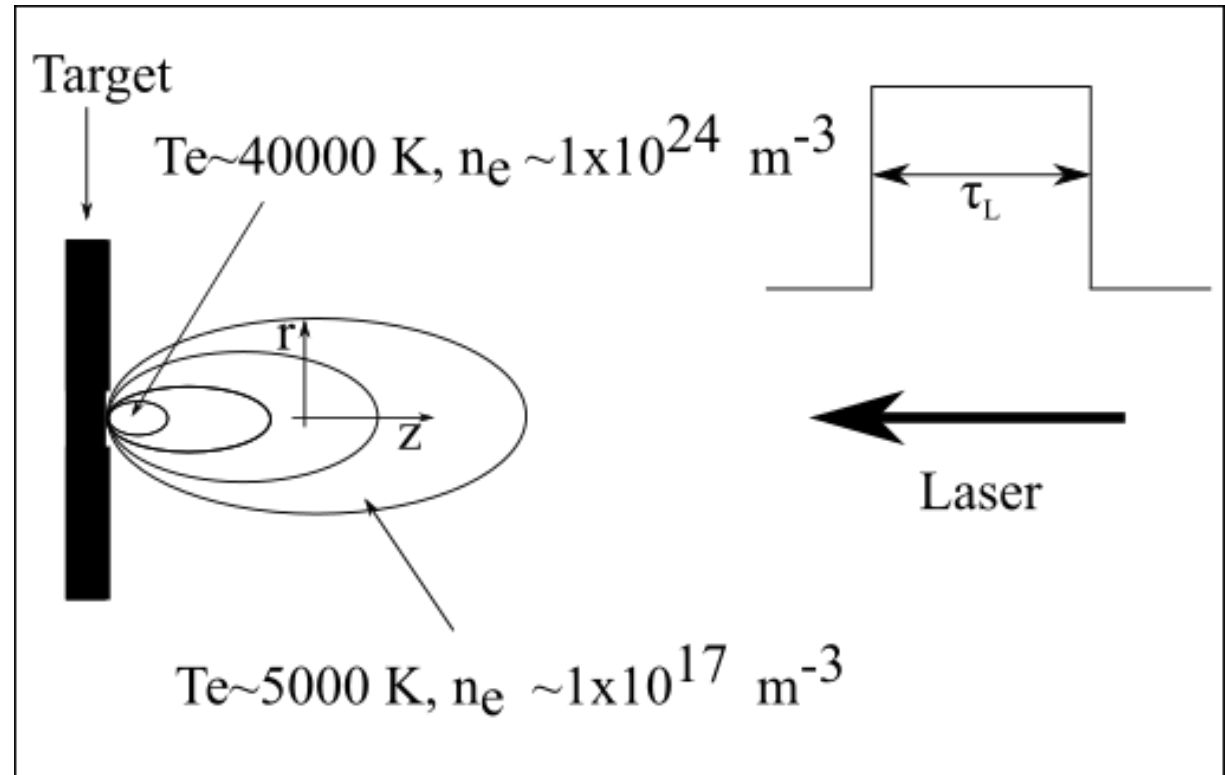
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- **Plasma cooling**
- Shock wave formation

$p \approx 20 \text{ Pa}$
 $t \approx 1 \mu\text{s}$

$T(r,z) \approx 40000 - 5000 \text{ K}$

$n_e(r,z) \approx 10^{24} - 10^{17} \text{ m}^{-3}$



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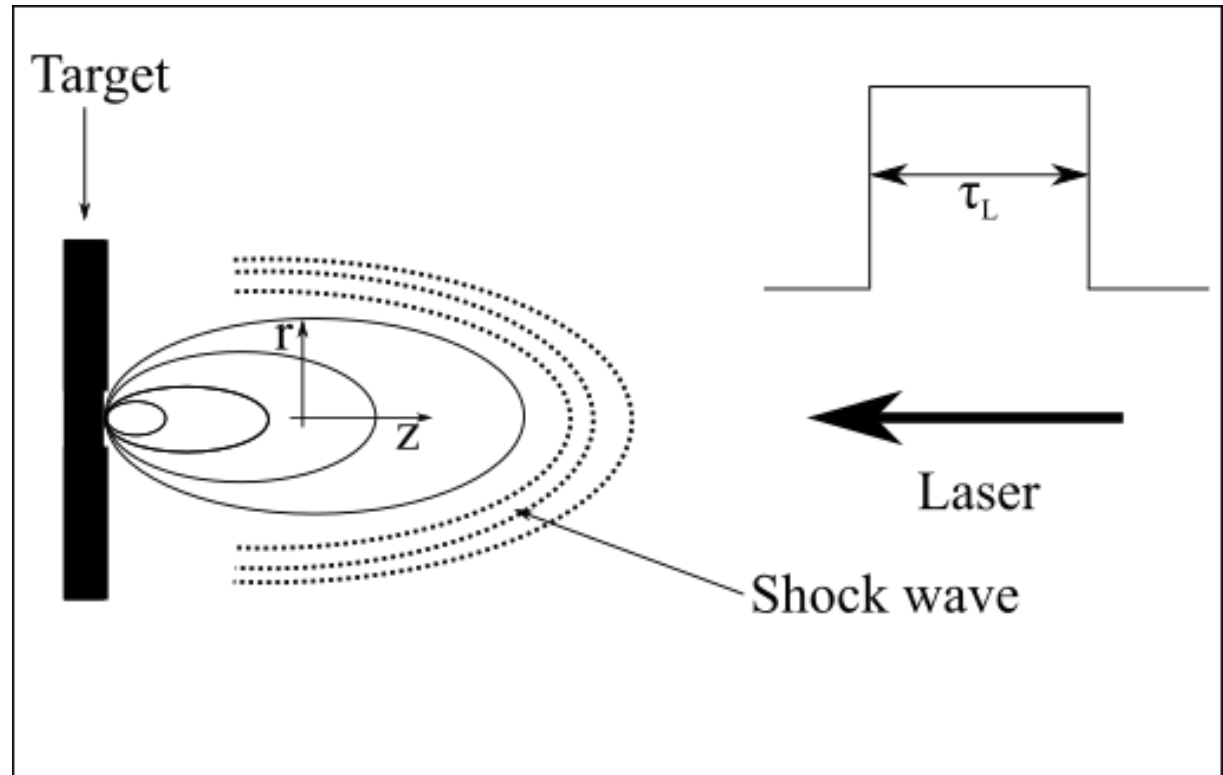
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- **Shock wave formation**

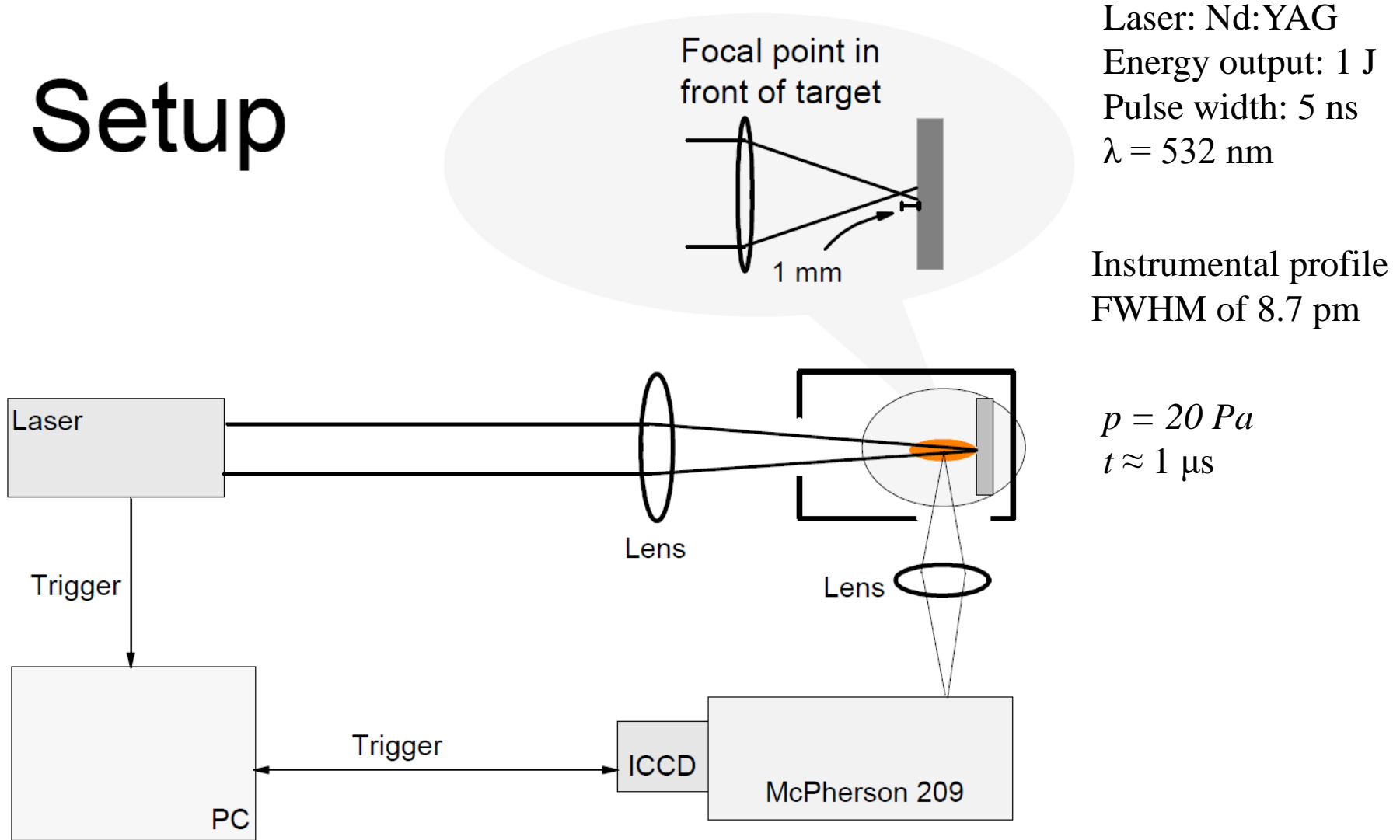
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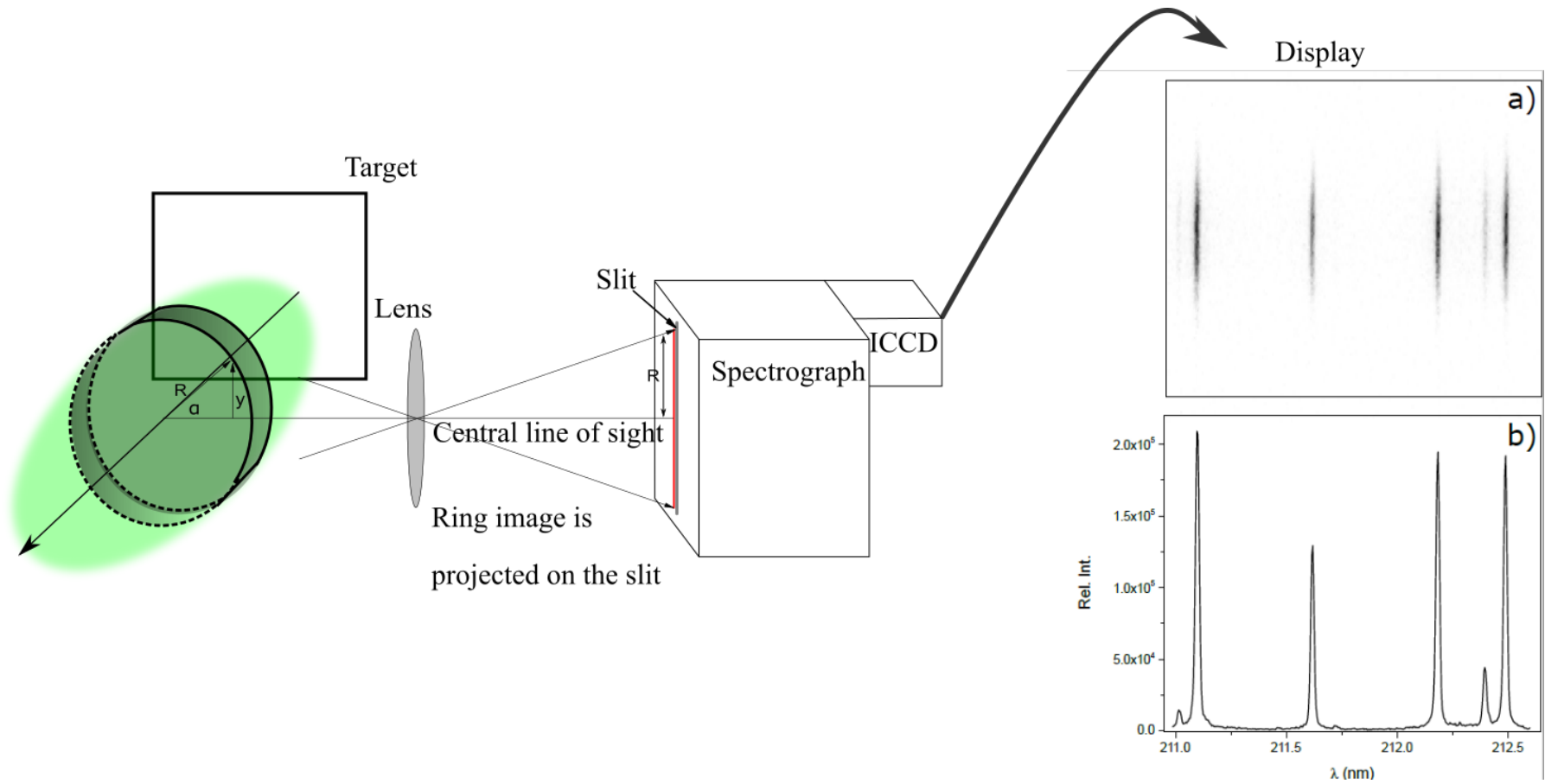
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Setup



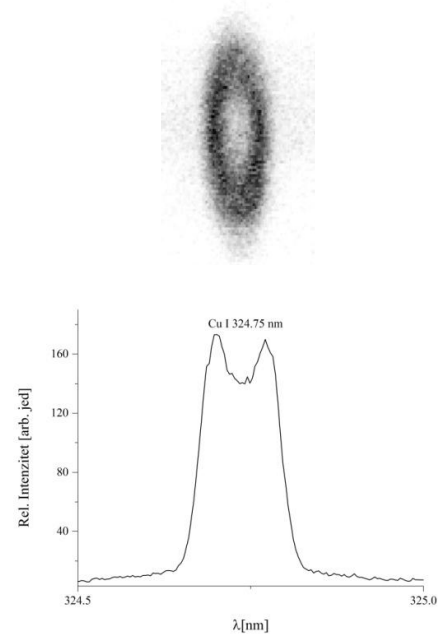
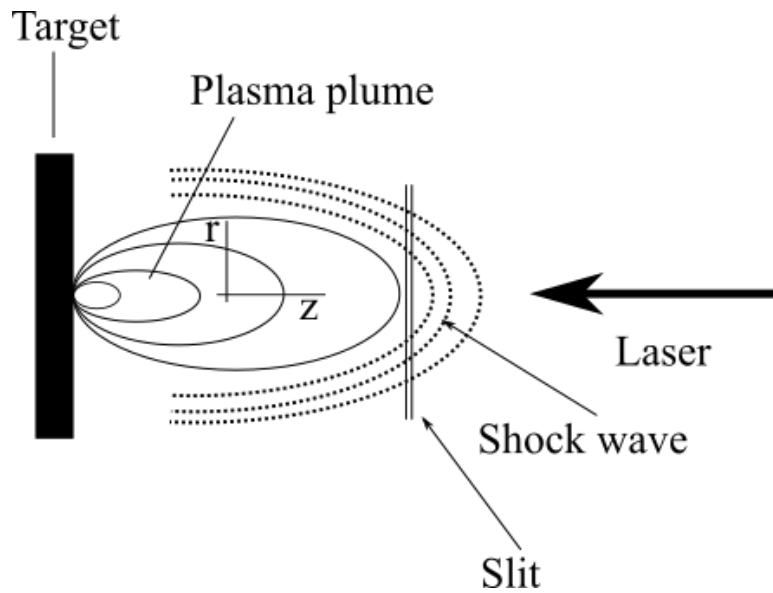
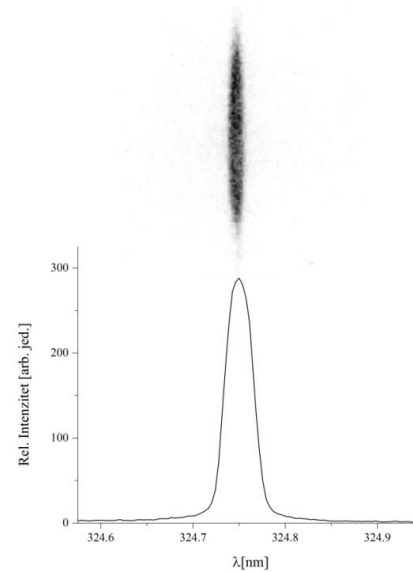
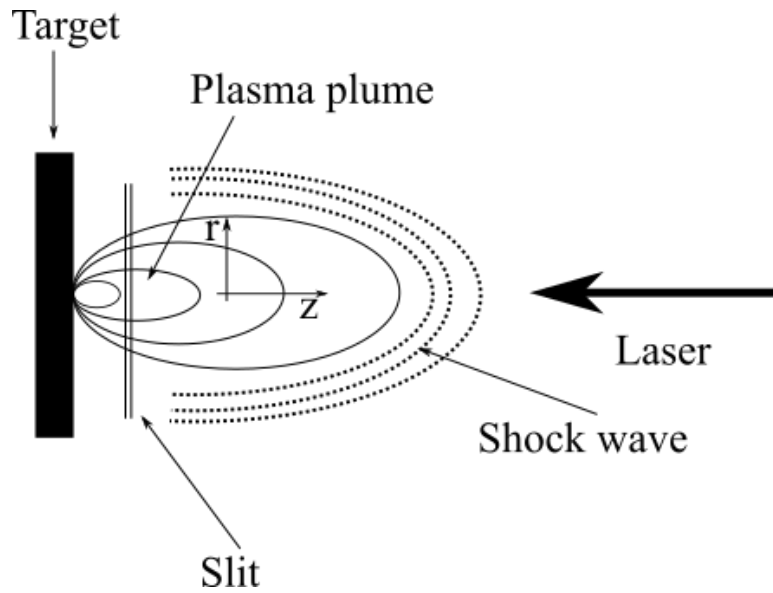


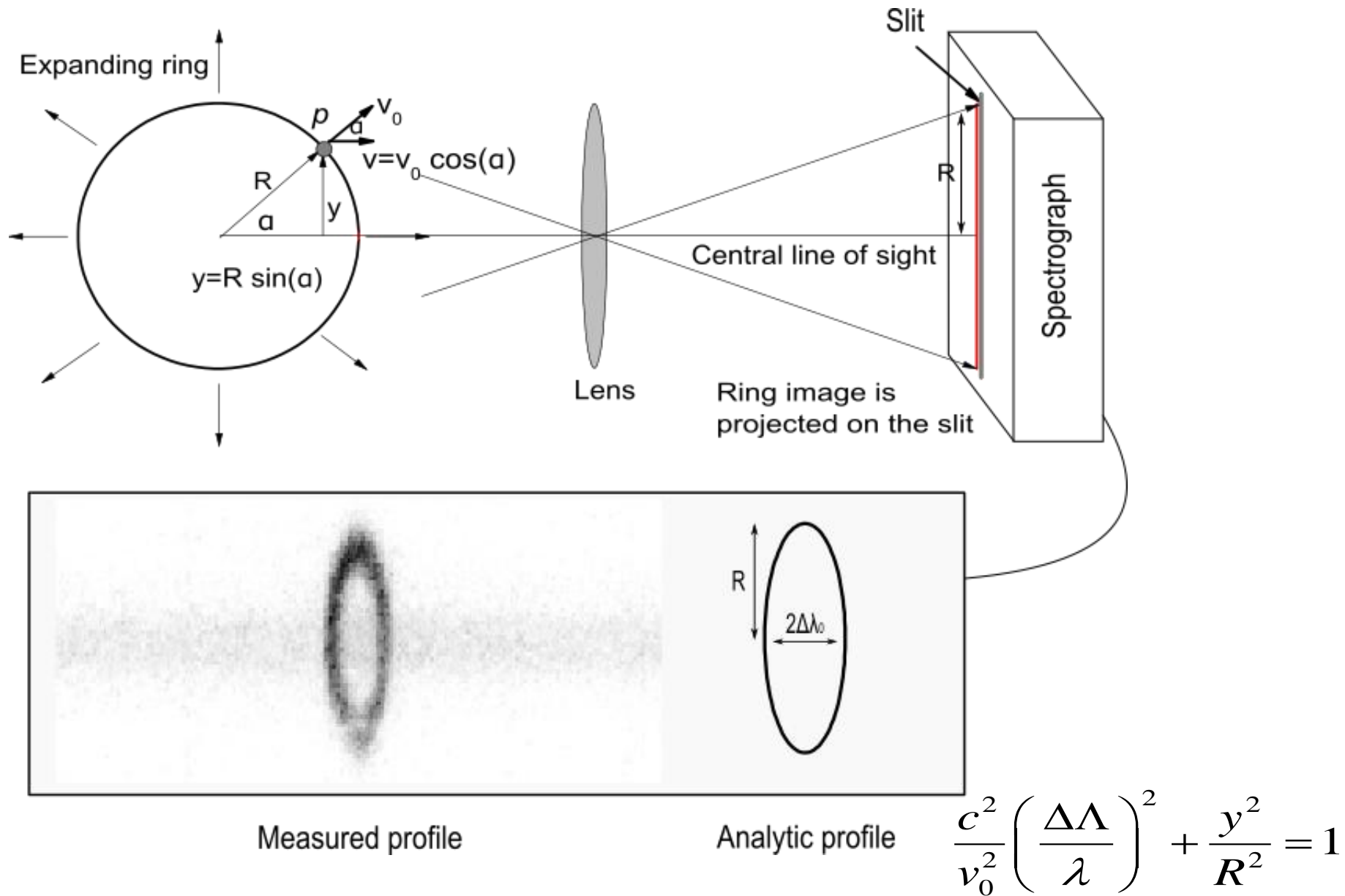
Introduction

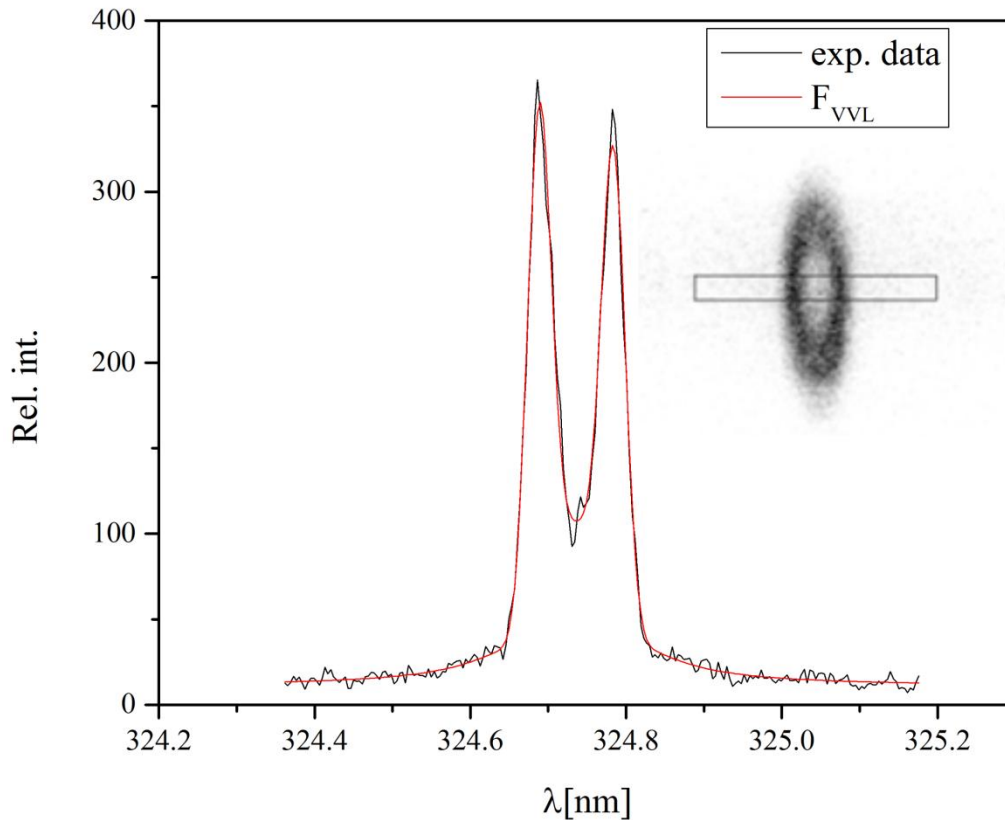
Experimental setup

Results

Conclusion







- 324.75 nm Cu I resonant line
- z position: 2.75 mm from target
- t: 40 ns after the laser pulse

- Doppler broadening due to thermal motion of the particles
- Stark broadening

$$F_{VVL}(\lambda; a_1, \lambda_{c_1}, a_2, \lambda_{c_2}, \sigma, \gamma, a_3, w, b) = V(\lambda; a_1, \lambda_{c_1}, \sigma, \gamma) + V(\lambda; a_2, \lambda_{c_2}, \sigma, \gamma) + L(\lambda; a_3, w) + b$$

Modal function

Modal function $F_{VVL} \Rightarrow$ parameters $\lambda_{c_1}, \lambda_{c_2}, \sigma$ from experimental data

From pick separation

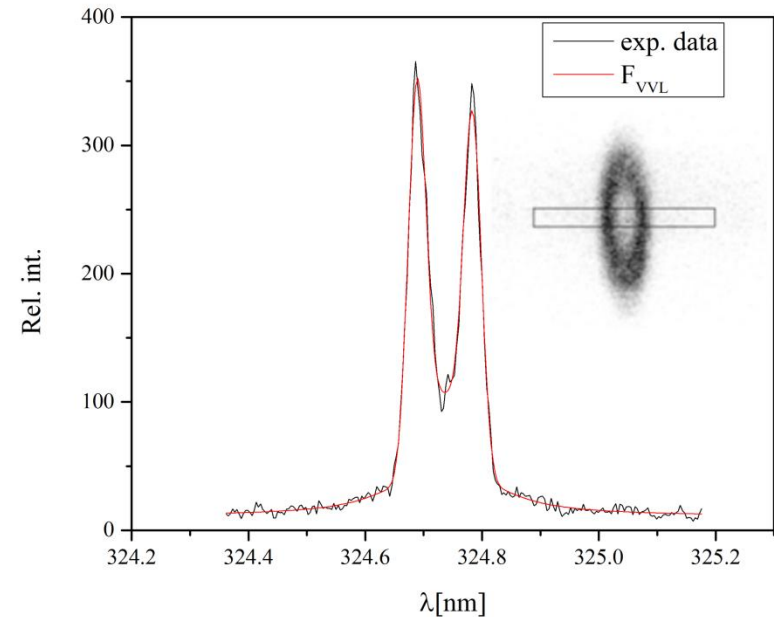
$$v_0 = \frac{c}{\lambda_c} (\lambda_{c_2} - \lambda_{c_1})$$

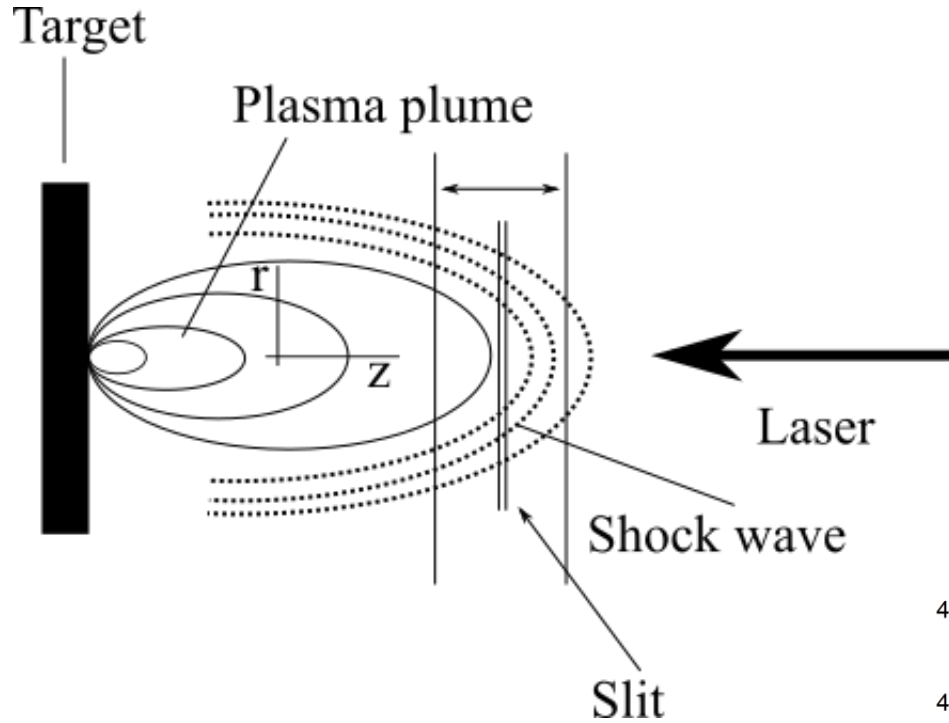
$$v_0 = (43700 \pm 200) \text{ m/s}$$

Temperature of the heavy particles:

$$T = \frac{mc^2 \sigma^2}{8k_B \ln 2 \lambda^2}$$

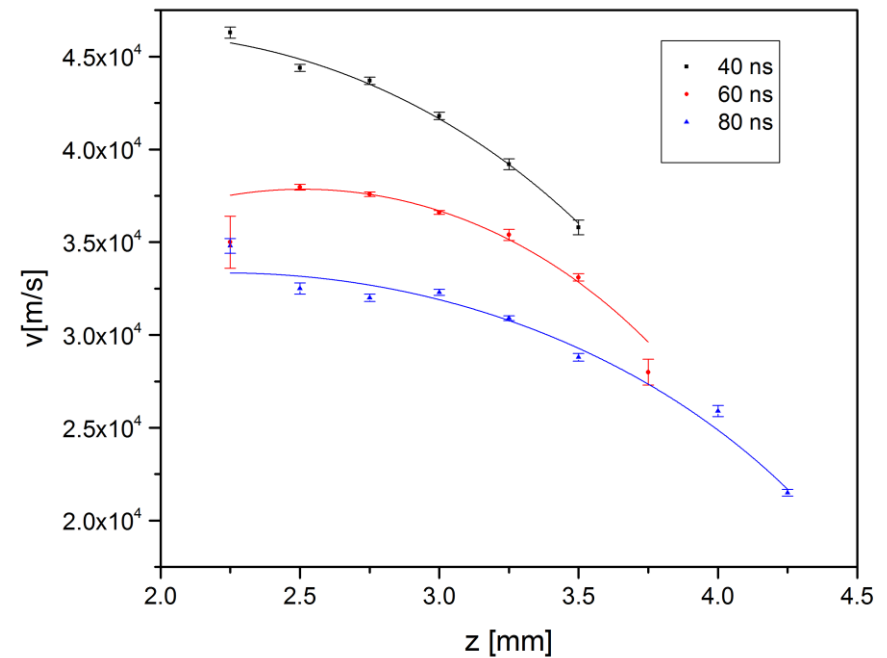
$$T = (560 \pm 60) \cdot 10^3 \text{ K}$$

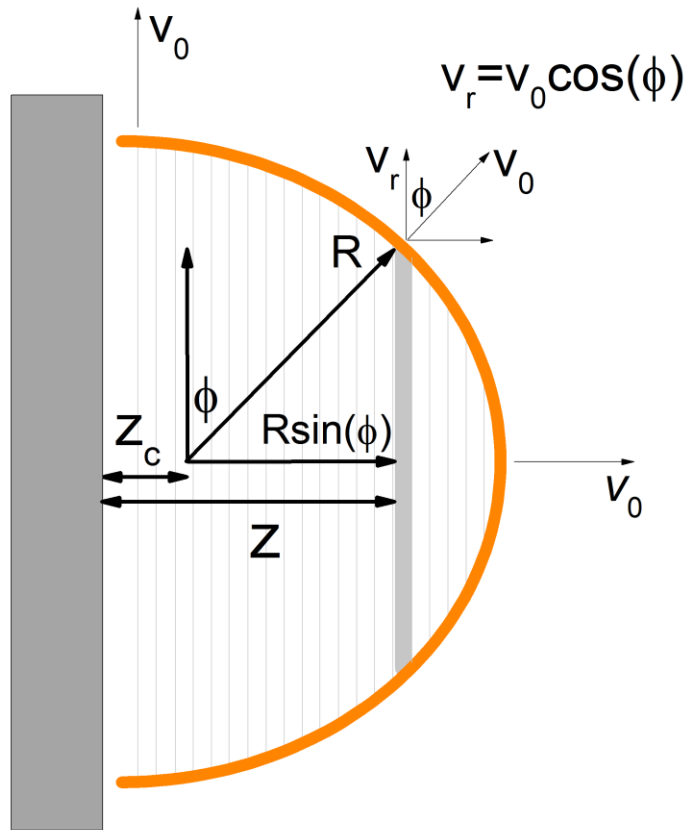




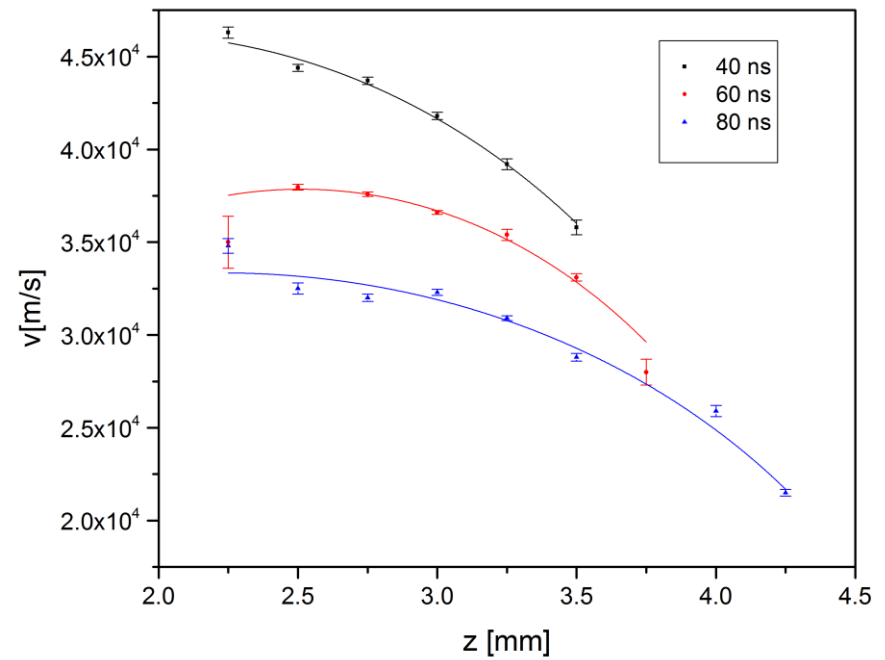
Cu I resonant line

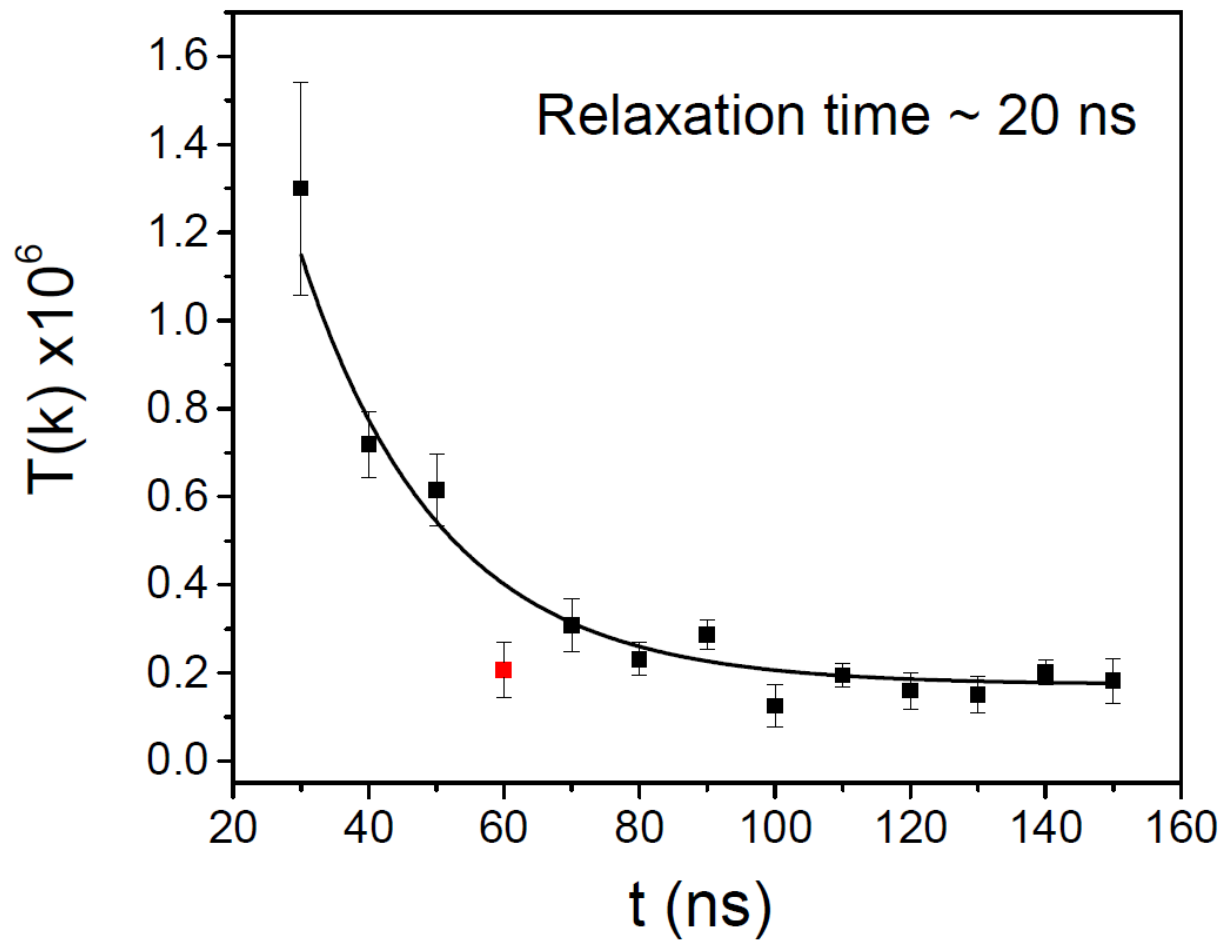
- z ranges from 2.25 mm to 4.25 mm
- t ranges from 40 ns to 80 ns





$$v = v_0 \sqrt{1 - \frac{(z - z_{cm})^2}{R^2}}$$





- We considered laterally resolved spectra recorded in typical side-on measurement in LIBS experiment.
- We demonstrated that characteristic oval shape of the spectral lines is caused by Doppler effect due to fast radial expansion of the laser induced plasma.
- Relying on Doppler splitting of the Cu I 324.75 nm line we evaluated velocity and temperature of the heavy particles.
- It was found that 40 ns after the laser was triggered the expansion velocity and temperature are approximately 50 000 m/s and 500 000 K.
- Also, we evaluated how expansion speed of the hot plasma front depends on spatial and temporal coordinates.

Group members:

- Prof. Stevan Đeniže
- Prof. Srđan Bukvić
- Miloš Burger
- Miloš Skočić
- Dejan Dojić

Acknowledgements:

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Thank you for your attention.

Postavka eksperimenta

