THE EMISSION ENHANCEMENT IN SINGLE PULSE LASER INDUCED BREAKDOWN SPECTROSCOPY

Laboratory for plasma spectroscopy and lasers

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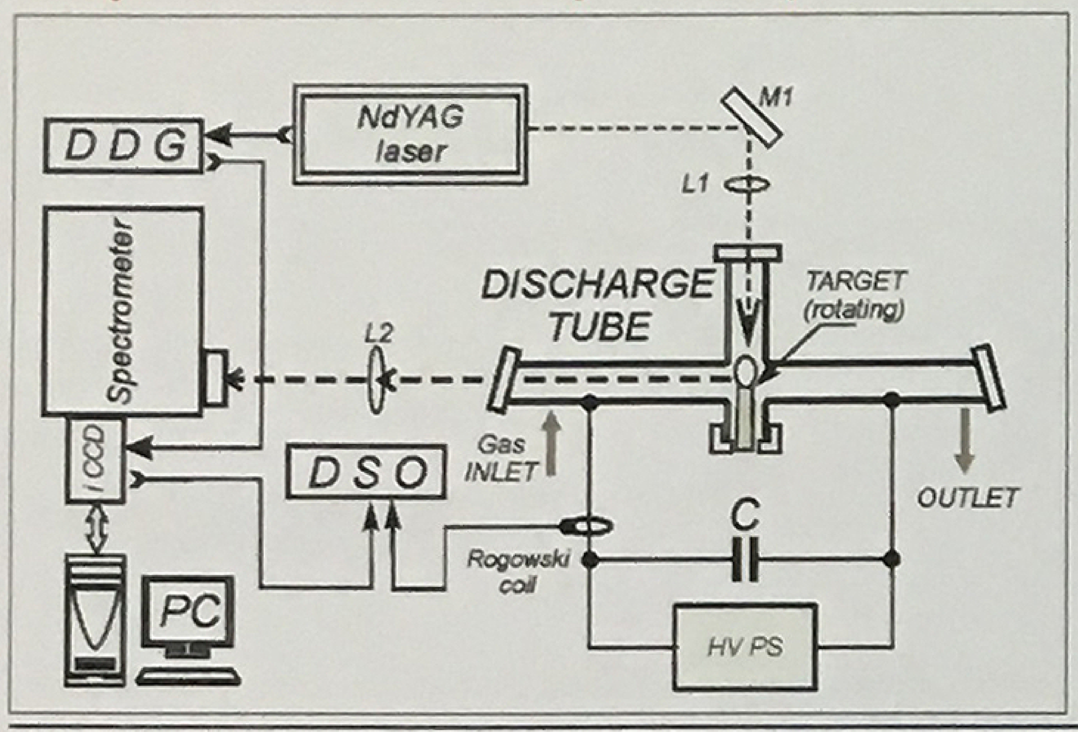
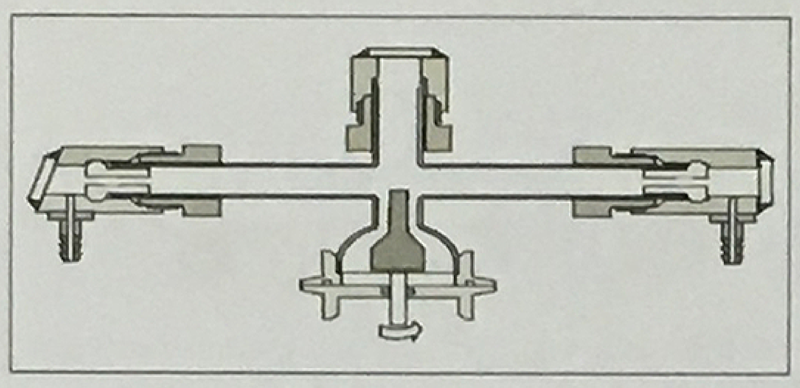
The results of an experimental study of the optical emission enhancement possibilities during single pulse laser induced breakdown spectroscopy of aluminum alloy are presented. Investigations were performed in air, argon and helium at different pressures with and without additional fast electric discharge—FED. Disadvantages of the single pulse LIBS was mainly overcome by enhancing optical emission by use of additional laser pulse in different double pulse technique configurations. In this work for same goal, alternative but cheaper technique like use of different surrounding atmospheres and additional fast discharge (initiated with a same laser pulse) were studied.

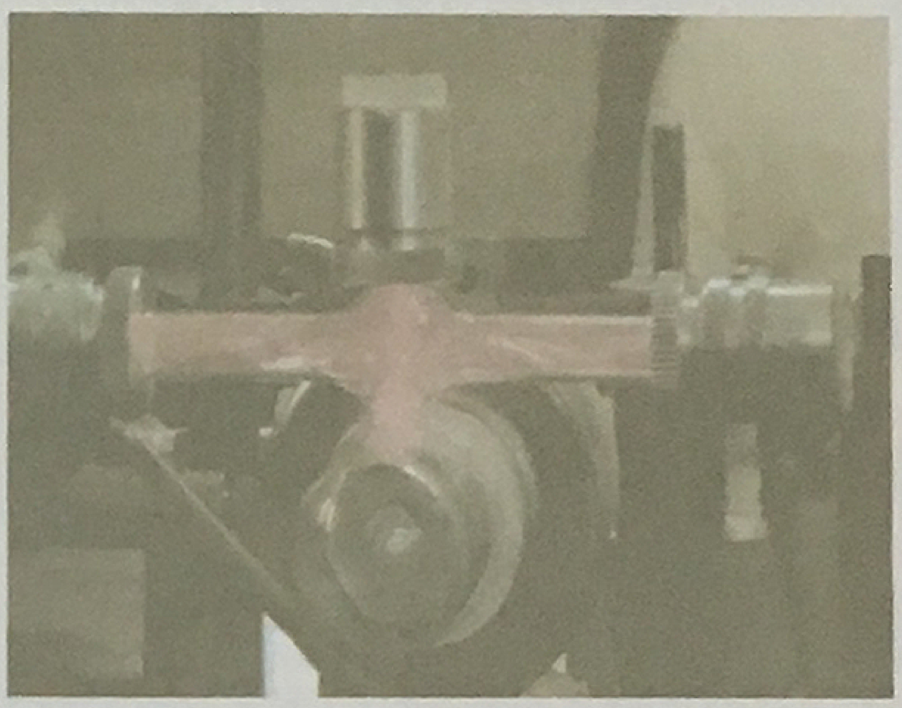
Experiment setup and procedure





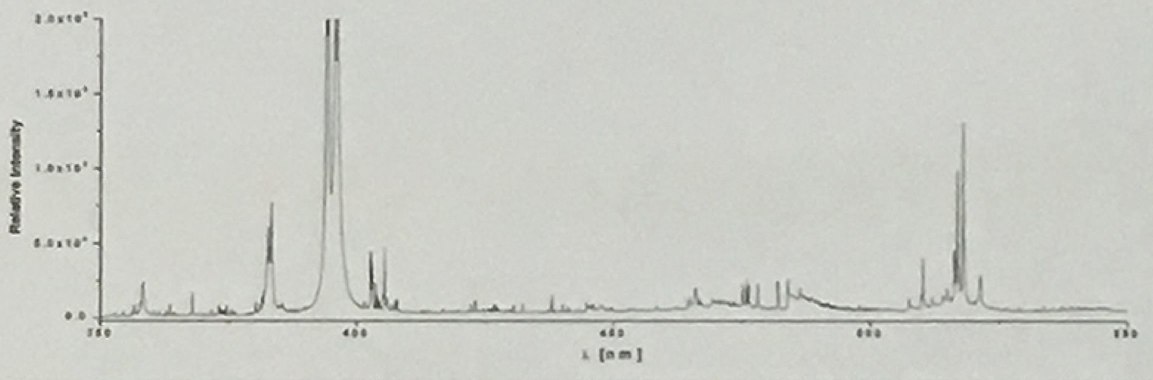
	Firm	Model
Nd-YAG laser	Molectron	MY 34
Vacuum pump	CIT-ALCATEL	2012A
Spectrometer	Andor	Shamrock 303-i
iCCD camera	Andor	DH 720 -18F-03

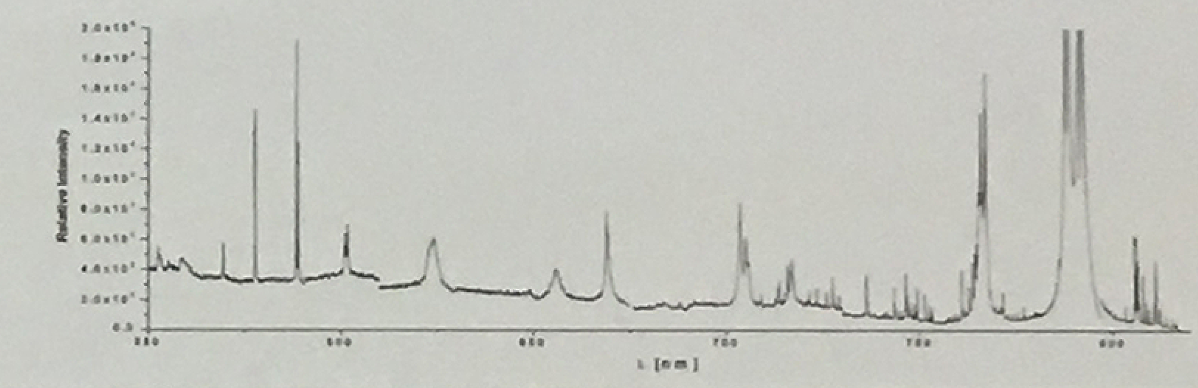
wavelength - 1064nm
energy - 50 mJ
pulse duration - 20 ns
beam diameter - 6 mm
focal length of lens L_1 - 10 cm
focal length of lens L_2 - 1.72 cm
fluence of radiance - 1.5 J/mm^2
target position in front of the focal point - 2mm
speed of rotation - 2 °/s
entrance slit - 10 mm
tube inner diameter - 10 mm
W electrodes - 12 cm apart



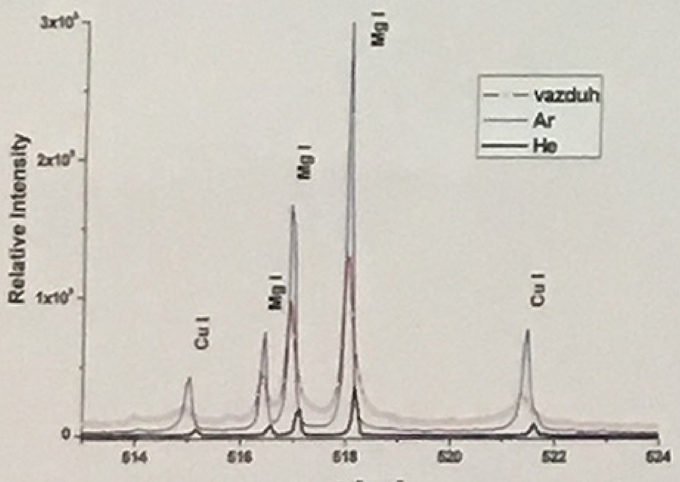
Results

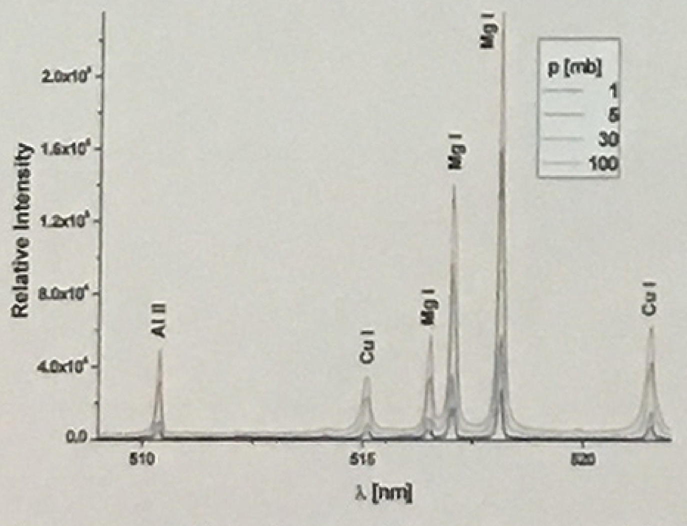
Air at atmospheric pressure



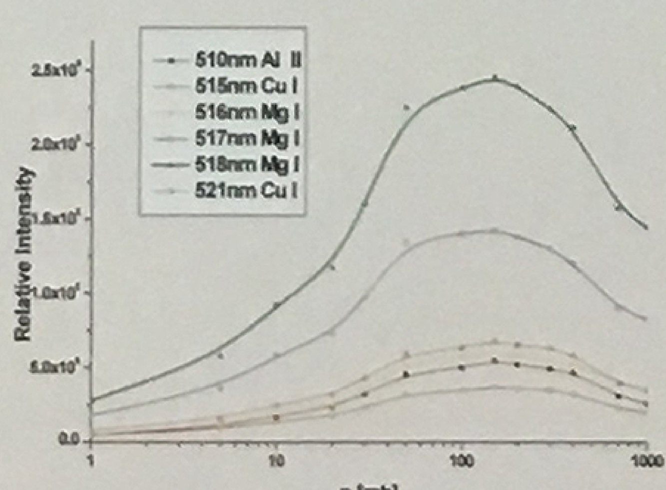


The effect of surrounding atmosphere

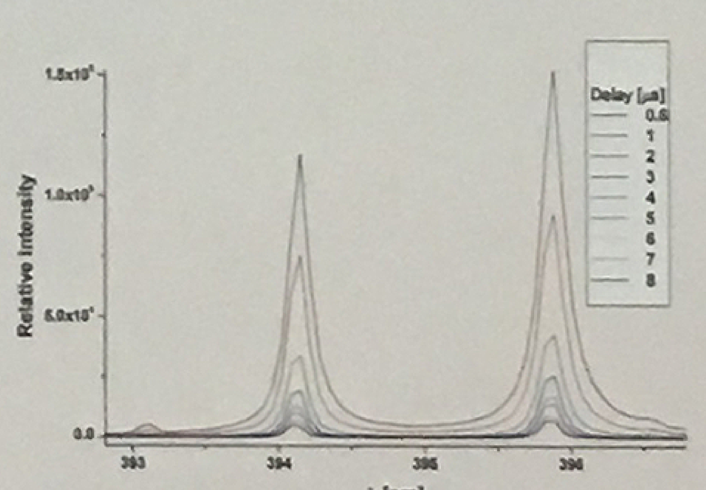


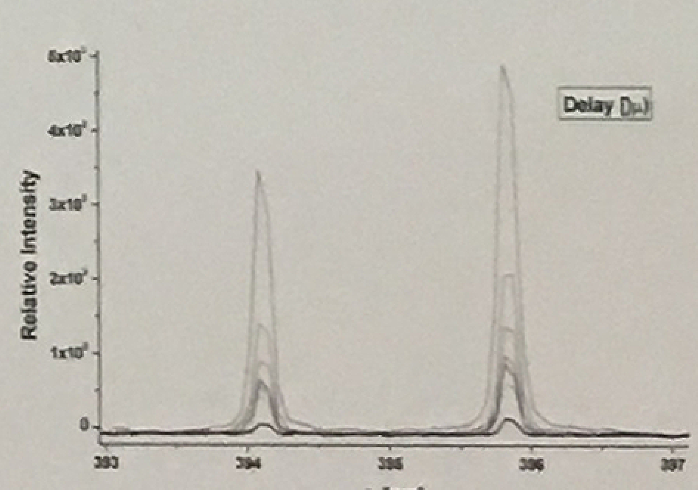


Ar Various p



Ar Various gate delay

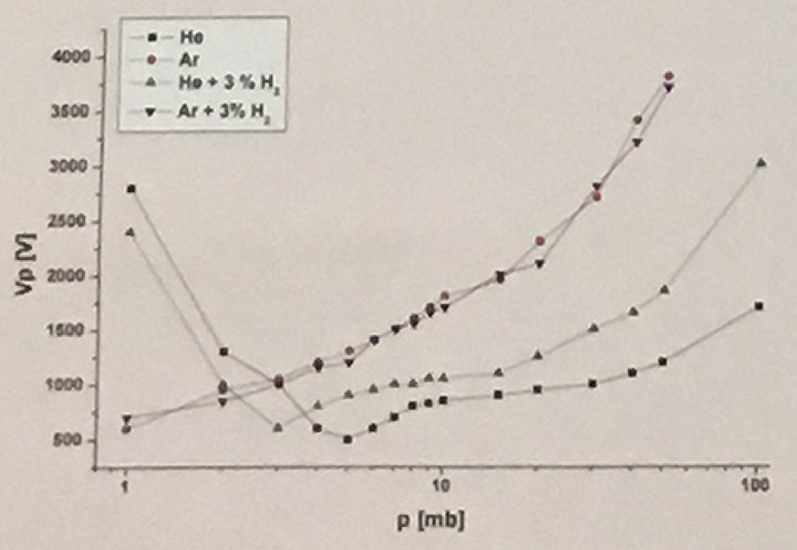




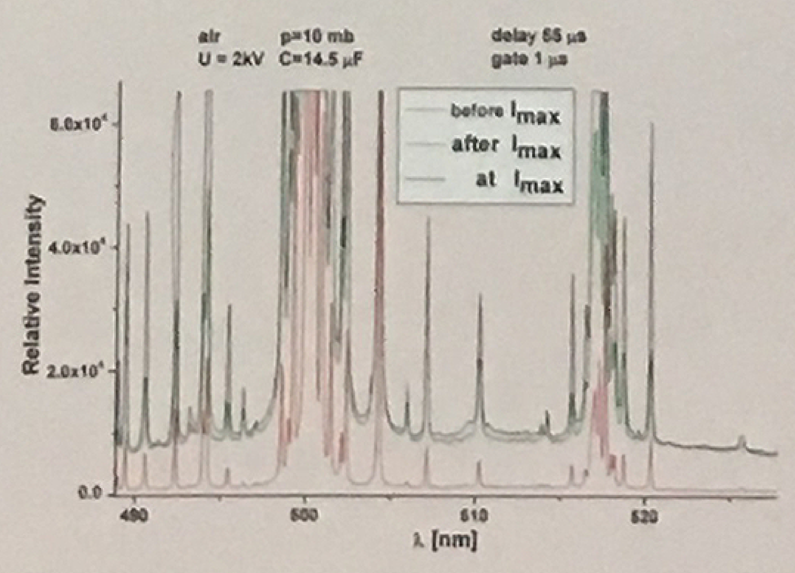
The observed optical signals were higher for Ar and lower for He gas compared to the signal obtained in an air atmosphere.
The enhancement was attributed to lower ionization potential of Ar leading to higher electron density.
The signal enhancement changes with the gas pressure. The optimum argon pressure in our case is 150 mbar.

The effect of additional fast discharge on signal intensity

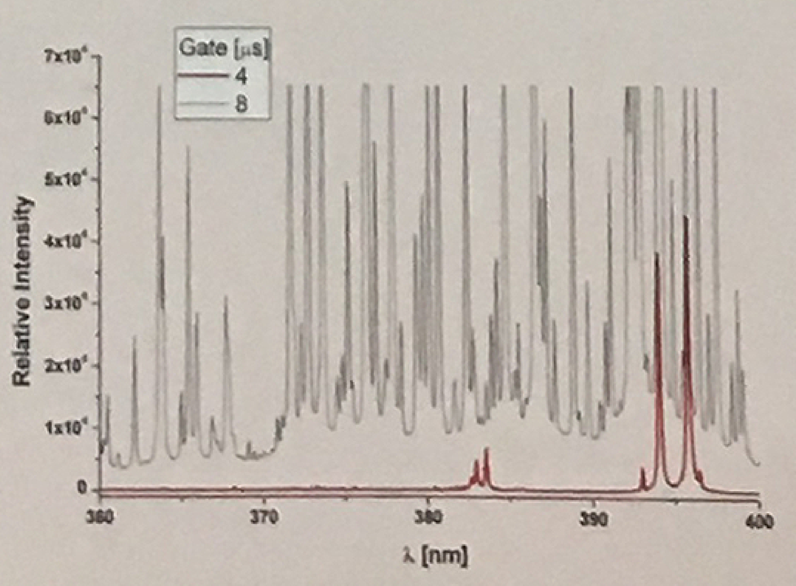
Pashen curve

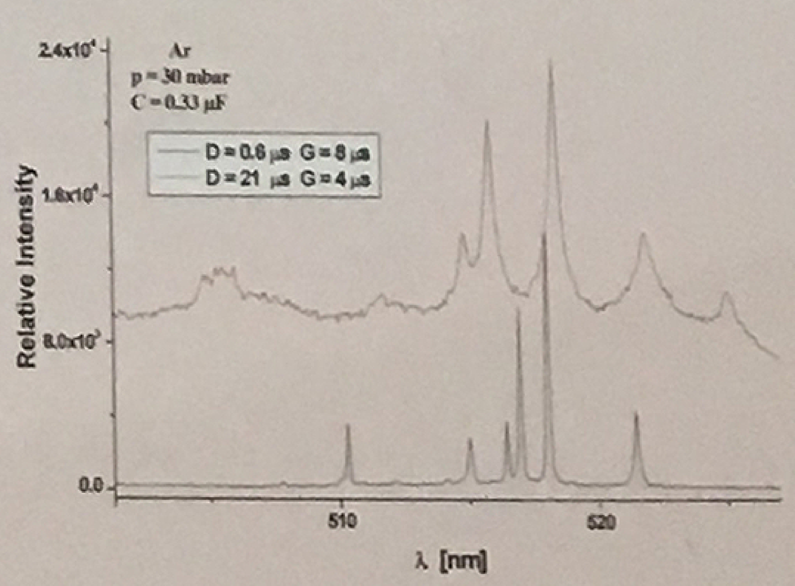


Air with FED



Ar with FED

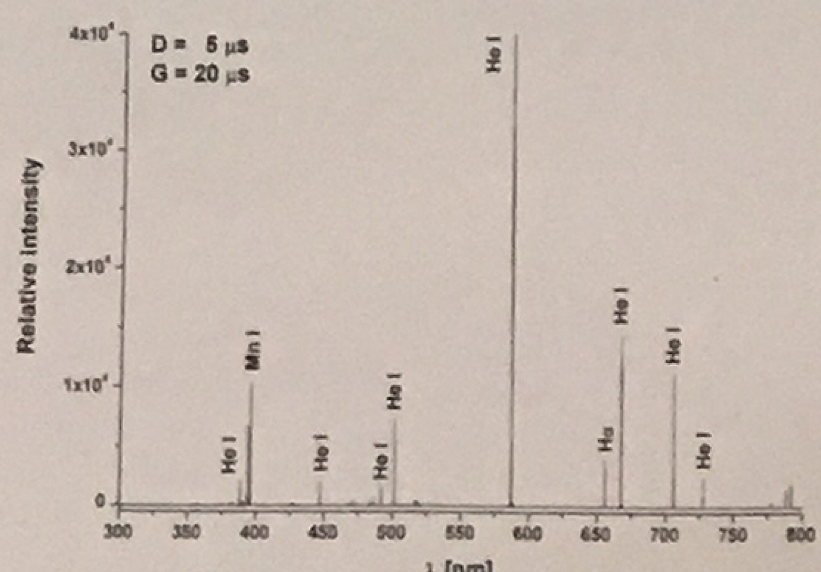


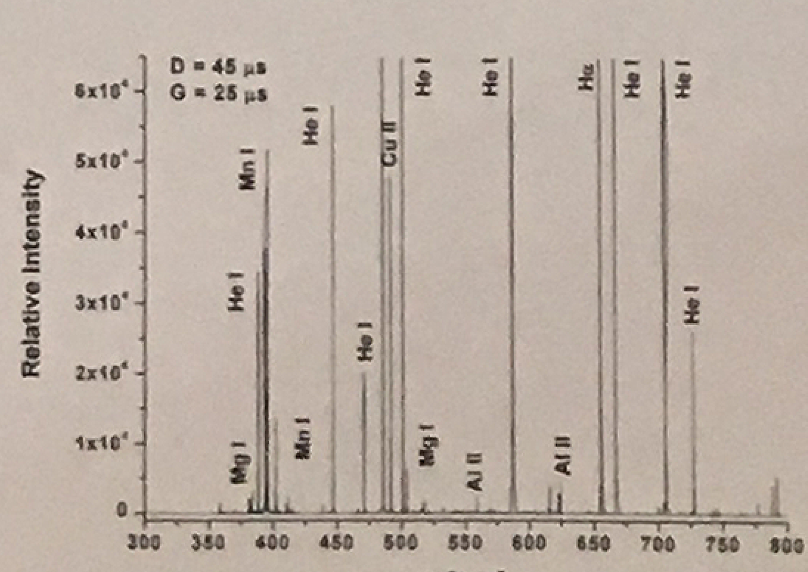


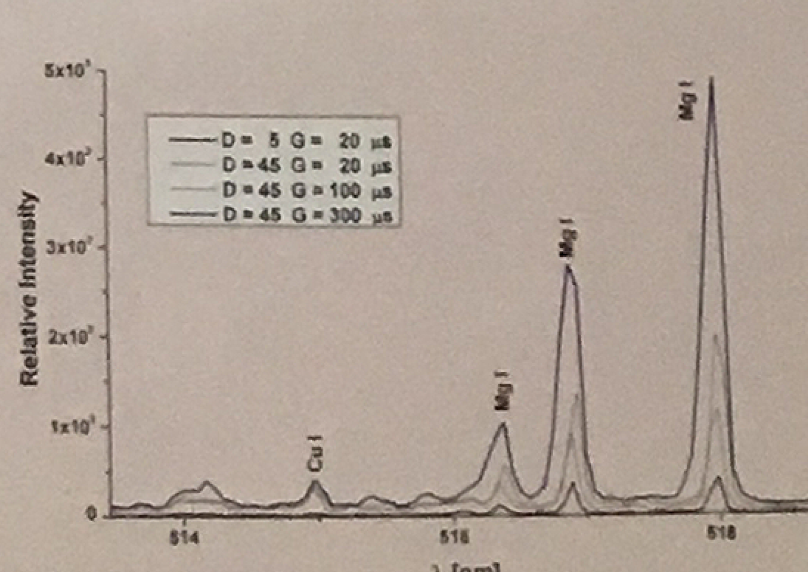
Influence of the applied voltage on the self-breakdown at different pressures (Pashen curve) and on time delay between laser and current pulse was determined. The optimum capacitance and gas type and pressure was determined from following conditions:

a) prevention of glow discharge development after laser initiation;
b) lowering energy losses, due to the multiple ionizations of elements present in plasma.

He with FED
p = 30 mbar
C = 0.33 μF
U = 1 kV







Conclusion

Enhancement of signals may be attributed to increase of plasma volume as well as its prolonged duration.

Acknowledgements:

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