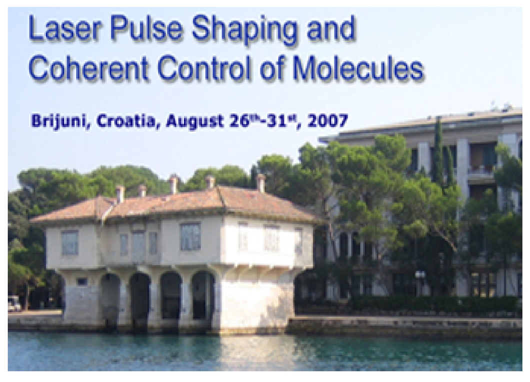
Development of molecular sources for deceleration and trapping experiments using dual-pulse laser ablation and cavity ring-down spectroscopy



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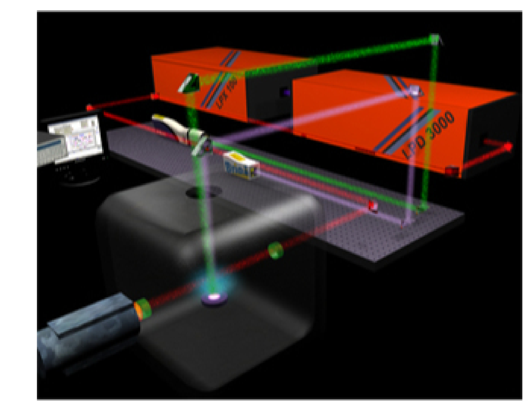
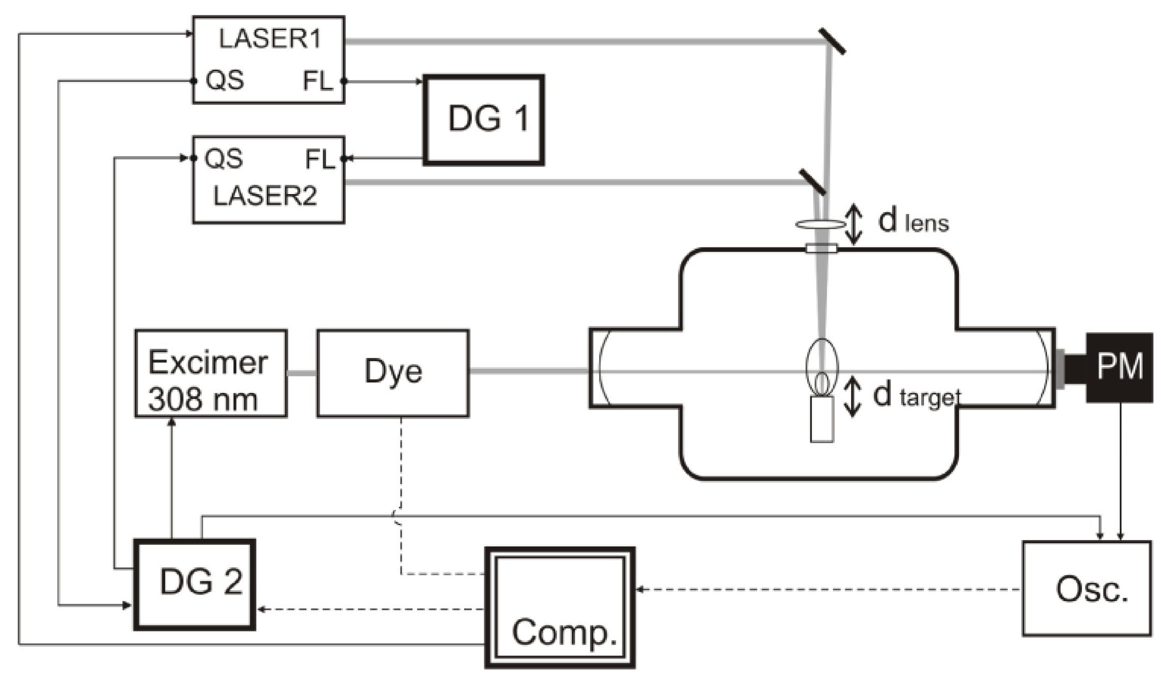


MOTIVATION

Development of novel molecular sources with intense molecular flux in a way appropriate for further cooling is one of important tasks for cold molecule physics. Laser ablation is considered as a valuable process since practically any molecule can be produced in this way. This can be achieved even in pure vacuum provided that appropriate target is used [1,2].

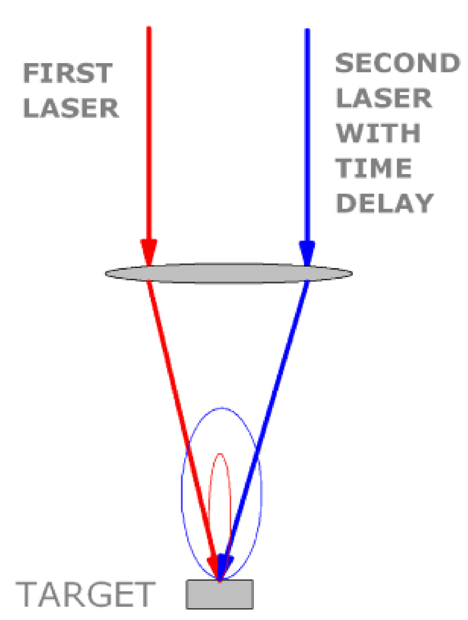
In the present work we use dual-pulse laser ablation with two ns lasers of precisely controlled time delay as a base of our molecular source. For molecular detection we use cavity ring-down spectroscopy which offers possibility to study the content of the plume in its dark region, important for molecules and in addition offers the time-of-flight selectivity.

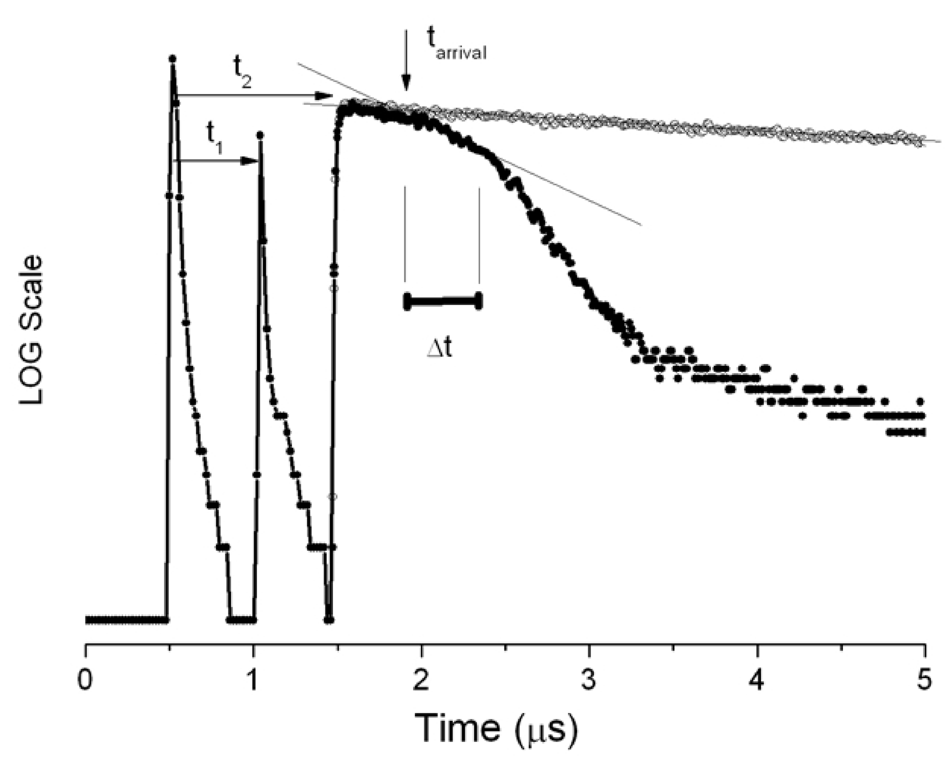


EXPERIMENTAL DETAILS

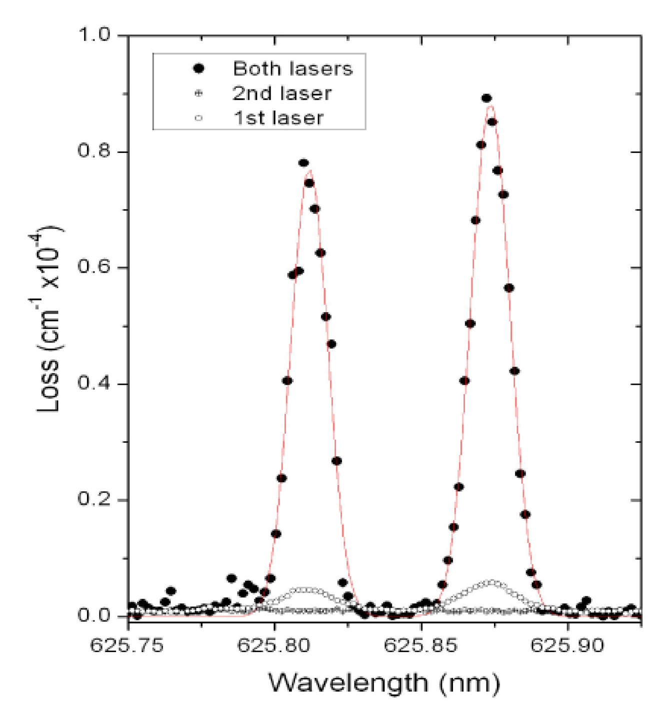
Dual-pulse laser ablation of various metal-containing targets was produced by Nd-YAG lasers in vacuum. Target was mounted on an X-Y translation stage to allow precise positioning in respect to the cavity formed by two high reflectivity mirrors. It was also rotated to avoid drilling. Both target and the focusing lens could be moved by stepping motors. Lasers, digital delay generator and step motors were controlled by a PC computer using a homemade LabVIEW program. For cavity ring-down spectroscopy (CRDS) an excimer pumped dye laser working with Rhodamine 110 dye was used and detection of the ringdown signals was performed by a photomultiplier. An appropriate interference filter was placed between the end-cavity mirror and the photomultiplier to stop the light from laser-induced plasma and scattered 1064 nm laser light. A digital oscilloscope was used to measure the CRD decay curves, which were stored in a PC for further analysis.

DUAL-PULSE LASER ABLATION and CRDS

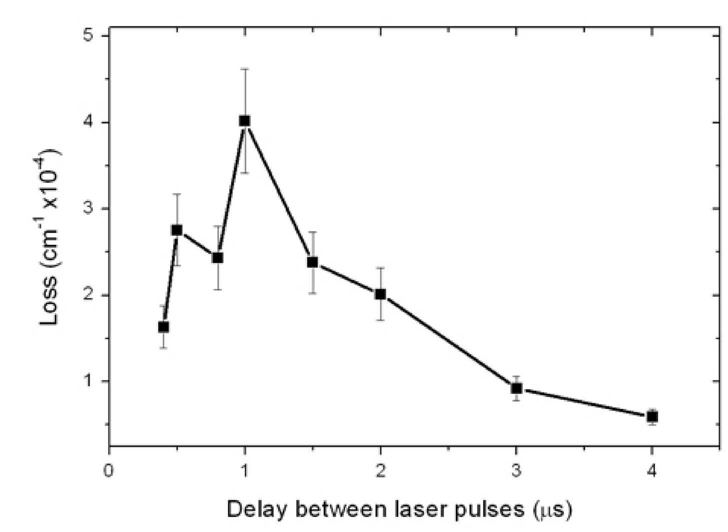




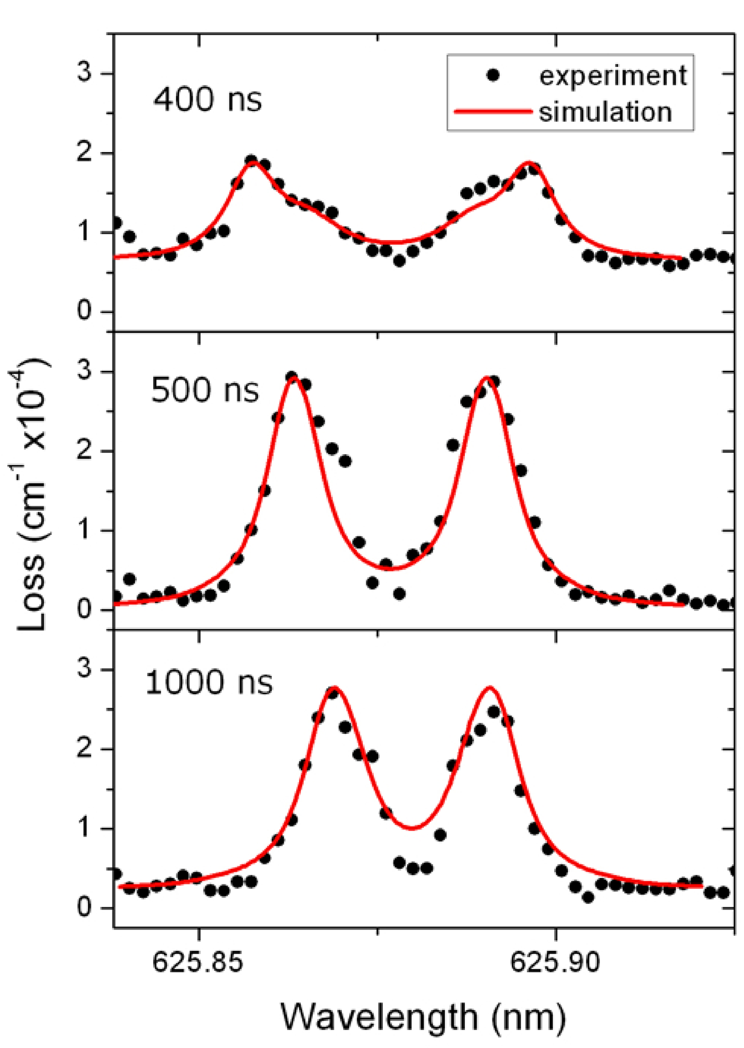
ATOMS OBSERVED

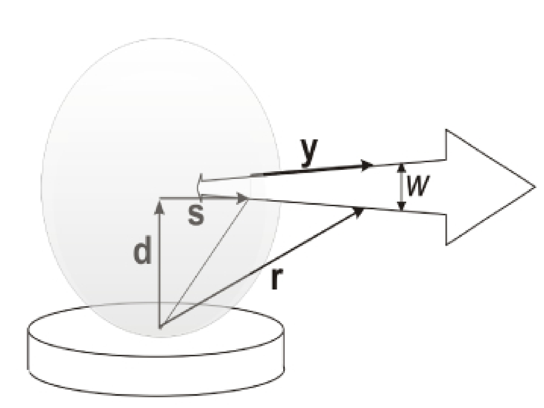


example Titanium



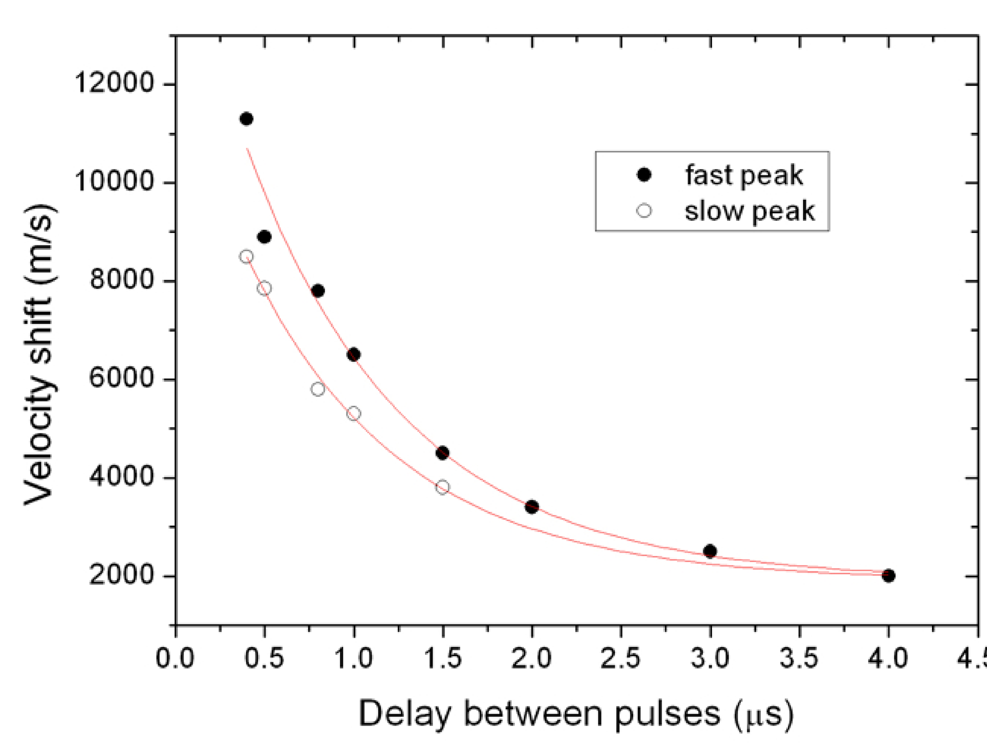
LINE SPLITTING

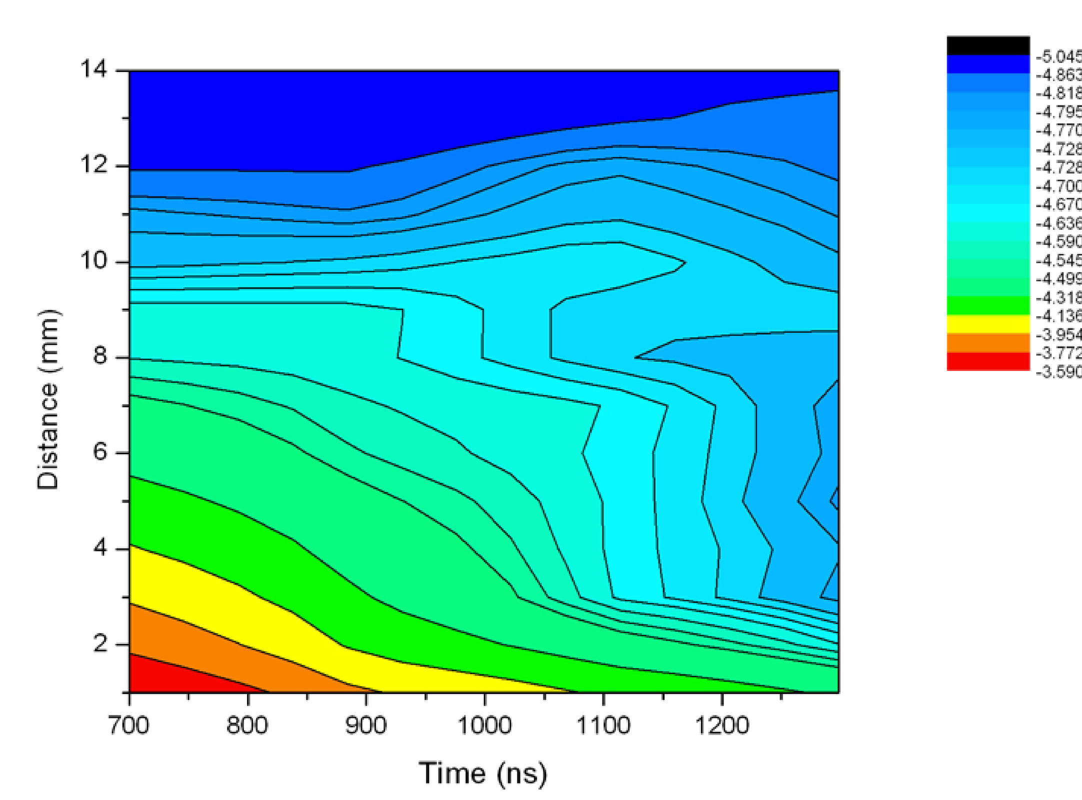




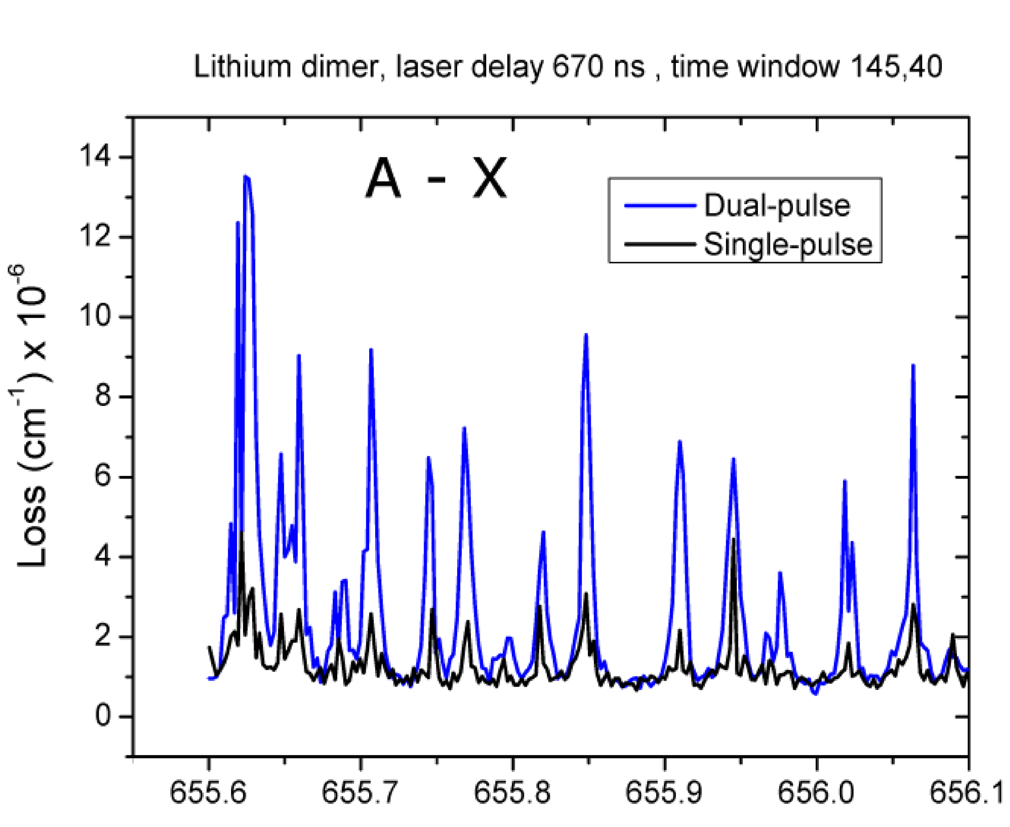
The Doppler-shifted lineshape and time-of-flight with CRDS

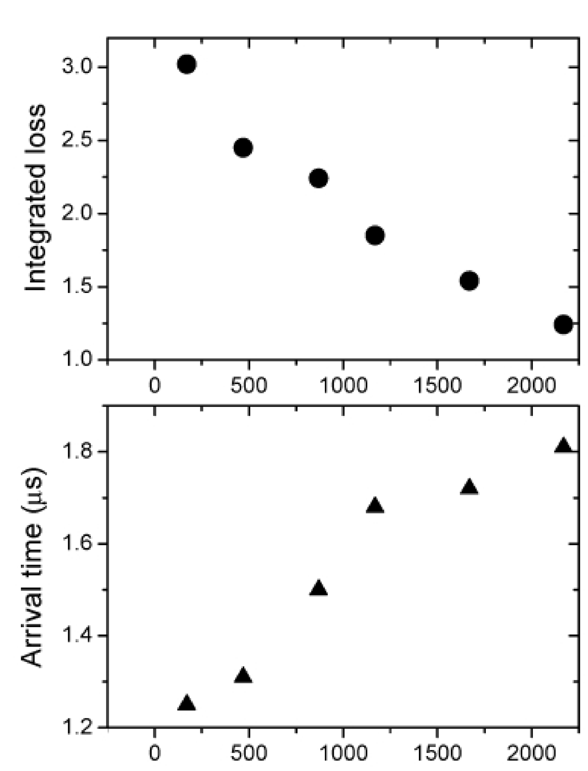
PLUME SPREADING AND DOUBLE VELOCITY DISTRIBUTIONS





MOLECULES OBSERVED





FUTURE WORK

		B	λ_{ss}	λ/B
GdO	$^9\Sigma$	0.355	-0.104	0.29
MnH	$^7\Sigma^+$	5.606	-0.004	7.2 10^{-4}
MnF	$^7\Sigma^+$	0.353	-0.005	1.3 10^{-2}
MnCl	$^7\Sigma^+$	0.158	0.037	0.24
CrH	$^6\Sigma^+$	6.132	0.233	3.8 10^{-2}
MnO	$^6\Sigma$	0.501	1.130	1.3
MnO	$^6\Sigma^+$	0.435	0.574	2.3
CrF	$^6\Sigma$	0.379	0.539	1.4
MnS	$^6\Sigma^+$	0.195	0.350	1.8
CrCl	$^6\Sigma^+$	0.167	0.266	1.6
CrO	$^5\Pi$	0.524	1.148	2.2
HoO	^5I	0.350		
FeO	$^5\Delta$			
CrN	$^4\Sigma$	0.624	2.611	4.2
VO	$^4\Sigma$	0.546	2.031	3.7
NbO	$^4\Sigma^-$	0.432		
TiH	$^4\Phi$	5.362		
NH	$^3\Sigma$	16.343	0.920	5.6 10^{-2}
O_2	$^3\Sigma$	1.438	1.985	1.4
CaH	$^2\Sigma$	4.277	n/a	n/a
CaF	$^2\Sigma$	0.339	n/a	n/a

CONCLUSIONS

Preliminary results show strong enhancement of both atomic and molecular content of the plume for particular time delay between lasers. Besides, the shape of the plume is changed dramatically with lot of atoms (molecules) having large velocity component parallel to the cavity axis [3].

REFERENCES

[1] I. Labazan, N. Krstulović, S. Milošević, LASER VAPORIZATION OF AlLiH4 SAMPLE, Chemical Physics Letters, **428** (2006) 13–17

[2] N. Krstulović, I. Labazan, S. Milošević, STUDY OF Mn LASER ABLATION IN METHANE ATMOSPHERE, Eur. Phys. D **37** 209-215 (2006).

[3] N. Krstulović, N. Čutić, S. Milošević, LINESHAPE SPLITTING OBSERVED IN CAVITY RING-DOWN SPECTROSCOPY OF DUAL-PULSE LASER ABLATION PLUME, in preparation (2007).

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