



**HAL**  
open science

## A New Pulsed Valve for High-Intensity Supersonic Jet

Alexander Kamasah, Chamara Abeysekera, Yuanyuan Shi, Baptiste Joalland,  
James M. Oldham, Arthur G. Suits

► **To cite this version:**

Alexander Kamasah, Chamara Abeysekera, Yuanyuan Shi, Baptiste Joalland, James M. Oldham, et al.. A New Pulsed Valve for High-Intensity Supersonic Jet. Atomic and Molecular Interactions, Gordon Research Conference, Jul 2014, Stonehill College, MA, United States. hal-01246961

**HAL Id: hal-01246961**

**<https://hal.science/hal-01246961>**

Submitted on 21 Dec 2015

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



# A NEW PULSED VALVE FOR HIGH-INTENSITY SUPERSONIC JET

Alexander Kamasah, Chamara Abeysekera, Yuanyuan Shi, Baptiste Joalland, James Oldham, and Arthur G. Suits  
 Department of Chemistry, Wayne State University, Detroit MI 48202 USA

Pulsed supersonic expansion is now a ubiquitous technique used in all laboratories interested in spectroscopic and reaction dynamics studies. The conversion of enthalpy to mass flow leads to the production of low temperature flows with well-defined kinetic energy. High speed valves are used to make short pulses allowing for high beam intensities with lower pumping requirements. Solenoid as well as piezoelectric disk valves have played a significant role but still show important shortcomings: low repetition rates, limited operational times and gas flows. To overcome these limitations, we have developed a new valve based on a high force piezo stack actuator. In this poster, we present the design of this new valve along with molecular beam characterizations obtained via DC slice ion imaging. This design can also be used to generate low temperature pulsed uniform supersonic flow as can be seen in the poster Abeysekara et al.

## Valve design

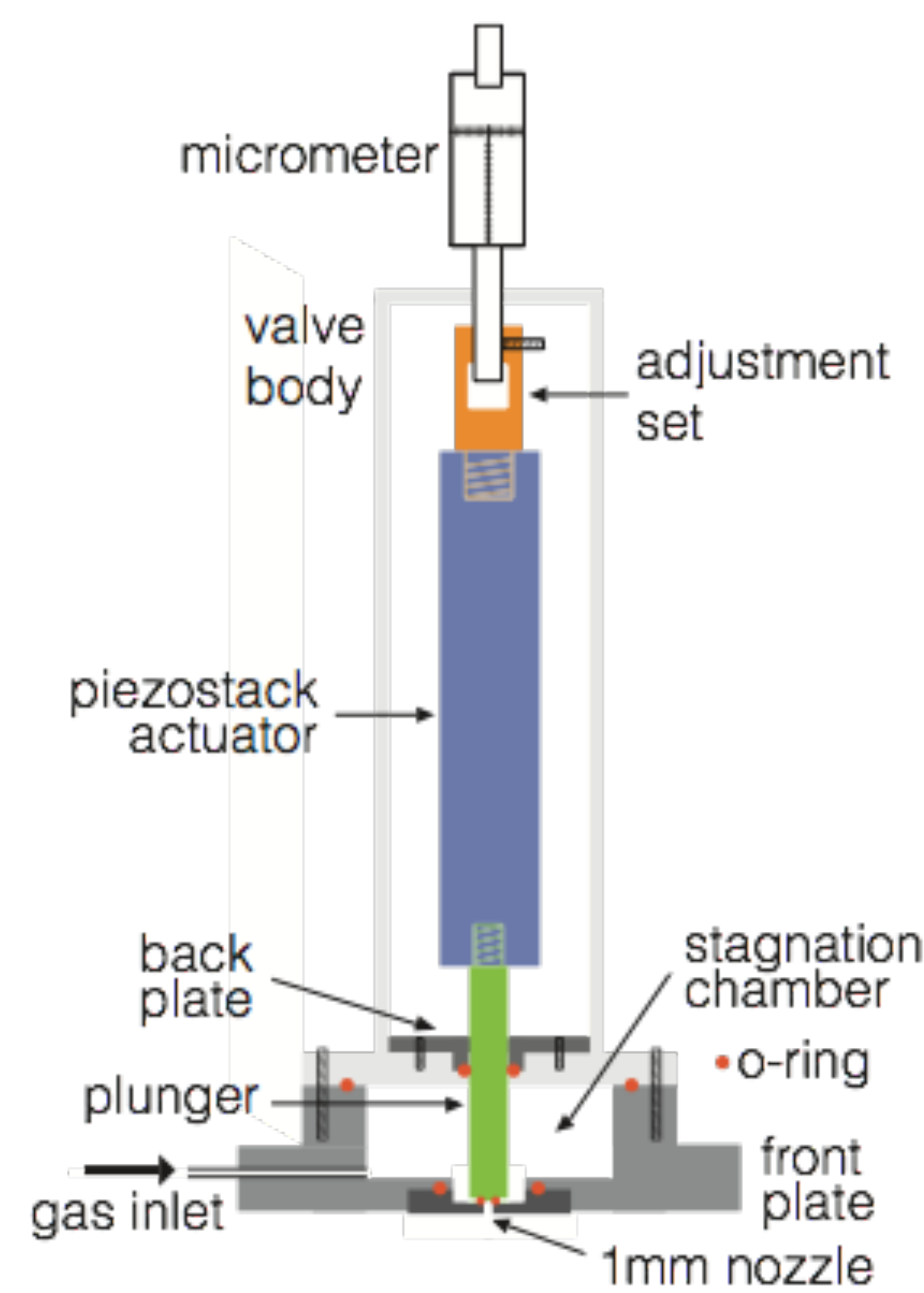


Fig 1: Cut view of the valve assembly. The piezostack actuator (Physik Instrumente, P-212.80, blue) is mounted in a stainless steel valve body (light grey). The position of the plunger (green) is adjusted by a micrometer. The different o-ring positions are symbolized by red disks. In particular, the plunger is sealed at two positions, i.e. by an o-ring at the nozzle it-self (Kalrez), and by another o-ring fixed at the top of the plunger, with its tightness adjusted by varying the pressure applied by the back plate.

## Experimental set-up

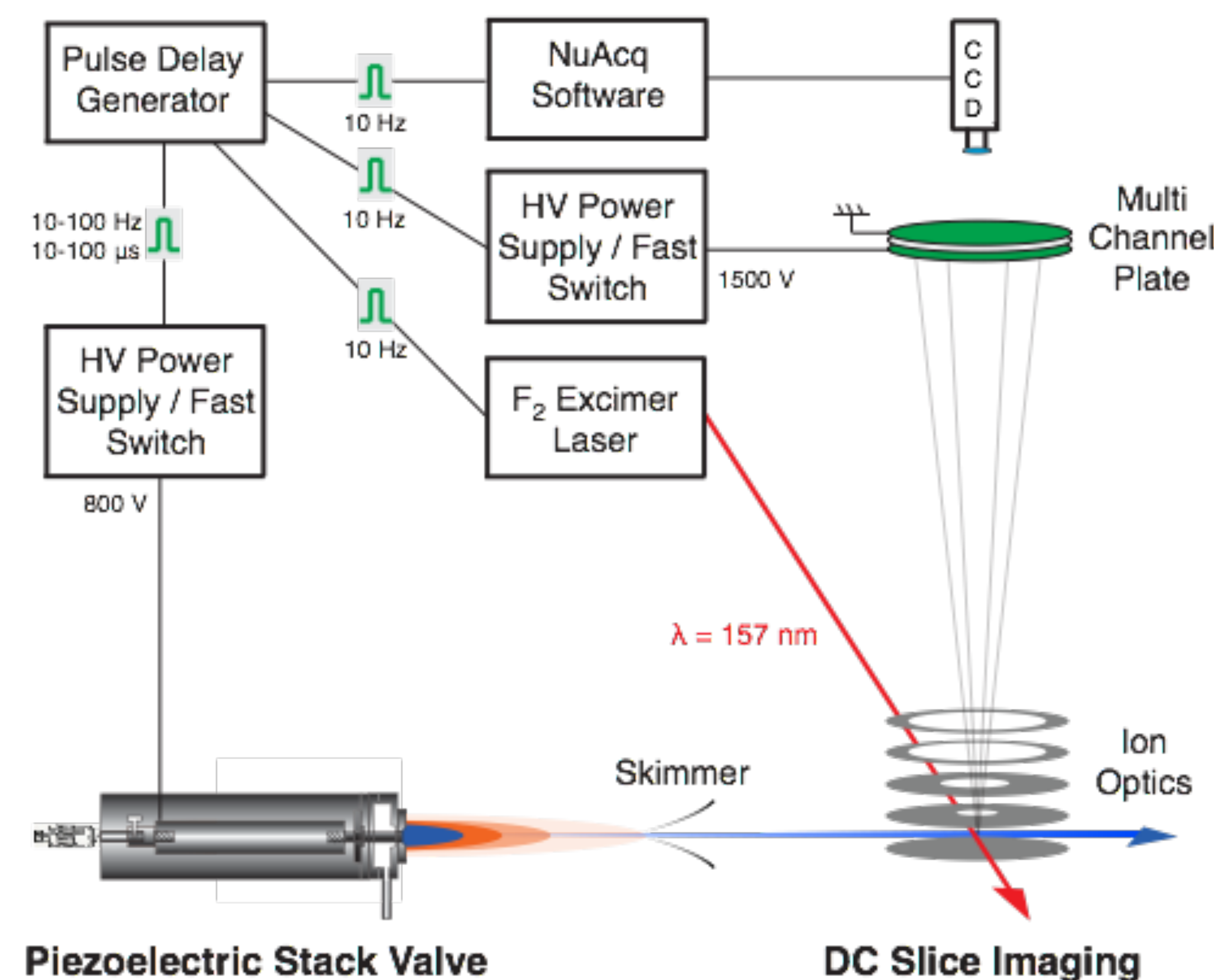


Fig. 2: Schematic of the experimental setup. The valve is closed by applying a constant high voltage (+800V) from a HV power supply. The applied voltage is rapidly reduced to 0 by a HV fast switch (Behlke HTS-61-03-GSM), which causes the piezoelectric material to contract and open the valve. The piezoelectric stack valve thus produces a pulsed molecular beam which is skimmed and probed by an unfocused 157nm F<sub>2</sub> excimer laser. The ions produced are accelerated by a DC ion optics assembly onto a dual microchannel plate detector coupled to a fast phosphor screen. The images were then recorded using a CCD camera.

## Molecular beam characterizations

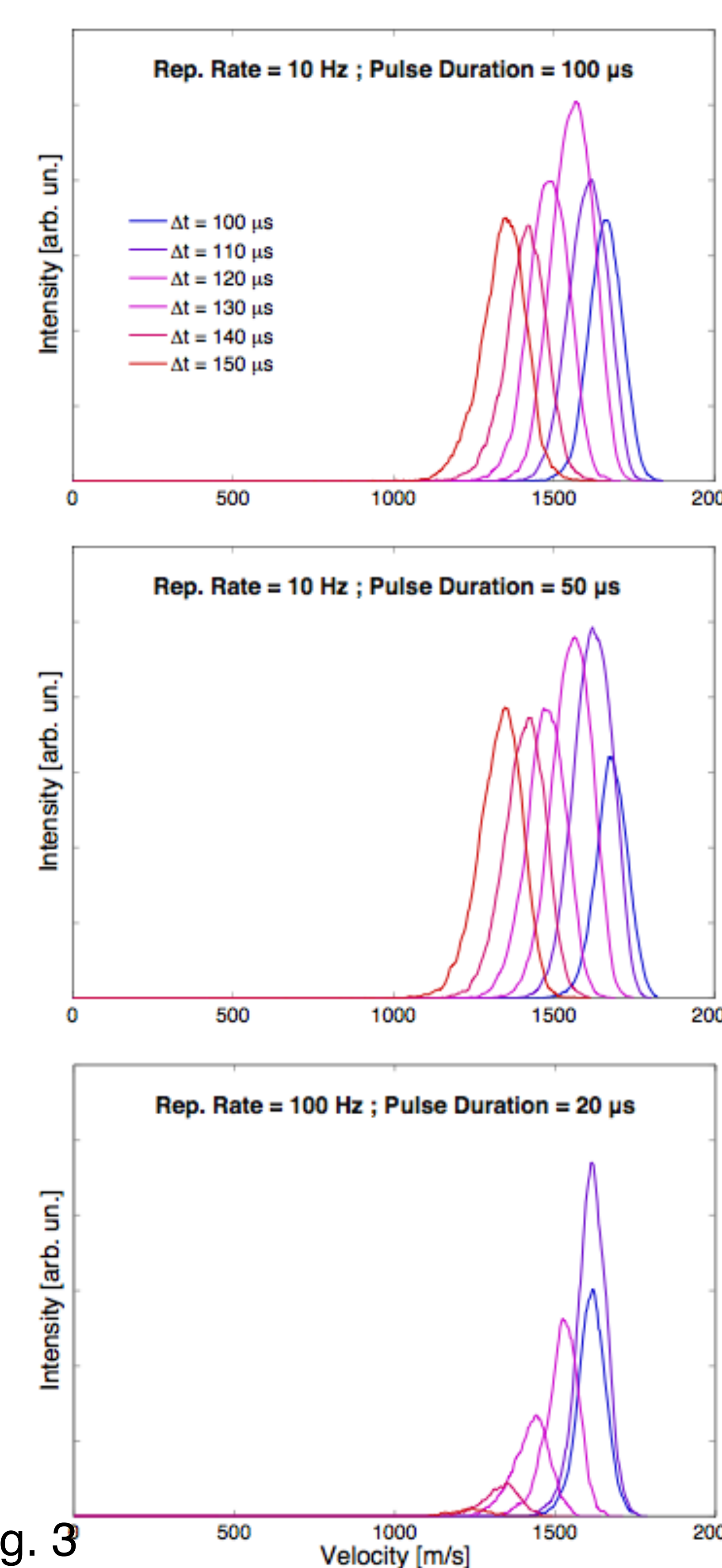


Fig. 3: Beam profiles at different valve opening-probe delays ( $\Delta t$ ) of dimers of 2,5-dimethylfuran (DMF) seeded in He (mixture 0.25% DMF/He) recorded with DC Slice Ion Imaging at repetition rates of 10 (top, middle) and 100 Hz (bottom) and pulse durations of 100 (top), 50 (middle), and 20  $\mu$ s (bottom).

Table 1: Speed ratios  $S_{tot}$  and  $S_{local}$  estimated from the velocity distributions shown in Fig. 3 ( $S = \langle v \rangle / \Delta v$ ).  $S_{tot}$  is calculated from the mean velocity in the sum of the different velocity distributions, while  $S_{local}$  is calculated from the velocity distribution with maximal intensity.  $\Delta v$  is estimated as the corresponding FWHM.

Rep. Rate (Hz)	Pulse Duration ( $\mu$ s)	$S_{tot}$	$S_{local}$
10	100	4	10
10	50	4	11
100	20	11	16

Table 1

## References and related literature

Proch, D., and Trickl, T. (1988). A high-intensity multi-purpose piezoelectric pulsed molecular beam source. Rev. Sci. Instrum. 60 (4), 713-716.  
 Physik Instrumente (PI) L.P. (2010). Tutorial: Piezoelectrics in nanopositioning, designing with piezoelectric actuators. Retrieved from [http://www.physikinstrumente.com/en/products/piezo\\_tutorial.php](http://www.physikinstrumente.com/en/products/piezo_tutorial.php).  
 U. Even, J. Jortner, D. Noy, N. Lavie, C. Cossart-Magos, J. Chem, Phys., 2000, 112, 8068

## Acknowledgments

The valve body was machined at J&N company, Detroit MI.

