

Dynamics of laser-induced desorption of Cs from porous glass

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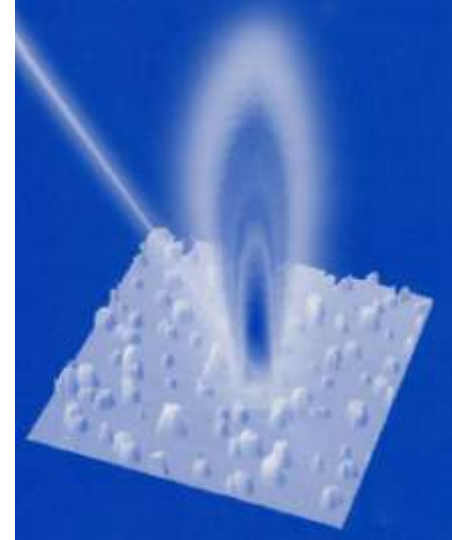
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ABSTRACT

Huge intensities of light-induced non-thermal alkali atoms desorbing from organic films have been recently observed in many experiments (see e.g. [1]). This phenomenon has now also been investigated for porous silica samples. The behaviour of the desorption from the porous silica and the organic films looks generally similar, but recently performed experiments show the existence of a few significant differences [2]. We have thus investigated the dynamics of short pulsed laser-induced desorption of Cesium atoms from porous silica sample.



The sample was loaded in an auxiliary chamber by vapor from a heated reservoir and then transferred to the main chamber vacuum system. Cs atoms were detected after desorption by the TPLIF (two-photon laser-induced fluorescence) method. The excitation took place in the focal point of two counterpropagating continuous-wave laser beams. The 460 nm photons were collected by a photomultiplier behind an interference filter. Time-of-flight (TOF) measurements were performed using a multichannel analyzer triggered by the 8 ns desorption laser pulse. Distances between the desorption laser spot on the sample and the detection focal point were $Dx = 8-11$ mm. We have found the temperature of the flux corrected Maxwellian distribution T_B to be 805 K what corresponds to a most probable kinetic energy $E_{mp} = 70$ meV for desorption beam fluences of 60 and 190 mJ/cm^2 .

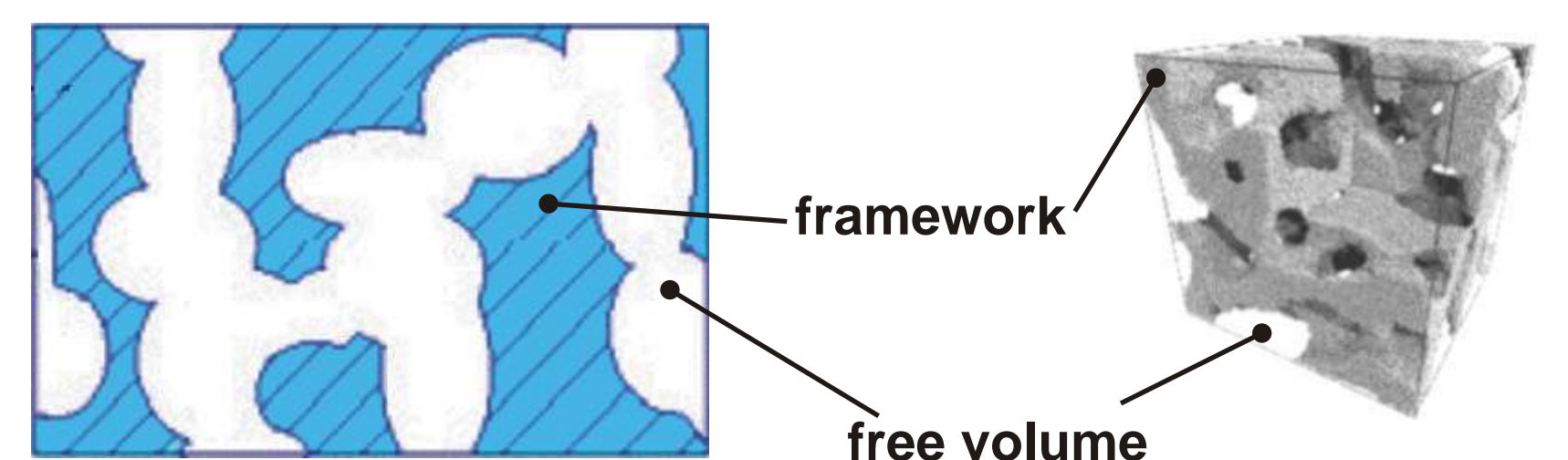
LIGHT INDUCED ATOMIC DESORPTION – LIAD

- LIAD is a non-thermal phenomenon resulting in a huge, light-induced emission of atoms from thin organic films [1]: siloxane compounds (PDMS, OCT) or paraffines
- the original LIAD effect has been investigated under equilibrium conditions in glass cells, for Na, Rb, K, Cs atoms and Na_2 molecules (e.g. [3])
- recently laser-induced desorption of atoms has also been observed under non-equilibrium conditions from PDMS covered glass plates in a high-vacuum apparatus using a pulsed laser
- time-of-flight (TOF) measurements have been used to obtain information about both the kinetic energies of the desorbing alkali atoms [4] and diffusion coefficient of atoms inside PDMS film [5]
- the LIAD phenomenon has been recently investigated for porous glass samples in the equilibrium regime. The behaviour of the desorption from the porous silica and the organic films differ significantly [2]

THE AIM OF THE EXPERIMENT...

...is to investigate the LIAD effect in porous glass sample by measuring the kinetic energies of the desorbing atoms as a function of desorption light fluence

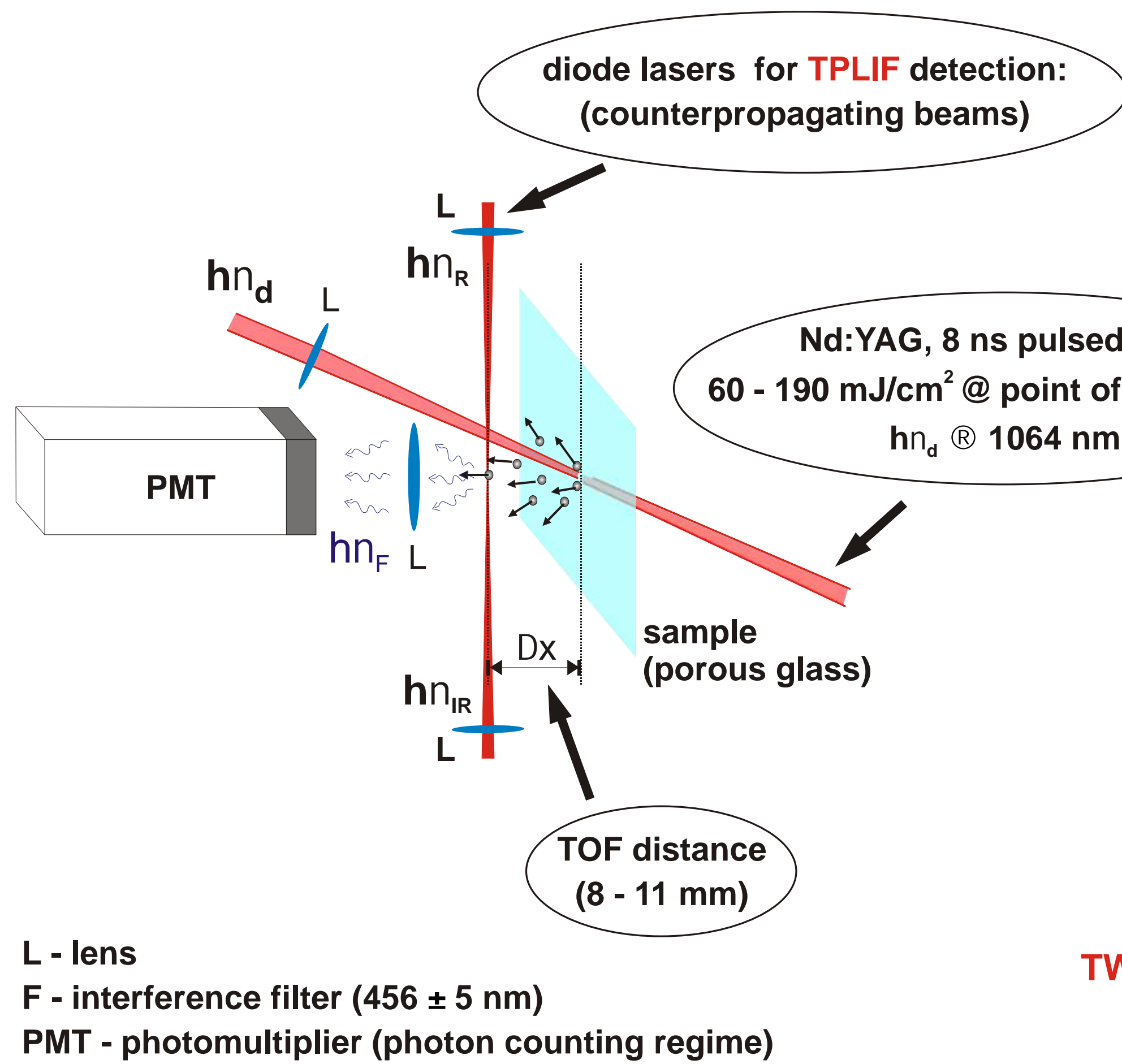
POROUS GLASS – BASIC CHARACTERISTIC [6]



- mean diameter of porous: 17 nm
- free volume: 52 %

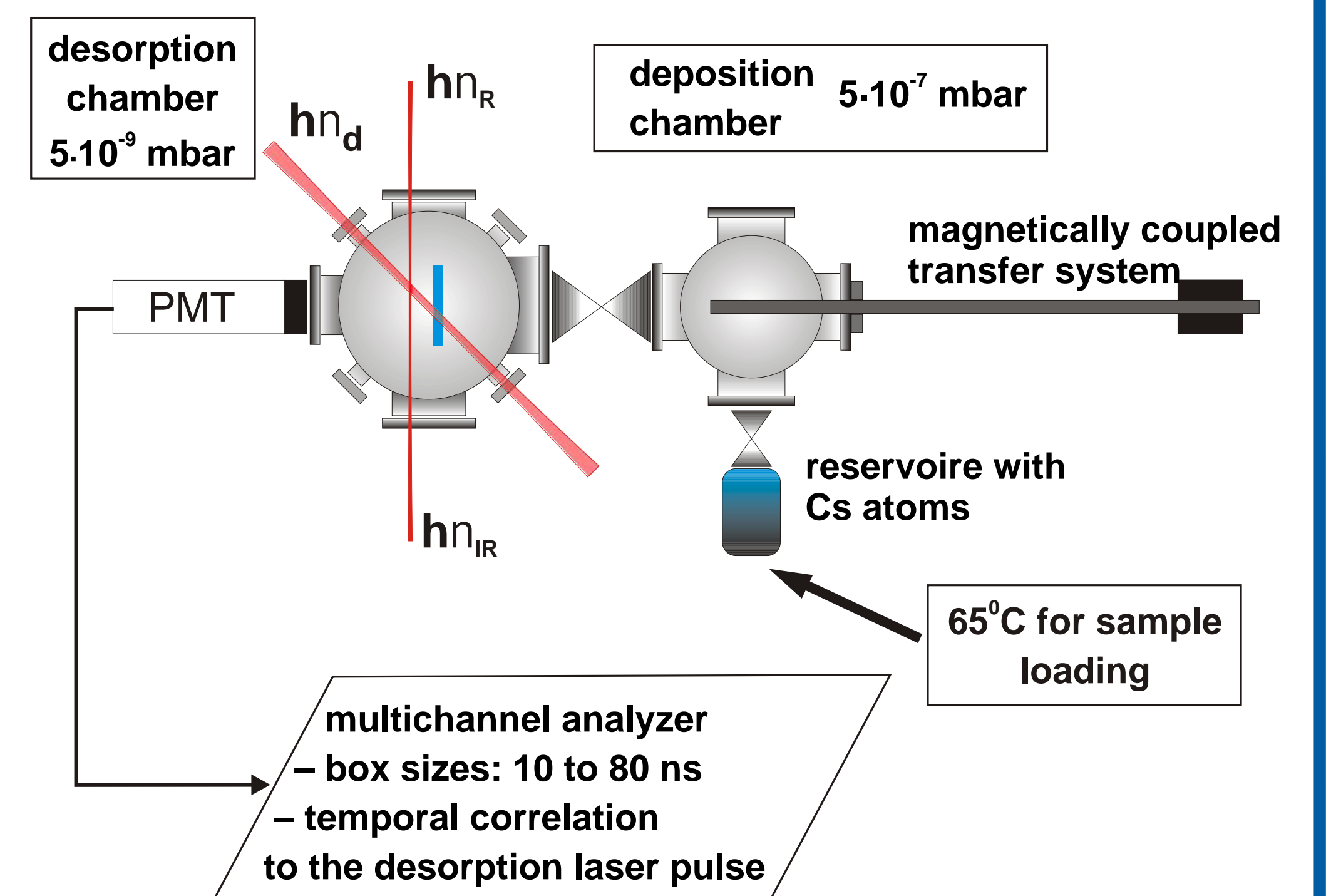
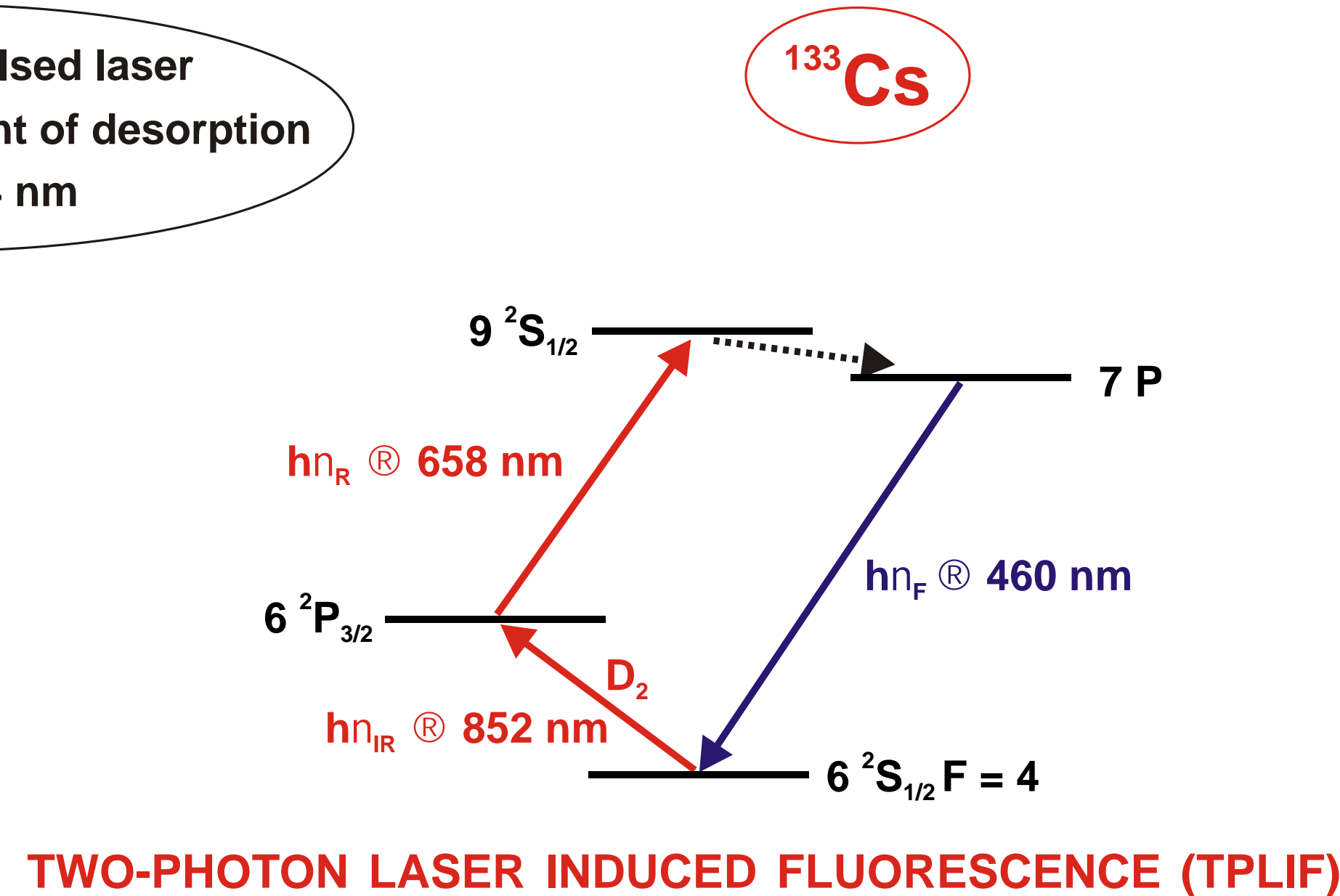
our sample: 30 × 15 × 1 mm³ plate

EXPERIMENTAL SETUP

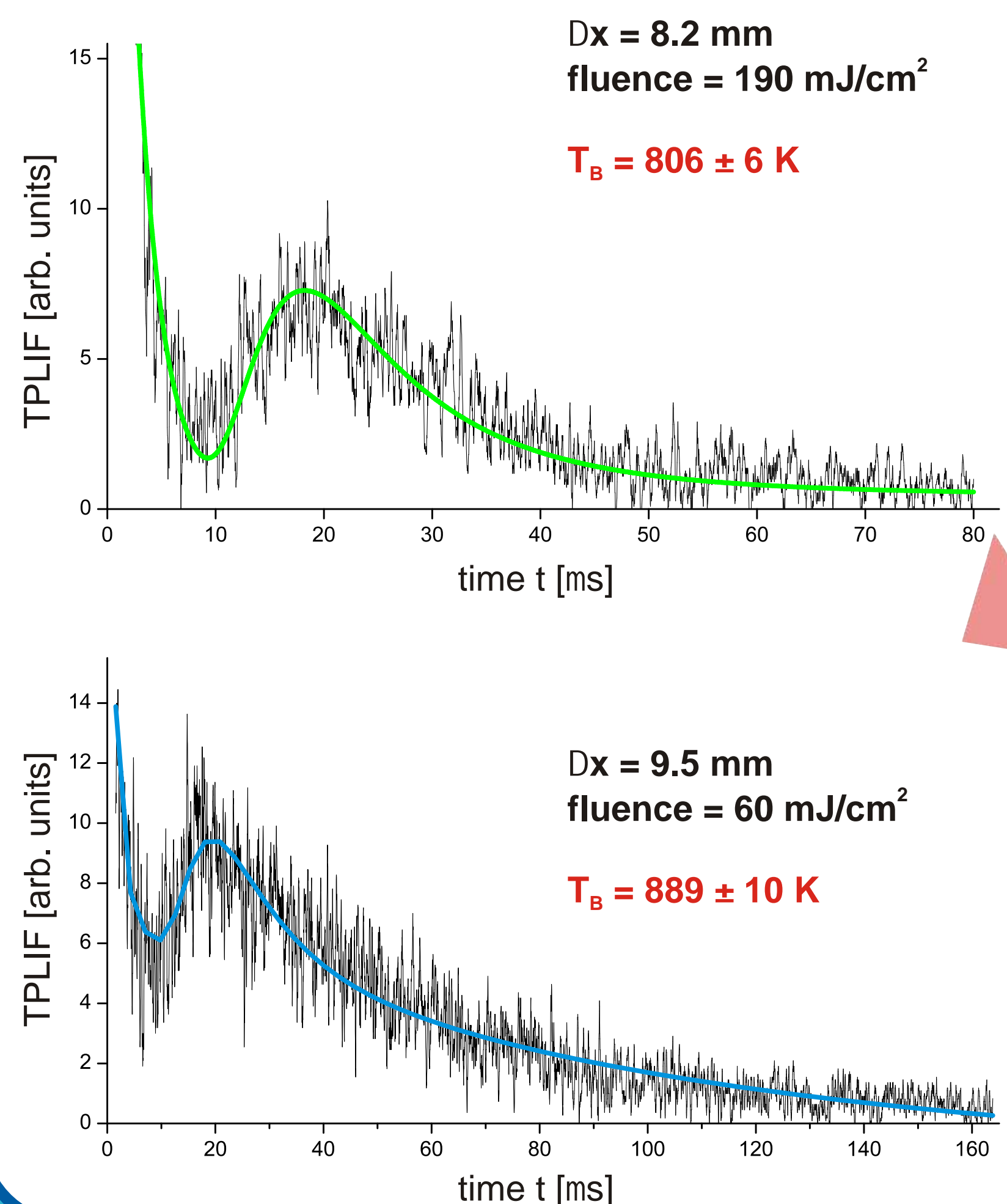


MAIN STEPS

- cleaning and baking the sample
- loading the sample in the deposition chamber for 4 - 48 hours
- transferring the sample to the high vacuum desorption chamber
- performing the measurements using TOF method with TPLIF detection



RESULTS



DATA ANALYSIS

flux-corrected Maxwell-Boltzmann distribution:

$$I(t) \propto t^{-4} \exp\left(-\frac{m \cdot \Delta x^2}{2k_B} \cdot \frac{1}{t^2 T_B}\right)$$

$I(t)$ – TOF signal
 Δx – TOF distance
 t – time
 T_B – temperature
 m – atom mass
 k_B – Boltzmann's constant

background contribution (scattered desorption light, ion fluorescence):

$$I_B(t) \propto \exp(-t/\tau)$$

$I_B(t)$ – background signal
 τ – decay time

| TOF distance Δx [mm] | fluence F_c [mJ/cm^2] | temperature of the distribution T_B [K] | most probable kinetic energy E_{mp} [meV] |
|---------------------------------|--|--|--|
| 8.2 | 190 | 806 ± 6 | 69.5 |
| 9.5 | 60 | 889 ± 10 | 76.6 |
| 11.0 | 190 | 806 ± 16 | 69.5 |

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WEB SITES

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<http://users.uj.edu.pl/~tkawalec> (Cracow)
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