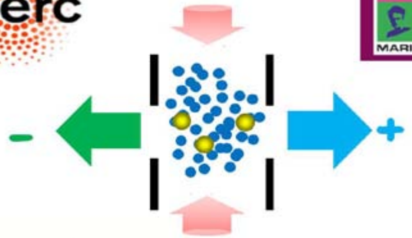


# Realization of a monochromatic electron source from 2D-MOT

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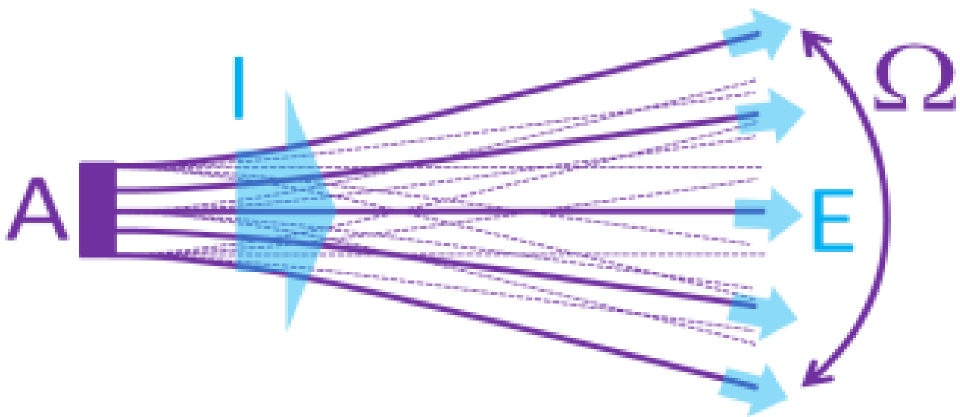
With Guyve Khalili, Neven Santic, Daniel Comparat
Laboratoire Aimé Cotton

ColdBeams
1er Octobre 2012

This work is supported by FP7-PEOPLE-2009-IAPP and ERC

# Point source / colimated source

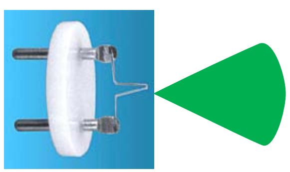


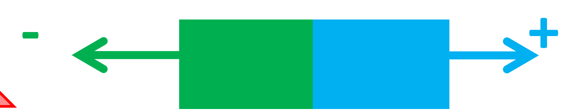

**Good focusing = Small Ɛ**

**Ɛ = AΩ**

**Conventional sources**

**New:** **LARGE SOURCE**






**Electrons -**

Small area A ~ 1 $nm^2$

Coulomb explosion

Large Ω, ΔE ~1eV

Large area A ~ 100 $\mu m^2$

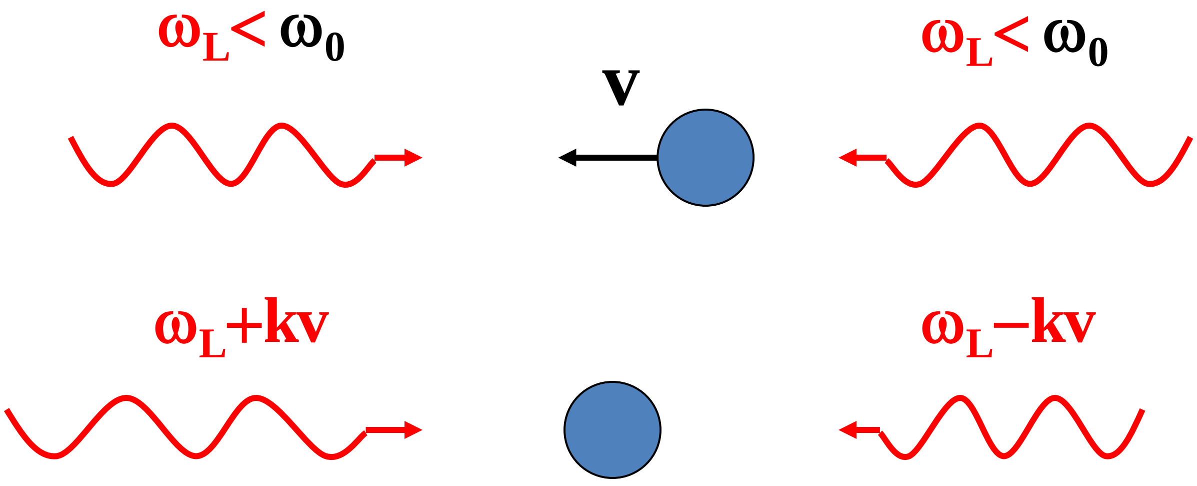
No Coulomb explosion

Small Ω, ΔE ~1 meV

**Needs:** Mono-Energy (ΔE < 0.1 eV) spectroscopy-chemistry-focus

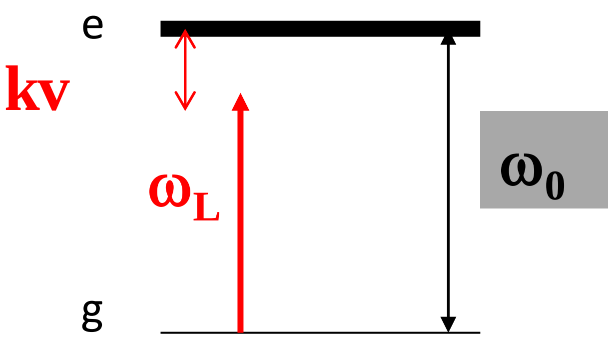
# Cold atoms

## Doppler effect

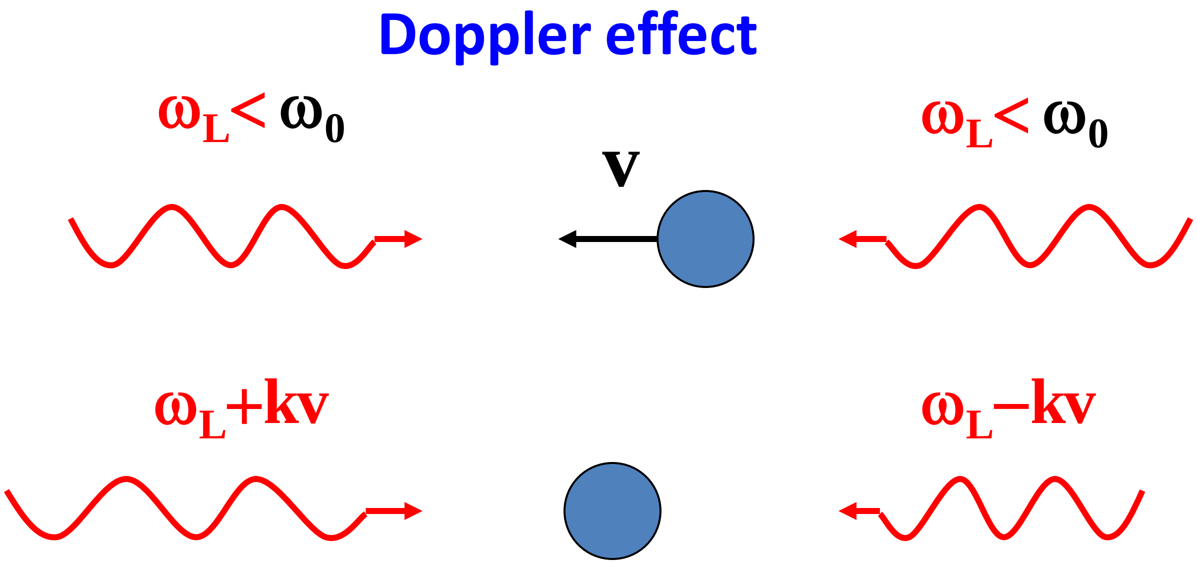



Laser frequency

Frequency see by the atom

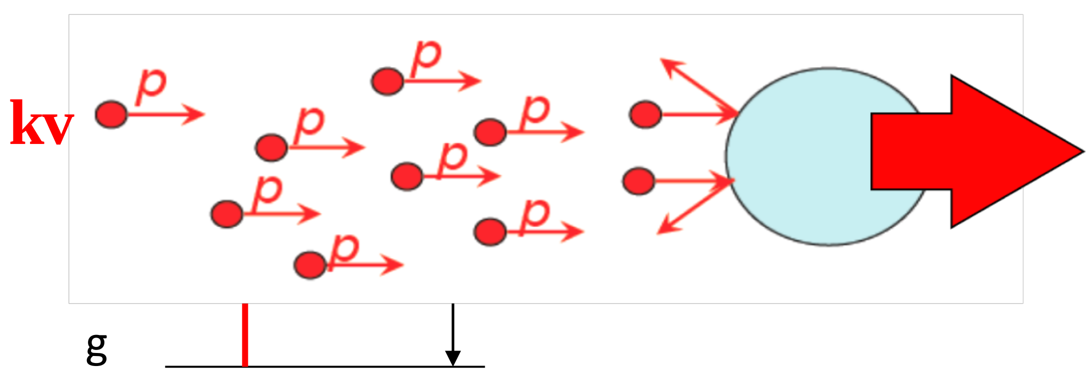


# Cold atoms




Laser frequency

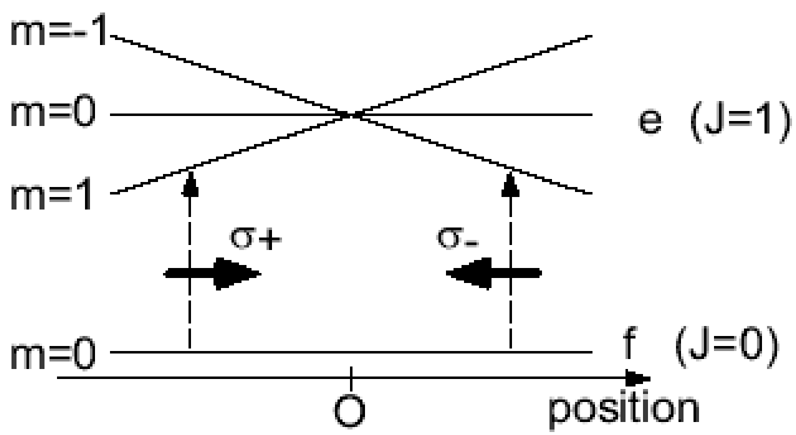
Frequency see by the atom

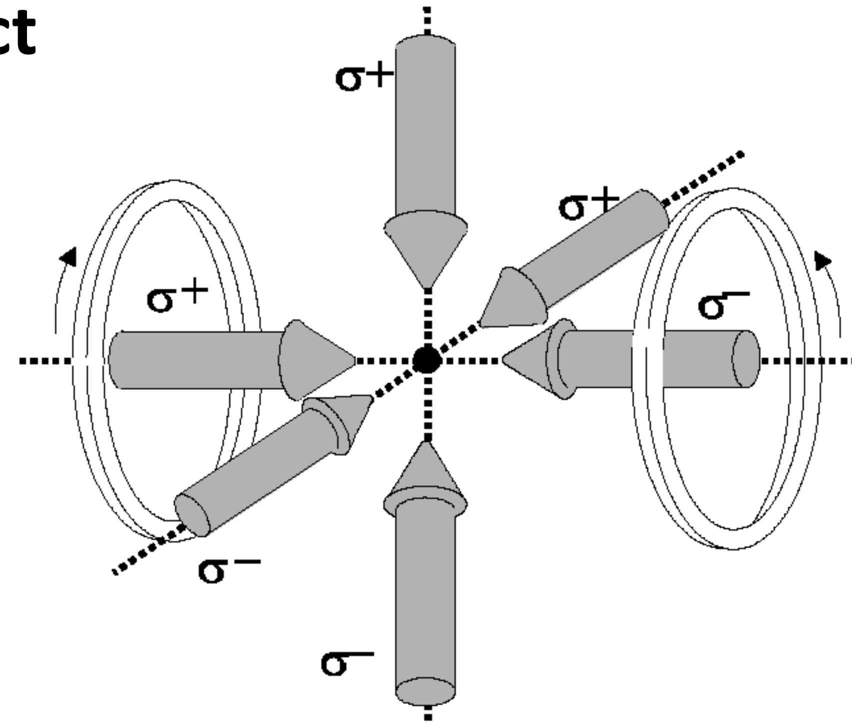



Radiation force

# Trapping cold atoms

**Zeeman effect**



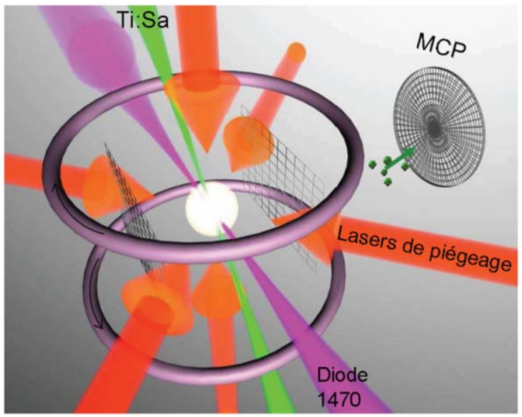

**Density $10^{11}$ at/cm$^3$**

**T = 100 µK**

**V = 0.1 m/s**

# Cold atoms sources

## 3D-MOT

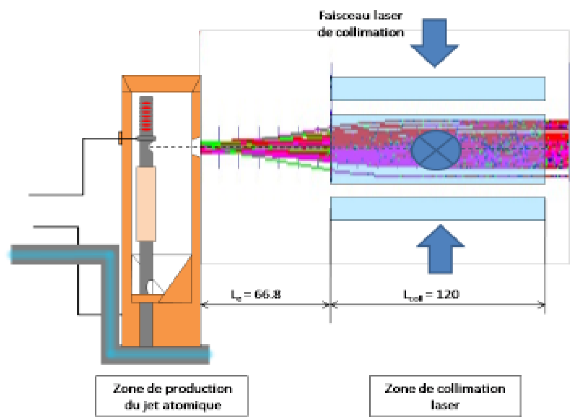



See E. Vredenbregt's talk
(on Monday 1st October at
9:10)

Transversaly cooled atoms beam

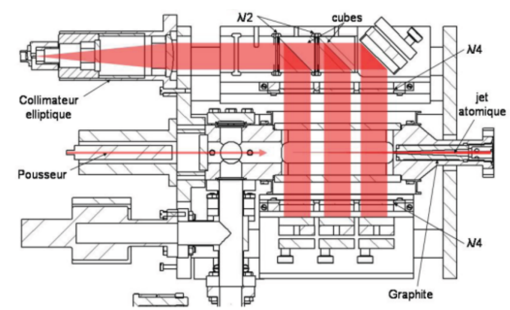
Continuous beam

## Oven




See L. Kime's talk
(on Monday 1st October at
14:35)

## 2D-MOT




Max current 1 nA

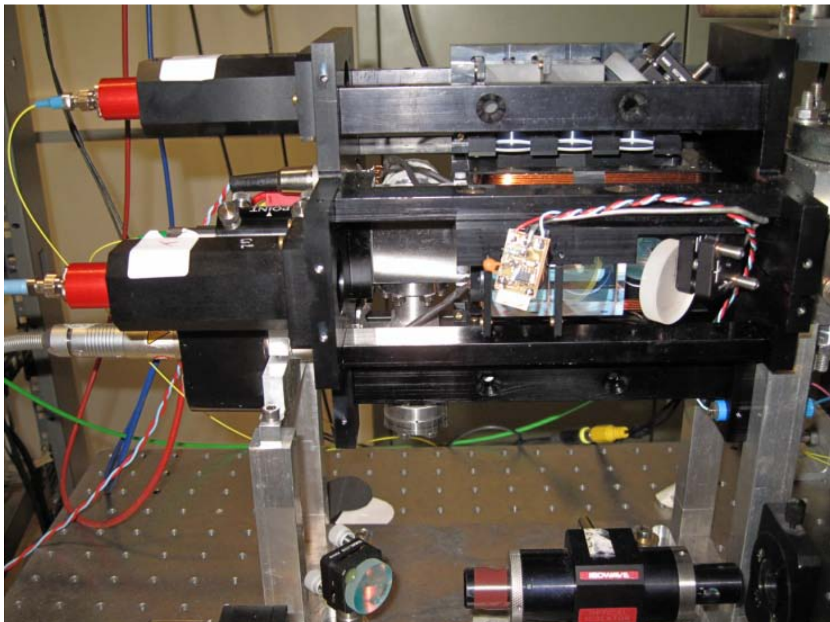
$\Delta E = 1 \sim 20 \text{ meV}$

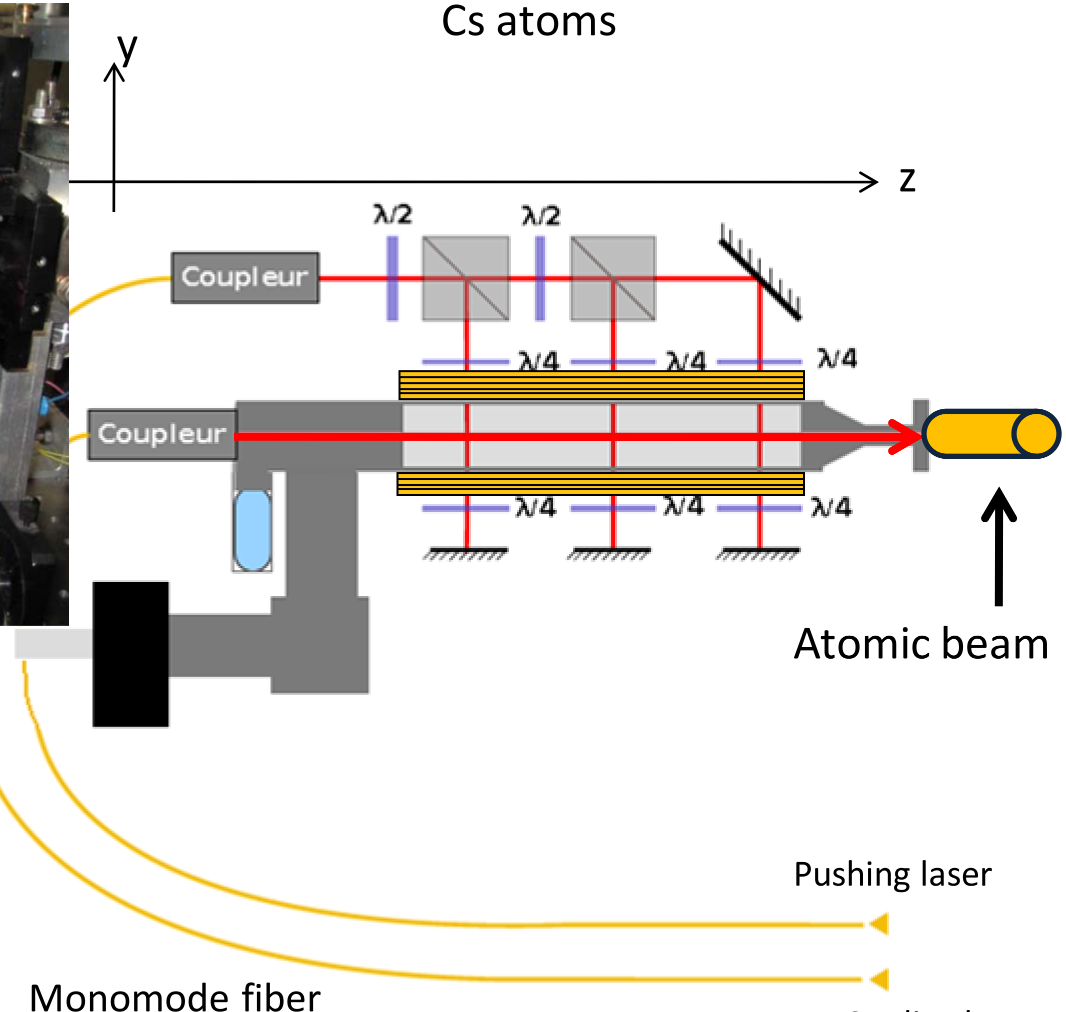
# Outline

- Presentation of the 2D-MOT
  - Inside the 2D-MOT and creation of the atomic beam
  - Study of the flux by fluorescence
  - Simulations on the electron trajectories with General Particule Tracer code (GPT)
- Future Improvements of the flux in the ionisation area
  - by compression
  - by changing the power of the pushing beam

# The standard 2D MOT

# The standard 2D MOT






Specifications provided by SYRTE for Rb 2D-MOT :

Maximal flux : $10^{10}$ atoms. $s^{-1}$

Longitudinal speed : 20 m. $s^{-1}$

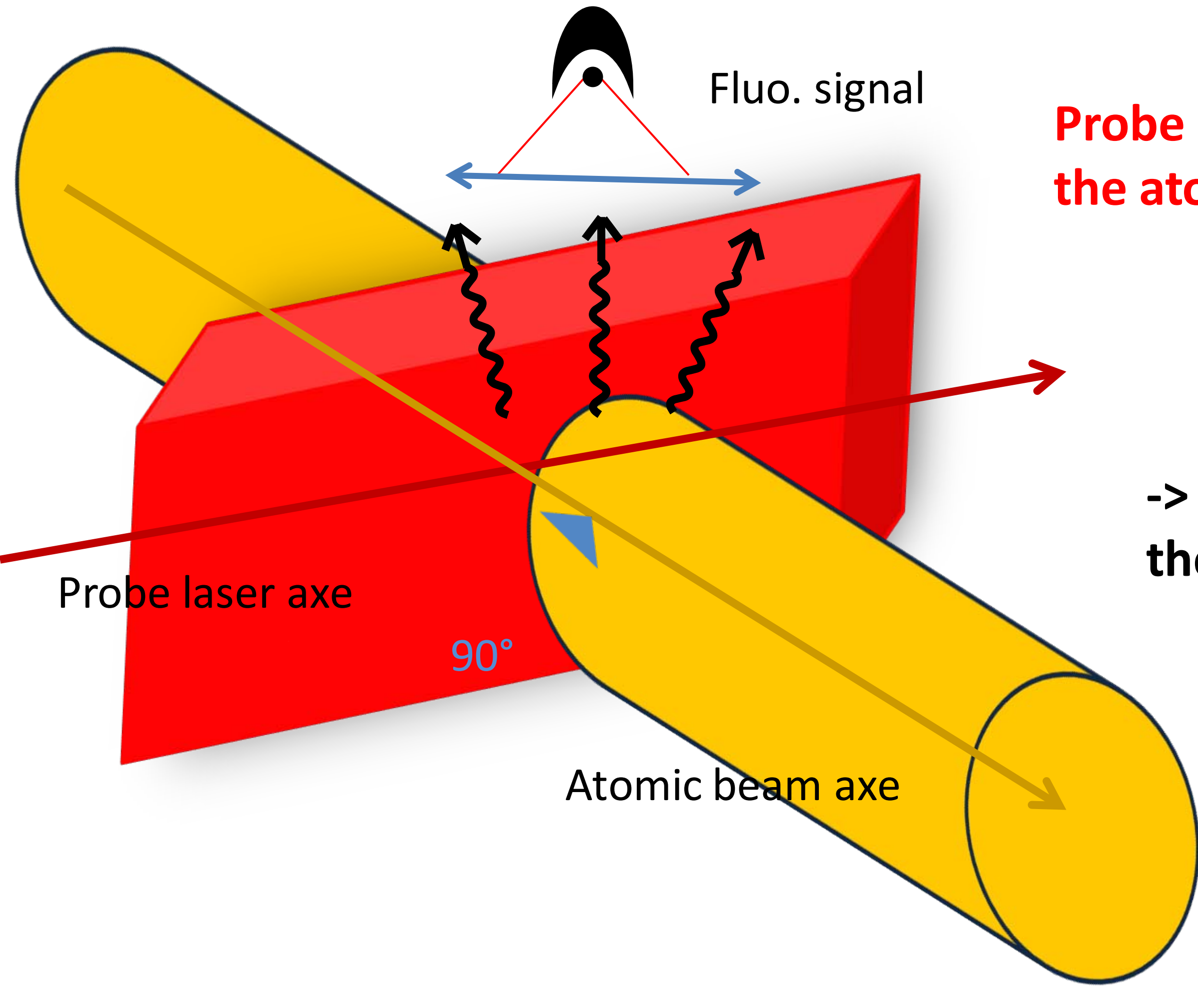
Transversal speed : 0.2 m. $s^{-1}$

require 100 mW for the cooling lasers

require 1 mW for pushing beam

Continuous atomic beam

# Caracterisation of the beam



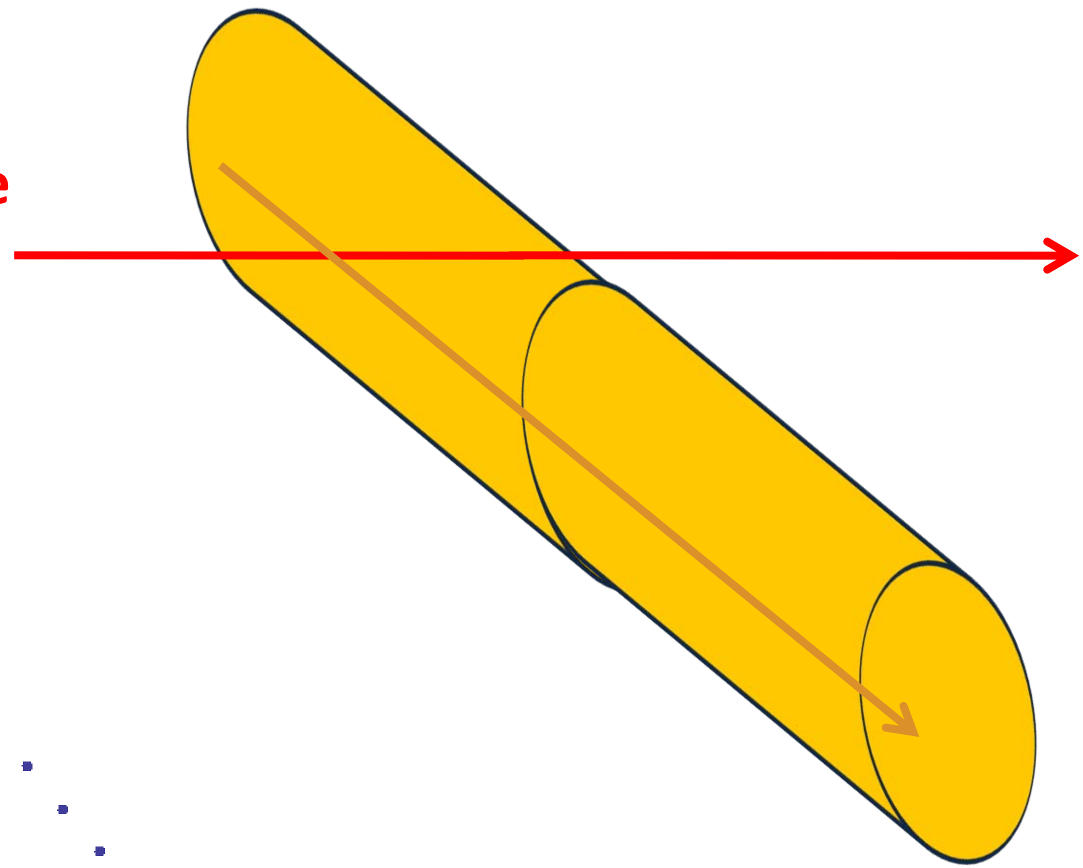

**Probe laser at 90° from the atomic beam axes**

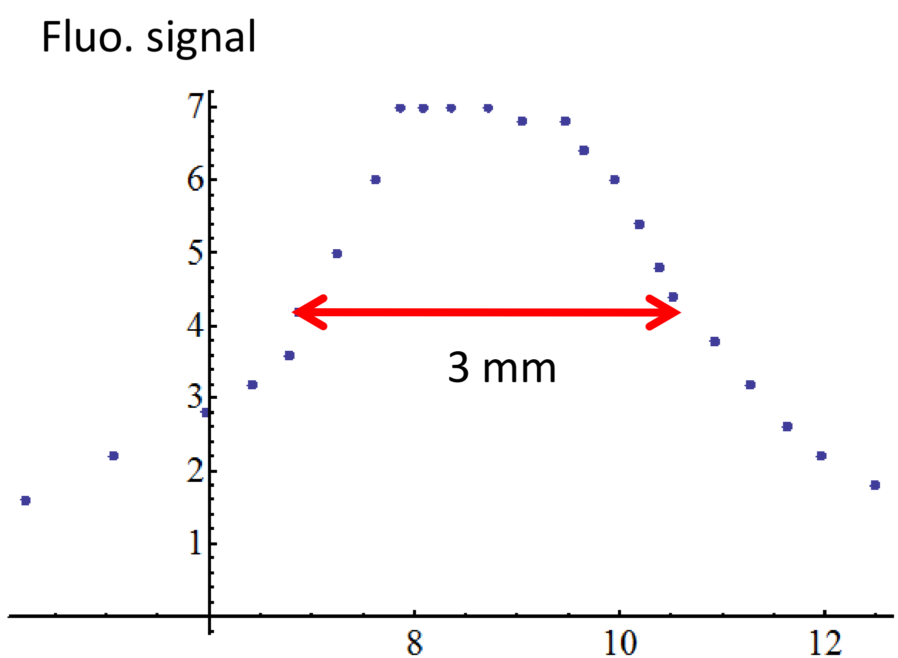
**-> the signal does not depend on the Doppler effect**

**-> Give the number of atoms in the lighting volume**

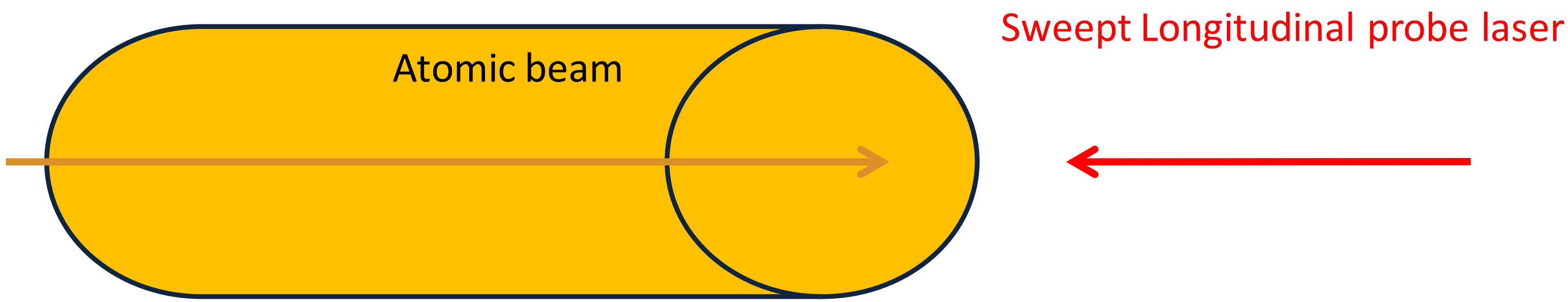
# Size of the beam

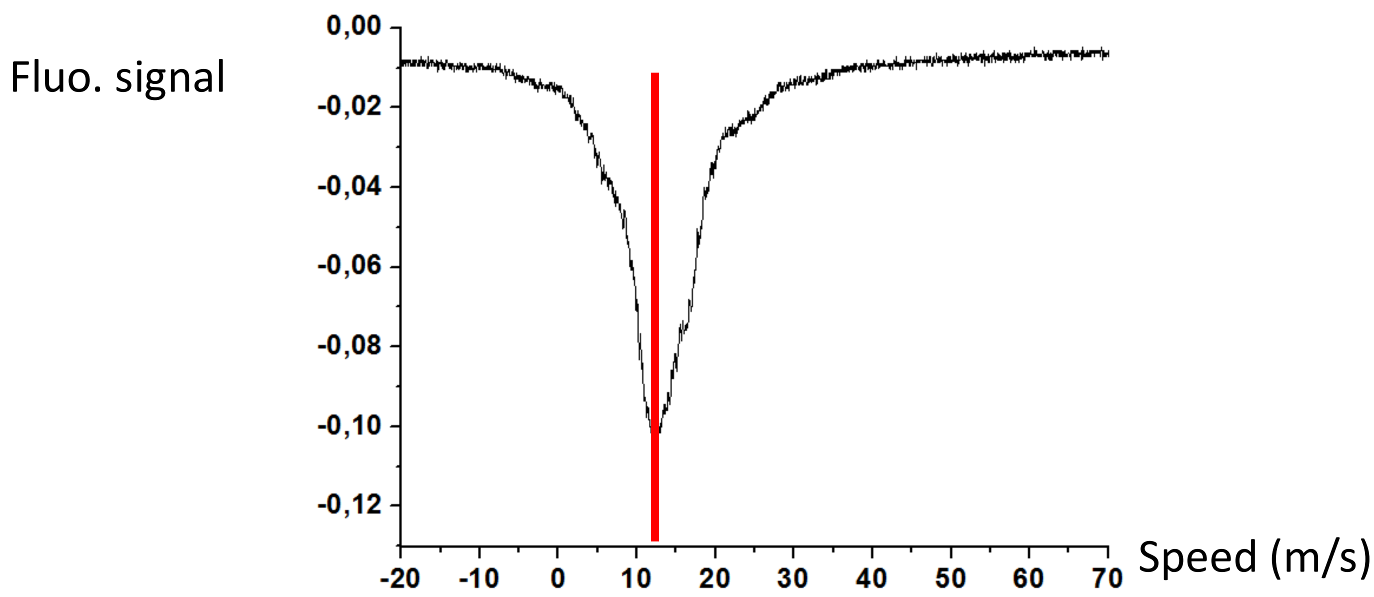
**Probe laser at resonnance**





# Speed of atoms

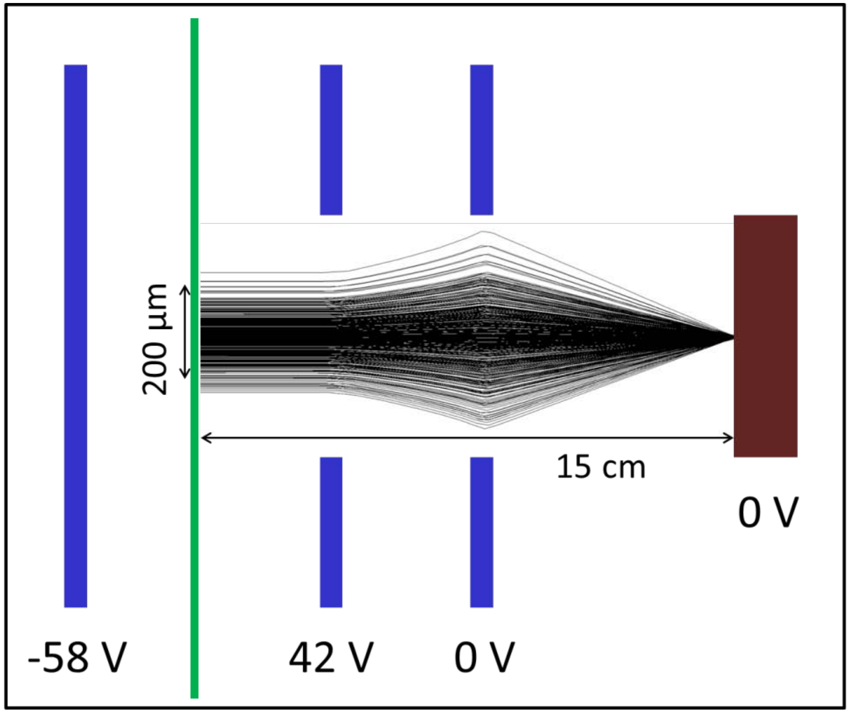


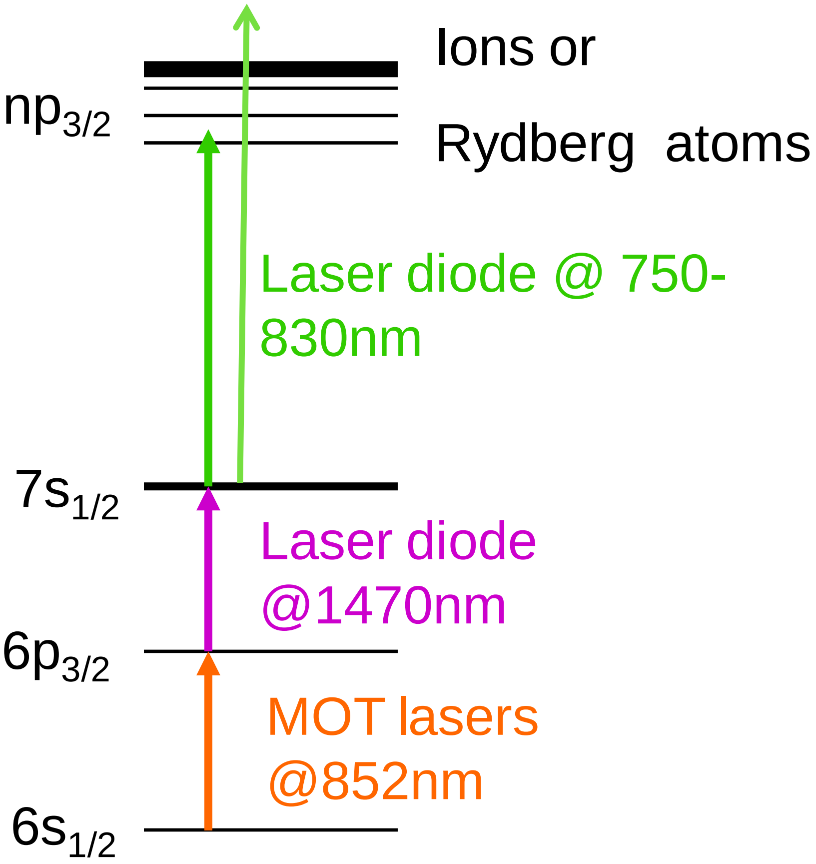



# GPT simulations

**Current : 10 pA**

**Photoionisation / Rydberg ionisation**



# GPT simulations

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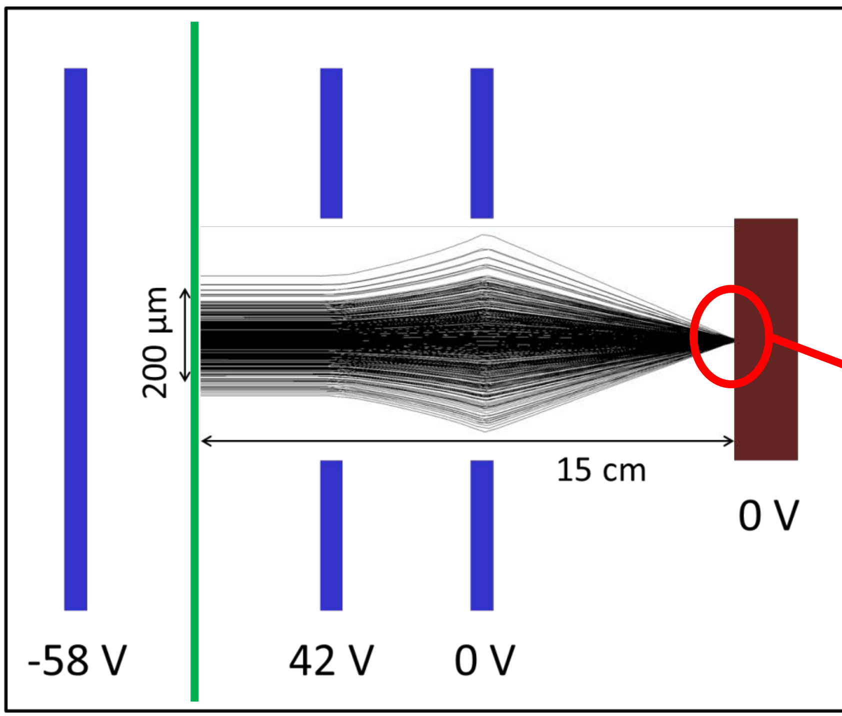
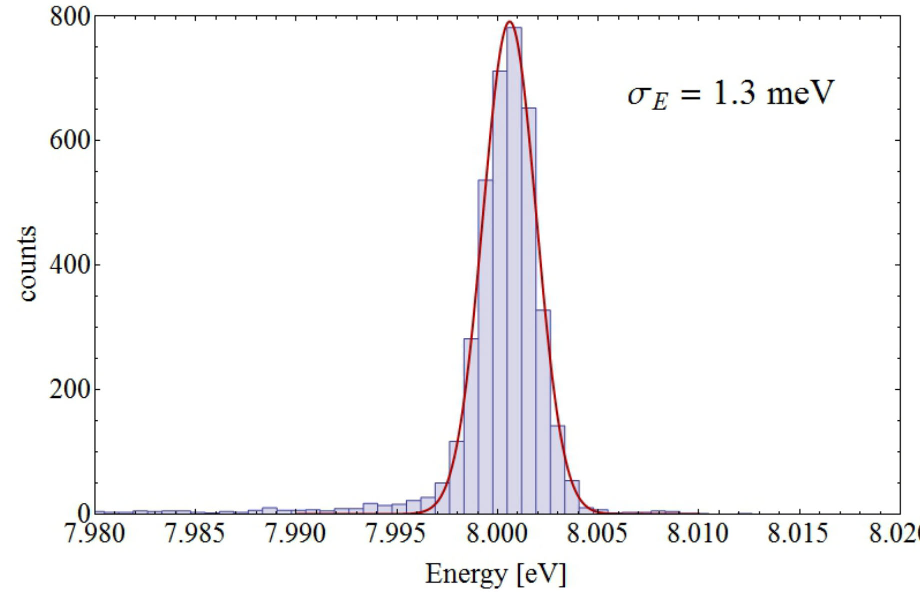
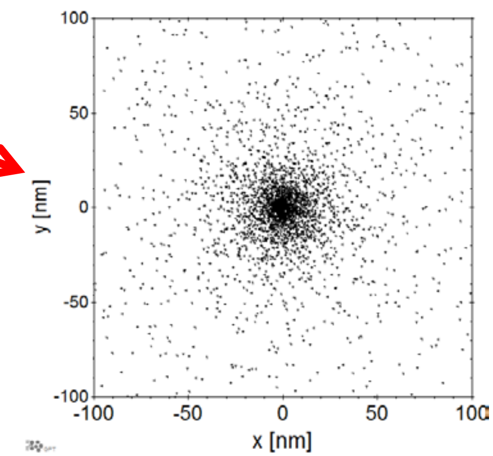
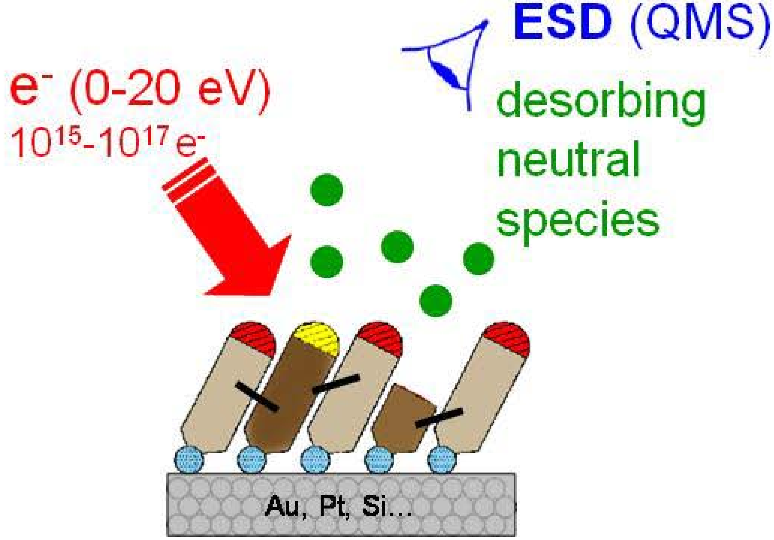


# Conclusion on these first results

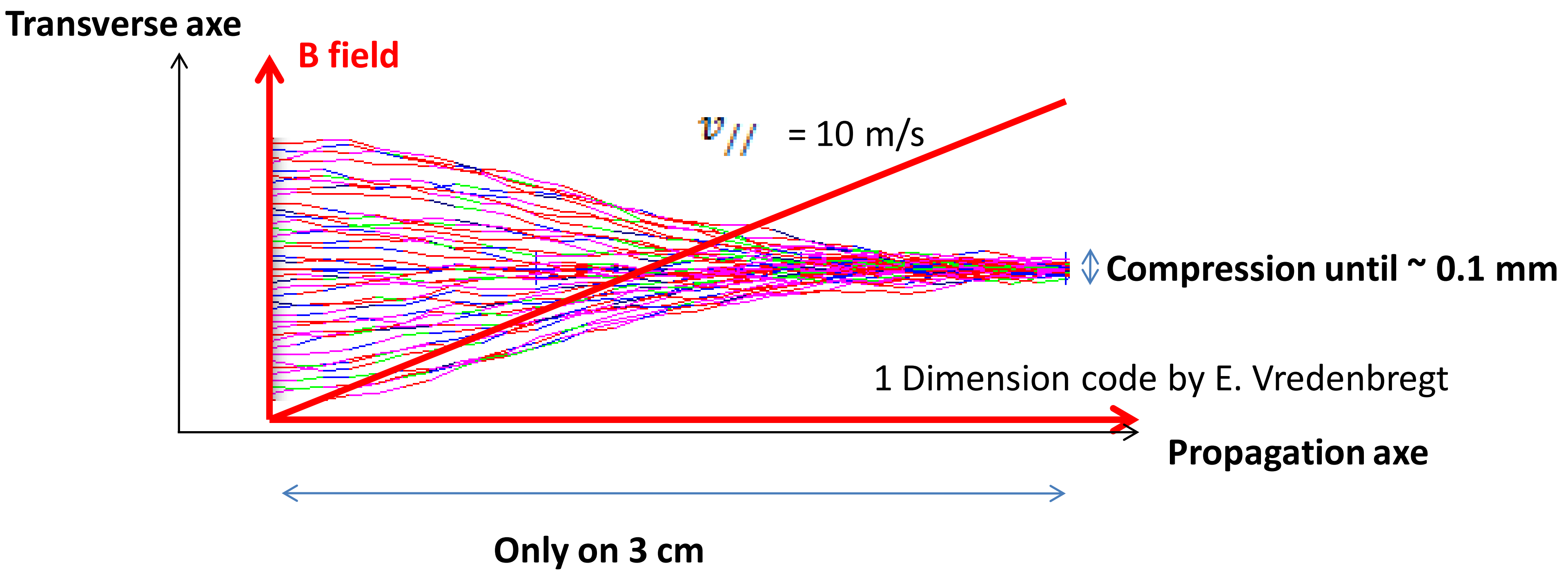
- **Current source: 5 µA on (1 mm²) (1 A/m²)**
- **New source: 10 pA on (40 nm)² (10⁵ A/m²)**




**Control of chemical breaking**

**Institut des sciences molécullaires d'Orsay**
**See A. Lafosse's talk (on Wednesday 3 October at 9:40)**

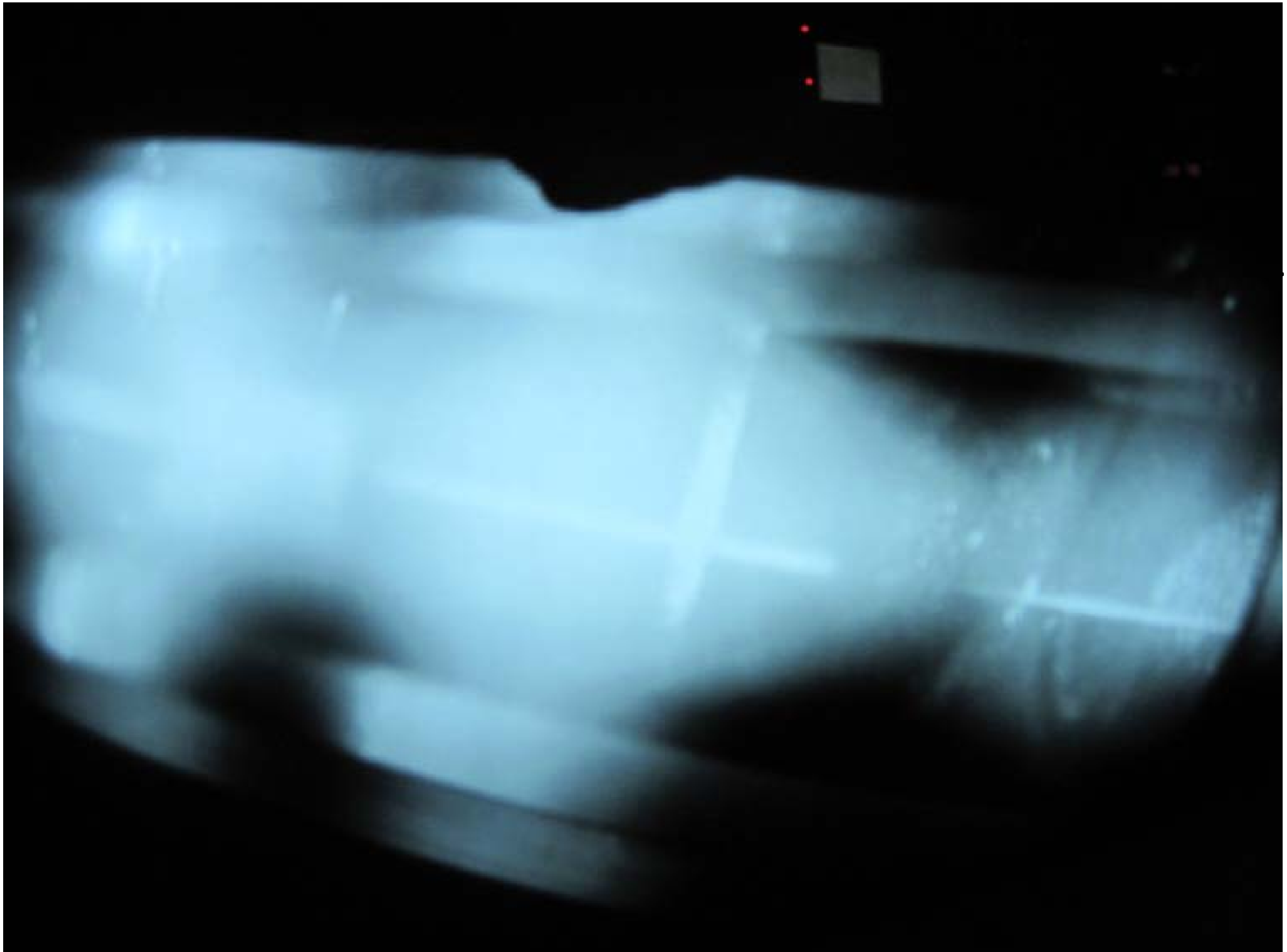
# Compression



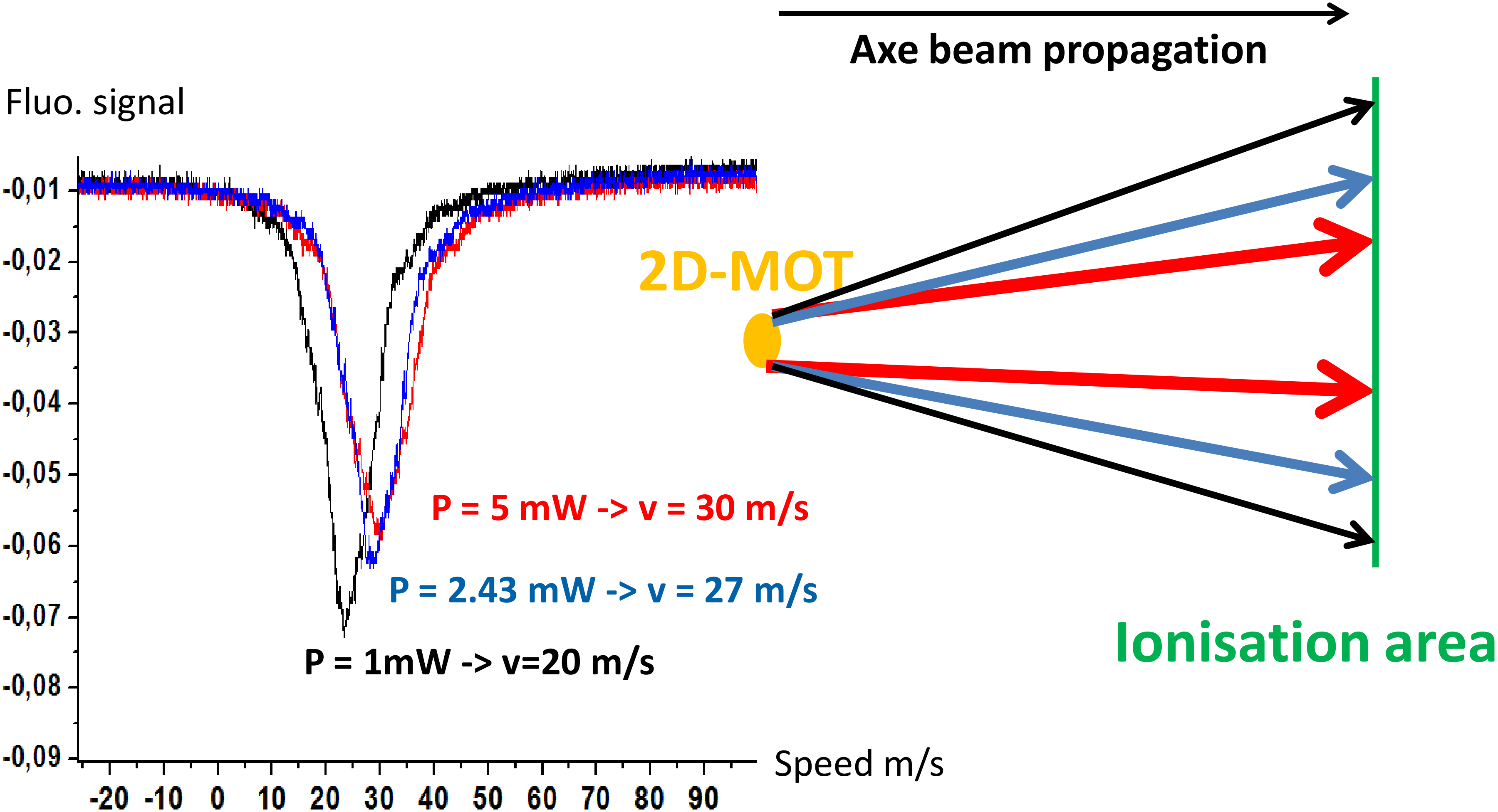

$n_{lim} = 10^{11}$ atoms.$m^{-3}$

$flux_{lim} = 10^{10} atoms/s$ (0.1 mm)²

# Compression



# Changing the power of the pushing beam



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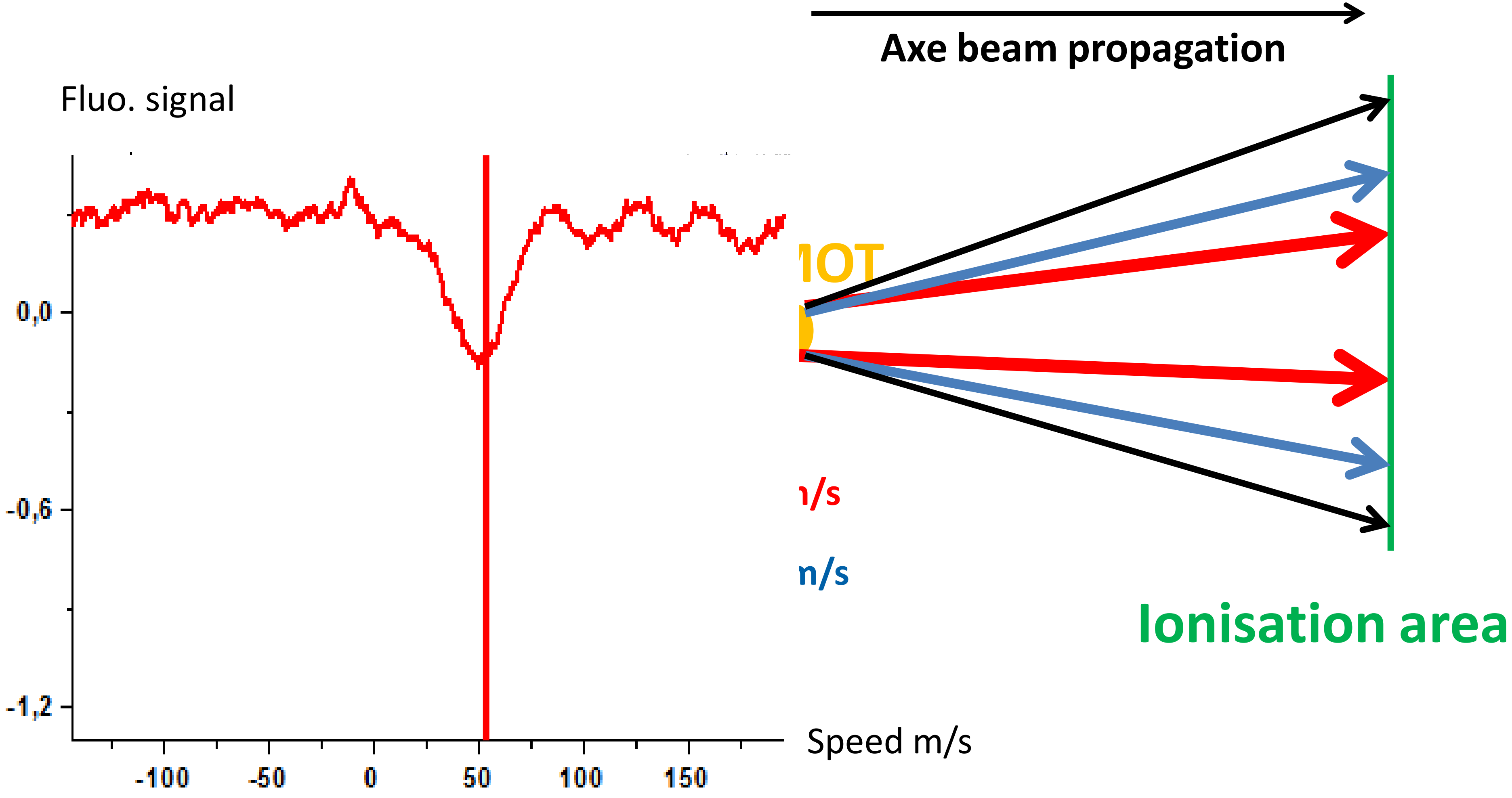

# Conclusion

**Current : 1 nA**