

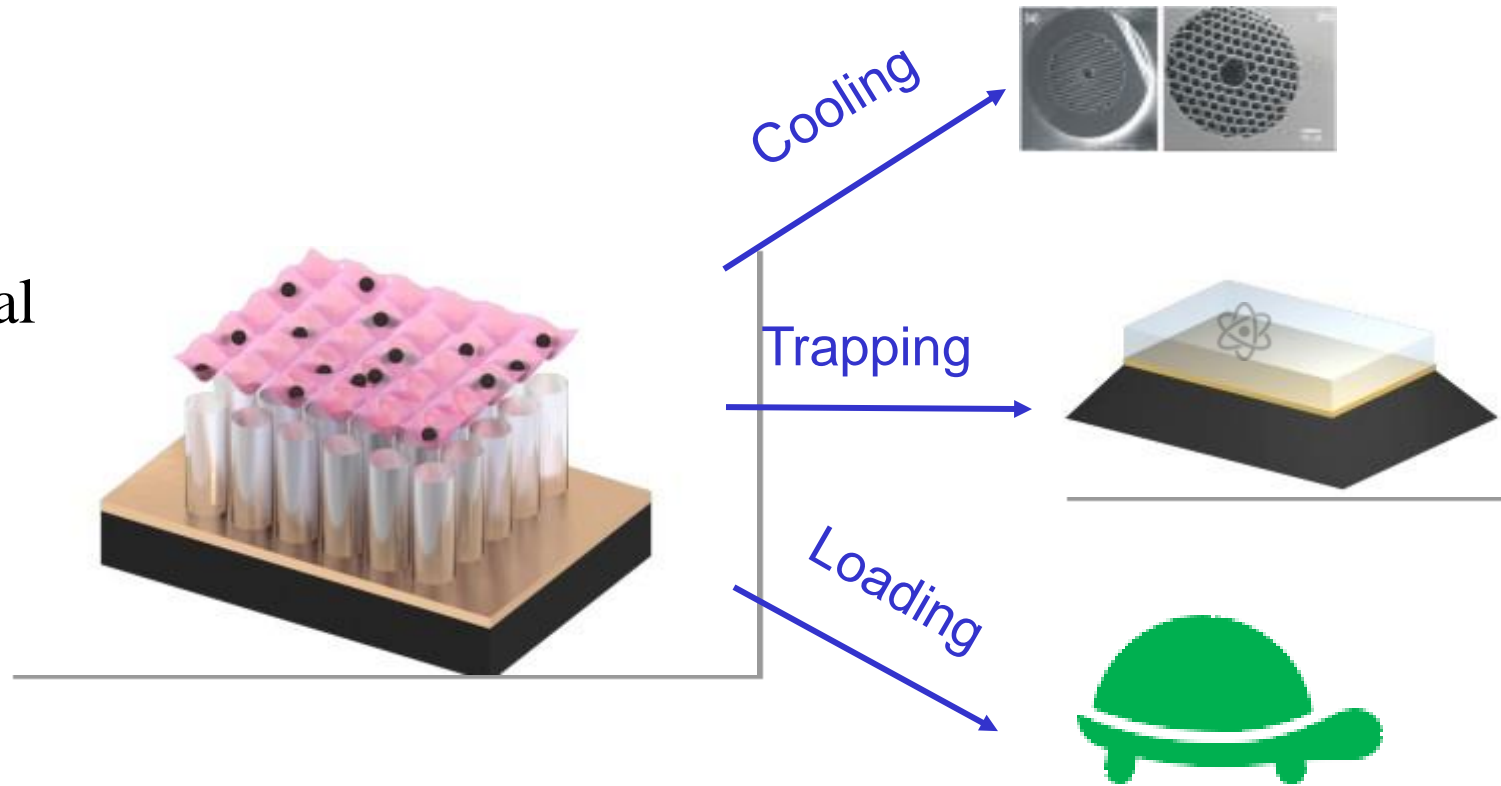
## AUFRONS:

Ultracold atoms in  
nanostructures optical  
lattices

2 Atomic species:

$^{87}\text{Rb}$  : boson

$^{40}\text{K}$  : fermion



Guillaume Baclet<sup>1</sup>, Adèle Hilico<sup>1</sup>, Vincent Mançois<sup>1</sup>, Romain Veyron<sup>1</sup>, Philippe Bouyer<sup>1</sup>, Simon Bernon<sup>1</sup>

<sup>1</sup>LP2N, Université Bordeaux, IOGS, CNRS, Talence, France



*Muquans*

Integrated  
Transportable laser systems  
Robust  
Versatile

Telecom laser frequency doubled  
using fibred component only



## Fréquency reference

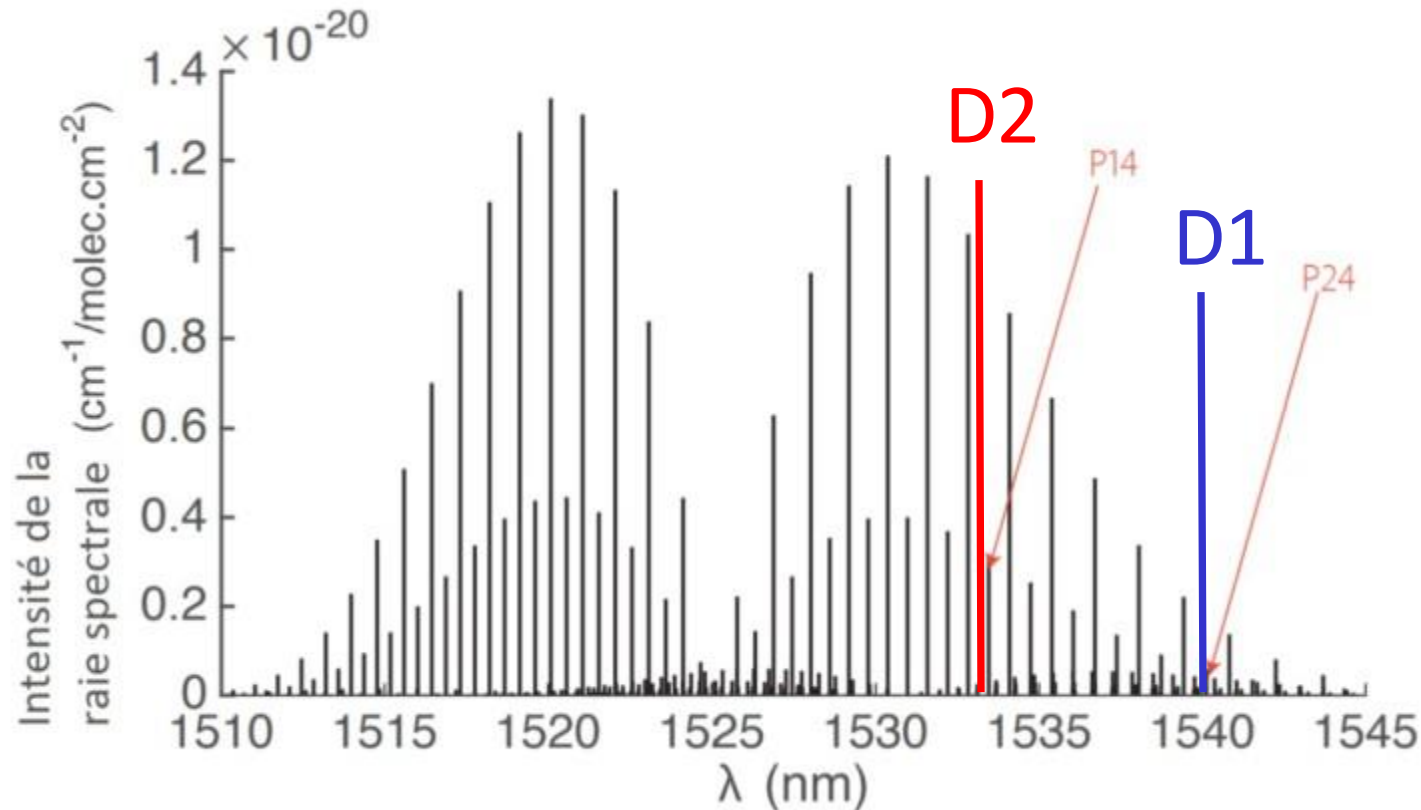


**Goal : Fibered Frequency reference**

**$10^{-9} \leftrightarrow 100$  kHz**

- **Compacity / robustness**
- **Agility in frequency**
- **Versatile system : digital electronics, laser architecture**

Potassium **D2 : 767 (1534 nm)** et **D1 : 770 (1540 nm)**



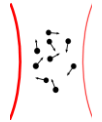
	$2\lambda_{D1,D2}$ (nm)	$\lambda_{C_2H_2,P14/P24}$ (nm)	Différence fréquentielle (GHz)
Transition D1/P14	1540.216	1540.125	11.456
Transition D2/P24	1533.402	1533.461	7.522

# Optimisation of the fiber parameters

## Broadenings:

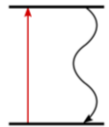
$$\Gamma_{\text{tot}}^2 = \Gamma_{\text{nat}}^2 + \Gamma_{\text{transit}}^2 + \Gamma_{\text{pressure}}^2$$

$$I_{\text{sat}} \propto \Gamma_{\text{tot}}^2 / \Gamma_{\text{nat}}^2$$



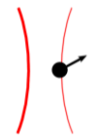
Doppler

$$\text{FWHM} \approx 472 \text{ MHz (T=300K)}$$



Natural

$$\Gamma_{\text{nat}} = \text{few Hz}$$



Transit

$$\Gamma_{\text{transit}} = \frac{0.19}{w_0} \sqrt{\frac{2k_B T}{m_{C_2H_2}}}$$



Collisional

$$\Gamma_{\text{pressure}} = (234 \text{ kHz / Pa}) \times P$$

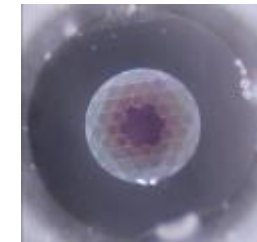
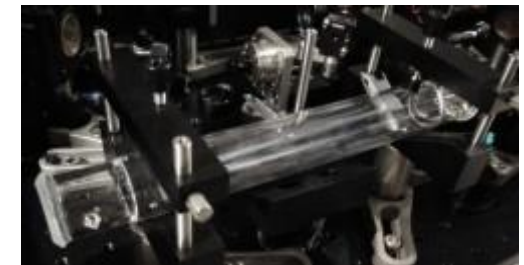
Metrology . . . pour

Agility :  $\Gamma$  large

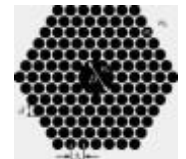
Fiber :  $\Gamma_{\text{pressure}} <$

$\Gamma_{\text{transit}}$

Cellule de référence



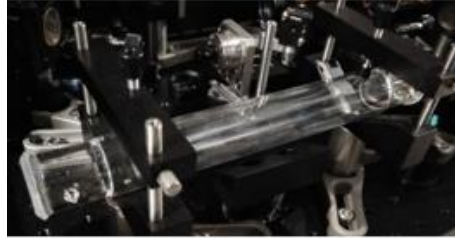
Large core



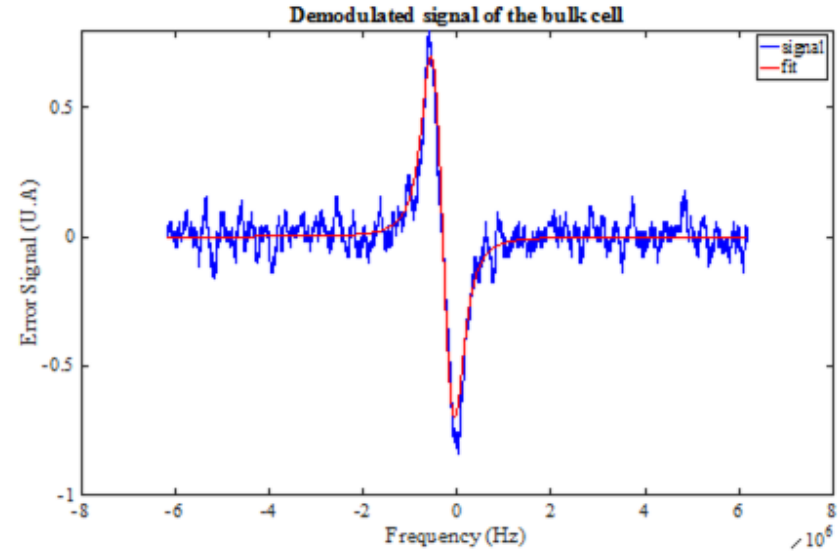
Small coeur  
SM

Cell	L (m)	P (Pa)	$w_0$ ( $\mu\text{m}$ )	$\Gamma_{\text{tot}}$ (kHz)	$P_{\text{sat}}$ (mW)	$I_{\text{sat}}$ ( $\text{W.cm}^{-2}$ )	Absorption (%)
Bulk	0.25	0.5	750	161	340	38	0.17
Fiber L	7.5	7.5	11.2	7600	170	86 000	20
Fiber p	4.5	30	2.7	31 000	170	1 500 000	45

# Bulk cell performance



**Linewidth  
160 kHz**



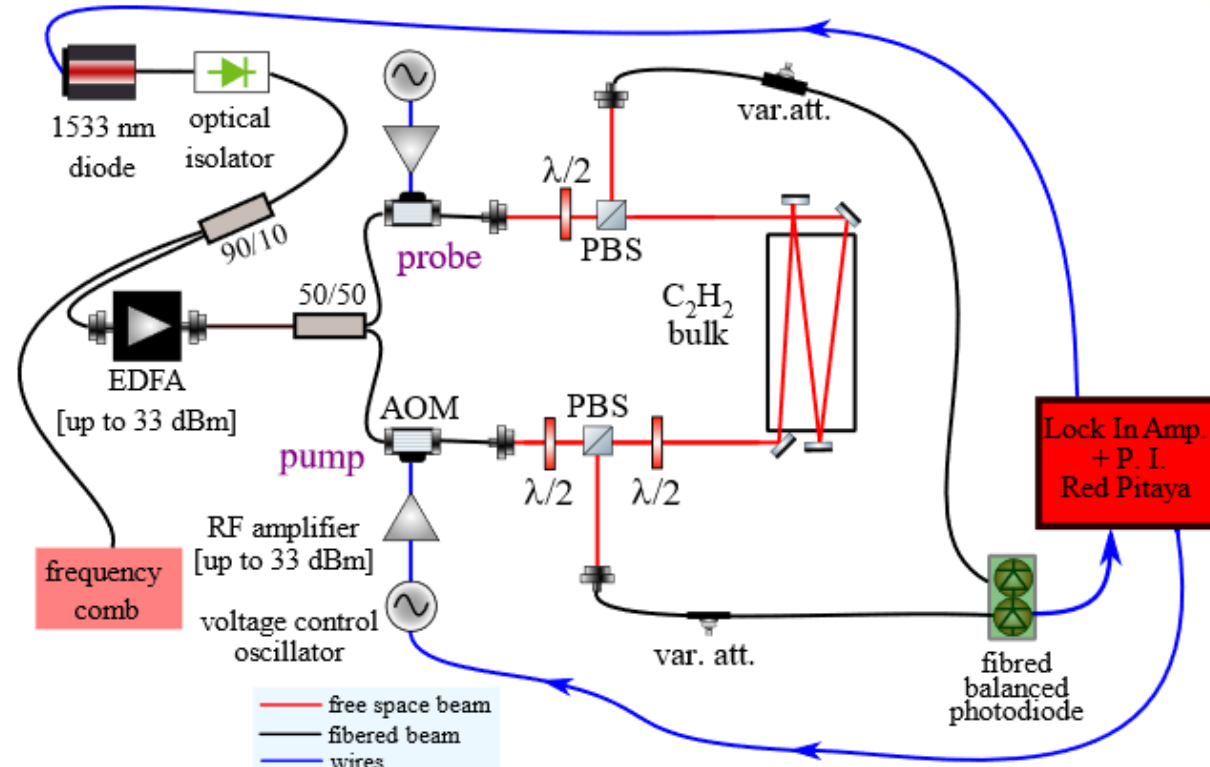
**Modulation frequency : 44 kHz**

**Modulation amplitude : 350 kHz**

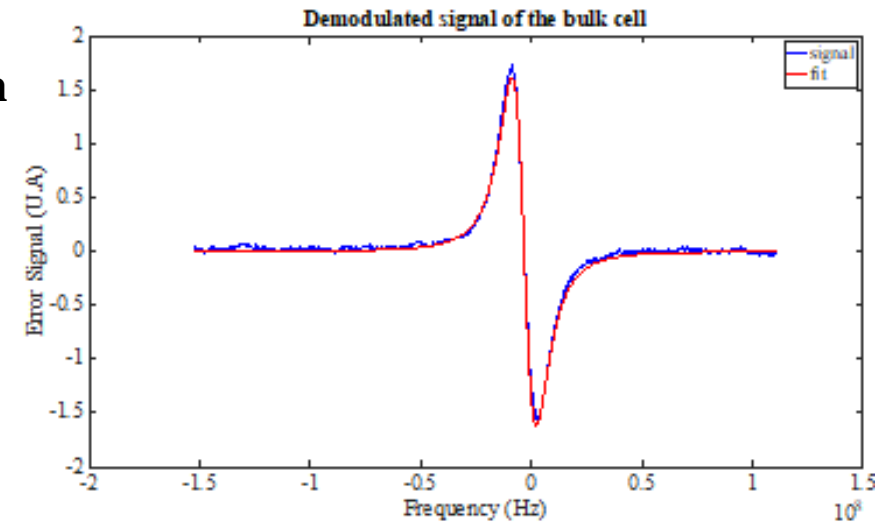
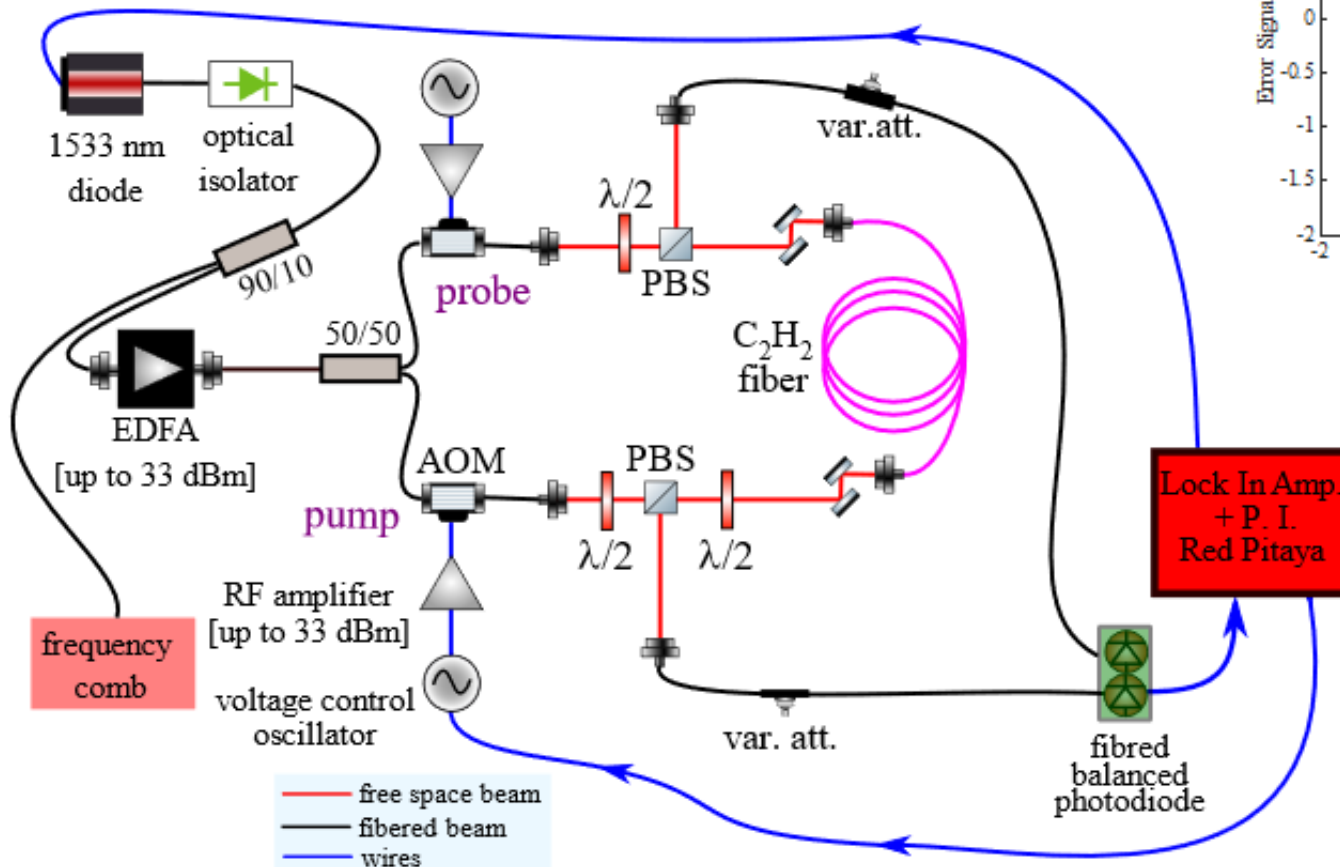
**Modulation factor : 8**

**Power : 90 mW**

**Detection BW : 1 kHz**



**Large core fiber:**  
30  $\mu\text{m}$  diameter  
21  $\mu\text{m}$  MDF  
Linewidth  
7.6 MHz



**Modulation frequency :** 130 kHz

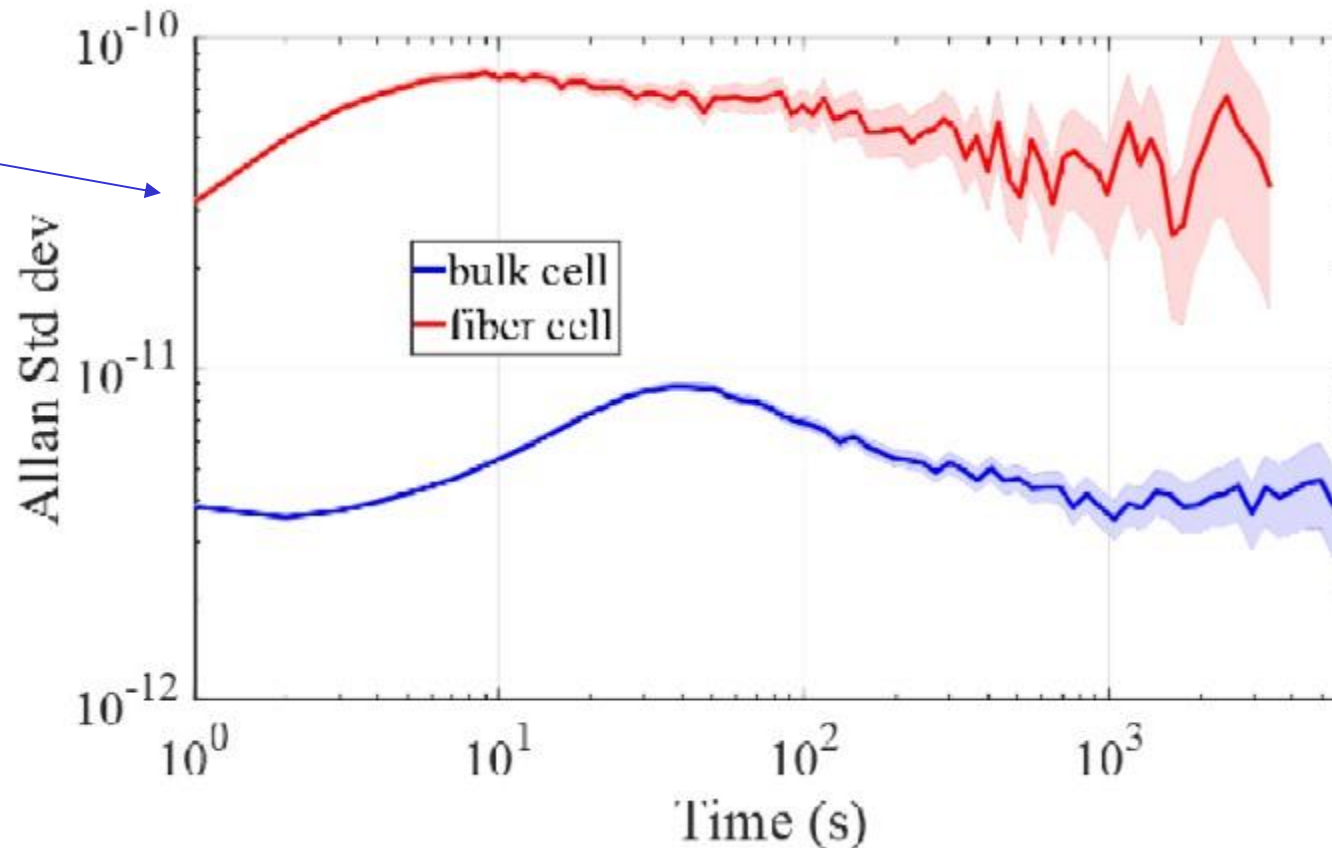
**Modulation amplitude :** 2000 kHz

**Modulation factor :** 15

**Power :** 100 mW

**Detection BW :** 500 Hz

Digital electronics  
limitation



Overall stability below  $10^{-10}$  (10 kHz)  $\Rightarrow$  Performance valid for laser cooling application

**Perspectives** : Improving set-up / electronics  
Investigating 10s instability  
Cooling atoms