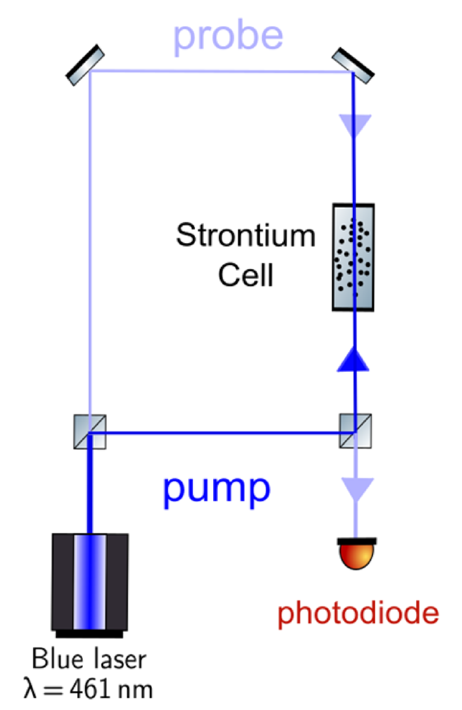
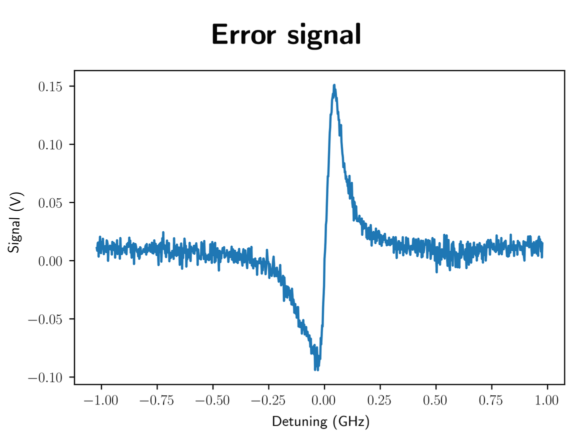
# Narrow-line spectroscopy to cool Strontium Atoms

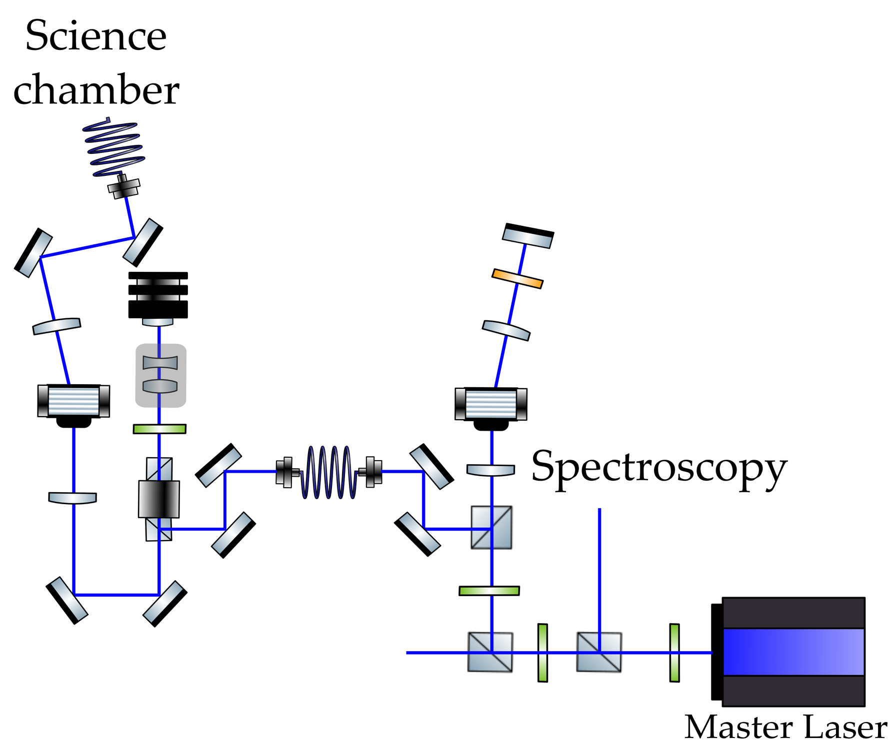
**Romaric Journet,** Clémence Briosne-Fréjaville, Anaïs Molineri, Florence Nogrette, Marc Cheneau
Laboratoire Charles Fabry, Institut d'Optique Graduate School–CNRS–Université Paris-Saclay, 91120 Palaiseau, France

- Construction of a new ultracold atoms experiment using Strontium atoms
- New spectroscopy scheme for the intercombination line developped in partnership with Laboratoire de Physique des Lasers (Paris 13)
- In-situ fluorescence imaging with sub-micron resolution and single-atom sensitivity
- Realize out of equilibrium dynamic experiments

## Saturated absorption spectroscopy



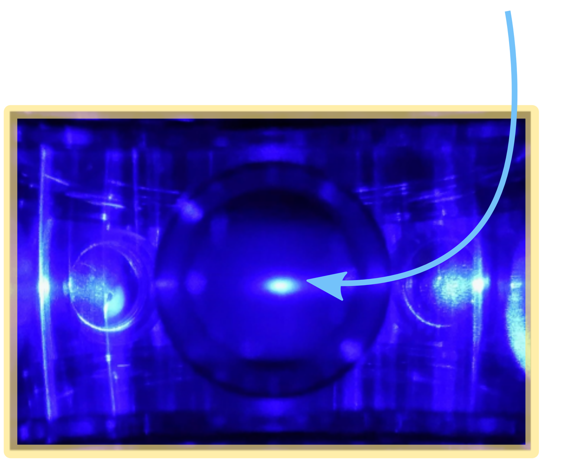




Master laser stabilized by saturated absorption spectroscopy on resonance with the 30-MHz blue transition. We inject Nichia slave diodes to amplify the laser power.

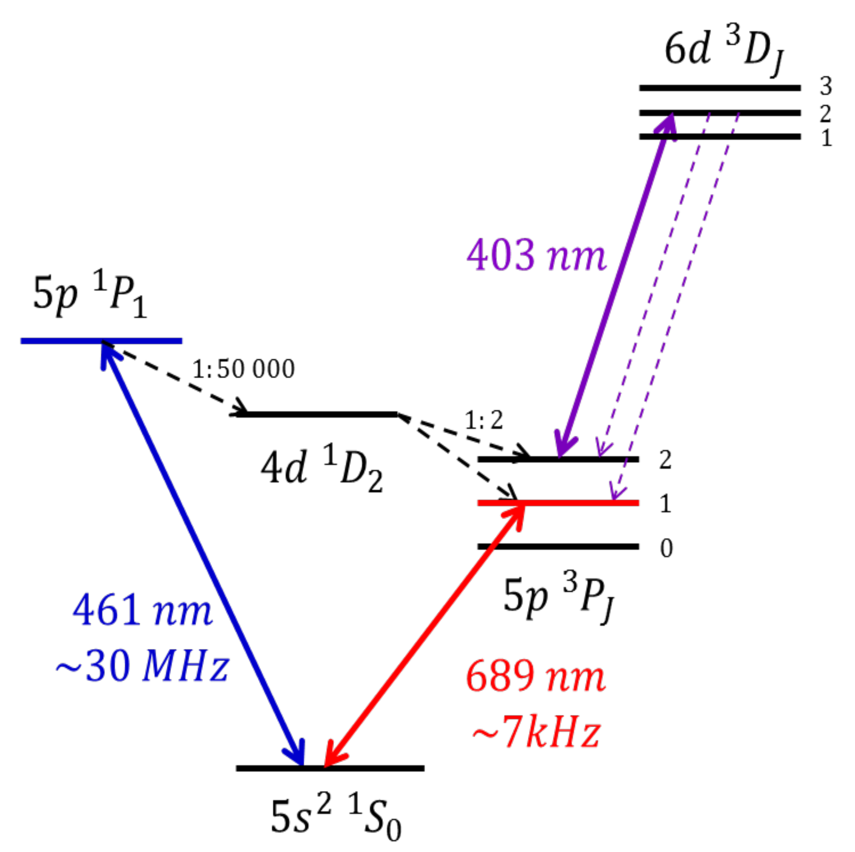
## Cooling on the blue transition

about 1 mK !

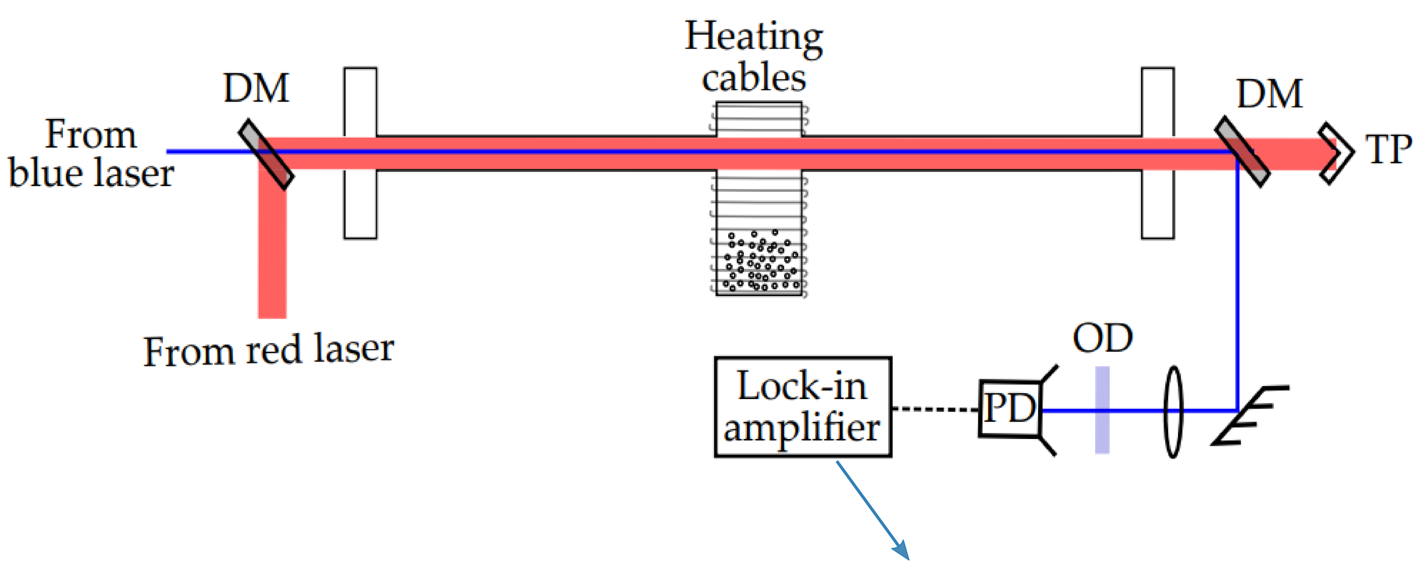


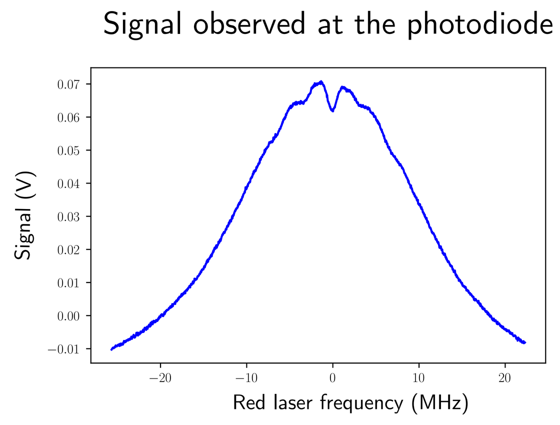
*A glimpse inside the vacuum chamber: first trapped atoms in March 2018*

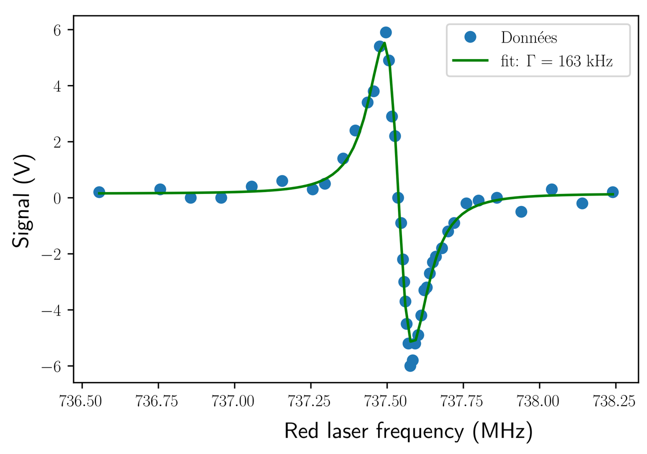
## Strontium Energy levels




## Shelving spectroscopy

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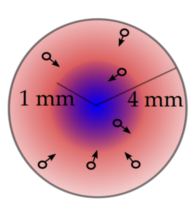
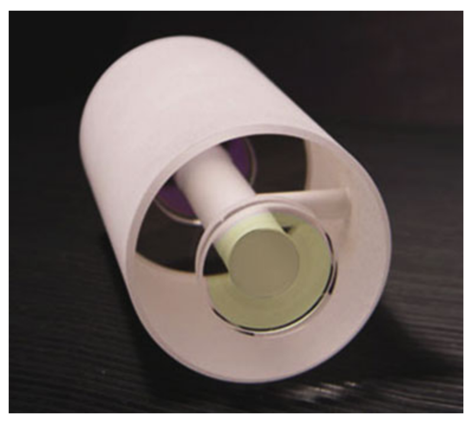
- New technique developped with Laboratoire de Physique des Lasers, Université Paris 13.
- Strontium absorption measured by blue laser set on resonance with the atomic transition (readout).
- Red laser (probe) frequency is scanned. Sub-Doppler structure obtained for atoms at v=0.
- Signal amplitude increased by a factor ~4000 compared to direct saturated absorption spectroscopy on the 7-kHz transition.
- Measurement accuracy for a single shot : 3.1 kHz
- Limited by :
  - → Transit time
  - → Power broadening
  - → Modulation amplitude




## 689-nm laser narrowing

### Pound-Drever-Hall locking

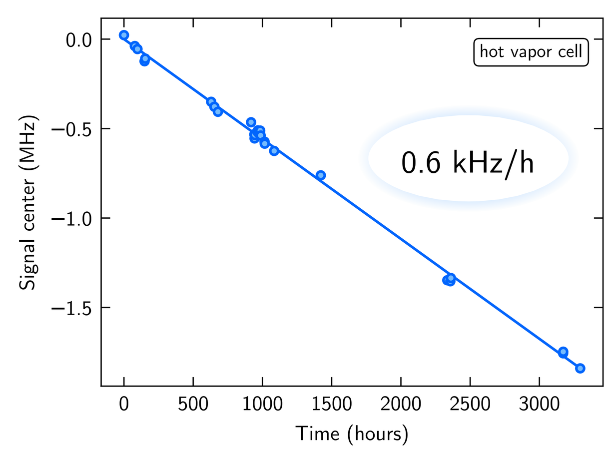


**High finesse Fabry Pérot Cavity**:

- F=20 000
- FSR = 1.5 GHz
- ULE spacer
- Under vacuum
- Acoustic isolation
- Temperature stabilized

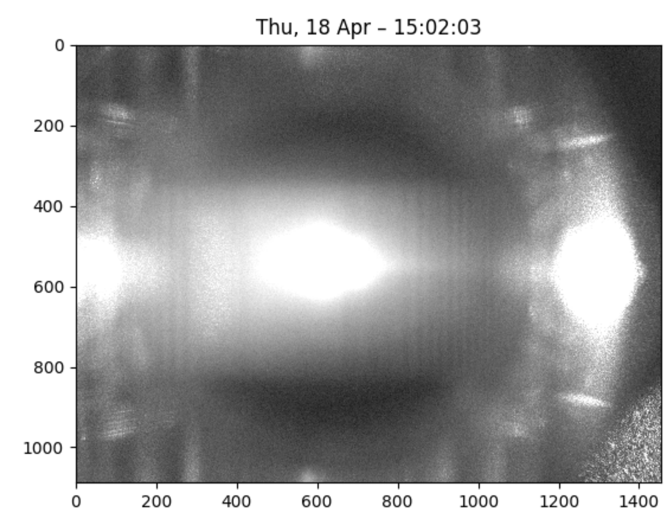
**100 kHz → 400 Hz**

Cavity Drift

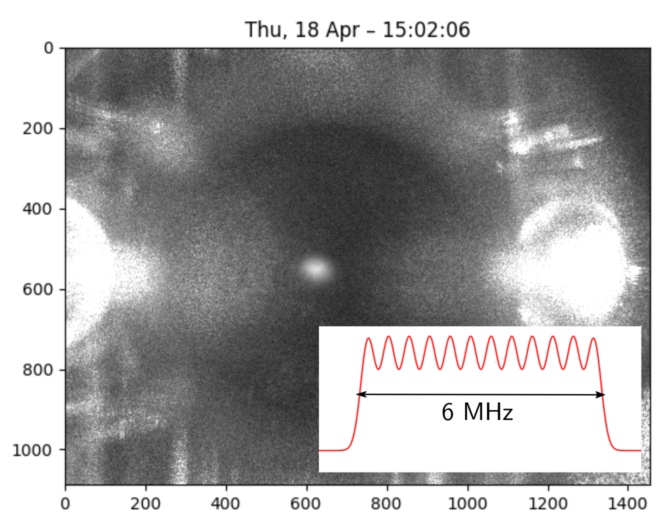



## Cooling sequence

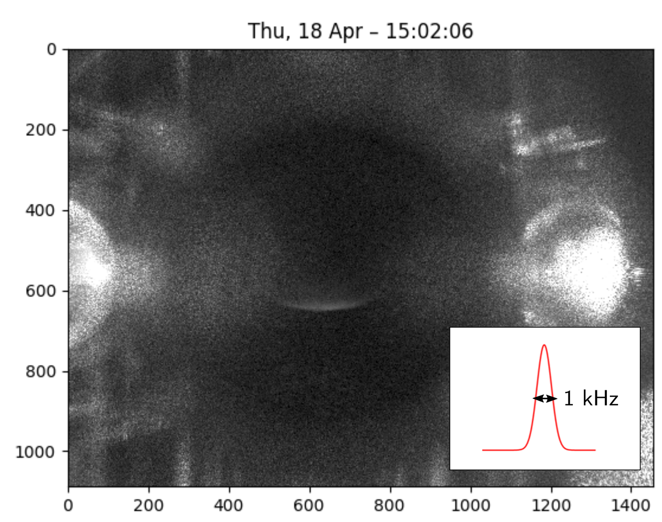
- **Blue MOT**




- **Metastable state loading**
- **Red MOT with broadened laser**




- **Red MOT**




**→ Atoms cooled down to about 30 μK**

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