

Équipe: *Électrodynamique quantique en cavité:*  
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### Aim of the experiment

Study of non-local quantized radiation field, using atoms as probes

### Requirements

**Cavity:**

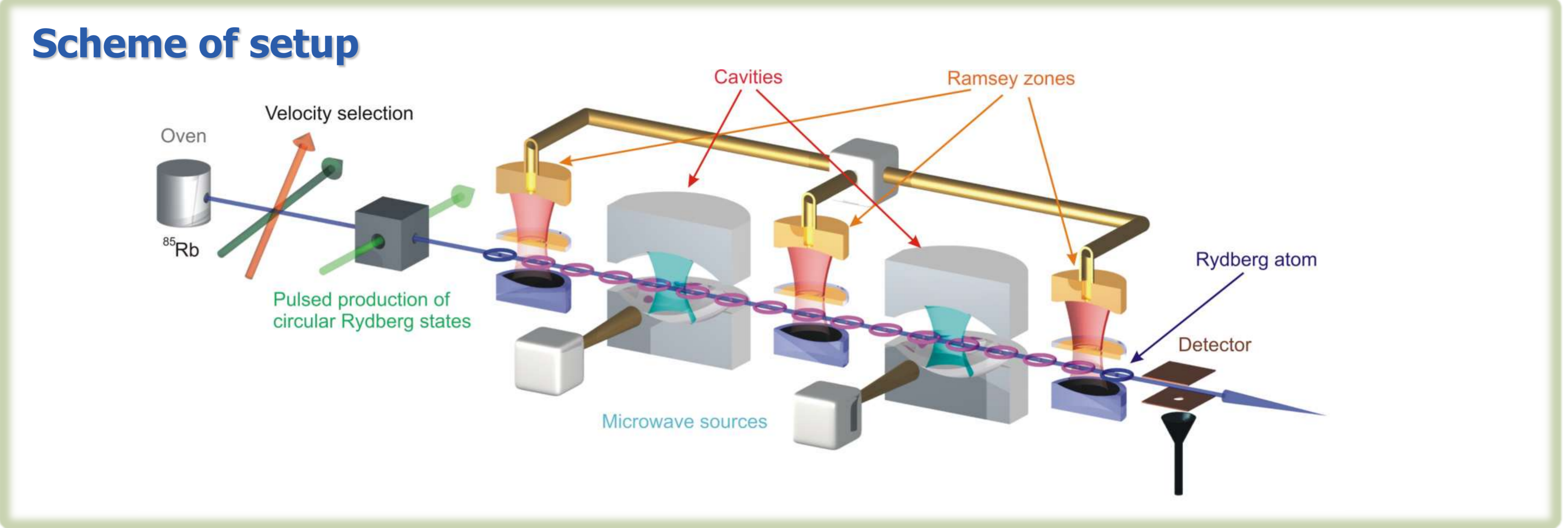
- a single mode of radiation field
- long lifetime for the mode

**Atom:**

- long lifetime
- large coupling to radiation field
- controllable interaction time
- efficient detection

**Detector:**

- ability to resolve different Rydberg levels



### High-finesse cavity

**Copper substrates**  
 Diamond machining  
 ~shape accuracy 300 nm  
 ~rugosity 10 nm  
 Toroidal surface → single mode

**12 μm Niobium layer**  
 Cathode plasma sputtering  
 CEA, Saclay

**Microwave injected from a side**  
 A "box" for microwave photons

- **Measured mode lifetime: 130 ms**  
 Corresponding to a width of 1,2 Hz
- **Measured width: 3,4 Hz**  
 Limited by mechanical vibrations

S. Kuhr et al., Appl. Phys. Lett. **90**, 164101 (2007)

### Circular Rydberg atoms

- ◆ Mesoscopic orbit size  
 0.25 μm in diameter
- ◆ Long lifetime (30 ms)
- ◆ Large coupling to radiation field
- ◆ Tunable via the Stark effect
- ◆ Efficient (> 80%) state sensitive detection

### Preparation of circular Rydberg atoms

**Detection**

### Experimental assembly

10 cm

### <sup>3</sup>He refrigerator

### Velocity selection

- Laser 1, perpendicular to the atomic beam
- Laser 2, non-perpendicular to the atomic beam, pulsed by AOM
- Velocity selected due to the **Doppler effect**, also by **time of flight** between velocity selection region and Rydberg state excitation

### Ramsey zones

**Double cavity**

- "good" cavity (Q = 2000) → filter the TEM<sub>00</sub> mode
- glass with thin gold layer
- "bad" cavity (Q = 40) → avoid spont. emission
- microwave absorber

**Ramsey fringes**