QuickTime™ et un décompresseur sont requis pour visionner cette image.

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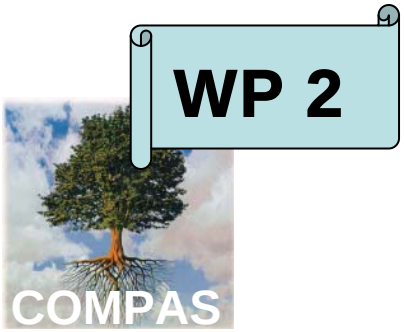


Mapping quantum states of light into and out of atomic ensembles

PIs : A. Bramati, J. Laurat, E. Giacobino

Grad Students : S. Burks, M. Scherman, L. Giner

Post Doc : O. Mishina

Quantum Optics
Laboratoire Kastler Brossel
UPMC, CNRS and ENS

COMPAS meeting
Brussels, november 30th 2009

Outline

- EIT-based *Quantum memory for coherent single sideband modulation*

PRL 101, 133601 (2008) PHYSICAL REVIEW LETTERS 26 SEPTEMBER 2008

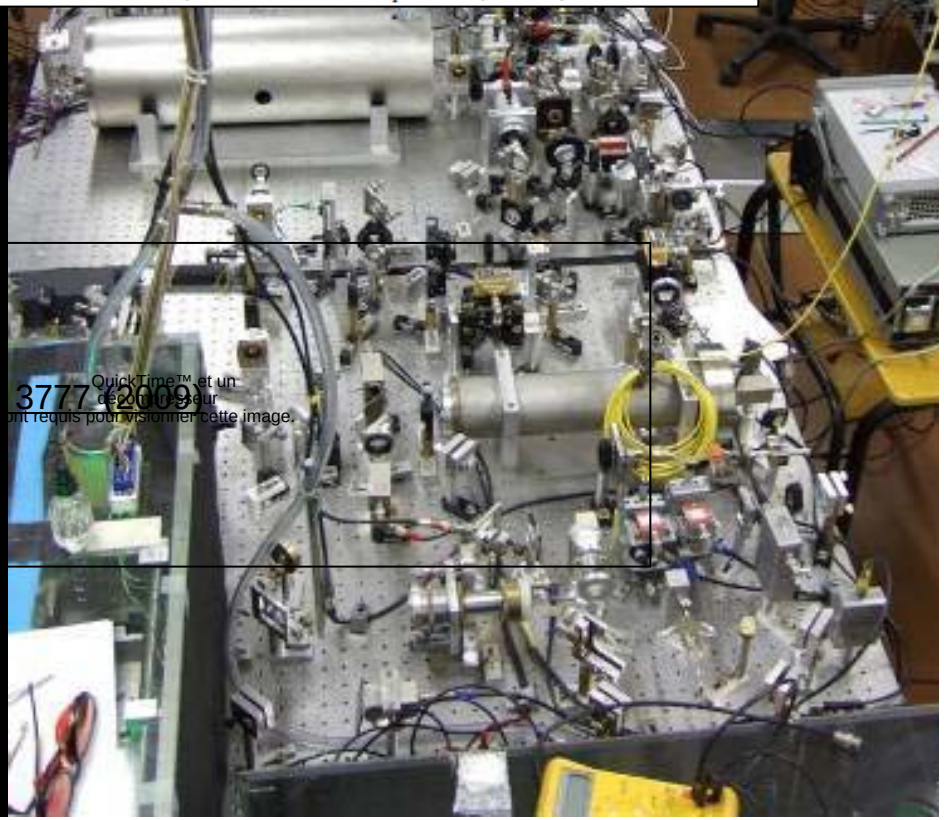
Reversible Quantum Interface for Tunable Single-Sideband Modulation

J. Cviklinski, J. Ortalo, J. Laurat, A. Bramati, M. Pinard, and E. Giacobino

Laboratoire Kastler Brossel, Université Pierre et Marie Curie, Ecole Normale Supérieure, CNRS,

- EIT and multilevel structure
- *Squeezed light at 852 nm*

Optics Express 17, 3777 (2009)

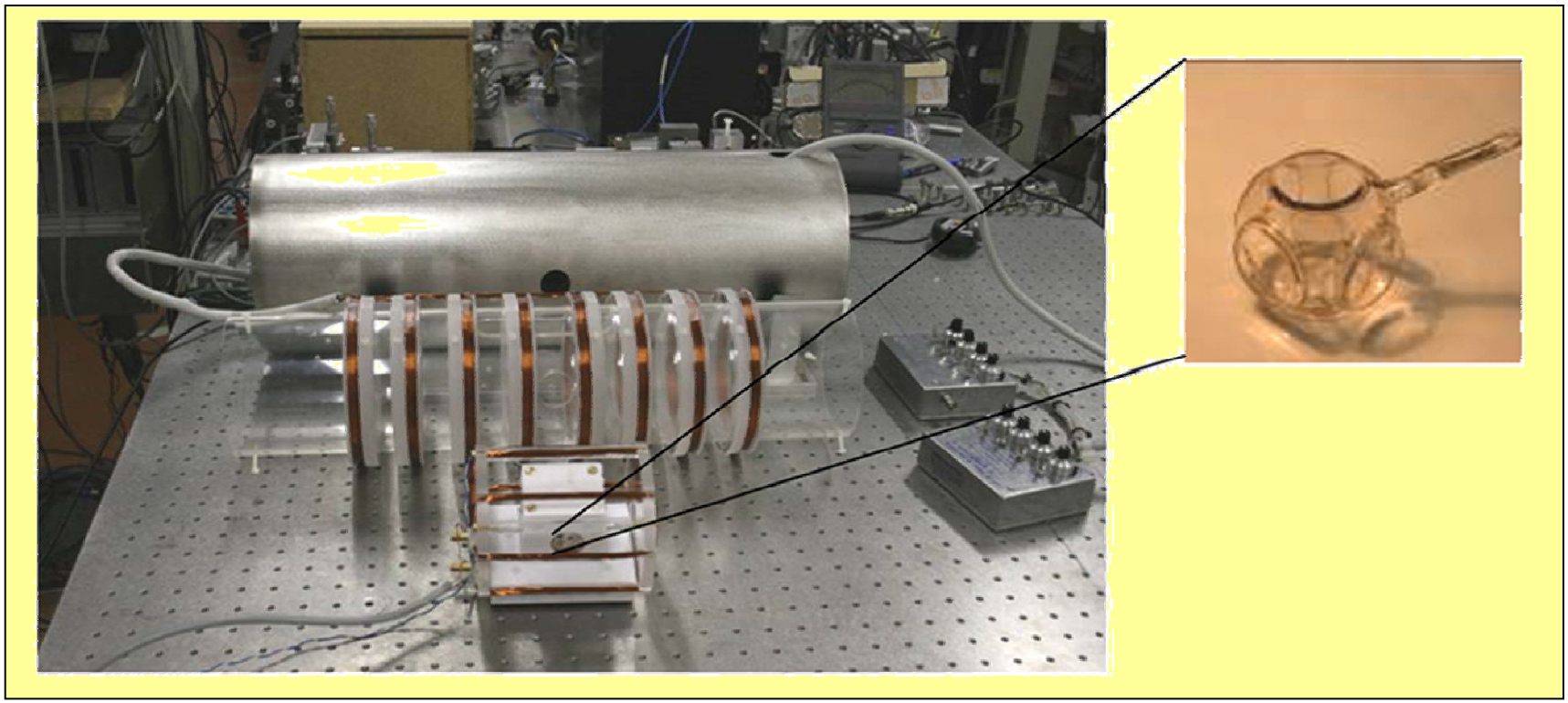


- *Mapping photonic entanglement*

Quantum Memory with Cs vapors

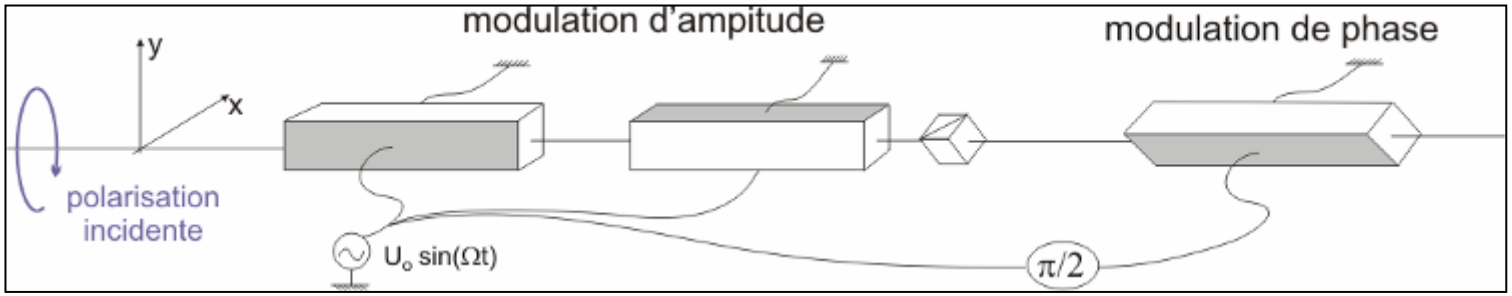
Cs vapor, D2 line at 852nm

- Paraffin coated cell, room T
- Magnetic shield with a set of coils (~1 to 3 Gauss at 10^{-3})
- T2 ~ 200 s (measured by RMO)

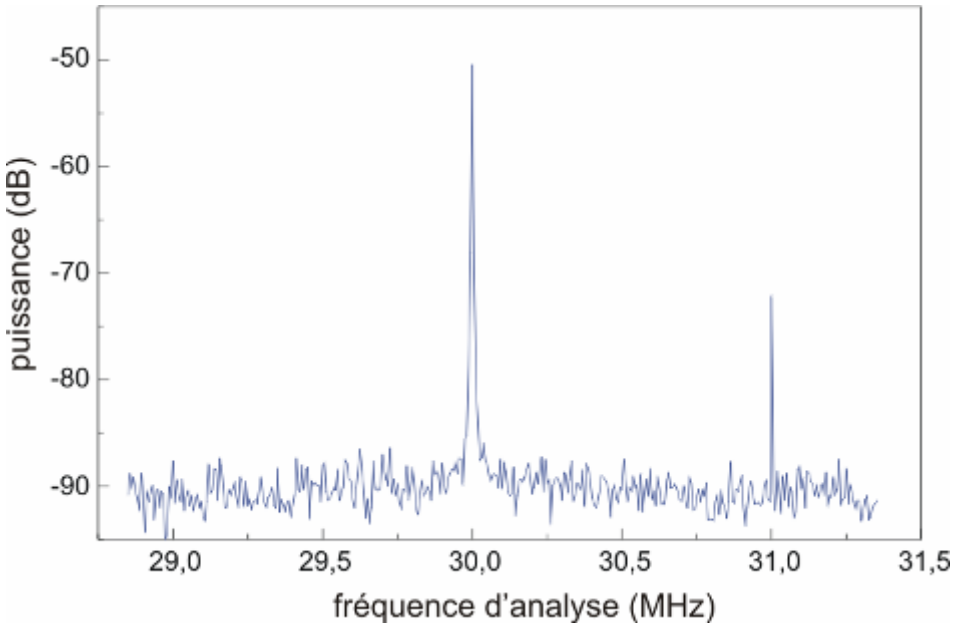


« Signal » = Single Sideband Modulation

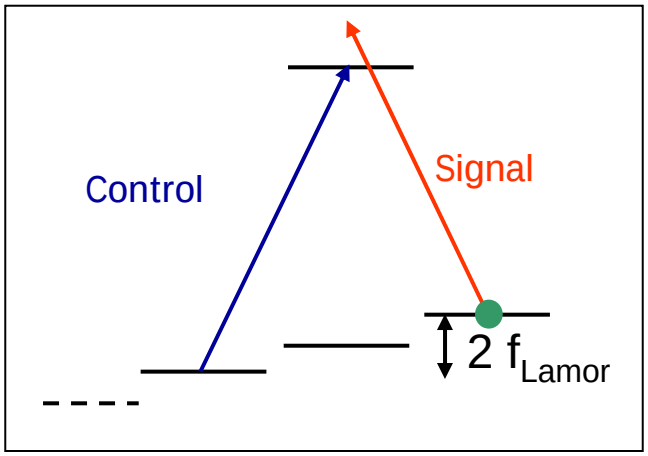
EO modulators



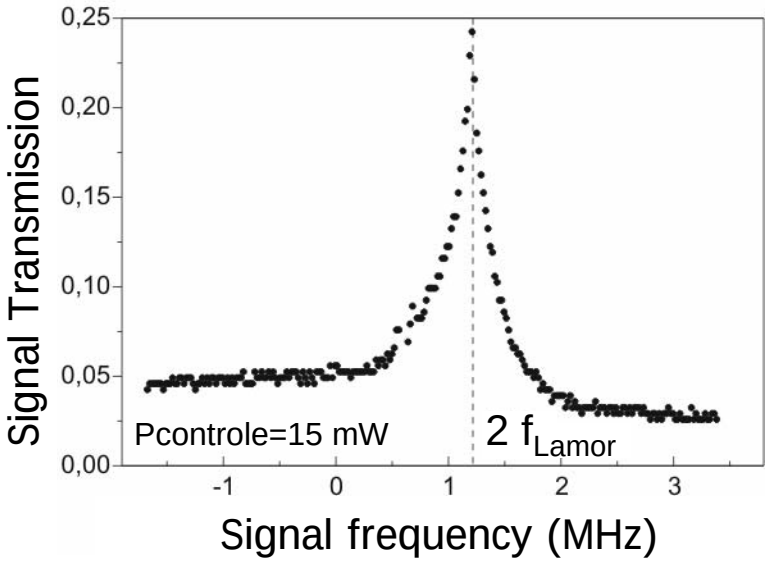
- Easy to use : Single sideband or double
- Carrier of orthogonal polarization , which provides a phase reference

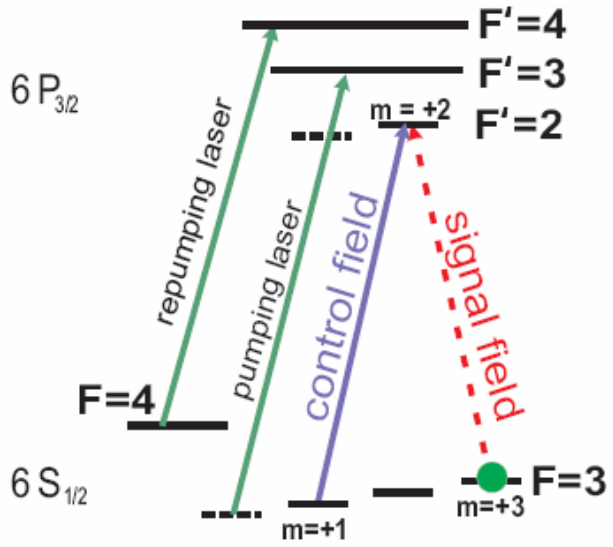


EIT Window : Position and Width

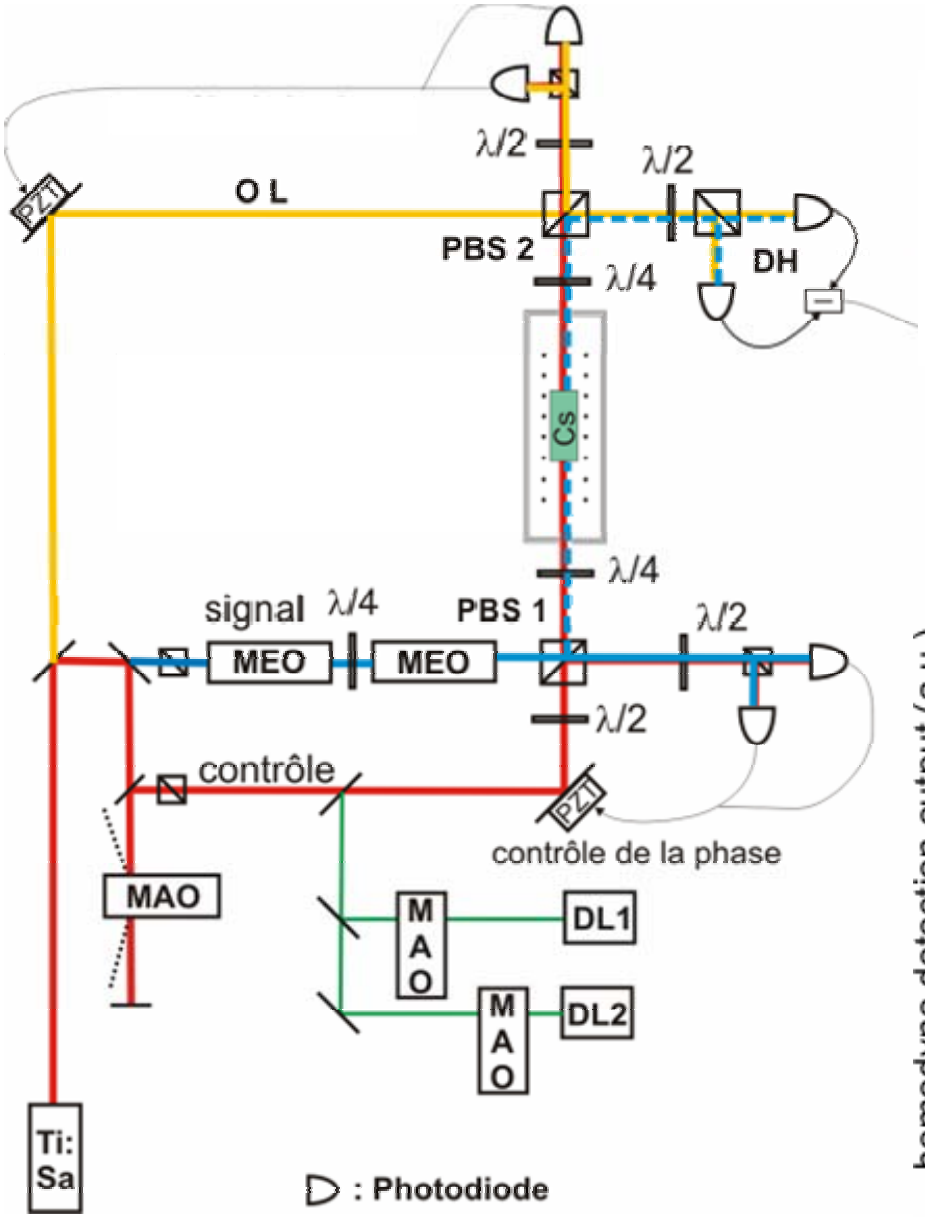


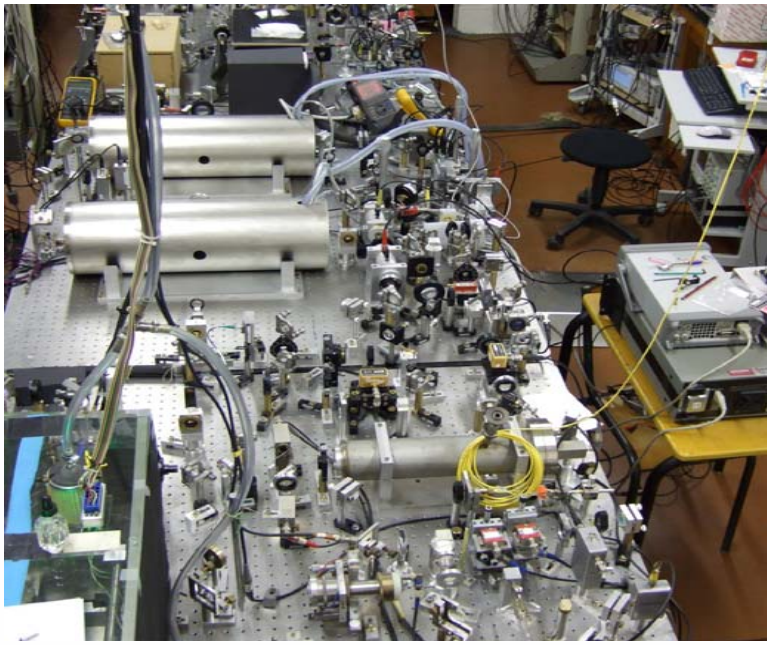
- Width given by control power
- EIT window position can be adjusted

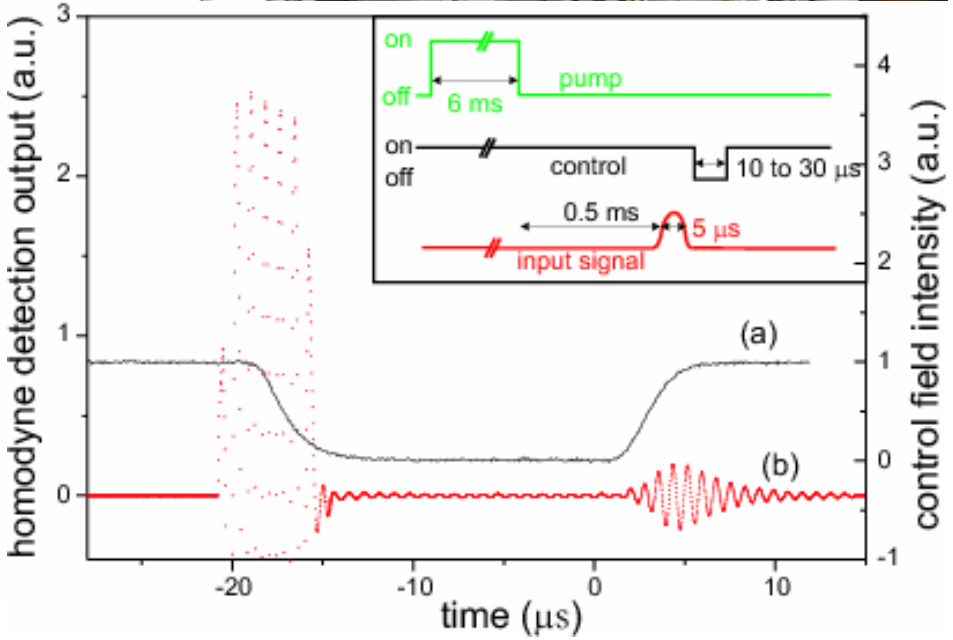




Experimental Setup

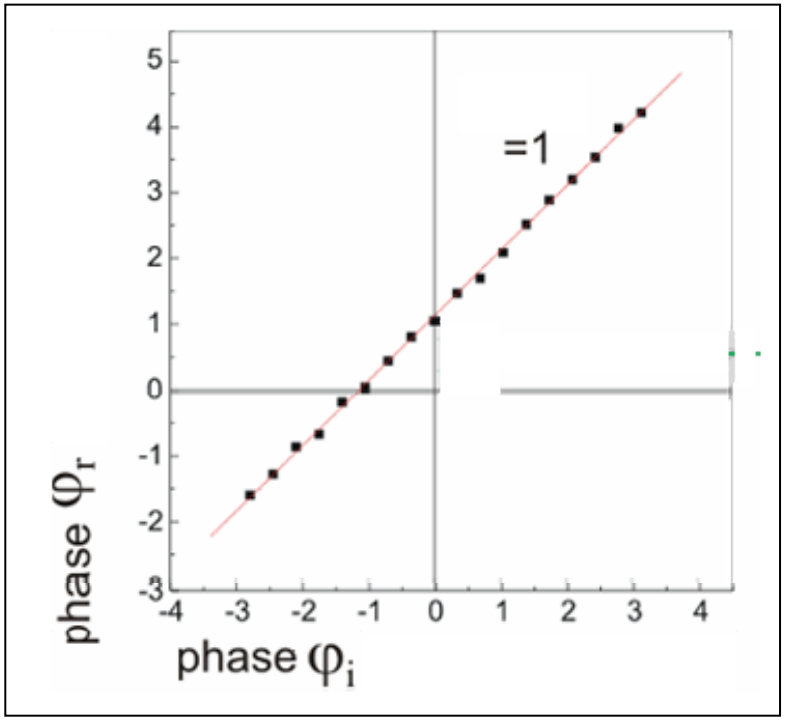






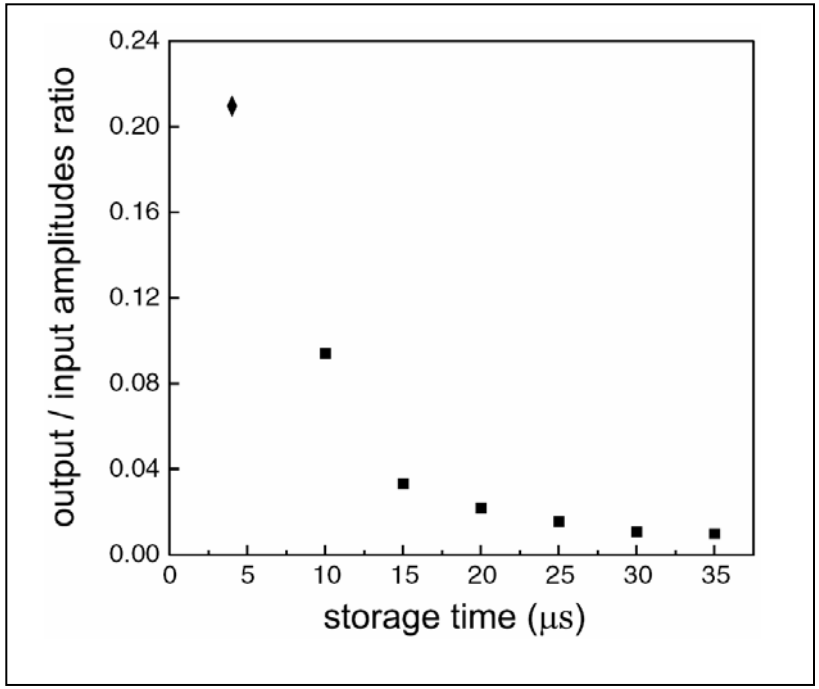
Experimental Results

Phase coherence



• Input phase retrieved
•Phase shift accumulated during storage due to non-perfect two-photon resonance

Retrieval efficiency

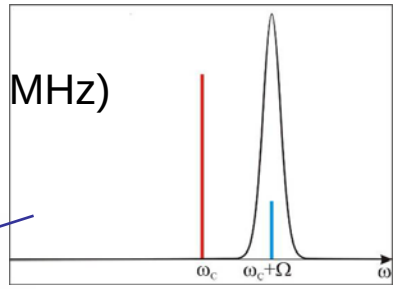


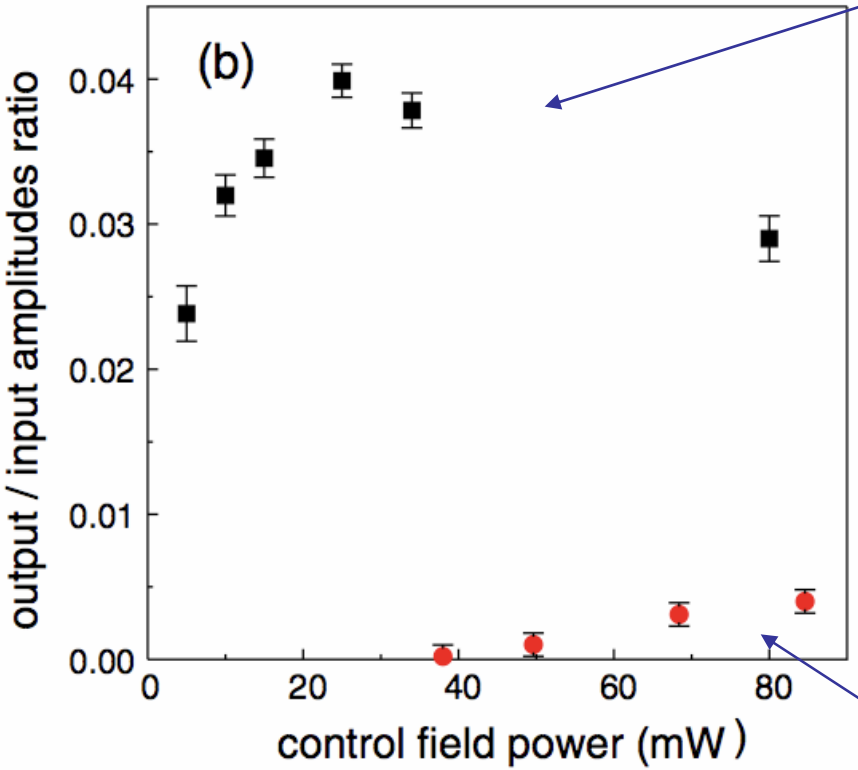
• 20 % for short time

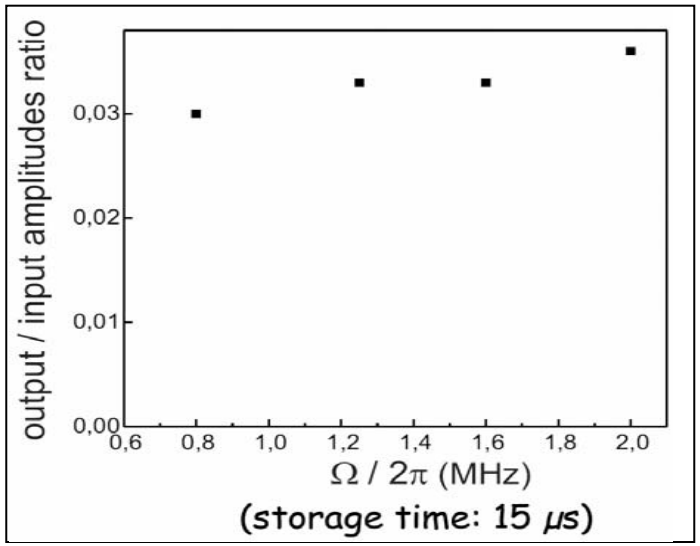
J. Cviklinski et al., "Reversible quantum interface for tunable single sideband modulation", Phys. Rev. Lett. **101**, 133601 (2008)

Single Sideband vs Double

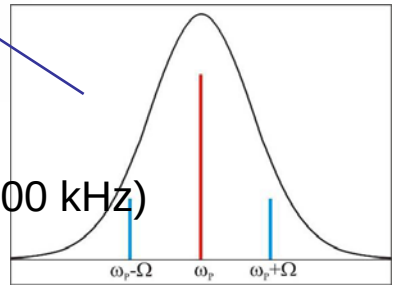
Single SideBand (Ω = 1,25 MHz)





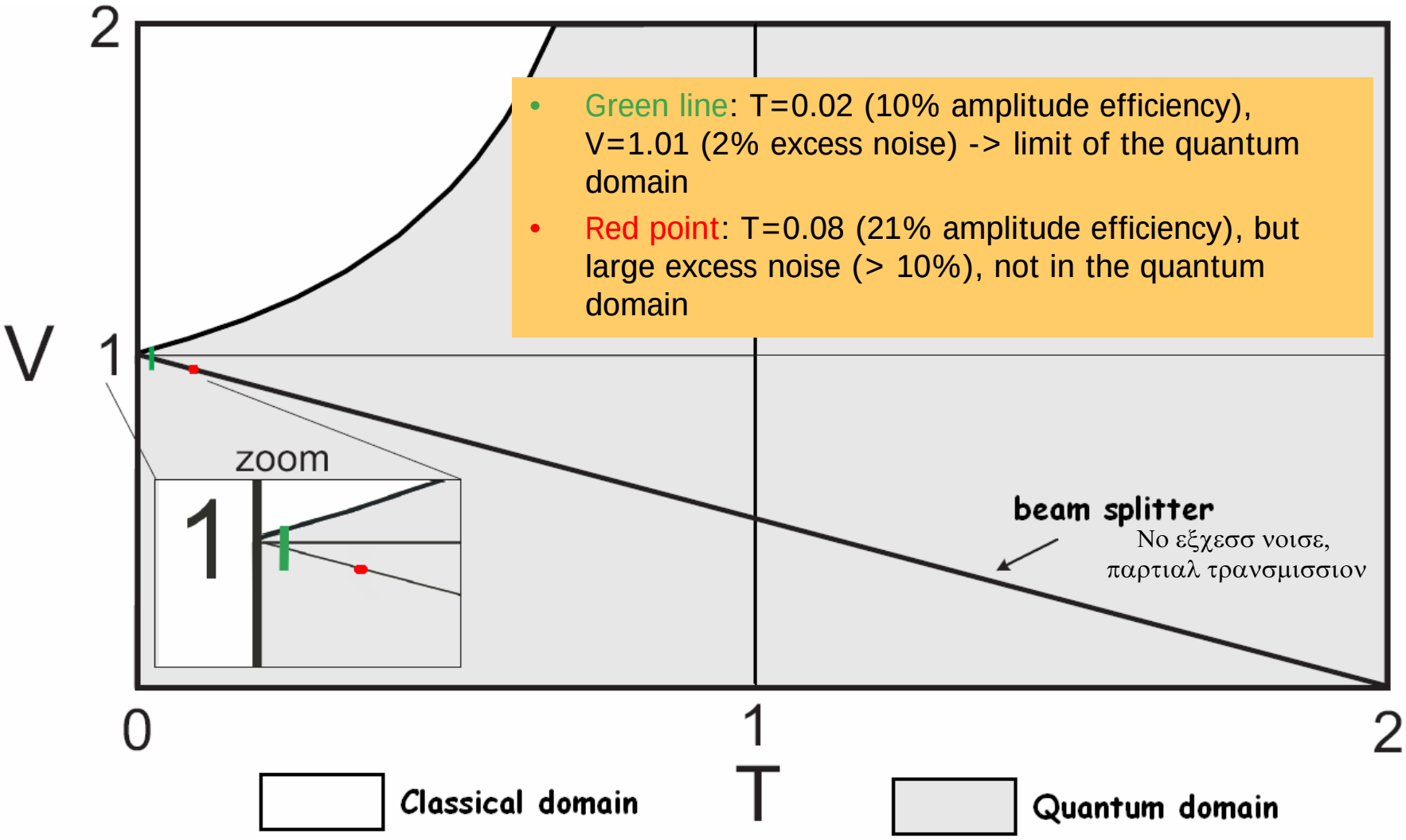


Double SideBand (Ω = 400 kHz)



- **EIT window position matched to the frequency of the signal**

A quantum memory



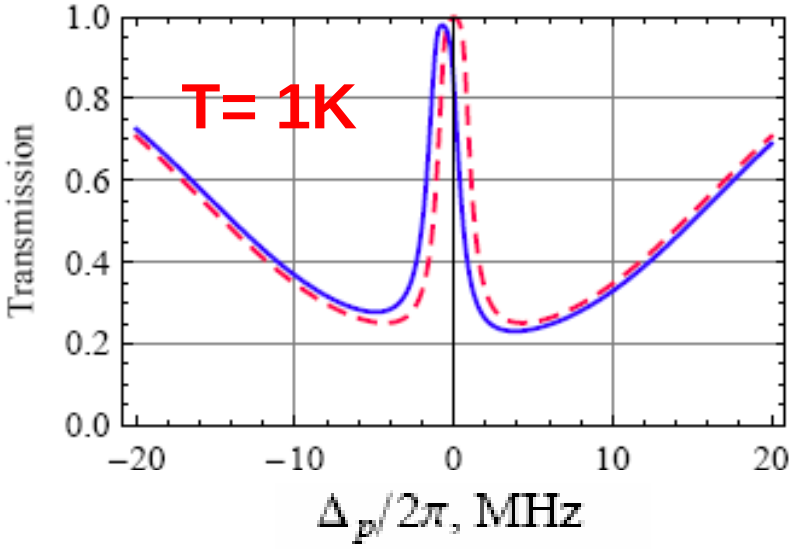
- Green line: T=0.02 (10% amplitude efficiency), V=1.01 (2% excess noise) -> limit of the quantum domain
- Red point: T=0.08 (21% amplitude efficiency), but large excess noise (> 10%), not in the quantum domain

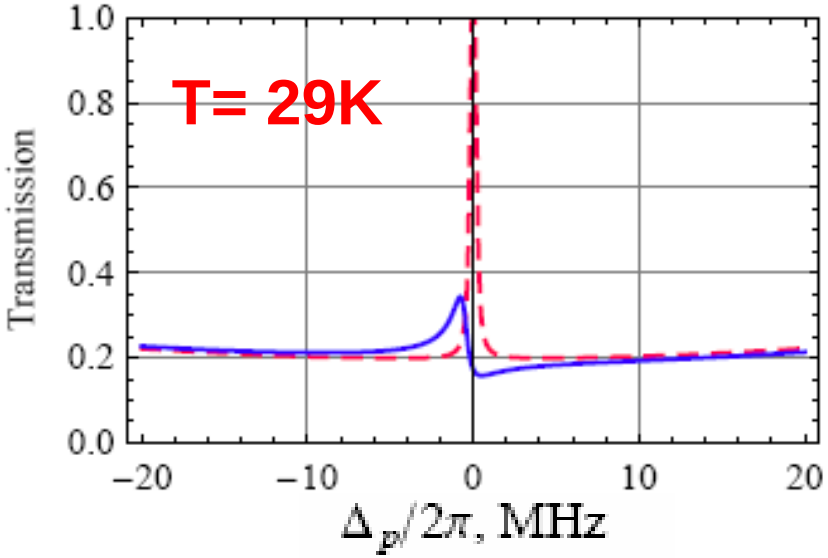
J. Cviklinski et al., “Reversible quantum interface for tunable single sideband modulation”, Phys. Rev. Lett. **101**, 133601 (2008)

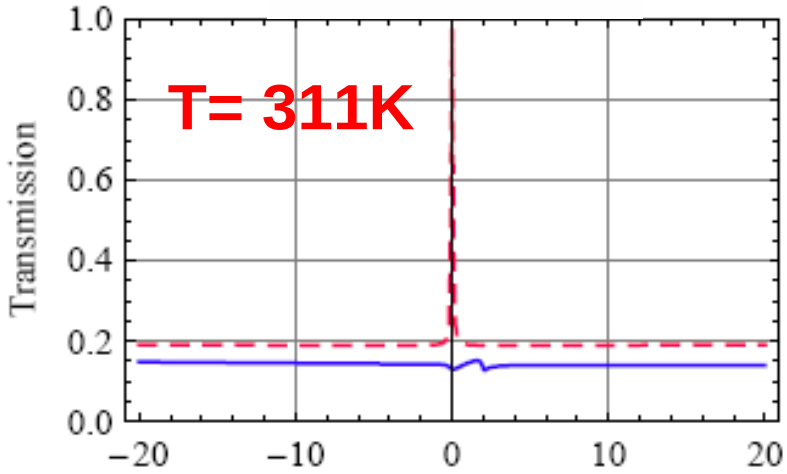
EIT and multilevel structure in Cs D_2 line

Red : 3 level
Blue : 6 levels

No effect for cold atoms







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décompresseur
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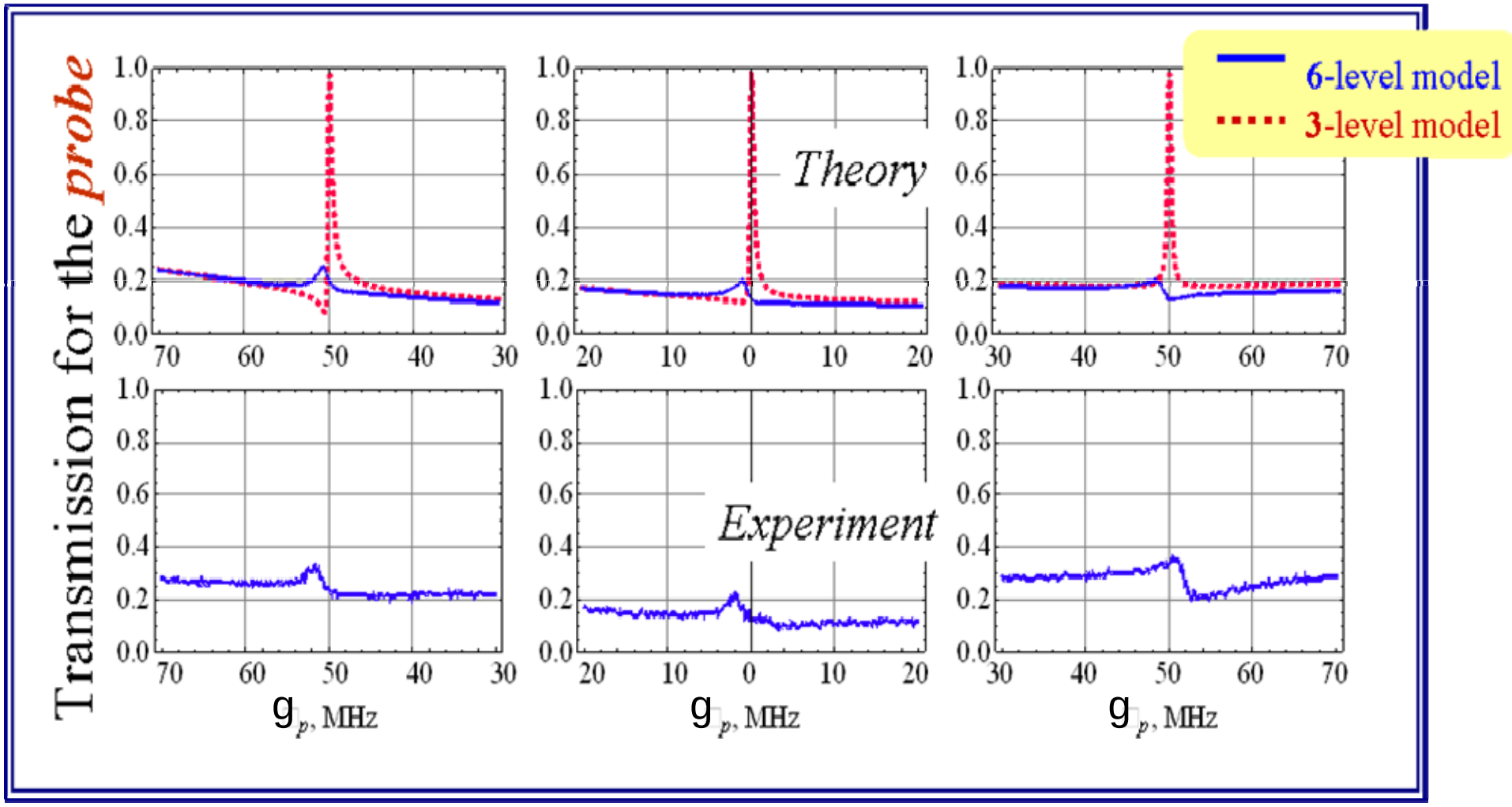
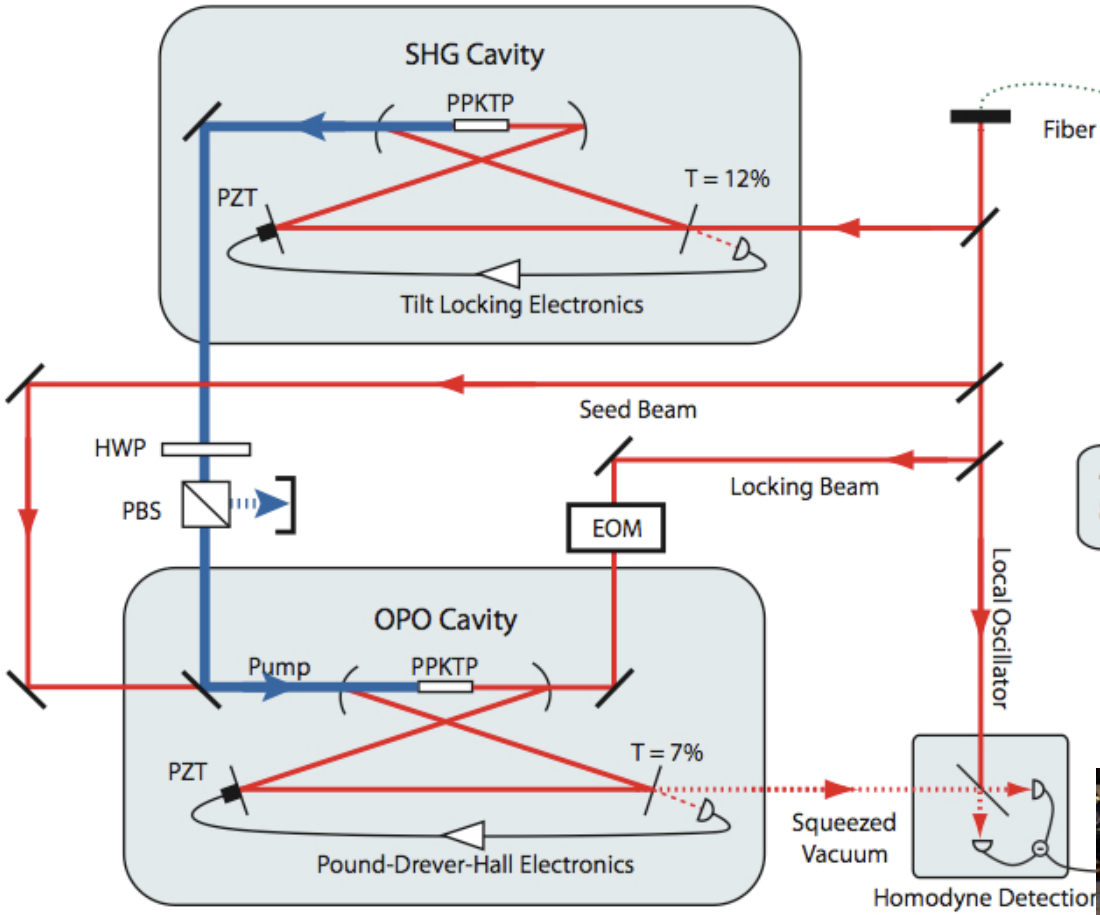
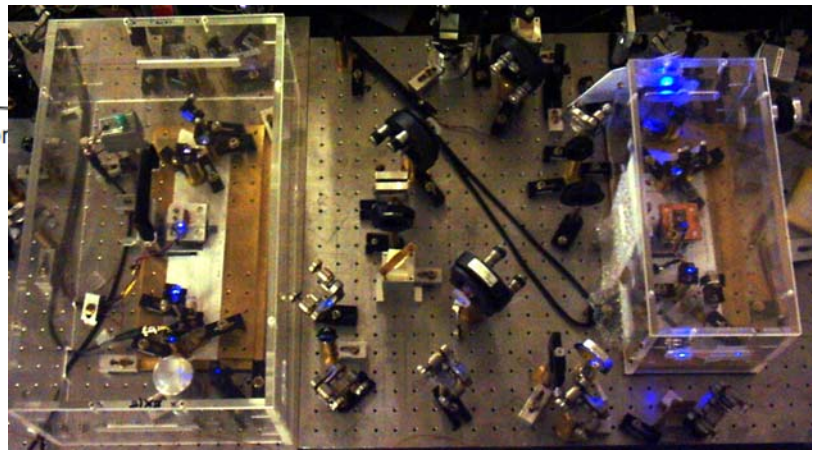
EIT: experiment / theory in vapor

Need to include a partial effective cooling: velocity-selective optical pumping

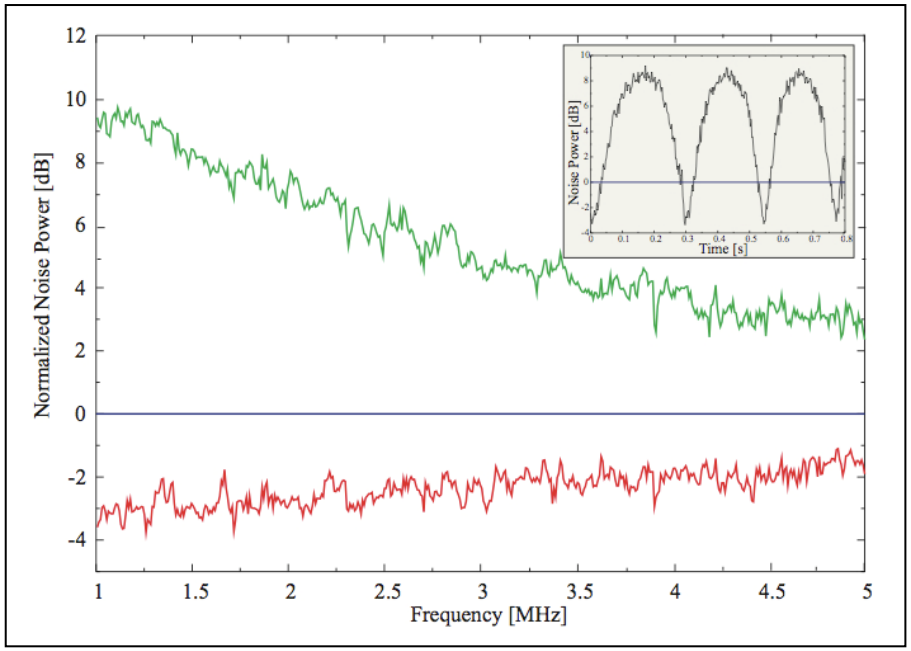


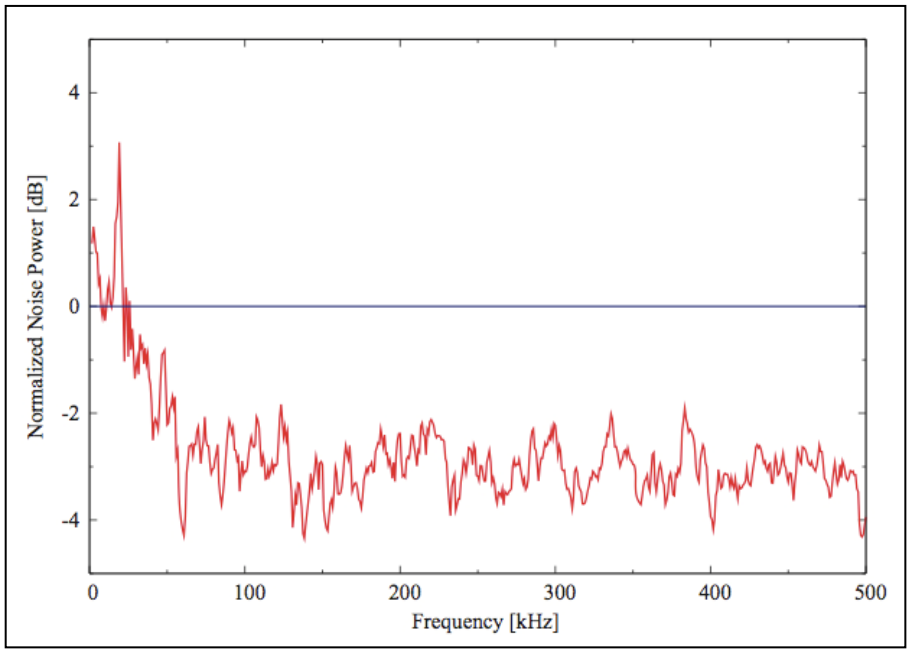
Squeezing at 852 nm (Cs D_2 line)





Squeezing Results



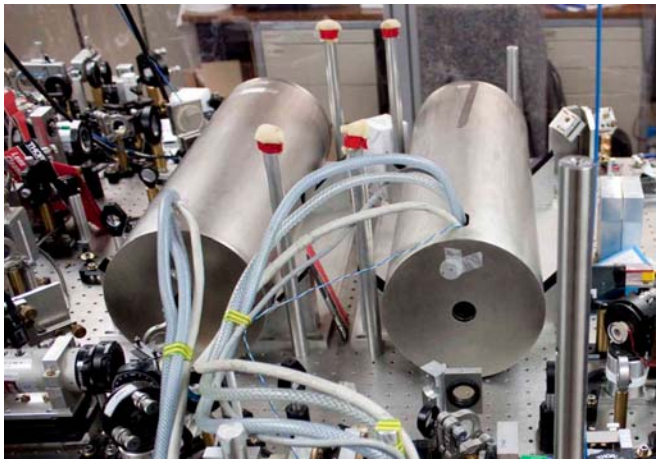


- **3dB down to 50 kHz**
- **In progress : storage of squeezed state in Cs vapor**

S. Burks et al., “Squeezed light at the D2 cesium line for atomic memories”, Opt. Express **17**, 3777 (2008)

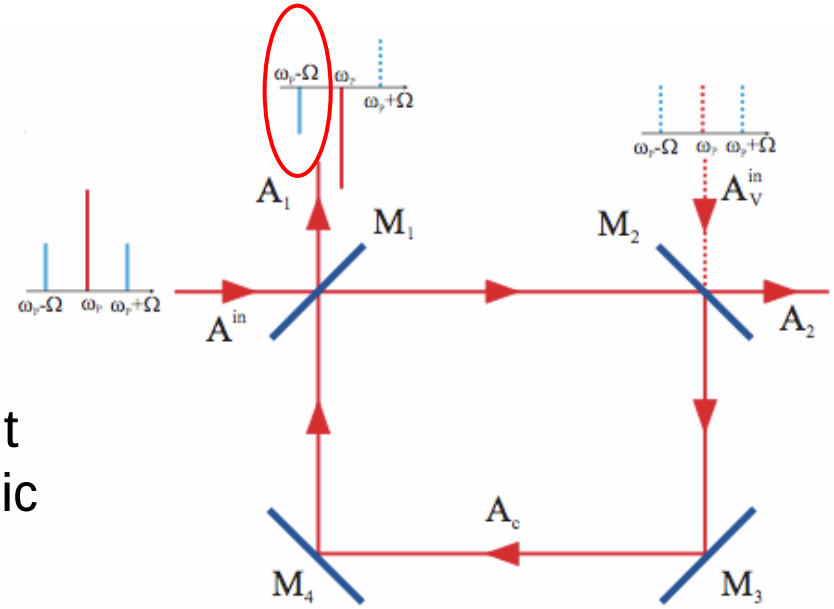
Mapping Bipartite Entanglement Into and Out

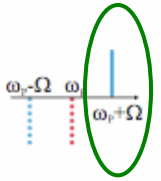
Idea

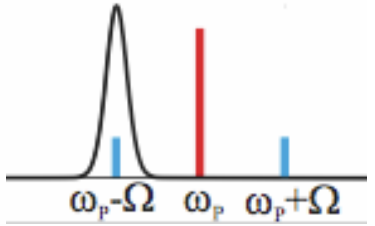


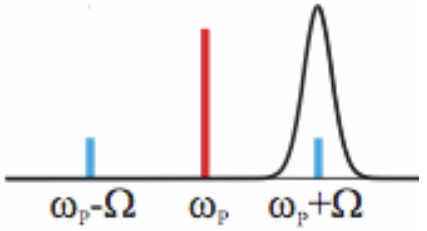
How to generate CV entanglement ?

Squeezed light





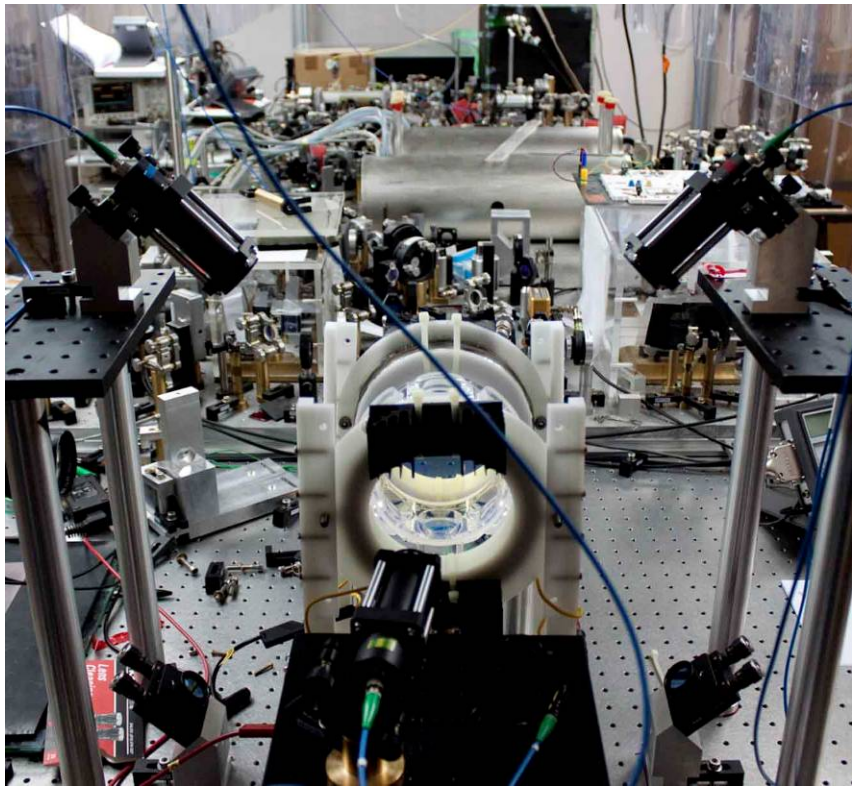


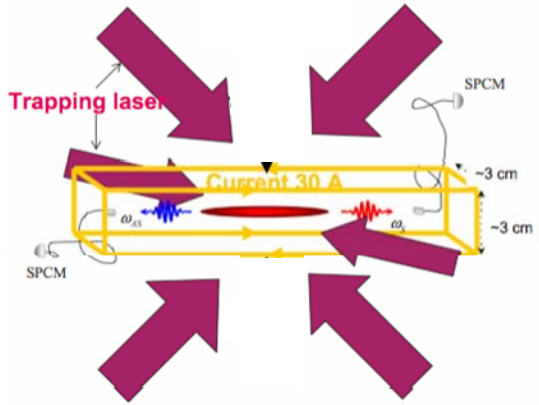


= entanglement between symetric sidebands

Cavity

New Cold Atom Setup

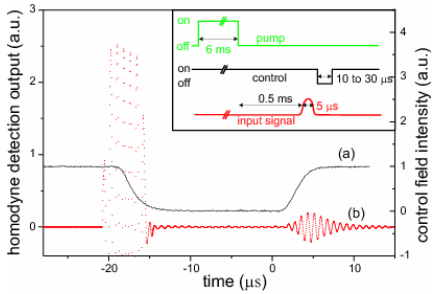




- 10^9 atoms
- Glass chamber to decrease residual magnetic fields
- Quasi-2D MOT for large OD

Summary

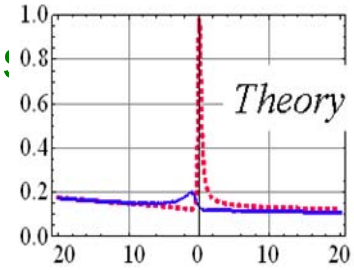
- EIT-based *Quantum memory for coherent single sideband modulation*



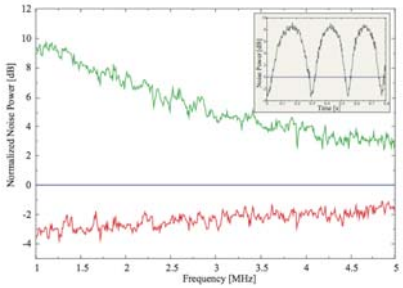
Phys. Rev. Lett. 101, 133601 (2008)

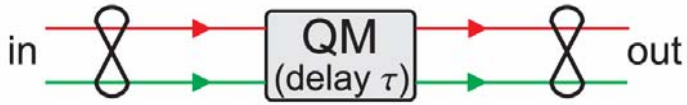
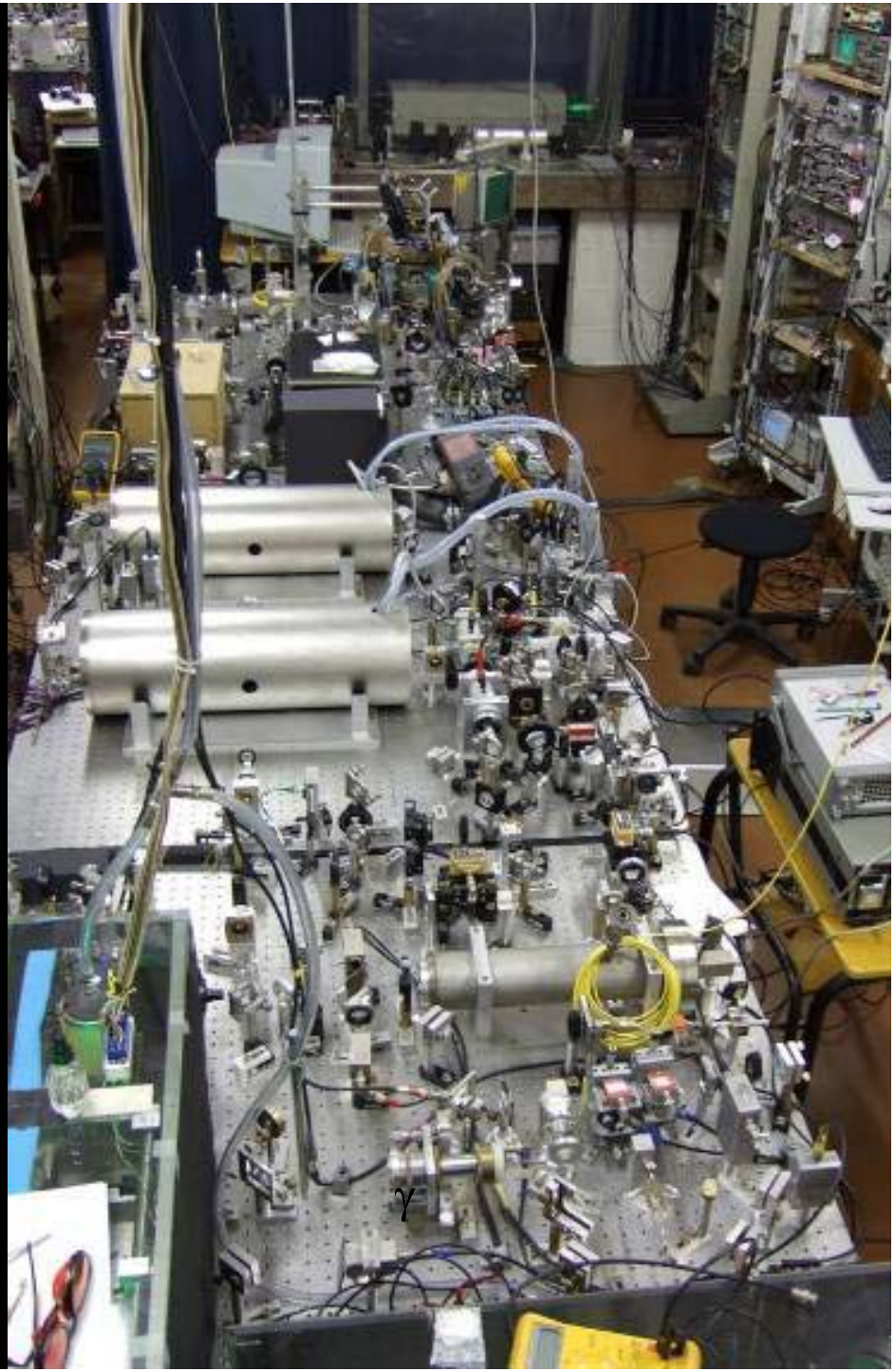
Journal of Physics B, 42, 114010 (2009)

- EIT and multilevel s



- *Squeezed light at 852 nm*



Optics Express 17, 3777 (2009)

- *Mapping photonic entanglement*