

HOLOGRAPHIC, MULTIMODE MEMORY IN RUBIDIUM VAPOURS

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INTRODUCTION

APPLICATIONS:

- Robust quantum memory for photons, resistant to loss of single atoms, working in a temperature >300 K!
 - Narrowband, single photons on demand.
 - Narrowband, squeezed light.
- Attractive process for various quantum protocols!

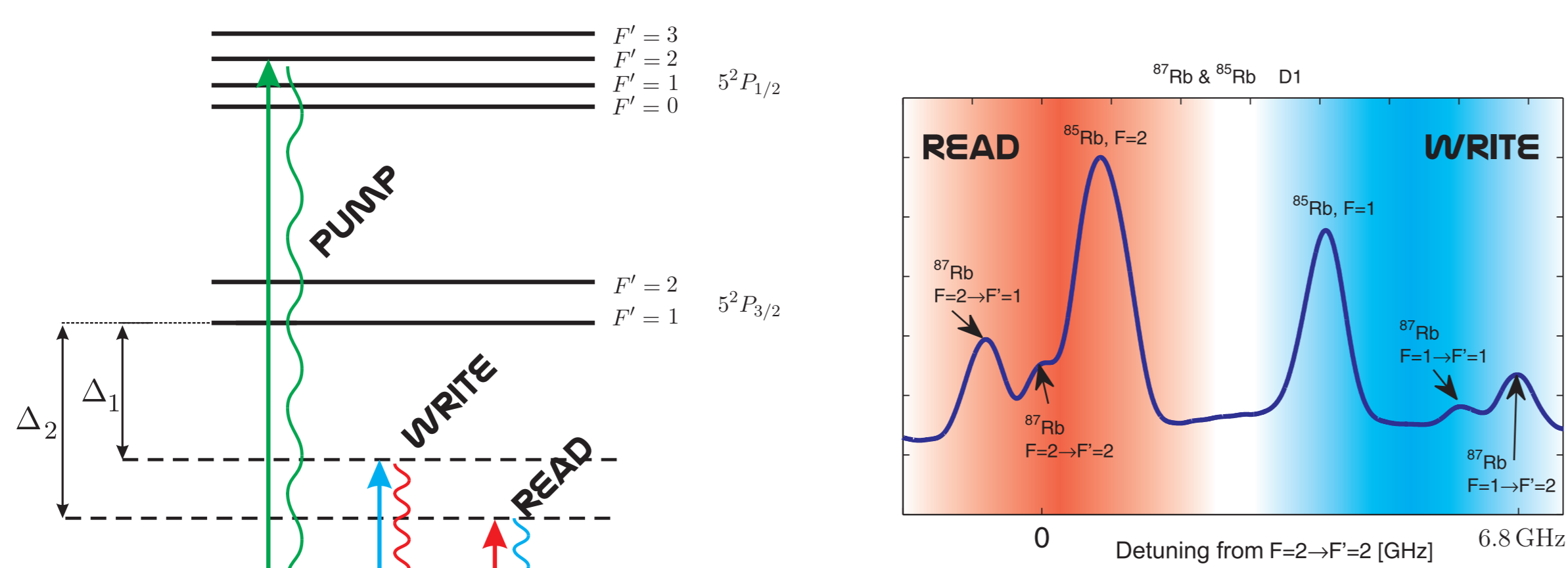
OBJECTIVE:

- Efficient write process: generation of the Stokes, Raman scattered light.
- Excitations - photons back conversion - storing and readout

CONDITIONS:

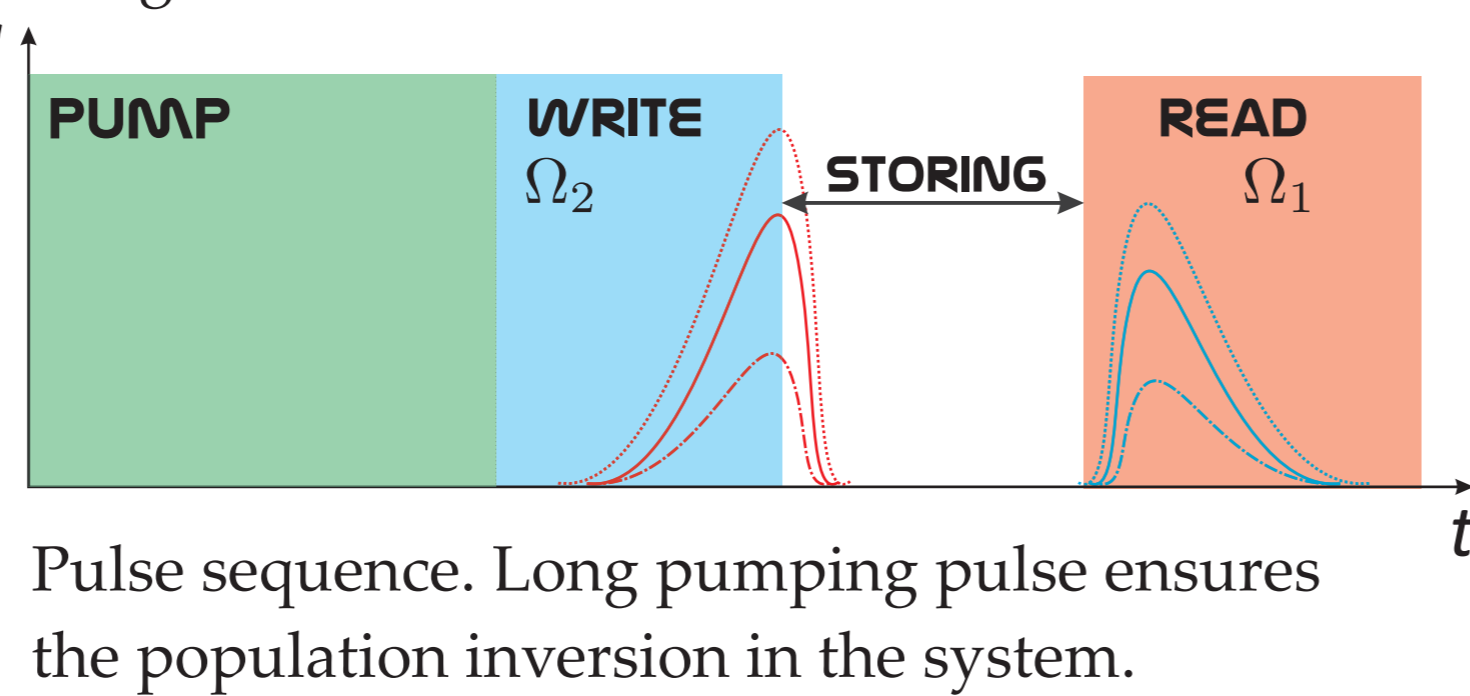
- Minimization of the decoherence.
- Optimization of the setup parameters.

LASERS & RUBIDIUM



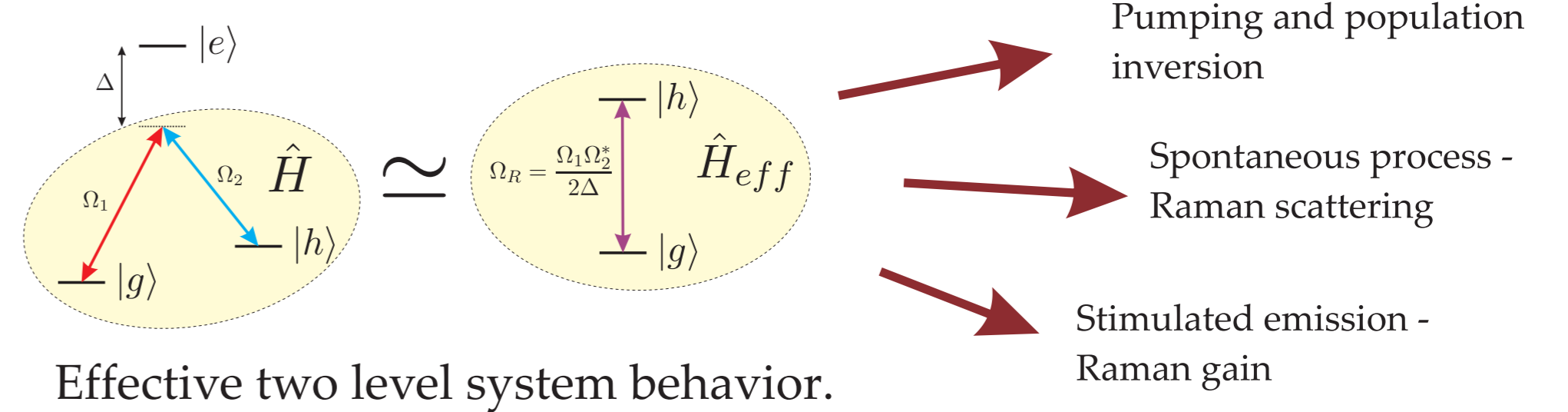
Lasers frequencies referred to the Rubidium absorption spectrum.

⁸⁷Rb energy levels and the photon energies. The pump -- resonant. Write & read -- off-resonant.

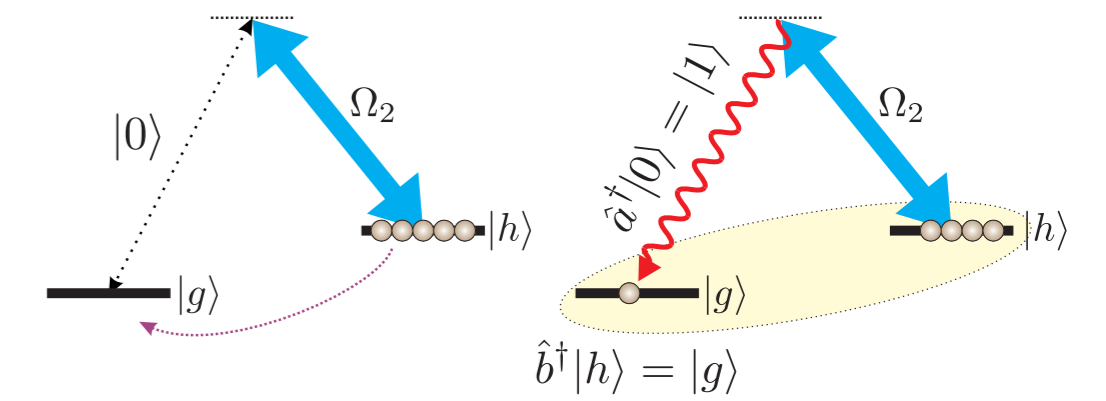


Pulse sequence. Long pumping pulse ensures the population inversion in the system.

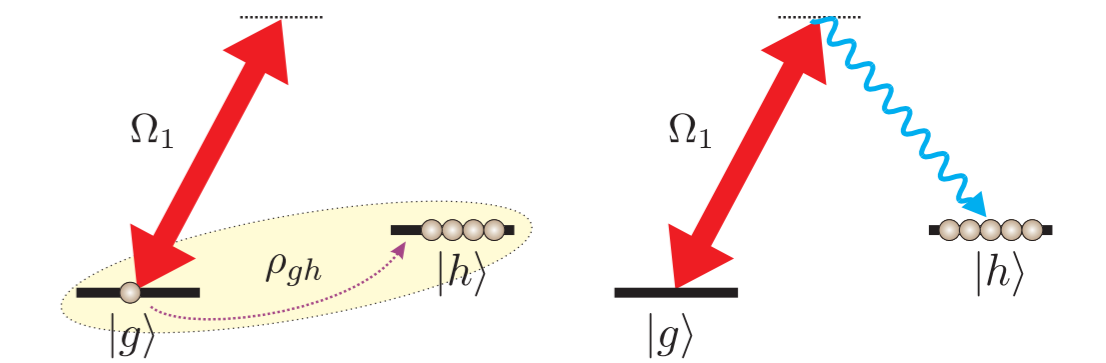
UNDERSTANDING OF THE RAMAN PROCESSES



WRITE
 Stokes scattering

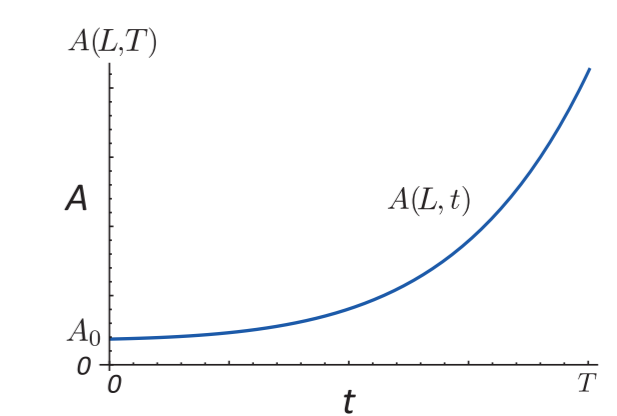


READ
 anti-Stokes scattering

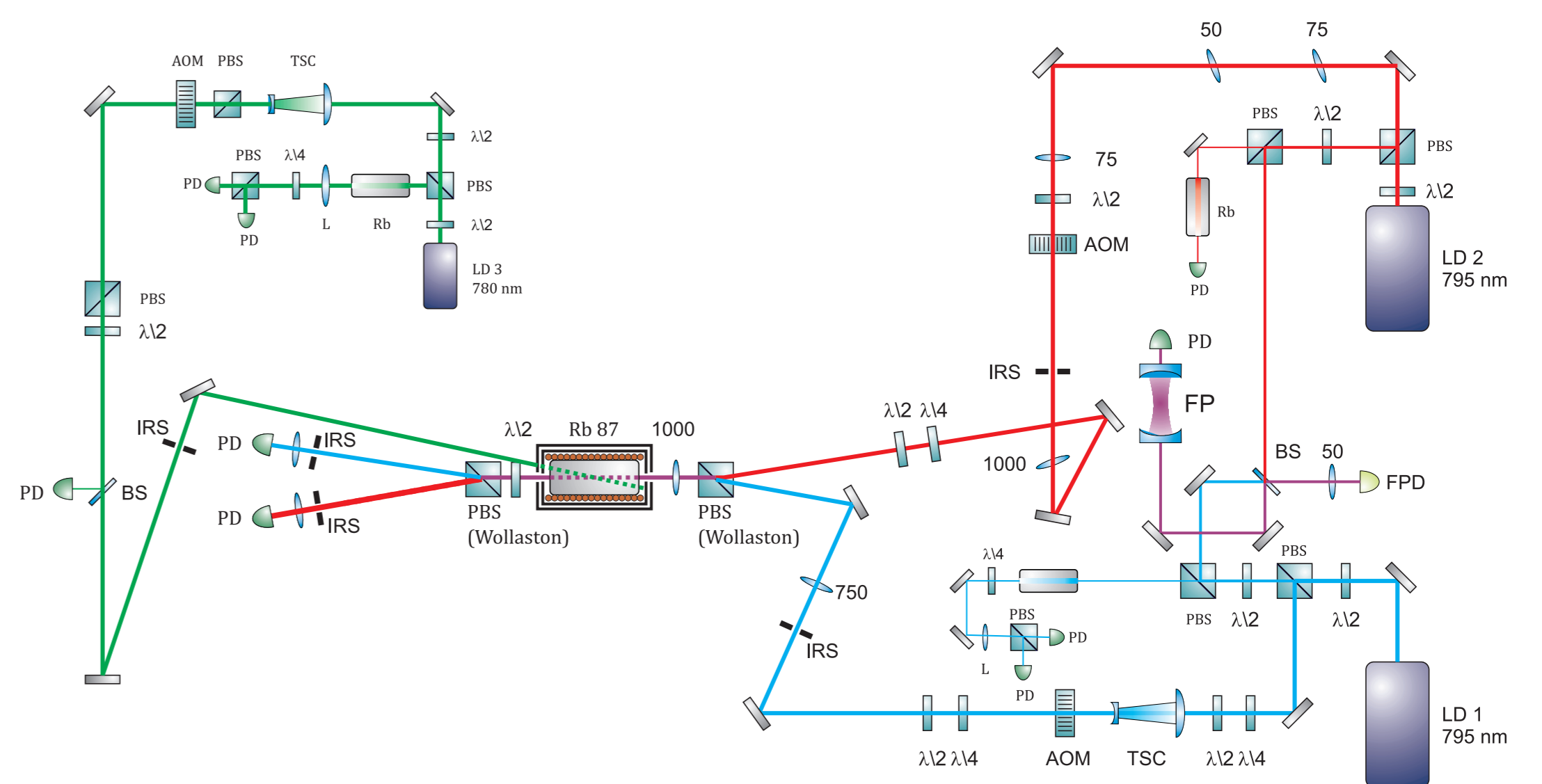


$$\frac{\partial \hat{b}^\dagger(z, t)}{\partial t} = g \hat{a}^\dagger(z, t)$$

$$\frac{\partial \hat{a}(z, t)}{\partial z} = g \hat{b}(z, t)$$

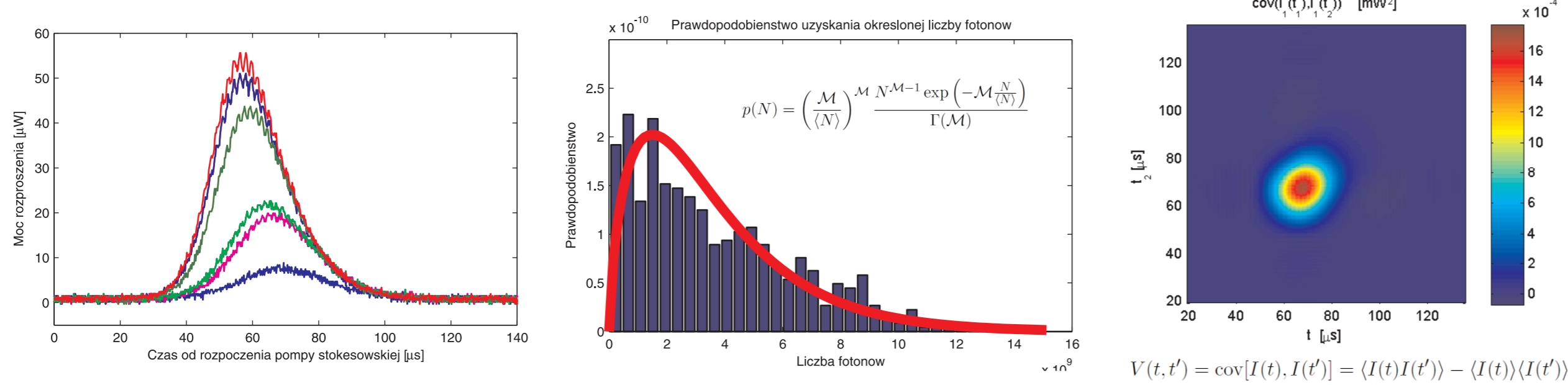


EXPERIMENTAL SETUP



2 LASERS @795 NM, 1 LASER @780NM
 DOUBLE SHIELDED CELL WITH RUBIDIUM 87

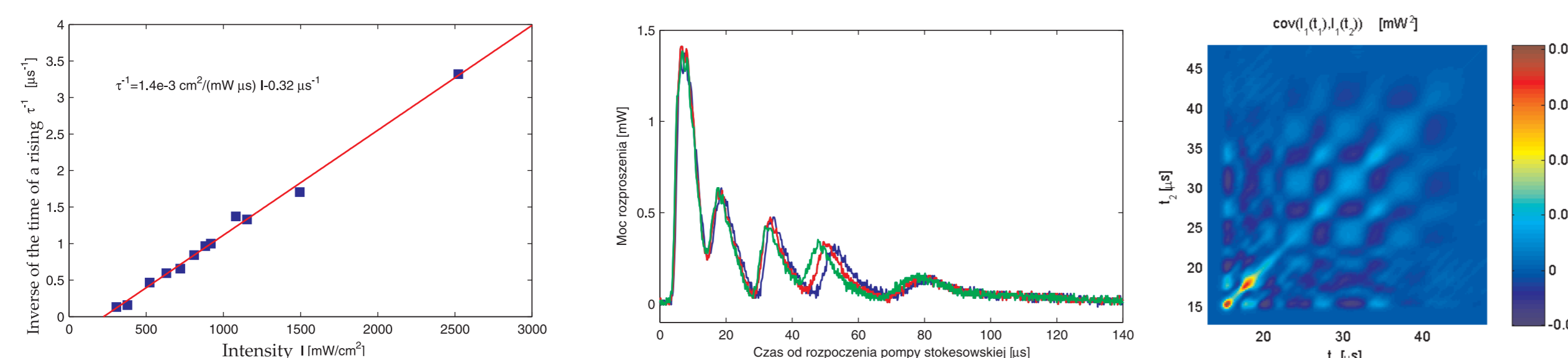
RESULTS: GENERATION OF THE STOKES LIGHT



Process optimized in terms of: frequency, wavelength, pumping, temperature, beam properties.

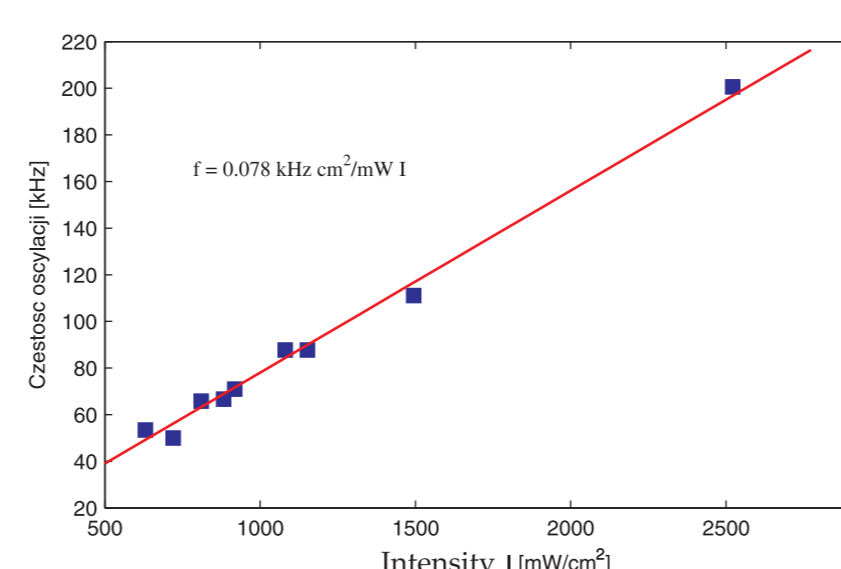
Unsaturated regime - ~1 mode - thermal photon statistics
 Up to 2mW out of 12 mW in the single pass emission!

SATURATION - DETERMINISTIC, OSCILLATING EVOLUTION



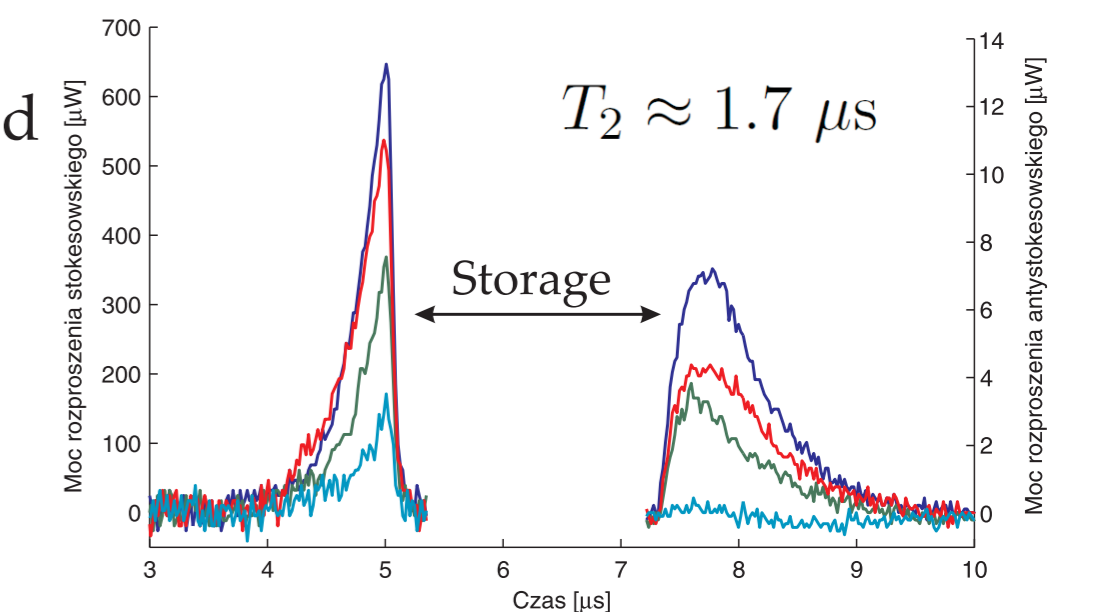
A finite threshold - indication of losses

Oscillations in the saturation regime proportional to the light intensity.



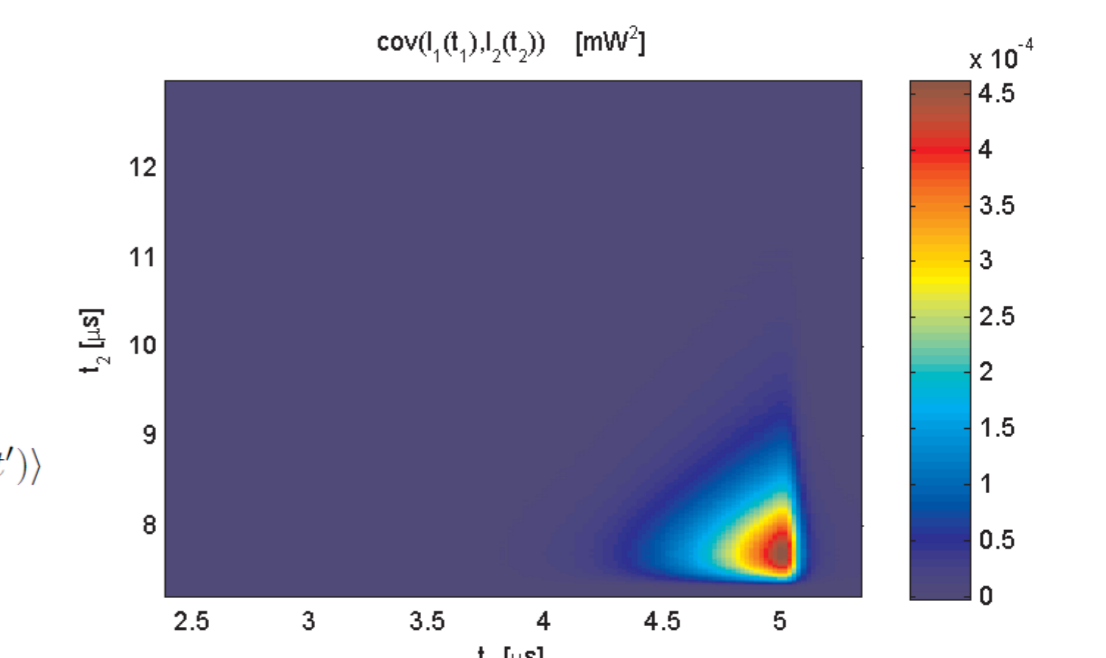
RESULTS: READ OUT - THE MEMORY EFFECT

Anti-Stokes scattering = the read out process observation with a variable storage time.



Correlations between Stokes and anti-Stokes light up to 95%

$$C(t, t') = \text{cov}[I_1(t), I_2(t')] = \langle I_1(t)I_2(t') \rangle - \langle I_1(t) \rangle \langle I_2(t') \rangle$$



Spatial correlations: the conservation of the momentum in the write and the read process

