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Institut d'Optique,
Palaiseau

Wave-Particle duality of Surface Plasmon Polaritons

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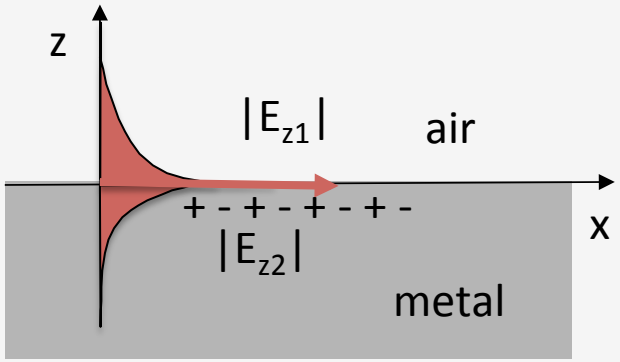
Surface Plasmon Polariton (SPP)

✧ Surface Plasmon Polariton (SPP)

Collective oscillation of electronic density at the interface between a metal and a dielectric coupled to an electromagnetic field.



✧ Key properties

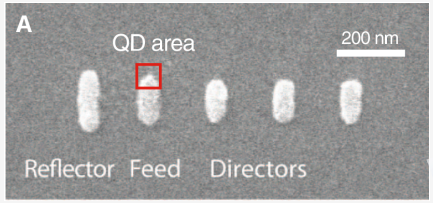
- High confinement of electric field
- High localized density of states
- Losses

Motivation (1/2)

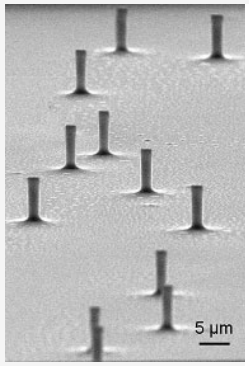
Potential applications for quantum communication and quantum information require …

Manipulation of single quantum systems

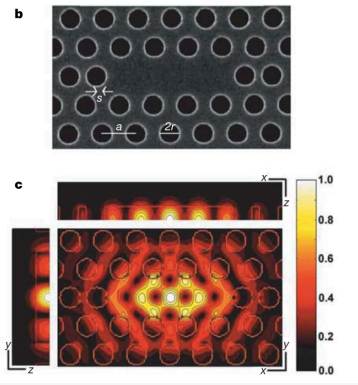
Controlling light-matter interaction at the nanoscale



G. Curto et al., Science 329, 930, (2010).



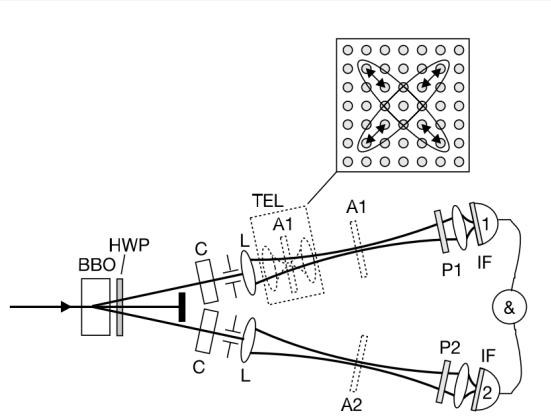
LPN, Marcoussis



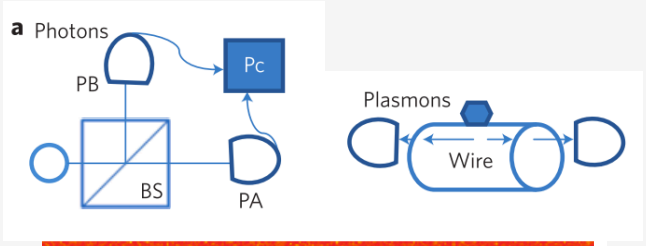
Yoshi, Nature, 2004

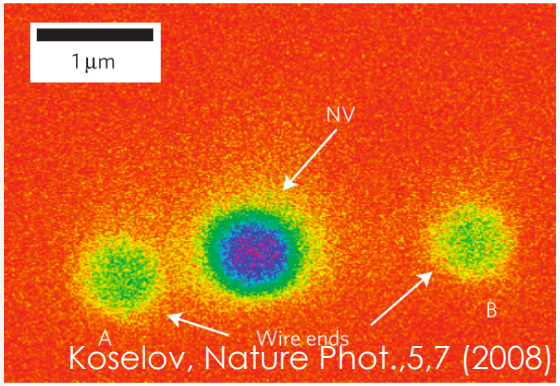
Development of new platforms for compact Quantum plasmonics

Motivation (2/2)

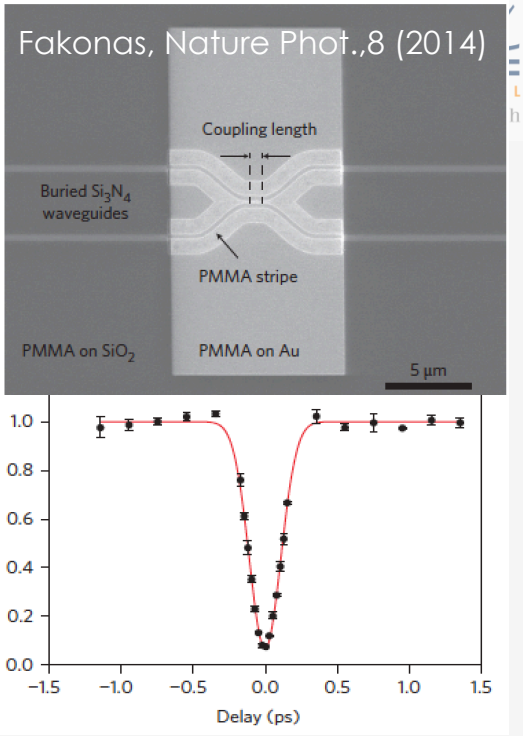


Altewischer, Nature, 418 (2002)





Koselov, Nature Phot.,5,7 (2008)



EUROPHYSICS LETTERS 15 February 1986

Europhys. Lett., **1** (4), pp. 173-179 (1986)

Experimental Evidence for a Photon Anticorrelation Effect on a Beam Splitter: A New Light on Single-Photon Interferences.

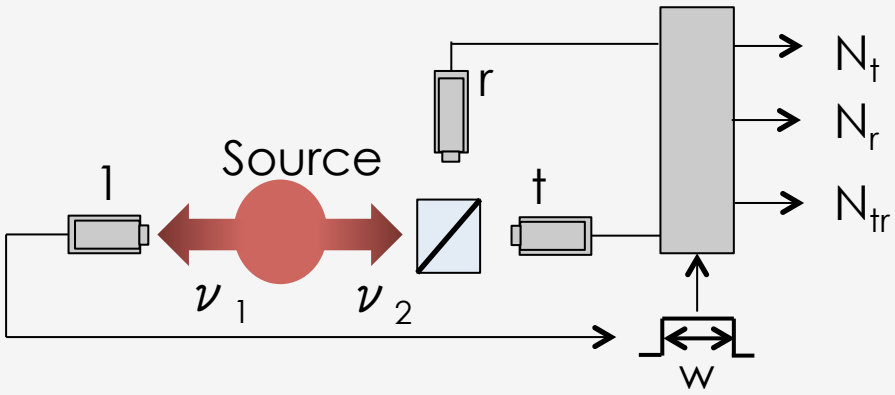
P. GRANGIER, G. ROGER and A. ASPECT (*)

Institut d'Optique Théorique et Appliquée, B.P. 43 - F 91406 *Orsay, France*

Grangier experiment:

Step 1: Hanbury Brown and Twiss experiment (HBT)

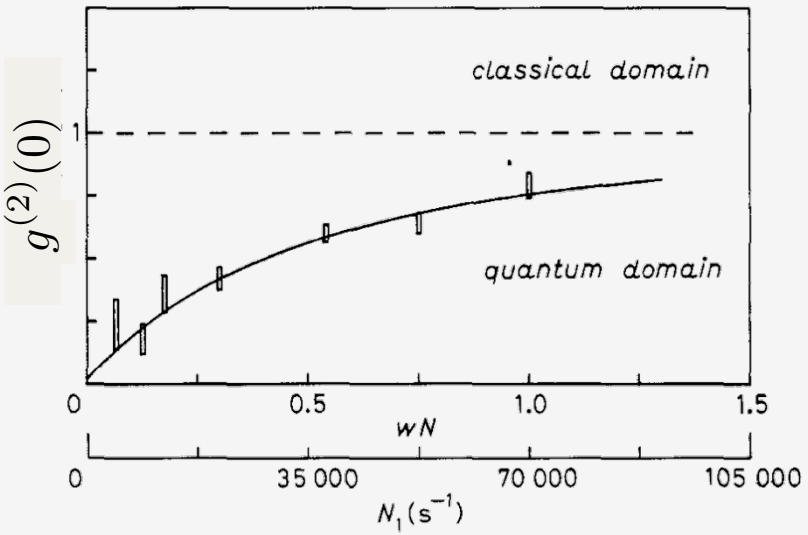
- Experimental setup



$$g^{(2)}(0) = \frac{P(1_t 1_r)}{P(1_t)P(1_r)}$$

- Degree of second order coherence (stationary light) :

$$g^{(2)}(\tau) = \frac{\langle : \hat{I}(t)\hat{I}(t+\tau) : \rangle}{\langle \hat{I}(t) \rangle^2}$$

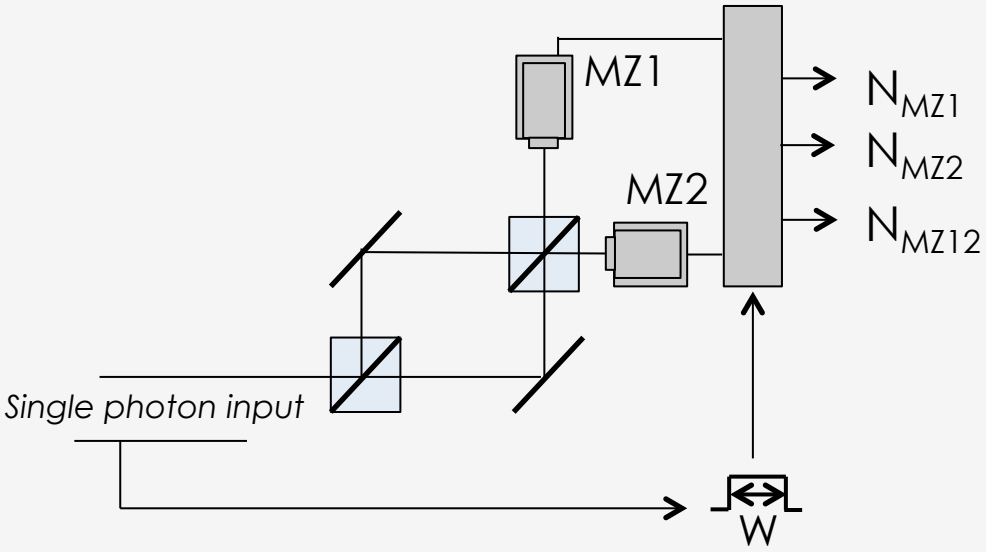


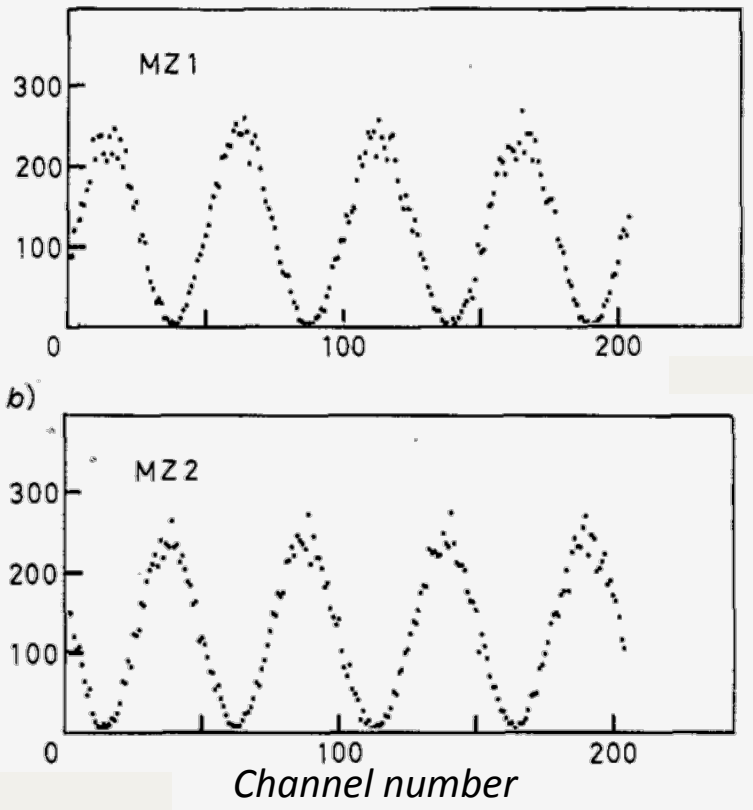
Particle behaviour

Grangier experiment:

Step 2: Single photon interferences in a Mach-Zehnder Interferometer (MZI)

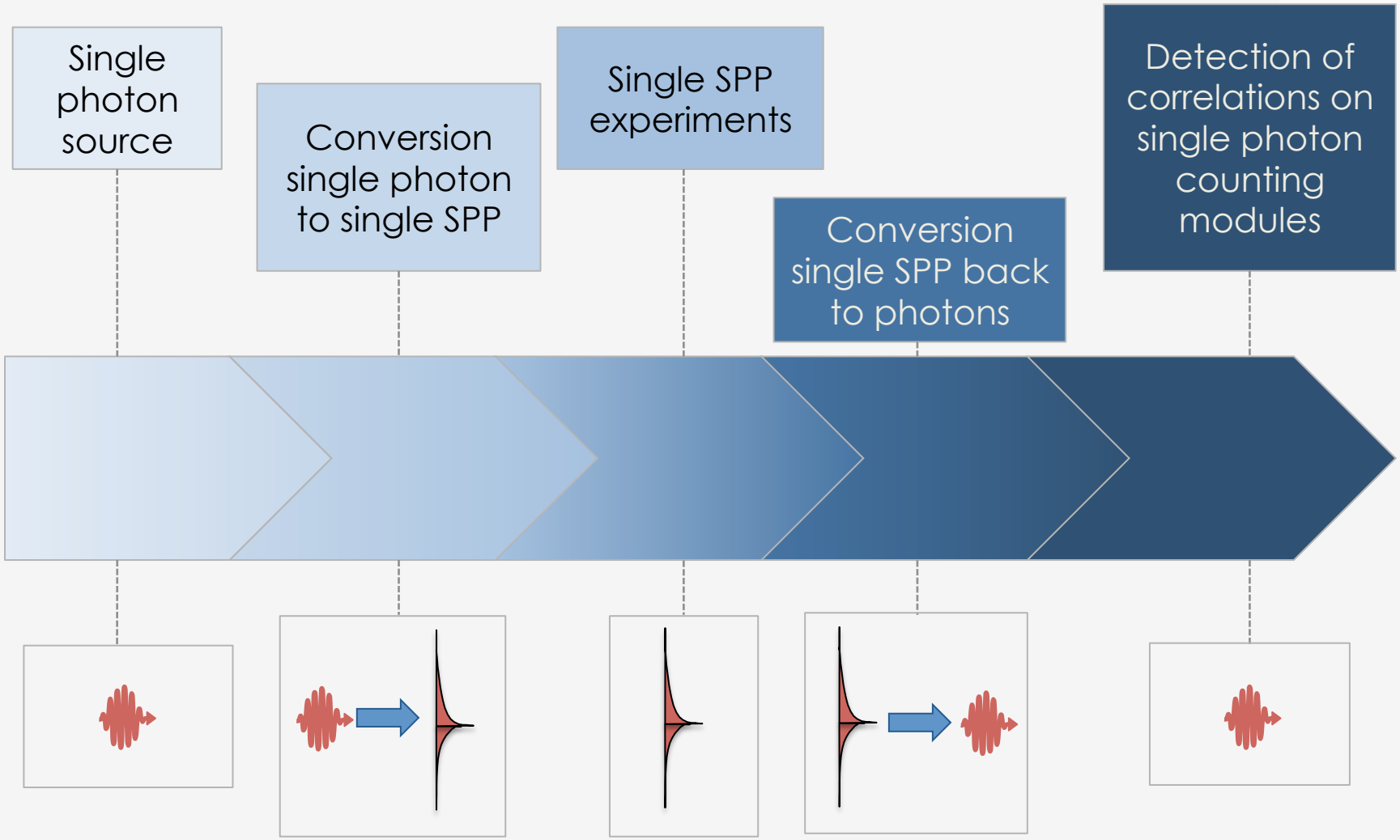
- Experimental setup



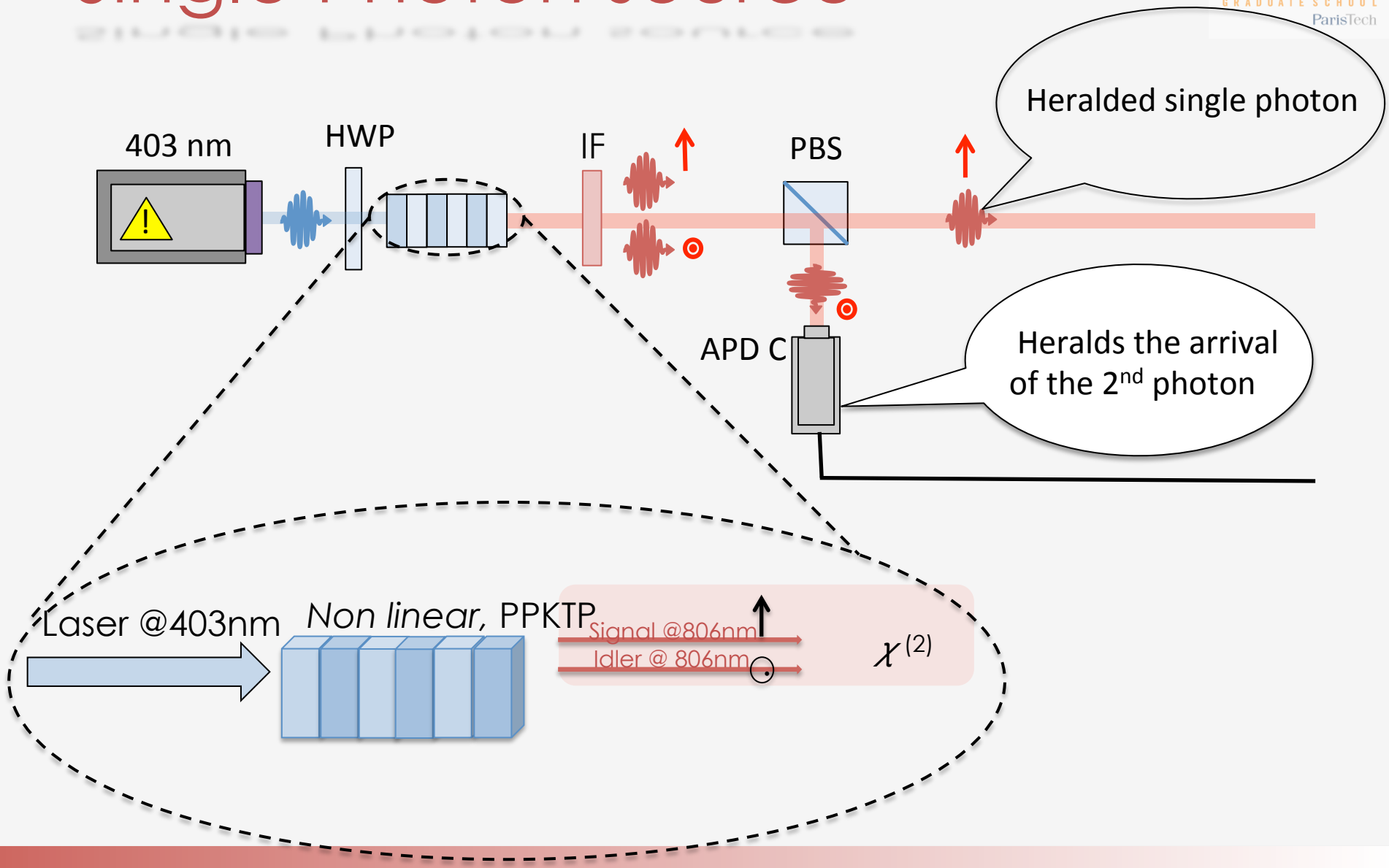


Wave behaviour

General scheme

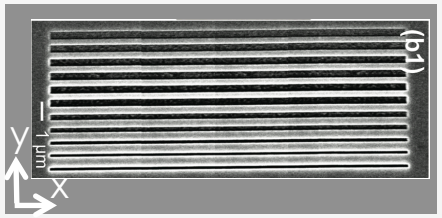


Single Photon source



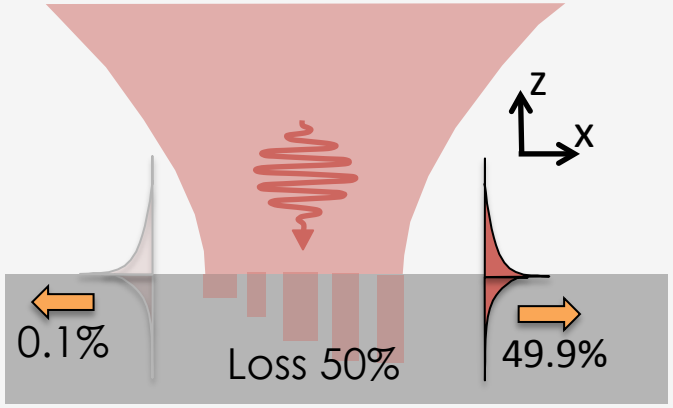
Photon-SPP conversion

How to generate the SPP ?

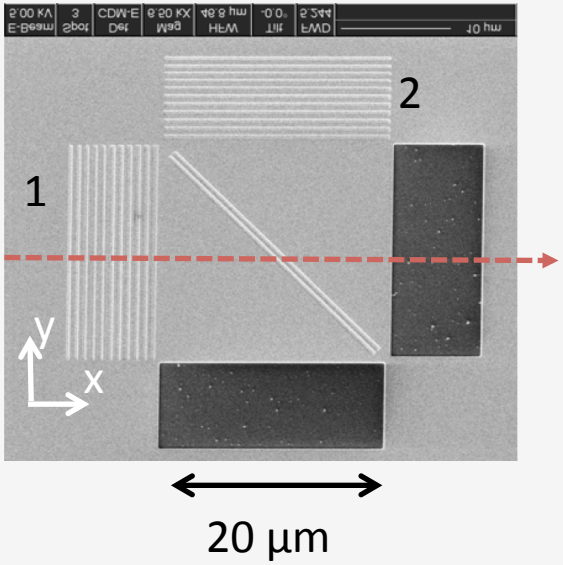


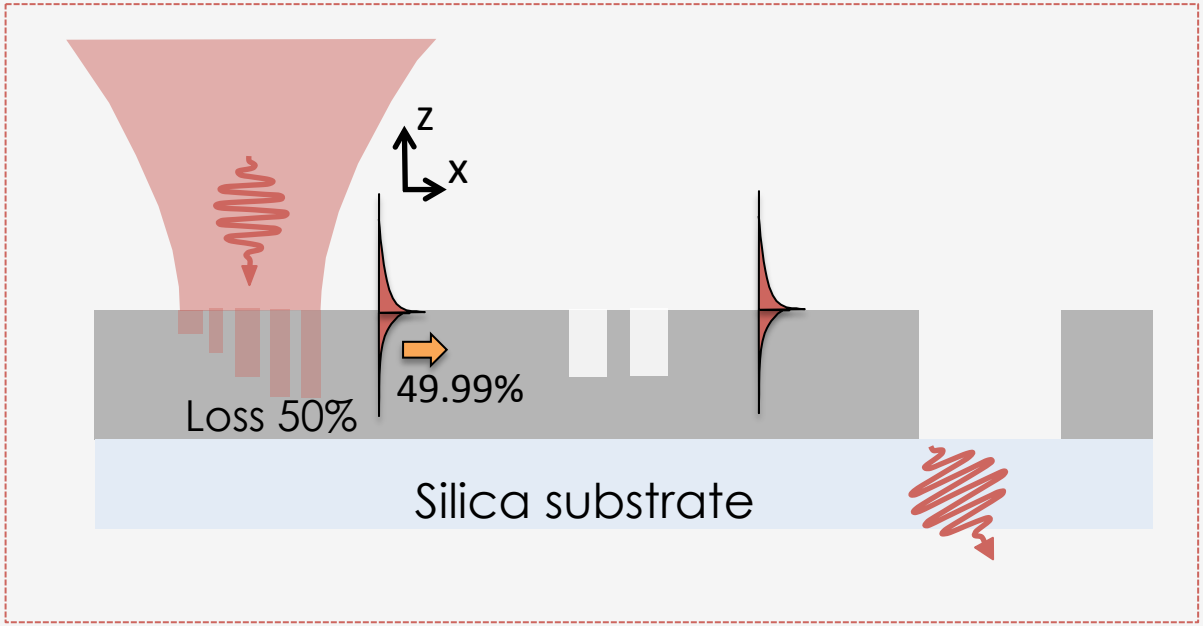
A. Baron,Nanoletters, 2012

Fabrication :
Eloise Devaux (ISIS)



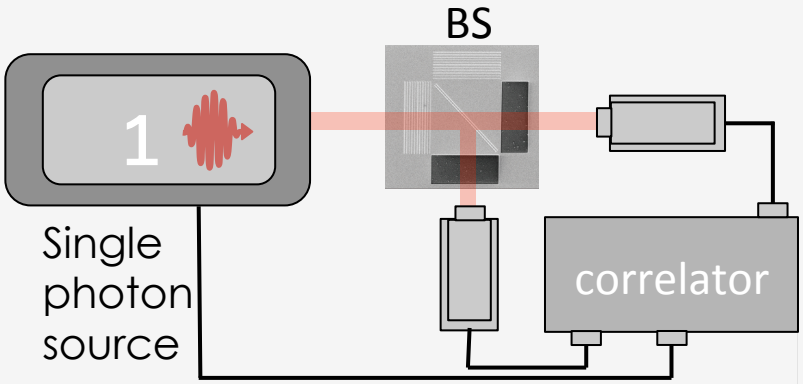
Top view of the Plasmonic sample



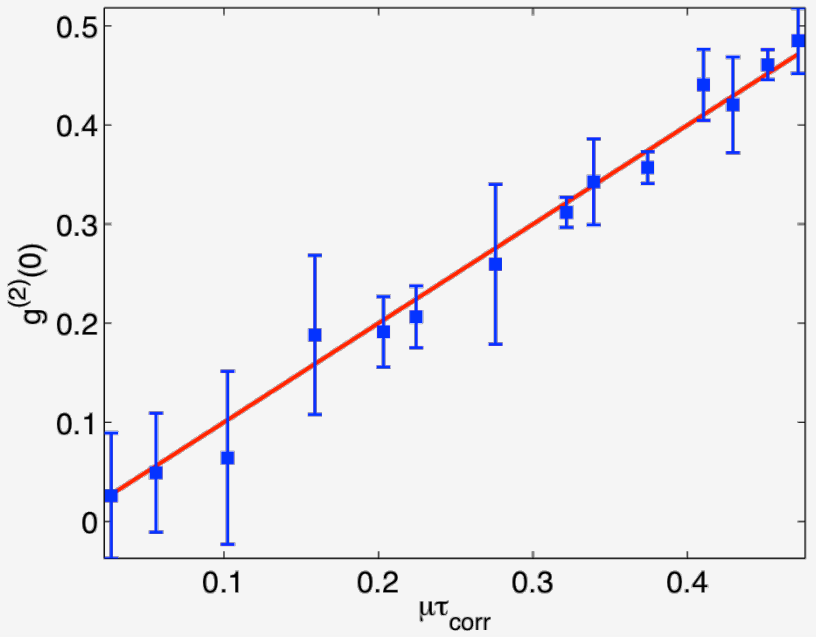


Single SPP source

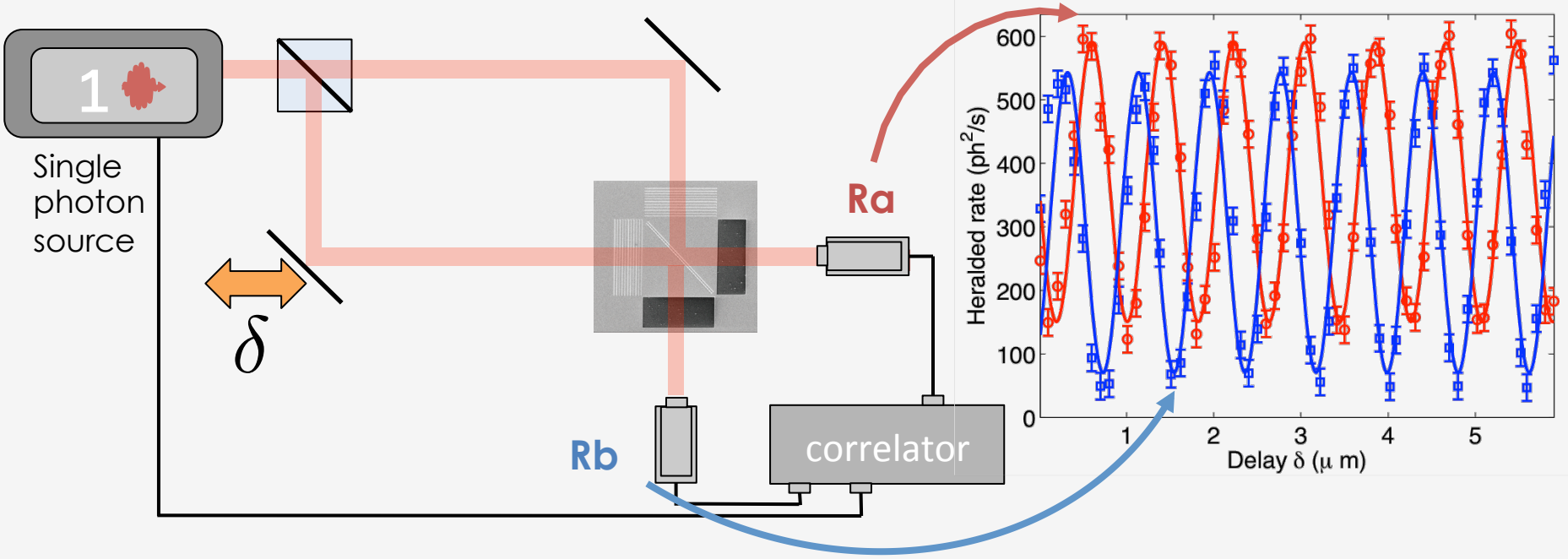
- HBT experiment :



- Characterization: $g^2(0)$=3% !!!

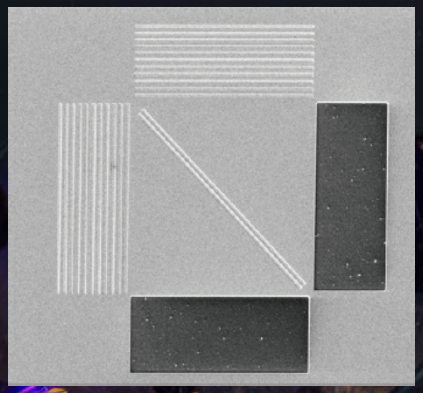


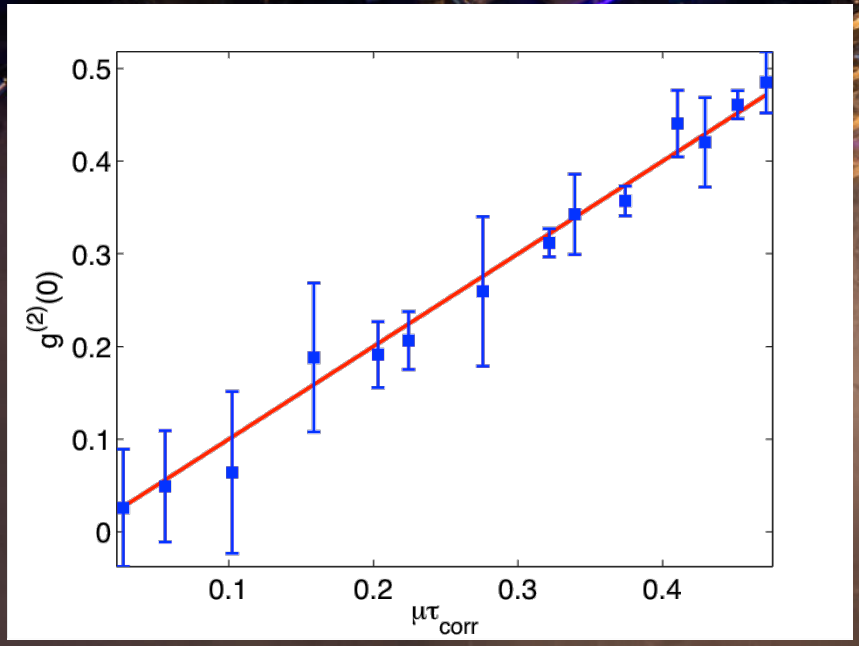
Results : SPP source

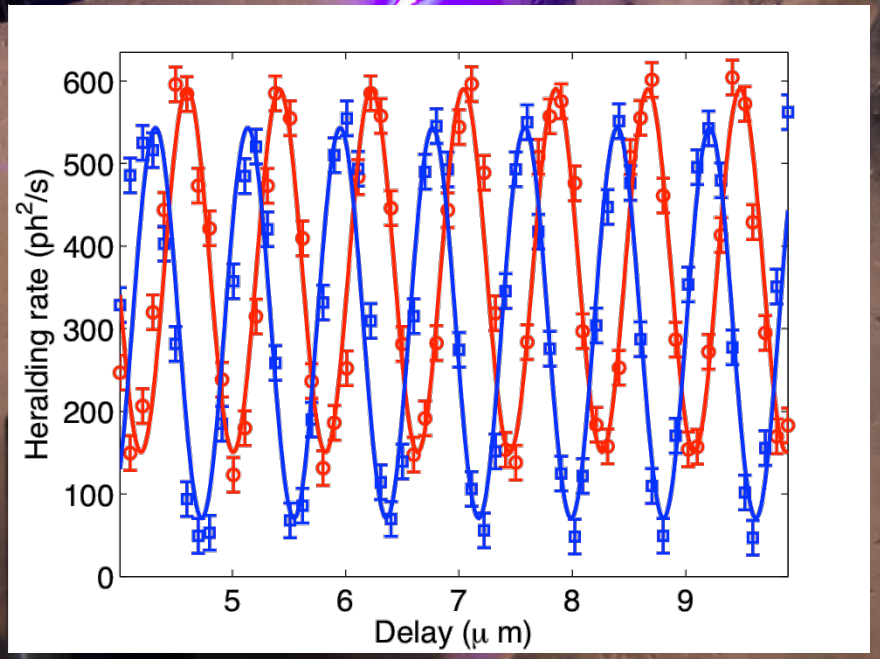


- Single SPP interferences !!!

- Remarks
  - Lossy BS -> $\Phi_r - \Phi_t \neq pi/2$
  - Asymetric offsets : asymmetric setup
  - Absorption depends on the path difference !!!







Thank you for your attention