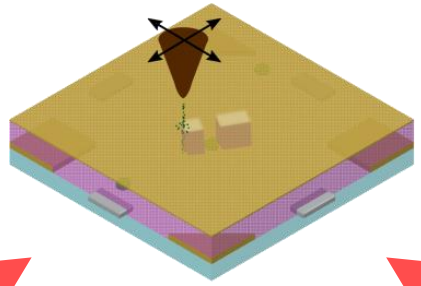
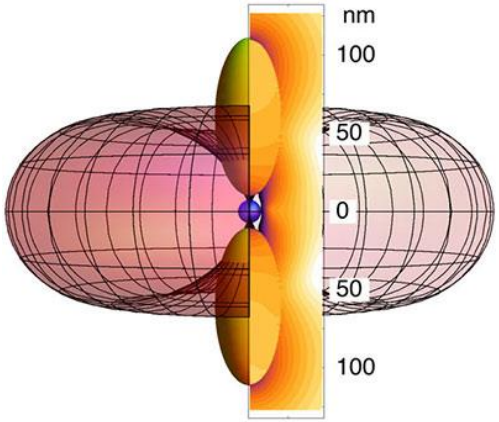
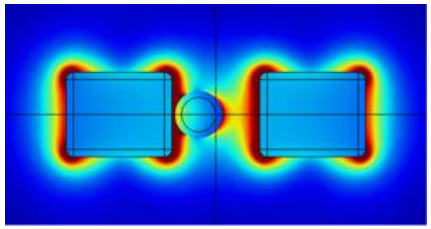
Nanoscale







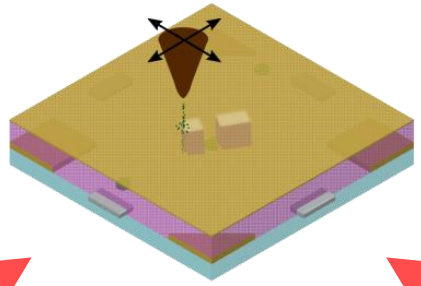
Quantum

Optics!

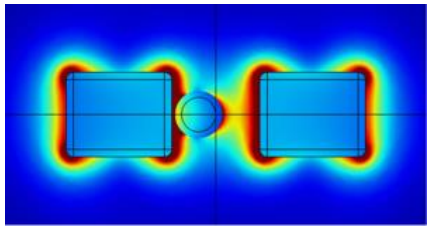
Nanoscale

N. Chauvet, M. Ethis de Corny, G. Laurent, A. Drezet, S. Huant, T. Gacoin, G. Dantelle, G. Nogues, and G. Bachelier

Institut NEEL, CNRS – UGA
LPMC – Ecole Polytechnique



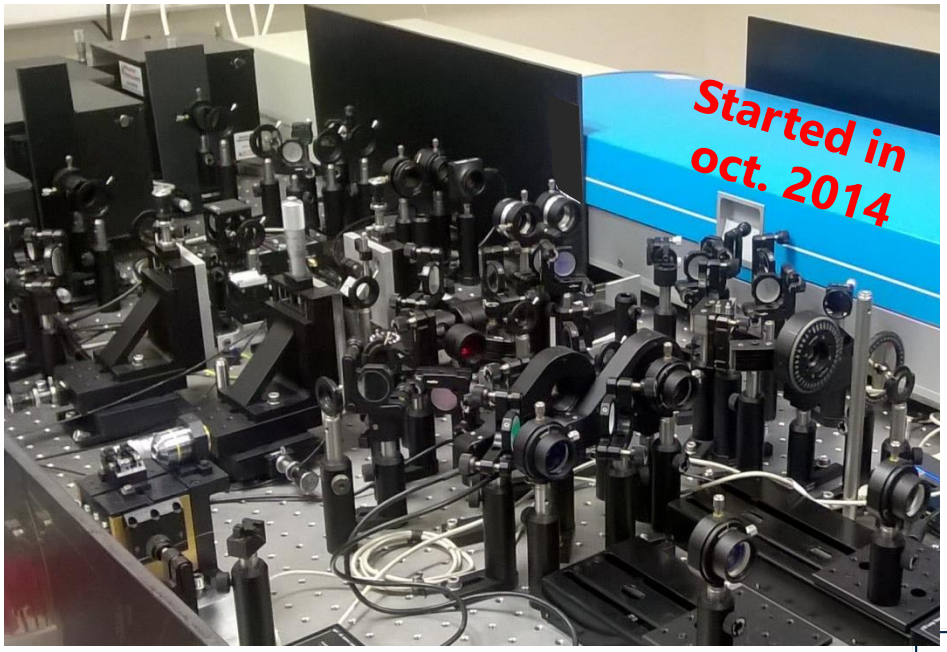
From nonlinear to quantum hybrid plasmonics



Quantum

Optics!

New experimental plateform

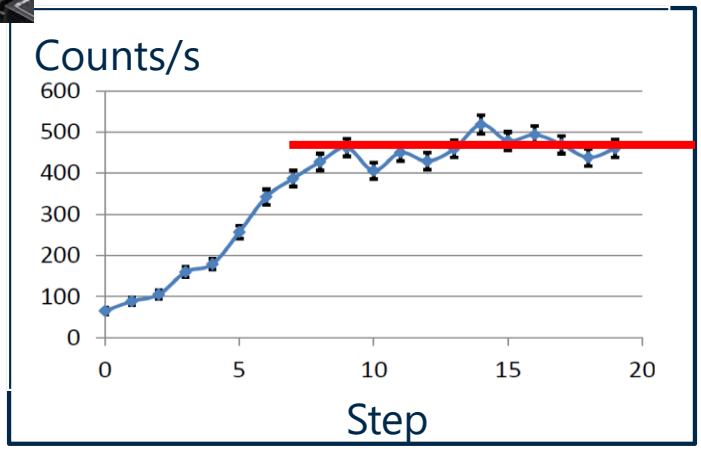


Multiphysics on the same single particle:

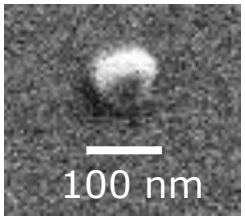
- Linear
- SHG/SFG
- SPDC
- Photon correlation/Bell inequality test experiment
- Near-field

Technical specificity:

- Low noise (<1 count/s)
- Long term stability
- Multiple wavelength
- Computer control



From plasmonic antenna to hybrid structures:



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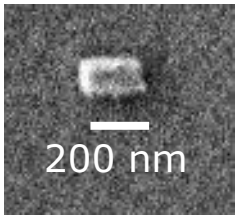

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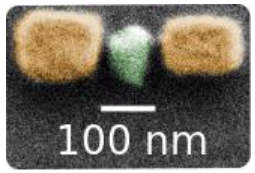

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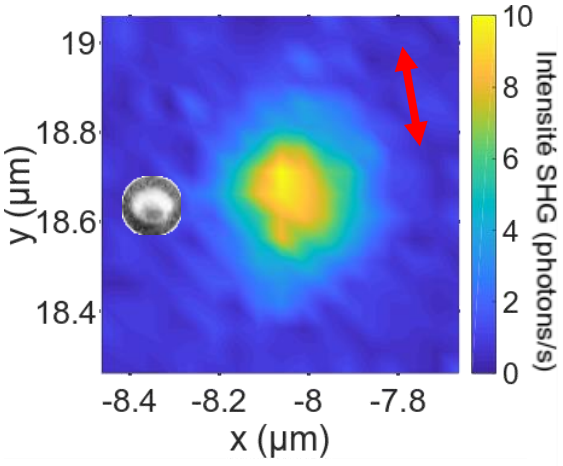
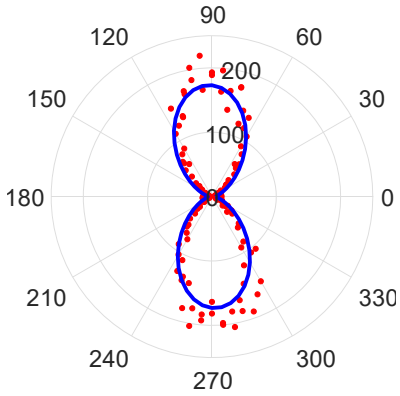
Nonlinear nanocrystal

Plasmonic antenna

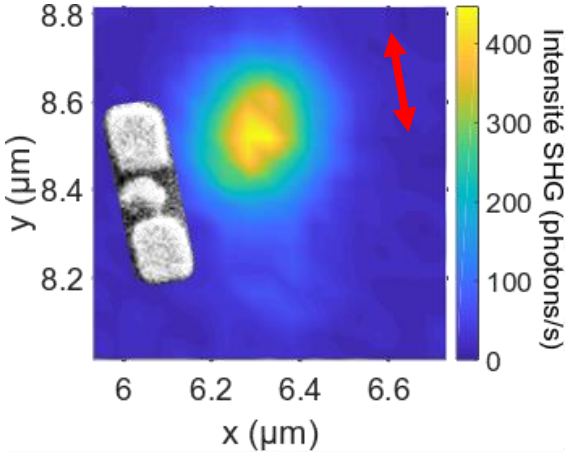
Hybrid nanostructure

Process:

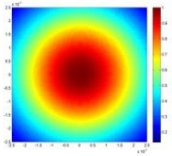




$(\theta,\varphi,\psi) = (50,90,80)$

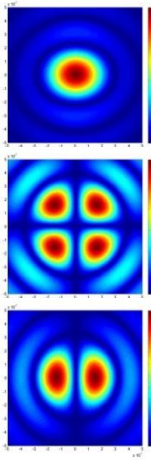


1 - Laser features



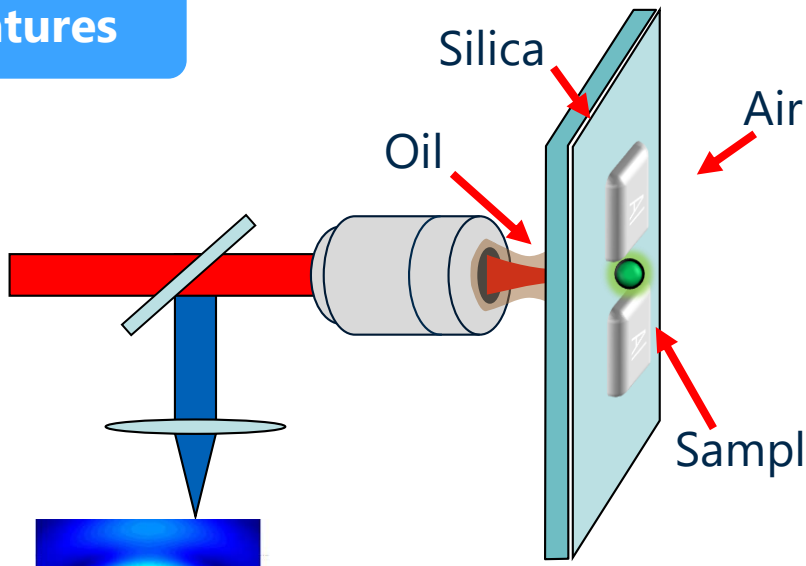
Analytical tools

2 – Local fields

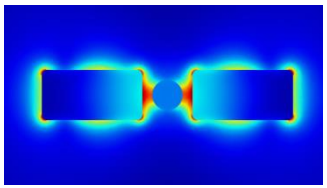


$\vec{E}_{in}$

Finite Element Methods



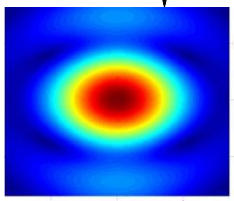
3 – Induced currents & Near-fields



$\vec{E}_{ind}$

Analytical tools

$\vec{E}_{sca}(\omega,2\omega...)$



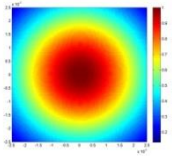
4 - Far fields

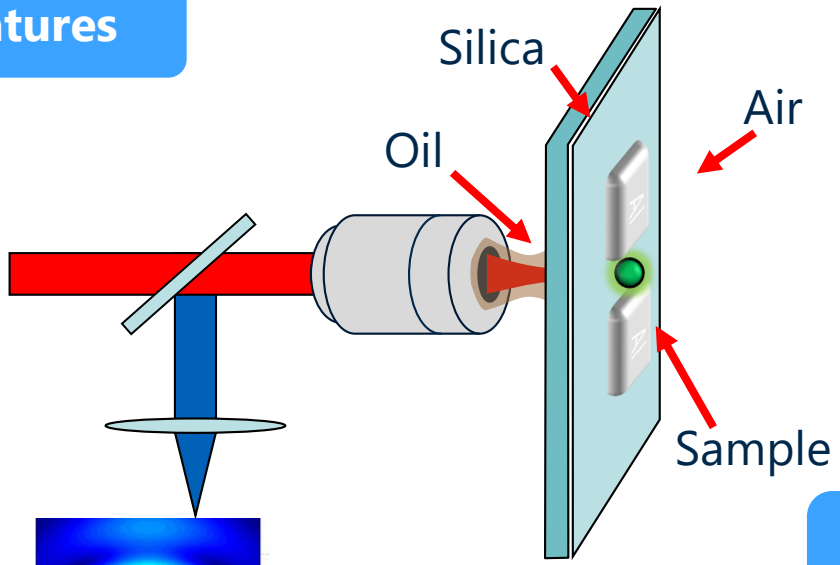
New simulation tools: Wave mixing

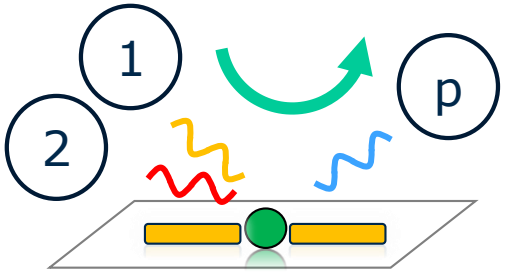
Analytical tools

2 – Local fields

1 - Laser features



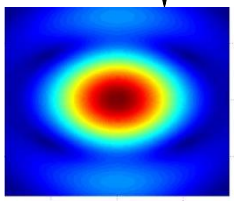




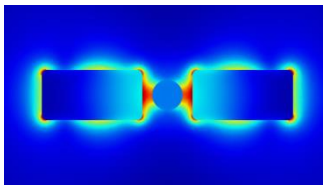
Classical

3 – Induced currents & Near-fields

$\vec{E}_{sca}(\omega,2\omega...)$



$\vec{E}_{ind}$



Analytical tools

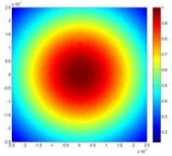
4 - Far fields

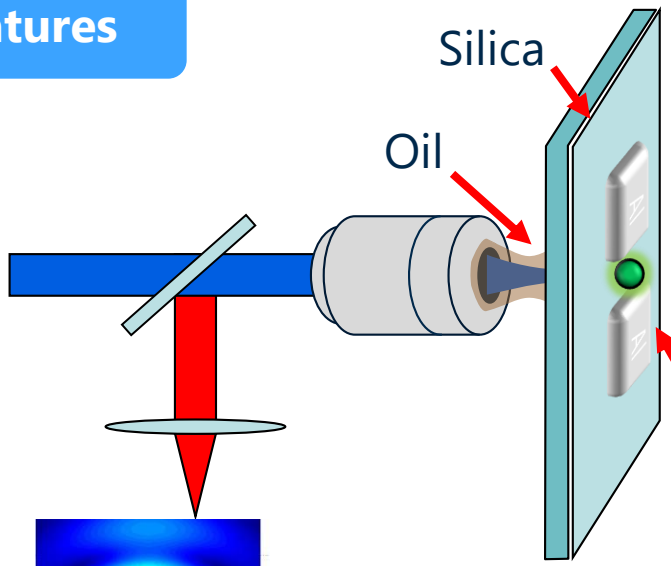
New simulation tools: Photon pair production

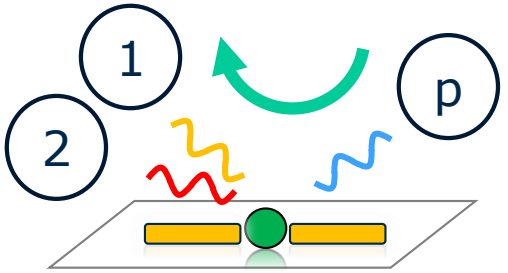
Analytical tools

2 – Local fields

1 - Laser features

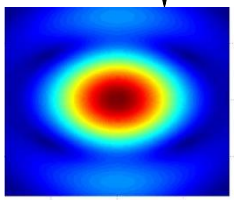






Quantum!

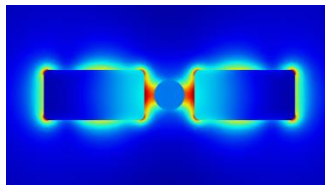
$\vec{E}_{sca}(\omega,2\omega...)$



3 – Induced currents & Near-fields

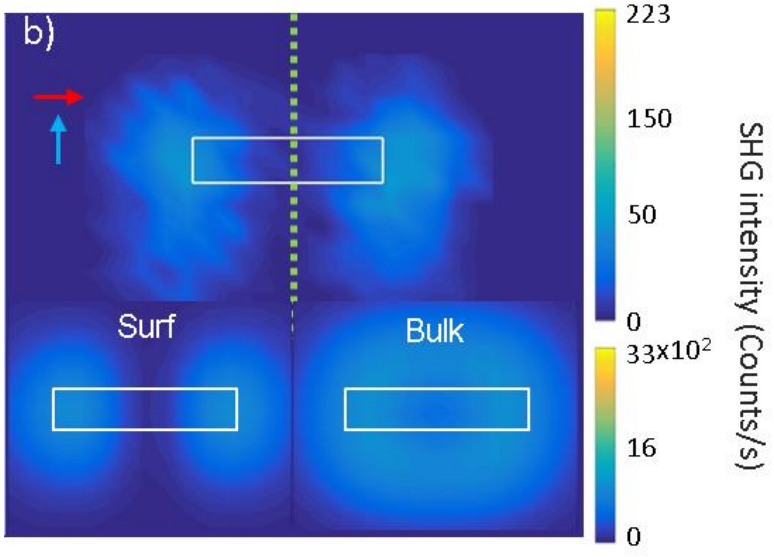
Analytical tools

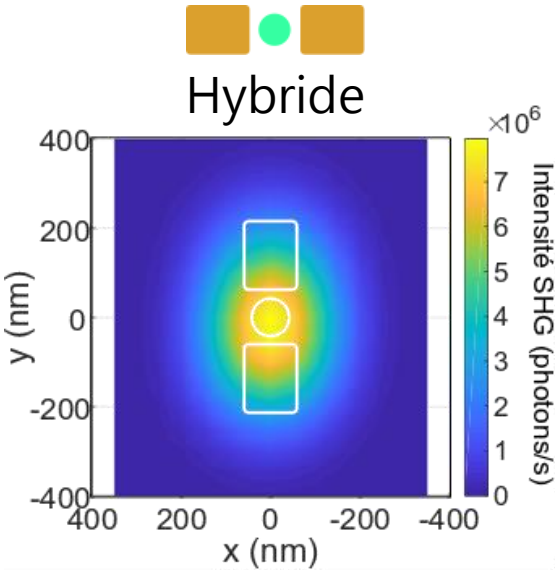
$\vec{E}_{ind}$



4 - Far fields

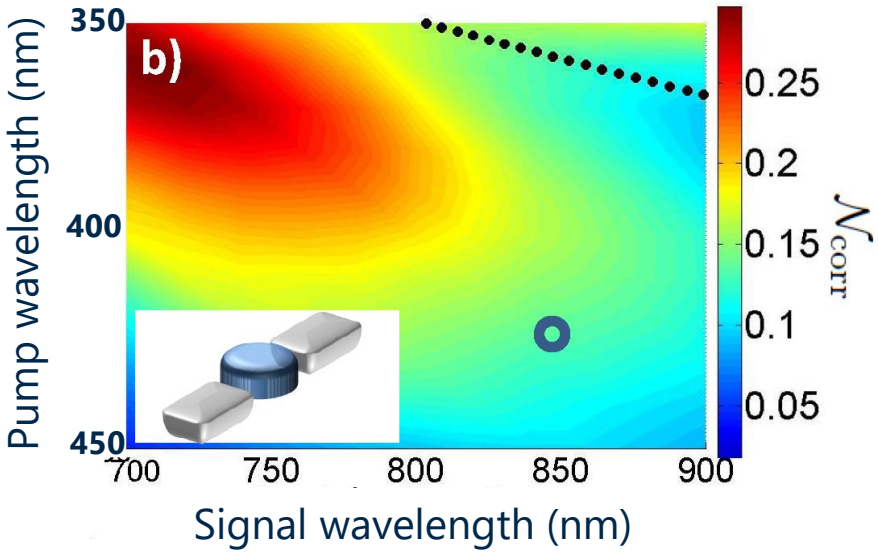
Second Harmonic Generation :

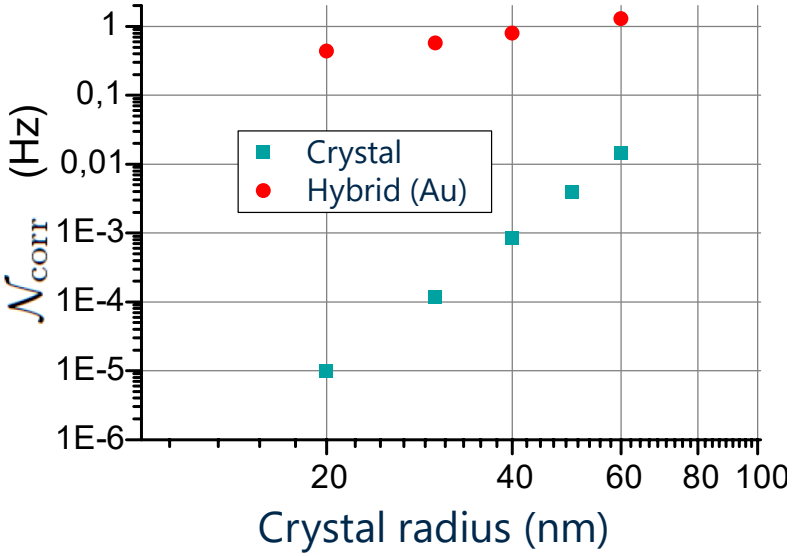




- Origin of SHG in plasmonic structures contradicting many claims in the literature
- Double resonance and mode matched conditions for up to 10^3 fold enhancement in hybrid structures

Photon pair production:

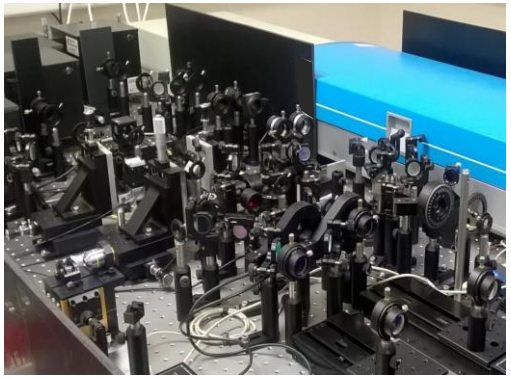




- First ever simulation of SPDC at the nanoscale
- Up to 10^5 fold enhancement in hybrid structures
- Photon pair production efficiency/V^2 comparable to the best source

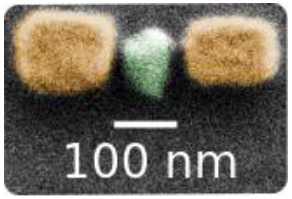
New tooboxes:

- Nanoscale optics plateform
- Hybrid structures fabrication
- Quantum numerical simulation with no adjustable parameter



New knowledge:

- SHG origin
- Photon pair generation in hybrid structures



New opportunities:

- Up to 10^3-10^5 fold enhancement
- Toward entangled state production with crossed antennas