

Nonlinear Optics in Plasmonic Nanostructures

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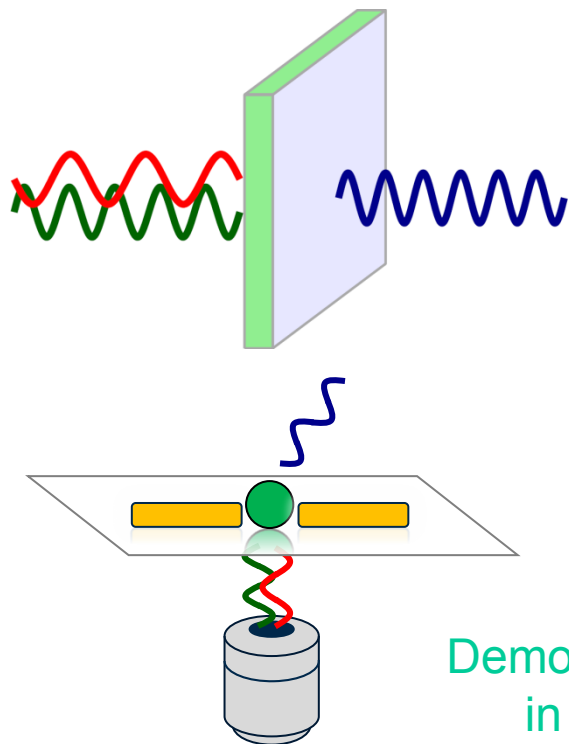
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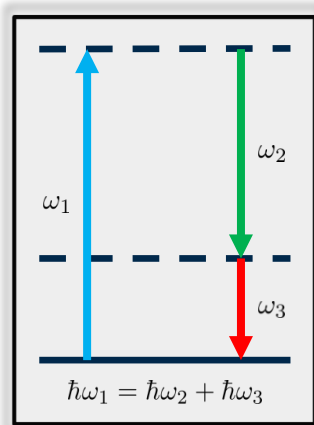
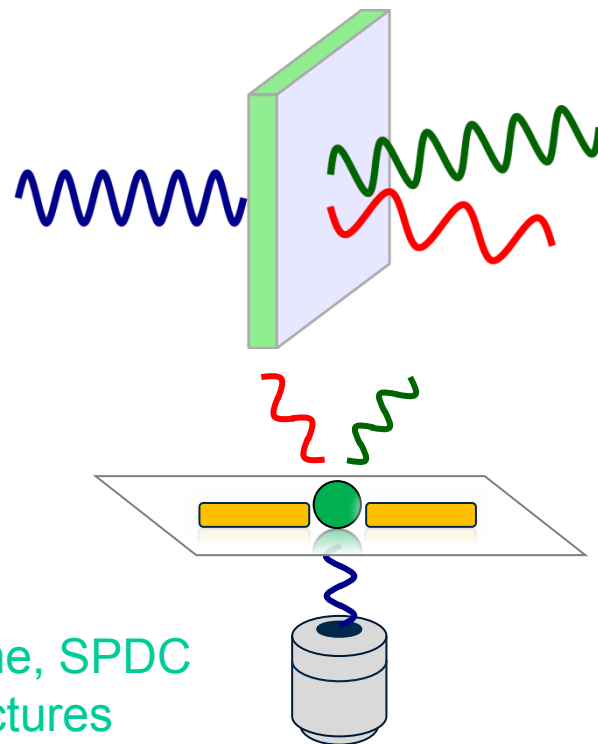
³LICB, CNRS – Université de Bourgogne, Dijon, France

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Up-conversion (SHG-SFG):

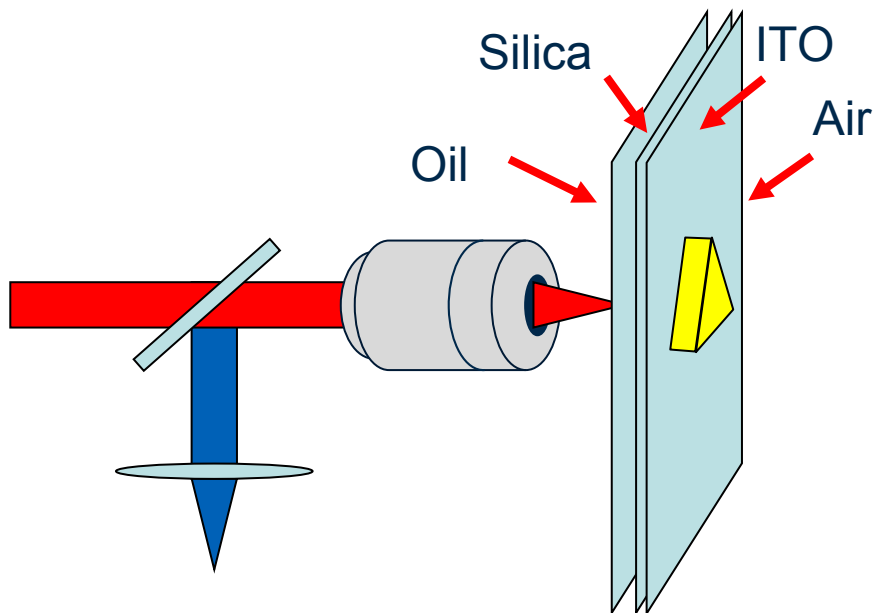


Down-conversion (SPDC):



Demonstrate, for the first time, SPDC in hybrid plasmonic structures

Up-conversion (SHG-SFG)



Optics:

- Focusing the laser beam
- Collecting the signal

Sample:

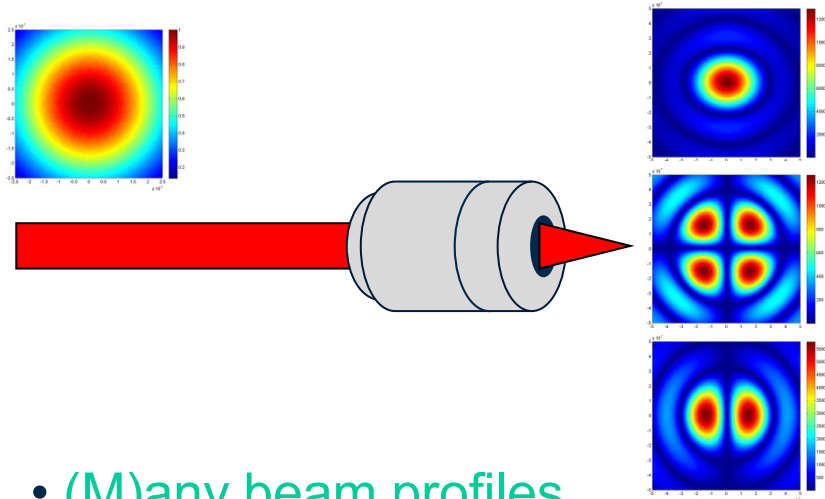
- Substrate
- Particle morphology

Physics:

- Linear/nonlinear currents
- 2D scans, spectrometry....

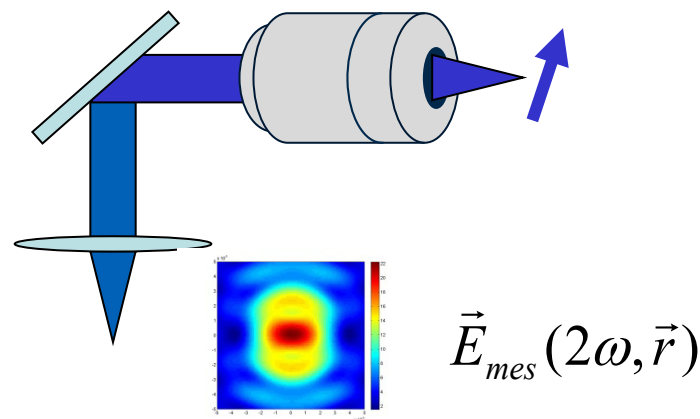
Matlab livelink:

$$\vec{E}_{in}(\omega, \vec{r}) \rightarrow \vec{E}_{foc}(\omega, \vec{k}) \rightarrow \vec{E}_{foc}(\omega, \vec{r})$$



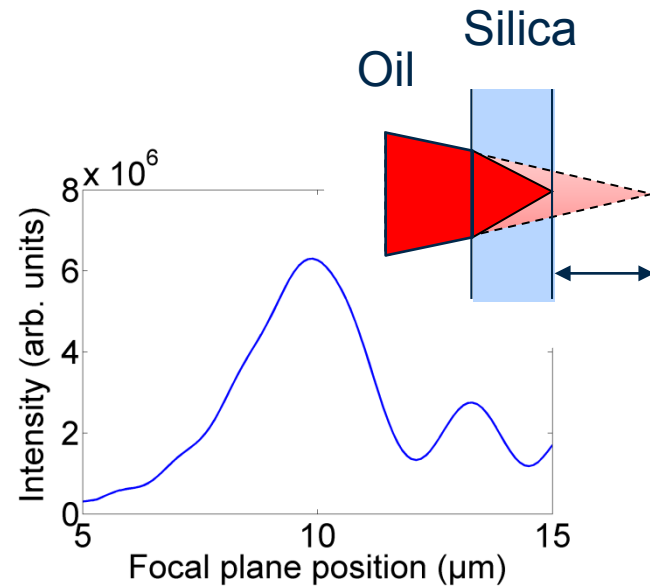
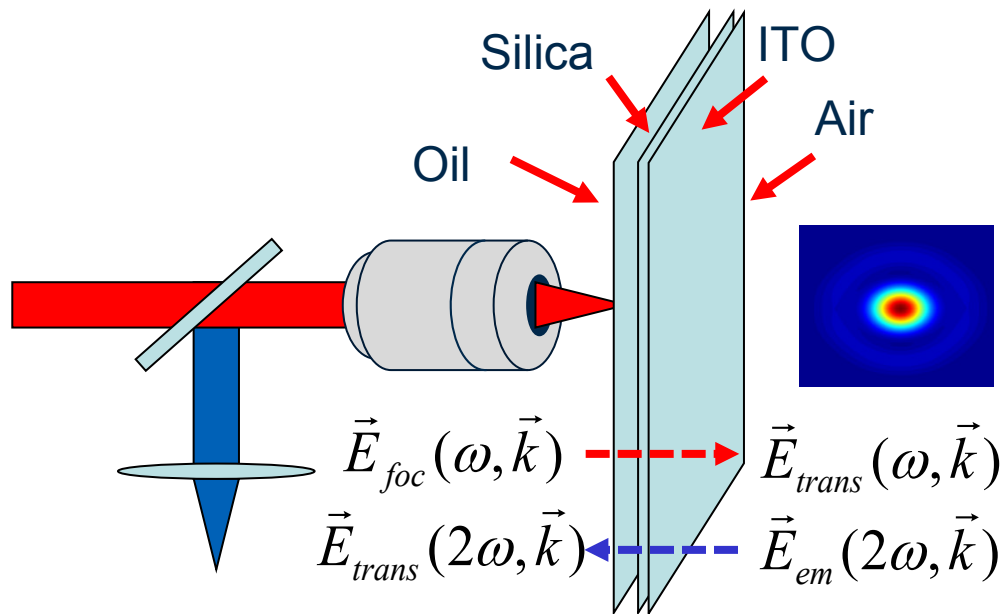
- (M)any beam profiles
- (M)any optical elements: lenses, microscope objectives, ...

$$\vec{E}_{col}(2\omega, \vec{r}) \leftarrow \vec{E}_{col}(2\omega, \vec{k}) \leftarrow \vec{j}(2\omega, \vec{r})$$



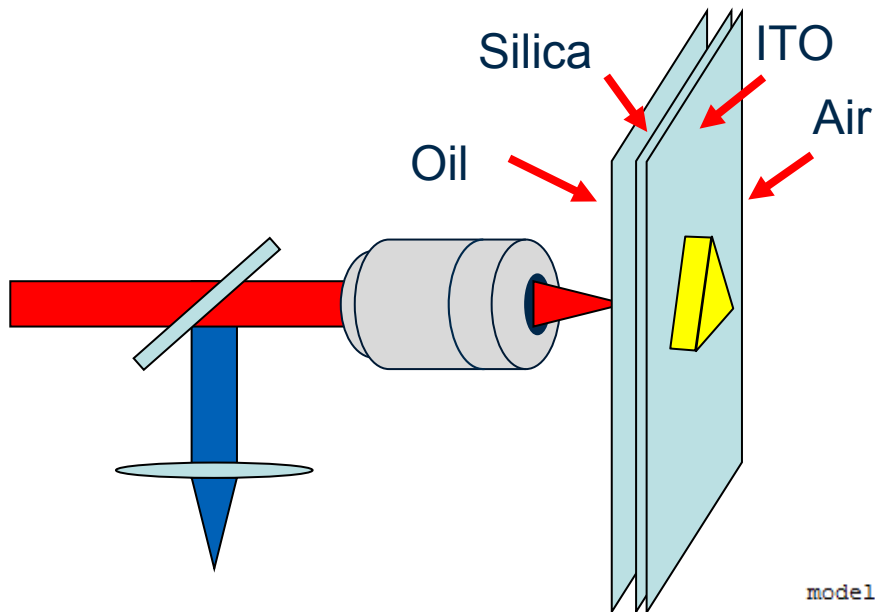
- (M)any current distributions

Matlab livelink:

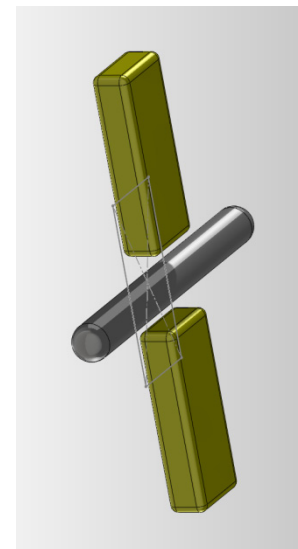
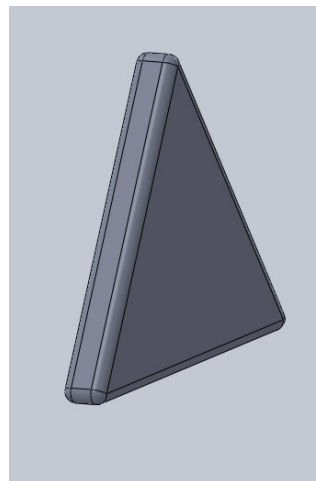


- (M)any configurations: transmission, reflection, substrate...

Solidwork Livelink:

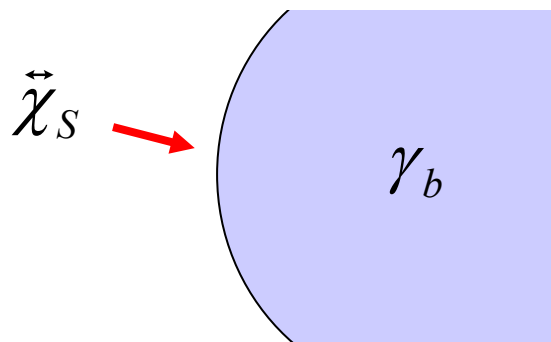


- (M)any particle shapes, spatial distributions

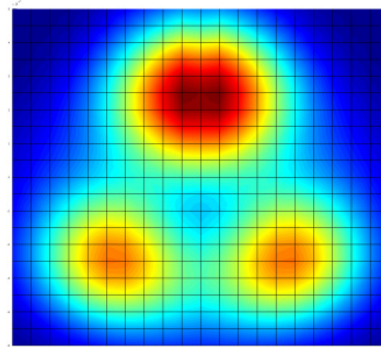


```
model.geom('geom1').feature.create('cad1', 'LiveLinkSolidWorks');
model.geom('geom1').feature('cad1').set('param', {'L@triangle' 'H@prism'
model.geom('geom1').feature('cad1').set('paramvalue', {'Lp*scaling' 'Hp*s
```

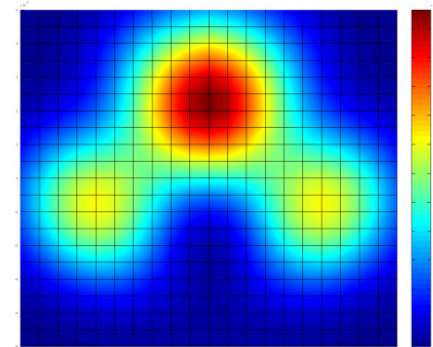
Comsol Multiphysics: weak formulation



bulk



surface



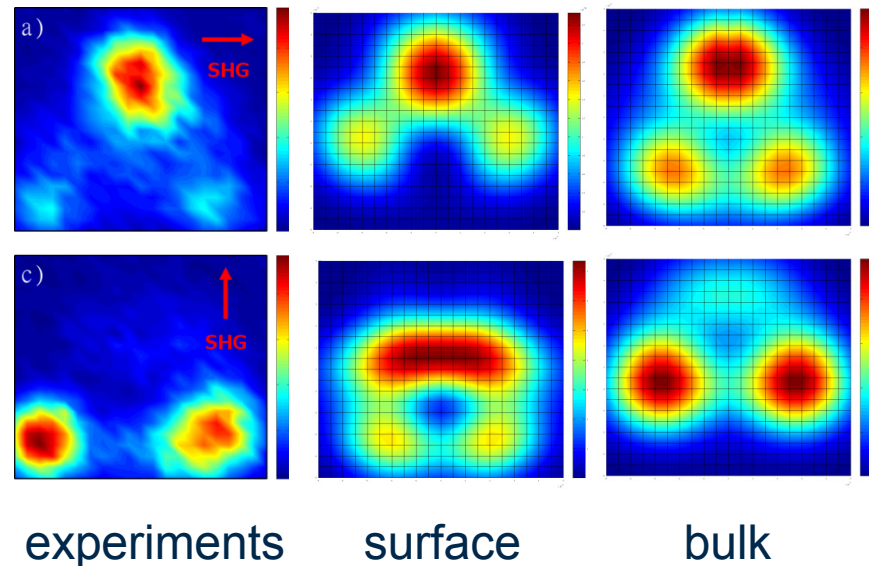
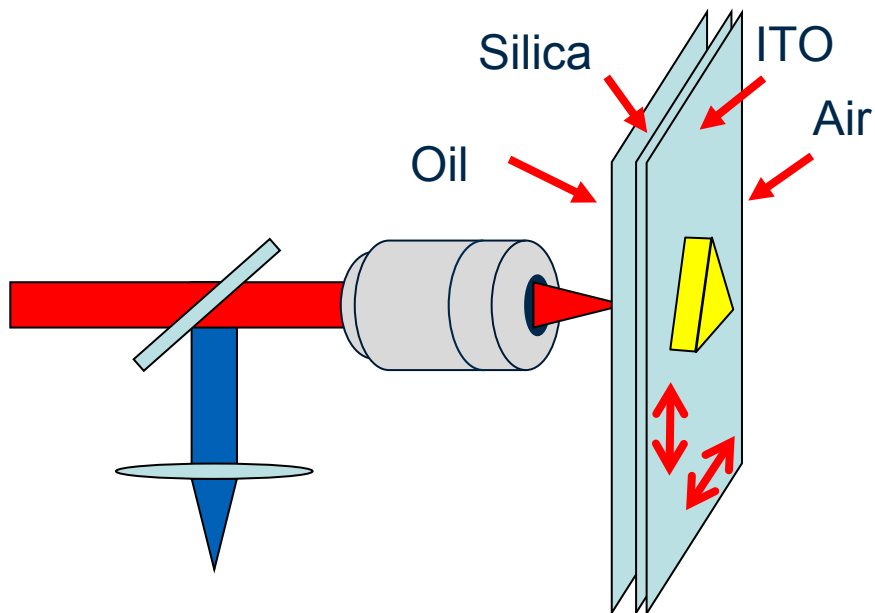
surface $\vec{j}_s(2\omega, \vec{r}) \sim \vec{\chi}_s : \vec{E}(\omega, \vec{r}) \vec{E}(\omega, \vec{r})$

bulk $\vec{j}_b(2\omega, \vec{r}) \sim \gamma_b \vec{\nabla} \left[\vec{E}(\omega, \vec{r}) \vec{E}(\omega, \vec{r}) \right]$

- (M)any nonlinear responses: surface, bulk, anisotropic materials...

Batch on cluster:

```
model.batch('p1').set('pname', {'Gp' 'beam' 'fill' 'Gi' 'f' 'NA'}
model.batch('p1').set('plistarr', {num2str(Gp_calc(ind_calc)) num
model.batch('p1').set('sweeptype', 'sparse');
```



- (M)any parametric studies (computation time/50 and file size/20)

Toolboxes:

- Analytical/numerical simulation reproducing the experimental configurations

Physics:

- Bulk contribution for gold prisms, surface contribution for AI antennas

Future:

- Nonlinearity in an anisotropic crystal
- SPDC: coupling FEM and quantum simulations

