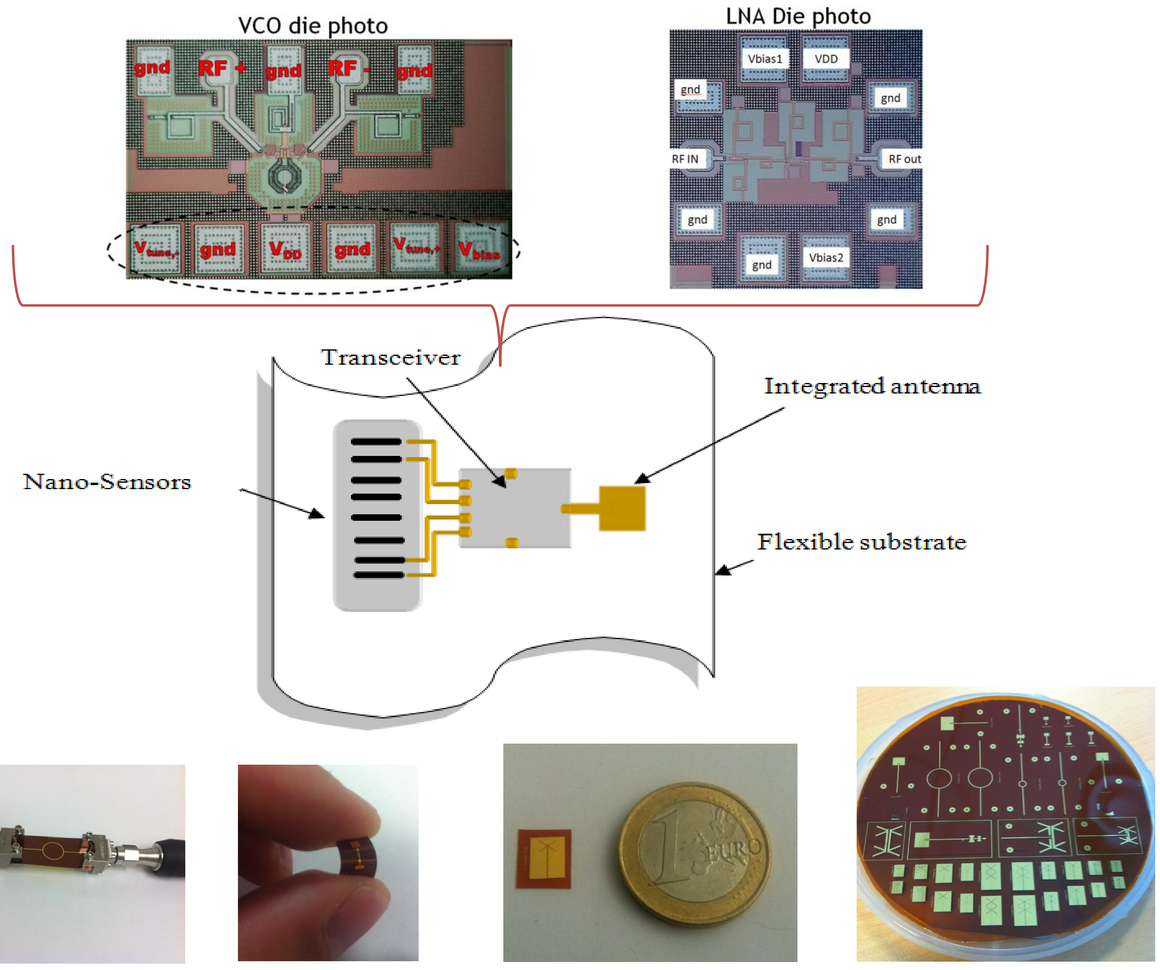
# Millimeter Wave Flexible Antenna

Zhening Yang[1,2], Samuel Charlot[1], Alexandre Rumeau[1], Alexandru Takacs[1,3], Daniela Dragomirescu[1,2]

[1] CNRS, LAAS, 7 Avenue du Colonel Roche, F-31400 Toulouse, France
[2] Univ de Toulouse, INSA, LAAS, F-31400 Toulouse , France
[3] Univ de Toulouse, UPS, LAAS, F-31400 Toulouse , France

Laboratoire d'analyse et d'architecture des systèmes - CNRS



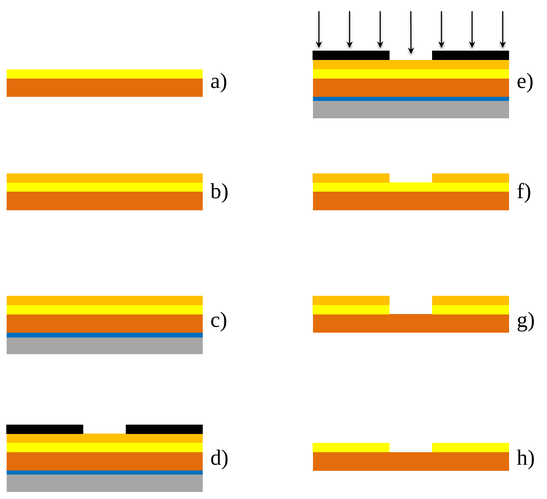

## Objective:

- high gain, high efficiency antenna on flexible substrate
- Two types antenna investigated (patch antenna, cross dipole antenna)

## State of art:

| Type of antenna | Substrate | Frequency band | Gain | Author |
|---|---|---|---|---|
| CPW monopole antenna | PEN | 60 GHz | 1.8 dB | A.Bisognin, UNS - France |
| Patch antenna array | LCP | 60 GHz | 5.3 dB | F.Aryanfar, Caltech - USA |
| Single patch antenna placed on metal | PEN | 60 GHz | 7.2 dB | V.Semkin, Aalto ELEC - Finland |
| Aperture Coupled Patch Antenna | Pyralux | 60 GHz | 7.9 dB | H.Vettikalladi, IETR - France |
| Patch antenna array | PDMS | 60 GHz | 12 dB | S.Hage-AliIEMN - France |
| Patch antenna array | PTFE | 60 GHz | 14 dB | A.Bondarik, Lund University - Sweden |

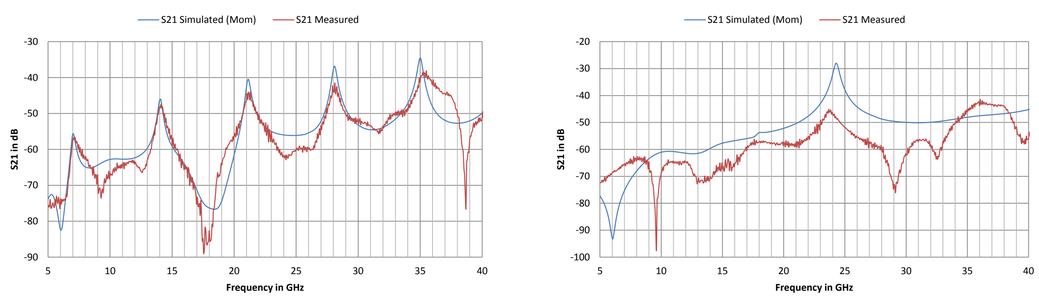
## Processing methods




a) Metallization(Au/Ti);
b) Apply photoresist (ECI);
c) Lamination on rigid substrate;
d) Place photomask;
e) Exposure UV;
f) Development;
g) Etching;
h) Strip resist;

## RF characterization of flexible substrate

- 127 µm thickness – avoid effect of capacitance for millimeter wave application
- Antenna performance – good RF properties (permittivity, RF losses) – Kapton 500HN
- Ring resonator method applied (broadband)




Transmission Coefficient of the ring resonator 7GHz




Transmission Coefficient of the ring resonator 24.125GHz

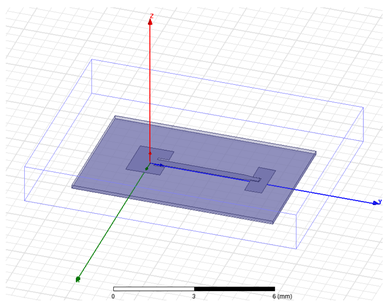
- Measurements matches simulations (ADS Momentum, MoM) from 5GHz to 40GHz

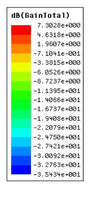
**Simulation model validated**

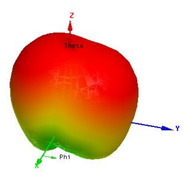
- Relative permittivity = 3.2
- The loss tangent = 0.002

⟺ Validated by measurements

## Antenna design and simulation (HFSS, FEM)

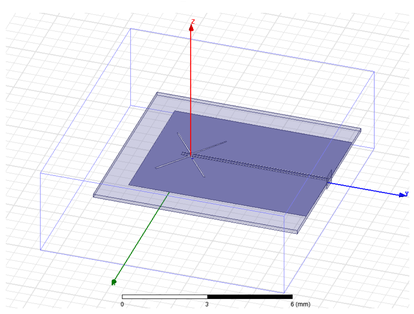


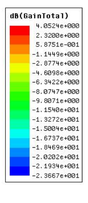


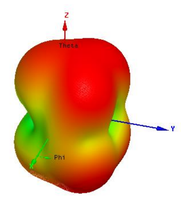



60 GHz patch antenna on Kapton

3d radiation pattern of 60GHz patch antenna



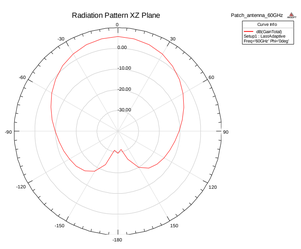


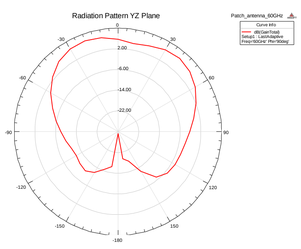



60 GHz cross dipole antenna on Kapton

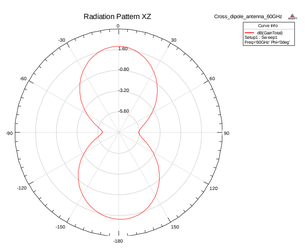
3d radiation pattern of 60GHz cross dipole antenna

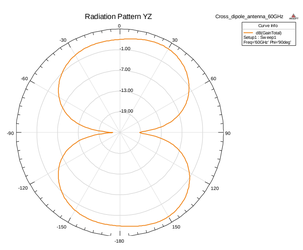
## Simulation of far-filed radiation pattern



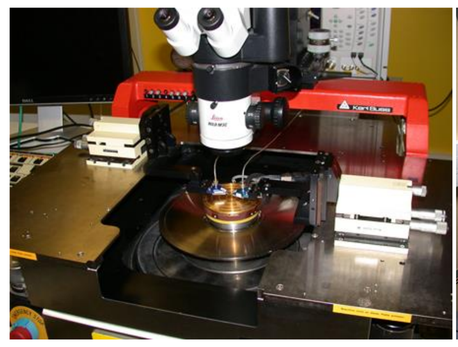

60 GHz patch antenna

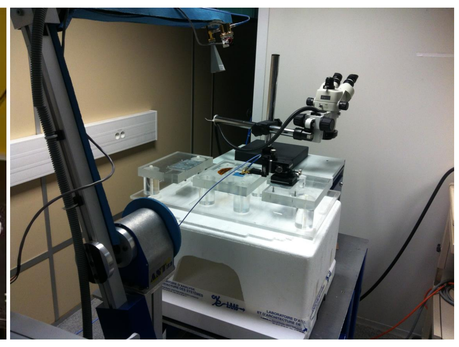



60 GHz cross-dipole antenna

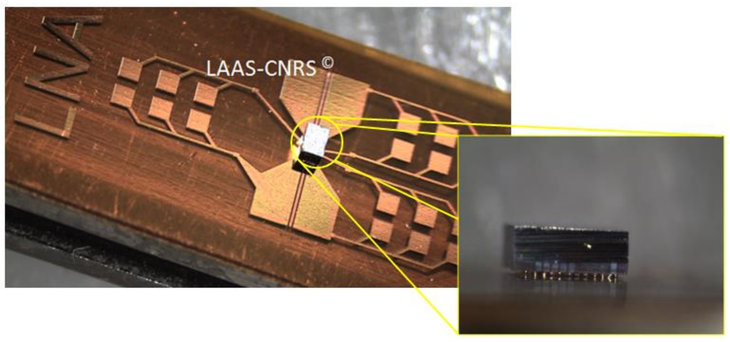
## Radiation pattern measurements in progress





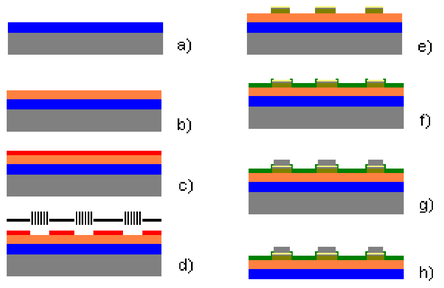
Probe station + rotation arms

## Towards 3D heterogeneous integration on flexible substrate wireless sensor nodes




### Processing methods

a) polymer spin coating for the adhesion;
b) polyimide lamination;
c) resin lift spin coating;
d) photolithography;
e) metallization resin stripping by lift off;
f) passivation layer;
g) soldering screen printing and reflow;
h) substrate peeling




## Future Work

- High performance and small size antenna
- Fully integration of sensor / transceiver / antenna on flexible substrate

Wireless Power Transmission for Sustainable Electronics