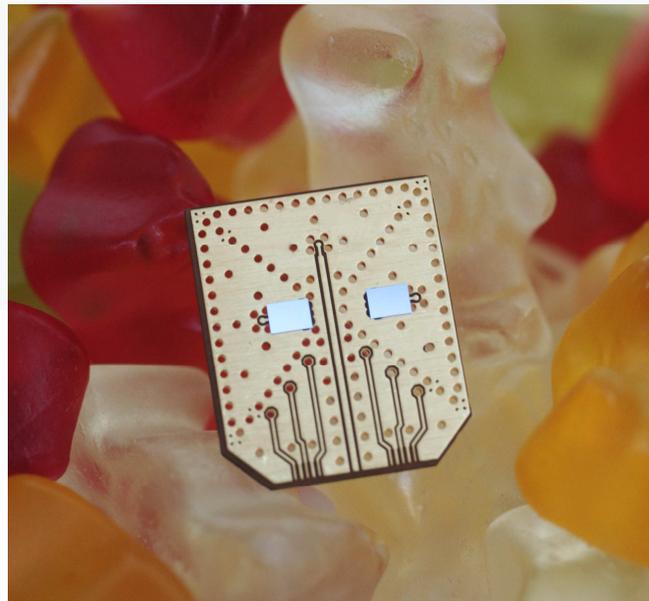


# Projet e-grain : Microsystemes distribués autarciques



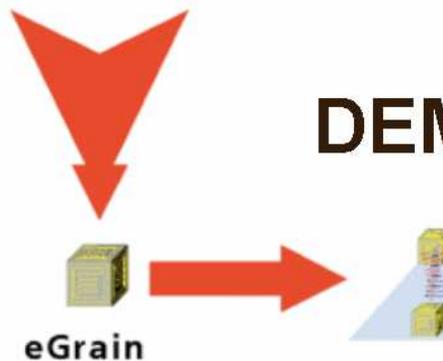
**C. Meliani**

**Ferdinand Braun Institut für Höchst-frequenztechnik  
(FBH), Berlin**

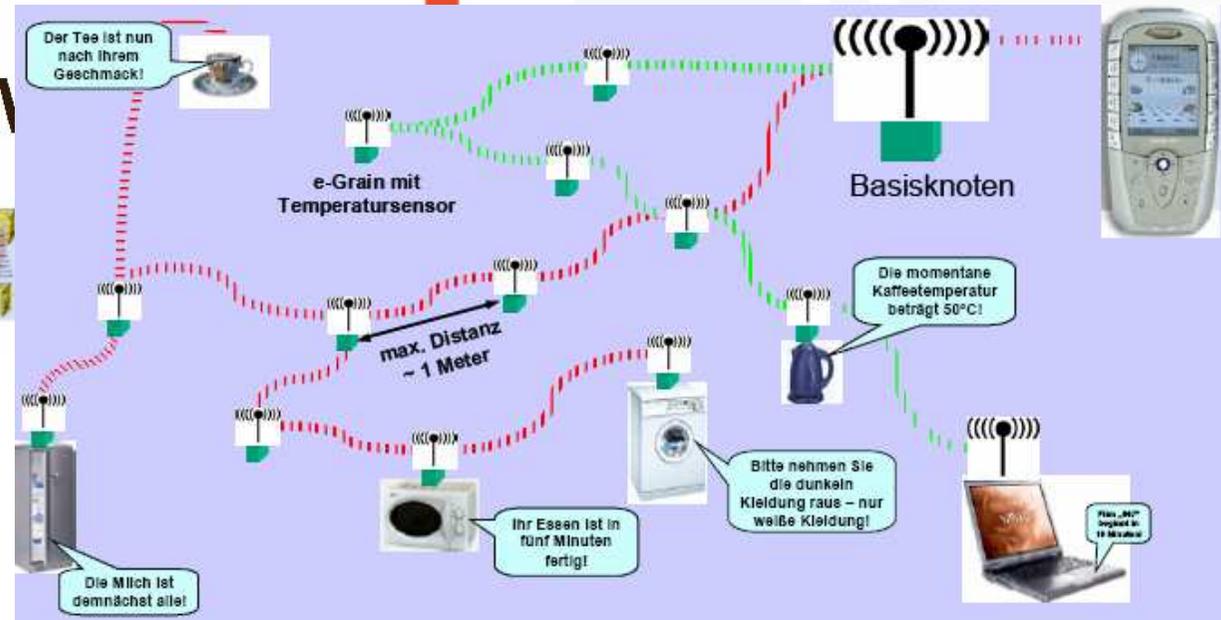
## Le concept (I)



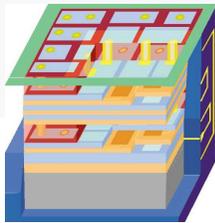
- Communication (bidirectionnels)
- Positionnement (directifs)
- Mesure



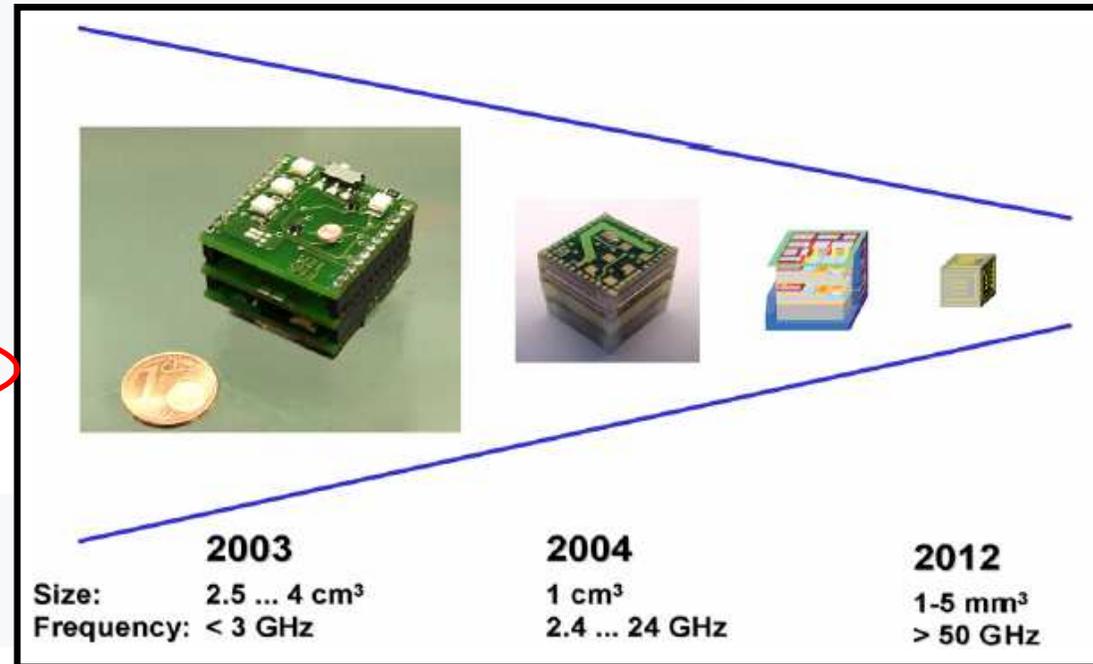
- Miniaturisés
- Multifonctions



## Le concept (II)

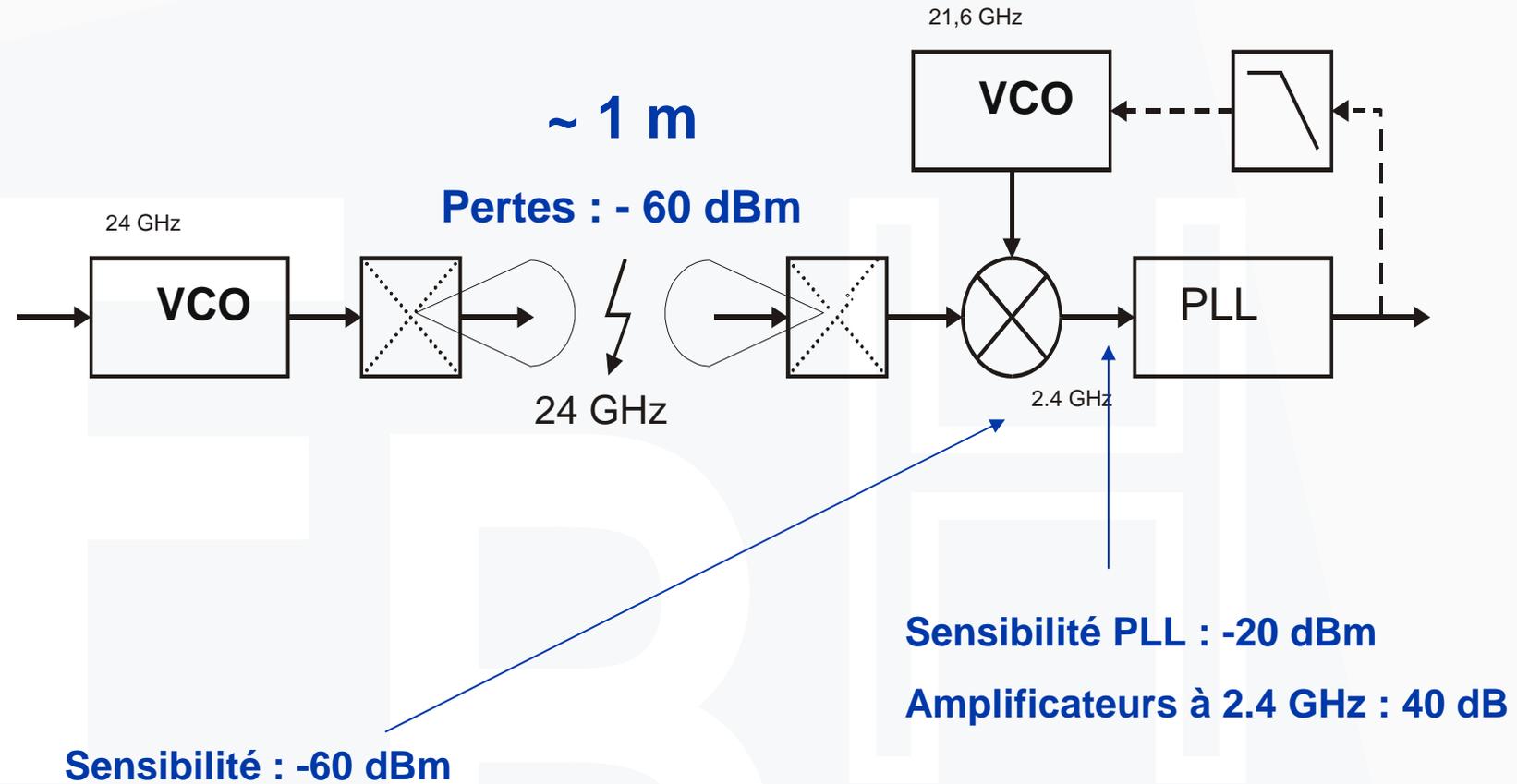


- RF (Composants ...)
- Organe de mesure
- Calculateur
- Énergie

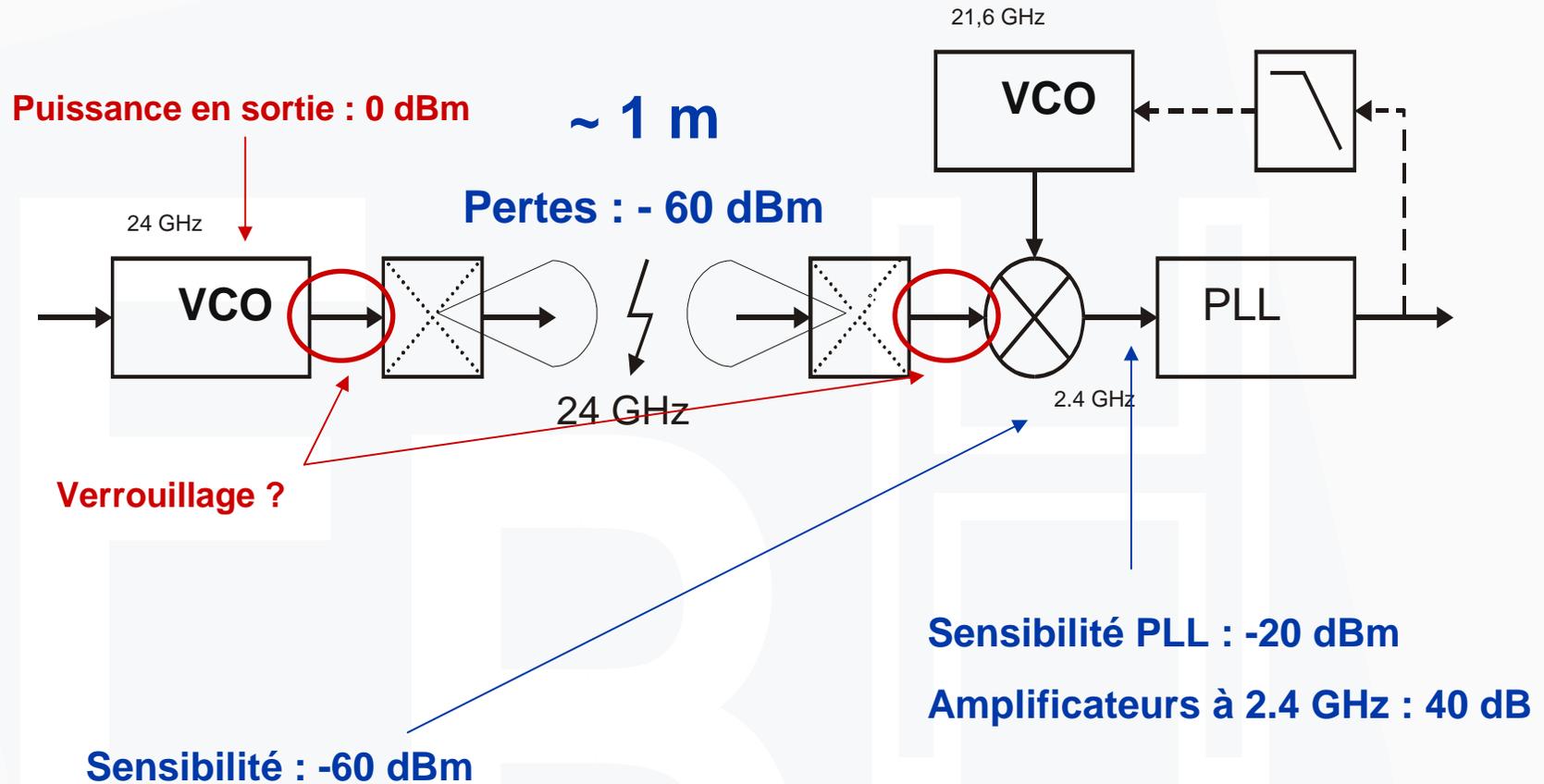


- Configuration système
- Circuits : Fabrication / conception / mesure
- Premières applications système ...

## Configuration système / Performances composants

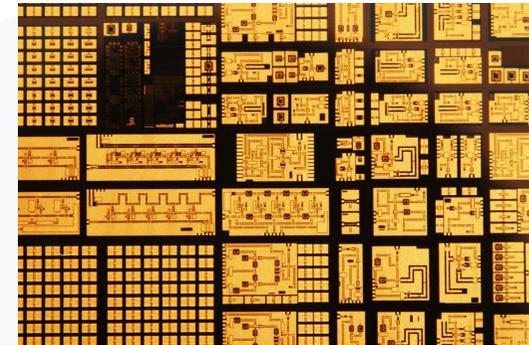


## Configuration système / Performances composants

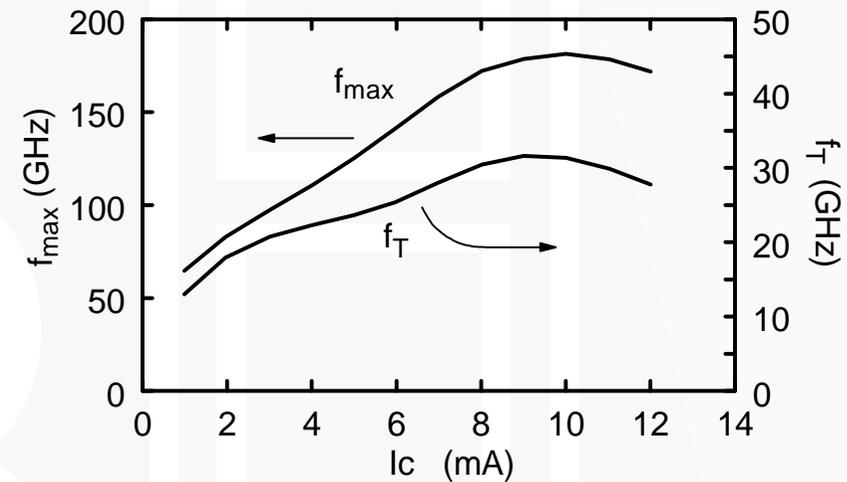


**État de l'art : rendement à 24 GHz ~ 12% → Consommation ~ 10 + 10 + 10 > 30 mW**

## GaAs HBT-MMIC

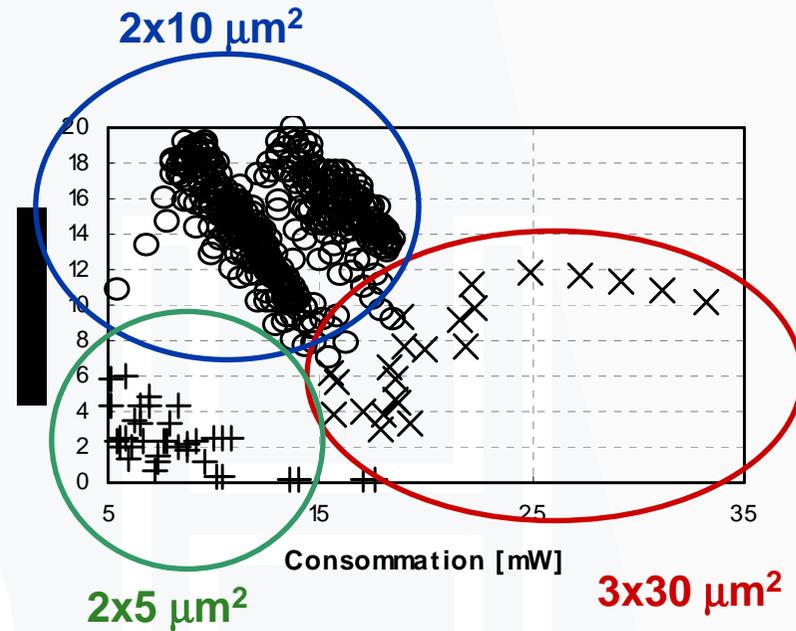
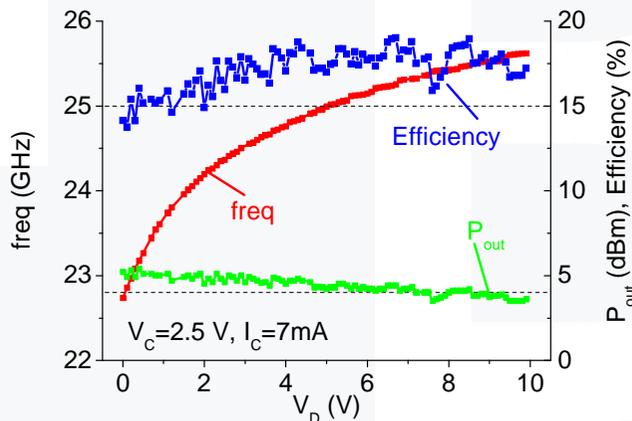
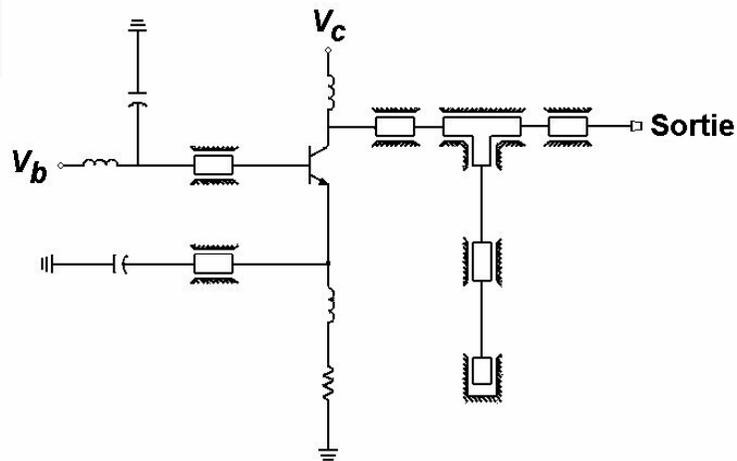


- MOVPE
- 4''
- Environnement coplanaire
- $f_t = 36$  GHz
- $f_{max} = 170$  GHz
- 40 mA ... de courant collecteur :  
 $3 \times 30 \mu\text{m}^2$
- 8 mA ... de courant collecteur :  
 $2 \times 10 \mu\text{m}^2$
- 4 mA ... de courant collecteur :  
 $2 \times 5 \mu\text{m}^2$



# Circuits RF (I)

## L'oscillateur



**Classe AB**

**2x10  $\mu\text{m}^2$**

**Consommation : 18 mW**

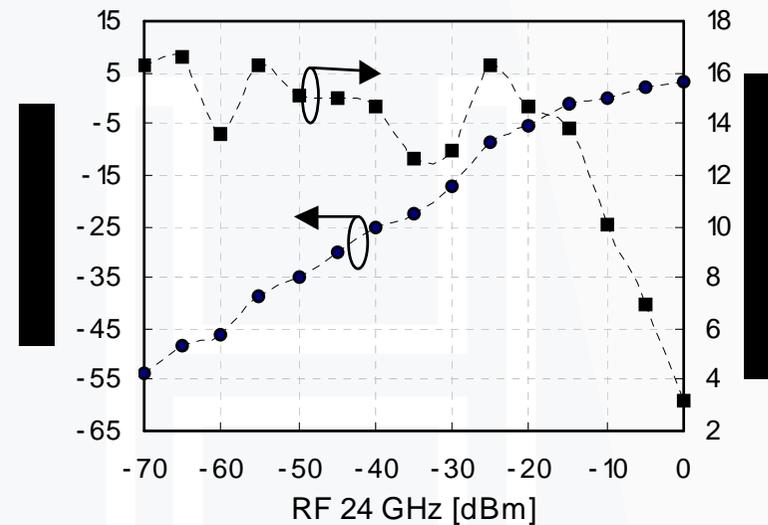
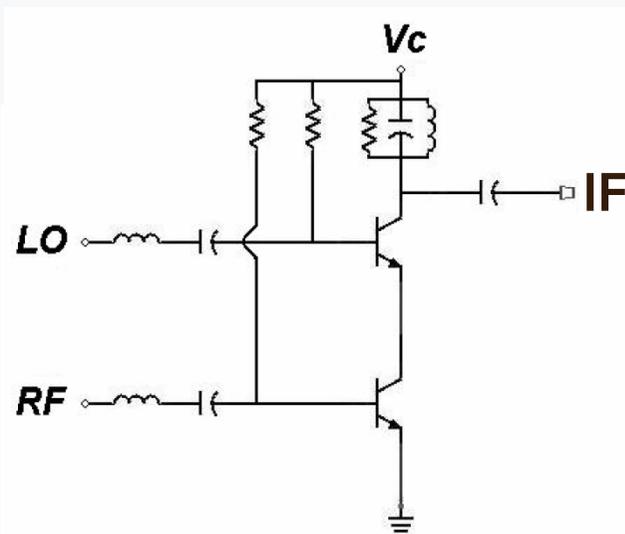
**Puissance en sortie : 5 dBm**

**Rendement : 17%**

**Bruit à 100kHz : -64 dBc/Hz**

## Circuits RF (II)

### Le mélangeur



**Cascode (Isolation + plus intéressant pour la consommation !!!)**

**2x10  $\mu\text{m}^2$**

**Consommation : 17 mW**

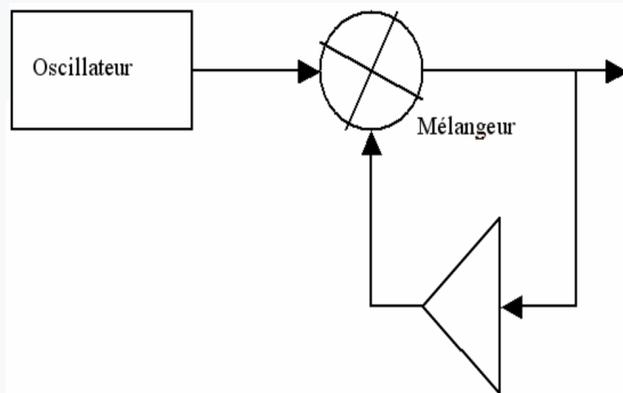
**Gain : 14 dBm**

**Sensibilité : -70 dBm**

**Connecté directement à l'antenne !!**

## Circuits RF (III)

### Le diviseur de fréquence



Division /2, /4

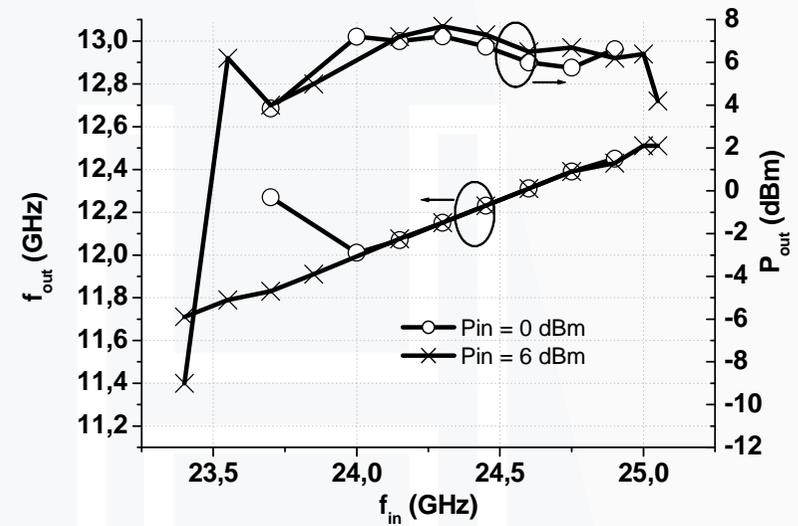
Cascode (Isolation)

$2 \times 10 \mu\text{m}^2$

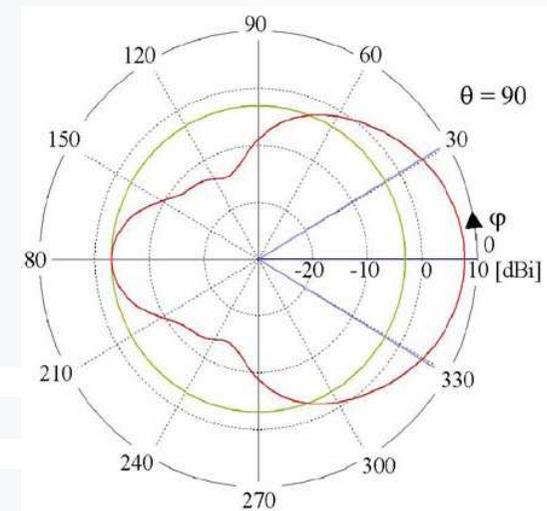
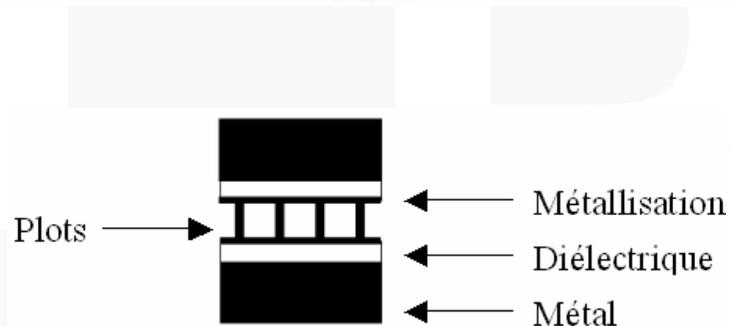
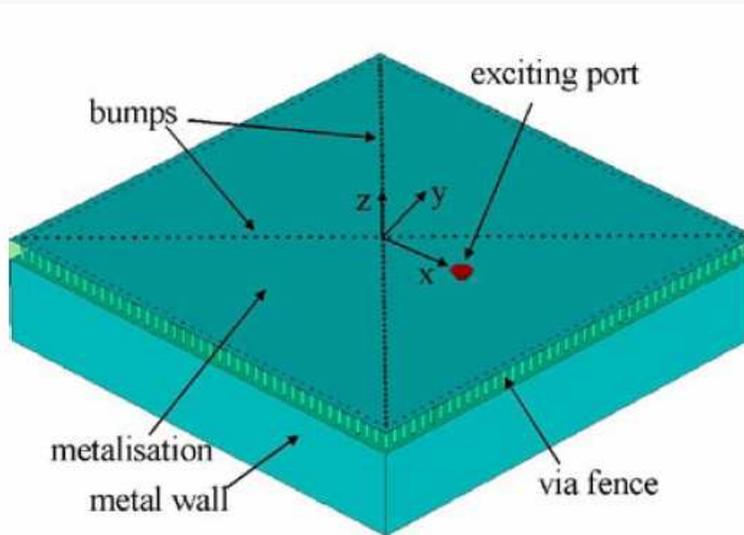
**Consommation : 24 mW !!!**

Puissance en sortie : 6 dBm

Sensibilité : 0 dBm



## Montage mécanique et Antenne (I)



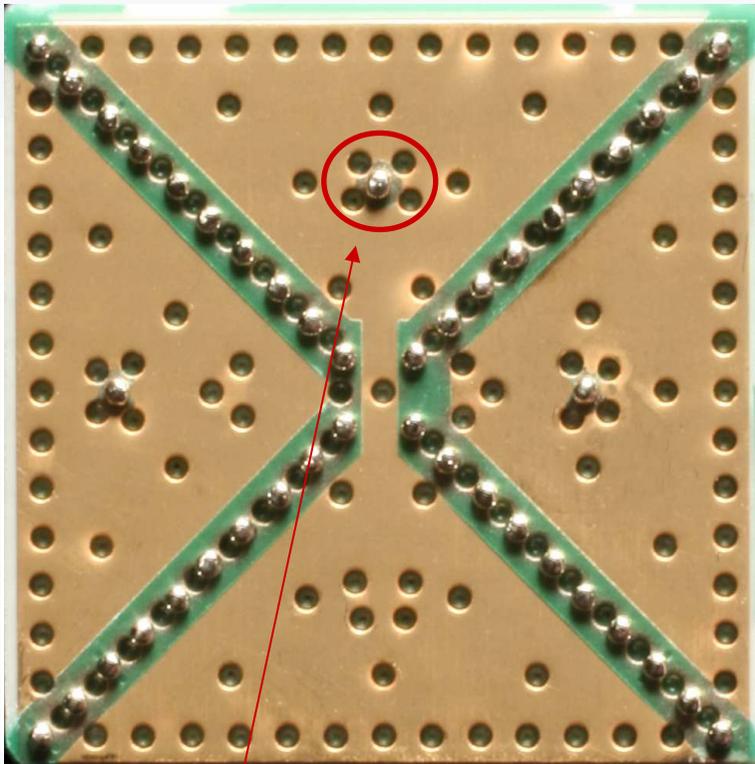
**10x10x0.4 mm<sup>3</sup>**

**4 Antennes**

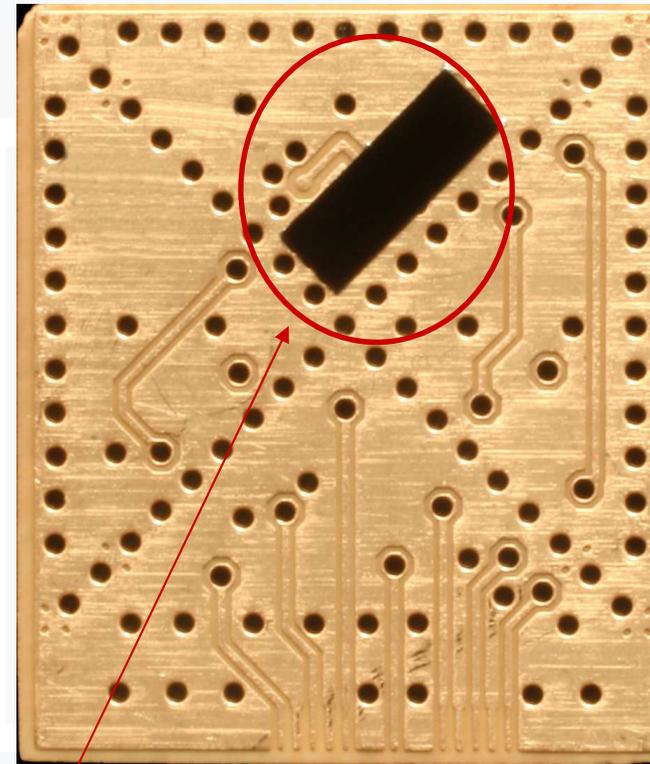
**Directivité : 7dBi**

**Gain : 3 dB**

## Montage mécanique et Antenne (II)

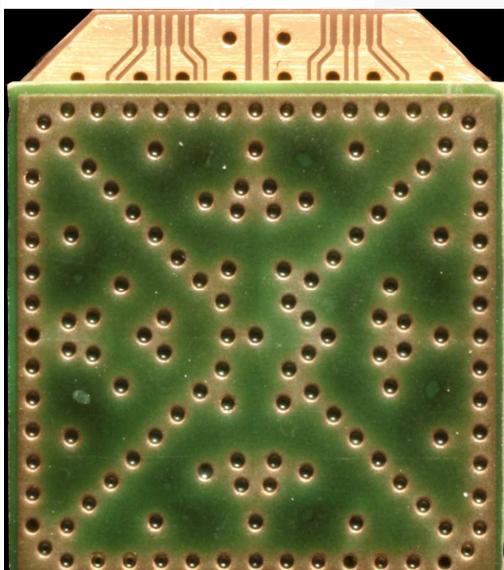


**Plots pour le Flip-Chip**

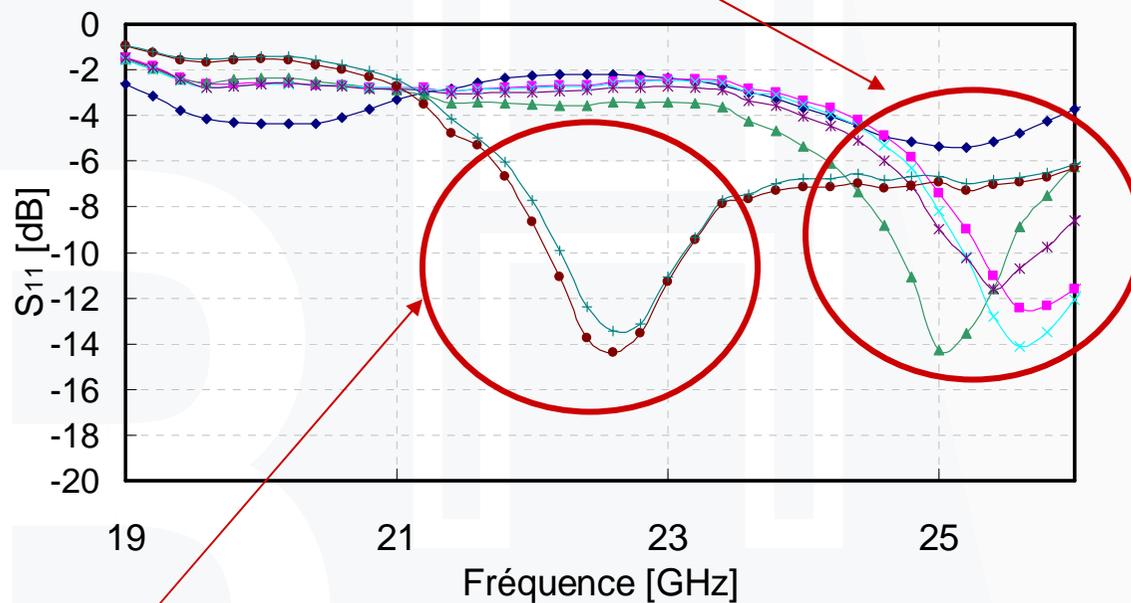


**Circuit mélangeur**

## Montage mécanique et Antenne (III)



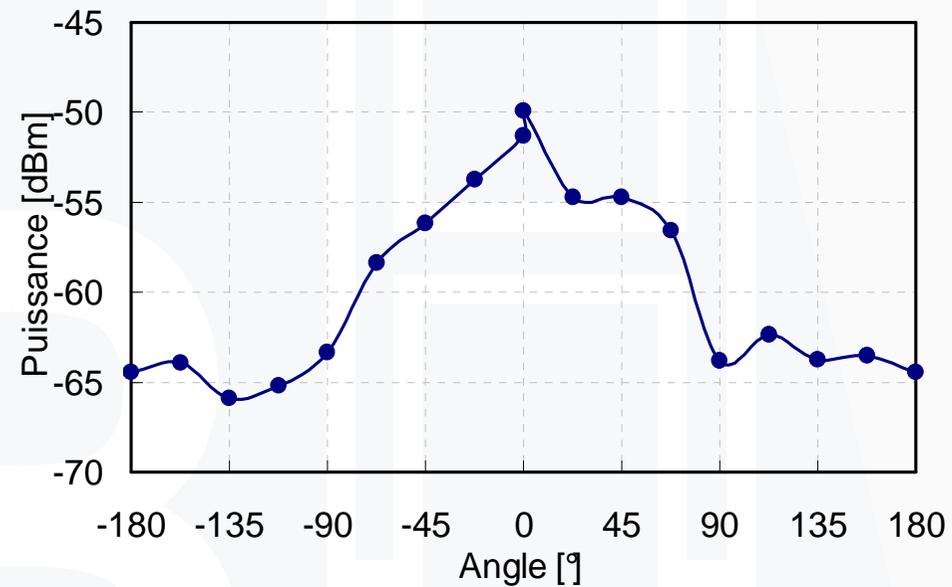
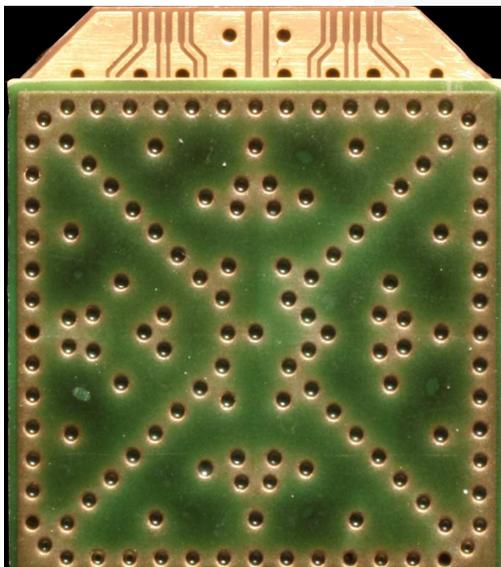
Avec un VCO dans l'antenne



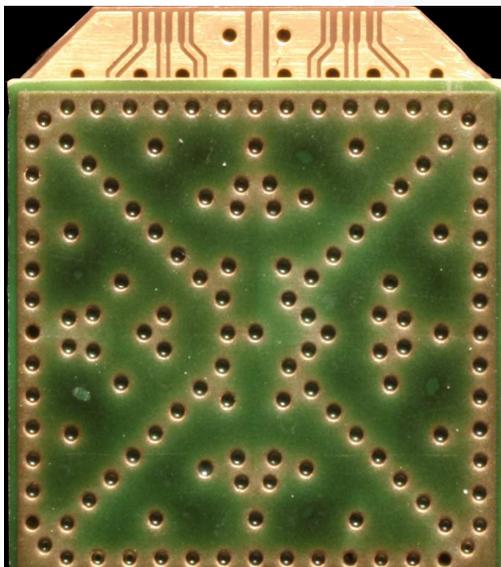
Sans circuits dans l'antenne

## Montage mécanique et Antenne (III)

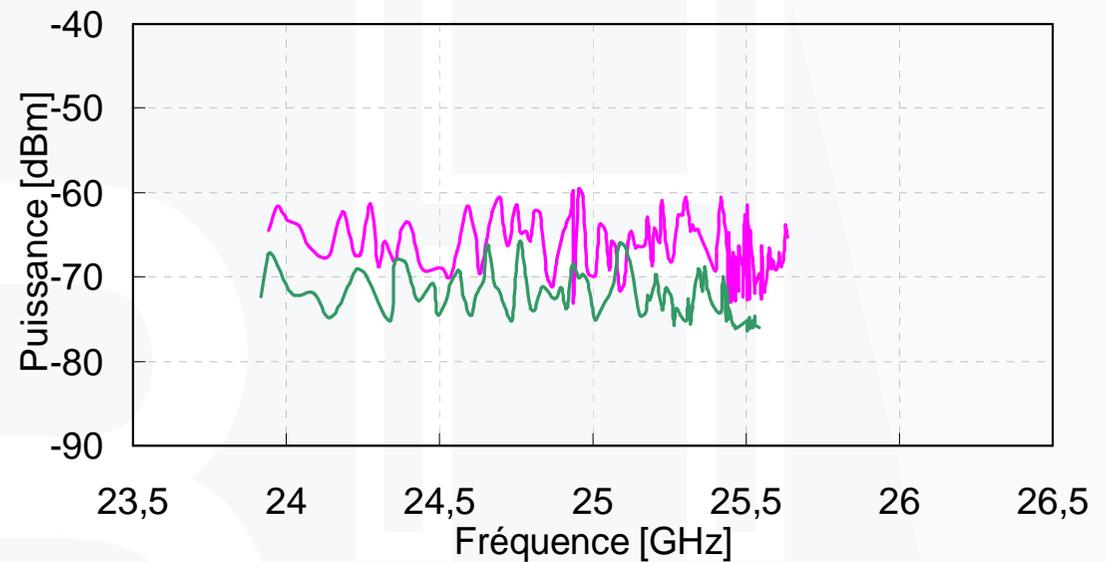
### Directivité à 40 cm



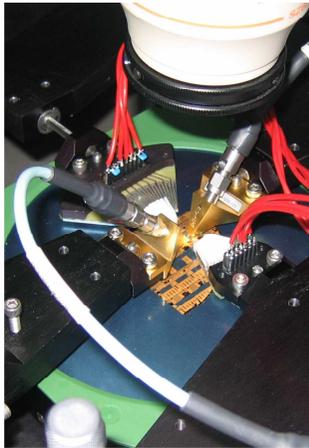
## Montage mécanique et Antenne (IV)



### Transmission à 1 mètre



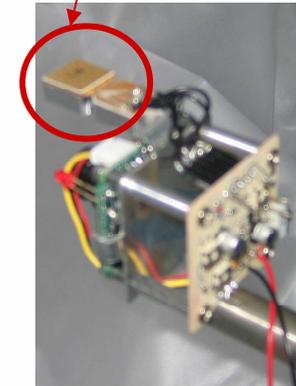
## Transmission vidéo à 24 GHz



Mélangeur sur wafer



E-grain



E-grain

Caméra

Modulation FM

50 MHz

## Transmission vidéo à 24 GHz



## Conclusions

- Réseau AVM 24 GHz
- 40 mW de consommation pour la partie RF
- Terminaux 1x1x0.4 cm<sup>3</sup>
- Antennes directives
- Transmission vidéo à 24 GHz
- La suite ...
- Plus petit
- Une autre technologie ...

