



# Utilisation des gammes de fréquences millimétriques et submillimétriques pour des applications sécuritaires

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Toulouse 11/10/2018

## MC2-Technologies over 14 years of RF Engineering

- **History** : Spin-off from the research laboratory IEMN (*Institute of Electronics, Microelectronics and Nanotechnology*) since 2004.
- **Located** at Lille, an European city in the northern tip of FRANCE between Paris, London and Brussels .
- **Employees** : approximatively 50 (in 2018), and 200 in 2022.
- **Turnover** : >10M€ in 2017.



### Main Partners



## MC2-Technologies New building



Surface: 2500 m<sup>2</sup>, Investment: 6 M€



## MC2-Technologies products and services

### Security Products

MM-Imager:  
Body scanner



UAV Scramblers

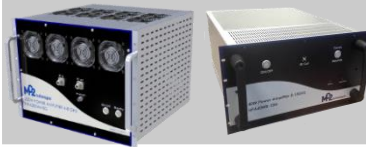


Shield meter

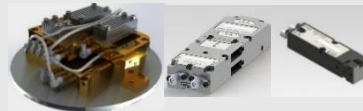


### Microwave Products

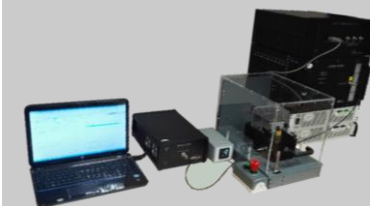
Amplifiers



TR modules  
mmW



Test benches

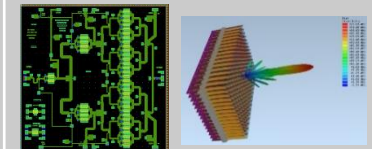


Bias tee, Kit  
SMM

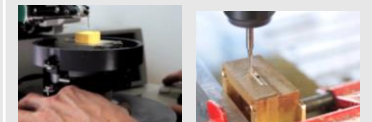


### Services

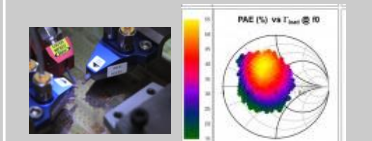
Design MMIC  
& antennas



Prototyping



Electrical  
Characterization



Reliability tests



**Continuous R&D program on all products and services (H2020, ANR)**

## MC2-Technologies products and services

### Security Products

MM-Imager:  
Body scanner



UAV Scramblers



Shield meter

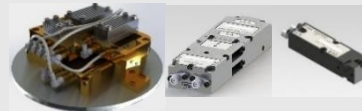


### Microwave Products

Amplifiers



TR modules  
mmW



Test benches

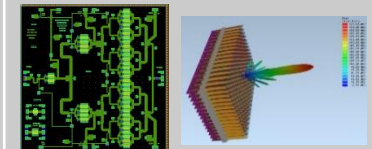


Bias tee, Kit  
SMM

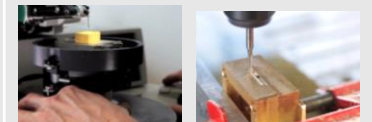


### Services

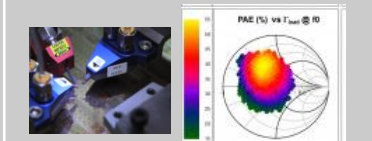
Design MMIC  
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Prototyping



Electrical  
Characterization



Reliability tests



Focus On

Continuous R&D program on all products and services (H2020, ANR)

## Security Products

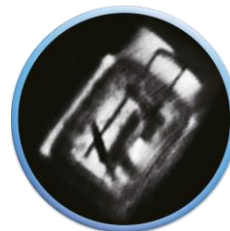
### MM-Imager technologies

#### MM-Imager90 series THz Passive Imaging System

- ✓ Innovative body security check system
- ✓ Based on the Passive Millimeter Wave Imaging
- ✓ Effective solution for non-contact security controls
- ✓ Automatic detection technologies: Respect of the personal privacy
- ✓ Detection of metallic or non-metallic objects hidden under the clothes
- ✓ Safer leading technology, more convenient, and without any risk for the people



MM-Imager's real-time technology was developed with the support of the French army (DGA) and the European commission as part of the program SPIDERS H2020 project (#674274)

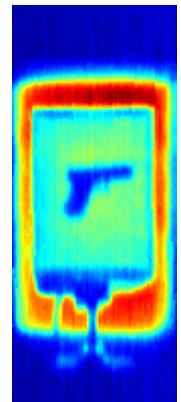
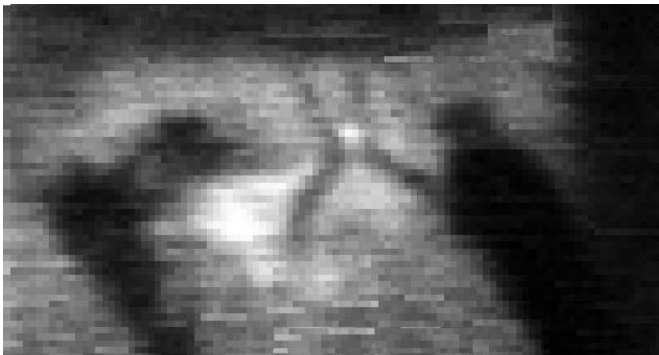
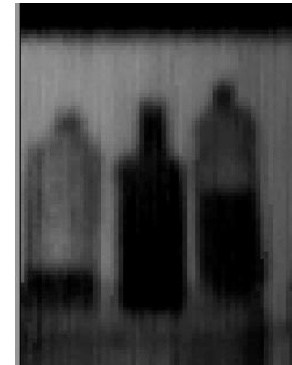
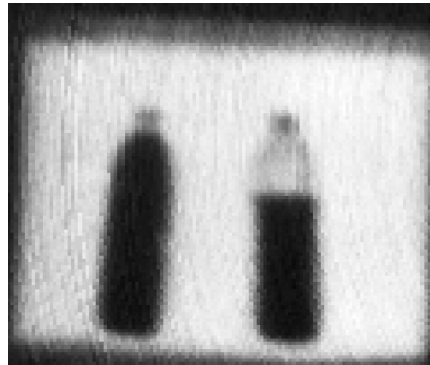
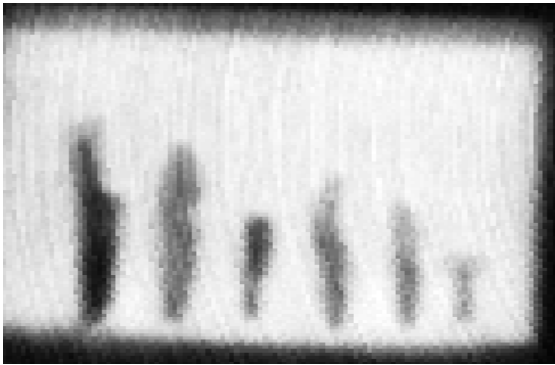


## Security Products

### MM-Imager technologies

MM-Imager90 series THz Passive Imaging System

- Post parcel post scan imaging





## Security Products

### MM-Imager technologies

MM-Imager90 series THz Passive Imaging System

- Typical human microwave images: Outdoor (1s/image).

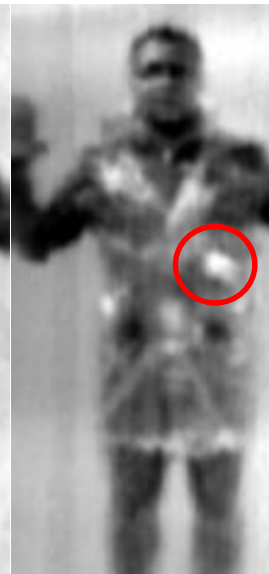
Keys and Water



Ceramic knife



Smart phone



Gun





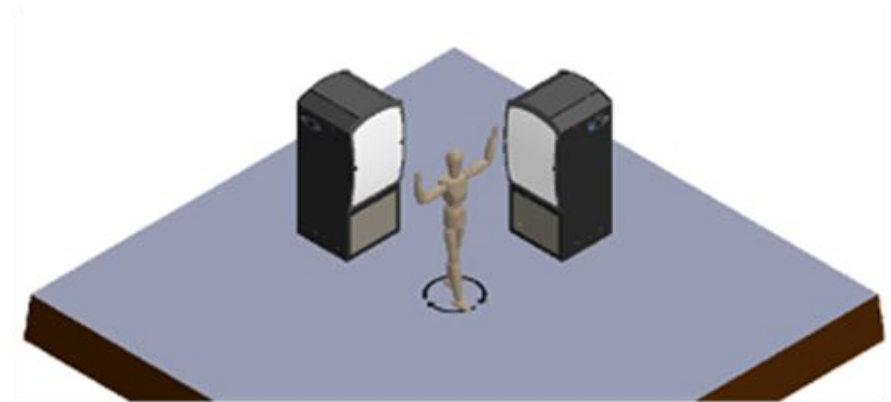
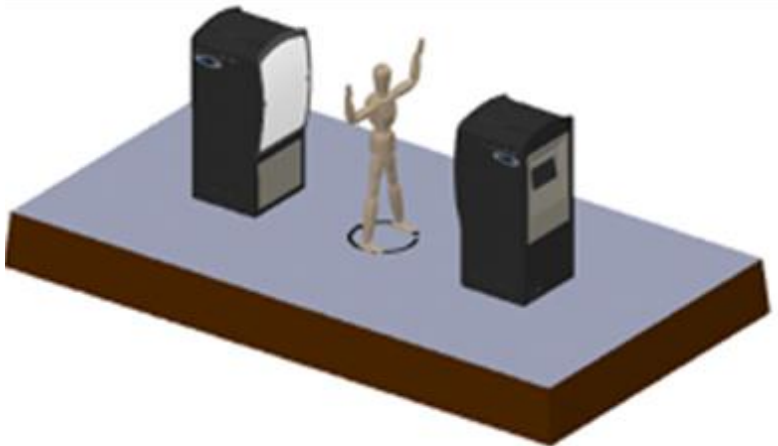
## Security Products

### MM-Imager technologies

#### MM-Imager90 series THz Passive Imaging System

- Real time operation up to 10f/s, automatic object detection in **collaborative mode**.

- People are screened at a checking area, 360° rotation is required.



## Security Products

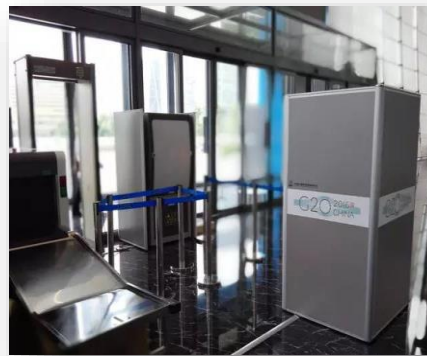
### MM-Imager technologies

MM-Imager90 series THz Passive Imaging System

Beijing Metro station



G20 2016 –China (Hangzhou)



Checkpoint police at Tumxuk



Shanghai exhibition center



Shanghai railway station



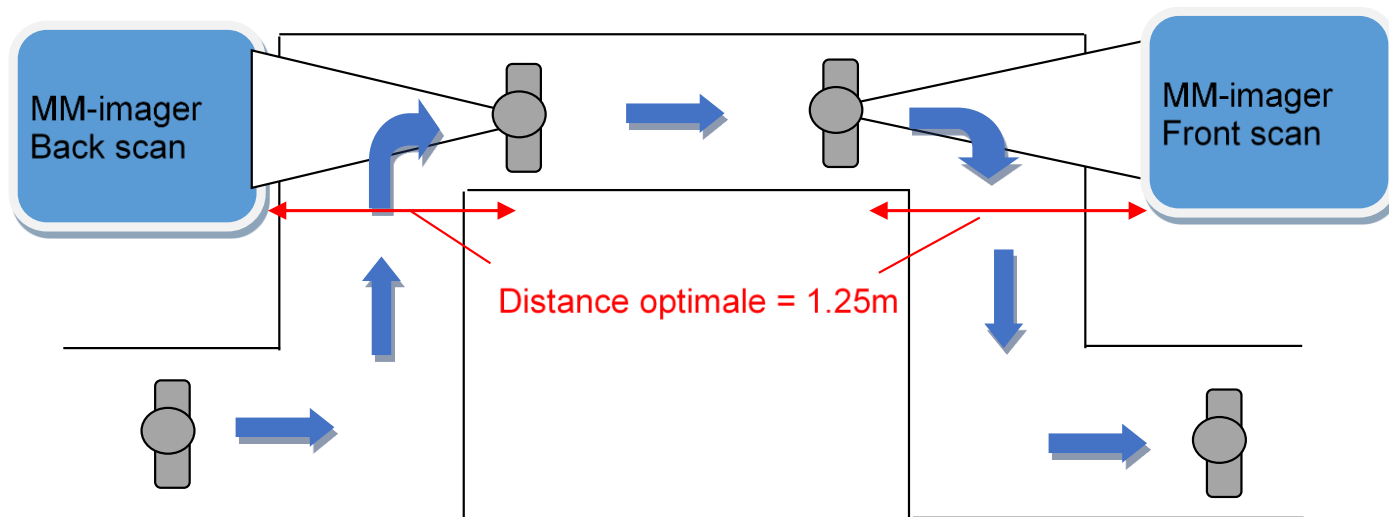
## Security Products

### MM-Imager technologies

MM-Imager90 series THz Passive Imaging System

- Real time operation up to 10f/s, automatic object detection in **non collaborative mode (corridor)** .

- People walking through a corridor and are scanned from the front and back.





## Security Products

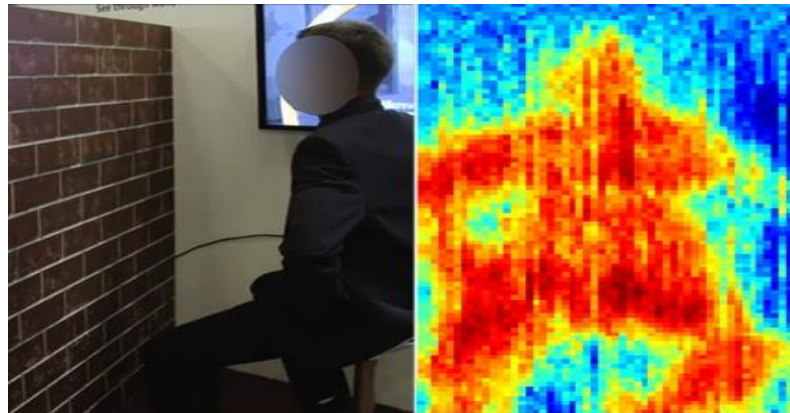
### MM-Imager30 Through-wall imaging systems



- ✓ Criminal investigation, anti-terrorism, hostage rescue
- ✓ Passive imaging technology, high sensitivity detectors
- ✓ Personnel location inside building, status monitoring
- ✓ Penetrable material: brick, concrete, wood, plaster, plastic, fabric, glass, fiber
- ✓ Work distance: 1-10m adjustable focus

## Security Products

### MM-Imager30 Through-wall imaging systems



Demonstration at EuroSatory Exhibition in Paris

## Security Products

### Landing Aid Technologies

All-weather airborne ILS (Instrument landing system) radar system



**Brownout = No Visibility**



Need a passive or active millimeter wave imager to obtain an image of the terrain below the rotorcraft during the landing.

**A specific approach is used before landing :**

1. Rotorcraft scan the terrain in front of and localize the good area for landing.
2. Rotorcraft goes above the good area.
3. Rotorcraft goes down in brownout (no visibility).

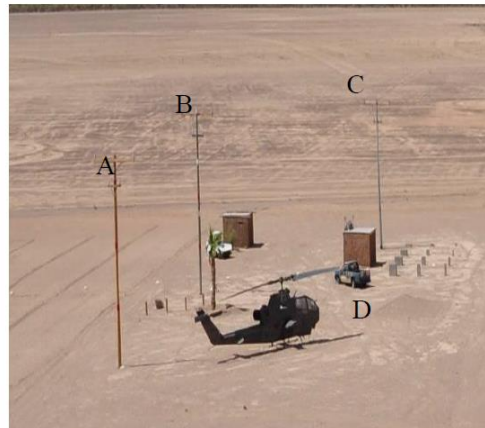
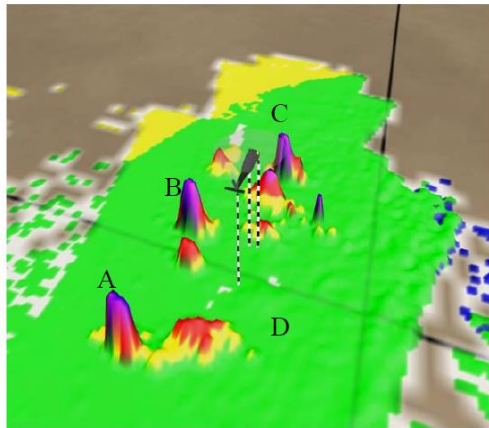
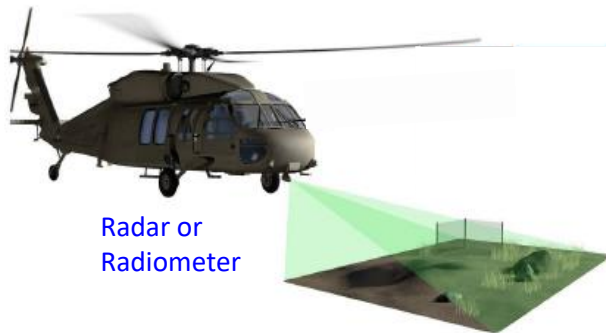




## Security Products

### Landing Aid Technologies

All-weather airborne ILS radar system



#### Multi sensors needed:

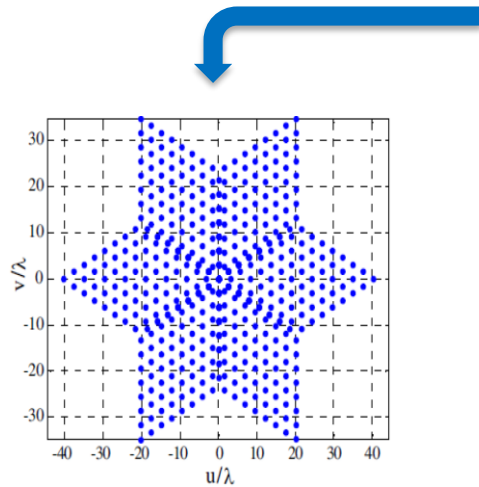
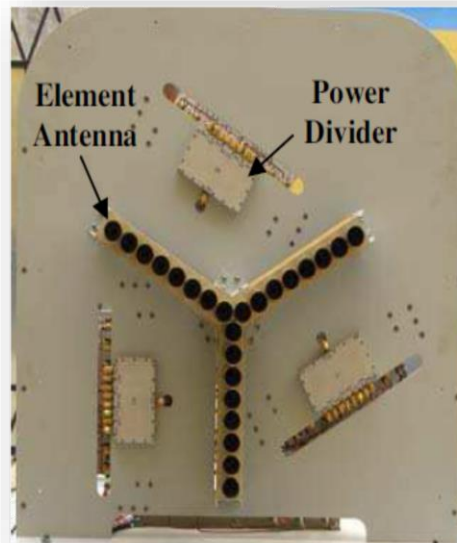
- Radar or radiometer systems working at 94GHz to obtain the terrain morphology.
- TR modules based on OMMIC MMIC are perfectly dedicated for such application:
  - Compact module
  - High power emitted (27dBm)
  - Low noise figure (<6dB)
- GPS + inertial navigation system to geo-locate radar returns relative to a stored digital terrain database.

## Security Products

### MM-Imager technologies

- New imager based on compressive synthetic aperture interferometric radiometer

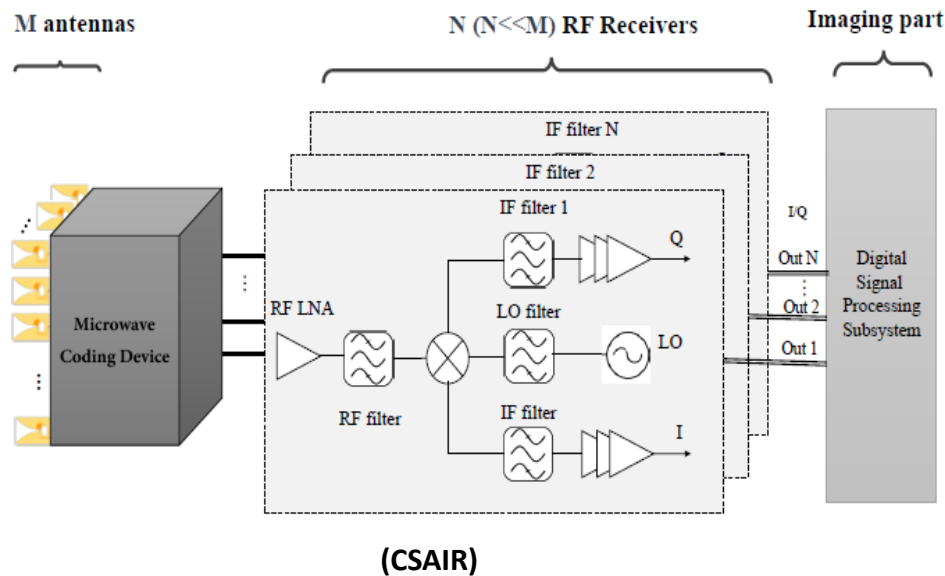
Synthetic Aperture Interferometric Radiometer (SAIR)



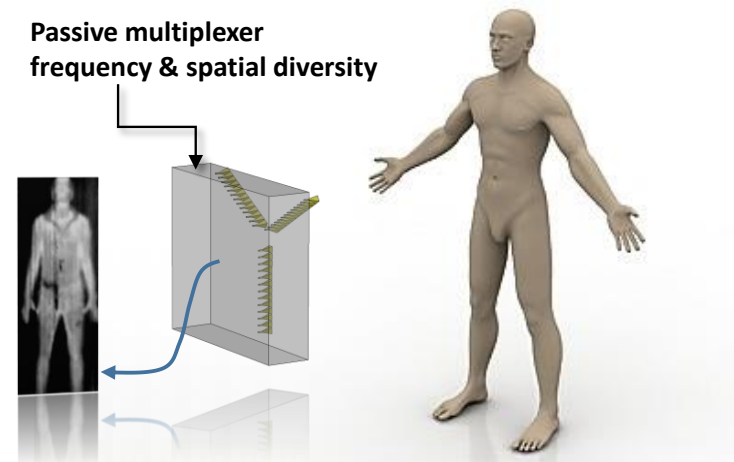
Cheng Zheng et al. Univ. of Nanjing  
PIER-B, 2013



# Security Products



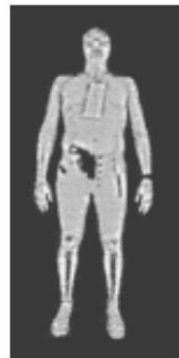
Passive multiplexer  
frequency & spatial diversity



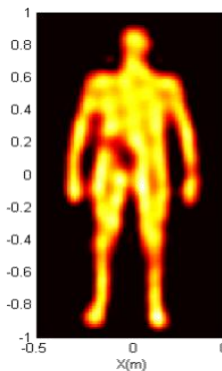
The projects PIXEL (#DS0901) and SPIDERS (#674274) are supported by the European Commission (EC), French army (DGA) and the French National Research Agency (ANR).



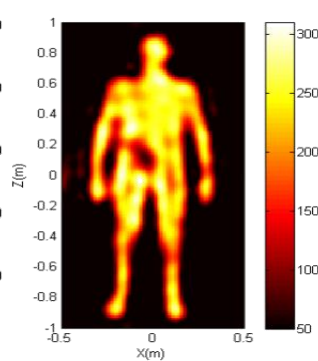
Original Image



SAIR



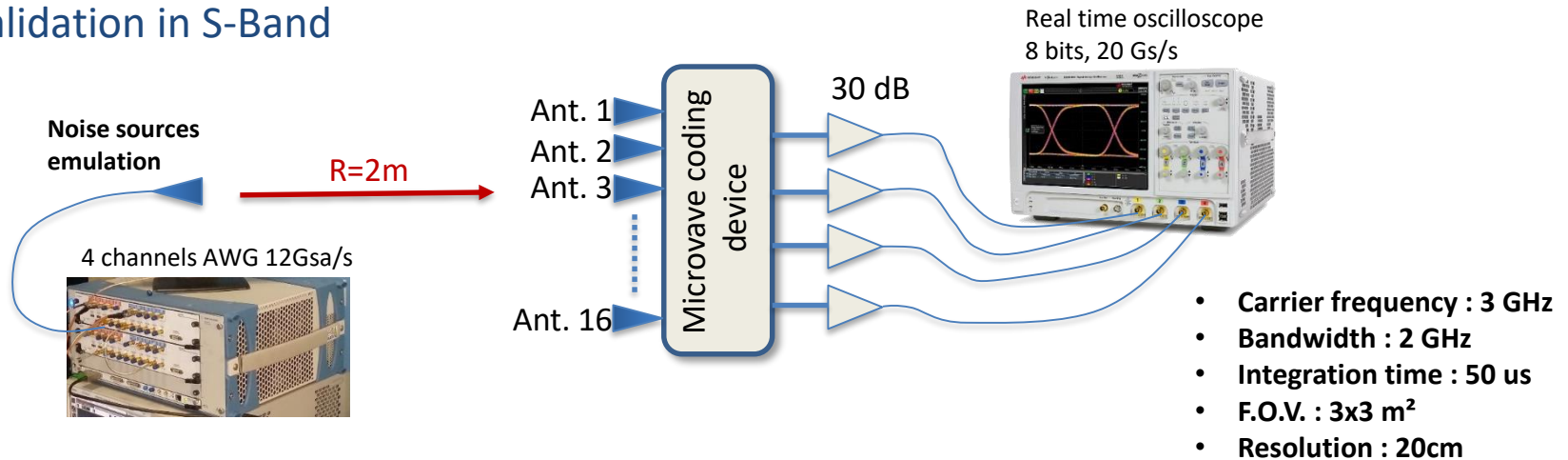
CSAIR



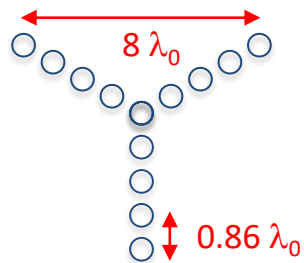


## Security Products

### → Validation in S-Band



### 16 Vivaldi Antennas

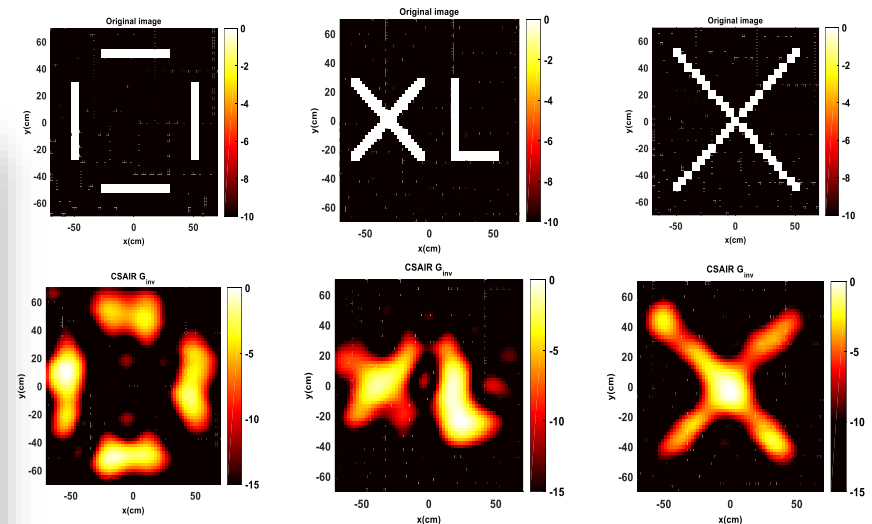


Vivaldi antennas



## Security Products

### Continuous source distribution emulation

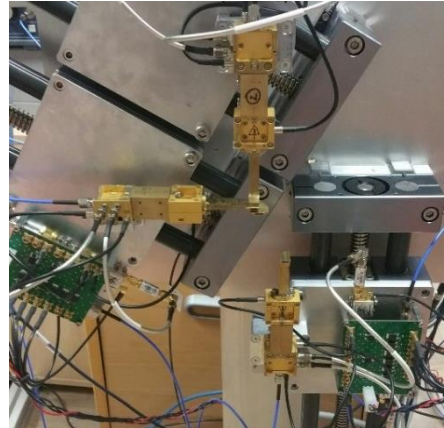


- ✓ Proof of the CSAIR concept in the S-Band (16 antennas and 4 receivers).

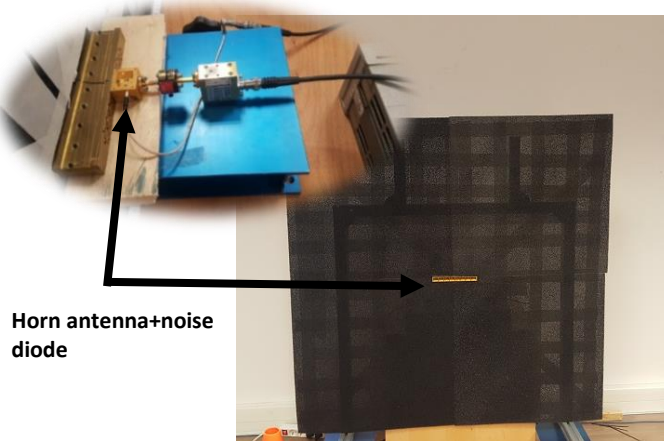
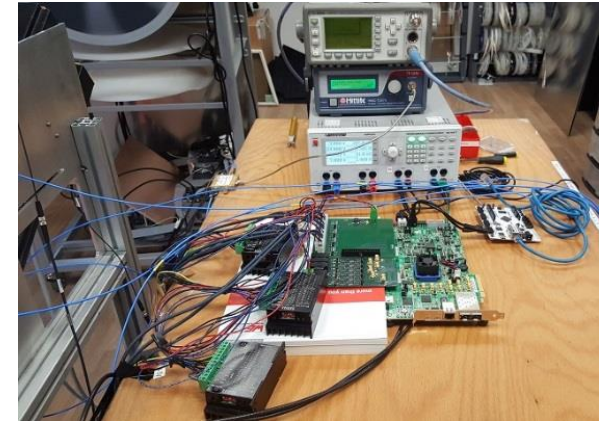
**What about the Millimeter-Wave CSAIR concept?**

# Security Products

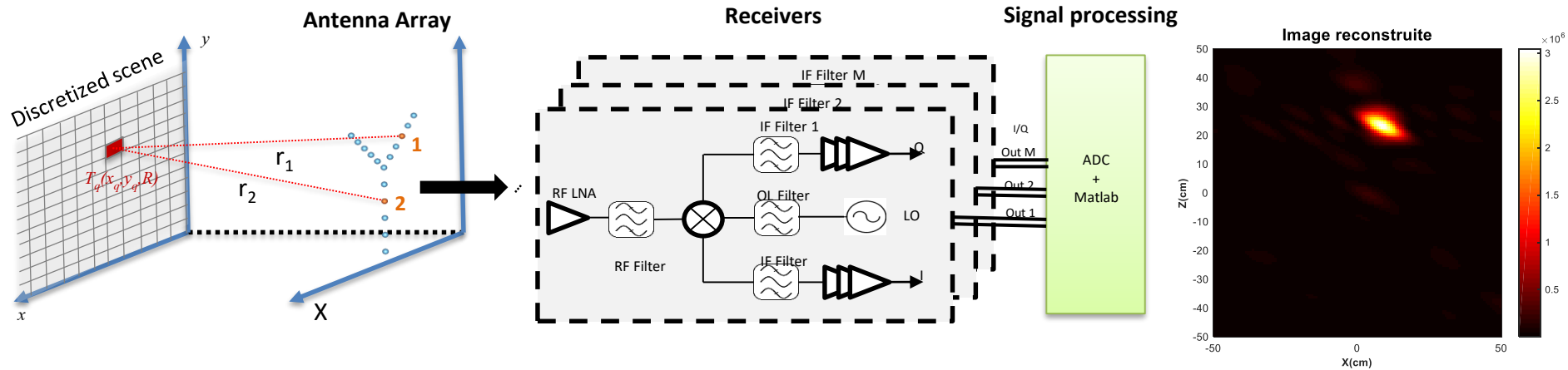
RF chaines+Horn antenna



ADC+FPGA



Horn antenna+noise diode

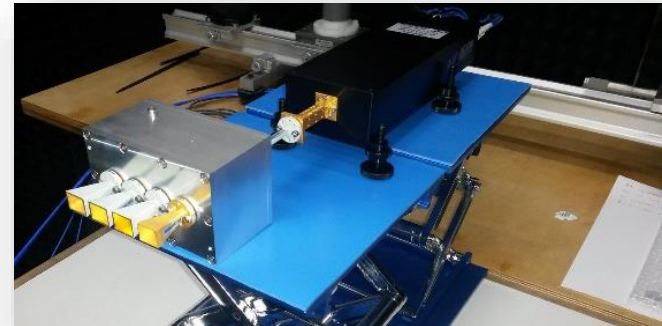
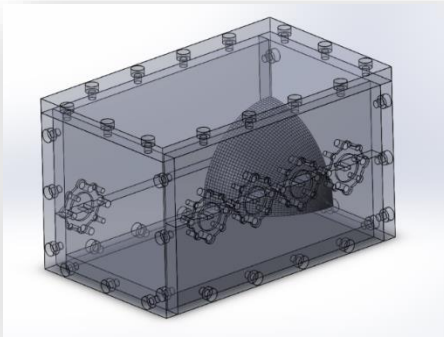




## Security Products

### 4x1 mmW cavity prototyping

- Cavity manufacturing (MC2, SAP)
- 3D impression (i3D concept)



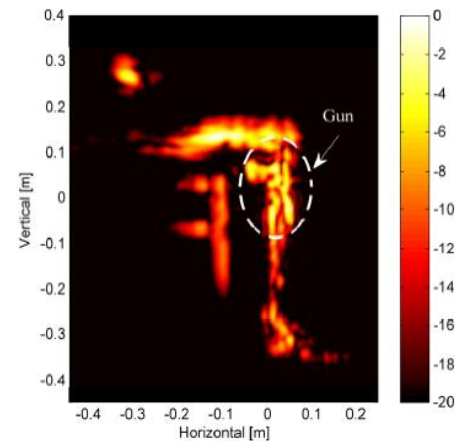
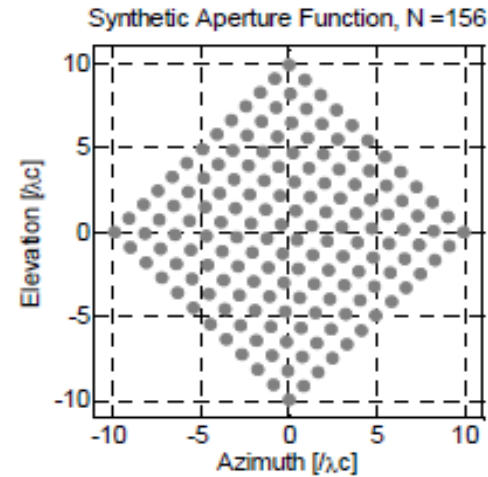
	$ S_{ij} $ moyen	Time Decay	Q factor
CST microwave	-15 dB	75 ns	45 000
Proto Meca	-18 dB	36 ns	22 000
Proto 3D	-29 dB	3 ns	2 000

## Security Products

Active systems : MIMO Radar imageur



*Zhuge et al. PhD dissertation, Delft Univ of Technologies*



# Thanks for your attention!

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