TeraSCREENn Project

Multi-frequency multi-mode Terahertz screening for border checks

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Multi-frequency multi-mode Terahertz screening for border checks

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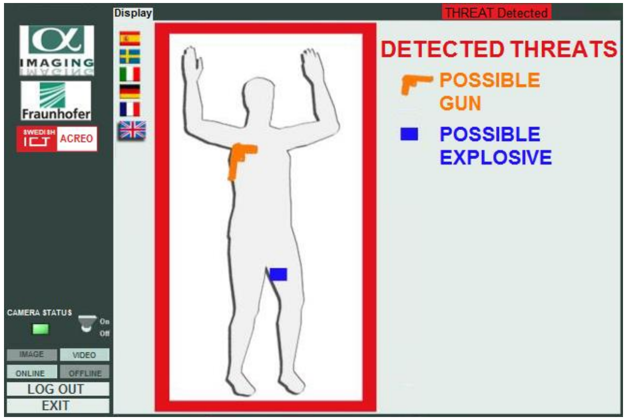
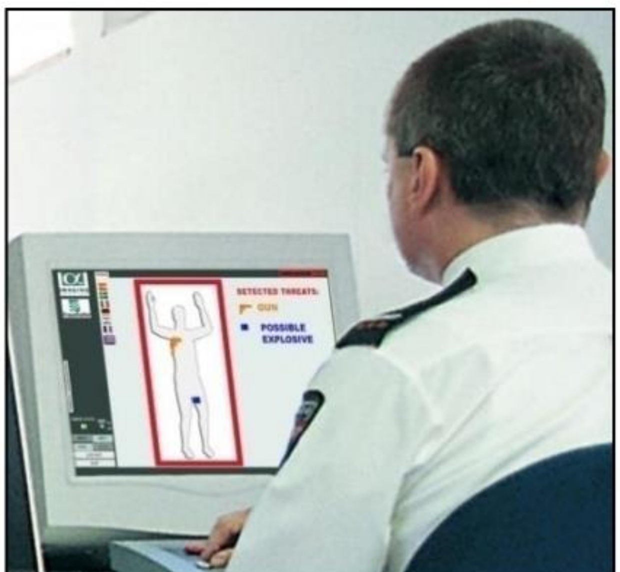
INTRODUCTION TO TERASCREEN PROJECT





Project parameters:

- Finish Oct. 2017
- 11 partners, 6 countries
- Project Coordinator: ICTS (UK)
- 4.7M€ (3.5M€ EU contribution)

Why?

- Growing security requirements
- Improve efficiency
- Improve security
- Reduce operator stress
- Maintain personal integrity

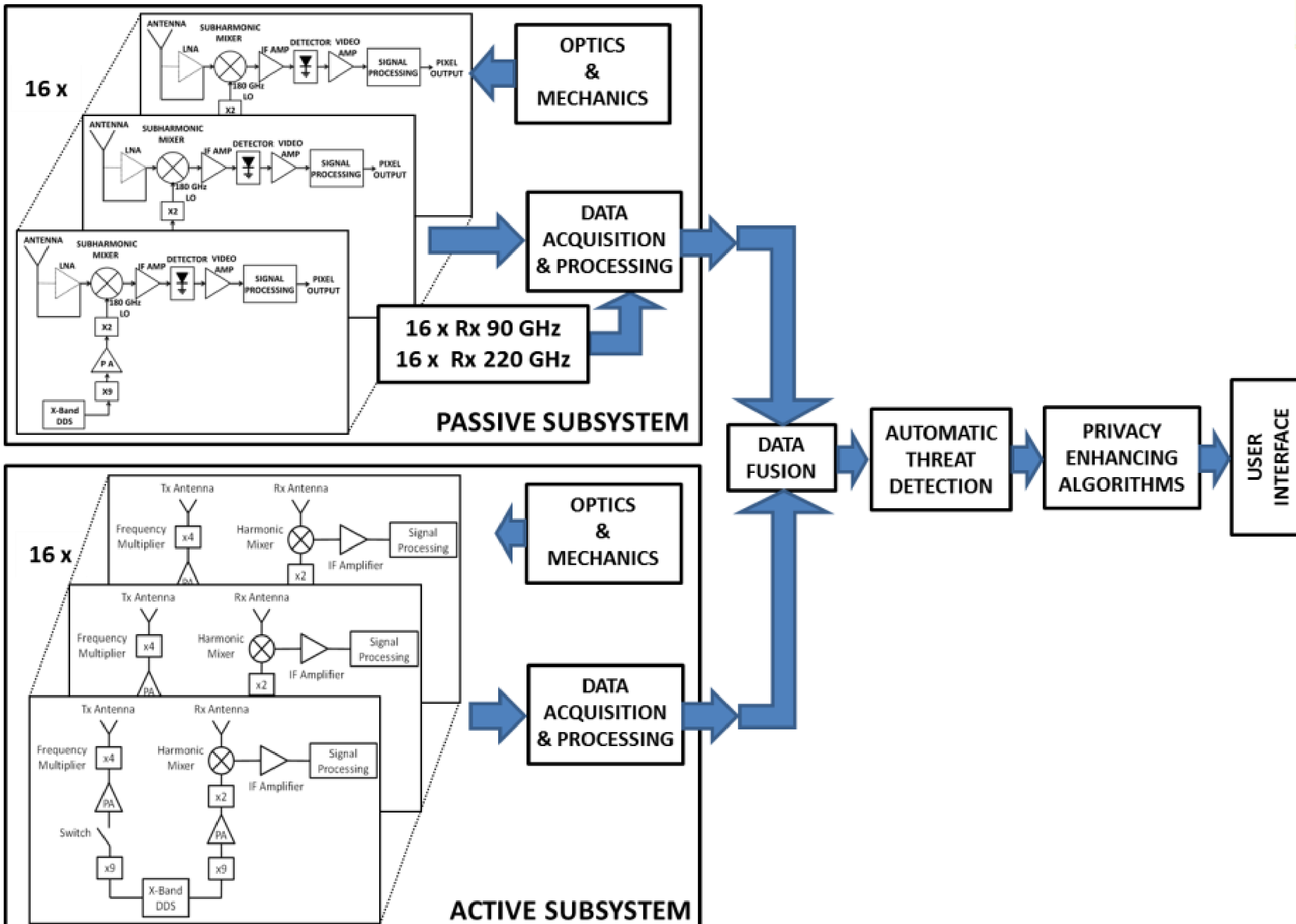
TERASCREEN PROJECT OBJECTIVES

- Develop a security screening system:
  - safe
  - high throughput
  - respects privacy
  - automatic potential threat detection and classification
- Demonstrate TeraSCREEN Prototype System in a live border control environment
- Develop components if no OTS alternatives
  - e.g. 360 GHz LNA, subharmonic mixer
- Develop sensor data fusion and image processing
  - including Automatic Object Detection and Classification
  - Privacy Enhancing algorithms complying with EC Regulations
- Develop TeraSCREEN Prototype System user interface

TERASCREEN CONCEPT

- Combine several passive operating frequencies (360 GHz, 220 GHz and 94 GHz passive subsystem)
  - emissive, transmissive, reflective & scattering properties of materials change with frequency
  - show material differences in the scene
  - thus increase the detection capability
  - provide first step towards object classification
- Combine passive operation with active at 360 GHz
  - active imaging in this band is safe
  - complements passive detection by providing high image resolution & depth (time of flight) information
  - provide second step towards object classification.

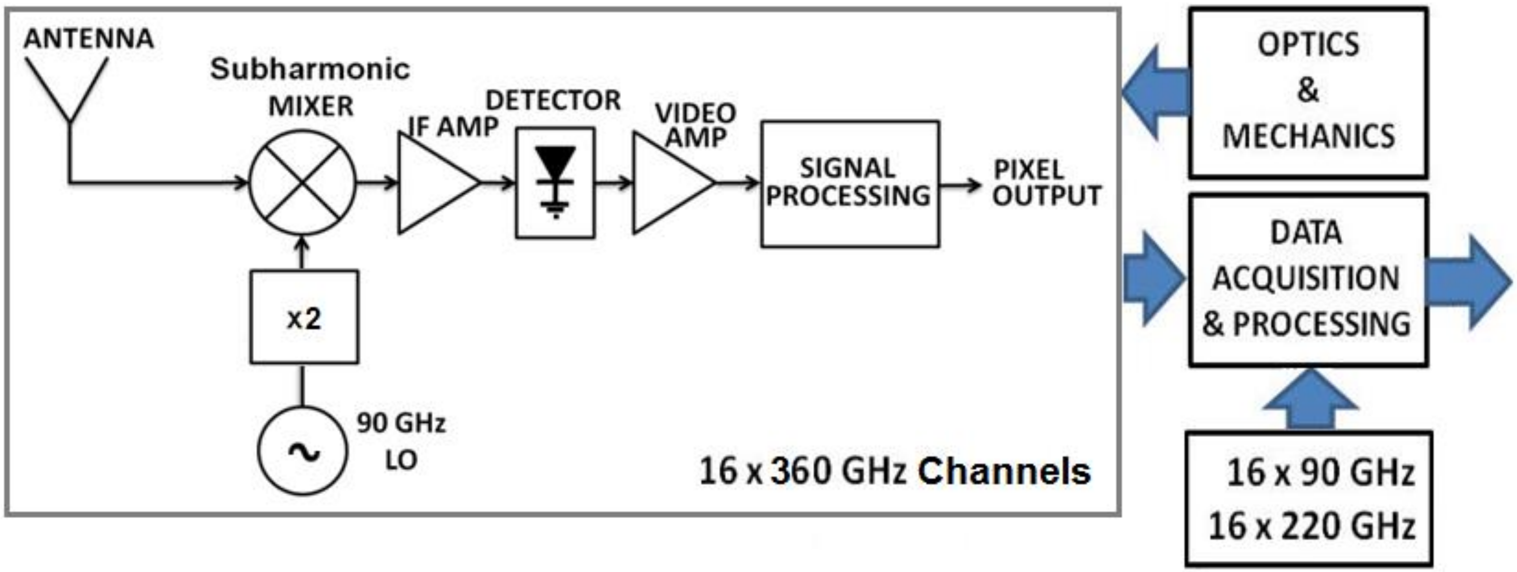
TERASCREEN CONCEPT



TERASCREEN
ACREO'S ROLE

- System simulation modelling
  - specification platform for 360 GHz passive subsystem
- 360 GHz passive subsystem packaging and assembly
  - transition, cavity, interconnect and package design
  - back-end electronics design
- 360 GHz passive subsystem module integration, characterisation and test
  - integration of 16 channel
- Complete passive subsystem integration
  - integration of 94 GHz, 220 GHz and 360 GHz arrays
- Integration with active subsystem

PASSIVE 360 GHz SUBSYSTEM

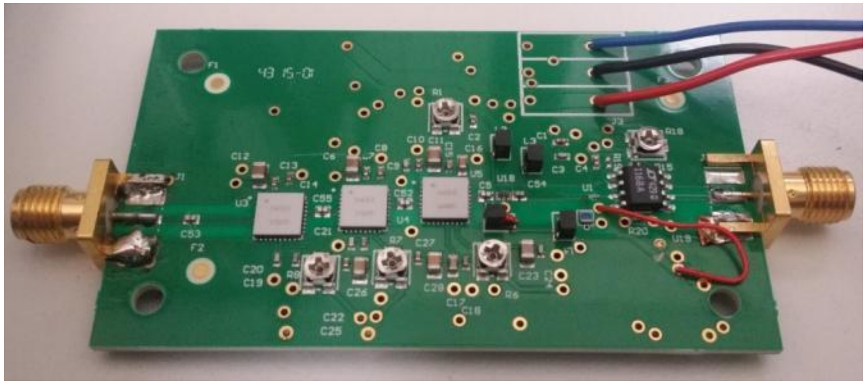


- 16 Rx pixels
- 30 GHz bandwidth (345 GHz → 375 GHz)
- Target distance 3-5 m

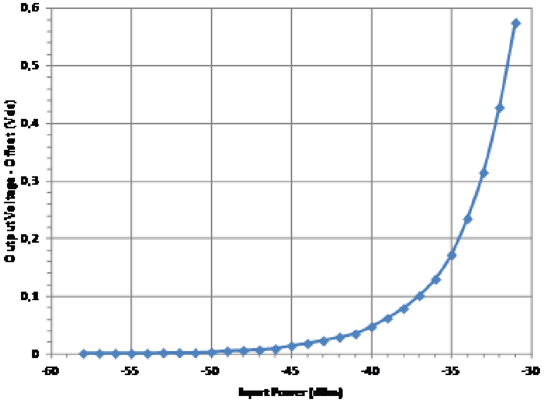
BACK-END ELECTRONICS

Back-end electronics for passive subsystem

- $800 per channel
- PCB manufactured, assembled and tested



Back-end electronics PCB
(1 channel)



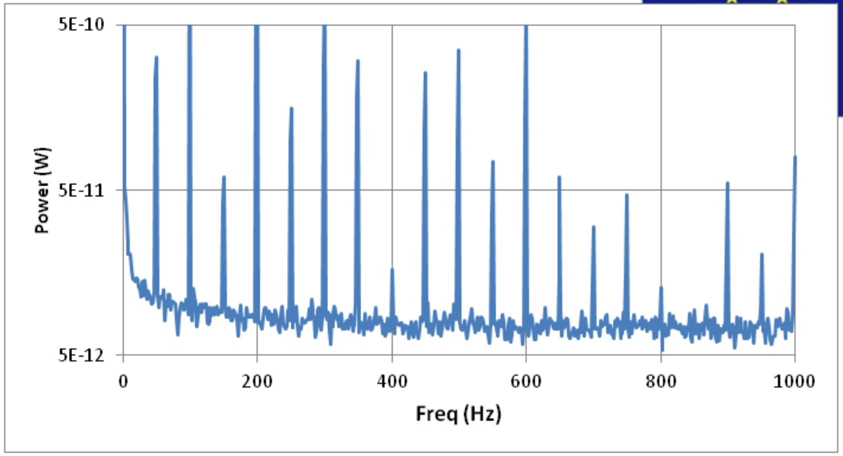
Responsivity for VNA sweep

FOR PASSIVE SUBSYSTEM SINGLE PIXEL LAB TEST

360 GHz antenna array

Gunn diode

16 x mixer and doubler



Noise spectrum from detector after video amp

- Rectangular horn antenna array from Anteral
- 90 – 180 GHz doubler from STFC-RAL (in package with subharmonic mixer)
- 360 GHz subharmonic mixer from STFC-RAL and Teratech
- OTS Gunn diode
- Back-end electronics from Acreo
- Y factor test pixel sensitivity = 1.4 µV/K
- RMS noise voltage = 0.37 µV
- NETD = 267 mK (≈ simulated value of 180 mK)

PASSIVE SUBSYSTEM IMAGER

- Imager mechanics and optics at Acreo – ALFA3 prototype from Alfa Imaging S.A.
- Similar to Cassegrain antenna with feedhorn antenna array block
- 8 Hz frame update – 16 pixels x 100 rows
- Next steps:

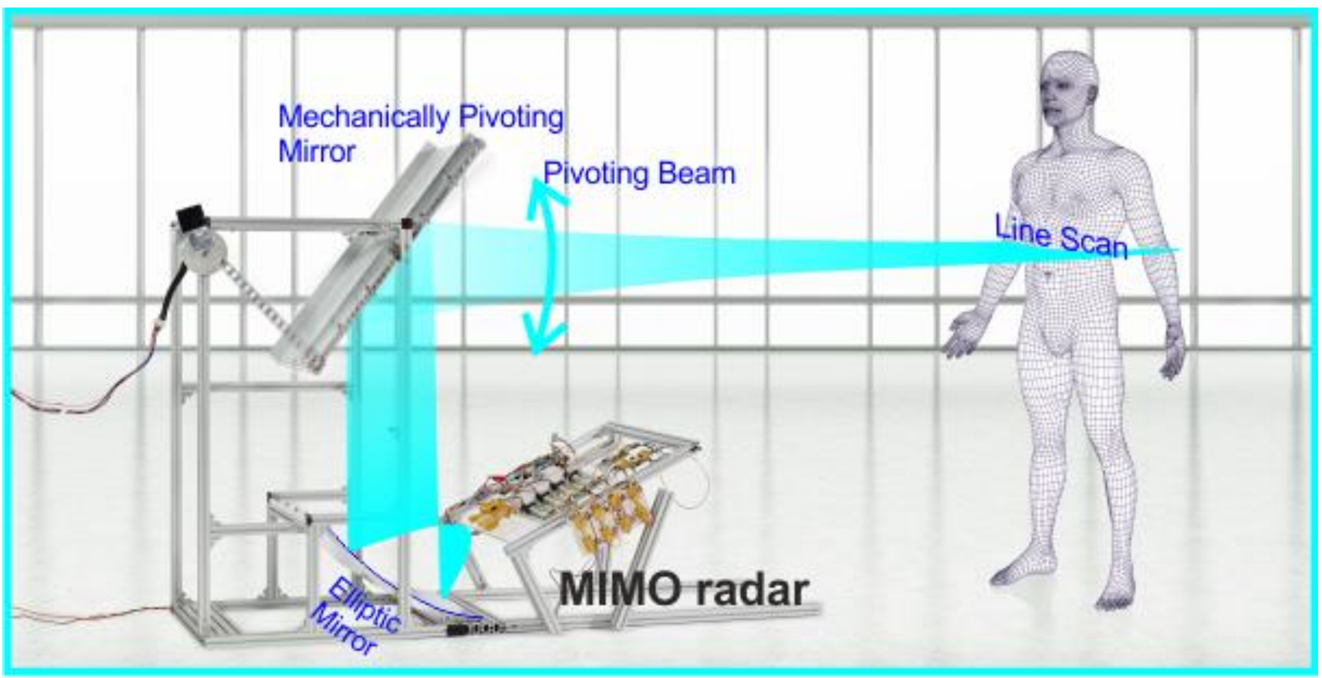
- Modify for integration of 94, 220 and 360 GHz sub-arrays
- Redesign of data acquisition and image capture for all three frequencies
- Acquisition of images at 360 GHz

ACTIVE SUBSYSTEM IMAGER

3D Imaging of passengers at airports in the submillimeter range

- 5 mm resolution
- 4 frames per second

→ MIMO to deal with fast measurement speed



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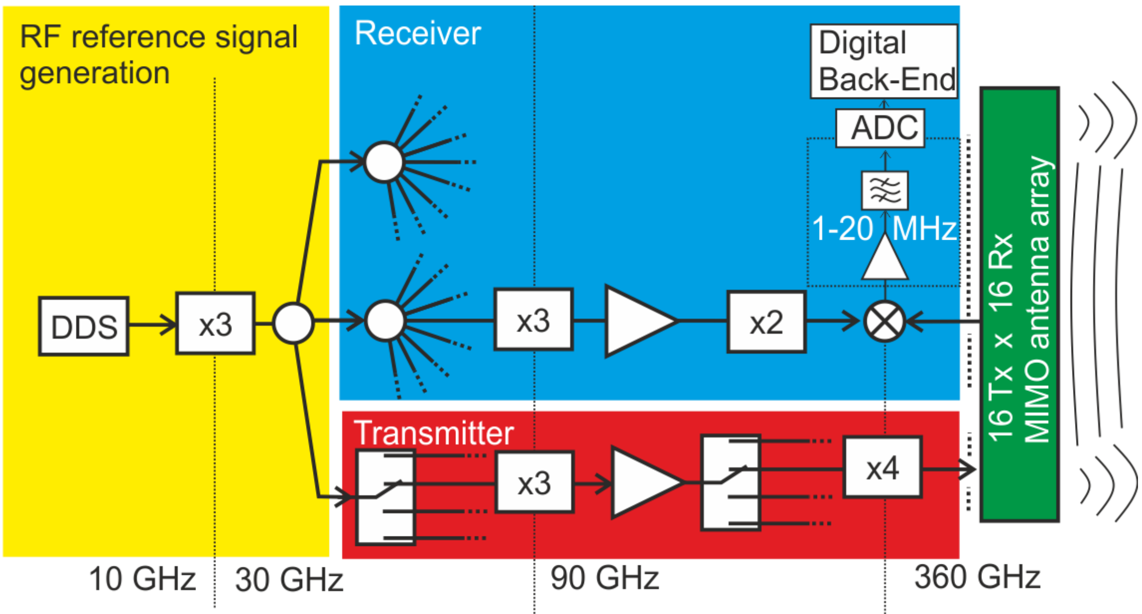
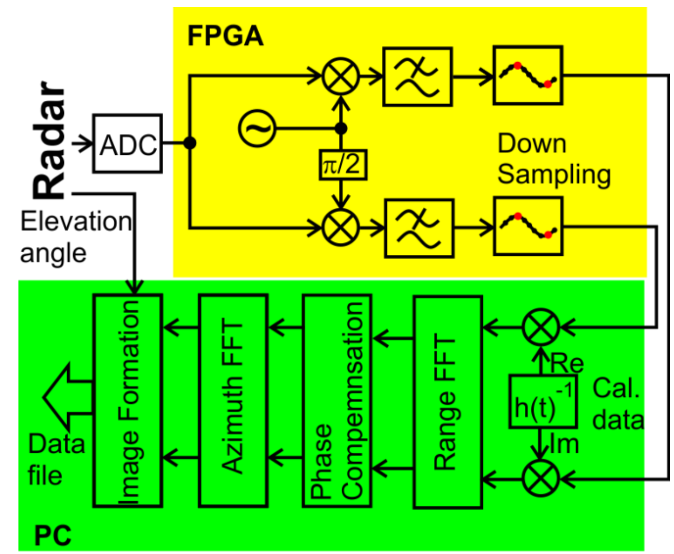
ACTIVE SUBSYSTEM IMAGER

Analogue Millimeter Wave Design



BackEnd



- Single DDS generates FMCW signal for 16 transmitters and receivers
- FPGA range windowing enables coping with huge amount of 3D voxels

CONCLUSIONS

- Simulation and preliminary single pixel measurement results indicate that a reasonable NETD (< 1K) can be achieved for the 360 GHz passive subsystem.
- Performance of components developed for the 360 GHz passive subsystem appears to be sufficient.
- More work required before the complete passive subsystem is fully integrated and operational.
- A passive mm-wave/THz scanning imager platform is available at Acreo for test of components in system.

POSSIBLE NEXT STEPS FOR A NEW PROJECT

- Exploitation and Licensing for further development
- Packaging and integration technology to reduce/eliminate the amount of split metal blocks, manifolds, etc. as well as reducing price.
- Work on imager scanner technology to improve the quality of images and reduce size of equipment.
- Improve signal processing algorithms for image quality and automatic threat detection.
- Migration of technology to other application areas, e.g. medical imaging.

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