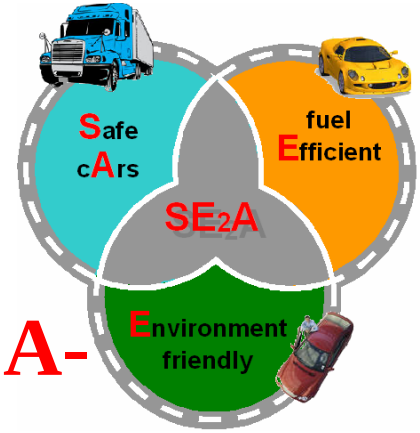
SE2A: Nanoelectronics for **S**afe, Fuel **E**fficient and **E**nvironment Friendly **A**utomotive Solutions



Progress in the ongoing ENIAC project SE2A-

IMT's contribution at a ground speed measurement system for SUV cars

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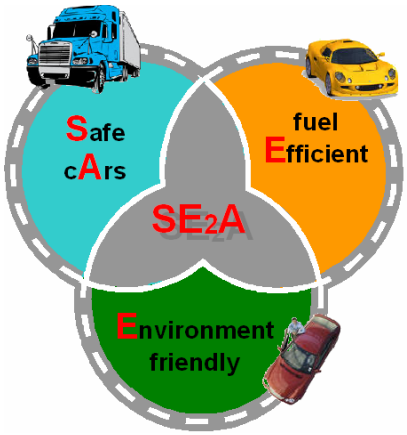


Outline

1.Introduction

- Nanoelectronics and the automotive industry

- Key challenges for the automotive industry

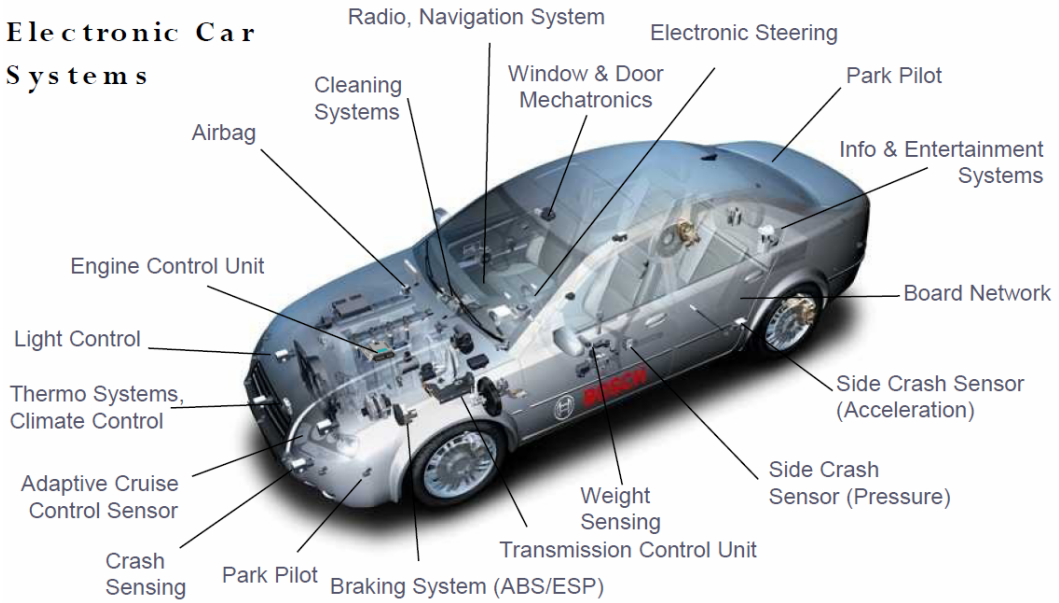
2. SE2A

- Project characteristics: consortium, structure, demonstrators

3. IMT work

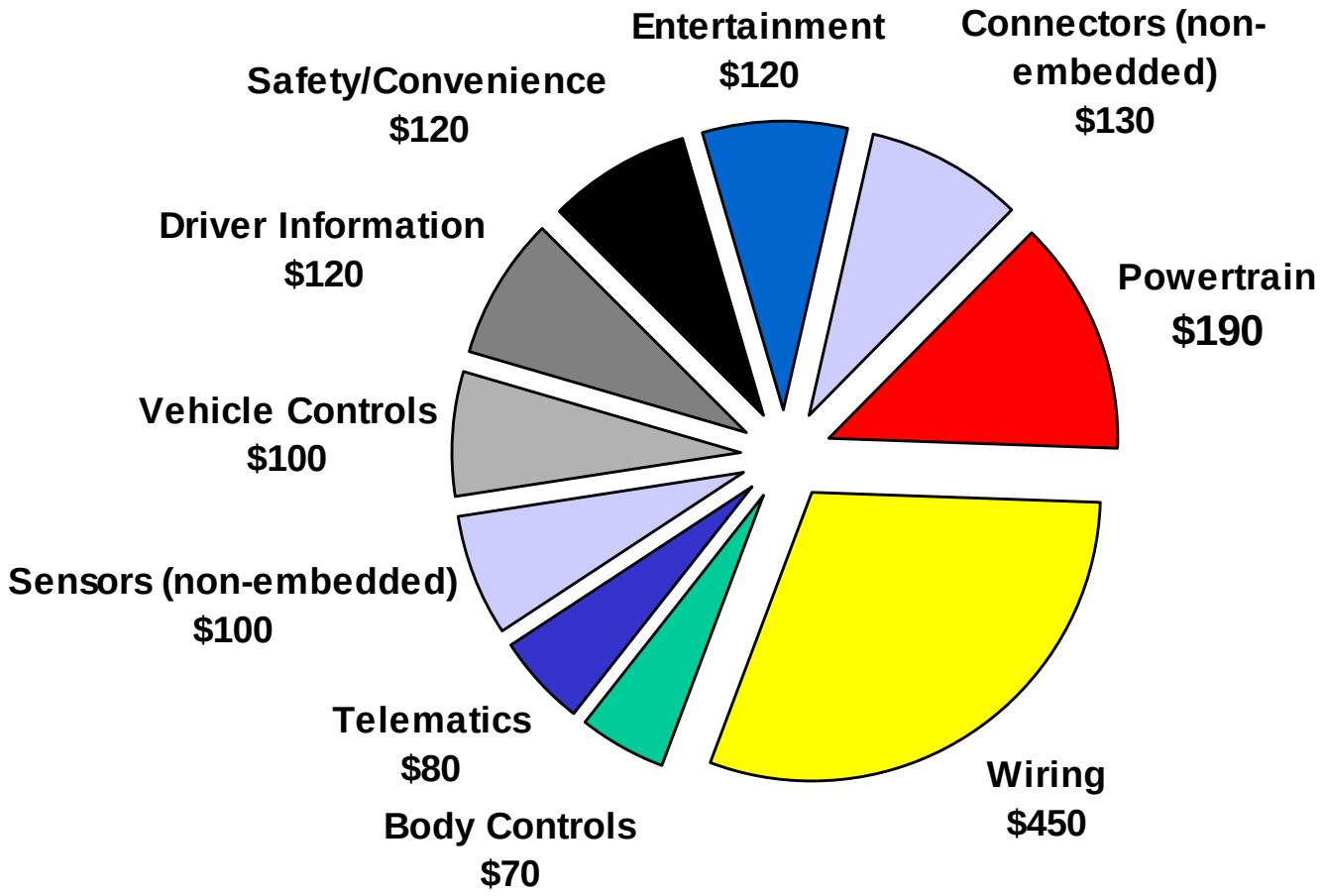
- Results and outcome

Nanoelectronics are the solution to the key challenges of the automotive industry



- **(Nano)electronics are more and more applied in cars and add even more value**
- **Today's cars are an army of (nano)-electronics that make them safer, more energy efficient and environment friendly**

Automotive Electronic Content Estimates for western Markets



Key challenges for the automotive industry

Fuel efficiency and CO_2 footprint improvement

- *75% of energy in fuel tank lost to engine and driveline inefficiencies and idling*

  ➔*Solution: engine control sensors (precision measurement systems that can withstand high temperatures and can dramatically improve efficiency and emissions)*

- *Much fuel is used due to heavy mechanical parts and wiring harness*

  ➔*Solution: replacement with electronic lightweight alternatives (ABS, ESP, CAN-, LIN-, FlexRay-network bus communication)*

- *15,000,000 liters of fuel is wasted a day due to low tire pressure*

  ➔*Solution: tire pressure sensors*

- *30,000,000 liters of fuel (or 70 ktons of CO2) are wasted in traffic jams*

  ➔*Solution: Green driving (Traffic control and intelligent traffic management systems)*

SE2A

SE2A has the ambition to contribute to the following parameters:

- Fuel efficiency by development of new sensors
- CO2 footprint by development of new sensors
- Safety by development of new sensors and systems and by enhancing reliability and lifetime predictability to a level of zero ppm and 95% accuracy

SE2A

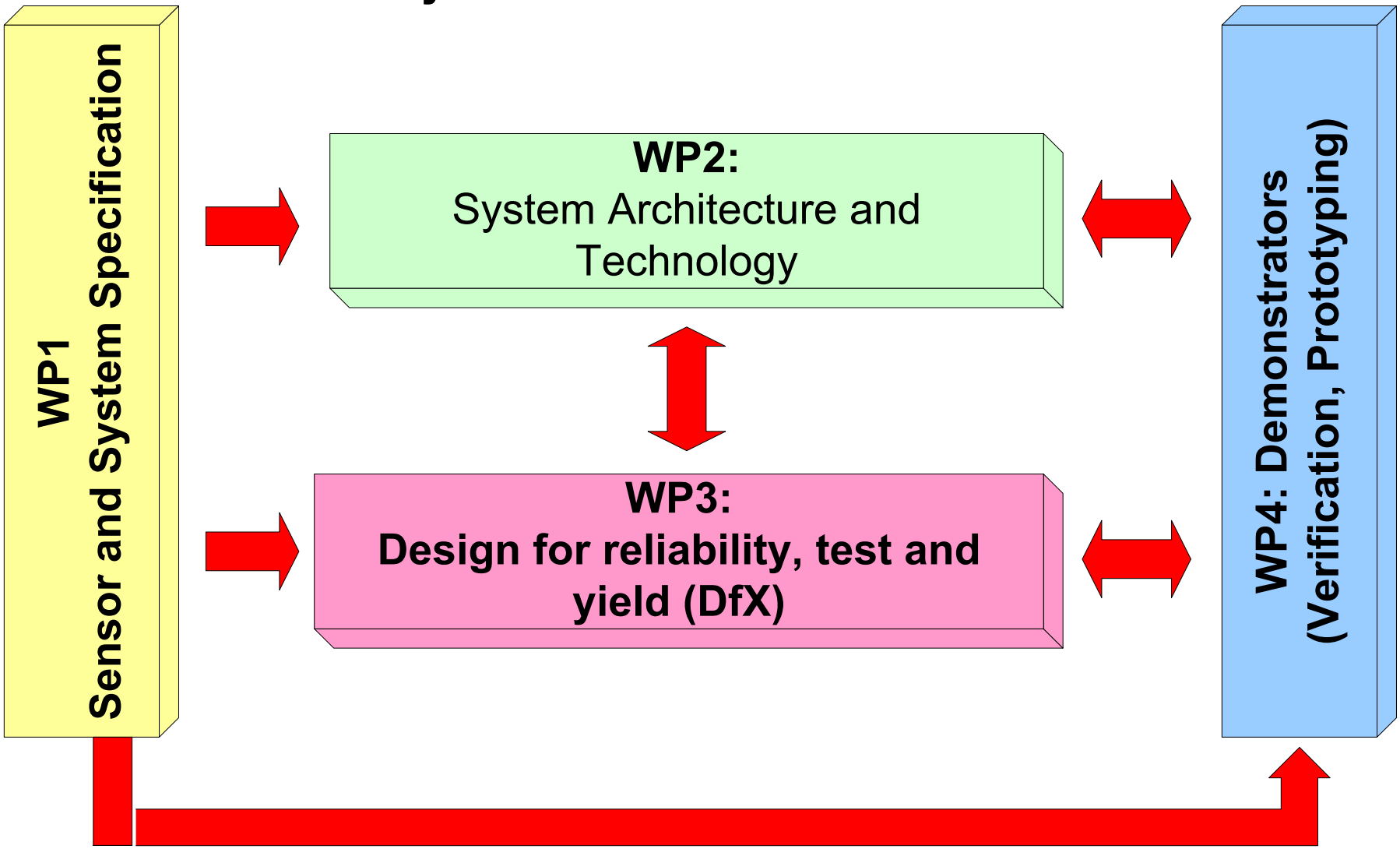
Project Consortium and Resources committed

- 20 partners from 7 countries
- 4 SMEs, 2 Universities, 11 Institutes, 3 LSEs
- Budget 21 MEuro, > 2,000 person months

Greece:	IMEL, THETA, FORTH
Hungary:	BHE, BME. MFA, WESZTA
Netherlands:	BTE, M2i, NXP, TNO
Poland:	ITE, WRUT
Portugal:	INESC-ID, INESC-MN, INOV
Romania:	IMT
Sweden:	VolvoTech, OPT, SP

SE2A

Project structure



SE2A

WP 4: Demonstrators and Results

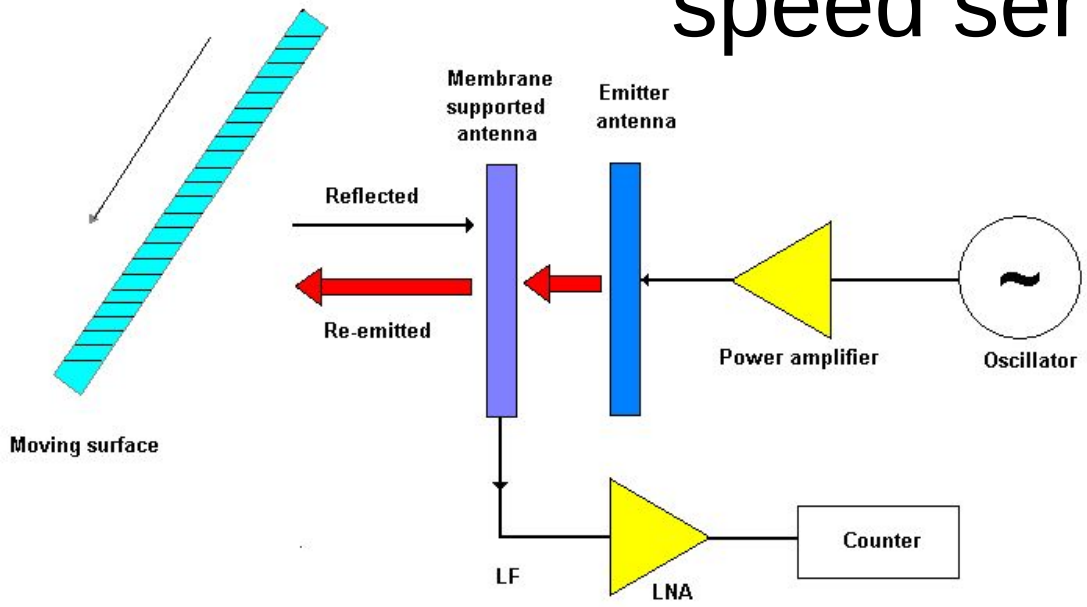
1. Vehicle configuration and application area
2. Sensor testing, verification and demonstration
3. Demonstration of the project result

	Demonstrator	Goal	Leader
1	True ground speed sensor		Volvo
2	DfX methodologies	Intrinsic Safety	NXP
3	Vibration sensor		ITE, WRUT
4	Tire integrated shear force sensor		MFA, Weszta
5	Inertia sensor		INOV
6	Gas flow sensor		IMEL
7	Low cost receiver for wireless sensors	Cost reduction	INESC-ID
8	Advanced encapsulation technology	Technology enabler	Boschman
9	e-Horizon software		TNO, TeleAtlas
10	CO_2 emissions prediction software		TNO

SE2A

IMT participation in WP2.1.1 (Sensors design and technology)

Basic principle/proof of concept for the true speed sensor



f_0 microwave frequency
v vehicle speed
c speed of light
α radiation angle

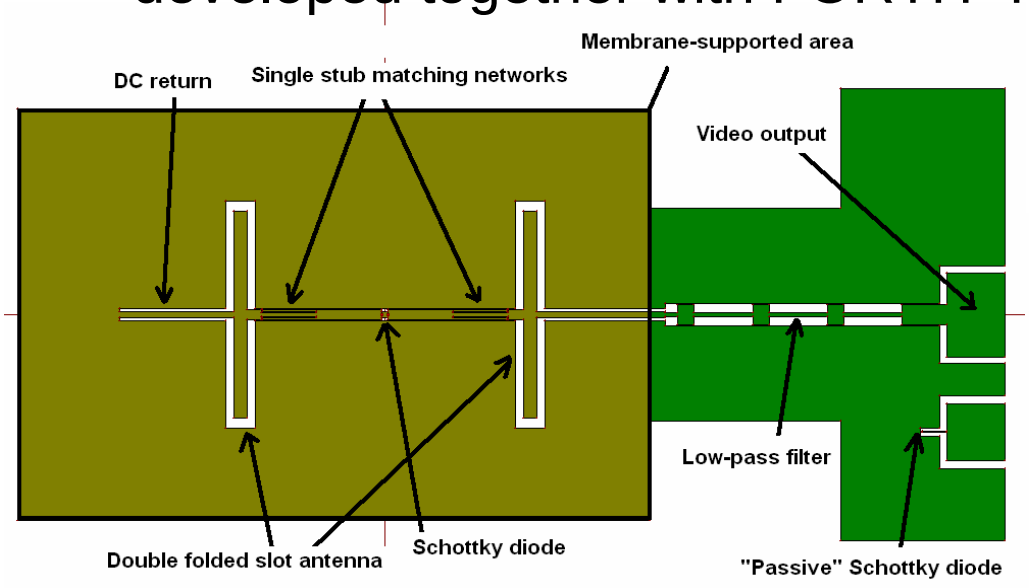
$$f_d = f_0 \cdot (2v/c) \cdot \cos \alpha$$

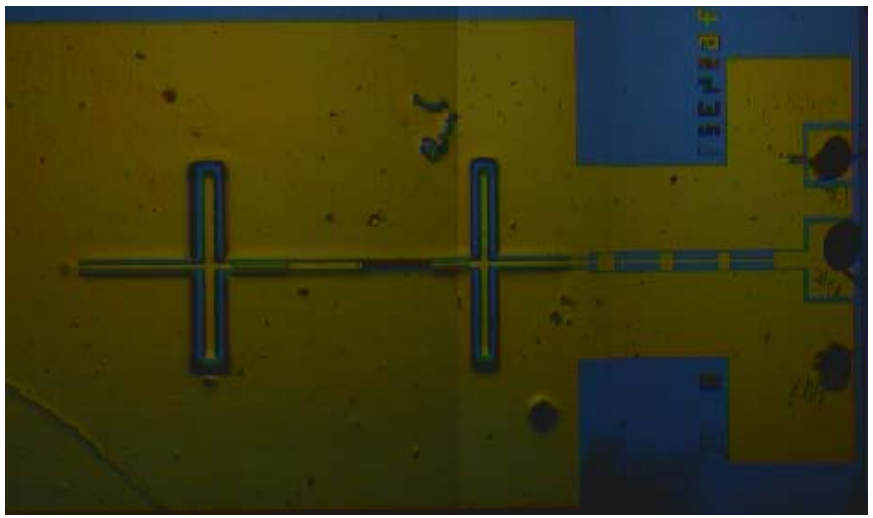
The proof of concept was done with existing antennas and membrane supported monolithic integrated direct (video-type) receiver modules based on GaAs micromachining for 38 GHz.

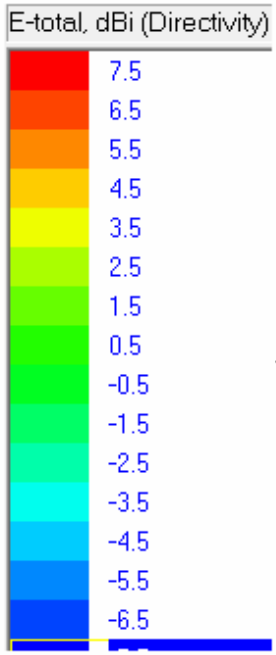
- **The signal generated by the synthesizer feeds the emitting microstrip antenna array. The emitter antenna was placed in the near field of the membrane supported antenna and the position (vertical and horizontal) was optimized for maximum coupling (the signal from generator was amplitude modulated).**
- **Via the two lobs of the membrane supported folded slot antenna (original architecture) the signal arrives to the moving surface. The reflected signal from the moving surface (slightly shifted in frequency due to Doppler effect) arrives to the direct receiver and is mixed with the incident signal.**
- **The output signal is amplified and displayed on an oscilloscope. The displayed signal frequency is dependent on the speed of the moving object**

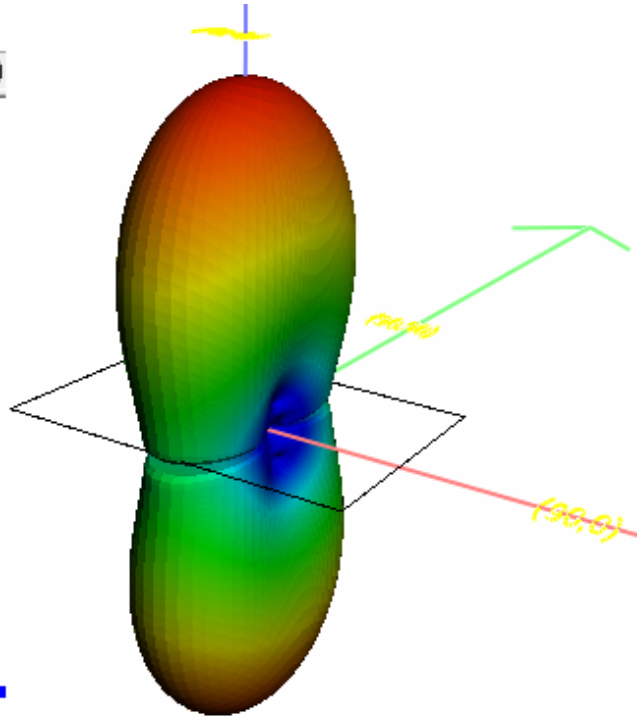
Membrane supported antenna integrated with a Schottky diode

developed together with FORTH- Heraklion- partner in the project



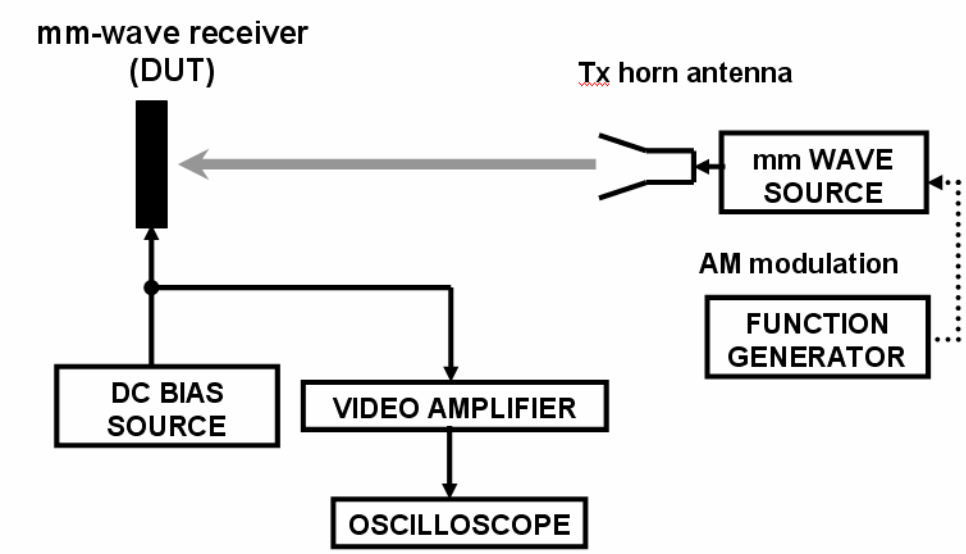


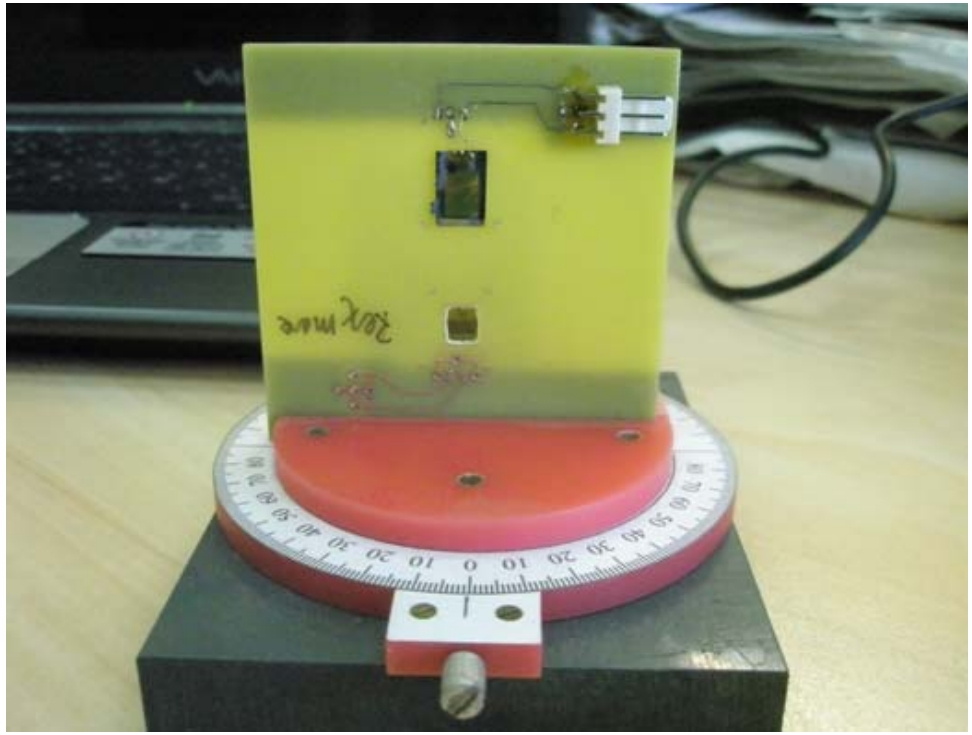




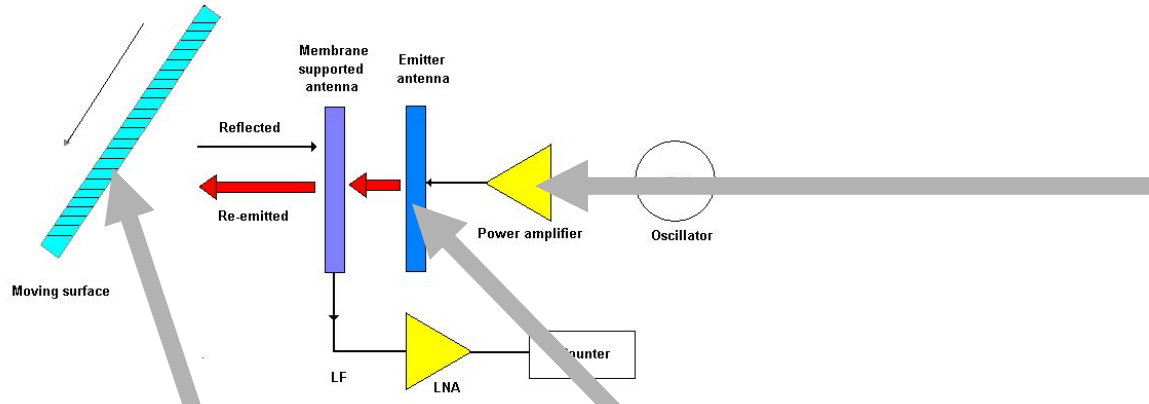
38 GHz Membrane supported receiver used for demonstration of the sensor principle

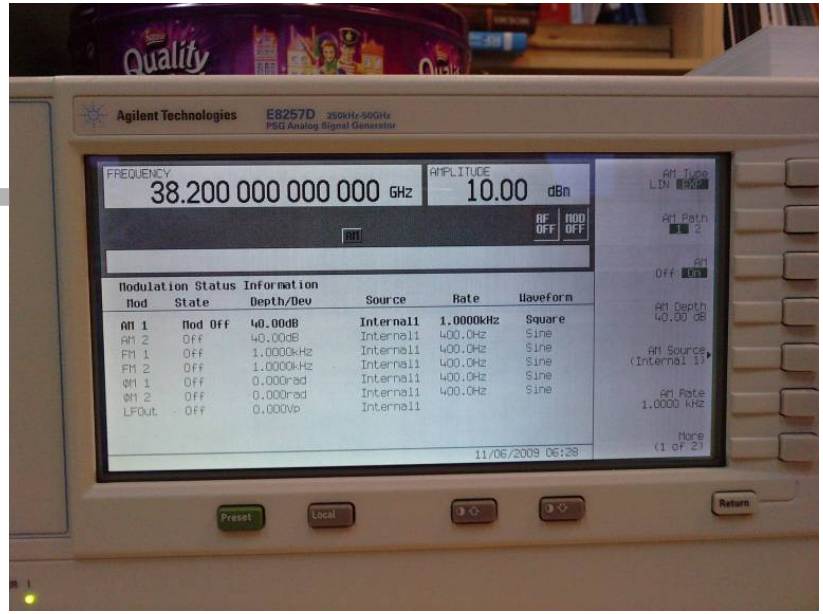
(also available at 60 GHz, 77 GHz, 200 GHz)

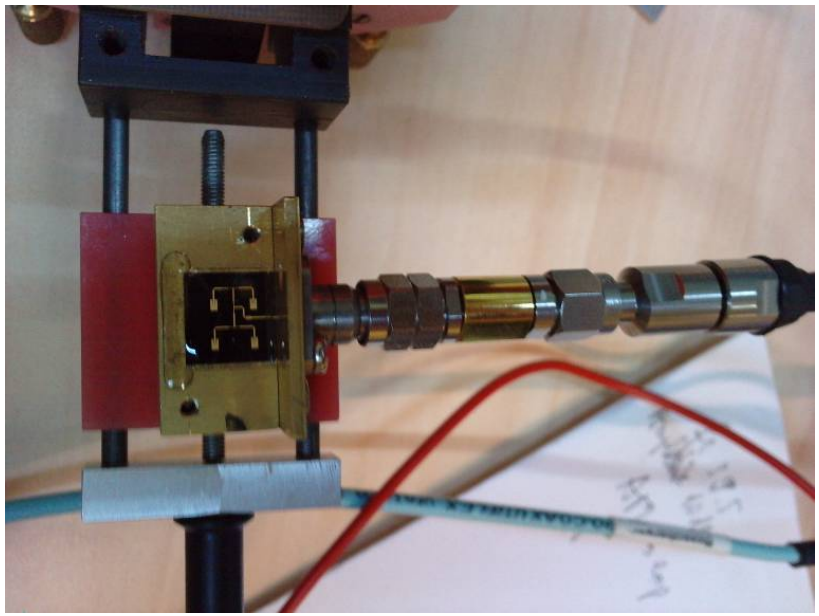




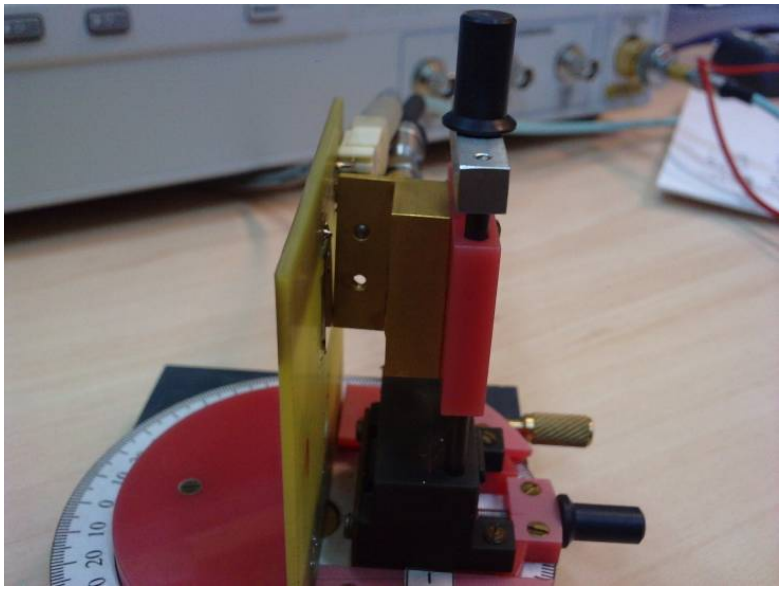
Proof of concept (38 GHz)

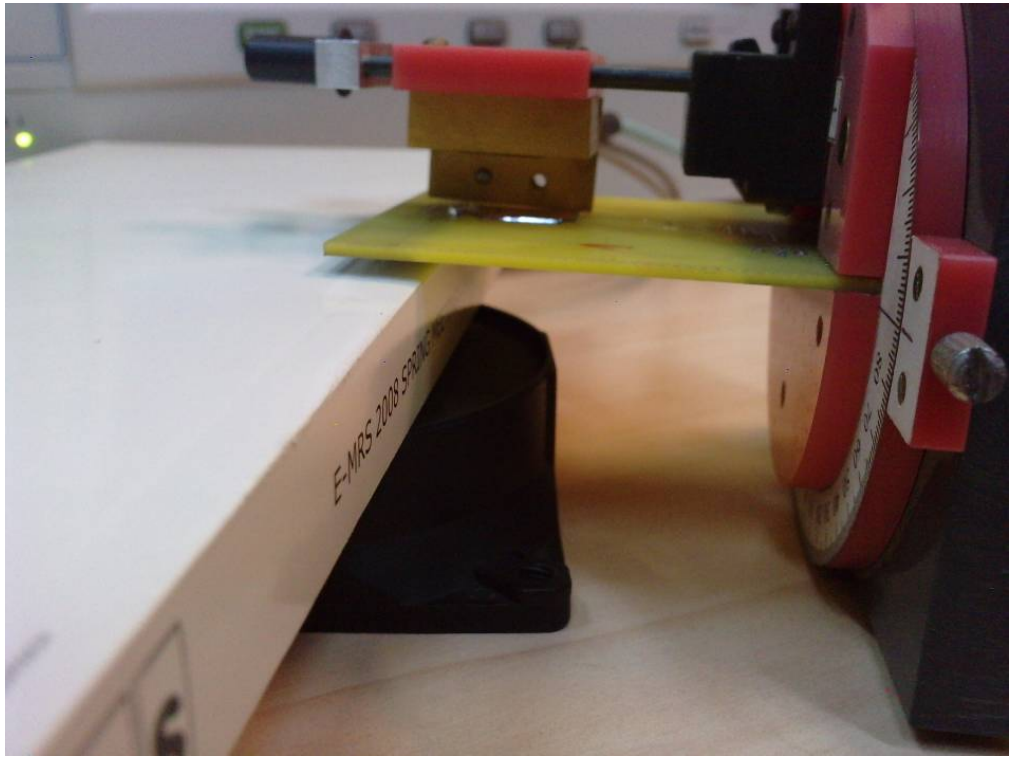




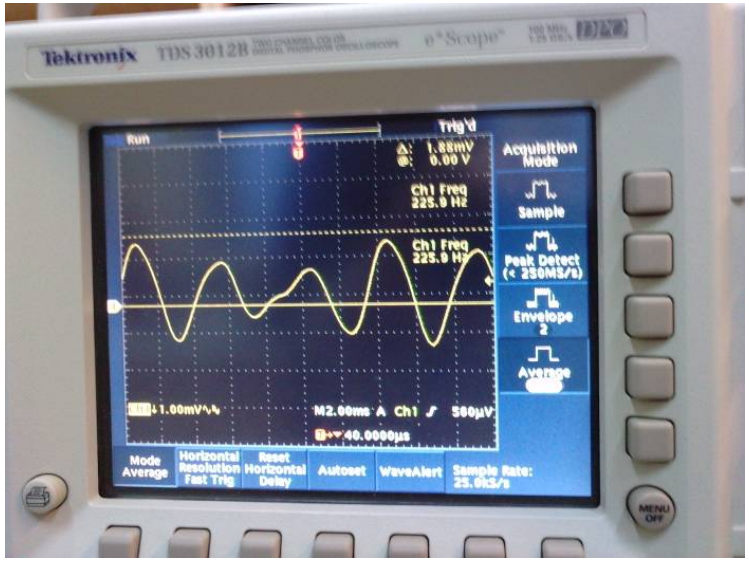


Proof of concept (38 GHz)



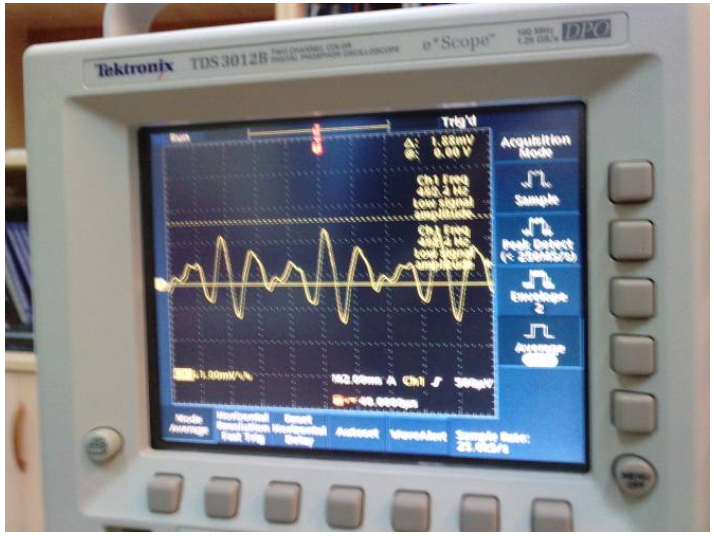


Proof of concept (38 GHz)

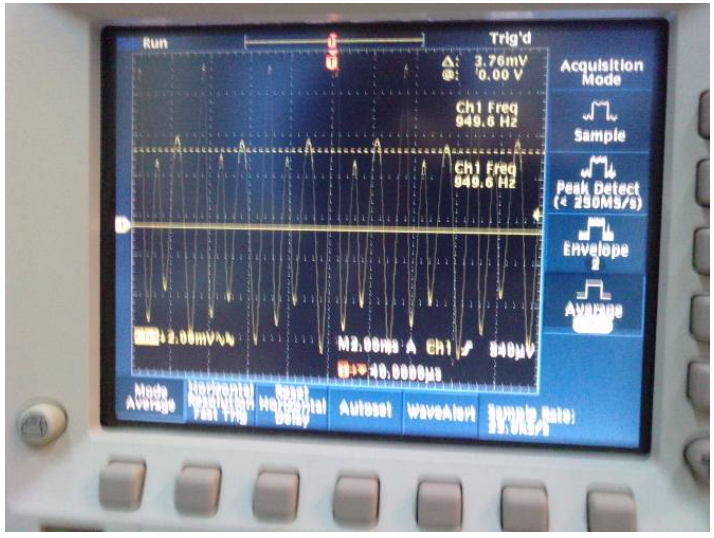


225 Hz

783 Hz



482 Hz



949 Hz

Next steps (38 GHz)

Improvement of the experimental setup and detailed sensor characterization (radiation pattern, frequency response, sensitivity, etc)

Next steps (77 GHz)

• Preliminary investigations using existing 77 GHz receiver structures (77 GHz horn antennas ordered and they will be purchased soon)

• Design and optimization of 77 GHz membrane supported receiver structures for Doppler sensor applications

• Structure fabrication (in cooperation with FORTH)

• Design and optimization of the 77 GHz HEMT CW source (in cooperation with FORTH)

• Hybrid integration of the Doppler sensor with 77 GHz source and packaging investigations

• mm-wave sensor experiments; integration with low frequency electronics and control/processing circuitry