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GaN RF
New Generations for Space Telecom

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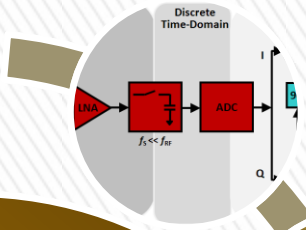
-> IT Aveiro -> Radio Systems

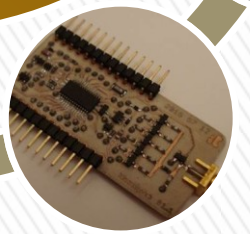
Radios Systems Characterization and Design



Software Defined Radio
Receiver Dynamic Range Increase

Software Defined Radio
Transmitter Efficiency

RF-DC Converter Efficiency



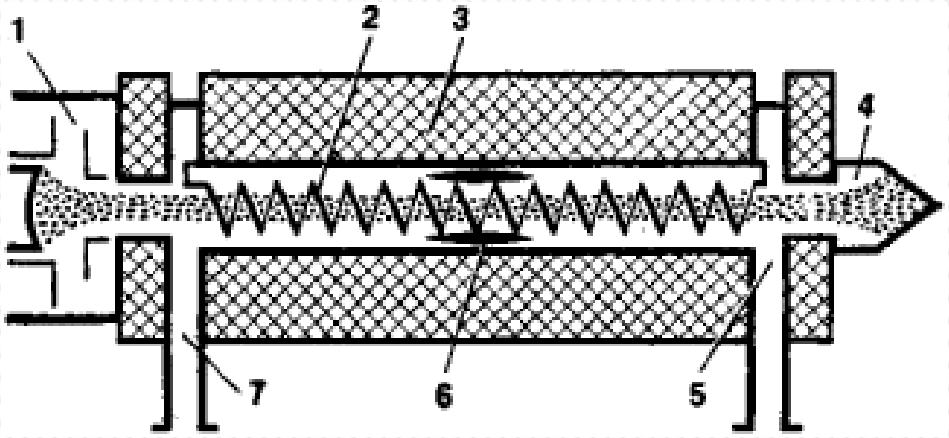
Analysis of nonlinear behavior for:

- Power Measurements
- Wireless Power Transmission

www.av.it.pt/rs/

RF Payloads

RF Payloads impose high value of power been delivered to earth …



Travelling Wave Tube Amplifiers – TWTA –Still been used intensively in space applications …

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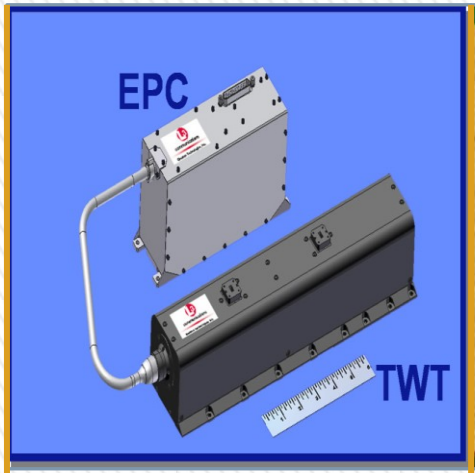
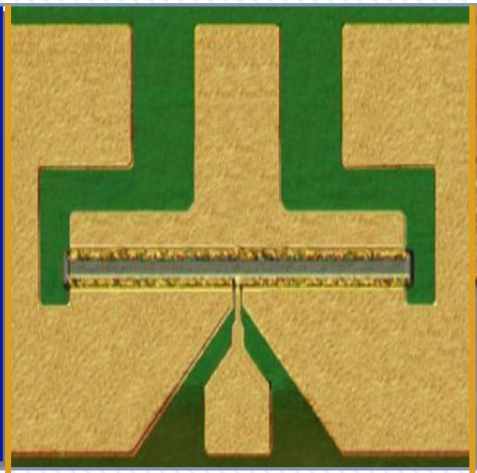
Evolution of RF Payload Power Transmission



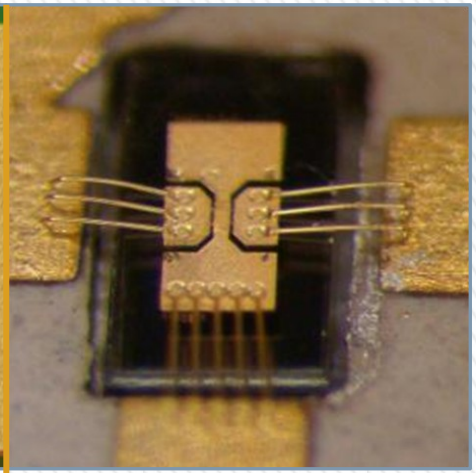
TWTA

Heavy, Expensive, big sized …



GaAs

Low Power capabilities, good for low noise applications



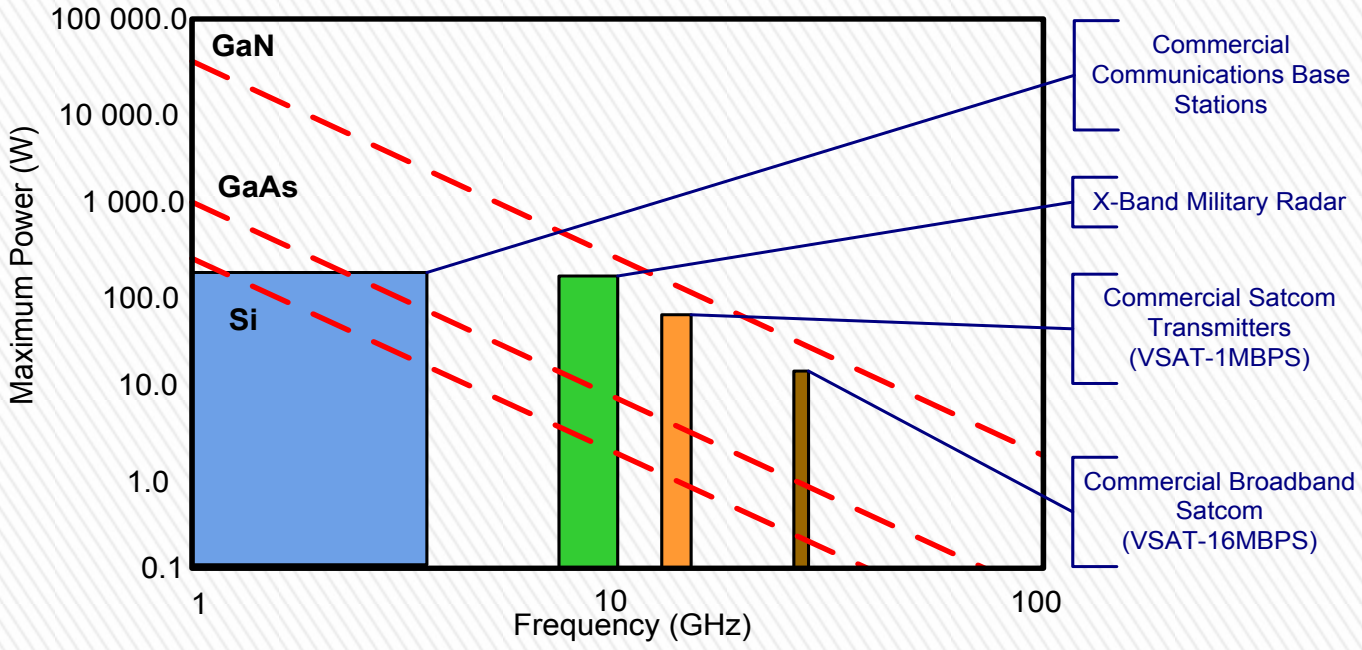
GaN

Promissing Technology for high power and also low noise applications

Evolution of RF Payload Power Transmission

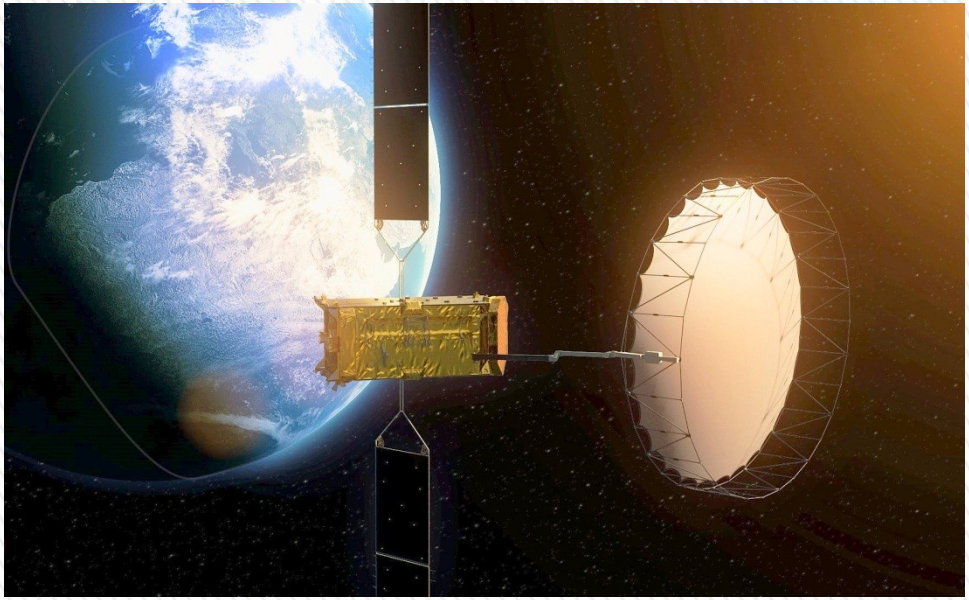
Why GaN on space ?

Power and Frequency Theoretical limits for Si, GaAs and GaN devices



Introduction and motivation

» AlphaSat project and Participants



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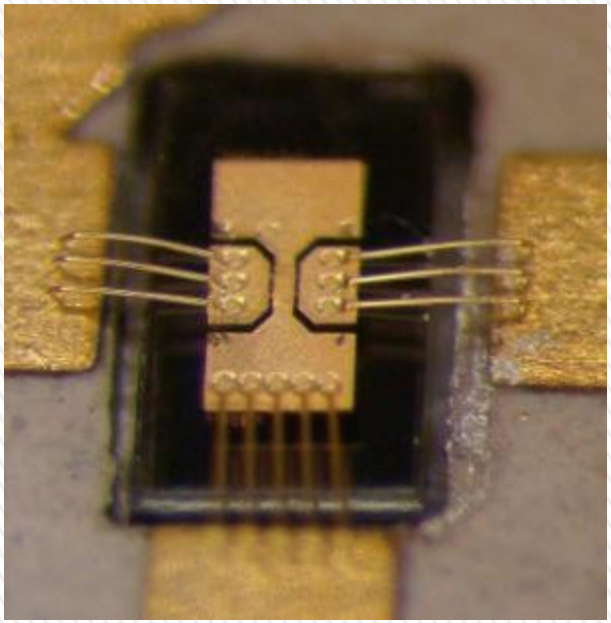
Introduction and motivation

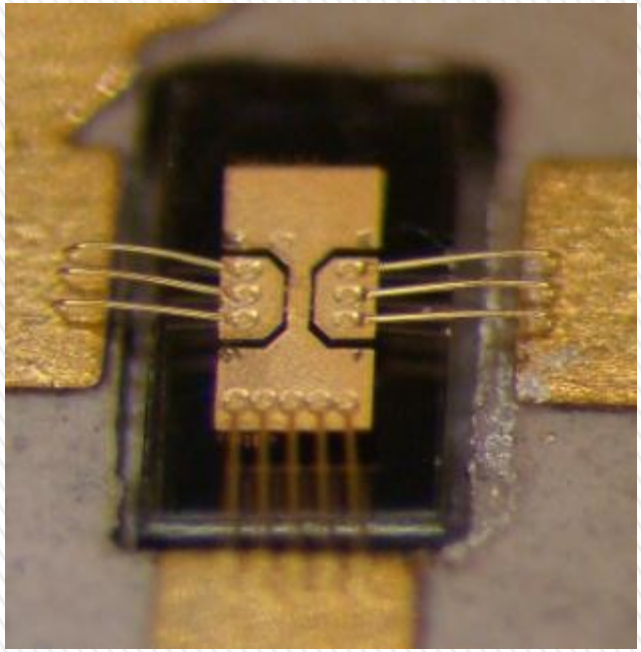
The main objective of the project is to test GaN Technology in space, mainly European versions.

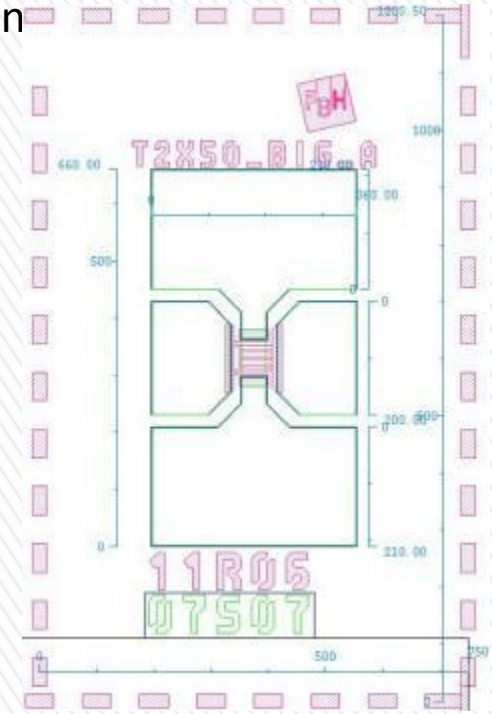


GaN Technology

- Transistor technology suplied by FBH
  (Fredinand-Braun-Institut)

- Cosmic radiation immunity
- High frequency operation
- High power handling





Circuit Selection

- Amplifier

  Pros: Optimum for mimic future applications of GaN technology onboard of satellites, possibility to study TWTA future changes.

  Cons: High values of consumed power, need for external signal source and driver circuit, mass increase due to several circuits need for data gathering.

- Oscillator

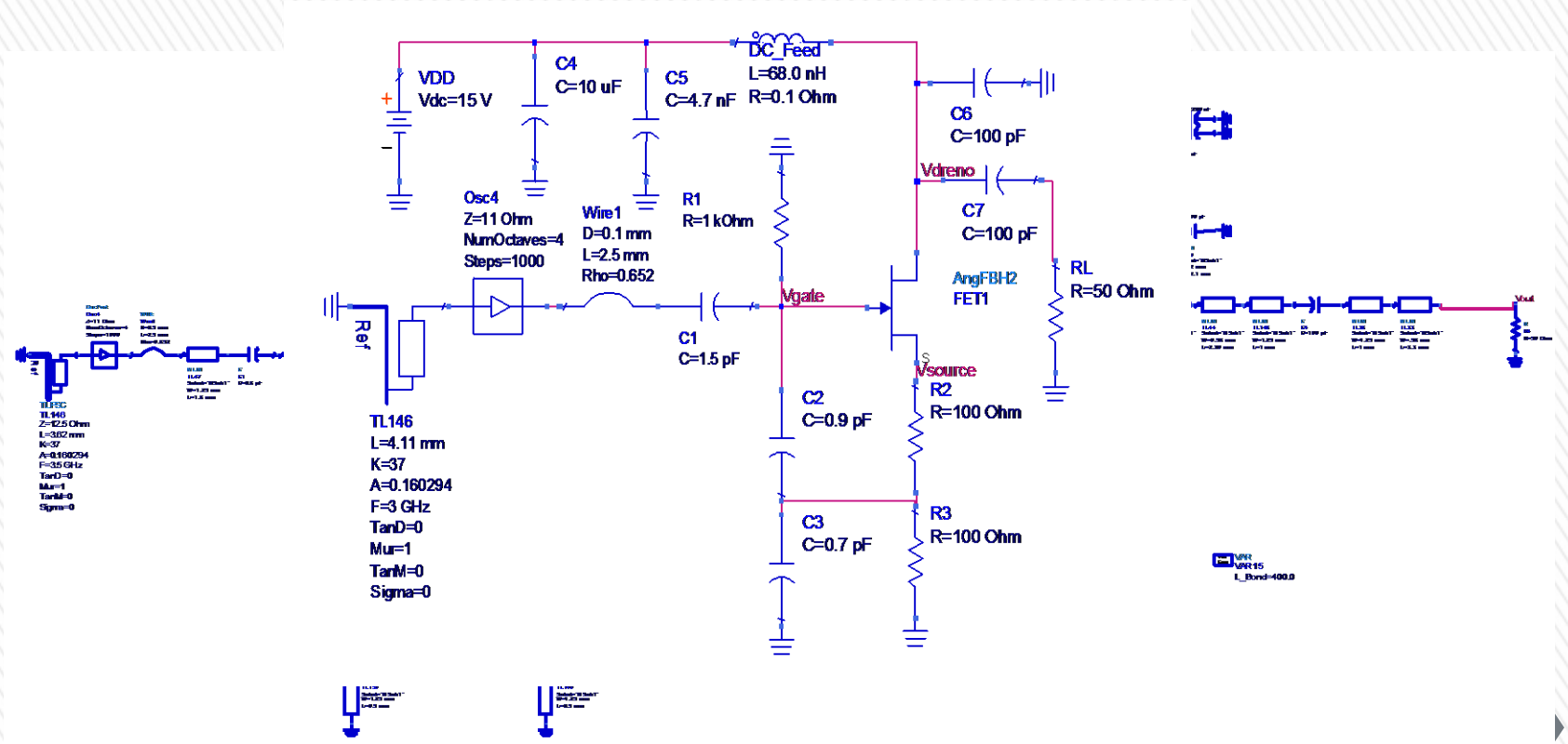
  Pros: No need for extra signal excitation sources, possibility of including all circuitry and its measurement systems inside the same box, reduction of power consumption and mass.

  Cons: Do not excite all characteristics of the technology under study.

Selected Circuit ›

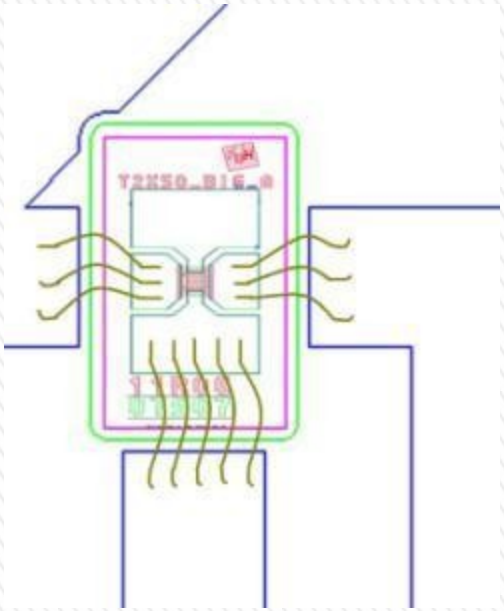
Oscillator Circuit

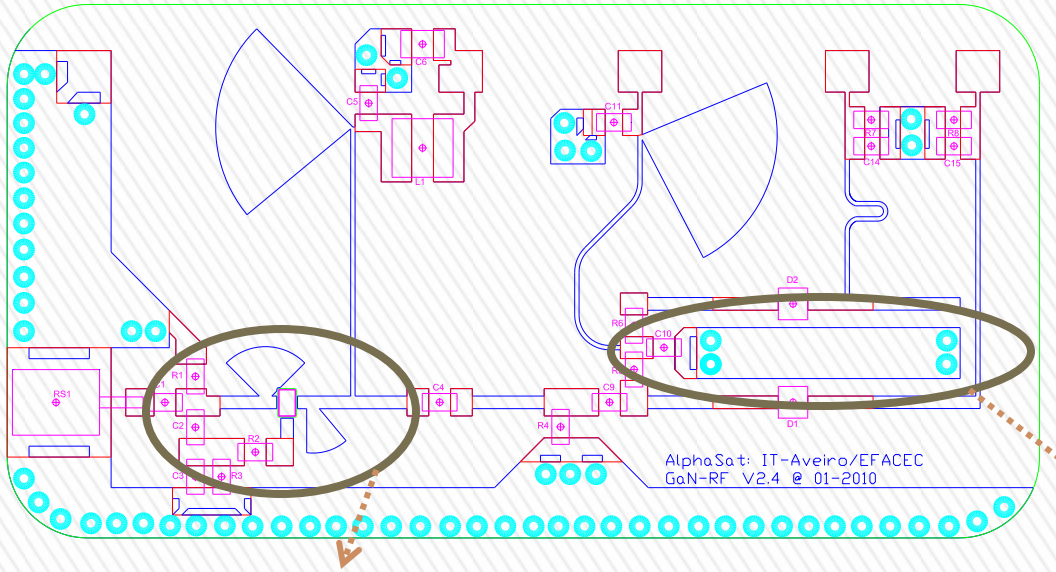
- Oscillator based on traditional Colpitz configuration
- Frequency of oscillations imposed by payload restrictions (near 2GHz)
- Ceramic resonator for high Q



Oscillator Circuit

- Prototype should consider high frequency oscillations due to impressive transistor quality
- Oscillations near 12-15GHz.



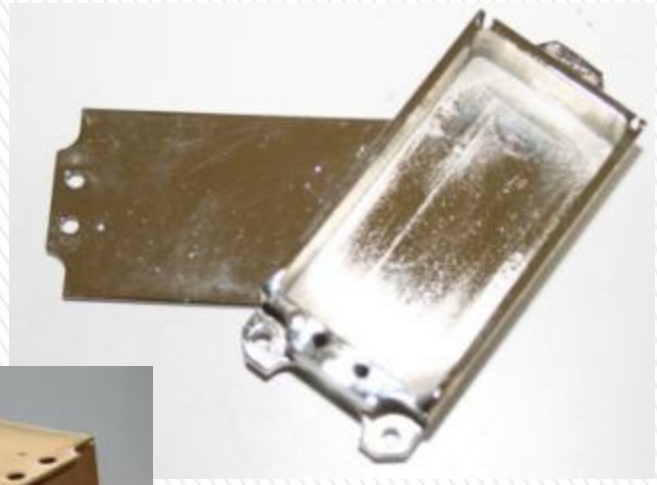


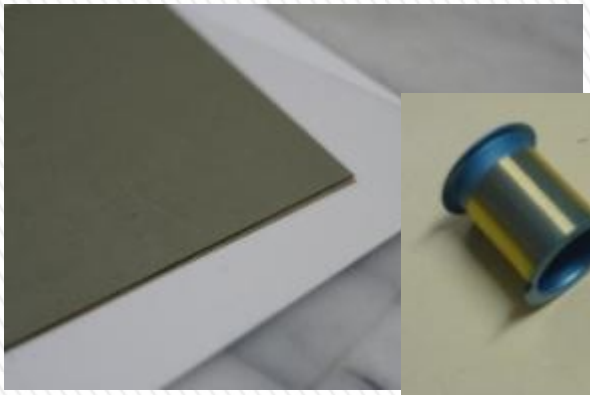
Stubs for high frequency spurious reduction

Measurement circuit
Power measurement

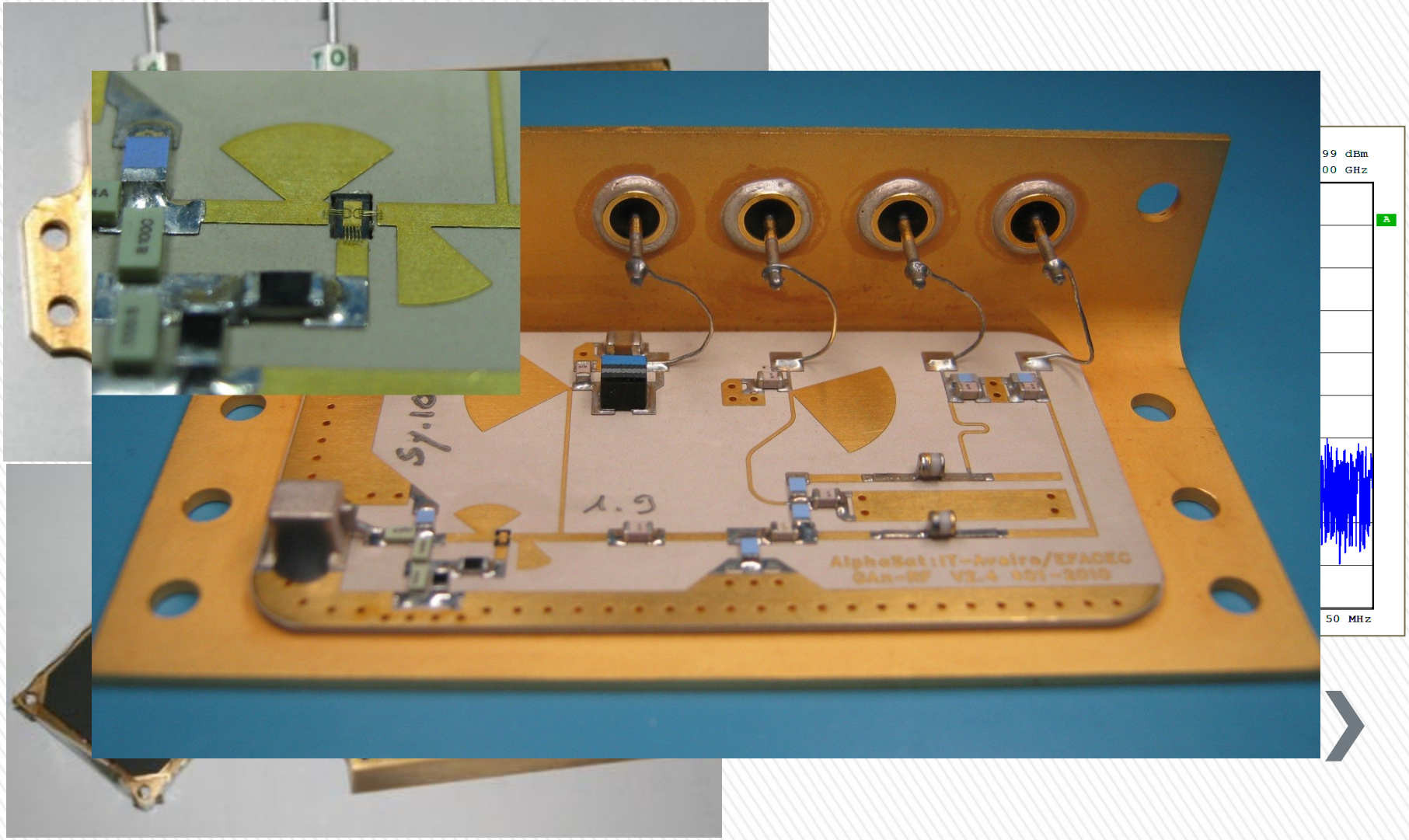
Oscillator Prototype

- Optimization of size and box weight, hardness
  - Concerns with material CET, electrical and thermal conductivity.
  - Gold wire for bonding
  - Epoxy glues to attach chip
  - Adhesives glues to PCB
  - Nickel and gold plating
  - Bonding with gold wire





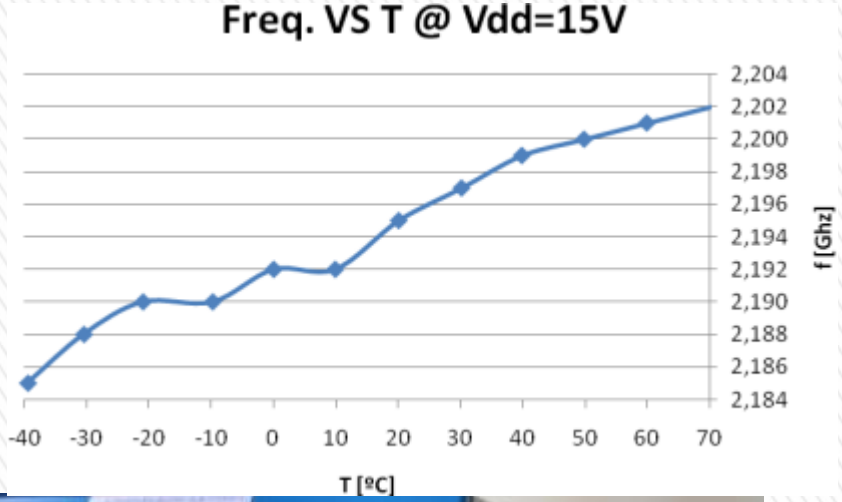
Oscillator Prototype

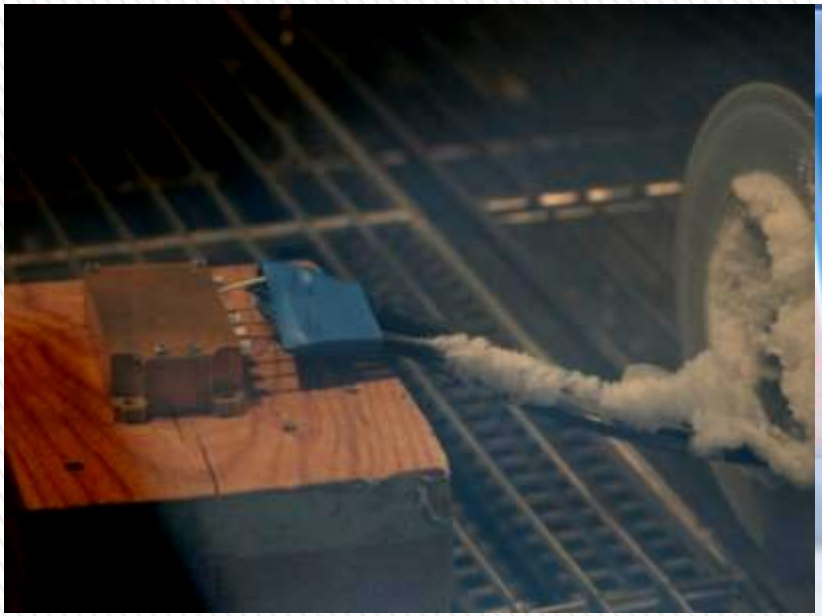


Oscillator Prototype

Thermal test cycles

Between -20ºC and 70ºC a maximum frequency drift of 12 MHz.

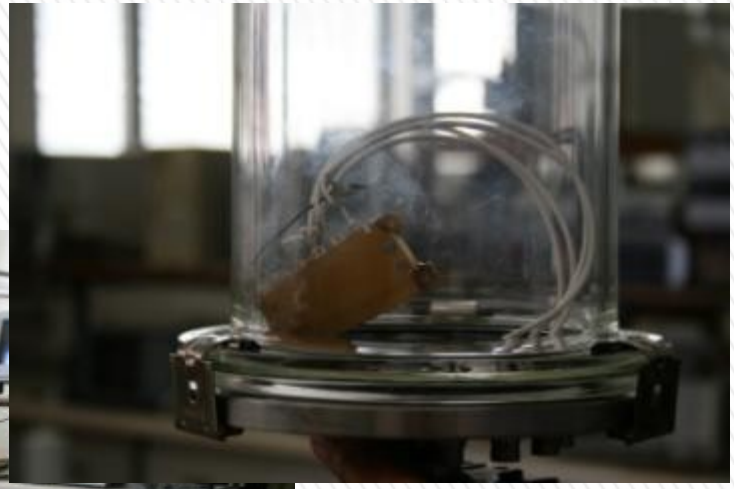




Oscillator Prototype

Vacuum tests

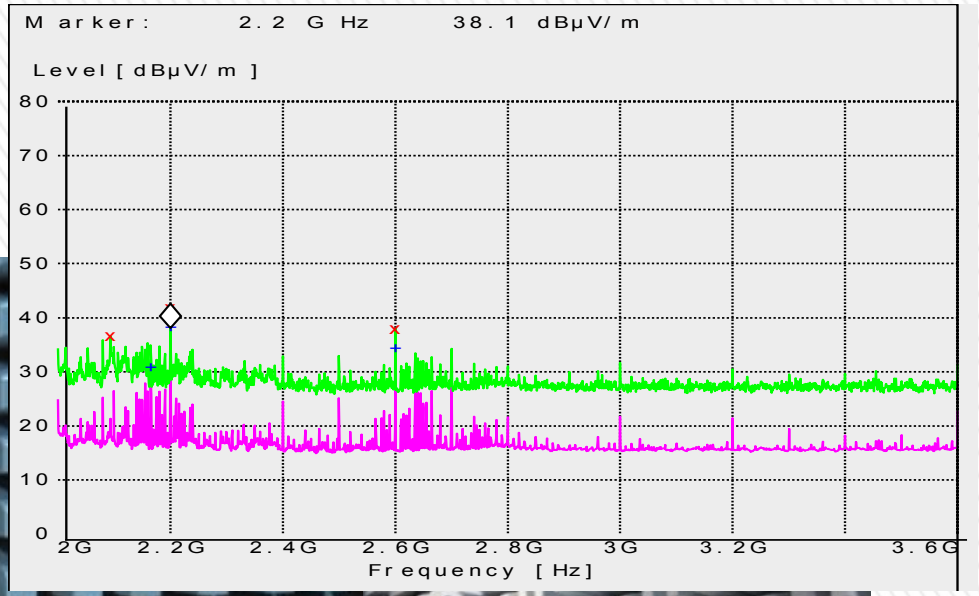
To avoid any particles or gases released not expected

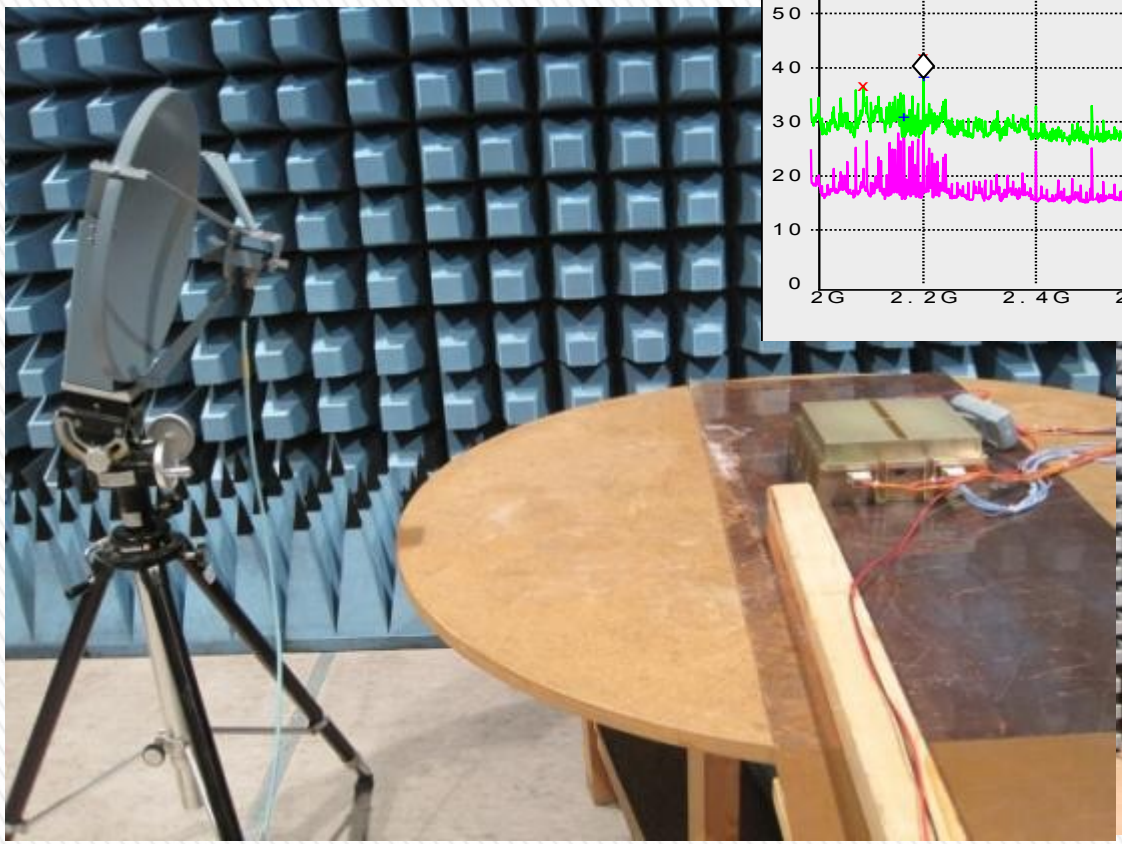


Oscillator Prototype

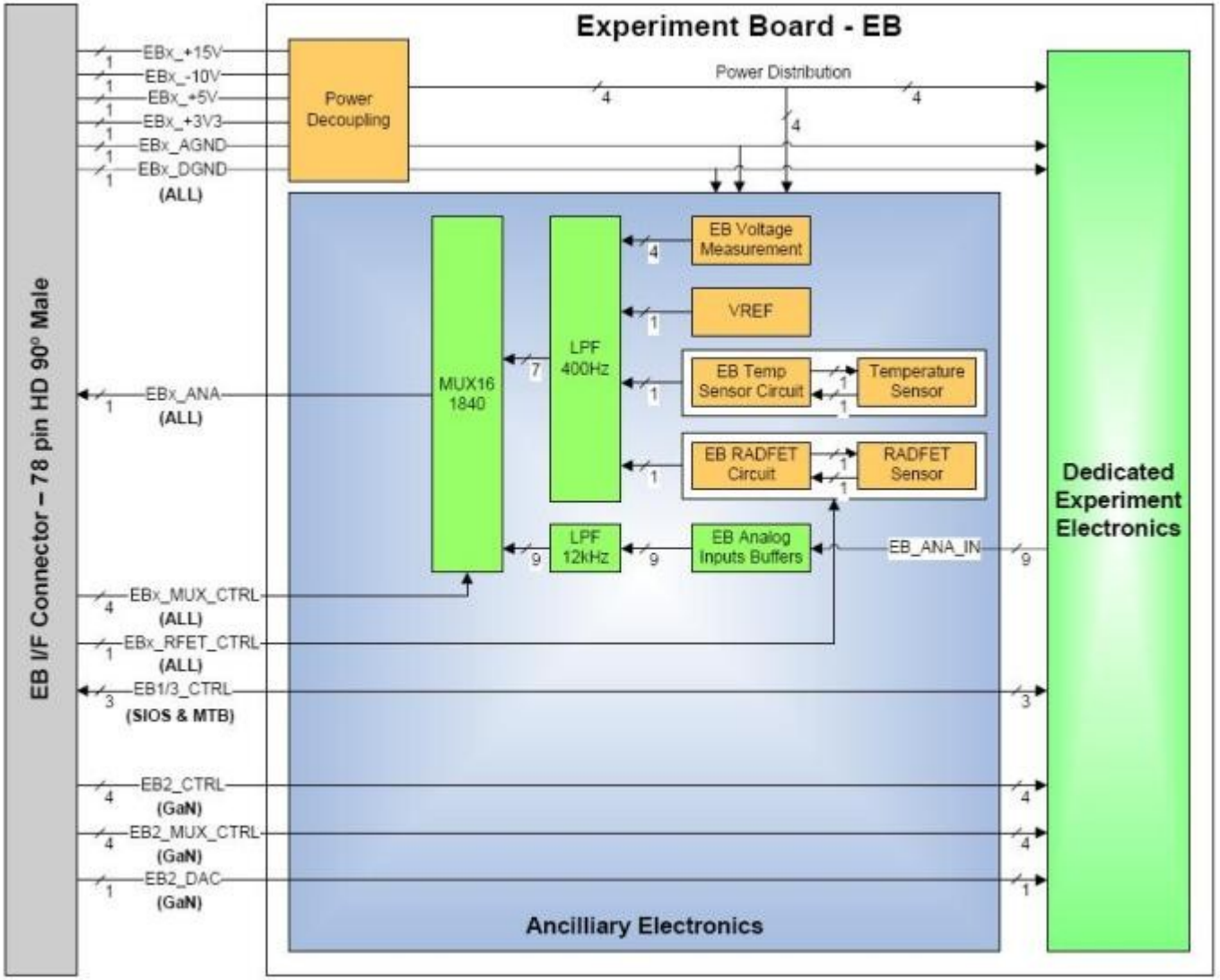
EMC tests

- US Military, agreement concern





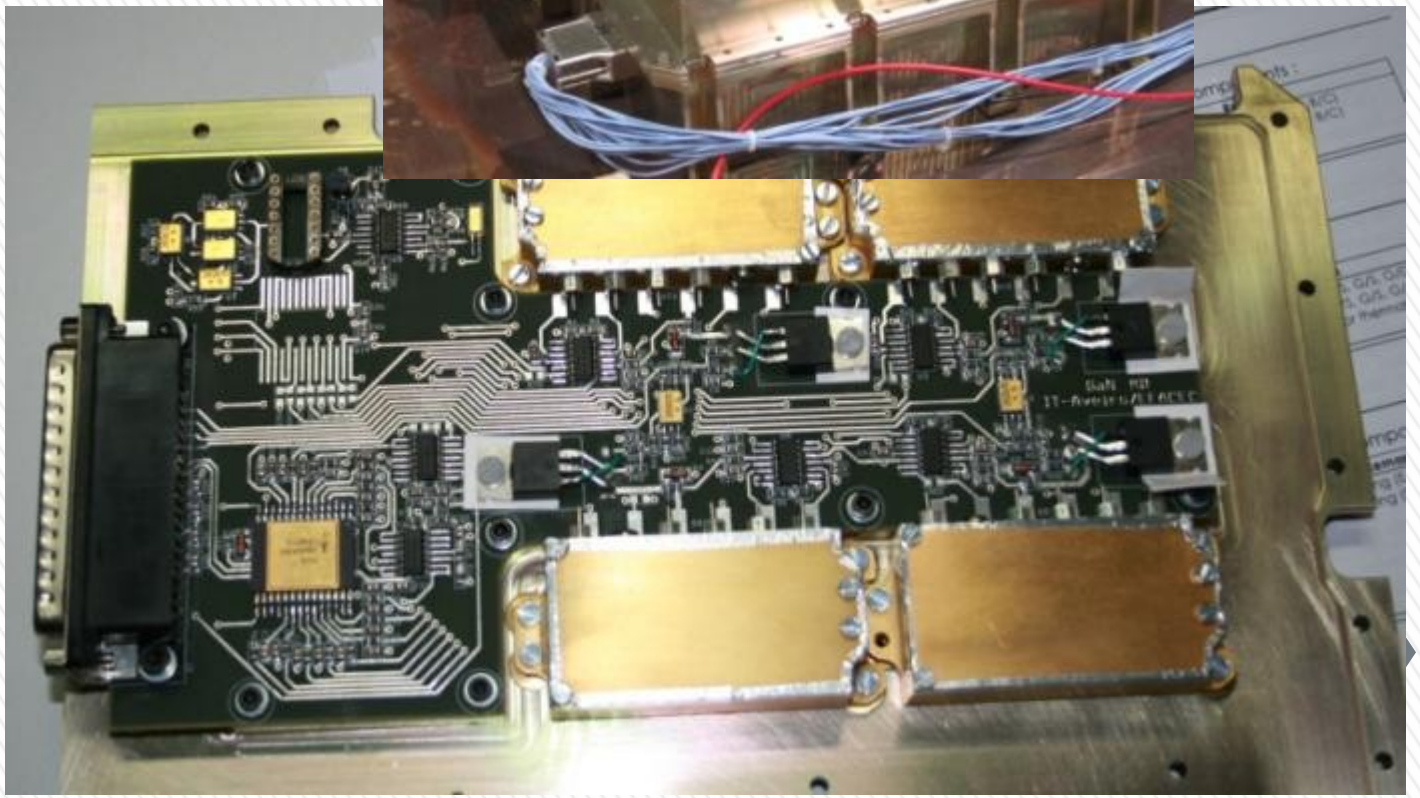
Overall experiment



Final prototype

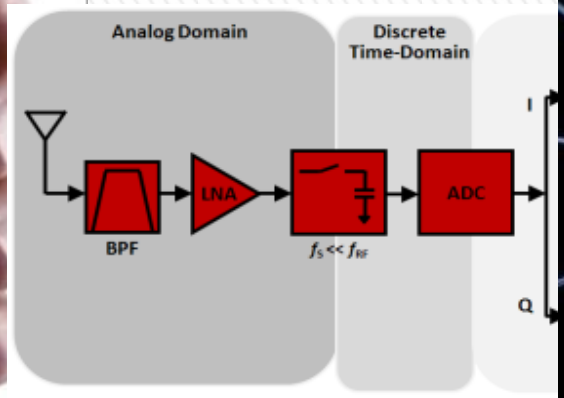
Oscillators:

Supply and control
RF power,
Id
Supply values
temperature
Radiation level
measurements



Challenges University of Aveiro Approach

Improved Radios will have impose cleaver ways to power management.
This implies that radios will have "intelligence" from its own.



1º Prémio PLUG APRITEL 2010

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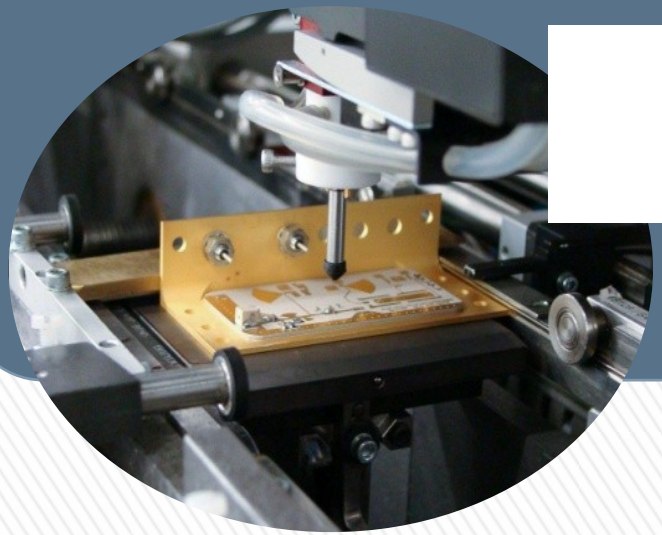
Acknowledgements

We would like to thank the fruitful discussions with:
Prof. José Carlos Pedro, Prof. Nuno Matos and Eng. Cupido
Prof. Mendiratta and Eng. Jorge Monteiro for the vacuum tests
and finally to Portuguese Communications Authority (ANACOM) for the electromagnetic compatibility tests.

Post graduation in Radio System Design

Start Apr - 2012



Post graduation in Radio System Design

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is an advanced postgraduate course that offers an opportunity for electrical engineers to update and advance their knowledge on the area of wireless communication systems.

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