SATURNE

Microsystems Based on Wide Band Gap Materials for Future Space Transmitting Ultra Wideband Receiving Systems

SEVENTH FRAMEWORK PROGRAMME

SATURNE PROJECT

www.saturne-project.com

A. ZIAEI
THALES Research & Technology

THALES

Project Overview

SATURNE: Microsystems Based on Wide Band Gap Materials for Future Space Transmitting Ultra Wideband Receiving Systems

Project number: 242458

Project Officer : Stefano Fontana

(Stefano.FONTANA@ec.europa.eu)

FP7-SPACE-2009-1

Work programme topics addressed

- **Activity 9.2 Strengthening the foundations of Space science and technology**
- **Area 9.2.2 Research to support space transportation and key technologies**
- **SPA.2009.2.2.01 Space technologies**

THALES

Consortium


EADS
UPPSALA UNIVERSITET
iemn
Recherche
Formation
Transfert
UMR CNRS 8520
TOP GaN
THALES
Research & Technology
ThalesAlenia
A Thales / Finmeccanica Company
Space
THALES

SATURNE Concept & Objectives

Integration of WBG devices and RF-MEMS

- **Monolithic integration approach**
- **Hybrid integration approach**
- **Hybrid and monolithic integration approaches**

1st demonstrator: Smart active antenna based on WBG devices and RF-MEMS

2nd demonstrator: A miniaturized reconfigurable front-end

3rd demonstrator: Re-configurable frequency-agile T/R module

THALES

Integration of WBG devices and RF-MEMS [1/3]

Monolithic integration approach

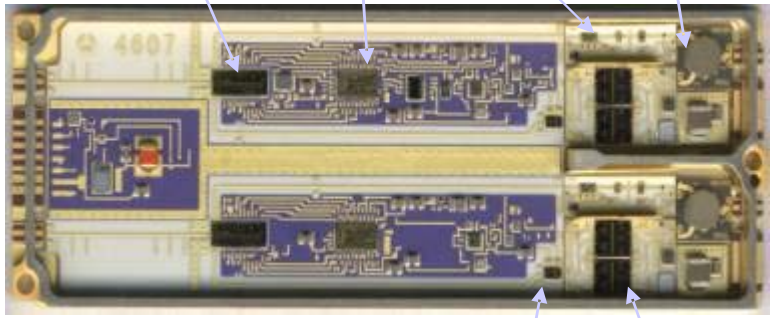
- **Assessment and compatibility of RF-MEMS fabrication process and GaN technology**
- **An elementary device, a GaN based RF-MEMS switch, will be developed with the following specifications:**
  - Frequency range: 2-20 GHz
  - Power handling: 10 W (40 dBm)
  - Isolation: -20 dB
  - Insertion loss: -0.4 dB
- **GaN-based-MEMS-RF subsystems: Single Pole Double Throw (SPDTs)**
- **Feasibility of a production process of these components compatible with the integration of both MMICs and RF-MEMS functions onto the same substrate will be evaluated**

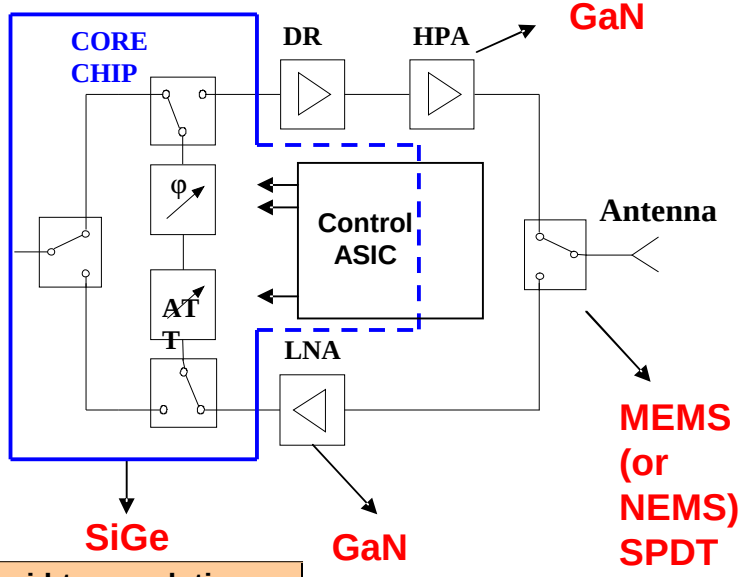
Þ 1st demonstrator: Smart active antenna based on WBG devices and RF-MEMS

THALES

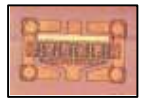
Context, SoA & Goals

GaN devices for microwave applications





		short-term solution	mid-term solution
HPA	S-band	Si BJT -> GaAs HBT	GaN HEMT
	X-band	GaAs HBT, P-HEMT	GaN HEMT
	C-Ku band	GaAs P-HEMT	GaN HEMT
Core-chip	all bands	GaAs P-HEMT	SiGe
LNA	all bands	GaAs P-HEMT	GaN HEMT
T/R Switch	all bands	Circulator	Power MEMS

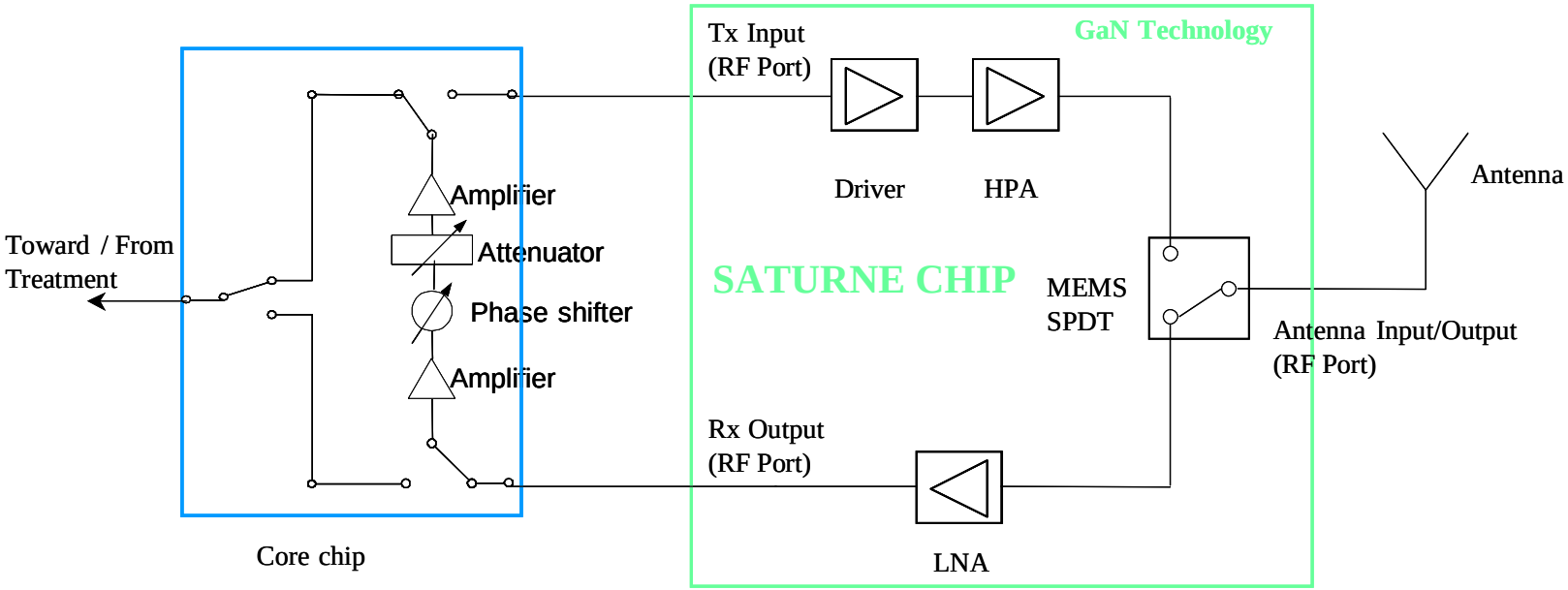


< 5 years

THALES

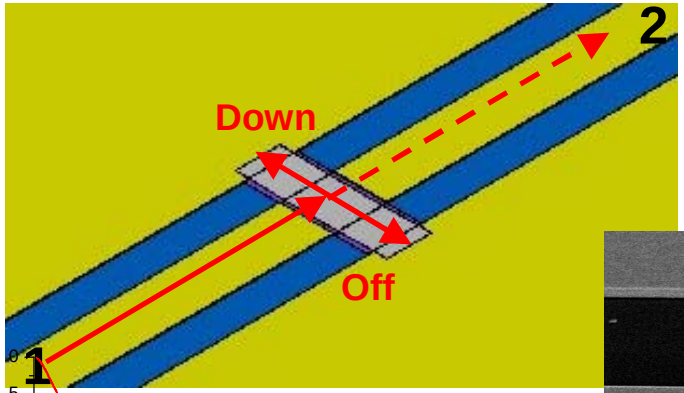
Demonstrator #1 (Thales Research & Technology)
High Power T/R module
Monolithic integration of GaN technologies

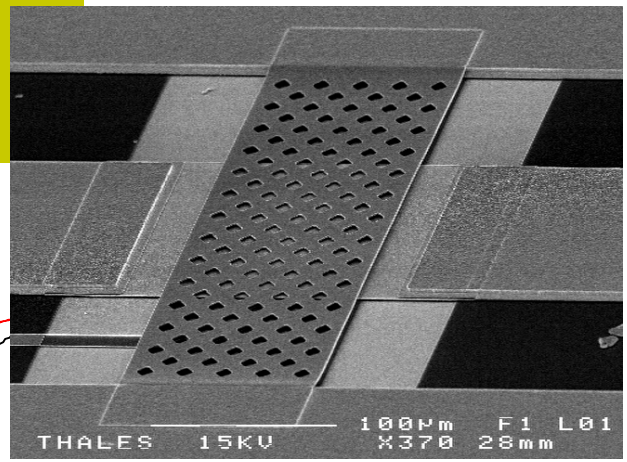
- **GaN-based HPA & LNA (20W X-Band)**
- **GaN-based RF-MEMS SPDT**

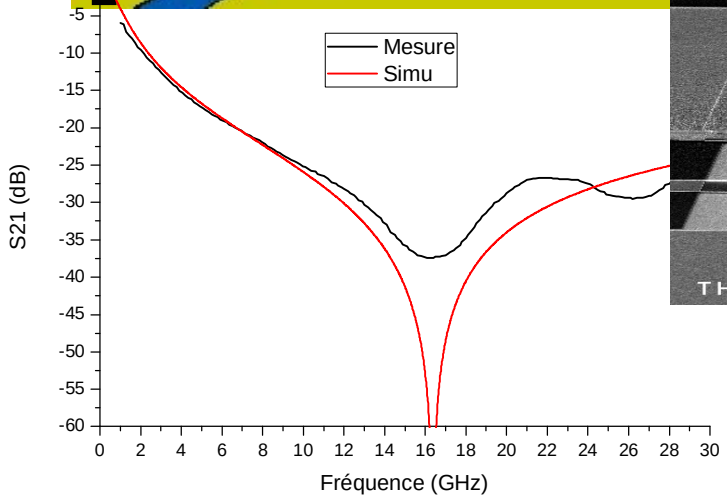


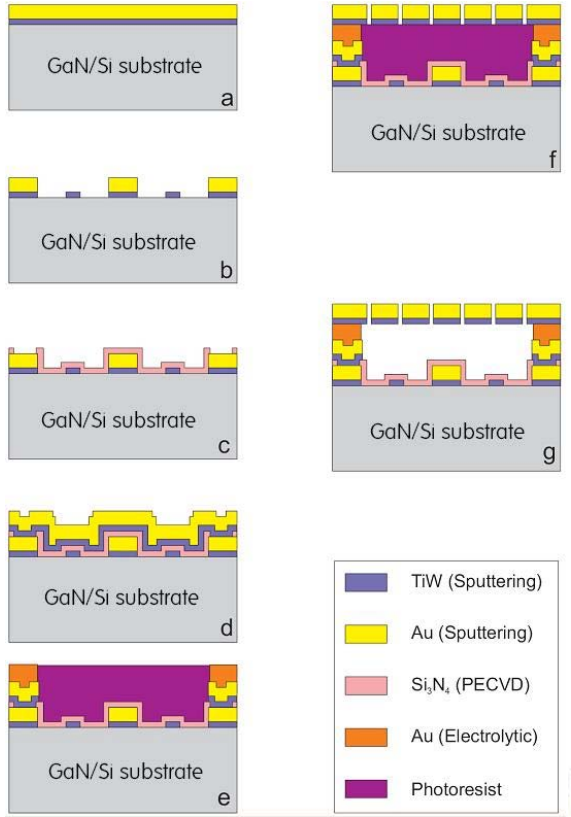
Monolithic integration of RF-MEMS on GaN

- **Shunt RF-MEMS on GaN/Si (Dielectric: PZT or TiO2)**
- **Next step: integration with GaN HEMT**









Integration of WBG devices and RF-MEMS [2/3]

Hybrid integration approach

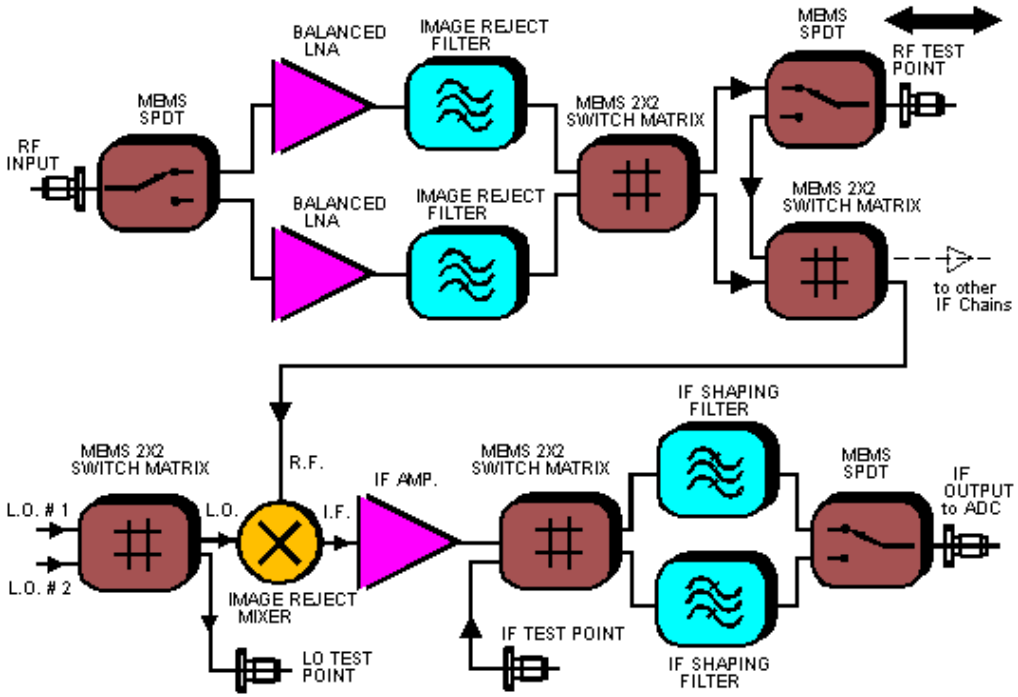
- **Feasibility and performance of re-configurable RF-MEMS based matching networks for GaN power and low-noise transistors by using a hybrid integration approach of both technologies**
- **RF-MEMS switches will be integrated on LTCC multilayer substrates**
  - RF-MEMS switches on LTCC
  - RF-MEMS SPDTs and 2x2 switch matrices on LTCC

Þ **2nd demonstrator: A miniaturized reconfigurable front-end**

THALES

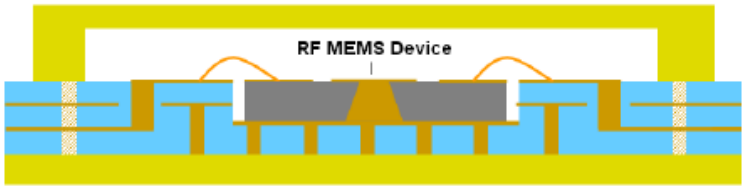
Demonstrator #2 (Thales Alenia Space Italy)
Multi-band re-configurable receiver
Hybrid integration on LTCC

- **GaN amplifiers on LTCC (C- & X-band)**
- **RF-MEMS SPDT & 2x2 matrix on LTCC substrates**

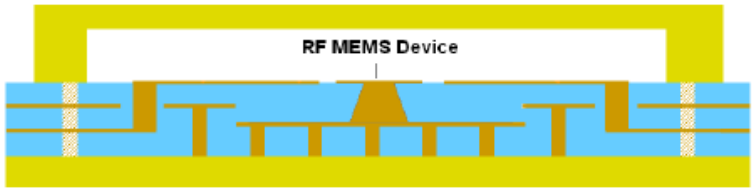


THALES

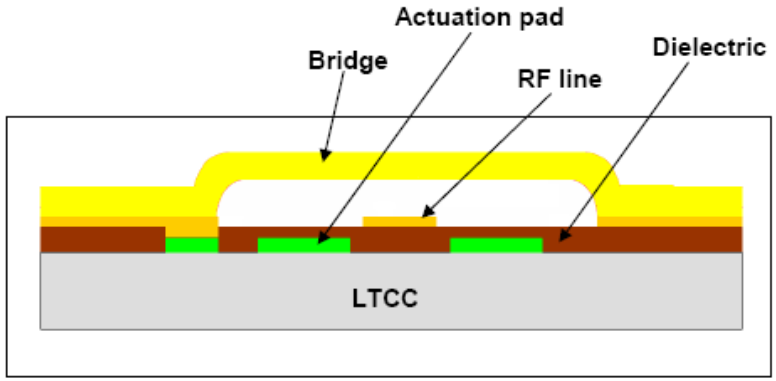
RF-MEMS on LTCC

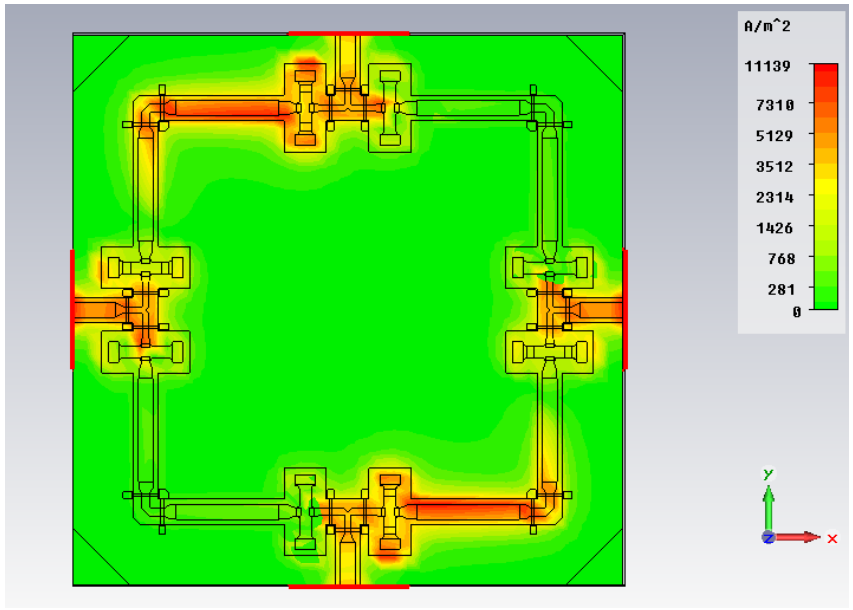


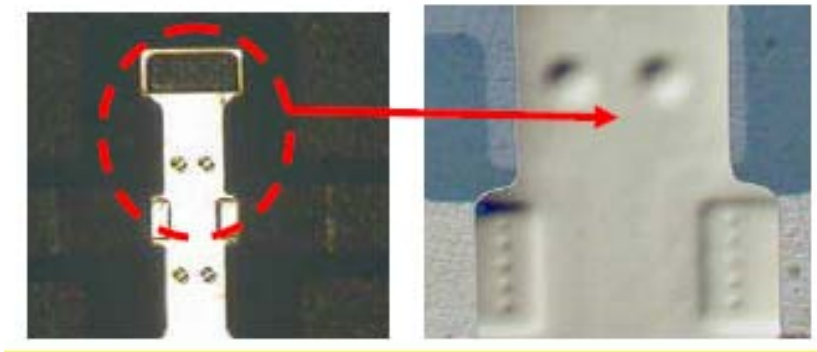
Silicon MEMS chip glued in a LTCC package with internal wire transitions



Integration of the MEMS directly on the LTCC substrate







The electrostatic actuation of the bridge is obtained by means of two resistive metallic pads (made of NiCr or TaN). The actuation pads are covered with a dielectric layer (polyimide).

THALES

Integration of WBG devices and RF-MEMS [3/3]

Hybrid and monolithic integration approaches

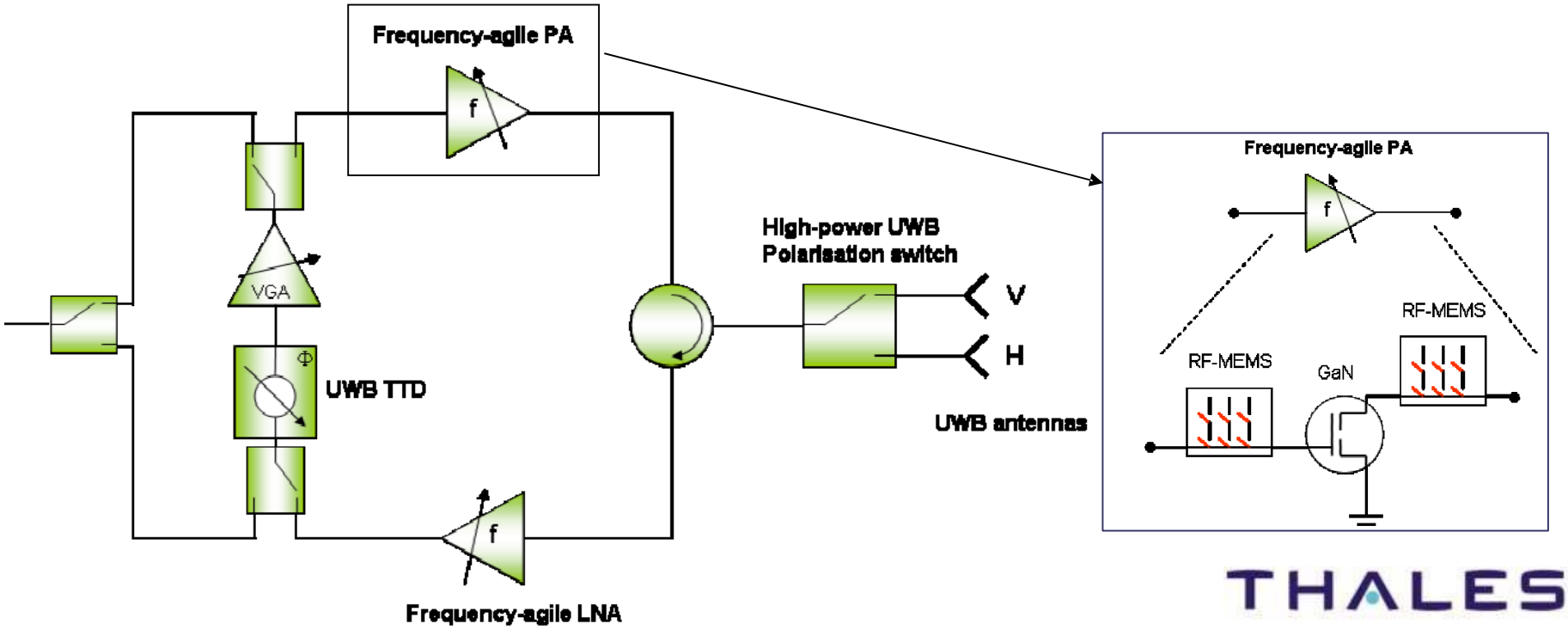
- **Re-configurable RF-MEMS based matching networks and high-power SPDT switches will be designed and manufactured on Silicon and on GaN**
- **These circuits will then be integrated with the GaN high-power and low-noise transistors on a LTCC RF-board**
- **Ultra-high performance true-time-delay (TTD) units**

Þ **3rd demonstrator: Re-configurable frequency-agile T/R module**

THALES

Demonstrator #3 (EADS)
Reconfigurable frequency-agile T/R-module
Hybrid integration on multilayer LTCC board

- **GaN-based amplifiers (from L- to Ku-band)**
- **Si-based RF-MEMS SPDT**

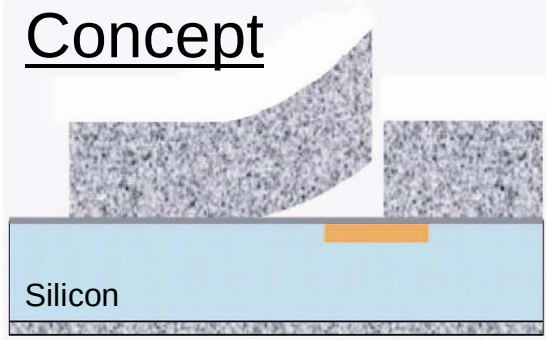


THALES

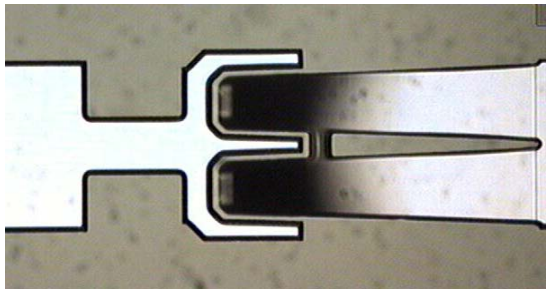
RF-MEMS switches on Si

- **high-resistivity silicon substrate**
  thermally grown silicon oxide
  Implantation layer for capacitive coupling
  only 3 lithography process steps
- **substrate thickness: 100um**
  black parts are bended upwards
  design focus on low-frequency behaviour
- **Frequency-range: 1.8 - 10GHz**
  Insertion loss: < -0.6dB
  Isolation:> -26dB

Concept



Fabricated switch



Measurement results