Mems at STMicroelectronics Aerospace Opportunity

Thibault BRUNET
Marketing Manager
Olivier GIRARD
Technology Advanced Program Manager

Agenda

- ST in Aerospace at a Glance
- ST : A Worldwide Leader in Mems
- ST Interest in Mems for Space : RF Switch
- Conclusion : Next Steps

vv

The Aerospace Equation

- Increasing Constraints in Aerospace
  - 15 Years Satellites Life Time tend to Increase
  - Radiation Qualification gets more Demanding
    - ELDRS – Proton….
  - Advanced Electronic Features SEU & SET free
  - Stable Production Outcomes over many Years
- ST Solution : Dedicated Products
  - Selected Technologies : Quality - Volume - Longevity
  - Specific Design with Specific Target
  - Specific Packaging
  - Specific Qualification
  - Specific Logistic

ST Portfolio for Aerospace

Discrete

- MOSFET
- Bipolar Transistor
- Schottky Diode
- Bipolar Diode

Logic & Interface

- Bus Driver
- Level Shifter
- ACMOS Logic
- HCMOS Logic
- CMOS4000

Analog & Sensor

- ADC
- Opamp
- Comparator
- Voltage Reference

CNES

Power

- Linear Regulator
- ICL

ESA

- MOSFET Gate Driver

LEGEND :

- ESCC
- DSCC
- Development
- 300 krad
- 50/100 krad
- Hirel

Technology Provider

2009 : ST Reconfirmed Leader in Motion Sensing

Over 850 Munit

MEMS Top-Ranking Suppliers for Consumer Electronics and Mobile Handsets Markets
2009 TAM: $1.1B (*)

		2006	2007	2008	2009	Main CE and mobile markets
				(Millions of Dollars)		
1	**STMicroelectronics**	30.6	96.8	221.2	218.0	Accelerometers, pressure, gyroscopes
2	Avago Technologies	111.5	137.4	192.1	215.3	BAW filters (BAW revenue of Infineon in 2008 included)
3	Knowles	87.8	92.6	117.9	105.9	MEMS microphones
4	Texas Instrument	457.4	305.0	174.3	101.4	DLP chips for RPTV and consumer front projectors
5	Epson Toyocom	8.9	29.4	52.4	95.4	Quartz MEMS Gyroscopes, Quartz MEMS oscillators
6	Bosch Sensortec	3.7	9.9	25.8	82.0	Accelerometers, pressure sensors
7	Invensense	0.0	8.3	15.9	57.7	Gyroscopes
8	Kionix	23.9	31.3	45.8	48.2	Accelerometers
9	Analog Devices	39.7	68.1	50.4	40.8	Accelerometers, gyroscopes and microphone in 2009
10	Freescale	24.0	30.0	27.0	38.0	Accelerometers, pressure sensors
11	Panasonic	23.3	24.5	24.0	23.9	Gyroscopes
12	Murata	29.5	35.5	29.2	22.6	Gyroscopes
13	MEMSIC	9.6	18.4	12.9	18.4	Accelerometers
14	Hokuriku	19.1	35.4	25.2	14.0	Accelerometers, pressure
15	EPCOS	4.9	11.0	7.8	9.4	Microphone, BAW and pressure sensors

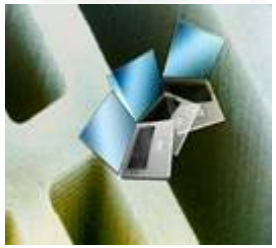
(*) **STMicroelectronics** became the leading manufacturer of MEMS for consumer electronics in 2008. STMicroelectronics's MEMS revenue in consumer electronics was flat in 2009, but the company has managed to maintain overall pole position. The vast majority of its MEMS revenue comes from accelerometers—ST dominated 56% of this market in 2008.

* Source : iSuppli Corp. | Dec 2009

What We Said : May 2008 - London

- Expanding our four traditional markets :
  - Mobile Phones
  - Portable Multimedia Players
  - Gaming
  - Laptop and HDD



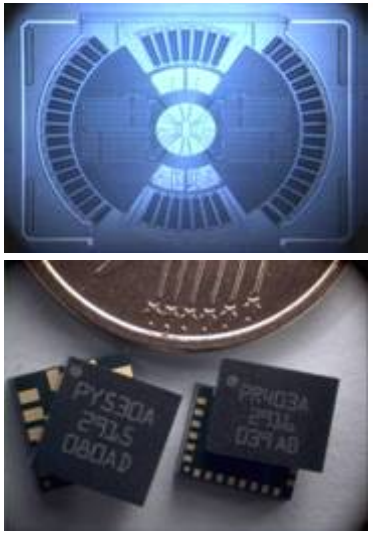



- Addressing new markets:
  - Digital Still Cameras
  - Remote Controllers
  - Personal Navigation Devices



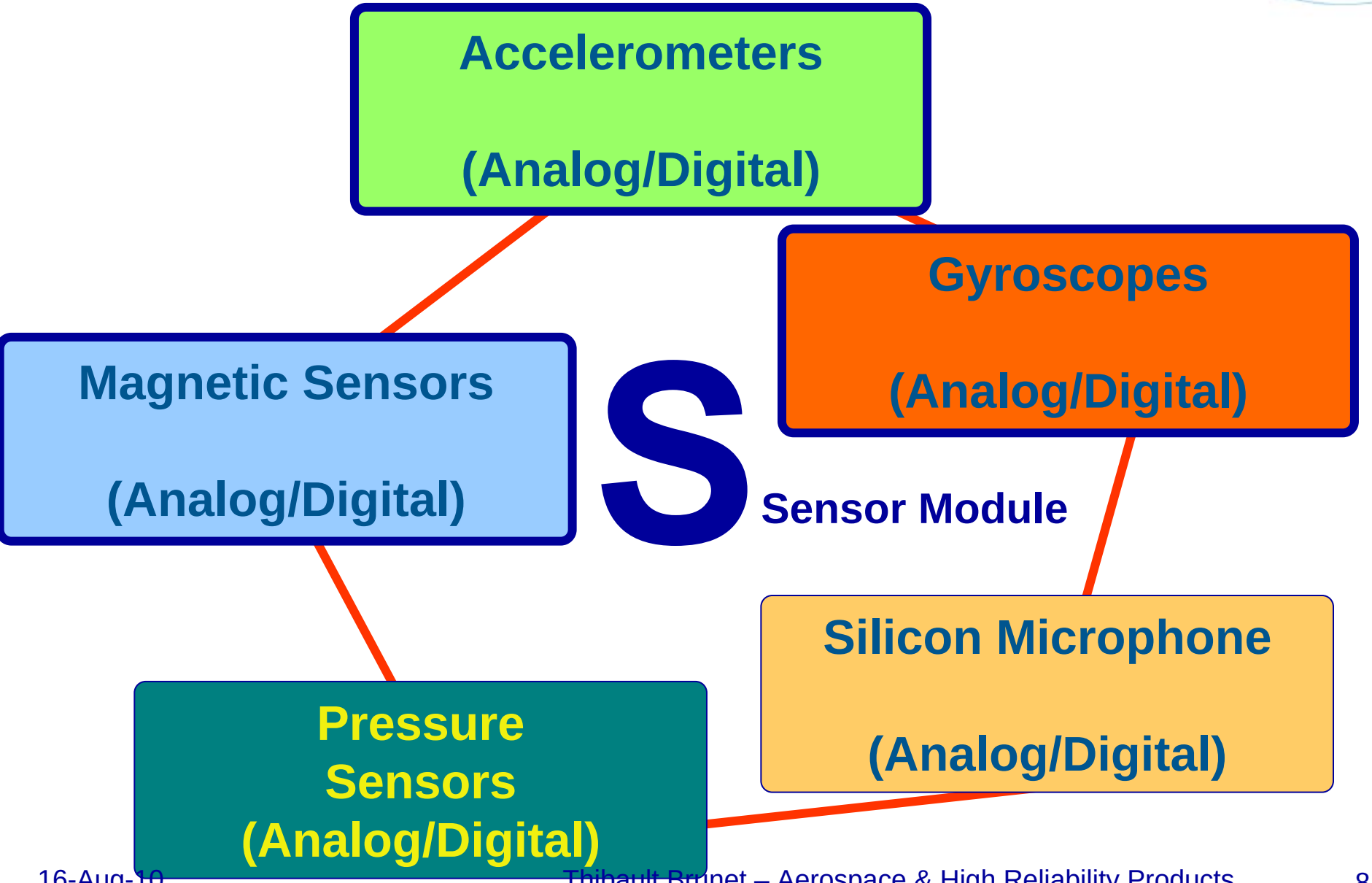
We Also Committed to :

- Enlarge our Portfolio with:
  - Ultra low power accelerometers
  - Multiple axis gyroscopes
  - Biosensors



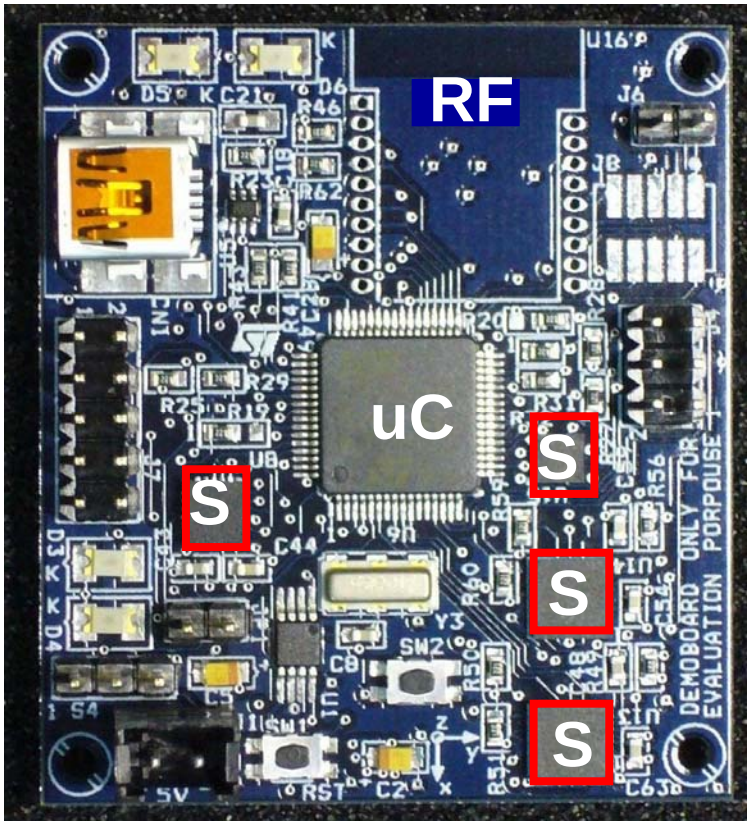
- Bring Consumer Market Economies of Scale to New Markets :
  - Automotive
  - Industrial
  - Healthcare

A Complete Sensor Portfolio



Smart Sensors Evolution

Miniaturization and Low Power Consumption are Critical



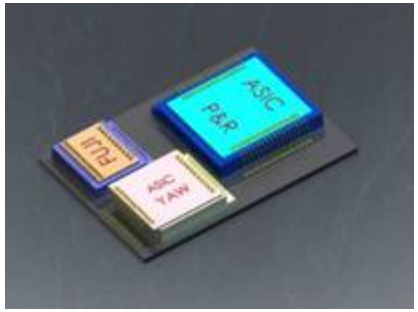
15 cm³

S : Sensor

Today

System in Package :

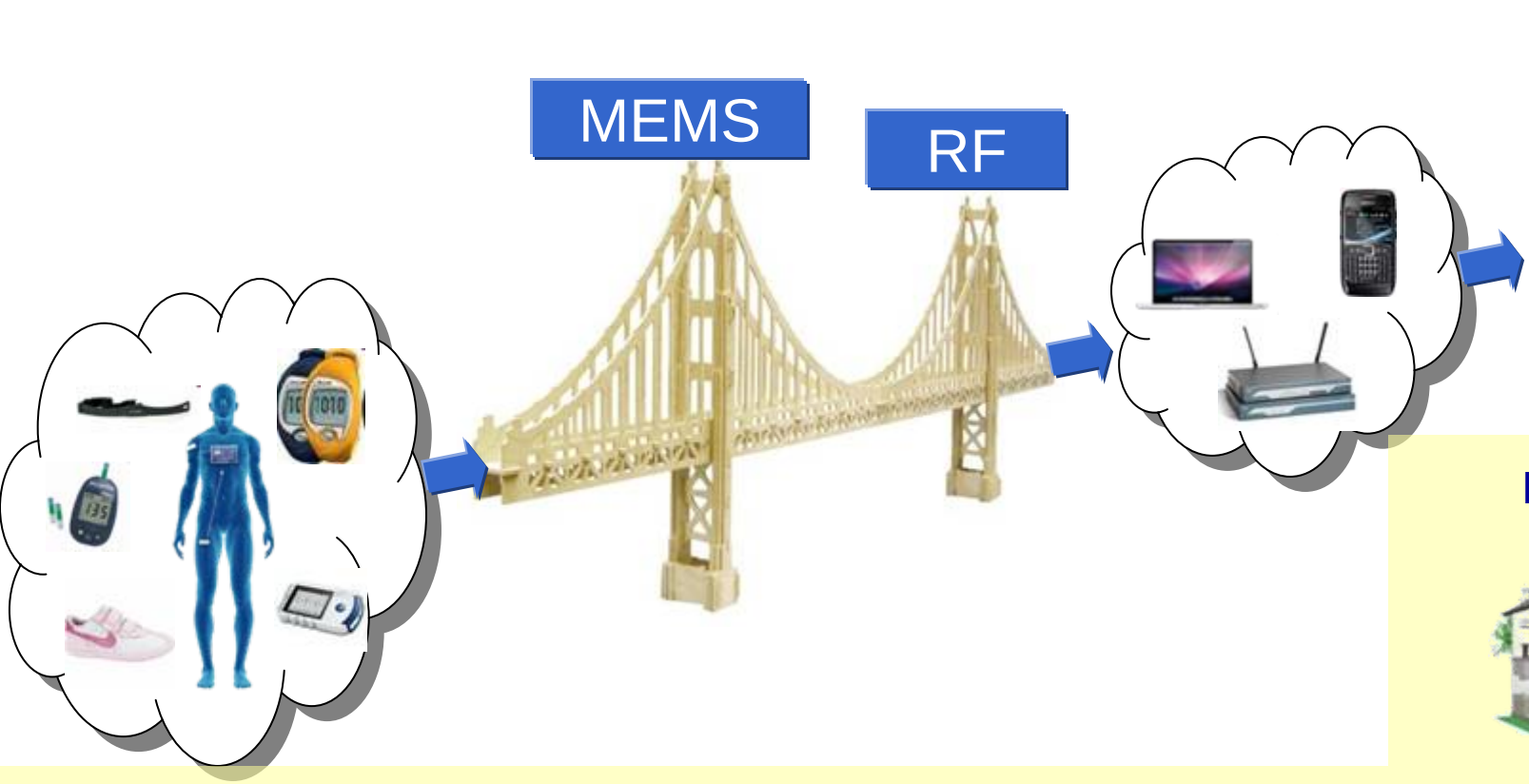
- Sensor
- Signal Conditioning
- Signal Processing
- Transmission (RF…)



50 mm³

Tomorrow

Smart Sensors for New Domains



BUILDING

SPORT & WELLNESS

FACTORY AUTOMATION

LOGISTICS

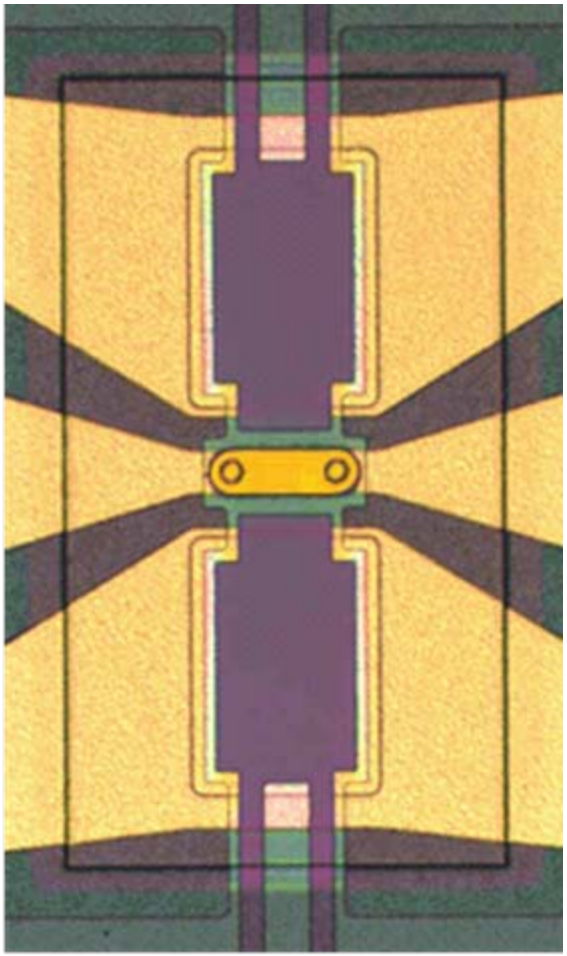
HEALTHCARE

MEMS : a Consolidated Leadership

- Leading the “MEMS Consumerization Wave”
- Consolidating leadership in Automotive and Industrial segments thanks to new, emerging applications
- Extending presence in Smart Sensors for Consumer, Automotive, Industrial and Healthcare segments
- Investigating business opportunities for Space

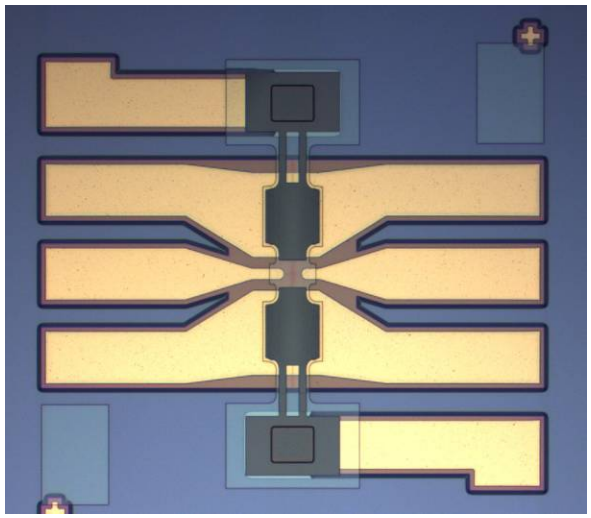
Mems Based RF Switches Status at STMicroelectronics

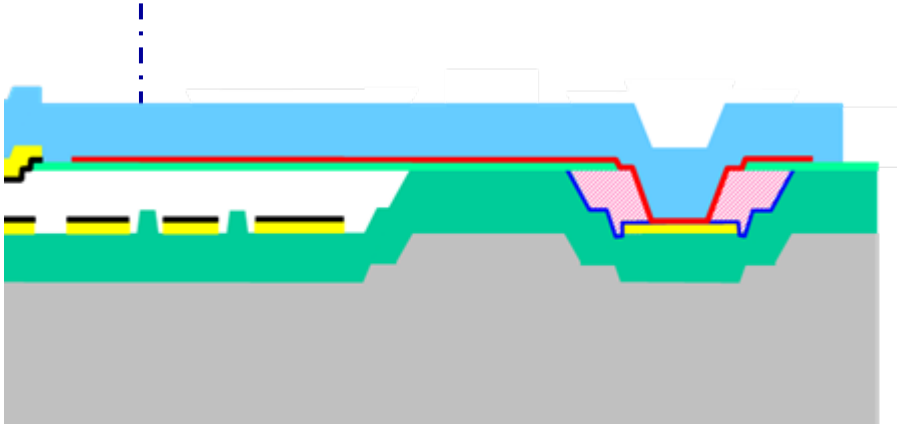
- Past Technical Investigations for Telecom
  - In Partnership with LETI
- Identified Potential Business for Space
- Resumed Discussions with LETI
  - Technical feasibility
  - Working Model
    - Design
    - Assembly & Test
    - Agency Qualification
    - Logistic
    - Business



Status on RF ohmic switch

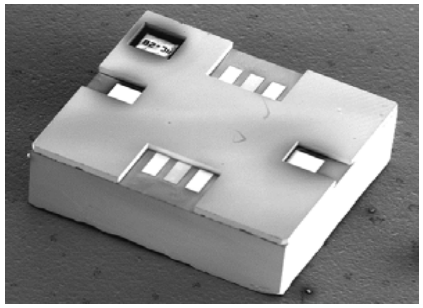
- Implemented features
  - Proven RF design
  - Packaging compatible with handling and assembly
- New features - from background
  - Ruthenium (Ru) contact
  - Hermetic packaging for higher reliability
- New features for higher actuation reliabilty – to be tested
  - Dielectric less actuation



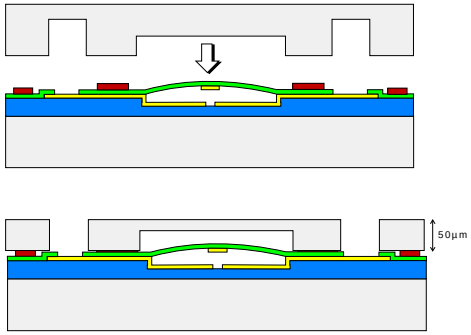


Packaging solutions

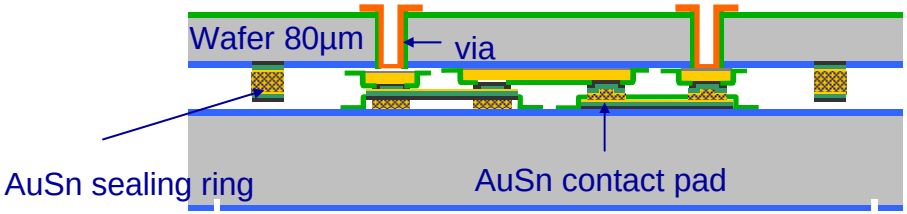
- Packaging : Available Solution
  - Wafer level packaging :
    - Nitrogen Atmosphere Based on Polymer Bonding (Not Hermetic)
  - Final packages height of 50µm
    - Compatibility with Wire Bonding & Flip-Chip Assembly

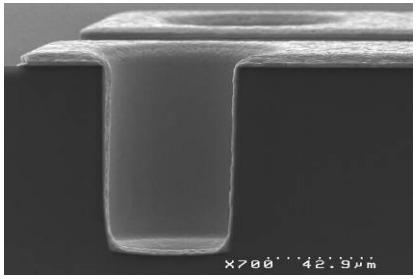


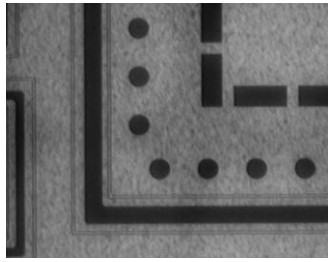
Optional TSV



- Improvement of packaging : work in progress
  - Work in progress on hermetic wafer level packaging (AuSn sealing)







Expected Key Parameters

Definition	Expected values
Isolation @ 5 GHz	- 38 dB
Insertion @ 5 GHz	- 0,15 dB @ 30V
Isolation @ 30 GHz	-20 dB
Insertion @ 30 GHz	-0,3 dB @ 30V
Actuation voltage	11 – 40 V
Actuation current	< 0.5 pA
Maximum number of cycles	10^{11} (cold switching)
Time life (worst condition)	(to be measured)
ON state commutation speed	500 ns
OFF state commutation speed	# 1 µs
Maximum power	> 2 W @ 10 GHz
Vibrations	1000g (Norme MIL STD 883D)
Temperature	- 40° / + 150°C
Radiations	80 kRads

- measured on previous switch with same RF design
- measured on miniature rheed relay with same contact
- Verified on new process flow on initial test vehicle

ST Next Steps in Mems for Aerospace

- Technical Feasibility Study
- Characterisation of LETI Dielectric less RF Switches
  - Target : End 4Q10
- Frozen Target Specification & Economical Viability
  - Market Survey and Funding Plan

Propose Industrialisation & Qualification Plan