Laboratoire d’électronique et de technologie de l’information

From Technologies to Applications

J.R. Lèquepeys, Head of Silicon Component Division

2012
AGENDA

• Brief overview of CEA-Leti
• Some of our technology roadmaps
• Leti plays a key role for boosting innovation through:
  • Close partnership with industrial partners
  • Startup creation
The CEA at a glance

Commissariat à l’Énergie Atomique et aux Énergies Alternatives is one of the largest research organizations in Europe, focused on energy, health, information technologies, and national defense.

>16,000 People (10% PhD and Post Doc)

10 Research centers
CEA-Leti | About Leti

Founded in 1967 as part of CEA

1,700 researchers
210 PhD students + 30 post PhD with 85 foreign students (35%)

Over 1,880 patents
273 generated in 2011
40% under license

250 M€ budget
~ 30M€ CapEx

50 start-ups
& 365 industrial partners

CEO
Dr. Laurent Malier
A single mission:

Create innovation & transfer it to industry

A clear focus:

• \( \mu \)-nanotechnologies, with critical mass in Si
• Advanced devices for new applications
CEA-Leti | Cooperation model

Proprietary

Corp Lab

Industrial R&D

Business Units

External Integration Lab

Disruptive concepts

Academic Lab

Academia Lab

Open

New products

Academic Lab

Academic Lab

Academic Lab

Academic Lab

Industrial R&D

Business Units

External Integration Lab
CEA-Leti | Cooperation model and postionning

Proprietary

Corp Lab

Industrial R&D

Business Units

Disruptive concepts

Pre competitive & generic focus

Externals

Focus on IP
Mix of precomp & comp

New products

Academia Lab
CEA-Leti | A Complete Set of Research Platforms

- Nanotec 300
- Smart Systems Integration
- Advanced CMOS 200
- Design
- MEMS 200
- Integrative Chemistry & Biology
- Nanoscale Characterization
- Photonics
• Brief overview of CEA-Leti

• **Some of our technology roadmaps**
  • CMOS, Memory, 3D, Sensors, Actuators, RF, Photonics, Power devices, Litho, Imagers, displays...

• Leti plays a key role for boosting innovation through:
  • Close partnership with industrial partners
  • Startup creation
Our main goal: find an alternative to planar Bulk with a good Speed/Power tradeoff:

- Variability reduced by 2
- Speed improved by 30%
- Power consumption reduced up to 40%

Our vision

- Planar FDSOI is the right choice for 20 and 14nm:
  - Simpler process than FinFET
  - Excellent Speed/Power tradeoff
- Nanowire will emerge for 10nm
- Alternative 3D integration process for further scaling
Our main goal: Explore embedded non-volatile memory

- Reduced fabrication cost
- Reduced power consumption (10x)
- Reduced latency
- Increased endurance (reach 1e15)

Our vision: Resistive memories (as PCM, CBRAM, OXRAM and MRAM) can offer these advantages => back-end solutions, low-voltages, fast speed, high endurance, good reliability, high scalability

« Embedded resistive memories »

One-to-one industrial collaborations

Technologies: PCM, CBRAM, OXRAM, MRAM

Objectives: Cost reduction, short latency, low power consumption, high endurance

Applications: Microcontrollers for automotive, smart cards & telecom

New applications

Non volatile logic with resistive switching devices

Applications: Reconfigurable circuits, resilient and non volatile logic circuits

Objectives: to reduce circuit size, power consumption and delays

New systems

Neuromorphic systems using resistive synapses

Applications: vision, security, transport, robotics, computing, neurosciences

Internal research program

PhDs

European and national projects

© CEA. Tous droits réservés
**Roadmap for Silicon Demonstrators**

**Today 2012-2013**
- Si interposer
  - TSV Ø10µm, 50µm pitch

**Tomorrow 2013**
- Memory on Logic
- Logic-on-analog
- Logic-on-logic (Advanced on Mature)

**2015**
- Active interposer (NOC interconnect)
- Modular and Stackable processor (NOC interconnect)

**Next >2016**
- Cache memory on many core (3D network-in-memory)
- Fine grain partitionning Pitch <10µm

**Technology add-on**
- **Mechanical Stress management modules**
  (stress buffer, compliant int.)
- **Specific packaging solutions**
  - Dicing, direct-on-board, bio-compatibility
- **Stacking**
  - Interconnects, underfill, P&P

**Core 3D Technology (200 & 300 mm)**
- TSV
  - Cu Damascene line
- Bonding
- Thinning
- RDL
- Bumps
- TSV last

**Modules for RF (integrated antenna)**

**Bio Techno Modules**
- Biocomp,…

**Silicon on Flex Modules**

**3D Technology Toolbox**
- 200 & 300 mm
Roadmap | Sensor at Leti (M&NEMS Platform)

- Miniaturized sensors
- Generic platform for sensor integration
- Sensors fusion
- No parasitic sensitive
- An approach for low power consumption

**MEMS size inertial mass**

+ **Nano-size piezoresistive gauge**

---

**3D Accelero**

**3D gyro**

**3D magneto**

**Microphone & Pressure sens.**

All these sensors on the same die, with the same IC for readout
AGENDA

• Brief overview of CEA-Leti
• Some of our technology roadmaps
• Leti plays a key role for boosting innovation through:
  • Close partnership with industrial partners
  • Startup creation
A key partner | With industrial Partners / Customers

One-to-one collaboration

- Dedicated personnel
- Research
- Proof-of-concept ➔ Prototypes ➔ Volume production
- Long-term IP approach and careful IPR management

Global Capabilities

- Common labs
- Access to Technological platforms
- Broad expertise provided
A key partner | **Transfer with industrial partners**

**Our model for cooperation:**

- **Joint programs**
  - ✔ Permanent & Continuous Transfer

- **Joint teams**
  - ✔ License Agreement
  - ✔ Win-Win partnership
A key partner | **Main Industrial transfers in microelec./microsystems**
A key partner | Open Collaboration with World Class Academia Partners

Leti: the gateway for greater access to technology thanks to world class links with academia and Research Labs
Camera for Mobile Phone

- VGA (300k pixels)
- Camera size evolution
- 3D impact on Embedded Cameras
Bolometer based Infrared Detector Arrays

- Pixel 17µm transferred
- Pixel 12µm demonstrated
- Wafer Pixel Packaging
- NETD = 50 mK

**Key Accomplishments | Industrial Transfer**

- Detector to read-out circuit contact pad
- Thermal insulation
- Mechanical holder
- Amorphous Silicon
- Reflector
- CMOS read-out circuit

**Commercial product**

640 x 480 - 25 µm
125Mb/s RFID for remote powering High Capacity Data Storage

- Coupling RFID (UHF & 13.56MHz) and UWB impulse radio
- Data rate from 54 to 125 Mbps @ 30cm
- Power consumption: 5mW
- Chip area: 4mm²
- ST CMOS 130nm, 1.2V

Download time of 10s for a 1 Gigabit of content from battery-less memory tags
DNA detection and IR Camera used for flu detection

(Avian flu, H1N1 flu)
Key Accomplishments | Industrial Transfer

Accelerometers
(automotive market)

- low G accelerometer
- On-Chip-Sealing on 200 mm
- 640 SOI wafers processed in LETI
3D Stacking Memory on logic Wide I/O demonstrator (application smartphone)

- Array of ~1000 TSVs
- Memory
- Array of ~1000 bumps
- 4 x 128bits @ 200MHz ➔ 12.8GBps

Leti Mag 3D platform
✓ Array of ~1000 TSVs

Memory
✓ Array of ~1000 µ-bumps
✓ 4 x 128bits @ 200MHz ➔ 12.8GBps
3D High Density Interposer

- 100 µm thick interposer
- 10 µm diameter TSV
- 100 000 intercos / Chip
- 0.5 µm resolution RDL

Available 200mm Transfer to 300mm running
Micro-displays for embedded entertainment

Above CMOS OLED displays:
- A low-power solution
- HD-TV compatible
- A natural 3D-view extension

Key Accomplishments | Industrial Transfer

Pixel size = 3µm
Embedded color filters
Collective packaging
1 Mpixel RGB

Colored filters
Cathode
OLED
Anode
Metal
CMOS
Substrat Si
Collective packaging
New generation of pacemaker

Cardiac Rhythm Management (CRM)

1. Heart activity measurement
Ventricular micro-probe: Asic + MEMS accelerometer

2. Heart activity stimulation
peripheral Asic + electrodes

3. Ultra Low Power RF Links

Key Accomplishments |
Industrial Transfer

- High integration
- Reliability
- Full hermeticity
- Blood biocompatibility
- High autonomy
- RF Link

3D for integration → PICS
MEMs: 28 years of industrial transfer

Key dates

- 80: MEMS technology
- 85: Comb drive accelero patent
- 90: Surface micromachining, bulk technology, Waferscale packaging
- 95: Above IC MEMS demonstration, Thin film packaging
- 00: M&NEMS concept, « Intra-CMOS » demonstration
- 05
- 10
- 15

Transfers

- 1997: Quartz accelerometer, THALES
- 2002: Weight sensor, Terraillon
- 2003: Hygrometer, GEFRAN COREC
- 2004: Pressure sensor, THALES
- 2005: Pacemaker accelerometer, elato, TRONIC'S
- 2006: Geophone, TRONIC'S
- 2007: Accelerometer, freescale
- 2008: Inertial platform, freescale

Startup

- 1997: TRONIC'S
- 2007: LETI / Caltech
- 2009: NanoSystems Partnership
- 2010: Common lab.
- 2011: APIX
AGENDA

• Brief overview of CEA-Leti
• Some of our technology roadmaps
• Leti plays a key role for boosting innovation through:
  • Close partnership with industrial partners
  • Start-up creation
Leti, 45 years of history

- 1967: Creation of Leti
- 1972: EFCIS created, 1st start-up of Leti for on-demand production of MOS circuits
- 1976: 1st French X scanner designed and built at Leti
- 1983: Silicon accelerometer patented and transferred to Terralun
- 1987: Sofradir created, a spin-off of Leti
- 1992: 1st 20 nm transistor produced by Leti
- 1999: Development of MEMS
- 2002: 200 mm wafers and transferred on 200 mm wafer line
- 2006: Inauguration of Minatec Campus of excellence
- 2008: Caltech Alliance
- 2009: IBM CMOS Alliance
- 2010: Fluoptics created, start-up of Leti (cancer detection)
- 2011: 300 mm 3D TSV Pilot Line Inauguration
- 2012: Creation of APIX, 1st start-up Leti/Caltech
- 2013:
- 2014:
- 2015:
- 2016:
- 2017:
- 2018:
- 2019:
Leti,
50 start-ups created

START-UPS CREATION: An efficient way to transform ideas/technologies into value/jobs
Since 2000
24 start up created
5 discontinued

Since 2008
13 start up created
2 discontinued

3053 active jobs
n° 3 WW in high-end infrared detectors
Leader in advanced substrates for microelectronics
Leader in concentration PV
High-end MEMS sensors
Operations in US & China
Leader in low cost infrared imagers
INTEL Capital invests 6.5M€

Leader in motion-sensing applications

5 yrs
Leader in micro-displays
Create a start-up at Leti: collective support to maximize the chance of success
A strong partner for innovation, from technologies to applications,
in a dynamic and global environment