



# Complementary Organic Semiconductor and Metal Integrated Circuits



COSMIC will generate an organic CMOS technology platform from design to manufacturing level.

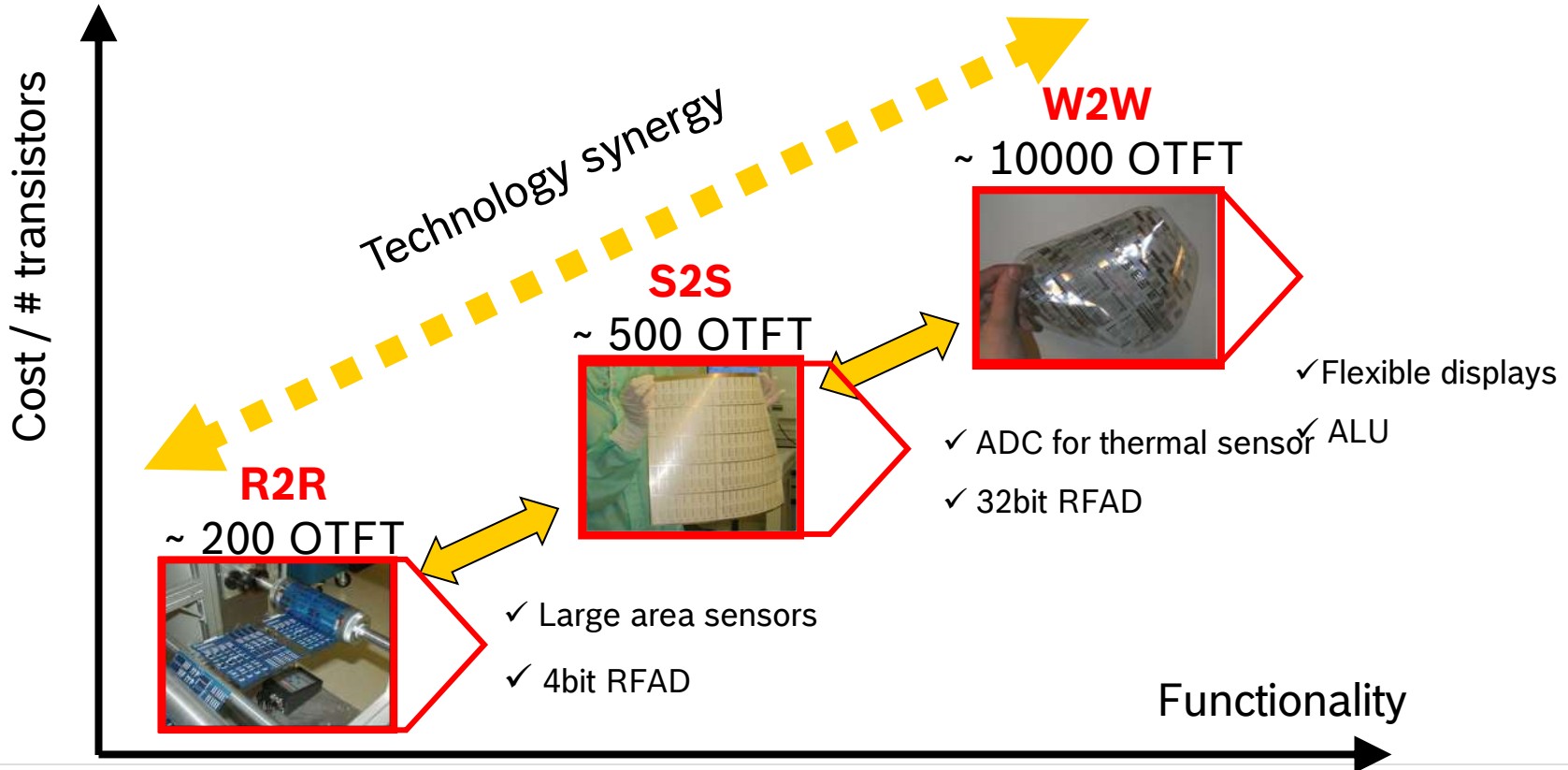
COSMIC will produce highly complex lead applications covering the whole FOLAE market with different manufacturing modes.








# Technology

**COSMIC develops one organic CMOS Technology Platform including 3 complementary manufacturing modes: W2W, S2S, R2R.**



# Complementary Manufacturing Modes and associated application areas.

|  | W2W   | S2S  | R2  |
|--|---|--|---|
|  |          |    |    |
| Lead application                       | Line-driver for display, Arithmetic logic unit  | ADC for thermal sensor<br>32 Bits RF-ID Silent Tag   | Low level signal processing for T sensor (Operational Amplifier)<br>4Bit-RF-AD (Silent Tag)   |
| Technology                             | Diameter 150 mm foil on carrier<br>Clean room<br>High yield                               | 320x380 mm sheets<br>Additive printing and corresponding processes<br>Clean room<br>Medium yield   | R2R processes web 210mm<br>Flow boxes<br>Continuous and stop-and-go processes<br>Lower yield  |
| Market segment of the lead Application | Line-driver: E-paper, OLED displays;<br>ALU: every integrated system that needs computing | <ul style="list-style-type: none"> <li>•Temperature sensor for skin and building integration</li> <li>•RF-authentication of consumable goods</li> </ul>                      | <ul style="list-style-type: none"> <li>•High throughput large area sensors</li> <li>•RF-authentication of consumable goods</li> </ul> |
| Other potential markets                | Displays, Sensor matrixes, microprocessors, integrated electronics systems ...            | <ul style="list-style-type: none"> <li>•All sensor and actuator on foil applications</li> <li>•Digital to analogue converters and mixed signal integrated systems</li> </ul> | Large-area sensing, Large volume organic electronics addressing low-cost segments   |



## **COSMIC** - Breakthroughs and expected results



### Circuit and demonstrators

- First fully printed A/D-Converter using analogue organic CMOS.***
- First flexible organic line driver for display or comparable complexity IC.***
- First organic RFID with receiver radio.***
- First organic ALU!***

### Materials and printing processes

New materials and printing processes with high mobility and stability under stress

Balance p-TFT and n-TFT characteristics :  $\mu_n \sim \mu_p$  ,  $|V_{thn}| - |V_{thp}| < V_{DD}/4$

Common and compatible technology for n and p: Dielectric, S&D level

Compatible interconnection technology for circuit processing

Controlled resistors

### Design/conception and model

Process tolerant design

Maximised noise margin

Organic SC models and simulation tools

Organic Analogue CMOS Design

Charge transport in LC polymers

### Reliability

Transistor parameter reproducibility

Minimise stress and stress sensitivity

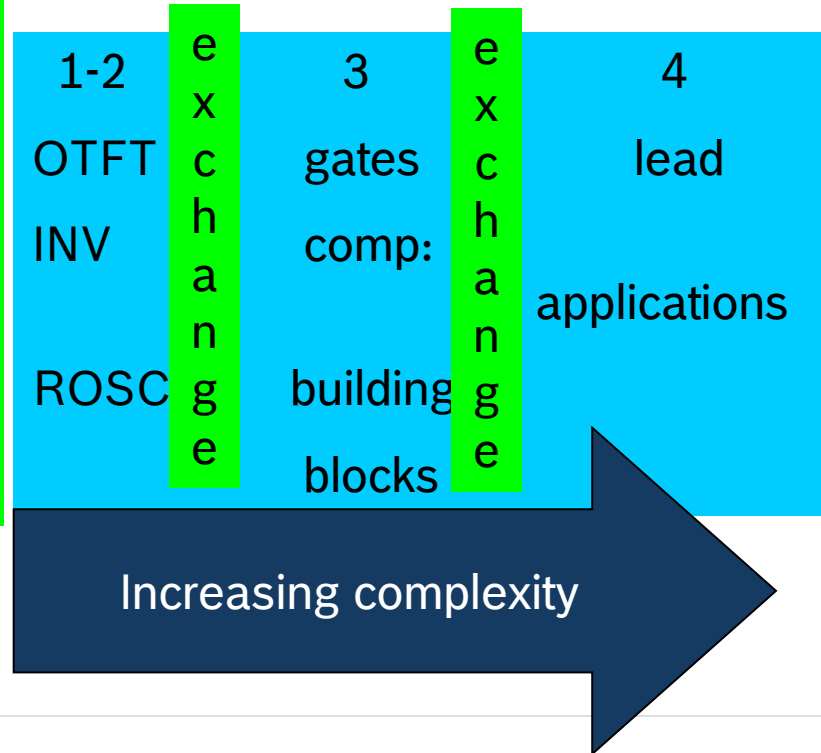
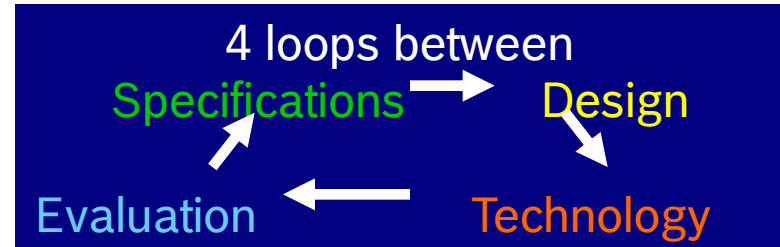


# Technical Concept

Lead application driven technology

|                           |                               |
|---------------------------|-------------------------------|
| Line driver or comp. IC   | high complexity               |
| ADC, Silent tag signal    | large area, printable, mixed- |
| Silent tag and Sensor-Amp | R2R, large volume             |

Process, sample material and data exchange



# Workpackage Structure

| WP         | Title  | WP's Objective   |
|------------|--|--|
| <b>WP1</b> | Lead Applications Specification and Exploitation | <i>Generation of specifications from industrial requirements.<br/>Evaluation of the valorisation potential</i>   |
| <b>WP2</b> | IC Design & Test                                 | <i>Design of test structures, analogue and digital building blocks and complex ICs for the lead applications</i> |
| <b>WP3</b> | CMOS Technology Platform                         | <i>Development of CMOS OTFT technologies fitting analogue and digital applications</i>                           |
| <b>WP4</b> | Reliability and Modelling                        | <i>Analyse, measure and model the devices</i>  |
| <b>WP5</b> | Lead Applications Design and Evaluation          | <i>System design, fabrication and verification of the lead applications</i>                                      |
| <b>WP6</b> | Management                                       | <i>To ensure an efficient management of a large project and to provide training and dissemination</i>            |

Table 1.3a. Short description of the work-packages



# Work packages

**WP1: Specifications:** IMEC  
IMEC, ST-I, CC, Friendly, TUE.

**WP2: IC Design:** TUE  
ST-I, TUE, UNICT, IMEC, CC

**WP3: CMOS Technology:** CEA  
FRAUNHOFER, CEA, IMEC, TNO, Flexink, TUB.

**WP4: Reliability and modelling:** CNR  
ST-I, CNR, TUE.

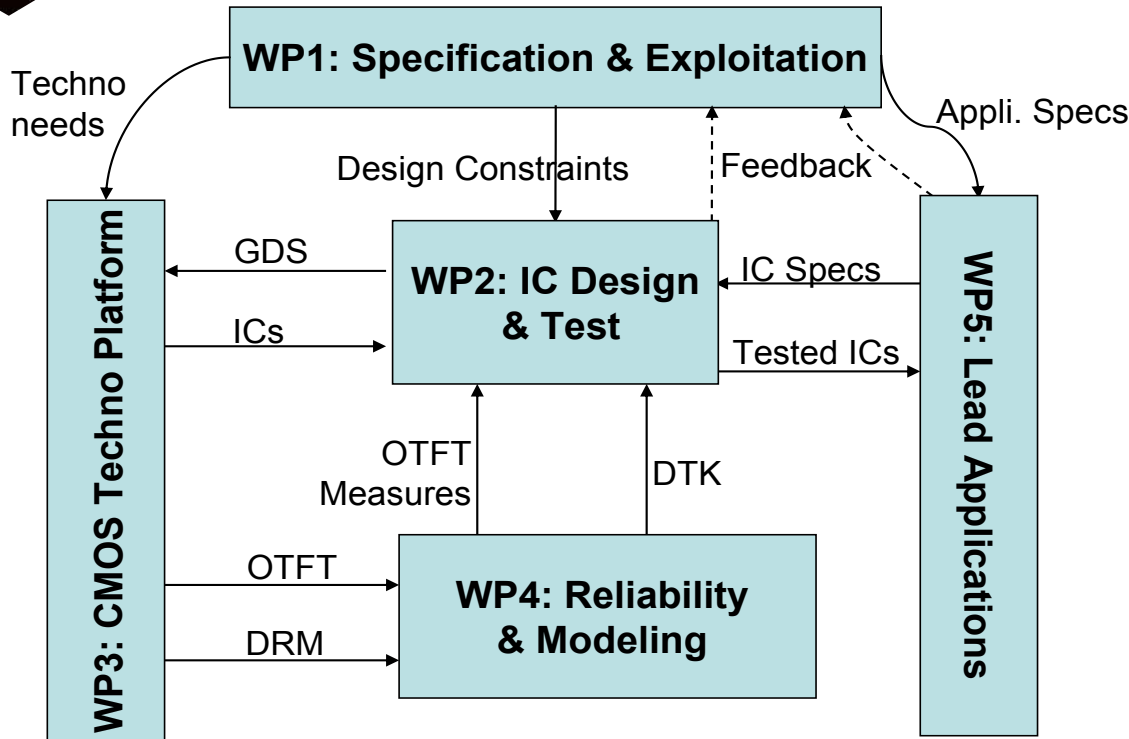
**WP5a and WP5b: Lead applications:** ST  
ST-I, CEA, IMEC, FRAUNHOFER, TUE, CC, Friendly.

**WP6a: Scientific coordination:** FRAUNHOFER.

**WP6b and WP6c: Management, Dissemination:** FRAUNHOFER.



# Interaction diagram of COSMIC



Very close iteration loops between:  
Design,  
Technology  
and  
Applications

## WP6 Management & Dissemination

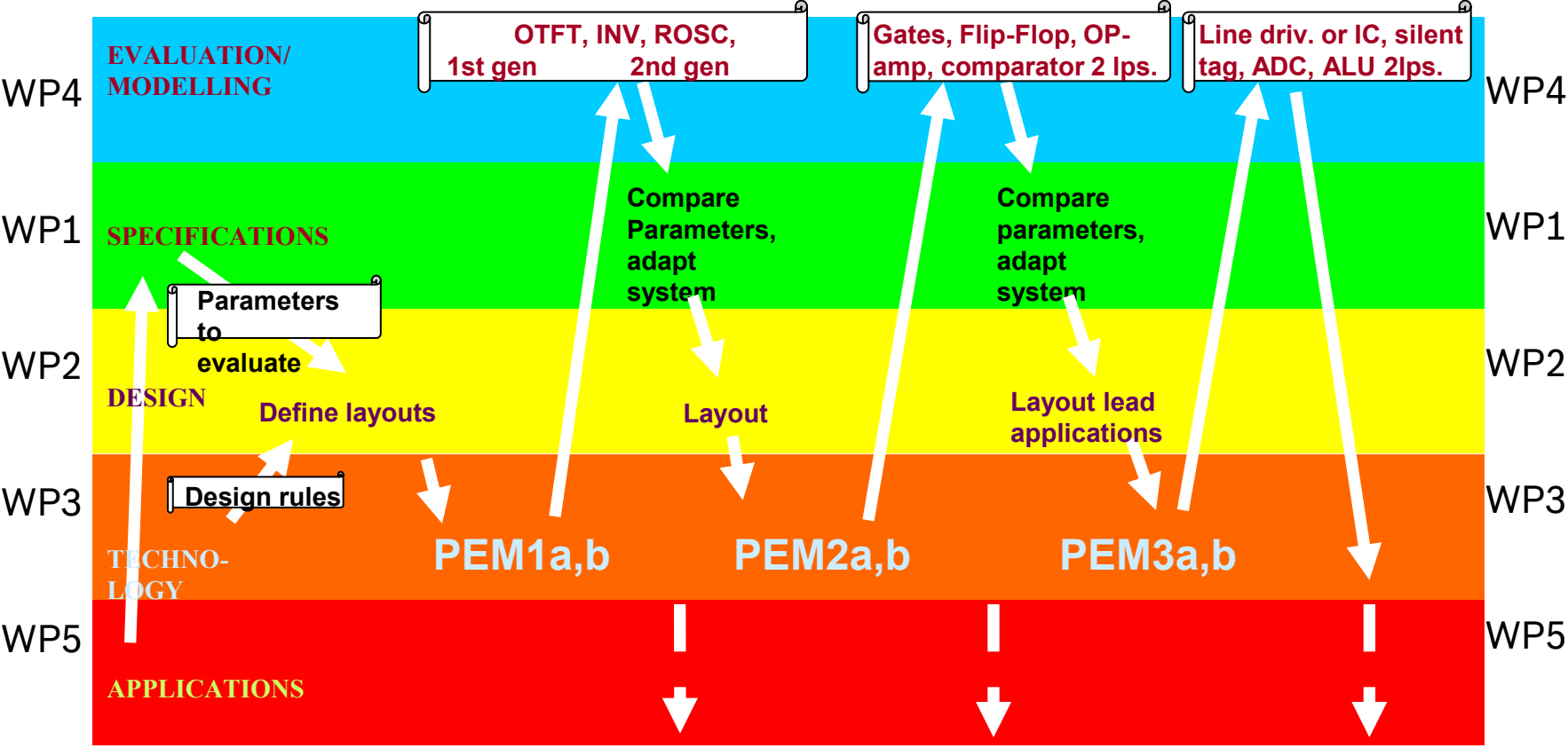
WP1: **IMEC**; WP2: **TUE**; WP3: **CEA**; WP4: **CNR**; WP5a,b: **ST-I**,  
WP6a,b,c: **FRAUNHOFER**

# Timeline of COSMIC



WORKPACKAGE

deliverables and targets



Common Evaluation board meeting Month      CEB 14      CEB 31      CEB 48

# Foreseen business opportunities



Large area organic electronics will bring benefits to existing product families (RF-ID, sensors, smart objects etc.) and enable new applications (large area sensors, energy harvesting and storage, etc.).

## SUI (SMART USER INTERFACE)

- Touch displays
- Smart keyboards
- .....

## DAI (DISTRIBUTED AMBIENT INTELLIGENCE)

- sensors,
- memories
- transceivers
- .....

## EHS (ENERGY HARVESTING & STORAGE)

- Solar cells,
- Energy escavenging
- Thin film batteries
- .....

## SMART SYSTEM INTEGRATION SUI+DAI+EHS

- Energy autonomous sensors
- RF-ID with added features
- Smart healthcare