Introduction to the 3D-HiPMAS project

Pilot Factory for 3D High Precision MID Assemblies

Logo

A new high precision technology for new market opportunities

A European project supported through the Seventh Frame Programme under the "Factories of the Future" initiative.
The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 314293

General project data

Title: Pilot Factory for **3D** **Hi**gh **P**recision **M**ID **As**semblies (3D-HiPMAS)

Call: FoF.NMP.2012-5

High precision production technologies for high quality 3D micro-parts

Period:	01/10/2012 – 30/09/2015 (36 month)
Budget:	5,350,276,20€
Grant:	3,499,600,00€
Partners:	12
Coordinator:	HSG-IMAT

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Project partners

HSG-IMAT

Plastipolis
PÔLE DE COMPÉTITIVITÉ PLASTURGIE

SEVENTH FRAMEWORK PROGRAMME

DE LA RECHERCHE À L'INDUSTRIE
cea

PRAGMA INDUSTRIES

LPKF
Laser & Electronics

HÄCKER Automation

Rayce
ARAYMOND CENTER OF EXPERTISE

Ensinger

Radiall

PHONAK

Photonic Science
Scientific Detector Systems

PEP
CENTRE TECHNIQUE DE LA PLASTURGIE

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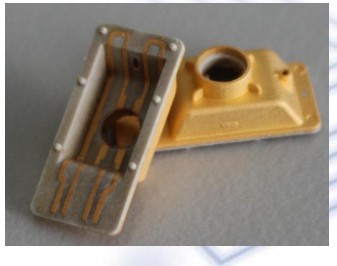
Content :

- State of the art
- Objectives
- Building Blocks – Beyond state of the art
- Resources - Budget
- Impacts
- Dissemination



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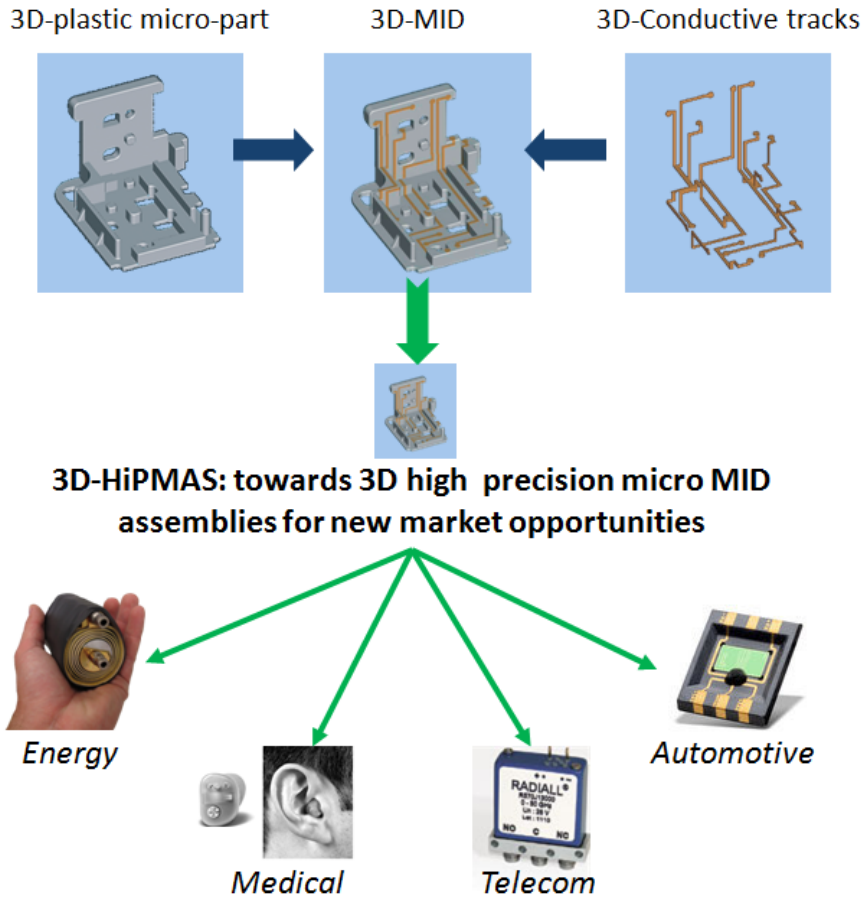
Subject : MID based 3D high quality, high precision 3D micro-parts

Process Flow:

- 3D plastics micro-parts
- conductive tracks
- components assembly
- online monitoring / quality inspection

→ Huge Potential for new Products and Production in Europe!



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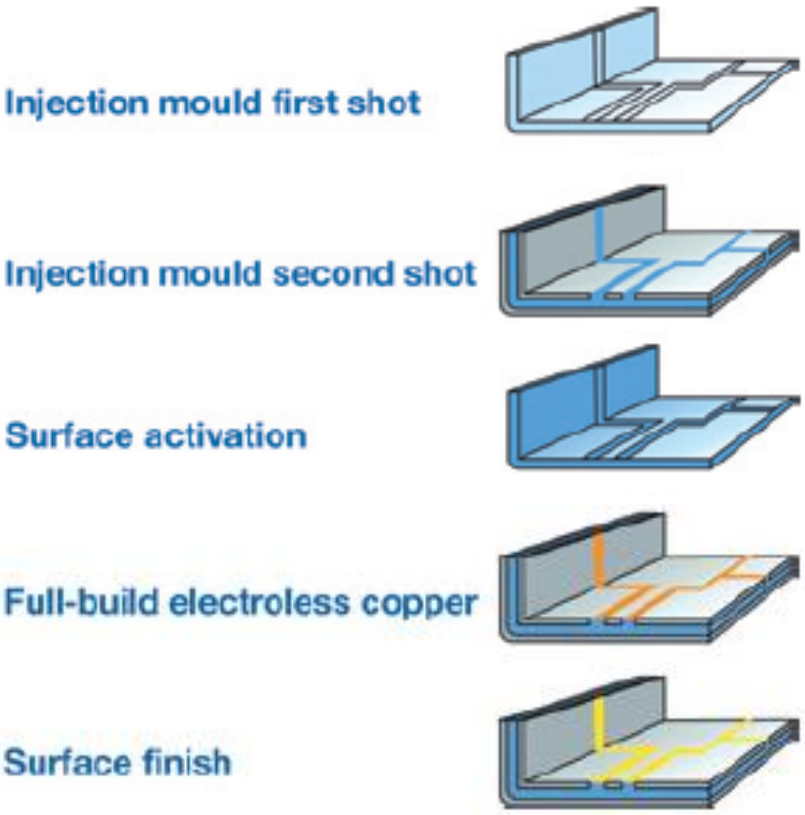
SoA : 2-shot MID Technology



Process Flow of 2-shot MID

Pressure Sensor Assembly:

- 2-shot MID saves ~50% of space
- 2-shot MID saves ~ 30% of cost

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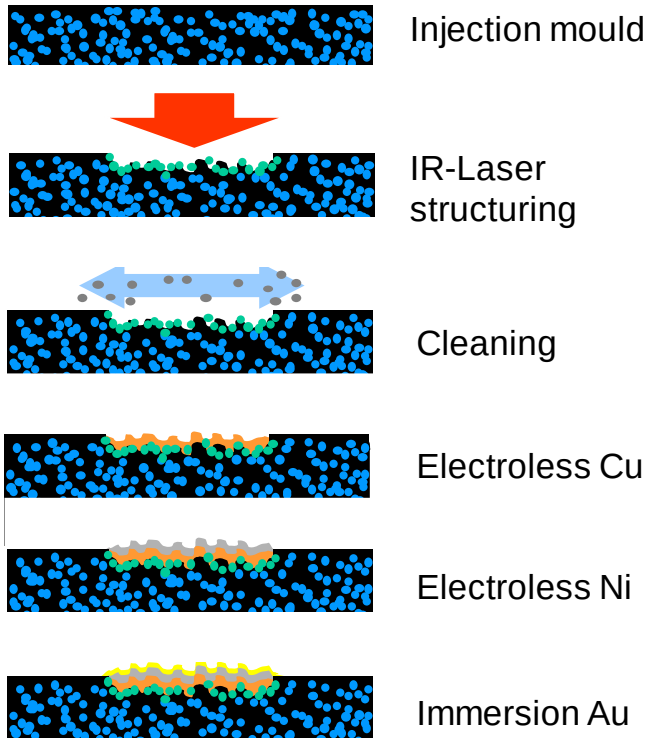
SoA : Laser Direct Structuring MID Technology (LDS)



Process Flow of LDS MID

Switch for Motor Cycle Handlebar

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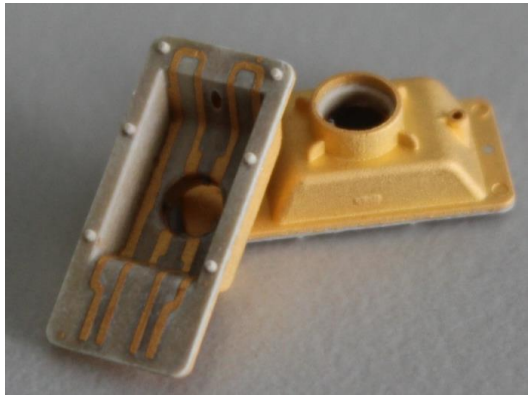
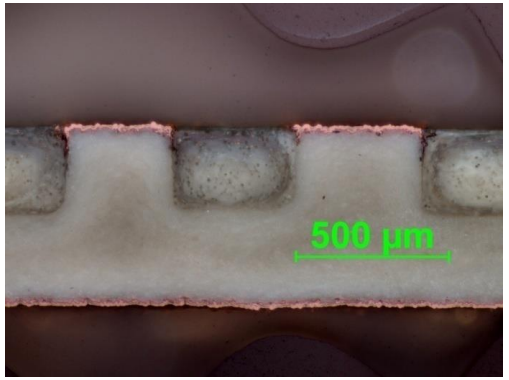
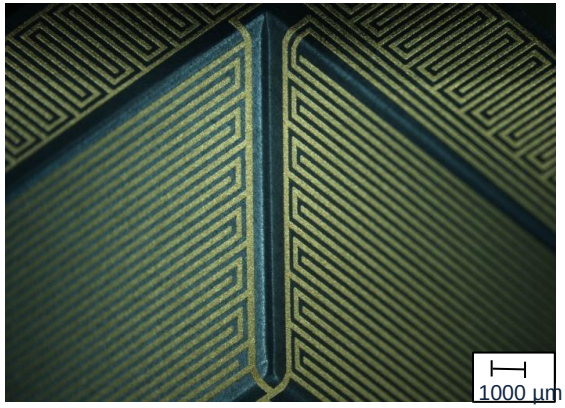
SoA : Electroless Metal Deposition for 2-shot and LDS MIDs



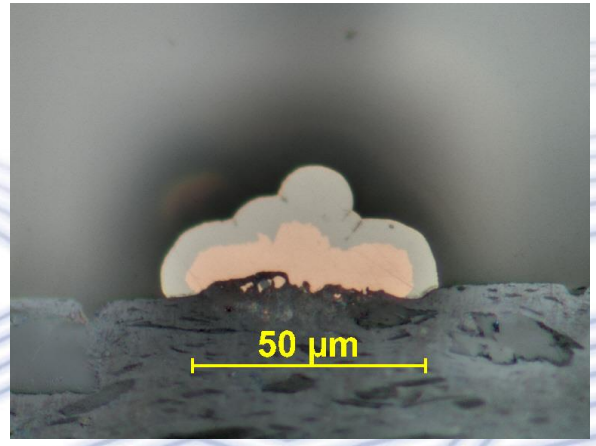
2-Shot MID at 600 µm pitch



Lateral metal over grow in 2-Shot MID



LDS MID at 300 µm pitch



Lateral metal over grow in LDS MID

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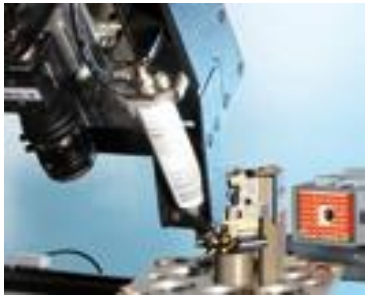
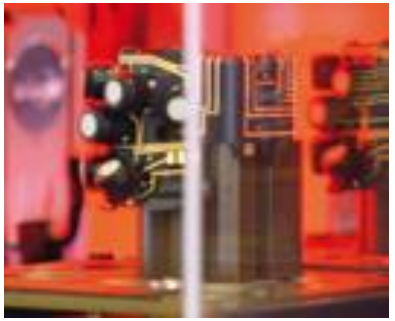
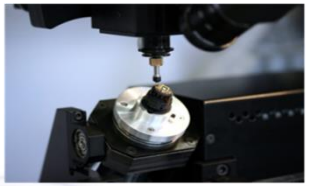
SoA : Assembling of Electronic Devices of 3D-MIDs





Motor cycle handlebar switch

Light sensor



3D chip assembly with tilt of MID

SMD assembly

Fabrication line

Light sensor for car environmental control

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State of the art bottlenecks to be addressed :

- Plastics Material
- 2-Shot moulding process
- Laser technology
- Electroless metal deposition
- Assembly of electronic components on 3D bodies
- In-line monitoring of 3D micro-parts
- Experience of industries along the MID assemblies process chain
- Production cost
- Material consumption and environmental protection

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Overall project objectives :

- **3D high precision 2-shot plastics micro-parts** with size reduction for conductive tracks from SoA 300µm to 150µm
- **3D high definition conductive tracks** by new generation of Laser Direct Structuring and plating technologies reduced from SoA 300 µm pitch in 3D (150 µm in 2D) to 150 µm pitch in 3D (75 µm in 2D)
- **3D precision electronic components assembly** with novel overall capability of positioning and alignment accuracy below 10µm compared to SoA 20µm
- **3D reliable and robust online monitoring and quality inspection system,** including quality management, and novel in-line 3D X-Ray tomography.
- **Integrating these 4 technologies to launch the future EU pilot factory** to save more than 50% of today's production costs
- **Assessment of the pilot factory through 4 advanced products** in the energy, medical, communication and transport applications.

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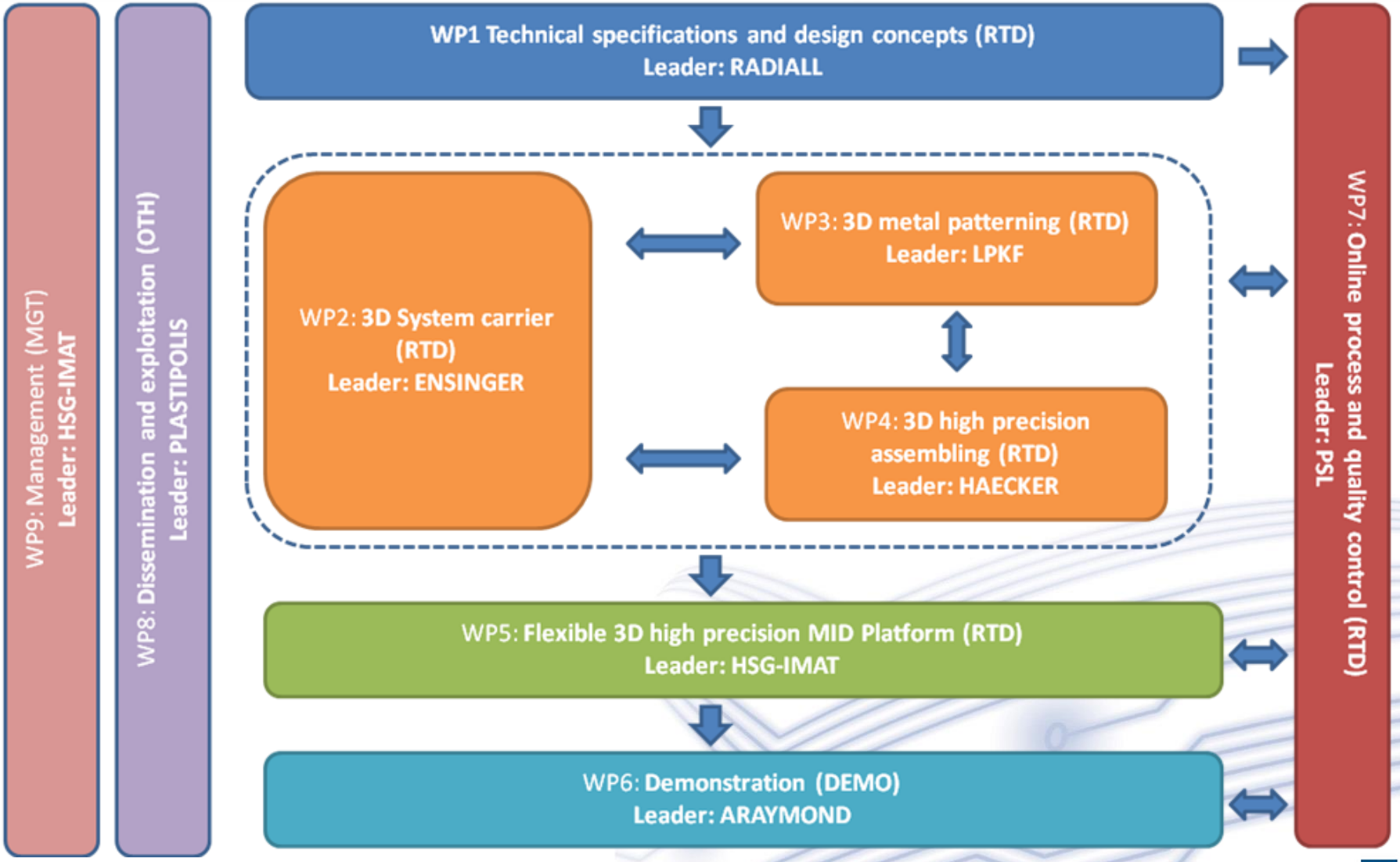

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Beyond SoA : 3D system carrier

New plastic materials with cost kept at present level:

- higher performance and precision 3D system carriers
- thermal expansion reduced by 30 %

New additives at size below 1 µm:

- enable LDS activation and plating phases
- good stability and perfect cohesion with the polymer matrix

Enhanced precision 2-shot molded 3D micro-parts:

- reduced wall thickness, line width and tolerances
- using rapid heat&cool, vacuum and compression moulding

Improved processing performance:

- reduction of material consumption by wall thickness and part size of 20%
- reduction of mould set up phase and time-to-market by 10 %
- improved precision by 50%

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Beyond SoA : 3D metal patterning

Improving laser machinery:

- Reducing laser spot size from 60 µm to below 25 µm
- Improving positioning accuracy from 10-20 µm (3 sigma) to 5-7 µm
- Enhancing Scanning velocity for same throughput (mm^2/s)
- Reducing machining cost by 50%
- Image processing for online process control

Improved metal plating for LDS and 2-shot (roughness, adhesion):

- Reduced size of metal lines for LDS (100%) and 2-Shot MID
- Cleaning processes for 50% less CO_2 or chemicals consumption
- Replace Ni-P/Au by Ag for less chemicals / metals consumption
- More pieces per batch due to smaller device size (30 - 50 %)

Reduced cost:

- laser machining ~50 %
- metal deposition ~35 – 60 %

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Beyond SoA : 3D high precision assembling

Improving precision and 3D capability of assembling machinery:

- Develop 3-D manipulation to work on a globe and around it to transfer parts, move parts, rotate parts and more
- Increase z-stroke from 45 mm to 150 mm for more complex MID
- Reduce cycle time at increased z-stroke while maintaining precision and accuracy
- Develop new sorting process for loose material parts to work piece carriers

Improving joining processes for new fine pitch MID:

- Establish new laser soldering capabilities for 3-D connections
- Develop joining processes for “bare dies”
- Develop joining processes for SMD
- Develop joining processes for micromechanical/micro optical components
- Develop automatic loading options for complex MID structures
- Implement image processing for real time control of assembly and dispensing results and reevaluate automatic error compensation.

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Beyond SoA : Advanced product and process control

Advance software platform for engineers for 3D-µ-MIDs products:

- MID/3D-MID domain-specific language specification
- Software environments dedicated to 3D-MID/MID process engineering

Relevant online process and product quality inspection strategy for 3D-µ-MIDs products

In-line non destructive 3 dimensional metrology tool:

- enabling feedback on production process / quality achieved
- innovative concept of X-Ray tomograph
- Radio Synthetic Control (RSC) for non destructive 3 D analysis of complex volumes analysis of material content using real time X-ray imaging acquisition
- Reduced overheads in reconstructing 3D data sets by 80-90%

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Demonstrator 1 : 3D micro fuel cell

Beyond SoA:
Integration of a.m.a.p of control and safety parts into MID / package

- control electronics
- sensors
- piezoelectric actuators for valves / circuit-breakers

Miniaturization:

- lower number of parts
- smaller size
- lower power consumption
- reduced cost by 60% for control and safety part

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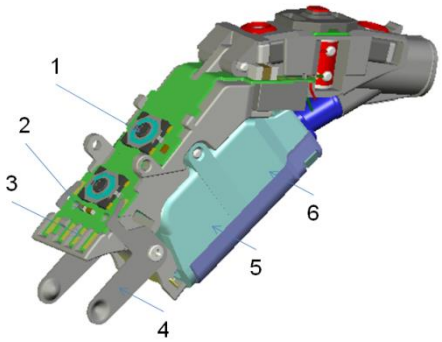
Demonstrator 2 : 3D micro hearing aids



Phonak BTE type hearing aid

Beyond SoA:

- **Integration of antenna structures**
- **3D integration of electronic components**
- **Integration of contact elements**
- **Evaluation of hard/soft material combination compatible to 3D MID process**

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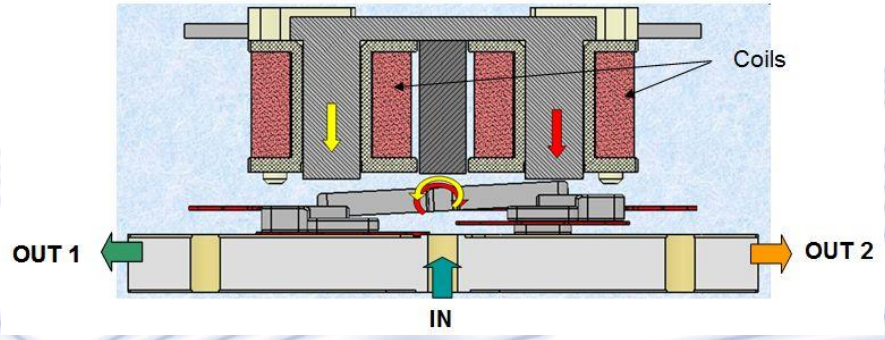
Demonstrator 3 : 3D micro switches

Beyond SoA:
Cost reduction for new market opportunity (~30%)

- Improved assembly process
- Less higher precision of parts (15 to 8)
- Chance of automation
- improved reliability

Improved RF performances

- new MID based design
- New RF line design for improved the frequency level (8 to 12 GHz)
- Improved harsch environment capability



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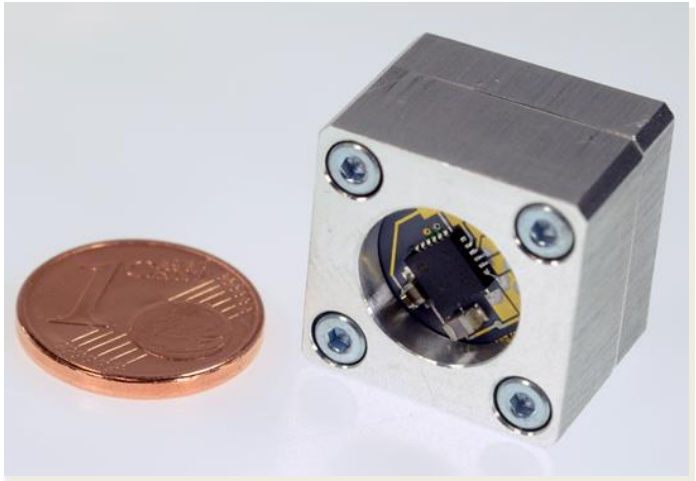
Demonstrator 4 : MID based pressure sensor



Thanks to MIDs, this very robust pressure sensor based on a membrane / capacitive principle with an integrated temperature sensor display a smaller package volume and will provide a cost-effective solution for many sensor applications.

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Assessment of pilot line performance during demonstration :

- Reduction of **plastics materials** input
- Reduction of **energy consumption** in materials compounding, injection moulding, metal deposition and laser machining
- Reduction of **CO_2 consumption** and/or chemicals in cleaning
- Reduction of consumption of process **chemicals** and **metals** in electroless plating (Au will be replaced to 100%)
- Improvement of **precision**
- Improvement of **yield**

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Planned resources

Participant Nr	Organization short name	Organization country	RTD	DEMO	MGT	OTH	**Total**	**Requested EU contribution**
1	HSG-IMAT	DE	599.504	131.016	171.488	35.126	**937.134**	**721.750**
2	LPKF	DE	507.576	60.576	0	16.032	**584.184**	**300.108**
3	PSL	UK	396.349	184.794	1.500	20.283	**602.926**	**411.441**
4	HAECKER	DE	372.307	81.692	0	29.419	**483.418**	**349.495**
5	RADIALL	FR	171.618	249.034	0	18.577	**439.229**	**228.903**
6	PRAGMA	FR	46.930	120.192	0	14.178	**181.300**	**109.471**
7	PHONAK	CH	65.370	238.484	0	11.706	**315.560**	**163.633**
8	PEP	FR	506.000	142.600	1.500	32.800	**682.900**	**485.100**
9	CEA	FR	385.198	45.742	0	13.297	**444.237**	**325.066**
10	PLASTIPOLIS	FR	0	0	0	113.076	**113.076**	**113.076**
11	ENSINGER	DE	173.155	30.014	0	8.616	**211.785**	**110.200**
12	RAYCE	FR	79.978	266.362	0	8.187	**354.527**	**181.357**
	TOTAL		3.303.985	1.550.506	174.488	321.297	**5.350.276**	**3.499.600**

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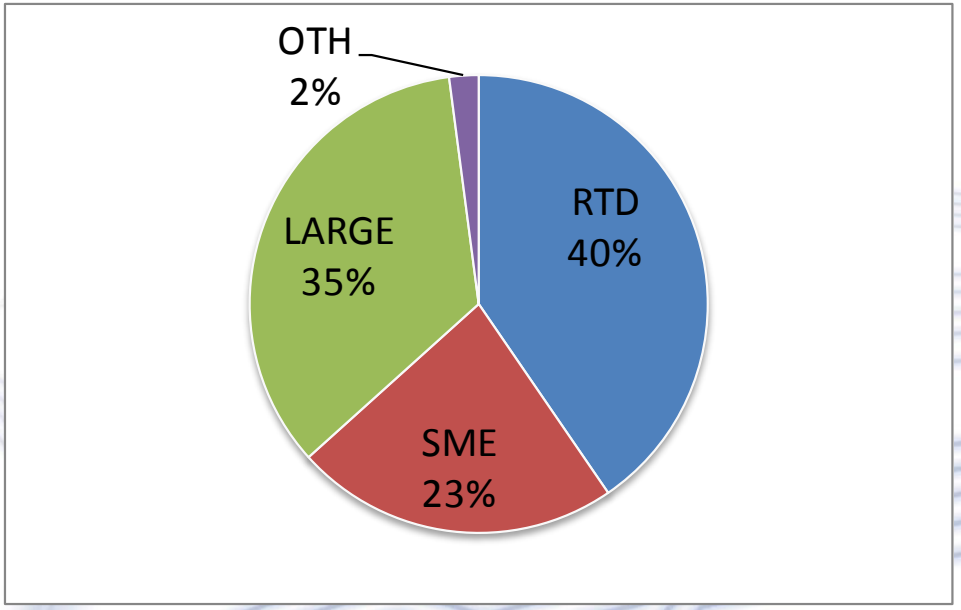
Budget share

	Budget [€]	Share [%]
Personal	4094032	76,52
Consumable Equipment Travel Other	1205444	22,53
Subcontracting	50800	0,95

Grant/Total Budget : 64%
Management Budget: 5%



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3D-HiPMAS impacts :

Provide the industry with a pilot factory able to offer customised solutions in terms of technical and economical performances

- **Supply chain:**
  - Consultation of companies on the Pilot Factory (precision, products size, shape, functions, materials, volume of production, time-to-market, product price, production costs …).
  - Studies on efficient production for manufacturing of MID components
  - Set up of fabrication lines within Europe

- **Open the way to new future products not possible to be realized using SoA technology:**
  - Health care
  - Mobility
  - Communication
  - Energy

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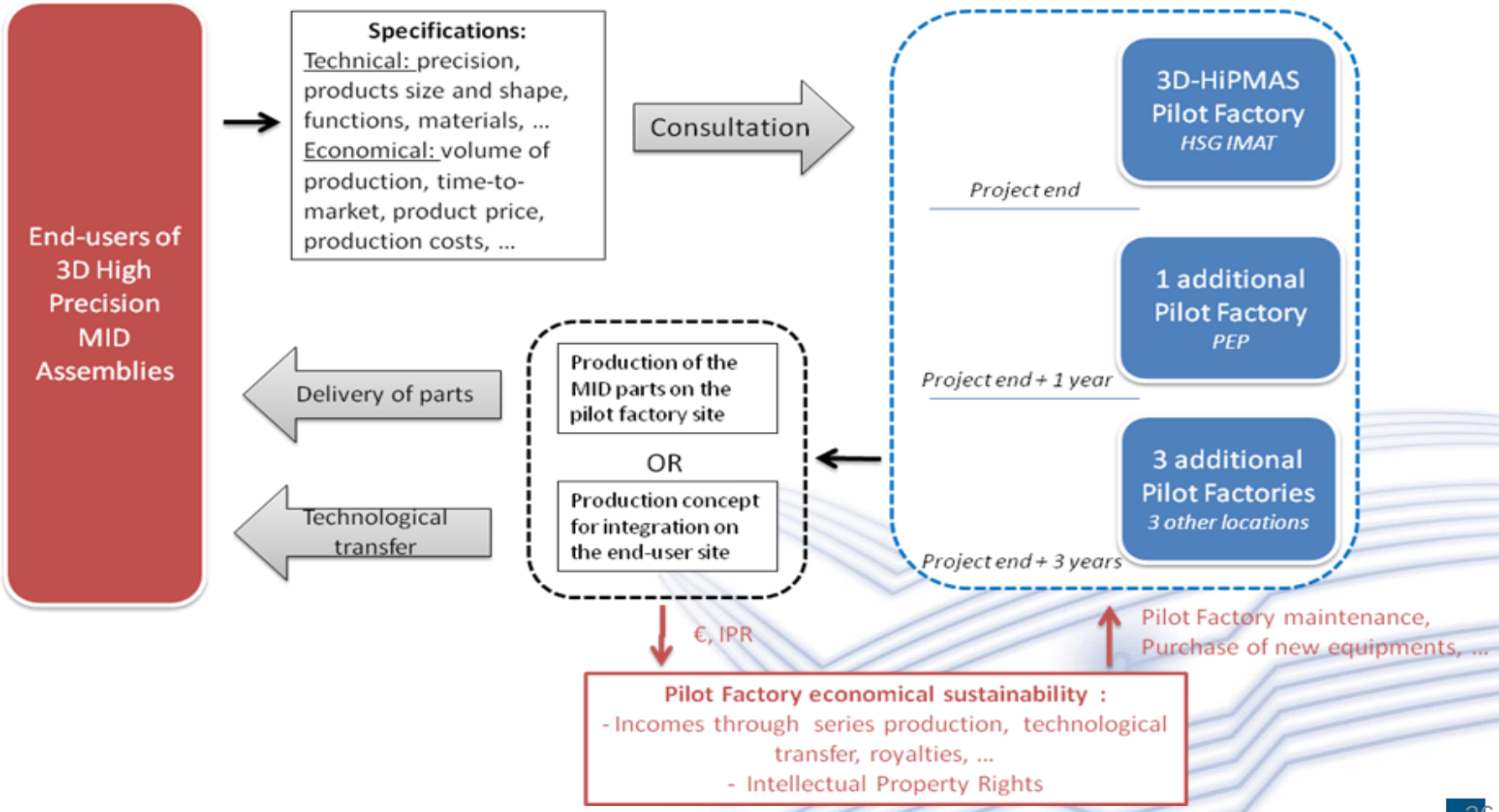
Dissemination of the 3D-HiPMAS pilot line :



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Dissemination of the results and IP :

- **Communication:**

Website, brochure, press releases, conferences journals

- **Pilotline:**

Consulting, training courses, pilot production, production services…

- **Satellite Group:**

Direct contact to interested industries

- **Workshop with contest:**

Case studies, pilot production

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THANK YOU FOR YOUR ATTENTION

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