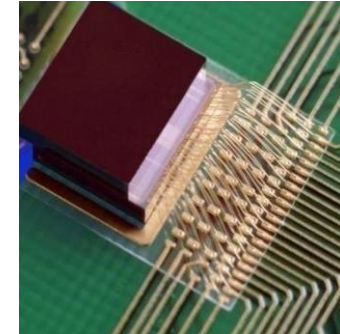


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# Fraunhofer IZM



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Fraunhofer Institute for Reliability and Microintegration  
Gustav-Meyer-Allee 25  
13355 Berlin  
Germany

Dipl.-Ing. Thomas Fritzsch

Contact: [thomas.fritzsch@izm.fraunhofer.de](mailto:thomas.fritzsch@izm.fraunhofer.de)

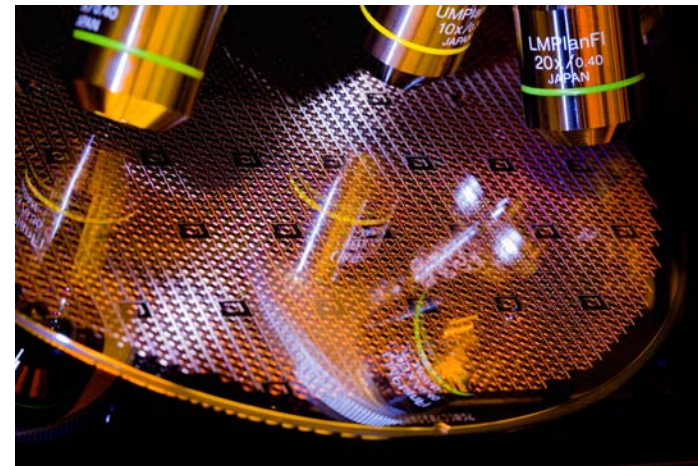
23/02/2010

[thomas.fritzsch@izm.fraunhofer.de](mailto:thomas.fritzsch@izm.fraunhofer.de)

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# Outline

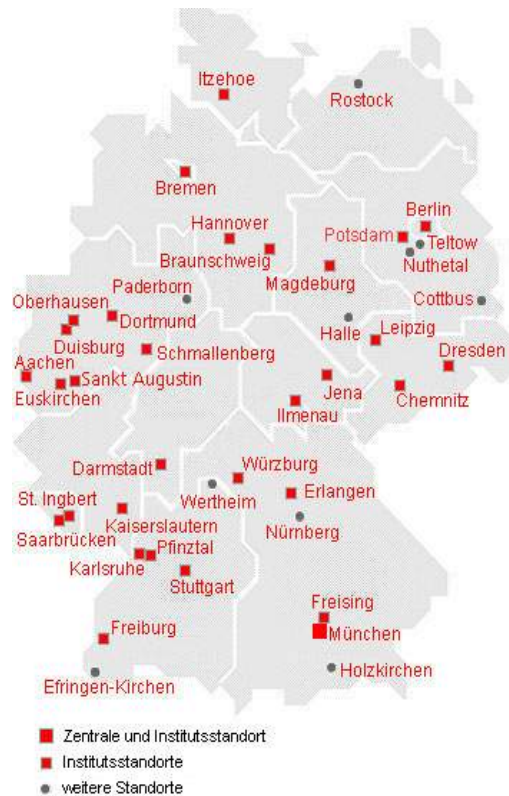
- Fraunhofer IZM
- Processes and Technologies
- Wafer Level Packaging
- Interconnection Technologies
- References



Datum

Name, Abteilung

# Overview Fraunhofer Gesellschaft



57 Institutes

15 000  
Employees

app. 1.4 Bil. €  
Turn Over

appr. 65%  
Contract Research

Information  
Technology

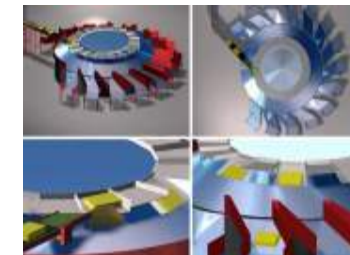
Micro  
Electronics

Surface  
Engineering/  
Photonics

Materials

Production  
Technologies

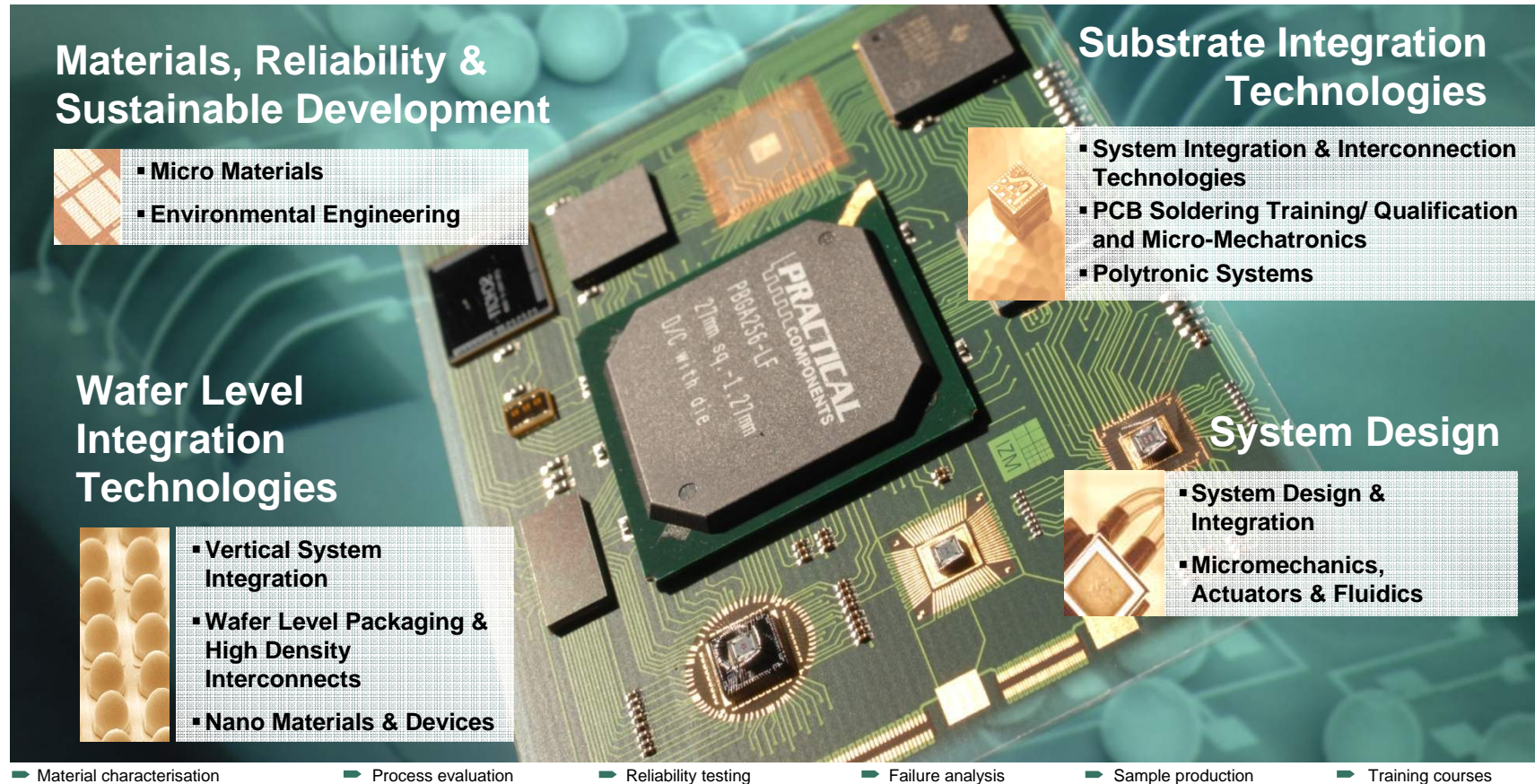
Life Science



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# Fraunhofer IZM – Focus of Activities



**Materials, Reliability & Sustainable Development**

- Micro Materials
- Environmental Engineering

**Substrate Integration Technologies**

- System Integration & Interconnection Technologies
- PCB Soldering Training/ Qualification and Micro-Mechatronics
- Polytronic Systems

**Wafer Level Integration Technologies**

- Vertical System Integration
- Wafer Level Packaging & High Density Interconnects
- Nano Materials & Devices

**System Design**

- System Design & Integration
- Micromechanics, Actuators & Fluidics

Material characterisation    Process evaluation    Reliability testing    Failure analysis    Sample production    Training courses

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# Fraunhofer IZM – Facts

## Figures 2008

- 
- 28 Mio. € turn over
  - 81 % contract research
  - 389 employees (242 full time, 147 PhD, trainee)

## Locations

- 
- Berlin  
Dr.-Ing. Dr. sc. tech.  
Klaus-Dieter Lang
  - Munich  
Prof. Dr.-Ing. Karlheinz Bock

## Director



## Your Contact Partner

- 
- **Thomas Fritsch**  
thomas.fritsch@izm.fraunhofer.de

Material characterisation    Process evaluation    Reliability testing    Failure analysis    Sample production    Training courses

Datum

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# How to work with Fraunhofer IZM

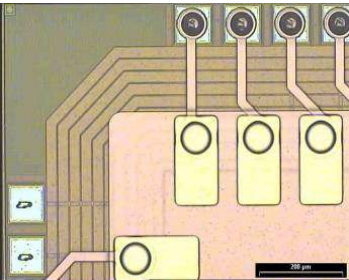
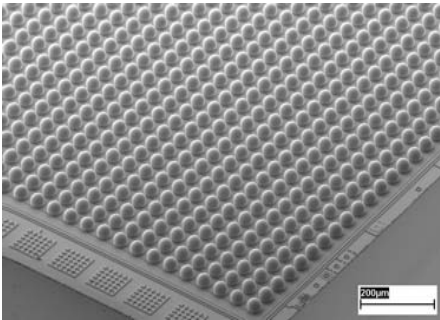
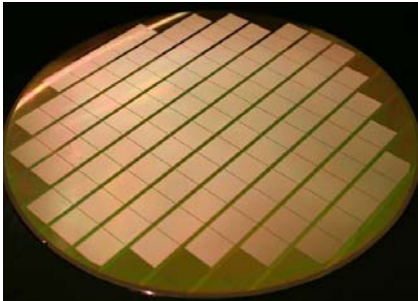


- **Industrial Contract Research**  
(e.g. R&D-projects world-wide, feasibility studies, technology & process development)
- **Services for Industry**  
(e.g. demonstrators, prototypes, technology service, equipment, personnel)
- **Strategic Alliances**  
(e.g. Packaging Manufacturing Lines)
- **Cooperative Projects**  
(funded jointly by public & industrial sources, State, EU)
- **Technology Transfer**  
(technologies and processes)
- **Common Basic Research**  
(with institutes and universities world-wide)

Datum

Name, Abteilung

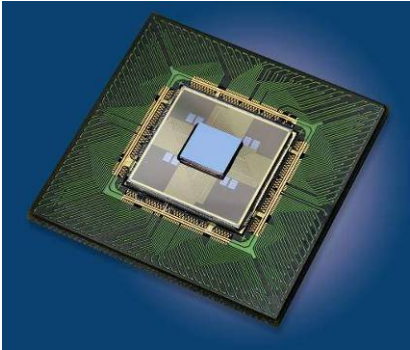
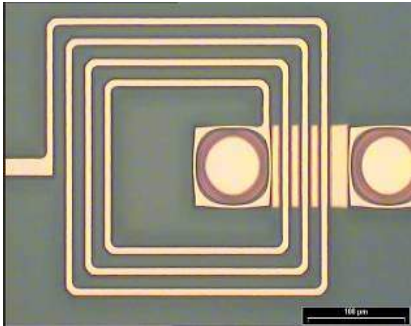
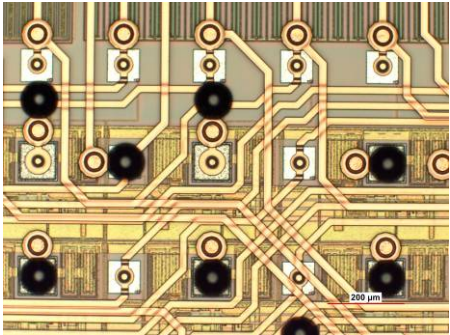
# Wafer Level Package (WLP)



Datum

## IZM Competence

- Chip Scale Packaging
- Bumping
- Thin Film Multilayer Substrates
- RF Modules
- Microsystems
- 3D Integration
- Mobile Power Supply



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# Wafer Level Packaging Technologies

## Layer Deposition

- Sputtering, Evaporation
- Electroplating

## Photostructuring

- Resist
- Polymeric Dielectrics

## Dry and Wet Etching

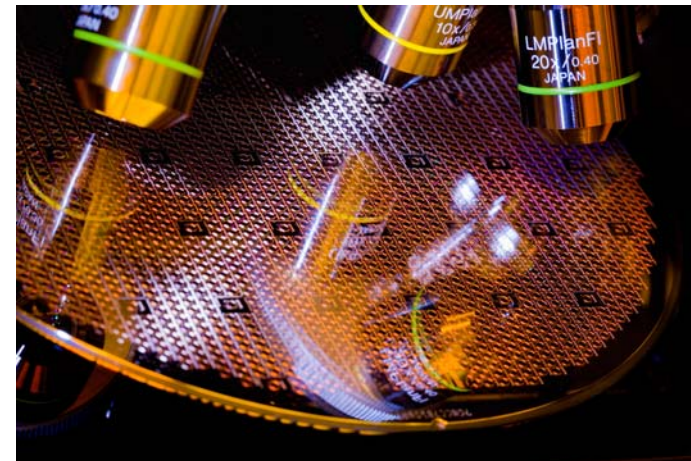
## Chemical Mechanical Polishing

## Grinding, Saw Dicing

## Thin Wafer Handling, Wafer Bonding

## Characterisation, Measurement, Inspection

Cleanroom facility 800 sqm



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# Process Capabilities from 100mm to 200mm (300mm)

**Sputtering**  
UNAXIS – TiW, Au, Cu, Ti, Cr, CrNi,  
Al, AlSi

**Lithography**  
Suess Microtech MA45, MA6, MA200  
EVG IQ Mask Aligner  
ACS 200 (ACS300)  
EVG spin- and spray coating tools

**Electroplating**  
SEMITOOL, RENA, Rammgraber  
Cu, Au, Ni, Sn, SnPb, SnAg, In

**Waferbonding: EVG Gemini**

**Dry Etching**  
MATRIX, STS Silicon Etch, STS Oxid Etch

**Oxide Deposition**  
Thermal Oxide (4", 6"), PECVD Oxide (6", 8")

**Thinning and Saw Dicing**  
Disco grinding tool, saw dicing for glass and silicon

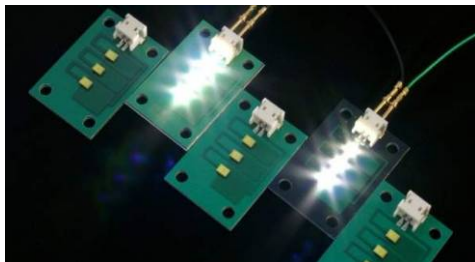
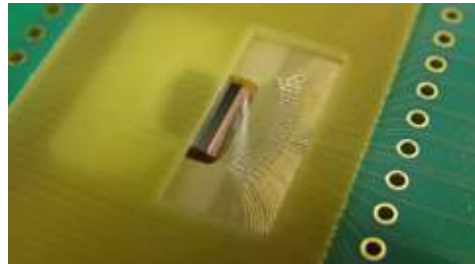
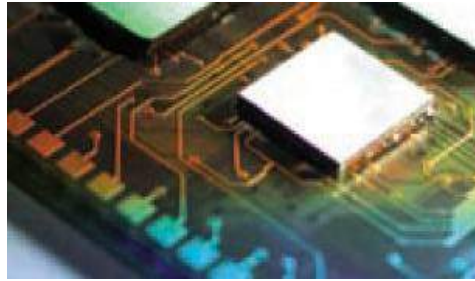
**Wafer Inspection: August**



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# System Integration & Interconnection Technologies

## Interconnection Technologies



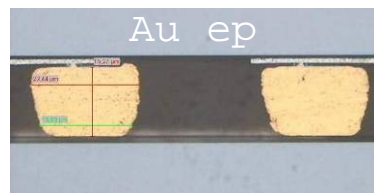
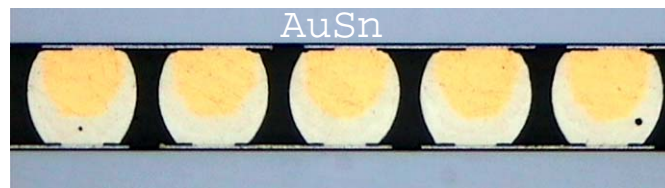
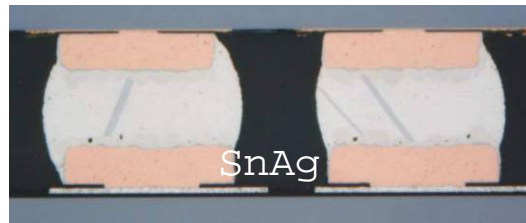
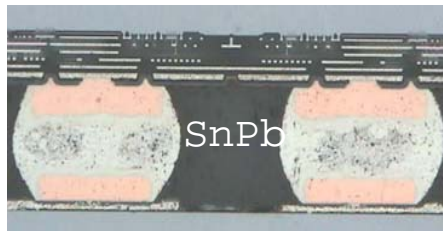
- Surface finishing and metallization, electroless nickel bumping and low-cost solder bumping
- Chip embedding
- Solder materials and innovative soldering processes
- Ultra thin and nano interconnects
- Flip chip and CSP processes
- Materials and technologies for chip on board and power electronics (e.g. Advanced chip & wire bonding)
- Optical fiber and planar waveguide coupling
- Assembly and interconnection technologies for RF, photonic components and systems

Datum

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# Flip Chip

## Micro bumping & assembly



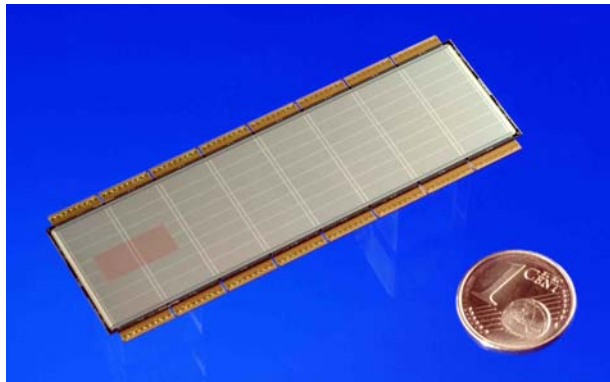
Datum

### IZM Competence

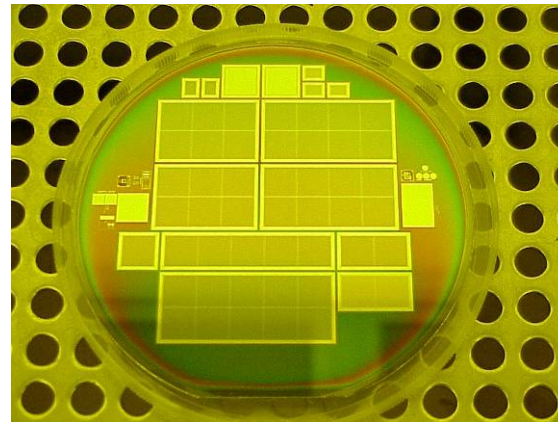
- Pitch below 50 µm
  - SnAg(Cu)
  - Au/Sn fluxless
  - Gold
- Thermode Bonding
  - Thermocompression
  - Thermosonic
- Reflow soldering
- Reliability investigation
- Flip Chip Assembly:
  - Suesc FC150
  - Panasonic
  - Datacon

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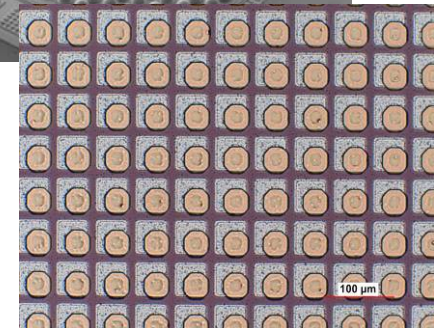
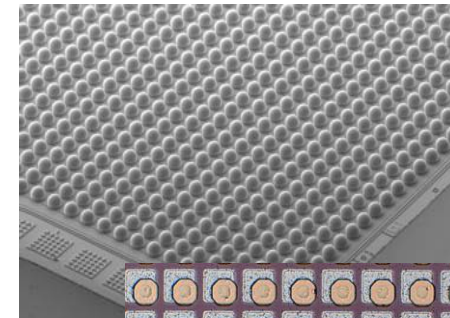
# Hybrid Pixel Detector Projects at Fraunhofer IZM



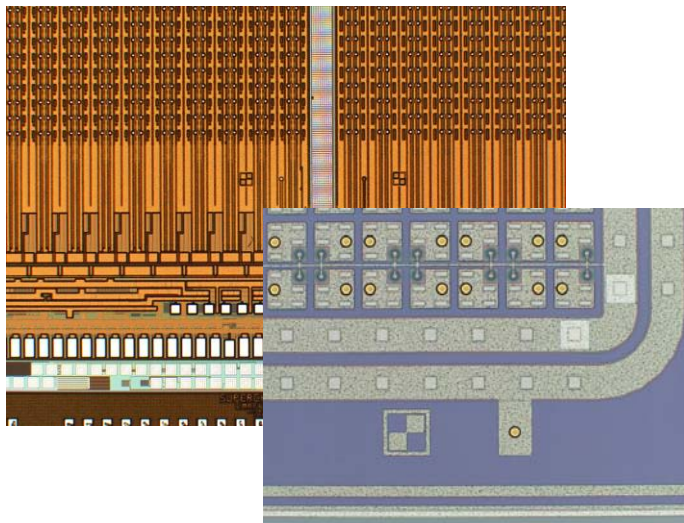
ATLAS Pixel Detector



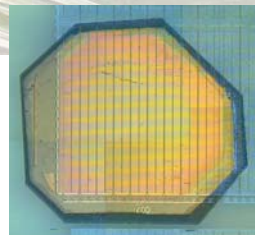
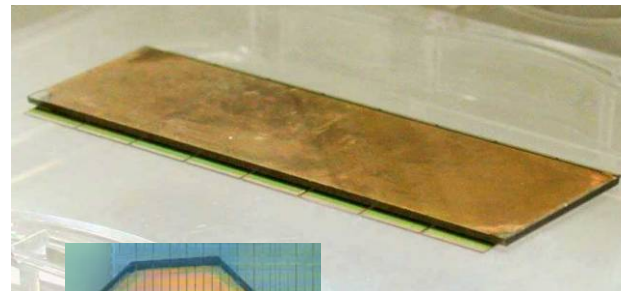
CMSFPPIX – Pixel Detector



MEDIPIX/TIMEPIX  
X-Ray Detector



XPAD3 for CNRS

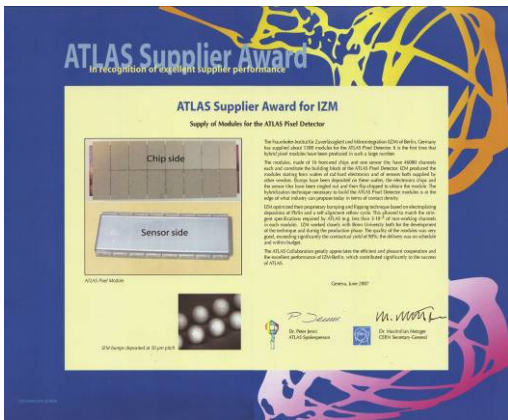
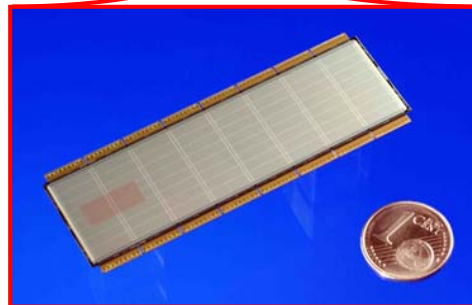
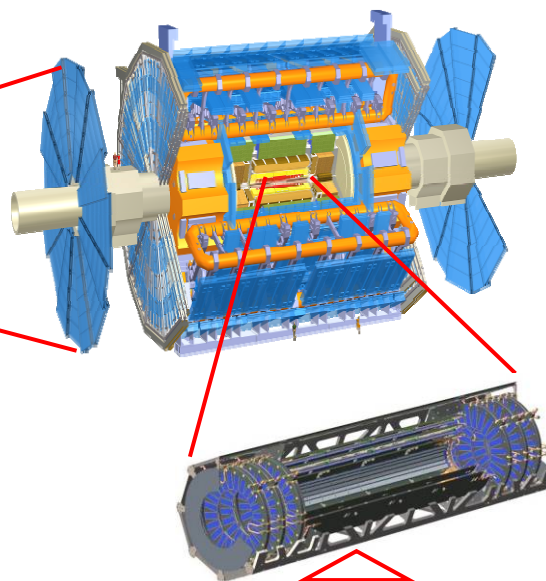
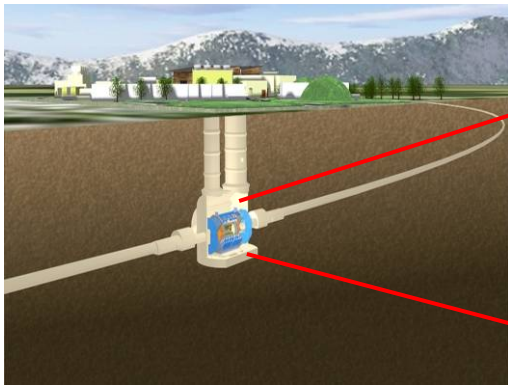


Diamond modules

Datum

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# Fine Pitch Silicon on Silicon Particle Detector Modules for the ATLAS Detector



## Production Phase:

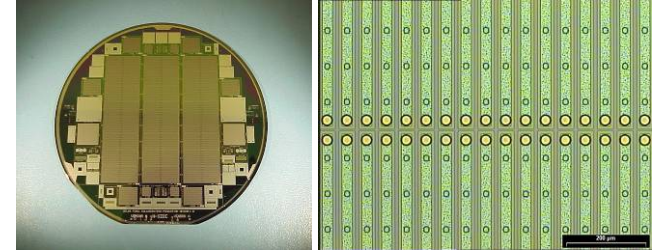
- 1150 ATLAS Bare Modules assembled at Fraunhofer IZM
- Assembled FE-I3 Chips: ~ 18600 chips
- Total Module Yield: 97 %

Pixel Detector Modules assembled at Fraunhofer IZM

- Thin-Film-Multichipmodul
- Size 22 x 64 mm<sup>2</sup>
- Silicon Sensor + 16 Readout ICs
- 46144 IO-Bumps, pitch 50 μm

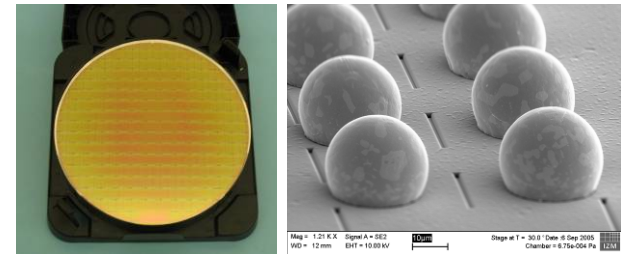
## Process steps at IZM:

### 1. UBM Processing of Sensorwafer



520 processed 4" Sensor Pixel Wafer

### 2. Bumping of the FE-I Chipwafer



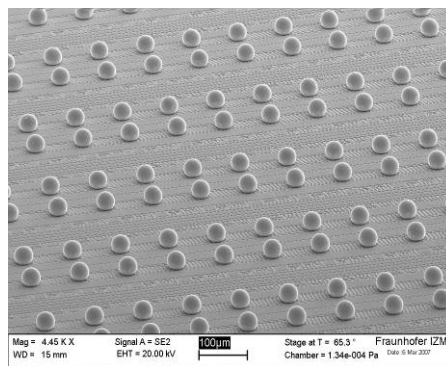
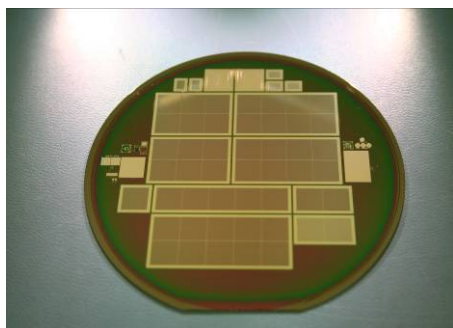
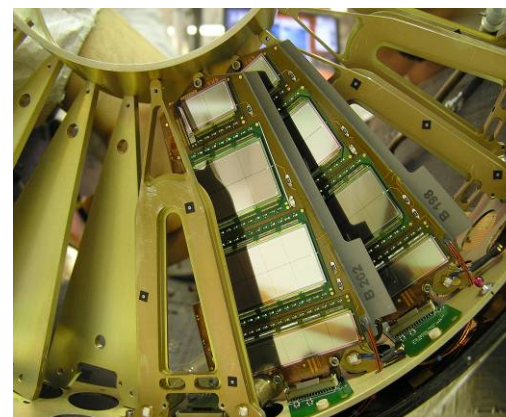
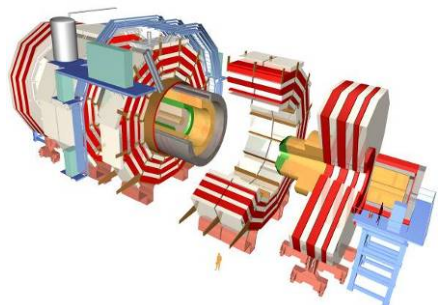
98 SnPb bumped 8" Si-Wafer

### 3. Module Assembly

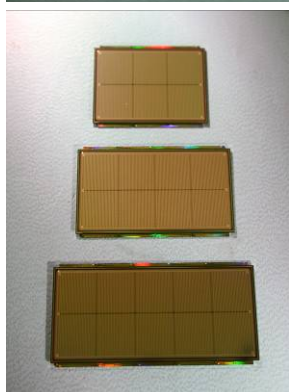
1150 assembled bare modules

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# Fine Pitch Silicon on Silicon Particle Detector Modules for the CMS Detector at LHC at CERN



CMS silicon pixel detector endcap segments with modules manufactured at Fraunhofer IZM



CMS ROC bumped at Fraunhofer IZM

CMS pixel detector 4" wafer and endcap bare modules after flip chip assembly at Fraunhofer IZM

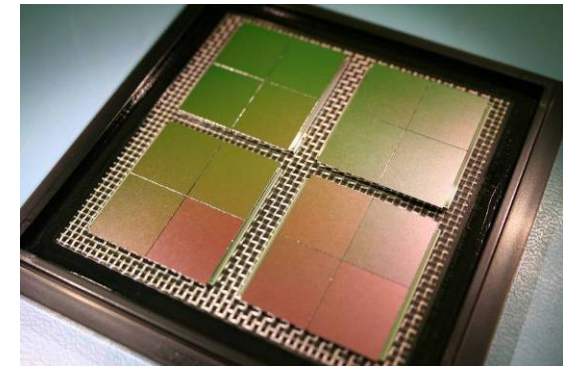
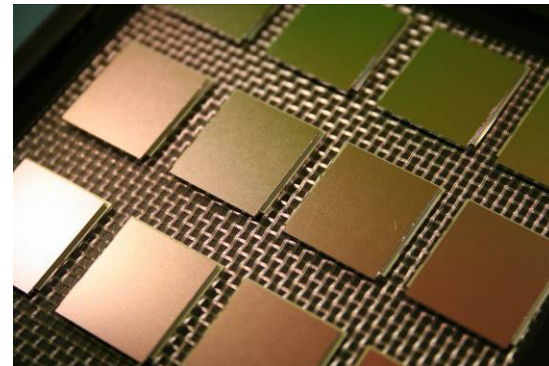
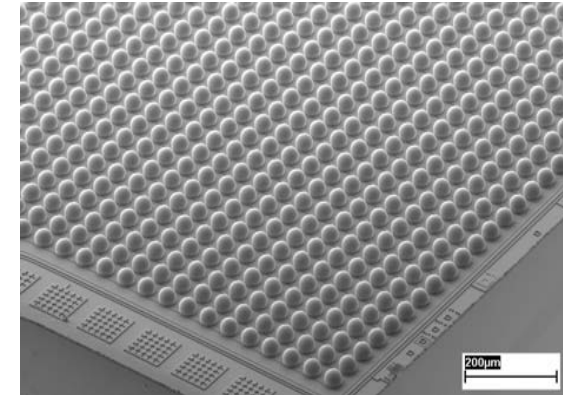
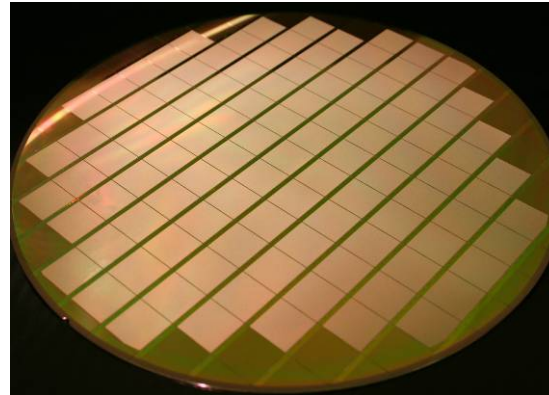
**More than 530 modules have been manufactured during production phase from October 2006 to February 2008**

Datum



# MEDIPIX/TIMEPIX Pixel Detectors

- Leadfree SnAg ECD-Bumping on 200mm Medipix CMOS Wafer
- Bump Pitch 55 $\mu$ m
- 65536 IOs per Chip
- About 6 Mio.bumps per Wafer
- Chip to Chip Assembly
- **More than 500 single chip modules assembled**



Datum

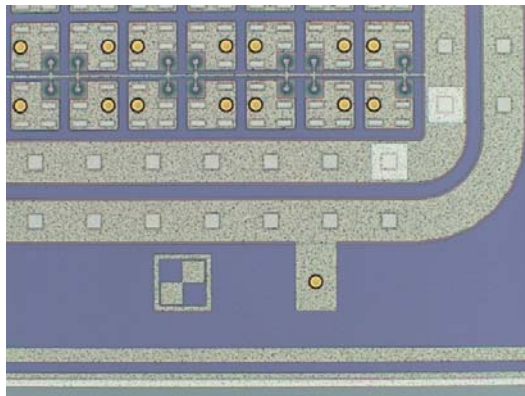
Name, Abteilung

# Hybridization of XPAD3 7-Chip Modules for CNRS/CPPM

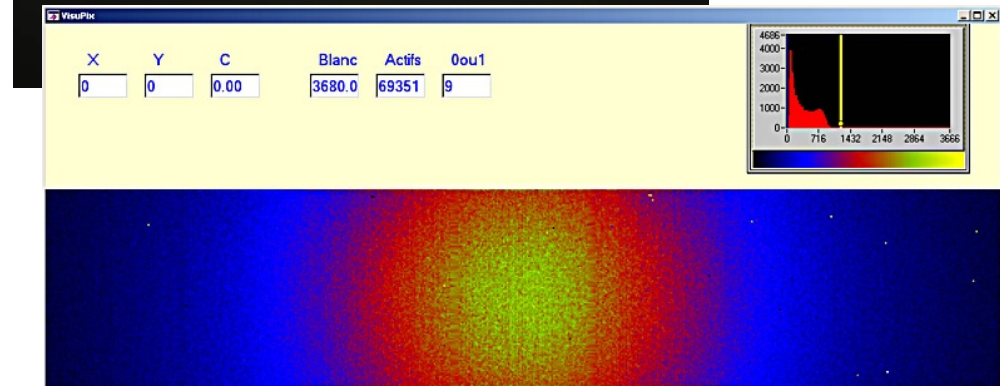
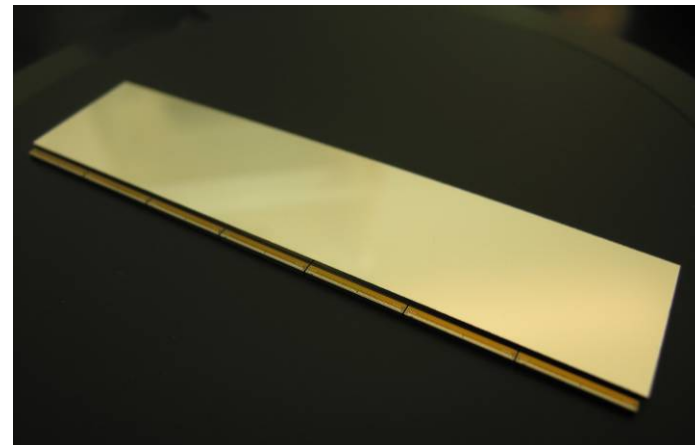
Wafer processing at IZM:



Bumping of XPAD3 ROC Wafer



Pixelpadmetallization on XPAD Sensor Wafer



7-Chip Module after Hybridization at IZM and result of functional test at CPPM

Datum

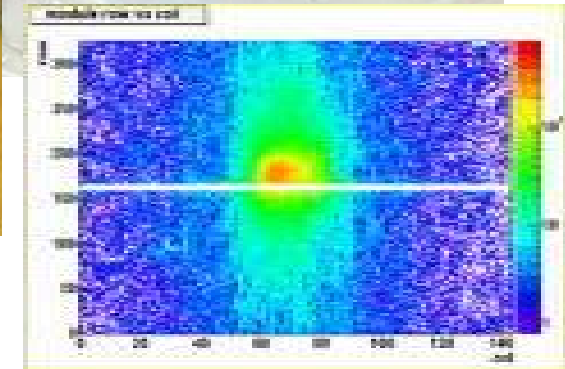
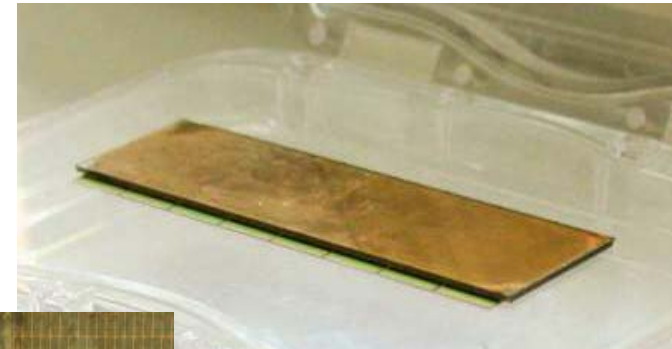
Name, Abteilung



# CVD Diamond Pixelsensor Module Prototypes

## Bumping und Assembly of world first CVD Diamond 16x-Multichip-Pixelsensor

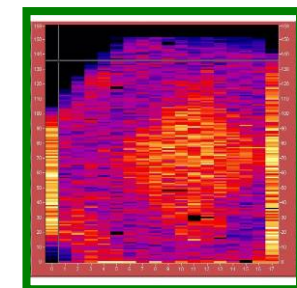
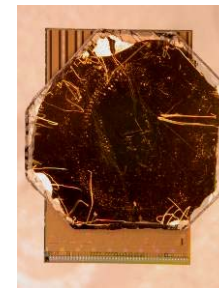
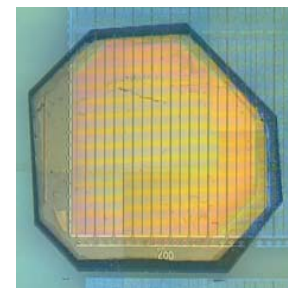
- Pixel and pad metallization deposited at Fraunhofer IZM
- ~ 46000 Pixel on 6x2 cm<sup>2</sup> diamond
- 16 ATLAS FE-I3 ROC Module



## Bumping und Assembly single crystal CVD Diamond Pixelsensor

Chip embedding technology developed at Fraunhofer IZM for single chip processing on wafer level

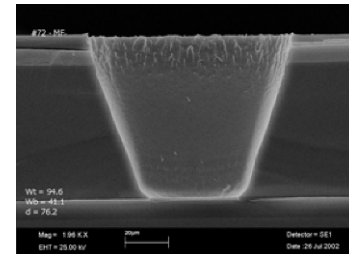
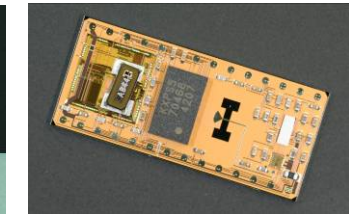
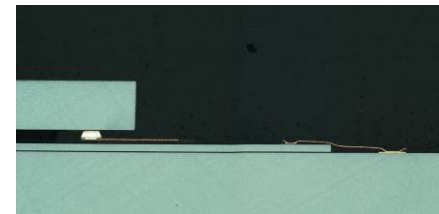
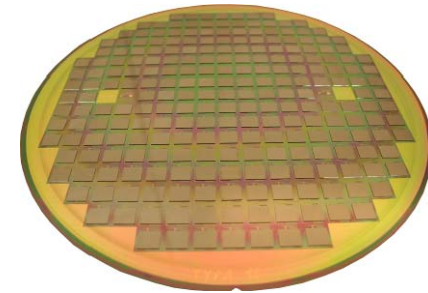
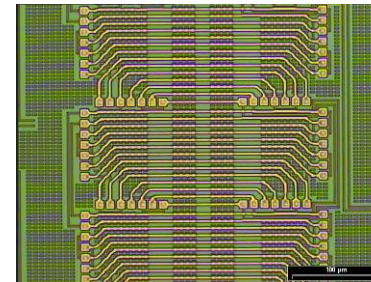
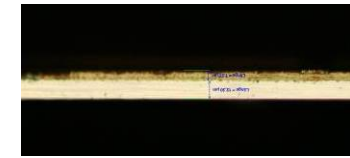
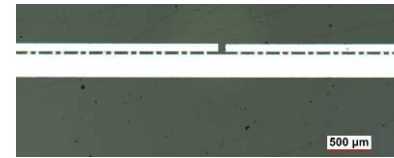
Single crystal diamond module:



Datum

# Advanced Packaging Technology - Developments

- Advanced wafer thinning technologies and thin chip flip chip assembly
- Thin chip assembly on wafer level
- Thin chip integration technology: 20µm thin chips embedded in redistribution layer on wafer level
- Through silicon via technology
- Ultrafinepitch wiring for redistribution on wafer level 4µm lines/space
- Development of low temperature interconnects: electroplated Indium bumping, nanoporous compressible interconnects



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# Thank you for your attention!



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