SUMMARY AND PROSPECTS

ACADEMIA MEETS INDUSTRIES

Abdenour LOUNIS WORKSHOP
AIDA 9 AVRIL 2013

AIDA WORKSHOP RECALL

- ***AIDA 2012 - Academia meets Industry: Solid-State Position Sensitive Detectors from Monday, March 26, 2012 at 09:00 to Tuesday, March 27, 2012 at 14:00 (Europe/Zurich) at DESY***

  State of the art in Position Sensitive Solid-State Detectors
  - The ALICE Inner Tracking System Upgrade
  - ATLAS pixel detector
  - CMS strip tracker
  - LHCb
  - High Energy Physics community needs
  - Detector Challenges at the Free-Electron Lasers
  - Silicon Tracking and Vertexing at a Linear Collider
  - Some applications of pixel sensors in life sciences
  - imaging Functional computed tomography using energy resolved photon counting detectors
  - Position Sensitive Silicon Detectors for particle beam diagnostics
  - Monitoring of Mixed Radiation Fields and Dosimetry with Pixel Detectors
  - DECTRIS Solid State Position Sensitive Detectors in Synchrotron Applications

13 Industrial companies involved

AIDA 2013 - ACADEMIA MEETS INDUSTRY: ADVANCED INTERCONNECTIONS FOR CHIP PACKAGING IN FUTURE DETECTORS
FROM 8 APRIL 2013 09:00 TO 9 APRIL 2013 14:00
AT FRASCATI

- 77 Registrants , 13 Companies:
- IMEC
- IPIDIA
- T-MICRO
- Tezzaron
- Printech Circuits
- DIGITAL SIPM, Philips
- Dectris
- EMFT
- Ketech Gmbh
- TECHTRA
- IBM
- ADVACAM
- Philips

Research Institutions

- CEA/LETI
- Fraunhoffer, IZM

ACADEMIA

- Italy : Frascati, Roma, Milano, Pisa, Bergamo
- France: LAL Orsay, Paris VI, CEA, CPPMarseille, CMP
- Germany: Desy Hamburg, GSI Darmstadt, MPI Munich, Bonn, Manheim
- Greece: Athens, Democritos,
- England: Liverpool
- Poland: Cracow
- Czech: Praha
- CH: Geneva
- CERN
- Sweeden: Stockholm
- Spain: Barcelona
- Finland: Helsinki

25 Institutions

AIDA 2013 - ACADEMIA MEETS INDUSTRY: ADVANCED INTERCONNECTIONS FOR CHIP PACKAGING IN FUTURE DETECTORS

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- *Needs of communities*
  - **Particle Physics**
  - **3D needs and opportunities in X-ray detection**
  - **Medical Imaging**
  - **Astroparticle Physics**

Integration of sensor with 3D electronics

A quiet good View of Industry offers in terms of technological solutions
For 3D Interconnections

PROJECTS THAT NEEDS 3D EVOLUTION

High energy Physics & astro

- HL-LHC Trackers: upgrades (ATLAS,CMS, LHCB)(thin silicon, fine granularity)
- X ray and γ ray for particle detection (Medipix)
- Linear Collider vertex, CLIC, Muon collider
- Soft γ ray astronomy

Other Scientific Interests

- SIPM in 3D
- Xray Detection, (HELMOtZ Cube)
- Xray Detectors
- Medical applications
- Active Real Time Space dosimetry (Medipix)

THE PROJECTS DEMANDS AND THE OFFERS

3D and Interconnection Projects needs

- High space resolution tracking
- Thin sensors, miniaturization
- Granularity, reduce occupancy
- Low noise, low consumption
- readout electronics (<65nm CMOS)
- High speed electronics (40 MHz clock)
- Radiation tolerant issue ~100 MRad
- Cooling issue, operate < -20 ^{0}
- 4side butable (Edgless)
- To couple Edgless sensors with submicronic readout electronics
- Heterogenious layers
- Affordable costs

Industry and R&D Institutes offers

- TSV process flow
- Via First,Via Last, Via Middle process
- Micro-bumps
- SLID
- Interposers
- Advanced packaging integration and density
- Oxide Bond Process

EXPERTISE IN 3D RESEARCH INSTITUTES & INDUSTRIES AND TRENDS

- Overview, state-of-the-art, and MEDIPIX, CEA Leti- Fr
- Tezzaron TSV-related activities (US)
- Method for selecting optimal 3D IC techn or detectors (T-Micro,Jap)
- Packaging technologies at IMB-CN)
- Micro bump-bonding and TSV egration expertise at Fraunhofer IZM,(Berlin, GE)
- Vertical Integration techn ues used for MEMS, Fraunhaufer (GE)
- Trend in Industry, IBM (US)

A quiet impressive amount of know how

- CAD tools for 3D-IC and TSV-based designs, CMP, Grenoble, France
- Methods for architectural design - methods of 3D-integrated systems, EAS, Dresden, GE

Tools

R&D IN TSV, CHIP STACKING, MICROBUMPS, SLID INDUSTRY &RESEARCH INSTITUTES EXPERTISE

- SiPM Interconnections to 3D electronic, MPI, GE
- Sensor Interconnectivity to the TSV readout ASIC, ADVACAM, Finlande
- Digital Photon Counting Technology – horizontal integration of SPAD and CMOS electronics (Philips), Aachen,GE
- Vertical Integration techniques used for MEMS, Fraunhofer ENAS, GE
- IMEC's activities in imagers and imager stacking, Be
- Capabilities and Frontiers of Through Silicon Via Technologies, EMFT, GE
- IPDiA's Interposer and TSV solutions , France
- Development of HV CMOS - sensors for 3D integration, U.Heidelberg, GE
- Capacitively coupled active sensors in 180nm HV-CMOS technology, CERN,CH
- FE_TC4_P1, hybrid pixel circuit en Tezzaron-Chartered technology, CPPMarseille
- TSV and SLID for planar Silicon Detectors, MPI, Munich, GE
- The combined technology of TSV and SLID bond, EMFT, GE

Frontiers in interconnections

- Unconventional fabrication approaches create ... ...ies for 3D integration, KTH

Exploit the continous ongoing progress driven by the industry

From was seen during the workshop

- Various processes for TSV fabrication available
- There are 3 TSV families with various properties, applications and maturity levels :
  - TSV pre-process : R&D level
  - TSV Middle : consumer / High end - pre-industrialization level
  - TSV last : CIS / Imaging – Mass production
- Lot of companies & R&D centres are working on TSV developments and industrialization (See the List Before and more ….)
- The 3D & TSV supply chain is starting to be available
- Some industrial products have been already achieved with TSV

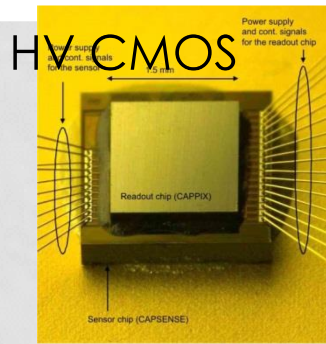
- Prospects
  - For TSV community : to find the "killer application" for TSV adoption in the consumer market
  - To disseminate the TSV technologies on other markets :
    - High energy Physics
    - Astrophysics
    - Synchrotrons
    - Medical Application
    - Portable applications
    - Spatial / aerospace
    - Dosimetry
    - …

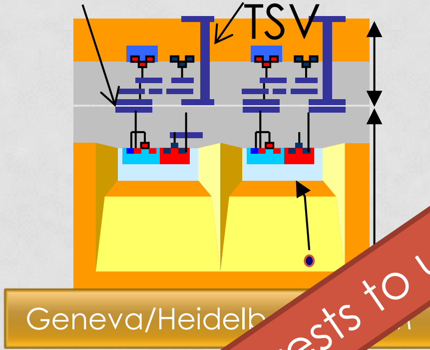
A Intense R&D Activity and Interests to use State of the Art 3D Technology

Fraunhoffer IZM

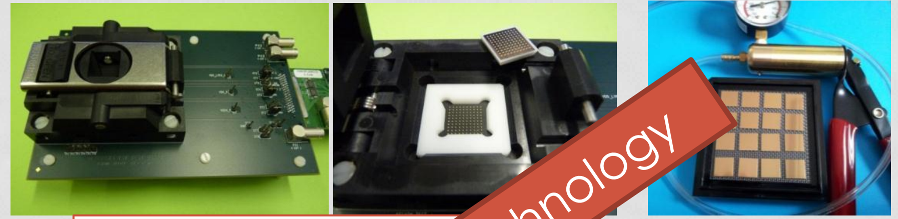
3D Camera module with Flex

HV CMOS





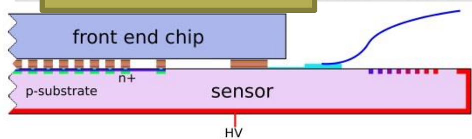
Geneva/Heidelb

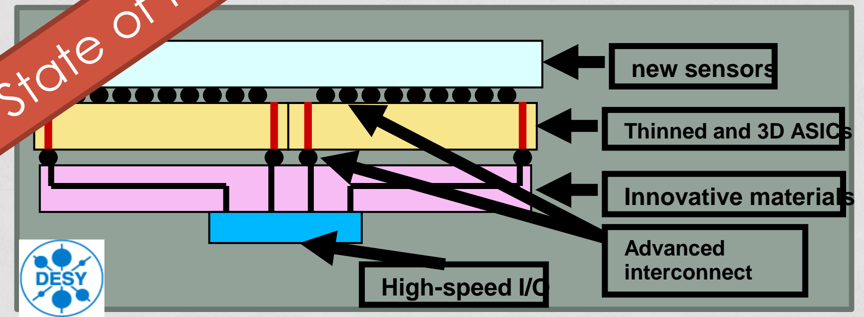


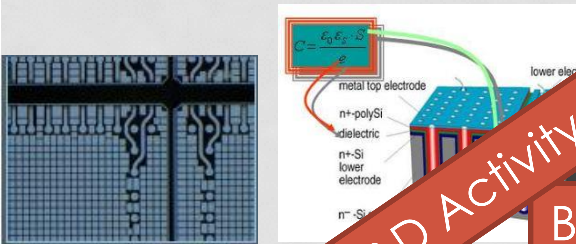
CERN CEA/LE

MEDIPIX

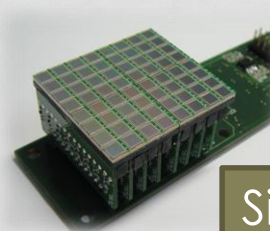
EMFT/ MPI

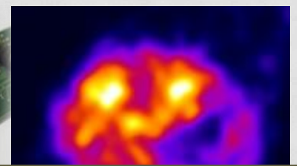




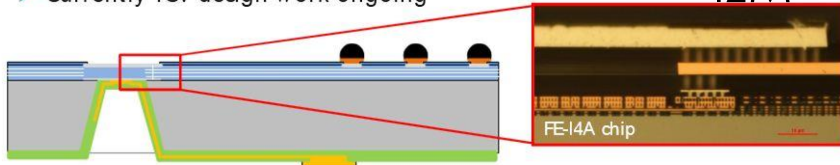


BelleTech/IPIDIA



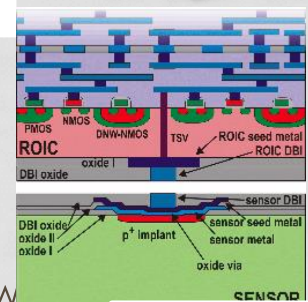


Si PM Based PET/MRI

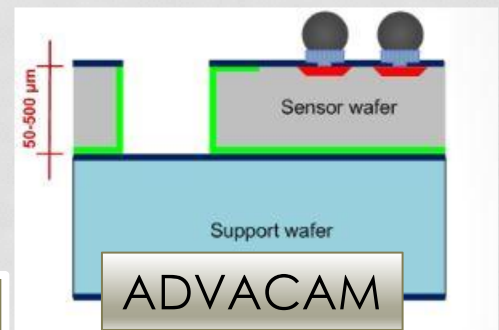


- Currently TSV design work ongoing

IZM



Ziptronix



ADVACAM

CONCLUSIONS

- Impressive amount of progress shown during this workshop
- **How can our community achieve (afford) the 3rd Dimension?**
  - To improve the physics performance for our future challenging HEP projects (innovative vertex detectors, Intelligent Trackers)
  - To answer fundamental questions related to the story of the Universe raised by astronomy (origin of cosmic, rays, gravity..)
  - To increase the performance of diagnostics tools in medicine and miniaturized medical sensors (Scanners,3D ultra thin pacemakers, Xray DNA imaging)

Very Important to get organized and intensify the worldwide and EU collaborations inside-projects (LHC, HEP groups), inter-academia and open Industries and also encourage international consortiums (3D IC…)

(ie to share developments efforts, costs (MPW), design licences, Software and simulation Tools)