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Round Table on
Nano CMOS and 3D electronics for Scientific Instrumentation and Imaging:
Opportunities and practical aspects

Round table introduction slides

Bart Dierickx\textsuperscript{1,2}

\textsuperscript{1}Caeleste CVBA, Antwerp, Belgium
www.caeleste.be
contact: bart@caeleste.be

\textsuperscript{2}Vrije Universiteit Brussel (VUB)
Brussels, Belgium
Why do we need nano & 3D?

• Supply & demand situation

Demand:
• There are needs (don’t ask me – you tell me! But it has something to do with)
  → Size
    Macroscopical (array)
    Pixel size
  → Data bottlenecks
    speed, processing
    close to the signal
    source, integrity
  → Performance
    noise, S/N, sensitivity
  → Cost

Supply:
• There happens to be a micro-electronics industry that has an enormous drive for “scaling”
• Supply is discriminatory
  → Technology research caters ONLY to the very high volume markets
  → Other markets “may use as is” and use affordable modifications
The purpose of integration and scaling, and the associated challenges are:

- Cost of functionality
- Energy per operation
- Data integrity

Q: where does nano / 3D fit in the picture?
Q: where do the nuclear/medical communities fit in the picture?

95% of all specs and purposes can be reduced to one of these three.

- Size
- Power
- Yield

- Fashion, trends?
- Backward compatible
- Interfaces
- Standards
- Ergonomics?
- Speed/power
- Signal/noise
- Reliability
- Confidentiality
- Operational lifetime
- Security
- ...
- ...

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A wealth of opportunities, but also an explosion of degrees of freedom for design.
3D? Yes there is significant progress

3D integration is driven by mainstream [SoC] industry
Spinouts to 2nd tier markets has potential

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19.6 Megapixel CMOS Image Sensor Fabricated in Three-Dimensional Integrated Circuit Technology

MIT, Lincoln Laboratories, Lexington, MA
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<td>10,000 Cycles, 9/9 PASS</td>
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Hybridization & noise

• Going 3D brings major “goodies”
  – Optimal technology and design for each layer
  – Unprecedented functionality density

• If you leave the 2D plane you might lose other “goodies”
  – Buried photodiodes (dark current!)
  – Pinned photodiodes (CDS, low noise)
  – Low pixel interconnect capacitance (kT/C noise)

Alternatives do exist but are more “expensive”:
• External CDS, NDR; analog or digital CDS
• Active reset, tapered reset, silencing reset
Worth remembering

- Industry technology push is directed to mainstream markets
- Ride on the wave
  - Uses the emerging [partial] technologies
  - 3D trend
    - Fine pitch
    - High yield & reliability
    - Moderate? cost (yet! # Si does not decrease!)
    - Power density?
  - Nano (2D)
    - Extreme high density of functionality
    - Has its own challenges!
      - reliability; variability; low VDD; analog