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Expression of interest by Academia

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2009-06-18

Key elements to make a detector

- Material
- Processing
- Readout
- Hybridisation
- (Reliability and yield)

Material

- Silicon – quality is OK
 - or maybe???

Doping gradients in a Silicon wafer

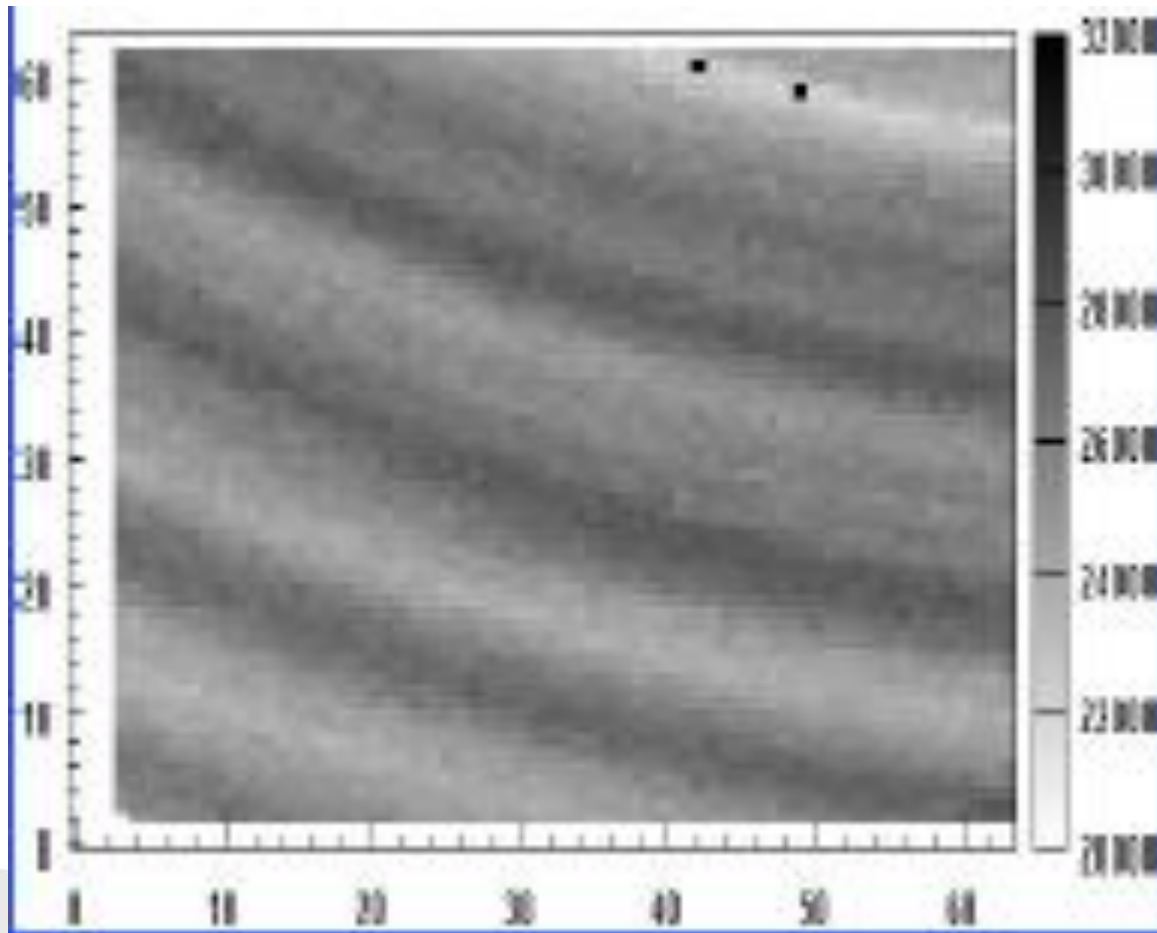
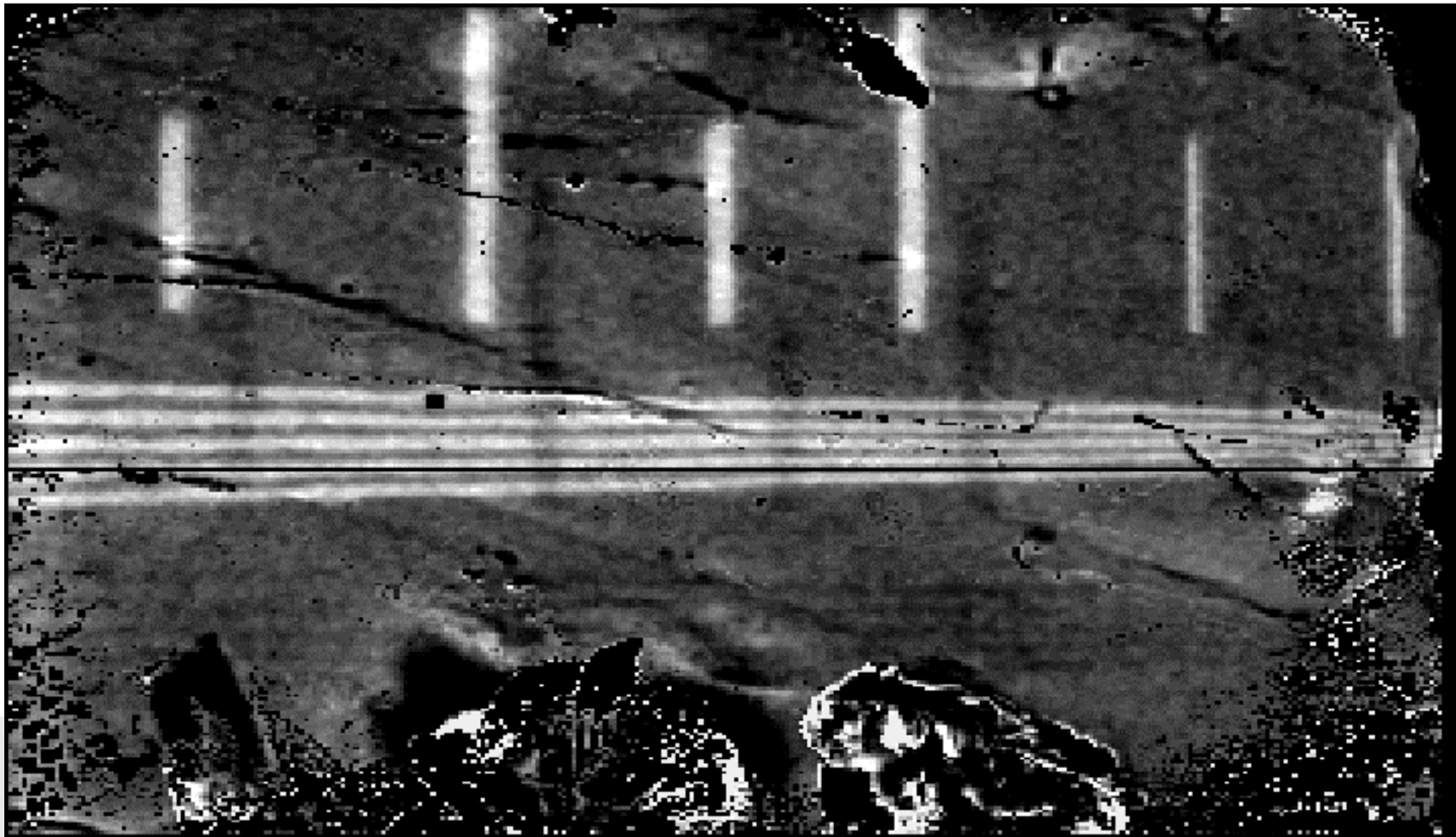


Image taken with a MEDIPIX2 system at low bias. The effect is less significant at overdepletion

Material

- Silicon – quality is OK
 - or maybe???
- X-ray imaging requires high-Z materials with excellent uniformity and good charge collection
 - CdTe ???
 - GaAs ???
- .. except from poor quality these materials also suffer from X-ray fluorescence

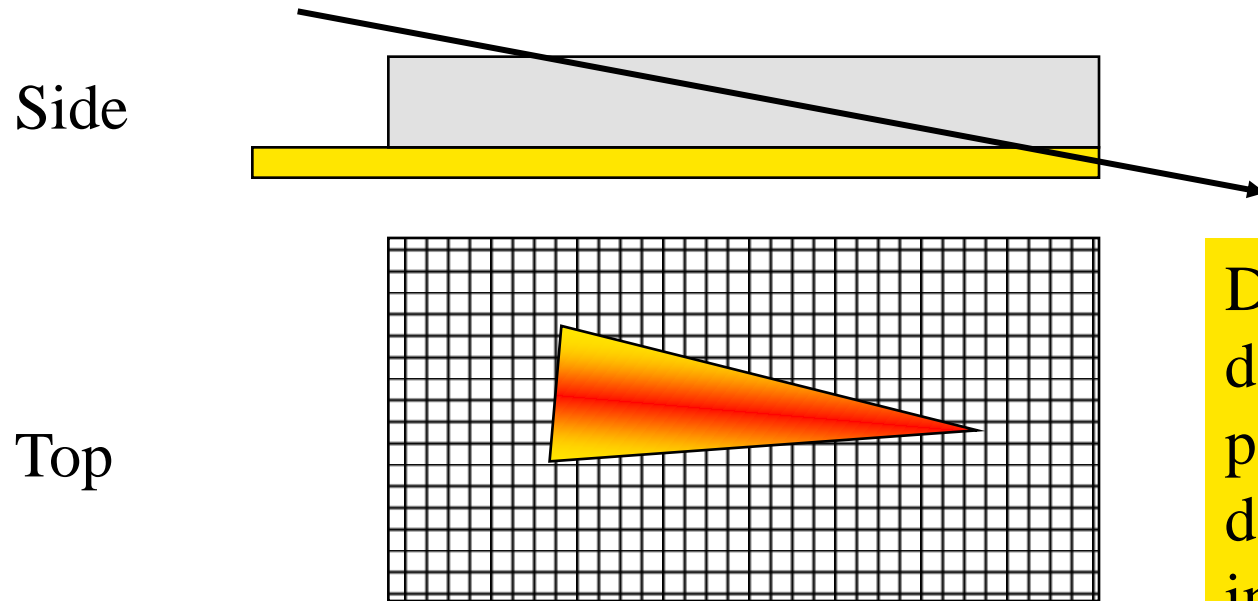
Image taken with a CdTe sensor (old)



Processing

- **Thickness**
 - Very thick detectors for tracking
 - Very thin detectors
- **Area**
 - Large area for imaging
- **Noise**
 - Low leakage
- **Radiation hardness**
 - Main issue in high energy physics
 - Becoming important in other applications

Pseudo 3D tracking

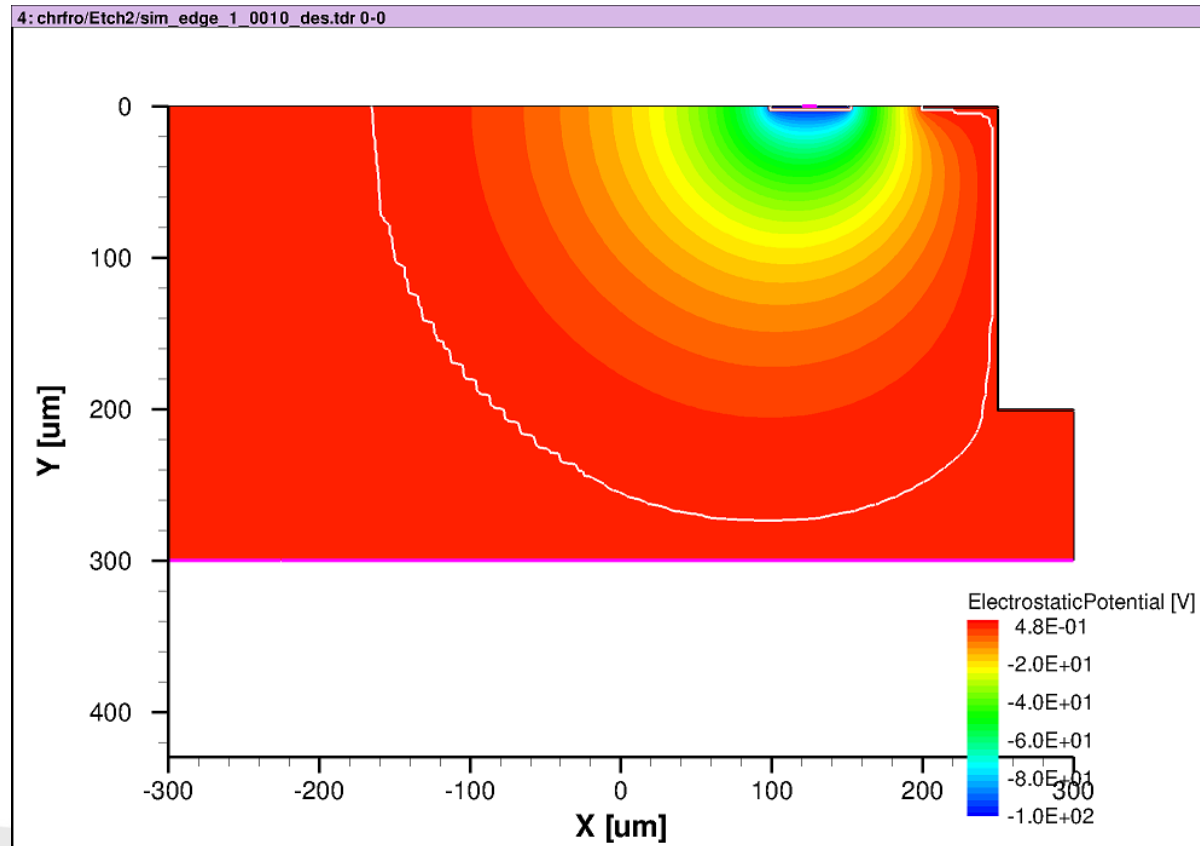


Direction can be determined from position and depth of interaction

Processing

- Guard ring structures
 - Narrow guard rings for thick sensors
 - Active edge sensors
- 3D sensors
 - Reduced charge sharing
 - Short charge collection path
- Fan out
 - Sensor chip larger than readout chip to allow seamless tiling

Narrow guard ring

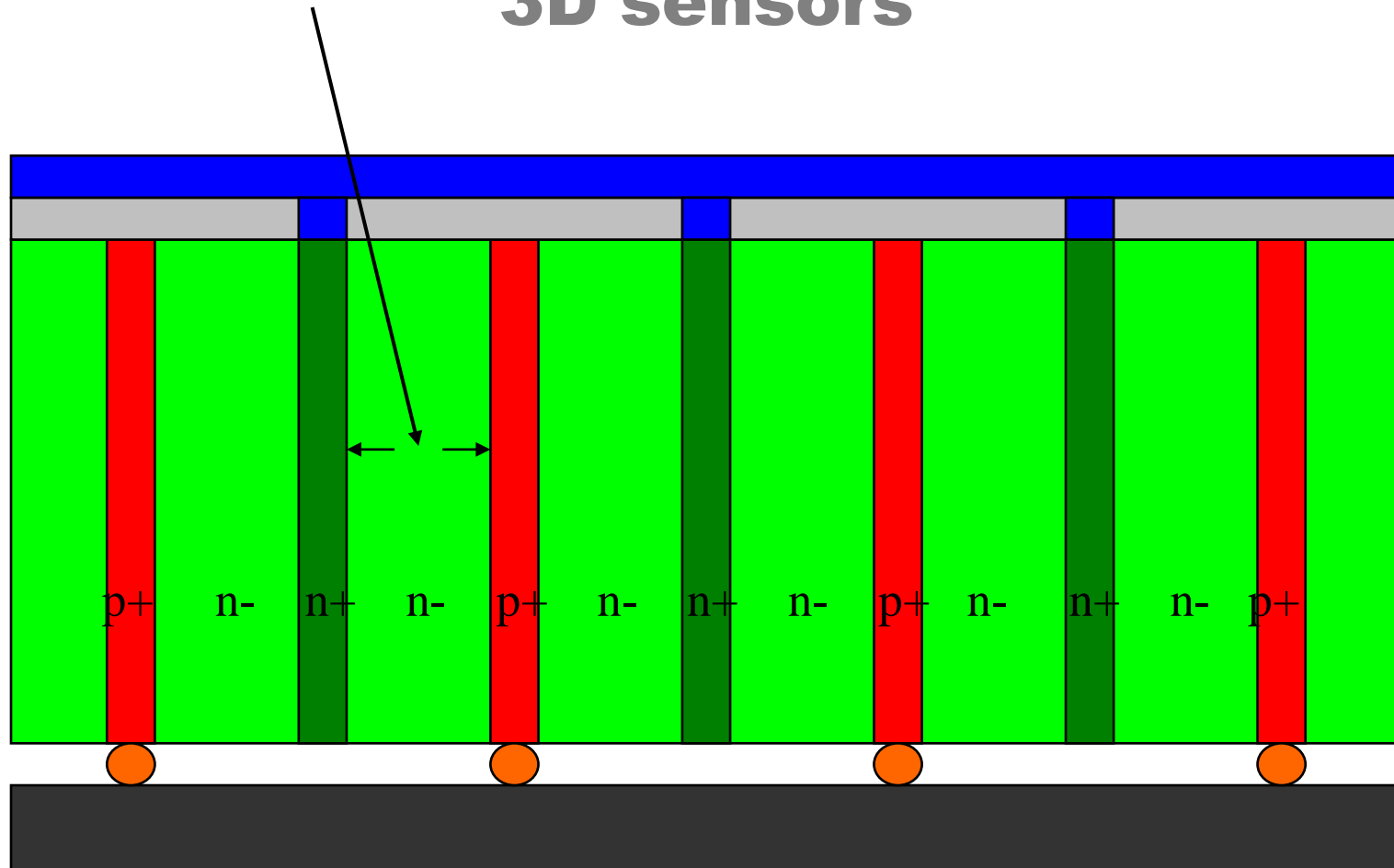


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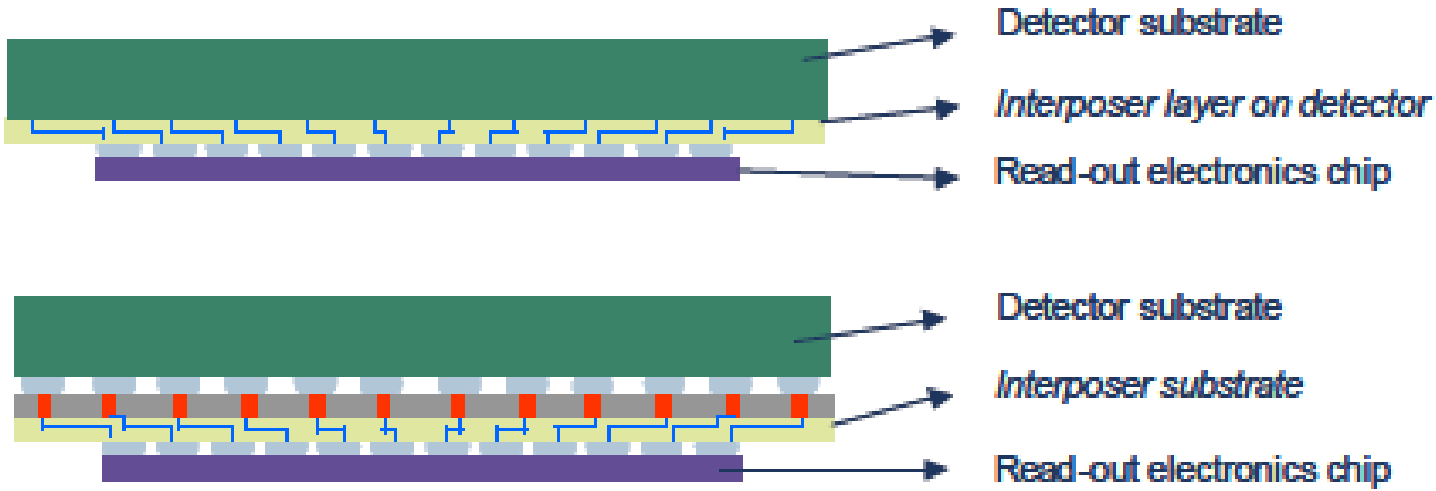
3D sensors



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Fan out



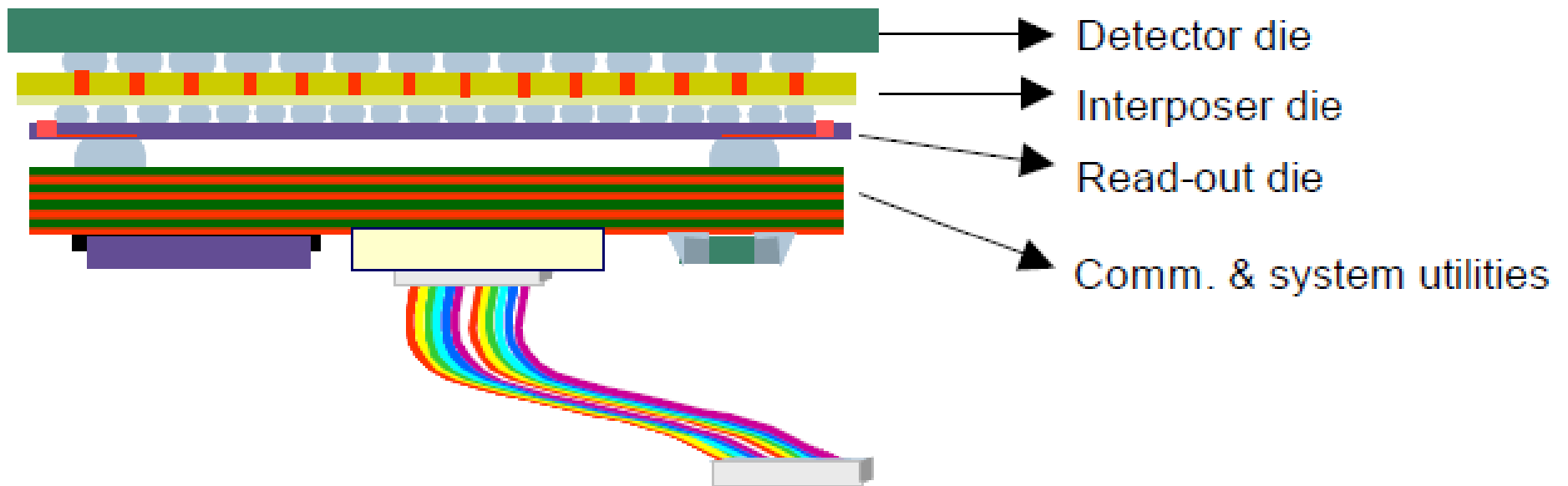
Design

- Speed
 - Fast counting (synchrotrons, free electron laser)
- Noise
 - Processing low energy photons
 - Precision in energy determination
- Adjustment
 - Accurate energy determination over full matrix
- Pre processing
 - Charge summing

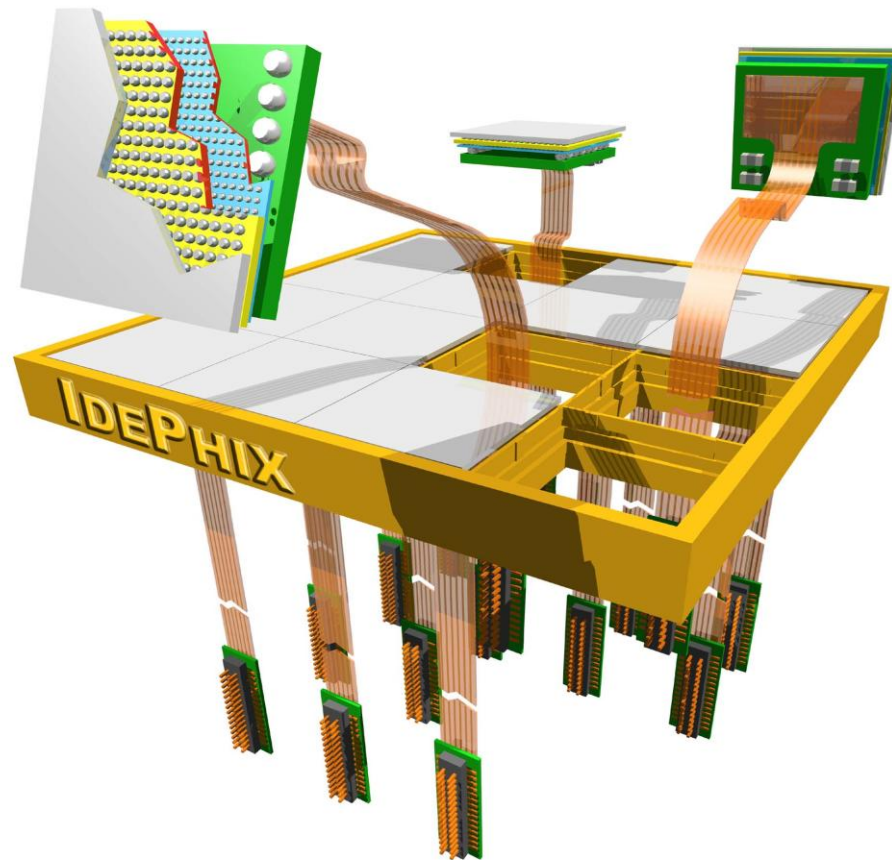
Hybridisation

- Bonding
 - Reliable and cost effective methods to join sensor and readout chip with millions of connection points
- 3D stacking
 - Separate chips for analogue and digital pixel electronics
 - Local memories, pre-processing and communication circuits

3D stacking



A modular detector with seamless tiling



2009-00-10



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Conclusions

- There are still many research issues in developing next generation of radiation detectors
 - Academic institutions can do development, testing and maybe some small series production
- Reliability and yield issues will probably be crucial for the industry
 - Research in this field?

Funding – FP7 Capacities

- **INFRA-2010-1.1.29: Detectors for future accelerators.**
A project under this topic should aim at integrating the key research infrastructures in Europe for the development of advanced detector technologies.
- What is an accelerator?
 - LHC
 - ESS ?
 - The Synchrotrons and XFEL

Funding – FP7 Health

- **Development and implementation of Quantum Imaging of X-rays/Y-rays for Diagnosis:** The research should develop and implement quantum X- or Y-ray detection for a diagnostic imaging setting. Potential applications should concern major chronic disease, such as neurological or cardiovascular disorders, or cancer. The developed method(s) should be tested at least pre-clinically.

Lobbying

- To get substantial funding for detector research we need to get this into the Work programmes of IST and NMP (design, hybridisation and materials)
- We then need to show a large potential market and a large impact on the competitiveness of European industry