A totally personal and subjective summary of IWORID-8

Heinz Graafsma

Some statistics

- Total # participants: 105
- Italian participants: 26
- Non European partic.: 9

- Number of talks: 40
- Number of slides: 1037
- Total size of ppt files: 391 Mb (100Mb/day)
- Number of posters: 25

Some observations:

- Very well prepared presentations!
- Increasing focus on applications!
- Increasingly diverse applications:
  - From Terra-Hertz to gamma rays
  - From photons to neutrons
  - From medical to space science
- What was new in applications?

Passive terahertz imaging with superconducting antenna-coupled microbolometers

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Tekes, the Finnish Funding Agency for Technology and Innovation (Decision #40384/05)

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Charles Dietlein, UC Boulder,CO
Zoya Popovic, UC Boulder, CO
NIST/Office of Law Enforcement Standards
UC Boulder/ NSF, award #0501578

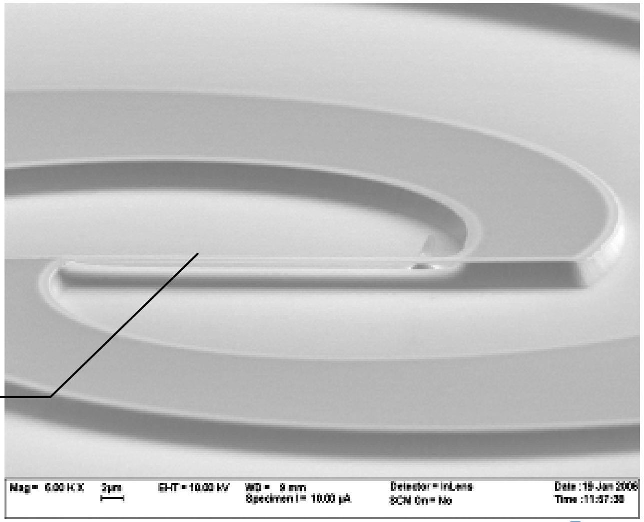
Rapiscan Systems
Oxford Instruments

MilliLab

Superconducting Antenna-coupled microbolometers for passive THz imaging

- Broadband (0.1 - 1 THz lithographic antenna) on Si
- Bolometer material
  - Nb for 1st generation devices
  - NbN for 2nd generation
- Similar to a Transition Edge Sensor; but with a large temperature gradient
- V-bias + T-gradient→ phase separation
- Bias + RF dissipation (DC) takes place in the N state region, some RF dissipated also in the superconducting region (gap varies across the bridge)
- Bias power modulates the size of the hot-spot → modulation of *R* → modulation of current through the bridge
- Electrical measurements in 2003; $NEP_e = 14\ fW/Hz^{1/2}$
- *Extremely* simple to fabricate
- Speed requirement? Real time scanned imagery: 30 Hz $\times$ 200 scan positions ~ 6 kHz

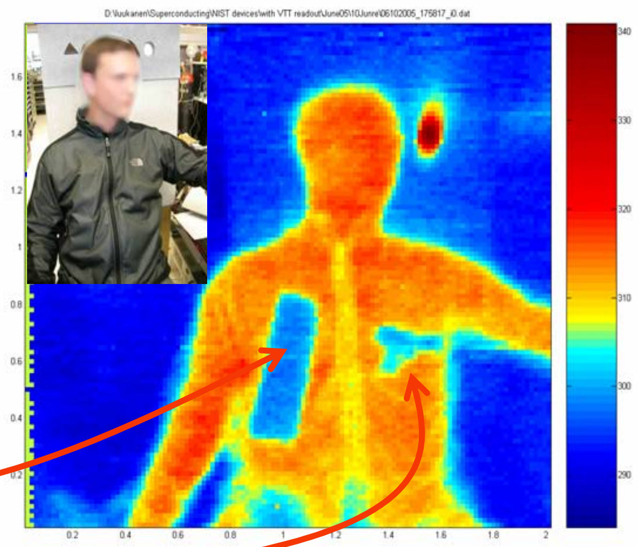
A. Luukanen, J.P. Pekola, Applied Physics Letters, Volume 82, Issue 22, pp. 3970-3972 (2003).
Arttu Luukanen, Robert H. Hadfield, Aaron J. Miller, Erich N. Grossman, Proc. SPIE Vol. 5411, p. 121-126, Terahertz for Military and Security Applications II; R. Jennifer Hwu, Dwight L. Woolard; Eds. (2004)

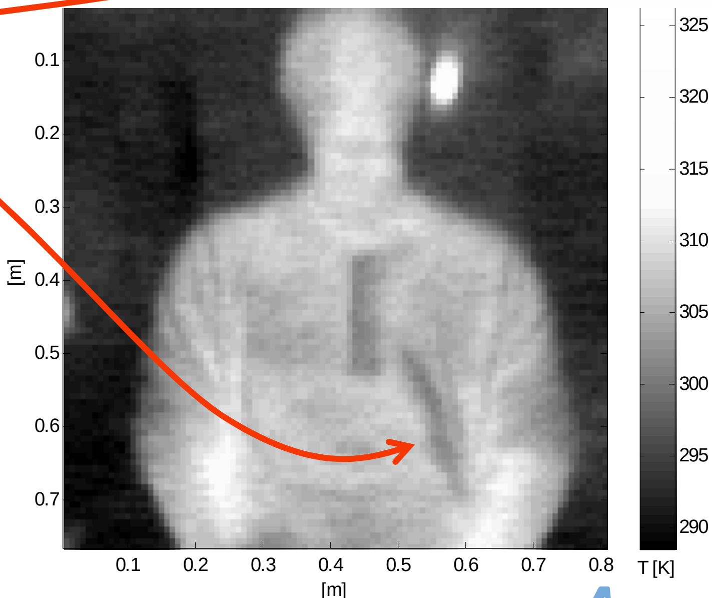


36x1x0.05 $(\mu m)^3$ suspended Nb Bridge

Examples of acquired images (single pixel, Nb device)

- General parameters:
  - Distance: 0.8–2 m
  - Spatial pixel size: ~ 4–8 mm square
  - Pixel integration time: 10 ms
  - Calibration: hot water & background average area
  - Clothing variations: cotton, polyester, windblocker jacket, thermal sweater
  - Concealed objects:
    - RAM (AN-72)
    - metal gun
    - ZrO_2 knife
- Measured fluctuation in smooth background of images
  - 200-500 mK depending on area and image
- Important measured temperature contrasts
  - 8K: concealed threat objects
  - 5K: zippers, thick clothing overlap
  - 0.5-1.5K: wrinkles/folds in clothes, i.e., clutter
- Observed spatial resolution
  - ~ 1 cm features plainly resolved





CCLRC

Detectors for the European X-ray Free Electron LASER

Richard Farrow

CCLRC UK

IWORID-8

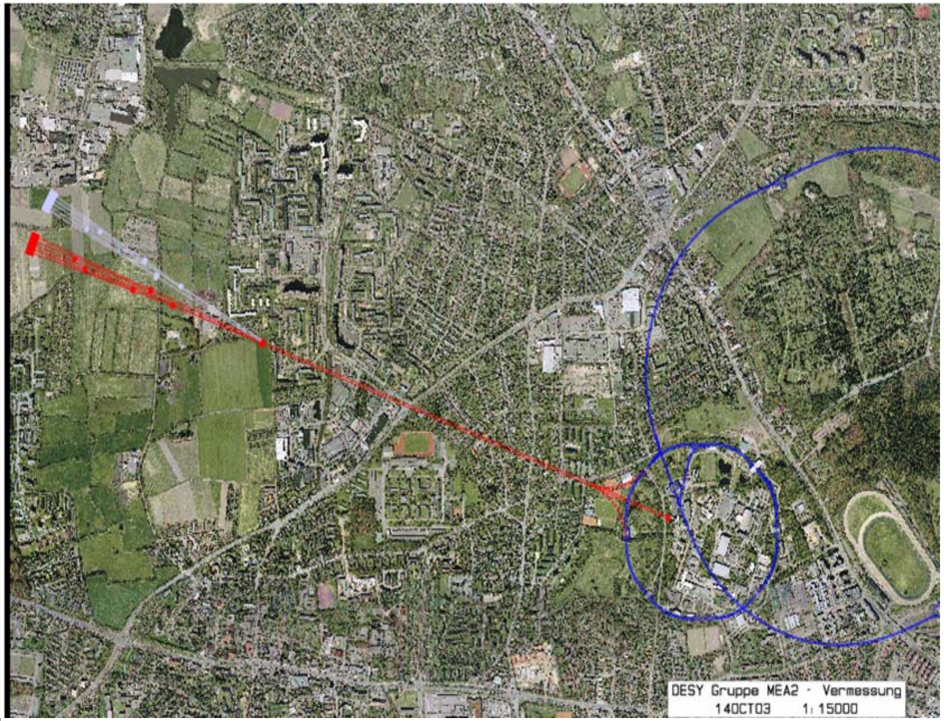
XFEL

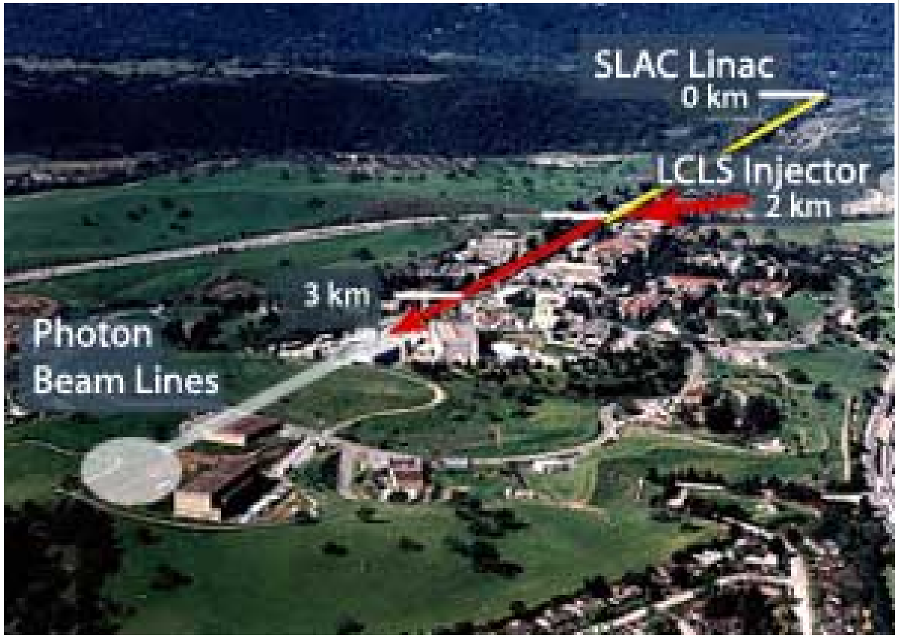
X-Ray Free-Electron Laser

DESY

Linac-based X-ray Free-electron Lasers

European XFEL Project, Hamburg →





← Linear Coherent Light Source, SLAC, Stanford

XFEL
X-Ray Free-Electron Laser
DESY

	Detector II: Pump Probe Crystalline	
XFEL radiation source	SASE-1 (and/or U1)	
Photon energy range	12	KeV
Energy resolution	No	eV
Quantum efficiency	>0.8	
Radiation hardness	10^{16}	12 keV X-ray ph/pixel
Total angular coverage	120	degrees
Angular resolution or pixel size	100	μm
Number of pixels	3000 x 3000	
Acceptable tiling constraints	<10% dead area	
Maximum local rate	$3x10^6$ (10^3)	ph/pixel/100fs pulse
Maximum global rate	10^7 (10^5)	ph/100fs pulse
Timing	10	Hz
Flat field response	1%	
Dark current	<0.01 eq X-ray photon	per pixel per exposure
Read-out noise	<0.01 eq X-ray photon	per pixel
Linearity	1%	
Point spread function	100 um (300 um)	FWHM (FW1%M)
Image latency	10^{-6}	Subsequent images
Operating environment	ambient	
Vacuum compatibility	No	
Maintenance	See below	
Other requirements	Central hole	

Imaging and Spectroscopy with Modern Silicon Radiation Detectors

Heike Soltau, Robert Hartmann,
Peter Holl, Peter Lechner,
Andreas Liebel, Adrian Niculae,
Rouven Eckhard, Klaus Heinzinger

PNSensor GmbH
Munich, Germany

Lothar Strüder, Gerhard Lutz,
Florian Schopper, Johannes Treis,
Stefan Wölfl

Max-Planck-Institute for
ExtraterrestrialPhysics
Garching, Germany

Andrea Castoldi, Carlo Fiorini, Chiara
Guazzoni, Antonio Longoni

Politecnico di Milano
Milano, Italy
INFN, Italy

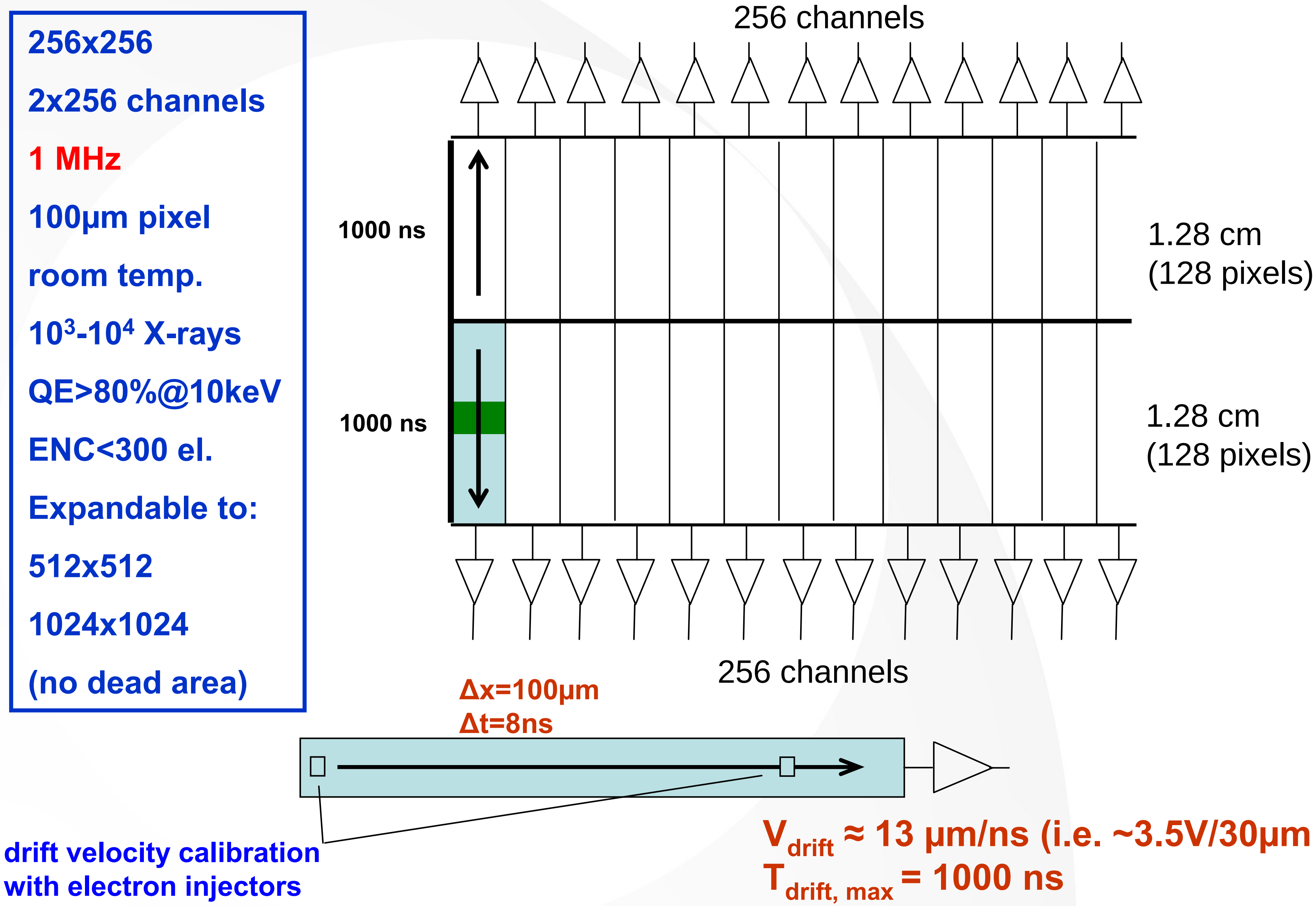
IWORID 2006 in Pisa (Italy)

PNSensor

The Controlled Drift Detector* (CDD)

Device proposal for the XFEL

- 256x256
- 2x256 channels
- 1 MHz
- 100µm pixel
- room temp.
- 10^3-10^4 X-rays
- QE>80%@10keV
- ENC<300 el.
- Expandable to:
- 512x512
- 1024x1024
- (no dead area)



$V_{drift} \approx 13$ µm/ns (i.e. ~3.5V/30µm bias)

$T_{drift,\,max} = 1000$ ns

Gas Pixel Detectors

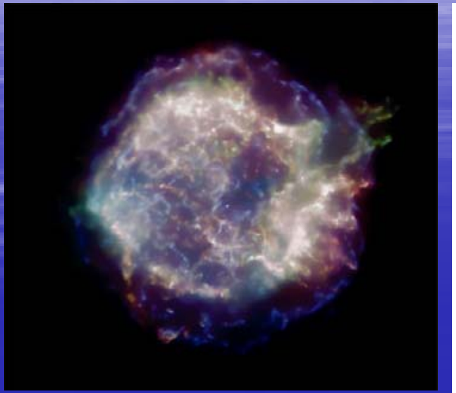
Ronaldo Bellazzini
INFN - Pisa

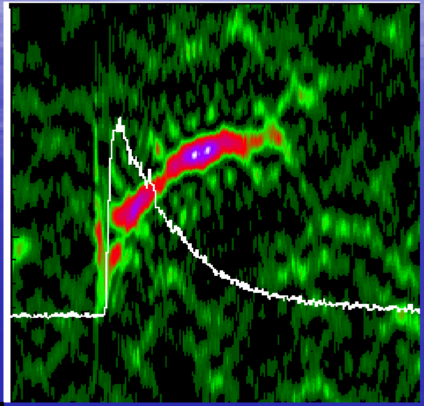
8th International Workshop on Radiation Imaging Detectors (IWORID-8)
Pisa 2-6/july 2006

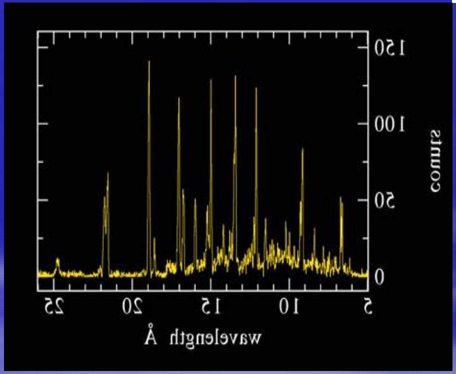
Polarimetry: The Missing Piece of the Puzzle

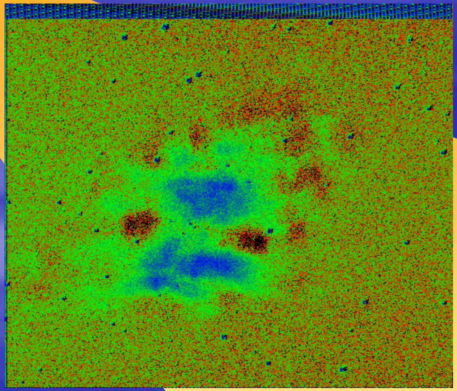
Imaging: Chandra

Timing: RXTE





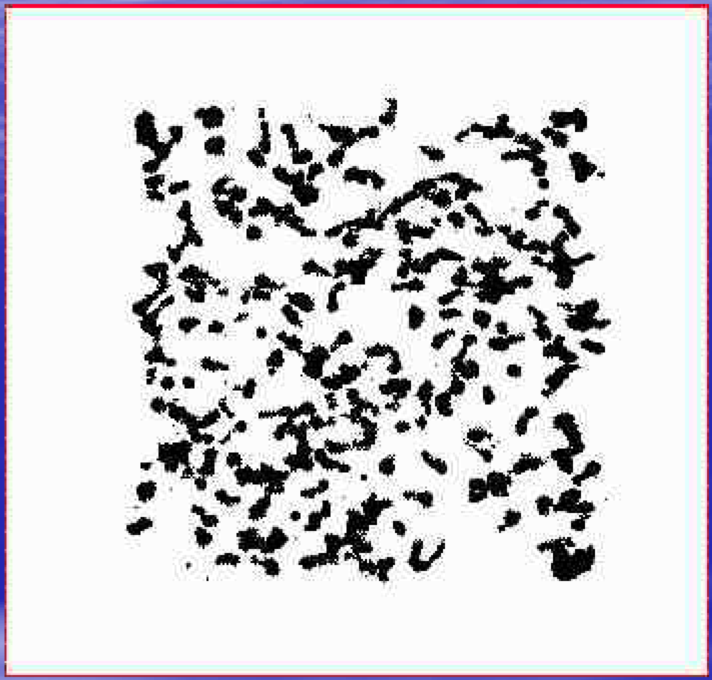


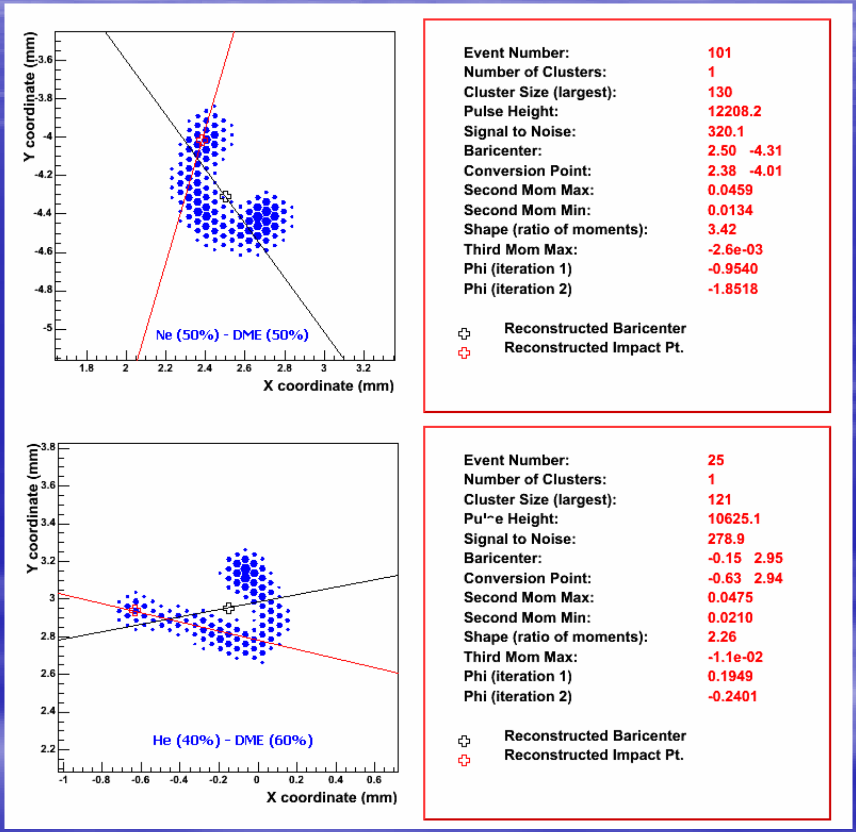


Spectroscopy: AstroE2, Constellation-X, Chandra

Polarimetry: ?

Track morphology and angle reconstruction





What about technologies?

- No new Chips?
- There are more chips than Medipix! (see Bellazzini)
- CMOS MAPs impressive.

Recent Development on CMOS Monolithic Active Pixel Sensors

Tracking detector applications

Giuliana Rizzo
Università degli Studi di Pisa & INFN Pisa

8th International Workshop on Radiation Imaging Detectors

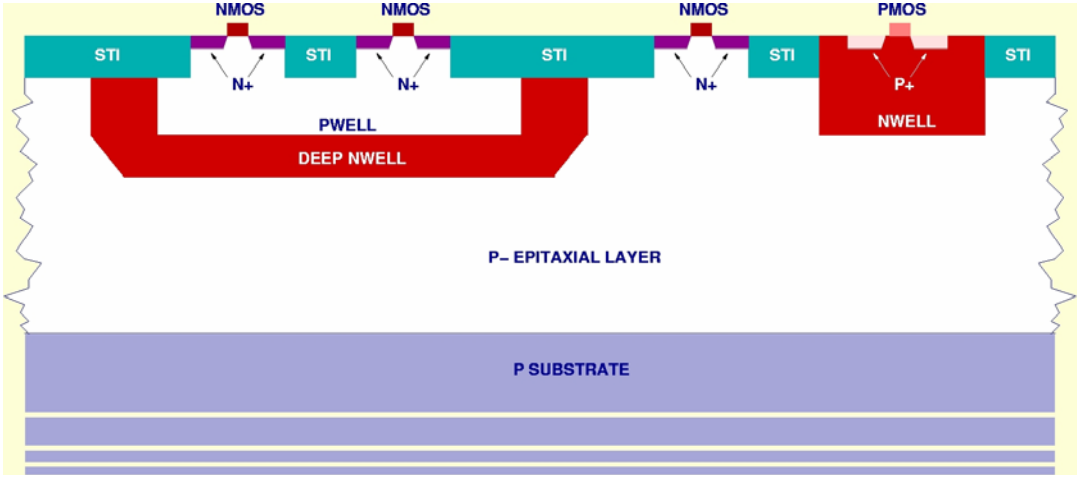
Pisa, July 2-6 2006

Triple well CMOS MAPS (I)

SLIM5-Collaboration

- Use of commercial triple-well CMOS process proposed to address some limitations of conventional MAPS
  - improve readout speed with in-pixel signal processing
  - improve single pixel signal with a larger collecting electrode

In triple-well processes a deep n-well is used to provide N-channel MOSFETs with better insulation from digital signals

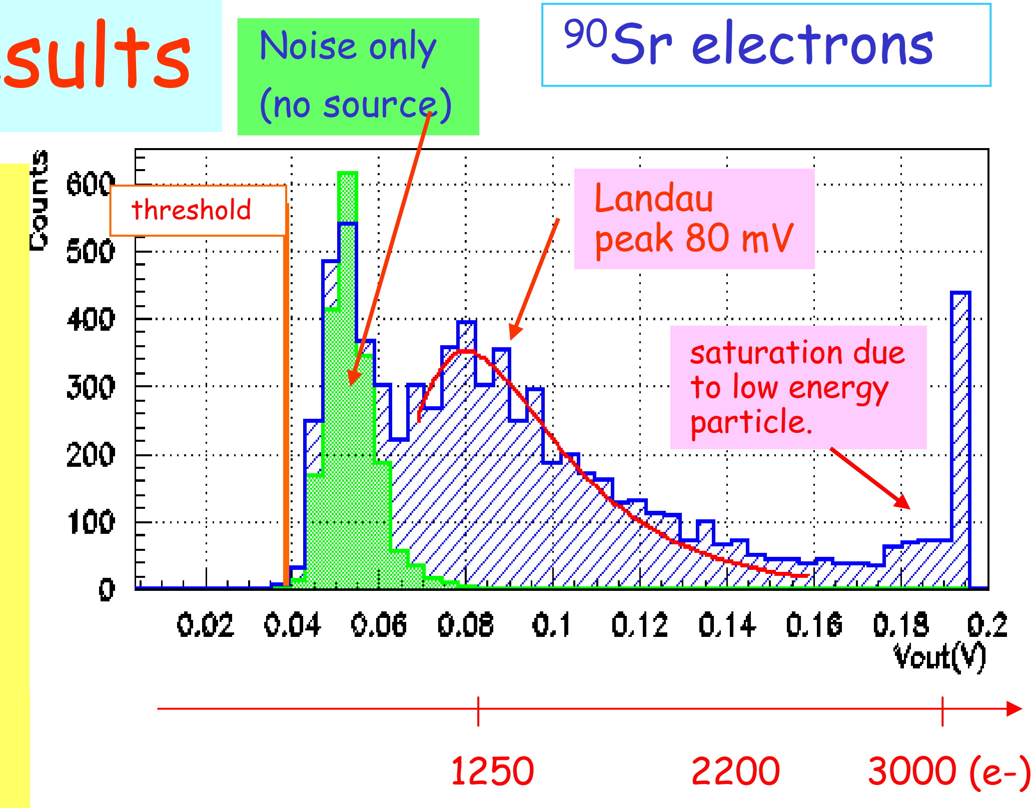


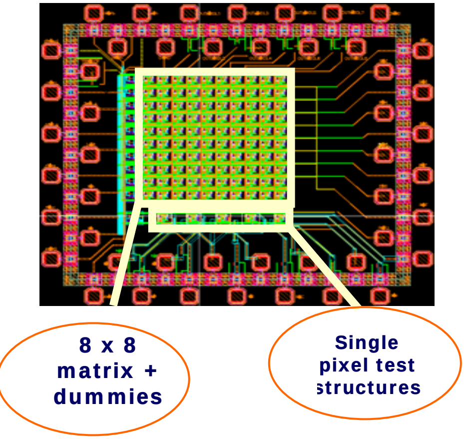
This feature exploited for a new approach in the design of CMOS pixels:

- The deep n-well can be used as the collecting electrode
- A full signal processing circuit can be implemented at the pixel level overlaying NMOS transistors on the collecting electrode area

Triple Well MAPS Results

- First prototype chip, with single pixels, realized in 0.13 μm triple well CMOS process (STMicrolectronics)
- Very encouraging results:
  - Proof of principle
  - S/N = 10 (^{90}Sr β source)
    - Single pixel signal ~1250e- (only 300 e- in conventional MAPS!)
    - High pixel noise ENC = 125 e- (due to underestimated deep nwell capacitance)





Second prototype under test:

- Pixel matrix (8x8, 50x50 μm^2) with simple sequential readout tested up to 30 MHz.
- Pixels with varying electrode size (900-2000 μm^2)
- Improved front-end: pixel noise ENC = 50 e-
  → M.I.P. Expected S/N ~ 25
- Problems: threshold dispersion measured ~300 e-, ground line bouncing in digital transitions.

What about technologies?

- No new Chips?
- There are more chips than Medipix! (see Bellazzini)
- CMOS MAPs impressive.
- Steady progress in materials; comeback for GaAs?
- Post processing of chips gives many possibilities.

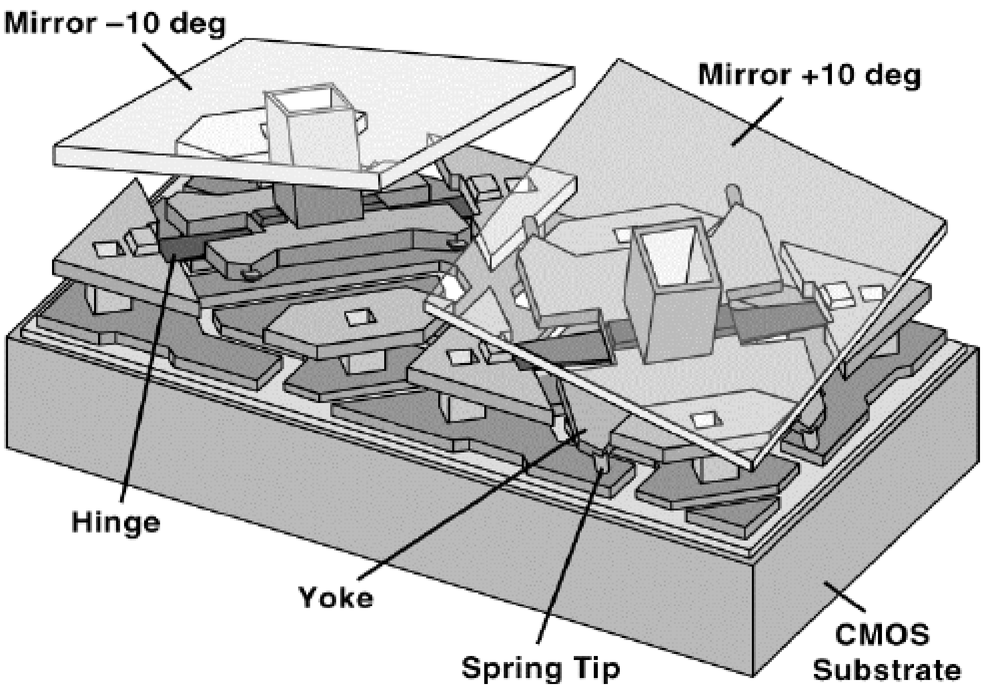
University of Twente

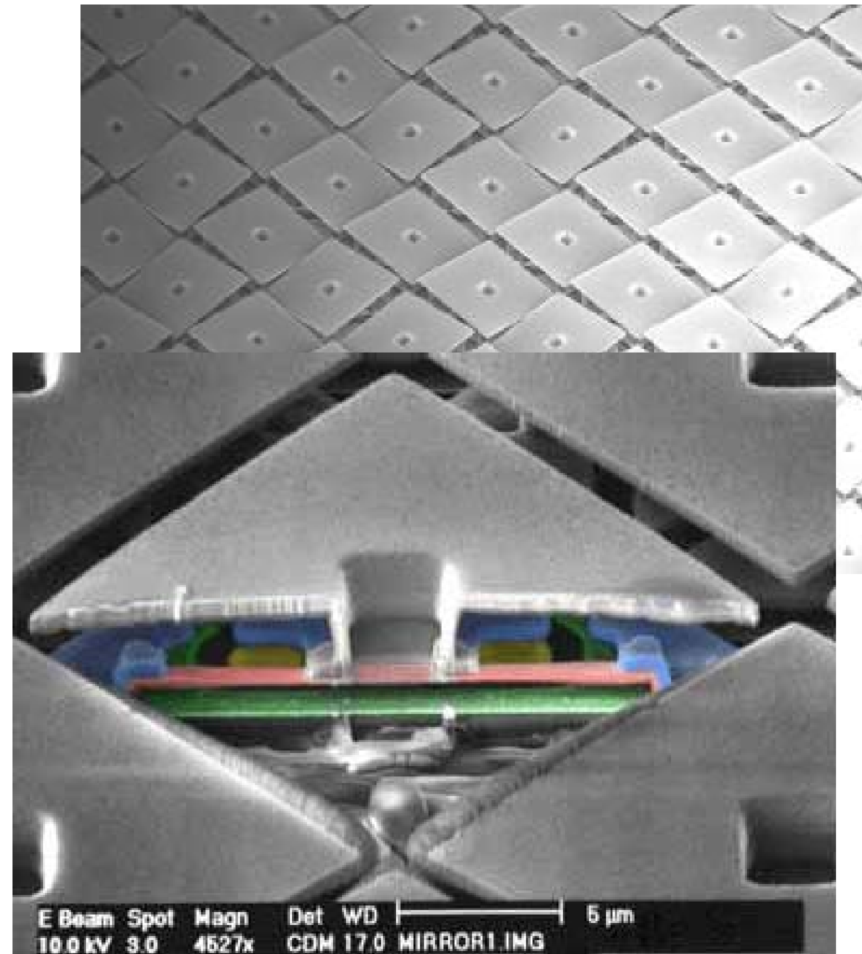
Wafer-level CMOS post-processing

Jurriaan Schmitz

University of Twente
The Netherlands

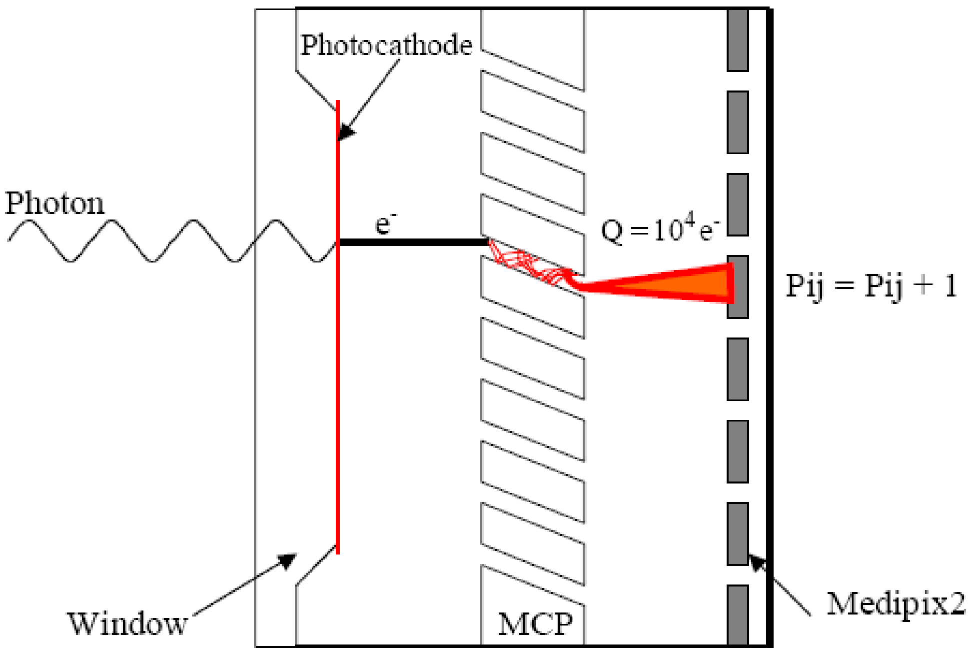
TI's micromirrors



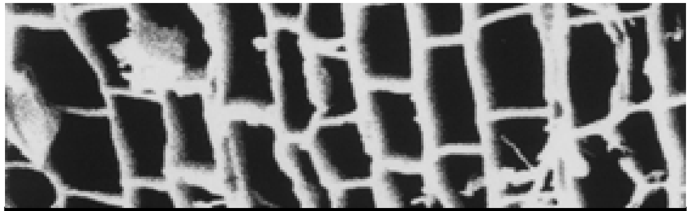


Integrated microchannel plates

Principle: J. Vallerga et al., IWORID 2004



Wafer-level manufacturing:
Porous alumina?



Naked Medipix2 chip

J. Melai et al., IWORID 2006

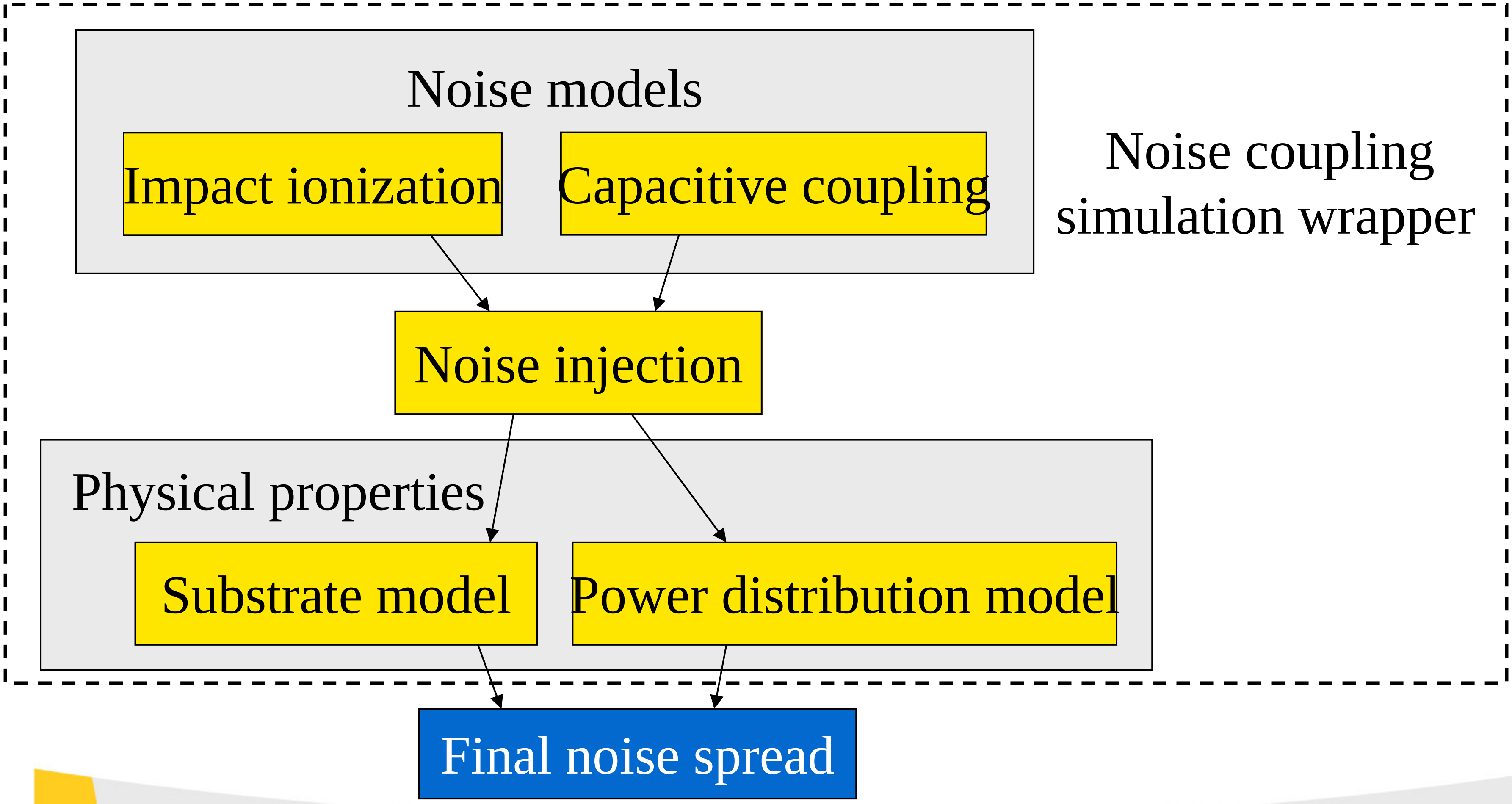
Theory?

- Noise performance; mixed activity on chip
- Sensor simulation
- ASIC simulation
- Image processing (tomographic reconstructions)

Power Distribution and Substrate Noise Coupling Investigations on the Behavioral Level for Photon Counting Imaging Readout Circuits

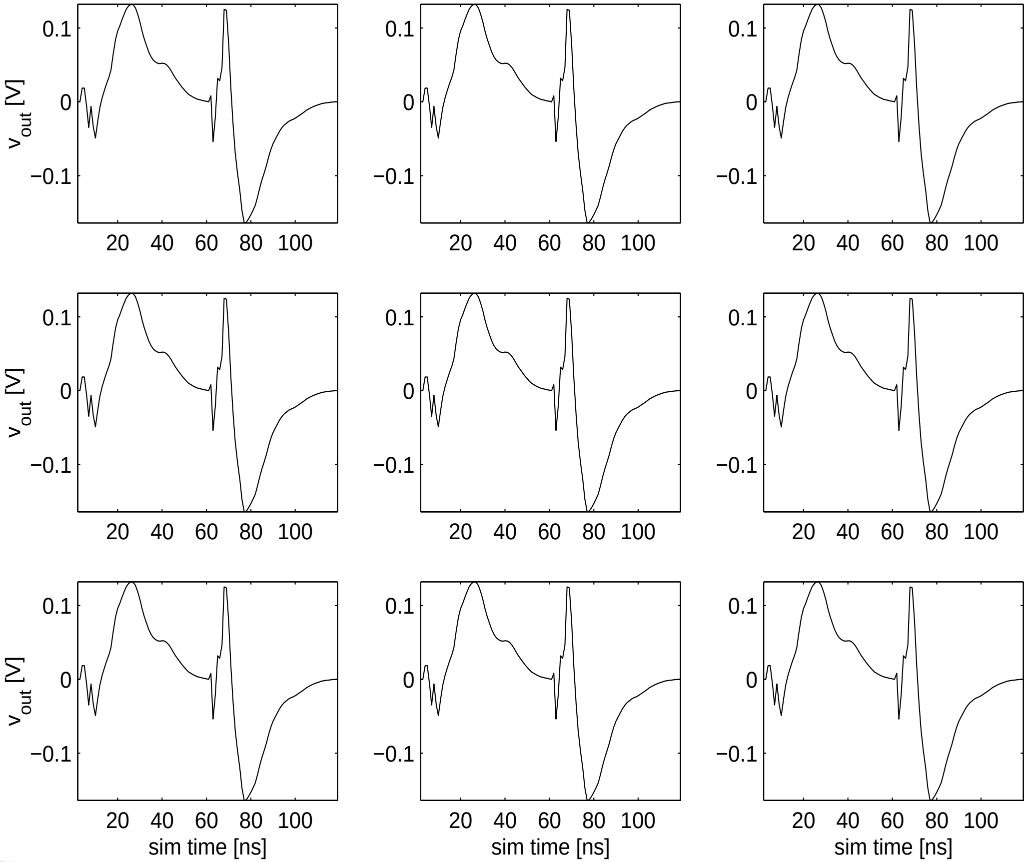
Jan Lundgren, Suliman Abdalla, Mattias O´Nils, Bengt Oelmann

BeNoC model description



Simulation examples

With power distribution noise coupling



Noise voltage on <u>analog</u> blocks in a 3x3 pixel structure.

Conclusion

- IWORID-8 was a great success
  - BUT WHY????

Enthusiastic speakers:

Great audience

An attentive audience

Deep thoughts

A good atmosphere

Conclusion

- IWORID-8 was a great success
  - BUT WHY????

- Because:

Local organizing committee did a marvelous jobs: THANKS.

First announcement: The 9th iWoRiD in Erlangen 22 – 26 July 2007

Physikalisches Institut Universität Erlangen-Nürnberg