

MEDIPIX2 for VERY LOW DOSE INITIAL LHC BENCHMARKING



ERIK H.M. HEIJNE
CERN Genève

**LHC RADIATION
WORKSHOP**

29 November 2005



MINIATURE SPECIFIC DOSIMETER 'MEDIPIX'



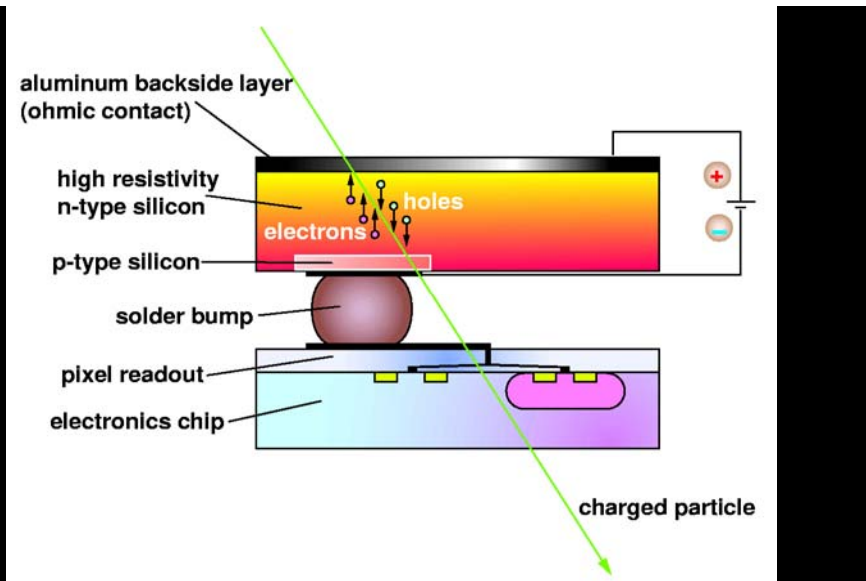
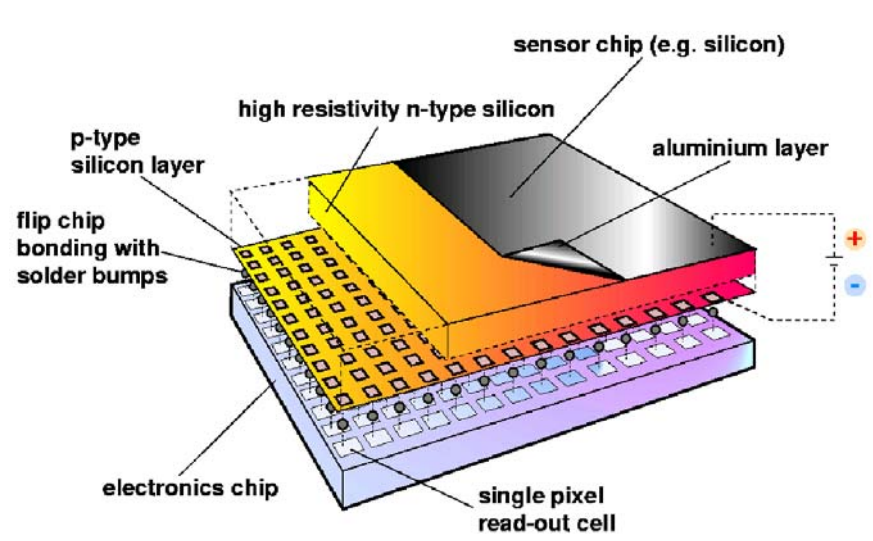
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HYBRID PIXEL DETECTORS

PERFECT APPROACH for SPECIFIC RESPONSES at LOW RATE

VARIOUS DOSIMETER APPLICATIONS at HORIZON



ORIGINALLY:
SYNCHROTRON LIGHT IMAGING
MEDICAL IMAGING



MEDIPIX2 CHIP PHOTO



256 x 256 pixels
~33M transistors/chip

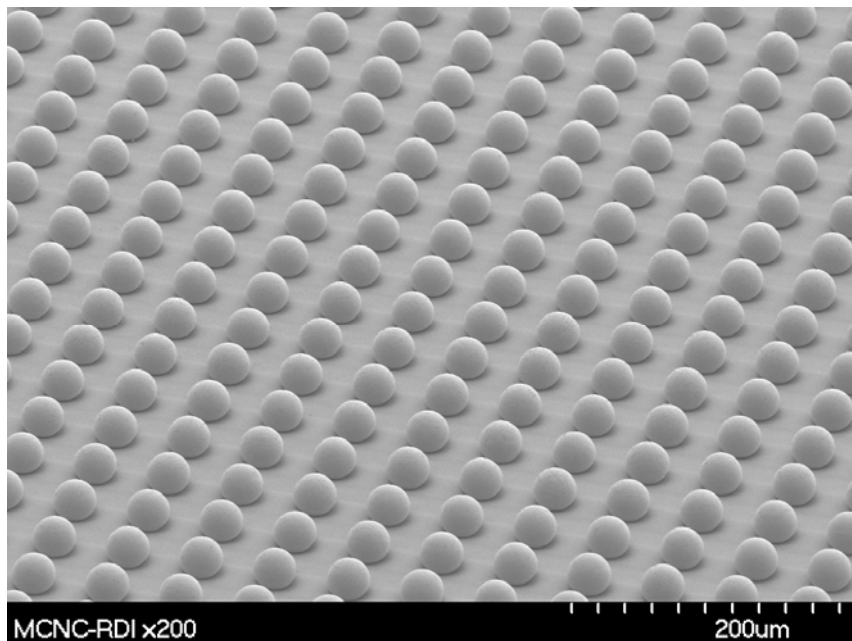
Total active area ~2 cm²
3-side buttable

POWER static 500 mW
+ 100 mW digital

CHIP DESIGN at CERN
Xavier LLOPART, Michael CAMPBELL



BUMP BONDING Medipix2



0.25 μm CMOS CHIP
CERN 2001
CAMPBELL & LLOPART
256 COLUMNS x 256 ROWS
pixel 55 μm x 55 μm

**BUMP DEPOSITION
& SEM PHOTOS
COURTESY MCNC-RDI DURHAM NC**

PITCH 55 μm

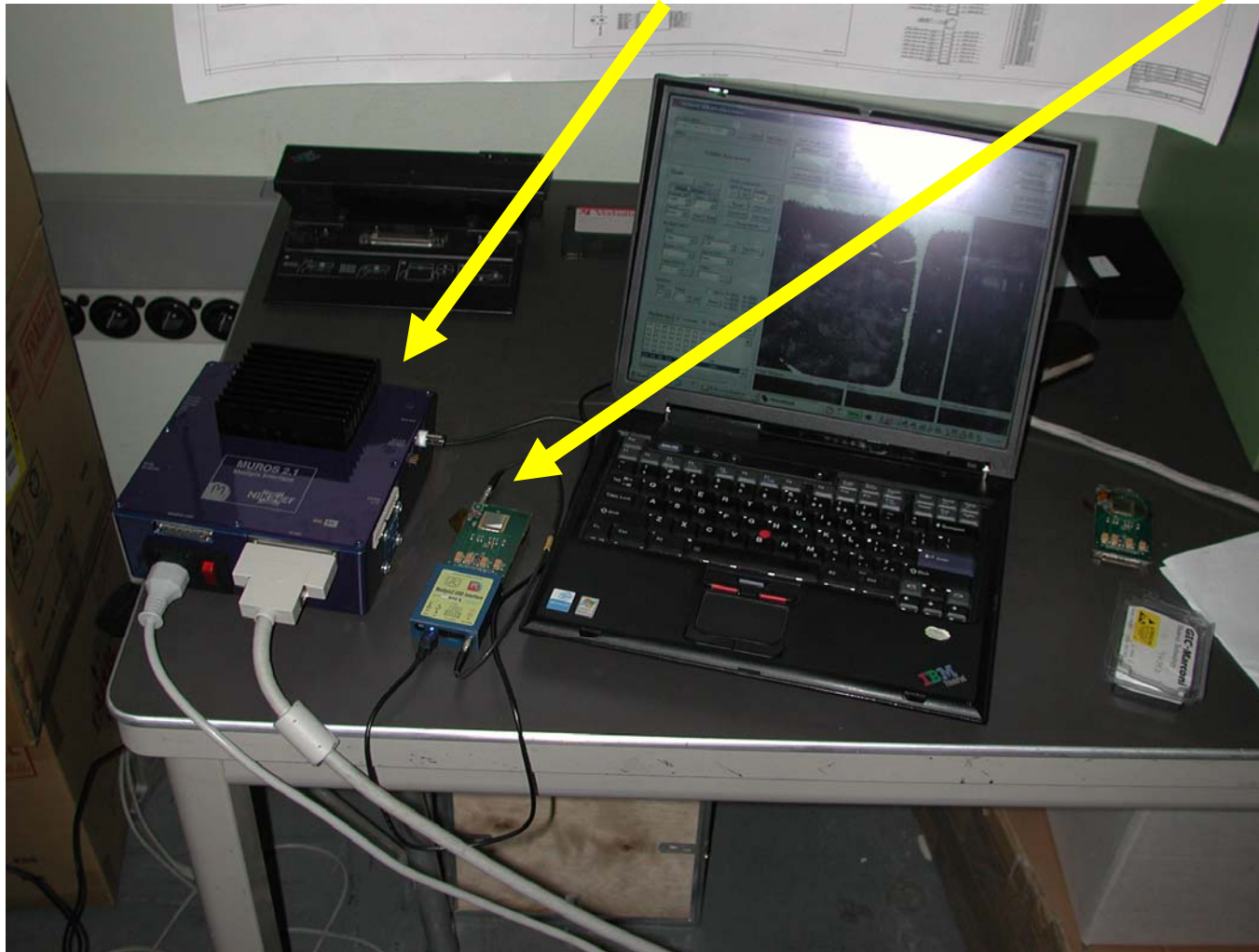
**HIGH RESISTIVITY
Si SENSOR MATRIX
CANBERRA SEMICONDUCTOR**



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MEDIPIX2 MUROS2 NIKHEF vs USB PRAGUE



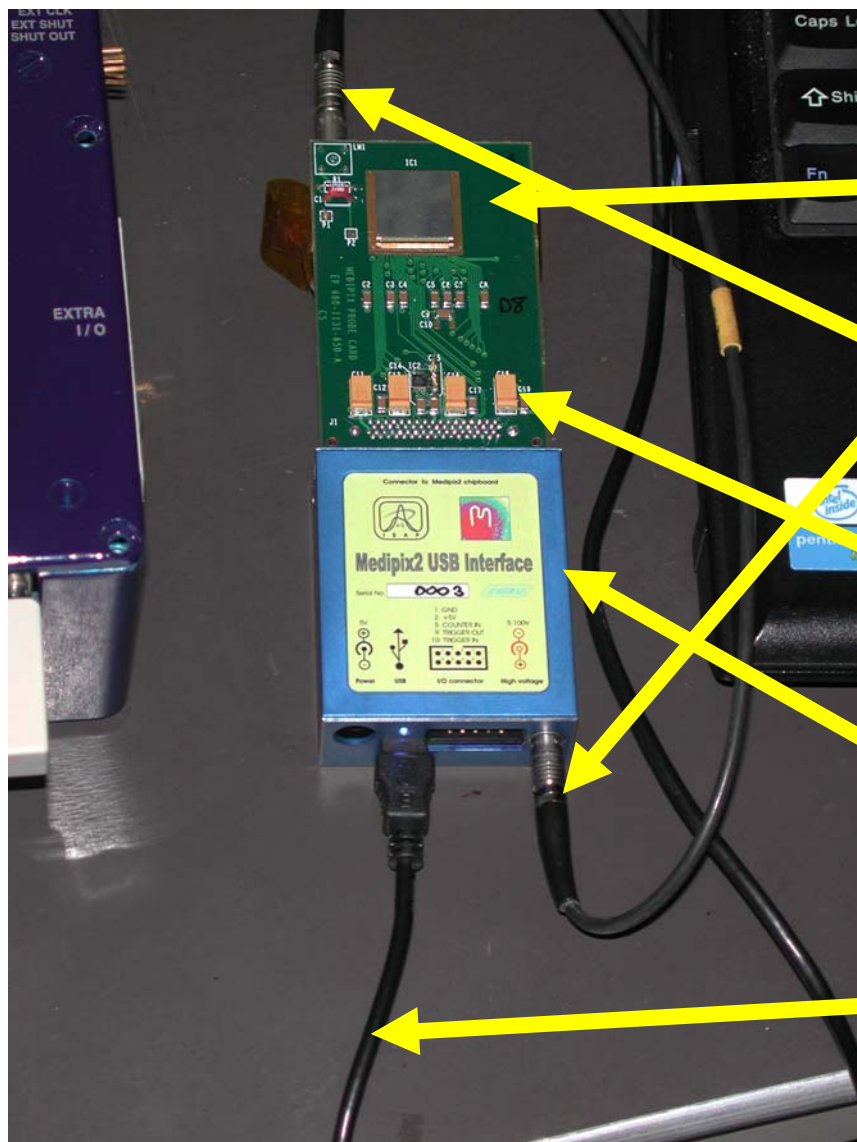
MUROS2 also needs
+ SENSOR BIAS
+ Nat Instr DAQ CARD
in PC

REDUCTION in
SIZE
CABLES
POWER

CAPABILITY in SPEED
not yet equal



MEDIPIX2 USB CLOSE-UP PRAGUE-CERN



BUMP-BONDED SENSOR (300 um)+ R/O

**BIAS VOLTAGE up to 100V
Generated in the USB**

**FILTERING FAR TOO BIG NOW
USE SMALLER CARD & COMPONENTS**

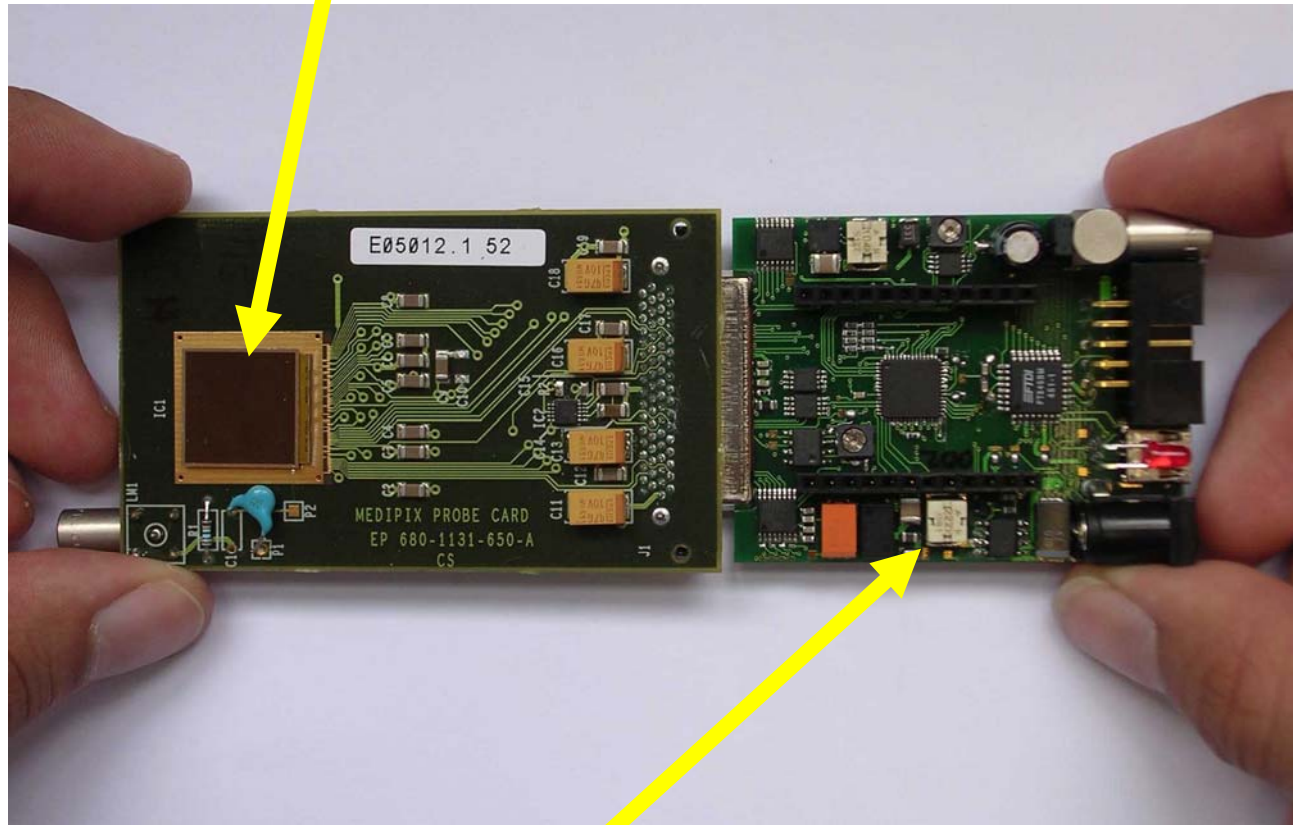
**COMPLETE USB PROCESSOR
in NICE BOX, serial 0003**

STANDARD USB CABLE to NOTEBOOK



MEDIPIX2 USB OPEN PRAGUE

BUMP-BONDED SENSOR (300 um)+ R/O



COMPLETE USB PROCESSOR
NO BOX



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MEDIPIX2 PARTNERS

- U INFN Cagliari
- CEA-LIST Saclay
- CERN Genève
- U d'Auvergne Clermont
- U Erlangen
- ESRF Grenoble
- U Freiburg
- U Glasgow
- IFAE Barcelona
- Mitthoegskolan
- MRC-LMB Cambridge
- U INFN Napoli
- NIKHEF Amsterdam
- U INFN Pisa
- FZU CAS Prague
- IEAP CTU in Prague
- SSL Berkeley



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<http://medipix.web.cern.ch/MEDIPIX/>

SPOKESMAN Michael CAMPBELL
Deputy Jan VISSCHERS

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INTEGRATION of LOCAL PROCESSING



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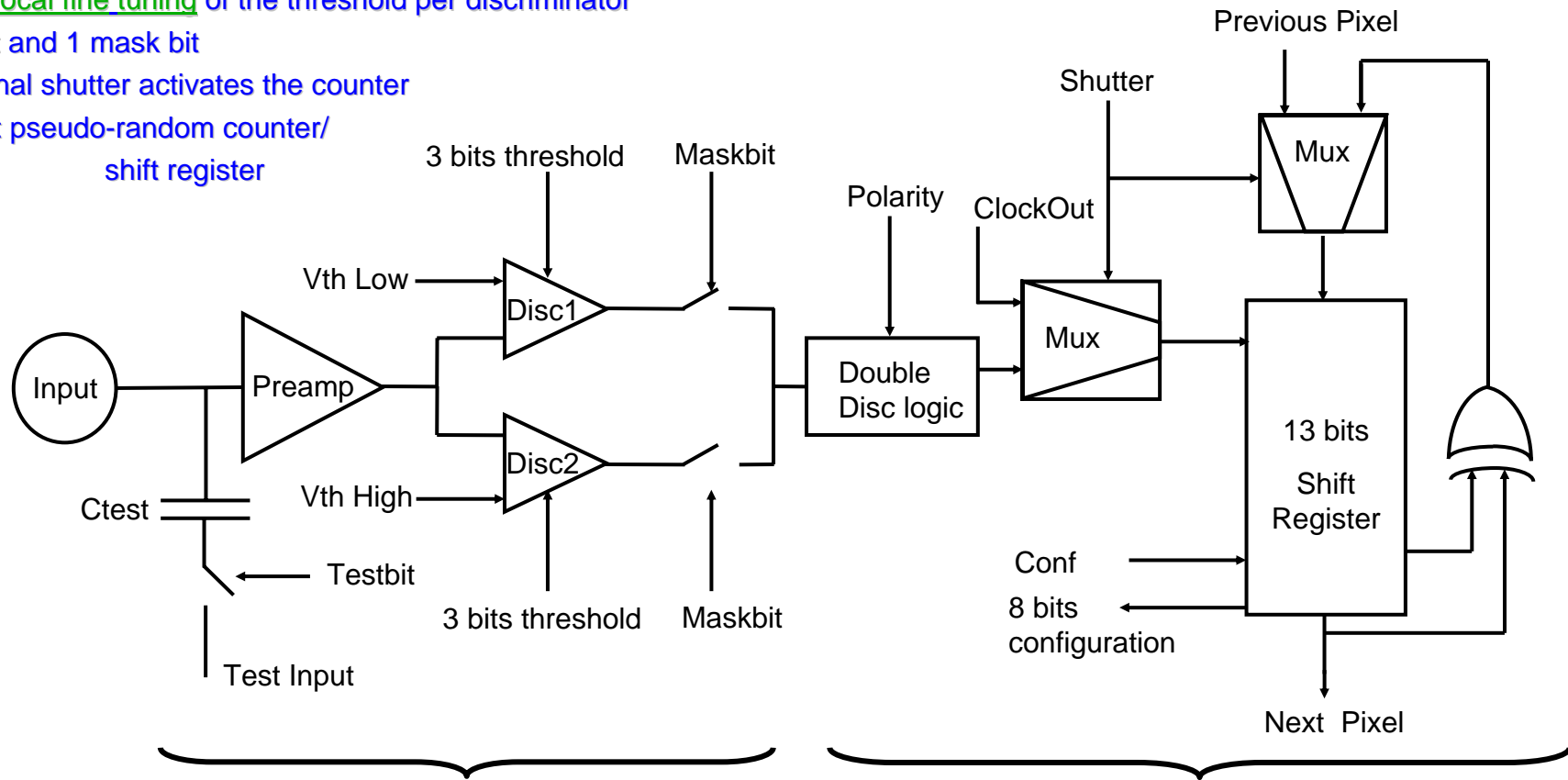
INTEGRATION of LOCAL PROCESSING

MEDIPIX EXAMPLE : LOGIC +COUNTER



MEDIPIX2 PIXEL BLOCK DIAGRAM

- accepts positive and negative input → different detector materials
- charge sensitive preamplifier with individual leakage current compensation
- 2 discriminators with globally adjustable threshold
- 3-bit local fine tuning of the threshold per discriminator
- 1 test and 1 mask bit
- external shutter activates the counter
- 13-bit pseudo-random counter/
shift register



Analog

Digital



Medipix2 PIXEL CELL LAYOUT

CMOS technology $0.25\mu\text{m}$

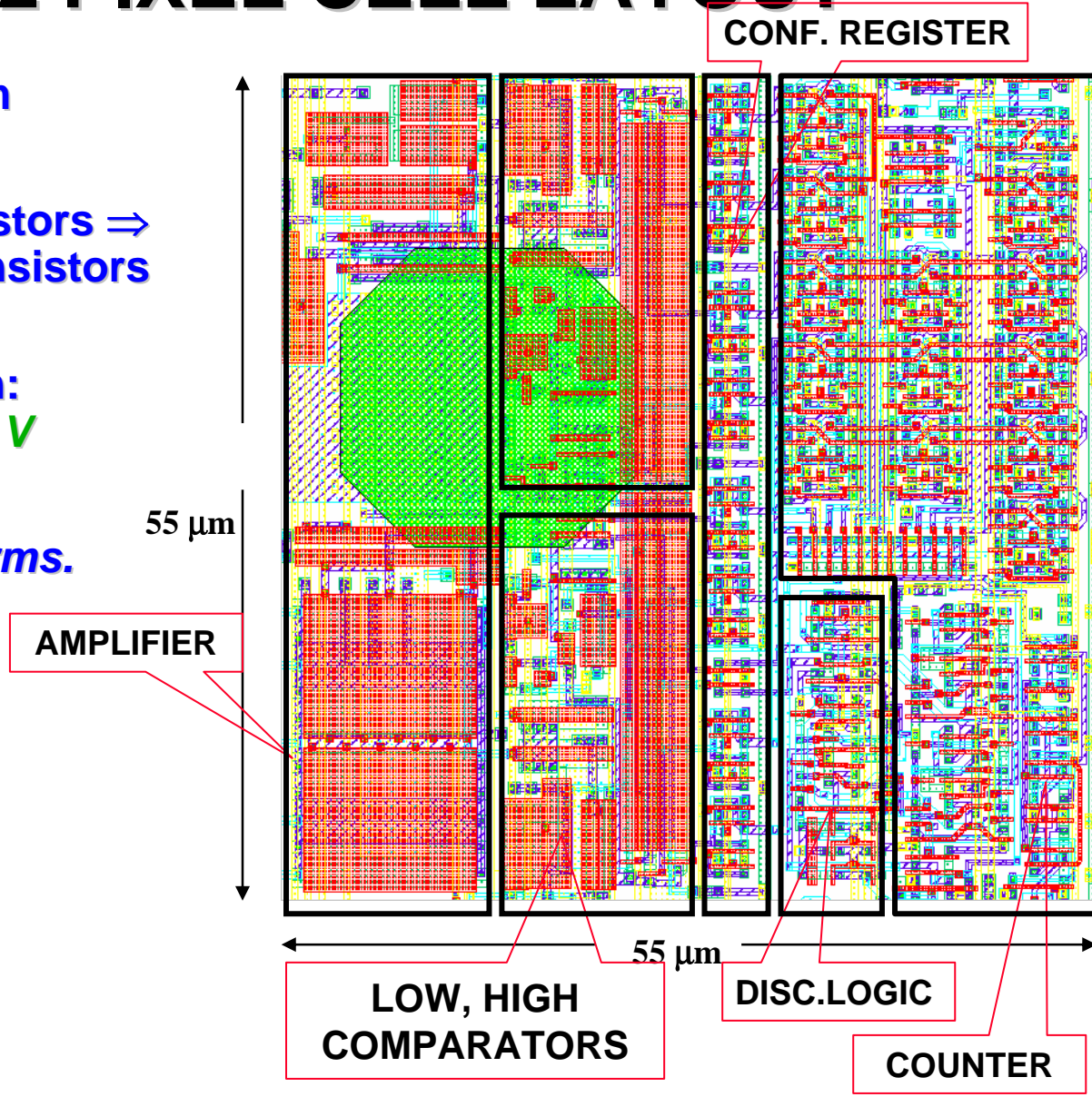
6 metal layers

pixel cell has ~ 500 transistors \Rightarrow
chip ~ 33 million transistors

Static power consumption:
 $\sim 8\mu\text{W}/\text{channel}$ @ 2.2 V

Amplifier Gain: $\sim 11\ \mu\text{V}/e^-$

Electronic Noise: $\sim 100\ e^- \text{ rms.}$



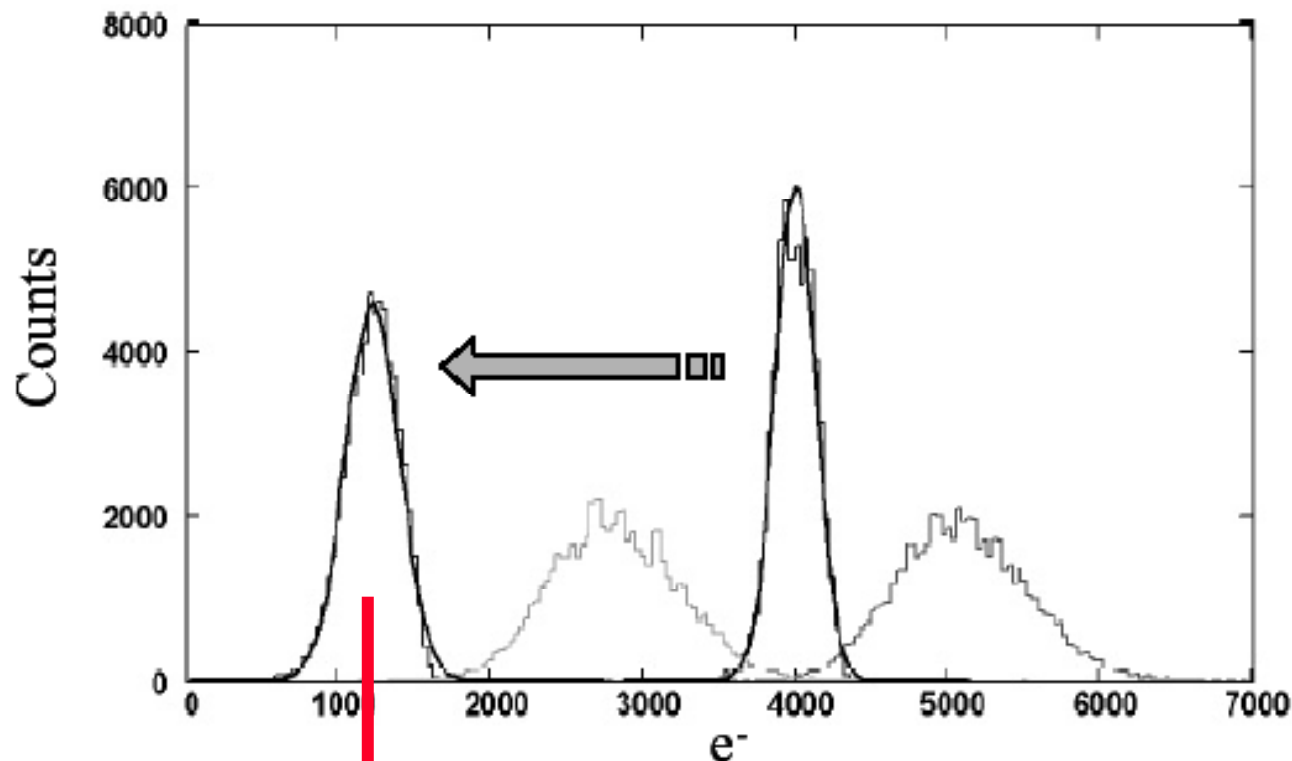
DEMO MEDIPIX2

'ELECTRONIC EMULSION'

PORTABLE 'SPARK/BUBBLE' CHAMBER



LOW SIGNALS CAN BE EMPLOYED



MEDIPIX2
SMALL PIXEL CELL
55 μ m x 55 μ m

LOW NOISE
LOW THRESHOLD
BINARY DETECTION

THIN DETECTOR
LOW RESISTIVITY :
AT ROOM TEMP
LESS DAMAGE

TRIMMED THRESHOLD can be MOVED to ~LOWEST VALUE

1100 e⁻ or 4 keV in Si

GENERATED by M.I.P. in ~25 μ m Si



INSPIRATION for FUTURE DETECTORS

**MICROELECTRONICS TECHNOLOGIES for
COMMUNICATION**

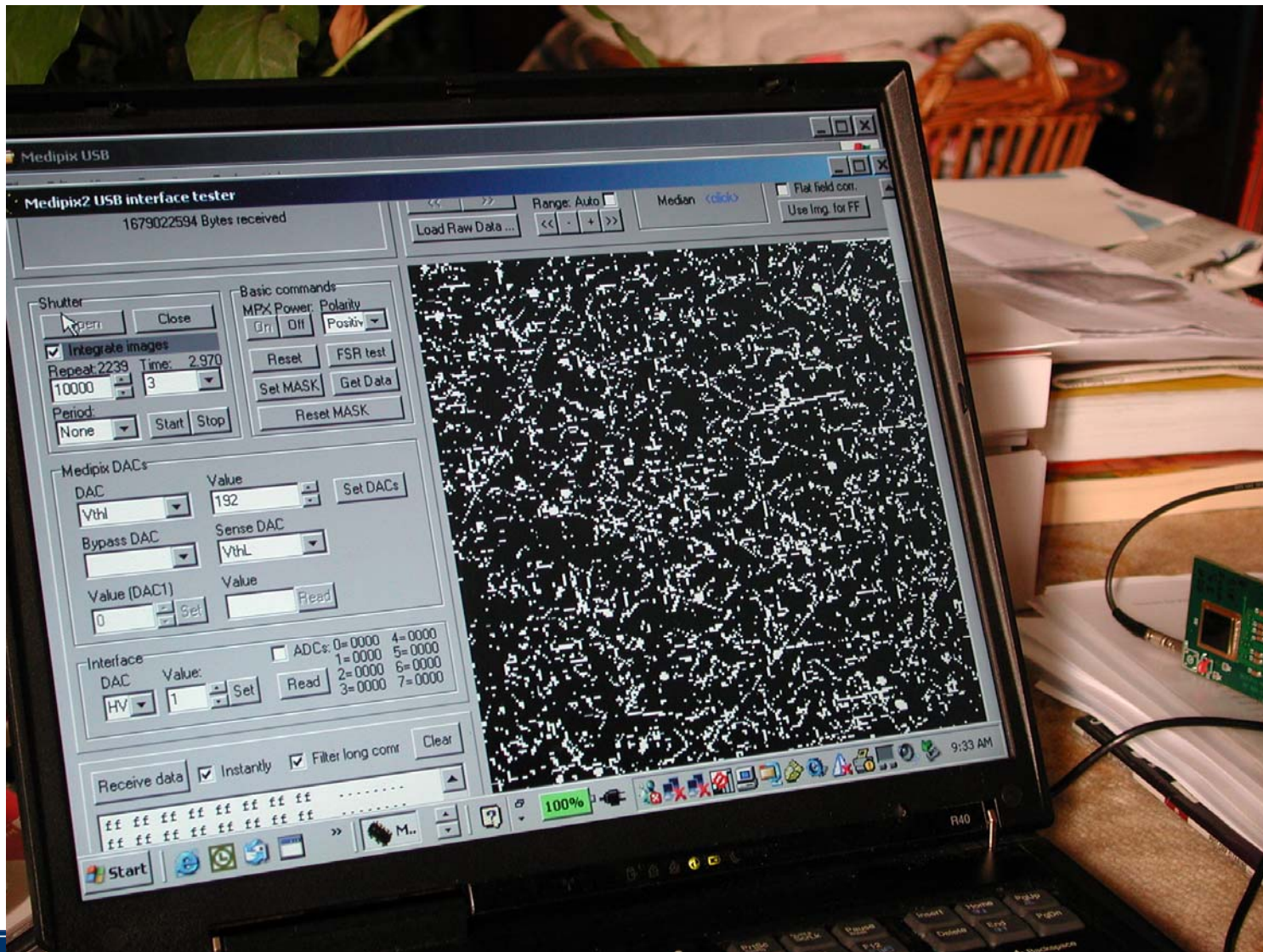
USE THESE also for NEW PHYSICS



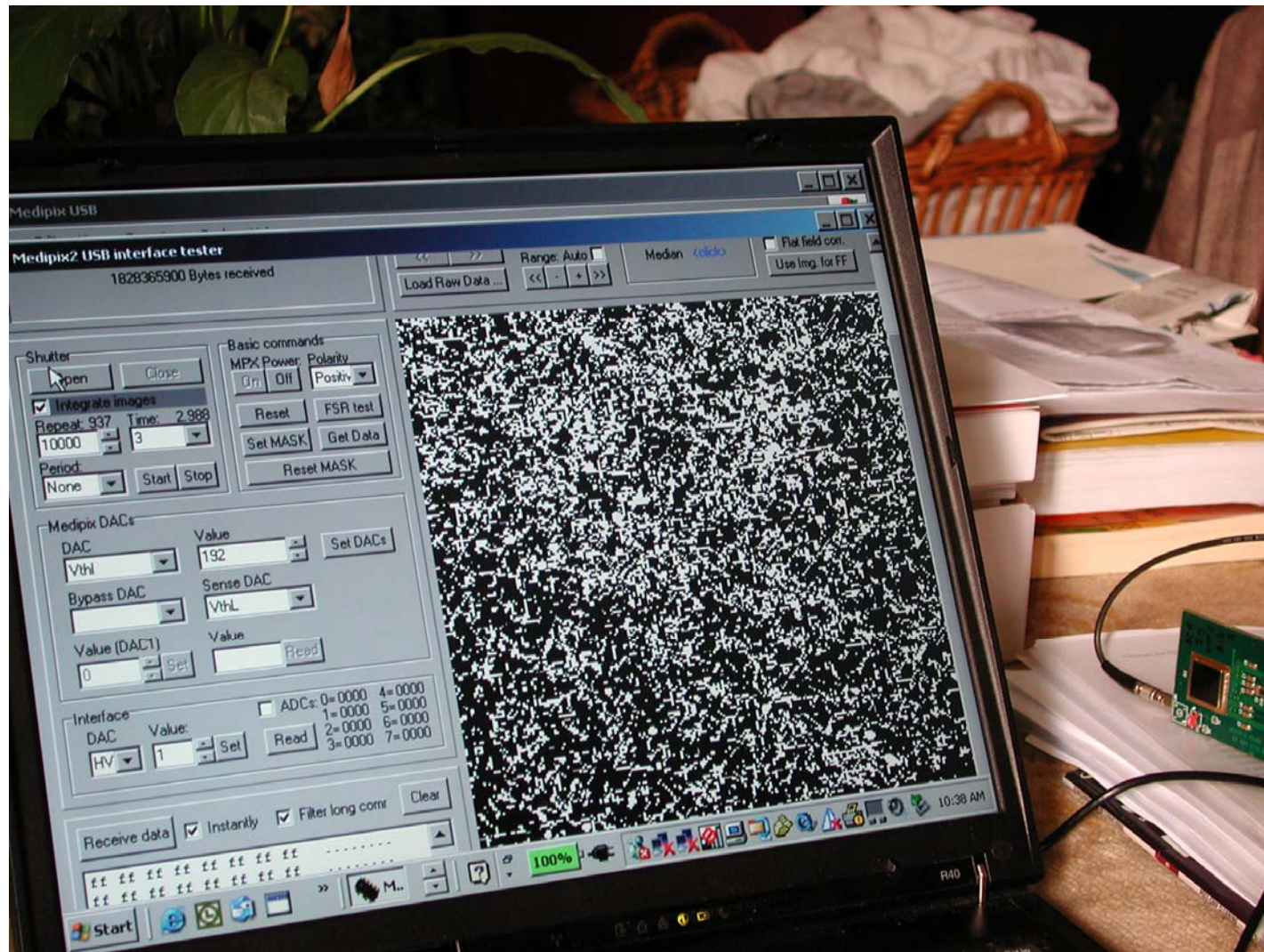
BETTER DETECTION of **GOOD TRACKS**
IDENTIFY BEAUTY also inside **JETS**
IMPROVE SELECTIVITY at **HIGH RATES**
super **LHC** or **FURTHER**
TRACK VECTOR at **$\sim 100\text{ns}$** timescale



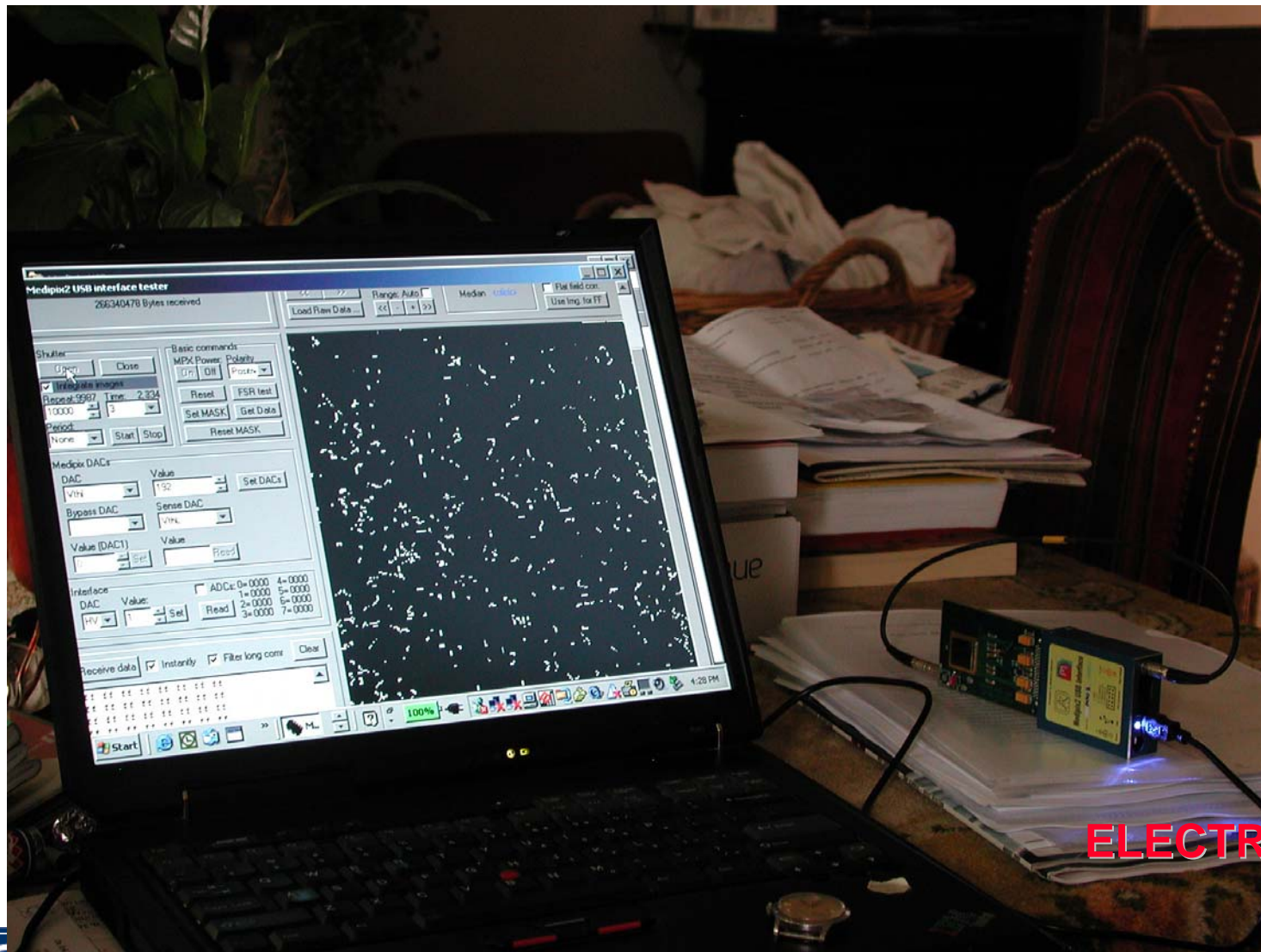
MEDIPIX2-USB COSMICS



MEDIPIX2-USB + BACKGROUND



DISPLAY MEDIPIX2-USB



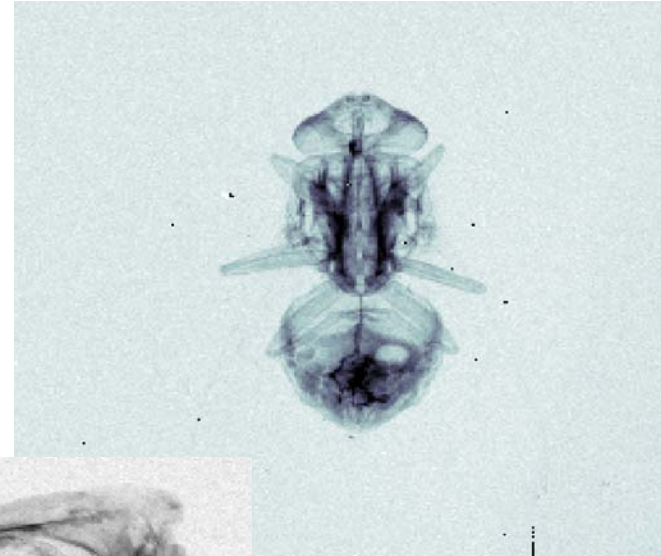
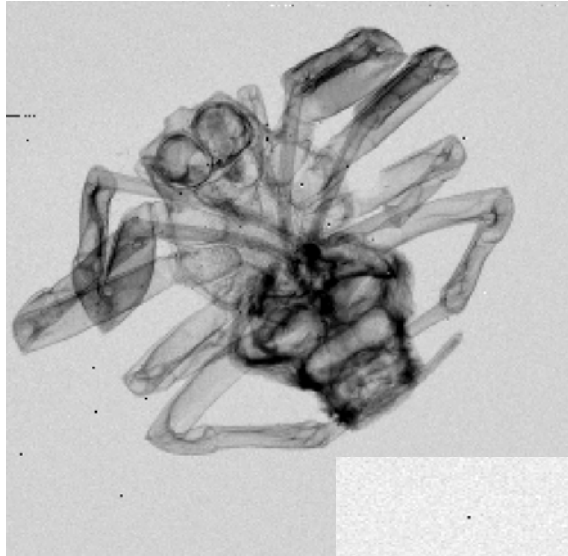
ELECTRON TRACKS



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SOME IMAGES MEDIPIX



**THRESHOLD EQUALIZATION
FLAT-FIELD CORRECTIONS
APPLIED**

Lukas Tlustos, CERN



Narrow threshold
distribution and
± narrow spectra
8-14kV, 15-35kV
125µm Al FOIL
5mm PMMA



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