ECFA/DESY Study on Physics and Detectors
for a Linear Electron-Positron collider
7th Workshop
DESY, Hamburg, September 22 - 25, 2000

Monolitic Active Pixel Sensor
testbeam studies
(preliminary results)

Yu.Gornushkin

(on behalf of IReS - LEPSI collaboration, Strasbourg)

To study the performance of MAPS detector with m.i.p.s

MIMOSA I and II prototypes have been tested at CERN SPS 150 GeV π beam (June, August 2000)

Objectives:

- Signal/Noise
- Efficiency
- Resolution

measurement for different configurations and options of MAPS

MIMOSA I: 0.6 μm CMOS, $\approx$ 15 μm epi-layer
4 matrixes: 64x64 pixels, 20x20 μm^2
(1 diode/pixel - 4 diodes/pixel options)

Testbeam setup:

8 planes of Silicon Strip Telescope
2x4 mm^2 trigger counter
($\approx$ 800 triggers/spill)

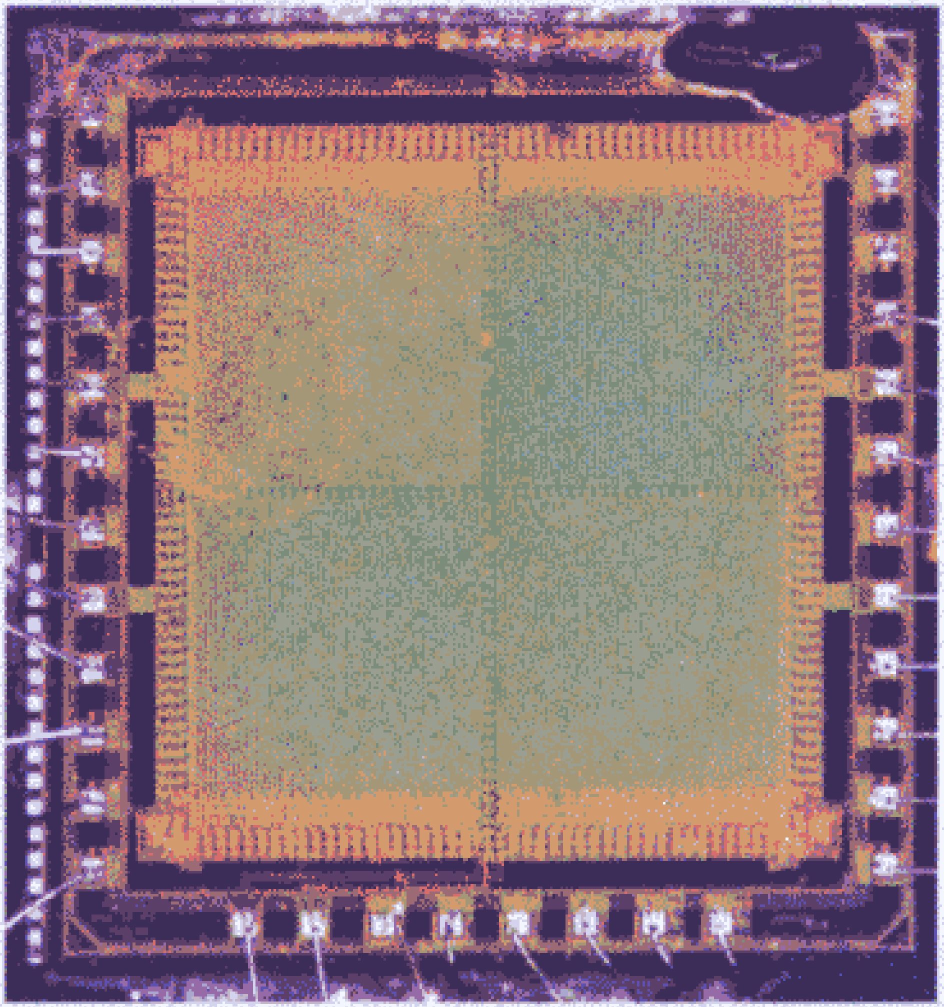
MIMOSA readout : serial analog
12 bit FADC, 2.5-10 MHz
8192 channels buffer->
Correlated Double Sampling
to suppress noise

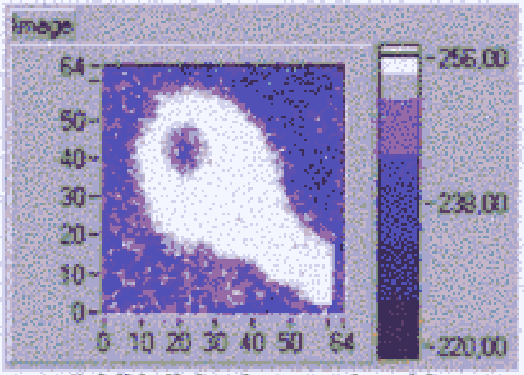
Grzegorz Deptuch
deptuch@lepsi.in2p3.fr

MIMOSA I (Minimum Ionising particle MOS Active pixel detector)

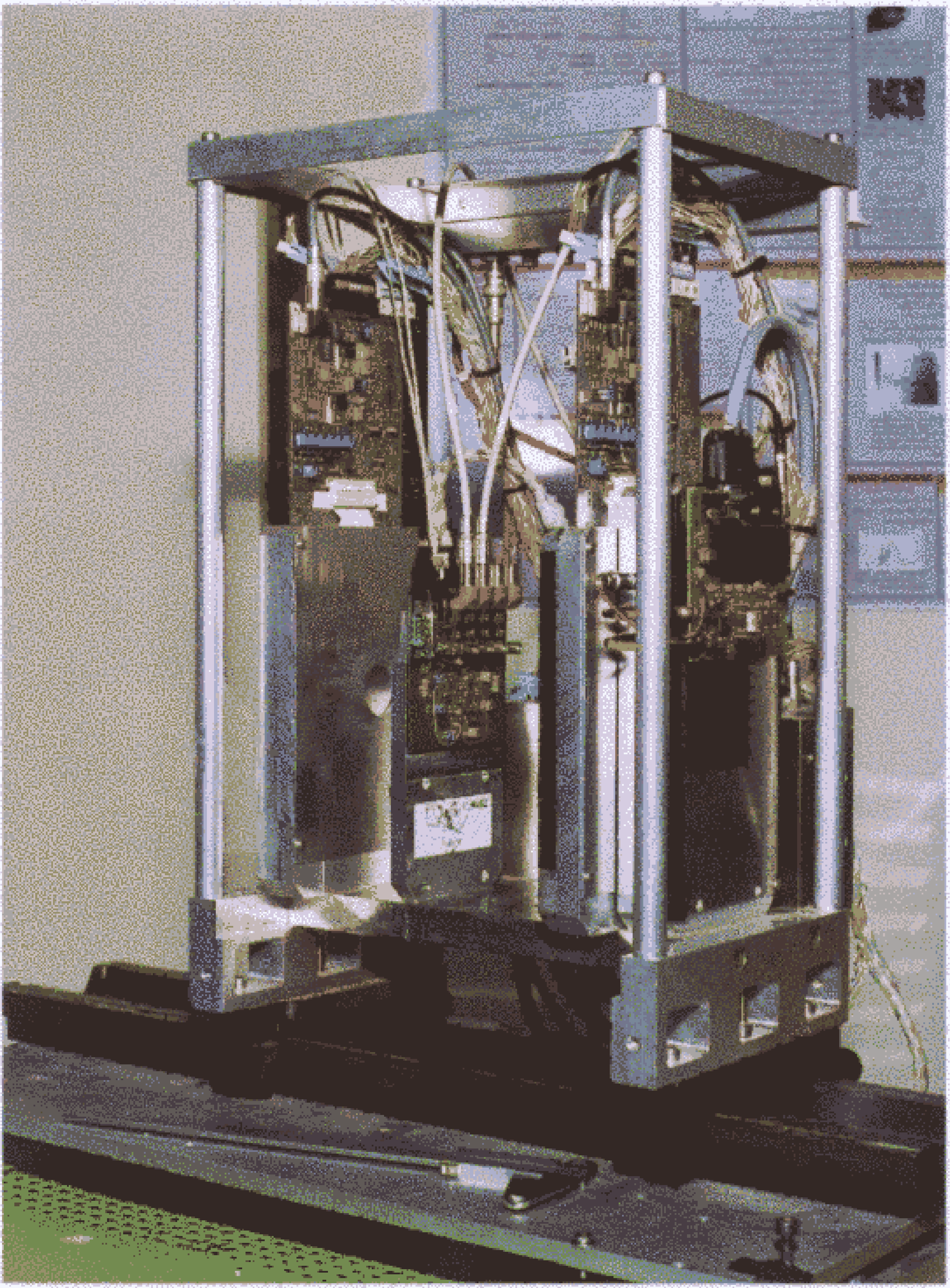
Goal of fabrication:

- feasibility study
- understanding/tests
  - standard 0.6μm CMOS *(tox=12.7nm)*
  - 14μm thick EPI layer *($10^{14}cm^{-3}$)*
  - 4 arrays 64x64 pixels
  - pixel pitch 20x20μm
  - diode *(nwell/pepi)* size 3x3μm - *3.1fF*
  - readout clock f<10MHz
  - readout - serial analog
  - die size 3.6x4.2mm²





"visible light photography with MIMOSA"



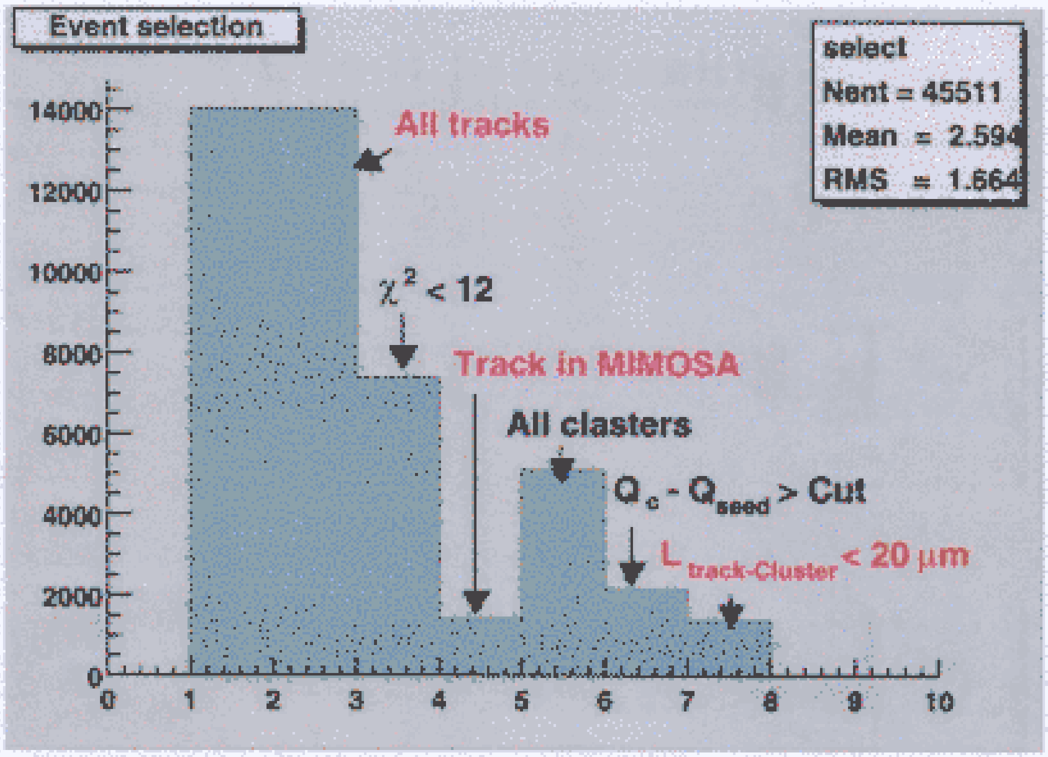
Event processing

* Track search in Silicon Telescope

*Cluster search in MIMOSA matrix

(Signal/Noise for the pixel > 5)

*Match Track position with found cluster

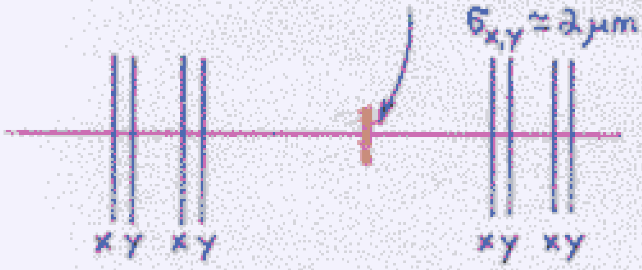


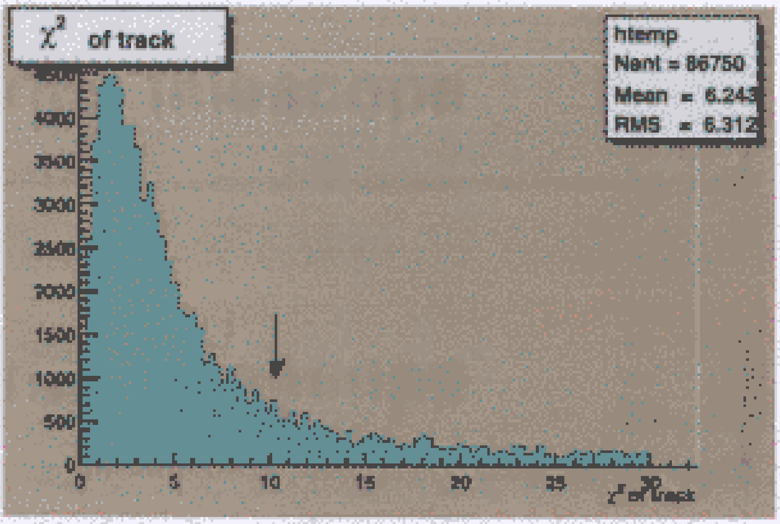
Silicon strips telescope

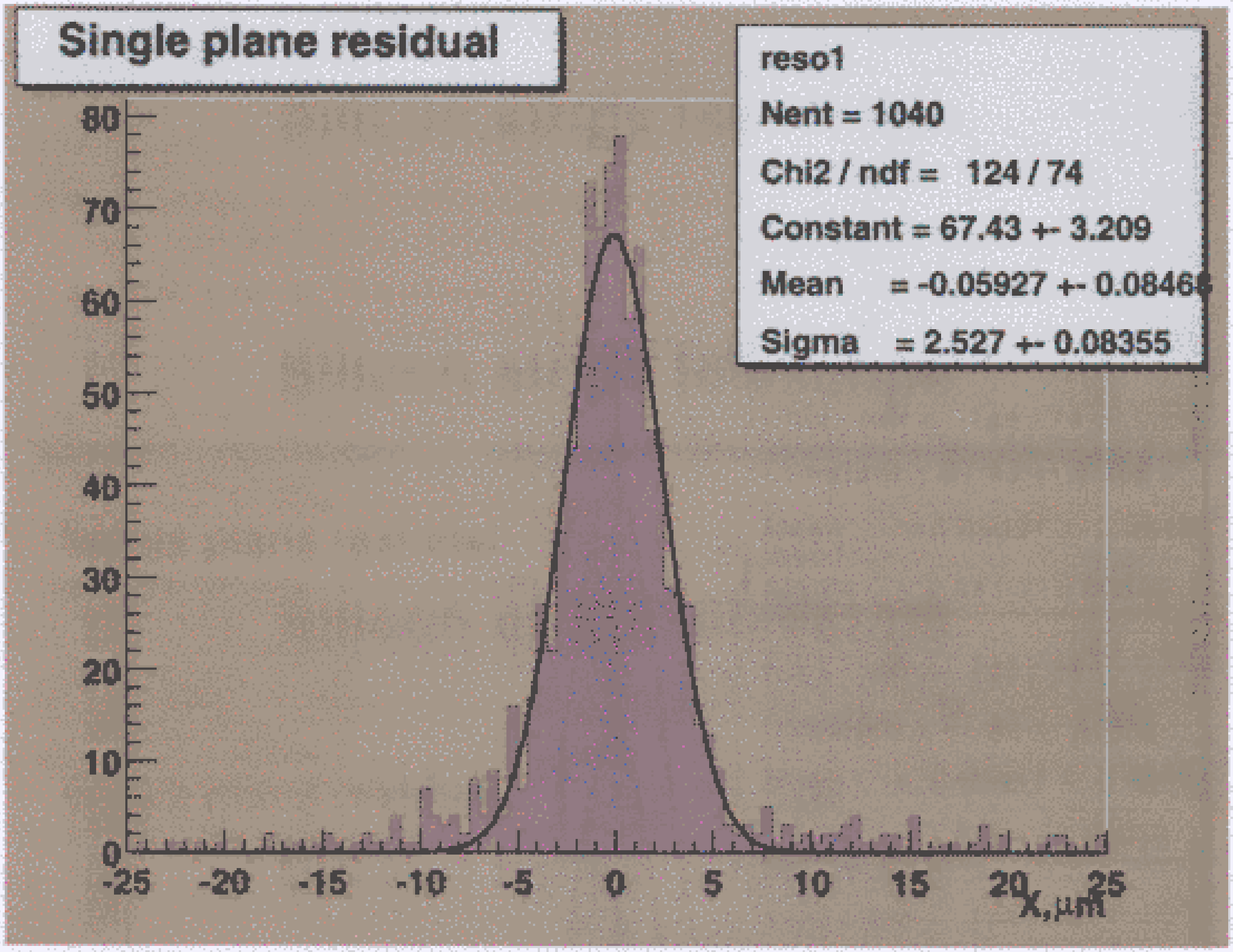
8 planes silicon telescope

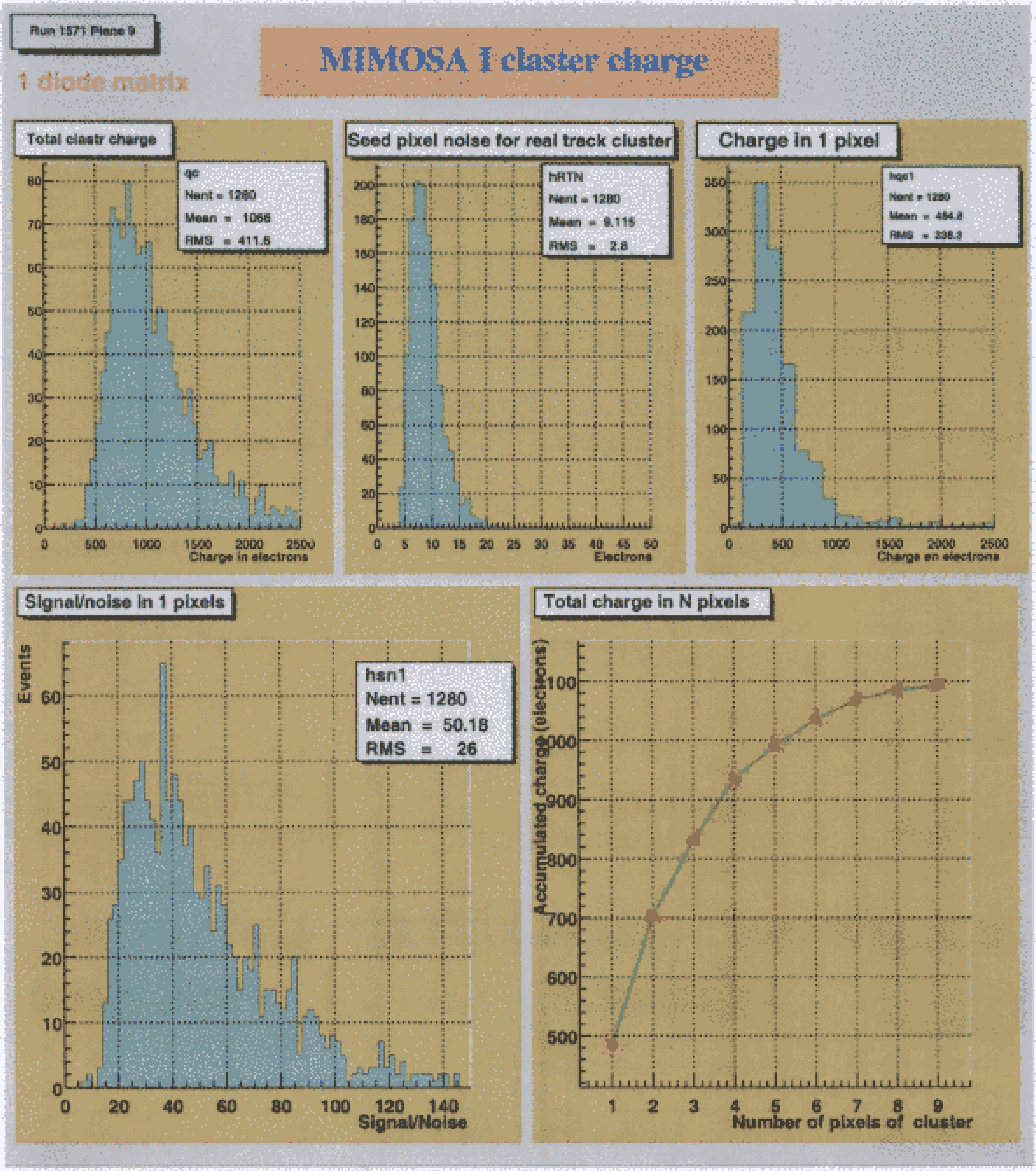
50 μm pitch

≤ 1 μm track position measurement



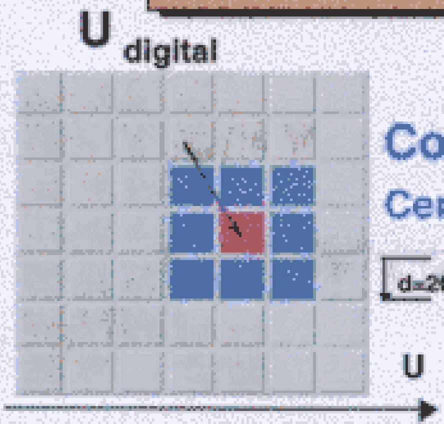






Run 1571 Plane 9
MIMOSA I claster charge
1 diode matrix
Total clastr charge
qc
Nent = 1280
Mean = 1066
RMS = 411.6
Charge in electrons
Seed pixel noise for real track cluster
hRTN
Nent = 1280
RMS = 2.8
Electrons
Charge in 1 pixel
Charge en electrons
Signal/noise in 1 pixels
Events
hsn1
Nent = 1280
Mean = 50.18
RMS = 26
Signal/Noise
Total charge in N pixels
Accumulated charge (electrons)
Number of pixels of cluster

MIMOSA I spatial resolution



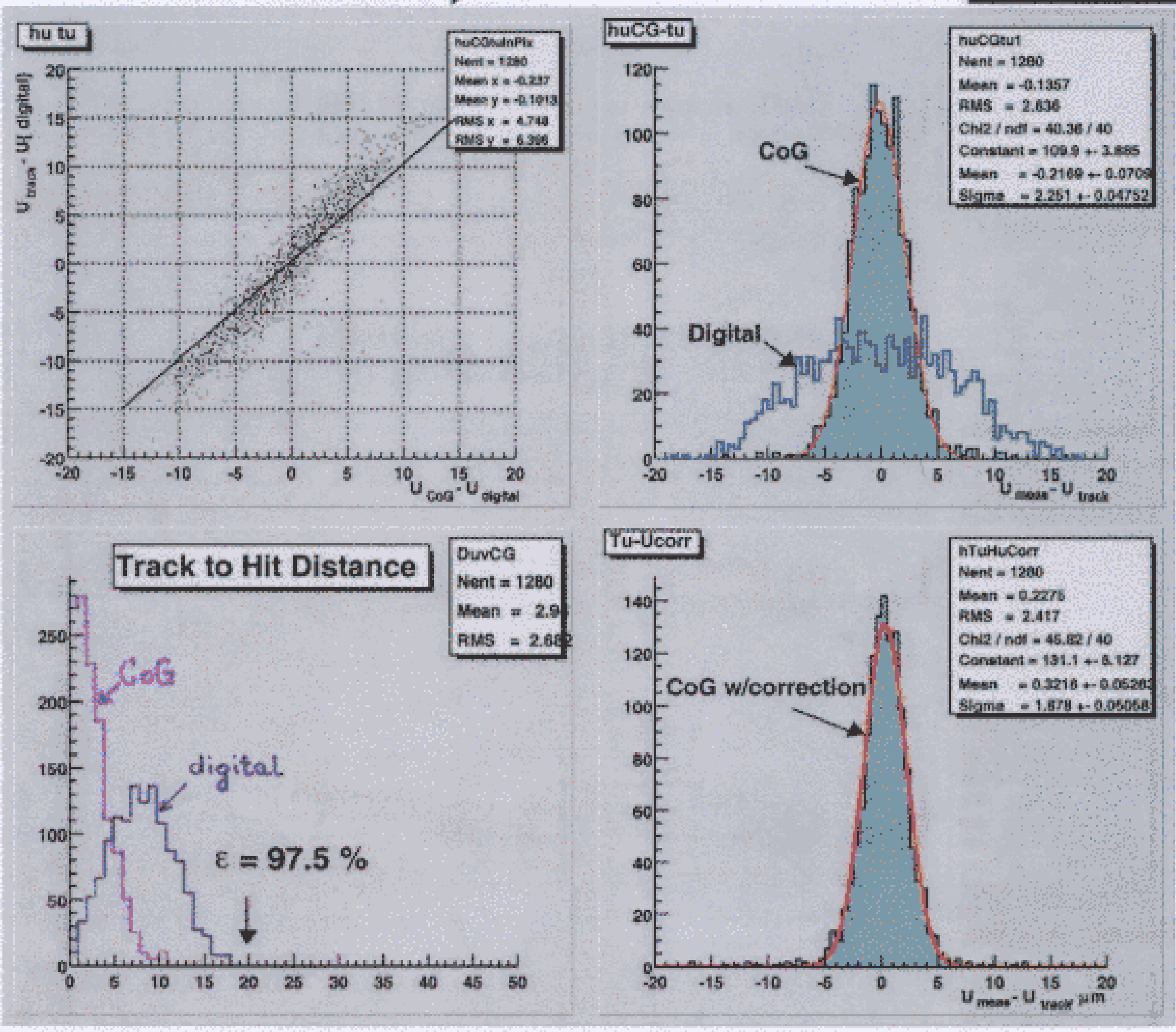
Coordinate calculation:

Center of Gravity of 3x3 claster with correction

$$U_{CoG} = U_{digital} + d \bullet \frac{q_0 - q_2}{\sum q_i}$$

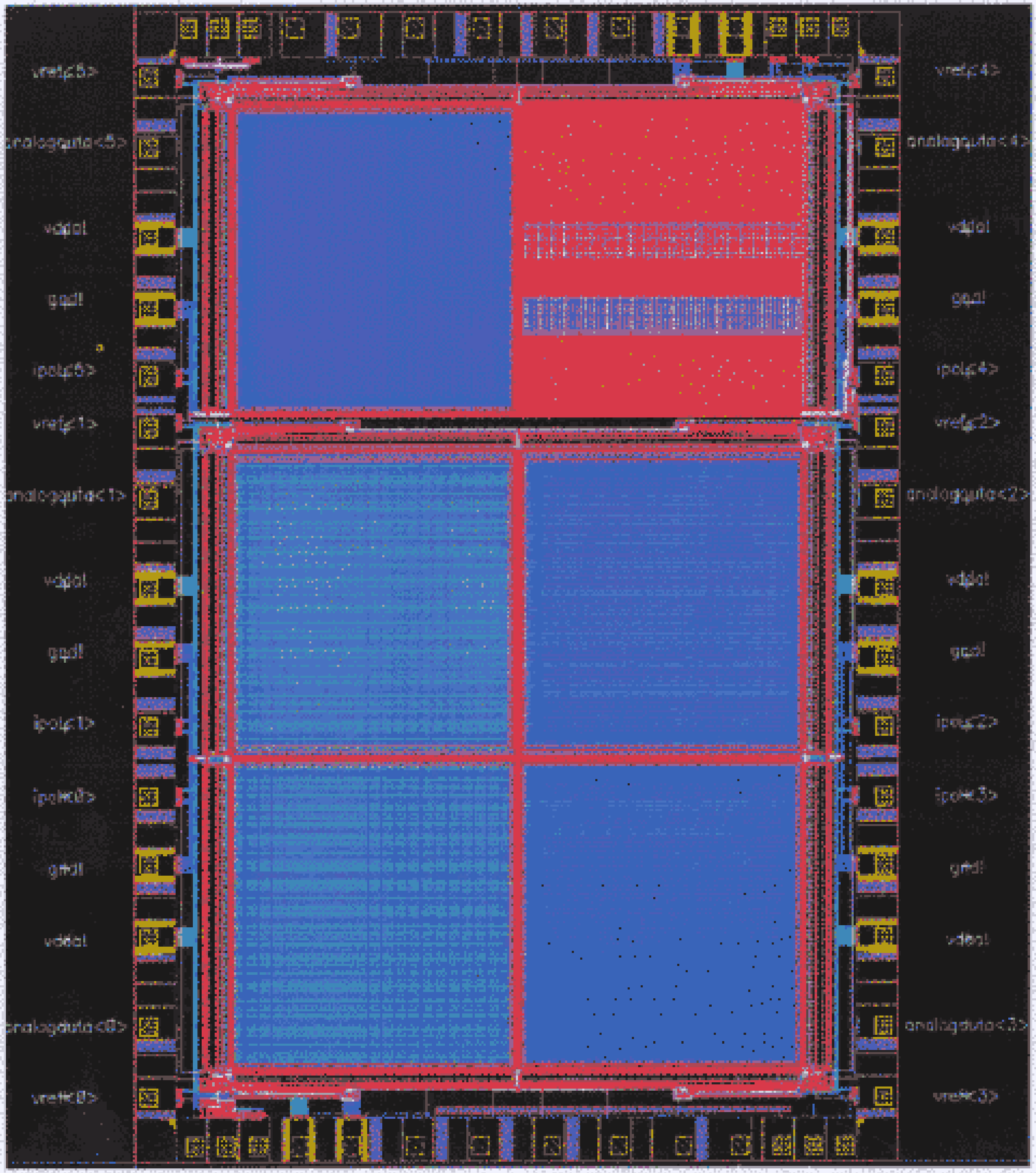
1 diode matrix

Run 1571 Plane 9

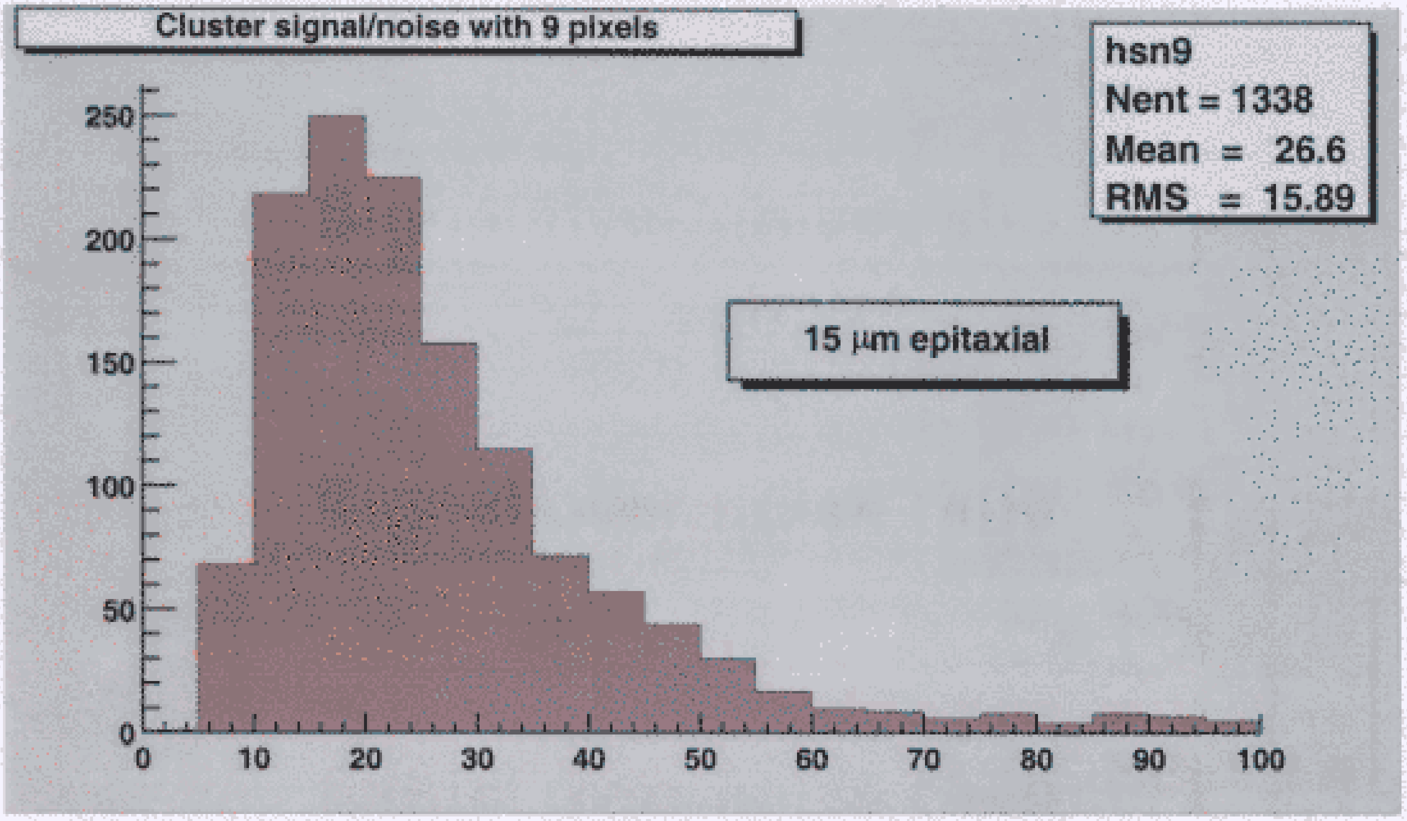


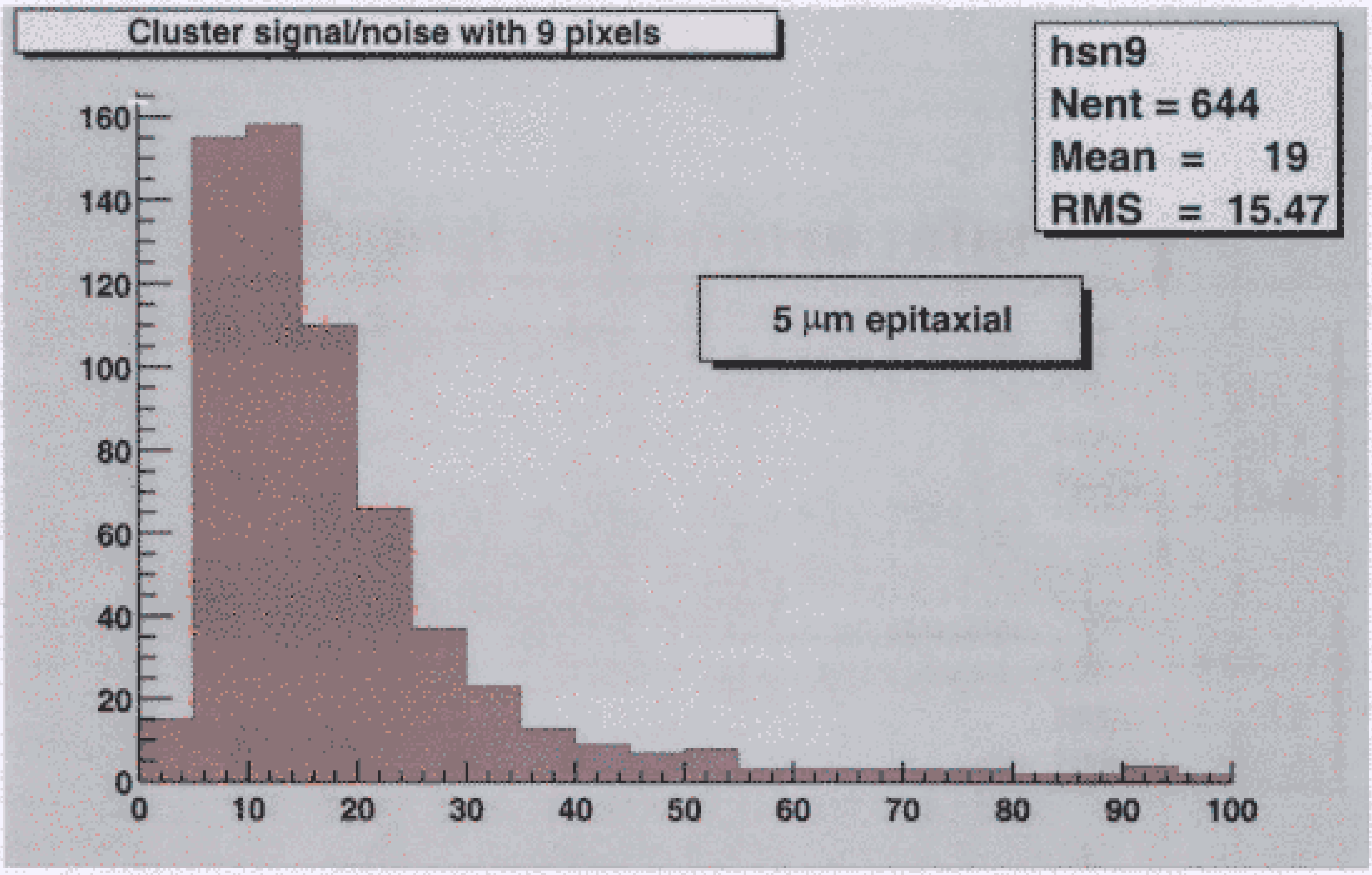
MIMOSA–2

- Techno 0.35 µm MIETEC
- Zone épitaxiale ~ 5 µm
- Résistance au rayonnment
- 6 matrices :
  1) Diodes s/ maillage carré
  2) Diodes s/ maillage hexagonal
  3) idem avec 2 diodes/pixel
  4) Reset « automatique » (faible bruit attendu)
  5) Design à la MIMOSA–1
  6) Diode remplacée par Photo–FET



Signal over noise ratio





SUMMARY and OUTLOOK

- MIMOSA I-II have been tested with a beam to study the performance

  $\langle S/N \rangle \geq 30$-$35$, $\varepsilon > 97.5\%$,

  $\sigma_{x,y} \leq 2 \div 3\ \mu m$

  MIMOSA II (0.35 μm technology: 5 μm epi-layer) works as well

- data taken for different design options:
  → design improvement(hexagonal geometry, 1-4 diodes/pixel, radiation hard design...)

Next steps:

- radiation hardness test(neutrons,protons...)
- magnetic field and low temperature test
- make a larger detector module (50 mm^2 → ...)
- go for an intelligent and fast sensor:
  - integrate decision electronics in each pixel
  - develop read-out electronics with ∅ suppression