Large dynamic range 64 channels ASIC for CZT or CdTe detectors

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Outline

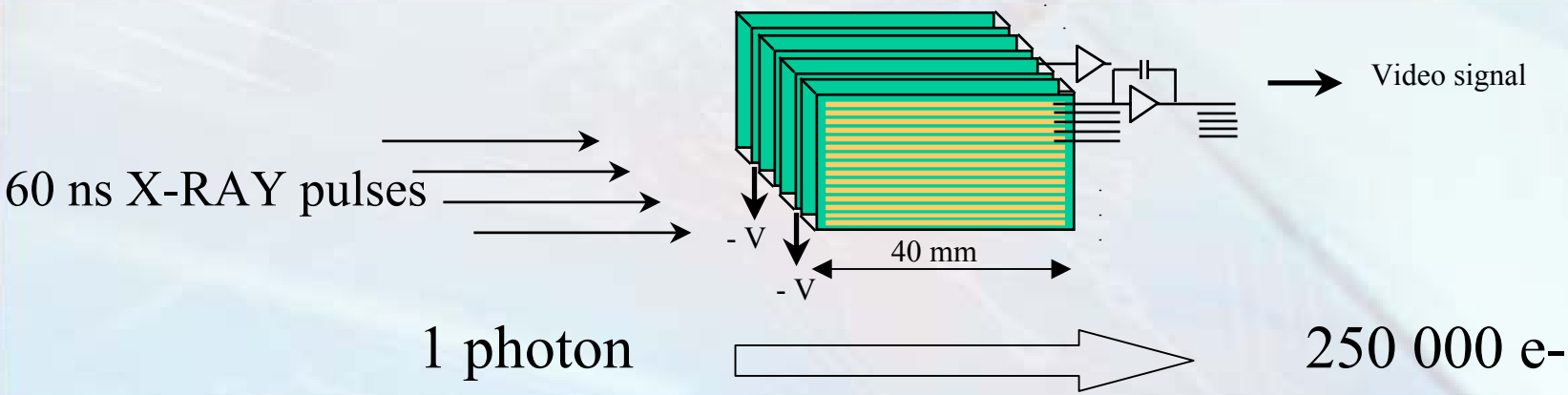
- The flash radiography detector specification
- CZT solution
- Specifications of Alix chip
- Alix architecture
- Performances
- Detector integration and tests
- Conclusion

Flash radiography detector specification

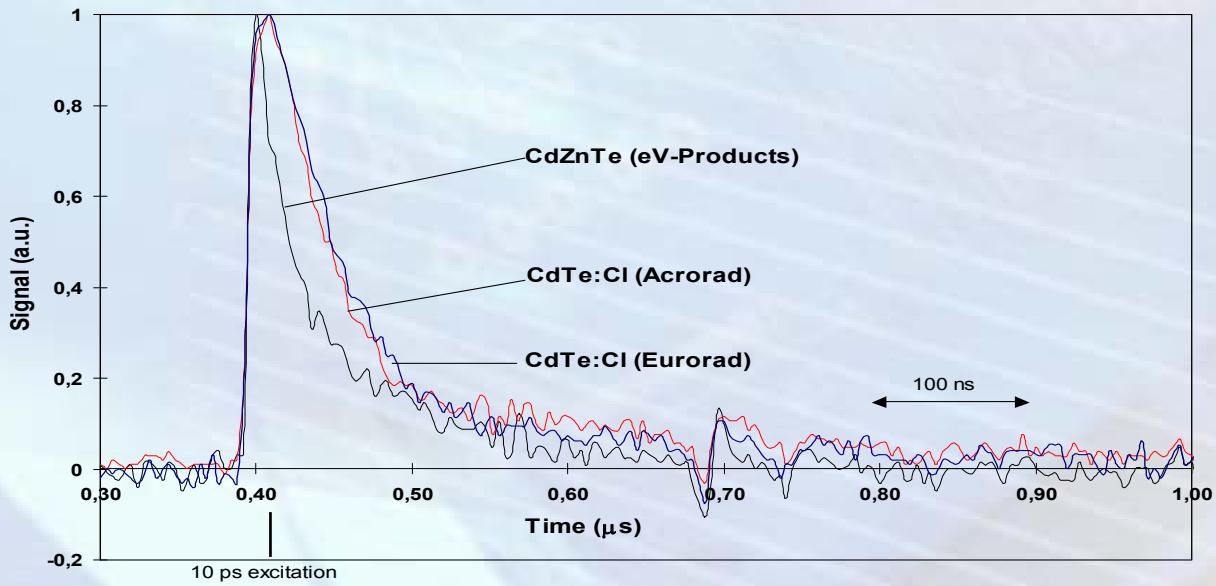
Goal of the study: radiography of dense and fast moving objects

- high energy : about 20 MeV
- a few short X-ray pulses of 60 ns duration
- large dynamic : $2.\ 10^4$
- detector stopping power better than 50 %

CZT solution



1 photon → 250 000 e-



ASIC justification

Why an ASIC ?

- reduced place : electronics behind the detector
- need of a large dynamic and fast acquisition

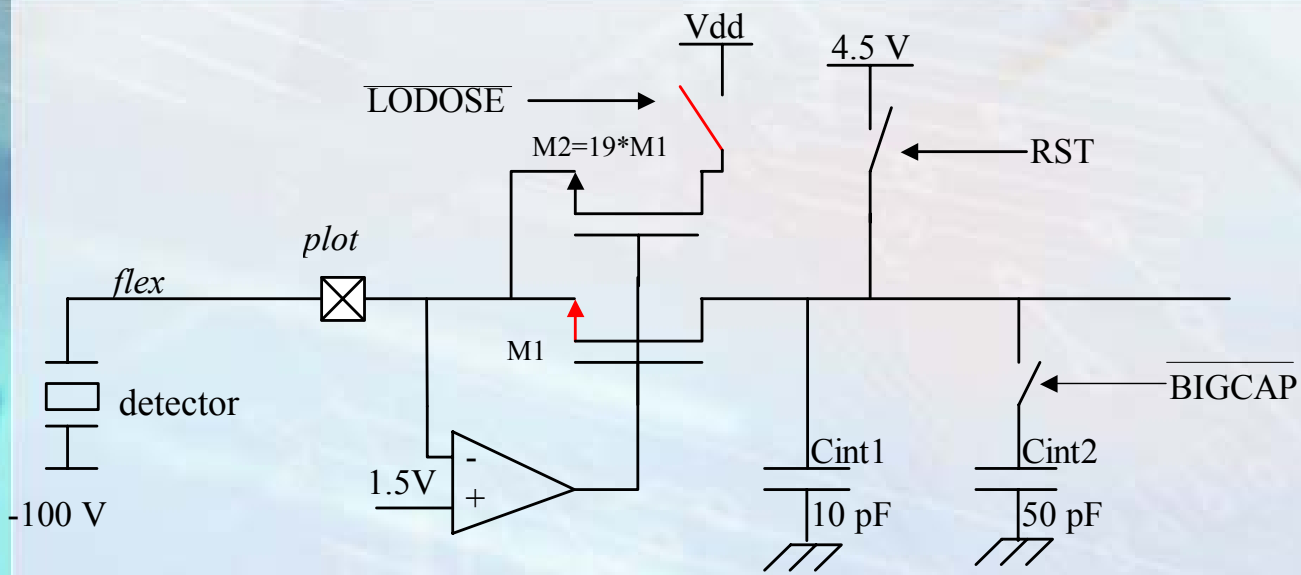
Why integration mode ?

- very high number of photons : maximum of about 1 000 photons per ns and per mm^2

Specification of ALIX chip

- 64 channels
- 8 pulses of 60ns every 250 ns
- External synchronisation
- Range : 5 nGray (150 fC)→100 µGray (3 nC)
- Output of the measurements in less than 700 µs
- Consumption <100 mW
- Dark current and afterglow correction

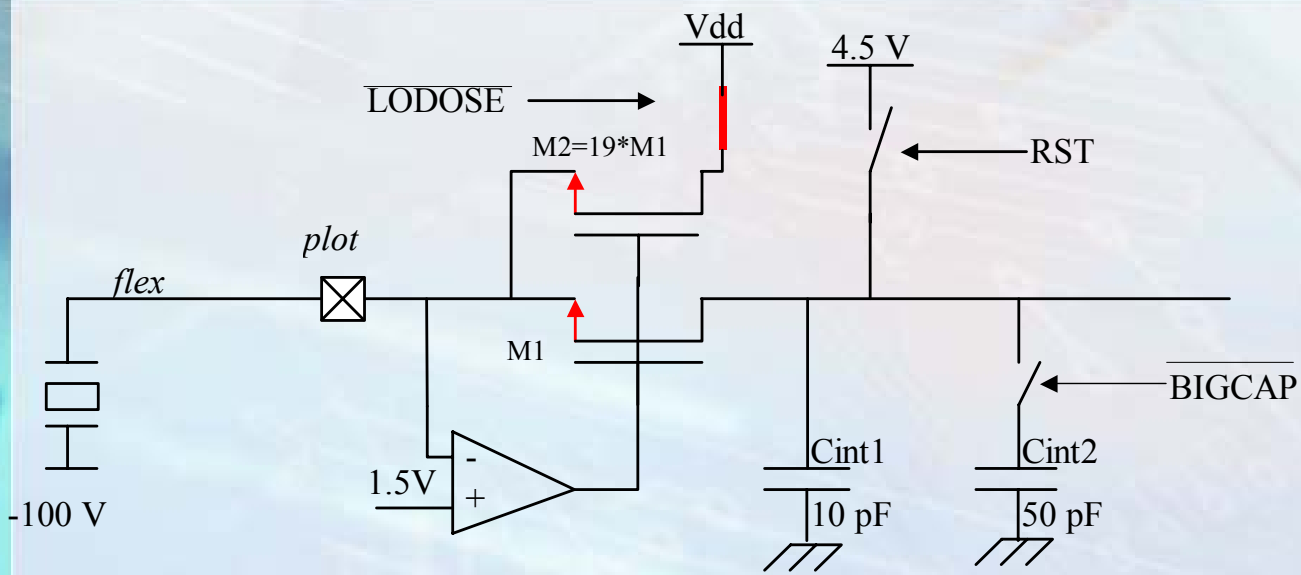
Charge integrator



Apparent capacitance (pF): 10, 60, 200, 1200

Corresponding maximum charge (pC): 25, 150, 500, 3000

Charge integrator

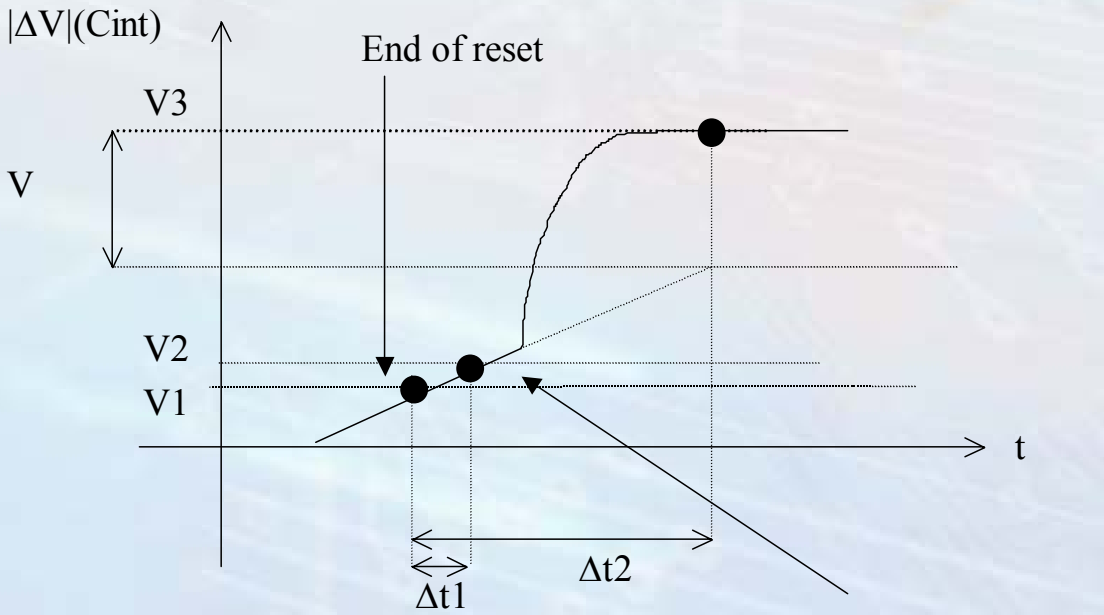


Apparent capacitance (pF): 10, 60, 200, 1200

Corresponding maximum charge (pC): 25, 150, 500, 3000

Afterglow correction

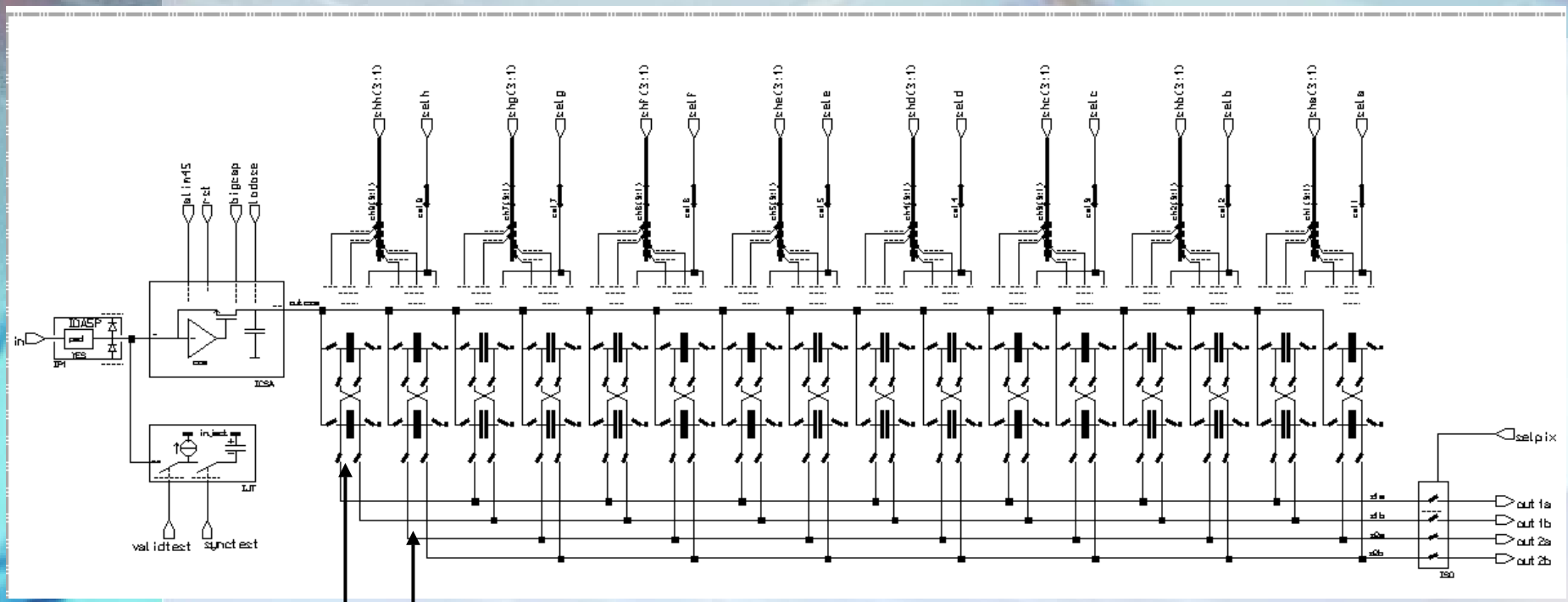
●= sample and hold



$$V = (V3-V1) - (\Delta t2/\Delta t1)(V2-V1)$$

VIDEO2 VIDEO1

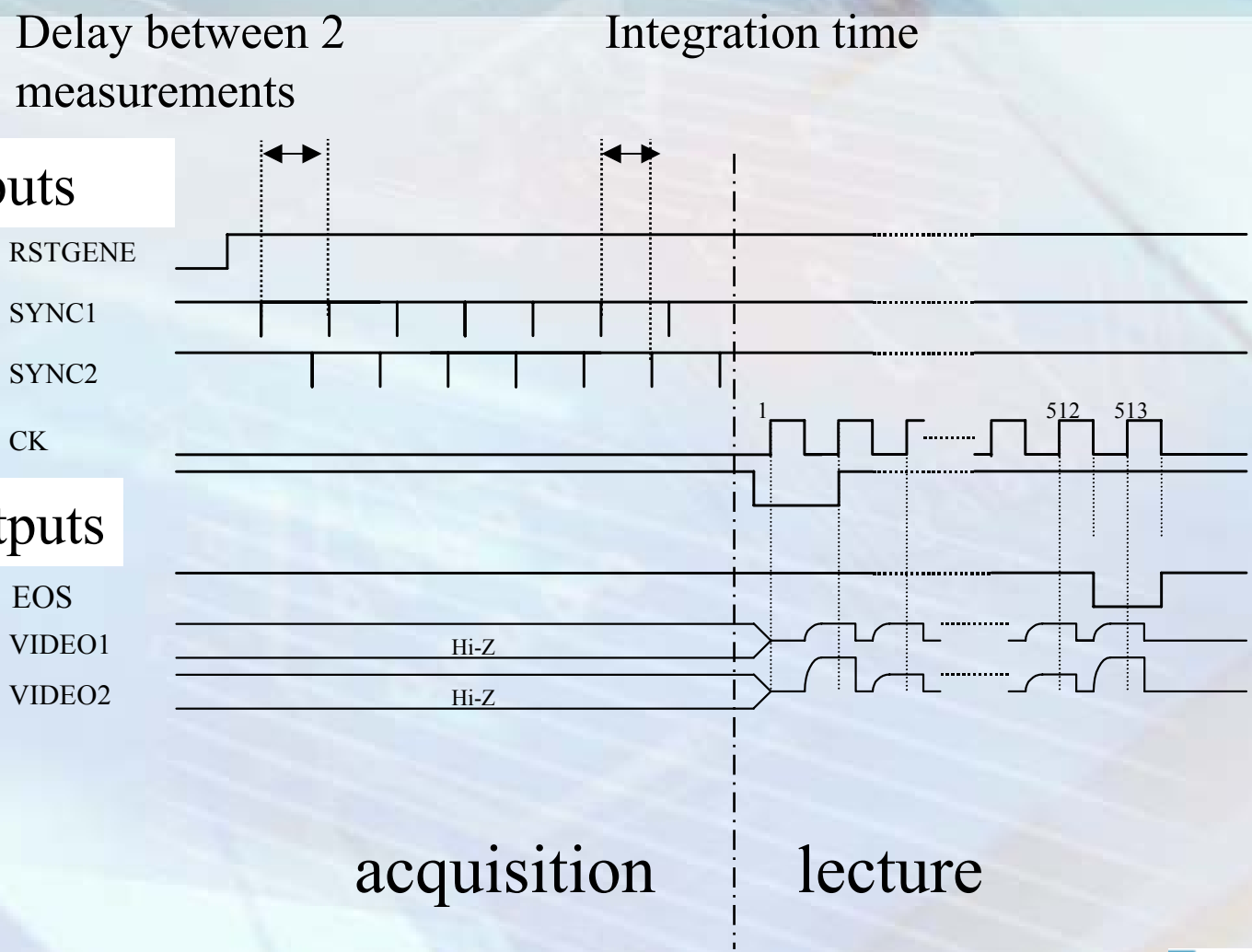
Measurement ligne



Sample and hold of V1 and V3, output of (V1-V3)/2

Sample and hold V1 et V2, output of (V1-V2)/2

Chronogram

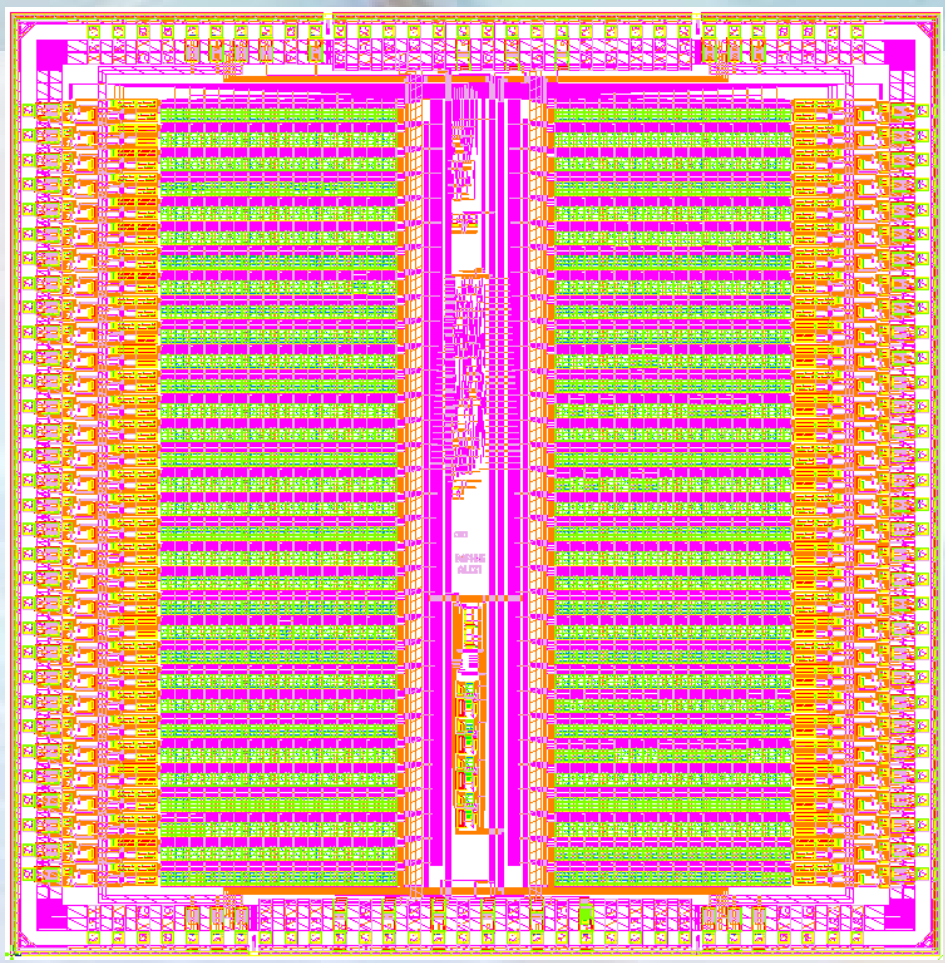

Delay between 2 measurements
Integration time
Asic inputs
RSTGENE
SYNC1
SYNC2
CK
1
512
513
Asic outputs
EOS
VIDEO1
Hi-Z
VIDEO2
Hi-Z
acquisition
lecture

Layout

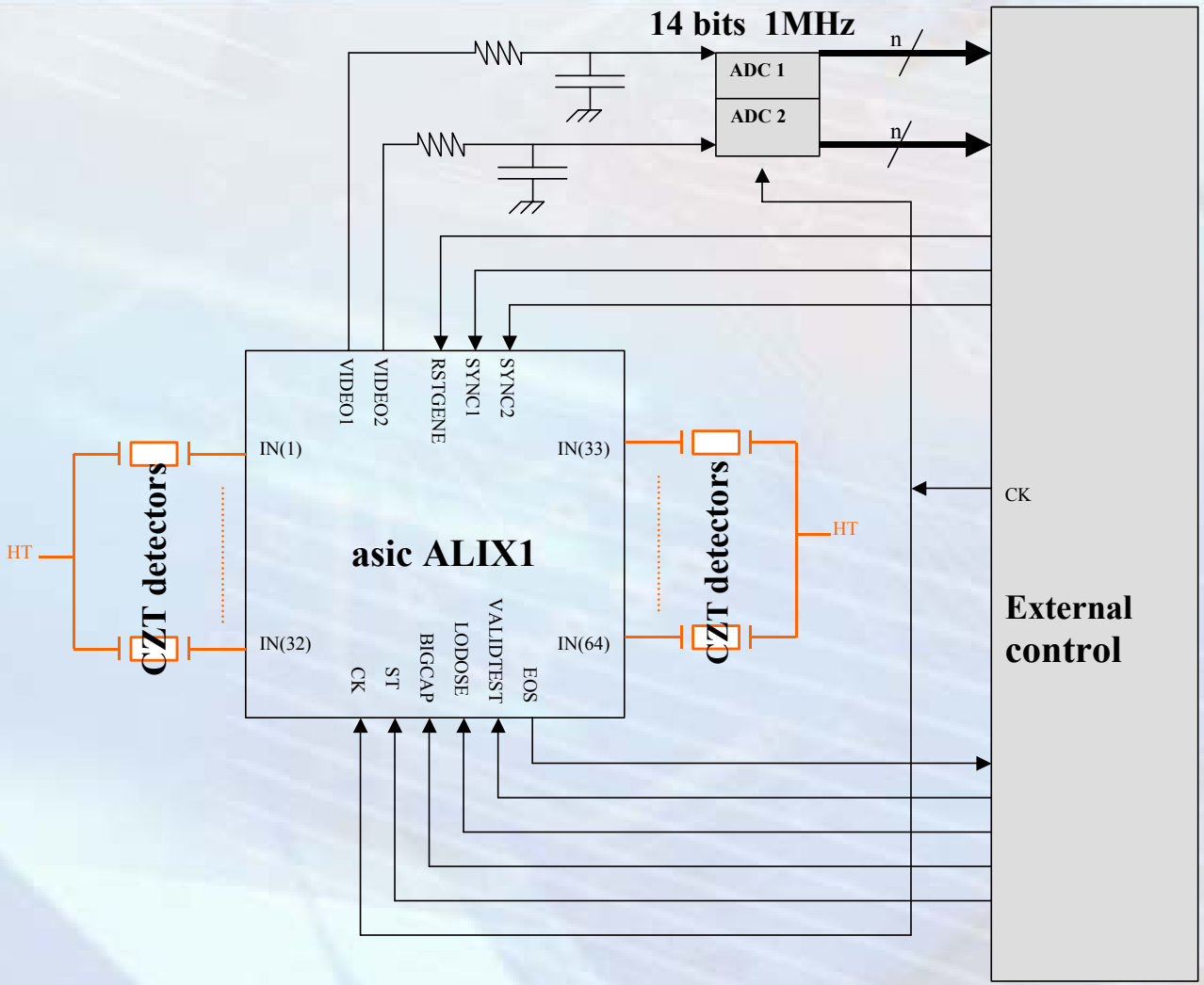
- Techno AMS 0.8 µm
- ΔX=7,7 mm
- ΔY=7,6 mm
- 64 input channel

1st run : may 2000

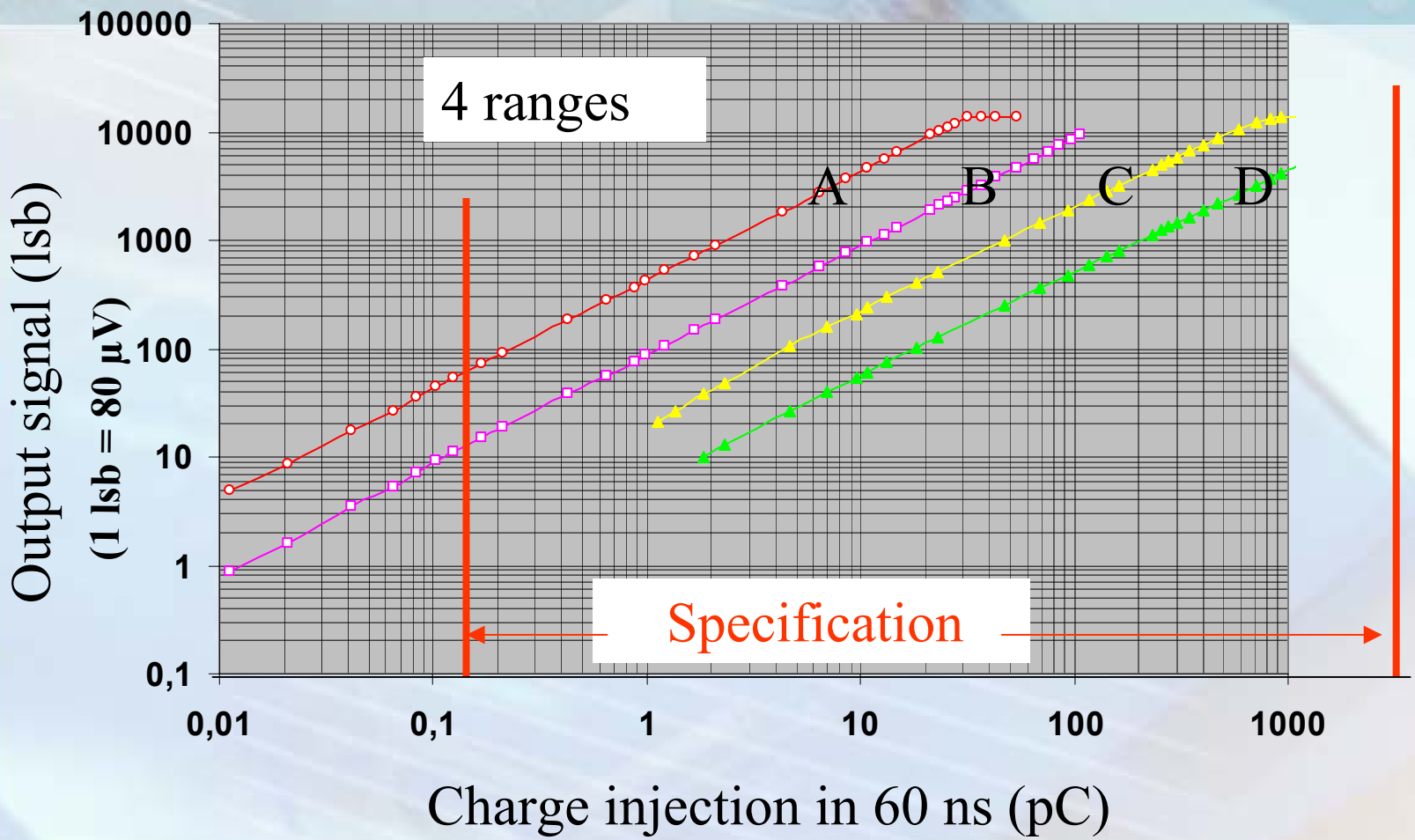
2nd run : may 2001



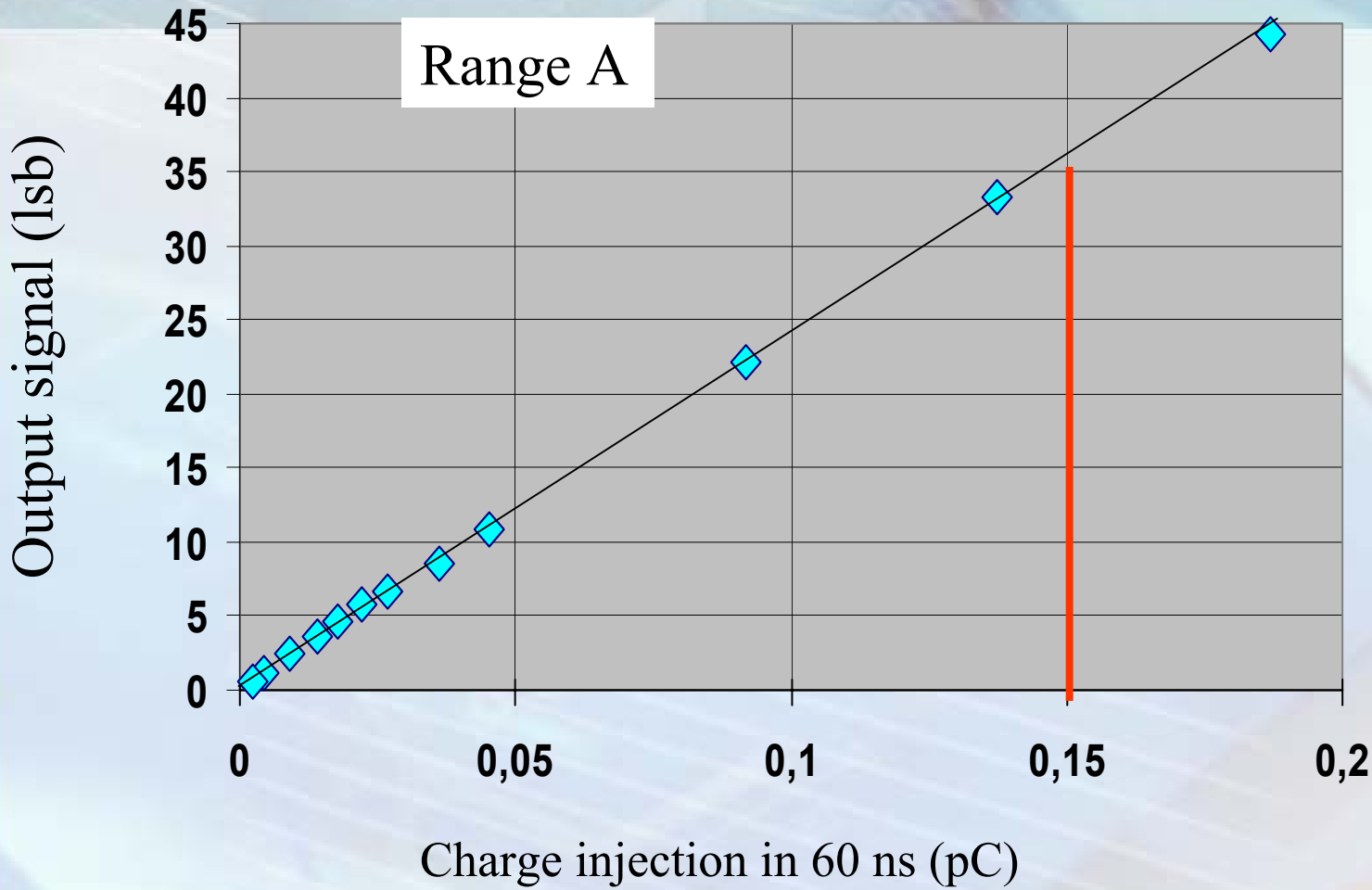
External connexion



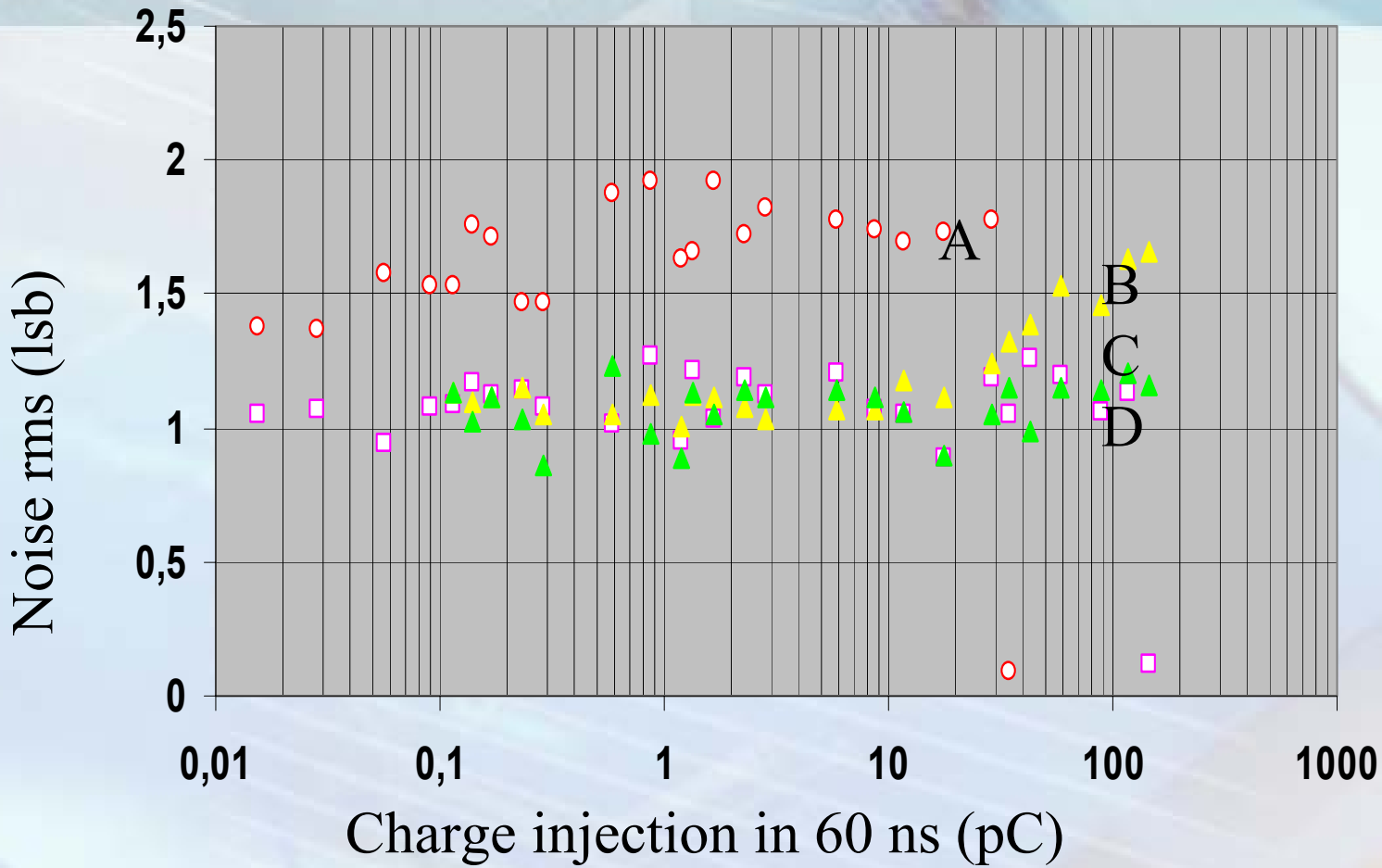
Linearity measurement



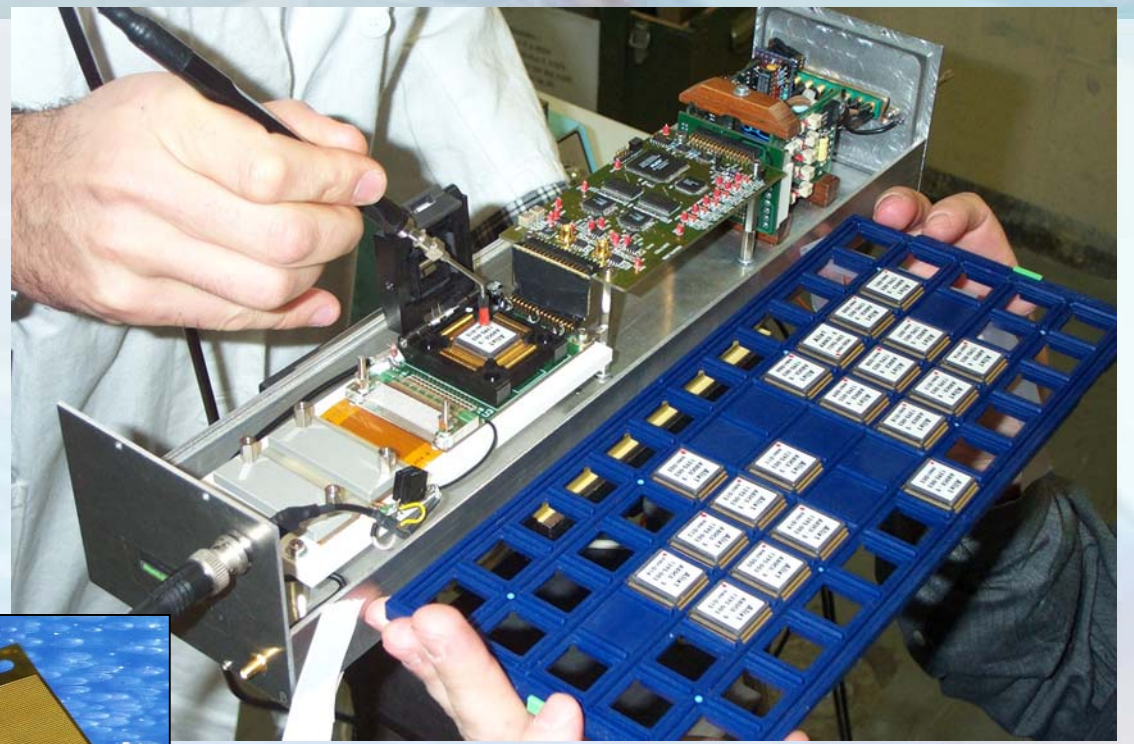
Low level Linearity

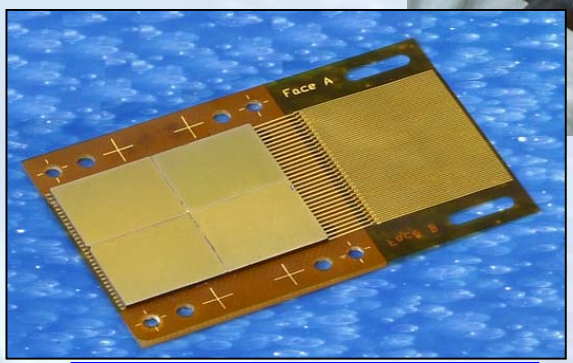


Noise


2,5
2
1,5
1
0,5
0
Noise rms (lsb)
0,01
0,1
1
10
100
1000
Charge injection in 60 ns (pC)
A
B
C
D

Test bench with CZT detectors





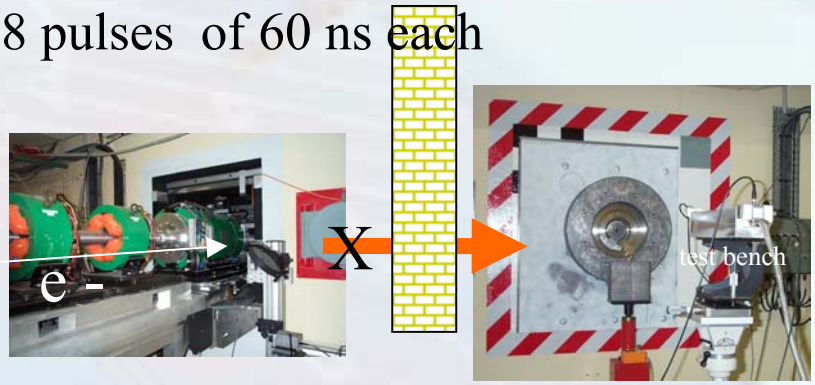
X-Ray

CdZnTe strip detectors
2x32 channel of 1x1x40 mm

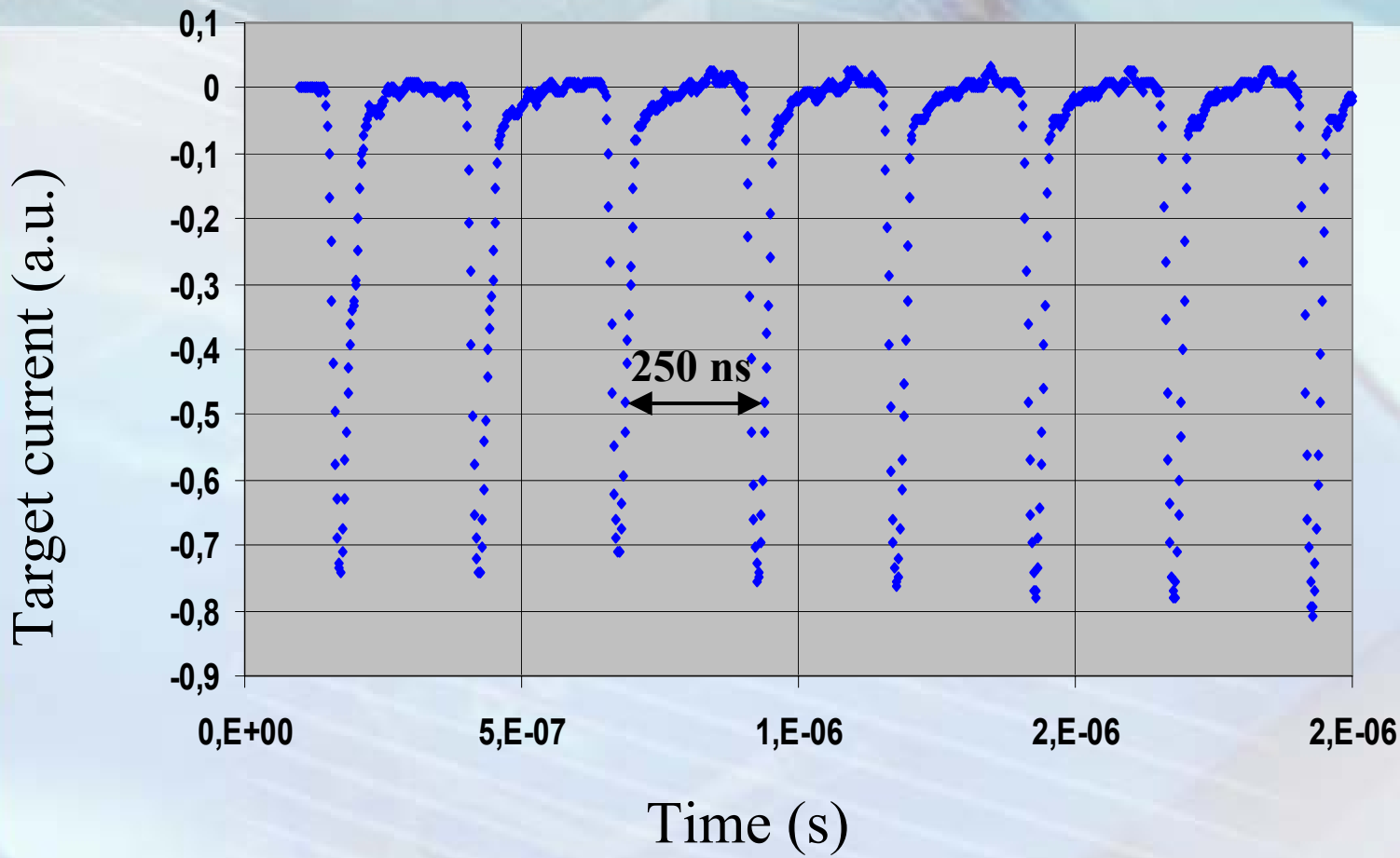
linear accelerator X-ray source

energy : 20 MeV

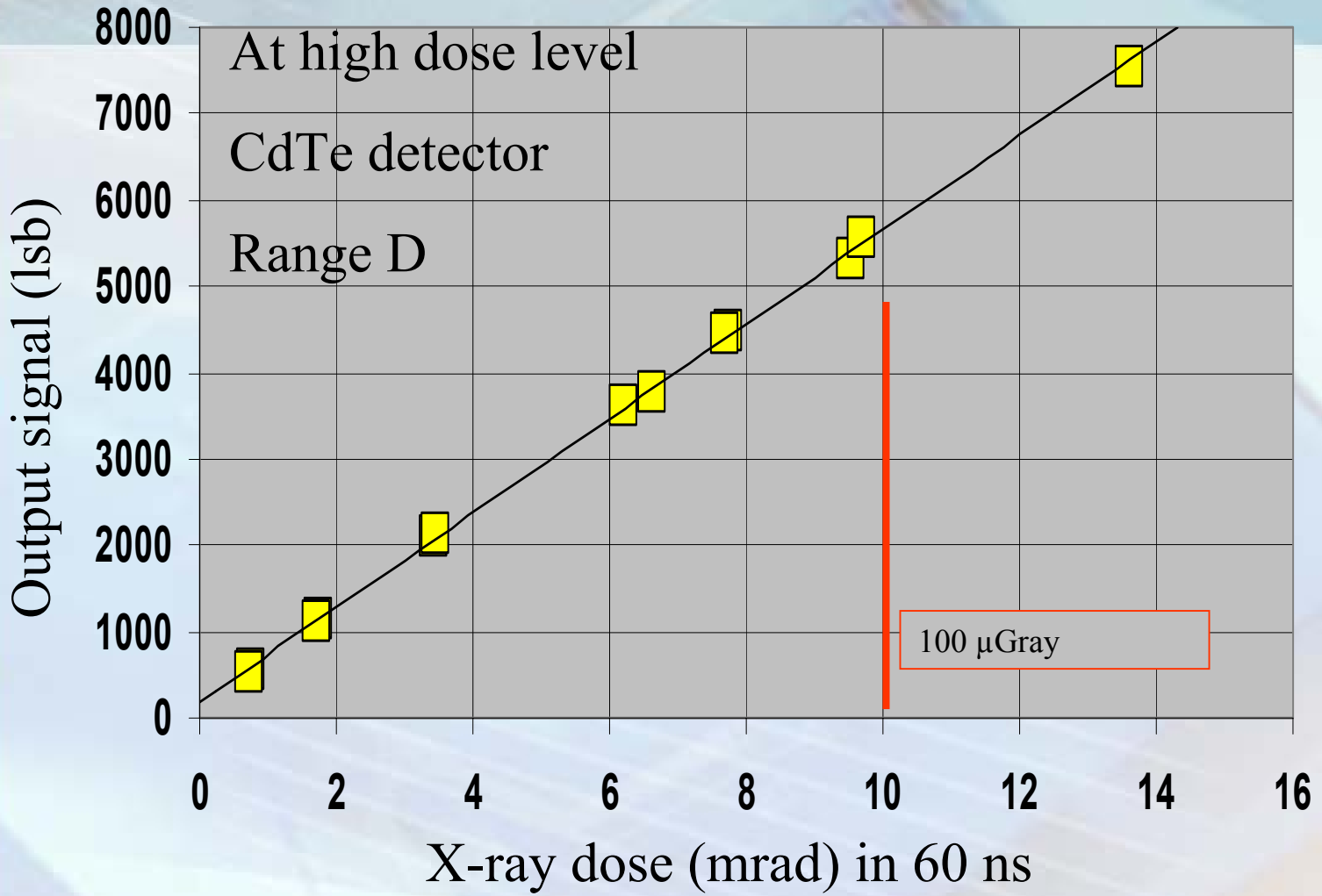
8 pulses of 60 ns each



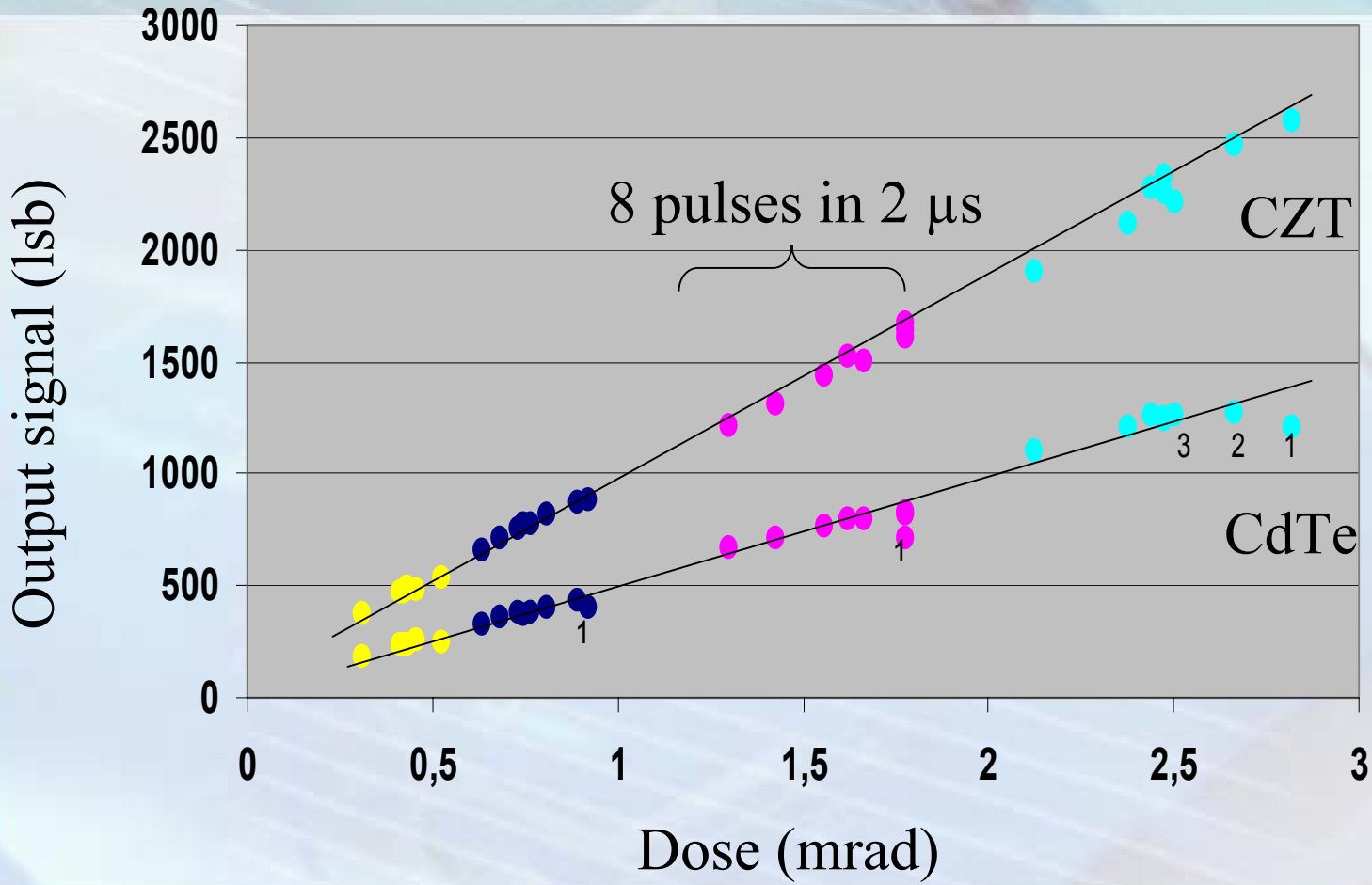
Typical incident X-ray beam



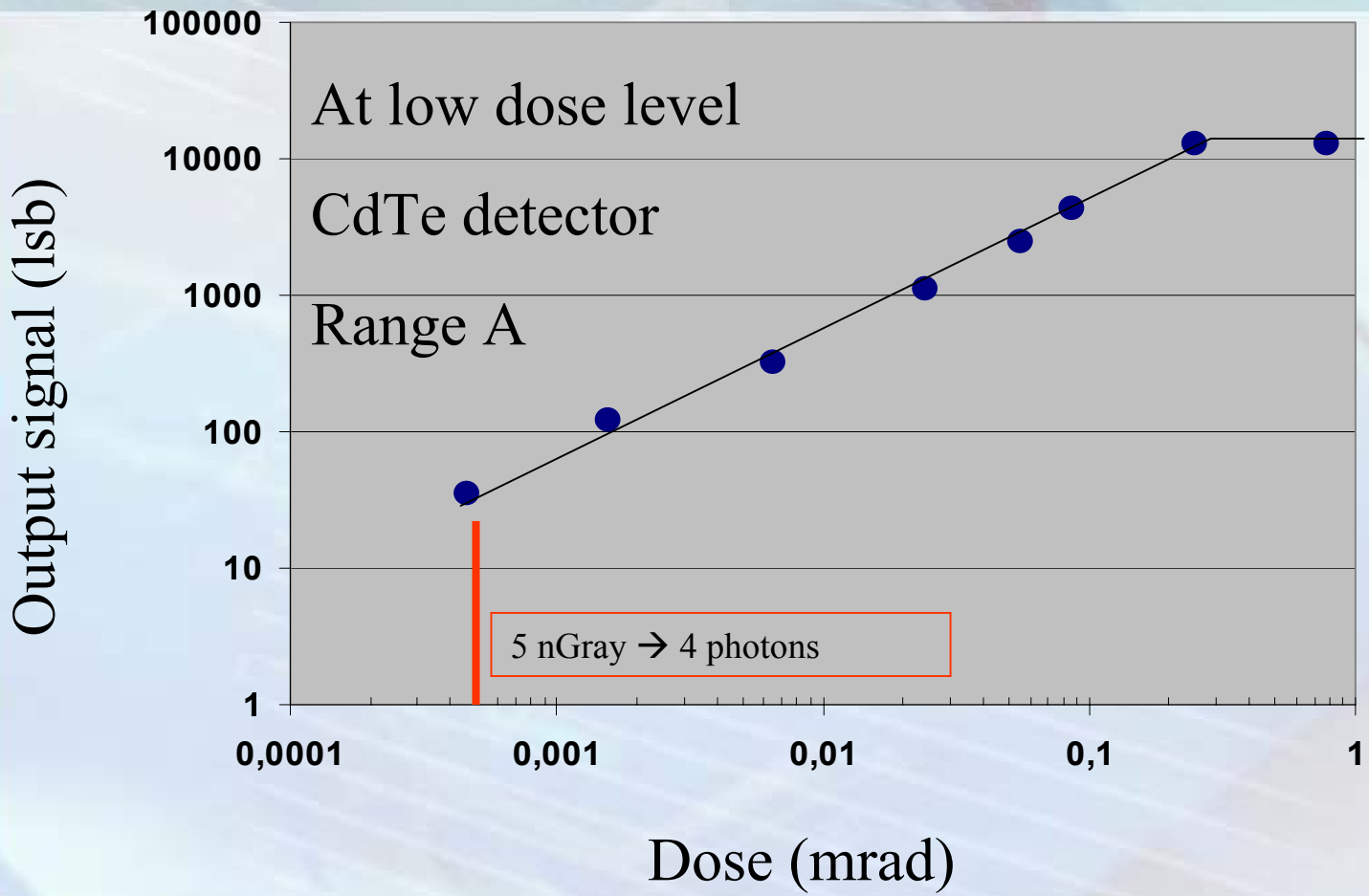
Linearity with detector connected



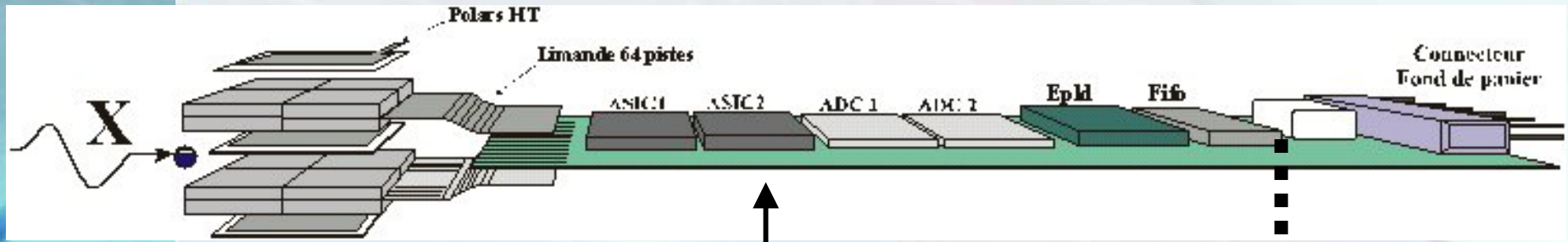
Dynamic linearity



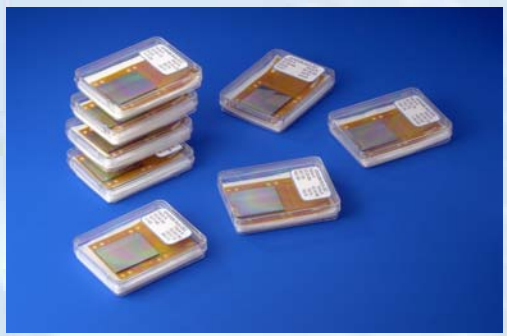
Linearity at low dose level

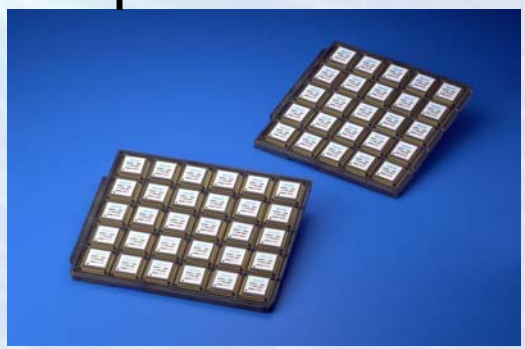


Future developments



8 boards





Conclusion

Detector

- 350 CZT and 200 CdTe detectors have been tested : the yield is better with chlorine doped detectors (monocristalline)

- The linearity with CZT is better at high doses

ASIC

- 2 runs were necessary to optain a good linearity on the whole dynamic

- 85 Asics of the second run have been tested :

→ yield better than 60% (less than 0.5% pixel defect)

- Such an ASIC with a high dynamic and fast measurements capabilities should be usefull for other applications