PARIS LCWS

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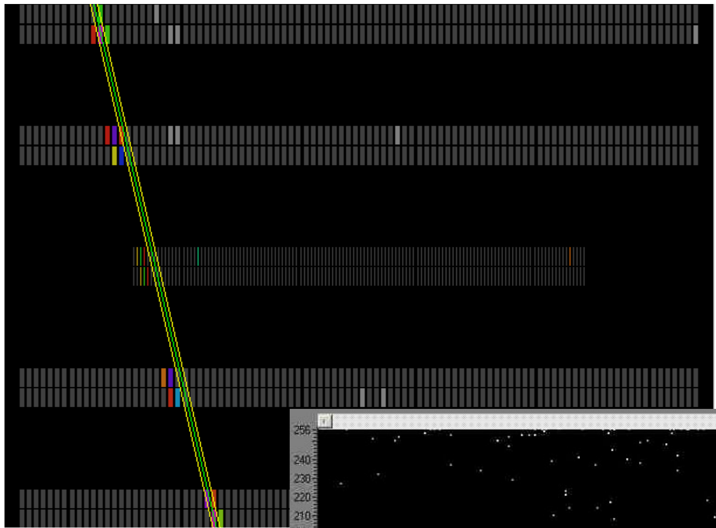
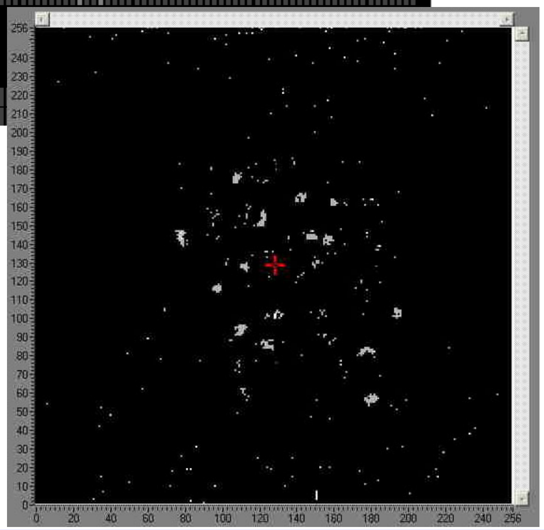
Two options for the LC-TPC electronics

P. Colas (DAPNIA Saclay)





- TESLA TDR : 2x6 mm anode pads (gas amplification by means of a Micromegas or GEMs –or wires-)
- Alternative possibility (see J. Timmermans's talk) : digital TPC readout by anode pixels
- Compare data volume and specificities

Standard readout

2x6 mm pads. Signal risetime limited by dispersion and track inclination: 20 MHz sampling frequency suffice, 10 to 12 bits required for charge measurement accuracy (dE/dx and resolution) 1.5 million channels.

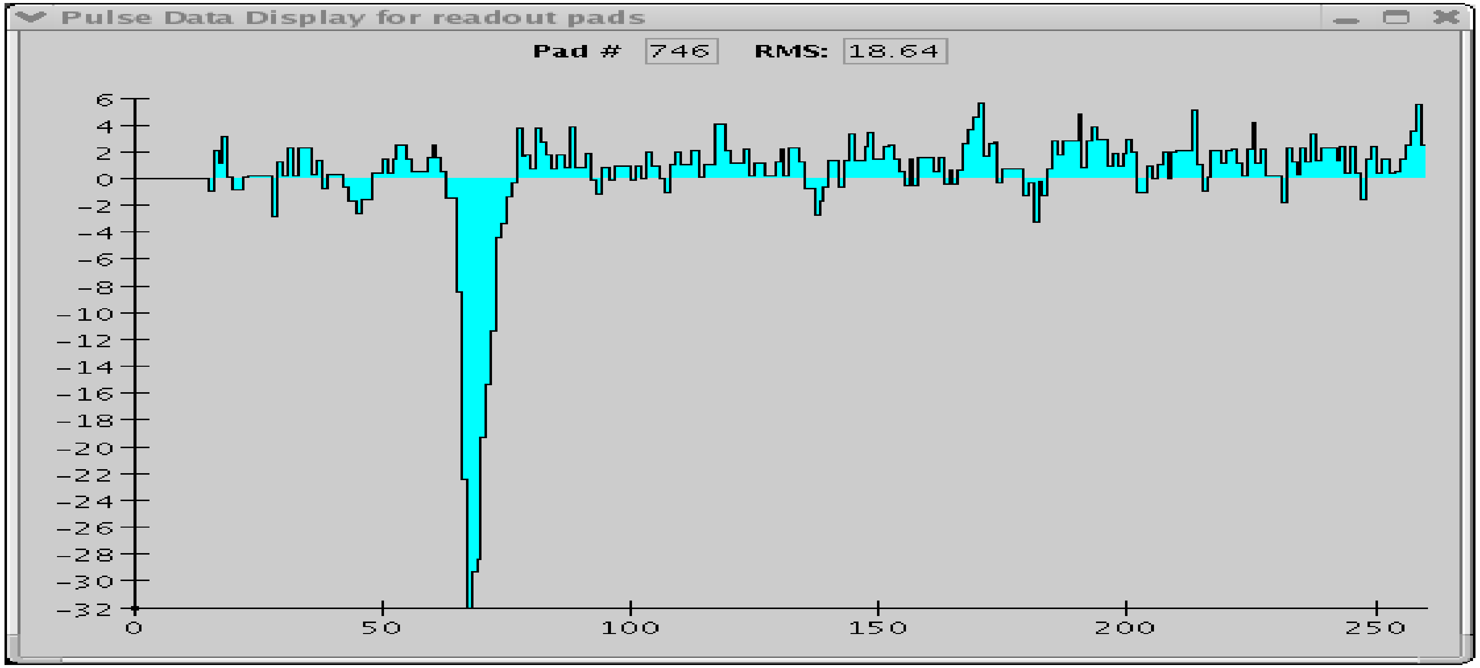
Requirements:

Low noise, low power, dense packing

(8 ch/cm^2)

STAR example

Now look at ALTRO chip



Typical signal with a 20 MHz 10-bit sampling (STAR readout)

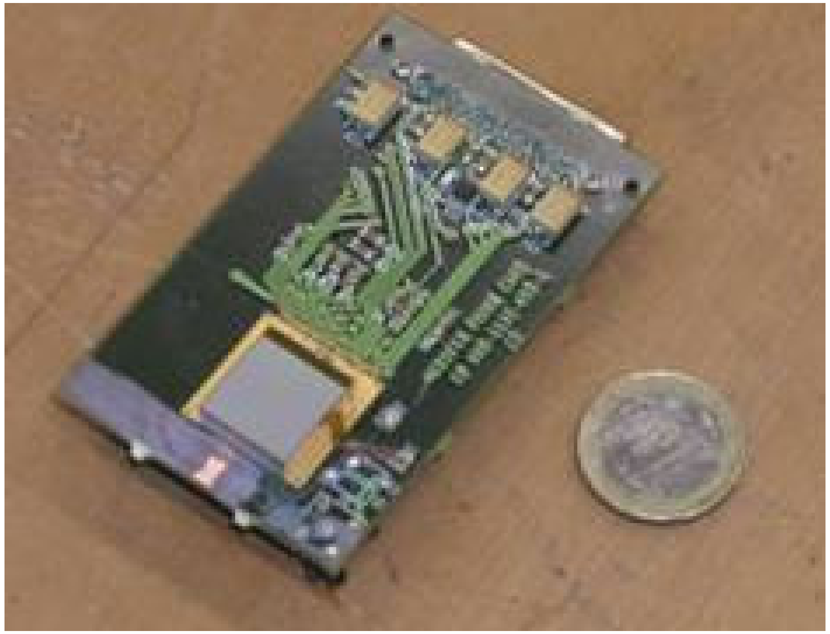
Integrated pixel readout

Proof of principle obtained by P.C., H. Van der Graaf et al. (see J. Timmermans's talk)

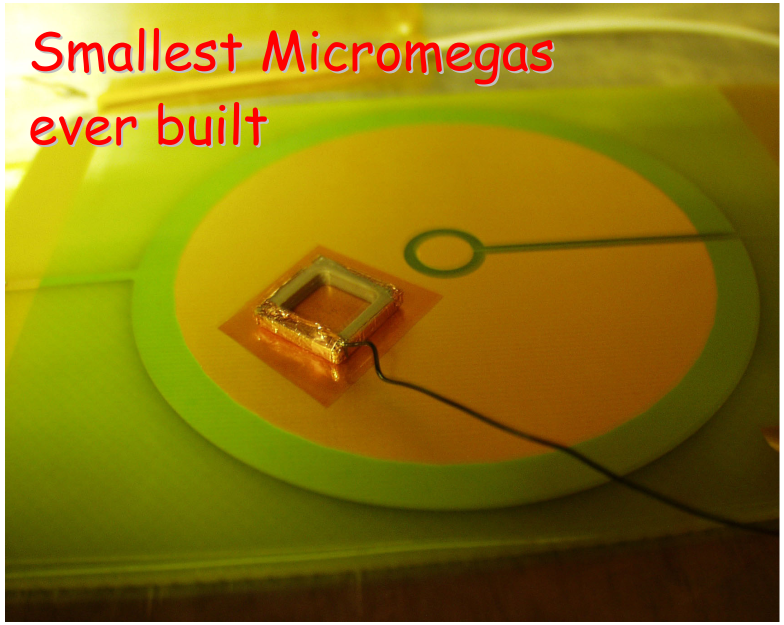
Medipix2 CMOS chip in 0.25μm technology with 65000 55x55 μm^2,

Al on Si pixels

(threshold at 3000 e-)



After an amplification stage by a Micromegas (Ar+5% isobutane)



First data from a Micromegas+pixel detector

Feb. 13, '04

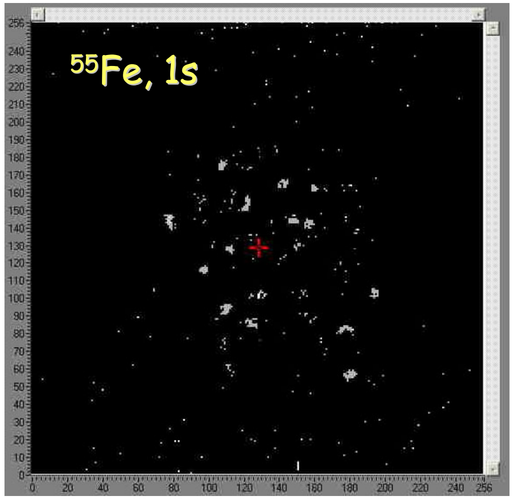
MICROMEGAS

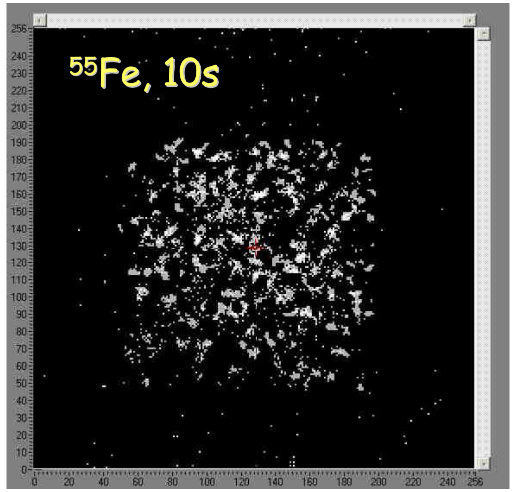
Clear signal from an iron 55 source (220 e- per photon)

300μx500μ clouds as expected

15 mm drift

GAIN=700





GEM

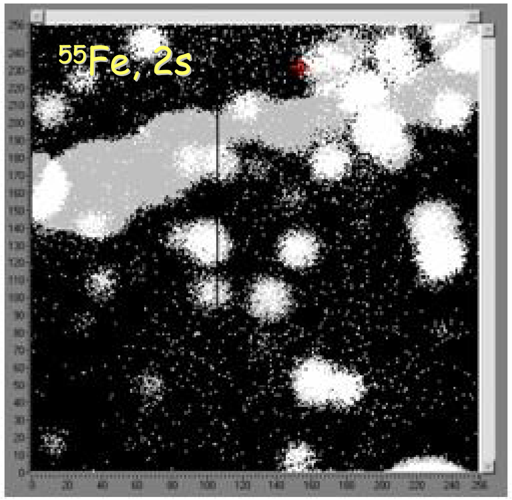
3-GEM device already saw particles

(March '03, Feb. '04)

Larger spread (O(1mm)) due to mm-thick gaps with kV/cm fields

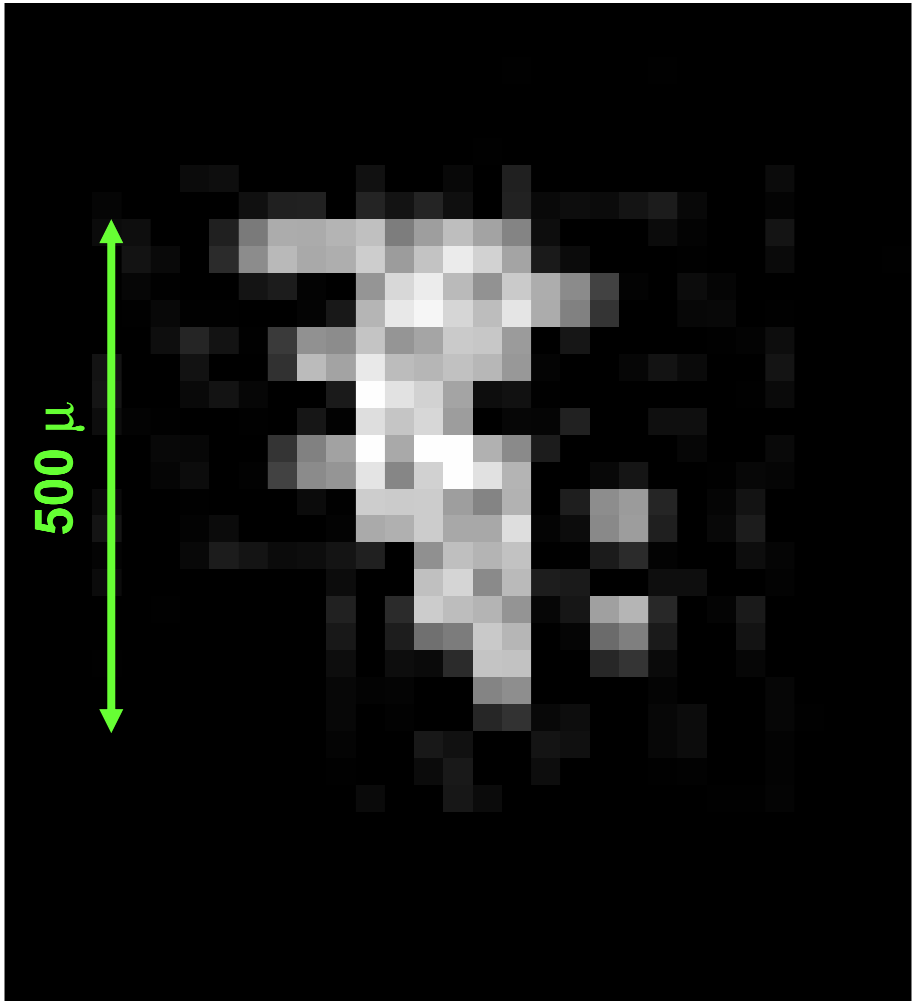
100 mm drift

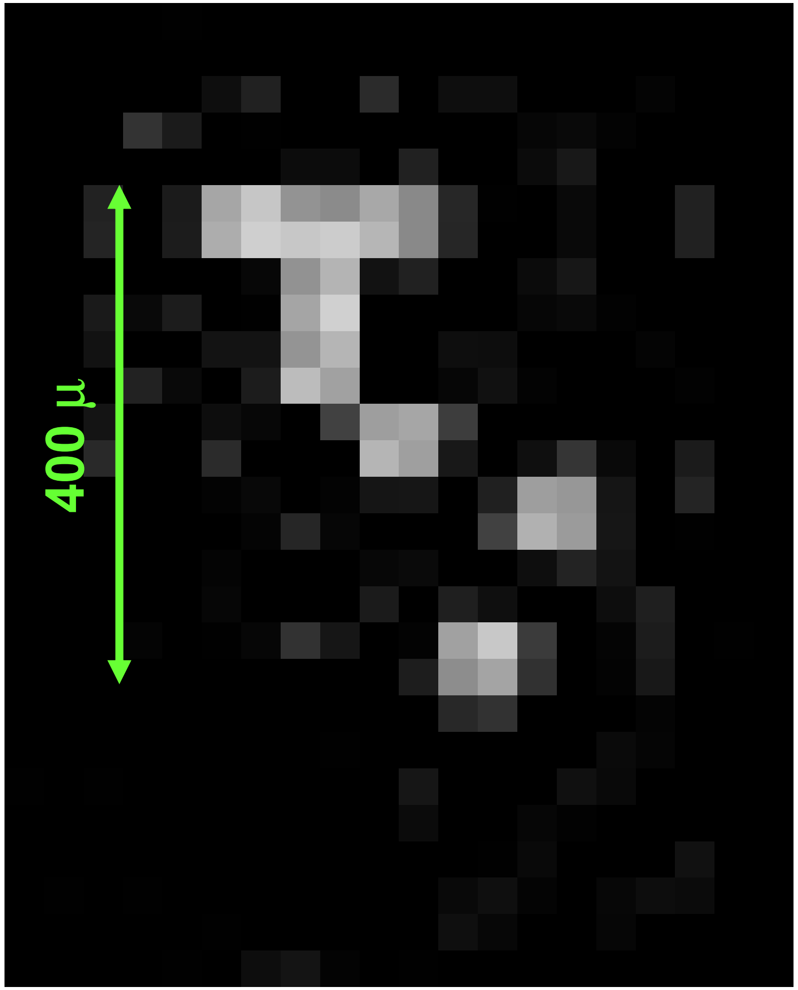
GAIN = 40 000



MICROMEGAS + PIXELS :very promising device + powerful tool for studying Micromegas

^{55}Fe 6 keV photons with Micromegas+Medipix2





- Similar results by Bellazzini et al. with GEMs
- End of March 2004: minimum ionizing tracks seen in a He+20% isobutane seen. Expect 0.9 cluster/mm
- Time to consider a pixel readout (digital TPC)
- For 0.3x0.3 mm : 10^8 channels, but 1 bit each : 12.5 MBytes instead of 2.

(would be 4×10^7 channels for 0.5x0.5 mm pixels, and 10^{10} channels for 50x50 micron pixels)

- Z measurement accuracy will be improved (no track inclination effects). It will be limited by the number of clusters per track (about 2000) and dispersion (typically 4mm per point)
- Efficient zero suppression needed (« fax »-type)

- Note that with small pixels, the probability of having 1 pixel hit twice in a TESLA bunch train is very low: just have to record hits and their time bucket (depth of 20000 required to record a full train crossing)
- During our tests in NIKHEF, with careful operation, we broke about 1 chip per day: PROTECTION will be a crucial issue:
  - Hardware protection against sparks (strong metallisation, resistive layer?)
  - Electronic protection (but noise is also an important issue: single electron detection needs high gain, thus high ion back-flow if the threshold is high)
- Very challenging design