Update on Silicon Pixel Readout for a TPC at NIKHEF

TILC09 - Tsukuba

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NIKHEF

Full post-processing of a TimePix

· Timepix chip + SiProt + Ingrid:

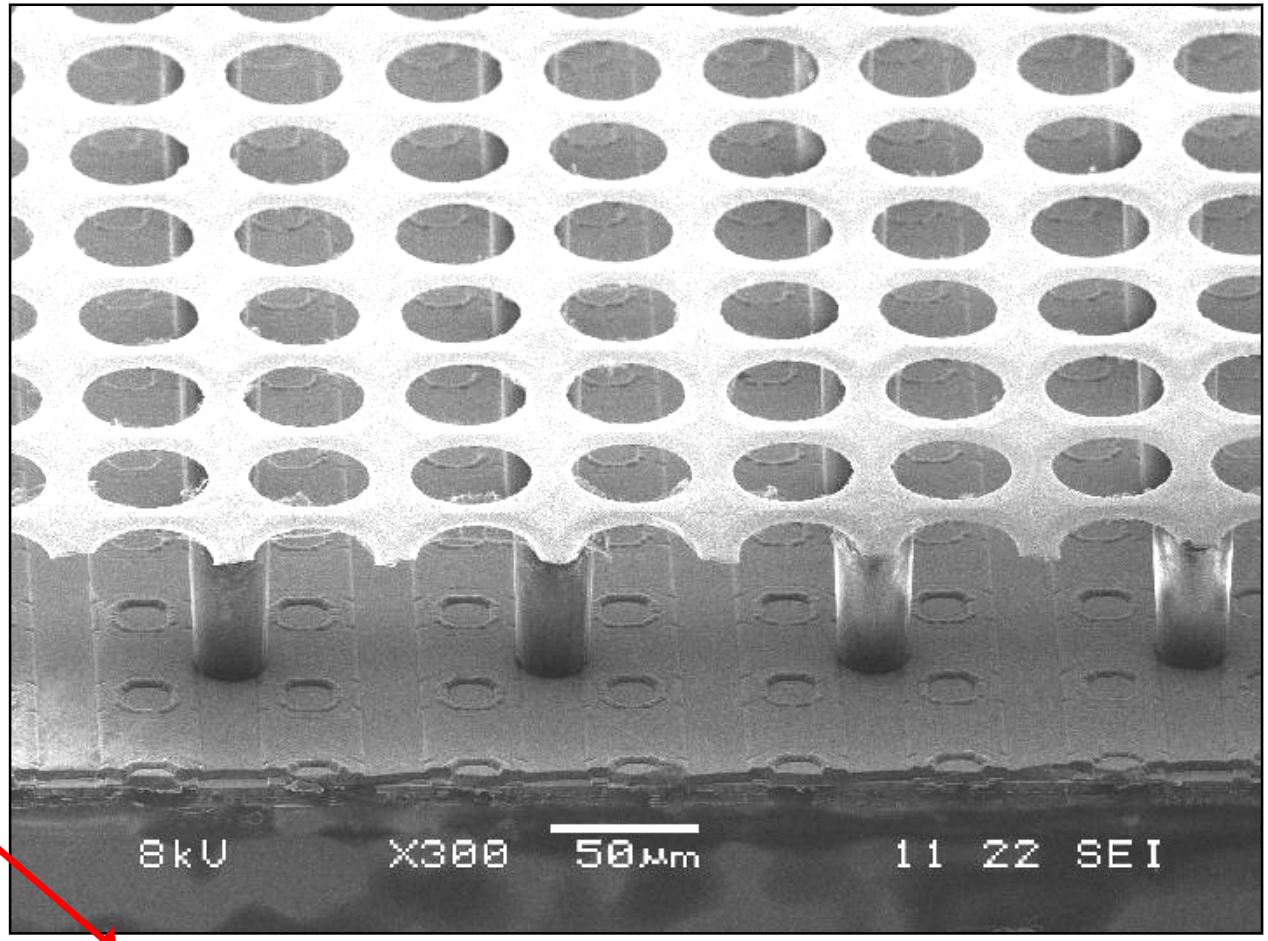
Timepix chip:

- 256x256 pixels
- pixel: 55x55 μm^2
- active surface: 14x14 mm^2

MESA+: Ingrid

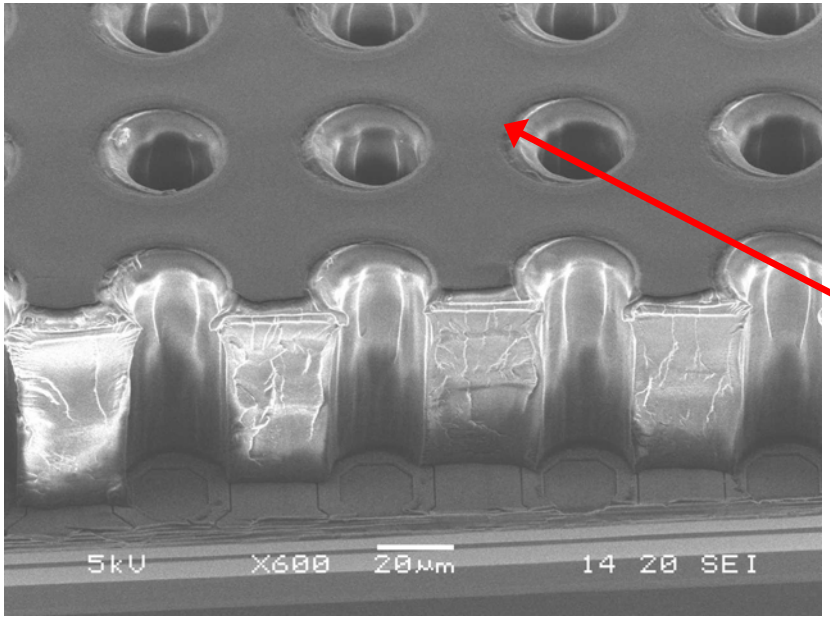
IMT Neuchatel:

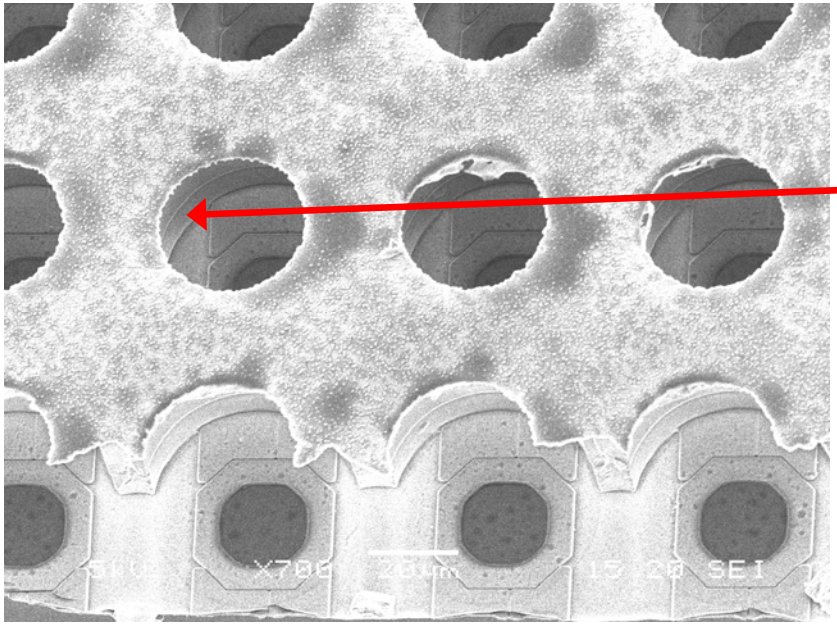
15 or 20 µm highly resistive aSi:H protection layer



Now also Si_3N_4 protection layers (7 µm)

Alternative Grid structures





GemGrids

(mechanically more robust than Ingrids)

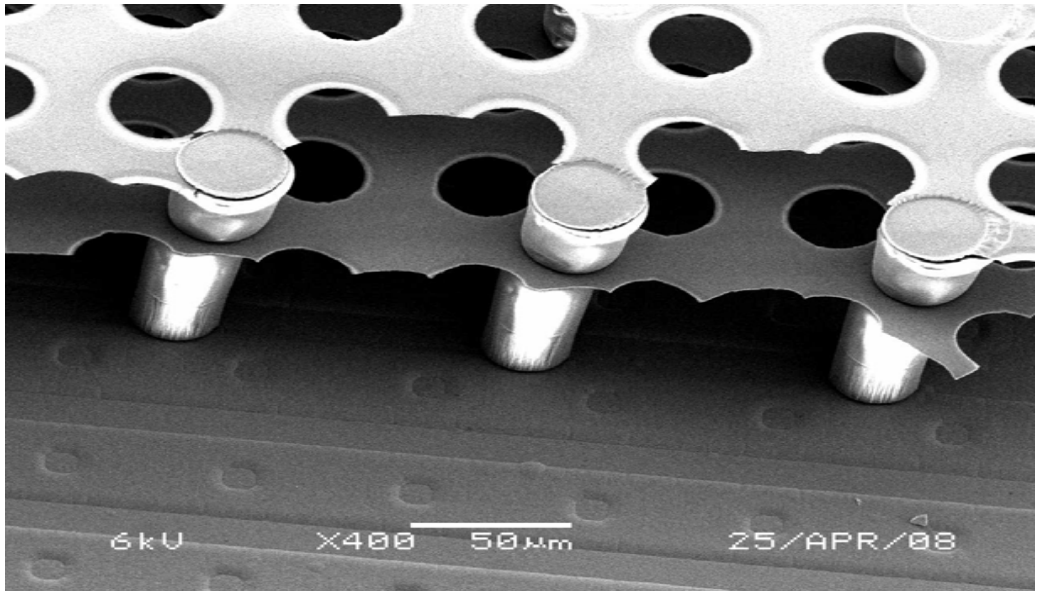
- **recessed metal:**

Much less gain than with pillars (micromegas-like)

- **recessed insulator:**

Somewhat less gain, but OK

TwinGrid



Possible advantages:

- Separate high-gain region from anode
- Or share total gain over the two regions;

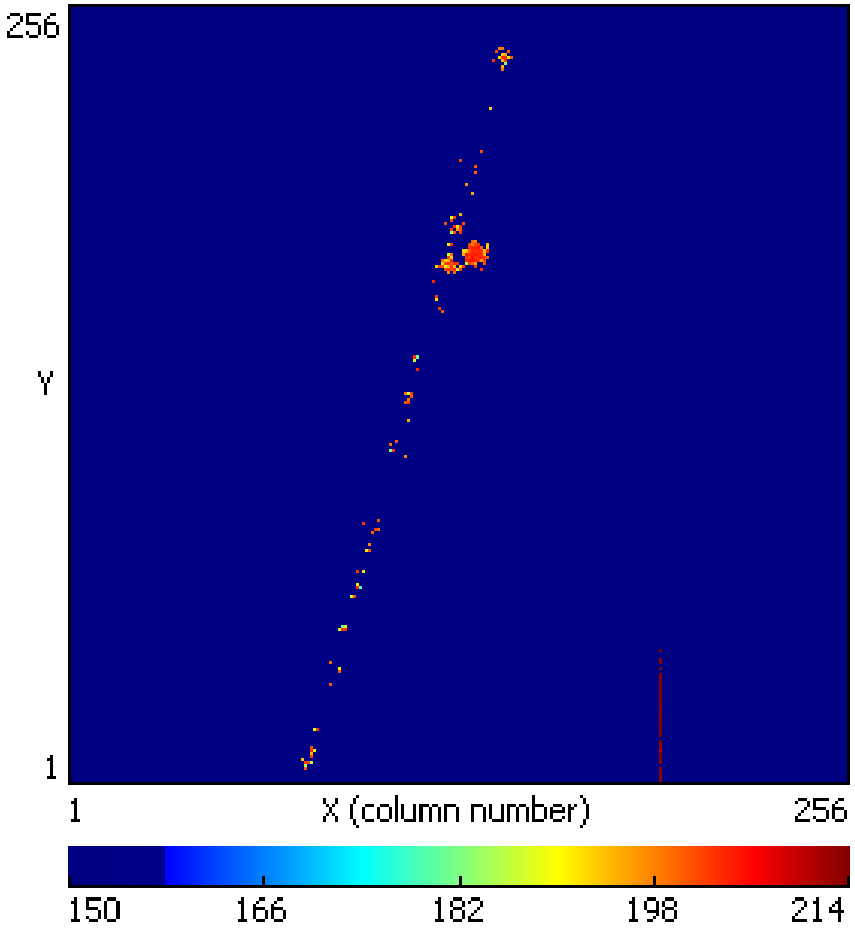
→ Both give reduction of discharge probability

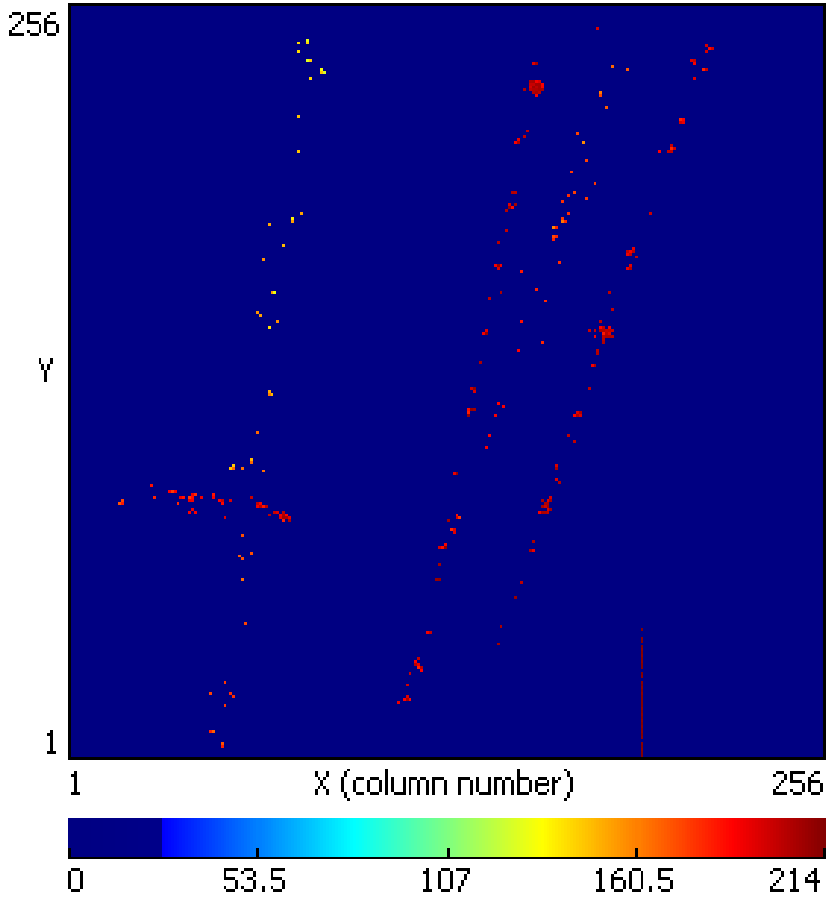
- Lower ion backflow: not yet measured

It works! (but not yet perfect)

Some tracks

(with Ingrid in 5 GeV CERN T9 testbeam)



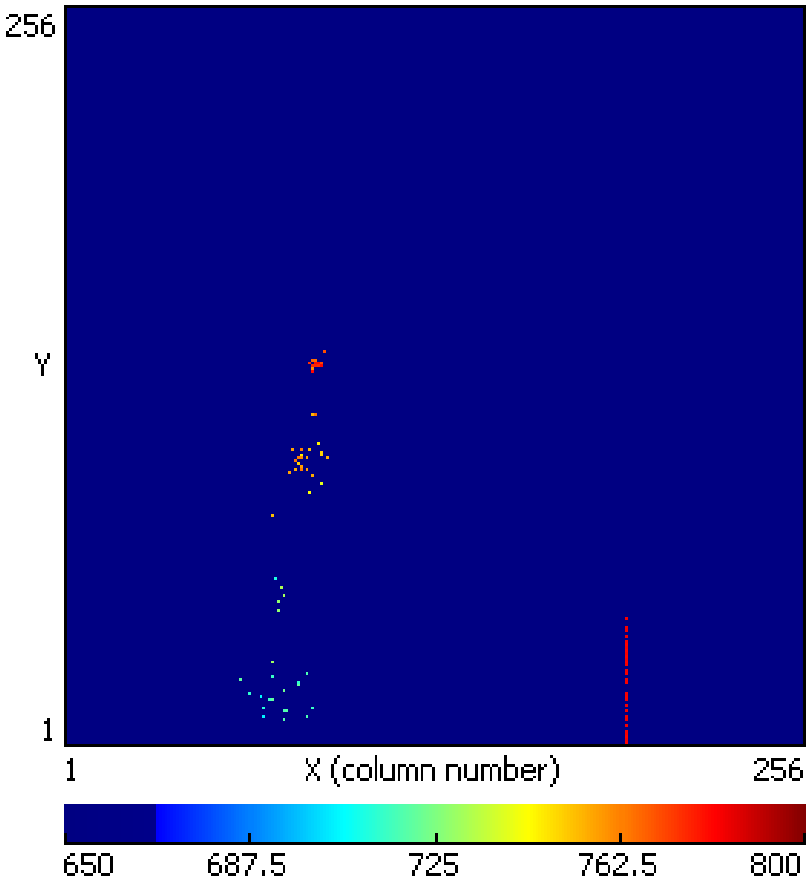


Colour code is drifttime

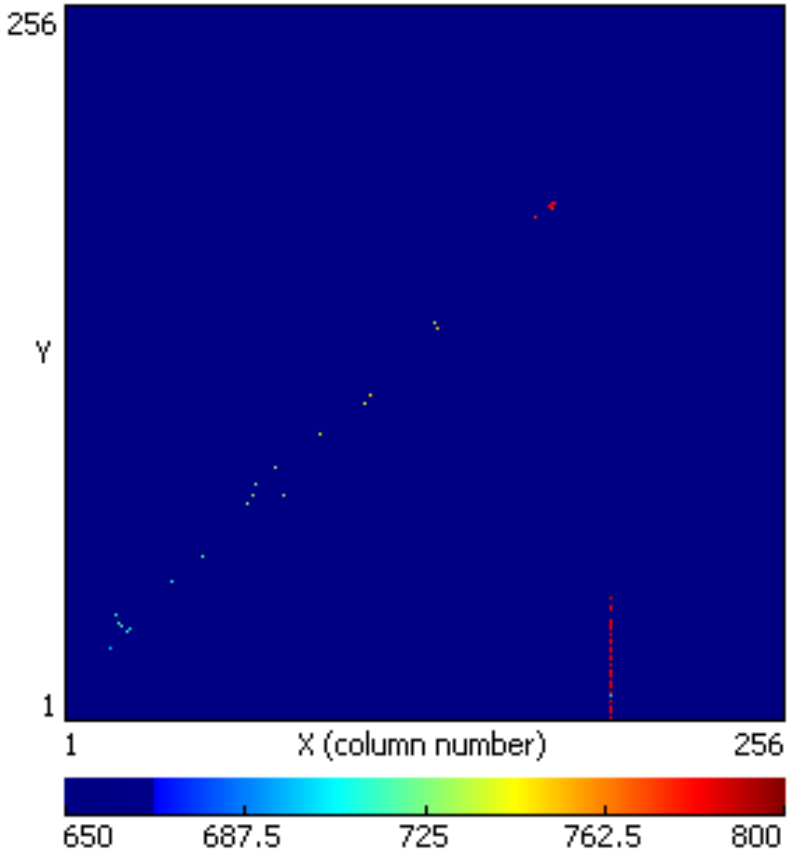
Cosmic tracks traversing ~ 30 mm drift space

Ingrid and Ar-CF4-iC4H10 (95/3/2%)

0 T



1 T



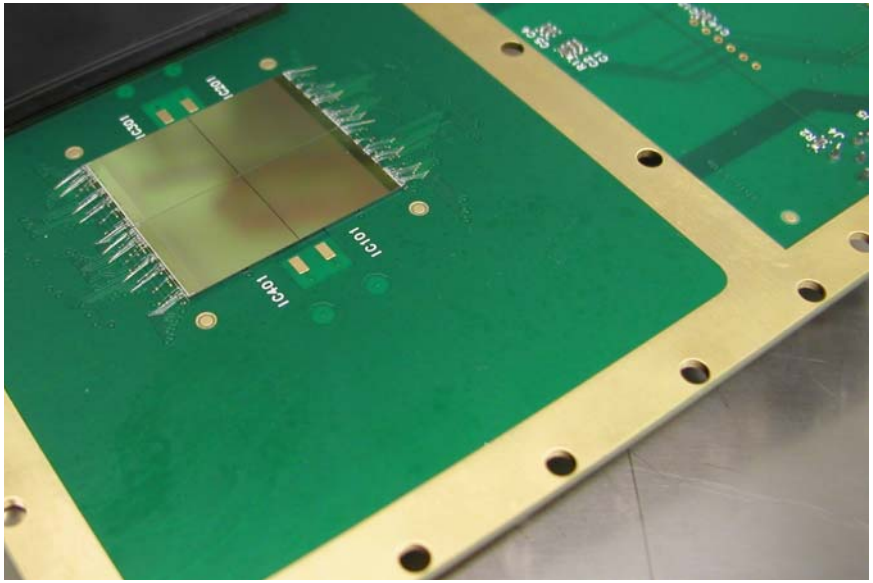
"large" diffusion

"little" diffusion

Work in progress

- (Post) processing in Twente.
  - Both Si_3N_4 and InGrid can be applied.
  - Treating chip squares of 3X3 timepix chips instead of individual chips.
  - Search for high res InGrids. (Si_3N_4)
- Optimize protection and signal integrity.
  - Discharge test structures.
- Recovering from problems with Ingrids production; delivering soon

- Scaling up.
  - 4 chip detectors (3X3 cm): soon
  - 64 chip detector (12X12 cm): later in 2009/10
- Timepix2 development



Cluster counting with Timepix

A few plots from Master thesis
Lucie de Nooij

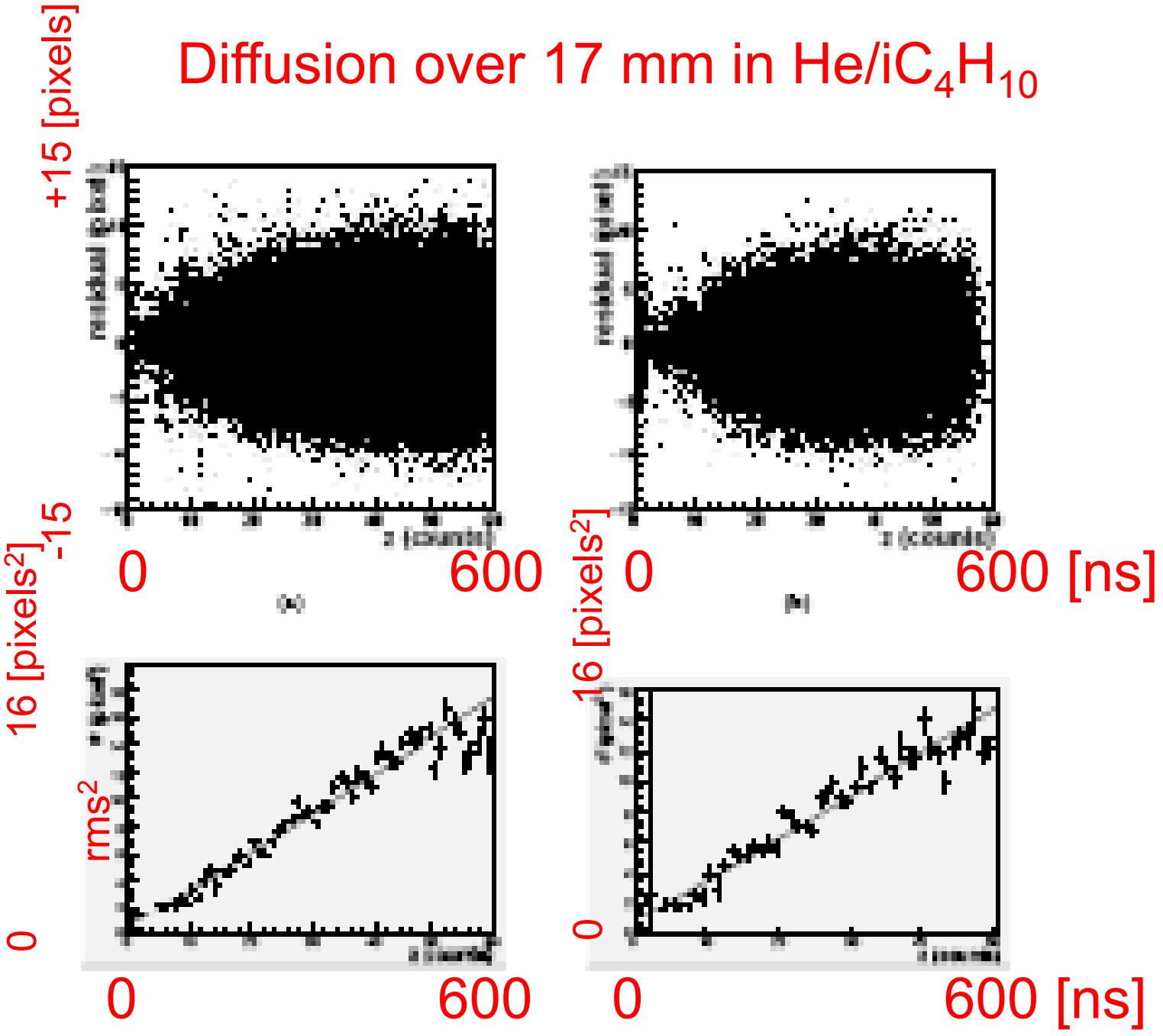
Data from 5 GeV π/e testbeam

- Gases used:
  - He/iC_4H_{10} 80/20
  - Xe/CO_2 70/30
  - $Ar/CF_4/iC_4H_{10}$ 95/3/2
  - Ar/CO_2 70/30

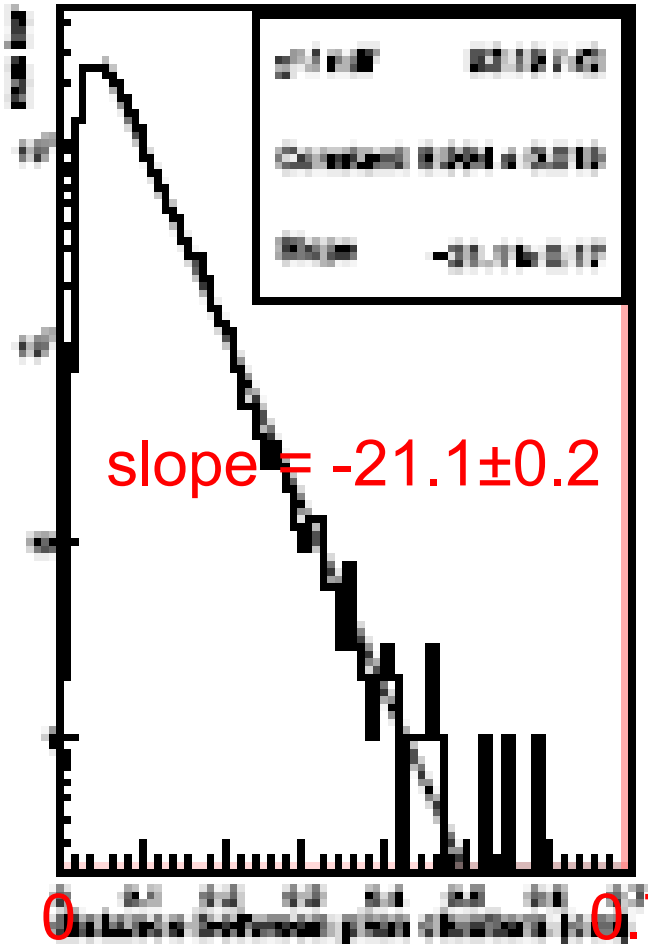
Data analysis

- Track search/reconstruction using Hough transforms
- 2D and 3D track fits
- Drift velocity measurements (value for $Ar/CF_4/iC_4H_{10}$ low by almost factor 2)
- Diffusion measurements: He/iC_4H_{10} "OK" other mixtures "off"
- Cluster distances and cluster counting

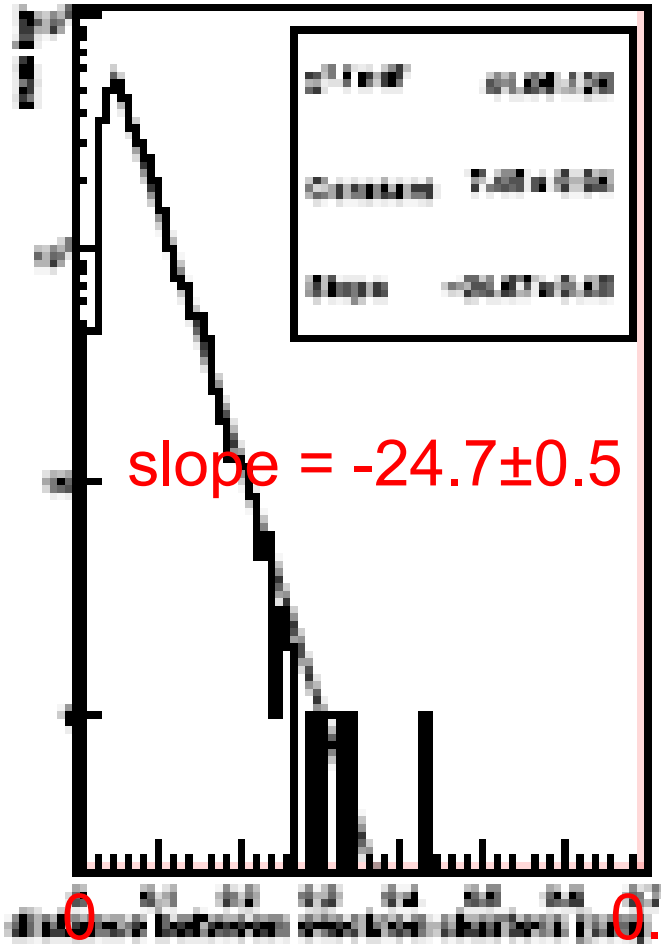
Diffusion over 17 mm in He/iC_4H_{10}



Cluster distance distribution in He/iC4H10

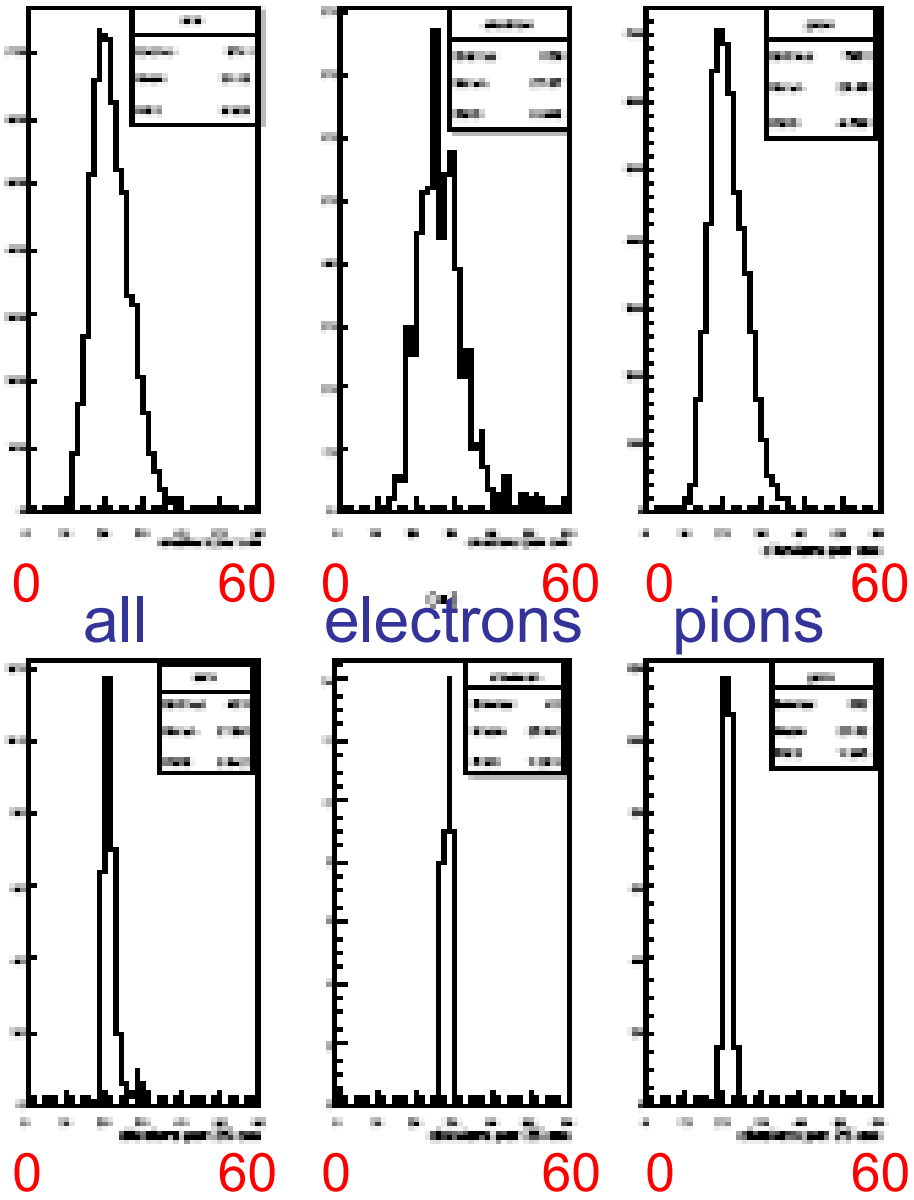


pions



electrons

Cluster counting distribution in He/iC4H10



- Using 1 cm tracklength

Electrons:

Avg=27.1/cm rms=6.3

Pions: 21.0/cm 4.8

- Using 25 cm tracklength

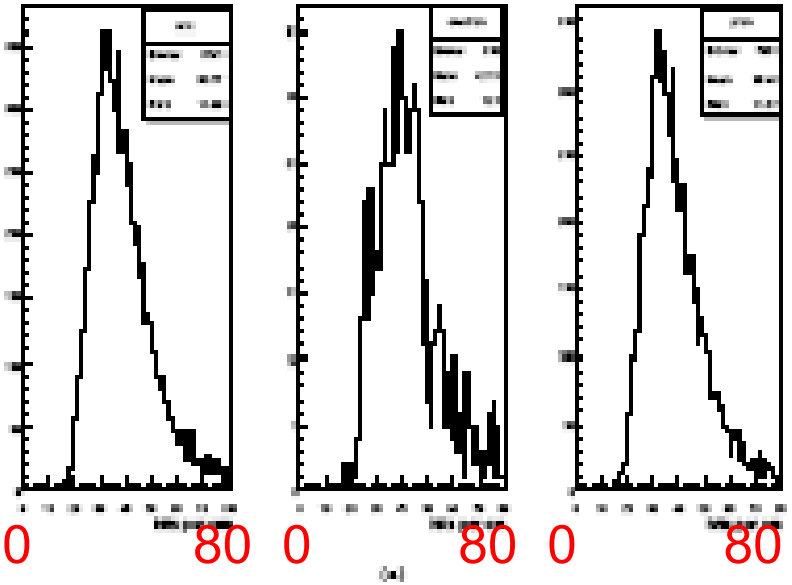
Electrons:

Avg=28.4/cm rms=1.2

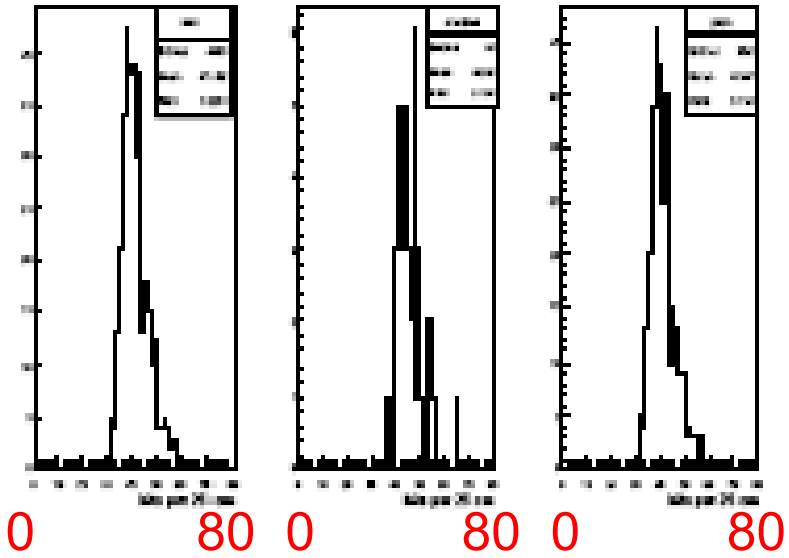
Pions: 21.0/cm 1.2

4.4 σ difference

Single hits counting distribution in He/iC4H10



all electrons pions



- Using 1 cm tracklength

Electrons:

Avg=42.2/cm rms=12.1

Pions: 38.4/cm 11.6

- Using 25 cm tracklength

Electrons:

Avg=46.0/cm rms=5.1

Pions: 41.5/cm 5.1

0.6 σ difference

Summary

- A lot of progress made in last ‘year’; not mentioned many details on energy and point resolution studies and on signal development (see PhD thesis Max Chefdeville, Jan.2009)
- First (prel.) results on cluster counting from 2008 beam tests (Master thesis Lucie de Nooij, Jan.2009)
- Part of the technology is ready:
  - Very good energy resolution for Ingrid devices
  - Ion backflow at the few per-mil level at high field ratio
- Discharge protection seems working for Ingrid (and Micromegas) devices under “normal” conditions

Next:

- Build larger multi-chip detector systems with fast readout
- Through-Si connections & full 8” wafer post-processing

Backup for “amusement”

A 5 cm^3 TPC (two electron tracks from ^{90}Sr source)

B = 0.2 T