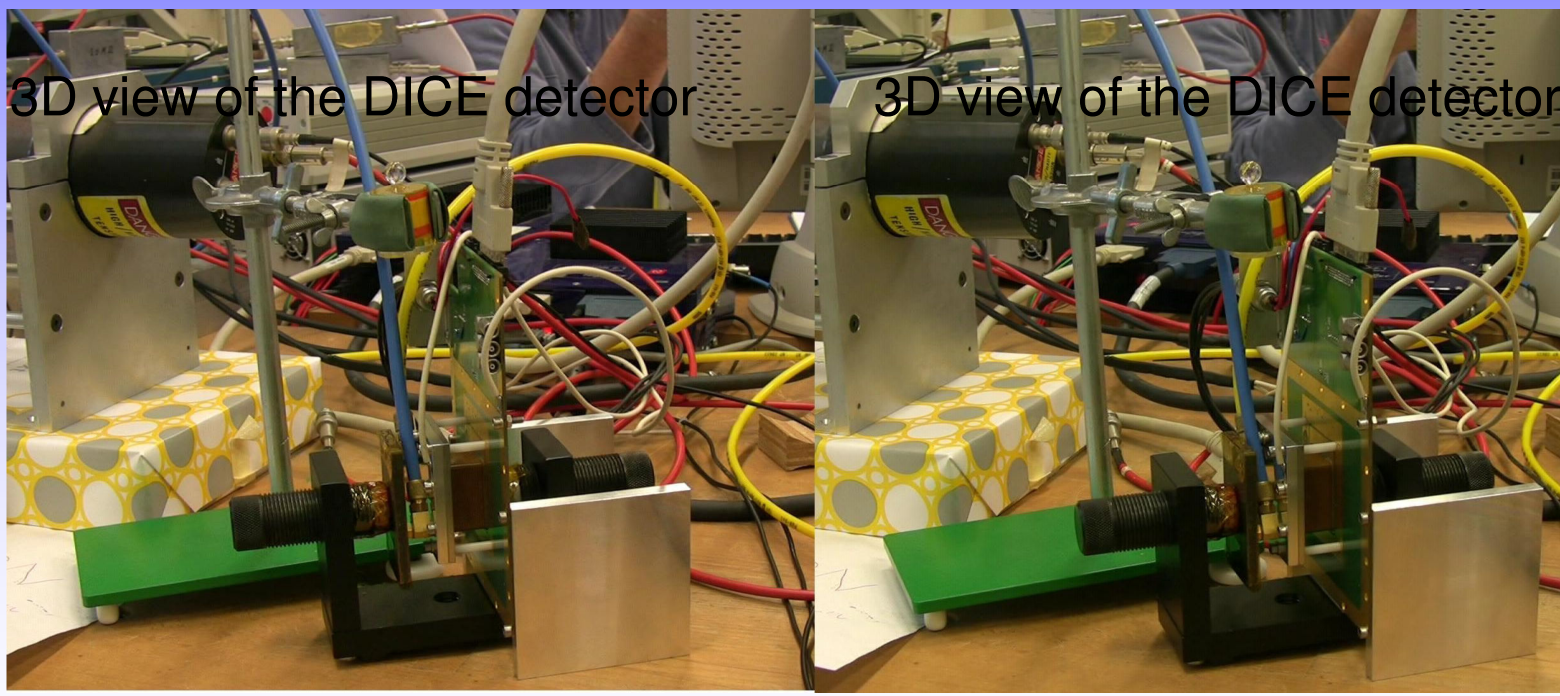
Gridpix; post processing and test results

Martin Fransen, Nikhef

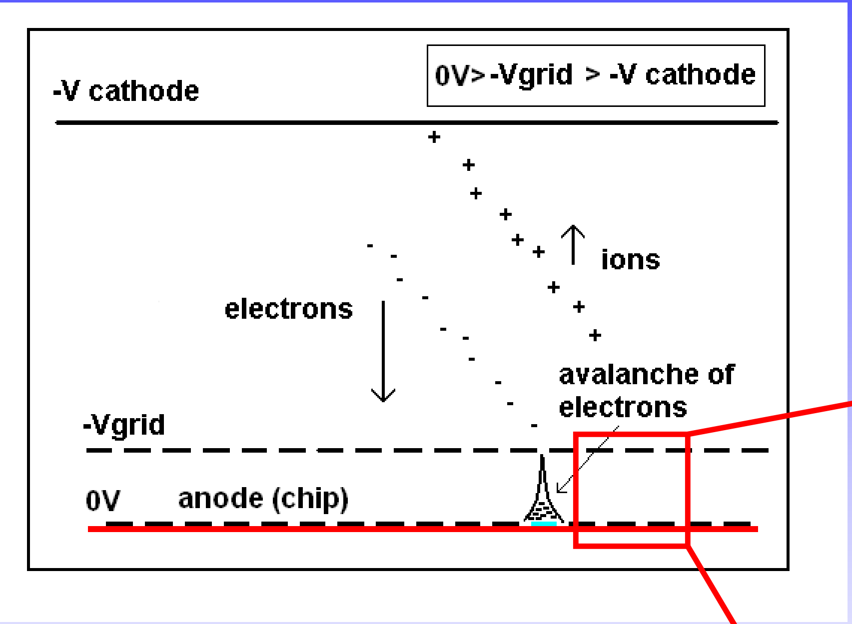


NIKHEF

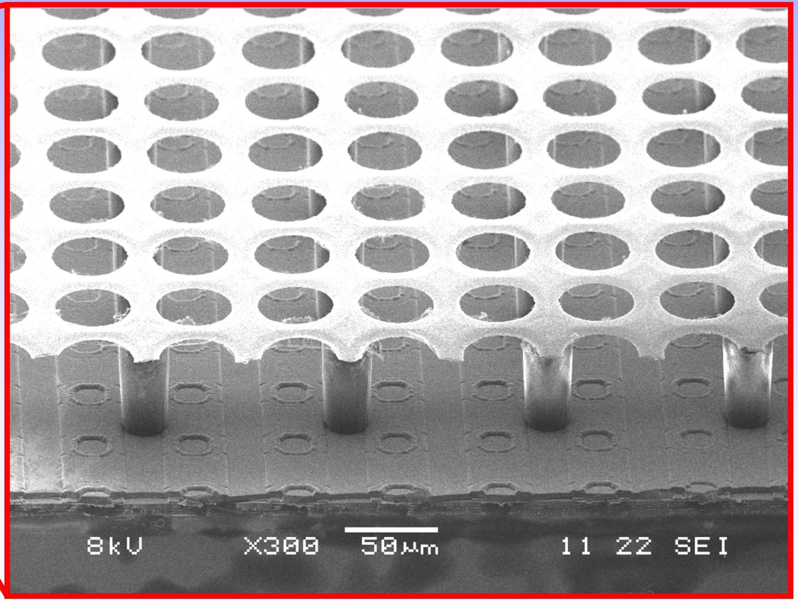
Outline

- Chip post processing
- Testing GridPix at DESY
- Testing Gossip at CERN
- Iflink and optical powering

Gridpix detectors

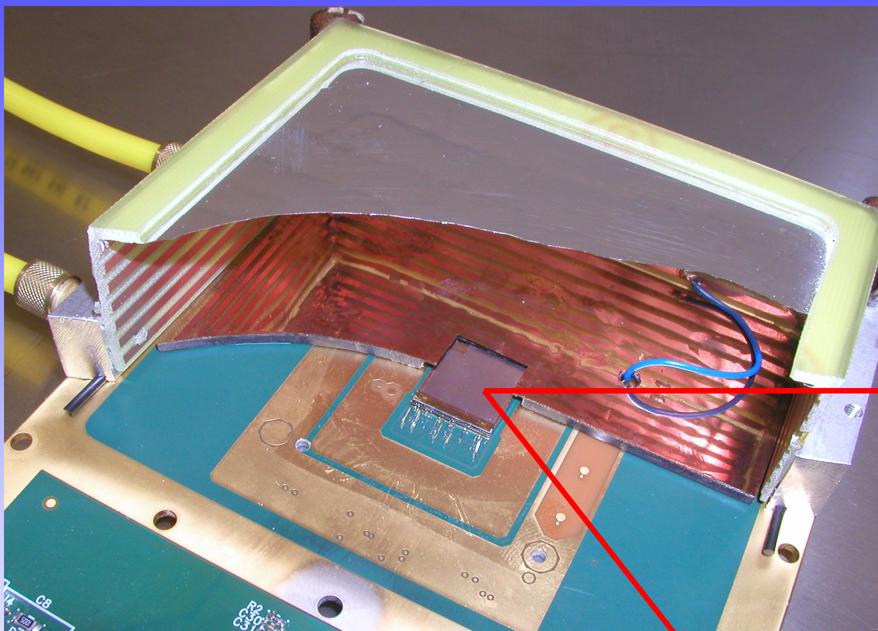


- Drift time gives z coordinate.

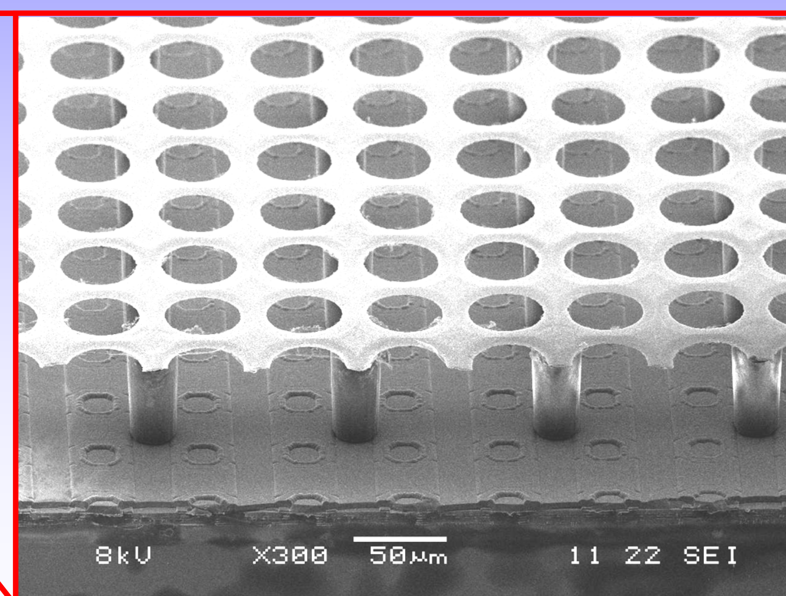


- Cathode
  - Drift volume (~mm to ~m)
- Grid
  - Gain region (~50 um)
- Pixel readout chip

Gridpix detectors



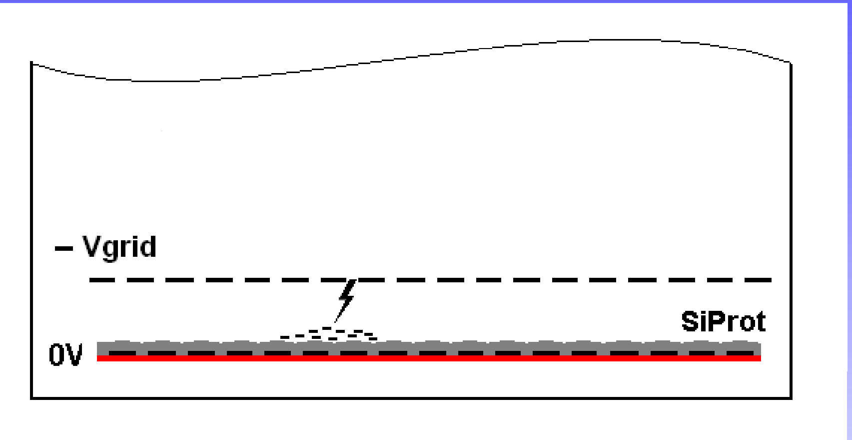
- Drift time gives z coordinate.



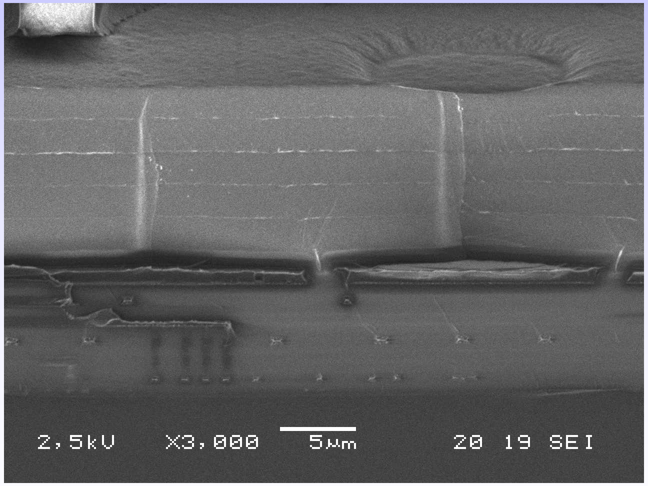
- Cathode
  - Drift volume (~mm to ~m)
- Grid
  - Gain region (~50 um)
- Pixel readout chip

Chip post processing

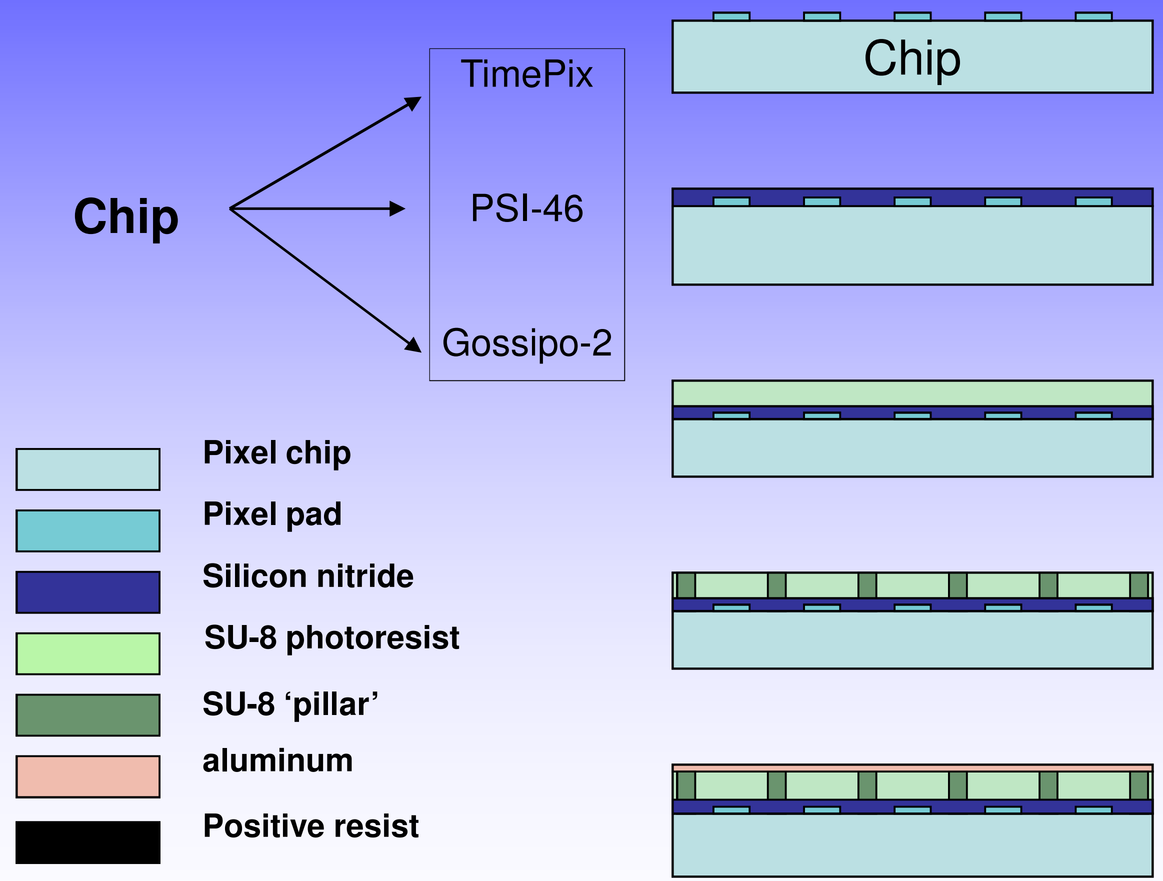
- Apply protection layer
  - Discharge quenching
- Apply Ingrid
  - Gain region



- Si_3N_4 , silicon rich silicon nitride high res layer
- Charge pileup during discharge

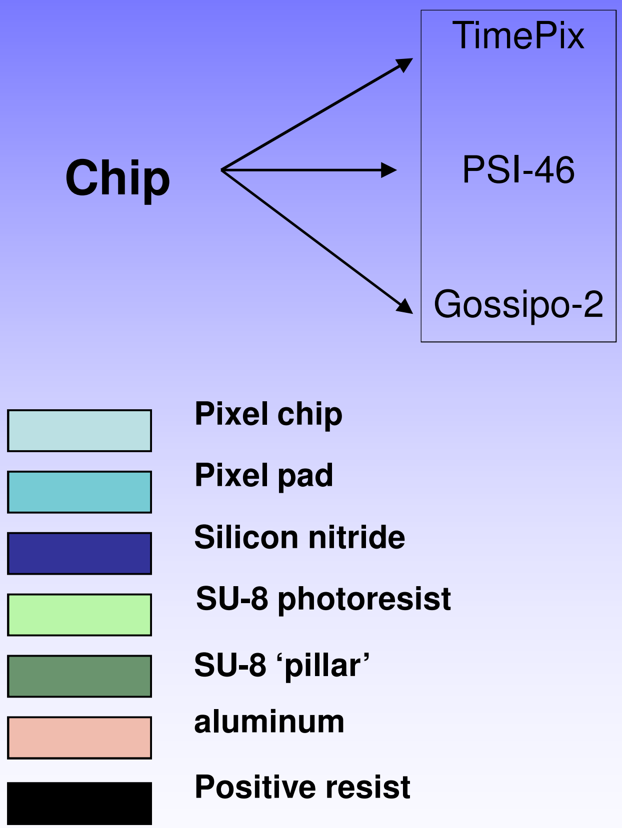


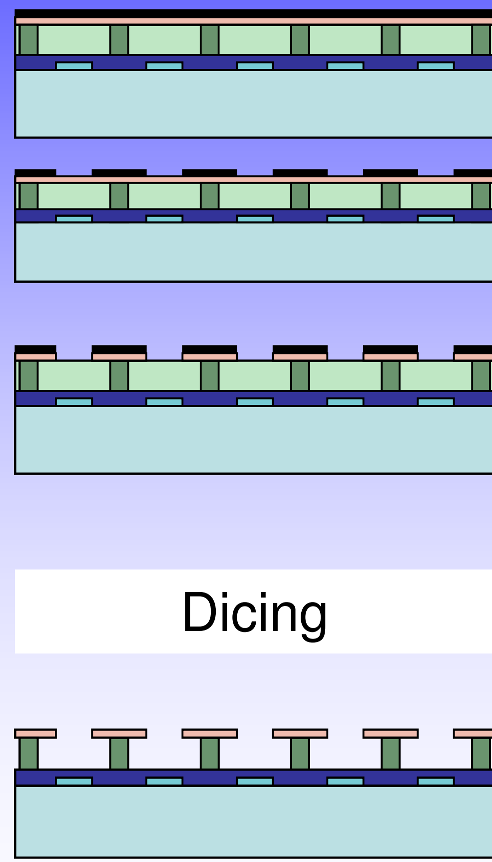
Chip post processing



- Start with naked chips on square
- Si_3N_4 in Multiple steps to prevent overheating
- Spin coating of SU8
- Exposure for pillars
- alu in Multiple steps to prevent SU8 crosslinking

Chip post processing

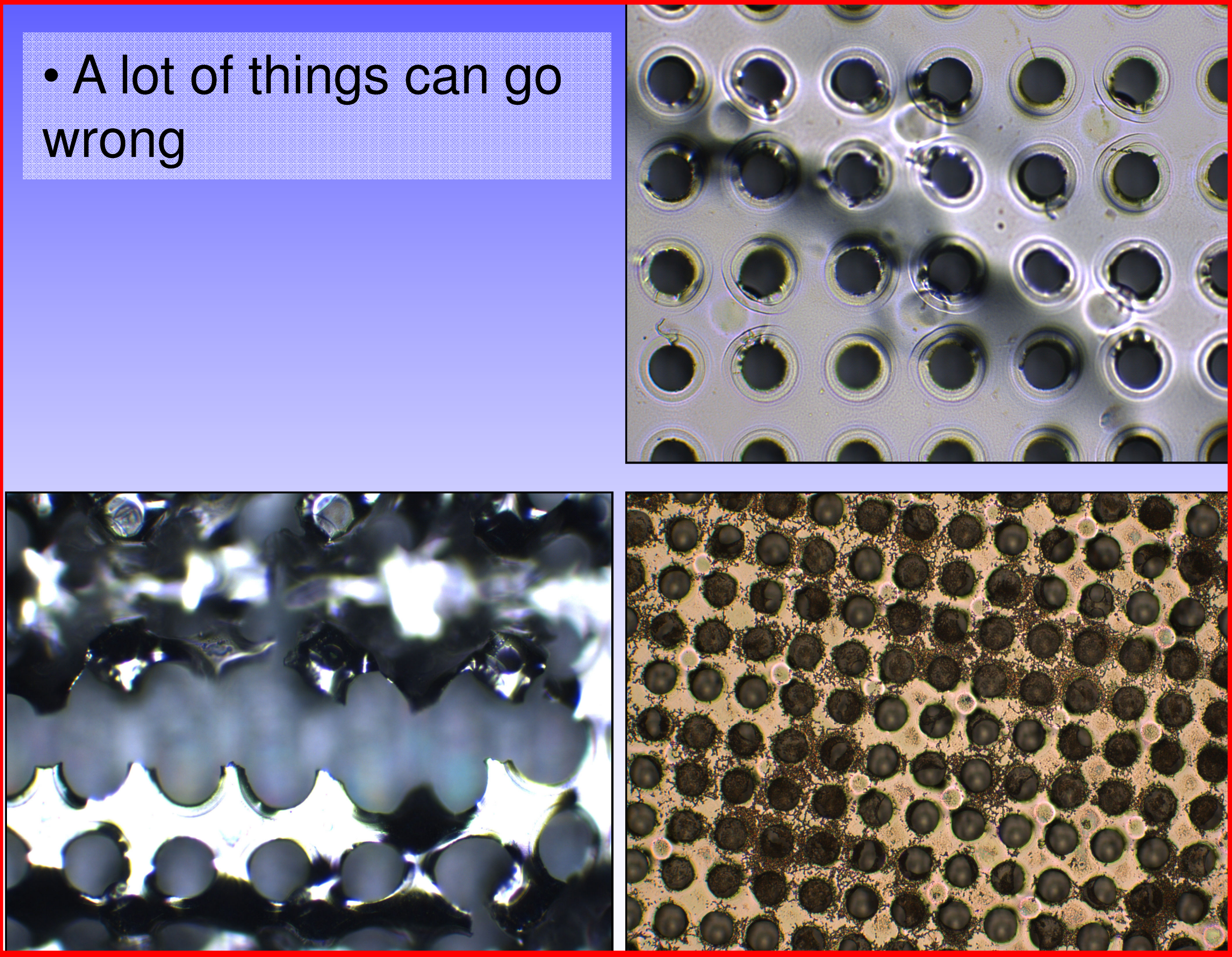


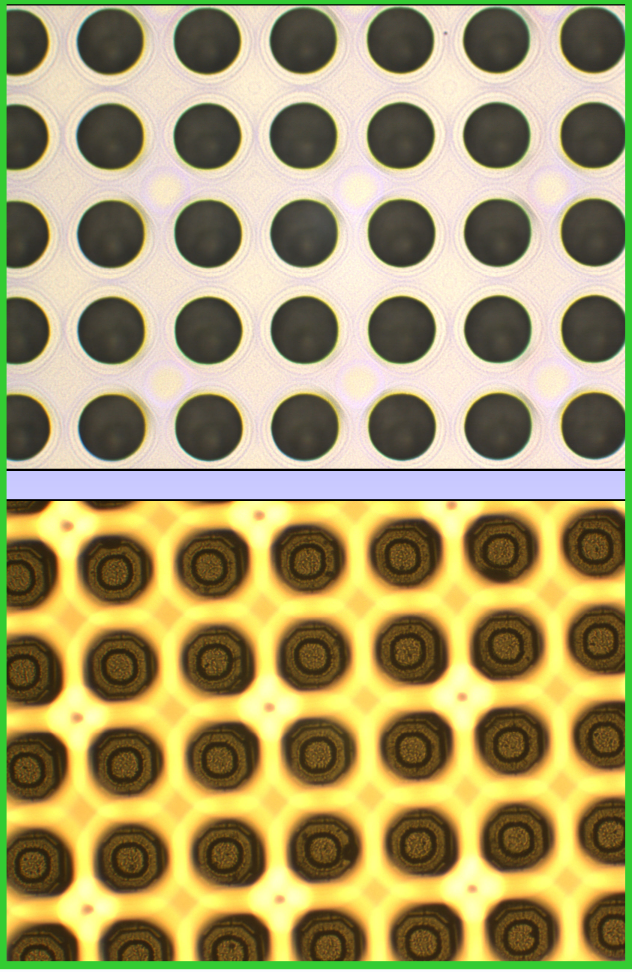


- photoresist on alu
- expose and develop
- etch alu
- try not to damage alu, apply temp layer of photoresist
- develop SU8

Chip post processing

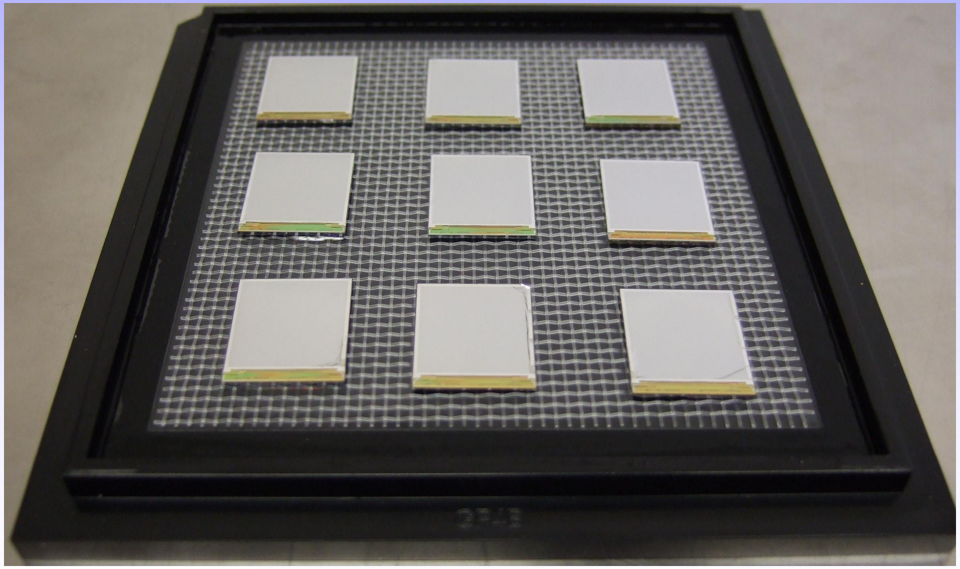
• A lot of things can go wrong





Chip post processing

- Since October 2009 acceptable yield from parallel processed TimePix chips
- First batch of those to Saclay (finally!) for end modules



Beamtests at DESY

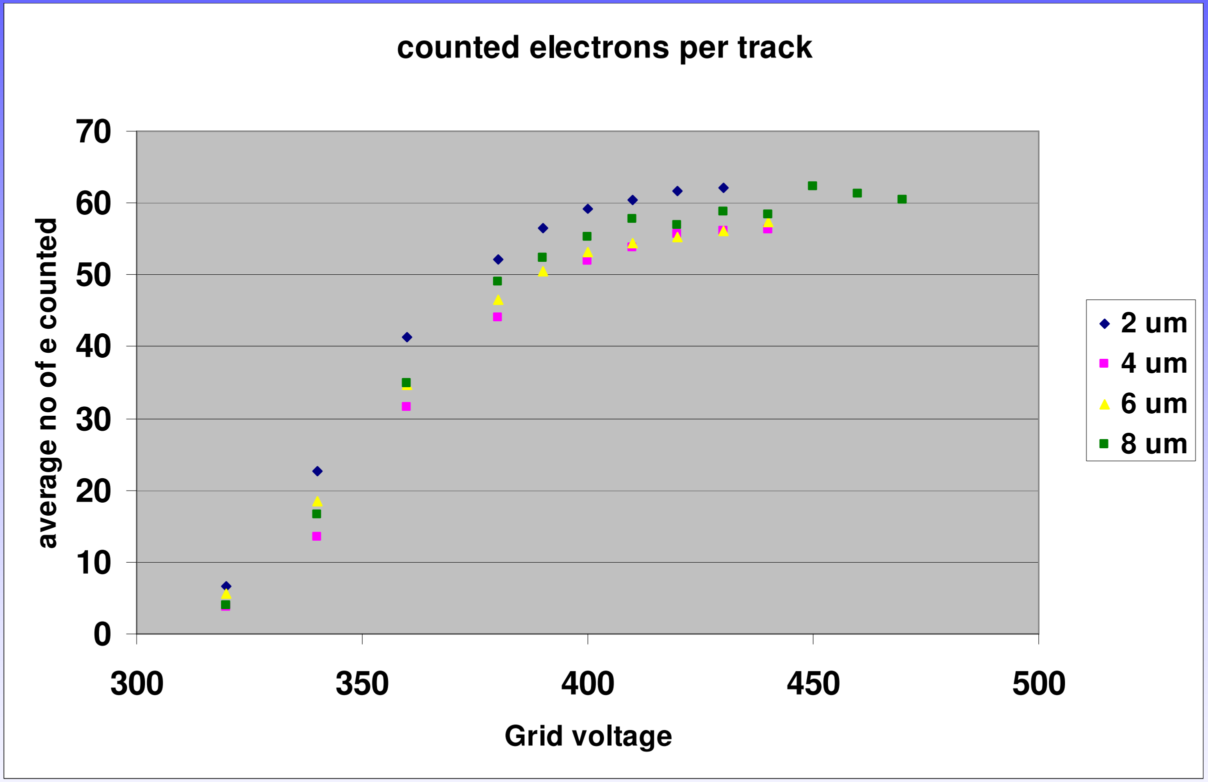
- Few GeV e to test;
- Signal development
- When do the chips break down?

  (this is, of course, the last test to be performed)

- The Gridpix detectors:
- TimePix chips with 2,4,6,and 8 um silicon nitride
- 11.5 mm drift gaps
- Used gases:
  - Ar/ISO 80:20
  - He/ISO 80:20
  - T2K, Ar/CF4/ISO 95:3:2
  - Ar/CO2 70:30
  - He/CO2 70:30

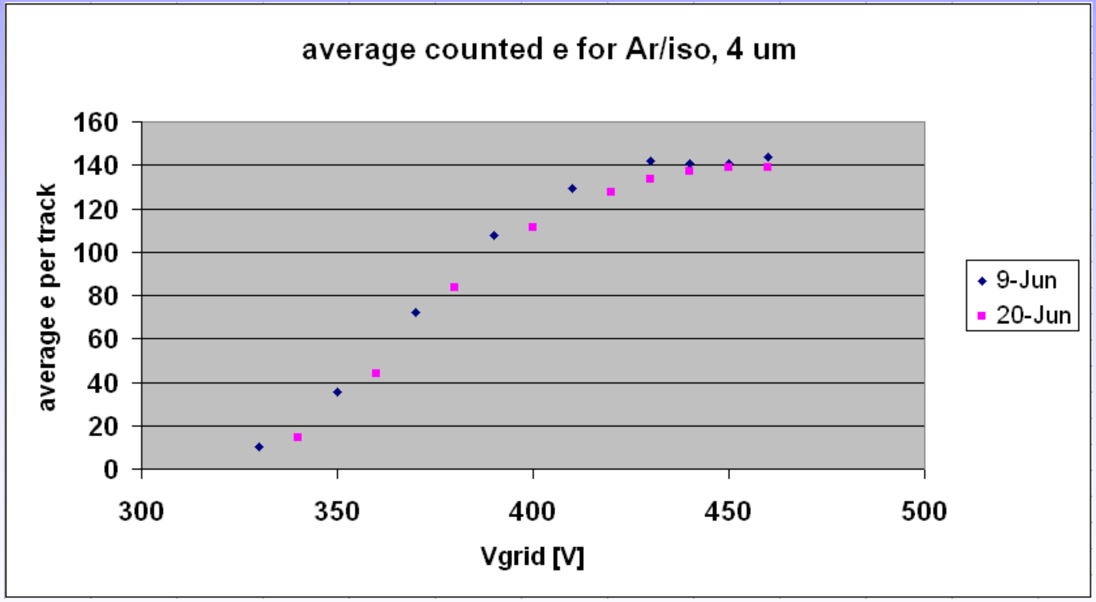
Beamtests at DESY

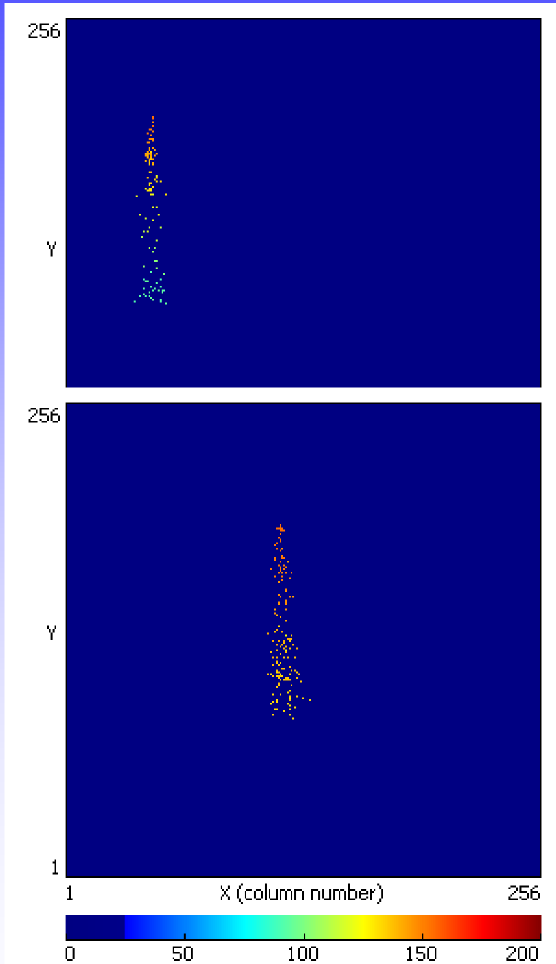
- (pretty) raw data
- He/ISO 80:20
- E drift = 450V/cm
- counting electrons per track.
- compare this per chip.
- Until sparking (and the 8 um a bit further)



Beamtests at DESY

- Ar/ISO 80:20
- E drift = 900V/cm
- continue using the 4 um chip
- For other gasses no plateau reached

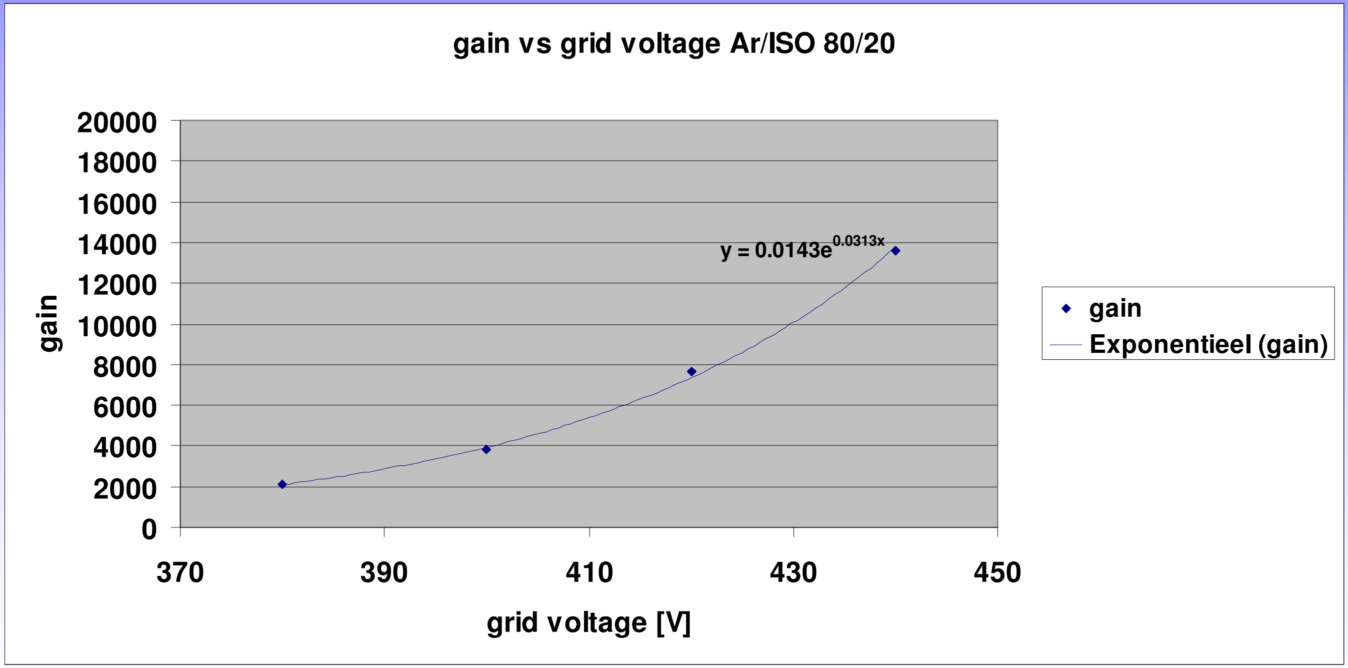




Pixelman software: IEAP, Prague

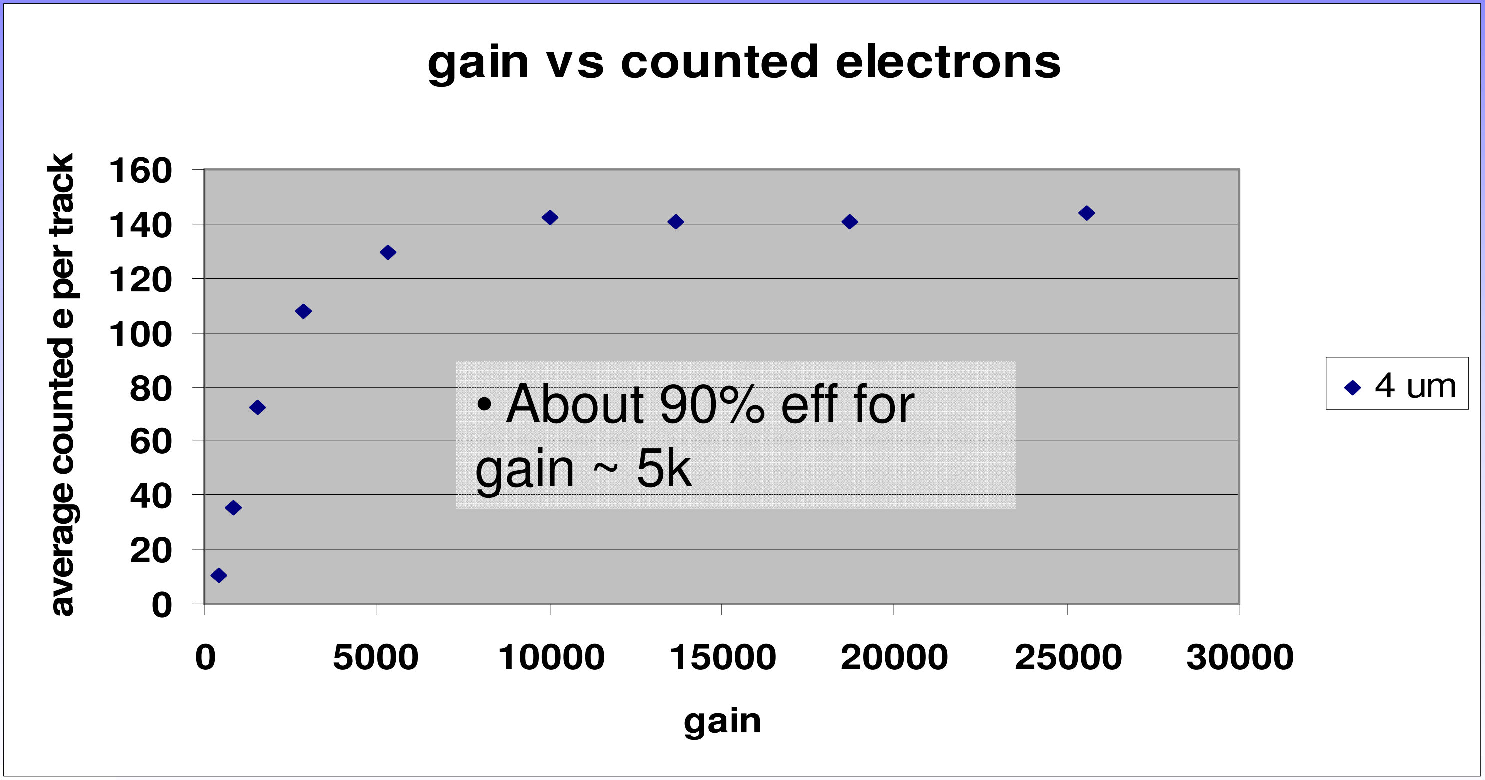
Beamtests at DESY

- Ar/ISO 80:20
- Use 55Fe
- Give or take 50%



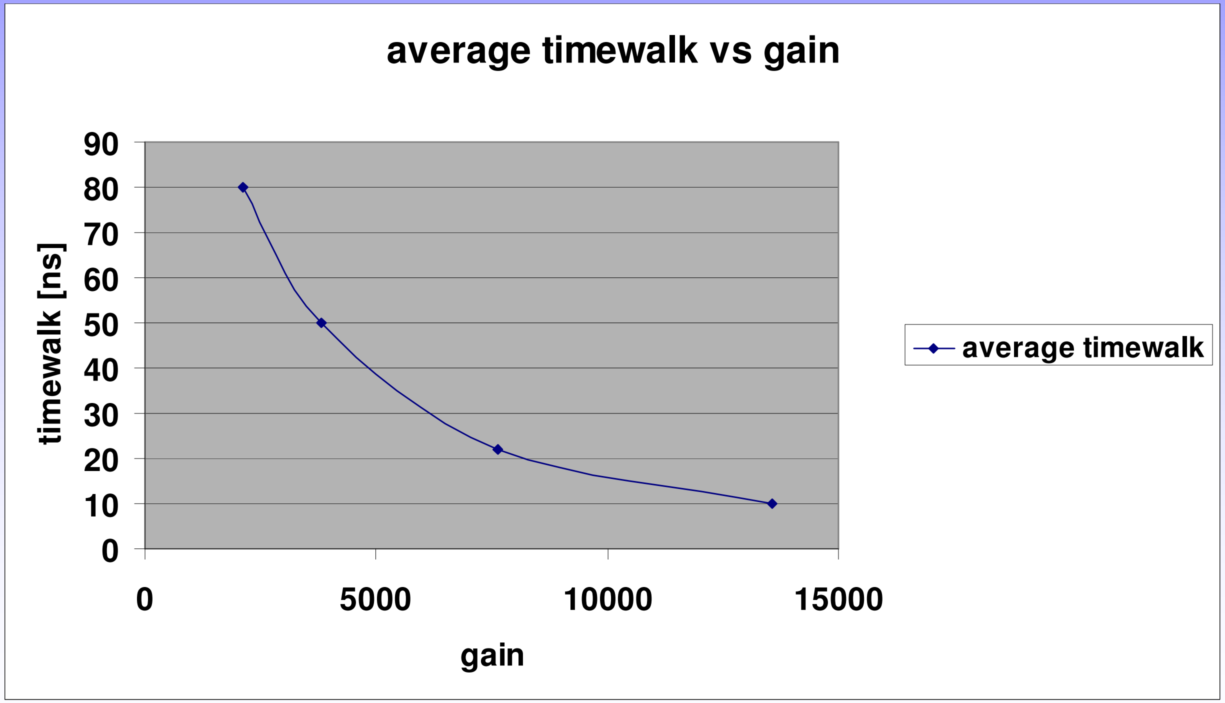
Beamtests at DESY

- Ar/ISO 80:20



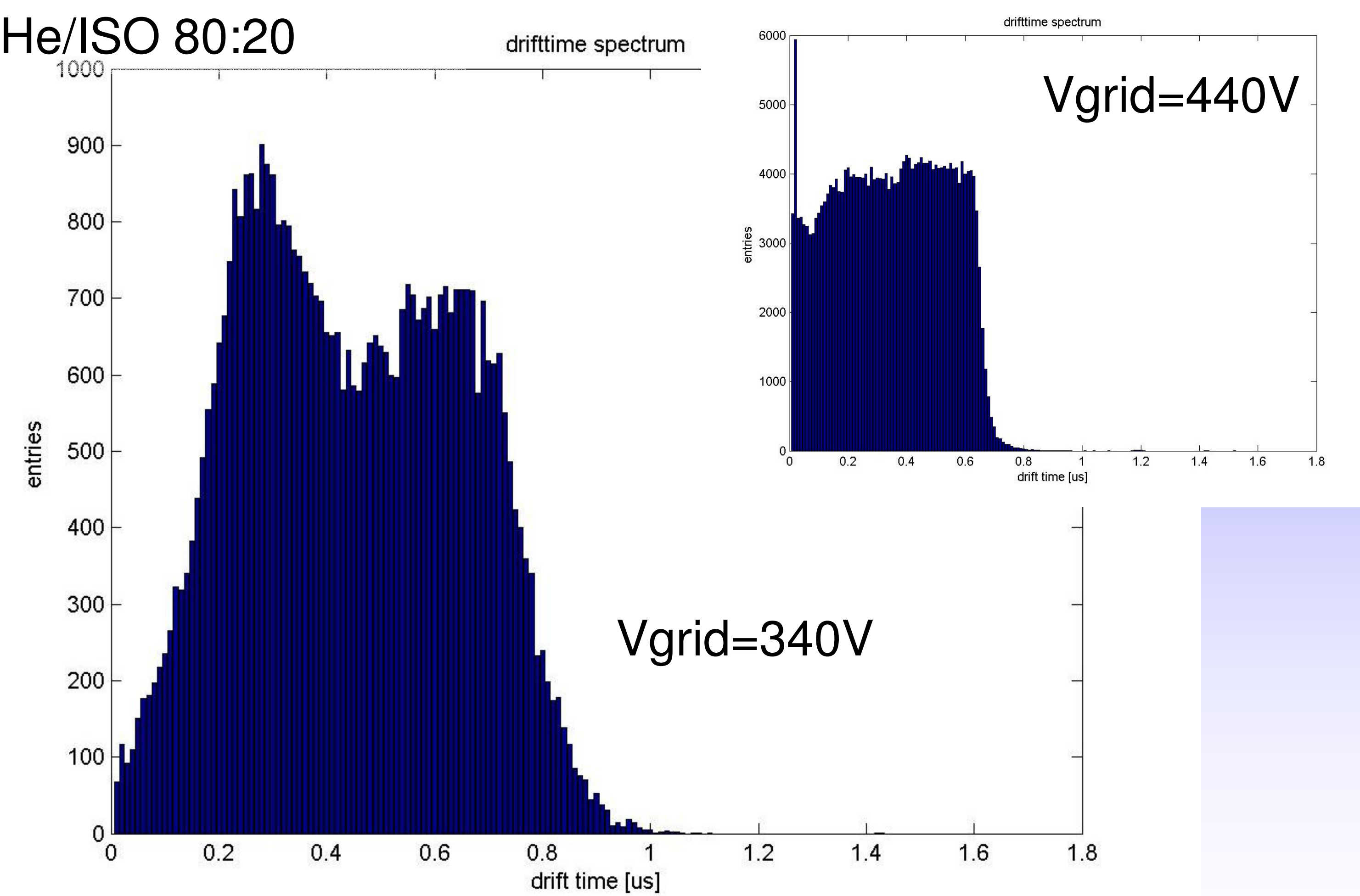
Beamtests at DESY

- Ar/ISO 80:20
- probably worse for low gains



Beamtests at DESY

- He/ISO 80:20

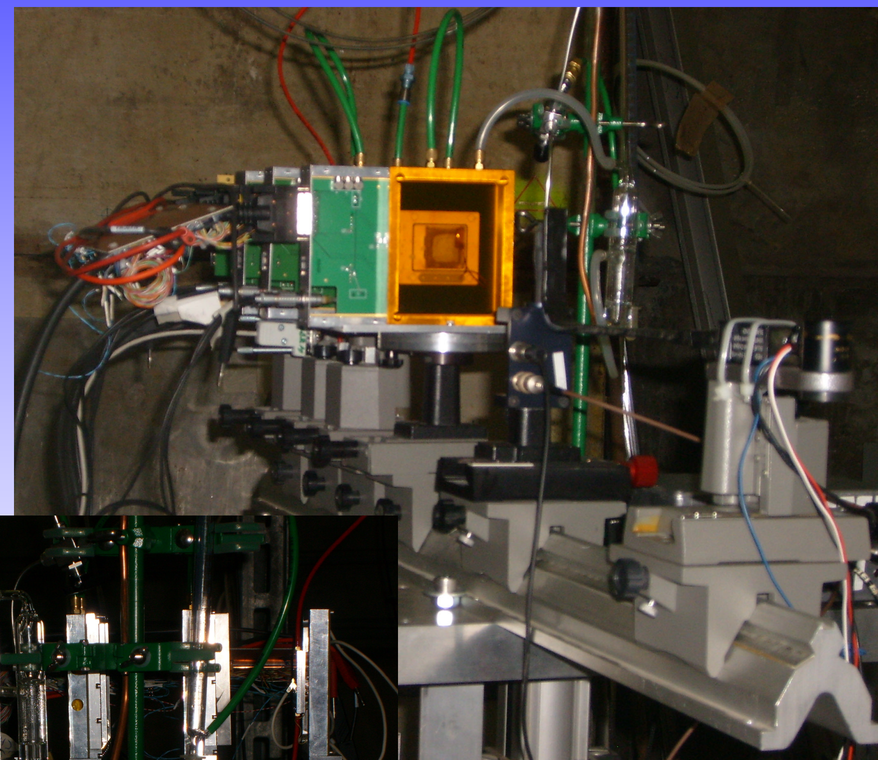


Beamtests at DESY

- And finally destruction…
- After hours of suffering >2 sparks/sec, the 4 um chip is still doing fine BUT:
- After few more days, under normal operation:
  - The 6 um dies (Ar/ISO 80:20, Vgrid -430V)
  - 10 days later the 2 um dies (He/CO2 70:30, Vgrid -520V)
  - Another 6 days, the 4 um (T2K, Vgrid -360V)
- All breakdowns are similar, regardless of thickness of SiNi Layer.

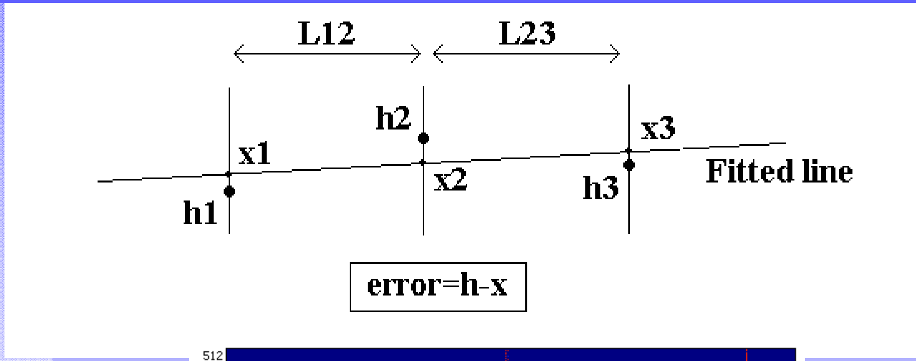
Beamtests at CERN

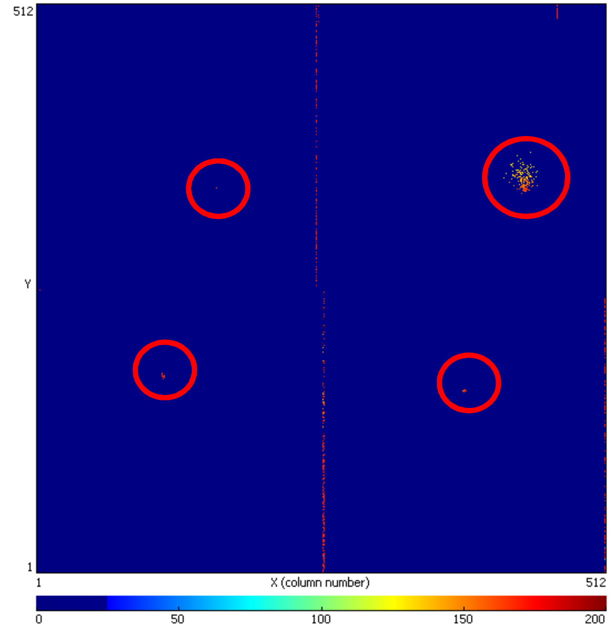
- TimePix chips
- 3 X Gossip and DICE in series
- DICE drift length 19.5 mm
- Gossips: 1, 1.4 and 1.5 mm drift
- Ar/ISO 80:20 and CO_2/DME 50:50
- E drift = 900V/cm and 2kV/cm



Beamtests at CERN

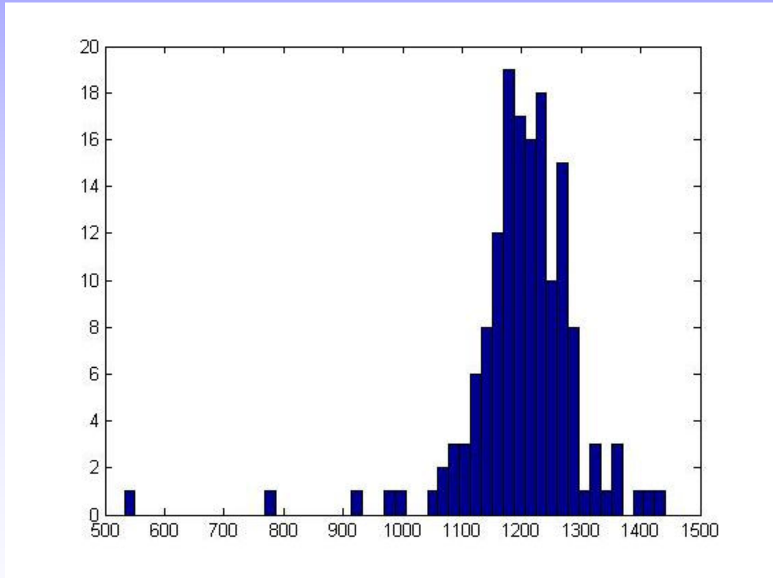
- DICE is reference detector
- Determine center of gravities h1,h2 and h3
- No time information used (too much timewalk)
- Determine relative positions of chips
- L12, L23; distance between detectors
- X1,2,3; best fit

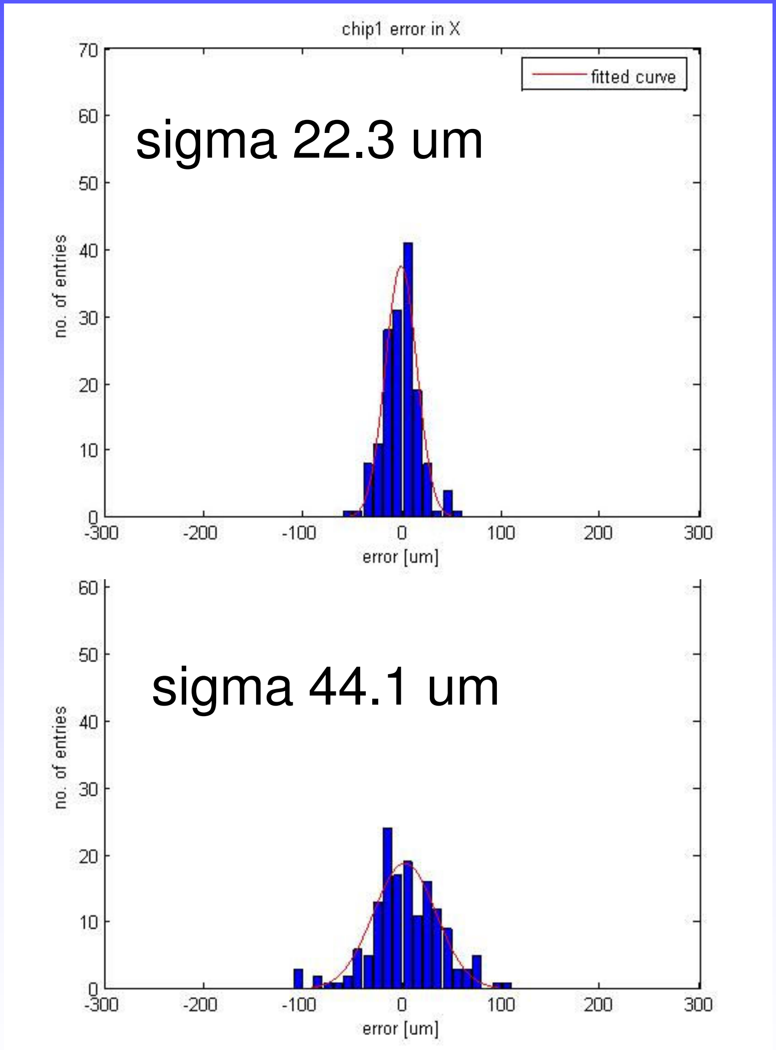




Beamtests at CERN

- 150 GeV “stuff” from SPS
- Ar/ISO 80:20





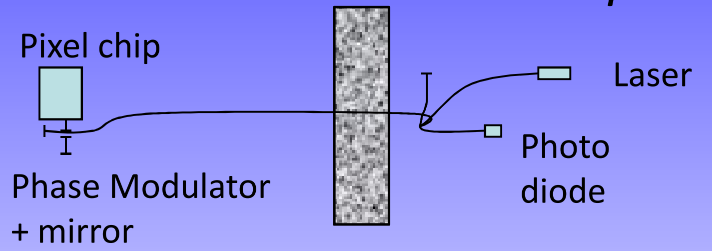
Iflink

- Optical data connection
- based on interferometer
- Laser and sensor outside detector

- Low material budget
- Low power requirement inside detector
- Fast, Gb/s

H vd Graaf, Nikhef, Amsterdam
vdgraaf@nikhef.nl

Test setup modulator



- First tests done
- Issues to work on:
- sensitivity
- Rad hard?
- Noise (one interferometer ‘arm’ in ‘rough’ environment)

- optical ‘twisted pair’

Optical powering

- Investigate feasibility for an optical power connection
- Lots of lasers through lots of fibers to distribute power.
- Why?
- Low material budget Cu→SiO_2

(remember, high I low V required)

- Power pulsing easily possible
- floating electronics (less pickup, no groundloops, no serial powering problems etc.)

- since a few years, multi W ~808 nm lasers are affordable
- commercal laser efficiency 40-50% (~60% in lab experiments)
- Theoretical P_l to P_e conversion >60% efficient for single wavelength for kW/cm^2.

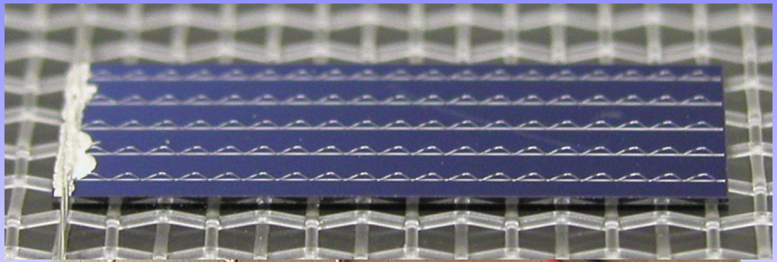
H. Miyakawa et al. / Solar Energy Materials & Solar Cells 86 (2005) 253–267

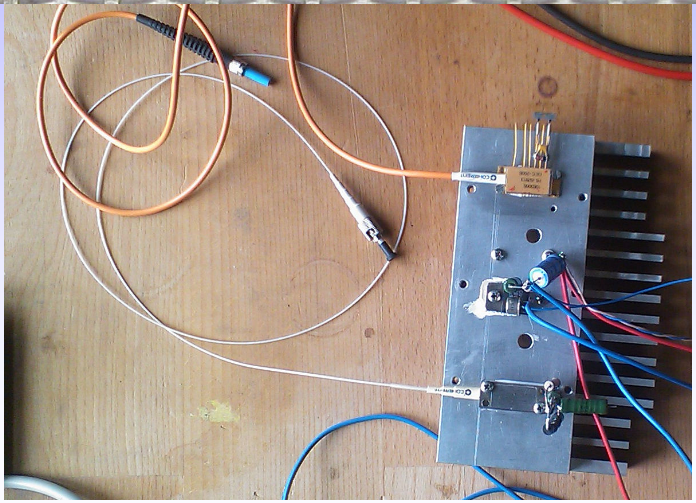
- about 40-50% eff for present power supplies (cable losses)
- In this case 15-30 % efficiency

Optical powering

- Some naïve numbers:
- Assume ‘thick’ 250 um fibers
- 30 kW power needed
- 2-3 W laser light per fiber
- 1 W electrical output per fiber →
- 30000 fibers needed, bundle of ~5 cm
- Lots of heat at the wrong place (CO_2 cooling?)
- Expensive? (~500k EUR on lasers)

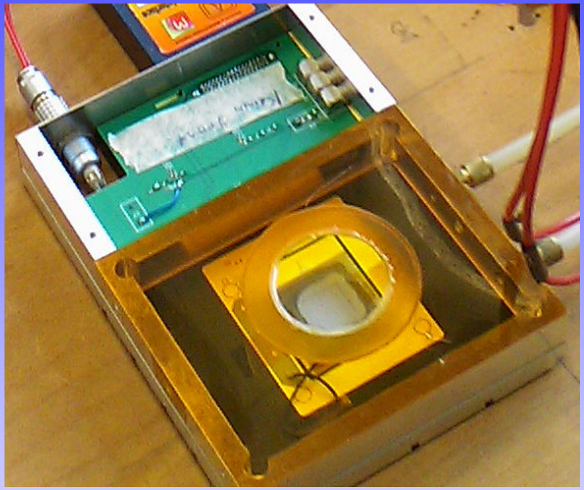
- Rad hard? (fiber, PD)
- Other practical problems?

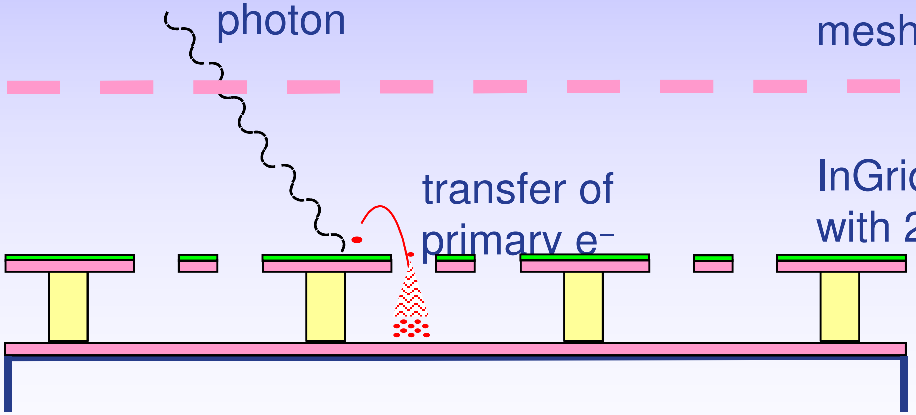


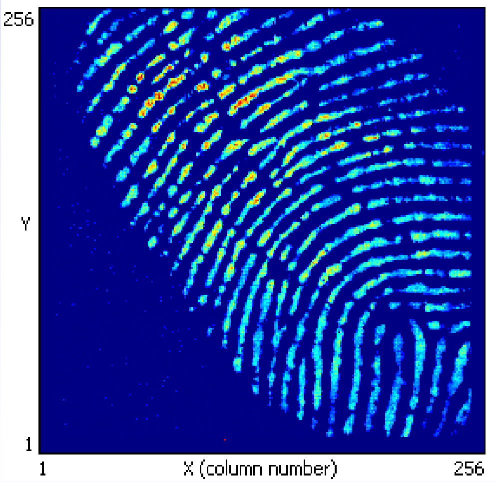


‘Optical’ Gridpix

- Univ. Twente and Weizmann institute
- Timepix with 80 μm InGrid
- Gossip detector set up
- UV light source D_2 lamp







Summary

- Reproducible parallel postprocessing possible
- a *good* 4 um silicon nitride layer is sufficient spark protection
- But what causes that still sometimes a chip dies?
- for He/iso and Ar/iso mixture we can run with e eff > 90%
- Do more analysis on the data
- use data to verify/improve Gridpix simulations
- Investigate improvement of Iflink
- Investigate feasibility of optical powering

Questions? (or remarks)