# NIKHEF activities within EUDET/SiTPC

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*Munich*

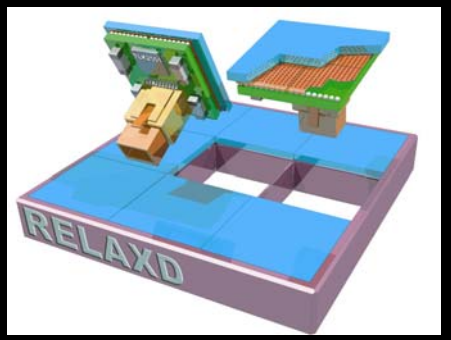
# Overview

- (motivations)
- An integrated Micromegas
  - Study of geometry, gain & resolution
- A protection against gas discharges
  - A high resistive layer as spark quencher
  - Recording discharge signals…
- A double stage integrated detector
  - Between GEM and Micromegas…

# Pixel readout of gaseous detector

Electronic channels x $10^3$
*Data rate ~ Gbits/s !*

*Endplate: chip tiling, dead areas*

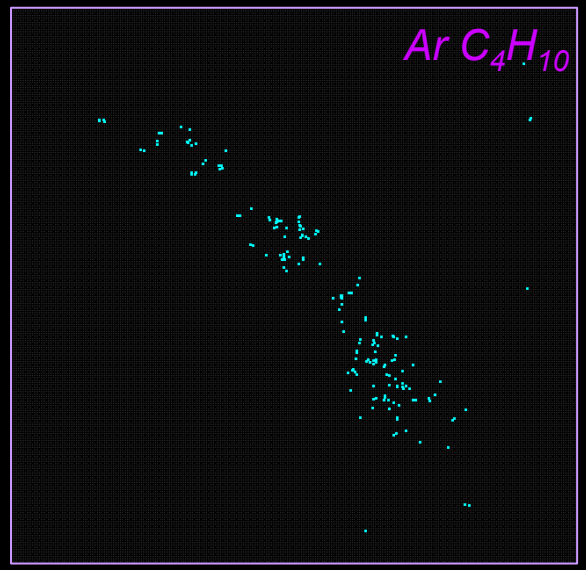


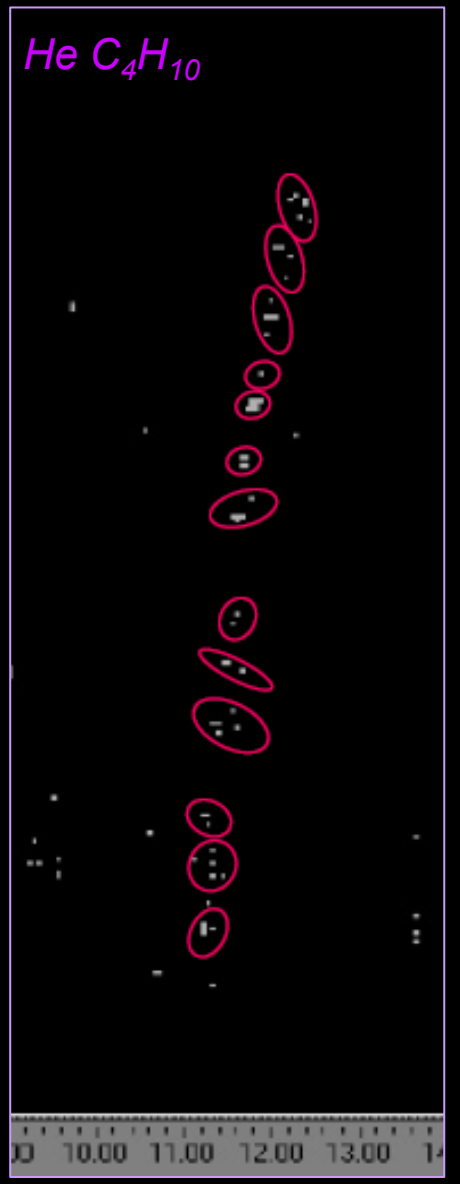

High granularity (pixel size)

Single electron sensitivity
*Cluster counting (?)*

Low input capacity (~ 50 fF)
*Low gain operation*
*Reduced discharge risk*
*Reduced ion backflow*

δ-rays suppression



# InGrid, an integrated Micromegas

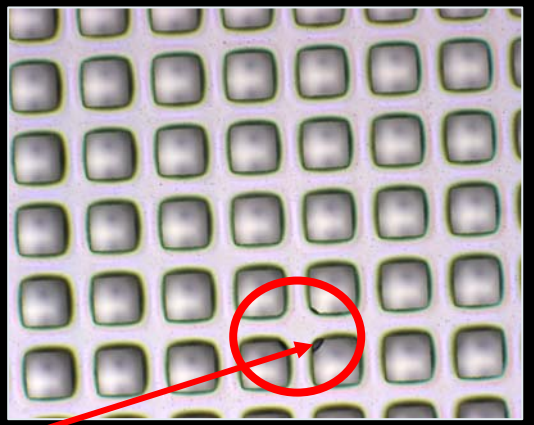
- **Integrate grid by wafer post processing**

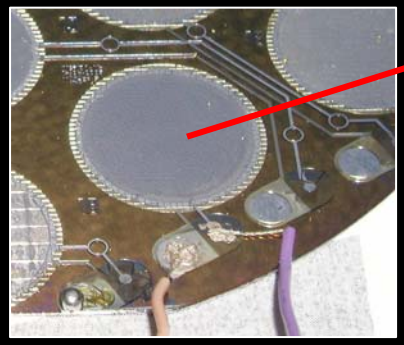
  Low tempertaure process (spin coating, wet etching)

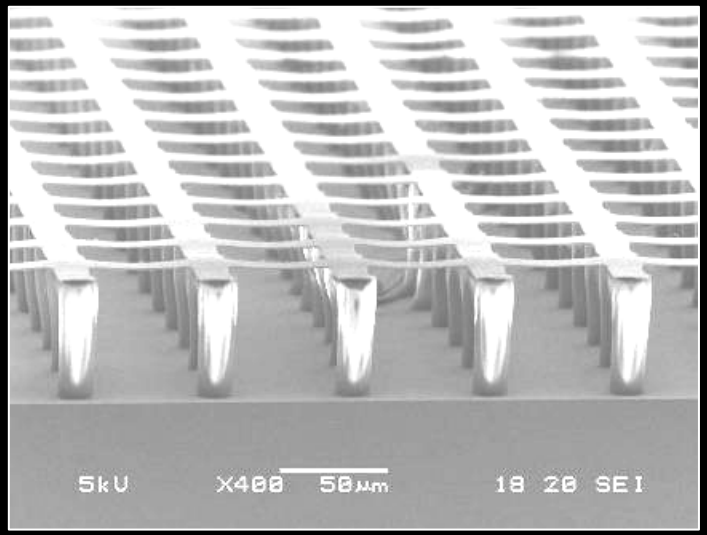
  Perfect alignment between grid holes and pixel pads

  No dead areas due to pillars

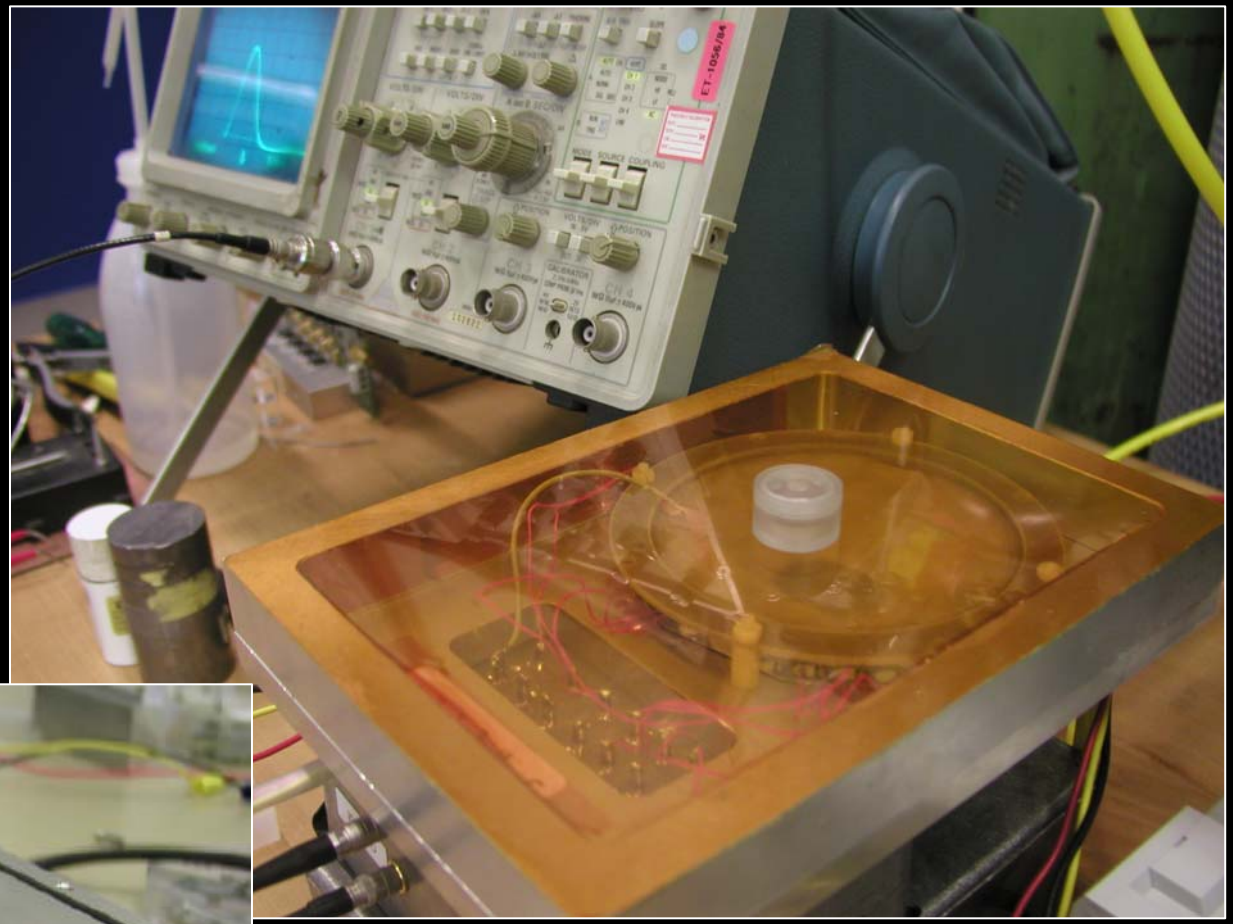
  Flexible design

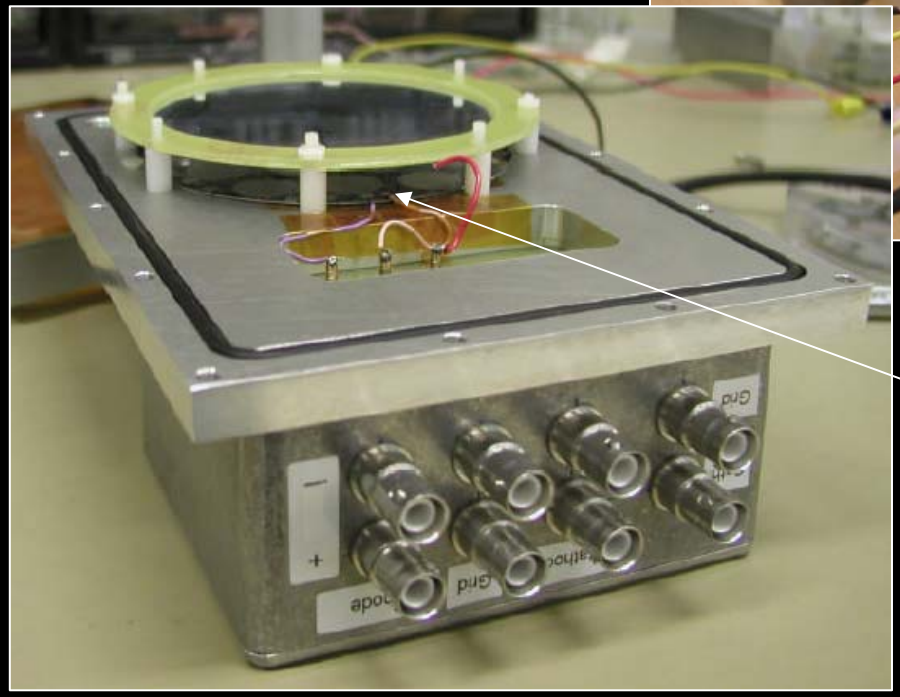


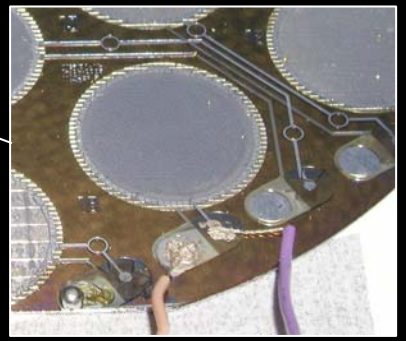





# Experimental setup

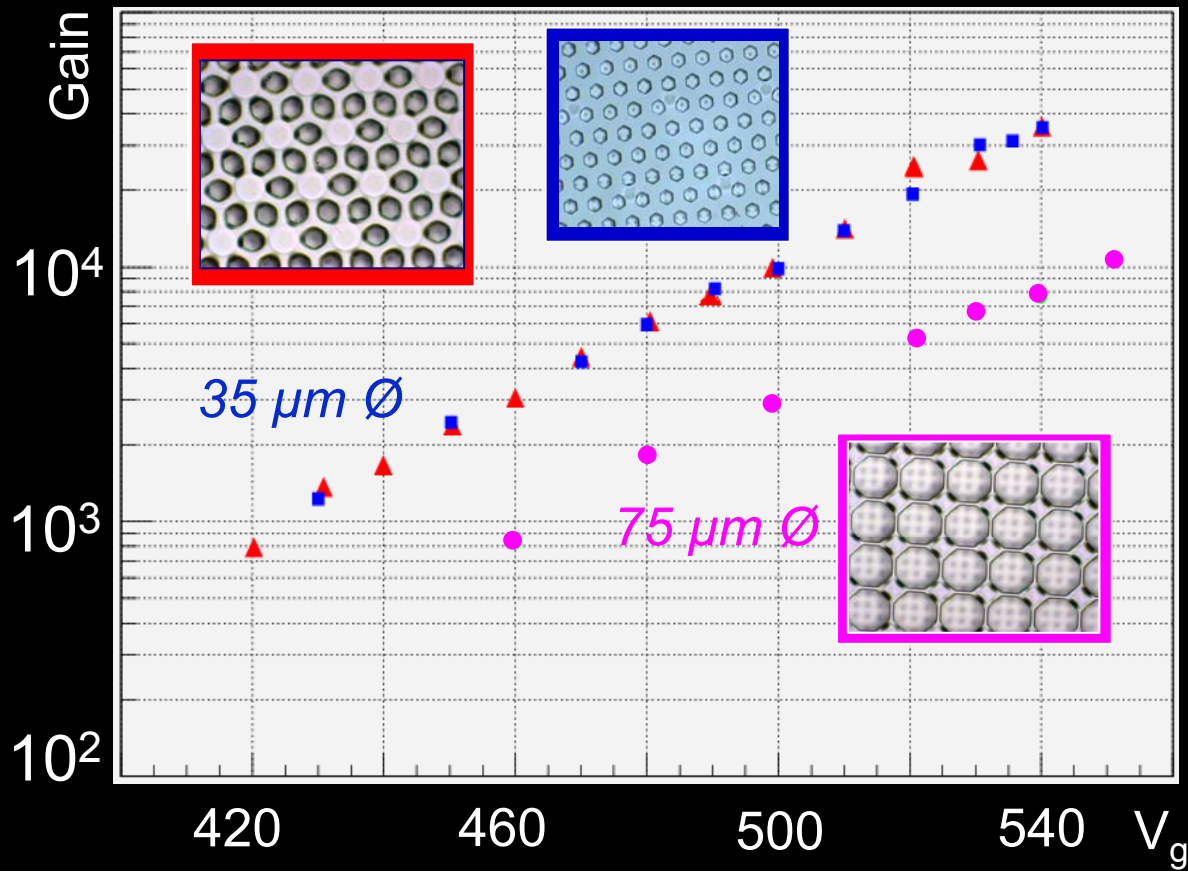




# Grid geometry study (I)

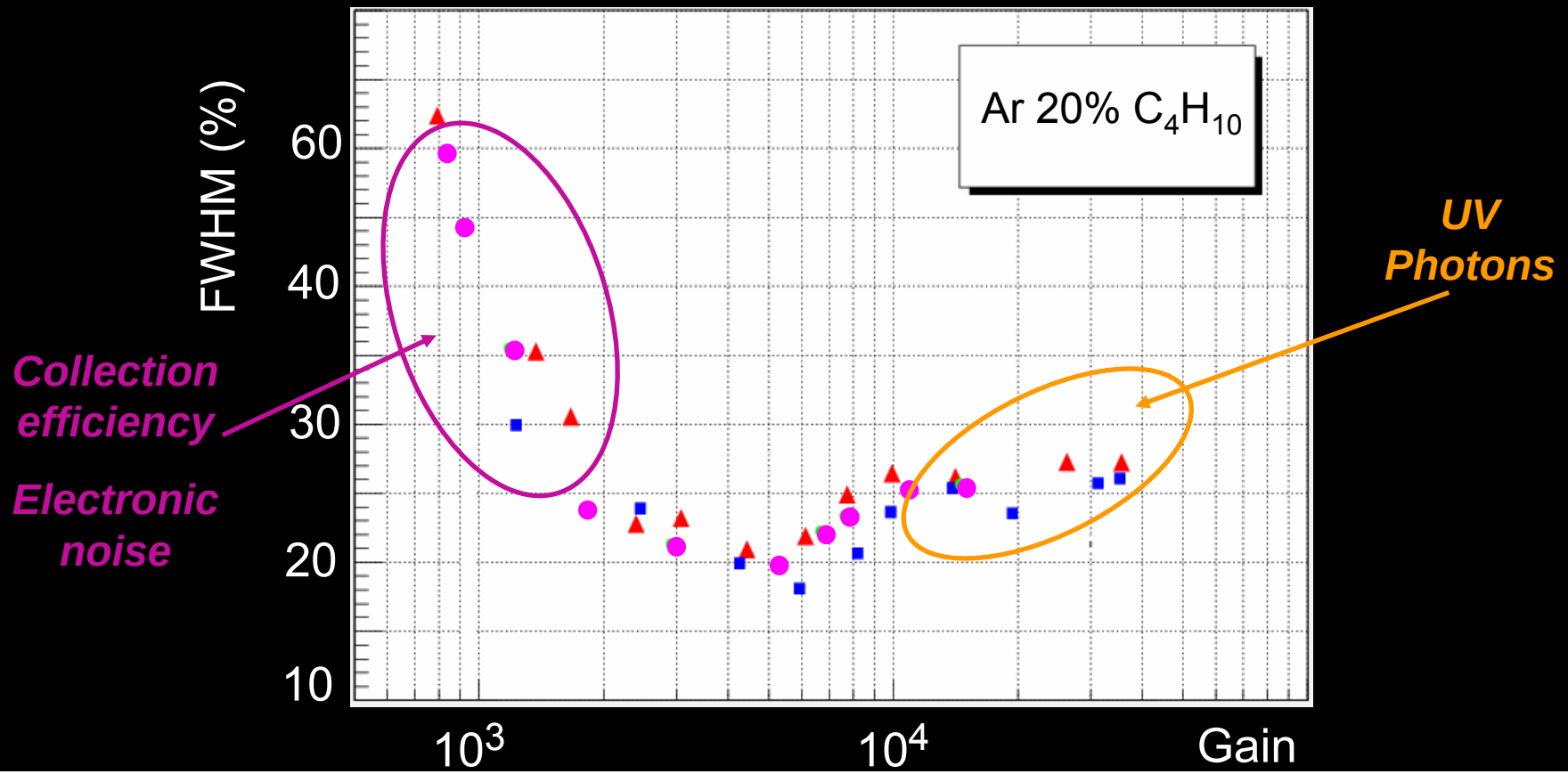
- Gain larger for smaller holes
- Gain slope independant of grid geometry
- Gain maximum @ 75 µm de gap ~ $4.10^4$




- *75 µm gap*
- *Ar 20% $C_4H_{10}$*

# Grid geometry study (II)

- Resolution minimum @ G ~ $5.10^3$
- Resolution almost independant of grid geometry
- Resolution record for 50 µm gap InGrid of 13 % FWHM



# Gain and gap theory

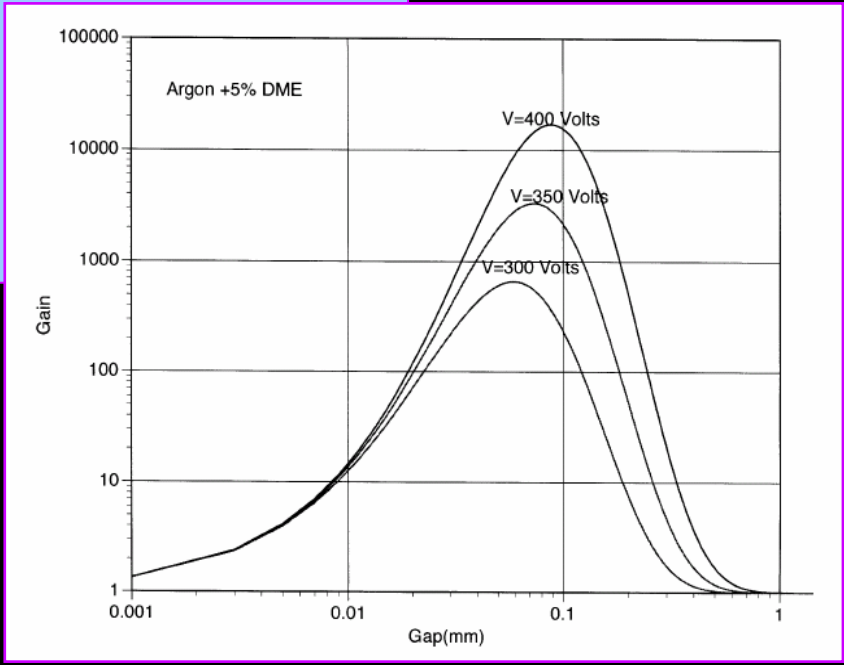
$$Gain = e^{Nion} = e^{\alpha d} = e^{\alpha g}$$

$$\alpha = APe^{-BP/E}$$

*Rose and Korf formula*

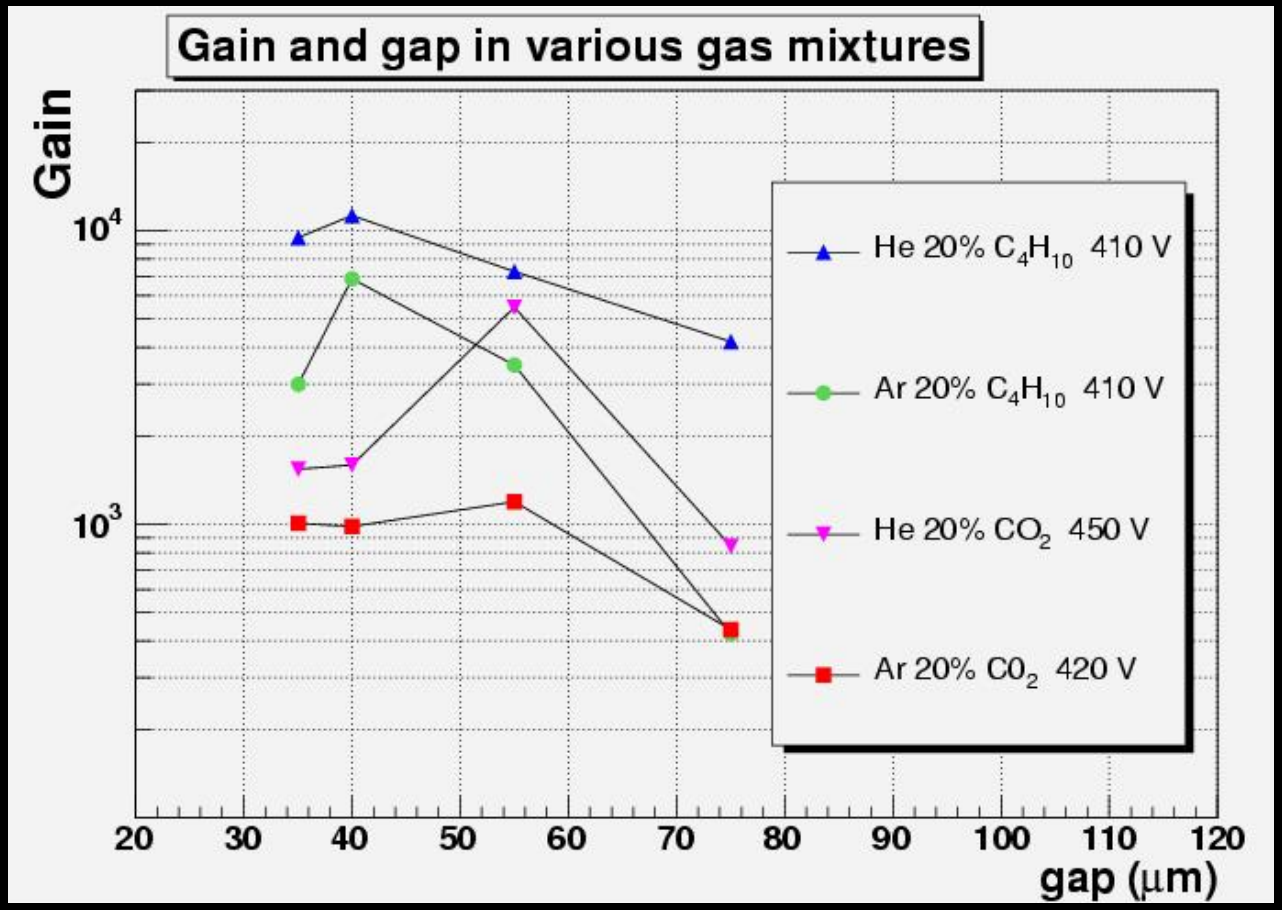
$$Gain = e^{gAPe^{-BP/E}}$$

Maximum predicted for a given gas and grid voltage



# Gain and gap study

- Gas used: Ar / He / $C_4H_{10}$ / $CO_2$
- Prototypes: 35, 40, 55, 75 µm gap InGrids

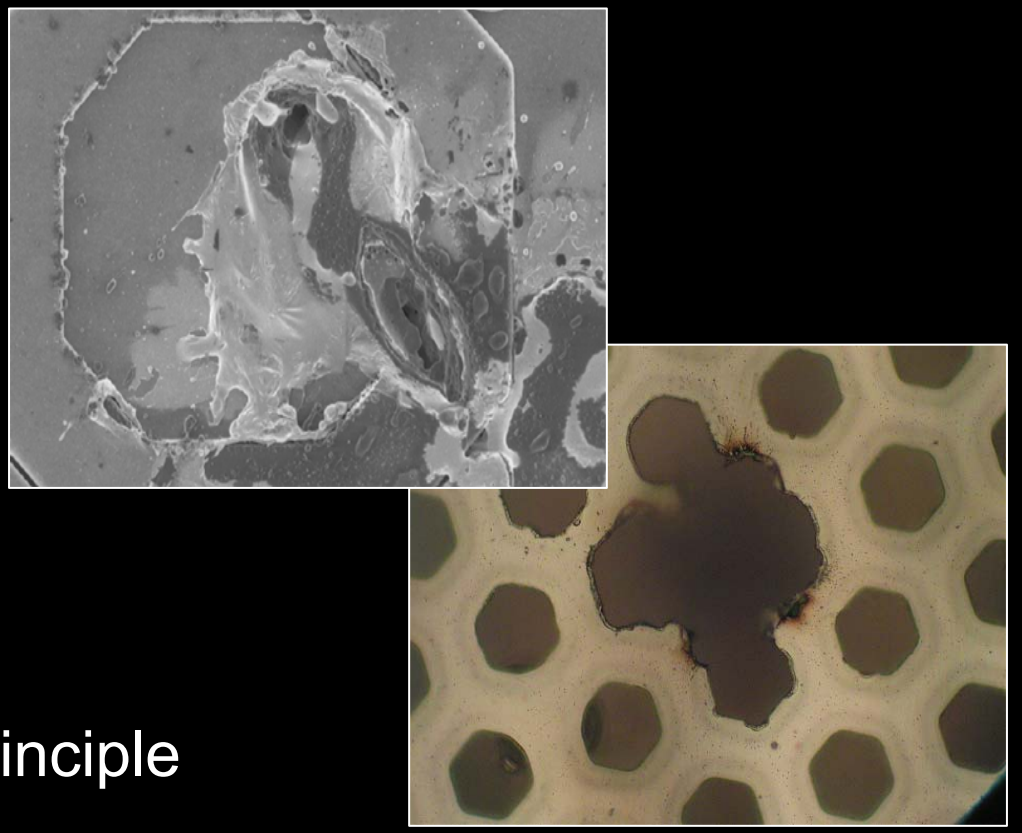


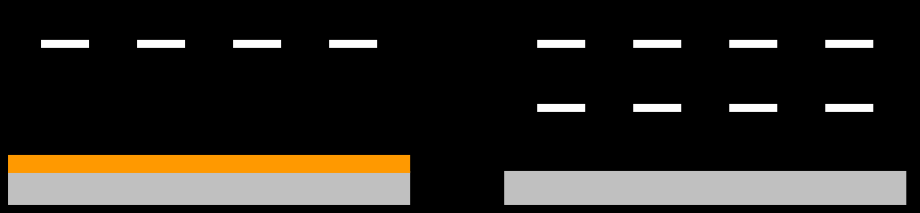

**More gap thicknesses required**

**Optimum gap between 40 µm and 55 µm**

# Gas discharge protection

- Melt pixel pad
- Grid damaged
  - 1 µm thin grid
  - Aluminum $T_f$ ~ 660 °C
- Proposals:
  - Resistive layer, RPC principle
    - ***SiProt***
  - Multi-stage amplification
    - ***TwinGrid***

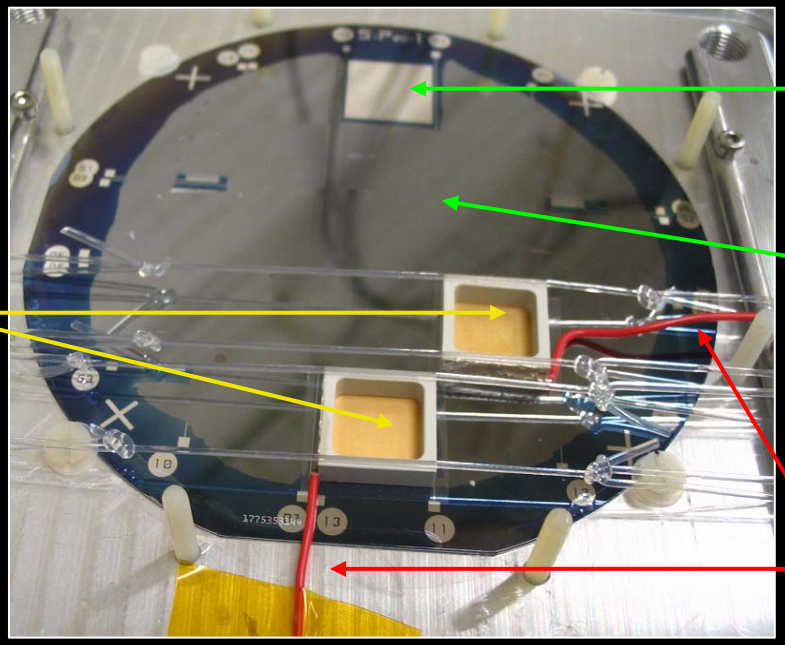




# The SiProt chamber

- Low temperature deposition (< 250°C) of a 4 µm thick a-Si layer of $10^{11}$ Ω.cm resistivity

- Experimental setup:
  - 1 bare anode and 1 a-Si covered anode with Micromegas on top
  - Gain curve with an Iron 55 source
  - Induce discharges by means of 5 MeV alphas
  - Record grid signals

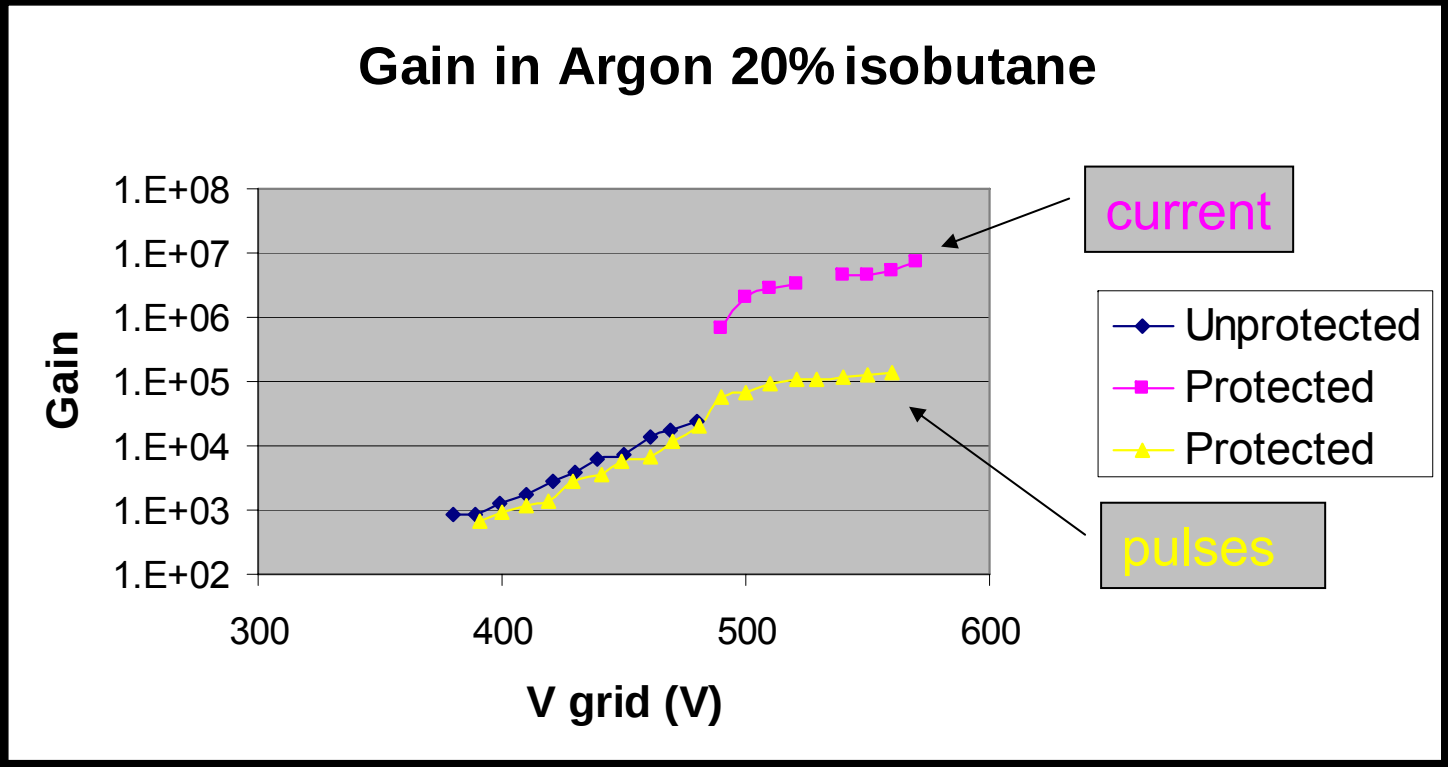


# Gain

Iron 55 source

Look at the pulses from a pre amplifier (low grid voltage)

Look at the current flowing through the power supply (high grid voltage)

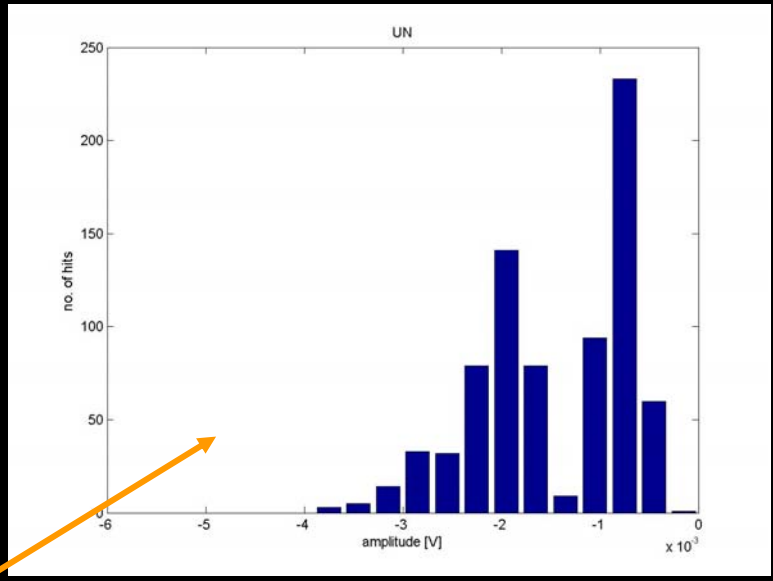



No sparks up to 570 V on the grid !

Burn the grid above 570…

# Signals study

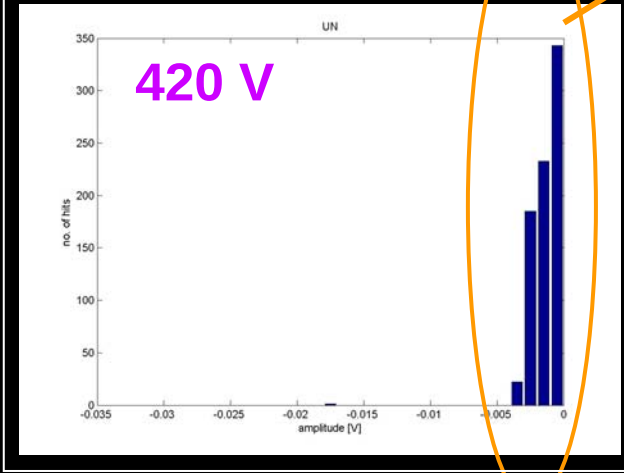
- No pre amplifier
- Ar 20 % $C_4H_{10}$
- Signals from ~ 5 MeV alphas
- Fast digital scope

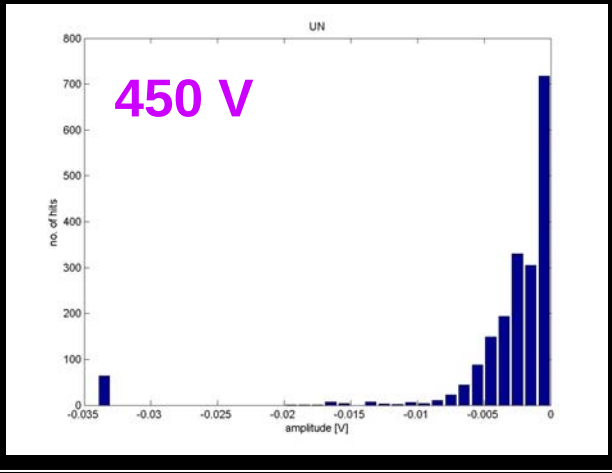


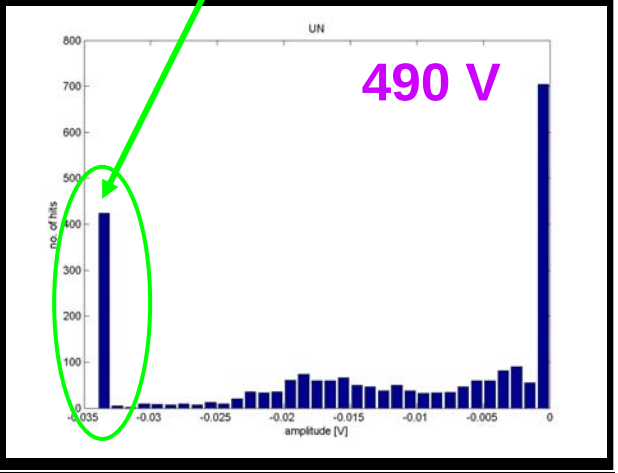

**proportionals**

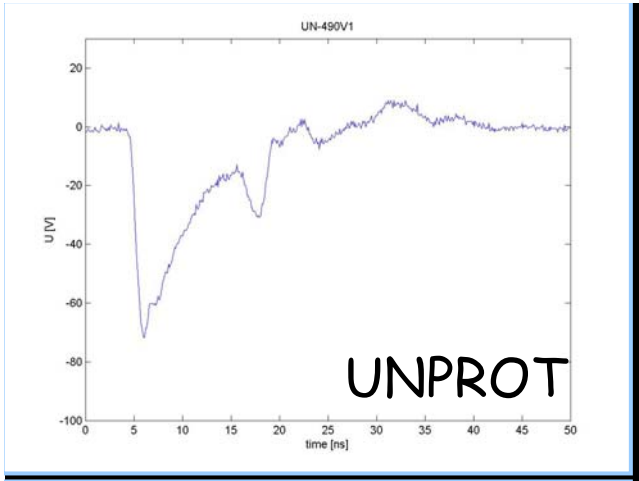
**discharges**

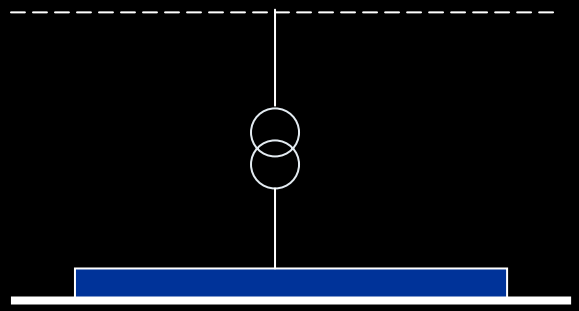
Charge spectra

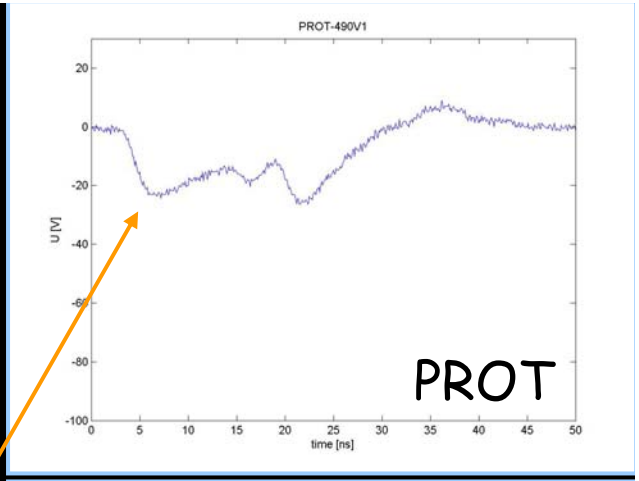


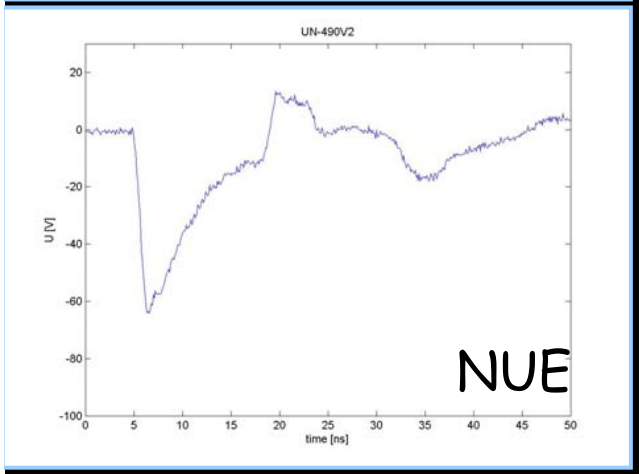



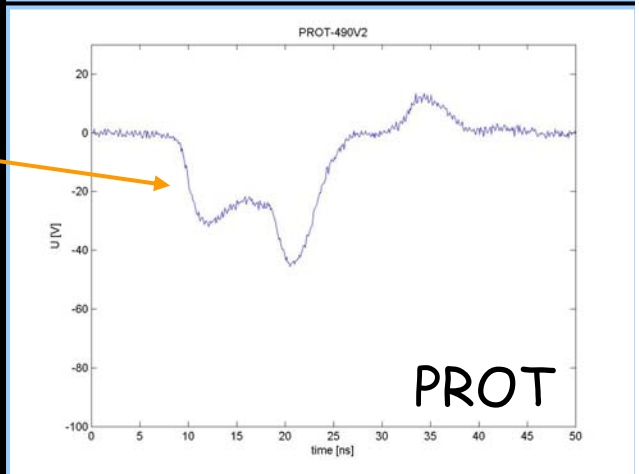


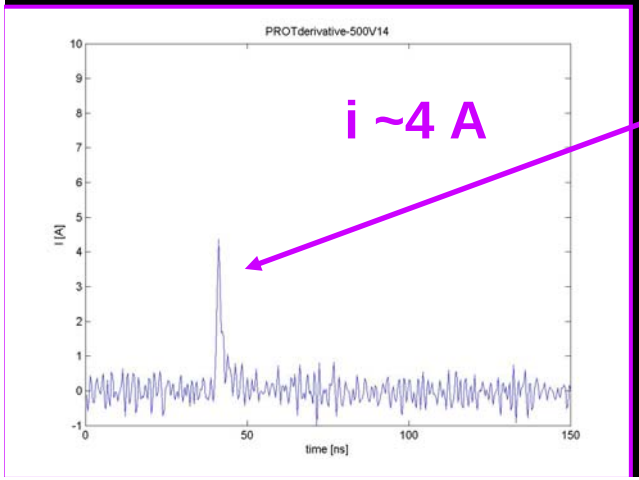






Slope less steep for protected anode

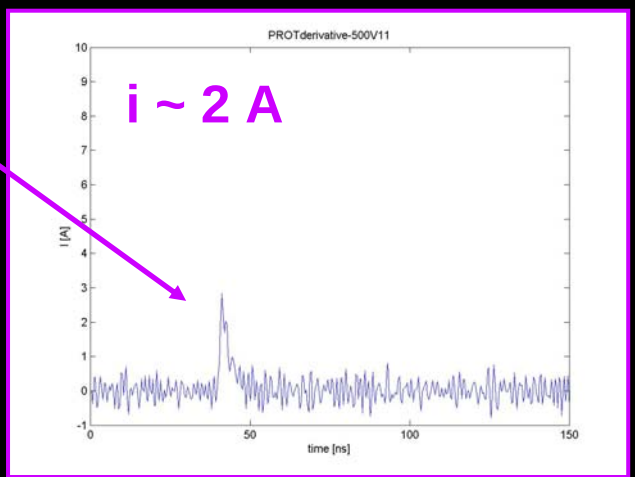


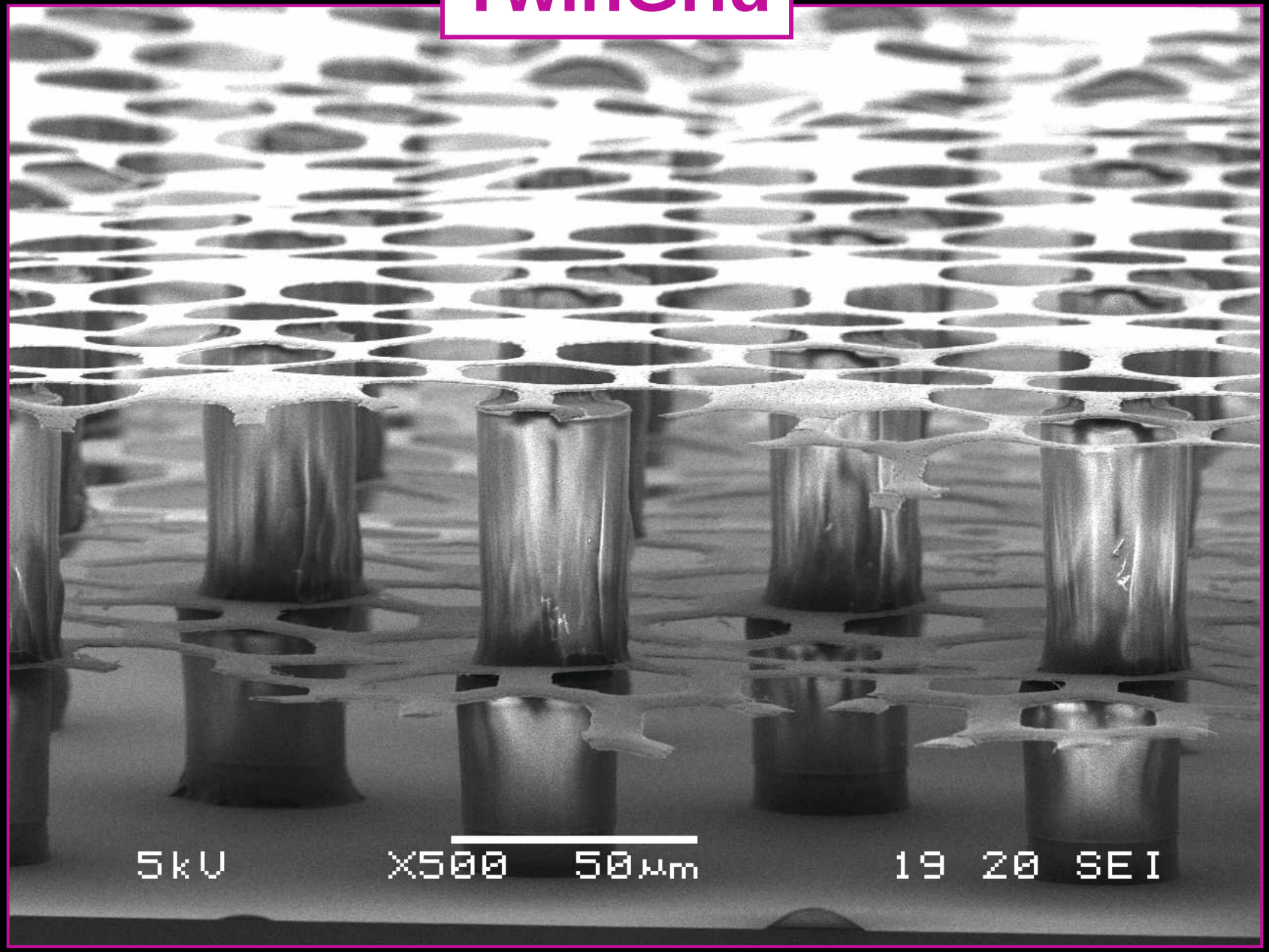

Current reduced

Enough to protect the chip?



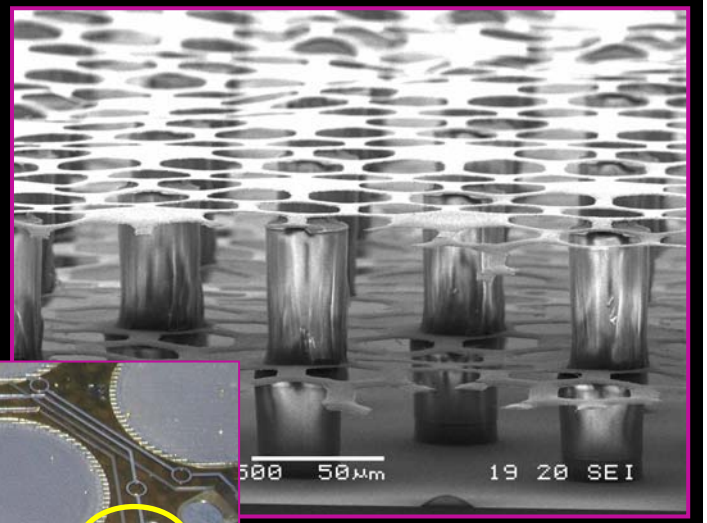
If SiProt is not enough …

# TwinGrid

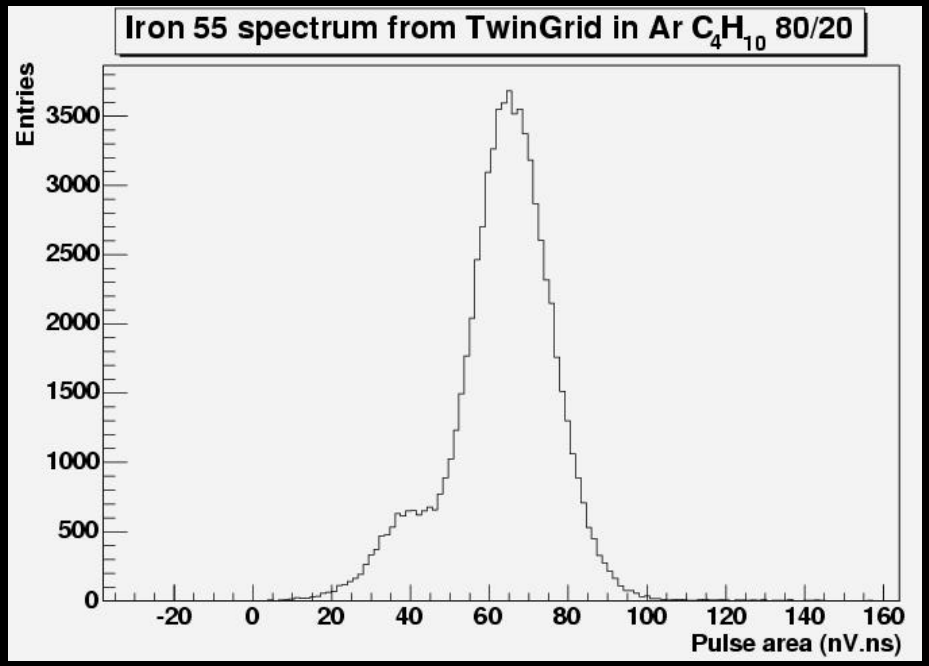


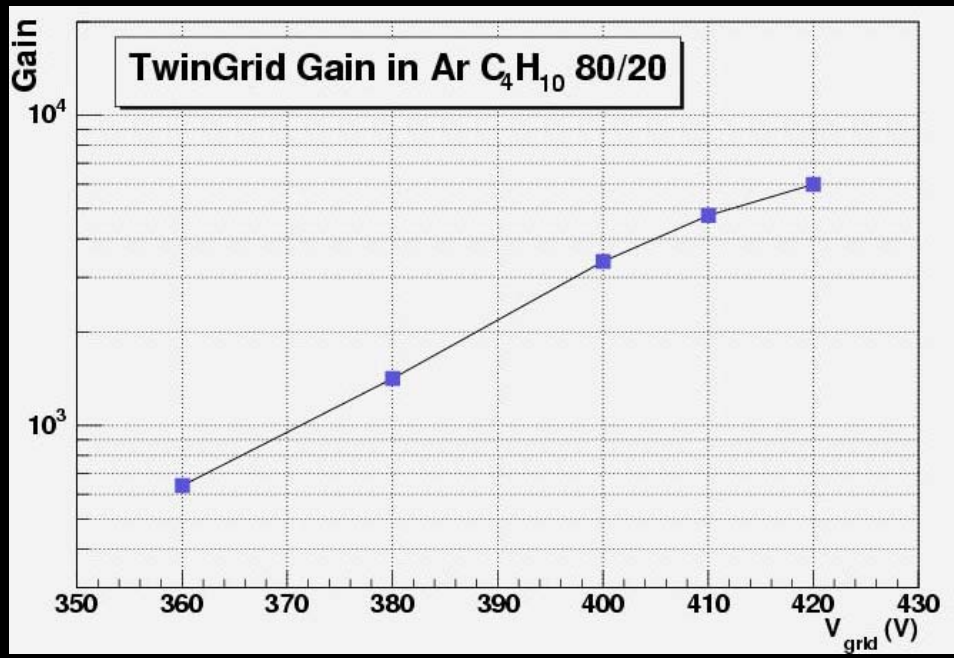
# And it works!

- Ar 20 % $C_4H_{10}$, Iron 55 source
- Voltage on top grid, middle grid floating
- Signal development? Field shape?
- Readout grid signals



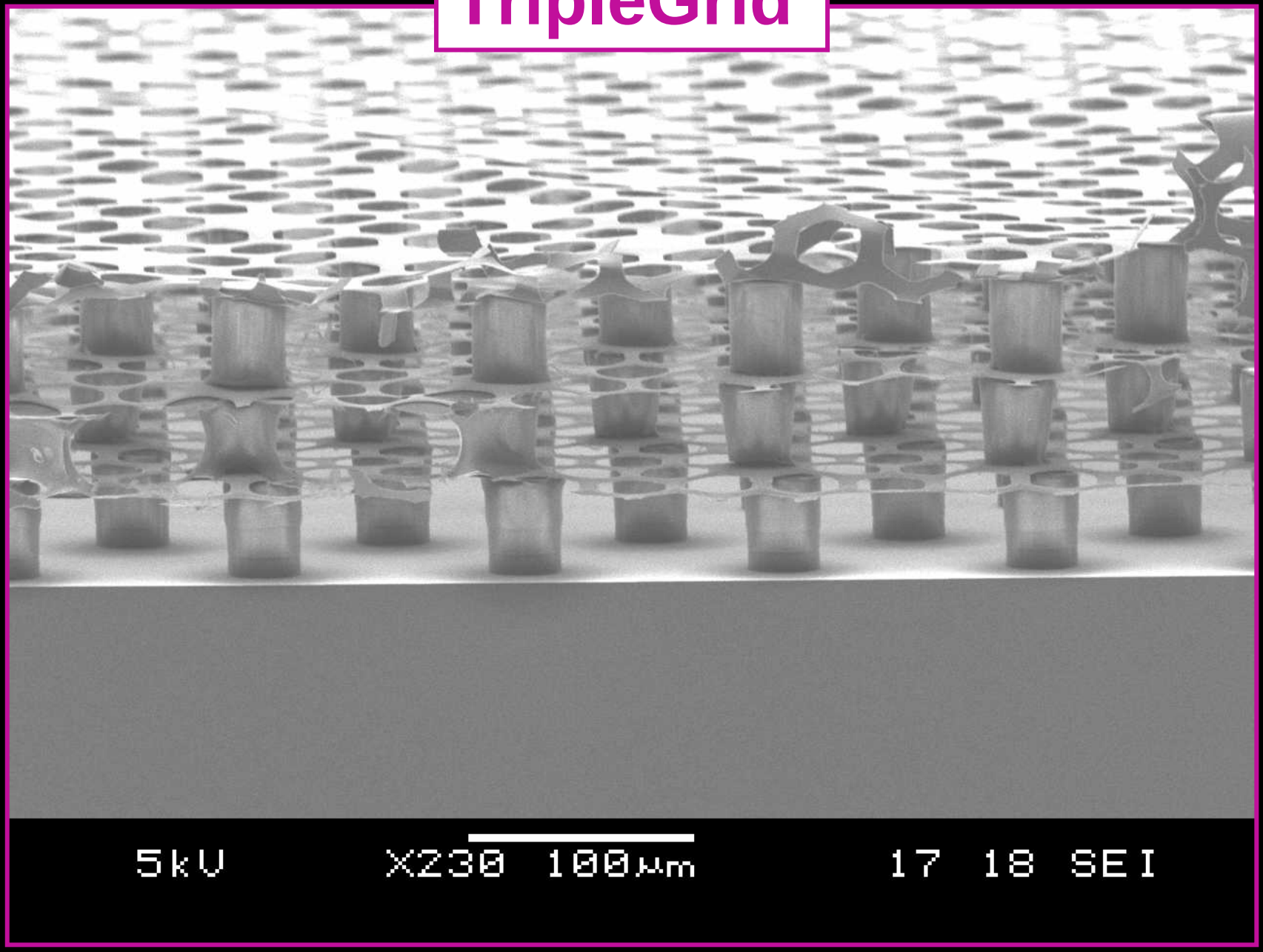

**2 grid lines on top of each other**



If TwinGrid is not enough …

# TripleGrid



# Acknowledgments


| | |
|---|---|
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