大面積Micro Pixel Chamberの開発 4

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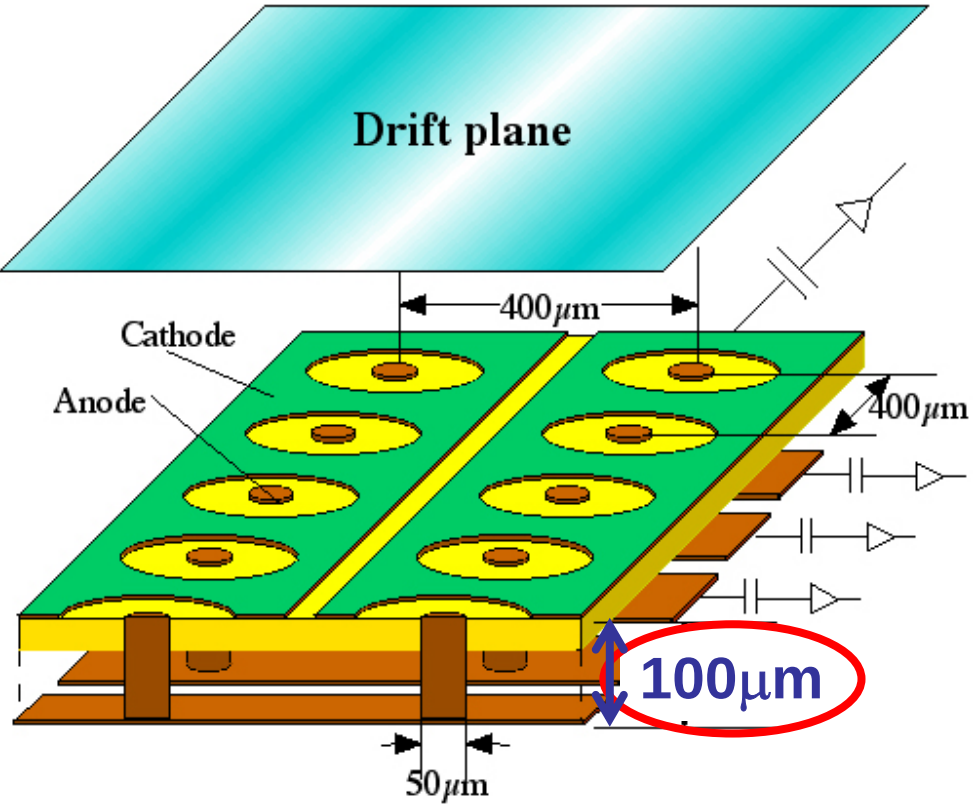
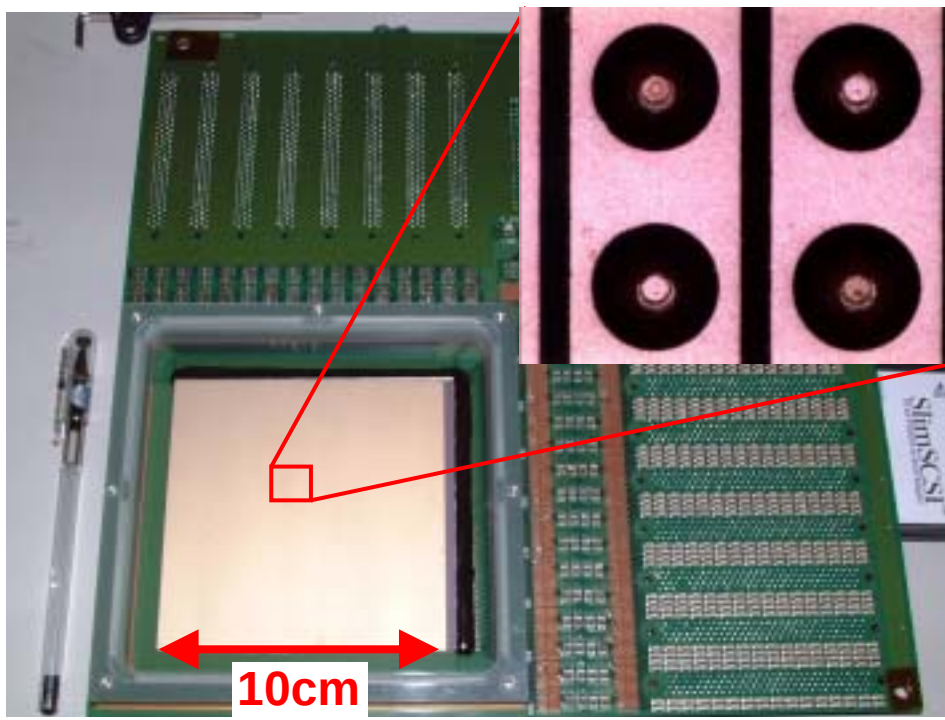
Contents

- Micro Pixel Chamber
- Simulation study
  - ✓ Electron collection (→ net gas gain)
  - ✓ Electric field (→ discharges)
- Large area detector
- Summary

Micro Pixel Chamber (μ-PIC)



- PCB technology
- Pixel electrode
- 2D readout

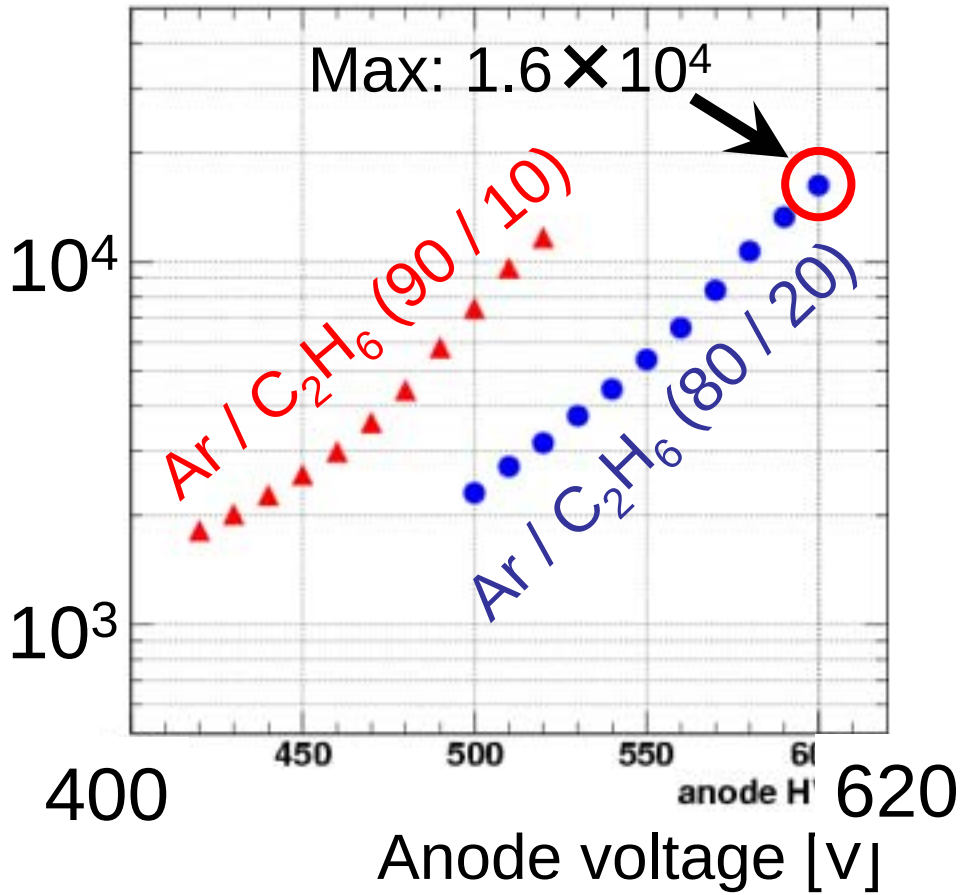


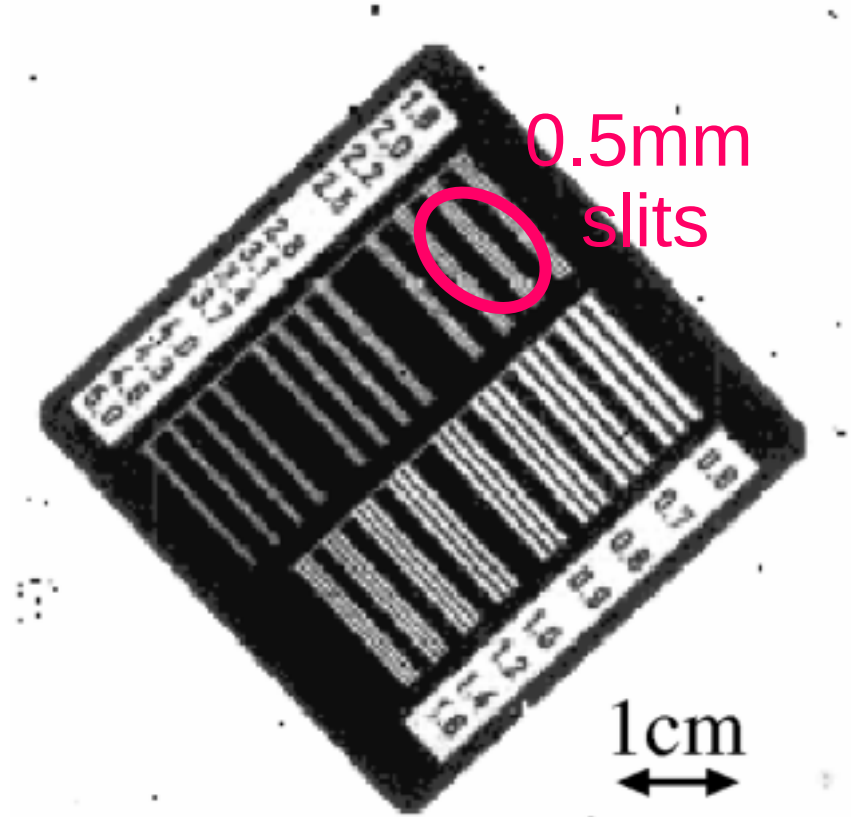
Detection area = 100cm^2

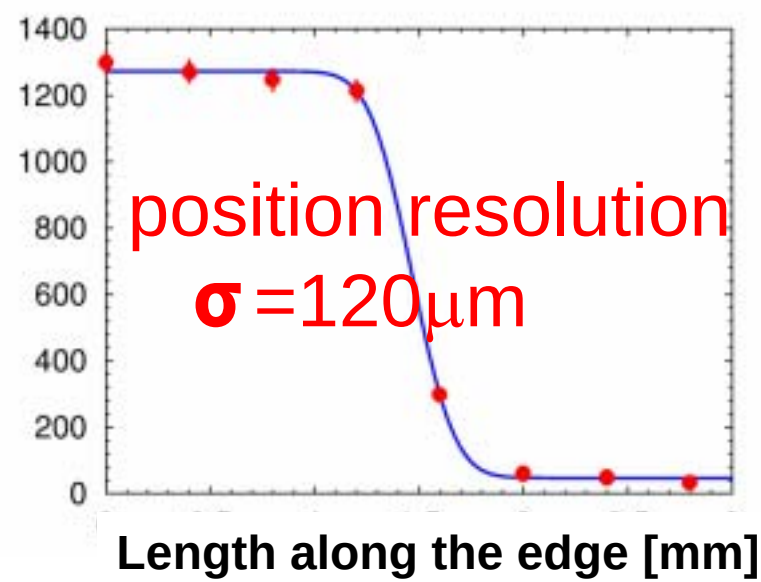
- 400μm pitch electrodes
- 256 anodes and
  256 cathodes

Performances

Gas gain

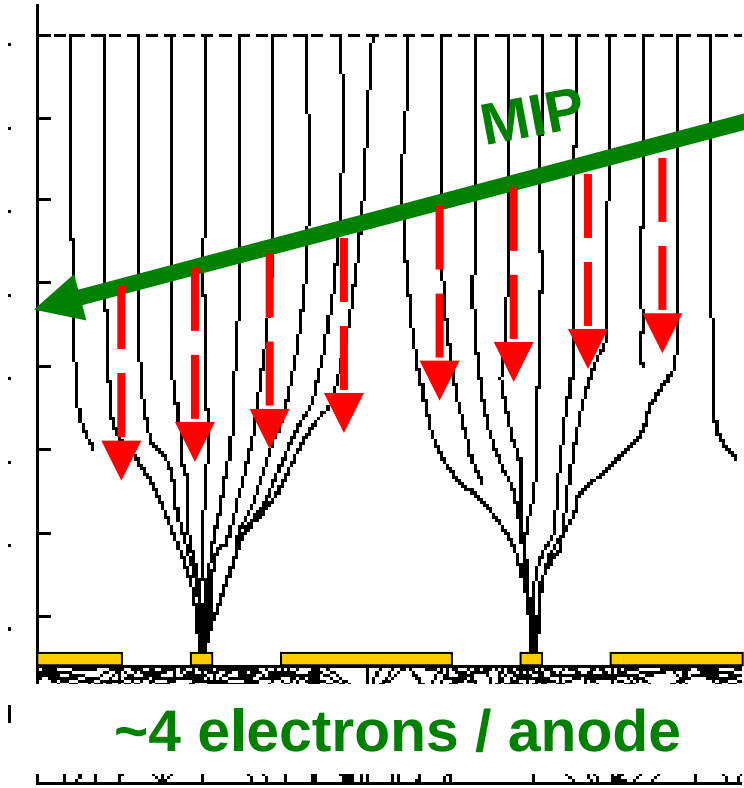






Gas gain { Max: 1.6✕10⁴
Stable: ~6000

Next development



Current status

- Max gas gain >10^4
- Stable operation (>1 month)
  @ gas gain ~ 6000

Next step

- Stable operation @ gas gain > 10^4
- Detection area = 30×30cm^2

Tracking of MIPs

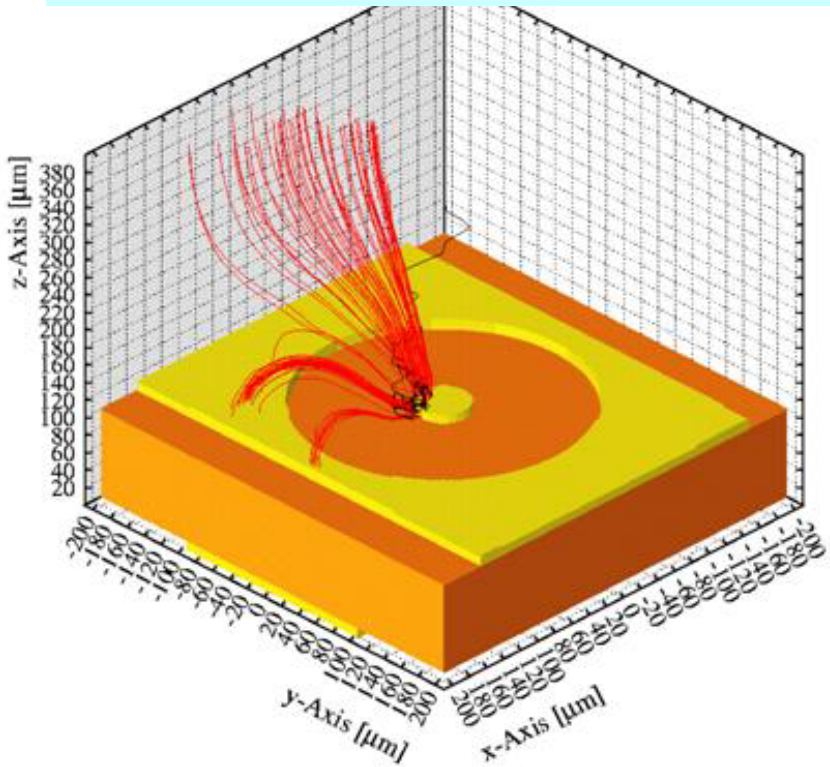
Simulation study for optimization of the electrode

Simulation

μ-PIC … 3D structure
Dielectrics

Maxwell & Garfield

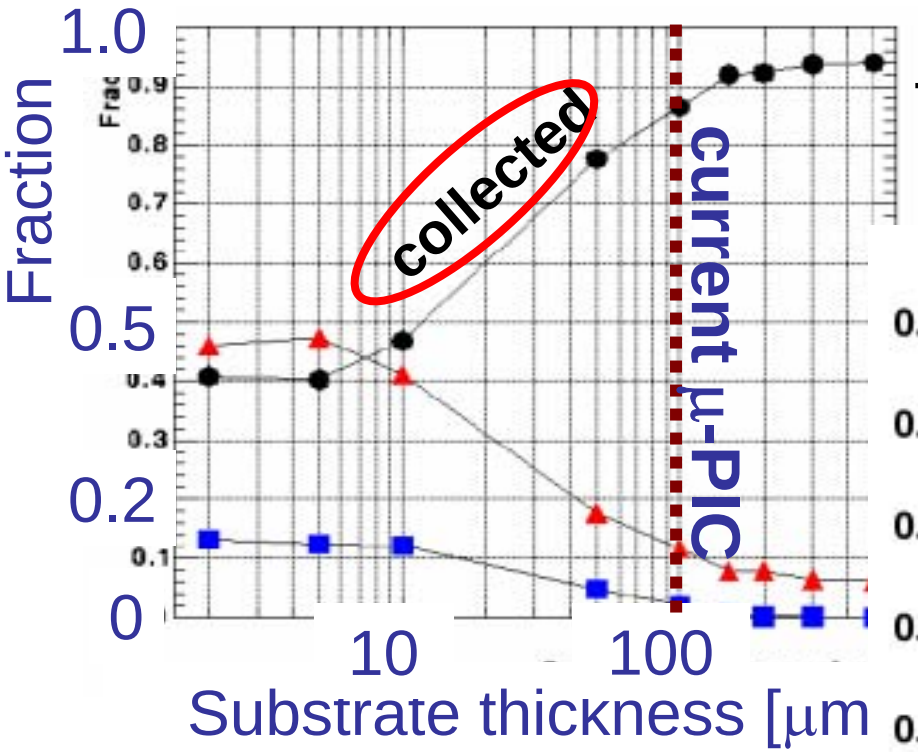
- Maxwell
  - 3D structure
  - Finite element method
- Garfield
  - Electron drift
  - Gas multiplication



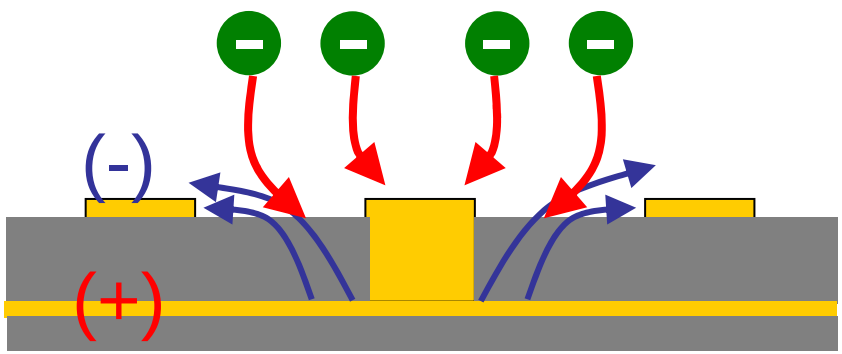
MAXWELL → Field map → GARFIELD → Expected performance

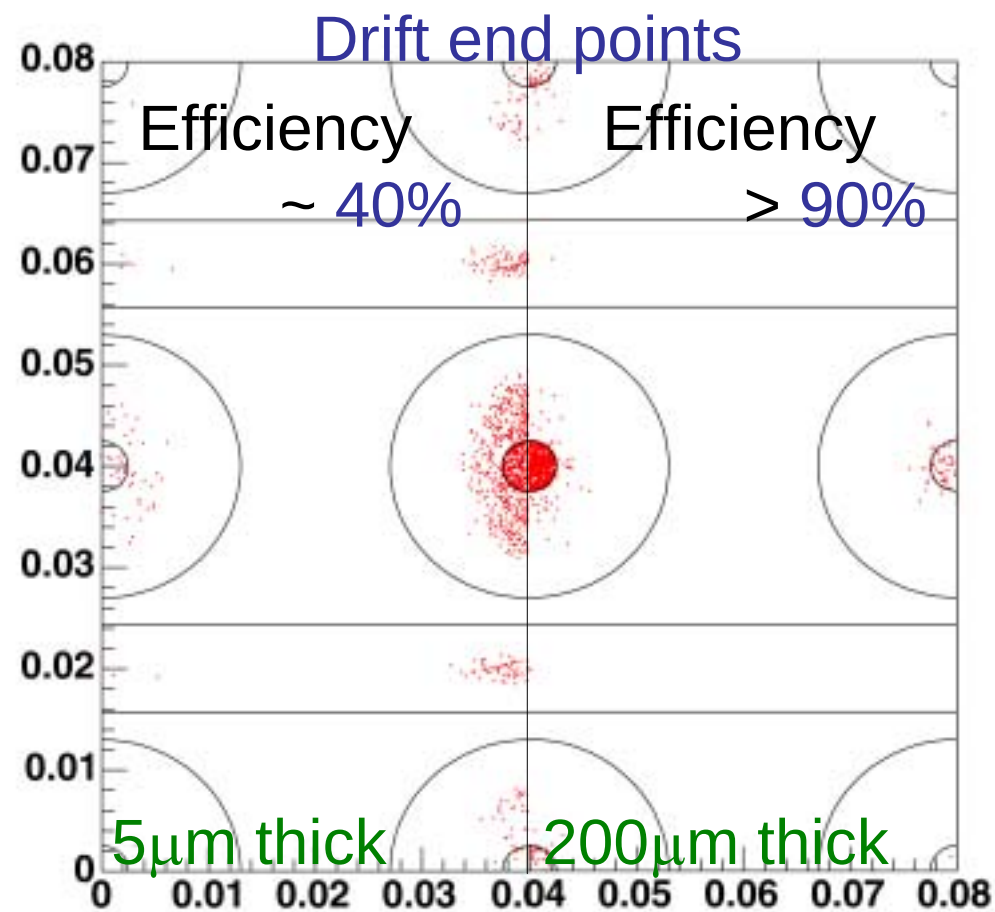
Electron collection

Dependence on substrate thickness



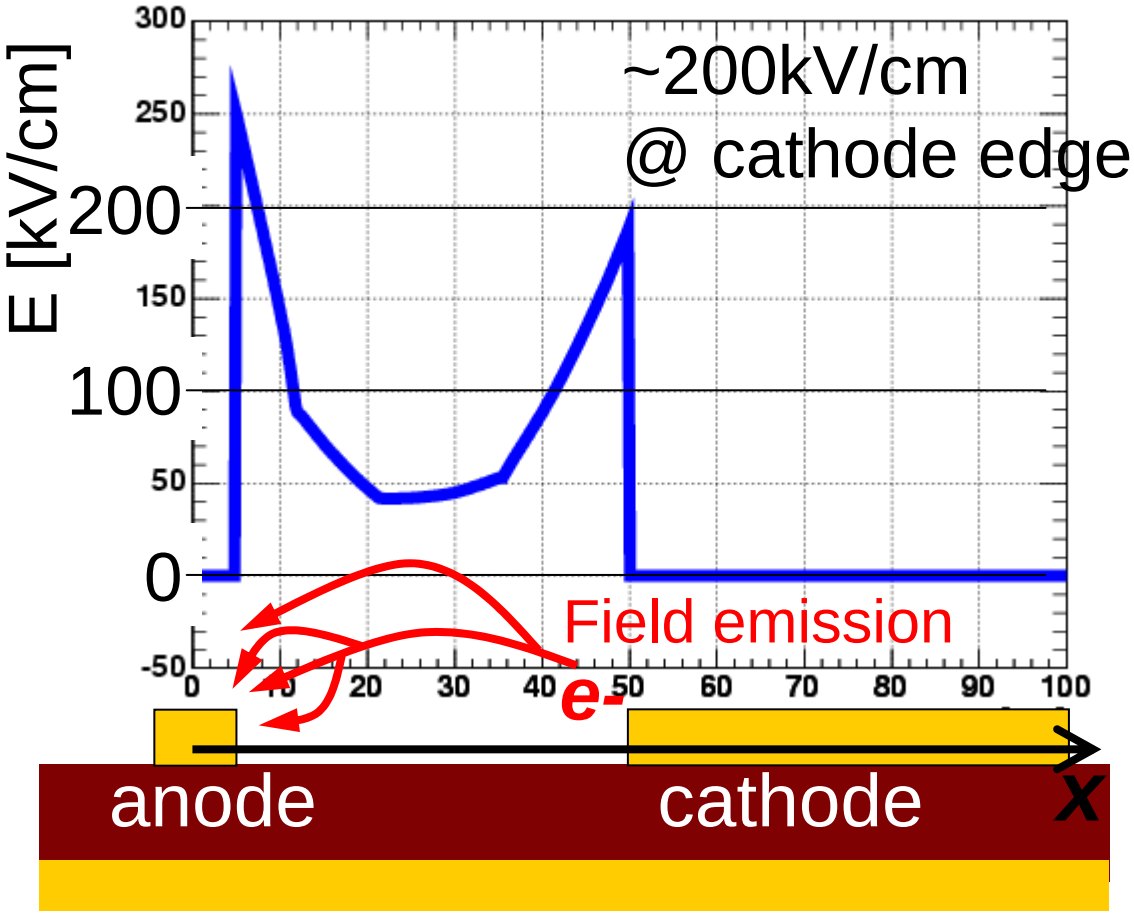
Thin substrate → low efficiency
→ small signal



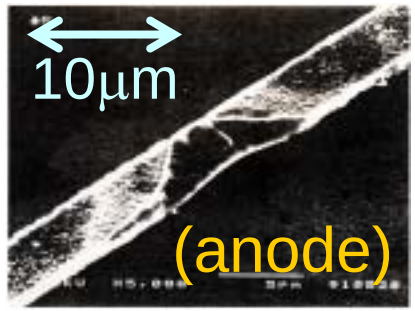


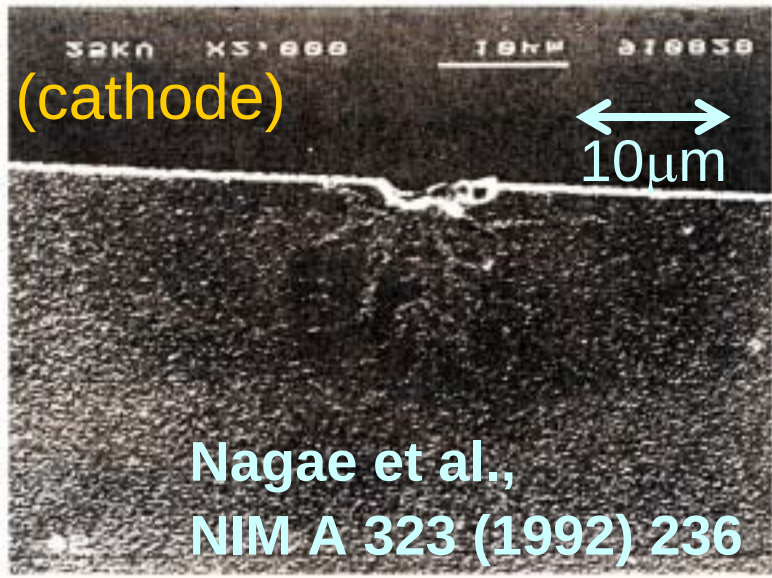
Discharge

~ Limit of MSGC ~



Damaged electrodes of MSGC





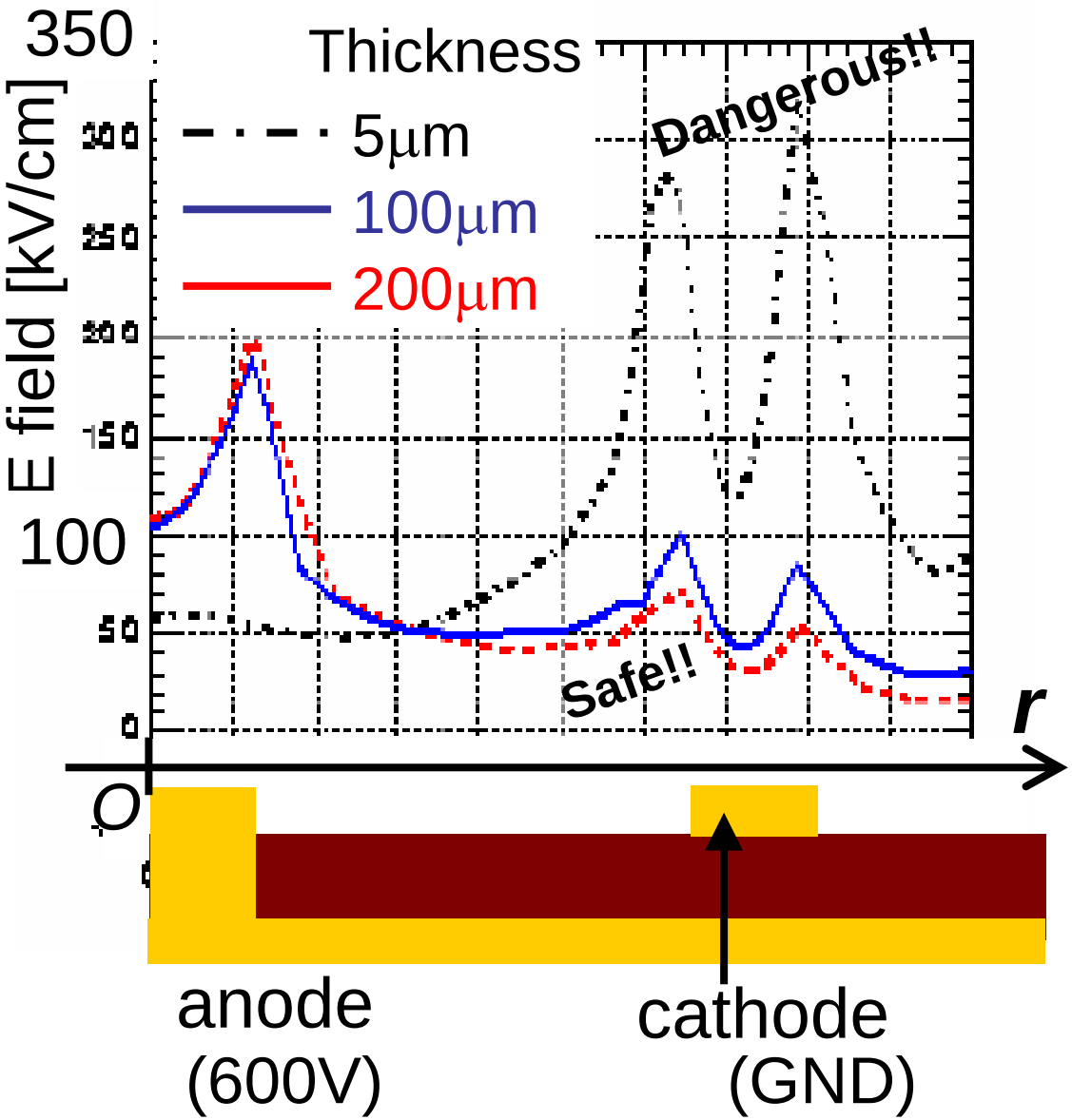
High field → field emission

… one of the discharge mechanisms

To avoid discharge:
Low electric field
@ cathode edge

Electric field

Dependence on substrate thickness

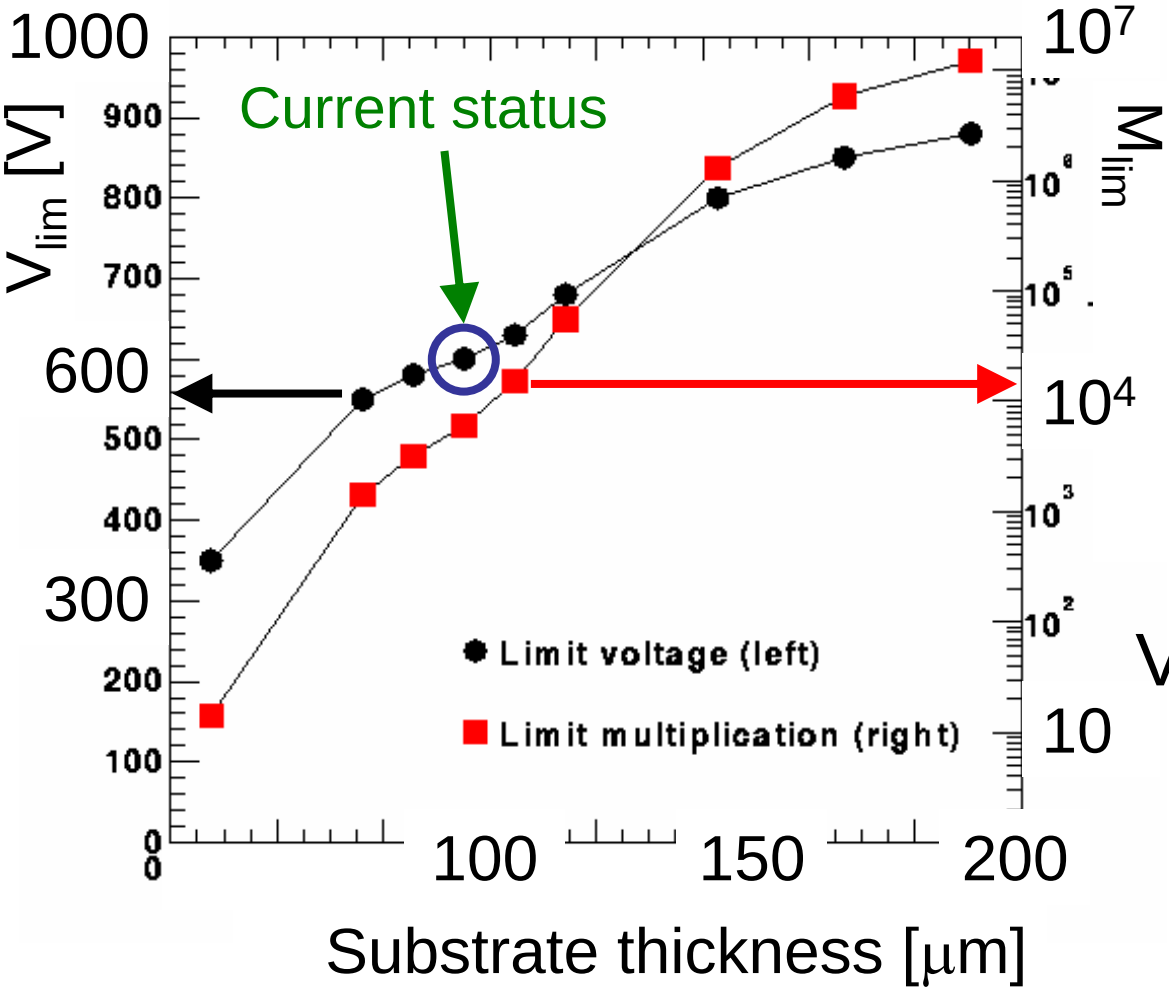


Thin substrate …

- High electric field @ cathode edge
  ➡ Discharge
- Low electric field @ anode top
  ➡ Low gas gain

Substrate should be THICK.
(> 100μm)

Maximum gas gain



Experiment

→ V_{lim} = 600V

(Thickness=100μm)

E ~ 200kV/cm

@cathode edge

V_{lim} for each thickness

→ M_{lim}

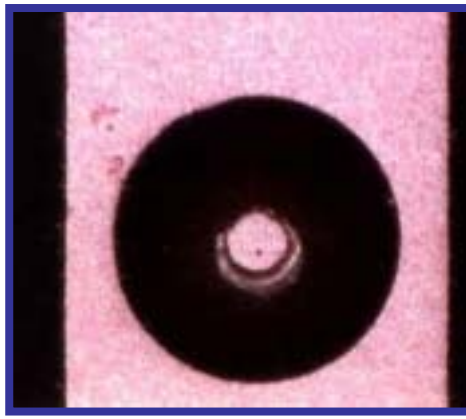
Thickness = 150μm

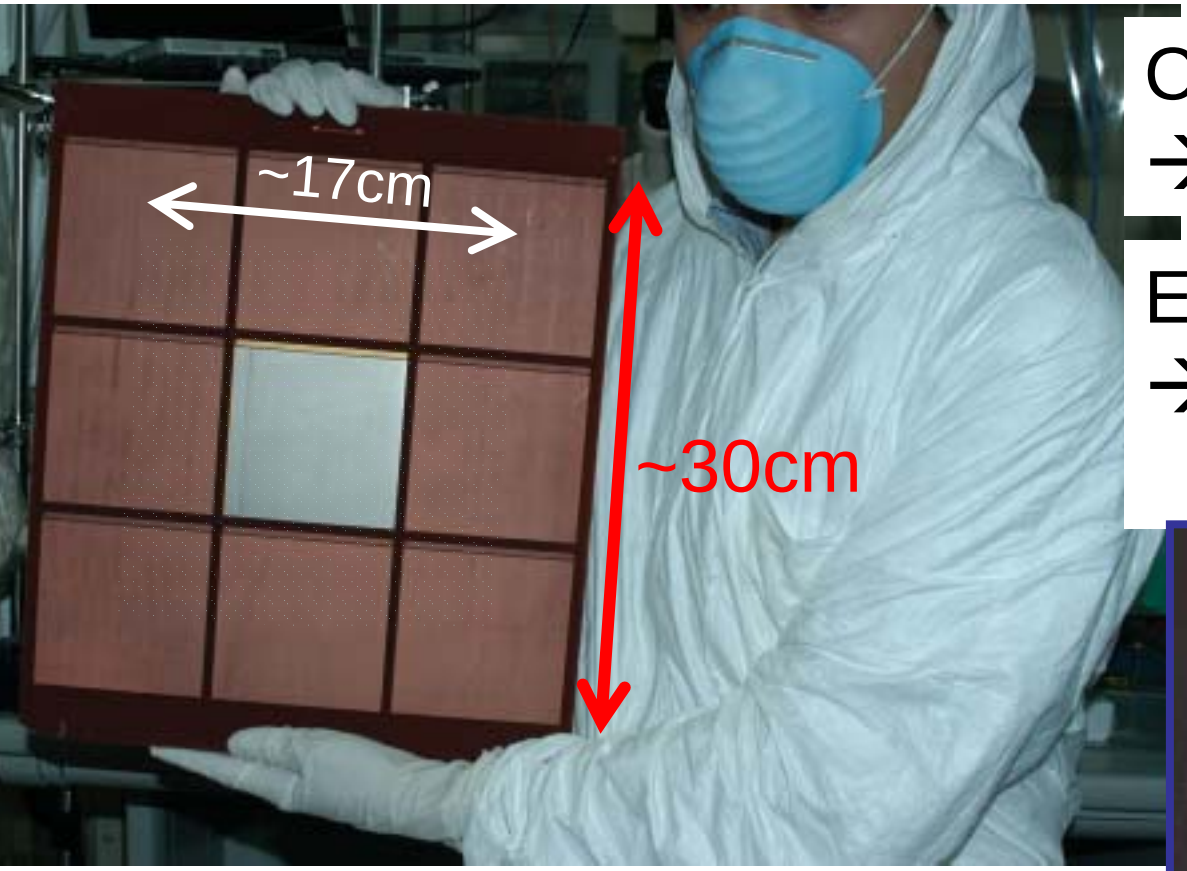
→ $M_{lim} > 10^5$

30×30cm² μ-PIC

9 μ-PICs on 1 substrate

→ Single 30×30cm² detector is feasible.





Center 17×17cm²

→ very small offset

Edge region

→ thermal expansion should be corrected

Summary

- Micro Pixel Chamber (μ-PIC)
  - Gas gain >10^4 (max)
  - Position resolution ~ 120μm
- Optimization of the electrode structure
  - 3D simulation using Maxwell & Garfield
  - Thicker substrate (150μm) → gas gain >10^5
- Next development
  - 30×30cm^2 area detector
  - 150μm thick substrate
    High quality electrode

→ gas gain >10^5 in near future