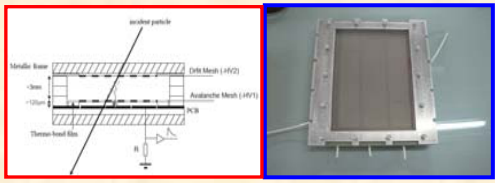


Recent MicroMegas Activities @ USTC

Liang Guan

University of Science and Technology of China

RD51 WG1,19 July 2010

Outline

- Introduction
- Small prototypes
- Resistive prototype
- Summary

Introduction: Review

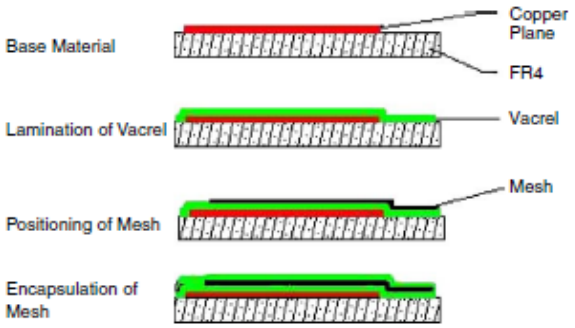
Different materials

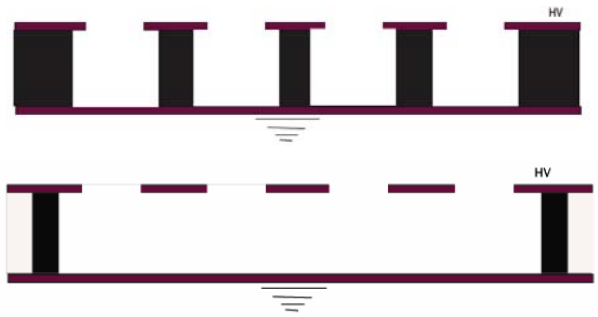
mesh: grid by chemical etching, electroformed … (stainless steel, copper, nickel, gold…)

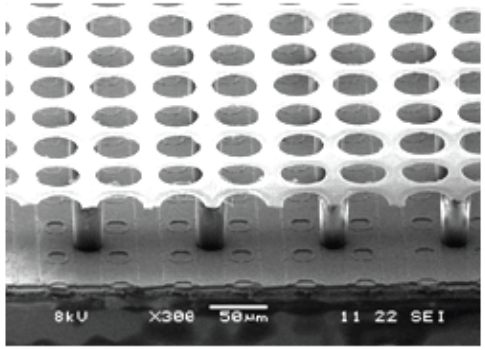
woven wires (nickel, copper, stainless steel)

spacer: quartz fibers, pillars by photo-lithography, Kapton ring, fishing line…

Different technologies







Bulk

Lithography & woven mesh

Microbulk

Standard lithography and kapton etching

InGrid

CMOS compatible InGrid technology

Introduction: Thermo-bond films

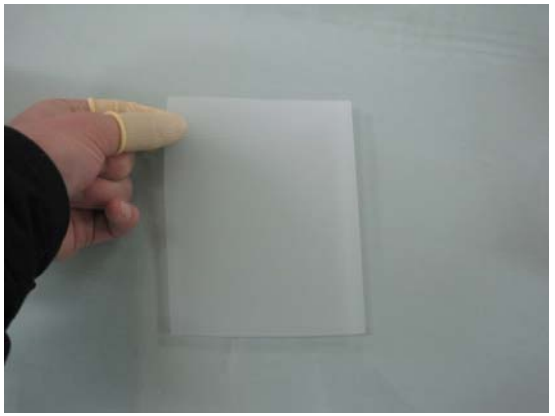
An novel idea to construct amplification gap of Micromegas: use Thermo-bond film

Thermo-bond film

- adhesive bonding film, flexible & insulating
- substrate sandwiched by two bond lines /only two bond lines
- solid @ room temperature, adhesive ← heat

Features

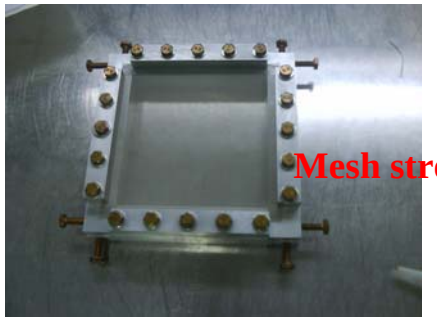
- various thickness: 80μm,125μm,155μm,160μm…
- good mechanical property:
  tensile strength @break--several thousand psi
- softening temperature 100-200℃
- dielectric property: dielectric constant ~2.4, volume resistivity>10^{17}ohm/mil
- excellent metal adhesion
- uniform adhesive thickness



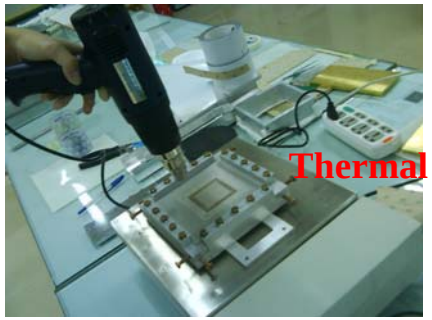
Motivation and Prospect

- Quick, Easy fabrication, Economical
- Large sensitive area, Multi Mesh Chamber
- No internal solid state support structure

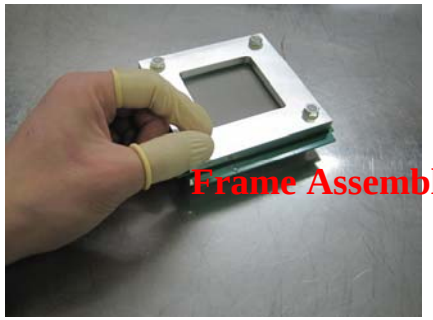
Small Prototypes: Fabrication



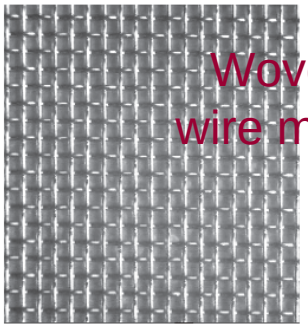
Mesh stretching



Thermal attaching

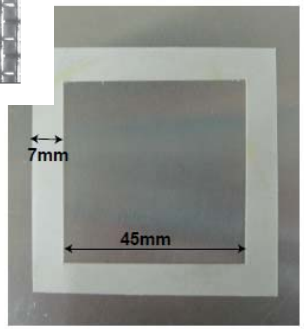


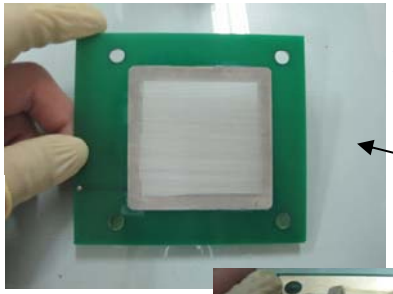
Frame Assembling



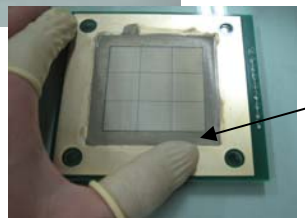
Woven wire mesh

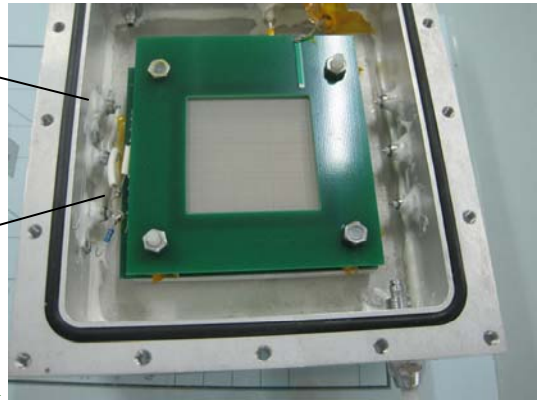
350LPI





Drift electrode





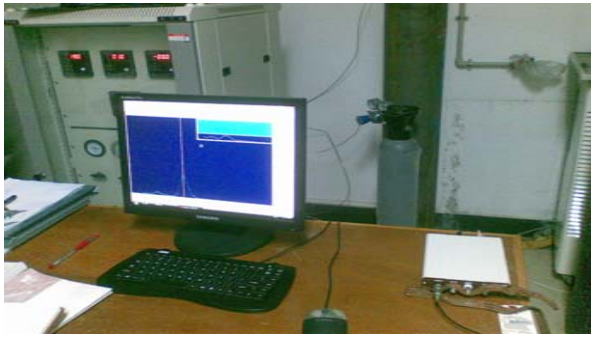
"Bulk" avalanche region

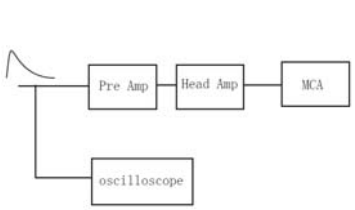
Readout: 9 Pads(15mm*15mm)

Sensitive area: 45mm*45mm

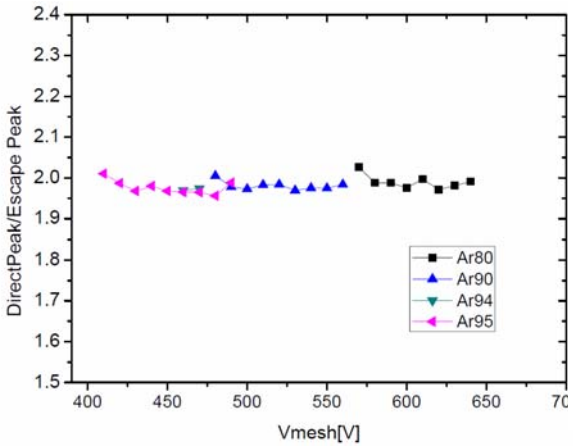
Drift Gap: 2~9mm

Test Results — 155μm films

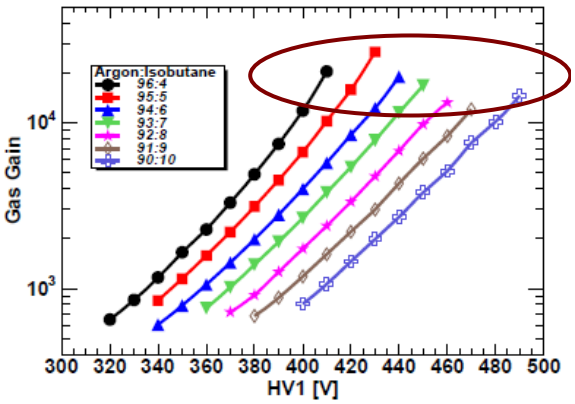




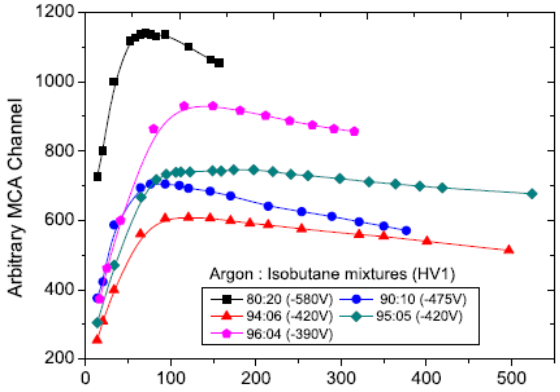
Energy linearity



Gas Gain

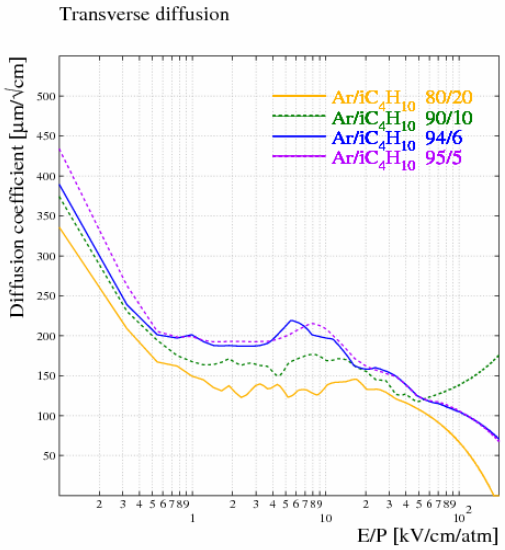


Electron transparency



- V_{MESH} fixed ,change V_{Drift} for different field ratio
- Higher electric field ratio to reach maximum electron transparency

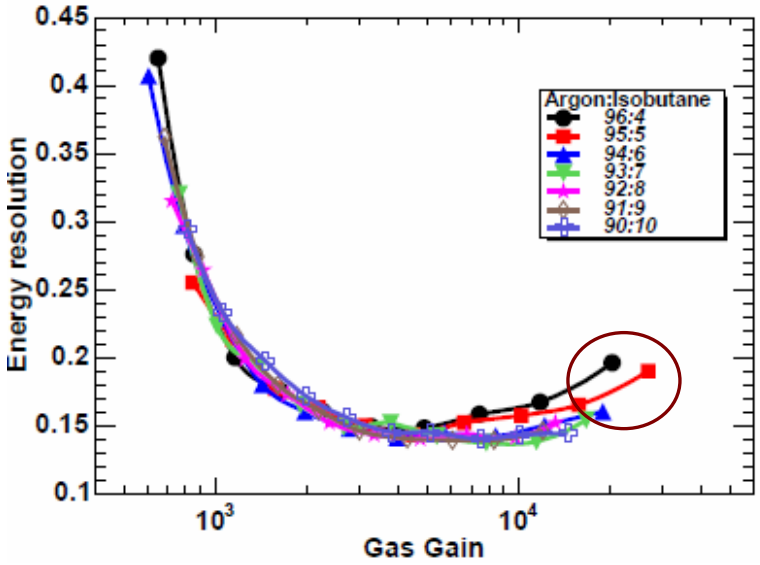
for Ar-rich gas ←Trans. Diffusion



Magboltz

Test Results — 155μm films

Energy resolution



Best energy resolution **13.7% (FWHM)**

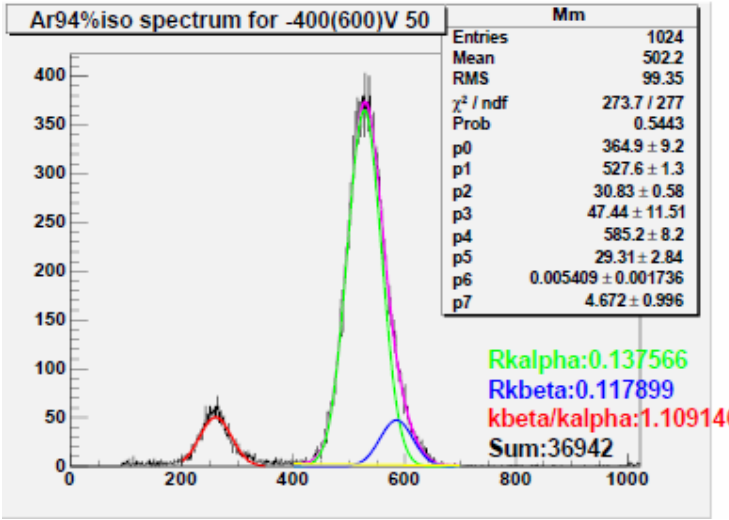


Photo-peak ratio: K_α/K_β 1.109(Exp) ↔ 1.102(Theory)

- Energy resolution for 5.9 keV x-ray can be better than 20% over one order of magnitude in gain
- Deterioration of energy resolution for argon-rich gas mixture: influence of polyatomic molecular

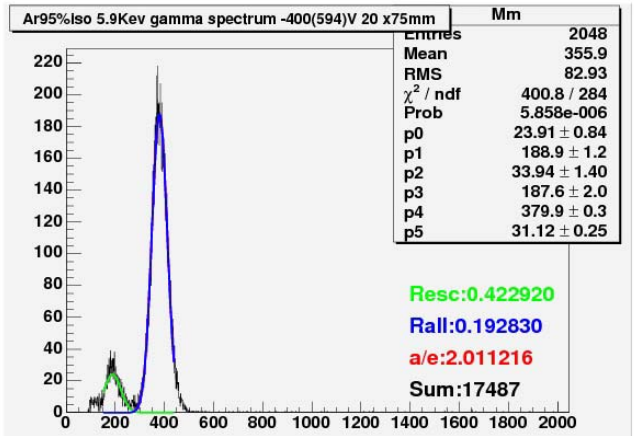
S. Behrends and A.C. Melissinos, NIM A 1889 (1981)

Test Results — 155μm films

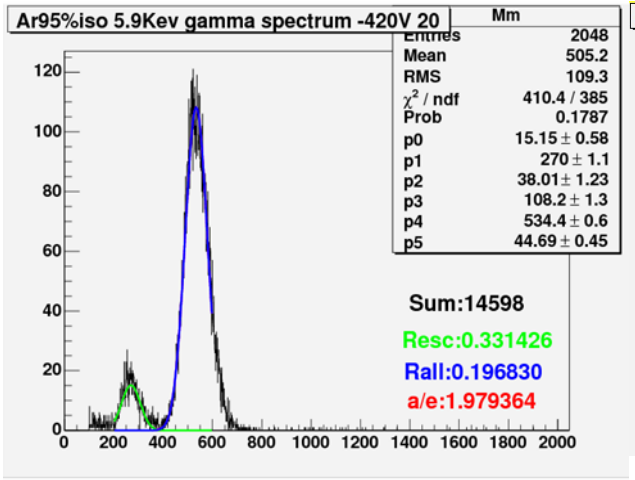
- Energy resolution obtained for different mesh

FWHM @5.9KeV

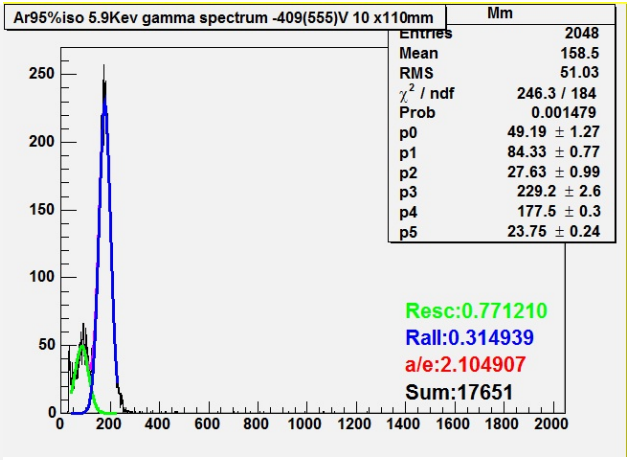
350lpi



400lpi / ϕ = 20 μm



400lpi / ϕ= 26 μm

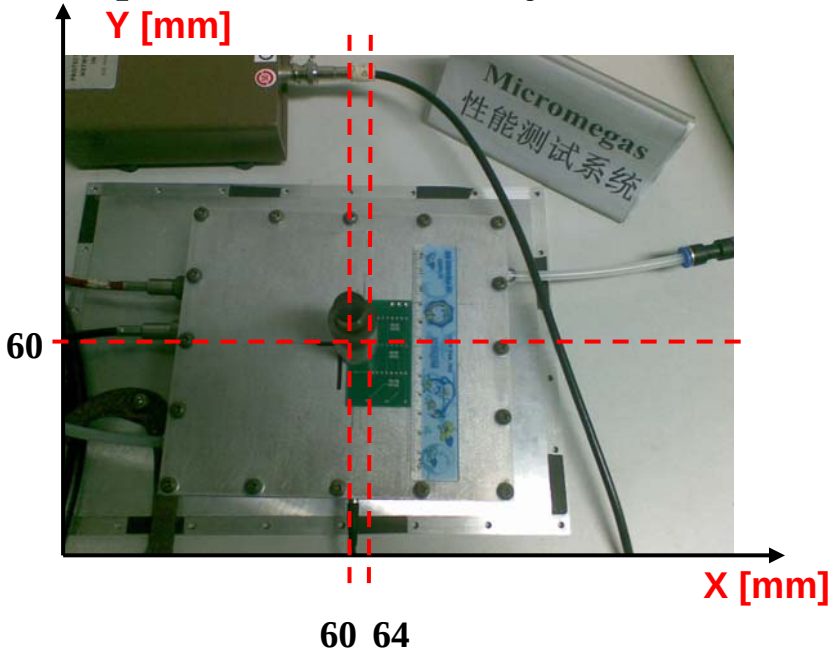


MESH wire diameter	350lpi	400lpi	
	20 μ m	20 μ m	30 μ m
FWHM	**19.28**	**19.68**	**31.49**

Test Results — 155μm films

Uniformity

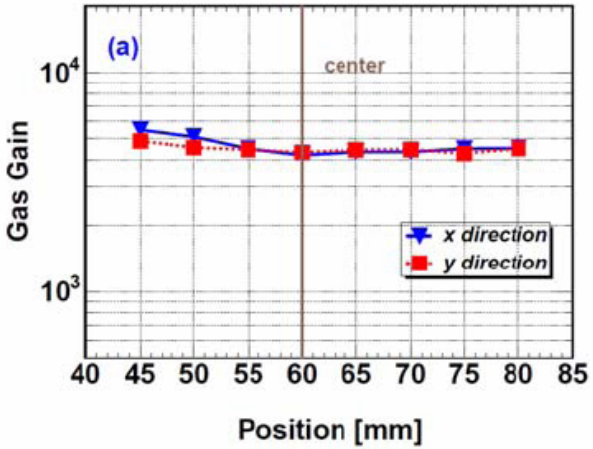
• setup for raw uniformity scan

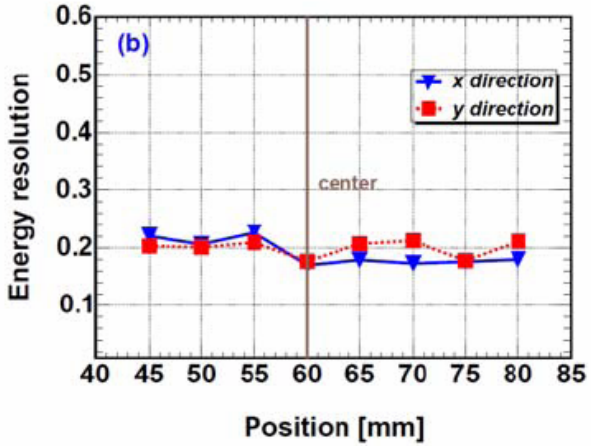


Rough scan
Radioactive source: ^{55}Fe

Gas mixture: Argon + iC_4H_{10} (1atm, 300K)

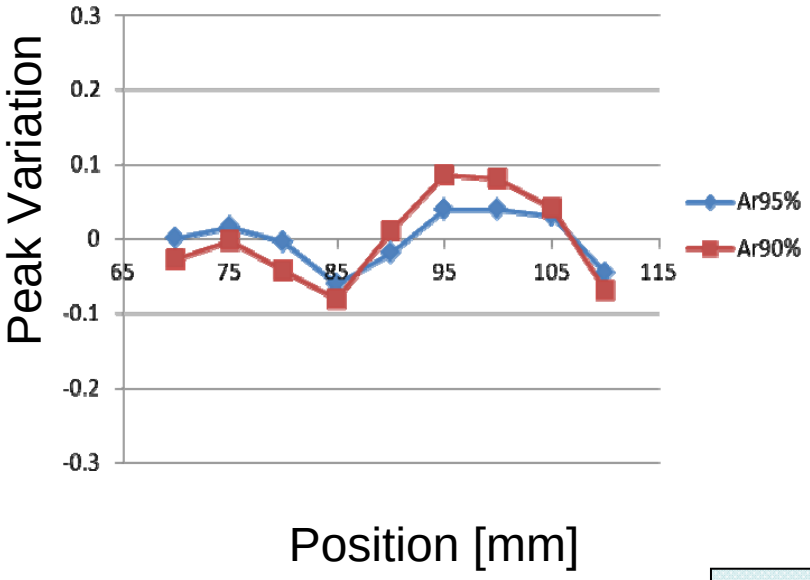
• ***Argon / iC4H10 95/5***



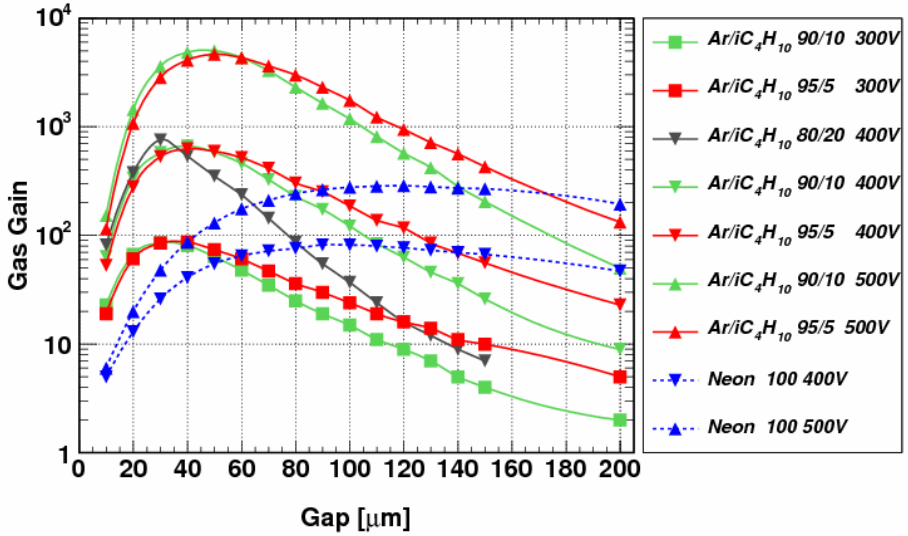


Test Results — 155μm films

Uniformity study



Garfield Simulation



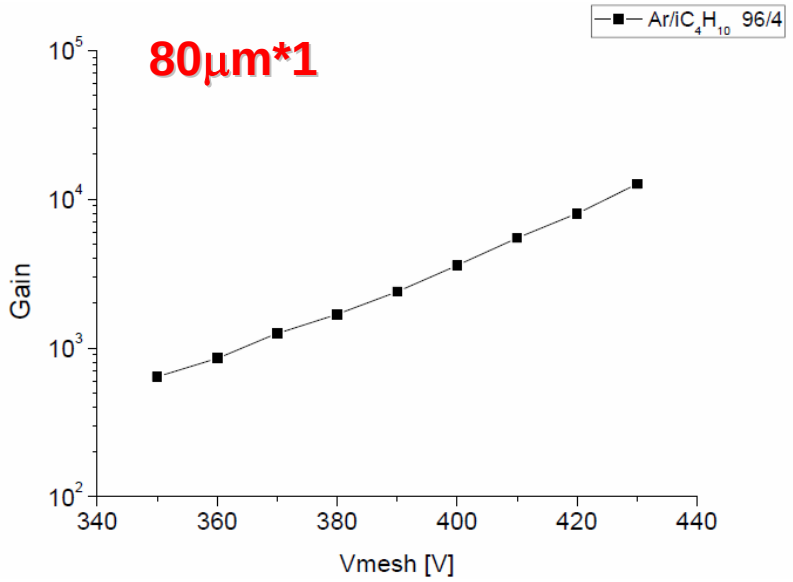
Gain described by Rose-Korff formula

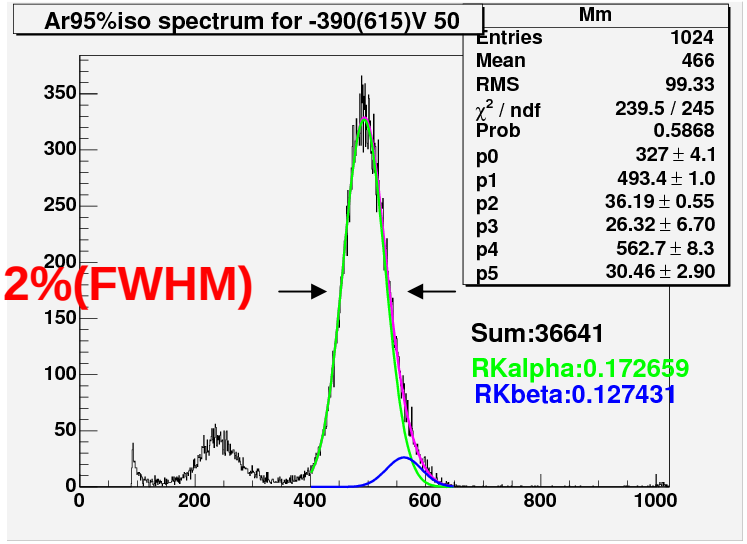
$$G = e^{\alpha d} \qquad \alpha = Ap\exp(-\frac{Bpd}{V}) \quad \Rightarrow \quad \ln\alpha \propto -\frac{1}{E}$$

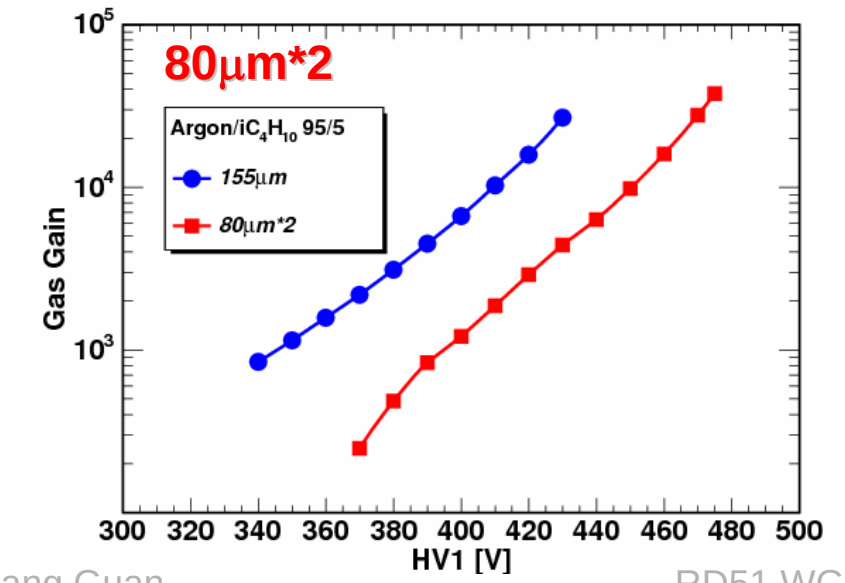
To improve uniformity:

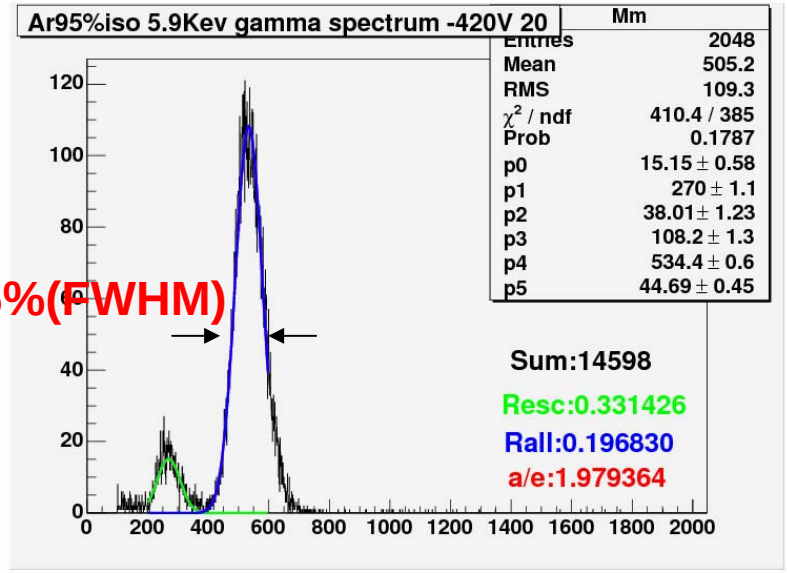
- *Use Argon-rich/Neon gas and proper avalanche gap*
- *Take good care of thermo-attaching process, pressure, temperature control…*

Test Results — 80μm films



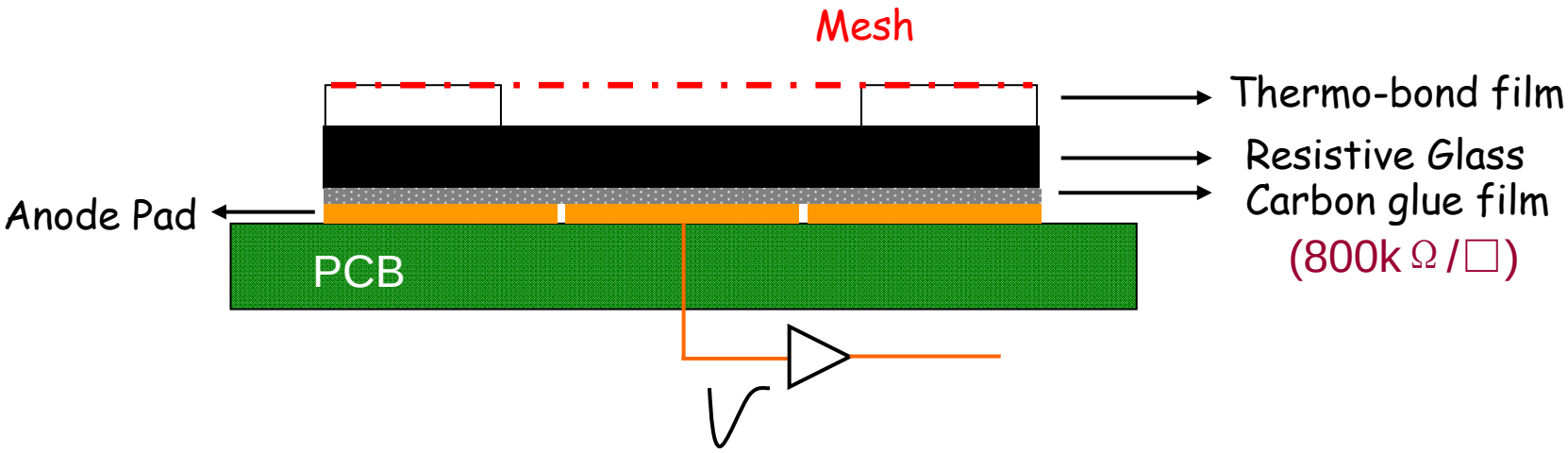






Resistive Prototypes: Fabrication

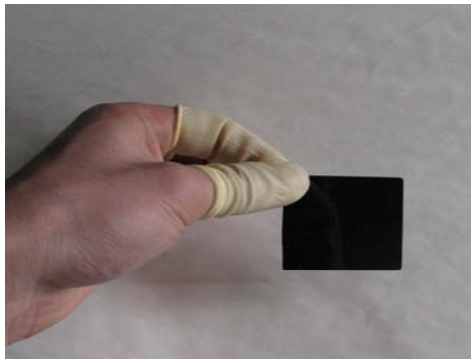
- Metal anode -> sparks at gain>$2*10^4$



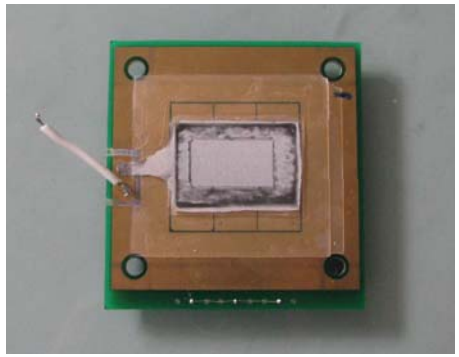
Resistive glass: volume resistivity ~10^{10} ohm·cm

Mesh: 400LPI

Sensitive area: 16mm*26mm

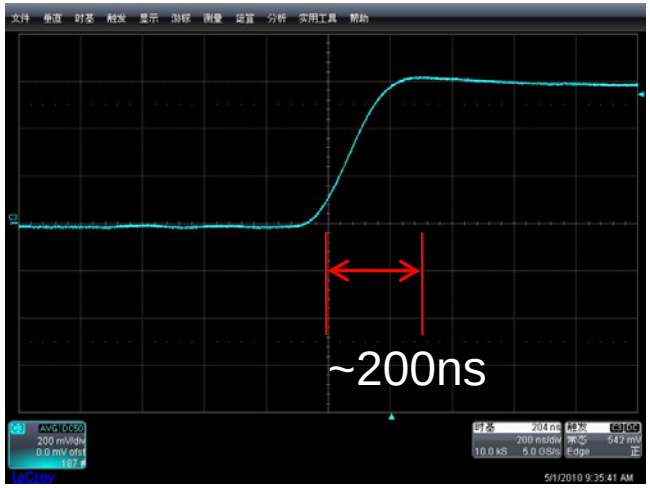


Resistive Glass

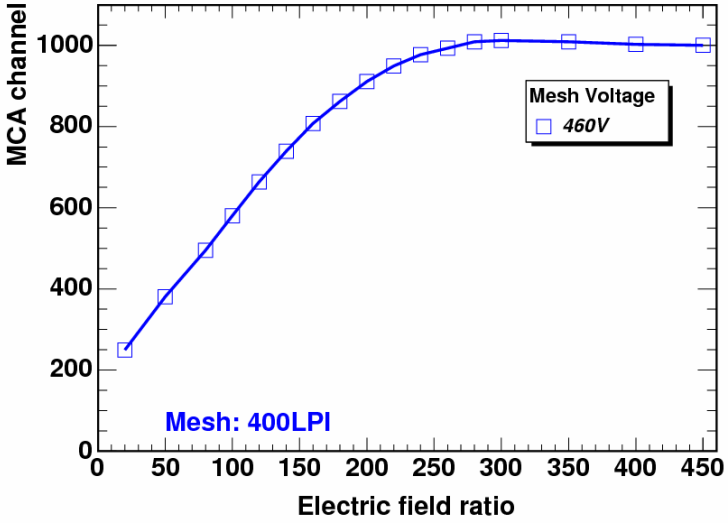


Small prototype

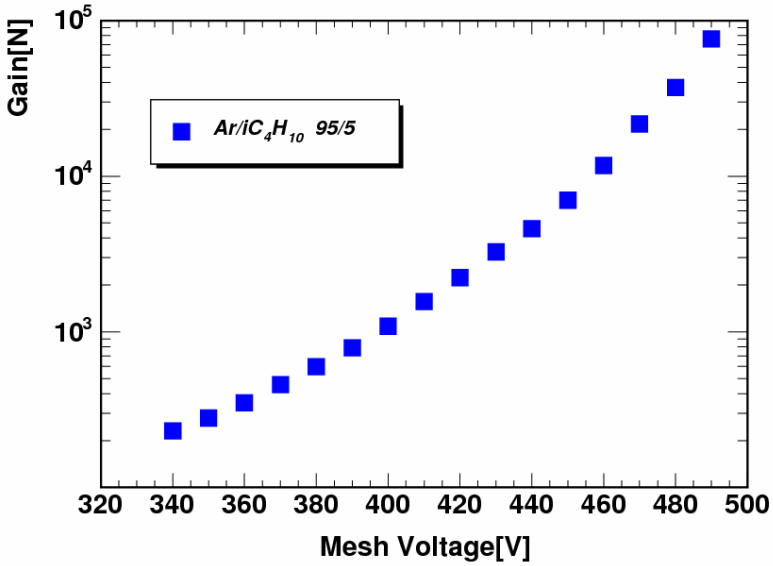
Resistive Prototypes: Test results



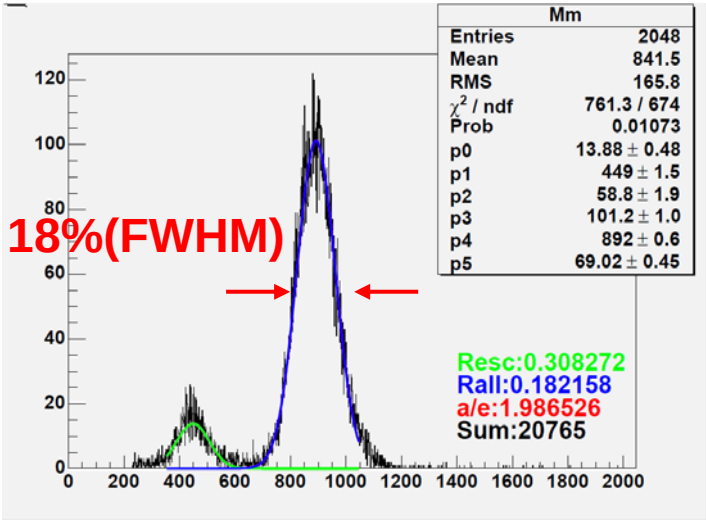
Signal



Electron transmission



Gain



Spectrum of ion-55

Summary

- An novel idea: use thermo-bond films to separate the avalanche mesh from the anode plane.
- Prototypes with 45mm*45mm sensitive area (no internal support structure) Gas Gain>$3.7*10^4$, best energy resolution: 13.7% @ 5.9keV x-ray .
- Micromegas prototype with resistive anode (resistive glass) has been made successfully. Gain ~$7*10^4$.
- Continues efforts should be made to systemically study the performances of detectors.

Need to exchange good ideas and share experiences …

Thank you for your attention!