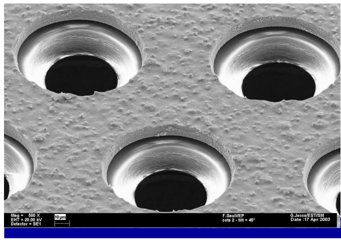


# Update on Mass Produced Micro Pattern Gas Detectors

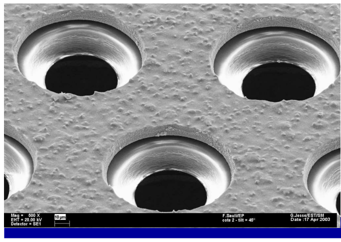
Mass Production of GEMs (Chicago/Purdue/3M)

Aging of mass produced GEMS (Purdue)

Operation of GEMS in Negative Ion Gases (Purdue/Temple/WSU)

Towards mass production of MICROMEGAS (Purdue/3M)

Jun Miyamoto, Ian Shipsey
Purdue University

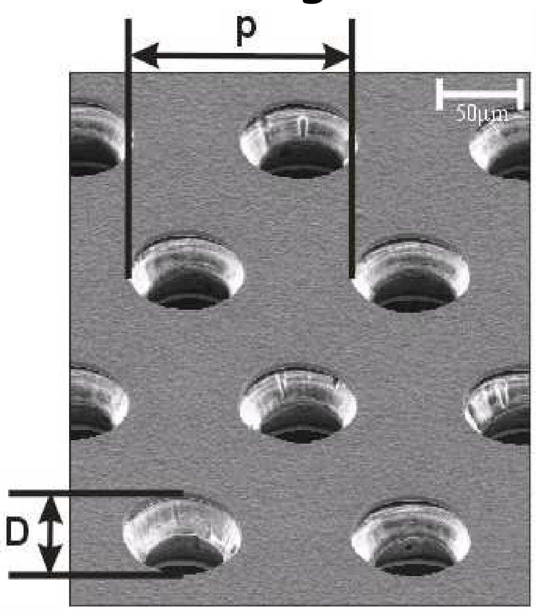


# Reminder: GEM and Micromegas

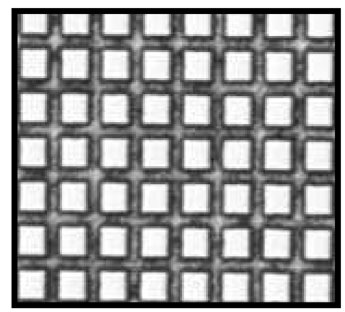
GEM: □□o co□□er □er□ora□ed □oi□s se□ara□ed □□ an ins□□a□or

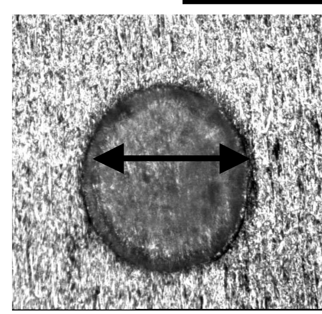
□□e m□□i□□ica□ion □a□es □□ace in □□e □o□es□

□s□a□□□ □sed in □ s□ages□ e□en □




Micromegas : a micromes□ s□s□ained □□ □□□□□□ µm □□ig□ ins□□a□ing □i□□ars□
□□e m□□i□□ica□ion □a□es □□ace □e□□een □□e anode and □□e mes□
□ne s□age



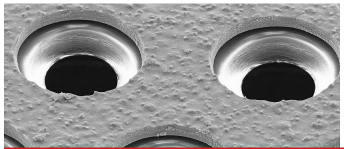


□□□ µm

*Slide stolen from P. Colas Amsterdam Tracking meeting March 31 2003*

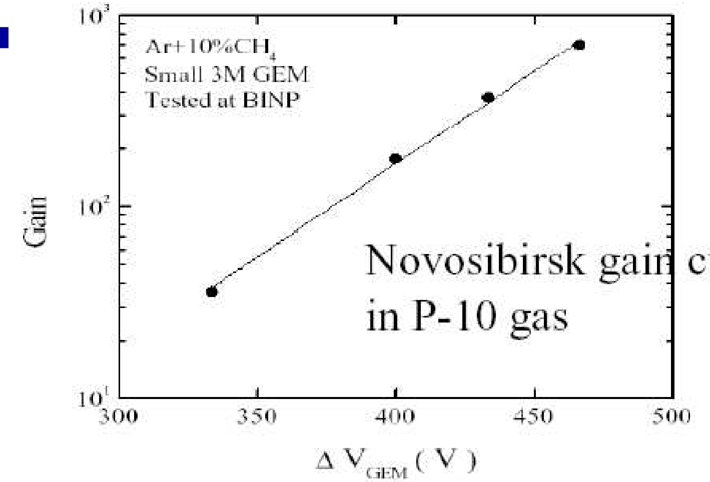
# First Mass Production of Gas Electron Multipliers

(3M Proprietary Flex Circuit Fabrication Technique)

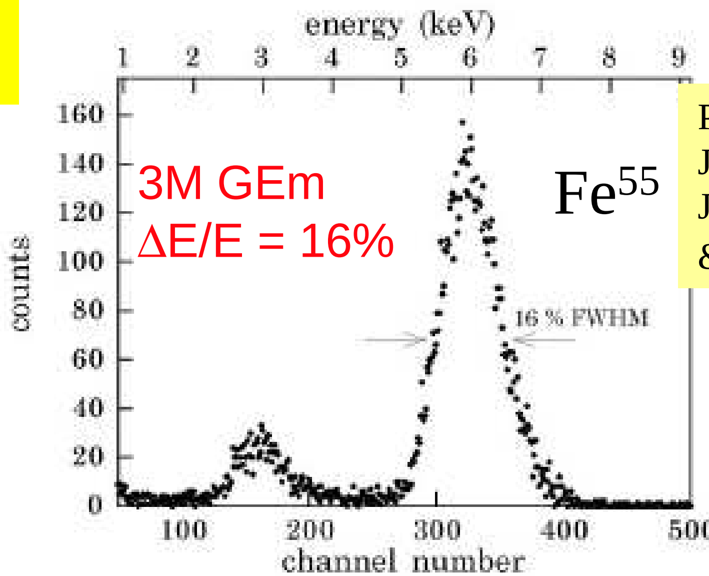


- **3M** Reel-to-reel process, rolls of 16"'x16" templates of detachable GEMs in any pattern.
- Batch of 1,980 GEMs produced end '02 and tested at Chicago/Purdue Spring '03
- Now widely inspected/tested elsewhere: CERN/Novosibirsk/NASA Goddard/BNL etc.

Single roll of ~1,000 GEMS




Novosibirsk gain curve in P-10 gas



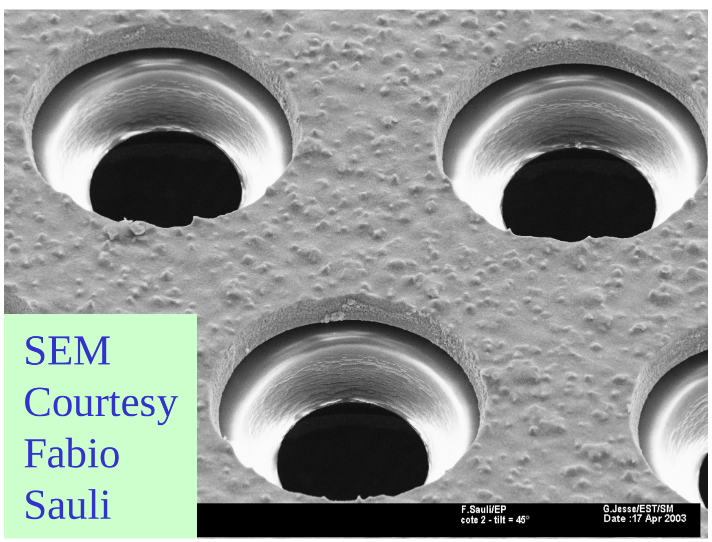

3M GEm

$\Delta E/E$ = 16%

$Fe^{55}$

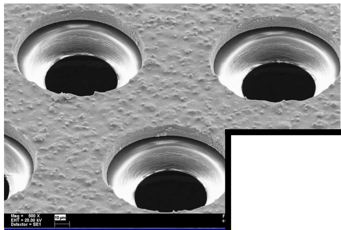
P. Barbeau &
J. Collar (Chicago)
J. Miyamoto,
& I. Shipsey (Purdue)

**hep-ex/0304013**




SEM Courtesy Fabio Sauli

Preliminary studiesŁ performance is equivalent to CERN GEMs, cost potentially lower



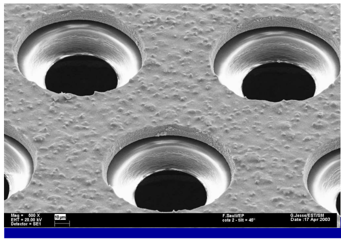
# Summary Comparison CERN and 3M GEM

| | 3M GEM | CERN GEM |
|---|---|---|
| $I_{leak}$ | 0.02nA/cm$^2$ @ 600V in air at 40% R.H. | 0.005nA/cm$^2$ @ 500V in $N_2$ |
| Gain<br>ΔE/E<br>ΔG(x,y)/G(x,y) | **~1,000 @ 500V Ar/CO2 7:3**<br>~16%<br>9% | **~1,000 @ 500V Ar/CO2 7:3**<br>~18%( typical)<br>-- |
| Electron Transparency<br>Ion Transparency | 0.9<br>0.9 | 0/9<br>0.6 |
| Ion Feedback | 0.1 at G=20<br>$E_{drift=}$150V/cm | 0.08<br>$E_{drift=}$150V/cm |
| Ageing | *To be measured* | 25 mC/mm$^2$ Triple GEM @ Purdue (2000) |

?

Table from I.Shipsey ALCW Cornell, July ‘03

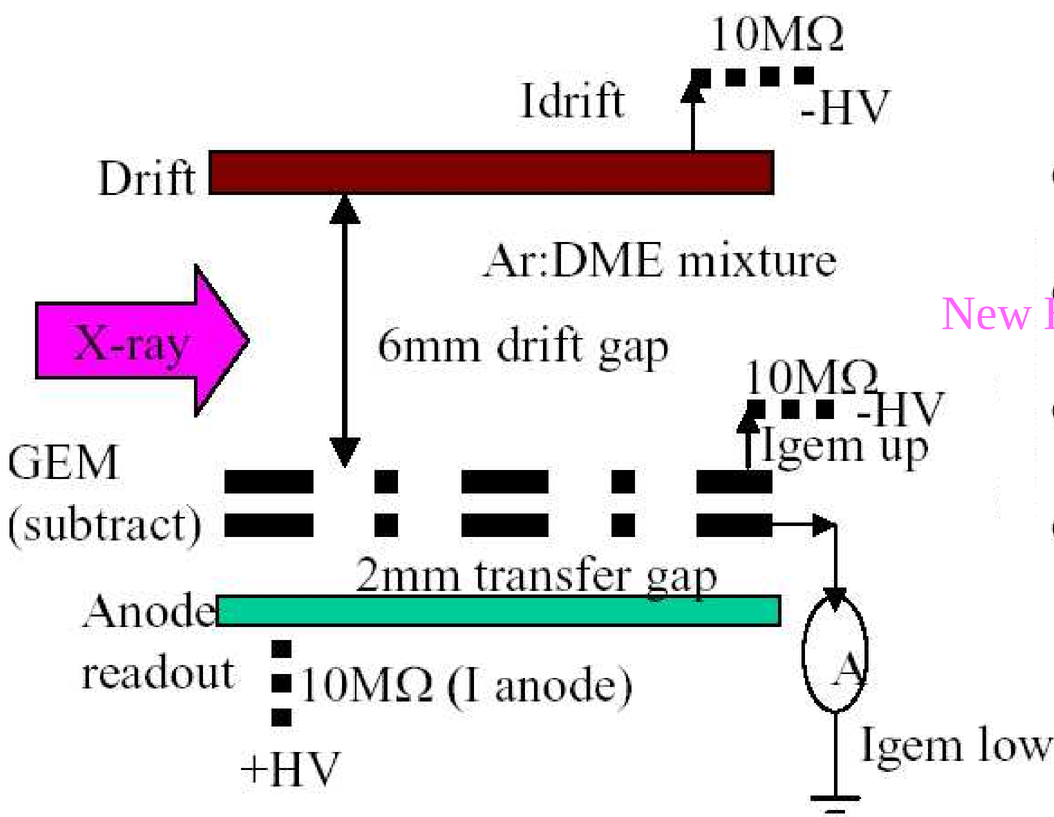
First mass production of ~2,000 GEMs Preliminary studiesŁ performance is equivalent to GEMs made at CERN. See hep-ex/0304013 & Imaging 2003 proceedings. An ageing study had yet to be done....

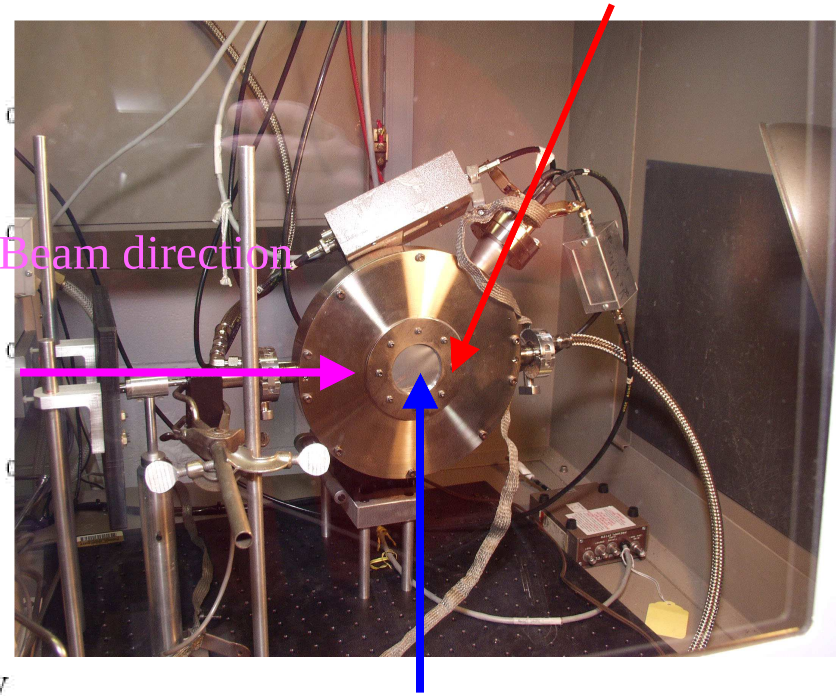


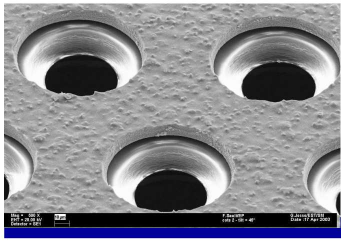
# First Aging Study of a Single 3M GEM

X-ray beam parallel to the GEM surface Ł homogenous irradiation over a large area: provides a more realistic aging simulation (NEW)

Presented at IEEE 2003, Portland
Oct 22 2003 by J. Miyamoto
and extended here.

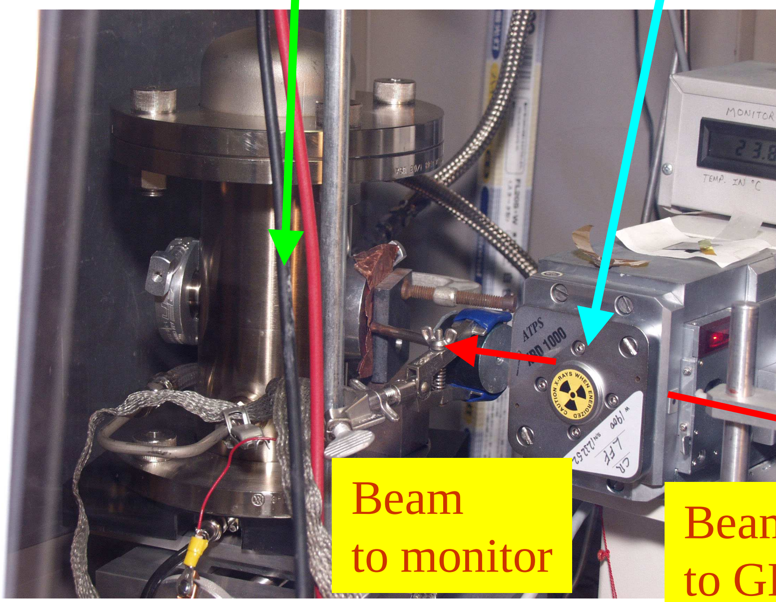


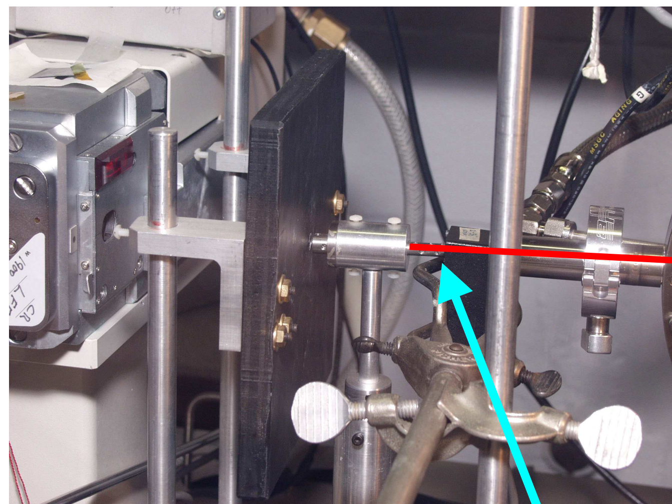





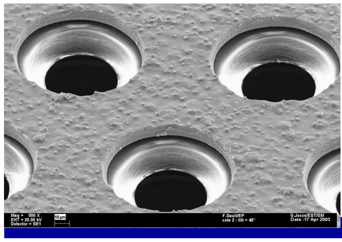
# First Aging Study of a Single 3M GEM

Ambient conditions (P,T) gas quality & X-ray tube stability are accounted for with a single wire proportional monitor chamber in the *same* gas system receiving beam from the *same* X-ray tube

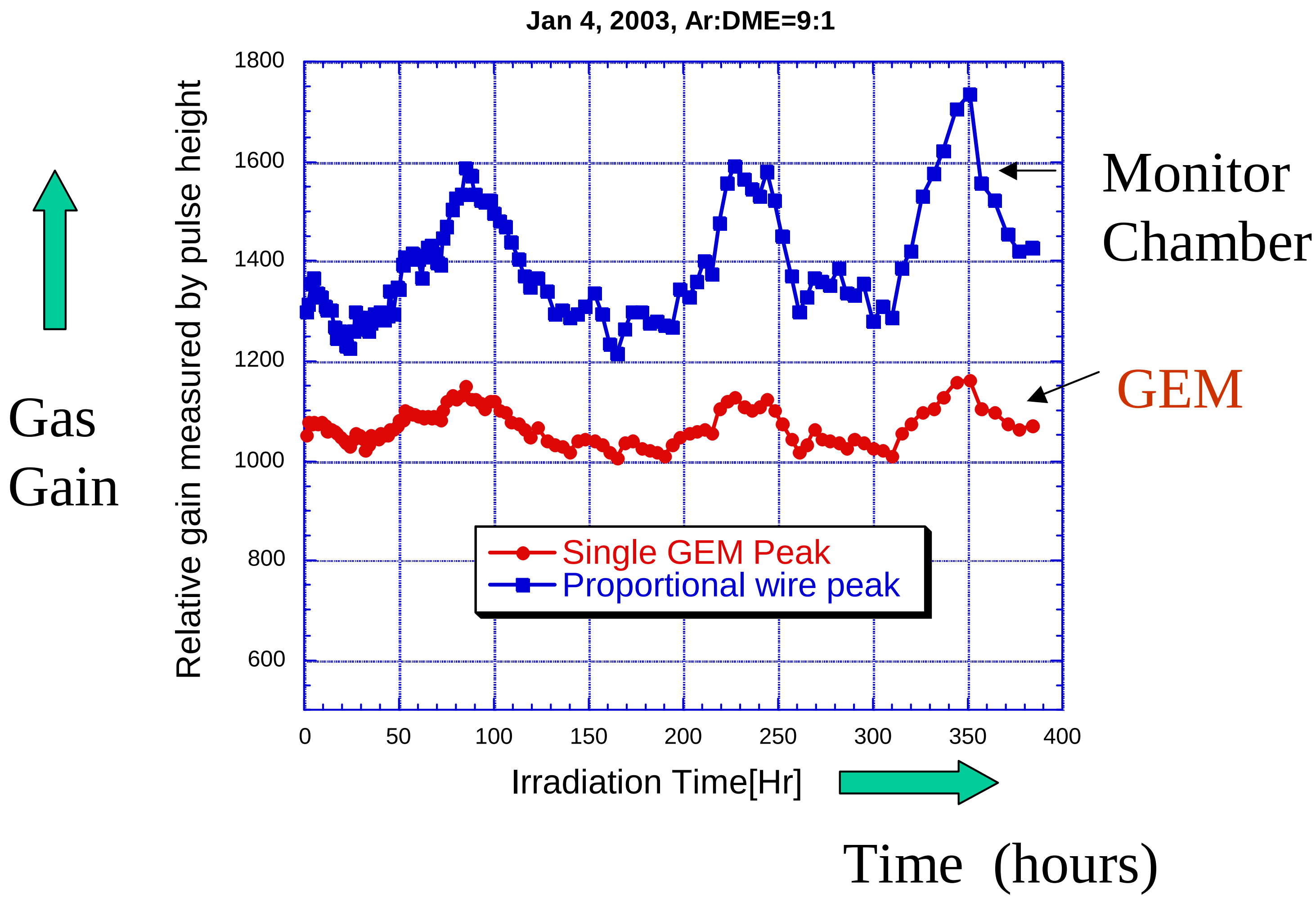


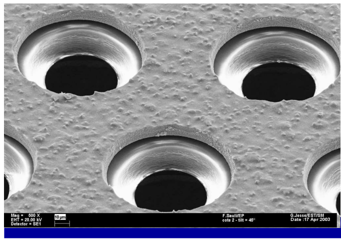

Spectra are obtained without pile up via an absorber & reduction in the X-ray current



# Pulse height of monitor chamber and a single GEM with time



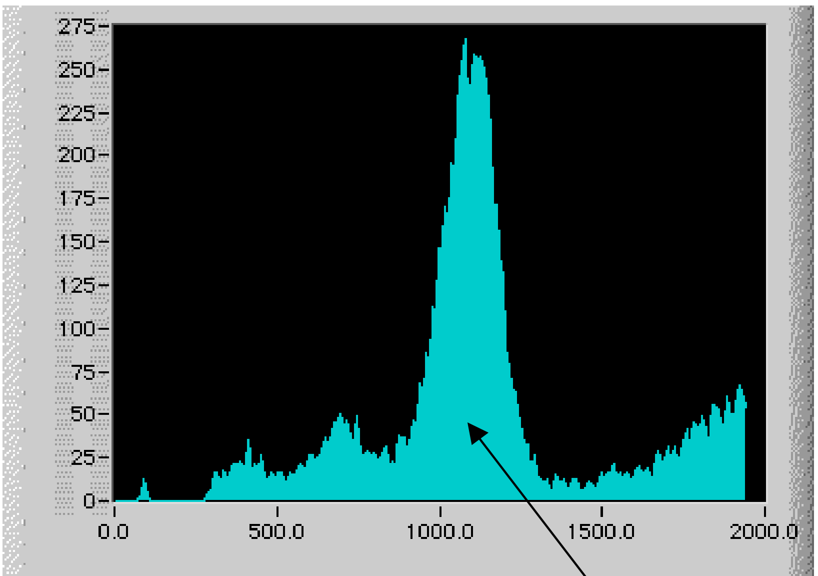

(The fluctuations in gain are due to changes in atmospheric pressure.)

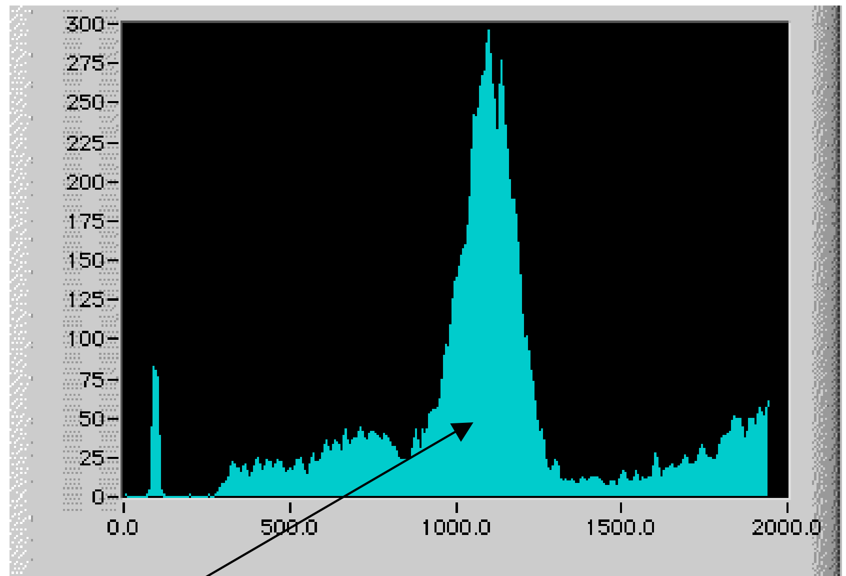


# Energy resolution remains constant throughout the experiment

Beginning of ageing study

After 400 hours of irradiation



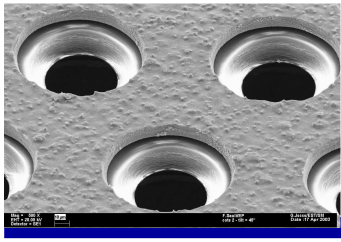




Gas Gain

5.4 keV X-ray peak

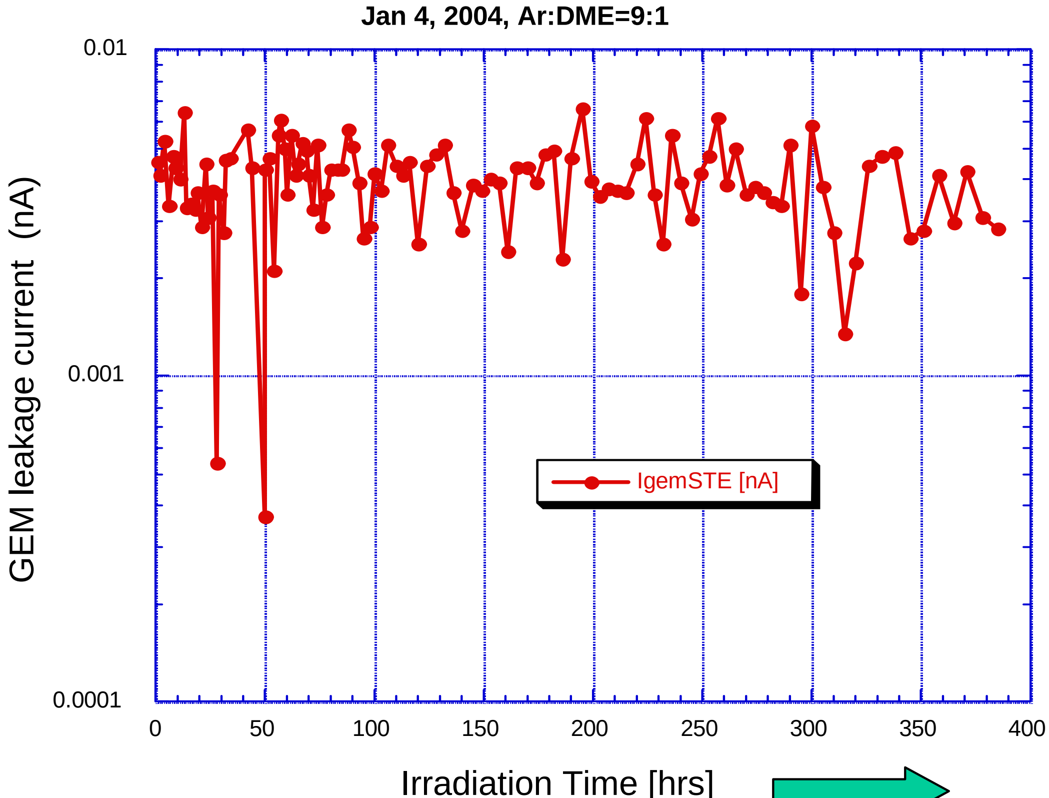
Gas Gain

Total accumulated charge 2.5 $mC/mm^2$ (corresponds to ~16,000 years at a LC [ref Lepeltier]).



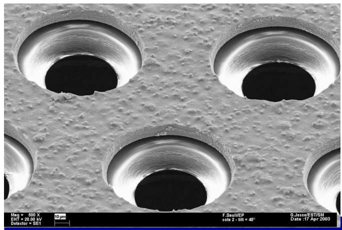
# 3M GEM Leakage Current During Irradiation

$I_{leak}$(nA)




Time (hours)

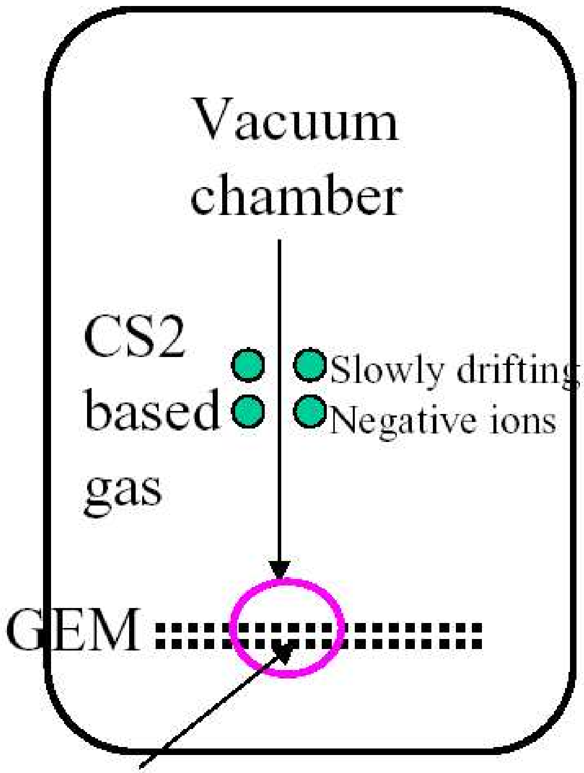
Leakage current remains in the region expected
for a normally functioning GEM throughout the period
of irradiation Ł stability of the insulator.



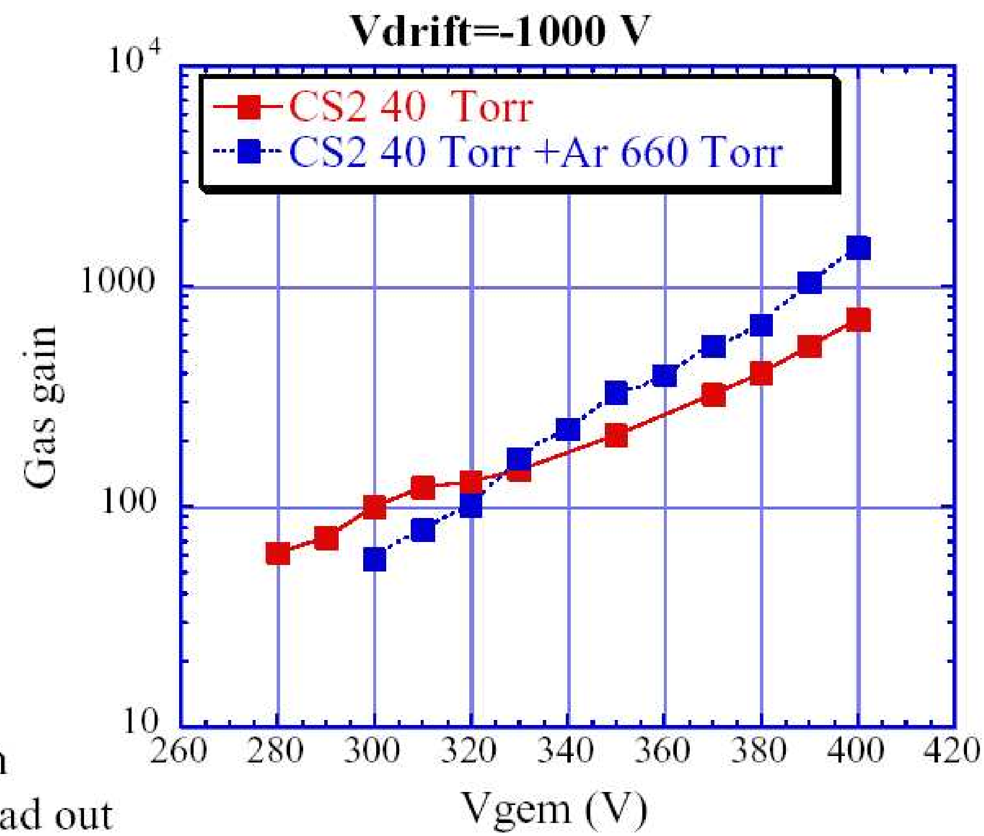
# New Application:
# 3M GEMs for Negative Ion TPC

Application: LC and axion searches (Purdue/Temple/WSU Sept. ‘03)

**hep-ex/0310124**




Electron release and multiplication
in high E-field region and signal read out



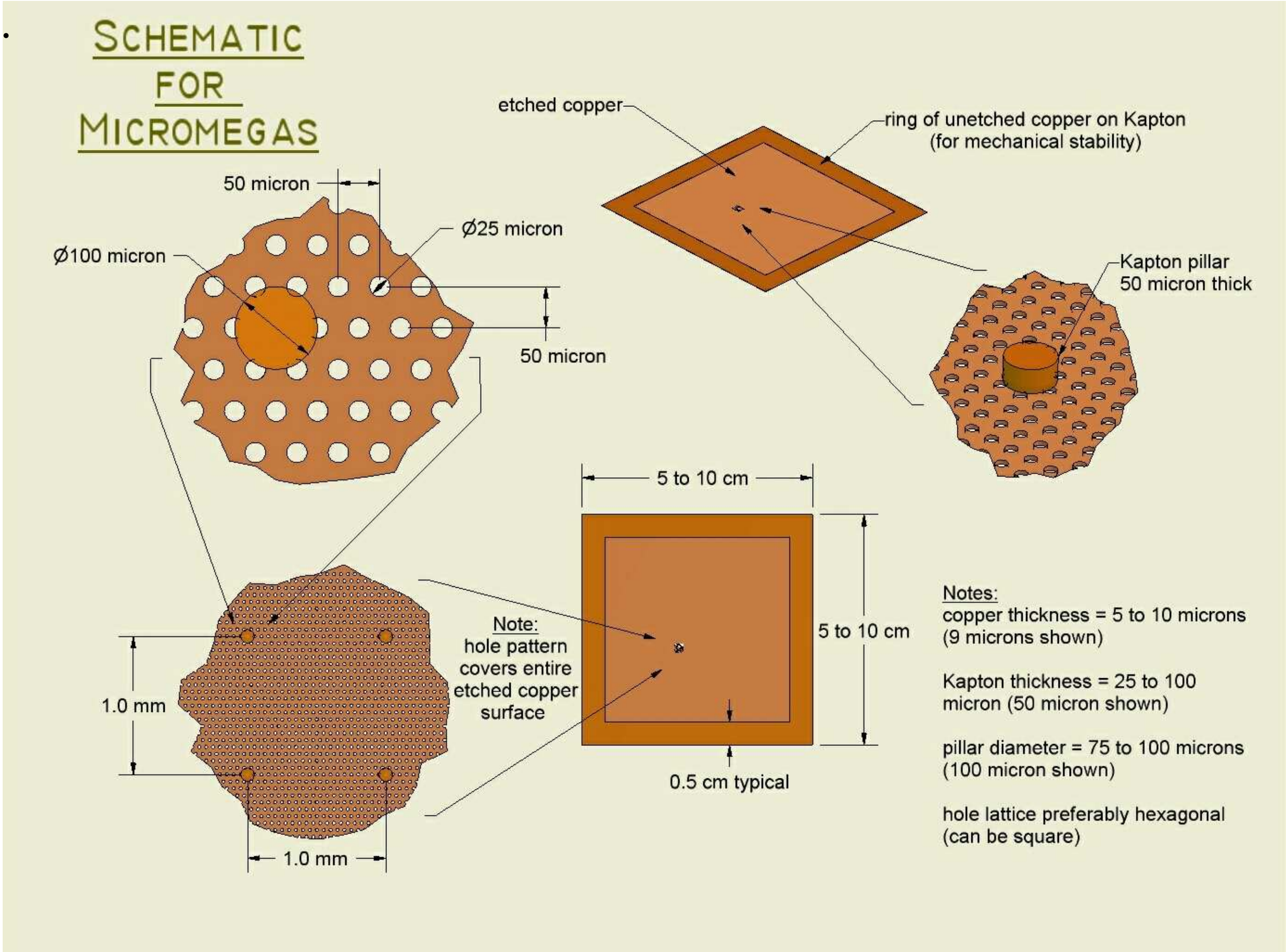

Single stage gains up to ~1,000

(He mixtures also tested)

# Towards Development of Mass Produced MICROMEGAS

3M Flex Circuit Fabrication Technique better suited to GEMS than MICROMEGAS but worth a try…

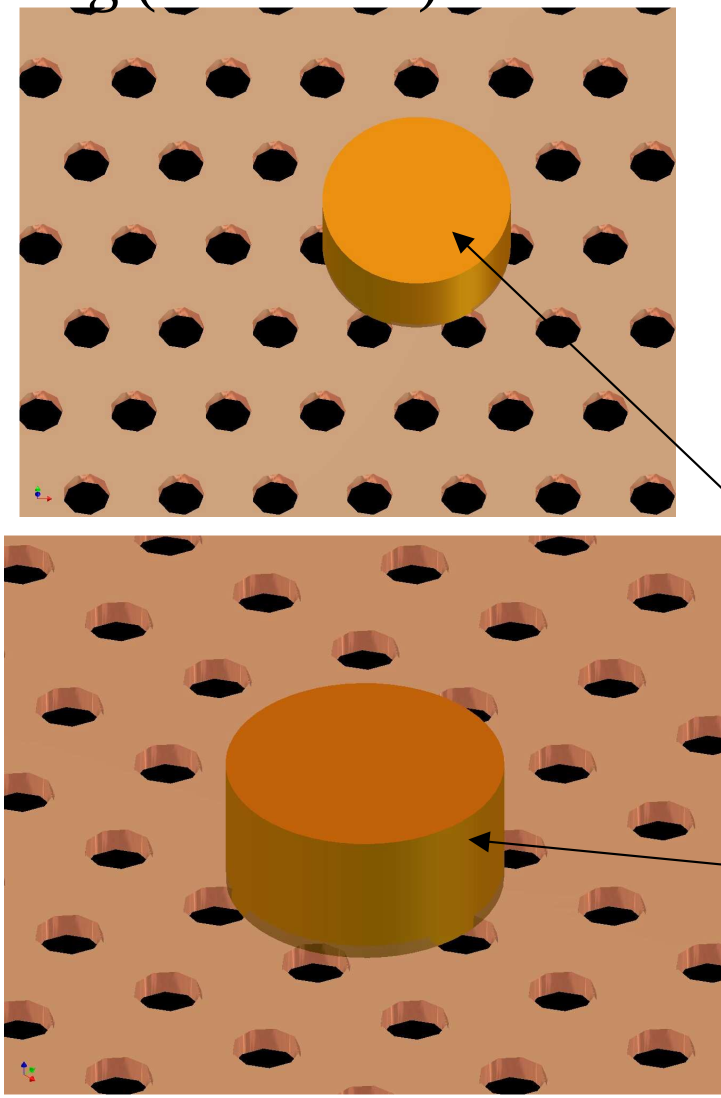
(Micromegas are harder to make because they are effectively GEMs with one layer of conductor and most of the insulator removed)



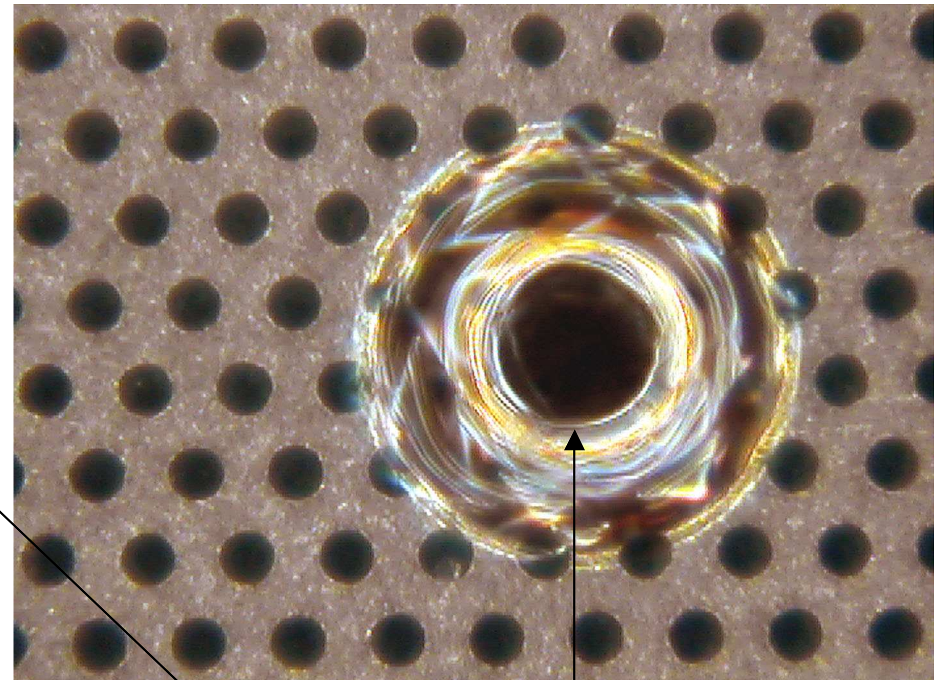
# Development of mass produced MICROMEGAS

November-December 2003

Drawing (two views)



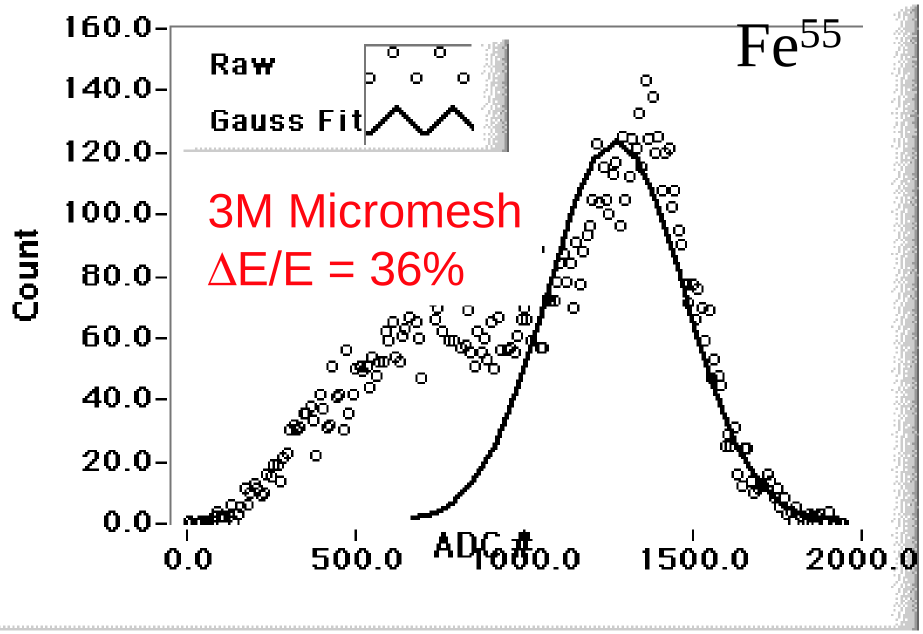
Reality



Kapton pillar
(tapered on right)_

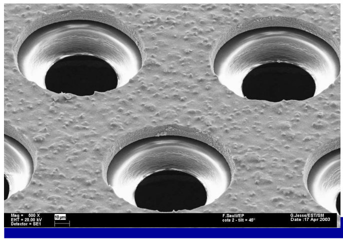
# 1st Spectrum with a Mass Produced MICROMEGAS

very preliminary




Successful operation in Ar-DME gas but the performance (energy resolution) is inferior to a traditional MICROMEGAS presumably due to an observed (severe) lack of uniformity and imperfections in the micromesh.

3M believe they know how to cure this and a new batch of micromesh foils is expected in the next few weeks.



# Summary

Mass produced GEMs now tested by a variety of groups performance similar to CERN GEMS (Chicago/Purdue/3M)

New

Mass produced GEMs are radiation hard (Purdue). Need other groups to confirm this result.

New

GEMS operate in negative ion gases (Purdue/Temple/WSU)

Very New

The first steps towards successful mass production of a MICROMEGAS have been taken. In our opinion most of the challenges still lie ahead. However, we are cautiously optimistic. More news (hopefully) in a few weeks. (Purdue/3M)