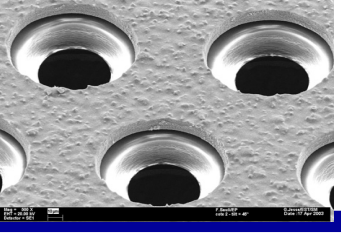


Update on Mass Produced Micro Pattern Gas Detectors

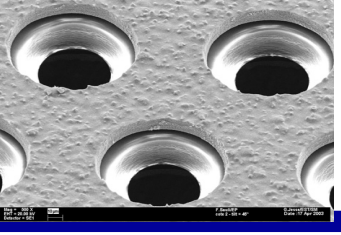
Mass Production of GEMs (Chicago/Purdue/3M)

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

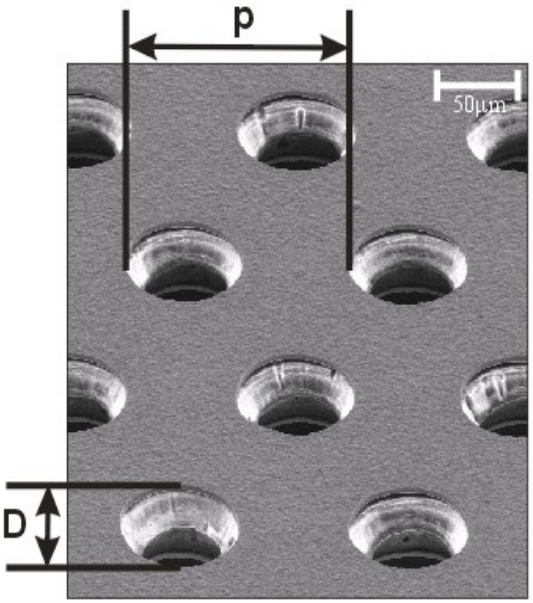


Reminder: GEM and Micromegas

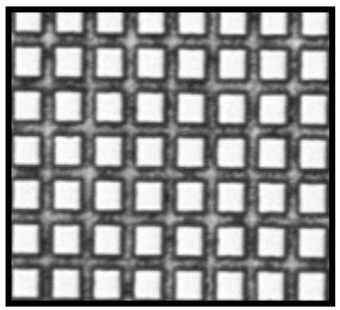
GEM: Two copper perforated foils separated by an insulator

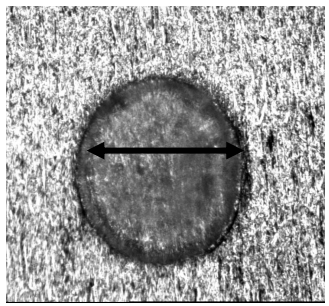
The multiplication takes place in the holes.

Usually used in 3 stages, even 4



Micromegas : a micromesh sustained by 50-100 µm - high insulating pillars.
The multiplication takes place between the anode and the mesh
One stage





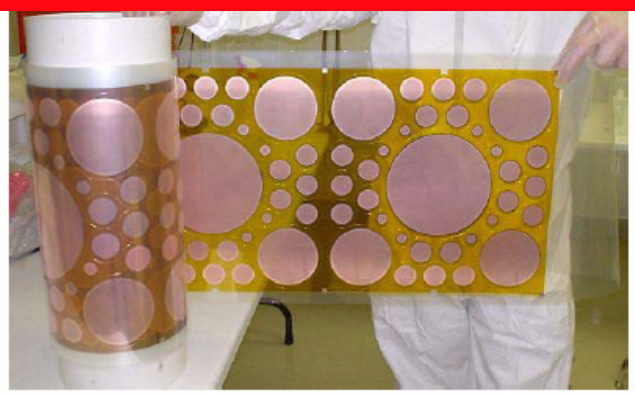
200 µm

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

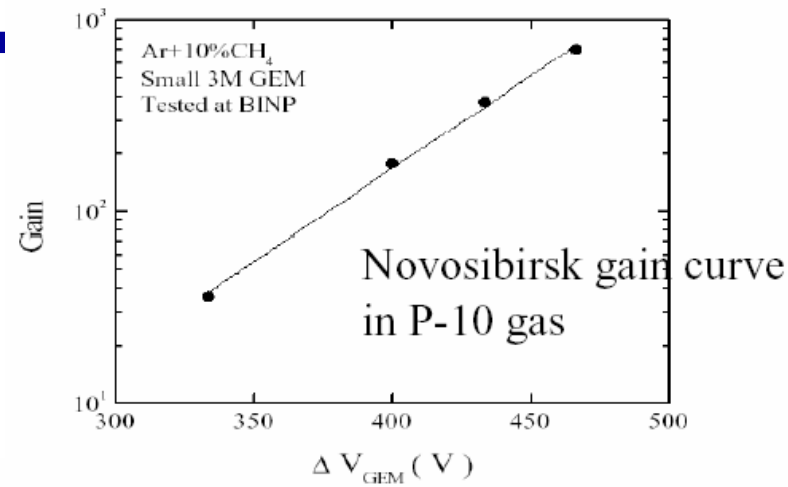
First Mass Production of Gas Electron Multipliers

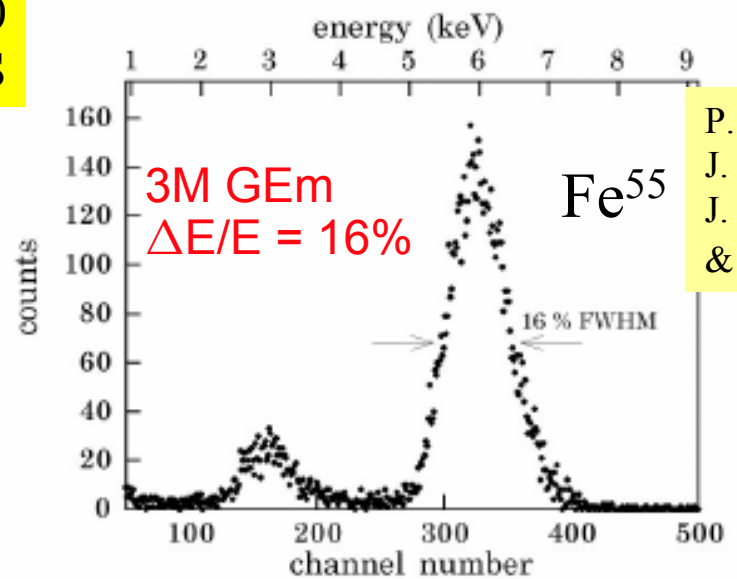
(3M Proprietary Flex Circuit Fabrication Technique)

- **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.



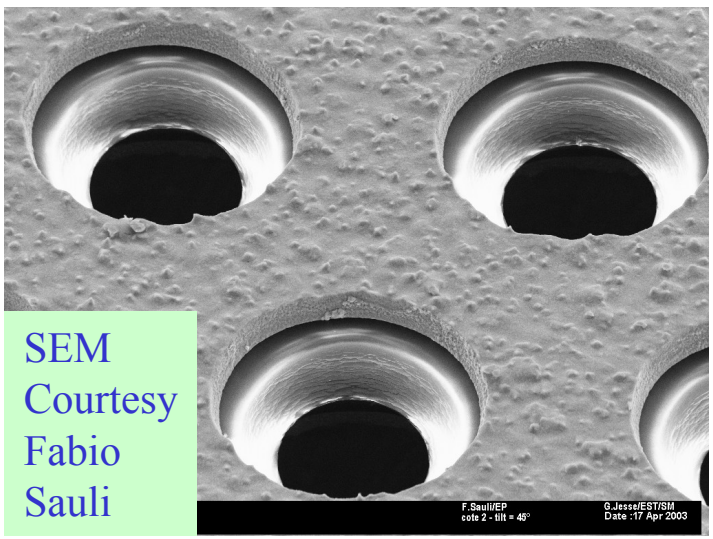
Single roll of ~1,000 GEMS





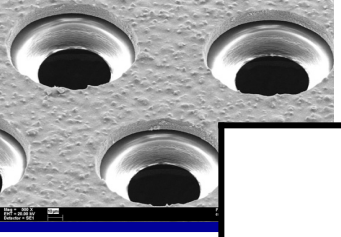
P. Barbeau &
J. Collar (Chicago)
J. Miyamoto,
& I. Shipsey (Purdue)

hep-ex/0304013



SEM Courtesy Fabio Sauli

Preliminary studies➔ performance is equivalent to CERN GEMs, cost potentially lower



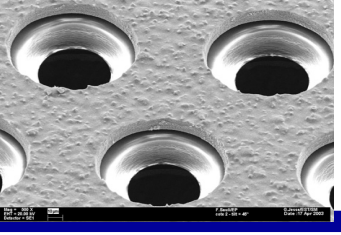
Summary Comparison CERN and 3M GEM

	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 $\Delta E/E$ $\Delta G(x,y)/G(x,y)$	**~1,000 @ 500V Ar/CO2 7:3** ~16% 9%	**~1,000 @ 500V Ar/CO2 7:3** ~18%(typical) --
Electron Transparency Ion Transparency	0.9 0.9	0/9 0.6
Ion Feedback	0.1 at G=20 $E_{drift=}$150V/cm	0.08 $E_{drift=}$150V/cm
Ageing	*To be measured*	25 mC/mm^2 Triple GEM @ Purdue (2000)

?

Table from I.Shipsey ALCW Cornell, July '03

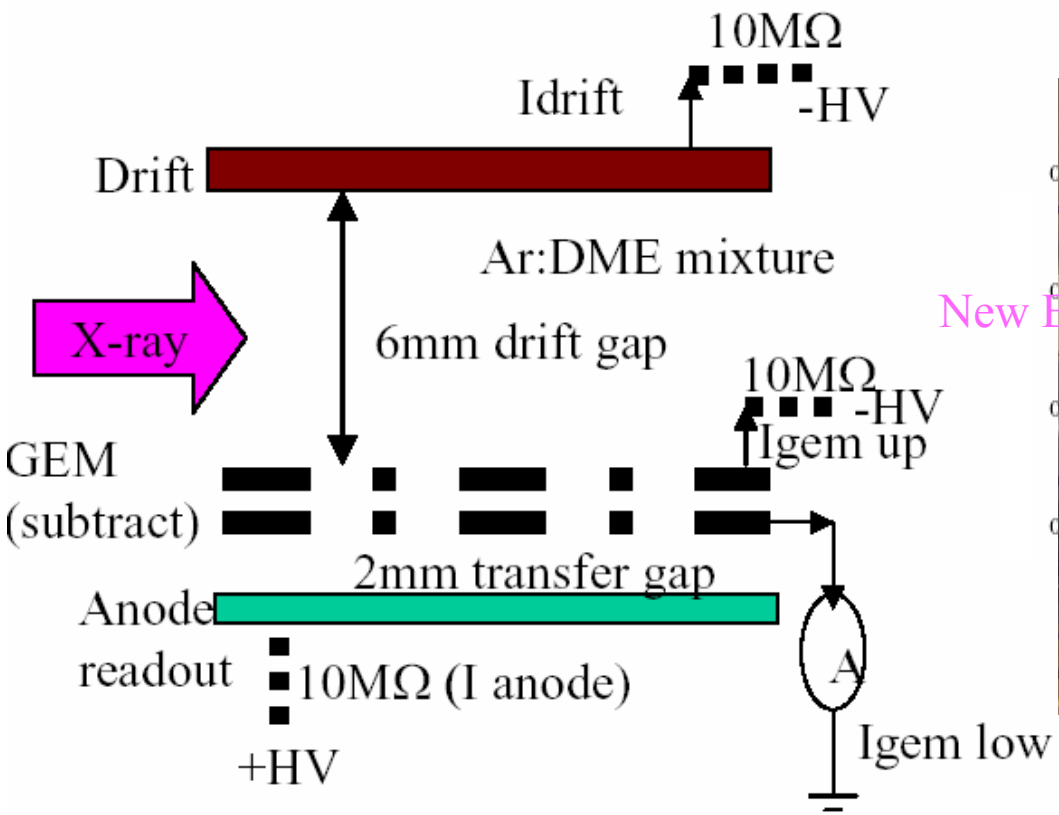
First mass production of ~2,000 GEMs Preliminary studies➔ performance is equivalent to GEMs made at CERN. See hep-ex/0304013 & Imaging 2003 proceedings. An ageing study had yet to be done....

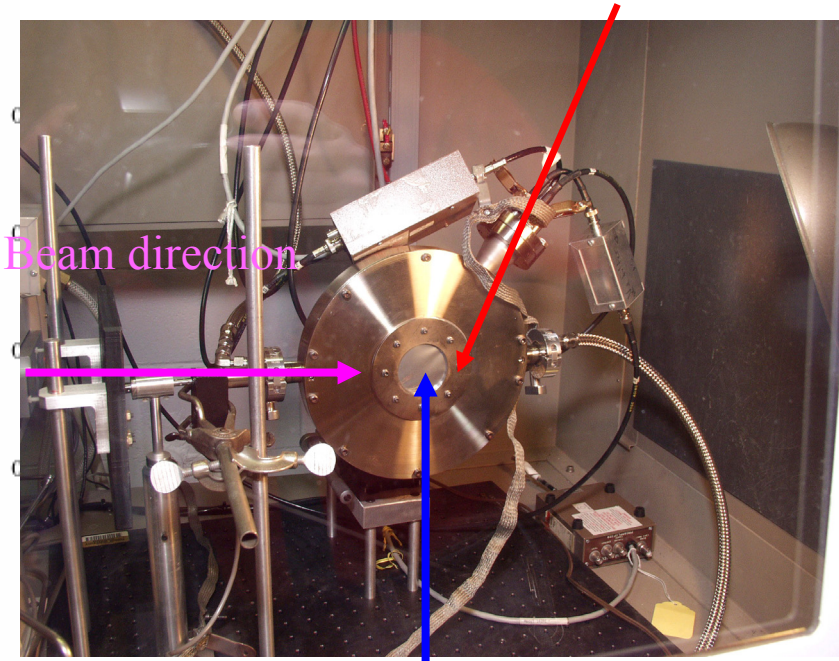


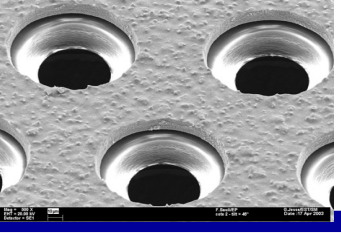
First Aging Study of a Single 3M GEM

X-ray beam parallel to the GEM surface ➔ 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.

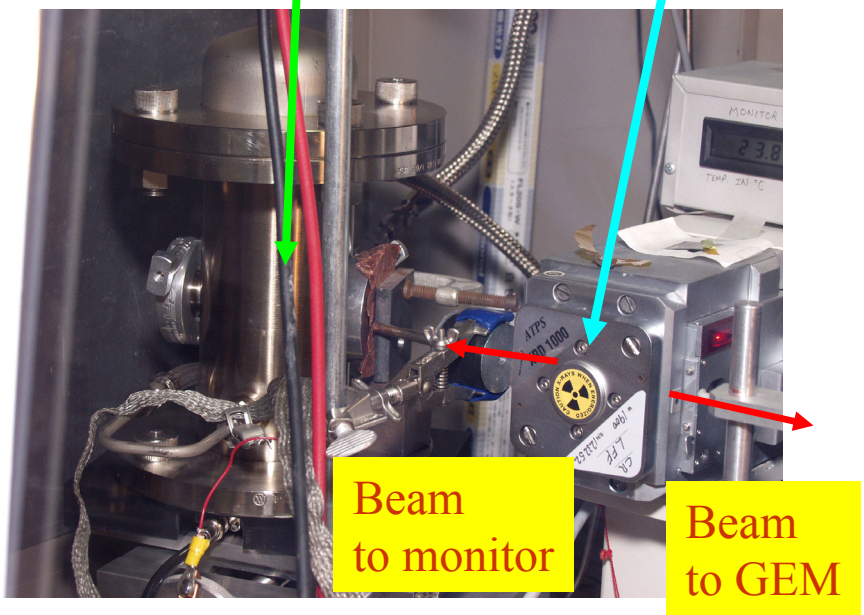


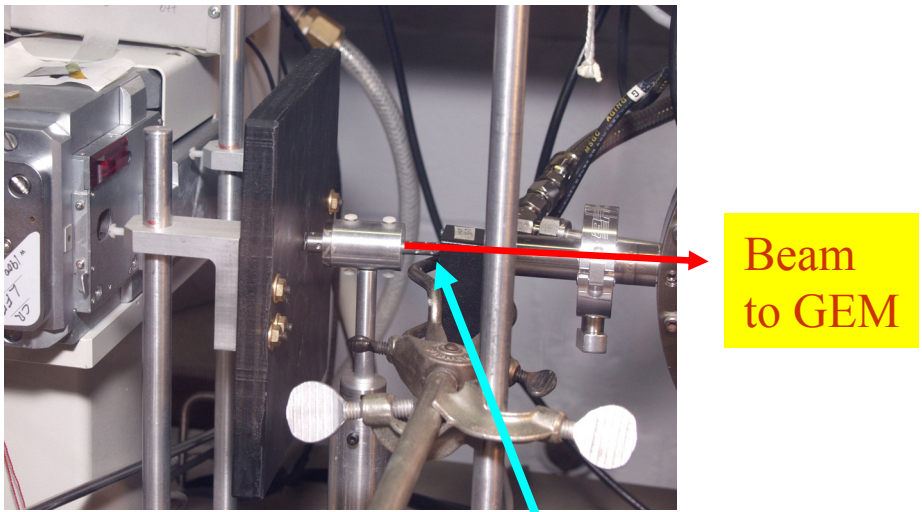




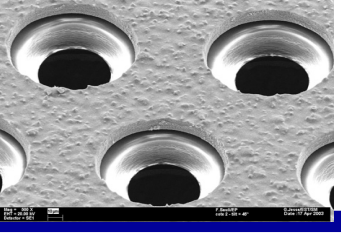
First Aging Study of a Single 3M GEM

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

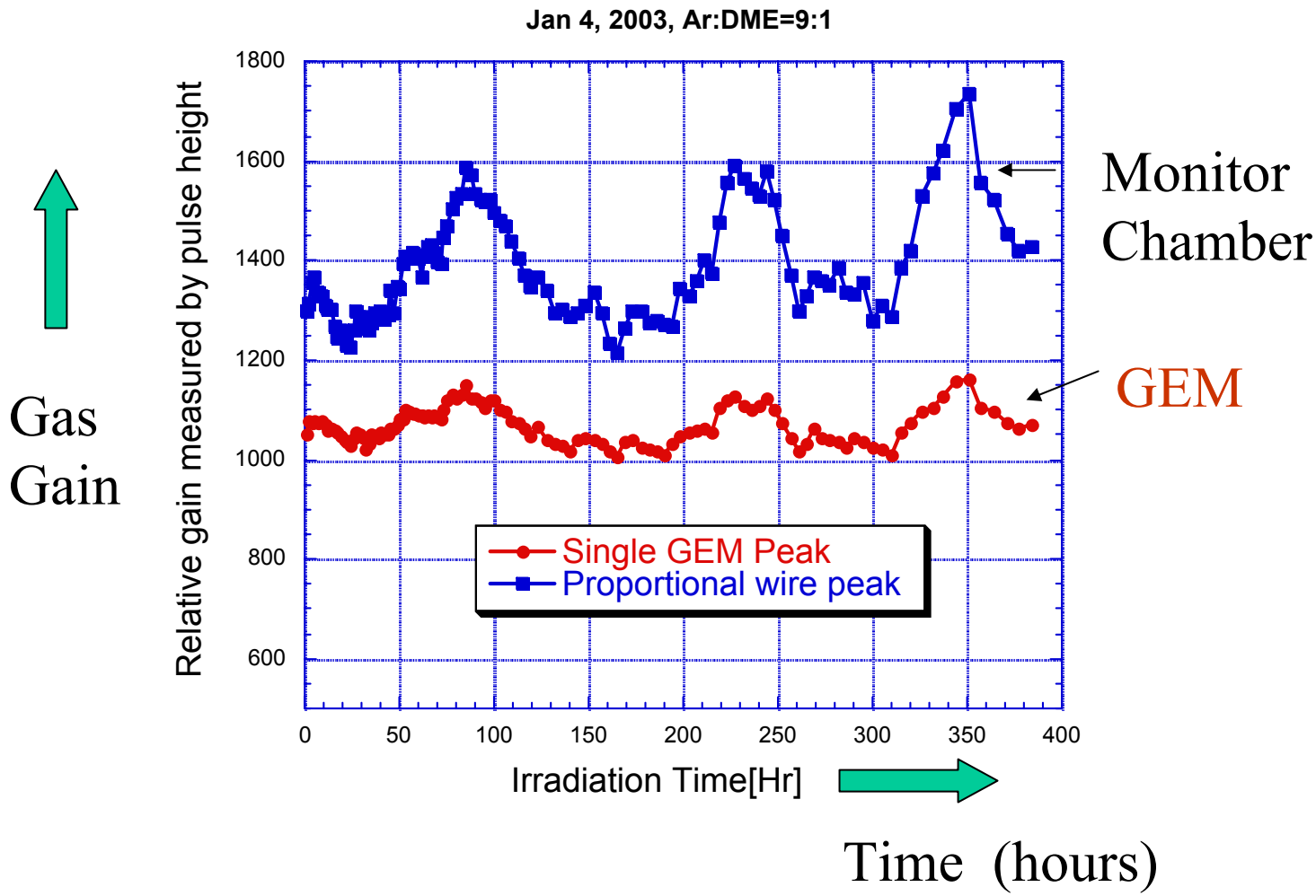




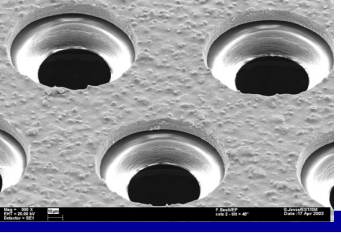
Spectra are obtained without pile up via an absorber & reduction in the X-ray current



Pulse height of monitor chamber and a single GEM with time

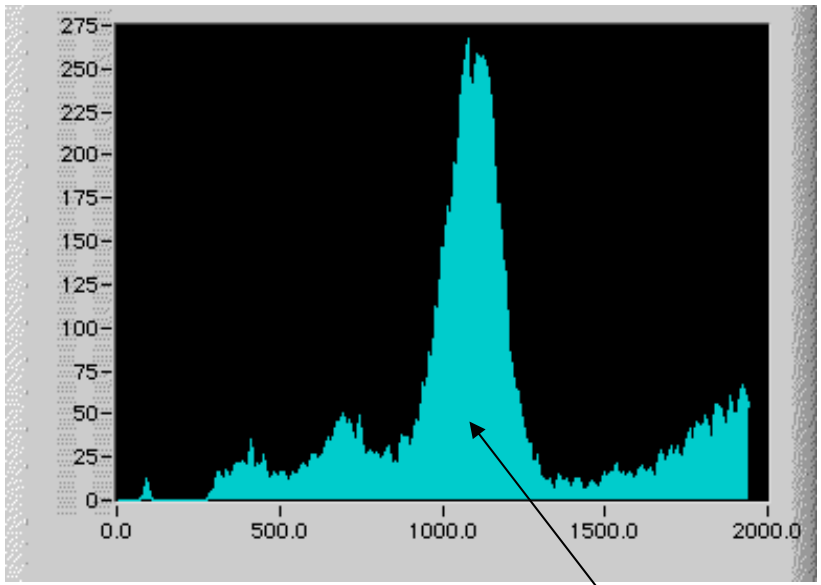


(The fluctuations in gain are due to changes in atmospheric pressure.)

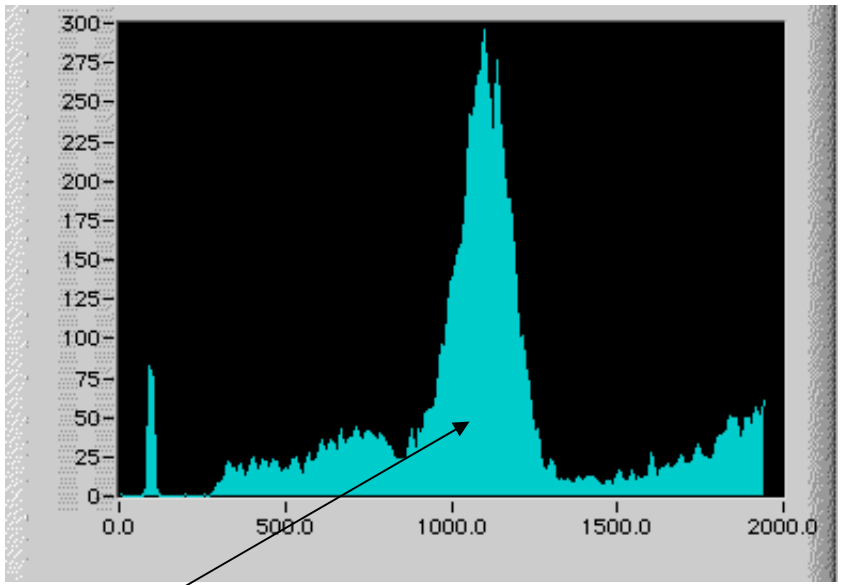


Energy resolution remains constant throughout the experiment

Beginning of ageing study



After 400 hours of irradiation

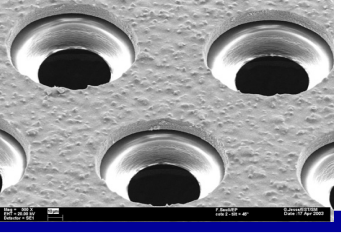


Gas Gain →

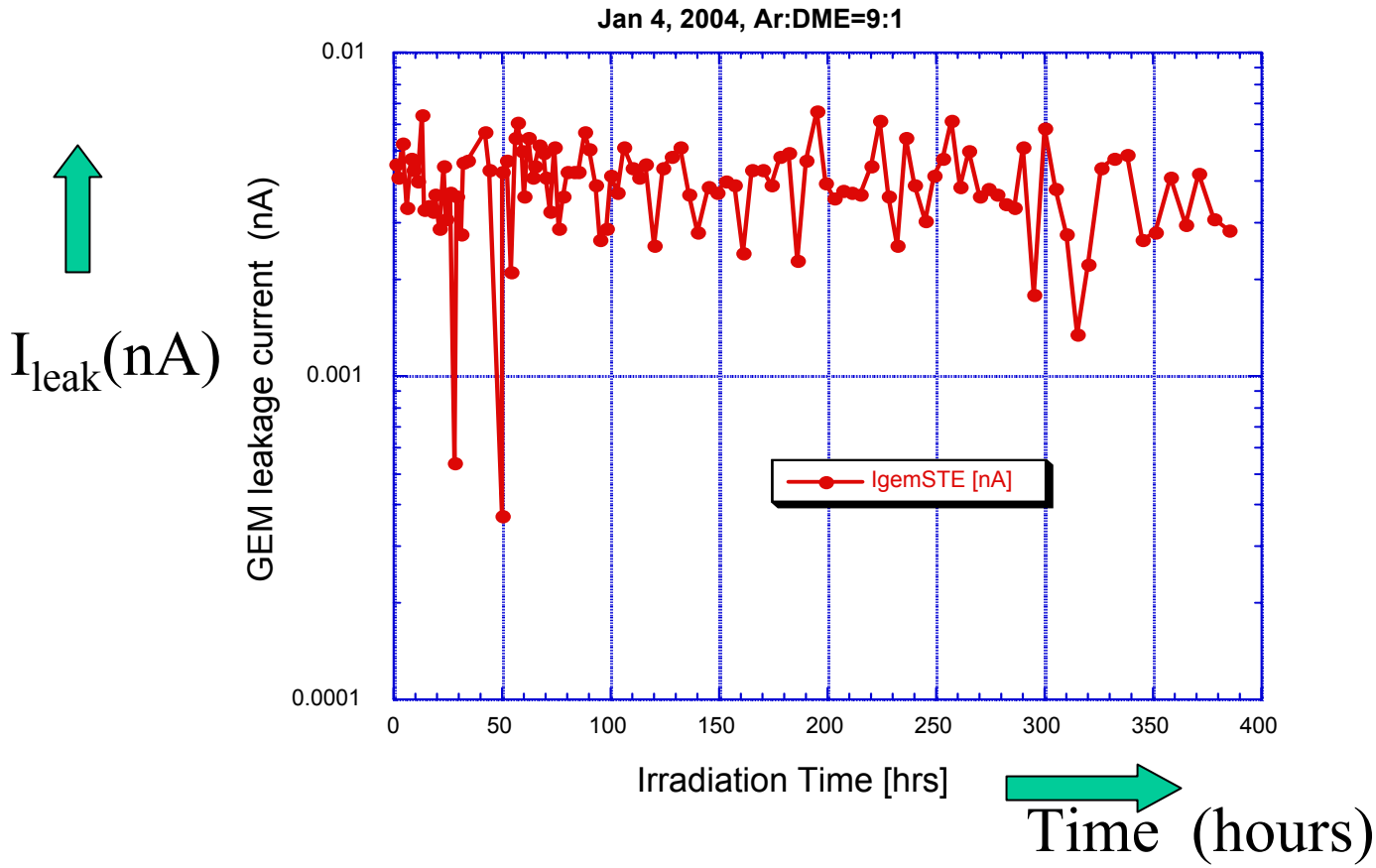
5.4 keV X-ray peak

Gas Gain →

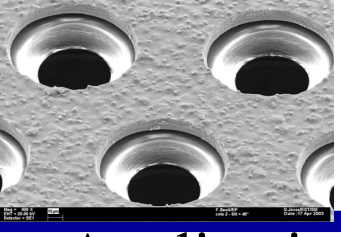
Total accumulated charge 2.5 mC/mm^2 (corresponds to ~16,000 years at a LC [ref Lepeltier]).



3M GEM Leakage Current During Irradiation



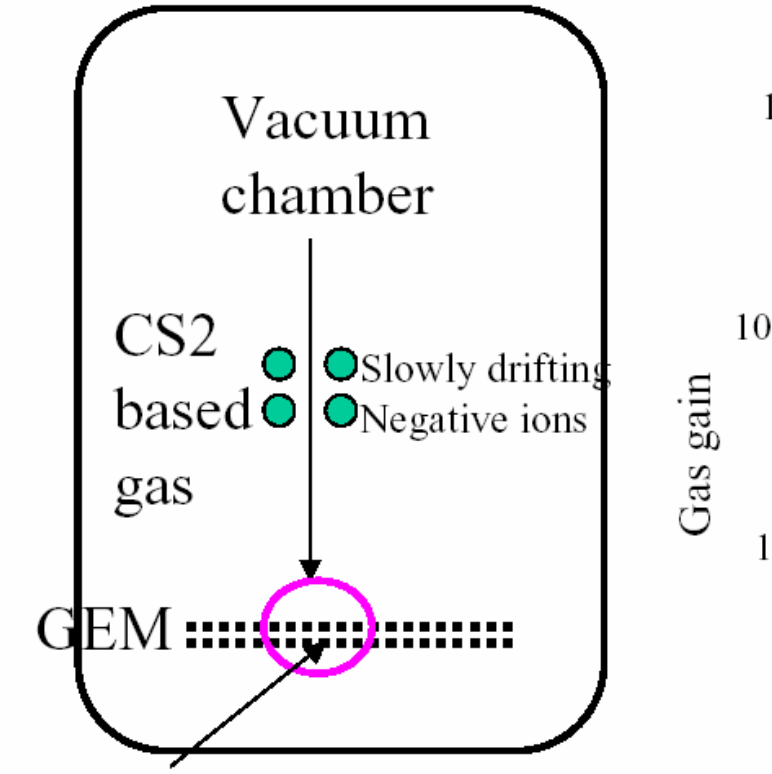
Leakage current remains in the region expected for a normally functioning GEM throughout the period of irradiation ➔ stability of the insulator.



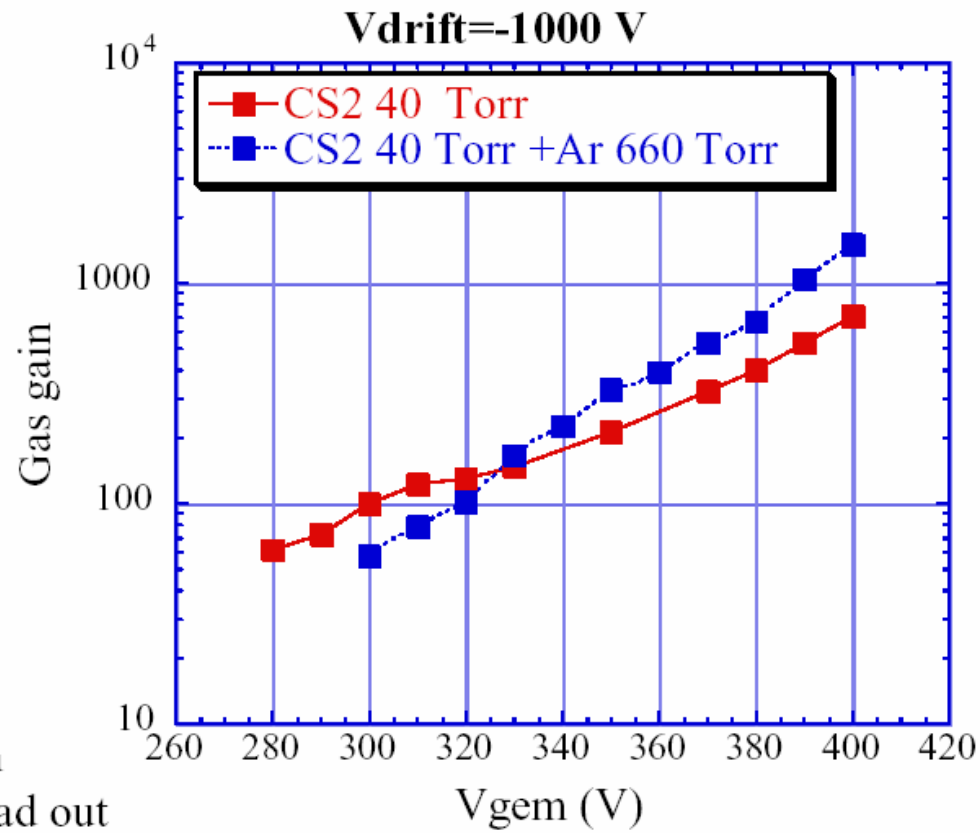
New Application: 3M GEMs for Negative Ion TPC

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



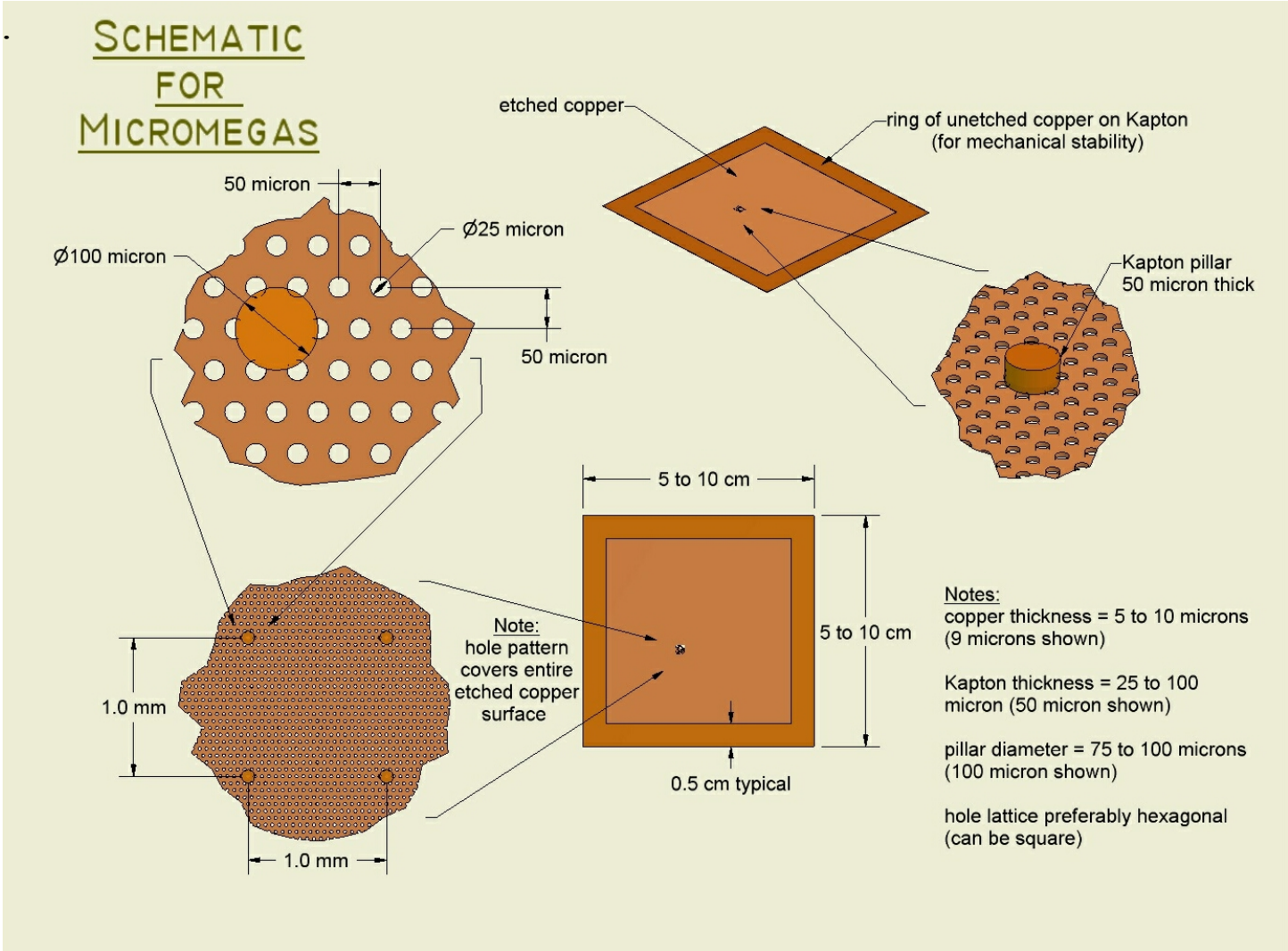
Single stage gains up to ~1,000

(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…

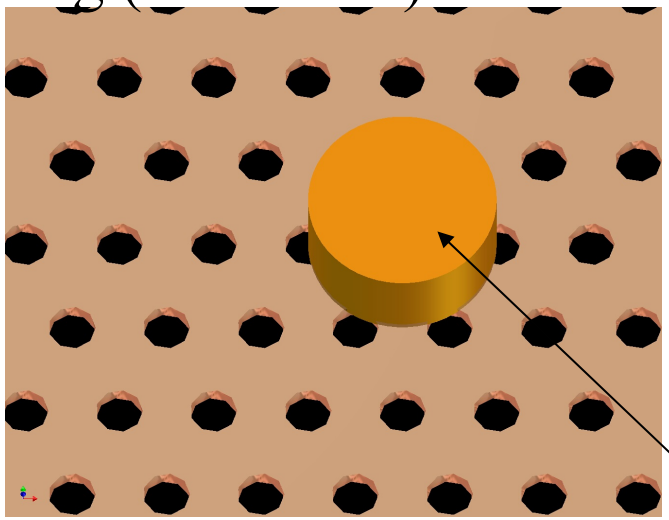
(Micromegas are harder to make because they are effectively GEMs with one layer of conductor and most of the insulator removed)

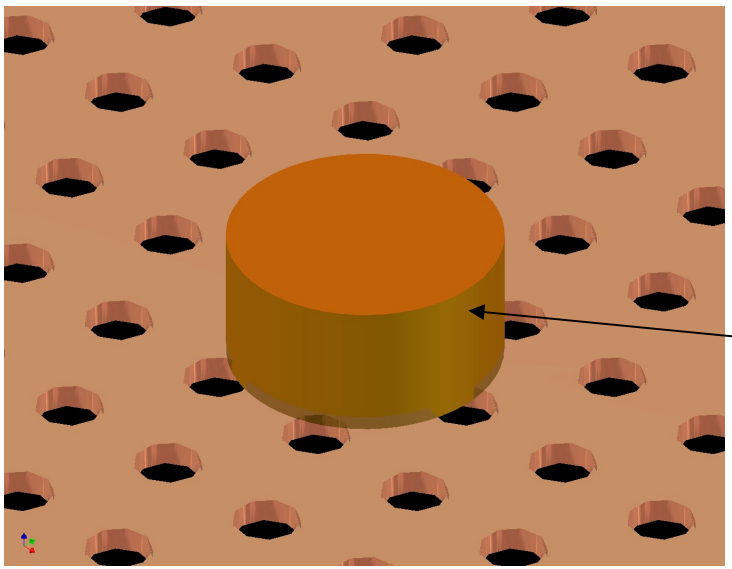


Development of mass produced MICROMEGAS

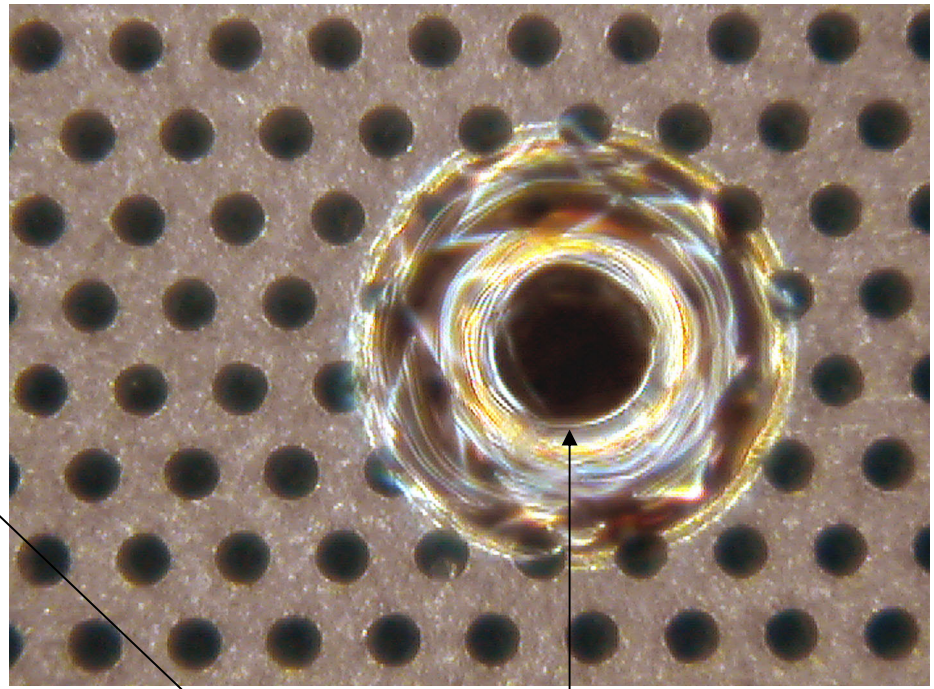
November-December 2003

Drawing (two views)





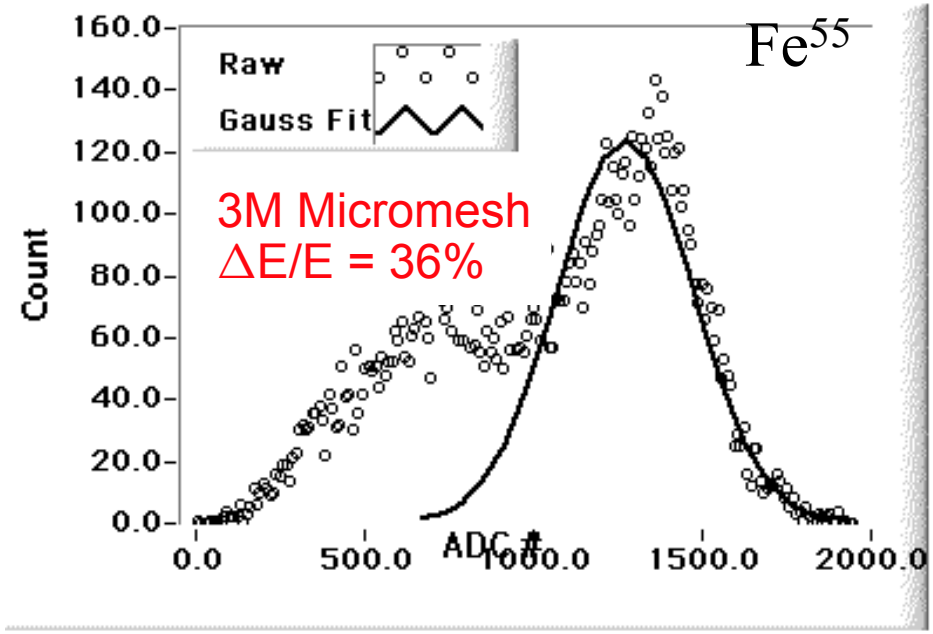
Reality



Kapton pillar
(tapered on right)_

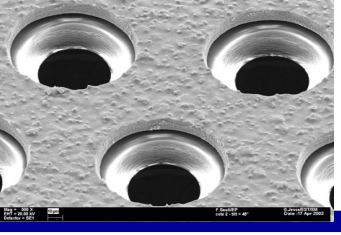
1st Spectrum with a Mass Produced MICROMEGAS

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)