Recent activities on Micropatterned Gas Detectors at Purdue

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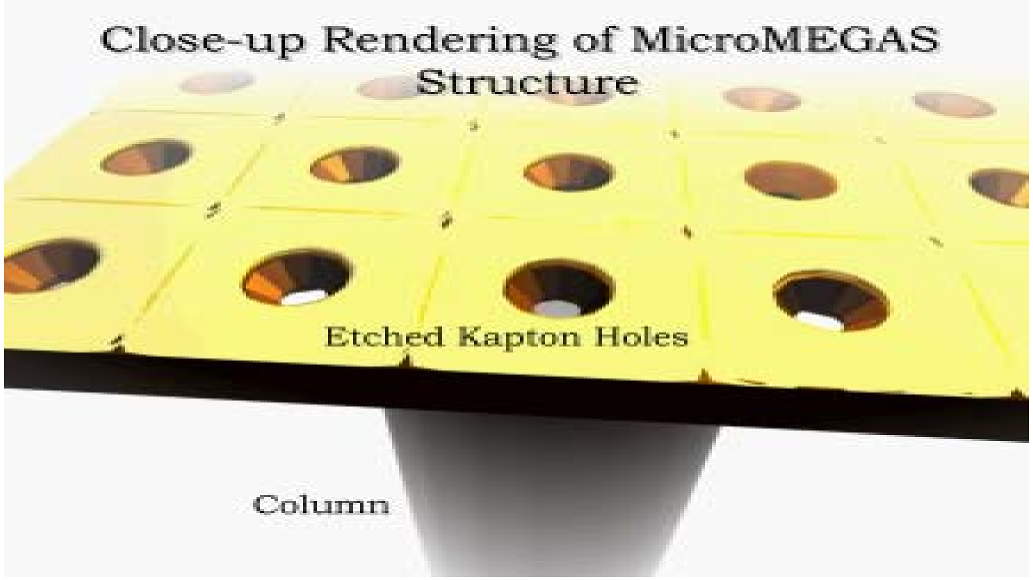


Presented for the Santa Cruz Linear Collider Retreat, June 27-29, 2002

For more information, please visit **www.physics.purdue.edu/msgc**

Our experience with various gas detectors for tracking devices

1. MSGC (Microstrip gas Chamber) or MSGC+GEM
2. **GEM (Gas electron Multiplier), double, triple**
3. **MICROMEGAS(Micro Mesh Gas Detector)**
4. LEM(Large Electron Multiplier)(not meant for TPC)
5. Radiation damage study with all above

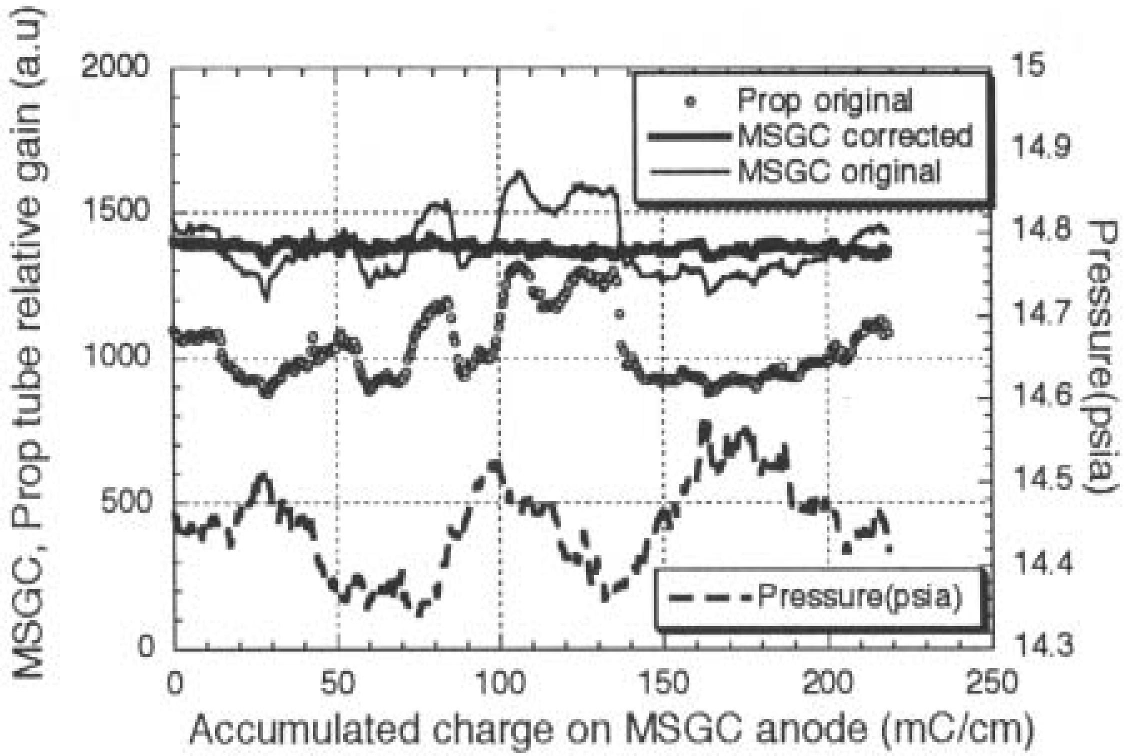
A lot of different Micropatterned detectors were invented since the birth of MSGC but today GEMs and MICROMEGAS are the most promising and these devices are interesting for TPC readout at a LC.

MSGC+GEM aging study

Single GEM+MSGC(shared gain) (1 mm pitch) aging in Ar-DME

ref: Como 1997 Purdue work(Nuclear Physics B, 78(1999) pp. 695-702)

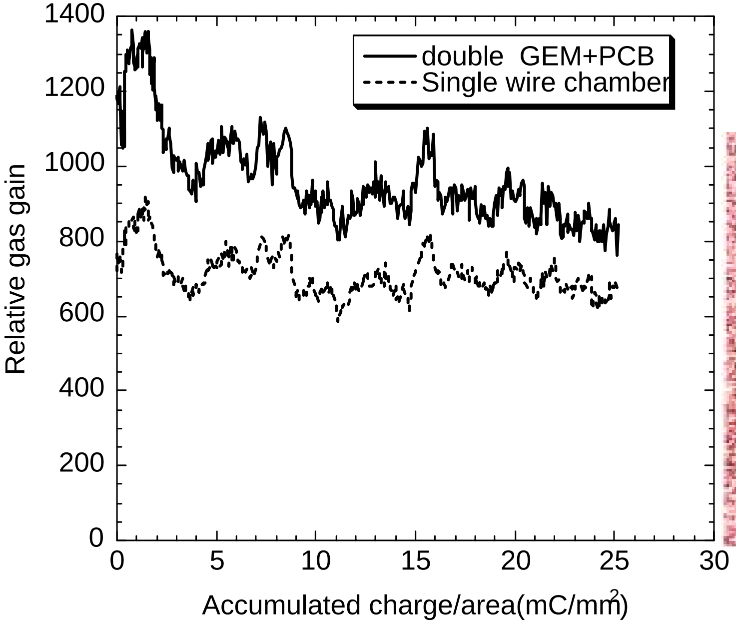
220 mC/cm and both the GEM and MSGC without any degradation in gas gain or energy resolution of the detector"



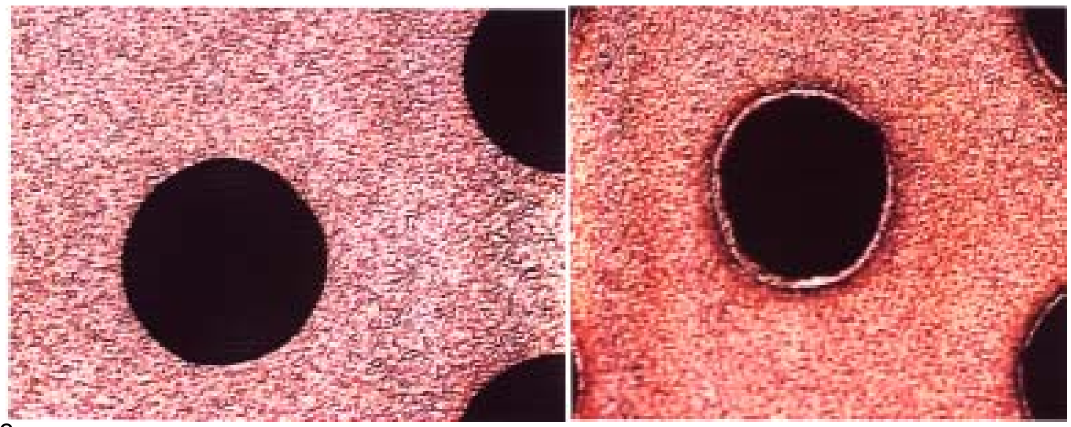
Some aging seen in double GEM

Double GEM aging in Ar/CO_2 (ref: NSS Lyon 2000 by Purdue)

1. The MSGC is eliminated by using 2 gems in series and collect the charge with a Kapton PCB at unity gain.
2. GEMs aged slowly after more than 25 mC/mm^2 was accumulated
3. Irradiated metals and Kapton degraded a little



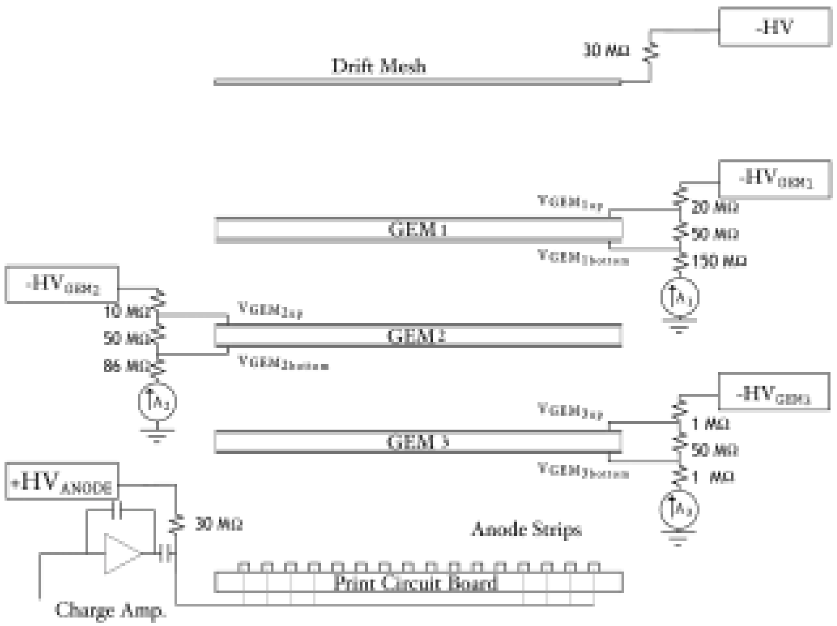
Before and After irradiation

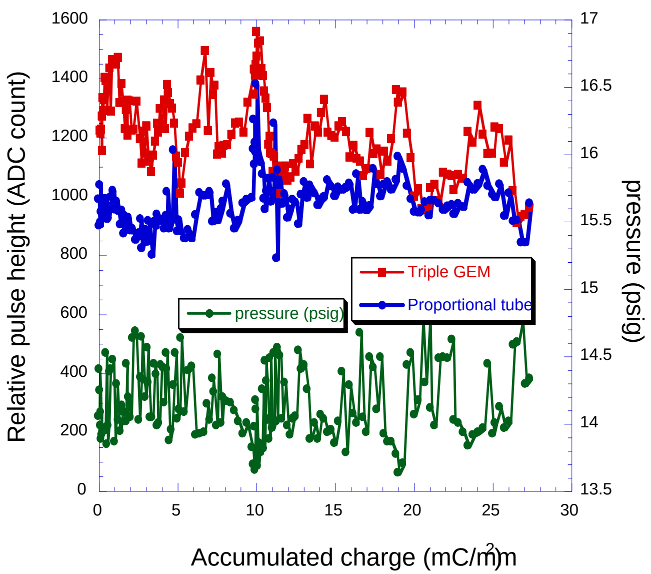


Minimal aging in triple GEM

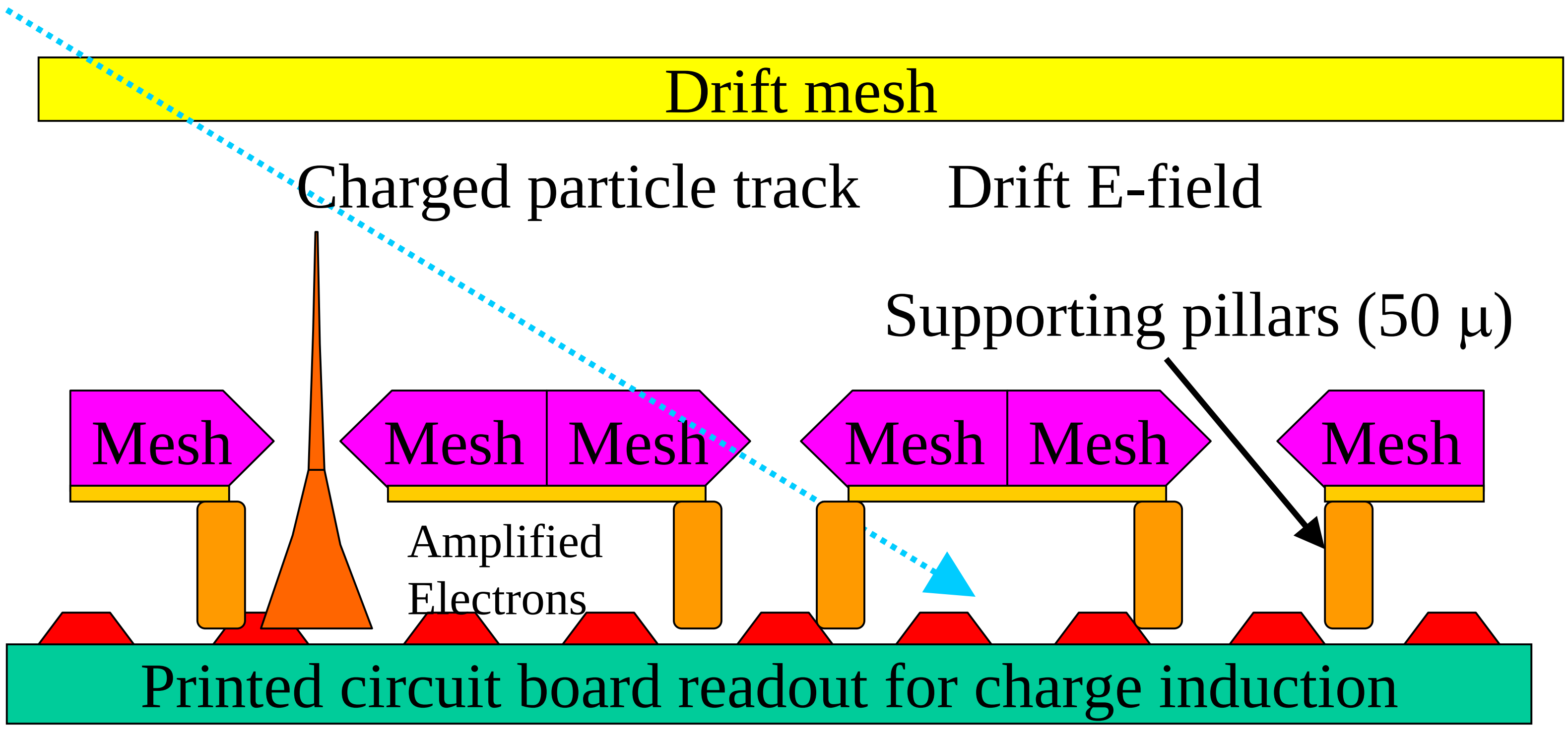
ref: Vienna 2001 Purdue work, NIM A478, p.263(2002)

A slight reduction in the gain with accumulated charge, but that this aging is less severe than in a double gem(no visible changes on the GEM surface).





New generation MICROMEGAS with Kapton pillars

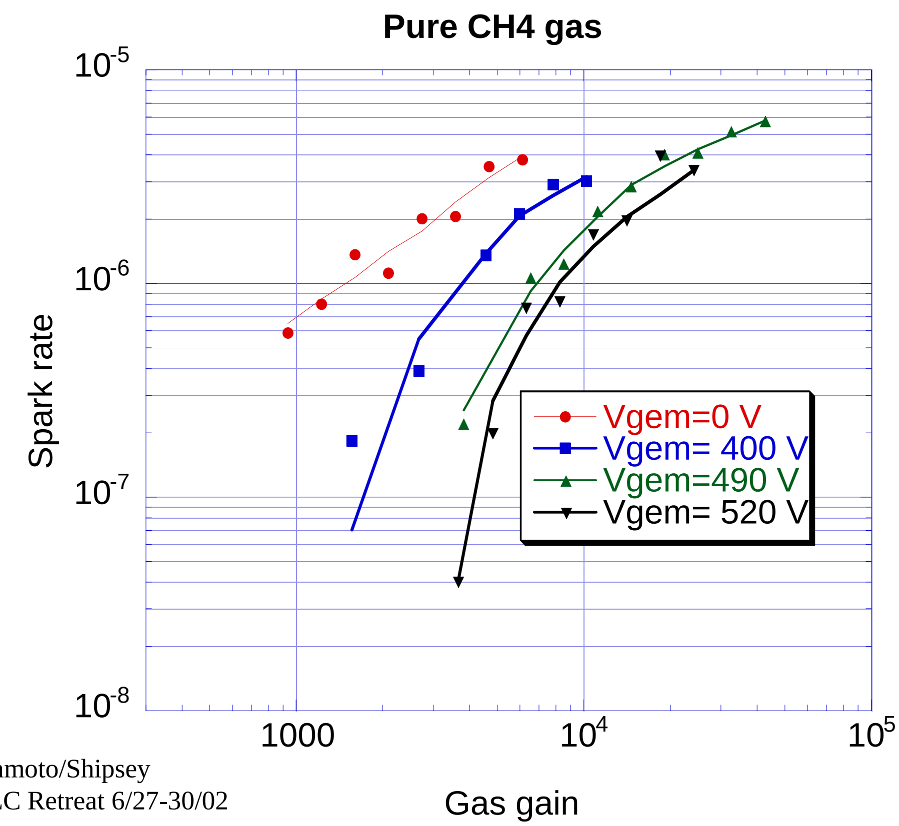


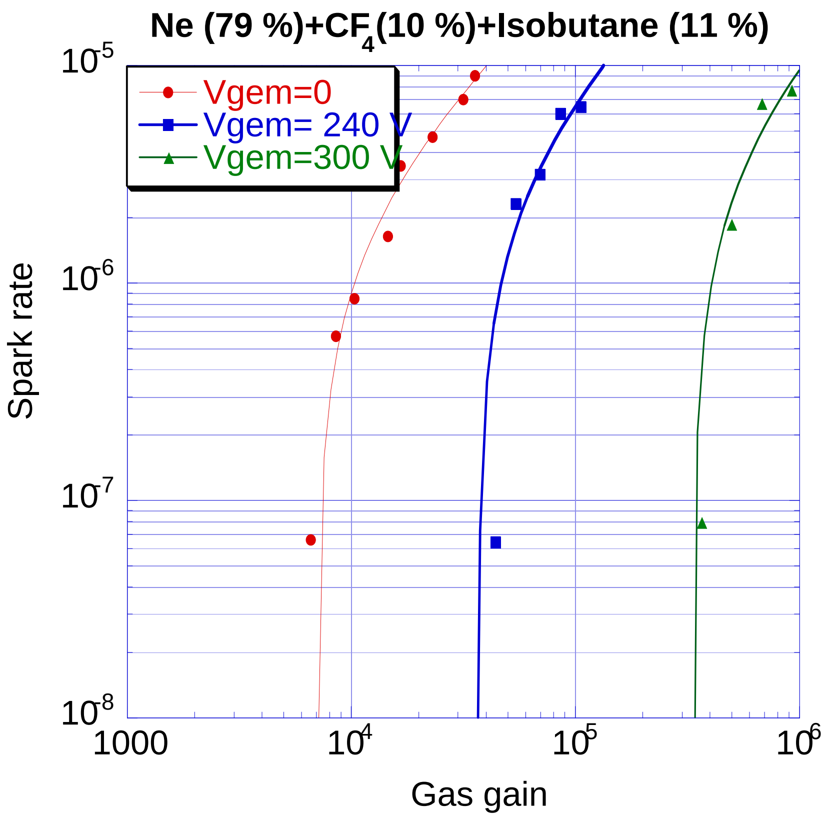
MICROMEGAS + GEM preamplification to minimize sparking

Beam test at CERN by Purdue with 10 GeV/c protons (June, 2001)

With the right gas mixture **10E-8** spark rate at gas gain of 10E+5.

ref: COMO 2001 Proceedings





Micropatterned VS. Marcopatterned

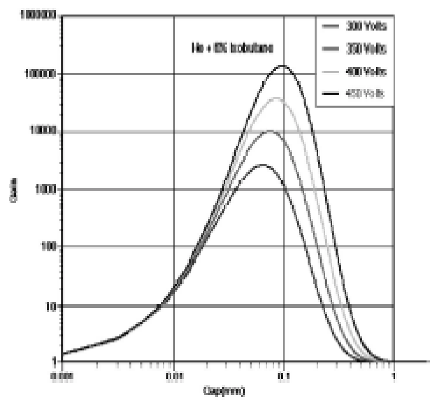


Fig 2. The expected gain as a function of the amplification gap.

Most Micro-Patterned devices have the amplification length=50-100 μm
But **Lithography** is a must

A very crude GEM called LEM
Large Electron Multiplier

LEM has 500 μm thickness and 1 mm pitch
Can be made **all mechanically**
But requires huge bias (>1000V)

Time Projection Chamber(TPC)

1. Size=large (e.g. r=170 cm, L=2 x 273 cm for TESLA)

a. Good momentum resolution

b. Efficient pattern recognition in a dense jet or with large background

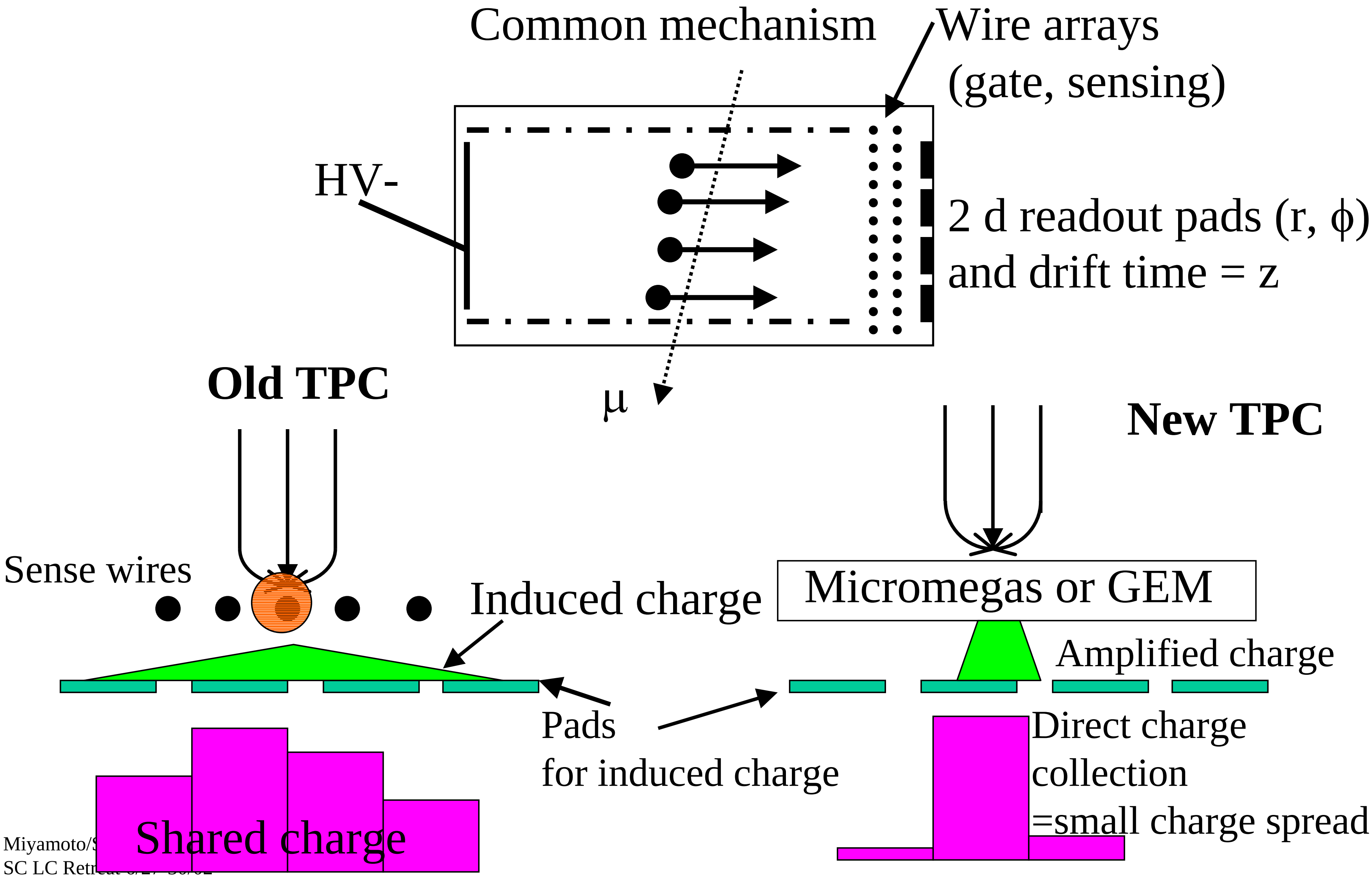
c. Decay products with long half-lives can be traced.

2. Precise measurements of 3 D position

3. dE/dx measurement possible for particle identification

4. The new TPCs for Linear Colliders fully exploit micro-patterned gas detector technology

Old and New TPCs



Many advantages of using micro-patterned devices for TPC

1. Ion feedback negligible (<1%) for favorable E-field lines

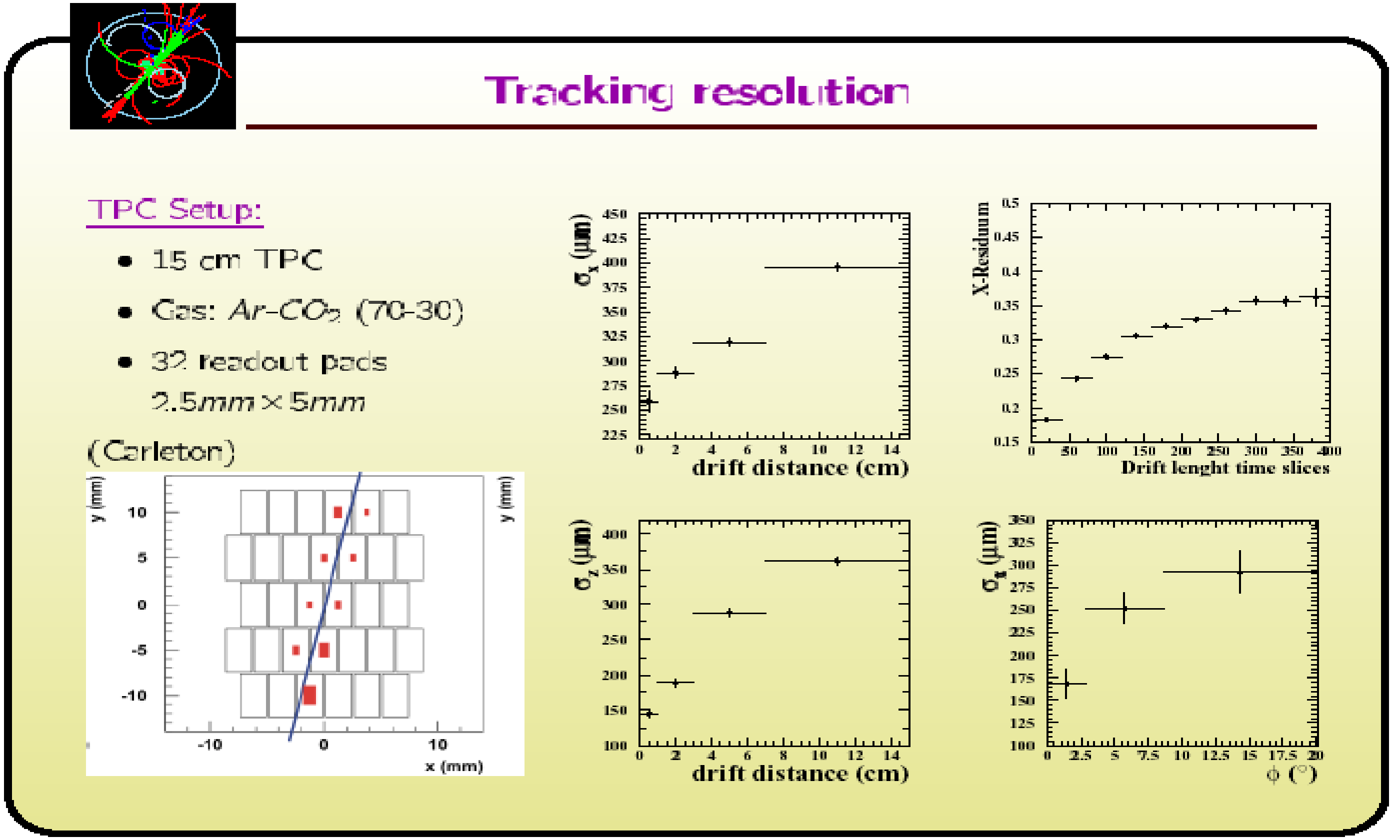
2. Negligible E x B effect

3. MPGD devices eliminate the need of wire tension

and saves a lot of materials=simple design

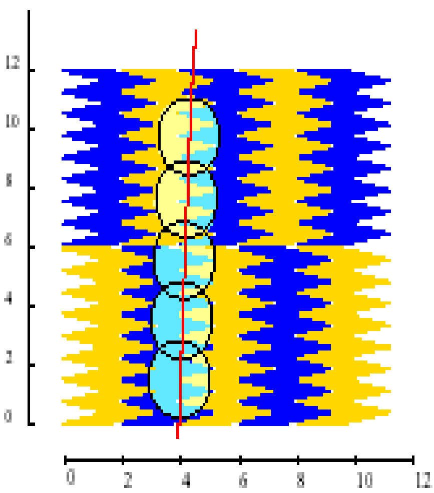
A recent result at DESY for TESLA with double GEM

presented at INSTR02, Novosibirsk, March 2002



Chevron TPC readout at DESY for TESLA

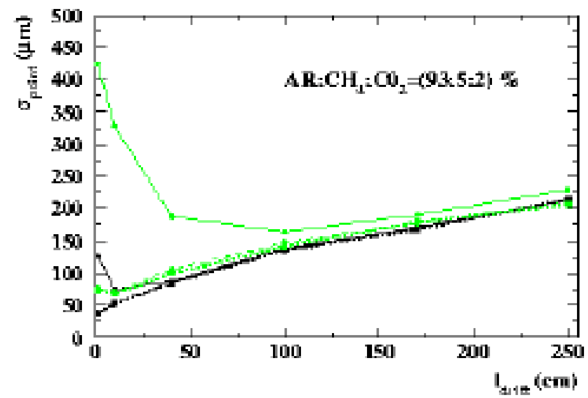
presented at the Adriatic School on Particle Physics, Croatia, Sep, 2001



for GEM readout use different pad geometies e.g. 'chevron'–pads

$\rightarrow$ better charge sharing

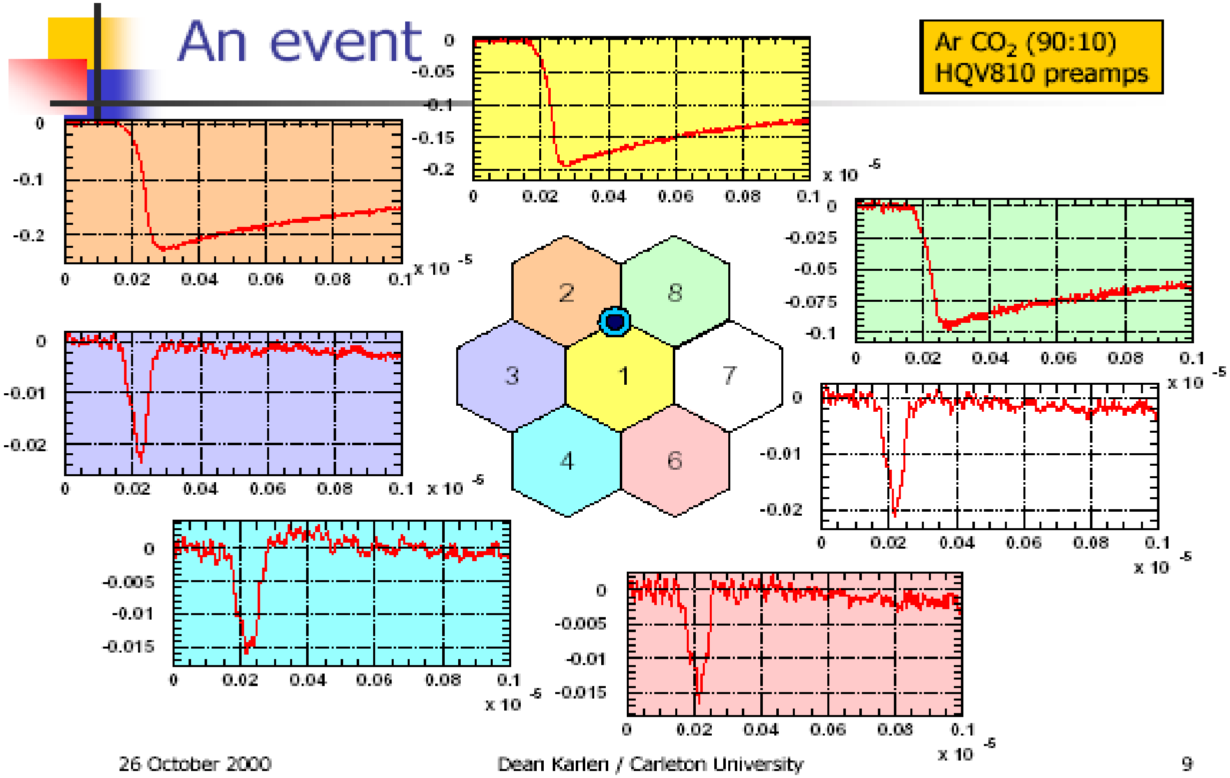
Simulation under TESLA conditions:



pad size: green: $2 \times 6\,\mathrm{mm}^2$, black: pad size: $1 \times 6\,\mathrm{mm}^2$
pad shape: solid curve: rectangular, dashed: chevrons, dotted: diamond

Hexagonal readout with 2GEMs at Carleton University

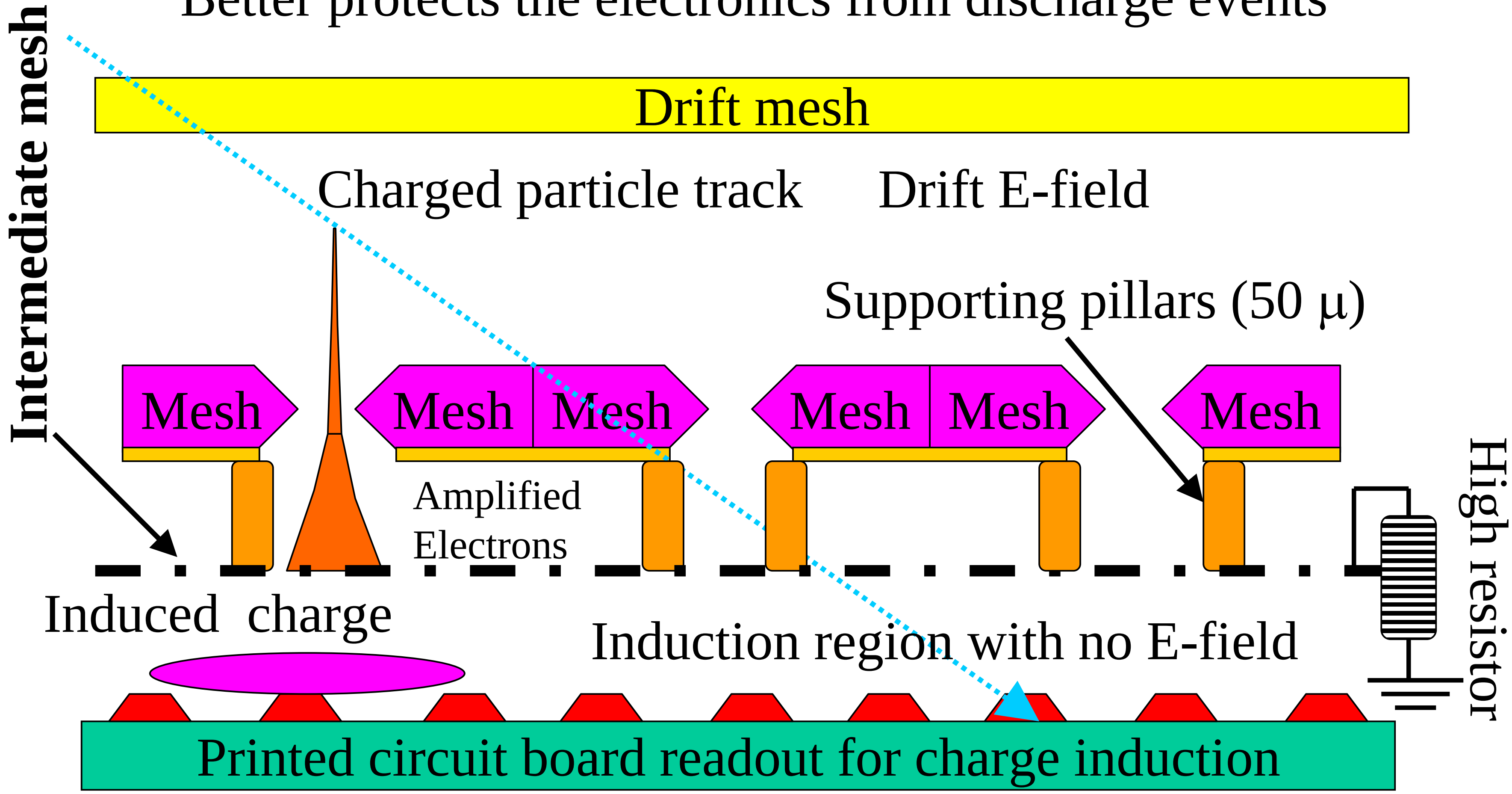
presented at LCWS, Fermi, Oct, 2000



A new MICROMEGAS

ref: Michigan Radiation Measurement Conference Proceeding, May, 2002

Better protects the electronics from discharge events



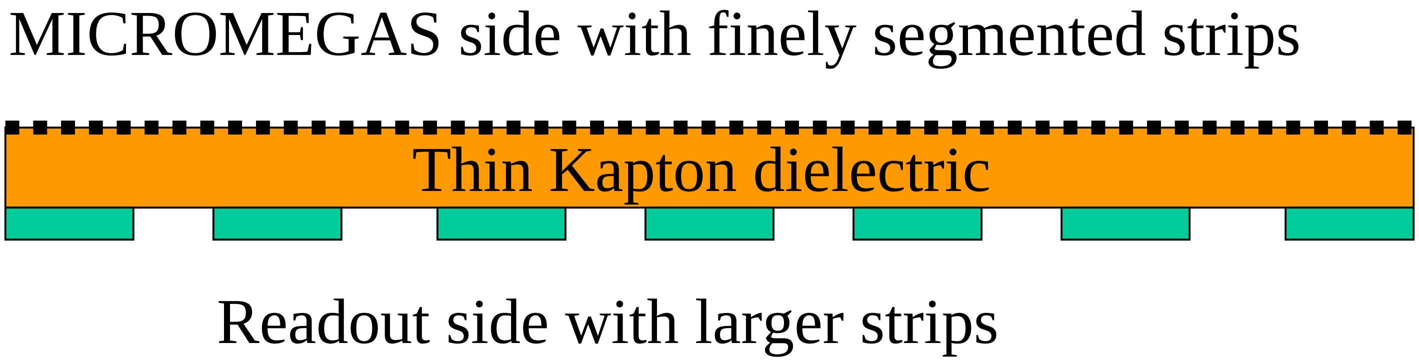
The new MICROMEGAS for tracking underway

1. Necessary to segment the intermediate mesh

2. Individual anode strips need high resistors

3. Charge spread over many strips degrade position accuracy

Solution:Kapton dielectric patterned on both sides (anode=upper, induction=lower may work (in progress)



Future work on GEM/MICROMEGAS for TPC

Construction of GEM and MICROMEGAS(or with a single GEM if necessary) with various readout schemes (e.g. pads, chevron, diamond) and communicate with the TESLA/Carleton groups.

Apply our MPGD work for TPCs with the Cornell Drift Chamber group(ref: Dan Peterson's talks on Sunday)

Our experience with MPGD's is a good match to the Cornell experience with drift chambers. Cornell and Purdue University will combine to build a TPC test chamber with MPGD readout to carefully evaluate TPC technology for the LC"