Tracker for GLD/ILC

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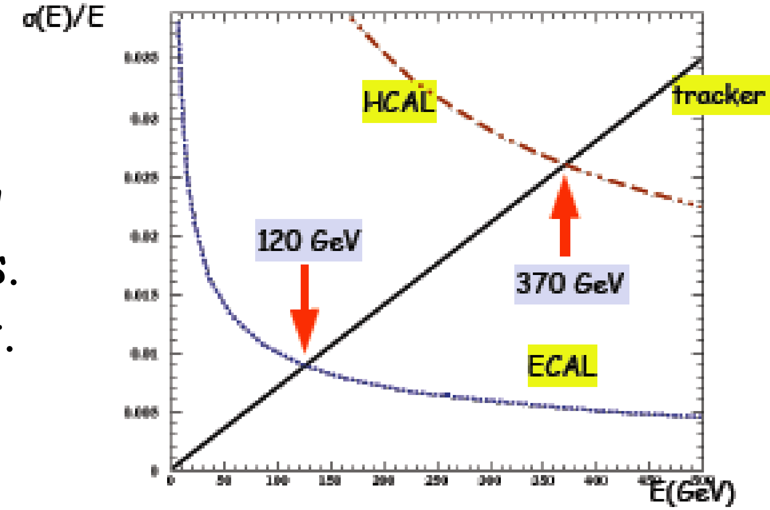
- What is required for Tracker
- What can satisfy these requirements
  - resolution
  - 2 trk. separation
  - others we have to worry about
- TPC study

Requirements to ILC Tracker

Resolution tracker - Calorimeter

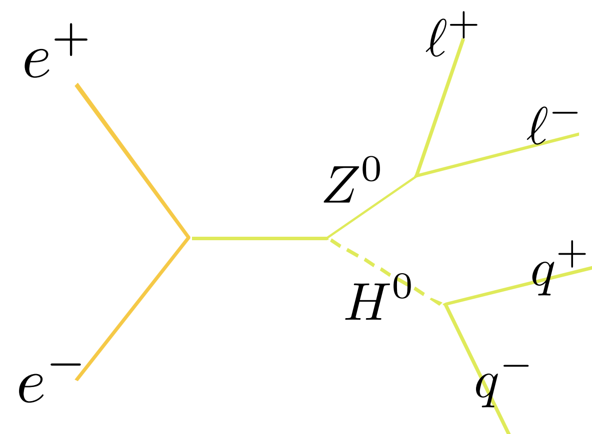


From a point of PFA

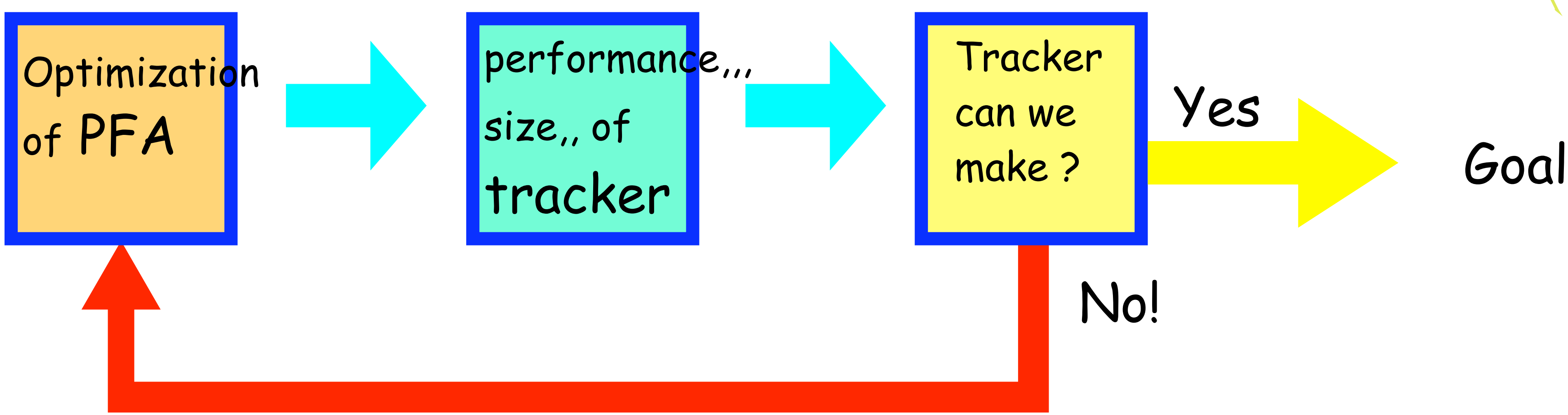
resolution of charged track is good enough comparing to CALs.

efficient tracking in high multiplicity is more important.

Good 2 track separation



Tracker also has to provide good resolution for low multi. process



Initial requirements

B = 3T
Rmin = 40 cm,   Rout = 200cm
Z =+-235cm

Resolution

Missing mass resolution of Higgs ~ Beam energy resolution due to photon radiation

-> mom. resolution ~ $1\times10^{-5} * P_T$ (with VTX)

Main tracker only ~ $1\times10^{-4} * P_T$

$$\left(\frac{\delta p_T}{p_T}\right)_{meas.} = \frac{3.3\sigma_{r\phi}p_T}{BL^2}\sqrt{\frac{720}{n+4}}$$

If we take
σ = 150 um
n = 200

~$1.2\times10^{-4} * P_T$

2 track separation

2 mm : not optimized yet <-- need justification by simulation

Size of signal width << 2 mm   how small ?

Can we achieve 150 um in σ and 2 mm in separation ?

These two performances are much related to **Diffusion**

Diffusion

$$\sigma_{SF} = \sqrt{(\sigma_0^{prf})^2 + D(B,E,gas)^2 z}$$

$$\sigma_{r\phi} = \sqrt{\sigma_0^2 + D(B,E,gas)^2 \frac{z}{\alpha N}}$$

σ_0 resolution not related to diffusion

σ_{SF} Signal Shape width

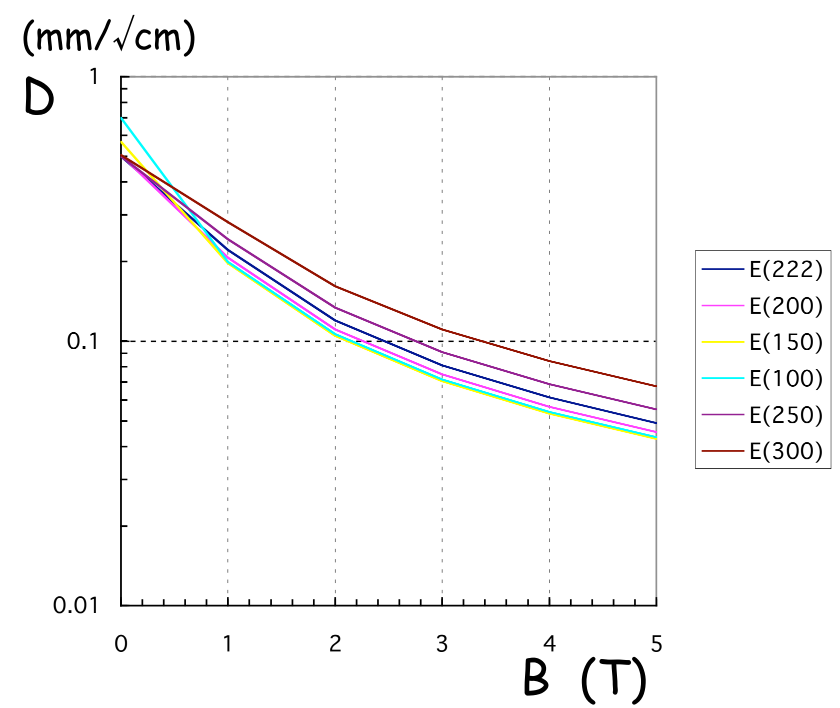
σ_0^{prf} width of point response function

z drift length

$$D(B,E) = \frac{1}{\sqrt{1+\omega^2\tau^2}} D(0,E)$$

$$\omega\tau = B\frac{v}{E}$$

TDR(Ar:CH_4:CO_2=93:5:2) case ->



D = 75 um/cm @ 3T

$\sigma_{r\phi}$ = 144 um @ 235cm drift

σ_{SF} = 1.1 mm

with assumption of $\sigma_0 = \sigma_0^{prf} = 0$

$\alpha = 1$

Need to check how the real world is

Small Prototype test "Proof of Principle"

Resolution +

Mom. resolution is determined by combining effort of
Tracker and VTX and **Inner/Outer SiT**

VTX and **Inner/Outer SiT** can provide enough resolution w/o TPC
from Sugimoto's calculation

TPC must pay more attention to 2 track separation

What else ?

dE/dx

Background

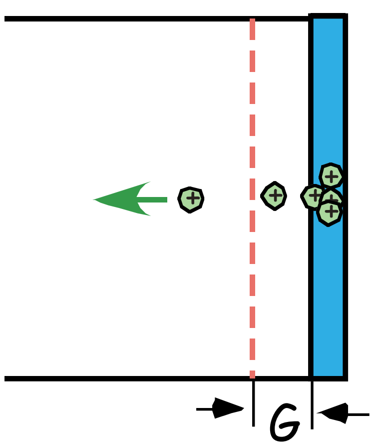
pair background

The most of them are curled by B field
and would not appear in TPC so much

neutron MDI issues

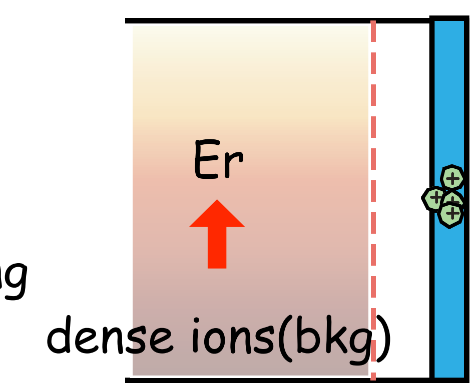
n interactio to H will produce dense ion deposit
How much netron will come into TPC ?
do we have to reduce Hydro-Carbon component?

ion back drift

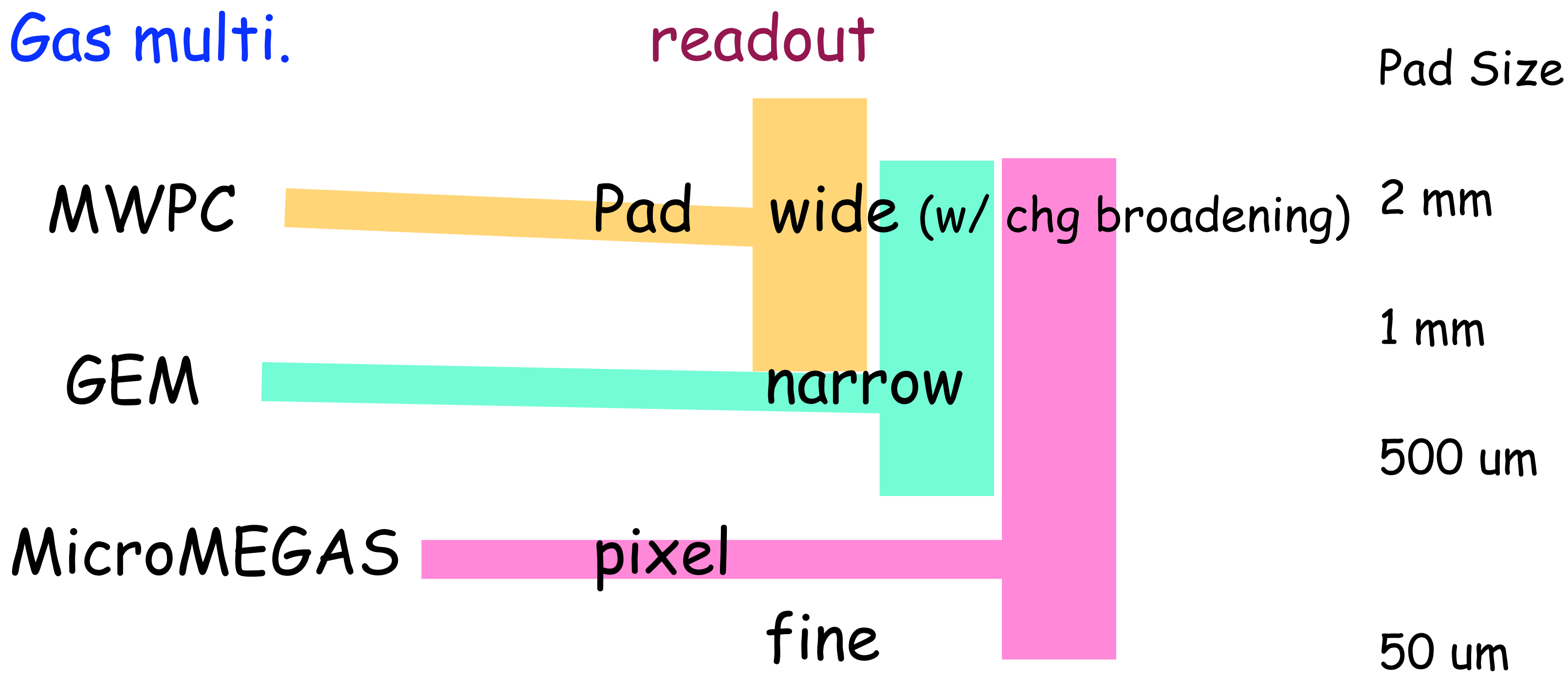


TPC has to continue data taking for a whole train (~ 1 msec)
produced ions@ sensor takes 500 msec to travel
to the central cathode
====> We need Gating GRID to stop ions into drift region
drift vel. ~0.5cm/msec G ~ a few cm is enough

Primary effect : produced ions by phys. sig./bkg
are inevitable
ions drift to the center for ~ 3 trains Xing



TPC : combination of sensor x readout



MWPC TPC

Good !

Stable operation w/ wire
well known tech.
smaller # of read out channel

Bad !

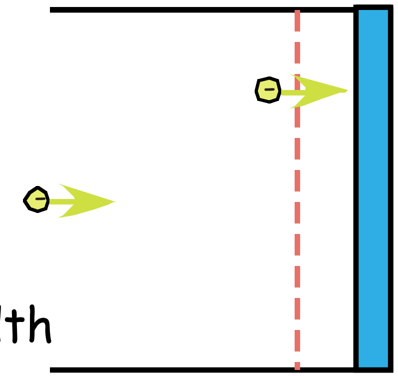
Lager gap between wire and readout plane
wider signal
larger ExB effect
large size/sect. boundary

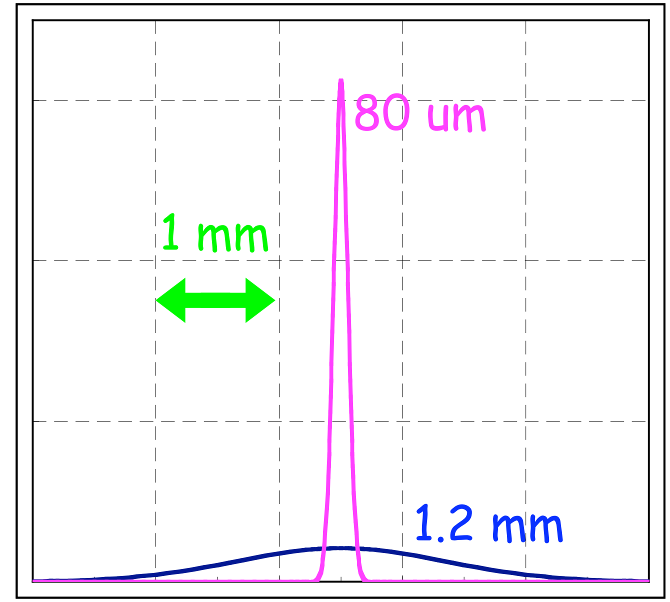
MPGD TPC

narrow signal
small ExB

Stability is not established
large size production ?
large # of read out channel
(too many channel)

alternative solutions

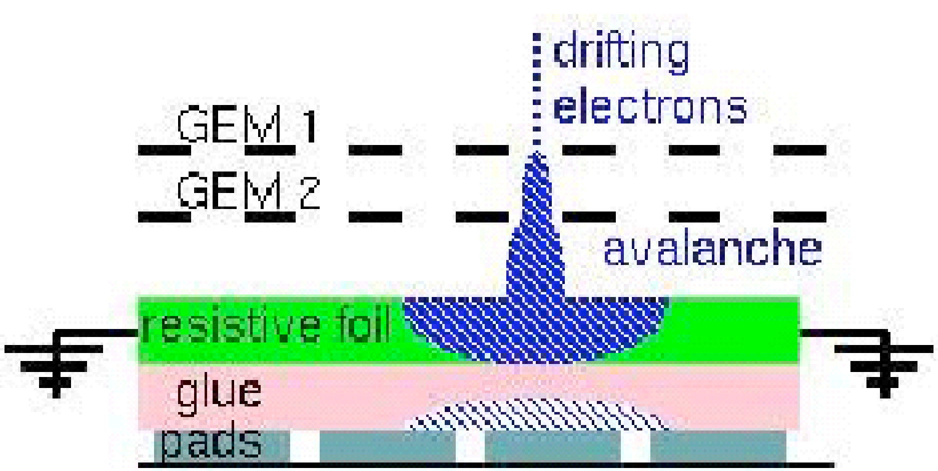




How to optimize Pad Size
for 15 times different signal width

~ 80 um @min. drift
~ 1.2 mm @max. drift

A) charge broadening w/ wider pad
narrow signal provide poor resolution
charge distribution



B) readout individual electron
optimize to narrower sig.

track : dense inner rad.
not necessary to aim 80um ?
optimization is a issue of Sim.

Analog or Digital readout ?

try to find better gas !!

Comparison of GEM vs. MicroMEGAS

	GEM	MicroMEGAS
gas multi. gap	Kapton sheet (50 um)	spacer(50~100 um)
E field	focus	parallel
signal	electron (+ induction)	electron+ion
gain	small (~10) multi layer	large ($<10^5$) (too high)

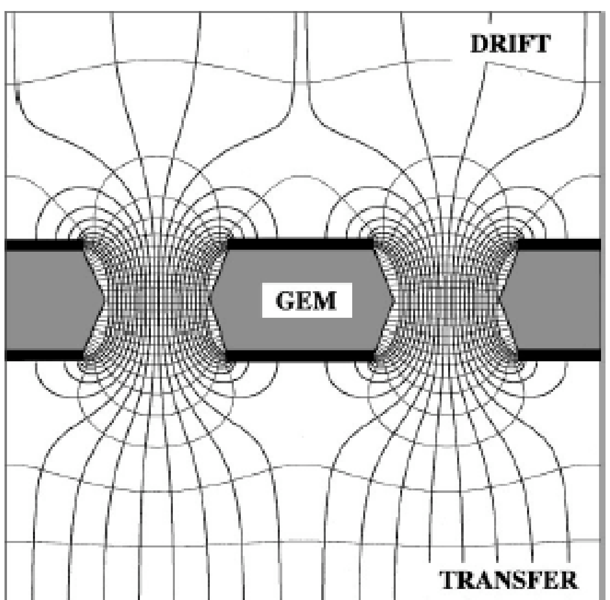
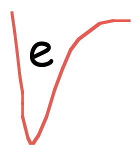
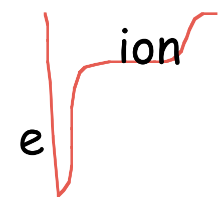


Figure 34 Electric field and equipotentials lines in the gas electron multiplier.





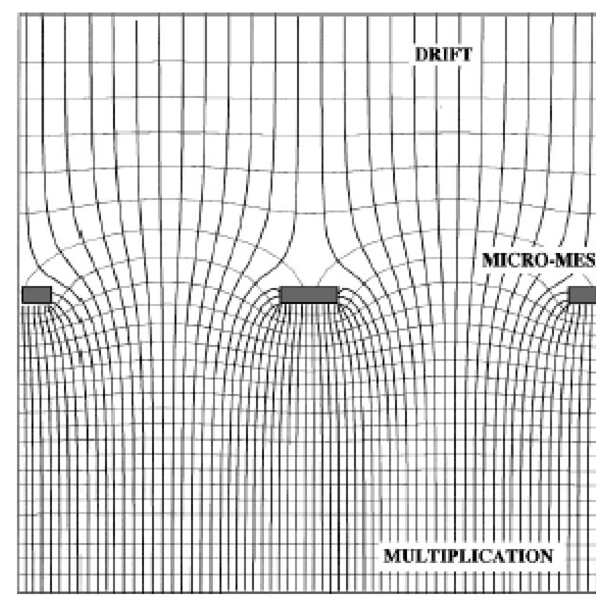


Figure 28 Schematics and electric field map in the micromegas. A metallic micromesh separates a low-field, or drift, region from the high-field multiplication region.

Other component of TPC

Readout electronics — Largely depend on the choice of readout pad
surface mount is necessary to reduce mat.
digitization........

Sector design — Depend on MPGD/ available size, support mechanism,
how to reduce dead space at boundaries

Field Cage/gas container — field uniformity, temp. control ,,,

Large size MPGD — GEM: need more than 30x30cm ?
reasonable segmentation?

DAQ

Schedule

What we have done this year

MWPC-TPC beamtest '04 w/ B field clear the diffusion effects and position resolution	O. Nitoh(TUAT)
GEM-TPC cosmic test '05 w/ B field	T. Kuroiwa(Hiroshima)
GEM R&D (Fuchigami's GEM)	T.Yamamoto(Saga)
Pad optimization	Y. Kato(Kinki)
Requirement to Tracker from FPA	A. Yamaguchi(Tsukuba)

Plan

complete a comparison of MWPC/GEM/MicroMEGAS - TPC

using same TPC / readout electronics / analysis

understand everything of "the principle"

R&D of MPGD

GEM : quantitative study + simulation study

optimization

MicroMEGAS : see how the beam test will be

Simulation study

optimize TPC from the point of PFA

realistic middle/large prototype design