SiD Muon Detector

- Simulation studies done and to do.
- Benchmark Physics Reactions.
- Straw(wo)man SiD Muon Detector.
- Scintillator-based muon system cost guesses.

Muon ID – Isolated Muons

Marcello Piccolo and Caroline Milstene

- Minimum no. of layers for μ ID? (12/12)

  For $p_\mu > 10$ GeV/c Algorithm that finds hits within angular roads is efficient.

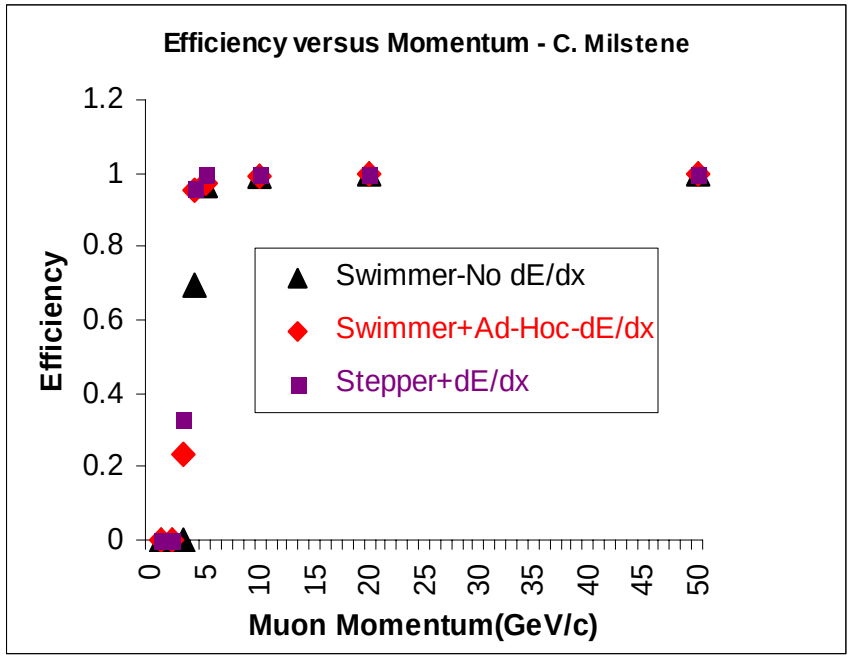
  For $p_\mu < 10$ GeV/c dE/dx & mult. scatt. require momentum dependent ang. roads.

  For $p_\mu < 3$ GeV/c Muons range out before 13" of Fe in the μ detector.

- Why worry about low energy muons at the ILC? What physics? Smuons?

Simulation Software

- Java Analysis Studio
  R. Markeloff – NIU, '01
  C. Milstene



- dE/dx improvement
- Low pt tracking eff.
- B field trk following

E(Gev) /Tech	3	4	5	10
No dE/dx	0.06%	70%	97%	99%
Ad-Hoc dE/dx	23%	95%	97%	99%
V x B & dE/dx	33%	96%	99%	100%

So far, barrel muons only

- Need to develop forward muon strategy, algorithms, specifications, etc.,
- May be needed to understand background muons.

Non-Isolated Muons

- Test algorithms with e+ e- => b pairs

Find:

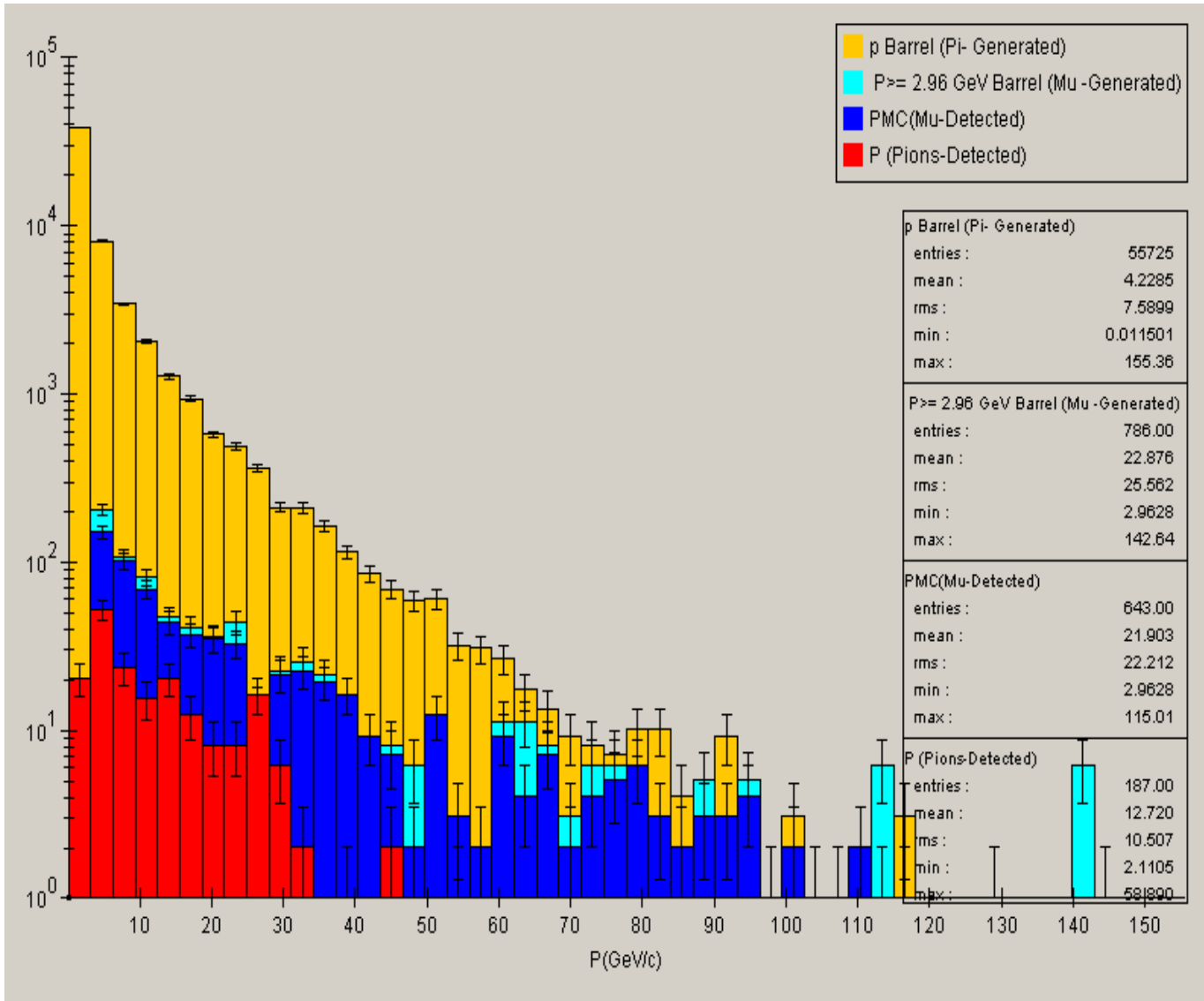
π and K decays to μ (irreducible bkgd);

hadrons that have not interacted;

tracking can't distinguish nearby hadrons from the μ candidate.

=> Kalman filter – Milstene talk Mon 8/22

P-Distribution of μ & π Generated vs Detected from 10000 B-Bbar 500 GeV



- Generated Pions in Yellow
- Generated Muons in light blue
- Detected Muons in navy blue
- Pions Detected as Muons in Red.

The Pion Rejection is shown to be ~80 to 1

!Preliminary!

C. Milstene 4/2004

Benchmark Physics Studies

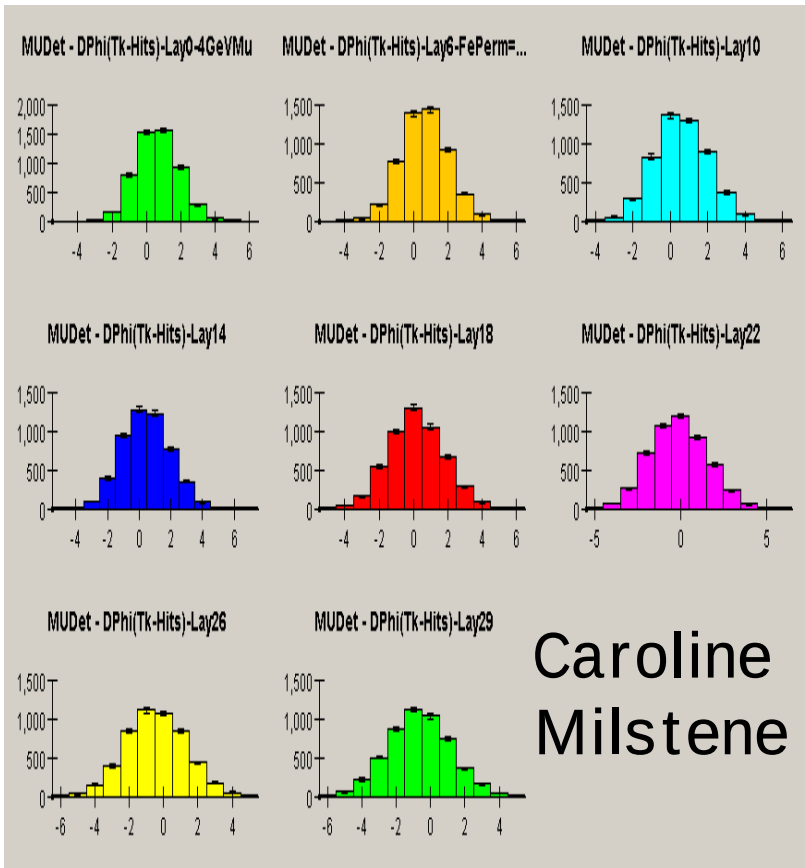
- Single μ's - Algorithm development
- e+ e- => b b X - Kalman filter; μ's/jets
- e+ e- => Z H - multi-μ's; high profile case
- e+ e- => smuon pairs
- Womersley's Question: How good is muon ID using only calorimeter info? How much punchthrough?

μ Detector as Calorimeter?

- For 5T B field (6.3λ) it may be hard to justify – needs study & test beam.
- If 5T is too expensive, hard to prove the need, or technically too risky, then tail catcher may be more interesting.

SiD Muon Detector Spatial Resolution

5 cm Fe plates, 1.5 cm gaps
4 GeV $\Delta\phi$ @ layer 0, 6, 10, …



$\Delta\phi = \text{proj. track } \phi - \text{meas. } \phi$

$(\Delta\phi)_{rms}$ = 1.3 bins * 21mr/bin

$(\Delta\phi)_{rms}$ = 27 mr

$(\phi_o)_{rms} = (13.6/p)\sqrt{L/L_0}$

= 28 mr

For 6 plates Fe + gap = 39 cm

$\Rightarrow (\Delta x)_{rms}$ = 1.1 cm

RPC res ~ 1 cm

Scint.: 4.1/sqrt(12) = 1.2 cm

Muon Detector Technologies

- SiD will/should consider RPCs & scintillator-based systems. What about wire chambers?
- WCs have delivered well in the past; recent example of IHEP, JINR, TATA Inst scint + WCs on D0.
- JINR & IHEP will join ILC muon studies. They have institutional support.
- See R&D and performance reports 8/22 , 8/23.

Scintillator-based System Costs
from prototype costs

- M&S cost for 8 planes 2.5m (H) X 5m (W) approximately 1040 strips 100m^2
  - Chemicals $5K
  - Extruded Scintillator $7K
  - WLS & Clear Fiber (1.2mm) $27K $3.28/m
  - MAPMTs w/bases 20 - 64ch $30K*
  - Digitizing/RO electronics $25K*

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  $94K

MB estimate $2000/$m^2$ => $200K - close! W/esc, .

SiD Muon System Strawman

- 6-8 planes of x,y, u or v WCs upstream of Fe flux return for xyz and dir of charged particles that enter μ sys after the solenoid.
- 24 10cm plates w/23 instrumented gaps: technology to be chosen. ~1cm spatial resolution. Min of N planes

  N = ?

SiD Muon System Studies

- Womersley's question: Why doesn't the calorimeter system satisfy muon ID? Punchthrough?
- How many muon planes do you need to ID muons and separate hadrons from muons?
- Using only tracking and calorimetry what is the low momentum muon ID efficiency and punchthrough?
- What is the cost/benefit of muon system calorimetry?
- Is spatial resolution in the tracking and muon system sufficient for high momentum muons?
- What other physics benchmark studies are needed?
- Haven't discussed electronics – technology dependent