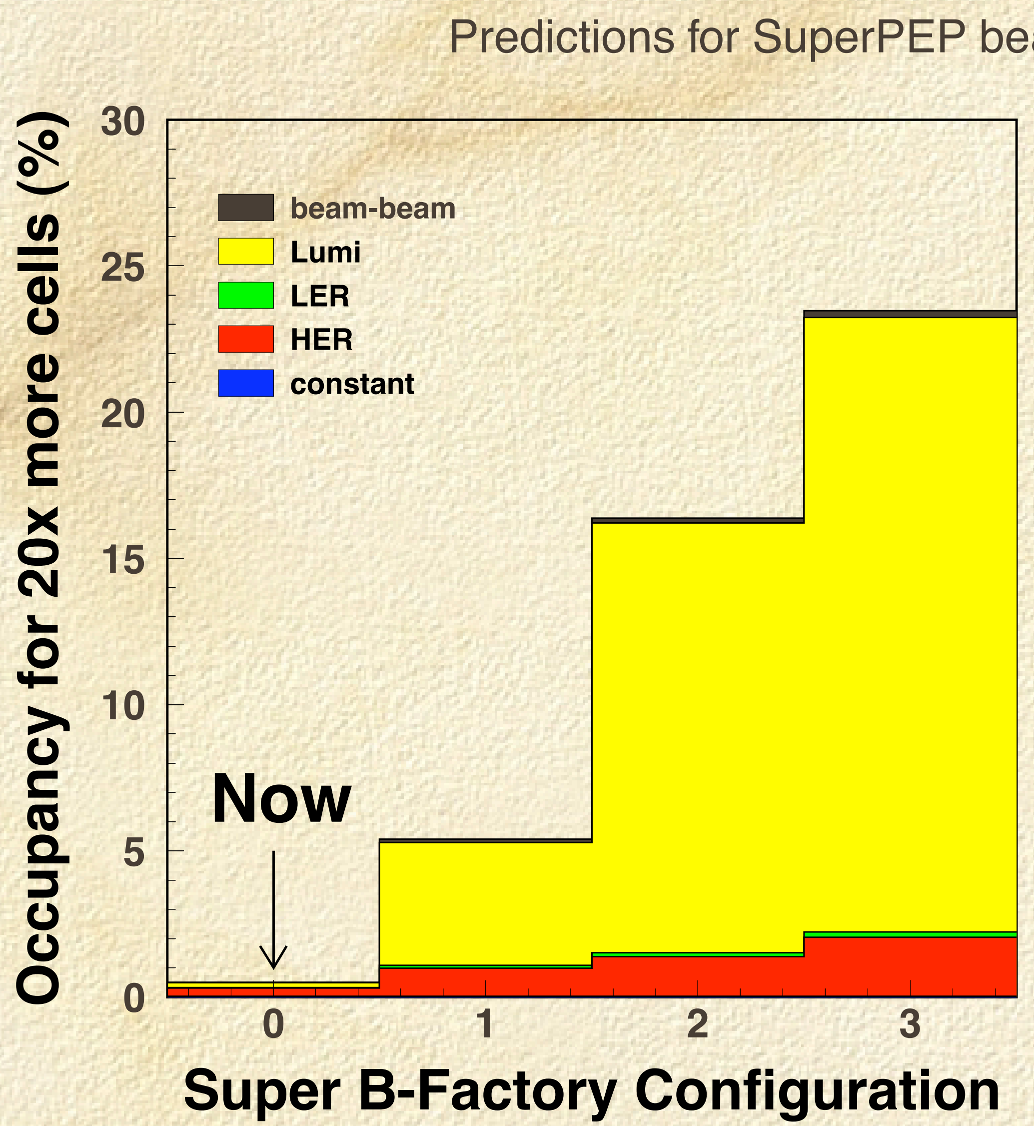
Silicon Based Tracking at a Super B Factory Detector

Aaron Roodman
Stanford Linear Accelerator Center
Hawaii Super B Factory Workshop 2005

Backgrounds



from Markus Cristinziani

Conf.	I_{LER}	I_{HER}	$\mathcal{L}(10^{33})$
0	2.2A	1.4A	8
1	11A	4.8A	200
2	15.5A	6.8A	700
3	23A	10.1A	1000

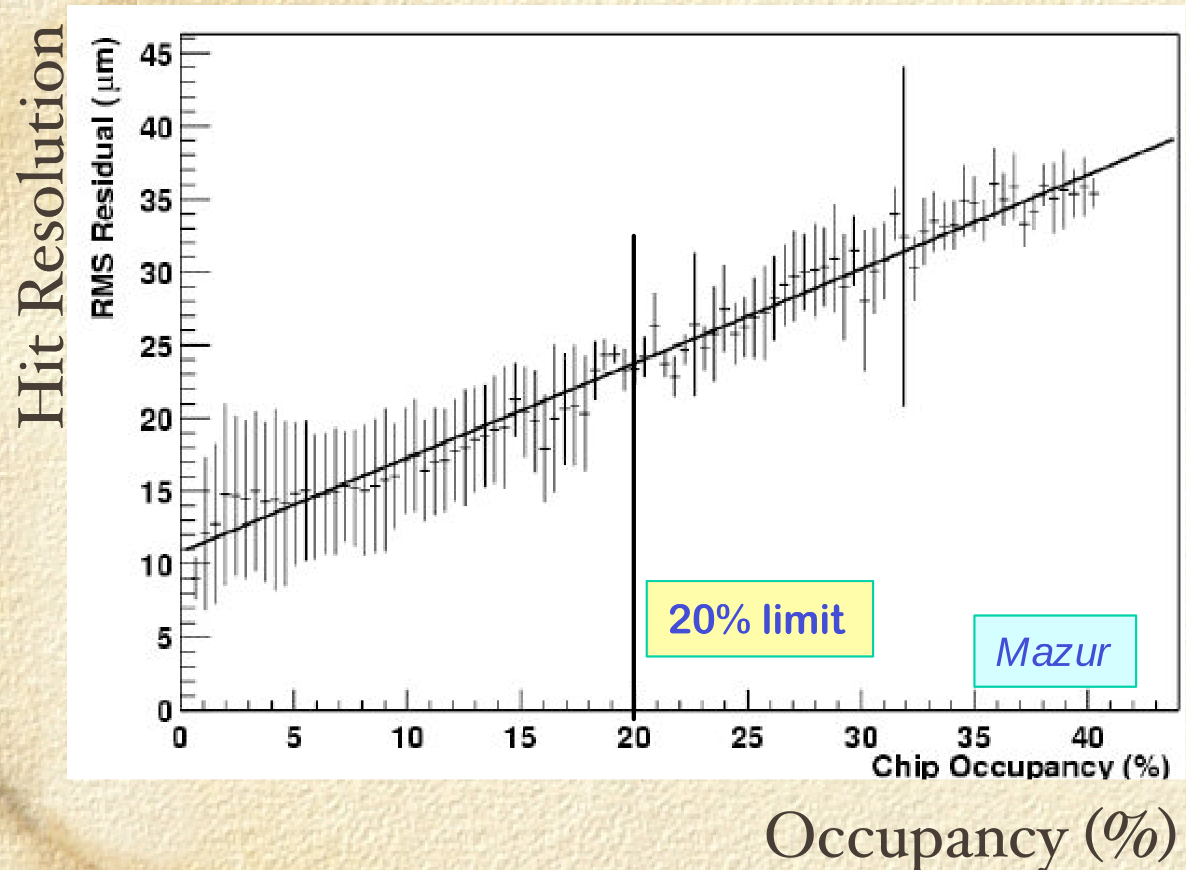
assumed an improvement factor of 20 in susceptibility to backgrounds compared to the BABAR drift chamber

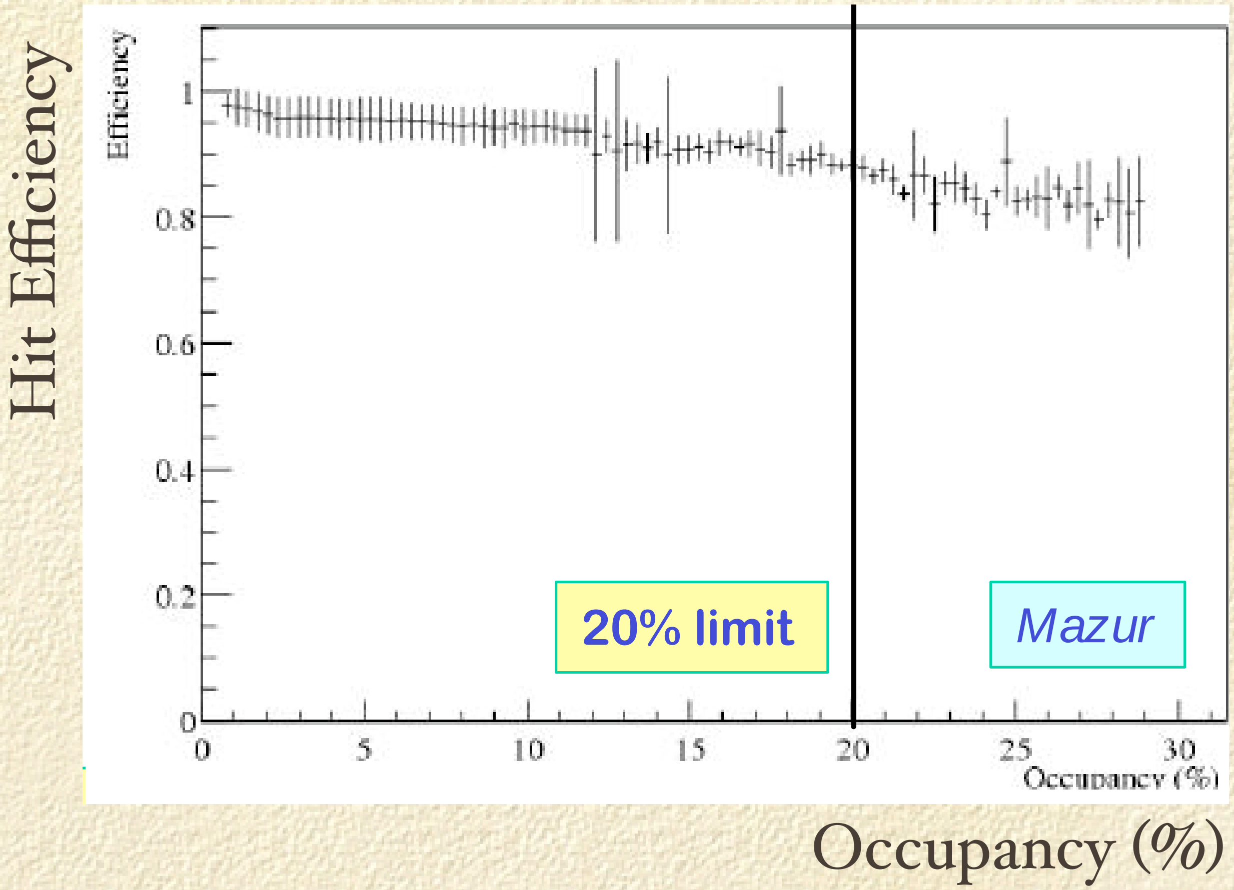
Luminosity term completely dominates
- radiative Bhabha scattering
- BABAR simulations need to confirm effect
- can it be reduced? by what factor?

Occupancy Limits

What is the occupancy limit in a Silicon Tracker?

consider effects of occupancy on current BABAR SVT





all-Silicon tracking will be more sensitive to single hit efficiencies, given the small number of layers, so efficiency drop due to background occupancy is an important effect

Occupancy Scaling

BaBar DCH

1.7 - 2 cm diameter cells
260 cm long
2 μsec read-out

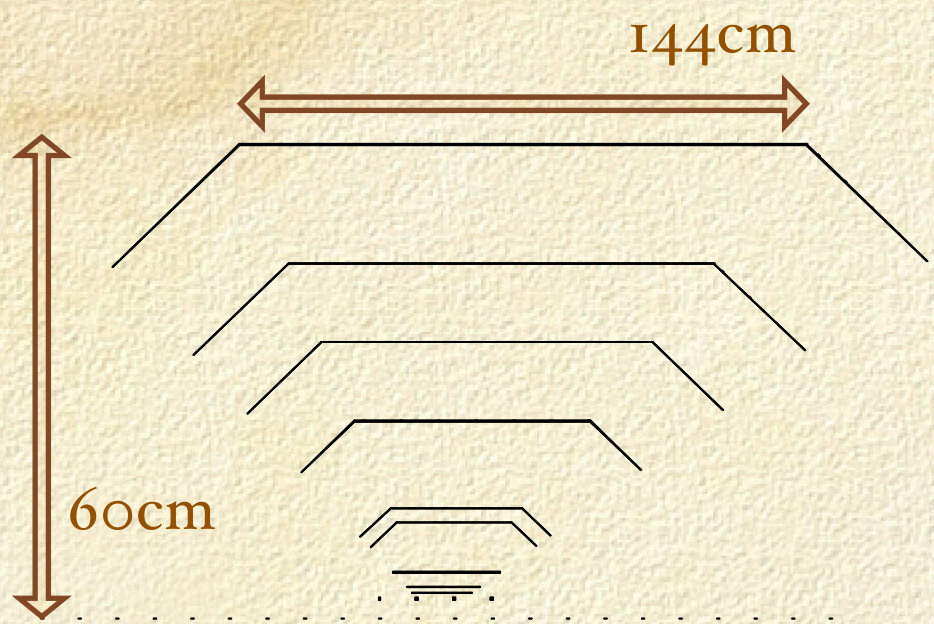
Silicon Tracker

100 μm strips (50 μm pitch with floating strips)
25 cm long strips
400 nsec shaping time

Geometrical factor = 2000
Time factor = 5
Radiation Length factor = 0.015
Total = 150

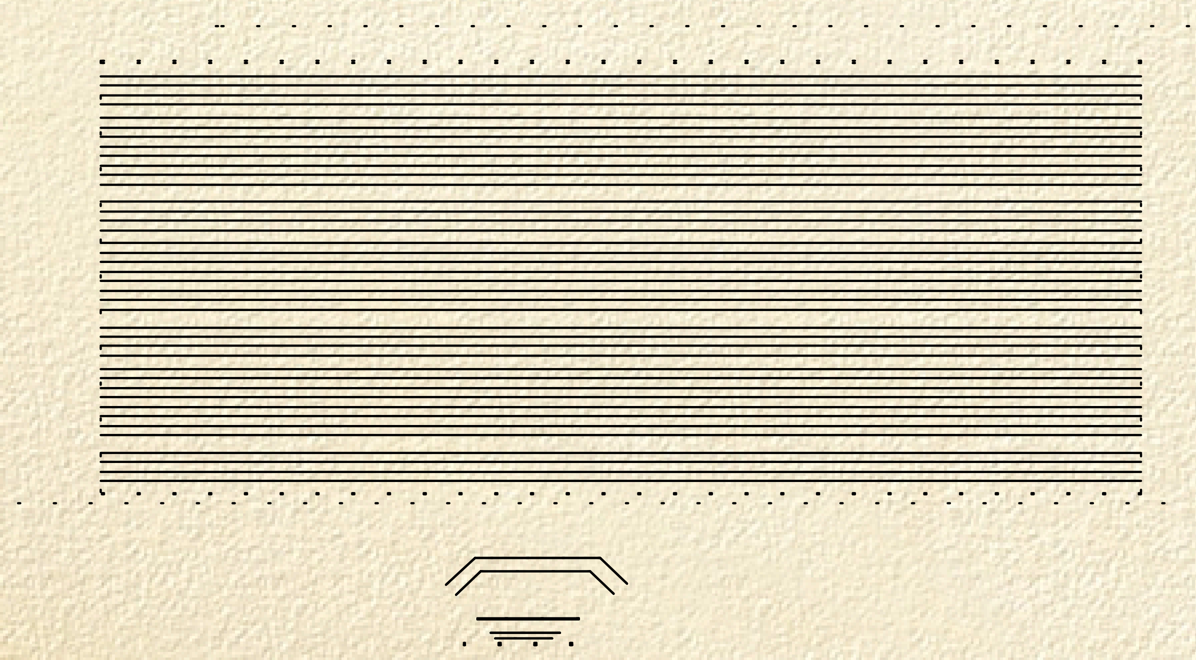
Silicon Tracker

conceptual
Silicon Tracker



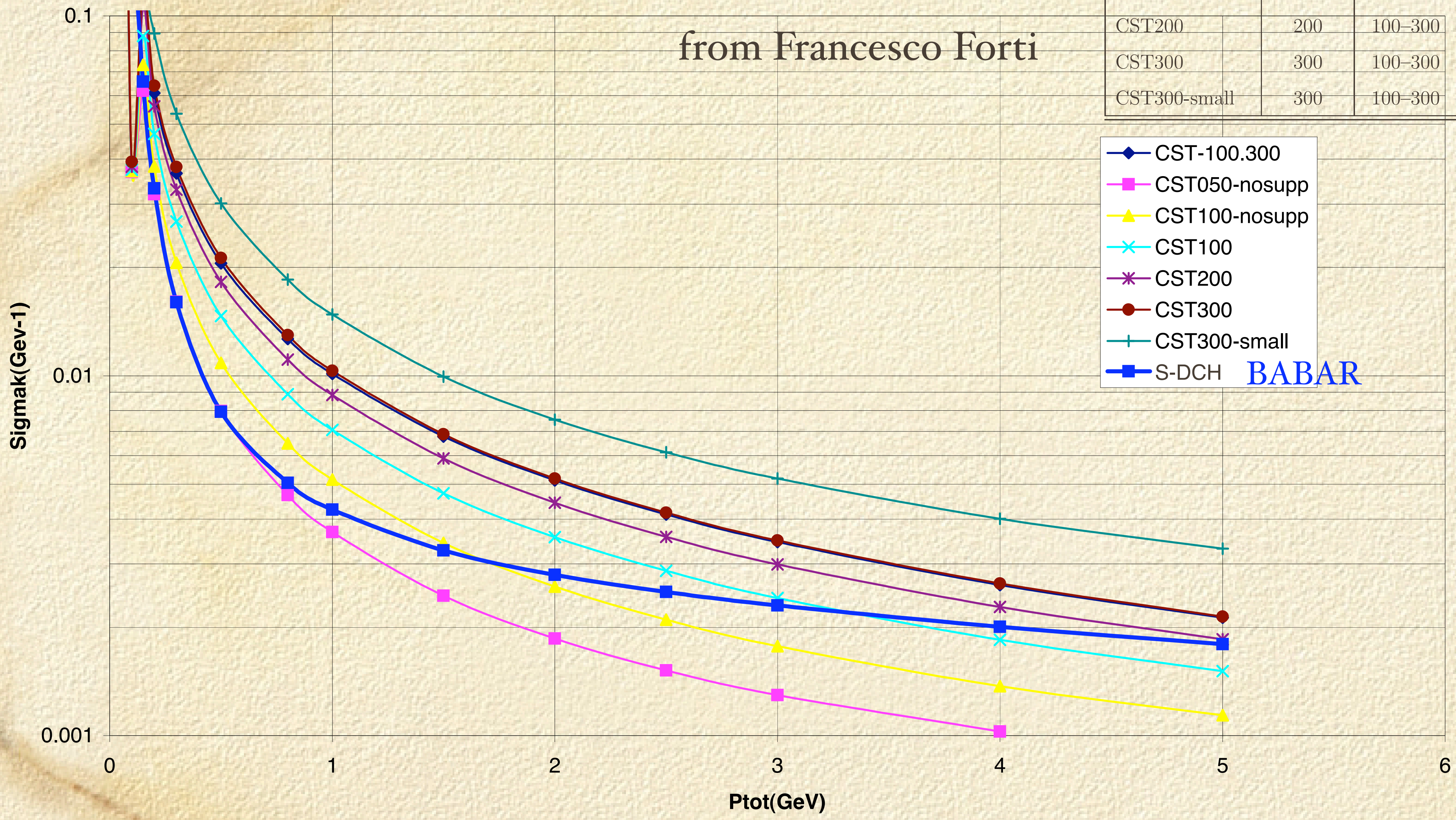
5 layers Vertex Detector
4 layers Tracking Detector

BABAR
SVT and DCH



Momentum Resolution

Name	Silicon Si μm	Support C.F. μm	Outer radius cm	R&D required A.U.
CST050-nosupp	50	none	60	dream
CST100-nosupp	100	none	60	dream
CST100	100	100–300	60	+++++
CST-100.300	100–300	100–300	60	++++
CST200	200	100–300	60	+++
CST300	300	100–300	60	++
CST300-small	300	100–300	40	+

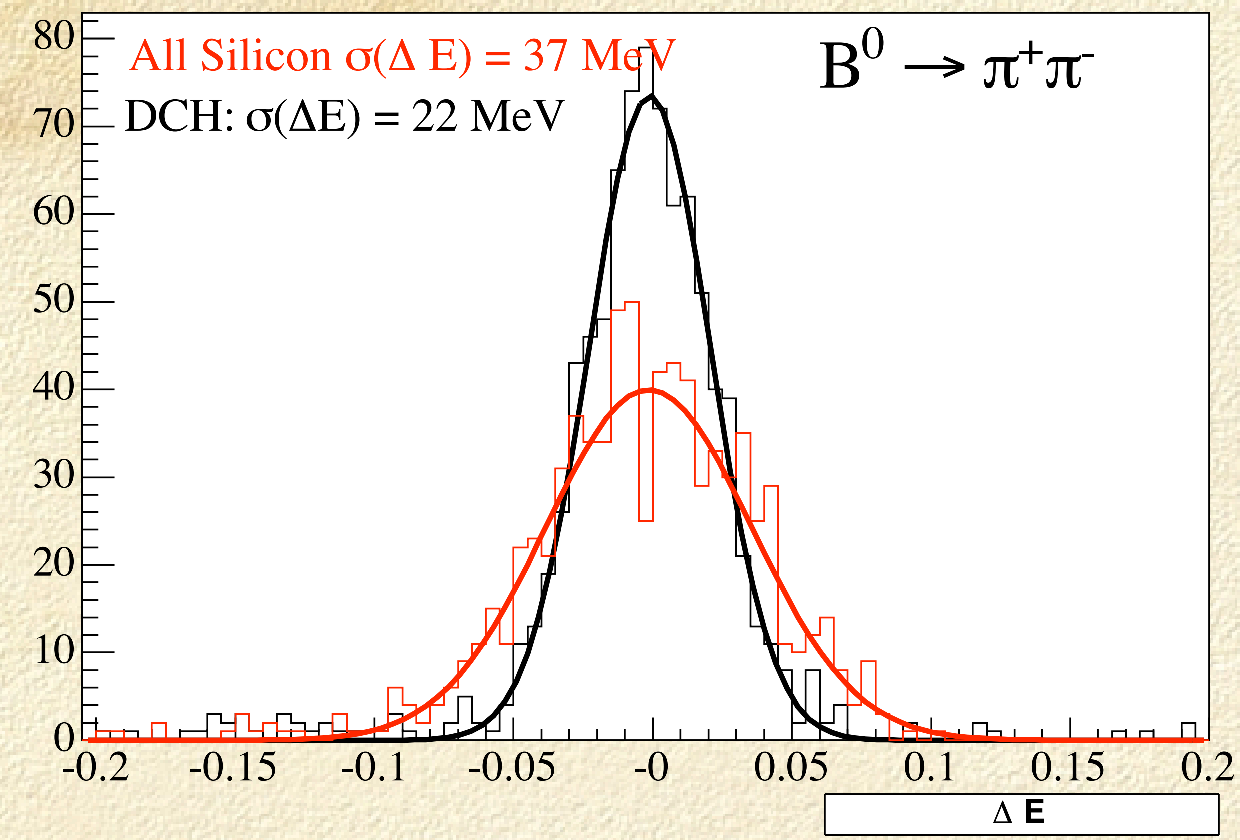


CST300 has 300μm Silicon sensors

100μm carbon fiber supports for inner 5 layers

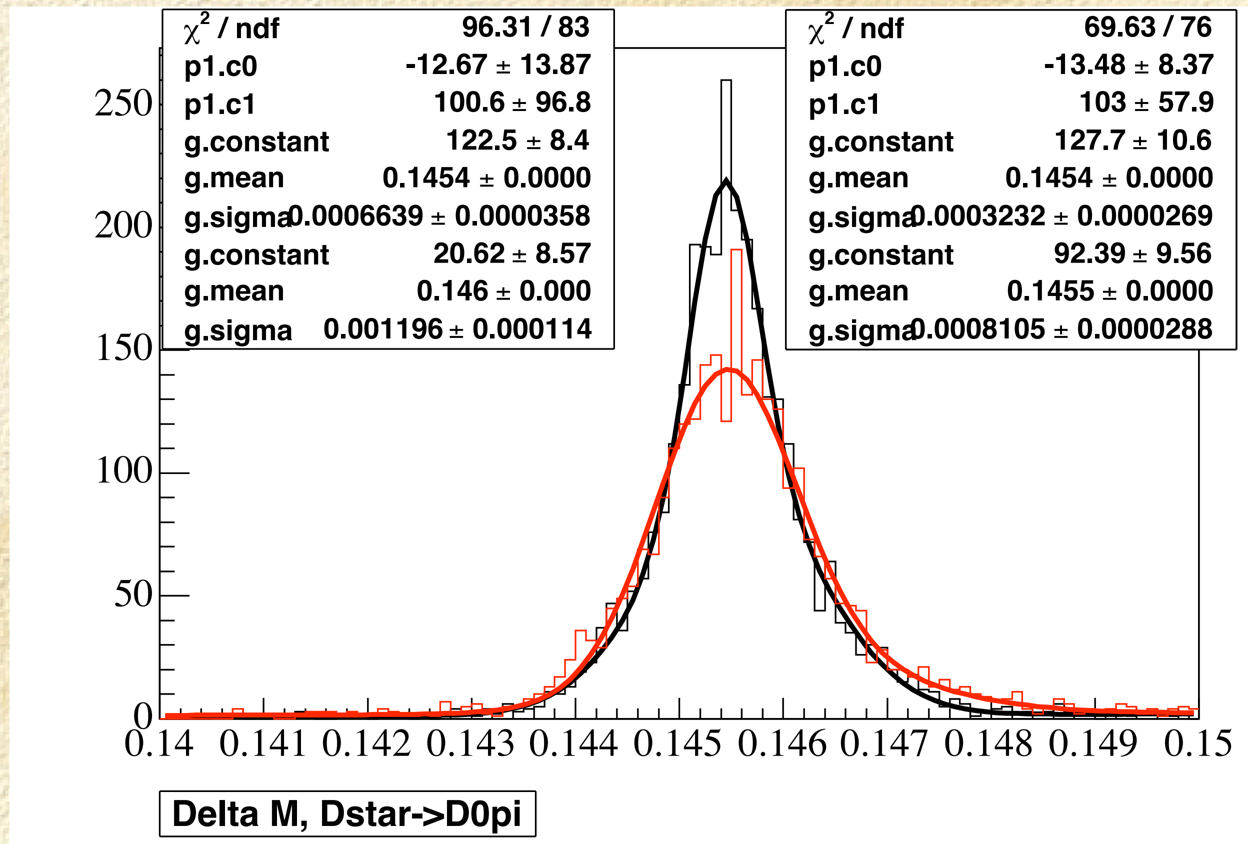
300μm carbon fiber in outer 4 layers

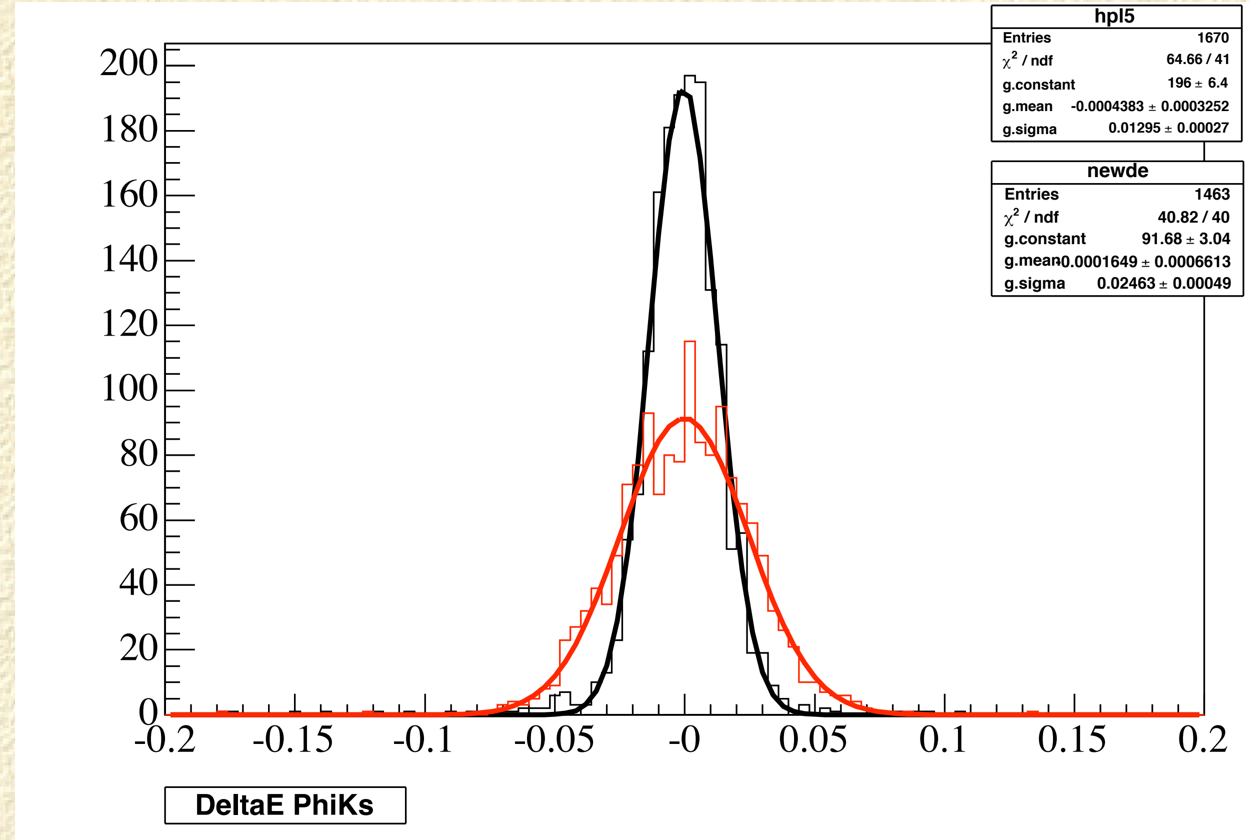
Mass Resolution

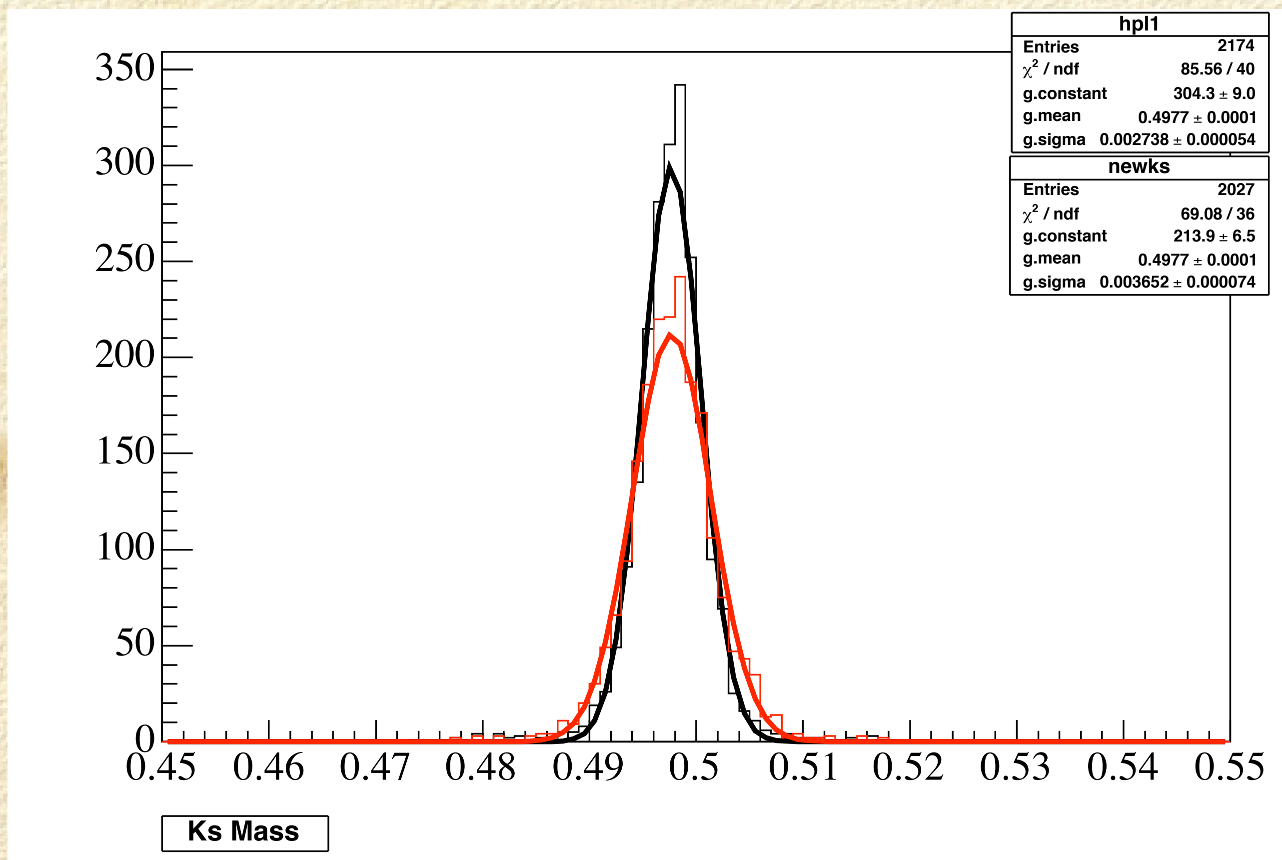


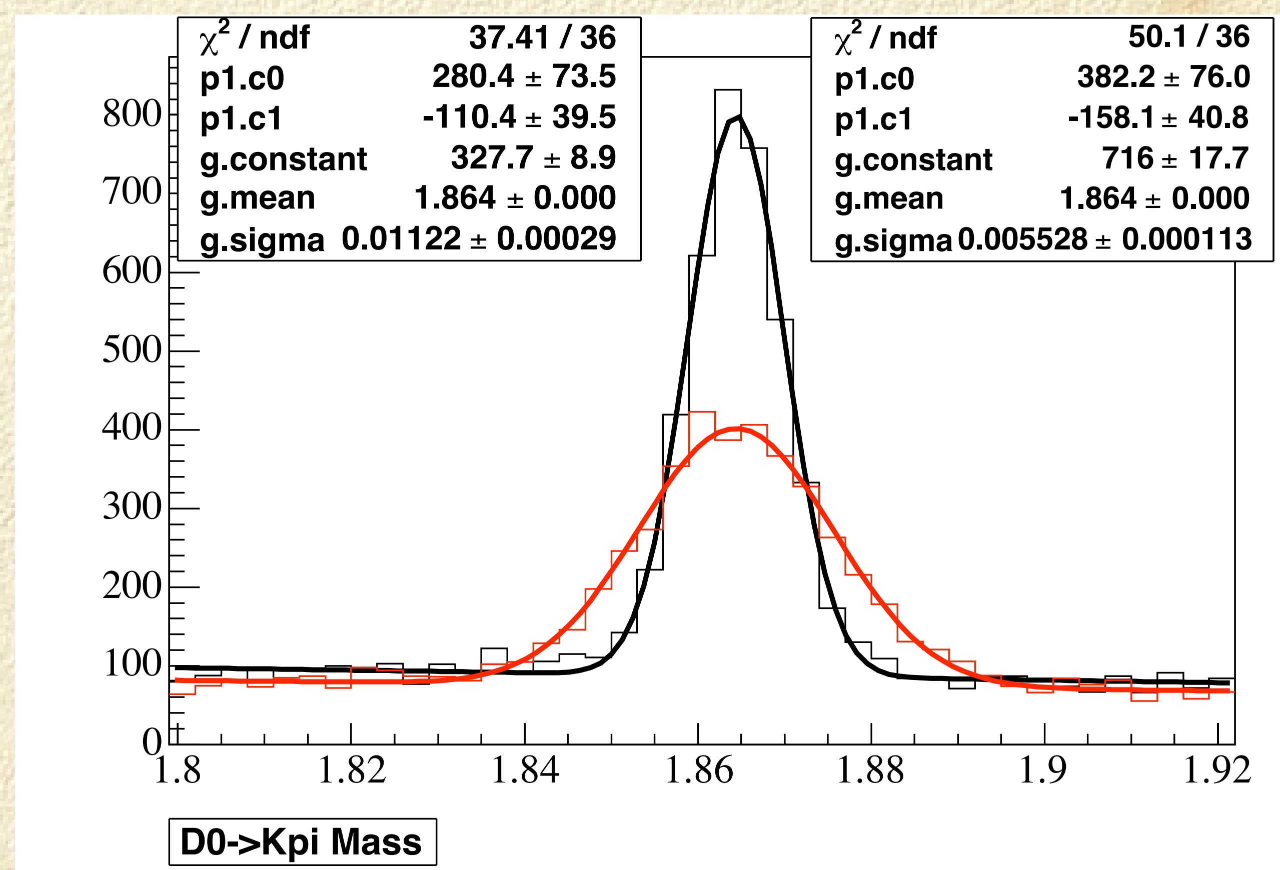
Quantity	*BABAR*	SVT+DCH	CST300	CST200	CST100
$\Delta E(B^0 \to \pi^+\pi^-)$	22	23	35	30	25
$\Delta E(B^0 \to \phi K_s^0)$	17	13	25	21	17
$m(\phi \to K^+K^-)$		2.5	2.9	2.7	2.5
$m(K_s^0 \to \pi^+\pi^-)$	2.2	2.7	3.7	3.4	3.1
$\Delta E(B^0 \to D^{*+}D^{*-})$	8.0	6.1	9.0	8.2	7.2
$\Delta m(D^* - D^0)$	0.30	0.36(0.9)	0.69(1.9)	0.67(2.0)	0.61(1.6)
$m(D^0 \to K^+\pi^-)$	7.0	5.5	11.0	9.6	7.9

Mass Resolution









Design Considerations

Minimize material - no cooling in fiducial volume
so no readout electronics either

Long ladders or long cables ?

Agilent 0.5 μm CMOS process (qualified by GLAST)

Min-i for 300μm Si is about 24,000 electrons

Shaping (μs)	Length (cm)	Noise (e^-)
1	100	2200
1	200	3950
3	100	1250
3	200	2200

from Bruce Schumm
simultions at LCWS 05

occupancy increases in both space & time

Design with cables and very low mass support

innovative support and cable plant needed

More Design Considerations

Sensors

integrate electronics (JFet, DepFet)

allow thiner sensors

Double sided (tracking) or Single sided (momentor)

small Drift Chamber cells

worse hit resolution affects high momentum tracks

Silicon tracking

poor low momentum resolution

Hybrid - Silicon & Gas chamber

optimize momentum resolution, background susceptibility, track finding efficiency

Conclusions

- Luminosity background term
- Momentum Resolution
- Design of a low mass support
- New thin sensors
- Hybrid design