Issues for LDC

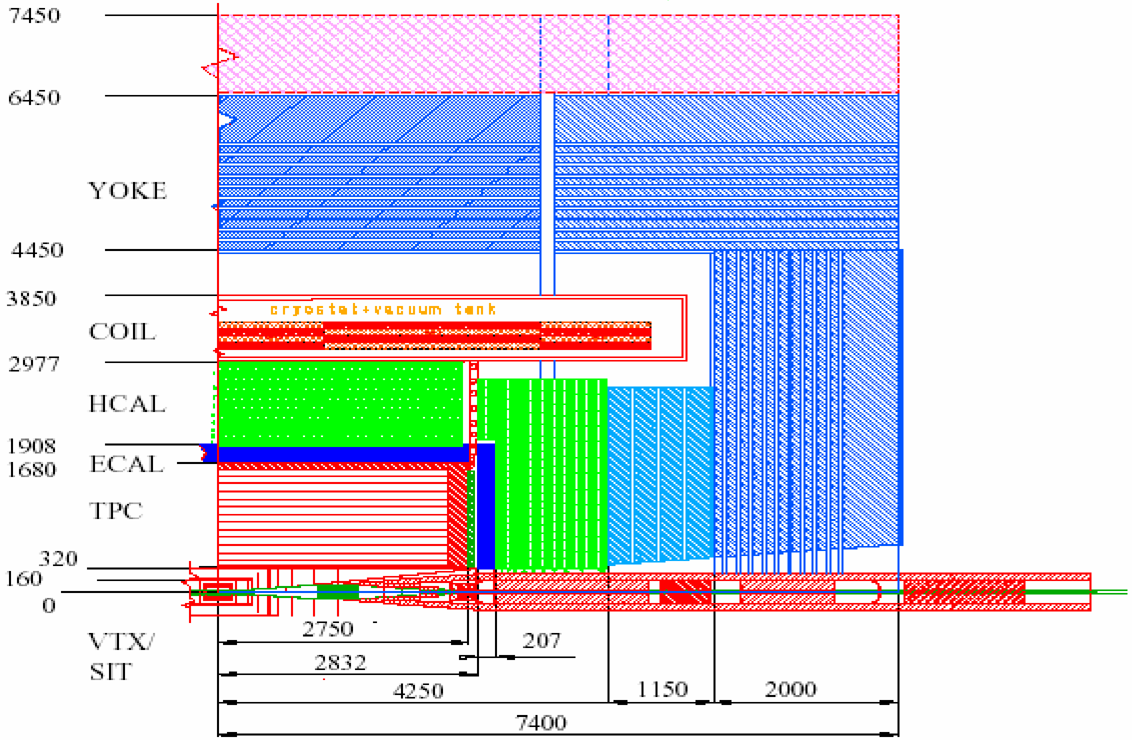
- Tracking Issues in the DOD
- Another thing

Large Detector Concept example

- Flavor tag $\delta(\mathrm{IP}) \sim 5\mu\mathrm{m} \oplus \frac{10\mu m \ \mathrm{GeV}/c}{p \sin^{3/2}\theta}$
- Track momentum $\delta(1/p_t) \sim 3\times10^{-5}\ \mathrm{GeV}/c^{-1}$
- **Particle Flow** $\delta E/E \sim .30 / \sqrt{E}$

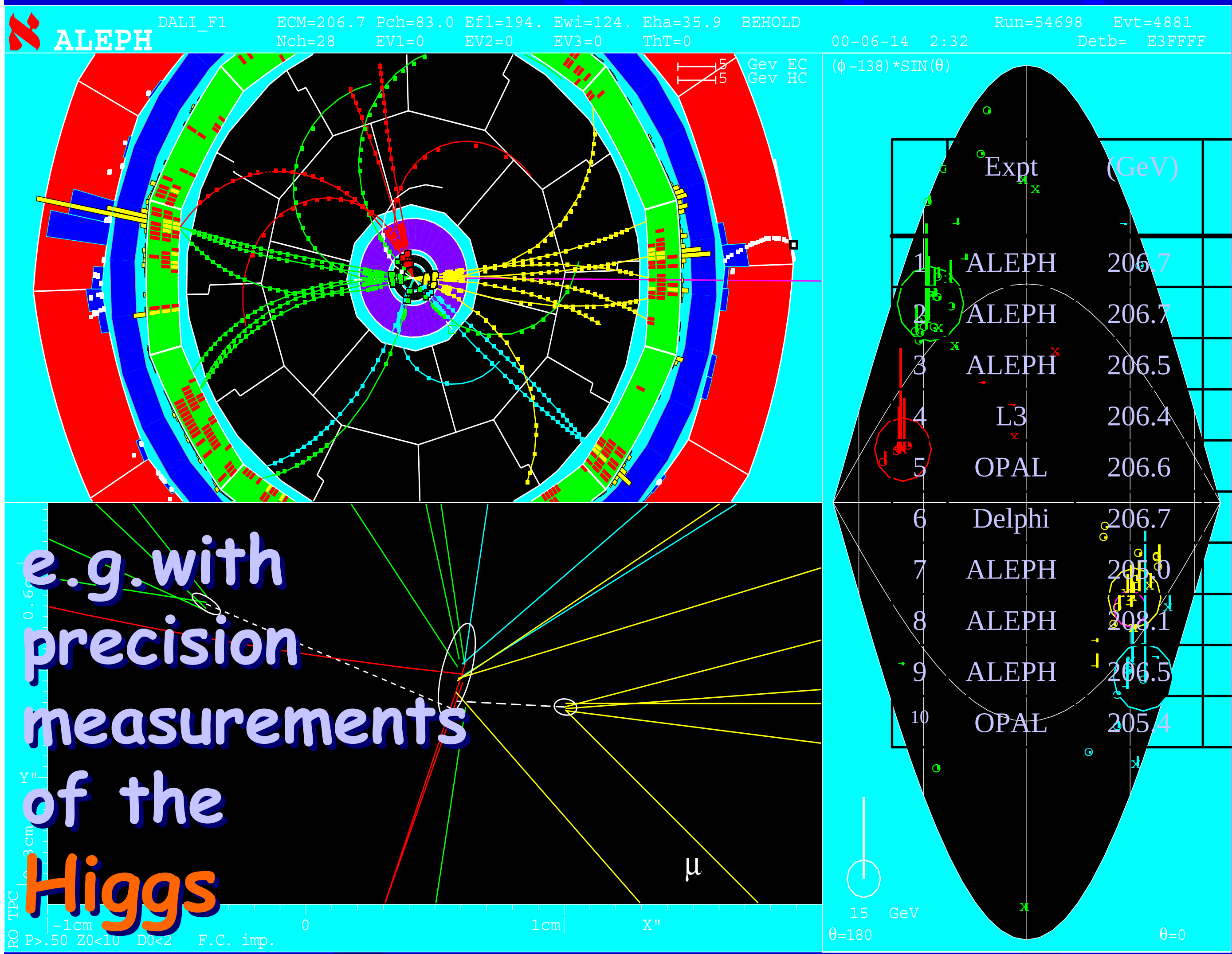
Energy flow
- granularity
- hermeticity
- min. material inside calos
- calos inside 4 T coil

(N.B. below are TDR dimensions, which have changed for latest LDC iteration)



- 5

Goal: to revisit the Higgs…



e.g. with precision measurements of the Higgs

	Expt	(GeV)	Decay Channel	(GeV/c^2)	ln(1+s/b) 115 GeV/c^2
1	ALEPH	206.7	4-jet	114.3	1.73
2	ALEPH	206.7	4-jet	112.9	1.21
3	ALEPH	206.5	4-jet	110.0	0.64
4	L3	206.4	E-miss	115.0	0.53
5	OPAL	206.6	4-jet	110.7	0.53
6	Delphi	206.7	4-jet	114.3	0.49
7	ALEPH	205.0	Lept	118.1	0.47
8	ALEPH	208.1	Tau	115.4	0.41
9	ALEPH	206.5	4-jet	114.5	0.40
10	OPAL	205.4	4-jet	112.6	0.40

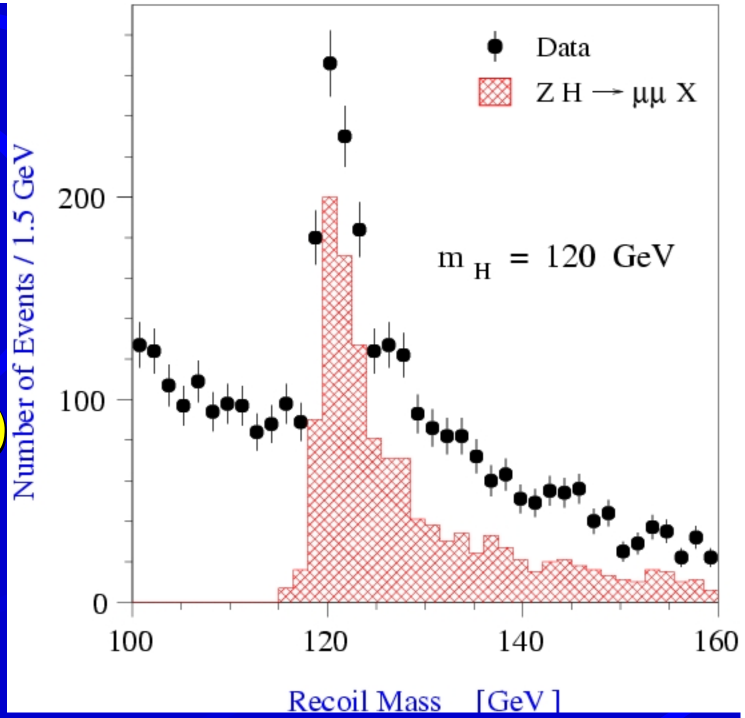
Physics determines detector design

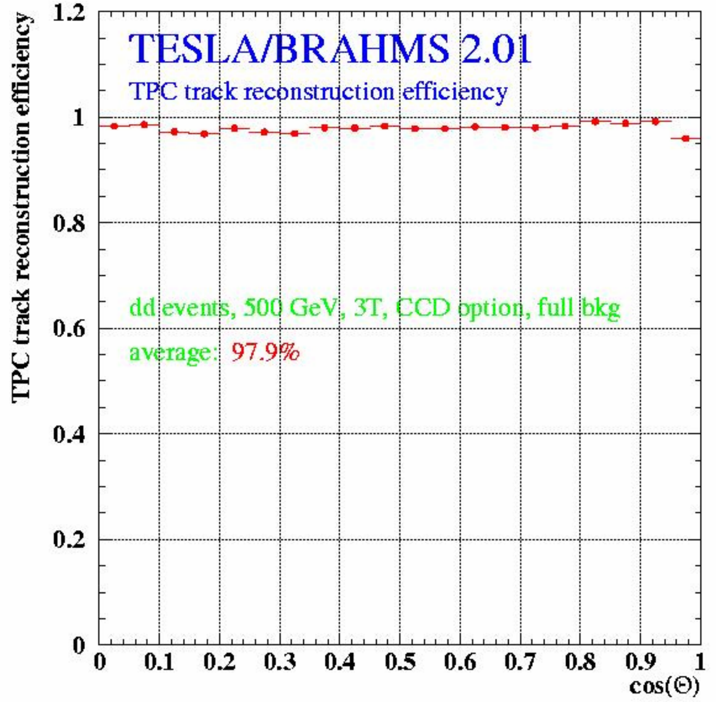
- momentum: $d(1/p) \sim 10^{-4}$/GeV(TPC only)
  $\sim 0.6 \times 10^{-4}$/GeV(w/vertex)
  (1/10xLEP)

  $e^+e^- \rightarrow ZH \rightarrow ll\ X$ goal: $\delta M_{\mu\mu} < 0.1 x\ \Gamma_Z$
  → δM_H dominated by beamstrahlung

- tracking efficiency: 99% (overall)

  excellent and robust tracking efficiency by combining vertex detector and TPC, each with excellent tracking efficiency





Performance

- Momentum precision needed for overall tracking?
- Momentum precision needed for the TPC?
- Good dE/dx resolution, V° detection
- Requirements for
  - 2-track resolution (in rφ and z)?
  - track-gamma separation (in rφ and z)?
- Tolerance on the maximum endplate thickness?
- Tracking configuration
  - Calorimeter diameter
  - TPC
  - Other tracking detectors
- TPC OD/ID/length

LCTPC resolution in the DODs

Table 2: Typical list of performance requirements for a TPC at the ILC detector.

Size	$\phi = 3.2 - 4.1$m, L $= 4.2 - 4.6$m
Momentum resolution	$\delta(1/p_t) \sim 10^{-4}$/GeV/c (TPC only; $\times$ 2/3 when IP included)
Solid angle coverage	Up to at least $\cos\theta \sim 0.98$
TPC material budget	$< 0.03X_0$ to outer fieldcage in r
	$< 0.30X_0$ for readout endcaps in z
Number of pads	$\sim 1.3\times10^6$ per endcap
Pad size/no.padrows	$\sim$ 1mm$\times$6mm/$\sim$200
$\sigma_{\text{singlepoint}}$ in $r\phi$	$\sim 100\mu$m (average over driftlength)
$\sigma_{\text{singlepoint}}$ in rz	$\sim$ 0.5 mm
2-track resolution in $r\phi$	$<$ 2 mm
2-track resolution in rz	$<$ 5 mm
dE/dx resolution	$<$ 4.5 %
Performance robustness	$>$ 95% tracking efficiency (TPC only), $>$ 98% overall tracking
Background robustness	Full precision/efficiency in backgrounds of ca. 20% occupancy, whereby simulations estimate $<$ 0.5% for nominal backgrounds.

ACFA8--July2005

A Study of Tracker Performance with Jupiter

Atsushi Yamaguchi Tsukuba Univ.
Keisuke Fujii KEK
Akiya Miyamoto KEK
Tomoaki Fujikawa Tohoku Univ.
Kotoyo Hoshina Wisconsin Univ.
Yuzo Asano Tsukuba Univ.
other acfa-sim-j members, cdc group

Tracker parameters used in this study

TPC

- lever arm = 155 [cm] (Rmin = 44cm)
- half length = 255 [cm]
- N_{sample} = 200
- $sigma_{r\varphi}^2$ = $55^2 + 55^2/28 \times Z_{drift}$ [μm^2]
- $sigma_z$ = 600 [μm]

(measured for a GEM-TPC with P5 gas --> K. Ikematsu's talk)

IT

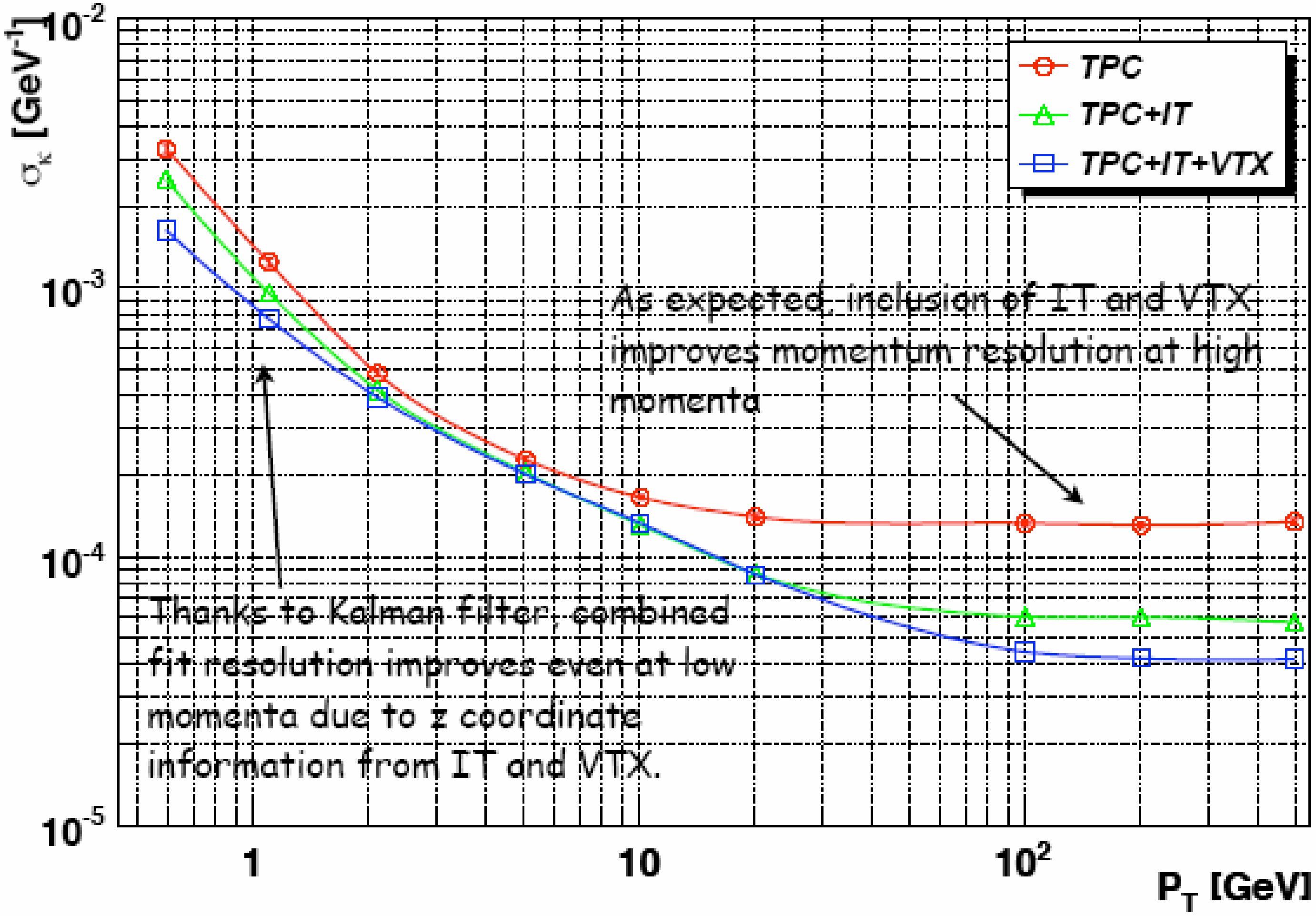
- N_{layer} = 4 (R_{min} = 9cm, R_{step} = 7cm)
- thick = 560 [μm] (silicon)
- $sigma_{r\varphi, z}$ = 10 [μm]

VTX

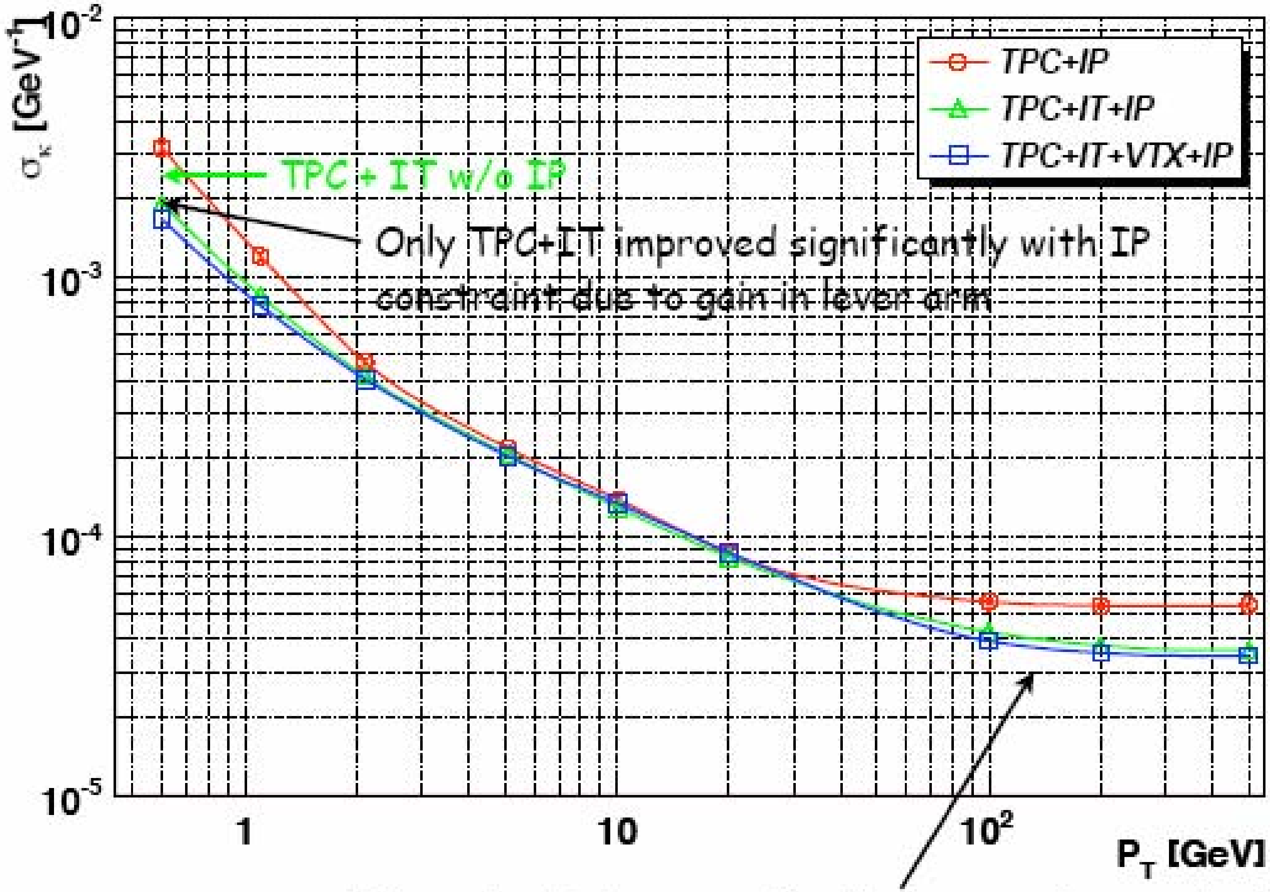
- N_{layer} = 4 (R_{min} = 2.4cm, R_{step} = 1.2cm)
- thickness = 330 [μm] (silicon)
- $sigma_{r\varphi, z}$ = 4 [μm]

Momentum resolution vs transverse momentum

(|cos| < 0.7)

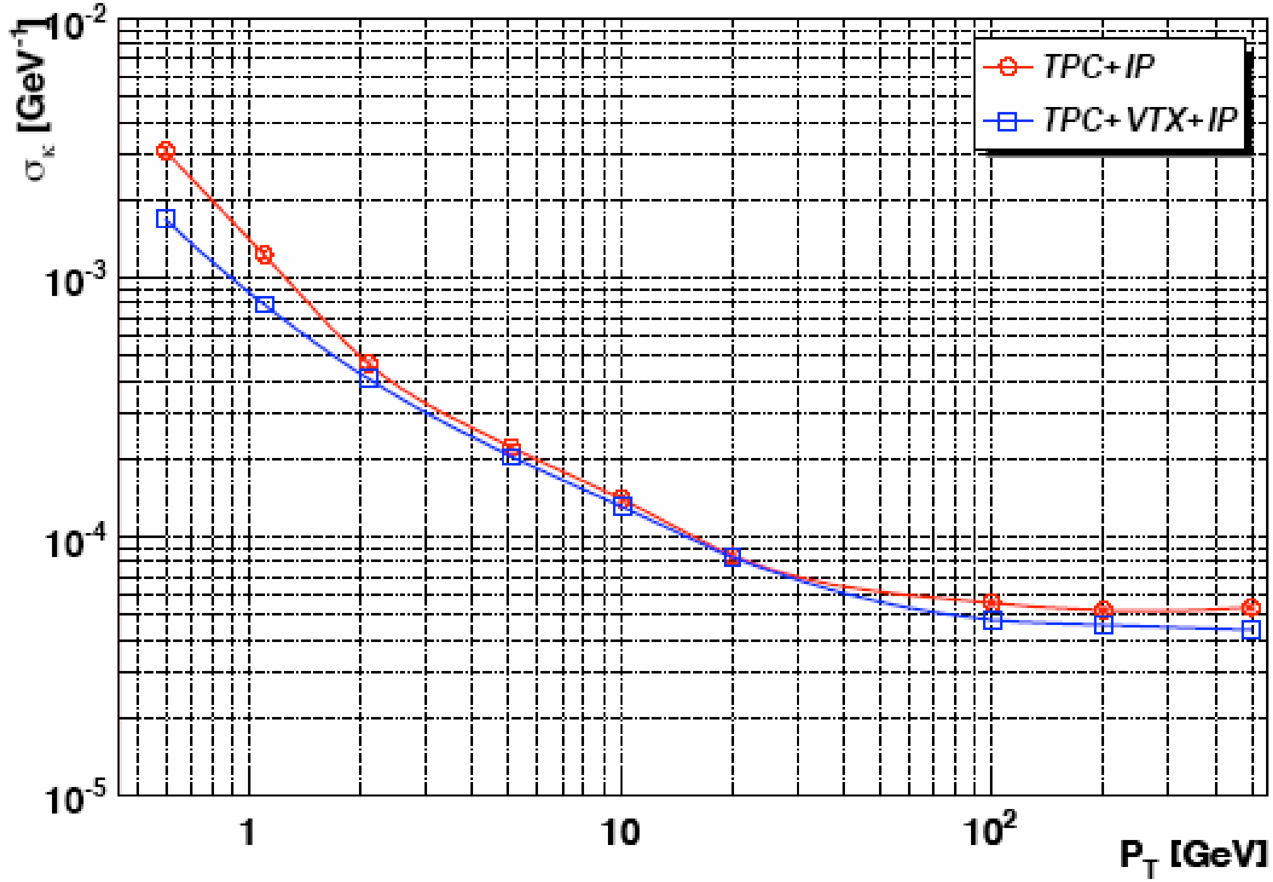


Momentum resolution vs transverse momentum with IP constraint



IP constraint improves the high momentum region in particular for the TPC-only and TPC+IT cases.

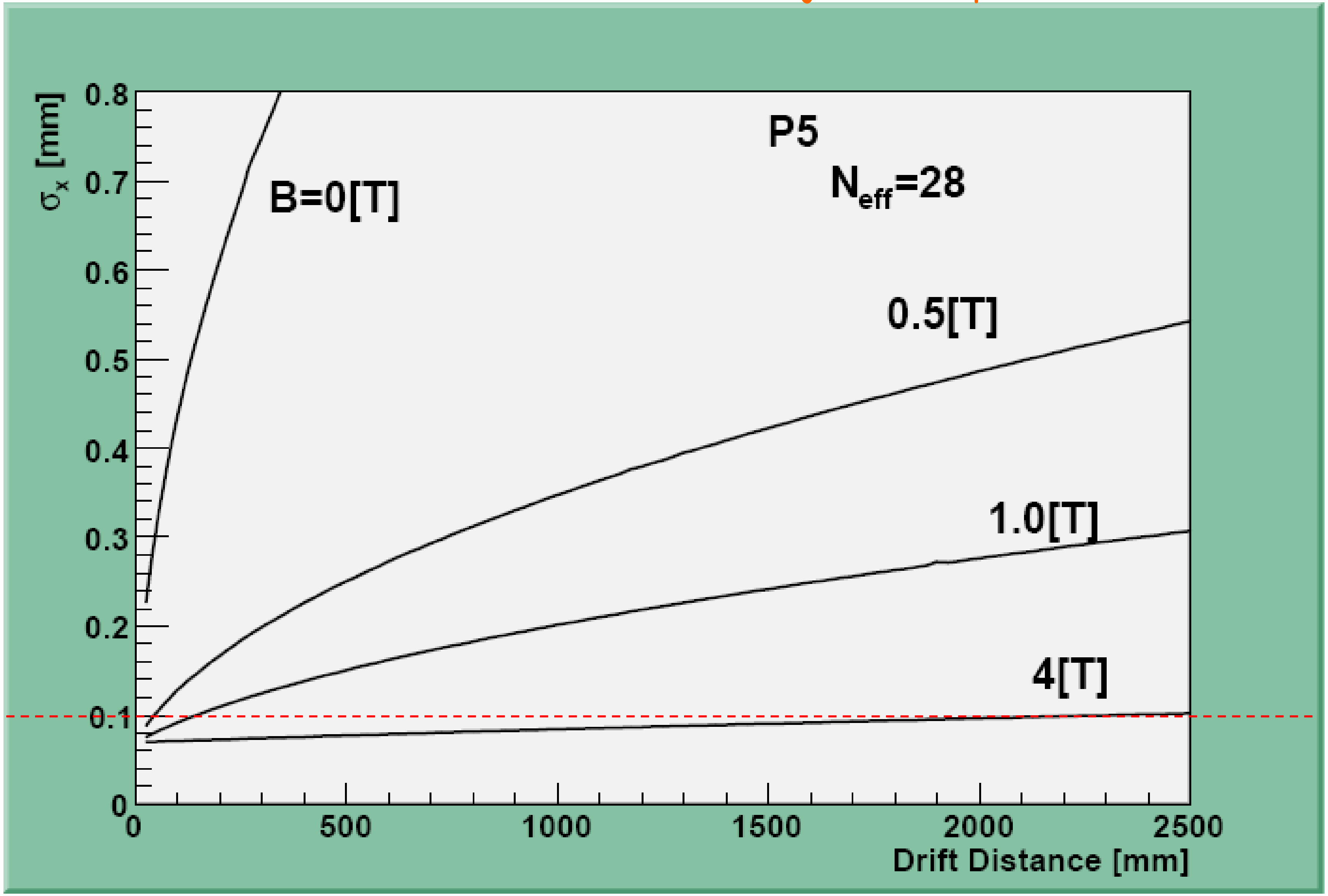
Momentum resolution vs P_t with IP constraint (not using IT)



Performance

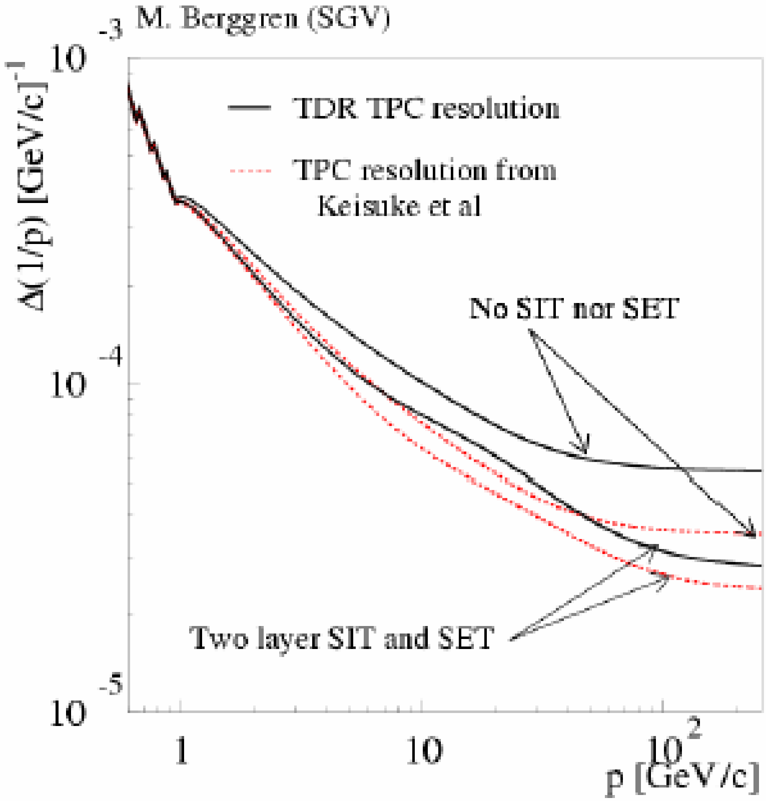
- Momentum precision needed for the TPC→
- What is the best we can do?

Keisuke Fujii, PRC report



TPC resolution and the Si envelope

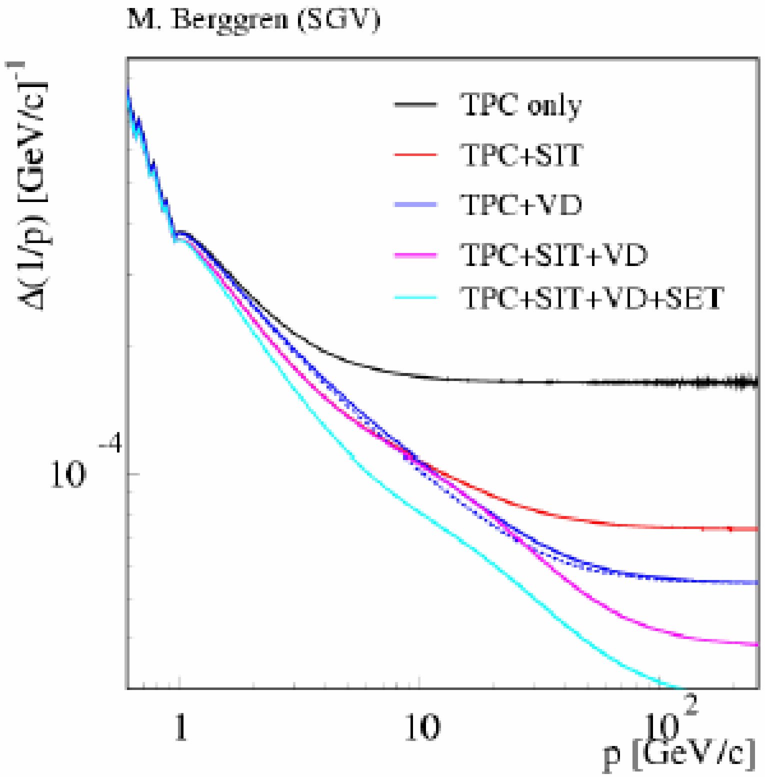
- In the forward ...
  - TDR → ameliorated
  - Add SIT-SET and FTD
  - ... and ECT
- In the barrel ...
  - TDR → ameliorated
  - Add SIT-SET



The interplay of the tracking detectors in the barrel

Momentum resolution at 90deg

- TPC alone
- TPC and SIT
- TPC and VD. Solid line: The material of the SIT is included. Dashed line: No Sit at all.
- TPC, VD and SIT. Note the region 8 to 25 GeV !
- TPC, VD, SIT and SET.

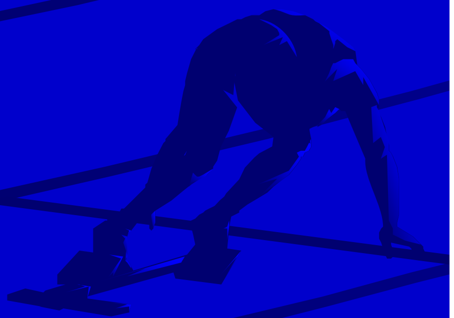


Issues for LDC

- Another thing

Now is maybe a good time to look briefly at the physics of the ILC.

From my talk at the Arlington LC Workshop January 2003:



WHY LC?

TWO-PRONG ATTACK at LC on PHYSICS beyond the SM

→ INDIRECT

PRECISION MEASUREMENT

Higgs – Top – WW – $q\bar{q}$ – GZ – M_W

⇒ High statistics
⇒ Polarized beams

e.g., $M_{Z'} \sim$ 5 TeV

→ DIRECT

DISCOVERY

Susy – Alternative Theories

e.g., 'Susy Forest'

→ <u>**NECESSARY**</u> COMPLEMENT to LHC

Example of Experimental Programme

- ILC

$\sqrt{s}$ = 91 500 800/1000 GeV

$\mathcal{L} = 6 \times 10^{33}$ 3×10^{34} 5×10^{34} $cm^2 s^{-1}$

- PHYSICS

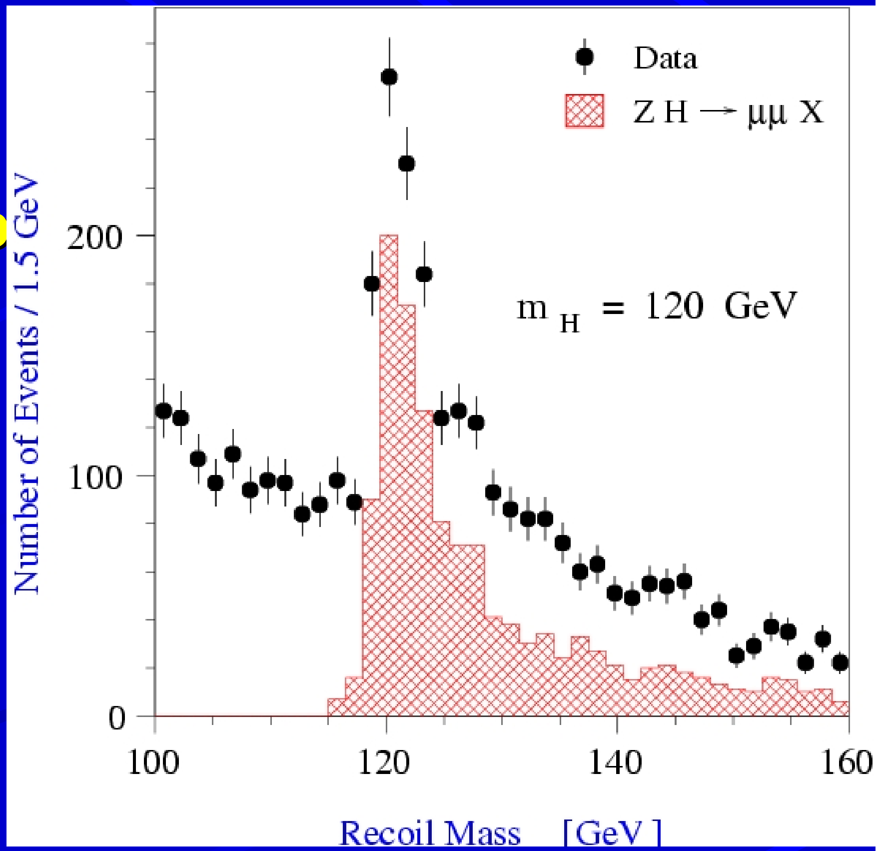
Year	Physics	$\sqrt{s}$ Gev	$\int \mathcal{L}dt$ fb^{-1}	Years Runnin
2016	Commissioning			1
2017	Higgs	250	200	2
2019	Top	350	200	1
2022	WW, HHH	500	500	2
+y	Susy			
2025	Yukawa ttH	750	1000	2
+y	New Physics			
y	GZ	91	50	1
y	M_W	161	100	1

$\Sigma \sim$ 25

Physics determines detector design

★ Momentum resolution: d(1/p
?????

$e^+e^- \rightarrow ZH \rightarrow ll\ X$
$\rightarrow$ couplings, δM_H ?



★ Redo study at √s = 220 GeV and using vertex constraint!