

# (asymptotic) $1/p_T$ resolution

ILC vs. SiD  
(and modifications thereof)

# Simple track “model”

- **Infinite momentum:**
  - Straight tracks
  - No multiple scattering
  - $\Theta = 90^\circ$ ,  $\phi = 90^\circ$
- **DBD geometry and single-point resolutions**
- **Fit (weighted) track points using 2nd order polynomial and obtain curvature  $\rightarrow 1/p_T$** 
  - Without and with IP constraint

# ILD single point resolutions

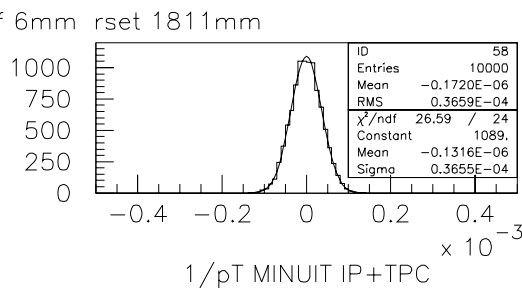
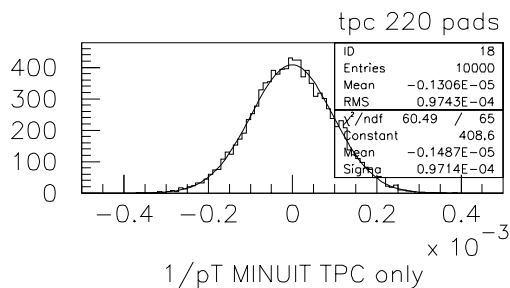
Detector	R (mm)	Sigma ( $\mu\text{m}$ )
VTX	16.0	2.8
	18.0	6.0
	37.0	4.0
	39.0	4.0
	58.0	4.0
	60.0	4.0
	SIT	153.0
300.0		7.0
TPC (220 points)	380 - 1694	100.0
SET	1811.0	7.0
I.P.	0.0	0.7

# Results ILD plots: TPC 220 pads; $R_{SET} = 1811$ mm

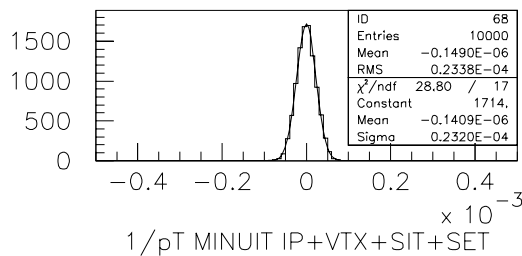
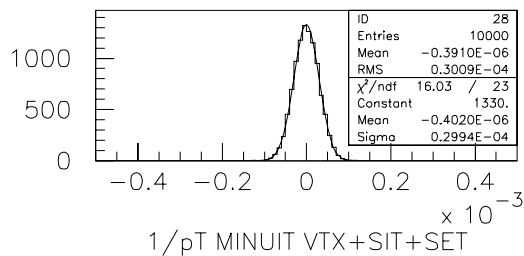
Without IP

With IP

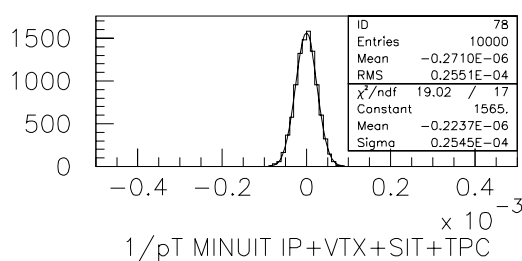
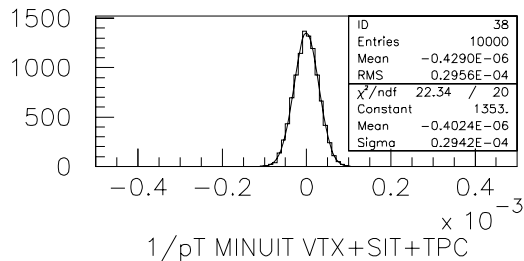
TPC only



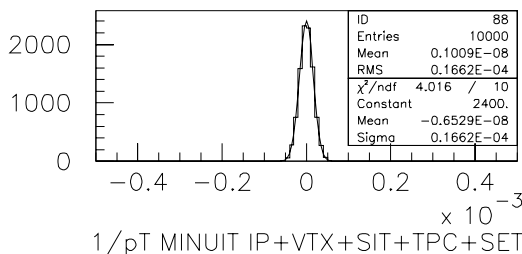
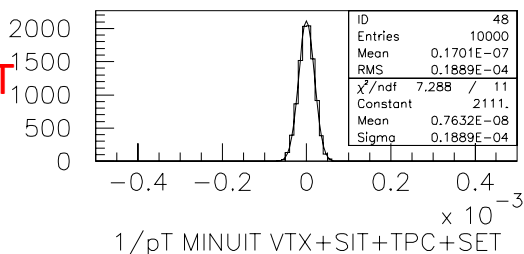
VTX+SIT+SET



VTX+SIT+TPC



VTX+SIT+TPC+SET



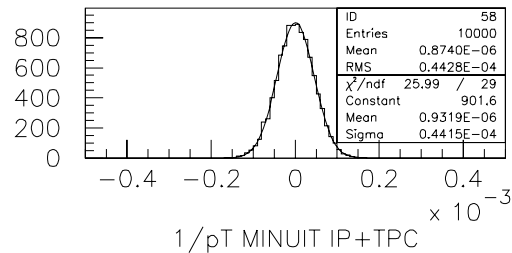
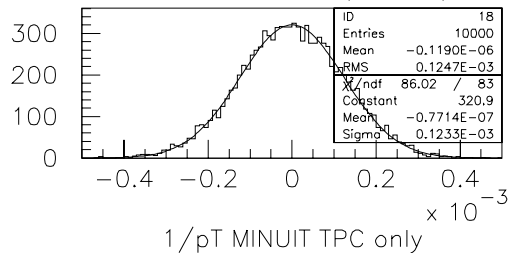
# Results ILD plots: TPC 200 pads; $R_{SET} = 1691$ mm

Without IP

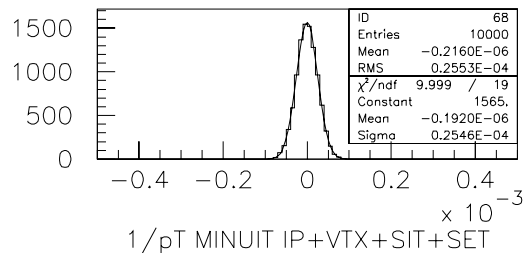
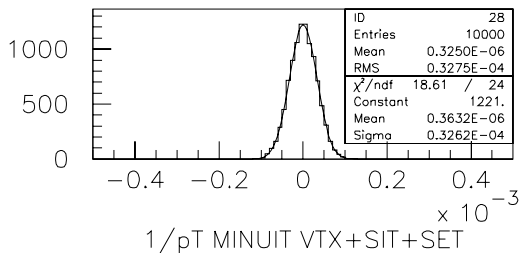
With IP

tpc 200 pads of 6mm rset 1691mm

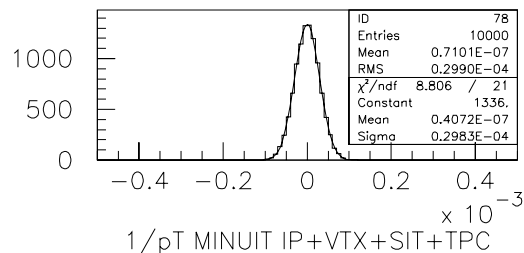
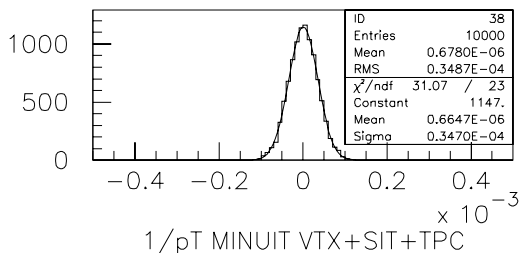
TPC only



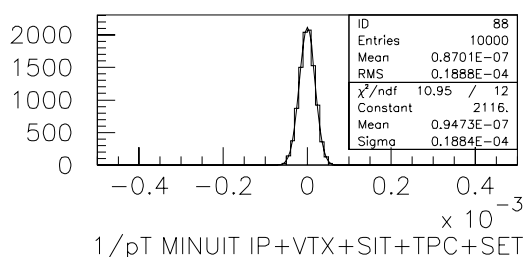
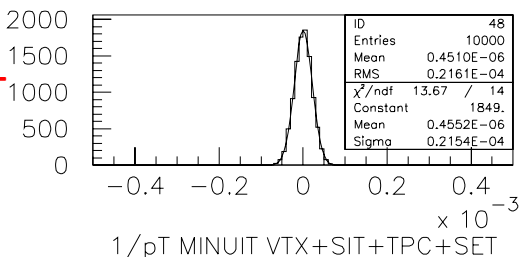
VTX+SIT+SET



VTX+SIT+TPC



VTX+SIT+TPC+SET

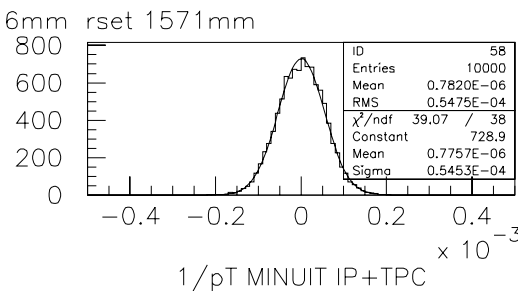
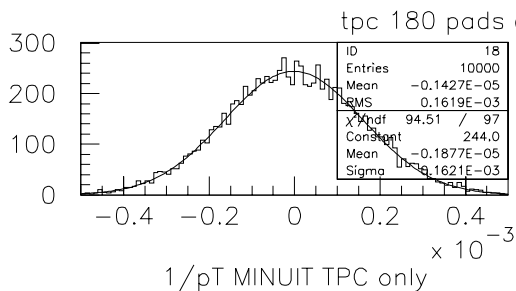


# Results ILD plots: TPC 180 pads; $R_{SET} = 1571$ mm

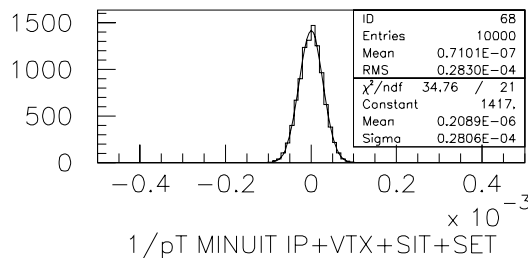
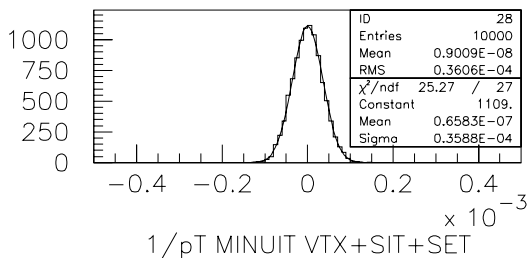
Without IP

With IP

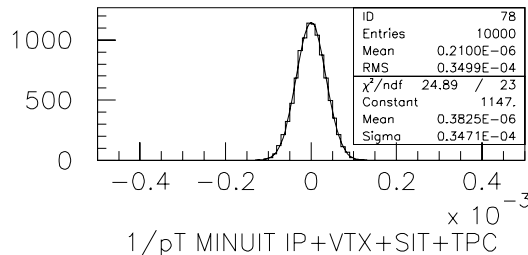
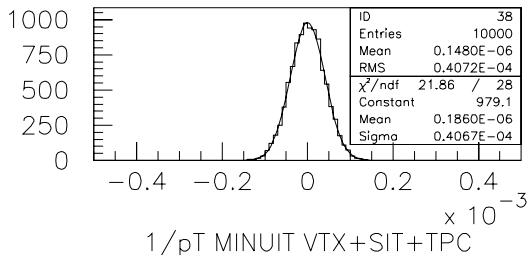
TPC only



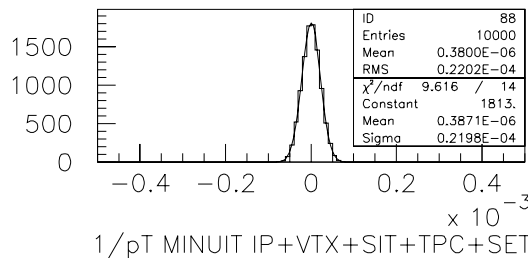
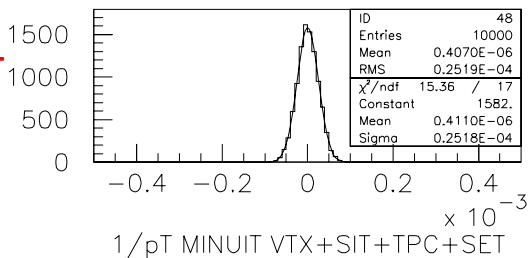
VTX+SIT+SET



VTX+SIT+TPC



VTX+SIT+TPC+SET

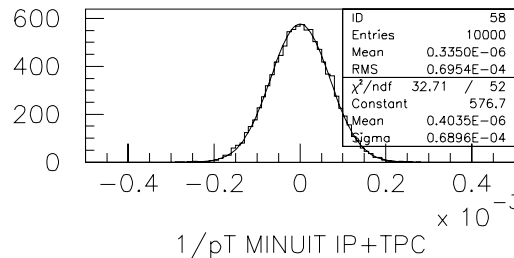
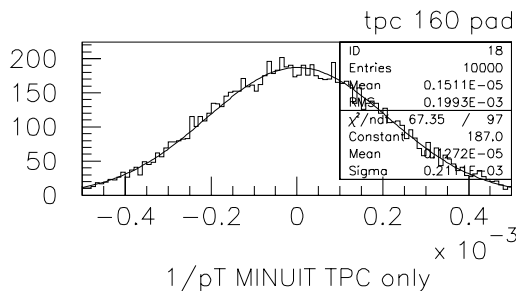


# Results ILD plots: TPC 160 pads; $R_{SET} = 1451$ mm

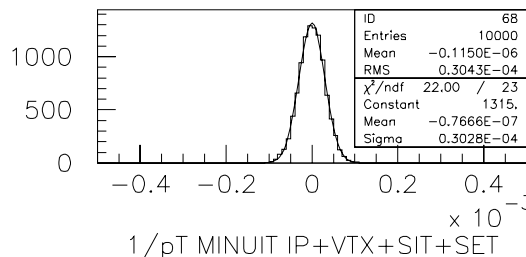
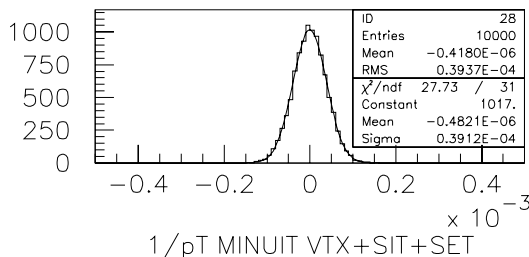
Without IP

With IP

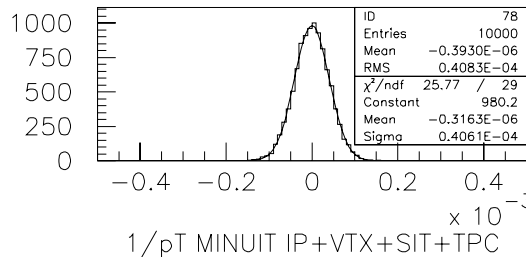
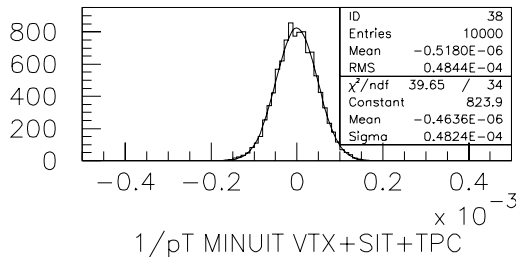
TPC only



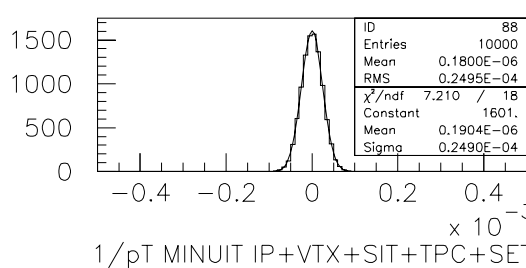
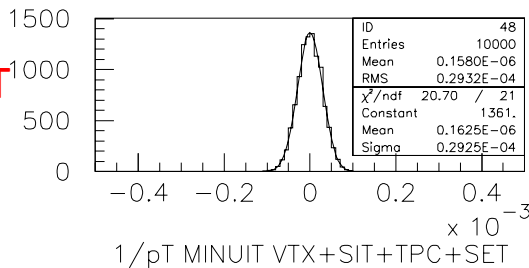
VTX+SIT+SET



VTX+SIT+TPC



VTX+SIT+TPC+SET



# ILD $1/p_T$ resolution summary

(in units of  $10^{-5} \text{ GeV}^{-1}$ )

	TPC 220 pads $R_{\text{SET}}=1811\text{mm}$	TPC 200 pads $R_{\text{SET}}=1691\text{mm}$	TPC 180 pads $R_{\text{SET}}=1571\text{mm}$	TPC 160 pads $R_{\text{SET}}=1451\text{mm}$
TPC only	9.71	12.3	16.2	21.1
VTX+SIT+SET	2.99	3.26	3.59	3.91
VTX+SIT+TPC	2.94	3.47	4.07	4.82
VTX+SIT+TPC+SET	1.89	2.15	2.52	2.93

+ IP constraint	TPC 220 pads $R_{\text{SET}}=1811\text{mm}$	TPC 200 pads $R_{\text{SET}}=1691\text{mm}$	TPC 180 pads $R_{\text{SET}}=1571\text{mm}$	TPC 160 pads $R_{\text{SET}}=1451\text{mm}$
TPC only	3.66	4.42	5.45	6.90
VTX+SIT+SET	2.32	2.55	2.81	3.03
VTX+SIT+TPC	2.55	2.98	3.47	4.06
VTX+SIT+TPC+SET	1.66	1.88	2.20	2.49



# SiD single point resolutions

(note: the sigmas (from M. Stanitzki) are (much) better than for ILD)

Detector	R (mm)	Sigma ( $\mu\text{m}$ )
VTX	14.0	2.5
	22.0	2.5
	35.0	2.5
	48.0	2.5
	60.0	2.5
Tracker	219.5	5.5
	469.5	5.5
	719.5	5.5
	969.5	5.5
	1219.5	5.5
I.P.	0.0	0.7

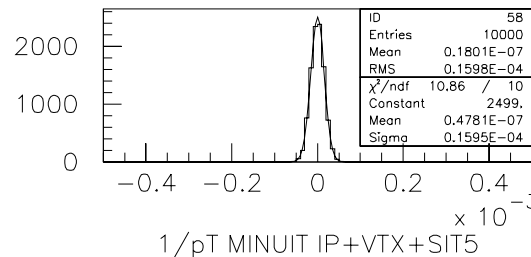
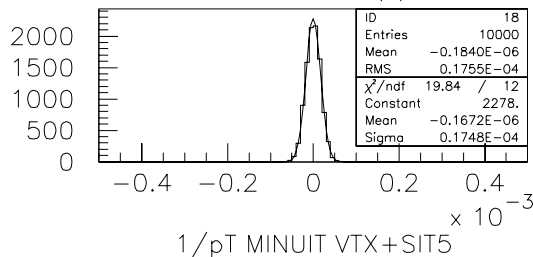
# Results SiD plots: resolution VTX=2.5 $\mu$ m; SiT=5.5 $\mu$ m

Without IP

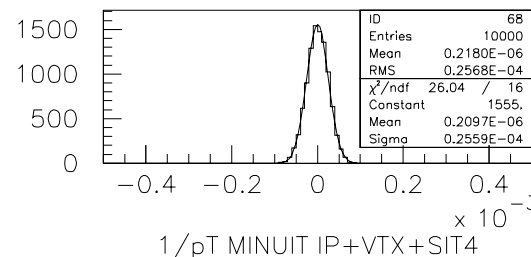
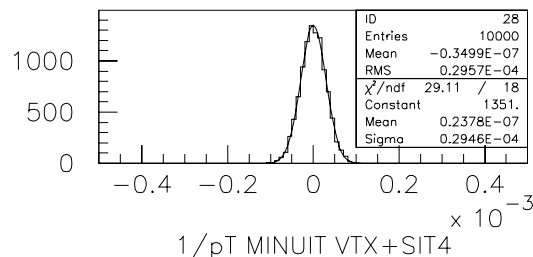
With IP

SiD 1/pT resolutionz VTX 2.5um SIT 5.5um

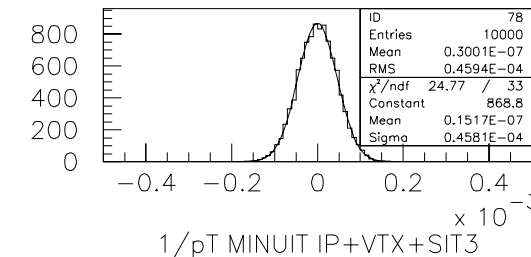
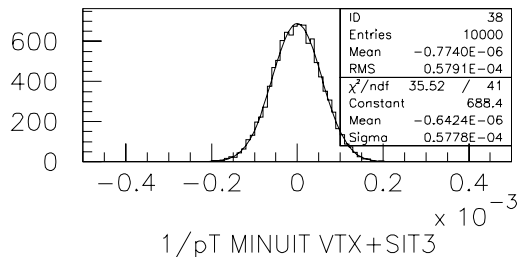
SiT 5 layers



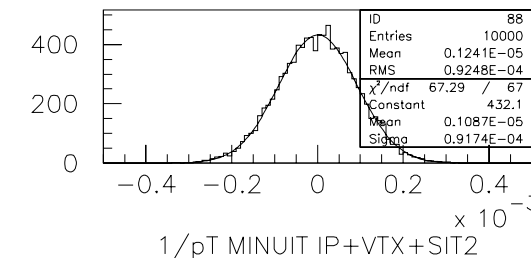
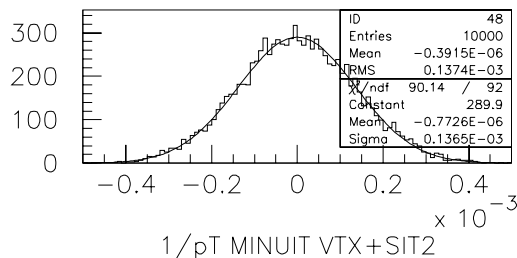
SiT 4 (inner) layers



SiT 3 (inner) layers



SiT 2 (inner) layers

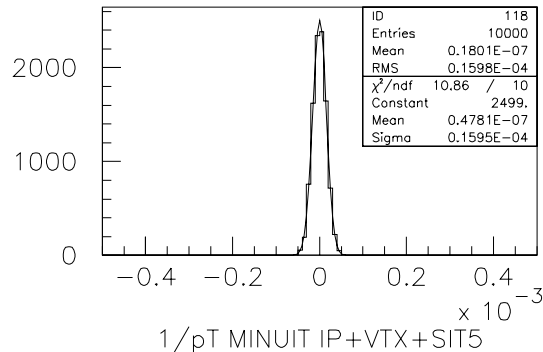
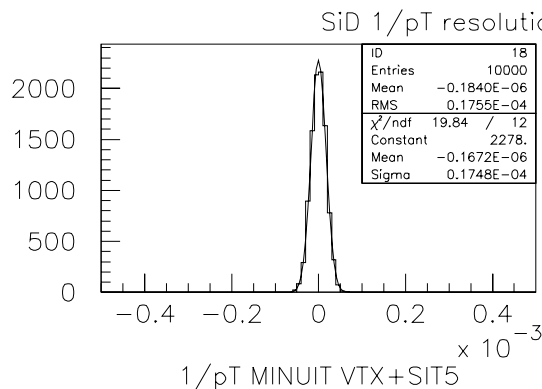


# Results SiD plots: resolution VTX=2.5 $\mu$ m; SiT=5.5 $\mu$ m

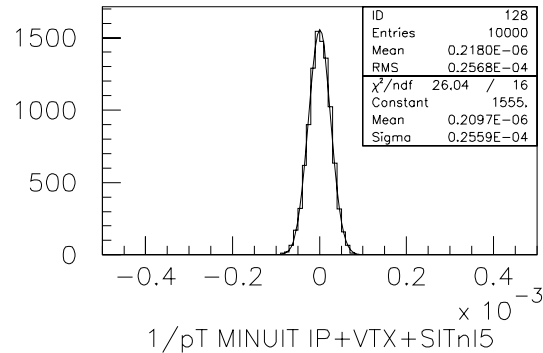
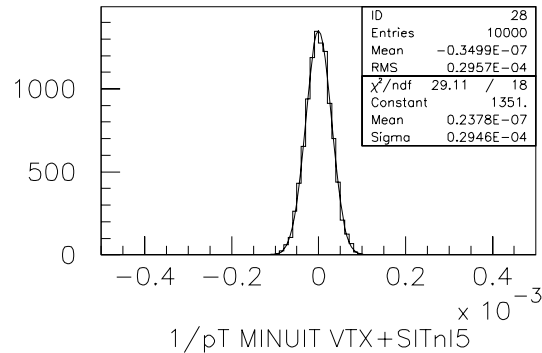
Without IP

With IP

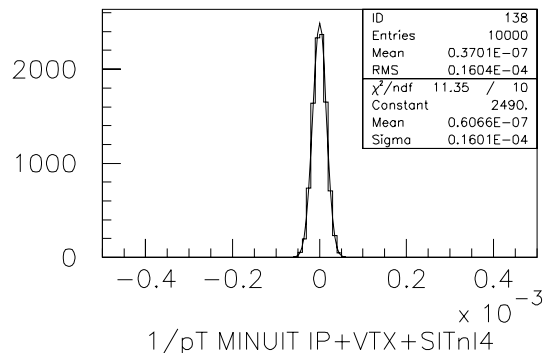
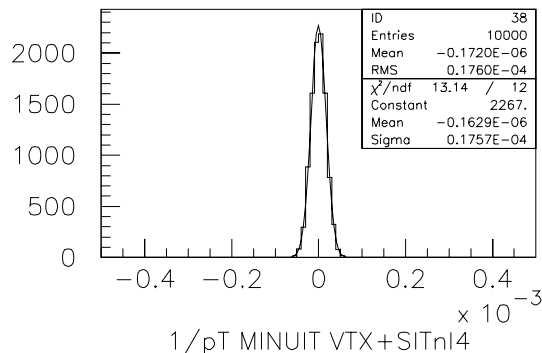
SiT 5 layers



SiT 4 layers; NOT 5



SiT 4 layers; NOT 4

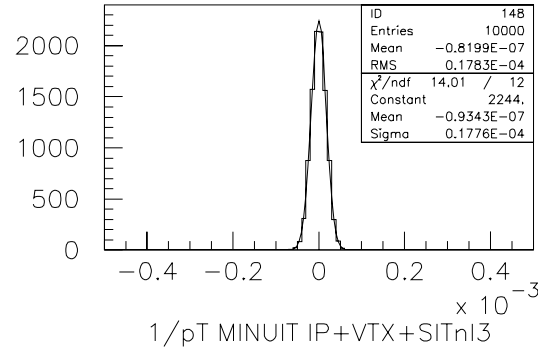
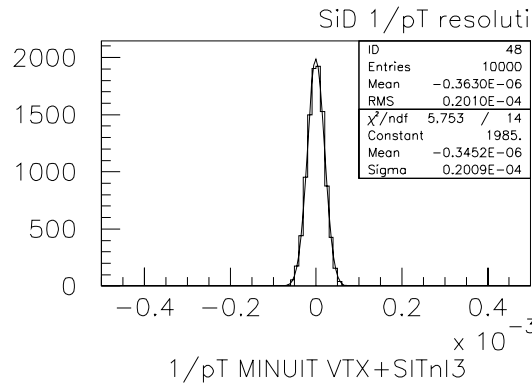


# Results SiD plots: resolution VTX=2.5 $\mu$ m; SiT=5.5 $\mu$ m

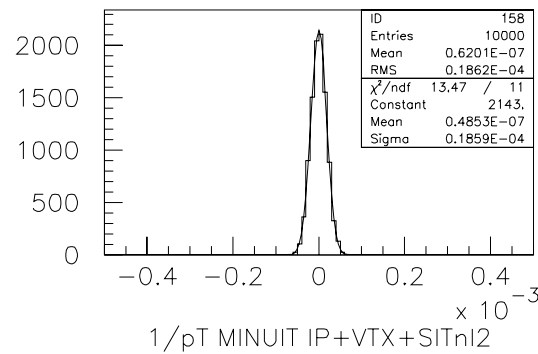
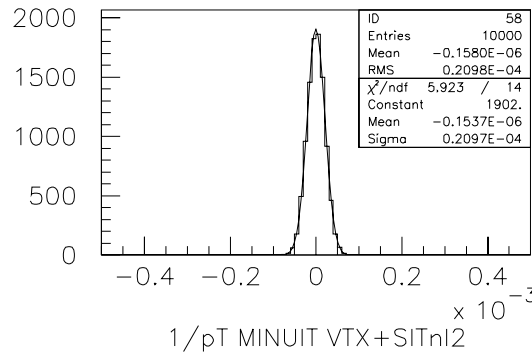
Without IP

With IP

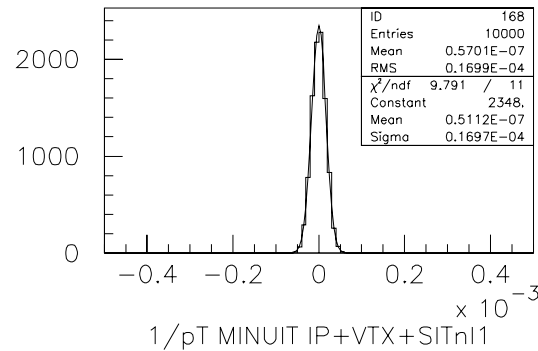
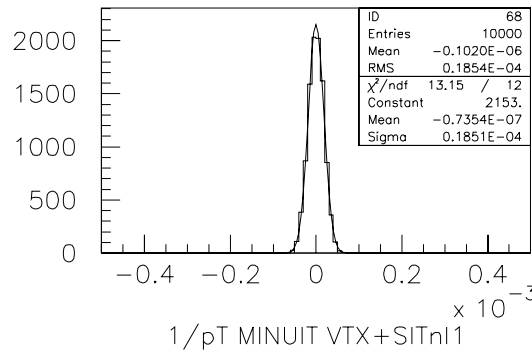
SiT 4 layers; NOT 3



SiT 4 layers; NOT 2



SiT 4 layers; NOT 1

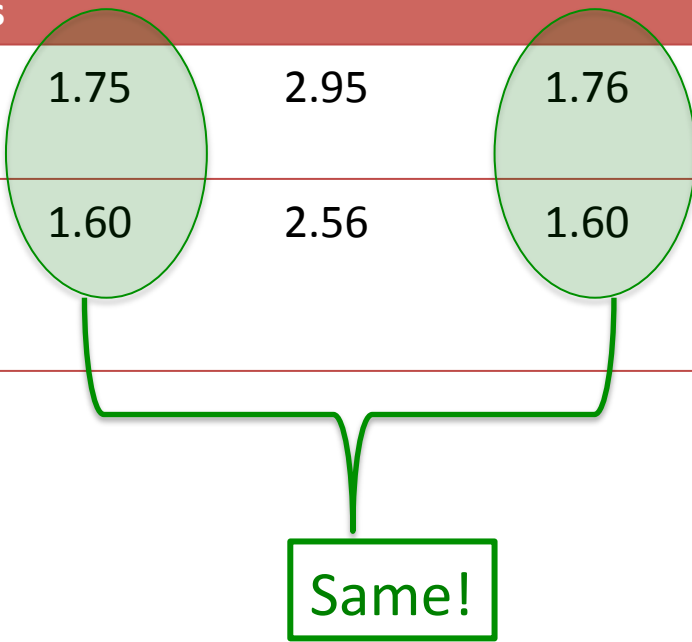


# SiD $1/p_T$ resolution summary

(in units of  $10^{-5} \text{ GeV}^{-1}$ )

One layer missing

Using M. Stanitzki's single p. resolutions	SiT 5 layers	SiT 4 layers; NOT layer 5	SiT 4 layers; NOT layer 4	SiT 4 layers; NOT layer 3	SiT 4 layers; NOT layer 2	SiT 4 layers; NOT layer 1
VTX + n SiT layers	1.75	2.95	1.76	2.01	2.10	1.85
IP + VTX + n SiT layers	1.60	2.56	1.60	1.78	1.86	1.70



# SiD single point resolutions

(using “same” sigmas as for ILD; my choice!)

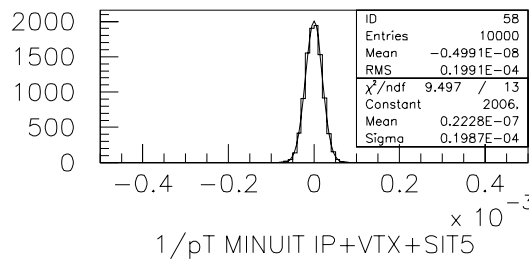
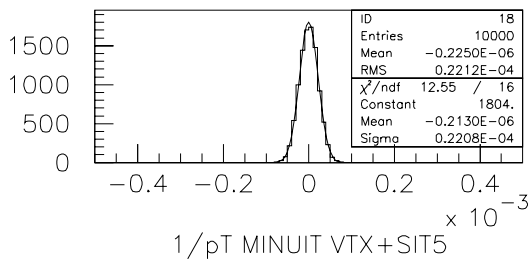
Detector	R (mm)	Sigma ( $\mu\text{m}$ )
VTX	14.0	3.0
	22.0	3.0
	35.0	3.0
	48.0	3.0
	60.0	3.0
Tracker	219.5	7.0
	469.5	7.0
	719.5	7.0
	969.5	7.0
	1219.5	7.0
I.P.	0.0	0.7

# Results SiD plots: resolution VTX=3.0 $\mu\text{m}$ ; SiT=7.0 $\mu\text{m}$

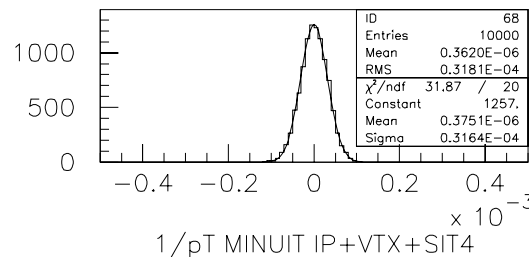
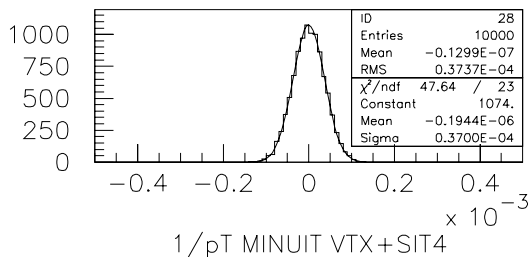
Without IP

With IP

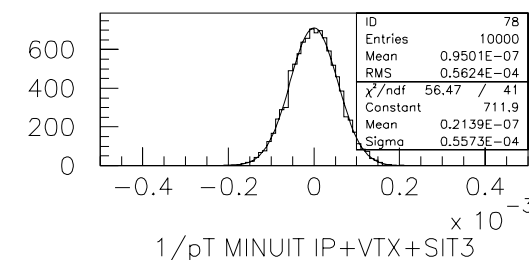
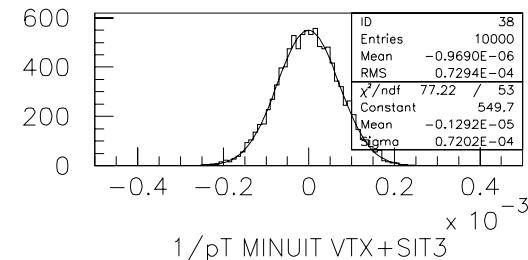
SiT 5 layers



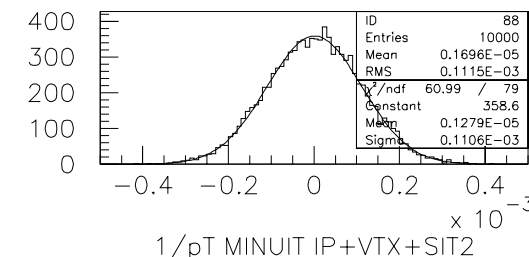
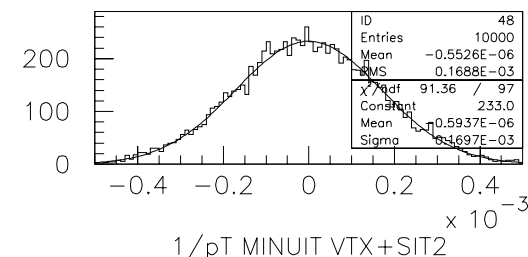
SiT 4 (inner) layers



SiT 3 (inner) layers



SiT 2 (inner) layers



# SiD $1/p_T$ resolution summary

(in units of  $10^{-5} \text{ GeV}^{-1}$ )

Using M. Stanitzki's single p. resolutions	SiT 5 layers	SiT 4 (inner) layers	SiT 3 (inner) layers	SiT 2 (inner) layers
VTX + n SiT layers	1.75	2.95	5.78	13.7
IP + VTX + n SiT layers	1.60	2.56	4.58	9.17

Remember: for (nominal) ILD 1.89 resp. 1.66

Using ILD single p. resolutions	SiT 5 layers	SiT 4 (inner) layers	SiT 3 (inner) layers	SiT 2 (inner) layers
VTX + n SiT layers	2.21	3.70	7.20	17.0
IP + VTX + n SiT layers	1.99	3.16	5.57	11.1



# My conclusions

- It's the physics that should decide what momentum resolution is needed
- Nominal asymptotic ILD resolution slightly worse than nominal SiD ( $1.89$  vs.  $1.75 \times 10^{-5} \text{ GeV}^{-1}$  )
- ILD better than SiD when “same” Si resolutions are assumed in both ( $1.89$  vs.  $2.21 \times 10^{-5} \text{ GeV}^{-1}$  )

# Backup

# ILD $1/p_T$ resolution summary

(in units of  $10^{-5} \text{ GeV}^{-1}$ )

(in green: VTX  $\sigma=2.5 \mu\text{m}$ ; SIT/SET  $\sigma=5.5 \mu\text{m}$ )

	TPC 220 pads $R_{\text{SET}}=1811\text{mm}$	TPC 200 pads $R_{\text{SET}}=1691\text{mm}$	TPC 180 pads $R_{\text{SET}}=1571\text{mm}$	TPC 160 pads $R_{\text{SET}}=1451\text{mm}$
TPC only	9.71 (9.71)	12.3	16.2	21.1
VTX+SIT+SET	2.99 (2.31)	3.26	3.59	3.91
VTX+SIT+TPC	2.94 (2.62)	3.47	4.07	4.82
VTX+SIT+TPC+SET	1.89 (1.65)	2.15	2.52	2.93

+ IP constraint	TPC 220 pads $R_{\text{SET}}=1811\text{mm}$	TPC 200 pads $R_{\text{SET}}=1691\text{mm}$	TPC 180 pads $R_{\text{SET}}=1571\text{mm}$	TPC 160 pads $R_{\text{SET}}=1451\text{mm}$
TPC only	3.66 (3.66)	4.42	5.45	6.90
VTX+SIT+SET	2.32 (1.80)	2.55	2.81	3.03
VTX+SIT+TPC	2.55 (2.21)	2.98	3.47	4.06
VTX+SIT+TPC+SET	1.66 (1.43)	1.88	2.20	2.49

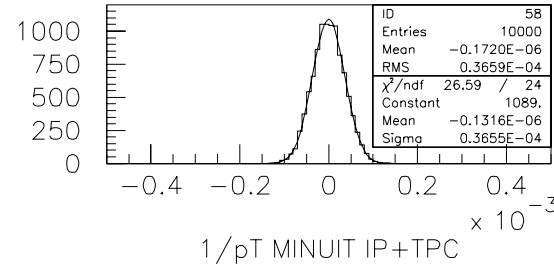
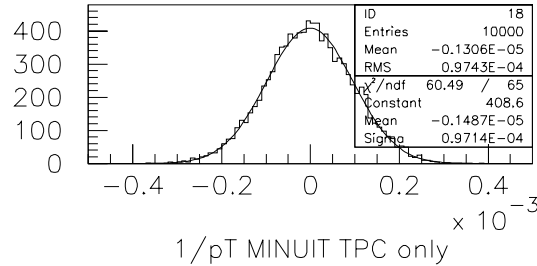
# Results ILD: TPC 220 pads; VTX 2.5 $\mu$ m; SIT/SET 5.5 $\mu$ m

Without IP

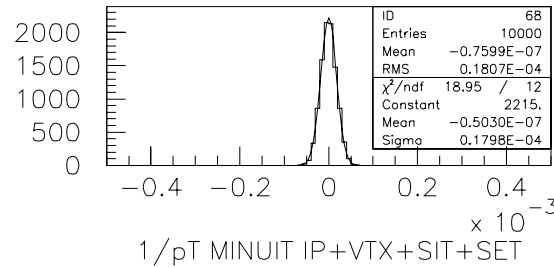
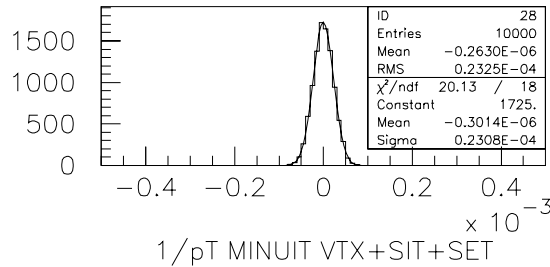
With IP

ILD 1/pT resolution – TPC 220 pads of 6mm – VTX 2.5 $\mu$ m – SITSET 5.5 $\mu$ m

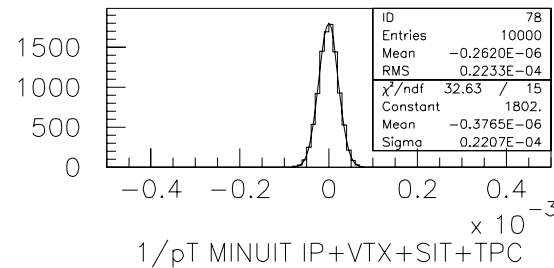
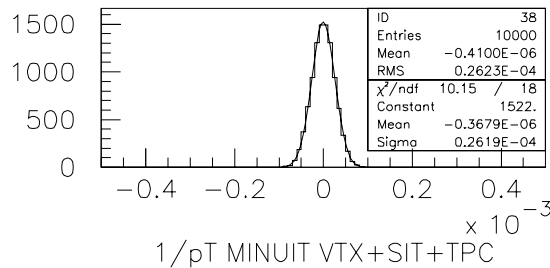
TPC only



VTX+SIT+SET



VTX+SIT+TPC



VTX+SIT+TPC+SET

