

Track fit improvement and back-propagation studies

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Reminder: Track reconstruction chain

Hit reconstruction

Track search

Track fit

Back propagation to IP

Luminosity fit

Track reconstruction chain

Hit reconstruction

Track search

Track fit

Back propagation to IP

Luminosity fit

Minuit

Kalman Filter

Track reconstruction chain

Changes in Track Fit

Hit reconstruction

Track search

Track fit

Back propagation to IP

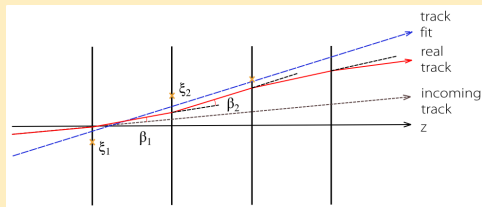
Luminosity fit

Minuit ("broken lines")

~~Kalman Filter~~

Track Fit with «broken lines» approach

Linear Track Fit



$$x_l = a + bz$$

$$\chi^2 = \sum_{l=1}^n \frac{(\xi_l - x_l)^2}{\sigma_{x_l}^2}$$

Multiple scattering \rightarrow hits weights ($\sigma_X^{p/1} < \sigma_X^{p/2} < \sigma_X^{p/3} < \sigma_X^{p/4}$)

Broken lines

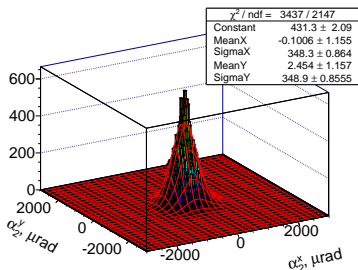
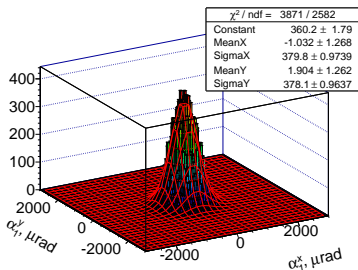
$$x_l = a + bz + \sum_{J=1}^N \alpha_J \cdot (z_l - Z_J) \cdot \Theta(z_l - Z_J)$$

$$\chi^2 = \chi^2(a, b, \alpha_1, \dots, \alpha_N) = \sum_{l=1}^n \frac{(\xi_l - x_l)^2}{\sigma_{x_l}^2} + \sum_{J=1}^N \frac{(\beta_J - \alpha_J)^2}{\sigma_{s_J}^2}$$

Track Fit with «broken lines» approach

Resolution

Broken angles on 2nd and 3d planes after track fit (1.5 GeV/c)



Beam Momentum	Track Parameter	hits with varied weights	broken lines track approximation
1.5 GeV/c	$X_{start}, \mu\text{m}$	14.12 ± 0.02	14.03 ± 0.02
	$\theta, \mu\text{rad}$	341 ± 1	293 ± 1
	ϕ, mrad	6.63 ± 0.04	6.21 ± 0.03
15 GeV/c	$X_{start}, \mu\text{m}$	13.86 ± 0.02	13.89 ± 0.03
	$\theta, \mu\text{rad}$	63.1 ± 0.2	63.1 ± 0.2
	ϕ, mrad	1.58 ± 0.01	1.58 ± 0.01

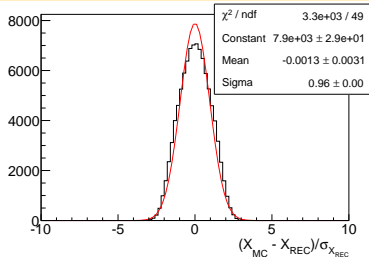
Improvement for low energies

Track Fit with «broken lines» approach

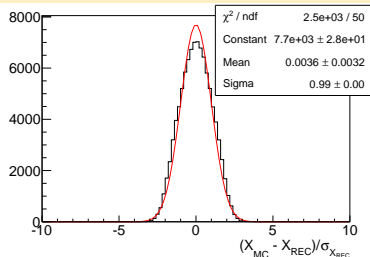
Pulls

$P_{beam} = 1.5 \text{ GeV}/c$

Broken lines



Weighted hits



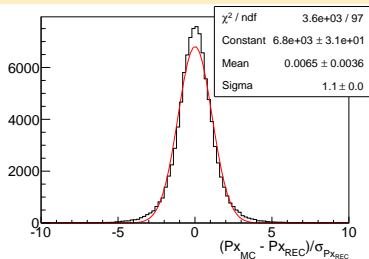
For coordinates error estimation as good as for «weighted hits»

Track Fit with «broken lines» approach

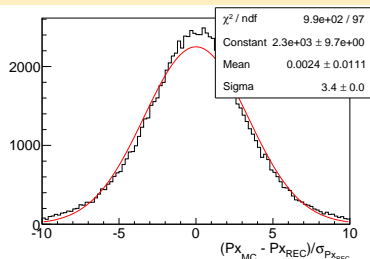
Pulls

$P_{beam}=1.5 \text{ GeV}/c$

Broken lines



Weighted hits



For direction vector error estimation improved

Resolution change after back propagation

P_{lab} 1.5 GeV/c

Simulation with uniform generator, 1 trk/ev
point-like beam (ideal)

Resolutions after trk-fit

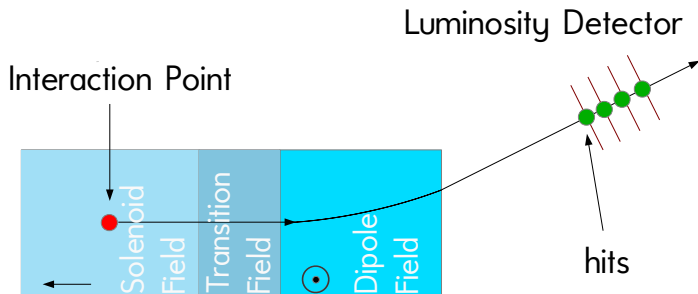
Param	Resolution
X_{start}	$14.03 \pm 0.02 \mu\text{m}$
Y_{start}	$14.04 \pm 0.02 \mu\text{m}$
P_x	$444 \pm 2 \text{ keV}$
P_y	$443 \pm 2 \text{ keV}$
P_z	$18 \pm 0.1 \text{ keV}$
ϕ	$6.21 \pm 0.03, \text{ mrad}$
θ	$293 \pm 1, \mu\text{rad}$

Resolutions after BP

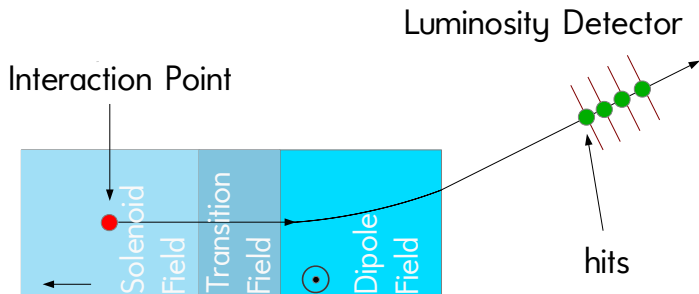
Param	Resolution
X_{start}	$5588 \pm 15 \mu\text{m}$
Y_{start}	$5276 \pm 14 \mu\text{m}$
P_x	$1247 \pm 3 \text{ keV}$
P_y	$790 \pm 2 \text{ keV}$
P_z	$6.03 \pm 0.02 \text{ keV}$
ϕ	$116.2 \pm 0.3, \text{ mrad}$
θ	$678 \pm 2, \mu\text{rad}$

Decreasing for all variables, e.g. for $\theta \sim 2$ times

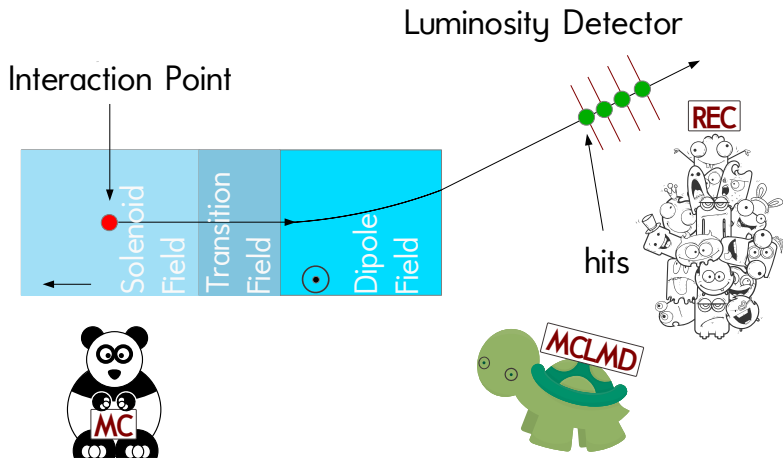
Study of track parameters behavior



Study of track parameters behavior

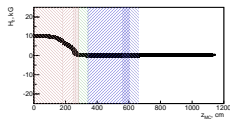
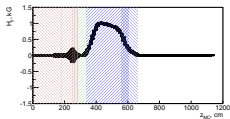
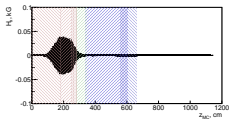
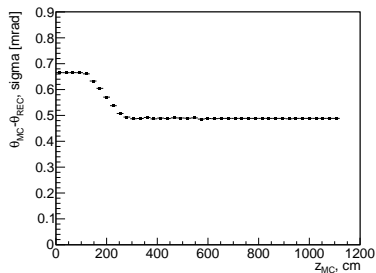
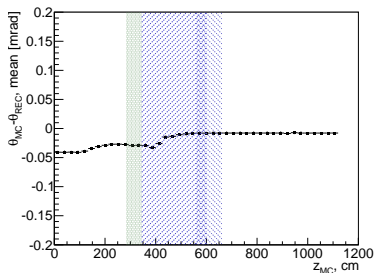


Study of track parameters behavior



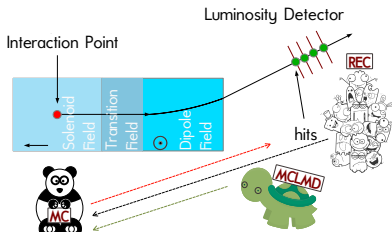
θ resolution behavior vs. z-coordinate (GEANE)

($P_{lab}=1.5$ GeV/c; solenoid, transition, dipole)



$$|\Delta\theta(MC - REC)| \sim 40 \mu\text{rad}, \quad |\sigma_{\theta}(MC - REC)| \sim 680 \mu\text{rad}$$

Back propagation study summary



$$\Delta_{\theta}(MC - REC) \sim -40 \mu\text{rad}$$

$$\Delta_{\theta}(MCLMD - REC) \sim -15 \mu\text{rad}$$

$$\Delta_{\theta}(MCLMD - MC) \sim 20 \mu\text{rad}$$

$$|\sigma_{\theta}(MC - REC)| \sim 680 \mu\text{rad}$$

$$|\sigma_{\theta}(MCLMD - REC)| \sim 400 \mu\text{rad}$$

$$|\sigma_{\theta}(MCLMD - MC)| \sim 460 \mu\text{rad}$$

$$\Rightarrow \Delta_{\theta}(MC - REC) \approx \Delta_{\theta}(MCLMD - REC) - \Delta_{\theta}(MCLMD - MC) = -35 \mu\text{rad}$$

$$\Rightarrow \sigma_{\theta}(MC - REC) \approx \sqrt{\sigma_{\theta}^2(MCLMD - REC) + \sigma_{\theta}^2(MCLMD - MC)} = 610 \mu\text{rad}$$

Contribution from uncertainty of transportation by GEANT4!

Conclusion

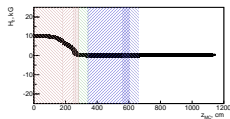
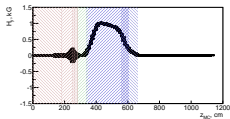
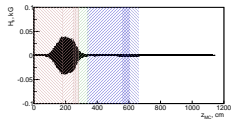
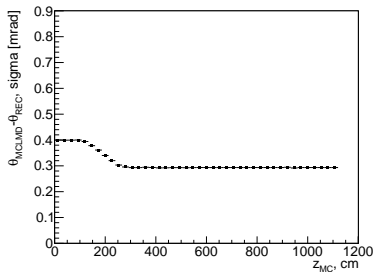
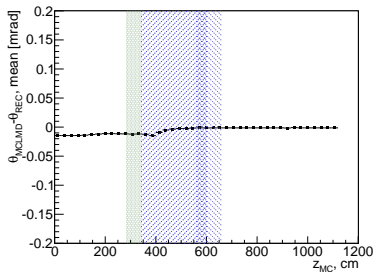
- Track Fit was improved and «broken lines»(Minuit) strongly suggested as a main Track Fit tool
 - ▷ Better parameters resolution
 - ▷ Good parameters errors estimation
- Decreasing of resolution during BP with GEANE
 - ▷ Studied with forward and backward propagated tracks (MC, REC)
 - ▷ Forward/backward with GEANE is consistent
 - ▷ GEANE forward and GEANT4 transport. are different
 - ▷ Comparison backward REC and backward MCLMD shows smaller decreasing of resolution!

Next time

Background studies

θ resolution behavior vs. z-coordinate (GEANE)

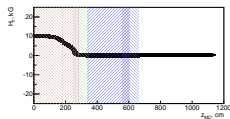
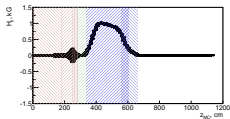
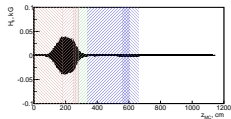
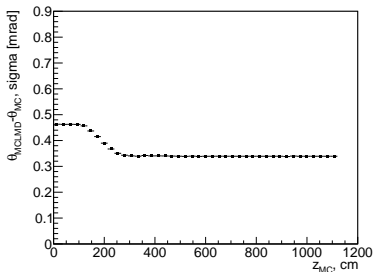
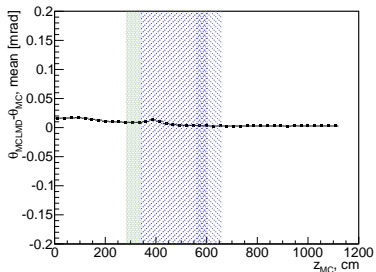
($P_{lab}=1.5$ GeV/c; solenoid, transition, dipole)



$$|\Delta_{\theta}(MCLMD - REC)| \sim 15 \mu\text{rad}, \quad |\sigma_{\theta}(MCLMD - REC)| \sim 400 \mu\text{rad}$$

θ resolution behavior vs. z-coordinate (GEANE)

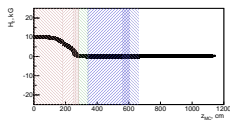
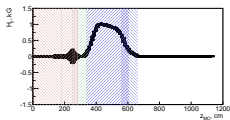
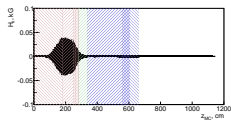
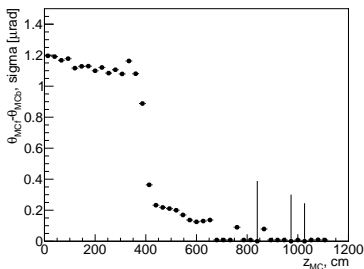
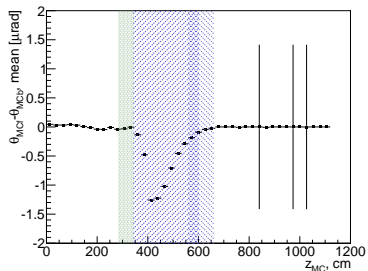
($P_{lab}=1.5$ GeV/c; solenoid, transition, dipole)



$$|\Delta_{\theta}(MCLMD - MC)| \sim 20 \mu\text{rad}, \quad |\sigma_{\theta}(MCLMD - MC)| \sim 460 \mu\text{rad}$$

θ resolution behavior vs. z-coordinate (GEANE)

($P_{lab}=1.5$ GeV/c; solenoid, transition, dipole)



$$|\Delta\theta(MCf - MCb)| \sim 0 \mu\text{rad}, \quad |\sigma_\theta(MCf - MCb)| \sim 1.2 \mu\text{rad}$$