Extracting Luminosity

Topics:

- Overview cross-section and goals
- Relation t <-> θ (fitting observables)
- Convolution of detector resolution
- Results & Outlook

Method

1) $L = N|_{\text{3-8mrad}} / \sigma|_{\text{3-8mrad}}$

$N|_{\text{3-8mrad}}$ measured (counted)
but: $\sigma|_{\text{3-8mrad}}$ exact enough known (model-dep.)?

2) $dN/dt = L * d\sigma/dt$:

dN/dt ($dN/d\theta$) measured

fit ($L *$) $d\sigma/dt$ to data

Problems:
- cross section
- t-range small
- detector resolution

Elastic Cross Section

At low momentum transfer the cross section is usually parameterized as

$$\frac{d\sigma}{dt} = \frac{\pi}{k^2}\left|f_C e^{i\delta} + f_H\right|^2 = \frac{d\sigma_C}{dt} + \frac{d\sigma_{int}}{dt} + \frac{d\sigma_H}{dt},$$

where

$$\frac{d\sigma_C}{dt} = \frac{4\pi\alpha_{EM}^2 G^4(t)}{\beta^2 t^2};$$

$$\frac{d\sigma_{int}}{dt} = \frac{\alpha_{EM}\sigma_{Total}}{\beta|t|} G^2(t) e^{\frac{1}{2}Bt}(\rho\cos\delta + \sin\delta)$$

$$\frac{d\sigma_H}{dt} = \frac{\sigma_{Total}^2(1+\rho^2)}{16\pi}e^{Bt}.$$

(1)

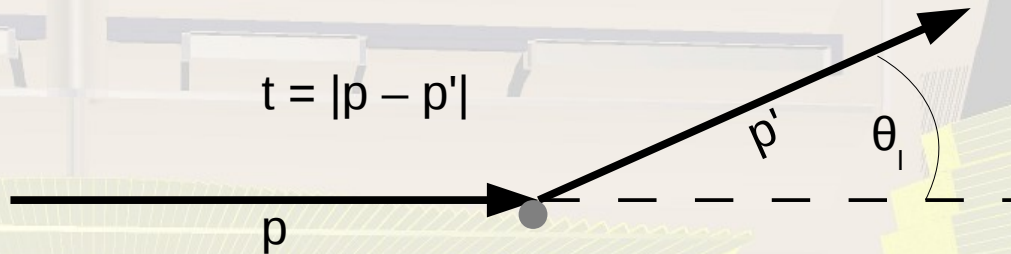Here, $d\sigma_C/dt$ and $d\sigma_H/dt$ are the Coulomb and hadronic parts of the cross section, re-

Hadronic part with model-parameter: **ρ, B, σ**$_{Total}$
　　=> Influence to luminosity measurement?

Coulomb part divergent to t=θ=0
　　=> Cant be convoluted analytically

Relation t & θ

t = |p − p'|

p

p'

θ_l

Measurement θ_l-distribution, but cross section t dependent
=> either transform data with t(θ_l) or transform cs.

$$t = 2\,P_{cm}^2\,(1 - \cos\theta_{cm}), \quad \theta_{cm} = 2\,atan\,(\gamma\tan\theta_l)$$
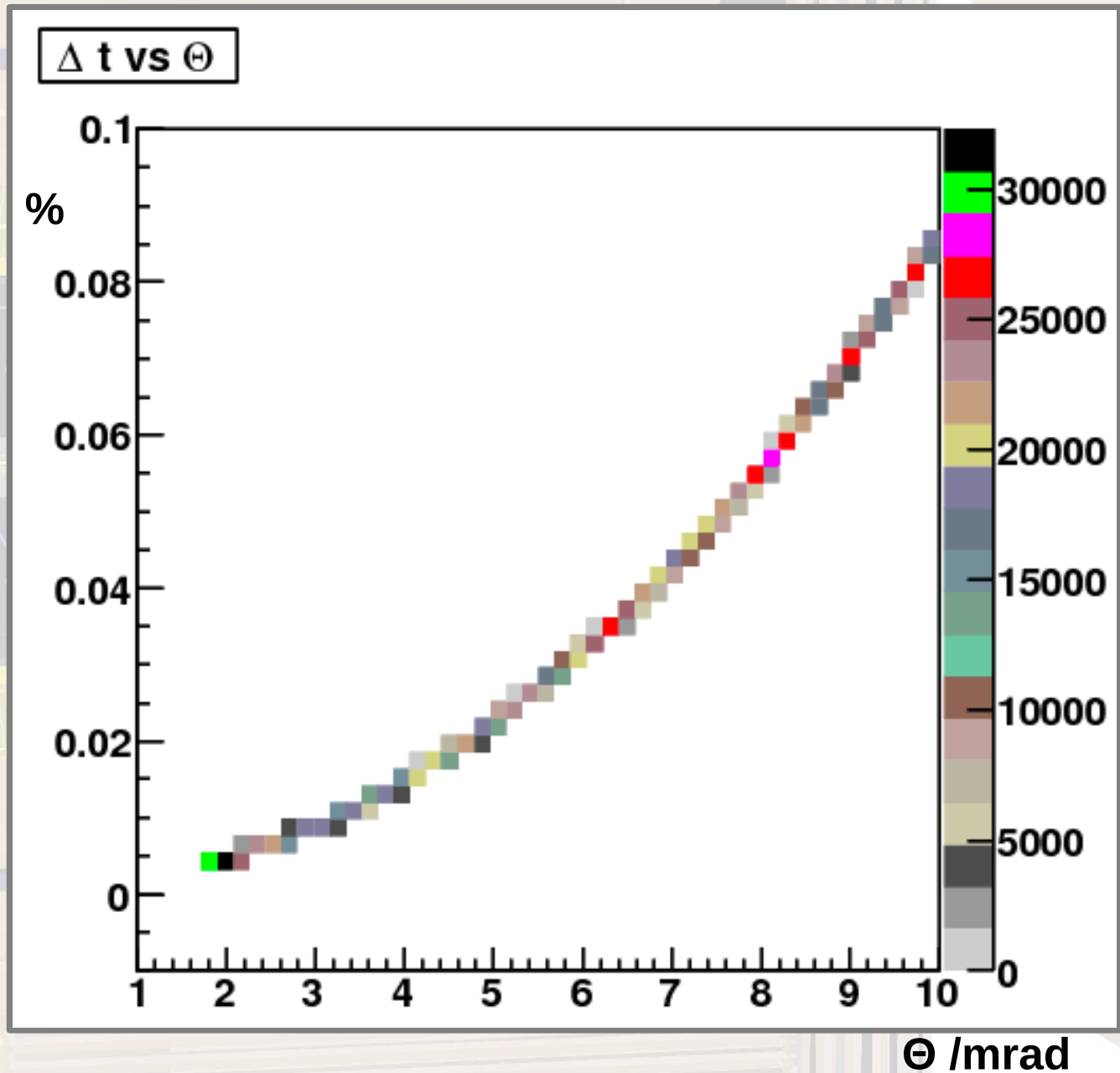
$$\frac{d\sigma}{d\theta_l} = \frac{d\sigma}{dt}\,\frac{dt}{d\theta_l}$$

$$\frac{dt}{d\theta_l} = \frac{8\,\gamma^2\,P_{cm}^2\,sec^2\theta_l\,\tan\theta_l}{(1+\gamma^2\tan^2\theta_l)^2}, \quad sec\,\theta_l = \frac{2}{\cos(2\theta_l)+1}$$

Detector resolution better known in θ_l

t from DPMGen

$$\Delta t = t(\Theta) - (p_{in} - p_{out})^2$$

Detector resolution

Toy-data:
smear θ from each DPMGen event with gaussian distribution
calculate t out of smeared θ values
create histograms for t, $\log_{10} t$ and θ

Analysis:
use RooFit for convolution of cs with gauss (FFT & caching)
fit convoluted function to smeared toy-data with:
   Parameters (ρ, B, σ_{Total}) fixed to DPM values

   Parameters fixed 5% off DPM values
   Parameters 5% off but free
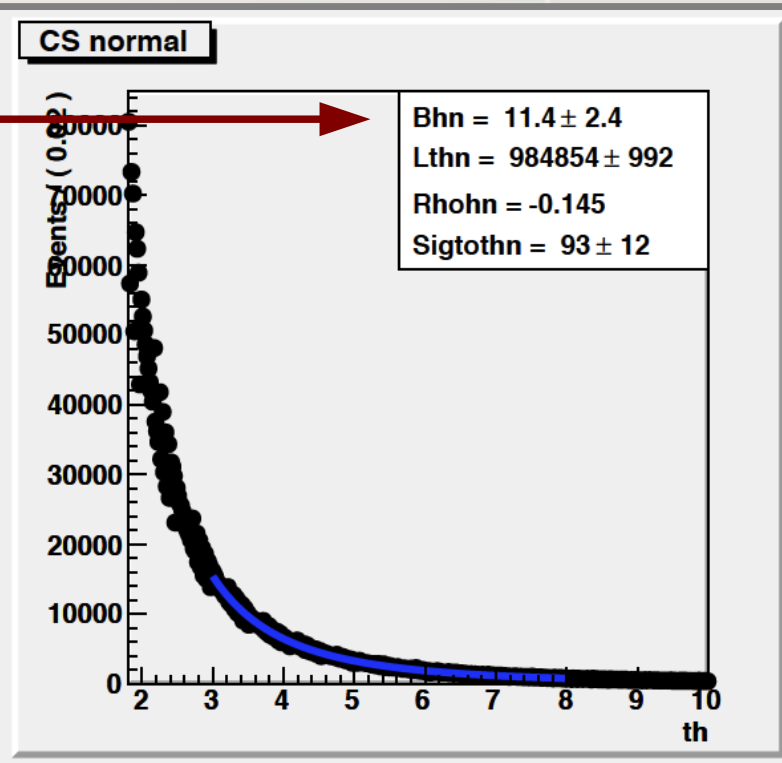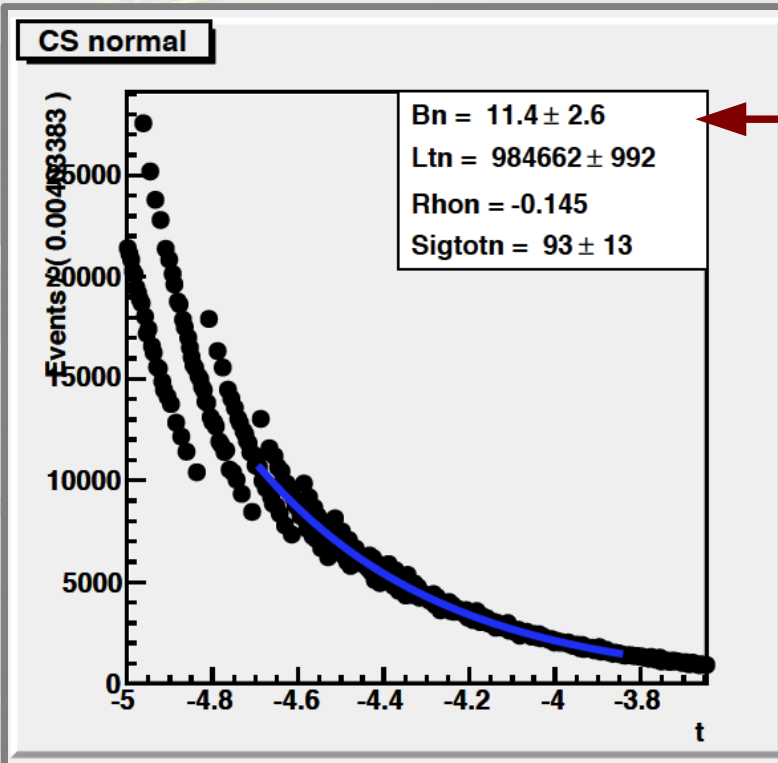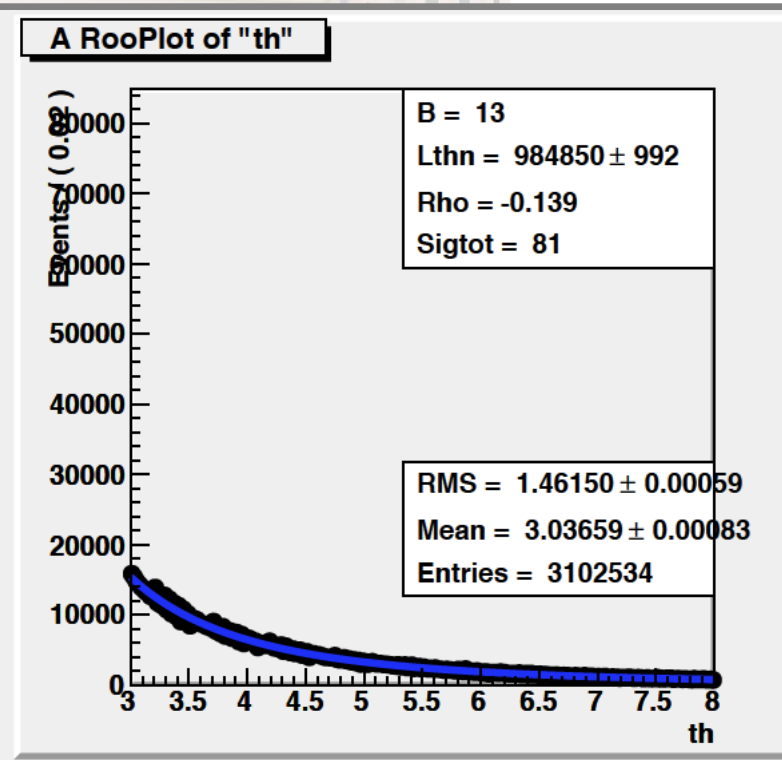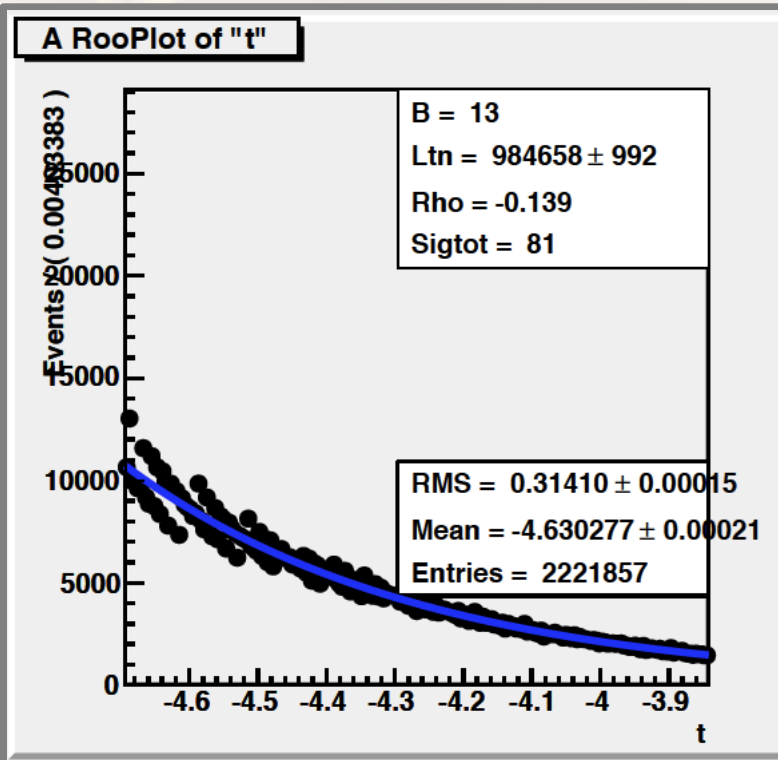   Parameters fixed but detector resolution 33% to small

Smearing:
0, 0.5 & 1.5 mrad @ 1.5 GeV/c
0, 0.3 & 0.9 mrad @ 6 GeV/c
0, 0.3 & 0.9 mrad @ 15 GeV/c

Fixed DPM Parameter:

A RooPlot of "t"

B = 13
Ltn = 984658 ± 992
Rho = -0.139
Sigtot = 81

RMS = 0.31410 ± 0.00015
Mean = -4.630277 ± 0.00021
Entries = 2221857

A RooPlot of "th"

B = 13
Lthn = 984850 ± 992
Rho = -0.139
Sigtot = 81

RMS = 1.46150 ± 0.00059
Mean = 3.03659 ± 0.00083
Entries = 3102534

1.5 GeV/c

Free Parameter:

CS normal

Bn = 11.4 ± 2.6
Ltn = 984662 ± 992
Rhon = -0.145
Sigtotn = 93 ± 13

CS normal

Bhn = 11.4 ± 2.4
Lthn = 984854 ± 992
Rhohn = -0.145
Sigtothn = 93 ± 12

07.06.2011

7

Fixed DPM Parameter:

1.5 GeV/c

Free Parameter:

Top-left panel (CS (x) gauss convolution smeared):
- B = 13
- Lts = 1089369 ± 1044
- Rho = -0.139
- Sigtot = 81
- mg = 0.0
- sg = 0.083

Top-right panel (CS (x) gauss convolution smeared):
- B = 13
- Lths = 1090114 ± 1044
- Rho = -0.139
- Sigtot = 81
- mgth = 0.0
- sgth = 0.50

Bottom-left panel (CS (x) gauss convolution smeared):
- Bs = 11.4 ± 1.6
- Lts = 862458 ± 2402
- Rhos = -0.145
- Sigtots = 81.34 ± 0.48
- mg = 0.0
- sg = 0.083

Bottom-right panel (CS (x) gauss convolution smeared):
- Bhs = 14.114 ± 0.056
- Lths = 1090115 ± 1044
- Rhohs = -0.145
- Sigtoths = 76.7774 ± 0.0089
- mgth = 0.0
- sgth = 0.50
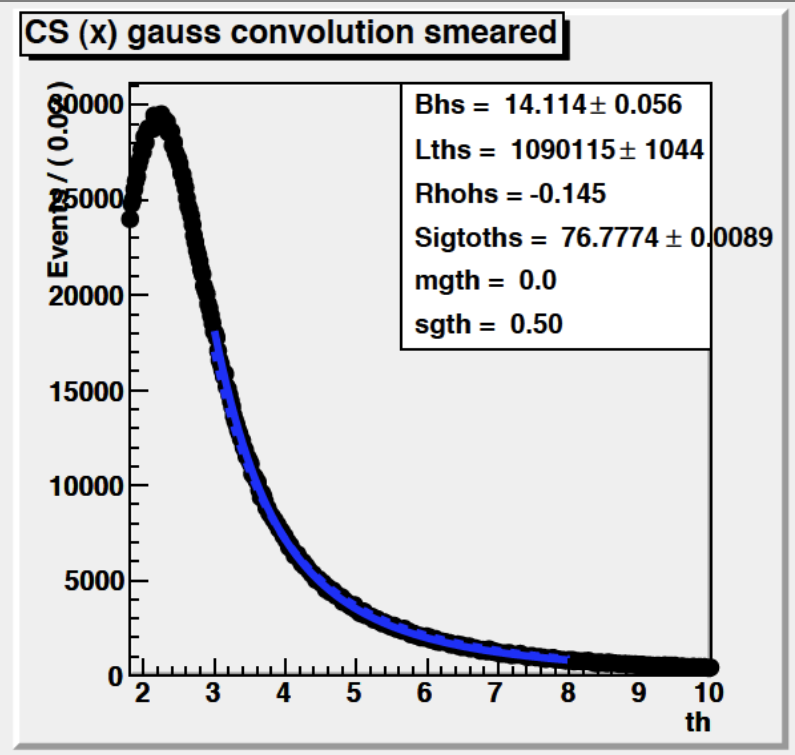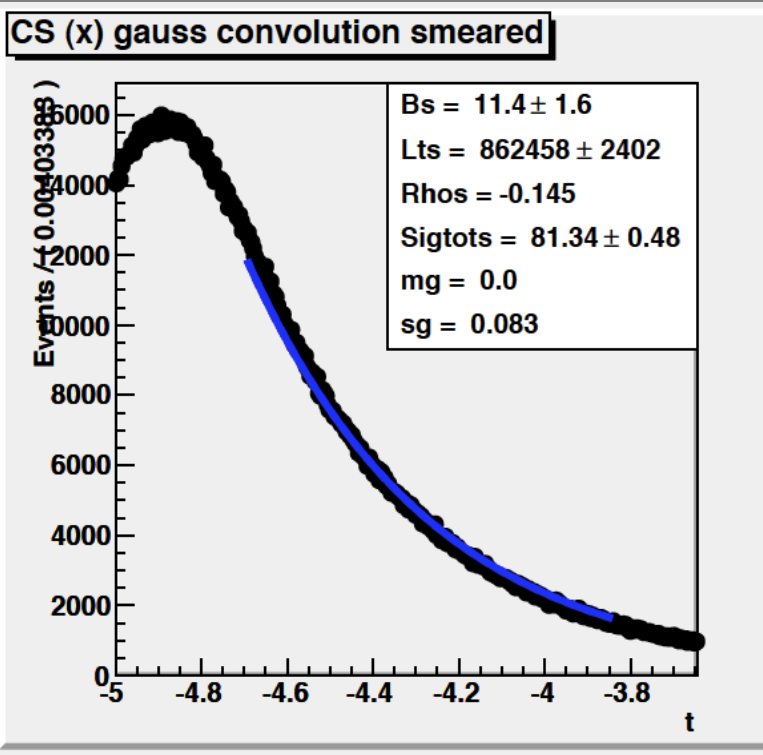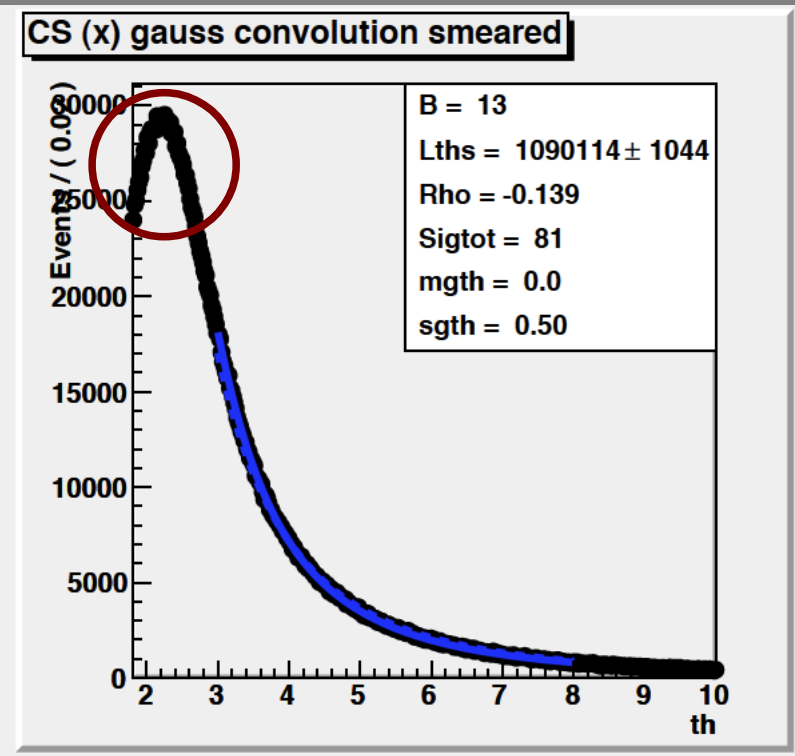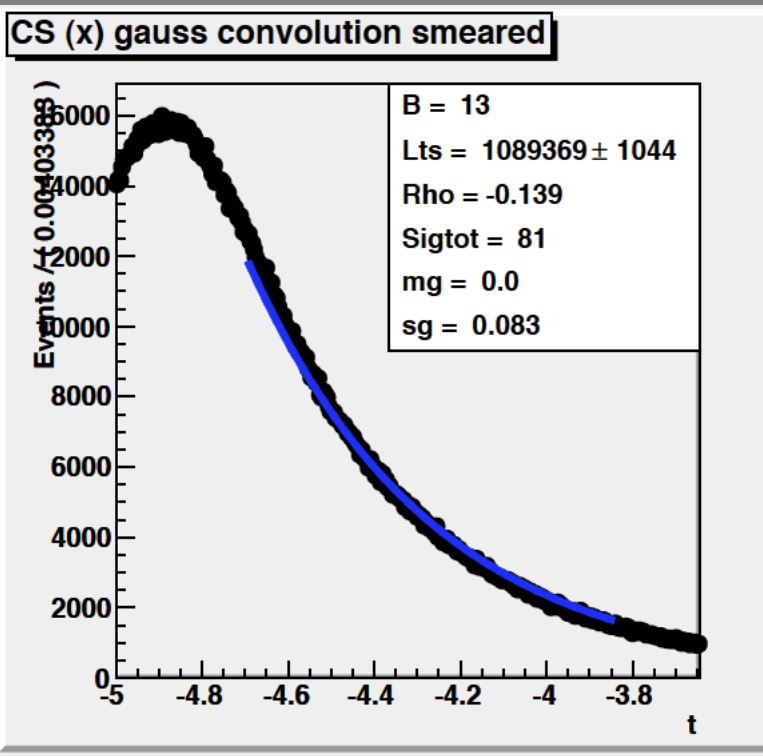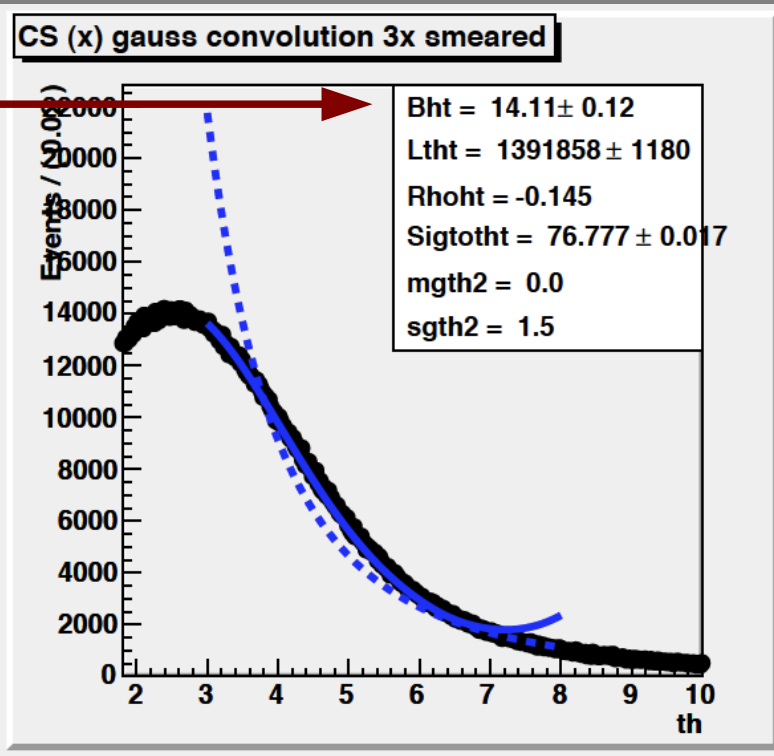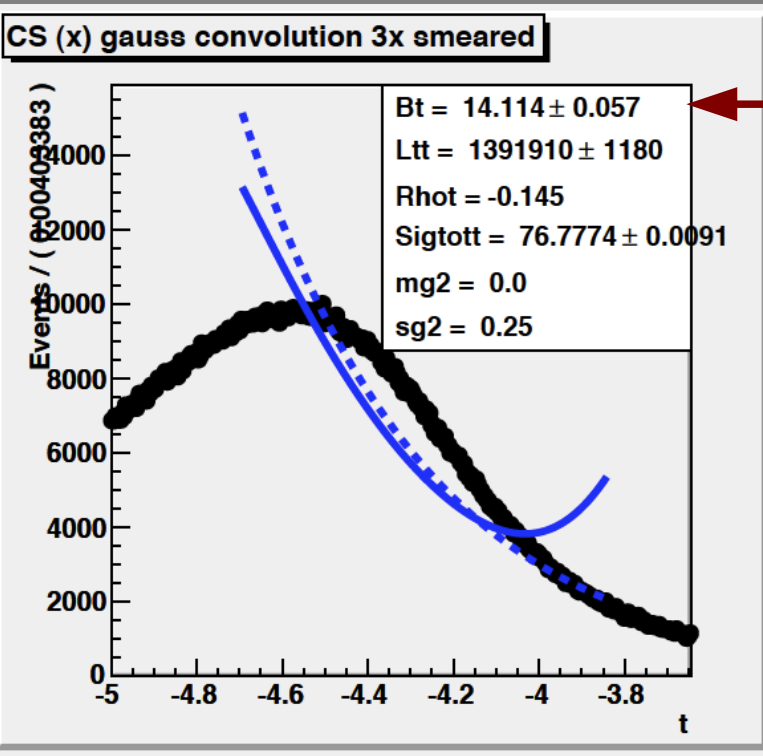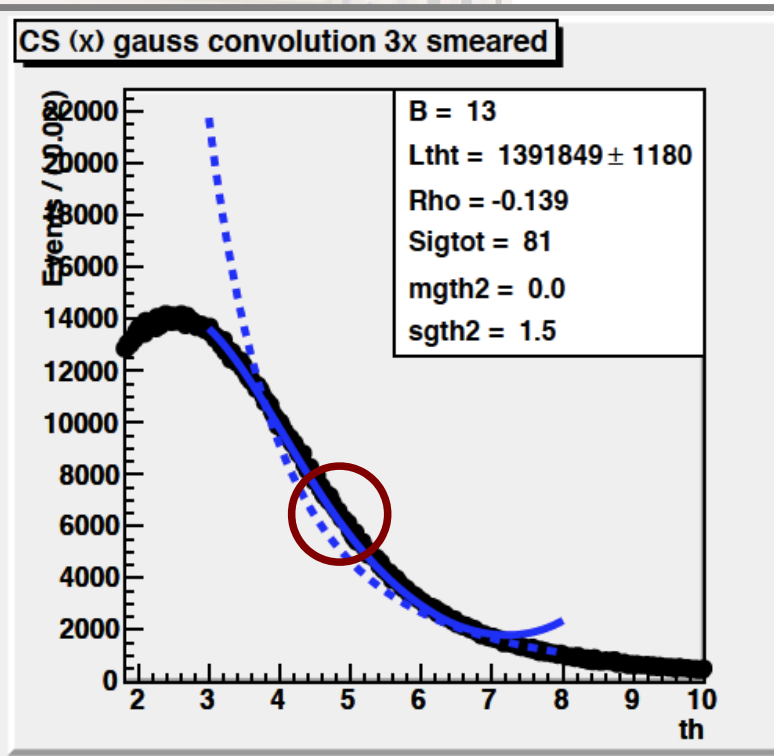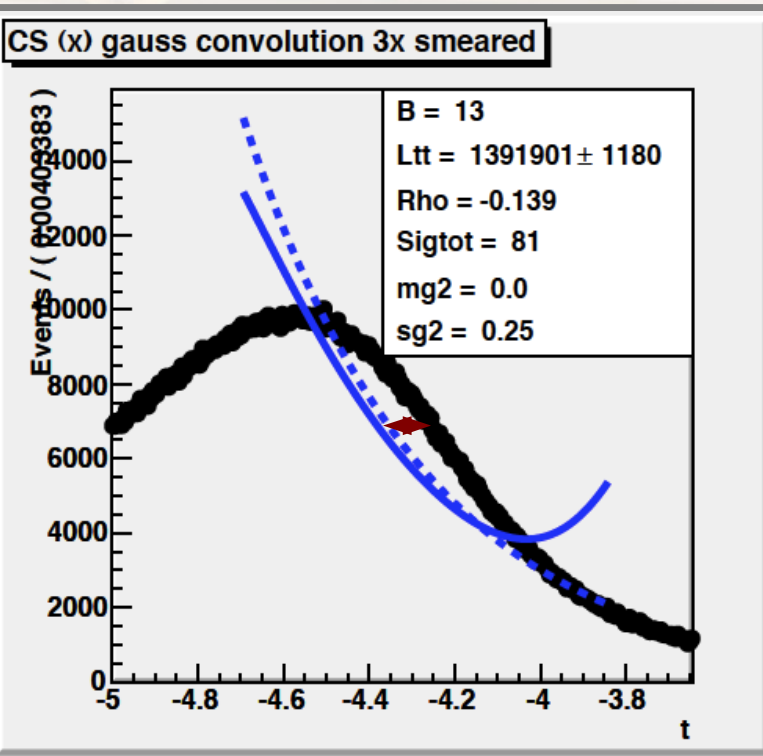
Fixed DPM Parameter:

1.5 GeV/c

Free Parameter:

07.06.2011

9

Fixed DPM
Parameter:

1.5 GeV/c

Wrong
Resolution:

CS (x) gauss convolution 3x smeared

B = 13
Ltt = 1391901 ± 1180
Rho = -0.139
Sigtot = 81
mg2 = 0.0
sg2 = 0.25

CS (x) gauss convolution 3x smeared

B = 13
Ltht = 1391849 ± 1180
Rho = -0.139
Sigtot = 81
mgth2 = 0.0
sgth2 = 1.5

CS (x) gauss convolution 3x smeared

B = 13
Ltt = 1391901 ± 1180
Rho = -0.145
Sigtot = 85
mg2 = 0.0
sg2 = 0.16

CS (x) gauss convolution 3x smeared

B = 13
Ltht = 1391849 ± 1180
Rho = -0.145
Sigtot = 85
mgth2 = 0.0
sgth2 = 1.0
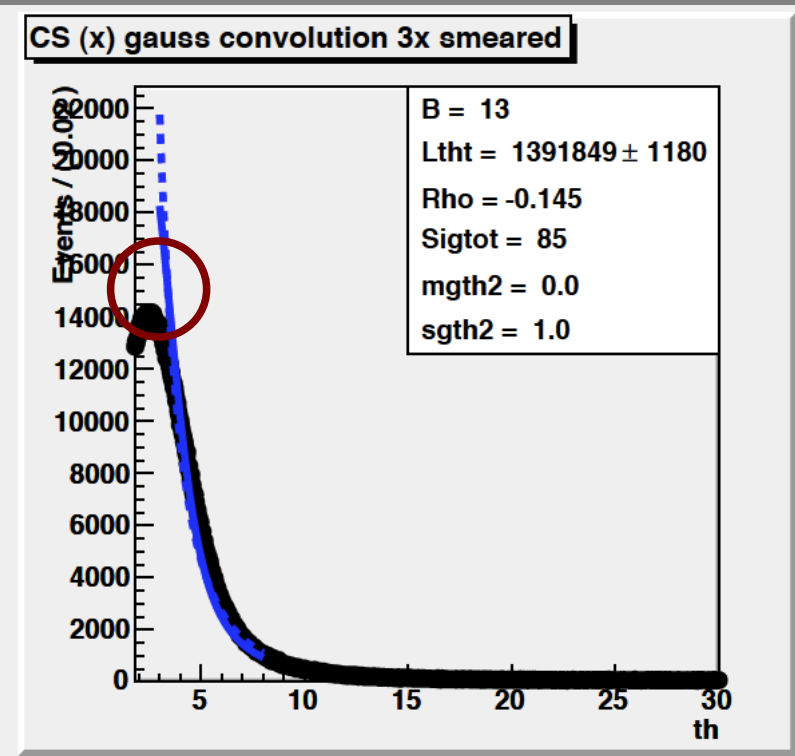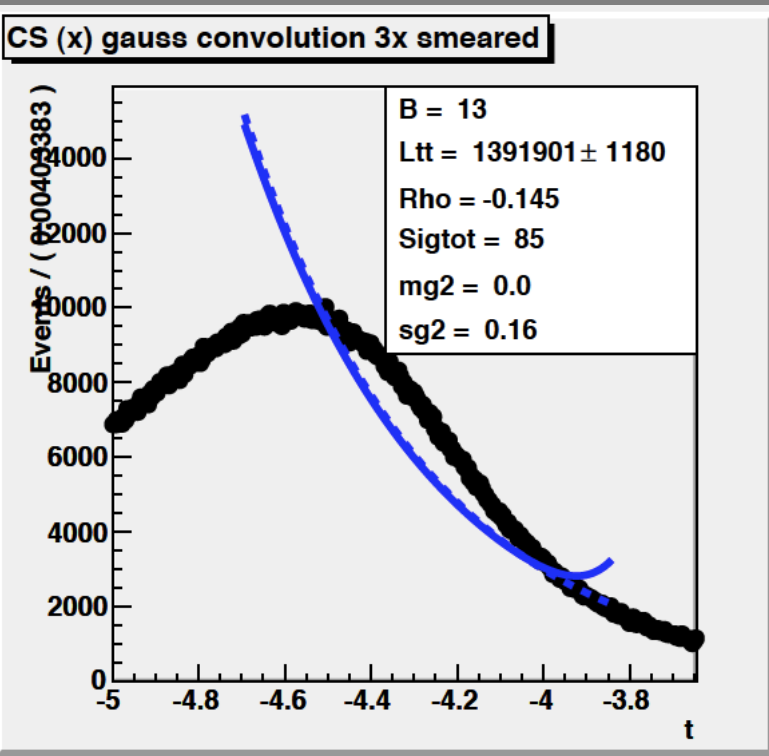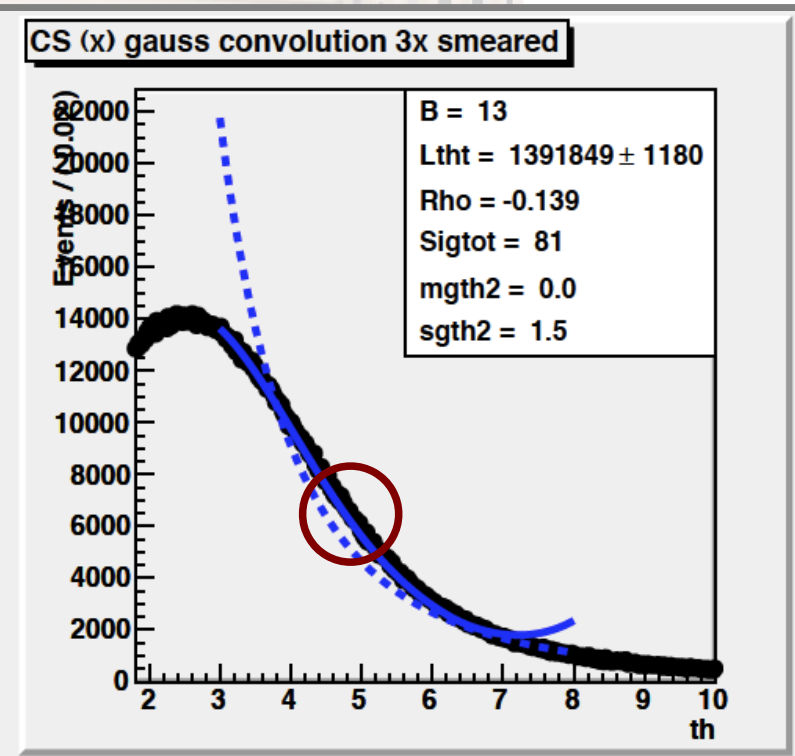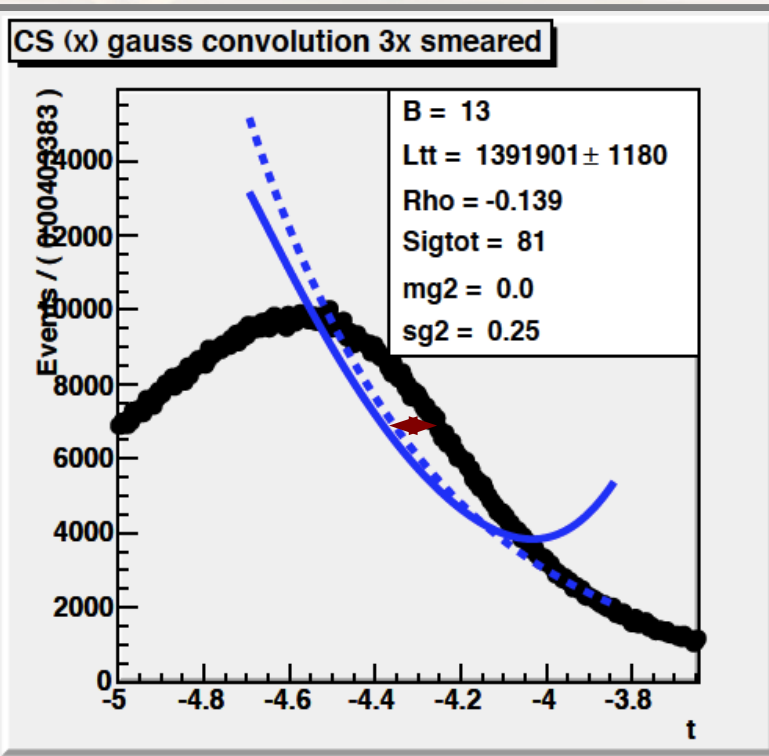
1.5 GeV/c Extend Par.

t-Θ=190

	Fixed par	Wrong par	Free par	Wrong res
Unsm. t	9.8466e+05 +/- 9.92e+02	9.8466e+05 +/- 9.92e+02	9.8466e+05 +/- 9.92e+02	9.8466e+05 +/- 9.92e+02
Unsm. Θ	9.8485e+05 +/- 9.92e+02	9.8485e+05 +/- 9.92e+02	9.8485e+05 +/- 9.92e+02	9.8485e+05 +/- 9.92e+02
Smeared t	1.0894e+06 +/- 1.04e+03	1.0894e+06 +/- 1.04e+03	1.0894e+06 +/- 1.04e+03	1.0894e+06 +/- 1.04e+03
Sm. Θ	1.0901e+06 +/- 1.04e+03	1.0901e+06 +/- 1.04e+03	1.0901e+06 +/- 1.04e+03	1.0901e+06 +/- 1.04e+03
3x sm. t	1.3919e+06 +/- 1.18e+03	1.3919e+06 +/- 1.18e+03	1.3919e+06 +/- 1.18e+03	1.3919e+06 +/- 1.18e+03
3x sm. Θ	1.3918e+06 +/- 1.18e+03	1.3918e+06 +/- 1.18e+03	1.3919e+06 +/- 1.18e+03	1.3918e+06 +/- 1.18e+03

100 %	...
+10.5 %	...
+43.1 %	...

6. GeV/c

	Fixed par
Unsm. Θ	2.6105e+05 +/- 5.11e+02
Sm. Θ	2.6701e+05 +/- 5.17e+02
3x sm. Θ	3.0848e+05 +/- 5.55e+02

100 %
+2.28 %
+18.2 %

15. GeV/c

	Fixed par
Unsm. Θ	6.7151e+05 +/- 8.19e+02
Sm. Θ	6.7326e+05 +/- 8.21e+02
3x sm. Θ	6.8126e+05 +/- 8.25e+02

100 %
+0.25 %
+1.45 %

1.5 GeV/c EDM

	Fixed par	Wrong par	Free par	Wrong res
Unsm. t	3.47498e-08	3.47498e-08	1.69791e-05	
Unsm. Θ	1.51405e-08	1.51282e-08	0.000133531	
Smeared t	1.71556e-07	1.71525e-07	400444	1.72158e-07
Sm. Θ	2.29246e-07	2.35703e-07	0.00177246	2.39123e-07
3x sm. t	4.96046e-05	4.96047e-05	0.00173371	4.96833e-05
3x sm. Θ	5.04455e-05	5.04577e-05	0.000900205	5.05491e-05

100%	-0.1%	*e04	
*15	+3%	*e04	+4%
*3300	+-0%	*e02	+0.2%

Summary & Outlook

Summary

- RooFit stable with folded resolution

- Fitting in t, log(t) & Θ successful with same results

- Estimate of counted events due to smearing

Outlook

- Lumi extraction in RooFit

- DPM-Gen resolution / effects

- Estimate feed in & feed out

- Double gauss smearing

- Θ- / t-dependence of smearing

- Combine inelastic events