Small-angle elastic pp scattering track reconstruction

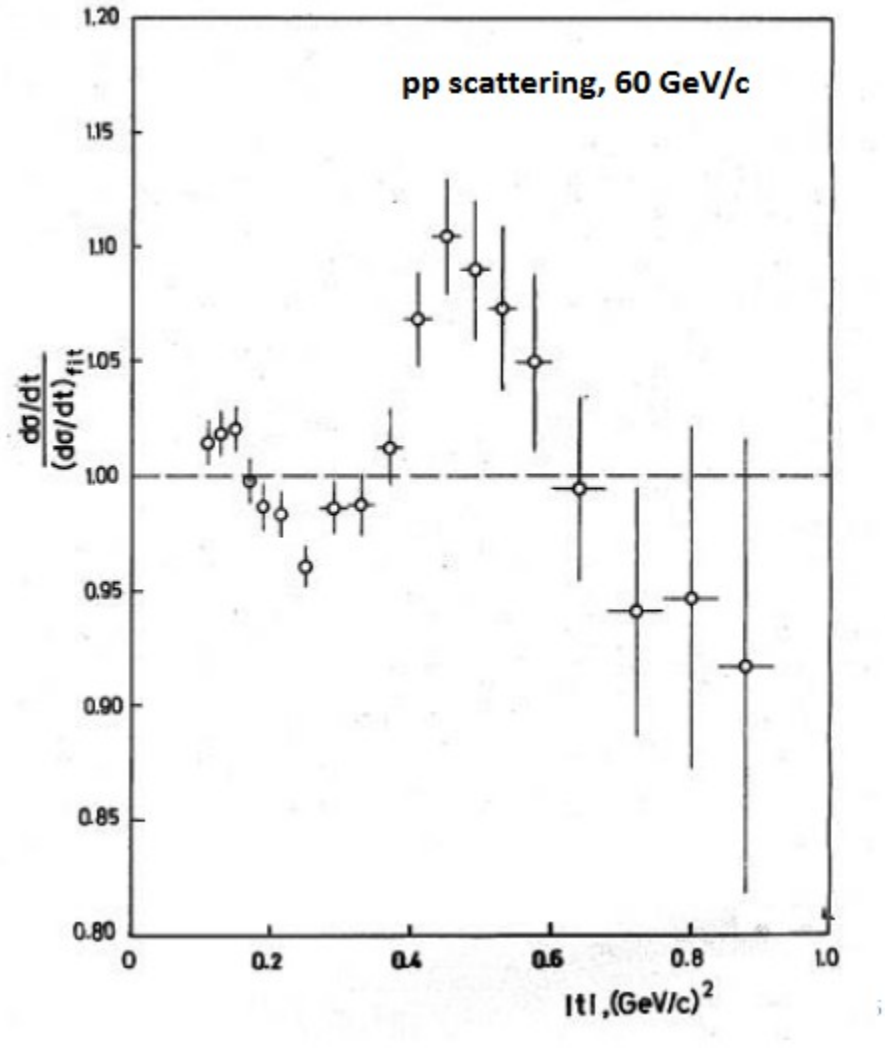
A. Terkulov

Lebedev Physical Institute, Moscow

slide from A.L'vov presentation:

https://indico.jinr.ru/event/1373/

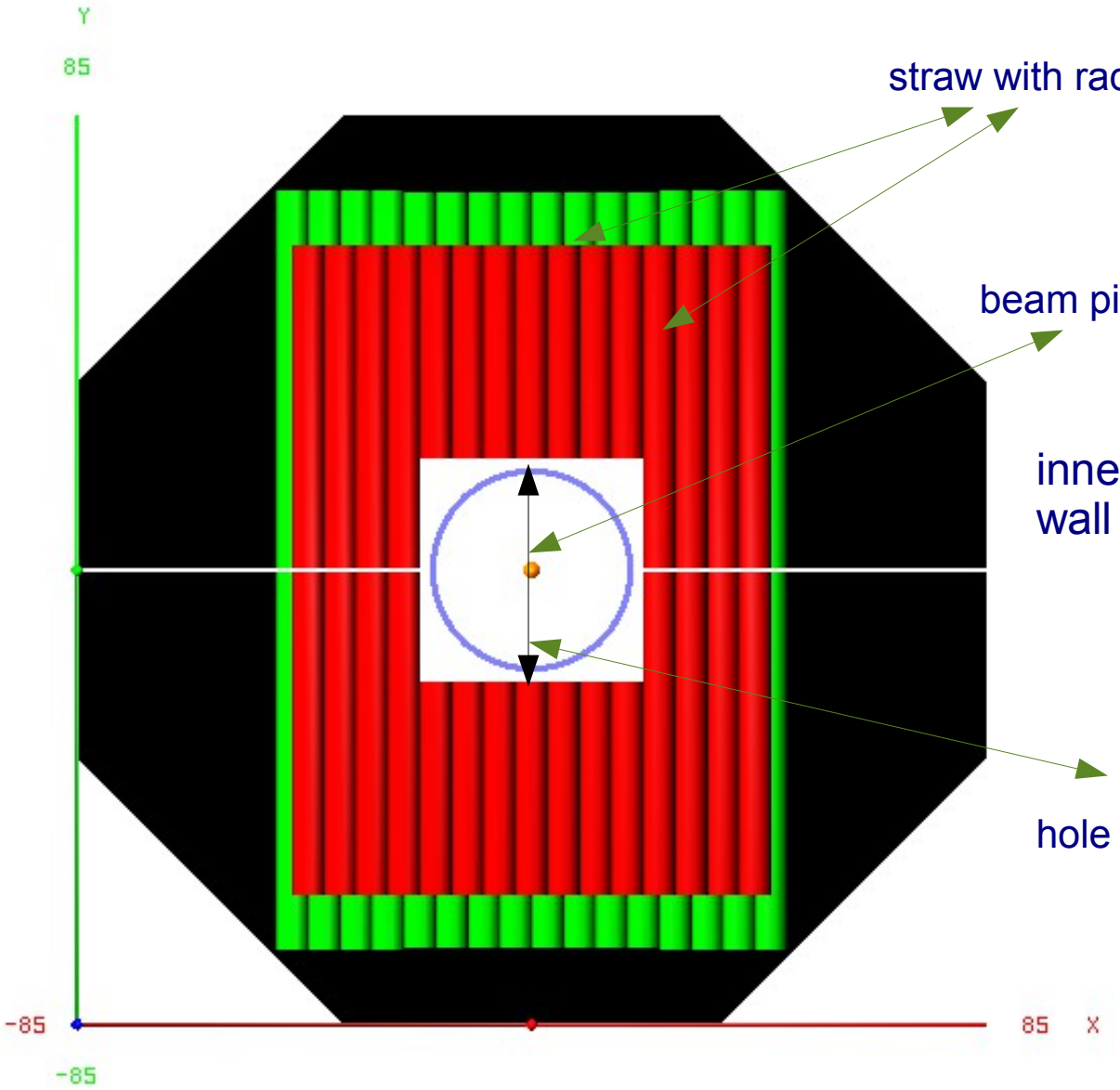
pp scattering (Protvino)



Antipov et al. preprint 1976.

A. L'vov. 4th SPD Physics and MC meeting, JINR, 17.06.2020

endcap planes with straws



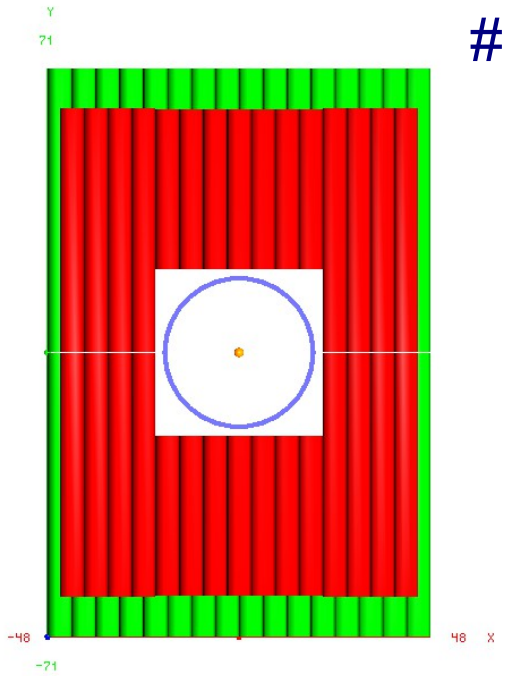
straw with radius 1cm

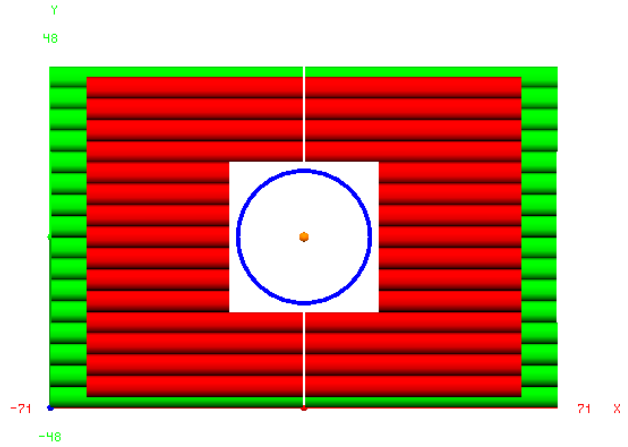
beam pipe radius 3.2cm

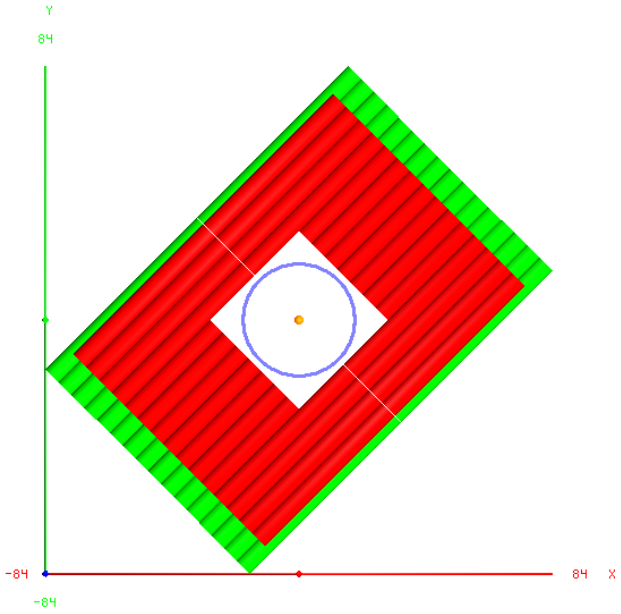
beam pipe:
inner part material – beryllium
wall thickness – 1mm

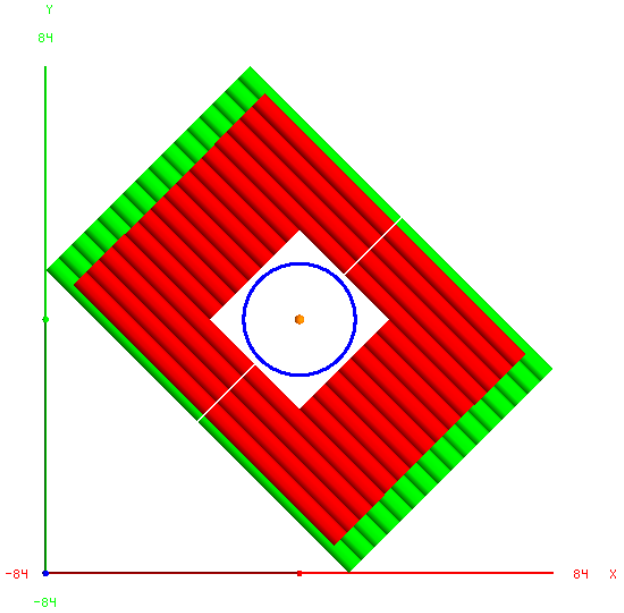
hole 3.5cm

of planes in endcap tracker – 52 in each direction









Simulation:

protons with E=13.5Gev in opposite directions

$t = -0.15\text{Gev}^2\ -0.2\text{Gev}^2\ -0.3\text{Gev}^2\ -0.4\text{Gev}^2\ -0.5\text{Gev}^2$

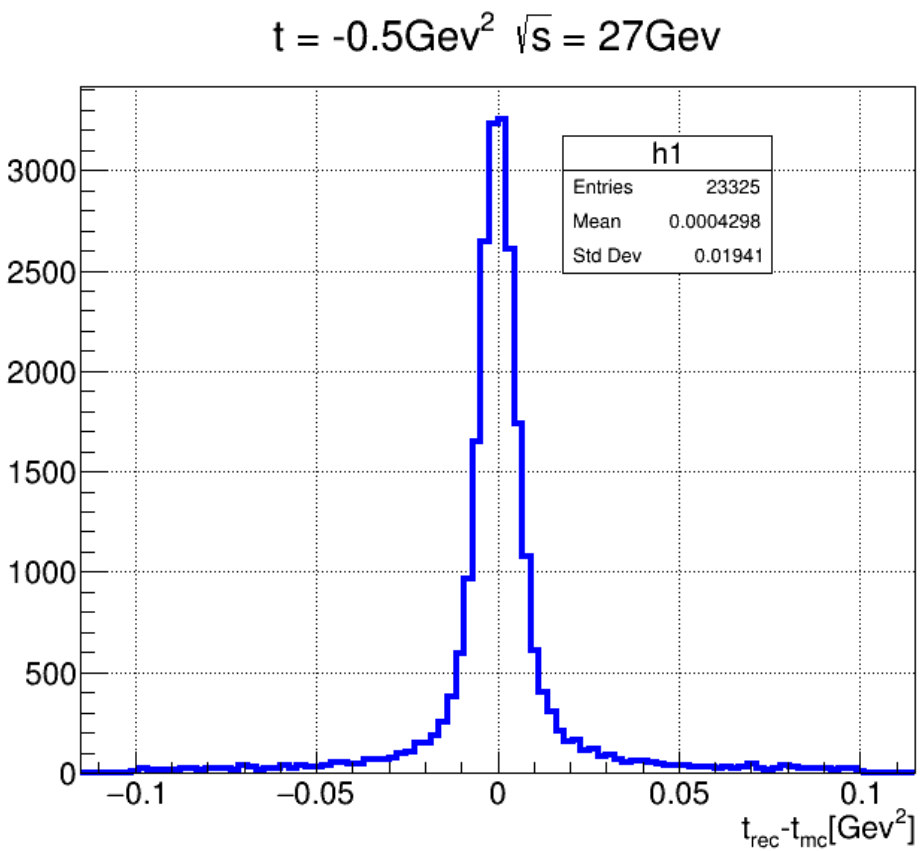
azimuthal φ: uniform distributed between 0 and 2π

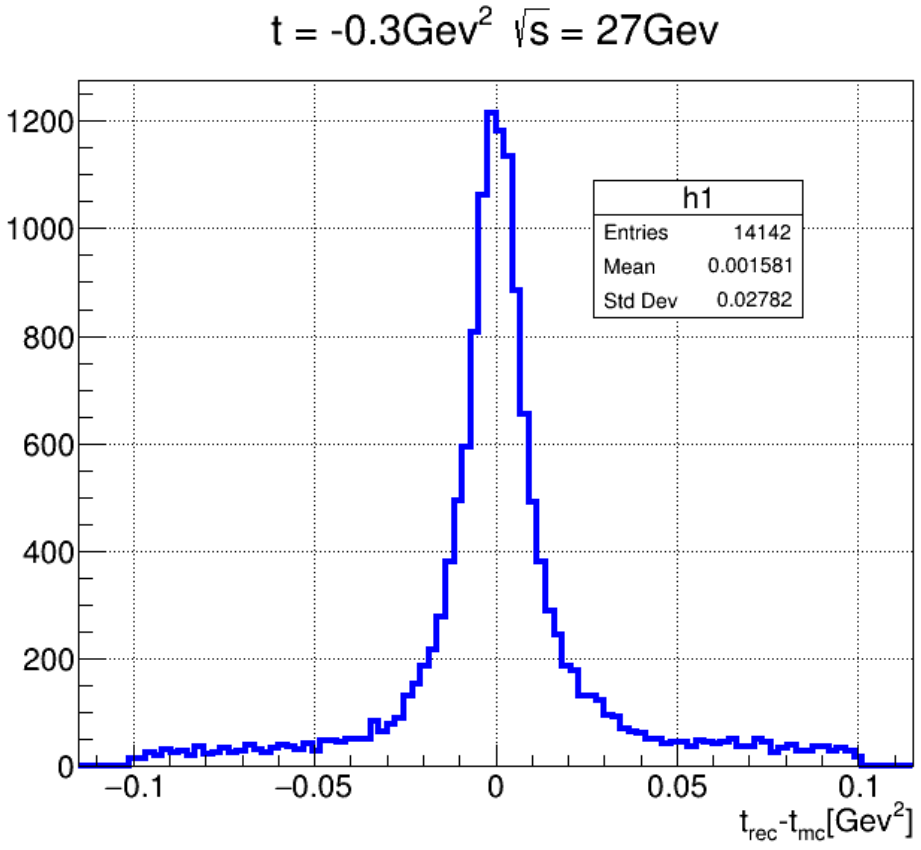
polar angle θ: according with corresponding t

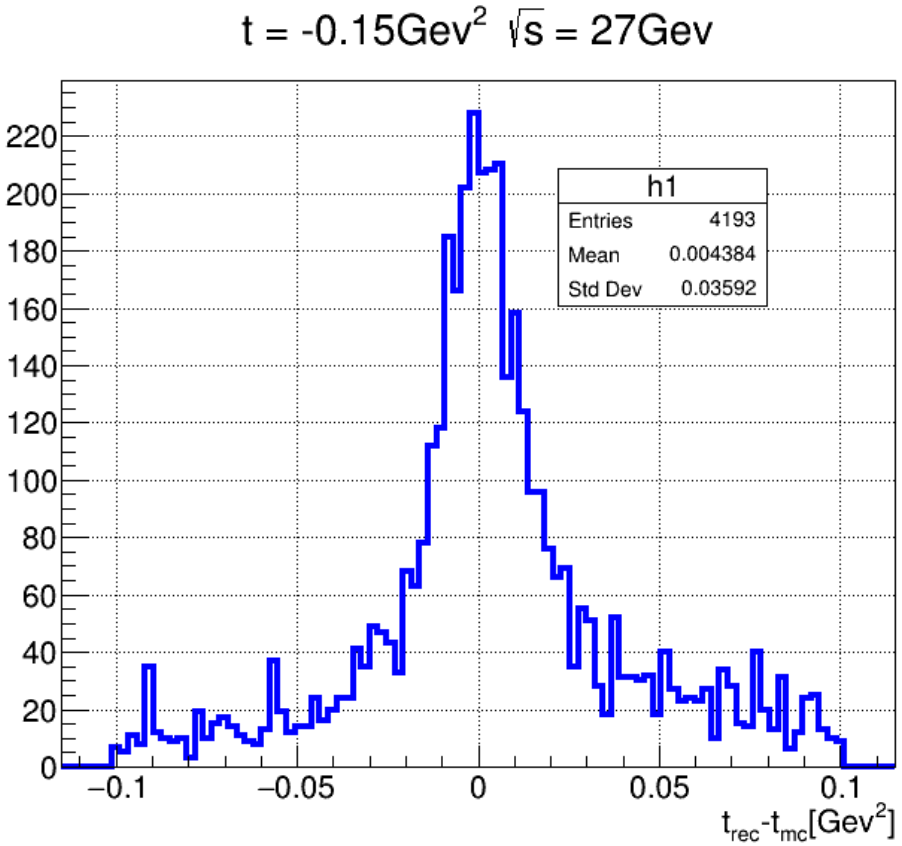
Reconstruction:

from GenFit2 take reconstructed polar and azimuthal angles only

energy of the scattered proton set equal
initial energy of the proton


t = -0.5Gev² √s = 27Gev
h1
Entries 23325
Mean 0.0004298
Std Dev 0.01941
3000
2500
2000
1500
1000
500
0
−0.1
−0.05
0
0.05
0.1
t_rec-t_mc[Gev²]

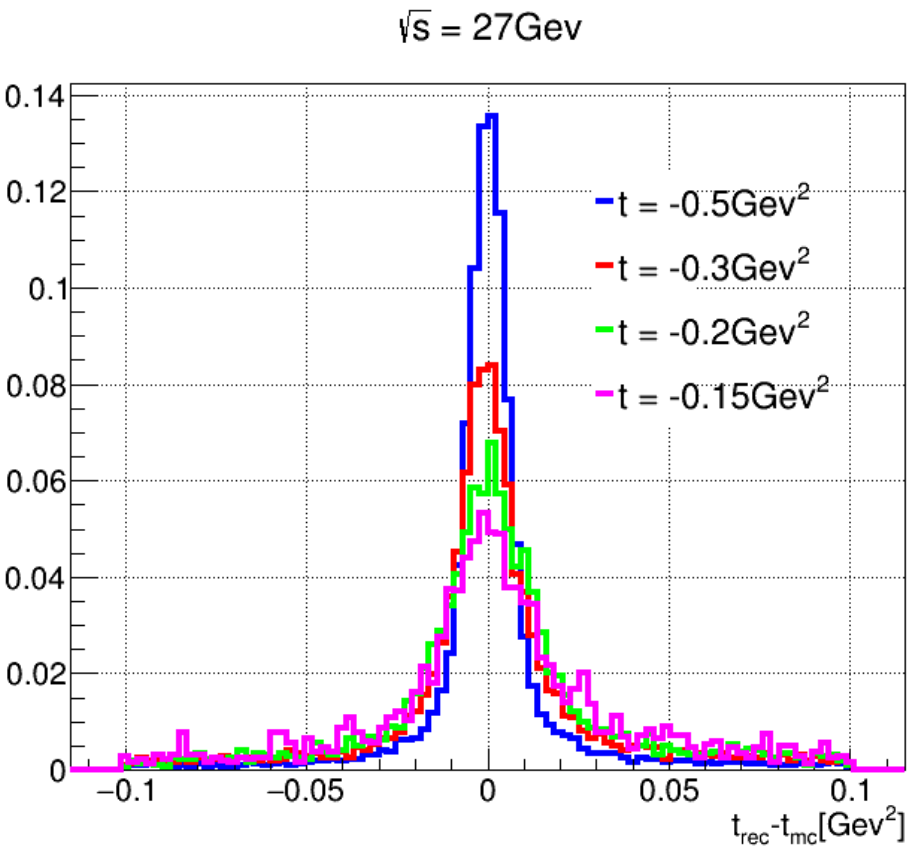

t = -0.3Gev² √s = 27Gev
h1
Entries 14142
Mean 0.001581
Std Dev 0.02782
1200
1000
800
600
400
200
0
−0.1
−0.05
0
0.05
0.1
t_rec-t_mc[Gev²]



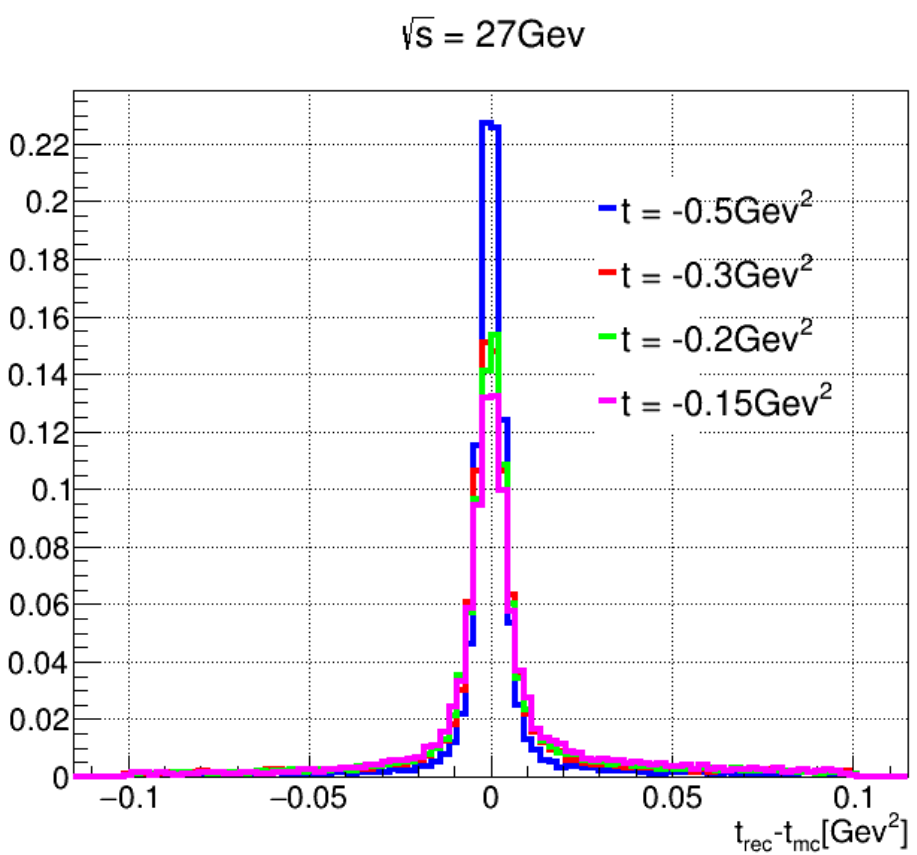
particle path in beam pipe wall

t	θ	path
-0.1Gev^2	1.35^0	~4.3cm
-0.15Gev^2	1.65^0	~3.5cm
-0.2Gev^2	1.9^0	~3cm
-0.5Gev^2	3^0	~1.9cm

with beam pipe

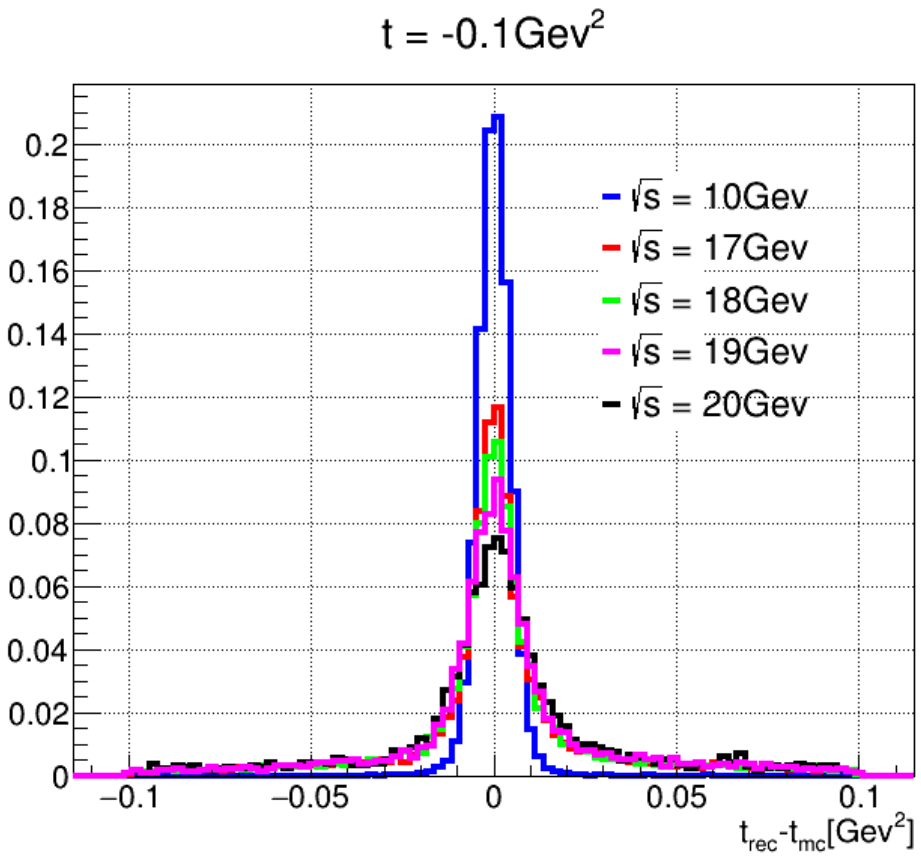


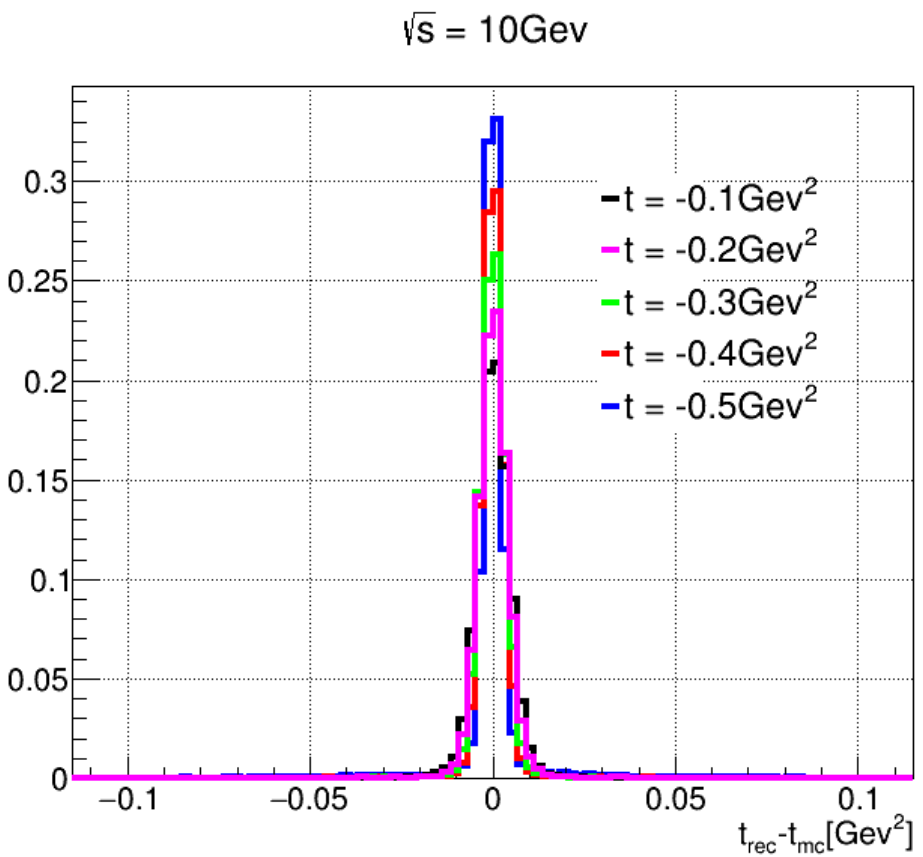
without beam pipe



one possibility – change total energy

less energy → larger polar angle → less path in beam pipe wall





Summary

1. For small-angle elastic pp scattering with t around -0.1Gev^2 it needs change initial energy for incoming particles to smaller value

Backup

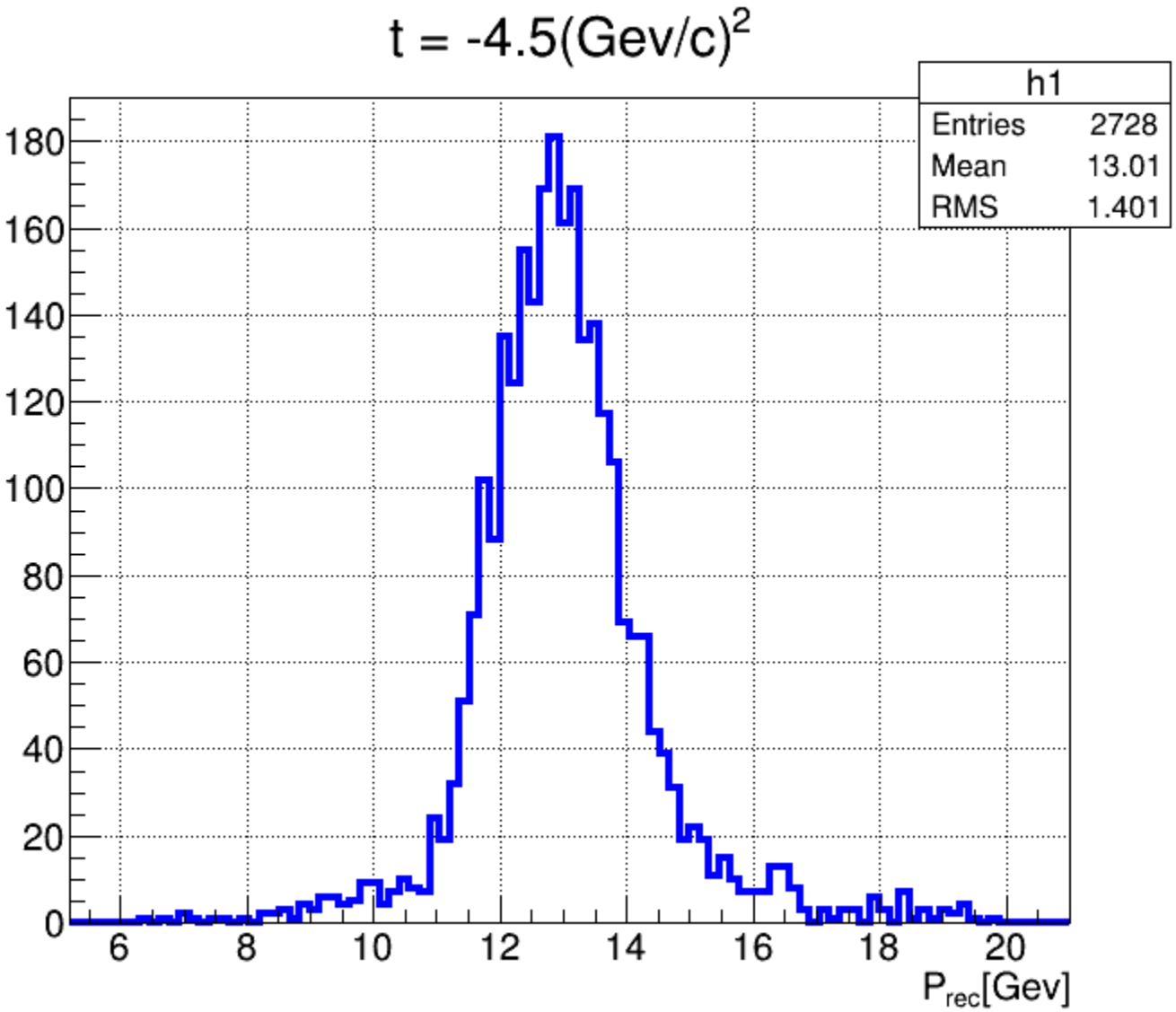
of planes in endcap tracker – 52 in each direction

$t = -0.1(Gev/c)^2$ → polar angle 1.35^0

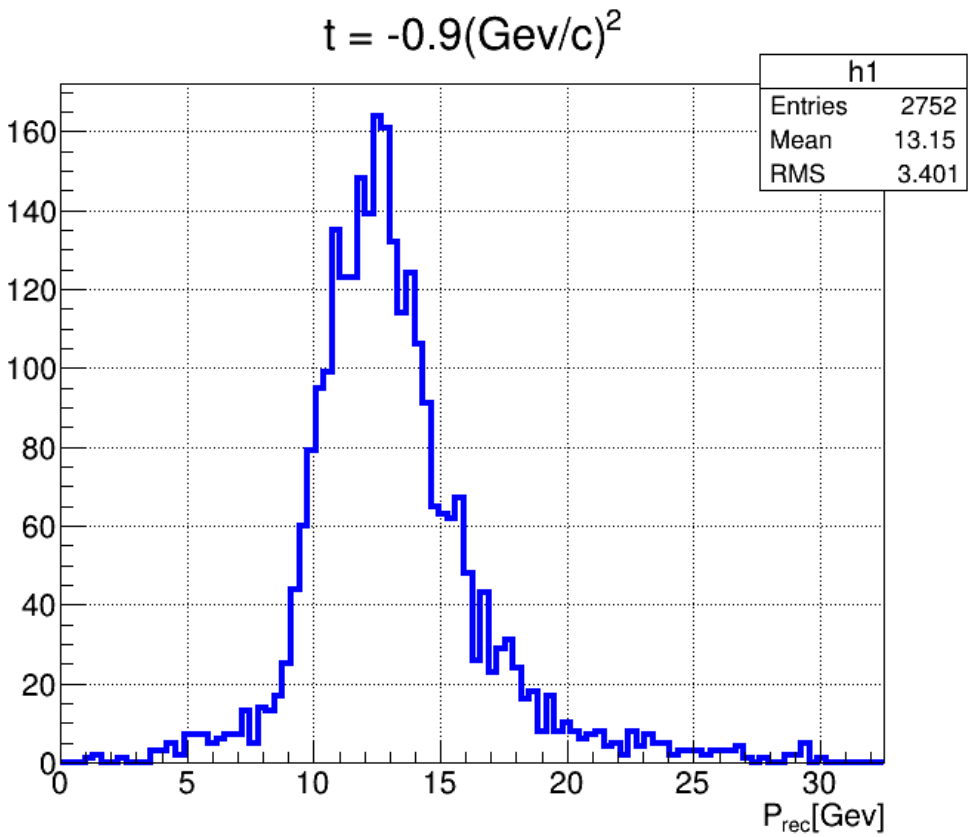
$t = -0.5(Gev/c)^2$ → polar angle 3^0

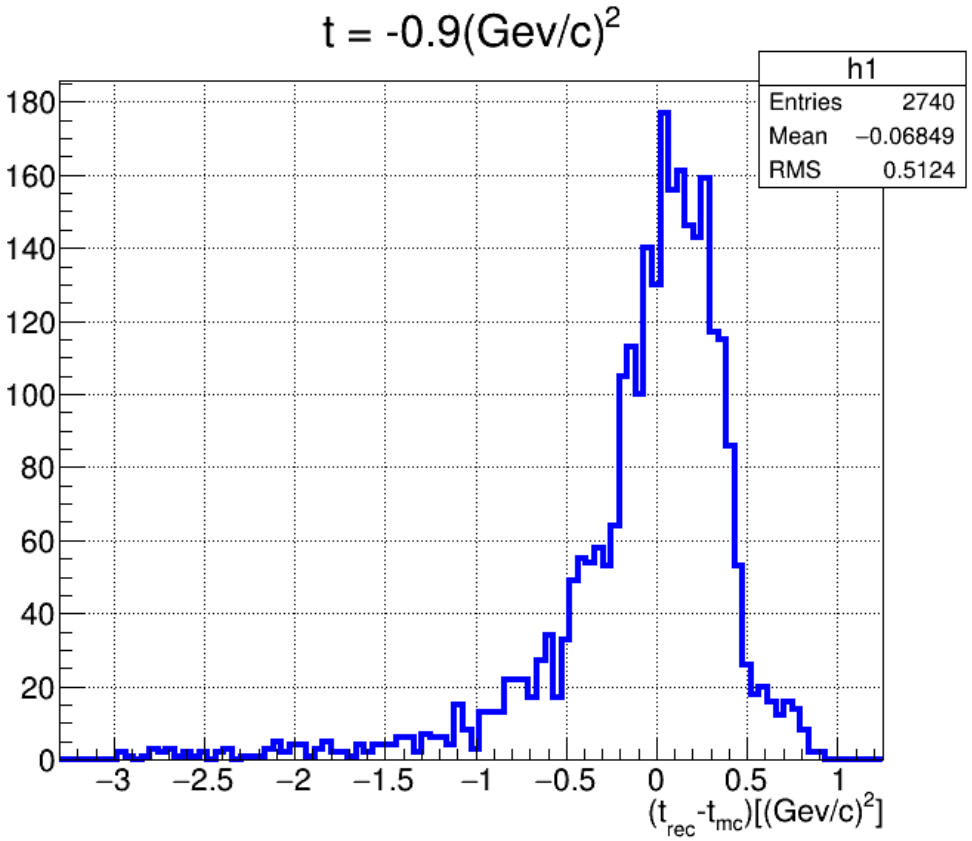
$t(Gev/c)^2$	hits in vertex tracker	hits in barrel tracker	hits in endcap tracker
-0.1	0	0	~7
-0.2	0	0	~19
-0.3	0	0	~45
-0.4	0	0	~52
-0.5	~1	0	~52
-0.9	~4	0	~52
-4.5	~5	0	~52

Kalman fit

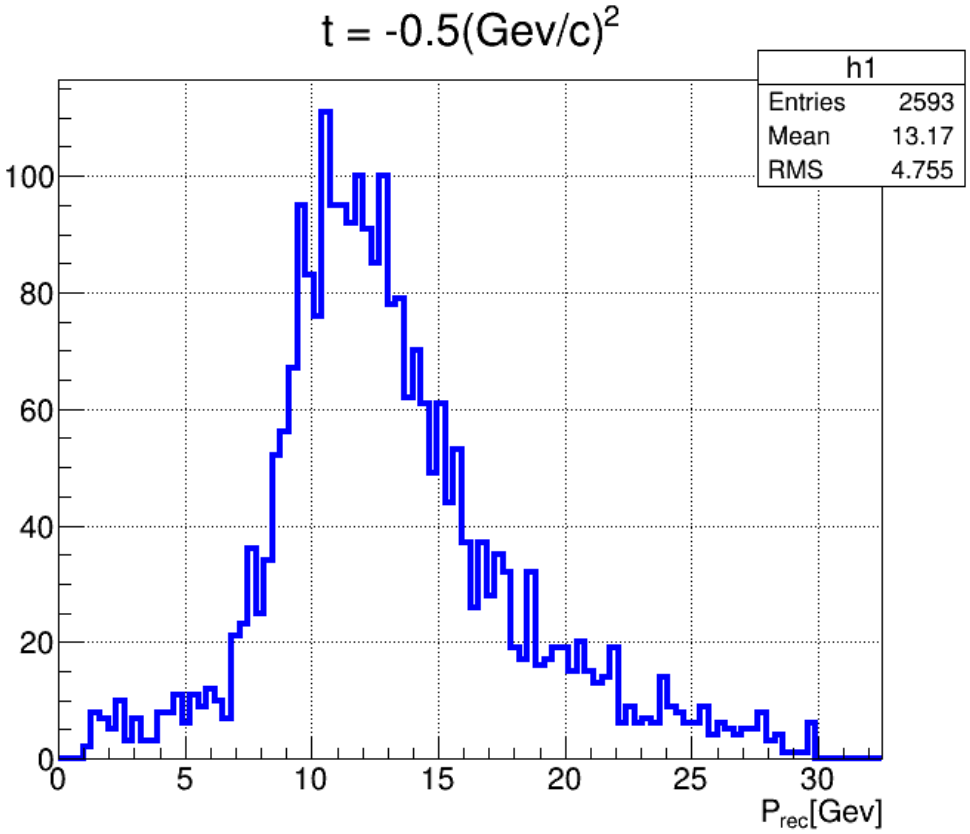

t = -4.5(Gev/c)^2
h1
Entries 2728
Mean 13.01
RMS 1.401
180
160
140
120
100
80
60
40
20
0
6
8
10
12
14
16
18
20
P_{rec}[Gev]

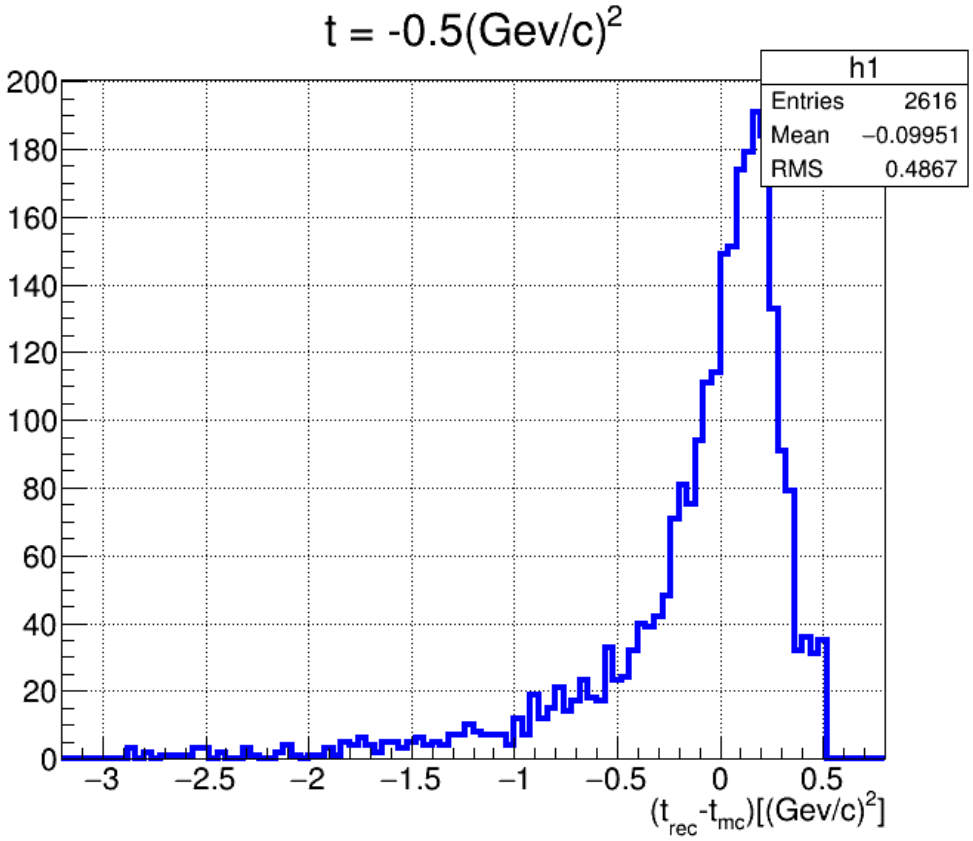
Kalman fit


t = -0.9(Gev/c)^2
h1
Entries 2752
Mean 13.15
RMS 3.401
P_{rec}[Gev]


t = -0.9(Gev/c)^2
h1
Entries 2740
Mean −0.06849
RMS 0.5124
$(t_{rec}-t_{mc})$[(Gev/c)^2]

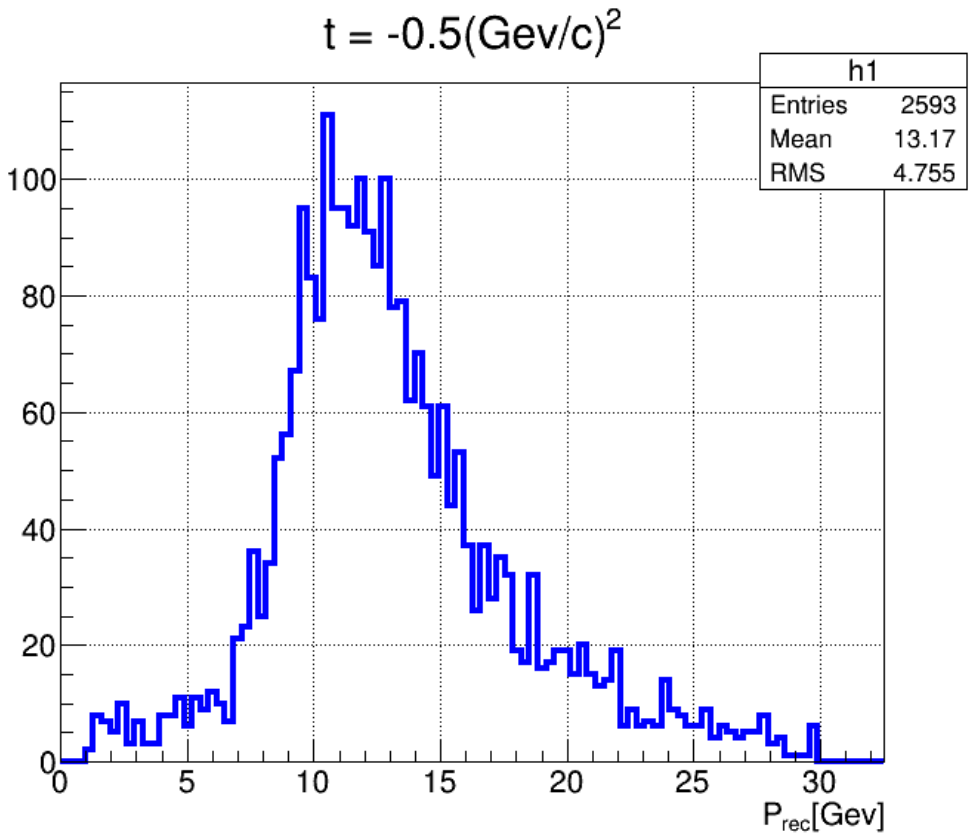
Kalman fit


t = -0.5(Gev/c)^2
h1
Entries 2593
Mean 13.17
RMS 4.755
P_{rec}[Gev]

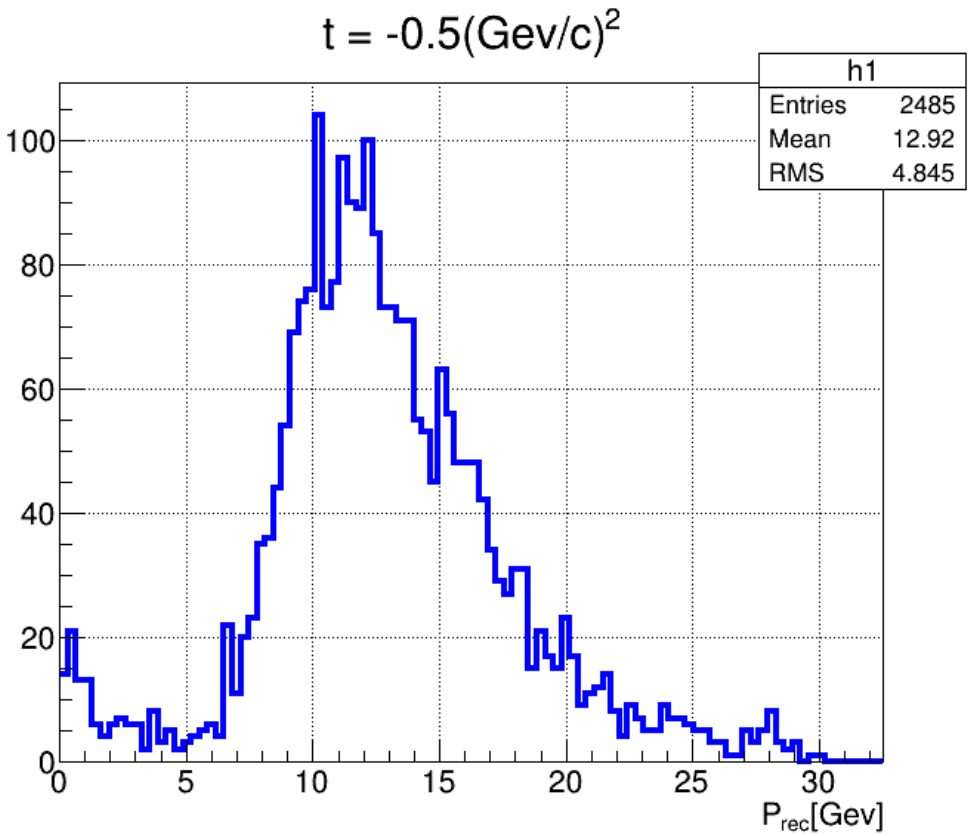

t = -0.5(Gev/c)^2
h1
Entries 2616
Mean −0.09951
RMS 0.4867
$(t_{rec}-t_{mc})[(Gev/c)^2]$

Kalman fit

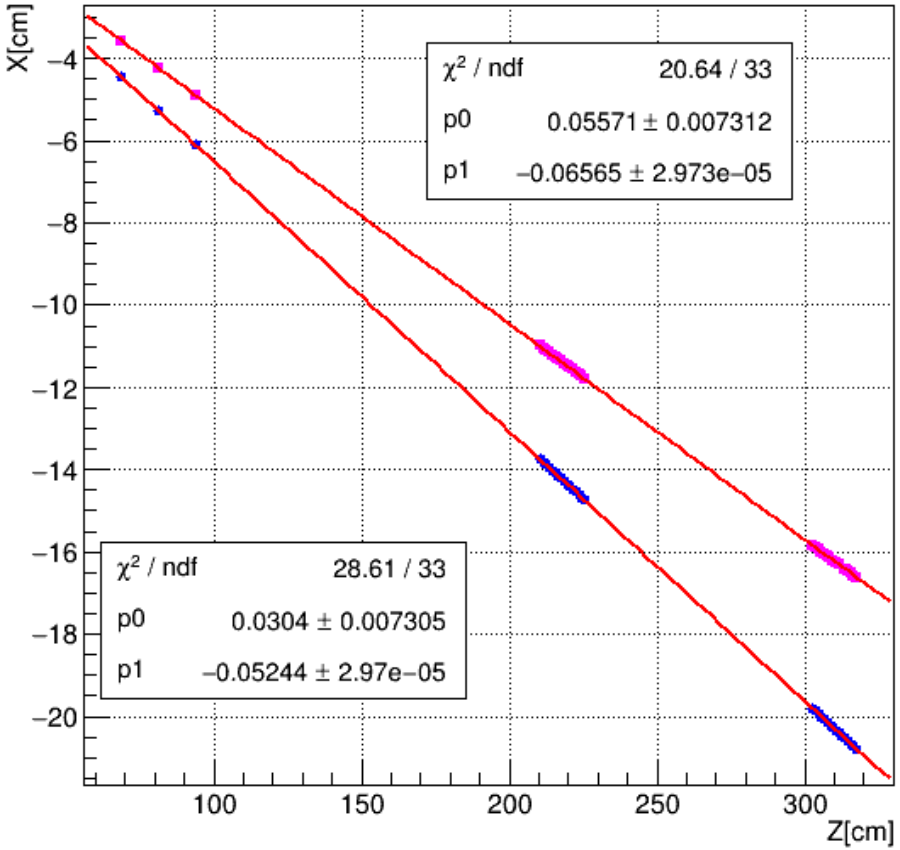
fit start P = 13Gev



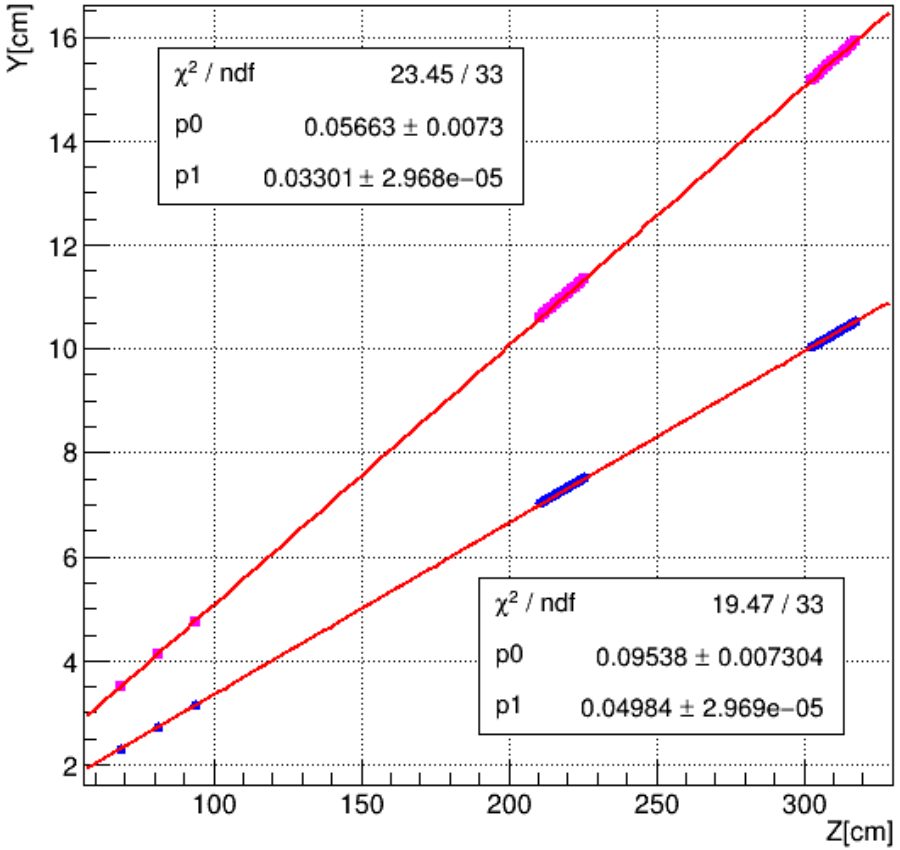
fit start P = 1Gev

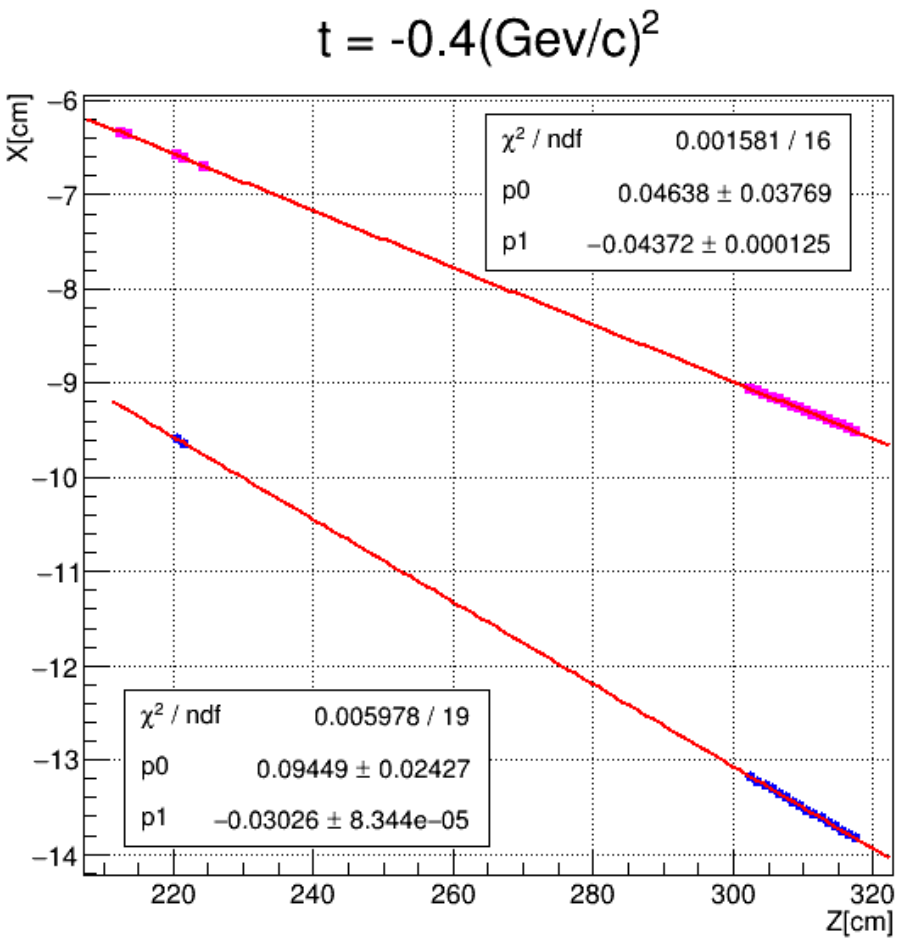


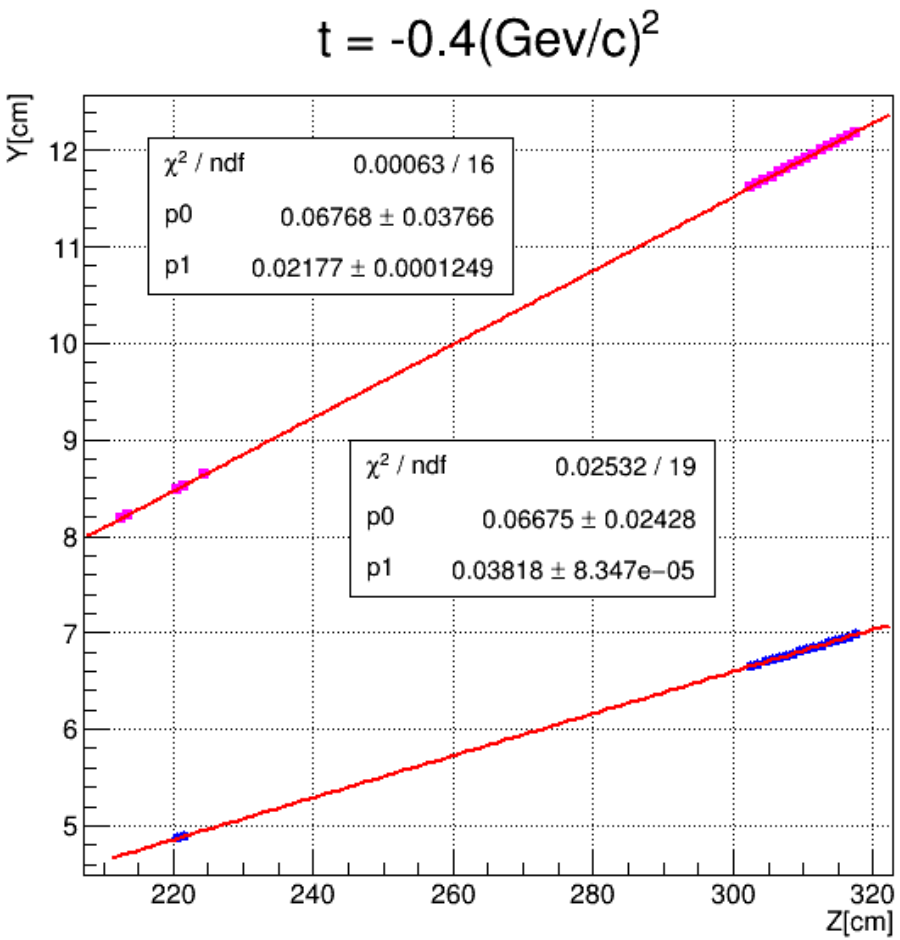
t = -0.9(Gev/c)^2



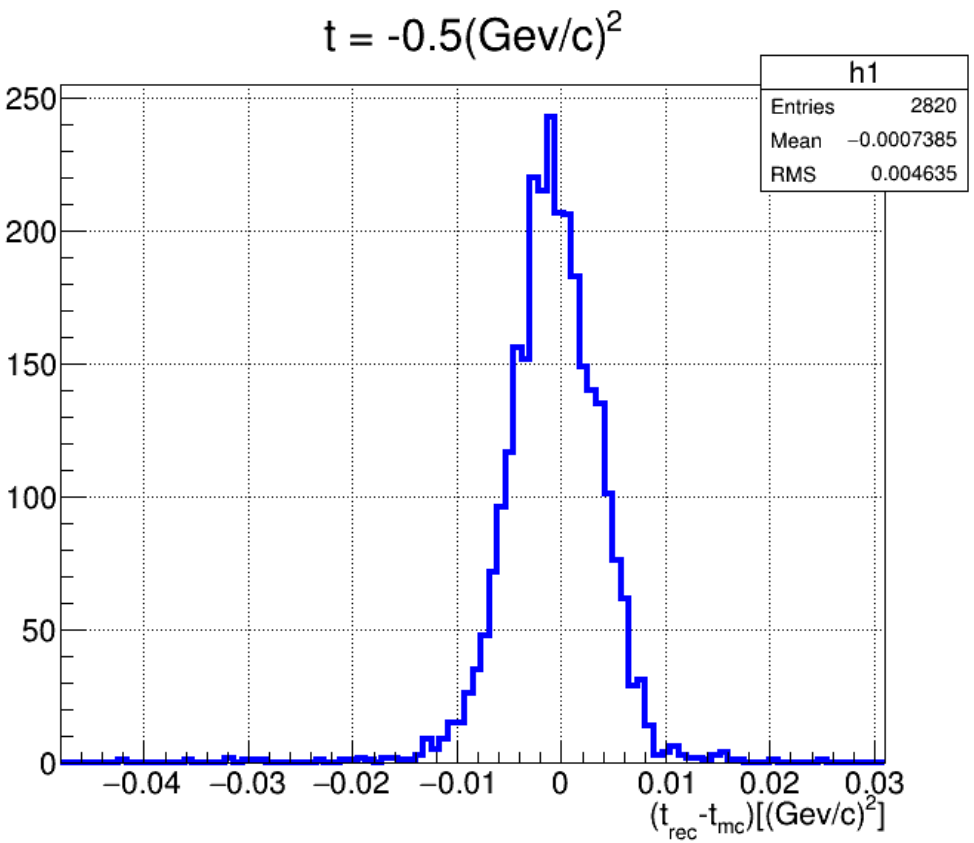
t = -0.9(Gev/c)^2

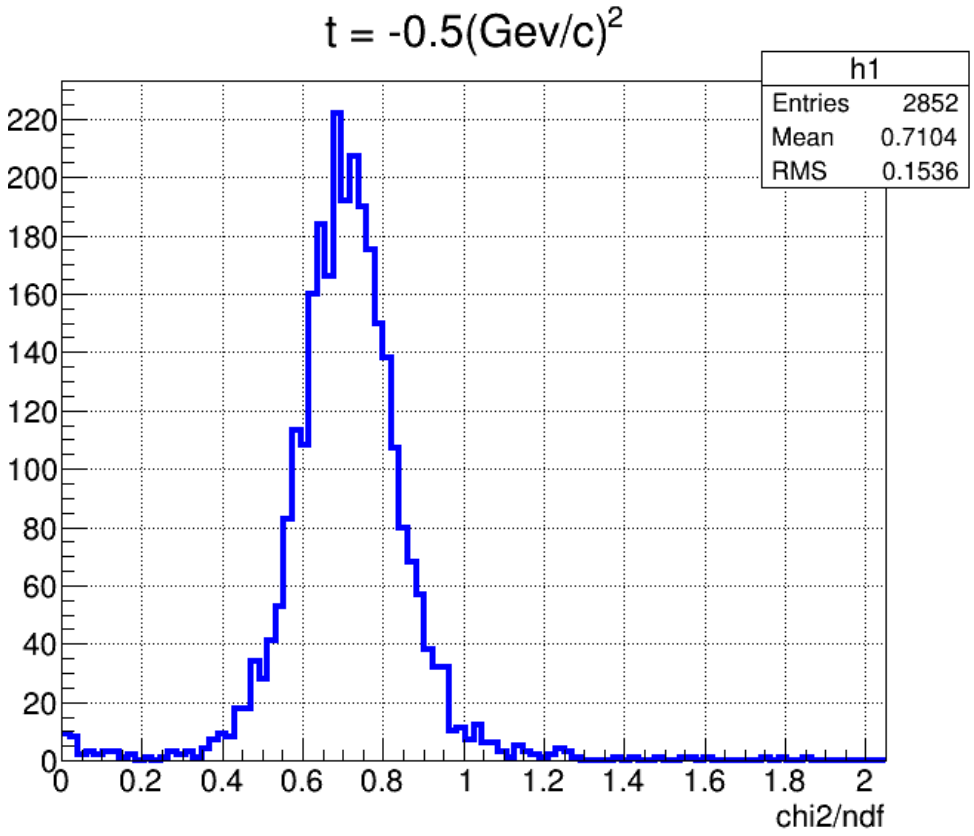



t = -0.4(Gev/c)^2
X[cm]
Z[cm]
χ^2 / ndf 0.001581 / 16
p0 0.04638 ± 0.03769
p1 −0.04372 ± 0.000125
χ^2 / ndf 0.005978 / 19
p0 0.09449 ± 0.02427
p1 −0.03026 ± 8.344e−05

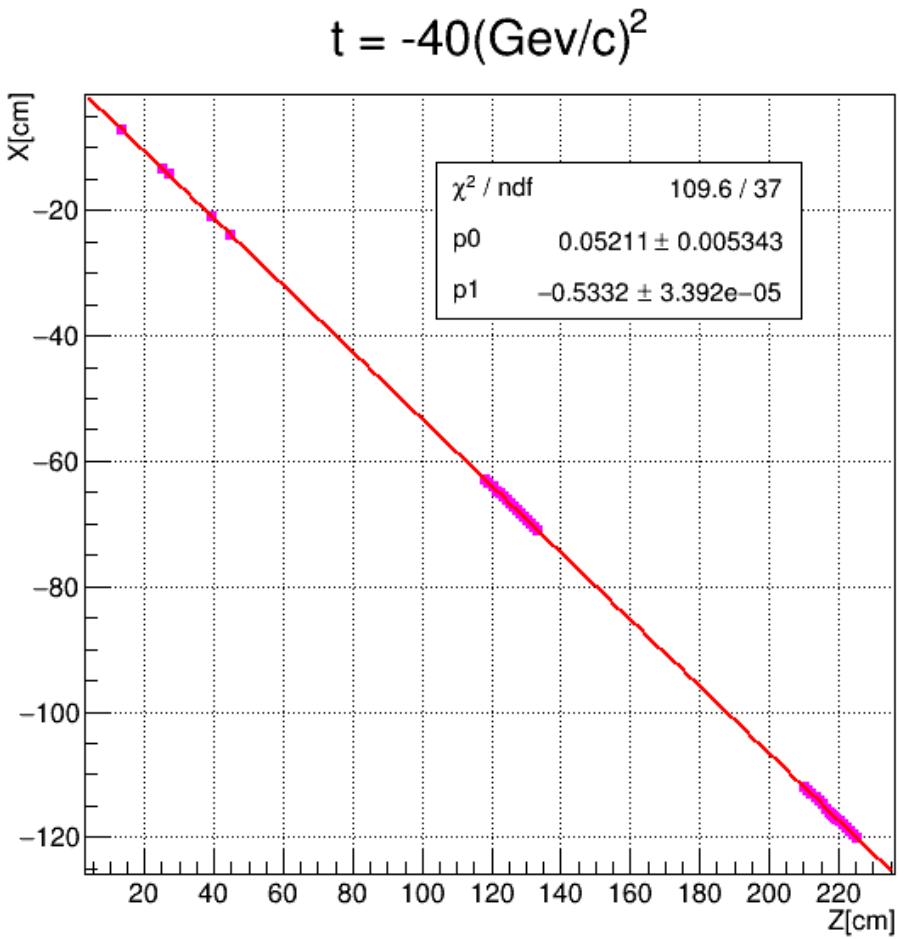

t = -0.4(Gev/c)^2
Y[cm]
Z[cm]
χ^2 / ndf 0.00063 / 16
p0 0.06768 ± 0.03766
p1 0.02177 ± 0.0001249
χ^2 / ndf 0.02532 / 19
p0 0.06675 ± 0.02428
p1 0.03818 ± 8.347e−05

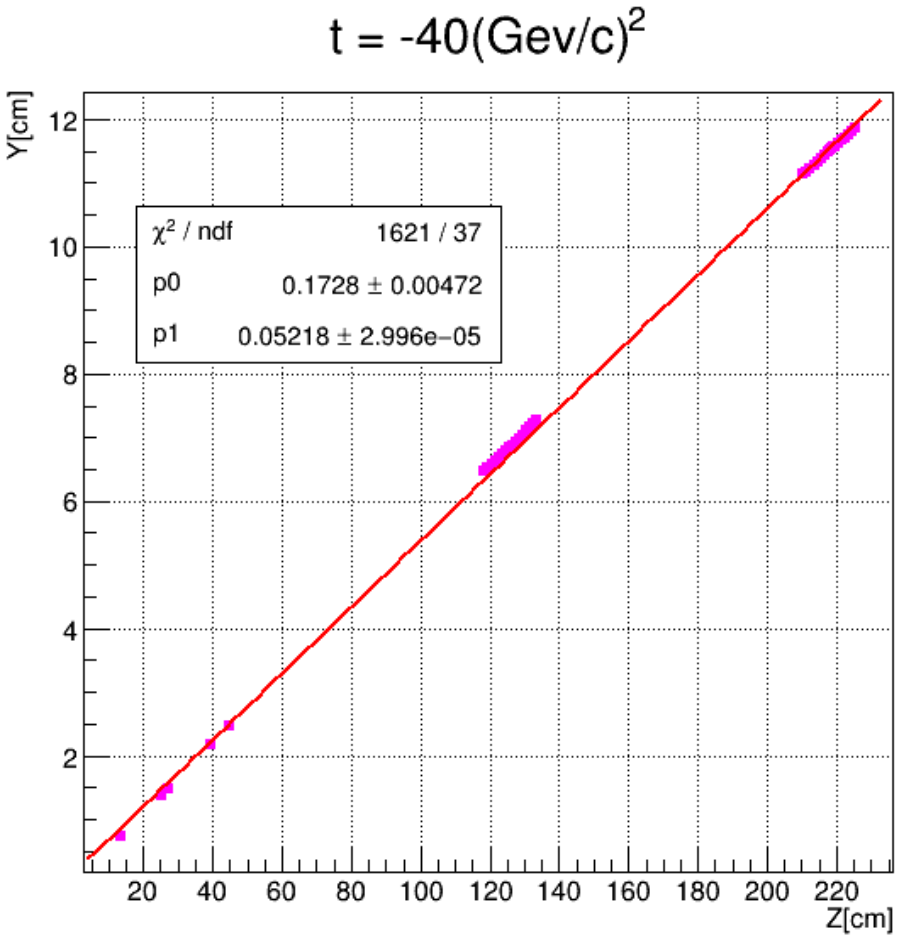
fit by straight line, no Kalman fit

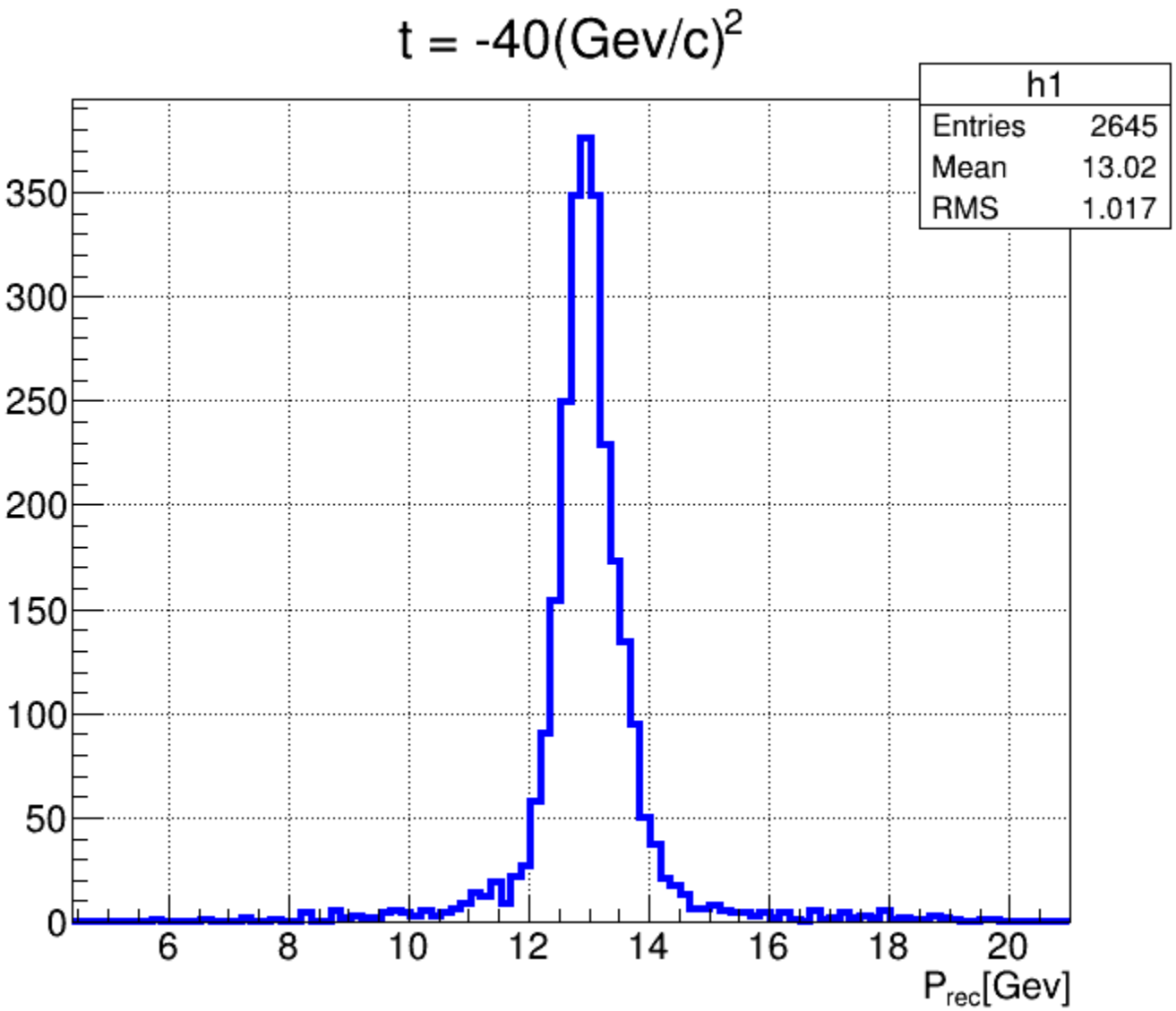




polar angle 28^0






t = -40(Gev/c)^2
h1
Entries 2645
Mean 13.02
RMS 1.017
350
300
250
200
150
100
50
0
6
8
10
12
14
16
18
20
P_{rec}[Gev]