Small-angle elastic pp scattering

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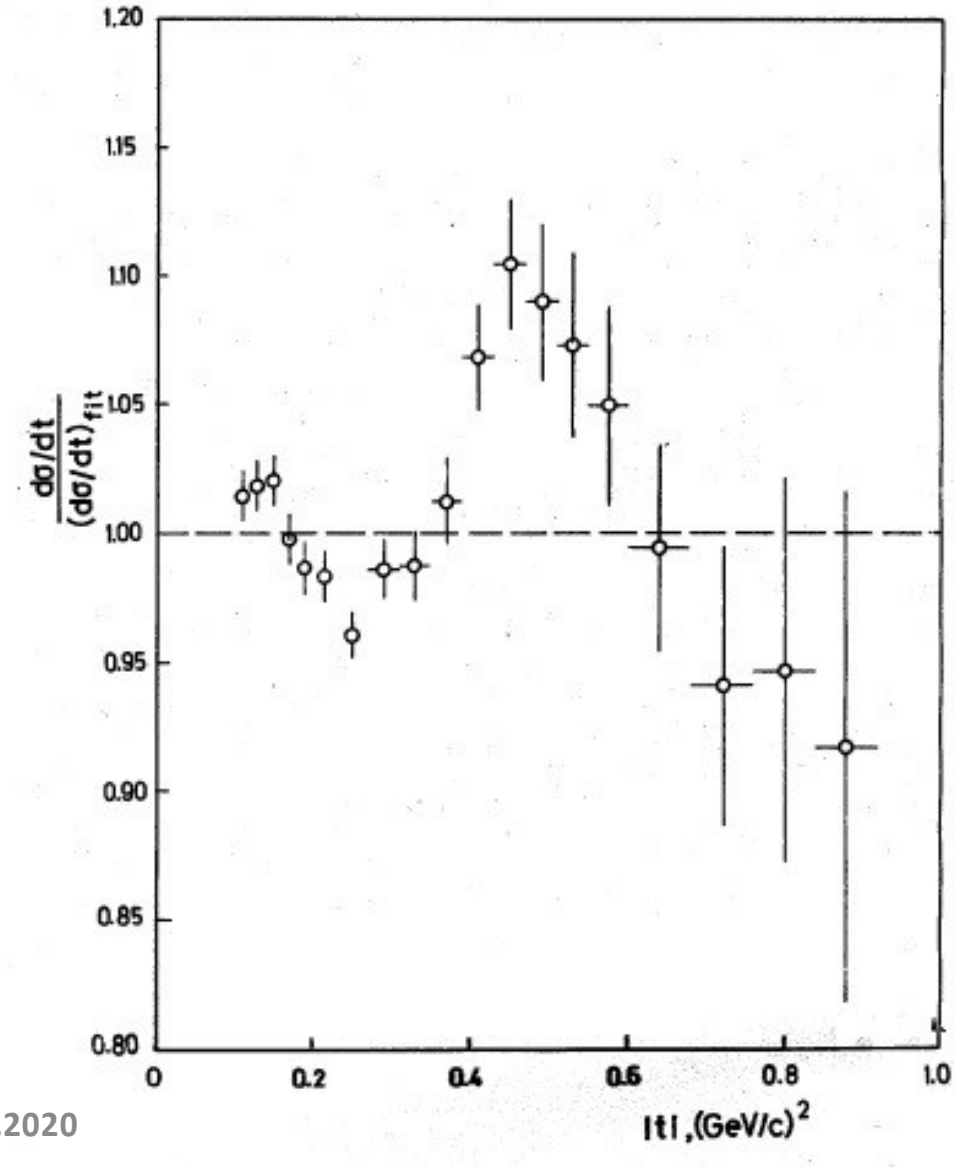
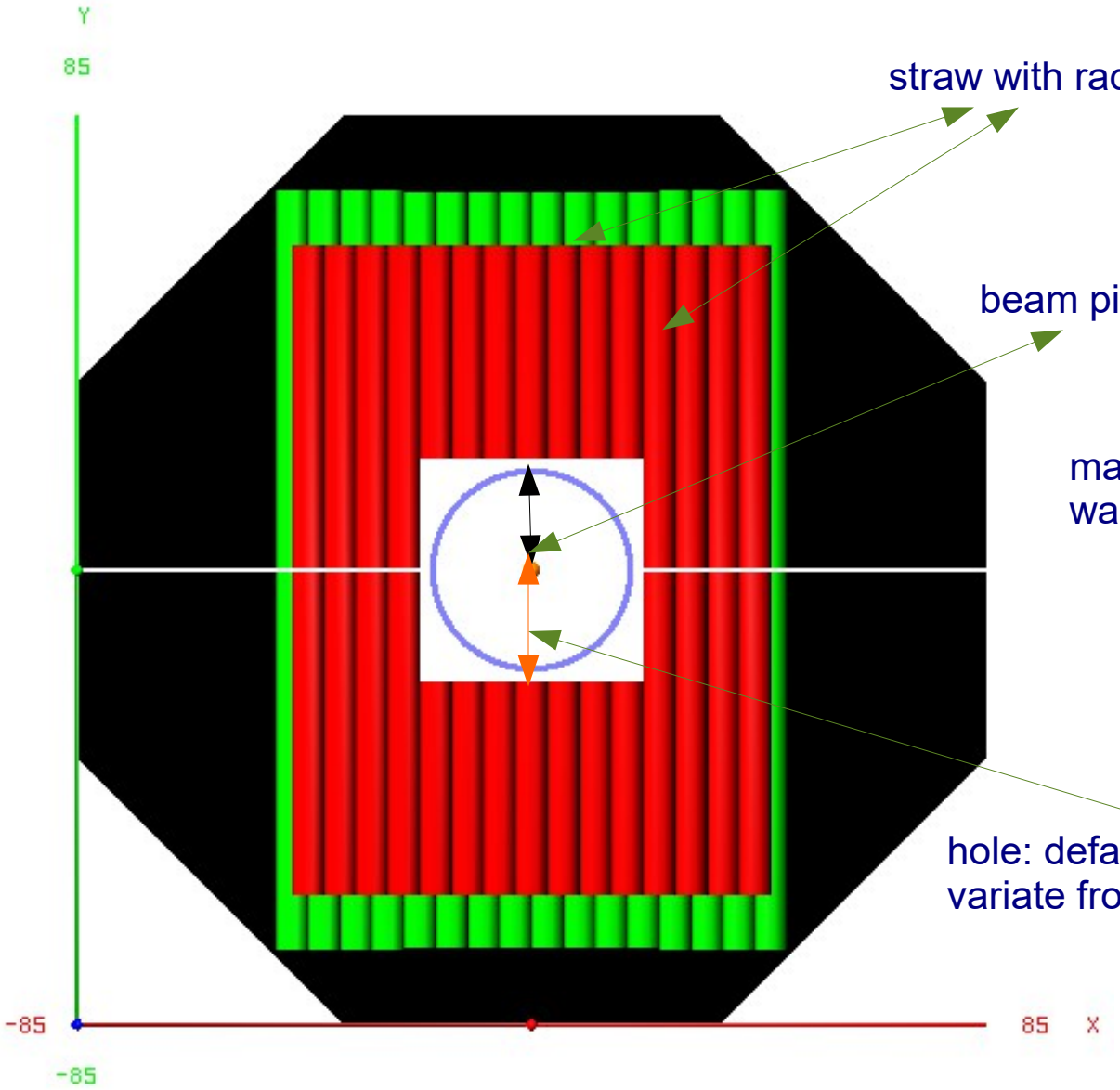
slide from A.L'vov presentation:

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



Antipov et al. preprint 1976.

endcap planes with straws



straw with radius 1cm

beam pipe radius 3.2cm

beam pipe:
material – aluminium
wall thickness – 1mm

hole: default half size – 10cm
variate from 3.5cm to 10cm

Simulation:

protons with $\sqrt{s}$ = 3.5Gev – 10 Gev in opposite directions

t = -0.1Gev^2 -0.2Gev^2 -0.3Gev^2 -0.4Gev^2 -0.5Gev^2

azimuthal φ: uniformly distributed between 0 and 2π

polar angle θ: according with corresponding t

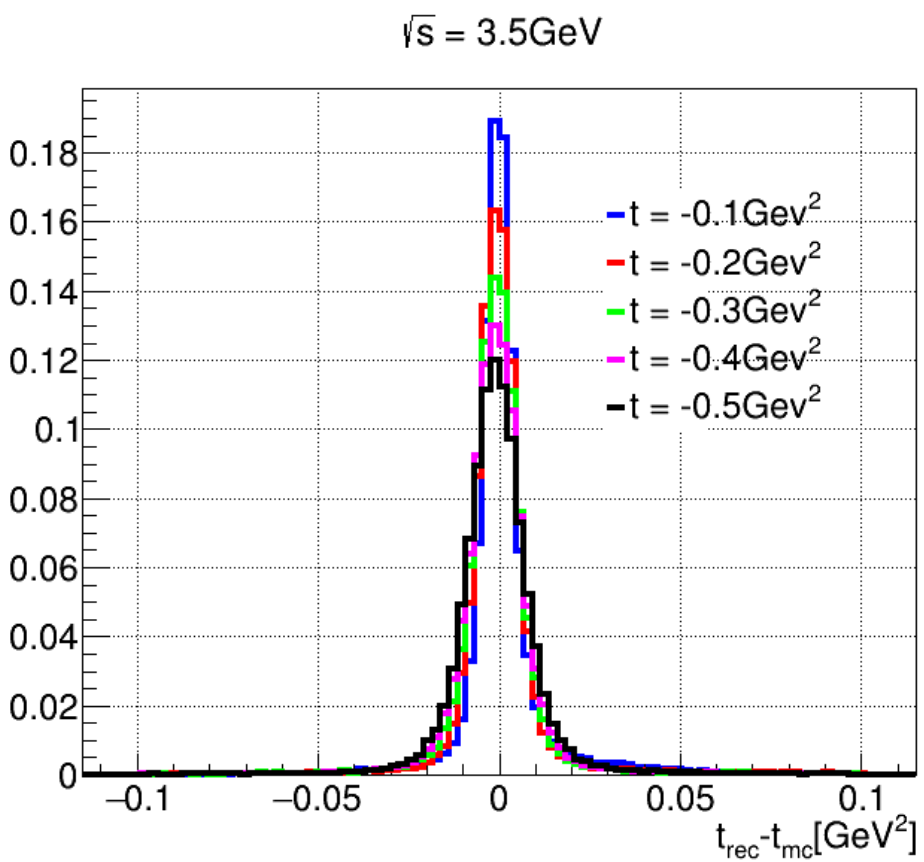
Reconstruction:

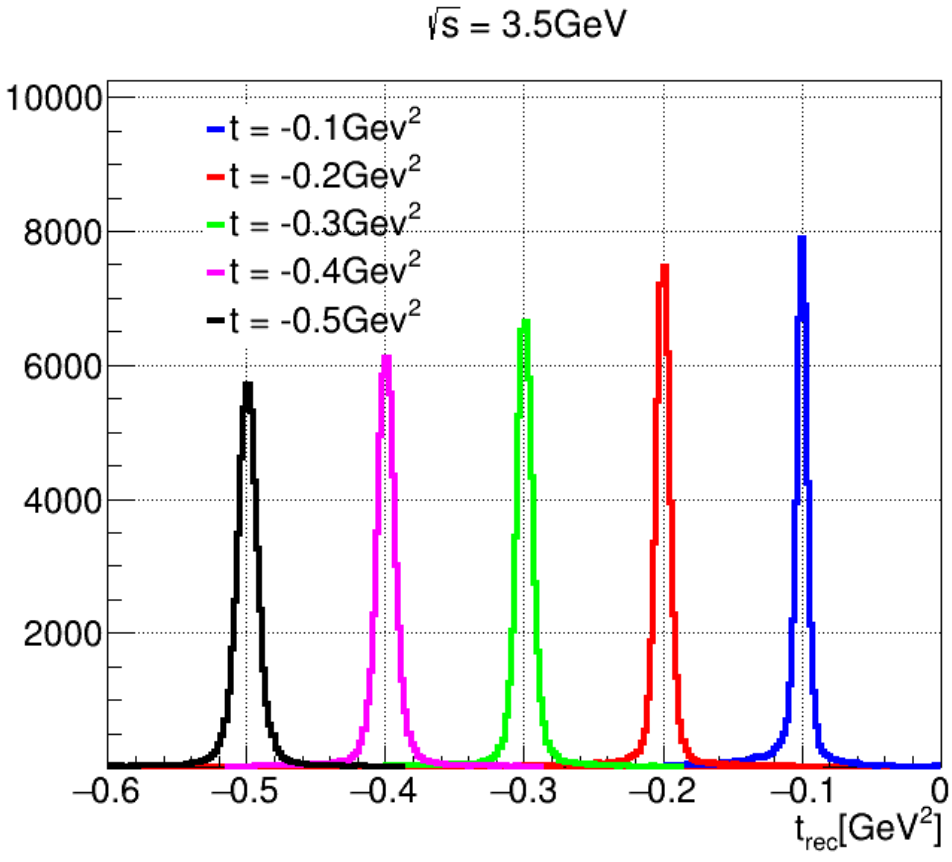
from GenFit2 take reconstructed polar and azimuthal angles only,

energy of the scattered proton sets equal
to initial energy of the proton

$\sqrt{s}$(GeV)	t(GeV^2)	hole half size(cm)	hits in vertex tracker	hits in barrel tracker	hits in endcap tracker
3.5	-0.1	10	~0 - 2	~0 - 2	~8-12
3.5	-0.2	10	~2 - 3	~8 - 10	~12 - 14
3.5	-0.3	10	~2 - 3	~10 - 18	~14 - 16
3.5	-0.4	10	~2 - 3	~20 - 30	~15 - 16
3.5	-0.5	10	~2 - 3	~25 - 35	~16 - 18

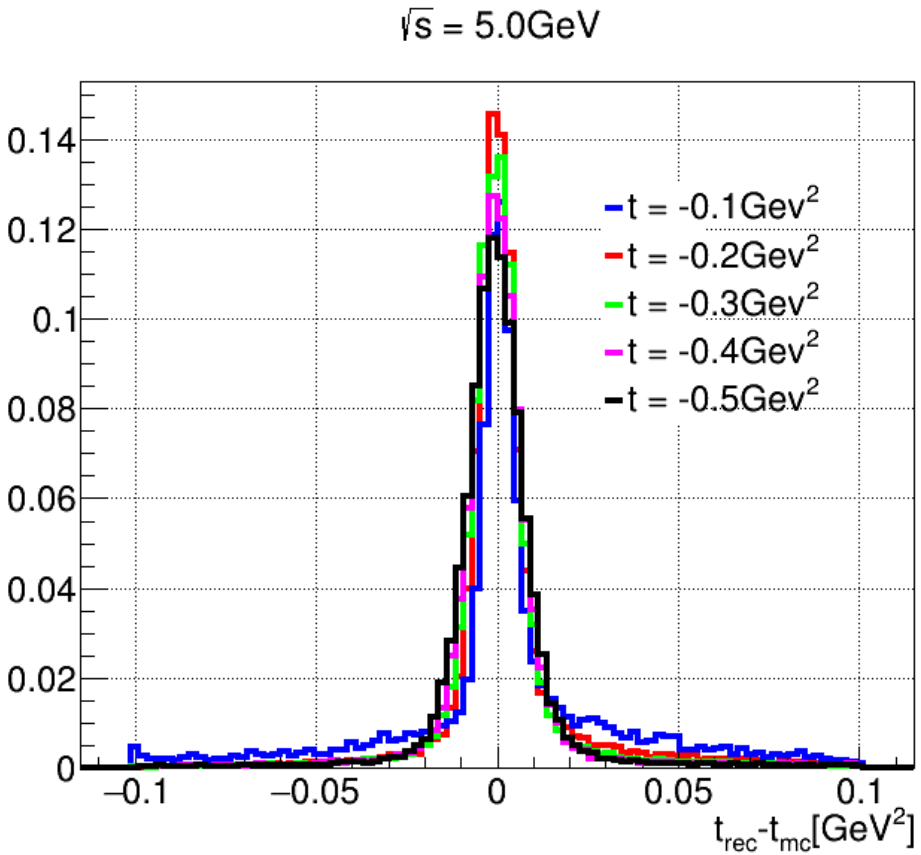
hole half size - 10cm

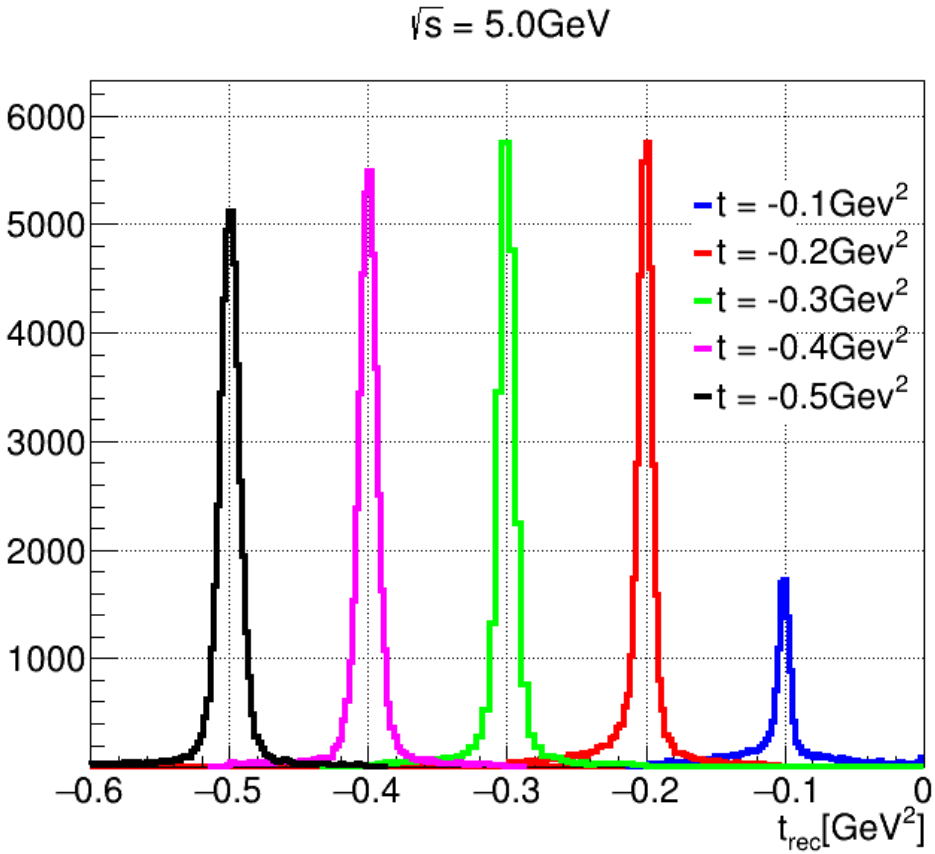




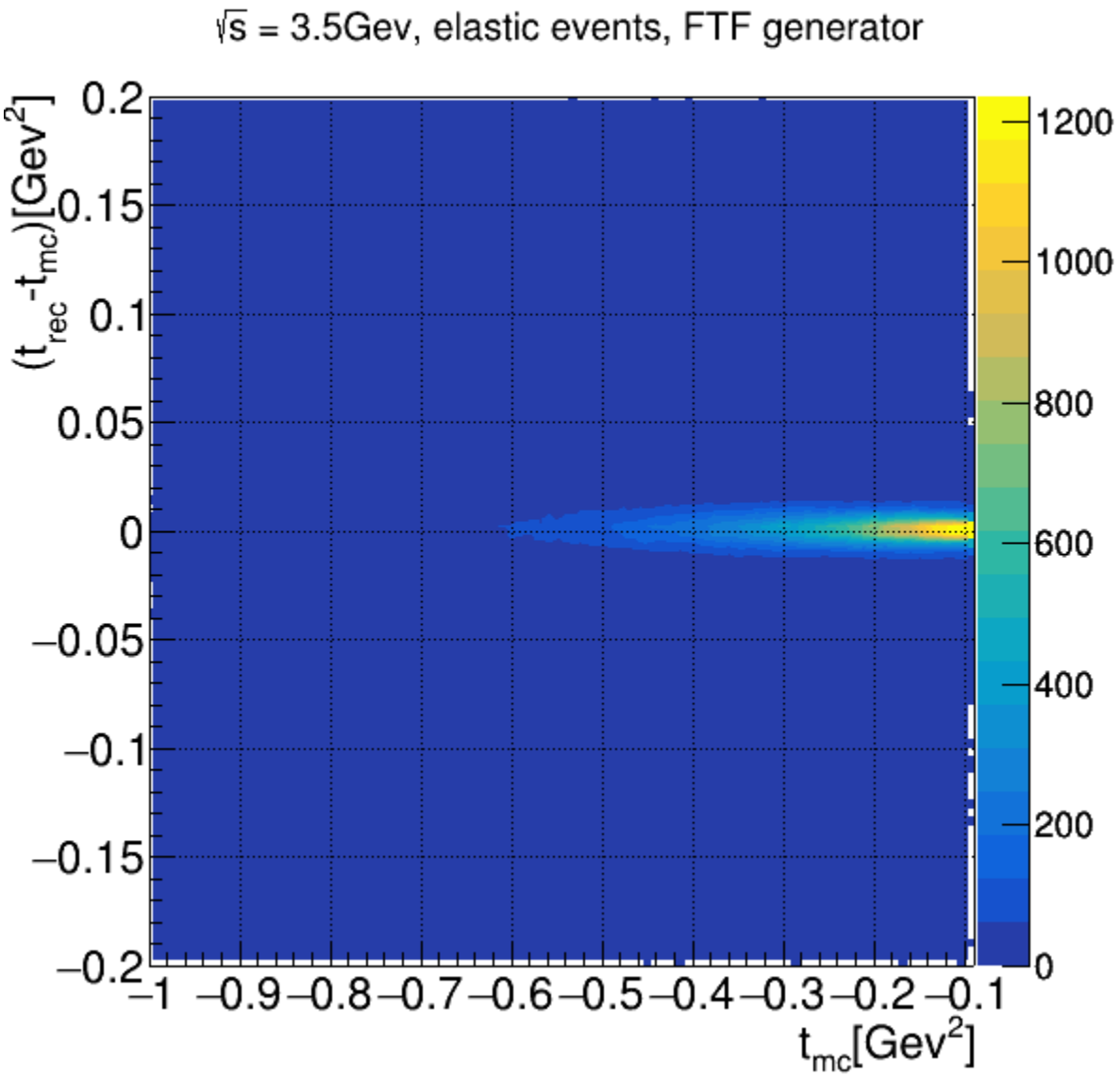
√s(GeV)	t(GeV^2)	hole half size(cm)	hits in vertex tracker	hits in barrel tracker	hits in endcap tracker
10	-0.1	10	0	0	0
10	-0.2	10	0	0	~1 - 2
10	-0.1	6.5	0	0	0
10	-0.1	5.0	0	0	0
10	-0.1	4.0	0	0	~2 - 4
10	-0.1	3.5	0	0	~3 - 7
10	-0.2	3.5	0	0	~8 - 12
5	-0.1	10	~1	0	~8 - 10
5	-0.2	10	~1	0	~10 - 12
5	-0.3	10	~1 - 2	~2 - 4	~12 - 14
5	-0.4	10	~2 - 3	~4 - 7	~12 - 15
5	-0.5	10	~2 - 3	~8 - 10	~14 - 16

hole half size - 10cm

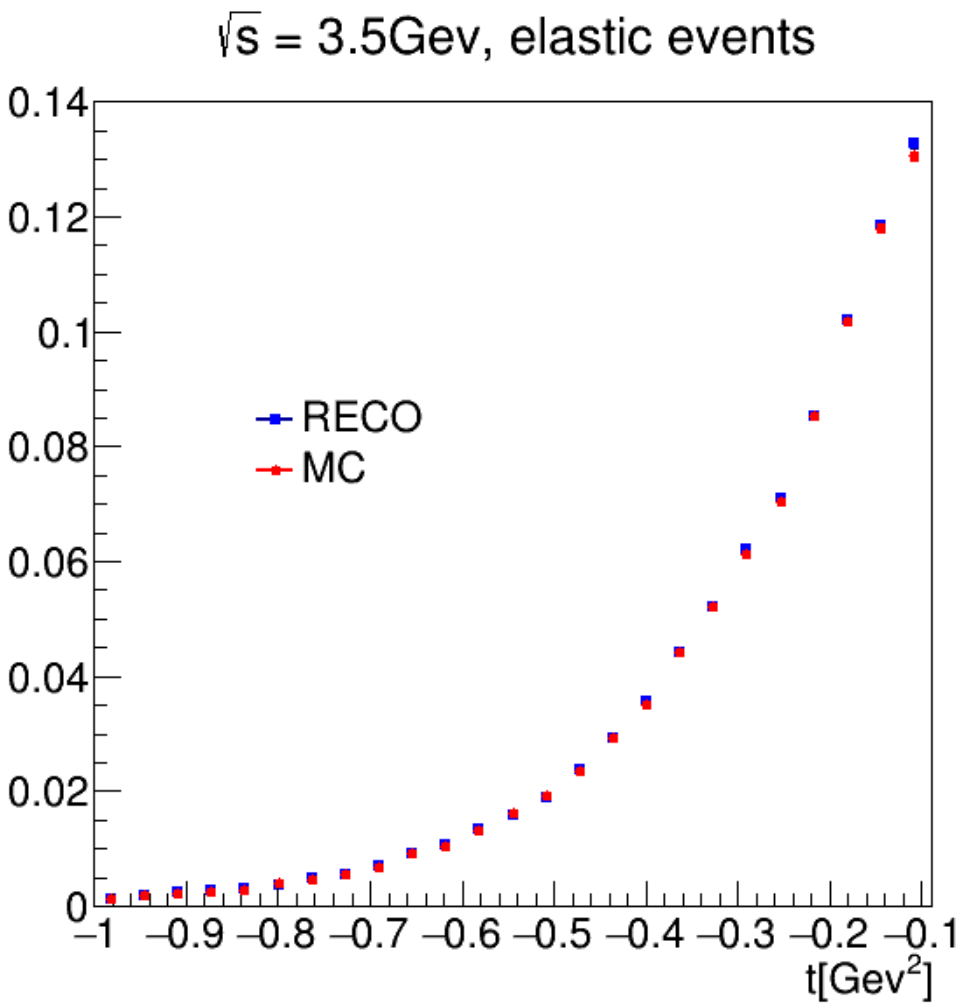


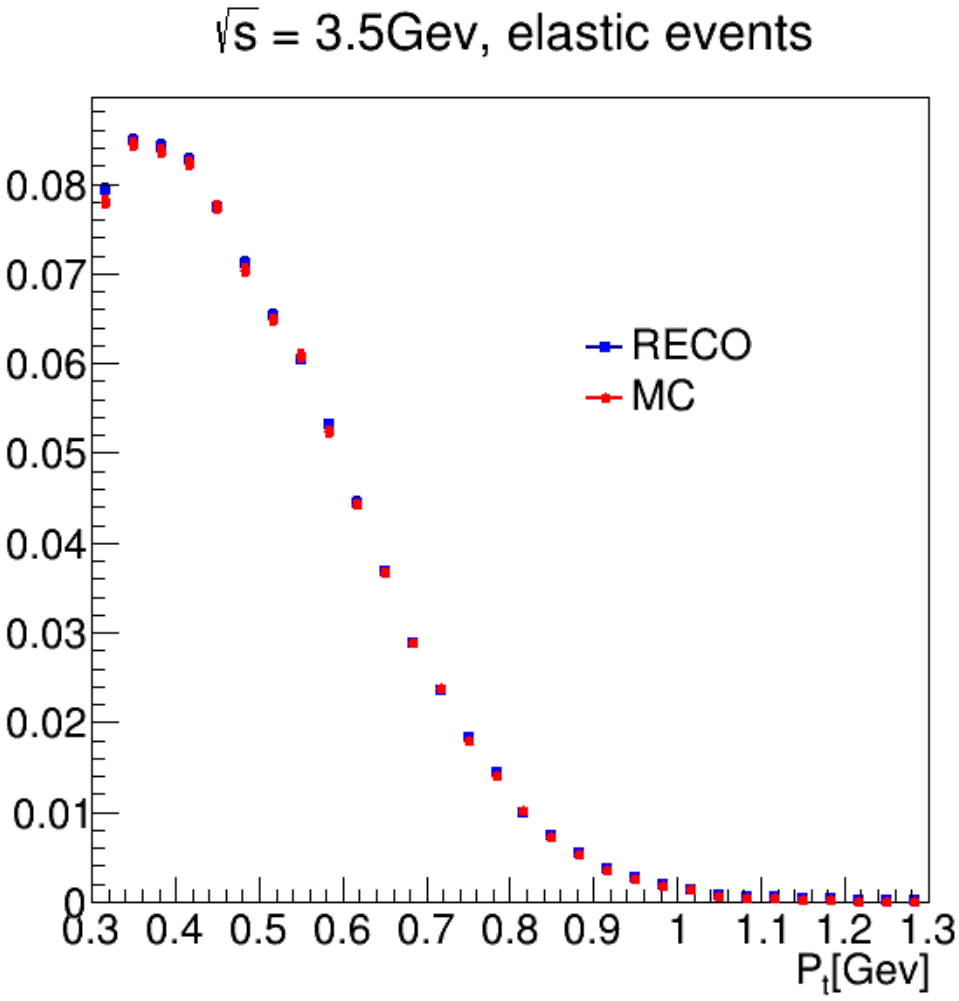


FTF generator with total energy √s = 3.5GeV

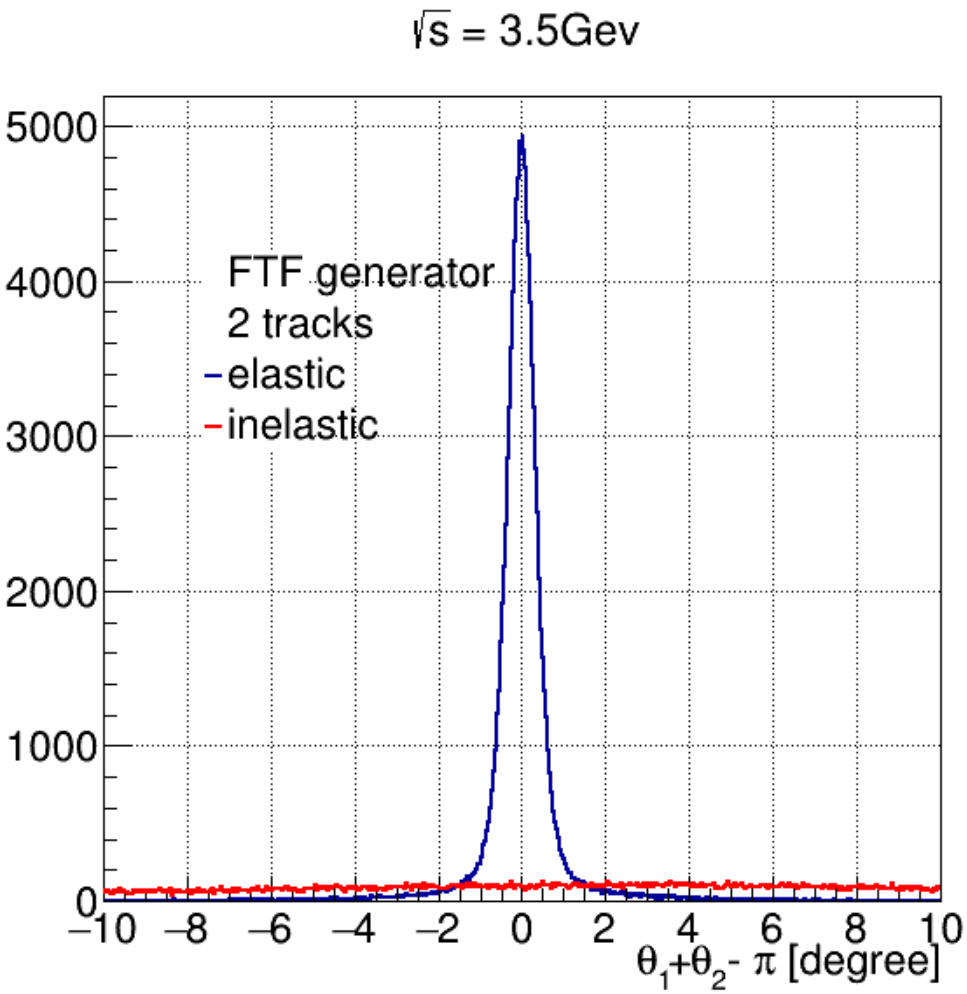


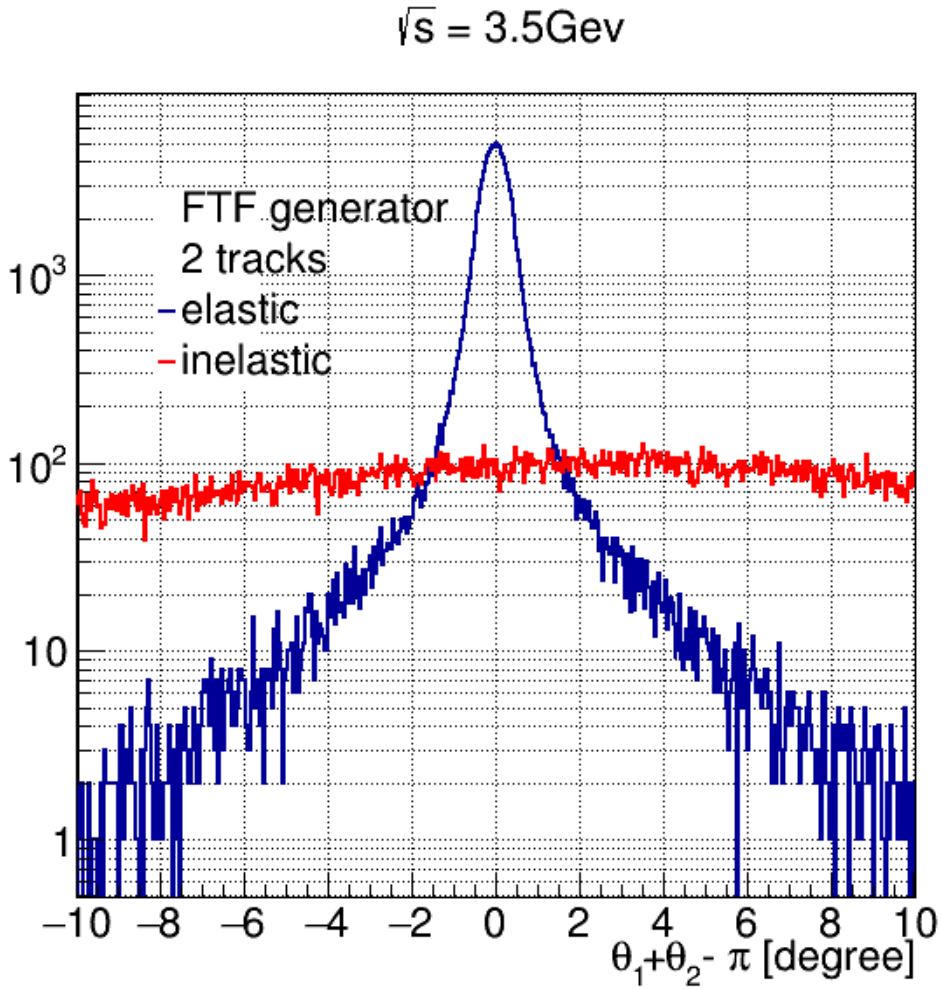
FTF generator with total energy √s = 3.5GeV



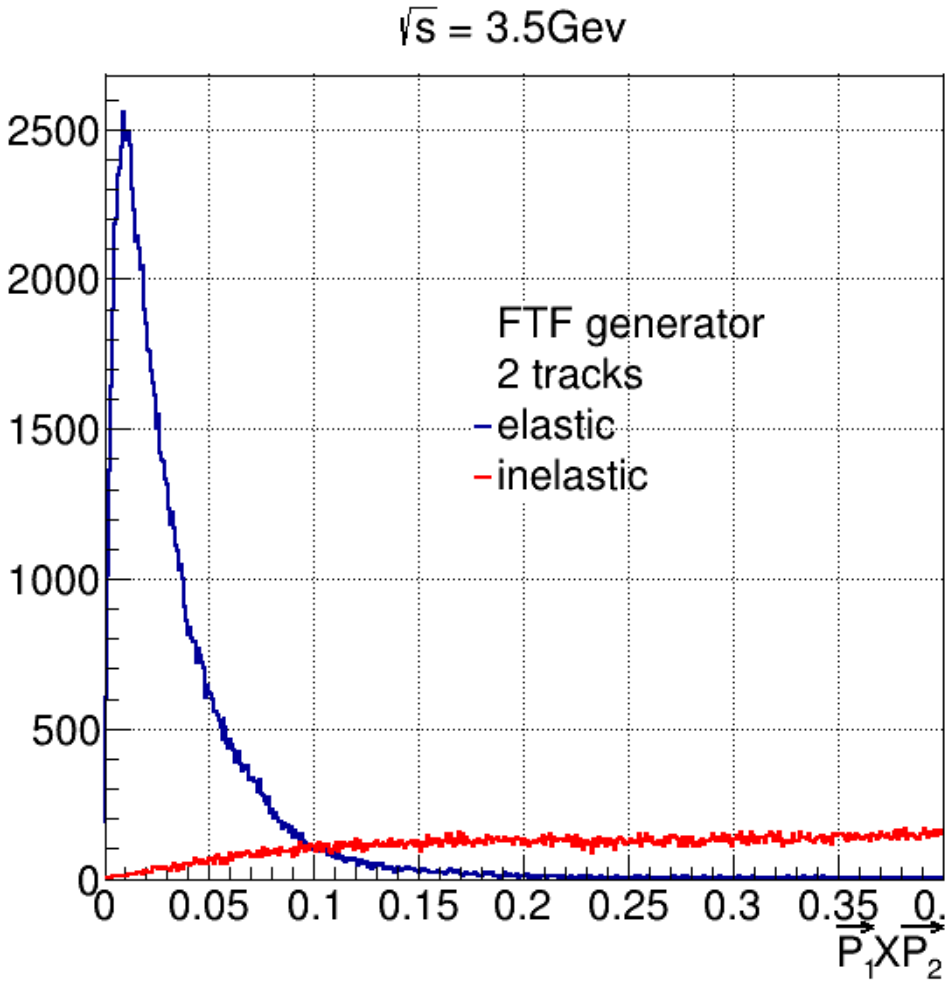


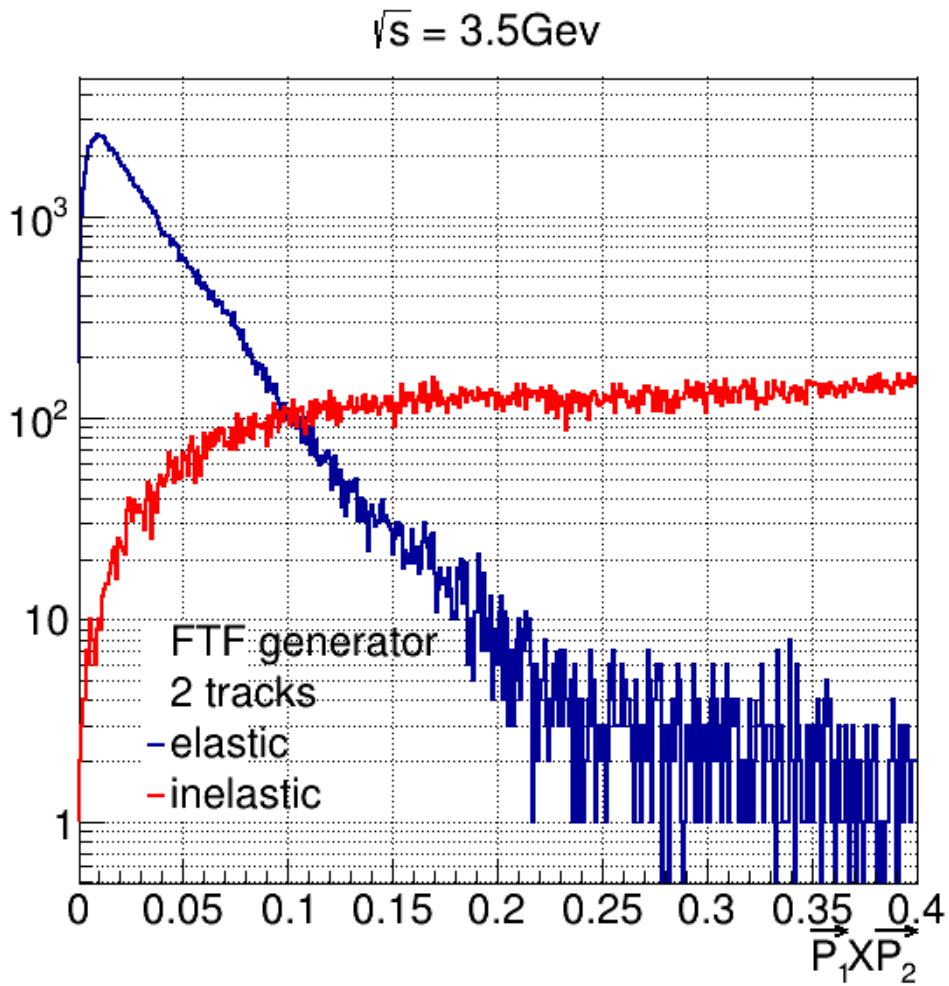
FTF generator with total energy √s = 3.5GeV





FTF generator with total energy √s = 3.5GeV



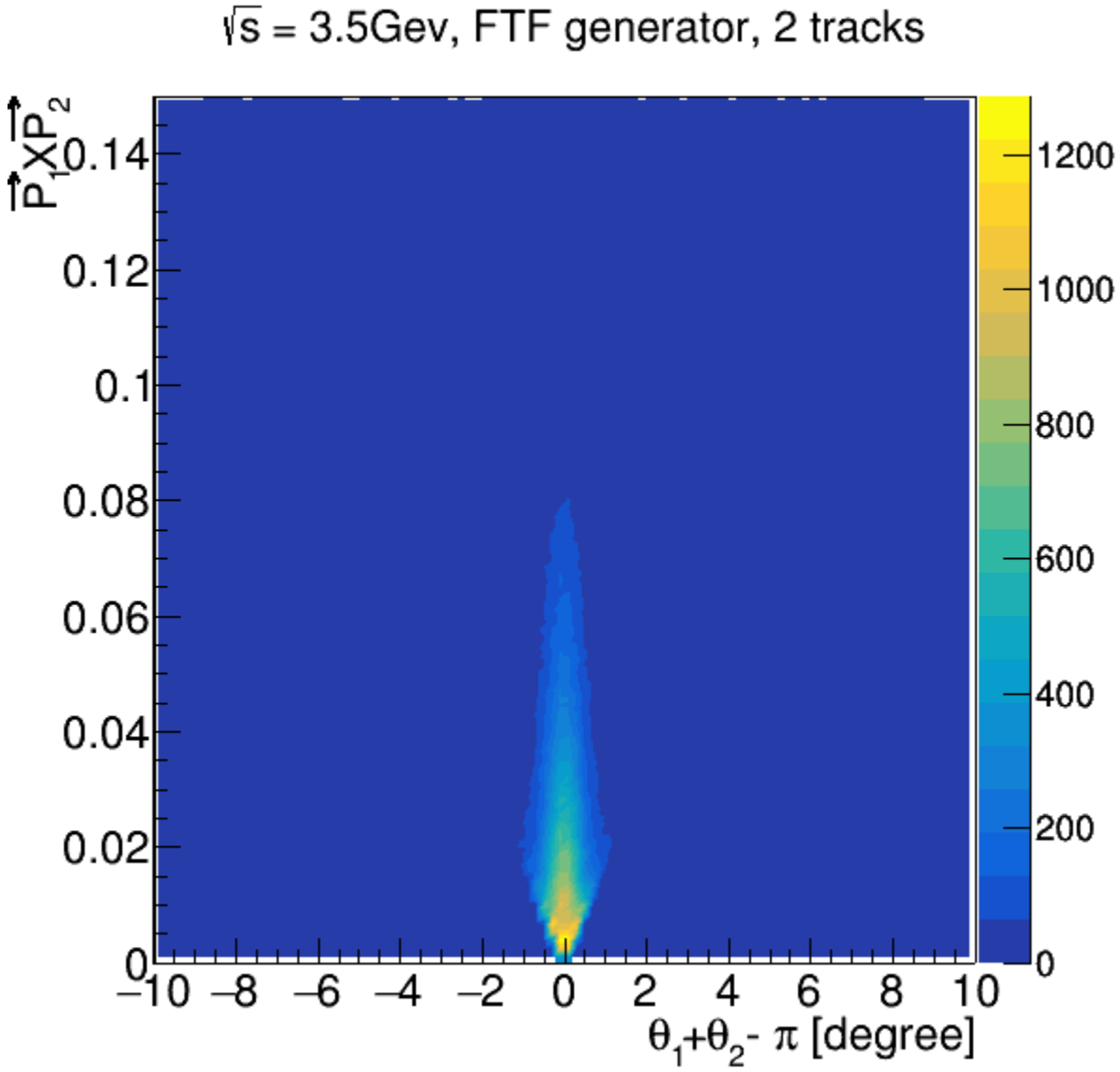


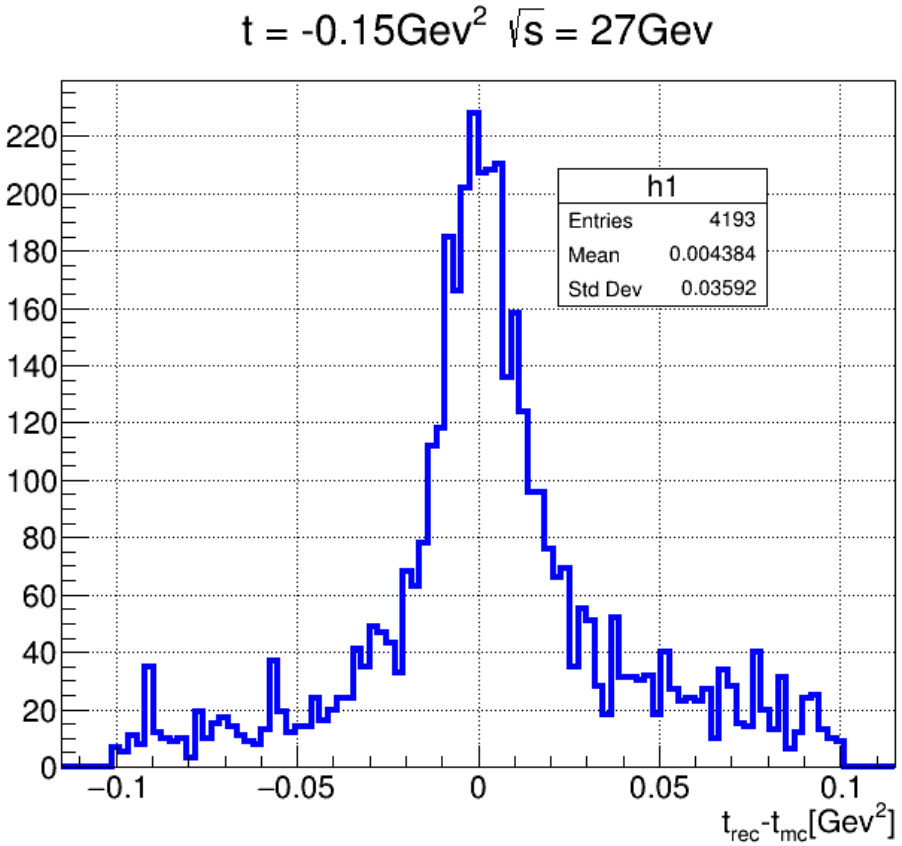
Summary

1. For small-angle elastic pp scattering with t around -0.1Gev^2 and total energy $\sqrt{s}$ = 10 GeV no possibility detect outgoing particles. It needs to have smaller initial energy.

2. At the initial stage of operation total energies $\sqrt{s}$ = 3.5GeV and $\sqrt{s}$ = 5GeV are suit for us.

FTF generator with total energy √s = 3.5GeV

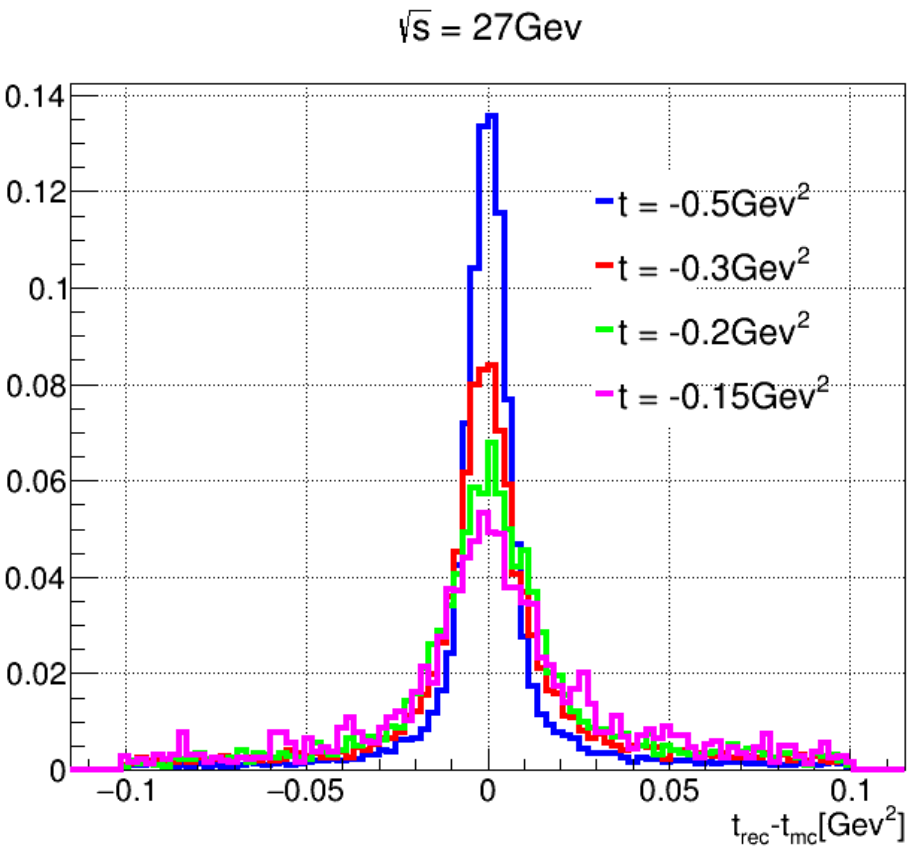




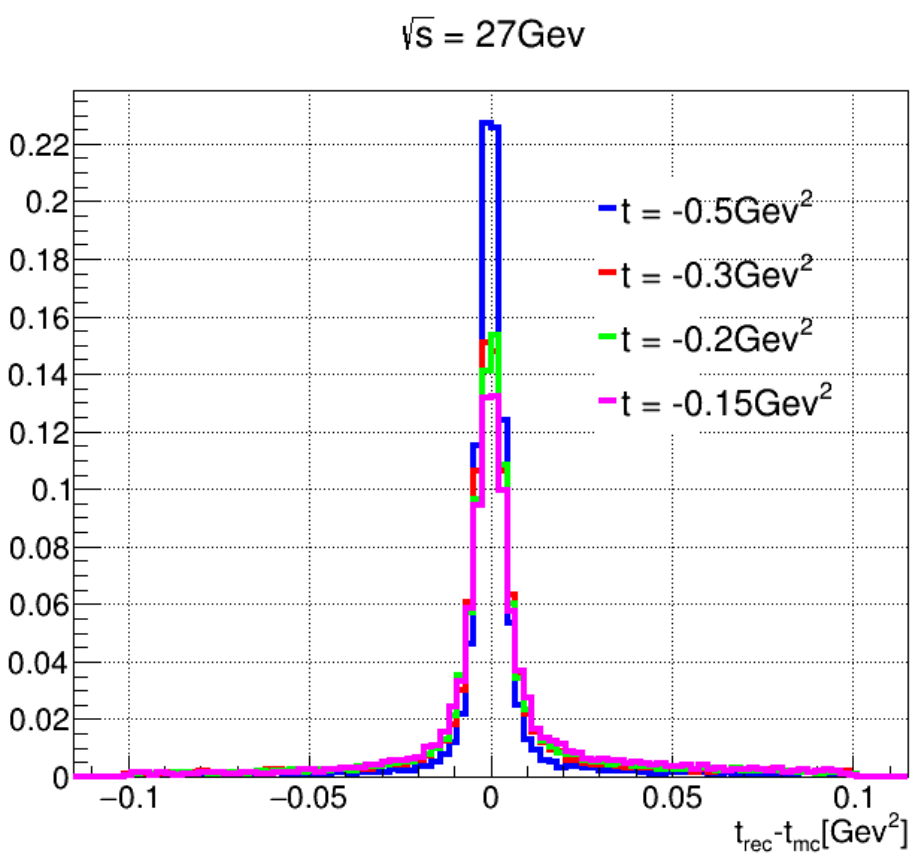
particle path in beam pipe wall

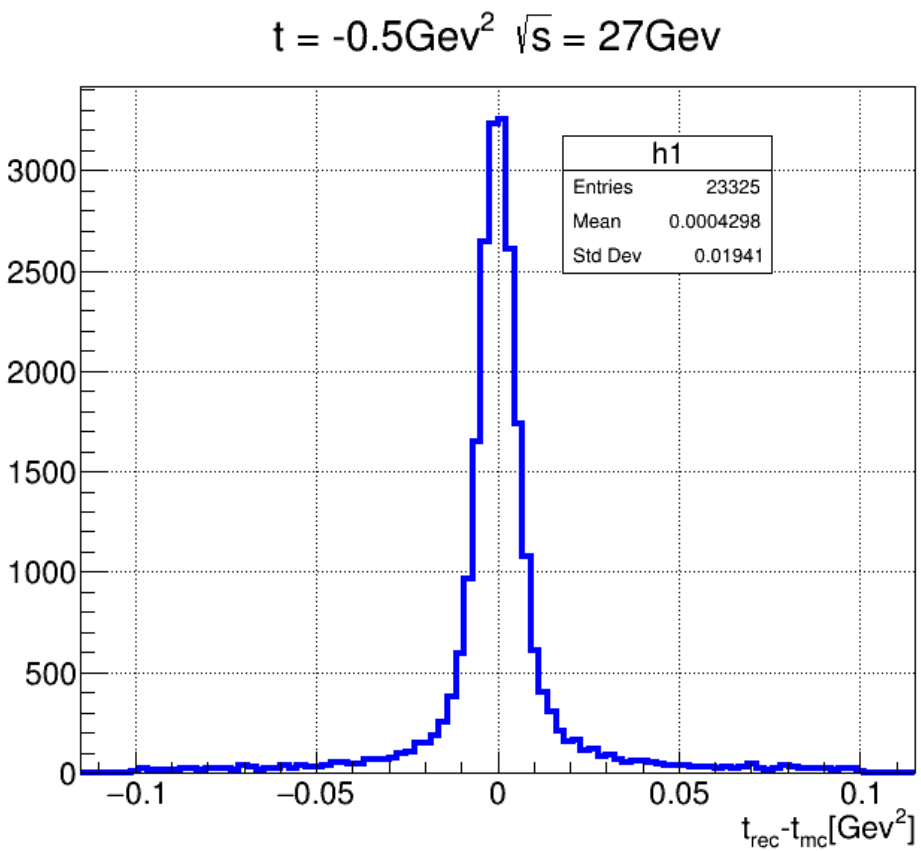
t	θ	path
-0.1Gev^2	1.35^0	~4.3cm
-0.15Gev^2	1.65^0	~3.5cm
-0.2Gev^2	1.9^0	~3cm
-0.5Gev^2	3^0	~1.9cm

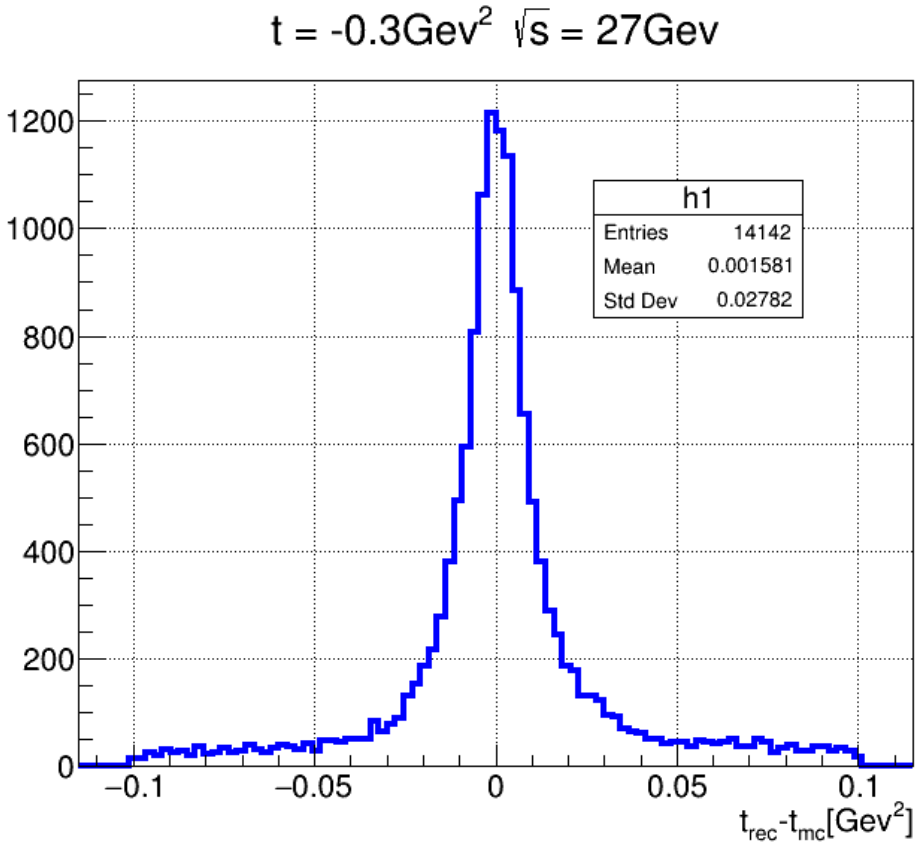
with beam pipe



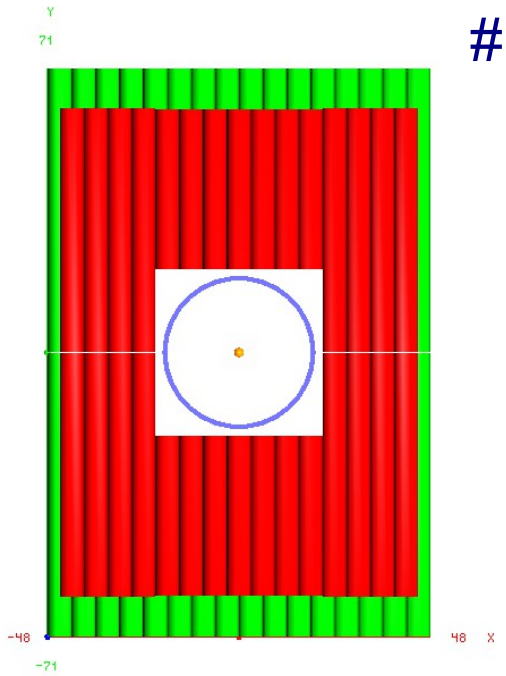
without beam pipe

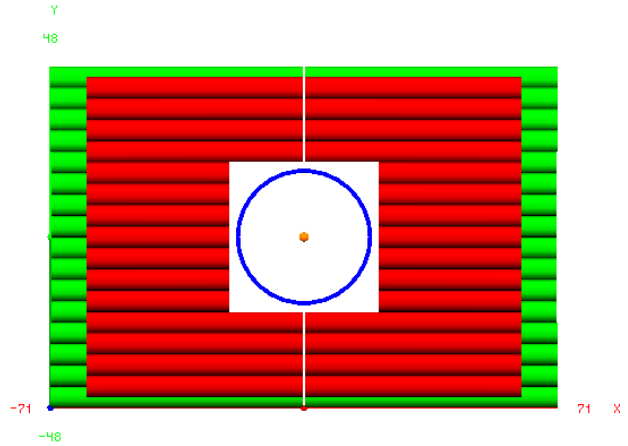


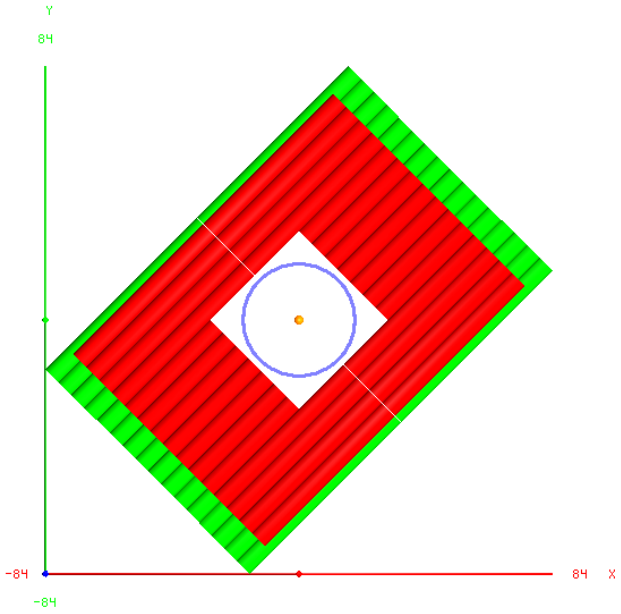

t = -0.5Gev² √s = 27Gev
h1
Entries 23325
Mean 0.0004298
Std Dev 0.01941
3000
2500
2000
1500
1000
500
0
−0.1
−0.05
0
0.05
0.1
t_rec-t_mc[Gev²]

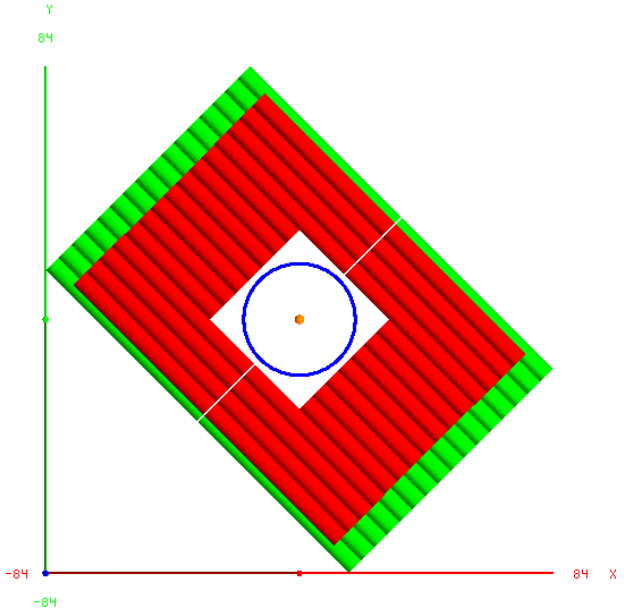

t = -0.3Gev² √s = 27Gev
h1
Entries 14142
Mean 0.001581
Std Dev 0.02782
1200
1000
800
600
400
200
0
−0.1
−0.05
0
0.05
0.1
t_rec-t_mc[Gev²]

of planes in endcap tracker – 52 in each direction



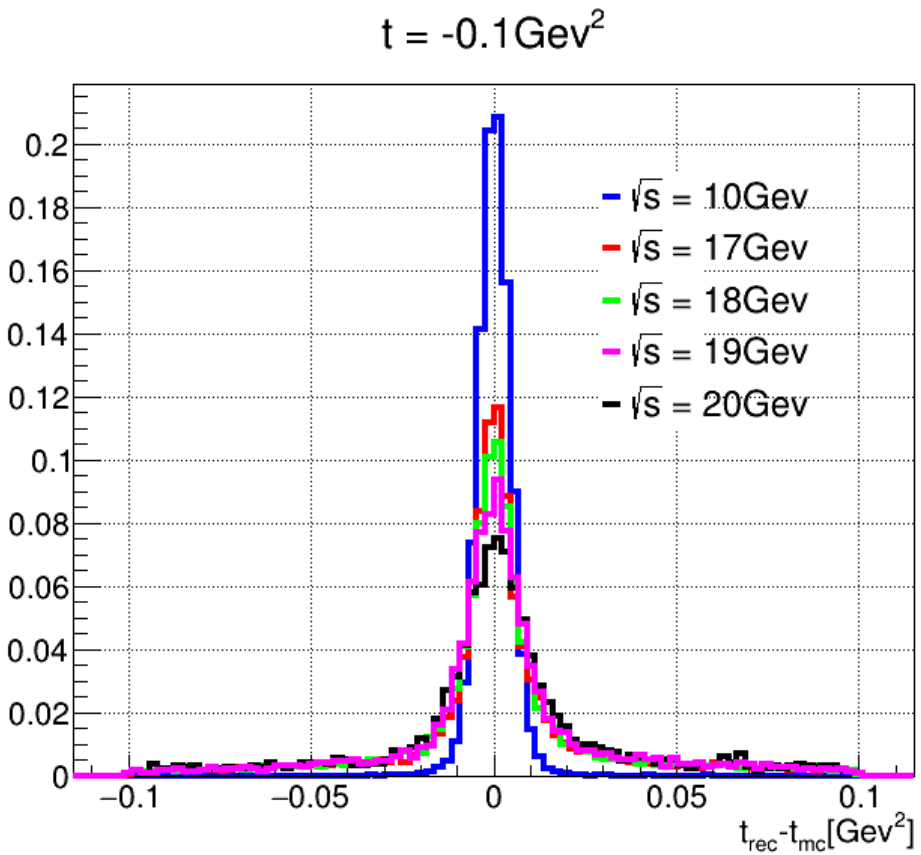


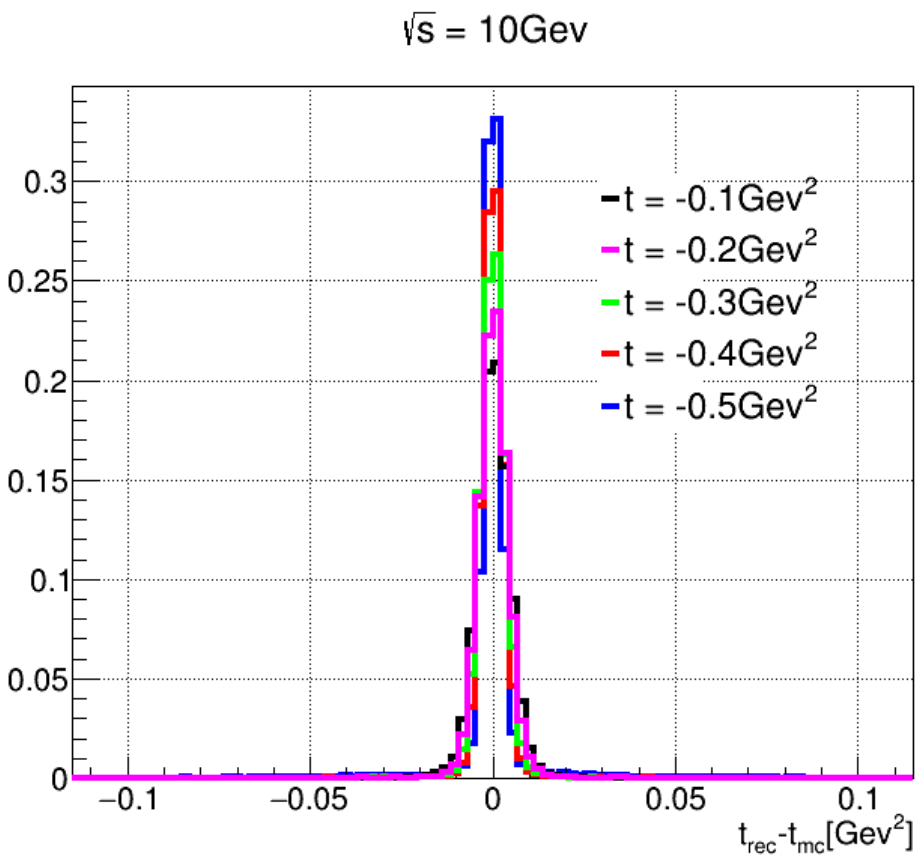




one possibility – change total energy

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





Backup

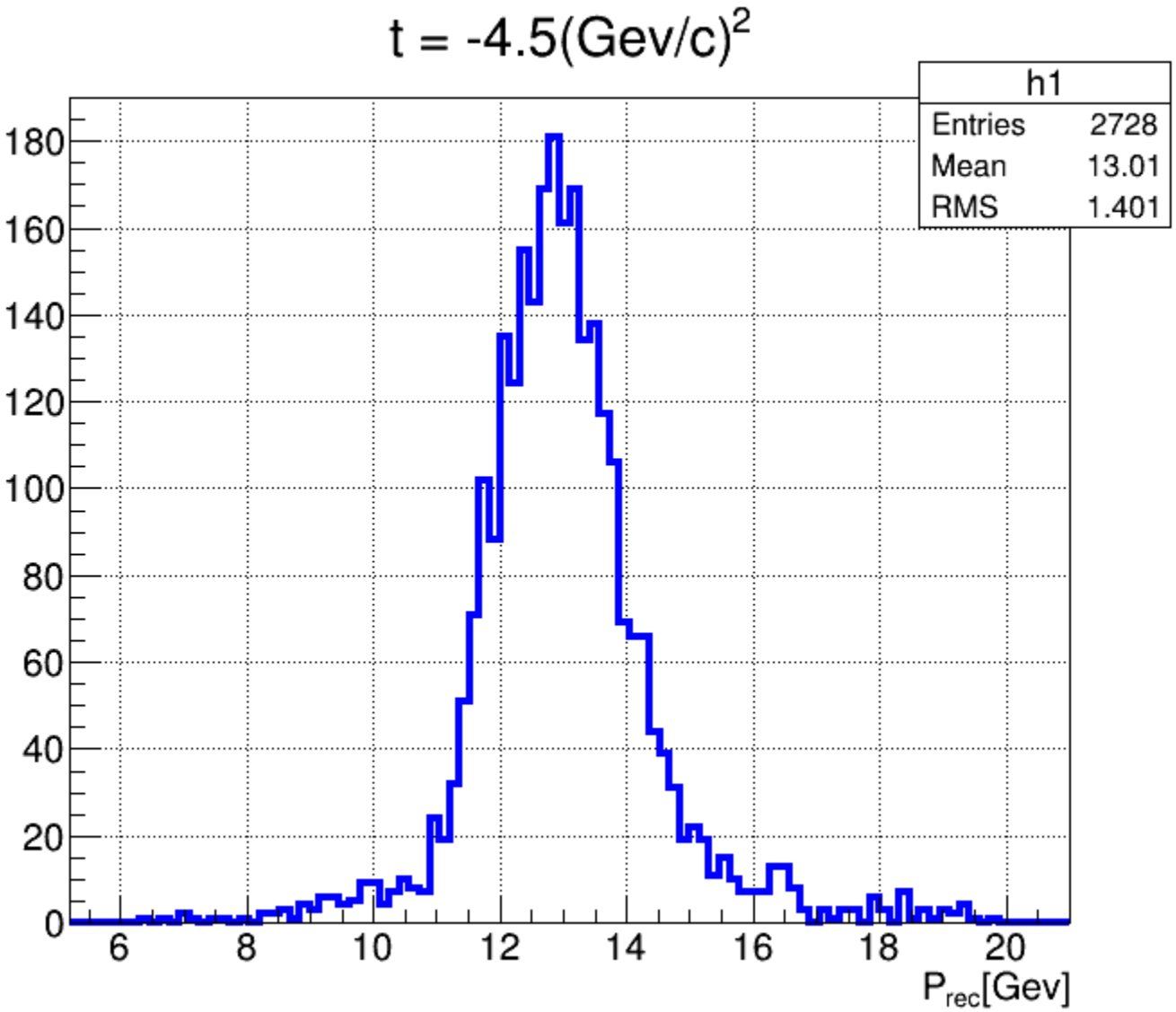
of planes in endcap tracker – 52 in each direction

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

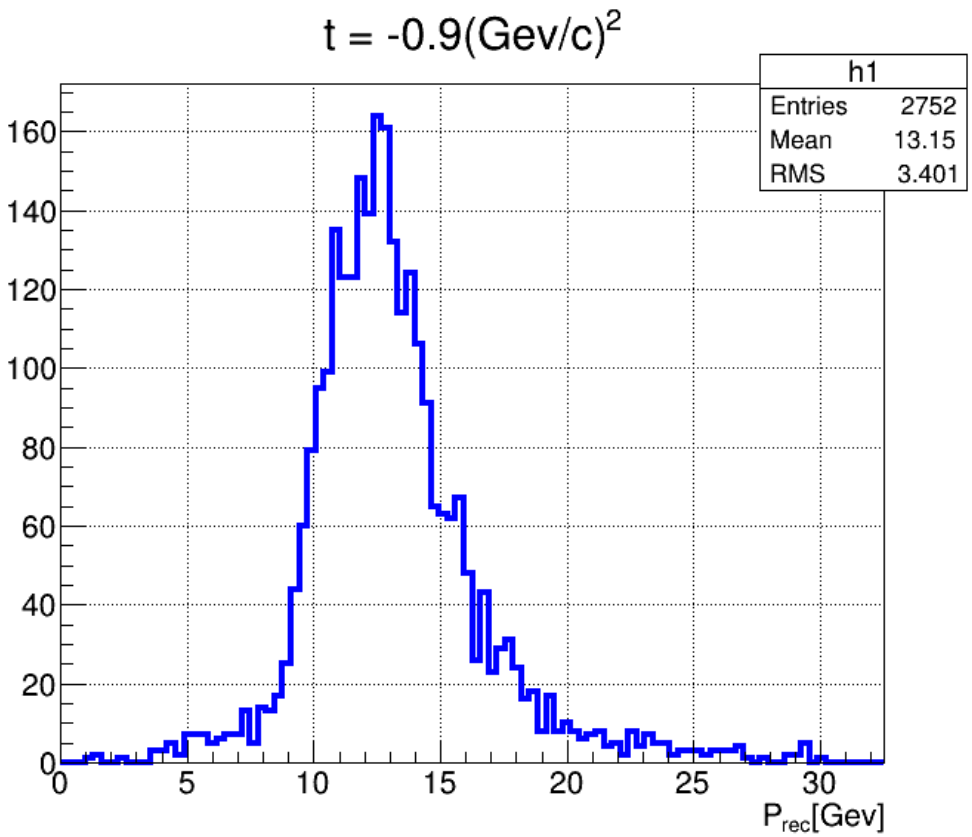
$t = -0.5(Gev/c)^2$ → polar angle 3^0

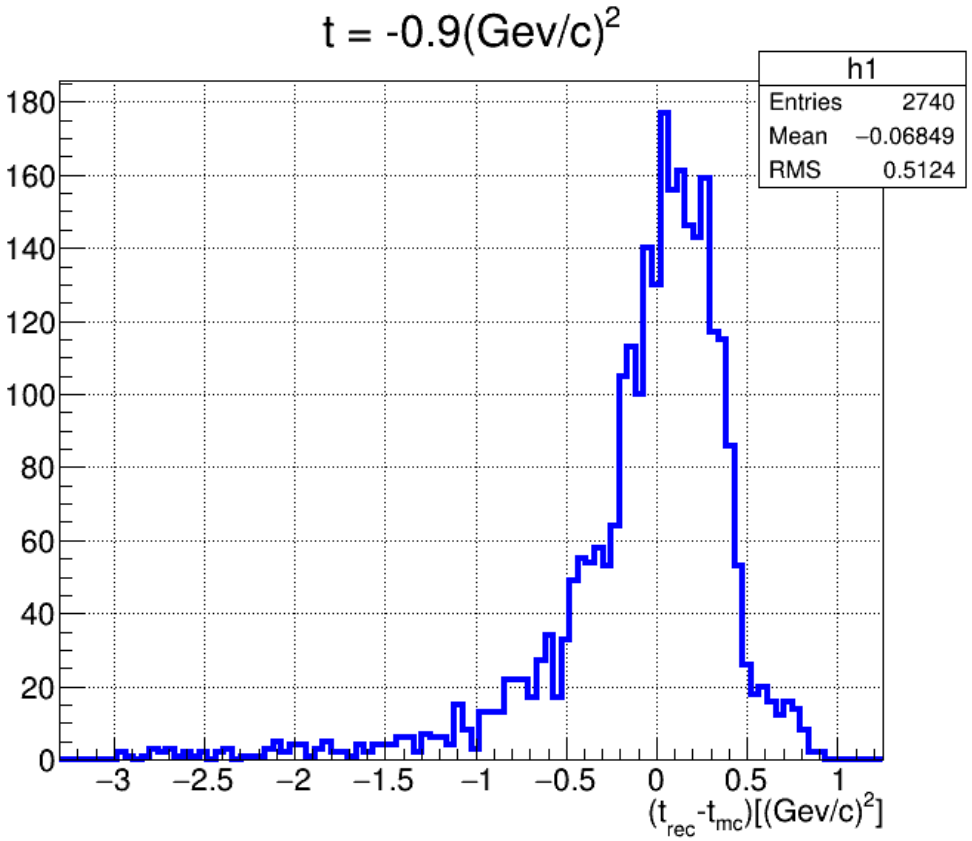
$t(Gev/c)^2$	hits in vertex tracker	hits in barrel tracker	hits in endcap tracker
-0.1	0	0	~7
-0.2	0	0	~19
-0.3	0	0	~45
-0.4	0	0	~52
-0.5	~1	0	~52
-0.9	~4	0	~52
-4.5	~5	0	~52

Kalman fit

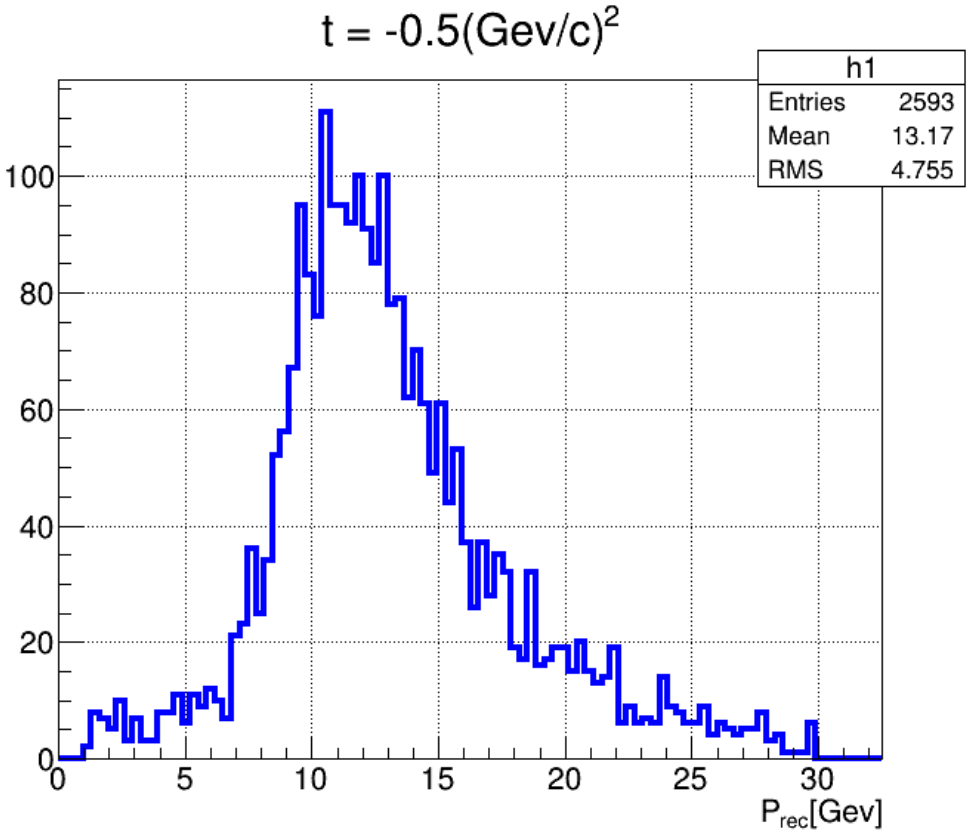

t = -4.5(Gev/c)^2
h1
Entries 2728
Mean 13.01
RMS 1.401
180
160
140
120
100
80
60
40
20
0
6
8
10
12
14
16
18
20
P_{rec}[Gev]

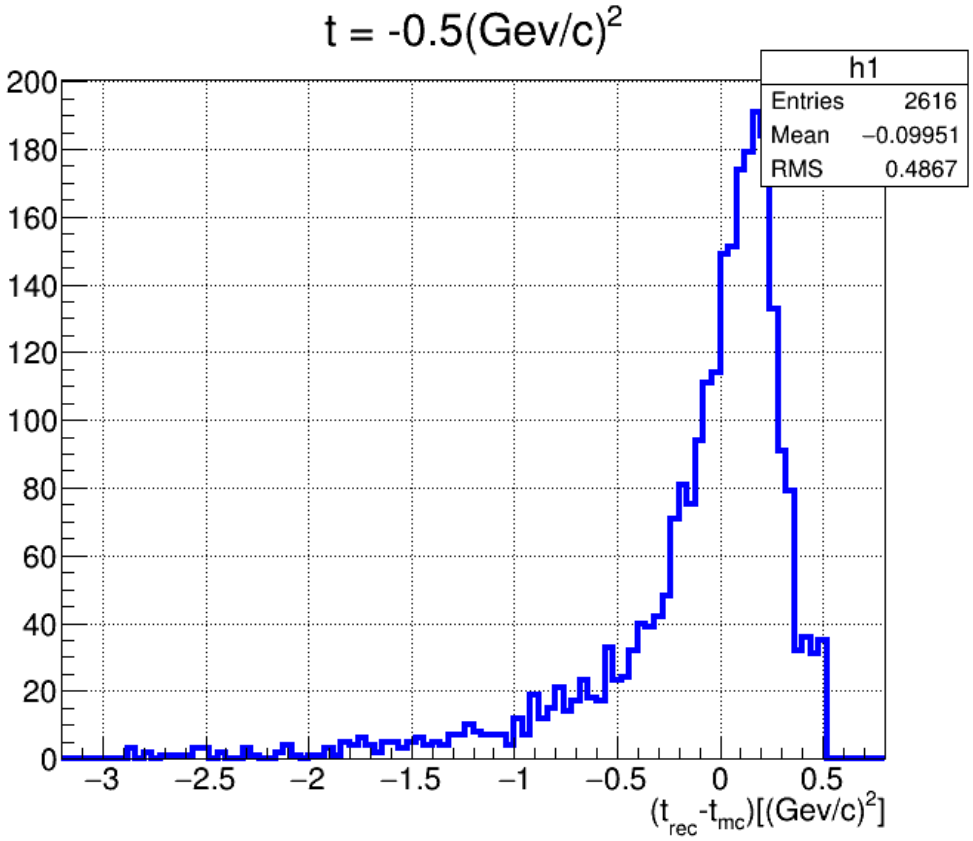
Kalman fit


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]

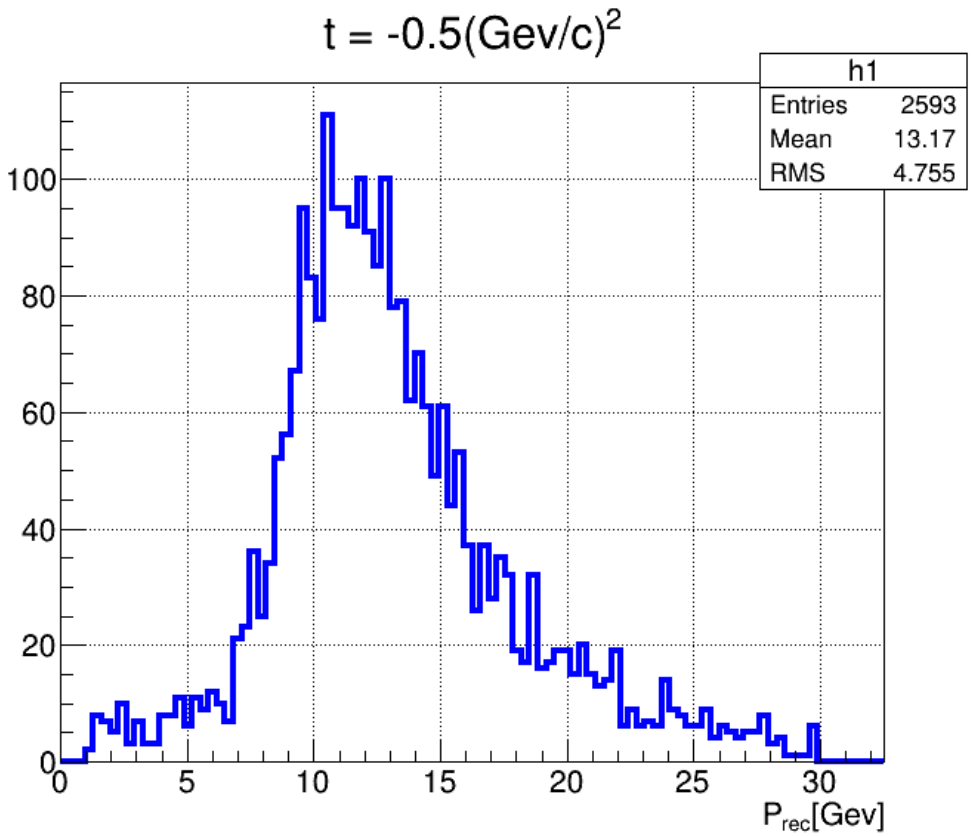
Kalman fit


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

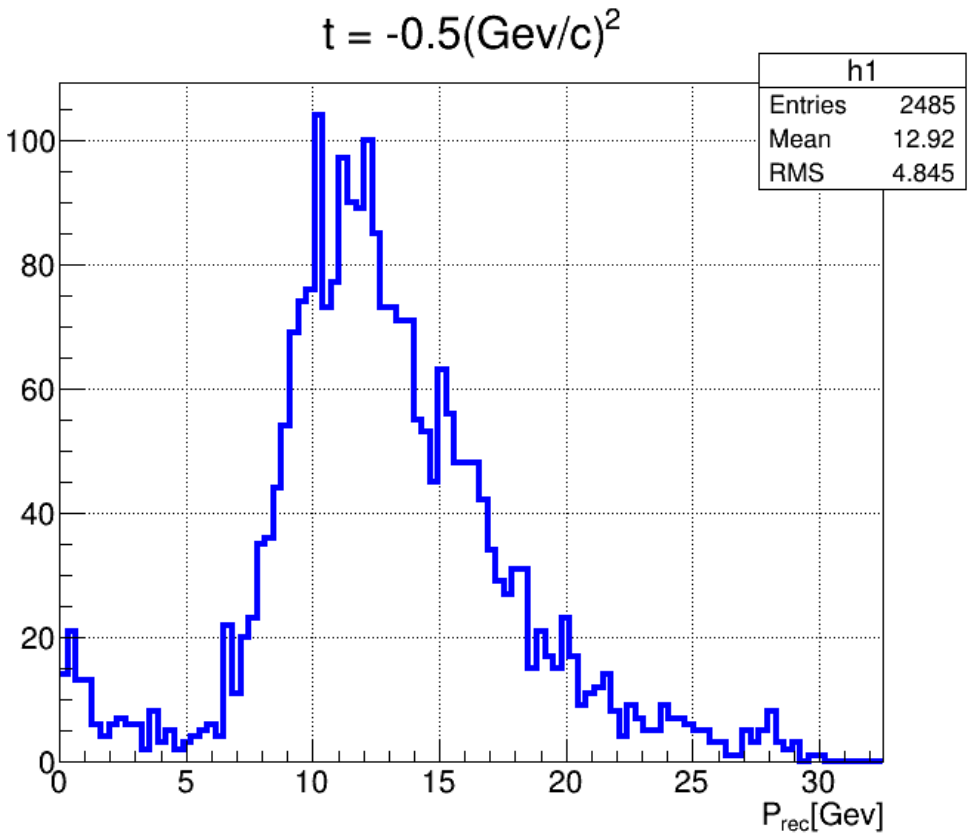

t = -0.5(Gev/c)^2
h1
Entries 2616
Mean −0.09951
RMS 0.4867
$(t_{rec}-t_{mc})[(Gev/c)^2]$

Kalman fit

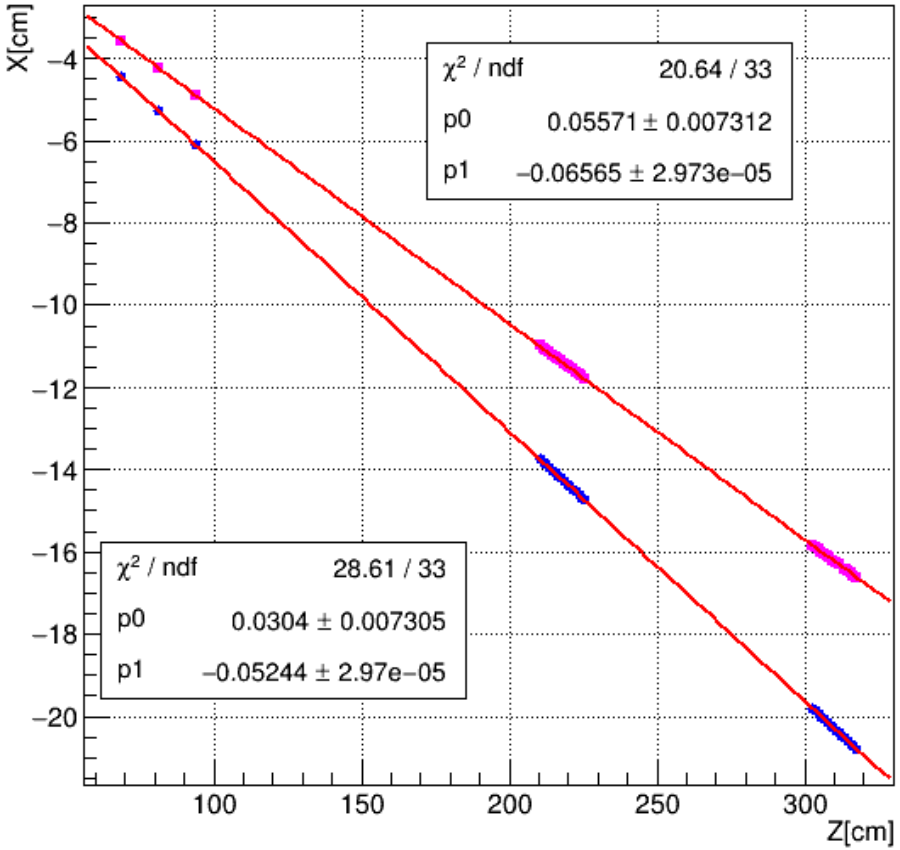
fit start P = 13Gev



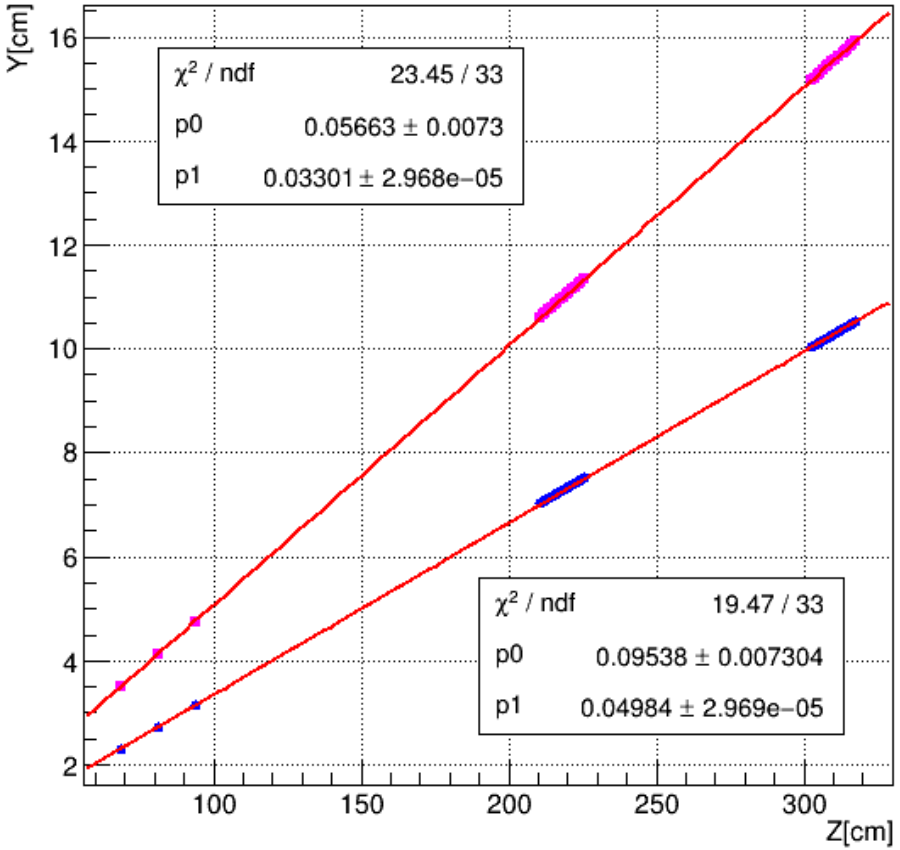
fit start P = 1Gev

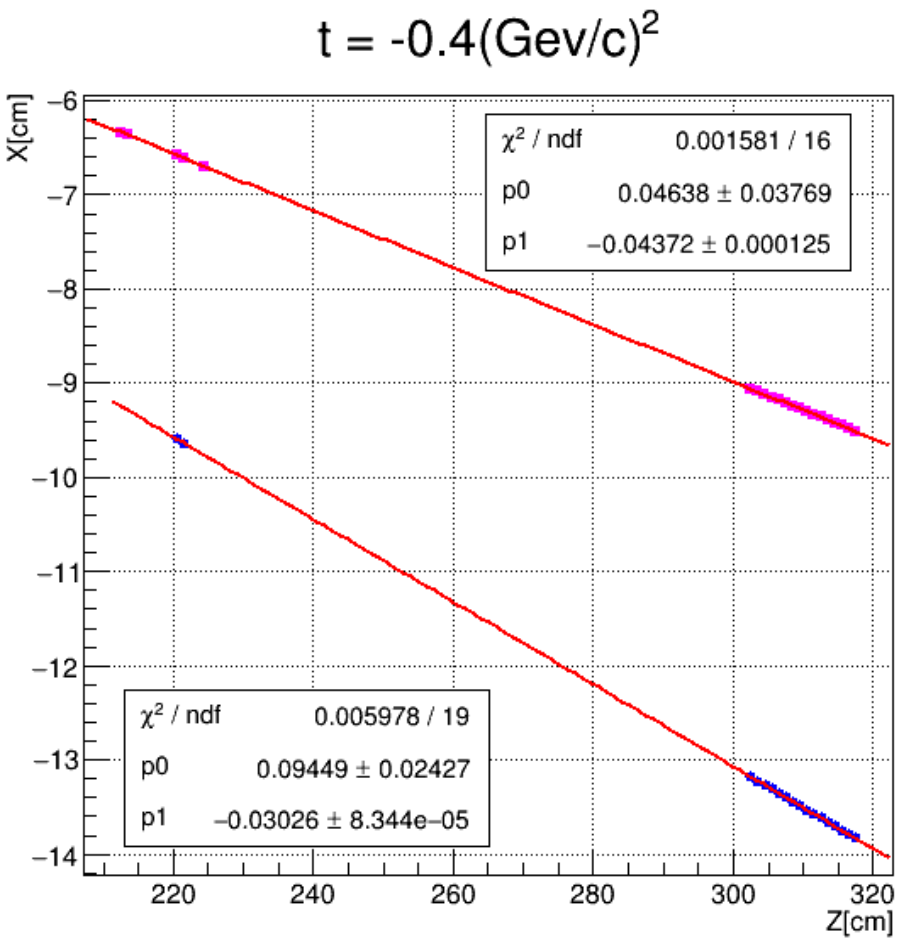


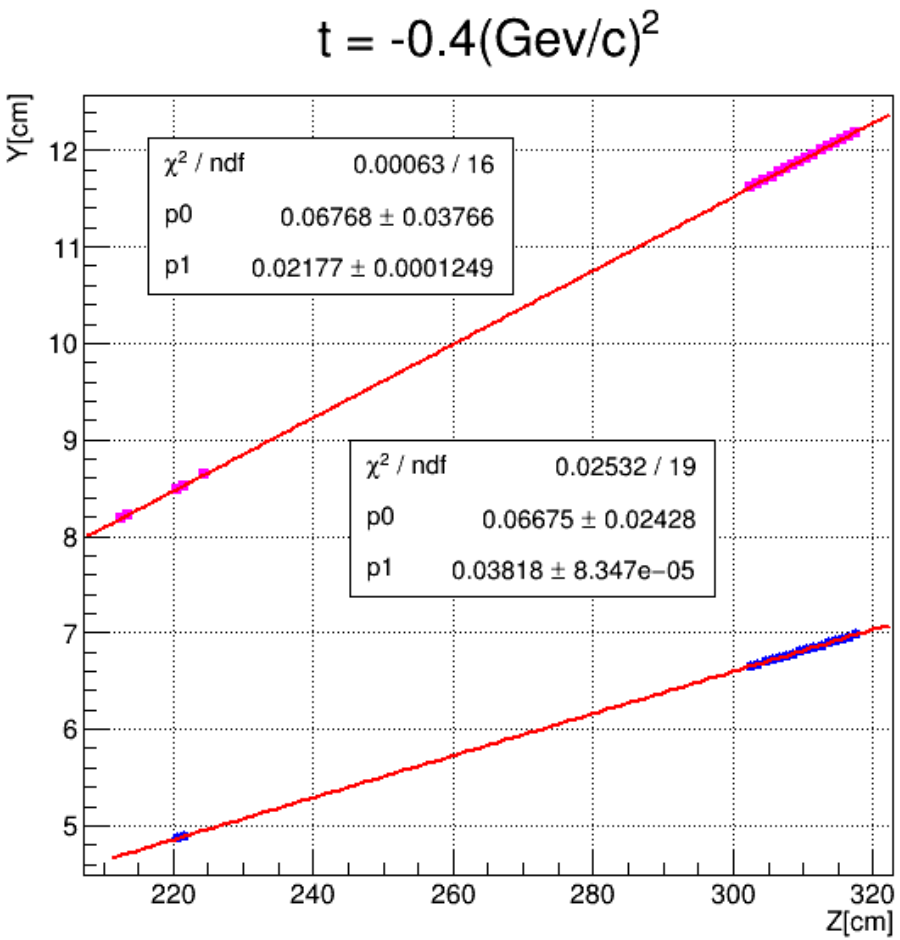
t = -0.9(Gev/c)^2



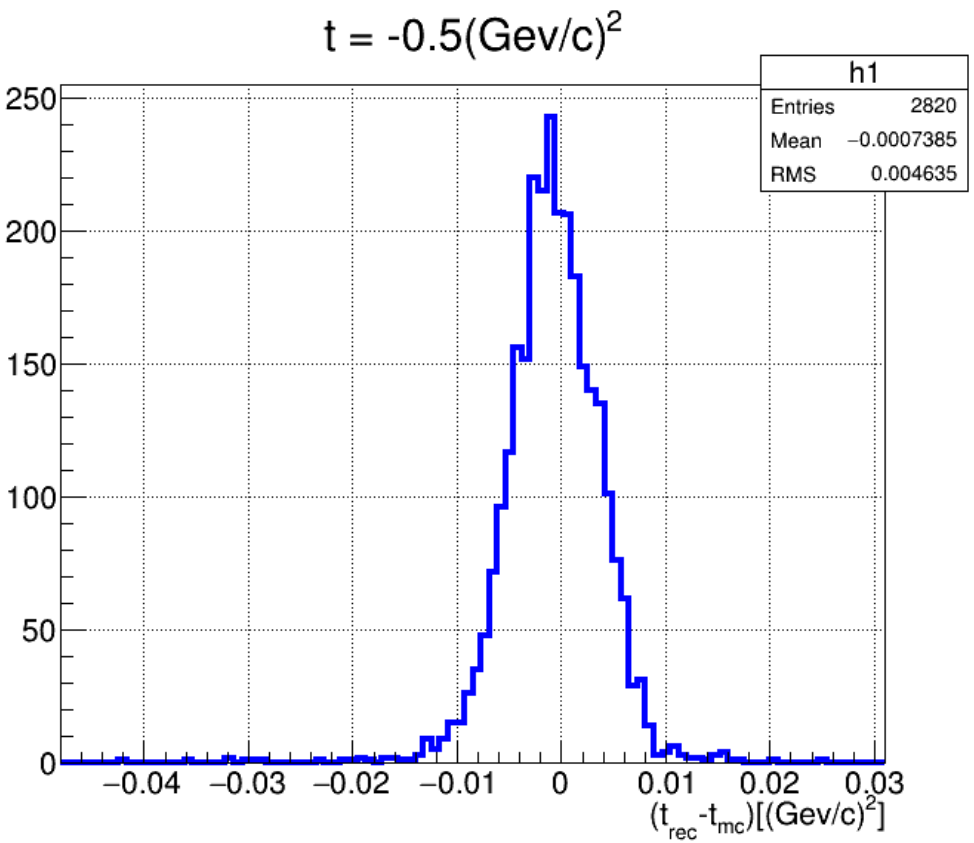
t = -0.9(Gev/c)^2

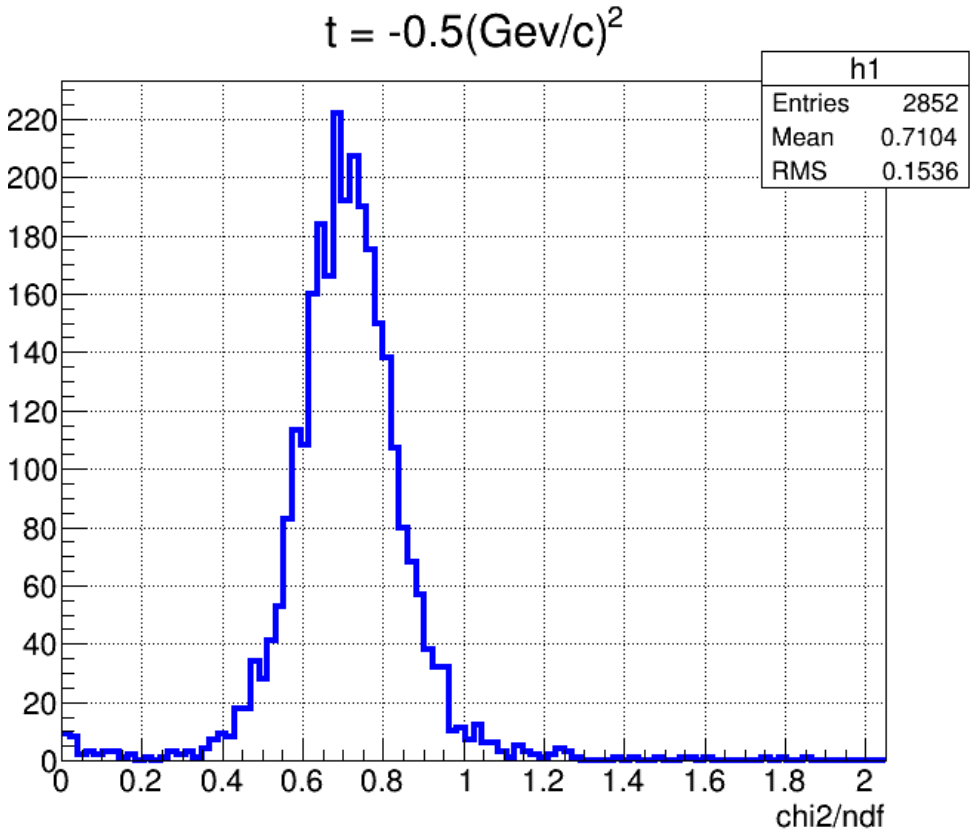



t = -0.4(Gev/c)^2
X[cm]
Z[cm]
χ^2 / ndf 0.001581 / 16
p0 0.04638 ± 0.03769
p1 −0.04372 ± 0.000125
χ^2 / ndf 0.005978 / 19
p0 0.09449 ± 0.02427
p1 −0.03026 ± 8.344e−05

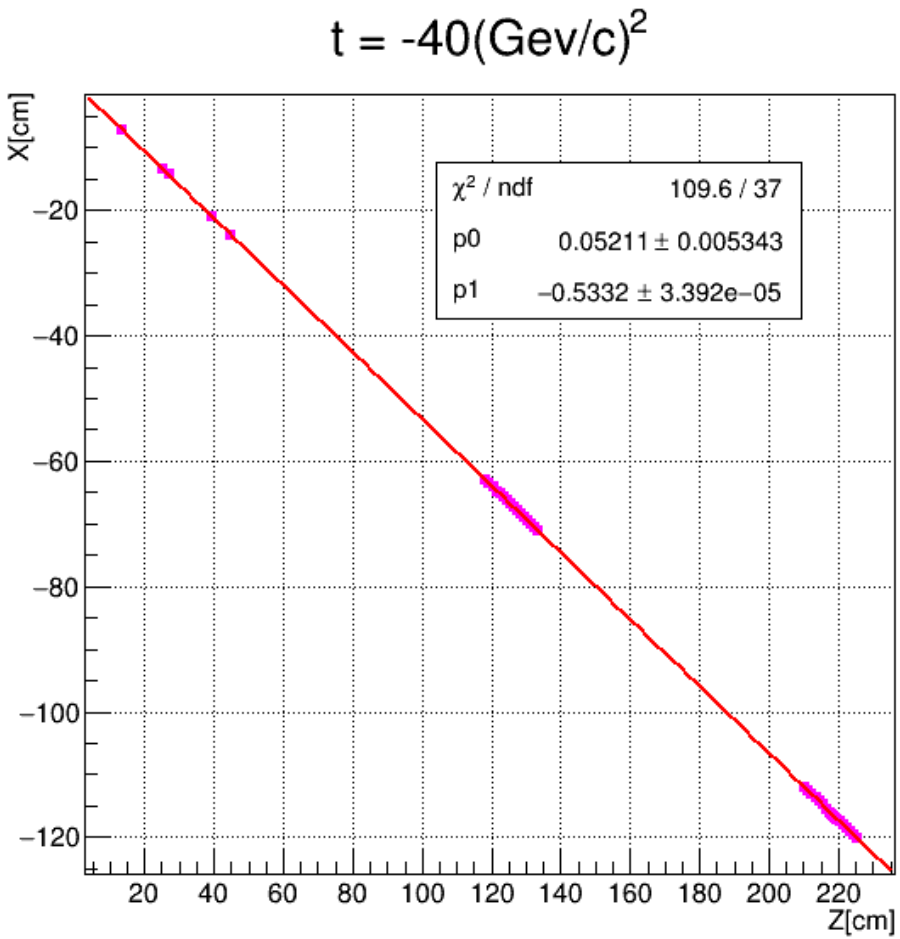

t = -0.4(Gev/c)^2
Y[cm]
Z[cm]
χ^2 / ndf 0.00063 / 16
p0 0.06768 ± 0.03766
p1 0.02177 ± 0.0001249
χ^2 / ndf 0.02532 / 19
p0 0.06675 ± 0.02428
p1 0.03818 ± 8.347e−05

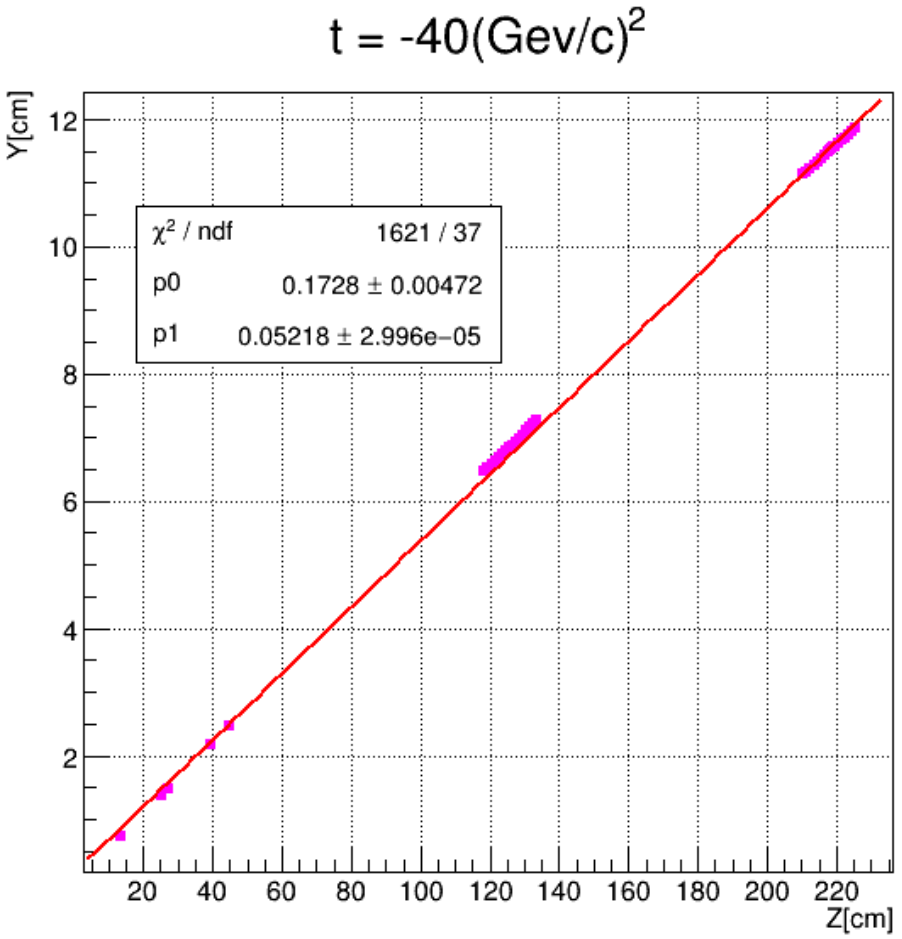
fit by straight line, no Kalman fit

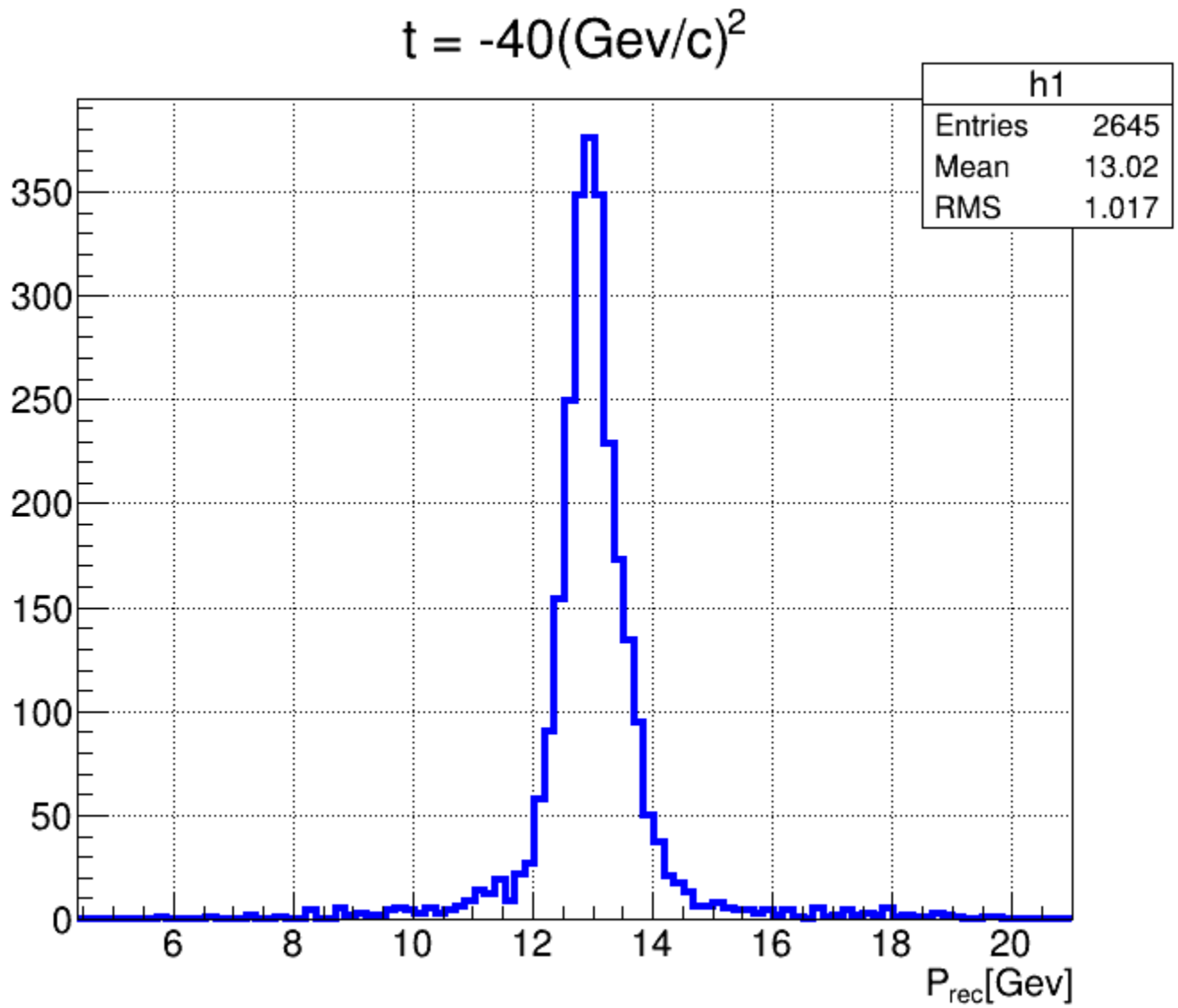


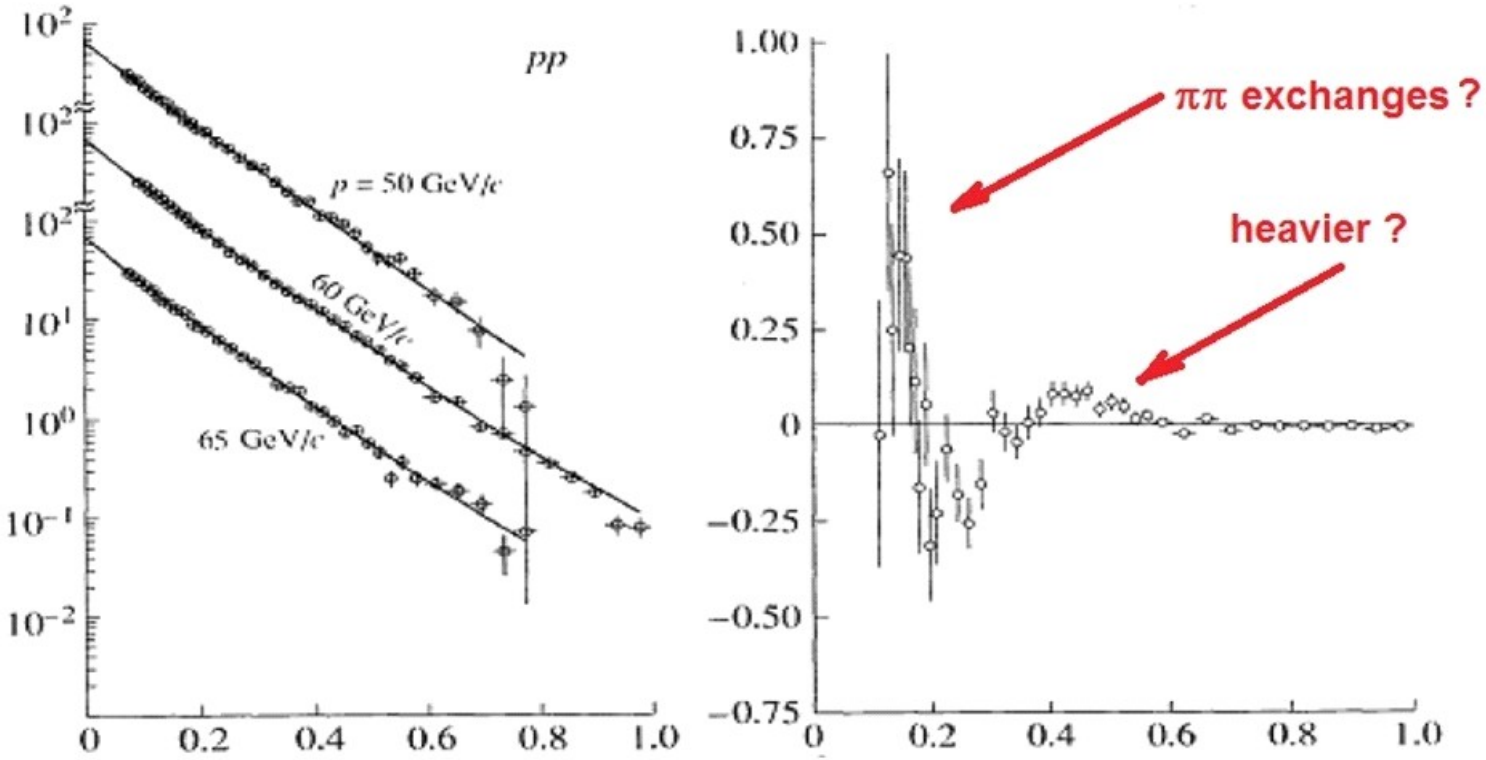


polar angle 28^0






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]



Antipov et al. preprint 1976.