Transverse Single Spin Asymmetry of forward Neutrons

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Large transverse spin asymmetry for forward neutrons

- Large x_F neutron production in ep collisions by ZEUS, are mainly reproduced by a pion exchange.

- Observed large asymmetry for the neutron production is considered to come from the interference between a spin-flip amplitude due to the pion exchange and non-flip amplitudes from other Reggeon exchange.

- We aim to see with energy of collisions which essentially scan over wide range of x_F. run-6 (62 GeV), run-9 (500 GeV) run-11/12/13 (510 GeV), 200GeV published.

Neutron Detection and Single Spin Asymmetry

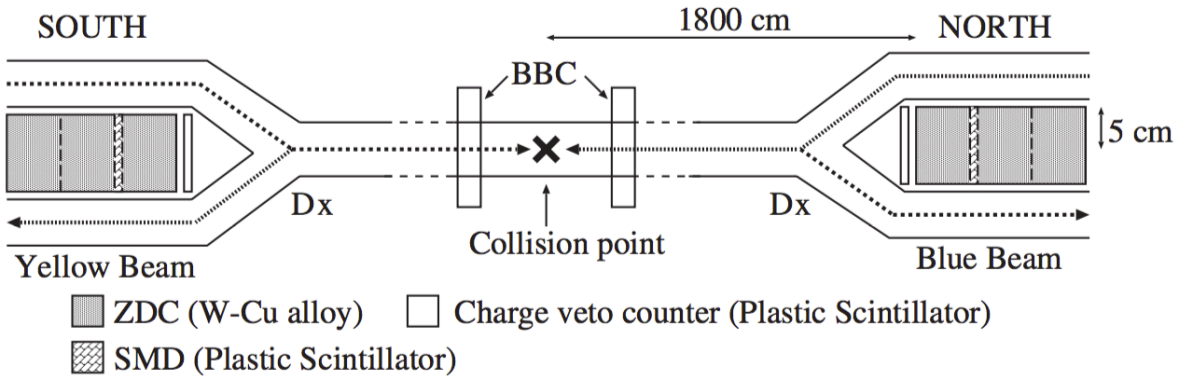
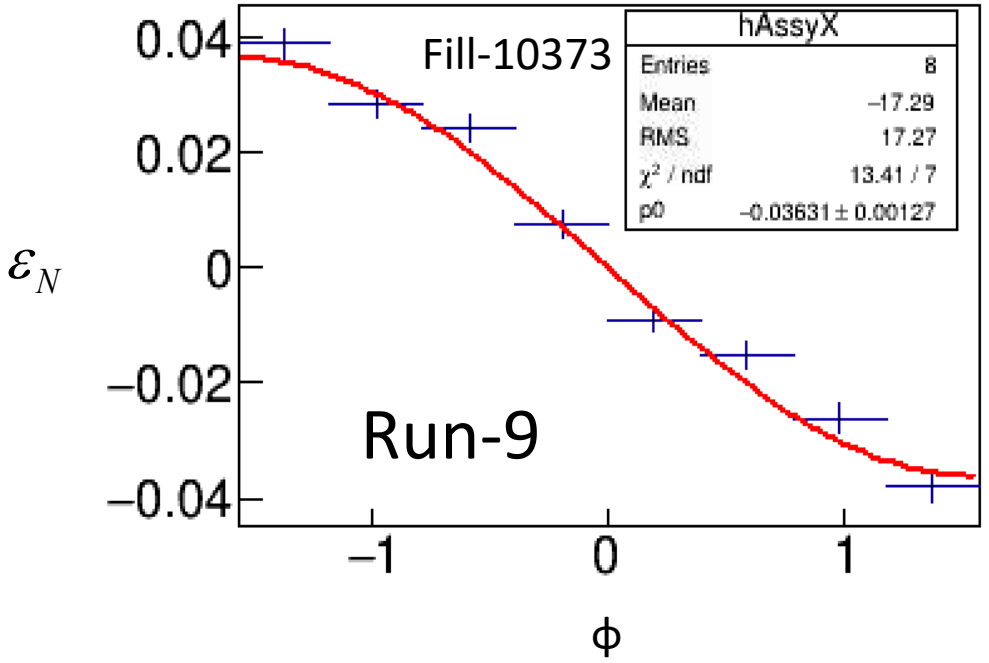


Figure 4.10: A layout of the ZDC and BBC.

cross ratio method



$$\varepsilon_N \equiv \frac{\sigma_\uparrow - \sigma_\downarrow}{\sigma_\uparrow + \sigma_\downarrow} \approx \frac{\sqrt{N_L^\uparrow N_R^\downarrow} - \sqrt{N_L^\downarrow N_R^\uparrow}}{\sqrt{N_L^\uparrow N_R^\downarrow} + \sqrt{N_L^\downarrow N_R^\uparrow}}$$

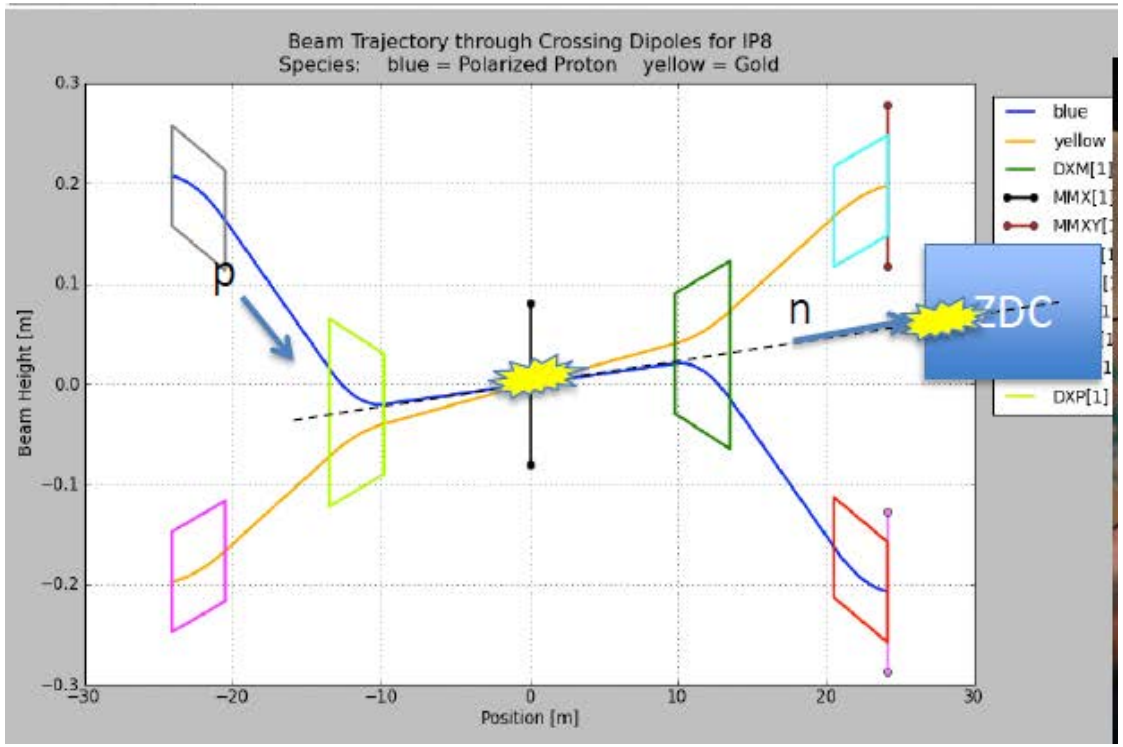
$A_{N.} = \varepsilon_N$ /Beam Polarization

Event cuts :
tdc0,1 < 3800, r < 5cm

Charge Particle Rejection :
zdc raw adc for **veto plane** < 0.5*MIP (charge particle rejection, proton)

Photon rejection :
- E(2^{nd})/E(total)-zdc module > 0.01
- Number of smd hits >1 (radiation length of 1st ZDC module, 50 X0)

Background in neutron detection



Earlier GEANT3 simulations

ZDCN|S trigger

√s (GeV)	Proton fraction (%)	Kaon fraction (%)
62	16.6	0.5
200	1.6	1.0
410	0.2	1.3

BBCLL1&(ZDCN|S) trigger

√s (GeV)	Proton fraction (%)	Kaon fraction (%)
200	1.2	1.0
410	0.3	1.4

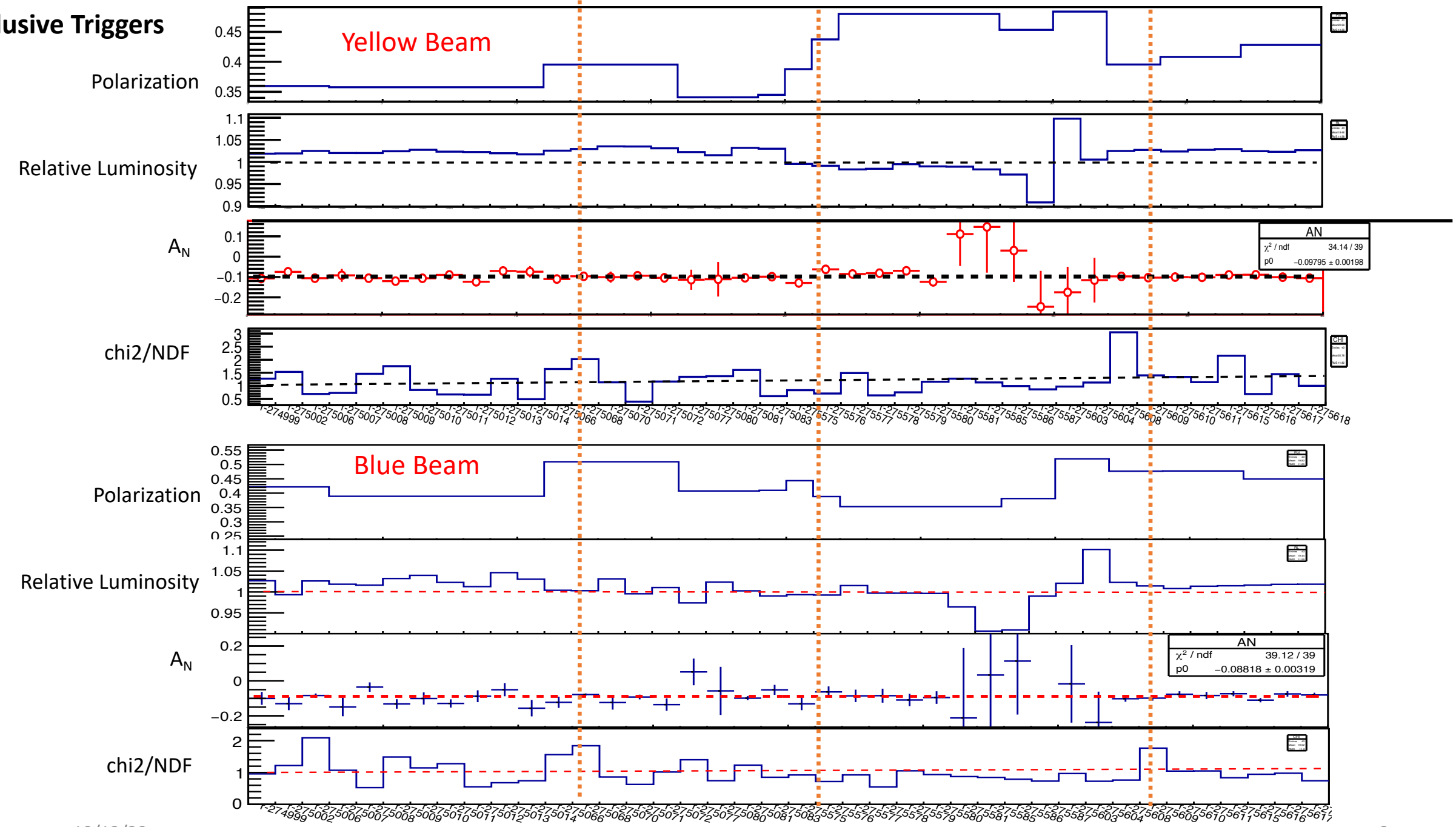
Table 5.1 Background fractions for each energies estimated by Geat3 and pythia event generator.

- Elastic/diffractive scatterings will generate particle shower by hitting the DX magnet and have a chance to deposit energy in the ZDC
- Main backgrounds for neutron measurement are photon and proton

$\sqrt{s}$ =500 GeV

RUN9 transverse data is used (Fill#10340, 10348, 10371 and 10373). Event samples are 74.6M and 5.3M for “BBCLL1&(ZDCN|ZDCS)” and “ZDCN|S” triggers, respectively. Polarization is ~ 42% in this

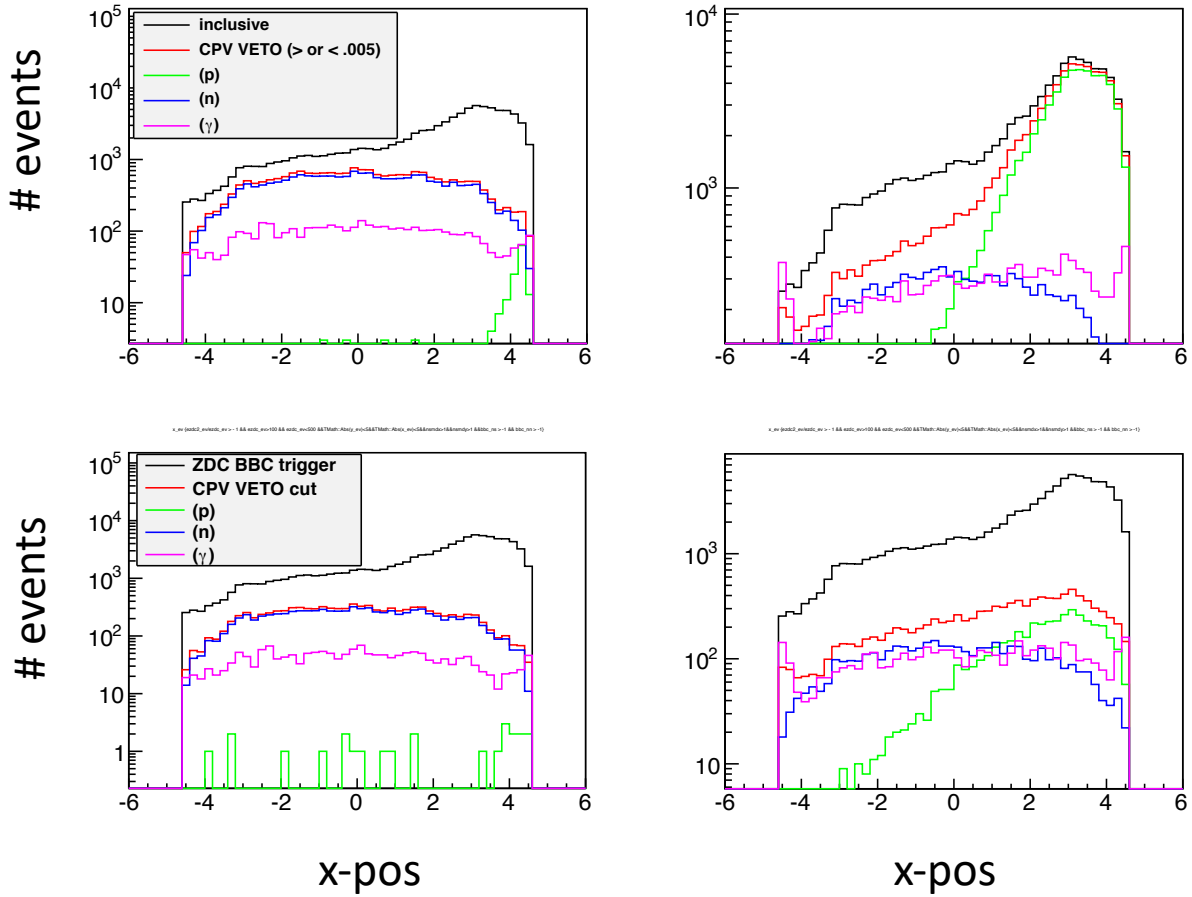
Inclusive Triggers



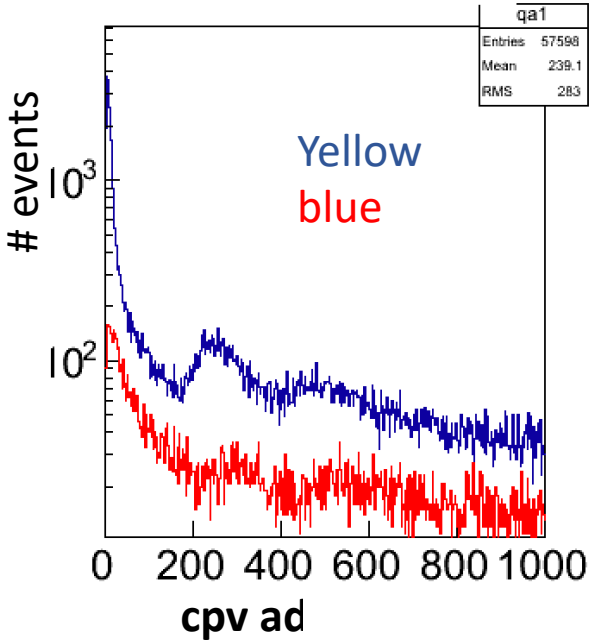
Background Estimation

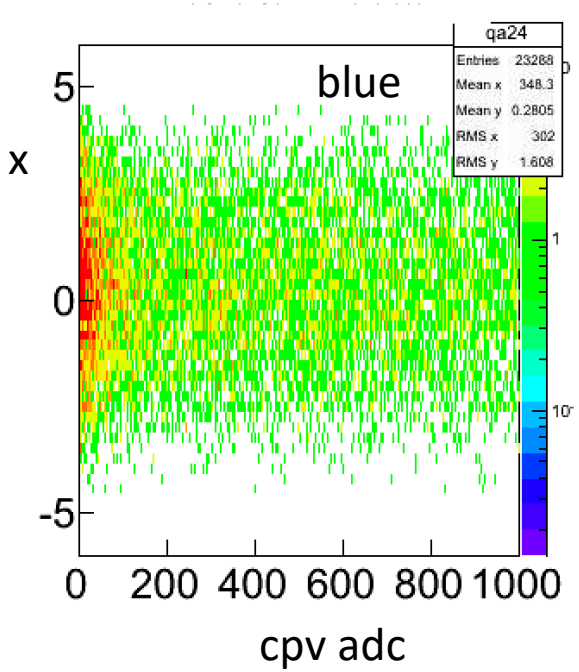
Trigger and MIP cond.	n	p	gamma
Inclusive < MIP	0.898	0.001	0.179
Inclusive > MIP	0.182	0.740	0.193
Zdc&bbc < MIP	0.900	0.001	0.167
Zdc&bbc > MIP	0.438	0.382	0.418

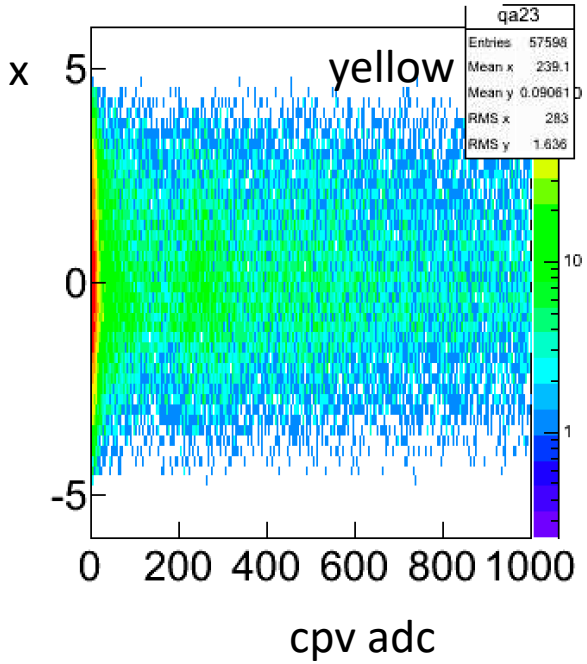
Veto cut < .0005 GeV



Charge particle Veto







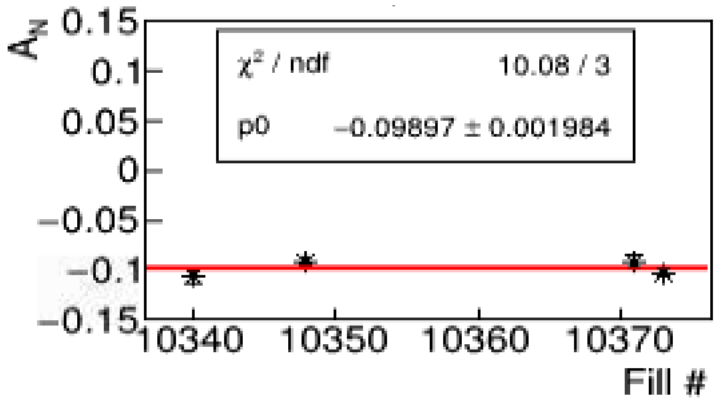
CPV peak at about 230 ADC

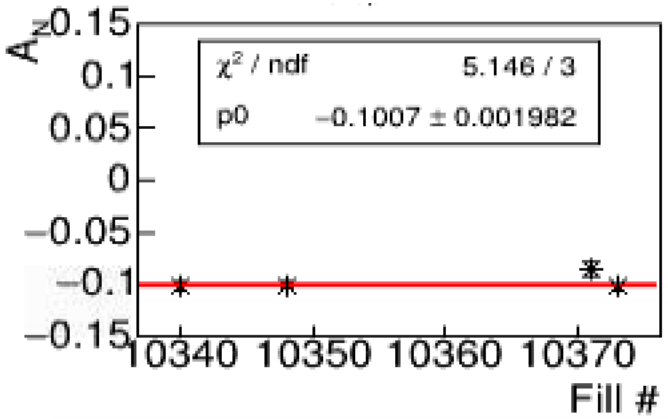
Asymmetries for CPV threshold

ADC < 100

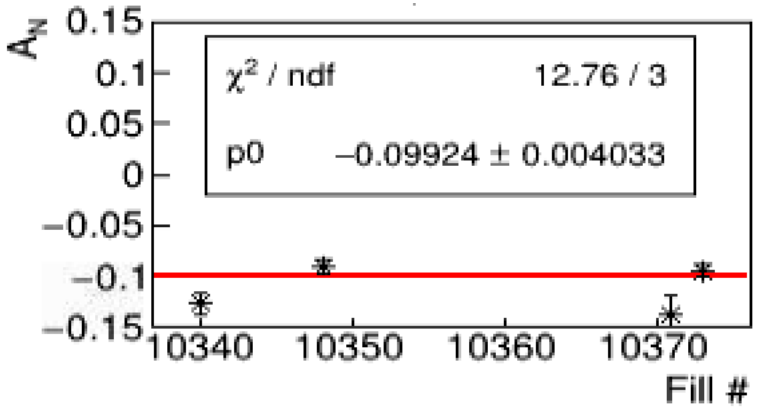
ADC > 100

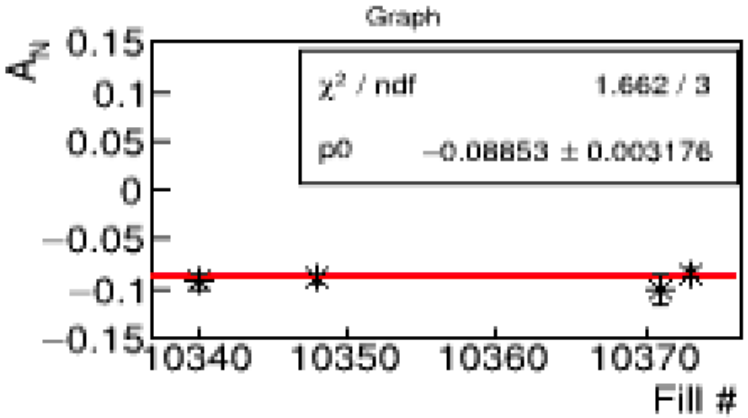
Yellow





Blue





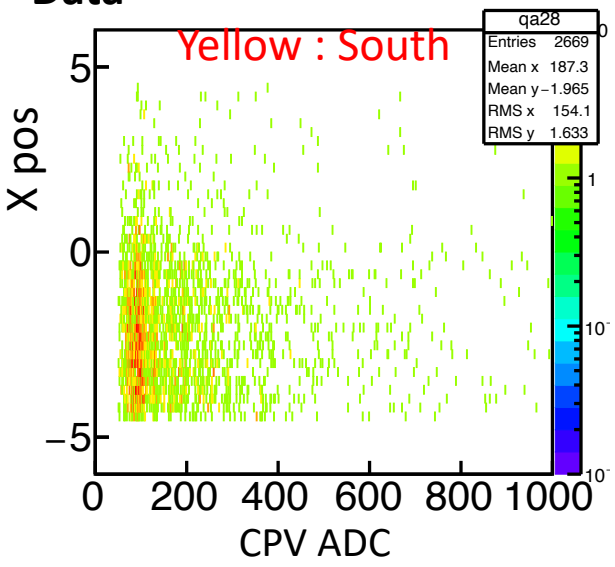
Run–6 analysis

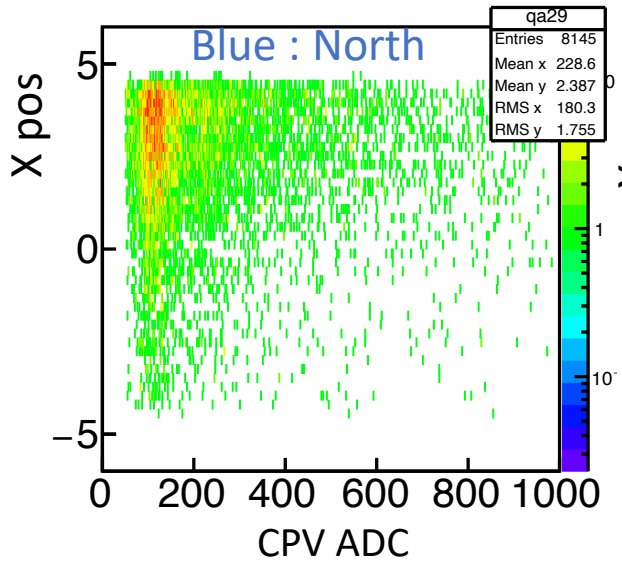
$\sqrt{s}$ =62 GeV

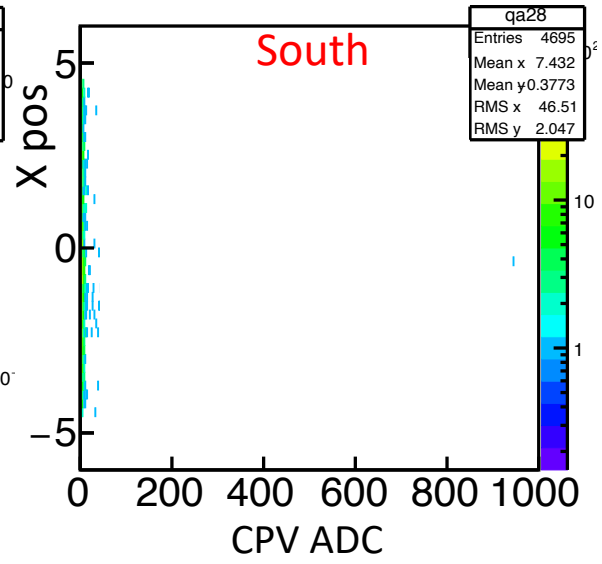
RUN6 transverse data is used (Fill#8005,8015,8016,8021,8022,8023,8024 and 8025). Event sample is 62.8M for “ZDCN|S” triggers. Polarization is ~ 49% in this period.

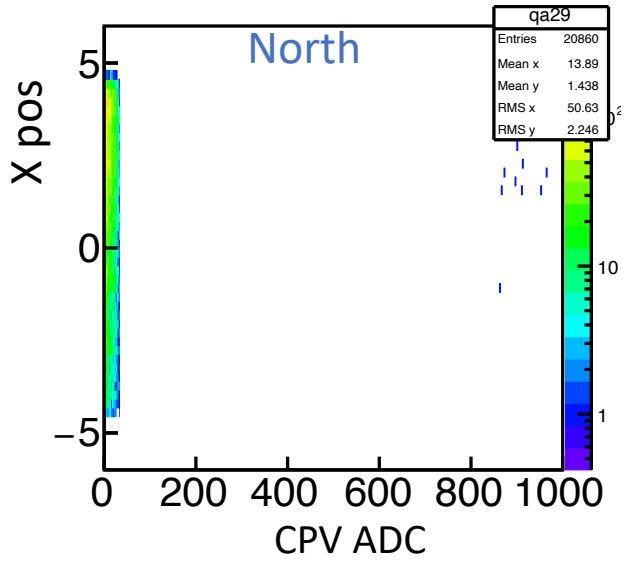
In RUN6, the charge veto counter (a scintillator paddle in front of the ZDC) is not covered the ZDC acceptance for NORTH side. Thus, we can not do correct measurement for NORTH side.

Data

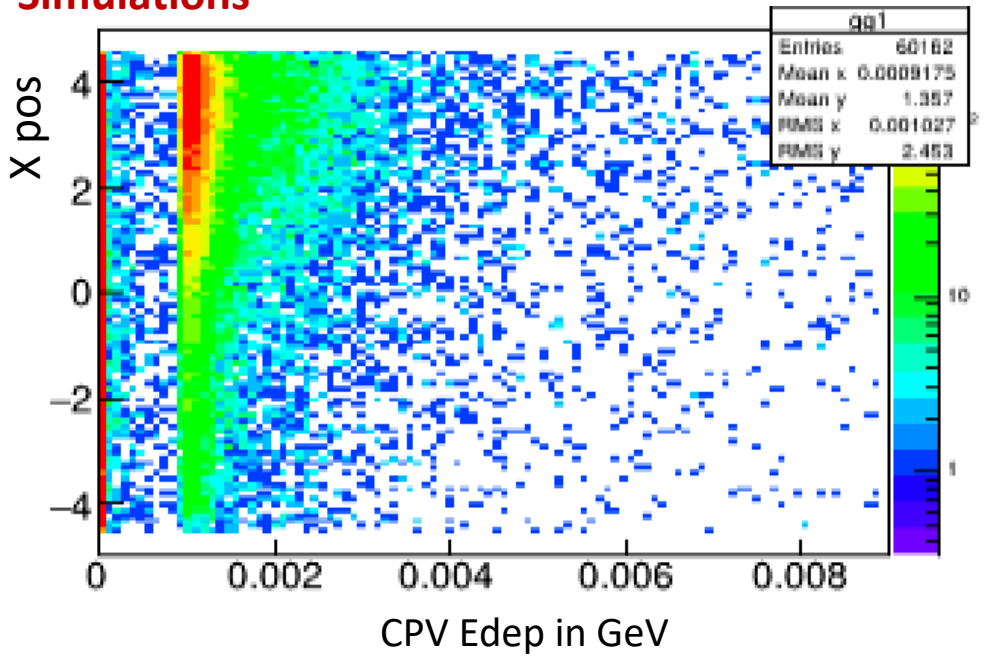


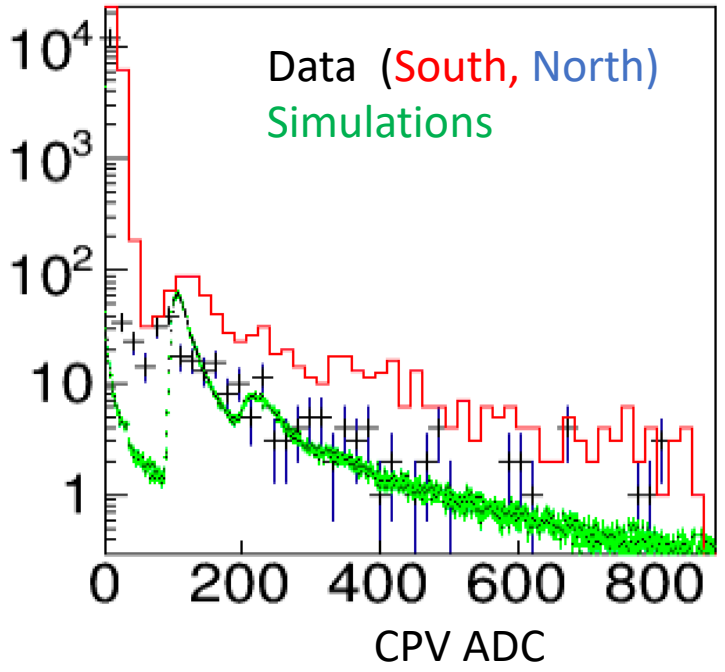






Simulations

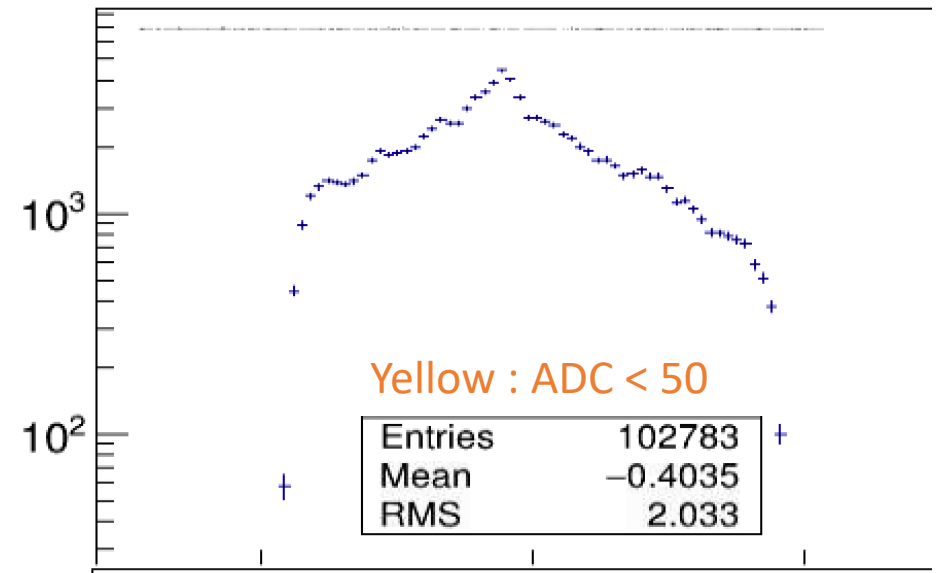


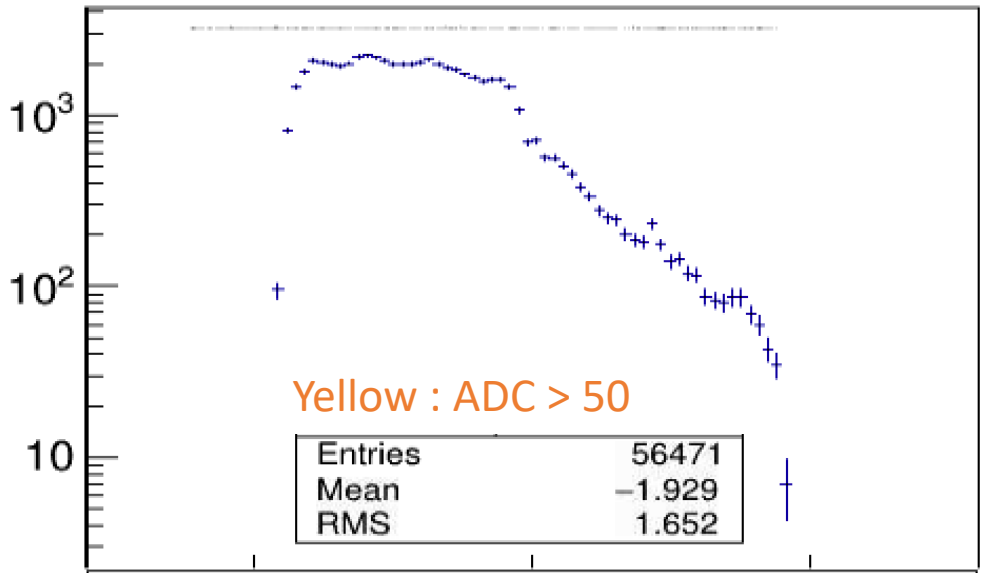


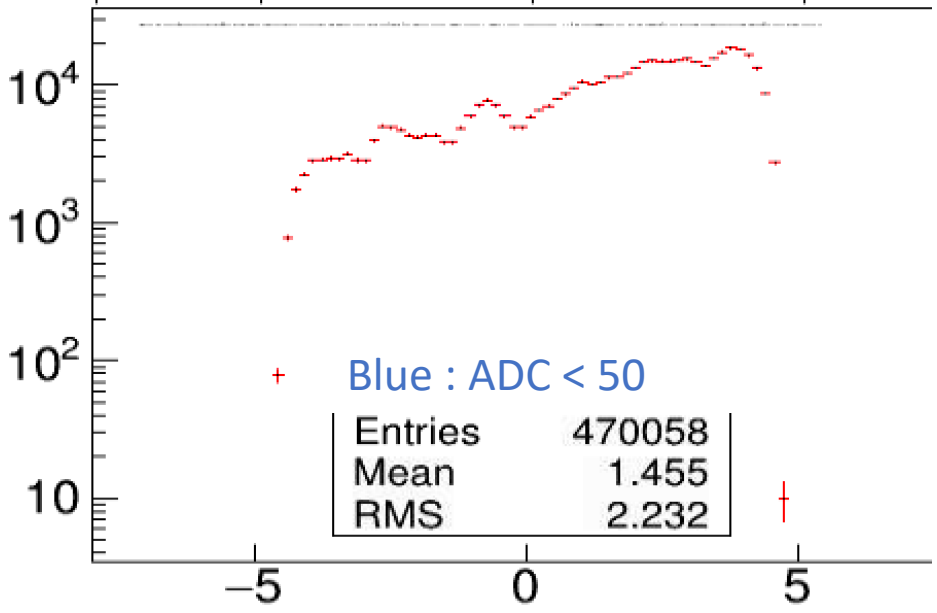
CPV distribution shapes in data and simulations differs widely

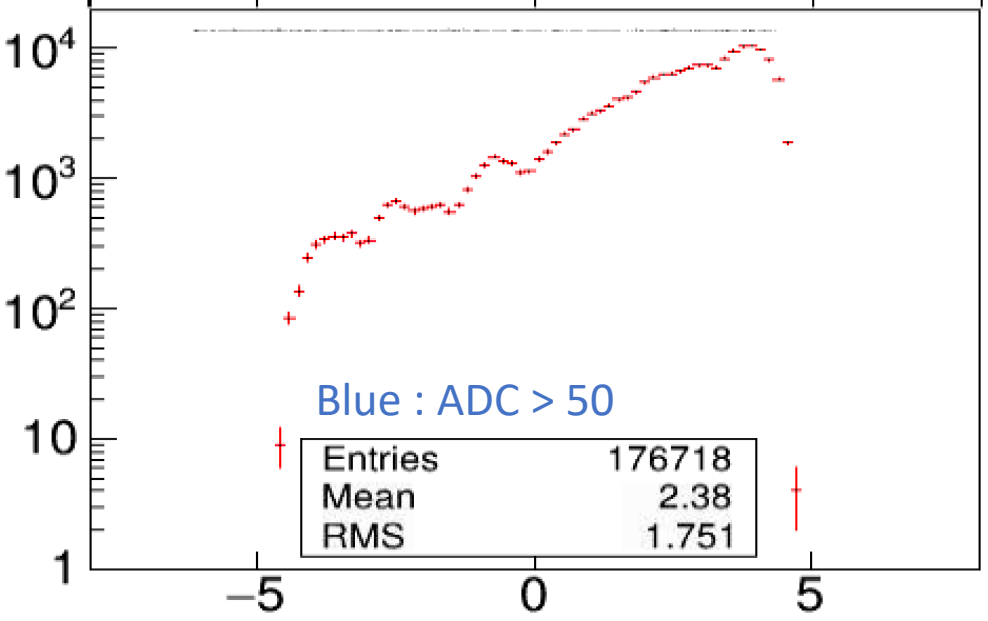
Data based background estimation necessary

X-positions in North is not suppressing background significantly

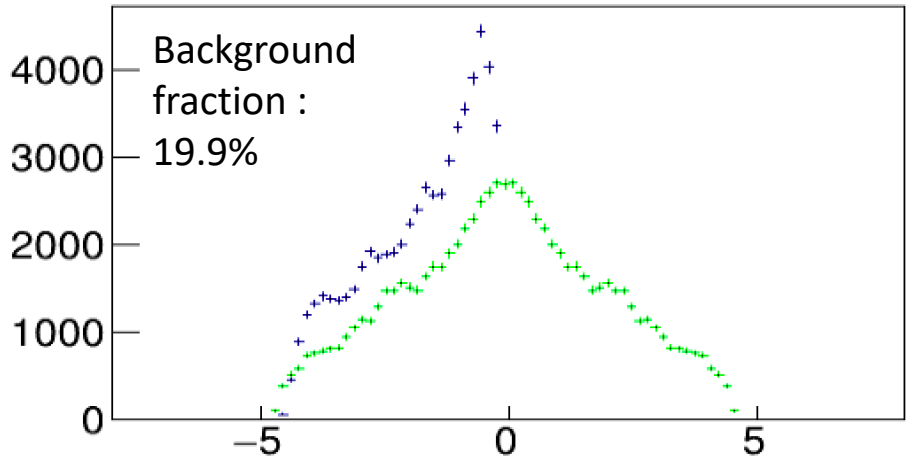


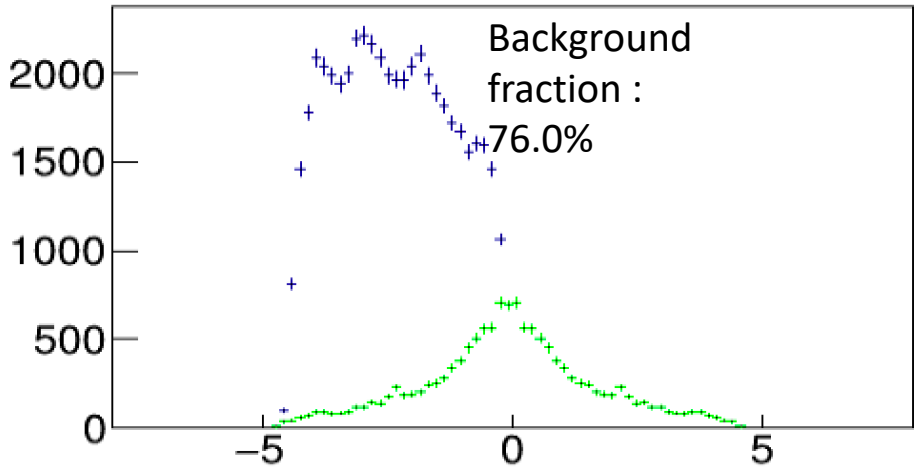


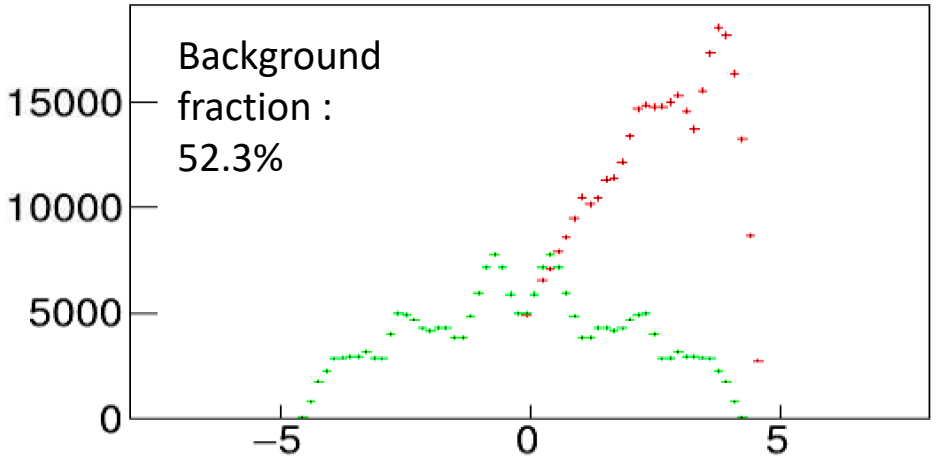


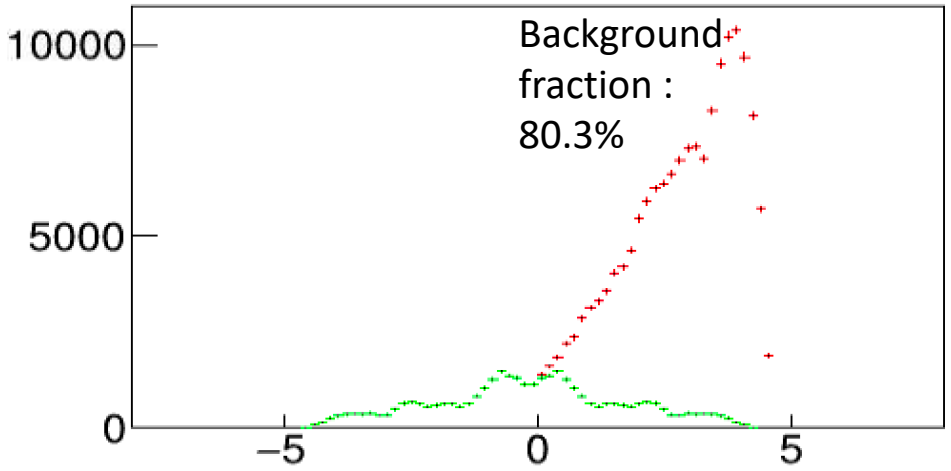


Estimation of **asymmetric background** from data



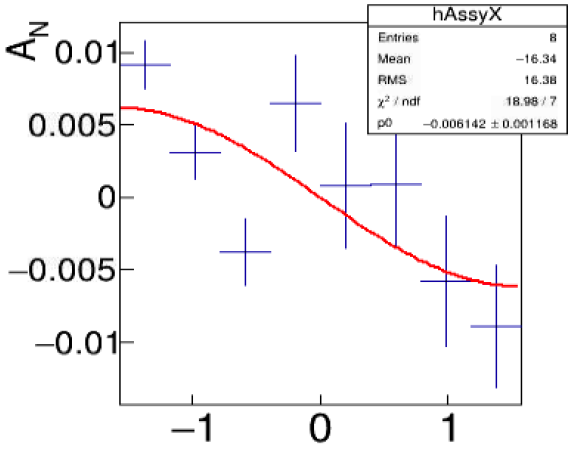


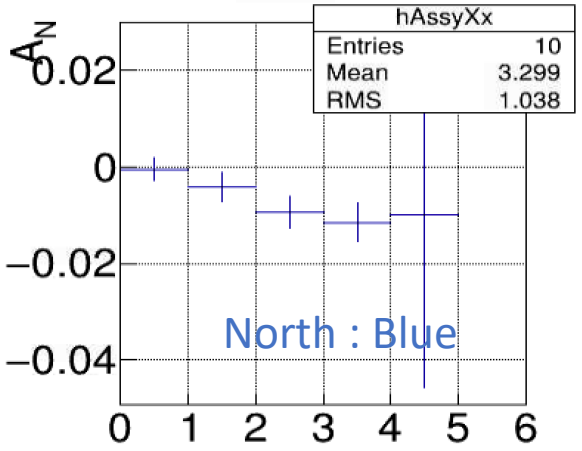


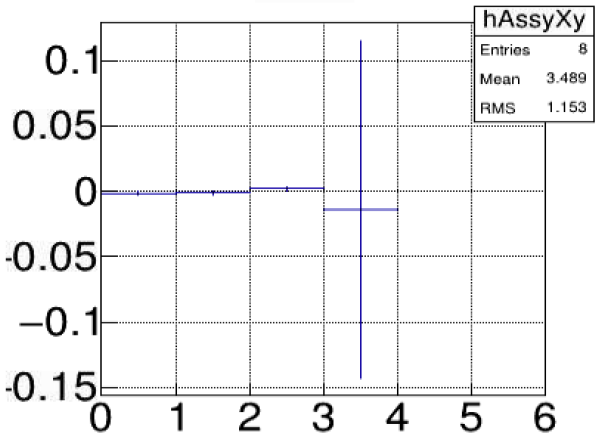


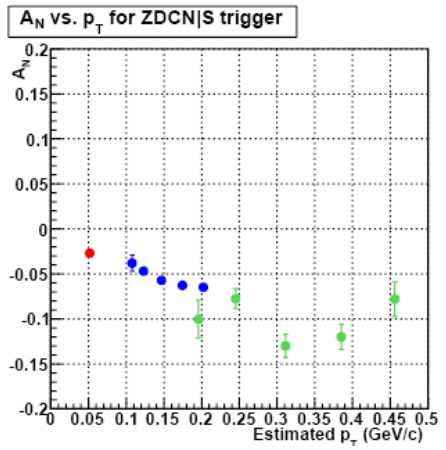
62.4 GeV Asymmetries and x-y scan

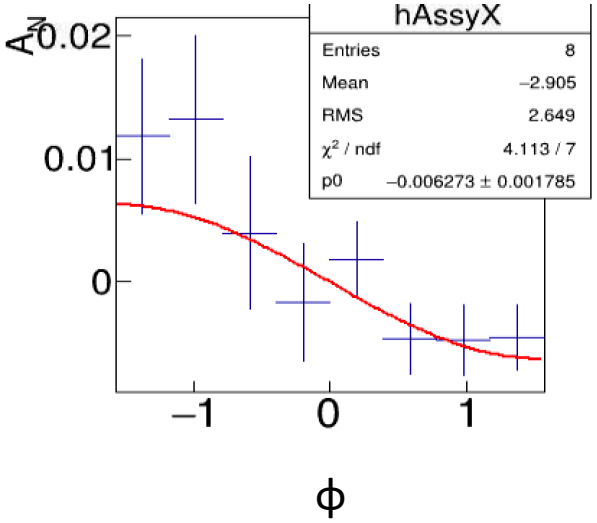
From preliminary note

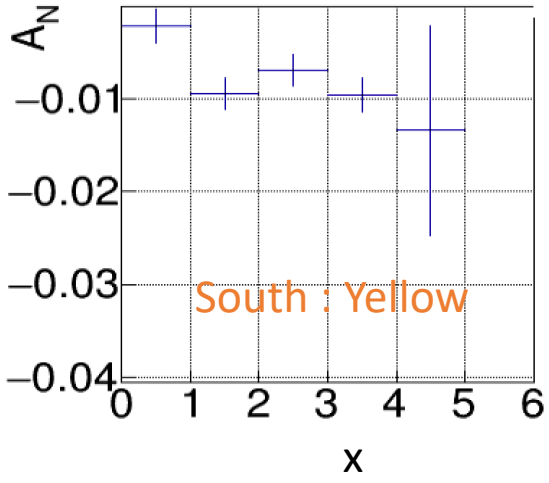


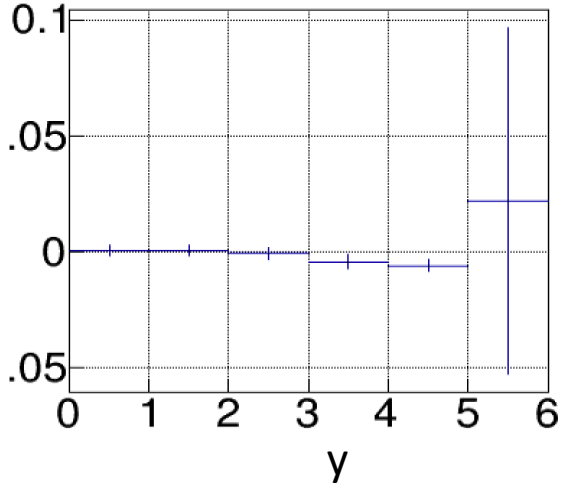


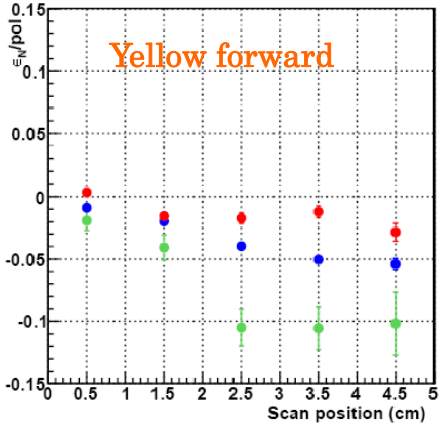








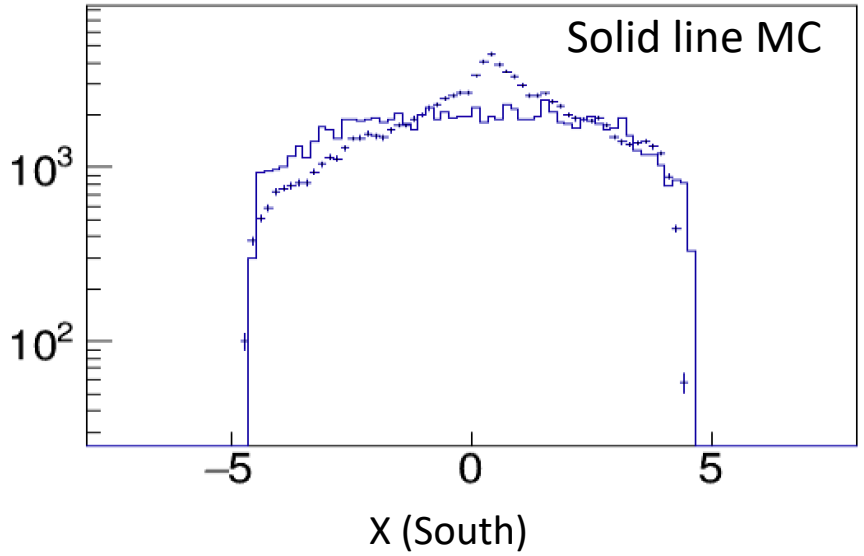


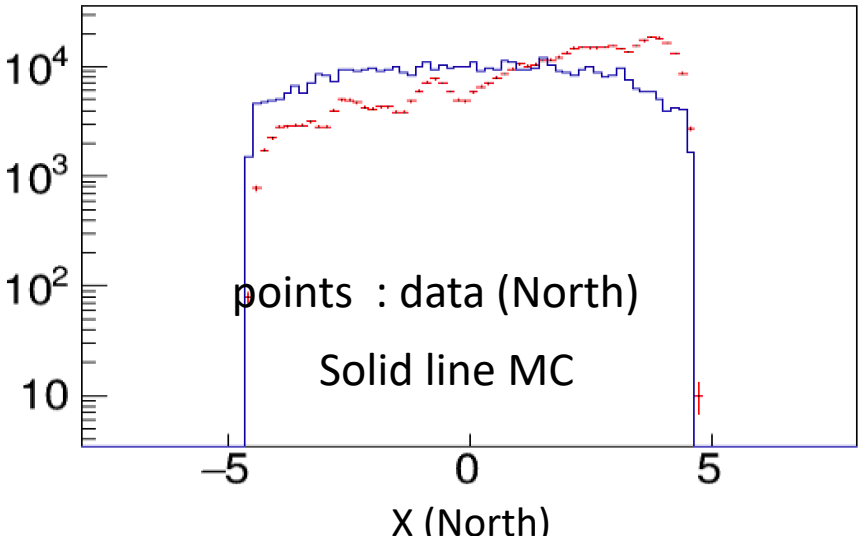


Seems to not getting full statistics as compared to older plots

Data MC comparison of x-positions

points : data (**South**) x-mirrored

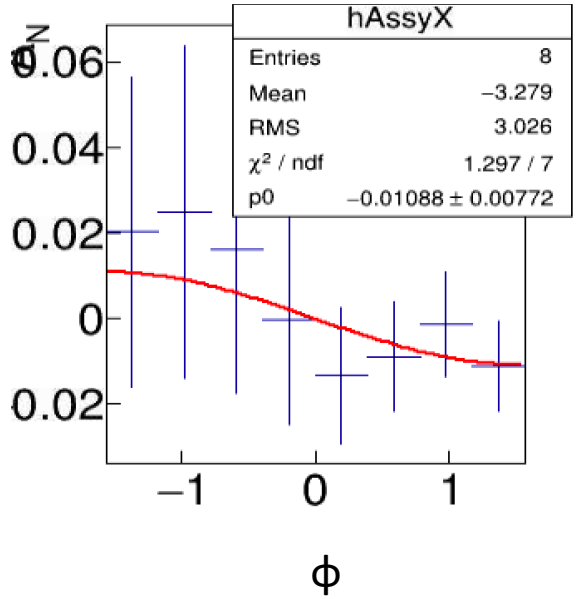




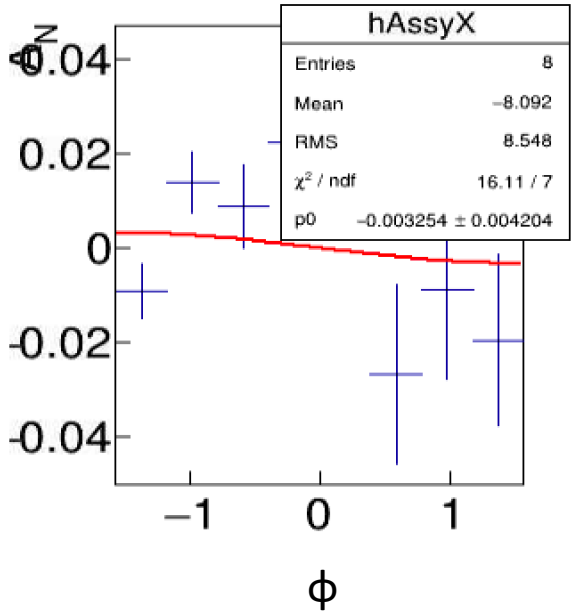
CPV not suppressing North side asymmetric background

Asymmetry for signal and background - **south**

ADC > 50



ADC < 50

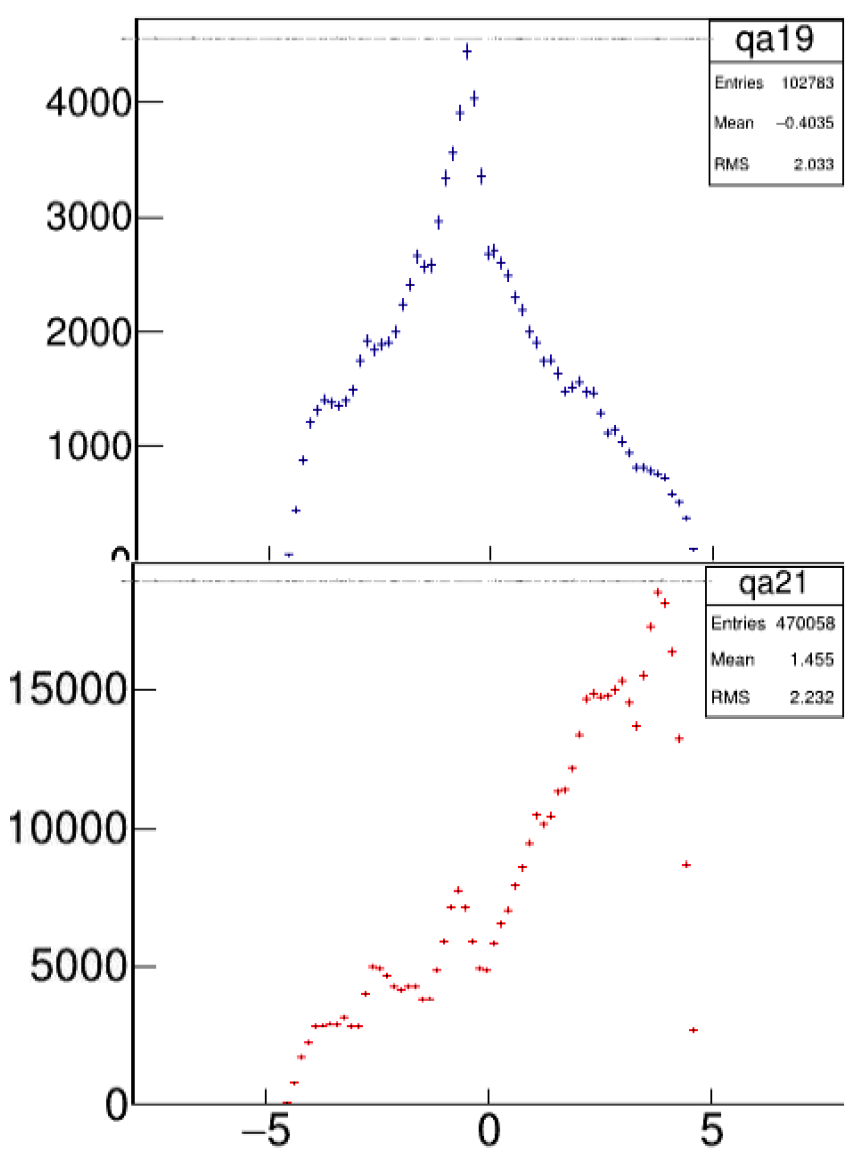


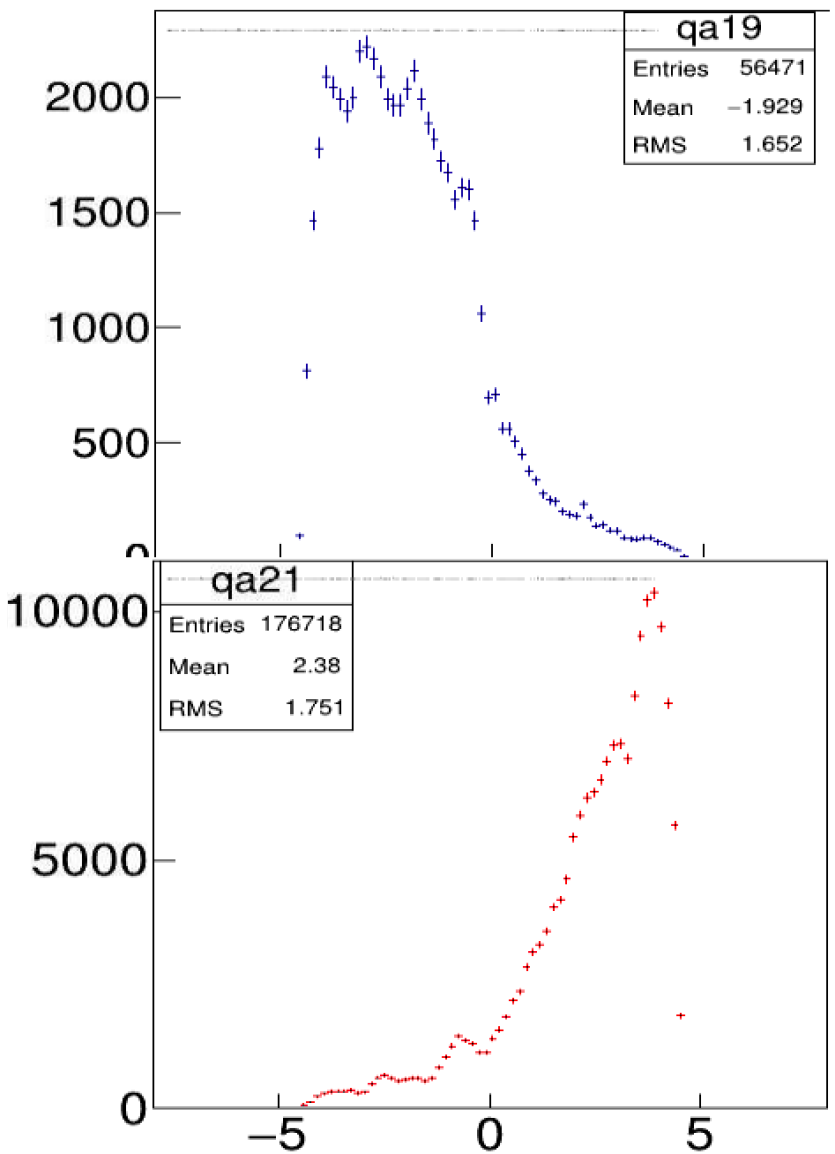
Need to check where losing the statistics

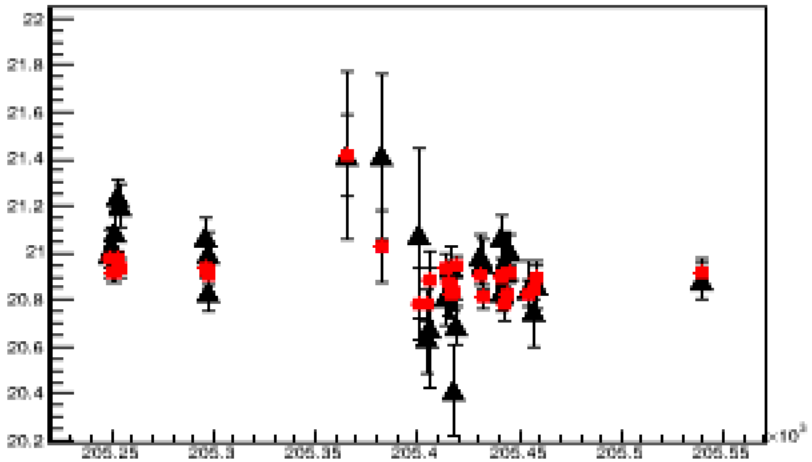
Summary

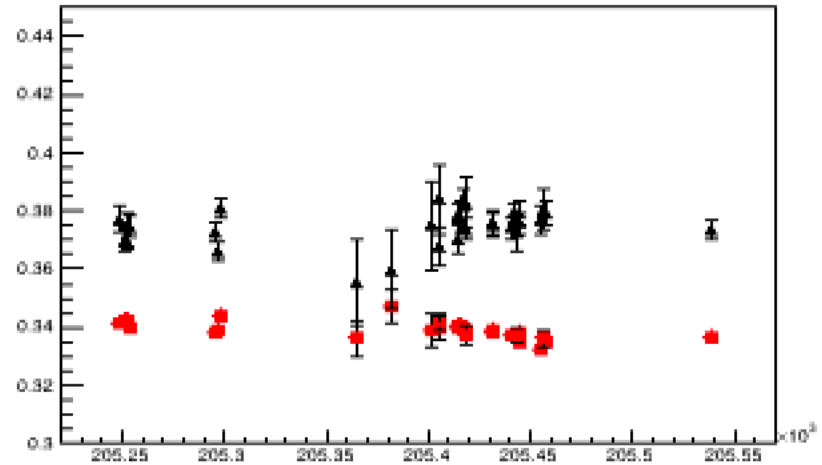
- For run-9 500GeV asymmetry is large and background fraction in below 1% level. Simulation shows in 0.1% level. The background looks symmetric
- Corrected Asymmetry numbers to be estimated from data and simulations

- Run-5 background estimation from data and simulations is made.
- Run-5 need to checked to increased the missing statistics

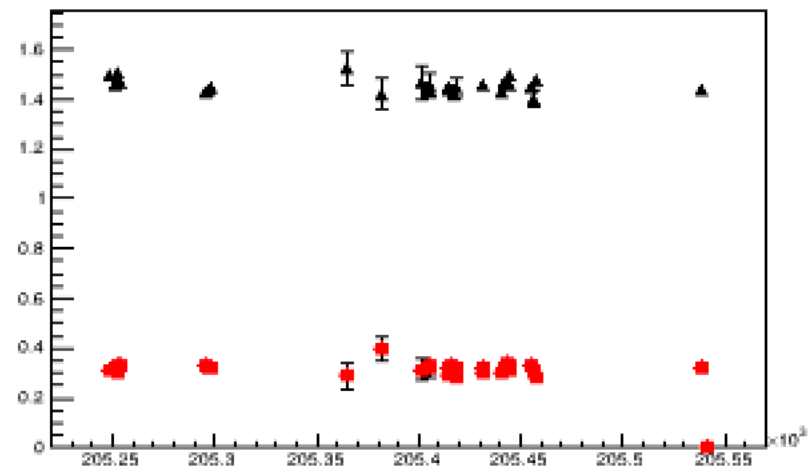

qa19
Entries 102783
Mean −0.4035
RMS 2.033
4000
3000
2000
1000
0
qa21
Entries 470058
Mean 1.455
RMS 2.232
15000
10000
5000
0
−5
0
5


qa19
Entries 56471
Mean −1.929
RMS 1.652
2000
1500
1000
500
0
qa21
Entries 176718
Mean 2.38
RMS 1.751
10000
5000
0
−5
0
5

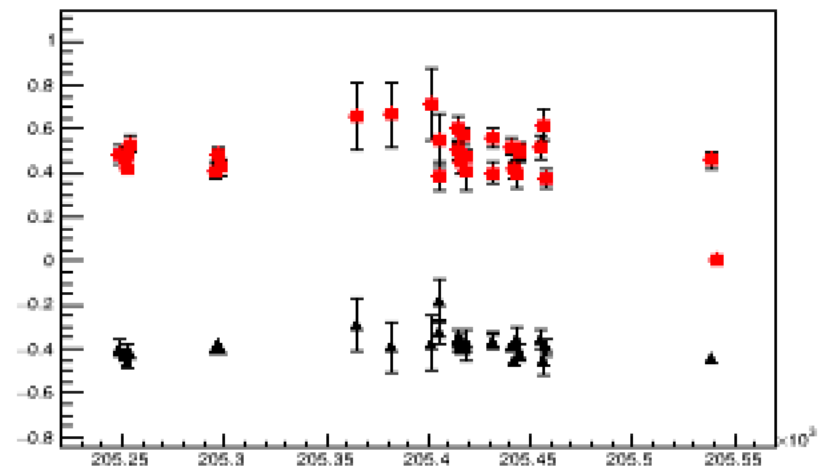

22
21.8
21.6
21.4
21.2
21
20.8
20.6
20.4
20.2
205.25
205.3
205.35
205.4
205.45
205.5
205.55
×10³

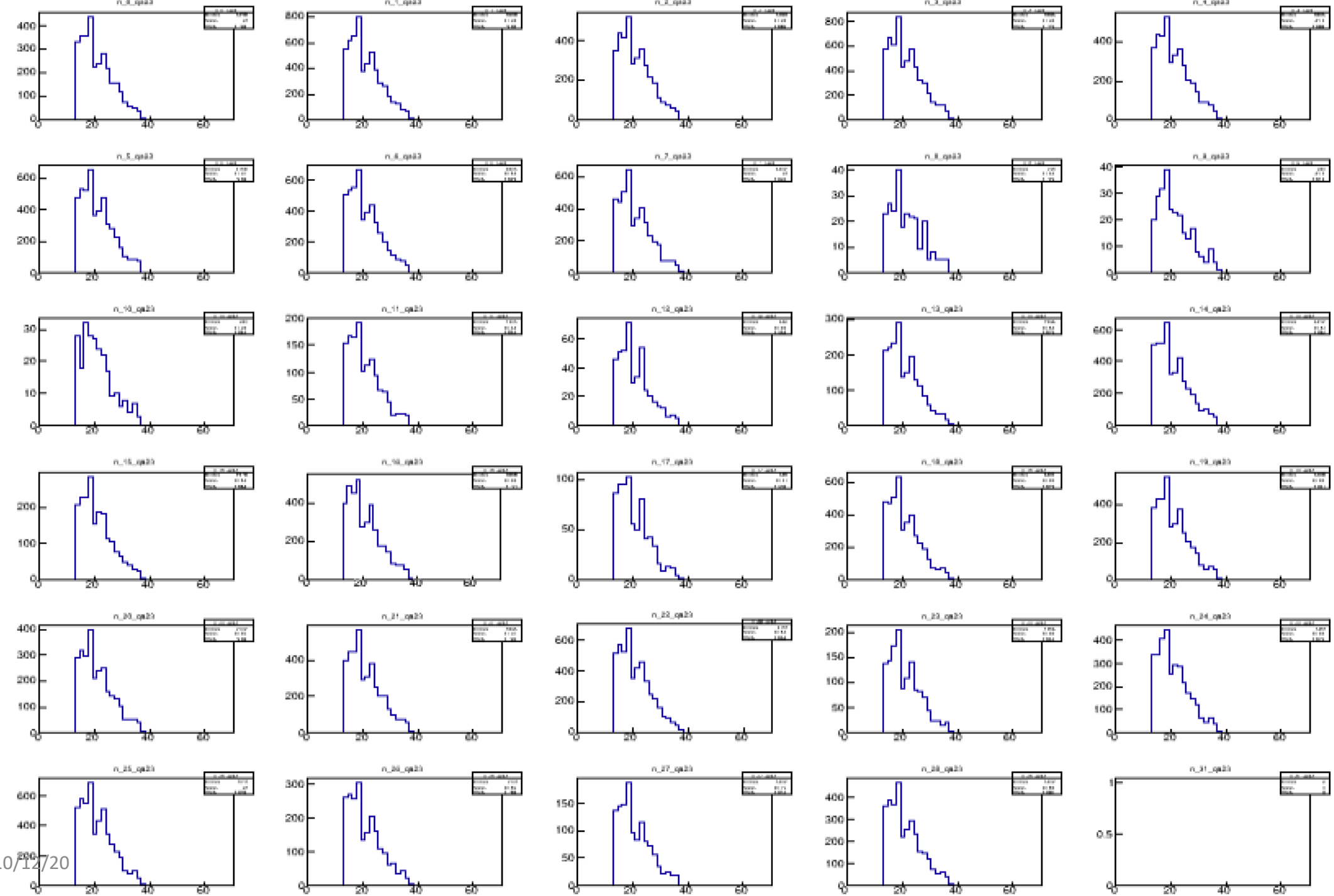

0.44
0.42
0.4
0.38
0.36
0.34
0.32
0.3
205.25
205.3
205.35
205.4
205.45
205.5
205.55
×10³

Graph


1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
205.25
205.3
205.35
205.4
205.45
205.5
205.55
×10³

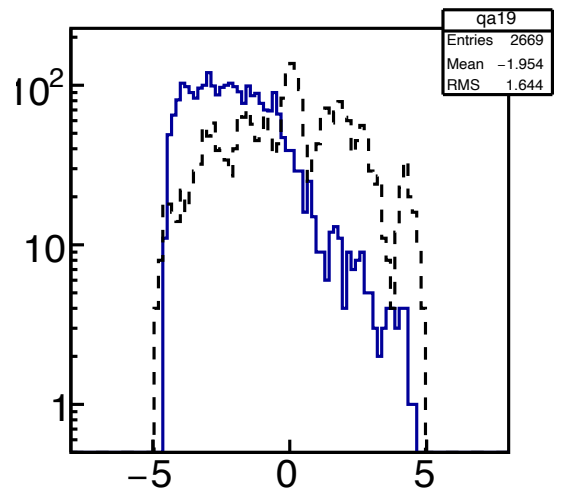
Graph


1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
205.25
205.3
205.35
205.4
205.45
205.5
205.55
×10³

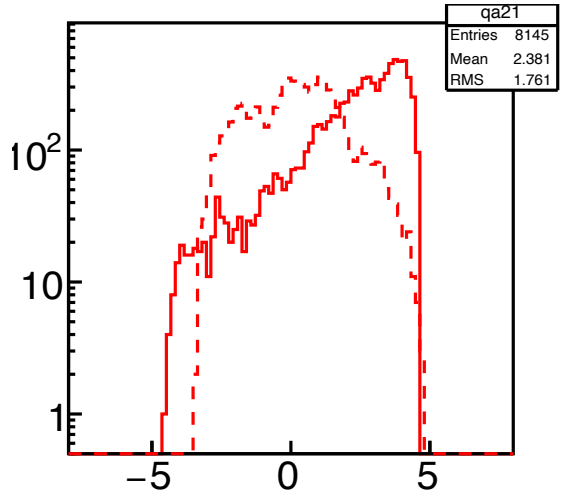


CPV in North is not suppressing background significantly

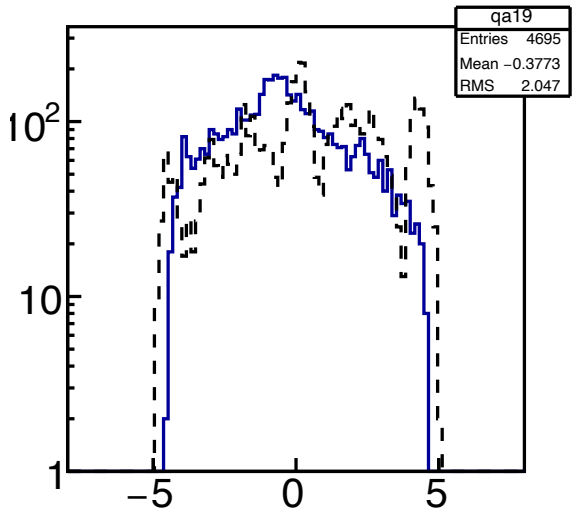
Yellow - South [0]

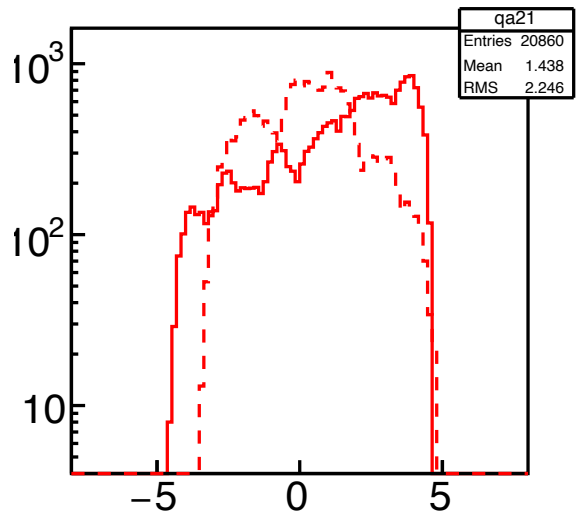


Blue - North [1]



CPV ADC > 50





CPV ADC < 50