Custom simulation for SPS data runs

700001922 (282 GeV)

700001911 (200 GeV)

700001981 (100 GeV)

700002039 (50 GeV)

700002082 (20 GeV)

Parameters modified in the configuration files for simulation

beamtest06

Gleam

Distributions for some parameters before/after simulation changes

Gleam Job options

```
BeamTransform.point_on_beamline = {203.4, 34.72, -47.0};

BeamTransform.table_rotation=0.69;

BeamTransform.OutputLevel = 0;


GlastDetSvc.xmlfile="$(XMLGEODBSROOT)/xml/cu06/cu06SegVols.xml";
HepRepSvc.GeometryDepth = 7;
mcRootReaderAlg.Outputlevel=4;
mcRootReaderAlg.clearOption = "ALL";
mcRootWriterAlg.clearOption = "ALL";




// Tell Gaudi how many events to generate
ApplicationMgr.EvtMax = 4000;
//meritAlg.generated = 10000000;
```

(1)

(2)

(1) Beam incidence position (X,Y) at Z = -47mm

(2) Beam incidence angle in X direction

(3) Beam incidence angle in Y direction, not implemented yet

These quantities are directly retrieved from inspection of data runs. Easy stuff (~ 1 minute)

Beamtest06 SPS job option

```
# Macro file for 2006 sps electron runs
# Sets some default verbose
/control/verbose 2
/run/initialize
/run/verbose 2

/Cern/random/run 0
/Cern/random/event 1
#####################################################
#END OF GLOBAL CONFIG FILE
#Following lines should be written by the script
#####################################################


#Automatically written by JOcreator on Fri Dec 15 17:45:39 2006
#Using Analysis report is True
#/Cern/detector/trigger 2
#/Cern/detector/field 0
/Cern/gun/ydiv 1.000000 mrad
/Cern/gun/zdiv 1.000000 mrad
/Cern/gun/edispersion 1.000000
/Cern/gun/ywidth 1.000000 cm
/Cern/gun/zwidth 1.000000 cm
/gun/particle e-
/Cern/gun/pos -5000. 0 0 cm
/Cern/detector/cherenkovpressure 0.800000
/Cern/gun/energy 196.120000 GeV
/run/beamOn 100
```

(1)

0.00001 for all SPS runs; no significant change

(1) Quantities derived from beam profile inspection (sigma_x, sigma_y) are not those values. No direct relation is known. Used approach is to simulate many beams and find those numbers iteratively…

Beamtest06 SPS job option

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# Sets some default verbose
/control/verbose 2
/run/initialize
/run/verbose 2

/Cern/random/run 0
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/Cern/gun/edispersion 1.000000
/Cern/gun/ywidth 1.000000 cm
/Cern/gun/zwidth 1.000000 cm
/gun/particle e-
/Cern/gun/pos -5000. 0 0 cm
/Cern/detector/cherenkovpressure 0.800000
/Cern/gun/energy 196.120000 GeV
/run/beamOn 100
```

(2)

(2)

Beam divergence has to be tunned too !!

Life is always more complex than expected…

(1)

0.00001 for all SPS runs; no significant change

(1) Quantities derived from beam profile inspection (sigma_x, sigma_y) are not those values. No direct relation is known. Used approach is to simulate many beams and find those numbers iteratively…

Parameters (data and mc) for data run 700001981 (100 GeV)

G4config:
WidthX= 0.01cm
WidthY = 0.05 cm

DATA

```
   Beam characteristics for RUN NUMBER  1981
*********************************************************************

Beam incoming direction (cosinus directors):
       Tkr1ZDir =    -0.9999800892
       Tkr1XDir =   0.002378752476
       Tkr1YDir =   0.005818358866

Beam impact point on Calorimeter input (CalZ =  -47 mm):
      PosXAtCalZ (mm) =      203.7445139
      PosYAtCalZ (mm) =      38.30663758

Beam width (Sigma) estimated from projected beam width (X,Y) on
the first hit height, and incoming beam direction:
Beam Width (Sigma) in X direction (mm) = 1.637112678
Beam Width (Sigma)  in Y direction (mm) = 2.850366796

Upper limit for Beam divergence:
         CosMaxBeamDivergence() =      0.999999758
     MaxBeamDivergence(degrees) =     0.03741211046
```

MC

```
   Beam characteristics for RUN NUMBER  Custom MC 1981
*********************************************************************

Beam incoming direction (cosinus directors):
       Tkr1ZDir =    -0.9999967387
       Tkr1XDir =   0.002270743892
       Tkr1YDir =  2.495750907e-05

Beam impact point on Calorimeter input (CalZ =  -47 mm):
      PosXAtCalZ (mm) =      203.6796565
      PosYAtCalZ (mm) =      38.48796213

Beam width (Sigma) estimated from projected beam width (X,Y) on the
first hit height, and incoming beam direction:
Beam Width (Sigma) in X direction (mm) = 2.673393089
Beam Width (Sigma)  in Y direction (mm) = 2.946653218

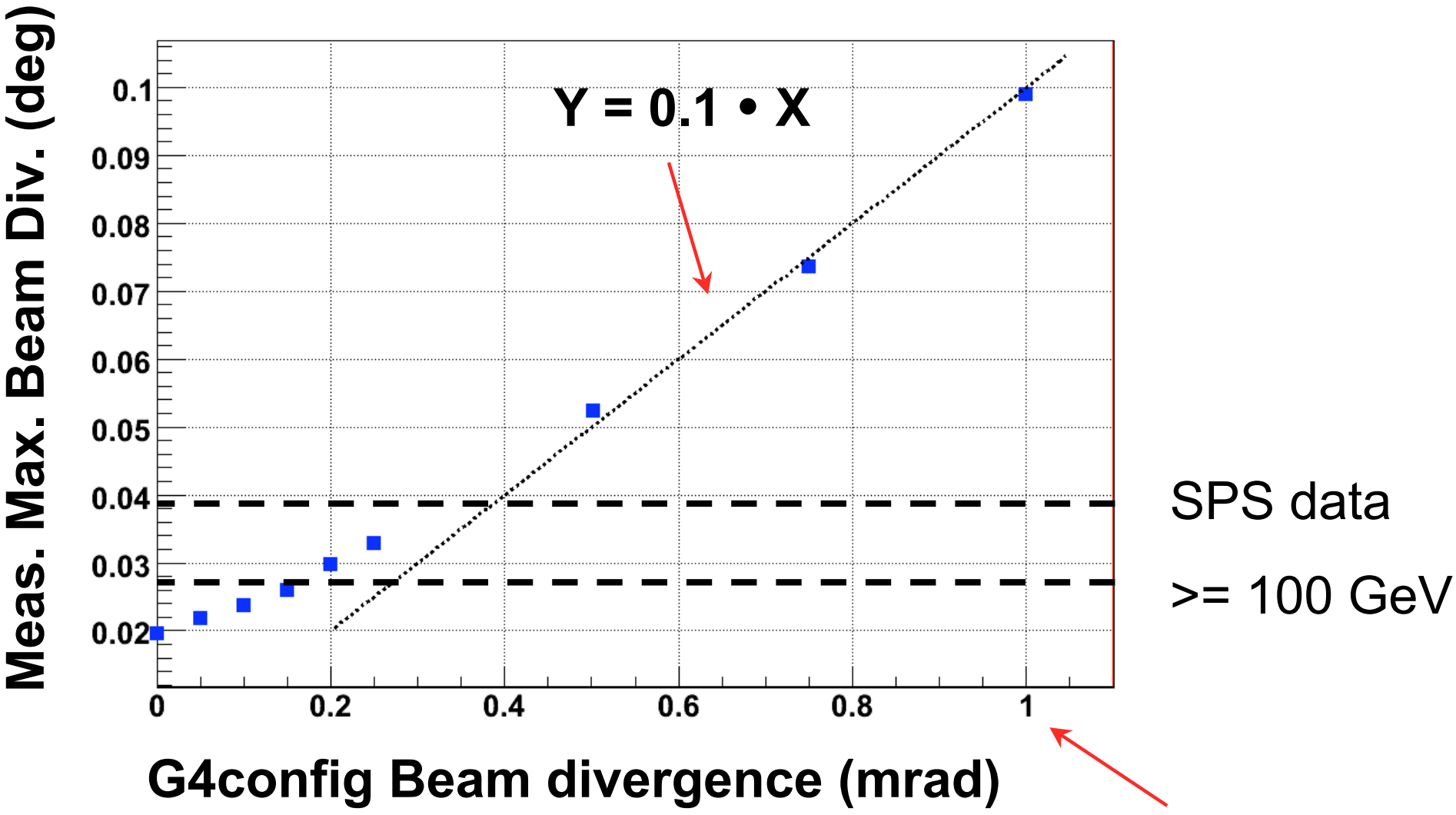
Upper limit for Beam divergence:
         CosMaxBeamDivergence() =      0.9999984699
     MaxBeamDivergence(degrees) =     0.09903284305
```

$$Cos(Max.BeamDivergence) = cos(XthetaBeam)* Tkr1XDir + cos(YthetaBeam)* Tkr1YDir + cos(ZThetaBeam)* Tkr1ZDir$$

$$Max.BeamDivergence \sim BeamDivergence \otimes CU\ angular\ resolution$$

When using 1 mrad in G4config (default value), beam divergence was dominating the beam width (x,y)

Relation between G4config beam divergence and Measured Max. Beam Divergence



SPS data

>= 100 GeV

Default value in G4config files

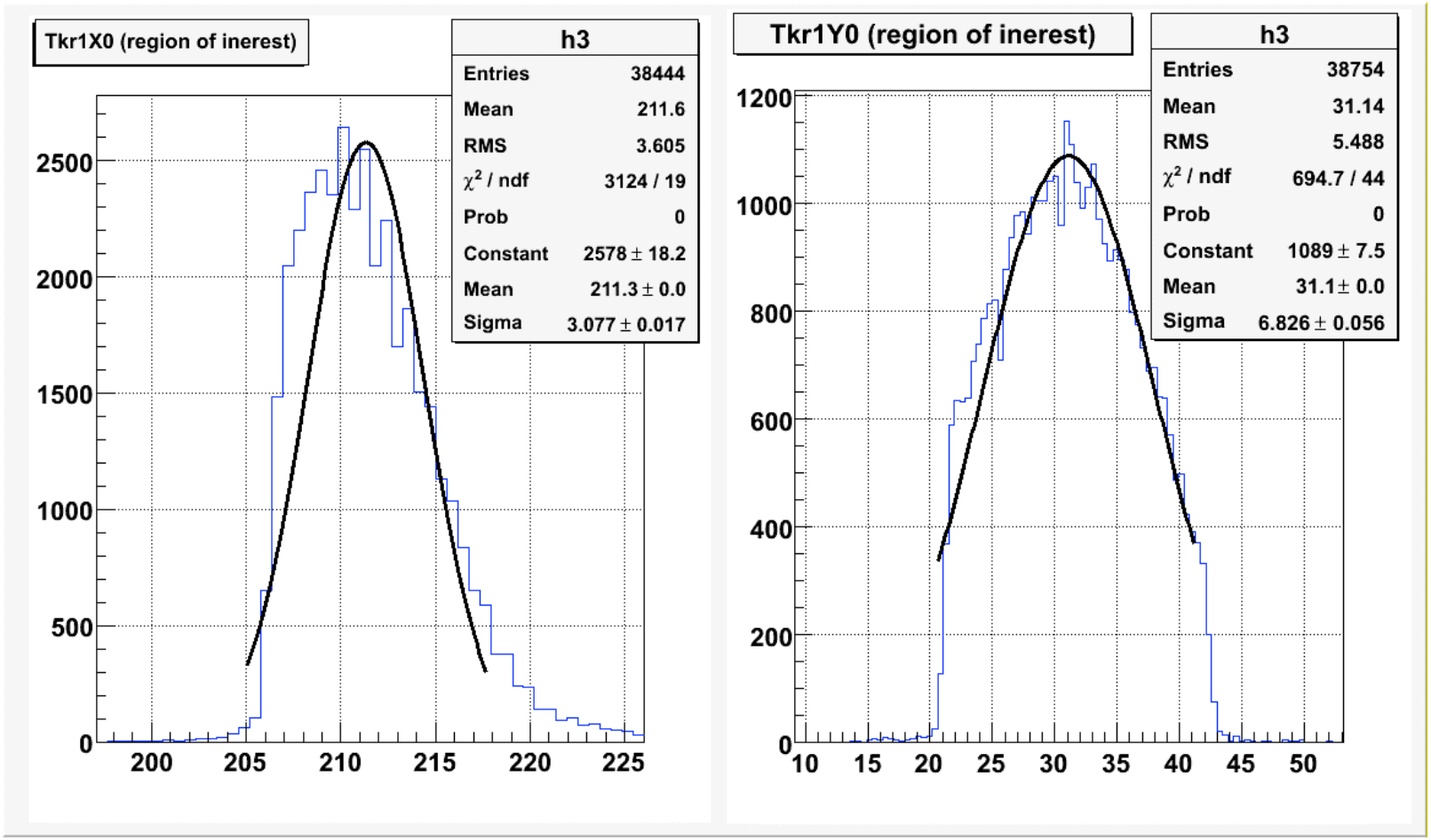
I could find parametes which describe nicely the beam profile from data runs at 280 GeV (1922), 200 GeV (1911) and 100 GeV (1981)

BUT

I do have problems with the beam profile from runs at 50 GeV (2039) and 20 GeV (2082)

Problems to produce beam profile for data run 2082 (20 GeV)

Beam profile for DATA



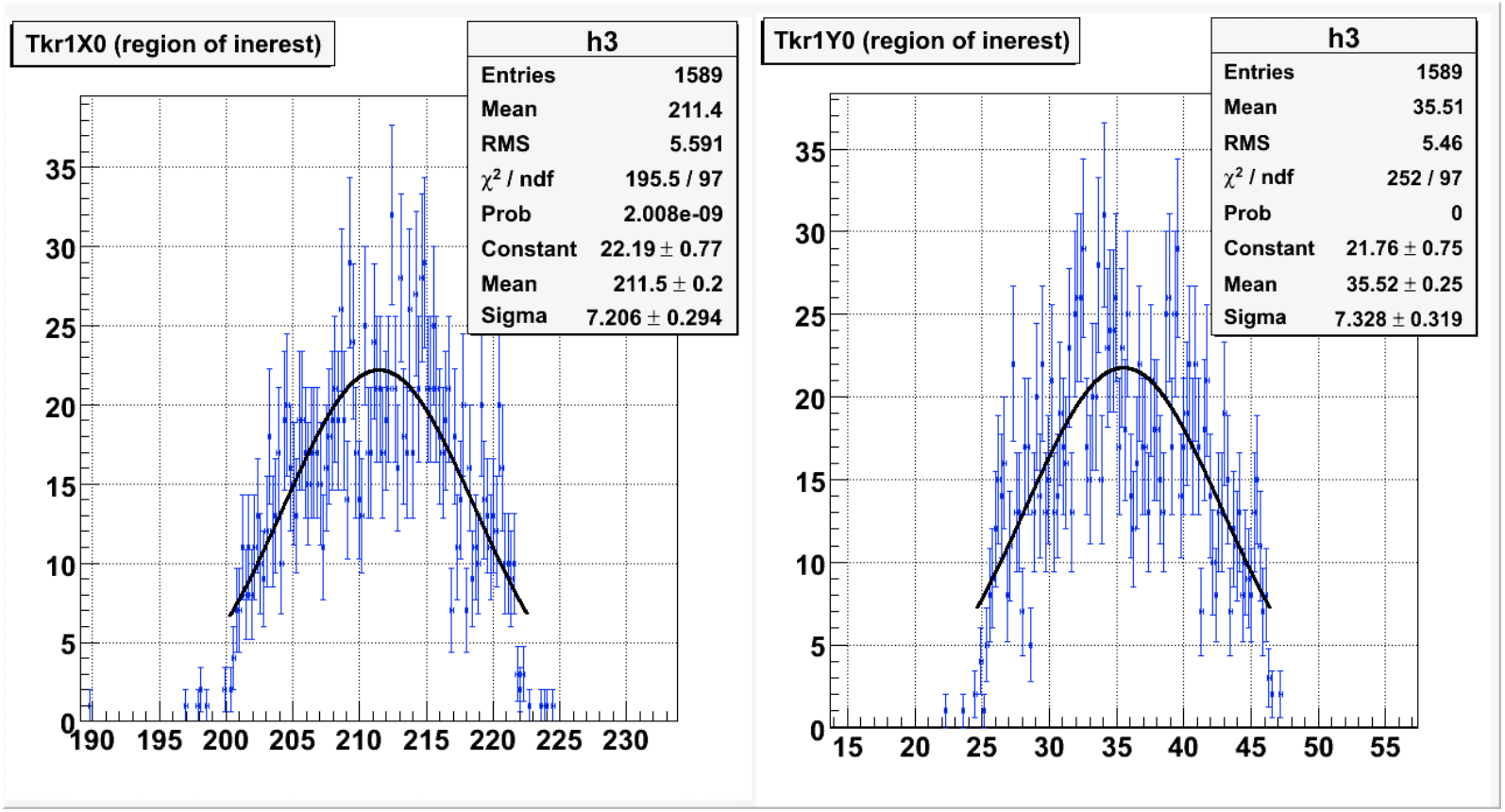
Slightly truncated in X direction (one side), and Y direction (2 sides). ***Width_y ~ 2 Width_x***

Custom MC simulation with G4 config parameters

Divergence in X = 0.00 mrad; Divergence Y = 0.25 mrad

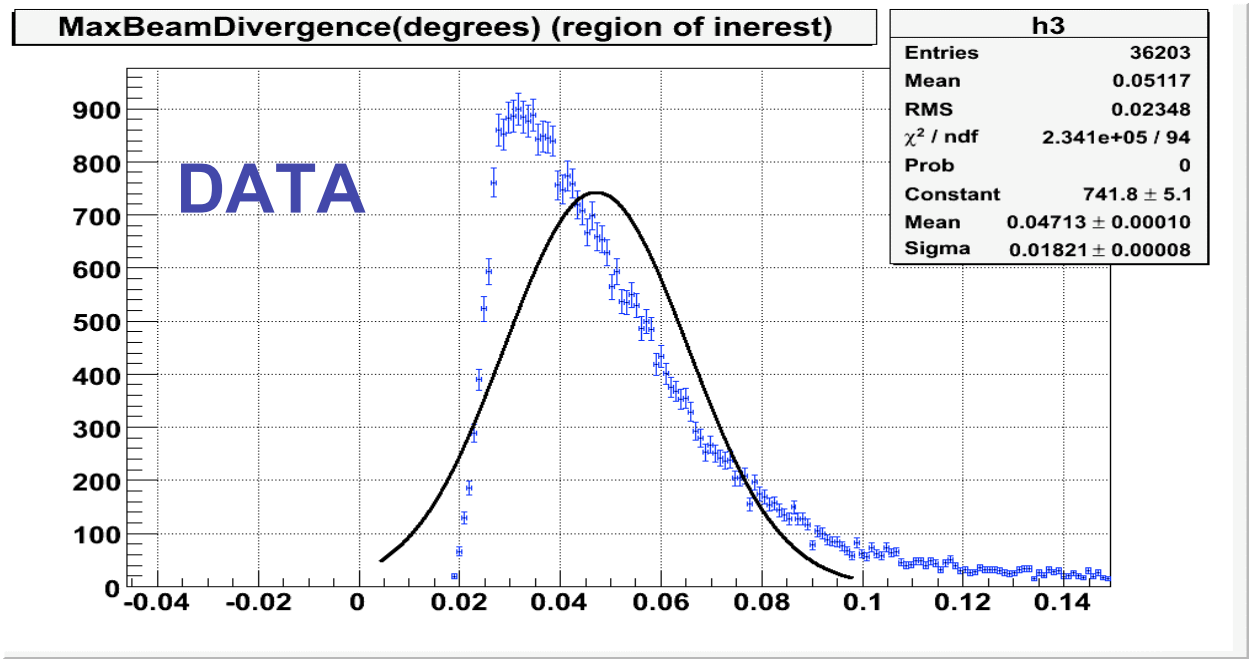
Width_x = 0.1 cm; Width_y = 0.2 cm

I tried different widths and divergences… those quantities are irrelevant !!! I always get the same (???). Something increases the beam dimensions…

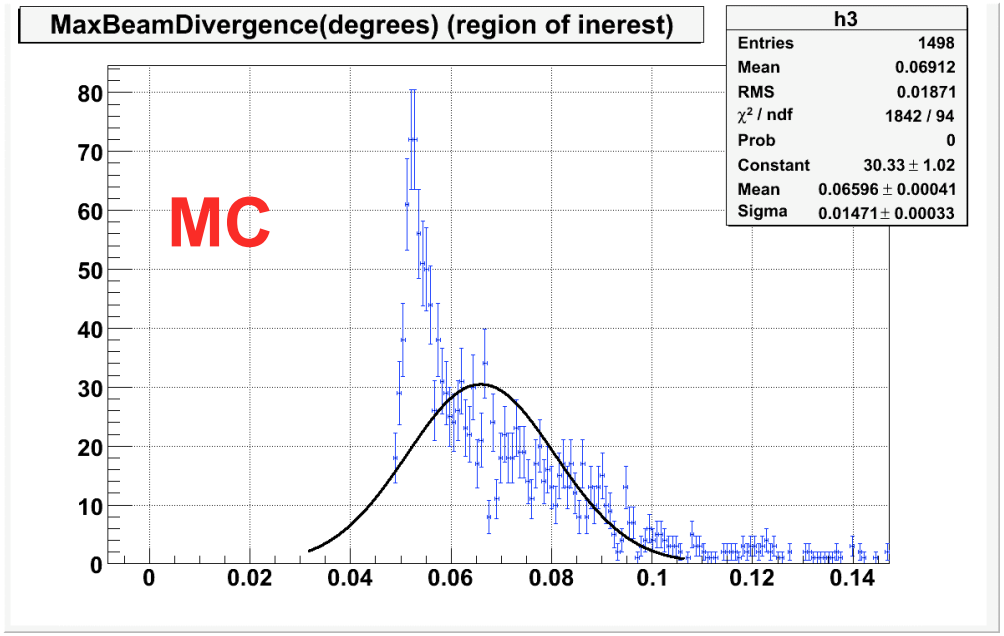


Custom MC simulation with G4 config parameters

Divergence in X = 0.00 mrad; Divergence Y = 0.25 mrad



Any idea of what is producing this increase in beam dimensions and diveregence ??



This is NOT occuring for MC at highest energies, thus effect seems to be energy dependent…

Same effect occurs with data run 700002039 (50 GeV), but the difference is smaller.

Data run has beam width of 3.2 mm, while in the MC I cannot get it smaller than 3.9 mm

Max. Beam divergence in data is 0.03 degrees, which I can get in MC when setting the beam divergence (in G4config) to 0.00

Consistent with the effect being energy dependent …

Perhaps this effect is also related to the increase in beam divergence noticed in PS MC runs (presented in Workshop 4, Paris, Nov 2006).

1 - Estimation of the photon beam dispersion in the MC data (full brems)

beam dispersion for the selected energy bins can be calculated as:

$$Cos(PhotonBeamDispersion) = cos(XthetaBeam)* McXDir + cos(YthetaBeam)* McYDir + cos(ZThetaBeam)* McZDir$$

I computed the "PSF" exactly in the same way (counting up to 68%, and 95% containment), but this time using ***PhotonBeamDispersion instead of***

McDirErr or MyDirErr

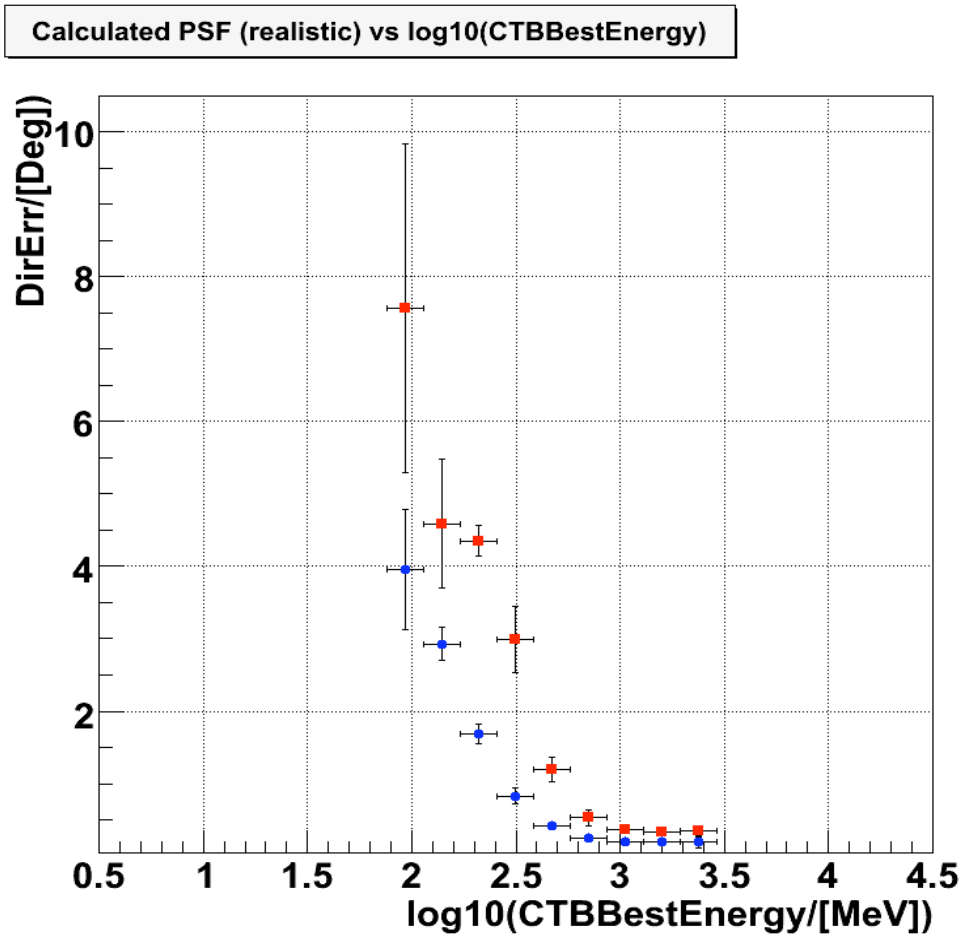
```
// Incoming direction of the photon beam 0 deg
Double_t cosXTheta = 0.0;
Double_t cosYTheta = 0.0;
Double_t cosZTheta =-1.0;
```

1 - Photon beam dispersion for each of these energy bins

For MC 129 (2.5GeV), the "PSF68" from this dispersion is ENERGY dependent. It converges assimptotically to 0.2 at high energies.

-**"PSF" 95 Containment**
-**"PSF" 68 Containment**

Run MC 129 (0 deg)



The question I need to answer is whether this effect is related to the one seen in the SPS runs…

I did not have time to play with the "new" full brems MC

MC run 129 is "OLD" (August 2006) MC.

Quick Comparison data-mc for some parameters

Important remark

The only cuts applied to the data are :

1 - CalEnergyRaw > 10 MeV (No-empty events)

2 - TkrNumTracks > 0.5 (events with at least 1 track)

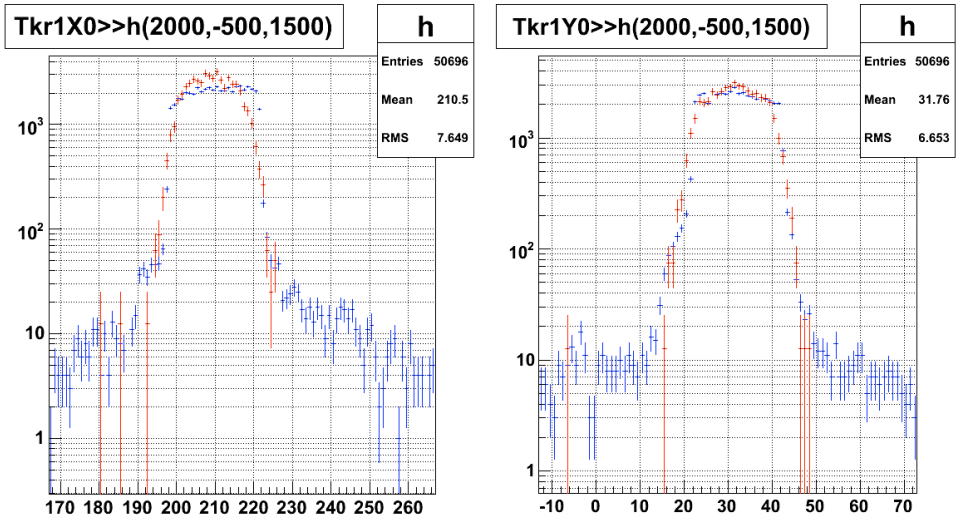
These are very simple cuts which are expected to be fulfilled by all the electrons (>20 GeV) entering in the calibration unit.

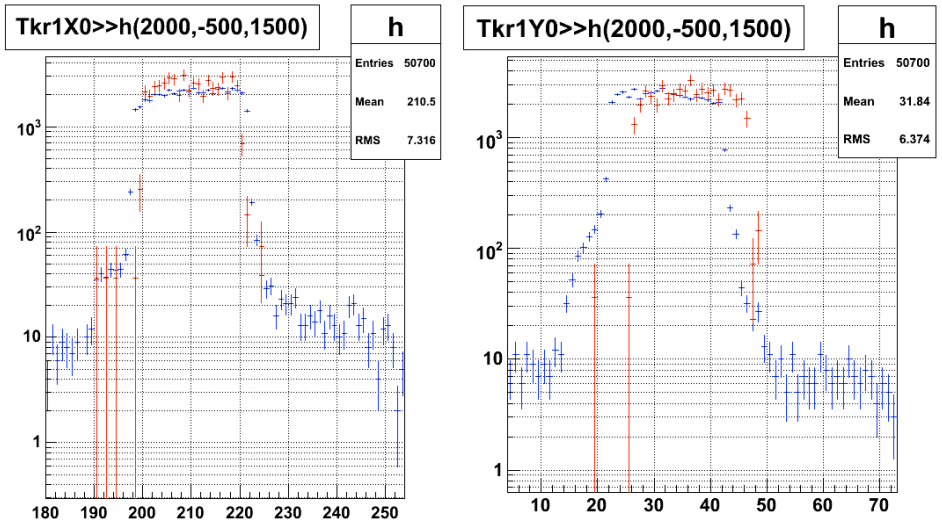
More sophisticated cuts (e.j. removing events crossing cracks, removing MIPs…) which might improve the agreement data-mc are NOT applied. These additional cuts must be applied with care, since they might also bias the comparison if not carefully done

BT-1922, which matches with data run 700001922

E = 282 GeV , 0 deg **MC in red**; **Data in blue**

Run 1922





Before

Very good agreement data-mc !!

MC beam a bit more roundish than data

After

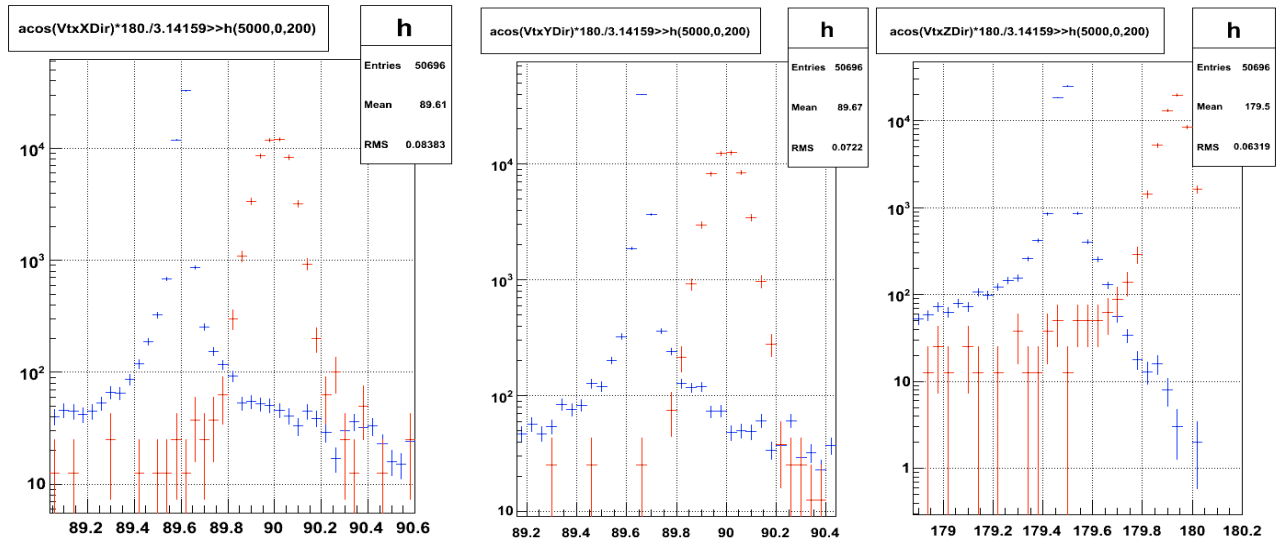
MC beam as truncated as data beam

Little displacement of ~4 mm in Y direction due to the NON correction for incidence angle in Y

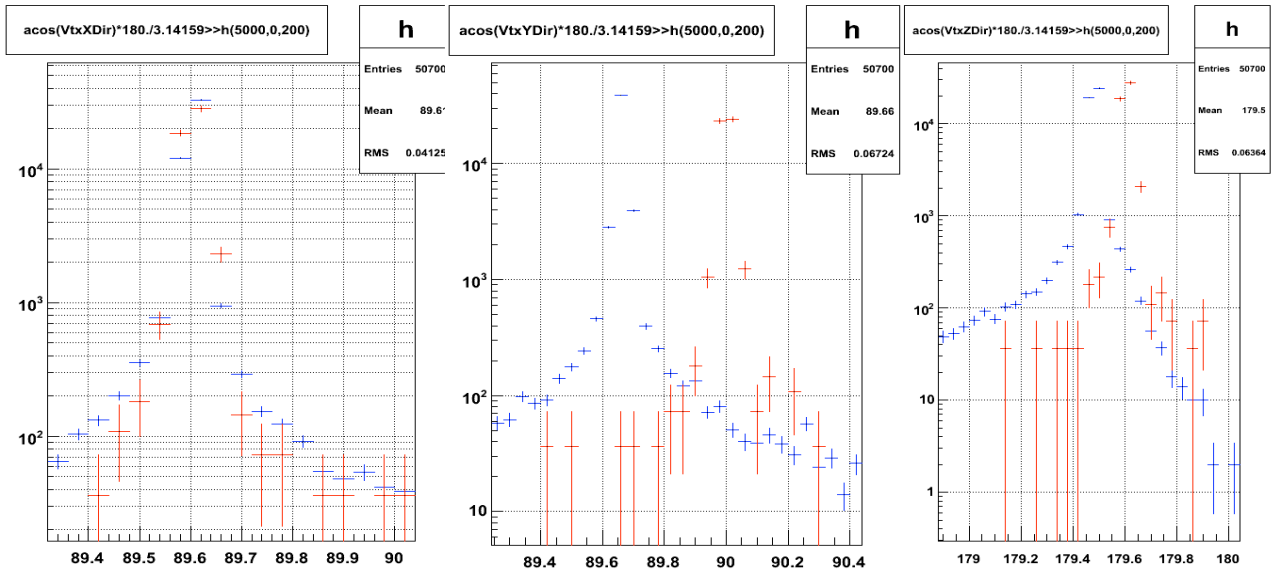
BT-1922, which matches with data run 700001922

E = 282 GeV , 0 deg **MC in red**; **Data in blue**

Run 1922



Before

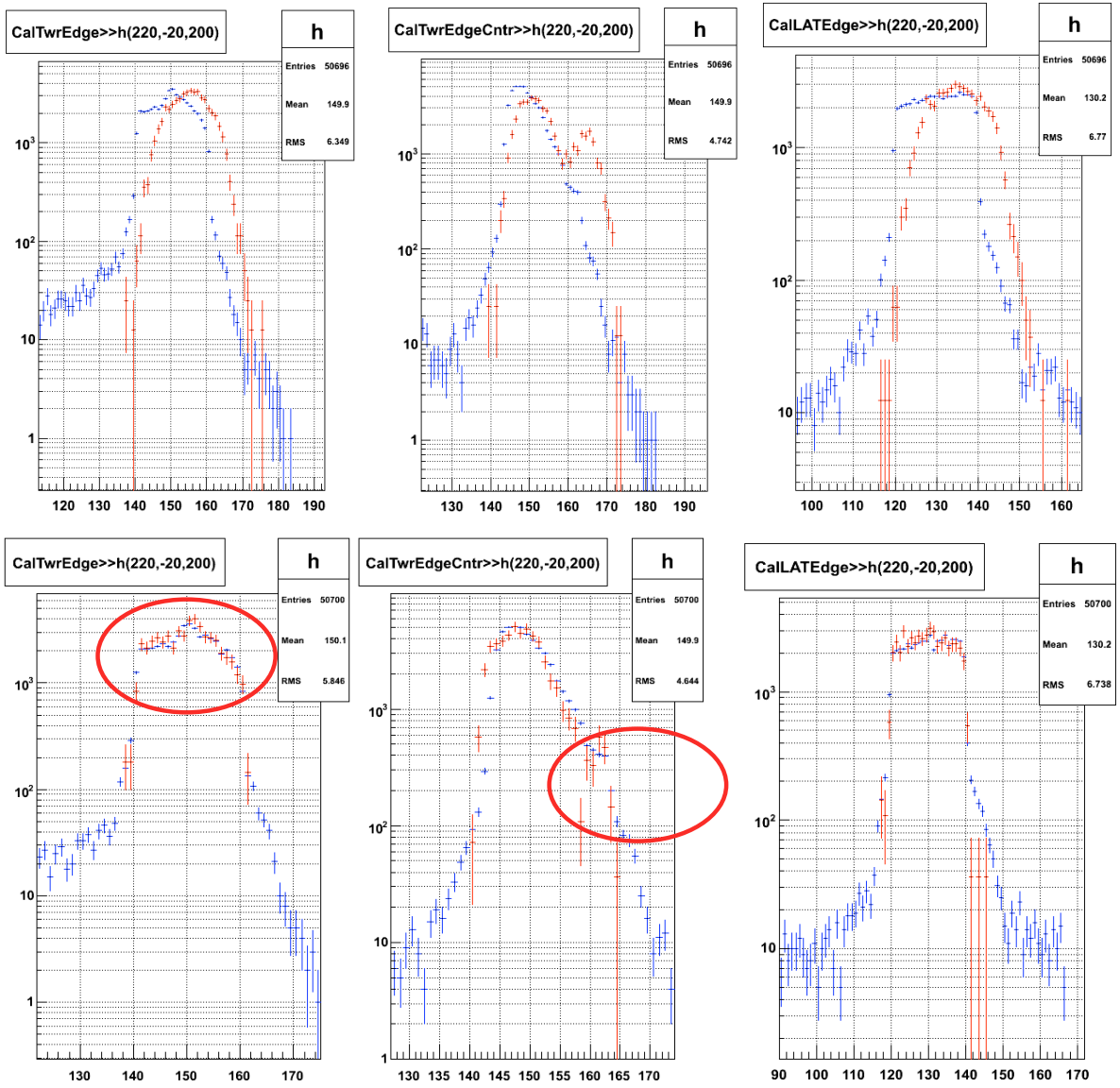


After

About 0.35 deg disagreement in Y direction (~4 mm in 650 mm displacement in Z)

BT-1922, which matches with data run 700001922

E = 282 GeV , 0 deg **MC in red**; **Data in blue**



Before

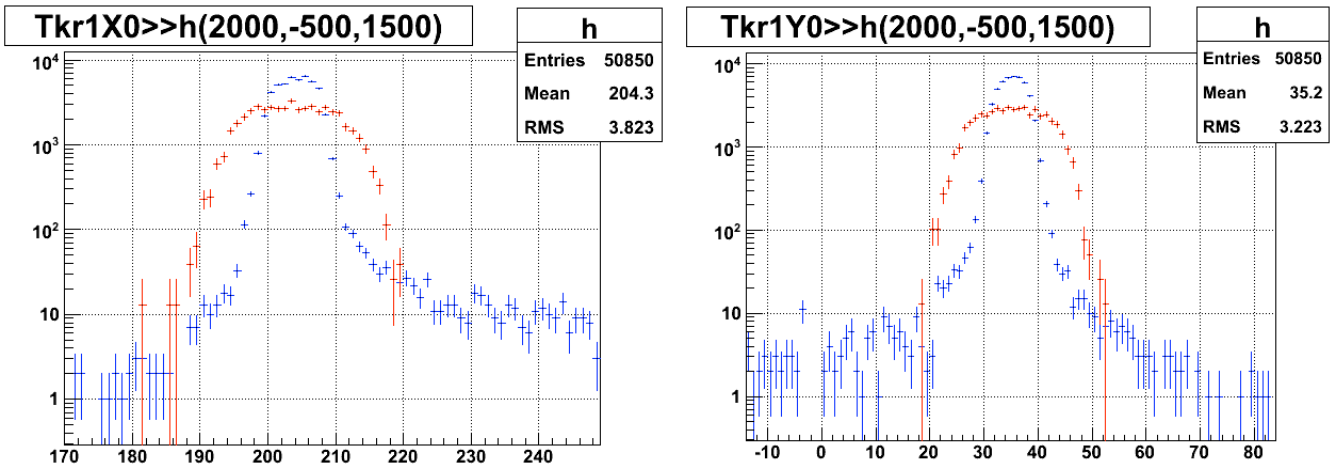
After

The agreement is very good; even in “bumps”

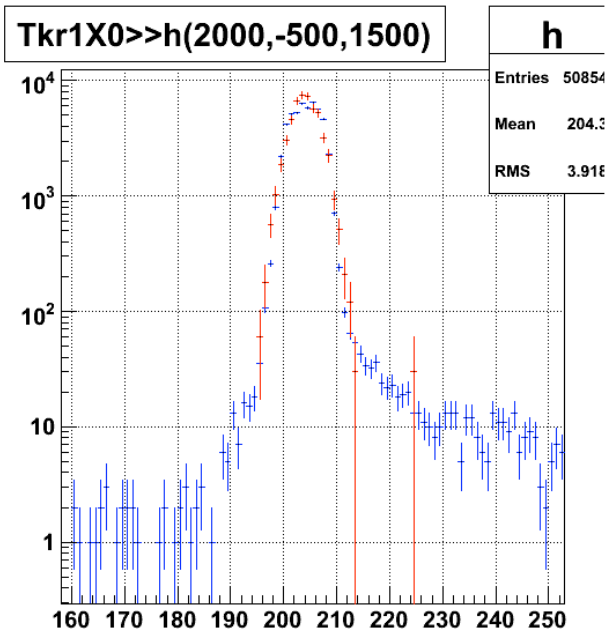
BT-1885, which matches with data run 700001911

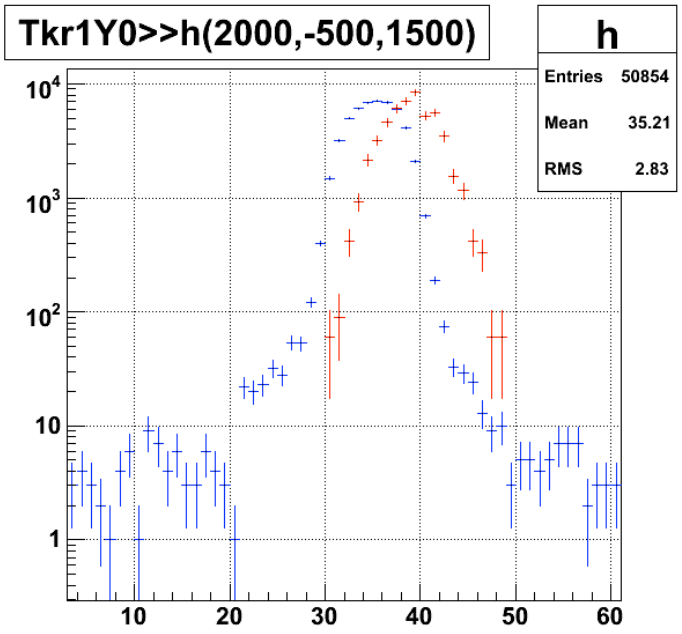
E = 196 GeV , 0 deg **MC in red**; **Data in blue**

Run 1911



Before





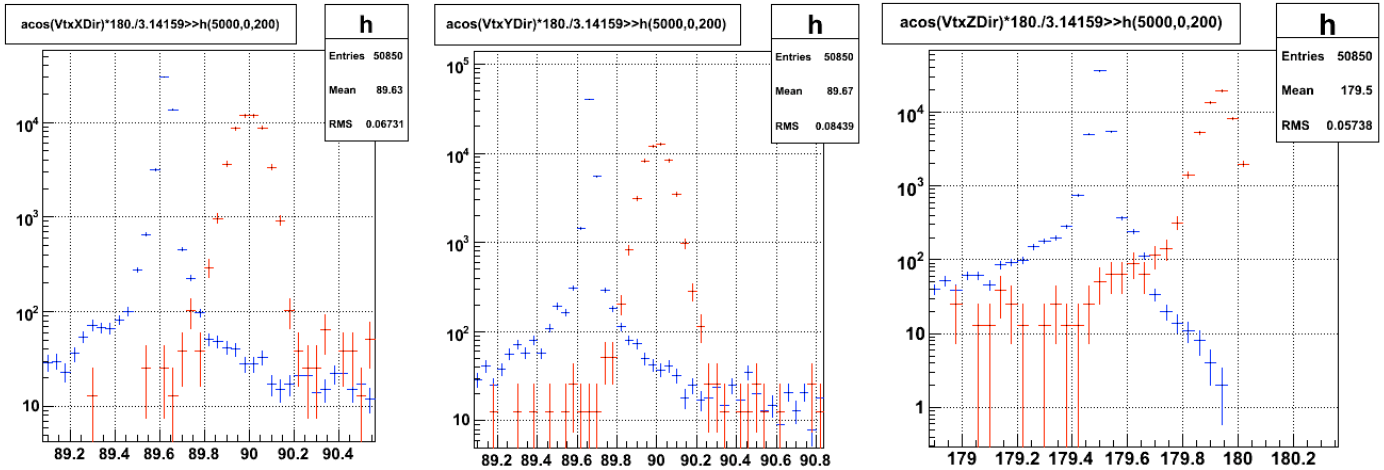
After

Little displacement of ~4 mm in Y direction due to the NON correction for incidence angle in Y

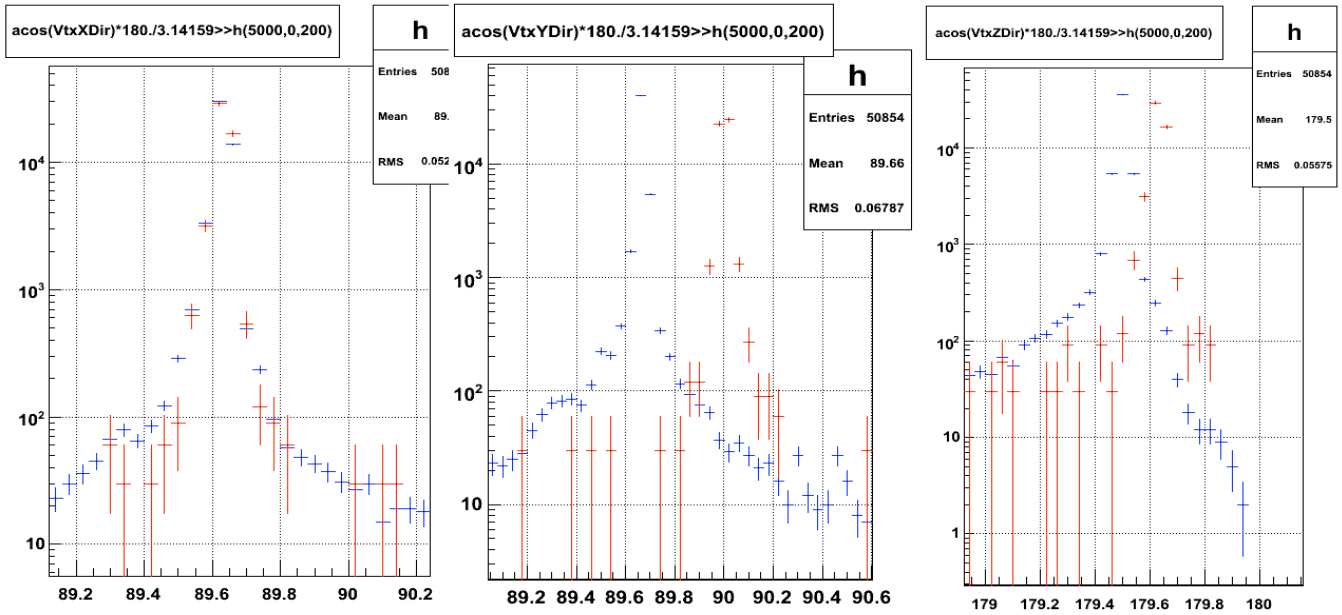
BT-1885, which matches with data run 700001911

E = 196 GeV , 0 deg **MC in red**; **Data in blue**

Run 1911



Before

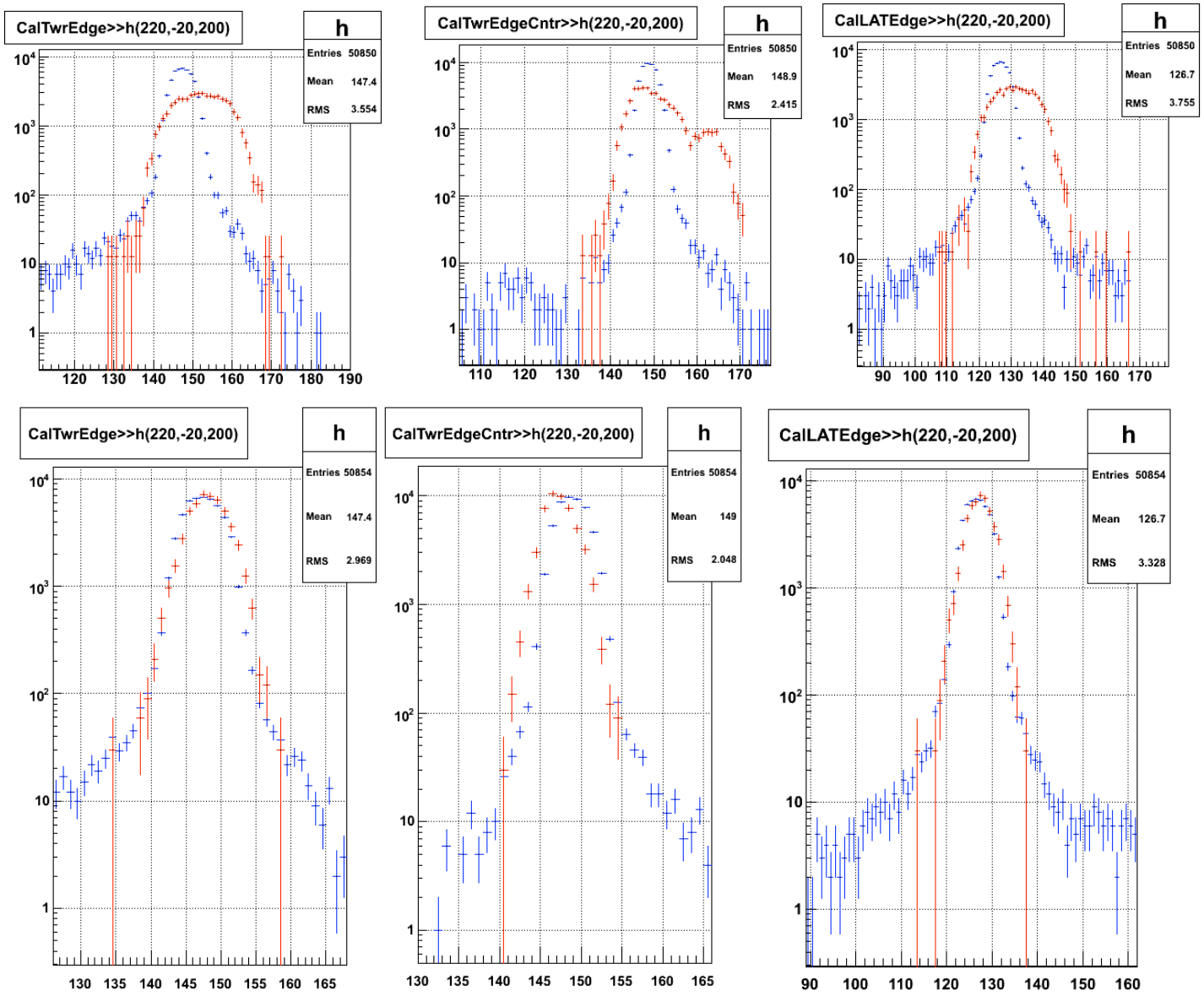


After

About 0.35 deg disagreement in Y direction

BT-1885, which matches with data run 700001911

E = 196 GeV , 0 deg **MC in red**; **Data in blue**



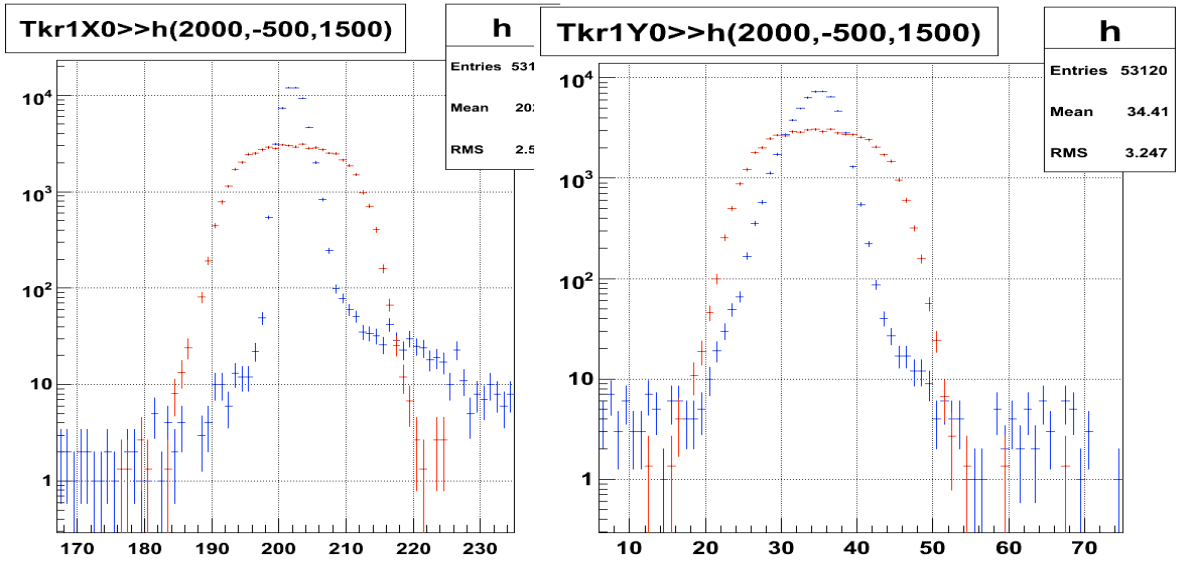
Before

After

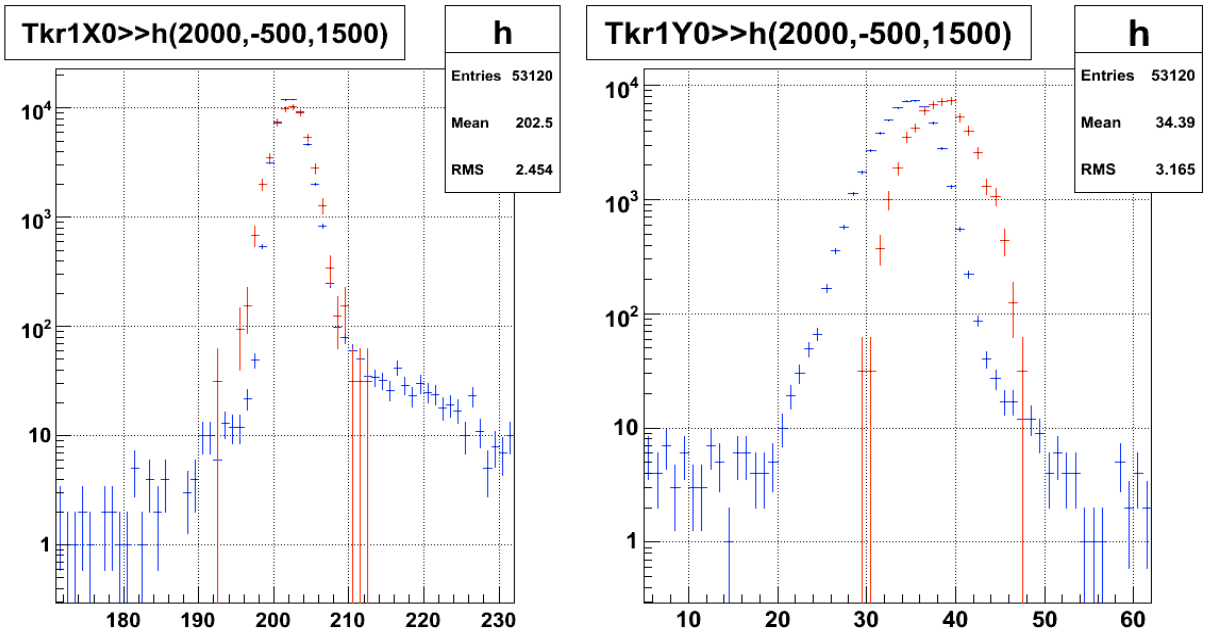
Very good agreement

BT-1981, which matches with data run 700001981

E = 100 GeV , 0 deg **MC in red**; **Data in blue**



Before

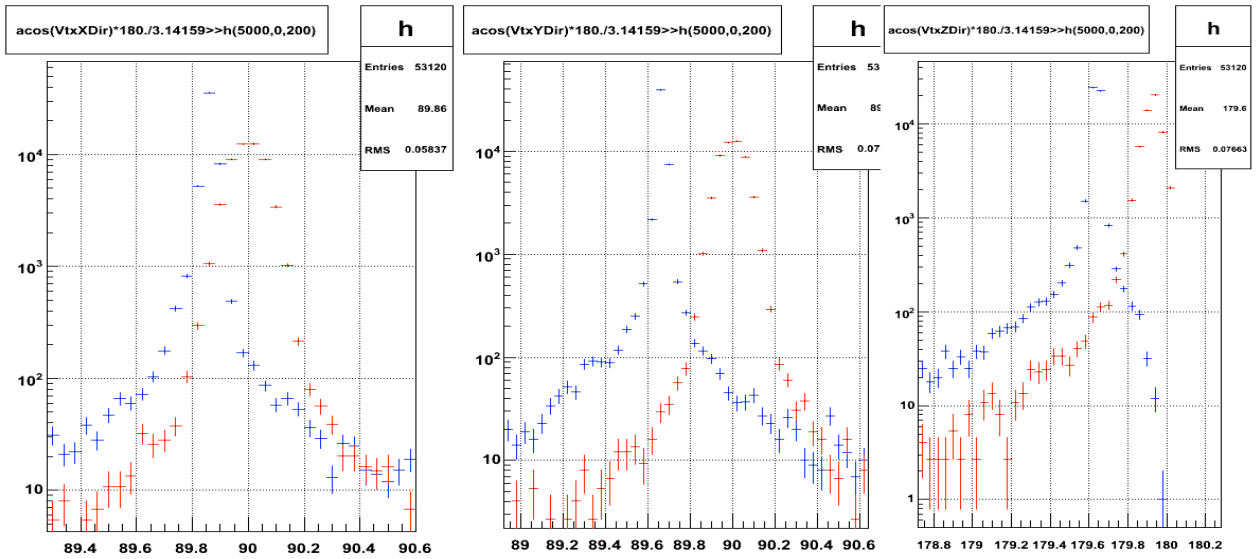


After

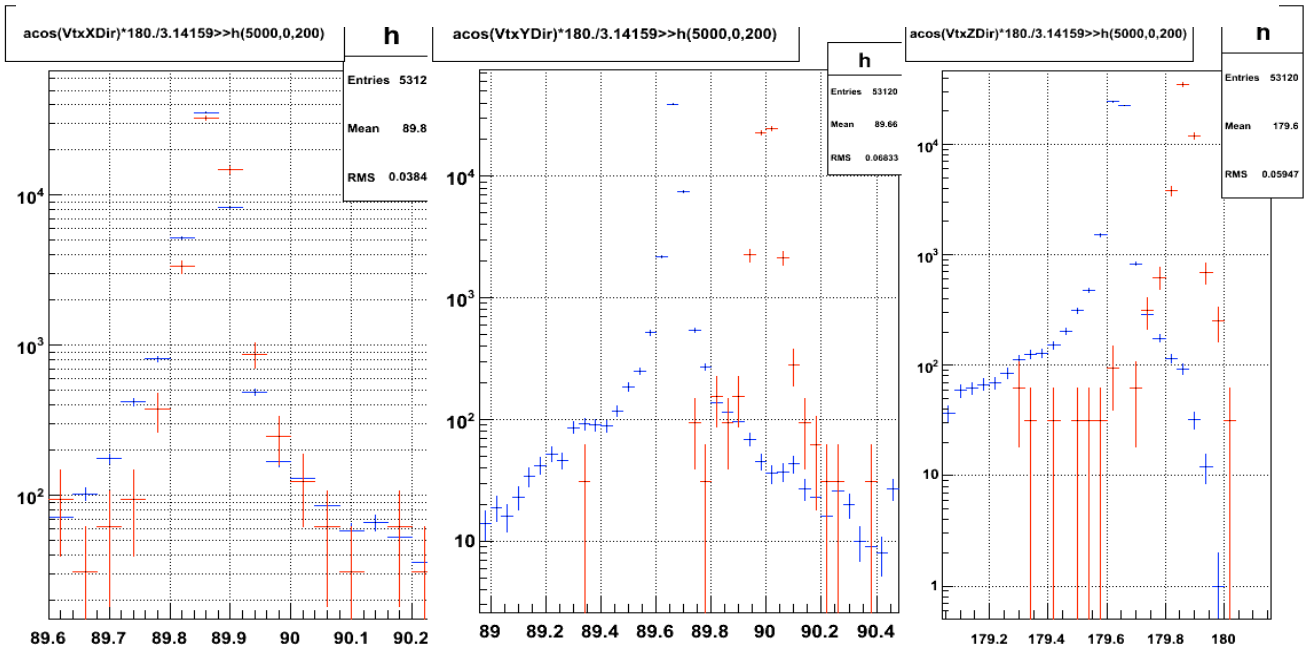
Little displacement of ~4 mm in Y direction due to the NON correction for incidence angle in Y

BT-1981, which matches with data run 700001981

E = 100 GeV , 0 deg **MC in red**; **Data in blue**



Before

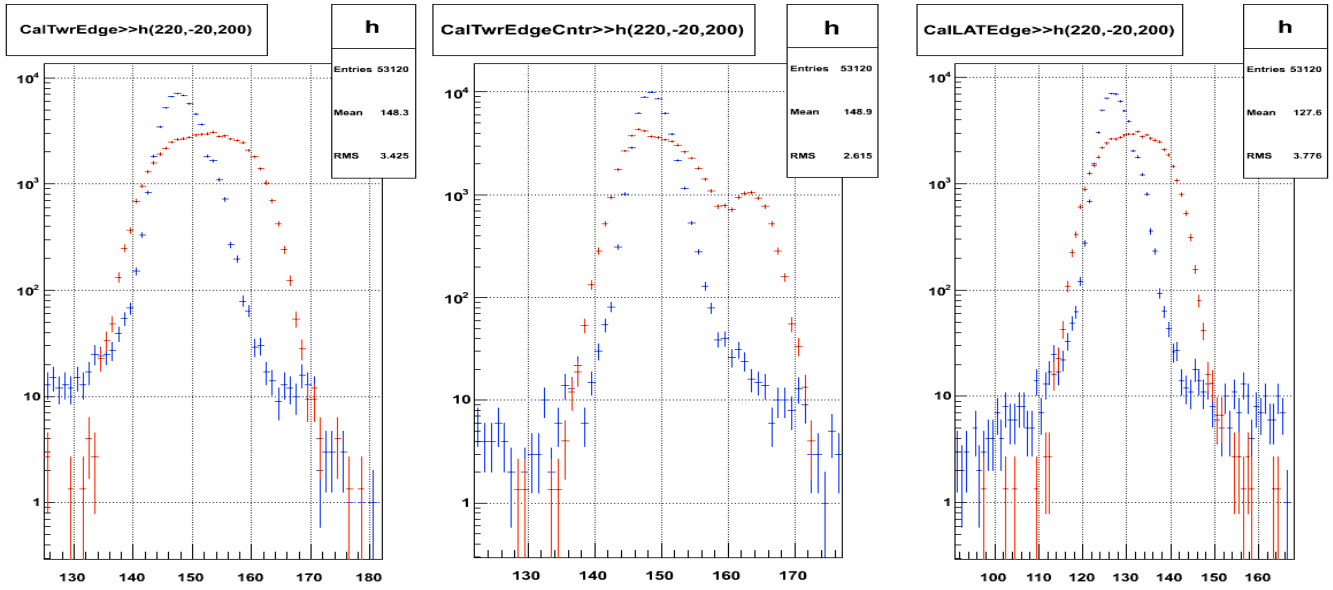


After

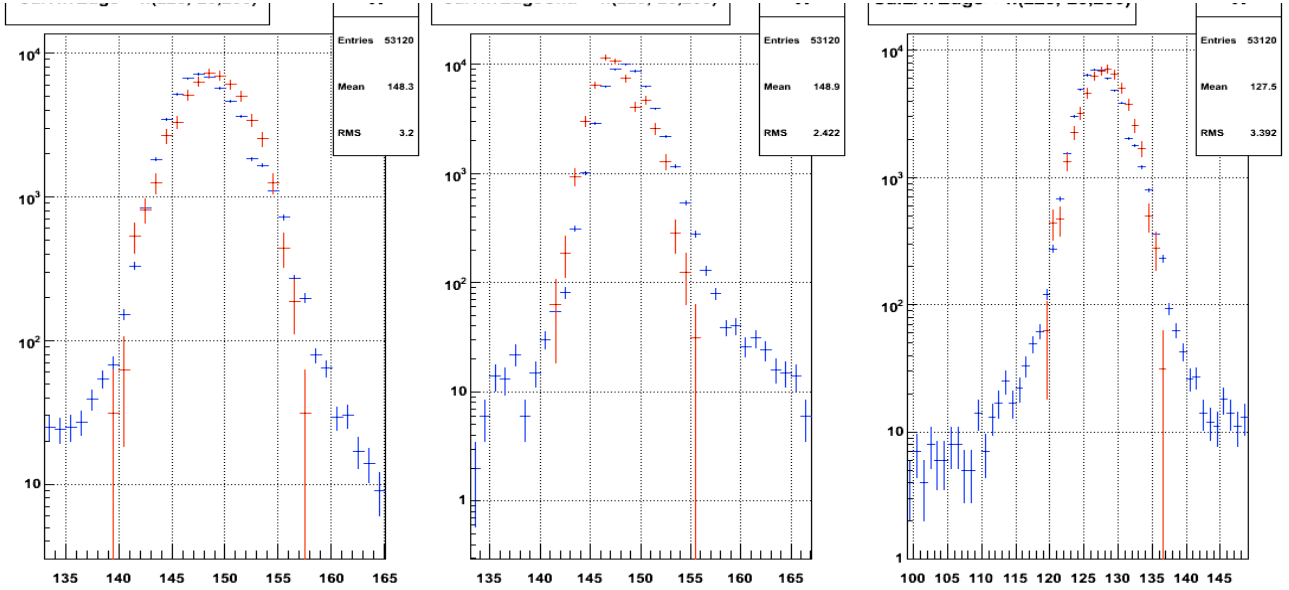
About 0.35 deg disagreement in Y direction

BT-1981, which matches with data run 700001981

E = 100 GeV , 0 deg **MC in red**; **Data in blue**



Before



After

Very good agreement

Conclusions

Proper estimation of parameters to be used in the config files for beam simulation improves the agreement data MC

But process is slower than anticipated (more parameters than anticipated need to be tuned…)

Besides, I have not been able to reach convergence at energies =< 50 GeV. It seems that there is a non-understood increase in beam divergence (and dimensions) which depends on beam energy