Leading neutron p_T distributions in DIS

Status Report

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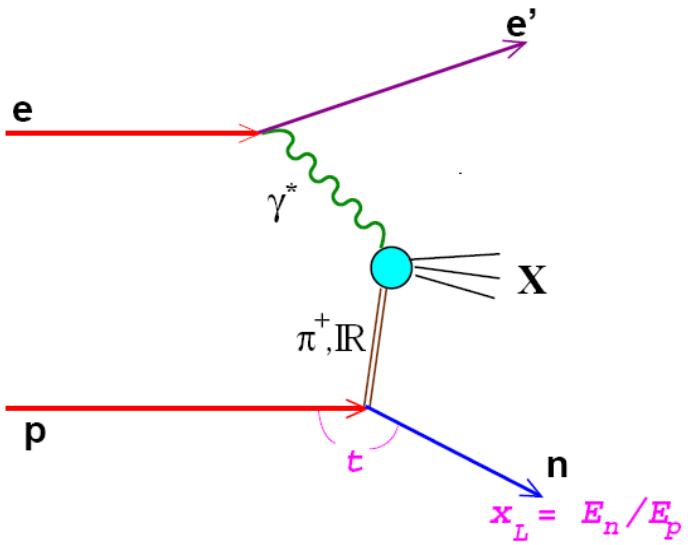
- **Introduction**
- **Datasets, Lumi, Selections**
- **Missing neutrons at Y=4.5**
- **Discontinuities in energy versus coordinate dependence**
- **Trying MC with FNC Shower Library switched off**
- **Attempt to improve coordinate calculation algorithm**
- **Control plots**
- **Summary and Outlook**

Introduction



Goal of the Analysis: Measure double differential cross section of leading neutron production $d^2\sigma_{LN}/(dx_L dp^2_T)$ and give constraints on the pion flux parameterizations.

In the π-exchange picture leading neutron production cross section can be expressed as a product of the pion flux $f_{\pi/p}(x_L,t)$ and the positron-pion cross section :

$$\sigma_{ep\to enX}(\beta, Q^2, x_L, t) = f_{\pi^+/p}(x_L, t) \times \sigma_{e\pi\to eX}(\beta, Q^2), \quad where\ \beta = x/(1-x_L)$$

Studying $d^2\sigma_{LN}/(dx_L dp^2_T)$ t or p_T dependence we can obtain an information about the pion flux.

Data samples and Luminosity

Data and MC

Data from 2006-2007 e+, E_p = 920 GeV is used

Run range is 470900-500611

MC: RAPGAP 3.1 π^+-exchange 19M events and DJANGOH (diffraction excluded) 13M events.
These simulations are tuned for FNC – forward vertex at primary one's position, RT-noise on.

Data and MC are DST7, H1OO version is 4.0.24

Luminosity Calculation

Production trigger is s88: (SPCLe_IET>1 || SPCLe_IET_Cen2) && FNC_Esum && CIP_T0

Zvtx cut is 35 cm, default nominal vertex position was used (-0.24cm)

Runs with the subtrigger s88 prescale factor equal to 1 were selected (4% event loss)

Excluded runs where FNC was not in readout or FNC/BR10 DAQ was broken

Lumi: 128.0 pb^{-1} (QEDC from h1oo 4.0.24, uncorrected value was 121.6 pb^{-1})

Selection

Subtrigger s88

Using the the Y-Average(e,da) method for kinematic variables calculation

Z_{Vtx} cut is 35cm, Reconstructed by CJC Vertex

$6\ GeV^2 < Q^2 < 100\ GeV^2$

$0.05 < y < 0.6$

Scattered electron: $\Theta_e > 156^o$, RClusSpacal > 12 cm, $E_e > 11$ GeV

$35\ GeV < E\text{-}P_z < 70\ GeV$

$|y_e - y_{da}| < 0.25$ && $|y_e - y_h| < 0.25$

$0.32 < x_L < 1.0$

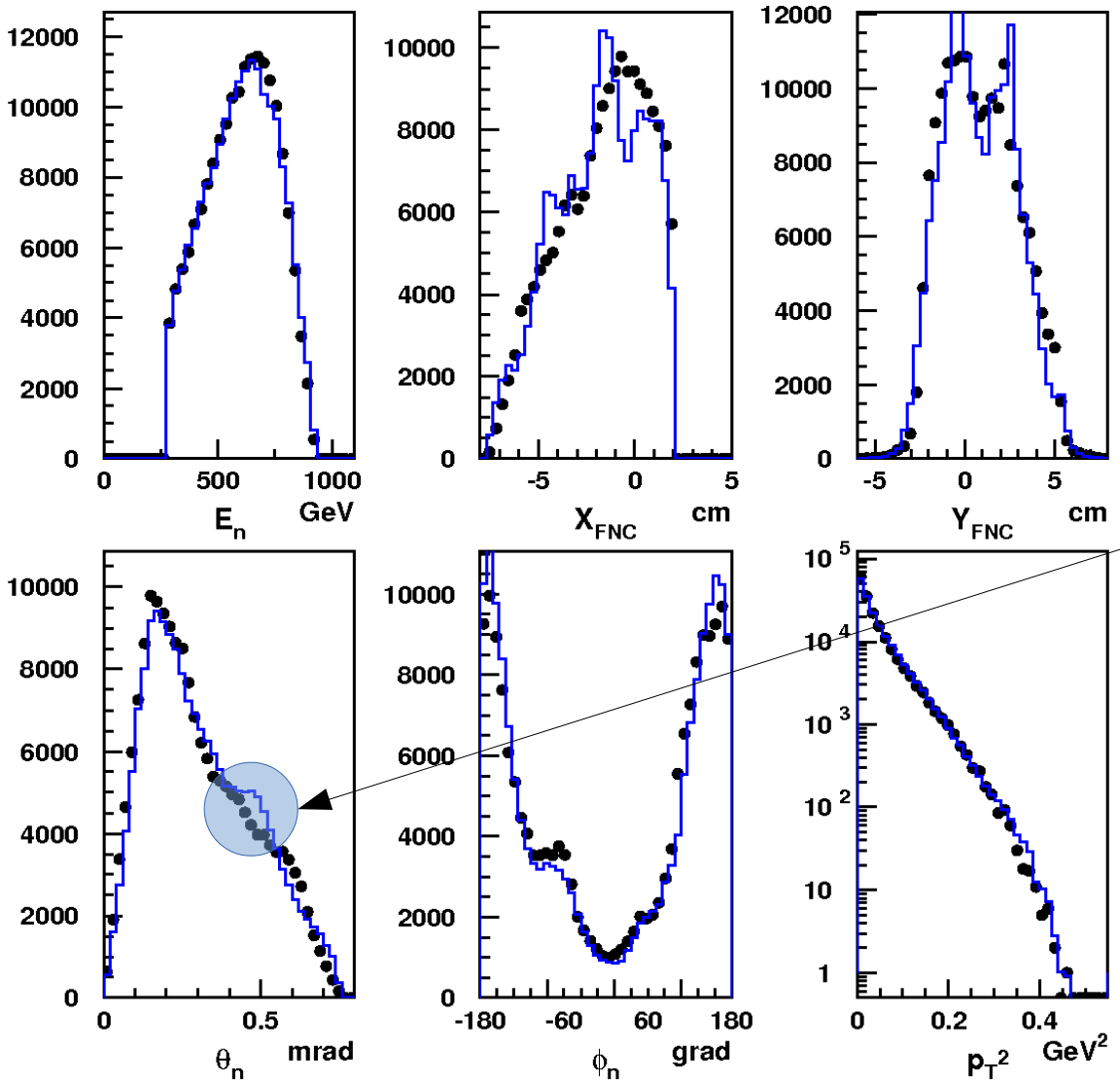
$\Theta_n < 0.75$ mrad

$x_{FNC} < 2$ cm && $y_{FNC} < 7.5$ cm

FNC cluster type 3 used (the shower starts in the Preshower => better coordinate resolution)

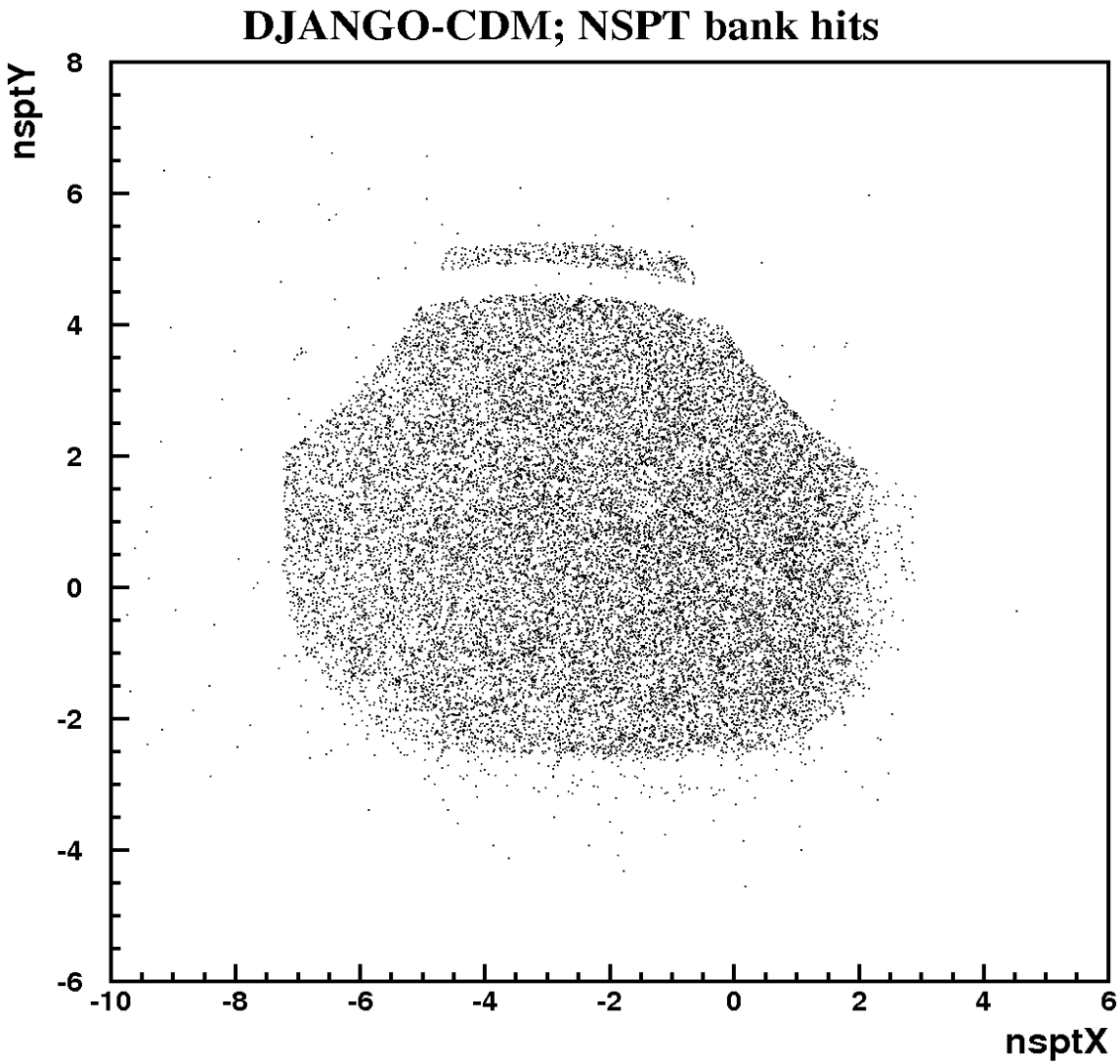
179671 events passed all cuts

FNC control plots, data compared with MC



θ_n spectrum has bump in MC

Hole in the XY scatter plot (1)



Using empty volume NSPT near FNC in GEANT one can find a hole at Y = 4.5cm.
These events are absorbed by something in the beam line simulation.

Hole in the XY scatter plot (2)

The hole at Y=4.5cm.

Suspicious are beam-pipe segments:

JB66 Z=55.80-56.10 ElTube a=3.78-3.98 b=2.78-2.98

JB67 Z=56.10-57.10 ElTube a=3.78-3.98 b=2.78-2.98

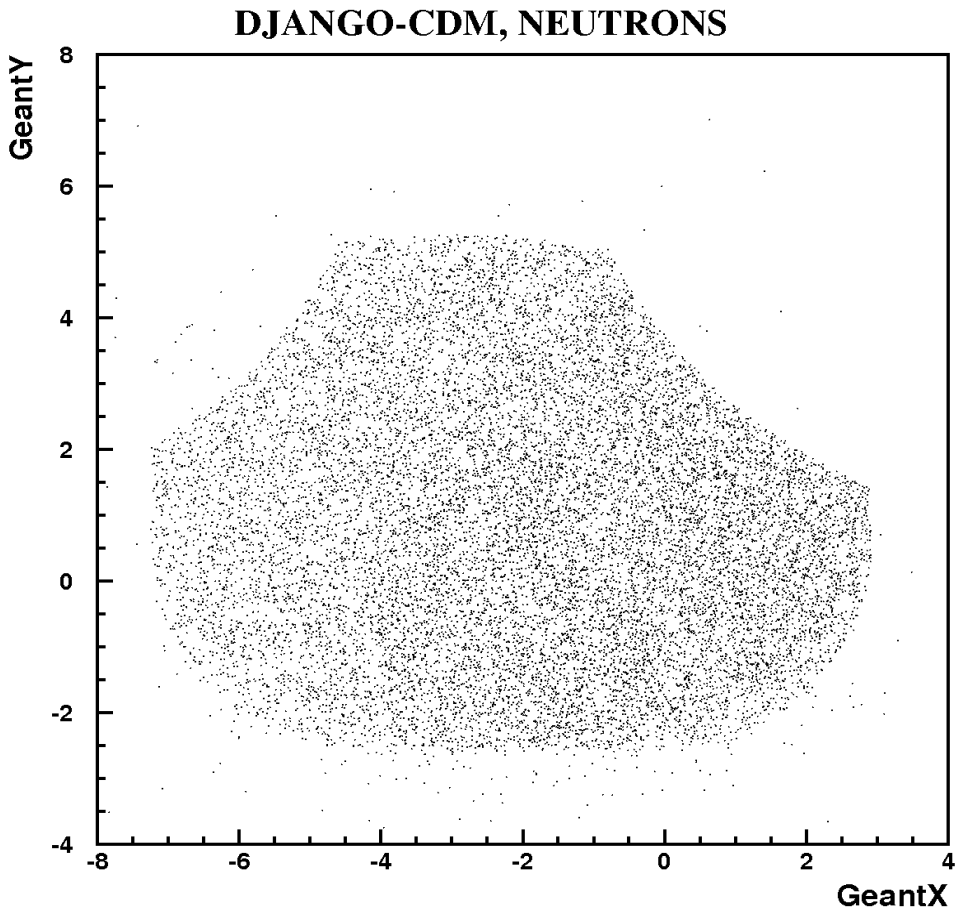
JB68 Z=57.10-57.28 ElTube a=3.78-3.98 b=2.78-2.98

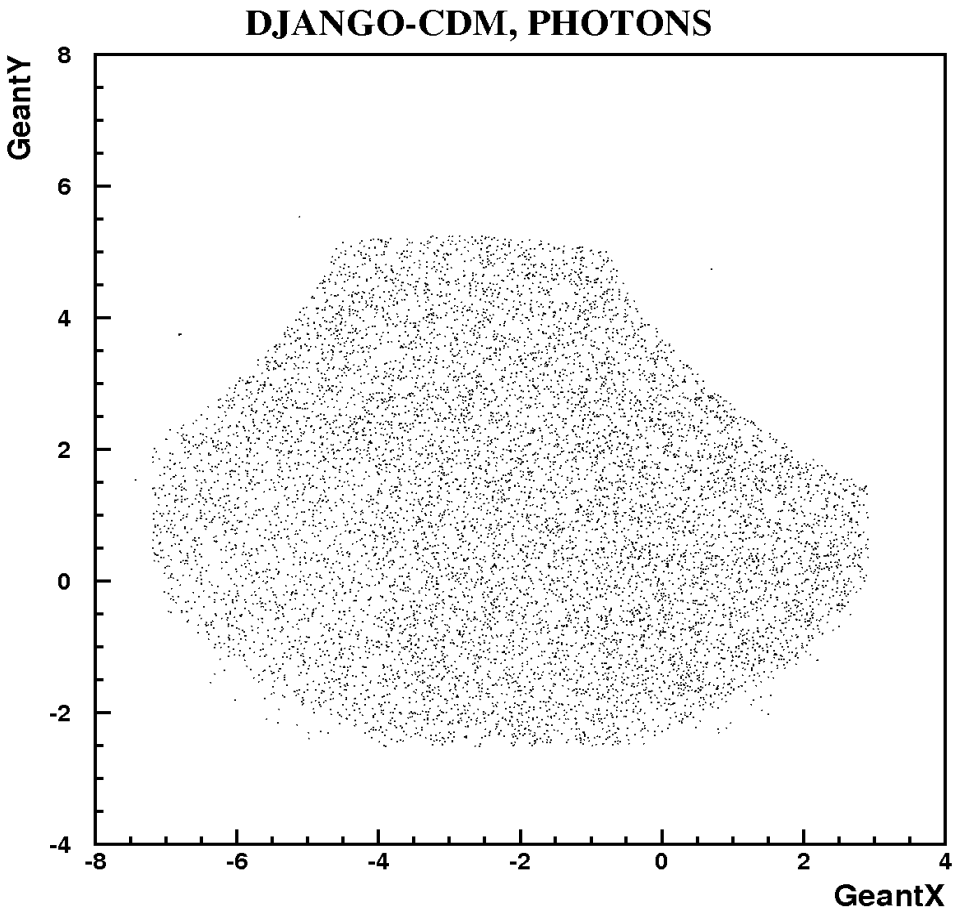
They are made of steel with wall thickness of 2mm.
Total thickness in Z is 2m.

After removing these segments the hole disappeared.

Added modified JGDO bank to the h1simrec steering
(only for FNC analysis simulations)

Hole in the XY scatter plot (3)

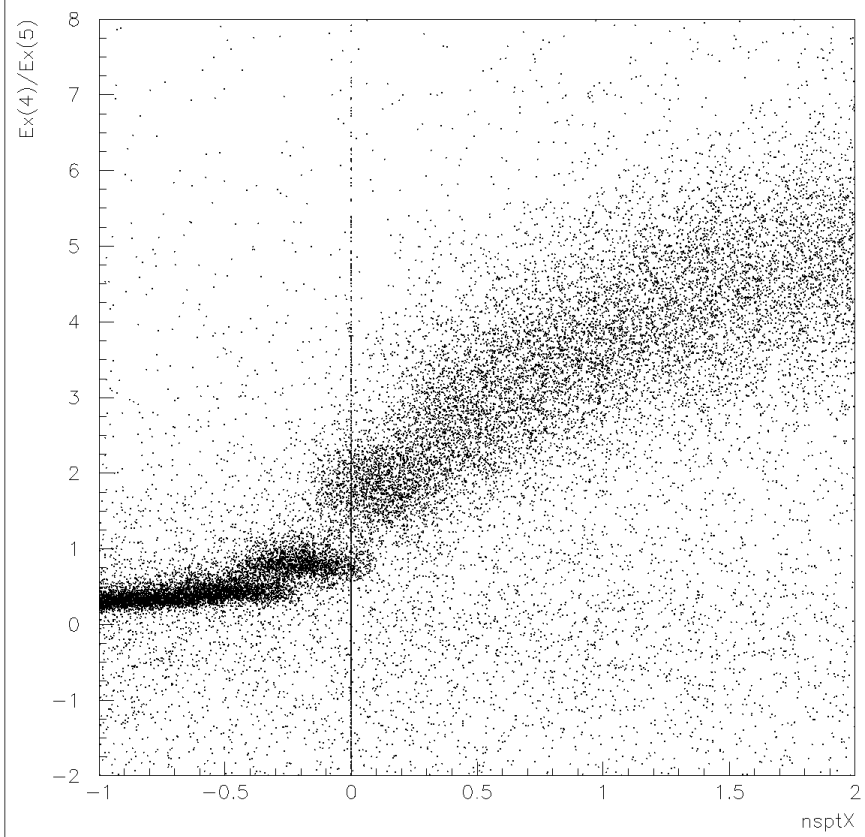




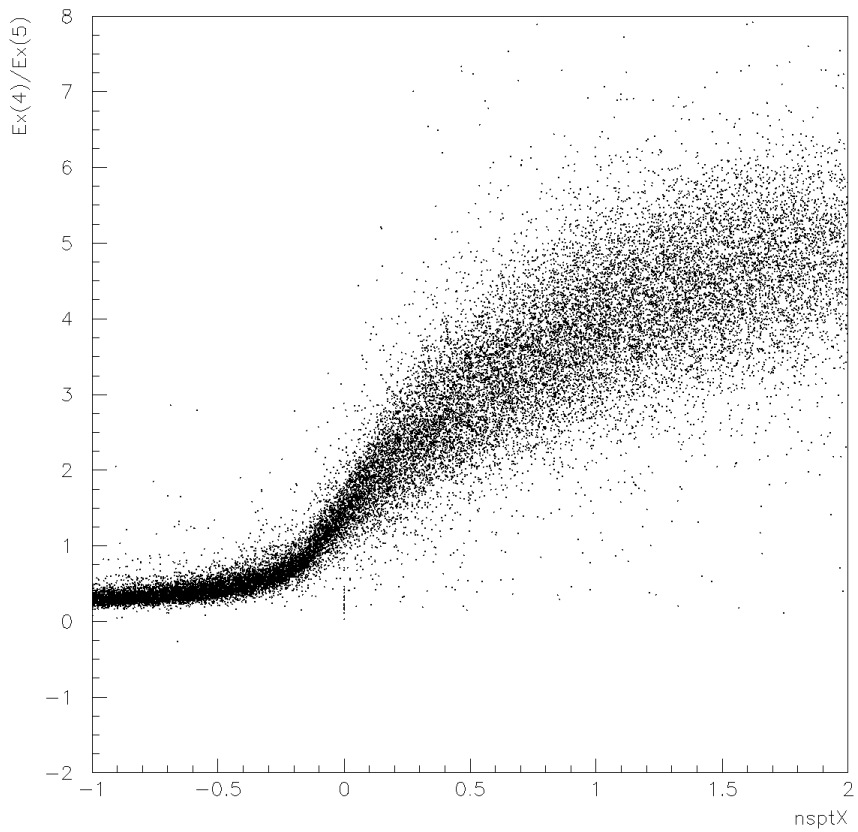
The hole disappeared both for neutrons and photons
after removing those three elliptic beam-pipe segments.
Resulting cross section decreased by ~4%.

Neighboring cells energy ratio VS neutron position

With Shower Library

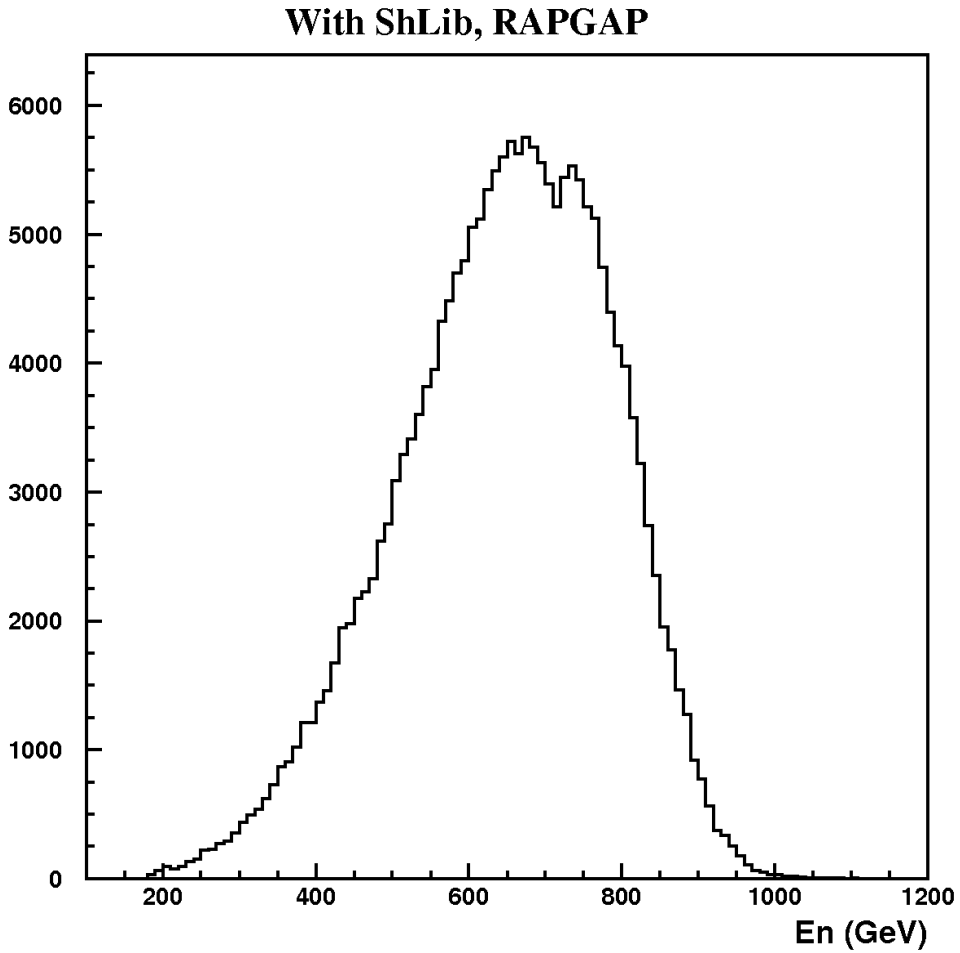


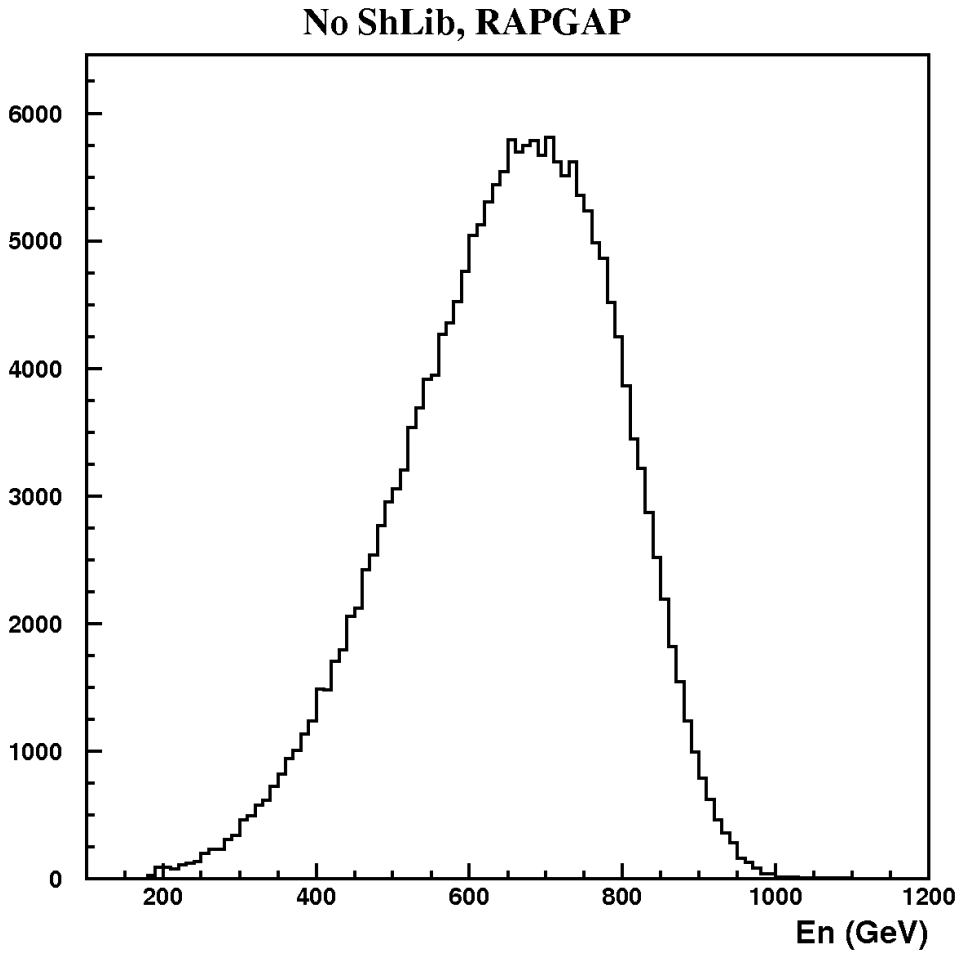
Without Shower Library



Reconstructed coordinate is proportional to logarithm of ratio of energies in neighbouring cells,
I found that the ratio have discontinuities when the FNC Shower Library is used.
Using MC simulation with FNC shower library switched off improves the situation.

Energy Spectrum, with and without FNC Shower Library





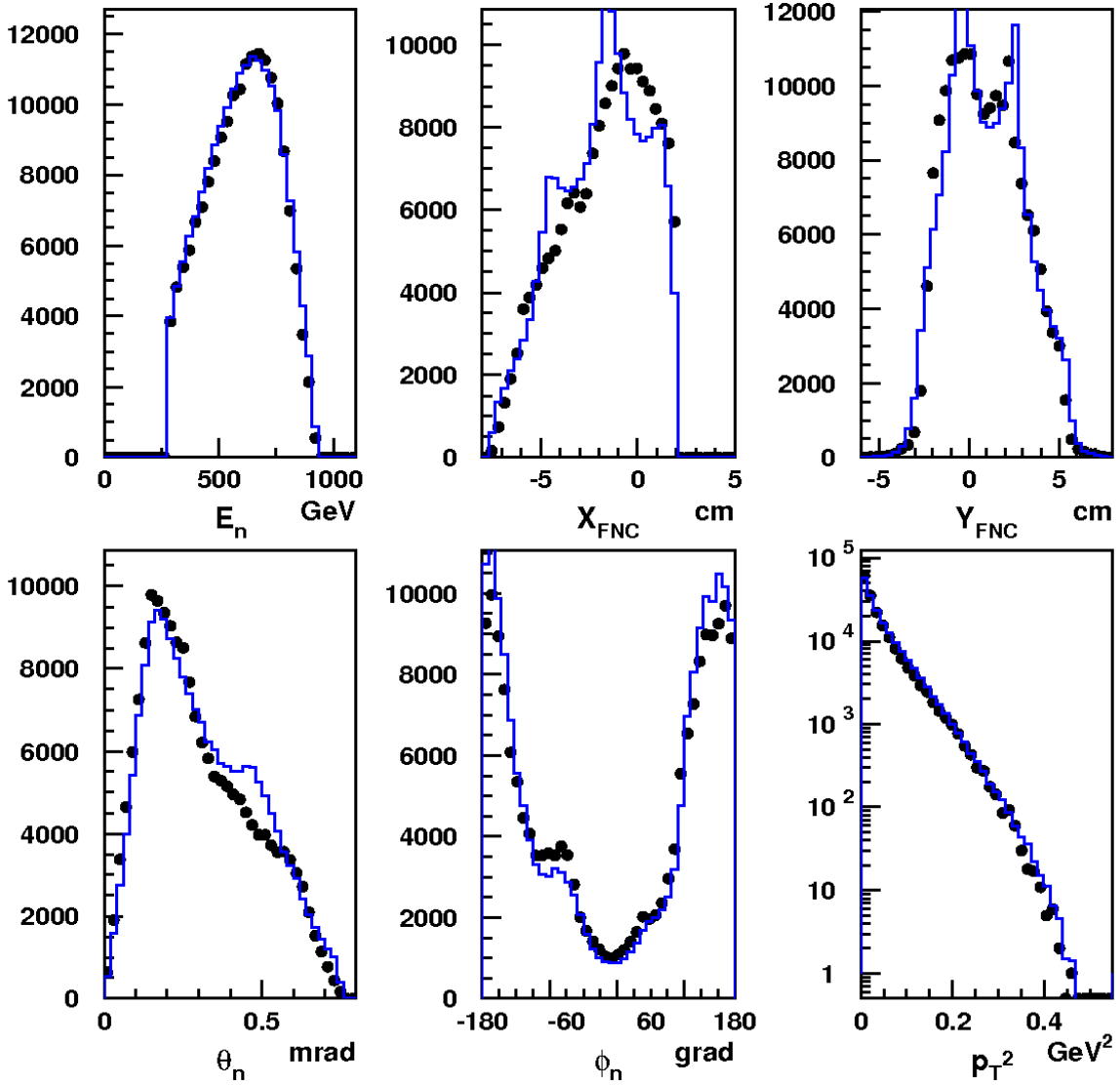
Switching off FNC shower library has a side effect of smoothing energy spectrum.

Control Plots 2, with ShLib, standard coord. rec.

Spiky X and Y,
θ_n spectrum has
bump at 0.45 mrad

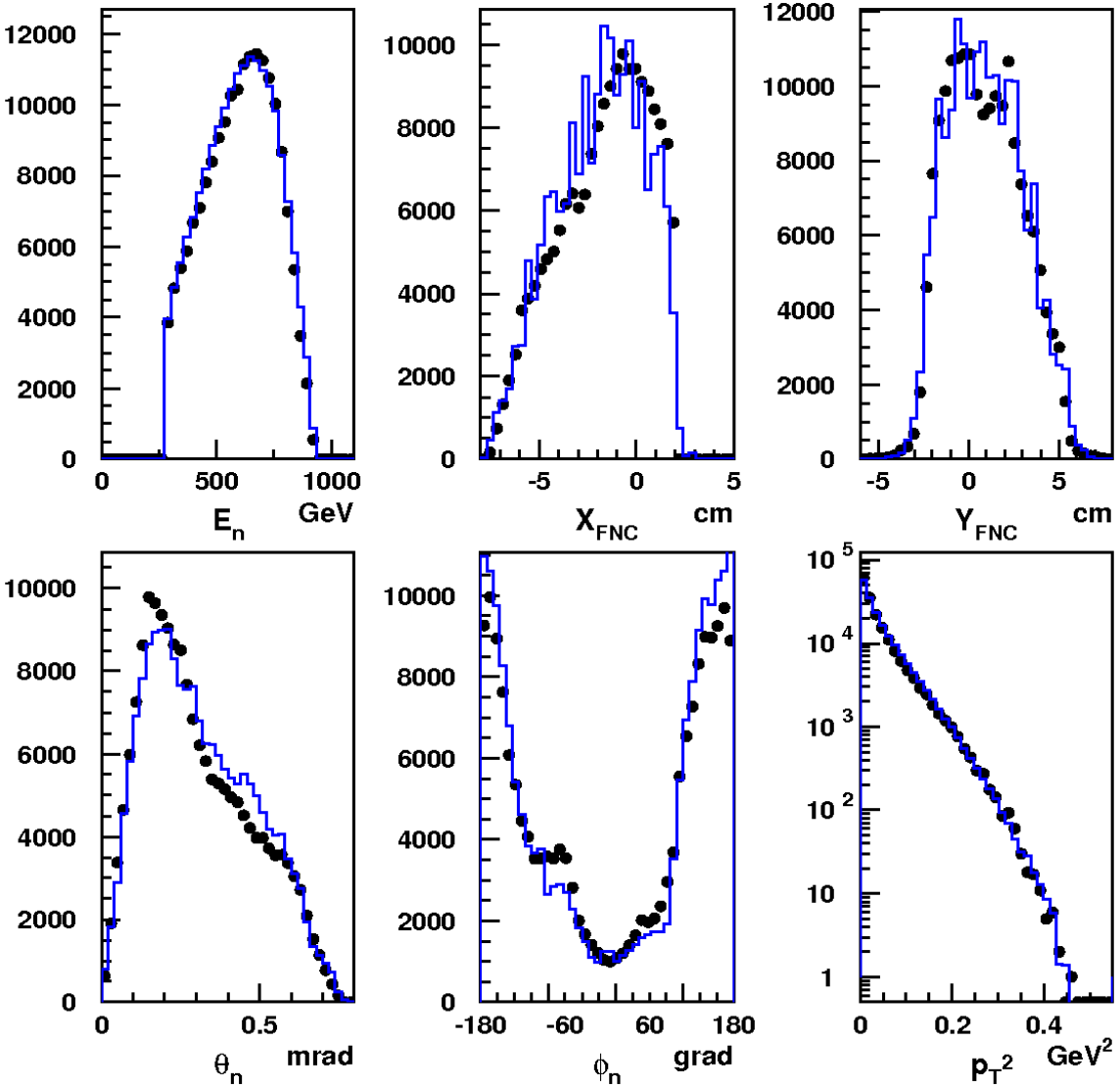
(hole at y=4.5 is there)

Control Plots 2, without ShLib, standard coord. rec.



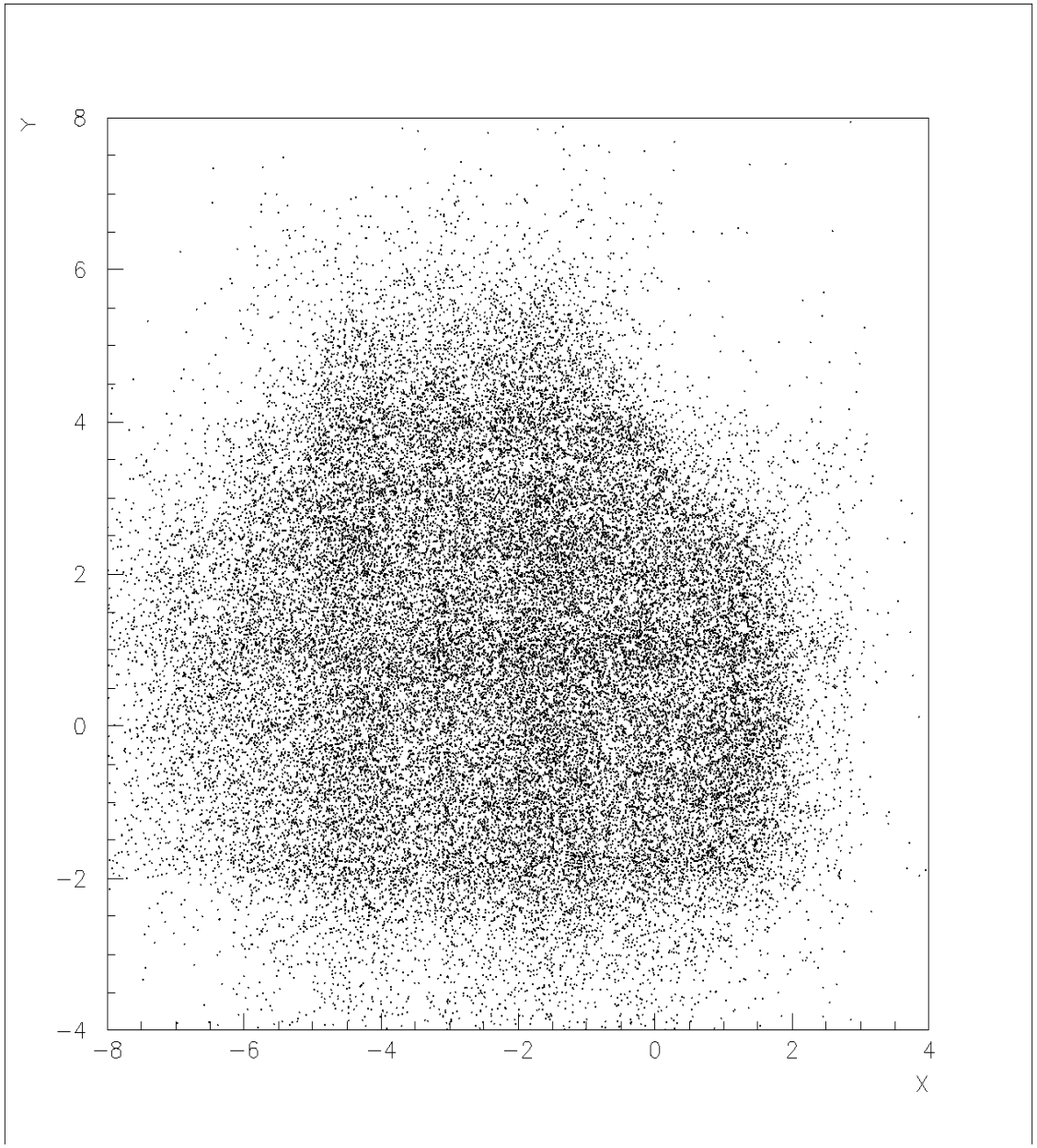
θ_n spectrum have larger bump due to extra neutrons at Y=4.5cm

Control Plots 2, without ShLib, new2 coord. rec.



X and Y improved.
θ_n spectrum is changed
pT^2 is better at large pT^2

XY scatter plot, center of gravity method



Centre of gravity method
gives somewhat smoother picture

Summary and Outlook

1) The reason for the hole in XY-scatter plot is found. New h1sim steering with removed beam-pipe segments is tested and ready.

2) Added exponential cross talk. Lateral shower profile is fine but no improvement in coordinate reconstruction. Left out.

3) Steps in energy versus coordinate dependence. Steps disappear when FNC shower library is switched off in h1sim.

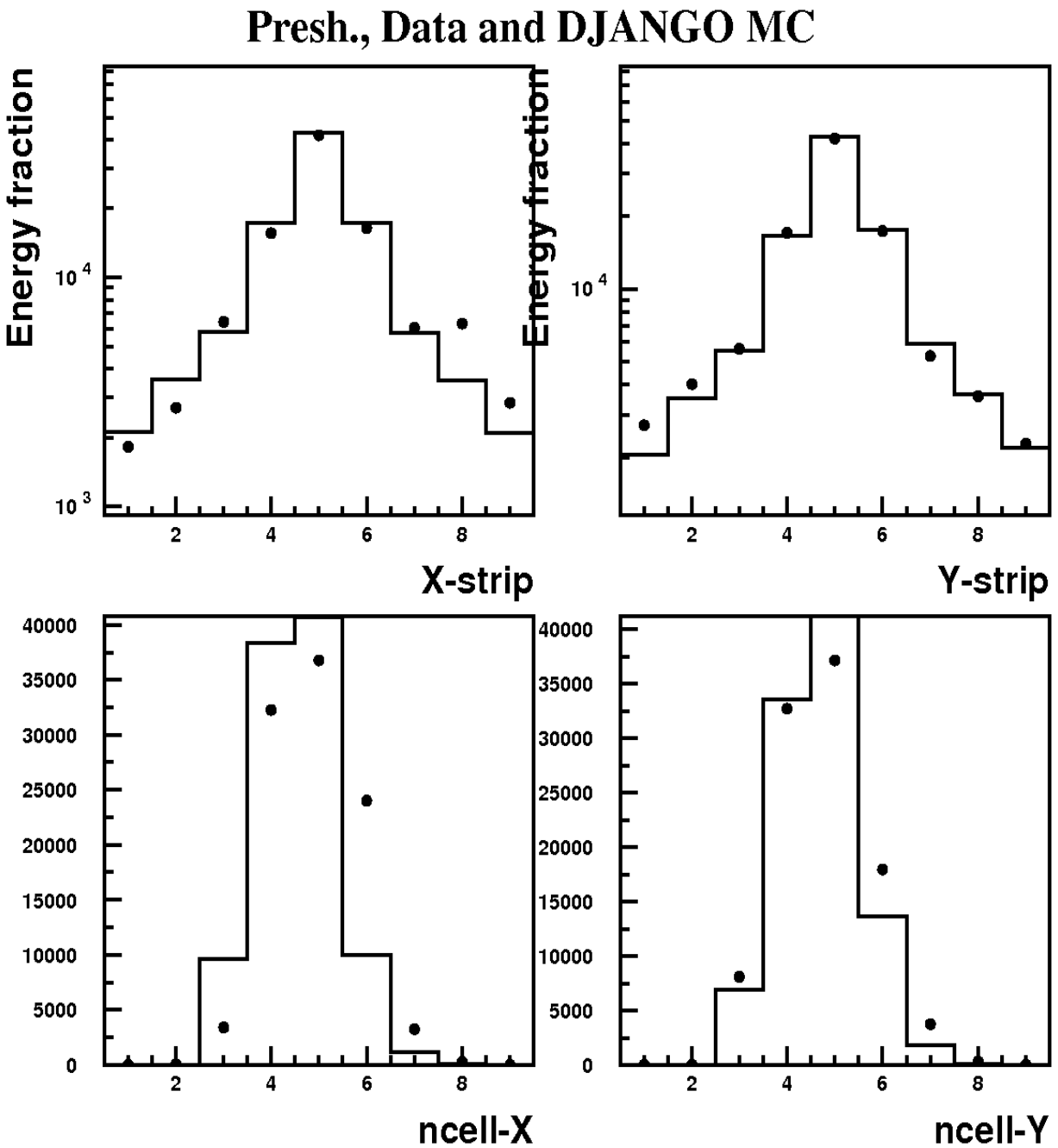
4) MC requests redone with beam-pipes removed and FNC ShLib off.

5) Tried centre-of-gravity method of coordinate reconstruction, no real improvement.

=> Have to proceed further with existing coordinate reconstruction.

BACKUP SLIDES

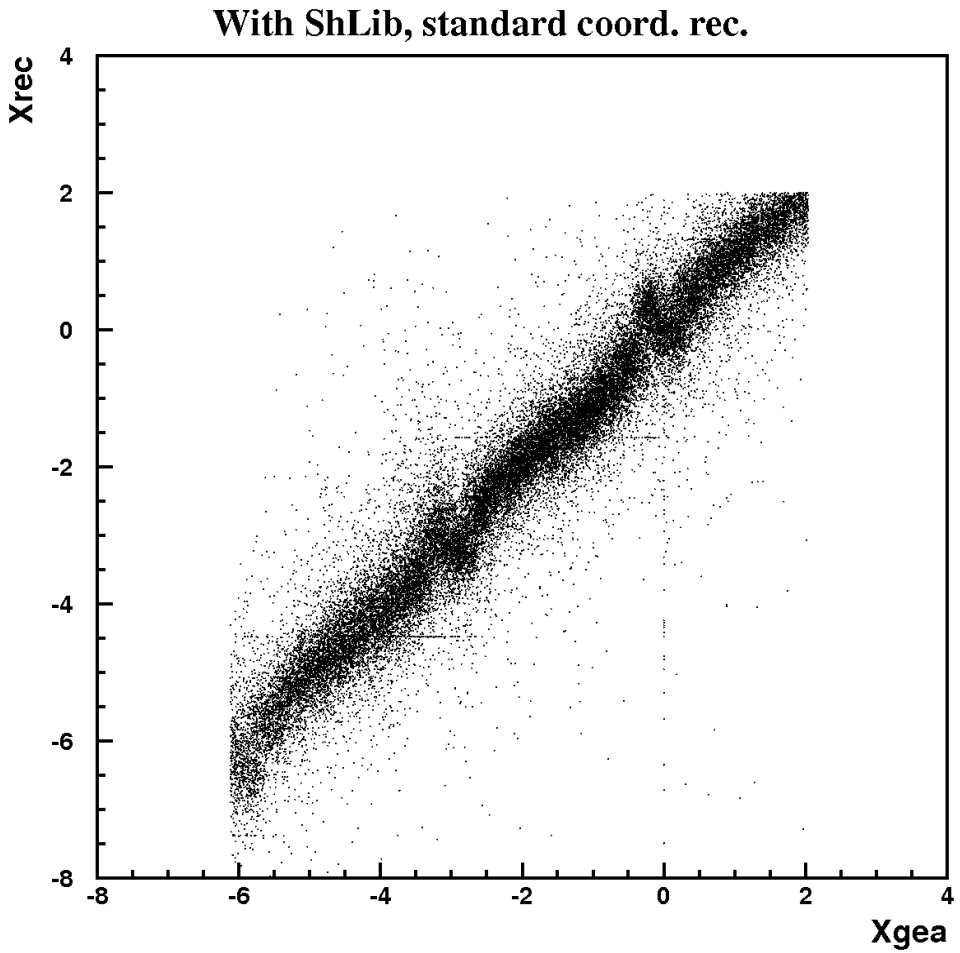
FNC Preshower shower profile (2)

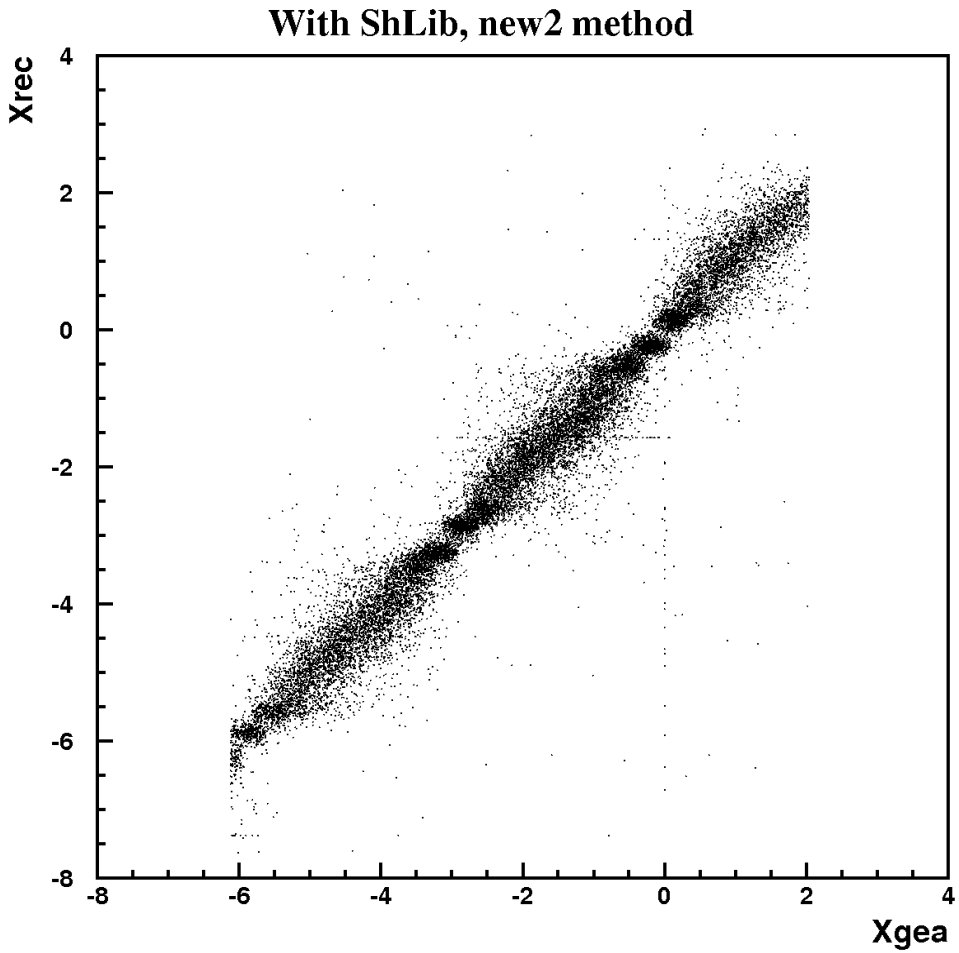


It is possible to add inter-cell cross-talk to describe lateral “shower profile”, but it doesn't improve situation with coordinate reconstruction

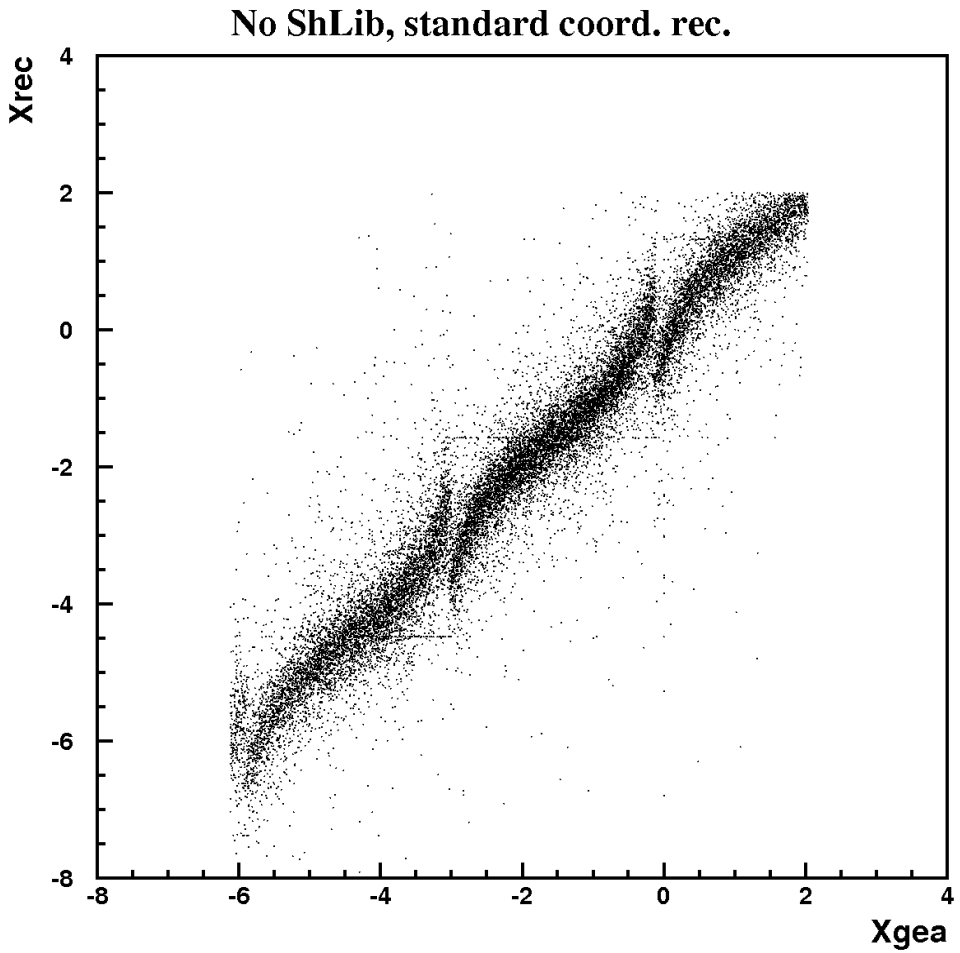
Ecell > 0.05 Esum

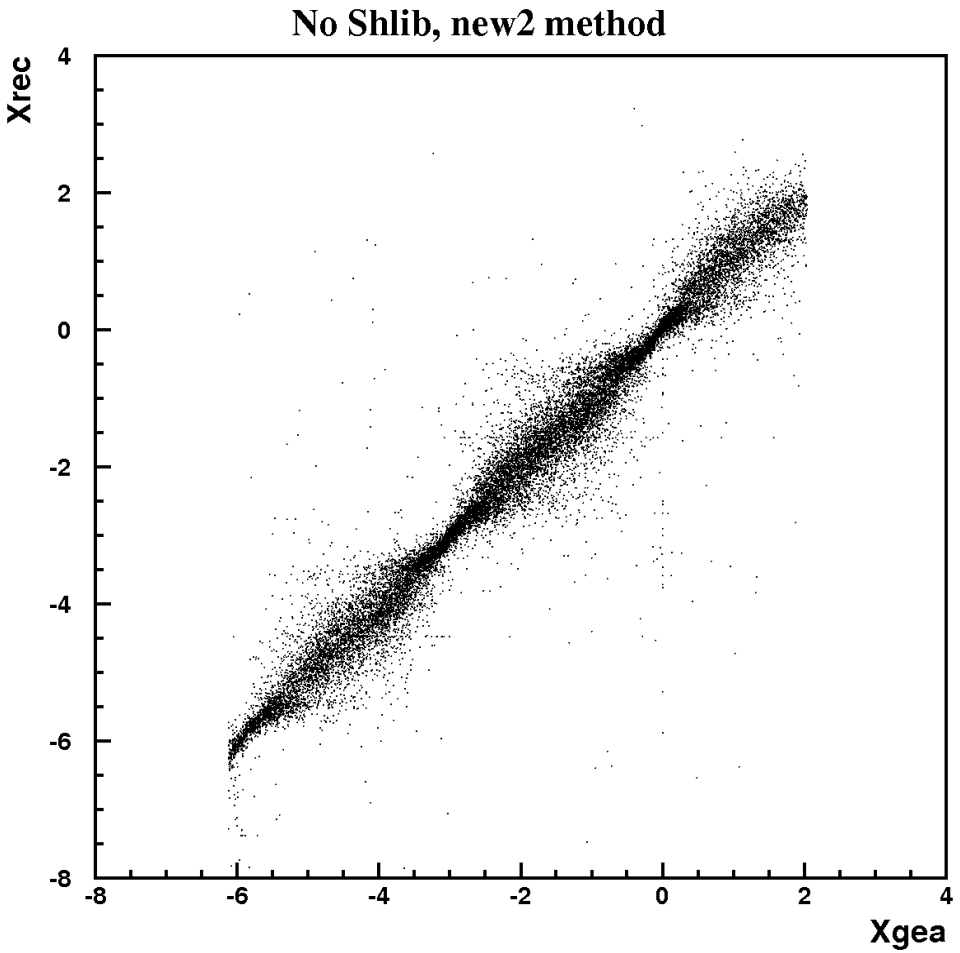
Xrec vs Xgen, with FNC Shower Library



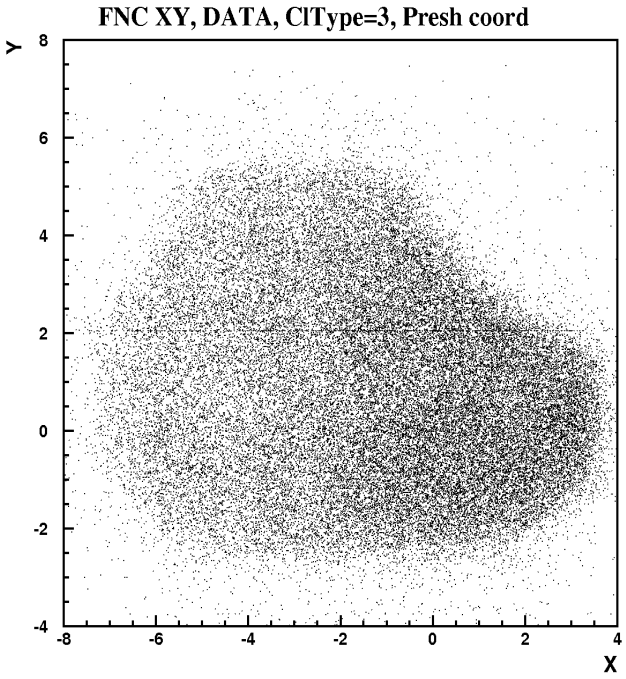


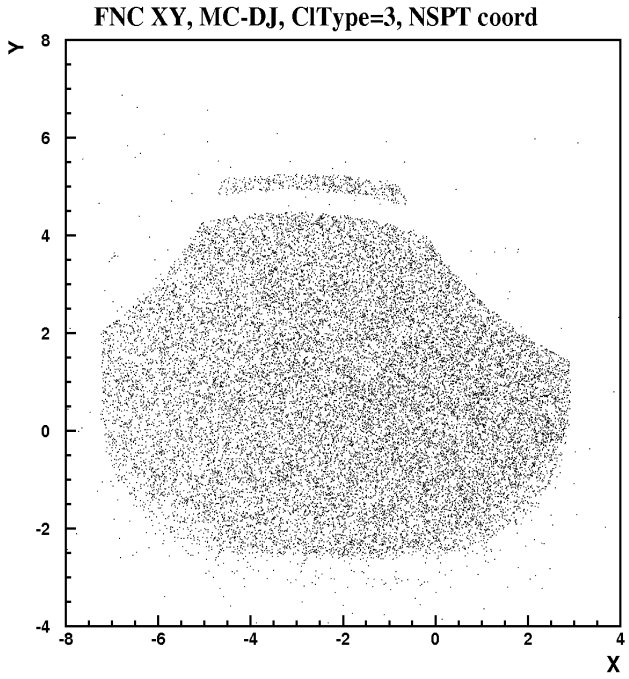
Xrec vs Xgen, without FNC Shower Library

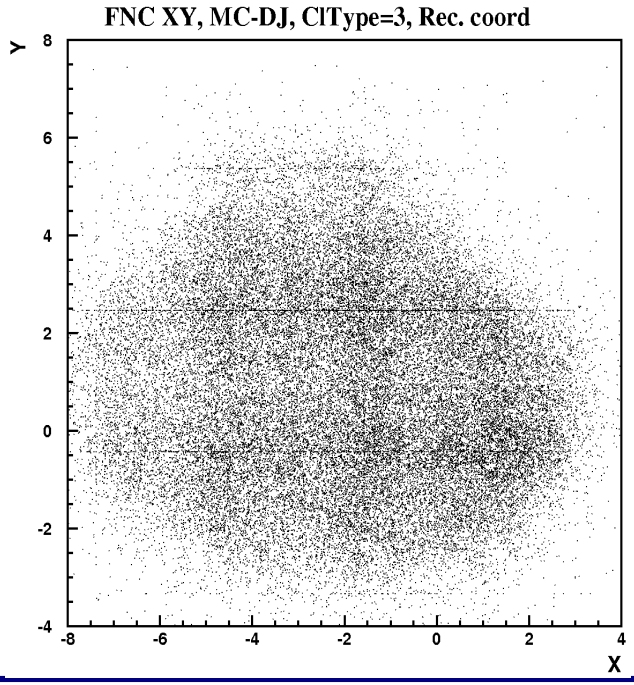


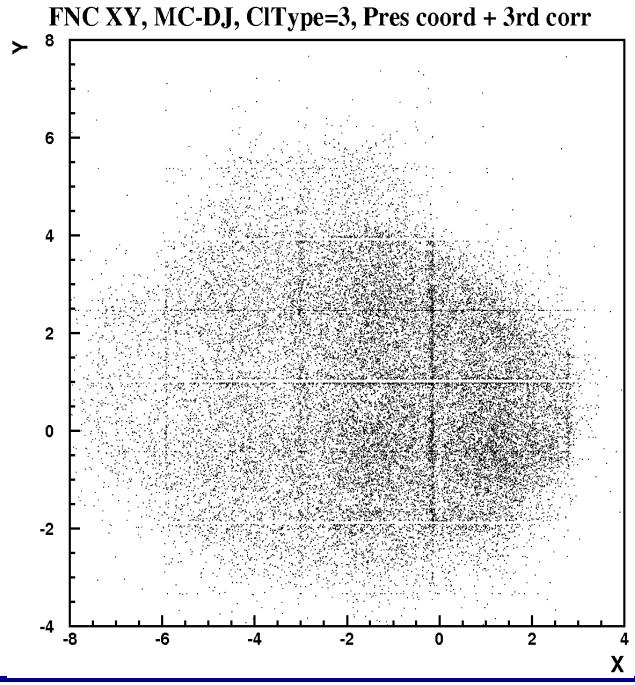


XY scatter plots: Data, Geant, MC, MC w/ corr.



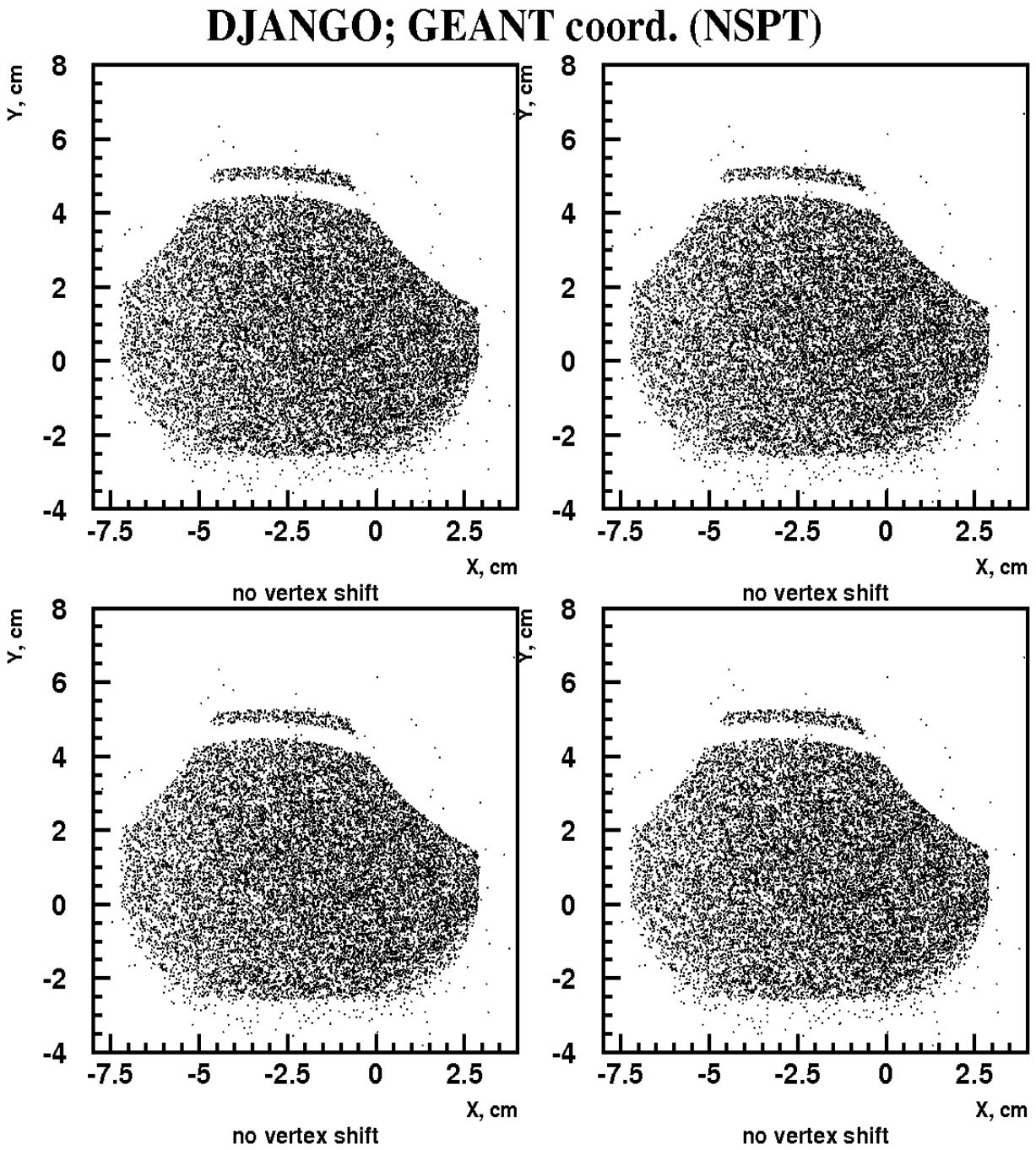




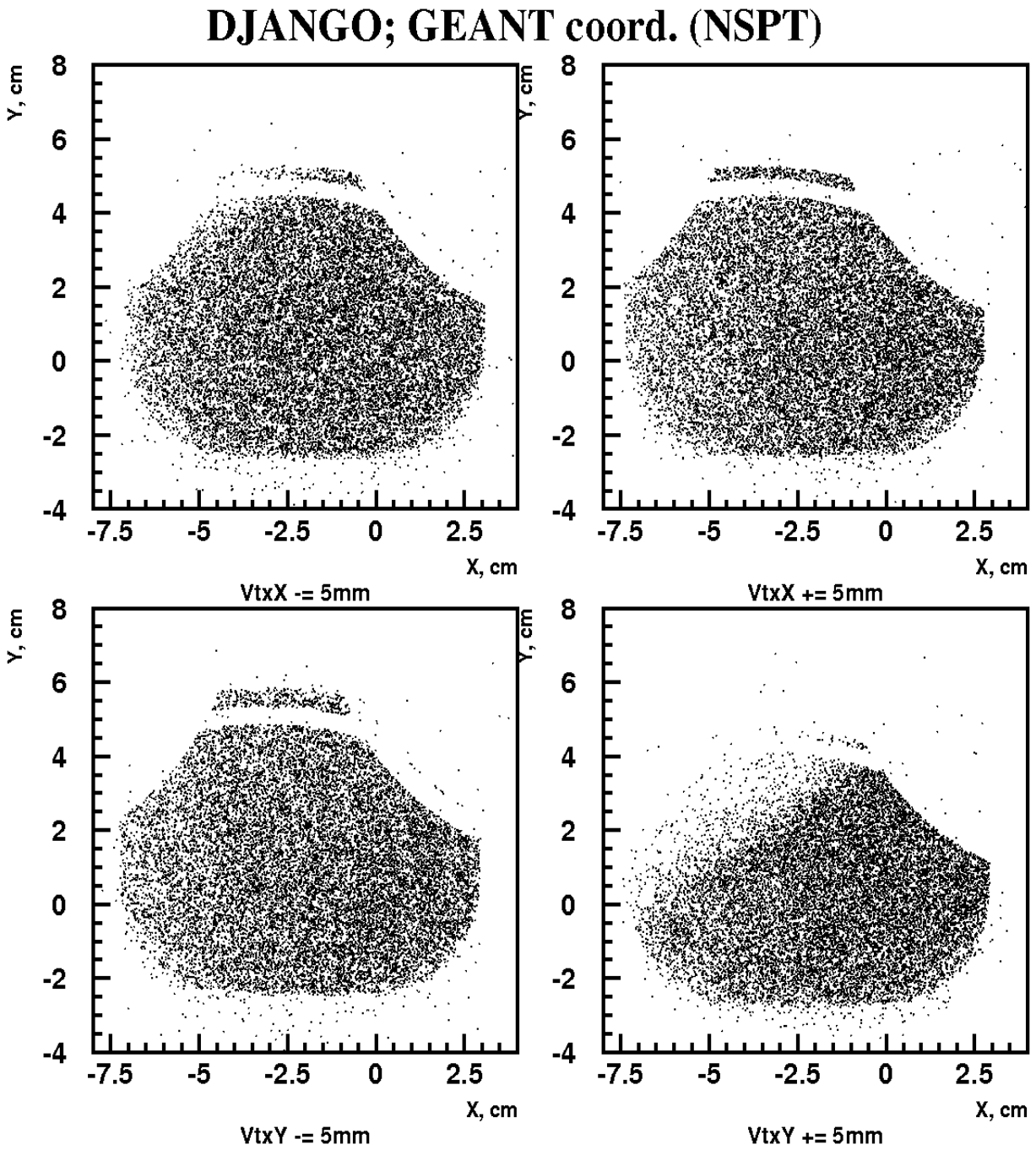


DATA, Type3, Pres || MC, Type3, NSPT
MC, Type3, Pres || MC, Type3, Pres+Corr3

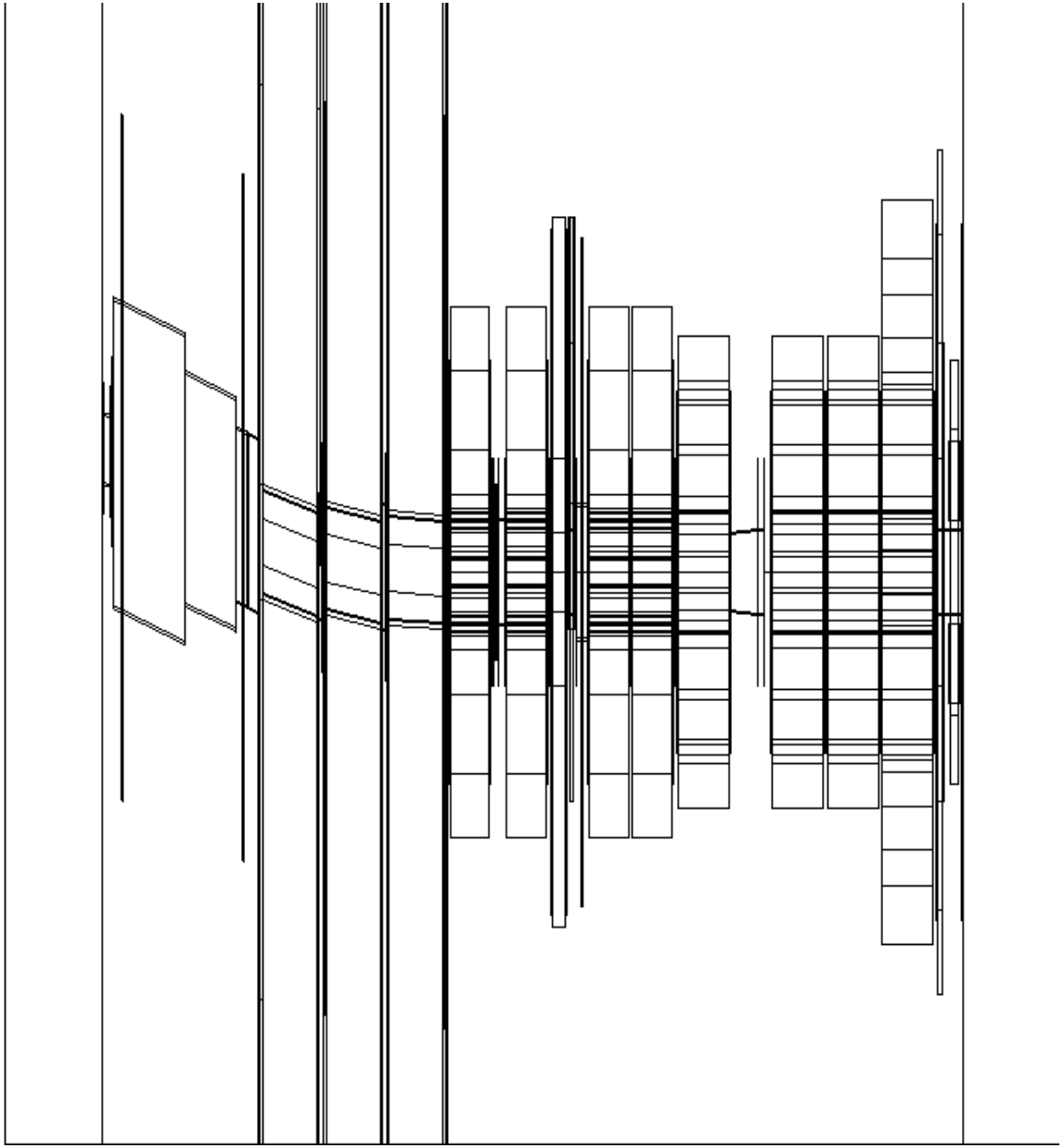
XY scatter plots (no Fw.Vtx. shift)



XY scatter plots (5mm Fw.Vtx. shifts)



GEANT, FBL2 volume (before FNC), side view



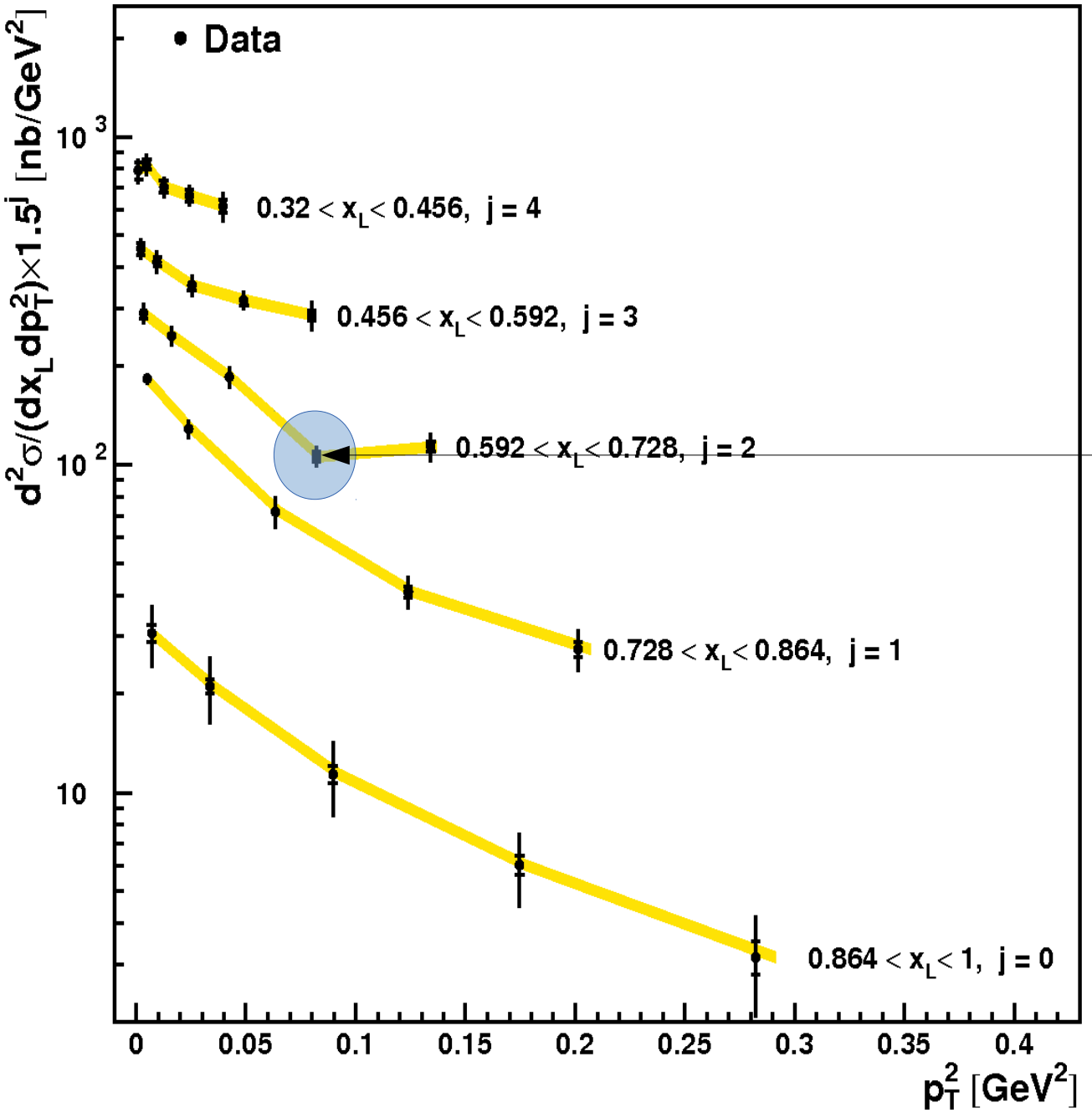
Notes on FNC related h1simrec

Simulation chain without the shower-library:
1) Let GEANT collect hits.
2) Distribute hits among Preshower strips (optical cross-talk)
3) Sum hits and produce FRCE bank -- cell energies
3a) Optionally store cell energies and Gen X,Y to the shower library
4) Reconstruct FNC E,X,Y using cell energies from FRCE

Simulation chain using the shower-library:
1) Ignore Geant hits, instead call shower-libary in GUSTEP
   (when particle crosses FNC volume boundary).
2) Using Geant coordinates from GTRAK common (absolute coordinates)
   search shower-libarry bin corresponding to the needed
   X, Y, p_X/p, p_Y/p
3) Take cell energies from shower-library bin and fill FRCE bank
4) Reconstruct FNC E,X,Y using cell energies from FRCE

2 bugs in h1sim shlib., negligible

Cross section, log Y-axis, Cov. matr.



Big deviation