Report on SF (MID) system studies 3

- Aim : Compatibility between DATA and MC in SF system.

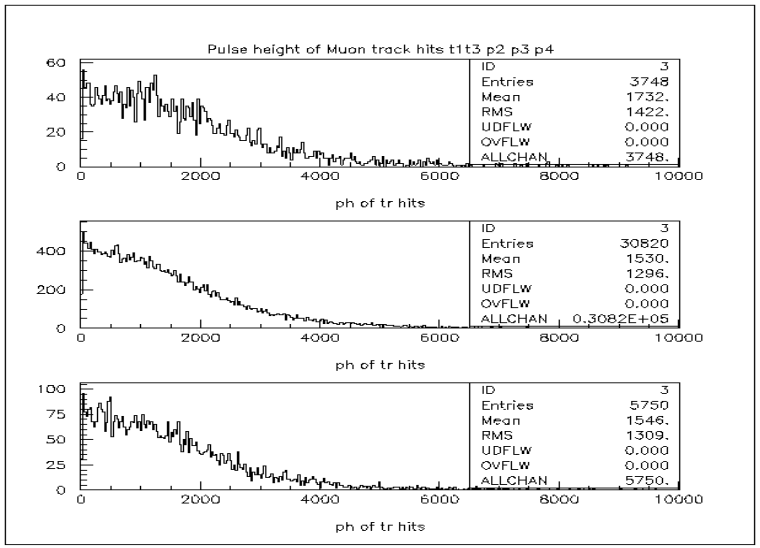
- Methods under study :
  - Apply pulse height cut in DATA.
  - Create new Hybrid MC files with the following procedure:

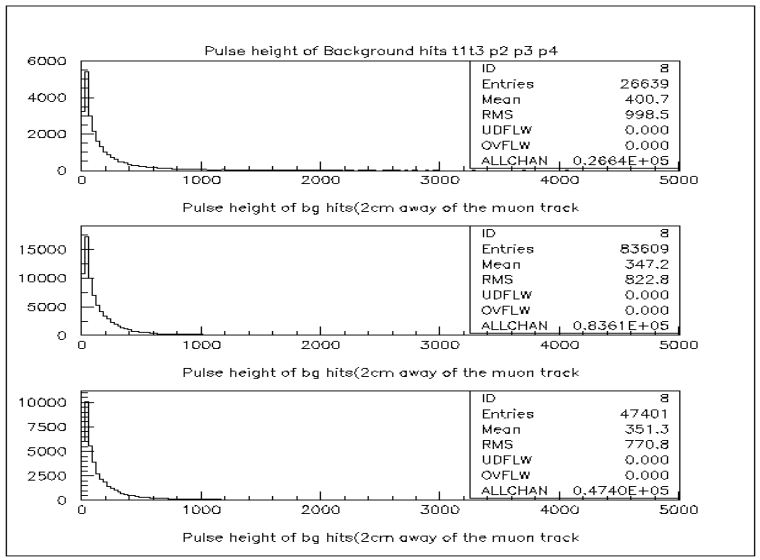
    i) Use t1t3 events and remove muon tracks hits and background hits (with pulse height < the pulse height cut we used in data).

    ii) Use these as "empty frames" and mix with Data.

- In this report we present results of these studies for period 3 and period 4 not muons.

Pulse height of background and muon track hits in t1t3 events periods 2 3 4

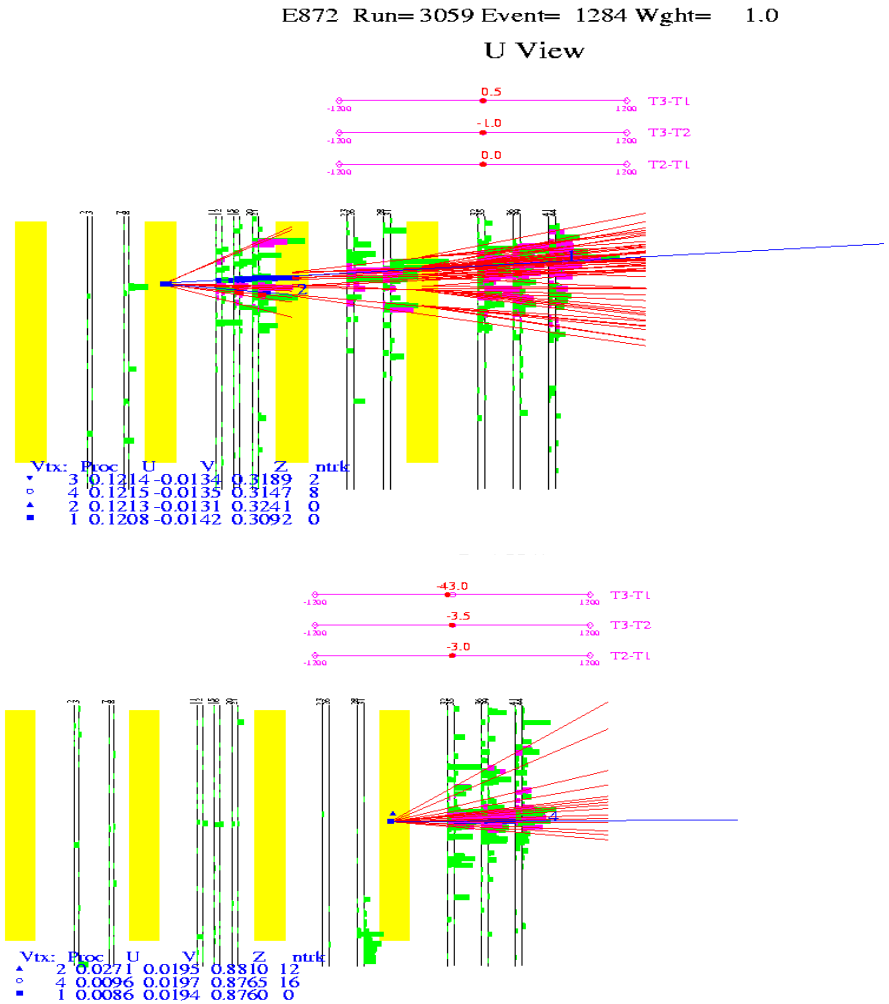




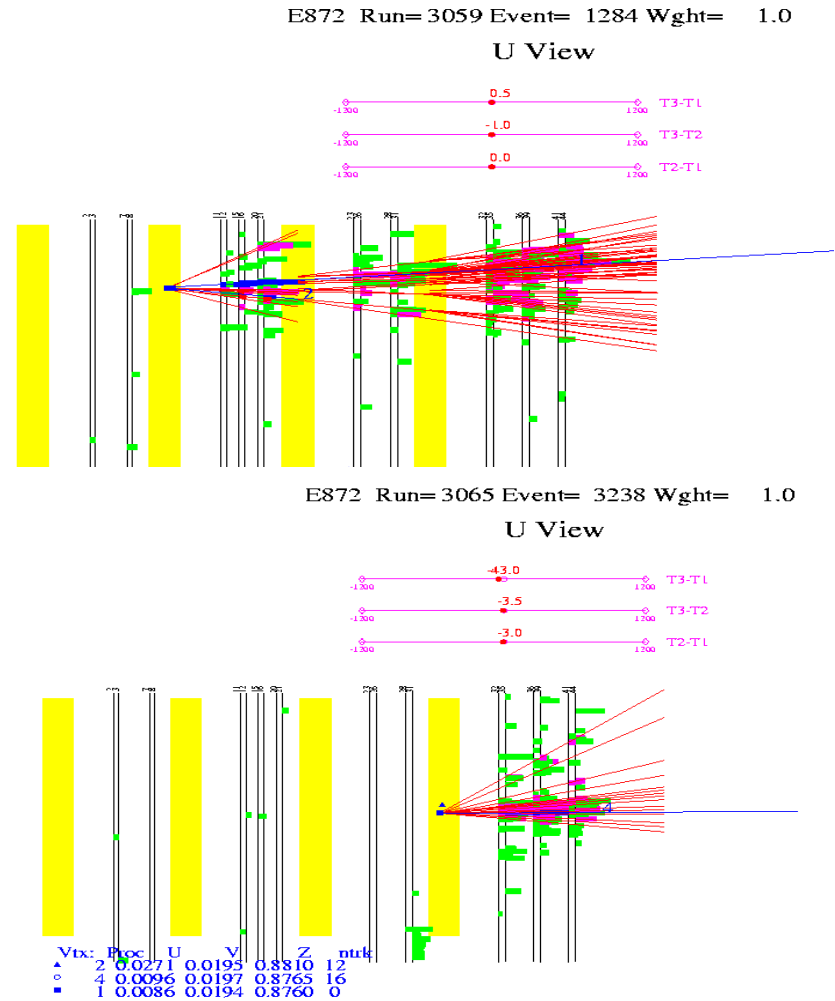
- On the left figure we see the pulse height distributions of muon tracks hits in t1t3 events for periods 2 , 3 and 4. No great differences are observed (mean p2 ~ 1700 mean p3 ~ 1530 mean p4 ~ 1550).
- On the right figure we see the pulse height distributions of background hits in t1t3 events for periods 2 , 3 and 4. Again we don't see differences in these three histograms. (mean p2 ~ 400 mean p3 ~ 350 mean p4 ~ 350).
- We can assume that the pulse height cut we are using (= 1000) should be the same at least for periods 2 3 and 4.

Pulse height cut 1000 in event Display

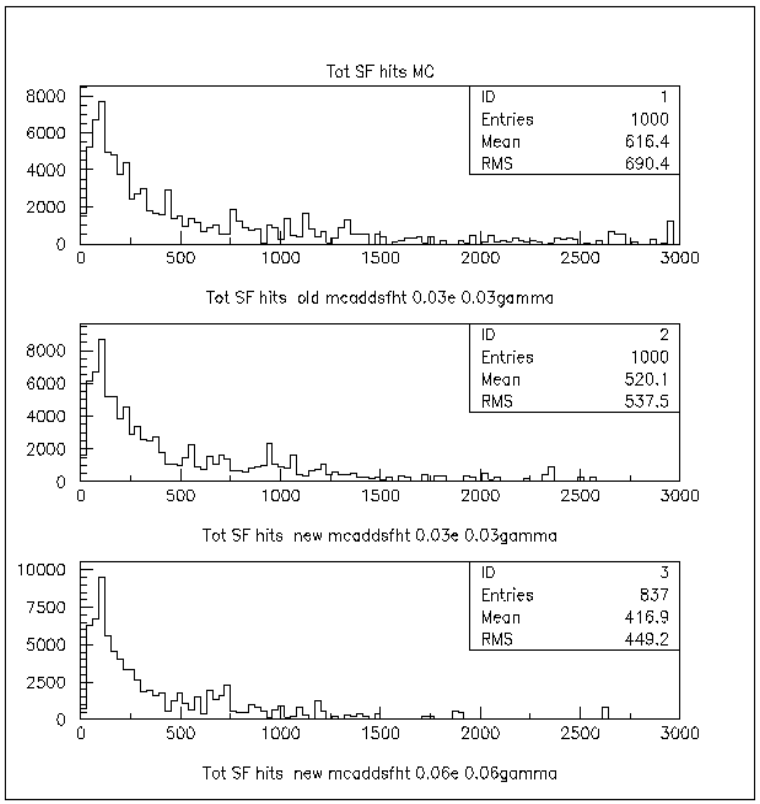
Before pulse height cut



After pulse height cut 1000



Long tail on MC total SF hits distributions



- In the top histogram you see the total SF hits distribution for MC data with geant cuts for electron and gamma 0.03 0.03 (GeV).
- In the middle histogram you see the same distribution with the same geant cuts but with routine MCADDSFHT modified :

Calculation of number of hits in the same fiber :

i) Get the fiber number xxx.yyy of the fiber that has a hit

ii) Convert fiber number to a) xxx.5 (if yyy > 0.5)

b) xxx.0 (if yyy < 0.5)

iii) Get the fiber number zzz.hhh of another fiber that was hit

iv) If | xxx.5(.0) - zzz.hhh | < 0.01 don't count the second hit and just update pulse height .

New procedure in calculating number of hits in the same fiber :

i) Get the fiber numbers xxx.yyy , zzz.hhh that have a hit.

ii) If | xxx.yyy - zzz.hhh | < 0.5 don't count the second hit and just update pulse height .

- In the bottom histogram you see the tot. SF hit distribution with **new mcaddsfh** and **geant cuts** for **electron and gamma 0.06 0.06 GeV.**

p3 and p4 comparison between Data and MC

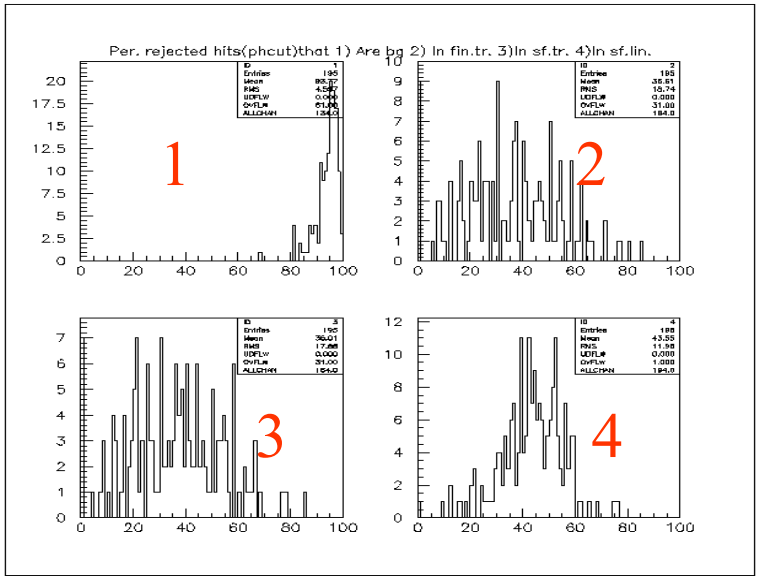
- We use p3 and p4 not muons to compare with MC (this eventually is going to be performed for all available neutrino data).

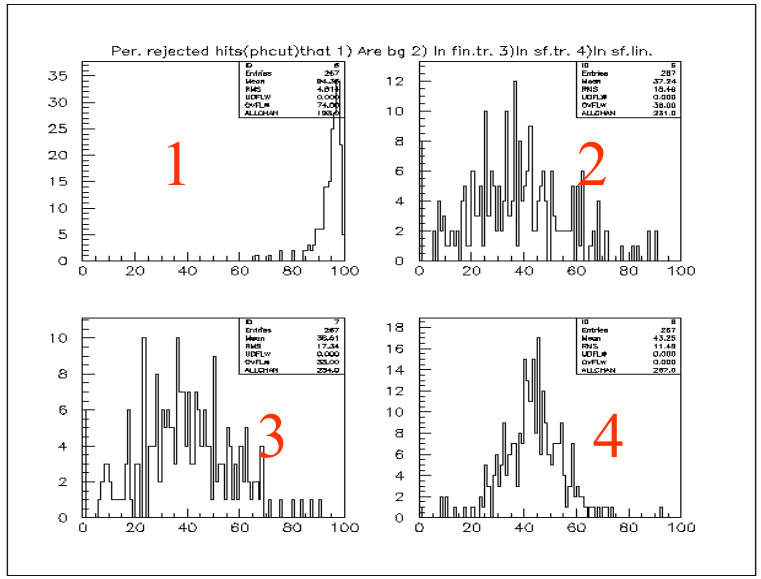
- We compare Data in which "background" hits and hits with pulse height < 1000 are removed with MC.

- We compare Data with pulse height cut 1000 with Hybrid MC files. The hybrid MC files are produced by:
  - removing from t1t3 events muon track hits and hits with pulse height below the 1000 cut ("empty frames").
  - Superimpose "empty frames" with MC data

- In all the following results the MC files are produced using new **mcaddsfht** routine and geant cuts 0.06 GeV for electron and gamma and 0.03 GeV for the rest particles.

Percentage of rejected hits (ph<1000) the belong to final and sf tracks and sf lines.





Period 3 not muons.

Period 4 not muons

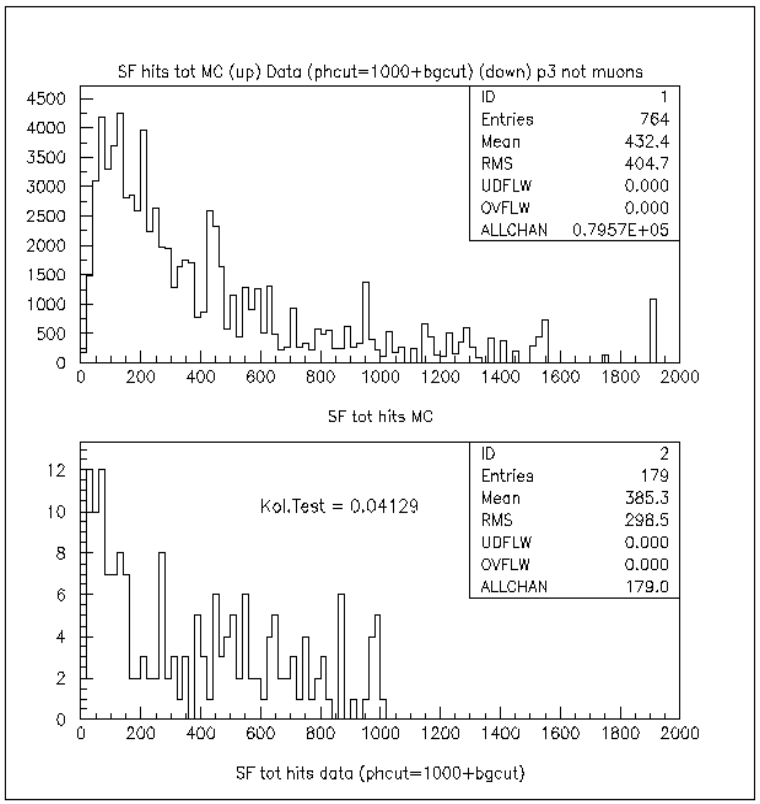
1) % of rejected background hits ~ 95 %

2) % of rejected hits that belong to final tracks ~ 36%

3) % of rejected hits that belong to SF tracks ~ 36 %

4) % of rejected hits that belong to SF lines ~ 43 %

P3 not muons Data and MC (SF system)

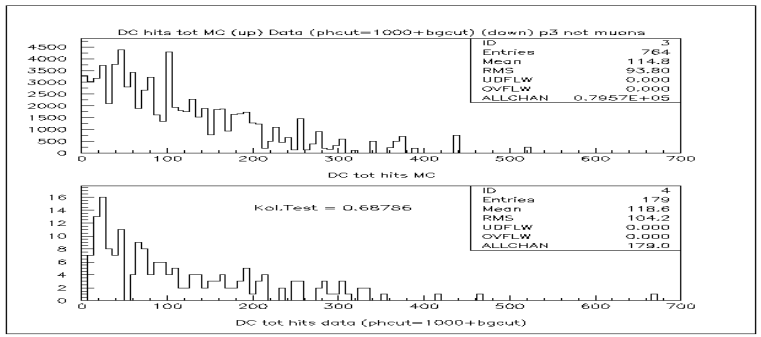


- On the top histogram we see the distribution of total SF hits in MC.
- On the bottom we see the same distribution in DATA.
- The compatibility between data and MC is quite good and the Kolmogorov test gives a result of 0.04129

P3 not muons Data and MC (DC EMCAL)

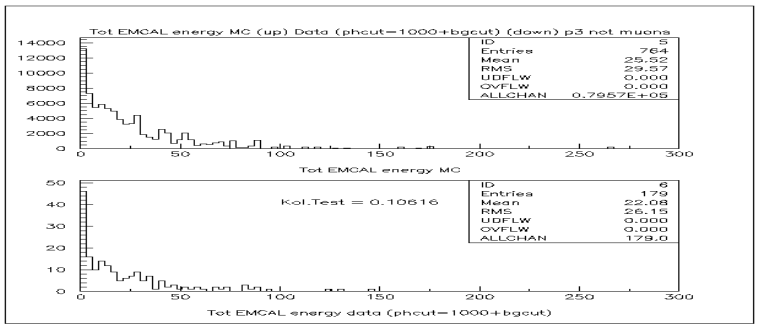
Total DC hits MC(up) Data (down)

Kolmogorov test = 0.68786



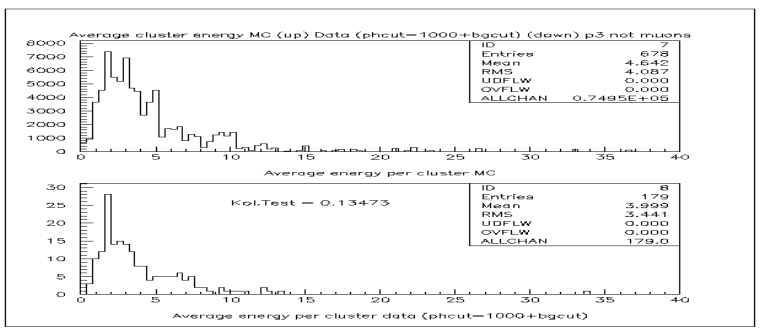
Total Emcal Energy MC(up) Data (down)

Kolmogorov test = 0.10616



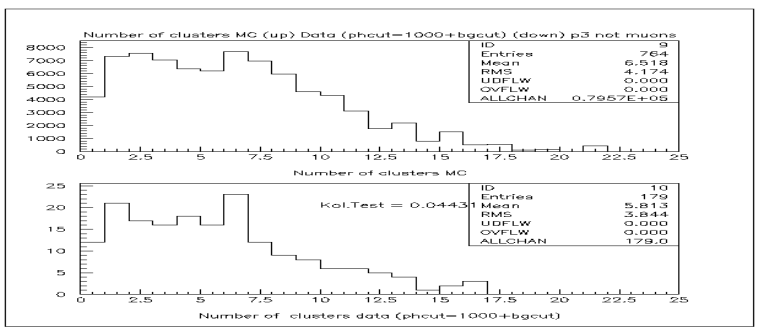
Average Cluster Energy MC(up) Data (down)

Kolmogorov test = 0.13473



Number of Clusters MC(up) Data (down)

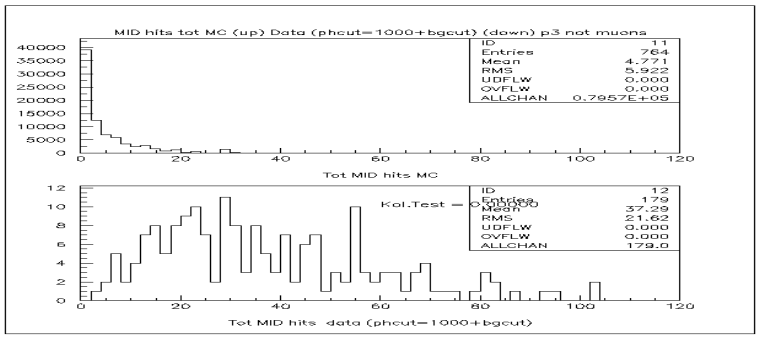
Kolmogorov test = 0.04431



P3 not muons Data and MC (MID)

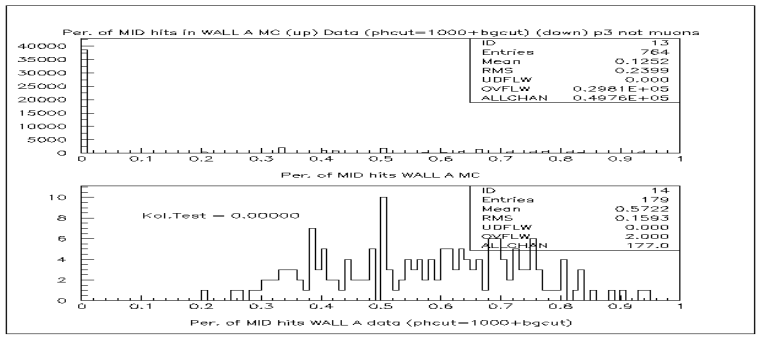
Total MID hits MC(up) Data (down)

Kolmogorov test = 0.00000



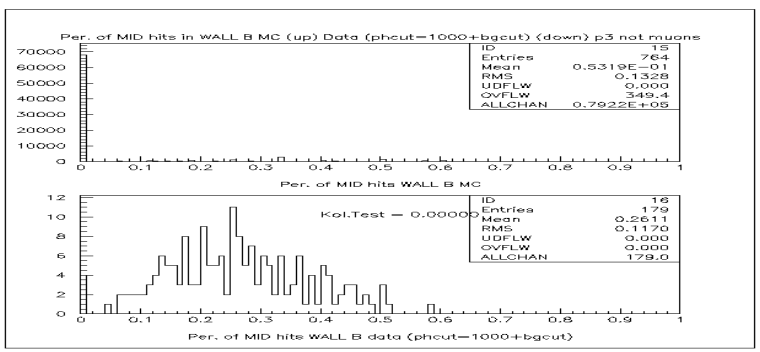
% of MID hits wall A MC(up) Data (down)

Kolmogorov test = 0.00000



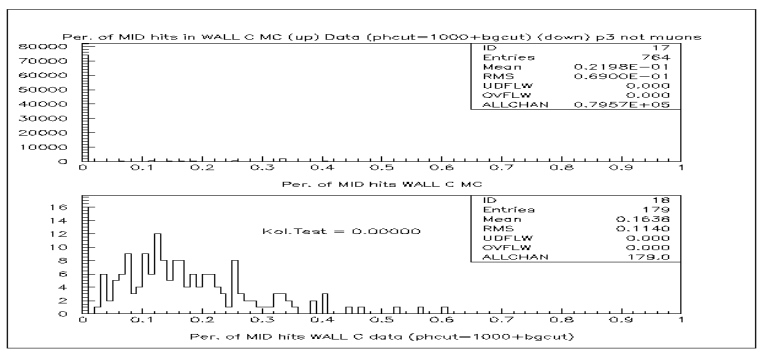
% of MID hits wall B MC(up) Data (down)

Kolmogorov test = 0.00000

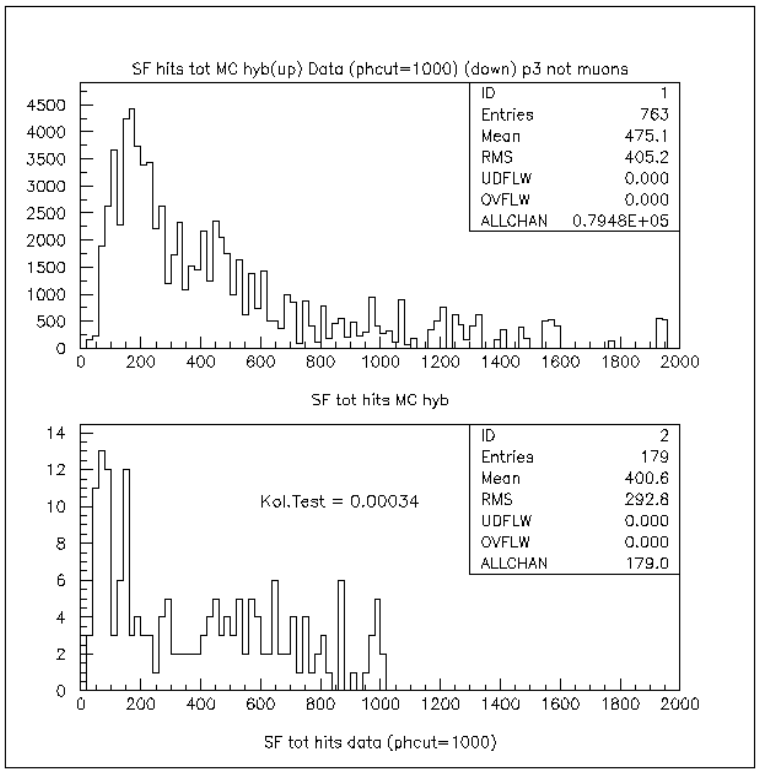


% of MID hits wall C MC(up) Data (down)

Kolmogorov test = 0.00000



P3 not muons Data and Hybrid MC (SF system)

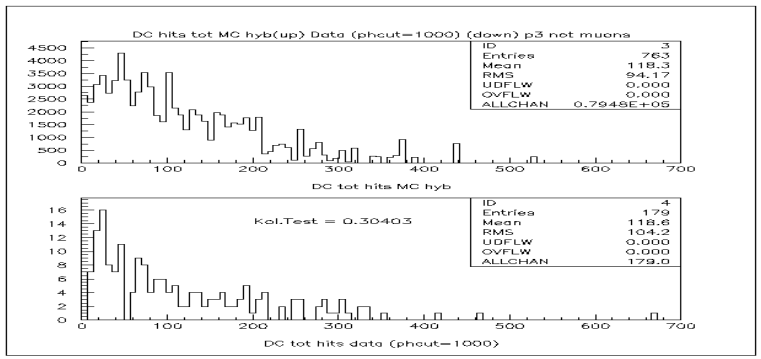


- On the top histogram we see the distribution of total SF hits for hybrid MC.
- On the bottom we see the same distribution for DATA (ph cut 1000 and background hits removed).
- The compatibility between data and Hybrid MC is not as good as between MC and Data and the Kolmogorov test gives a result of 0.00034.

P3 not muons Data and Hybrid MC (DC EMCAL)

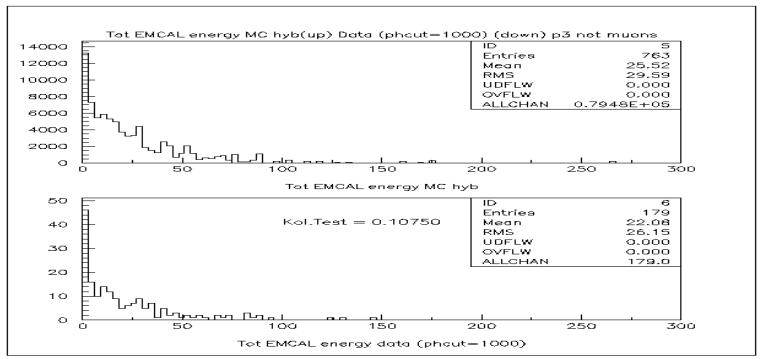
Total DC hits MC(up) Data (down)

Kolmogorov test = 0.30403



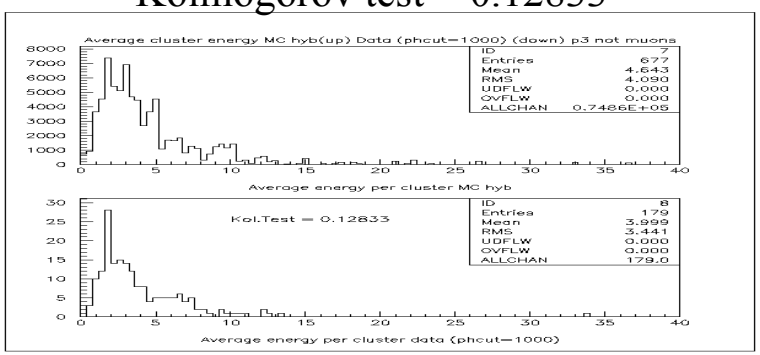
Total Emcal Energy MC(up) Data (down)

Kolmogorov test = 0.10750



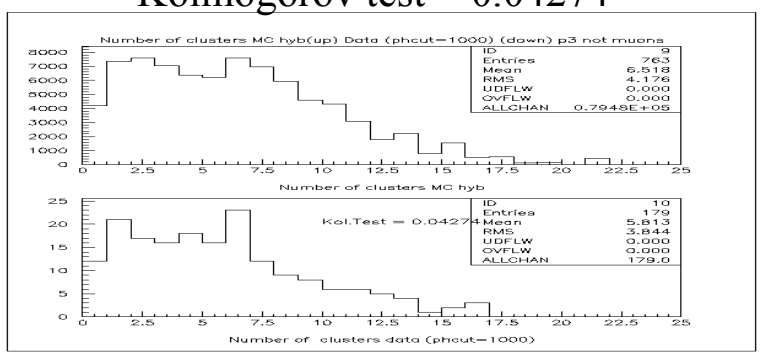
Average Cluster Energy MC(up) Data (down)

Kolmogorov test = 0.12833



Number of Clusters MC(up) Data (down)

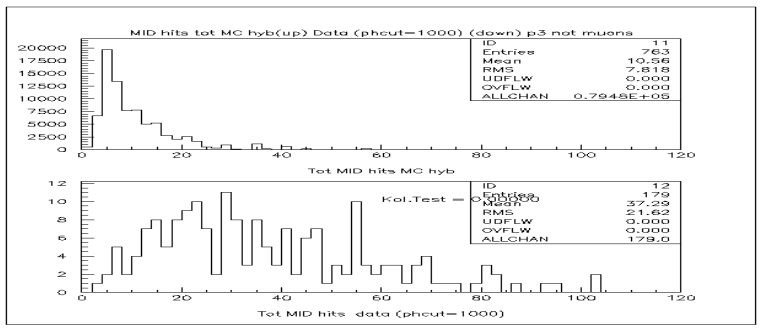
Kolmogorov test = 0.04274



P3 not muons Data and hybrid MC (MID)

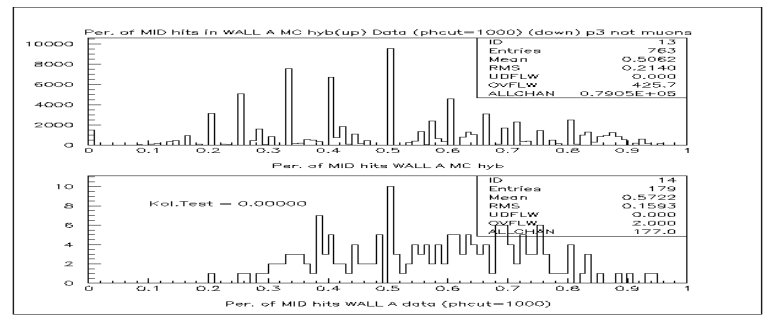
Total MID hits MC(up) Data (down)

Kolmogorov test = 0.00000



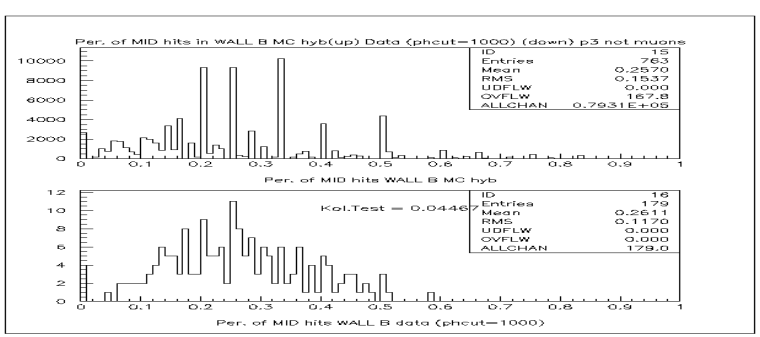
% of MID hits wall A MC(up) Data (down)

Kolmogorov test = 0.00000



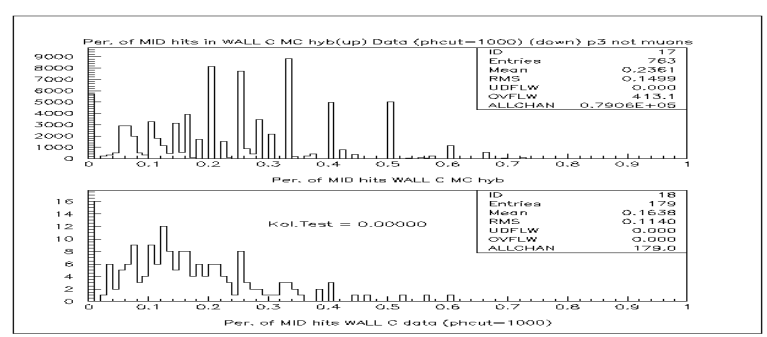
% of MID hits wall B MC(up) Data (down)

Kolmogorov test = 0.04467



% of MID hits wall C MC(up) Data (down)

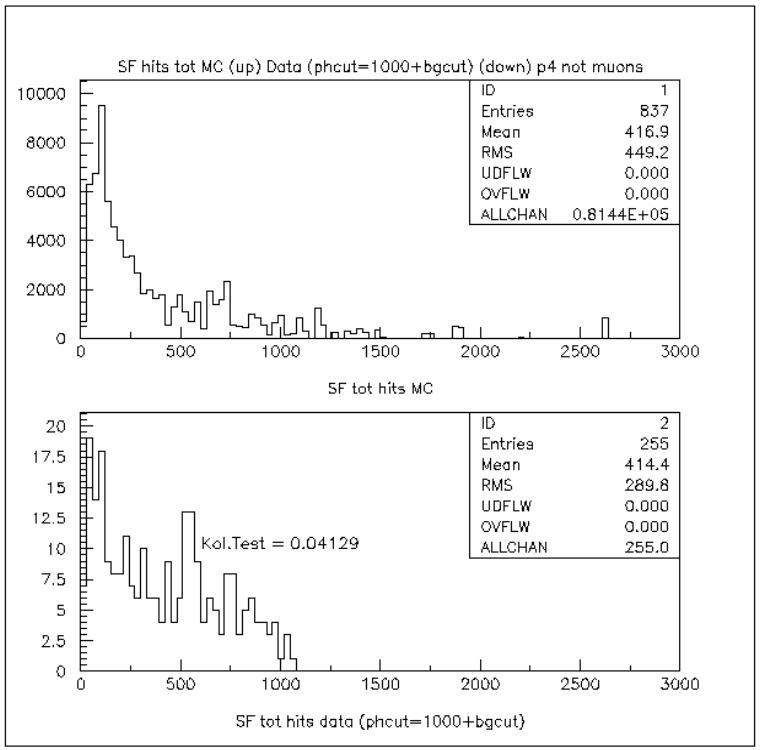
Kolmogorov test = 0.00000



Conclusions on p3 not muons

- The SF system looks compatible between Data and MC.
- All systems except MID show no great differences between data and MC.
- The SF system shows smaller compatibility between Data and Hybrid MC than Data and MC.
- All systems show on the average the same compatibility between Data and Hybrid MC as Data and MC.
- The MID system shows similarity on the % of MID hits in walls A B and C between Data and Hybrid MC.

P4 not muons Data and MC (SF system)

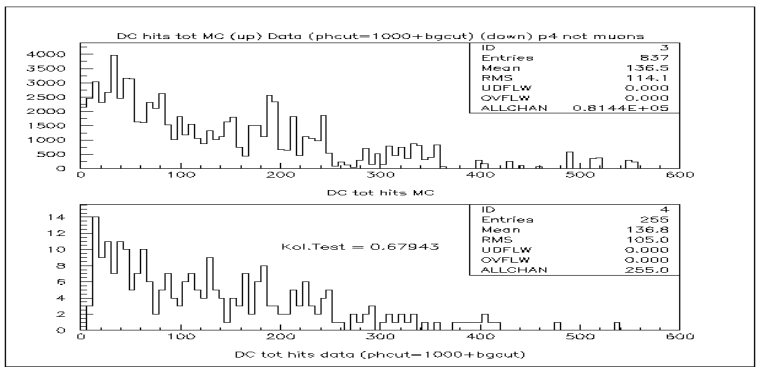


- On the top histogram we see the distribution of total SF hits for MC.
- On the bottom we see the same distribution for DATA.
- These two distributions don't show great differences (as they used to) but the result of the Kolmogorov test = 0.00001 is quite small.

P4 not muons Data and MC (DC EMCAL)

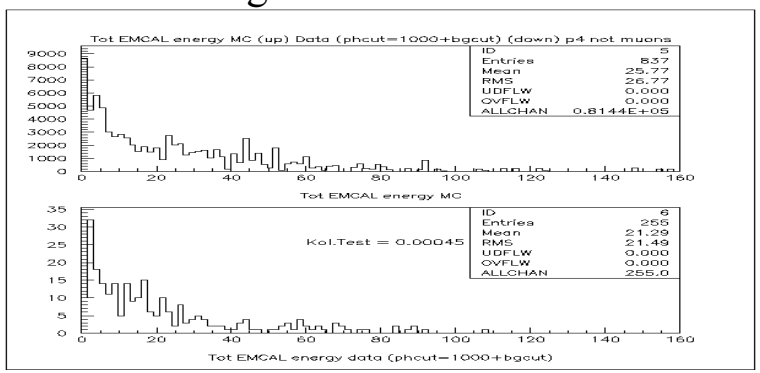
Total DC hits MC(up) Data (down)

Kolmogorov test = 0.67943



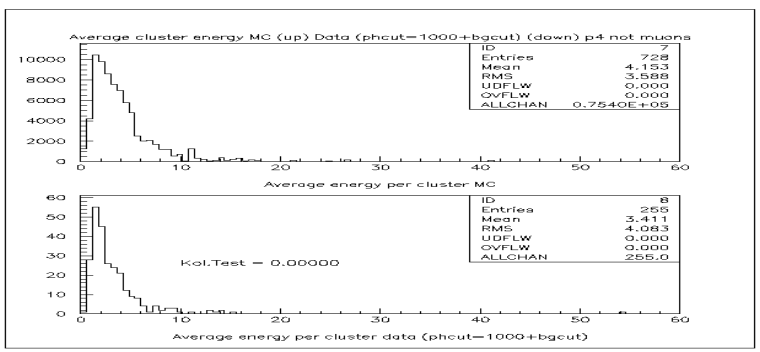
Total Emcal Energy MC(up) Data (down)

Kolmogorov test = 0.00045



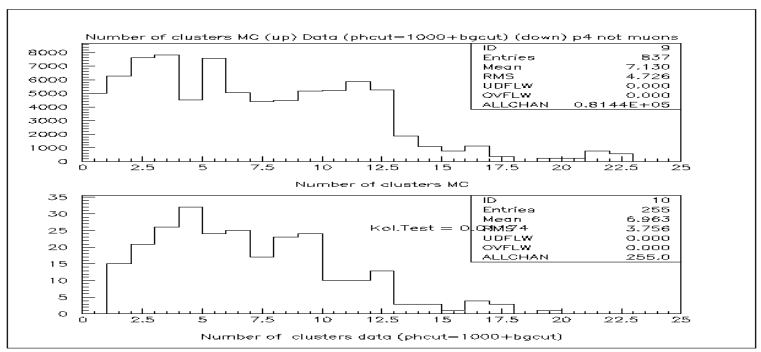
Average Cluster Energy MC(up) Data (down)

Kolmogorov test = 0.00000



Number of Clusters MC(up) Data (down)

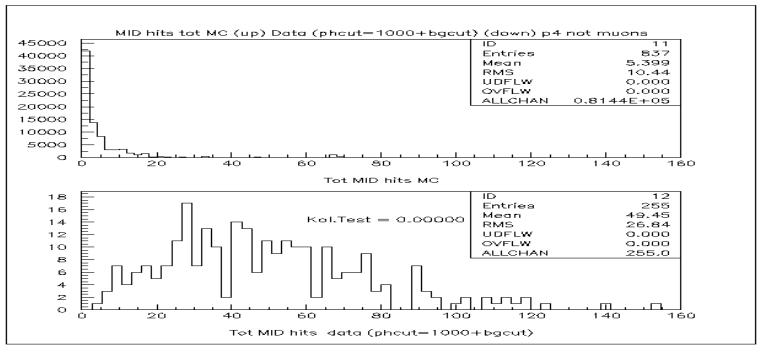
Kolmogorov test = 0.01174



P4 not muons Data and MC (MID)

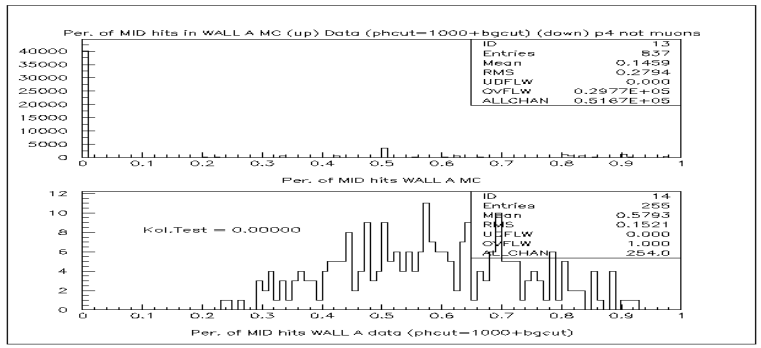
Total MID hits MC(up) Data (down)

Kolmogorov test = 0.00000



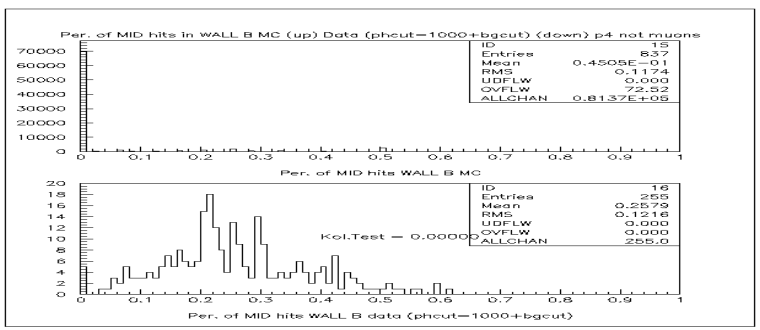
% of MID hits wall A MC(up) Data (down)

Kolmogorov test = 0.00000



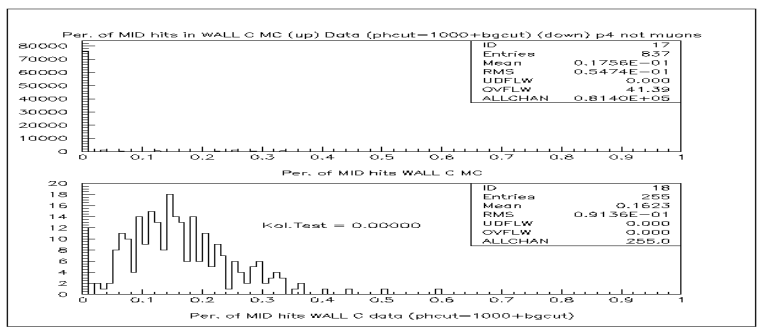
% of MID hits wall B MC(up) Data (down)

Kolmogorov test = 0.00000

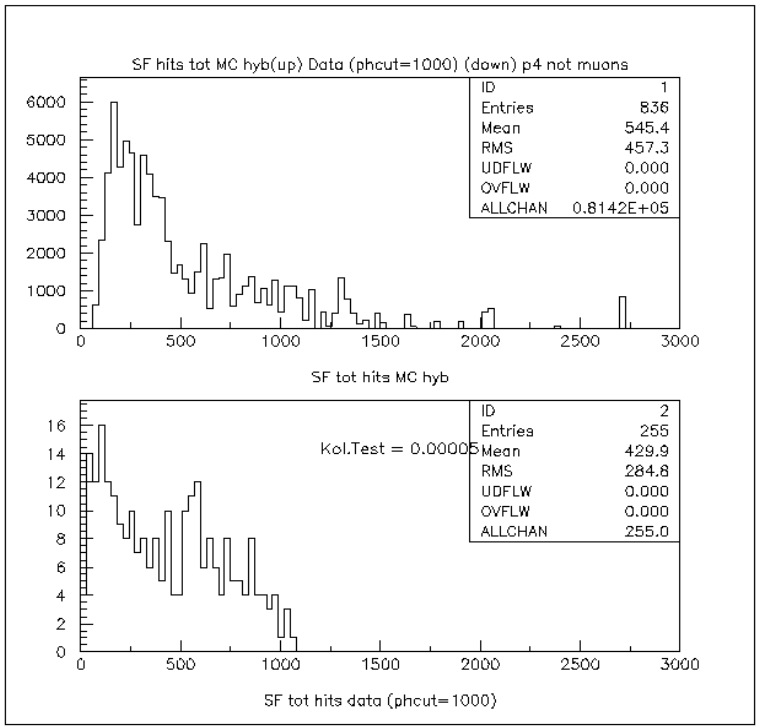


% of MID hits wall C MC(up) Data (down)

Kolmogorov test = 0.00000



P4 not muons Data and Hybrid MC (SF system)

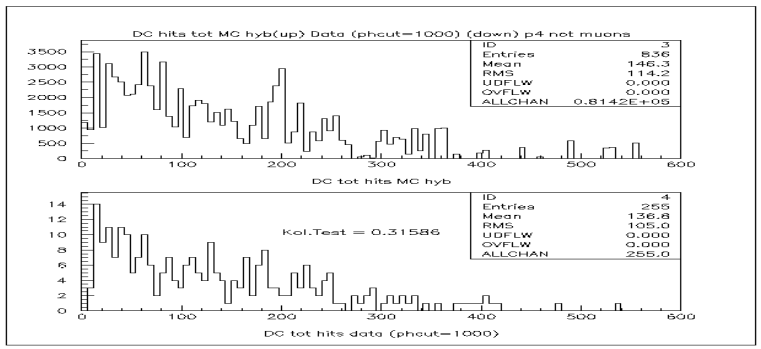


- On the top histogram we see the distribution of total SF hits for hybrid MC.
- On the bottom we see the same distribution for DATA (ph cut 1000 and background hits removed).
- The compatibility between data and Hybrid MC is still not very good and the Kolmogorov test = 0.00005

P4 not muons Data and Hybrid MC (DC EMCAL)

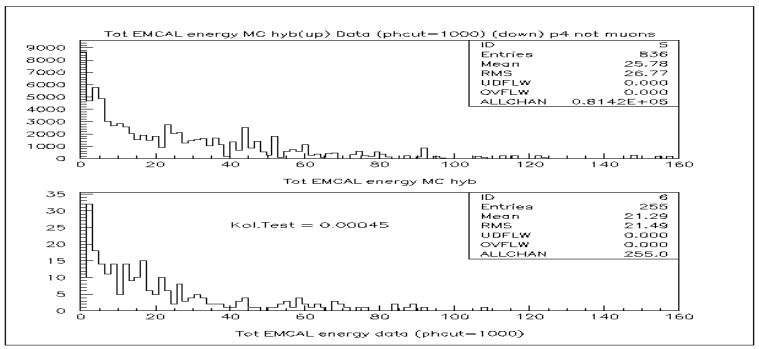
Total DC hits MC(up) Data (down)

Kolmogorov test = 0.31586



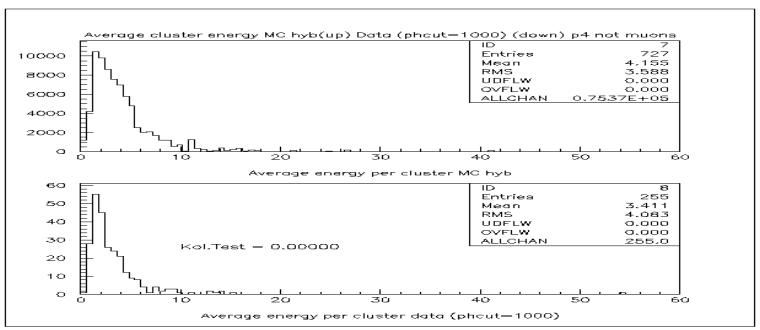
Total Emcal Energy MC(up) Data (down)

Kolmogorov test = 0.00044



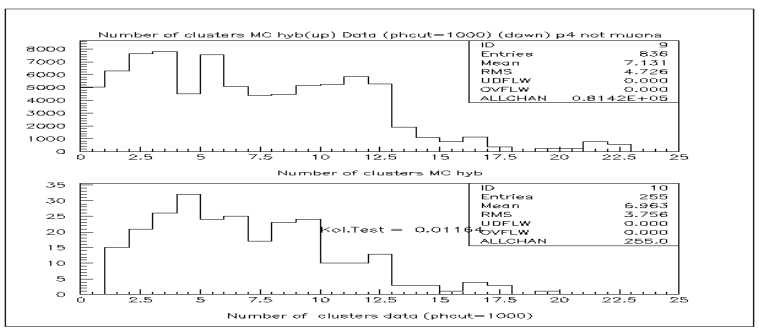
Average Cluster Energy MC(up) Data (down)

Kolmogorov test = 0.00000



Number of Clusters MC(up) Data (down)

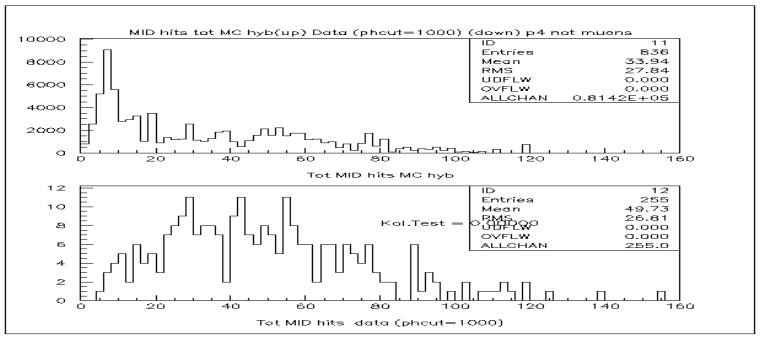
Kolmogorov test = 0.01174



P4 not muons Data and hybrid MC (MID)

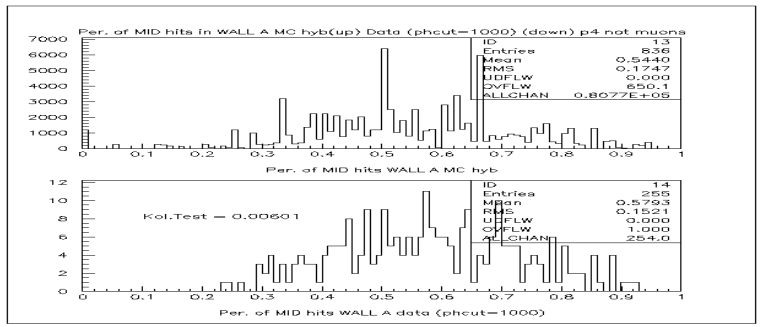
Total MID hits MC(up) Data (down)

Kolmogorov test = 0.00000



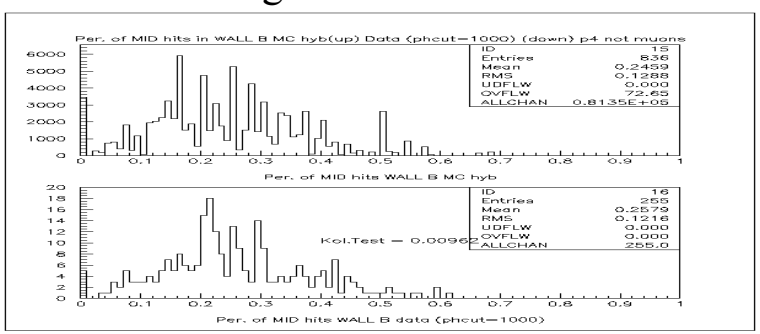
% of MID hits wall A MC(up) Data (down)

Kolmogorov test = 0.00601



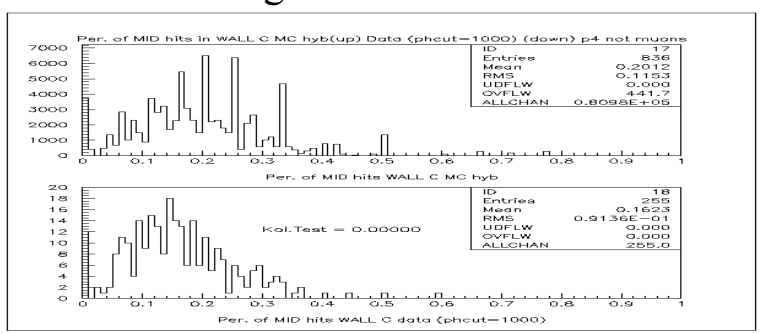
% of MID hits wall B MC(up) Data (down)

Kolmogorov test = 0.00962



% of MID hits wall C MC(up) Data (down)

Kolmogorov test = 0.00000



Conclusions on p4 not muons

- The SF system does not look very different between Data (with pulse height cut=1000) and MC.
- All systems except MID show no great differences between data and MC but p3 not muon data are much more compatible with MC than p4.
- The SF system shows nearly the same compatibility between Data and Hybrid MC as between Data and MC.
- All the rest systems except the MID show on the average the same compatibility between Data and Hybrid MC as between Data and MC.
- The MID system shows similarity on the % of MID hits in walls A B and C between Data and Hybrid MC.

Conclusions

- Pulse height cut 1000 seems to be appropriate for all four periods (has to be verified for period 1 t1t3 events as well).
- The pulse height cut (1000) we have selected improves the compatibility between Data and MC in the SF system.
- The hybrid MC files have as an advantage that they improve very much compatibility of the MID system.
- Period 3 not muons show in general greater similarity between data and MC than p4 not muons. This could be due to fact that p4 not muons might not be a clear not muon set.
- We have to do the study presented for all four periods of data and for the whole data set (901 neutrino events).
- The disadvantage of the pulse height cut we have selected is that it rejects ~ 35 % of final and sf track hits and ~ 40 % of sf line hits.