Difu, Dilu and Phot optimization

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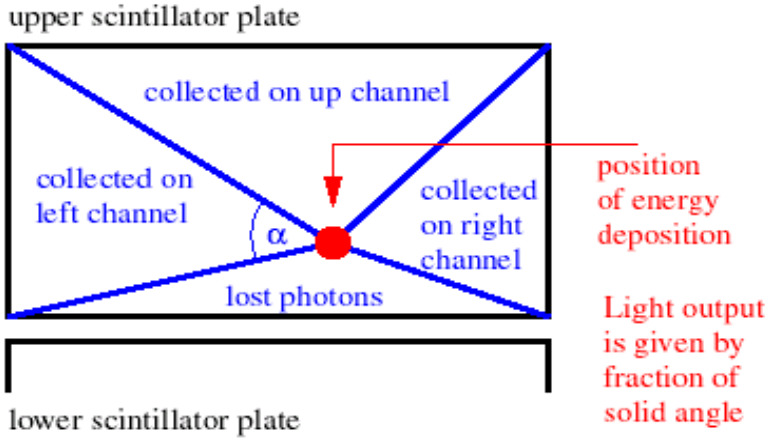
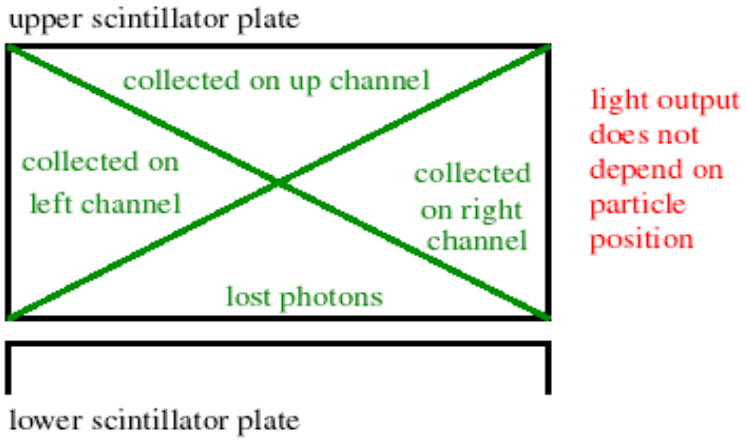
- Quick reminder of the meaning of the parameters.
- Effect of the parameters on the total energy distribution (eud), the energy asymmetry distribution (η) and the Analysing Power (AP).
- Optimization of the best combination for Difu, Dilu and Phot.
- Conclusion.

General picture of Difu and Phot parameters

Position–dependent light collection



Diffuse light collection



Note: each side (channel) as a different gain factor.

- When energy is deposited in the scintillator plates, it creates photons (the parameter PHOT controls how many photons are created by GeV). These photons are then collected on the side of the plates. The # of photons (N) on each side depends on the position of the energy deposition:

$$N_{side} = N_{total} \cdot \alpha_{side} / 360^{o}$$

- Some of these photons don't reach the sides directly. They can be absorbed/reflected at the front and back side of the plate, absorbed on their way to the side and re-emitted in another direction, or reflected on one side and thus being collected to another side... When such things happen, the proportion that should end in the up/down channel and left/right channel should be given by the following probabilities w/(h+w) and h/(h+w), where h = 2.5cm is the height between the center and the up channel and w = 6 cm is the width between the left and the right channel.
- The proportion of photons collected using this probability principle (Diffuse light collection) is controlled by the parameter Difu.

Explanation of Dilu

- The parameter Dilu controls the proportion of light that crosses the aluminum plate separating the up and down calorimeter:

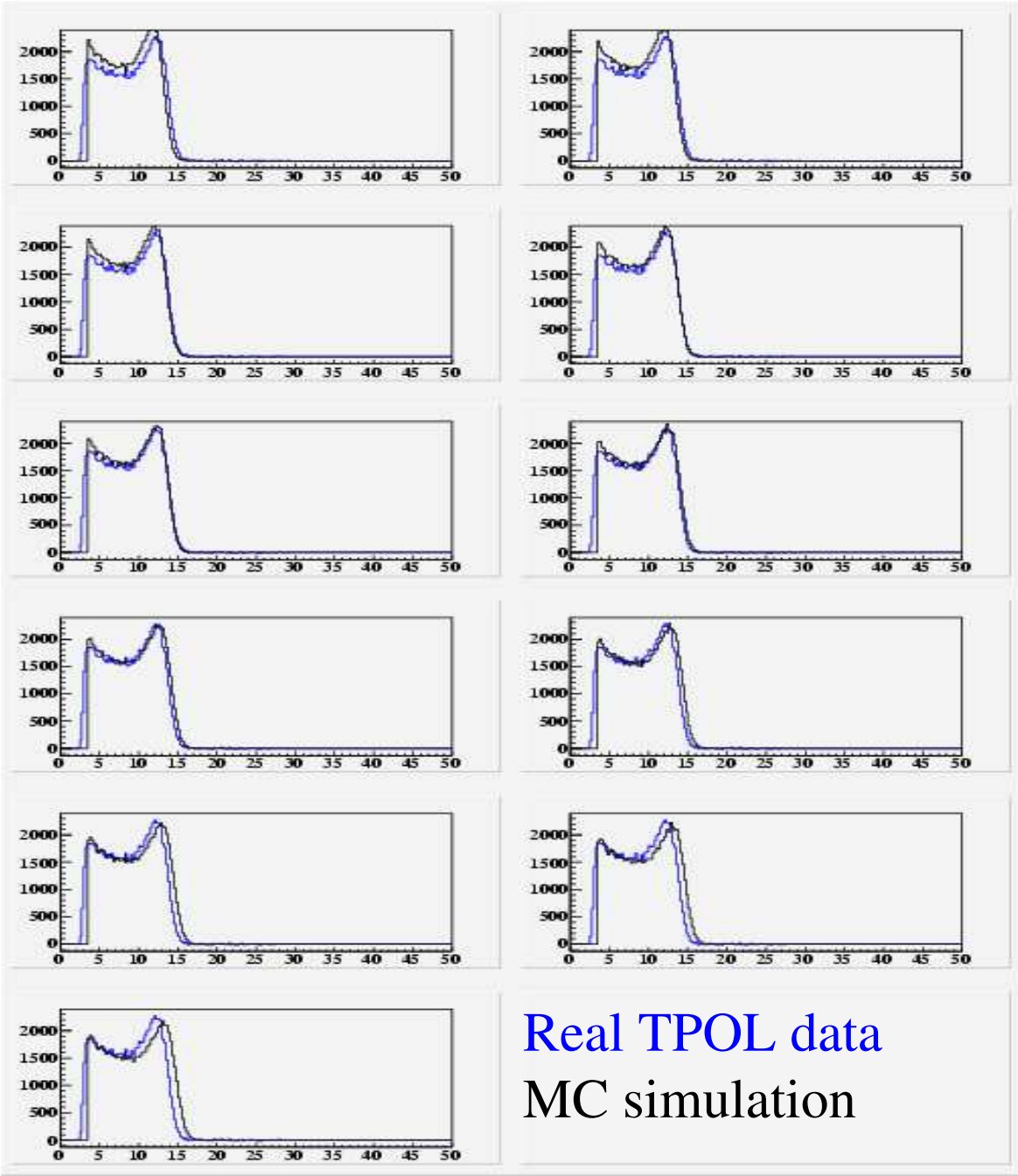
$$N_{cross} = Dilu \cdot N_{lost}$$

- Note: the way the simulation is done, N_{cross} is collected in the opposite horizontal channel (ex: light that crosses from down to up is all collected in the up channel... nothing on the left and right channels).
- It must be understood that all the photons not crossing the aluminum plate are considered to be lost.

Expected effect on (eud) and η

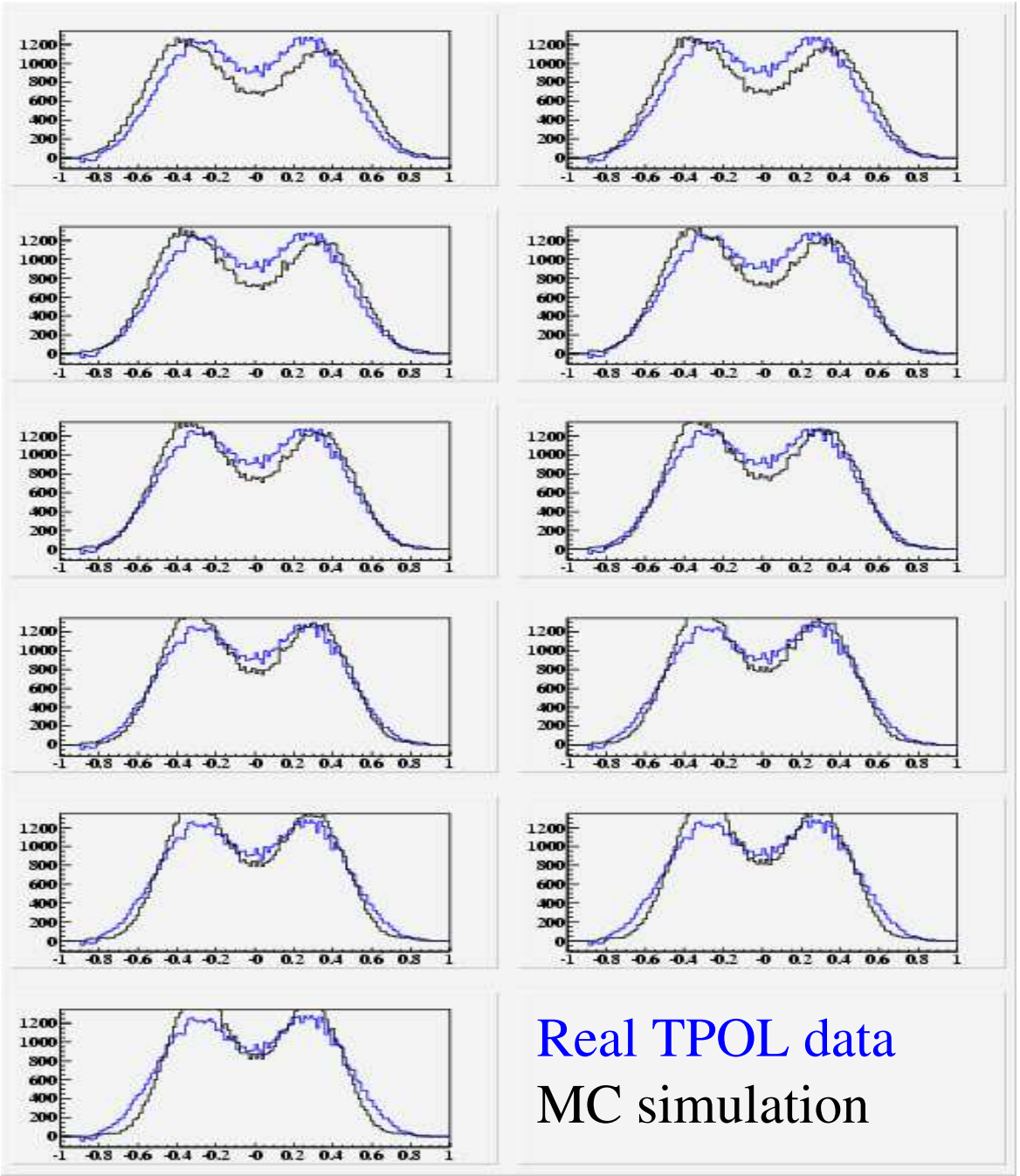
Since the energy deposition is concentrated around y = 0 (position of the aluminum plate) and since the energy that doesn't cross the plate is lost, we expect the following:

- As Dilu increases ⇒ proportion of lost energy decreases ⇒ the total energy (eud) increases.
- As Dilu increases ⇒ difference between E_{down} and E_{up} decreases ⇒ $|\eta|$ decreases.
- As Difu increases ⇒ proportion of light going into the aluminum plate decreases ⇒ (eud) increases.
- As Difu increases ⇒ proportion of light going into the aluminum plate decreases ⇒ diluted energy decreases ⇒ difference between E_{down} and E_{up} increases ⇒ $|\eta|$ increase.
- As Phot increases ⇒ more photons created by GeV deposited ⇒ eud increase.
- As Phot increases there is no obvious reason why $|\eta|$ should change.



Effect of Dilu on eud distribution

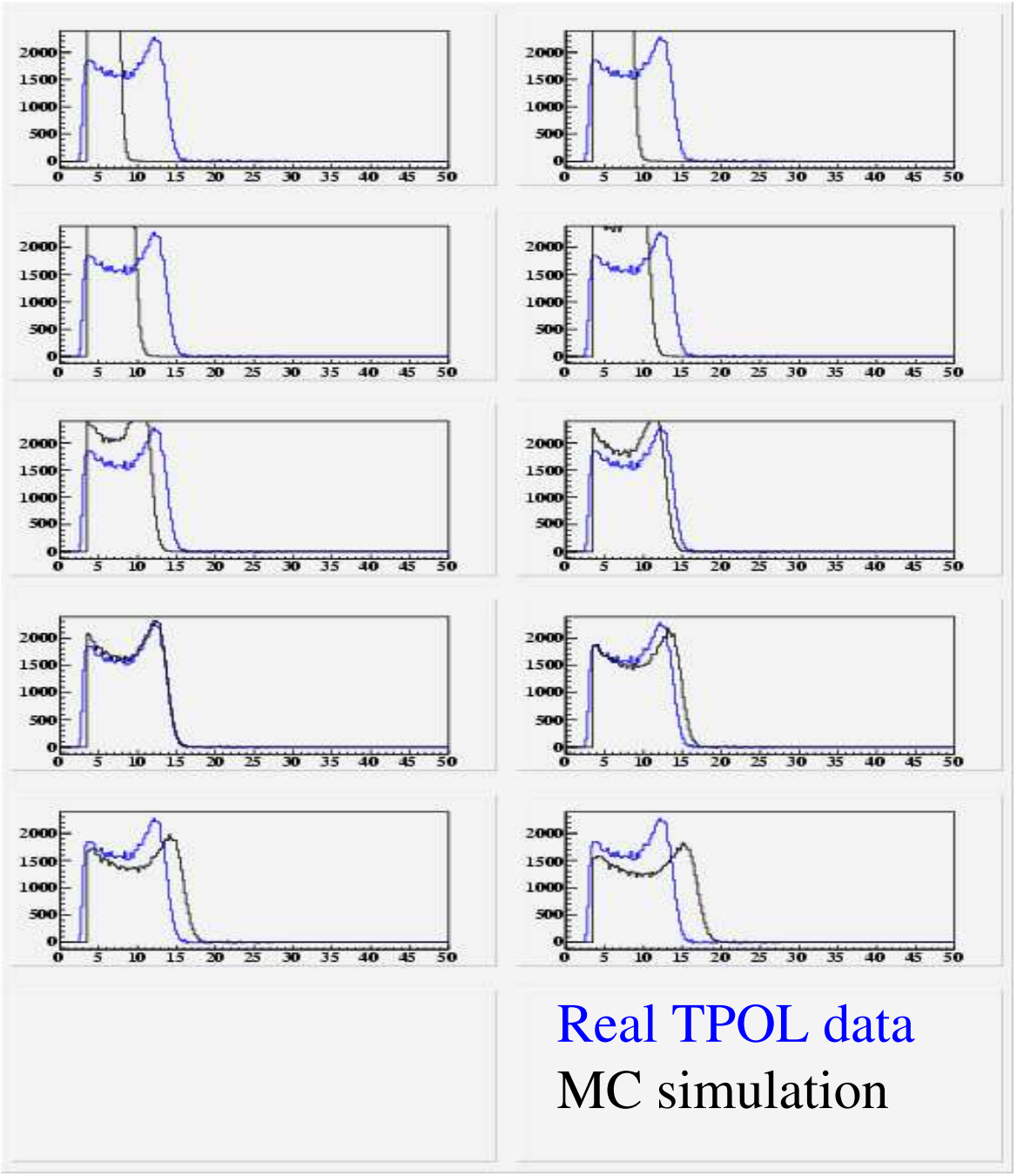
- For all these plots, Difu = 60% and Phot = 15 000 photons/GeV. The first graph (up-left) shows MC data for Dilu = 0% and the last one (down-left) is for Dilu = 10%. In between, from left to right, Dilu increases by 1%.
- As expected, when Dilu increases; eud increases.



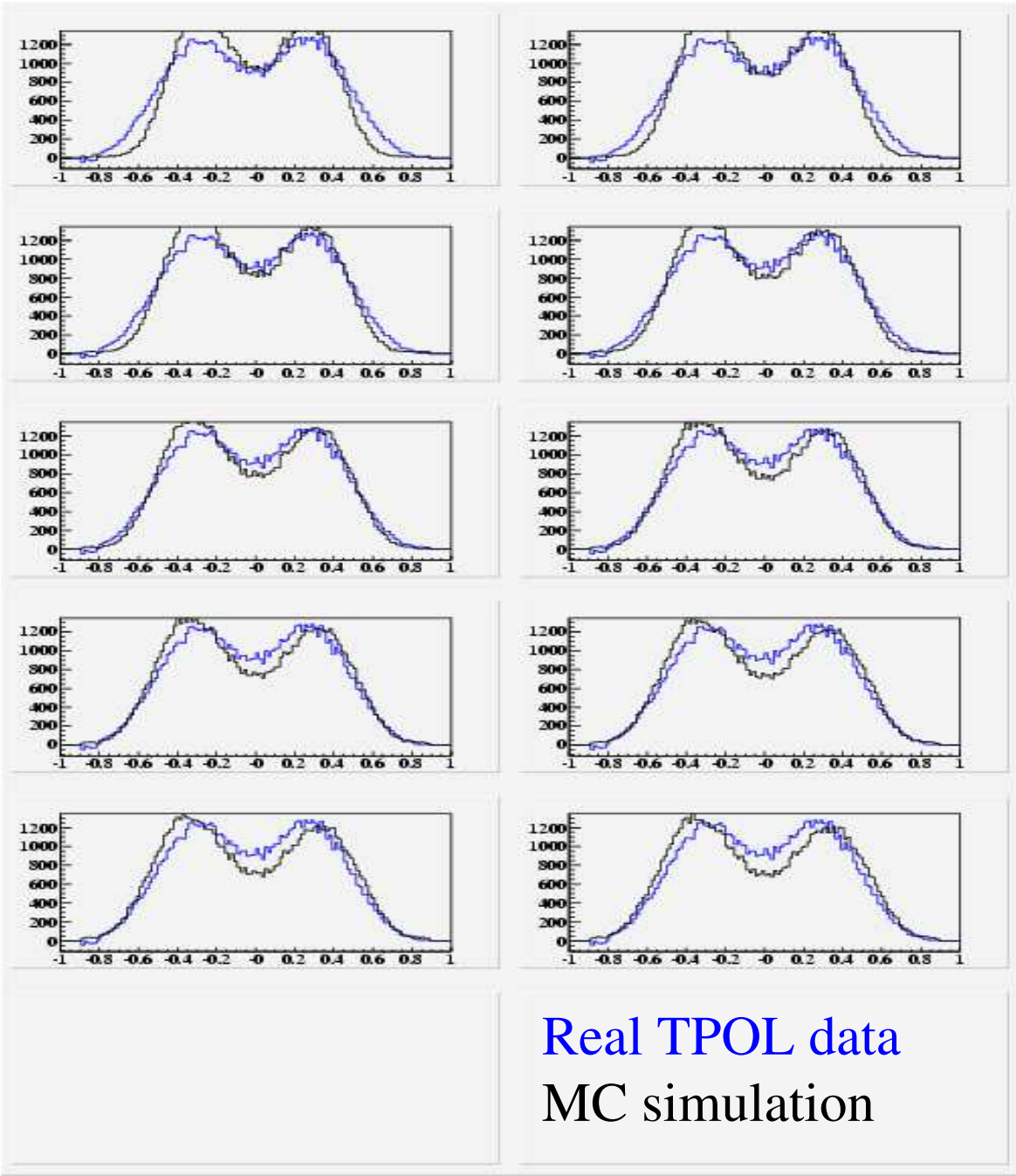
Effect of Dilu on η distribution

- For all these plots, Difu = 60% and Phot = 15 000 photons/GeV. The first graph (up-left) shows MC data for Dilu = 0% and the last one (down-left) is for Dilu = 10%. In between, from left to right, Dilu increases by 1%.
- As expected, when Dilu increases; $|\eta|$ decreases.

Effect of Difu on eud distribution

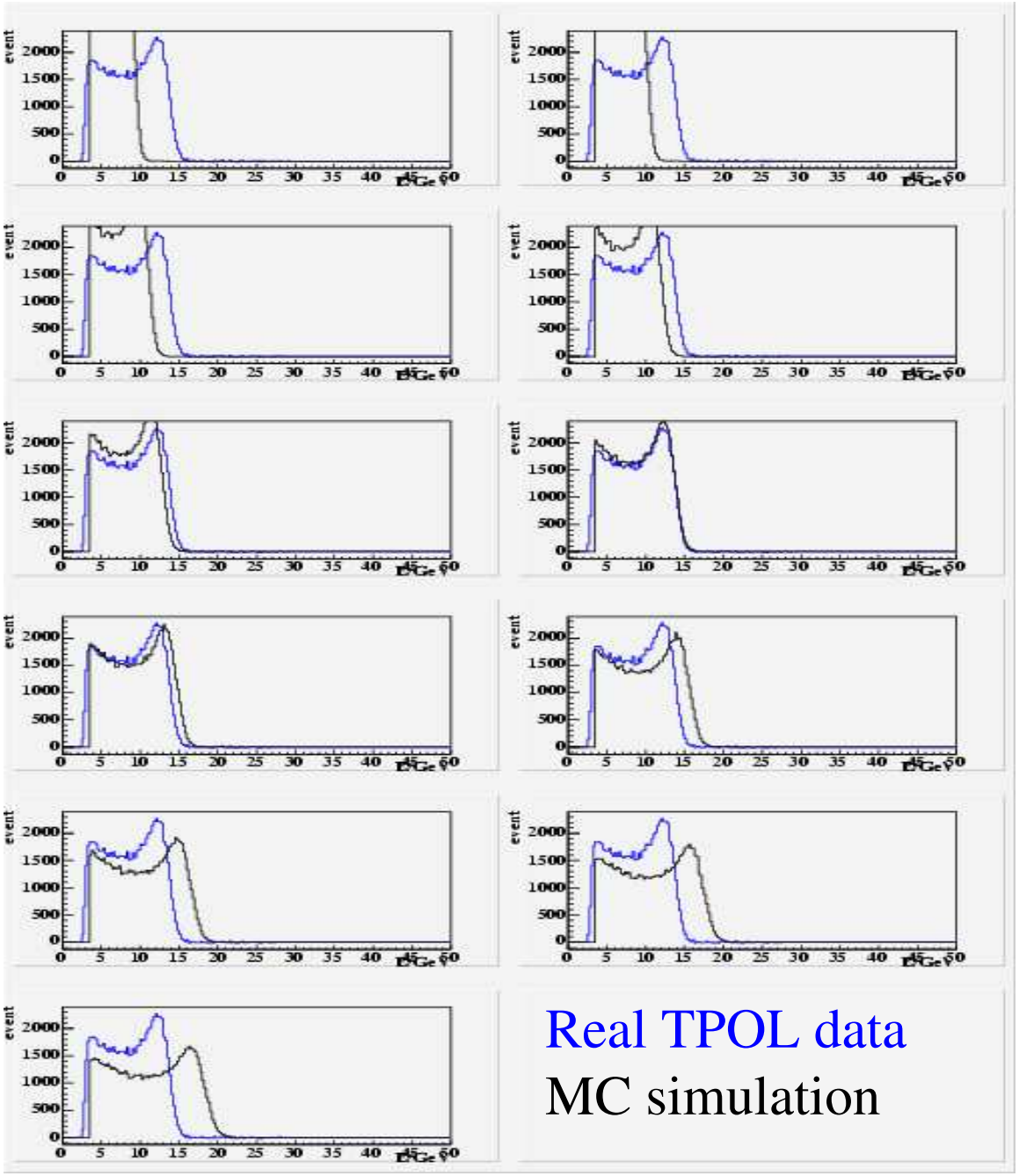


- For all these plots, Dilu = 4% and Phot = 15 000 photons/GeV. The first graph (up-left) show MC data for Difu = 0% and the last one (down-right) is for Difu = 90%. In between, from left to right, Difu increases by 10%.
- As expected, when Difu increases; eud increases.



Effect of Difu on η distribution

- For all these plots, Dilu = 4% and Phot = 15 000 photons/GeV. The first graph (up-left) shows MC data for Difu = 0% and the last one (down-right) is for Difu = 90%. In between, from left to right, Difu increases of 10%.
- As expected, when Difu increases; $|\eta|$ increases.

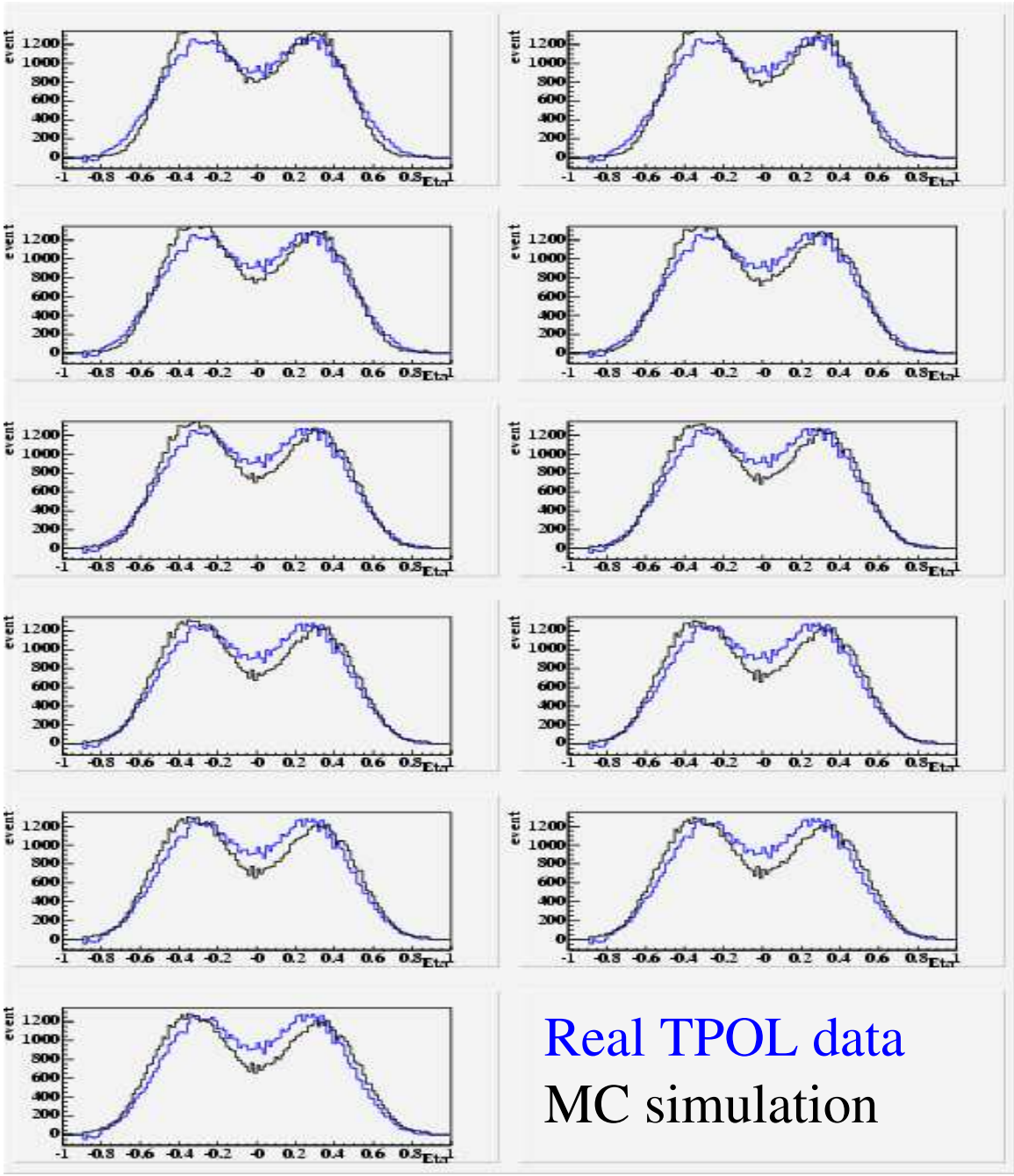


Real TPOL data

MC simulation

Effect of Phot on eud distribution

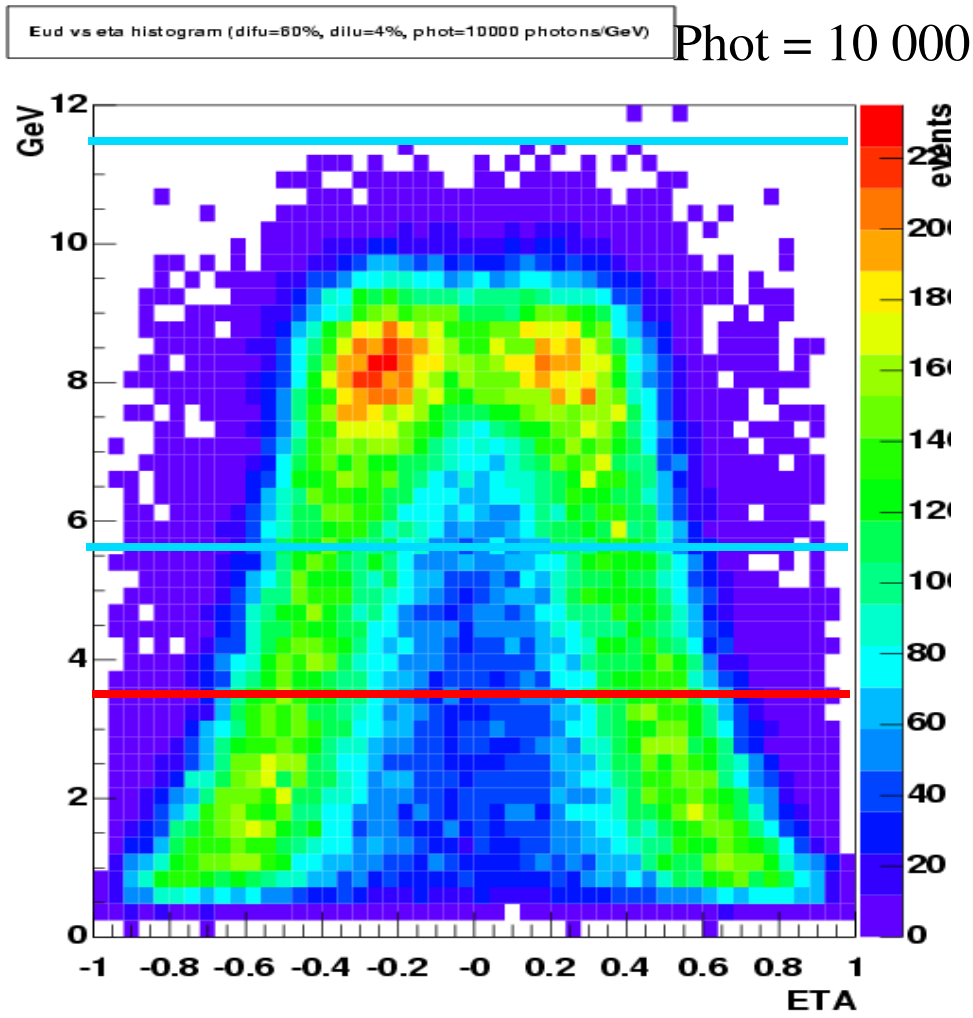
- For all these plots, Dilu = 4% and Difu = 60%. The first graph (up-left) shows MC data for Phot = 10 000 photons/GeV and the last one (down-left) is for Phot = 20 000 photons/GeV. In between, from left to right, Phot increases of 1 000 photons/GeV.
- As expected, when Phot increases; eud increases.



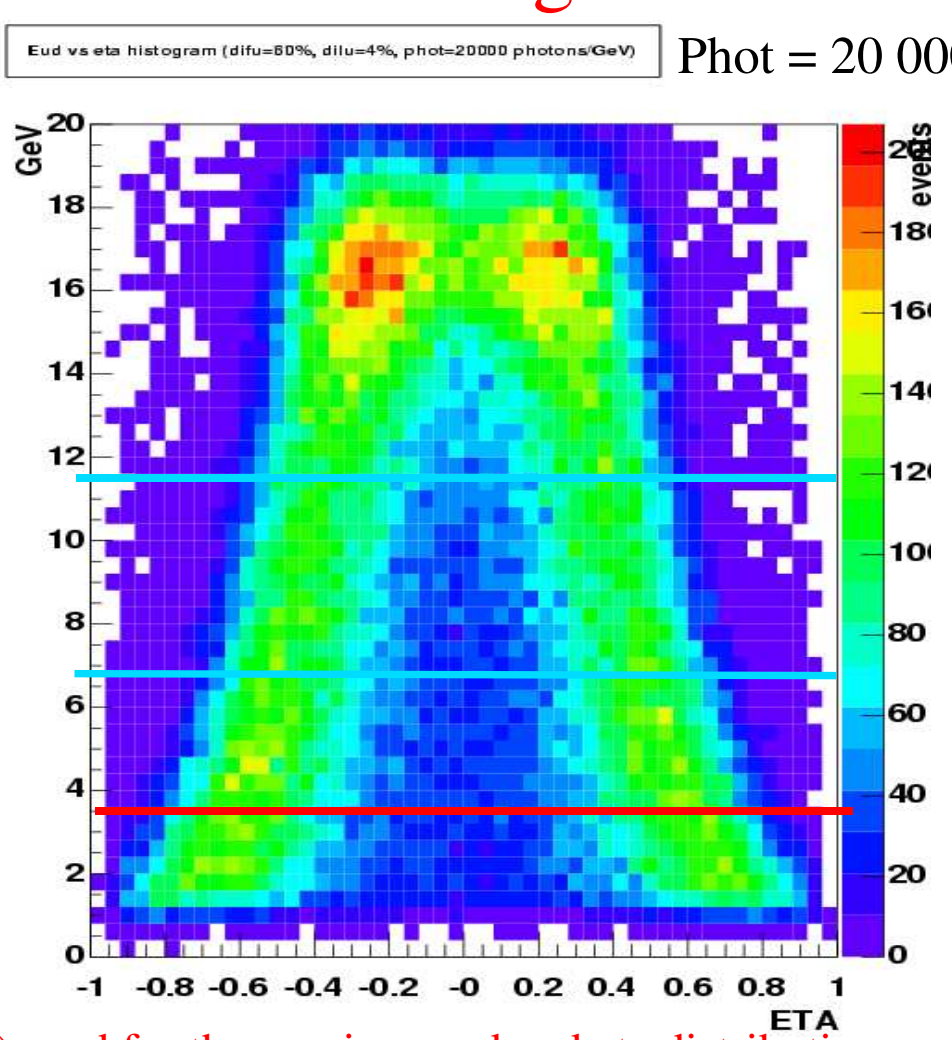
Effect of Phot on η distribution

- For all these plots, Dilu = 4% and Difu = 60%. The first graph (up-left) shows MC data for Phot = 10 000 photons/GeV and the last one (down-left) is for Phot = 20 000 photons/GeV. In between, from left to right, Phot increases of 1 000 photons/GeV.
- When Phot increases; $|\eta|$ increases... WHY???

Effect of Phot on the eud vs eta histogram



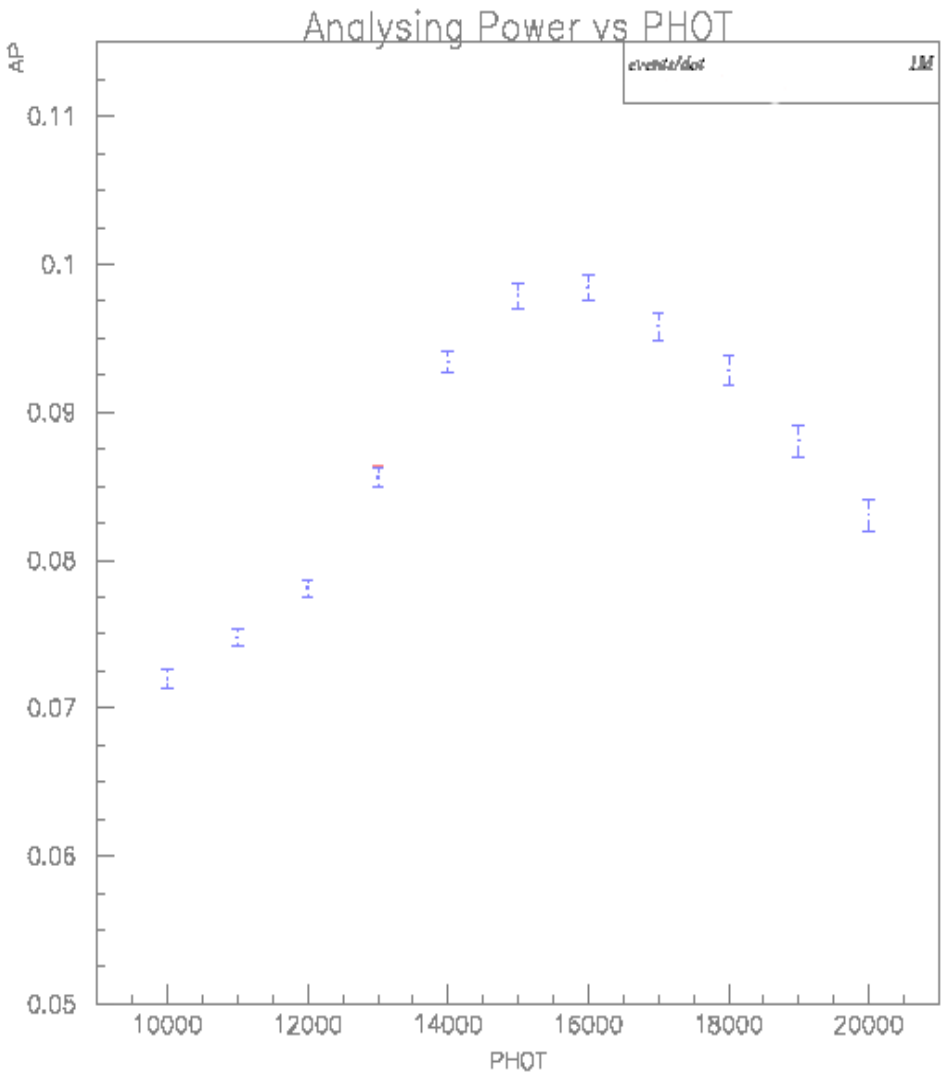
Phot = 10 000



Phot = 20 000

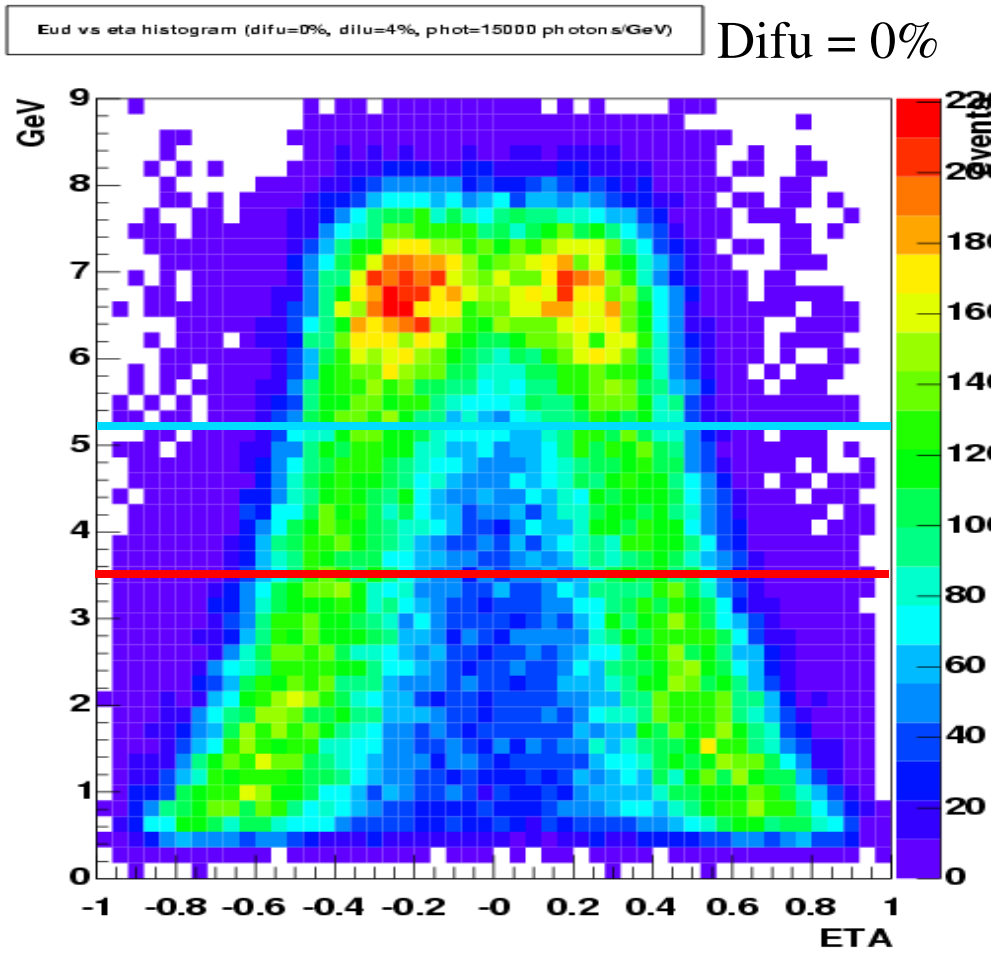
- The red line shows the energy cut (E > 3.5 GeV) used for the previous eud and eta distribution.
- The turquoise lines show the energy cut for the calculation of the AP (5.225 < E < 11.4)GeV.
- We see that Phot only affects the η distribution because of the fixed energy cut.

Effect of Phot on AP

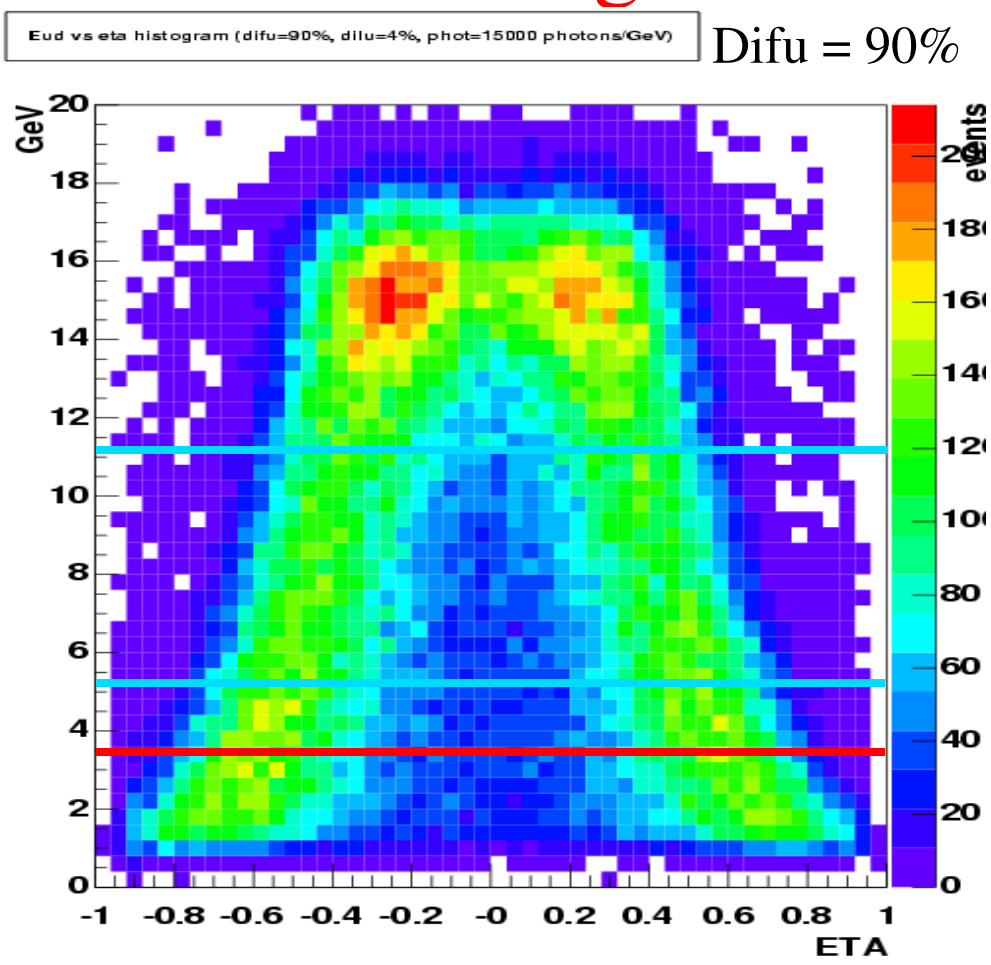


- The parameter Phot has a strong influence on the AP.
- However, this is only a consequence that the energy cut are fixed.
- As Phot increases ⇒ $|\eta|$ increases ⇒ AP increases.
- However, when Phot keep increasing the upper bound start to have an impact ⇒ we lose events with high energy ⇒ lose sensibility over helicity ⇒ AP decreases.

Effect of Difu on the eud vs eta histogram



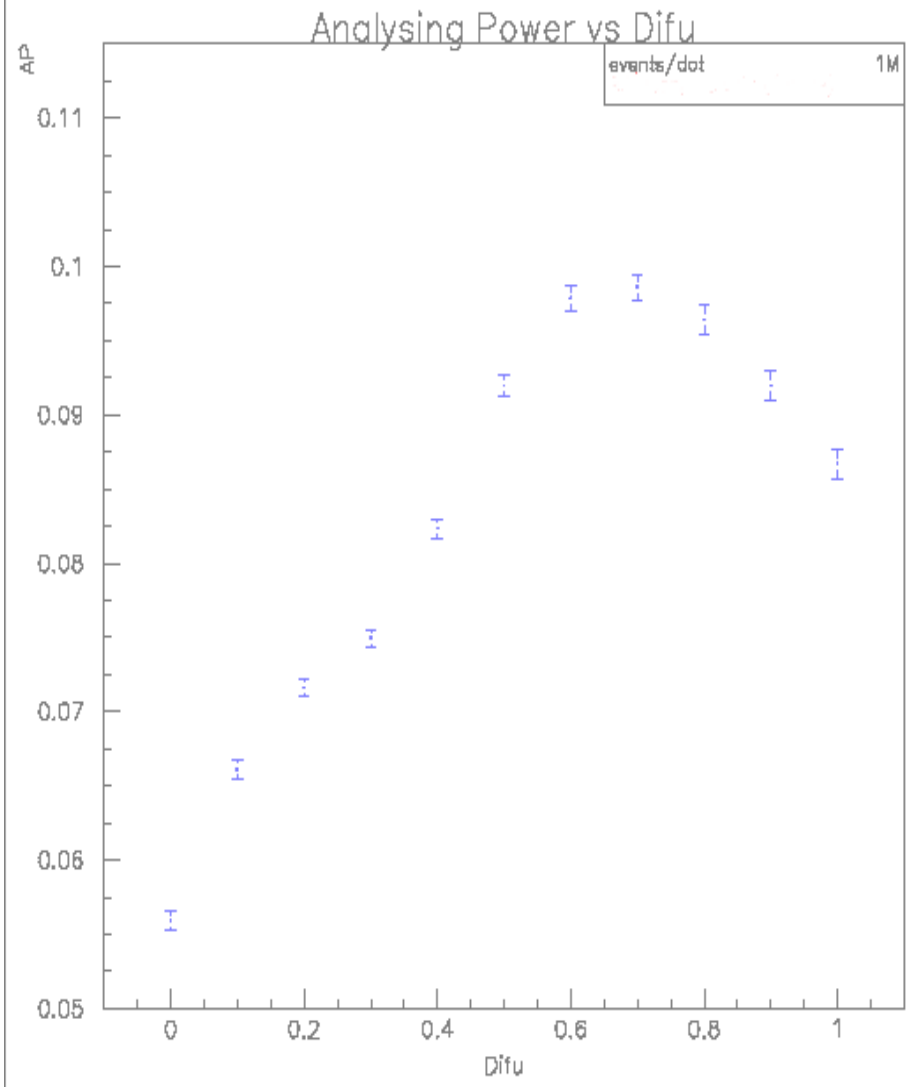
Difu = 0%

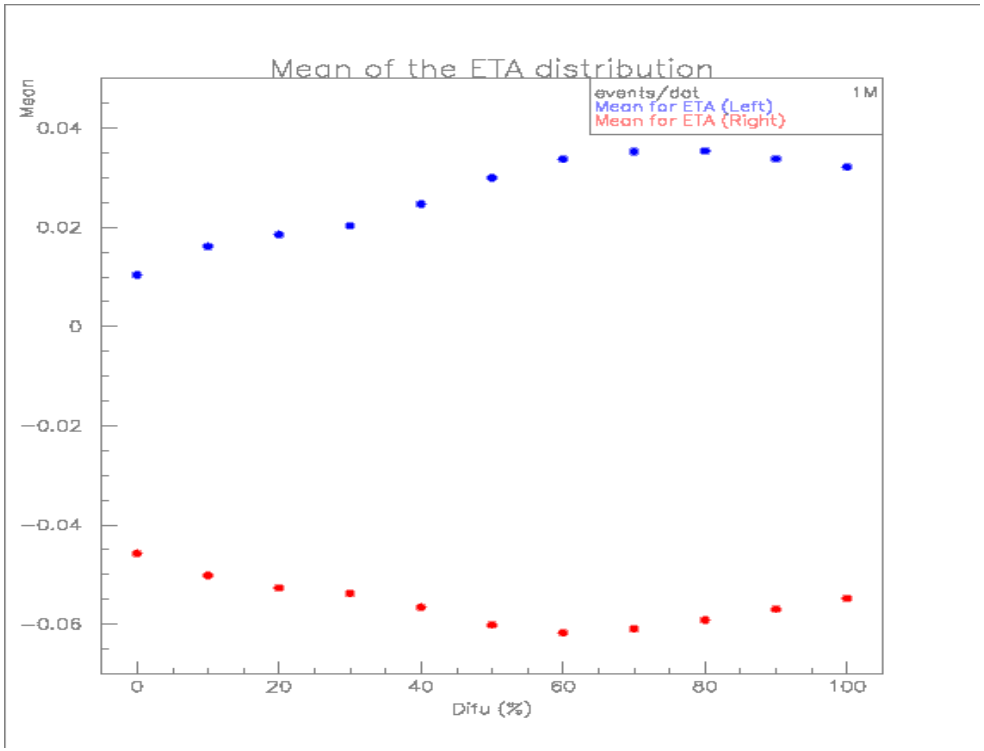


Difu = 90%

- The red line shows the energy cut (E > 3.5 GeV) used for the previous eud and eta distribution.
- The turquoise lines show the energy cut for the calculation of the AP (5.225 < E < 11.4)GeV.
- We see that Difu, like Phot, only affects the η distribution because of the fixed energy cut.

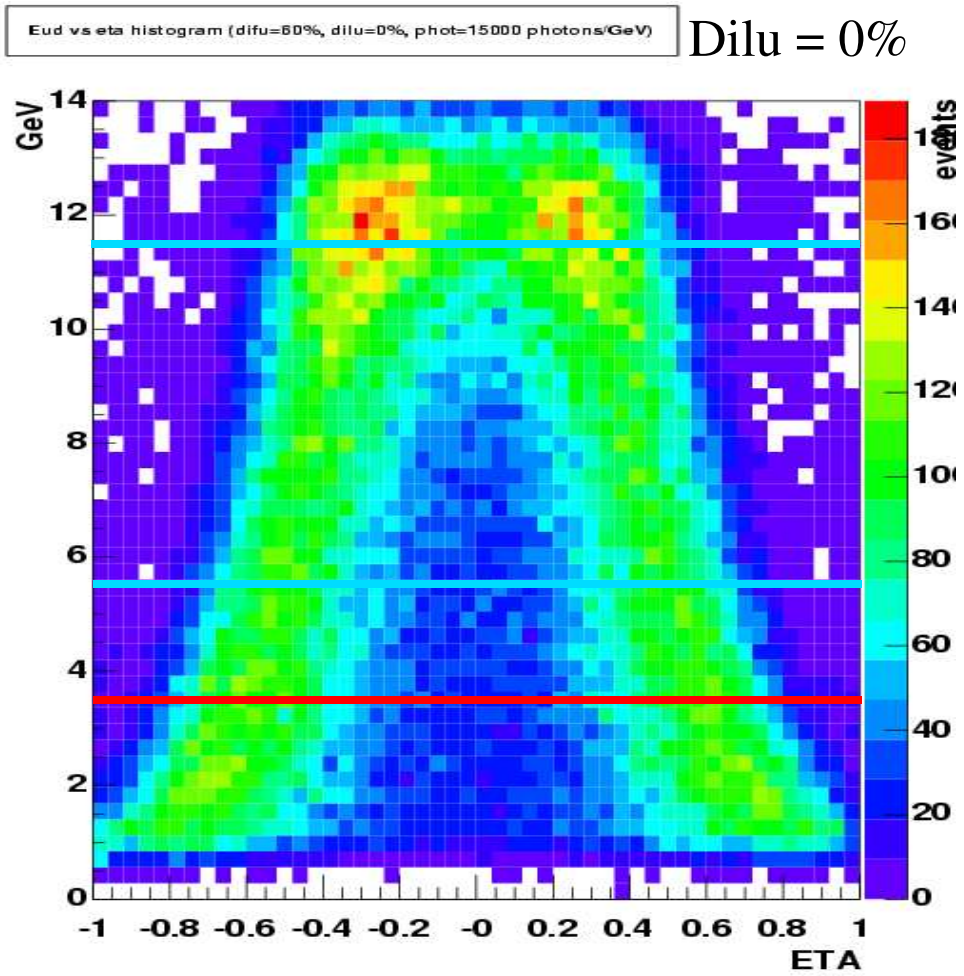
Effect of Difu on AP



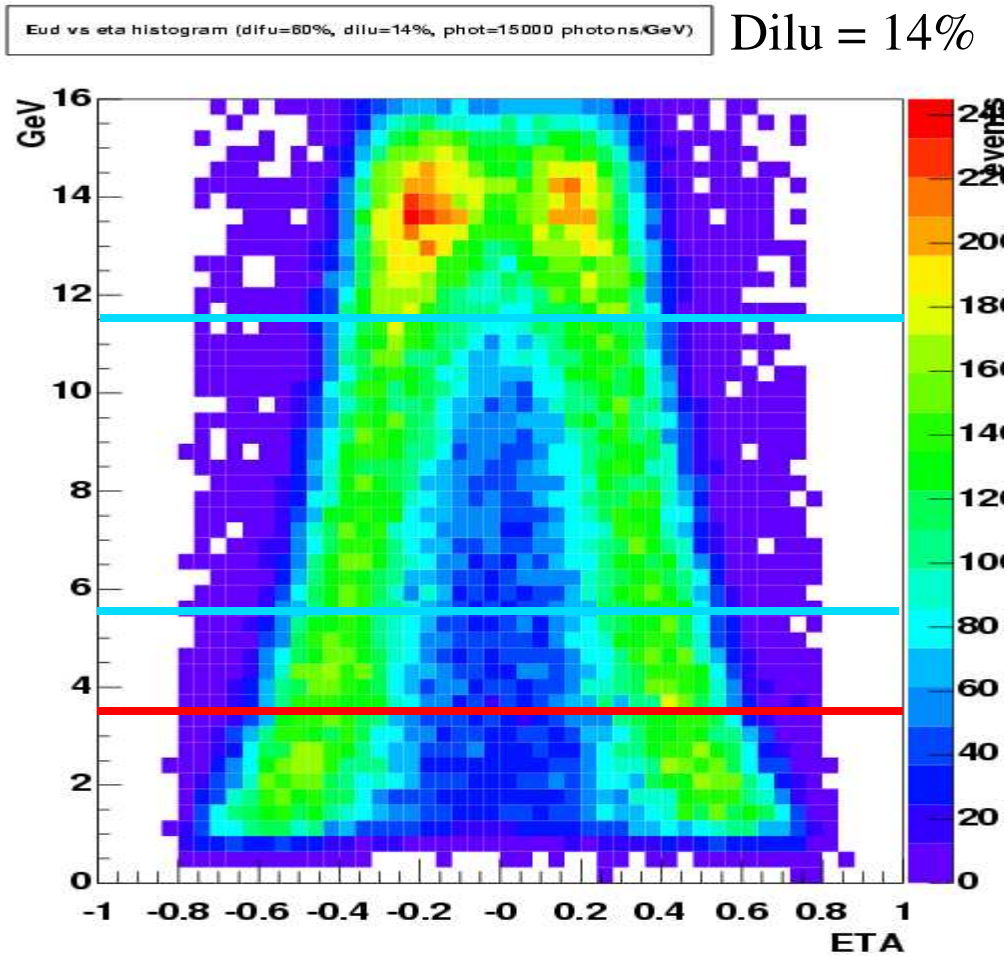


- We see that Difu affects AP exactly on the same way that does Phot and exactly for the same reason.
- The upper-right graph confirm that we lose sensibility over the helicity of the photons when eud (Difu or Phot) get too high.

Effect of Dilu on the eud vs eta histogram



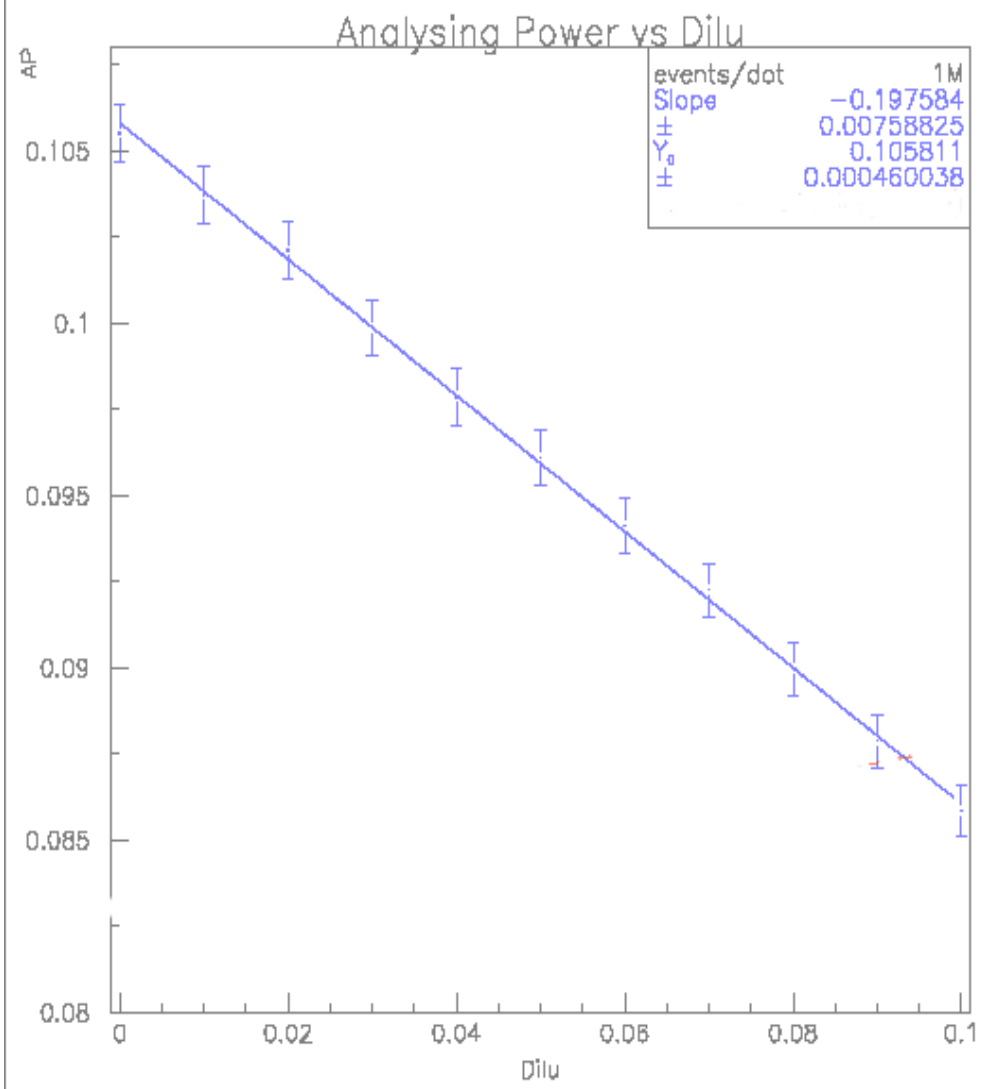
Dilu = 0%



Dilu = 14%

- The red line shows the energy cut (E > 3.5 GeV) used for the previous eud and eta distribution.
- The turquoise lines show the energy cut for the calculation of the AP (5.225 < E < 11.4)GeV.
- We see that Dilu really affects $|\eta|$ (the graph "squeeze" as Dilu increases) and affects weakly eud.

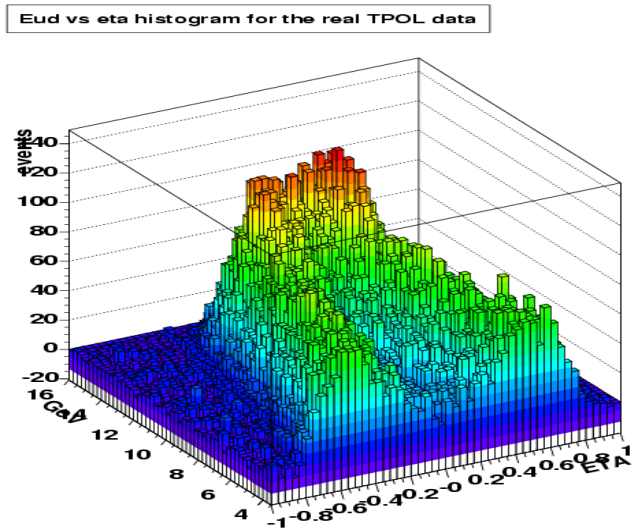
Effect of Dilu on AP

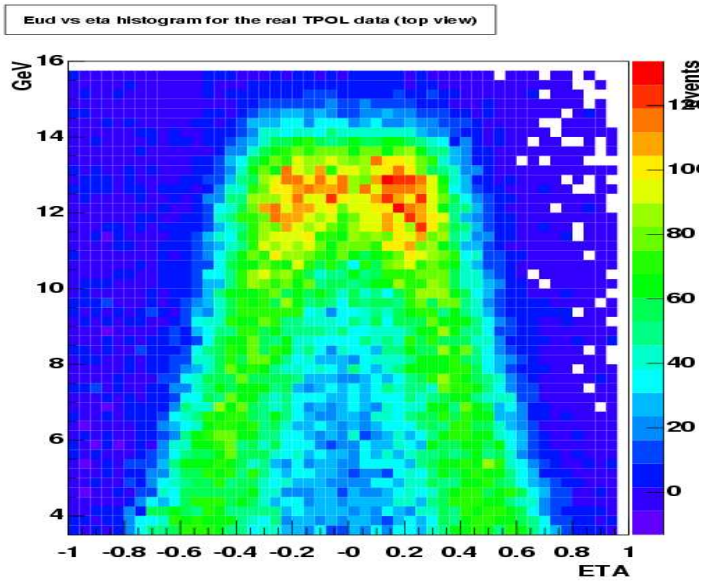


- Dilu increases ⇒ $|\eta|$ decreases ⇒ AP decreases

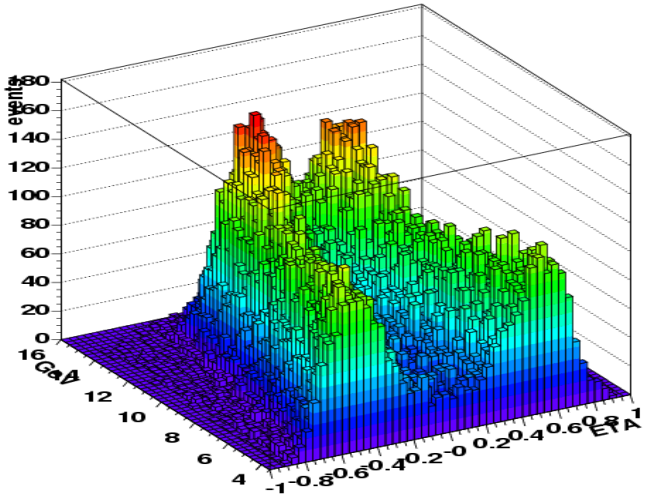
Optimizations of the parameters.

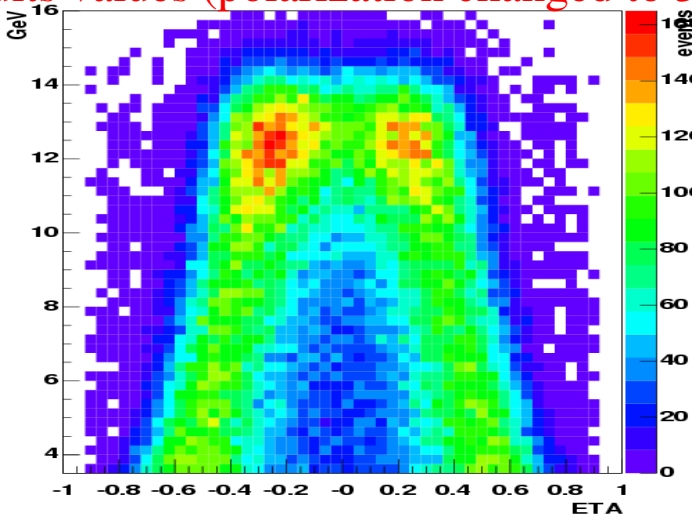
Real TPOL data for periode of June.





MC simulation with the actual defaults values (polarization changed to 30%)

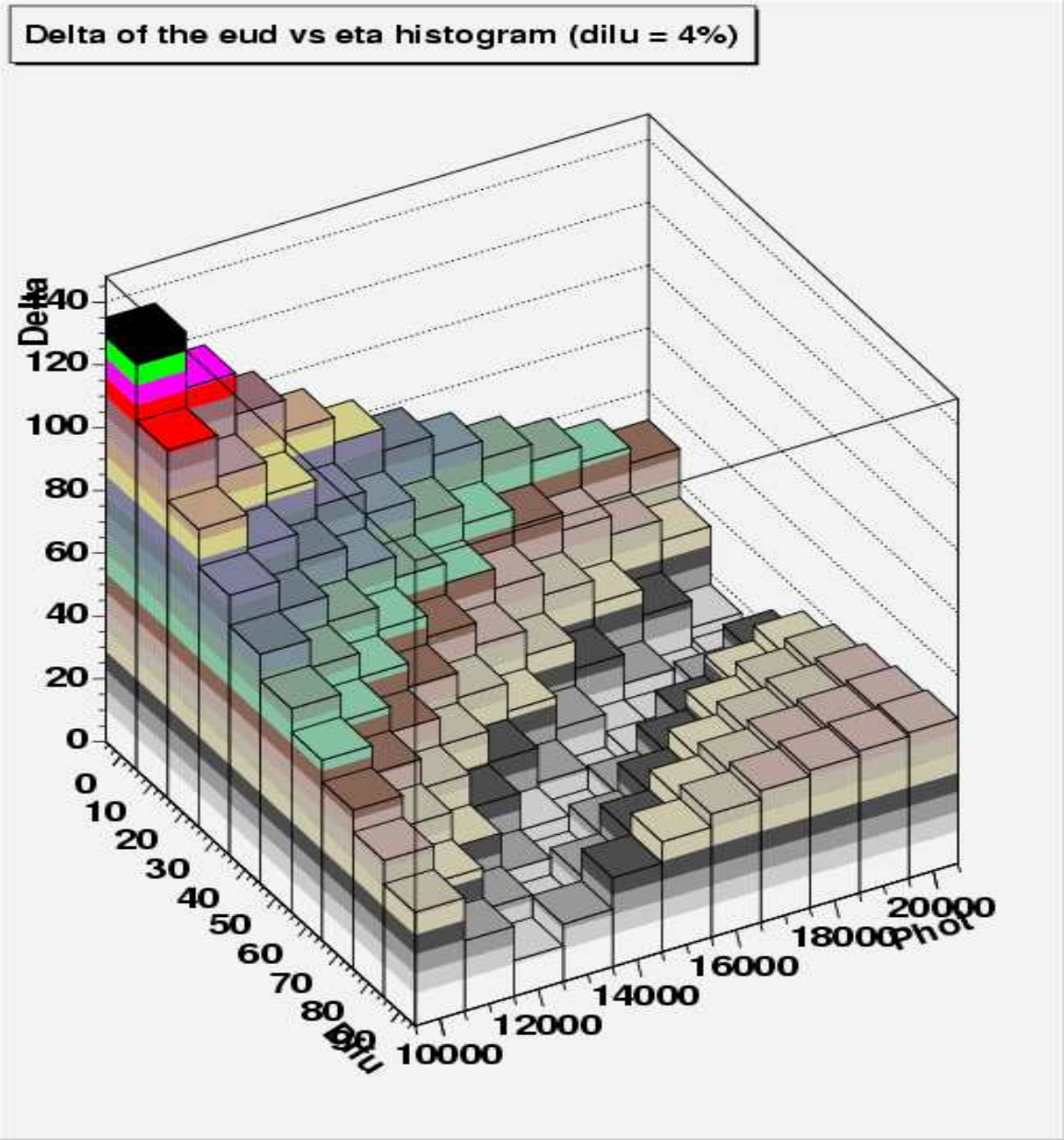




- Our goal is to find which combination of (Difu, Dilu, Phot) that make the simulation agree the best with the real TPOL data.
- We will try to minimize Δ defined as:

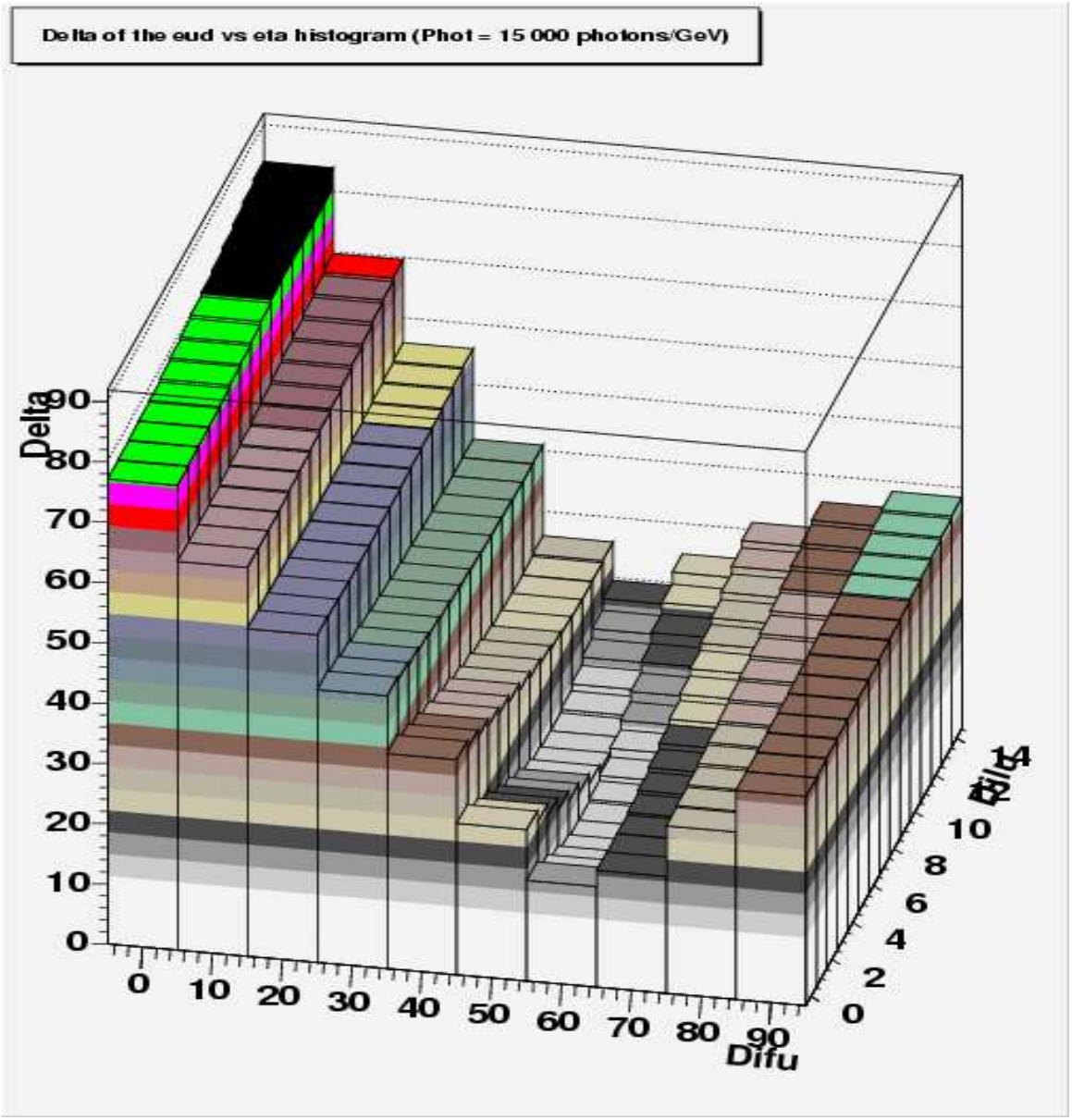
$$\Delta = \sqrt{\frac{\Sigma_{bin}\left(MC_{bin} - Real_{bin}\right)^2}{number\ of\ bin}}$$

Grid for Difu vs Phot



- Note that Difu is in % and Phot in photons/GeV. Dilu is fixed at 4%.
- The best combination is (Difu = 30%, Phot = 19 000 photons/GeV) with Δ = 10.37.
- However, there is a lot of possible minimums on the line starting from (90, 12 000) to (20, 20 000).
- Default parameters (60, 15 000) give the third smallest Δ with 11.35.

Grid for Difu vs Dilu



- Note that Difu and Dilu are in %. Phot is fixed at 15 000 photons/GeV.
- The best combination is (Difu = 60%, Dilu = 5%) and give Δ = 11.30. However, the second best Δ is 11.35 and is given by the default combination (Difu = 60%, Dilu = 4%).
- This time we don't have a serie of minimums.

Conclusion

- The default values Difu = 60%, Dilu = 4% and Phot = 15 000 photons/GeV give one of the best Δ and there is no real need to change them, but we should keep in mind that other combination could be as good.
- Thus, even if we found some of the best values for our present model, it doesn't mean that our model is optimal... and realistic. Is it realistic a Difu = 60% and Dilu = 4%? Is it realistic to assume that almost all the energy that reach the aluminum plate is lost?
- Do we need a new parameters (ex: light reflected on the aluminum plate)?
- This analysis also showed that the AP is extremely sensible over the energy cuts taken.