Tof Wall and ZID studies

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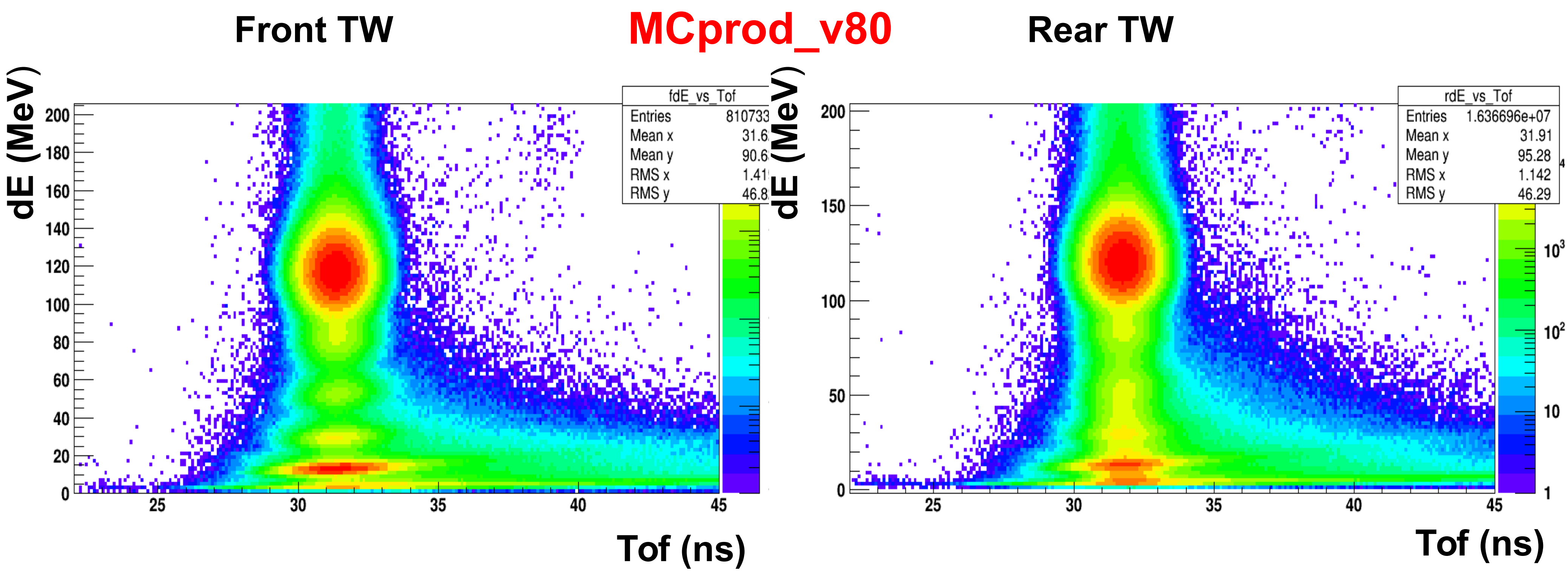
Outline

- Bethe-Bloch fits in MC for the ZID
- Distance from Bethe-Bloch curves
- TW Central Slats Equalization
- Some TW problems and open questions

Bethe-Bloch fits in MC for the ZID algorithm

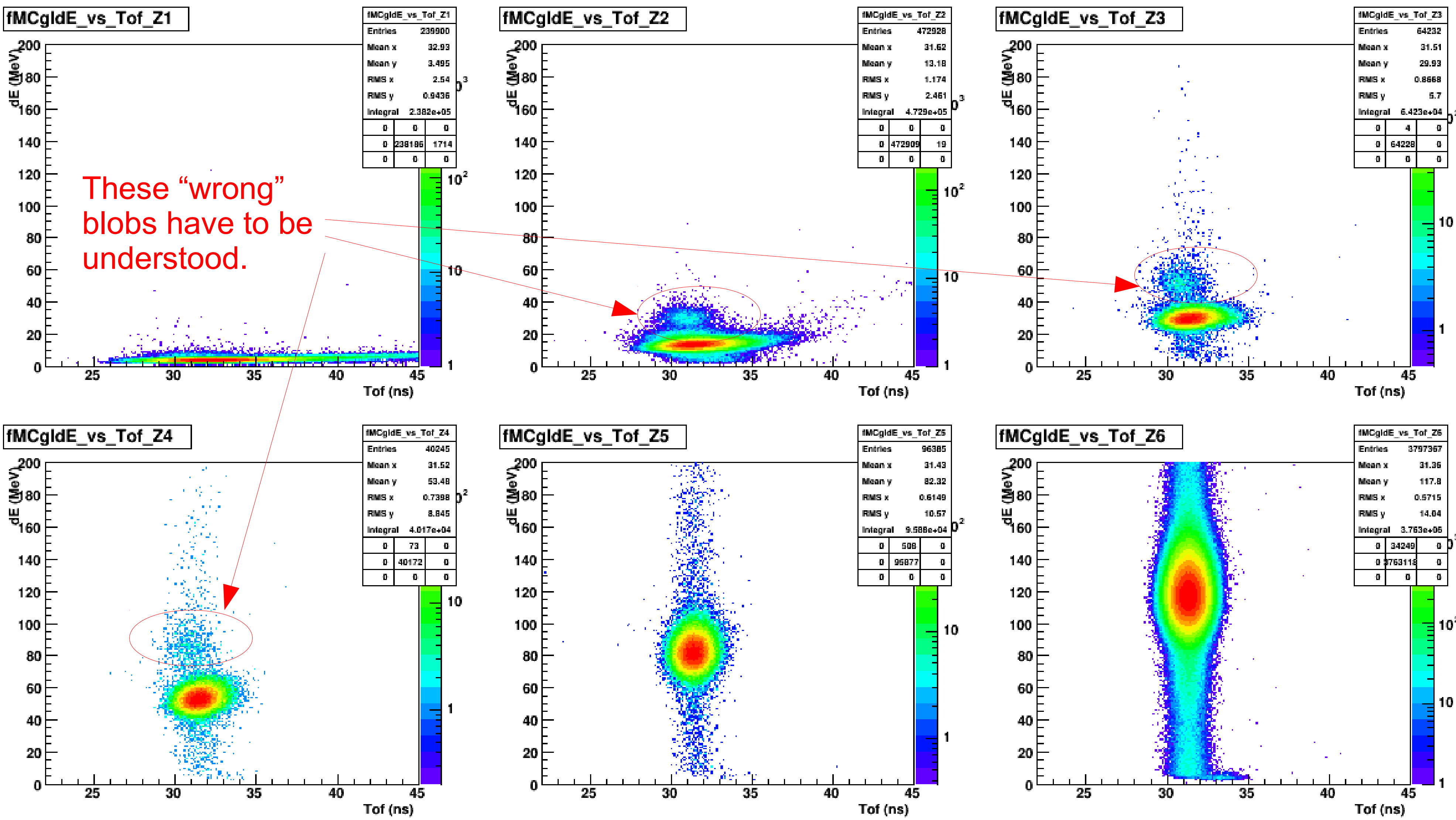
The starting point in MC



- This is the energy dE released in the Tof Wall front and rear vs Tof (Log scale) for MC. All the statistics is used.
- The ZID algorithm in FIRST is based on fitting the six blobs in these plots corresponding to the fragments and carbon charges with the six Bethe-Bloch curves (one for each Z)

The cuts used for fitting in MC

- In the following plots of Eloss vs Tof in the MC I select the fragments using the MC truth matching.



The Bethe-Bloch formula used

(Slide from S.Salvator talk in FIRST meeting, May 2013)

The formula used is based on Bethe-Bloch with low energy part and no corrections :

The energy released dE is thought like a function of the Tof

$$\Delta E = a_1(Z) \cdot \frac{Z^2}{\beta^2} \left[\ln\left(\frac{b\beta^2}{1-\beta^2}\right) - \beta^2 \right] \Delta x.$$

$$\text{with} \quad \beta = \frac{d}{c \cdot ToF}$$

→ d = 6.64 m is the path distance for carbons that goes straight. So the constrain 0<β<1 implies ToF > 22 ns

$$a_1(Z) = \text{“quenching factors”},$$

For plastic scintillator <I>=64.7 eV →

$$b = \frac{2m_e c^2}{I} = 6645.,$$

→ 15795

$$\Delta x = \text{thickness of the slat} = 15.\ \text{mm}$$

→ 1 cm

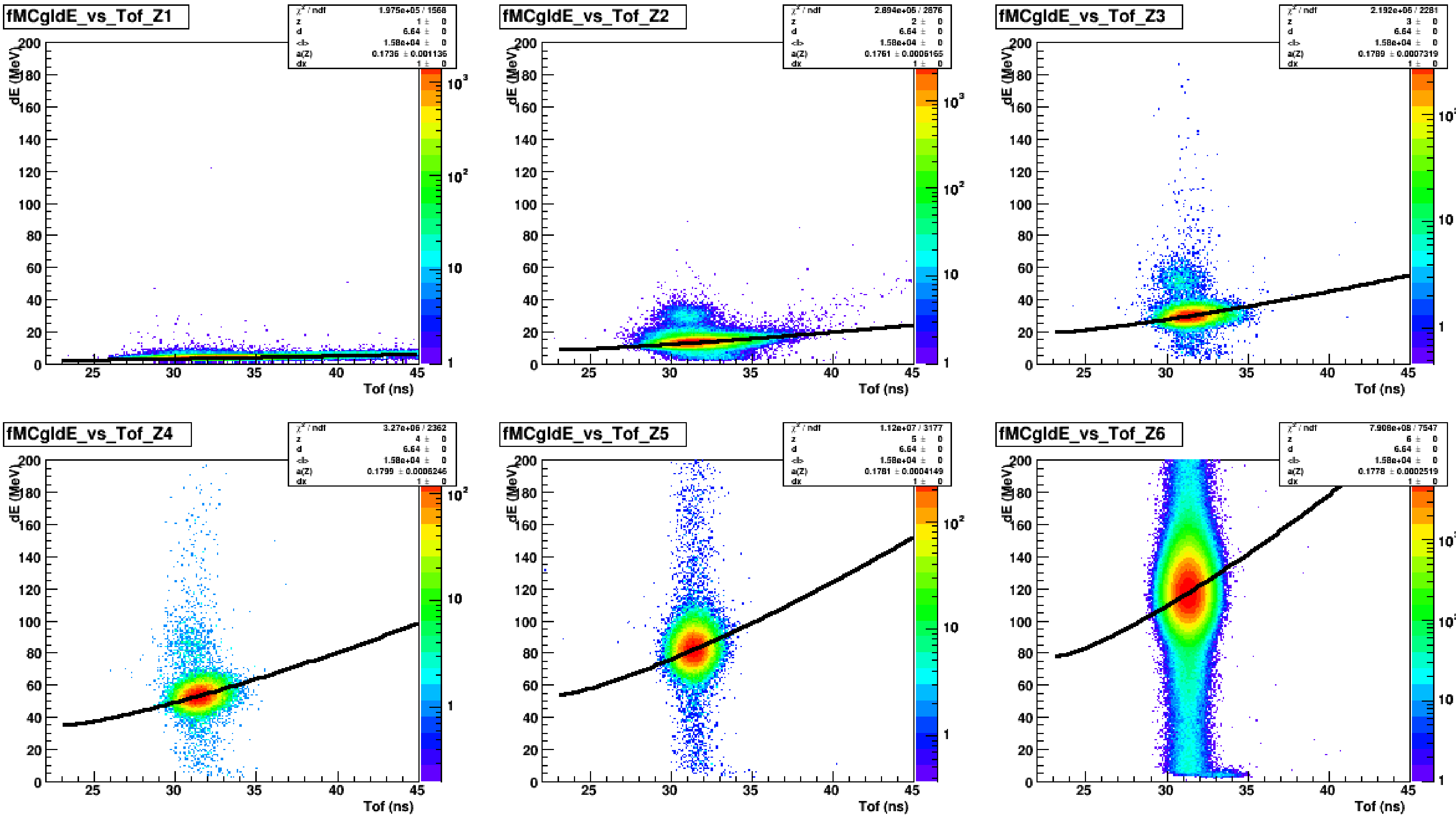
Basically, only $a_1(Z)$ are left as free parameters, the others should be known.

The factor $a_1(Z_{TG})$ can be calculated in MC for a BC-408 plastic scintillator:

$a_1(z) = 4\pi N_A (r_e\text{\^{}}2) * m_e c\text{\^{}}2 * \rho_{TG} (Z_{TG}/A_{TG}) = 0.1716$ MeV/cm

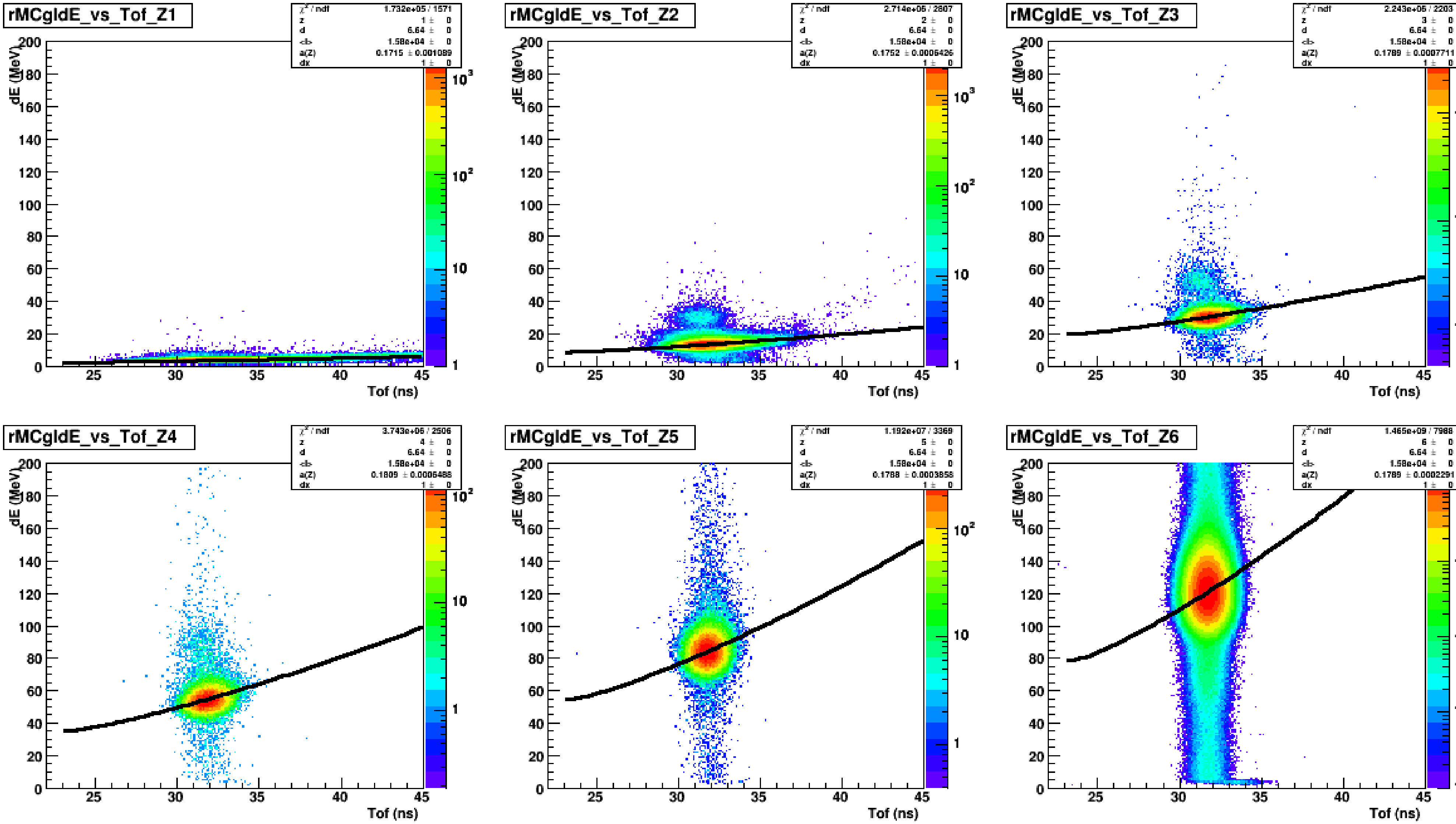
Front and rear ToF Wall are studied separately both for data and MC so the fits return different parameters.

Bethe-Bloch fit for front TW



For each fit the parameter $a_1(z)$ obtained is very close to the one that has been calculated 0.1716 MeV/cm (we are in MC!!)

Bethe-Bloch fit for rear TW

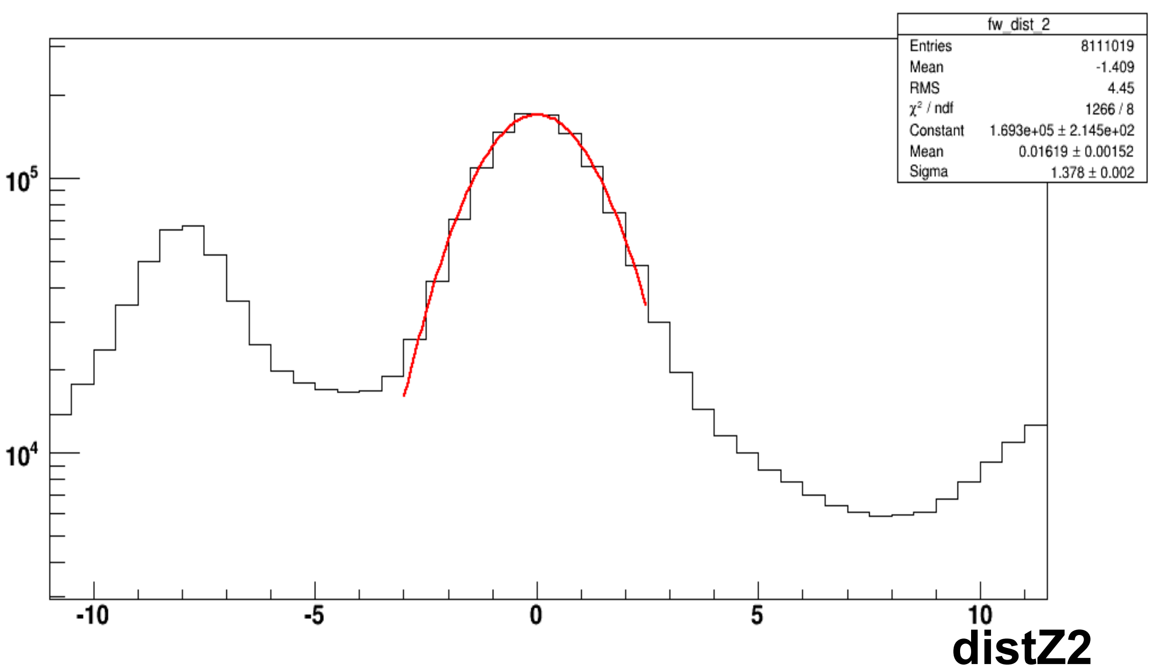


For each fit the parameter $a_1(z)$ obtained is very close to the one that has been calculated 0.1716 MeV/cm (we are in MC!!)

Gaussian fits on the distance peaks

- After the new fits the distributions of the distances from the 6 Bethe-Bloch curves are better centered in zero.
- However a small bias exists again. This is probably due to the fact that in the fit of the Bethe-Bloch curve we introduce an error when we fix the path distance for each track to 6.64 m (right only for straightforward tracks) that can't be factorized in the a(Z) factor

Distance from Bethe-Bloch with Z = 2

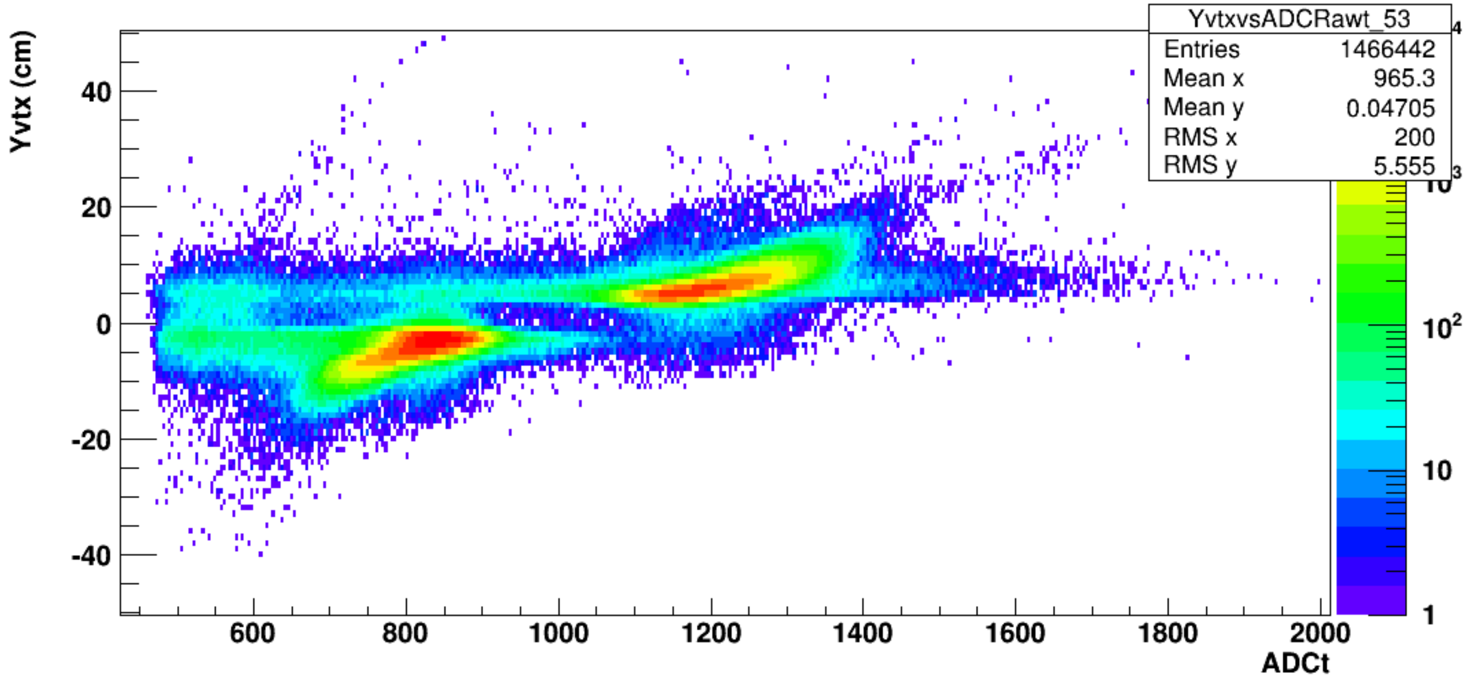


To correct this small bias I've extracted the sigma and the mean from a gaussian fit for each distance distribution peaked in zero and I've taken the minimum value of the quantity: **(distance – mean)/sigma** from the 6 Bethe-Bloch curves to assign the charge to each track.

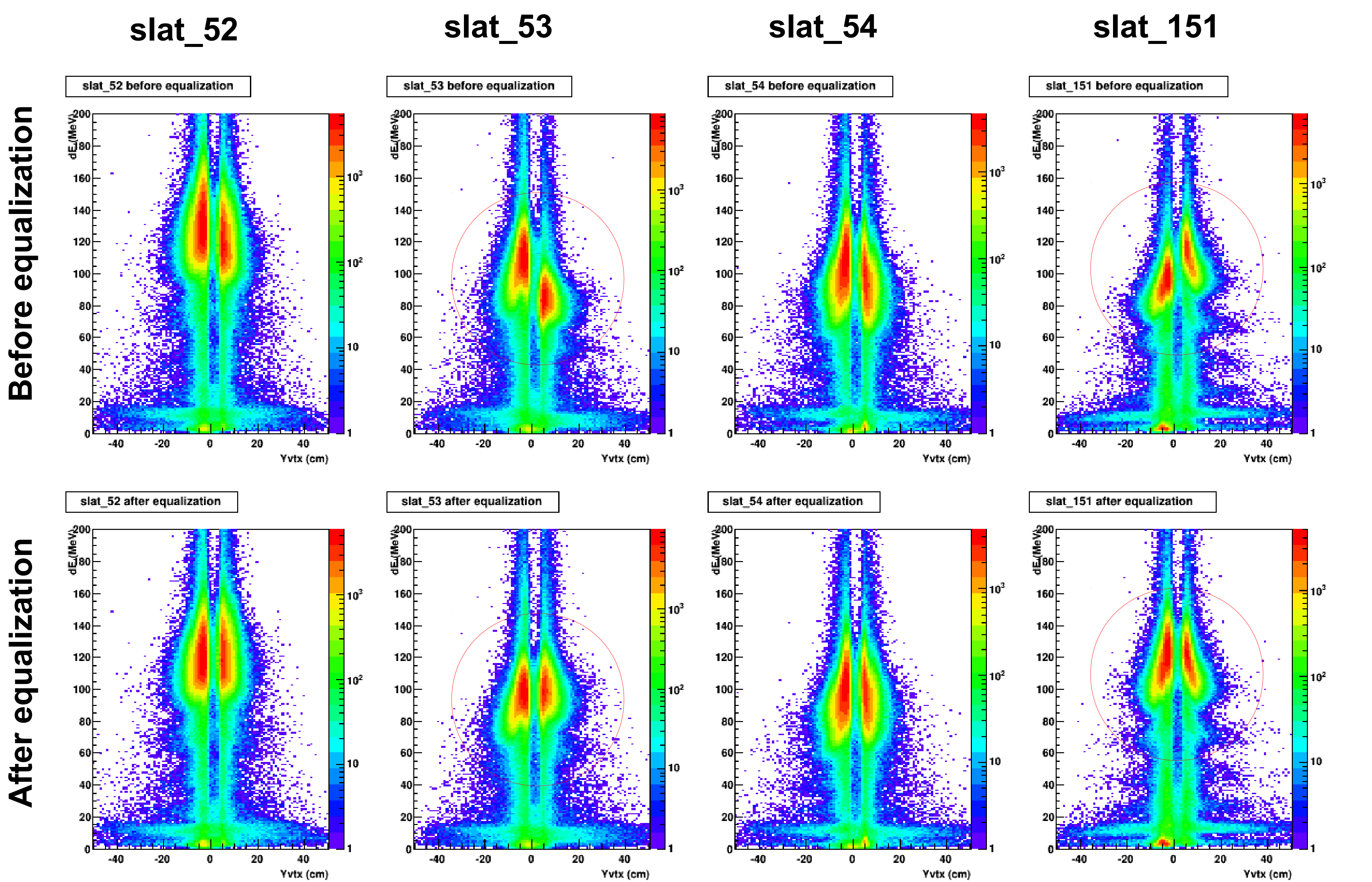
Central Slats Equalization

Central slats Equalization

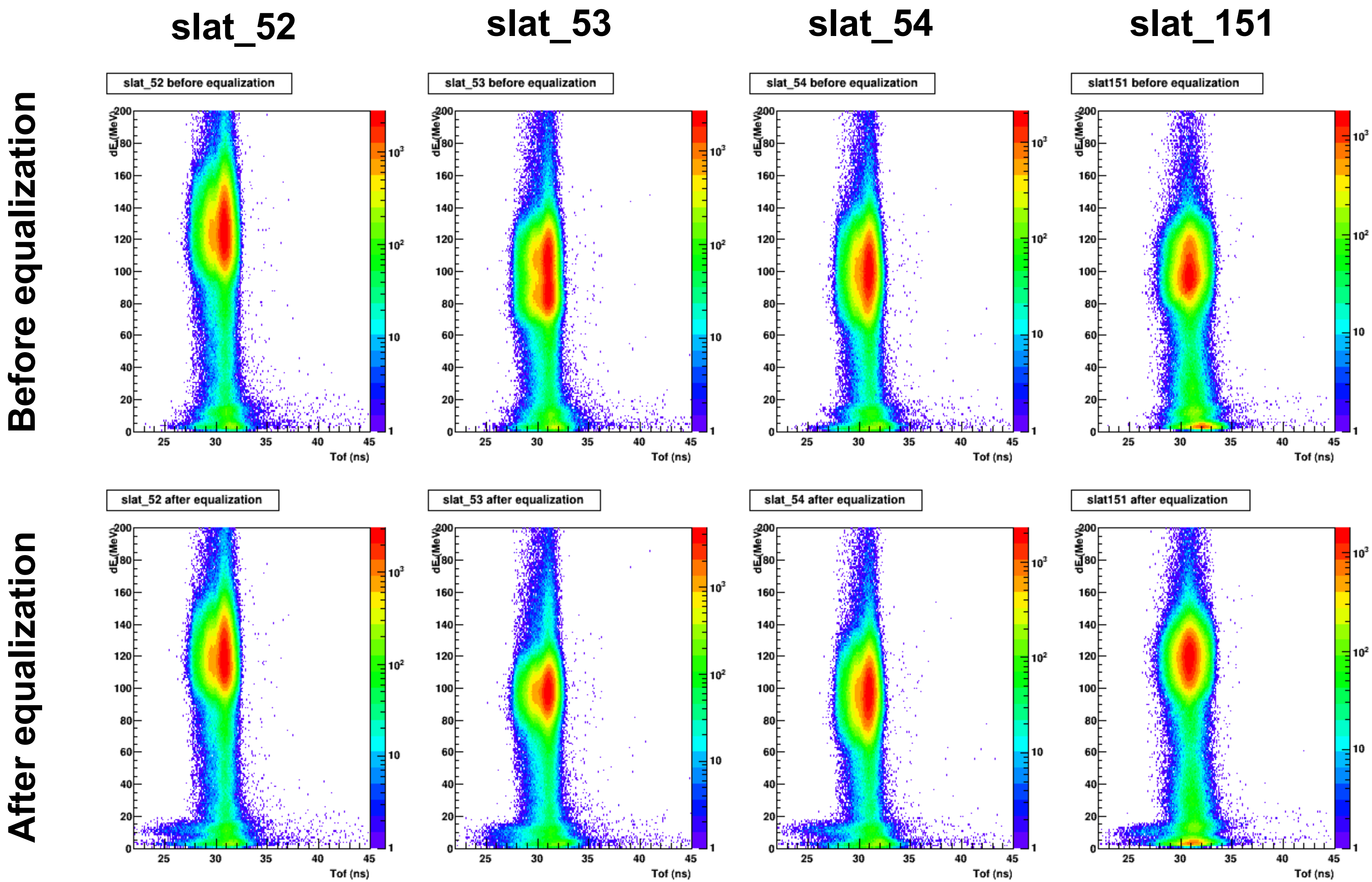
- For central slats we have the problem of the hole: the same ADC (in fig. ADC top for slat 53) reads two different charges for the same carbon energies up (Y>0) and down (Y<0) the hole.
- Until now this has implied two different Eloss because the scale factor to convert ADC charge in energy was the same for Y>0 and Y<0
- We have used the Y information to compute two distinct scaling factor for each ADC (top and bottom) to have a properly equalized light



Eloss vs Yvtx for central slats



Eloss vs Tof for central slats



Thank to this equalization we have finally achieved just one carbon peak for each central slat!!

Some TW problems and open questions

- The following study is done on the full Data statistics
- The slats studied until now are for front TW 38<slat<70 and for rear TW 137<slat<165
- The only cuts used are:

1. Matching with BM
2. Vtx validity (N of tracks in the vertex >= 1)
3. Events for which only a vertex exist

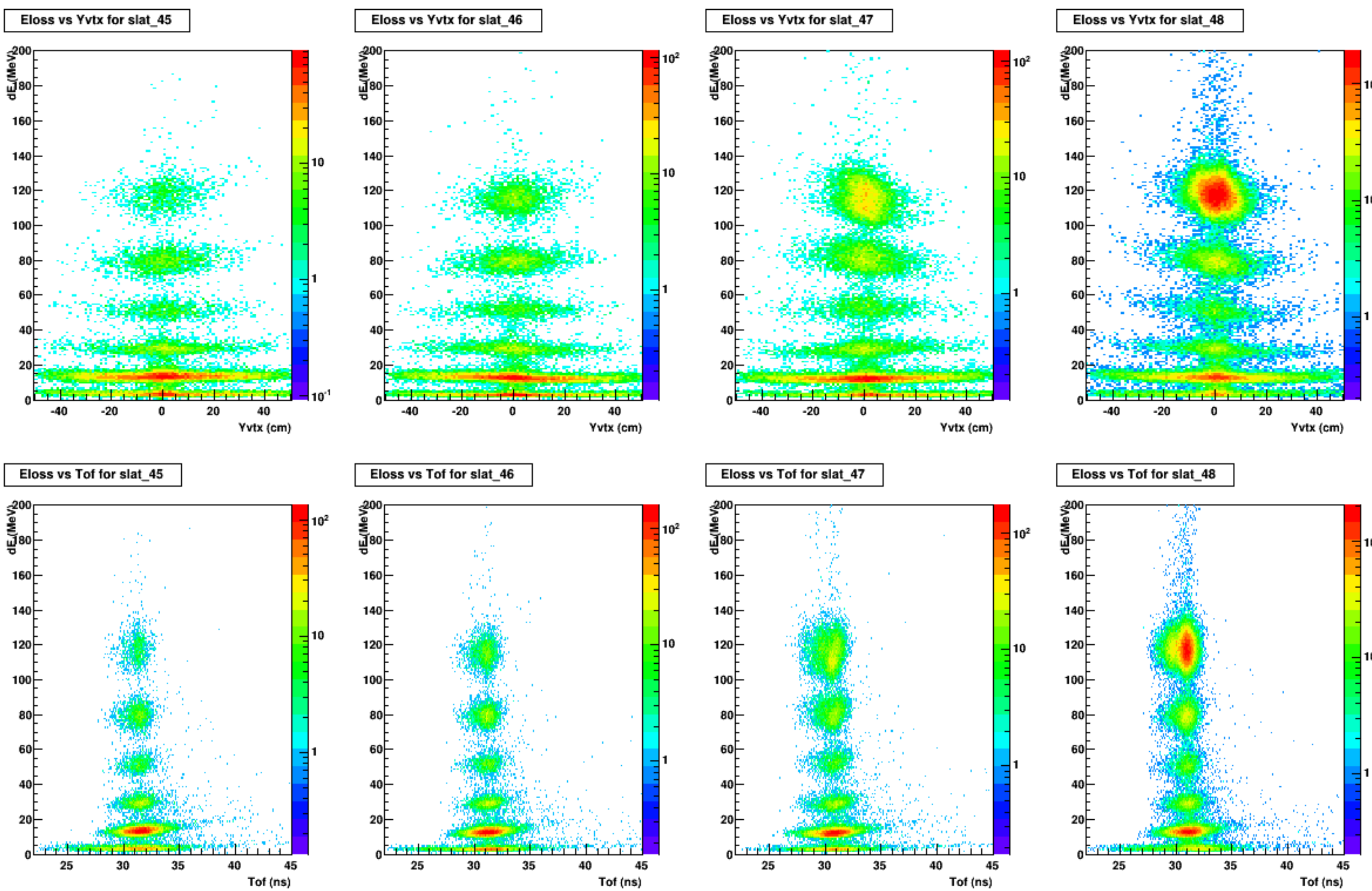
Good slat, bad Tof - 1

- For the slat of the front Tof Wall there is some problem with the Tof of some events: there is a tail to the left of the central spot of the Carbon (also true for the other fragments)

slat_45 **slat_46** **slat_47** **slat_48**

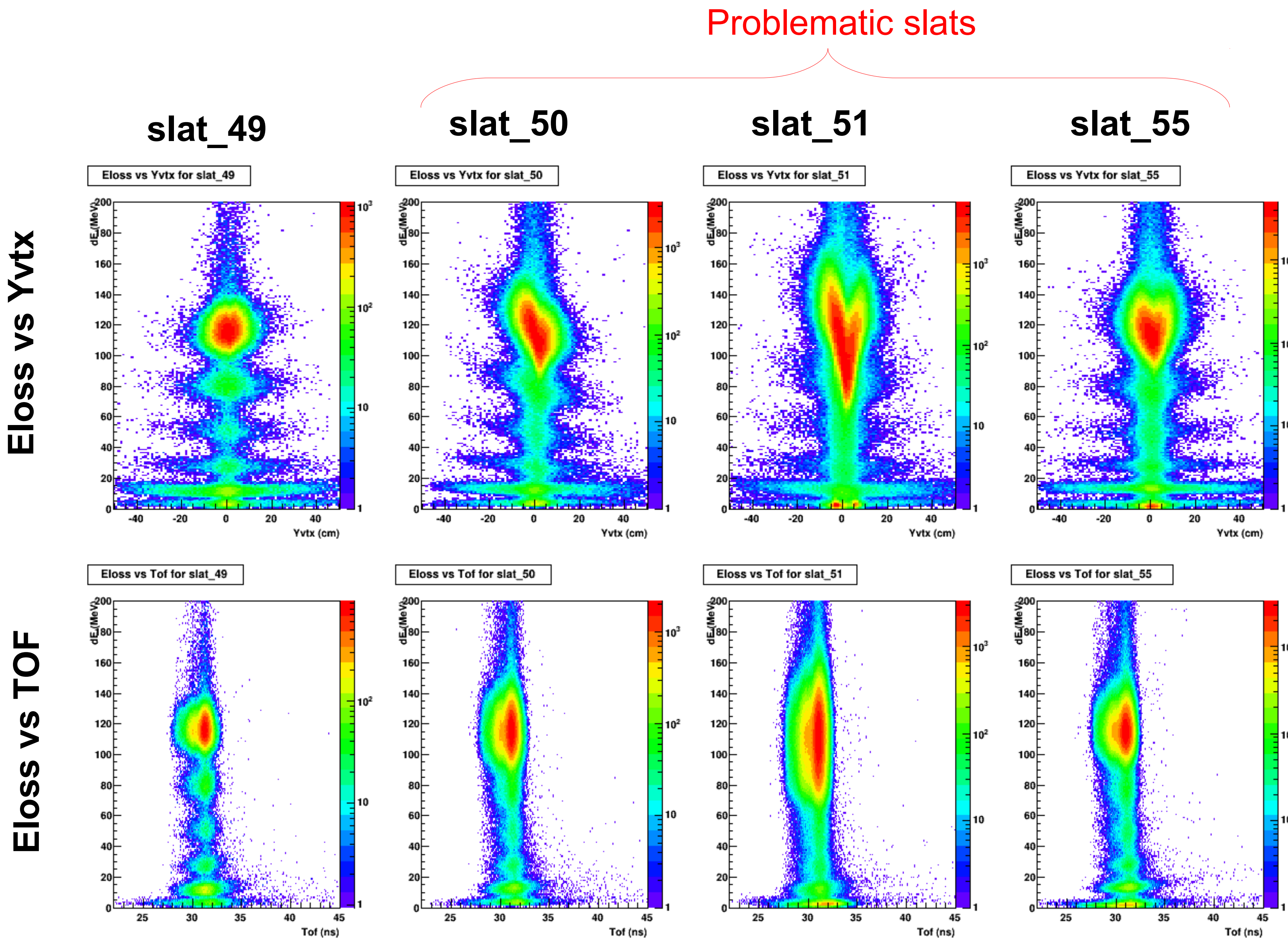
Eloss vs Yvtx

Eloss vs TOF



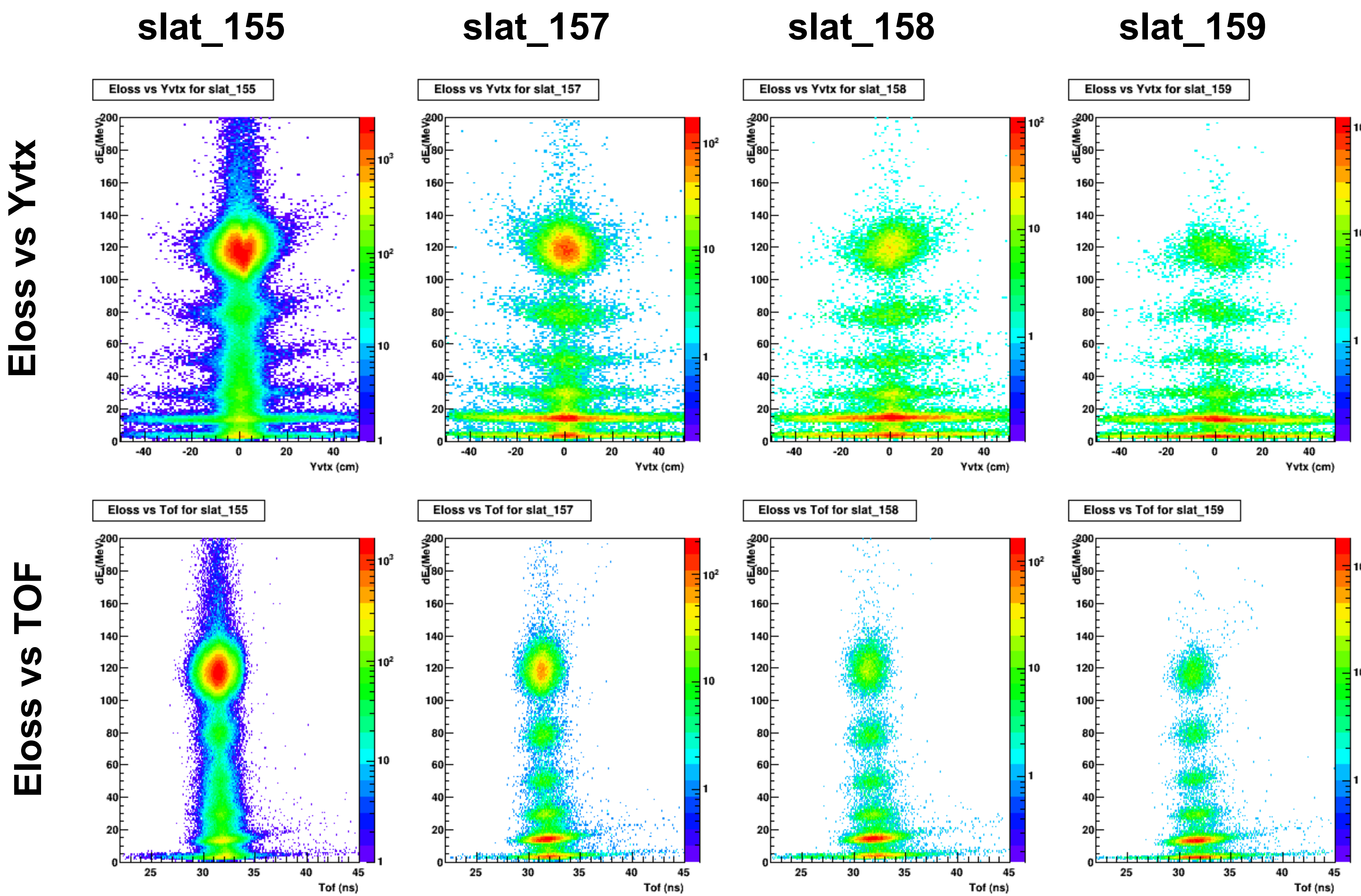
Good slat, bad Tof - 2

- This effect is more evident for the central slats



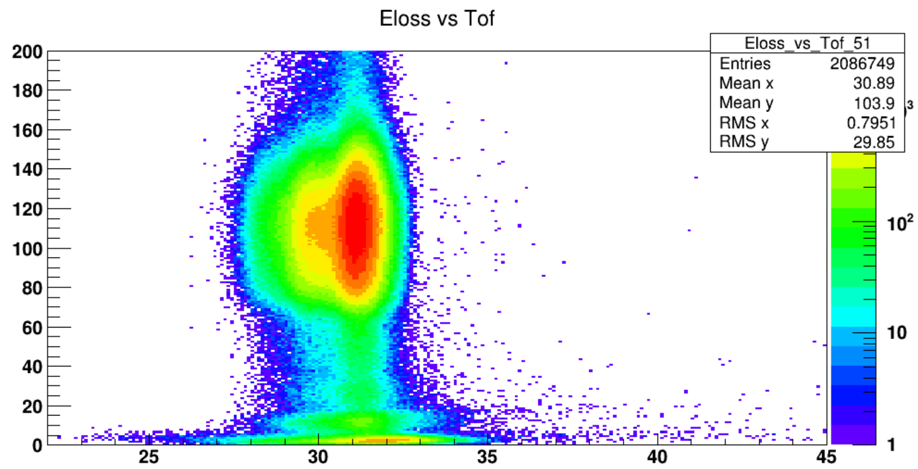
Good slat, bad tof - 3

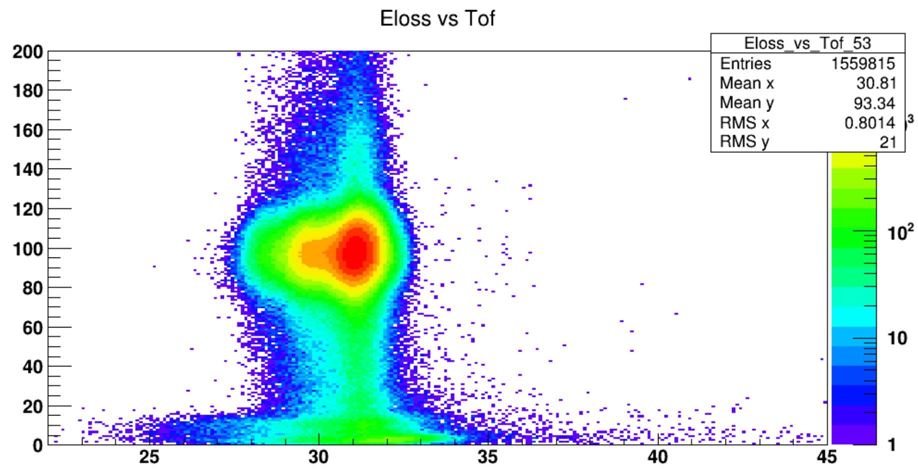
- This effect is absent for rear Tof Wall

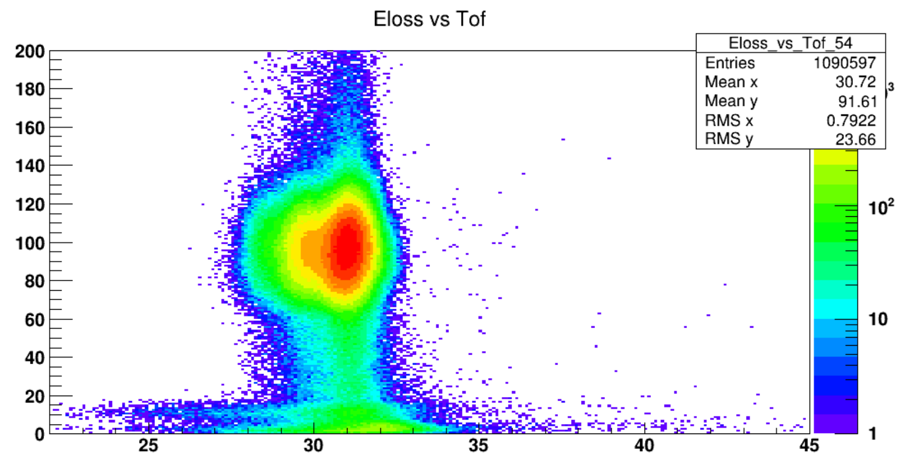


Problems with slats 51, 53 and 54

- These are the only three slats with the carbon blobs centered about in Eloss = 100 MeV instead of about 120 MeV. To improve our ZID is crucial to re-centered the carbon peak in these central slats where we have the great part of Boron to be distinguished from Carbon.

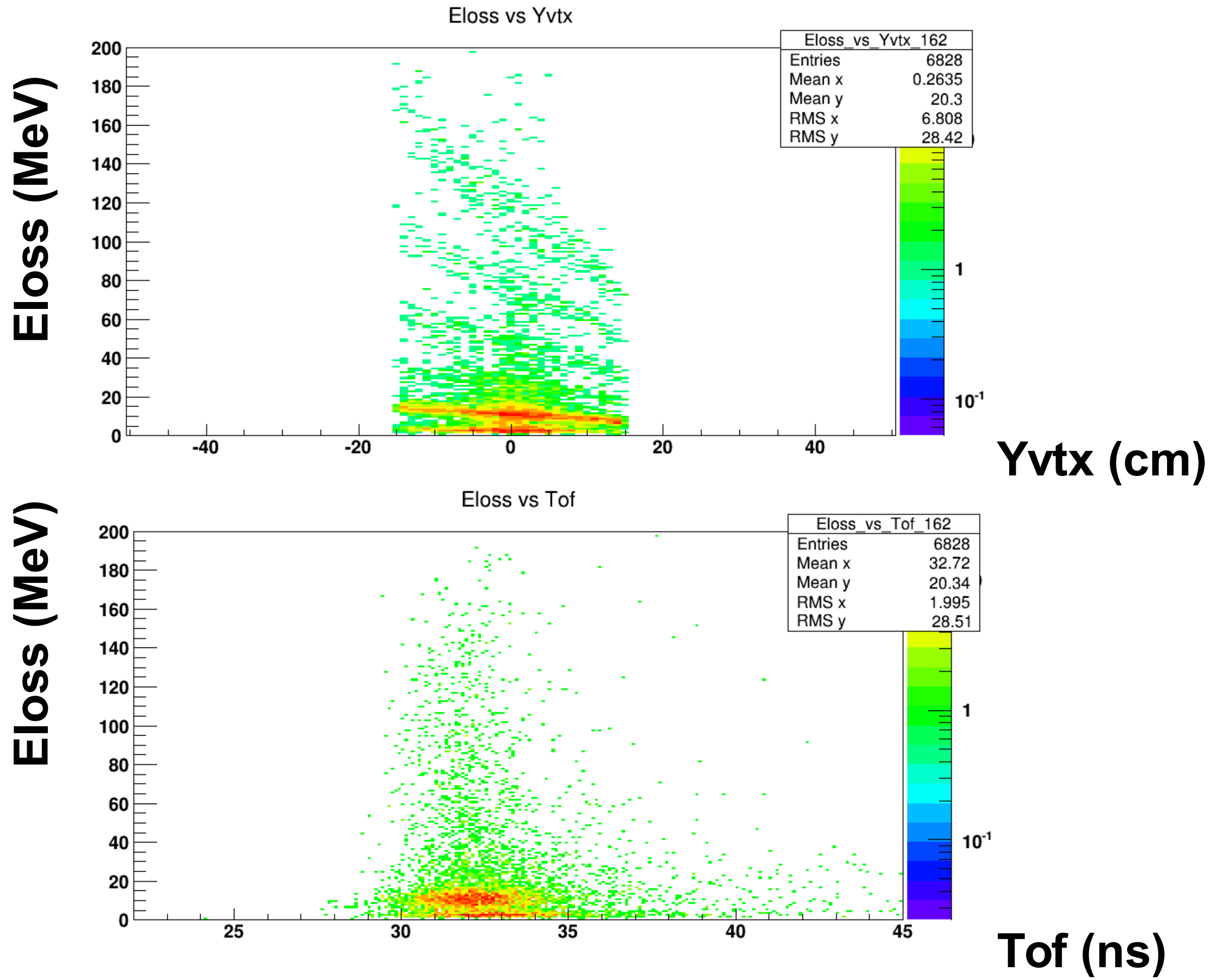






Slats with only one ADC working

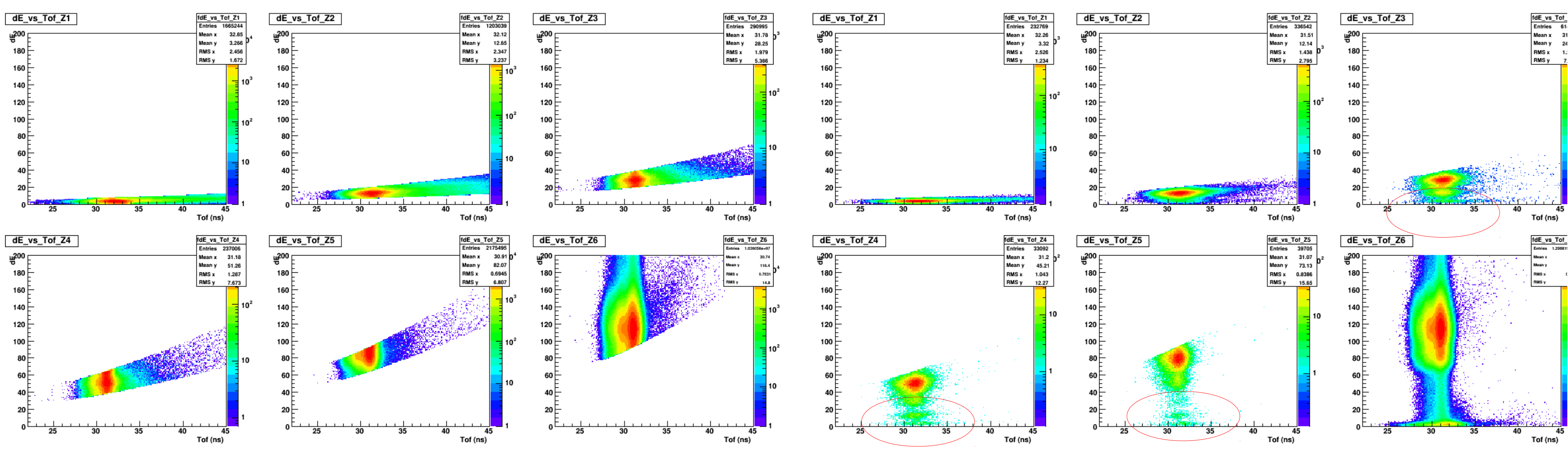
- In the intervall analysed these slats are 66, 139, 142, 144, 162
- They all have the following aspect:



Some problems with the reconstructed charge

- The plots shows Eloss vs Tof for all the statistics (all the slats of front TW) for each Z.
- For each global tracks I take the attached hit in the front wall and its charge and the reconstructed charge associated to that global track.
- The plot on the right is done cutting with the reconstructed charge, while the plot on the left is done using the charge of the TW hit
- In the plot on the right appears some blobs outside the right position that emphasize when we assign a bad reconstructed charge to the global track

➔ These are small effects that can be corrected with Z from the vtx detector!



Conclusions

- The (distance-mean)/sigma has been tested and implemented also for MC...no much difference btw it and the absolute distance from Bethe-Bloch curves
- The equalization of TW central slats improves the Eloss distribution
- A recalibration of central slats has to be done in order to properly re-center the energy peaks
- A study slat by slat for the TW was done and now we have collected the evidence that some slats need further investigation
- Last important issues to be addressed in the near future: bias in Tof distribution btw data and MC