

Study of retriggers (continued)

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The correlation of retriggers with the pedestal positions in BX have been first reported on 17 Dec 2016 and explained in more detail on 7 Jan 2016. Report on 14 Jan contains some (negative) results on retrigger correlation with BX, with channel number and with muon position.

Here, I'd like to extend this study to both pedestals and hits in all BX, BX+1, BX+2, ...

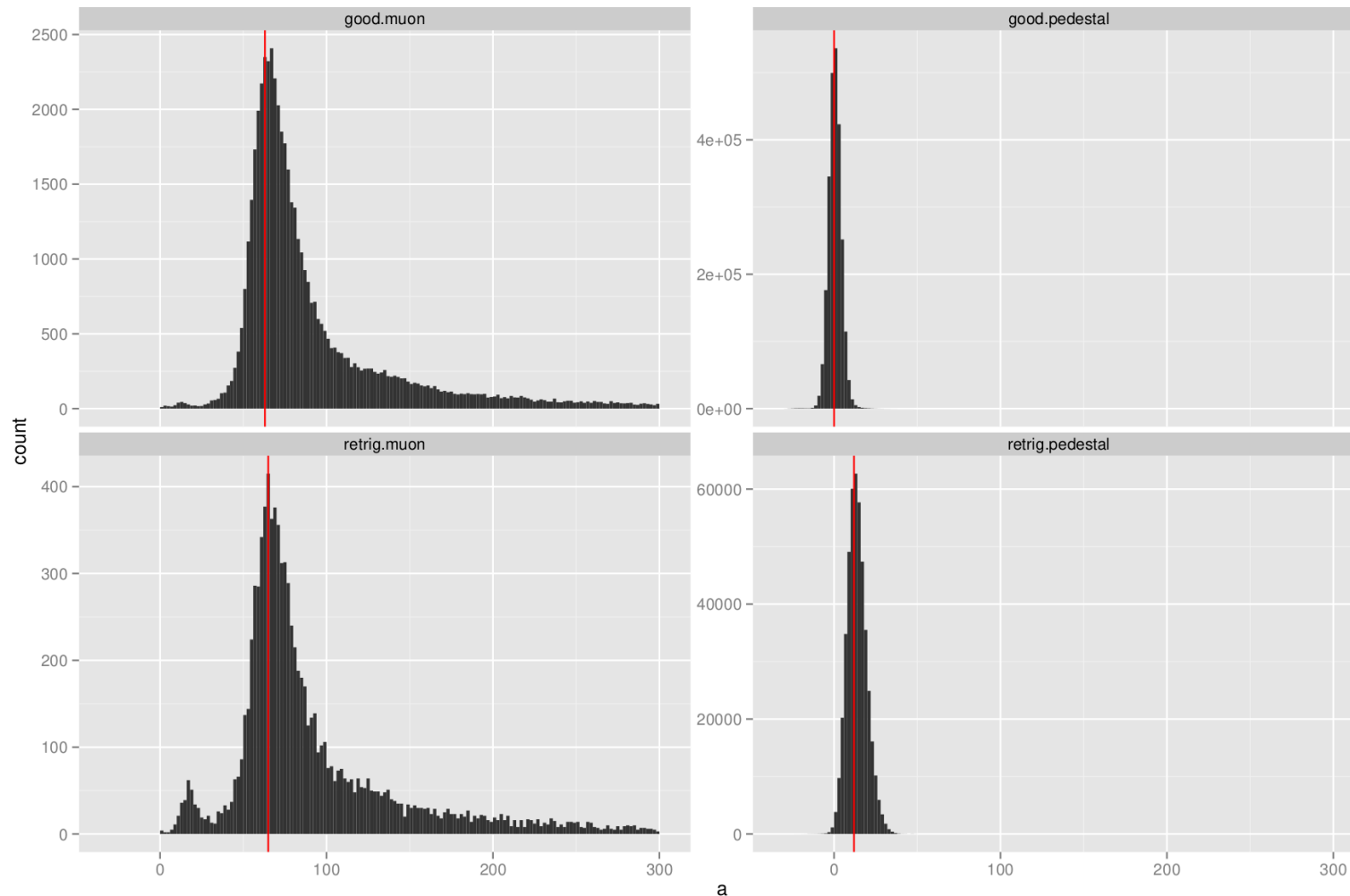
Based on all plots (past and presented today on the next slides), yesterday, I think, I've realized the picture how retriggers occur. Then, I've checked the picture with the data, and it seems the effect is really there.

I am not going to tell you, however, and you'll need to judge yourself (for those who likes difficult puzzles). Everything I knew by yesterday, I tried to collect and present at the meetings (including the next slides).

Position of MIPs in retriggered events

Contrary to pedestals, the muon peak position BEFORE pedestal subtraction is almost not affected by the retrigger.

On the plot, "good" means a clean sample without retriggerers in BX+1,+2, etc., while "retrig." is for ≥ 10 hits in SCA=2 (strong retrigger). "Muon" and "pedestal" ADC are for triggered and not triggered channels.



The same in one “density” plot for better visualization

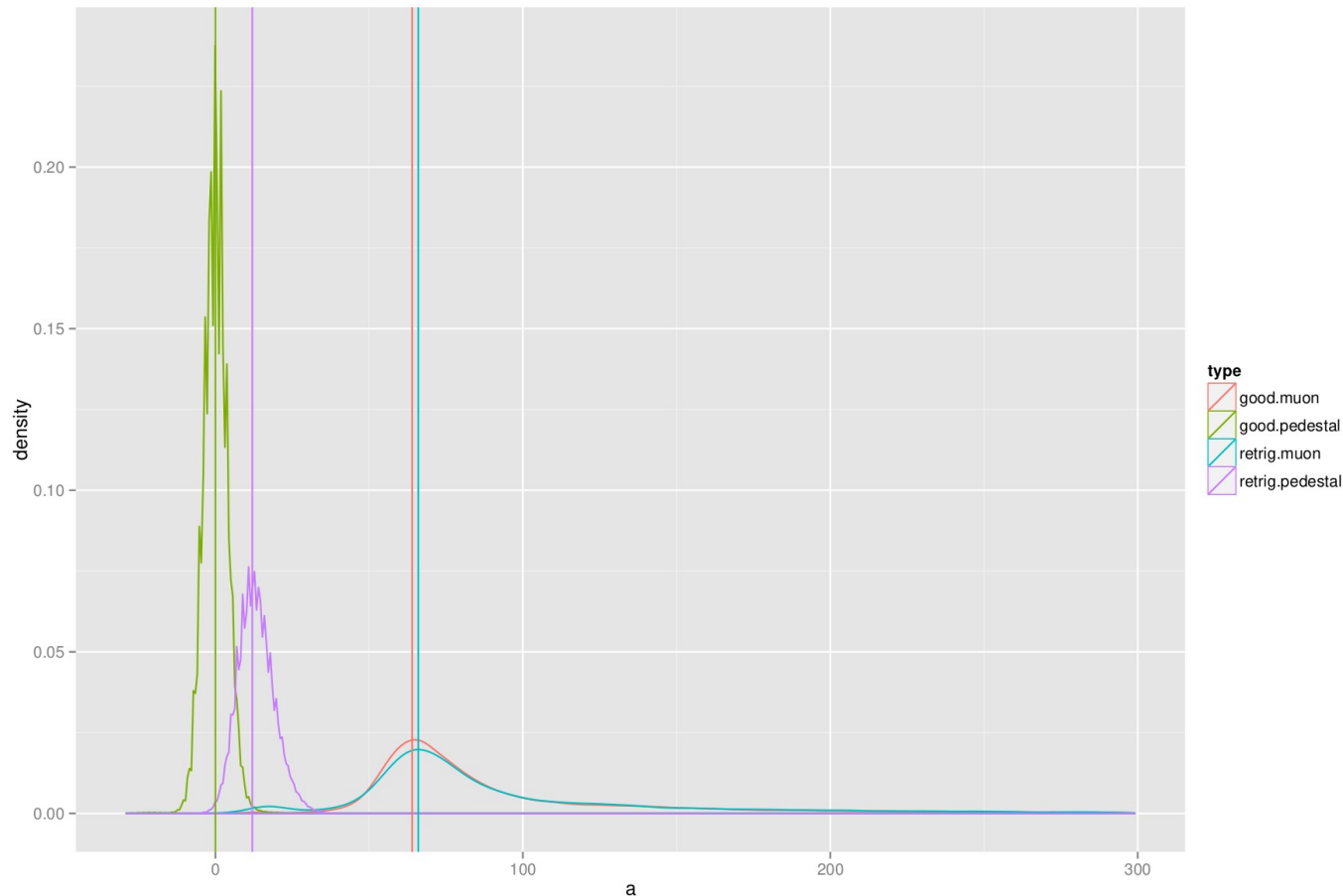
Density plots where the distributions are smoothed and normalized for comparison.

Vertical lines show my approximate guess of the peak positions in the smoothed spectra (no fit, though, just by eye).

The average pedestal shift is 12 channels, while the muon shift looks to be not more than 2.

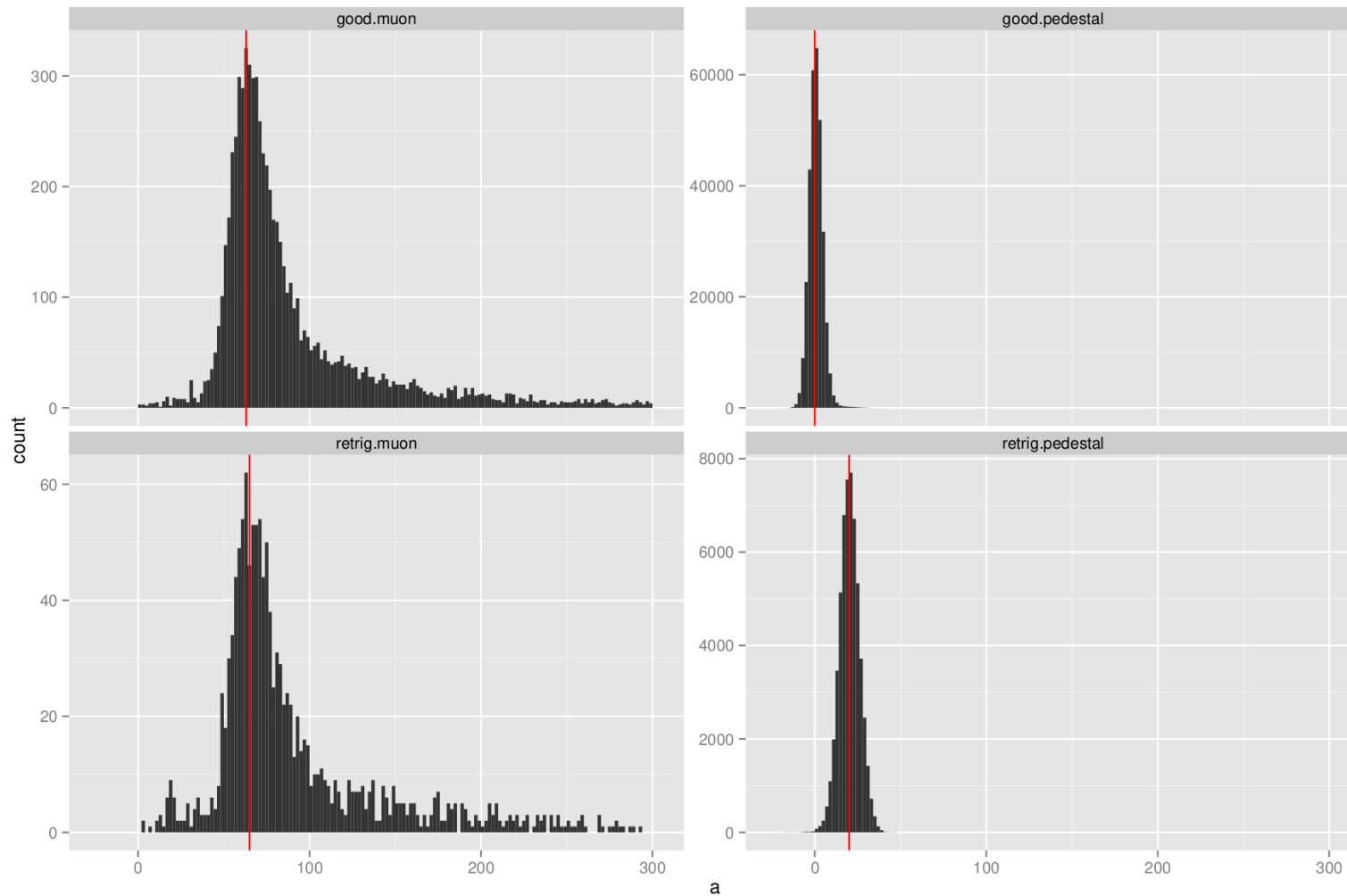
Recall that for both MIP spectra I have subtracted the same constant good.pedestals.

Therefore, one can conclude that MIP absolute position (before the subtraction) is also essentially constant, while pedestals shift to the right by 12 ADC counts in case of retrigger.



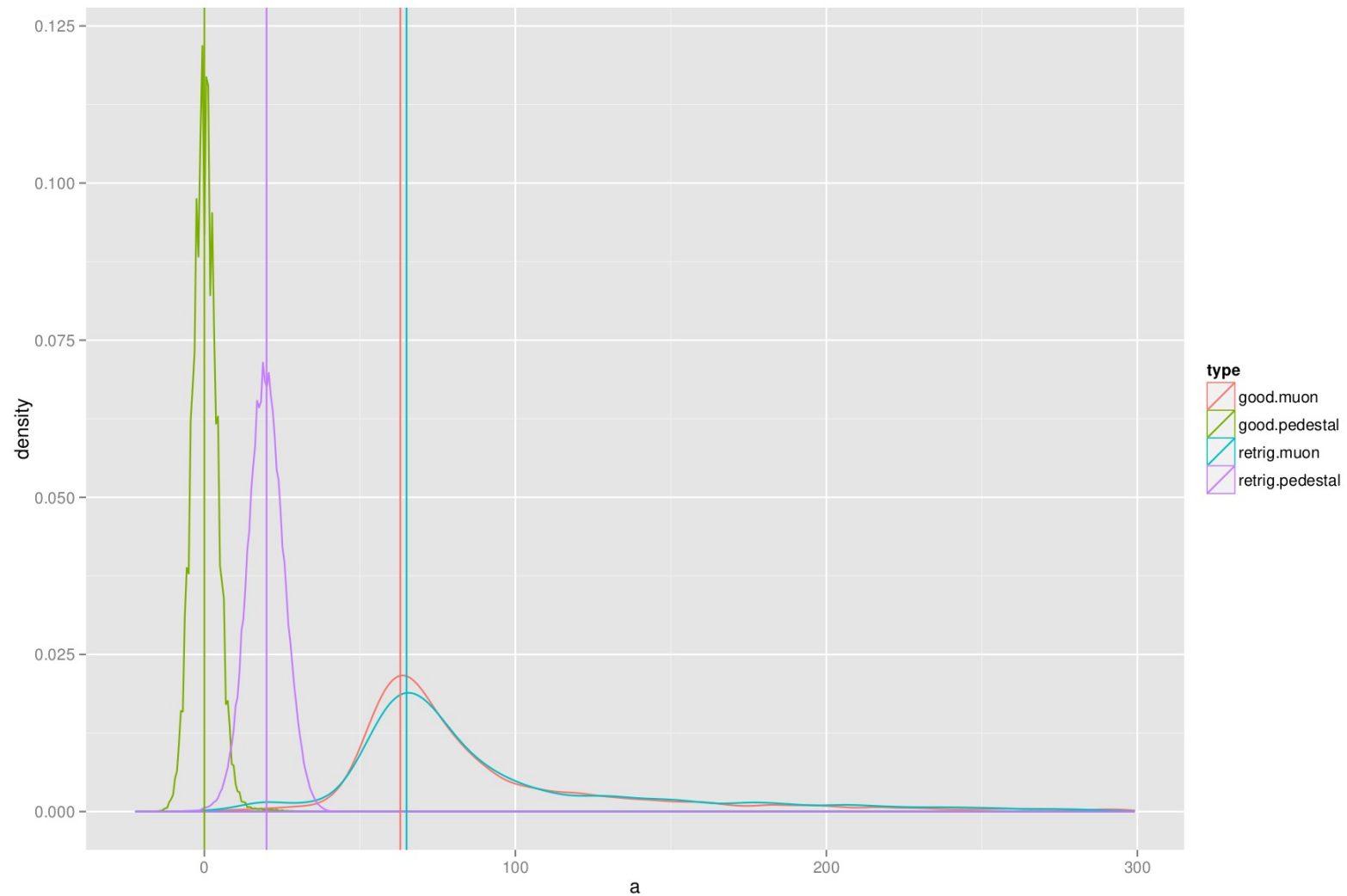
The same for channels 56...63

The same, but for only upper 8 channels (56...63, for both muons and pedestals. ie. for both hits and untriggred data), where the pedestal shift is larger (to see the effect better).



Density plots for channels 56...63

No MIP shift. The average pedestal shift is now 20 channels, while the muon shift again looks to be not more than 2. Showing simultaneously the shifts of both pedestal and MIP peaks is probably quite convincing.



Copy of my recent mail to Omega

Please, find attached 4 plots which show both pedestals and muon MIPs in various cases of 0, 1, 2, 3 retriggers. Again, this is the same 2 hours muon run 361, DIF 1 with the largest splitting between the pedestals. All channels of DIF1 are combined.

The horizontal axis is (ADC - pedestal), where pedestal is calculated per channel and per SCA only from events without any retriggers (as in the previous mail).

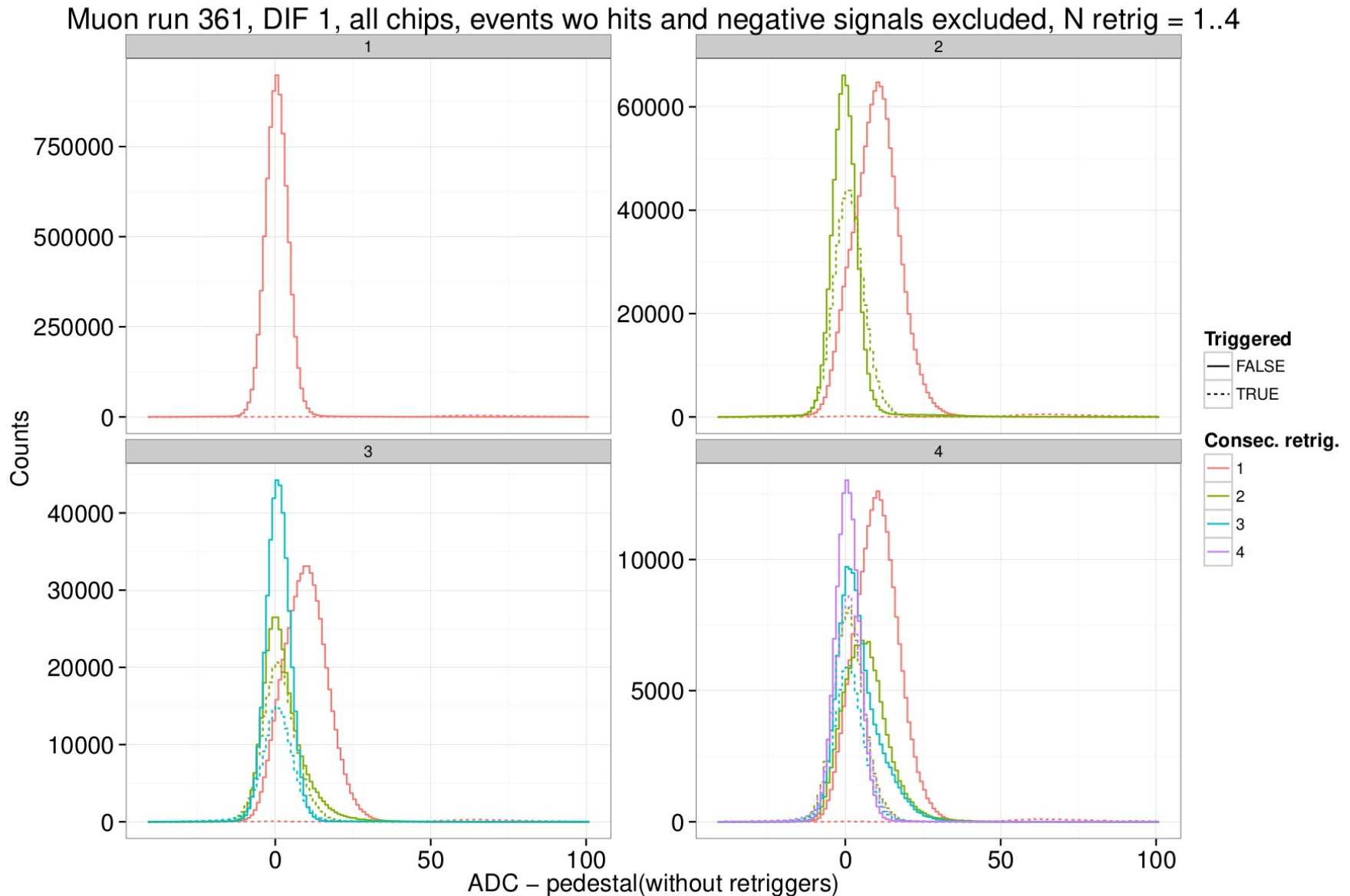
I slightly modified the logic how the retriggers are determined. As you remember, the "normal" (well understood) case of retrigger is when there are no hits in BX+1. Such events normally have the same left (correct) pedestal in BX as nice events without retriggers. For simplicity, for the plots in this mail, I removed all events *containing no triggers.* In this way, such an event with BX followed by BX+1 *without triggers* (removed) is now classified as the "no-retriggers" case (where it naturally belongs to).

Another difference compared to the previous mail is that now I take all SCA's (pedestal is subtracted per SCA and per channel, so all channels+SCA's have the same zero and may be summed up). Note, that since the muon rate was not high, only the first SCA's were mainly fired.

In all plots, the pedestal and MIP are shown by solid and dashed lines, respectively.

Pedestal in all (re)triggered events

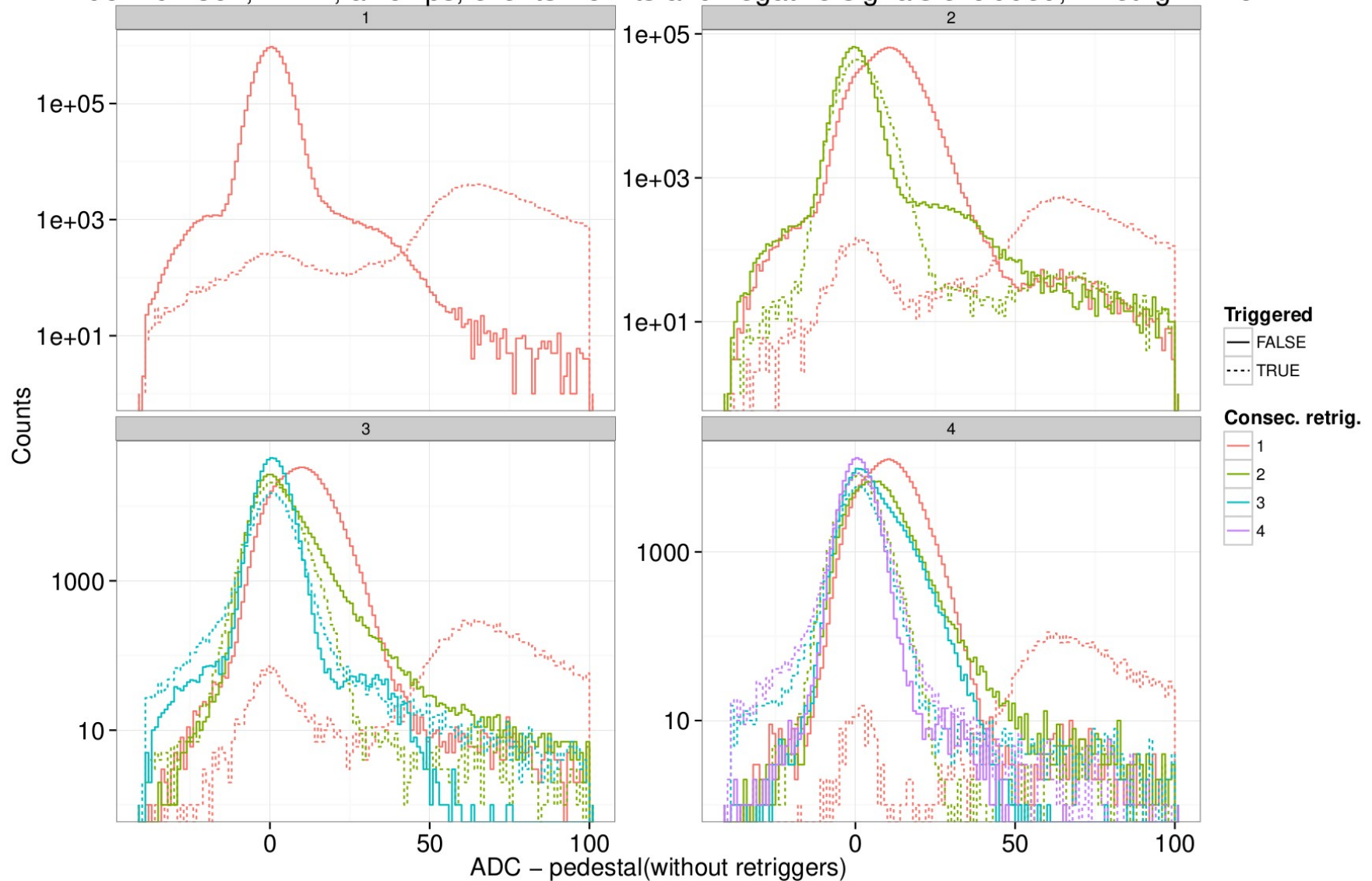
Two identical plots but shown in linear and logarithmic scales (next slide). Events with 0, 1, 2 and 3 retriggers are selected for four plots. They are numbered starting from one: "Consec. retrig. = 1,2,3,4". The color distinguishes BX, BX+1, BX+2 and BX+3.



Pedestal in all (re)triggered events

Same, log scale

Muon run 361, DIF 1, all chips, events w/o hits and negative signals excluded, N retrigger = 1..5



Pedestal in all (re)triggered events

Eg. in the bottom-left with 2 retriggers and 3 BX's, there are 3 colors for BX, BX+1, BX+2.

Again, dashed is for triggered signals. In the physical event in BX, there is normally 1 trigger and 63 pedestals, so pedestals dominate and MIP signal is not visible in the linear scale (only in logarithmic). In retriggers BX+1,+2,+3 there are many plane events, so that pedestal and triggered statistics are comparable. The red pedestal curve for BX in case of retriggers is shifted to the right and is wider because it is smeared by variations in pedestal splitting, as I've discussed in the previous mail.

The pedestal in the very last retrigger (eg. BX+2 with "Consec.retrig."=3 in bottom-left with BX,BX+1,BX+2, or "Consec.retrig."=4 in the bottom-right) is always

- centered at zero and
- narrow.

Pedestals in the middle BX's, ie. not the first and not the last (BX+1 in bottom-left and BX+2,+3 in bottom-right) have two contributions, from both left and right pedestals.

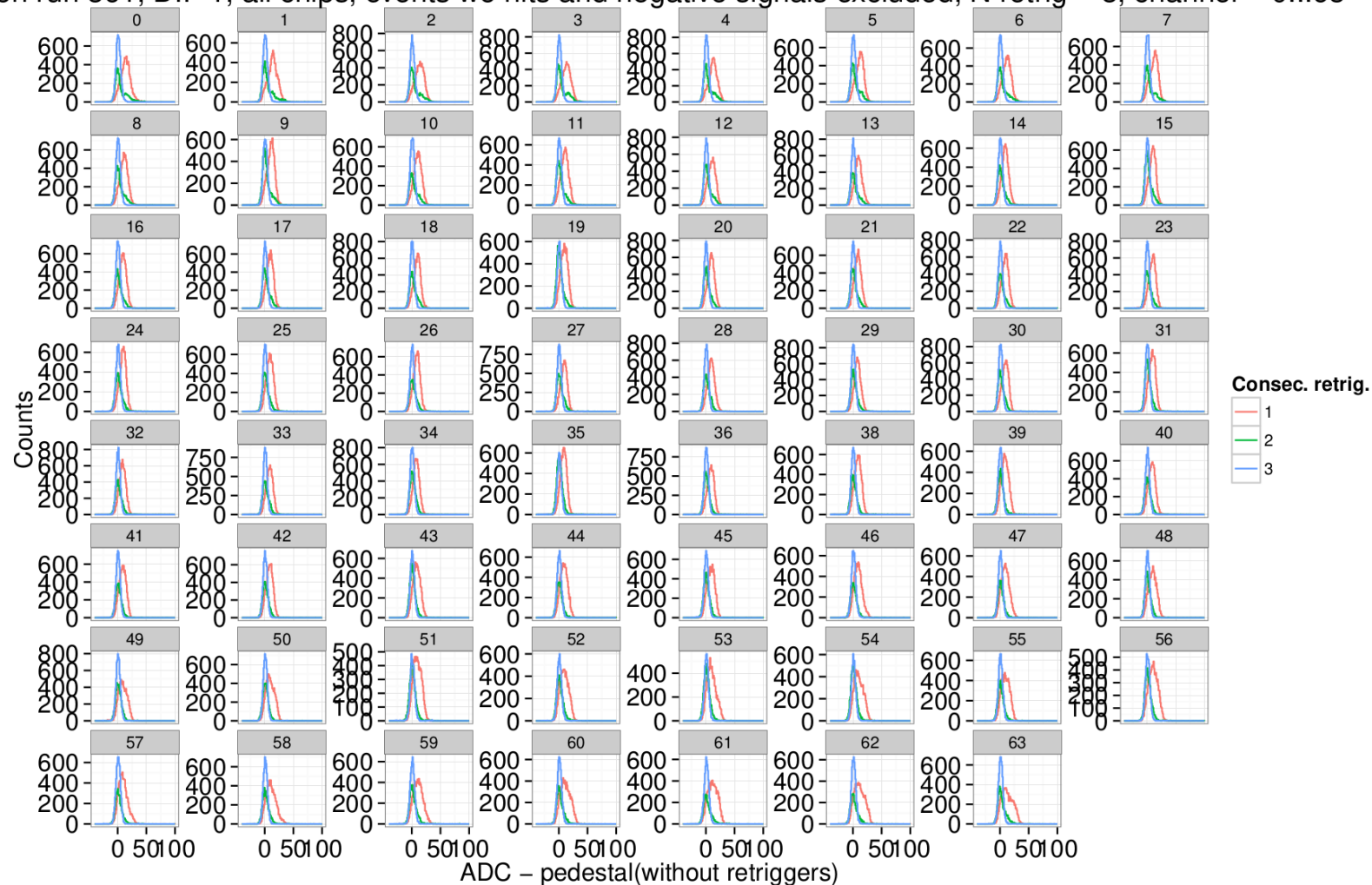
They are in between the right red pedestal (for BX) and the last BX.

Triggered signals are rather close to the (left) pedestal.

Pedestal depends on retriggers!

Here, I've summed up all chips but have shown the channels individually. For simplicity, I've taken only the case with 3 BX's: BX, BX+1, BX+2. As before, there are 3 curves separately for BX, BX+1, BX+2. It seems that the green for BX+1 (middle) has a contribution from the bad right pedestal (red, for BX) only for the first, *lower* channels. This is opposite to the effect of larger pedestal splitting for *upper* channels.

on run 361, DIF 1, all chips, events w/o hits and negative signals excluded, N retrigger = 3, channel = 0...63



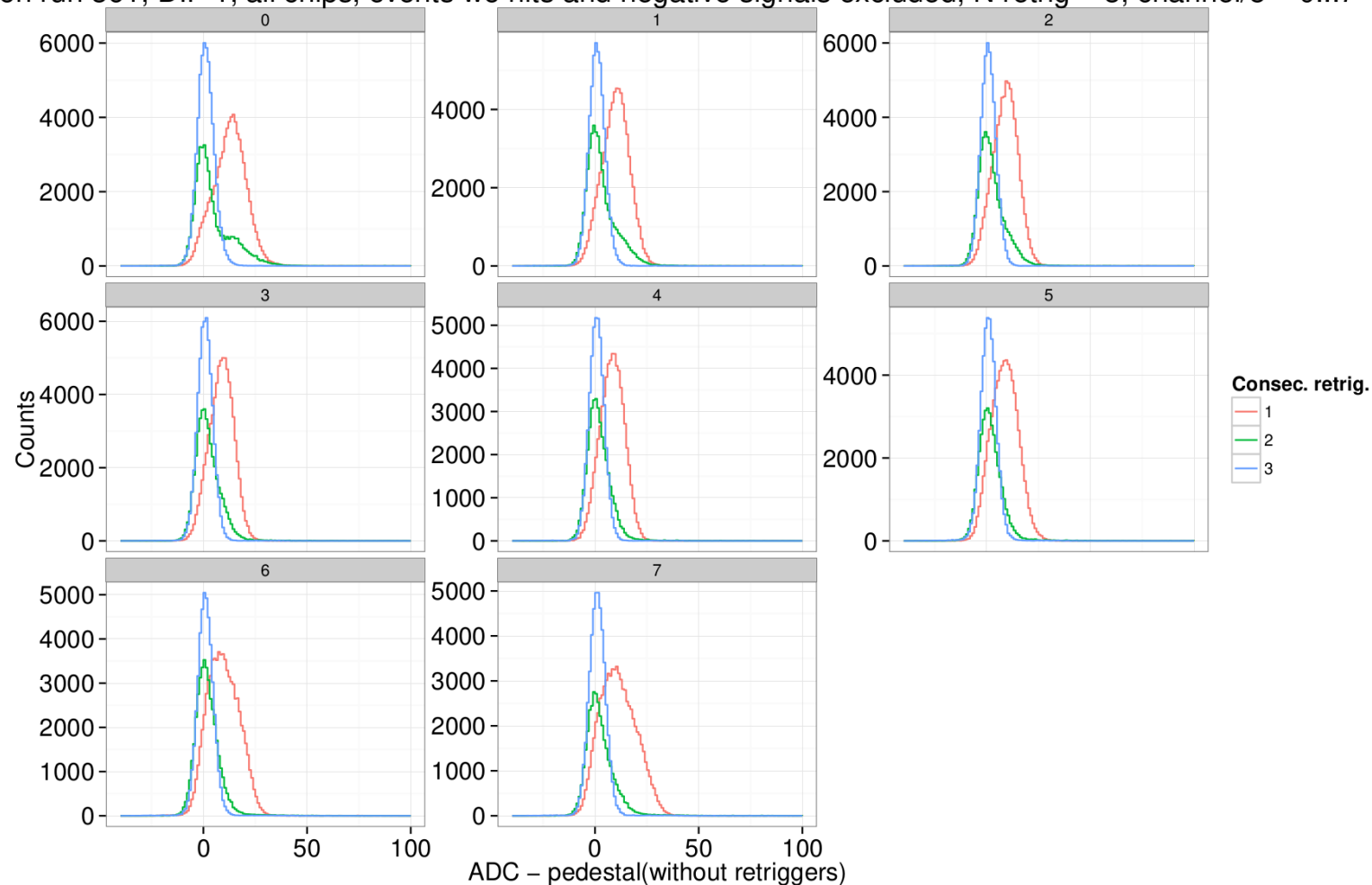
Same per 8 channels

To see the effect better, I've prepared the last picture, where the channels are grouped by 8. I.e. instead of 64 plots, there are only 8, and each contains 8 channels. Eg. the first top left plot is for channels 0...7. It seems, that the green propagates more to the right only for lower channels 0..7, 8..15 and may be for 16..23.

To summarize: the maximal pedestal shift to the right due to the following retrigger is only in BX. The retrigger is finished when the pedestals are in the correct left (not shifted) positions. In the intermediate BX+1,+2 (not the first and not the last BX), the pedestal has both contributions from the left (normal) and the right (abnormal) peaks. Triggers in retriggered data have very little signals, close to the left (normal) pedestal.

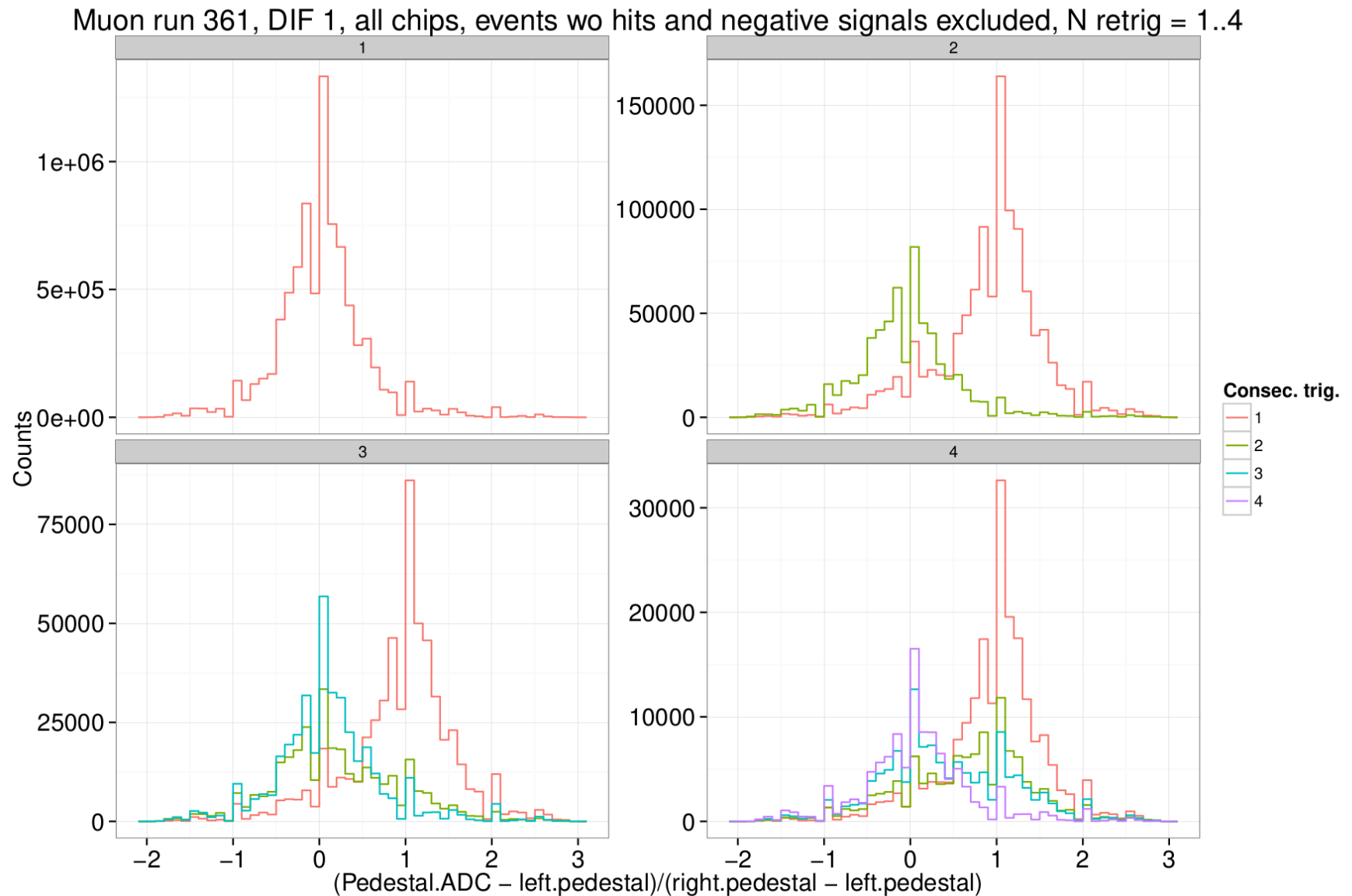
The question is, how such triggers can fire essentially without signals? I would suspect something in the trigger logic related to the pedestals.

on run 361, DIF 1, all chips, events wo hits and negative signals excluded, N retrigger = 3, channel/8 = 0...7



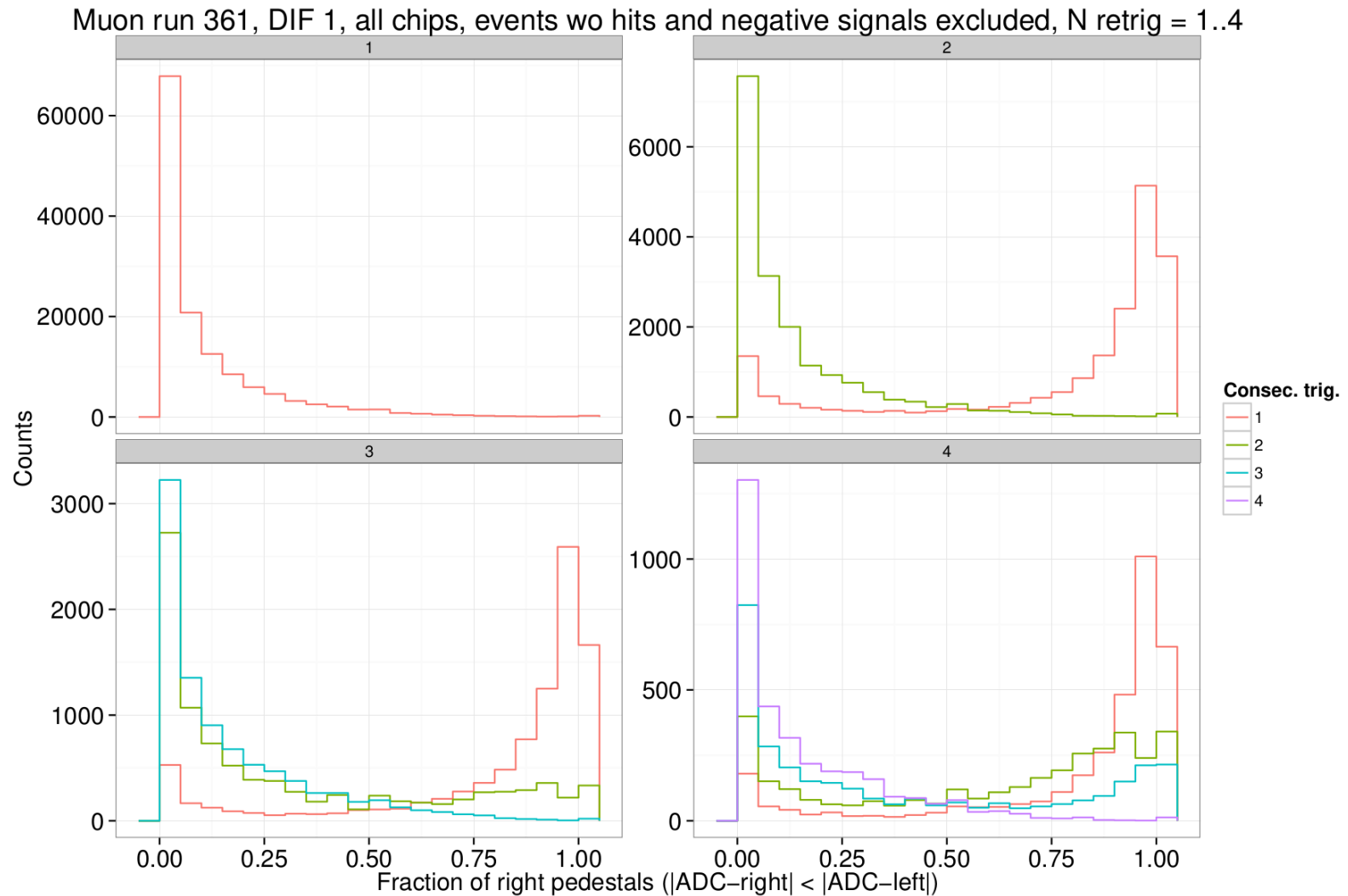
Most recent plots

One can discriminate between left – right pedestals using the variable $(\text{ADC-left}) / (\text{right-left})$, which peaks at 0 or at 1. All channels are combined. The same 2x2 matrix of plots as in slides 7-8 for 1..4 consecutive triggers.



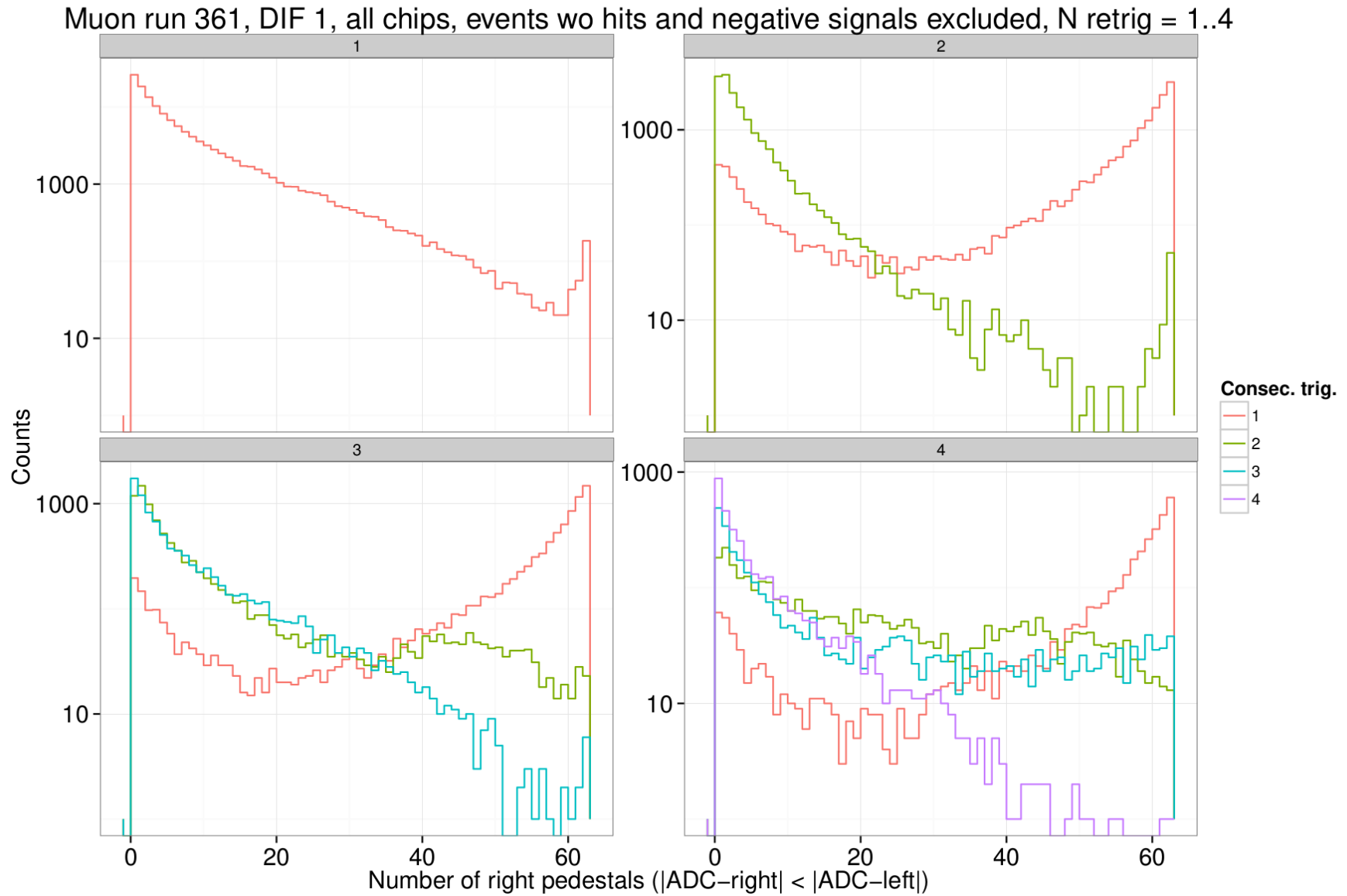
Most recent plots

Fraction of right pedestals (ie. the ones which are closer to the right than to the left)



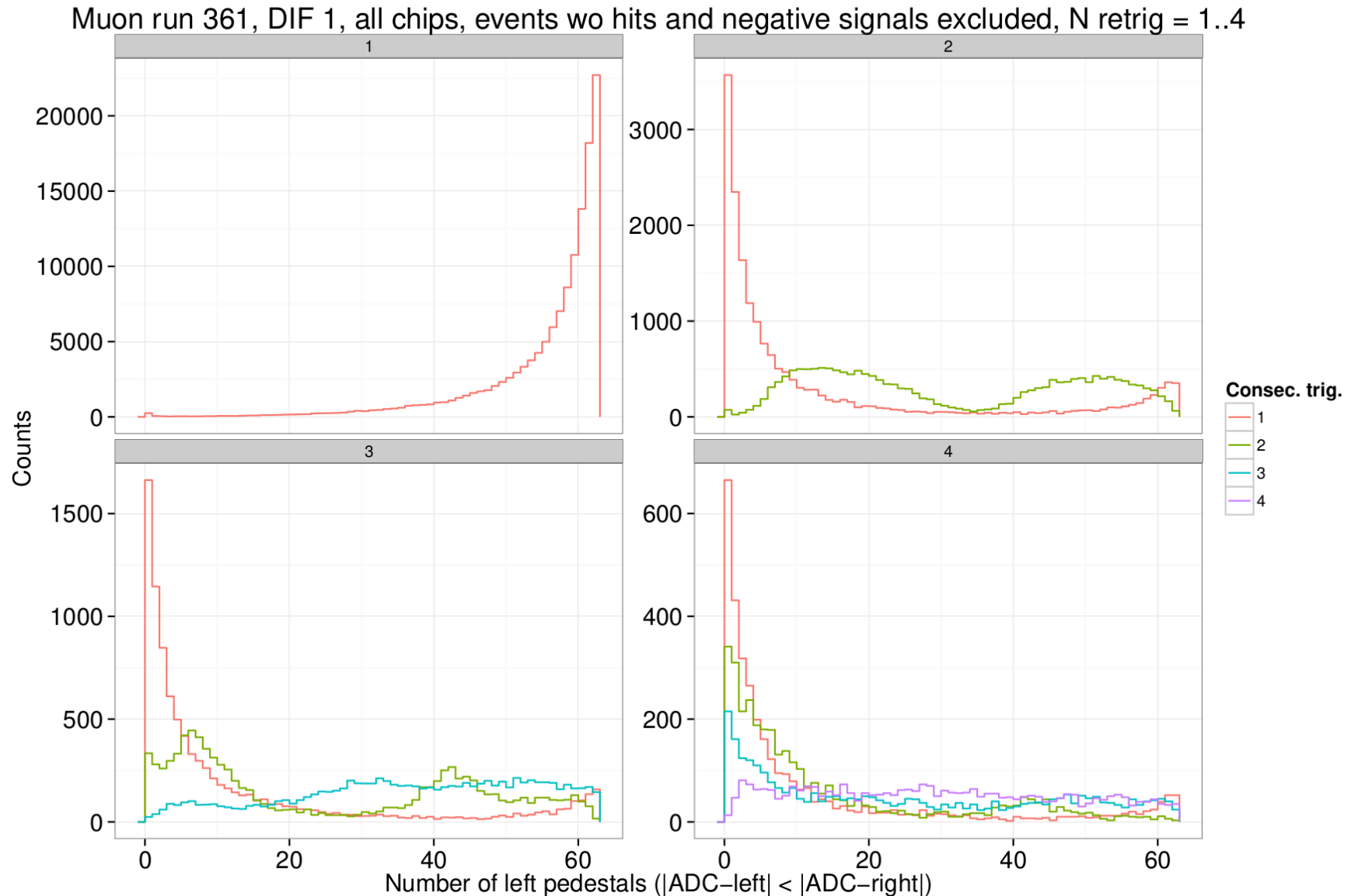
Most recent plots

Absolute number of right pedestals, in log scale (otherwise only peaks are visible)



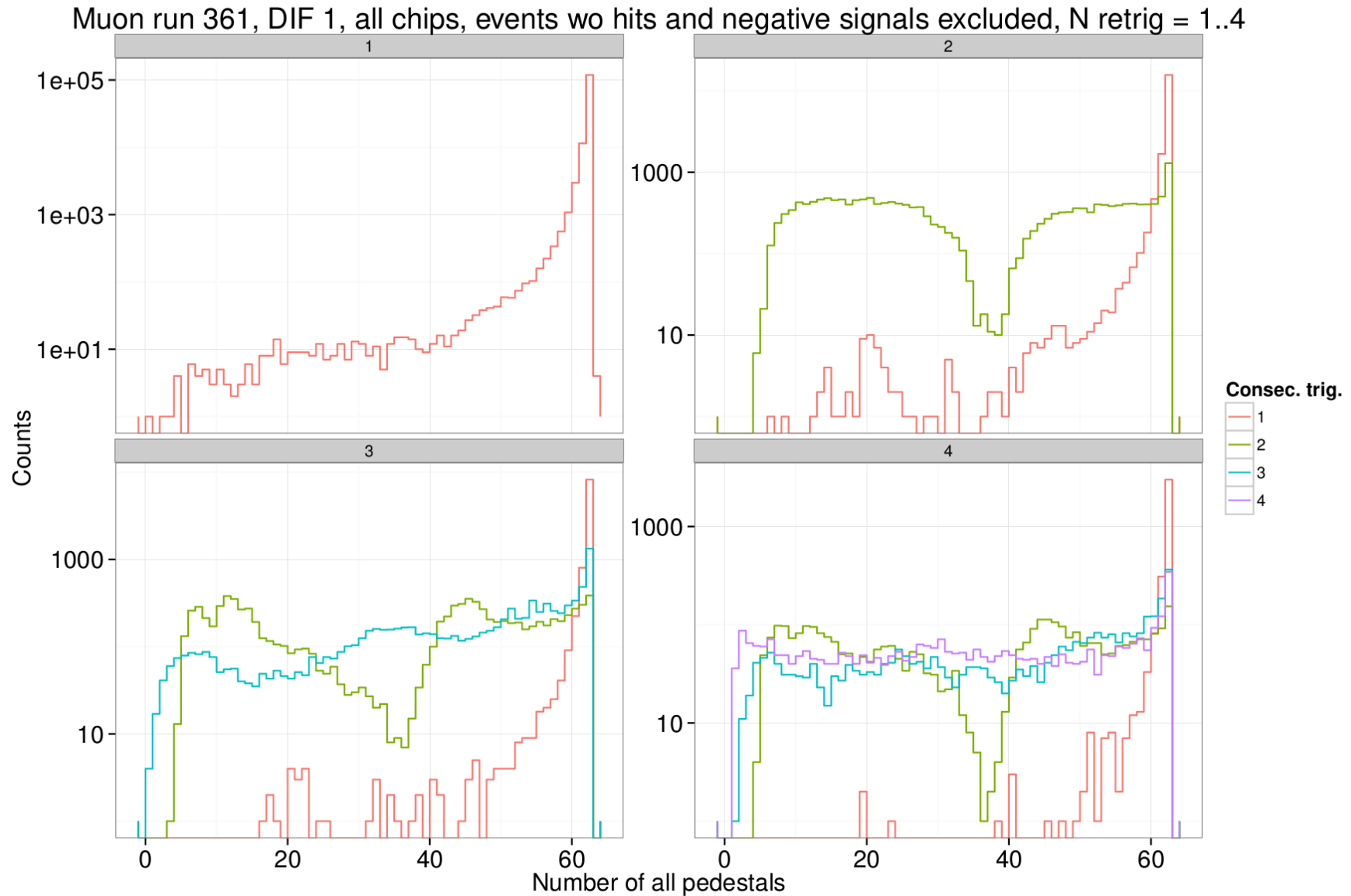
Most recent plots

Absolute number of left pedestals, linear scale



Most recent plots

Absolute number of all pedestals (== not triggered channels), log scale



Most recent plots

Absolute number of hits (== triggered channels), log scale

