MUID noisy events rejection
status update : January 22, 2013

A fraction of events show very large activities in MUID, and could be caused by either electronics noise (ringing) and/or large beam backgrounds. These events slow down the production/reconstruction, due to many false road candidates as input for MUTR etc. The events would need to be rejected for any physics analysis involving the muon arms. (The MUIDLL1 trigger has a rejection for these sort for events, but for users of other triggers, the noisy events have to be rejected.)

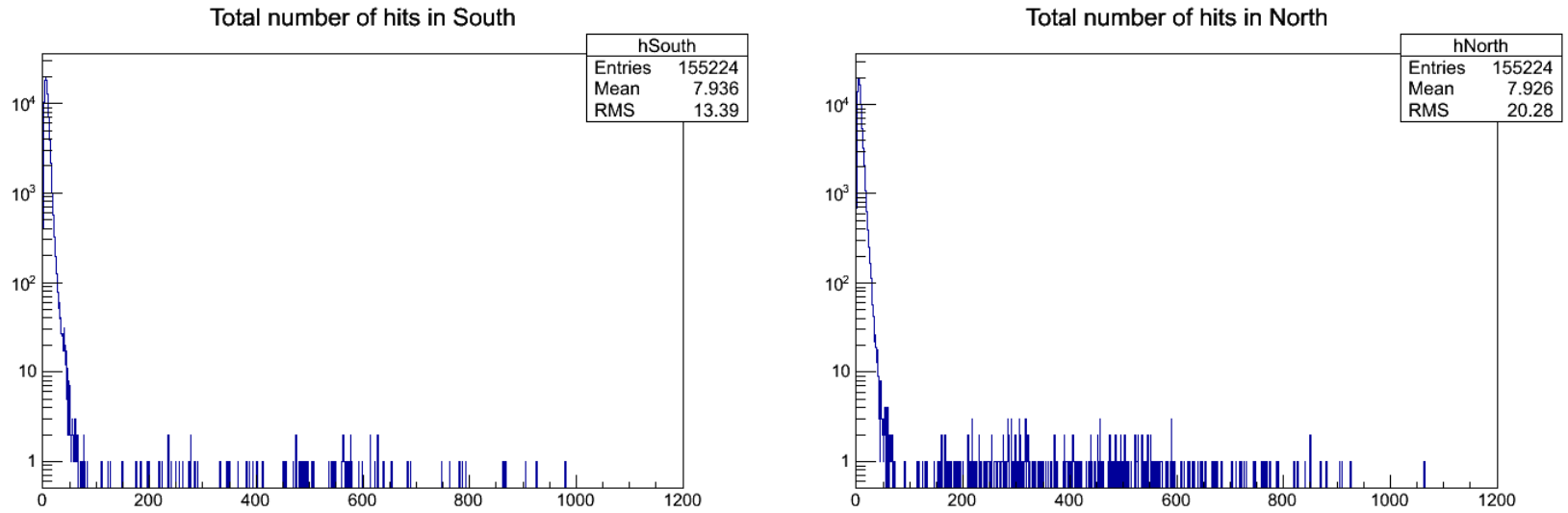
The runs that have been looked at so far are (all events in a file included, i.e. no extra trigger selection):

1. pp: runs 365723 and 368790. The plots below are from run 365723 - a segment that was on Achim's list of long/problematic production jobs.
2. U+U: Plots below are from run 372006.

For recent Au+Au: only checked in online mon. so far. Should have less hits than central U+U though...

Total number of hits per event - pp

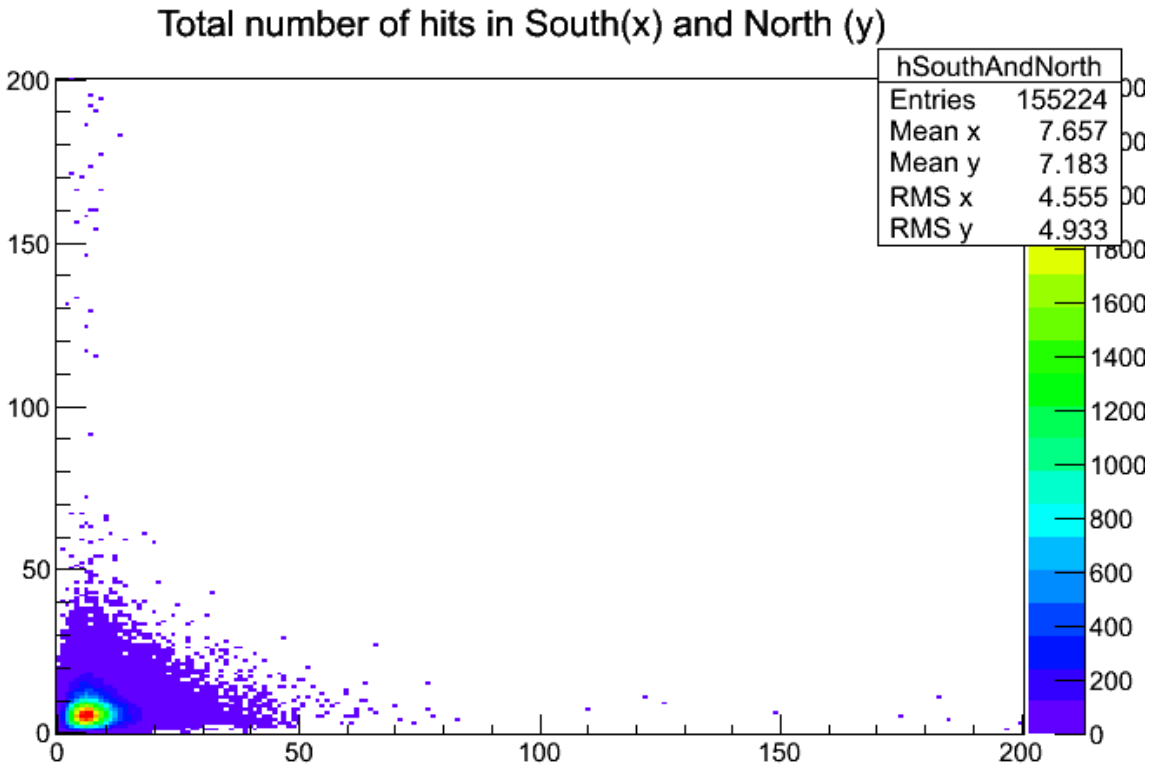
First we look at the total number of hits per event. Note the y-axis log scale. A few hundred of the total approx. 155k events in the studied file have an unphysically large number of hits.



[South left, North right]

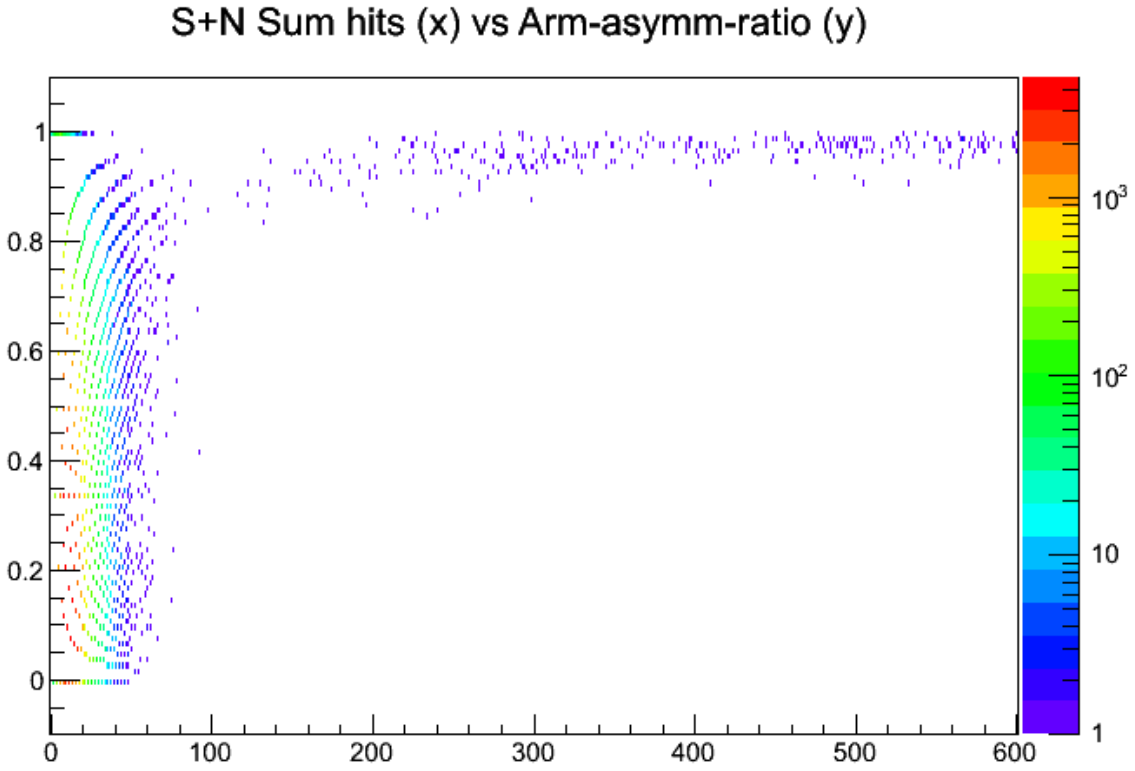
Total number of hits per event - pp : 2D

Another way of looking at the distribution of hits is with one arm vs the other. In the plot below, the number of hits in North (y-axis) vs South(x-axis) is shown. One can see that in the cases with very large number of hits in one arm, there are few hits in the other, which is consistent with what is expected for noise.



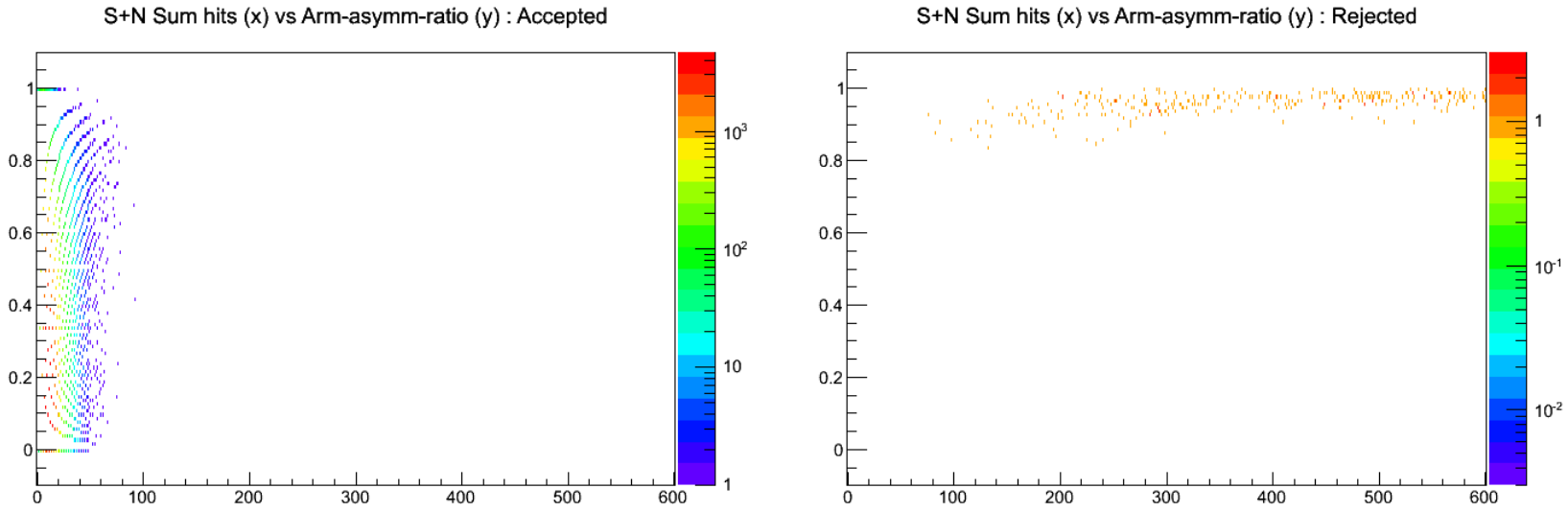
Total number of hits per event - pp : Asymmetry ratio 4

One way to quantify the difference between the two arms is to plot the difference between them, divided by the sum, i.e. $(max - min)/(max + min)$. In the plot below, this ratio (y-axis) vs the sum value is shown. The events with the largest number of hits show a large asymmetry.



Total number of hits per event - pp : Asymmetry cut 5

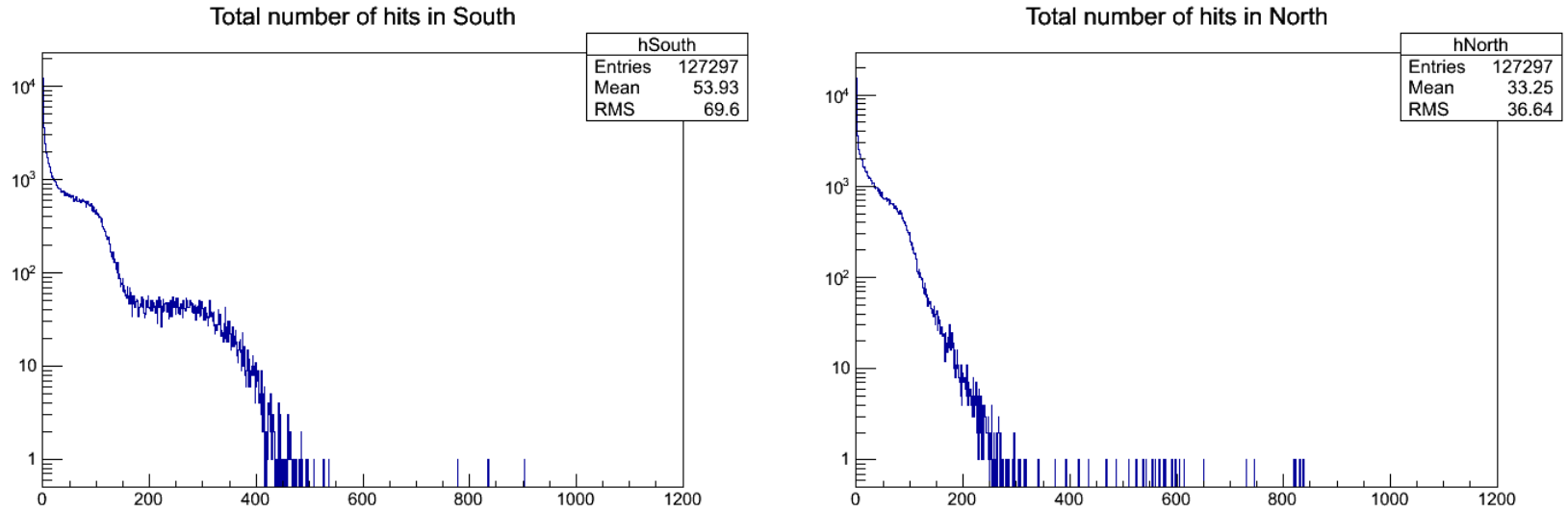
Vince made a good suggestion for a first principle cut for the asymmetry ratio, which changes with the sqrt of the total number of hits, i.e. $(max - min)/(max + min) > Z/\sqrt{max + min}$ would be rejected. For the plots below $Z = 8$ (meaning also that no events with 64 or less hits would be removed by this cut) is used, and seems to do a reasonable job.



[Accept left, Reject right]

Total number of hits per event - UU

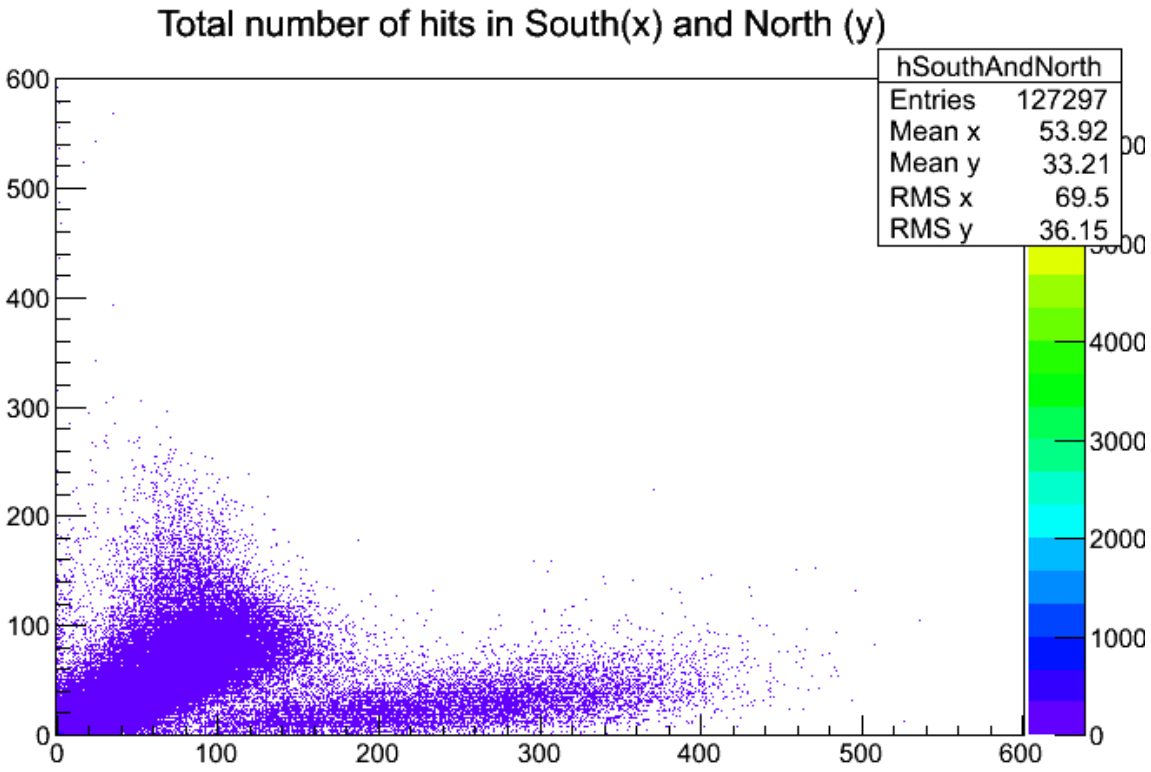
Next: let us look at data from $U + U$. As before, first we look at the total number of hits per event. Note the y-axis log scale. You can see that the amount of hits per event go out further than for pp. Note also the significant bump and extended tail for the South arm.



[South left, North right]

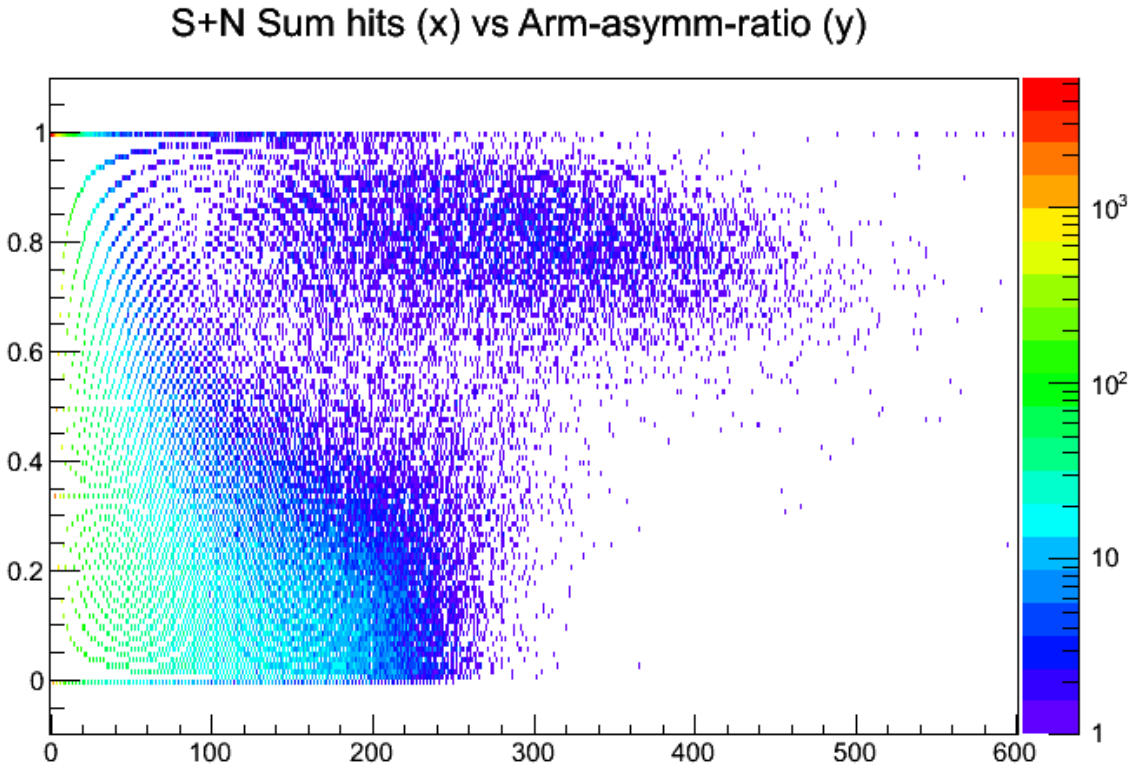
Total number of hits per event - UU : 2D

In the plot below, the number of hits in North (y-axis) vs South(x-axis) is shown. One can see that besides the normal wide-correlation of hits in the two arms, there is an extra band, with more hits in the South (x) than in the North (y) arm.



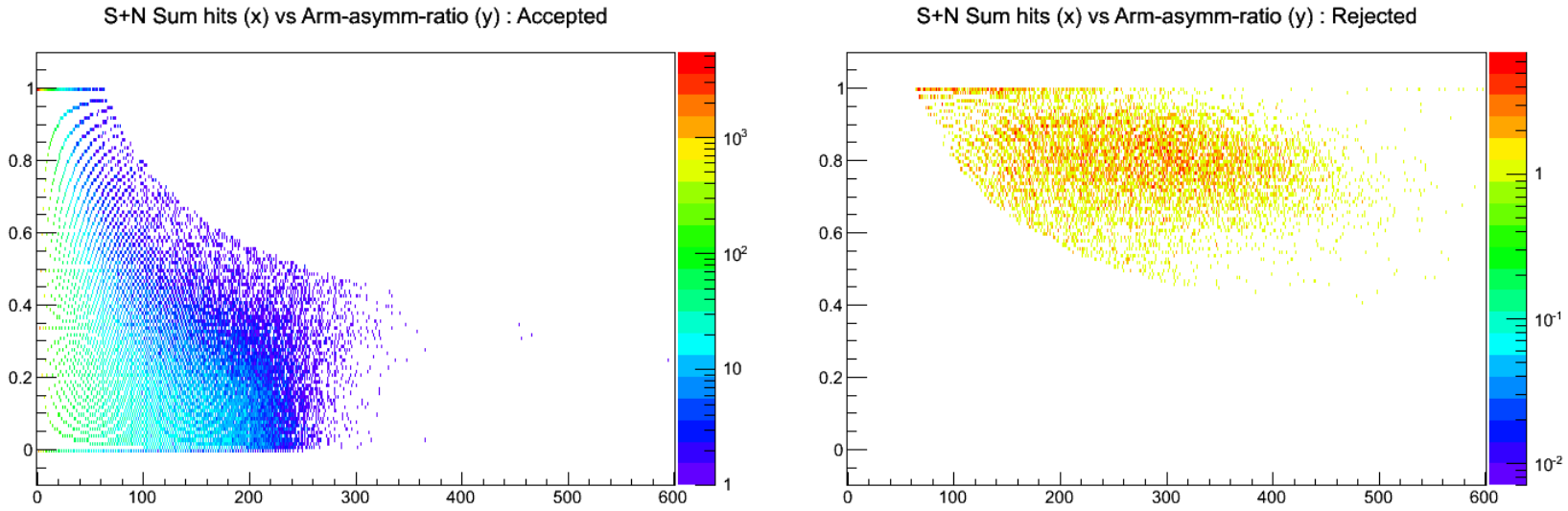
Total number of hits per event - UU : Asymmetry ratio 8

Again, another way of quantifying the difference between the two arms is to plot the difference between them, divided by the sum, i.e. $(max - min)/(max + min)$. In the plot below, this ratio (y-axis) vs vs the sum value is shown. One can again see that for the events with really a large number of hits, there is a large asymmetry.



Total number of hits per event - UU : Asymmetry cut 9

Here we use the same asymmetry cut as for pp i.e. $(max - min)/(max + min) > Z/\sqrt{max + min}$ would be rejected. For the plots below $Z = 8$ (as for pp) is used, and seems to do a reasonable job. Q: Would others prefer to have a looser cut?



[Accept left, Reject right]

Summary

1. We would like to cut away more of the noisy events than the (loose) rejection cut that was in the offline code (more info in back section) can be expected to do.
2. Not completely trivial to make a simple cut that works for all species (from pp to $U + U$).
3. We propose to remove events with very large asymmetries or differences between the muon arms, as unphysical and caused either by noise/ringing and/or beam backgrounds.
4. Vince's suggestion for the asymmetry cut:
   $max = max(nHitsSouth, nHitsNorth)$;
   $r = (max{-}min)/(max{+}min)$; $if((max{+}min) > Y \&\& r > Z/sqrt(max{+}min))skipEvent()$;
   An update to MuiooReco, with default value of Z=8.0 (Y=Z^2) was committed to cvs trunk on Fri Jan 18. Cut value can be changed from reconstruction macro level.
5. If people agree with this approach, it can also be put into production.
6. To-do items (QA) on next page...

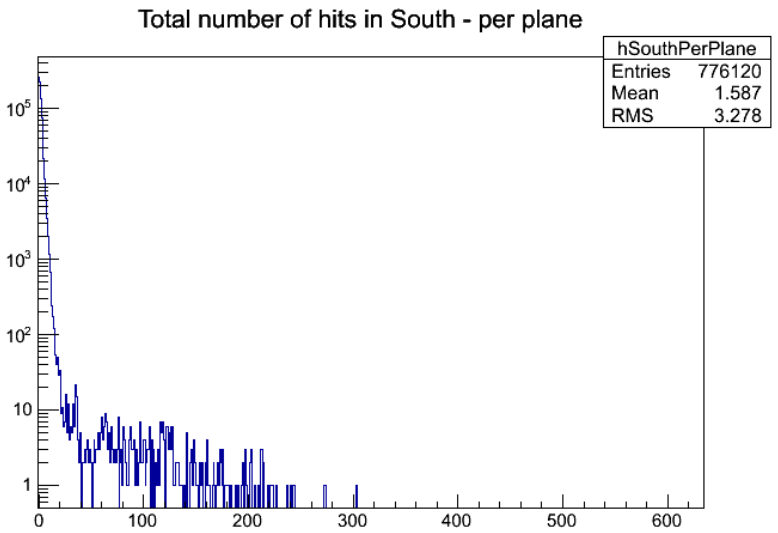
To-do items (QA)

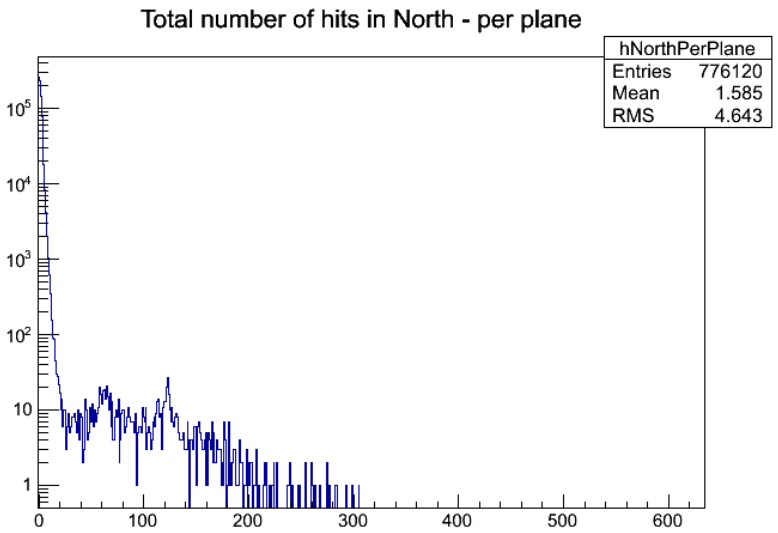
1. Stefan suggested adding asymmetry plots to MUID QA, to see 'before' and 'after'-cut plots.
   DS: Agree - but not sure if QA is only filled at the end for accepted events (so one would not be able to see the 'before cut' plots..)
2. Cesar suggested that a revamp of QAMui is needed, e.g. for lvl1 trigger selection usage.
   DS: Agree - the MUID QA code has not been touched for some years and probably needs a significant update. (Help would be welcomed)
3. Cesar suggested that MuId Eff ntuples (filled during production) are taking up too much space, and suggests to include the info in the MUID QA.
   DS: not so straightforward to do. Hopefully rejecting the noisy events will help reduce the size. One could potentially also tighten the cuts for the ntuple filling. Getting all the multi-dim info from the ntuple (Colorado eff. method; from Sean K. and Jamie N.) into histogram usage would not be unproblematic, I think.
4. Other suggestions/requests?

Total number of hits per event - pp : per plane 13

Same plots as on the previous slides, but now we look at the number of hits per plane, i.e. 5 times as many histogram fills as events (since we have 5 planes per arm).

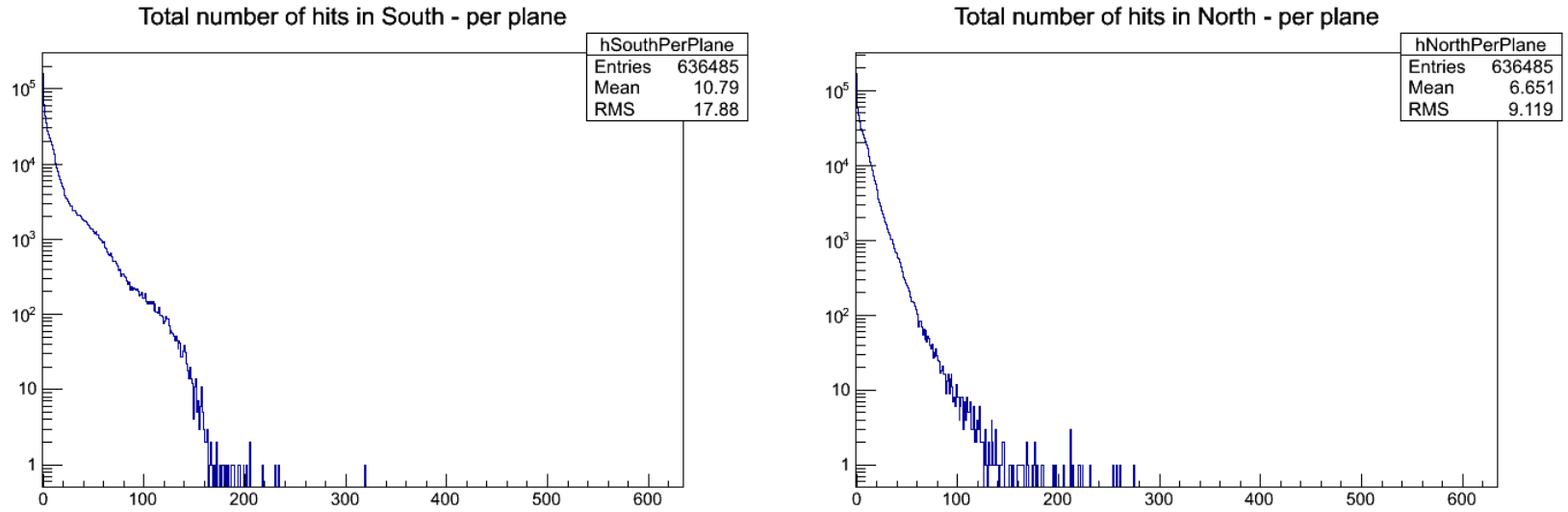
The previous offline cut (in MuiooReco) is to cut away any event where there were more than 300 *clusters* in any plane. Note that the plot below is for *hits* and not *clusters*. The definition of a MUID cluster (with the default ISOLATED clustering mode) is one or two adjacent hits. With a total number of 326 horizontal and 308 vertical possible hits per plane, the maximum number of hits in a plane is 634 and I believe the maximum number of clusters is thus (every other one fired) 317. So, we should expect a maximum cluster cut of 300 in a plane to not cut away many events at all. There is in addition however also a cut in the roadfinder: it will skip any arm with more than 300 hits (and prints a message when doing so).





Total number of hits per event - UU : per plane (gap) 14

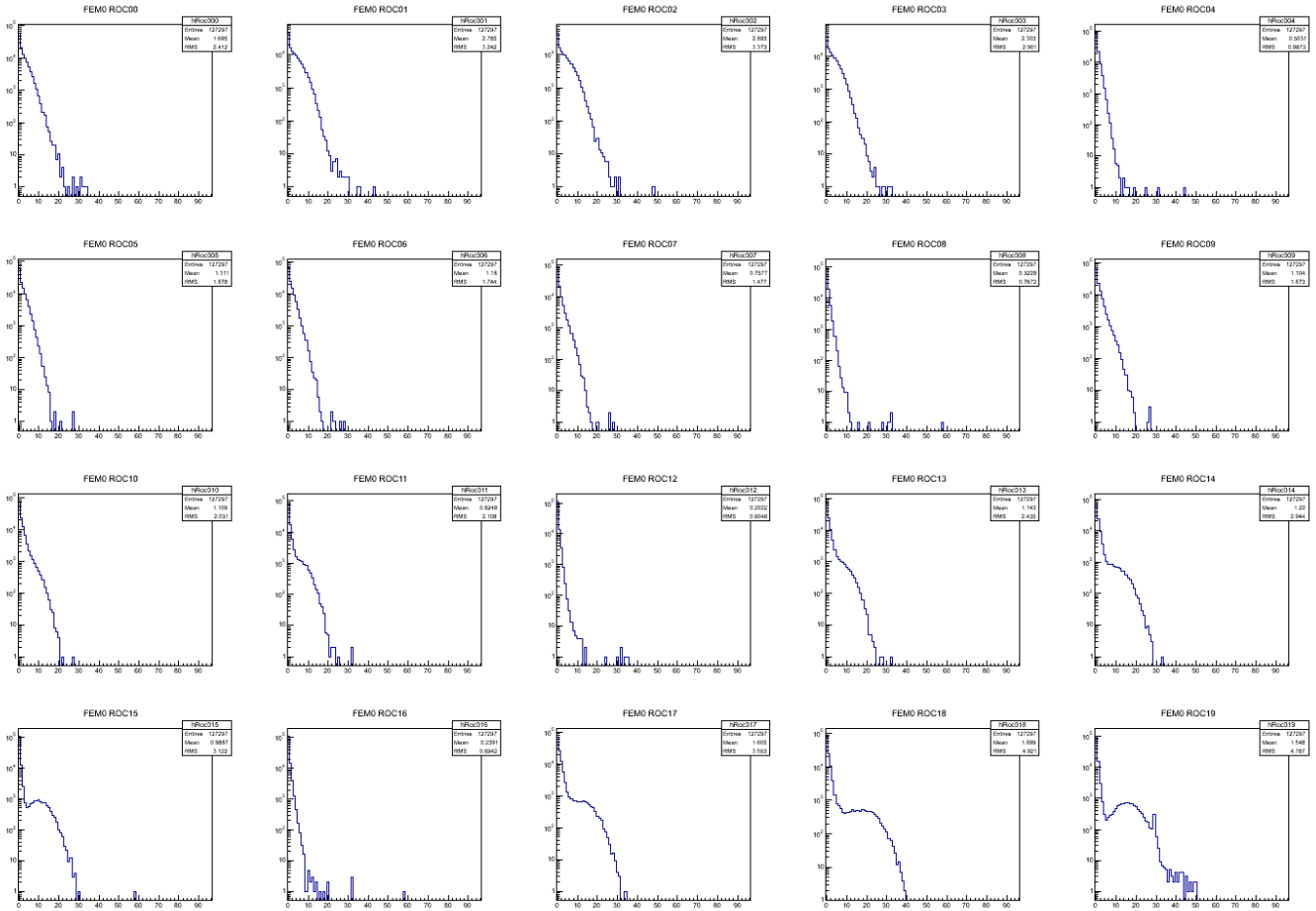
As for pp, let us also look at the number of hits per plane. i.e. 5 times as many histogram fills as events (since we have 5 planes (gaps) per arm).
Note that only approx. one event (for the South arm) in the studied PRDF file would potentially be removed by the offline > 300 clusters or hits/event cut.



[South left, North right]

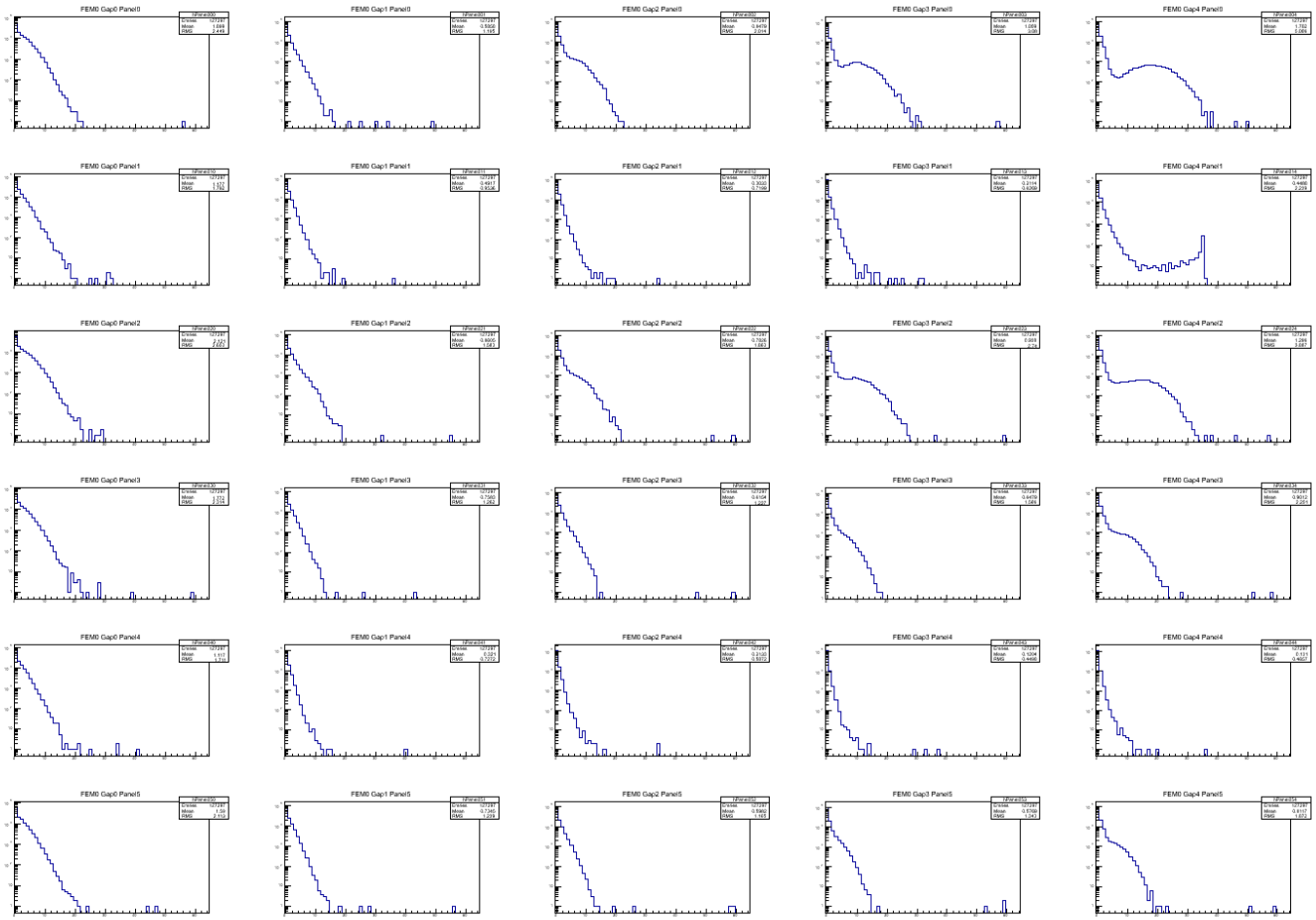
Nhits per event - UU : per ROC, South Horiz

To further investigate where the extra MUID hits may be coming from, we can also see if the number of hits correlate with some particular ReadOut Cards; there are 20 of those in each orientation. The plot below is for South Horizontal FEM (1/4th of full MUID). One can see bumps in the distribtions for the later ROCs (corresponding to later gaps).



Nhits per event - UU : per Panels, South Horiz

We can also see if the number of hits correlate with some particular detector panels; there are 20 of those in each orientation. The plot below is for South Horizontal FEM (1/4th of full MUID), with the 5 columns from left to right corresponding to the MUID gaps, and the 6 rows of plots corresponding to the panels (0 at the top). One can see a background bump in the last gaps, perhaps in particular for panels 0-2 (upper panels).



Nhits per event - UU : per Panels, North Horiz

Same plot as on previous slide, but now for North Horizontal FEM (1/4th of full MUID). The pattern seen for the South (background bump in the last gaps) is not really observed in the North arm.