Onboard Filter Update

Performance after updated cuts

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Summary of Main Points from Last Meeting

- The Filter performance had improved substantially
  - This was done through minor changes to the logic
- The Filter vetoed a fraction of events that remained after the Rome goodEvent cuts
  - I had not yet applied the updated pruning or background cuts
- The albedo gammas were a concern, but I was considering one solution

Progress Since Last Meeting

- After implementing ALL the cuts: goodCal, goodPSF, zdir_cut, bk_veto==0.0, and pruning,
  - the fraction of events vetoed by the filter drops from 3-8% to <4.3% at worst
  - the effective area drops
- I can explain where these vetoes come from, and I'm looking for solutions
- The albedo gammas are still the greatest challenge
  - The most obvious solution hurts events with low/no Cal deposit
  - The need to remove albedo gammas complicates potential fixes to the 4% gamma veto problem

The Cuts

- goodCal = "CalTotRLn>2&&CalEnergySum>5.0&&IMgoodCalProb>0.2"
- goodPSF = "IMcoreProb>0.2&&IMpsfErrPred<3.0"
- zdir_cut = "Tkr1ZDir<-0.2"
- Background = “Bk_Veto==0.0”
- Pruning = "((AcdActiveDist<-20 && AcdRibbonActDist<-20) || Tkr1SSDVeto>2)“**

goodEvent = goodCal&&goodPSF&&zdir_cut

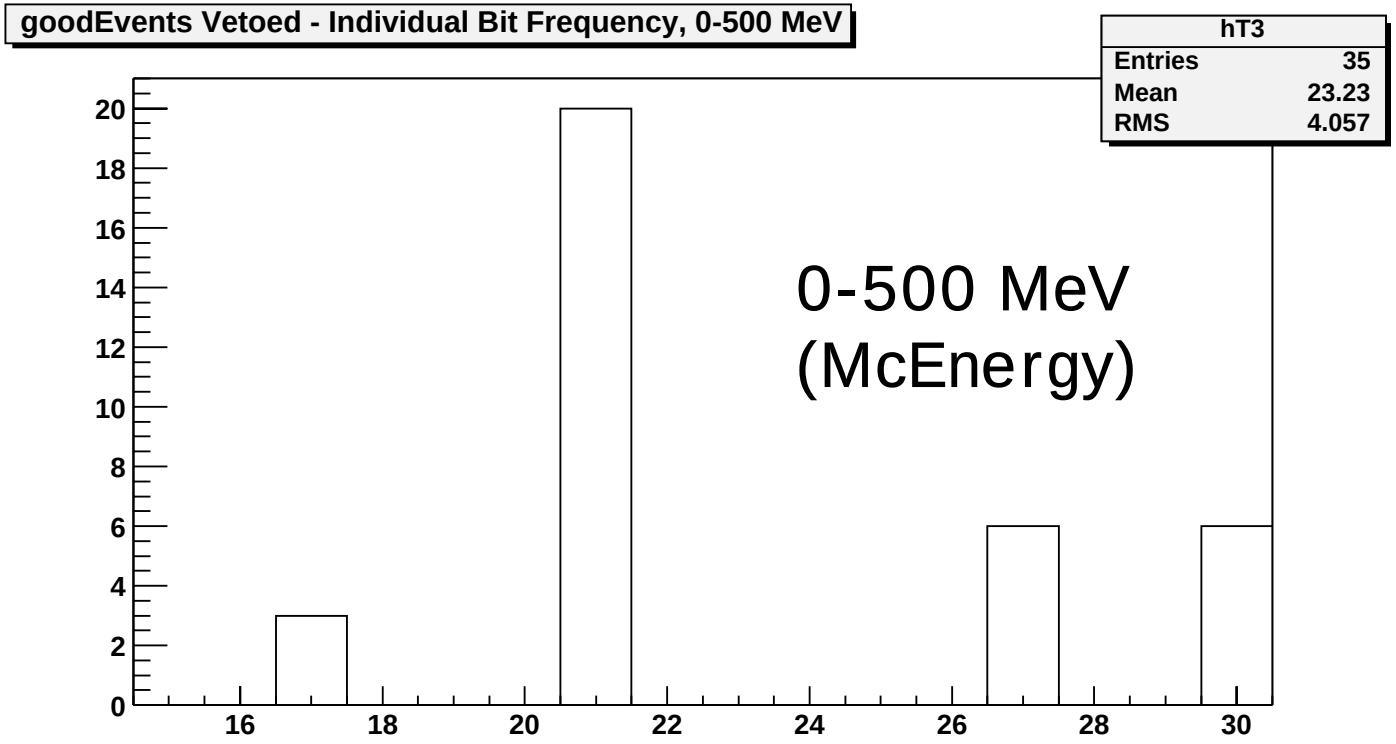
All Cuts = goodEvent&&Background&&Pruning

**From Bill’s DC1 talk. The online summary page of pruned files has Tkr1SSDVeto>1

Updated Cuts: The Effective Area and Fraction Vetoed

Cuts	Energy	0- 100 MeV	100-500 MeV	500-1000 MeV	1-10 GeV	10-180 GeV
goodEvent	Pk Aeff no Filt	4169	10009	10850	10918	10134
	FOV	2.32	2.6672	2.75	2.66	2.50
Last Time	Pk Aeff w/ Filt	**4019**	**9394**	**10219**	**10384**	**9731**
	FOV w/ Filt	2.32	2.636	2.68	2.599	2.49
	Filt damage %	**3.33**	**7.96**	**8.27**	**7.22**	**4.24**
goodEvent	Pk Aeff no Filt	1943	8055	10311	10685	10090
&& Background	FOV	2.2	2.47	2.69	2.63	2.50
	Pk Aeff w/ Filt	1943	7851	9791	10222	9680
	FOV w/ Filt	2.2	2.47	2.62	2.58	2.50
	Filt damage %	0.0	2.77	7.4	6.29	4.04
goodEvent	Pk Aeff no Filt	1943	7957	10030	10287	9412
&& Background	FOV	2.2	2.48	2.65	2.61	2.47
&& Pruning	Pk Aeff w/ Filt	**1943**	**7782**	**9770**	**10024**	**9181**
Updated	FOV w/ Filt	2.2	2.47	2.60	2.566	2.46
	Filt damage %	**0.0**	**2.5**	**4.1**	**4.3**	**3.2**

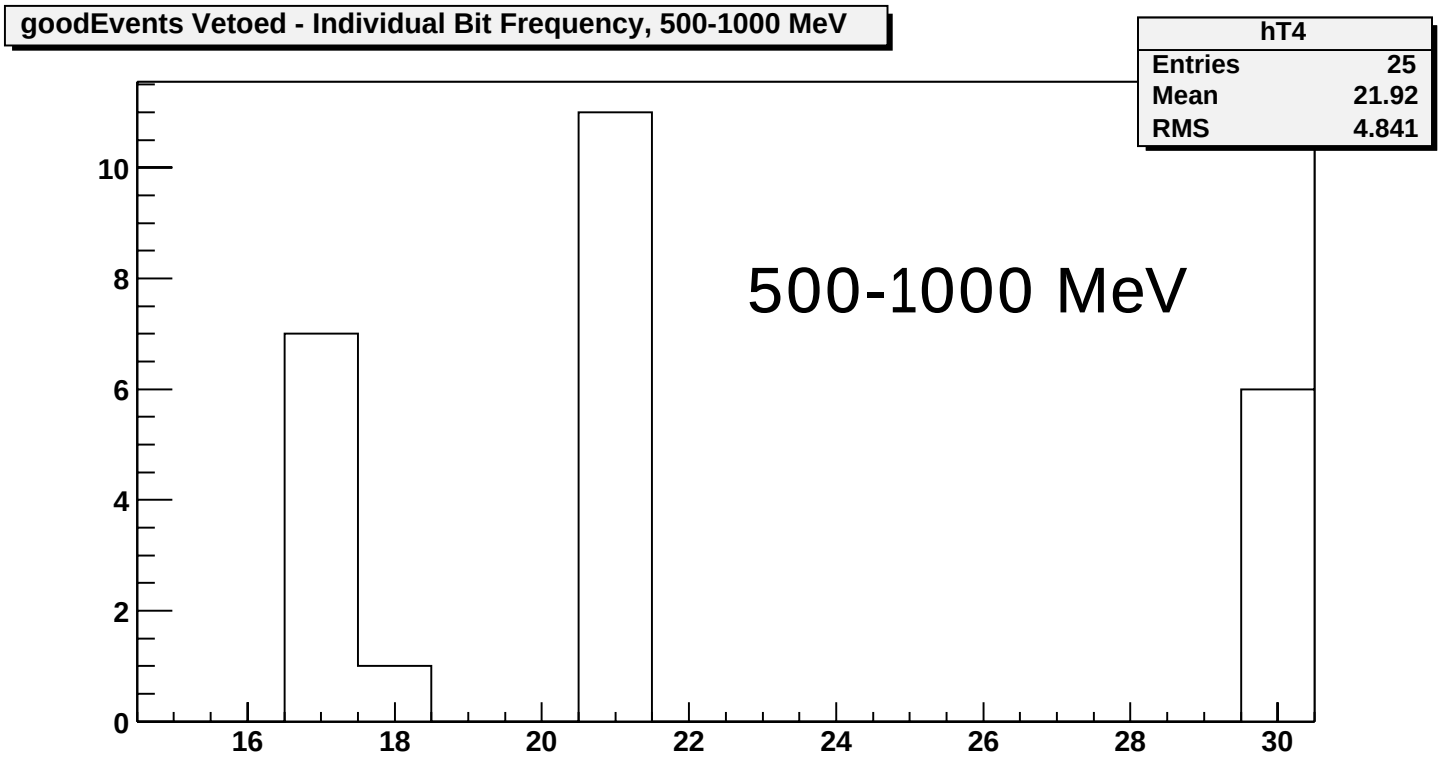
Reasons for Event Vetoes (by Energy Bin)



Veto 21: “zbottom,” no evidence of a track in the layers immediately above the Cal

Vetoes 27 & 30: an ACD filter tile is hit, but little/no energy in the Cal. Filter tile means top two rows.

Veto 17: no track found

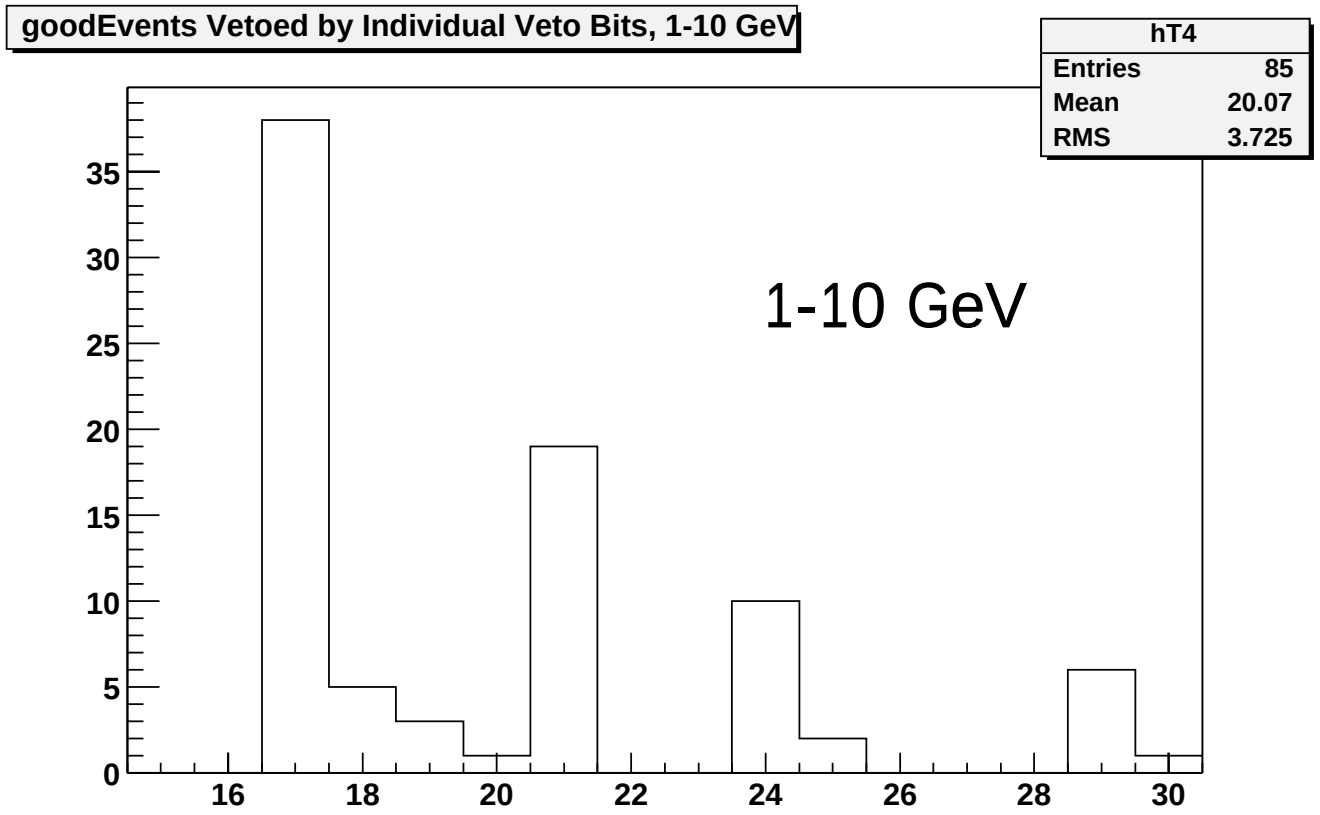


Veto 21: zbottom again

Veto 17: no track found

Veto 30: ACD filter tile hit, but no energy in Cal

Veto 18: track intersects a hit side ACD tile



Veto 17: no track found

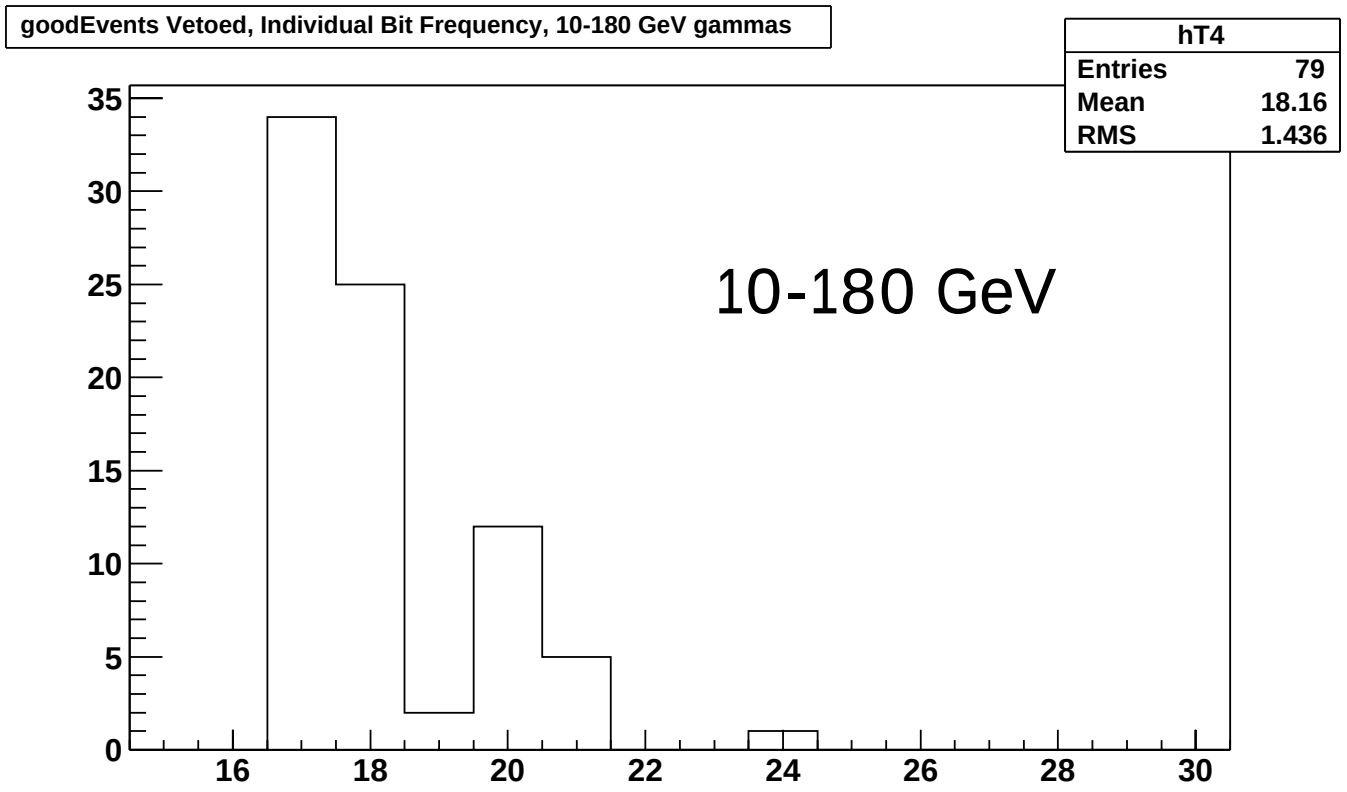
Veto 21: zbottom

Vetoes 24 & 25: triggered tower is shadowed by a hit ACD tile on the side or top

Veto 29: Splash veto

Veto 18, 19, 20: track intersects hit ACD tile on side or top

Veto 30: ACD filter tile hit, but no energy in Cal



Veto 17: no track found

Vetoes 18, 19, 20: track intersects a hit ACD tile on the side or top

Veto 21: zbottom

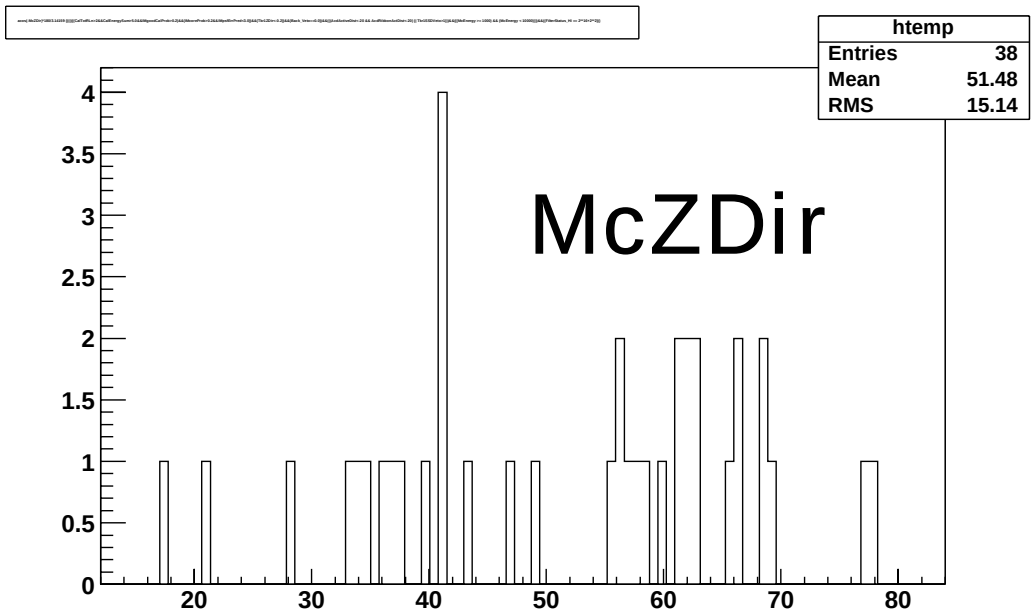
Veto 24: triggered tower is shadowed by a hit ACD tile on the side

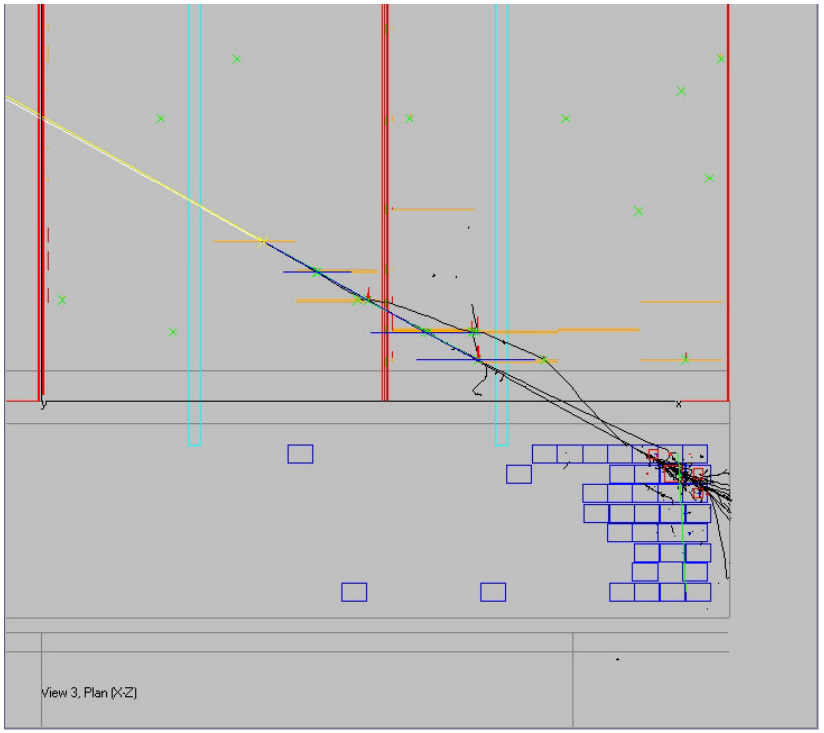
Summary of the Veto Problem

- Can be divided into two groups: <1 GeV and >1 GeV
  - <1 GeV: zbottom is the big problem, along with the "no tracks" veto, and a tile hit with no associated energy
  - >1 GeV: no tracks, then splash related vetoes (a random tile hit is associated with a tower or a track), and zbottom again

The “no tracks” Veto

- These are caused by tracks that come in at an angle between 30-70 degrees from zenith, and cross tower boundaries
  - The Filter can only find tracks in individual towers, and boundary crossings often don’t provide enough layers to look at in any given tower





“no tracks” solution

- Two solutions (?)
  - Rewrite the Filter so that it can look across towers
    - This is not a good option!
  - Remove or restrict the “no tracks” veto
    - Minimal impact on the backgndavgpdr source, but must examine impact on the albedo_gamma_upwards source.
      - “no tracks” may be one of the more effective vetoes for these albedo gammas

The Other Vetoes

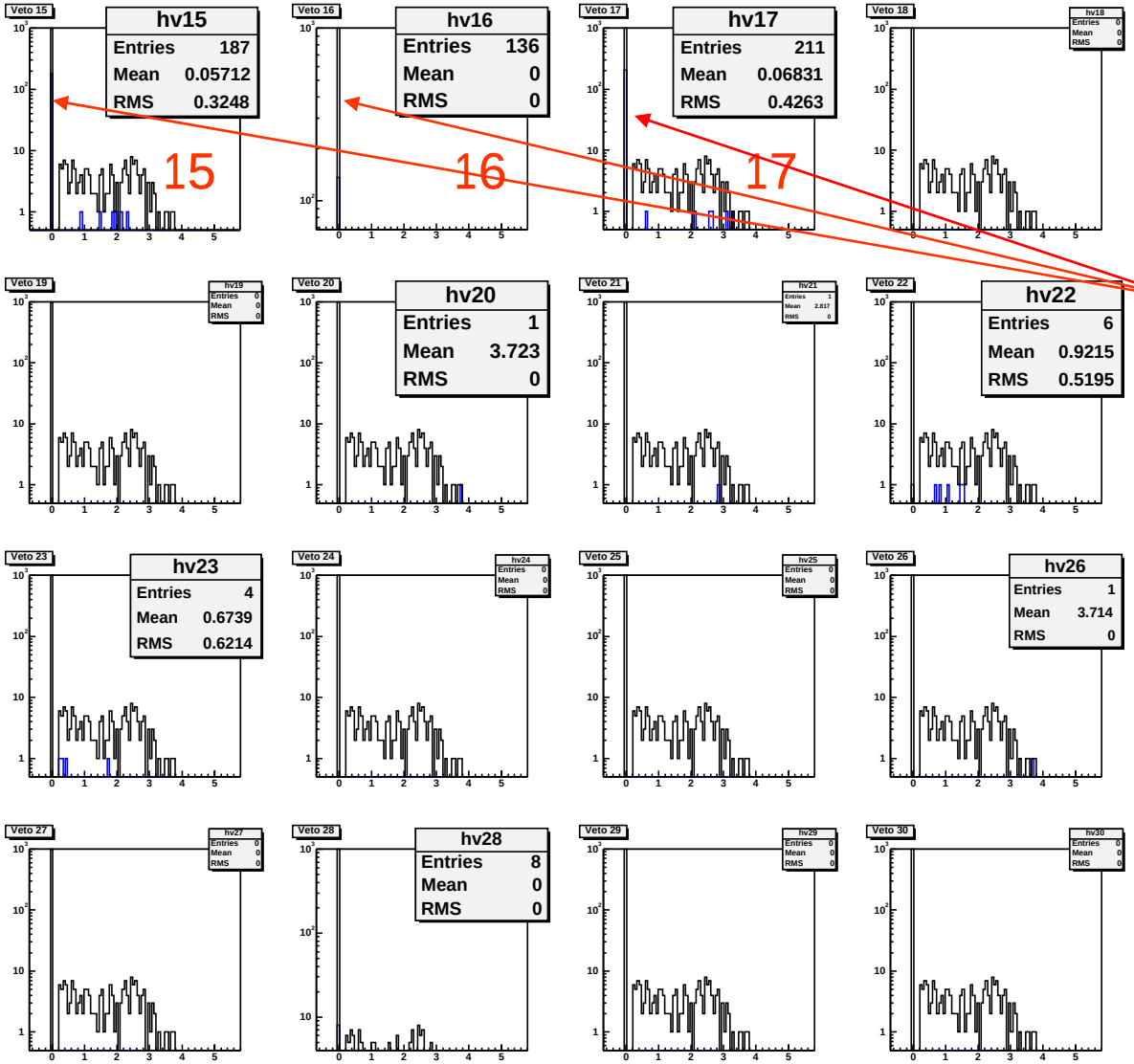
- Examining these one by one
  - They are more difficult to deal with than "no tracks"
- Looking at the impact on backgndavgpdr and albedo_gamma_upwards sources

The albedo_gamma_upwards source

- Last time, 135 Hz got through the filter
- If I reintroduce Veto 15* below 5 MeV, only 35 Hz gets through
  - The problem: this also eliminates the low energy gammas that don't deposit in the Cal
    - With the current "goodCal" selection, this has zero impact! But this could change, and onboard science may be impacted

*("no evidence of 2 tracks for events with E<350 MeV")

Main Vetoes that Kill albedo_gamma_upward with the original Filter configuration (straight from JJ)



Log10(CalEnergySum)

90% of these albedo gammas are vetoed (blue line)

Hard to see blue line, but most vetoes are at E=0

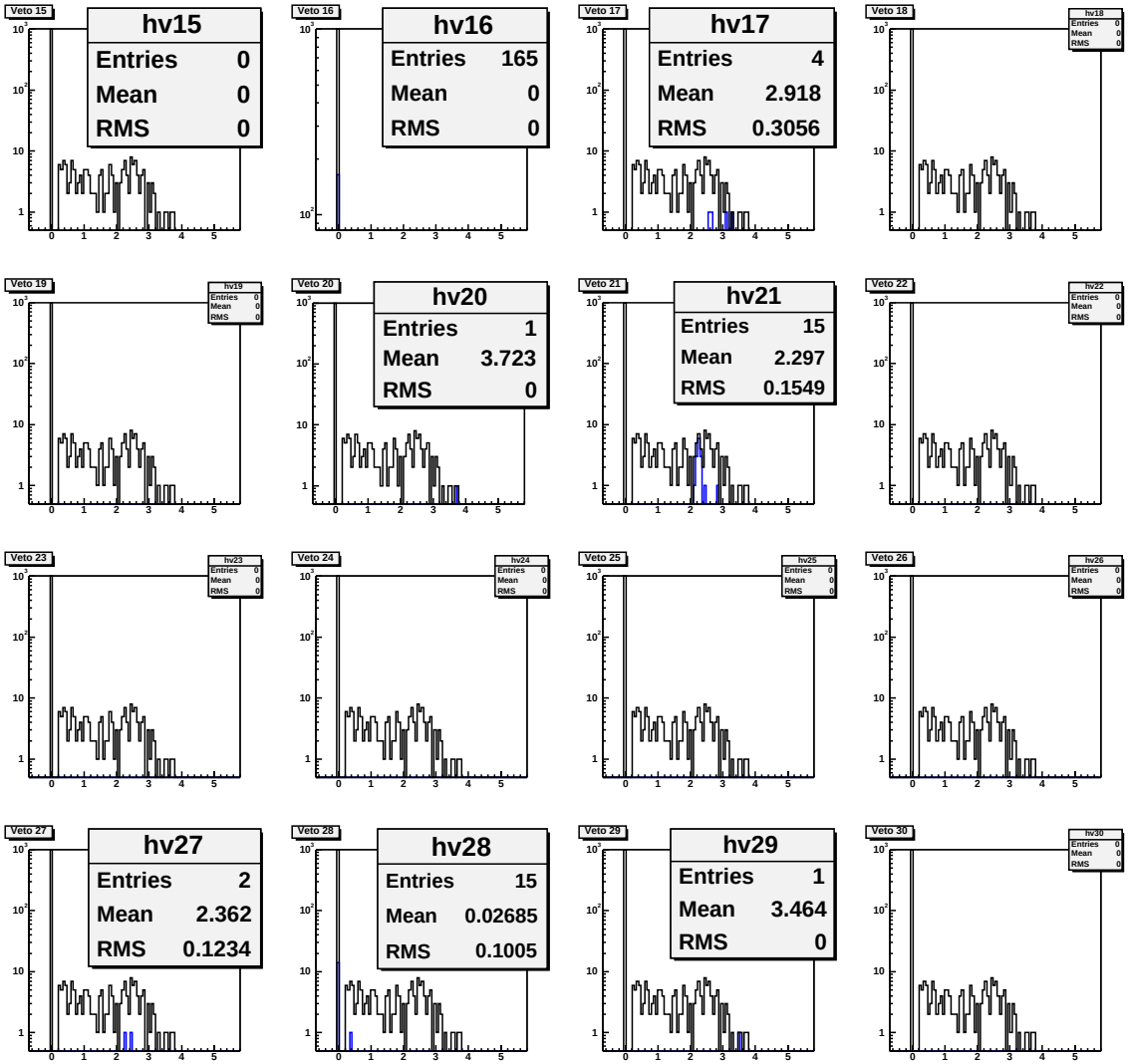
Most Effective Vetoes

Veto 15 (no 2-track evidence): 17.6% of vetoes

Veto 16 (track into skirt region): 12.8% of vetoes

Veto 17 (no track found): 19.8% of vetoes

Vetoes that Kill albedo_gamma_upwards Using Filter Config I Introduced at the Last Meeting



Log10(CalEnergySum)

Only 50% vetoed! Why?

To save low energy gammas, I had removed Veto 15, and restricted Veto 17 to E>250 MeV.

One solution to albedo problem: allow veto 15 and/or 17 to enact when E==0, or E<5 MeV or so.

Also consider removing Veto 21, which is bad for goodEvent gammas.

Next: what happens when we start altering vetoes

Recovering Gammas

- It is clear from earlier slides that the no tracks veto (Veto 17), and the zbottom veto (Veto 21), are among the most damaging to goodEvent gammas

Can we remove or restrict these?

- Restricting Veto 17 to E<5, and removing Veto 21 sends the backgndavgpdr rate to 570 Hz – no good!
- Just restricting 17, but leaving 21 as it is sends the backgndavgpdr rate to 360 Hz – much better.
  - This reduces the "Filter damage" by 44% above 1 GeV, and also helps a bit at low energy. Filter damage is reduced to <3% across all energy bins.

However, this does not help with albedo gammas.

The rate is still about 130 Hz.

Killing Albedo While Keeping goodEvents

- Recall that vetoes 15, 16, and 17 were most effective at killing albedo gammas in JJ's original filter.
  - 15 was removed, and 17 was restricted to E>250 MeV to recover low energy, non-albedo gammas
  - We are testing the restriction of 17 to E<5

What about restricting 15 to E<5 MeV?

Answer: backgndavgpdr rate→ 304 Hz
albedo_upwards rate→ 35 Hz

Total ~340 Hz

Disadvantages: impact on onboard science? And throwing out gammas before they reach the ground.

Is There Another Way?

- Vetoes 15, 16, and 17 are the only vetoes that are very effective at removing albedo gammas
  - Putting E<5 MeV restrictions on 15 and 17 is an effective way to eliminate albedo, while not harming “goodEvents”
- However, it is worth further study to see if the same goal can be accomplished without resorting to an energy cut
  - Perhaps a study of non-vetoed albedo in the event display will reveal something

Summary

- Applying all pruning, background, and goodEvent cuts, reduces the Filter damage to ~4% at max.
- The remaining vetoes are caused by a small number of Filter cuts
  - different reasons above and below 1 GeV
- Small changes to the Filter reduce the filter damage to less than 3%, and the total background flux goes down to ~340 Hz
- Although the method of killing albedo is simple and effective, there are disadvantages
  - It eliminates gammas before they are sent to the ground
  - It may impact onboard science that depends on gammas with no energy deposit

In case this method is not acceptable, we are searching for alternatives