Veto Note 2
Nontriggerable Firing of Channels (Percentages)

1. Motivation

The motivation for this study came about from my previous study of the different types of events within the veto shield. The three types of events are as follows: Triggerable events, Nontriggerable events, and Single Trigger events. Single Trigger events are considered Nontriggerable events, but as the percentage of Nontriggerable events are predominantly Single Trigger events, the Single Trigger events are considered important enough to warrant it's own class and possible future study in relation to muon trigger efficiencies. The previous study yielded that of the total percentage of triggers, the Nontriggerable events constituted $\sim (25 \pm 10)\%$. As these percentages of events are abnormally high compared to initial expected results, a closer look into these Nontriggerable events was warranted.

2. Possible Explanations

The exact cause of this high percentage of events is unknown at the current time, but possible explanations offer promising insight into the data given below in figures 2 through 5. Before these possible explanations can be laid out in full, a basic discussion of how the data is read from the varying tubes must be had.

As discussed in the previous note, the architecture of the veto shield and the electronics that interpret the signals from the veto shield are as follows in figure 1.

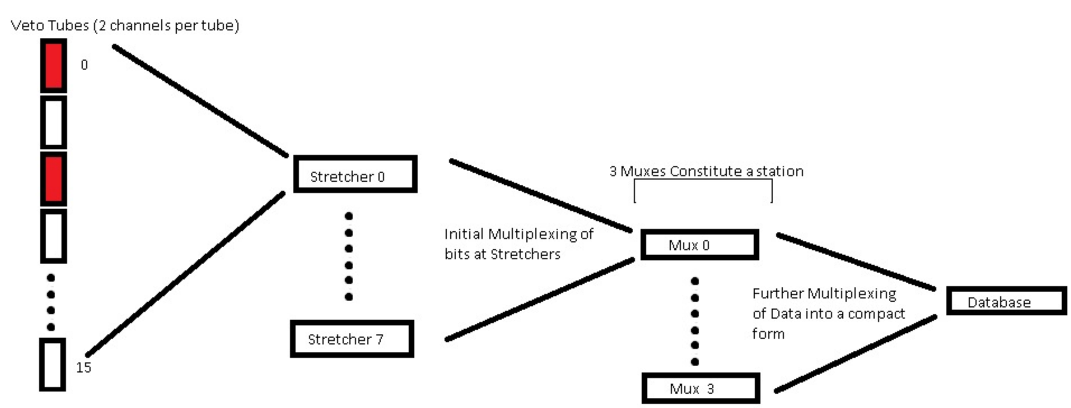

Fig 1: As can be seen is this figure we have the general data flow starting from triggers in the Veto tubes illustrated by the far left 'boxes' in the diagram. 16 of these tubes are connected to a stretcher (256 bits), with eight stretchers in a given mux. The binary data from the tubes are multiplexed at the stretchers. From these eight stretchers, the multiplexed binary data is multiplexed further at the Muxes where the data from Mux 0 to Mux 2 is saved as .gz files in the database.

As can be seen in the above figure the basic flow of the data starts when a particle interacts with the proportional tubes that constitute a given tube. On each tube there are two channels. 16 of these tubes are connected to a stretcher (32 bits), where 8 of these stretchers are connected to a mux, where 2 to 3 of these muxes make a station. These 8 stretchers constitute 256 bits of binary where a one represents a channel firing (particle passing through that half of the corresponding tube) and a zero represents no interaction with any particle. The mux reads and multiplexes these 256 bit binary values in a specific way that could result in a higher percentage of nontriggerable events. Specifically once a trigger occurs, the front end electronics will read in the first four bits from stretcher 0-3, then the first four bits from stretcher 4-7. After this it will read in the next four bits from stretcher 0-3, then the next four bits from stretcher 4-7, and so on and so forth until all bits are read. This can cause what appears to be nontriggerable events within the data stream if the front end electronics timing is slightly off. If this is the case then the front end electronics could cut off bits in the data stream resulting in events being saved to the database that results in what appears to be events that are of the nontriggerable type.

3. Data

*Note-data points that are zero percent are channels that have low/high rates of firing that were taken out by setting low and high bounds on the rate of firing.

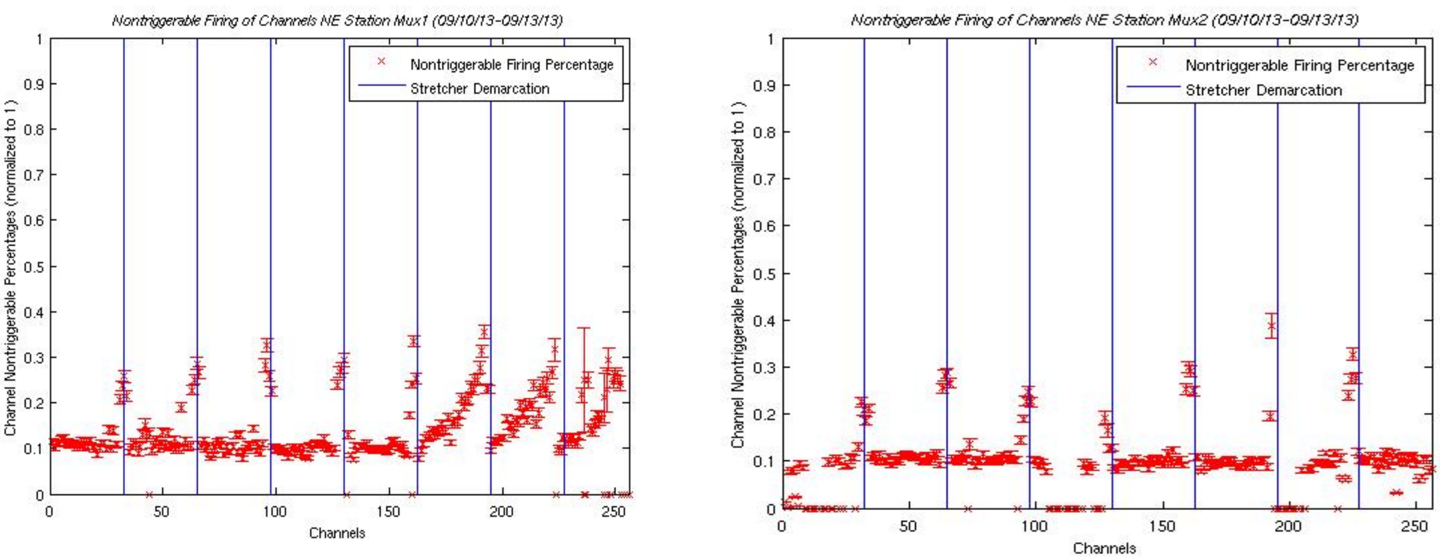

Figure 2: In this figure we have nontriggerable firing percentages for each channel on mux 1 (left) and mux 2 (right) for the northeast station of the veto shield.

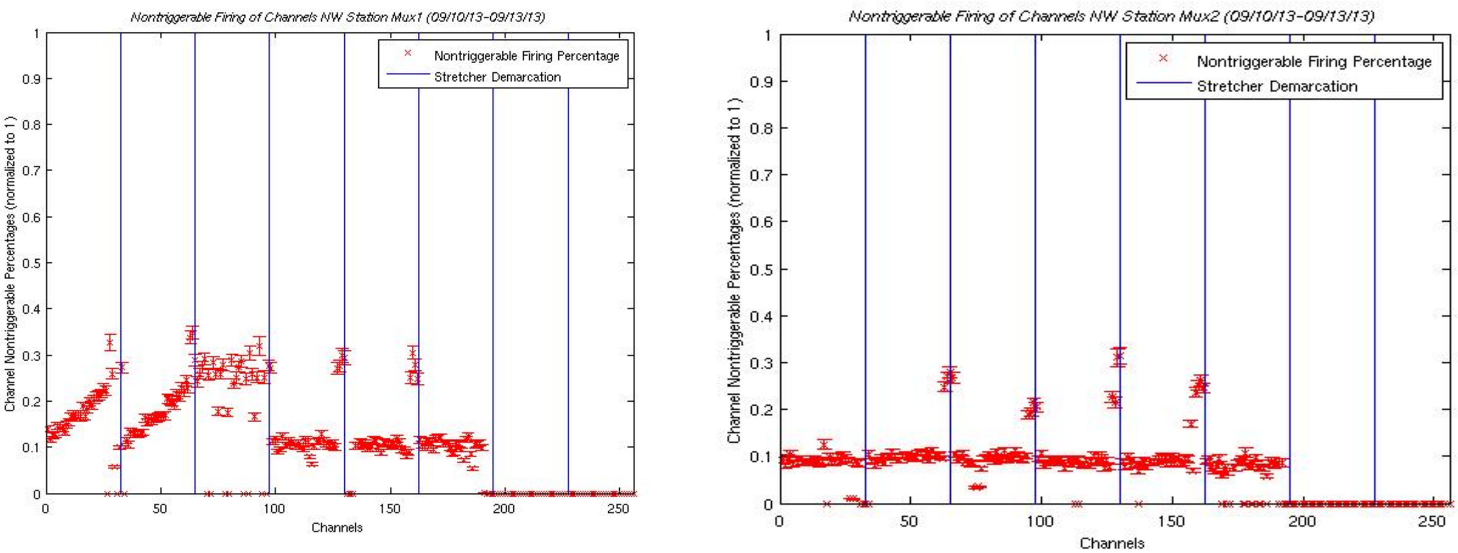

Figure 3: In this figure we have nontriggerable firing percentages for each channel for mux 1 (left) and mux 2 (right) for the northwest station of the veto shield. Stretchers 6 and 7 (from stretcher 0 to 7) have fire rates that are below the given bounds, and therefore these stretchers will yield negligible effect on the total percentage of nontriggerable events.

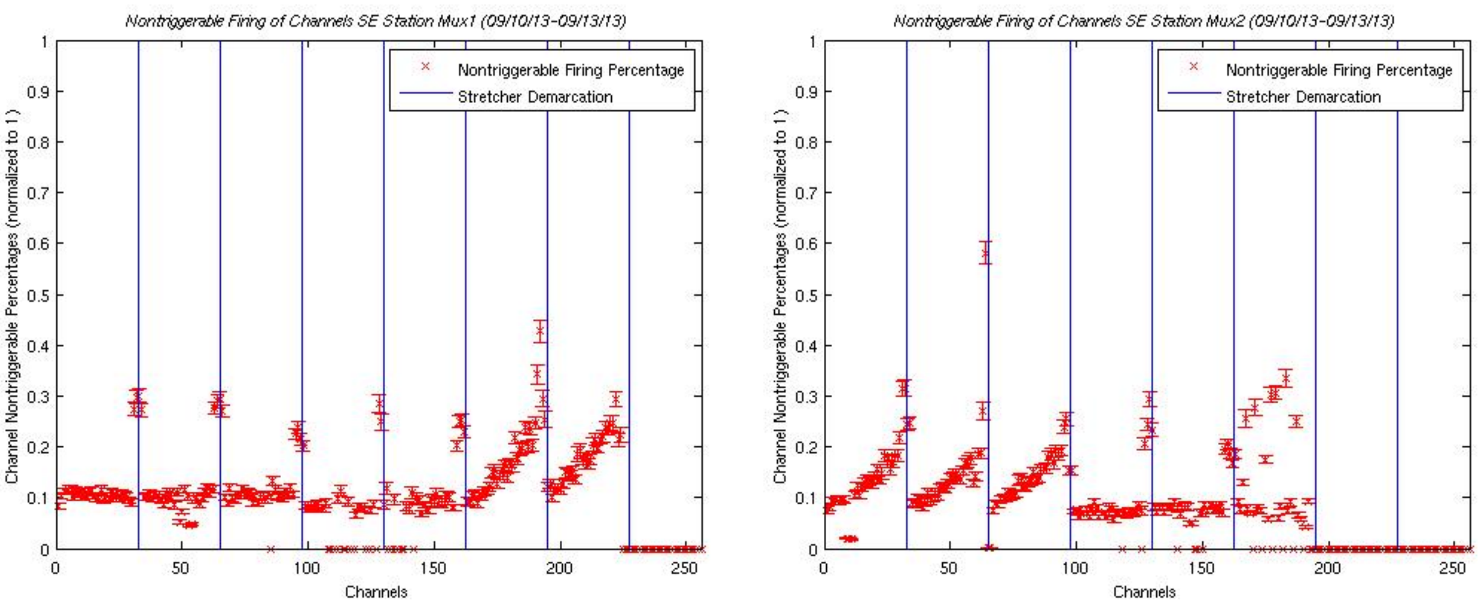

Figure 4: In this figure we have nontriggerable firing percentages for each channel for mux 1 (left) and mux 2(right) for the southeast station of the veto shield. Similarly to northwest station, this portion of the veto shield gives negligible fire rates for higher valued stretchers (stretcher 6-7).

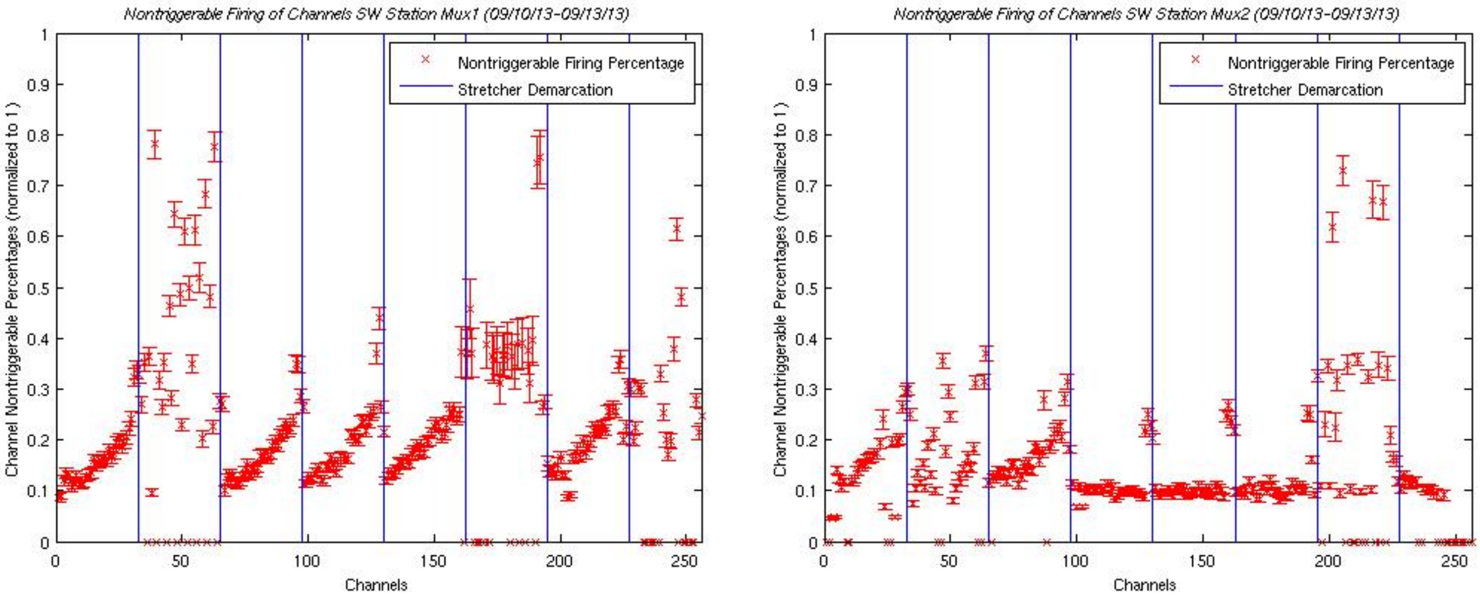

Figure 5: In this figure we have nontriggerable firing percentages for each channel for mux 1 (left) and mux 2 (right) for the southwest station of the veto shield. As the there is a smaller number of dropped channels in the higher valued stretchers then it's easy to see that the tubes corresponding to these stretchers are firing at a rate within my set bounds for the fire rate.

Quick Note: the bounds on the fire rate were stated very loosely. Many of the channels had nontriggerable firing counts of 250-750 over the course of 3 days. The lower bounds stated that any channel <75 counts were omitted, and any channel <1100 counts were omitted. If this is an issue we can talk about this tomorrow and the plots can be redone.

4. Discussion

As can be seen in the above figures there is some scalloping in the Nontriggerable percentages versus channels. The possible explanation outlined above has the possibility of describing this scalloping in the following way. If the timing is indeed off in the front end electronics, then for higher bit values for each stretcher, the timing has the possibility of cutting off good triggers and saving the resulting string of zeros and ones as a good trigger although the combination of ones and zeros is of the nontriggerable type. Therefore for some stretchers we should see an increase in nontriggerable events in higher bits for each stretcher. This can be seen for some stretchers in the above graphs.

Although the previous explanation accounts for the scalloping effect we see in some of the stretchers for the varying stations, the overall average of the nontriggerable percentages for each mux does not yield results that are in agreement with my previous study with the average nontriggerable percentages of the muxes. This leads me to believe that the appropriate way to average these nontriggerable channel percentages is to take into account the firing rate of each channel. As can be seen in the figure below that each channel is firing at varying rates. This is indicative that each channel is contributing 'differently' to the overall average done in the previous study. As of now, the exact way in which these channels are contributing differently to the overall average of nontriggerable percents in a given mux is unclear, but it can be summarized by the below equation.

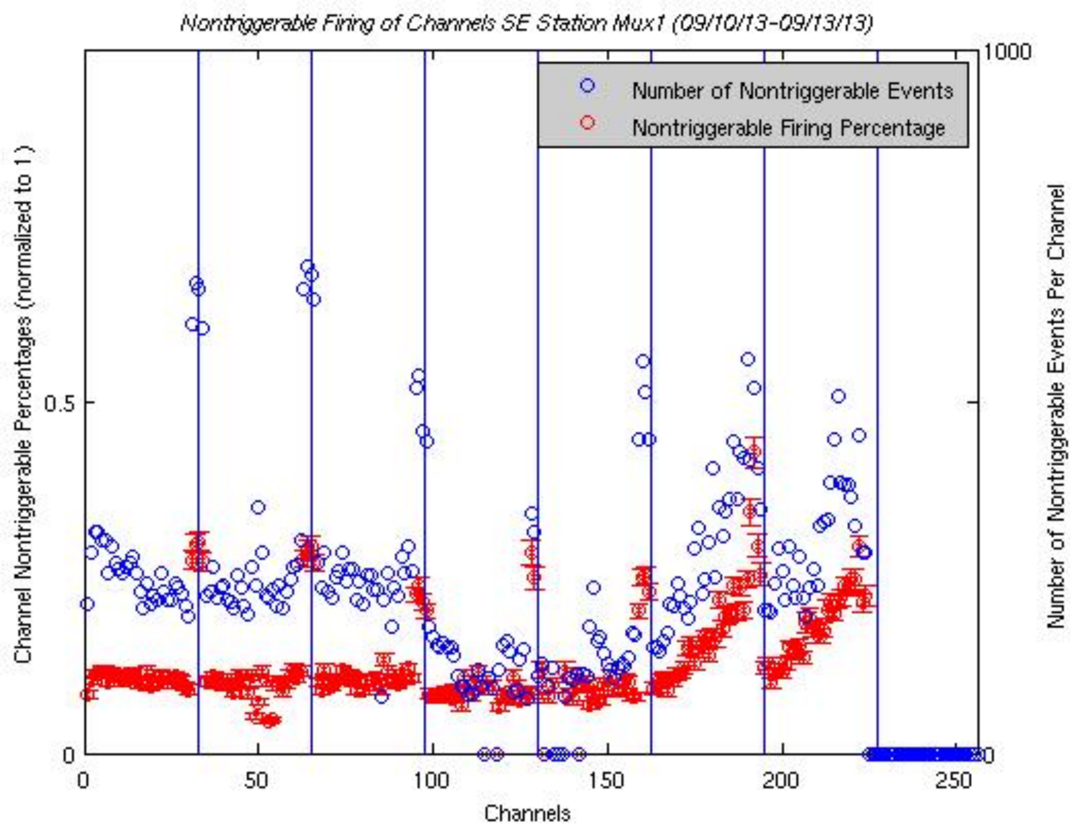

Fig 6: as can be seen in this figure we have the nontriggerable percentages (red) for each channel, and there corresponding non-normalized fire counts. This plot is to show that some channels will hold a hire rate of firing, which could affect the overall percentage of nontriggerable events for that given mux.

$$\eta_{ave} = \sum_i C_i \eta_i$$

Where the constants η_{ave}, η_i, C_i are the average nontriggerable percentages, the nontriggerable percentages of a given channel and a constant that relies on a given channel and it's corresponding firing rates. As this is unverified right now, I'll be working on figuring out this relation between the nontriggerable percentages of a given channel and the average nontriggerable percentages over the course of the next week.