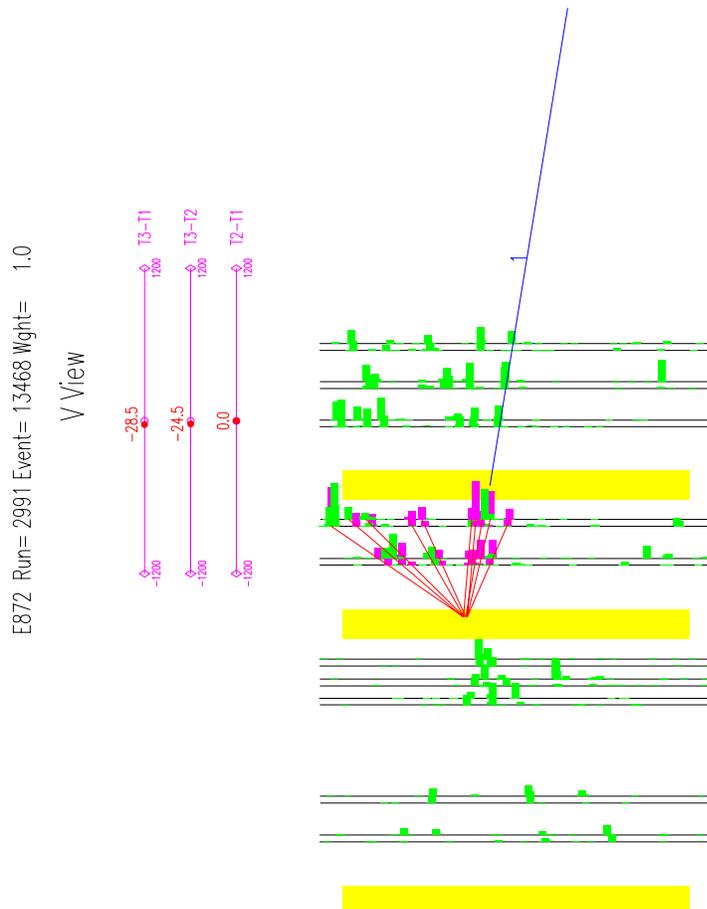


## “Back splash” Study of Neutrino Interactions Using Data

Some percentage of our neutrino interactions will generate particles that travel backwards (opposite of beam direction) in the lab frame. These type of events are of some concern because of the possibility of self-vetoing. The  $\nu$  interaction generates a track that fires the veto wall and hence the interaction will not be triggered on. A rather spectacular example is shown in Figure 1. The typical energy of a backward emitted particle is  $\sim 100$  MeV(?). It should be recalled that 4 inches of lead exist upstream of the 1<sup>st</sup> module and downstream of the veto wall.

**Figure 1: A neutrino interaction in module 3 with at least three tracks emitted backward in the lab frame**



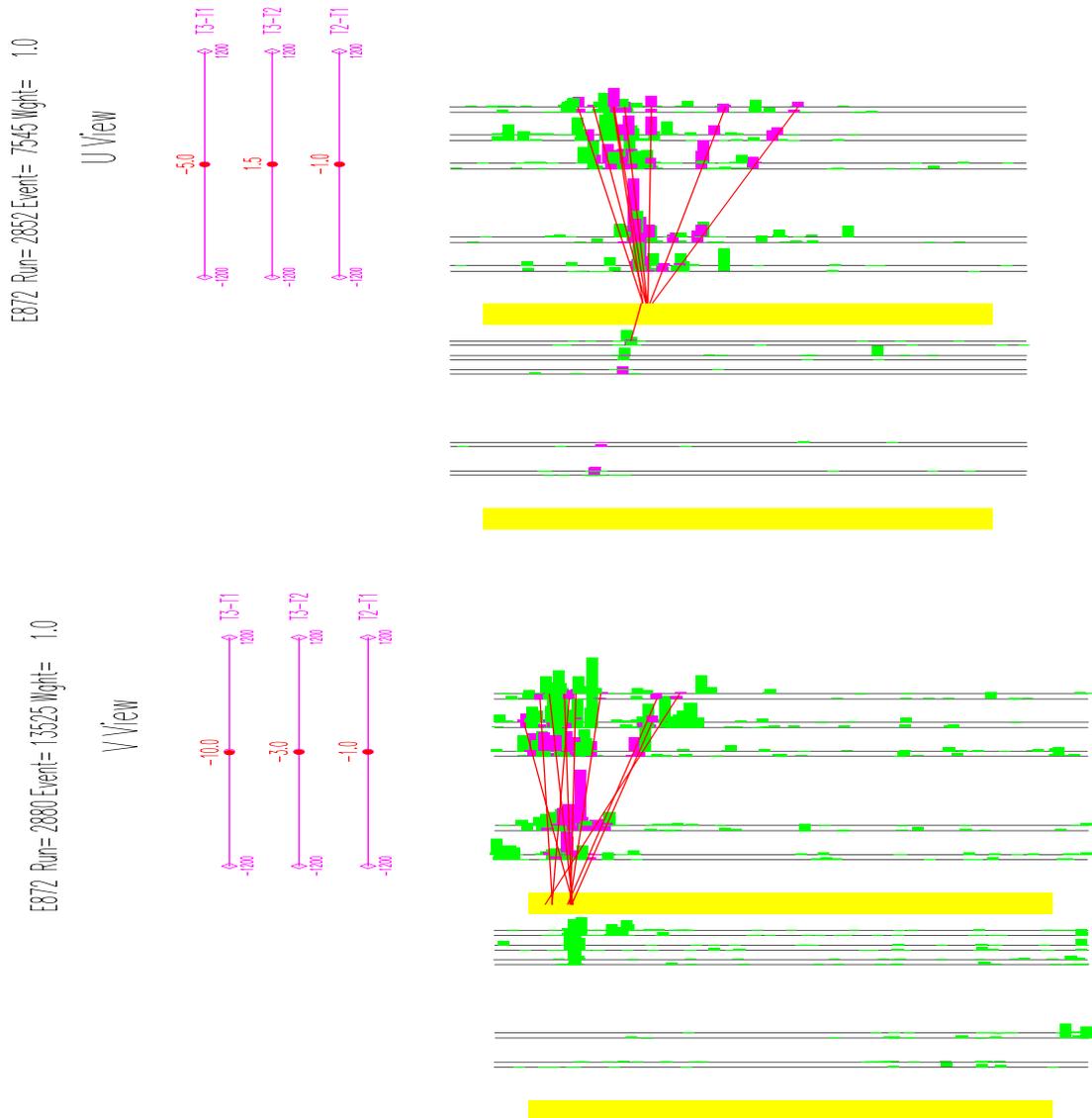
I have looked at the neutrino interaction files **per\_1\_1,2,3,4.int** and **per\_2\_5,6.int**. These files were sent to the Nagoya group to be visually scanned. I

extracted the neutrino interactions in modules 3 and 4 (module 2 was not installed for period 1 and 2) and searched the event for evidence of a track stub in the fiber planes upstream of the  $\nu$  interaction. The results of this search are listed in table 1. An example of a full(partial) back splash event is shown in figure 2(3).

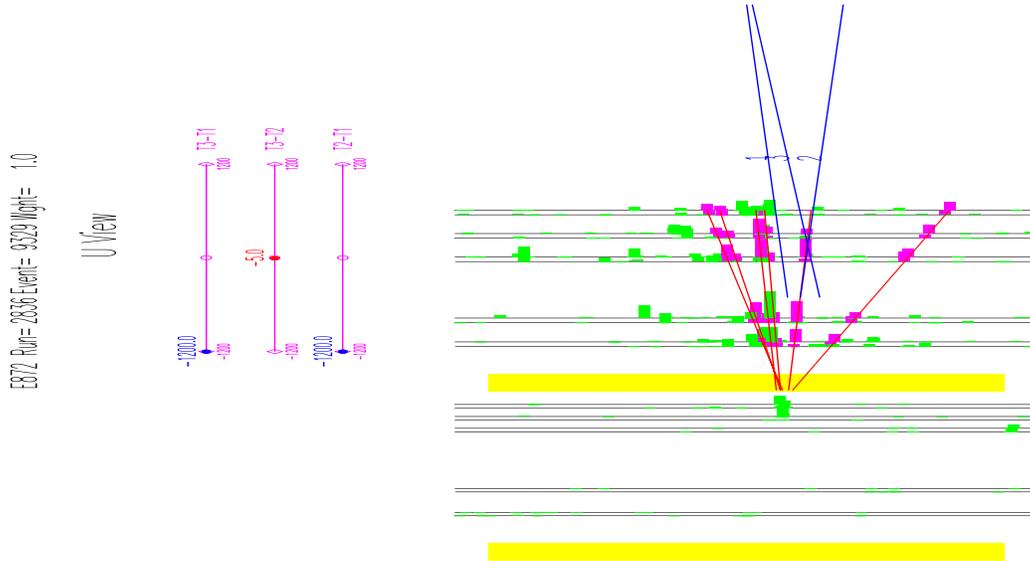
**Table 1: Breakdown of back splash events in clean neutrino interactions in modules 3 and 4.**

Total number of clean $\nu$ events in modules 3 and 4.	Number of events with any evidence of a back splash track.	Number of events with more than 4 fiber planes (full) on for back splash track	Number of events with $\leq$ than 4 fiber planes (partial) on for back splash track
133	29(22%)	22(17%)	7(5%)

**Figure 2: Neutrino events in module 3 with evidence of a "full" back splash track.**



**Figure 3: An neutrino event in module 3 with evidence of a "partial" back splash track**



For all neutrino interactions (modules 1,3, and 4) I checked the veto wall latches to determine if any PMT had fired. Recall there are 10 veto wall counters with PMTs on both ends for a total of twenty. The latch gate for the veto wall is 150 nsec wide and therefore particles out of time (low energy backward tracks) could still in principle fire the latch but not veto the event. Table 2 is a summary of what I found:

**Table 2: Summary of Veto Wall behavior for  $\nu$  interactions**

Total number of interactions.	Total number of interactions in module 1,3,4.	Total number of interactions with any veto wall PMT on.	Total number of interactions in module 1 with any veto wall PMT on.	Total number of interactions in module 3 with any veto wall PMT on.	Total number of interactions in module 4 with any veto wall PMT on.
214	81,104,29	20	15(19%)	4(4%)	1(3.5%)

Figure 4 is the spatial distribution of Veto Wall latches that fired for the  $\nu$  interactions in all modules.

This study is not complete – I need to interpret the data presented here and compare with Monte Carlo. However it is clear that the number of events with evidence of back splash is not insignificant. The question still remains: How many events did we self-veto? Note the fiber plane study is sensitive to back splash charge tracks only, while the Veto Wall study is more sensitive to neutral (neutrons) back splash tracks because of the 4 inches of lead between it and the emulsion modules.

Distribution of veto wall Latches that tired for neutrino interactions

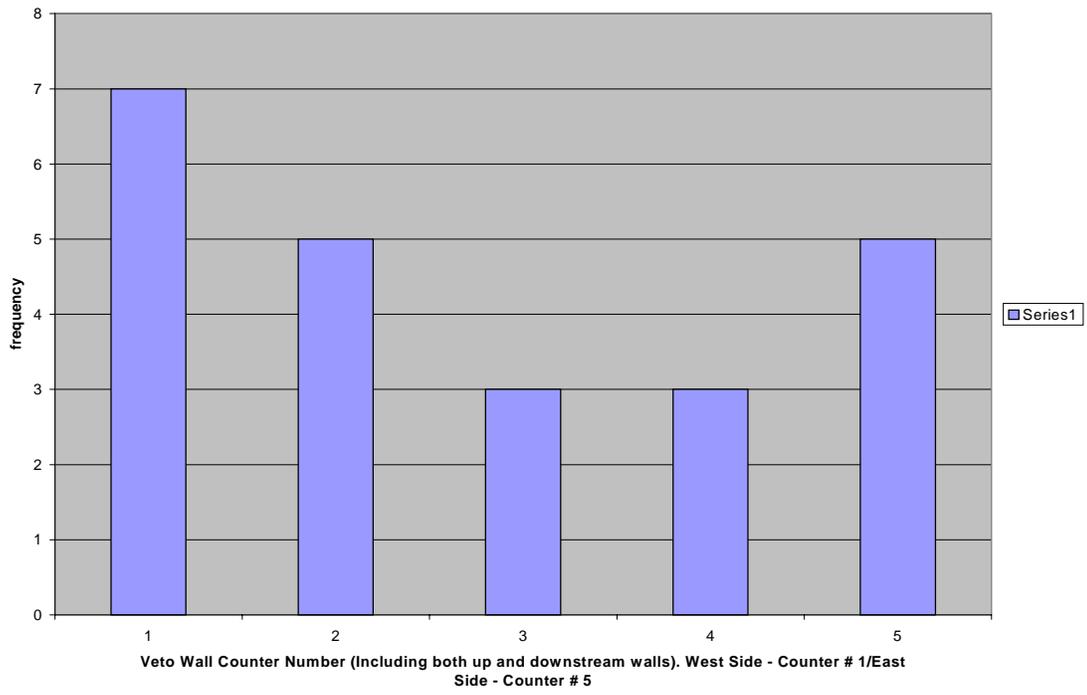


Figure 4