ACD Recon Upgrade

Over the last several months I have been working a large re-work of the ACD reconstruction. There are some major motivations for this:

1. To correctly handle the track error extrapolations and to get that infomation into the Merit Variables
2. To rationalize the way that we test track-tile and track-ribbon associations and try and but several variables on an equal footing
3. To use new information from items 1) and 2) to simplify and improve the ACD parts of the background rejection analysis.
4. To add information needed for instrument perfomance studies, in particular efficiency studies.

Major Changes

This was a very large re-working, there were lots of sizable changes. Starting with the most significant:

- Use pattern recognition in addition to GEANT model to determine which tiles and ribbons to associate with tracks
  - This allows us to handle near misses, which is needed to do efficiency studies. An start on one such study is here.
  - More detailed description of pattern recognition technique is here
- Have information be associated with tracks, instead of having a single big set for the whole event
  - This makes using the event display much easier
  - This makes getting access to information in Recon root files easier
  - More information about new ACD recon data structures is here
- Handle track errors correctly
  - This wasn't being done before
  - This looks nice in the event display
  - More information about error propagation is here
- Sort ACD - track associations by a combined signal size/ distance quality measure instead of using only distance
  - This gets rid of problems with shadowing, where one association with a small signal masked another nearby one with a larger signal
  - More information about quality measures is here
- Always calculate gaps to tiles
  - Before this was a hodge podge, we had to handle cases where the track hit ribbons, tiles and missed everything differently.
  - More information about how we treat gaps is here
- Sort gaps by the probability that the track went into the gap, including the size of the gap and the error projection
  - Before gaps were sorted only by the distance to the gap

Minor Changes

In the process of doing all this work a couple of smaller improvements presented themselves:

- Change the way the distance of closest approach is calculated when the POCA occurs exactly at the head of the track
  - This effects some events track which graze side tiles (and a very few which graze to tiles), but only when the distances of closest approach is quite large
- Use the hardware veto information instead of the energy information in counting number of tiles hit in the Merit Variables
  - This handles issues with the slower timing of the PHA electronics

New information in Merit ntuple

We wish to add some new information to the Merit Ntuple. Mainly this is information about the combined signal size and track projection estimator of how likely a given tile is to veto a track.

Noticable changes in existing Merit quantities

We see discrepencies in the existing Merit ntuple from several sources. In order of importance:

1. We changed the way the "best" track-tile, track-ribbon and track-gap associations are selected. This causes some small fraction of the events to have changes in a couple of merit variables. The effects are different various cases. Here is a page that summarized the effects.
2. We change the way we report the point of closest approach when it occurs at the head of the track. This affects tracks near the sides an top of the LAT with high incident angles w.r.t. the tiles or ribbons. Here is a page that describes this in more detail.
3. We use the hardware veto bit directly to count hits in the various parts of the ACD. Before we were using the signal size that was equivalent to the intended veto threshold. This causes a few events to move around in the various counting variables.
4. We set an upper limit of 10000 sigma for all associations. This causes a few events with large negative active distances to return to the default values of -2000.

Effects on background rejection

Here is a page that describes so efforts to use the new variables to do background rejection.

Improvements to event display

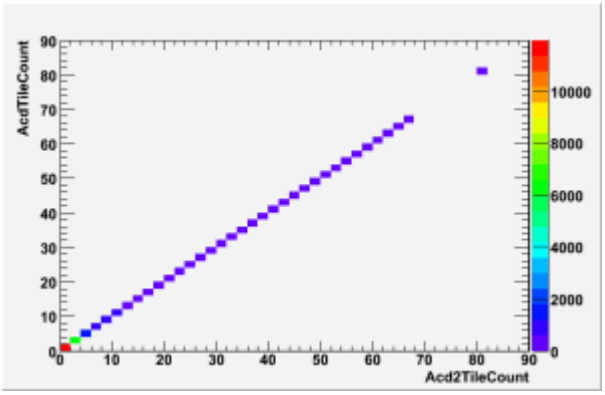
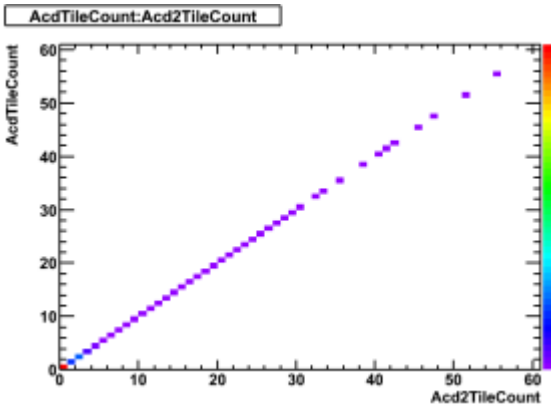
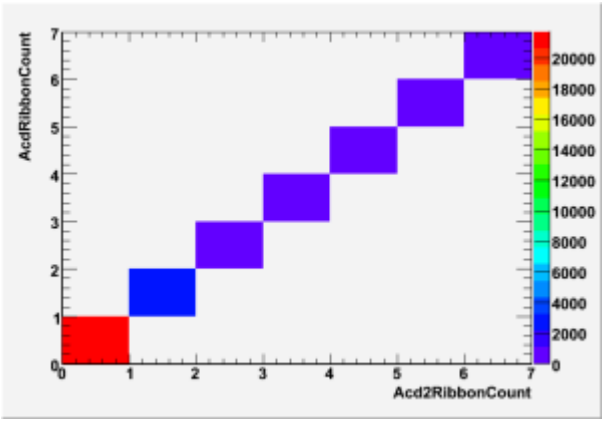
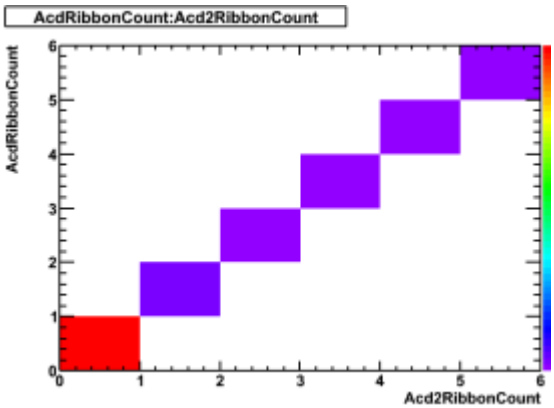
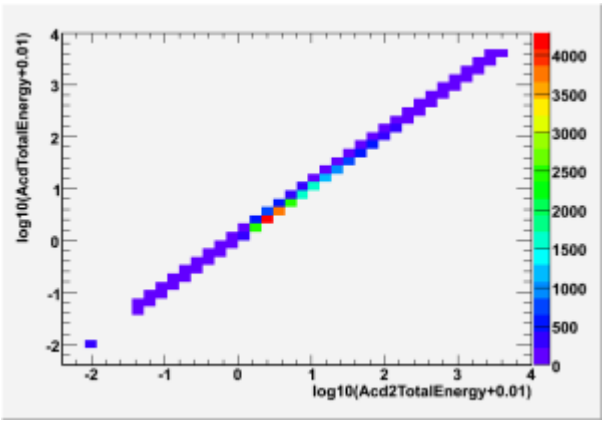
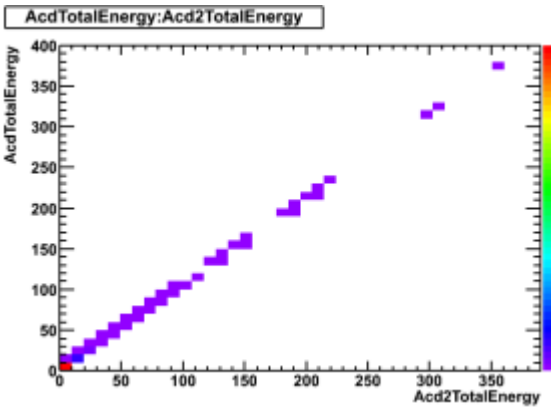
Here is a page that describes how this information is visualized in the event display.

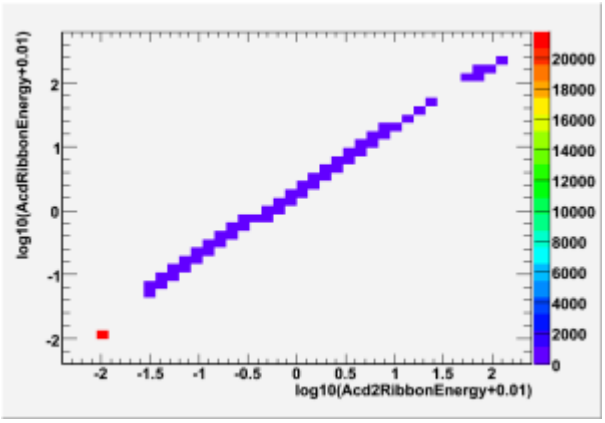
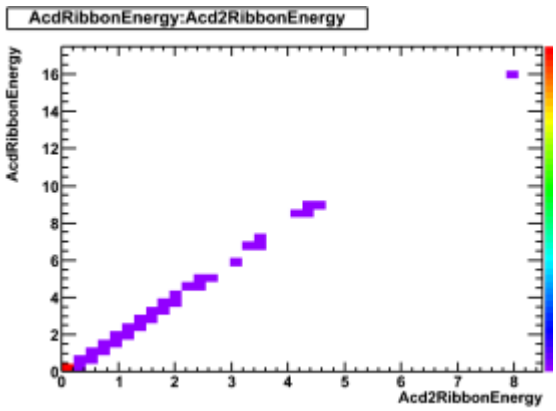
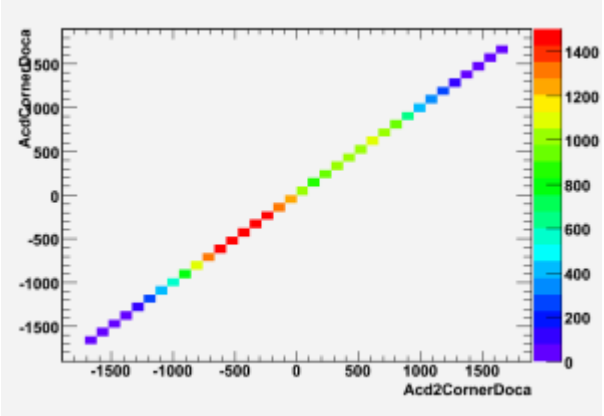
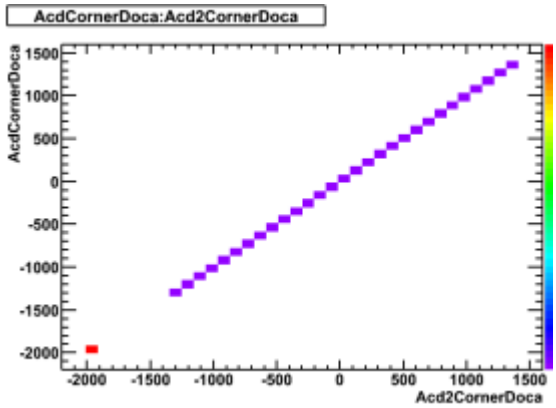
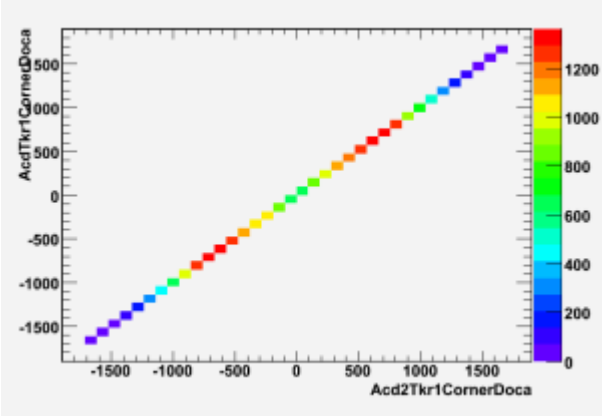
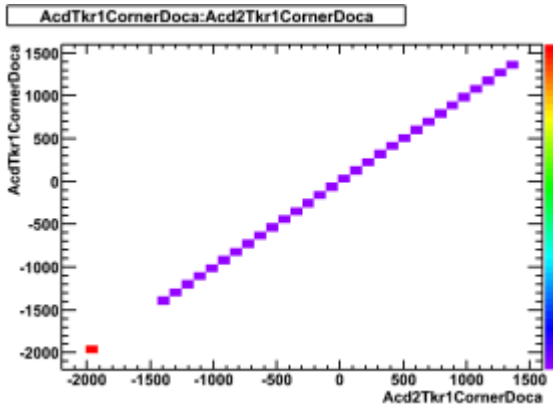
Path towards deployment

Here is a page that describes the issues with and suggests a path towards deploying this stuff

Testing and Comparison

Merit Variables that stayed exactly the same

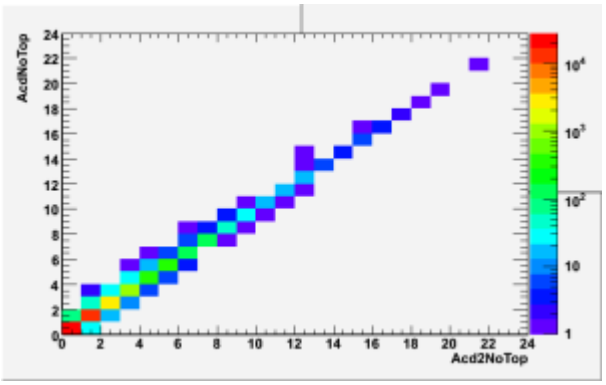
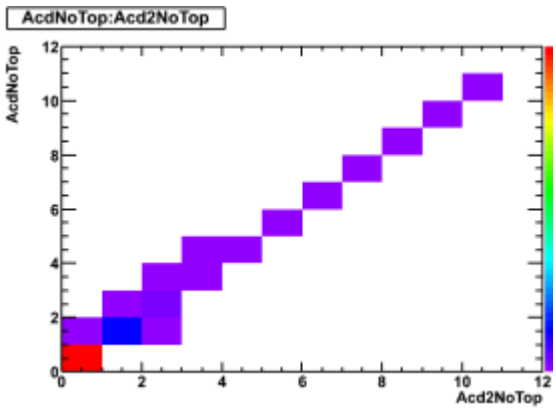
Variable	P6 Plot	P7 Exist?	P8 Plot
AcdTileCount (also AcdNoRow3 Readout):		✓ (✗)	
AcdRibbonCount:		✗	
AcdTotalEnergy (also AcdEnergyTop, AcdEnergyRow[0-3]):		✓ (✓, [0,2,3] ✓)	

AcdRibbonEnergy:			
AcdCornerDoca:			
AcdTkr1CornerDoca:			

Changes from the hardware veto.

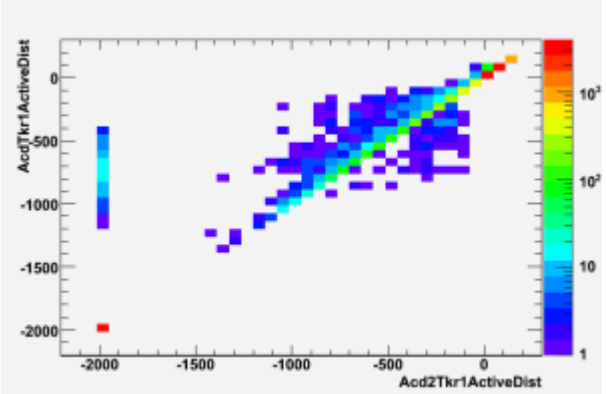
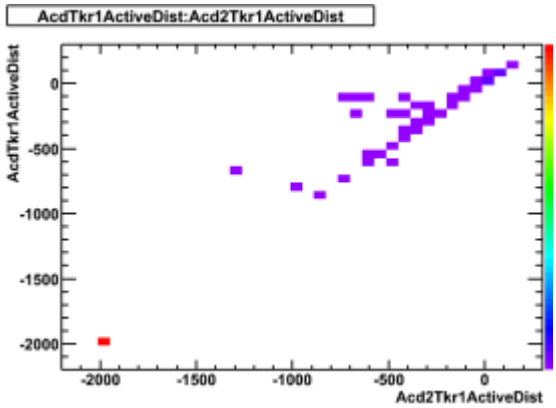
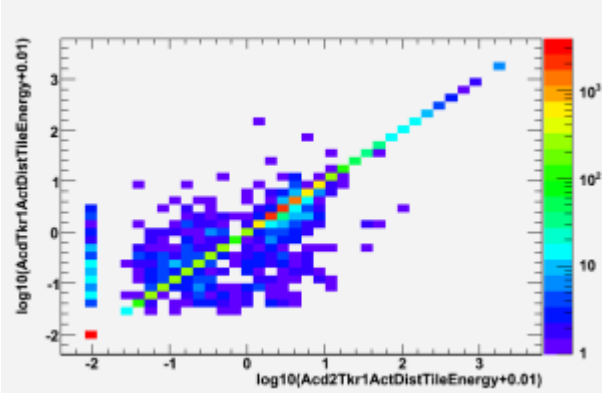
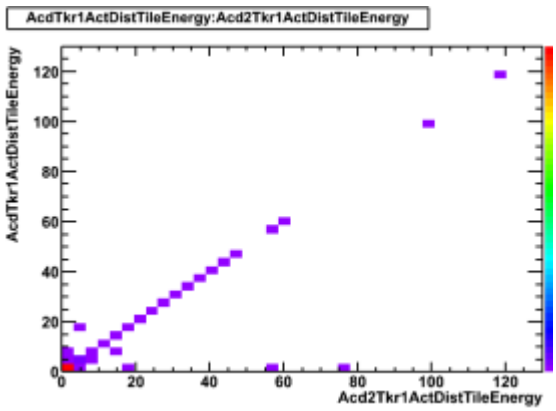
These variables changed slightly because we are using the hardware veto to count hits instead of the Energy corresponding to an expected veto

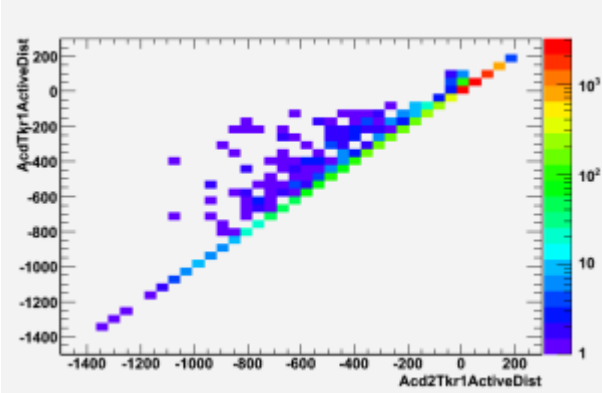
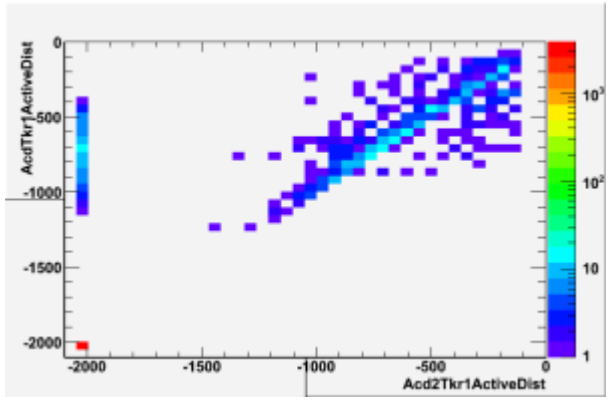
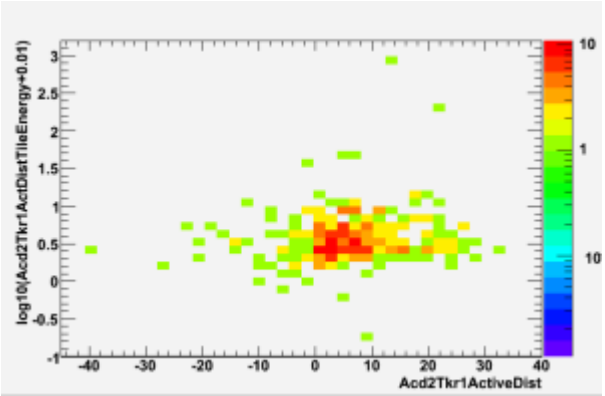
Variable	P6 Plot	P7 Exist?

AcdNoTop (and AcdNoSideRow[0-3]):		( )	

Changes in the AcdTkr1ActiveDist set of variables

These are mainly caused by changes in the way we sort associations, but a couple of other small effects also contribute.

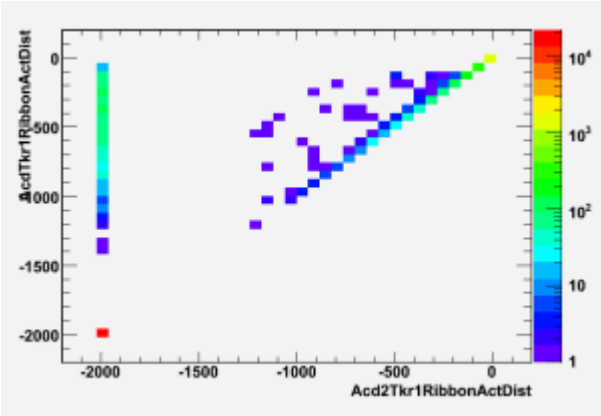
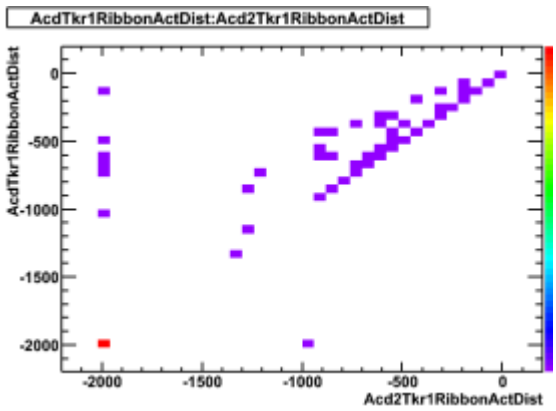
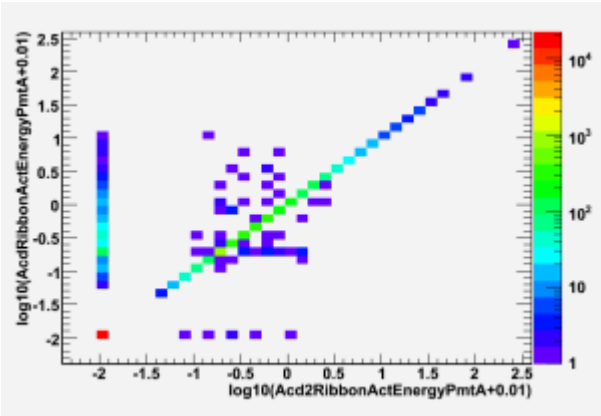
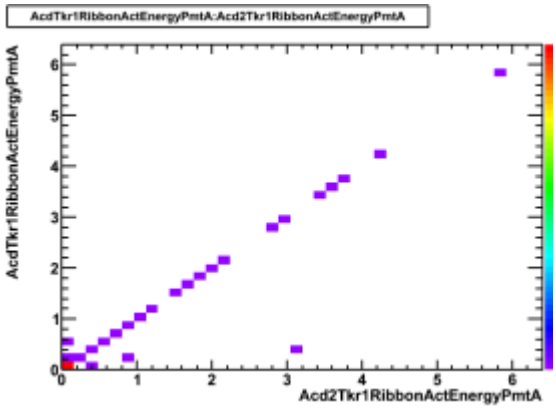
Variable	P6 Plot	P7 Exist?	P8 Plot
AcdTkr1ActiveDist: All Events			
AcdTkr1ActDistTileEnergy: All Events:			

AcdTkr1ActiveDist: Events where POCA occurs above track			
AcdTkr1ActiveDist: Events where POCA occurs at track start			
Acd2Tkr1ActDistTileEnergy v Acd2Tkr1ActiveDist: Events where AcdTkr1ActiveDist > 0 and Acd2Tkr1ActiveDist: != AcdTkr1ActiveDist			

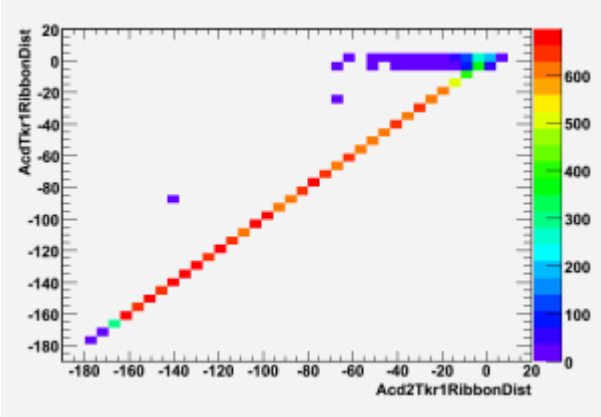
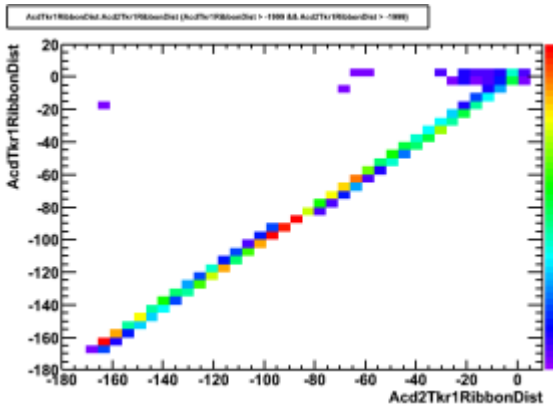
Changes in the AcdTkr1RibbonActDist set of variables

These are mainly caused by changes in the way we sort associations, but a couple of other small effects also contribute.

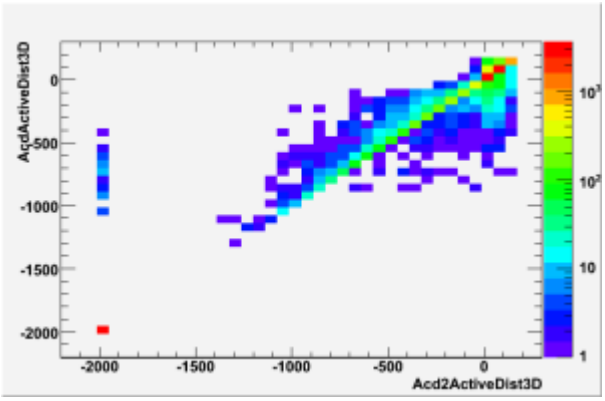
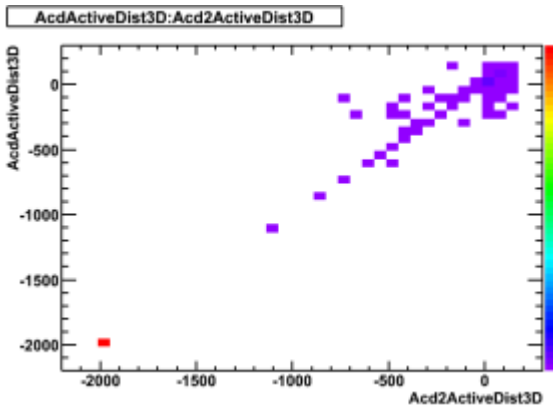
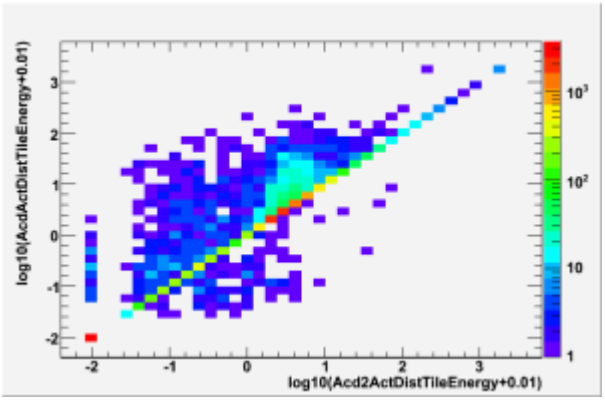
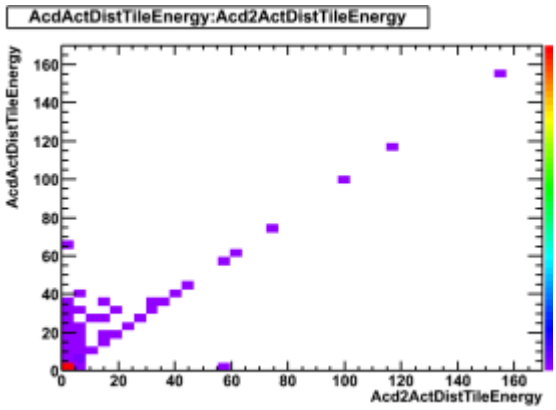
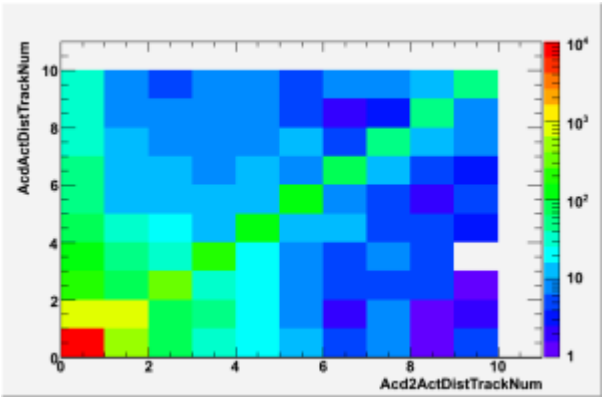
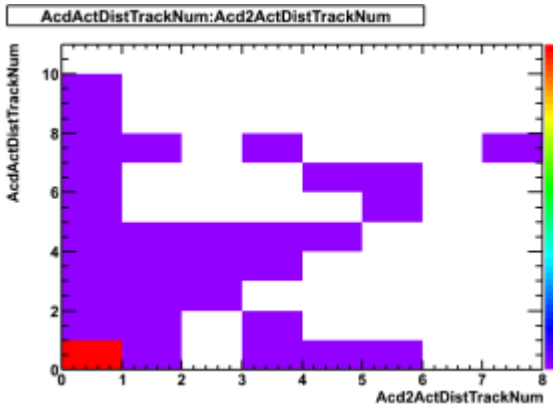
Variable	P6 Plot	P7 Exist?	P8 Plot

AcdTkr1RibbonActDist		✓	
AcdTkr1RibbonActEnergyPmtA[B]		✓✓[✓]	

Changes in the AcdTkr1RibbonDist series of variables

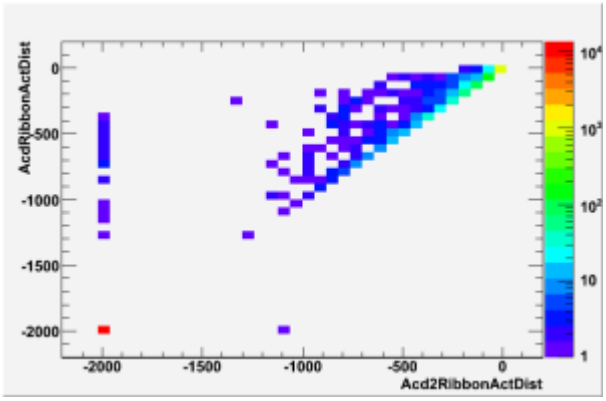
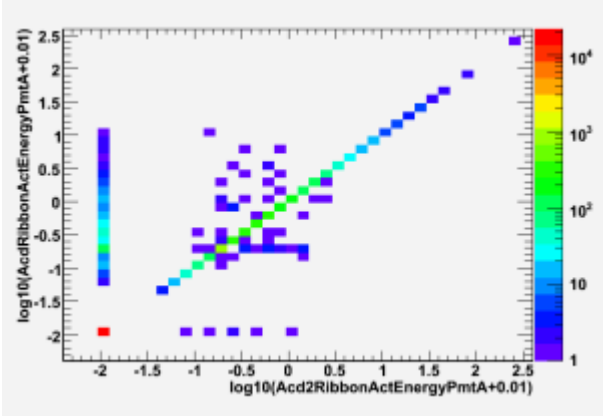
Variable	P6 Plot	P7 Exist?	P8 Plot
AcdTkr1RibbonDist		✓	

Changes in the AcdActiveDist3D series of variables

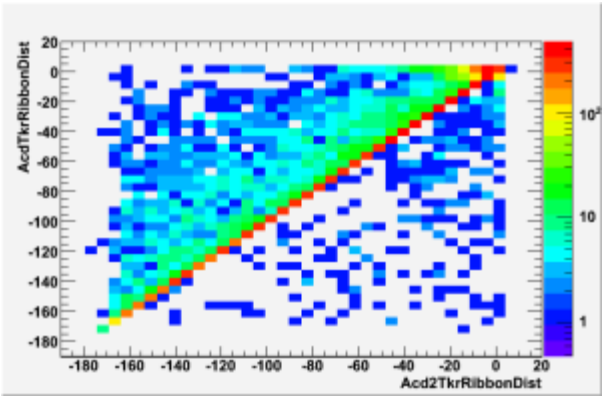
Variable	P6 Plot	P7 Exist?	P8 Plot
AcdActiveDist3D		✓	
AcdActiveDistTileEnergy		✗	
AcdActDistTrackNum		✗	

Changes in the AcdRibbonActDist series of variables

Variable	P6 Plot	P7 Exist?	P8 Plot	Comment

AcdRibbonActDist		✗	✗	
AcdRibbonActEnergyPmtA [B]		✗ [✗]	✗	

Changes in the AcdTkrRibbonDist series of variables

Variable	P6 Plot	P7 Exist?	P8 Plot
AcdTkrRibbonDist		✓