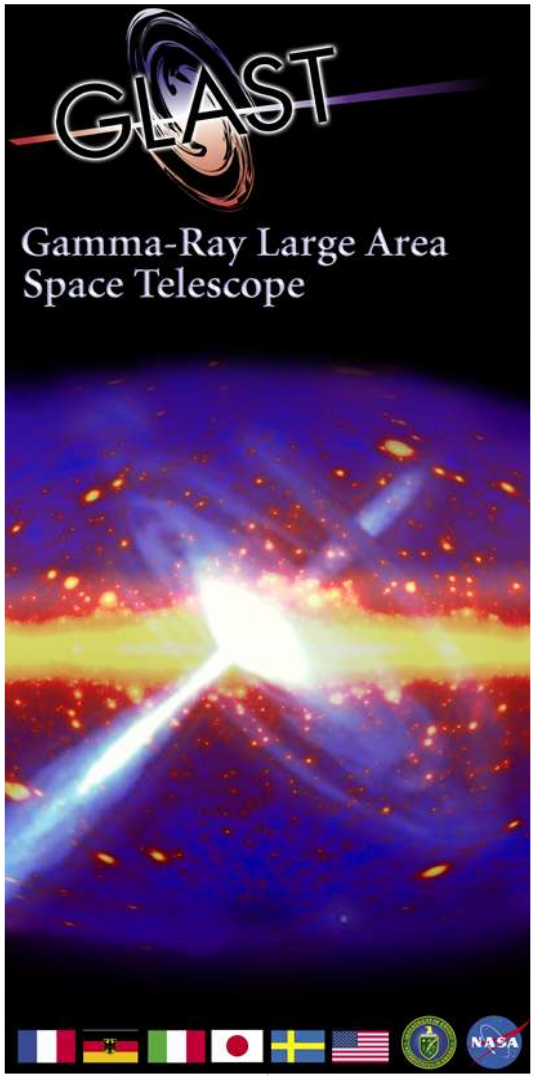
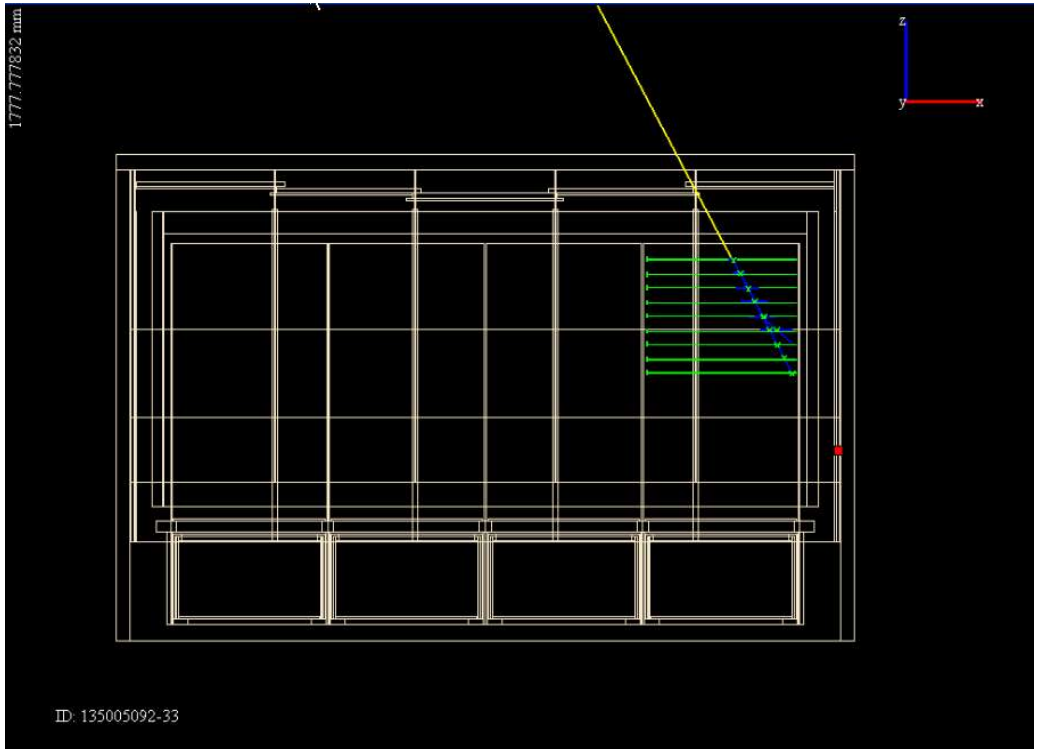


Searching for photons in the LAT

Francesco Longo
Elisabetta Bissaldi

University & INFN Trieste, Italy

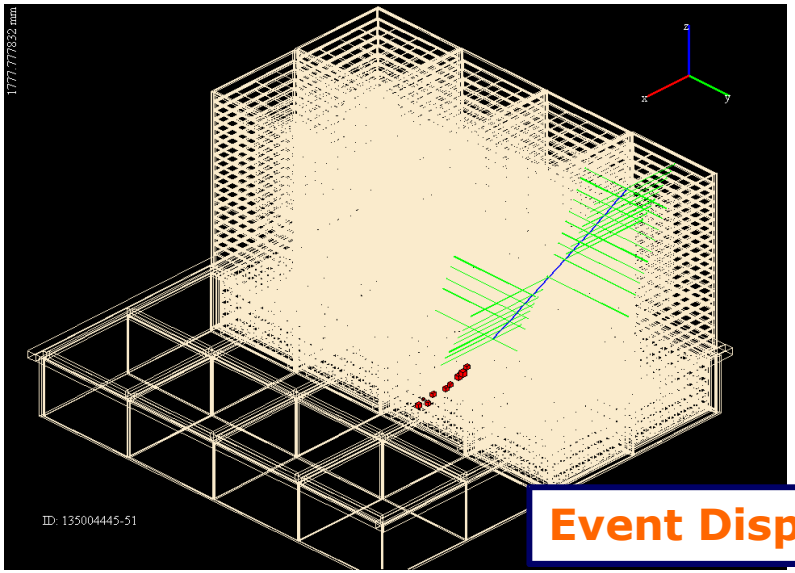
Overview



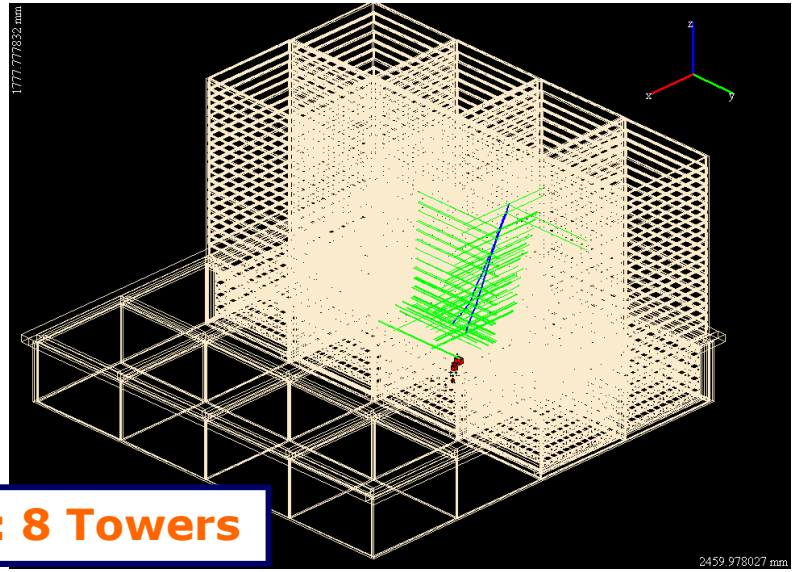
- Searching for photons in cosmic ray data
- Description of simple selection cuts (see Elisabetta, IA5)
- Analysis of 8 and 16 Towers configurations
- Application of DC2 cuts
- Preliminary analysis with R.Rando's random forests program
- Conclusions

Ground Analysis

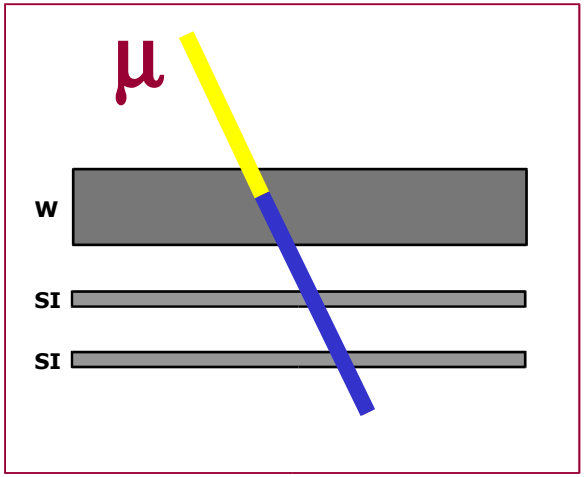
Cosmic Ray Muons

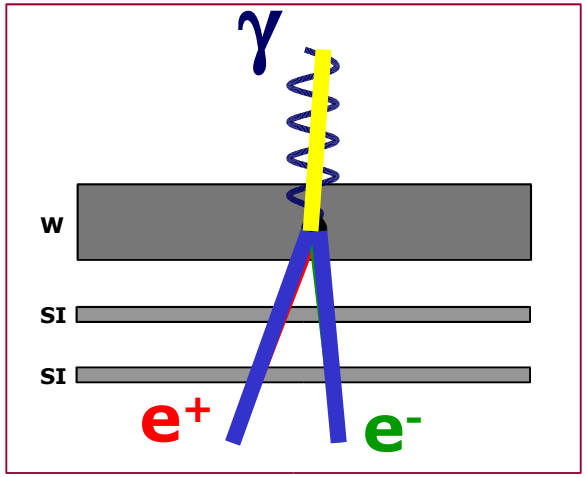


Cosmic Ray Photon Candidates



Event Display: 8 Towers





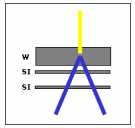
1) "Photon cuts": Simple selections on 2 - 16 towers

Photon Candidate Selection

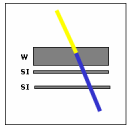
Bill Atwood (march 2005)

2. Original idea (see **IA3**)

4. Analysis of **Monte Carlo samples** to study Photons and Muons distributions
   - Initial selection cuts
   - Definition of 2 γ topologies



VtxAngle>0. **"VERTEX"**



VtxAngle=0. **"1TRACK"**

10. Development of an algorithm based on **classification trees**
    - Study of relative importance of variables for selection

11. Application of the algorithm to cosmic ray data collected with a **single tower configuration (RUN 1338)**

Elisabetta (august 2005)

- **Extended analysis (see IA5)**

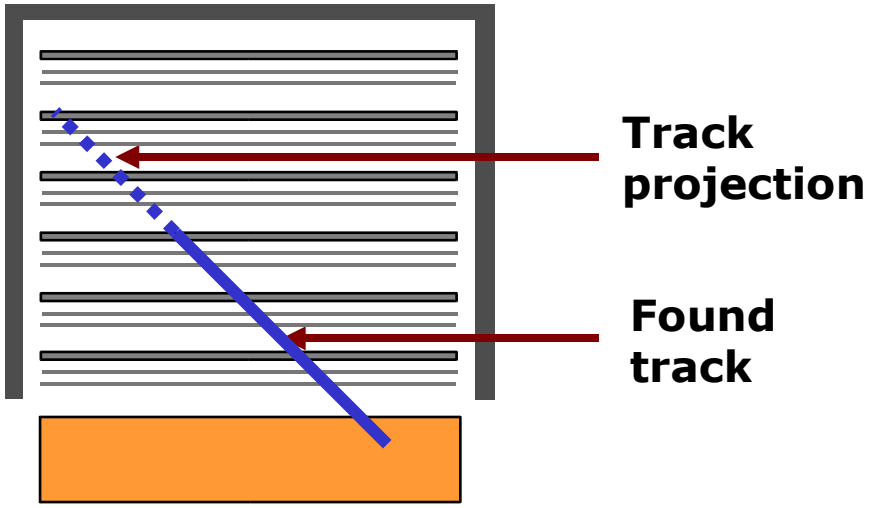
- Used only **"VERTEX" topology**

- Searched for further **selections** analysing important variables

- **2, 4, and 6 towers configurations** **new: 8 and 16**
- Deepened the analysis by studying **different vertex topologies**

Example of variable selection: "Tkr1SSDVeto"

- **Tkr1SSDVeto** ≡ Number of silicon planes between the top of the extrapolated track and the first plane that has a hit near the track. Only planes that have wafers which intersect the extrapolated track are considered. Can be used as a back-up for the ACD.



- Selection: At least 1 plane before start of track

Tkr1SSDVeto>1

MonteCarlo and DATA samples

MC AllGamma

- **2, 4, 6, 8 Towers**
  - 1 x 10^6 simul. events
  - Isotropic
  - 18 MeV – 18 GeV
  - [v5r0608p7]
- **16 Towers**
  - 4 x 10^6 simul. events
  - 10 MeV – 20 GeV
  - [v5r0703p4]

MC Muons

- **2, 4, 6, 8 Towers**
  - 4 x 10^6 simul. events
  - Isotropic
  - PDG formula and low energy extension
  - [v5r0608p7]
- **16 Towers**
  - [v5r0703p4]

DATA Cosmic Rays

- 2 Towers: **RUN 135002134** (**462678** triggered events) [v5r0608p6]
- 4 Towers: **RUN 135002778** (**61996** trig. events) [v4r060302p23]
- 6 Towers: **RUN 135004075** (**390035** trig. events) [v5r0608p6]
- 8 Towers: **RUN 135004453** (**510562** trig. events) [v5r0608p6]
- 16 Towers: **RUN 135005345** (**470286** trig. events) [v5r0703p4]

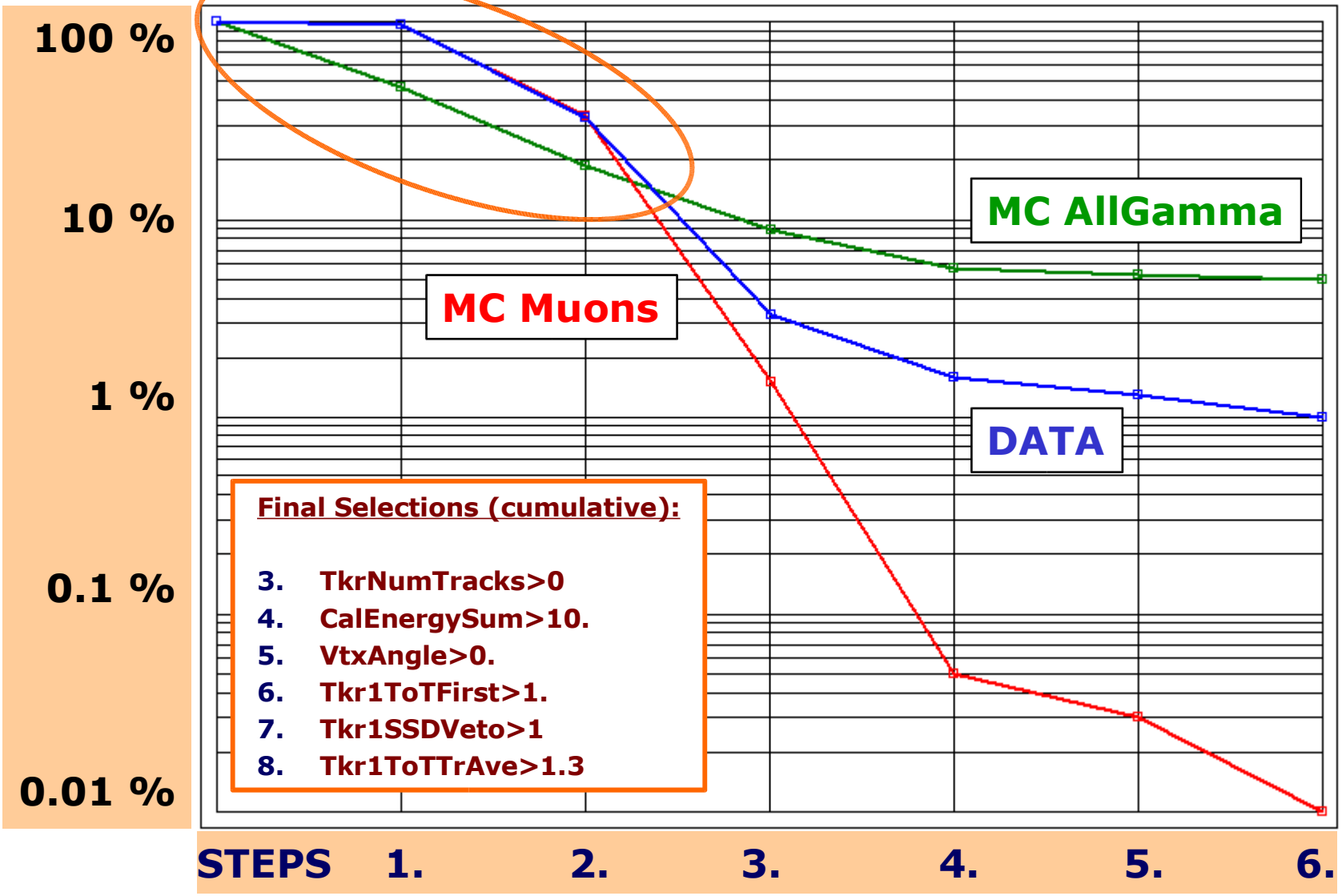
2, 4, 6, 8 and 16 Towers Results

Final Selections (cumulative):

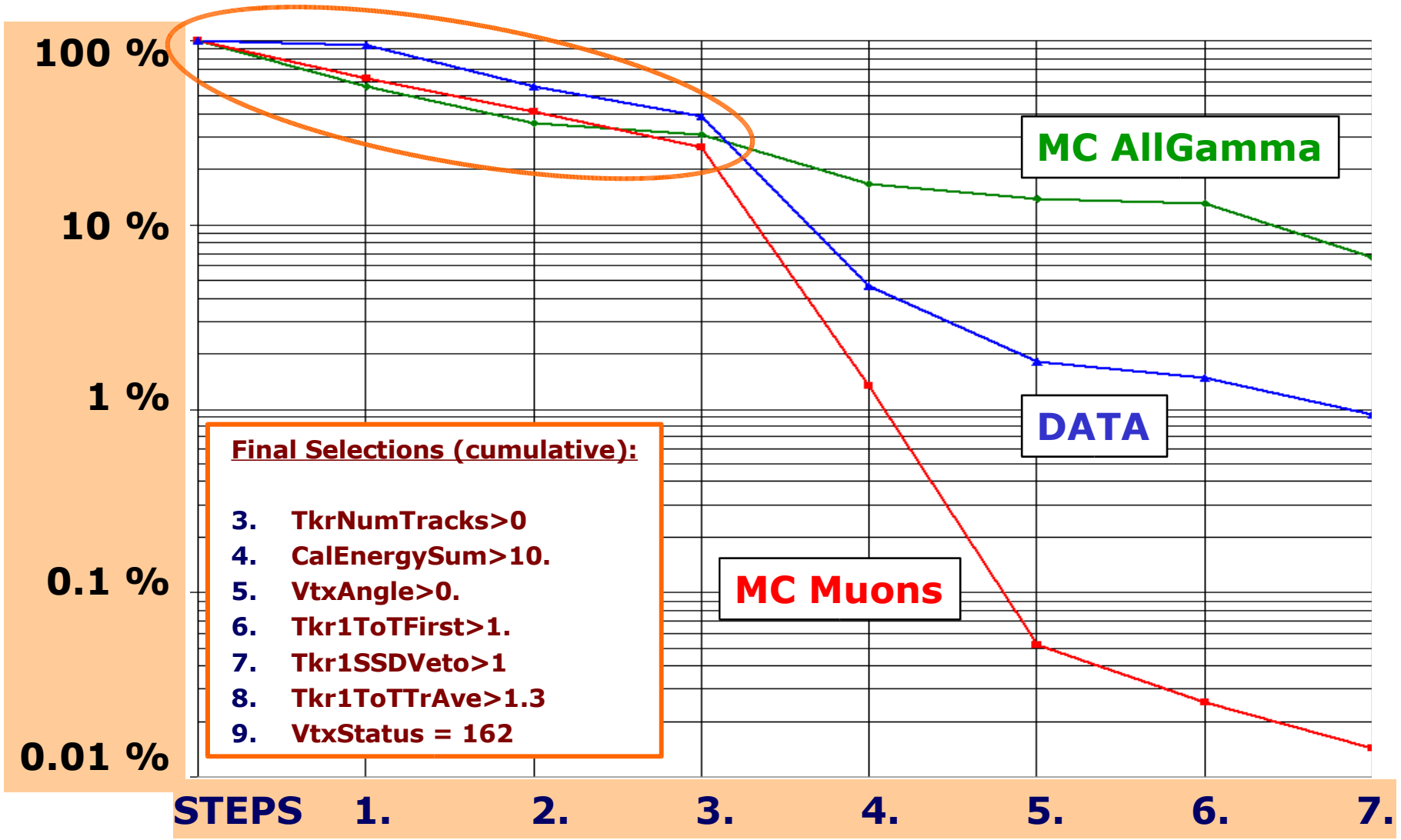
2. TkrNumTracks>0
3. CalEnergySum>10.
4. VtxAngle>0.
5. Tkr1ToTFirst>1
6. Tkr1SSDVeto>2
7. Tkr1ToTTrAve>1.3

		MC Photons		MC Muons		DATA	
Towers config.	STEPS	N°events	%	N°events	%	N°events	%
2	No cuts	33341	100	219322	100	462676	100
	Final Sel.	1672	5.0	25	$1.1\ 10^{-2}$	4715	1.0
4	No cuts	62070	100	391538	100	61996	100
	Final Sel.	5002	8.1	73	$1.9\ 10^{-2}$	764	1.2
6	No cuts	89638	100	558757	100	390035	100
	Final Sel.	8451	9.4	144	$2.6\ 10^{-2}$	5224	1.3
8	No cuts	117604	100	729585	100	510562	100
	Final Sel.	11845	10.1	178	$2.4\ 10^{-2}$	6610	1.3
16	No cuts	944445	100	2120472	100	470286	100
	Final Sel.	122873	13.0	537	$2.5\ 10^{-2}$	6930	1.5

2 Towers Results

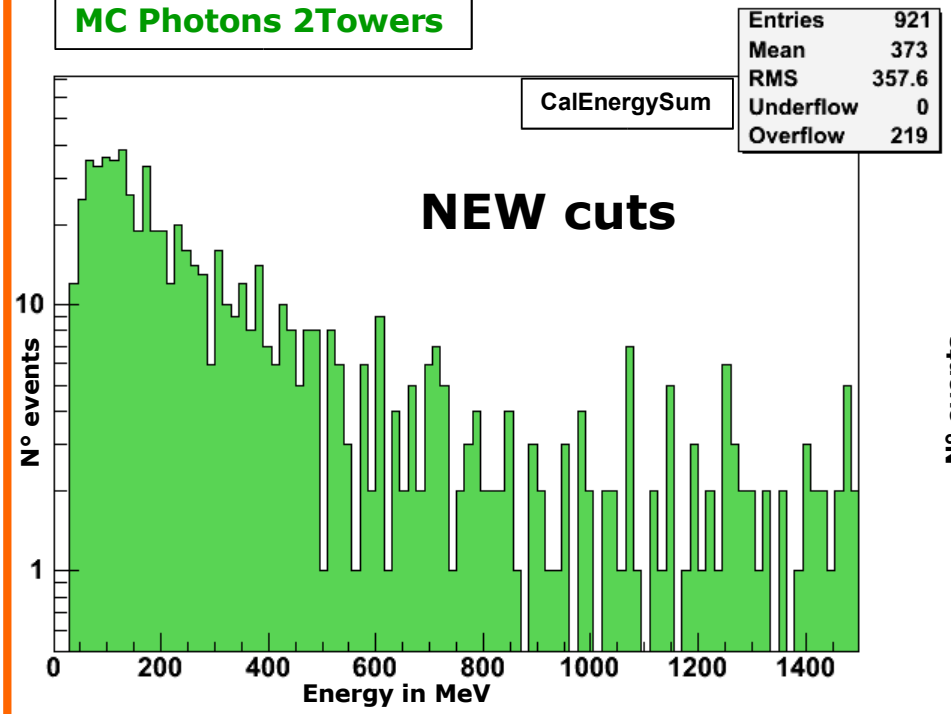


16 Towers Results

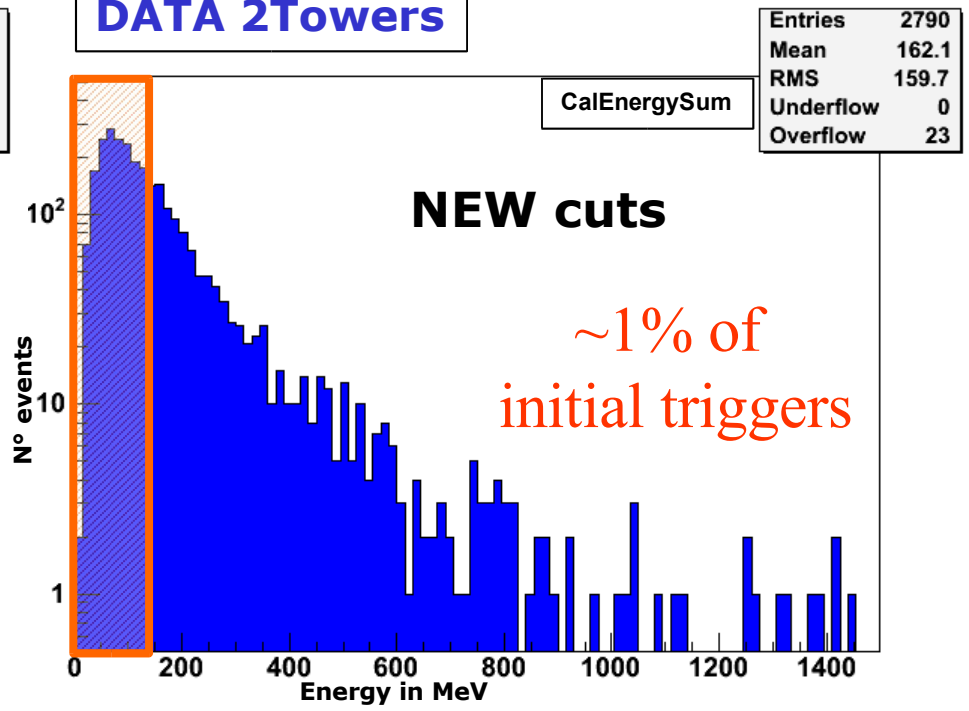


Photon Sample from Elisabetta's analysis

MC Photons 2Towers



DATA 2Towers



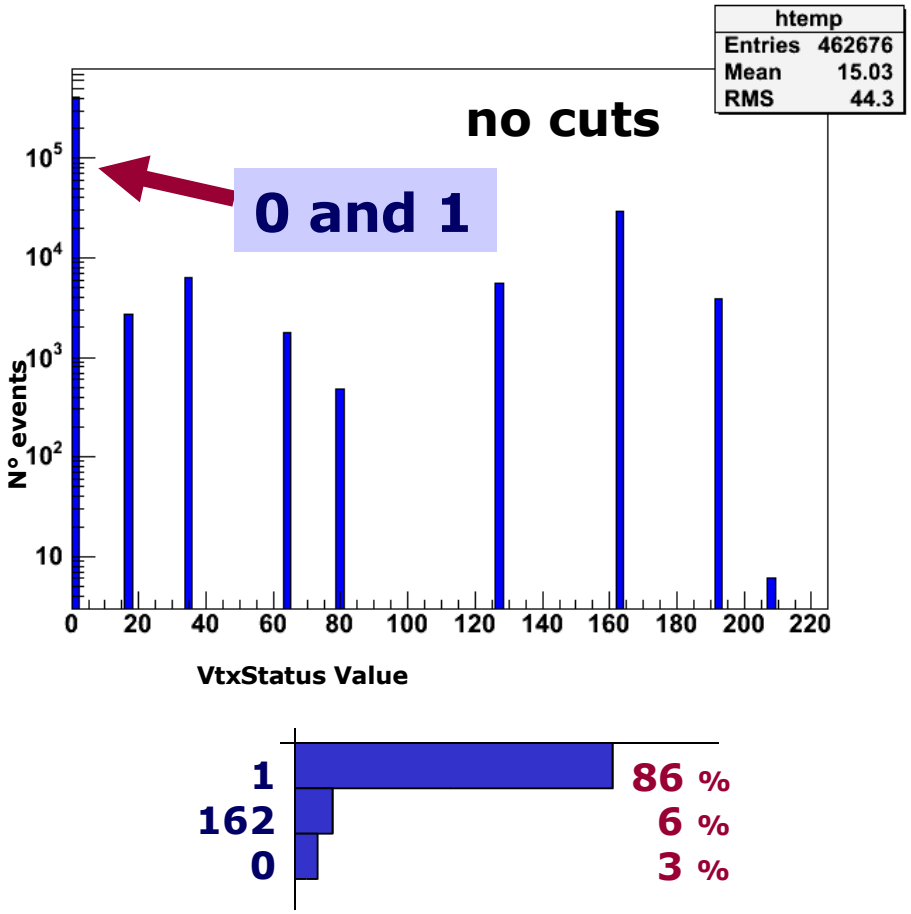
TkrNumTracks > 0
CalEnergySum > 10.
VtxAngle > 0.
Tkr1TotFirst > 1.
Tkr1SSDVeto > 1
Tkr1ToTTrAve > 1.3
VtxStatus = 162

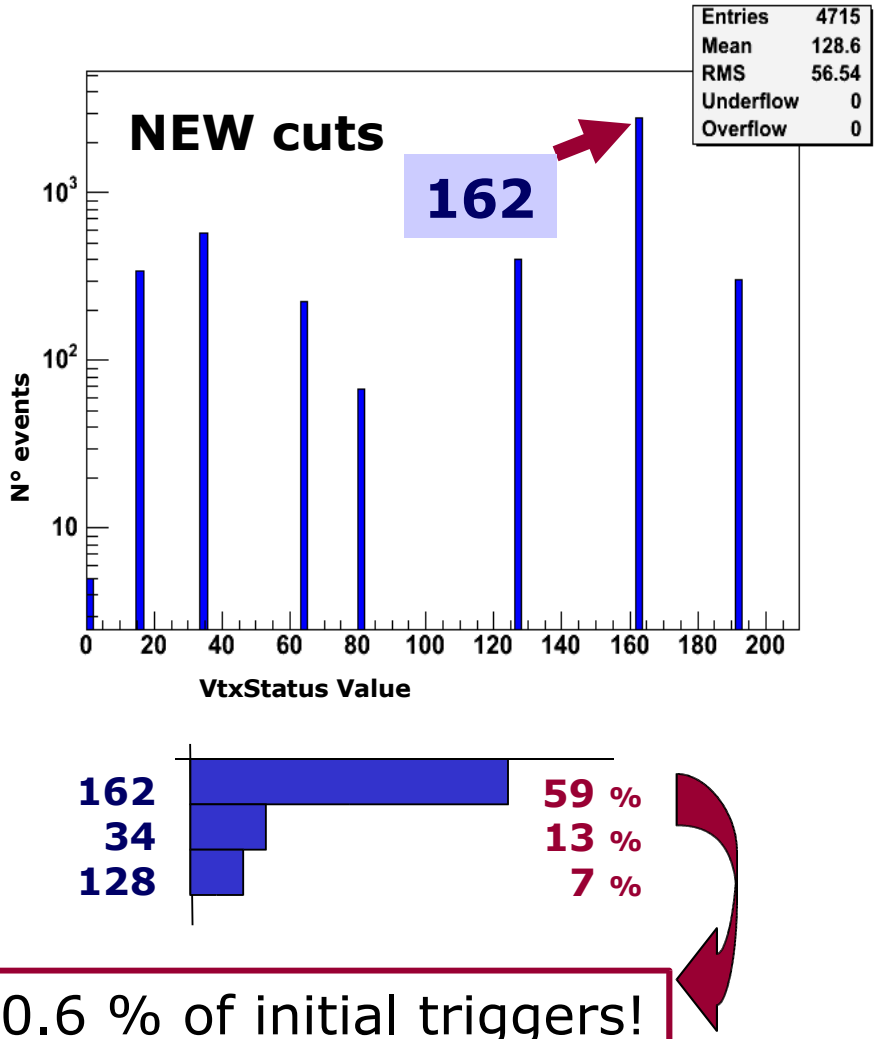
Extrapolate these numbers for full LAT we expect a factor of 100 more photon candidates in the next data set

Should we apply Elisabetta's cuts and create a photon sample for everyone?

VtxStatus Distribution

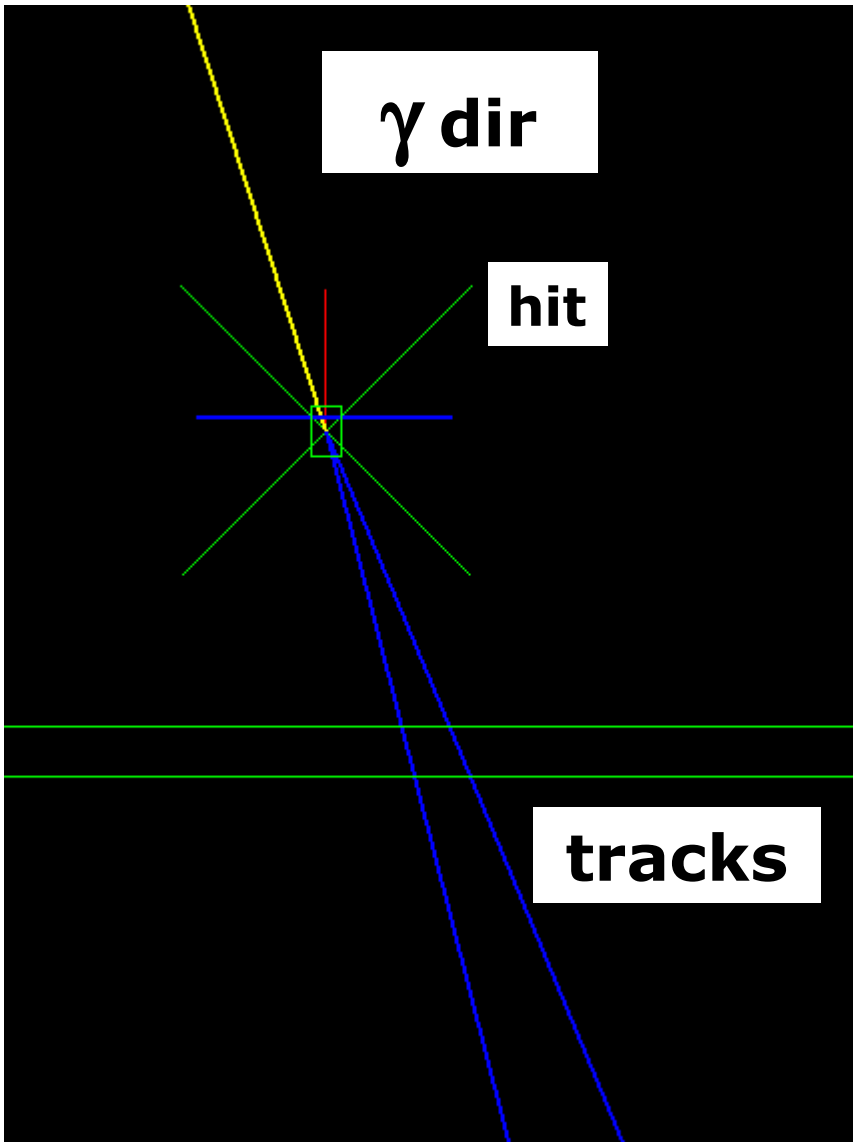
DATA 2 Towers

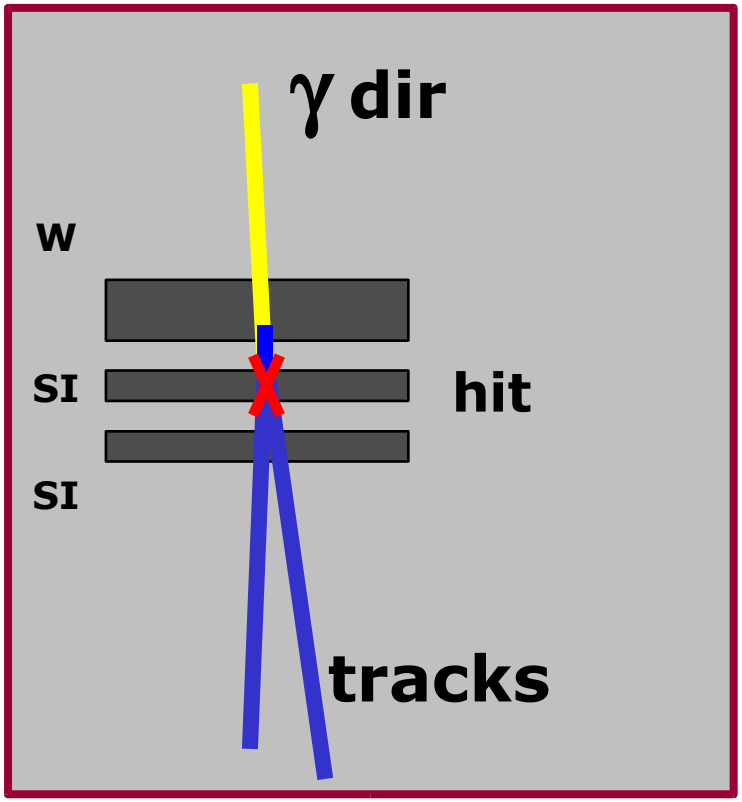




0.6 % of initial triggers!

VtxStatus 162

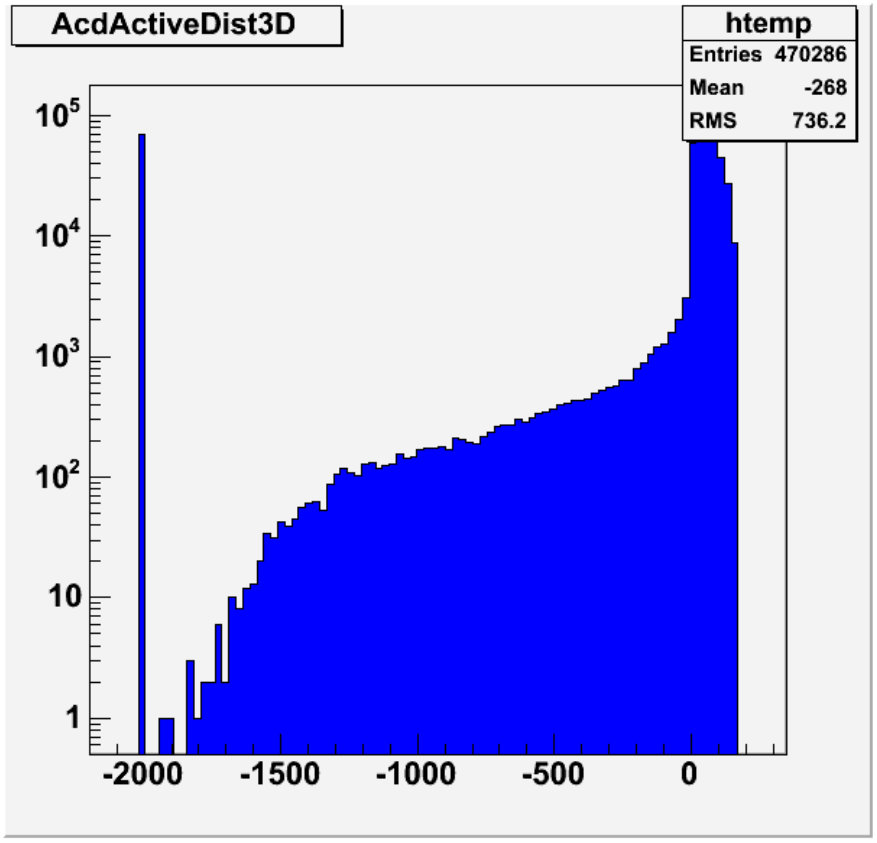


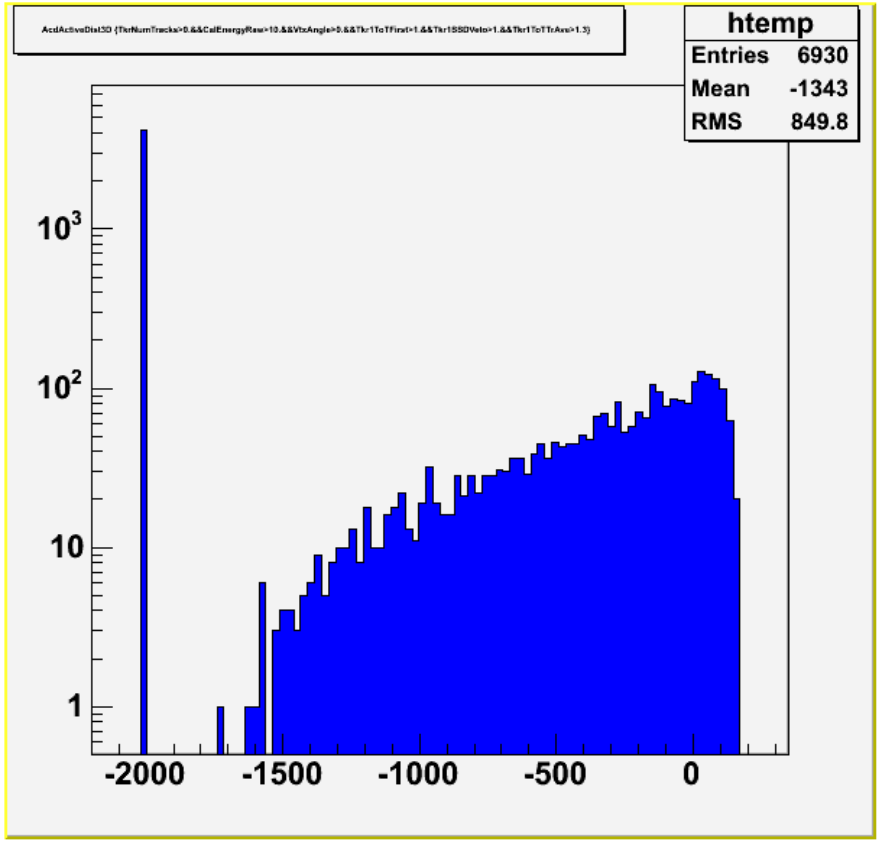


VtxStatus = 162

2 tracks vertex, vertex tracks share first hit and DOCA point lies inside track hits

AcdActiveDist3D





No Cuts

Simple Cuts

1) Analysis with DC2 cuts

How to get CTB variables in?

- Take original merit file
- Use GlastClassify executable file “apply.exe”
- Recalculates the CTB variables and fill the ntuples
- No need for reading back the recon file
- This will be needed if we asked also for “Onboard” filter type variables

"DC2" Cuts

- TCut DC2Trigger="(GltWord&10)>0&&(GltWord!=35)";
- //TCut DC2Filter="FilterStatus_HI==0";
- TCut DC2PrefilterCal="CalEnergyRaw>5&&CalCsIRLn>4";
- TCut DC2AcdVeto="(AcdCornerDoca>-5&&AcdCornerDoca<50&&CTBTkrLATEdge<100)||((AcdActiveDist3D>0 || AcdRibbonActDist>0)&&Tkr1SSDVeto<2)";

// Filter out high energy electrons

- TCut DC2ElectronVeto="((min(abs(Tkr1XDir),abs(Tkr1YDir)) < .01 && Tkr1DieEdge < 10 && AcdActiveDist3D > 0) || (Tkr1SSDVeto < 7 && AcdActiveDist3D > -3) || (AcdActiveDist3D >(-30 + 30*(Tkr1FirstLayer-2)))) && (CTBGAM+0.17*CTBBestLogEnergy)<1.75";

// Filter out some events at low-med energy where the Track 2 starts higher up than Track 1.

- TCut DC2AnotherVeto="(Tkr1FirstLayer - Tkr2FirstLayer) < 0 && Tkr2FirstLayer > 2 && Tkr2TkrHDoca>10 && (CTBGAM+0.16*CTBBestLogEnergy)<1.32 ";

Following Bill and Julie presentations at C&A group

"DC2" Cuts

// Heavy Ion Filter

- TCut HeavyIonVeto = "CTBBestEnergy>1000 && (((CalTransRms-1.5) *Tkr1ToTTrAve)<5)&&CTBGAM>0.5";

// Anti-correlated filter

- TCut AntiCorrVeto = "CTBBestEnergy<500&& ((CalCsIRLn+2.5*Tkr1CoreHC/Tkr1Hits)<8 || (Tkr1CoreHC/Tkr1Hits)<0.03)";

//Cosmic proton filter

- TCut ProtonVeto = "Tkr1FirstLayer<6&&AcdActiveDist3D>-80 && ((AcdActiveDist3D/100)>1)";

//Global Ribbon Extension and AcdCornerDoca Extension

- TCut GlobalRibbonVeto = "(AcdRibbonActDist > -10) || (AcdCornerDoca >-5 && AcdCornerDoca<50 &&CTBTkrLATEdge<200)";

- TCut DC2Vetos = DC2AcdVeto||DC2ElectronVeto||DC2AnotherVeto|| HeavyIonVeto||AntiCorrVeto|| ProtonVeto||GlobalRibbonVeto;

- TCut Basic = "CTBCORE>0.1&&CTBBestEnergyProb>0.1&&CTBGAM>0.";
- TCut ratecut = "CTBBestZDir<-0.3&&CTBBestEnergy>100.";

"DC2" Cuts

- TCut DC2Base1 = "CTBCORE>0.1 &&CTBBestEnergyProb>0.3 &&CTBGAM>0.35";
- TCut DC2Base2 = "CTBCORE>0.1 &&CTBBestEnergyProb>0.1 &&CTBGAM>0.55";
- TCut DC2Base3 = "CTBCORE>0.35 &&CTBBestEnergyProb>0.35 &&CTBGAM>0.50";

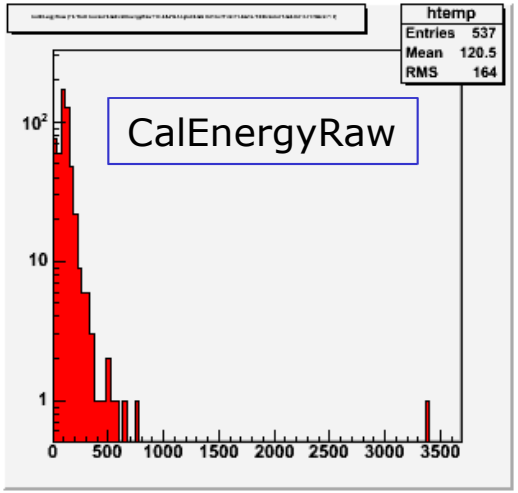
// Final Analysis Classes

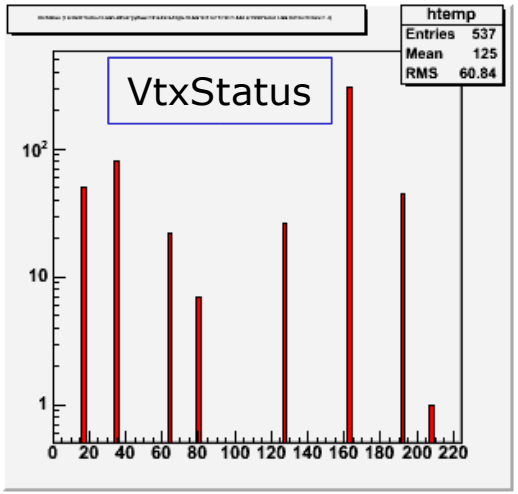
- TCut GoodEvent1=(DC2Base1&&DC2Trigger&&DC2PrefilterCal) &&!DC2Vetos;
- TCut GoodEvent3=(DC2Base3&&DC2Trigger&&DC2PrefilterCal) &&!DC2Vetos;

// For DC2 we propose using the GoodEvent1 and GoodEvent3 analysis classes.

- TCut EventClassA = GoodEvent3;
- TCut EventClassB = GoodEvent1&&!GoodEvent3;

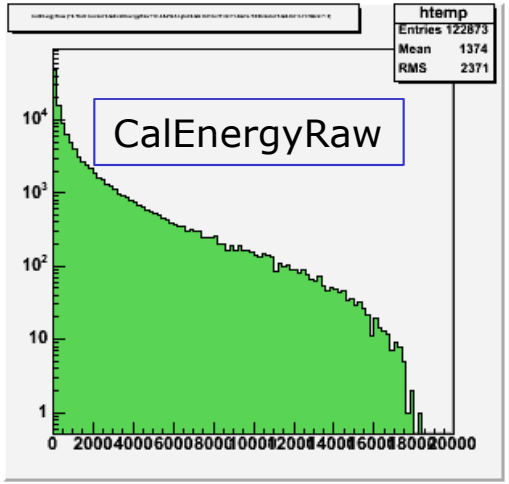
Results

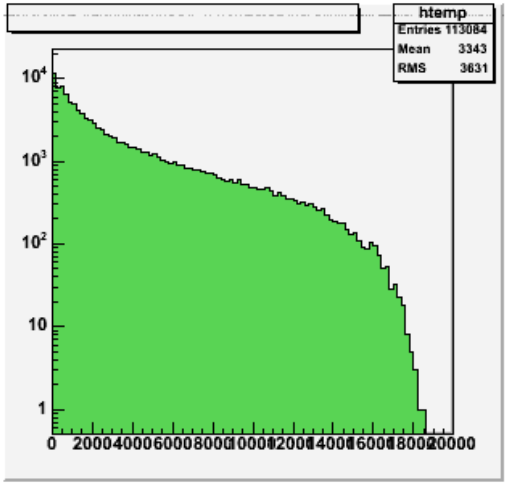


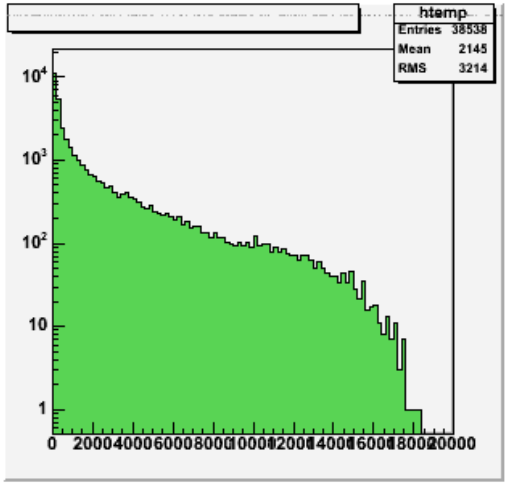


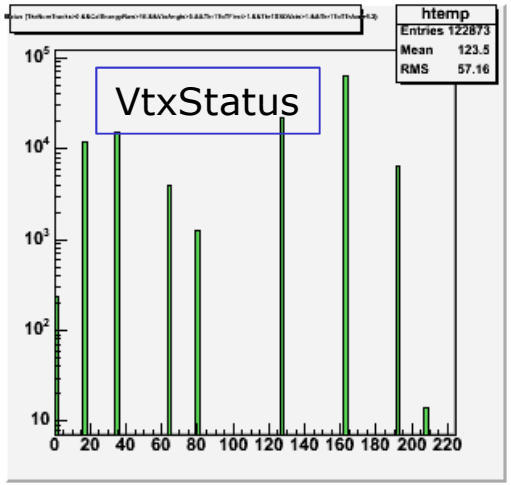
Simple Cuts **"DC2" EventClass A and B**

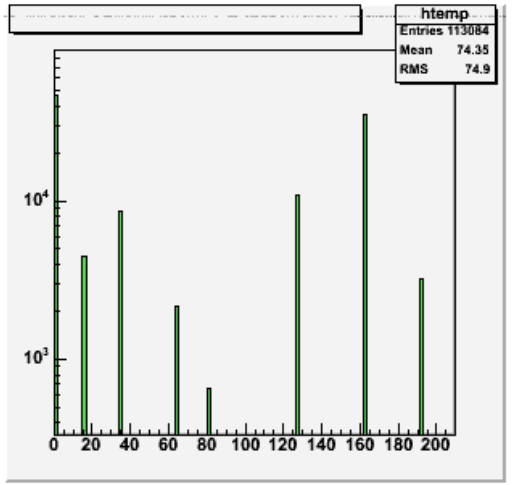
Results

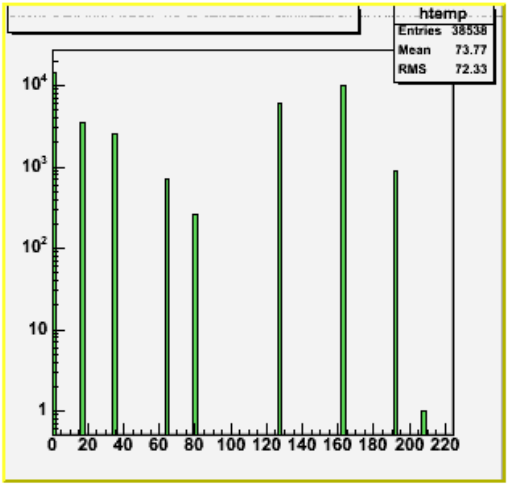






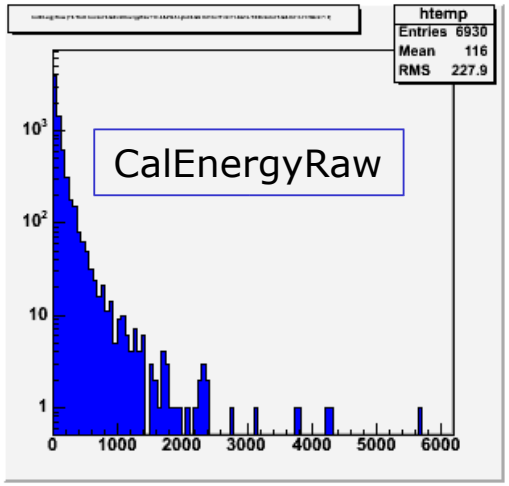


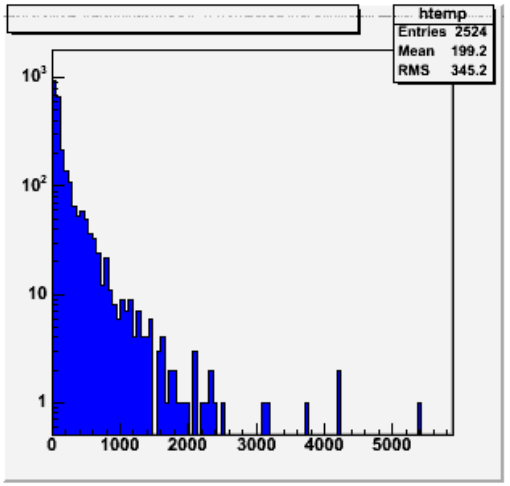


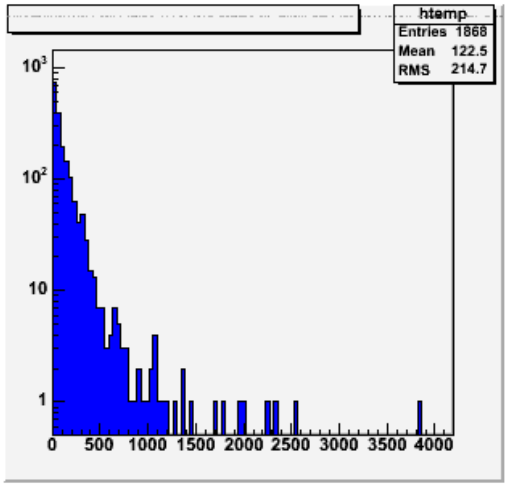


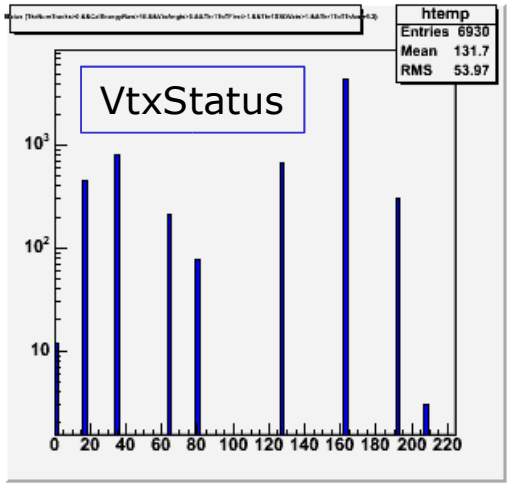
Simple Cuts **"DC2" EventClass A and B**

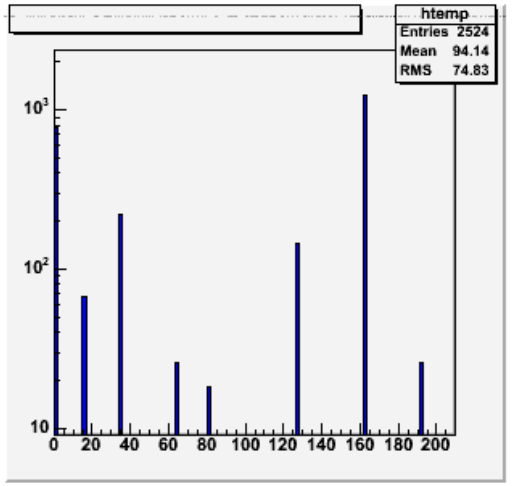
Results

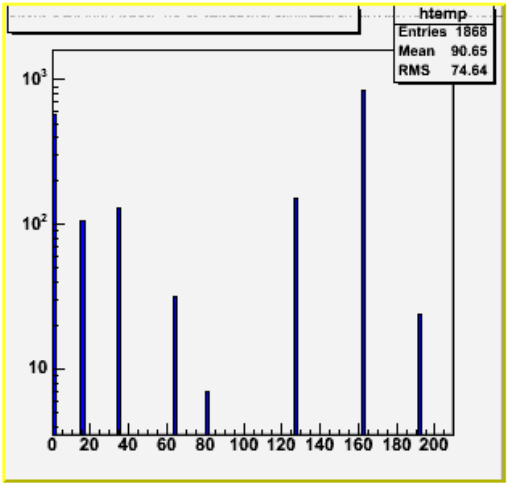












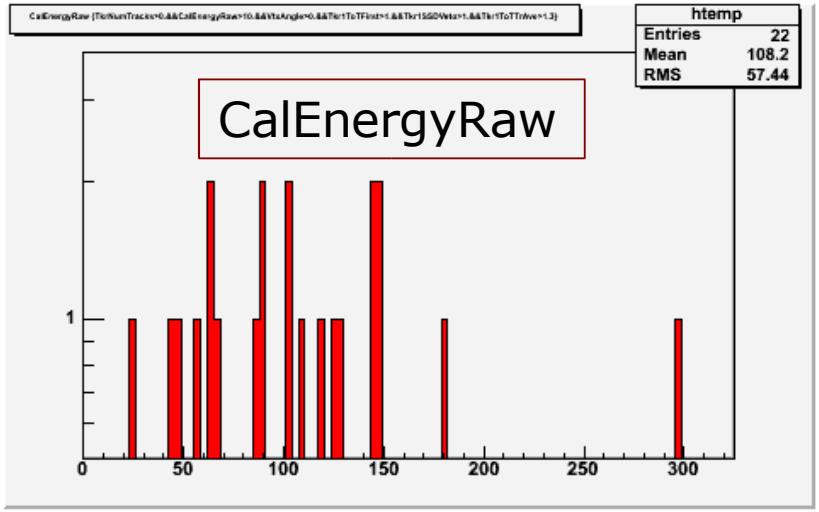
Simple Cuts "DC2" EventClass A and B

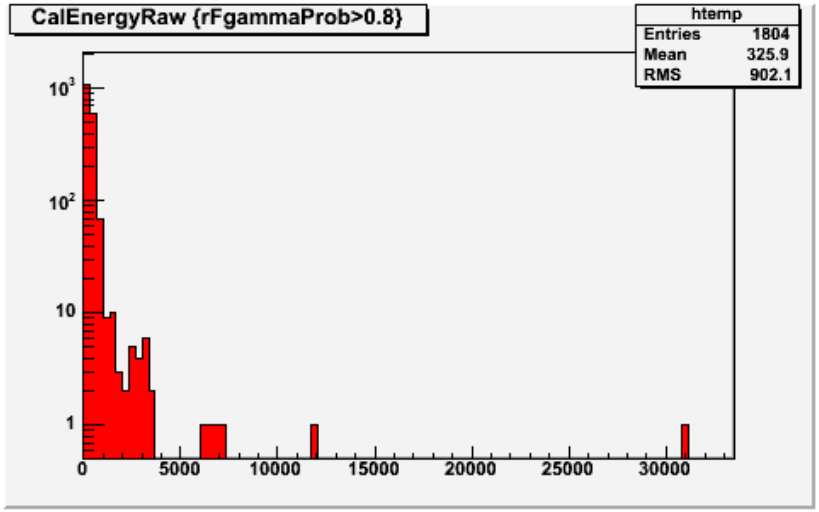
1) Analysis with rForest (random forest package developed by R.Rando)

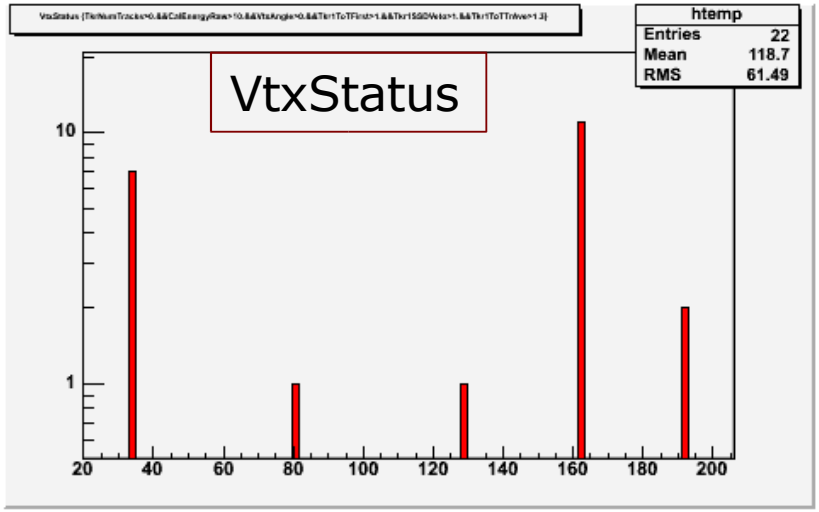
How to do that?

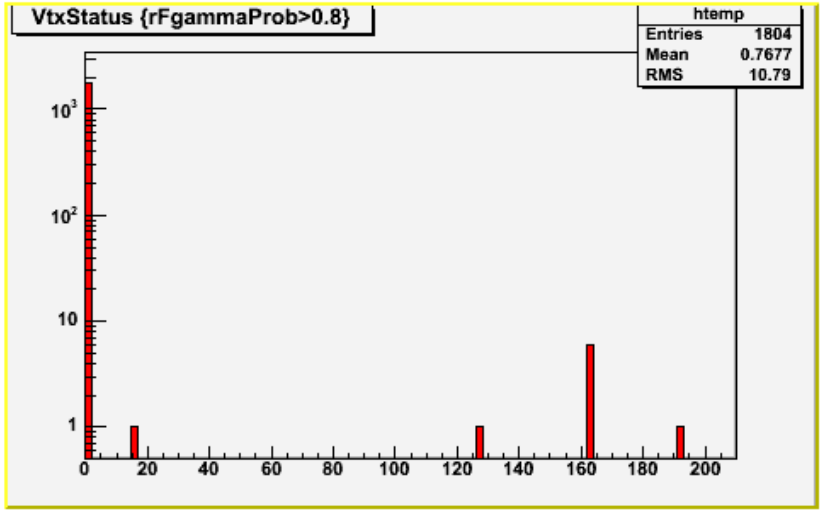
- Package available in /users/rando/rForest
- Actually tag v2r1p2
- Two executables + some utilities
- Create two sets of data (gamma and muon sample)
- fcreate.exe takes the input merit files of the classes to be analysed and create the selection tree file
- More details on rForest could be found at Riccardo's tutorial at the INFN GLAST SW meeting http://glast.ba.infn.it/~glast/f2f/bari2_rando.pdf
- fprocess.exe calculates the result for each event

Results





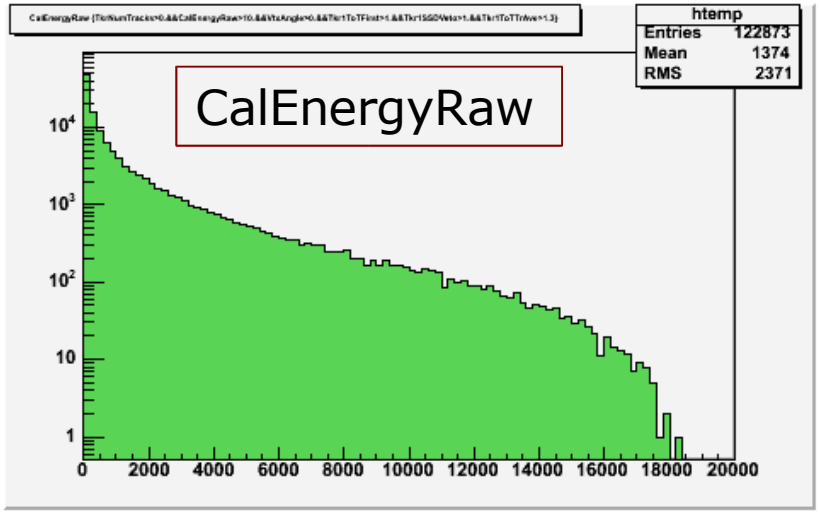


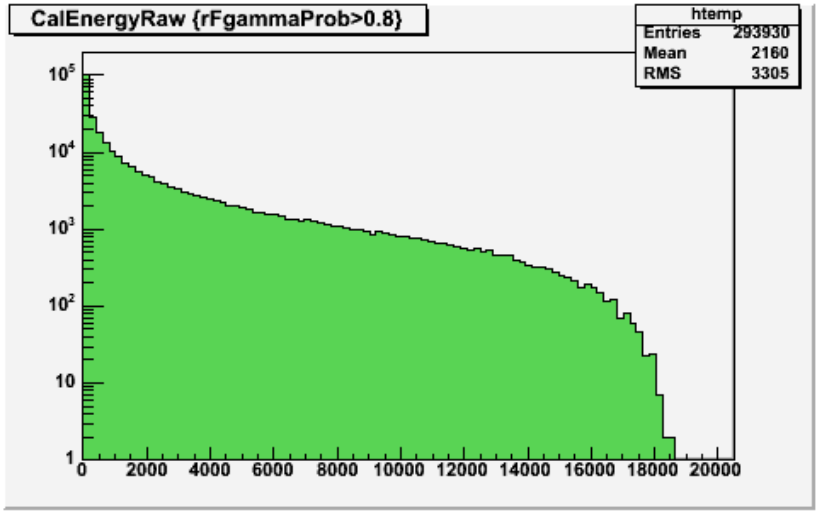


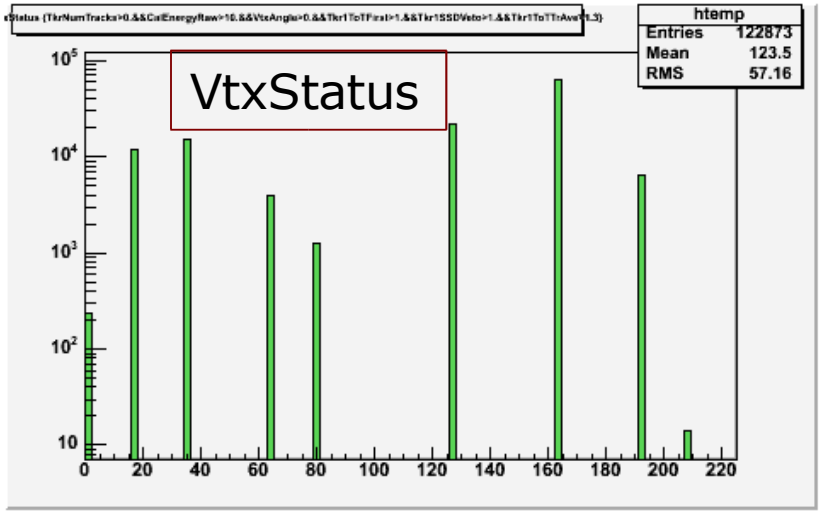
Simple Cuts **rForest (not optimized)Cuts**

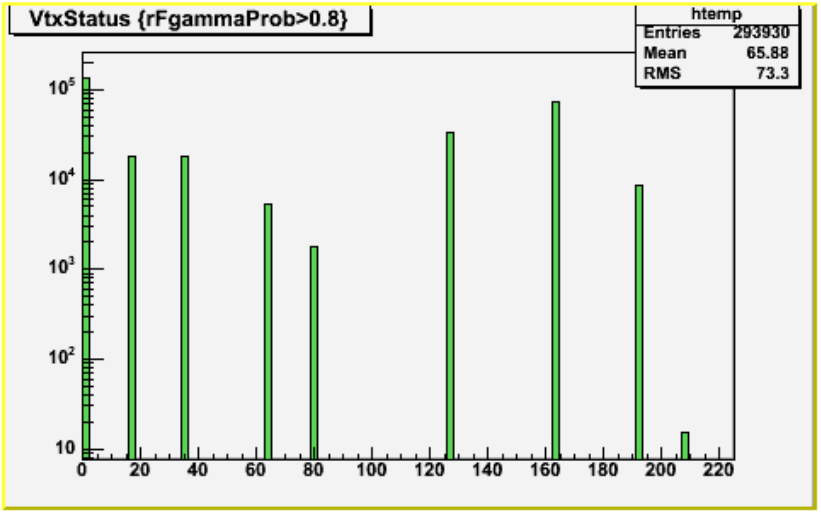
NB. Different surface muons file (due to a technical problem)

Results



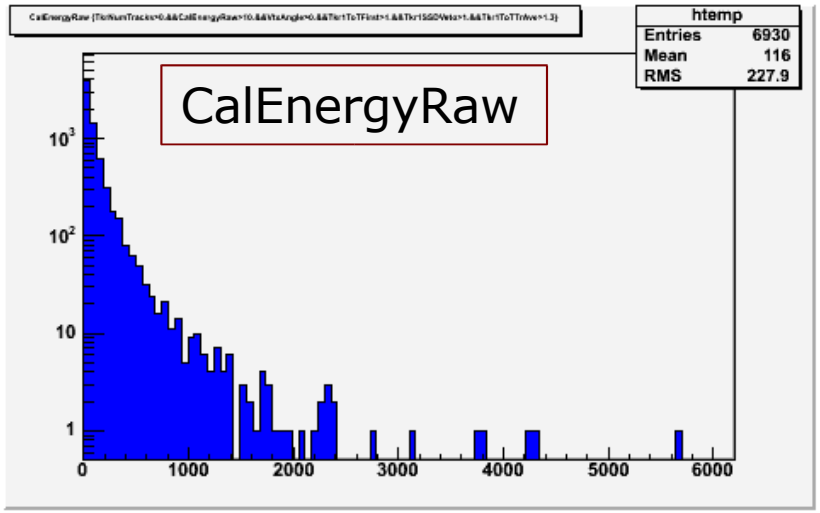


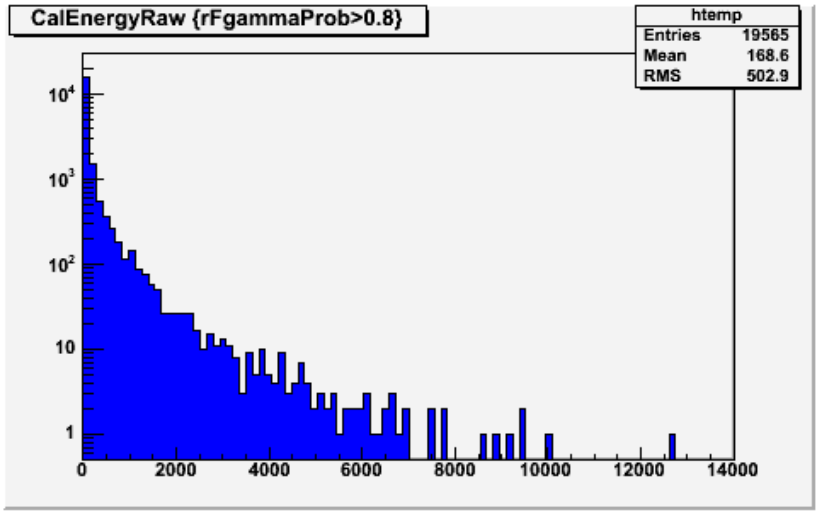


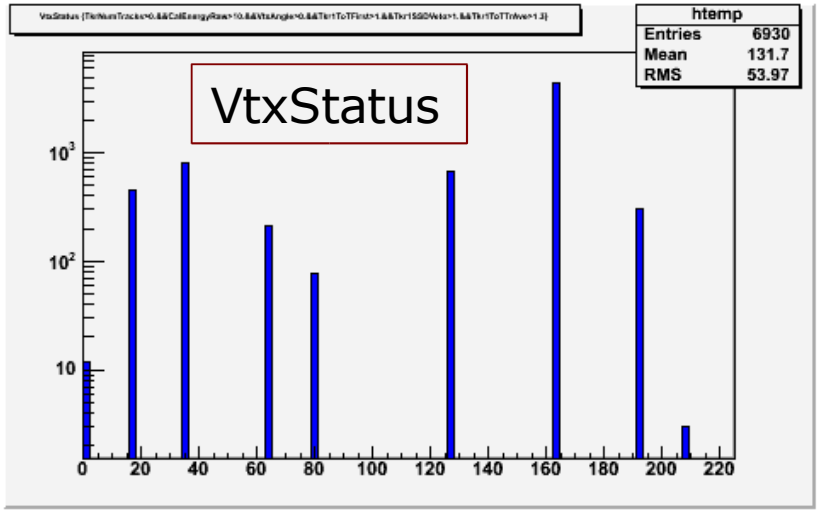


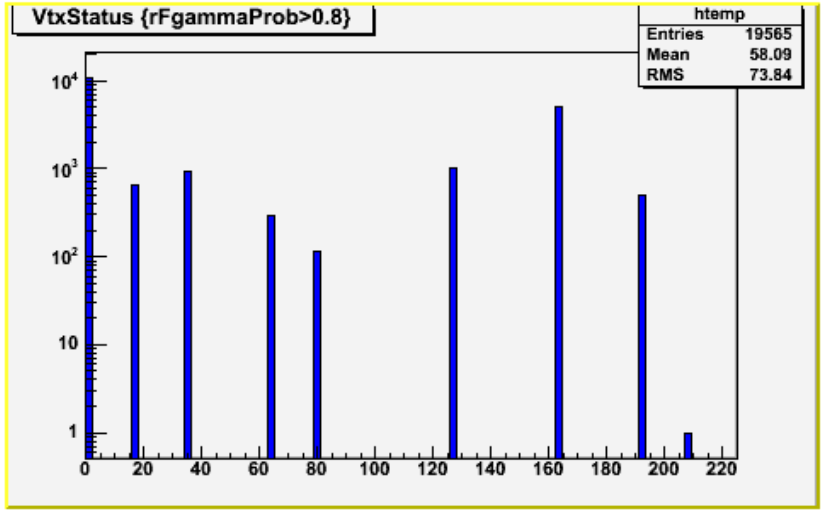
Simple Cuts **rForest (not optimized)Cuts**

Results







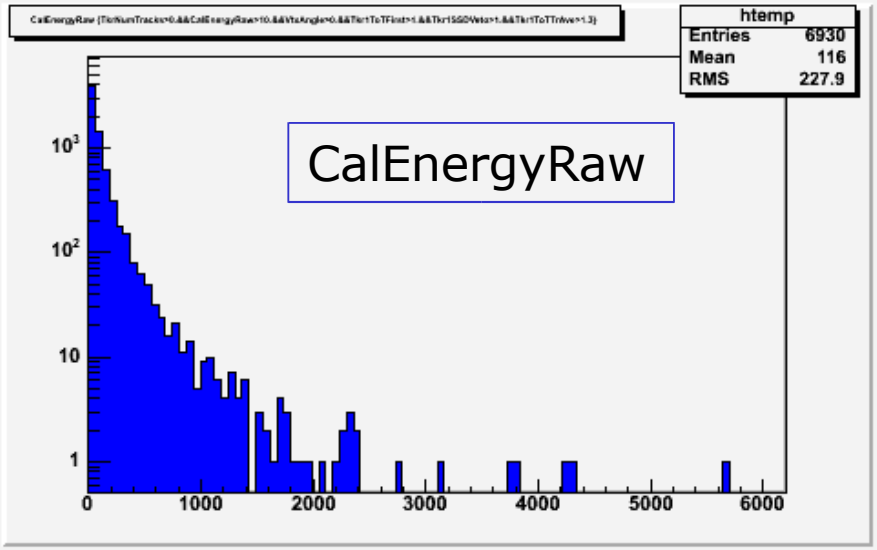


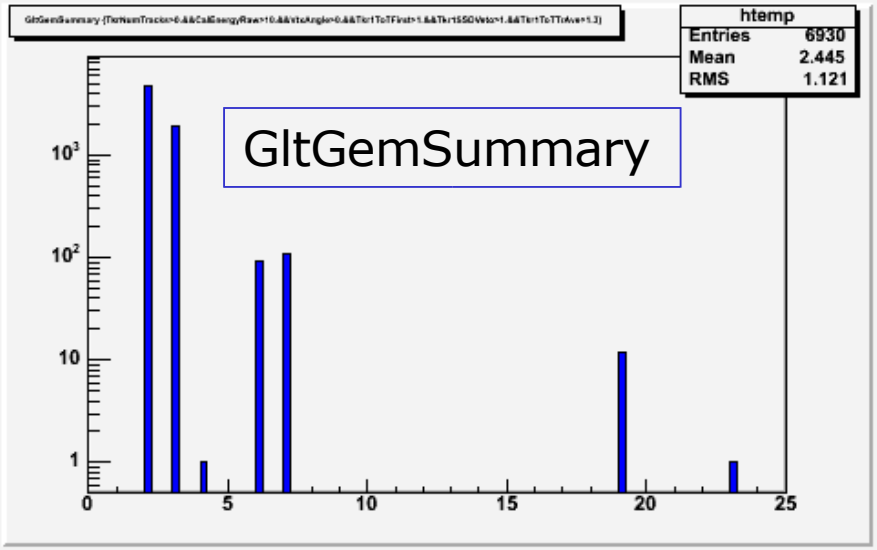
Simple Cuts **rForest (not optimized)Cuts**

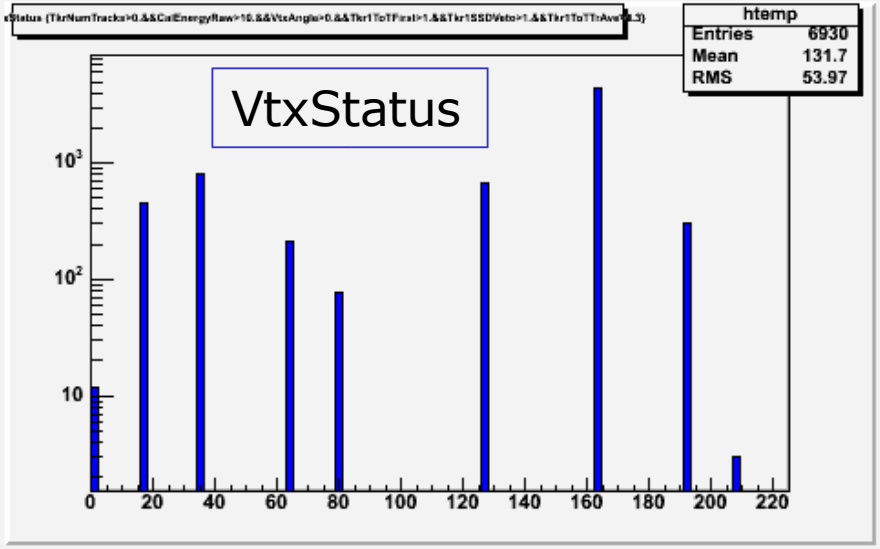
Plot of overall distributions in "photon samples"

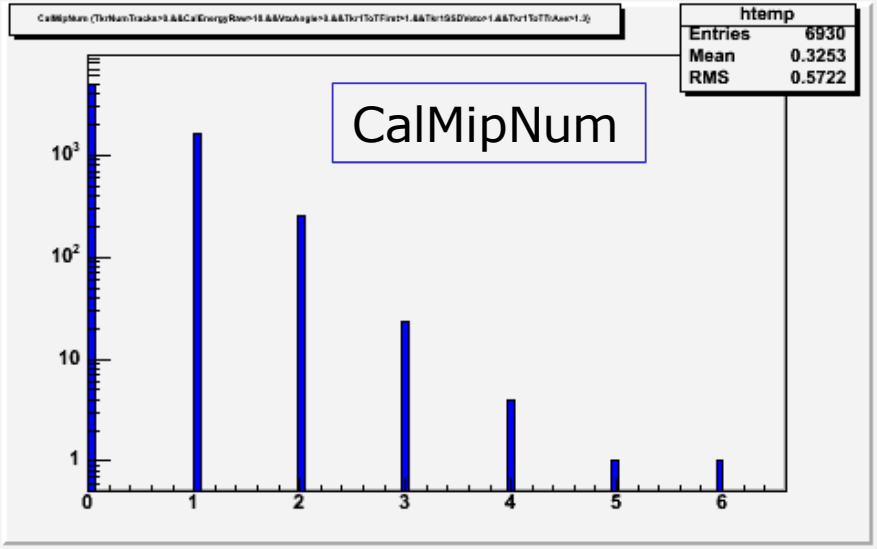
Preliminary analysis

Simple Cuts (1) Results (6930 evts)

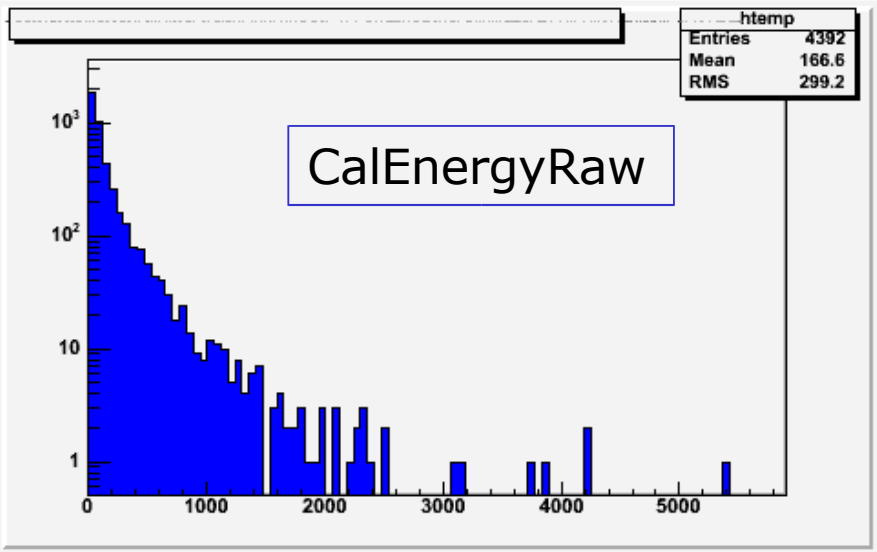


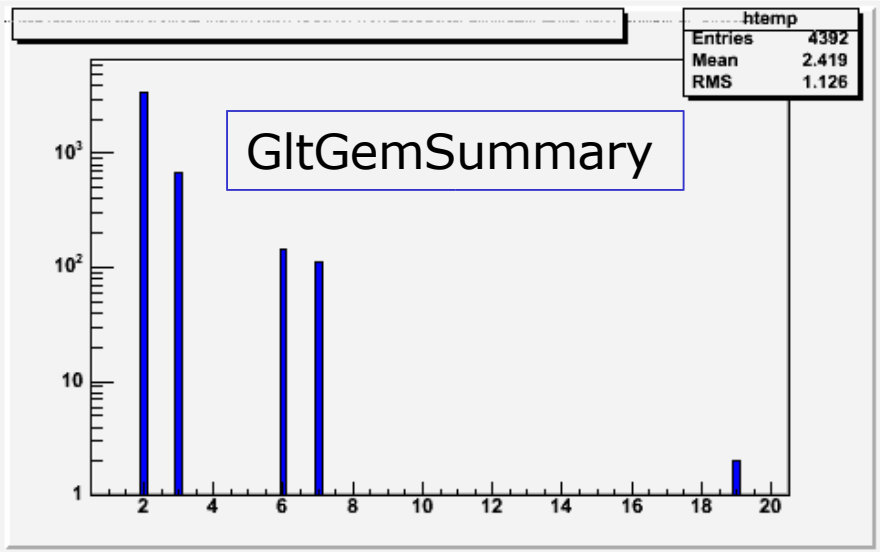


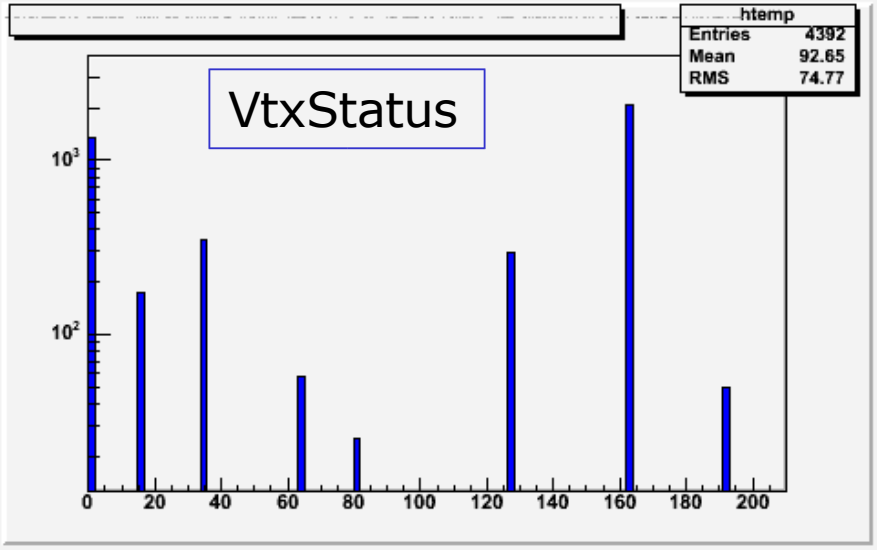


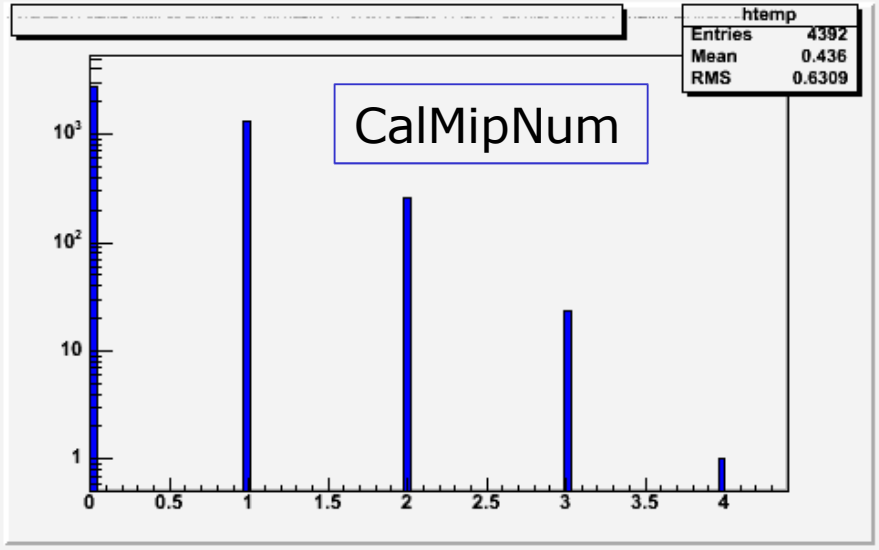


"DC2" (2) results (4392 evts)

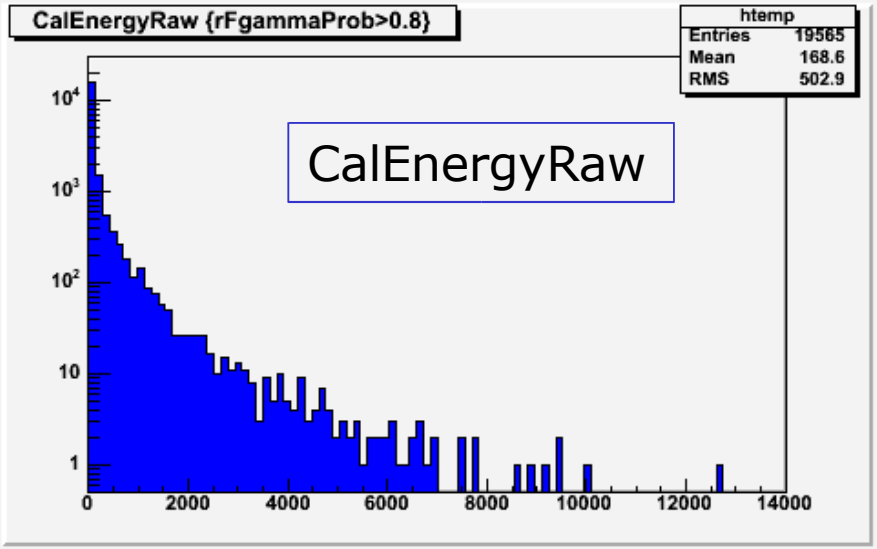


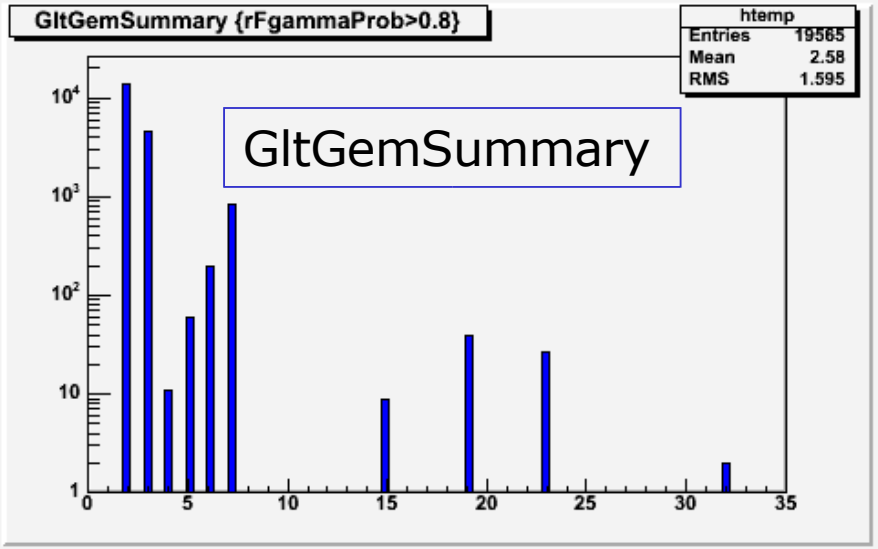


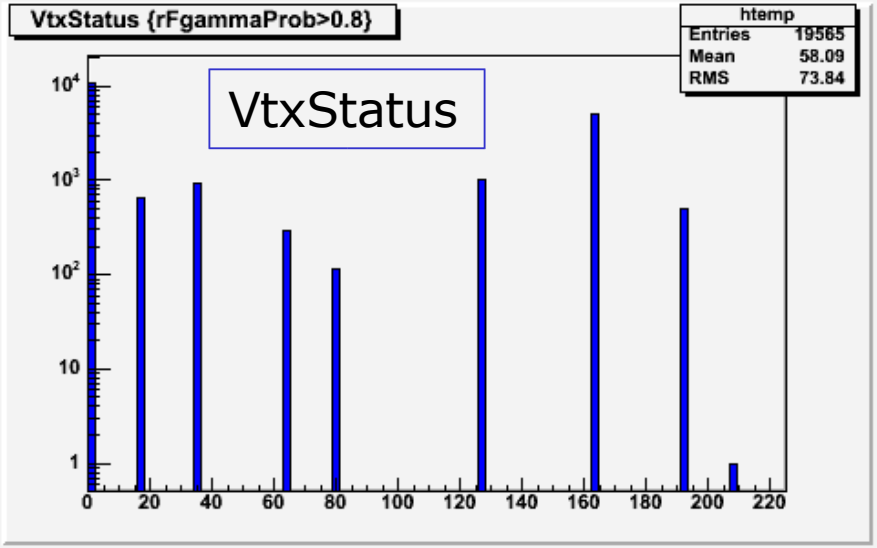


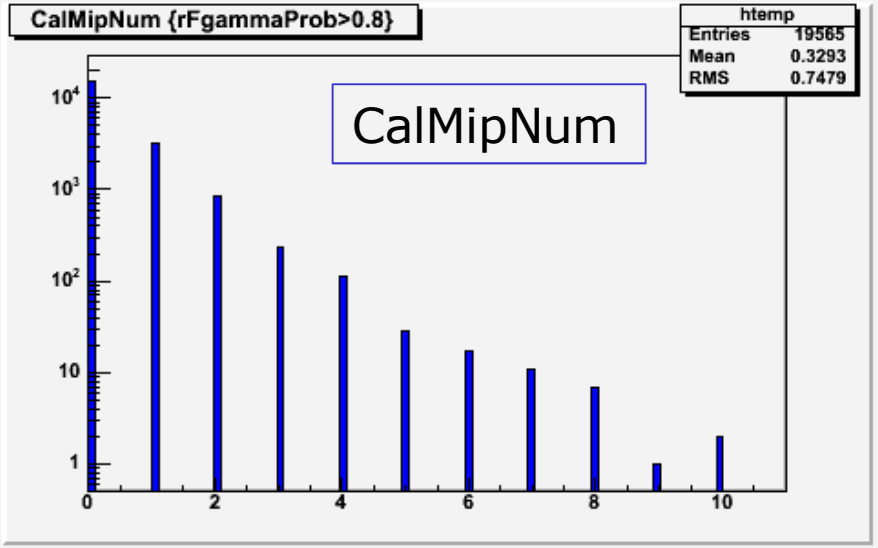


rForest (3) Results (19565 evts)

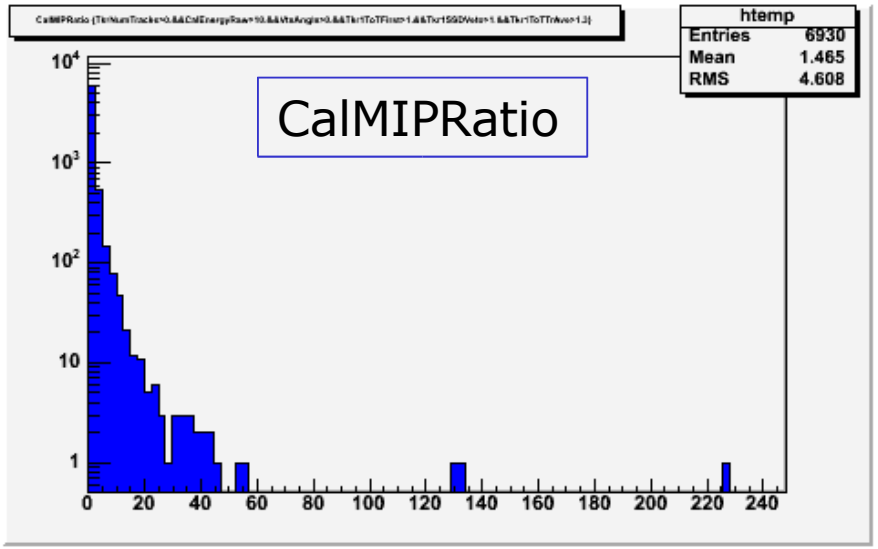


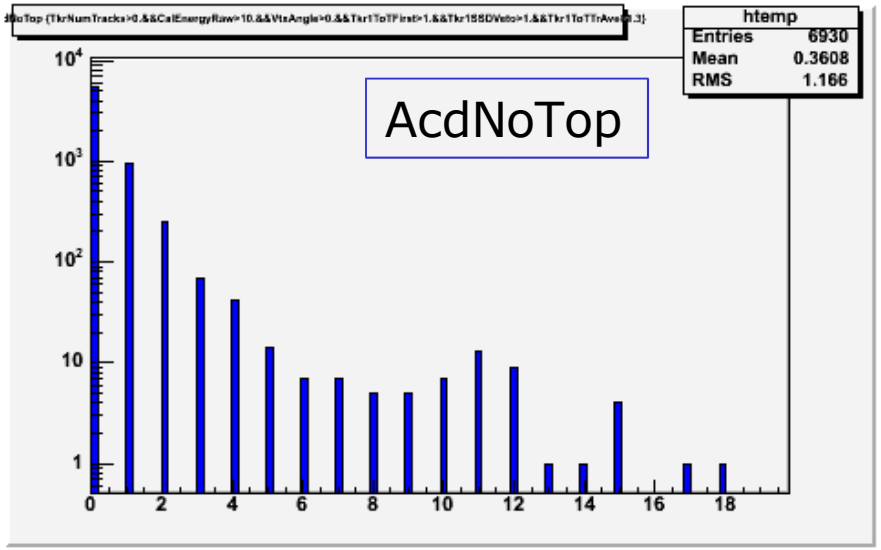


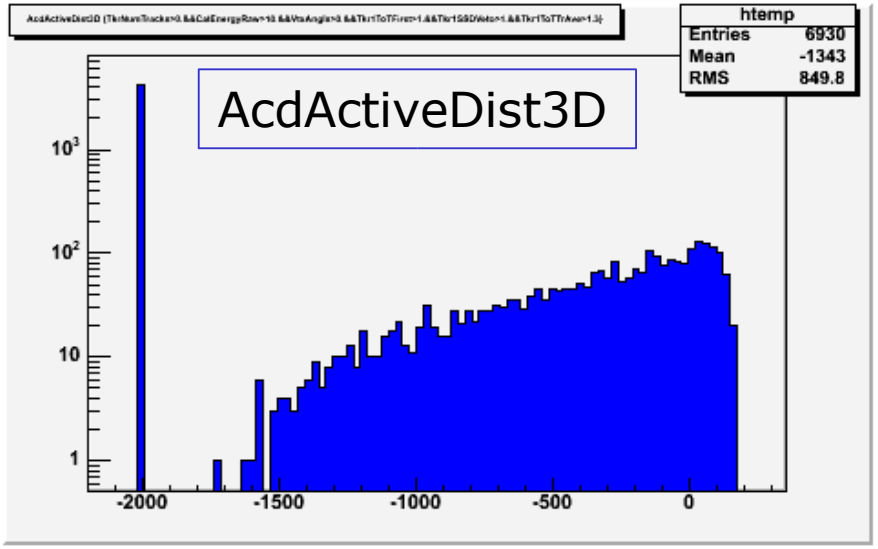


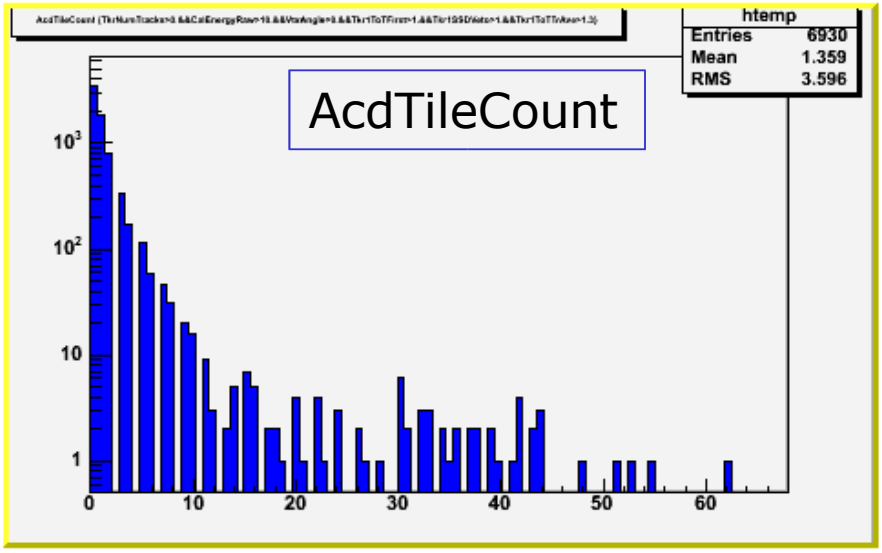


Simple Cuts (1) results

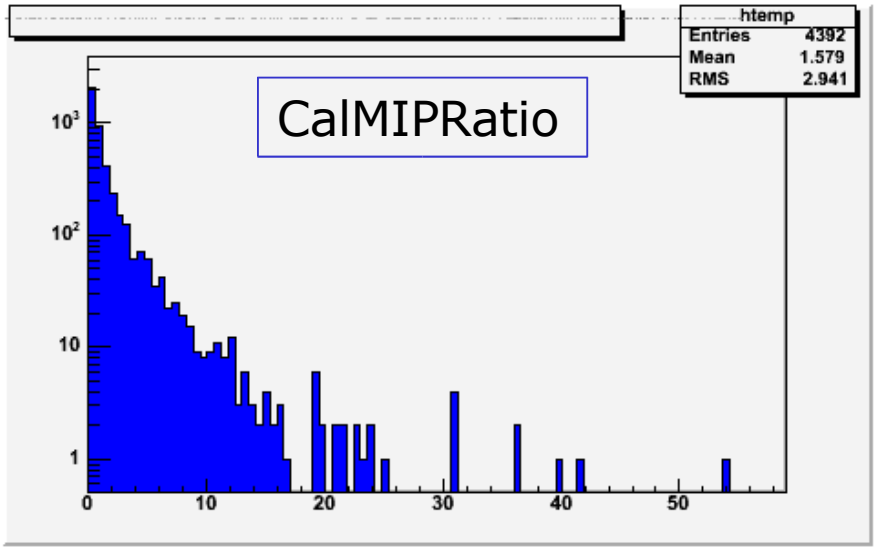


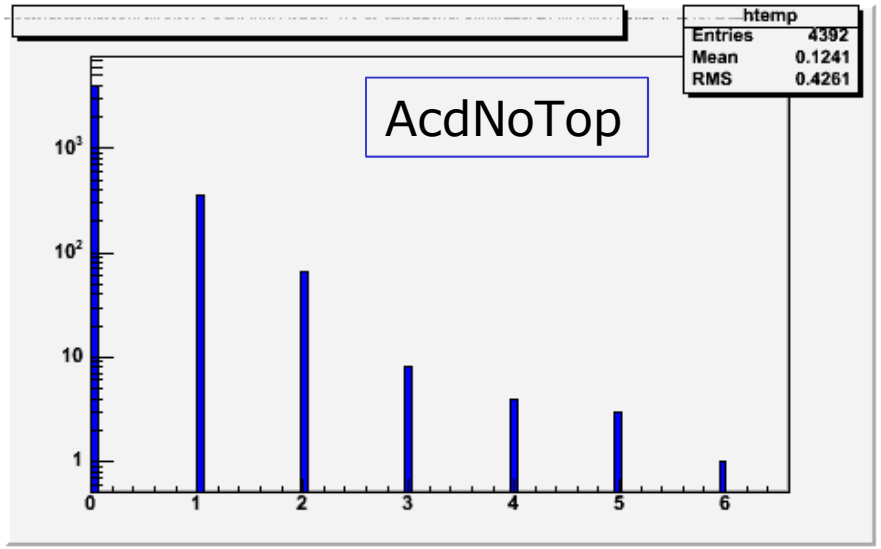


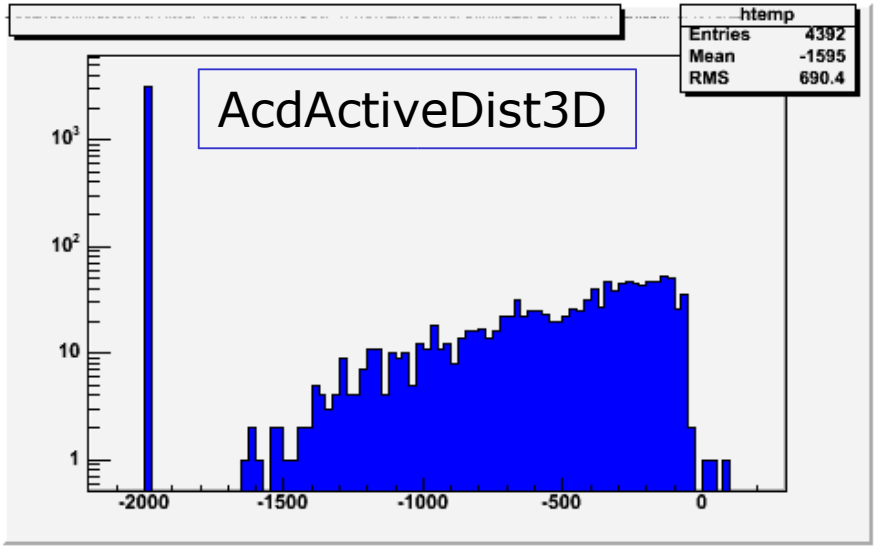


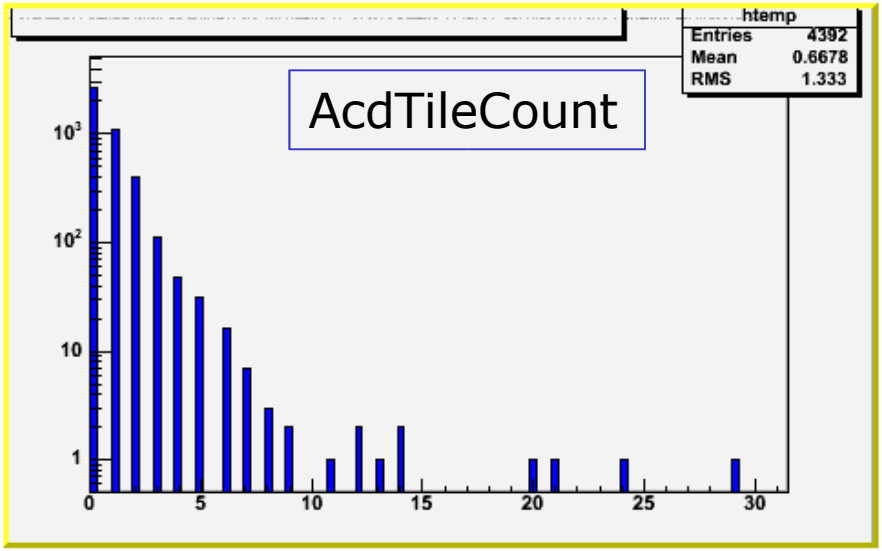


"DC2" (2) results

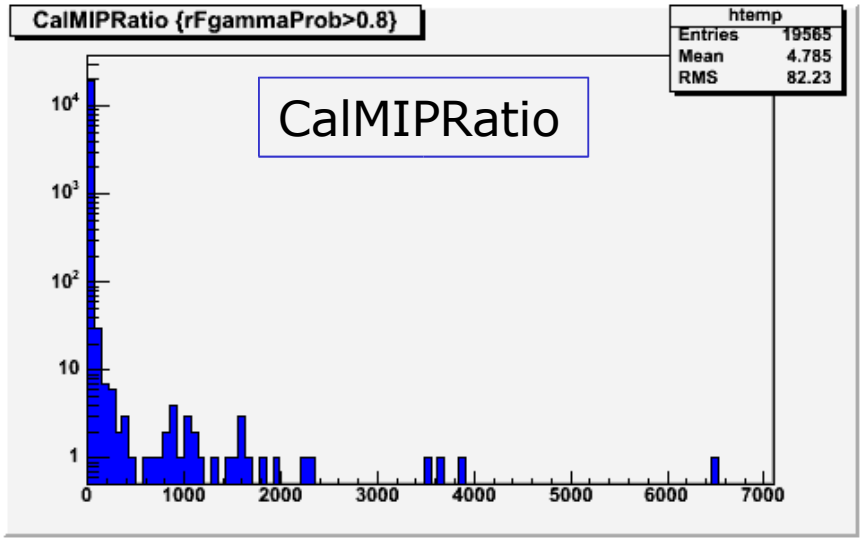


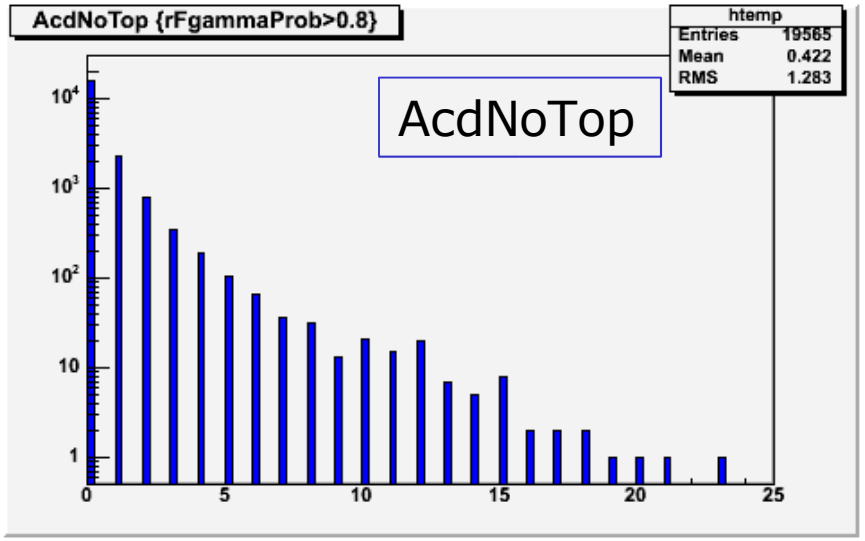


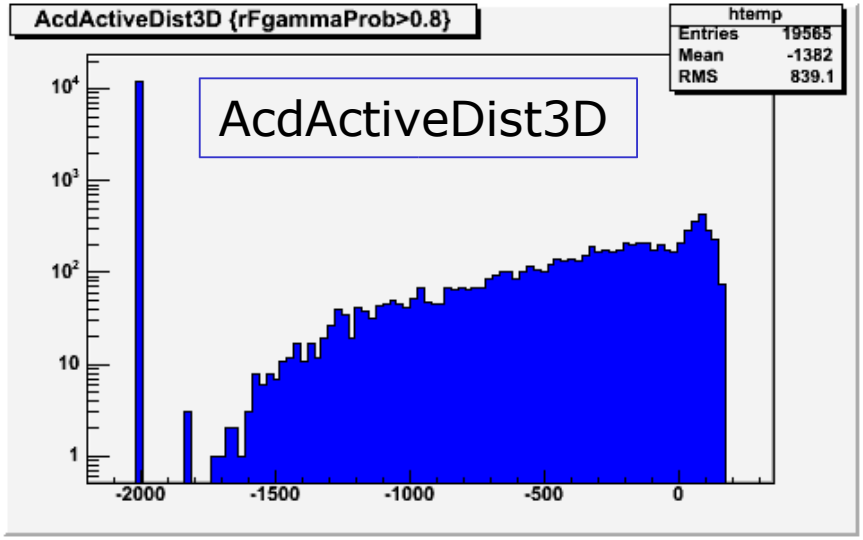


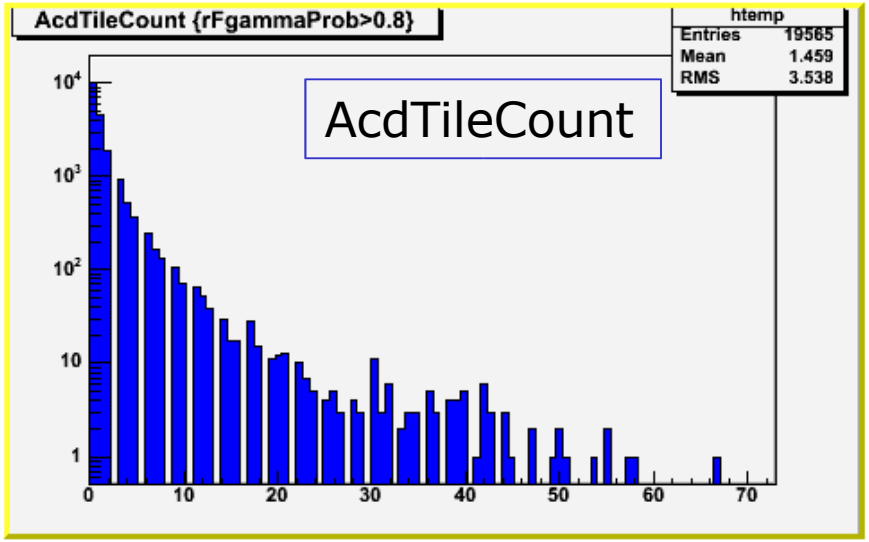


rForest (3) Results









To Do List

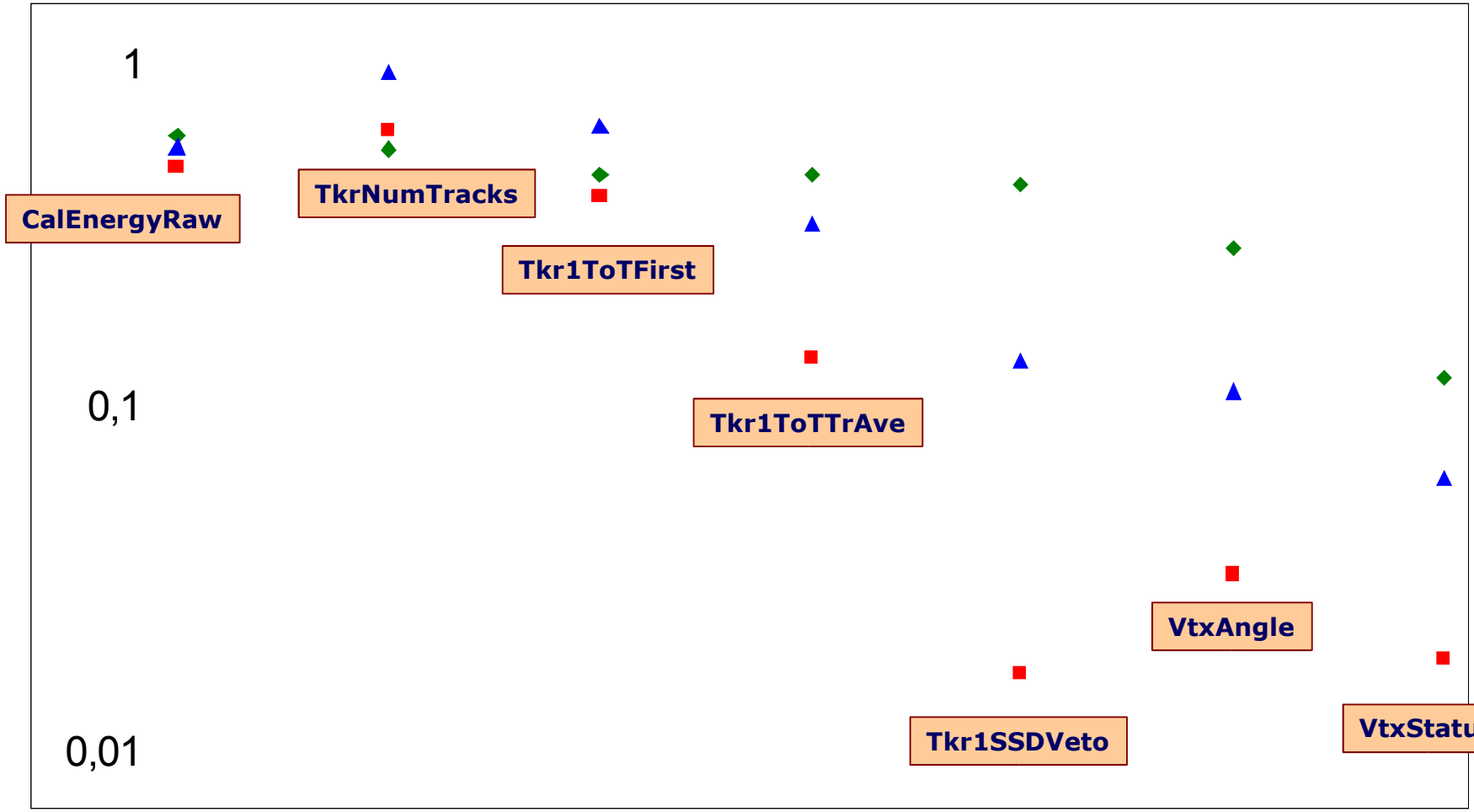
- Refine rForest analysis
- Try GlastClassify analysis
- Closer look to selected photon candidates
- Deeper use of ACD and CAL variables
- Analysis of selected distributions
- Redo for FSW
- Reanalysis of “muon” recon candidates

Conclusions

- Simple selection cuts seem to be satisfactory
- Need to develop ad hoc selection trees
- Simple analysis performed
- Need to continue with other runs

Backup

Variables' Importance



CTB Variable Definitions

CTBAcdLowerTileCount	AcdNoSideRow3
CTBAcdUpperTileCount	AcdNoTop+AcdNoSideRow0+AcdNoSideRow1+AcdSideRow2
CTBBestPSFerr	Acos(BestDir * McDir)
CTBBestXDir, YDir, ZDir	Best direction selected between VTX and Tkr1 Solutions
CTBBestDeltaEoE	Best Energy Error relative to MC energy D(E)/E
CTBBestEnergy	Best Estimated energy from among the 4 methods
CTBBestEnergyProb	**Energy Prob. Knob. Energy RESOLUTION:** Prob. for the selected energy correction method
CTBBestLogEnergy	Log(CTBBestEnergy) – base 10
CTBCORE	**Image Prob. Knod. IMAGE RESOULTION**
CTBCalDocaAngle	CalTrackDoca + 80*CalTrackAngle
CTBCalMaxXtalRatio	CalXtalMaxEne/CalEnergyRaw
CTBCalTransTCCD	CalTransRms + .1*(CalTrackDoca - 2.5*Tkr1CoreHC)
CTBGAM	**Bkg. Rejection Prob Knob: BACK GROUND CONTAMTINATION**
CTBLastLayerProb, ParamProb, ProfileProb, TrackerProb	Prob. for the "corrections" of each energy method against a fixed functional standard.

More... CTB Variable Definitions

CTBTkrCoreCalDoca	CalTrackDoca - 2.5*Tkr1CoreHC – Bkg. Rej. Variable
CTBTkrEnergyFrac	TkrEnergyCorr/EvtEnergyCorr – Bkg. Rej. Variable
CTBTkrLATEdge	742. - max(abs(Tkr1X0) , abs(Tkr1Y0)) – Fiducial Volume Var.
CTBTkrSHRCalAngle	CalTrackAngle - .2*TkrSurplusHitRatio – Bkg. Rej. Var.
CTBVTX	Internal Prob use to select between 1TKr solution and VTX