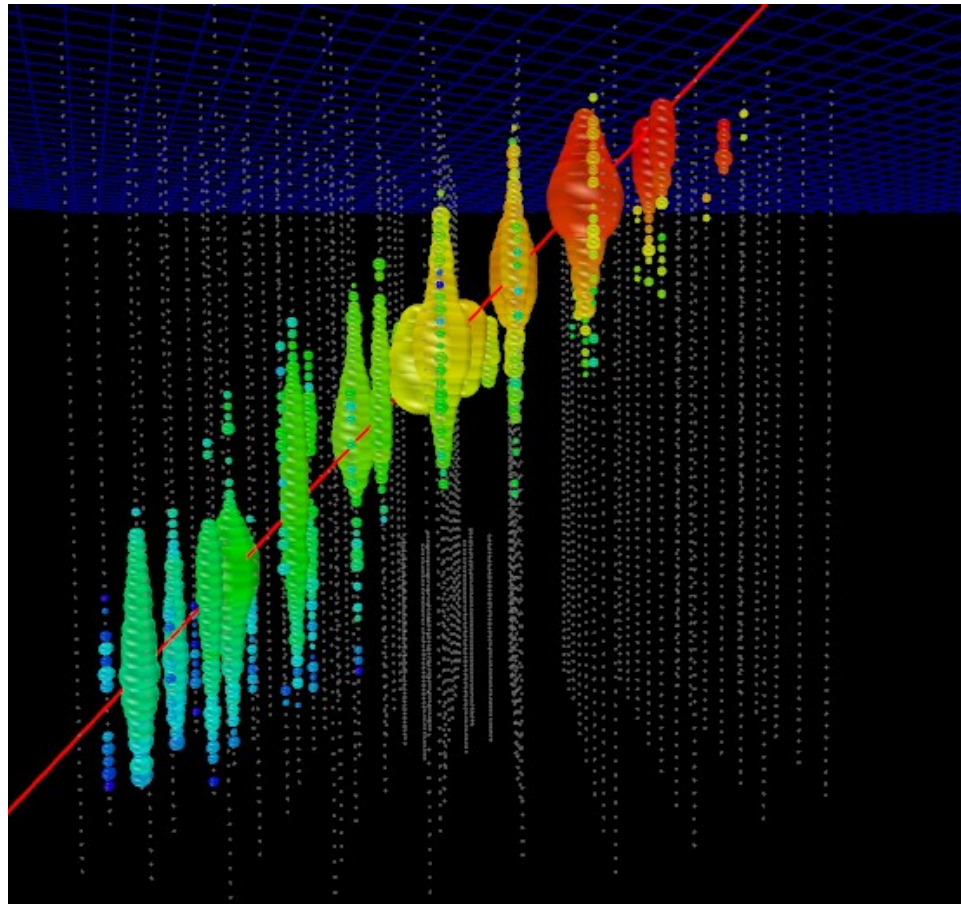




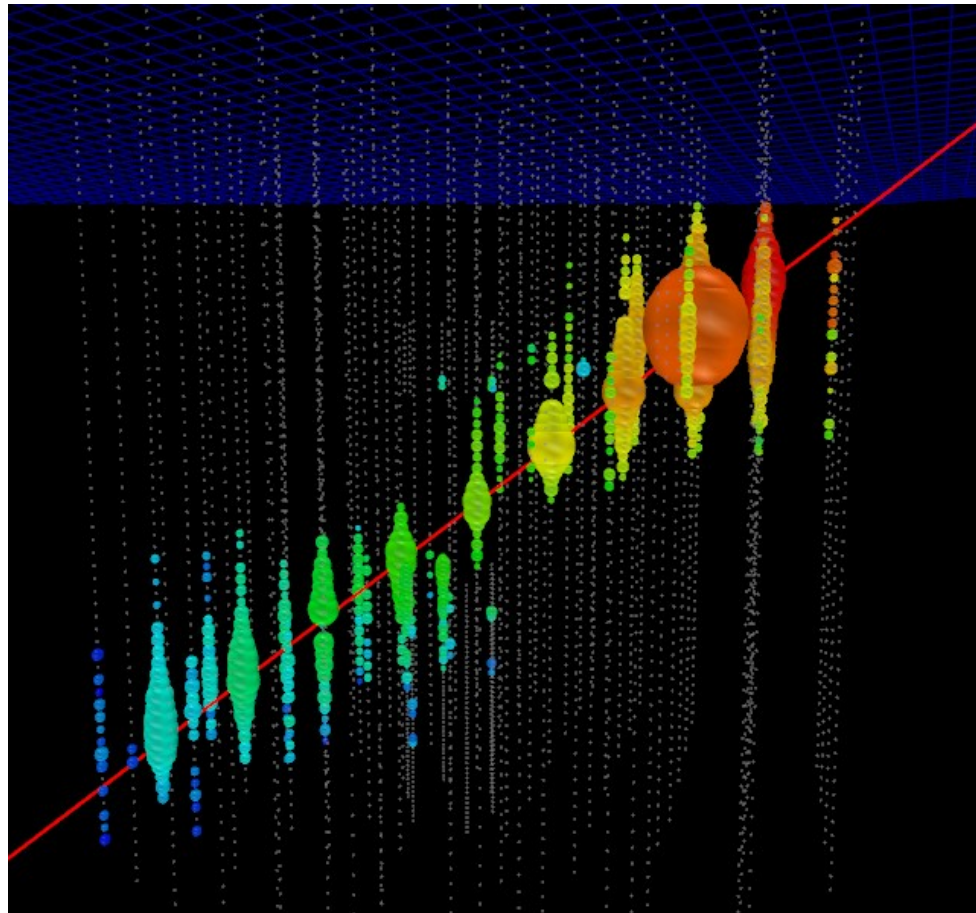
Reconstructing HE Muon Spectrum using Datamining (IC86)  
by  
Tomasz Fuchs

## Bundles

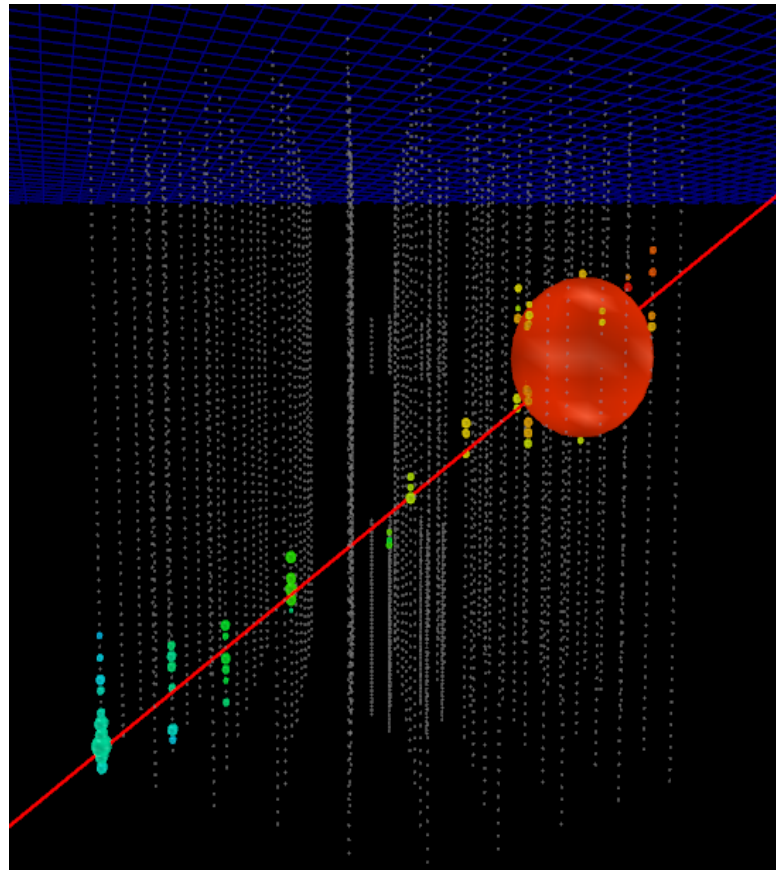




## HE Muons



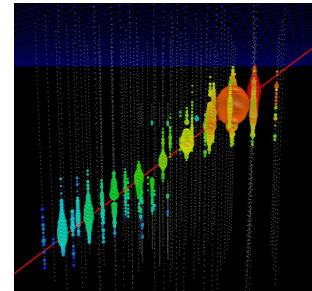
# Balloons



## Event Definition

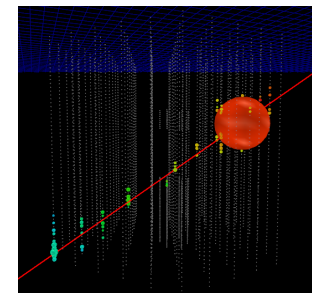
HE Muon:

$$E_{\max} / E_{\text{tot}} > 0.5$$
$$Q_{\max} / Q_{\text{tot}} < 0.2$$



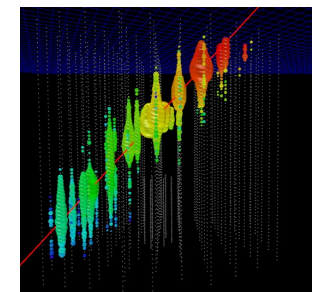
Balloon:

$$E_{\max} / E_{\text{tot}} > 0.5$$
$$Q_{\max} / Q_{\text{tot}} > 0.2$$



Bundle:

$$E_{\max} / E_{\text{tot}} < 0.5$$



## Quality Cuts

- PE > 1000
- TrackLengthC > 600m
- SplineMPE not failed

## # Events After Quality Cuts

9622:

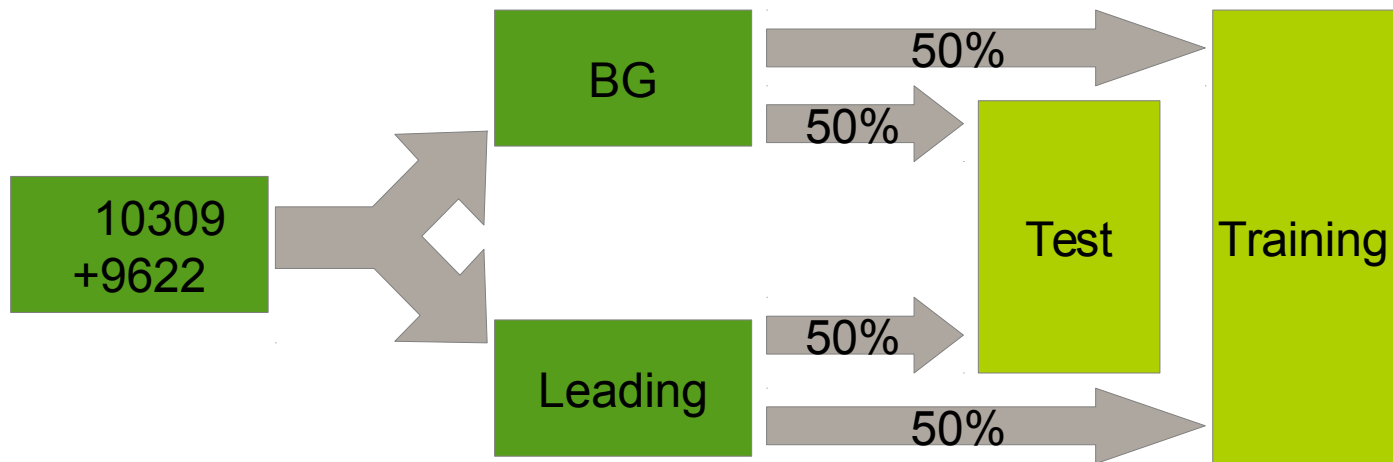
Leading Muons:	2.878
BG Muons:	31.108

10309:

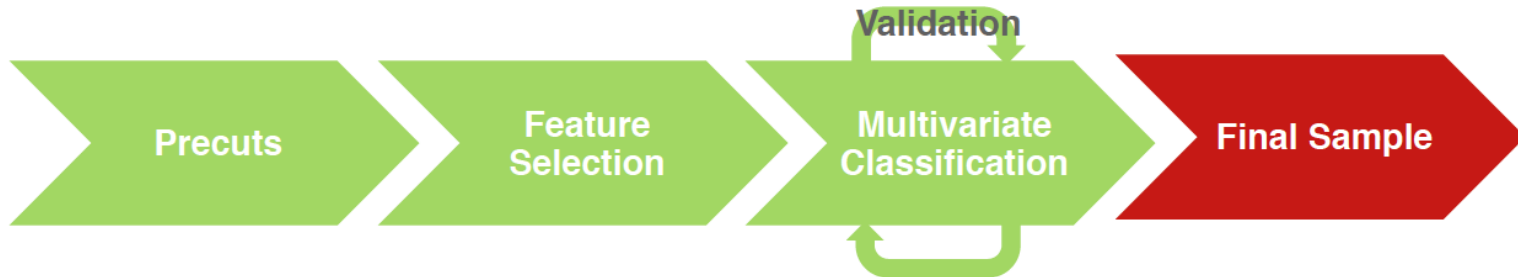
Leading Muons:	59.484
BG Muons:	1.272.674

# Data Mining

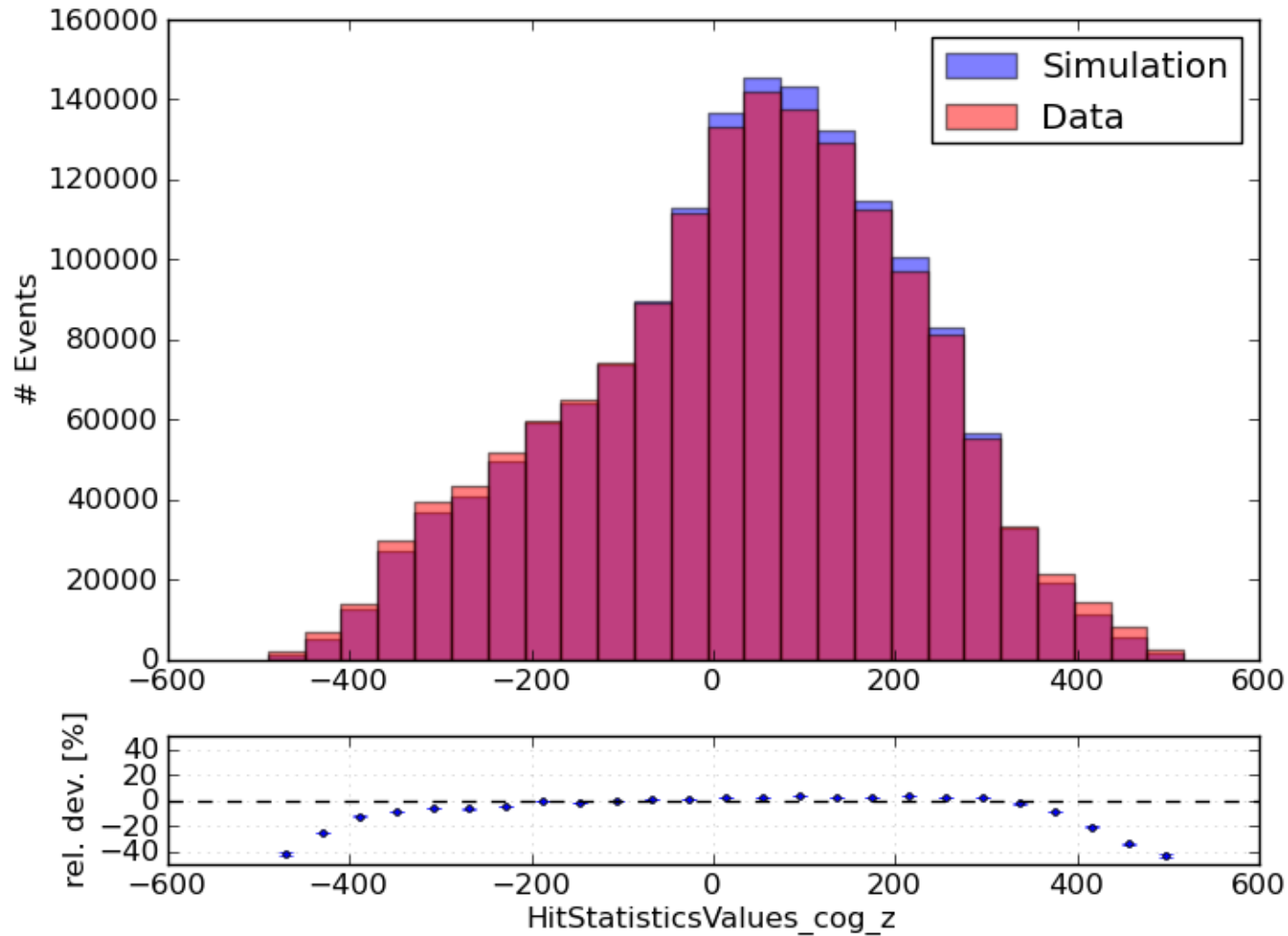


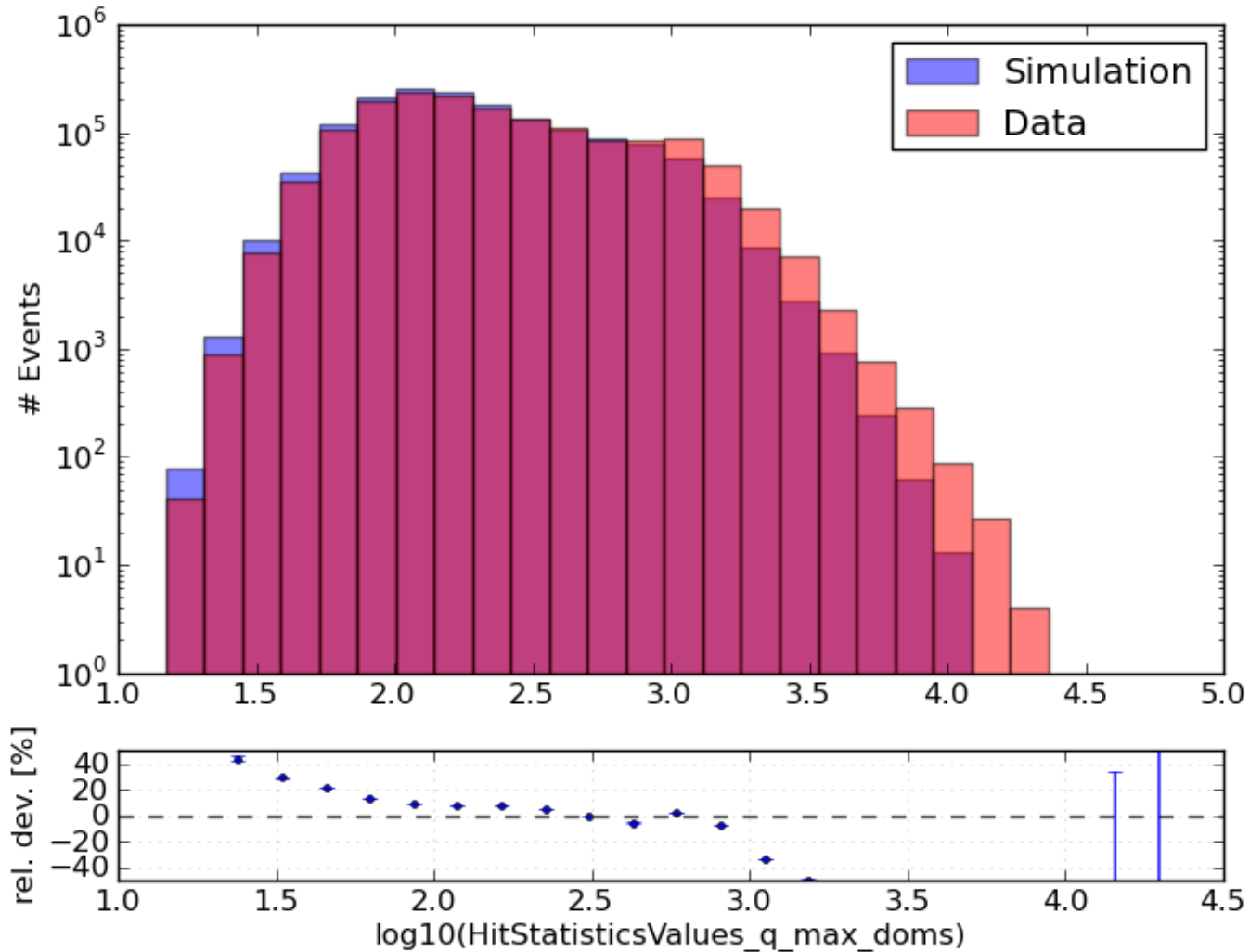


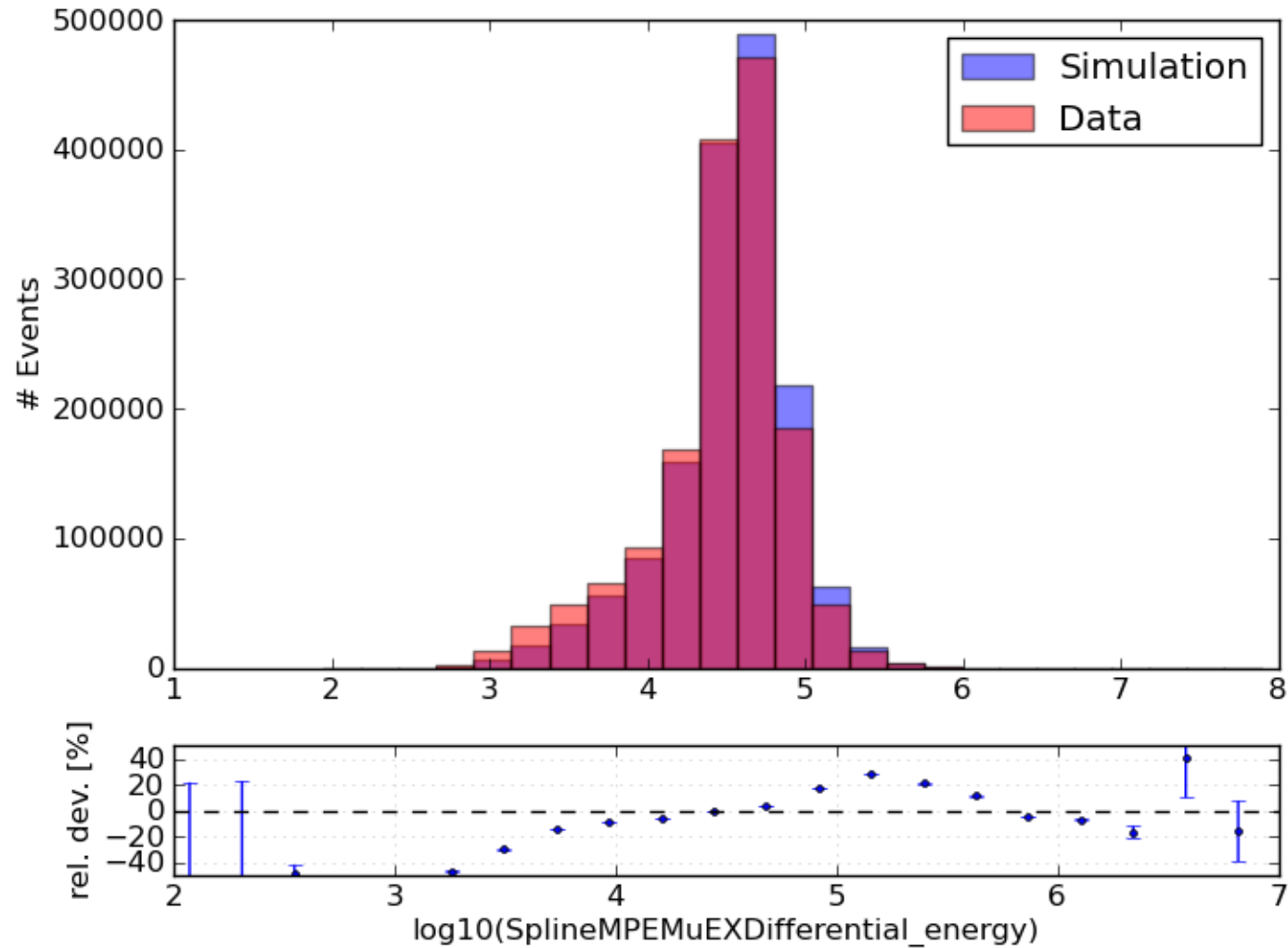
## Event Selecting (on standard L3/L4)



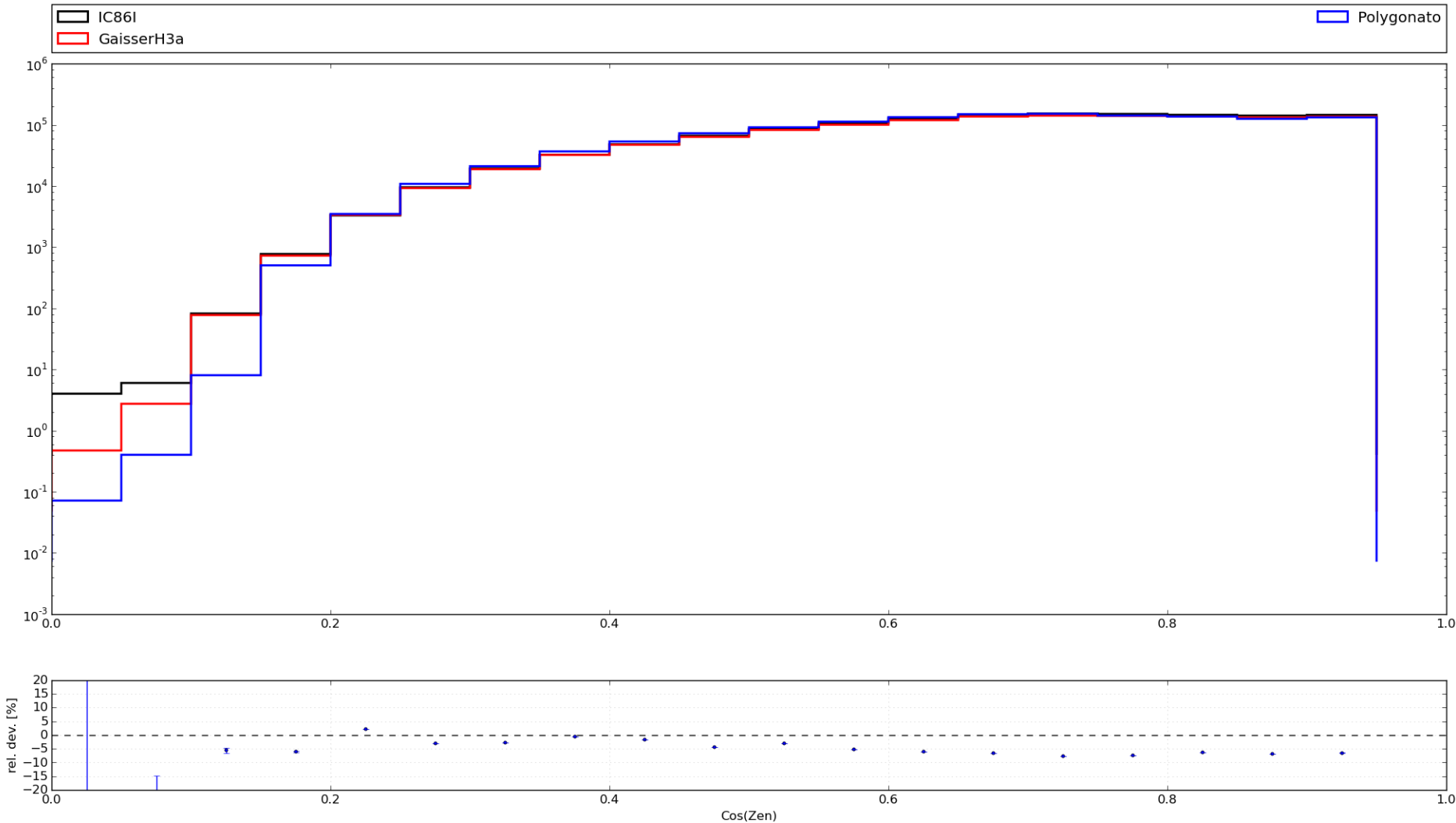
1. Select best simulated features by data vs MC agreement (400 → 142)
2. Remove correlated features (142 → 54)
3. Create new features (54 → 75)
  - $Q_{\max}/Q_{\text{tot}}$
  - $\text{abs}(\text{LineFit.zenith} - \text{SplineMPE.zenith})$
  - $\text{abs}(\text{distribution\_smoothnessA} - \text{distribution\_smoothnessB})$
  - ...
4. MRMR Feature Selection (75 → 30)



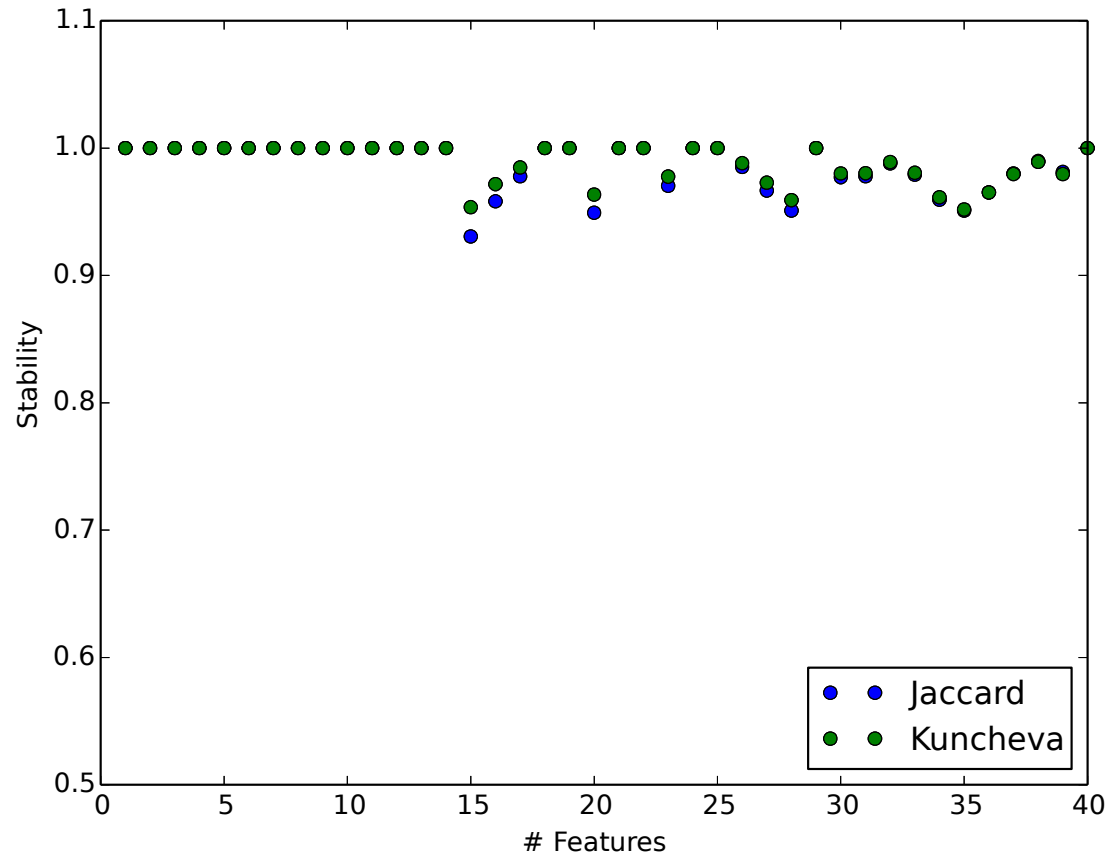




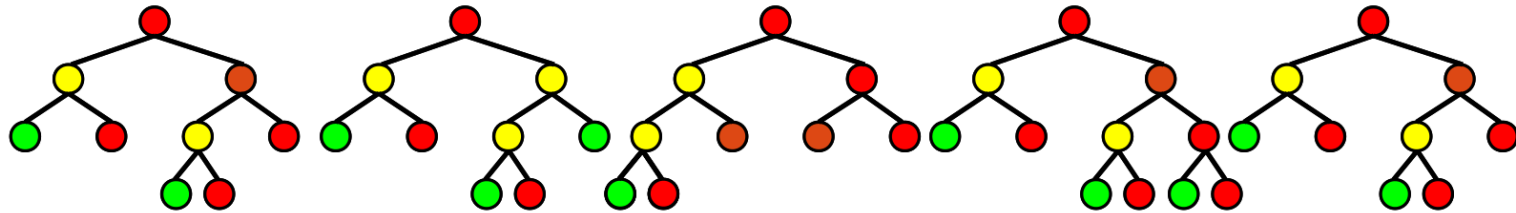




## Event Selecting (on standard L3/L4)



## Event Selecting (on standard L3/L4)

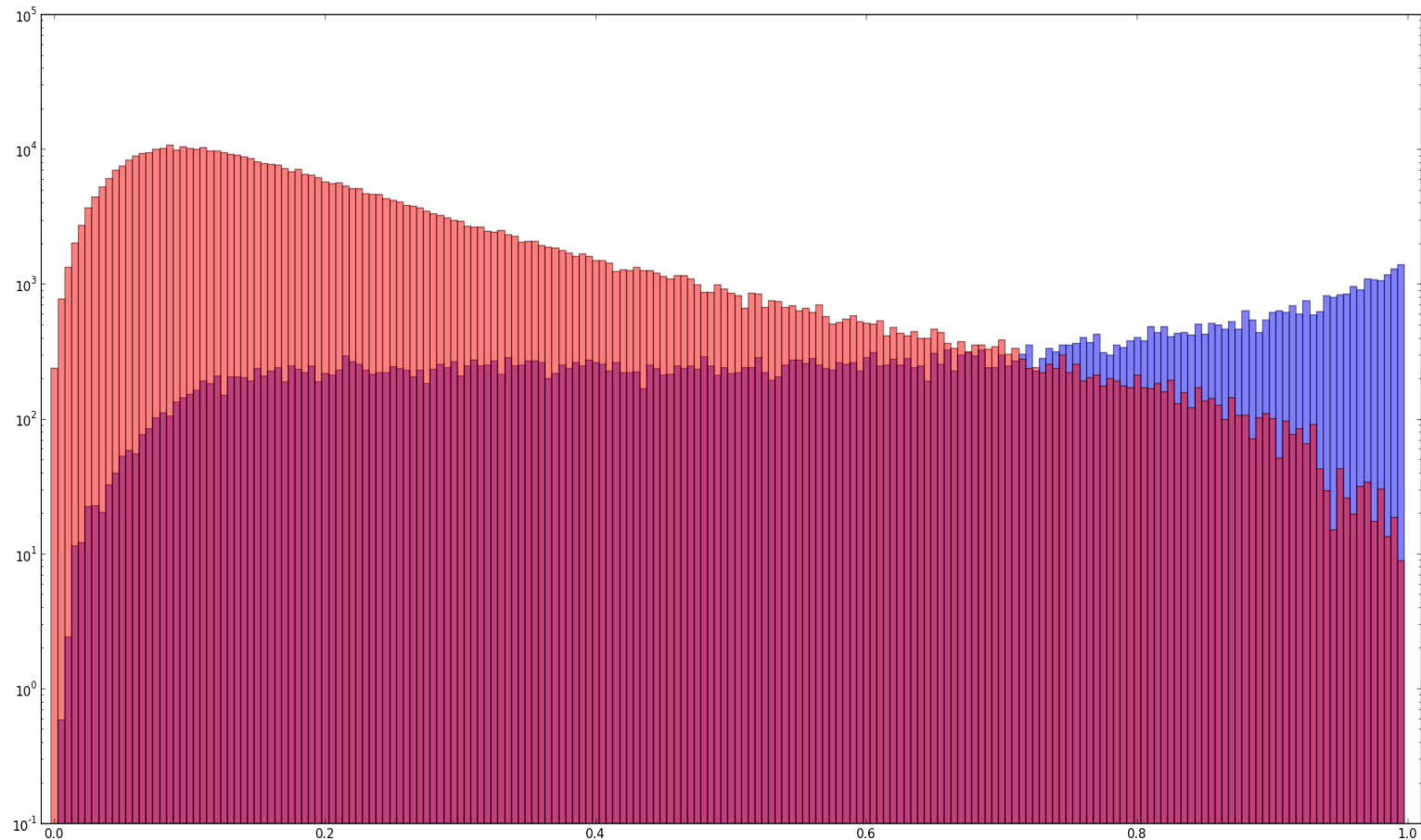


Random Forest:

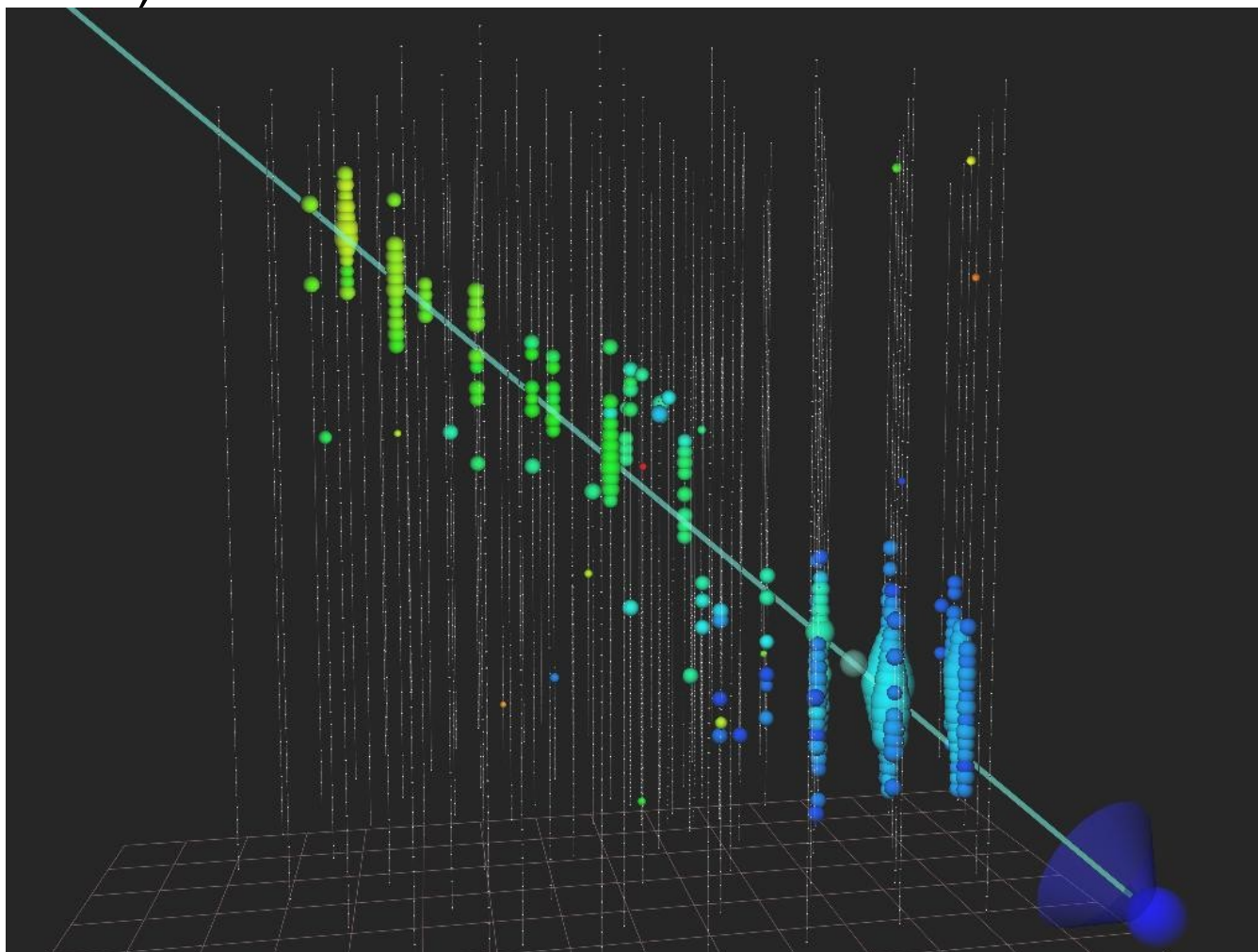
30 Features  
5 Features per node  
200 Trees (N)  
Training Ratio:  
20000 Leading  
60000 BG

Confidence:  $A / N$   
 $A = \# \text{Trees Predicted that this is a HE Muon Event}$

## Event Selecting (on standard L3/L4)

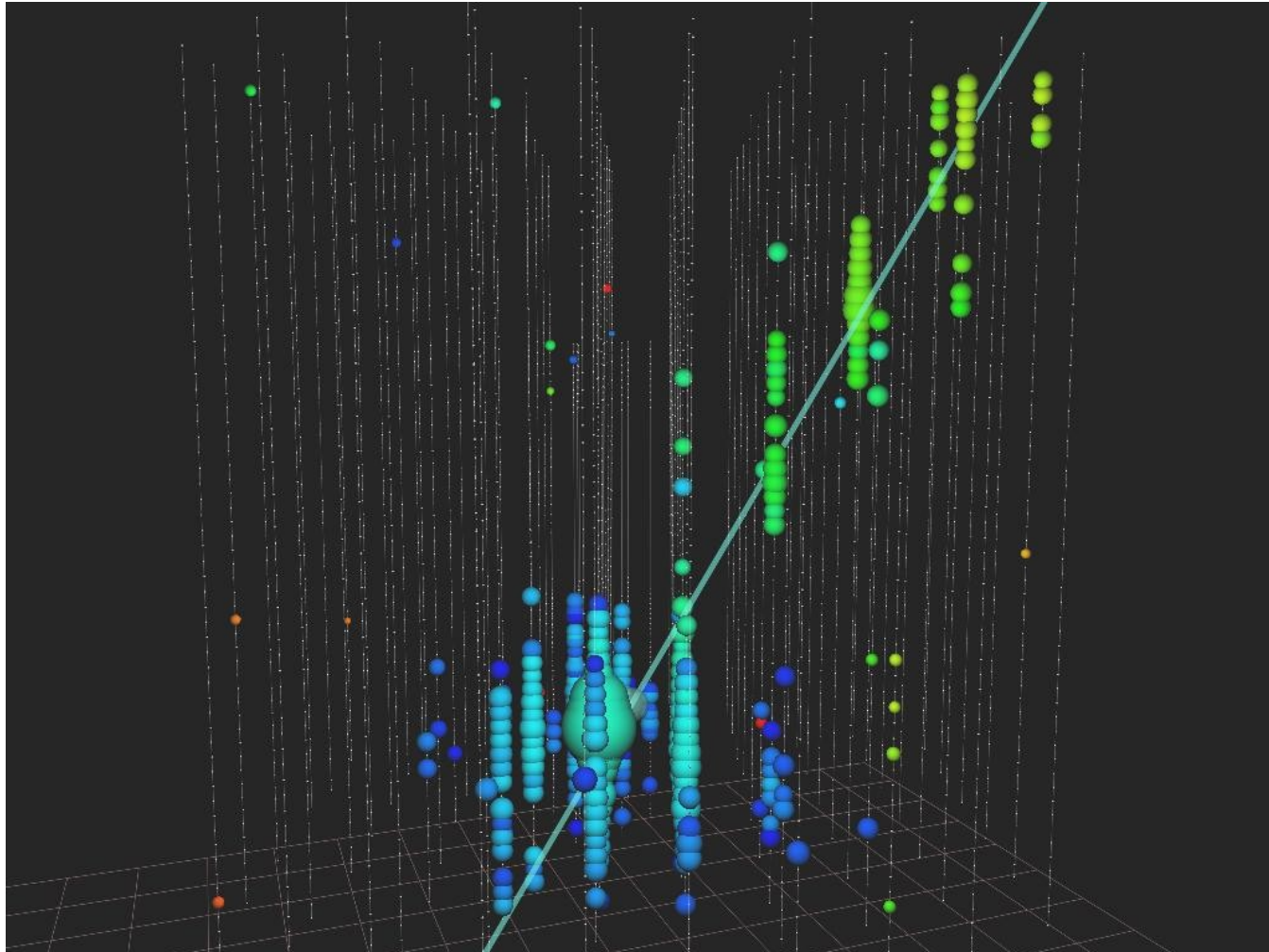


## MC (17 TeV)

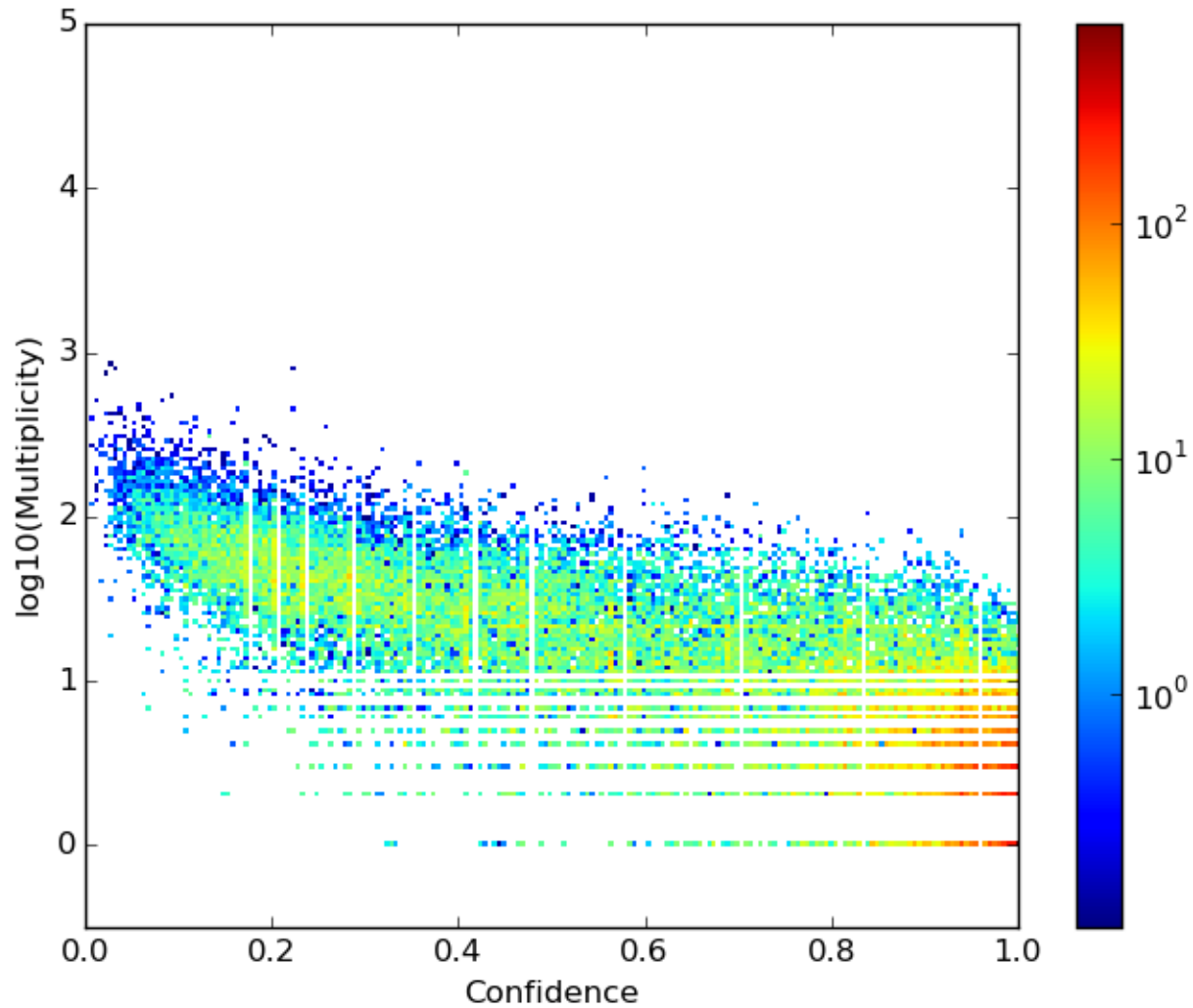


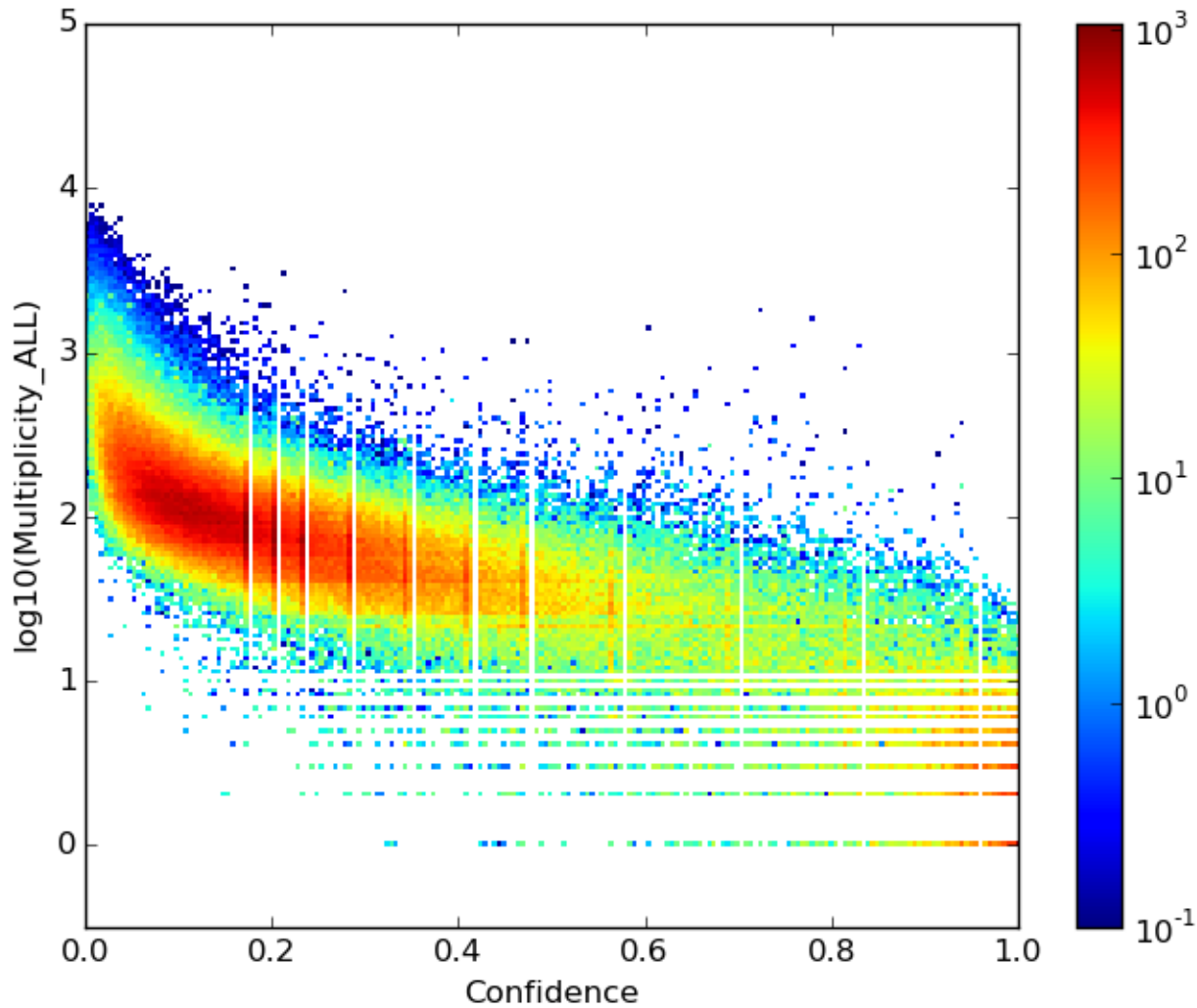


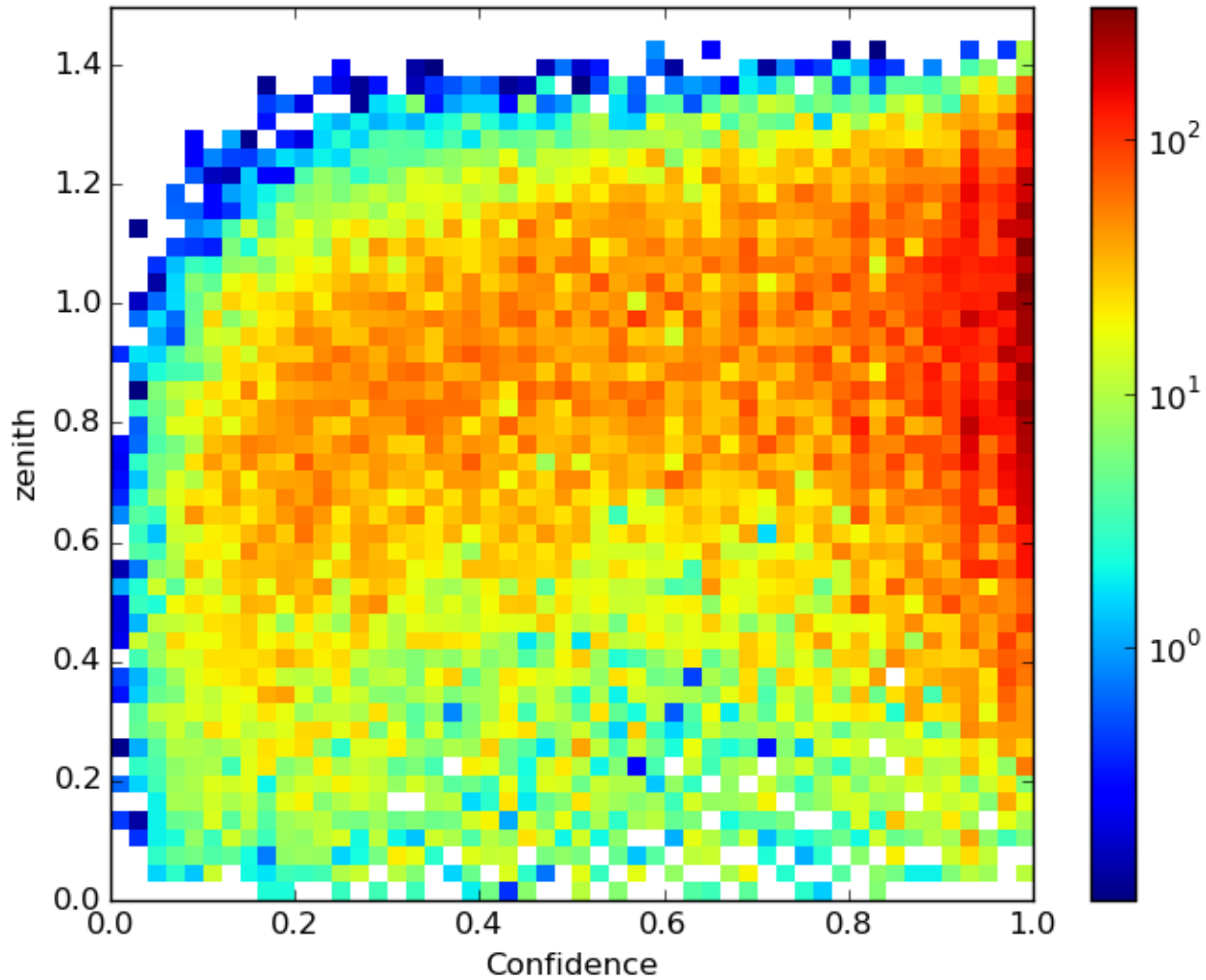
# Data



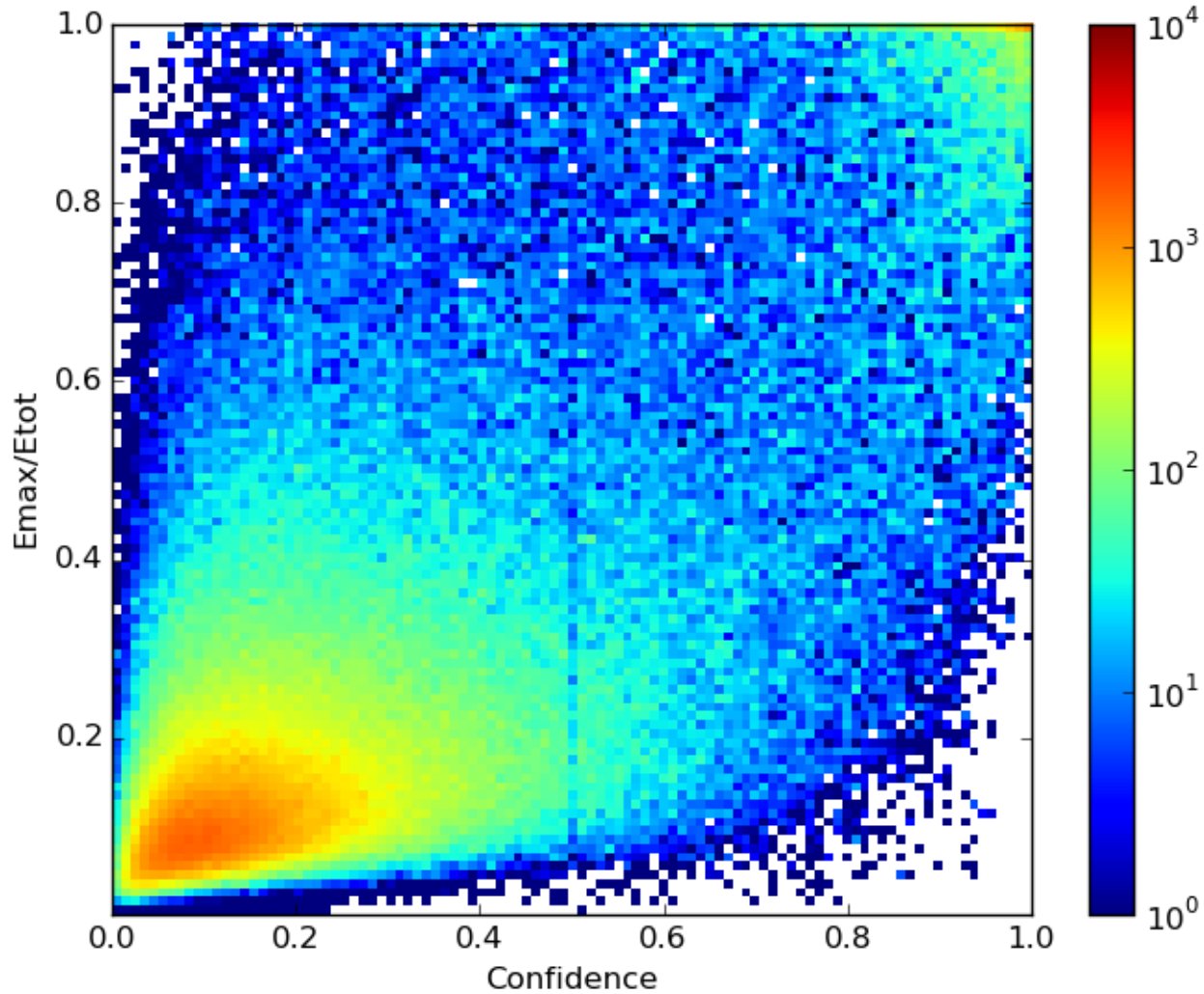
# Correlation of Attributes (for HE muons)

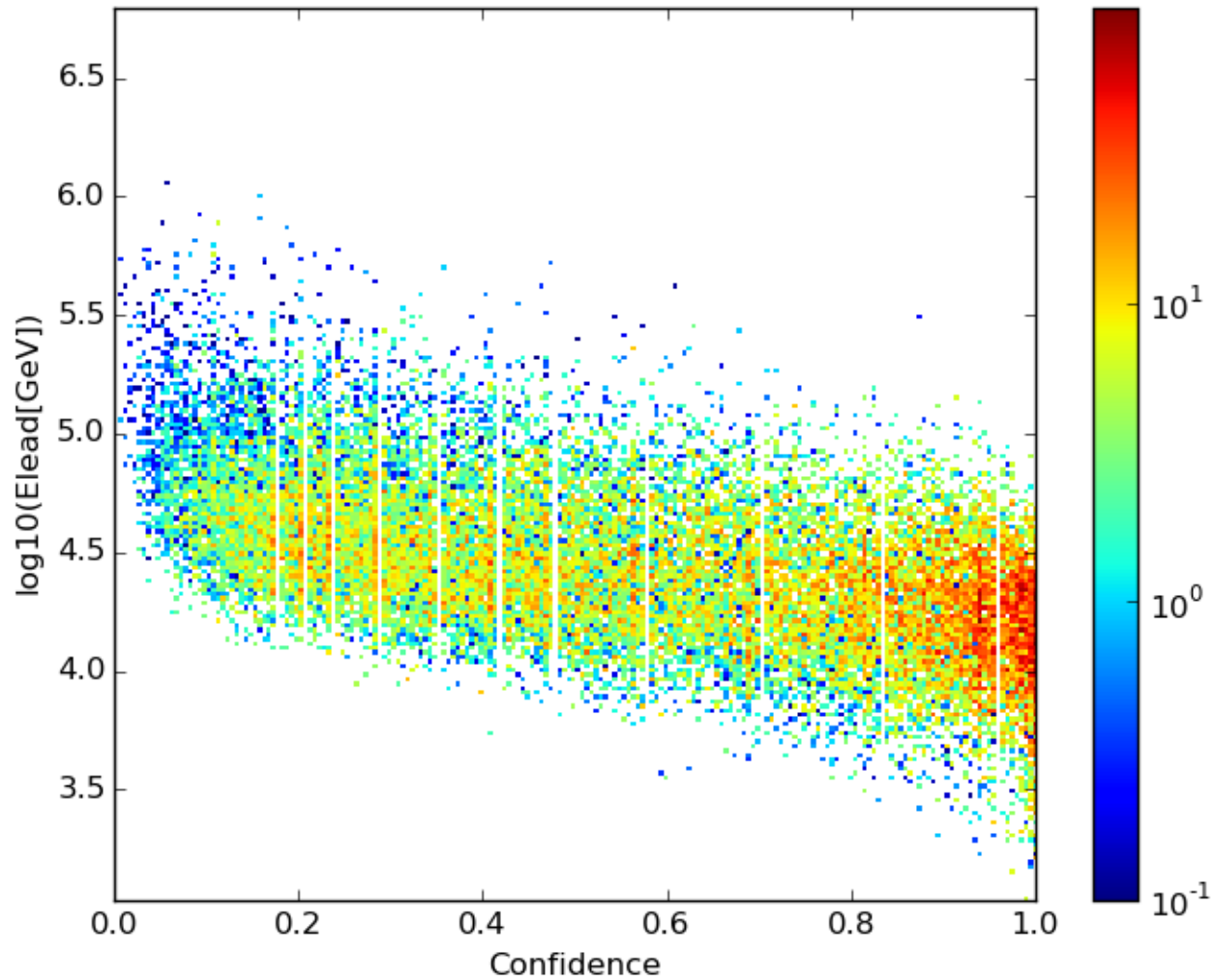


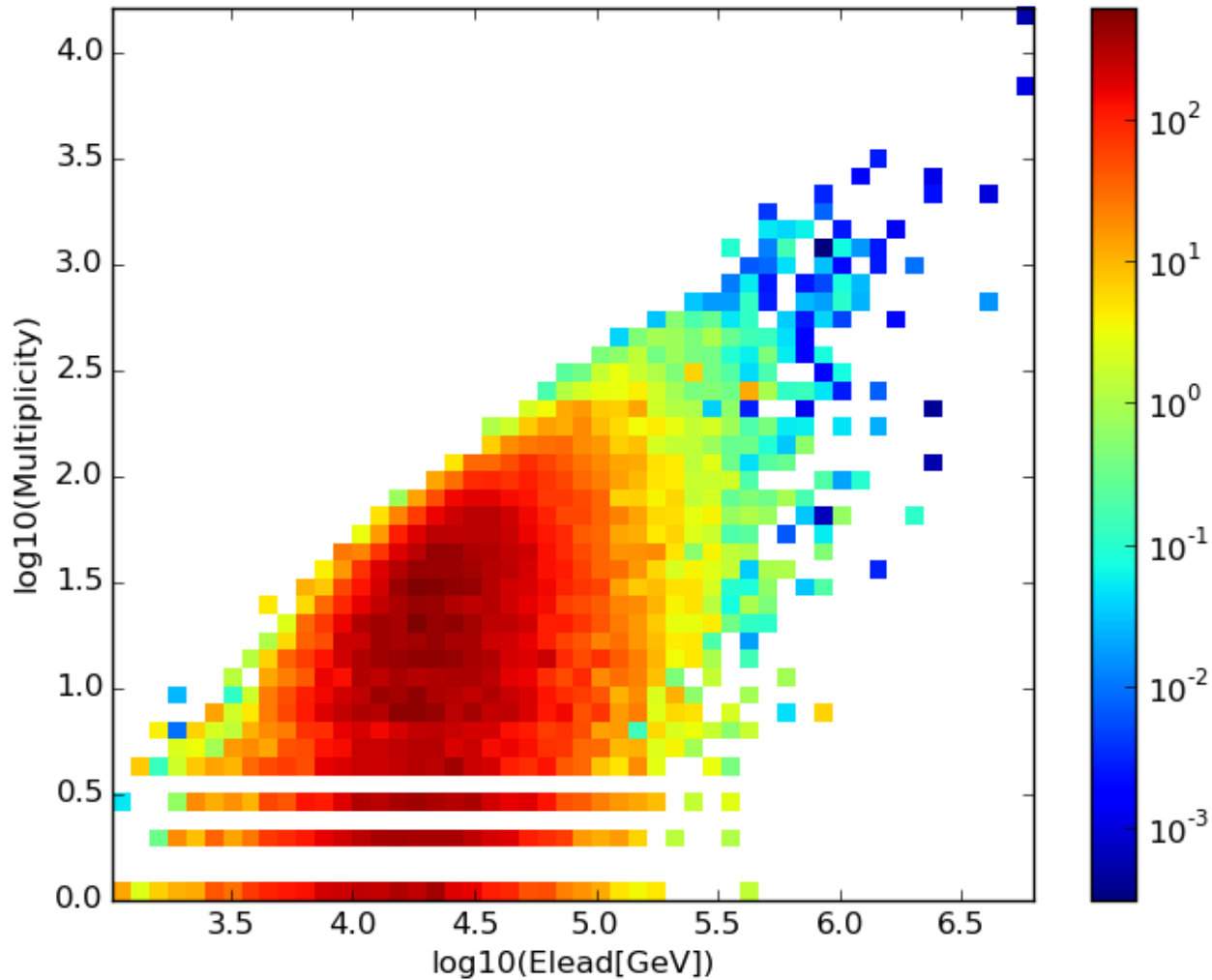




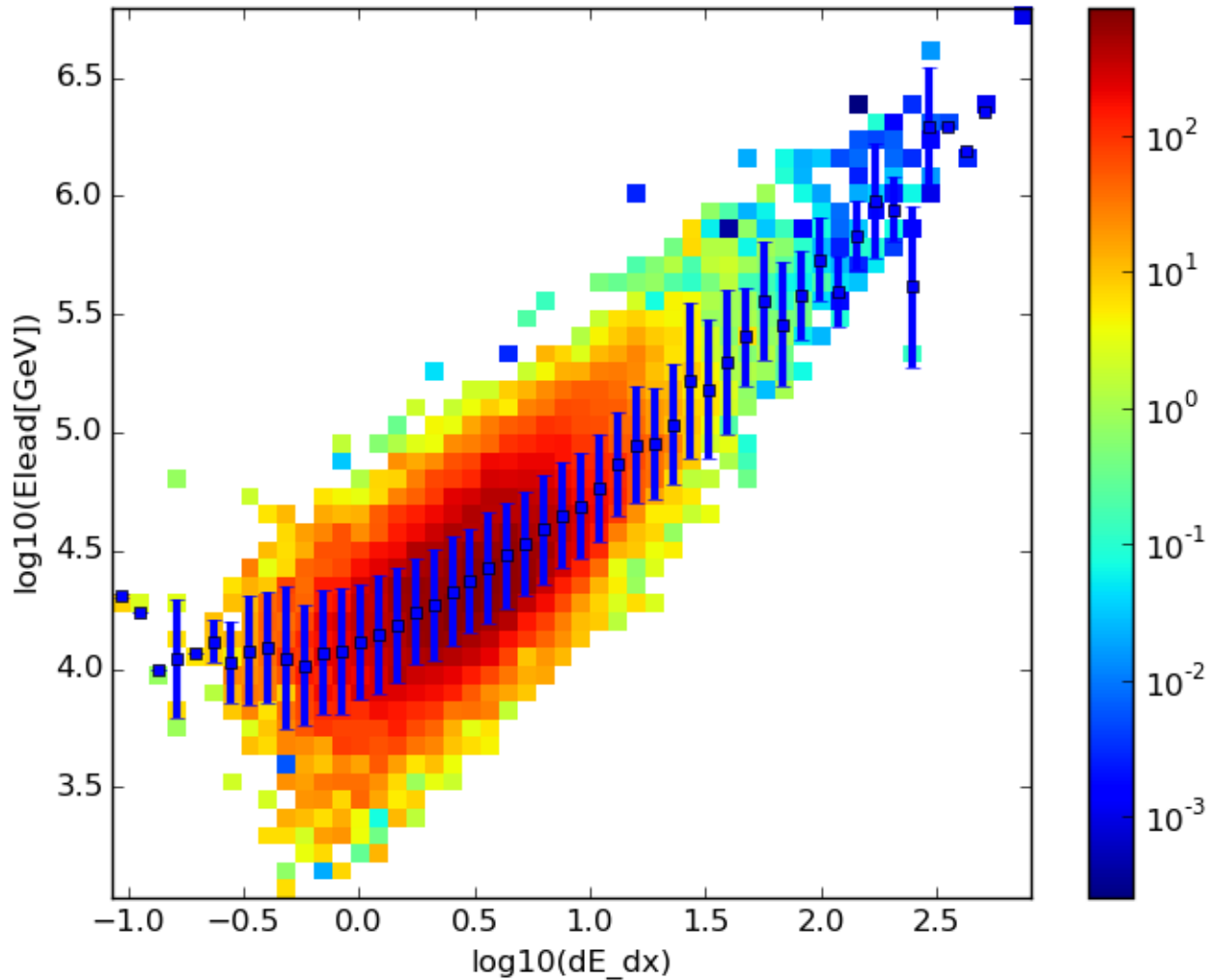






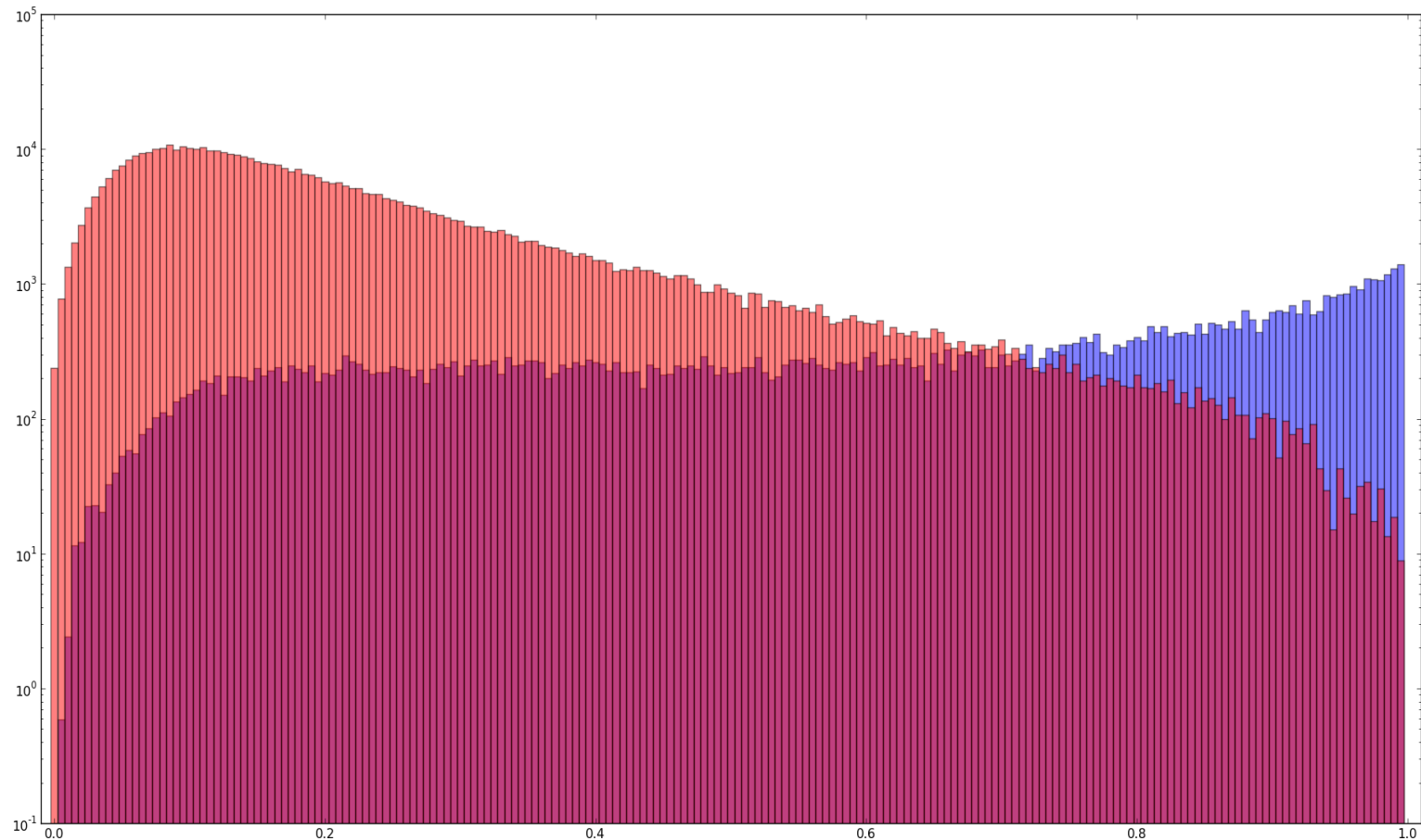


# Energy Korrelation



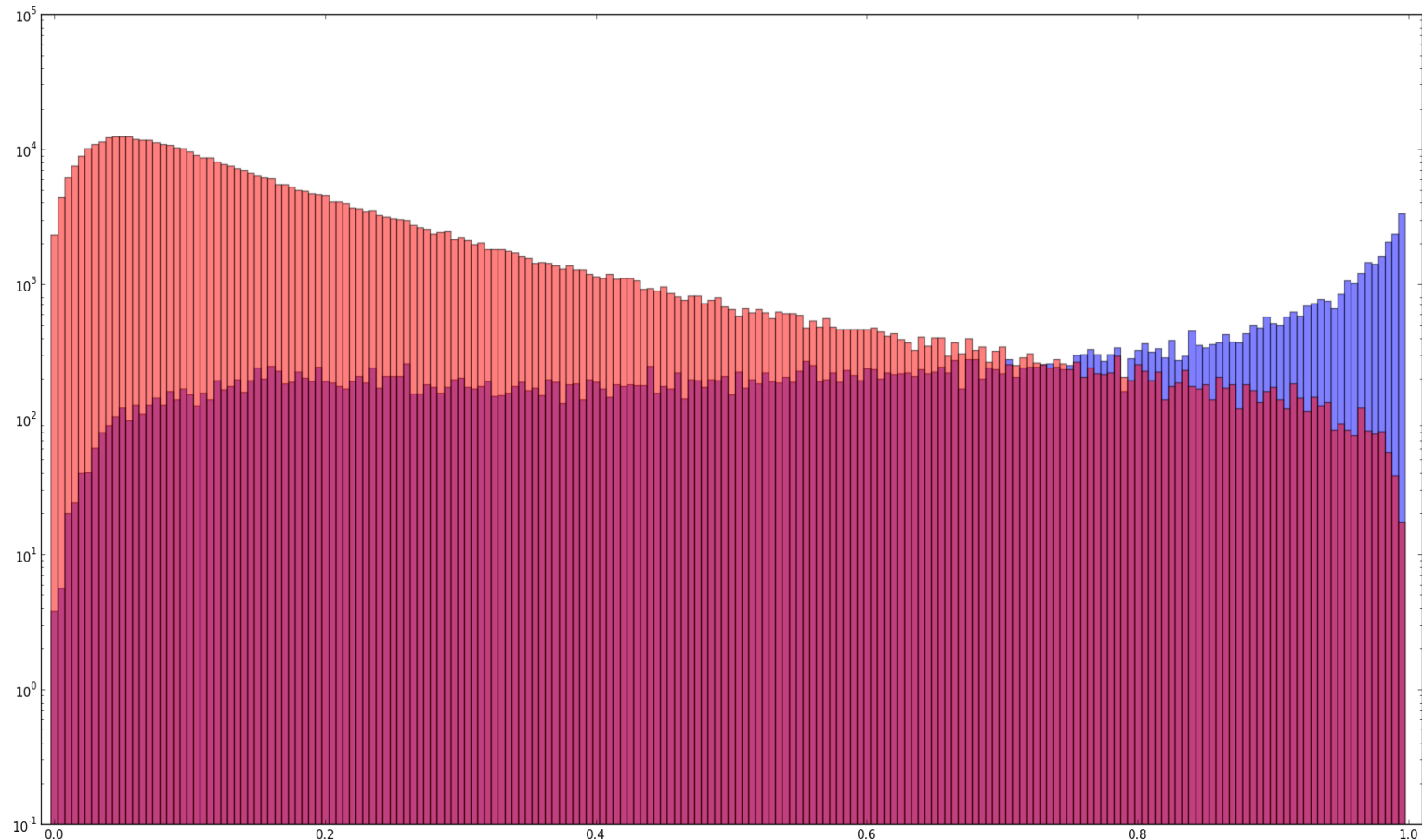
DDDDR

## Event Selecting (on standard L3/L4)





## Event Selecting (adding DDDDR)



# Data Wishlist

## Full MC highE(10809) and LowE(10668) sets

### Systematic Datasets to 10809:

- 1. 10% scattering and absorption ellipse around SPICE-Lea model
- 2. 10% scattering and absorption ellipse around SPICE-Lea model w/ +10% DOM efficiency
- 3. +10% DOM eff
- 4. (if enough resources 2+3 with -10% Dom eff.)

10% of a full dataset should be enough to check for systematic effects.

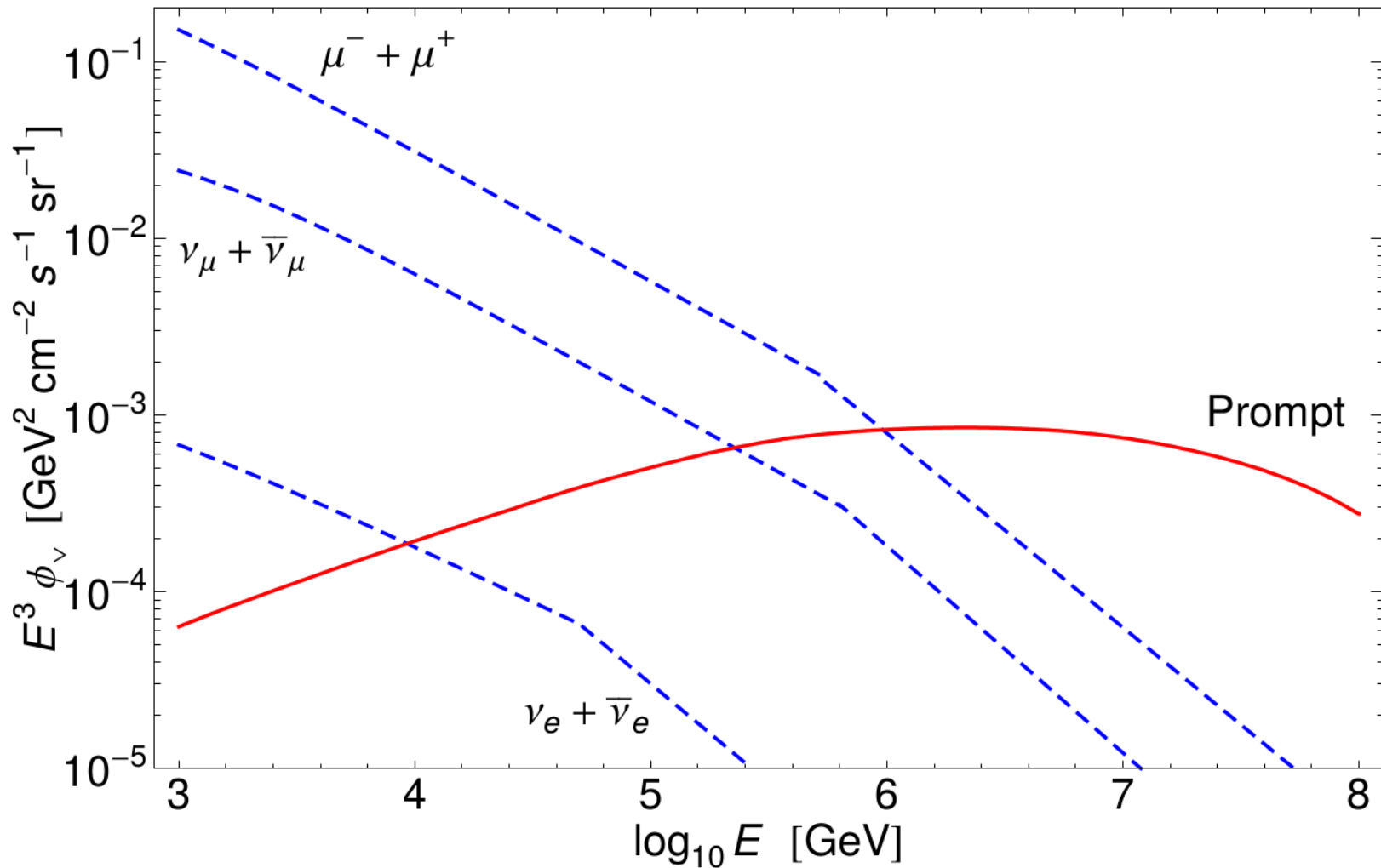
More information (little outdated ):

- [https://wiki.icecube.wisc.edu/index.php/Tfuchs\\_LeadingMuons](https://wiki.icecube.wisc.edu/index.php/Tfuchs_LeadingMuons)

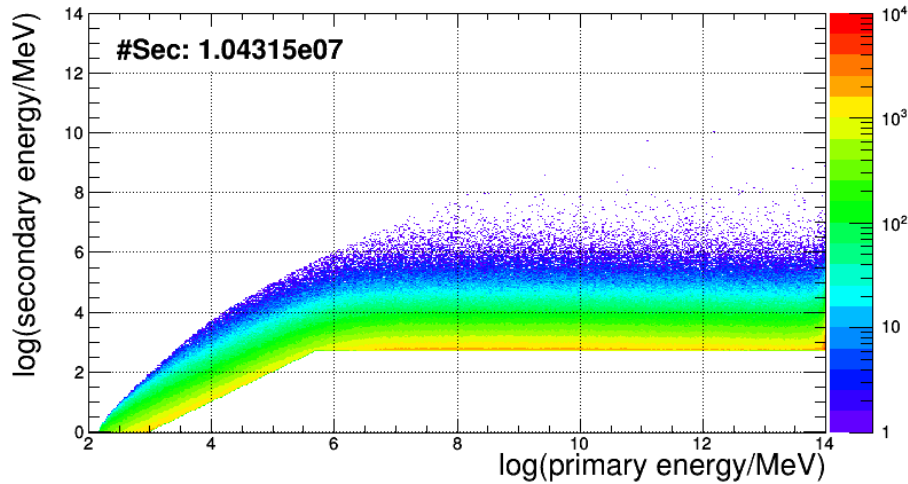
High Confidence Events:

- /home/TFUCHS/SelectedEvents

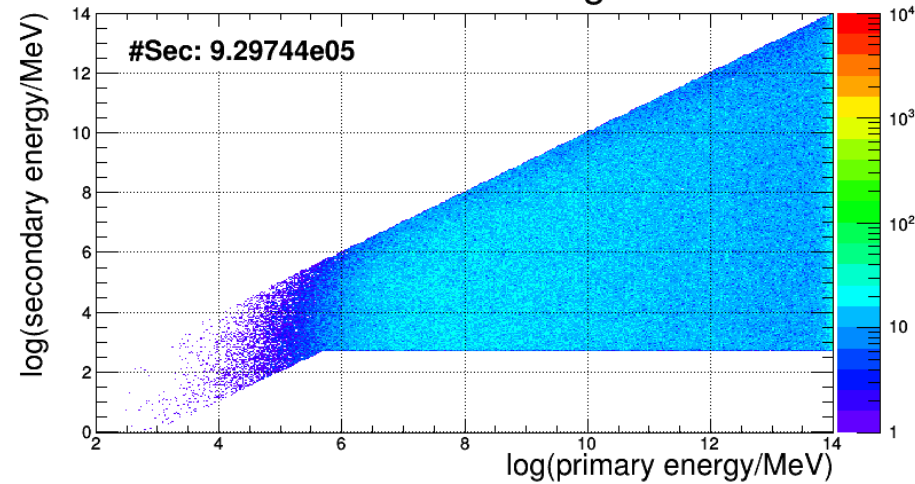
# Backup



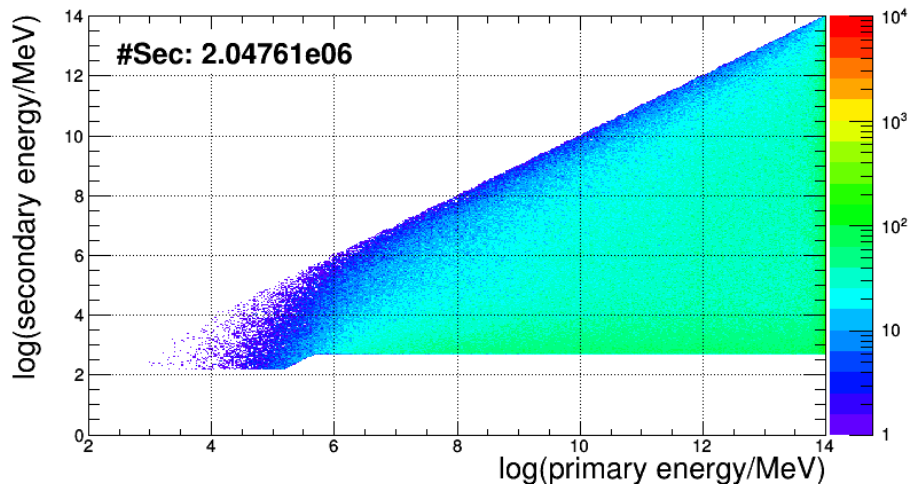
Ionization



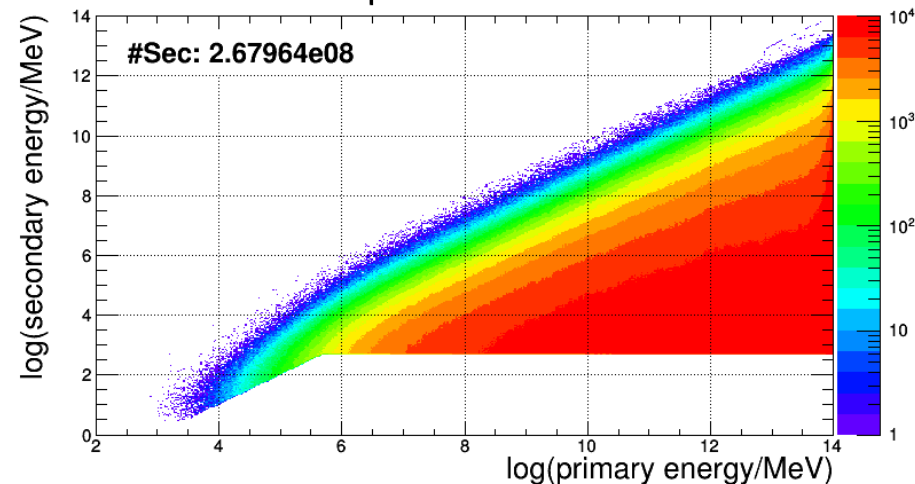
Bremsstrahlung



Photonuclear Interaction

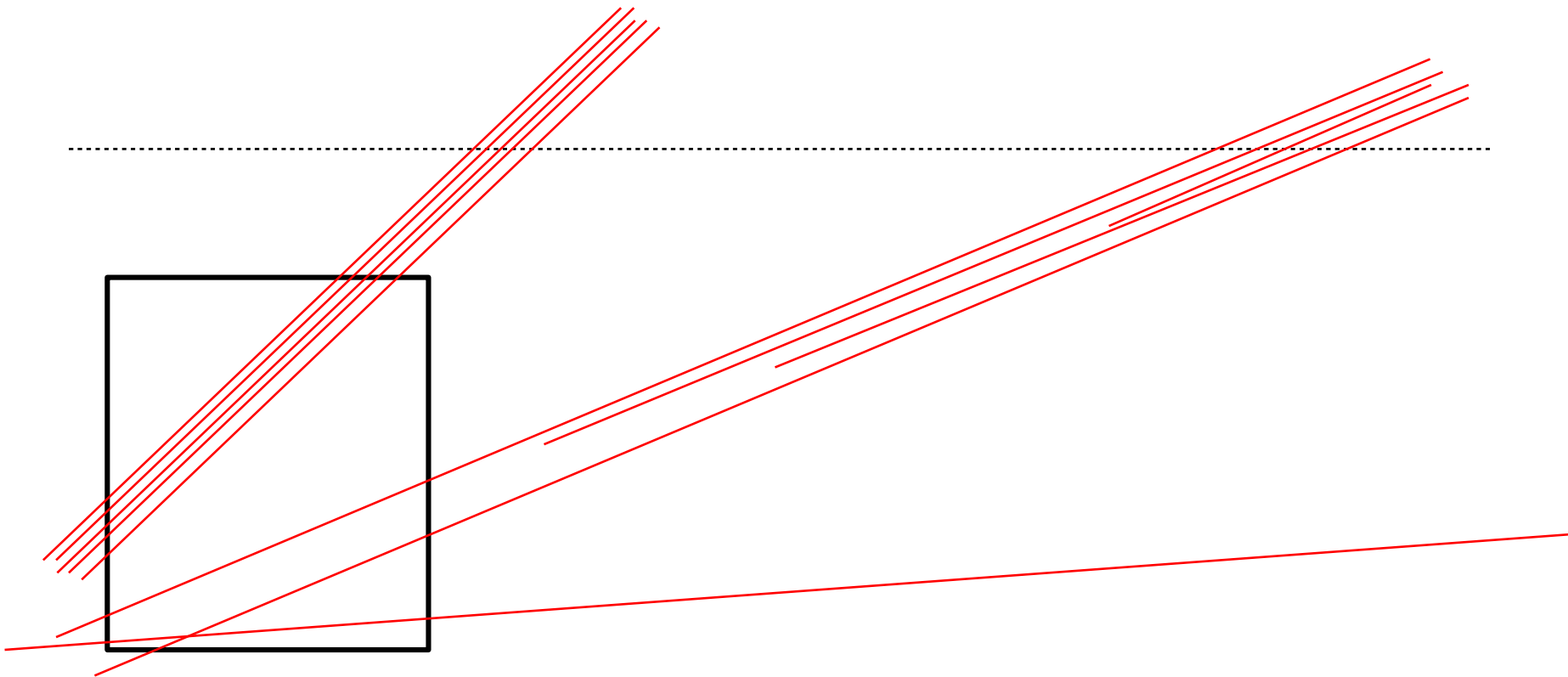


Pairproduction

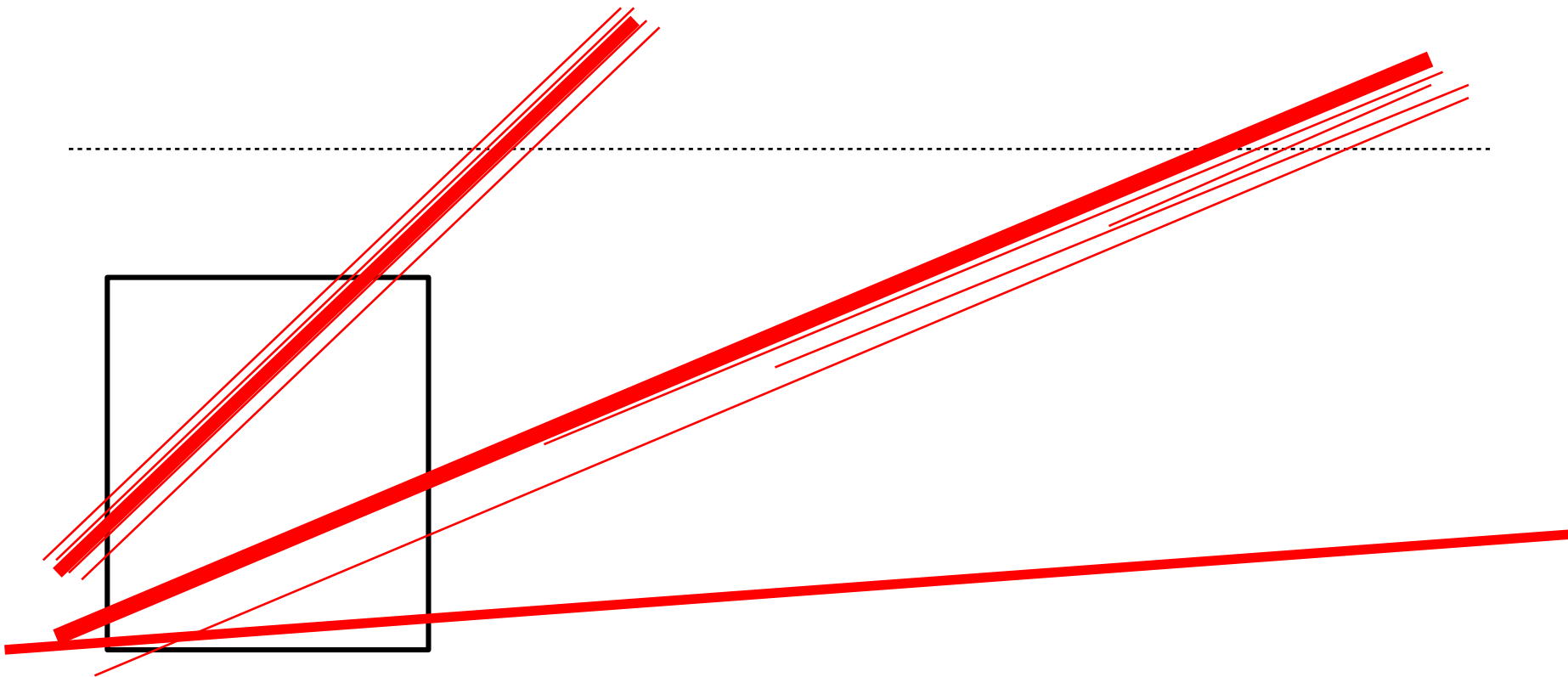




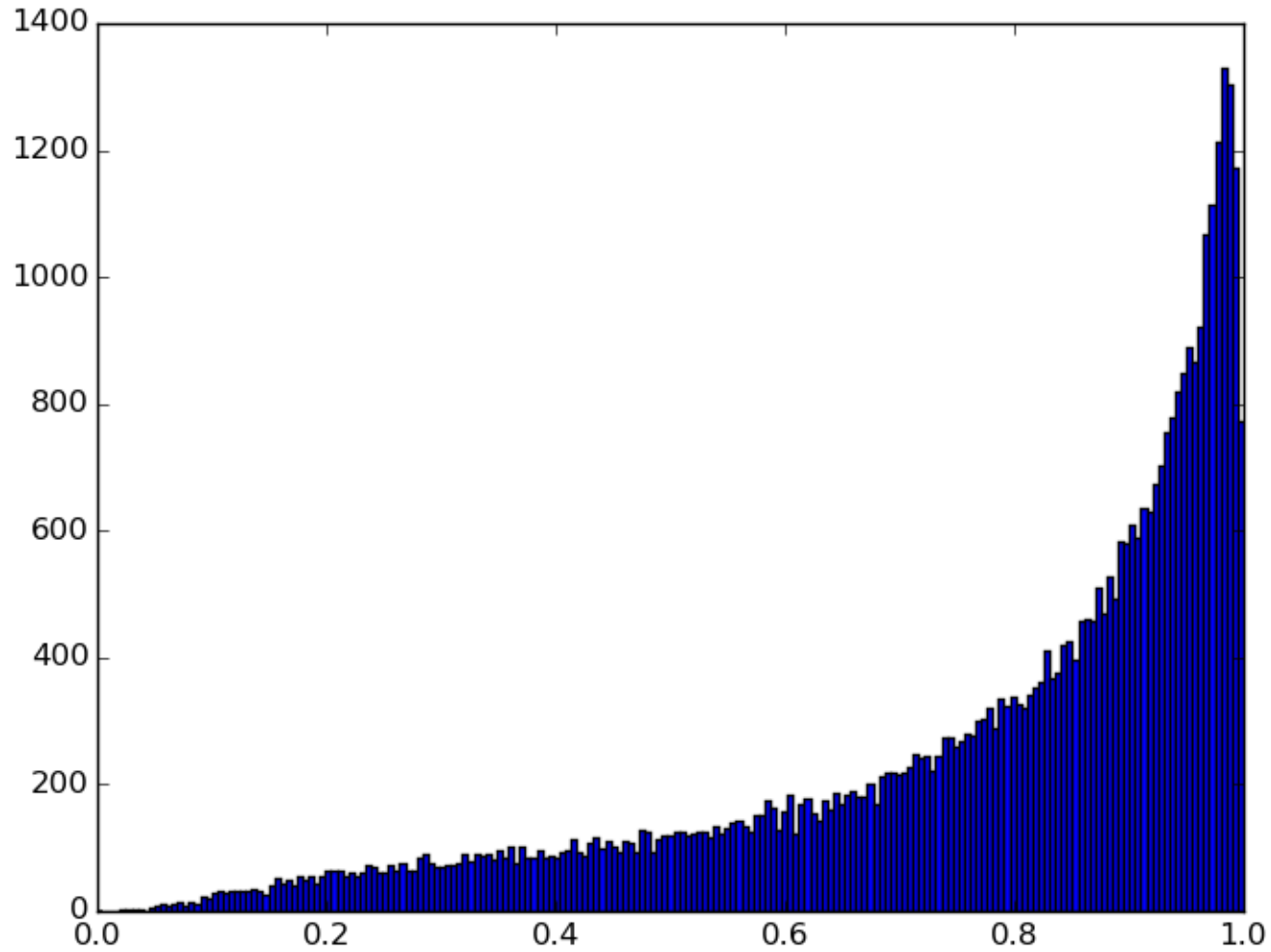
## Bundles

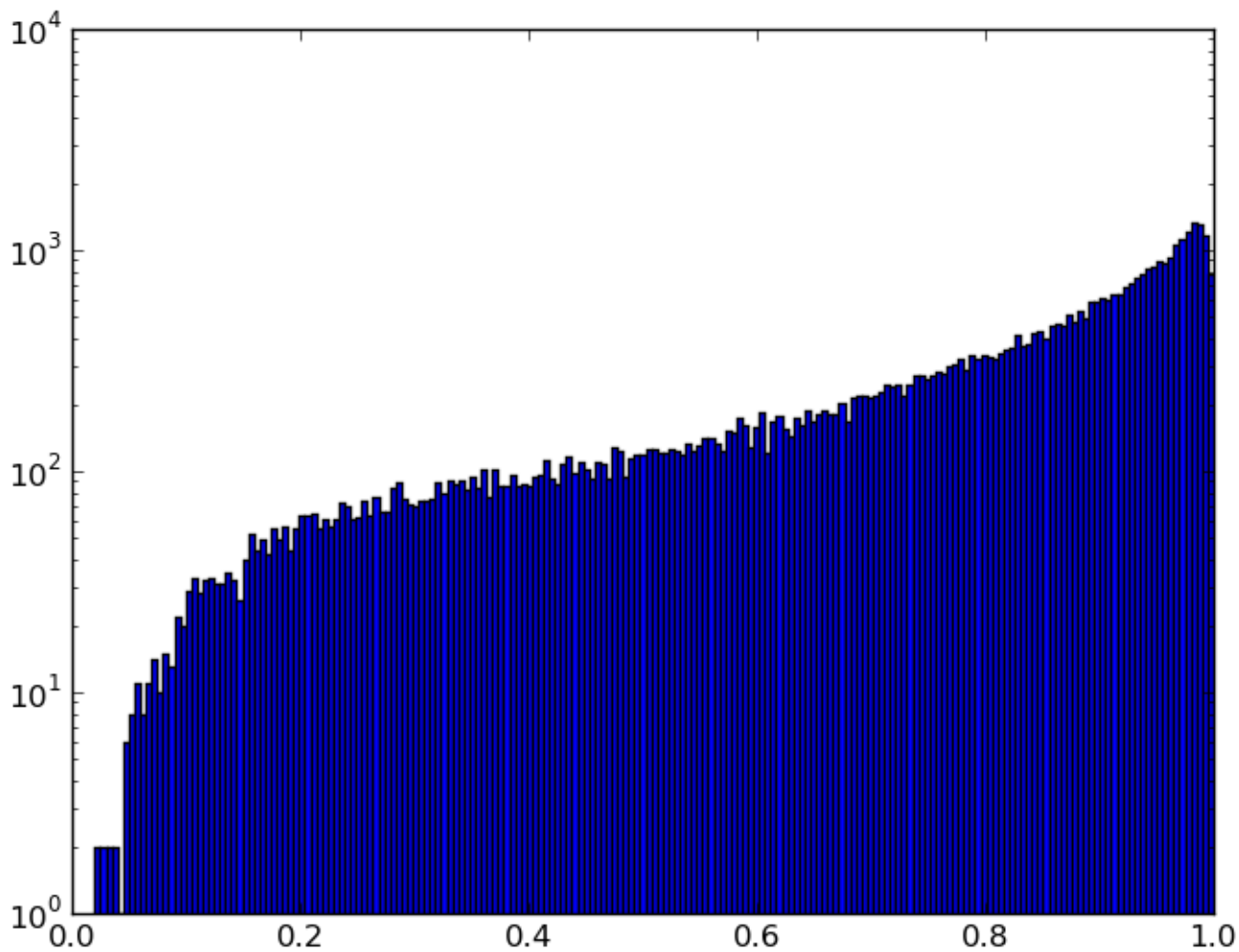


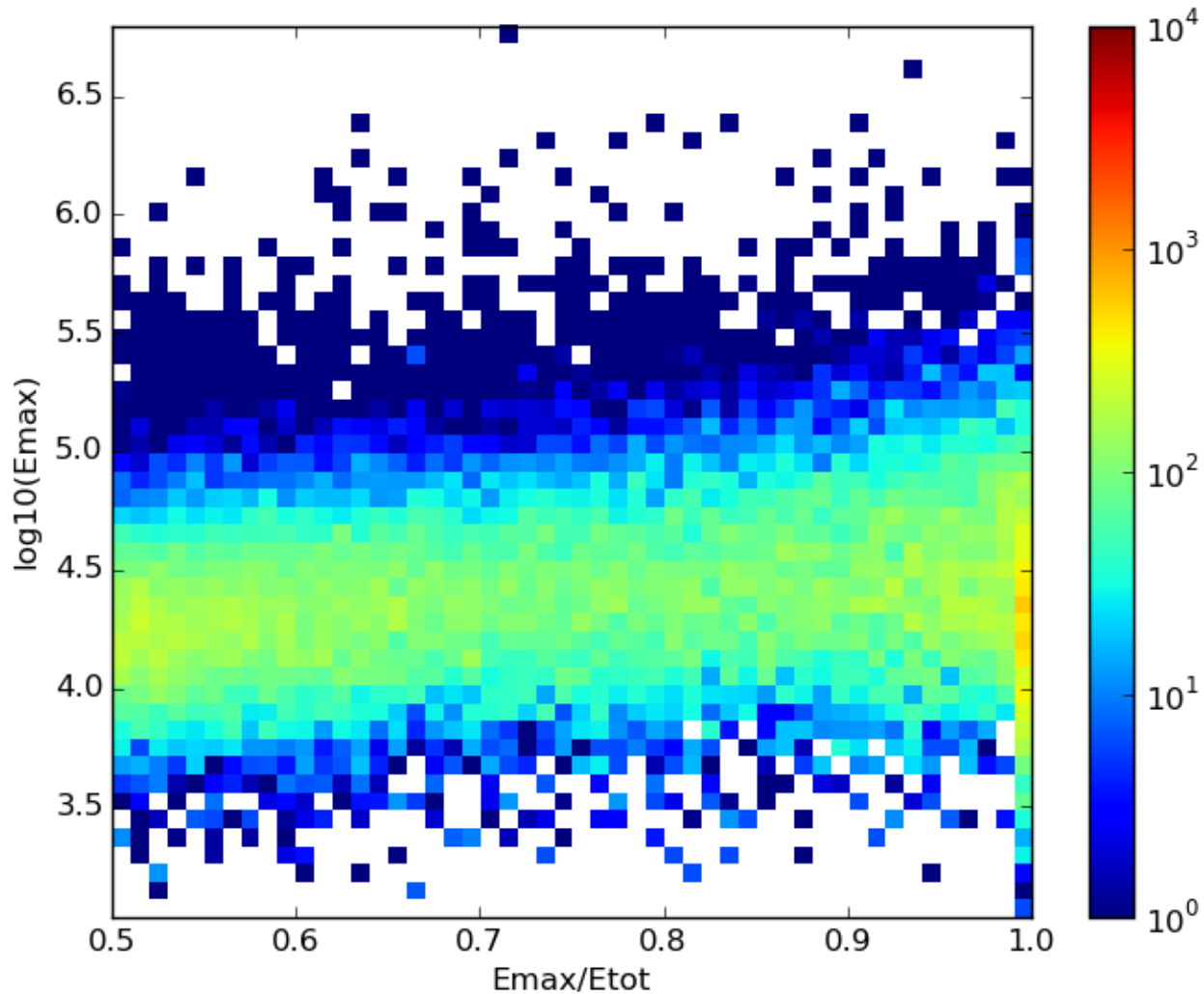
## HE Muons



# Confidence of Patricks Events

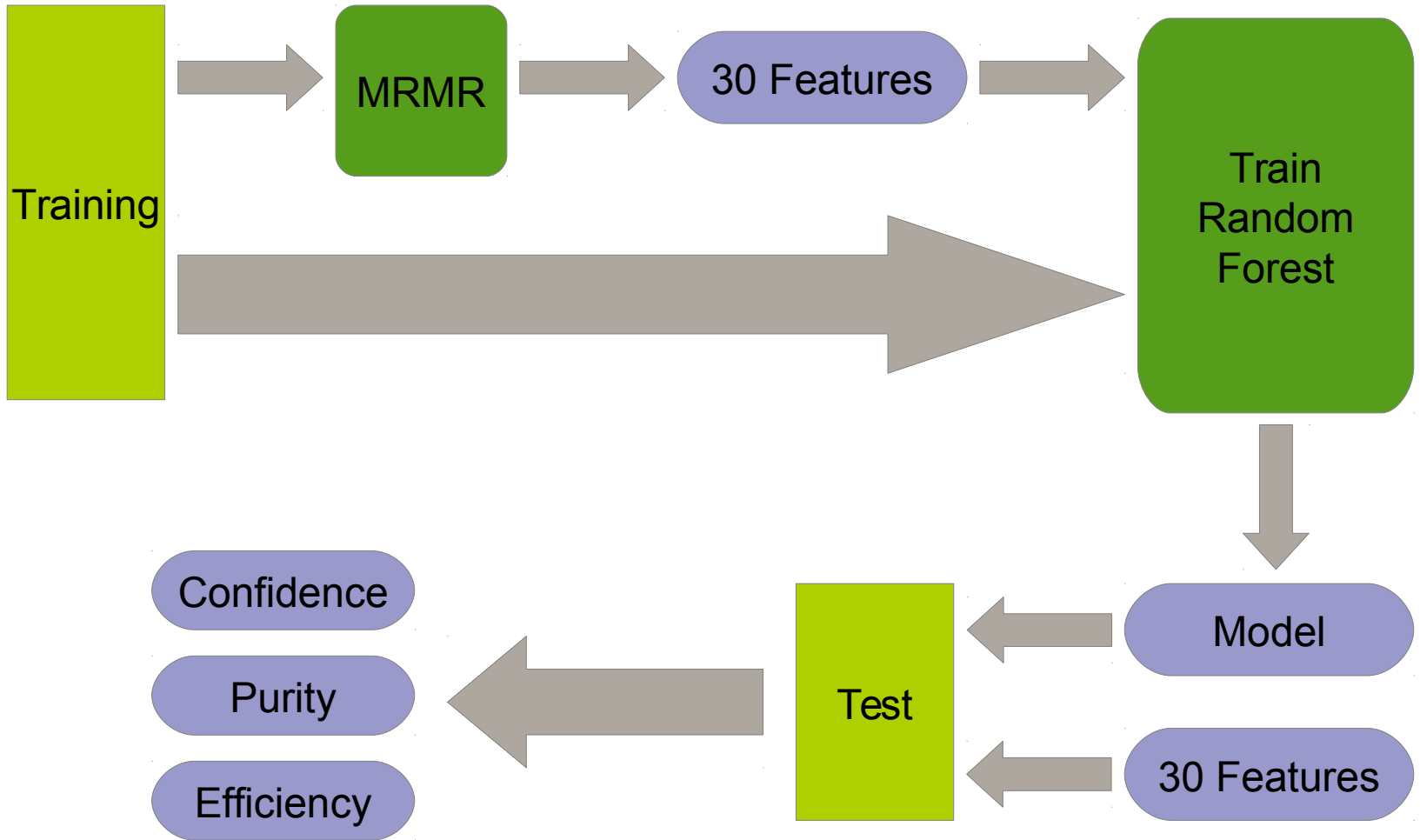






HitStatisticsValuescog_z	SplineMPECharacteristictrack_hits_separation_length
HitStatisticsValuescog_z_sigma	SplineMPEDirectHitsAn_early_doms
HitStatisticsValuesz_max	SplineMPEDirectHitsAn_early_strings
LineFit_TTParamslf_vel	SplineMPEDirectHitsCn_dir_strings
LineFit_TTParamslf_vel_z	SplineMPEDirectHitsEdir_track_hit_distribution_smoothness
LineFit_TTParamsn_hits	SplineMPEDirectHitsEn_dir_strings
MPEFitHighNoiseFitParamsnmini	SplineMPEFitParamsnmini
PoleMuonLlhFitCutsFirstPulseCutsl_dir	SplineMPEMuEXDifferentialenergy
PoleMuonLlhFitCutsFirstPulseCutsn_dir	SplineMPEMuEXDifferential_rvalue
PoleMuonLlhFitCutsFirstPulseCutss_dir	SplineMPEzenith
PoleMuonLlhFitFitParamsnmini	U_CogRxy
SPEFitSingle_TTFitParamsnmini	U_DEDXALLDOMS_L10
SplineMPECharacteristicsavg_dom_dist_q_tot_dom	U_DeltaZen
SplineMPECharacteristicempty_hits_track_length	U_QmaxOverQtot
SplineMPECharacteristictrack_hits_distribution_smoothness	U_SmoothnessE_ABS





## Dataset 10668 Details

**Type: PHYSICS**

### Description

- Level2 IC86.2011 CORSIKA-in-ice 5-component model with weighted spectrum of  $E^{-2.0}$ , using **SPICELea**
- ClSim**. Angular range of  $0\text{deg} < \theta < 89.99\text{deg}$  and energy range of  $600\text{GeV} < E_{\text{prim}} < 1\text{e}5\text{GeV}$ .

<b>seed</b>	int	<code>\$args(dataset)</code>
<b>spectrum</b>	string	<code>E^-2.6</code>
<b>summaryfile</b>	string	<code>\$sprintf("corsika.%06d.%06d.summary.xml", \$args(dataset), \$args(procnum))</code>