Summary

- Pass6
  - ➢ status, changes from Pass5
  - ➢ directions for Pass7
- IRF updates
  - ➢ updated Pass5
  - ➢ onward to Pass6
- OBF updates
  - ➢ proposed changes in bit 17,21
- Bkg model
  - ➢ Bkg model status
  - ➢ Comparison with Pamela

Pass6 analysis

Pass6

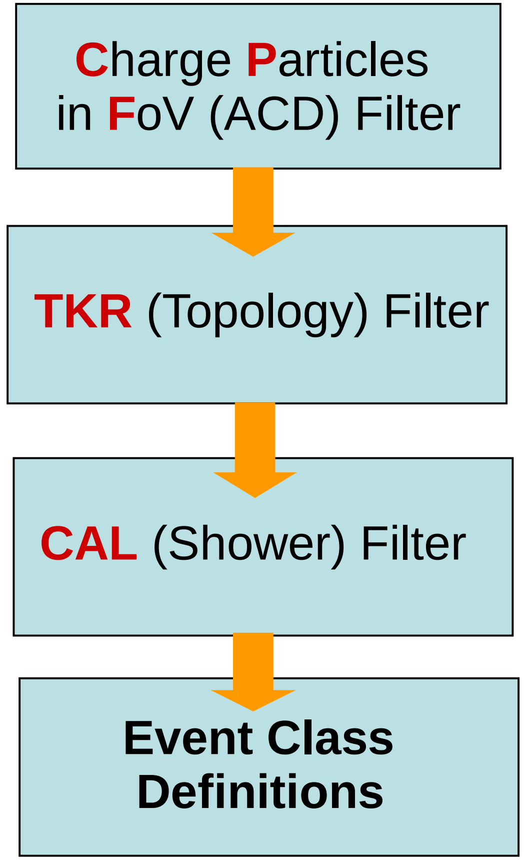
Data Sets:

Muons: allMuon-GR-v13r9 (14- Jan-2008)
AG: allGamma-GR-v13r9 (14-Jan-2008)
BKG: backgnd-GR-v13r9 (15-Jan-2008)

Initial Pruning Cuts:

ObfGamStatus >= 0	*Passed Onboard Filter*
TkrNumTracks > 0	*At least 1 track*
CalCsIRLn > 4	*Track intercepts CAL*
CTBCORE > .1	*Not unreasonable recon*

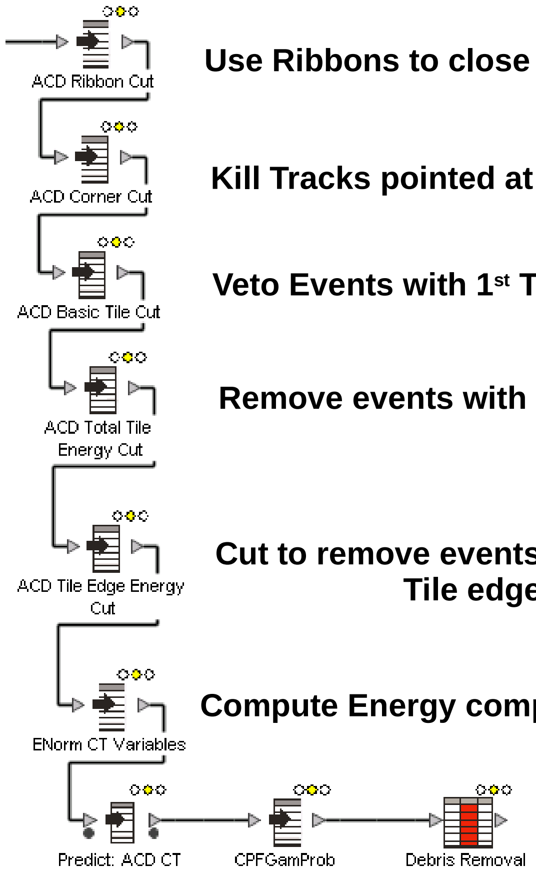
Background Rejection Scheme



https://confluence.slac.stanford.edu/download/attachments/4096462/Pass6_Bari_Overview.ppt?version=1

CPF overall scheme

Schematic



Use Ribbons to close gaps between ACD Tiles

Kill Tracks pointed at the ACD Corner Gaps

Veto Events with 1st Track pointed at hit Tile

Remove events with excess Total ACD Energy

Cut to remove events with low pulse height near Tile edges

Compute Energy compensated variables for CT usage

Compute CPFGamProb using CT Ensemble and Clean-up

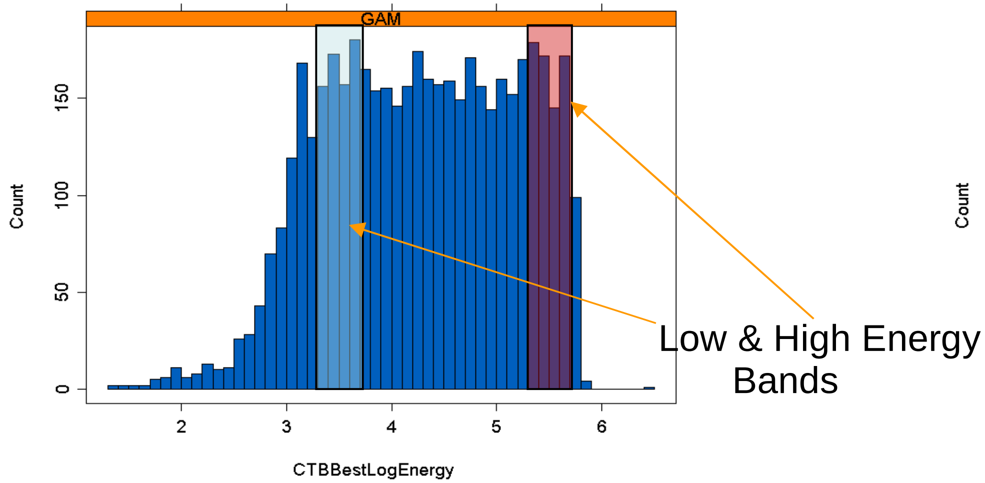
What's new since Pass 5

- Using Ribbons as intended
- Usage of scaled ACD energies
- Improved understanding of where self veto comes from

ACD: basic tile energy

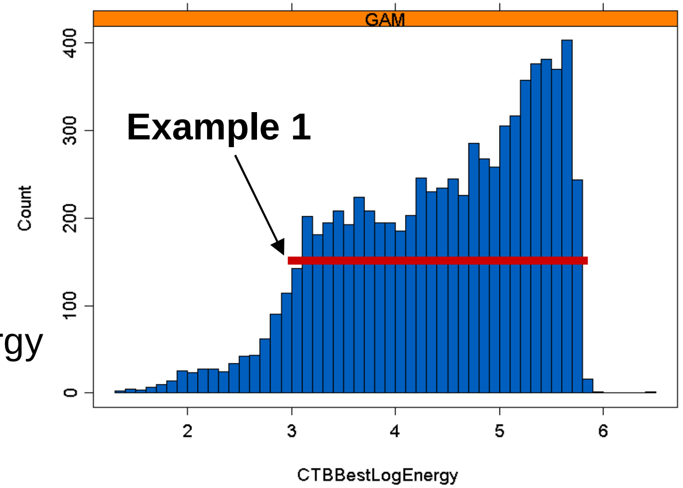
Example 1 Cut:

Tkr1SSDVeto == 0 &
AcdTkr1ActiveDist > 0 &
AcdTkr1ActDistTileEnergy > 1.



Example 2 Cut:

Tkr1SSDVeto < 5 &
AcdTkr1ActiveDist > 0 &
AcdTkr1ActDistTileEnergy > .2



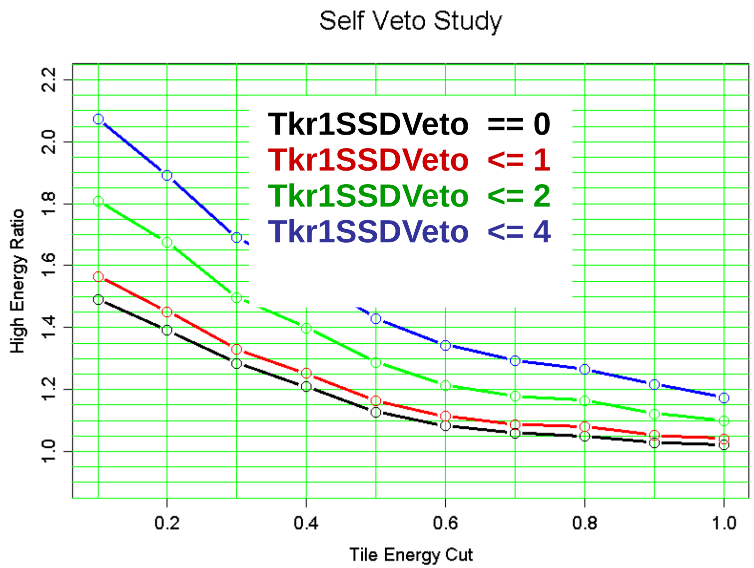
Note: This portion of the CPF Analysis was done with v13r7 since my v13r9 datasets all had the min. basics Active Dist.
- Tile Energy cut applied in the Skimmer.

Self Veto Study

Plot the ratio of events in Low & High energy bands as a function of the Tile Energy Cut.

Story

Having jumped ahead to the end of the analysis, there is an appreciable leakage of high energy events that can be missed by this cut. This sets limits on how liberal one can be with the Active Distance and associated Tile Energy. The scaled ACD energies become less capable as the reconstructed event energy increase (ie. > 10 GeV). These suggest that the Active Dist. Min is -16mm and Tile energy is .4 MeV. Fortunately the SSD req. is == 0



ACD: Total tile energy cut

Scaled ACD Tile Energies

Scaling the ACD energies to the total reconstructed energy lessens the self veto effect dramatically. Two scale energy variables are considered:

AcdTileEventEnergyRatio = AcdTkr1ActDistTileEnergy/CTBBestEnergy * 100

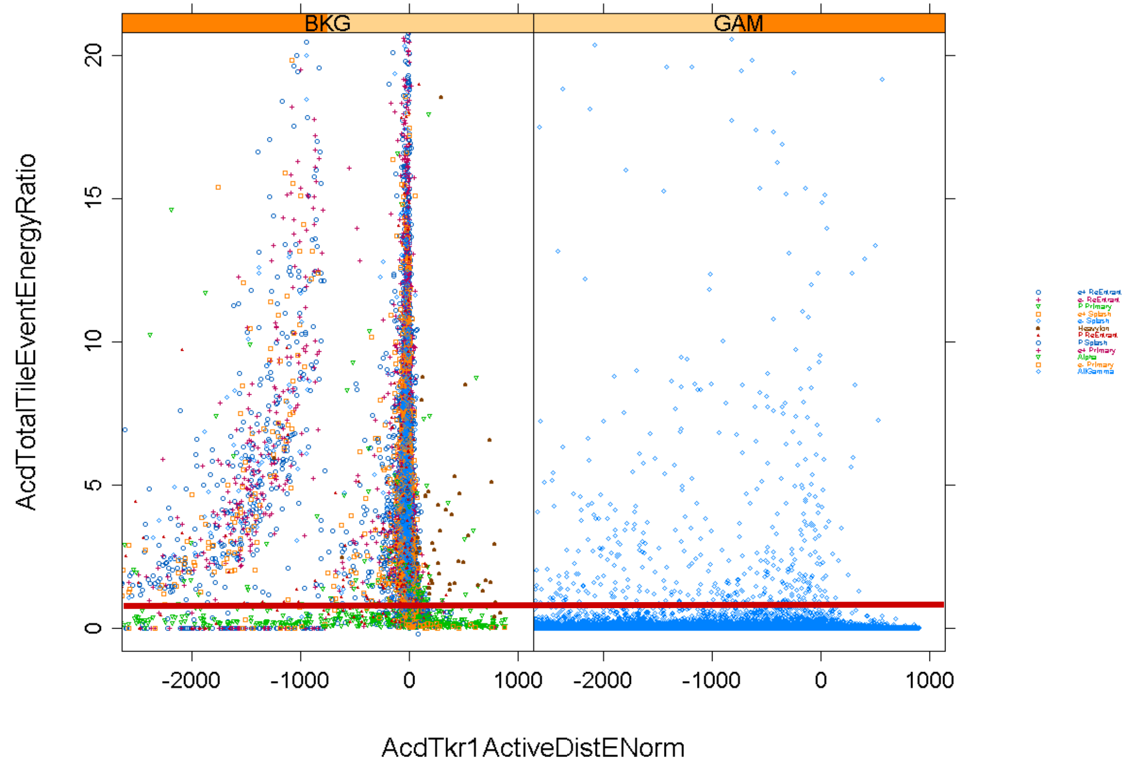
AcdTotalTileEventEnergyRatio = AcdTotalEnergy/CTBBestEnergy * 100

Advantages & Disadvantages

- Scaled responses automatically increase amount in ACD require to Veto an event as E increases
- The dependence on Tracking (along with its ~ 2% mis-tracking) is greatly reduced
- However as CTBBestEnergy increase, eventually even a MIP is passed…

First Cut
AcdTotalTileEventEnergyRatio > .8

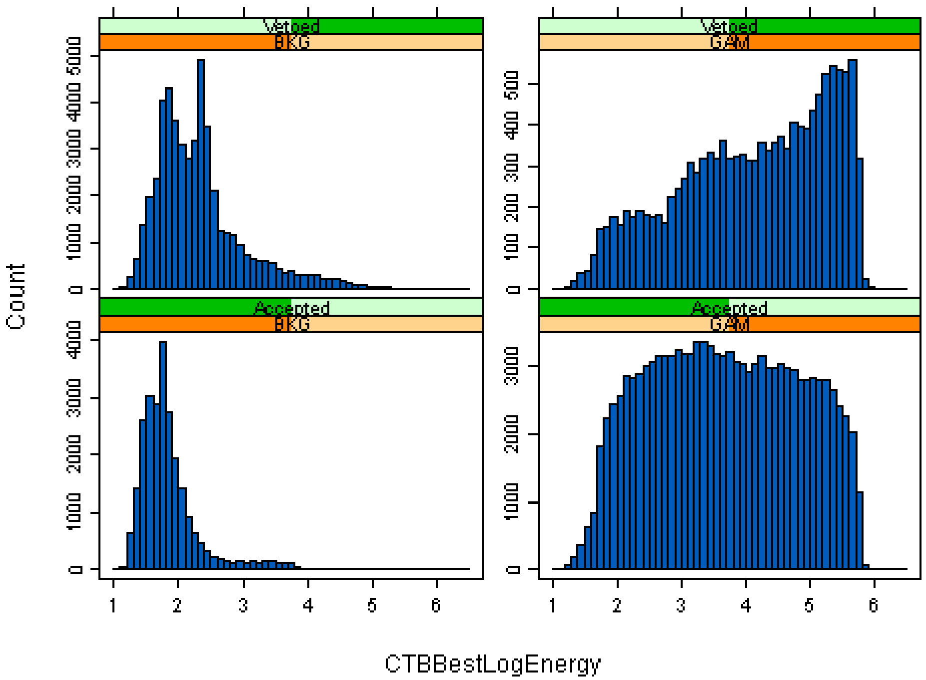
Note: something akin to this could be done onboard the LAT!

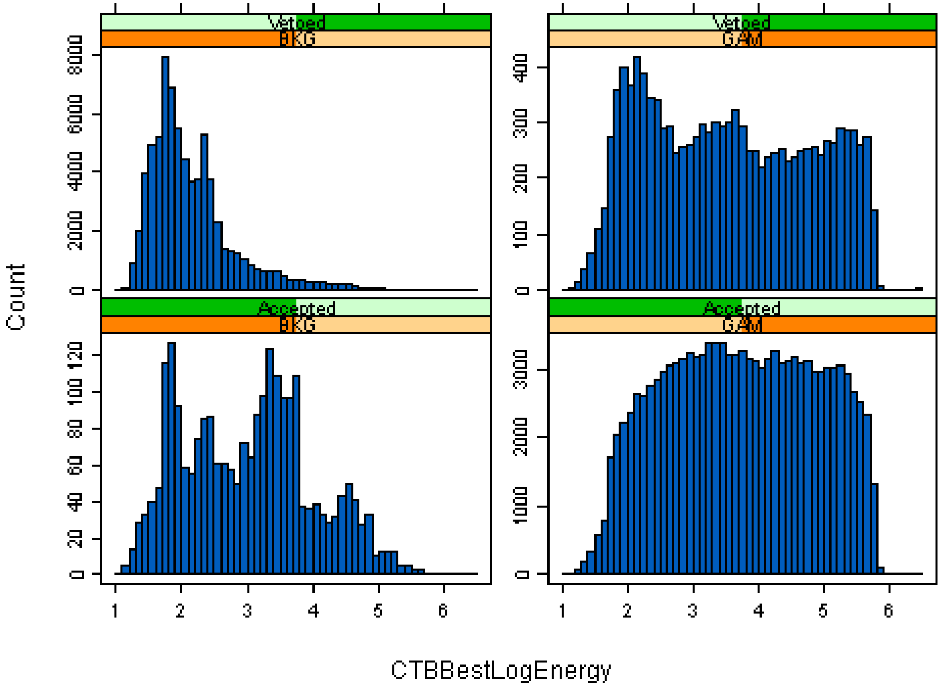


CPF: Pass 5 – Pass 6 comparison

		Veto.Pass5		Totals
		Accepted	*Vetoed*	
Event.Type	*BKG*	25123	49211	74334
	GAM	119362	13220	132582
Totals		144485	62431	206916

		Veto.Pass6		Totals
		Accepted	*Vetoed*	
Event.Type	*BKG*	2410	71924	74334
	GAM	120585	11997	132582
Totals		122995	83921	206916

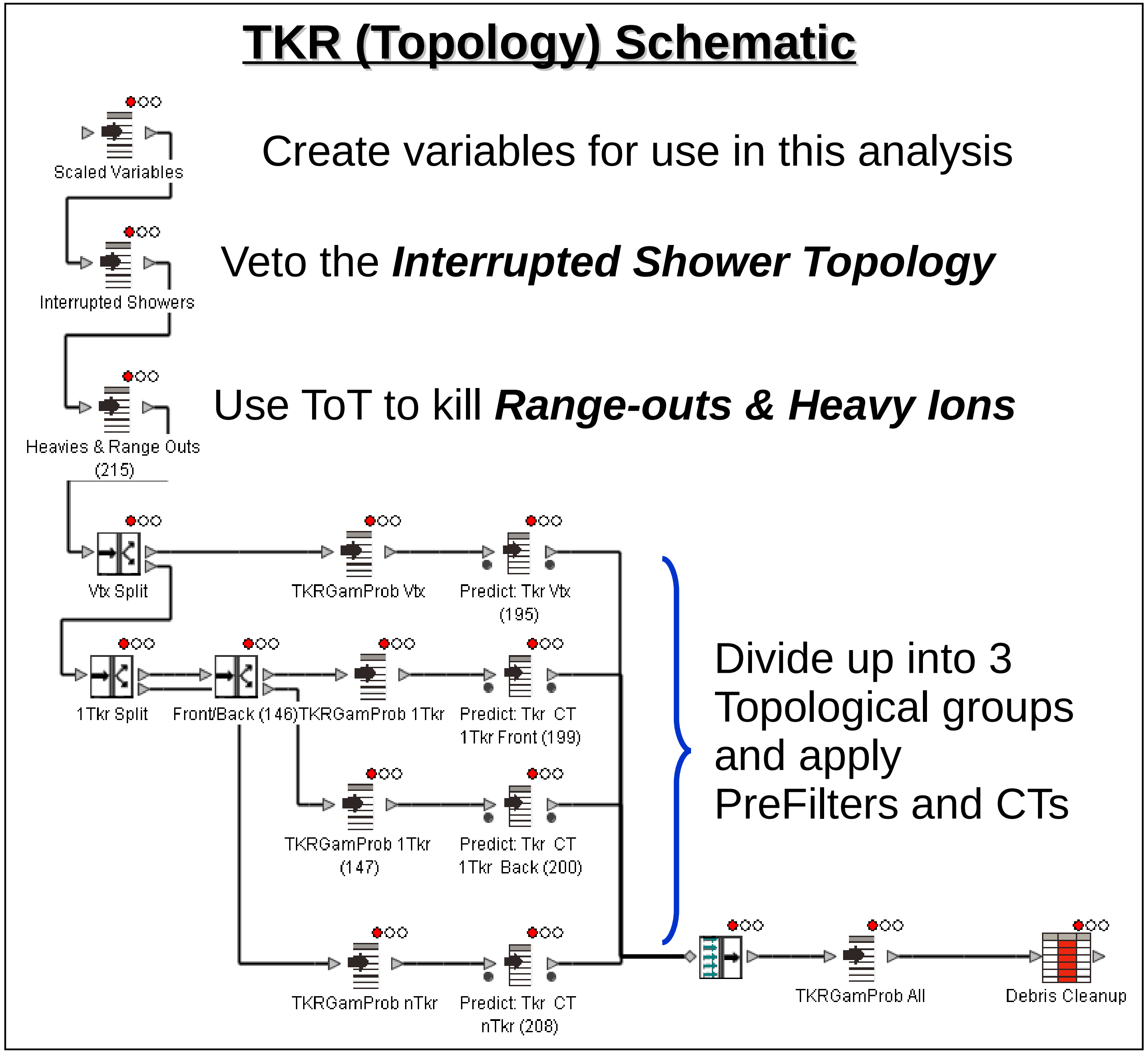




Note: These plots use the v13r7 data - skimmed v13r9 data have Basic Cut applied

<u>Conclusion:</u> Pass 6 is an order of magnitude better the Pass 5 while retaining the same Gamma efficiency!

TKR overall scheme



What's new in Pass 6?

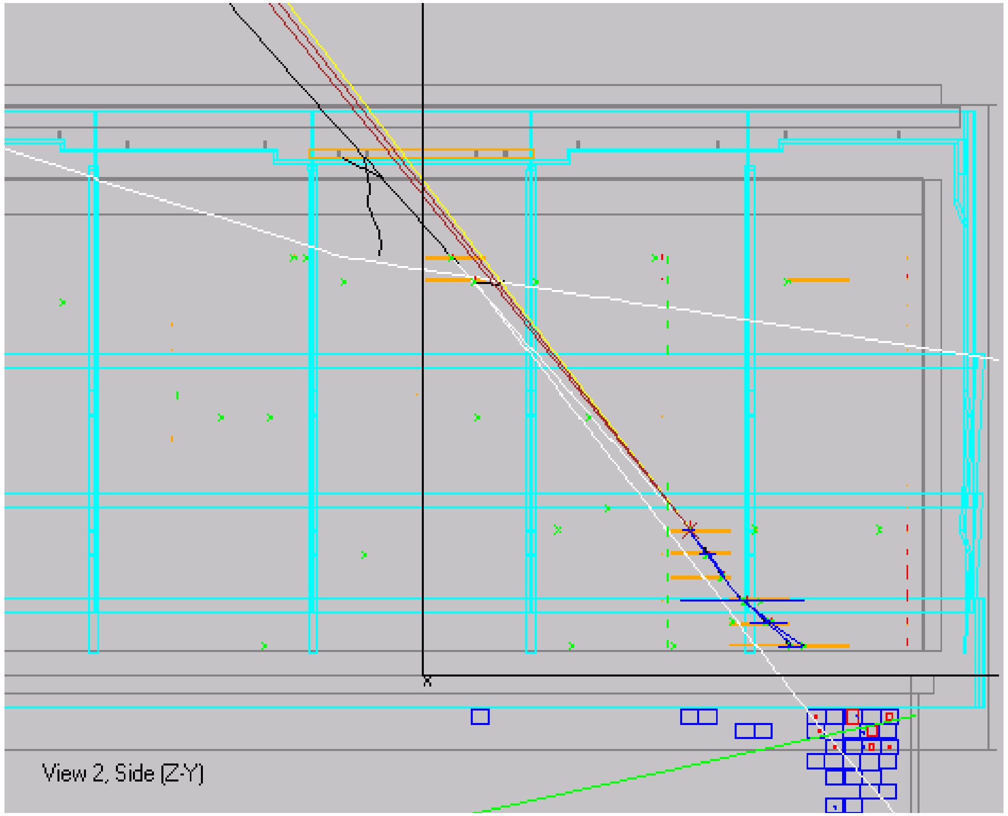
- Global IST Veto
- Global Heavies & Range-outs Veto

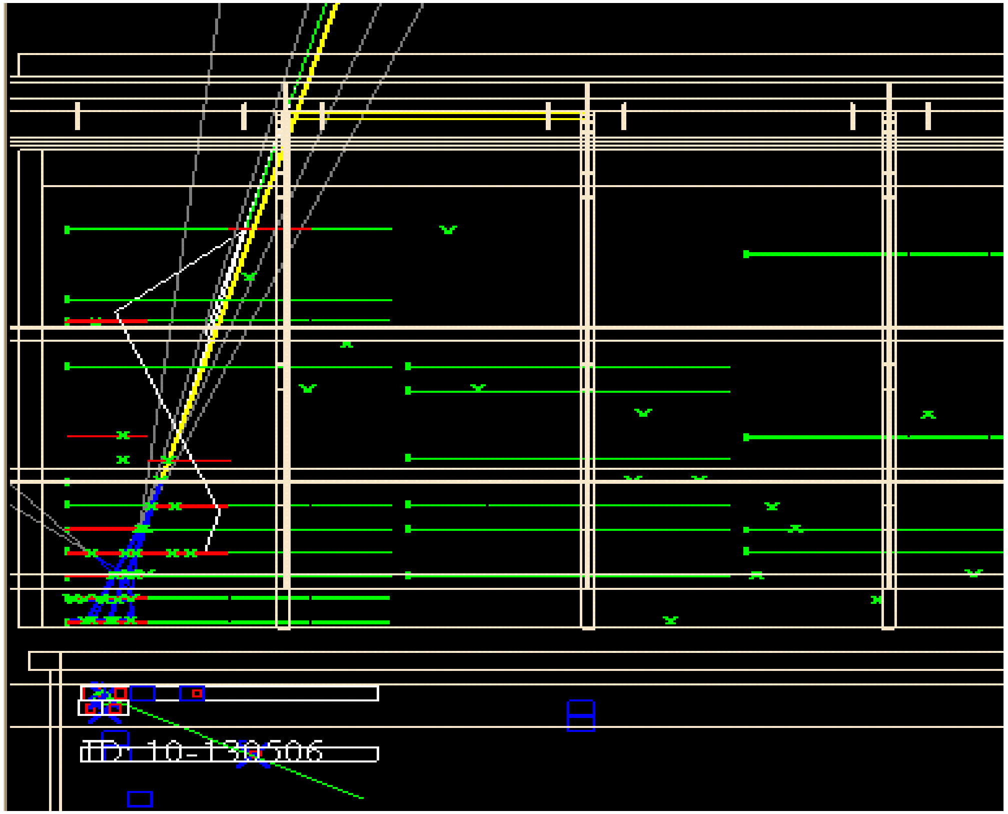
A new bkg class: IST

Incoming e+ and e- can interact in the first few layers going to an all-neutral state. The resulting gammas can then pair convert particularly in the thick layers. (R. Johnson)

Examples using incident e+

(from Robert)





<u>Interrupted Shower Cut</u>

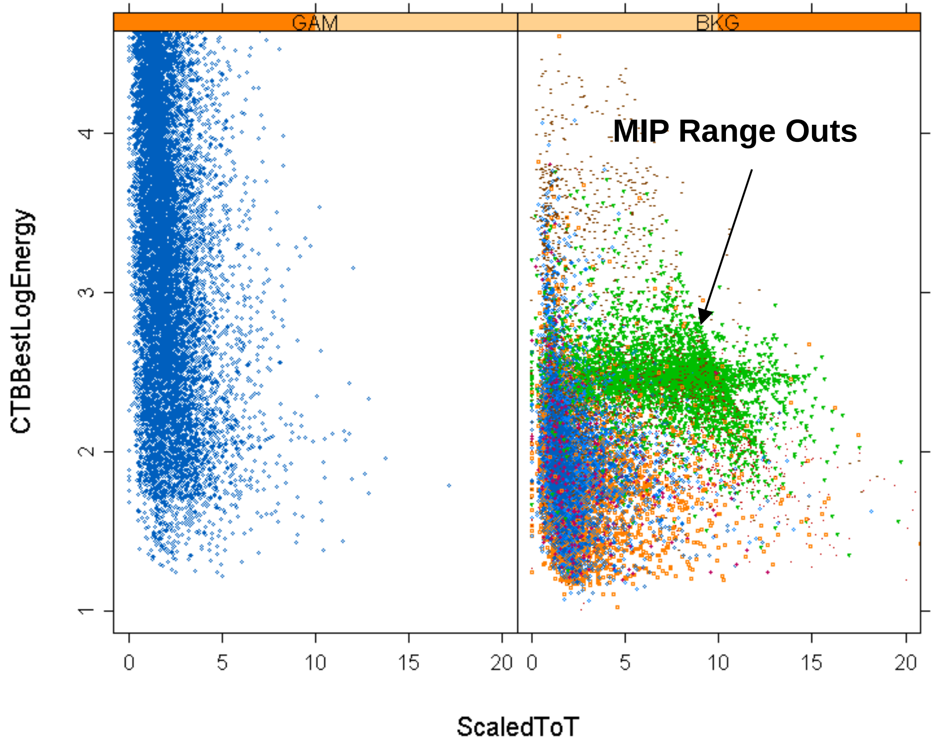
AcdTileEventEnergyRatio > max(.003, (6 - TkrUpstreamHC)* .006) &
AcdTileEventEnergyRatio > (-.015 - .00002*AcdTkr1ActiveDistENorm) &
TkrUpstreamHC > 0

		ISVeto		Totals
		Accepted	*Vetoed*	
Event.Type	*BKG*	90.41	9.59	72999
	GAM	98.02	1.98	153549
Totals		216506	10042	226548

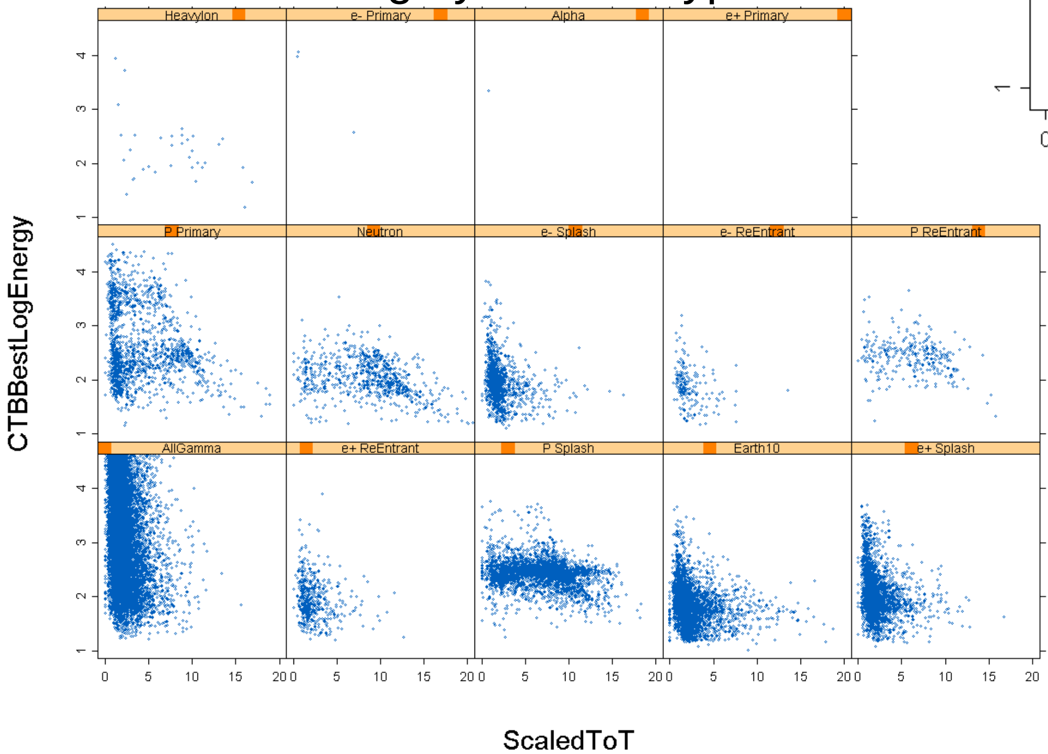
Heavy ions and from below

Tracker ToTs give a dE/dX meas.
Plotting Tkr1ToTFirst vs CTBBestLogEnergy suggested that scaling the ToT to energy had merit:

ScaledToT = Tkr1FirstTot * 2.5 / CTBBestLogEnergy



Decoding by Source Type

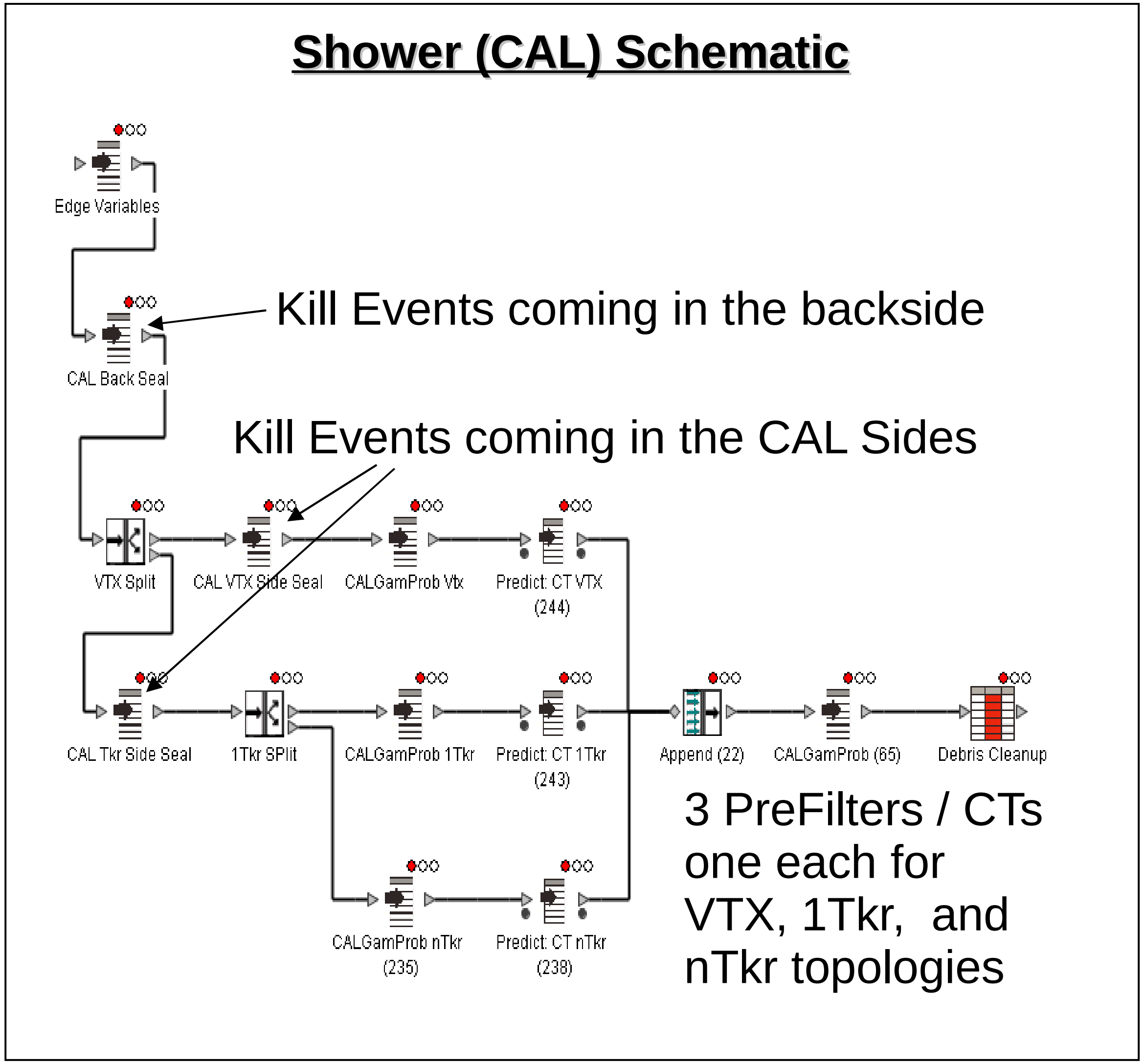


Heavies & Range Out Cut

Tkr1ToTFirst < .2 & CTBBestEnergy < 25000) |
Tkr1ToTFirst * 2.5/CTBBestLogEnergy > 6.5

		HRVeto		Totals
		Accepted	*Vetoed*	
Event.Type	*BKG*	75.62	24.38	72999
	GAM	98.68	1.32	153549
Totals		206732	19816	226548

CAL overall scheme



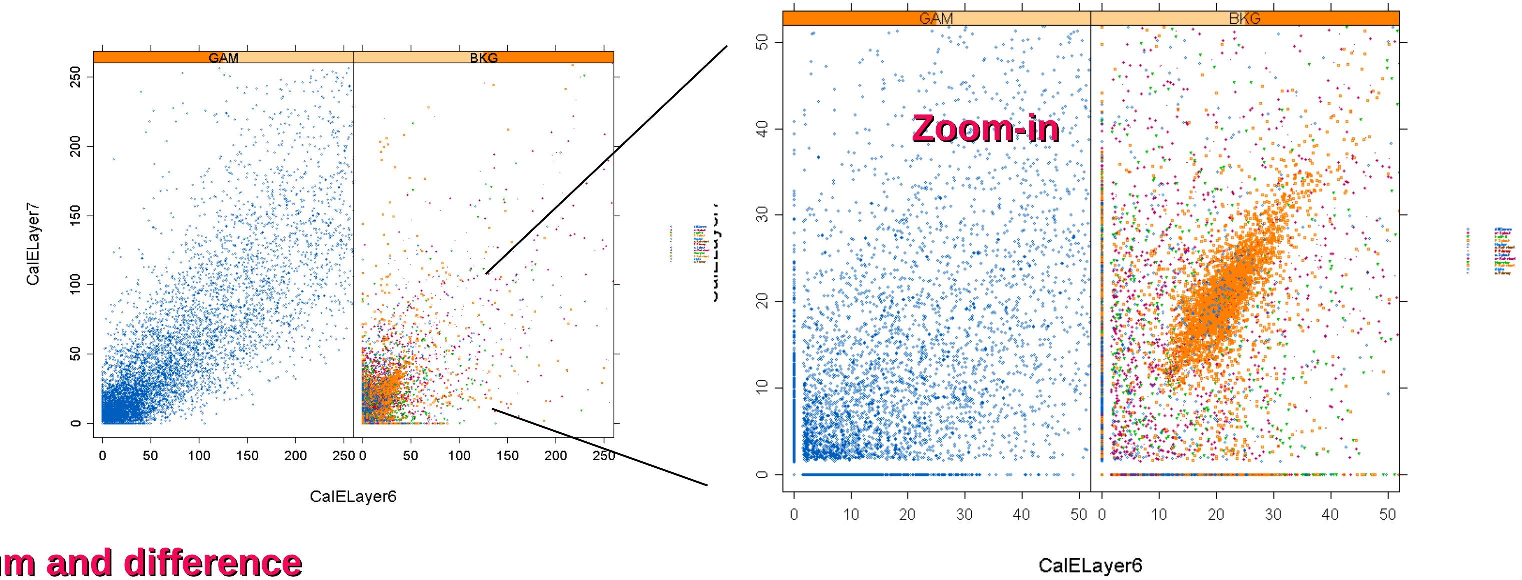
The data use for this required the CPF PreFilters (CPFGamProb > 0)

What New in Pass 6?

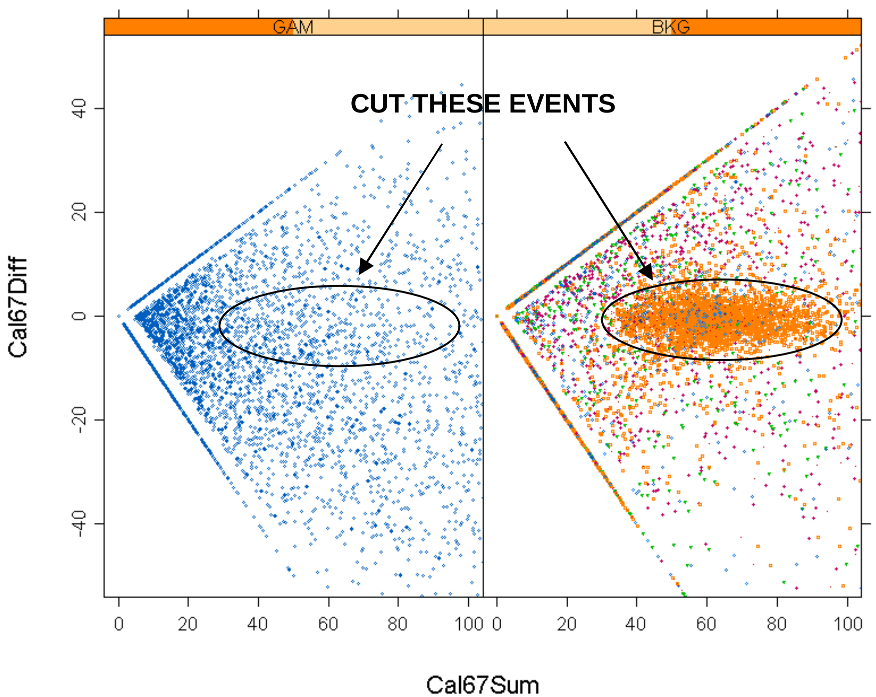
- Pass 5 PreFilters Recycled
- Attempt to limit CAL Back & Side entering Events

Backside entering

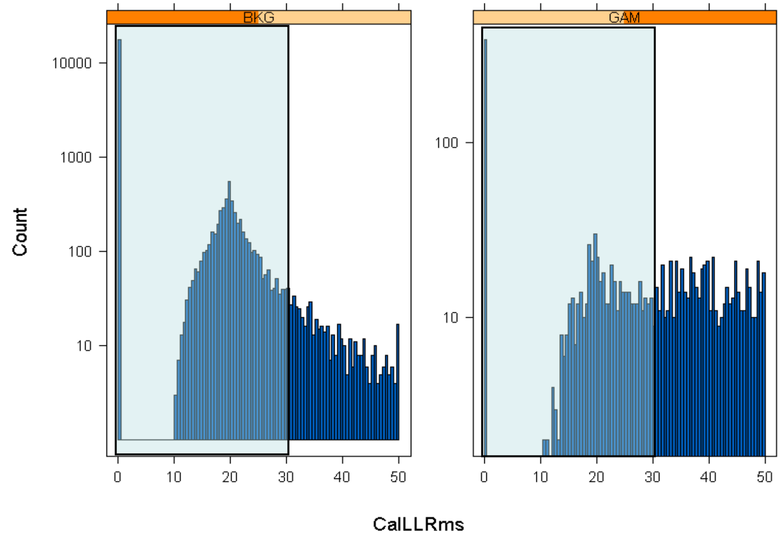
Pick up signal in last layers of CAL. Cross correlate Layers 6 & 7



Rotate: Take sum and difference



Check for Clean Entry



$$\mathrm{CalLLRms} = \sqrt{\mathrm{CalXPosLLRms}^2 + \mathrm{CalYPosLLRms}^2}$$

Event classes

<u>Pass 6 Transient Class</u>

CPFGamProb > .2 & CALSeal > 0 &
((TKRGamProb < 0 & CALGamProb > .1) |
(TKRGamProb > .1 & CALGamProb < 0) |
(TKRGamProb+CALGamProb > .5))

Results: Bkg. Left = 29226 -or- 2.02 Hz
Bkg. Above 100 MeV = 14676 -or- 1.02 Hz

<u>Pass 6 Source Class</u>

Transient+
(CTBTKRISVeto > 0 & CTBTKRHRVeto > 0)
CT with CalTkrComboCut

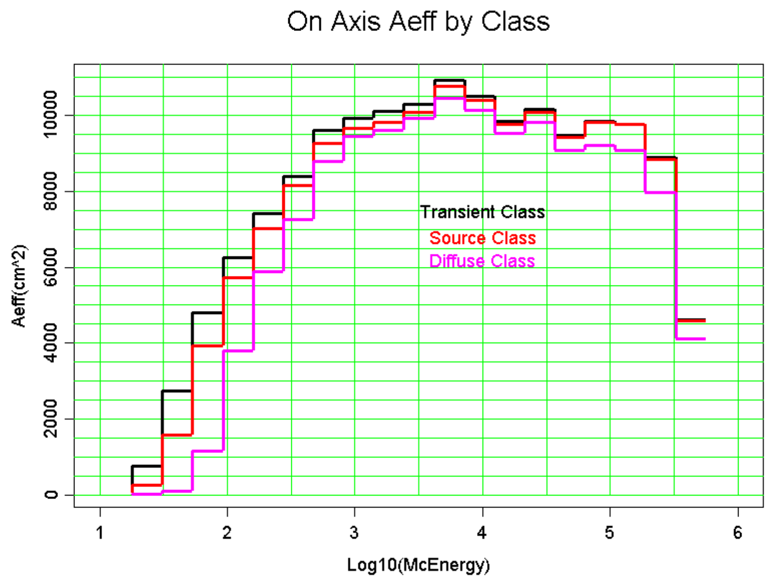
.4 Hz - AllProb > .10 (!)

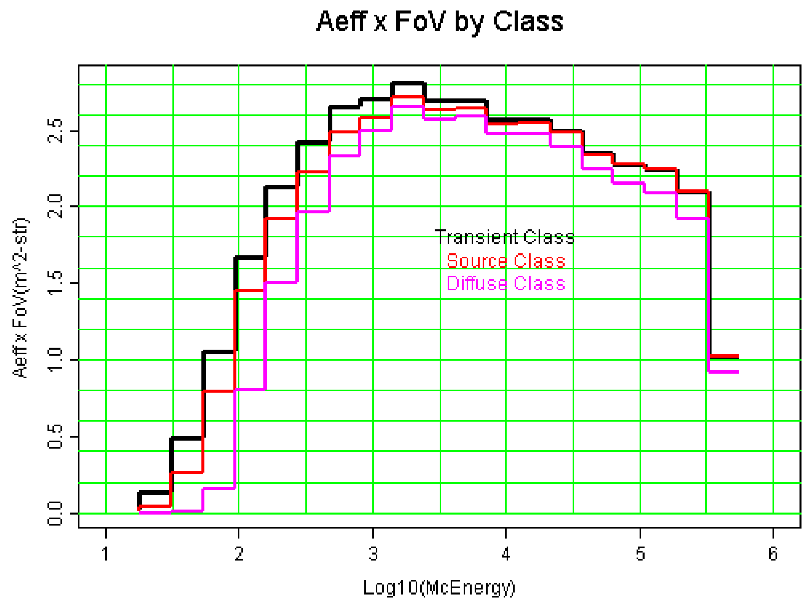
<u>Pass 6 Diffuse Class</u>

Transient+
AllProb>.4

Leaves: All = 1860 (.13 Hz)
E > 100 MeV = 1627 (.11 Hz)

Pass6 summary





Summary

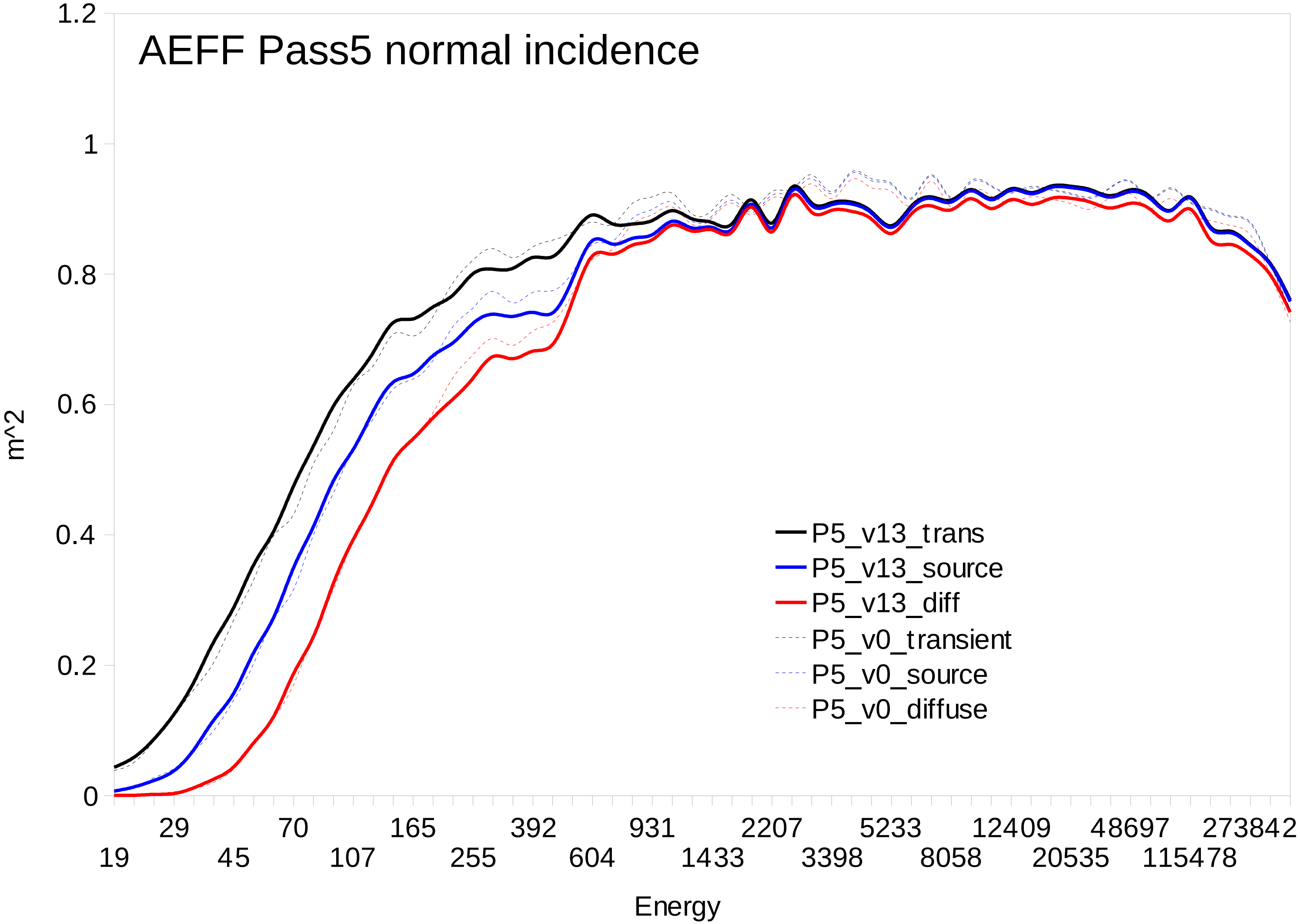
- Pass 6 improves on Pass 5
- The basics for optimize Event Class definitions are available
- Improvements needed to compensate for mis-tracking at high energy
- Pass 6 also includes the Neutral Energy Analysis presented at NRL last November
- Already in GlastRelease (since v13r9p4)

Directions for Pass7

Instrument Response Function

IRFs

Pass5: new irfs, reflecting GlastRelease v13r9
Currently in ScienceTools LATEST: P5_v13_0_(trans,source,diff)

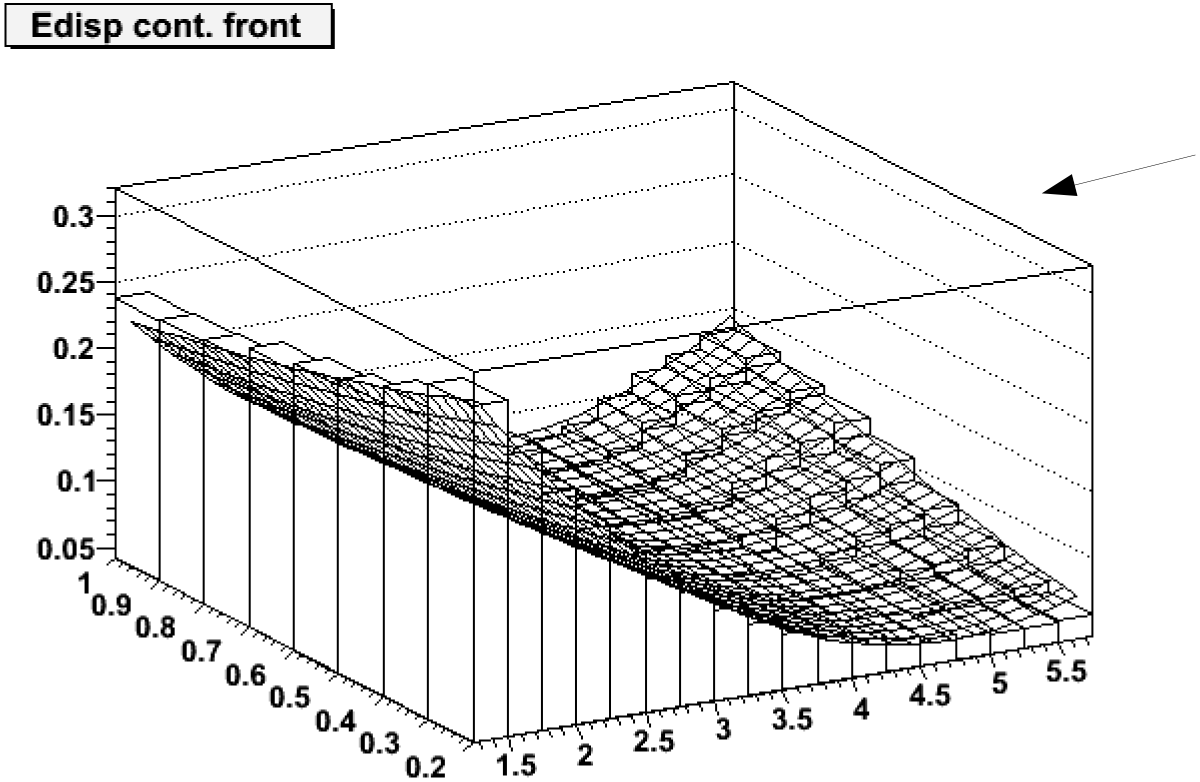


Smoothing Edisp, psf-like

Edisp is currently expressed in terms of $\frac{E_{CTB} - E_{MC}}{E_{MC}}$

Edisp shape varies quite a lot in the allGamma phase-space (logE vs cos(th))
This means that the parameters defining the Edisp in the irf representation vary quite a bit
This leads to systematics
A more smooth behavior is desirable

Let's see how wide is the energy RMS – use allGamma_v11-562G reprocessed p5
To have an idea of how the “energy resolution” varies let's have a look at P5_v0_transient



Edisp 68% containment, front (LEGO)
It's smooth enough, let's try to parametrize this with a simple shape, e.g. a quadric (mesh)

Scale function

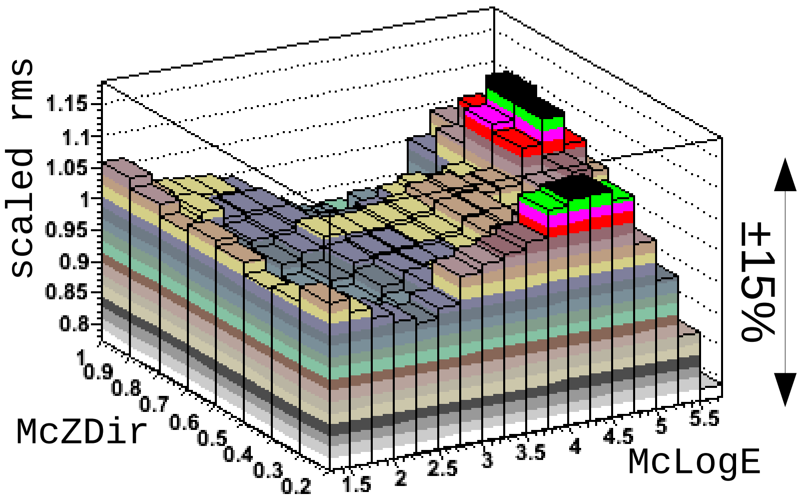
$$f_{scale}=a_0\cdot\log(E)^2+b_0\cdot\cos(\theta)^2+a_1\cdot\log(E)+b_1\cdot\cos(\theta)+cx\cdot\log(E)\cdot\cos(\theta)+d_{off}$$

Parameters (separate for front/back) are:

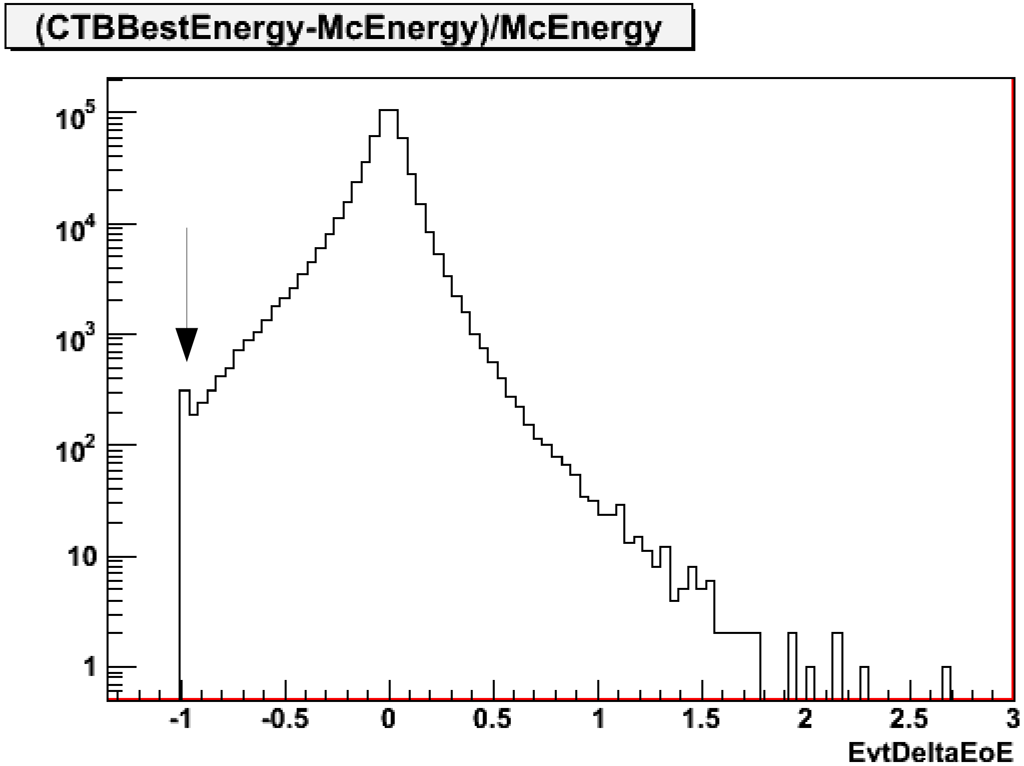
```
a0[]={0.021,0.0215};
b0[]={0.058,0.0507};
a1[]={-0.207,-0.22};
b1[]={-0.213,-0.243};
cx[]={0.042,0.065};
doff[]={0.564,0.584};
```

Lets rescale edisp by f: $McScaledDeltaE=\frac{1}{f_{scale}}\cdot\frac{E_{CTB}-E_{MC}}{E_{MC}}$

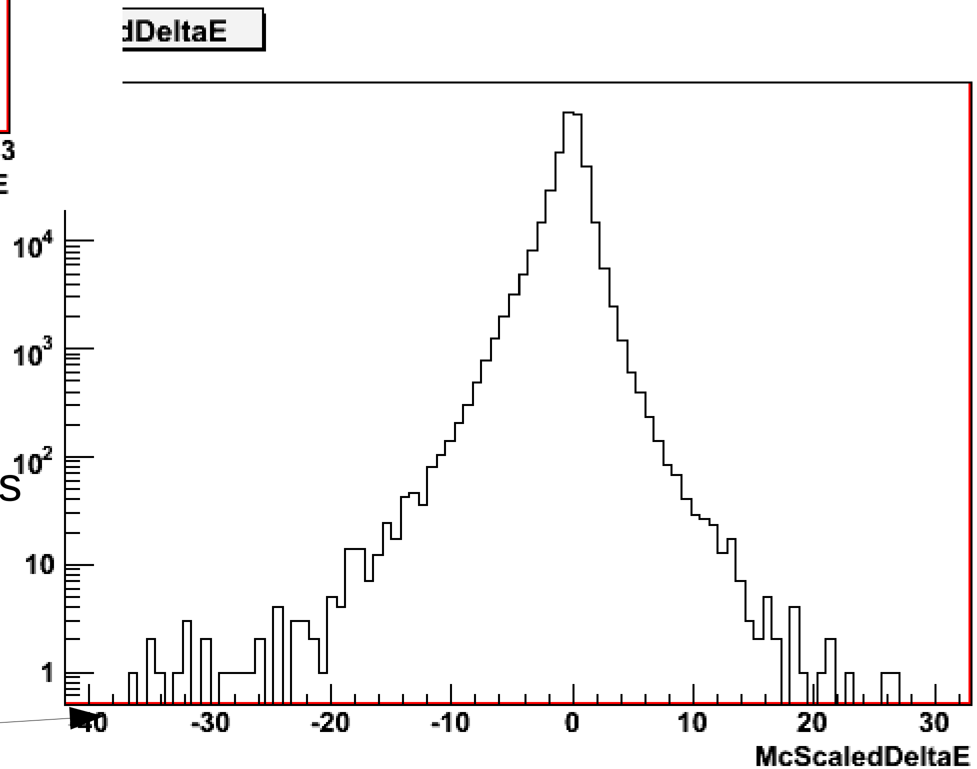
At this point the rms varies by a few %, except for extreme energies, one could work on this with cuts, CTs:



Scaled deviation



This is the usual plot we've seen thousands of times
Mind the shoulder on the left
All events at once, front+back



Same plot after rescaling
“Symmetric” around zero
Here one can try to cut tails

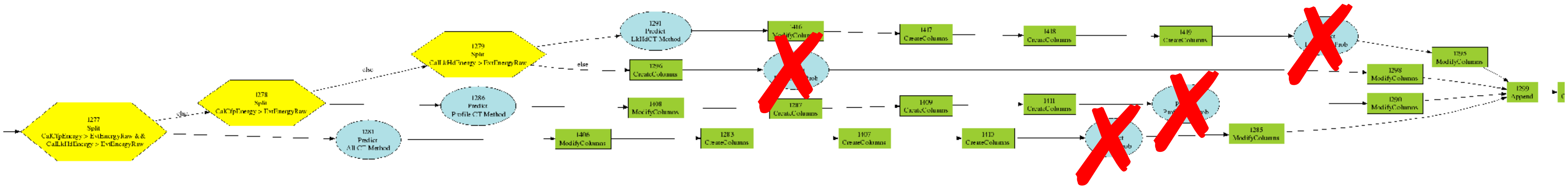
This is now in units of “core rms”

Tweak IM

Change the way GoodEnergy probability is assessed

Right now (P5_v0): ❑ **Current definition of good energy recon (**

- **GoodEnergy = ifelse((BestDeltaEoE > NSigmaHi*EnergyResModel | BestDeltaEoE < -NSigmaLow*EnergyResModel) , "BadEnergy", "GoodEnergy")**
  - **EnResModel = .02+.6/(McLogEnergy)2.5 + .005*(McLogEnergy-2.)2**
  - **NSigmaHi = 1.**
  - **NSigmaLow = 2.**



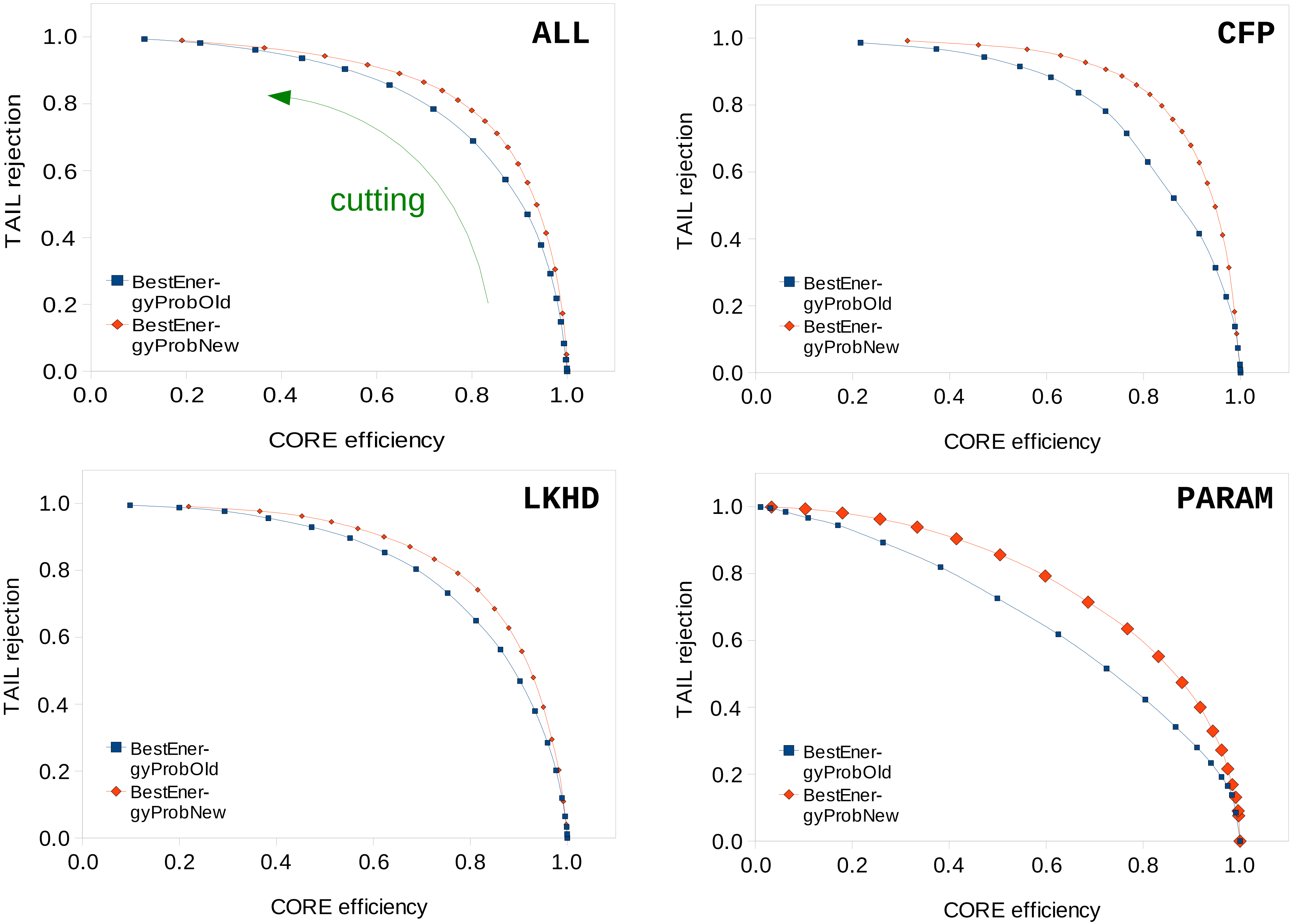
Substitute each simple CT with a series of two:

- First, BEP2 is probability that abs(McScaledDeltaE)<2
- Second, BEP3 is probability that abs(McScaledDeltaE)<3

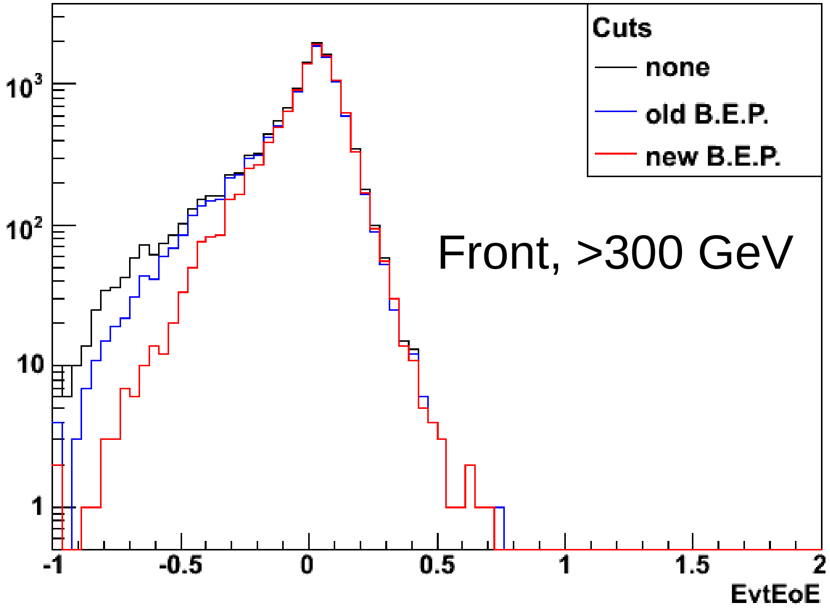
For the moment being BestEnergyProb=sqrt(BEP2*BEP3) in each pathway:

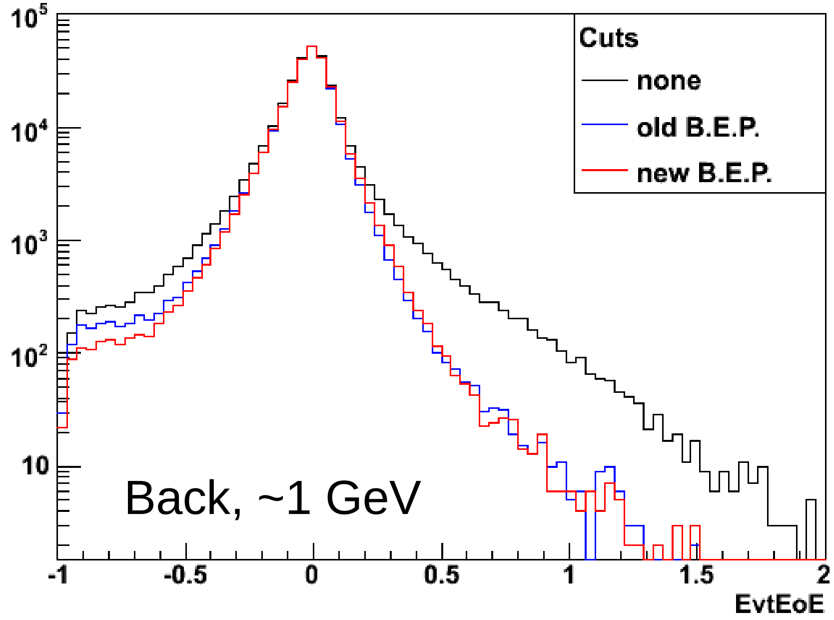
1) ALL
2) Profile
3) Likelihood
4) Parametric

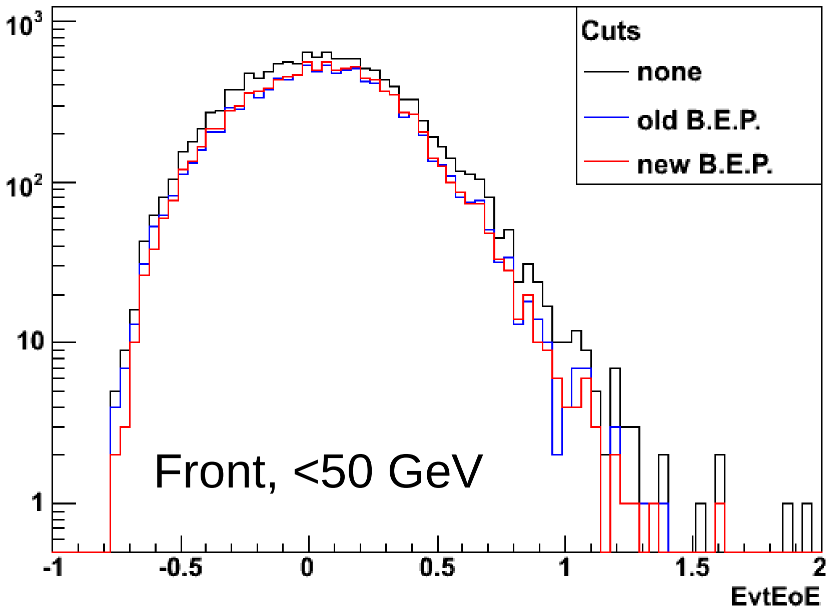
Power


ALL
CFP
LKHD
PARAM
cutting
TAIL rejection
CORE efficiency
0.0
0.2
0.4
0.6
0.8
1.0
BestEnergyProbOld
BestEnergyProbNew

Examples



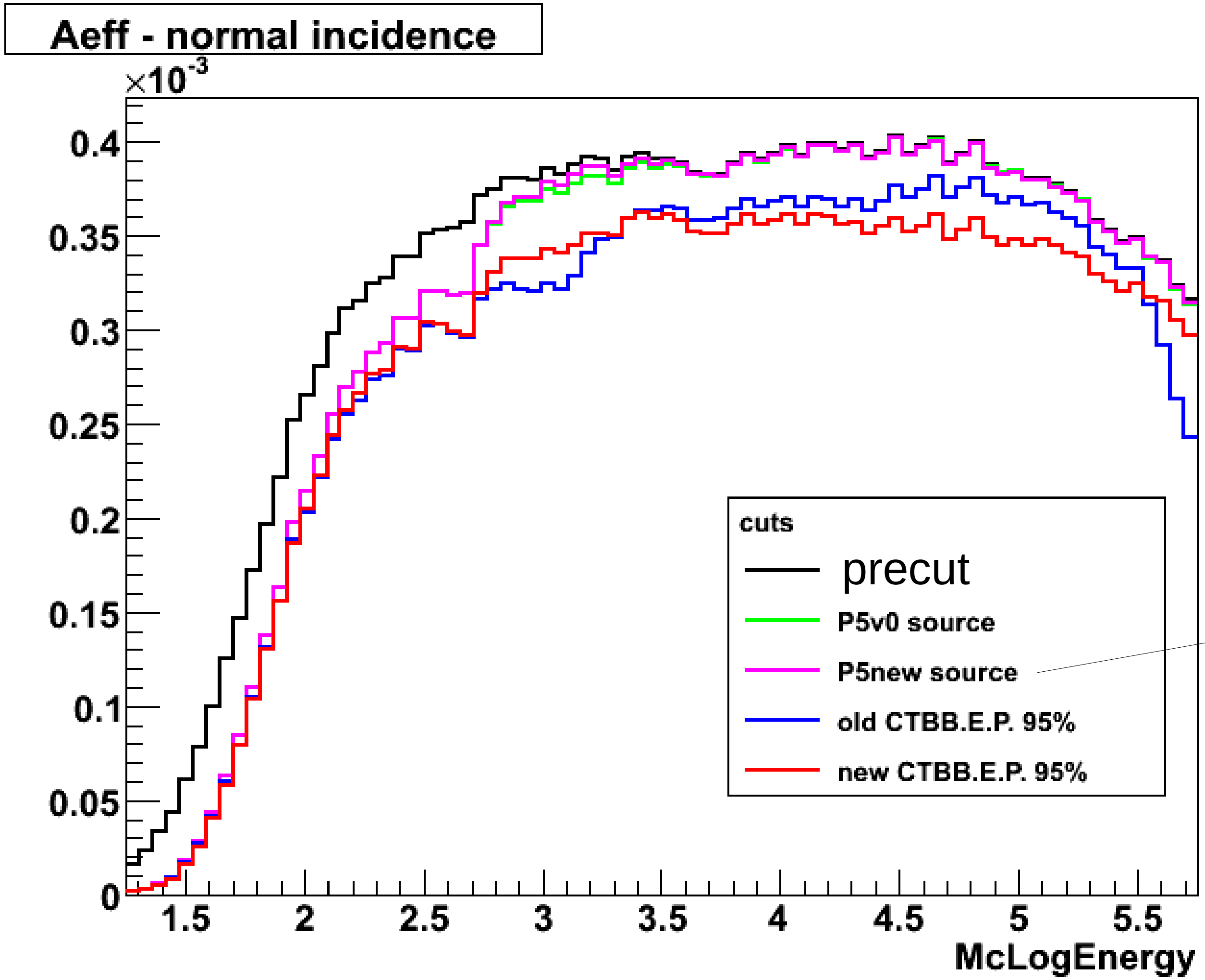




CTBBestEnergyProb(Old)>0.35

(
(CTBBestEnergyPath==1 &&
CTBBestEnergyProb>0.25) ||
(CTBBestEnergyPath==2 &&
CTBBestEnergyProb>0.2) ||
(CTBBestEnergyPath==3 &&
CTBBestEnergyProb>0.25) ||
(CTBBestEnergyPath==4 &&
CTBBestEnergyProb>0.3)
)

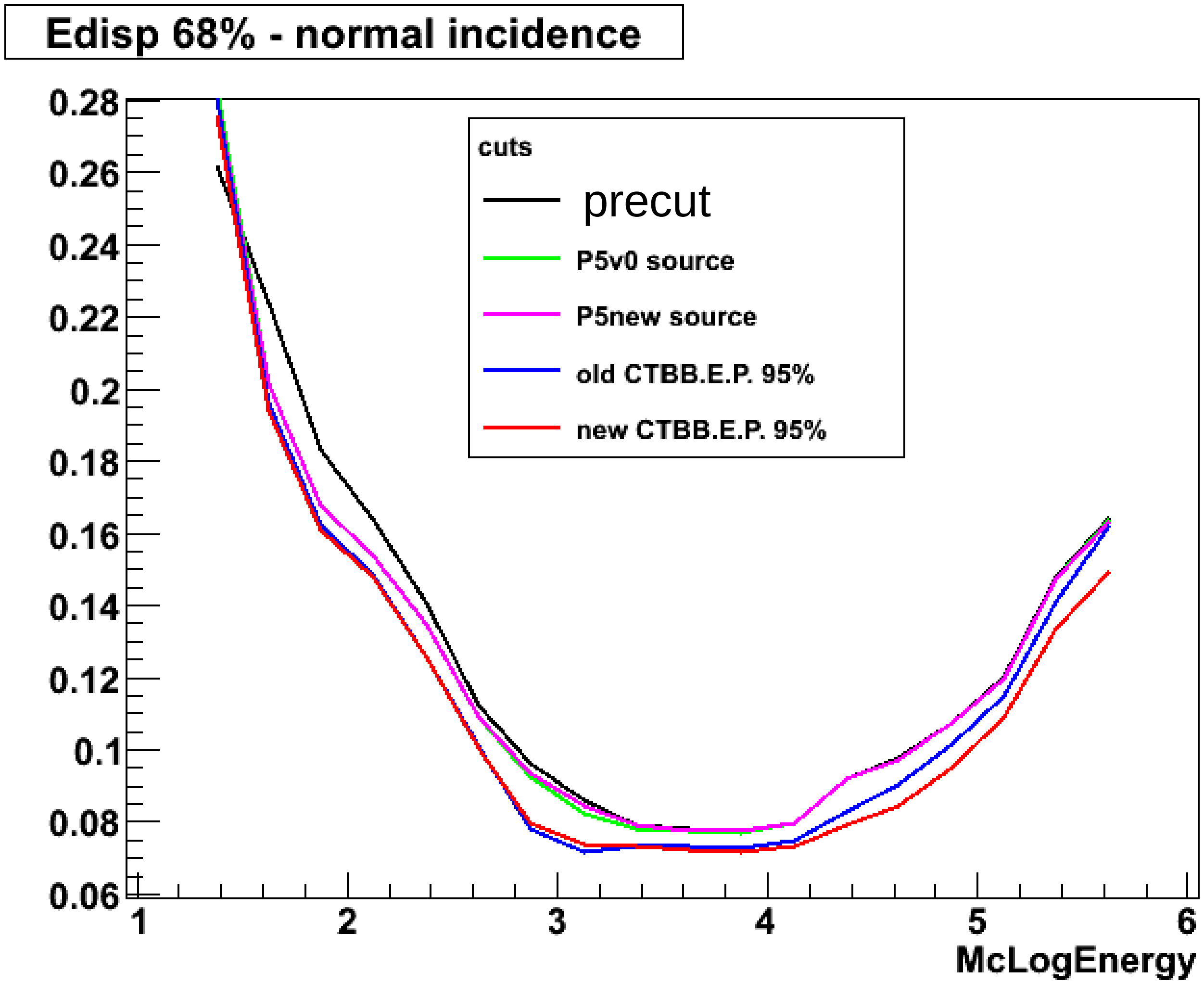
Performances



► BestEnergyProbNew>0

Here:
“precut” means Trigger + Obf + CTBClassLevel>0 + CTBCORE>0.1
that is, P5 Transient without the cut on BestEnergyProb

Performances 2



Here:
“precut” means Trigger + Obf + CTBClassLevel>0 + CTBCORE>0.1,
that is P5 Transient without the cut on BestEnergyProb

Summary

Pass5 irfs up to date with GlastRelease

Pass6 ready to include modifications to BestEnergyProbability
This improves (marginally at the moment) the cutting power on tails
Nowhere near the theoretical limit

On-board Filter

Onboard Filter

As shown at Nov. collaboration meeting:
Have studied a number of Filter parameter settings
Enabling/disabling filters can have large impact
Filter threshold allow us some finer adjustments

VETO17:
Designed to remove upward going cosmics that interact in CAL and create gammas. The gammas convert after traveresing a few layers of the TKR.

Activated if:
- No evidence of a track (only one projection)
- Energy > Tkr_ZeroTkrEmin
- Default value of threshold is 250 MeV

Threshold lowered to 0 MeV

VETO21:
Intended to remove low energy background like albedo.

Activated if:
No evidence of a track pointing to the cal (no hits in 4 of the bottom 6 silicon planes)
- Energy > Zbottom_Emin
- Default value of threshold is 100 MeV

Threshold lowered to 0 MeV

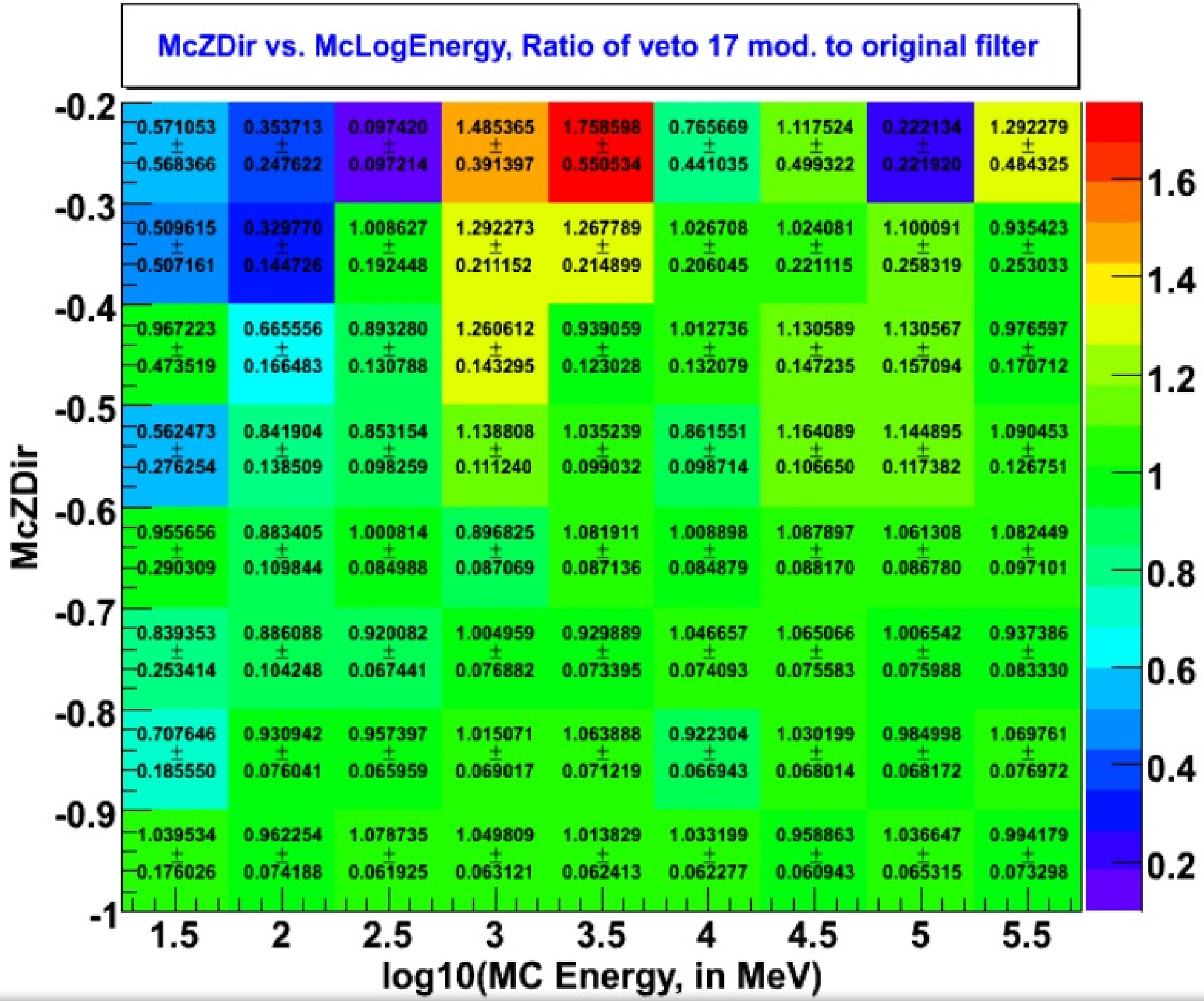
http://confluence.slac.stanford.edu/download/attachments/13899/CAmeeting_02182008_PDSmith_OnboardFilter.pdf
https://confluence.slac.stanford.edu/download/attachments/13899/CAmeeting_02252008_PDSmith_OnboardFilter.pdf

Veto 17: change

Ratio efficiency

Numerator is the sample with veto 17 modified
Denominator is sample with original filter settings

Bins affected seem to be along low energy and large angles
Errors are very large though

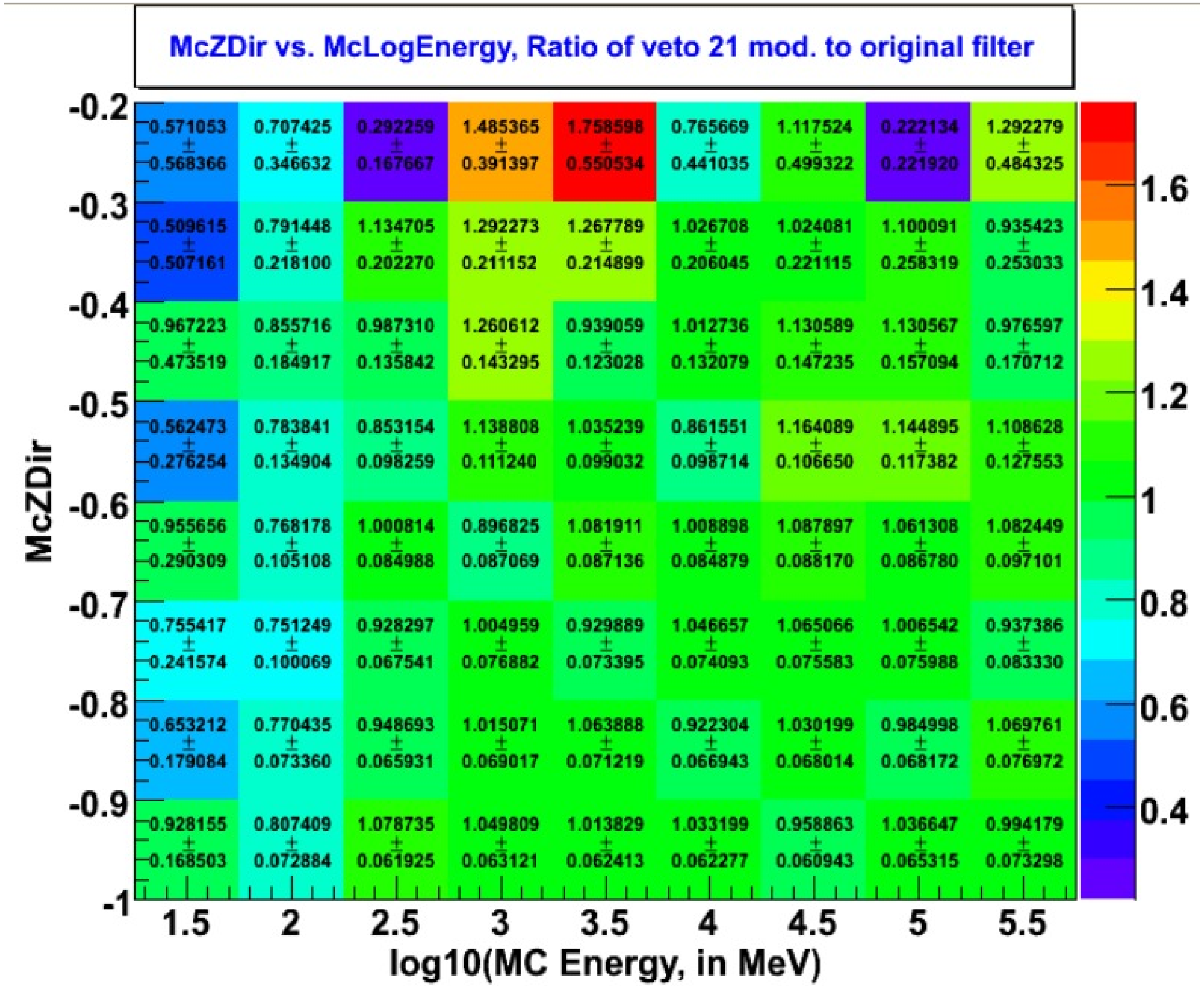


Veto 21: change

Ratio efficiency

Numerator is the sample with veto 21 modified
Denominator is sample with original filter settings

Bins affected seem to be along low energy and large angles
Errors are very large though



Background Model

Background model

- **The flux model will be updated frequently in early operation. We need to know what is implemented and what's not, but no single document can tell about this.**
- **Therefore, we prepared a confluence page**
  - **http://confluence.slac.stanford.edu/display/SCIGRPS/Background+Flux+Model+in+Gleam**
- **The page is not so friendly (no images…). This talk is intended to give <u>an overview of the current model</u>.**

- **Protons - primaries and secondaries**
- **Electrons - primaries and secondaries**
- **Positrons - primaries and secondaries**
- **Alphas - primaries**
- **Neutrons – secondaries**
- **Heavy Ions**
- **Trapped particles**
- **Earth(albedo) gammas**

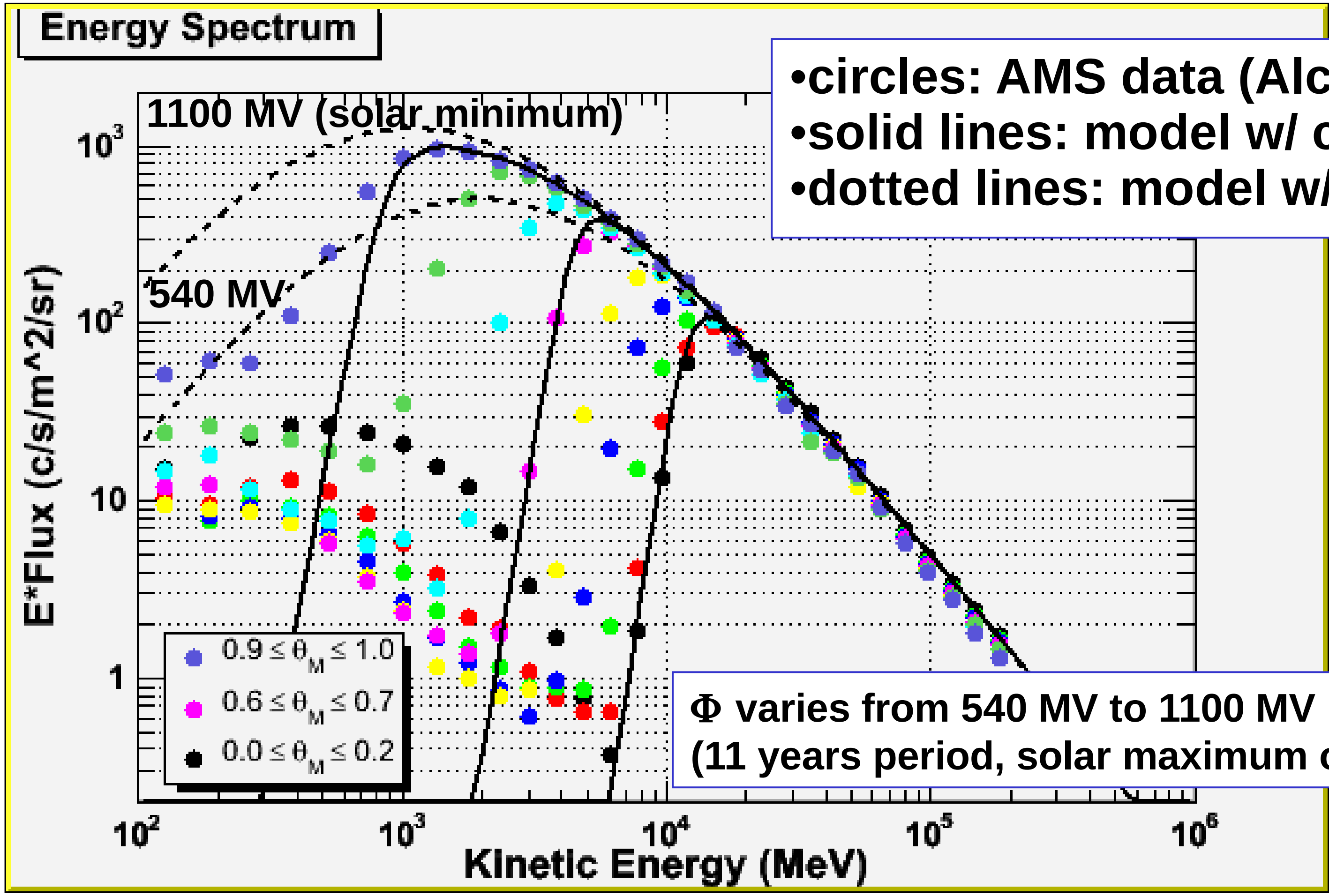
- **<u>Long efforts</u> by Pat, Toby, Eric, Tune, Masanobu, Benoit, Jonathan, Markus, T.M. and others!**

http://confluence.slac.stanford.edu/download/attachments/4096462/GLAST_BGModel_2008-02-06.ppt?version=1
http://confluence.slac.stanford.edu/download/attachments/13899/PamelaGLAST_2008-02-16_Mizuno_Ormes.ppt?version=2

Primary protons - spectrum

$$\mathrm{Primary}(E) = \boxed{\mathrm{Unmod}(E + Ze\Phi) \times \frac{(E)^2 - (Mc^2)^2}{(E + Ze\Phi)^2 - (Mc^2)^2}} \times \boxed{1 / \left(1 + \left(\frac{R}{R_{\mathrm{cutoff}}}\right)^{-12.0}\right)}$$

force-field approx. (Gleeson&Axford 1968) **geomag cutoff to reproduce AMS data**

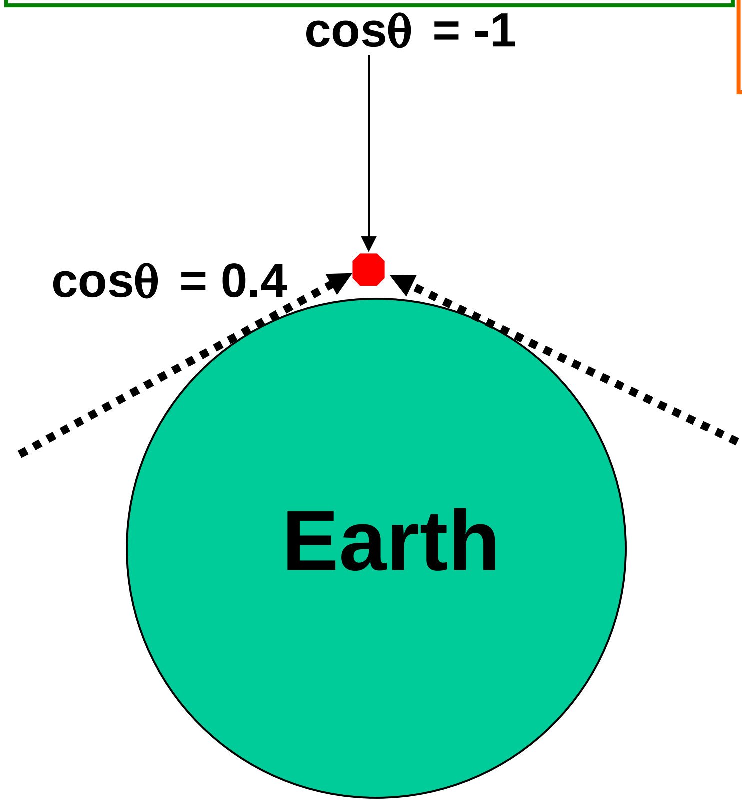


- **circles: AMS data (Alcaraz et al. 2000)**
- **solid lines: model w/ cutoff**
- **dotted lines: model w/o cutoff**

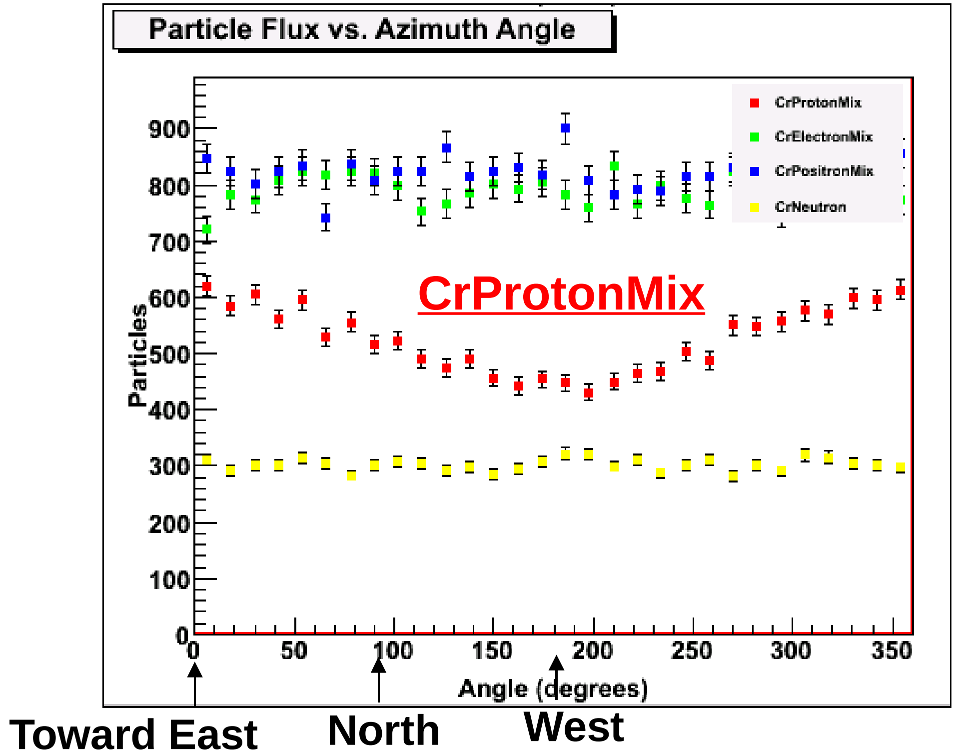
Φ varies from 540 MV to 1100 MV in sinusoidal curve (11 years period, solar maximum on 2001-11-1)

Primary protons – angular distribution

•No zenith angle dependence above the Earth rim (cosθ>-0.4).



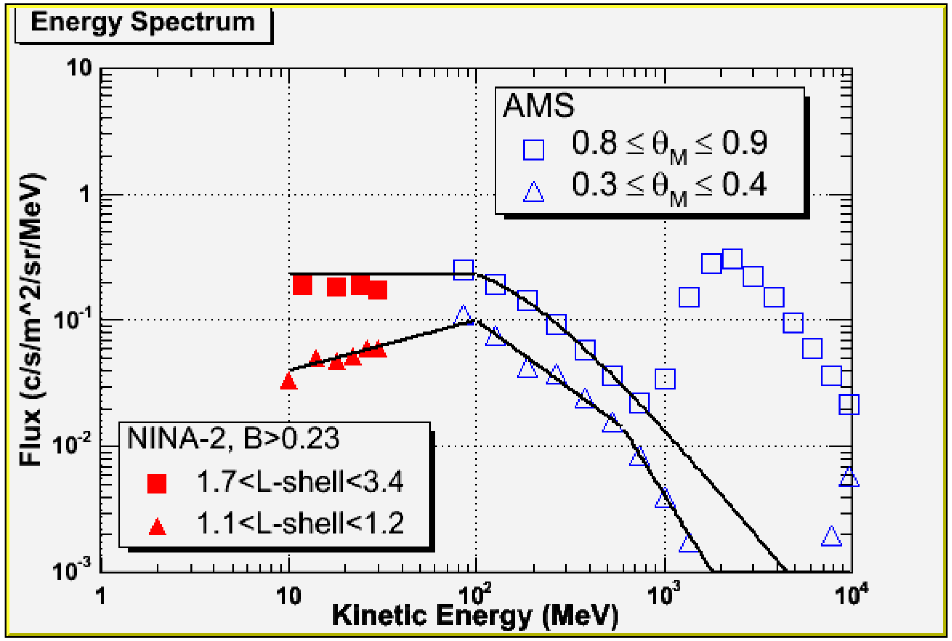
•<u>EW effect was approximately implemented</u>
- ➢generate particles uniformly above the Earth rim
- ➢calculate <u>Rc</u> and the flux for (θ, ϕ)
- ➢reject the event by the ratio of the flux to that form west



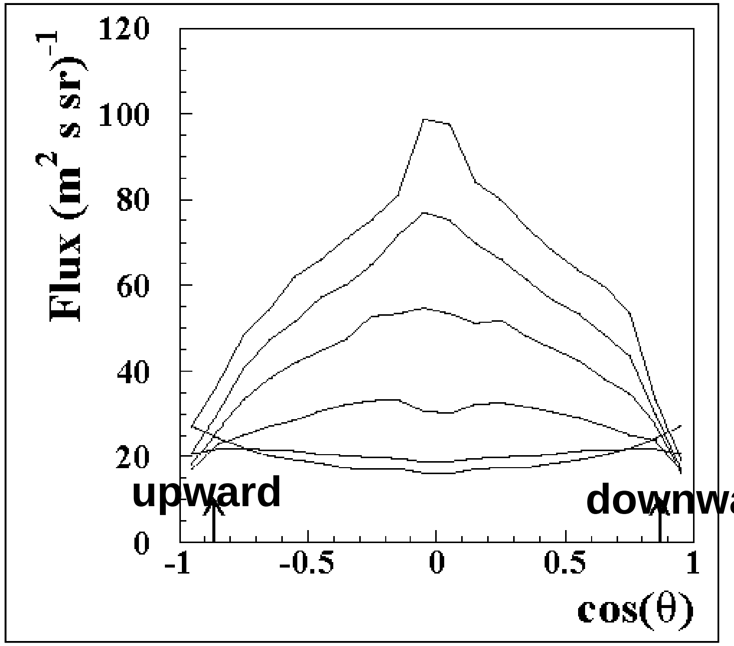
Secondary protons

- We refer to AMS data above 100 MeV
- Low energy data by NINA-2:
  - ➢spectrum is saturated or even decreased below 100 MeV.

- Calculated ang. distr. from L=1.01 to 2.09 (bottom to top). We approximate this by $1+a*\sin^2\theta$. <u>EW effect not implemented (yet).</u>



(cf. Alcaraz et al. 2000 and Bidoli et al. 2002. AMS is zenith pointing and NINA-2 is zenith or Sun pointing)

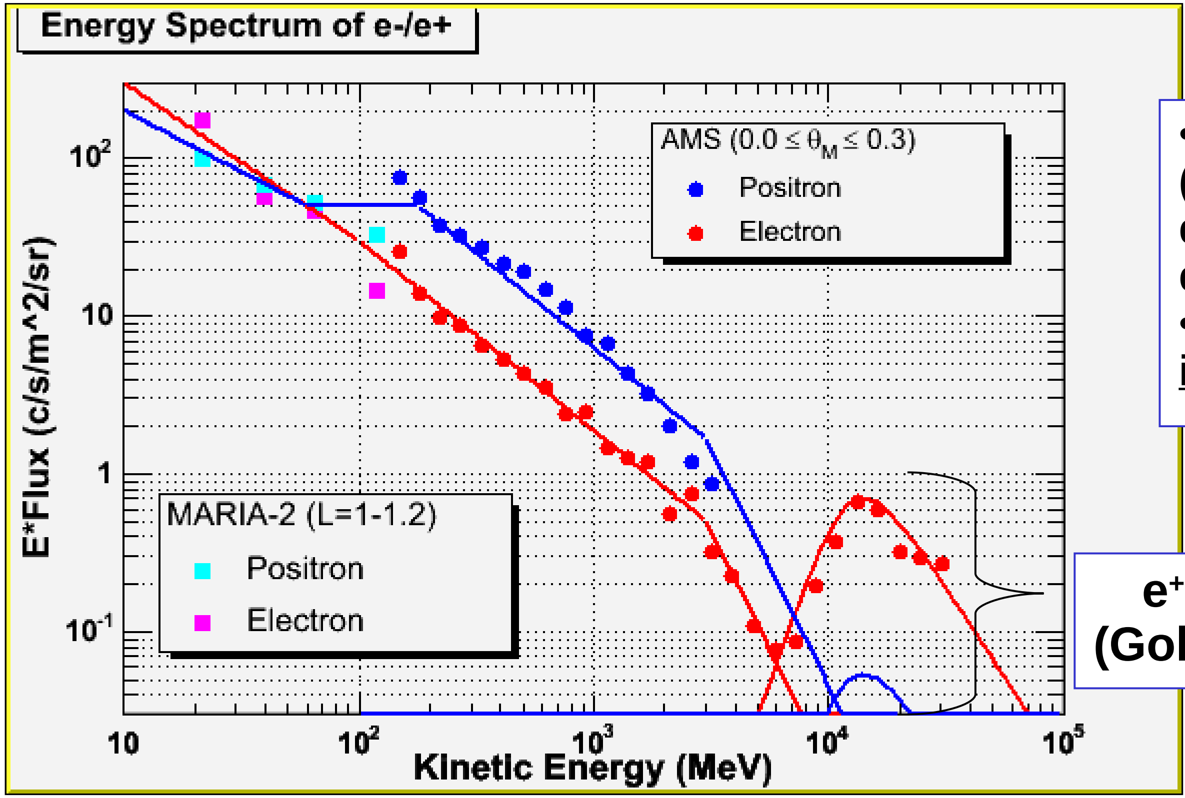


Zuccon et al. 2003

Leptons in equatorial region

•We refer to AMS data (Alcaraz et al. 2000) and MARIA-2 data (Voronov et al. 1991; Mikhailov et al. 2002)

- ➢Model formula for primary leptons is similar to that for primary protons. Angular distribution is the same.
- ➢<u>Large positron fraction</u> of secondary due to EW effect.
- ➢e^-/e^+ ratio below 100 MeV is close to 1 (since gyroradius is small and particles do not drift in geomeg. field)



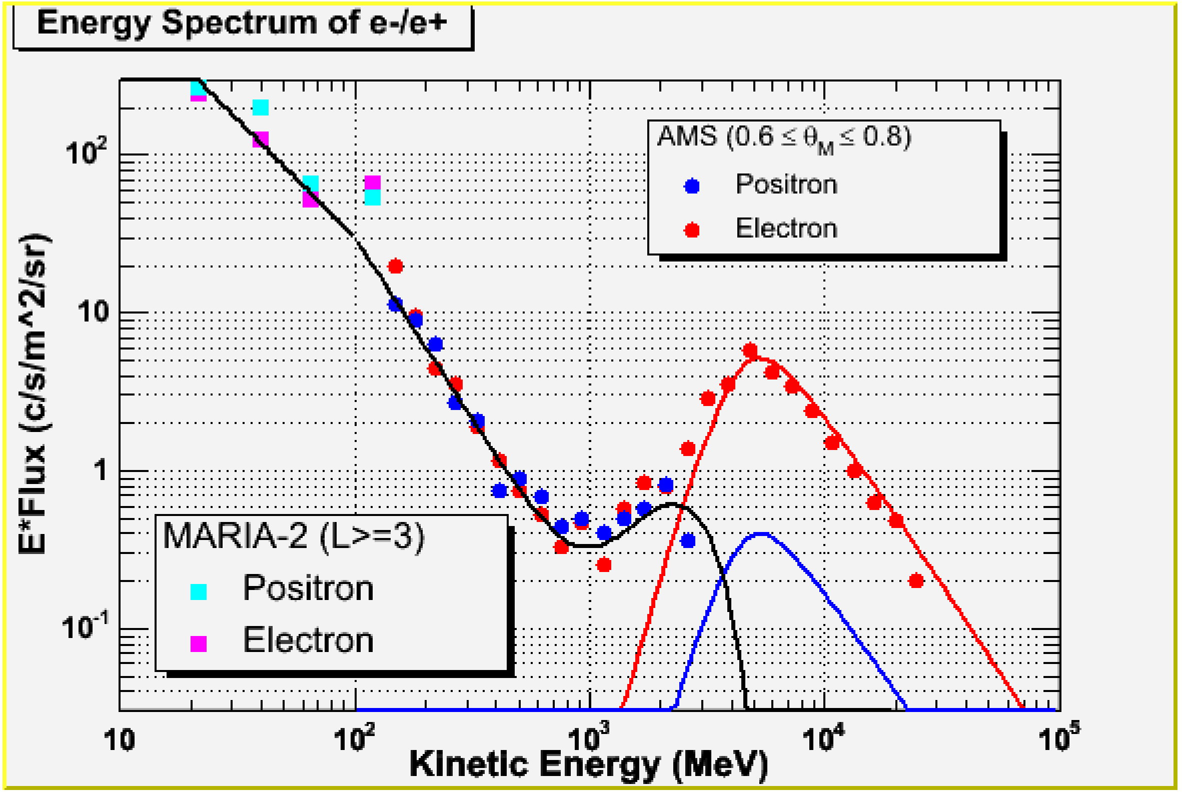
•No zenith-angle dependence is assumed. (AMS is zenith pointing and MARIA-2 doesn't report strong zenith angle dependence)

•<u>No EW effect for secondary leptons implemented (yet).</u>

$e^+/(e^++e^-)=0.078$ (Golden et al. 1994)

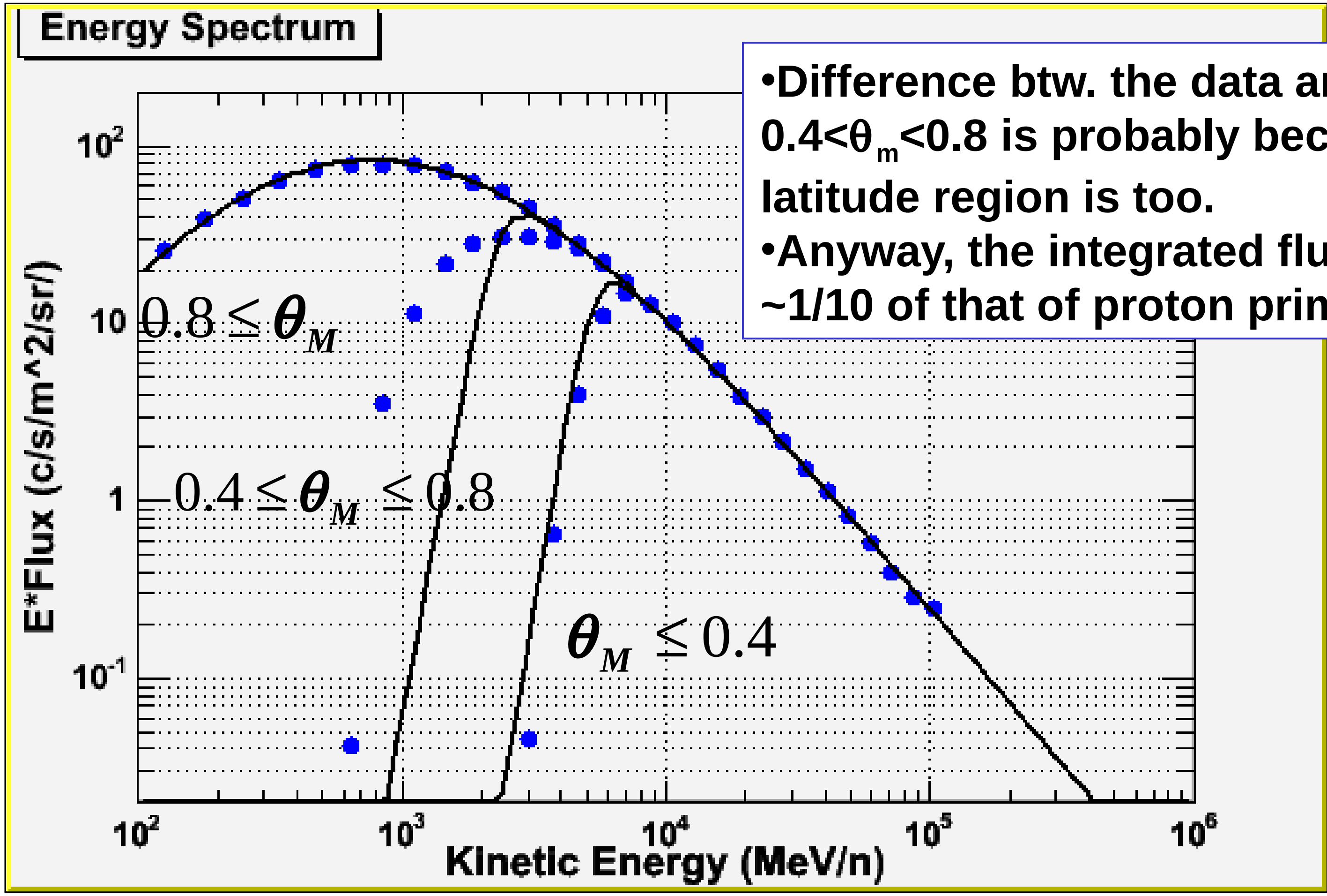
Leptons at high latitude

•e^+/e^- ratio is close to 1, since the EW effect for primary protons is small.
•Steep spectrum gives high flux below 100 MeV.



Alpha particles

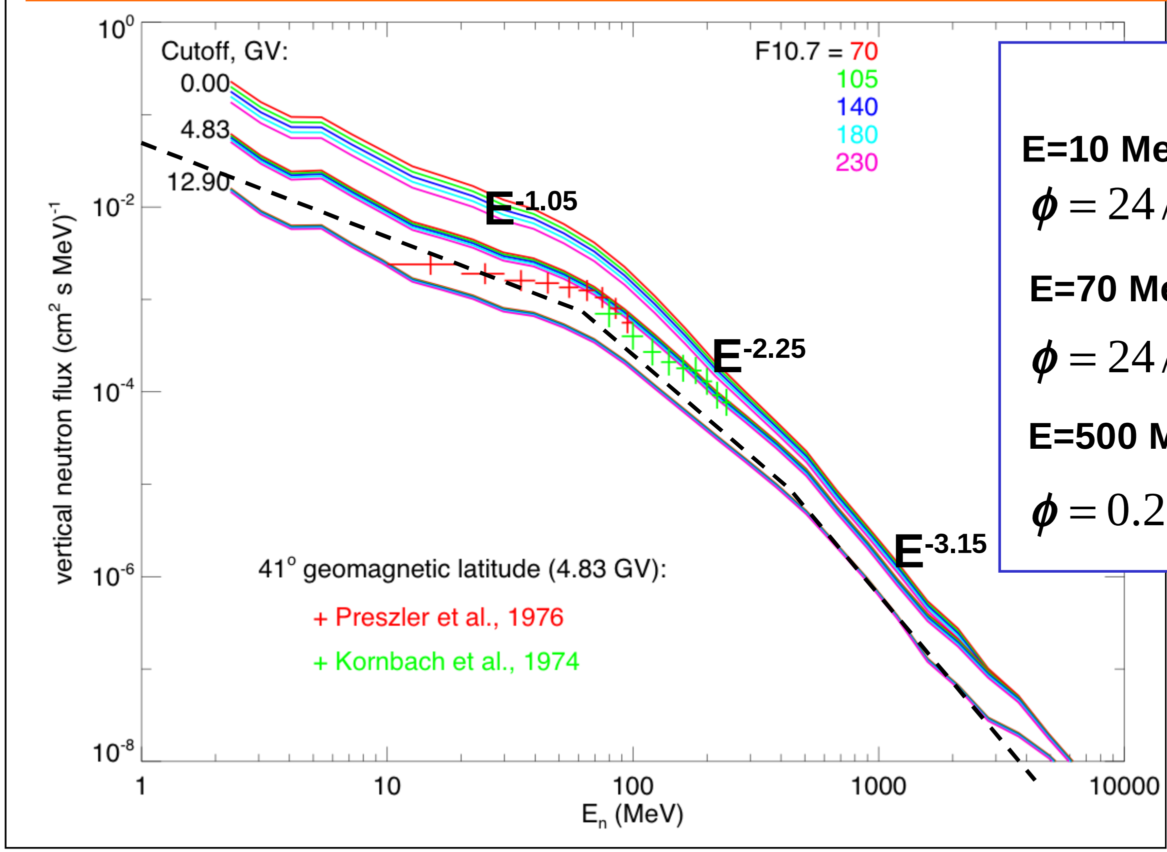
- The same formula as that of proton primaries, but Z=2. The same angular distribution as that of proton primaries
- Secondary not modeled. (We assume they are negligible)



- Difference btw. the data and model for $0.4<\theta_m<0.8$ is probably because the latitude region is too.
- Anyway, the integrated flux is only ~1/10 of that of proton primaryes.

Neutrons

•We refer to a recent calculation by Selesnik et al. (2007).



@Rc=5GV (see next)

E=10 MeV-70 MeV

$$\phi = 24/(2\pi)\times(E/70\text{MeV})^{-1.05}$$ **[c/s/m²/sr/MeV]**

E=70 MeV-500 MeV

$$\phi = 24/(2\pi)\times(E/70\text{MeV})^{-2.25}$$

E=500 MeV-1 TeV

$$\phi = 0.286/(2\pi)\times(E/500\text{MeV})^{-3.15}$$

•Uniform angular distribution above the rim is assumed.

NB Vertical flux here is defined as $J_{2\pi} = \int_0^{2\pi} d\psi \int_0^{\pi/2} \phi \cos\theta \sin\theta d\theta$, where ϕ is the angular flux.

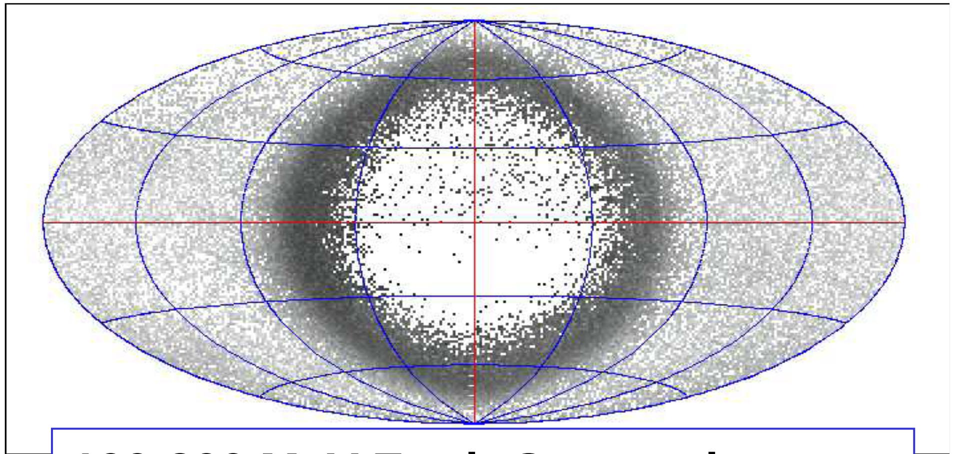
•Rigidity dependence of $e^{-0.152Rc}$, as measured by COMPTE (Morris et al. 1995). Implemented.

•HE neutrons are predicted to come from Earth rim (Selesnik et al. 2007). No yet implemented.

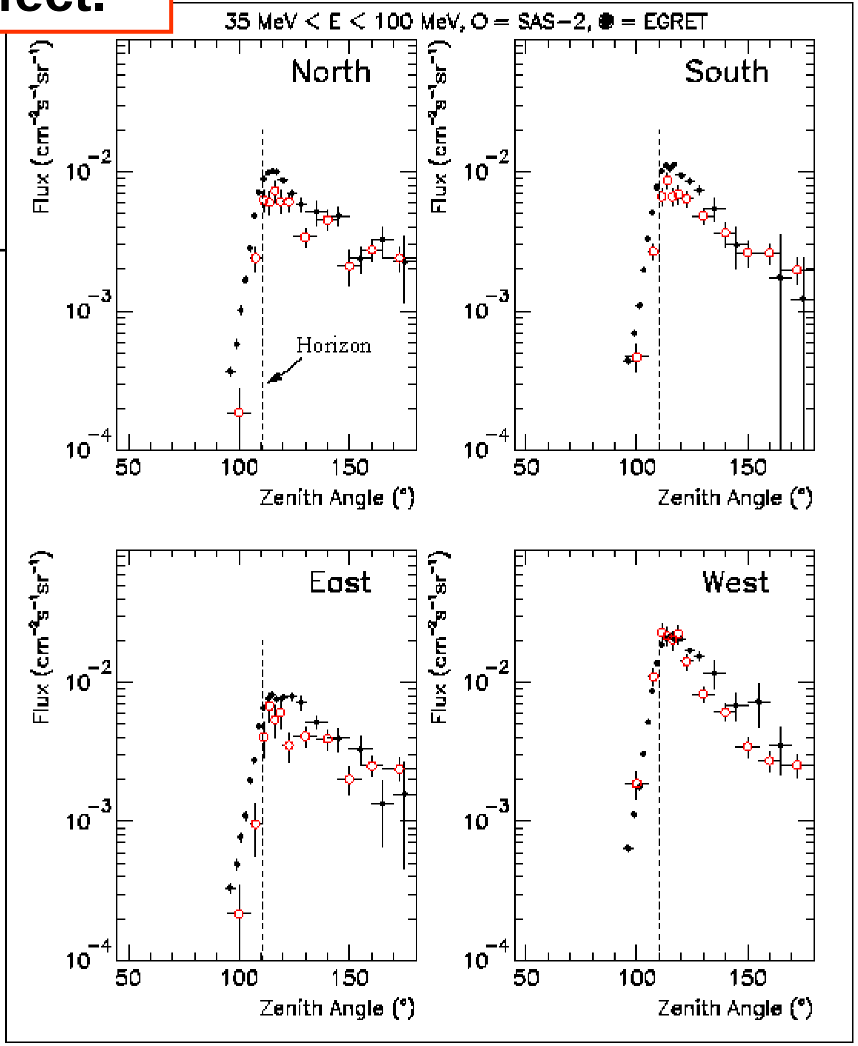
Earth gamma

- Developed by D. Petry using EGRET data
- Modeled in 10 MeV-10 GeV w/ EW effect.

- They contribute to the residual BG and GLAST is supposed to provide data with higher statistics and resolution. Somebody has to update the code. TM?

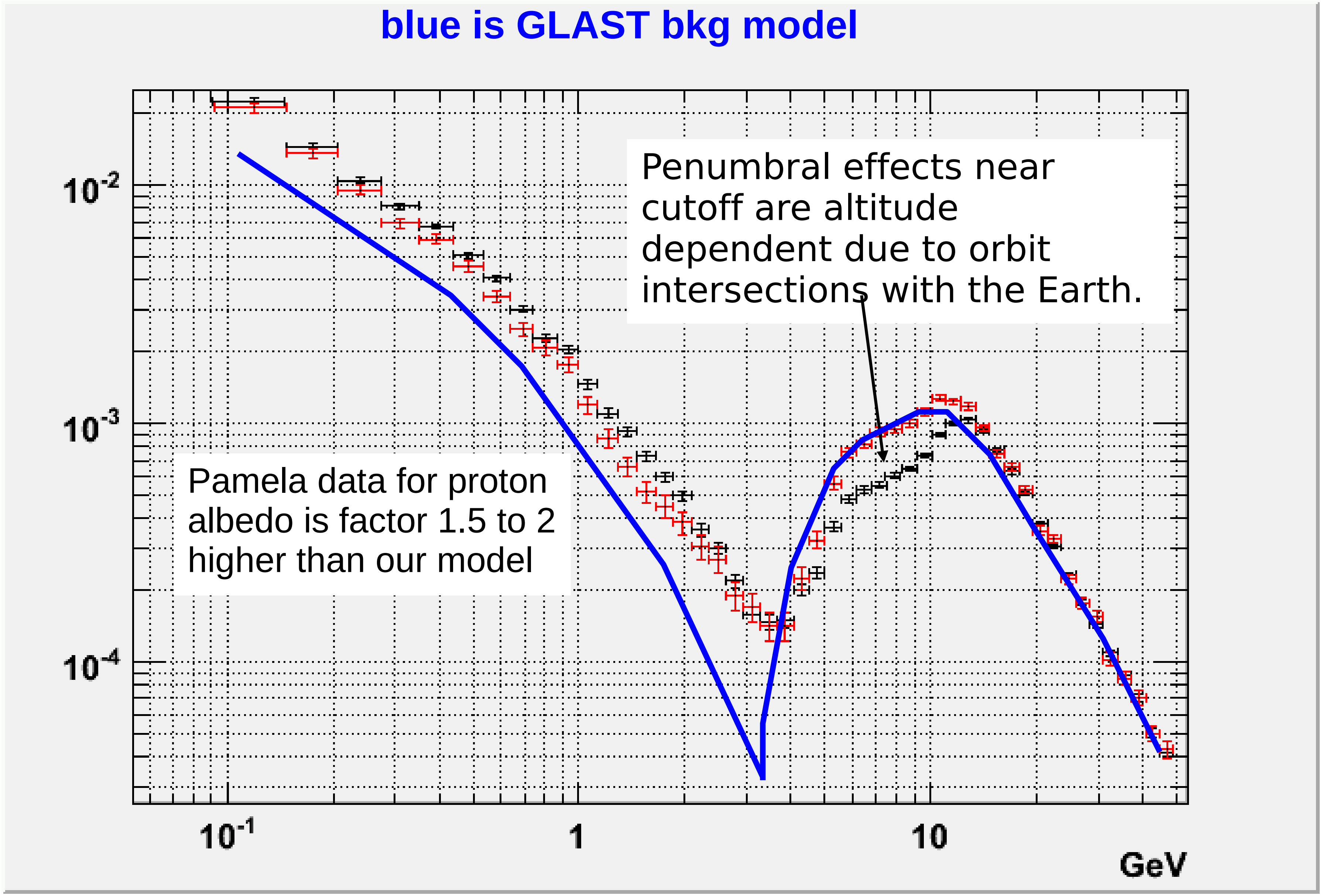


100-300 MeV Earth-Centered Hammer-Aitoff map by EGRET

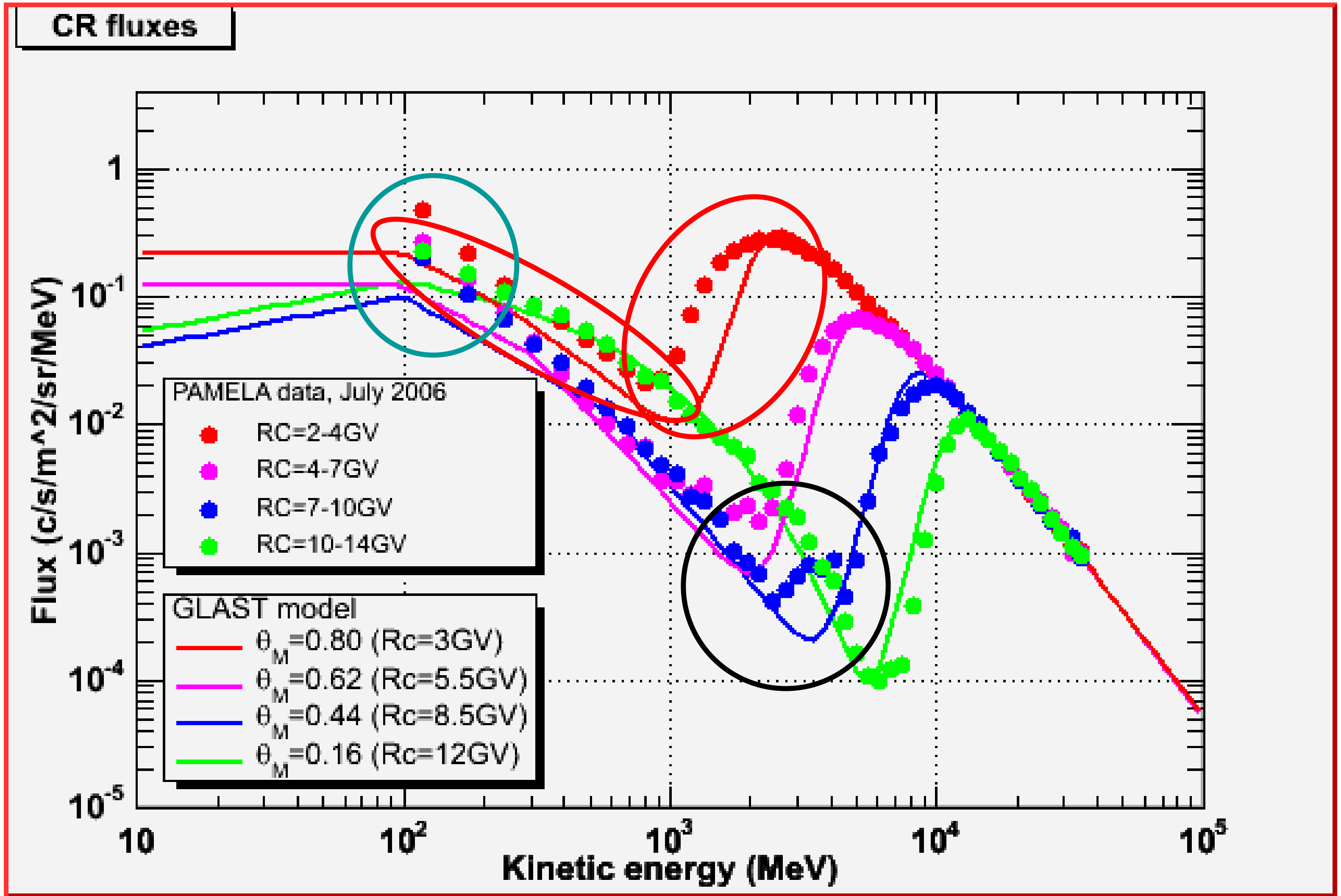


Orbit average comparison

Pamela data: red curve is for GLAST altitude, black for all altitudes



Pamela data vs GLAST model



- GCR flux above cutoff agrees very well (as expected).
- PAMELA measures a higher primary and albedo flux below cutoff especially at high geomagnetic latitudes (red curve).
- Low energy fluxes are above our model <300 MeV (blue and green).
- Sub cutoff excesses seen in Pamela data (black circle).

Background model summary

- PAMELA data (proton flux) is compared with GLAST model.
  - Thanks to Marco and PAMELA team!
- Good agreement (a few % level) in primary flux.
- Higher primary flux below cutoff in high latitude region.
- Higher secondary flux below 300 MeV and at high latitude.
  - Difference by a factor of 2 around 100 MeV.
    - End of both Pamela and AMS energy ranges
  - Due to small solar activity? (probably not)

- We could double the normalization of proton albedo to make it sure that the trigger rate is adequately simulated.

- We look forward to further Pamela data!

Summary