

## GLAST IRF study for DC1



- PSF
- Effective Area
- Energy Dispersion

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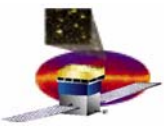
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**T. Burnett University of Washington**



## Data sample and selection

- **all\_gamma** run (currently run with GR v3r3p7) updated version (26 Nov 03) of *ag-v3r3p7-merituple-prune20031102-fulltup.root*
- 4.66 M (1/E distributed) generated photons
- **irfAnalysis** package v5
- **Bill Atwood cuts** to define "goodEnergy", "goodPSF" and Background Rejection
- **Define bins** in log energy and  $\cos \theta$ :  
**Energy bins** are centered at 46, 100, 215, 464, 1000, 2154, 4642, and 10000 MeV (width corresponds to a factor of 2.15, or three bins per decade)  
**Angle bins** edges are  $\theta = 0, 37, 53, 66$  and 78 degrees (0.2 in  $\cos \theta$ )
- Separate study for **Thin** and **Thick** sections

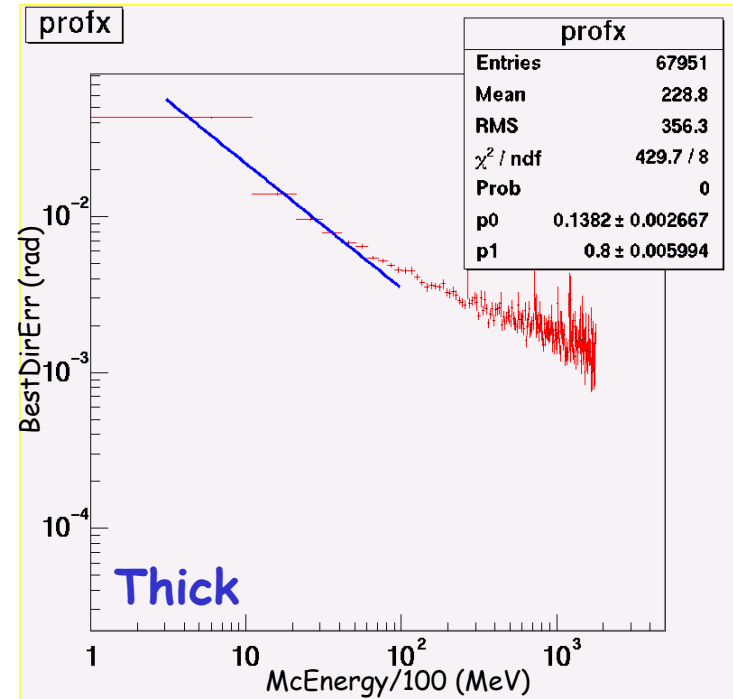
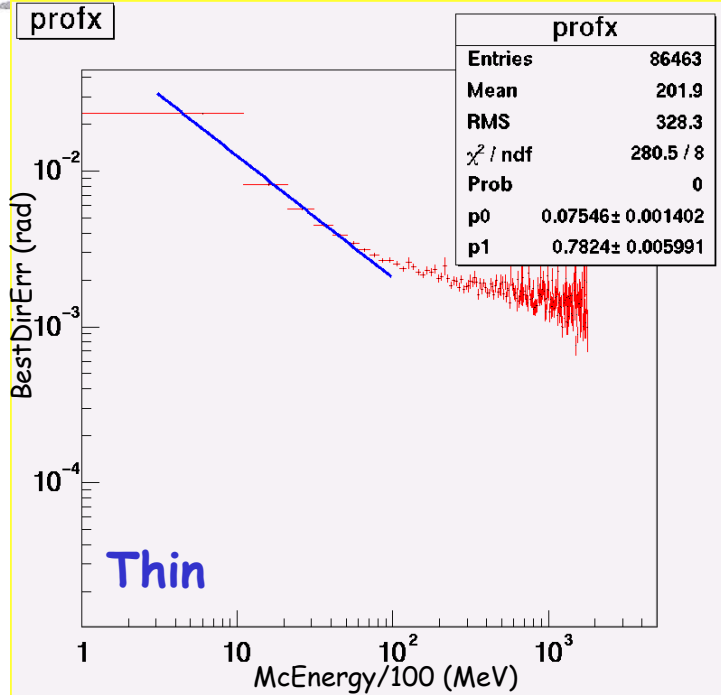


## PSF study

### PSF SCALING FUNCTION

- We observe that PSF depends on Energy as a power law
- Scaling the PSF by an empirical function describing this dependence  $\rightarrow$  all PSF distributions have similar shapes over all energy bins  $\rightarrow$  make simpler the fitting procedure

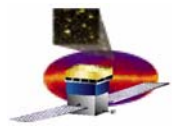
$$\text{Scale}(E \text{ MeV}) = p_0 \cdot \left( \min(E, 1e04)/100 \right)^{-p_1}$$



Results from fit:

$$p_1 = 0.8 \text{ (thin-thick)}$$

$$p_0 = \begin{cases} 0.08 \text{ thin} \\ 0.14 \text{ thick} \end{cases}$$



Fit Function is a sum of a **gaussian** and an **exponential** to a variable power:

$$x \cdot (p_0 \cdot \exp(-0.5 \cdot x^2/p_1^2) + p_2 \cdot \exp(-(x \cdot p_3)^{p_4}))$$

## Fitting algorithm

Estimation of starting values of the parameters determined by a separate initial fit to the peak and tails of PSF:

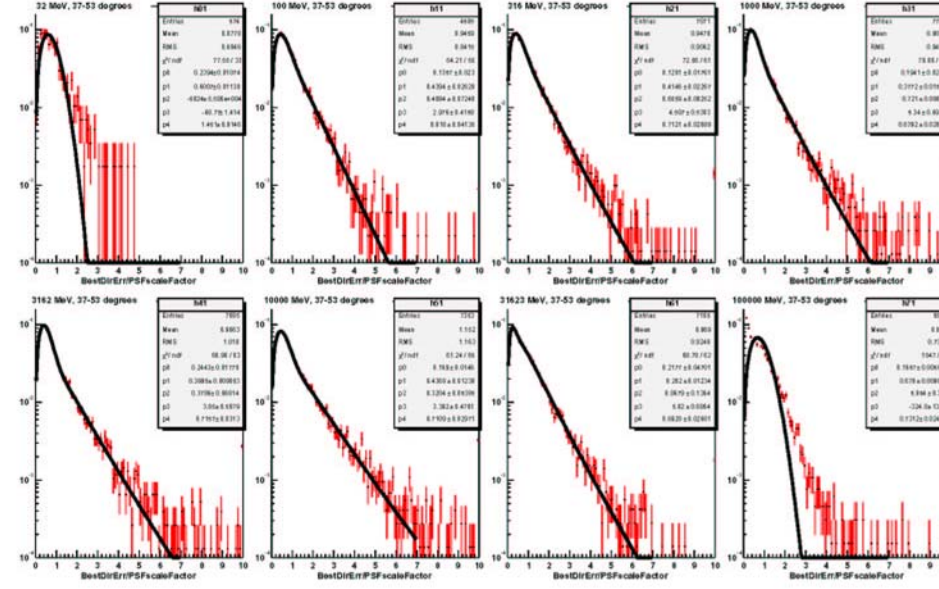
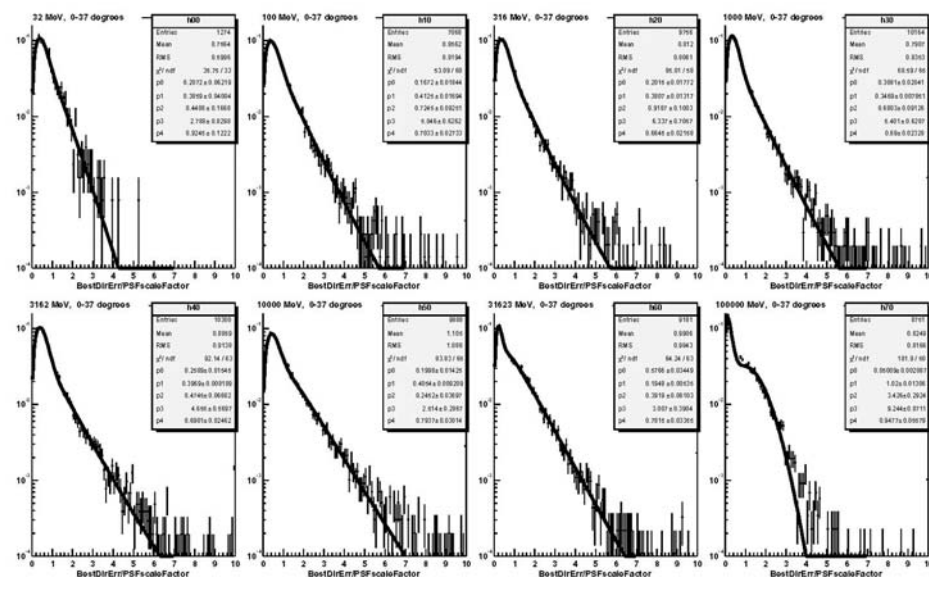
*Peak fitted by a gaussian*  $x \cdot (p_0 \cdot \exp(-0.5 \cdot x^2/p_1^2))$

*Tails fitted by an exponential*  $x \cdot (p_2 \cdot \exp(-(x \cdot p_3)^{p_4}))$



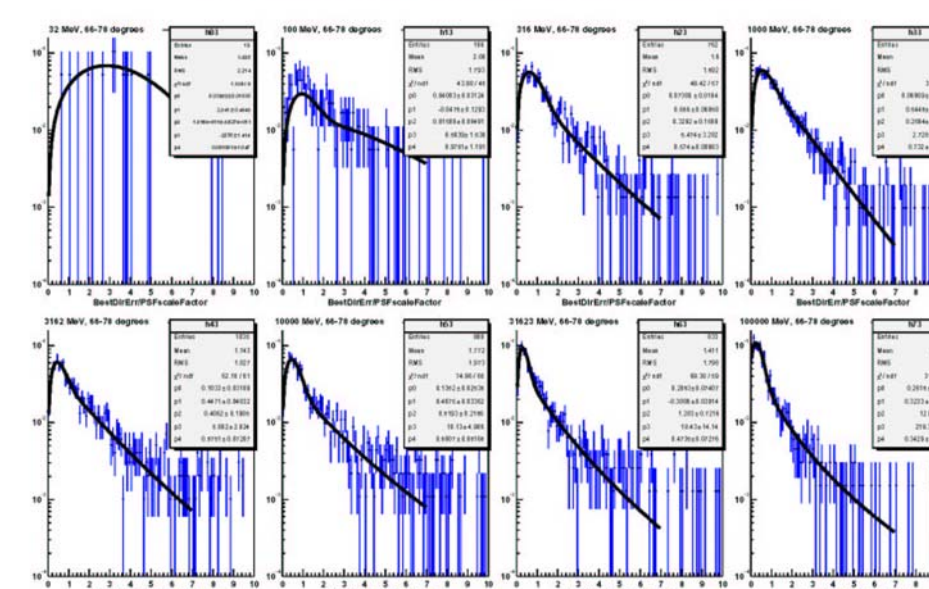
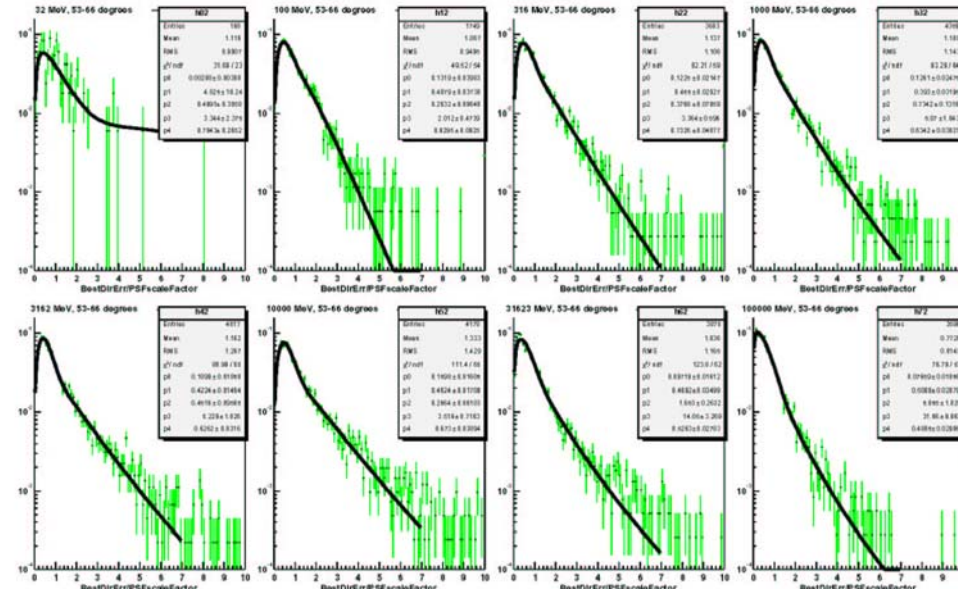
Plots from C:\users\claudia\RootAnalysis\irfAnalysis\4\data\psf\_thin.root Fri Dec 05 12:12:00 2003

Plots from C:\users\claudia\RootAnalysis\irfAnalysis\4\data\psf\_thin.root Fri Dec 05 12:12:00 2003

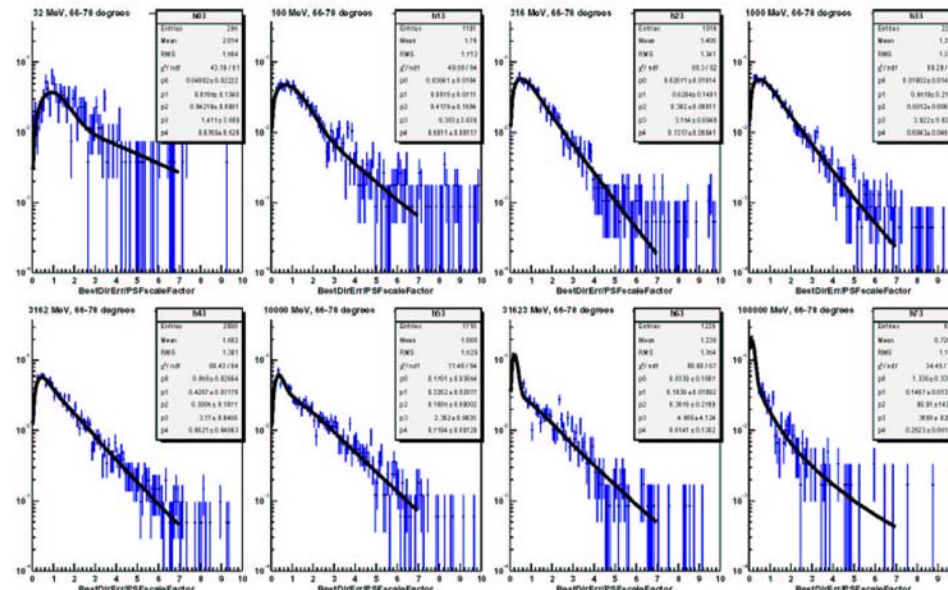
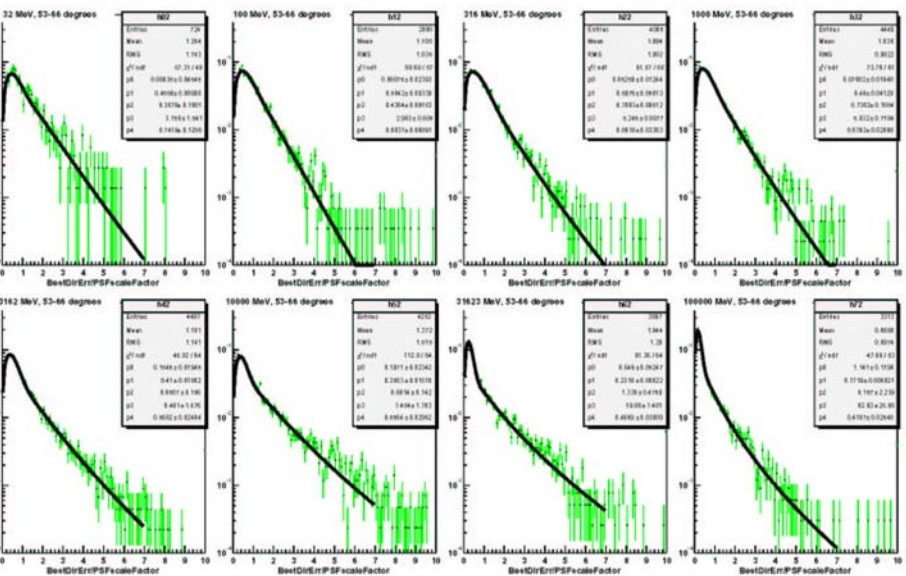
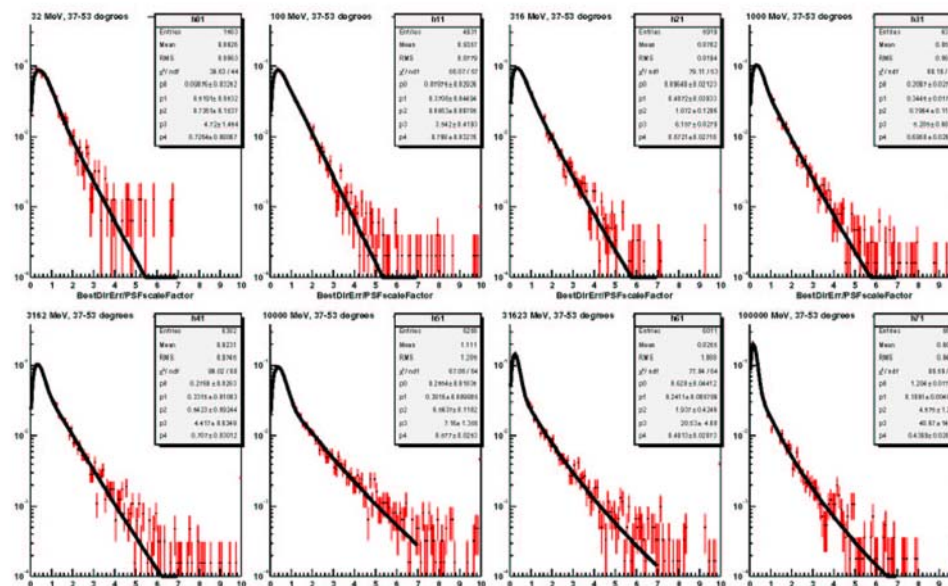
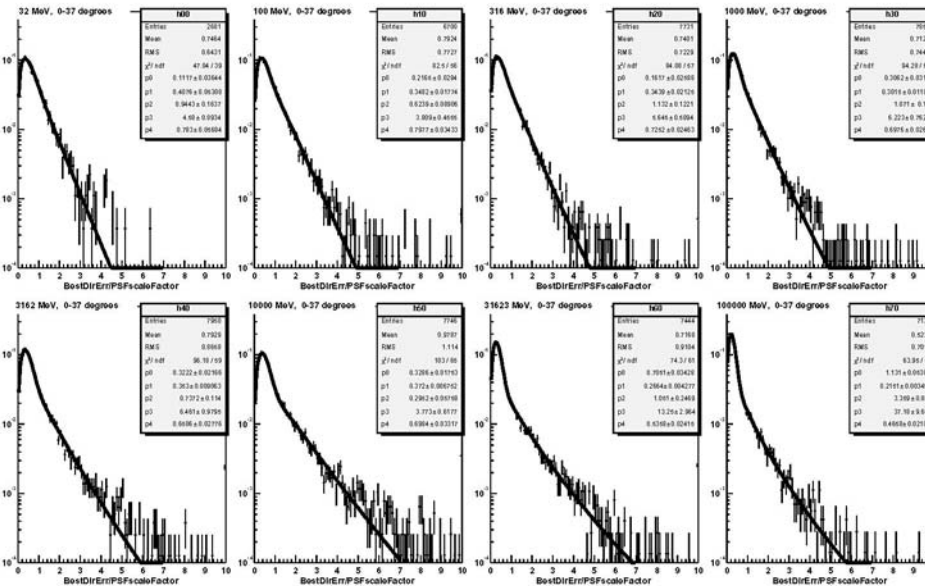


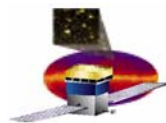
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Plots from C:\users\claudia\RootAnalysis\irfAnalysis\4\data\psf\_thin.root Fri Dec 05 12:12:00 2003









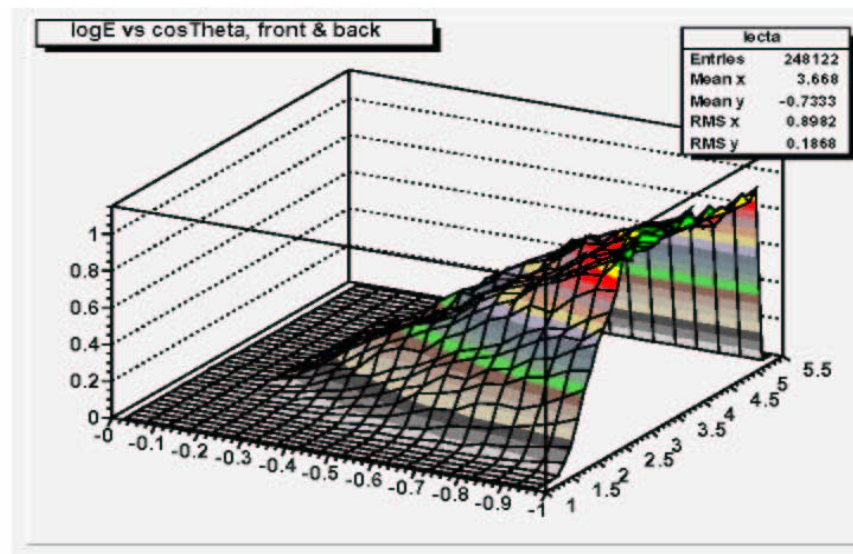
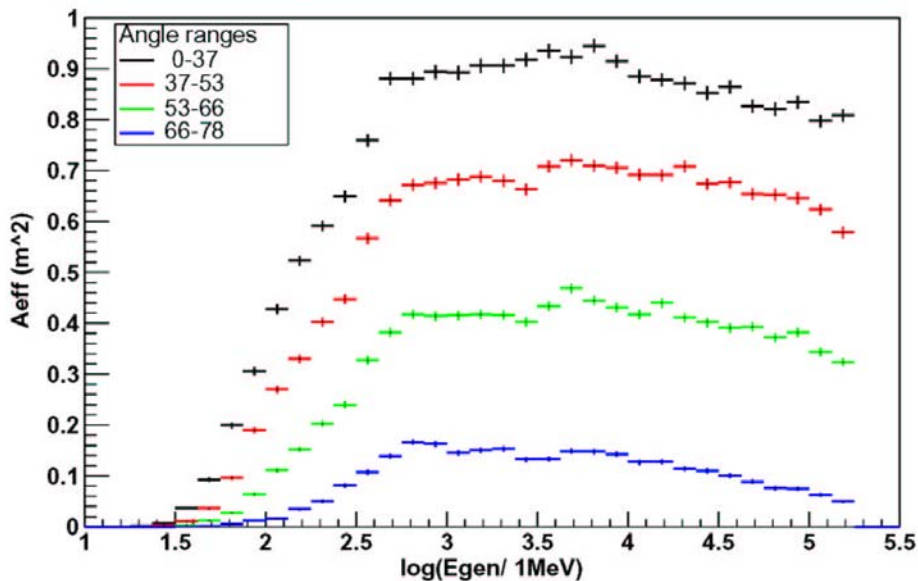
# Effective Area study

- $A_{tot} = 6 \text{ m}^2$
- Best fit parameters

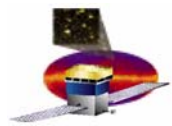
$$A_{eff} = A_{tot} \cdot \frac{N_{trig}}{N_{gen}}$$

plots from /lab/survey10/g/glast\_users/gground/hans/iv2r5p4/RootAnalysis/Analysis/v5/data/aeff\_all.root Fri Dec 5 10:31:19 2003

Effective Area vs. energy





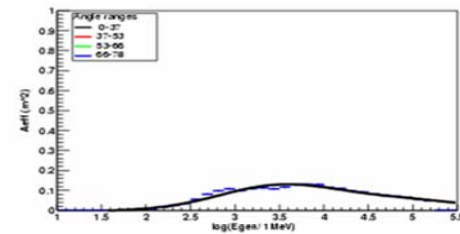
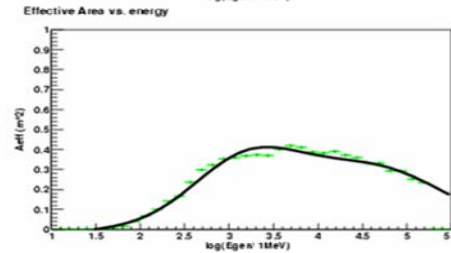
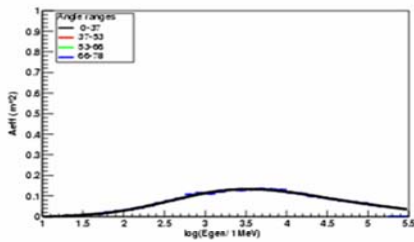
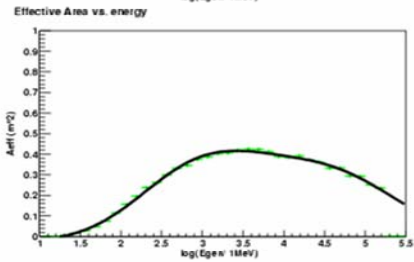
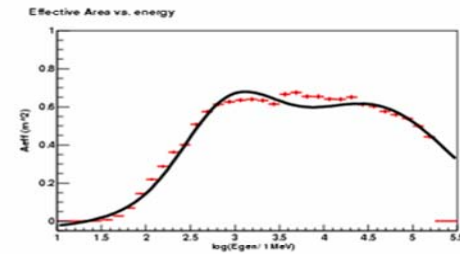
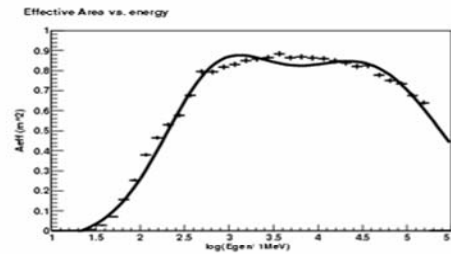
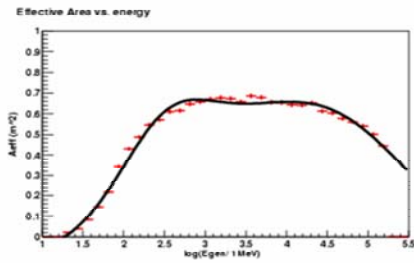
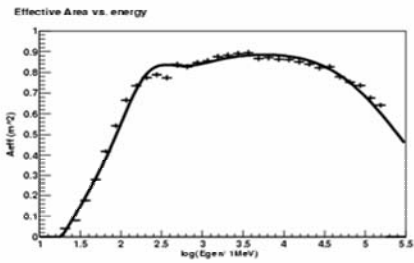


# Aeff fit

$$[0] * (1 - \exp(-[1] \cdot \log(E) + [2] \cdot \log^2(E))) \cdot \left( \frac{\text{Erf}(\log E - [3])}{2} \right) * (1 + [4] * \exp(-0.5 * ((\log E - [5])/[6])^2))$$

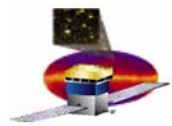
plots from /home/brigida/GlastRelease/RootAnalysis/InAnalysis/v4/data/canvas\_files/aeff\_all.root Fri Dec 5 11:09:12 2003

plots from /home/brigida/GlastRelease/RootAnalysis/InAnalysis/v4/data/canvas\_files/aeff\_all.root Fri Dec 5 11:09:12 2003



goodEvent

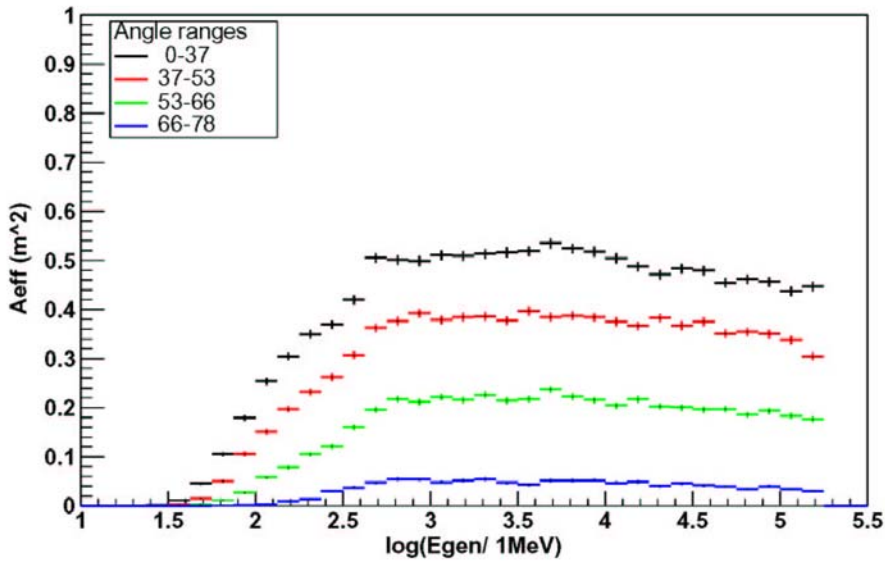
goodEvent&&bg\_cut



# Aeff thin and thick sections

plots from /afs/surrey/10/g.glast\_users/gigground/hans/v3r5p4/RootAnalysis/ltfAnalysis/v5/data/aeff\_front.root Fri Dec 5 10:35:10 2003

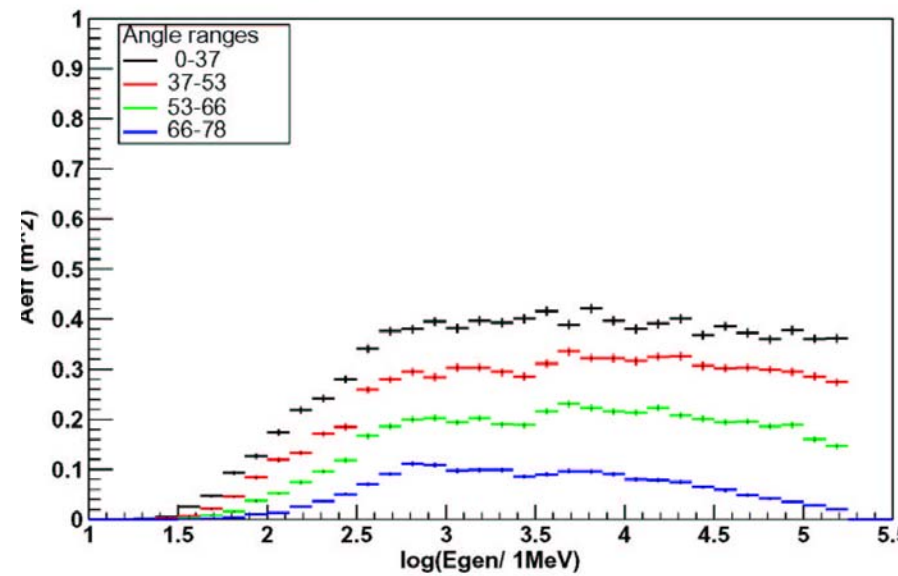
Effective Area vs. energy



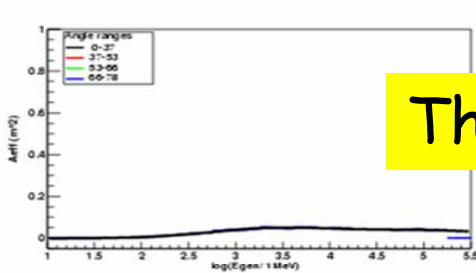
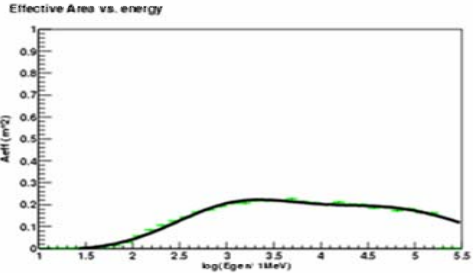
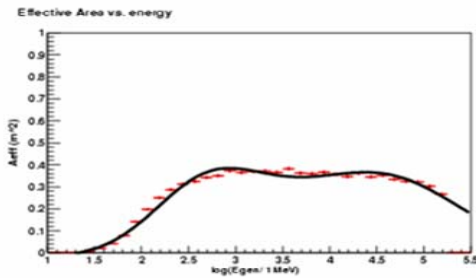
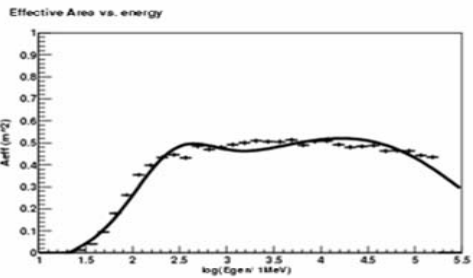
Thin

plots from /afs/surrey/10/g.glast\_users/gigground/hans/v3r5p4/RootAnalysis/ltfAnalysis/v5/data/aeff\_back.root Fri Dec 5 10:38:57 2003

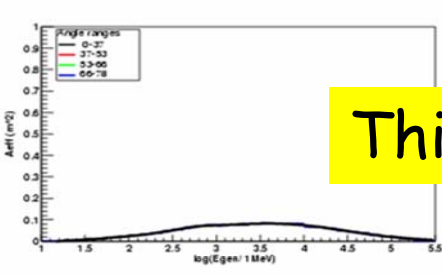
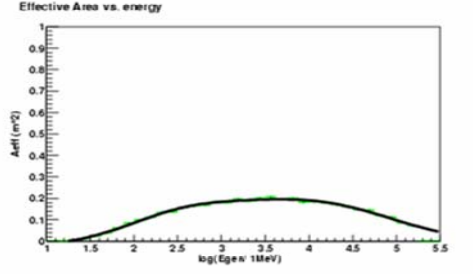
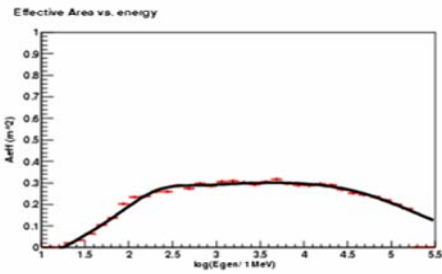
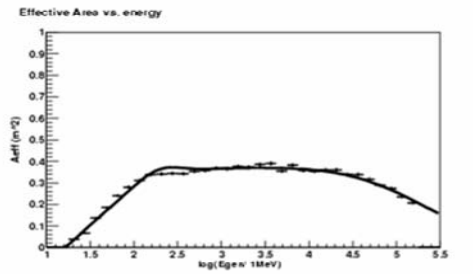
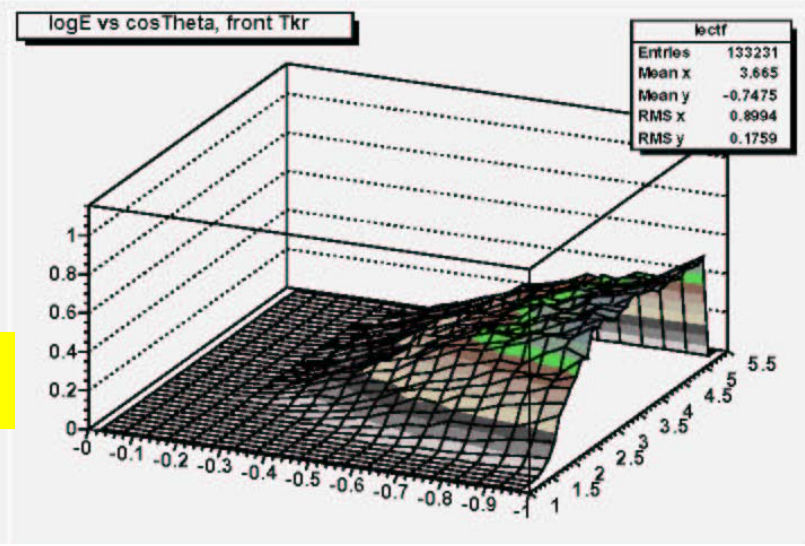
Effective Area vs. energy



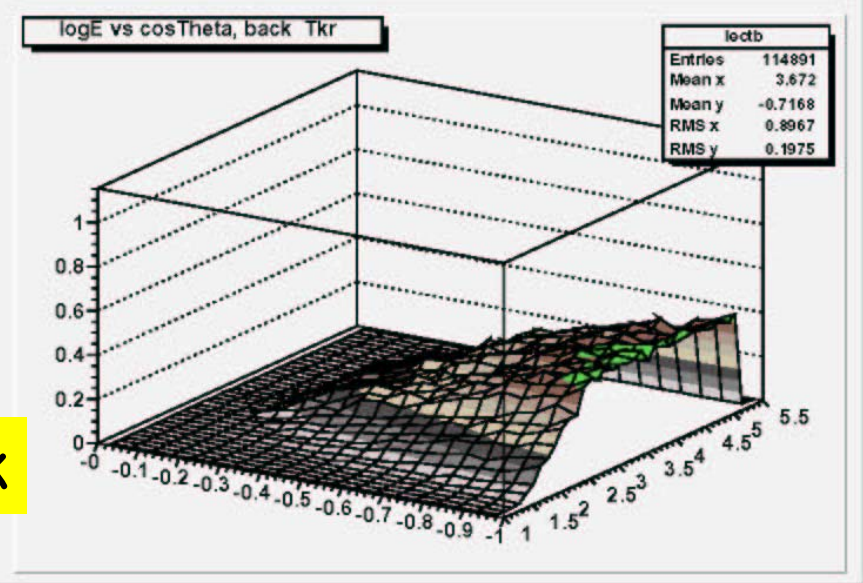
Thick

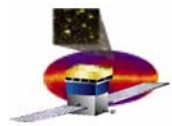


Thin



Thick

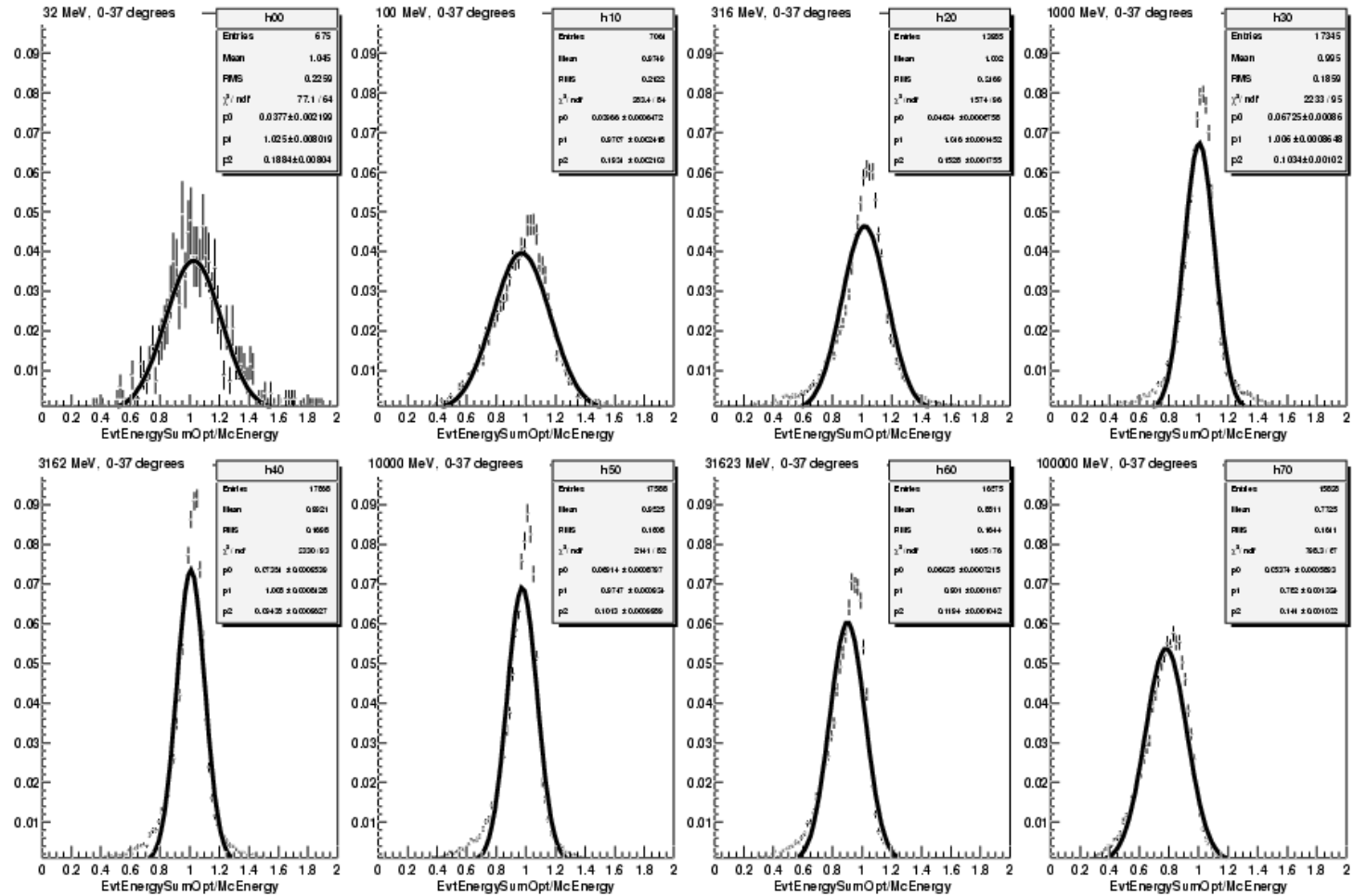




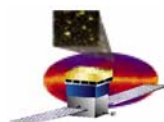
# Energy Resolution study

$E_{\text{meas}}/E_{\text{gen}}$

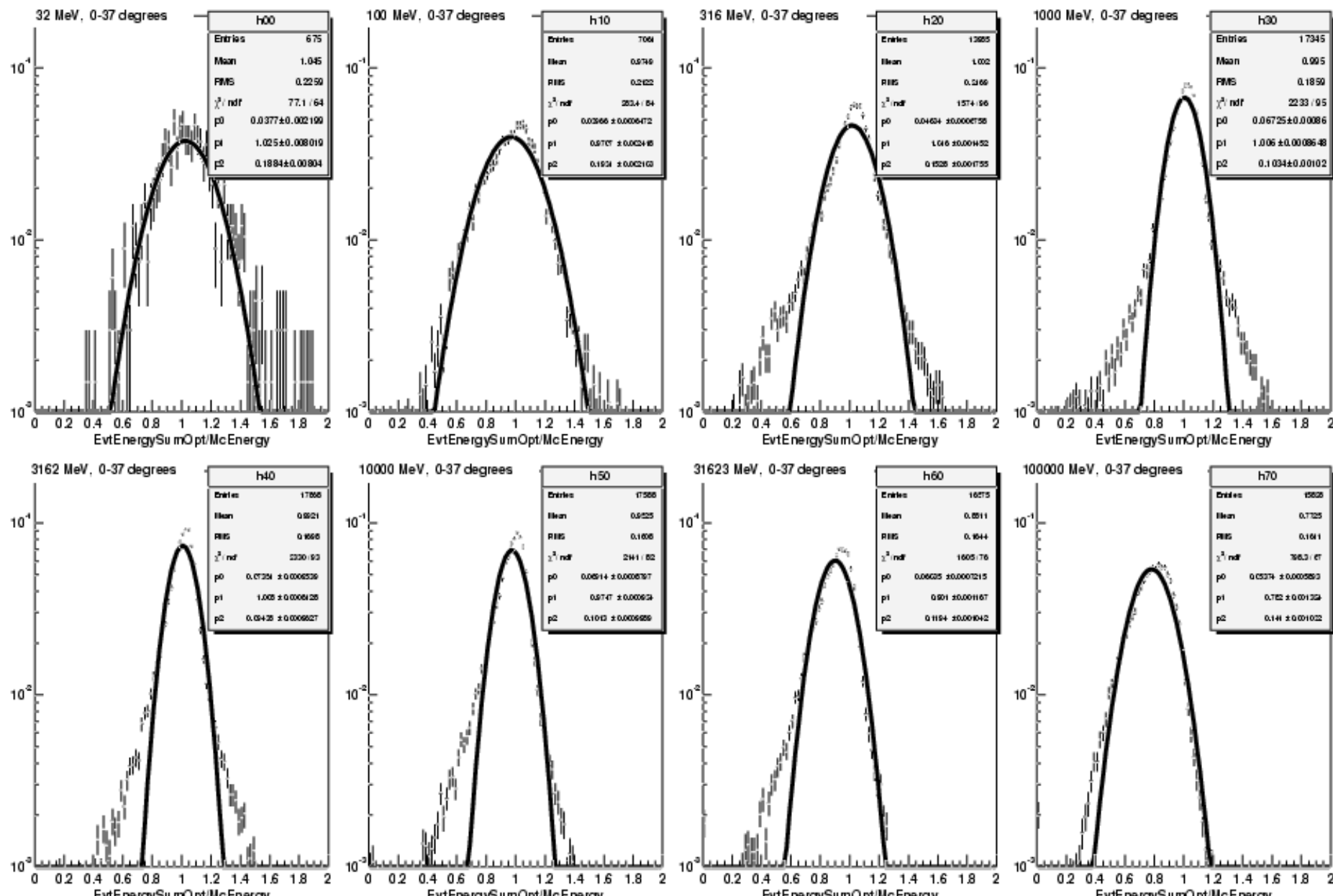
Gaussian fit

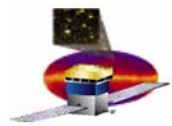






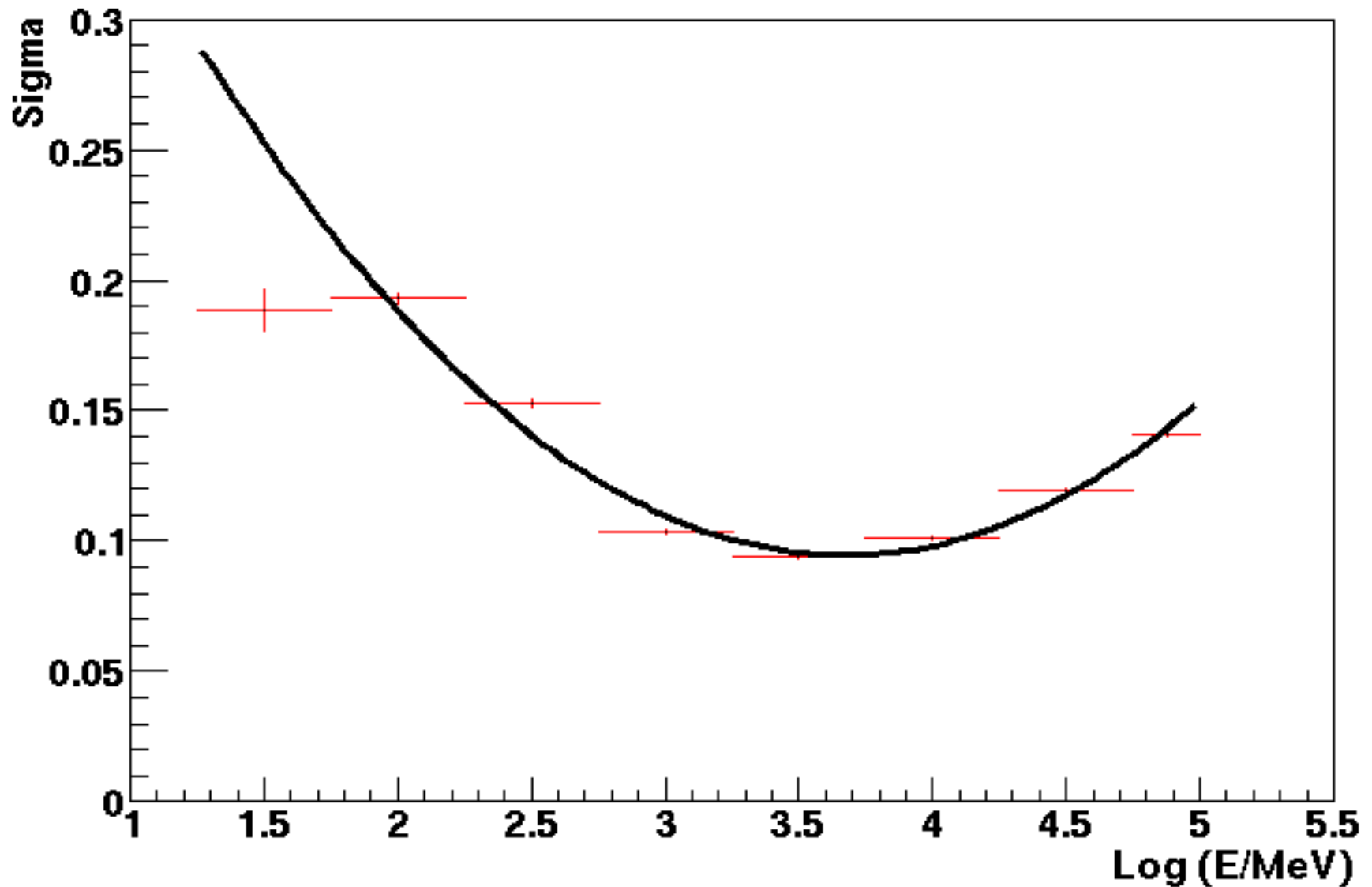
# Energy Resolution - Gaussian Fit in Log Scale

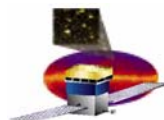




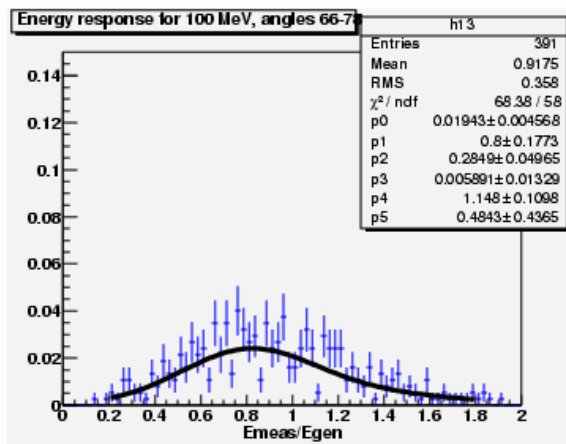
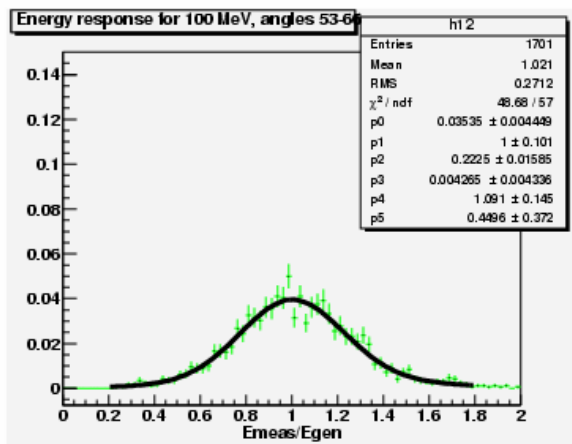
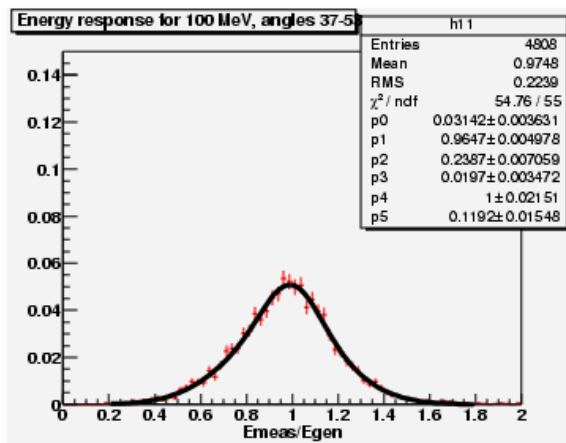
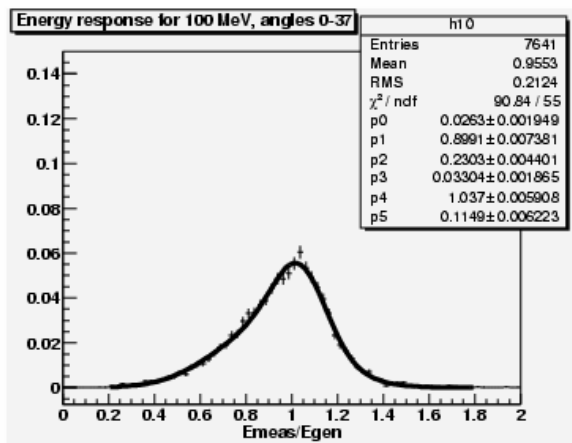
# Energy Resolution - Relative Error

$-1.0 < Z_{Dir} < -0.8$

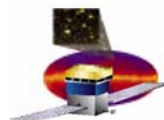




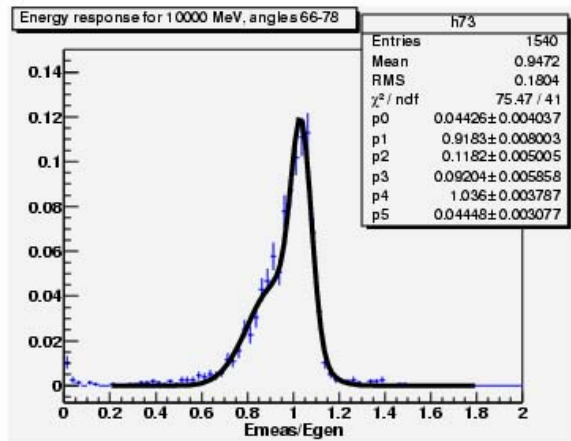
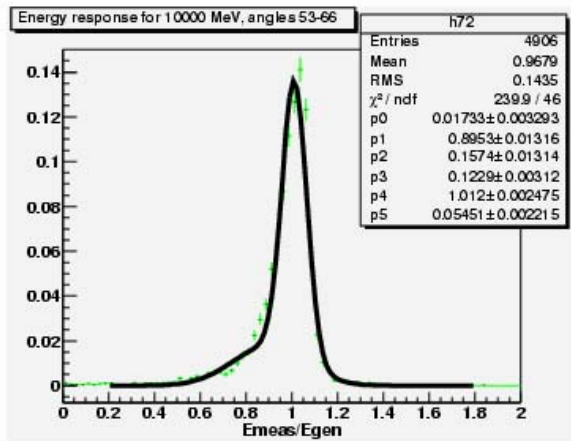
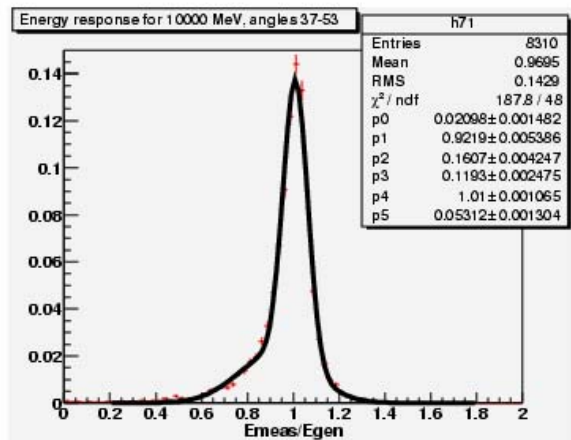
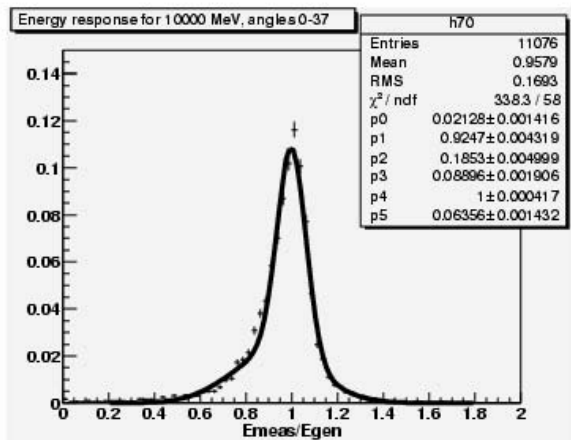
- Optimize fit with double gaussian:  
 $[0]*\exp(-0.5*((x-[1])/[2])^2)+[3]*\exp(-0.5*((x-[4])/[5])^2)$



No bg\_cut applied

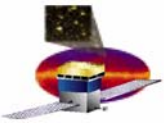


More statistics at higher energies  
double gaussian fit reproduces plot very well



No bg\_cut  
applied





## Conclusions

- IRF study and fits give good results for DC1
- no analytical function to describe parameters dependence on  $E$  and  $\theta$  → interpolation is needed for analysis tools
- v5 version of irfAnalysis contains fit's algorithms

# Attempt to parametrize fit parameters:

$p_0$  and  $p_1$  fixed to their average over energy for each angle

$p_2$   $p_3$   $p_4$ :

constrained for each angle to average over energy  $\pm$  stand dev.

