Quick look into PSF using full Bremsstrahlung data and MC

OUTLINE

0 - Full Brems data split into several energy bins

1- Calculation of PSF

Events with larger McDirErr (or DirErr)

Comparison of photon beam dispersion between several MC runs

2 - Comparison of PSF in data (run 1189) and MC (run 129)

0 - Full Brems data split into several energy bins

Logarithmic binning used: **23 bins in range 0.120-4.170**

Bin width increases by 50 % (suggested by Gary)

Description of bins in linear scale:

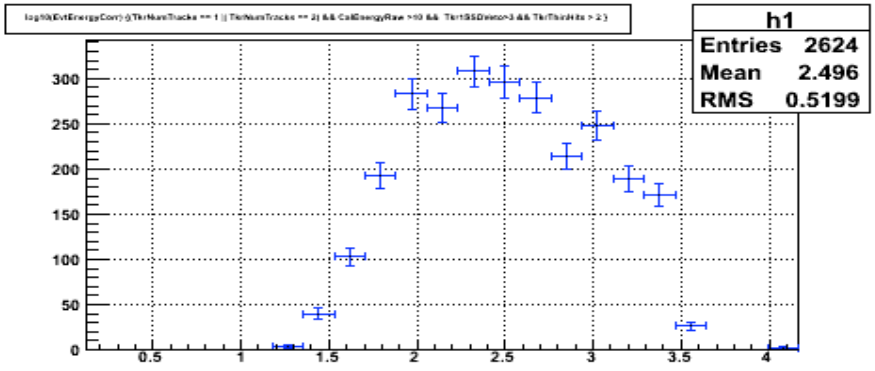
```
bin  1; 1.31687 - 1.97531 : Bin Width = 0.658436
bin  2; 1.97531 - 2.96296 : Bin Width = 0.987654
bin  3; 2.96296 - 4.44444 : Bin Width = 1.48148
bin  4; 4.44444 - 6.66667 : Bin Width = 2.22222
bin  5; 6.66667 -      10 : Bin Width = 3.33333
bin  6;      10 -      15 : Bin Width =       5
bin  7;      15 -    22.5 : Bin Width =     7.5
bin  8;    22.5 -   33.75 : Bin Width =   11.25
bin  9;   33.75 -  50.625 : Bin Width =  16.875
bin 10;  50.625 - 75.9375 : Bin Width = 25.3125
bin 11; 75.9375 -  113.906 : Bin Width = 37.9687
bin 12;  113.906 -  170.859 : Bin Width = 56.9531
bin 13;  170.859 -  256.289 : Bin Width = 85.4297
bin 14;  256.289 -  384.434 : Bin Width = 128.145
bin 15;  384.434 -  576.65 : Bin Width = 192.217
bin 16;  576.65 -  864.976 : Bin Width = 288.325
bin 17;  864.976 -  1297.46 : Bin Width = 432.488
bin 18;  1297.46 -  1946.2 : Bin Width = 648.732
bin 19;  1946.2 -  2919.29 : Bin Width = 973.098
bin 20;  2919.29 -  4378.94 : Bin Width = 1459.65
bin 21;  4378.94 -  6568.41 : Bin Width = 2189.47
bin 22;  6568.41 -  9852.61 : Bin Width = 3284.2
bin 23;  9852.61 -  14778.9 : Bin Width = 4926.31
```

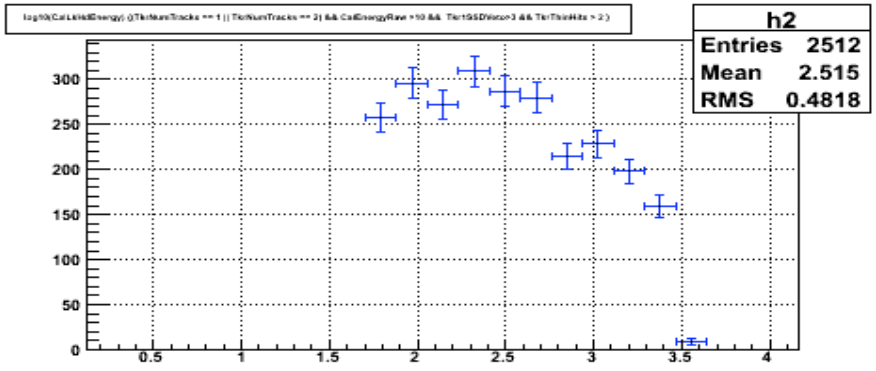
Selection of events applied (Events converted in thin layers)

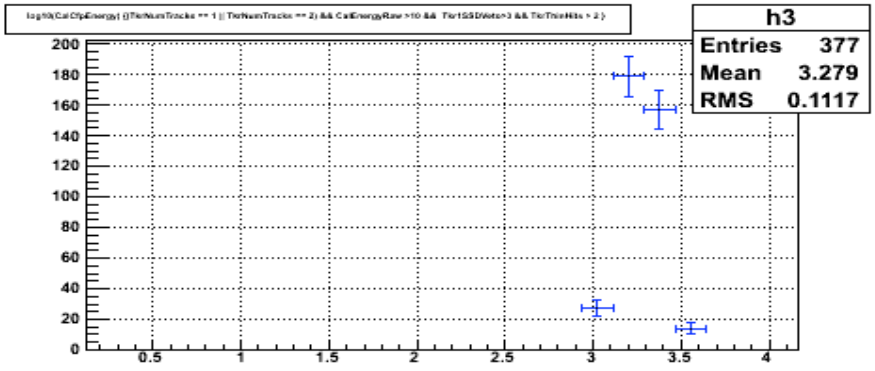
(TkrNumTracks == 1 || TkrNumTracks == 2) &&
CalEnergyRaw >10 && Tkr1SSDVeto>3 && TkrThinHits > 2

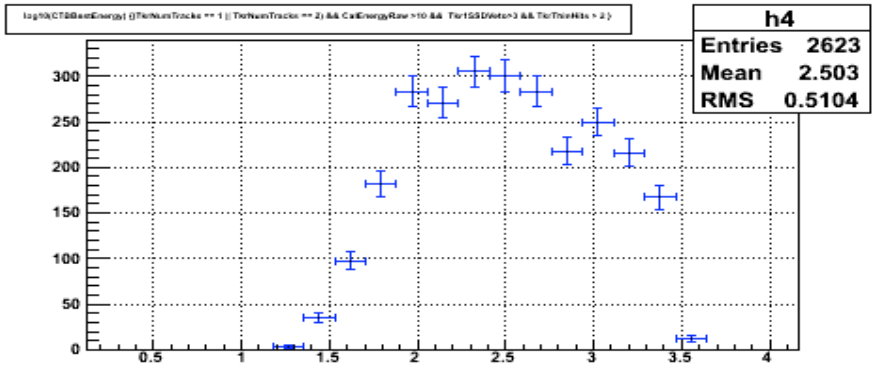
Distributions of McEnergy, CalEnergyRaw and Reconstructed energies

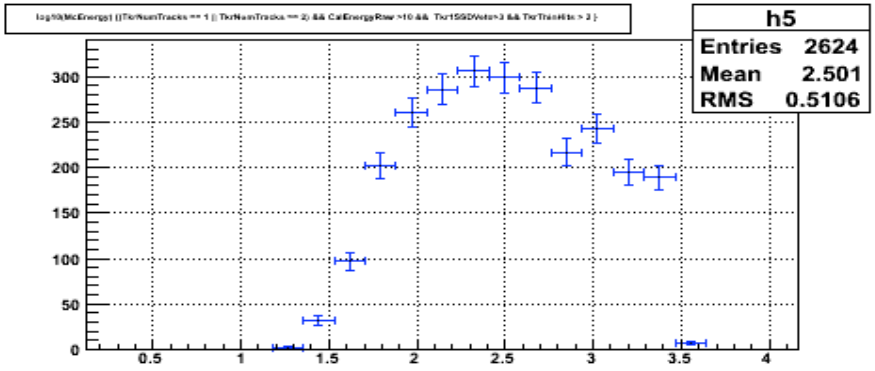
MC Run 125 (PSF will be computed using events from each of these bins)

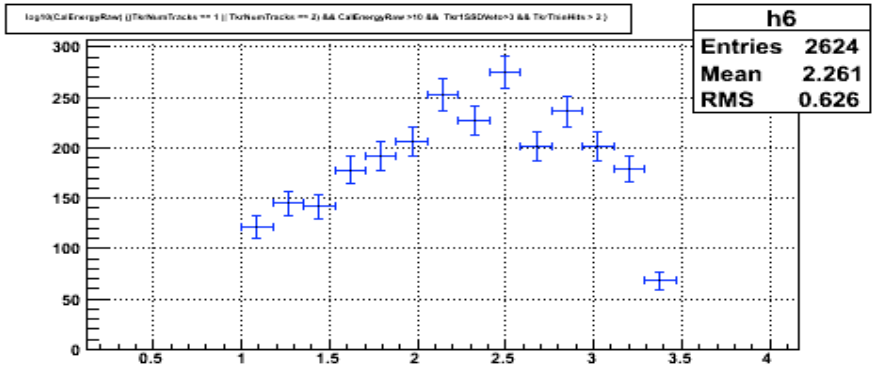












1 - PSF (from MCDirErr) for each of these energy bins (68% and 95%) (MC runs 125, 127, 129, 130)

Two PSF are computed, the one which contains 68% and the one which contains 95% of the events.

Selection of events applied (Events converted in thin layers)

(TkrNumTracks == 1 || TkrNumTracks == 2) && CalEnergyRaw >10 && Tkr1SSDVeto>3 && TkrThinHits > 2

*PSF; Position at which IntegratedNumOfEvents = Fraction*NumEvents*

Where fraction is 0.68 and 0.95

It also computes an error for each of the PSFs. Arbitrary definition:
PosHelp; Position at which

*IntegratedNumOfEvents = Fraction*NumEvents*+Sqrt(N*fraction*(1-fraction))

PSFErr = PosHelp-PSF

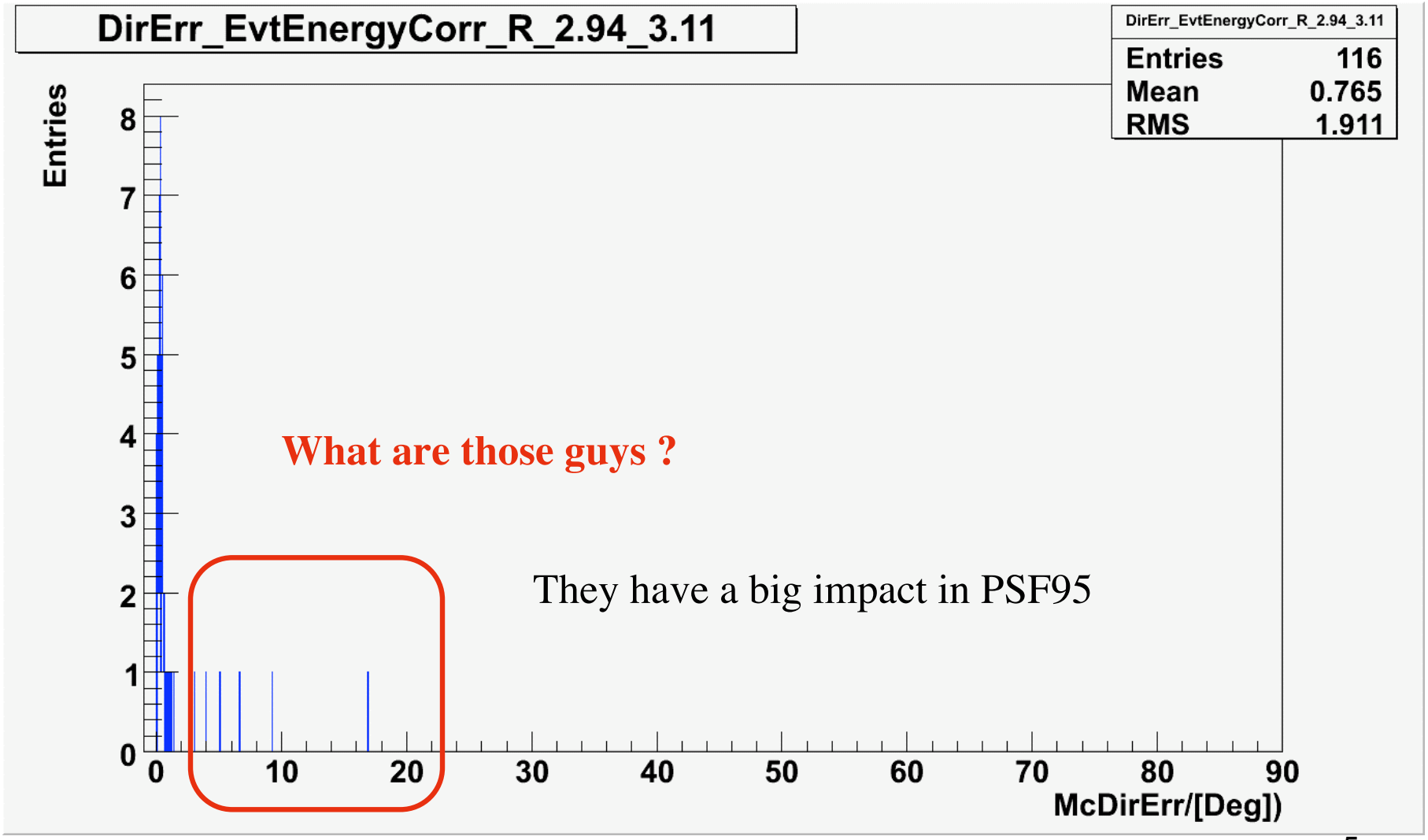
With this definition, the magnitude of this error depends on:

1 - The number of events in that particular energy bin

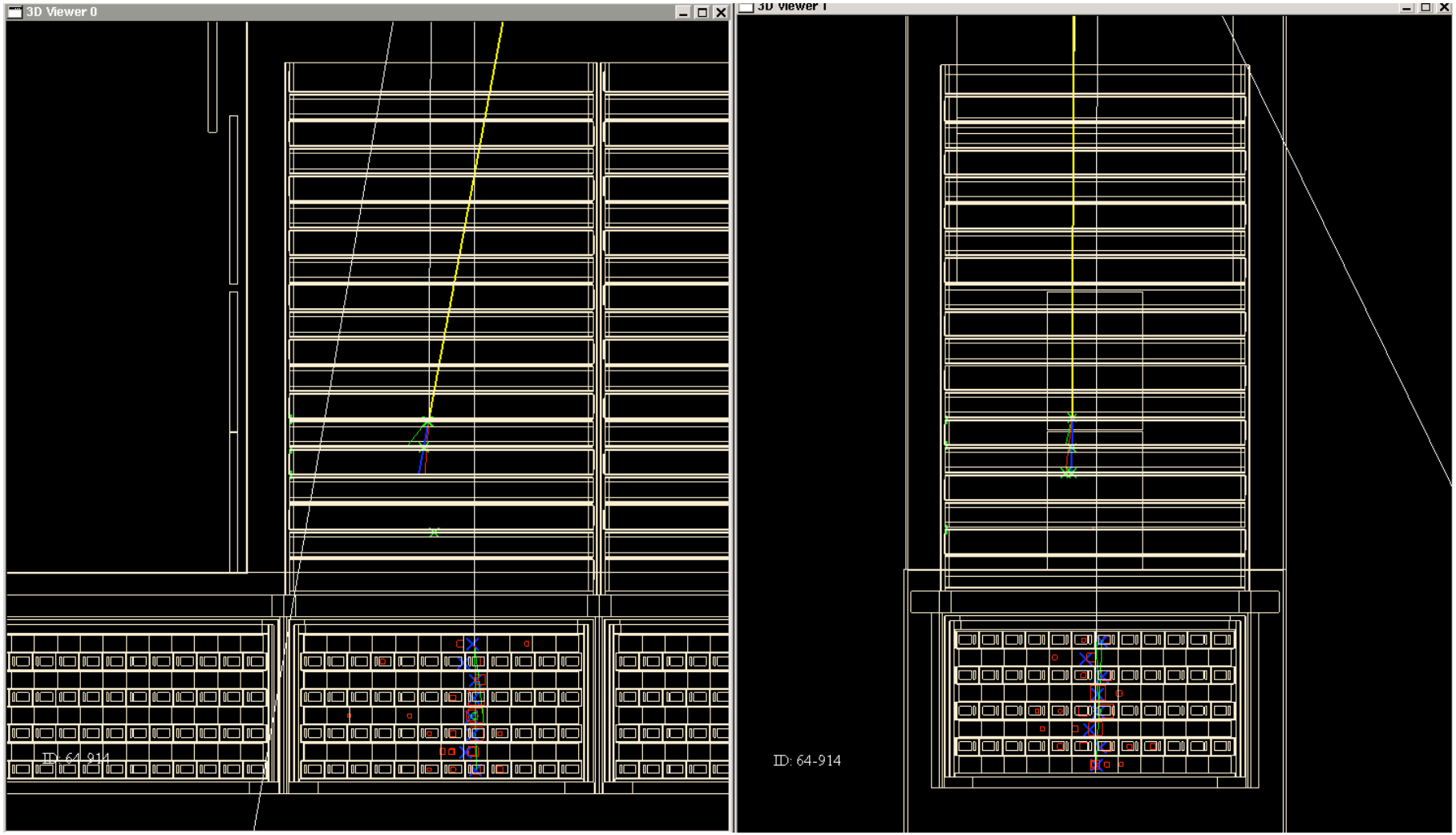
2 - Shape of the distribution of McDirErr

Energy (reconstructed) ~ 1 GeV

MC Run 129 (~1/2 statistics than MC 125)

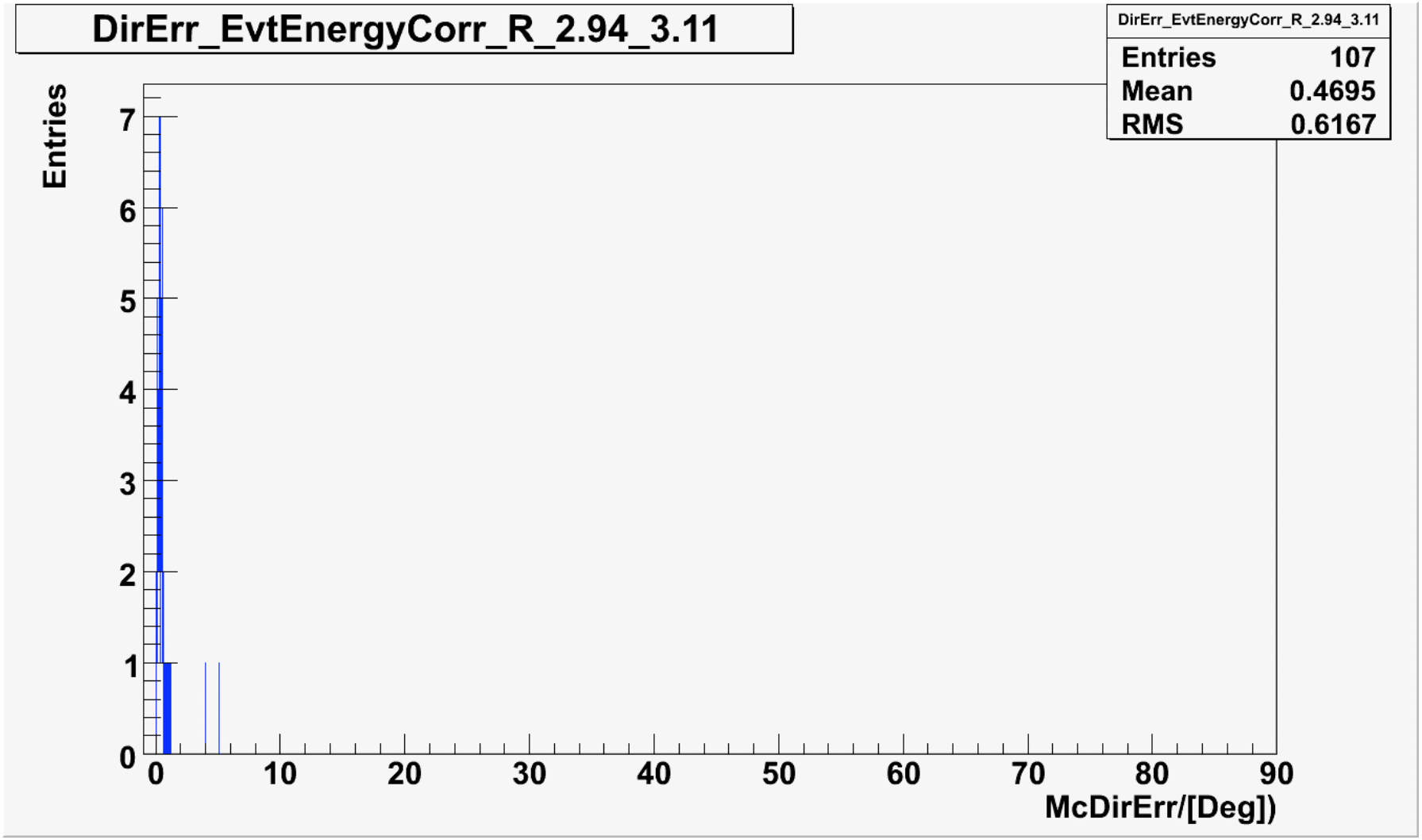


Two photon events in which the low energy photon (28 MeV in this case) scatters an electron (Compton) or produces a pair electron-positron, while the high energy electron (1.6 GeV in this case) gets converted in the Cal

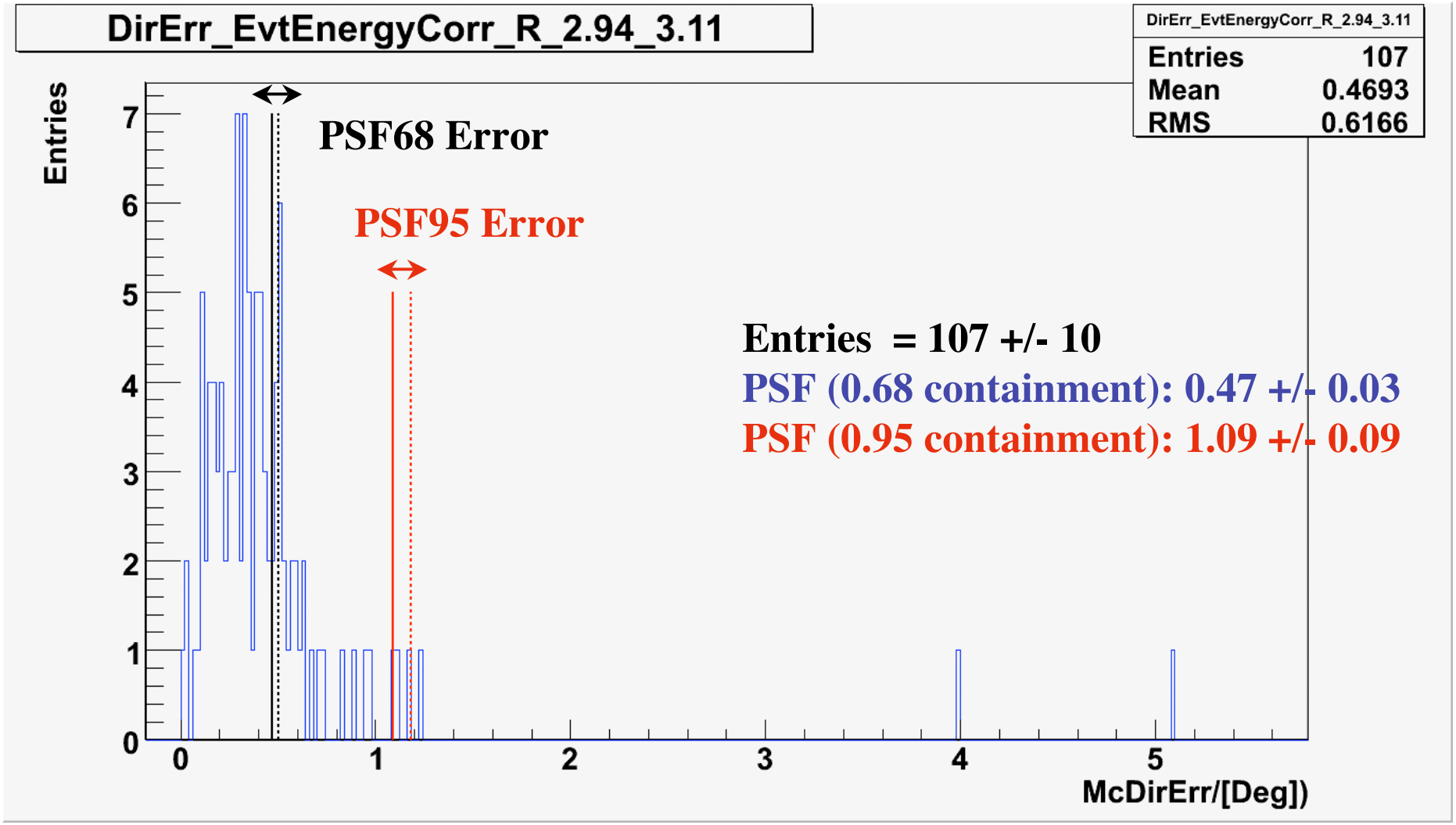


Many of those guys can be removed by requiring signal in the very last tracker layers (they do not have converter)

TkrBlankHits > 3

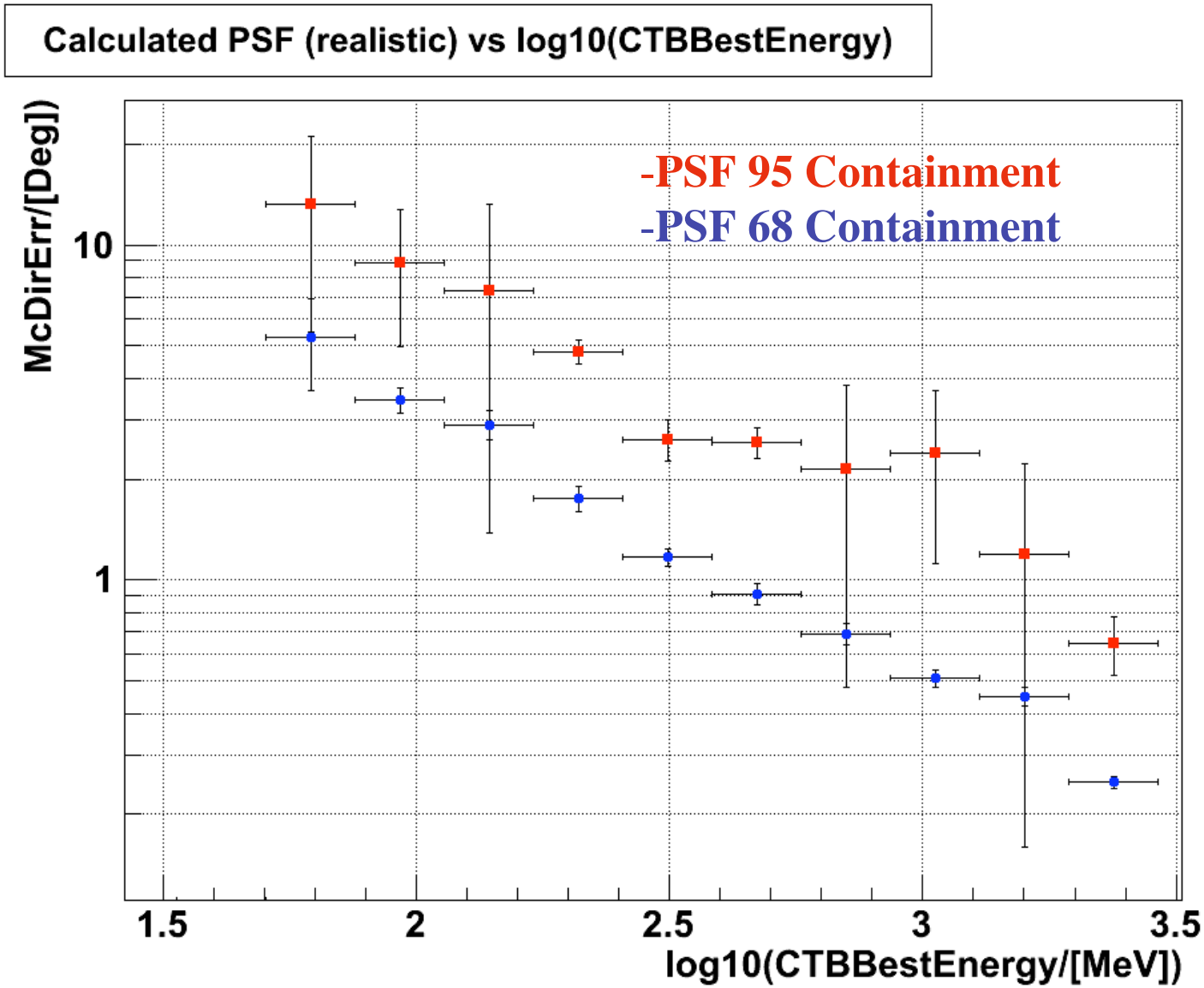


Example of calculation of PSF : MC run 129, log10Energy bin 2.94 - 3.11



1 - PSF (from MCDirErr) for each of these energy bins (68% and 95%)

MC runs 125 (0 incidence angle)



1 - PSF calculation using the beam direction

ReconstructedDirectionVector *= VtxXDir, VtxYDir, VtxZDir*

IncomingPhotonDirectionVector *= McXDir,McYDir, McZDir*
BeamDirectionVector *= cos(XthetaBeam), cos(YthetaBeam), cos(ZThetaBeam)*

I can use 3 DirErr s: **McDirErr**, **MyDirErr** and **BeamDirErr:**

$$Cos(MyDirErr) = McXDir^{*}\ VtxXDir + McYDir^{*}\ VtxYDir + McZDir^{*}\ VtxZDir$$

$$Cos(BeamDirErr) = cos(XthetaBeam)^{*}\ VtxXDir + cos(YthetaBeam)^{*}\ VtxYDir + cos(ZThetaBeam)^{*}\ VtxZDir$$

McDirErr is exactly the same **MyDirErr**

BeamDirErr >= MyDirErr because of the photon beam dispersion

1 - Estimation of the photon beam dispersion in the MC data

beam dispersion for the selected energy bins can be calculated as:

Cos(PhotonBeamDispersion) = cos(XthetaBeam)* McXDir +
cos(YthetaBeam)* McYDir +
cos(ZThetaBeam)* McZDir

I computed the "PSF" exactly in the same way (counting up to 68%, and 95% containment), but this time using ***PhotonBeamDispersion instead of***

McDirErr or MyDirErr

```
// Incoming direction of the photon beam 0 deg
Double_t cosXTheta = 0.0;
Double_t cosYTheta = 0.0;
Double_t cosZTheta =-1.0;
// Incoming direction of the photon beam 40 deg
Double_t cosXTheta = -6.4273634724861605e-01;
Double_t cosYTheta = 0.0;
Double_t cosZTheta = -7.6604311646595957e-01;
```

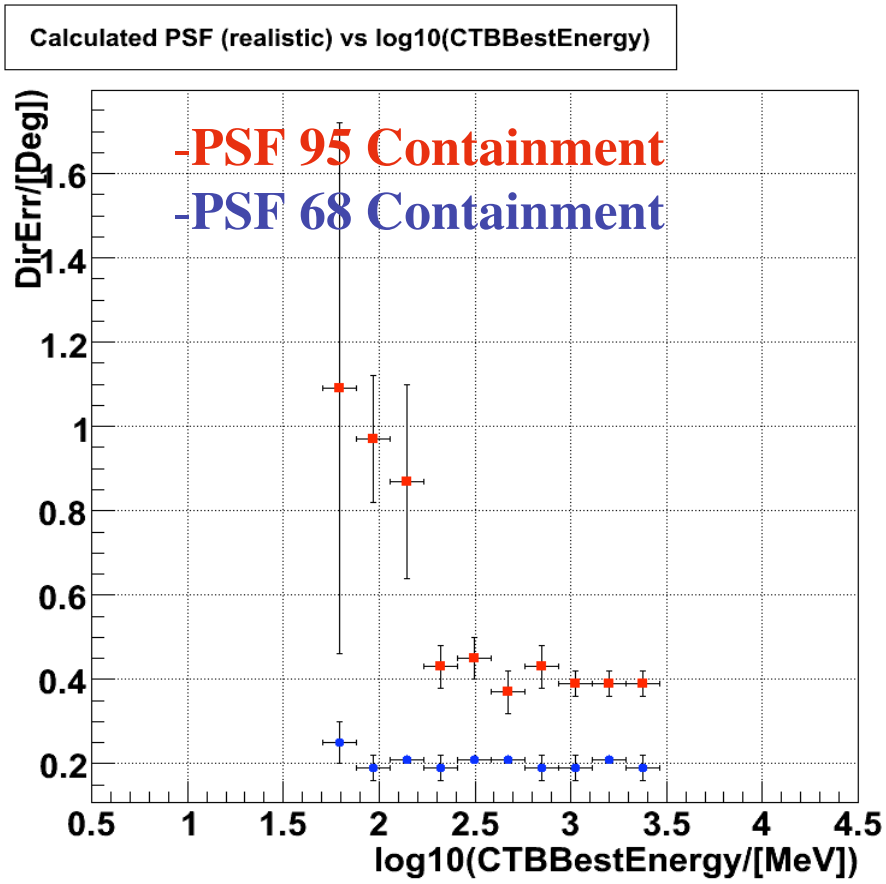
1 - Photon beam dispersion for each of these energy bins

For MC 125, the “PSF68” from this dispersion is FLAT, about 0.2 deg.

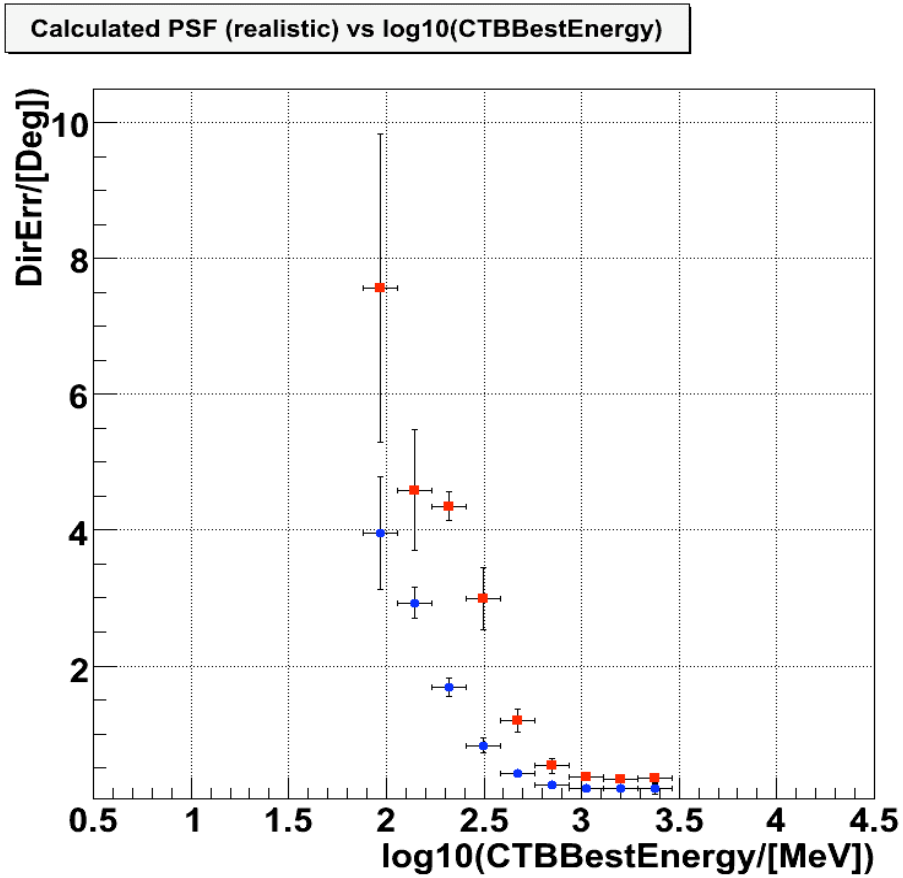
For MC 129, the “PSF68” from this dispersion is ENERGY dependent. It converges assimptotically to 0.2 at high energies.

WHY this difference ??

Run MC 125 (0 deg)



Run MC 129 (0 deg)



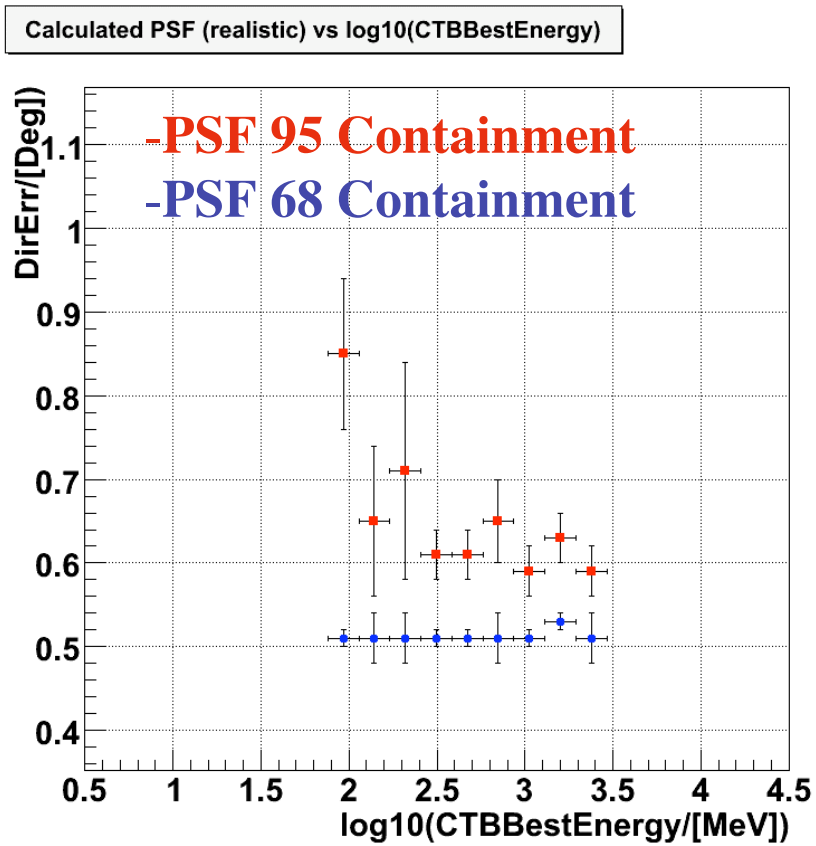
1 - Photon beam dispersion for each of these energy bins

For MC 127, the “PSF68” from this dispersion is FLAT, about 0.5 deg.

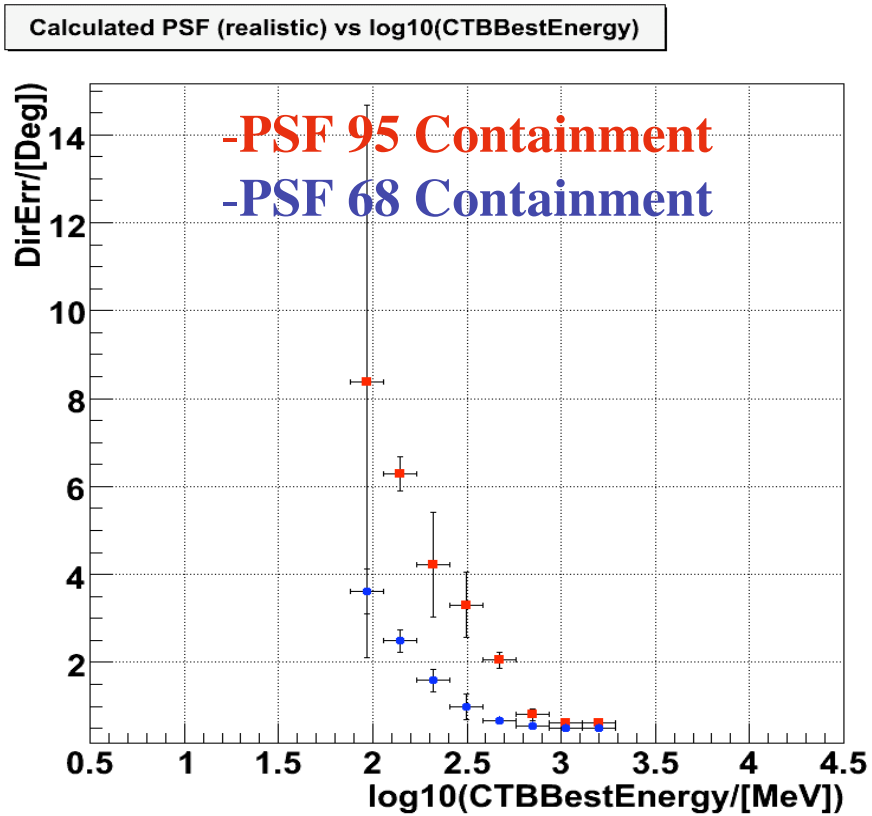
For MC 130, the “PSF68” from this dispersion is ENERGY dependent. It converges assimptotically to 0.5 at high energies.

WHY this difference ?? Why dispersion larger than at 0 deg ?? Do I make a mistake in the argumentation ??

Run MC 127 (40 deg)



Run MC 130 (40 deg)



2 - Comparison of PSF in data (run 1189) and MC (run 129)

Photons enter in the CU perperdicularly to plane X-Y (0 deg incidence angle)

PSF for DATA and MC calculated using the incoming direction of the beam, and not the incoming direction of the individual photons

As shown previously, the disperion of photons is small for this configuration, and thus it is a very good approximation

Selection of events applied

(TkrNumTracks == 1 || TkrNumTracks == 2) && CalEnergyRaw >10 && Tkr1SSDVeto>3 && TkrThinHits > 2 && TkrBlankHits > 3

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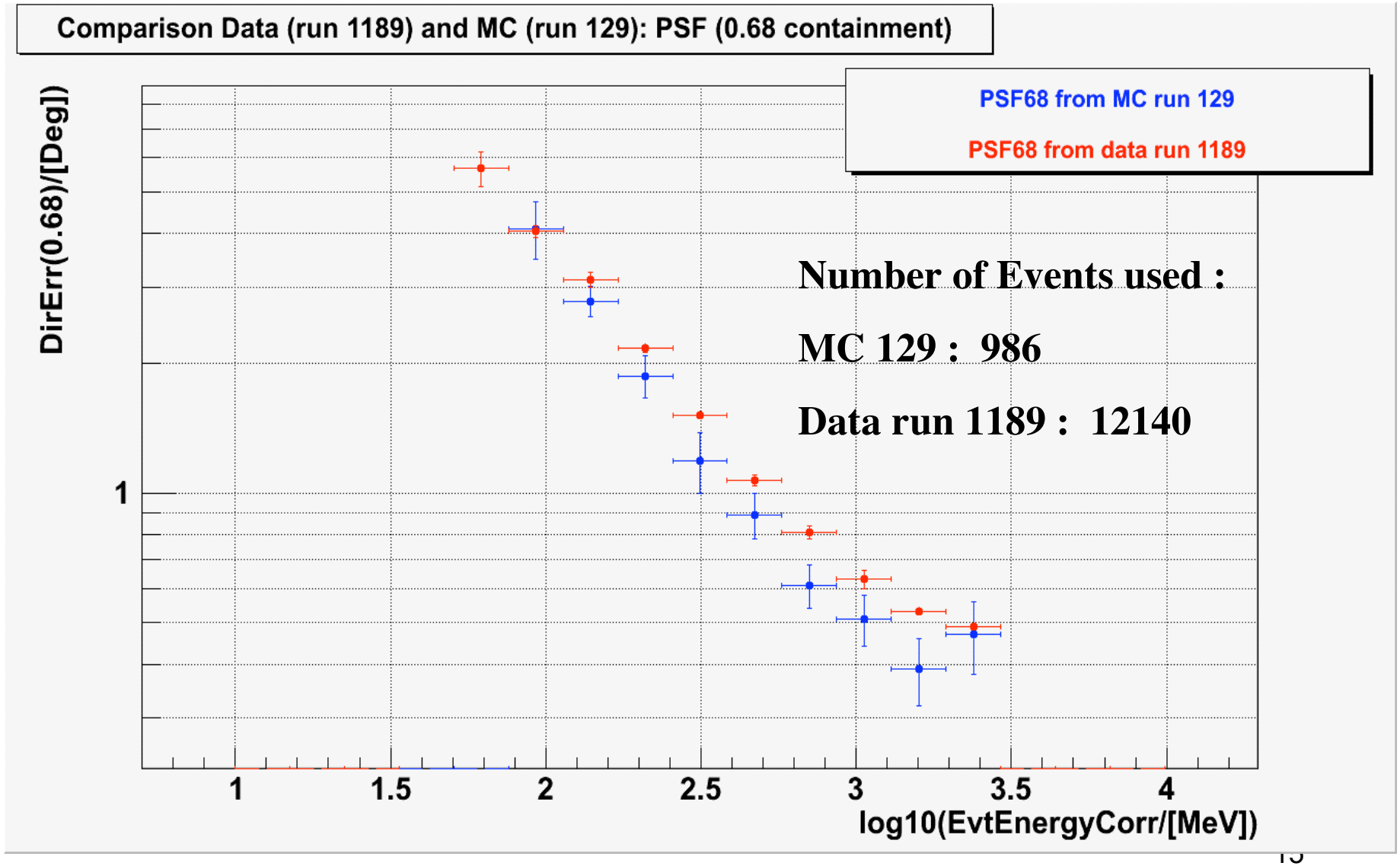

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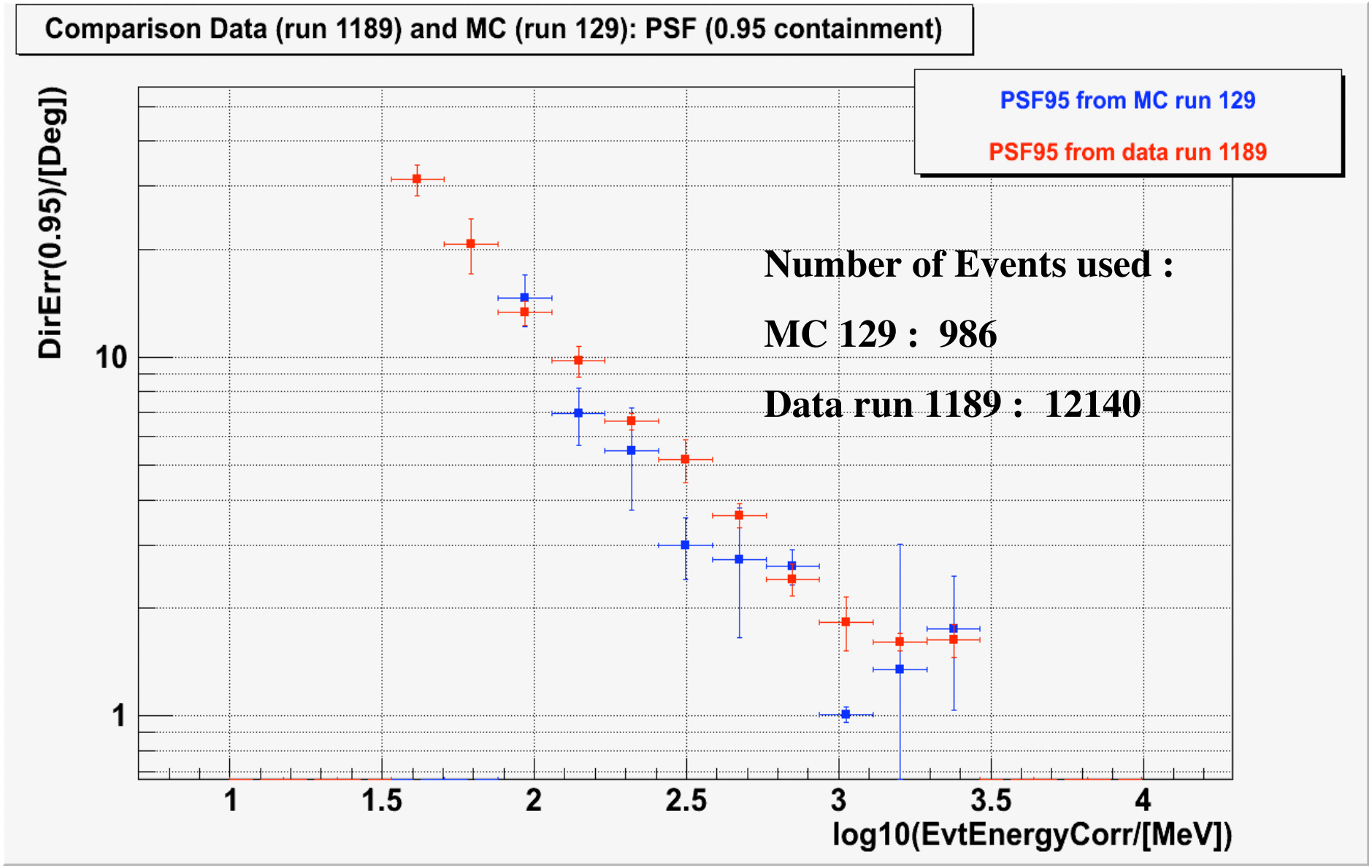

2 - Comparison of PSF in data (run 1189) and MC (run 129)

Agreement Data-MC in the computed PSF is RATHER GOOD.

Note however that it seems there are some systematic differences (~15%)

More data runs needed … specially, more MC runs to reduce error bars