Studying Annihilation Distributions

Adriano Del Vincio

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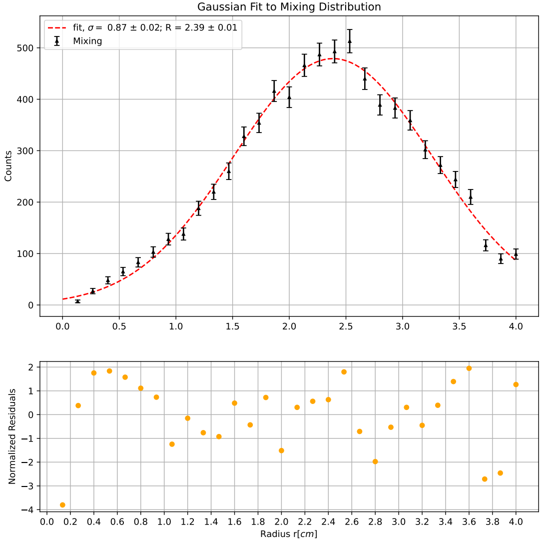
I tried to fit the distributions of the event annihilation with analytic models. This should improve the results, avoiding statistical fluctuations: The models are listed below:

- Pdf Mixing: the Normal distribution.
- Pdf Uwlosses: Rayleigh distribution $\frac{r}{\sigma^2} e^{-\frac{r^2}{2\sigma^2}}$.
- Pdf Cosmic: $\frac{1}{8}x$.

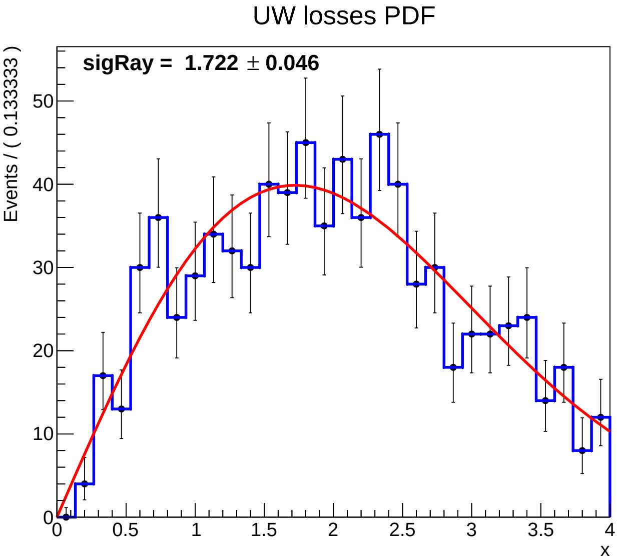
The factor $\frac{1}{8}$ for the cosmic is due to normalization. The Mixing, UW losses and cosmic data are fitted and the result are shown in the following slides

MIXING

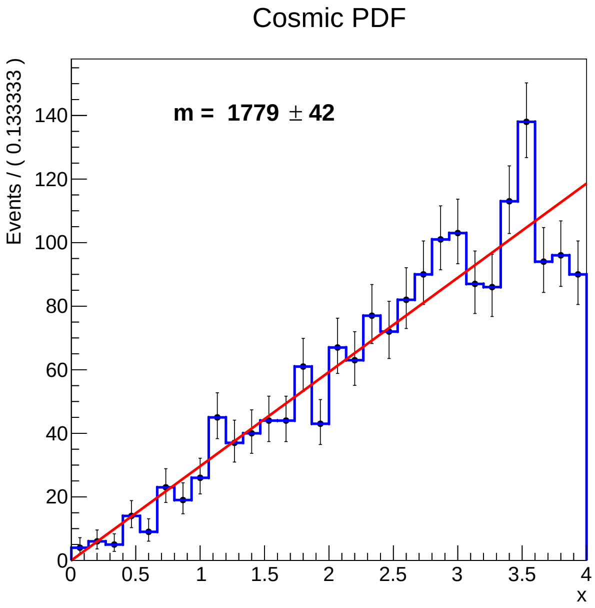


Gaussian Fit to Mixing Distribution
fit, σ = 0.87 ± 0.02; R = 2.39 ± 0.01
Mixing
Counts
Normalized Residuals
Radius r[cm]

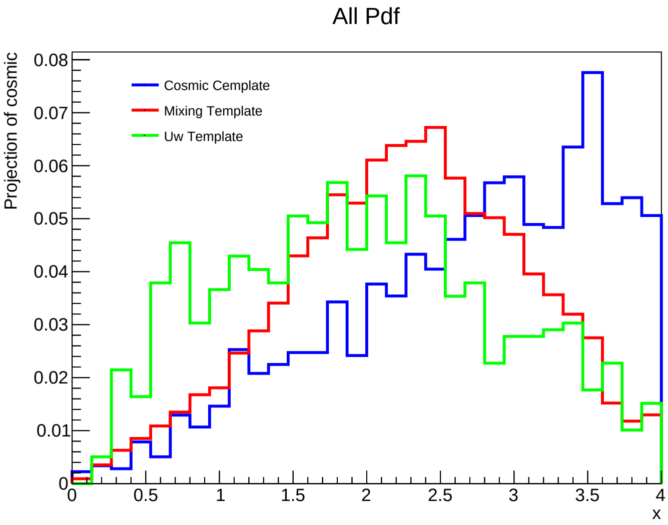
UWlosses


UW losses PDF
sigRay = 1.722 ± 0.046
Events / (0.133333)
0
10
20
30
40
50
0
0.5
1
1.5
2
2.5
3
3.5
4
x

Cosmic

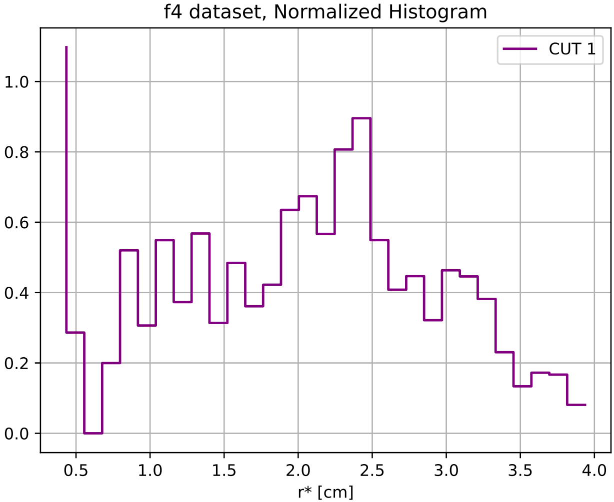

Cosmic PDF
m = 1779 ± 42
Events / (0.133333)
x
0
20
40
60
80
100
120
140
0.5
1
1.5
2
2.5
3
3.5
4

Pdfs normalized plotted together



Pdf with radius normalization

The histogram in r variable doesn't account for the different area of the bin which is $2\pi r \cdot dr$. So it is useful to normalize dividing per $2\pi r$.



Pdf with radius normalization

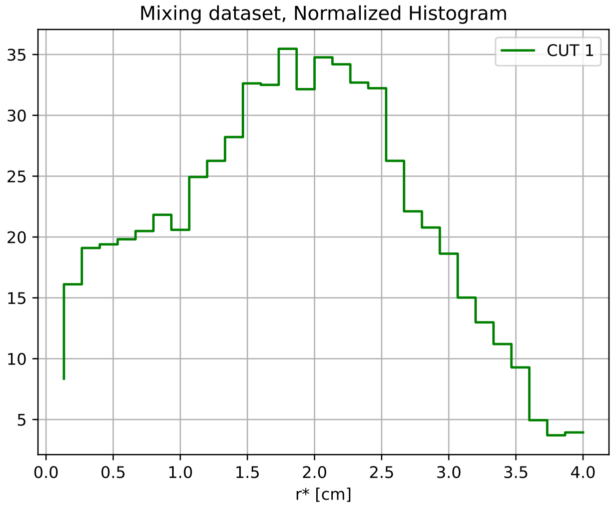


Figure: Pdf normalized for Mixing dataset

Pdf with radius normalization

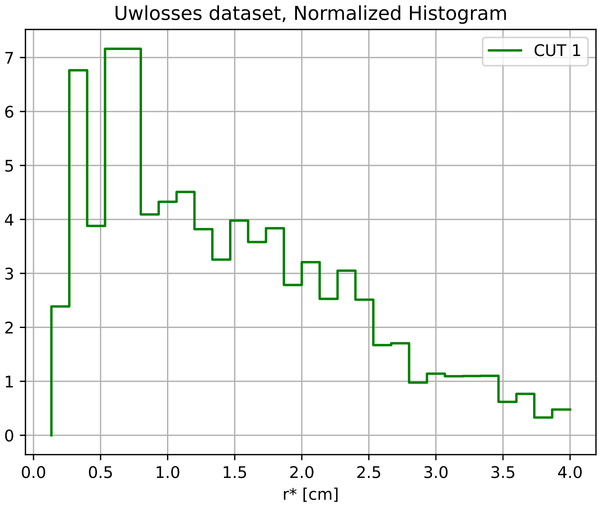


Figure: Pdf normalized for UW dataset

Pdf with radius normalization

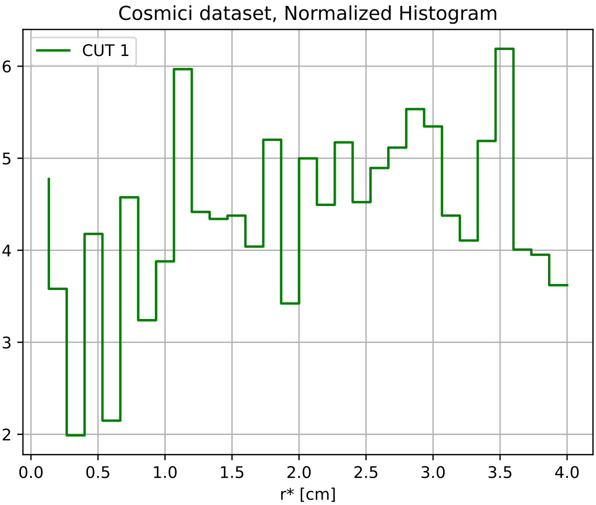
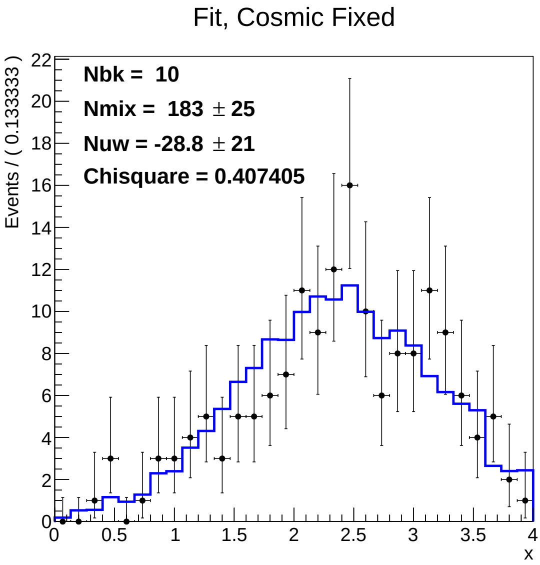


Figure: Pdf normalized for Cosmic dataset

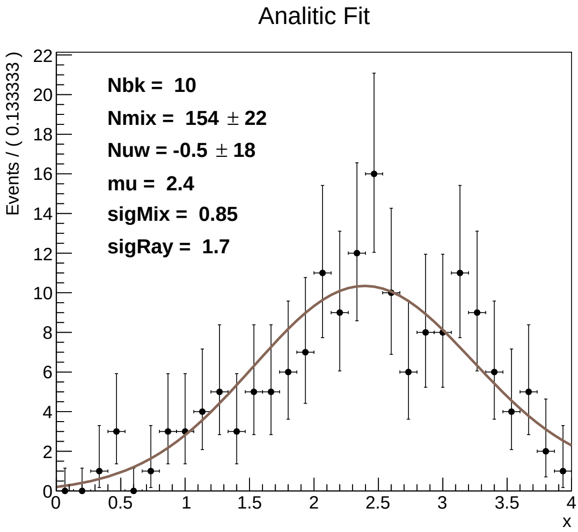
fit with all template

Pdf = Template Mixing + Template Uwlosses + Template cosmic



fit with analytic models

Pdf = Gaussian (Mixing) + Rayleigh (Uwlosses) + linear model (cosmic)



Montecarlo simulation

To study the accuracy of the algorithm to reconstruct the various parameter, a "toy" algorithm is done. The model to generate the data is:

$$Pdf_{total} = a \cdot Gauss_{mix} + b \cdot Rayleigh + c \cdot linearModel_{cosmic} \tag{1}$$

a, b, c represent the "weight", or degree or percentage of the various contributions to the Pdf used to generate the data. For simplicity the c is setted to zero.
We generate N data. Once the data are generated, they are fitted with the model:

$$Pdf_{fit} = N_{mix} \cdot Gauss_{mix} + N_{uw} \cdot Rayleigh + N_{bk} \cdot linearModel_{cosmic} \tag{2}$$

The parameters of the fit are N_{mix}, N_{uw} and N_{bk}. The "true value" are defined as:

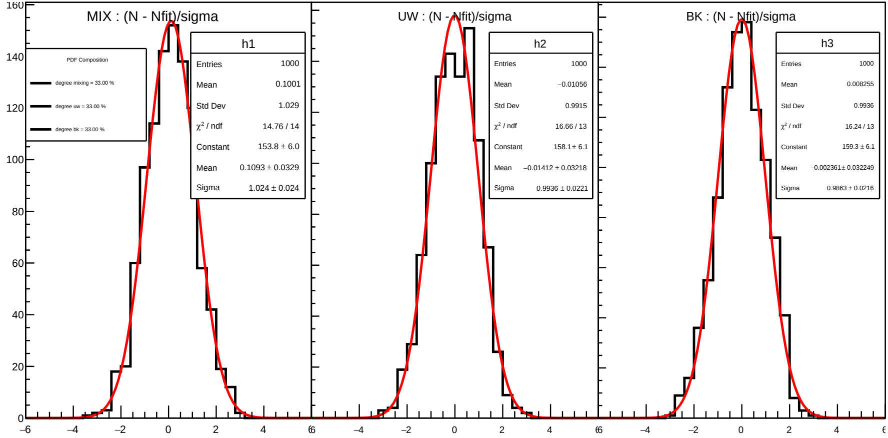
- Nmix true $= a \cdot N$
- Nuw true $= b \cdot N$
- Nbk true $= c \cdot N$

Toy: Nsample = 1000, a = %33, b = %33, c = %33

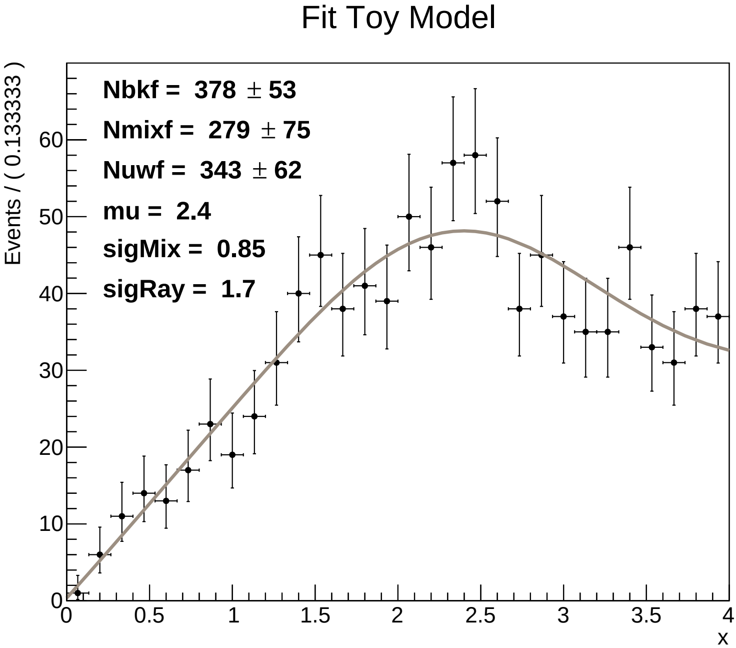
In this first following plot we have fixed the weight of each distribution to 33. The number of sampled data is one thousand and the number of iteration of is one thousand. This first plot is made to ensure that the algorithm is able to reconstruct the parameters, and check the presence of a bias.
The variable of the histograms are:

$$\frac{N_{fit} - N_{true}}{\sigma_{fit}} \tag{3}$$

Toy: Nsample $= 1000$, a $= \%33$, b $= \%33$, c $= \%33$

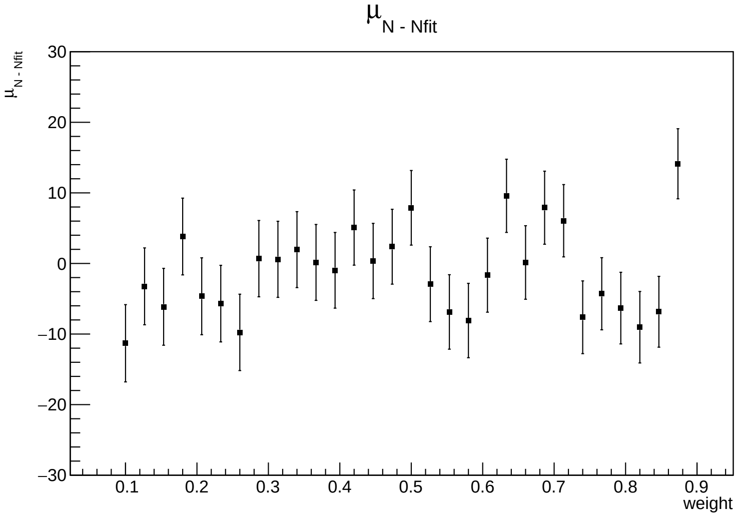


Example of fit, Toy: Nsample = 1000, a = %33, b = %33, c = %33



Coefficient variation

Now we study how or if the coefficients of the fit N_{mix}, N_{uw} and N_{bk} vary with the increase of the weight a, b and c. At fixed $c = 10\%$, a is raised from 10% to 80% and b is decreased accordingly. We end with:



σ versus weight a