Studying Annihilation Distributions

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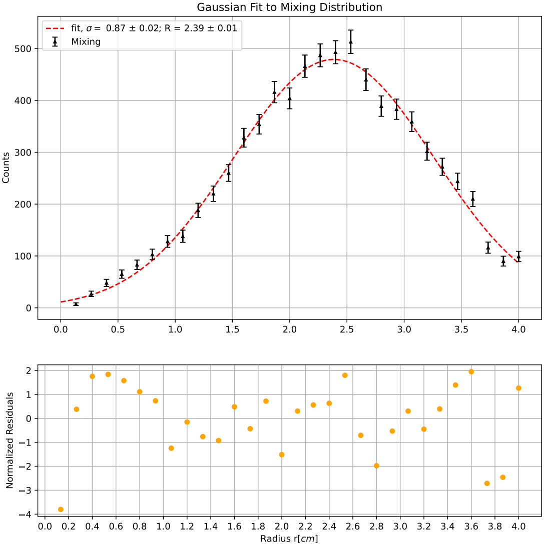
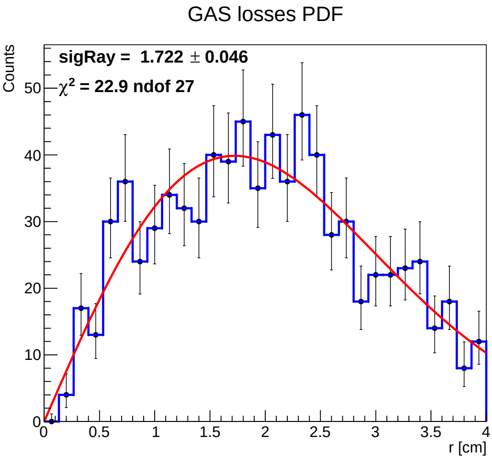
MIXING

Mixing dataset represents almost pure data of anti-hydrogen annihilation on the walls. The radius distribution is fitted with a Gaussian.



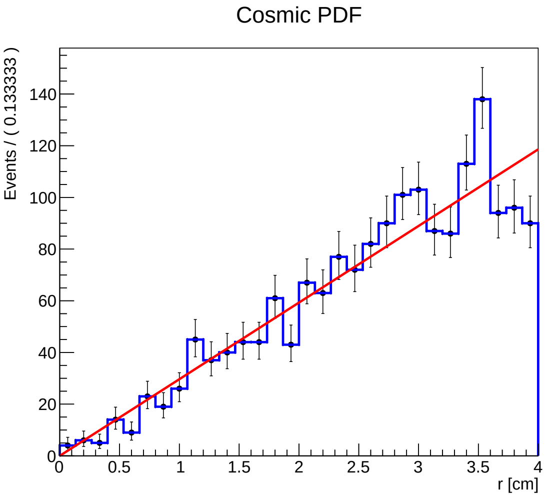
Residual Gas

The microwave losses represent an almost pure anti-hydrogen sample of annihilation events due to residual gas inside the trap. The data are fitted with Rayleigh distribution $\frac{r}{\sigma^2} e^{-\frac{r^2}{2\sigma^2}}$

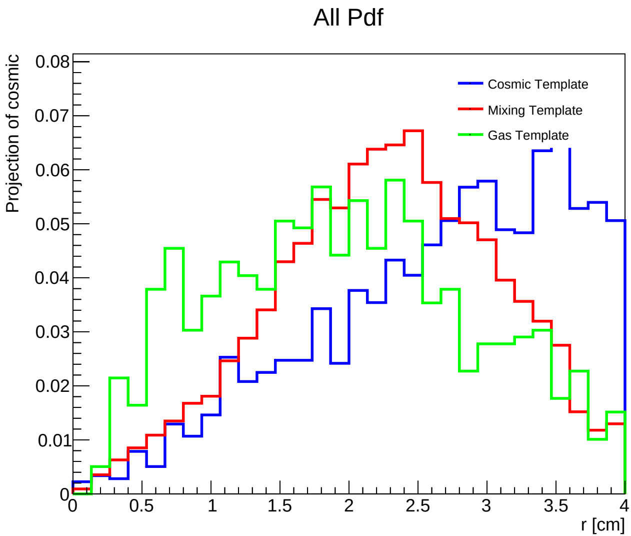


Cosmic

The cosmic distribution is obtained from a dataset without particles in the trap. A liner model $m \cdot x$ is assumed.

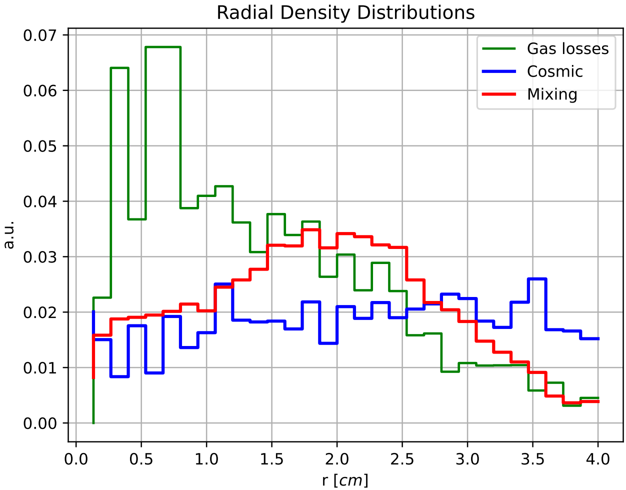


PDFs normalized plotted together



Radial Density

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 divide per $2\pi r$ to obtain the radial density of the events.



Monte Carlo Simulation Toy

To study the accuracy of the algorithm to reconstruct the various parameter, we have developed a "toy" simulation tool. The model to generate the data is:

$$F_{gen}(r) = N_{sample} \cdot (a \cdot PDF_{mix} + b \cdot PDF_{gas} + c \cdot PDF_{cosmic}) \tag{1}$$

where a, b, c represent the "weights" of the various contributions to the PDF used to generate the data. The number of annihilation is indicated as N_{sample}. Once the data are generated, they are fitted with the model:

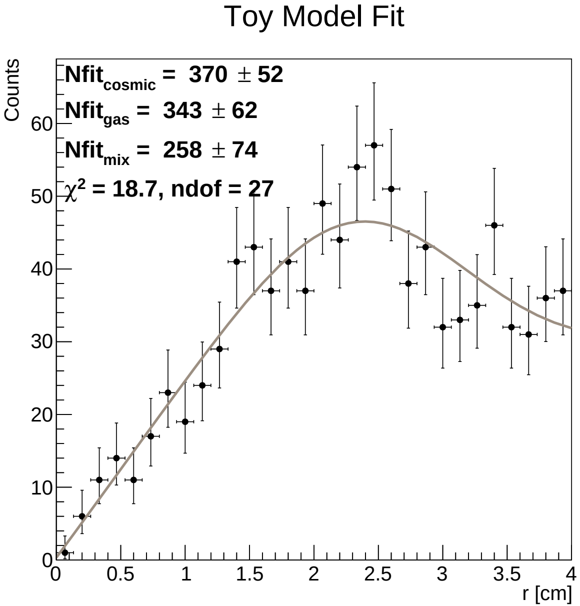
$$Nfit_{mix} \cdot PDF_{mix} + Nfit_{gas} \cdot PDF_{gas} + Nfit_{cosmic} \cdot PDF_{cosmic} \tag{2}$$

The parameters of the fit are $Nfit_{mix}, Nfit_{gas}$ and $Nfit_{cosmic}$. The "true value" are defined as:

- $Ngen_{mix} = a \cdot N_{sample}$
- $Ngen_{gas} = b \cdot N_{sample}$
- $Ngen_{cosmic} = c \cdot N_{sample}$

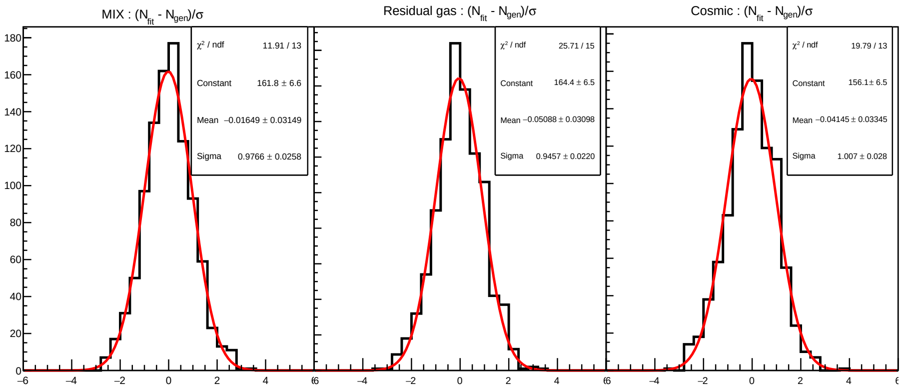
In generation $Ngen_{mix}$,$Ngen_{gas}$,$Ngen_{cosmic}$ are varied according to a Poissonian distribution.

Example of fit, Toy: $N_{sample} = 1000$, a = 33%, b = 33%, c = 33%



Toy: $N_{sample} = 1000$, a = 33%, b = 33%, c = 33%

In this plot we have fixed the weight of each distribution to 33%, with $N_{sample} = 1000$ and $N_{trials} = 1000$, to ensure that the algorithm is able to reconstruct the parameters, and check the presence of a bias. The variable of the histograms are: $\dfrac{Nfit - Ngen}{\sigma_{fit}}$. The distributions are normal and the fit procedure is behaving as expected.



$N_{sample} = 165, \; N_{trials} = 100$

Now we study how the coefficients of the fit $Nfit_{mix}$, $Nfit_{gas}$ and $Nfit_{cosmic}$ vary with the increase of the weight a. *Nsample* is fixed at 165, to reproduce a typical amount of events in real data (such as for a frequency of run 68465, after applying *cut1*). The value of c is fixed to reproduce the number of expected events from background ($c = 6\%$, $Ngen_{cosmic} \simeq 10$).