# Toy Model For Hyperfine Measurement

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# A brief introduction about the Monte Carlo

This Monte Carlo produces two `.root` files, that are a simulated dataset of the hyperfine spectrum of anti-hydrogen.

```
root [0]
Processing AnalysisLineShape.cpp...
+-----+----+------------+------+------------+
| Row | id | frequence  | Type | radius     |
+-----+----+------------+------+------------+
| 0   | 0  | -1.1593600 | 0    | 2.3544551  |
+-----+----+------------+------+------------+
| 1   | 1  | -1.1593600 | 0    | 2.3317903  |
+-----+----+------------+------+------------+
| 2   | 2  | -1.1593600 | 1    | 2.0915642  |
+-----+----+------------+------+------------+
| 3   | 3  | -1.1593600 | 1    | 2.3174902  |
+-----+----+------------+------+------------+
| 4   | 4  | -1.1593600 | 1    | 0.69147125 |
+-----+----+------------+------+------------+
| 5   | 5  | -1.1593600 | 1    | 1.2059323  |
+-----+----+------------+------+------------+
| 6   | 6  | -1.1593600 | 1    | 0.62781989 |
+-----+----+------------+------+------------+
| 7   | 7  | -1.1593600 | 1    | 1.7730544  |
+-----+----+------------+------+------------+
| 8   | 8  | -1.1593600 | 1    | 0.81372473 |
+-----+----+------------+------+------------+
| 9   | 9  | -1.1593600 | 1    | 1.4974816  |
+-----+----+------------+------+------------+
```

Figure: Structure of the dataset.

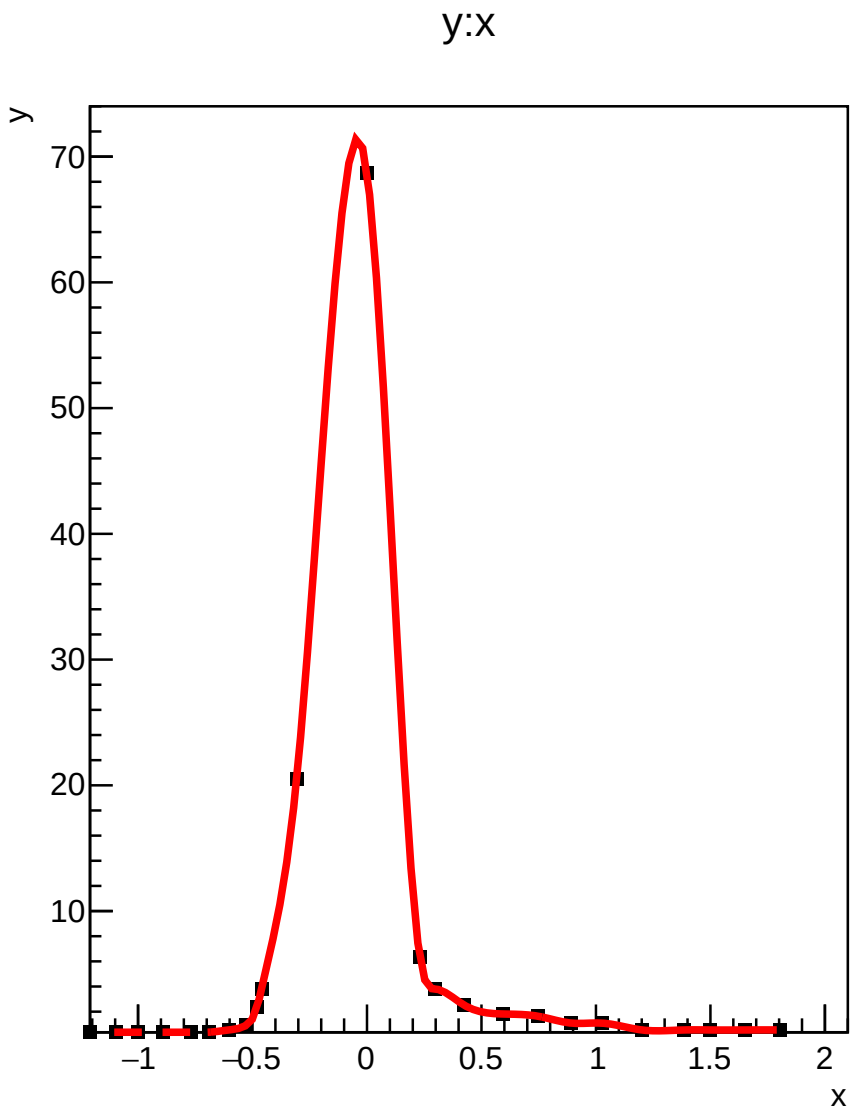
# A brief introduction about the Monte Carlo

The Annihilation on the walls ($N_{mix}$) are generated using the two pdf of the transitions (c $\rightarrow$ b) and (d $\rightarrow$ a). The Annihilation on the residual gas ($N_{gas}$) are generated uniformly on the frequency spectrum. The definition of the important parameters of the simulation is in the following figure:

```
void toyLineShape(double Mix_c = 0.5, double Mix_d = 0.5, double C = 0.5){
/////
int Nbin = 30;           // Number of Bins
int Ntot = 10000;        // Number of Total Events
int Ncosmic = static_cast<int>(0.492 * Nbin);   // Number of Cosmic Events
double pMix_c = Mix_c;  // Weight MIx pdf1
double pMix_d = Mix_d;  // Weight Mix pdf2
double c = C;           // Percentage of division two datasets
/////
double d = 1 - c;
Ntot = Ntot - Ncosmic;
double Nc = Ntot*c;
double Nd = Ntot*d;
double pGas_d = 1 - pMix_d; // Weight Gas
double pGas_c = 1 - pMix_c;
```

Figure: Parameter of the Montecarlo.

# Spline interpolation of the Spectrum.



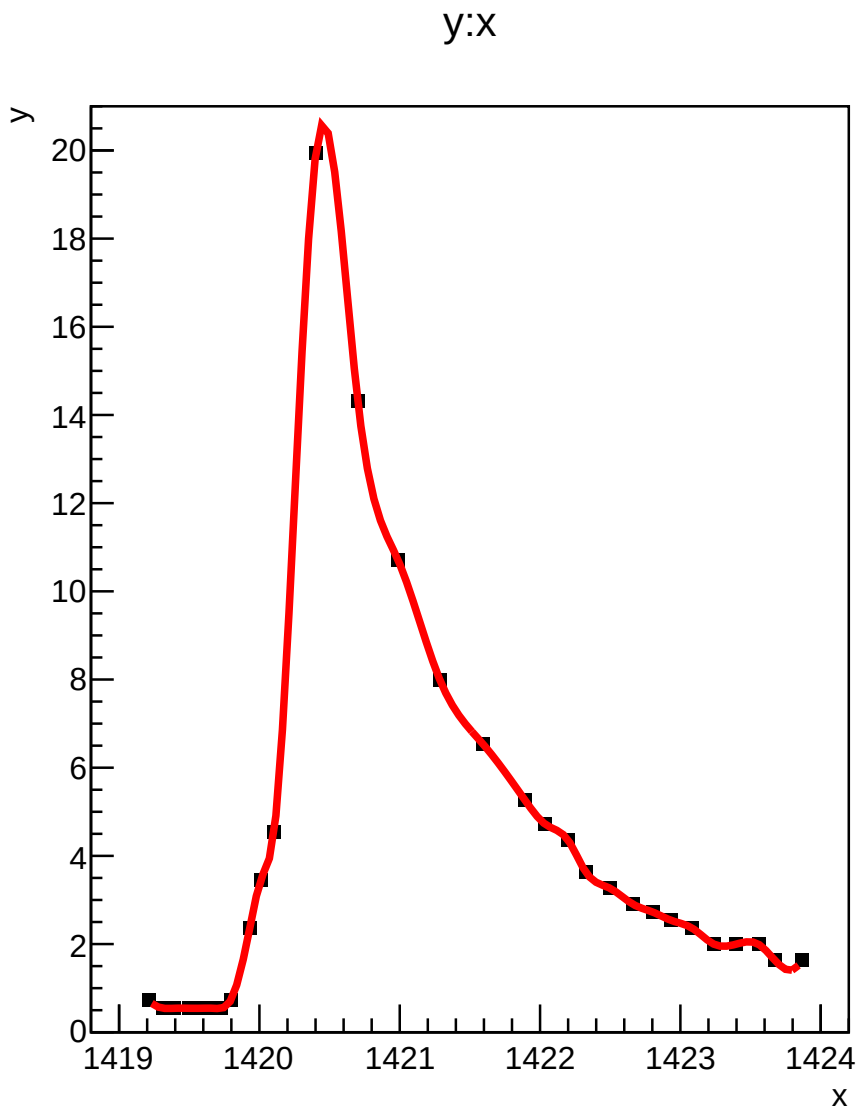




Figure: Data Obtained with PlotDigitizer

# Probability $pMix = 50\%$

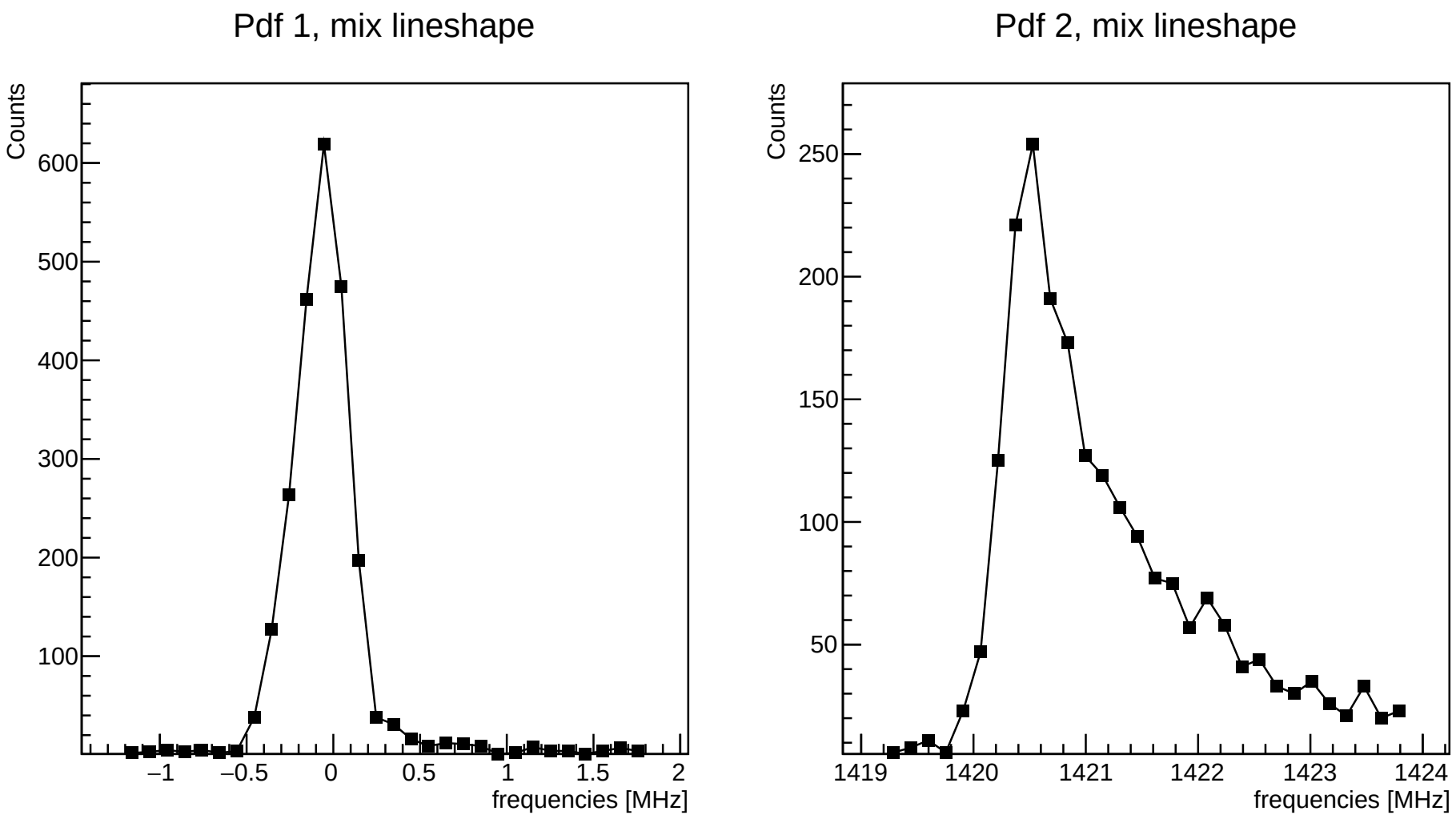



Figure: Events per frequence generated with the Pdf 1 (left) and Pdf 2 (right). The Data include **only** the annihilation on the walls (mixing).