Beam Halo Measurement and Estimation at ATF Extraction line

- Halo measured using wire scans
- Fitted to a function
- Fraction of beam in halo estimated
- Halo width versus core width
- Possible future work

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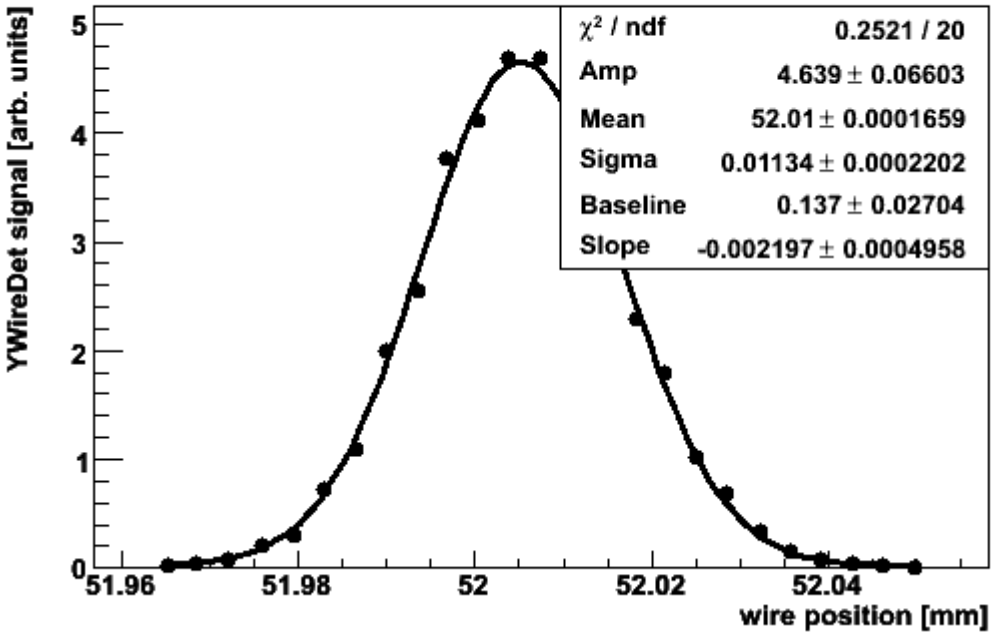
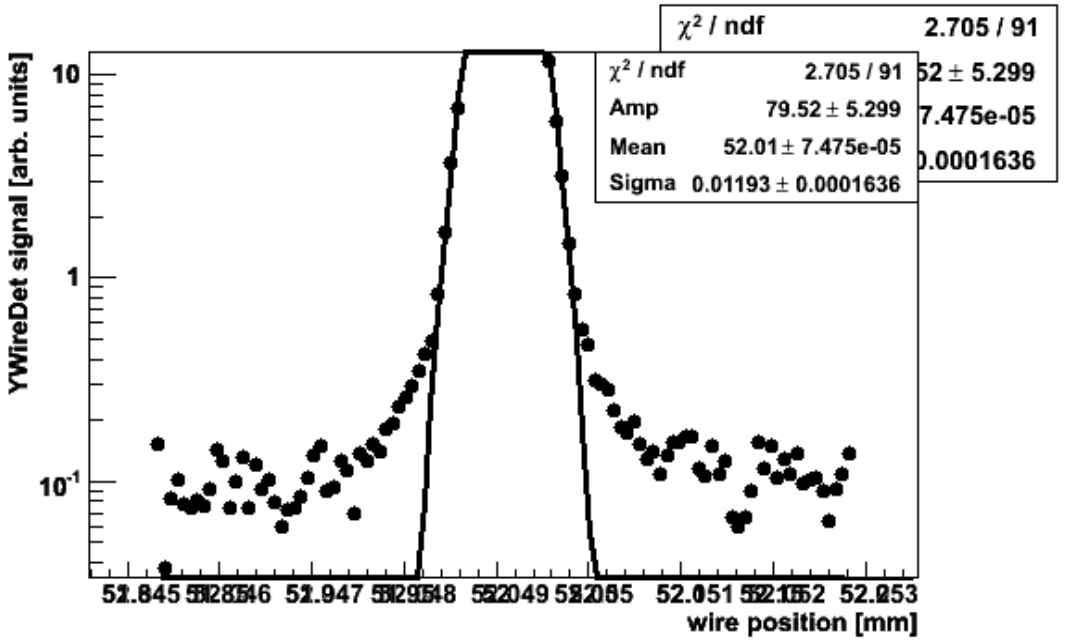
MW1X vertical- rough scan

- Wire scan fitted to gaussian



MW1X vertical – detailed scan- logarithmic scale



- The current in the detector was increased so that the tails could be seen.
- Small steps were taken over a long range.
- 10 shots for every wire position.
- Points above detector saturation level removed
- Fitted to a gaussian curve
- On logarithmic scale, non gaussian edges are visible

Fitting

- The points which fitted to the gaussian were removed
- The fitted gaussian was subtracted from the data
- The remaining points were fitted to the following function:

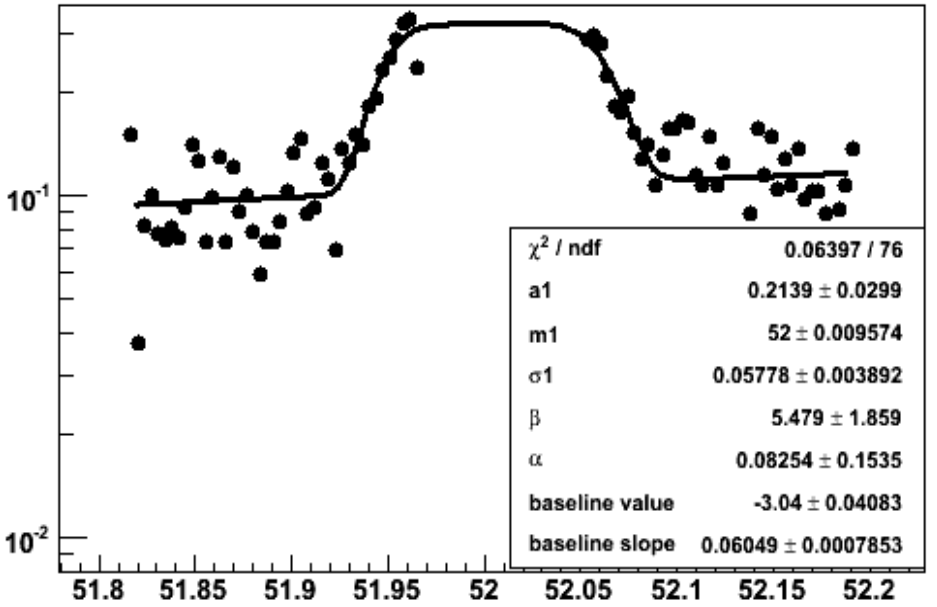
Fitting

$$f(x) = a_1 \, \mathrm{e}^{-0.5\left(\frac{|x-m_1|}{\sigma_1[1-\alpha\, sign(x-m_1)]}\right)^{\beta}} + Bx + C$$

- m is the mean position, a is the amplitude, alpha is an asymmetry parameter and beta determines the shape of the peak
- beta=1 -> spike
- beta=2 -> gaussian
- beta=3 -> flat top

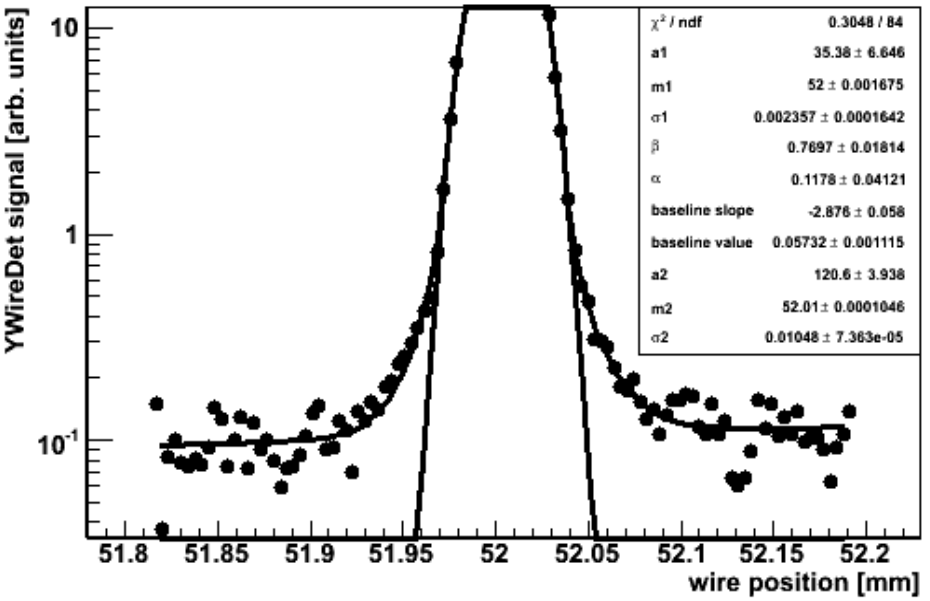
Fitting- MW1X vertical

- The results of this fit were used as the initia parameters to fit the sum of a gaussian and this function to all the points



Combined function

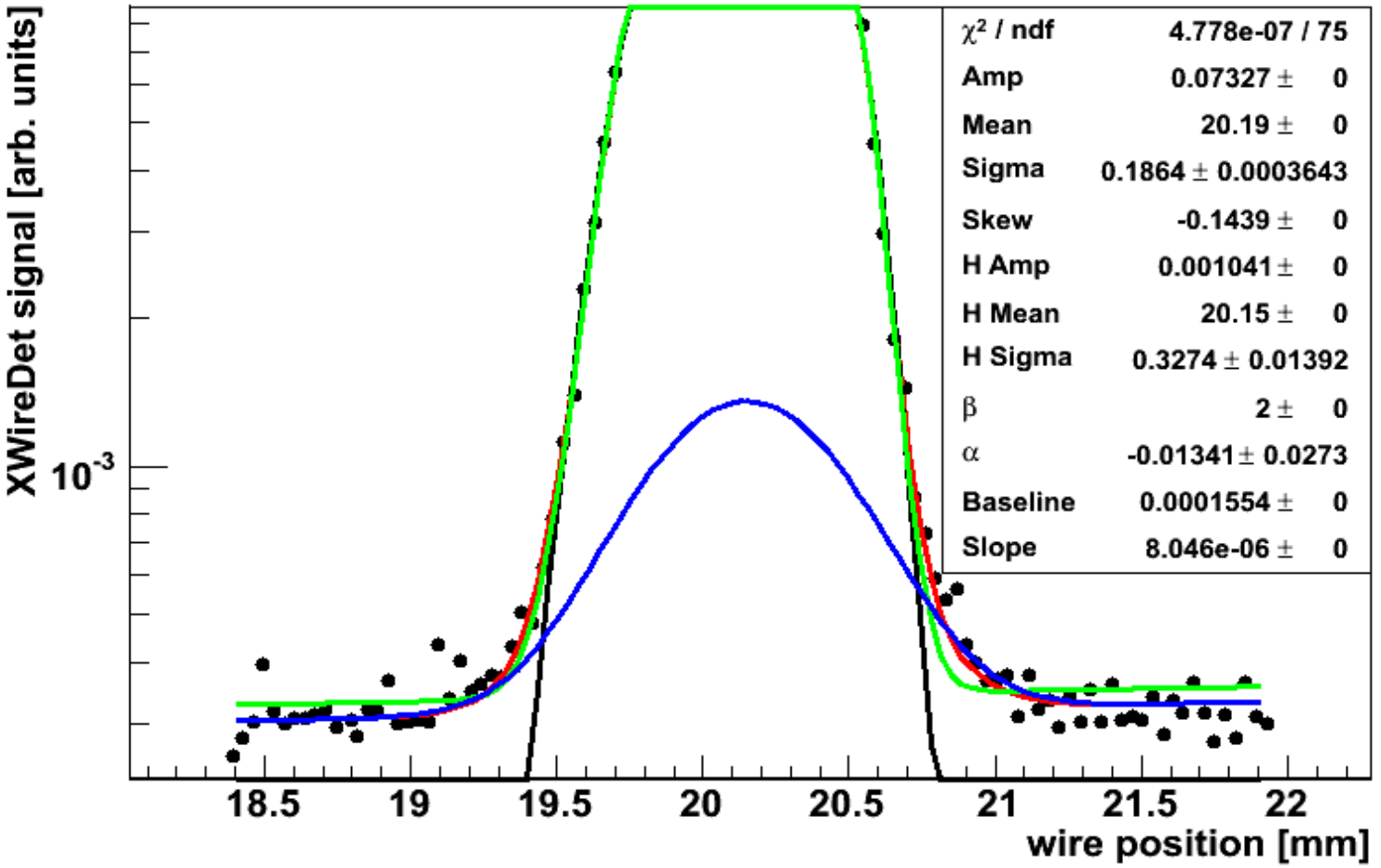
- A combined function was fit to the data
- Here it is shown on alongside the gaussian function
- The same procedure was carried out for the other wire scanners



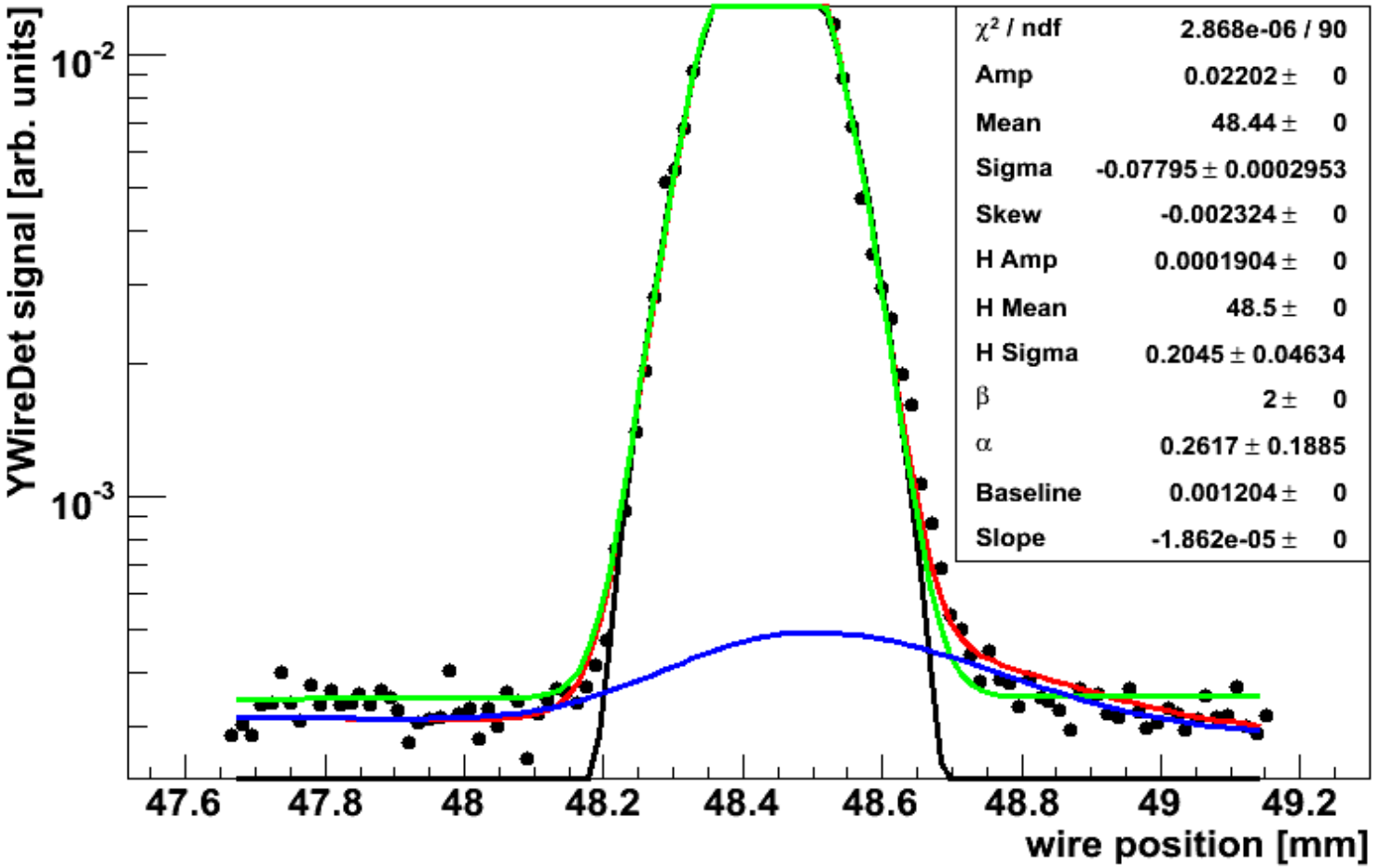
More fitting

- The mean of beta was 2 therefore the mean halo shape was gaussian
- Gaussian was a good fit
- I fitted scans from all horizontal and vertical wire scanners in the extraction line to the sum of two gaussians

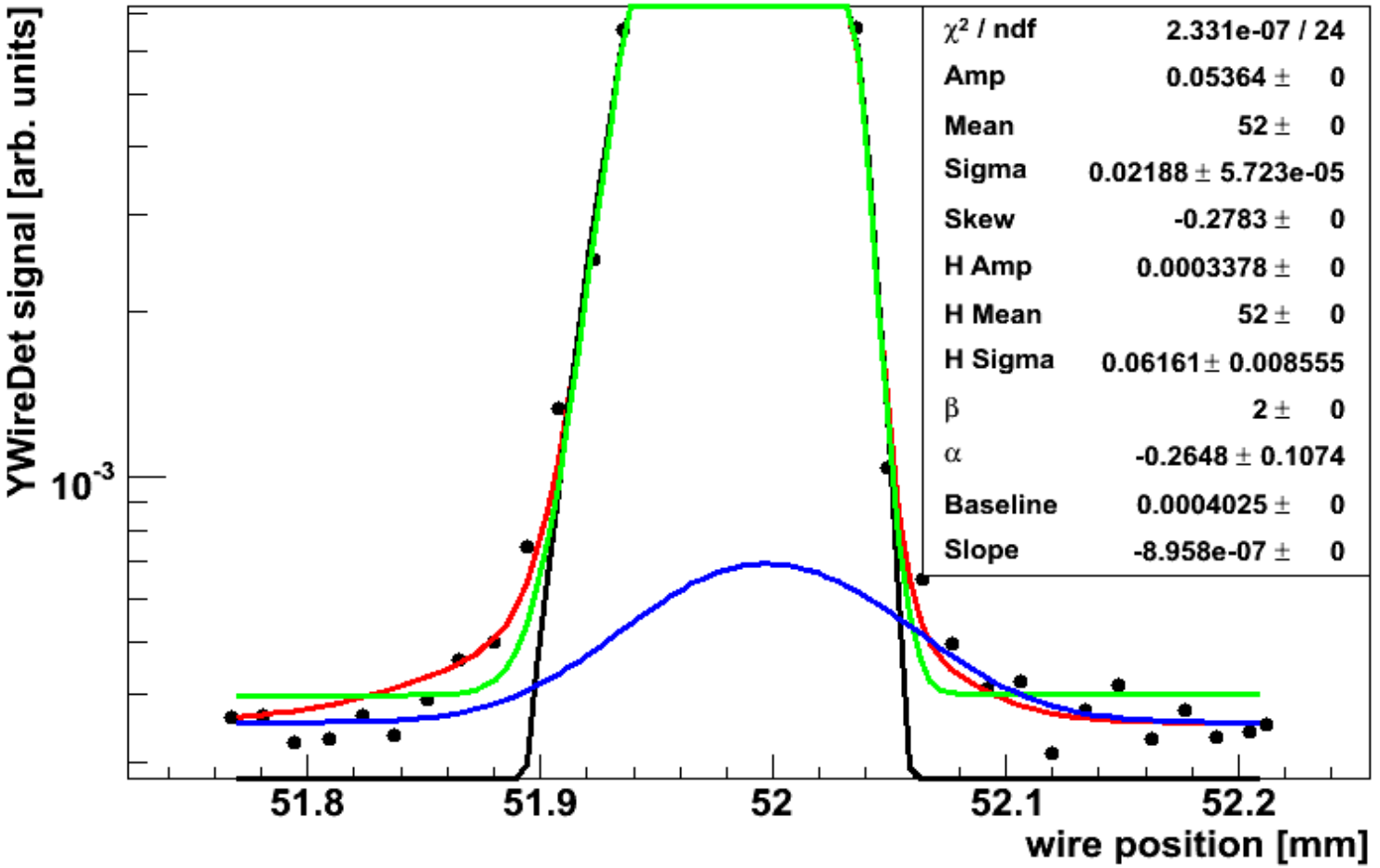
Results


XWireDet signal [arb. units]
10^-3
18.5
19
19.5
20
20.5
21
21.5
22
wire position [mm]
χ² / ndf 4.778e-07 / 75
Amp 0.07327 ± 0
Mean 20.19 ± 0
Sigma 0.1864 ± 0.0003643
Skew -0.1439 ± 0
H Amp 0.001041 ± 0
H Mean 20.15 ± 0
H Sigma 0.3274 ± 0.01392
β 2 ± 0
α -0.01341 ± 0.0273
Baseline 0.0001554 ± 0
Slope 8.046e-06 ± 0

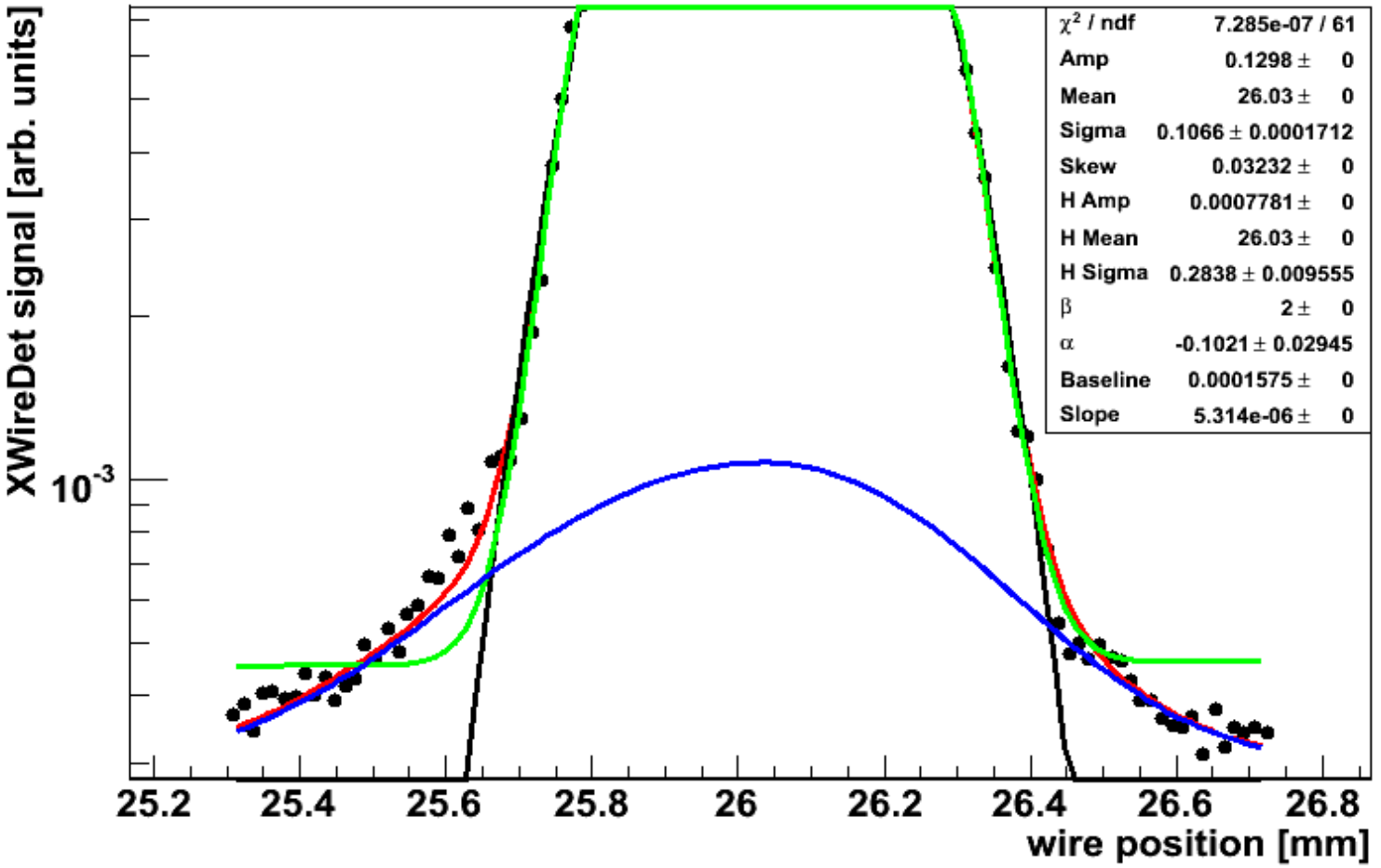
Results


YWireDet signal [arb. units]
10^{-2}
10^{-3}
47.6
47.8
48
48.2
48.4
48.6
48.8
49
49.2
wire position [mm]
χ^2 / ndf 2.868e-06 / 90
Amp 0.02202 ± 0
Mean 48.44 ± 0
Sigma -0.07795 ± 0.0002953
Skew -0.002324 ± 0
H Amp 0.0001904 ± 0
H Mean 48.5 ± 0
H Sigma 0.2045 ± 0.04634
β 2 ± 0
α 0.2617 ± 0.1885
Baseline 0.001204 ± 0
Slope -1.862e-05 ± 0

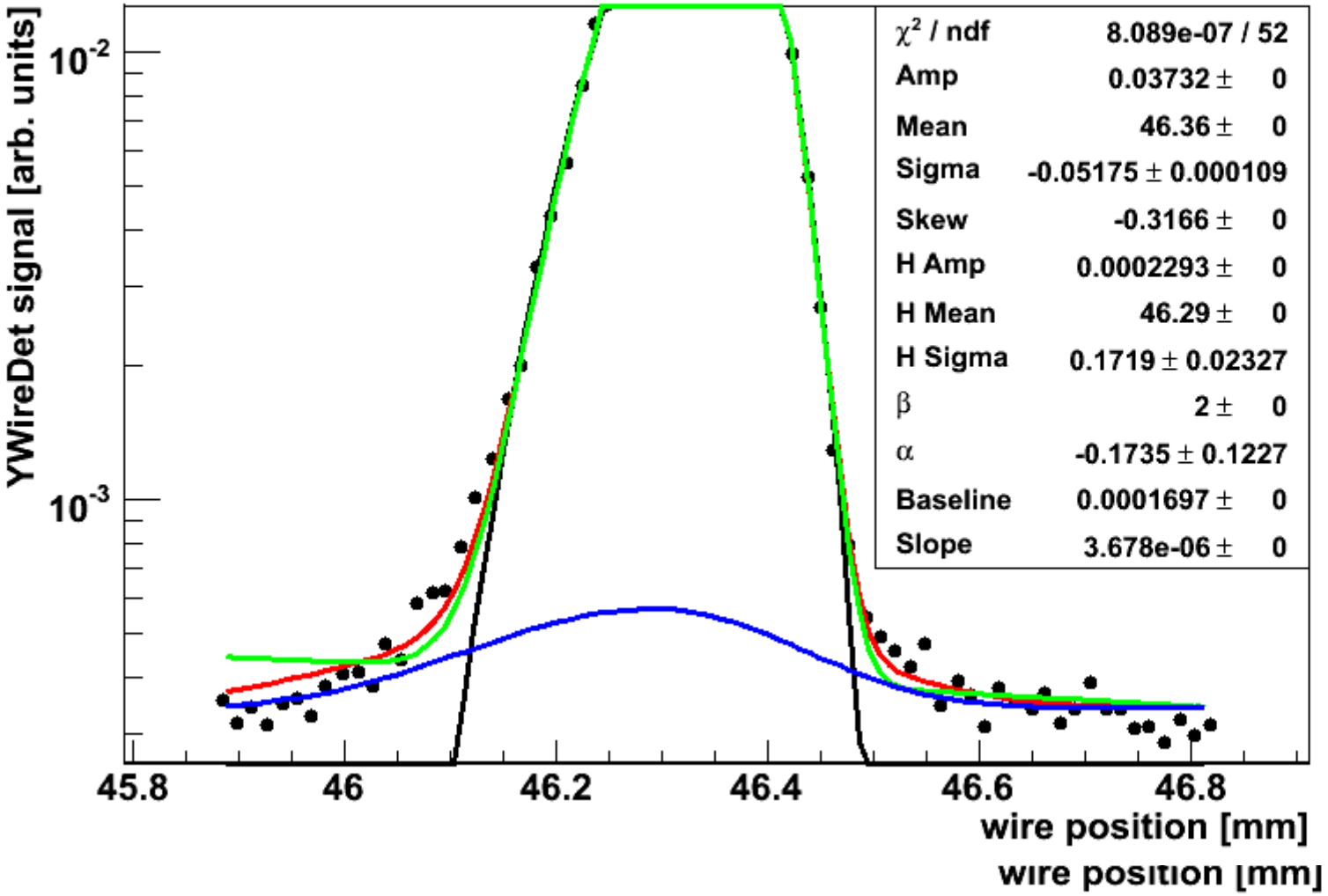
Results


YWireDet signal [arb. units]
10^-3
51.8
51.9
52
52.1
52.2
wire position [mm]
χ² / ndf 2.331e-07 / 24
Amp 0.05364 ± 0
Mean 52 ± 0
Sigma 0.02188 ± 5.723e-05
Skew -0.2783 ± 0
H Amp 0.0003378 ± 0
H Mean 52 ± 0
H Sigma 0.06161 ± 0.008555
β 2 ± 0
α -0.2648 ± 0.1074
Baseline 0.0004025 ± 0
Slope -8.958e-07 ± 0

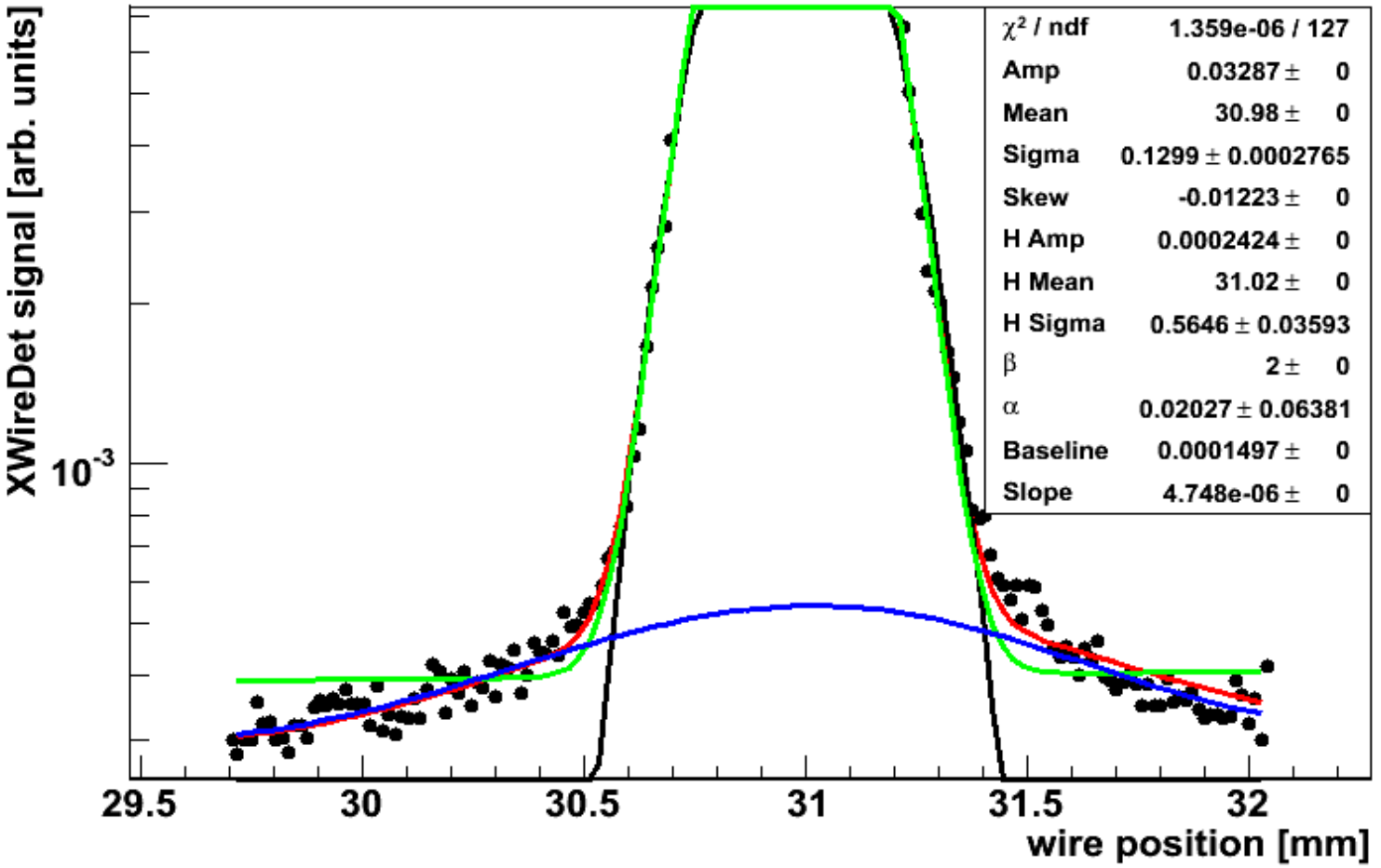
Results


XWireDet signal [arb. units]
10^-3
25.2
25.4
25.6
25.8
26
26.2
26.4
26.6
26.8
wire position [mm]
χ² / ndf 7.285e-07 / 61
Amp 0.1298 ± 0
Mean 26.03 ± 0
Sigma 0.1066 ± 0.0001712
Skew 0.03232 ± 0
H Amp 0.0007781 ± 0
H Mean 26.03 ± 0
H Sigma 0.2838 ± 0.009555
β 2 ± 0
α -0.1021 ± 0.02945
Baseline 0.0001575 ± 0
Slope 5.314e-06 ± 0

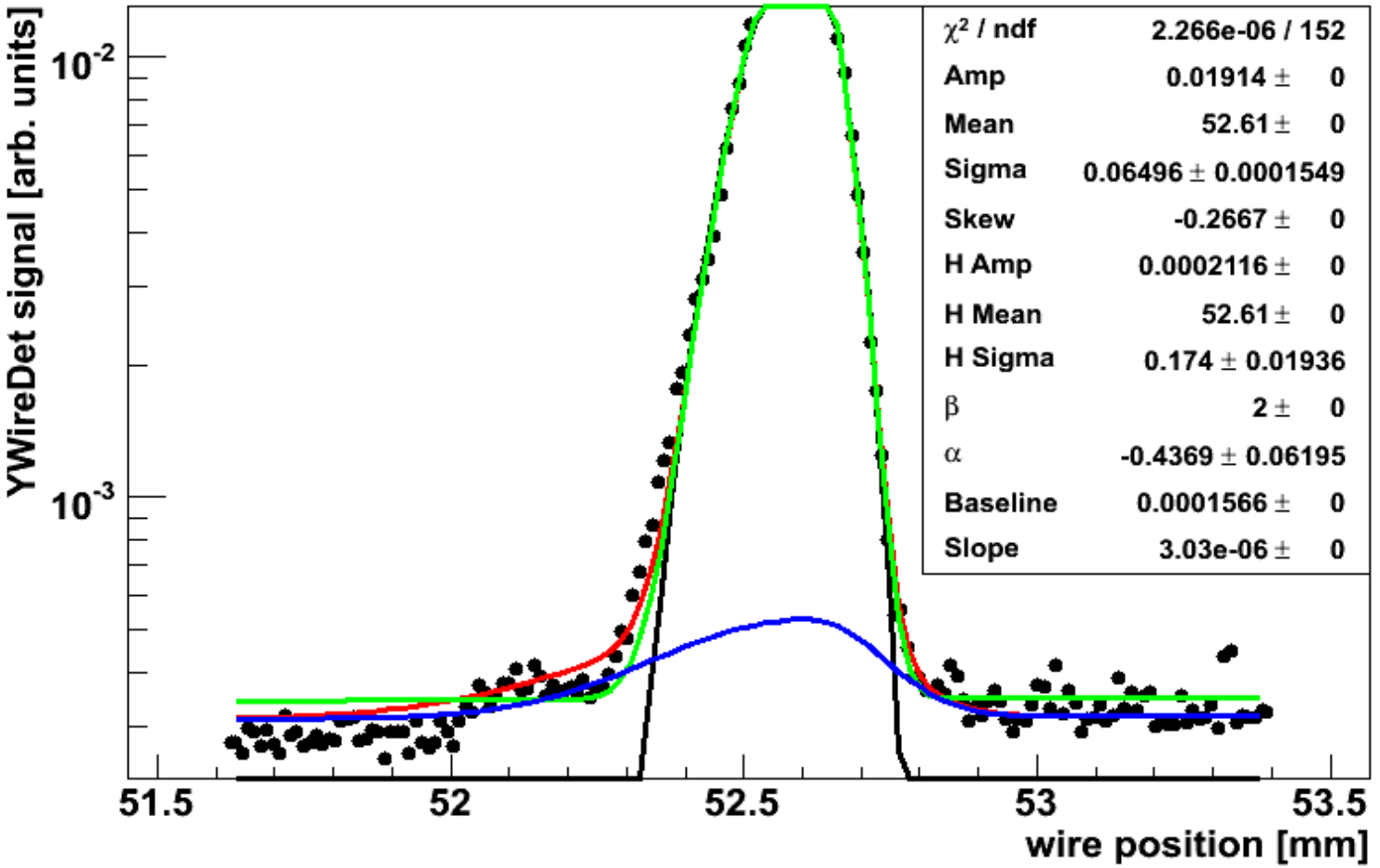
Results


YWireDet signal [arb. units]
10^{-2}
10^{-3}
45.8
46
46.2
46.4
46.6
46.8
wire position [mm]
wire position [mm]
χ^2 / ndf 8.089e-07 / 52
Amp 0.03732 ± 0
Mean 46.36 ± 0
Sigma -0.05175 ± 0.000109
Skew -0.3166 ± 0
H Amp 0.0002293 ± 0
H Mean 46.29 ± 0
H Sigma 0.1719 ± 0.02327
β 2 ± 0
α -0.1735 ± 0.1227
Baseline 0.0001697 ± 0
Slope 3.678e-06 ± 0

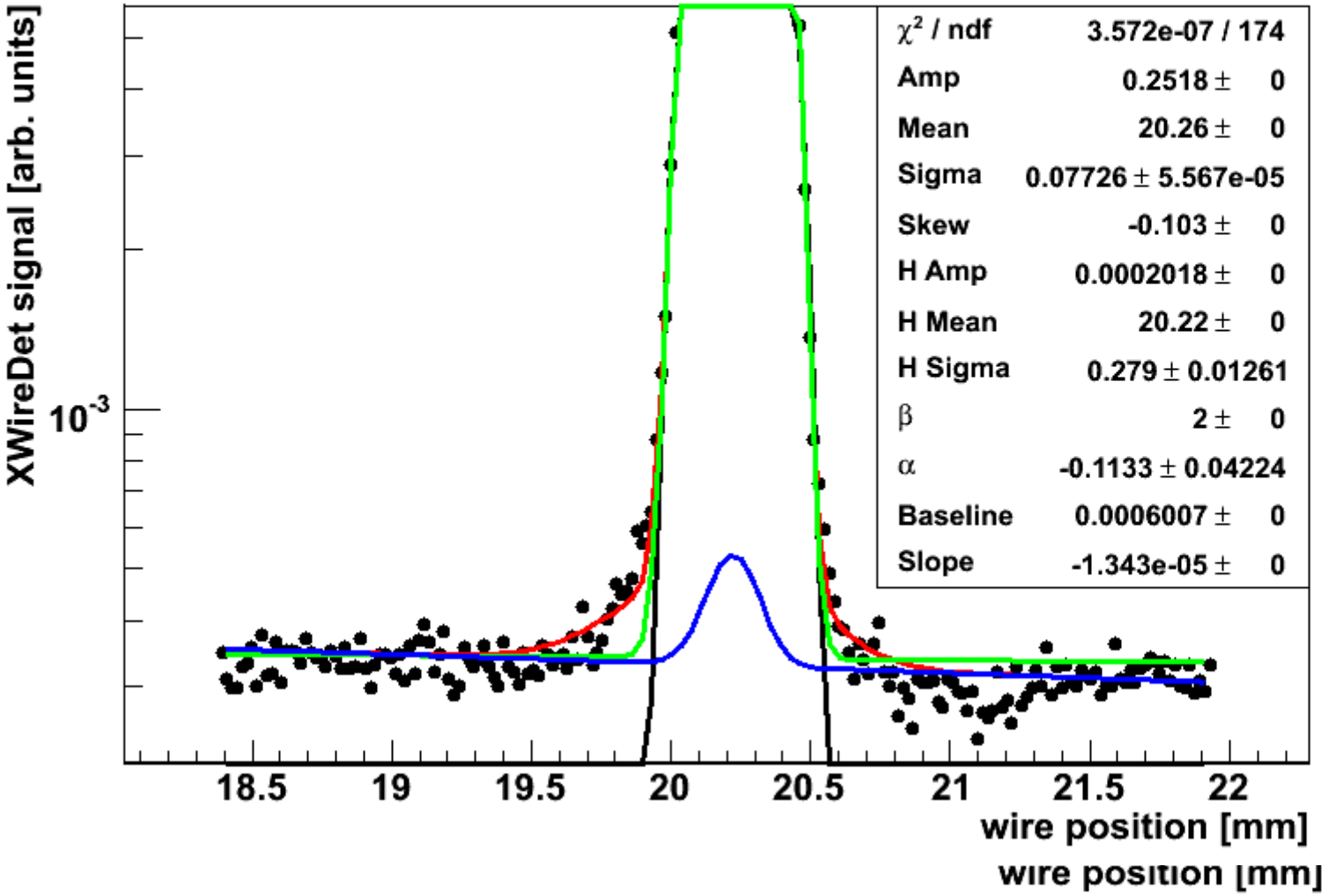
Results


XWireDet signal [arb. units]
10^-3
29.5
30
30.5
31
31.5
32
wire position [mm]
χ² / ndf 1.359e-06 / 127
Amp 0.03287 ± 0
Mean 30.98 ± 0
Sigma 0.1299 ± 0.0002765
Skew -0.01223 ± 0
H Amp 0.0002424 ± 0
H Mean 31.02 ± 0
H Sigma 0.5646 ± 0.03593
β 2 ± 0
α 0.02027 ± 0.06381
Baseline 0.0001497 ± 0
Slope 4.748e-06 ± 0

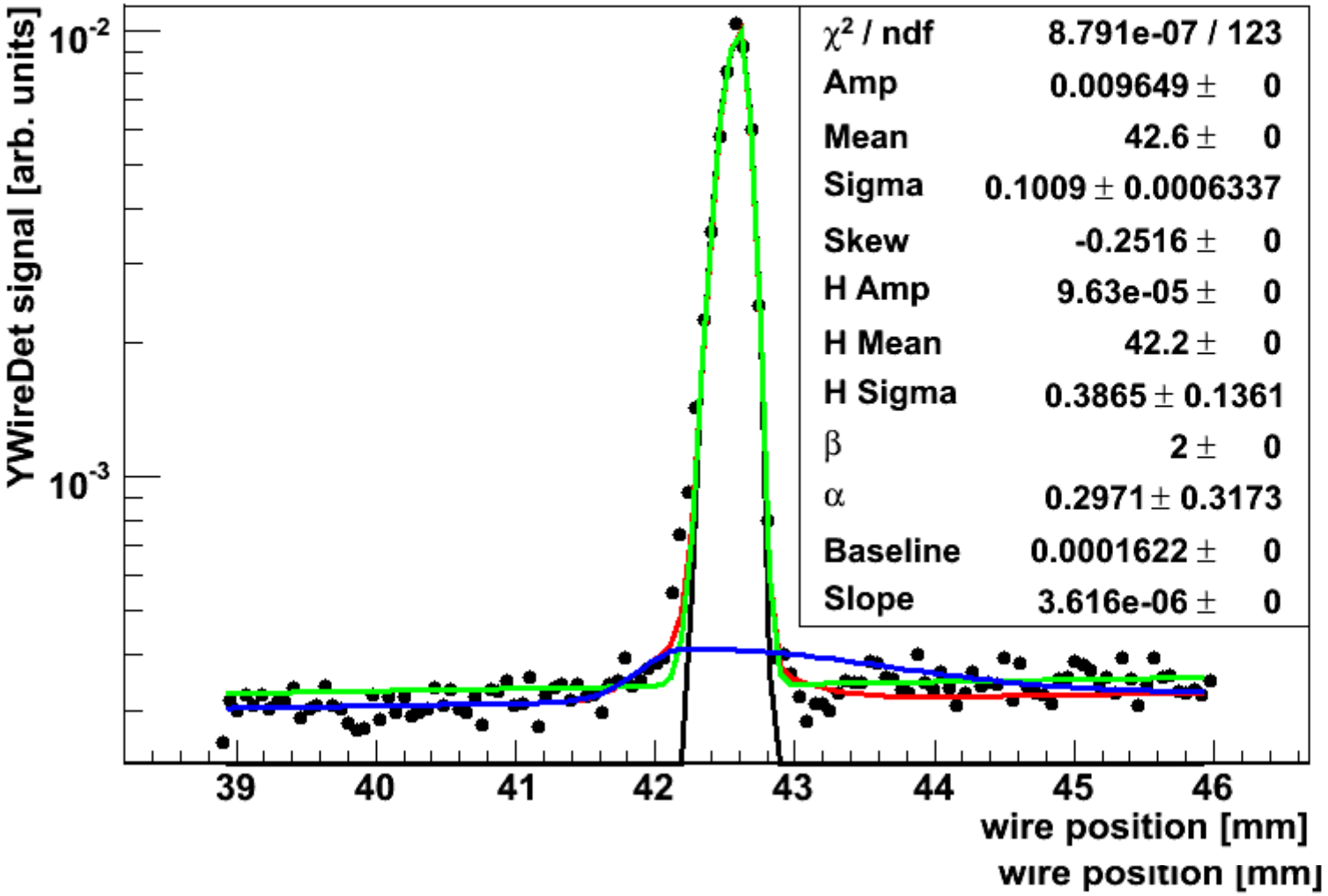
Results


YWireDet signal [arb. units]
10^{-2}
10^{-3}
51.5
52
52.5
53
53.5
wire position [mm]
χ^2 / ndf 2.266e-06 / 152
Amp 0.01914 ± 0
Mean 52.61 ± 0
Sigma 0.06496 ± 0.0001549
Skew -0.2667 ± 0
H Amp 0.0002116 ± 0
H Mean 52.61 ± 0
H Sigma 0.174 ± 0.01936
β 2 ± 0
α -0.4369 ± 0.06195
Baseline 0.0001566 ± 0
Slope 3.03e-06 ± 0

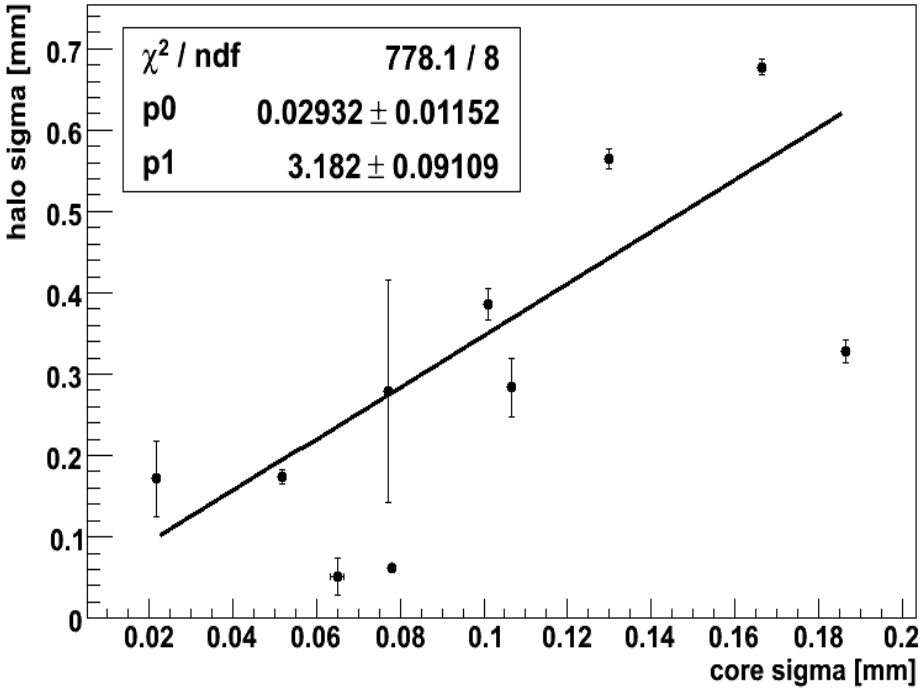
Results


XWireDet signal [arb. units]
10^-3
18.5
19
19.5
20
20.5
21
21.5
22
wire position [mm]
wire position [mm]
χ² / ndf 3.572e-07 / 174
Amp 0.2518 ± 0
Mean 20.26 ± 0
Sigma 0.07726 ± 5.567e-05
Skew -0.103 ± 0
H Amp 0.0002018 ± 0
H Mean 20.22 ± 0
H Sigma 0.279 ± 0.01261
β 2 ± 0
α -0.1133 ± 0.04224
Baseline 0.0006007 ± 0
Slope -1.343e-05 ± 0

Results

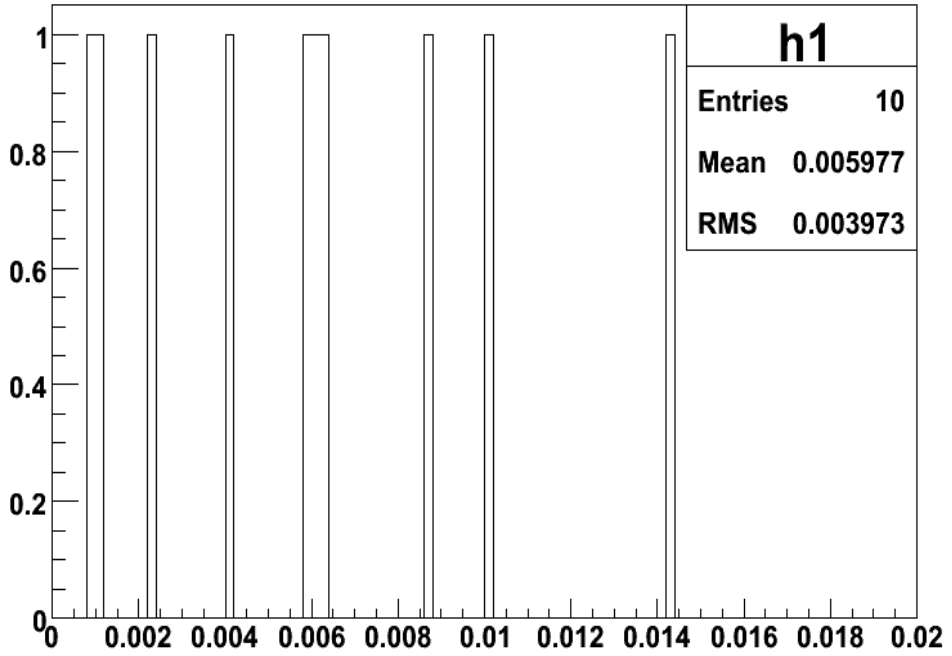

YWireDet signal [arb. units]
10^{-2}
10^{-3}
39
40
41
42
43
44
45
46
wire position [mm]
wire position [mm]
χ^2 / ndf 8.791e-07 / 123
Amp 0.009649 ± 0
Mean 42.6 ± 0
Sigma 0.1009 ± 0.0006337
Skew -0.2516 ± 0
H Amp 9.63e-05 ± 0
H Mean 42.2 ± 0
H Sigma 0.3865 ± 0.1361
β 2 ± 0
α 0.2971 ± 0.3173
Baseline 0.0001622 ± 0
Slope 3.616e-06 ± 0

Results- halo width vs core width



- Halo width was plotted against core width
- They are proportional
- This shows that halo particles trajectory is similar to core trajectory along extraction line

Results- estimation of fraction of beam in halo



Histogram of fraction of particles in halo.

- The core and the halo functions fit well to gaussian curves
- The fraction of particles in the halo was estimated by dividing halo function amplitude by core amplitude. Result: 0.6 +/- 0.4 %

Possible future work

- Take more data to obtain more precise result for fraction of beam in halo
- Simulate halo function in ATF2 extraction line to predict possible backgrounds
- Compare results with theory and other experimental work
- Try different beam pipe pressures to measure the effects of gas scattering on halo