Ortsaufloesung

May 13, 2024

0.1 Preperations

[1]:
```
import os
import numpy as np
import pandas as pd
import seaborn as sns

from matplotlib import pyplot as plt
from scipy.optimize import curve_fit
```

[2]:
```
sns.set_theme(context='paper', style="whitegrid", color_codes=True)

plt.rcParams["axes.titlesize"] = 13 # default: 9
plt.rcParams["axes.labelsize"] = 13 # default: 9
plt.rcParams["legend.fontsize"] = 11 # default: 8.8
plt.rcParams["legend.title_fontsize"] = 11 # default: 8.8
plt.rcParams["xtick.labelsize"] = 11 # default: 8.8
plt.rcParams["ytick.labelsize"] = 11 # default: 8.8
plt.rcParams["text.usetex"] = True
```

[3]:
```
x_col = r'$x\ [\mathrm{mm}]$'
x_err_col = r'$\Delta x\ [\mathrm{mm}]$'
n_col = r'$n\ [1]$'
n_err_col = r'$\Delta n\ [1]$'
r_col = r'$r\ [\mathrm{Hz}]$'
r_err_col = r'$\Delta r\ [\mathrm{Hz}]$'
```

0.2 Read & calc data

[4]:
```
data = pd.read_csv('Ortsaufloesung.csv', sep='\t')
data = data.rename(
    columns={
        'Position': x_col,
        'Count': n_col
    }
)
```

[5]:
```python
data[x_err_col] = 2
data[n_err_col] = data[n_col].pow(1/2)
data = data[[x_col, x_err_col, n_col, n_err_col]]
```

[6]:
```python
measured_time = 60 # seconds

data[r_col] = data[n_col] / measured_time
data[r_err_col] = data[n_err_col] / measured_time
```

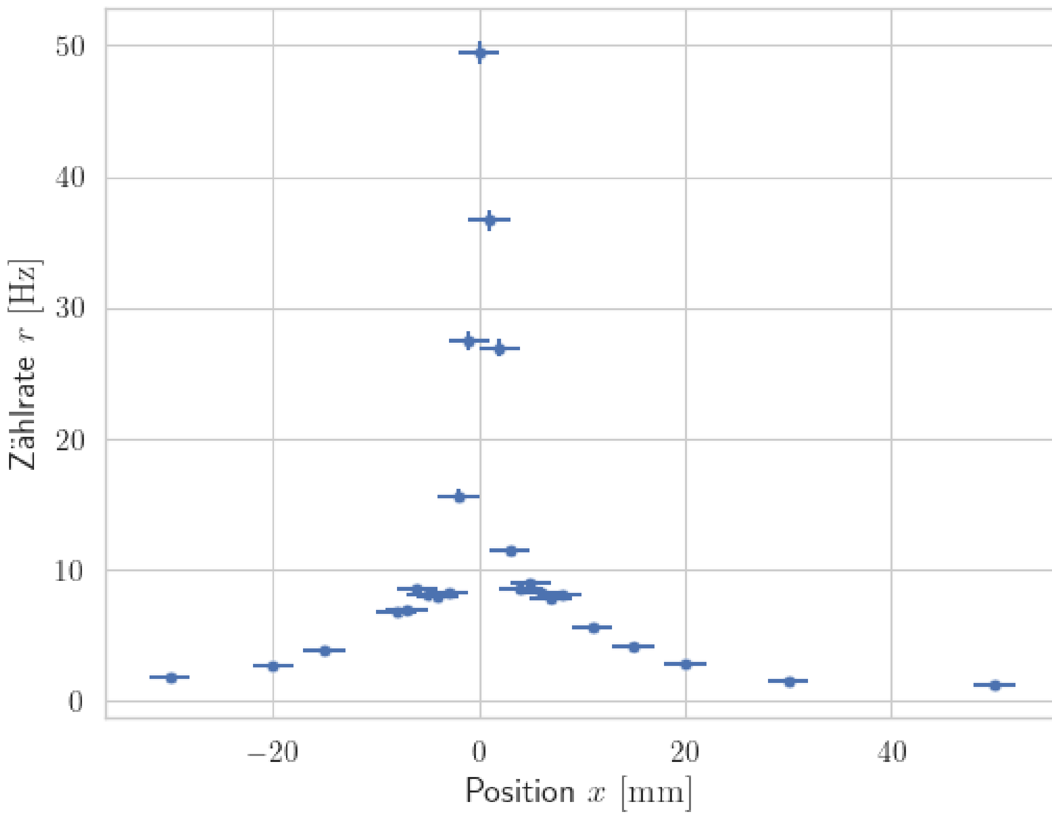
Inhalt der LaTeX-Tabelle

[7]:
```python
print(f"                {x_col} & {n_col} & {r_col} \\\\")
print(f"                \\hline")
for idx, row in data.iterrows():
    x = f"${int(row[x_col])} \\pm {int(row[x_err_col])}$"
    n = f"${int(row[n_col])} \\pm {int(row[n_err_col].round())}$"
    r = f"${row[r_col].round(2)} \\pm {row[r_err_col].round(2)}$"
    print(f"                {x} & {n} & {r} \\\\")
```

```
$x\ [\mathrm{mm}]$ & $n\ [1]$ & $r\ [\mathrm{Hz}]$ \\
\hline
$-30 \pm 2$ & $112 \pm 11$ & $1.87 \pm 0.18$ \\
$-20 \pm 2$ & $159 \pm 13$ & $2.65 \pm 0.21$ \\
$-15 \pm 2$ & $229 \pm 15$ & $3.82 \pm 0.25$ \\
$-8 \pm 2$ & $405 \pm 20$ & $6.75 \pm 0.34$ \\
$-7 \pm 2$ & $414 \pm 20$ & $6.9 \pm 0.34$ \\
$-6 \pm 2$ & $511 \pm 23$ & $8.52 \pm 0.38$ \\
$-5 \pm 2$ & $486 \pm 22$ & $8.1 \pm 0.37$ \\
$-4 \pm 2$ & $477 \pm 22$ & $7.95 \pm 0.36$ \\
$-3 \pm 2$ & $493 \pm 22$ & $8.22 \pm 0.37$ \\
$-2 \pm 2$ & $938 \pm 31$ & $15.63 \pm 0.51$ \\
$-1 \pm 2$ & $1650 \pm 41$ & $27.5 \pm 0.68$ \\
$0 \pm 2$ & $2971 \pm 55$ & $49.52 \pm 0.91$ \\
$1 \pm 2$ & $2202 \pm 47$ & $36.7 \pm 0.78$ \\
$2 \pm 2$ & $1616 \pm 40$ & $26.93 \pm 0.67$ \\
$3 \pm 2$ & $686 \pm 26$ & $11.43 \pm 0.44$ \\
$4 \pm 2$ & $512 \pm 23$ & $8.53 \pm 0.38$ \\
$5 \pm 2$ & $538 \pm 23$ & $8.97 \pm 0.39$ \\
$6 \pm 2$ & $498 \pm 22$ & $8.3 \pm 0.37$ \\
$7 \pm 2$ & $467 \pm 22$ & $7.78 \pm 0.36$ \\
$8 \pm 2$ & $487 \pm 22$ & $8.12 \pm 0.37$ \\
$11 \pm 2$ & $335 \pm 18$ & $5.58 \pm 0.31$ \\
$15 \pm 2$ & $249 \pm 16$ & $4.15 \pm 0.26$ \\
$20 \pm 2$ & $170 \pm 13$ & $2.83 \pm 0.22$ \\
$30 \pm 2$ & $95 \pm 10$ & $1.58 \pm 0.16$ \\
$50 \pm 2$ & $78 \pm 9$ & $1.3 \pm 0.15$ \\
```

[8]:
```python
ax = sns.scatterplot(data, x=x_col, y=r_col)
sns.mpl.pyplot.errorbar(x=data[x_col], y=data[r_col], xerr=data[x_err_col],␣
 ↪yerr=data[r_err_col], linewidth=0, elinewidth=1.5)
plt.xlabel(f"Position {x_col}")
plt.ylabel(f"Zählrate {r_col}")
```

[8]: Text(0, 0.5, 'Zählrate $r\\ [\\mathrm{Hz}]$')



0.3 Fitting

Die Kurve zum Fitten kriegt einen Faktor α, um die Fläche unter der Kurve anzupassen.

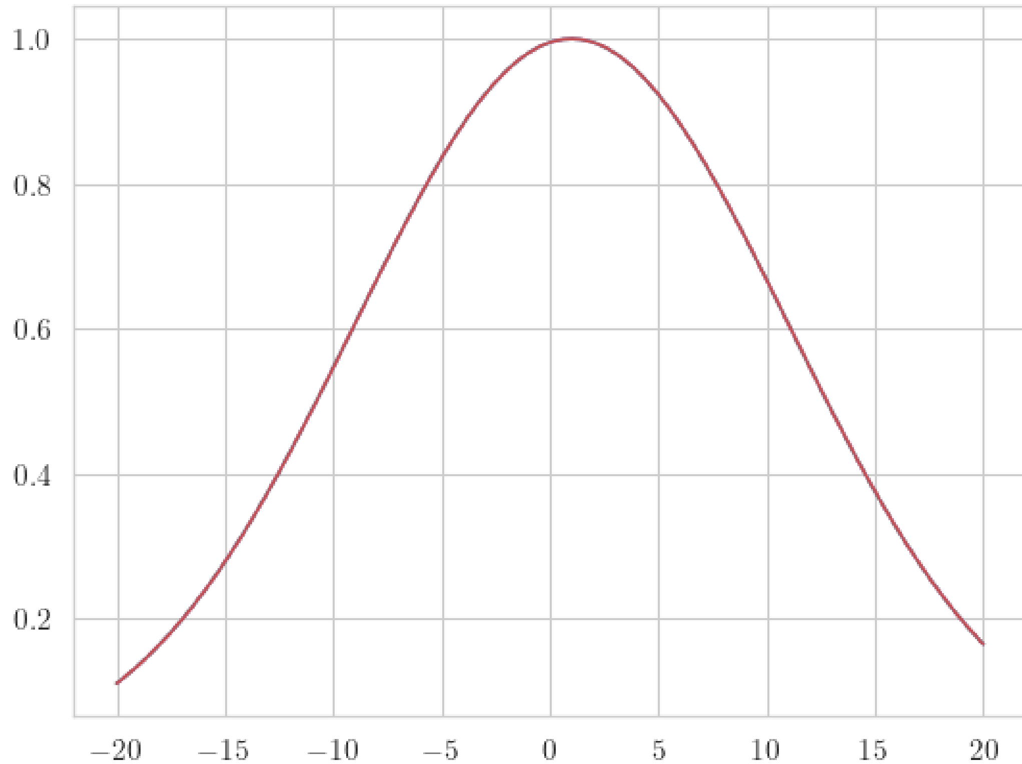
[9]:
```python
def gaussian(x, mu, sigma, factor, offset):
    nominator = (x-mu)**2
    denominator = 2 * sigma**2
    return factor * np.exp(-nominator/denominator) + offset
```

0.3.1 Test

Teste implementierte Methode & fitting

Dokumentation: https://docs.scipy.org/doc/scipy/reference/generated/scipy.optimize.curve_fit.html

[10]:
```
xdata = np.linspace(-20, 20, 100)
ydata = gaussian(xdata, 1, 10, factor=1, offset=0)

popt, pcov = curve_fit(gaussian, xdata, ydata)
# popt: resulting options from fit
# pcov: estimated approximate covariance of popt

plt.plot(xdata, ydata, 'b-', label='data')
plt.plot(xdata, gaussian(xdata, *popt), 'r-');
```



0.3.2 Fit

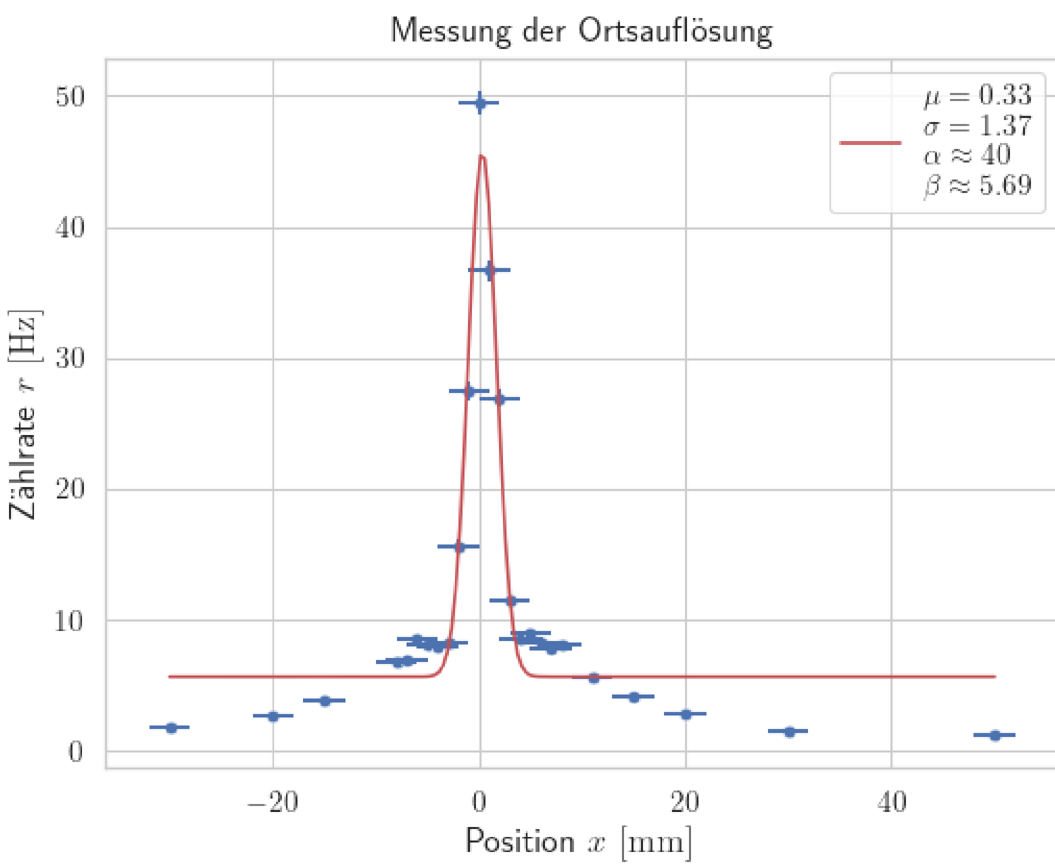
[11]:
```
xdata = data[x_col].values
ydata = data[r_col].values

x_range = np.linspace(xdata.min(), xdata.max(), 200)
```

[12]:
```
popt, pcov = curve_fit(gaussian, xdata, ydata)

mu = popt[0].round(2)
sigma = popt[1].round(2)
factor = int(popt[2].round(-1))
```

```
offset = popt[3].round(2)

results_str = f'$\\mu={mu}$, $\\sigma={sigma}$, $\\alpha\\approx{factor}$,␣
↪$\\beta\\approx{offset}$'
```

plot

[13]:
```
fig = plt.figure()
ax = fig.add_subplot()

sns.scatterplot(data, x=x_col, y=r_col, ax=ax)
plt.errorbar(x=data[x_col], y=data[r_col], xerr=data[x_err_col],␣
↪yerr=data[r_err_col], linewidth=0, elinewidth=1.5)
plt.xlabel(f"Position {x_col}")
plt.ylabel(f"Zählrate {r_col}")
plt.title("Messung der Ortsauflösung")

plt.plot(x_range, gaussian(x_range, *popt), 'r-', label=results_str.replace(',␣
↪', '\n'));
plt.legend();
```



[14]:
```
fig.figure.savefig("../../media/B3.4/Ortsaufloesung_fit.svg")
fig.figure.savefig("../../media/B3.4/Ortsaufloesung_fit.png");
```