# Auswertung

February 20, 2024

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

from io import BytesIO
from matplotlib import pyplot as plt
from scipy.stats import linregress
```

[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
```

## 0.1 Methods

[3]:
```
x_column = r'$z_0\ [\AA]$'
y_column = r'$\ln(I(z_0))\ [\ln(\mathrm{A})]$'
```

[4]:
```
def read_vert_file(path) -> pd.DataFrame:
    """
    Read a *.VERT file from the given path.

    1. Read the file and create a list of lines, which are seperated by \r\n
    2. Extract the Title field
    3. Extract the data: Starting 2 lines after a line named "DATA"
    4. Convert data into DataFrame
    """
    # read
    with open(path, 'rb') as io:
        txt = io.read()
    txt = txt.split(b'\r\n')

    # extract title
```

```
    for line in txt:
        if line.startswith(b'Titel'):
            title = line.split(b'=')[1]
            break

    # extract data
    for index, line in enumerate(txt):
        if b'\nDATA' in line:
            data = txt[index+2:] # data start 2 lines after the found line
            break

    # convert to df
    with BytesIO(b'\n'.join(data)) as io:
        df = pd.read_csv(io, sep='\t', index_col=0, header=None)

    df.attrs['title'] = os.path.basename(path)
    df = df.drop(columns=4)
    df = df.rename(columns={
        1: 'U [V]',
        2: x_column,
        3: '$I(z_0)$'
    })
    df[x_column] *= 0.0024
    df[y_column] = np.log(df['$I(z_0)$'])

    return df
```

[5]:
```
def plot(data, title=None, filename=None):
    data = data.copy()
    img = sns.relplot(
        data=data,
        x=x_column,
        y=y_column
    )
    if title is not None:
        plt.title(title)
    else:
        plt.title(data.attrs['title'])
    if filename is not None:
        img.figure.savefig(filename, bbox_inches='tight')
```

[6]:
```
def read_files(folder):
    data = {}
    for dirpath, dirnames, filenames in os.walk(folder):
        for f in filenames:
            filename = f"{dirpath}/{f}"
            print('read file: ', filename)
```

```
            df = read_vert_file(filename)
            data[df.attrs['title']] = df
    return data
```

[7]:
```
def regression(df):
    result = linregress(
        x=df[x_column],
        y=df[y_column]
    )
    print(f"$m = {round(result.slope, 2)} \\pm {round(result.stderr, 2)}$")

    x_values = np.linspace(df[x_column].min(), df[x_column].max())
    fig = plt.errorbar(
        x_values,
        result.slope * x_values + result.intercept,
        yerr=np.abs(result.stderr * x_values + result.intercept_stderr)
    )

    return result.slope, result.stderr
```

# 1 A

### 1.0.1 Messwerte

[8]:
```
data = read_files('a')
```

```
read file:  a/A231128.133315.VERT
read file:  a/A231128.133424.VERT
read file:  a/A231128.134137.VERT
read file:  a/A231128.134156.VERT
read file:  a/A231128.134230.VERT
read file:  a/A231128.134345.VERT
read file:  a/A231128.134401.VERT
read file:  a/A231128.134418.VERT
read file:  a/A231128.134446.VERT
```

[9]:
```
data['A231128.133315.VERT']
```

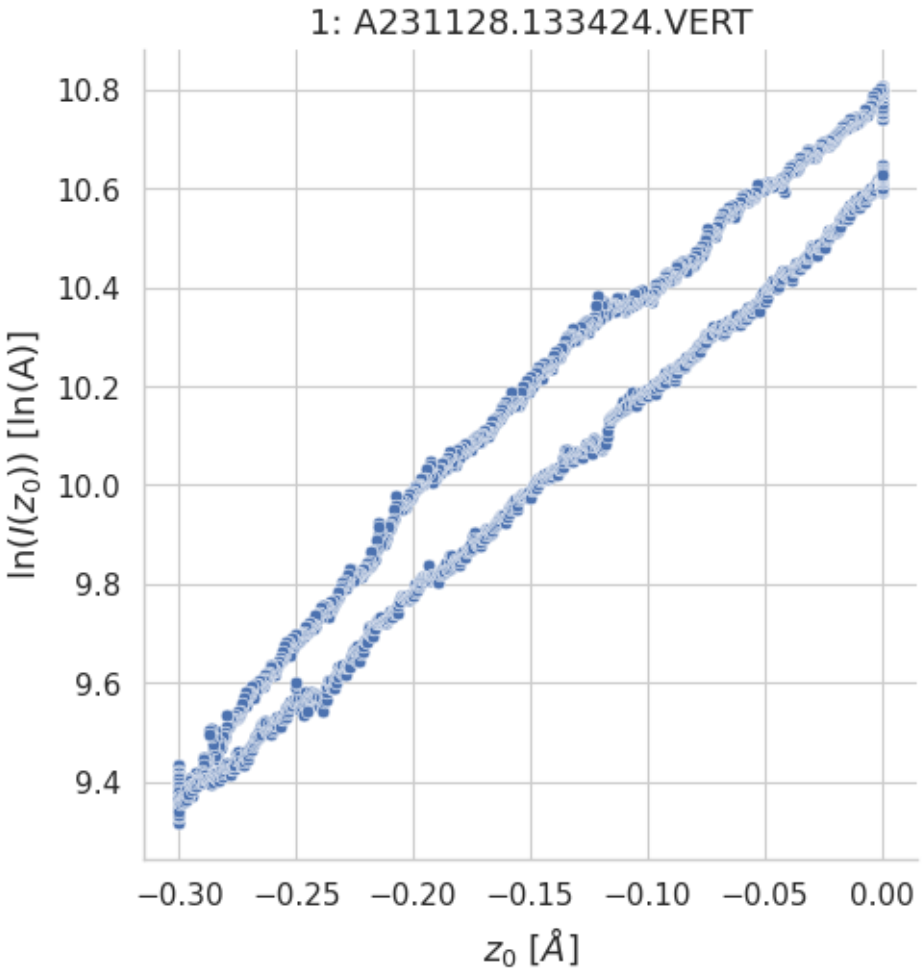
[9]:

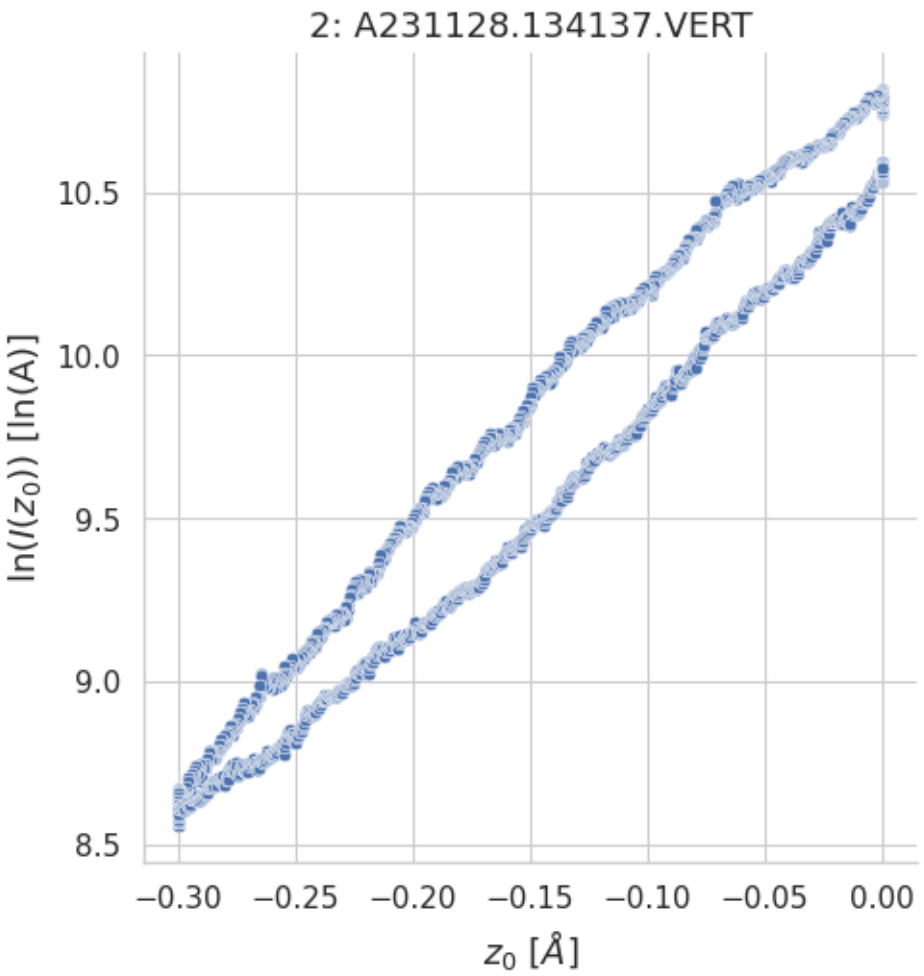
| | U [V] | $z_0\ [\AA]$ | $I(z_0)$ | $\ln(I(z_0))\ [\ln(\mathrm{A})]$ |
|---|---|---|---|---|
| 0 | | | | |
| 0 | 500.0 | 0.0 | 49948.9 | 10.818756 |
| 1 | 500.0 | 0.0 | 47002.5 | 10.757956 |
| 2 | 500.0 | 0.0 | 48437.0 | 10.788019 |
| 3 | 500.0 | 0.0 | 51164.5 | 10.842801 |
| 4 | 500.0 | 0.0 | 49354.3 | 10.806780 |
| … | … | … | … | … |
| 1995 | 500.0 | 0.0 | 40239.8 | 10.602612 |
| 1996 | 500.0 | 0.0 | 40602.4 | 10.611582 |

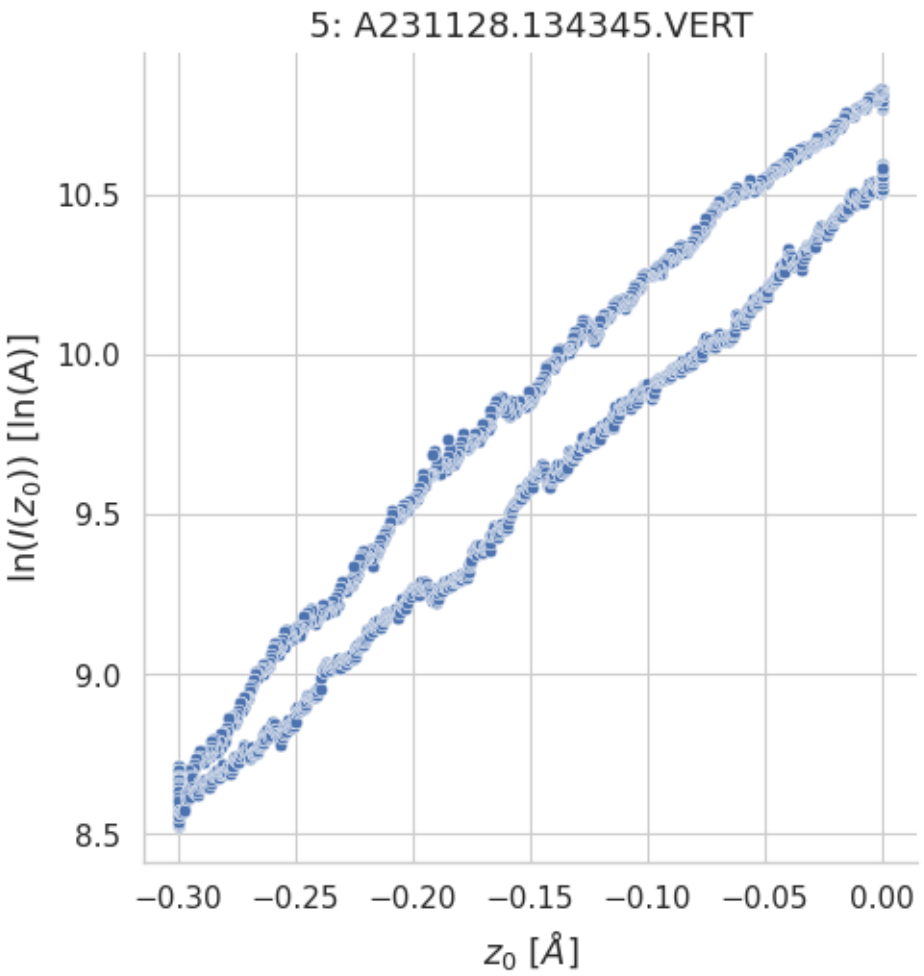
```
1997  500.0           0.0   40734.4                    10.614828
1998  500.0           0.0   40515.4                    10.609437
1999  500.0           0.0   40497.2                    10.608988

[2000 rows x 4 columns]
```

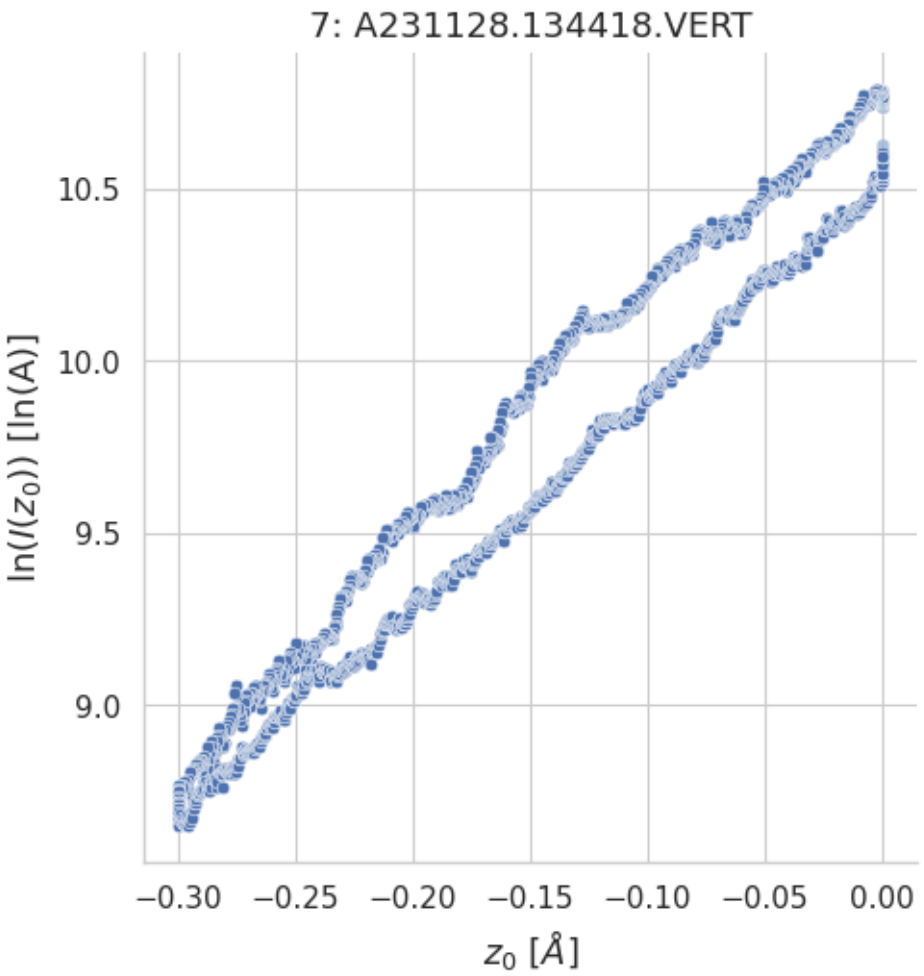
[10]:
```
# # Plotte alle Messungen
# for i, key in enumerate(data.keys()):
#     plot(data[key], title=f"{i}: {key}")
```

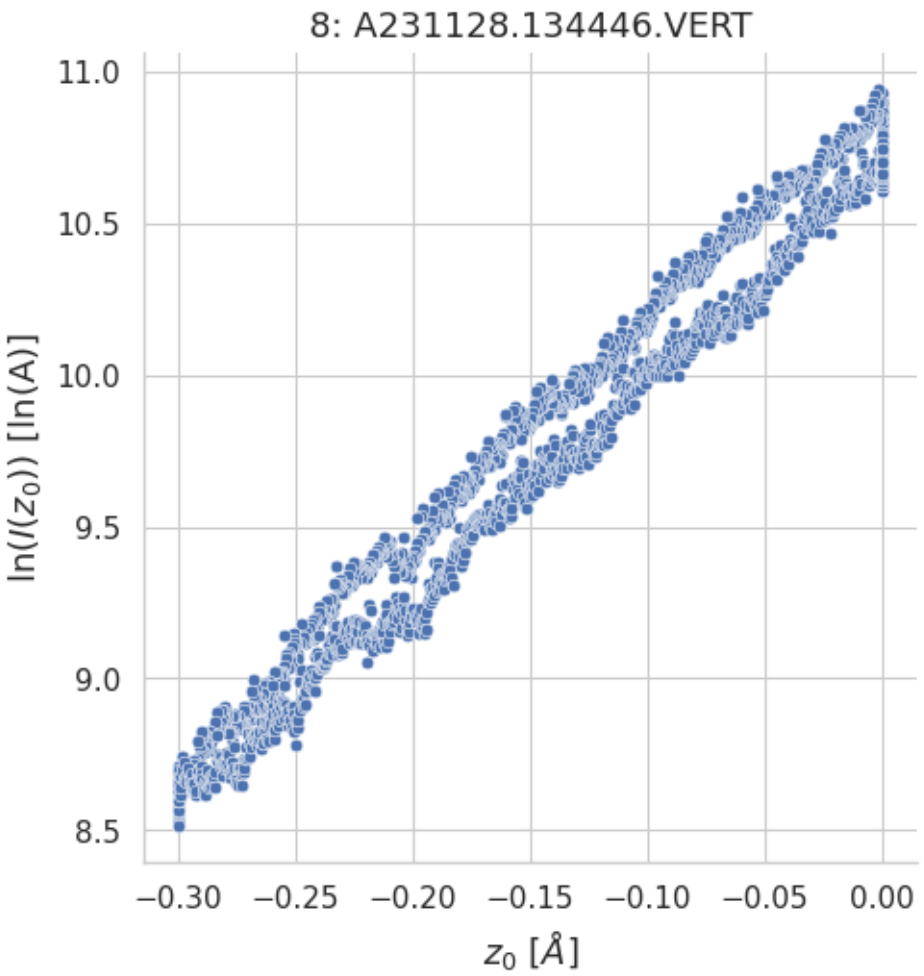
[11]:
```
# Plotte die 5 besten Messungen
selected_measurements_a = []
for i, key in enumerate(data.keys()):
    if i in (2, 5, 1, 7, 8):
        selected_measurements_a.append(data[key])
        plot(data[key], title=f"{i}: {key}")
```



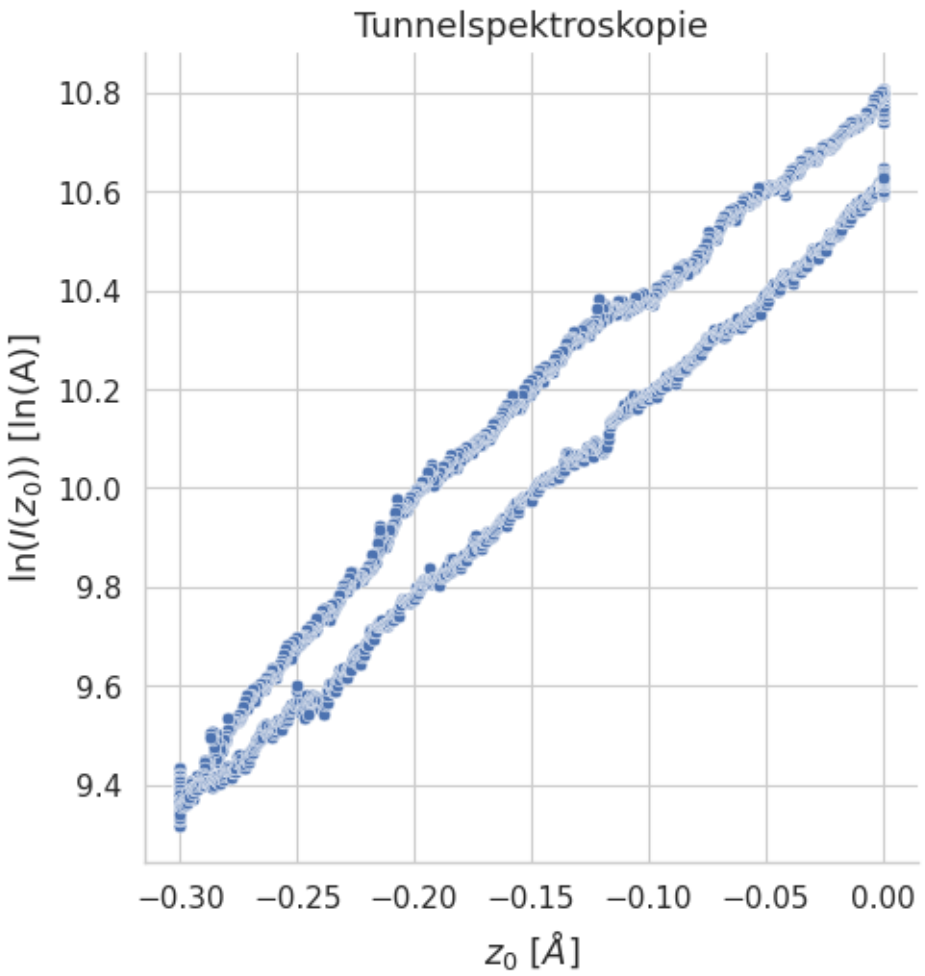

2: A231128.134137.VERT
10.5
10.0
9.5
9.0
8.5
ln(I(z0)) [ln(A)]
−0.30
−0.25
−0.20
−0.15
−0.10
−0.05
0.00
z0 [Å]


5: A231128.134345.VERT
10.5
10.0
9.5
9.0
8.5
ln(I(z0)) [ln(A)]
−0.30
−0.25
−0.20
−0.15
−0.10
−0.05
0.00
z0 [Å]


7: A231128.134418.VERT
10.5
10.0
9.5
9.0
ln(I(z0)) [ln(A)]
−0.30
−0.25
−0.20
−0.15
−0.10
−0.05
0.00
z0 [Å]



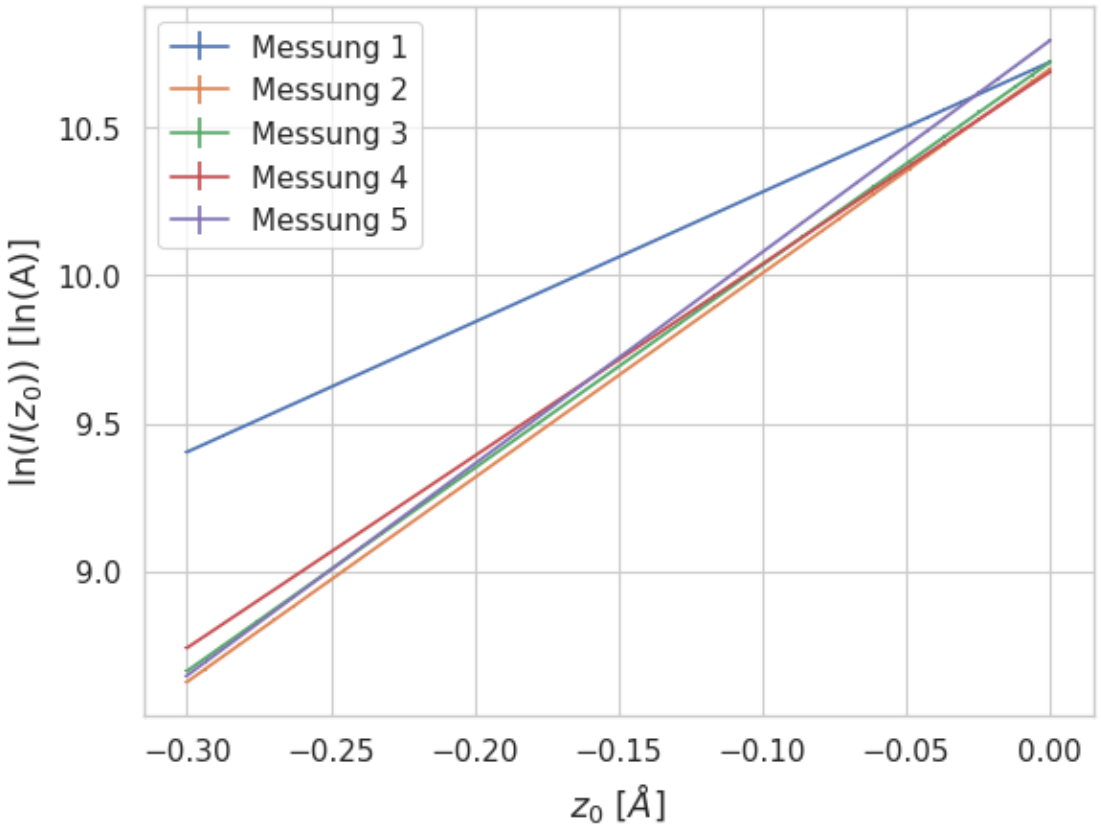

[12]:
```
plot(data['A231128.133424.VERT'], title="Tunnelspektroskopie", filename='../../.
↪./media/B2.5/Spektroskopie_1.svg')
```




### 1.0.2 Regression

[13]:
```
for df in selected_measurements_a:
    regression(df)
plt.legend([ f"Messung {i+1}" for i in range(5)])
plt.xlabel(x_column)
plt.ylabel(y_column)
plt.savefig('../../../media/B2.5/Spektroskopie_regression_a.svg')
```

```
$m = 4.4 \pm 0.02$
$m = 6.91 \pm 0.03$
$m = 6.86 \pm 0.03$
$m = 6.49 \pm 0.03$
$m = 7.16 \pm 0.02$
```




# 2 B

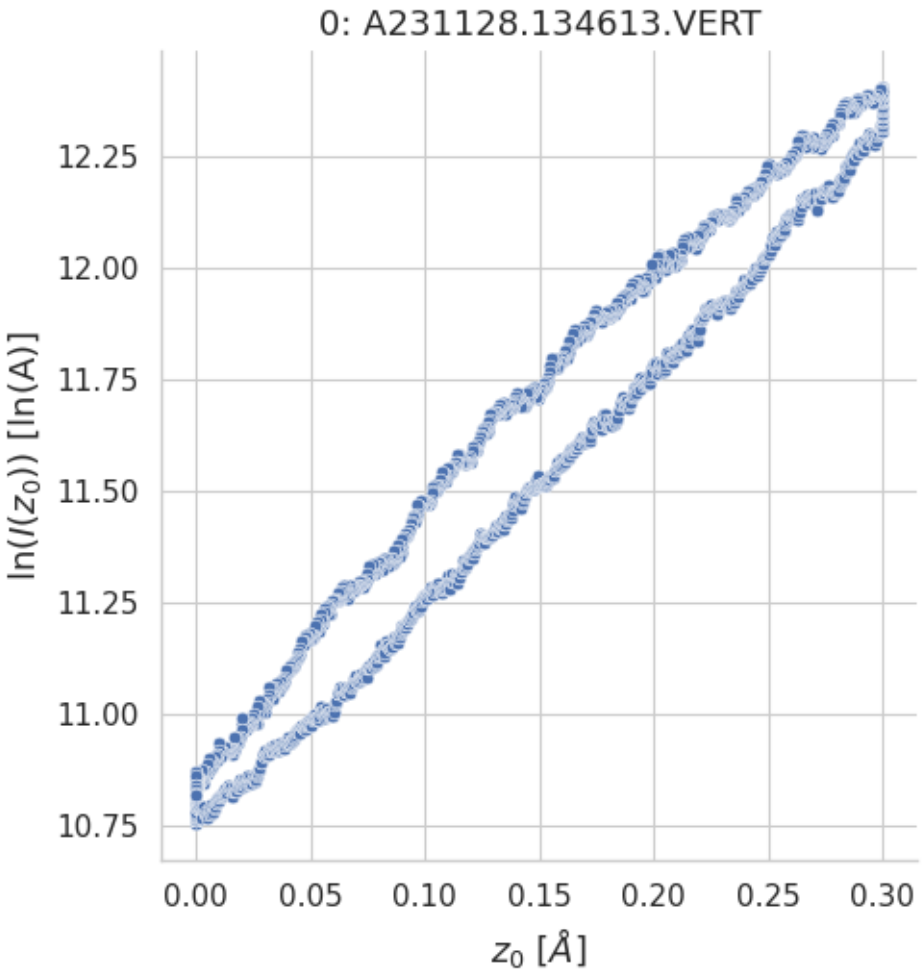
### 2.0.1 Messwerte

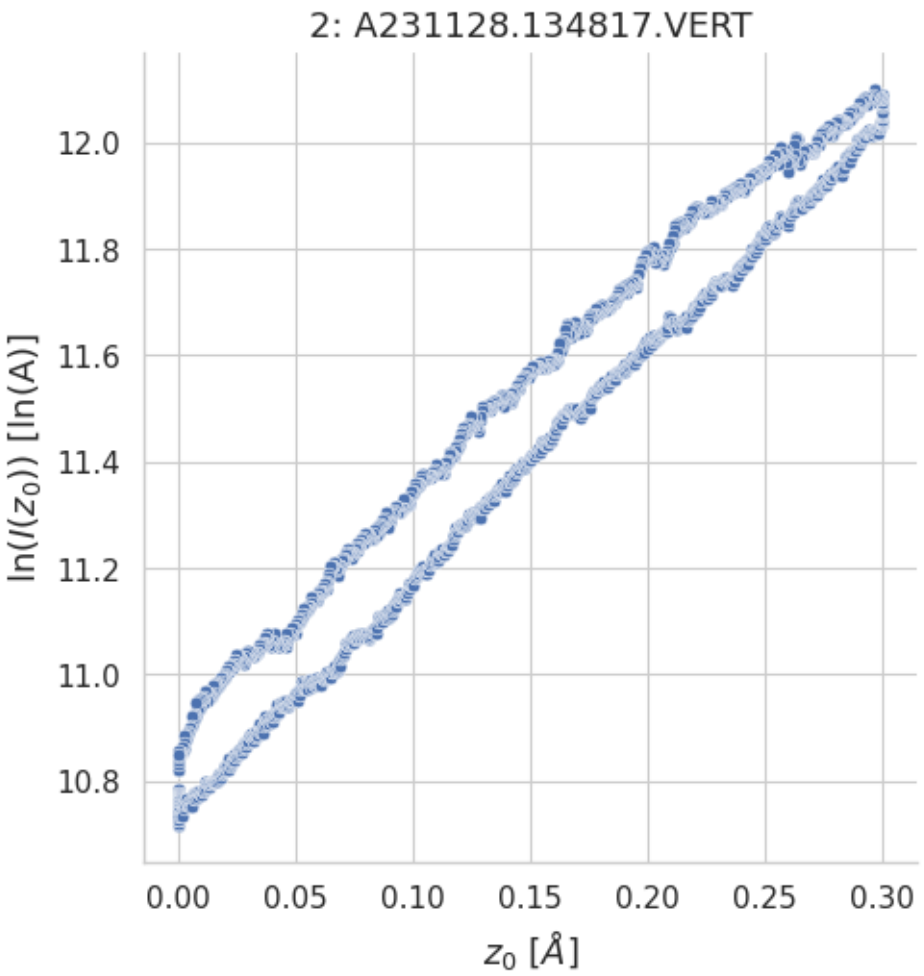
[14]:
```
data = read_files('b')
```

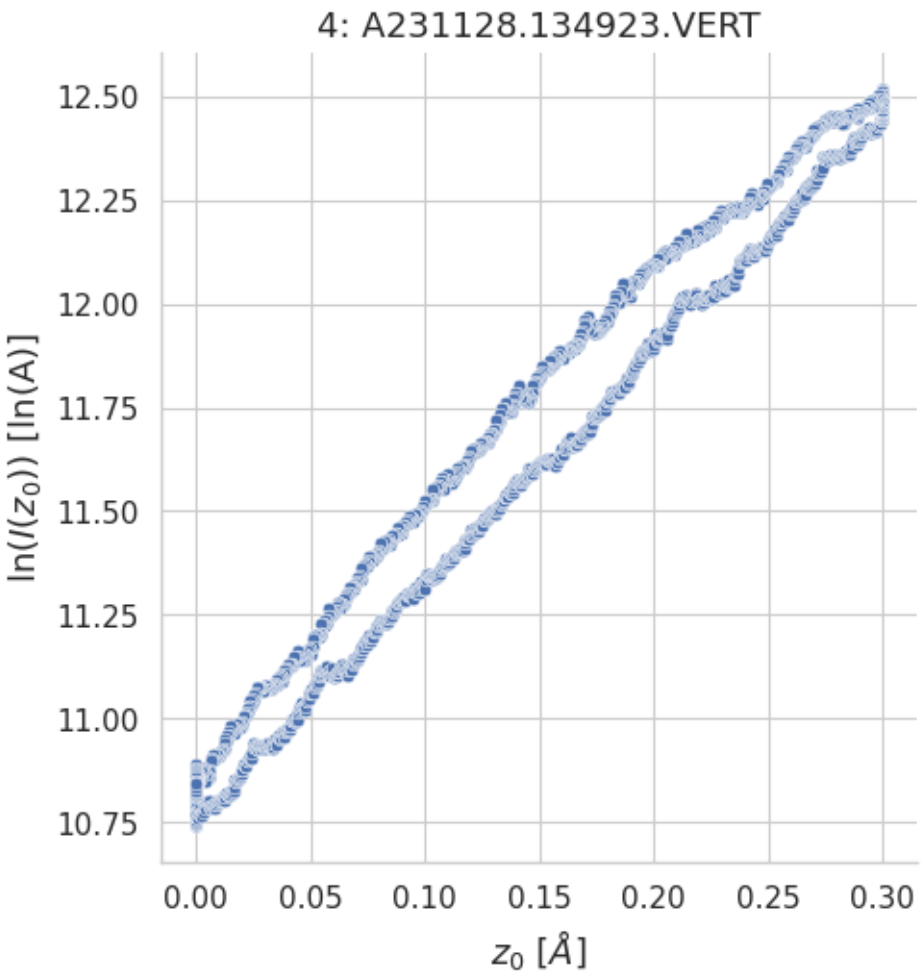
```
read file:  b/A231128.134613.VERT
read file:  b/A231128.134739.VERT
read file:  b/A231128.134817.VERT
read file:  b/A231128.134842.VERT
read file:  b/A231128.134923.VERT
read file:  b/A231128.134937.VERT
read file:  b/A231128.134951.VERT
read file:  b/A231128.135005.VERT
read file:  b/A231128.135041.VERT
```

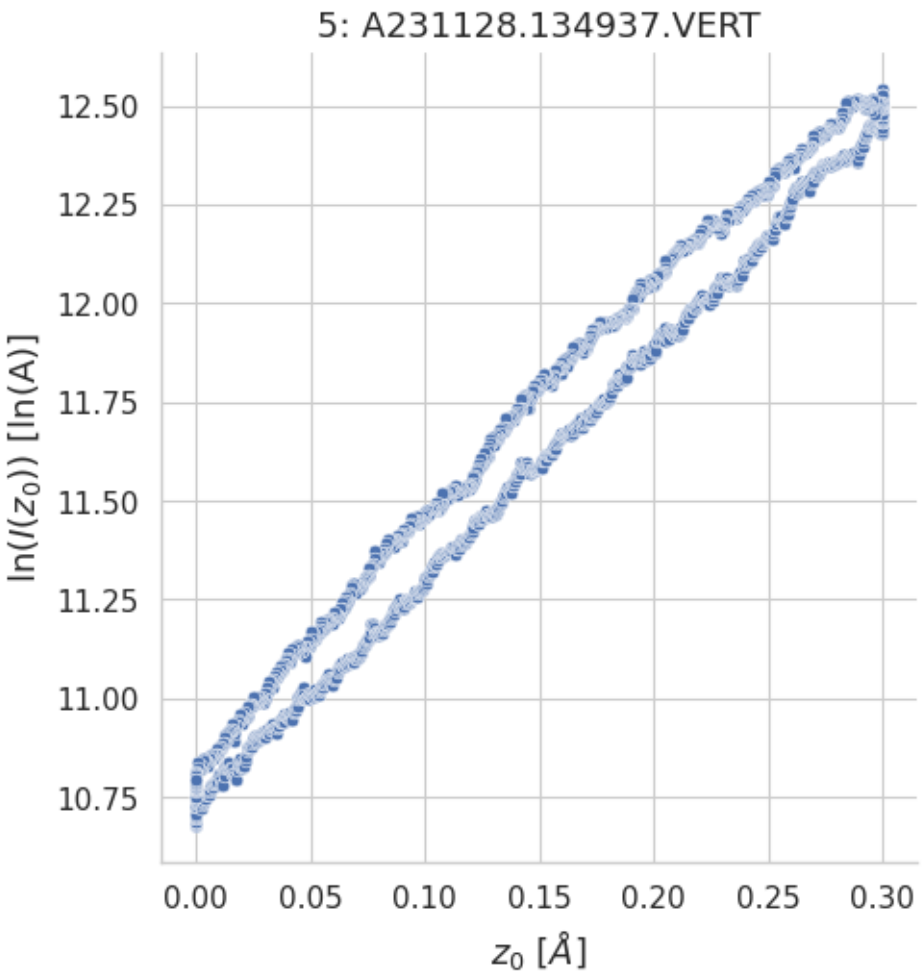
[15]:
```
# # Plotte alle Messungen
# for i, key in enumerate(data.keys()):
#     plot(data[key], title=f"{i}: {key}")
```

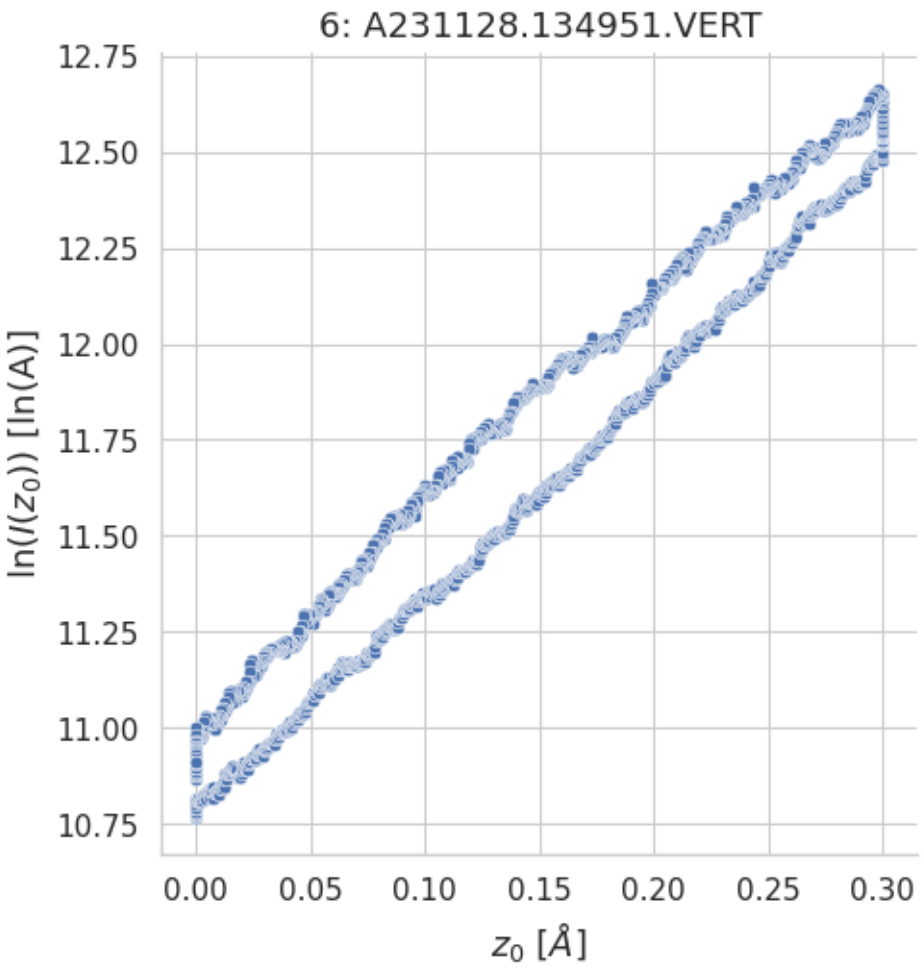
[16]:
```
# Plotte die 5 besten Messungen
selected_measurements_b = []
for i, key in enumerate(data.keys()):
    if i in (2, 4, 5, 6, 0):
        selected_measurements_b.append(data[key])
        plot(data[key], title=f"{i}: {key}")
```




2: A231128.134817.VERT
12.0
11.8
11.6
11.4
11.2
11.0
10.8
ln(I(z0)) [ln(A)]
0.00
0.05
0.10
0.15
0.20
0.25
0.30
z0 [Å]


4: A231128.134923.VERT
12.50
12.25
12.00
11.75
11.50
11.25
11.00
10.75
ln(I(z0)) [ln(A)]
0.00
0.05
0.10
0.15
0.20
0.25
0.30
z0 [Å]

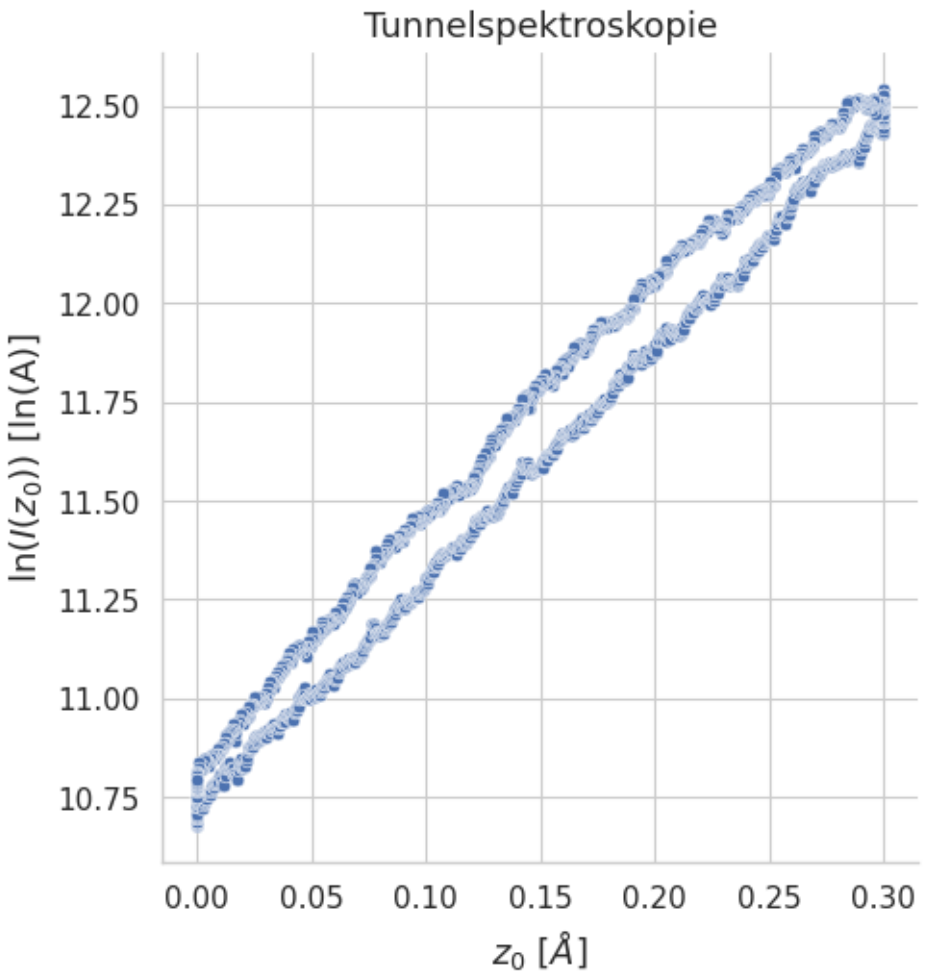

5: A231128.134937.VERT
12.50
12.25
12.00
11.75
11.50
11.25
11.00
10.75
ln(I(z0)) [ln(A)]
0.00
0.05
0.10
0.15
0.20
0.25
0.30
z0 [Å]




[17]:
```
print(data.keys())
```

```
dict_keys(['A231128.134613.VERT', 'A231128.134739.VERT', 'A231128.134817.VERT',
'A231128.134842.VERT', 'A231128.134923.VERT', 'A231128.134937.VERT',
'A231128.134951.VERT', 'A231128.135005.VERT', 'A231128.135041.VERT'])
```

[18]:
```
plot(data['A231128.134937.VERT'], title="Tunnelspektroskopie", filename='../../.
↪./media/B2.5/Spektroskopie_2.svg')
```



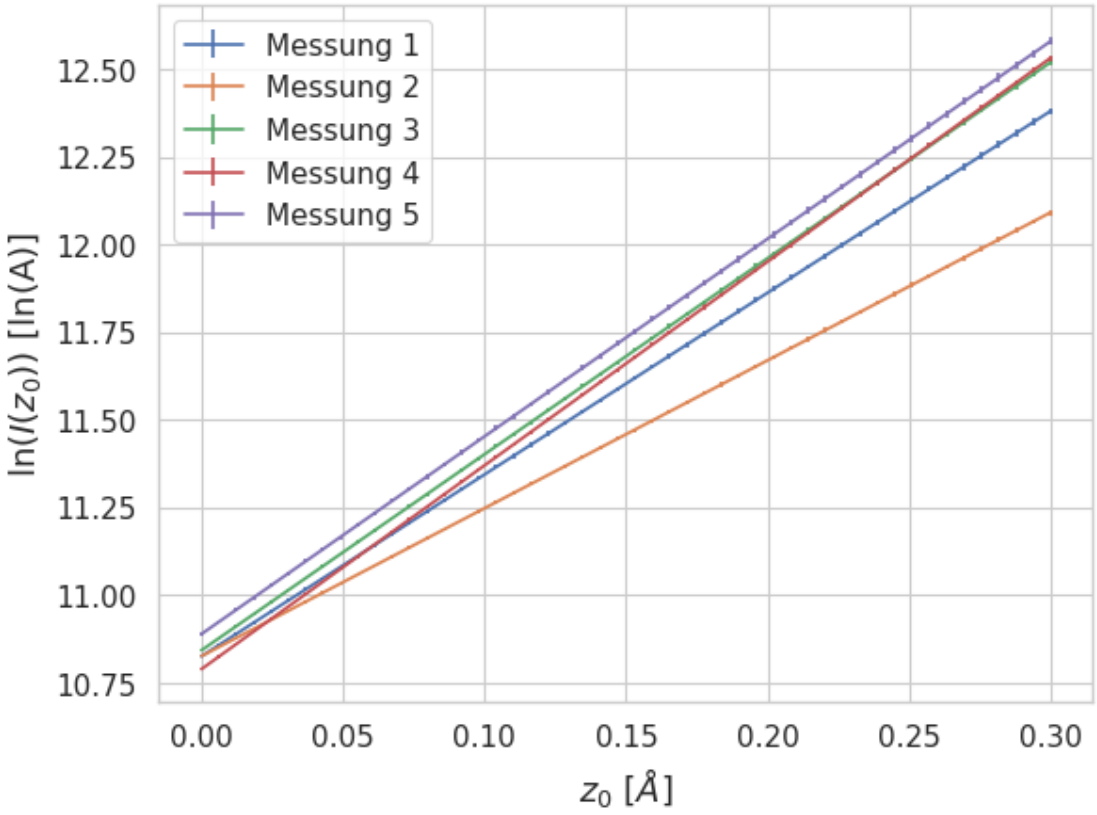

### 2.0.2 Regression

[19]:
```
# plotte alle Regressionen
# for df in selected_measurements_a:
#     plot_regression(df)
```

[20]:
```
for df in selected_measurements_b:
    regression(df)
plt.legend([ f"Messung {i+1}" for i in range(5)])
plt.xlabel(x_column)
plt.ylabel(y_column)
plt.savefig('../../../media/B2.5/Spektroskopie_regression_b.svg')
```

```
$m = 5.18 \pm 0.02$
$m = 4.22 \pm 0.02$
$m = 5.59 \pm 0.02$
$m = 5.81 \pm 0.02$
```

```
$m = 5.64 \pm 0.02$
```



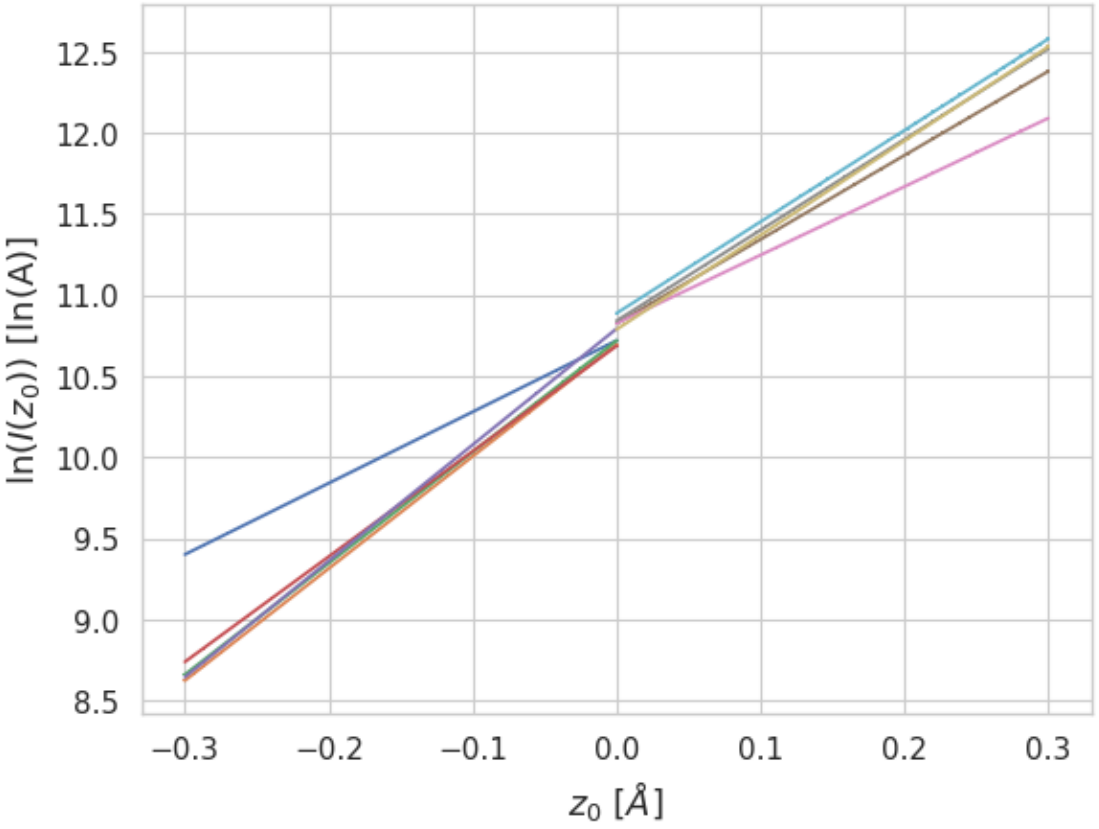

## 3 A und B

[21]:
```
ms = []
errs = []
for df in selected_measurements_a + selected_measurements_b:
    m, err = regression(df)
    ms.append(m)
    errs.append(err)
plt.xlabel(x_column)
plt.ylabel(y_column)
```

```
$m = 4.4 \pm 0.02$
$m = 6.91 \pm 0.03$
$m = 6.86 \pm 0.03$
$m = 6.49 \pm 0.03$
$m = 7.16 \pm 0.02$
$m = 5.18 \pm 0.02$
$m = 4.22 \pm 0.02$
$m = 5.59 \pm 0.02$
```

```
$m = 5.81 \pm 0.02$
$m = 5.64 \pm 0.02$
```

[21]:
```
Text(0, 0.5, '$\\ln(I(z_0))\\ [\\ln(\\mathrm{A})]$')
```




[22]:
```
for i in range(10):
    phi = (ms[i]/0.51)**2
    err_phi = (errs[i]/0.51)**2
    print(f'${round(ms[i], 2)} \\pm {round(errs[i], 2)}$ & ${round(phi, 3)}␣
 ↪\\pm {round(err_phi, 3)}$ \\\\')
```

```
$4.4 \pm 0.02$ & $74.283 \pm 0.002$ \\
$6.91 \pm 0.03$ & $183.471 \pm 0.004$ \\
$6.86 \pm 0.03$ & $180.925 \pm 0.004$ \\
$6.49 \pm 0.03$ & $161.996 \pm 0.003$ \\
$7.16 \pm 0.02$ & $196.918 \pm 0.002$ \\
$5.18 \pm 0.02$ & $103.284 \pm 0.002$ \\
$4.22 \pm 0.02$ & $68.402 \pm 0.001$ \\
$5.59 \pm 0.02$ & $120.152 \pm 0.001$ \\
$5.81 \pm 0.02$ & $129.797 \pm 0.001$ \\
$5.64 \pm 0.02$ & $122.115 \pm 0.002$ \\
```

[23]:
```
196.918/4, 68.402/4
```

[23]: (49.2295, 17.1005)