HW6

April 11, 2025

[32]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import os
from glob import glob
```

[33]:
```
def load_counts(file):
    df = pd.read_csv(file, sep=None, engine='python')
    return df['Count']
```

[34]:
```
def compute_stats(counts):
    total = counts.sum()
    mean = counts.mean()
    std = counts.std()
    theo_std = np.sqrt(total) / len(counts)
    return mean, std, total, theo_std
```

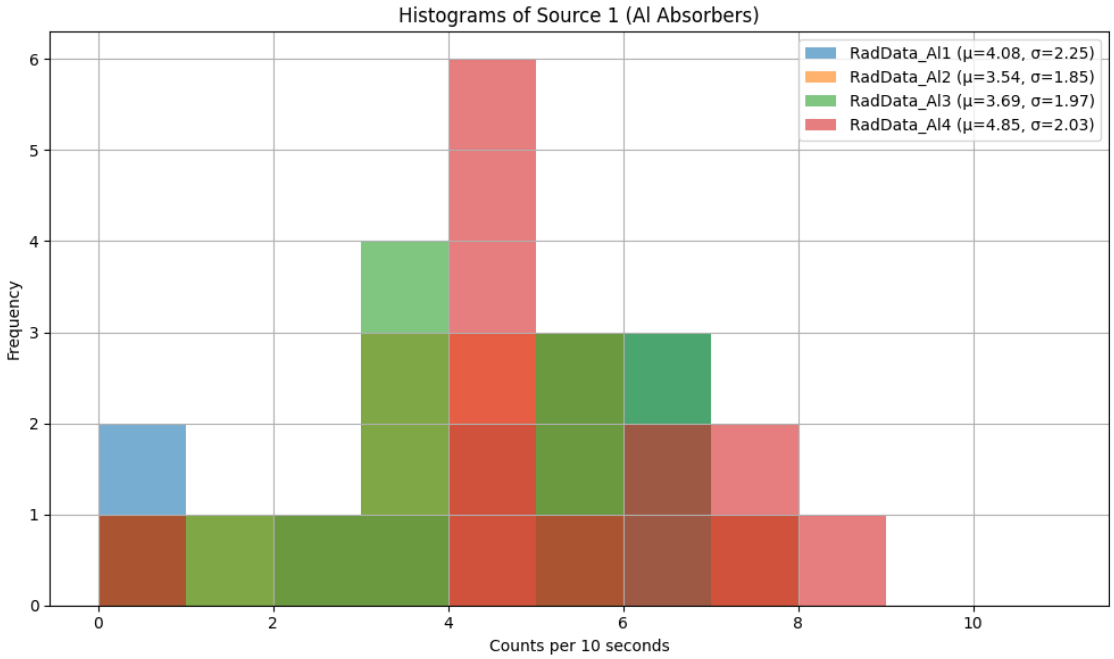
[35]:
```
def get_absorber_thicknesses(n):
    return np.arange(1, n+1)  # Al1, Al2, ... -> 1, 2, ...
```

[36]:
```
def total_counts_with_error(files):
    totals = []
    errors = []
    for file in files:
        counts = load_counts(file)
        total = counts.sum()
        error = np.sqrt(total)
        totals.append(total)
        errors.append(error)
    return np.array(totals), np.array(errors)
```

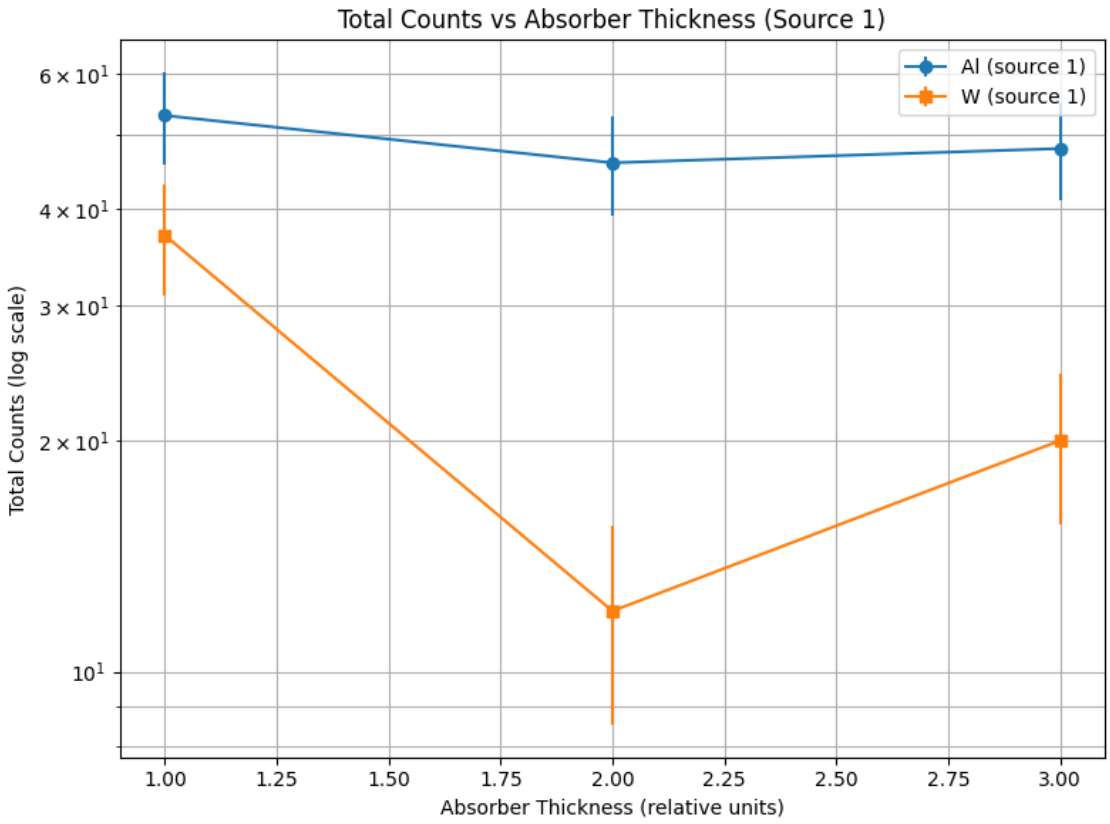
[37]:
```
def attenuation_coefficient(x, y):
    """
    Fit y = A * exp(-x) → log(y) = -x + log(A)
    Returns:  (attenuation coefficient), fit coefficients [slope, intercept]
    """
    log_y = np.log(y)
    coeffs = np.polyfit(x, log_y, 1)
```

```
    return -coeffs[0], coeffs
```

[38]:
```
# 1. Plot histograms for source 1 (Al1-Al4)
al_files_s1 = sorted(glob("RadData_Al*.csv"))
counts_dict = {}
stats_dict = {}

plt.figure(figsize=(10, 6))
bins = np.arange(0, 12, 1)

for file in al_files_s1:
    label = os.path.splitext(os.path.basename(file))[0]
    counts = load_counts(file)
    counts_dict[label] = counts
     ,  , total, theo_  = compute_stats(counts)
    stats_dict[label] = {'mean':  , 'std':  , 'total': total, 'theoretical_std':␣
 ↪theo_ }
    plt.hist(counts, bins=bins, alpha=0.6, label=f"{label} ( ={ :.2f},  ={ :.
 ↪2f})")

plt.xlabel("Counts per 10 seconds")
plt.ylabel("Frequency")
plt.title("Histograms of Source 1 (Al Absorbers)")
plt.legend()
plt.grid(True)
plt.tight_layout()
plt.show()
```



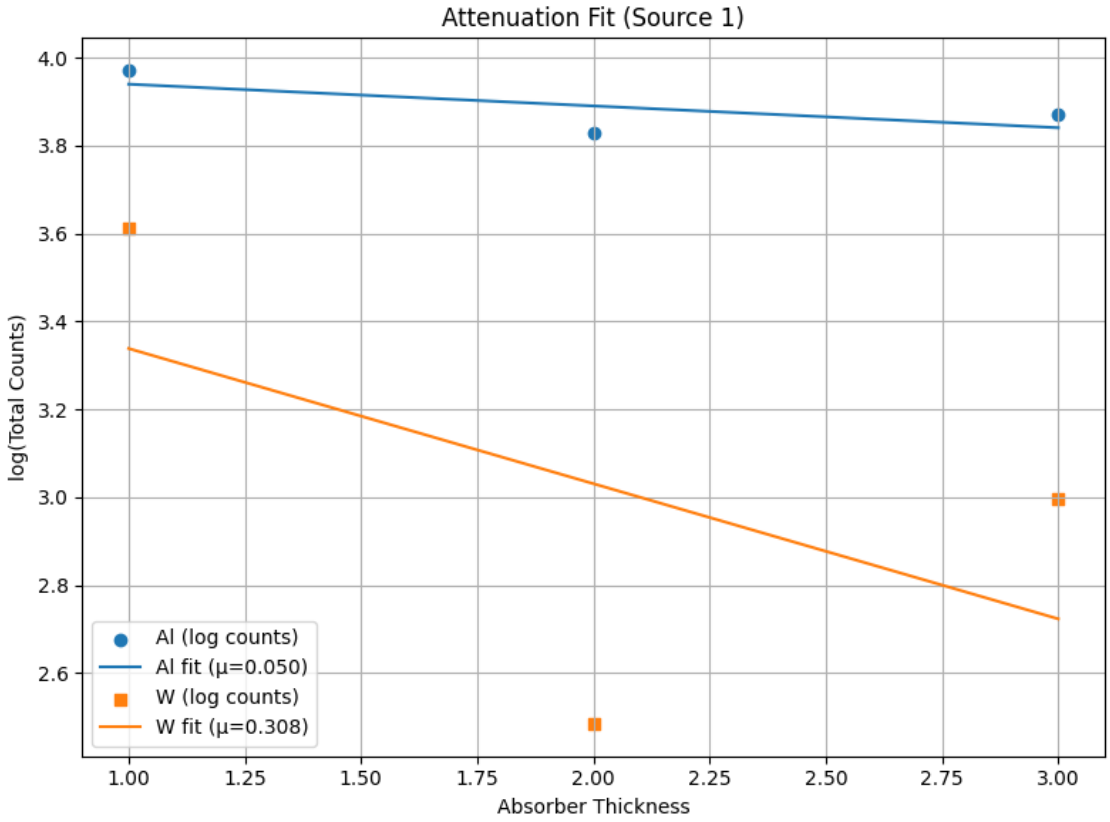
[39]:
```
# 2. Log plot: total counts vs absorber thickness (Al & W for source 1)
w_files_s1 = sorted(glob("RadData_T*.csv"))
al_totals, al_errors = total_counts_with_error(al_files_s1)
w_totals, w_errors = total_counts_with_error(w_files_s1)

# Trim to match sizes
min_len = min(len(al_totals), len(w_totals))
thickness = get_absorber_thicknesses(min_len)

plt.figure(figsize=(8, 6))
plt.errorbar(thickness, al_totals[:min_len], yerr=al_errors[:min_len],␣
 ↪fmt='o-', label="Al (source 1)")
plt.errorbar(thickness, w_totals[:min_len], yerr=w_errors[:min_len], fmt='s-',␣
 ↪label="W (source 1)")
plt.yscale('log')
plt.xlabel("Absorber Thickness (relative units)")
plt.ylabel("Total Counts (log scale)")
plt.title("Total Counts vs Absorber Thickness (Source 1)")
plt.legend()
plt.grid(True, which='both')
plt.tight_layout()
plt.show()
```



[40]:
```
# 3. Estimate attenuation coefficients and fit lines
_al, al_fit = attenuation_coefficient(thickness, al_totals[:min_len])
_w, w_fit = attenuation_coefficient(thickness, w_totals[:min_len])

print(f"Estimated  for Al (source 1): {_al:.3f}")
print(f"Estimated  for W  (source 1): {_w:.3f}")

plt.figure(figsize=(8, 6))
plt.scatter(thickness, np.log(al_totals[:min_len]), label='Al (log counts)',␣
 ↪marker='o')
plt.plot(thickness, np.polyval(al_fit, thickness), label=f'Al fit ( ={_al:.
 ↪3f})')

plt.scatter(thickness, np.log(w_totals[:min_len]), label='W (log counts)',␣
 ↪marker='s')
plt.plot(thickness, np.polyval(w_fit, thickness), label=f'W fit ( ={_w:.3f})')

plt.xlabel("Absorber Thickness")
plt.ylabel("log(Total Counts)")
plt.title("Attenuation Fit (Source 1)")
```

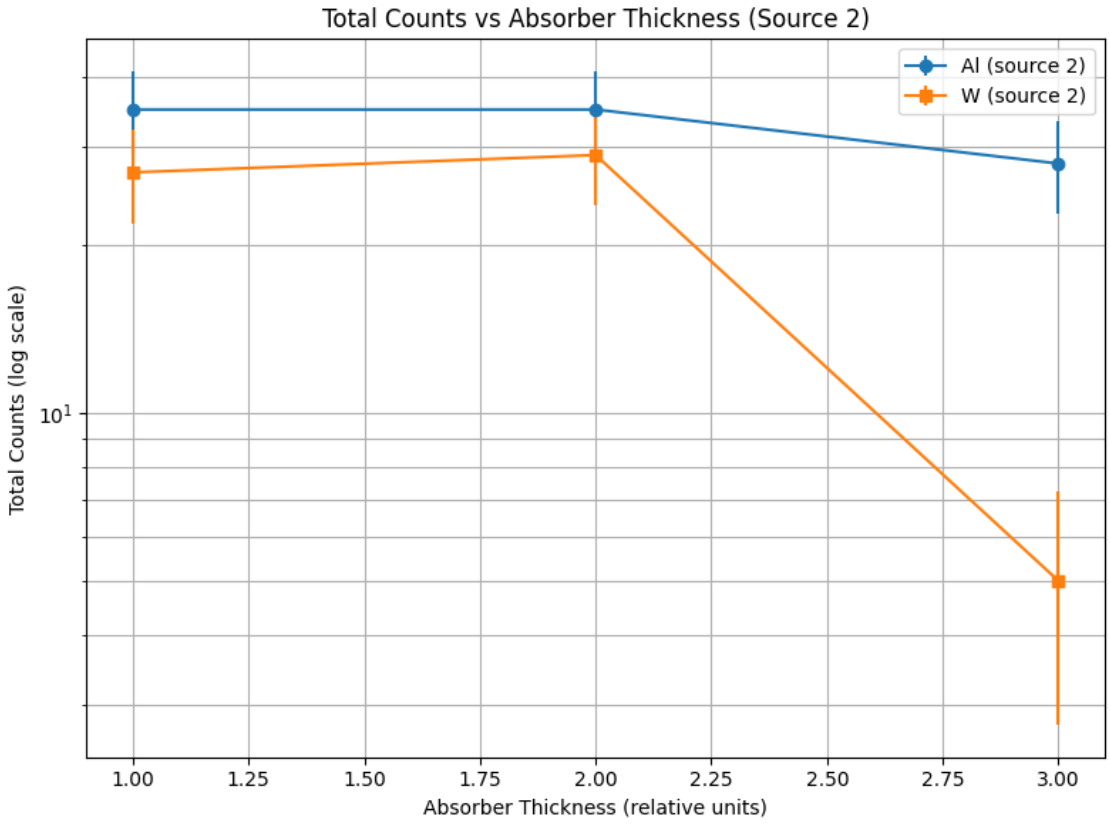
```
plt.legend()
plt.grid(True)
plt.tight_layout()
plt.show()
```

```
Estimated   for Al (source 1): 0.050
Estimated   for W  (source 1): 0.308
```



[41]:
```
# 4. REPEAT FOR SOURCE 2
al_files_s2 = sorted(glob("RadData2_Al*.csv"))
w_files_s2 = sorted(glob("RadData2_T*.csv"))

al2_totals, al2_errors = total_counts_with_error(al_files_s2)
w2_totals, w2_errors = total_counts_with_error(w_files_s2)
min_len_2 = min(len(al2_totals), len(w2_totals))
thickness2 = get_absorber_thicknesses(min_len_2)

plt.figure(figsize=(8, 6))
plt.errorbar(thickness2, al2_totals[:min_len_2], yerr=al2_errors[:min_len_2],␣
 ↪fmt='o-', label="Al (source 2)")
```

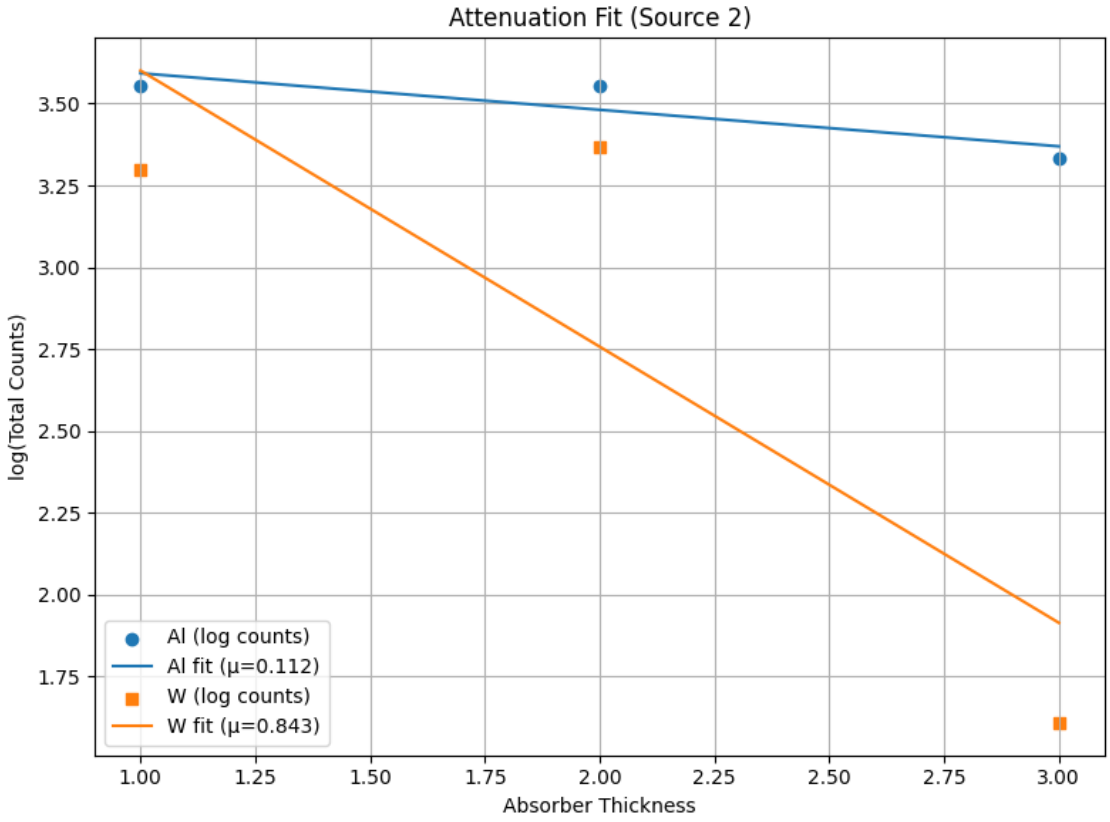
```
plt.errorbar(thickness2, w2_totals[:min_len_2], yerr=w2_errors[:min_len_2],␣
 ↪fmt='s-', label="W (source 2)")
plt.yscale('log')
plt.xlabel("Absorber Thickness (relative units)")
plt.ylabel("Total Counts (log scale)")
plt.title("Total Counts vs Absorber Thickness (Source 2)")
plt.legend()
plt.grid(True, which='both')
plt.tight_layout()
plt.show()
```



[42]:
```
# Fit and plot for Source 2
2_al, al2_fit = attenuation_coefficient(thickness2, al2_totals[:min_len_2])
2_w, w2_fit = attenuation_coefficient(thickness2, w2_totals[:min_len_2])

print(f"Estimated  for Al (source 2): {2_al:.3f}")
print(f"Estimated  for W  (source 2): {2_w:.3f}")

plt.figure(figsize=(8, 6))
```

```
plt.scatter(thickness2, np.log(al2_totals[:min_len_2]), label='Al (log␣
 ↪counts)', marker='o')
plt.plot(thickness2, np.polyval(al2_fit, thickness2), label=f'Al fit ( ={ 2_al:.
 ↪3f})')

plt.scatter(thickness2, np.log(w2_totals[:min_len_2]), label='W (log counts)',␣
 ↪marker='s')
plt.plot(thickness2, np.polyval(w2_fit, thickness2), label=f'W fit ( ={ 2_w:.
 ↪3f})')

plt.xlabel("Absorber Thickness")
plt.ylabel("log(Total Counts)")
plt.title("Attenuation Fit (Source 2)")
plt.legend()
plt.grid(True)
plt.tight_layout()
plt.show()
```

```
Estimated   for Al (source 2): 0.112
Estimated   for W  (source 2): 0.843
```



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