calibration

January 20, 2023

1 Calibration

[1]:
```
import f3ast
import numpy as np
import matplotlib.pyplot as plt
```

1.1 Export calibration stream

[2]:
```
calib_strm_savepath = 'calibstrm'

# create safe filename to prevent overwriting
calib_strm_savepath = f3ast.create_safe_savename(calib_strm_savepath)
f3ast.export_spot_calibration(calib_strm_savepath, start_time=1, end_time=15,␣
 ↪grid=[5, 3])
```

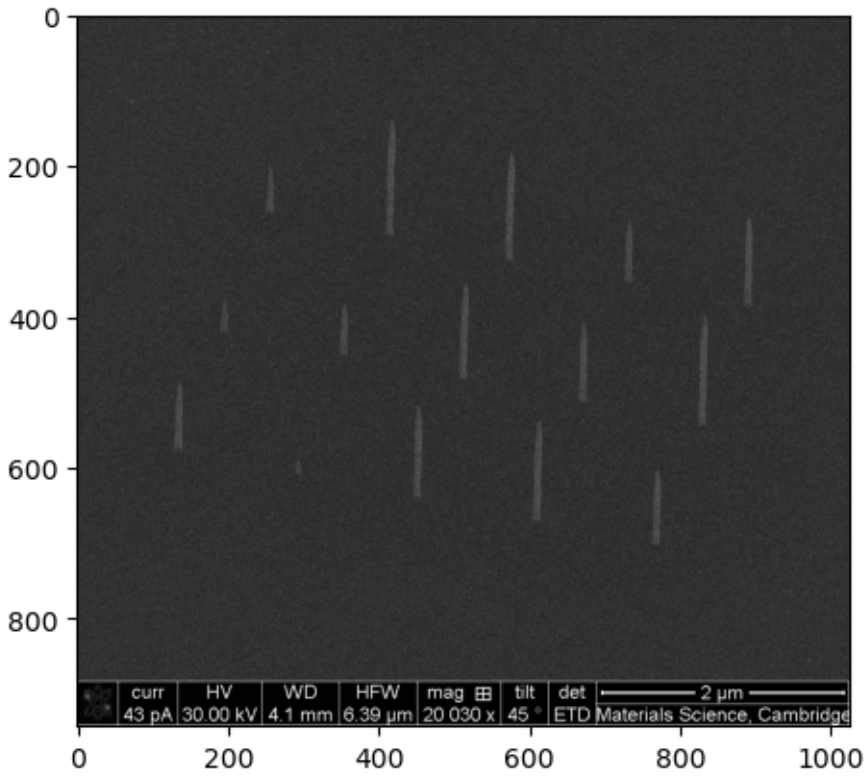
```
Total time:  0:02:00
```

1.2 Get calibration data from SEM image

1.2.1 Load SEM image and calibration reference data

[3]:
```
img_path = 'calib1_001.tif'
data_path = 'calib25-11-19_data.txt'
observing_angle = 45

data = np.loadtxt(data_path, delimiter='\t', skiprows=1)
dwell_times = data[:, 0]

img = f3ast.read_image(img_path)
plt.imshow(img)
```

[3]:
```
<matplotlib.image.AxesImage at 0x244a9d1e860>
```



1.2.2 Set the scale on SEM image (interactive)

[4]:
```
# scale_boundaries give upper left corner of scale bar region, as fraction of␣
 ↪image size
scale_boundaries = (0.6, 0.93)
scale_bar_size, observing_angle = 2., 45. # in um, deg

# need to use qt backend for interactive scale bar selection
# click at ends of scale bar to get the relation between pixel size and␣
 ↪physical length
%matplotlib qt
tracker = f3ast.select_scale(img, scale_boundaries=scale_boundaries)
```

```
81, 23
401, 23
```

[5]:
```
scale_bar_px = np.abs(tracker.scale_markers[1] - tracker.scale_markers[0])
ppn = scale_bar_px / scale_bar_size
print(f'{ppn:.1f} pixels per micrometer')
```

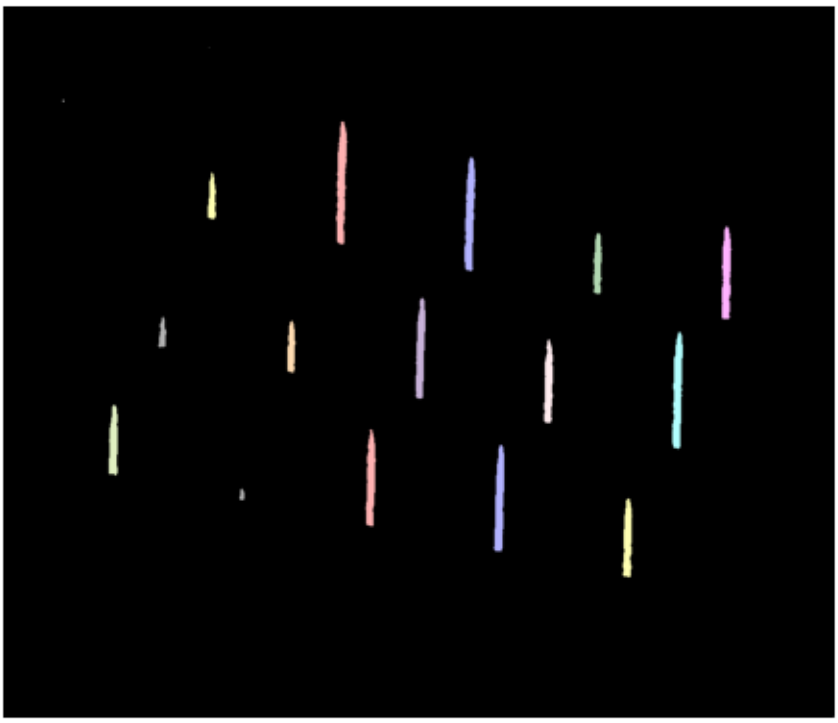
```
159.9 pixels per micrometer
```

1.2.3 Process calibration image

[6]:
```
%matplotlib inline

# remove the annotated region (= bottom scale boundary)
img_nobar = f3ast.remove_bottom_bar(img, bottom_factor=scale_boundaries[1])
# threshold the image to extract wire regions
img_thresh = f3ast.threshold_image(img_nobar, thresh=None)

# label image regions, corresponding to calibration wires
label_image, image_label_overlay = f3ast.get_labelled_image(img_thresh)
print(f'{len(np.unique(label_image)) - 1 } wires identified.')

# filter out too small wires
labels = f3ast.filter_small_labels(label_image, min_struct_size=300)
print(f'{len(labels)} wires selected for analysis.')
image_label_overlay = f3ast.label2rgb(label_image, image=img_thresh, bg_label=0)

# show all recognised labels
fig, ax = plt.subplots()
ax.axis('off')
ax.imshow(image_label_overlay)
```

```
18 wires identified.
13 wires selected for analysis.
```

[6]:
```
<matplotlib.image.AxesImage at 0x244aad6ba30>
```



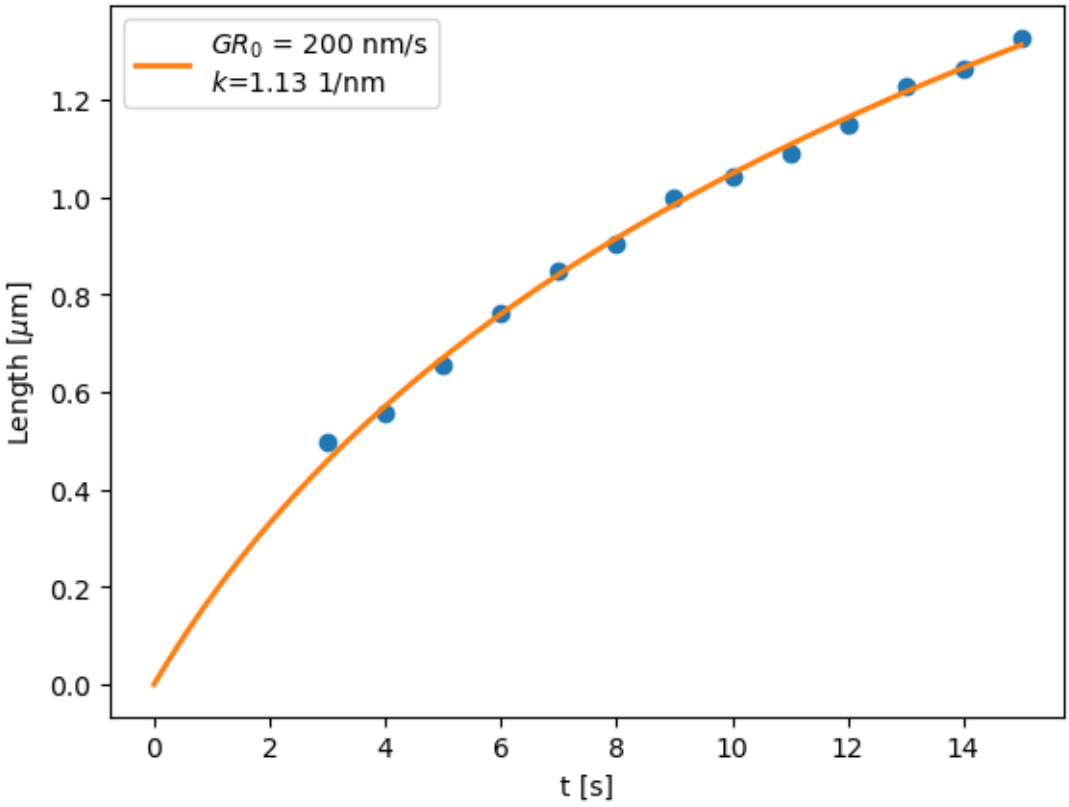
[7]:
```
# get real lengths of the wires (in um)
lengths_px = f3ast.get_lengths_px(label_image)
lengths_perspective = np.sort(lengths_px) / ppn
lengths_true = lengths_perspective / np.sin(np.deg2rad(observing_angle))
dwell_times = dwell_times[-lengths_true.size:]
```

1.2.4 Fit the model

[8]:
```
# fit the deposit model and get the parameters
deposit_model, popt, _ = f3ast.DDModel.fit_calibration(dwell_times,␣
 ↪lengths_true)
label = f'$GR_0$ = {popt[0]*1e3:.0f} nm/s\n$k$={popt[1]:.2f} 1/nm'

t = np.linspace(0, np.max(dwell_times), 1000)
plt.figure()
plt.plot(t, deposit_model(t, *popt), color='tab:orange', linewidth=2,␣
 ↪label=label)
plt.scatter(dwell_times, lengths_true)
plt.legend()
plt.xlabel('t [s]')
plt.ylabel(r'Length [$\mu$m]');
```

```
GR:  0.20027561692884874
```

```
k:  1.125666943107985
```

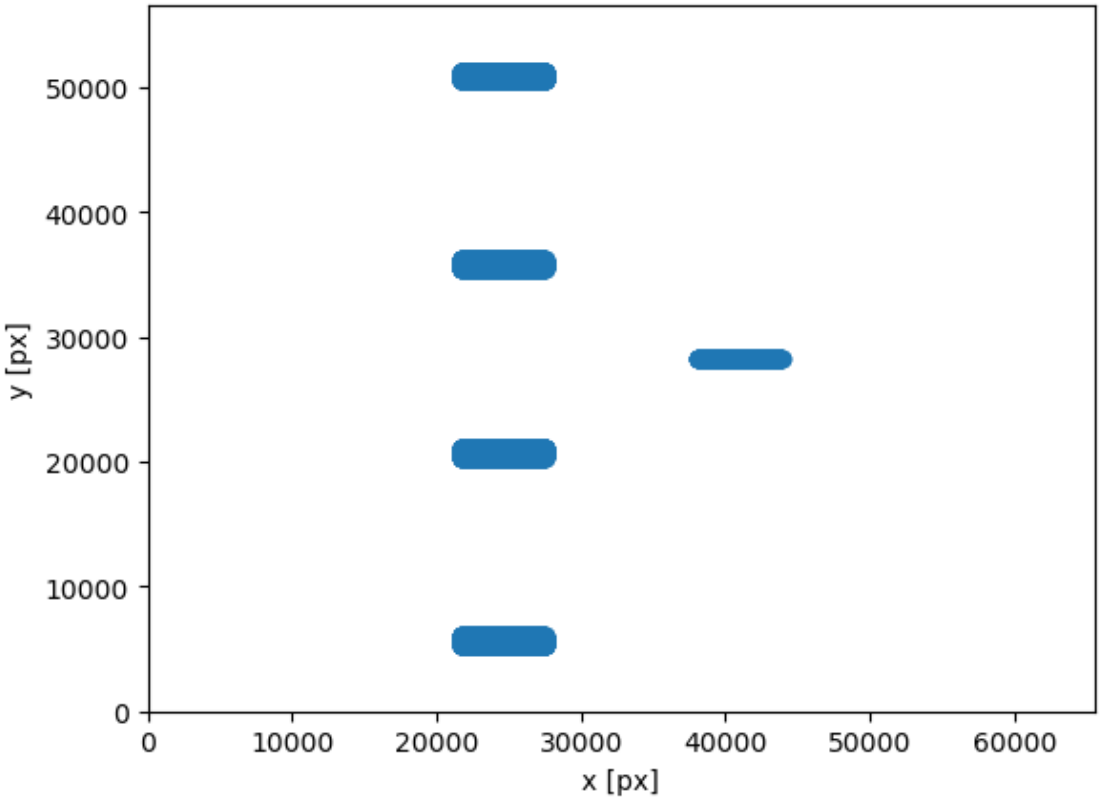


1.3 Get the sigma calibration structures if necessary

[9]:
```
import f3ast
import f3ast.calibration
```

[10]:
```
# check that correct SEM settings are loaded, or define manually (see above)
settings = f3ast.load_settings()

# create model with GR0 fitted above
#model = f3ast.RRLModel(struct=None, gr=popt[0], sigma=None)
model = f3ast.RRLModel(struct=None, gr=1., sigma=None)
sigma_list = [3, 4, 5, 6]
file_path = "sigma_calib"

# create sigma structures, and save calibration stream
sigma_strm = f3ast.get_sigma_structures(model, sigma_list, settings)
sigma_strm.print_time()
sigma_strm.write(f3ast.create_safe_savename(file_path))
sigma_strm.show_on_screen()
```

```
Solving for dwells…
Slicing…
Sliced
Solved
Solving for dwells…
Solved
Solving for dwells…
Solved
Solving for dwells…
Solved
Solving for dwells…
Slicing…
Sliced
Solved
Total time:  0:00:18.089335
```



[ ]: