LIBS of Sputtering Targets

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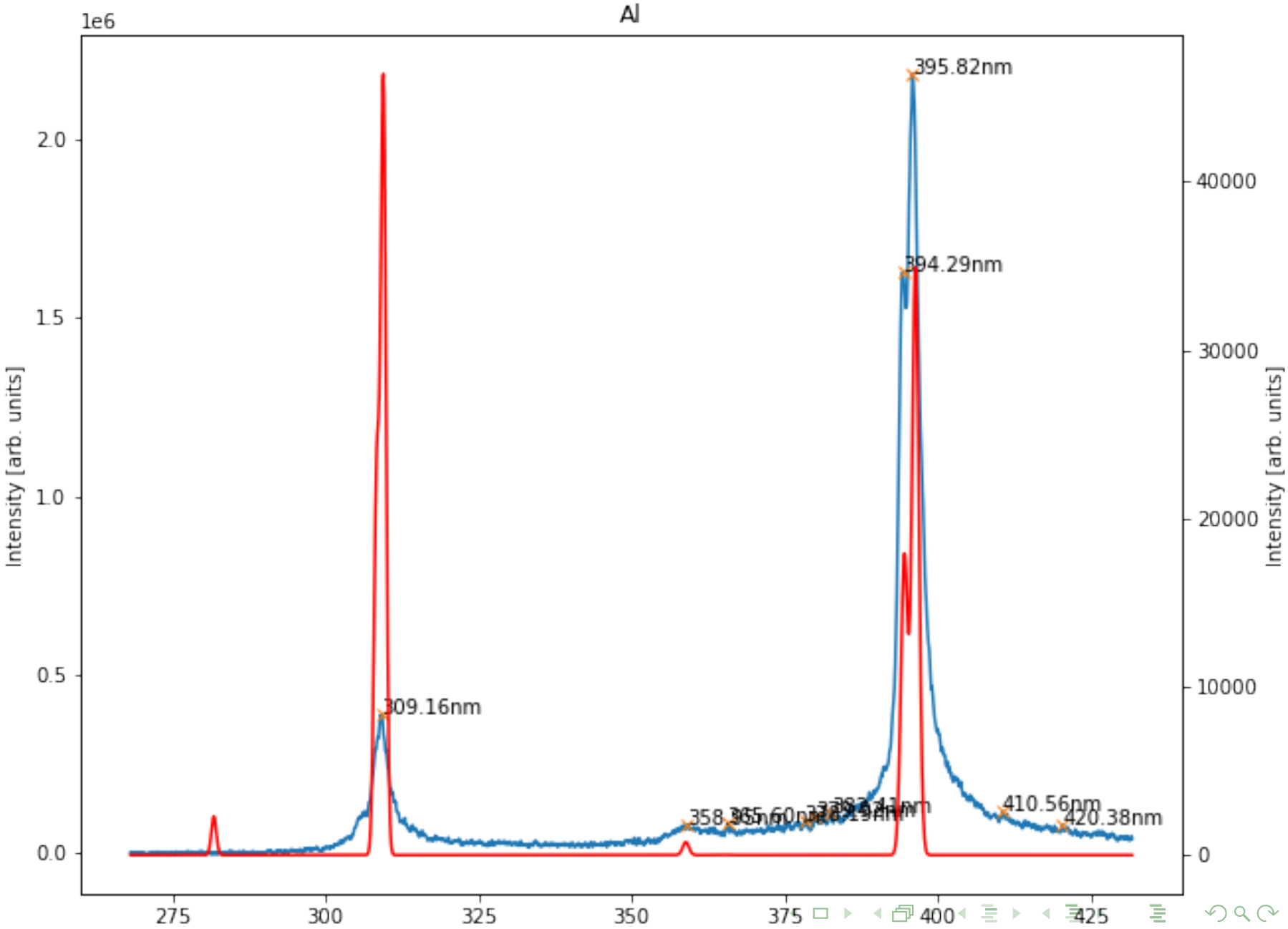
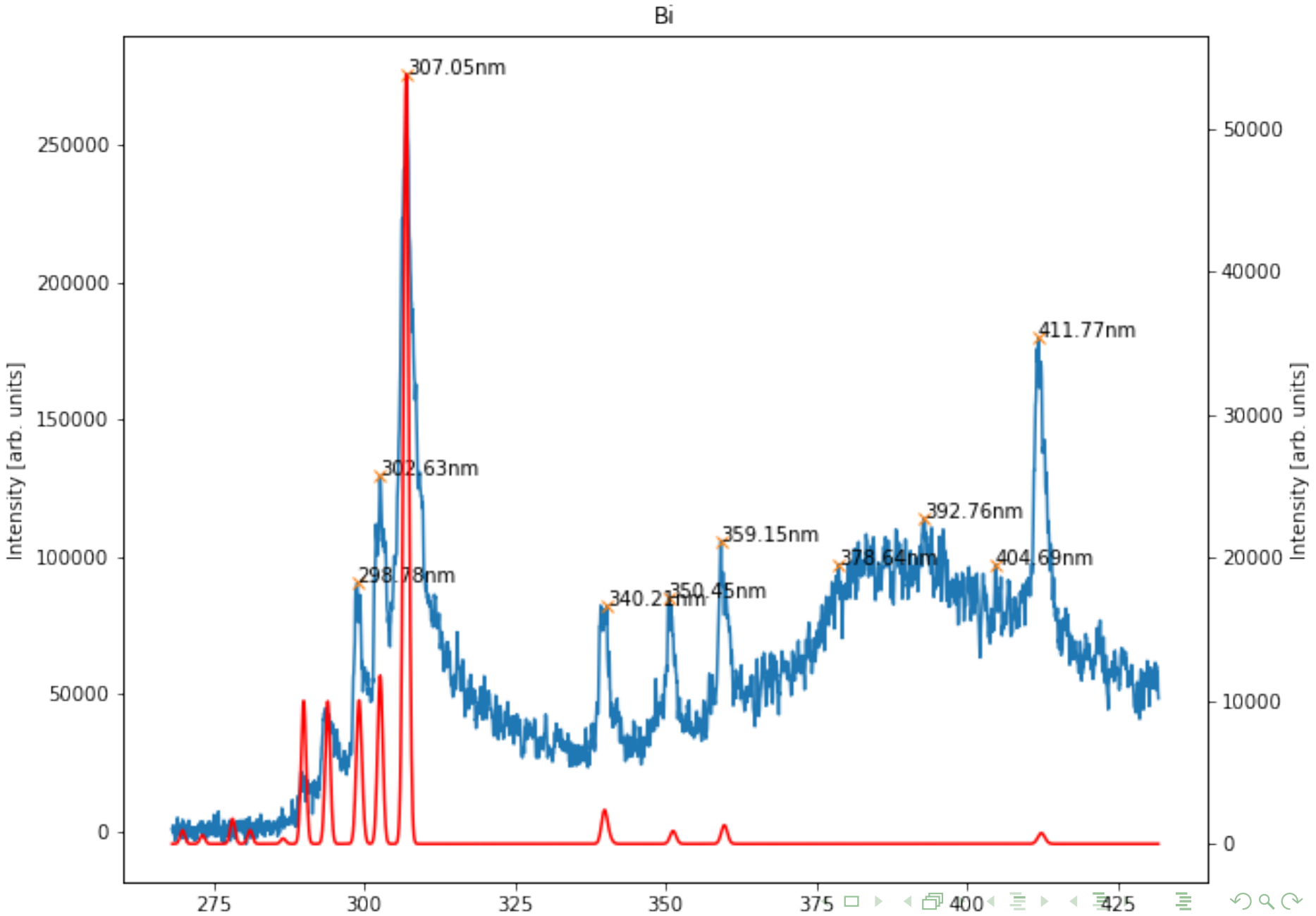
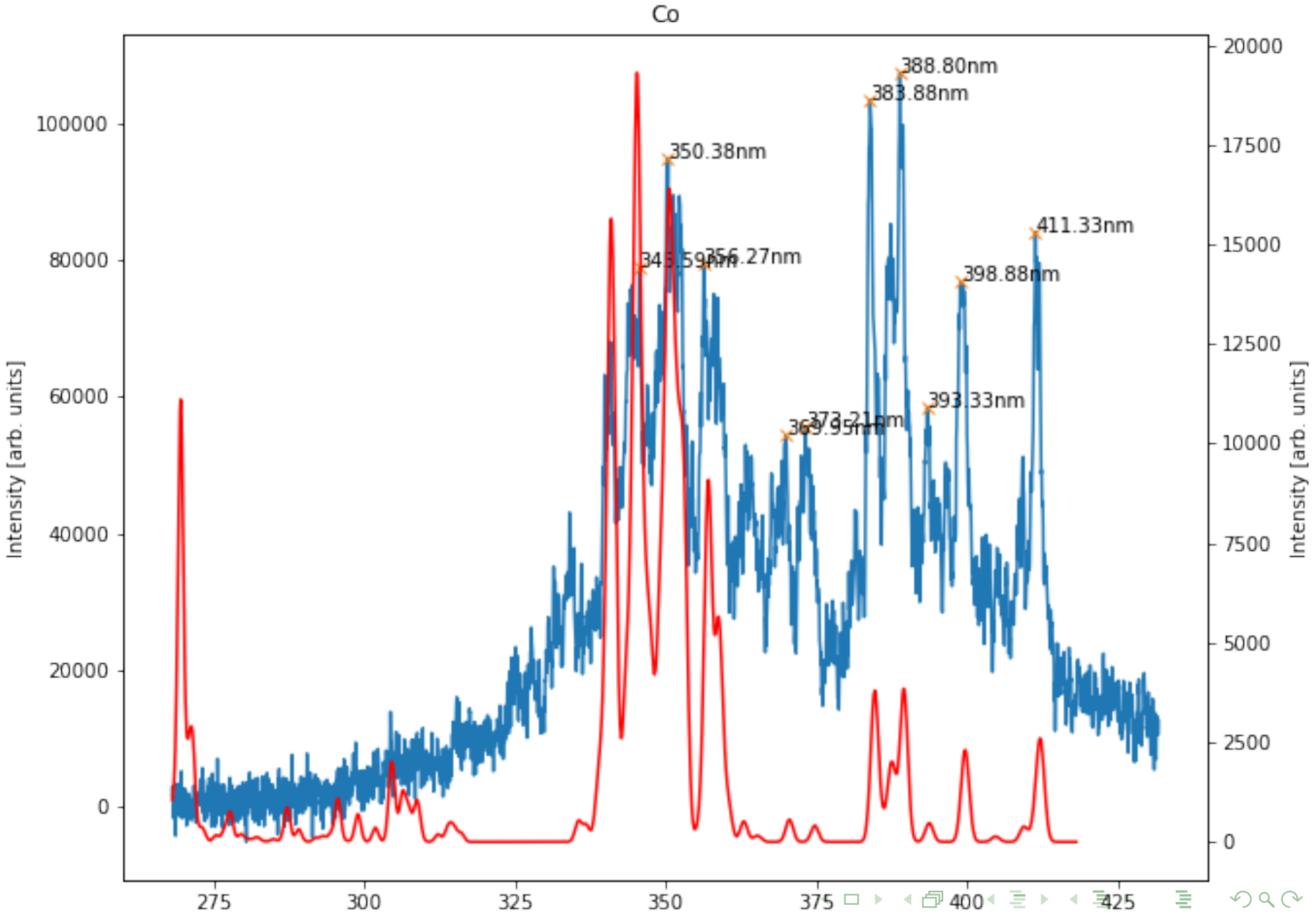
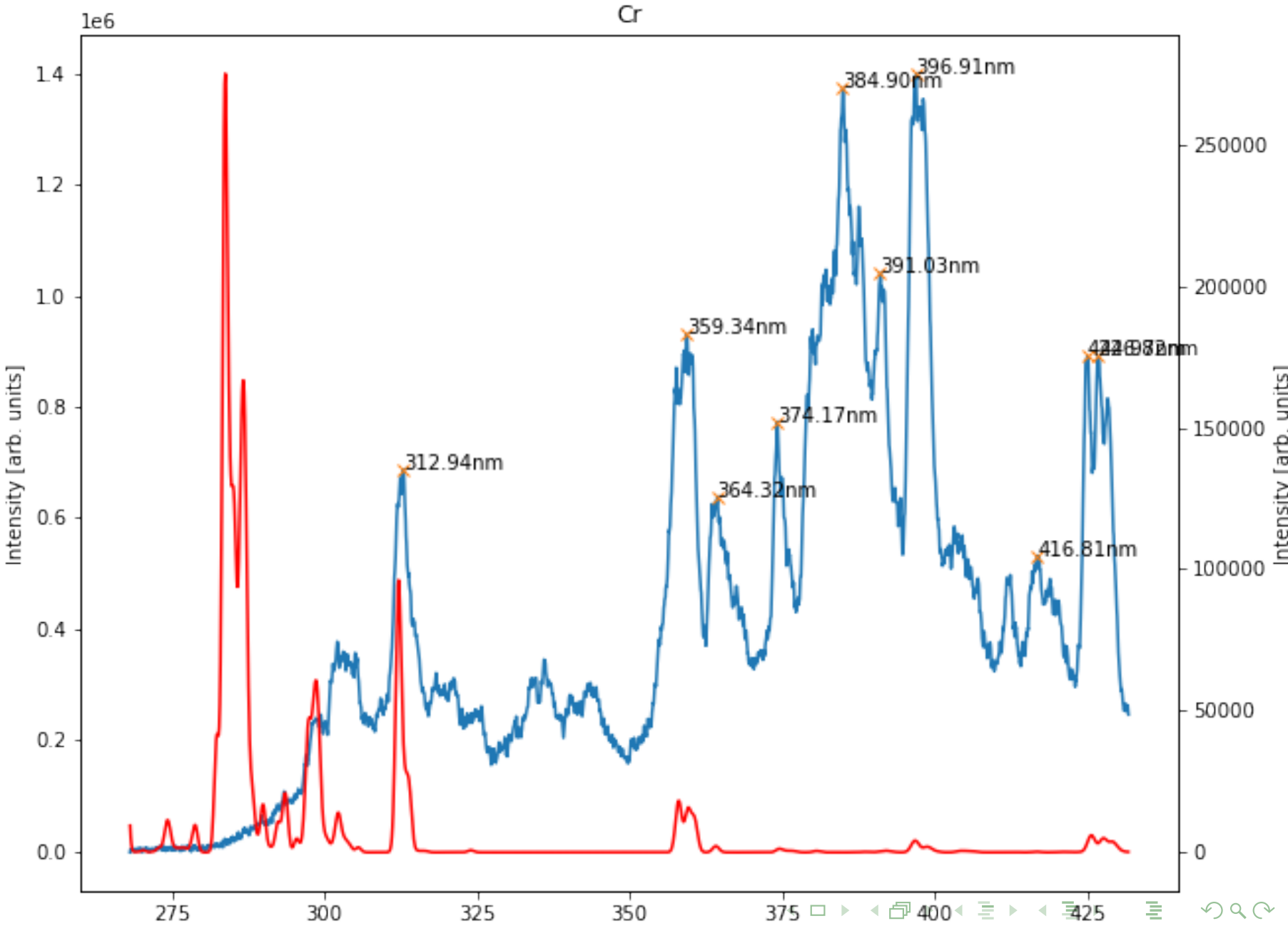
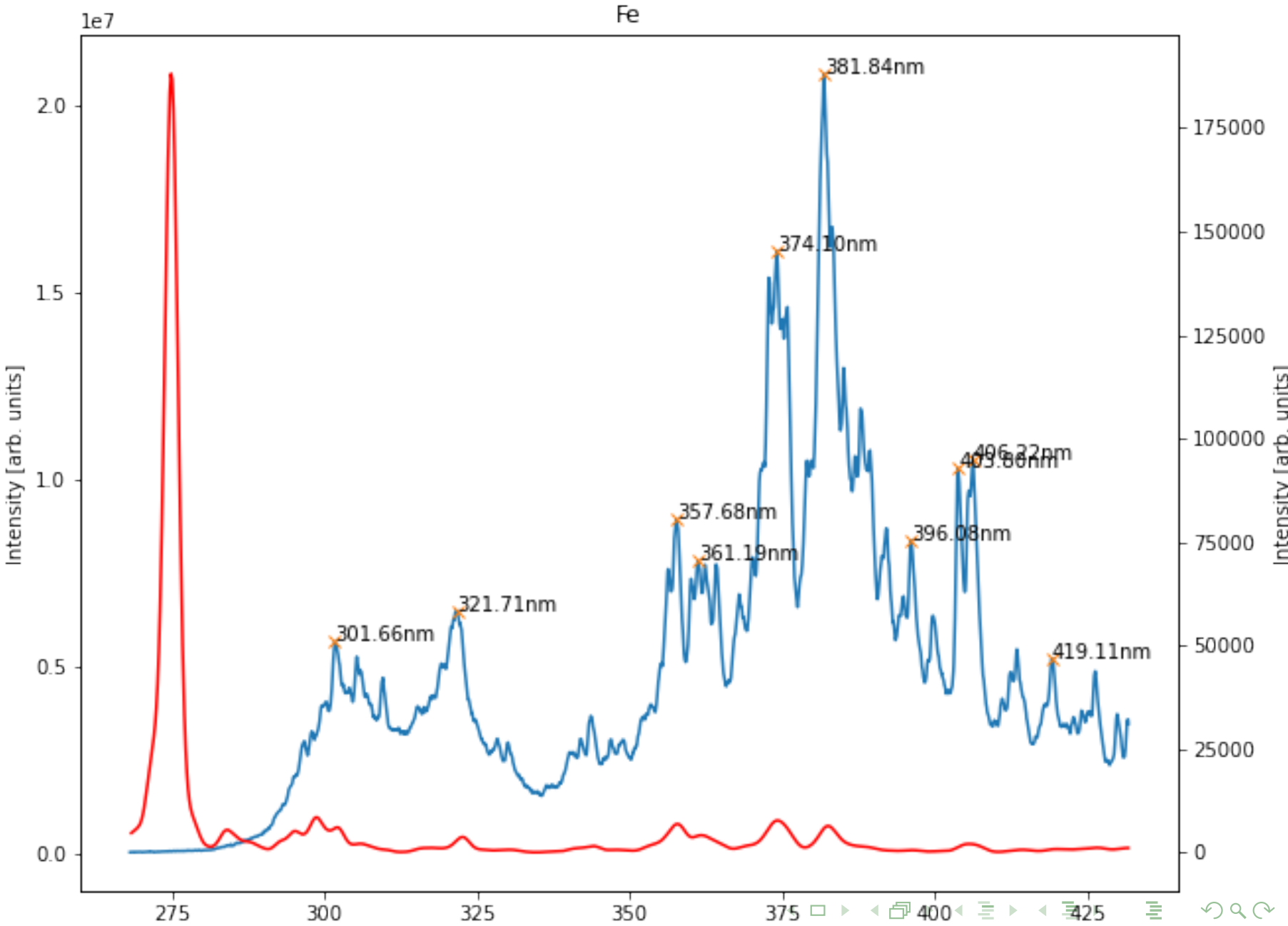
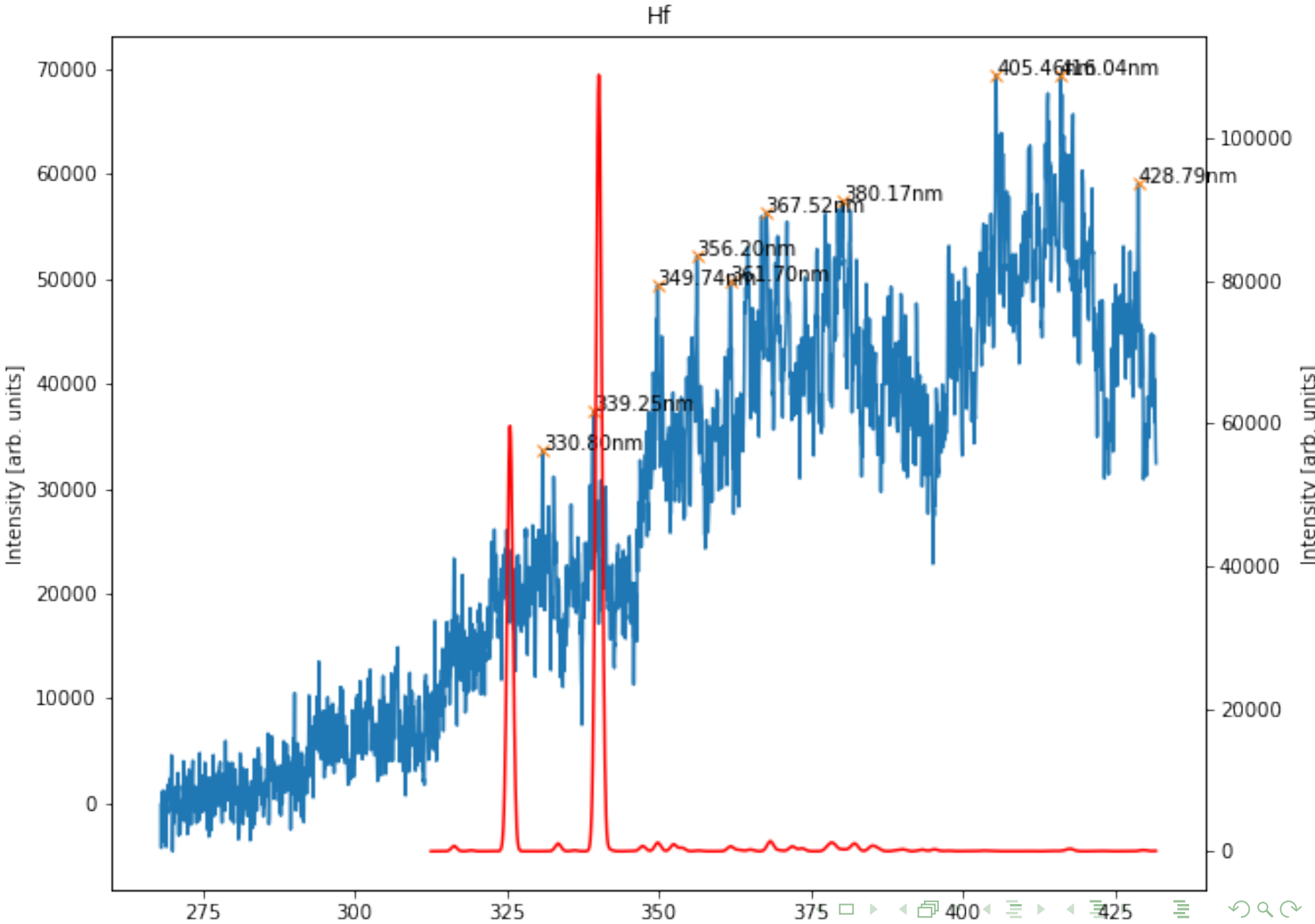

Al
1e6
Intensity [arb. units]
Intensity [arb. units]
395.82nm
394.29nm
309.16nm
410.56nm
420.38nm
2.0
1.5
1.0
0.5
0.0
40000
30000
20000
10000
0
275
300
325
350
375
400
425

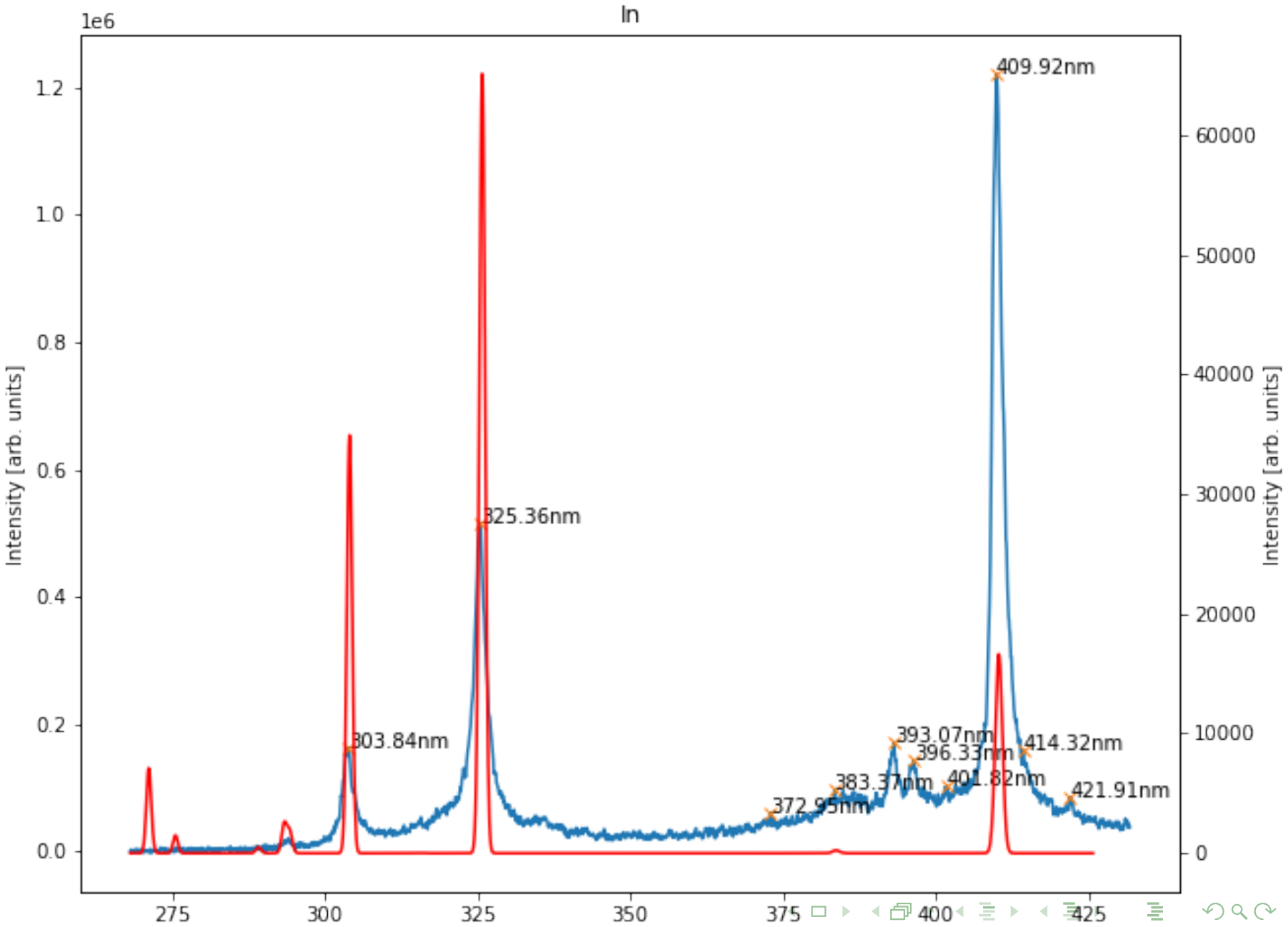

Bi
307.05nm
302.63nm
298.78nm
340.21nm
350.45nm
359.15nm
378.64nm
392.76nm
404.69nm
411.77nm
Intensity [arb. units]
Intensity [arb. units]
250000
200000
150000
100000
50000
0
50000
40000
30000
20000
10000
0
275
300
325
350
375
400
425

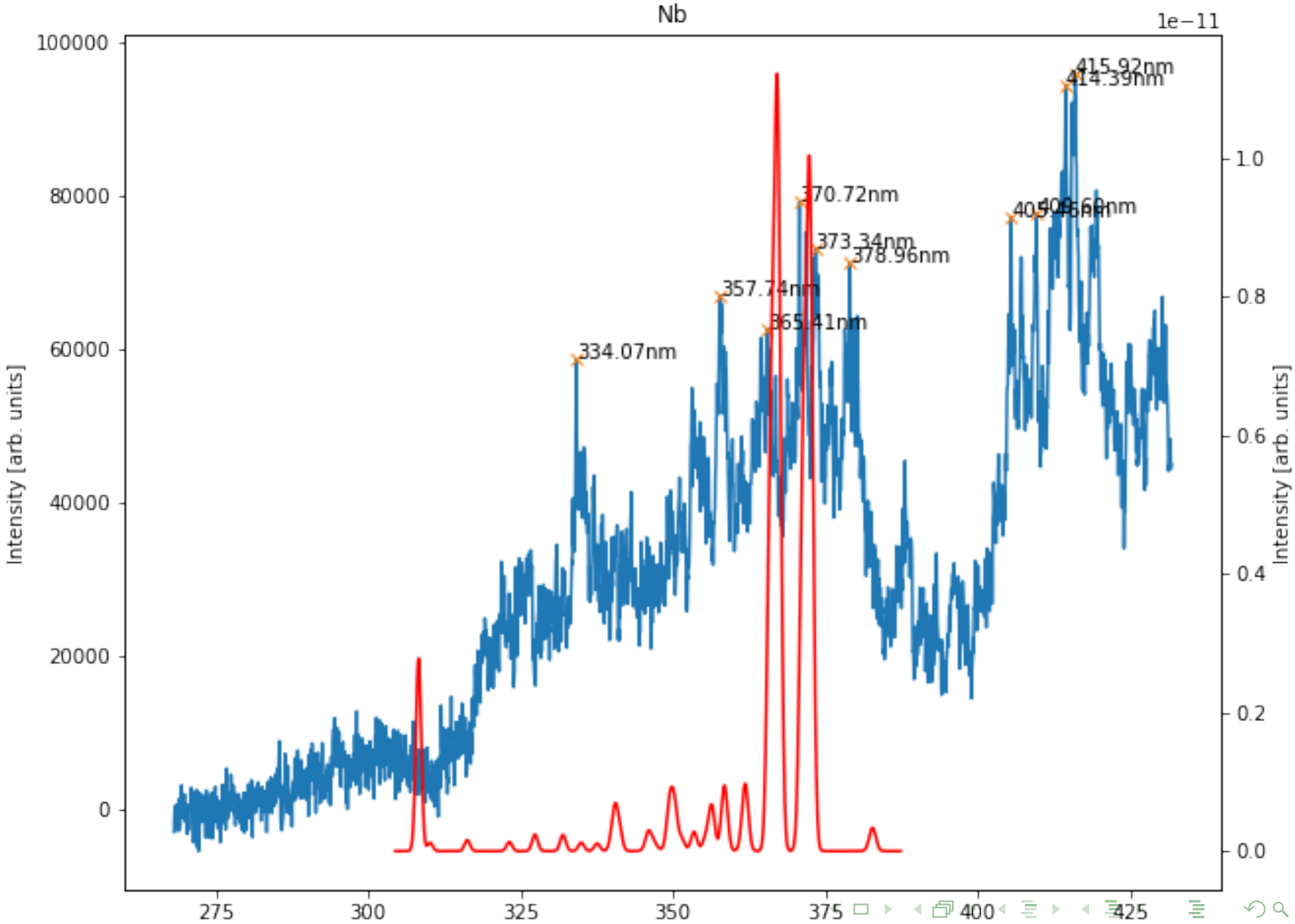

Co
Intensity [arb. units]
Intensity [arb. units]
388.80nm
383.88nm
350.38nm
411.33nm
398.88nm
393.33nm
373.21nm
356.27nm
100000
80000
60000
40000
20000
0
20000
17500
15000
12500
10000
7500
5000
2500
0
275
300
325
350
375
400
425

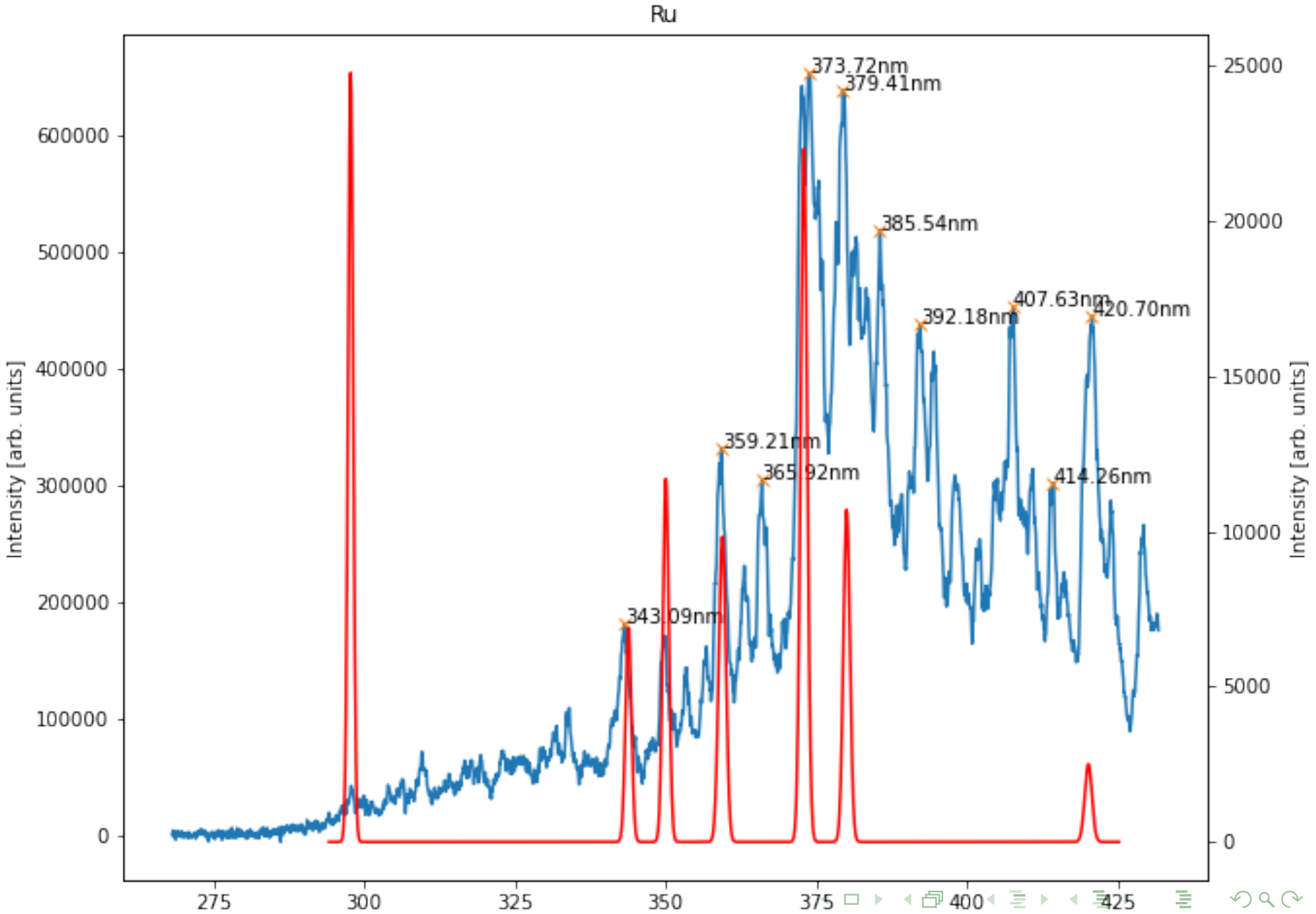

Cr
1e6
Intensity [arb. units]
Intensity [arb. units]
312.94nm
359.34nm
364.32nm
374.17nm
384.90nm
391.03nm
396.91nm
416.81nm

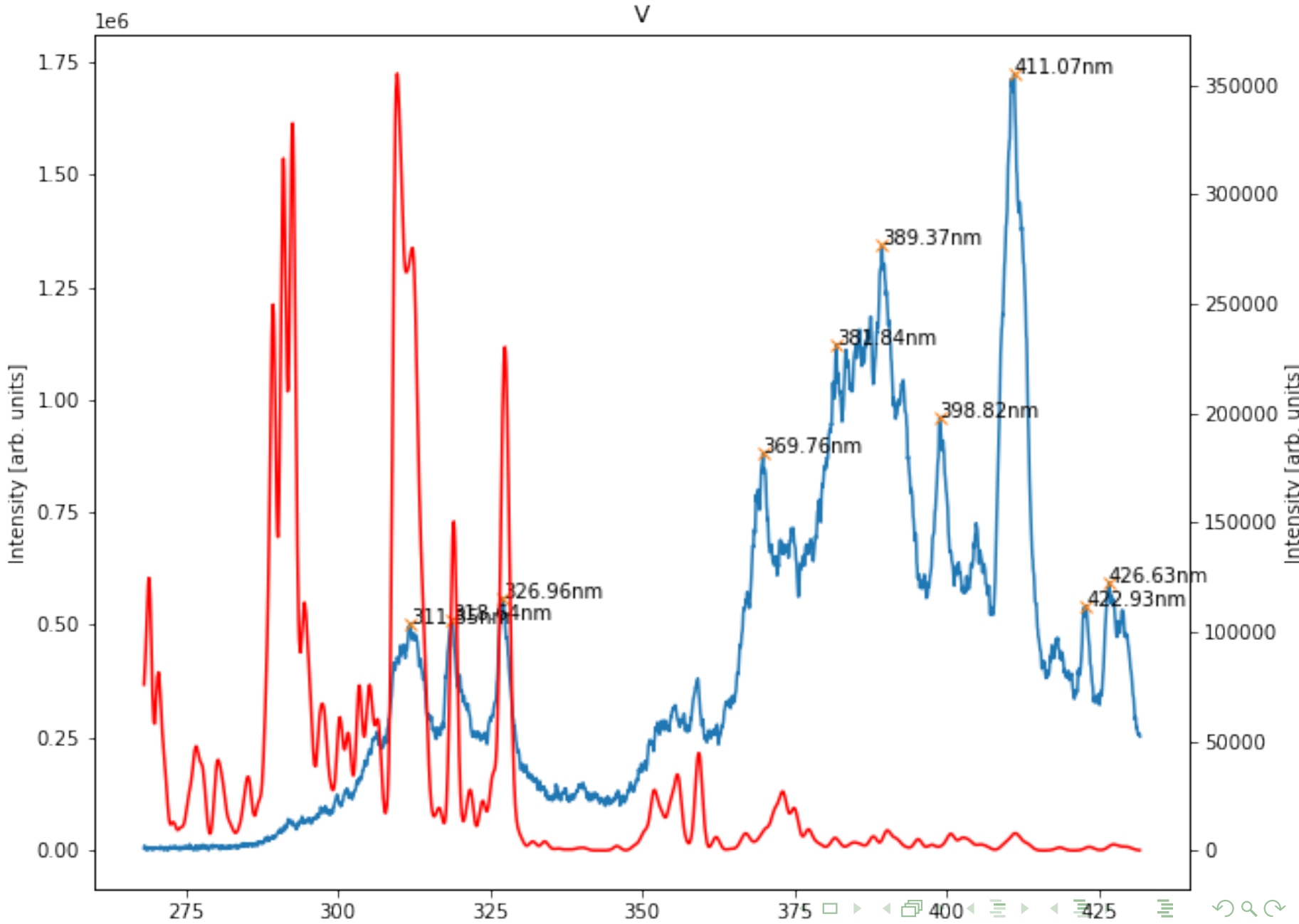

Fe
1e7
Intensity [arb. units]
2.0
1.5
1.0
0.5
0.0
175000
150000
125000
100000
75000
50000
25000
0
275
300
325
350
375
400
425
381.84nm
374.10nm
357.68nm
361.19nm
321.71nm
301.66nm
396.08nm
406.22nm
419.11nm

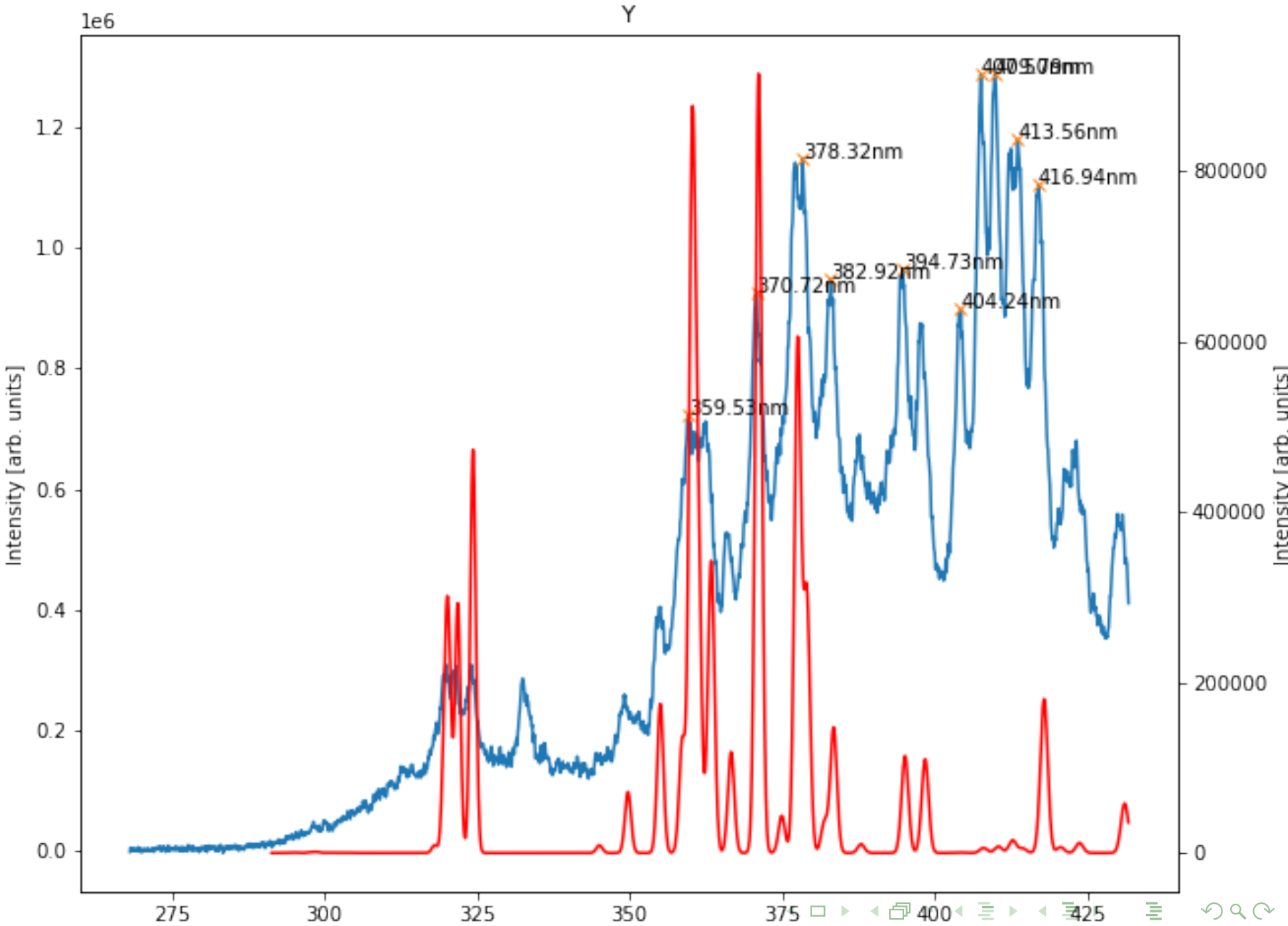

Hf
Intensity [arb. units]
70000
60000
50000
40000
30000
20000
10000
0
100000
80000
60000
40000
20000
0
275
300
325
350
375
400
425
405.46nm
416.04nm
428.79nm
380.17nm
367.52nm
356.20nm
349.74nm
361.70nm
339.25nm
330.80nm

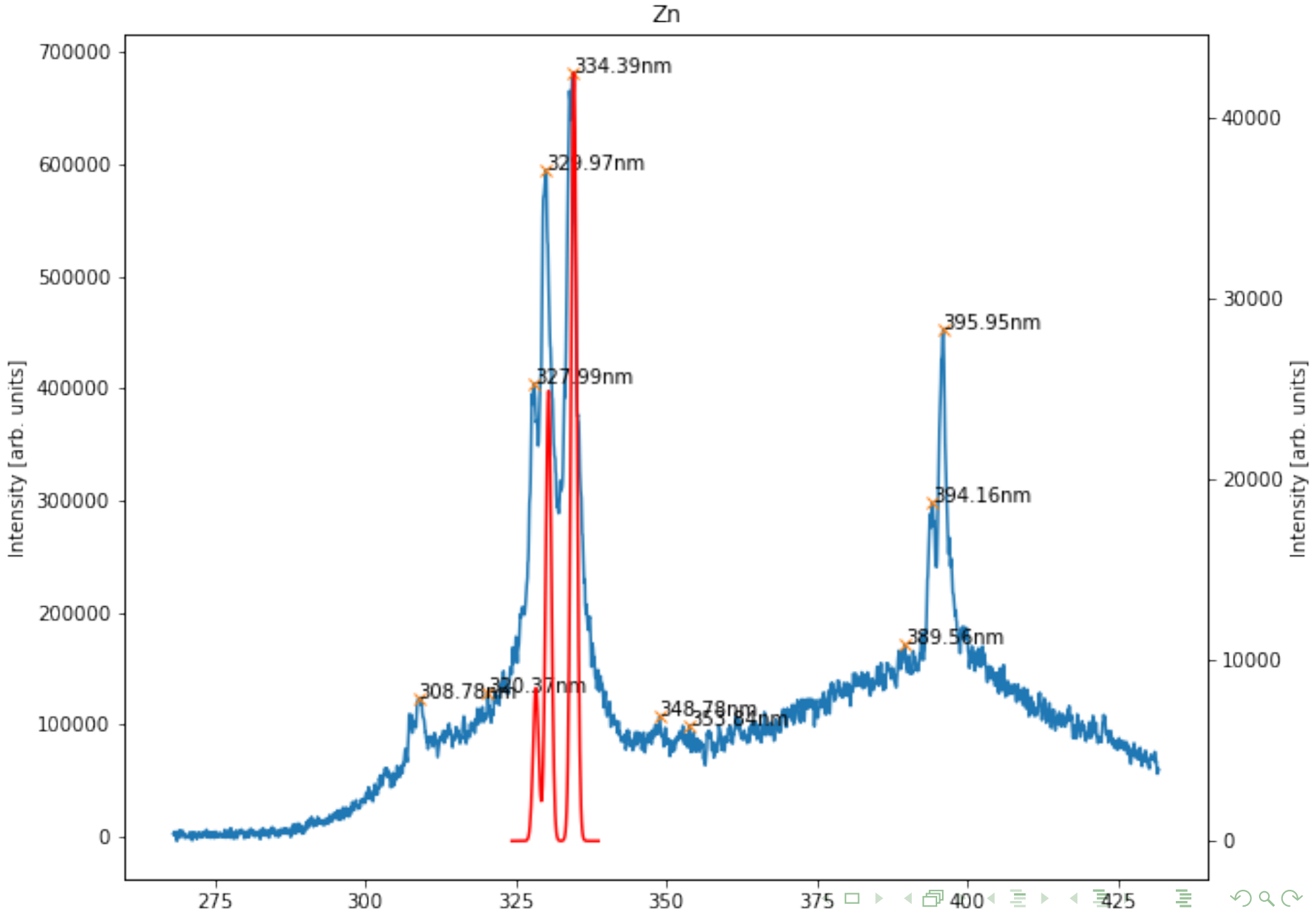

In
1e6
Intensity [arb. units]
Intensity [arb. units]
409.92nm
325.36nm
303.84nm
393.07nm
396.33nm
414.32nm
383.37nm
401.82nm
372.95nm
421.91nm
1.2
1.0
0.8
0.6
0.4
0.2
0.0
60000
50000
40000
30000
20000
10000
0
275
300
325
350
375
400
425

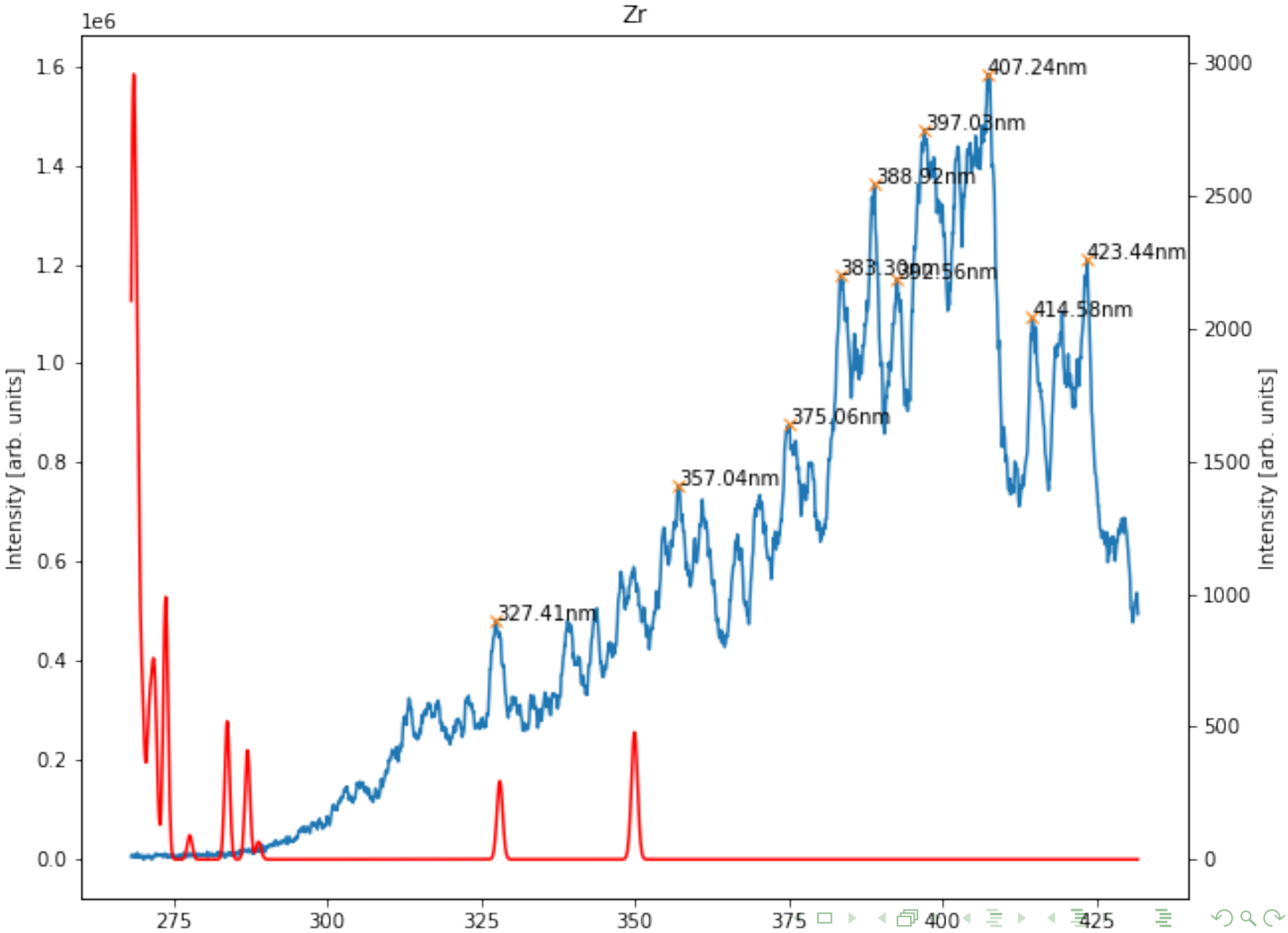

Nb
1e−11
Intensity [arb. units]
Intensity [arb. units]
100000
80000
60000
40000
20000
0
1.0
0.8
0.6
0.4
0.2
0.0
275
300
325
350
375
400
425
334.07nm
357.74nm
365.41nm
370.72nm
373.34nm
378.96nm
415.92nm
414.39nm

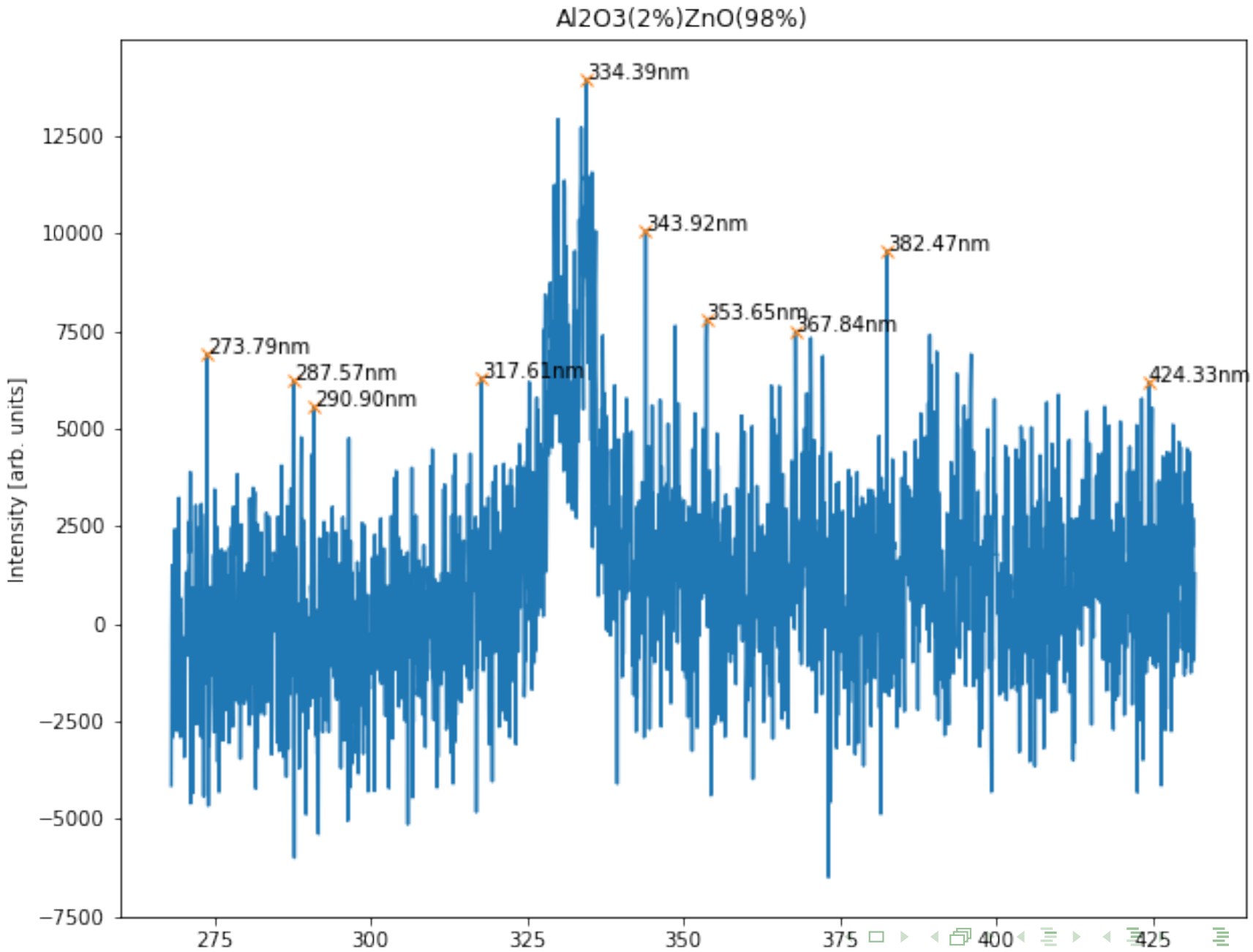

Ru
373.72nm
379.41nm
385.54nm
392.18nm
407.63nm
420.70nm
359.21nm
365.92nm
414.26nm
343.09nm
Intensity [arb. units]
Intensity [arb. units]
0
100000
200000
300000
400000
500000
600000
0
5000
10000
15000
20000
25000
275
300
325
350
375
400
425

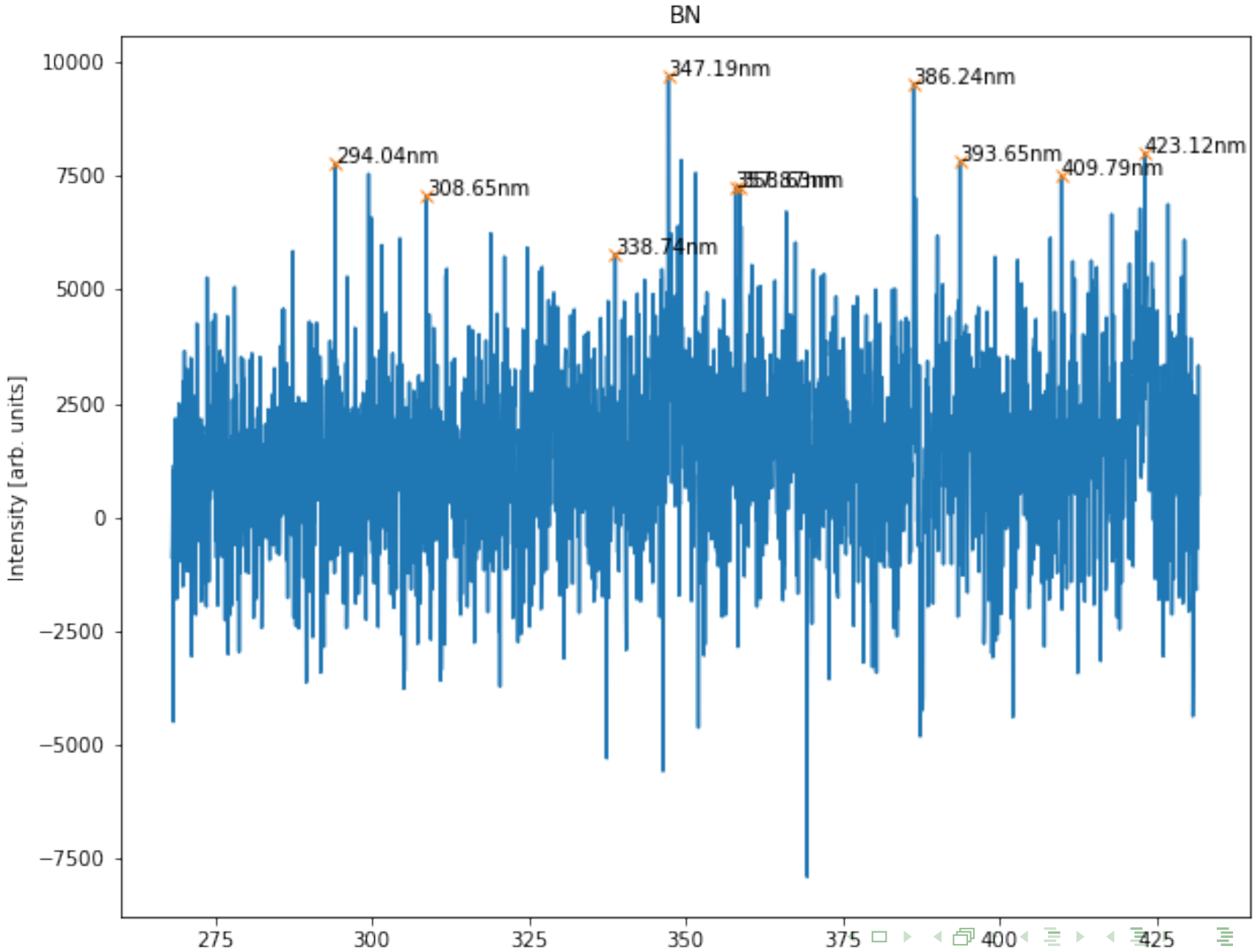

V
1e6
Intensity [arb. units]
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
350000
300000
250000
200000
150000
100000
50000
0
275
300
325
350
375
400
425
411.07nm
389.37nm
381.84nm
398.82nm
369.76nm
326.96nm
426.63nm
422.93nm

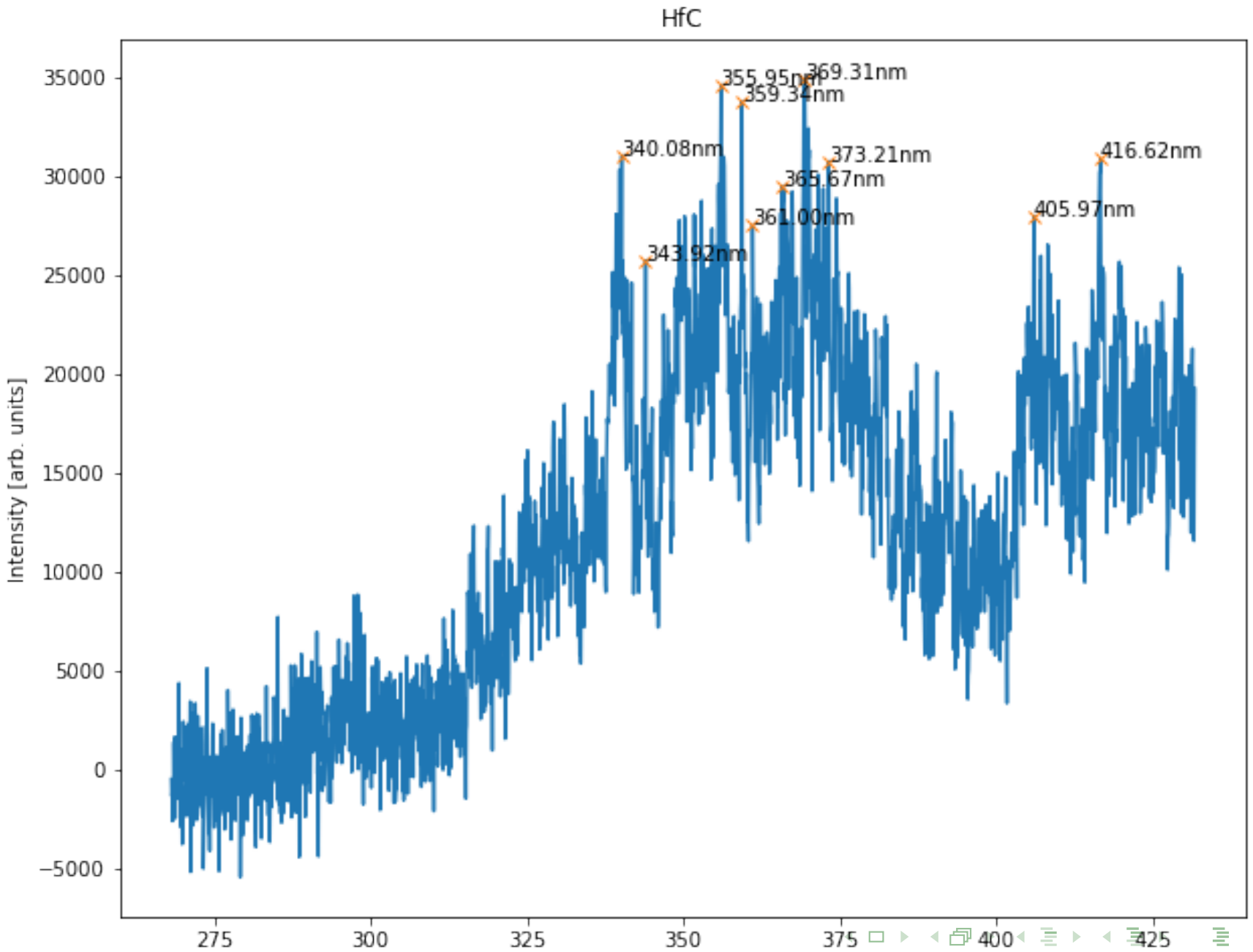

Y
1e6
Intensity [arb. units]
Intensity [arb. units]
359.53nm
370.72nm
378.32nm
382.92nm
394.73nm
404.24nm
413.56nm
416.94nm
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0
200000
400000
600000
800000
275
300
325
350
375
400
425

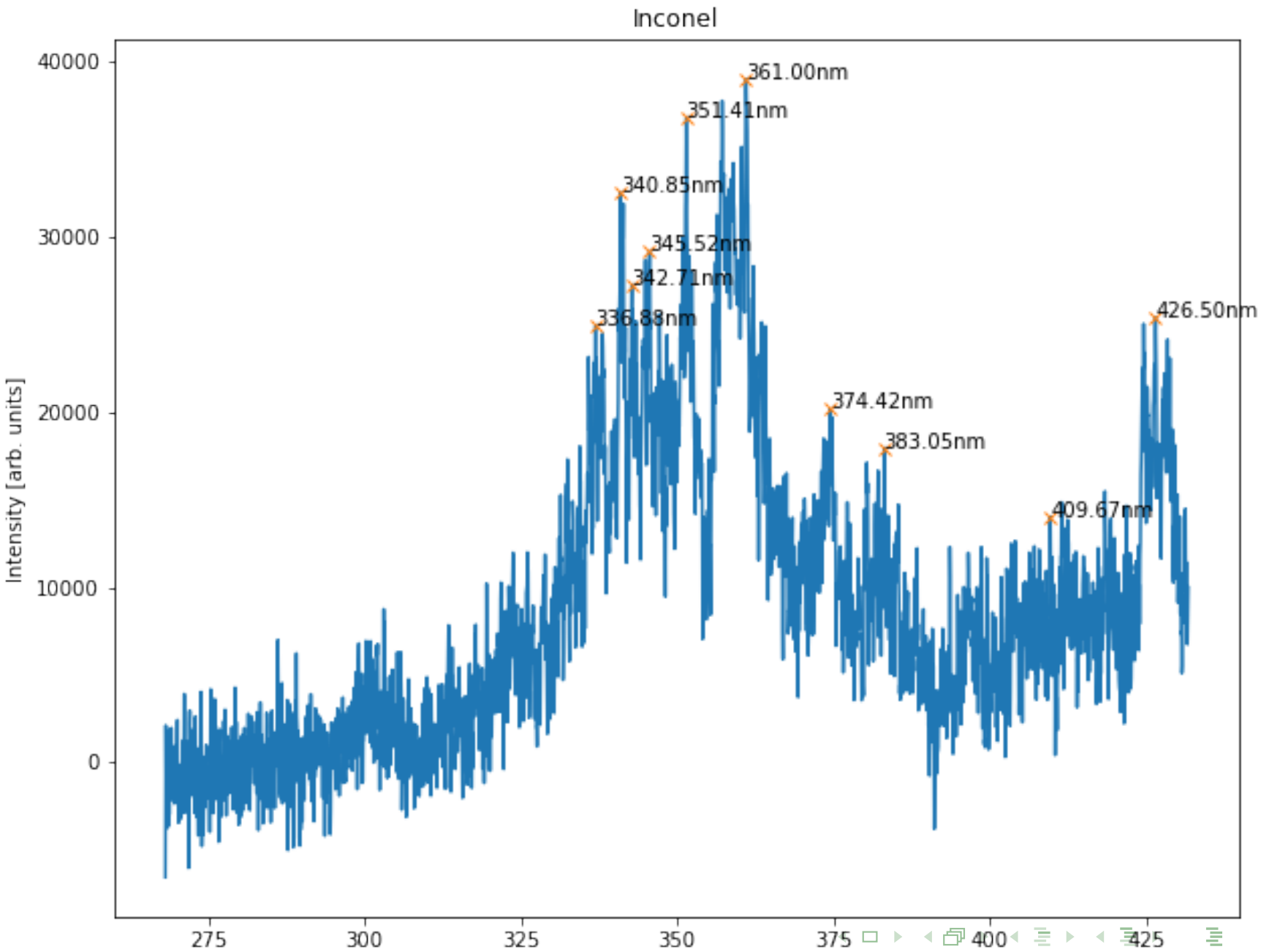

Zn
334.39nm
329.97nm
327.99nm
395.95nm
394.16nm
389.56nm
308.78nm
330.37nm
348.78nm
353.84nm
Intensity [arb. units]
Intensity [arb. units]
700000
600000
500000
400000
300000
200000
100000
0
40000
30000
20000
10000
0
275
300
325
350
375
400
425

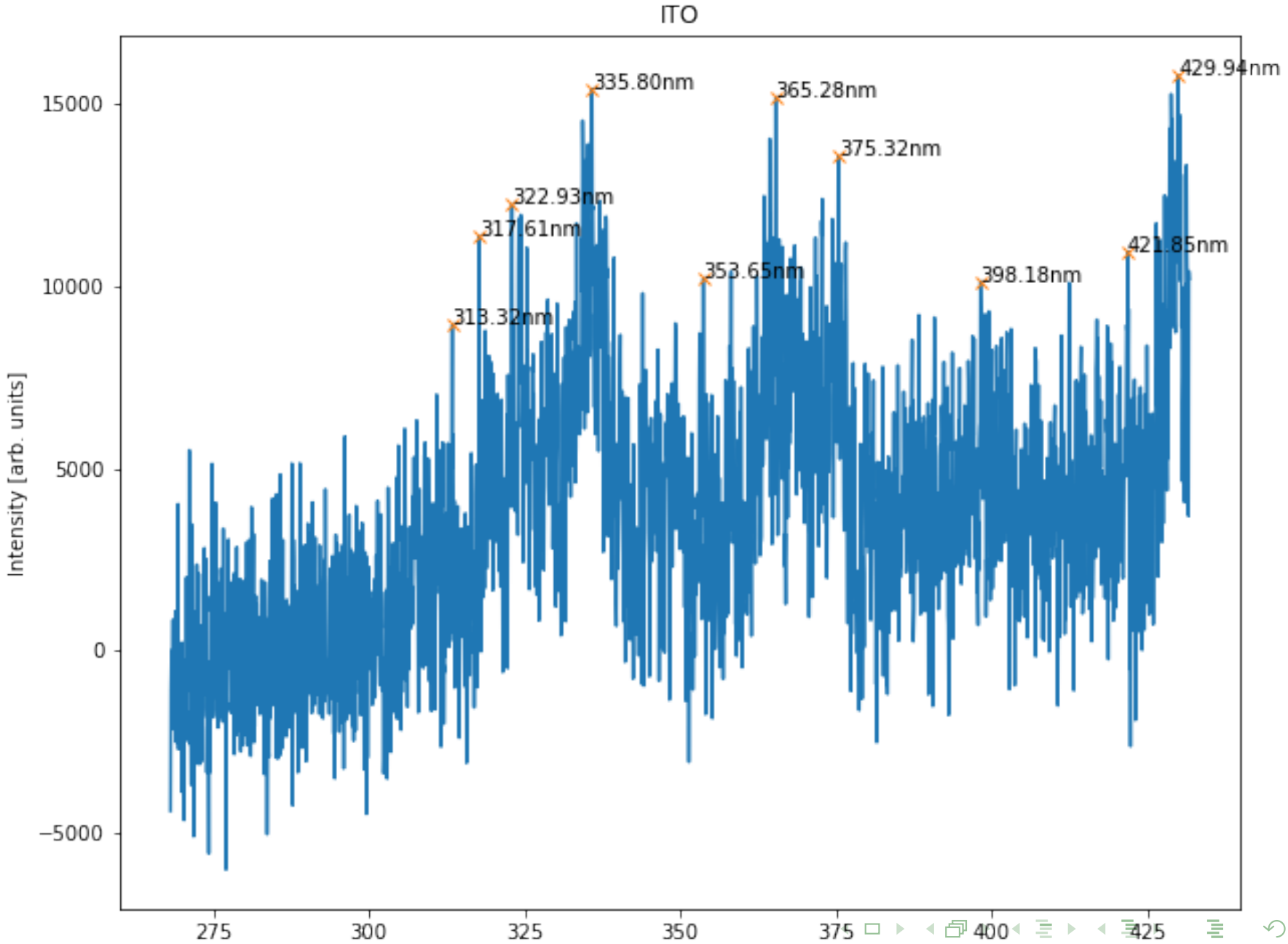

Zr
1e6
Intensity [arb. units]
Intensity [arb. units]
407.24nm
397.03nm
388.92nm
383.30nm
392.56nm
423.44nm
414.58nm
375.06nm
357.04nm
327.41nm
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
3000
2500
2000
1500
1000
500
0
275
300
325
350
375
400
425

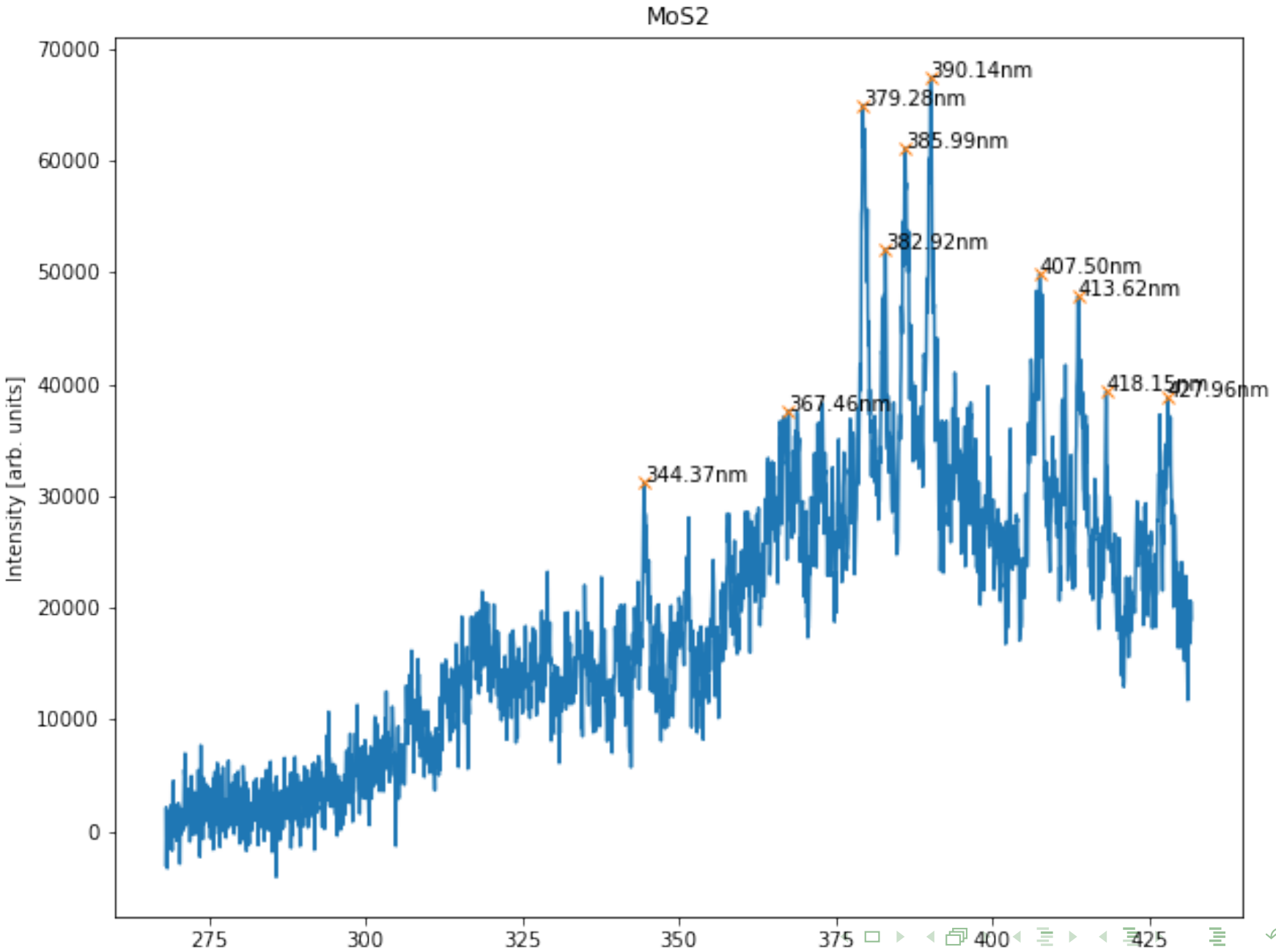

Al2O3(2%)ZnO(98%)
Intensity [arb. units]
334.39nm
343.92nm
382.47nm
353.65nm
367.84nm
273.79nm
287.57nm
290.90nm
317.61nm
424.33nm
12500
10000
7500
5000
2500
0
−2500
−5000
−7500
275
300
325
350
375
400
425

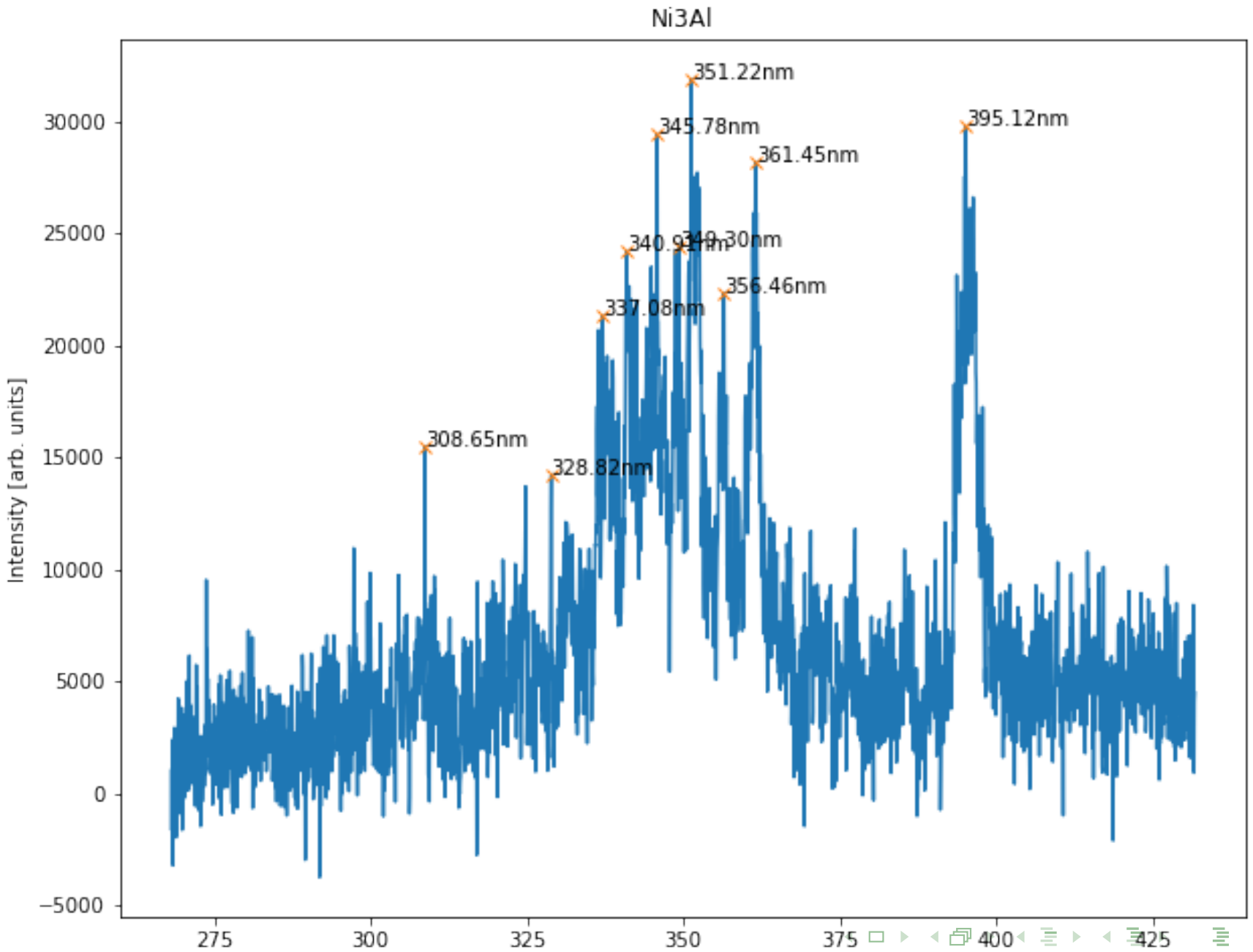

BN
Intensity [arb. units]
10000
7500
5000
2500
0
−2500
−5000
−7500
275
300
325
350
375
400
425
294.04nm
308.65nm
338.74nm
347.19nm
386.24nm
393.65nm
409.79nm
423.12nm

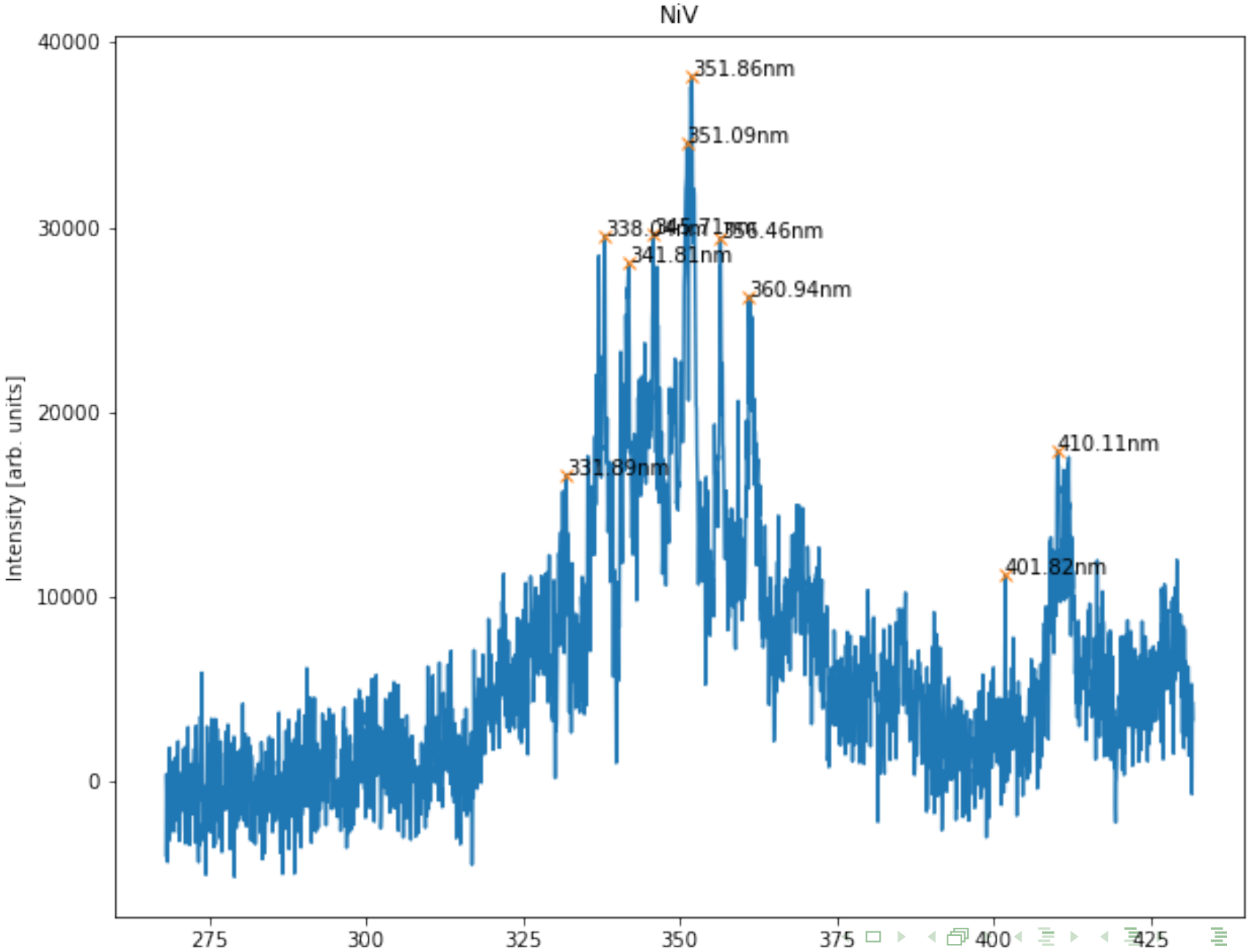

HfC
Intensity [arb. units]
35000
30000
25000
20000
15000
10000
5000
0
−5000
275
300
325
350
375
400
425
355.95nm
359.34nm
369.31nm
340.08nm
373.21nm
365.67nm
361.00nm
343.92nm
405.97nm
416.62nm

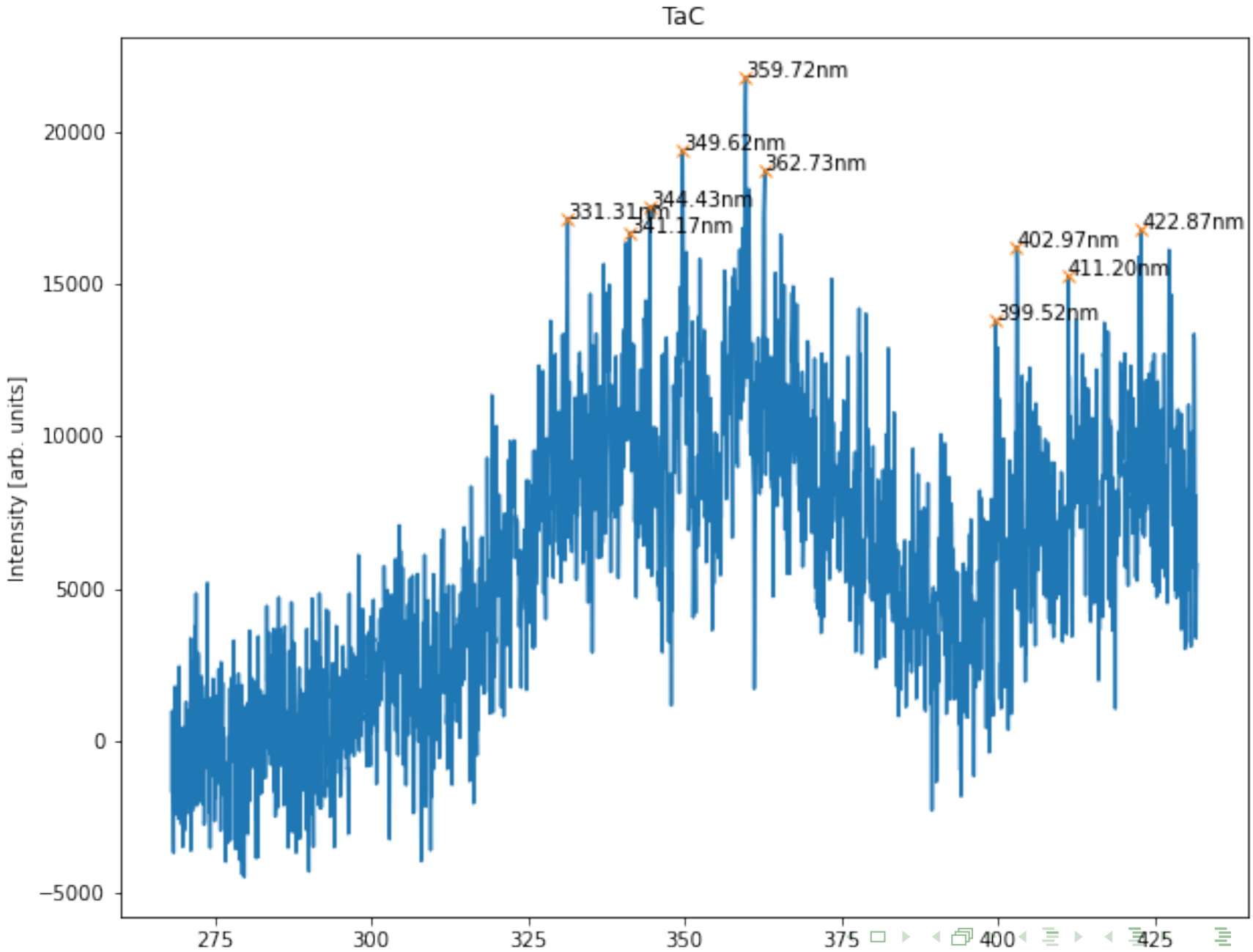

Inconel
Intensity [arb. units]
40000
30000
20000
10000
0
275
300
325
350
375
400
425
361.00nm
351.41nm
340.85nm
345.52nm
342.71nm
336.88nm
374.42nm
383.05nm
409.67nm
426.50nm

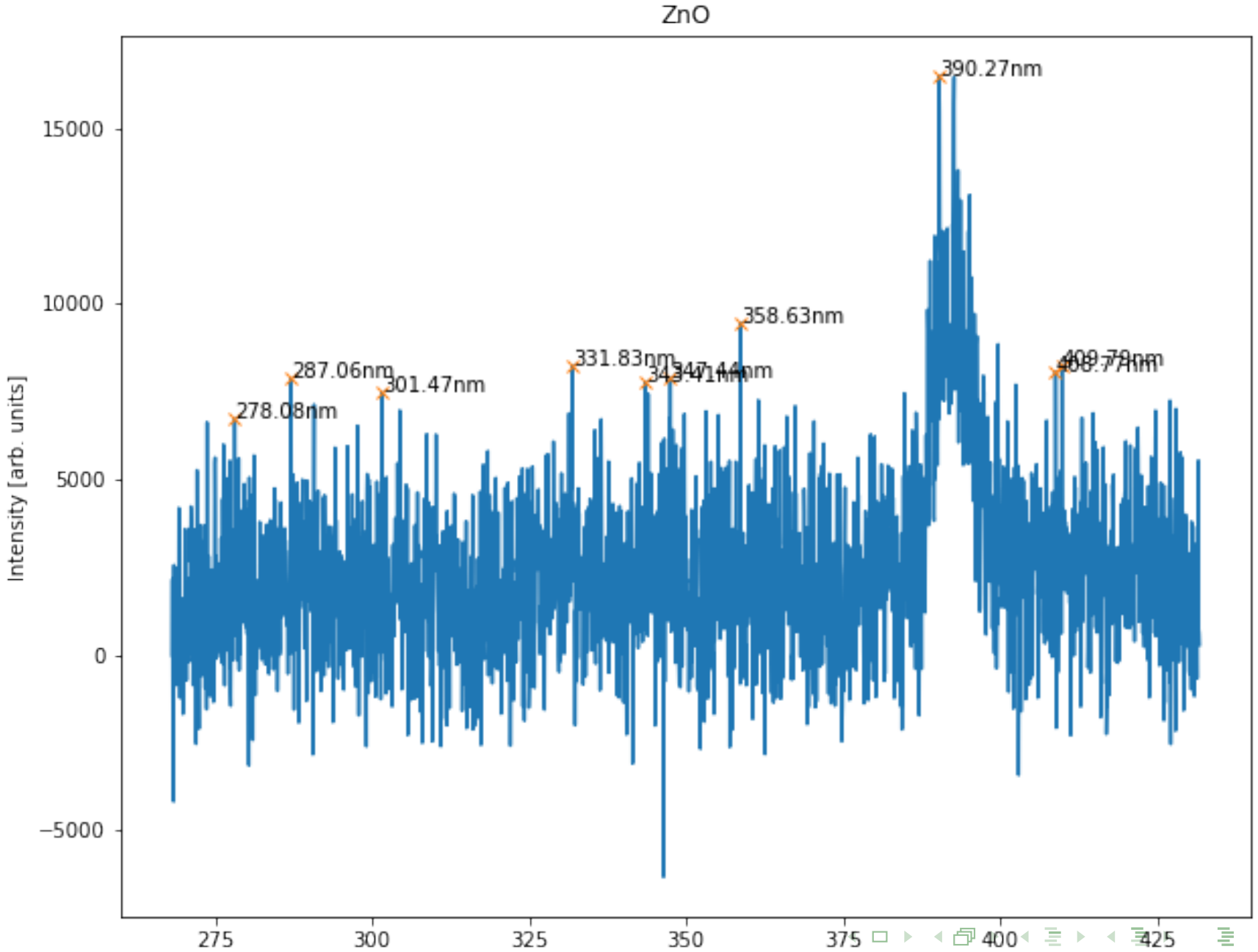

ITO
335.80nm
365.28nm
429.94nm
375.32nm
322.93nm
317.61nm
421.85nm
353.65nm
398.18nm
313.32nm
15000
10000
5000
0
−5000
Intensity [arb. units]
275
300
325
350
375
400
425


MoS2
Intensity [arb. units]
70000
60000
50000
40000
30000
20000
10000
0
275
300
325
350
375
400
425
390.14nm
379.28nm
385.99nm
382.92nm
407.50nm
413.62nm
418.15nm
427.96nm
367.46nm
344.37nm

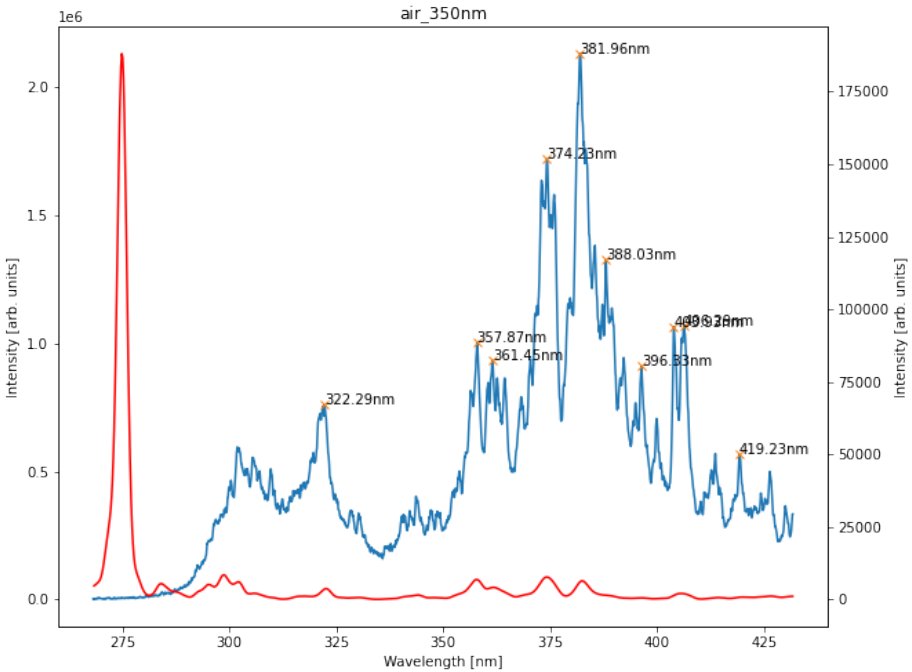

Ni3Al
351.22nm
345.78nm
361.45nm
395.12nm
340.91nm
349.30nm
356.46nm
337.08nm
308.65nm
328.82nm
Intensity [arb. units]
30000
25000
20000
15000
10000
5000
0
−5000
275
300
325
350
375
400
425

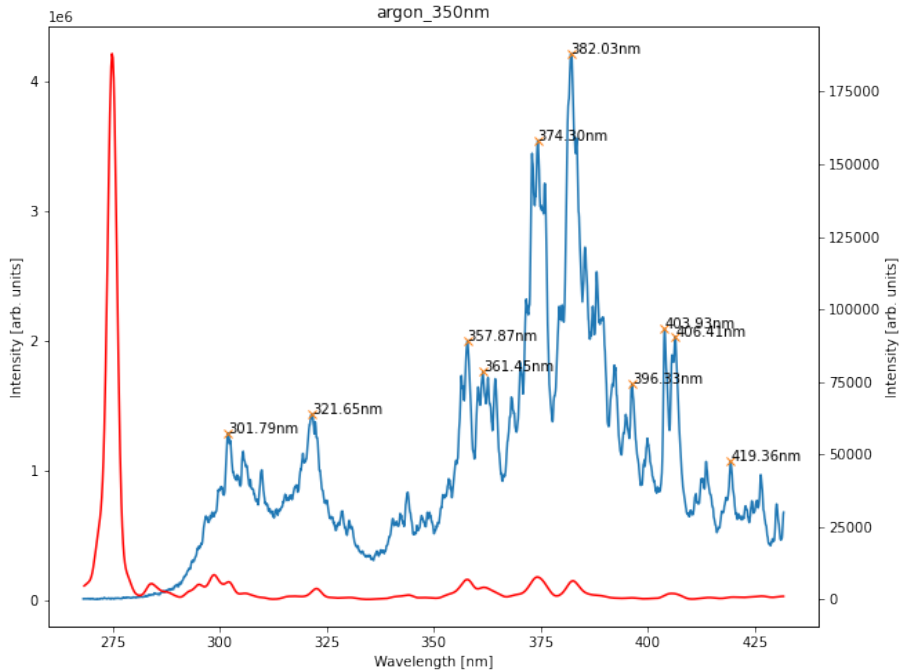

NiV
Intensity [arb. units]
40000
30000
20000
10000
0
275
300
325
350
375
400
425
351.86nm
351.09nm
338.04nm
345.71nm
356.46nm
341.81nm
360.94nm
331.89nm
410.11nm
401.82nm


TaC
359.72nm
349.62nm
362.73nm
344.43nm
331.31nm
341.17nm
402.97nm
422.87nm
411.20nm
399.52nm
Intensity [arb. units]
20000
15000
10000
5000
0
−5000
275
300
325
350
375
400
425

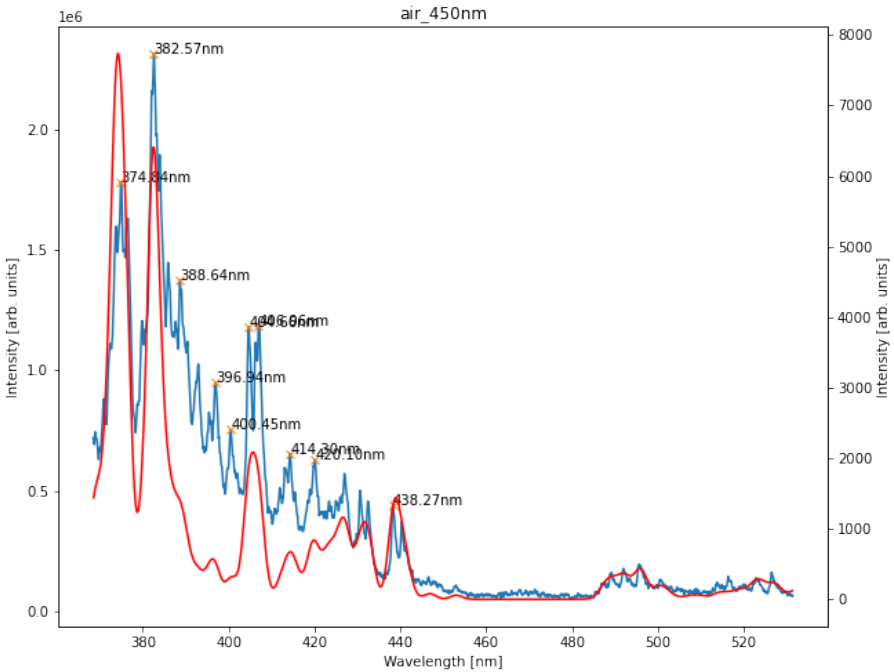

ZnO
Intensity [arb. units]
15000
10000
5000
0
−5000
275
300
325
350
375
400
425
278.08nm
287.06nm
301.47nm
331.83nm
358.63nm
390.27nm

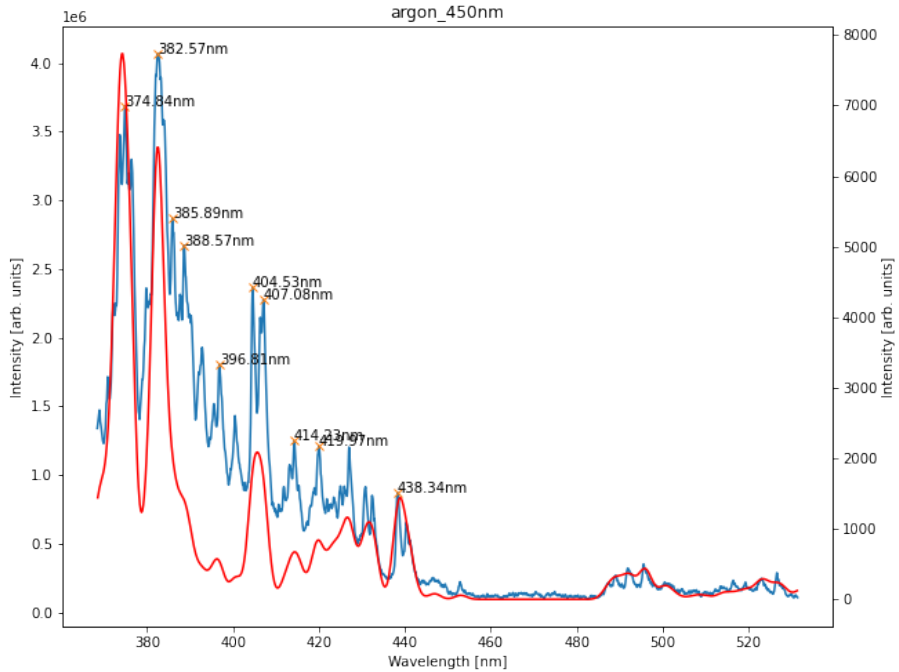
Fe Argon/Air Test



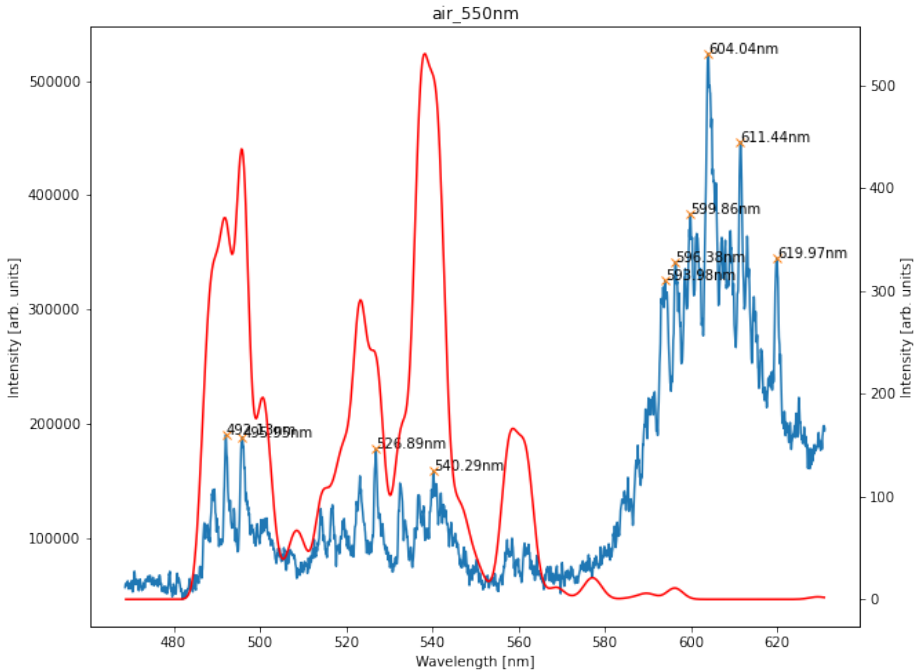


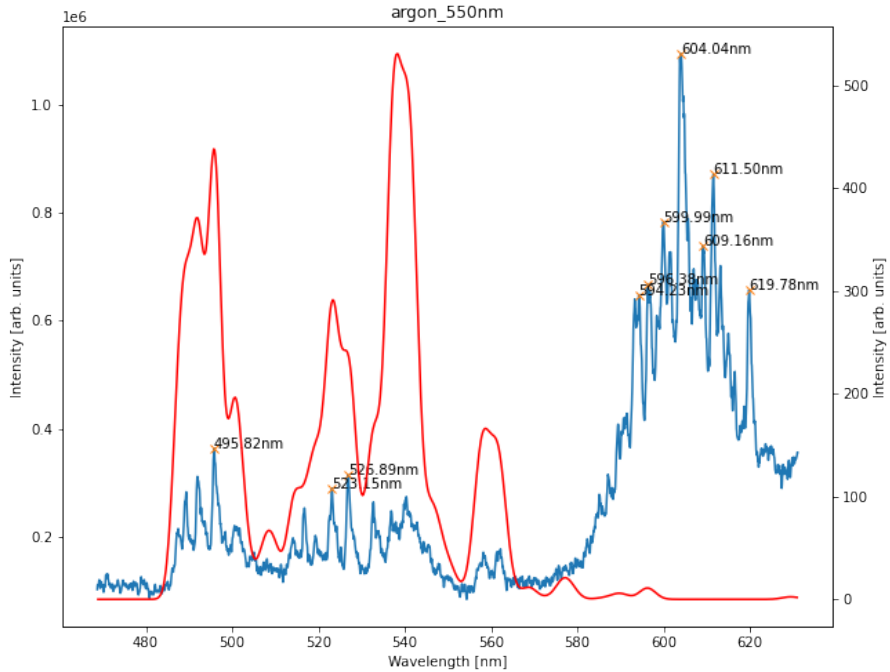
Fe Argon/Air Test

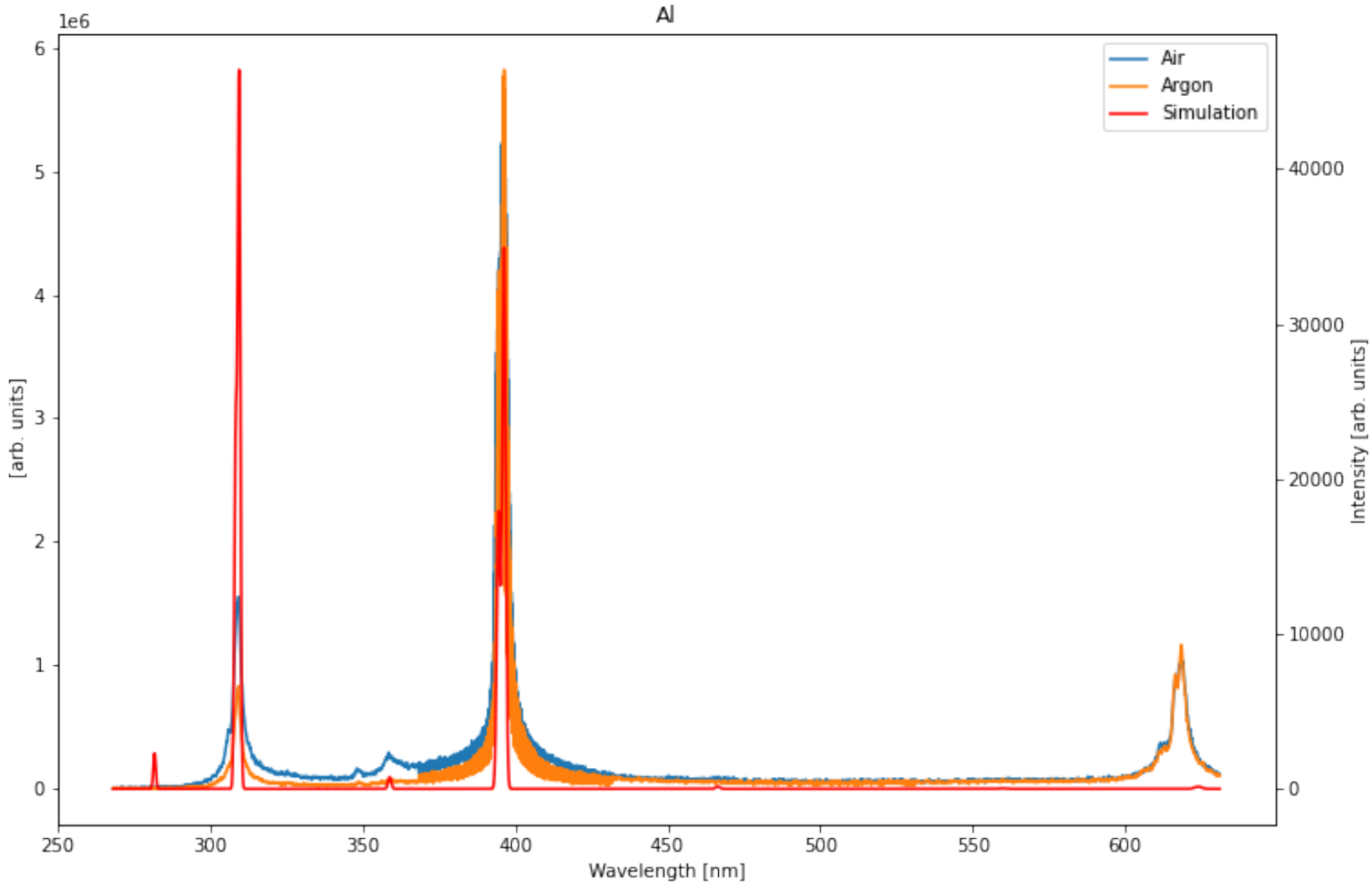


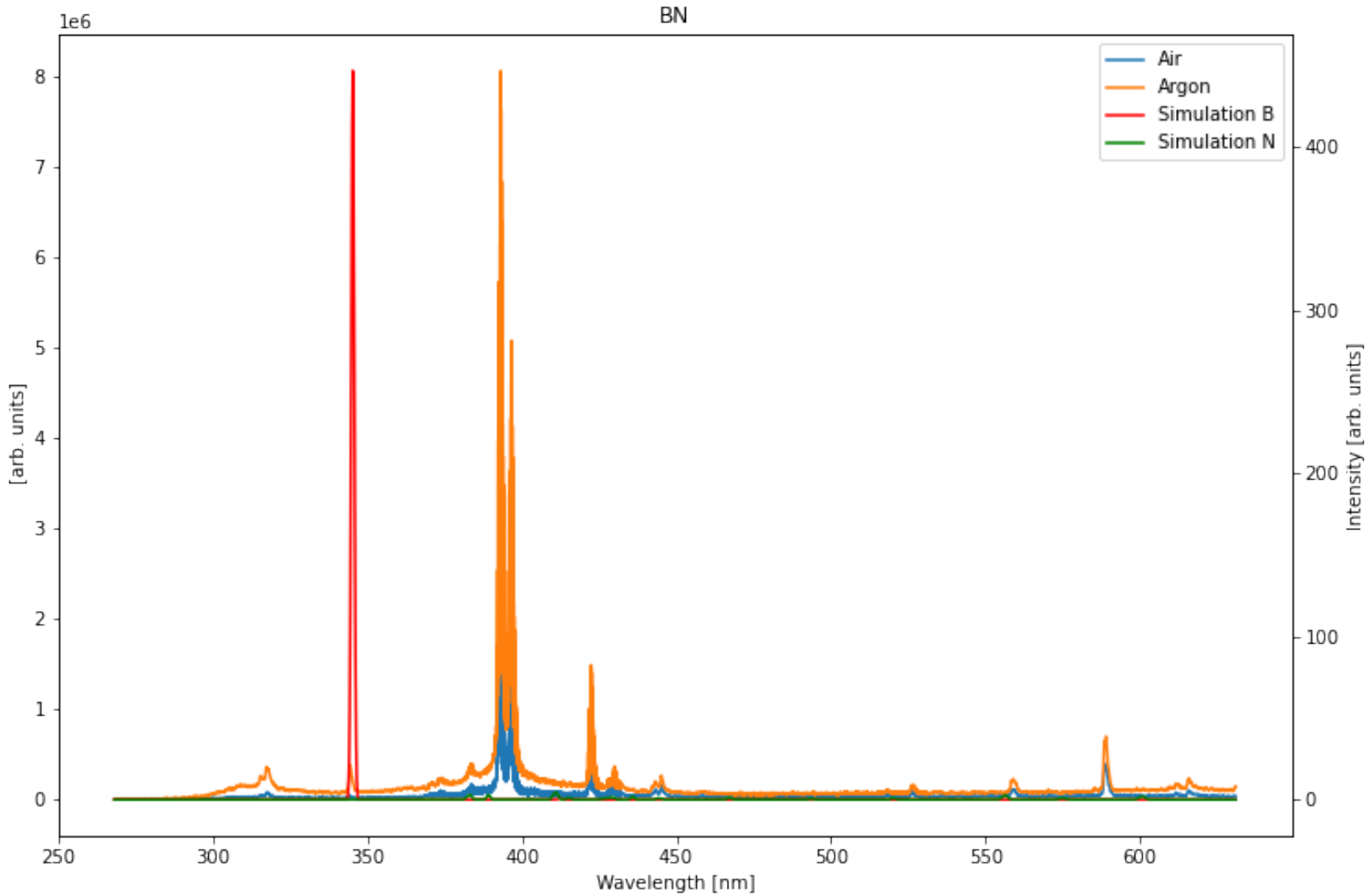


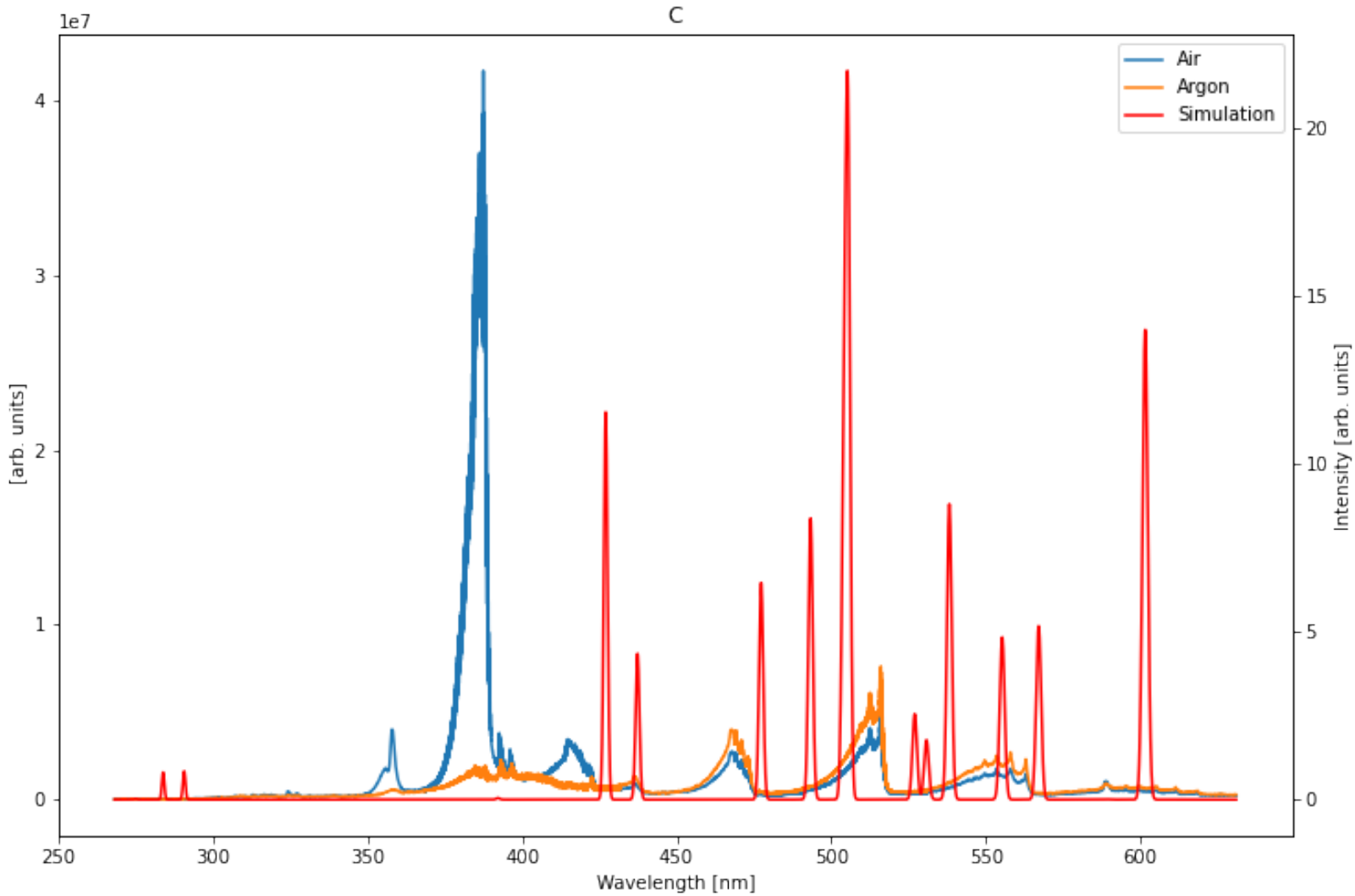
Fe Argon/Air Test

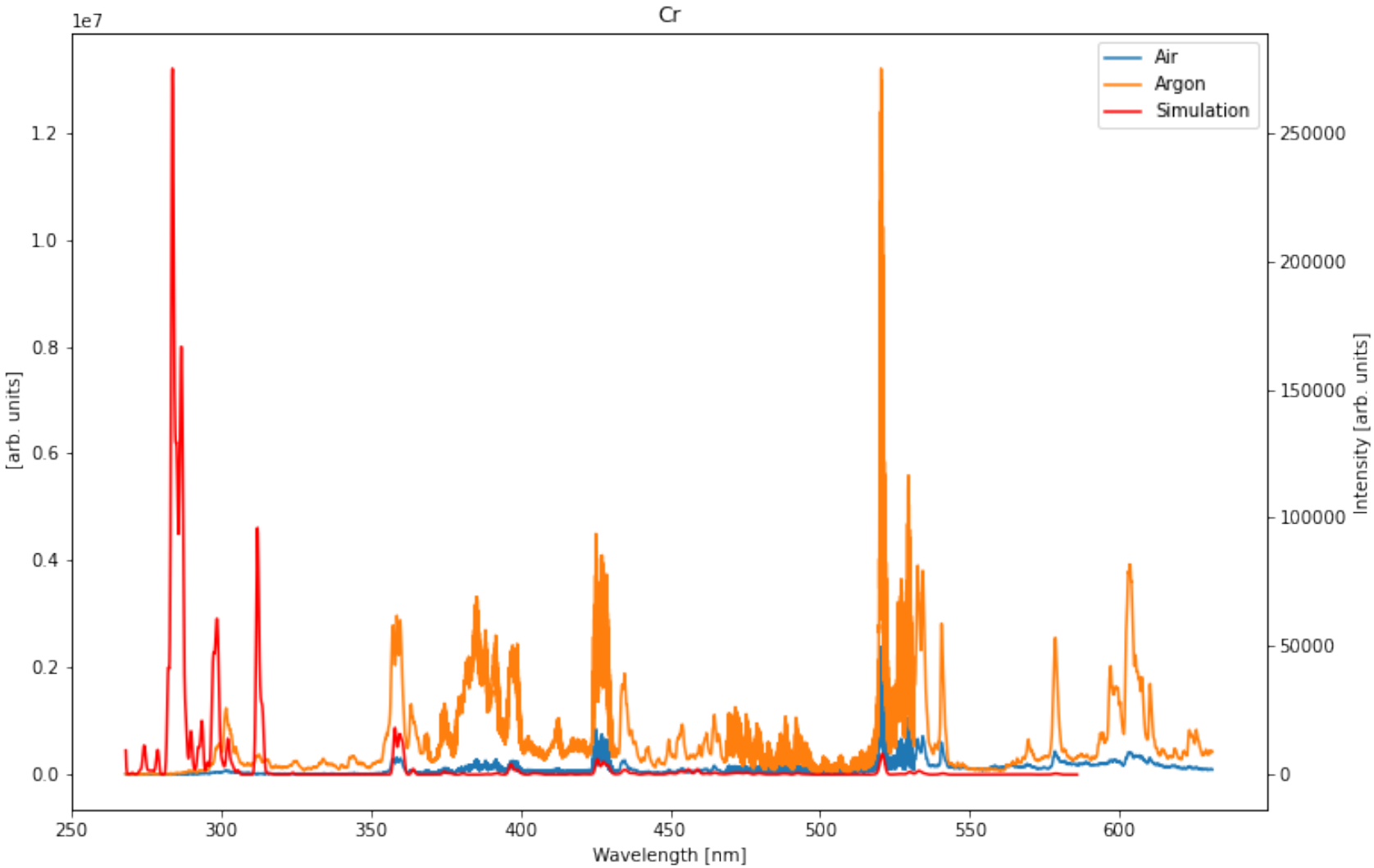


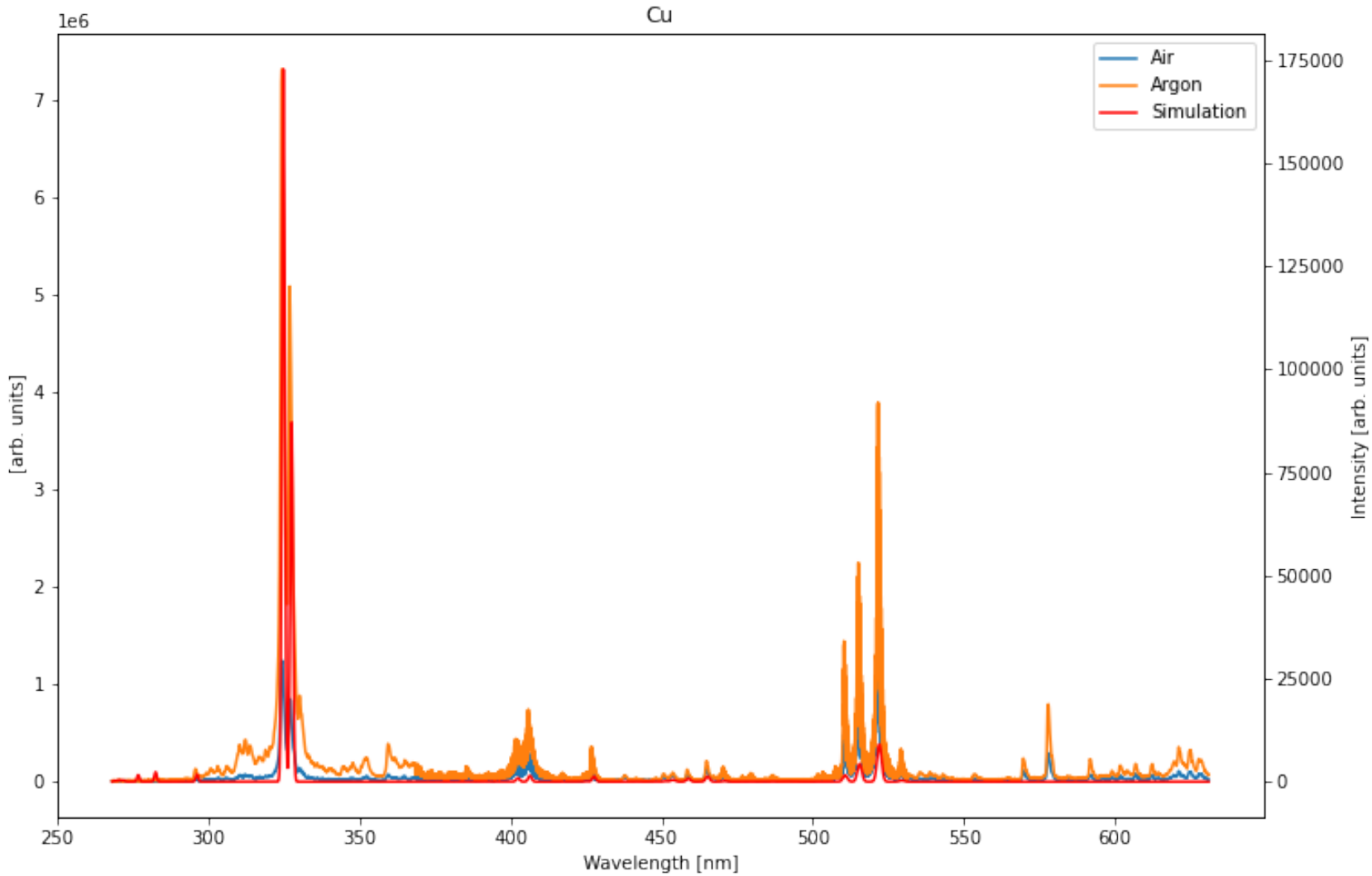


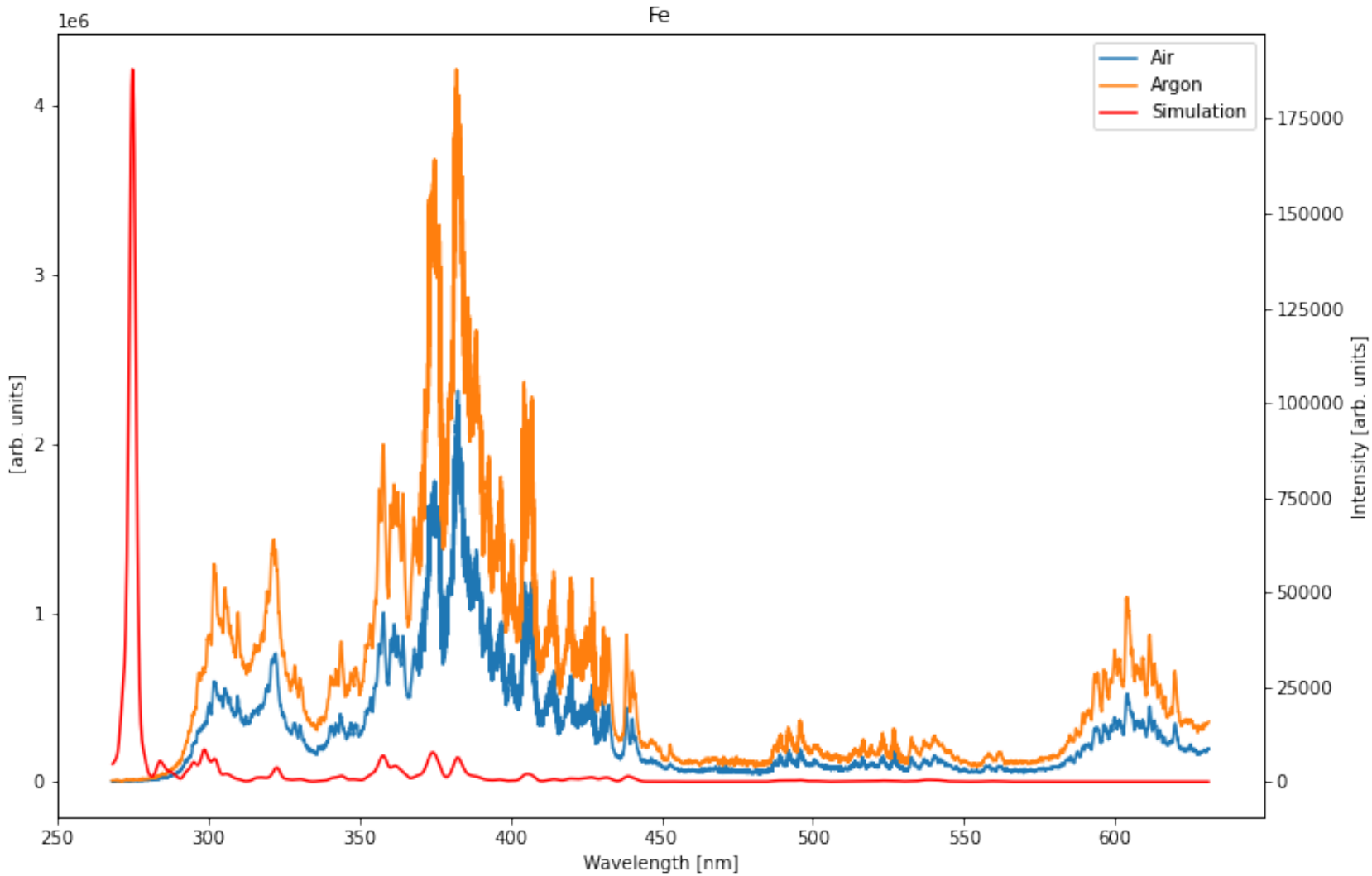

Al
1e6
Air
Argon
Simulation
[arb. units]
Intensity [arb. units]
Wavelength [nm]
0
1
2
3
4
5
6
0
10000
20000
30000
40000
250
300
350
400
450
500
550
600

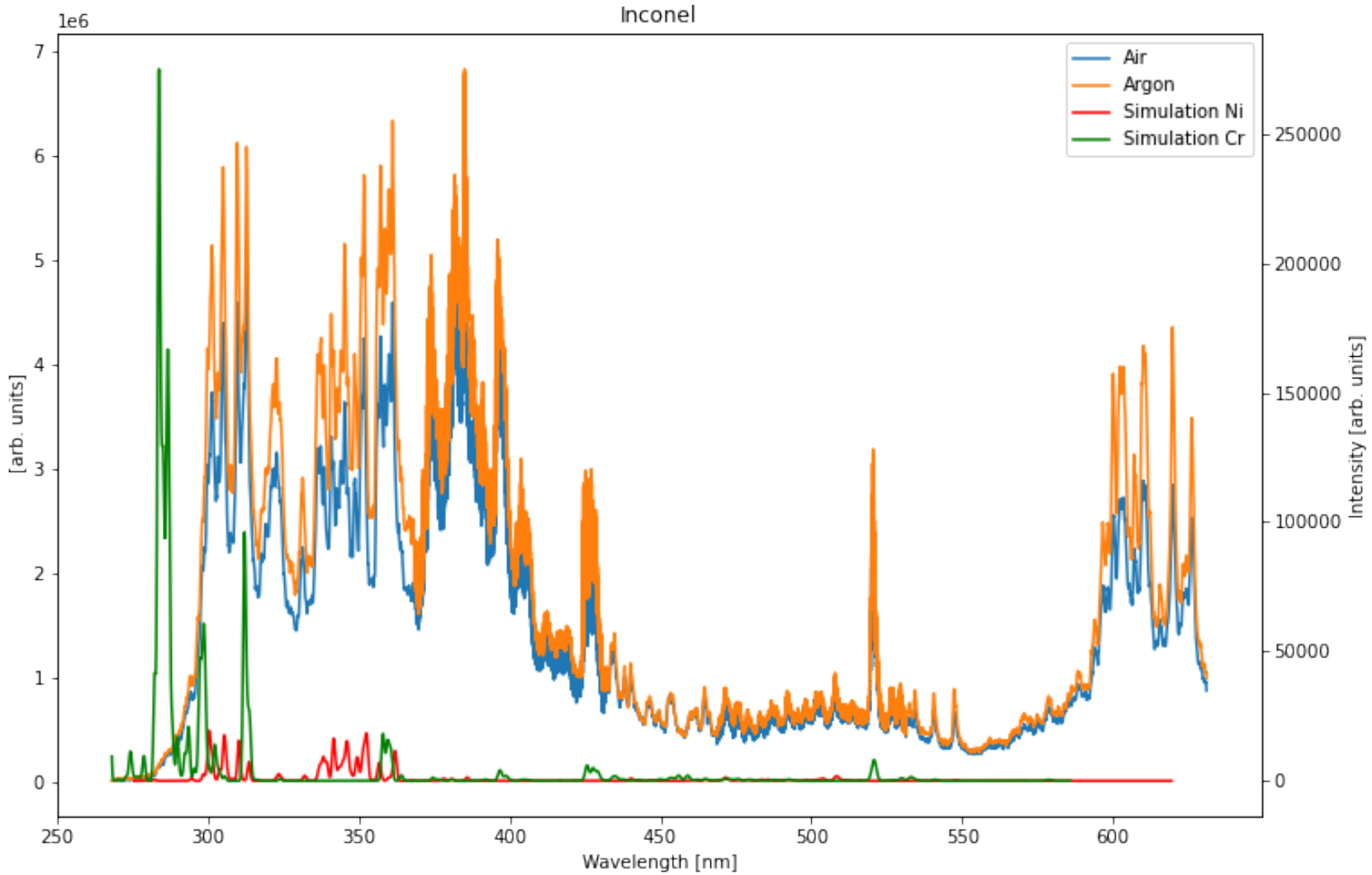

BN
1e6
Air
Argon
Simulation B
Simulation N
[arb. units]
Intensity [arb. units]
Wavelength [nm]
0
1
2
3
4
5
6
7
8
0
100
200
300
400
250
300
350
400
450
500
550
600

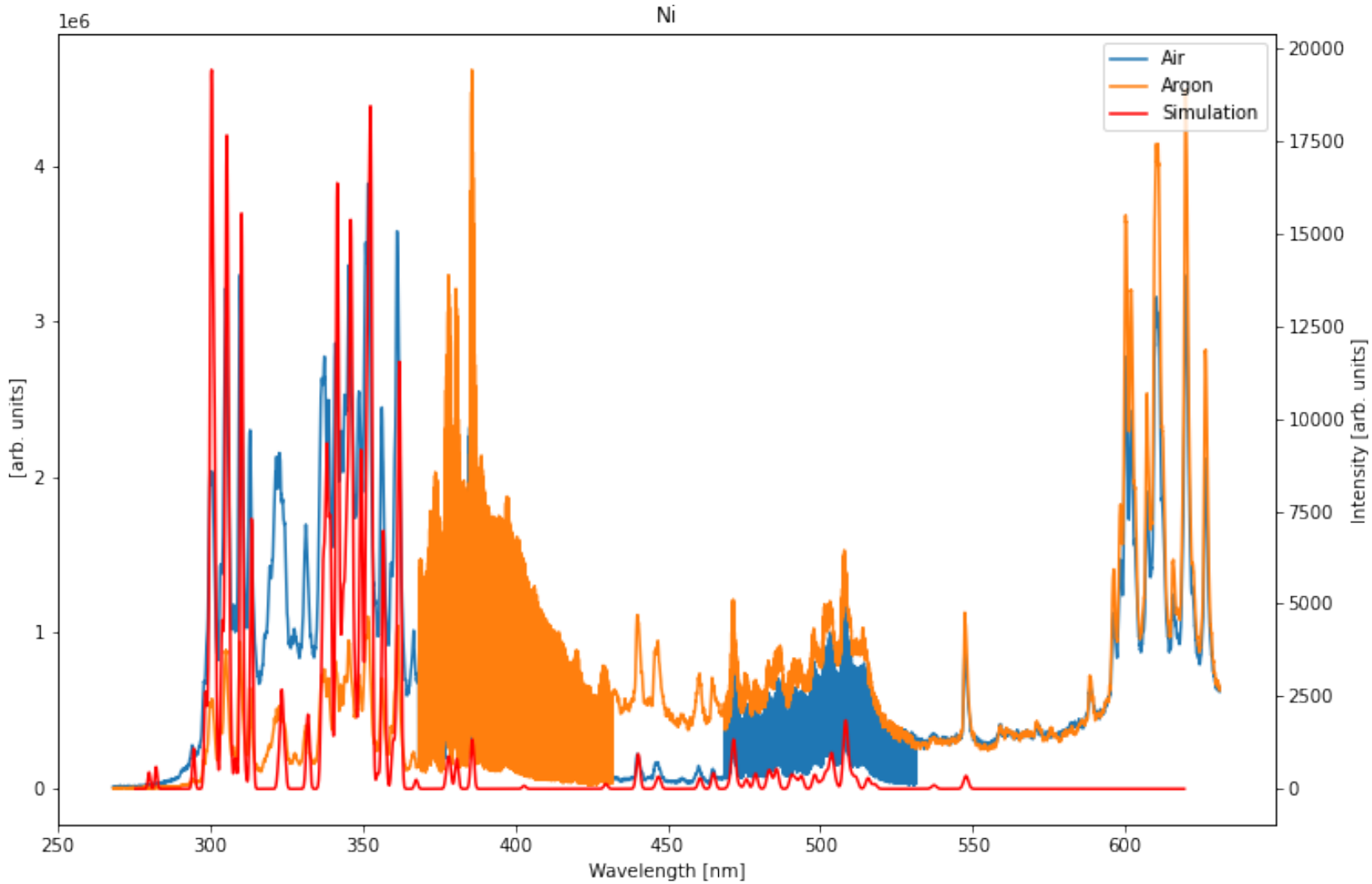

C
1e7
Air
Argon
Simulation
[arb. units]
Intensity [arb. units]
Wavelength [nm]
0
1
2
3
4
0
5
10
15
20
250
300
350
400
450
500
550
600

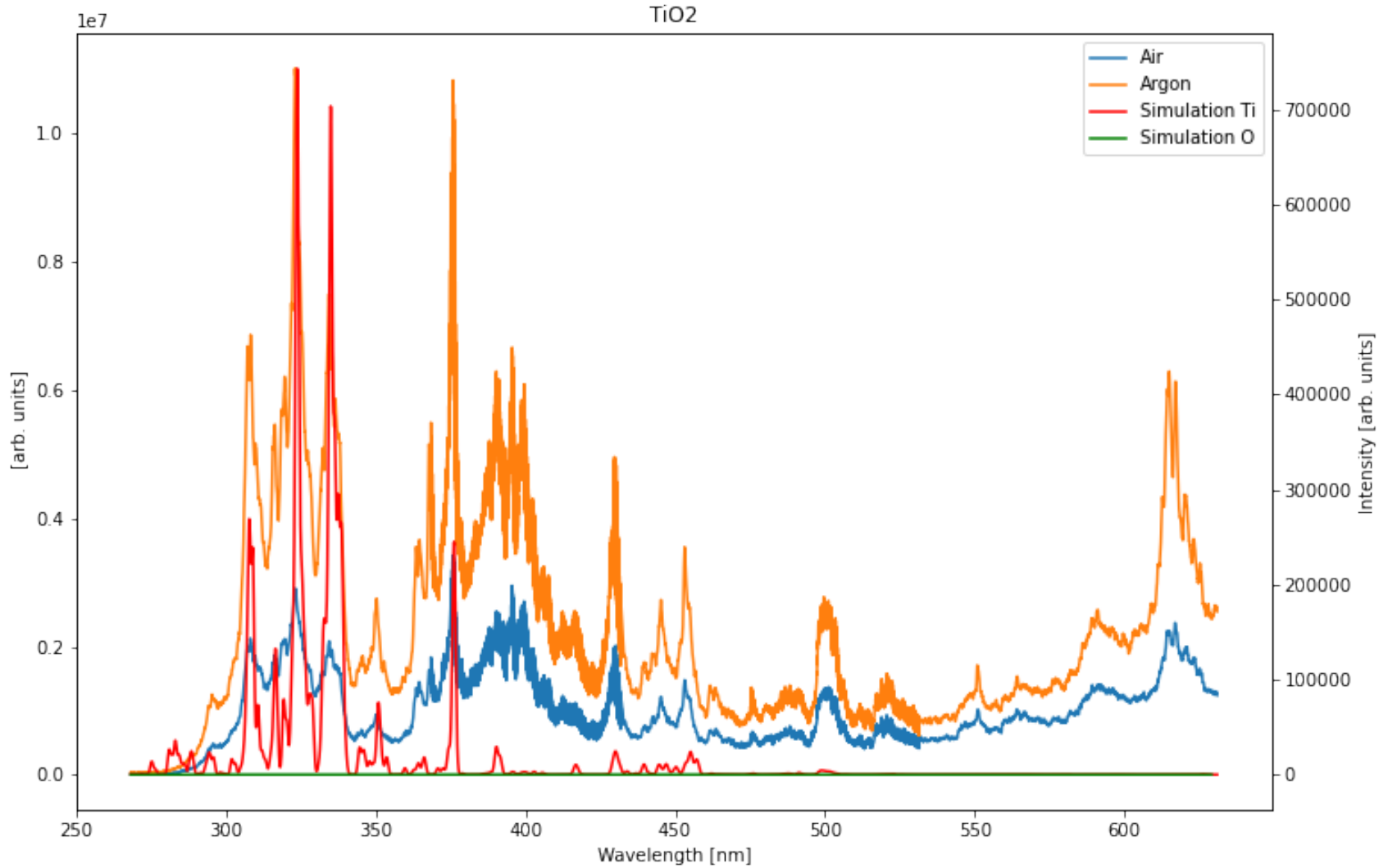

Cr
1e7
Air
Argon
Simulation
[arb. units]
Intensity [arb. units]
Wavelength [nm]
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0
50000
100000
150000
200000
250000
250
300
350
400
450
500
550
600

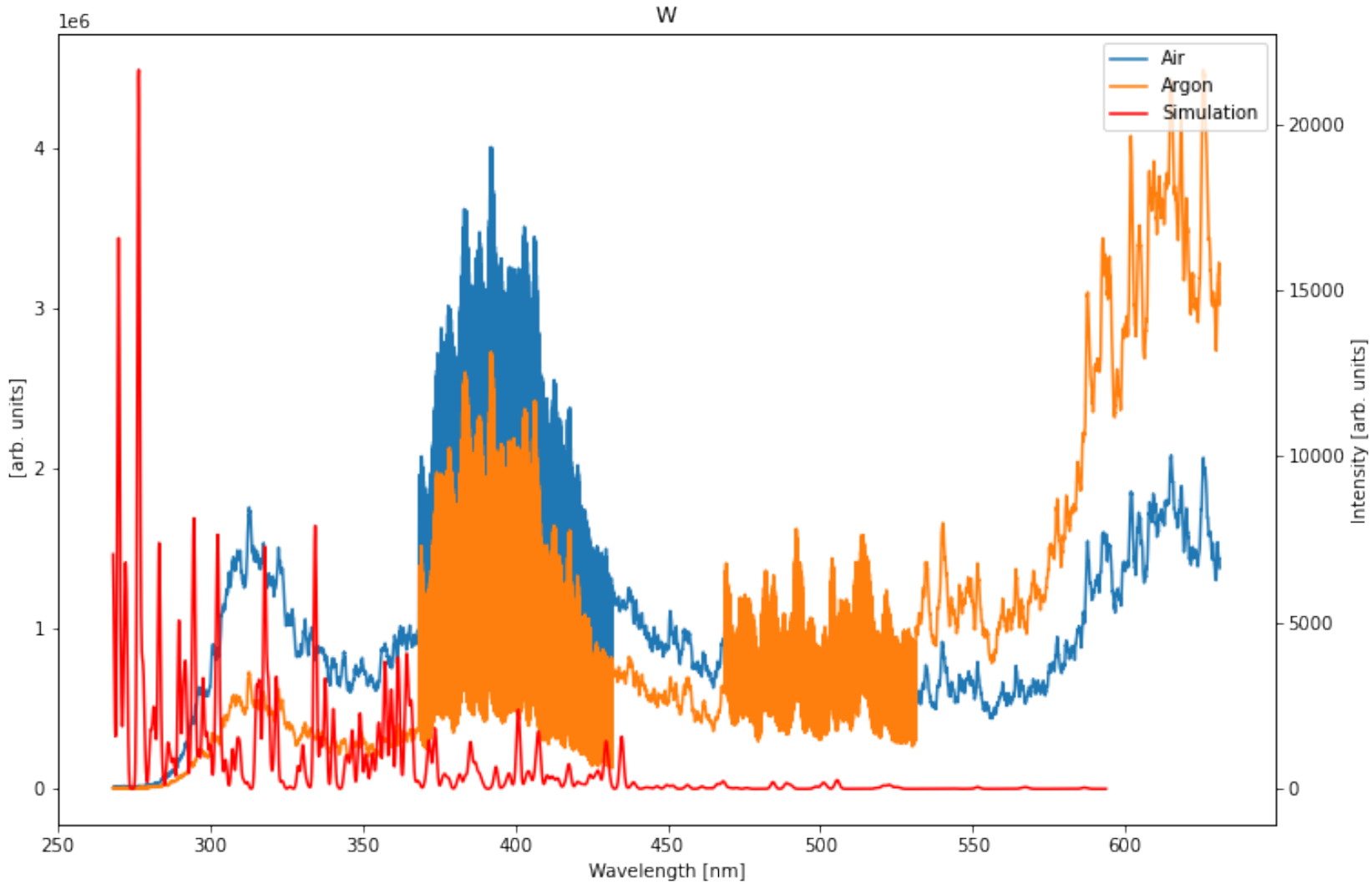

Cu
1e6
Air
Argon
Simulation
[arb. units]
Intensity [arb. units]
Wavelength [nm]
0
1
2
3
4
5
6
7
0
25000
50000
75000
100000
125000
150000
175000
250
300
350
400
450
500
550
600

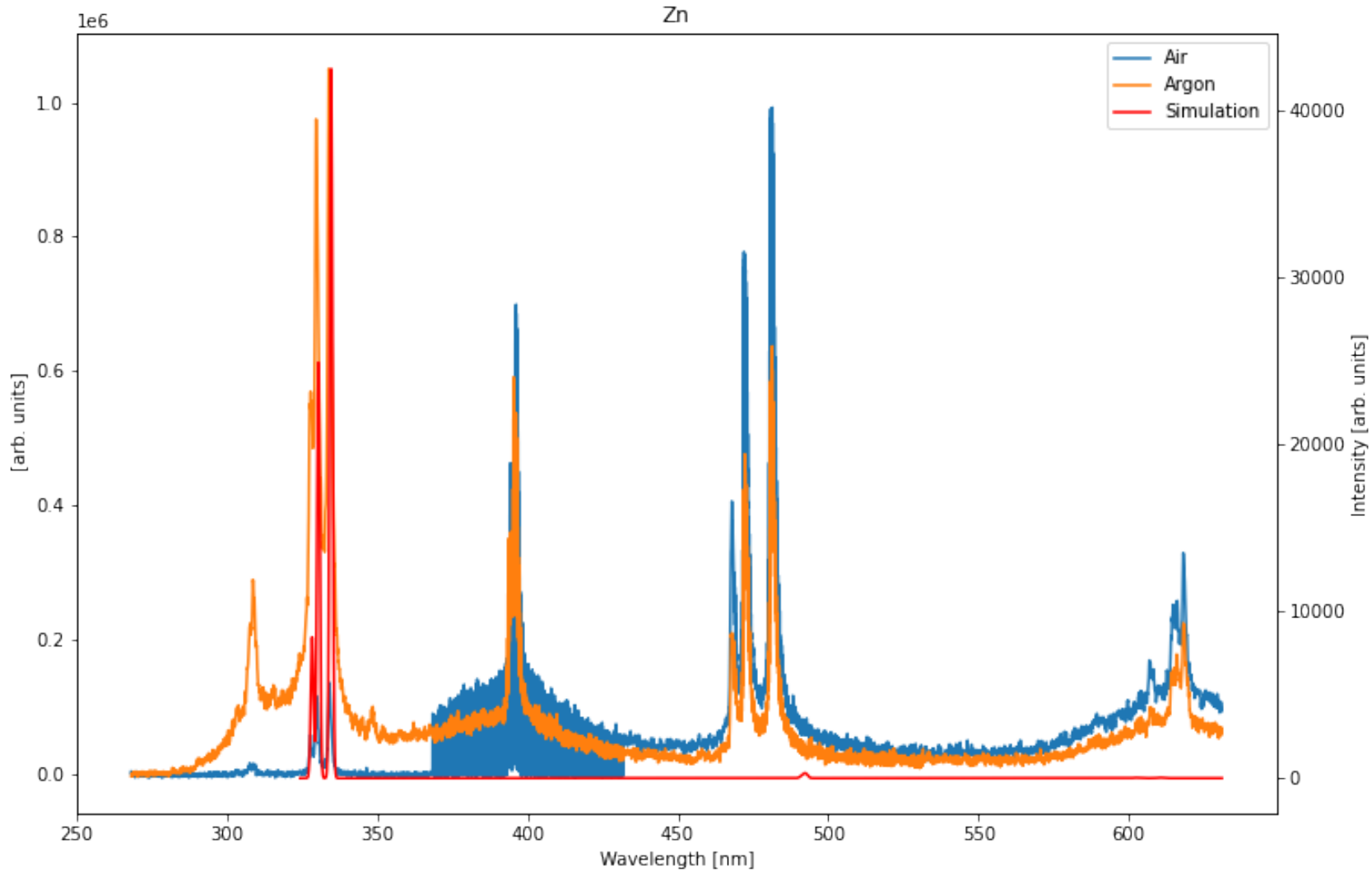

Fe
1e6
Air
Argon
Simulation
[arb. units]
Intensity [arb. units]
Wavelength [nm]
0
1
2
3
4
0
25000
50000
75000
100000
125000
150000
175000
250
300
350
400
450
500
550
600

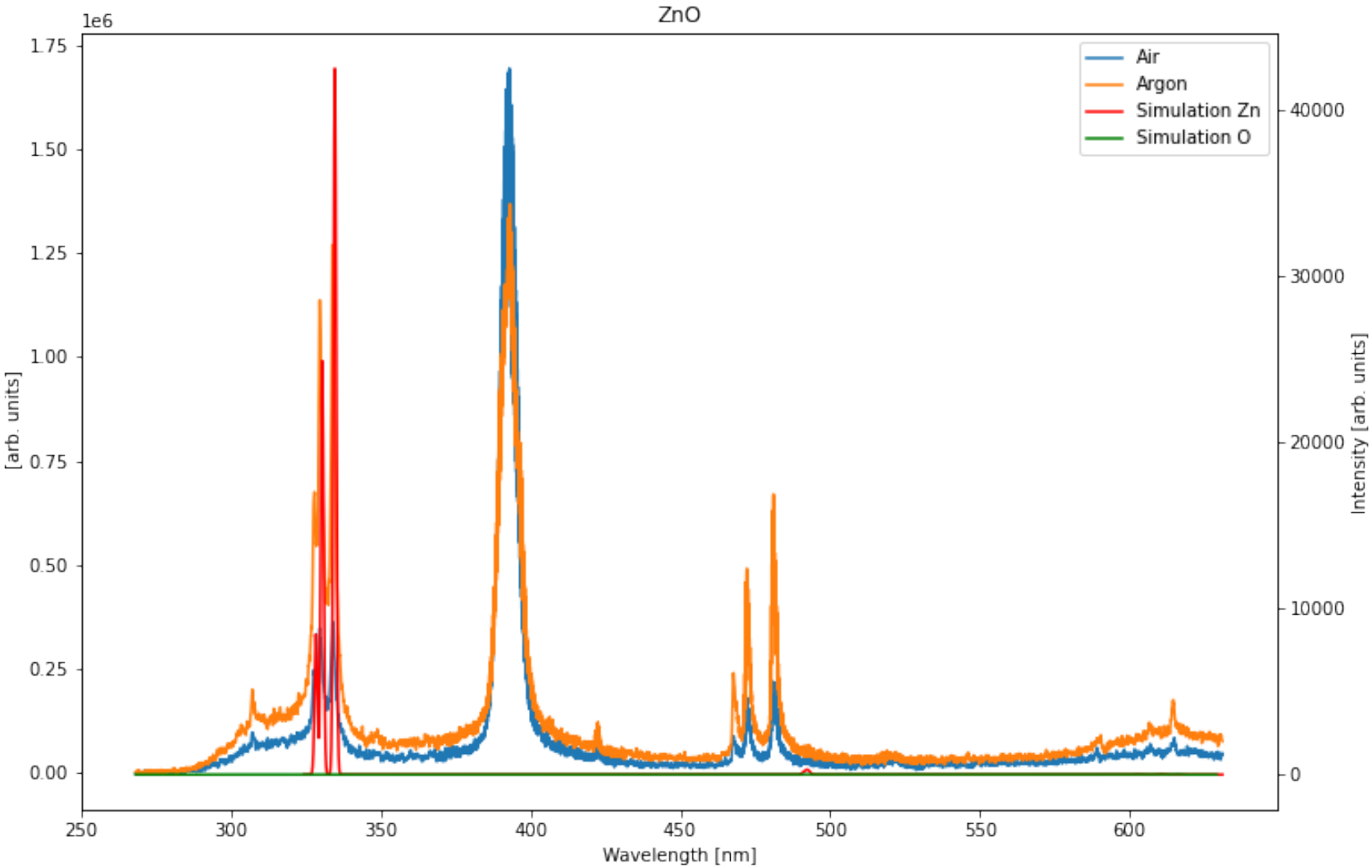

Inconel
1e6
Air
Argon
Simulation Ni
Simulation Cr
[arb. units]
Intensity [arb. units]
Wavelength [nm]
0
1
2
3
4
5
6
7
0
50000
100000
150000
200000
250000
250
300
350
400
450
500
550
600

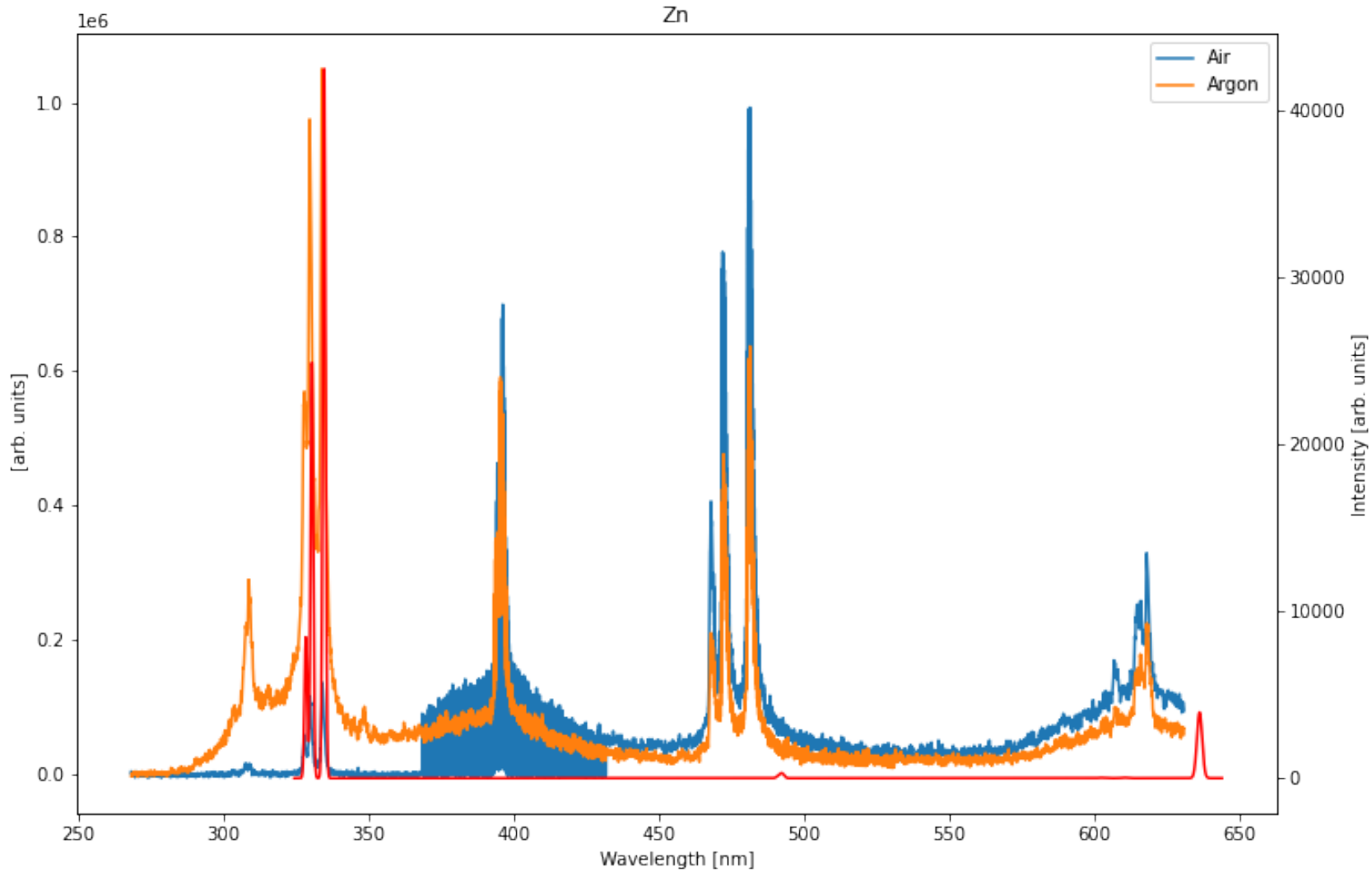

Ni
1e6
Air
Argon
Simulation
[arb. units]
Intensity [arb. units]
Wavelength [nm]
0
1
2
3
4
0
2500
5000
7500
10000
12500
15000
17500
20000
250
300
350
400
450
500
550
600

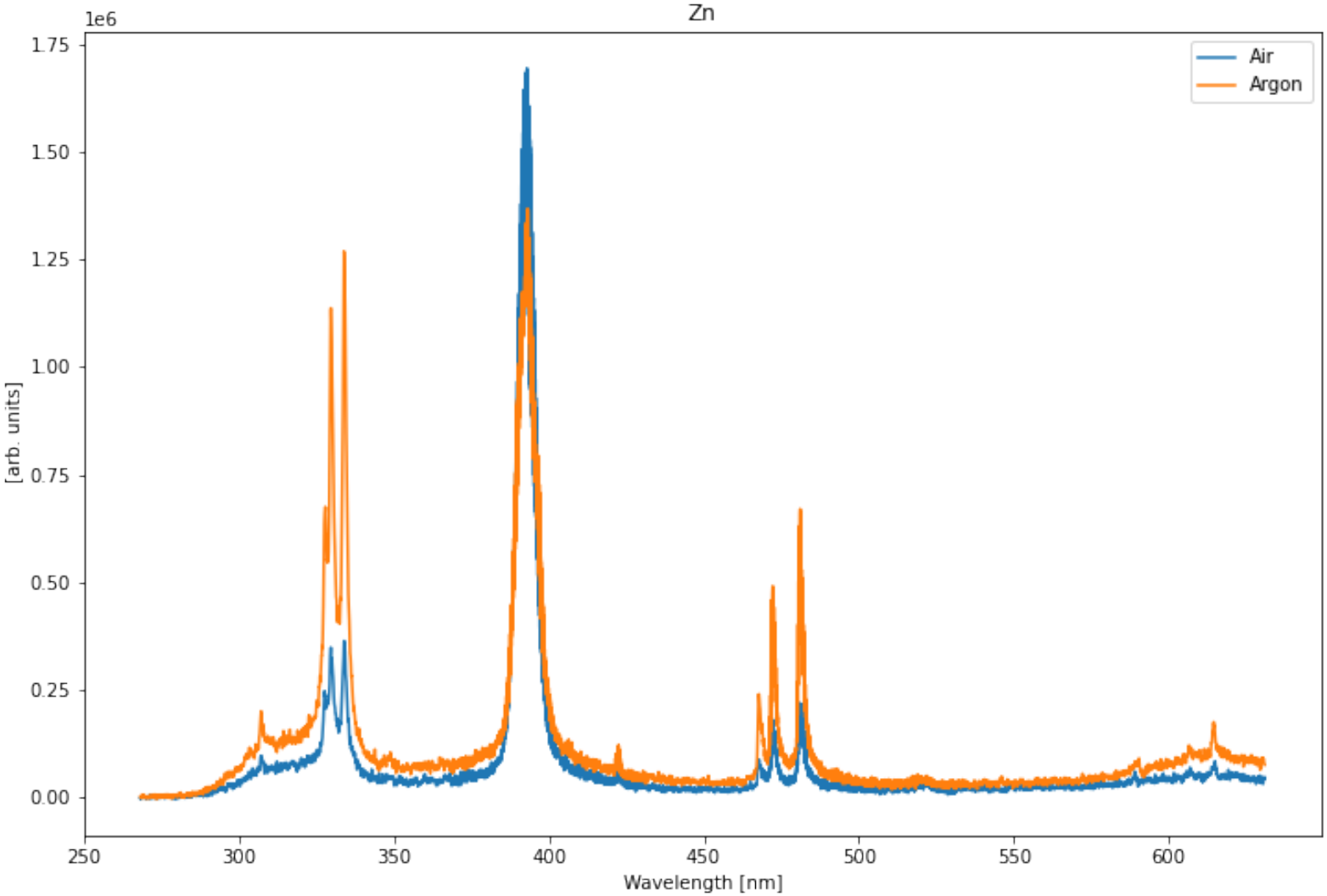

TiO2
1e7
Air
Argon
Simulation Ti
Simulation O
[arb. units]
Intensity [arb. units]
Wavelength [nm]
0.0
0.2
0.4
0.6
0.8
1.0
0
100000
200000
300000
400000
500000
600000
700000
250
300
350
400
450
500
550
600

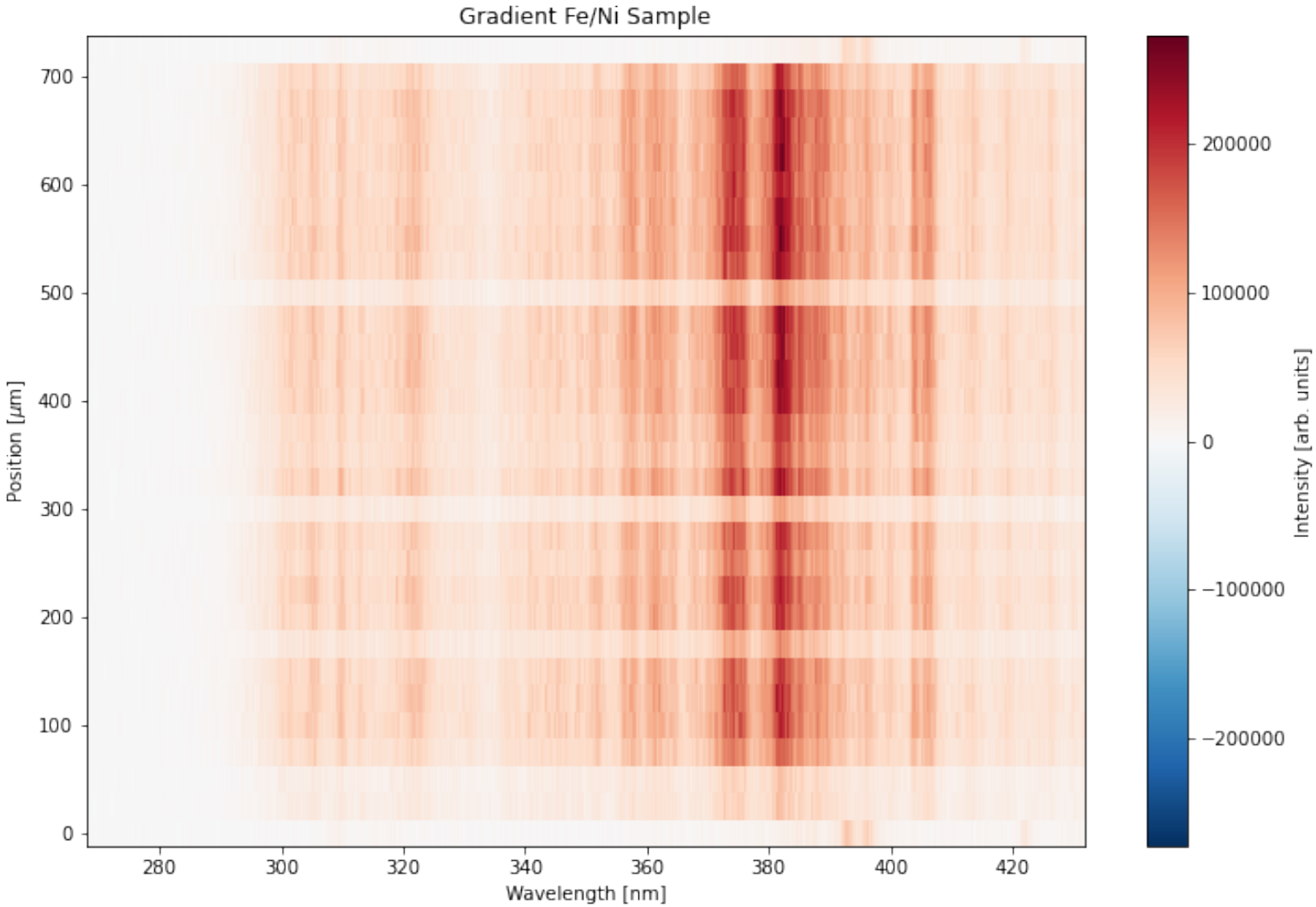

W
1e6
Air
Argon
Simulation
[arb. units]
Intensity [arb. units]
Wavelength [nm]
0
1
2
3
4
0
5000
10000
15000
20000
250
300
350
400
450
500
550
600

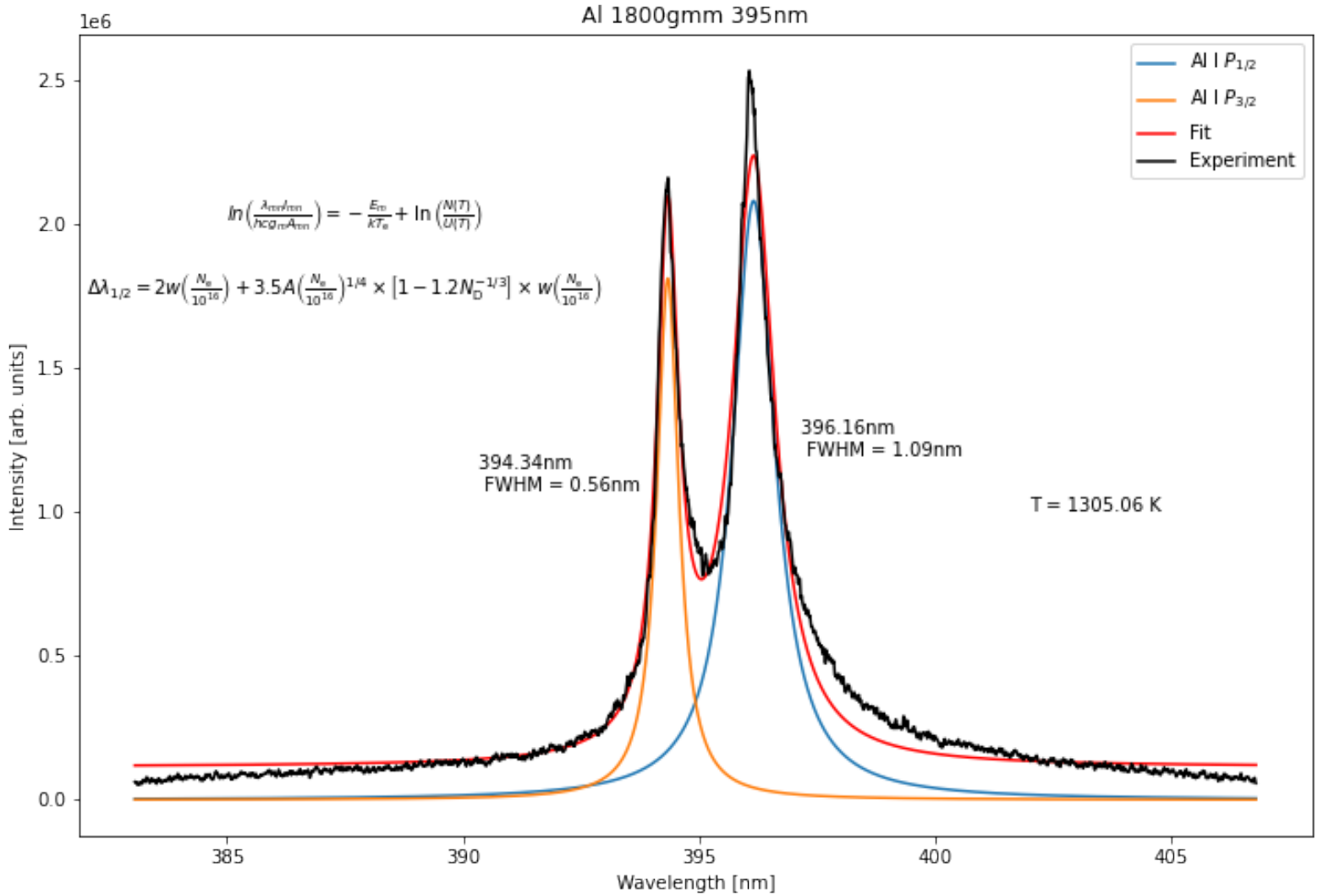

Zn
1e6
Air
Argon
Simulation
[arb. units]
Intensity [arb. units]
Wavelength [nm]
1.0
0.8
0.6
0.4
0.2
0.0
40000
30000
20000
10000
0
250
300
350
400
450
500
550
600


ZnO
1e6
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
[arb. units]
40000
30000
20000
10000
0
Intensity [arb. units]
250
300
350
400
450
500
550
600
Wavelength [nm]
Air
Argon
Simulation Zn
Simulation O


Zn
1e6
Air
Argon
[arb. units]
Intensity [arb. units]
Wavelength [nm]
1.0
0.8
0.6
0.4
0.2
0.0
40000
30000
20000
10000
0
250
300
350
400
450
500
550
600
650


Zn
1e6
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
[arb. units]
250
300
350
400
450
500
550
600
Wavelength [nm]
Air
Argon


Gradient Fe/Ni Sample
Position [μm]
0
100
200
300
400
500
600
700
280
300
320
340
360
380
400
420
Wavelength [nm]
200000
100000
0
−100000
−200000
Intensity [arb. units]


Al 1800gmm 395nm
1e6
Al I $P_{1/2}$
Al I $P_{3/2}$
Fit
Experiment
$ln\left(\frac{\lambda_{mn} I_{mn}}{hc g_m A_{mn}}\right) = -\frac{E_m}{kT_e} + \ln\left(\frac{N(T)}{U(T)}\right)$
$\Delta\lambda_{1/2} = 2w\left(\frac{N_e}{10^{16}}\right) + 3.5A\left(\frac{N_e}{10^{16}}\right)^{1/4} \times \left[1 - 1.2N_D^{-1/3}\right] \times w\left(\frac{N_e}{10^{16}}\right)$
394.34nm
FWHM = 0.56nm
396.16nm
FWHM = 1.09nm
T = 1305.06 K
Intensity [arb. units]
Wavelength [nm]
2.5
2.0
1.5
1.0
0.5
0.0
385
390
395
400
405

Other

- Optical Path Rebuild
  - Replaced mirrors with dual wavelength dielectric high reflectors
  - Replaced collection lens with UV enhanced achromatic doublet
  - Realignment and optimization
- Began building ML traning sets
  - 1000 spectra for each element
  - Identical parameters
- Software
  - Successfully interfaced with DAQ timing board with nidaqmx python library
  - Wrote code to send trigger pulses to laser and camera
  - Interfaced with spectrograph using ATSpectrograph Python library
  - Made progress interfacing with camera with AndorSDK3 Python library

    ★ Unable to get a LIBS spectrum, but can get a calibration lamp signal