August 19,2021

THE OHIO STATE UNIVERSITY

2021 ATLAS US SUPER

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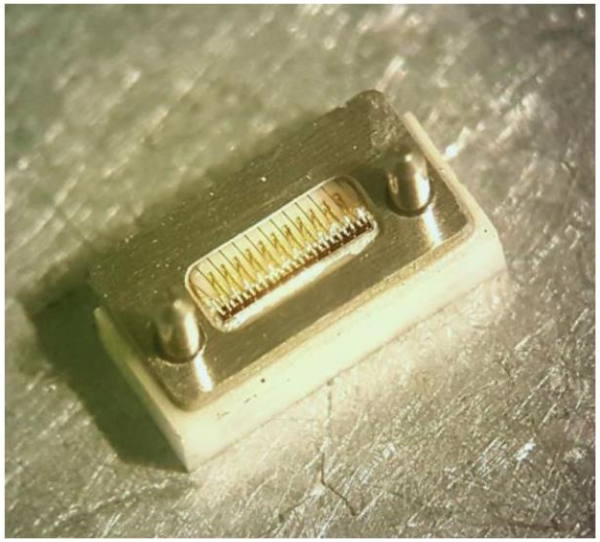
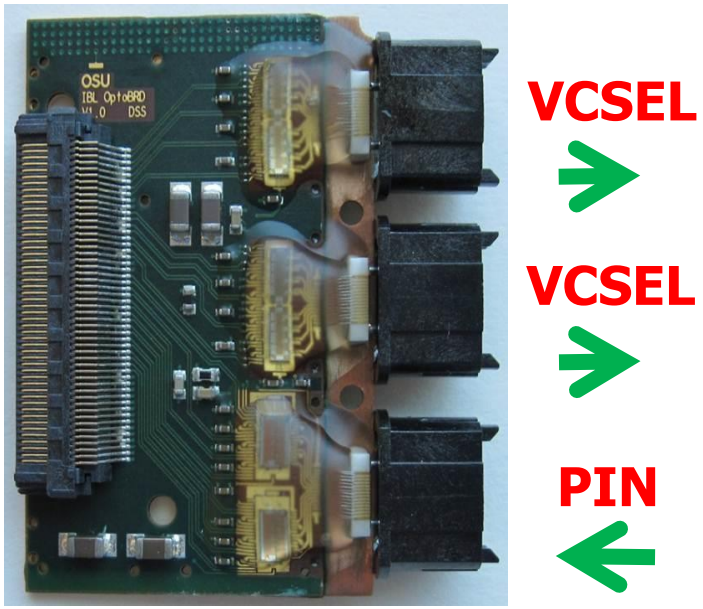
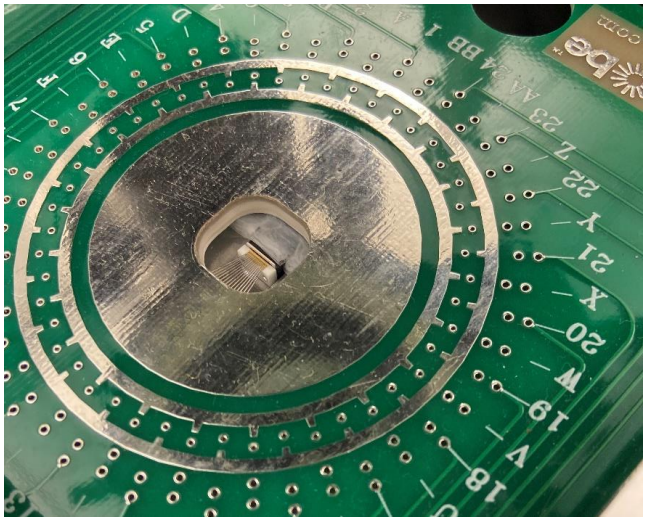
- Opto-board production used with PIN/VCSEL arrays for optical communication
- Convert optical signals to electrical (PINs) and vice versa (VCSELs)
- Inner 7 channels (of 12) in use



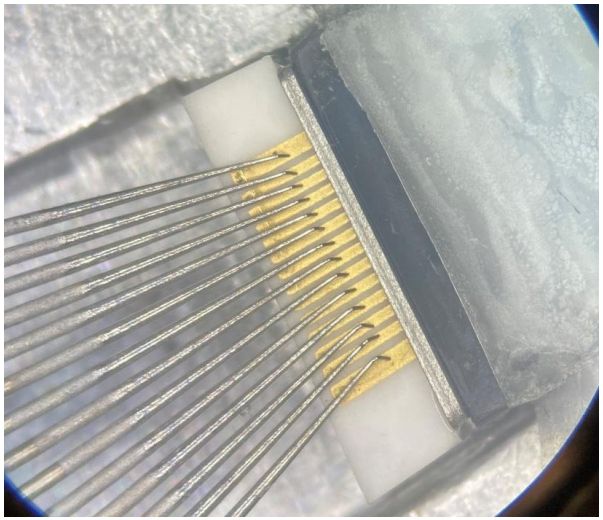


QA Data Collection

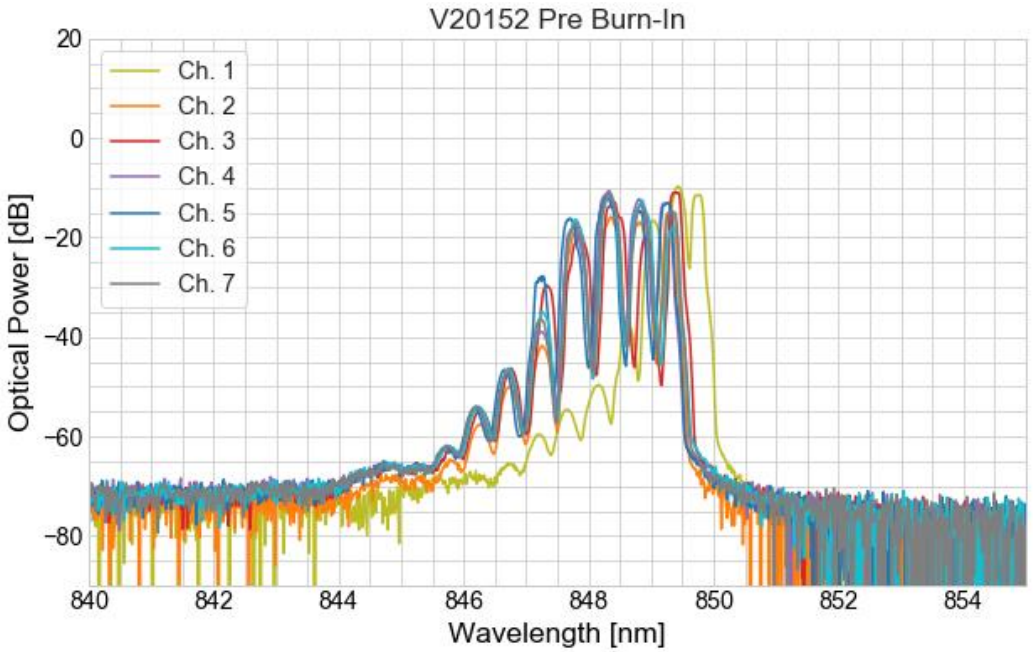
- VCSELs are QA'ed before and after burn-in process (PINs not burned in)



- VCSELs: Reference PIN measures light emitted from VCSEL under 6 mA of current



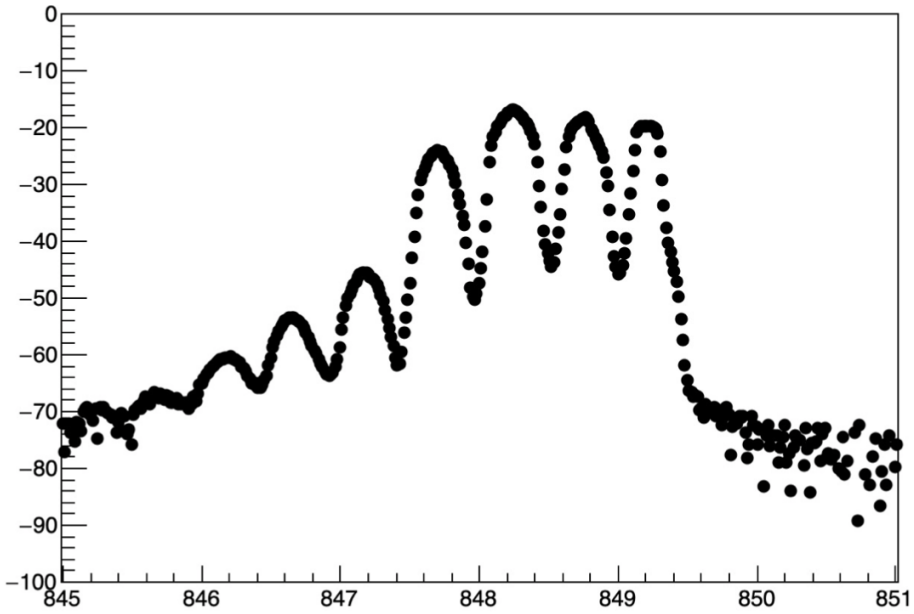
- Optical spectrum plotted for each VCSEL, channel
- Shifts in wavelength of one or more channels during burn-in indicates imminent VCSEL failure
- Shifts had previously been determined visually

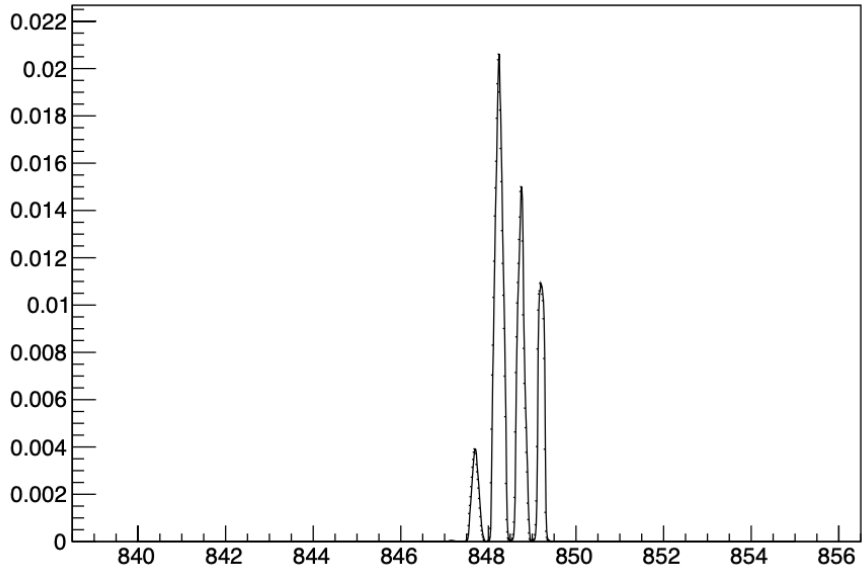


Summer Objectives:

- *Develop software to automatically fit peaks in OSA spectra to Gaussians*
- *Use Gaussian means before and after VCSEL burn-in to detect significant spectral shifts*
- *Note and recall VCSELs with detected spectral shifts after additional inspection*

Plan of Attack

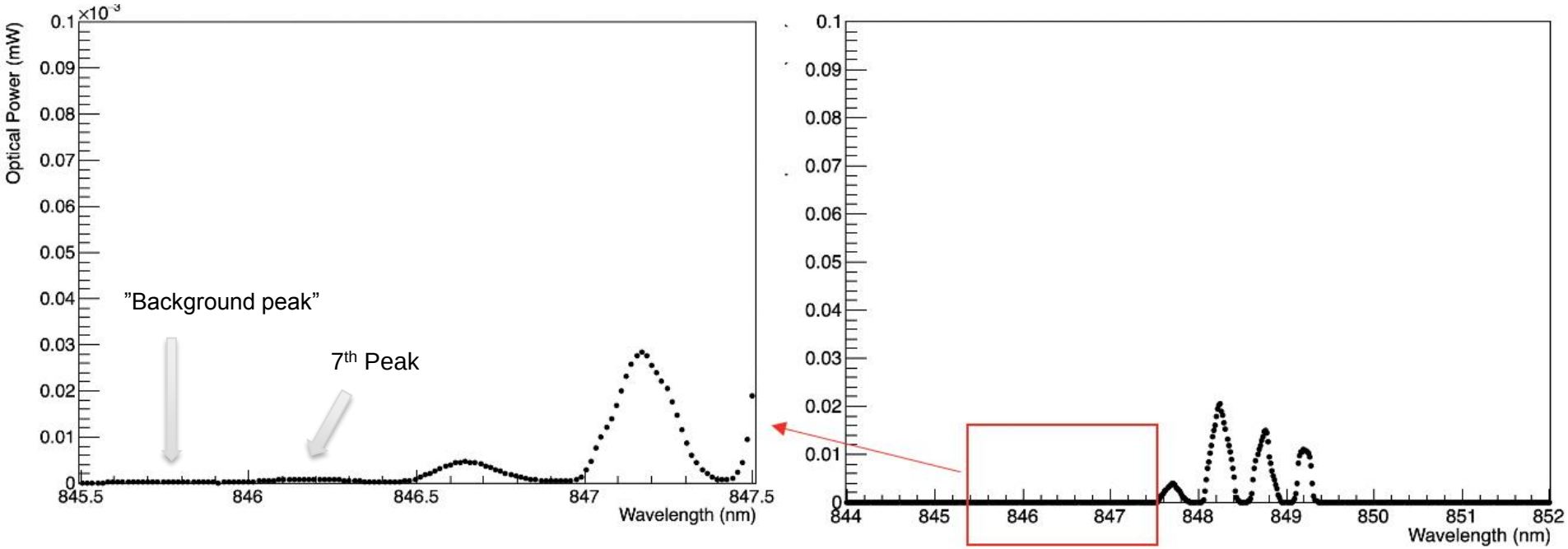




- Familiarize with Root
- Upload data, begin using RootFit
- Fit single data peak to Gaussian
- Logarithmic scale
- Background noise

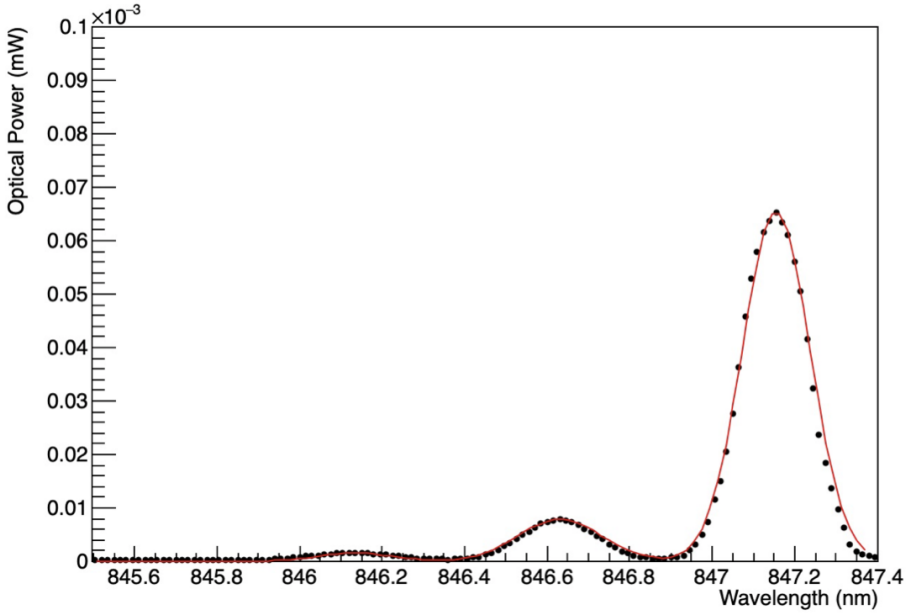
Logarithmic Scale Issue

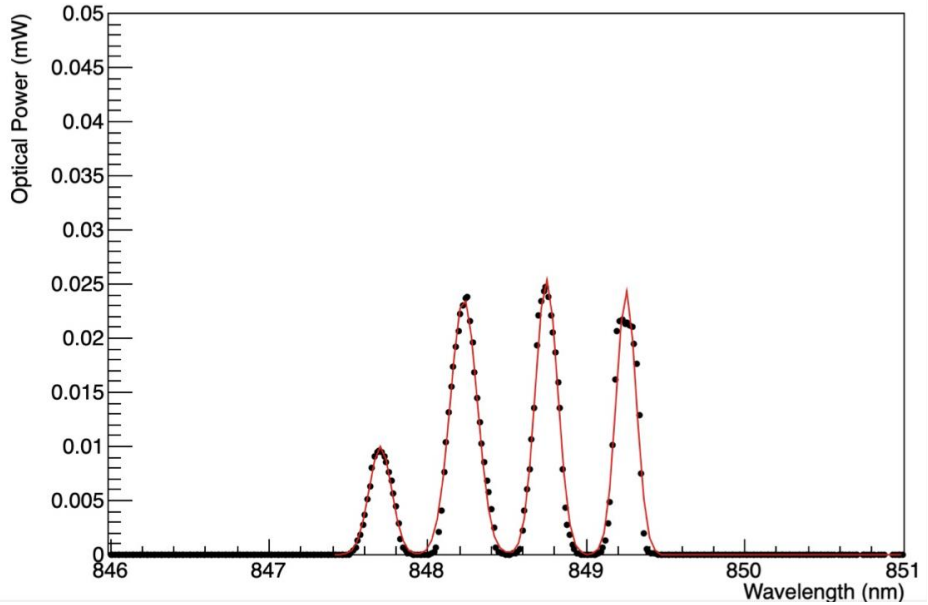
- First peaks are ~1000x smaller than last 4
- 8th ”background” peak is disregarded



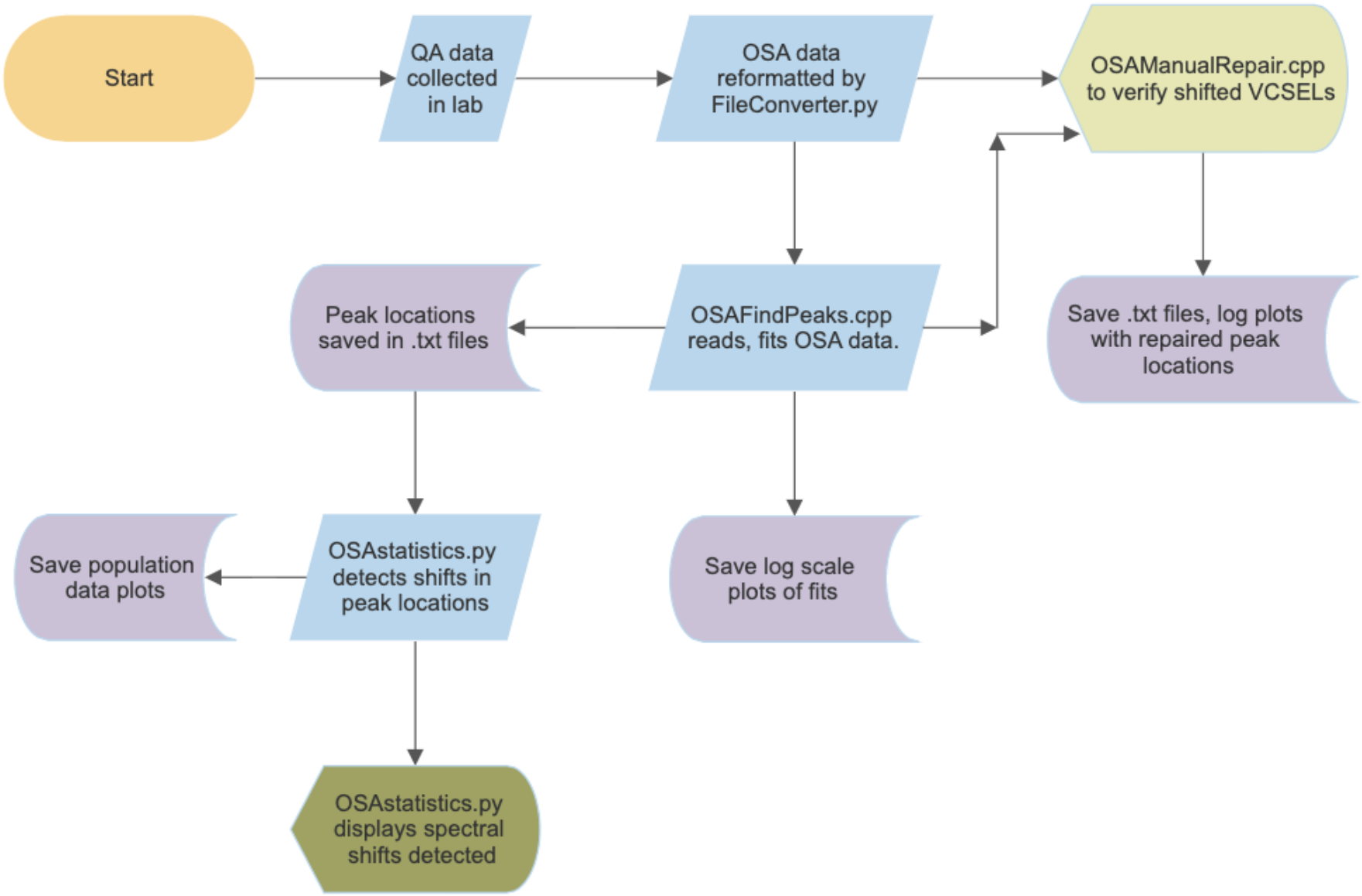
Plan of Attack cont.

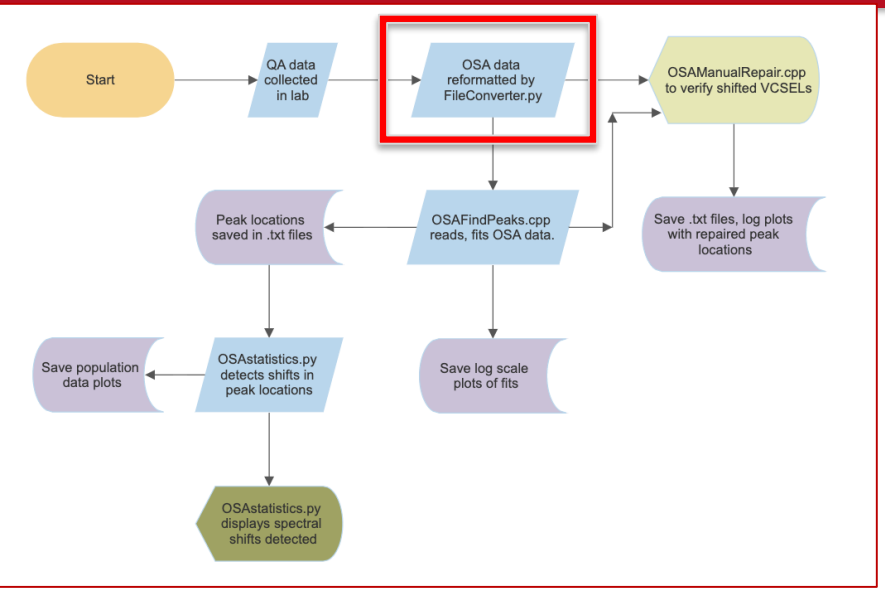
- Fit multiple/all peaks on a channel
- Iterated fitting: individual peak fit, 3 + 4 Fit Method
- Begin automation





Automation Flowchart





V20534_PreBurnIn-OSA.xlsx

Wavelength (nm)	Power (dBm)	VCSEL	Channel	Measurement
840	-210	V20534	1	Pre Burn-in
840.015	-74.776	V20534	1	Pre Burn-in
840.03	-78.493	V20534	1	Pre Burn-in
⋮	⋮	⋮	⋮	⋮
855	-210	V20534	1	Pre Burn-in
840	-210	V20534	2	Pre Burn-in
⋮	⋮	⋮	⋮	⋮

20534Pre1.txt

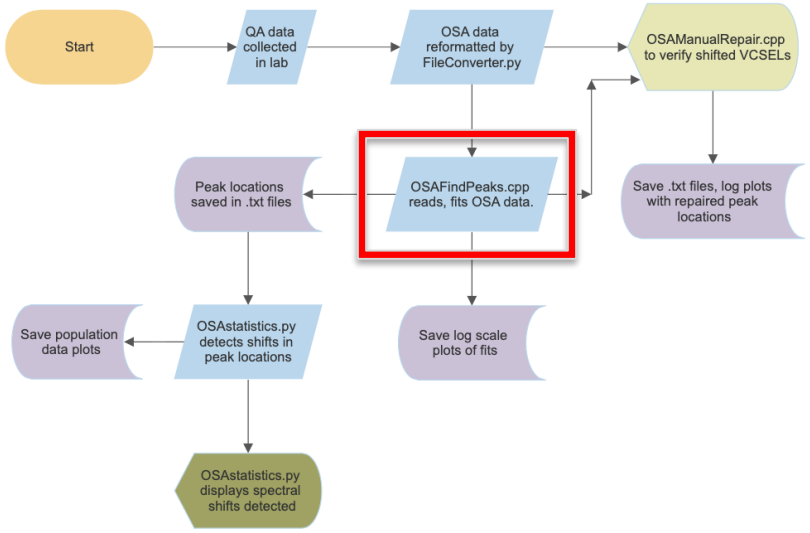
nm	mW	dBm
840	1e-21	-210
840.015	3.330e-8	-74.776
840.03	1.415e-8	-78.493
⋮	⋮	⋮
855	1e-21	-210

20534Pre2.txt

840	1e-21	-210
840.015	2.734e-8	-75.632
840.03	1e-21	-210
⋮	⋮	⋮
855	1.415e-8	-78.493

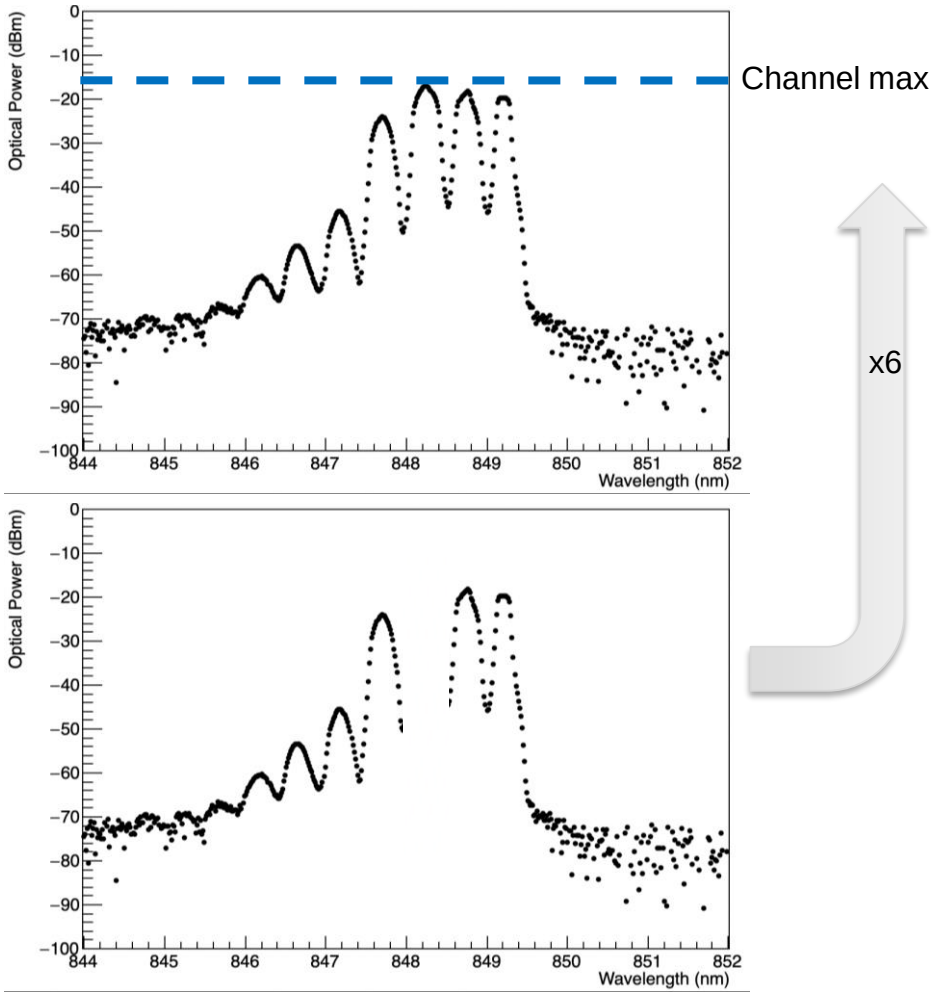
⋮

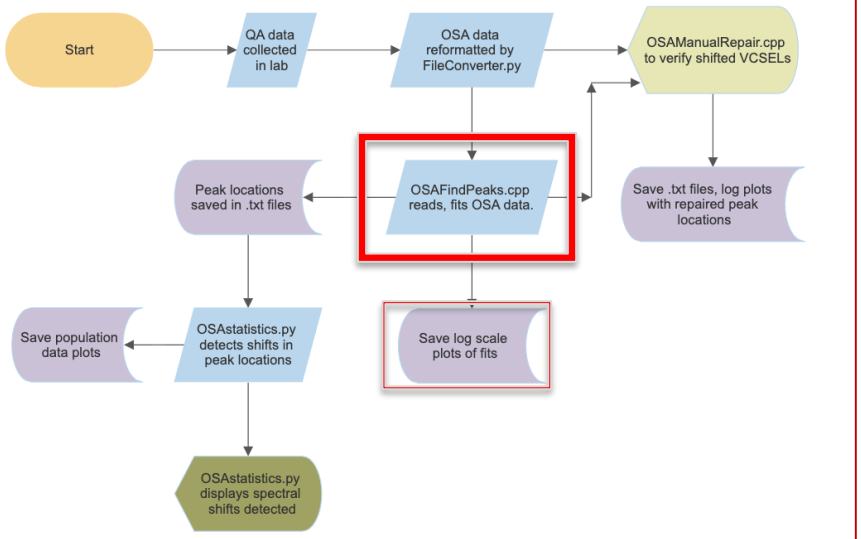
Peak Location

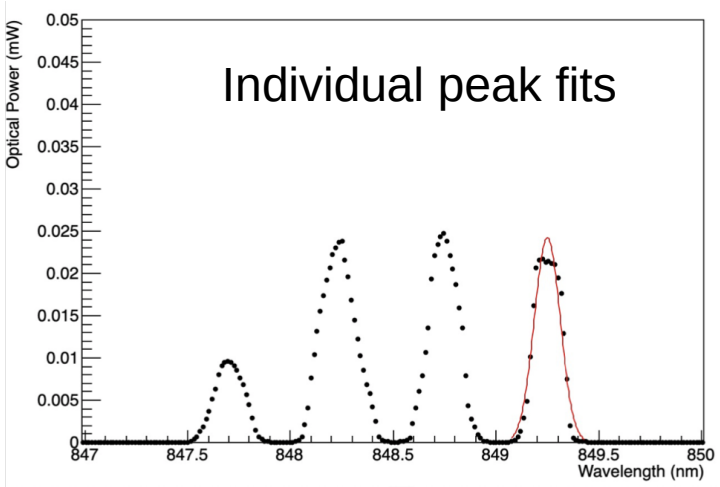


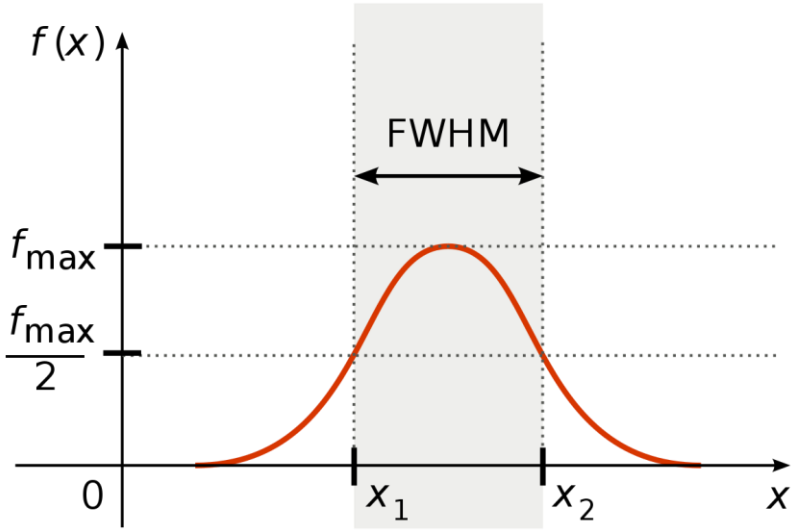
- Automatically detect peaks
- Channel max is recorded as peak
- Minima are located on either side of peak, data is erased in range
- Repeated until 7 peaks located

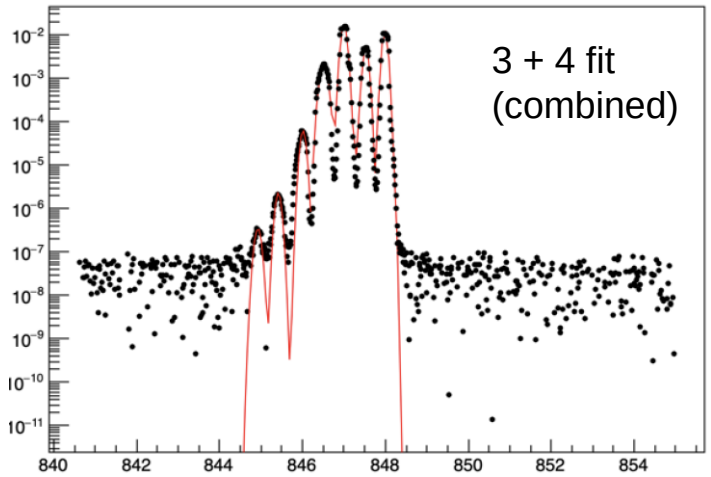
FindPeaks()



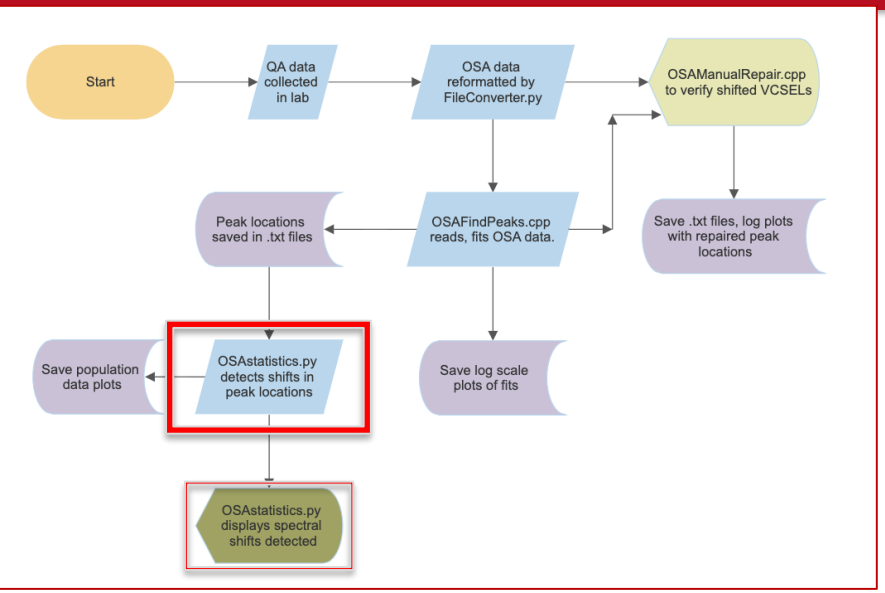

Start
QA data collected in lab
OSA data reformatted by FileConverter.py
OSAManualRepair.cpp to verify shifted VCSELs
Peak locations saved in .txt files
OSAFindPeaks.cpp reads, fits OSA data.
Save .txt files, log plots with repaired peak locations
Save population data plots
OSAstatistics.py detects shifts in peak locations
Save log scale plots of fits
OSAstatistics.py displays spectral shifts detected


Individual peak fits
Optical Power (mW)
Wavelength (nm)


f(x)
FWHM
fmax
fmax/2
0
x1
x2
x

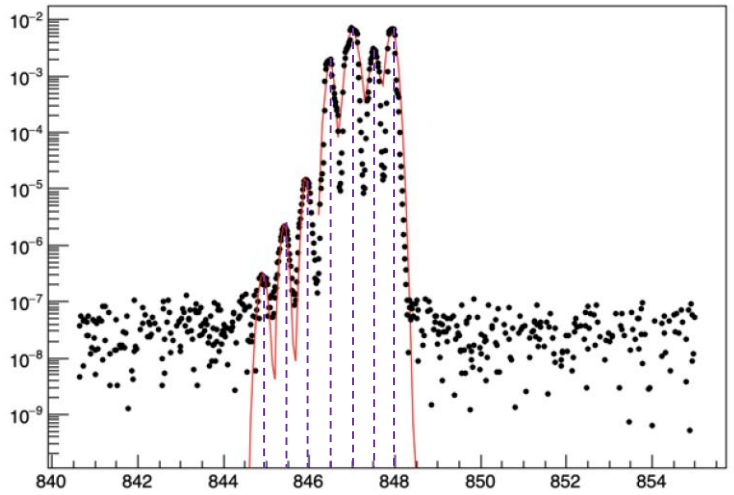

3 + 4 fit
(combined)

Quantifying Spectral Shifts

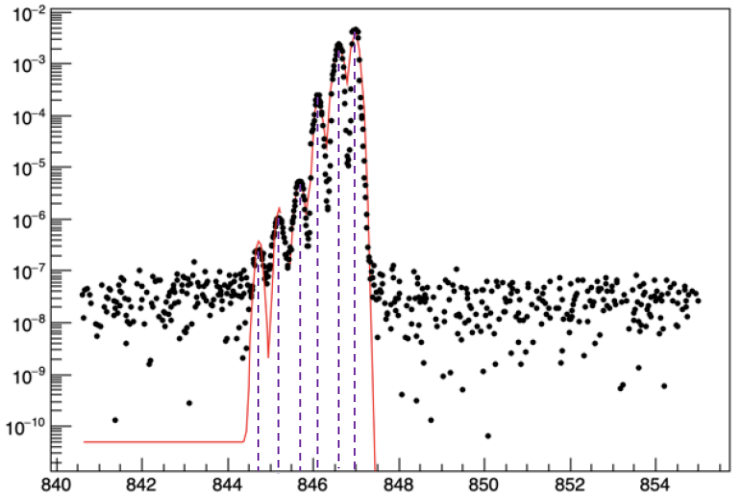


- Read .txt files with saved peak locations (from OSAFindPeaks)
- Compare pre/post burn-in peak locations to measure shifts
- Averages peak shifts on channel to quantify overall channel shift

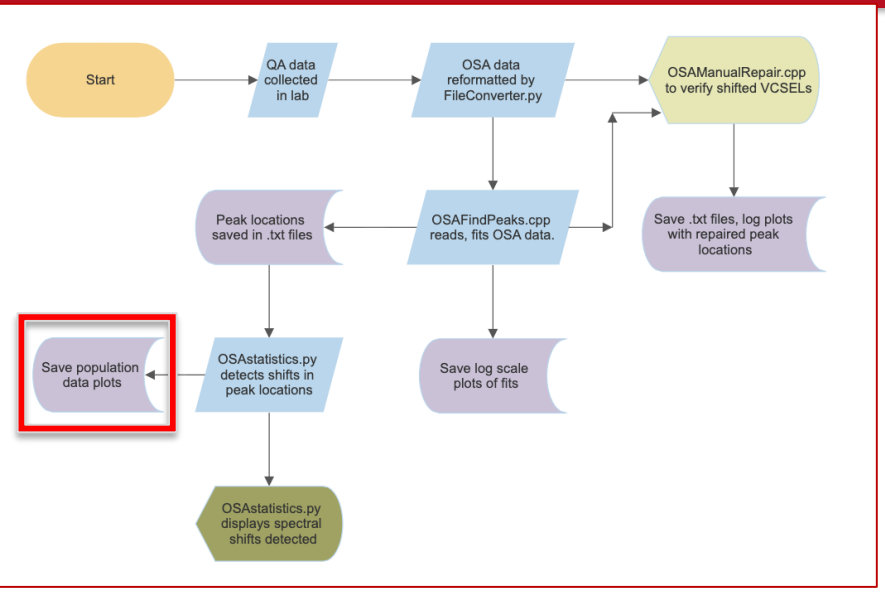
Pre Burn-In



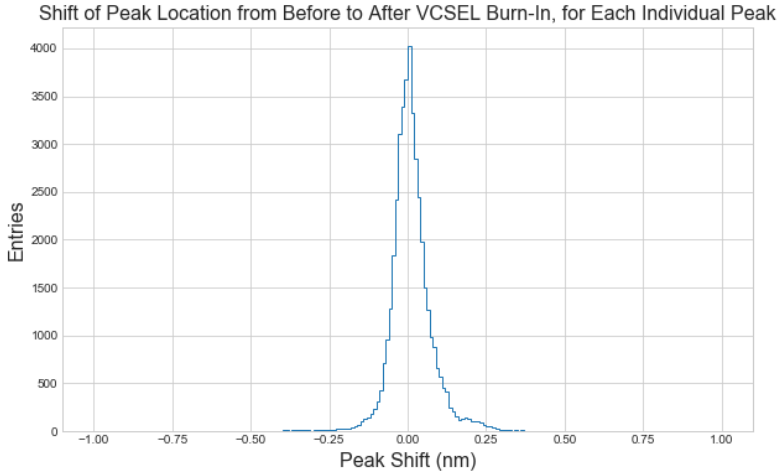
Post Burn-In

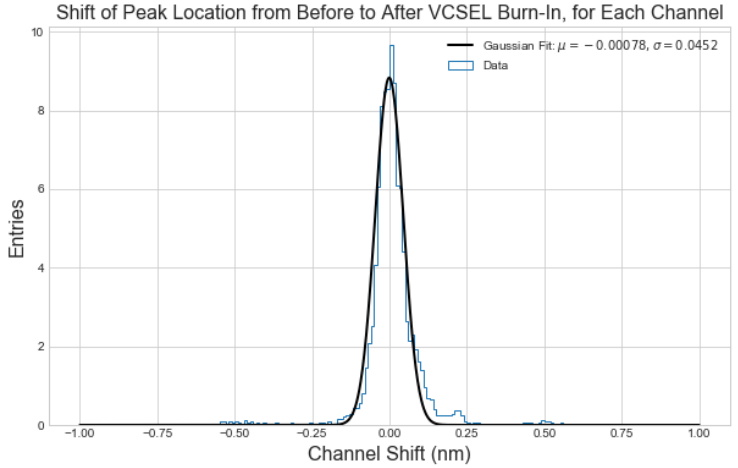


Population Data

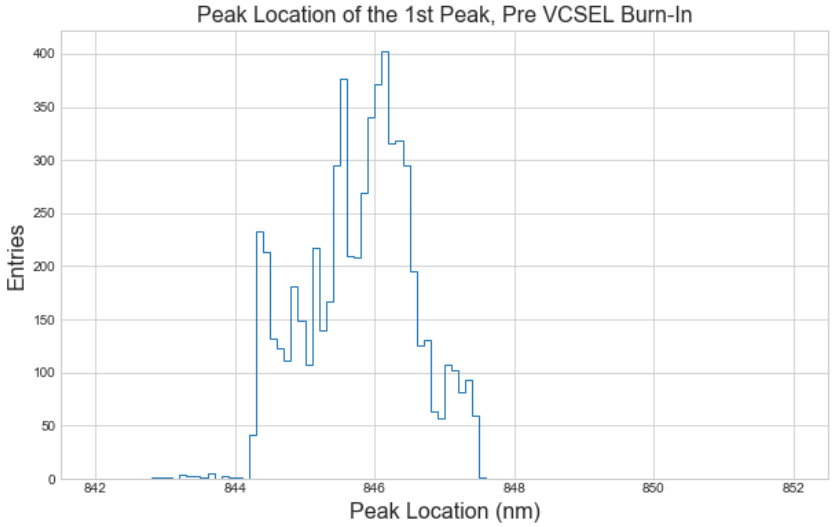


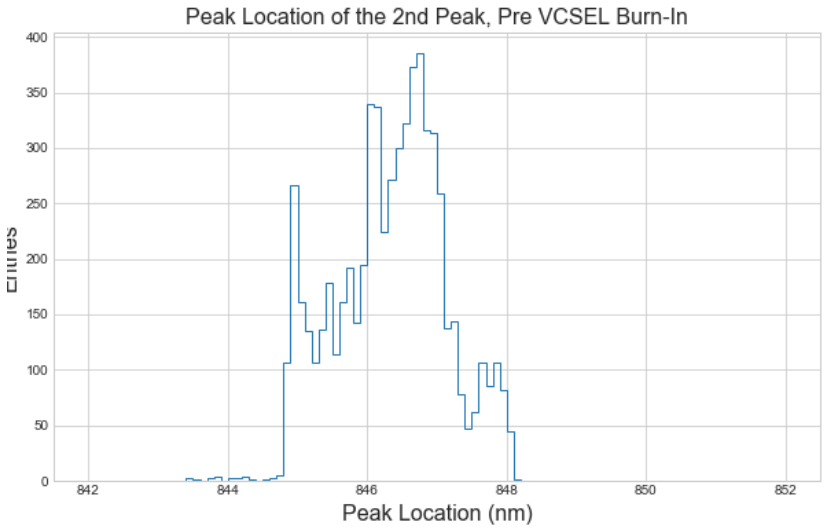
- Rejections to be made past $\pm 4\sigma$
- Secondary peak ~.2 caused by special sample; under investigation
  - Excluded from fit

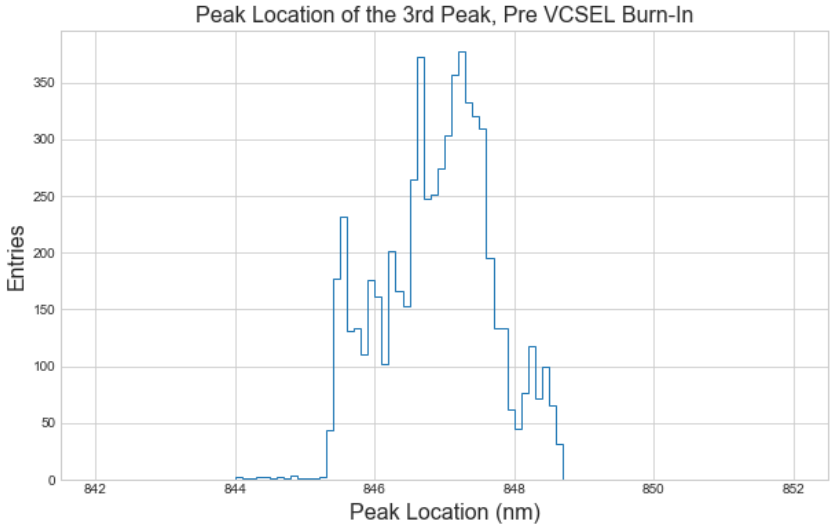


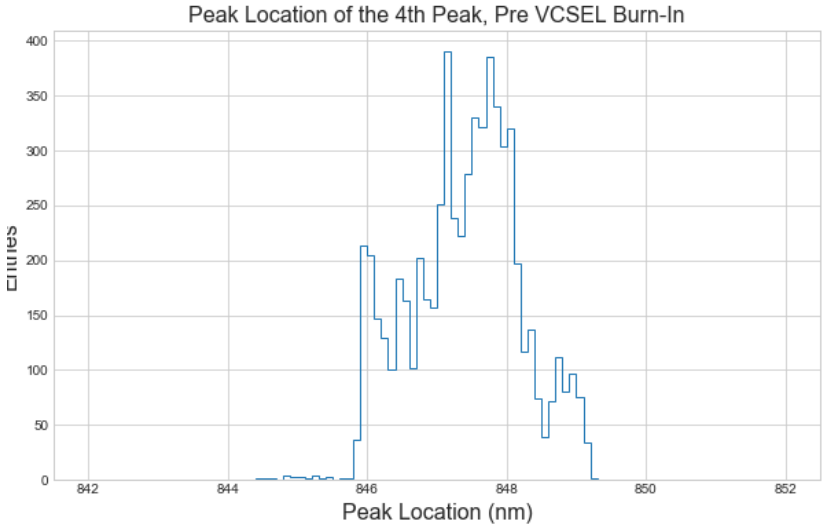


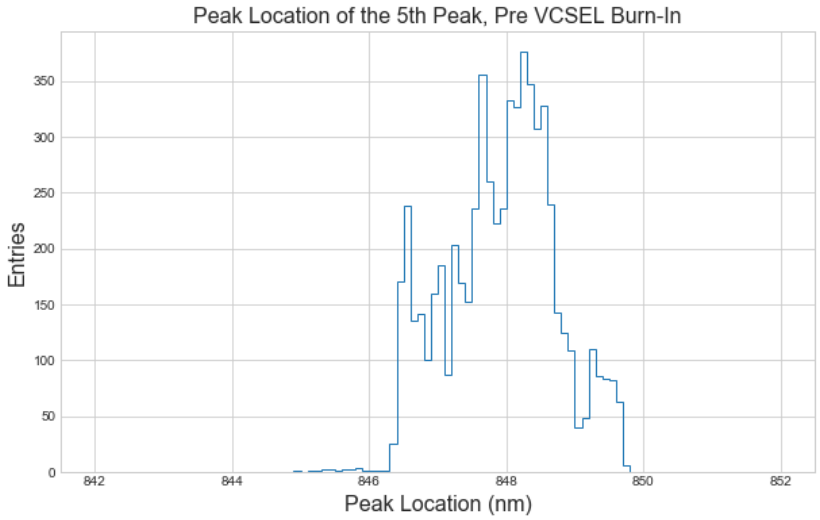
Population Data Cont.

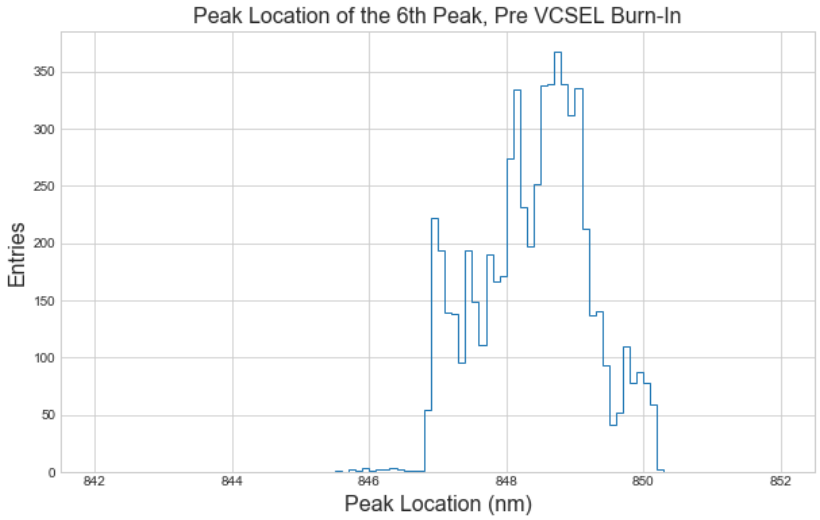


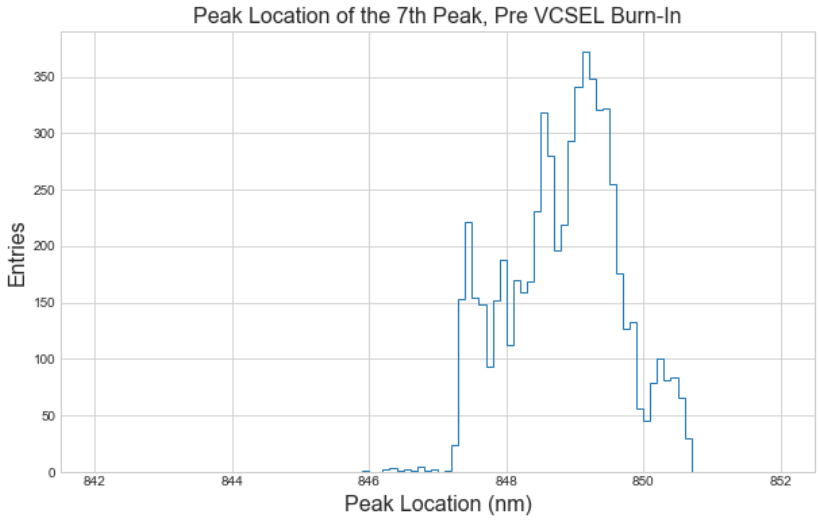




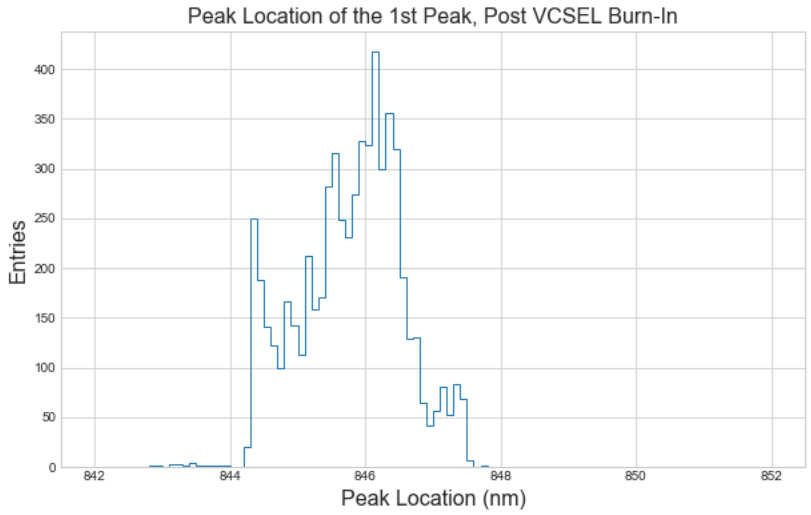


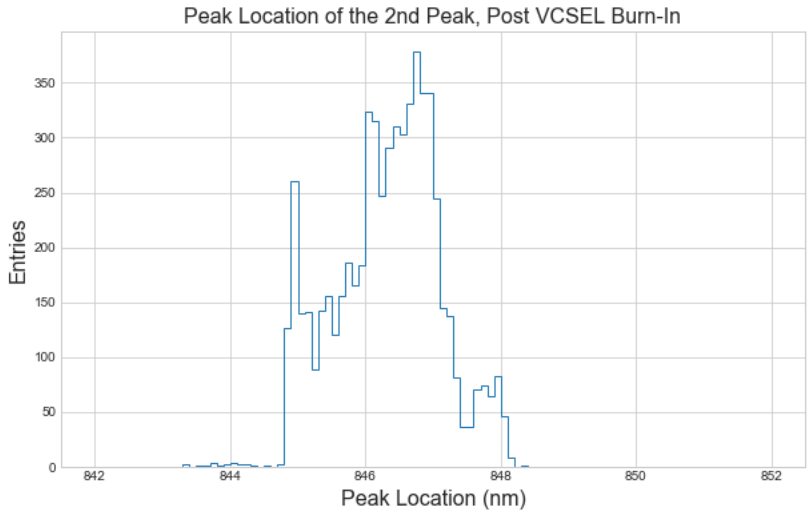

Peak Location of the 5th Peak, Pre VCSEL Burn-In
Entries
Peak Location (nm)
0
50
100
150
200
250
300
350
842
844
846
848
850
852

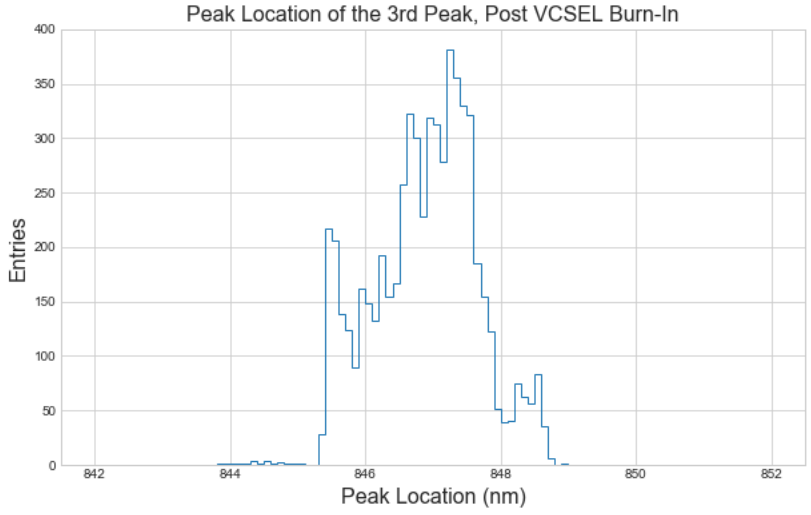

Peak Location of the 6th Peak, Pre VCSEL Burn-In
Entries
Peak Location (nm)
0
50
100
150
200
250
300
350
842
844
846
848
850
852

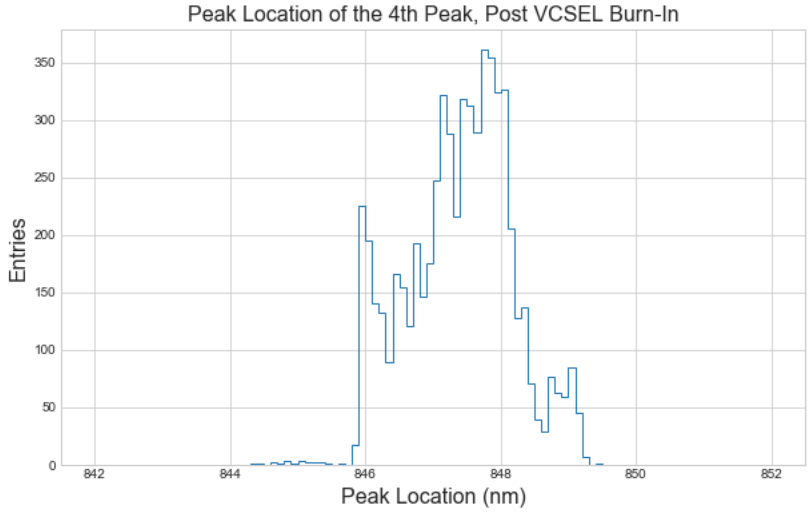

Peak Location of the 7th Peak, Pre VCSEL Burn-In
Entries
Peak Location (nm)
0
50
100
150
200
250
300
350
842
844
846
848
850
852

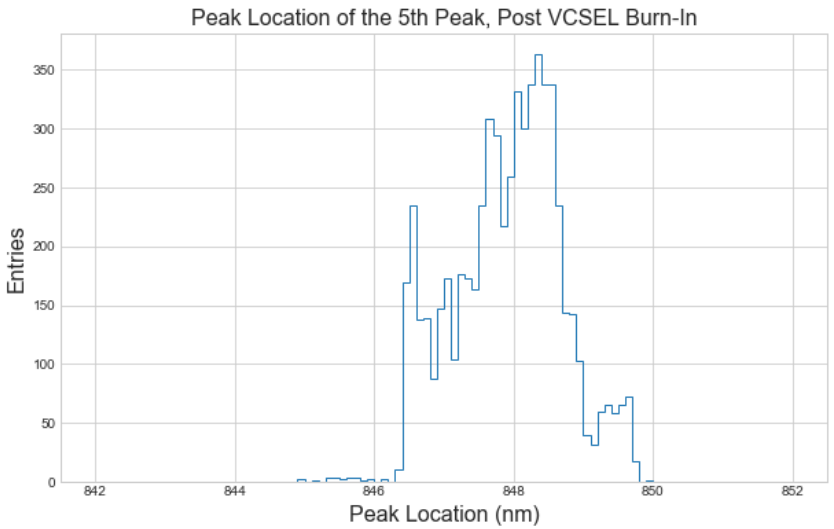
Population Data Cont.

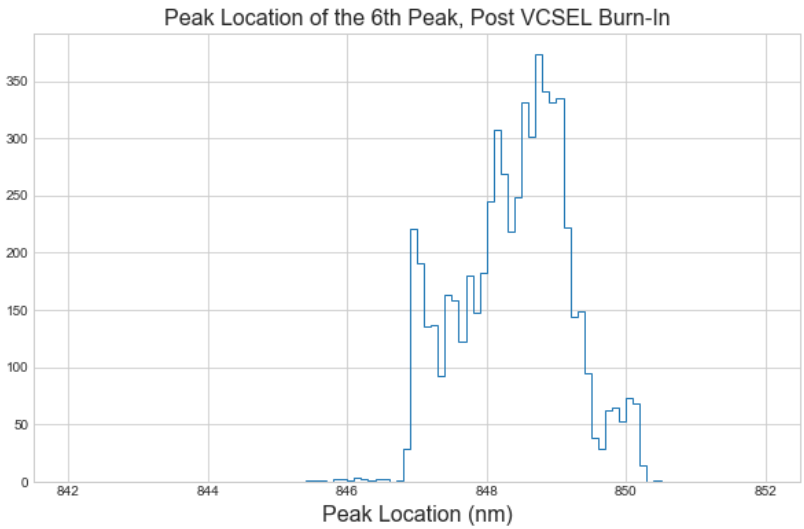


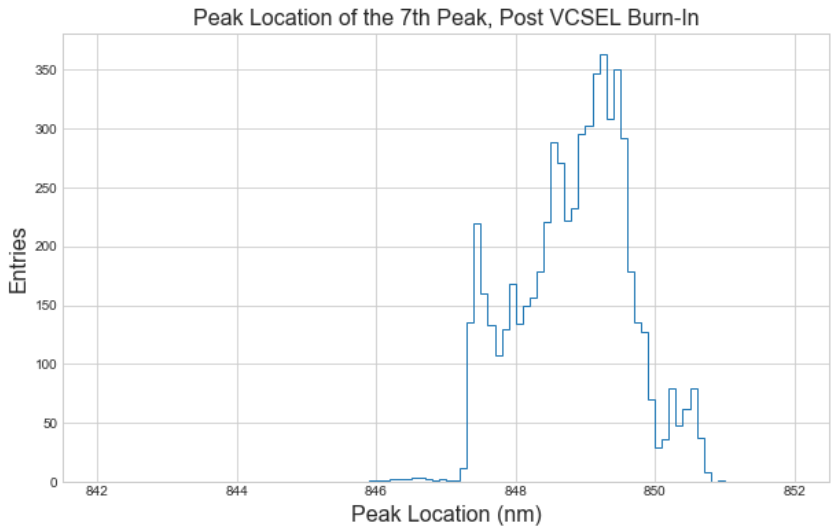


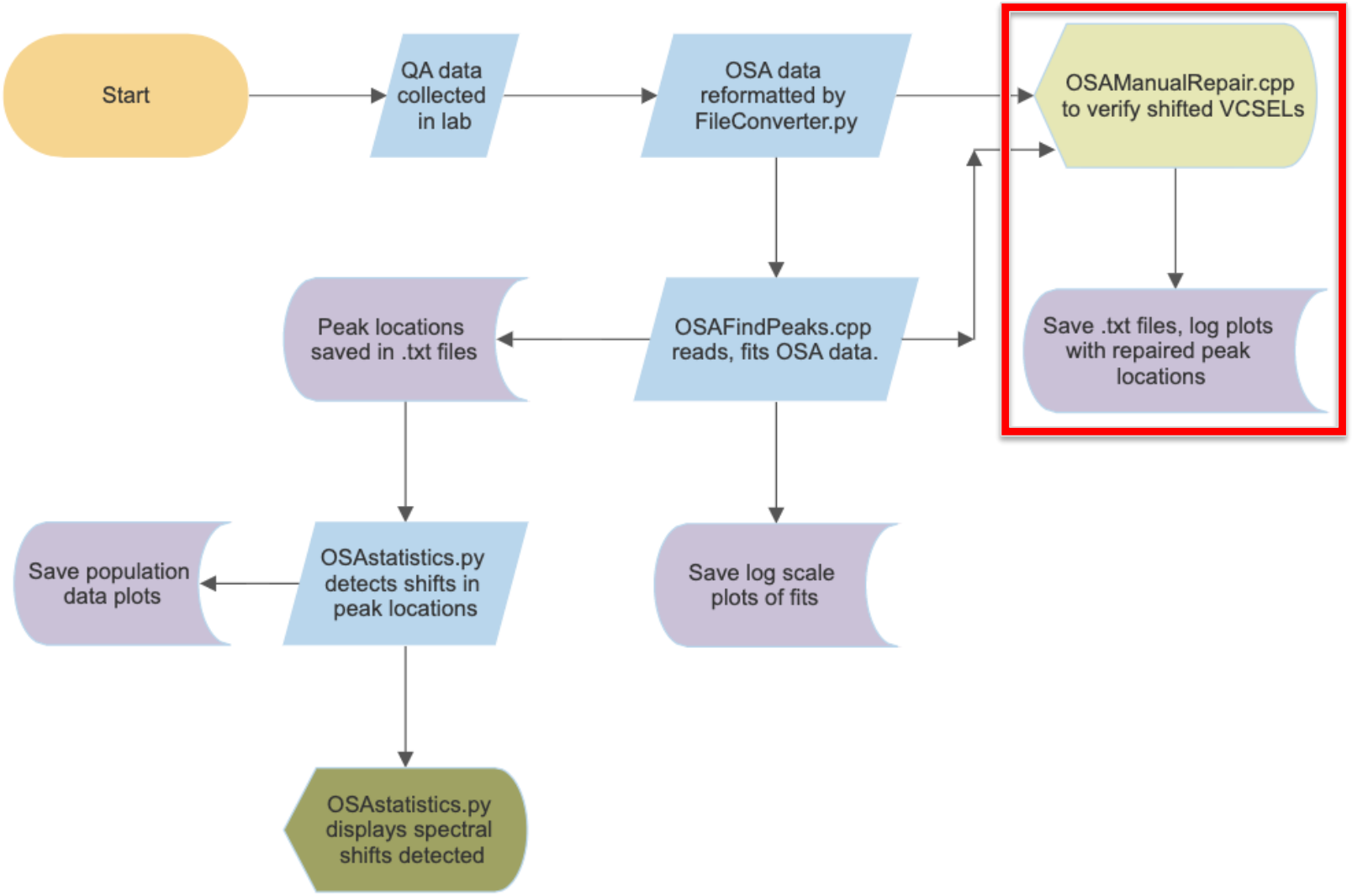





Peak Location of the 5th Peak, Post VCSEL Burn-In
Entries
Peak Location (nm)
0
50
100
150
200
250
300
350
842
844
846
848
850
852


Peak Location of the 6th Peak, Post VCSEL Burn-In
Peak Location (nm)
0
50
100
150
200
250
300
350
842
844
846
848
850
852


Peak Location of the 7th Peak, Post VCSEL Burn-In
Entries
Peak Location (nm)
0
50
100
150
200
250
300
350
842
844
846
848
850
852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Peak locations saved in .txt files
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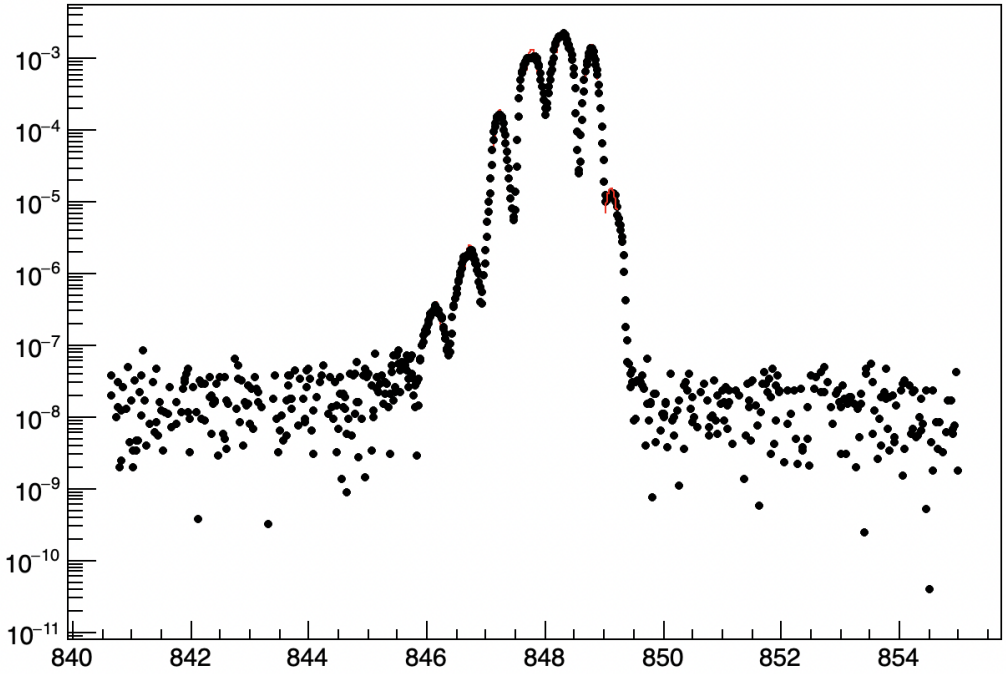
OSAstatistics.py detects shifts in peak locations
Save population data plots
OSAstatistics.py displays spectral shifts detected

- User input selected VCSEL, Channel, burn-in time
- Manually choose peaks for fitting, saving

```
Processing OSAManualRepair.cpp...
VCSEL number (20055 - 21071)?: 20121
Channel number (1 - 7)?: 4
Pre/Post burn-in?: Post

Looking at Post burn-in data for V20121, channel 4
Default peak locations? (y for yes): y
845.885
846.4
846.924
847.488
848.024
848.566
849.053
Save data as appears? (y for yes): n
```



- Individual peak fit only
- Fit range can be altered for problematic data

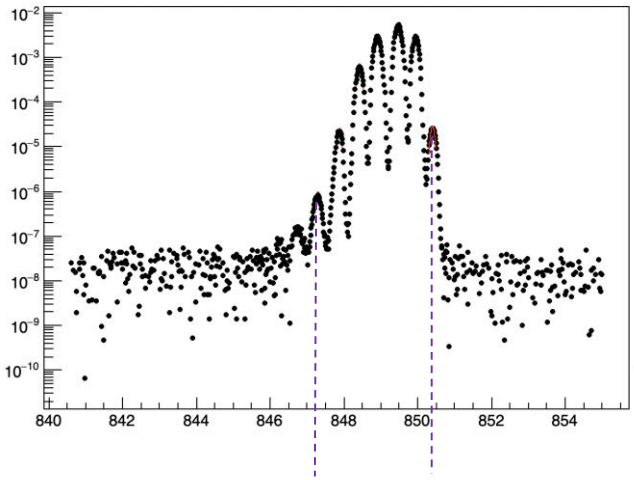
VCSELs with Spectral Shifts Detected (After Repair)

*installed

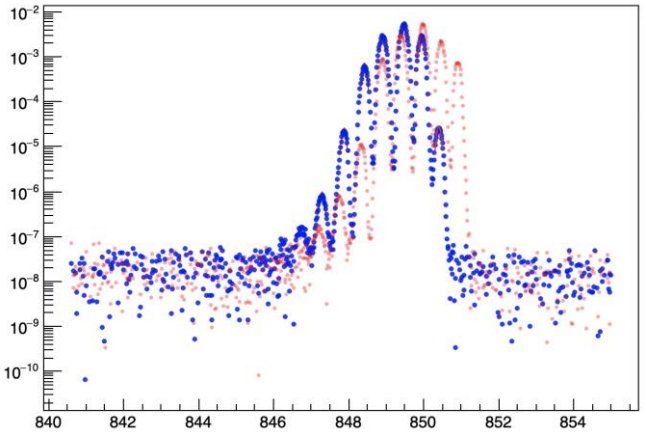
V20060 CH7 (-0.618 nm)
V20065 CH4 (-0.825 nm)
V20066 CH4 (-0.361 nm)
V20072 CH4 (-0.314 nm)
V20073 CH4 (-0.367 nm)
V20074 CH4 (-0.384 nm)
V20103 CH7 (-0.303 nm)
V20104 CH7 (-0.322 nm)
V20105 CH7 (-0.372 nm)
V20118 CH1 (0.434 nm)
V20118 CH 4 (0.601 nm)
V20119 CH4 (0.341 nm)
V20121 CH4 (0.575 nm)
V20125 CH4 (0.430 nm)
V20128 CH3 (0.852 nm)
V20129 CH3 (0.333 nm)
V20130 CH3 (0.339 nm)
V20132 CH3 (0.320 nm)
V20135 CH7 (-0.342 nm)
V20159 CH2 (-0.341 nm)
V20160 CH2 (-0.335 nm)
V20347 ALL (.355 nm ave.)
V21042 CH1 (0.490 nm)
V21042 CH2 (0.310 nm)

Example Shifts Detected cont.

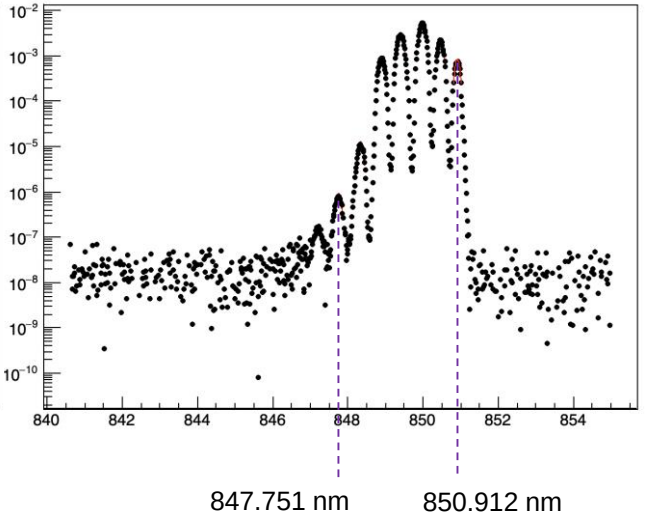
Pre Burn-In



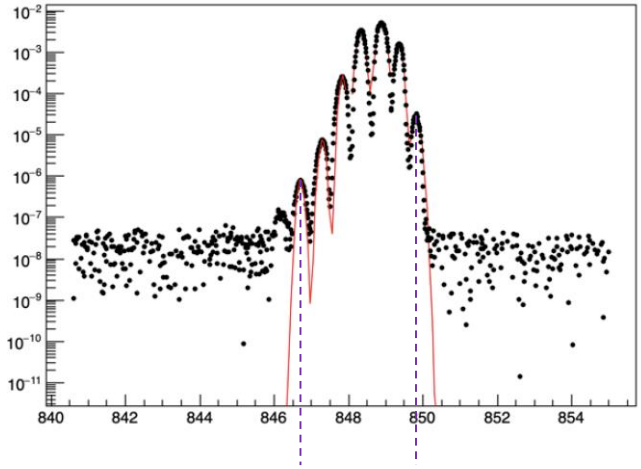
V21042 CH1 (0.490 nm)



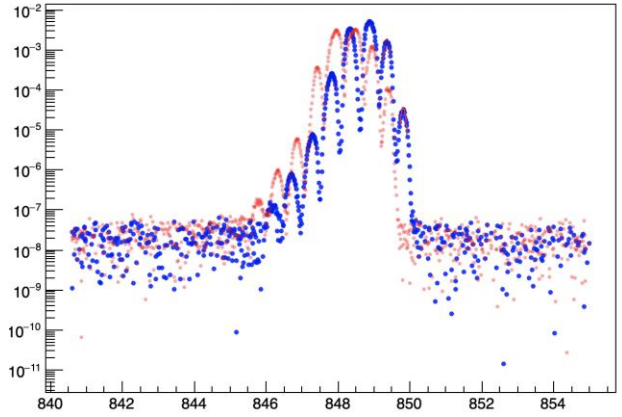
Post Burn-In



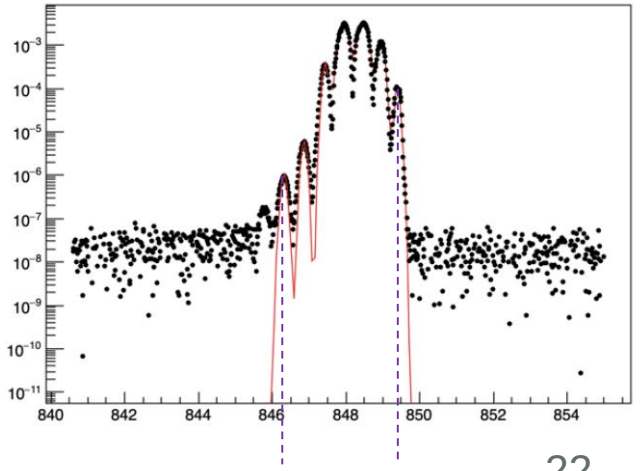
Pre Burn-In



V20347 CH1 (-0.406 nm)



Post Burn-In



Biggest Automation Roadblocks:

- Peak detection
  - Fake peak rejection
- Variation in the data
  - Peak location, size, number of peaks, dead channels
- Pre/Post burn-in data
- Processing time

Thank You!

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Questions?

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