FTIR Lab Data Collection

Week 1 [Jan. 14, 2020]

All data is stored under the `data/lab1/week1/` directory.

Knowledge Transfer from Arthur [Jan. 18, 2020]

- Check that canisters to the left of NO_2 and CO_2 are set at around 14.7 psi.

    - NO_2: 14.7 psi
    - CO_2: 15.7 psi
- Made a folder on the lab computer, called `2020_enph352_esther` to store my data temporarily.
- Apparently the lab manual is super out of date with how to use the software.
    - MUST bring a USB to the lab.
    - The computer is a linux machine.
- To change the pressure levels of the benchtop gas source, turn the knobs to the right (cw) to turn off.

Lab Procedures Conducted

Step 1

Just a note on how expensive the equipment is.

Step 2

Default Parameters for Acquisition Software:

Param	Default Value	Notes
Resolution	64 cm^{-1}	Is this how much the mirror moves per step inside the interferometer?
Velocity	3.16 mm/s	Is this how fast the mirror moves inside the interferometer?
Low pass filter	3 kHz	
High pass filter	100 Hz	
Gain	1	When do you change the gain?
Offset	0	The Offset field does not display numbers greater than 20. Look in the scanner value column for the actual offset value. When you apply new offsets, that's applied to the ones already existing.
No of acquisitions	1	max 32 scans

Acquisition Software Process

1. Set parameters to default

2. Press write params to scanner
3. Press Start ACQ
4. After done, press copy text to clipboard
5. Save data in a txt file.
6. Press gnuplot to plot data. Press a to refresh.

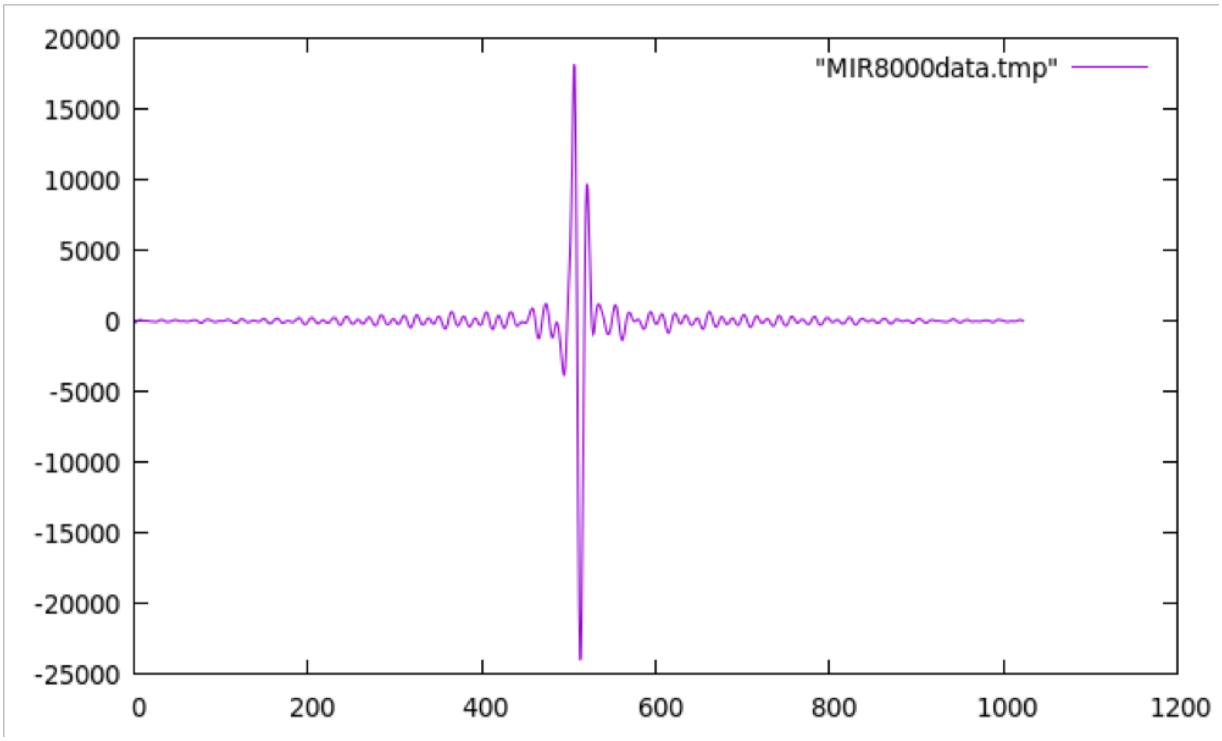
The highest intesity part of the interferogram is called the centre burst. Explain the general shape of the interferogram.

The general shape looks like a sinc function. It's the FT for the contour that it passes through, when no gas is applied.

Why is the interferogram shifted? (it shouldn't be, consider playing with the offset)

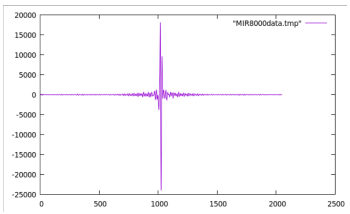
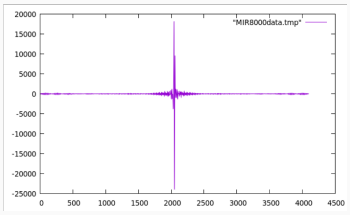
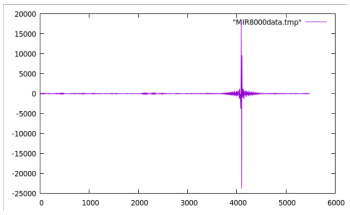
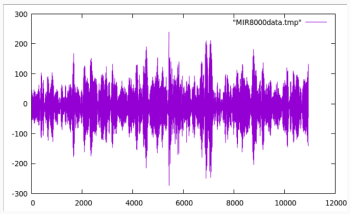
- The centre of the scan, the burst is the zero optical path difference (ZOPD). If it's shift, that means the ZOPD is not located when the mirror is at position zero.
- Why do we want the offset to be zero?
    - X axis is number of points. We want to capture the full interferogram. So we do an initial step of centering with the default values.
    - Set the burst to be at point 512.
- Calibration Example:

  file: `week1_centering.txt`



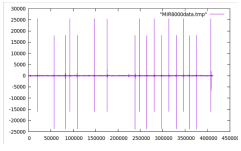
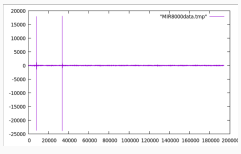
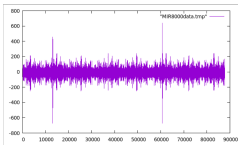
What happens to interferogram at higher or lower resolutions?

One acquisition was collected. Madnesss occurs at resolution of 4.

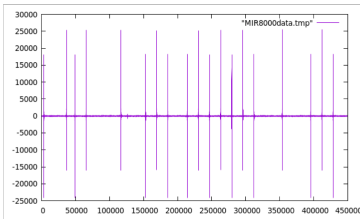
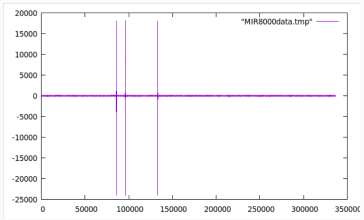
Resolution	Timestamp	Filename	Graph
32	2019-09-1714:57:17.528495	`week1_step2_res_32.txt`	
16	2019-09-1714:59:33.954924	`week1_step2_res_16.txt`	
8	2019-09-1715:03:29.803103	`week1_step2_res_8.txt`	
4	2019-09-17 15:04:45.047499	`week1_step2_res_4.tx`	

Step 3

Vary number of acquisitions. Task: acquire spectra without nitrogen flow at resolution of 4. You need to average several spectra for better SNR. How many? Conclusion: just do the max, 32 acquisitions.

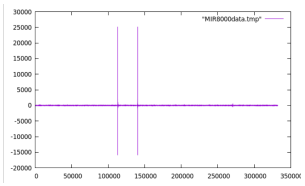
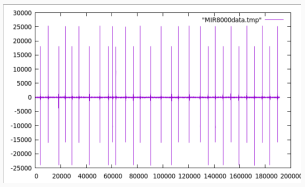
Number of Acquisitions	Timestamp	Filename	Graph
32	2019-09-1715:08:18.145604	`week1_step3_no_no2_32acq.txt`	
16	2019-09-1715:12:13.229219	`week1_step3_no_no2_16acq.txt`	
8	2019-09-1715:15:17.012119	`week1_step3_no_no2_8acq.txt`	

FTIR N2 flow: Didn't get data after 5 mins. 10 mis however. FTIR flow: 15. Cells set at 0. Read about FTIR flow rate.

Number of Minutes	Timestamp	Filename	Graph
10	2019-09-17 15:29:24.814325	`week1_step3_n2_10mins.txt`	
20	2019-09-17 15:37:25.882325	`week1_step3_n2_20mins.txt`	

Step 4

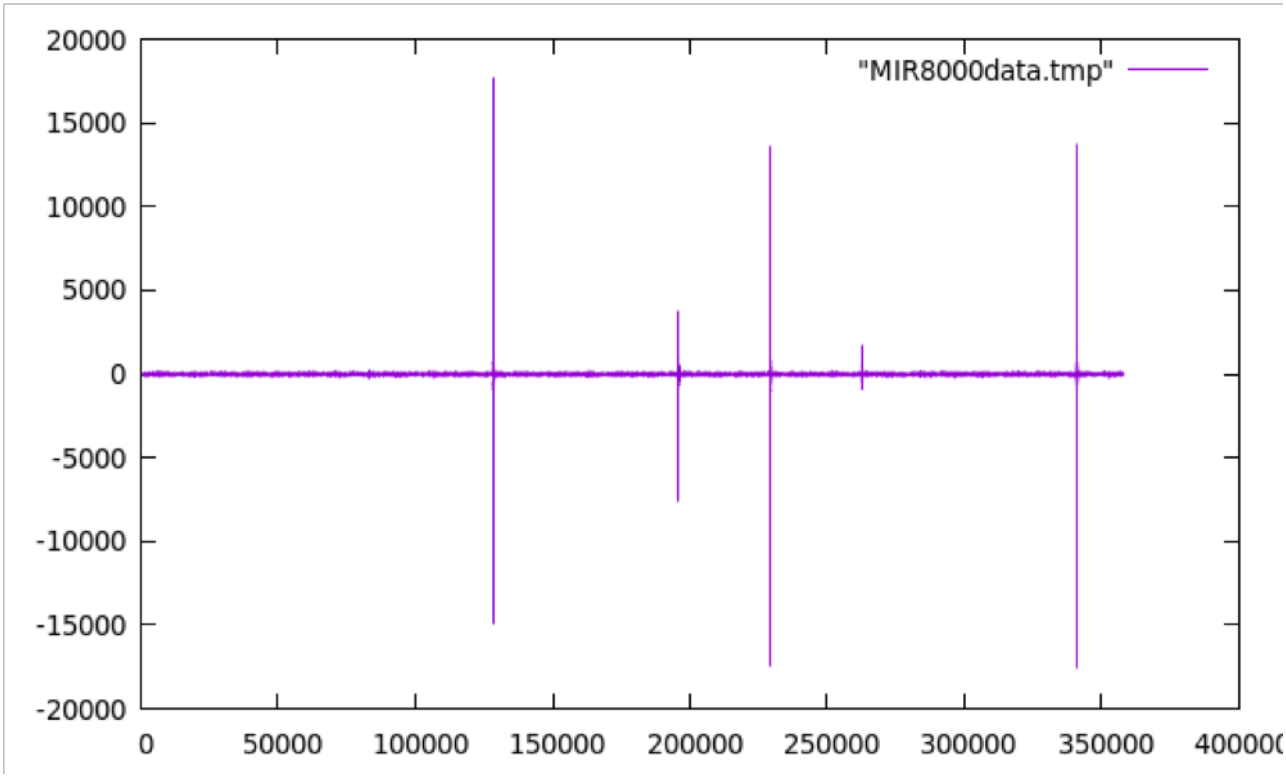
Signal to noise ratio. 32 acquisitions for resolutions.

Resolution	Timestamp	Filename	Graph
4	2019-09-1715:39:58.526794	`week1_step4_snr_res_4.txt`	
8	2019-09-1715:42:03.916245	`week1_step4_snr_res_8.txt`	

Step 5

Flushing of the cell. After 15 mins of flushing:

- 2019-09-17 16:02:19.182212
- `week1_step5_n2_flush.txt`



Notes

The MIR8000 uses a HeNe laser as reference.

The HeNe also goes through the interferometer, with no interaction with the IR laser. It creates a trigger pulse as HeNe goes through its fringes. This triggers the ADC. This gets sent to IR detector, that the ADC has moved another fringe pattern. Overall, this results in a data point being taken.

The points on the x-axis of the plots being acquired from the MIR8000 are the intesity points as the HeNe goes through zero. From this, we can find distance travelled precisely. Together, resolution + velocity will set the number of points being acquires.

TODO: we know that there are 1024 points being acquired for the default parameters. Hence, we can convert to the time domain. This will allow us to take the fourier transform to move into the frequency domain.

Important: For the offset, this needs to be calibrated each lab session. Set the peak to $\frac{1}{2}(\#\ \mathbf{pts})$, so 5122 for the default params. This only needs to be done at the beginning of each lab. After initial calibration, everything else is an integer multiple of the fringes anyways. We saw that skipping starts at resolution 8, becomes obvious at resolution 4. The resolution is in wavenumber units.

Flushing of Cell and FTIR

You can stick one end of the tubing to check the flow rate. Can also check the lab manual for the flow rates to calculate how much time is needed to flush the cell.

Week 2 [Jan. 21, 2020]

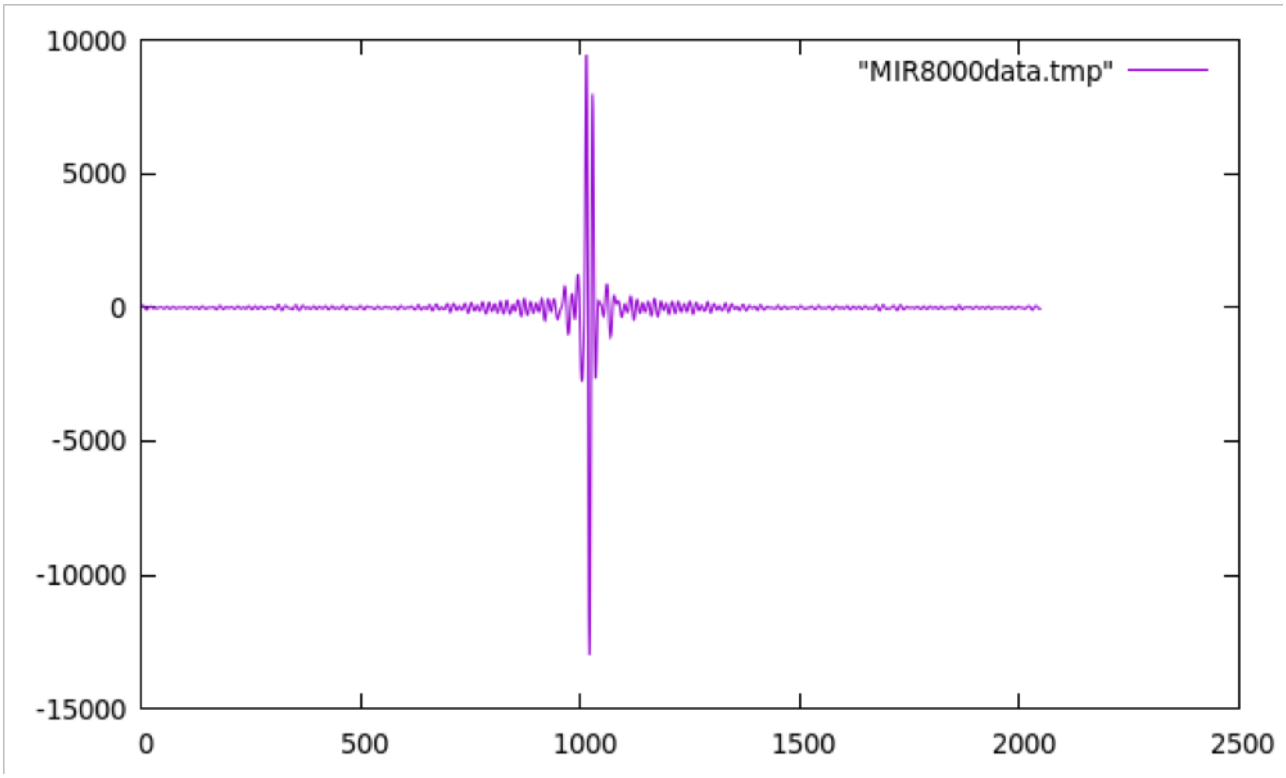
All data is store under the `data/lab1/week2/` directory. Conducted a portion of the experiment with Arthur.

Lab Procedures Conducted

Centering

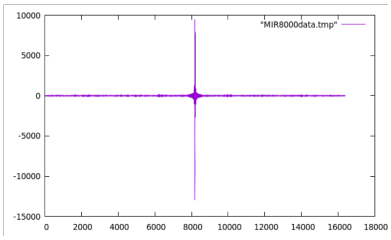
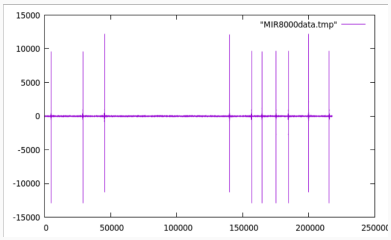
Use resolution of 32 parameters to set center burst to 1024. Also need to check if baseline is at 0. Spectrums are really noisy. Realized that IR source was off. Done with the cell in place,

- Only graph was saved.
- Remember, positive sign in offset field means to move burst to left



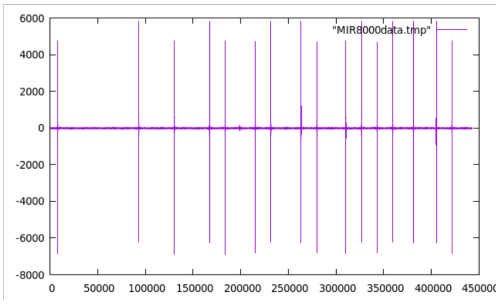
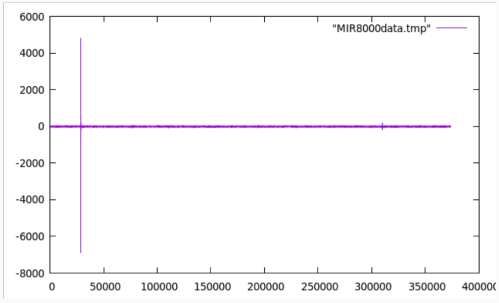
Step 7

Absorption of air. Flushed cell with air, hooked up by TA. Acquire a signal at 4cm^{-1} resolution. Worked with Arthur to purge the cell with air. Collect data with Arthur. Tried one acquisition, also wanted to see the forwards and backwards motion. so did it with 32.

Num Acquisitions	Timestamp	Filename	Graph
1	2019-09-1711:36:59.072198	`step7/air_cell_4cm-1.txt`	
32 (wanted to see backwards and forwards)	2019-09-17 11:43:26.764214	`step7/air_cell_4cm-1(32 acq).txt`	

Step 5

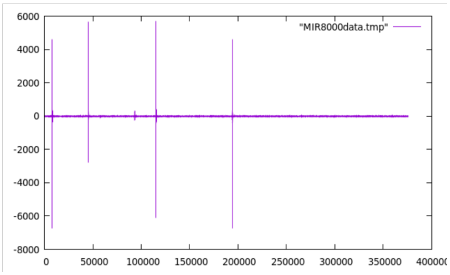
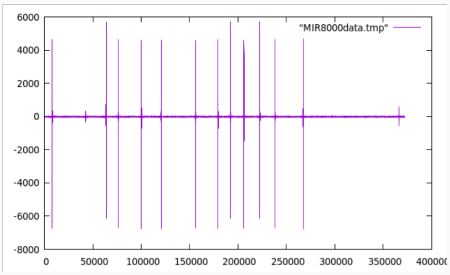
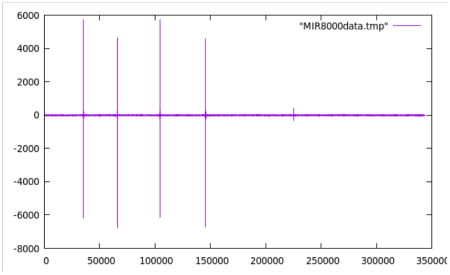
Flush cell with N2. Did after step 7, since air is mostly N_2. Flow rate on this is pretty pathetic. Should flush for 20 mins. Flushing rate at max 60. Having arduino problems. On the bright side, we have been flushing since 2:45pm. Got data after purging for 25 mins. All data were taken with 32 acquisitions

Trial #	Timestamp	Filename	Graph
1	2019-09-1712:12:17.068642	`step5/n2_cell_4cm-1 (32 ac).txt`	
2	2019-09-17 12:17:33.931597	`step5/n2_cell_4cm-1 (arthur 32ac).txt`	

Spoke to prof. Will need to filter off the acquisitions that have no prominent peak. They will only increase the S/N.

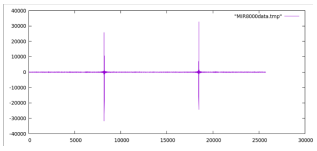
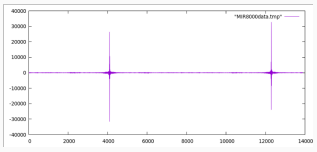
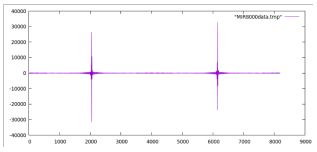
Step 6

Started CO_2 purging at 3:16pm. At 60. After one minute, take 32 acquisitions. We proceeded to take several rounds of data, each at different time points. Have to be careful about CO_2. We only purged for 1 minute, and we fanned the area afterwards.

Time after 1 min Purge [min]	Timestamp	Filename	Graph
1+4	2019-09-1712:22:39.932372	`step6/co2_cell_4cm-1.txt`	
3+4	2019-09-17 12:25:28.394080	`step6/co2_cell_4cm-1 (3min).txt`	
6+4	2019-09-17 12:27:38.830395	`step6/co2_cell_4cm-1 (6 min).txt`	

Step 4

Redid signal to noise measurements. Dr. Reinsberg suggested that we try the processing with more finer resolutions. I had let the FTIR purge with N_2 for a while.

Resolution [cm^{-1}]	Timestamp	Filename	Graph
4	2019-09-17 13:27:49.674836	`week2_step4_snr_res_4.txt`	
8	2019-09-17 13:40:53.559685	`week2_step4_snr_res_8.txt`	
16	2019-09-17 13:41:55.179366	`week2_step4_snr_res_16.txt`	

Notes

Resolution discussion cont.

Had a discussion with Dr. Reinsberg as to how to check if the MIR8000 is oversampling or not. Performing the calculations, we see that it might be. Need to use a positive control to determine for sure though.