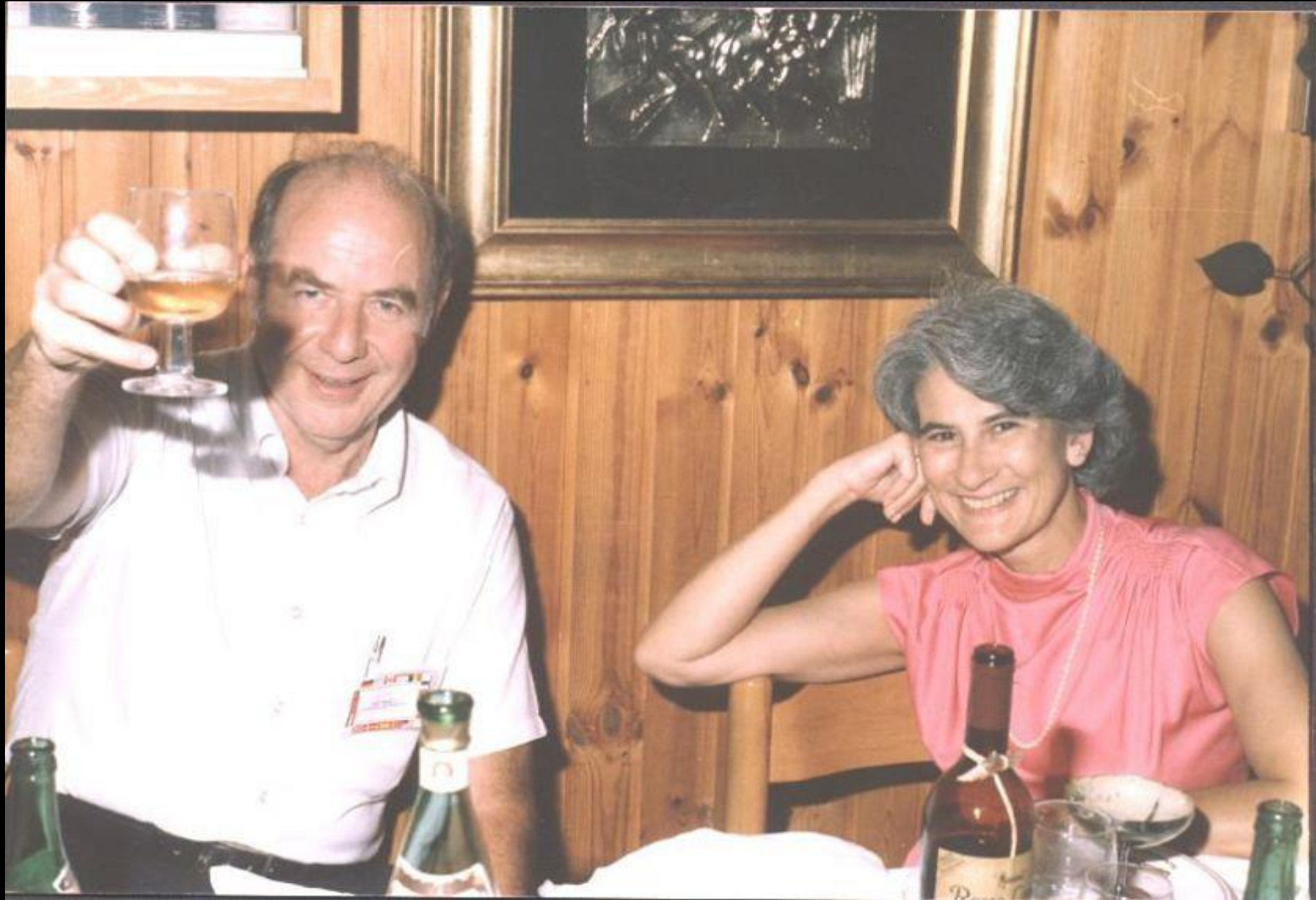


Research Group Pics



1986: Gleb and Charmaine Mamantov, toasting our group at the farewell banquet, NATO ASI on Molten Salt Chemistry, Camerino, Italy

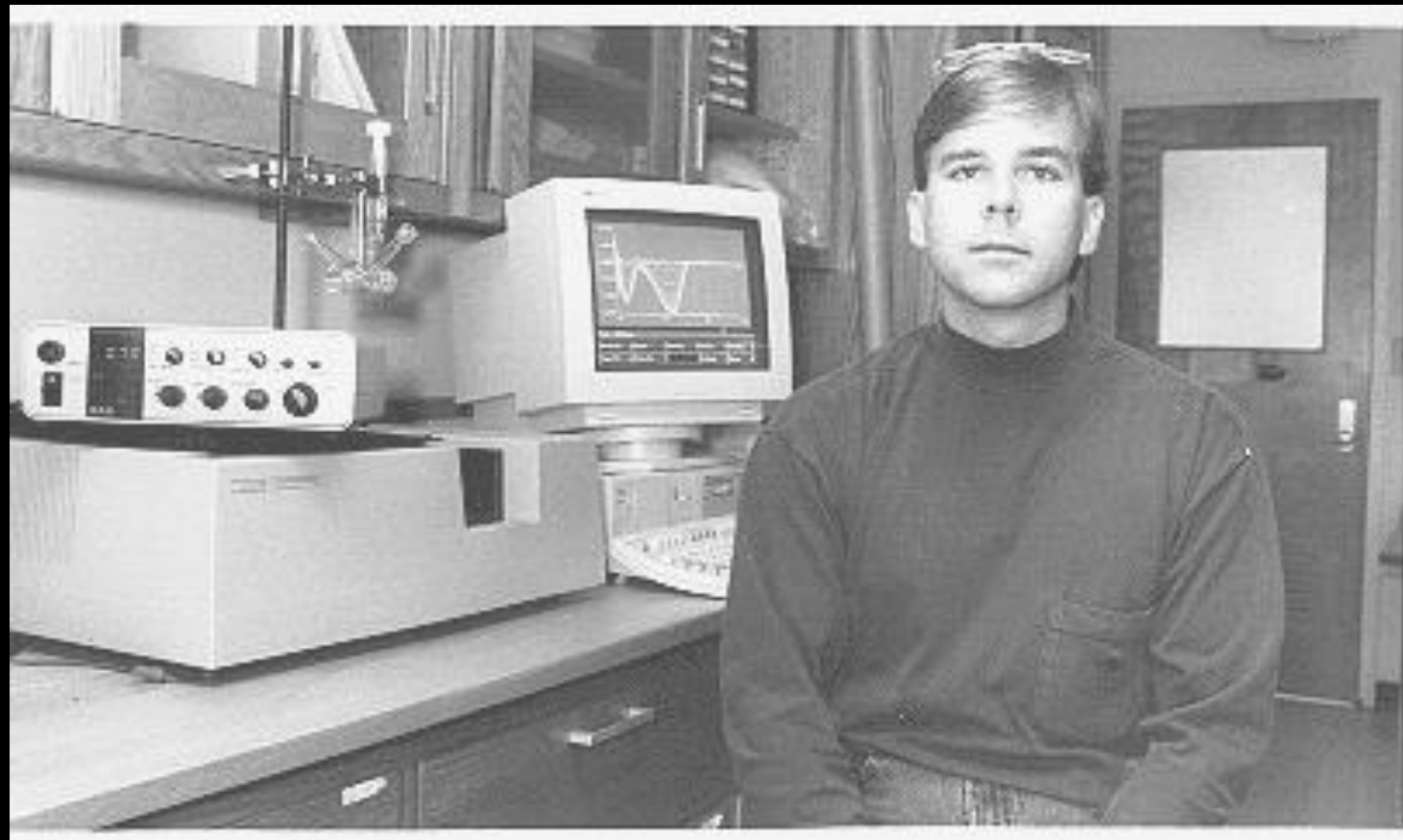
NATO
University of Camerino
Advanced Study Institute on
Molten Salt Chemistry
Camerino, Italy - August 3-15, 1986



1986: Attendees of the NATO ASI on Molten Salt Chemistry (too many folks to name!)



1987: Molten Salt Research Group, UT...left to right:
Back row – me, Dave Trimbell, Jim Coffield, Glen Hance, Karl Sienerth
Middle row – Tim L., Steve Williams, Charmaine Mamantov, Jean-Paul Schoebrechts, cool
German undergrad whose name escapes me
Front row – Bernard Gilbert, Gleb Mamantov, Yuzuru Sato, Bob Walton



1994: My first web page profile pic!...



1995: Working in the glove box...(me, Sherry Callendar, Chad Breneman).



1995: Amy Chavis torch-sealing a glass ampoule.



1996: (l-r) Leslie Lowry and Denise Huggins measuring Pb in tap water via AAS (subsequently scolded for letting the photographer convince them to remove the UV light shield!).



2000: Don Owens configuring a spectrometer for flow injection spectroelectrochemistry.



2001: Nick Dimery assembling a variable path length spectroelectrochemical cell.



2001: me, Michael Locklear, Don Owens



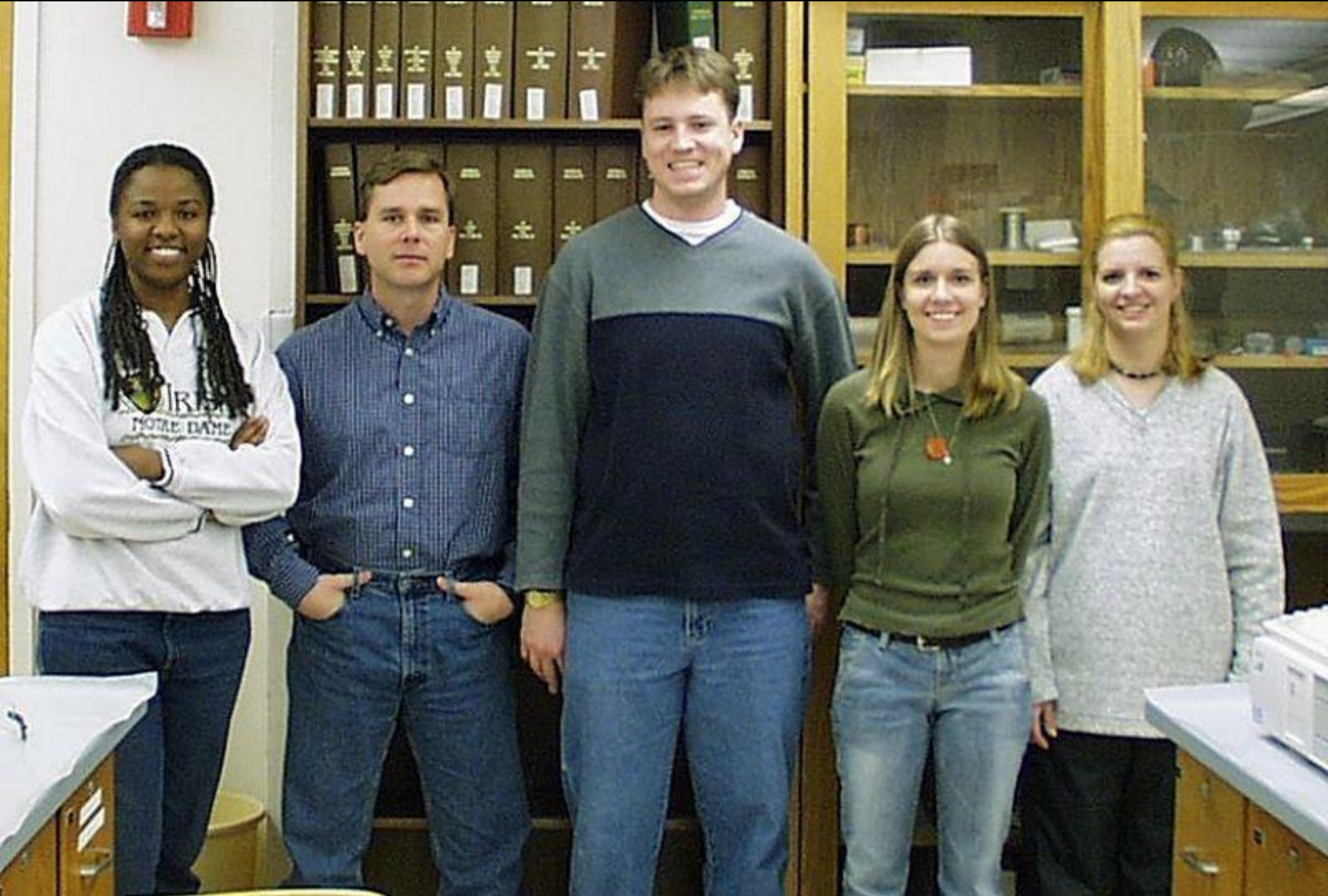
2002: me, Leanne Stanley, Kim Bullock, Olga Tarkington, Jamie Locklear



2002: me, Kim Bullock, Leanne Stanley, Stephanie White



2002: Angela Smith, Olga Tarkington, me, Tammy Schwab, Kim Bullock



2003: Florence Migele, me, Bruce Pier, Kim Bullock, Leanne Stanley



2004: Jeremy Emanuel, me, Leanne Stanley, Tamim Alsaedi



2004: Summer REU participants (l-r)
Back: Tom Dooling, Siva Mandjiny, me, James Evans, Matthin Easterlin
Middle: April Garner, _____, _____
Front: Brian Bachner, Megan Grimsley



2004: James Evans, Megan Grimsley, April Garner, me



2004: James Evans, Megan Grimsley, April Garner, giving me the respect I so fully deserve!



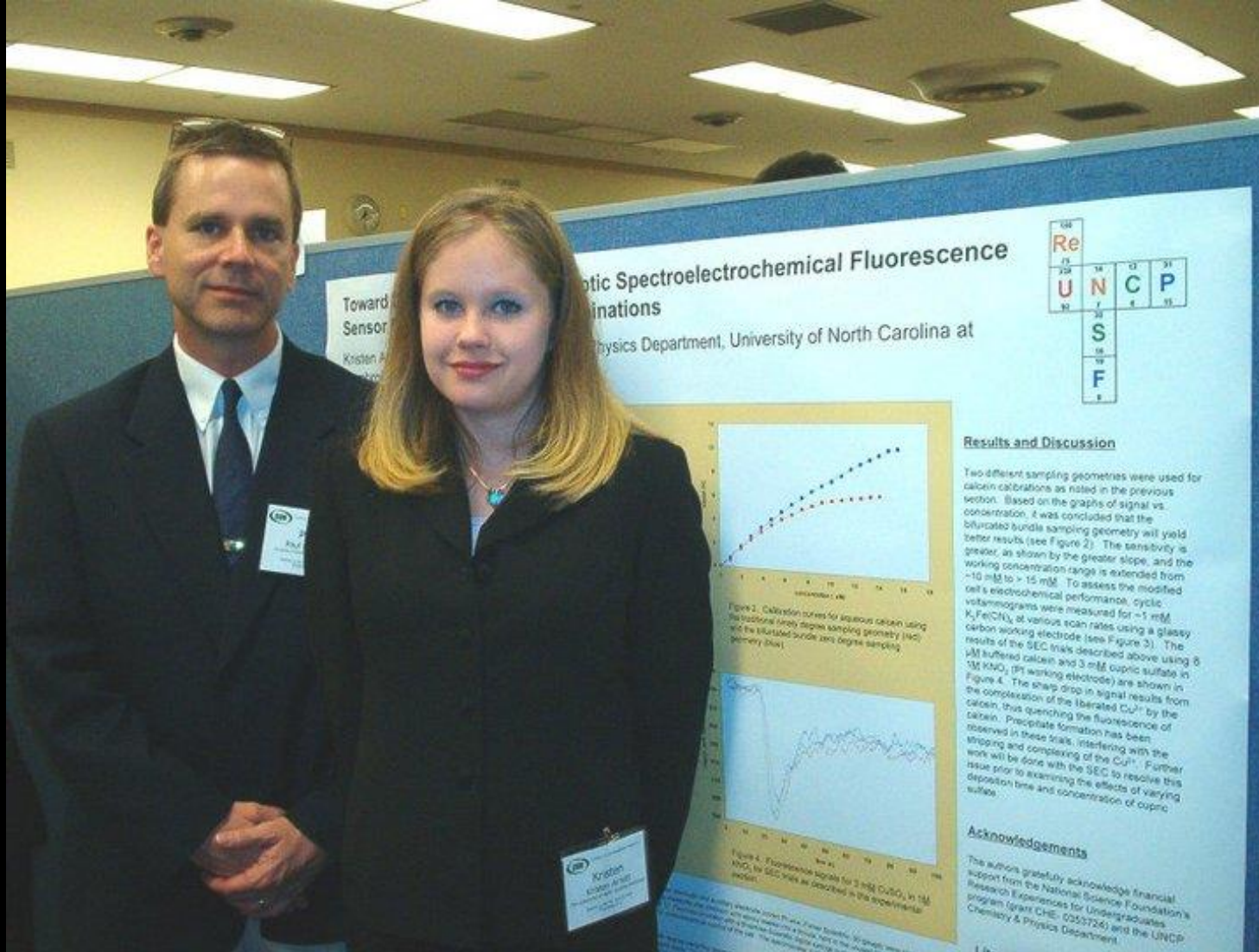
2005: Beth Butler, me, Ryan Rodriguez



2005: Summer REU participants

Back: _____, Janet Sandford, Marquita, Lilly, Tom Dooling, Siva Mandjiny, me, _____

Front: Kristen Arnett, Beth Butler, _____, Megan Grimsley



2006: me with Kristen Arnett at a CUR "Posters on the Hill" session, Washington DC



2006: Summer REU participants

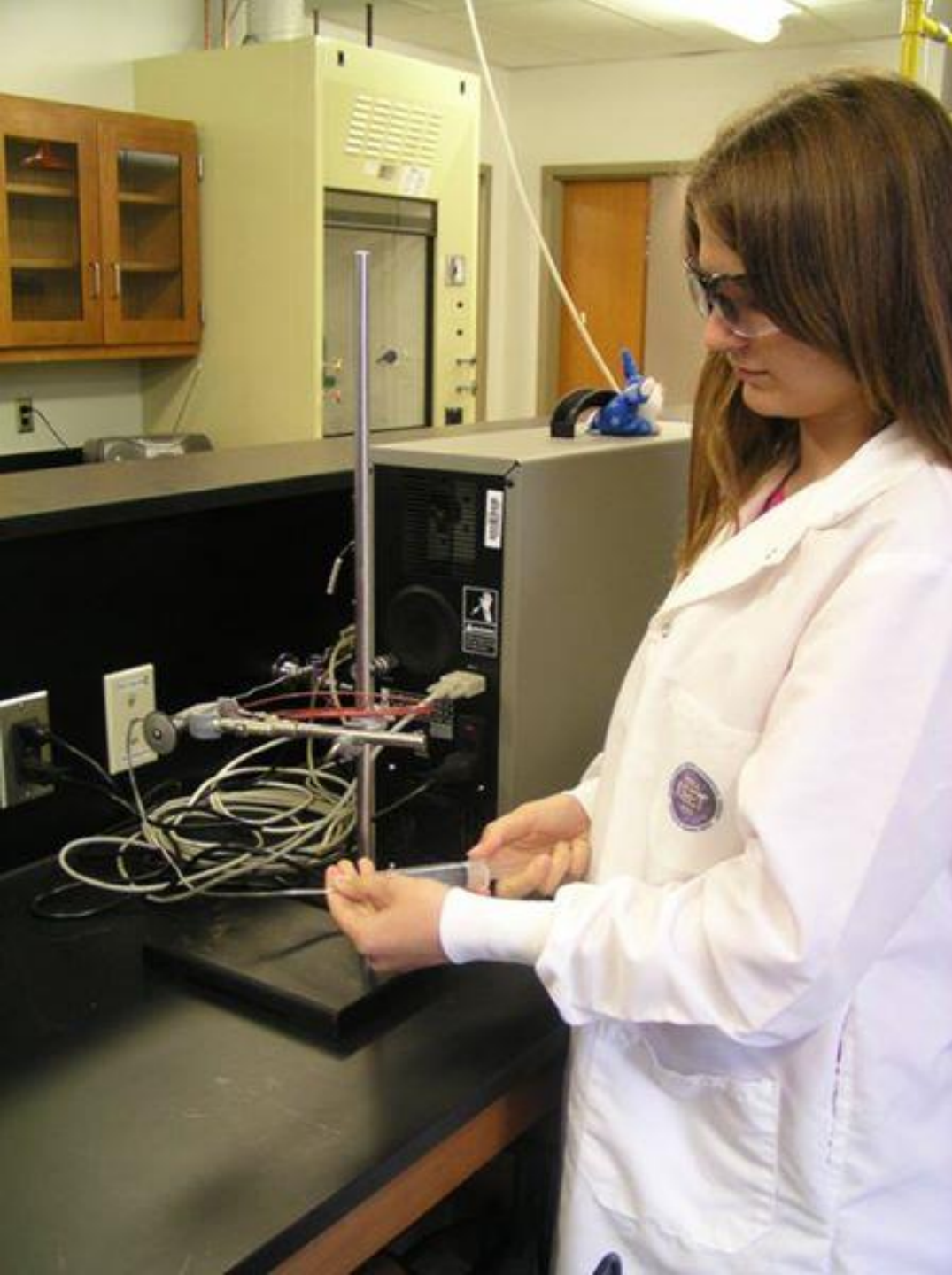
Back: James Smith, Eric Blue, _____

Middle: Tom Dooling, me, Siva Mandjiny, Jay Sibbett

Front: Sathya Mandjiny, Kristen Arnett, _____



2007: James Smith, Emily Howden, Jamie Hardee, me



2007: Emily Howden preparing a mass spectrometer for carbon dioxide measurements



2007: Shane Gutierrez assembling an electrochemical cell for ionic liquid electrolysis



2007: Josh Locklear installing a column on a gas chromatograph



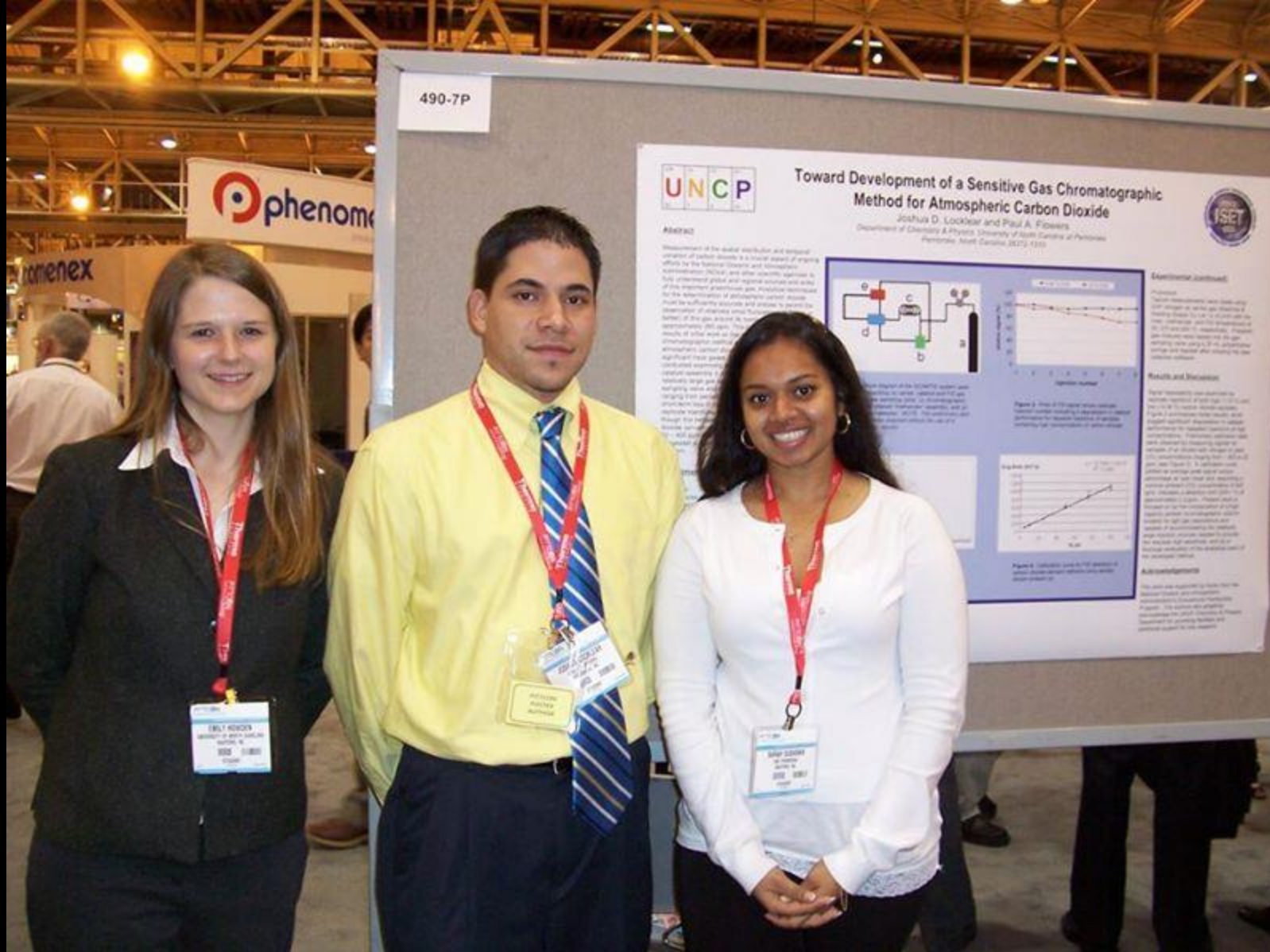
2007: Shane Gutierrez, Emily Howden, Josh Locklear, me



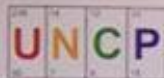
2008: Emily Howden and Sarah Subaran figuring out the shuttle routes at PittCon as Josh Locklear prepares to smoke the world's largest cigarette.



2008: Josh Locklear, Emily Howden, Sarah Subaran, and me at Pittcon.



2008: Emily Howden, Josh Locklear and Sarah Subaran standing by Josh's poster at Pittcon.



Toward Development of Ambient Pressure Sampling Mass Spectrometry for Determination of Atmospheric Carbon Dioxide

Emily K. Howden and Paul A. Flowers

Department of Chemistry & Physics, University of North Carolina at Pembroke
Pembroke, North Carolina 28372-1510



Abstract

Measurement of the spatial distribution and temporal variation of carbon dioxide is a crucial aspect of ongoing efforts by the National Oceanic and Atmospheric Administration (NOAA) and other scientific agencies to fully understand global and regional sources and sinks. Analytical techniques for the determination of atmospheric carbon dioxide must be sufficiently accurate and precise to permit the observation of relatively small fluctuations (0.1 ppm or better) of the gas around its nominal concentration of approximately 385 ppm. This poster describes the results of pilot work on the development of ambient pressure sampling mass spectrometry for the determination of atmospheric carbon dioxide. The performance of a commercially available open ion source quadrupole mass spectrometer was assessed by analysis of gas samples containing carbon dioxide at levels ranging from 150% to 25 ppm and sampled via several modes (static, flow-through, and recirculated) using an in-house fabricated manifold. Preliminary calibration data obtained via a flow-through sampling mode indicate that sub-ppm detection limits should be readily achieved, and work to further evaluate the analytical merits of this and other sampling modes is presently underway. Future studies of the utility of this approach for simultaneous multicomponent analysis are planned.

Experimental

Reagents: Compressed nitrogen and carbon dioxide (standard grade from Machine and Vending Company) were used for preparation of carbon dioxide standards. Ambient air in the laboratory was also utilized in the preparation of standards.

Apparatus: An ambient pressure sampling quadrupole mass spectrometer (Model QMS 200 gas analyzer, Stanford Research Systems) was used for all measurements reported here. A programmable syringe pump, 885-8009000, from Ramsey Scientific, Inc. was used to prepare gas mixtures via addition of measured volumes of each component gas. The gas sampling manifold was constructed in-house from stainless steel Swagelok fittings and valves (Kaesig Valve & Fitting).

Procedure - Flow through Mode: The experimental arrangement employed for flow-through sampling is depicted in Figure 1. With the 3 port metering valve closed and the spectrometer sampling ambient air at 1 mL/min, the carbon dioxide signal at 44 amu was monitored until a flat baseline was observed. The syringe pump was then cycled with a sample syringe programmed to deliver sample at a flow rate

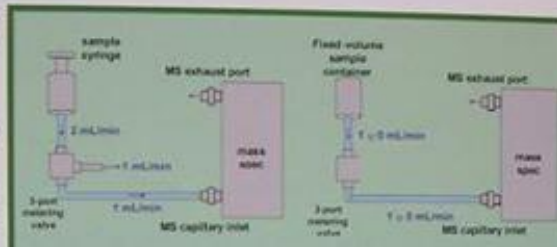


Figure 1. Schematic diagram of the system configured for sampling in flow-through mode.

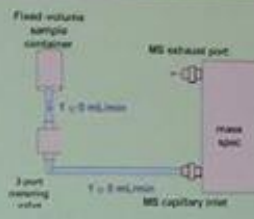


Figure 2. Schematic diagram of the system configured for sampling in static mode.



Figure 3. Typical signal traces measured while monitoring 44 amu signal during static sampling.



Figure 4. Typical mass spectrum for a CO2 standard (44 amu), and calibration curve for relative sampling CO2 in concentration ranging from approximately 1% to 100%.

Experimental (continued)

of 2 mL/min and static, and the 3-port valve was opened. When the signal at 44 amu was stabilized, a new analysis was acquired in the 41 to 47 amu range.

Procedure - Static Mode: Figure 2 depicts the experimental arrangement for static mode sampling. With the 3 port metering valve closed, the mass spectrometer was allowed to evacuate the connecting capillary. Carbon dioxide signal at 44 amu was monitored until a flat baseline was observed. The valve was opened while continuously monitoring the signal, creating a flow through track that was monitored for approximately 10 seconds.

Results and Discussion

Measurements made in static mode (as described above) generated signals as low as the one shown in Figure 3. These data are the sample of a quadrupole mass spectrometer. The signal-to-noise ratio (SNR) for these measurements was approximately 10:1.

Flow through sampling in the laboratory was also used to evaluate the system's performance. The signal-to-noise ratio for these measurements was approximately 10:1.

The signal-to-noise ratio for these measurements was approximately 10:1. The signal-to-noise ratio for these measurements was approximately 10:1.

The signal-to-noise ratio for these measurements was approximately 10:1. The signal-to-noise ratio for these measurements was approximately 10:1.

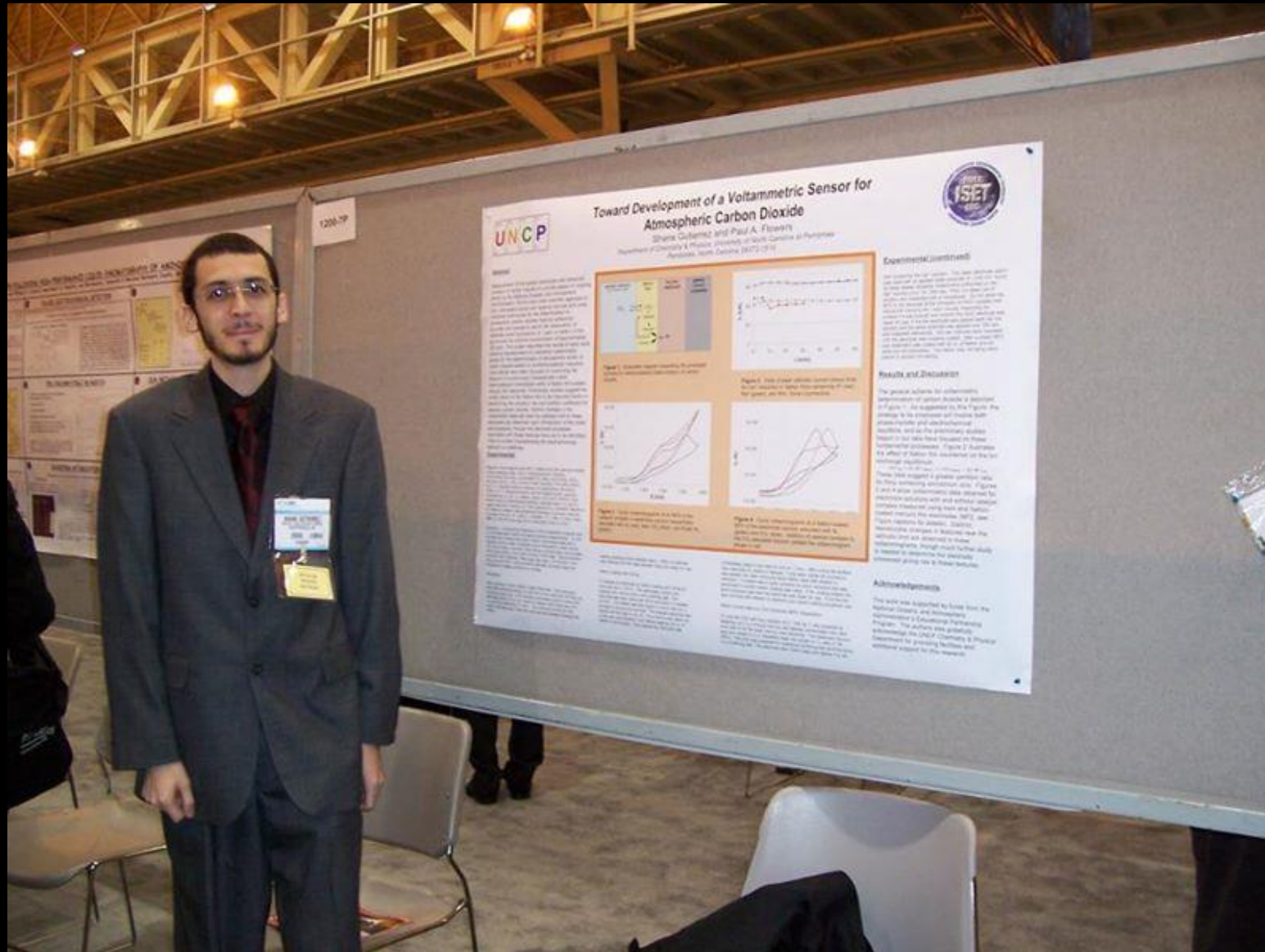
The signal-to-noise ratio for these measurements was approximately 10:1. The signal-to-noise ratio for these measurements was approximately 10:1.

The signal-to-noise ratio for these measurements was approximately 10:1. The signal-to-noise ratio for these measurements was approximately 10:1.

The signal-to-noise ratio for these measurements was approximately 10:1. The signal-to-noise ratio for these measurements was approximately 10:1.



2008: Emily Howden presenting her poster at Pittcon



2008: Shane Gutierrez presenting his poster at Pittcon



2009: Jordan Strickland, me, Cilia Iluku



2009: Jordan Strickland working with an electrochemical analyzer



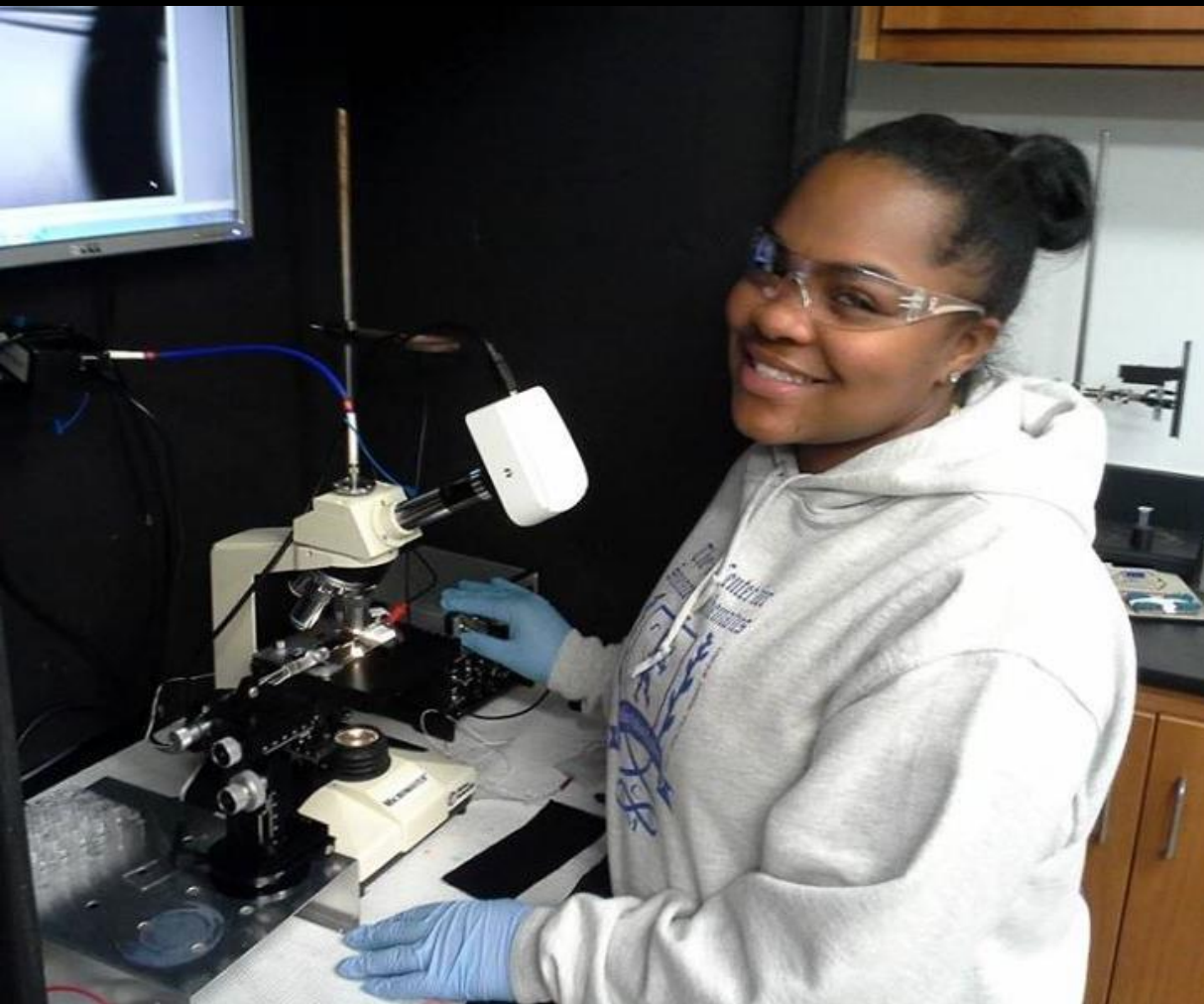
**2009: Cilia Iluku working with a
microspectrometer**



2010: Cilia Iluku and me assembling a gas manifold for introducing samples to a mass spectrometer.



2013/14: Bethany Winecoff, Jessica Stancil, Marsalis Smith, Angel Williams



**2013/14: Angel Williams
working with a
microiontophoresis rig**



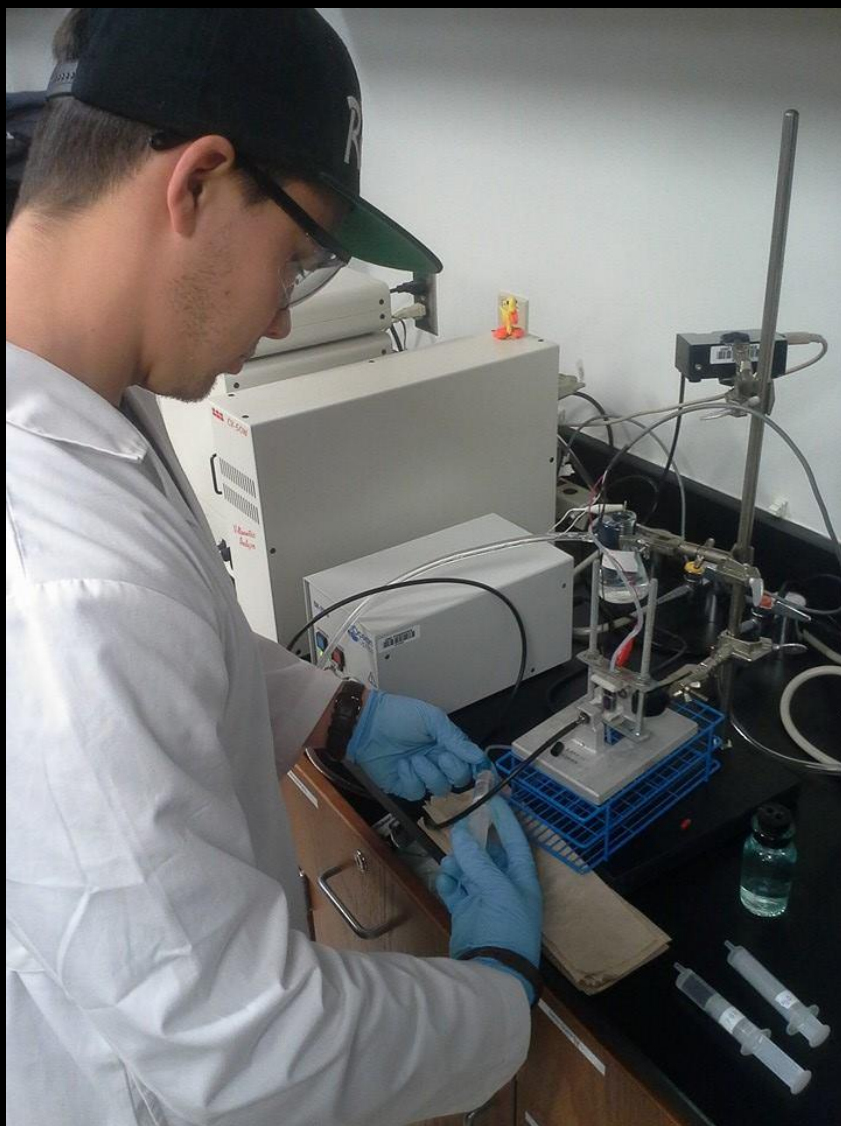
2013/14: Bethany Winecoff configuring a spectroelectrochemical flow cell



2013: Jessica Stancil preparing for spectral measurements with a microscale flow cell



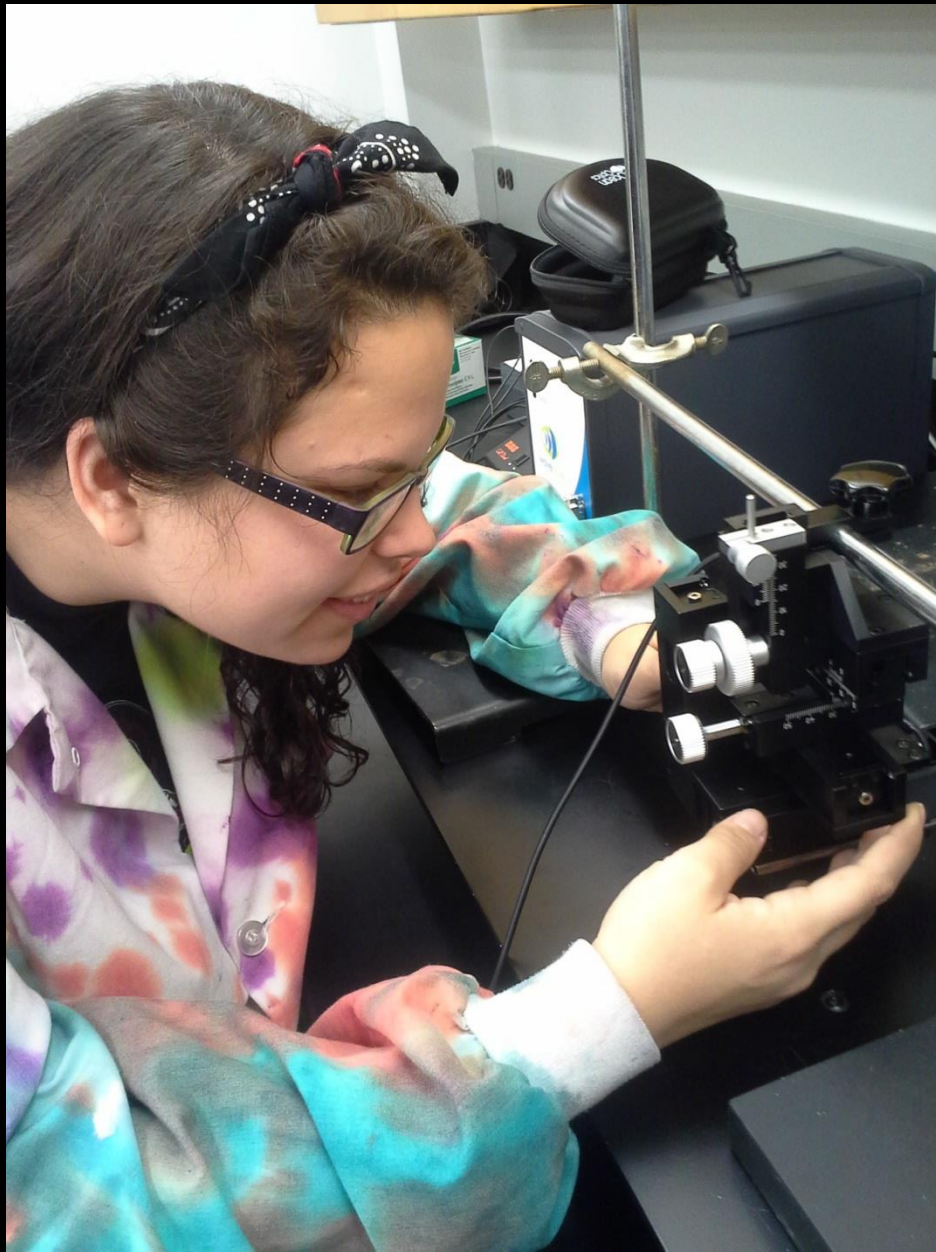
**2013/14: Marsalis Smith
fabricating micropipets for
iontophoresis**



2014: Matt MacDougall working with a spectroelectrochemical flow cell



Fall 2014 Research Group (l-r): Samantha Suggs, Sean Downes, Paul Flowers, William Robinson, Sunni Brown



2014: Samantha Suggs configuring a remote controlled micromanipulator



2014: Sunni Brown assembling a high-pressure electrochemical cell



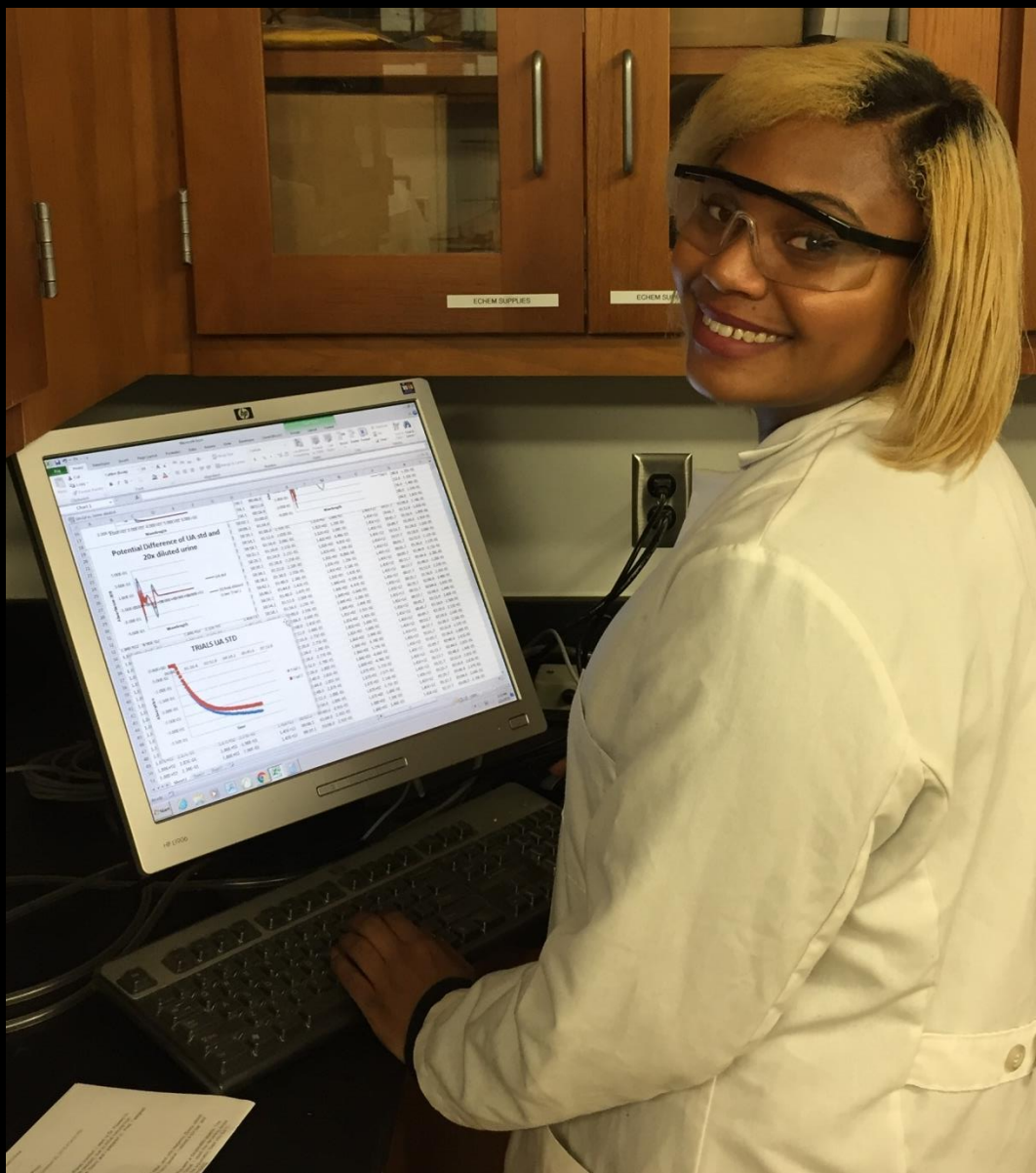
2014: Will Robinson preparing for a high-pressure infrared spectral measurement



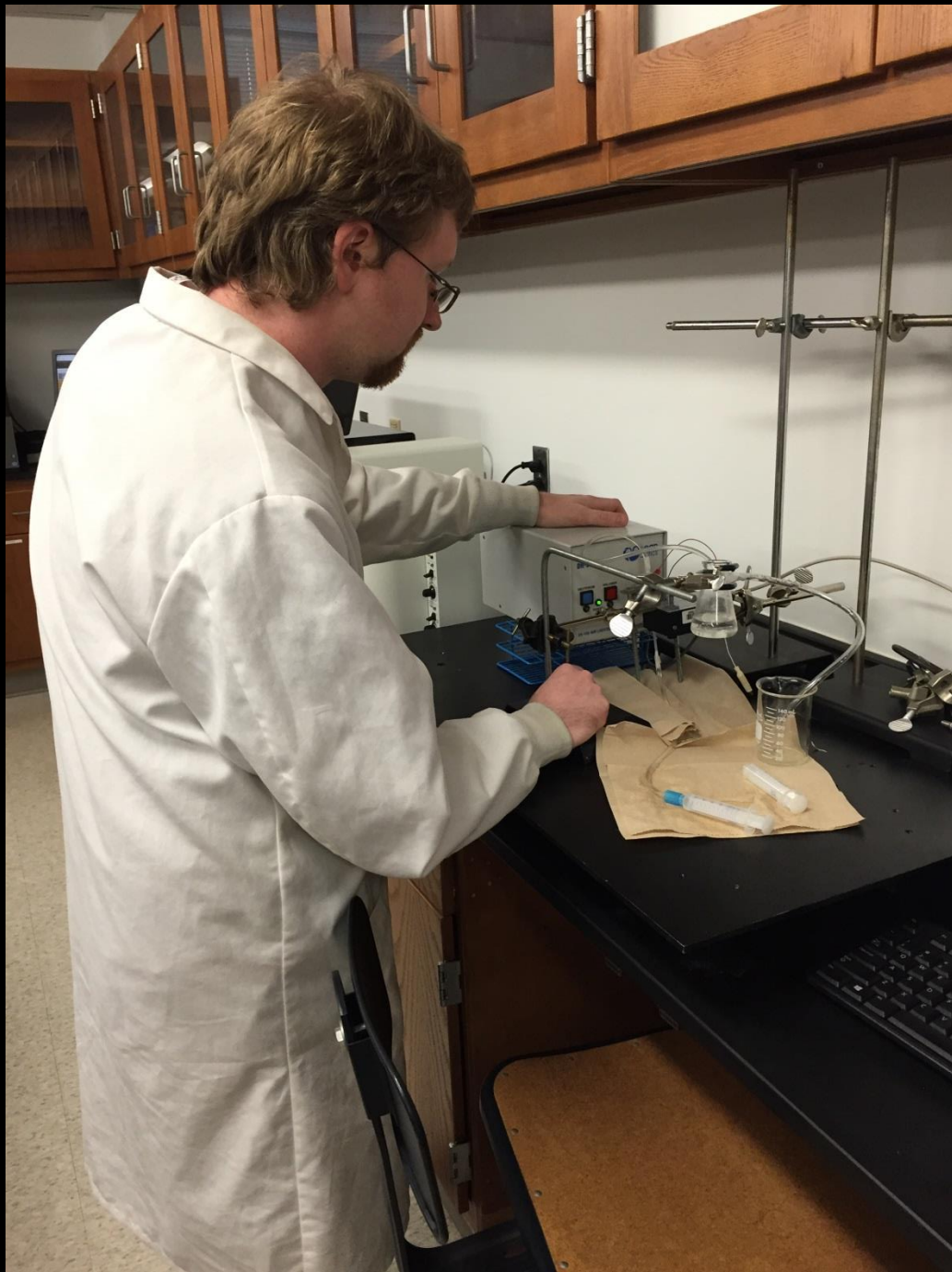
2014: Sean Downs positioning a NIR Raman laser probe



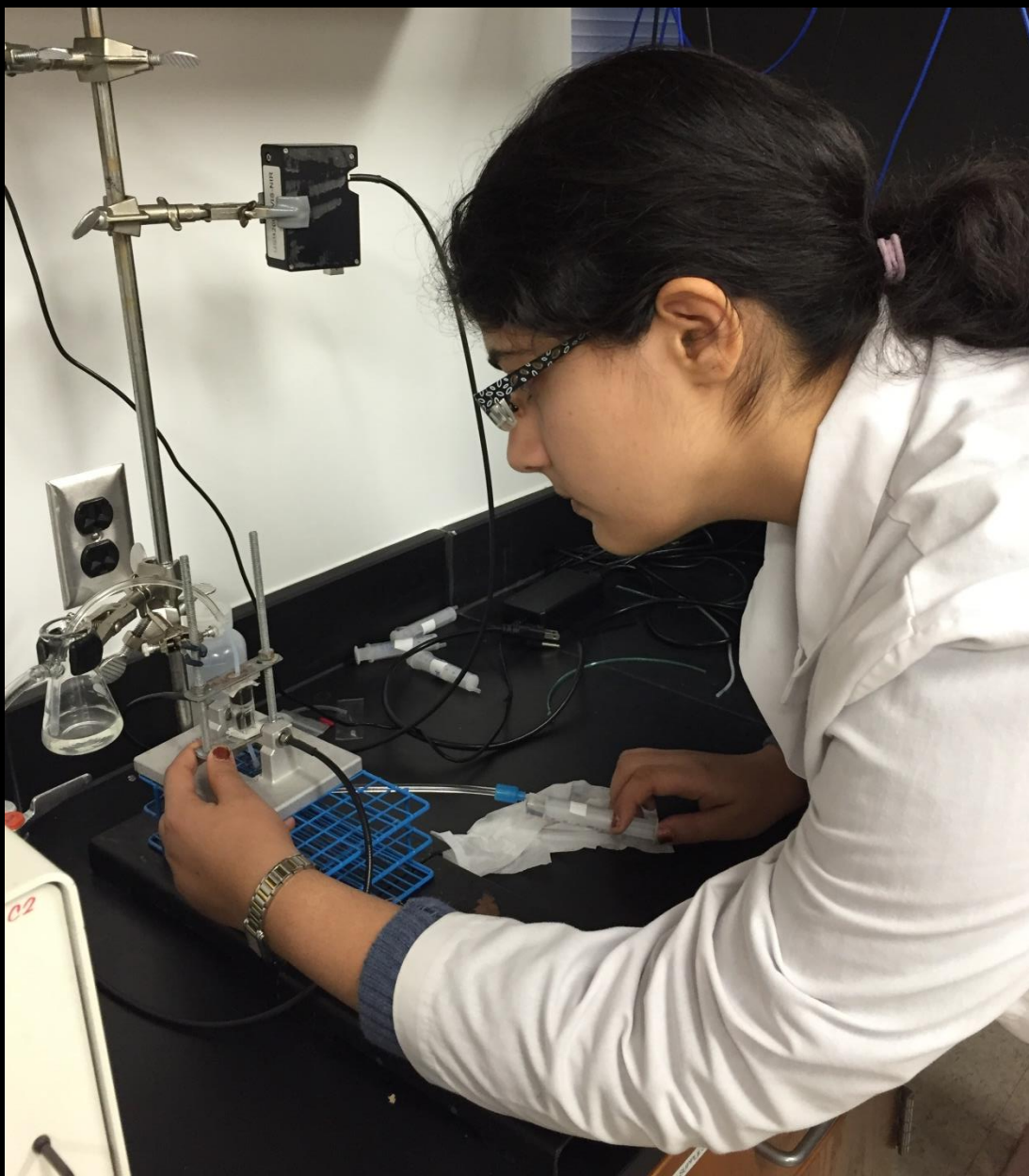
Spring 2015 Research Group (l-r): Natasha Wells, Paul Flowers, Sunni Brown, Ereny Gerges
(not pictured, Erin Barnhardt, Sean Downes and Samantha Suggs)



2015: Sunni Brown analyzing a fine day's worth of SEC calibration data



2015: Sean Downes aligning components of an SEC flow apparatus



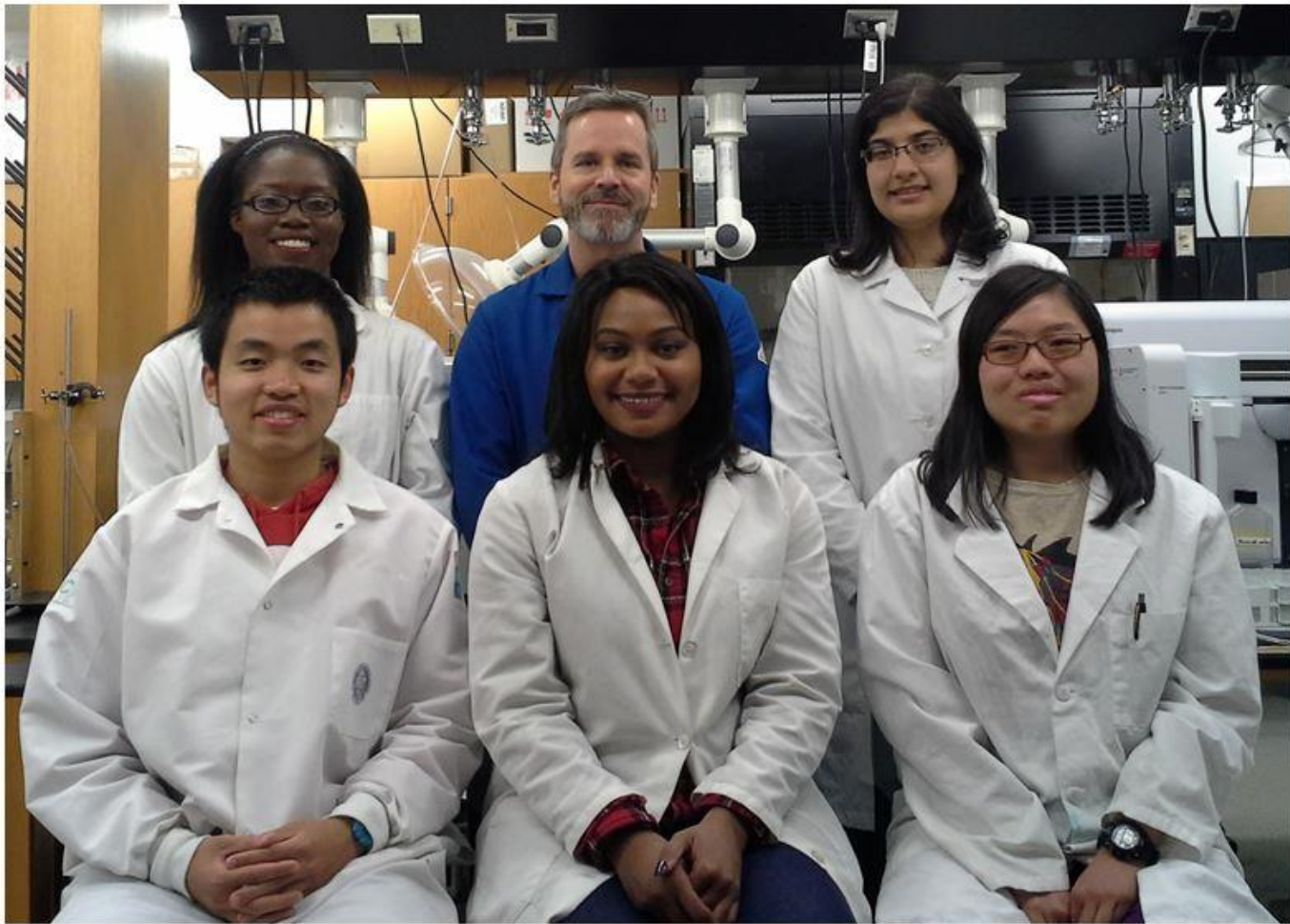
**2015: Ereny Gerges
preparing a flow cell for
spectroelectrochemical
measurements**



Fall 2015 Research Group: Ereny Gerges, Sunni Brown, Paul Flowers, Natasha Wells, Sean Downes



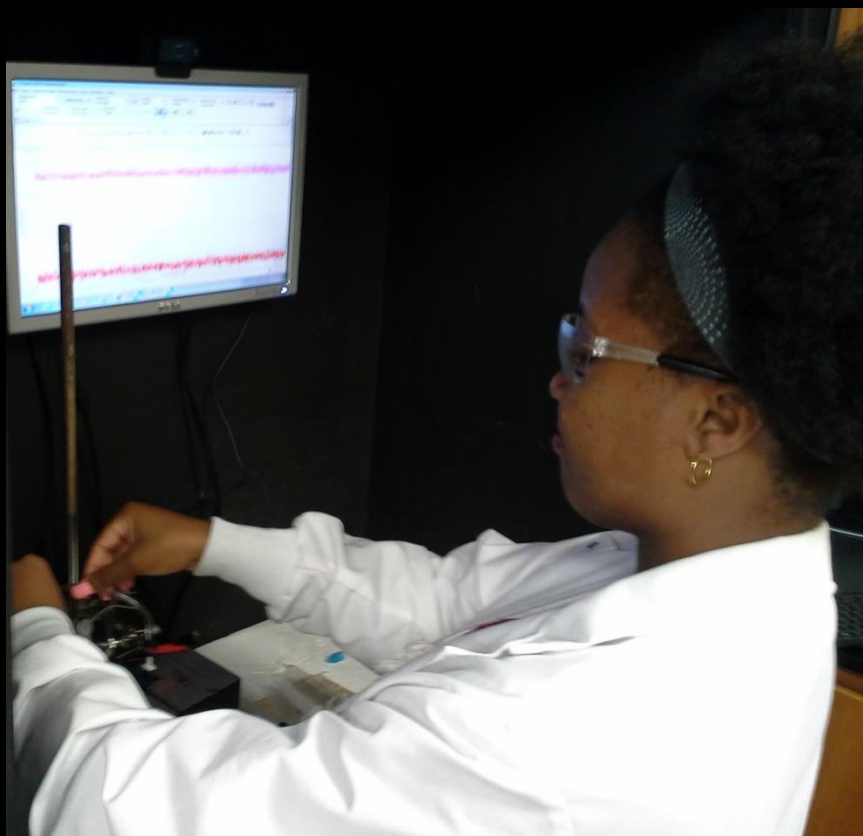
2016: Sunni Brown, Sean Downes and Natasha Wells at PittCon in Atlanta GA



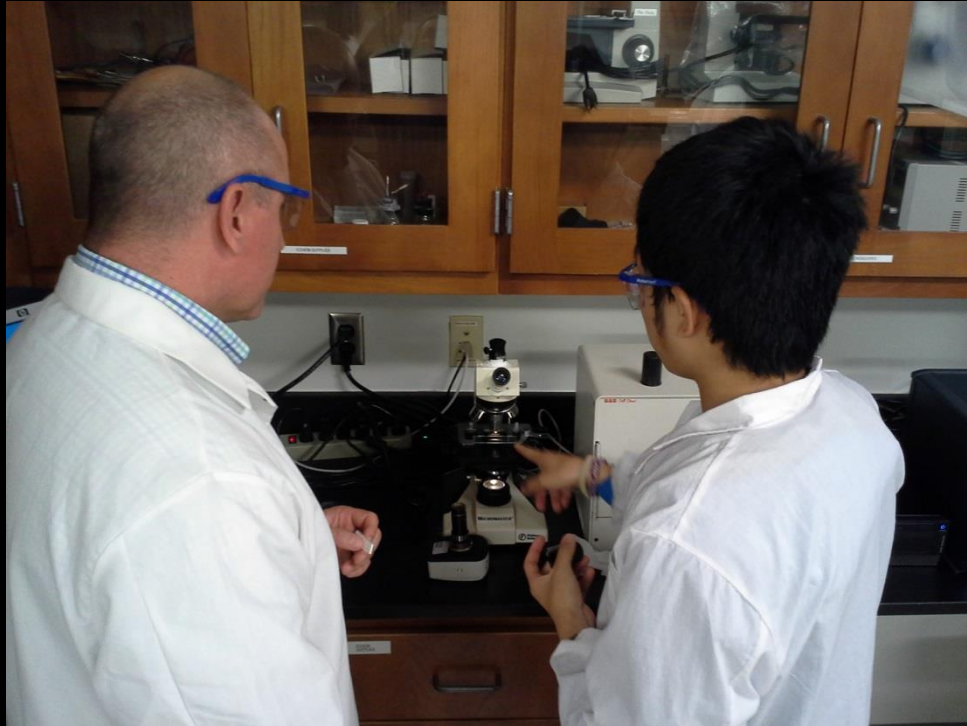
Spring 2016 Research Group: (front) Wei Wang, Sonvia Brown, Olivia Hinson; (back) Natasha Wells, Paul Flowers, Ereny Gerges



**2016: Wei Wang fabricating a
microscale spectroelectrochemical
flow cell**



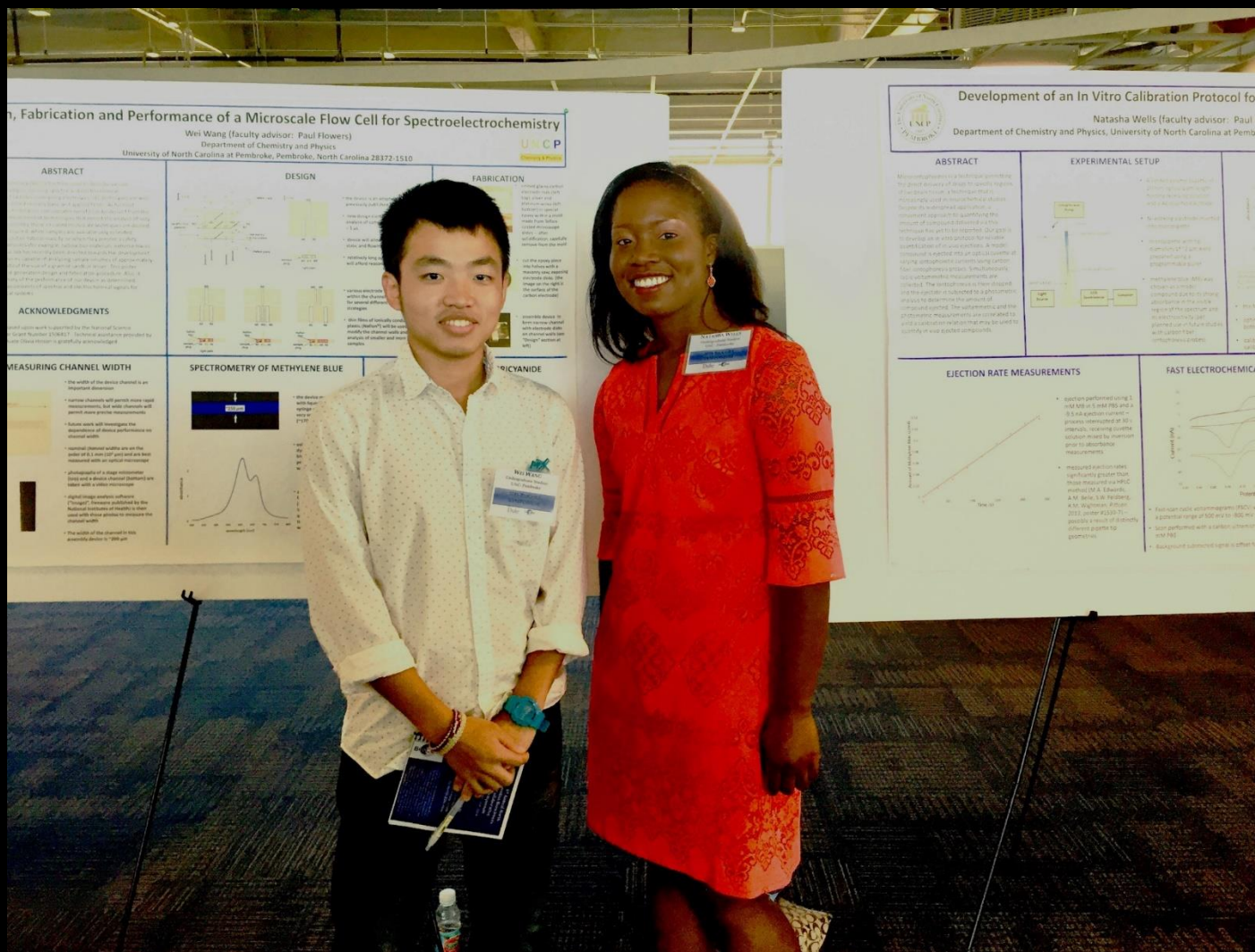
2016: Nwabata Nnani configuring a flow cell for spectroelectrochemical measurements



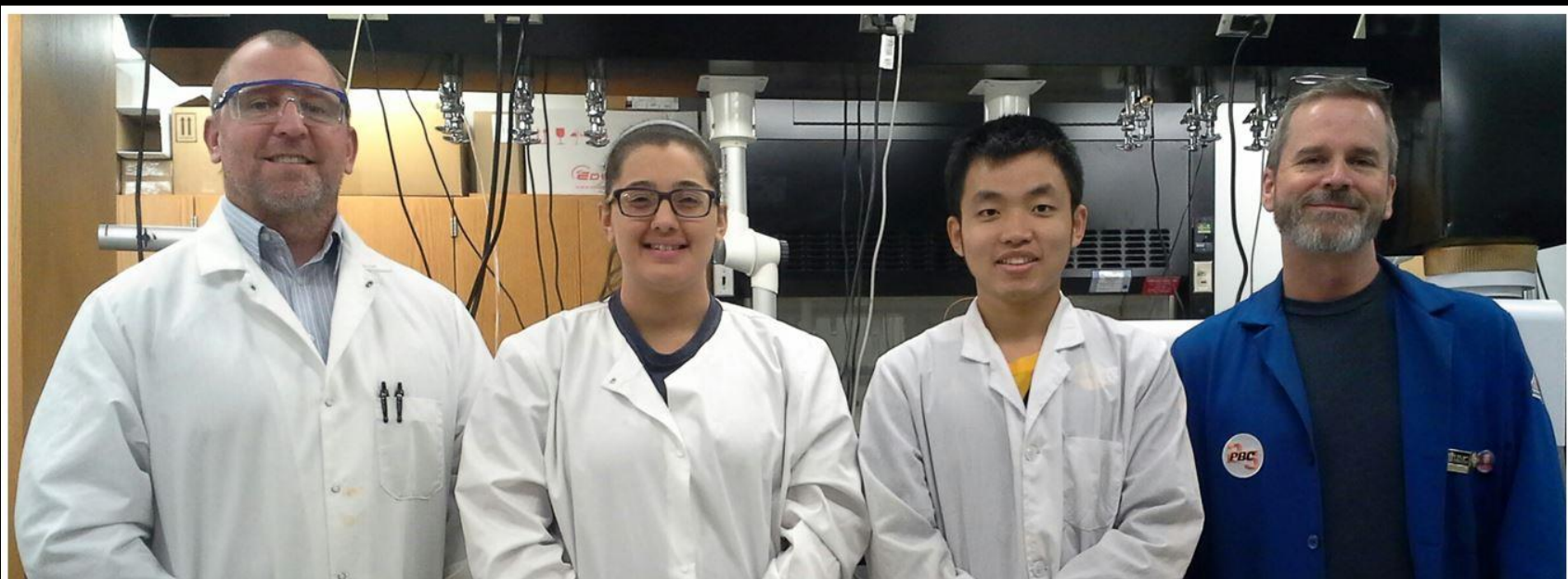
2016: Dayten Hodge and Wei Wang preparing for microscopic examination of a microscale flow cell channel



Summer 2016 research group (l-r): Dayten Hodge, Natasha Wells, Paul Flowers, Nwabata Nnani, Wei Wang



2016: Wei Wang and Natasha Wells presenting at Duke University's BIOCORE Conference



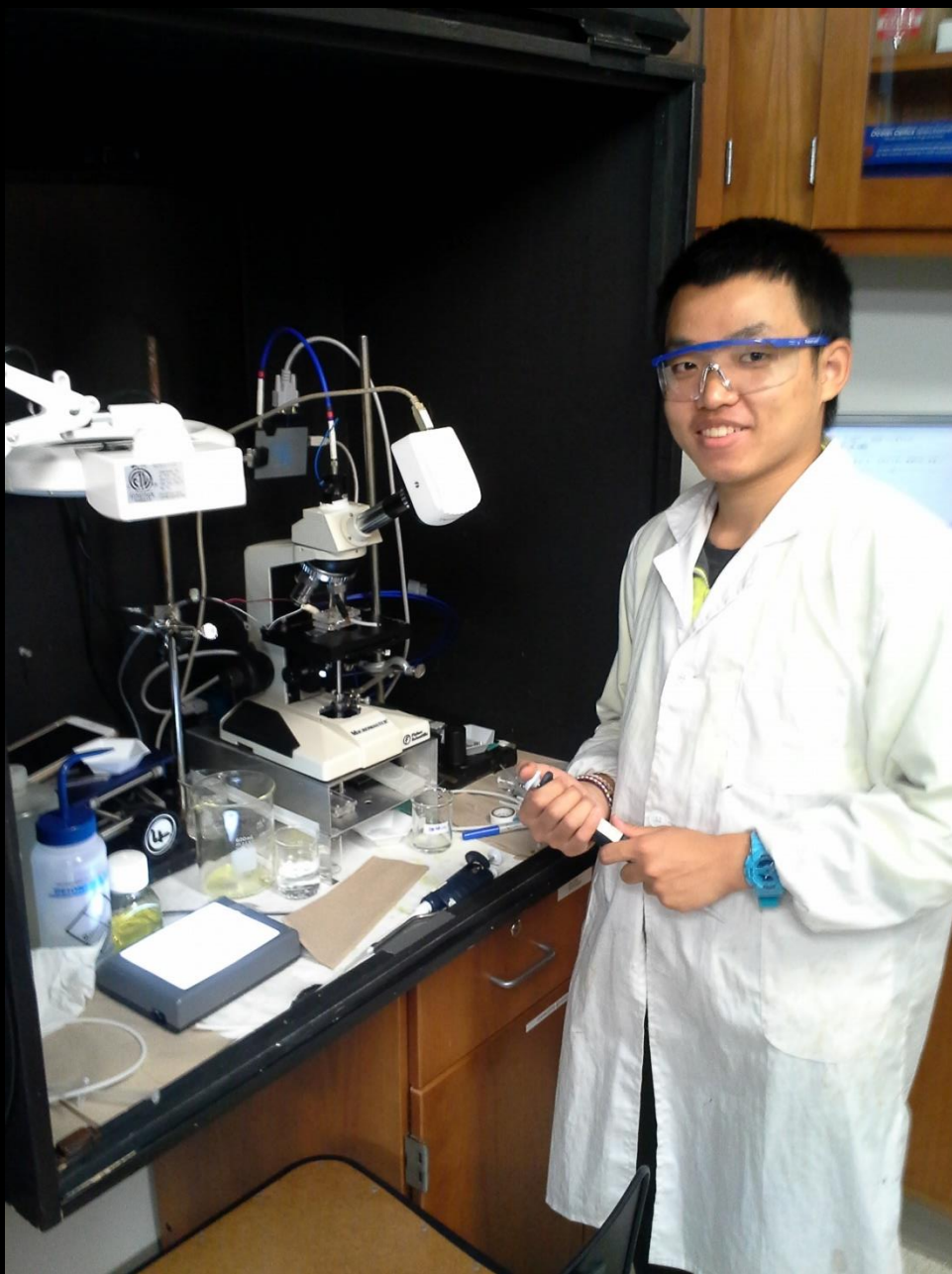
Fall 2016 Research Group (l-r): Dayten Hodge, Kaitlin Smith, Wei Wang, Paul Flowers



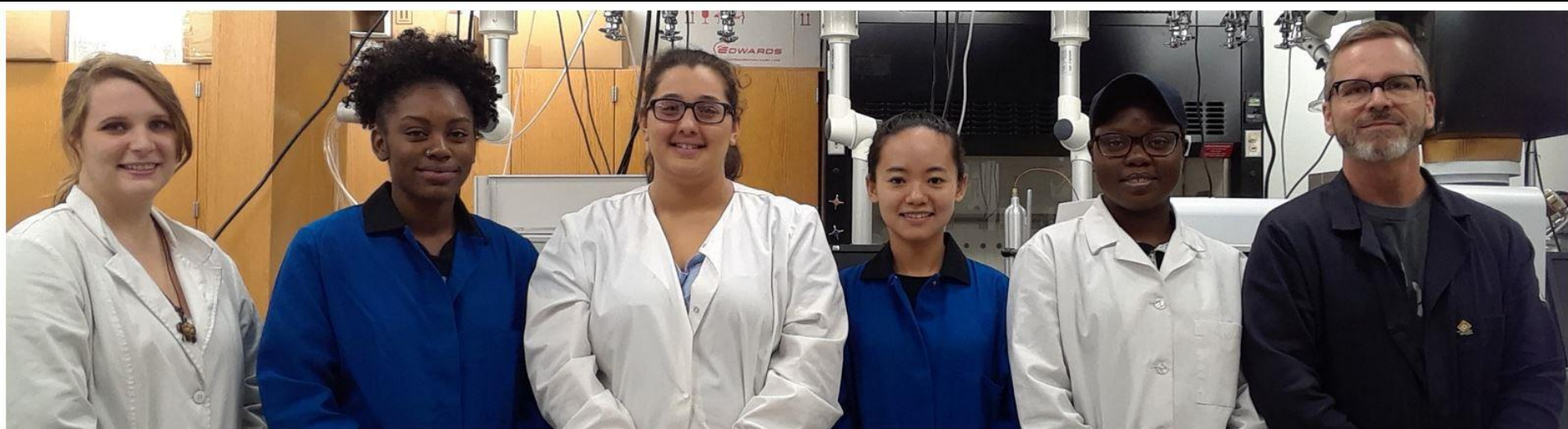
Spring 2017 Research Group (l-r): Wei Wang, Paul Flowers, Kaitlan Smith, Gabriell Greene (not pictured, Dayten Hodge).



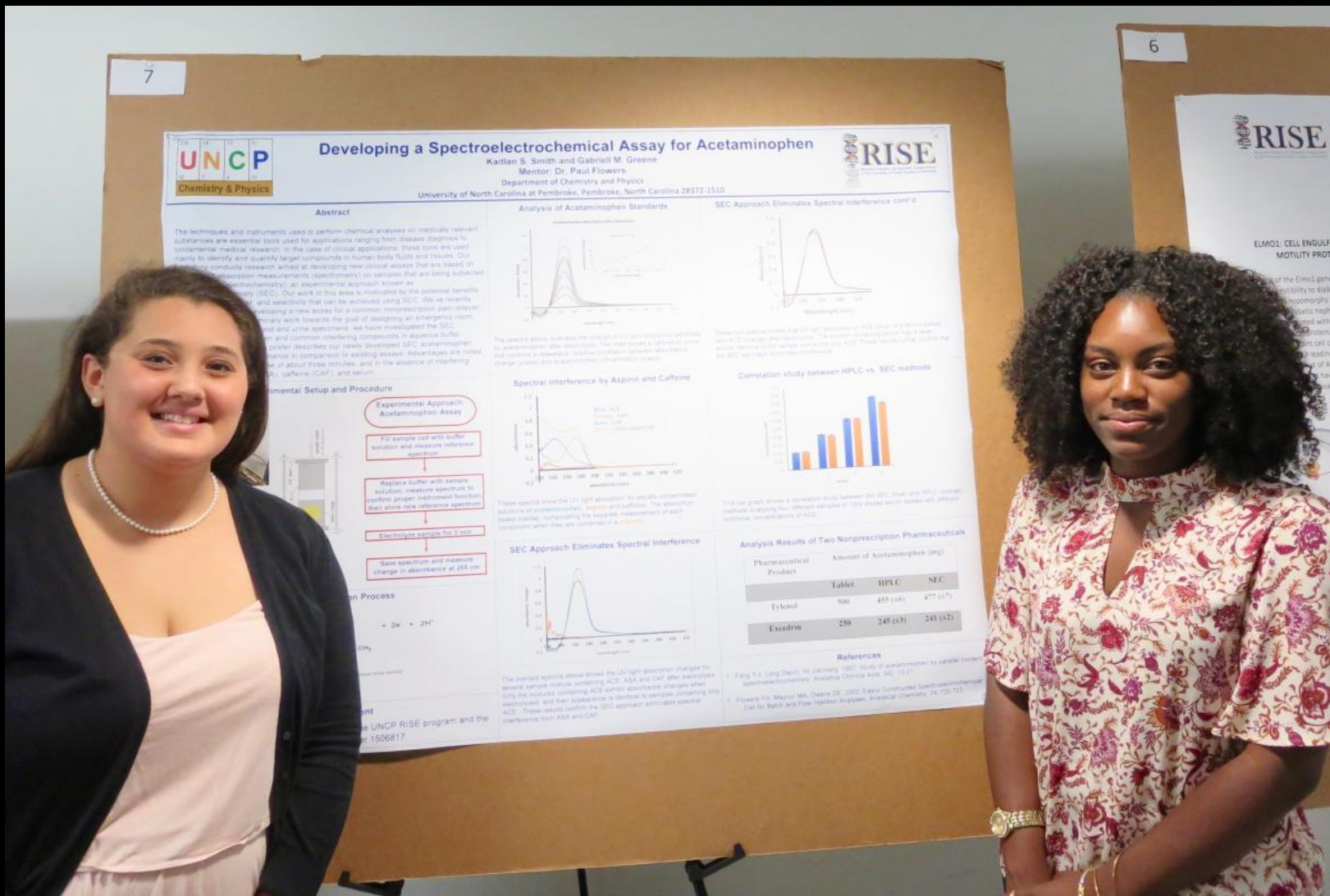
2017: Gabriell Green carrying out an SEC assay for uric acid



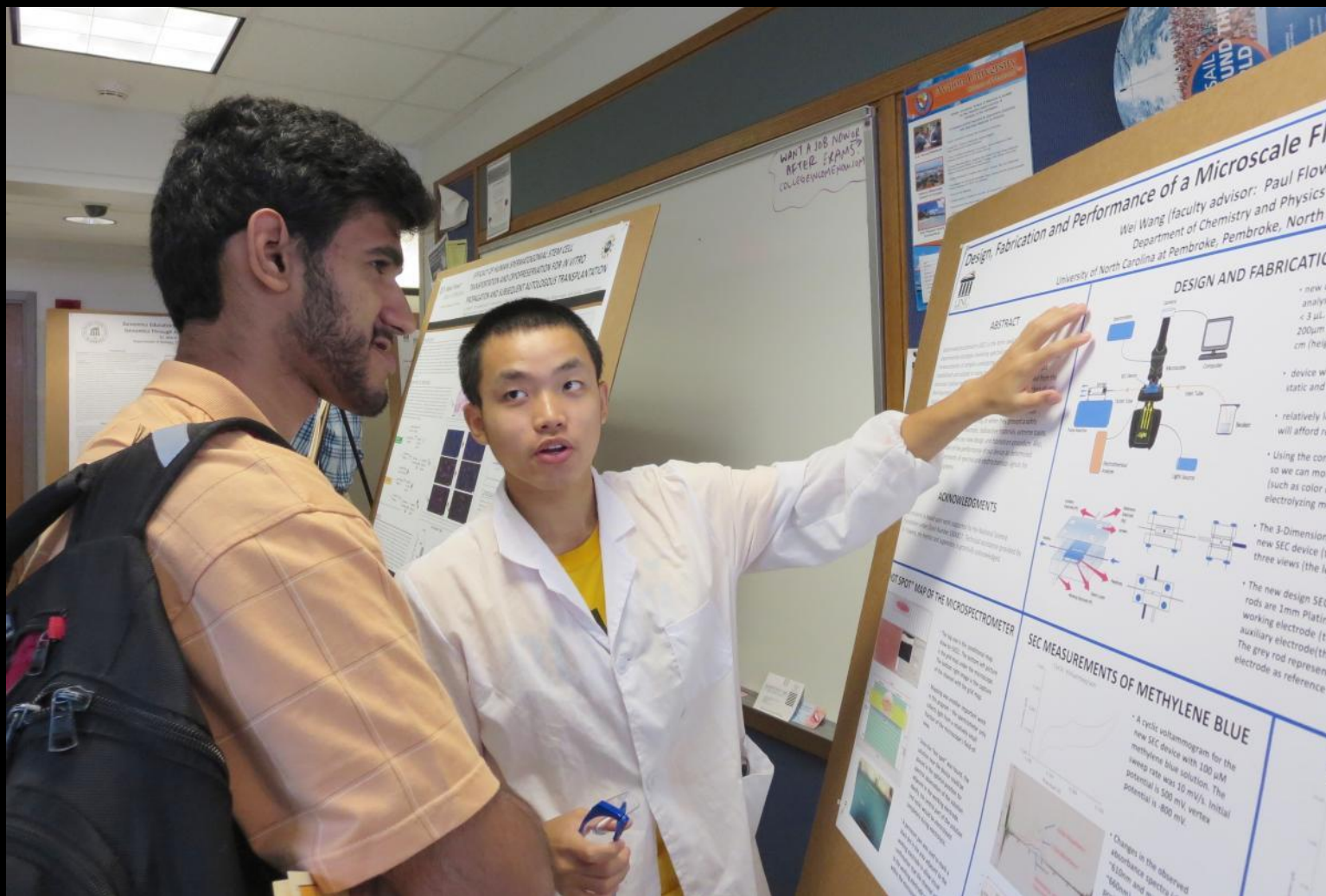
2017: Wei Wang pushing back the frontiers of microscale spectroelectrochemistry



Summer 2017 Research Group (l-to-r): Gabby Downs, Gabriell Greene, Kaitlan Smith, Xin Dong, Akpedje Nadohou, Paul Flowers



2017: Kaitlin Smith and Gabriell Greene presenting at the RISE end-of-summer symposium



2017: Wei Wang presenting at the RISE end-of-summer symposium

Spring 2018 Research Group



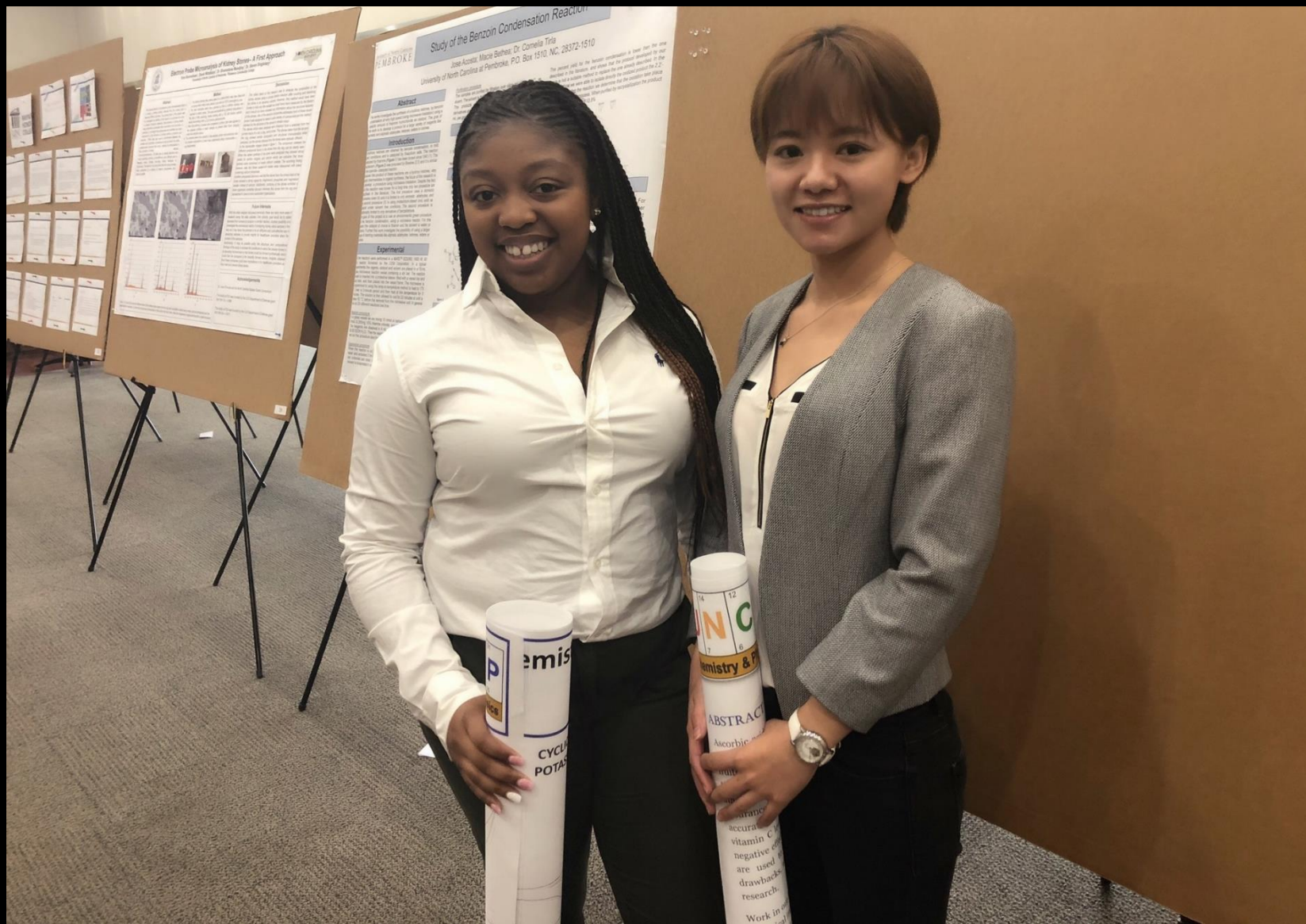
Tristan Sanborn

Jackson Bounds

Britney Alcira

Xin Dong

Paul Flowers



2018: Britney Alcira and Xin Dong setting up for poster presentations at the PURC Symposium

Summer 2018 Research Group

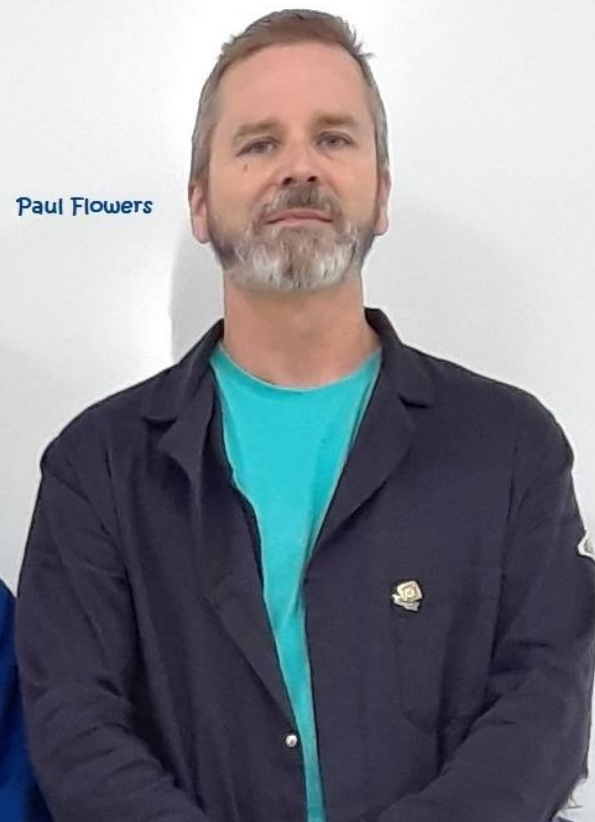
Dana Lamberton

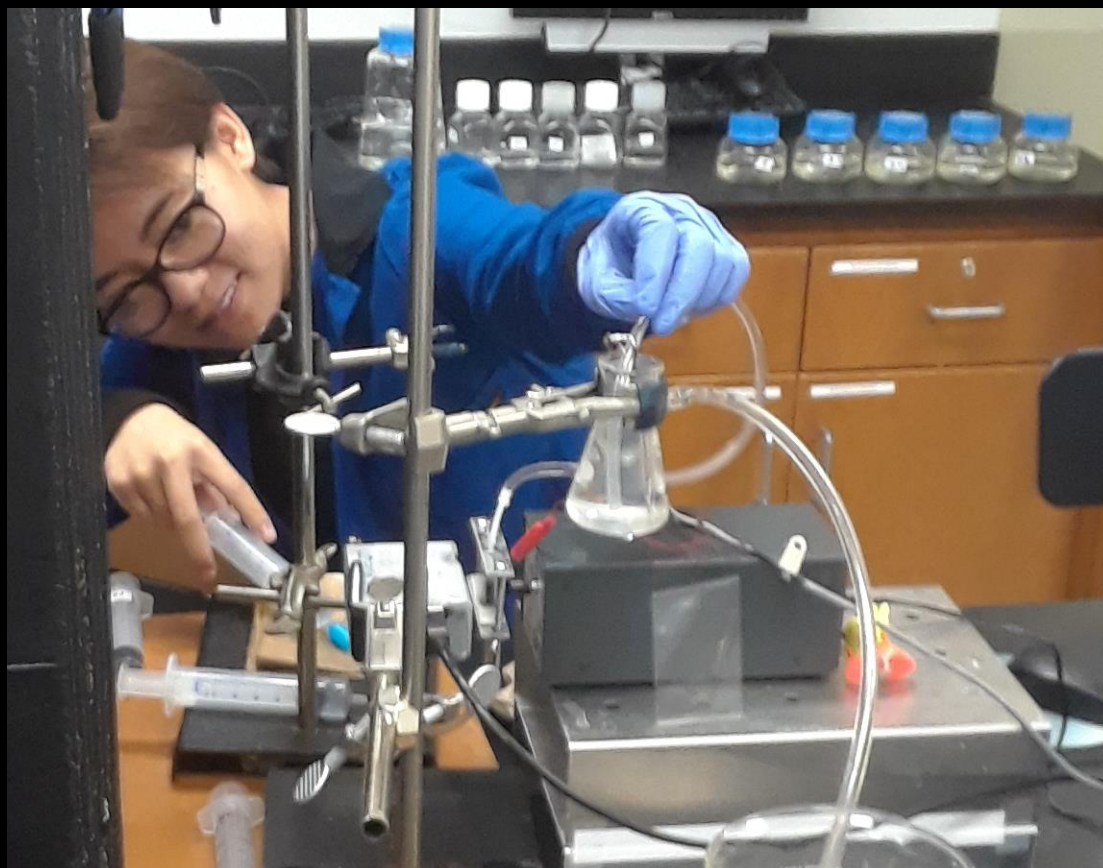


Xin Dong



Paul Flowers





2018: Xin Dong preparing SEC device for analysis of vitamin C samples



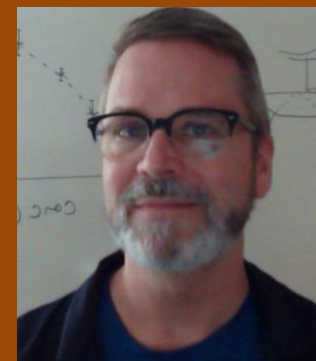
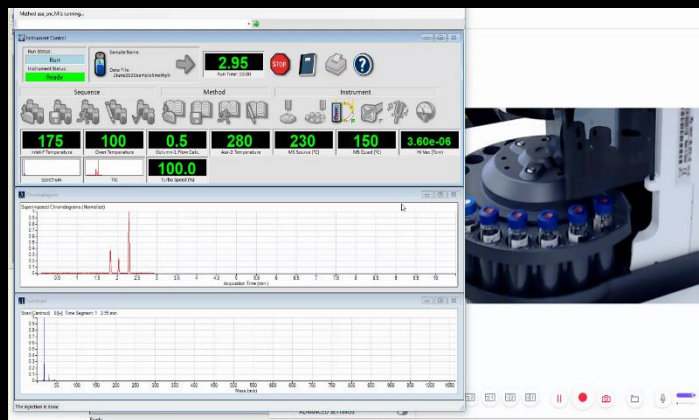
Fall 2018 research group: (l-r) Jackson Bounds, Jairus Salmon, me, Xin Dong



Spring 2020 research group: (l-r) Jared Hamlin, Nicholas Willard, me, Breanna Sigler, Katy Ryan



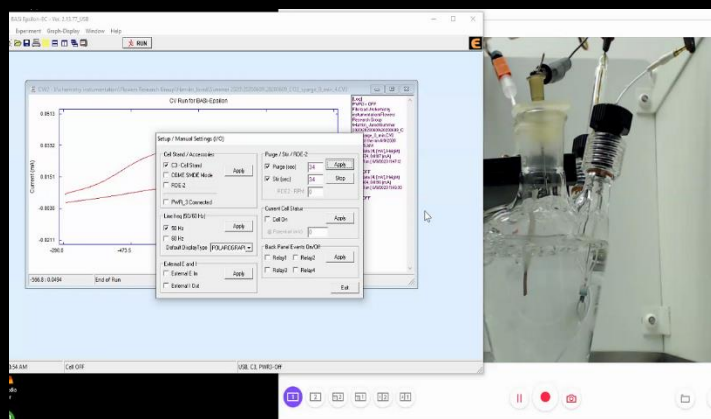
Samantha Cranford



me



Jared Hamlin



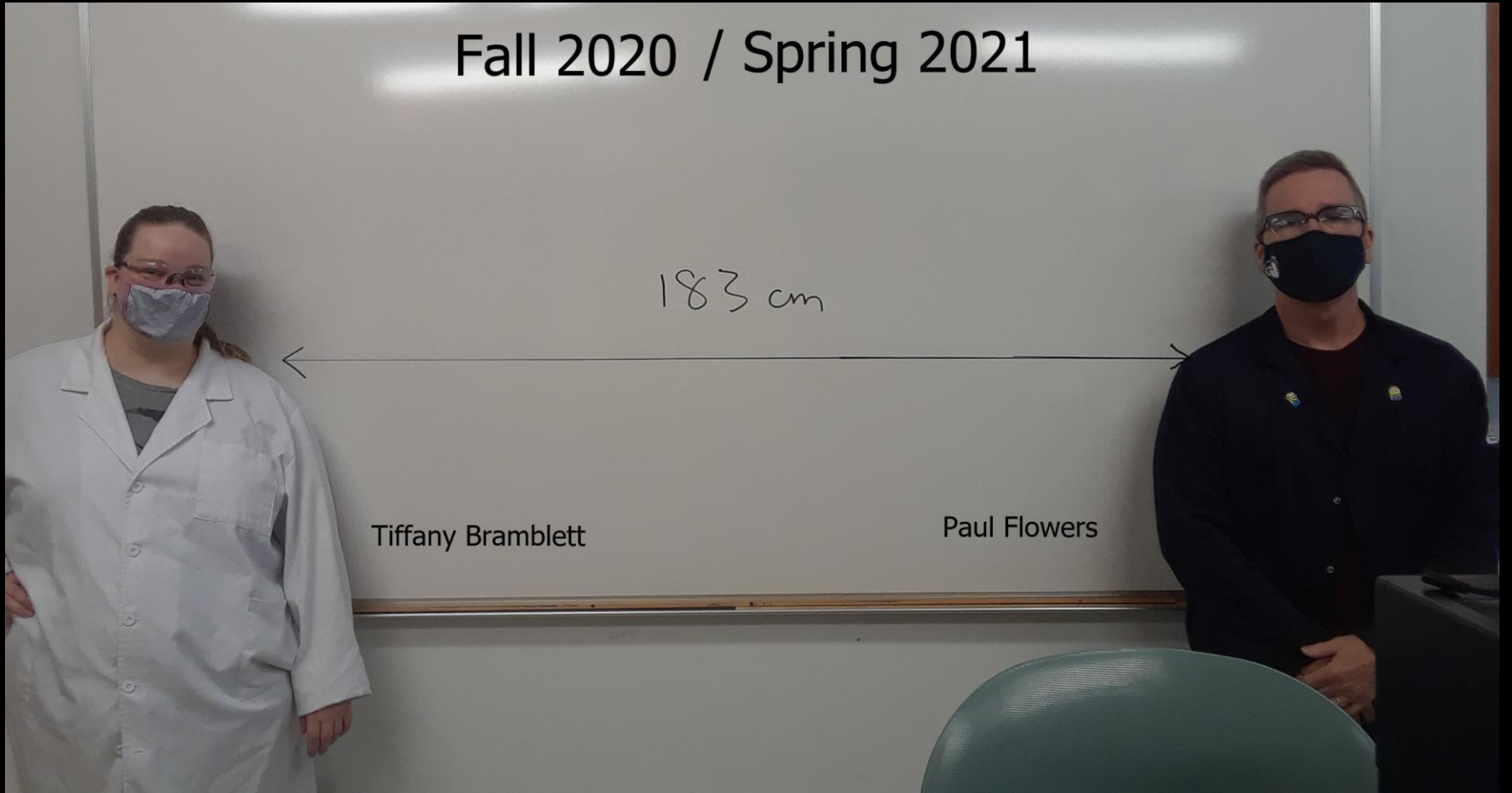
Summer 2020 (remote!) research group

Fall 2020 / Spring 2021

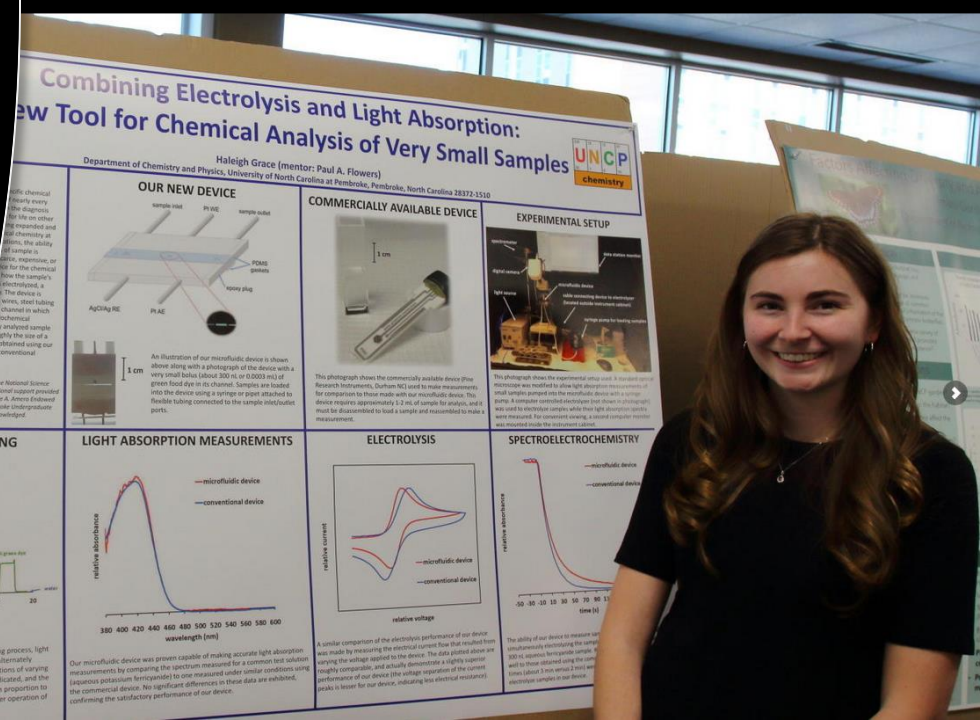
183 cm

Tiffany Bramblett

Paul Flowers



2022: Haleigh Grace presents her poster at the annual PURC Symposium.

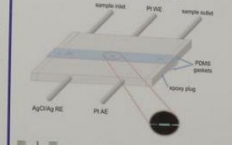


Combining Electrolysis and Light Absorption: A New Tool for Chemical Analysis of Very Small Samples

Haleigh Grace (mentor: Paul A. Flowers)
Department of Chemistry and Physics, University of North Carolina at Pembroke, Pembroke, North Carolina 28372-5310

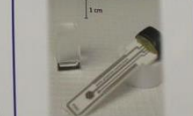


OUR NEW DEVICE



An illustration of our microfluidic device is shown above along with a photograph of the device with a very small ball (about 300 nL or 0.0003 mL) of green food dye in its channel. Samples are loaded into the device using a syringe or pipet attached to flexible tubing connected to the sample inlet/outlet ports.

COMMERCIALLY AVAILABLE DEVICE



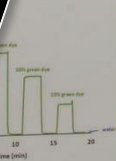
This photograph shows the commercially available device (Pine Research Instrumentation, Durham, NC) used to make measurements for comparison to those made with our microfluidic device. This device requires approximately 2 mL of sample for analysis, and it must be disassembled to load a sample and assembled to make a measurement.

EXPERIMENTAL SETUP

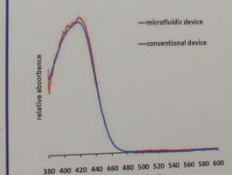


This photograph shows the experimental setup used. A microfluidic device was coupled to a green light absorption spectrophotometer. Small samples pipetted into the microfluidic device with a syringe pump. A constant potential electrolysis cell (Pine Research Instrumentation) was used to electrolyze samples while their light absorption spectra were measured. The concentration of a colored sample measured was measured under the instrument shown.

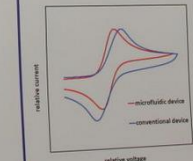
LOADING



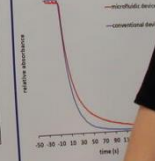
LIGHT ABSORPTION MEASUREMENTS



ELECTROLYSIS



SPECTROELECTROCHEMISTRY



concentration of the easy sample loading process, light absorption was measured over time while alternately pumping distilled water and green dye solutions of varying concentration. Smooth sample flow was indicated, and the light absorption was observed to increase in proportion to the dye concentration, confirming the proper operation of the microfluidic device.

Our microfluidic device was proven capable of making accurate light absorption measurements by comparing the spectrum measured for a common test solution (aqueous potassium ferricyanide) to one measured under similar conditions using the commercial device. The significant differences in these data are exhibited, confirming the satisfactory performance of our device.

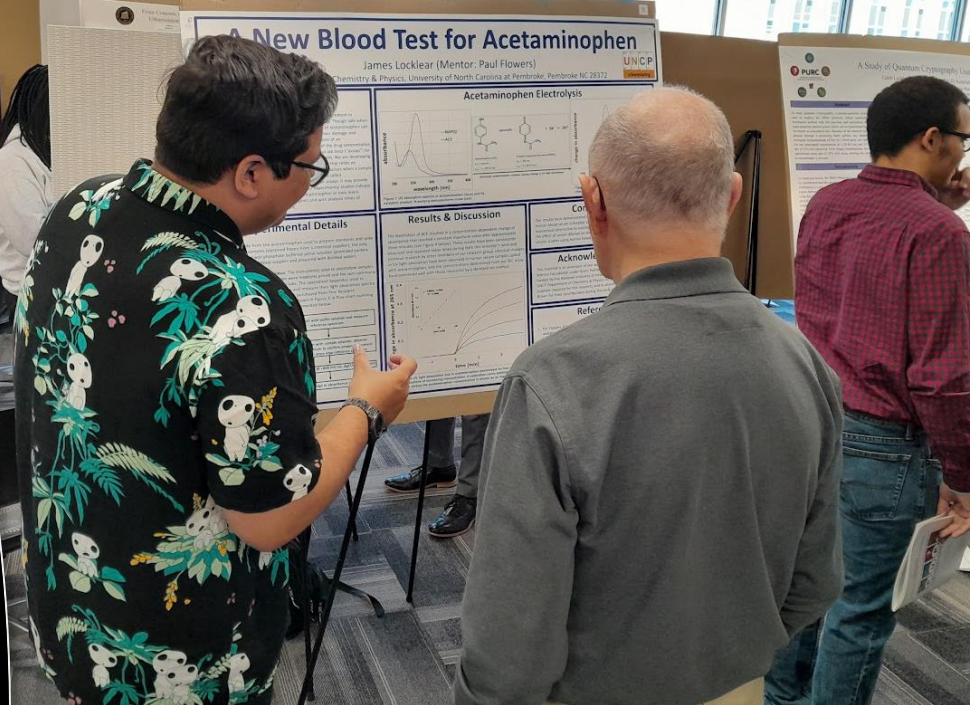
A similar comparison of the electrolysis performance of our device was made by measuring the electrical current flow that resulted from simultaneously electrolyzing the same 200 nL aqueous ferricyanide sample used for those obtained using the commercial device. The measured performance of our device (the voltage separation of the current peaks) is better for our device, indicating less electrical resistance.

The ability of our device to measure and simultaneously electrolyze the same 200 nL aqueous ferricyanide sample used for those obtained using the commercial device (the voltage separation of the current peaks) is better for our device, indicating less electrical resistance.



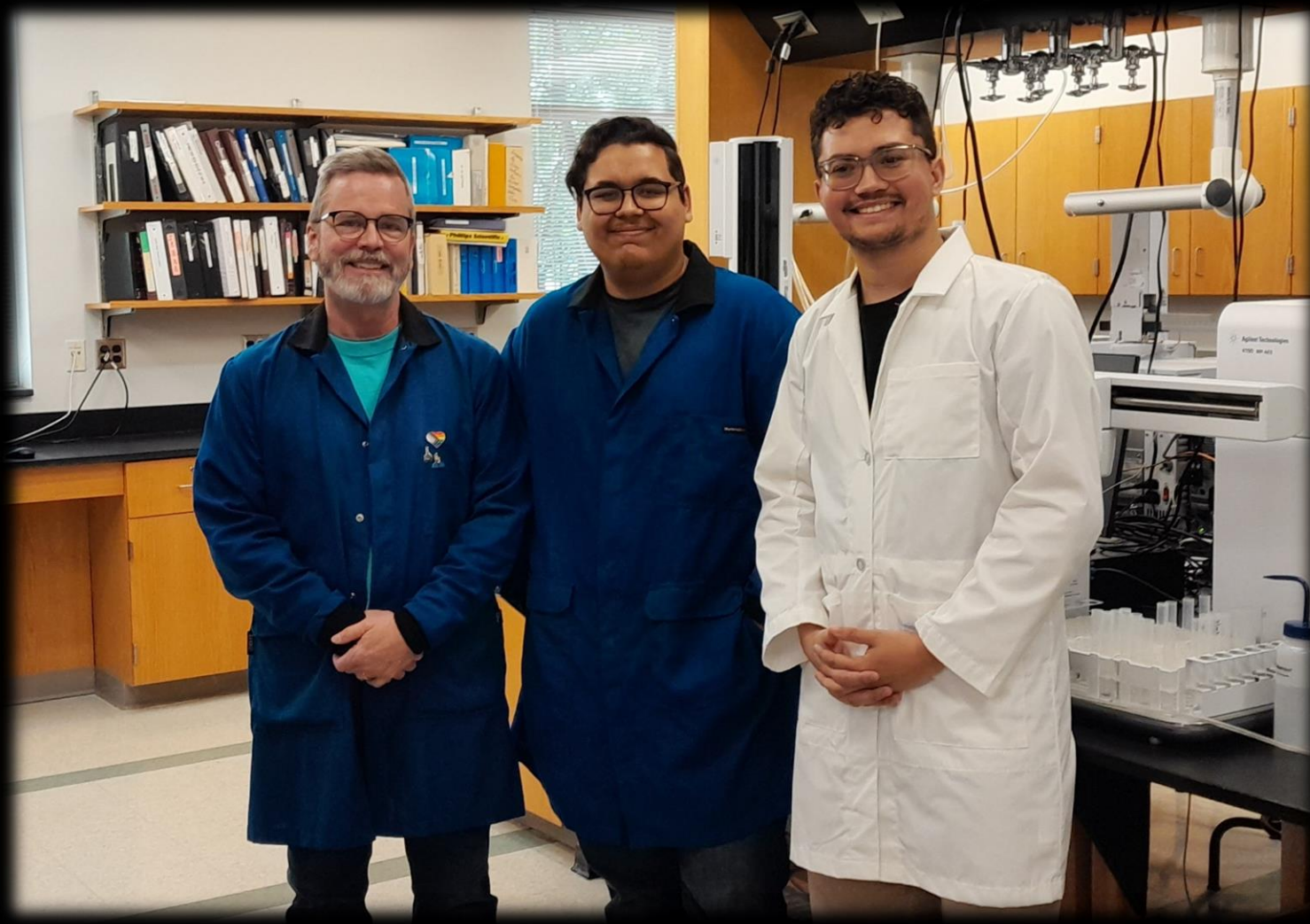
Fall 2021/Spring 2022 research group: (l-r) Melissa Sutton, me, Haleigh Grace

2023: James Locklear discussing his poster at the annual PURC Symposium.



2023: Todd Rogitz discussing his poster at the annual PURC Symposium.

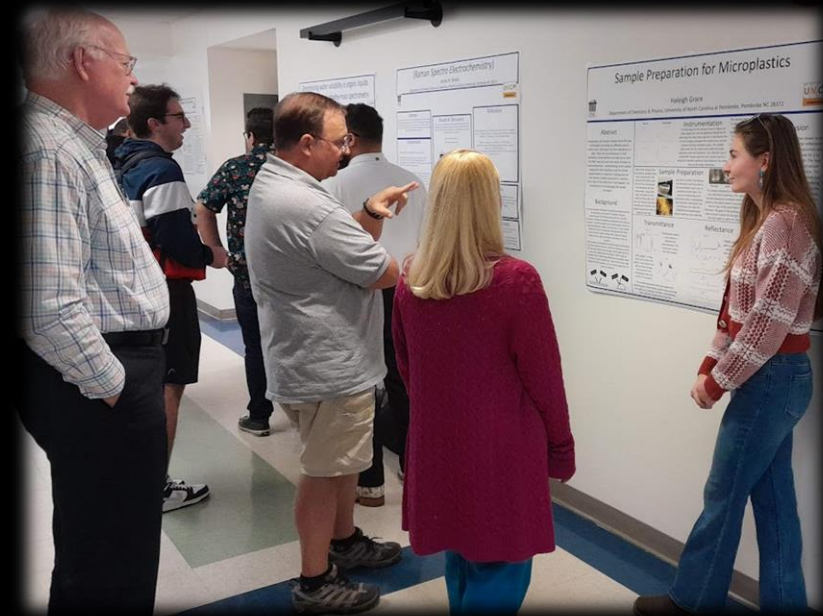
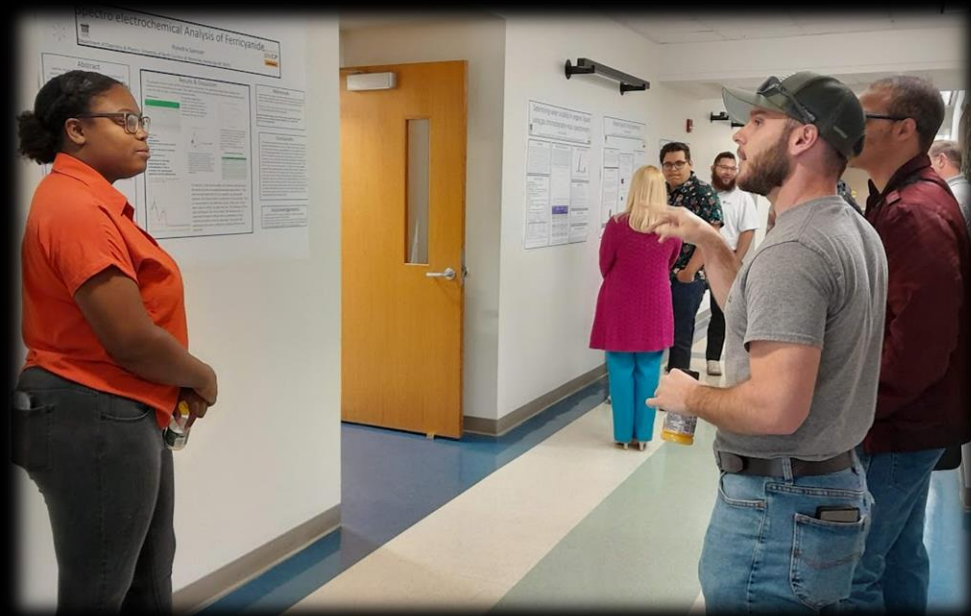
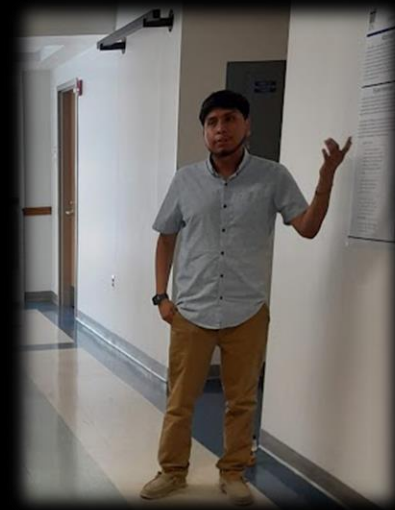




Fall 2022/Spring 2023 research group: (l-r) me, James Locklear, Todd Rogitz

Spring 2023 poster session for CHM 4270 student research projects

student presenters, clockwise from top-left: James Locklear, Nate Revels, Bryan Martinez, Nykedra Spencer, Haleigh Grace

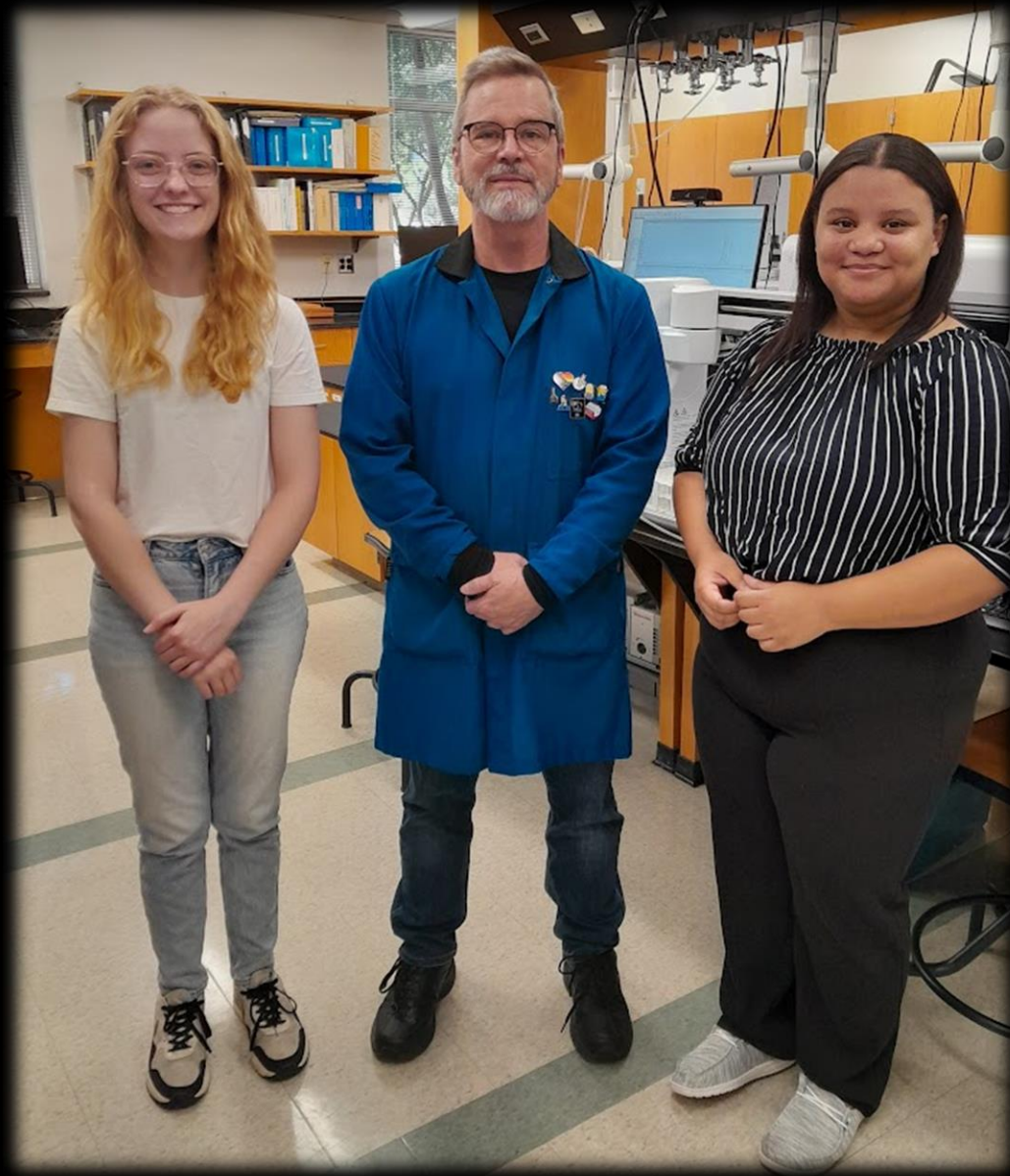




Fall 2023 research group: (l-r) Sara Ormsby, Keirah-Lee Garry, me, Anastasia Zakharova

Fall 2023 poster session for CHM 4270 student research projects





Spring 2024 research group: (l-r): Keirah-Lee Garry, me, Malia Locklear

Spring 2024 Pembroke Undergraduate Research & Creativity (PURC) Symposium

Spectroelectrochemistry on a Shoestring

Malia Locklear (Mentor: Paul Flowers)
Department of Chemistry & Physics, University of North Carolina at Pembroke, Pembroke NC 28372

Abstract
The development of an inexpensive, portable, and sensitive device for electrochemical analysis is a long-standing goal in analytical chemistry. This project aims to design and fabricate a low-cost electrochemical cell for the detection of acetaminophen in blood serum. The device is based on a shoestring and a piece of copper wire, which serve as the working and counter electrodes, respectively. The electrochemical cell is connected to a potentiostat, and the electrochemical response is measured using cyclic voltammetry (CV) and differential pulse voltammetry (DPV). The results show that the device is capable of detecting acetaminophen in blood serum with a detection limit of 1.0 μM. The device is simple to use and can be fabricated in a laboratory setting.


Results & Discussion

Component	Approximate Cost (\$)
shoestring	0.2
copper wire	0.2
40 ppm BVV	2
graphite lead	0.2
plastic tubing	0.4
total cost (BUNES)	3

References
1. M. Locklear, P. Flowers, *Journal of Electroanalytical Chemistry*, 2024, 915, 107000.
2. J. Wang, Y. Li, *Electrochimica Acta*, 2023, 438, 142100.
3. S. K. Kim, J. H. Park, *Sensors*, 2022, 22(12), 4567.

Conclusions
The device is capable of detecting acetaminophen in blood serum with a detection limit of 1.0 μM. The device is simple to use and can be fabricated in a laboratory setting.

Acknowledgements
This work was supported by the University of North Carolina at Pembroke.




Malia Locklear presenting results of her research on the fabrication and characterization of an inexpensive device for spectroelectrochemistry.

The Removal of Heavy Metal Ions from Water (Pb²⁺, Zn²⁺) using Calcium Alginate

Keirah-Lee Garry (Mentor: Paul Flowers)
Department of Chemistry & Physics, University of North Carolina at Pembroke, Pembroke NC 28372

Abstract
The presence of heavy metals in water is a significant environmental and public health concern. This project aims to develop a low-cost, efficient method for the removal of lead (Pb²⁺) and zinc (Zn²⁺) ions from water using calcium alginate. The alginate is cross-linked with calcium ions to form a hydrogel that can adsorb heavy metal ions. The adsorption capacity of the hydrogel is evaluated using batch adsorption experiments. The results show that the hydrogel has a high adsorption capacity for Pb²⁺ and Zn²⁺ ions, and it is stable in a wide range of pH values. The hydrogel is also easy to regenerate and reuse.

References
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Spectrochemical Assay for Acetaminophen in Blood Serum

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Abstract
The simultaneous application of electrochemical and spectrochemical methods for the measurement of acetaminophen in blood serum is a novel approach. This project aims to develop a low-cost, efficient method for the detection of acetaminophen in blood serum using a spectrochemical assay. The assay is based on the oxidation of acetaminophen to NAPQ, which is then detected using a colorimetric method. The results show that the assay is capable of detecting acetaminophen in blood serum with a detection limit of 1.0 μM. The assay is simple to use and can be fabricated in a laboratory setting.

Results & Discussion


Figure 3. Both the chemical structure and spectral information for the oxidation reaction of acetaminophen to NAPQ.

Figure 4. (a) Absorbance at 265 nm as a function of time as PBS and serum samples containing acetaminophen undergo electrolysis, indicated by blue and red traces respectively. (b) Calibration curve of average absorbance of PBS (blue) and Serum (red) based solutions at 265 nm averaged from replicate measurements.

Note that the pretreatment of serum yields spectra that are considerably lower than those in the absence of serum, leading to a decreased sensitivity as the former.

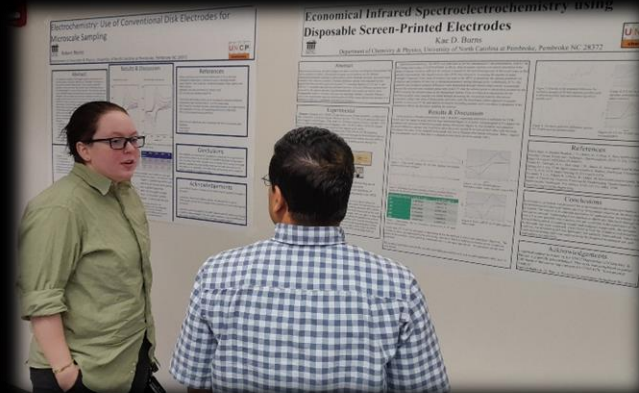
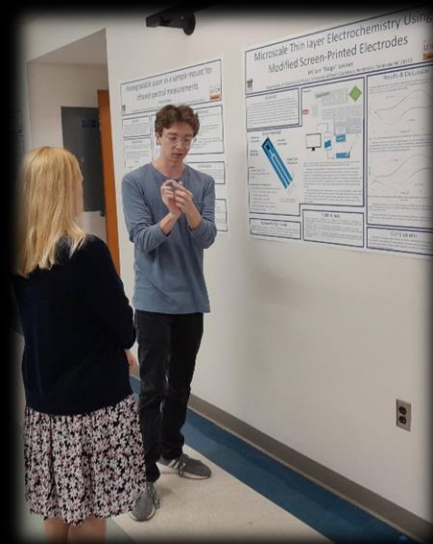
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Keirah-Lee Garry presenting results of her research on the development of a spectroelectrochemical assay for acetaminophen in blood serum

Spring 2024 poster session for CHM 4270 student research projects



CHM 4270 students (clockwise from top left: Avery Walker (with Rachel Smith); Corey Jeffries (with Rachel Smith and Tikaram Neupane); William Leviner (with Rachel Smith); Malia Locklear (with Sailaja Vallabha); Kae Burns (with Tikaram Neupane); Keirah-Lee Garry (with Tikaram Neupane). Not pictured: Robert Reicht