Declaration Reference and Key Data

Obligation Section Number: **5.07(c)(xi)**

Obligation Title: **Youth Internships**

Obligation Page Number: **55**

Obligation Trigger: **2010**

Obligation Start Date: **Summer 2010**

Obligation End Date: **Summer 2022***

Obligation Status: **Completed**

Obligation

Following the summer 2014 internship program, CU met with the principal of the school and developed the modifications described below. Empire State Development and Columbia University agreed to this modification on November 28, 2018. In September 2022, CU issued a letter to Empire State Development regarding the closeout of reporting for this commitment.

Modified Language:

Following the initial five years and in coordination with the School's leadership, CU has modified the internship program to focus on at least one aspect of Science, Technology, Engineering, Environment, Arts and/or Math (STEAM) and basic office etiquette. Working with various units within the University, the modified internship program will include the following adaptations:

New Title: Youth Internships
Timeframe: No longer limited to summer weeks.
Program Duration: Varies. Internships can range from 4 weeks to 9 months depending upon the specific program.
Number of Interns: No fewer than 15 internships comprised of CSS students and/or local community students.
Internship Locations: Within Columbia University offices and laboratories
Program Description: CU shall provide no fewer than 15 high school students attending the Columbia Secondary School for Math, Science and Engineering and/or living within the Local Area an opportunity to participate in one of several youth internship programs operated by Columbia University focusing on math, science, engineering and/or the environment/sustainability. Internship programs vary and are managed by departments, schools and other offices within the University. The internships will be located on the University's campuses.

*The Internship Program was reviewed in consultation with ESD in 2022 with the intent of ending reporting for this commitment. Although the obligation end date on this Implementation Plan Report has previously been shown as 2025, Columbia and ESD agree that reporting for this commitment can end after this submission. The internship programs included in the reporting will continue to be offered.

Evidence of Compliance

1. Annual report

Columbia University's Implementation Plan and all supporting documentation are made available on the Columbia Neighbors Webpage at https://neighbors.columbia.edu/content/community-commitments.

EOC Checklist for Obligation 5.07(c)(xi):

Please check to verify EOC items submitted for review.

☐ 1. Annual report

Monitor's Notes / Comments:

_____

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_____

Status:
Please check to indicate the status of Obligation 5.07(c)(xi):

☐ In Compliance

☐ In Progress

☐ Not In Compliance

☐ Not Triggered

Annual Report: Youth Internships

State Submission Annual Reporting Period: **October 2021 - September 2022**

In September 2022, Columbia University and Empire State Development agreed that this would be the final report submitted for this commitment.

Columbia University offers a variety of internship programs that help local youth gain valuable work experience:
Brain Research Apprenticeships in New York at Columbia (BRAINYAC) is a program that pairs high school students with scientists for intensive lab apprenticeships. This Zuckerman Institute program is an immersive science research experience in which Zuckerman Institute scientists open their doors to high school students, who in turn bring their talents and perspectives to the lab. Started in 2013, BRAINYAC pairs students with scientists who mentor them throughout seven weeks of intensive summer research. The program prepares students for laboratory research through training sessions, which run from January through May, followed by the seven-week period of intensive research during the summer. Upon completing the program, students come away with an increased understanding of how research in the lab leads to transformative discoveries. Eligible sophomores and juniors are drawn from select youth-serving programs: the Lang Youth Medical Program at New York-Presbyterian Hospital; the State Pre-college Enrichment Program run by Columbia University Medical Center; the Double Discovery Center; BioBus, Inc; and the Columbia Secondary School for Math, Science and Engineering (CSS). BRAINYAC receives generous support from the Pinkerton Foundation and the Stavros Niarchos Foundation.

The Columbia University Facilities and Operations (CUFO) High School Summer Internship Program is a structured, six-week initiative that provides students with practical work experience before graduation. The program was started in 2011 and is run by the Columbia University Department of Facilities and Operations for high schoolers that live in the 17 local zip code area. Local refers to those students whose primary residence is located within one of the following 17 zip codes: 10025, 10026, 10027, 10029, 10030, 10031, 10032, 10033, 10034, 10035, 10037, 10039, 10040, 10455, 10451, 10454, 10474.

Engineering the Next Generation (ENG) is a program for high school students interested in engineering.
ENG is an opportunity for motivated high school students from local partner schools to participate in a six-week intensive research program that includes both lab work and supplemental programming to develop their academic and professional skills. Students gain practical research experience, exposure to lab culture, new skills and multi-level mentorship. Program components include working with Engineering faculty, hands-on research skills and experience, master class, poster symposium presentation, college letter of recommendation, and the possibilities of ongoing research and publication in the Columbia Undergraduate Science Journal.

Internship Program	Total	# of Local Students	# of CSS Students
BRAINYAC	20	10	5
CUFO	7	7	0
ENG	15	2	2
TOTAL:	**42**	**19**	**7**

Contents of Report

- BRAINYAC Annual Report
- BRAINYAC Brochure
- BRAINYAC 2022 Open House Presentation
- BRAINYAC 2022 Information Manual
- BRAINYAC 2022 Graduation Program
- Columbia University Facilities and Operations (CUFO) Summer Internship Annual Report
- Columbia University Facilities and Operations (CUFO) Friday Session Schedule
- Columbia University Facilities and Operations (CUFO) Final Presentation
- Engineering the Next Generation (ENG) Annual Report
- Engineering the Next Generation (ENG) 2022 Application Packet
- Engineering the Next Generation (ENG) 2022 Final Presentations

Annual Report: Youth Internships - BRAINYAC

State Submission Annual Reporting Period: **October 2021 - September 2022**

- Information Session Dates: **October 21, 2021 & October 25, 2021**

The BRAINYAC program (Brain Research Apprenticeships In New York At Columbia) admits students with a stated interest in biomedical and specifically neuroscience research and provides immersive science research experience with Zuckerman Institute scientists. The program prepares students for laboratory research through training sessions, which run from January through May, followed by a 7-week period of intensive research during the summer. Upon completing the program, students come away with an increased understanding of how research in the lab leads to transformative discoveries. The program admits from five partner programs; Lang Youth Medical Program, State Pre-College Enrichment Program (S-PREP), Columbia Secondary School, the Double Discovery Center and BioBus, Inc. Participants must be at least 16 years of age in order to participate and are granted a stipend for their time in the program.

Program Information

During this reporting period, in order to prioritize the health and safety of all participants, the program was held in a hybrid format. The program was held virtually until the third session, when COVID cases began to decline. Virtual training sessions were held using Zoom, and Google Classroom was employed for posting assignments and announcements.

After the first three sessions had concluded, in March 2022, the students were invited to campus to complete the remaining spring training sessions and the 7-week summer internship. The BRAINYAC team worked to sustain and strengthen a sense of community for program participants from the beginning by working together to creatively find technological resources for the virtual learning environment. Throughout the summer internship program the BRAINYAC team continued use of the Slack application to communicate with students and mentors, and to encourage them to work in small groups and talk to each other - this was an effort to foster and enhance community and mimic an academic research environment.

The curriculum explored topics including research expertise, data analysis, computation, coding, and image processing, and guest speakers were scheduled to discuss their research and provide students with a first-hand account of what it would be like to be a research scientist.

	Intern Name	Zip Code	High School
1.	[redacted]	10027	Columbia Secondary School for Math, Science, and Engineering
2.	[redacted]	07109	Fordham Prep
3.	[redacted]	10034	The Bronx High School of Science
4.	[redacted]	11234	Midwood High School at Brooklyn College
5.	[redacted]	10031	Columbia Secondary School for Math, Science, and Engineering
6.	[redacted]	11370	St. John's Prep
7.	[redacted]	10033	All Hallows High School
8.	[redacted]	11378	Trinity School
9.	[redacted]	10456	Frederick Douglass Academy
10.	[redacted]	10918	Monroe Woodbury High School
11.	[redacted]	10451	The Bronx High School of Science
12.	[redacted]	10032	Columbia Secondary School for Math, Science, and Engineering
13.	[redacted]	11106	Columbia Secondary School for Math, Science, and Engineering
14.	[redacted]	10466	Beacon High School
15.	[redacted]	10025	Manhattan Hunter Science High School
16.	[redacted]	10035	Columbia Secondary School for Math, Science, and Engineering
17.	[redacted]	11234	Midwood High School
18.	[redacted]	10032	Wadleigh Secondary for the Performing and Visual Arts
19.	[redacted]	10033	Washington Heights Expeditionary Learning School
20.	[redacted]	11366	Fiorello H. LaGuardia High School of Music & Art and Performing Arts

Additional Supporting Documentation

- BRAINYAC Brochure
- BRAINYAC 2022 Open House Presentation
- BRAINYAC 2022 Information Manual
- BRAINYAC 2022 Graduation Program

The Zuckerman Institute's BRAINYAC program is an immersive science research experience at Columbia University for high school students.

BRAINYAC combines training in neuroscience with mentored laboratory research.

Learn to make images like this.
Image produced by Siegelbaum Lab/Columbia's Zuckerman Institute.

Do you want to be a BRAINYAC ?

You could be a BRAINYAC if you are:

- ✓ Genuinely interested in the biomedical sciences
- ✓ Ready to work in a sophisticated, high-tech lab environment
- ✓ Willing to commit to the entire program from January - August
- ✓ Enrolled in one of BRAINYAC's partner programs

VISIT US ONLINE

zuckermaninstitute.columbia.edu/brainyac
@zuckermanbrain
zuckermaninstitute

BRAINYAC
Jerome L. Greene Science Center
3227 Broadway
New York
NY 10027

212-853-0600
programs@columbia.edu

FUNDED BY

The Pinkerton Foundation

ΙΣΝ/SNF ΙΔΡΥΜΑ ΣΤΑΥΡΟΣ ΝΙΑΡΧΟΣ STAVROS NIARCHOS FOUNDATION

BRAINYAC

Brain Research Apprenticeships in New York at Columbia

COLUMBIA | Zuckerman Institute

Eligibility

To apply, you must be:

- ✓ A sophomore or junior in high school
- ✓ 16 years of age or older by the start of the summer session
- ✓ Able to commit to the entire program from January through August
- ✓ Enrolled in one of our partner programs

OUR PARTNER PROGRAMS

- Columbia Secondary School of Math, Science & Engineering
- Double Discovery Center at Columbia College
- Lang Youth Medical Program
- State Pre-College Enrichment Program (S-PREP)
- BioBus, Inc.

"My favorite part was learning information that became my base knowledge for the summer. I enjoyed being in an environment where questions were encouraged and I learned things I didn't know."

BRAINYAC student
class of 2019

What's involved

During the program you will be involved with:

- ✓ Saturday morning training sessions, twice per month, from January - May to build your science knowledge and technical skills
- ✓ A full-time laboratory internship, mentored by a Columbia University neuroscientist, from June - August
- ✓ Weekly advisory sessions through the summer to enhance your presentation skills
- ✓ A stipend that is paid in two installments
- ✓ At the end of the program you will present your research to your friends, family and mentors as well as researchers and the Columbia community

"I conducted my own experiment with a full understanding of my mentor's project and why even my participation was important."

BRAINYAC student
class of 2019

Outcomes

At the end of the program, you will:

- ✓ Have an advanced understanding of how lab research can lead to transformative discoveries
- ✓ Be familiar with a professional and academic environment
- ✓ Have a greater connection to science as a career

ALUMNI OPPORTUNITIES

After you graduate from the program, you can:

- Apply to be a Merit Fellow and get paid to continue working in your lab over the academic year or following summer
- Apply to work as a paid intern for the following year's BRAINYAC program
- Return for alumni events
- Be part of the Zuckerman Institute community

"This program has impacted my life by giving me confidence to believe in myself and trust that I am capable of handling any experience."

BRAINYAC student
class of 2017

COLUMBIA | Zuckerman Institute

MORTIMER B. ZUCKERMAN MIND BRAIN BEHAVIOR INSTITUTE

BRAINYAC

Brain Research Apprenticeships In New York At Columbia

OPEN HOUSE

Oct. 21 & 25: 6-7pm

2021-2022 Program details

General Q&A

Breakout rooms with staff & alumni

Join Zoom Meeting

WHAT ARE WE LOOKING FOR?

Enthusiasm for science
Interest in the brain and neuroscience
Willingness to learn and integrate into a lab

Willingness to put in the time and effort
Good communication skills

WHAT ARE WE LOOKING FOR?

At least 16 years old
by June 30, 2022

Enrolled in a participating partner program

APPLY NOW

Online:

https://bit.ly/BRAINYAC2022application

Due October 31, 2021

INTERVIEWS

If selected for an interview:

November 2021

ACCEPTANCES

Decisions sent:

December 2021

Spring training sessions

Summer research internship

ORIENTATION

Saturday 12pm-2pm
January 22, 2022

Virtual

SPRING SESSIONS

Saturdays 9am-11am
January 29 - May 14, 2022

12 sessions
Virtual

learn key research skills

strengthen communication skills

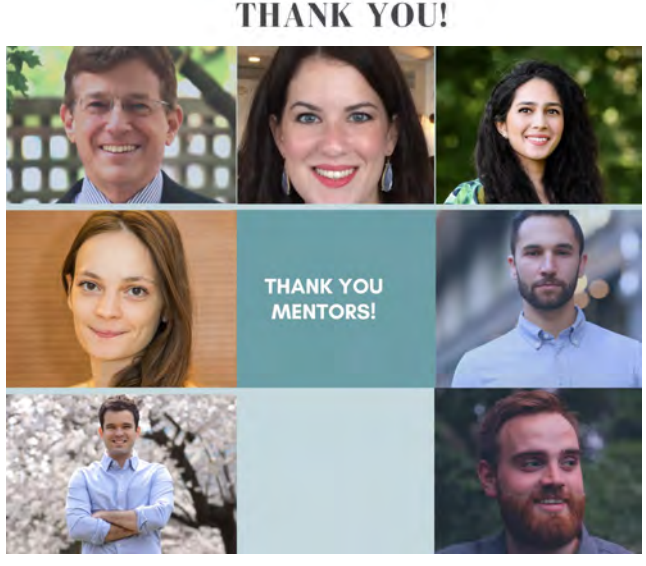
SUMMER SESSIONS

July 5 - August 19, 2022

Research placements
Monday-Friday

Weekly training sessions

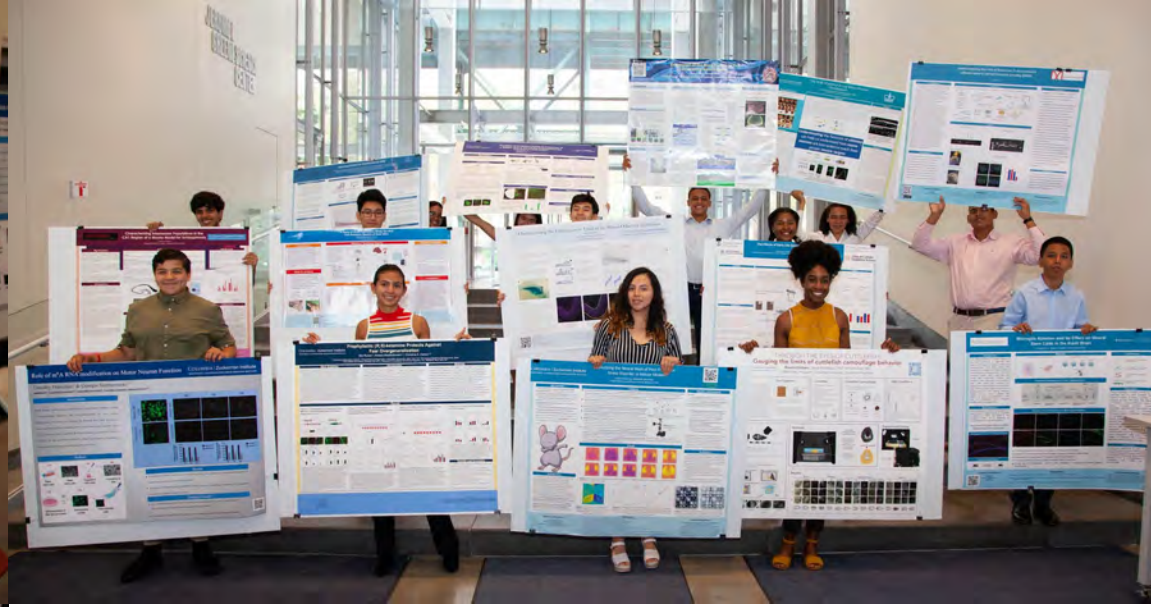
work alongside talented mentors



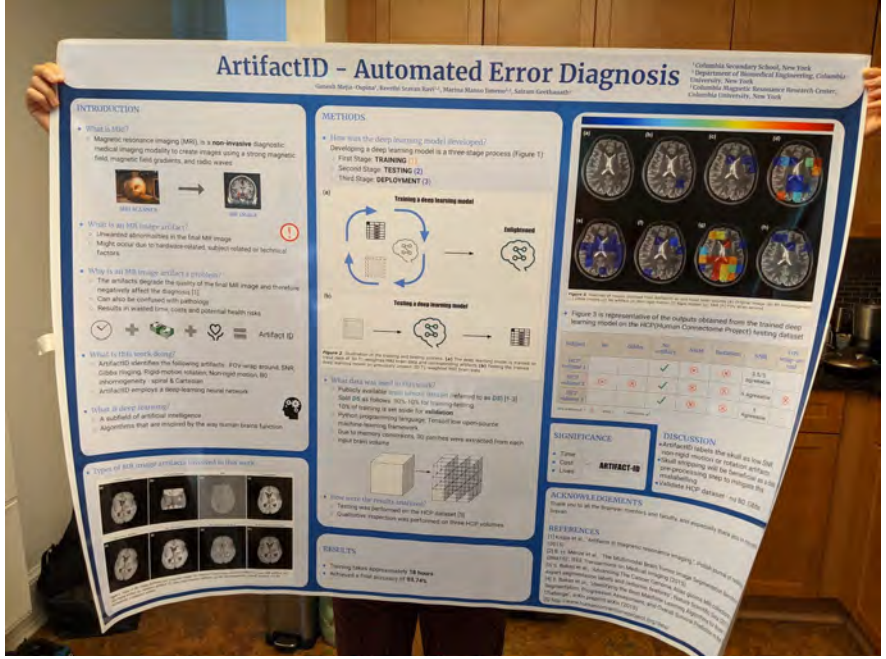
discover what science research looks like

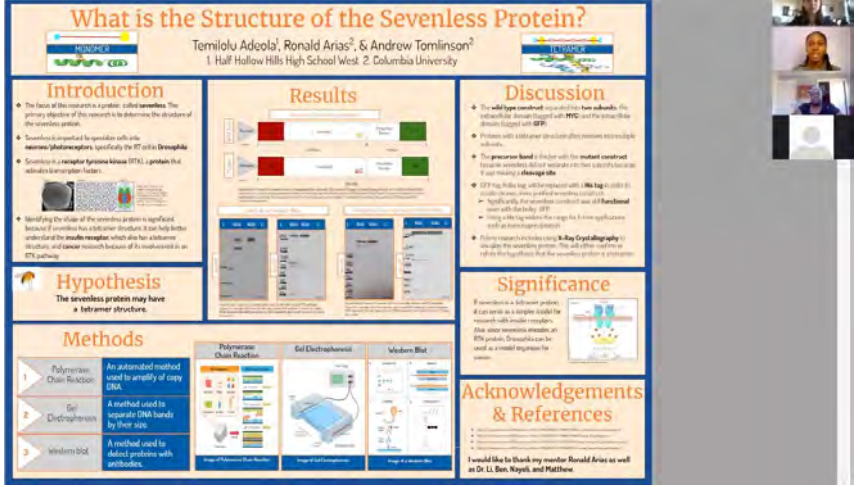
work on your own project

build lasting relationships

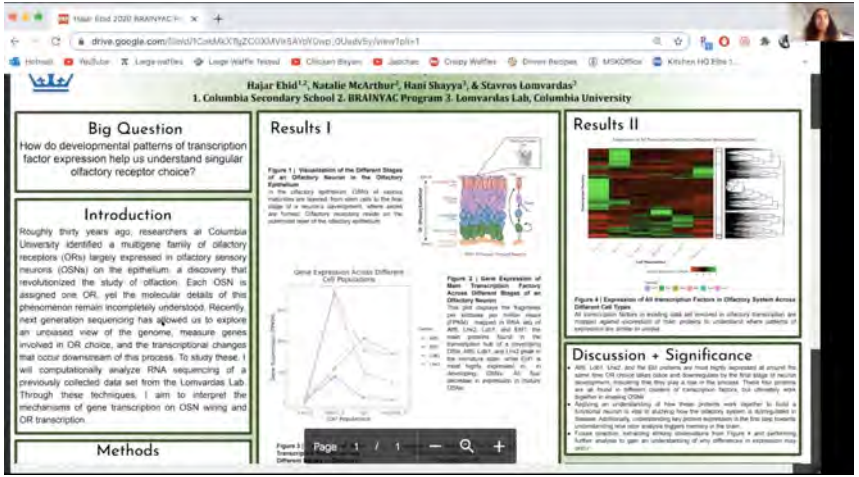


final poster presentation





final poster presentation



[Link - video of a past presentation]

graduation ceremony

DO YOU GET PAID?

Spring stipend: $1000
Summer stipend: $2500

CONTACT INFORMATION

programs@zi.columbia.edu

[redacted]

BRAINYAC Head Instructor

[redacted]

BRAINYAC Senior Instructor

[redacted]

BRAINYAC Program Manager

[redacted]

Assoc. Director of Public Programs

COLUMBIA | Zuckerman Institute

MORTIMER B. ZUCKERMAN MIND BRAIN BEHAVIOR INSTITUTE

Welcome to Columbia University's Mortimer B. Zuckerman Mind Brain Behavior Institute

Congratulations on being accepted into the Brain Research Apprenticeships in New York at Columbia (BRAINYAC) Program at the Zuckerman Institute.

This booklet describes the structure, organization, and contractual information for participation in the program. Students and parents or guardians should read through all the material together in order to become familiar with all program components.

By signing the Contractual Agreement, the first form at the end of this booklet, you are agreeing to participate in all training sessions and other events and to abide by all expectations as outlined in this Information Manual. Please understand that the program requires a large time commitment but yields deep benefits.

Our program begins with **Parent-Student Orientation** on **Saturday, January 22nd, 2022** from 12:00pm to 2:00pm on Zoom. Students must attend with at least one parent or guardian. We, along with the rest of the BRAINYAC staff, will provide additional information on all program components during the orientation.

We will continue to prioritize health and safety this year. Our plan is to hold as much of the program in person as possible. This means students will be able to access the Columbia University campus and laboratories for class sessions and mentored research. These plans are conditional on the stability of COVID-19 infection rates and hospitalizations across the city, as well as the Columbia University COVID-19 protocol. We will communicate any changes as they arise, including the possibility of shifting to a virtual program.

If you have any questions, please feel free to contact us. We look forward to meeting and working with each one of you this year.

Sincerely,

[redacted]

[redacted]

Public Programs Manager

[redacted]

[redacted]

Public Programs Associate

[redacted]

COLUMBIA | Zuckerman Institute

MORTIMER B. ZUCKERMAN MIND BRAIN BEHAVIOR INSTITUTE

BRAINYAC

Information Manual 2022

Table of Contents

Program Overview and Goals

The Zuckerman Institute's BRAINYAC program is an immersive scientific research experience in which high-school students train and work in neuroscience laboratories at Columbia University.

Founded in 2013, BRAINYAC runs annually from January through August and includes weekend training sessions in the winter and spring paired with a full-time laboratory research internship during the summer.

The program aims to:

- Develop students' research, technical, and critical thinking skills
- Boost students' understanding of and confidence in science
- Strengthen students' communication and presentation skills
- Foster a supportive network and community for its students

Program Structure

The first portion, from January through May, consists of Saturday morning class sessions about two to four times per month. During these sessions, students prepare for their summer internships by learning core concepts in biology and neuroscience, practicing essential research techniques, and building key skills that will benefit them in their summer projects. Towards the end of the first portion, students will refine their research interests and participate in a matching event to be paired one-on-one with neuroscientist mentors.

Our plan is for the program to be in person as much as possible. Spring class sessions will be held on Columbia University's campus. In addition, we will use online learning and communication platforms, including Google Classroom, Zoom, and possibly others (e.g. Slack), to remain connected outside of class sessions.

In the summer, students commence the laboratory research portion of the program at the beginning of July. During the seven-week summer session, students work full-time, Monday through Friday, to pursue a research project under the guidance of their mentors. Students will be placed in a neuroscience lab at Columbia University and might use techniques as diverse as brain imaging, microscopy, working with cells, or computer modelling.

Throughout the summer, students continue to meet once a week as a group for class sessions to work on their end-of-program poster presentations and communication skills. We plan for summer class sessions and mentored research to be held in person on Columbia's campus.

Poster Presentation

At the end of the seven-week lab project in August, students will participate in a poster presentation event as an opportunity to communicate their research to a diverse audience of friends, family, mentors, other researchers, and the broader Columbia community. Whether this event is in person or virtual is to be determined.

Student Eligibility

BRAINYAC admits students from select partner programs and schools in upper Manhattan and the south Bronx. Students commit to the program in its entirety from January through August, and those who successfully complete the entire program receive a stipend of $3,500 paid in two installments.

To be eligible for receiving the stipend, students must be either:

- A United States Citizen; or
- A United States Permanent Resident (Green Card Holder)

Students who do not meet these criteria can still participate in all aspects of the program, but may not be eligible to receive a stipend. We will be in contact with such students separately if this is the case.

Program Guidelines

In order to maintain program excellence and a positive experience for our students, we expect students to follow established guidelines:

Absences

- Class session absences: Should a student be unable to attend a class session due to illness or injury, it remains the responsibility of the student (and parent/guardian, where applicable) to notify BRAINYAC staff at least one (1) hour prior to the start of the session, where possible. An email should be sent to [redacted]

- Internship absences: Should a student be unable to attend any particular day of their internship due to illness or injury, it remains the responsibility of the student (and parent/guardian, where applicable) to notify their BRAINYAC laboratory mentor and BRAINYAC staff at least one (1) hour prior to the start of their internship schedule. An email should be sent to your mentor's email address and to [redacted]

Tardiness

- Class session tardiness: Should a student be tardy to a training session, it remains the responsibility of the student (and parent/guardian, where applicable) to notify BRAINYAC staff at least thirty (30) minutes prior to the start of the session. An email should be sent to [redacted]

- Internship tardiness: Should a student be tardy to any particular day of their internship, it remains the responsibility of the student (and parent/guardian, where applicable) to notify their BRAINYAC mentor and BRAINYAC staff at least thirty (30) minutes prior to the start of their internship schedule. An email should be sent to your mentor's email address and to [redacted]

We understand that the circumstances surrounding COVID-19 have brought up numerous challenges. If for any reason you are absent or tardy, you will not be penalized. The only requirement is that you communicate that to BRAINYAC staff and/or your mentor beforehand.

Dress Code

When on campus for class sessions or laboratory work, students are expected to wear comfortable closed-toed shoes and long pants or skirts in order to comply with safety regulations in laboratory spaces. When engaging in certain lab work, long hair must be tied back and loose clothing should be secured.

BRAINYAC 2022 Program Schedule

Forms Q&A (Optional)

In case you have questions about completing the forms in the packet prior to Orientation, please attend this optional event, which will be held on Zoom.

- **January 8** 12:00 pm to 1:00 pm

Parent-Student Orientation (Mandatory)

Orientation will be held on Zoom. Students must attend with at least 1 parent or guardian.

- **January 22** 12:00 pm to 2:00 pm

Spring Session Dates (January – May)

Training sessions are held on select Saturdays between 9:00 am and 11:00 am in the Education Lab on the first floor of Columbia University's Zuckerman Institute (Jerome L. Greene Science Center, 3227 Broadway, New York, NY 10027). In addition to in person classes, we will use platforms like Google Classroom, Zoom, and other online learning tools to remain connected between sessions. Some out of class work will be necessary.

- **January 29** Session 1
- **February 5** Session 2
- **February 12** Session 3
- **March 5** Session 4
- **March 12** Session 5
- **March 19** Session 6
- **March 26** Session 7
- **April 2** Session 8a
- **April 9** Session 8
- **April 30** Session 9
- **May 7** Session 10

- **May 14** Mentor Matching Meetings (time TBD)

Summer Session and Lab Internship dates (June – August)

Summer internship hours are **Monday through Friday, from 9:00 am to 5:00 pm**, in the students' respective host labs.

Training sessions run on **Thursday mornings during the summer from 9:00 am to 11:00 am** in the Education Lab on the first floor of the Zuckerman Institute.

Labs may be located at the Zuckerman Institute in the Jerome L. Greene Science Center, on Columbia University's Morningside Campus, or at Columbia University Irving Medical Center.

- **June 9** Lab/campus tour, ID acquisition (Tentative time 10:00 am – 1:00 pm)

- **June 30** Orientation & Safety Training (Tentative time 9:00 am – 5:00 pm)
- **July 5** First day of lab internships
- **July 7** Session 1
- **July 14** Session 2
- **July 21** Session 3
- **July 28** Session 4
- **August 4** Session 5
- **August 11** Session 6
- **August 18** Session 7 (optional)
- **August 18** Final Poster Presentation (2:00 pm to 4:00 pm)
- **August 19** Last day of the program (Celebration TBD)

- **Late August** American Museum of Natural History (AMNH) Consortium Summer Student Presentation Event (to be confirmed; Time & Date TBD)

Please be aware that the program schedule is subject to change, including shifting the program to a virtual format. Any changes to the schedule will be promptly communicated.

Important Information & Forms

On the following pages, you will find important information and forms.

Using this checklist, please read, complete, and sign these forms before Orientation (January 22nd, 2022). Forms in this checklist marked with an asterisk (*) are required.

If completing them online, please use DocuSign (instructions will be emailed to you) or paste a picture of your signature onto the forms and email them to [redacted] If completing the paper forms, please mail them back to [redacted] 3227 Broadway, Jerome L. Greene Science Center, Quad B New York, NY 10027 . Upon request, copies of signed documents may be mailed to you after the orientation.

BRAINYAC – Information Manual

NYC Science Research Mentoring Consortium – Welcome Letter

Pinkerton Foundation – Welcome Letter

- BRAINYAC Program Contractual Agreement *
- Parent/Guardian Information and Agreement *
- Columbia University Photo Release Agreement *
- BRAINYAC Allergy Awareness Policy
- AMNH Photo Permission & Release Form *
- W-9 Form *

Guidelines for Short-Term Visitors in Research Related and Clinical Activities

- Minor Visitors Parental Consent Form *
- Columbia Confidentiality Agreement *

BRAINYAC Research Study – Letter to Parents

- Assent Form for Student
- Consent Form for Parent/Guardian

Program Agenda

2:00 pm	Guest arrival Opening remarks Mentor appreciation Presentation of certificates
3:00 pm	Refreshments and research poster presentations
4:00 pm	Departure

SPECIAL THANKS TO:

Principal Investigators

[redacted]

Mentors

[redacted]

Program Staff

[redacted]

programs@zi.columbia.edu • 212.851.9612
zuckermaninstitute.columbia.edu/brainyac

ΙΣΝ / SNF ΙΔΡΥΜΑ ΣΤΑΥΡΟΣ ΝΙΑΡΧΟΣ STAVROS NIARCHOS FOUNDATION

The Pinkerton Foundation

NIH National Institute of Neurological Disorders and Stroke

2022 BRAINYAC Research Poster Presentation & Reception

COLUMBIA | Zuckerman Institute
MORTIMER B. ZUCKERMAN MIND BRAIN BEHAVIOR INSTITUTE

BRAINYAC 2022 graduates

CELEBRATING THE ACHIEVEMENTS OF THE
2022 BRAINYAC GRADUATES

AUGUST 18, 2022 • 2:00PM • JLG SCIENCE CENTER
Education Lab and Jerome L. Greene Science Center Lobby
3227 Broadway, New York

A Note of Thanks

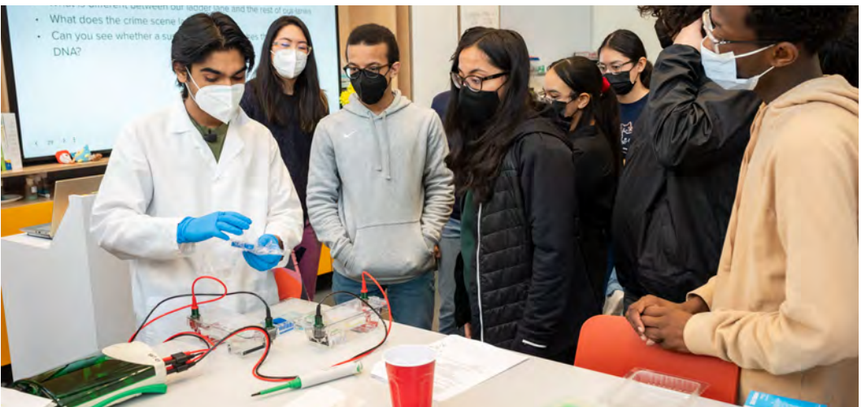
The Zuckerman Institute extends a sincere thank you to everyone who joined us here today to celebrate the achievements of the BRAINYAC class of 2022.

We owe a huge thank you to the principal investigators and mentors for opening their labs and mentoring the next generation of scientists. This program wouldn't be possible without their dedication and commitment.

We would also like to acknowledge our funders, The Pinkerton Foundation, the Stavros Niarchos Foundation, and the National Institute of Neurological Disorders and Stroke for their generous support.

We thank all the parents and guardians for their support throughout the program. We are also grateful to the BRAINYAC Alumni Interns for returning to share their experiences and skills.

And finally, a very big congratulations to the BRAINYAC class of 2022 for successfully completing the program. We wish you success through high school and in the next steps of your education and career trajectory.



BRAINYAC Students and Research Projects

[redacted]
Visualization of protocadherins on the cell surface

[redacted]
Understanding the role of Chromatin and Nuclear Architecture in Neuronal Identity

[redacted]
Pushing the frontiers of dyadic brain scanning technologies

[redacted]
Automated Brain MRS Spetra Processing with Deep Learning & Identifying Schizophrenia Using Structural MRI With Deep Learning

[redacted]
The spatial structure of gene expression in sensory cortex for innate odor preception

[redacted]
Characterizing a neural circuit underlying social regulation of emotional processing

[redacted]
Computer assisted mouse pose estimation

Students and Research Projects (Cont.)

[redacted]
Using viral vectors to understand how the brain perceives visual objects

[redacted]
Cytoskeletal Organization of Motor Nuerons

[redacted]
Development of novel compounds to prevent stress

[redacted]
The role on gene duplications in the evolution of the human brain

[redacted]
A meta analysis of functional neuroimaging data on DEI

[redacted]
Neural correlates of human memory

[redacted]
The impact of DNA stability and architecture on gene expression in the olfactory epithelium

[redacted]
Controversial face project

[redacted]
The effect of pain and social touch on oxytocin expression in the hypothalamus

Annual Report: Youth Internships - Columbia University Facilities and Operations

State Submission Annual Reporting Period: **October 2021 - September 2022**

The Columbia University Facilities and Operations (CUFO) Summer Internship Program is a 6-week long paid internship for high school students who are looking to gain real work experience before graduation. Previous work experience is a plus, but is not required. Interns must be at least 16 years old at the time of the intership and are paid New York State minimum wage.

This summer, the program began on July 11, 2022 and ended on August 19, 2022. Interns were placed in one of the following Facilities and Operations departments: Manhattanville Development Group, Finance and Administration, Planning and Capital Project Management, Strategic Communications, Student Center Operations, Environmental Stewardship, or Operations. Interns worked in their respective departments from Monday - Thursday and met as a group every Friday for special tours, workshops, and skills training.

** Local refers to those students whose primary resident is located within one of the following 17 zip codes: 10025, 10026, 10027, 10029, 10030, 10031, 10032, 10033, 10034, 10035, 10037, 10039, 10040, 10455, 10451, 10454, 10474.*

	Intern Name	Zip Code	High School
1.	[redacted]	10027	University Neighborhood High School
2.	[redacted]	10031	High School of Fashion Industries
3.	[redacted]	10032	Bronx Engineering & Technology Academy
4.	[redacted]	10035	Art & Design High School
5.	[redacted]	10451	Bronx Design and Construction Academy
6.	[redacted]	10029	High School for Health Professions & Human Services
7.	[redacted]	10029	High School of Fashion Industries

Additional Supporting Documentation

- 2022 CUFO Internship Program Friday Session Schedule
- 2022 CUFO Internship Program Final Presentations

CUFO Summer High School Intern 2022 Friday Session Schedule

Friday, July 15 – Ice Breaker, Presentation Skills Workshop, and Team Building Exercise with [redacted]

Friday, July 22 – Overview of Campus Services

- Tour of Alfred Lerner Hall with [redacted] Manager, Lerner Hall Operations
- Tour and Lunch at Ferris Booth Commons with [redacted], AVP and [redacted], Assistant General Manager
- Behind the scenes tour of Roone Aldridge Auditorium with [redacted], Assistant Director, Technical Services

Friday, July 29 - Tour of the Manhattanville Campus

- Overview of the model of the new campus and video with [redacted], Executive Assistant
- Tour of Control Room and Underground Energy Plan with [redacted], Assistant Vice President and [redacted], Director
- Tour of the Wallach Art Gallery, Exhibit: Dead Lecturer/Distant Relative Works by Asian Americans and African American Artists
- Tour of The Forum the Urban Layer with [redacted]
- Tour of the Jerome L. Greene Science Center with [redacted]
- Columbia Business School Geffen Hall – Overview of Business School Community Programs with [redacted], Senior Program Manager

Friday, August 5 – Tour of the Lamont-Doherty Earth Observatory

- Tour of Lamont-Doherty Core Repository and research activity with [redacted], Curator
- Walking tour of the campus

Friday, August 12 – Finalize and Practice Presentation

- Met with [redacted], General Manager to discuss room set up and specifications
- Met with [redacted], Audio Visual Manager to discuss all A/V needs

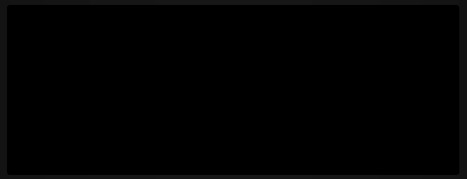
Friday, August 19 – Final Presentation

Welcome Everyone!

Summer Internship Award Show

08.19.2022.

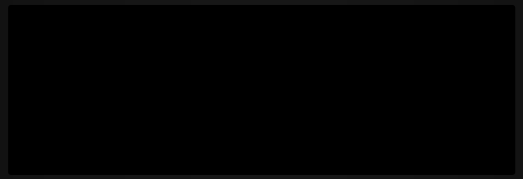
The Nominees



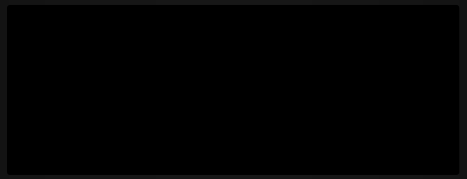
CU Grow / Vendor Development Program

[redacted]

Communications



Dining Services



Manhattanville Development

Awards

Design & Organization

Social Media Manager

Program Outreach & Web Design

Menu & Allergen Management

Organization & Maintenance

The Winners

Design & Organization

[redacted]

Interning at Architecture Department

Mentor: [redacted]

About:

- Highschool of Fashion Industries; Business Major, Class of 2023

Initial Career:

- A Science Field (took AP Bio) but I believe Architecture is meant for me

Why intern this summer?

- To gain knowledge on something completely new + get out my comfort zone

[redacted]

Interning at Architecture Department

Mentor: [redacted]

My Experience:

- I've learned that Architecture isn't only about how appealing a building looks from the outside or inside but how kept up to date it is. Maintenance, teamwork and comfortability is key for a successful building.

- What I loved: Touring Construction sites and being able to see buildings in progress + going to some meetings and seeing how Developers and Designers collaborate. I also loved touring around campus on Fridays.

- Projects I've worked on: Designing covers for Building Profiles (building information that needs to keep up with) and condensing building information into Excel to keep up with maintenance

- Overall, I think this internship has helped me plant great seeds for my future and was a both educational and fun experience to have :)

Program Outreach & Web Design

[redacted]

CU GROW / Vendor Development

Mentor: [redacted]

- I go to Bronx Design And Construction Academy and I am a rising senior (Class of 2023)
- My Mentor over the summer is [redacted] Program Administrator for Supplier Diversity in the CBI Department
- I am currently deciding on what I want to do after High School but I'm looking into BlockChain Technology or Construction etc.
- I was recommended the Columbia Internship by one of the Grant Associates representatives because she felt I would do good here and she wanted me to learn some of the business aspect of construction.

[redacted]

CU GROW / Vendor Development

Mentor: [redacted]

As a the Construction Business Initiative Intern

- My focus was to support the department capacity building programs, the CU Grow Program and the Ascend NYC Program.

For Ascend NYC Program:

- Supported their National Conference and learned is that Networking is the most important part of a business and you won't make it as far working alone.

For the CU Grow Program:

- I was responsible for the program website cleanup. Some tasks included:
- Gathering data on all the CU Grow Graduates and Participants and verifying that their information is accurate.
- Assist the Communications Officer remaking the website so it's easier to navigate. To improve opportunities for graduates.
- I've also been helping the current participants in the program to set up their business with strategy meetings with their Marketing Experts and Construction Experts. This will allow firms not only set goals for their business but also expand their business.

Social Media Management

[redacted]

Strategic Communication

Mentor: [redacted]

About Me:

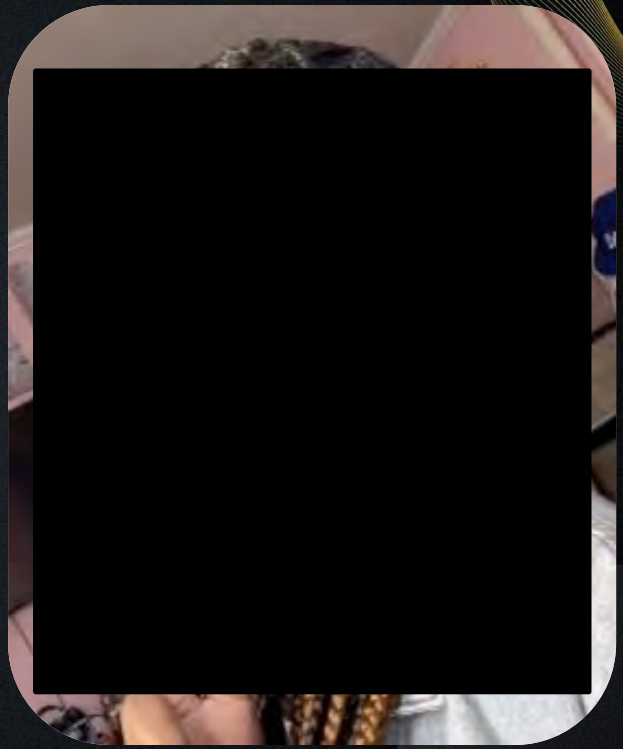
- I am a rising Sophomore and Business major at HSFI (High School Of Fashion Industries) Class of 2025

Internship facility:

- In my mentorship I work with Public Safety and Housing Communications along side my mentor [redacted]

Career Path:

- When I complete high school I want to continue majoring in Business and Marketing to prepare me when opening up my own business



[redacted]

Strategic Communication

Mentor: [redacted]

Projects worked on:

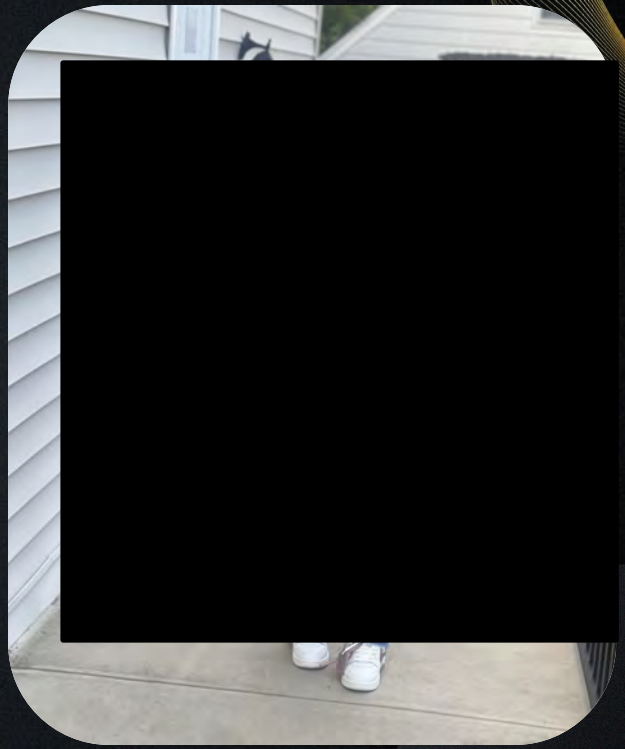
- Helping with updating Crime Prevention Tips, giving feedback on social media pages, reviewing Columbia websites and comparing it to other Universities

Why:

- I decided to do this Internship because I wanted to experience a work environment and learn more about different opportunities.

Learned:

- I learned that there are lots of steps to make a website informational but still interactive with viewers/students.


[redacted]

Menu and Allergen Management

[redacted]

Dining Services

Mentors: [redacted]

About Me:

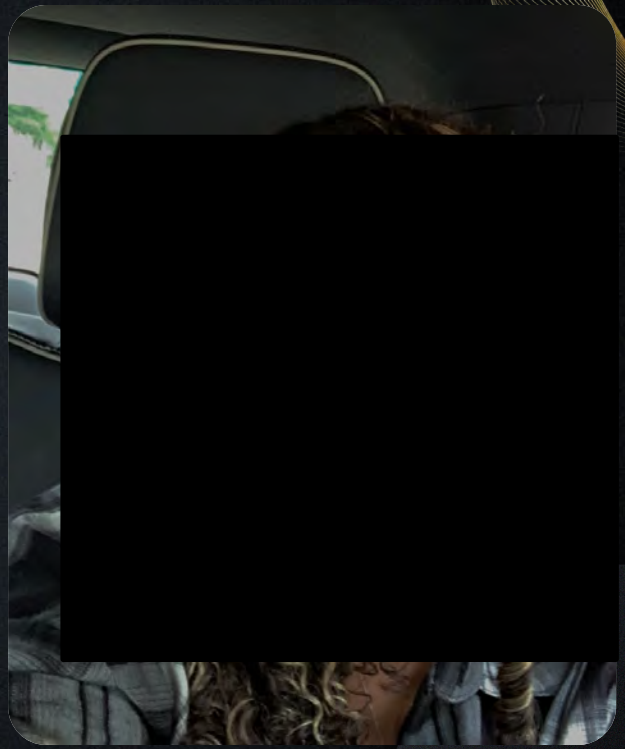
- Upcoming Junior at the High School for Health Professions and Human Services (Class of 2024)
- Part of a 3 year Medical Assisting Program

Career I would like to pursue:

- Neurosurgeon or Neurologist; however, I am open to any job in the medical field

Purpose for doing this internship:

- Work Experience/Career Development
- Personal Growth
- College



[redacted]

Dining Services

Mentors: [redacted]

My Experience:

- I was matched with our Registered Dietitian/Dining Services
- Dining isn't as easy as it looks. Chefs and other people working within Dining Services depend on each other in order to come with up recipes, menus, and of course, food for their students.

Assignments I worked on:

- Updated allergens of recipes
- Coffee Specials
- Facilitating a presentation for over 200 employees about allergens
- Understanding food trends and contributing ideas by attending food innovation show.

Things I enjoyed:

- Sysco food show
- Helping setup for events

Organization & Maintenance

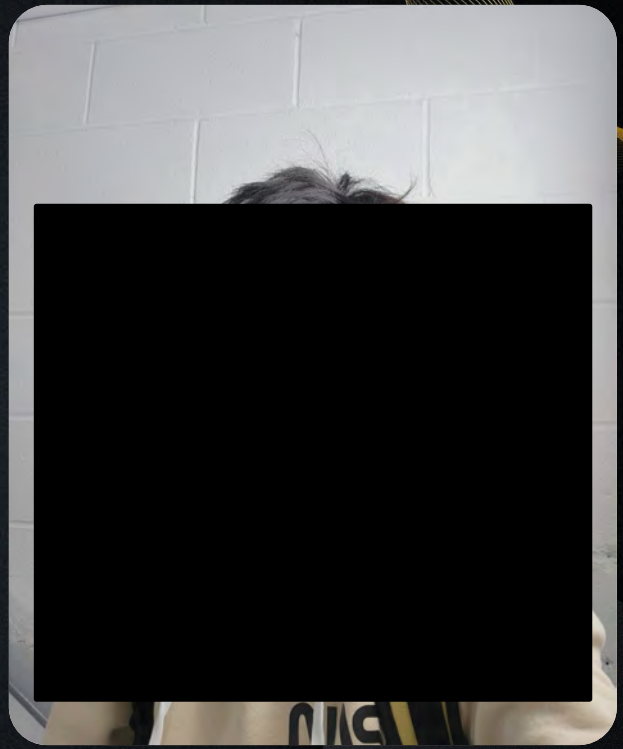
[redacted]

Manhattanville Development

Mentor: [redacted]

About Me:

- My name is [redacted]
- I'm a rising 11th grader
- I go to school at BETA high school. (Bronx Engineering And Technology Academy)
- I’m interested in Studying Computer Science.
- I applied to this internship to open up my work experience and learn how it is having a job. I was recommended this program because it would look great on my resume for when I apply to college.



[redacted]

Manhattanville Development

Mentor: [redacted]

My Experience at Manhattanville:

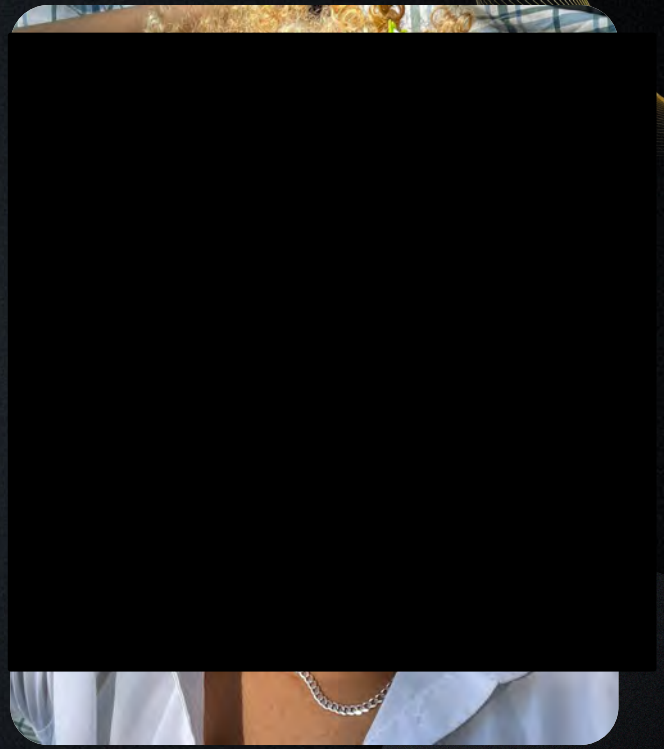
- Attended meetings in the Manhattanville Development Group to learn about the tasks that staff must accomplish in order to complete the development projects currently under construction.
- Assisted [redacted] with tasks such as: Staff directory updates, office organization, Personal Protective Equipment (construction hats, vests and goggles) assembly.
- I had a few informational interviews such as:
  - [redacted] sistant Director of Information Technology to talk about IT and computer science
  - [redacted] Executive Director of Quality Control and Quality Assurance to talk about testing materials like glass and concrete to make sure they are manufactured properly and can withstand the weather or weight they will be used to support.
- I visited development sites under construction - the new residential housing project on 125th St and a Business School retail project.

[redacted]

Technical Services

Mentor: [redacted]

- Attending Hunter College in the fall, graduate of Art and Design High School
- Passion for social justice
- A lifelong artist, planning on pursuing a studio arts degree
- Interested in being a small business owner
- Coffee fiend



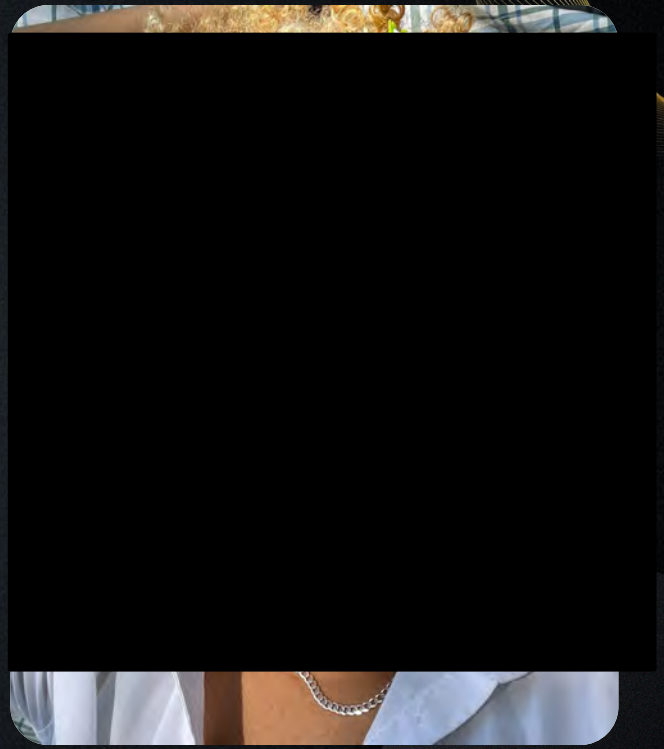
[redacted]

Technical Services

Mentor: [redacted]

Learned About:

- Planning an event from a technical standpoint
- The difficulty of managing a team of 20+ people
- The importance of developing rapport with your co-workers
- (i *strongly dislike* microsoft excel)



Congratulations

Winners

Thank You Mentors!

Annual Report: Youth Internships - Engineering the Next Generation

State Submission Annual Reporting Period: **October 2021 - September 2022**

- Application Deadline: **March 21, 2022**

Following a shift to virtual programming during the height of the COVID-19 pandemic, Engineering the Next Generation returned to in-person programming in 2022.

Rising high school seniors match with engineering labs and research mentors, and supervised by faculty members. Program components include research, mentoring, college preparation, presentation skills, as well as academic and professional workshops. Students are challenged with high-level academic expectations of both the researchers and undergraduate mentors. This year recruitment of students included the initial four partner schools, Columbia Secondary School, The High School for Math, Science and Engineering (HSMSE) at the City College of New York, and ELLIS Preparatory Academy, and Bronx Center for Science and Math, as well as other additional schools in order to increase the diviersity of the applicants. As a result, this year the selection was highly competitive with 80 completed applications. Participants must be at least 16 years of age in order to participate and are granted a stipend for their time in the program. In addition, CU partnered with New York City's Department of Youth and Community Develop (DYCD) to utilize the Summer Youth Employment Program (SYEP) so that eligible students could receive a greater stipend than in previous years.

Program Information

For six weeks, students work with Columbia Engineering researchers and participate in programming to develop their academic and professional skills. Students gain practical research experience, collaborate with research faculty, staff, and students, practice new skills, and take part in multi-level mentorship.
Program components include experience in working on genuine engineering research projects, research skills and college prep workshops, science communications workshops, and additional supplemental seminars and opportunities. ENG participants are on-campus 25 hourrs a week, and have the option to attend cohort building trips ranging from attending a Yankees game to visiting the New York Botantical Garden for a STEM workshop.

Engineering the Next Generation 2022 Participants

	Intern Name	Zip Code	High School
1.	[redacted]	11222	Stuyvesant HS
2.	[redacted]	10458	Bronx Center for Math and Science
3.	[redacted]	10467	Bronx Center for Math and Science
4.	[redacted]	10025	Gregio Luperon HS for Math and Science
5.	[redacted]	10040	Columbia Secondary School
6.	[redacted]	10021	Gregio Luperon HS for Math and Science
7.	[redacted]	11204	Brooklyn Technical HS
8.	[redacted]	10467	Bronx Center for Math and Science
9.	[redacted]	10468	ELLIS Preparatory Academy
10.	[redacted]	10128	Columbia Secondary School
11.	[redacted]	11372	The Young Women's Leadership School of Astoria
12.	[redacted]	10301	Susan Wagner HS
13.	[redacted]	11368	The Young Women's Leadership School of Astoria
14.	[redacted]	11385	Brooklyn Technical HS
15.	[redacted]	11218	Brooklyn Technical HS

Additional Supporting Documentation

- Engineering the Next Generation 2022 Application Packet
- Engineering the Next Generation 2022 Final Presentations

ENG 2022 Application

Start of Block: Block 1

Program Description Engineering the Next Generation (ENG) is a 6-week, full-time summer research program at Columbia Engineering for academically competitive NYC rising high school seniors (i.e. current juniors). High school researchers will be matched with research mentors and supervised by Columbia faculty members and graduate students. The 2022 summer program will run from July 5 to August 12, 2022. Program components include research, mentorship, college preparation, as well as academic and professional development workshops. Possible extensions of the program include continuing research through the following academic year, publication and paper co-authorship, and a letter of recommendation from the research lab's supervising professor.

Eligibility: Students must have completed their junior year of high school by the start of the program to apply. While there is no minimum GPA, students should excel academically overall. Applicants will have demonstrated an interest and commitment to STEM (ex: advanced STEM classes and extra-curricular activities). Students must also show strong self-motivation and responsibility. Students must follow Columbia University's public health protocols, which include vaccination against COVID-19, masking, and distancing where appropriate.

Please note that this application has many steps and requires an essay component as well as uploading a resume and school transcript. You will be able to save your application and finish it at a later date.

You will need to include all of the following documents in order to complete your application:
- Completed application document (this form)
- Completed essay questions (this form)
- Resume
- School transcript
- Completed recommendation form by a teacher (http://bit.ly/ENGREC2021)

Deadline: Applications and letters of recommendation are due March 21st, 2022 11:59 PM EST. Potential finalists for the program may be contacted for an interview prior to admission to the program. Decisions for the 2022 program will be shared in April 2022. Please email engineeringoutreach@columbia.edu if you have any questions or concerns.

End of Block: Block 1

Start of Block: Applicant Information

First Name First Name

_____

Q3 Last Name

_____

Q4 Email Address

_____

Q5 Preferred Name/Nickname

_____

Q6 Birth Date

_____

Q7 Home Address

_____

Q8 City

_____

Q9 State

_____

Q10 Zip Code

_____

Q11 Phone Number

_____

Q12 Pronouns

- O She/Her/Hers (1)
- O He/Him/His (2)
- O They/Their/Theirs (3)
- O Other (4) _____

Q13 Ethnicity

- [ ] Asian (1)
- [ ] Black/African (2)
- [ ] Caucasian (3)
- [ ] Hispanic/Latinx (4)
- [ ] Native American (5)
- [ ] Pacific Islander (6)
- [ ] Prefer not to answer (7)
- [ ] Other (8) _____

End of Block: Applicant Information

Start of Block: Parent/Guardian Information

Q14 Parent/Guardian (1) Full Name

_____

*

Q15 Parent/Guardian (1) Email Address

_____

*

Q16 Parent/Guardian (1) Phone Number

_____

Q17 Parent/Guardian (2) Full Name

_____

Q18 Parent/Guardian (2) Email Address

_____

Q19 Parent/Guardian (2) Phone Number

_____

Q20 Emergency Contact Name

_____

Q21 Emergency Contact Relationship to You

_____

Q22 Emergency Contact's Phone Number

_____

End of Block: Parent/Guardian Information

Start of Block: Academic Information

Q23 Name of School

_____

Q24 What is your current grade level?

_____

Q25 Current GPA

_____

Q26 Please upload your most current school transcript as a PDF

Q46 If you do not have access to your high school transcript, please include the e-mail address of an administrator or teacher who can provide those to us.

_____

Q27 Please provide the name of one teacher (preferably STEM) who will complete the required recommendation form on your behalf. We MUST receive your completed recommendation form by the application deadline.

Please direct this teacher to the following link to complete the recommendation form: https://seas.co1.qualtrics.com/jfe/form/SV_1YXxXDzR9FbLgB8

_____

Q28 Please provide this teacher's email address. We will follow up with them at this email address if they do not complete the recommendation form by the application deadline.

Please note that it is still your responsibility to reach out to notify them about completing this form by the application deadline.

_____

End of Block: Academic Information

Start of Block: Extracurricular Information

Q29 For the following section, please describe your extracurricular involvement including but not limited to: academic or social clubs, religious or cultural organizations, work experience, personal projects or interests, etc.

Q30 Extracurricular/Organization Name and Your Position/Role in the Activity; Ex: FIRST Robotics Competition (FRC); Member, Captain, Vice President

_____

_____

_____

_____

_____

Q32 Describe your involvement and why your participation in this activity is impactful.

_____

_____

_____

_____

Q42 Extracurricular/Organization Name and Your Position/Role in the Activity; Ex: FIRST Robotics Competition (FRC); Member, Captain, Vice President

Q43 Describe your involvement and why your participation in this activity is impactful.

Q44 Extracurricular/Organization Name and Your Position/Role in the Activity; Ex: FIRST Robotics Competition (FRC); Member, Captain, Vice President

Q45 Describe your involvement and why your participation in this activity is impactful.

_____

_____

_____

_____

_____

*

Q33 Please upload a most recent resume highlighting your most recent academic, extracurricular, work, and/or volunteer experiences.

If you need help writing a resume, follow this link: https://www.asvabprogram.com/media-center-article/64

End of Block: Extracurricular Information

Start of Block: Essay Questions

Q35 Please answer the following essay questions and limit your responses to 300 - 500 words. There are no “right” answers to any of these questions; essays will be judged for creativity, innovation, and your ability to convey your ideas clearly and concisely.

Q36 1. What does the opportunity to conduct research mean to you?

_____

_____

_____

_____

_____

Q37 2. Describe a social, personal, or academic challenge that you have faced in the last three years. How did you approach and overcome this challenge?

Q38 3. Columbia Engineering aspires to create a more sustainable, healthy, secure, connected, and creative humanity. What does this vision mean to you and how might you tackle a challenge using engineering to improve humanity for your own community?

Q39 4. What are your future career aspirations? What are your plans for achieving these aspirations?

End of Block: Essay Questions

Start of Block: Application Completion Confirmation

Q40 Please check the boxes below to confirm your application

- ☐ I verify that all information provided in the application is true and accurate. (1)
- ☐ I understand the program requirements and will commit for the full duration of the summer program upon acceptance. (2)
- ☐ I acknowledge that I will participate in an interview in order to be considered as a finalist for acceptance to this program. (3)

Q41 By typing my full legal name below, I verify that all of the provided information is my own, true, and accurate to the best of my knowledge. I agree that my electronic signature is the equivalent of a manual signature and approve the submission of this application to the ENG summer program.

_____

End of Block: Application Completion Confirmation

Engineering the Next Generation

COLUMBIA ENGINEERING FOR HUMANITY

Engineering the Next Generation Final Presentations

Thursday, August 11th, 2022

Welcome!

Find someone near you that you don't know

Name

What brought you here today

Answer this question of the day: If you could meet anyone in the world today, who would it be?

Agenda

Presentations
Break
Presentations
Certificate Distribution

Square Lattice Patterns in Chromium Sulfur Bromide

[redacted]

Thursday, August 11th, 2022

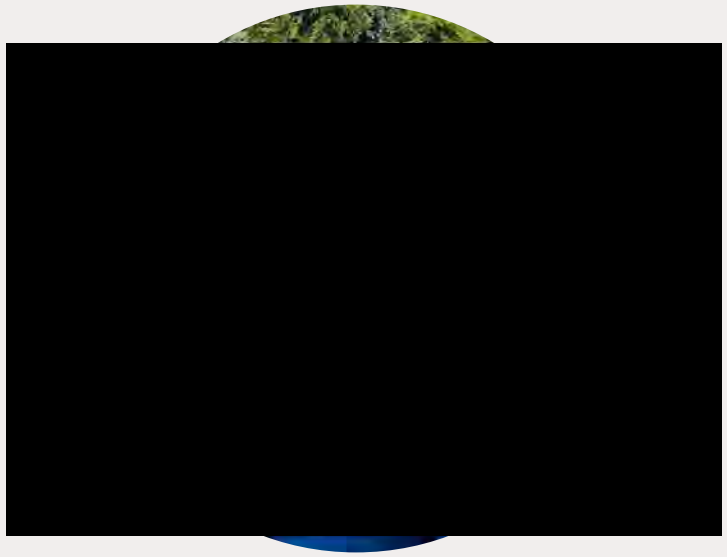
Introductions

[redacted]

- Queens, New York
- The Young Women's Leadership School of Astoria
- Programming

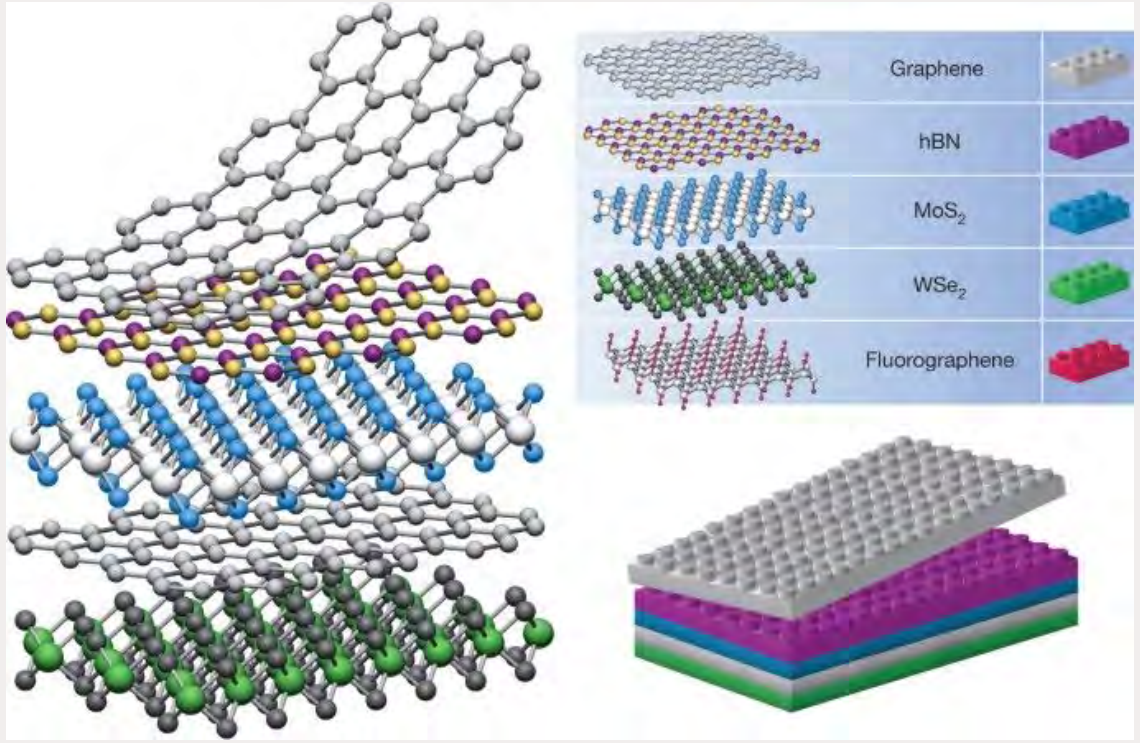
[redacted]

- Queens, New York
- Brooklyn Technical High School
- Dentistry

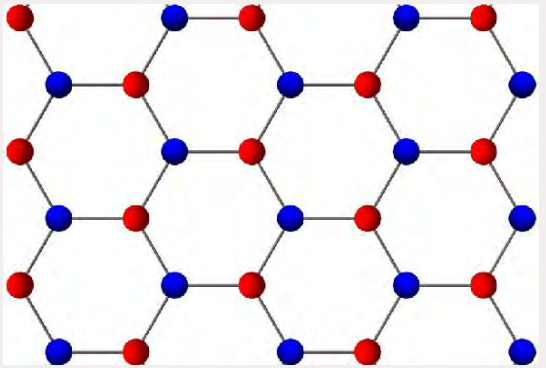


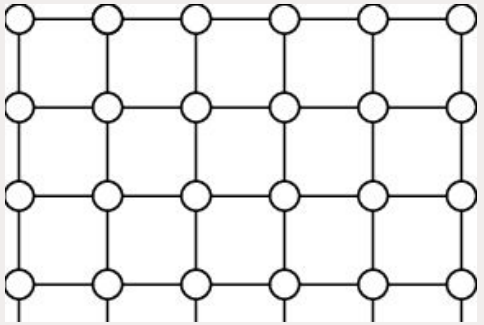
Key Terms

- ***Van der Waals Crystal:*** 2D layers that are bound in 3D
- ***Lattice:*** an ordered set of points that define the structure of a crystal



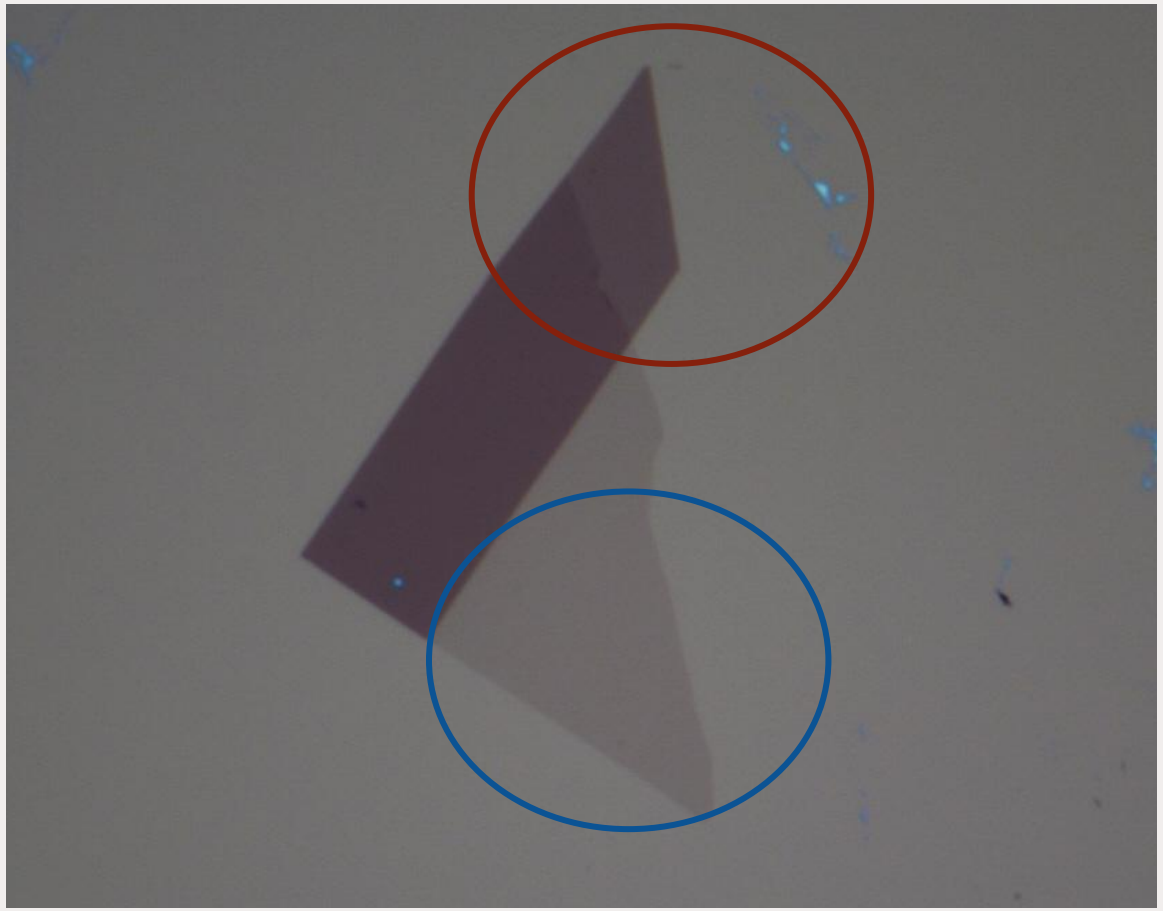
© Nature Publishing Group





Symmetry breaking and lattice kirigami: Finite temperature effects (ResearchGate)
General Bounds for Identifying Codes in Some Infinite Regular Graphs (ResearchGate)

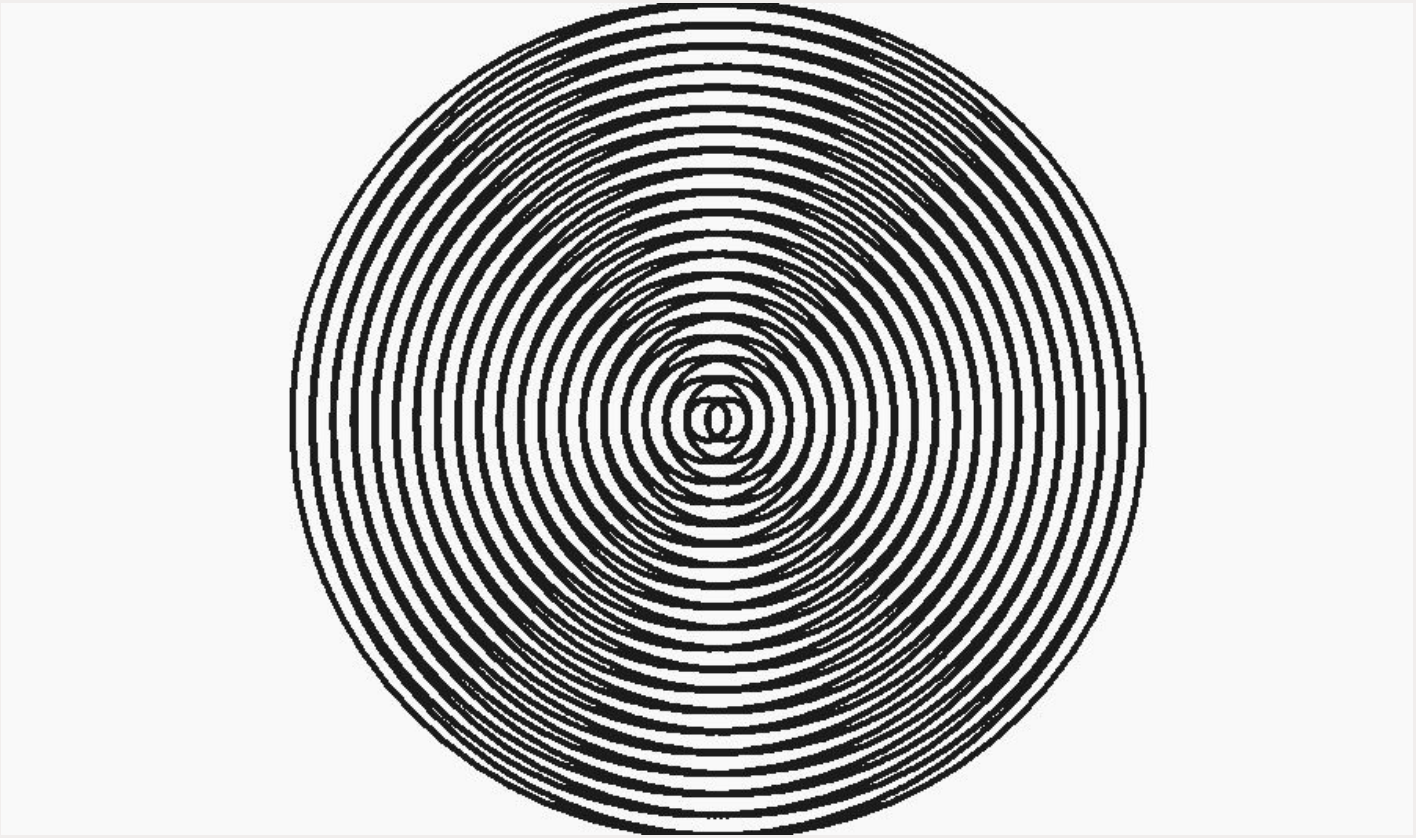
Key Terms



- ***Monolayer:*** A singular layer; used to define thickness
- ***Bilayer:*** Two layers; used to define a thickness

Key Terms

Moire Pattern: large-scale interference patterns



Jacopo Bertolotti, Wikimedia Commons

Key Terms

- ***Conductivity:*** Ability to transfer heat or electricity
- ***Superconductivity:*** Ability to transfer electricity with 0 resistance

Griselda Garcia, Brownsville Independent School District

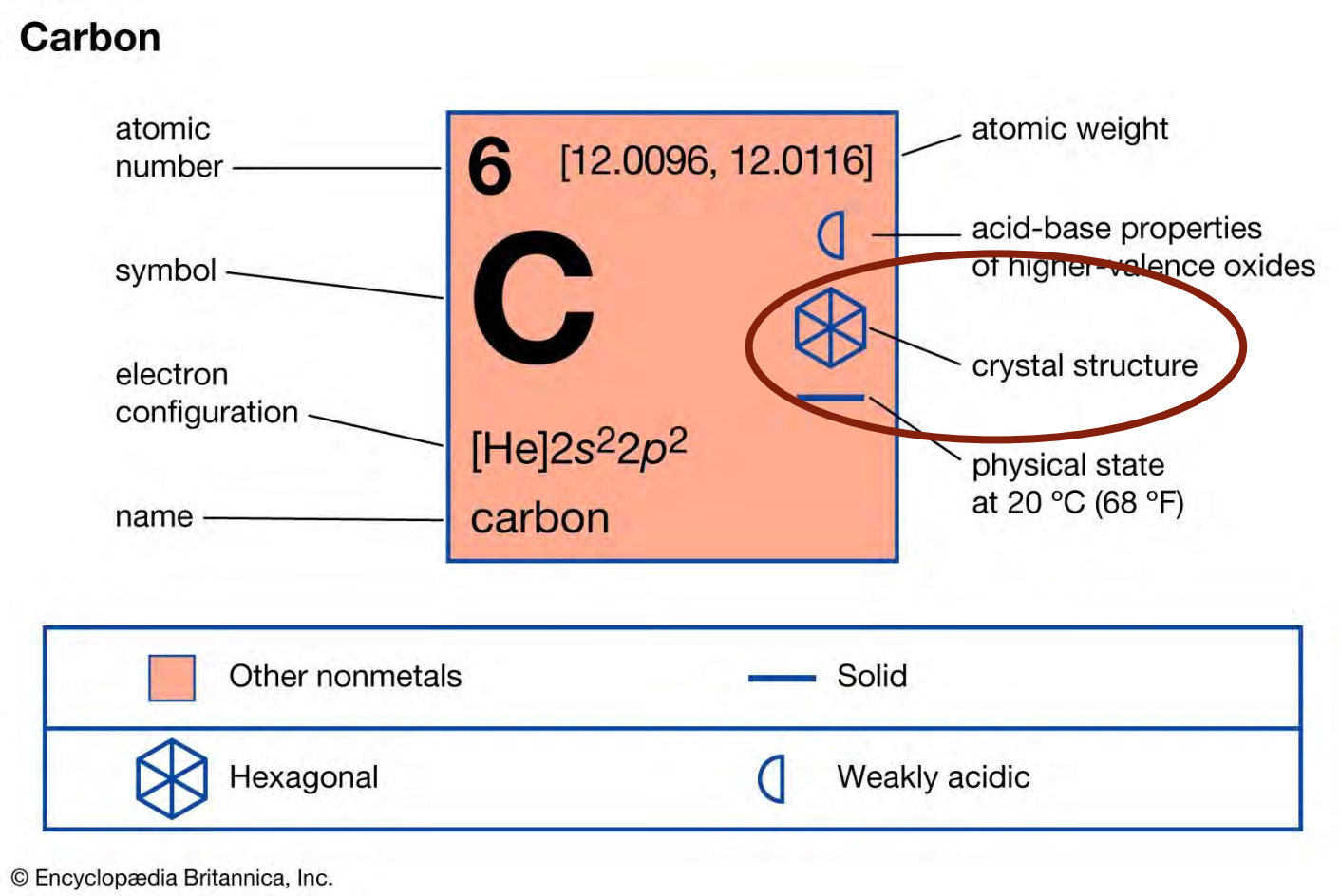
Graphite Properties

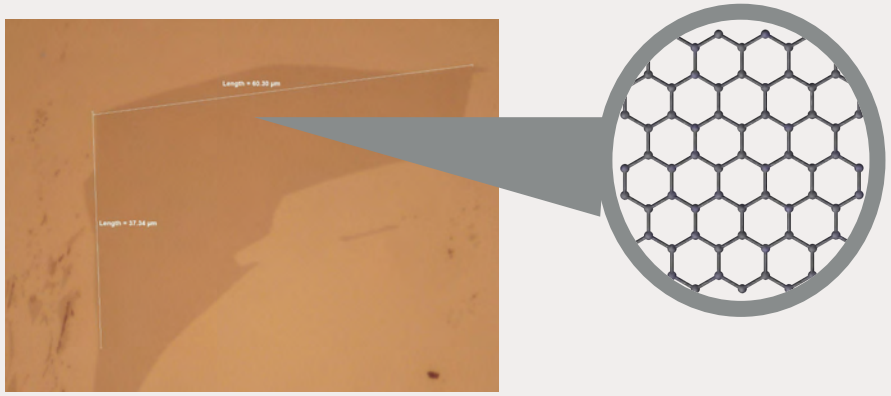
Graphite

- One of the crystal form of Carbon
- Common uses: pencils & batteries

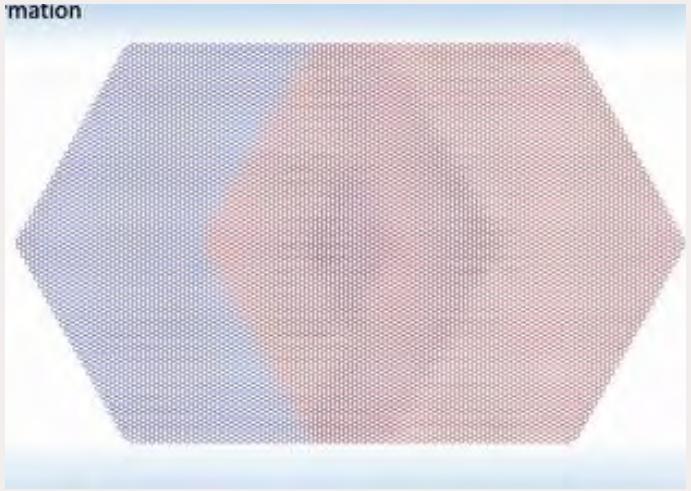
Miriam Doerr Martin Frommherz / Shutterstock
Adobe / New Africa
Home Stratosphere

Graphite Properties



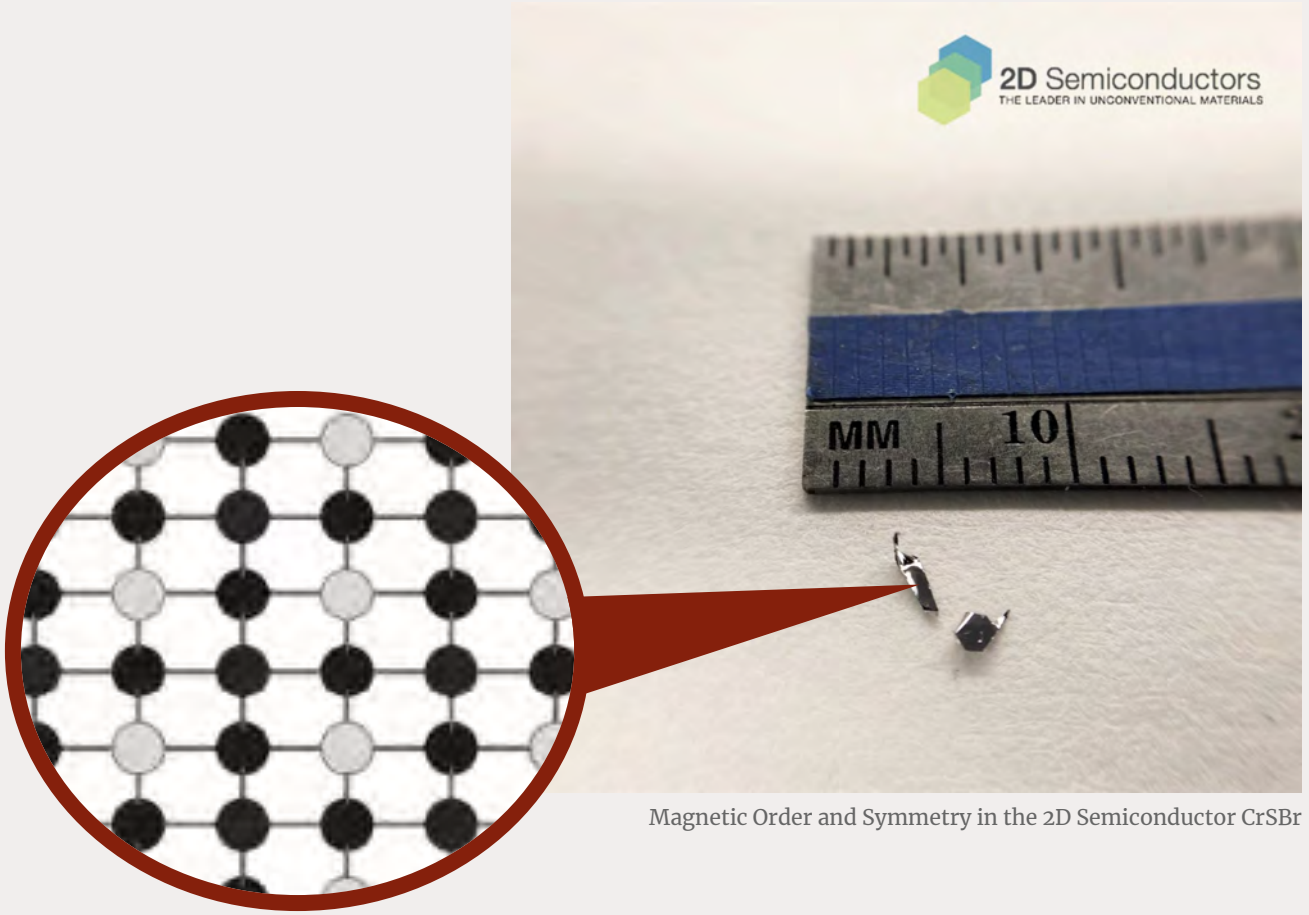


Industrial-Scale Graphene Nanoplatelets & Dispersions | ACS Materials



Josh R. Swann, Graduate Student, Dean Lab, Columbia University

CrSBr Properties



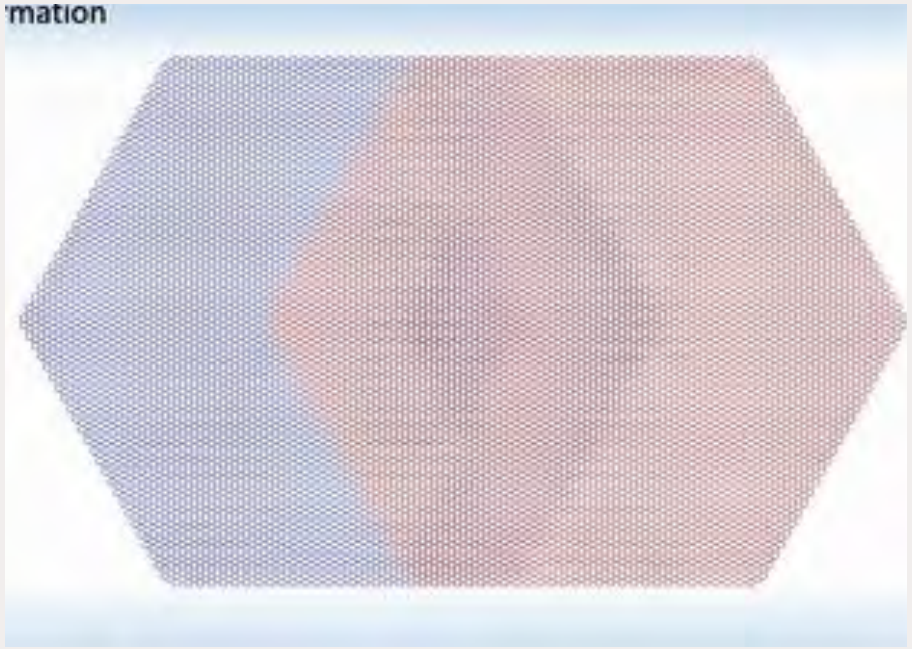
Magnetic Order and Symmetry in the 2D Semiconductor CrSBr

Chromium Sulfur Bromide (CrSBr)

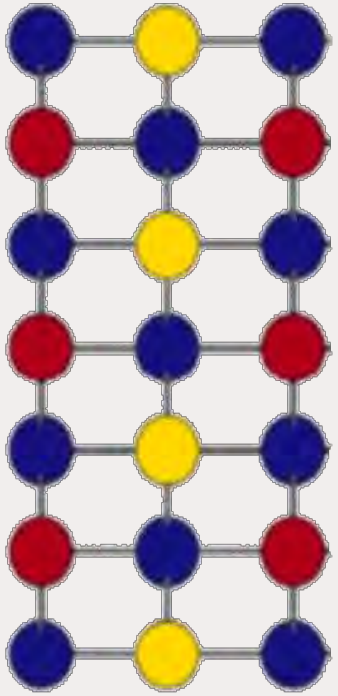
- Van der Waals crystal
- Air sensitive at monolayer stage
- Rectangle lattice structure
- Magnetic
- Semiconductor

Why CrSBr?

Hexagonal moire patterns in crystals have been studied the most.



Twisted hexagonal lattice of Graphene

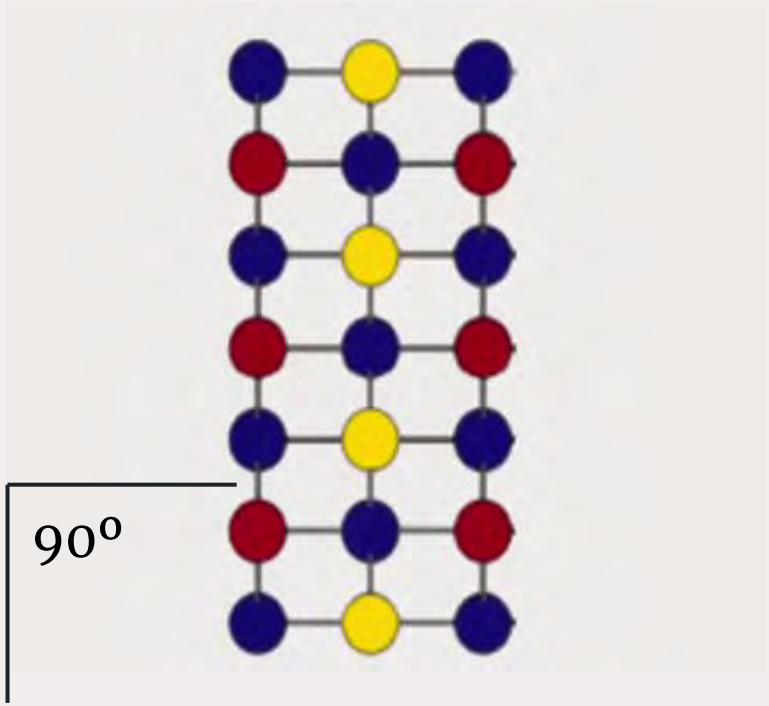


Rectangular lattice of CrSBr

Josh R. Swann, Graduate Student, Dean Lab, Columbia University
Magnetic Order and Symmetry in the 2D Semiconductor CrSBr

Goal

Create the ***square superlattice pattern of CrSBr*** by twisting them 90 degrees relative to each other.



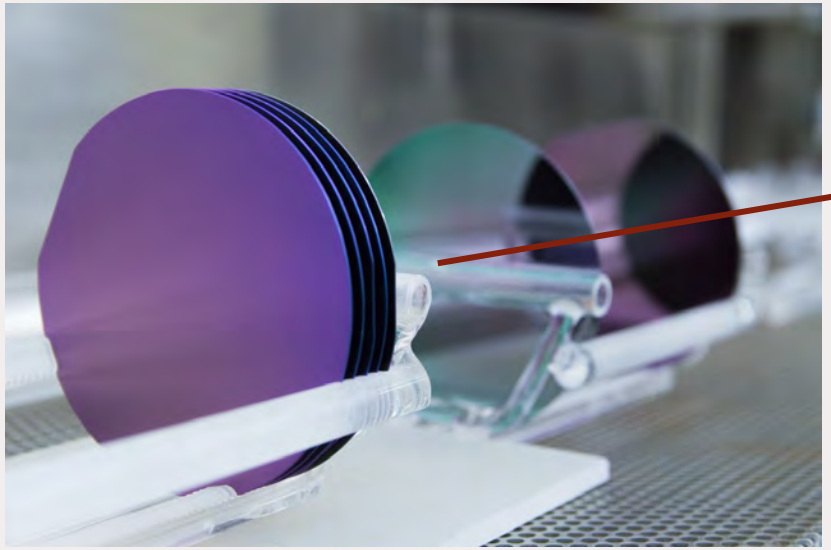
Magnetic Order and Symmetry in the 2D Semiconductor CrSBr

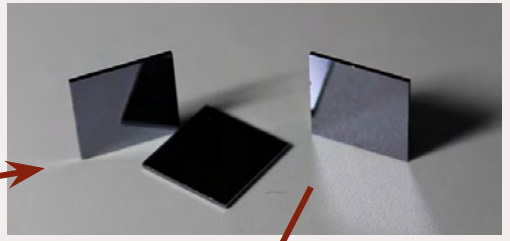
Methods

Mechanical exfoliation

Materials:

- Scotch Tape
- 2D Crystal
- Tweezers
- Silicon Chip
  - 90 mm
  - 250 mm

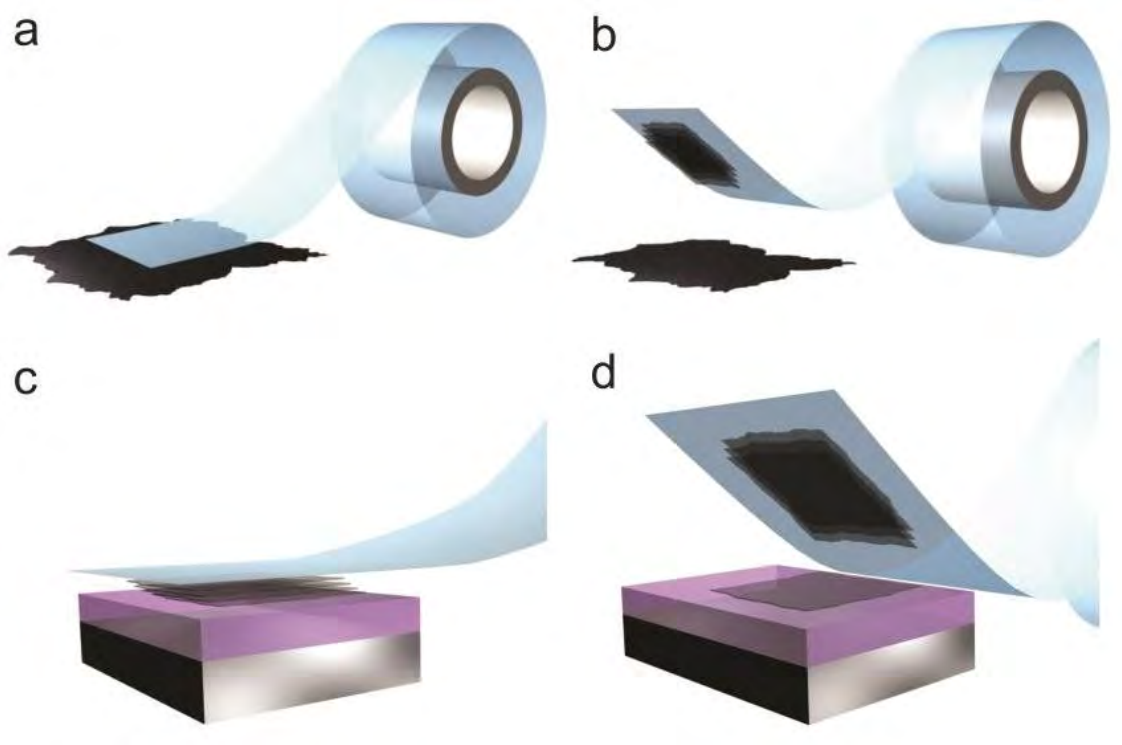




Silicon Wafers | Semiconductor Materials Products | Mi-Net Technology
AliExpress
Clean Room Packed Ultra-Flat Silicon Wafers / Ted Pella Inc.

Methods

Mechanical exfoliation



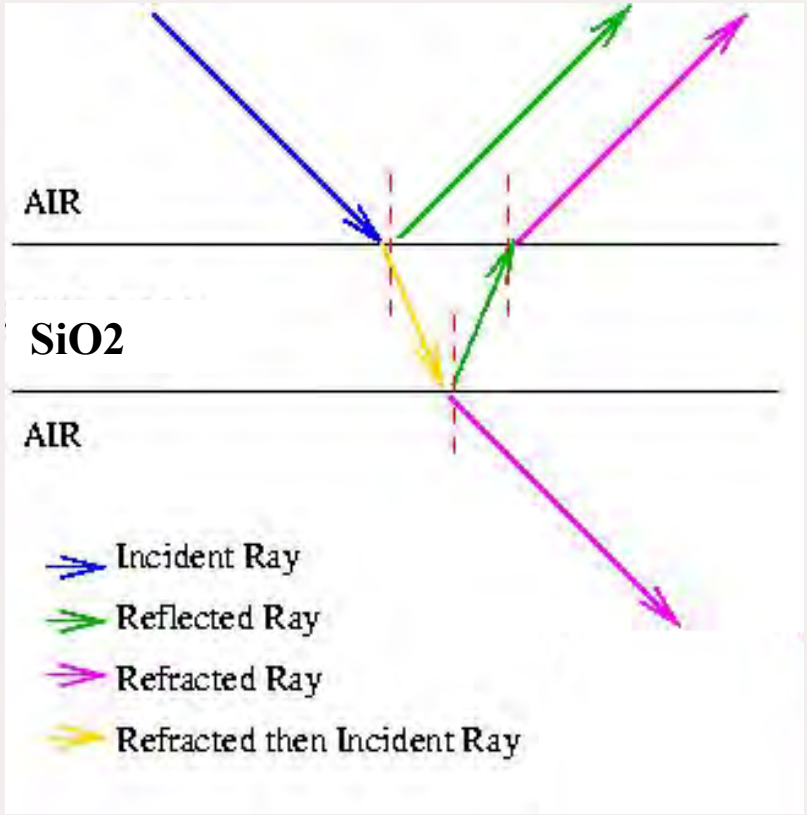
Fabrication and Characterization of Macroscopic Graphene Layers on Metallic Substrates / ResearchGate

The process of using tape to thin down crystals.

The tape carries a thin part of the flake and places it down on the SiO2 chip and the 2D crystal.

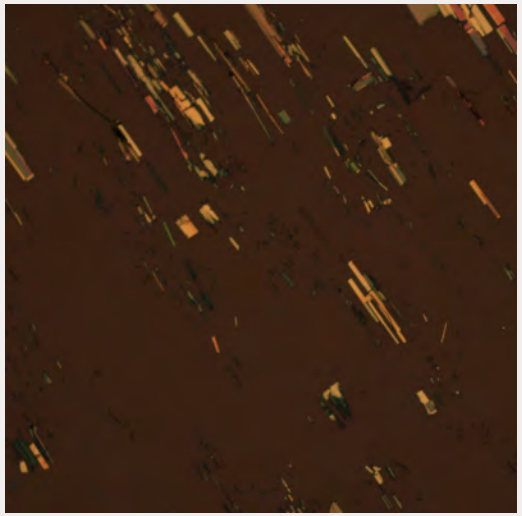
Thin-Film Interference

Measured by the intensity of the radiation of a wavelength produced by electromagnetic fields, light waves reflect off of exfoliated 2D materials to define the thickness of flakes.

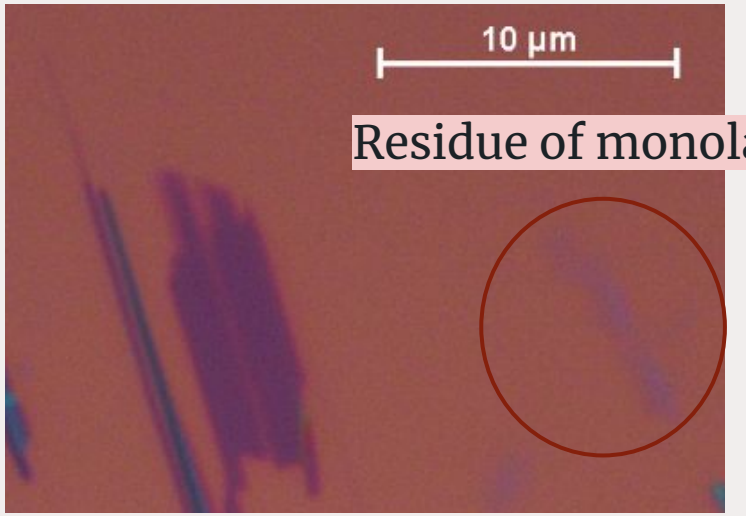


Light and Optics - Interference from Thin Films - Physics 299

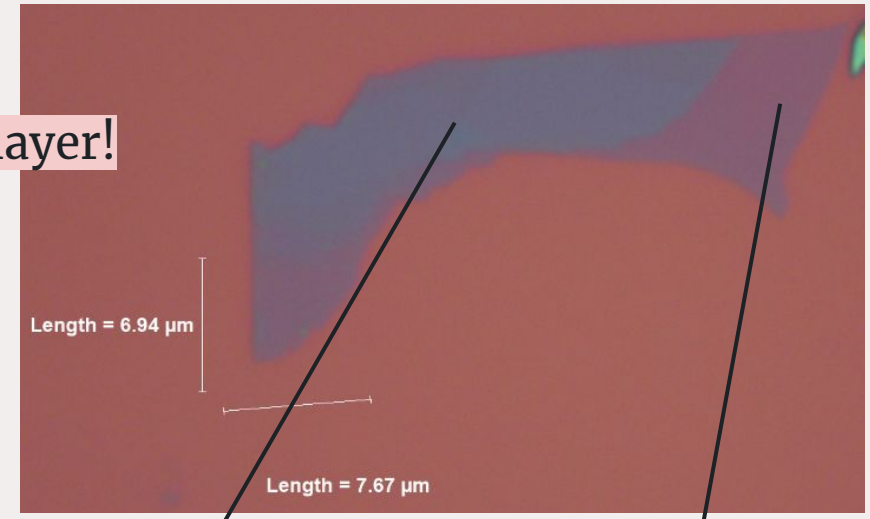
Thin-Film Interference



CrSBr on 90 mm SiO2 chip



Thickness: 30-40 nm



Thickness: 10-20 nm

Thickness: 1-10 nm

Methods

(Dodecanol) Chip Coating

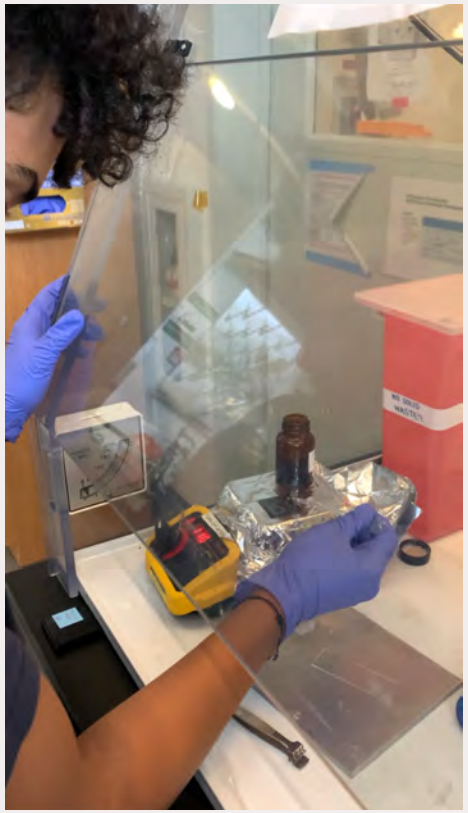
Dodecanol: A fatty alcohol used to reduce the adherence of a material from the surface of a chip.

Purpose: 2D crystals that adhere to SiO2 chips.

Material: FeOCl & CrSBr

Technique: using a pipette

Amazon



Methods

(PMMA) Chip Coating

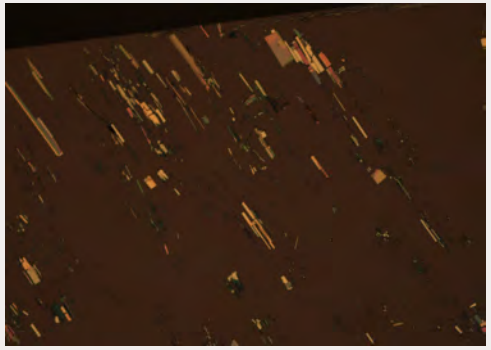
Polymethyl-methacrylate (PMMA): A synthetic resin used to reduce the adherence of 2D crystals to a chip.

Purpose: 2D crystals that adhere to SiO2 chips.

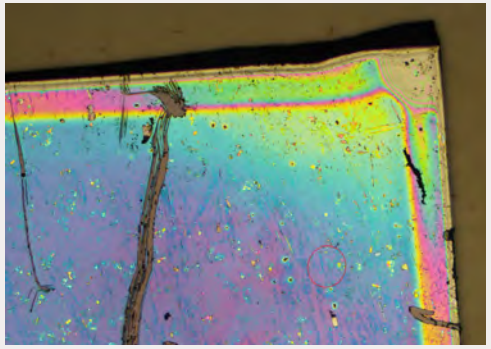
Material: CrSBr

Technique: Spin coating

The University of Memphis

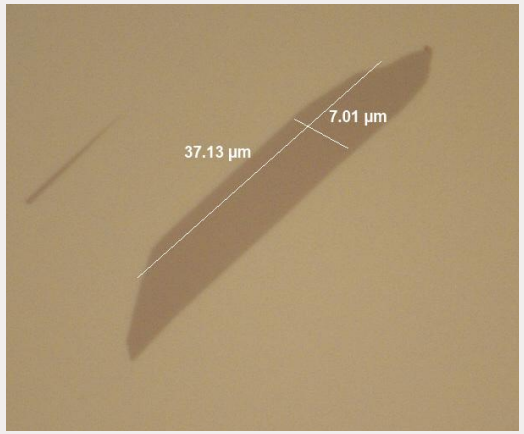


Dodecanol



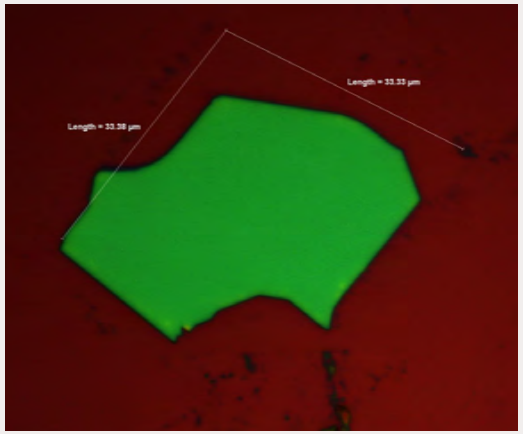
PMMA

2D Crystal Exfoliations



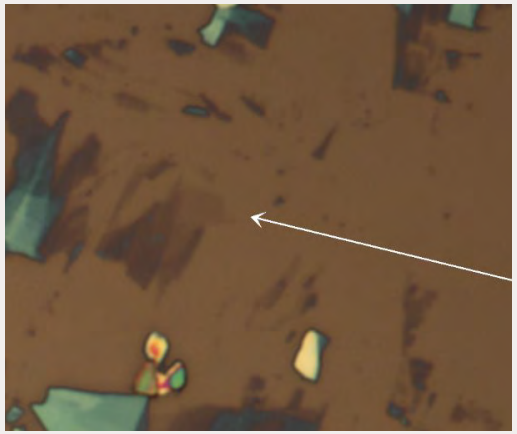
Graphene

Size: 37 x 7 µm
Layers: 50-60 nm



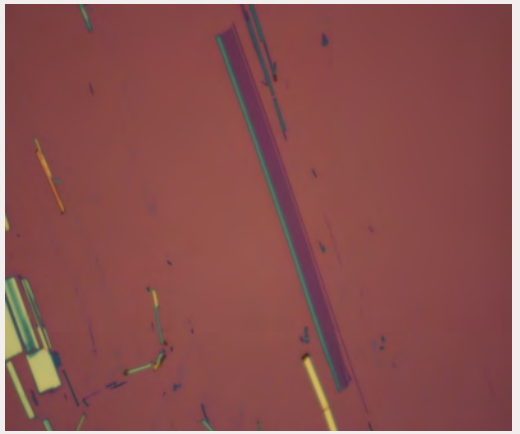
Hexagonal Boron Nitride (*h*BN)

Size: 33 x 33 µm
Layers: 50-60 nm



Iron Oxychloride (FeOCl)

Size: 5 x 7 µm
Layers: 1-5 nm

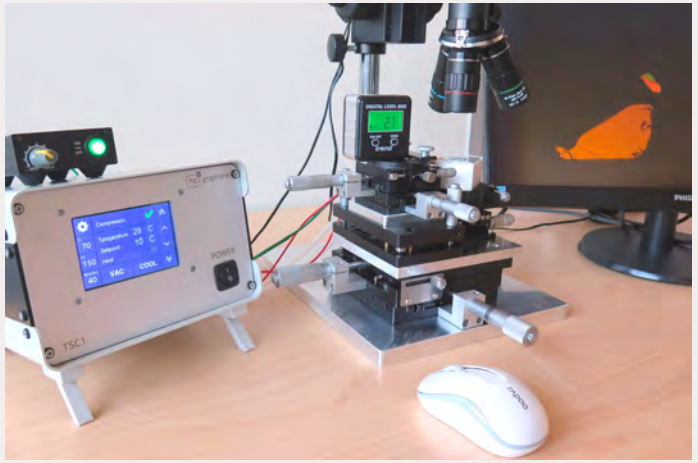


Chromium Sulfur Bromide (CrSBr)

Size: 80 x 10 µm
Layers: 10-20 nm

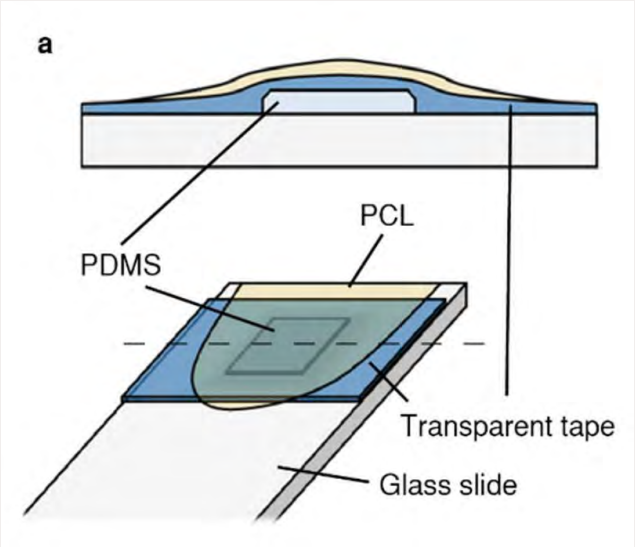
Methods

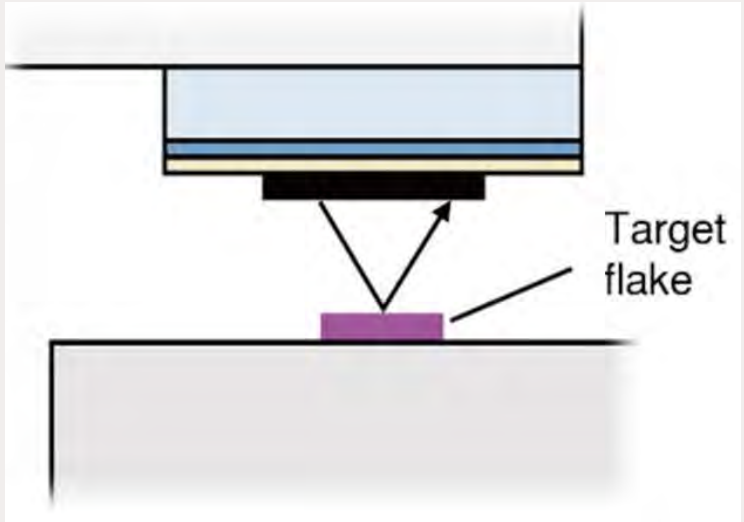
2D Crystal Stacking



Filgen biosciences and nanosciences

2D Heterostructure Transfer System **(Stacker)**

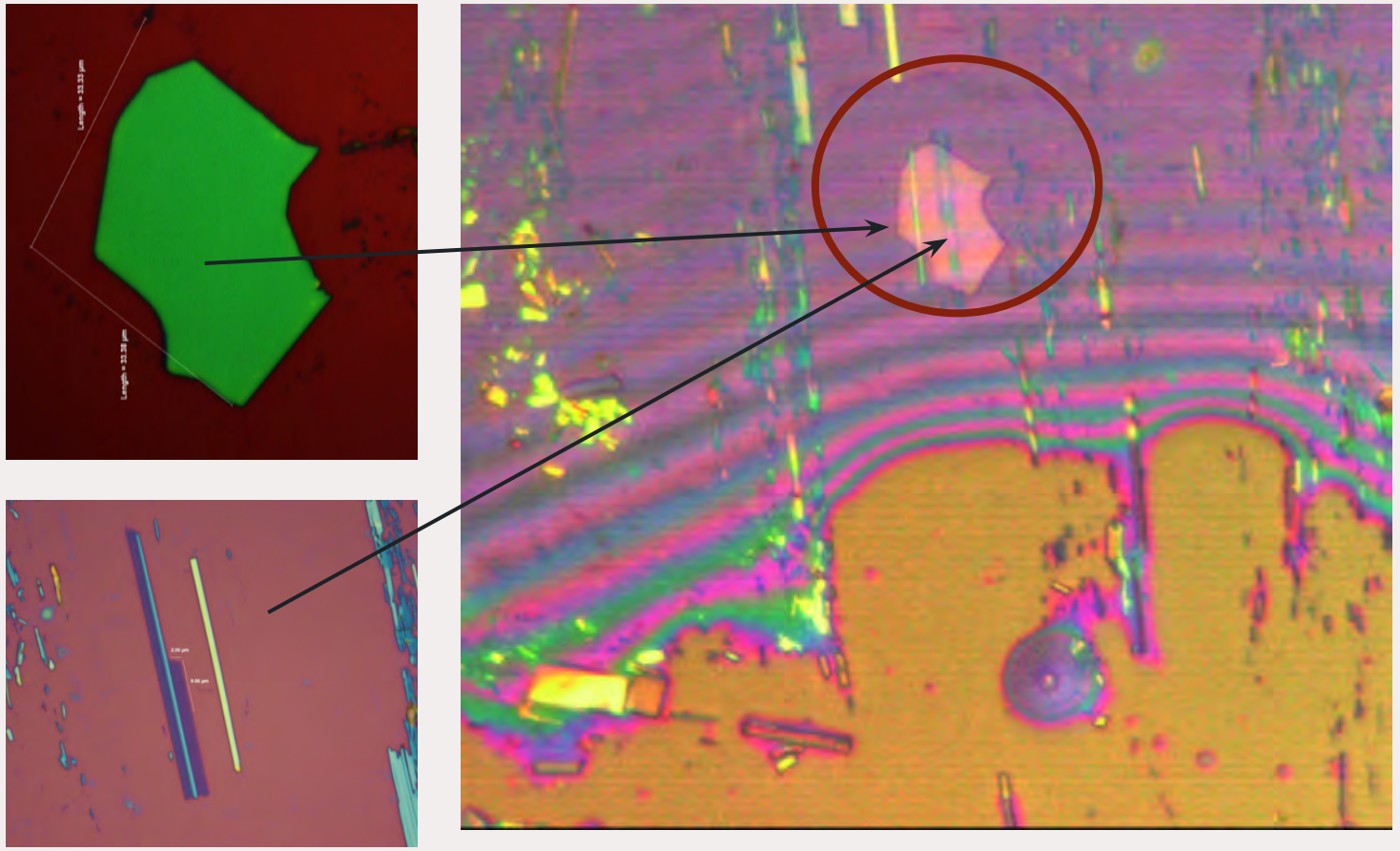




Strongly Adhesive Dry Transfer Technique for van Der Waals Heterostructure / Son et al

Methods

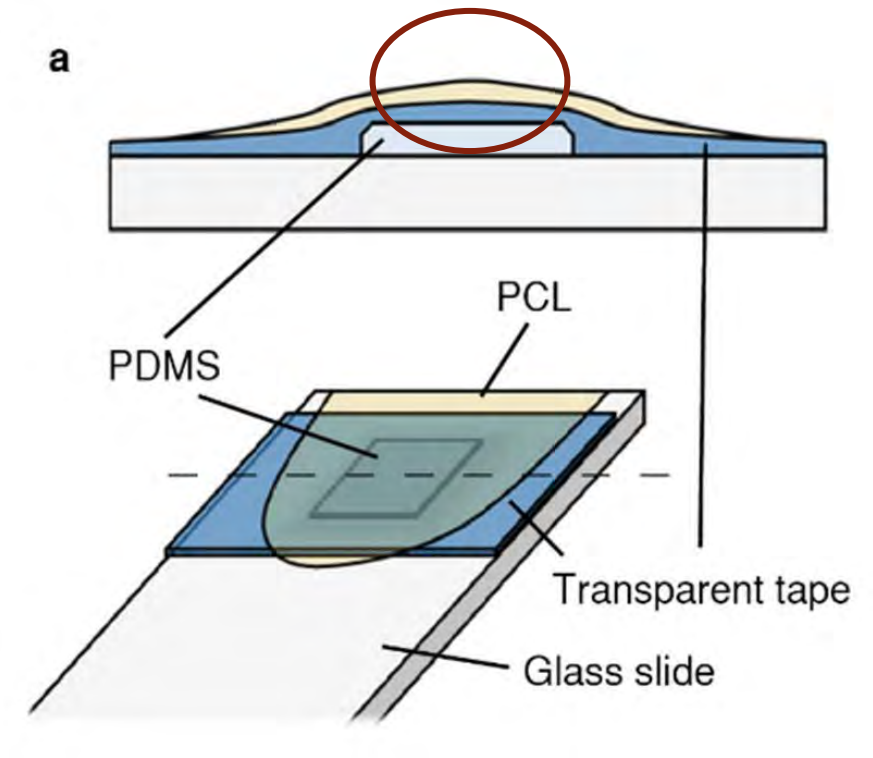
2D Crystal Stacking

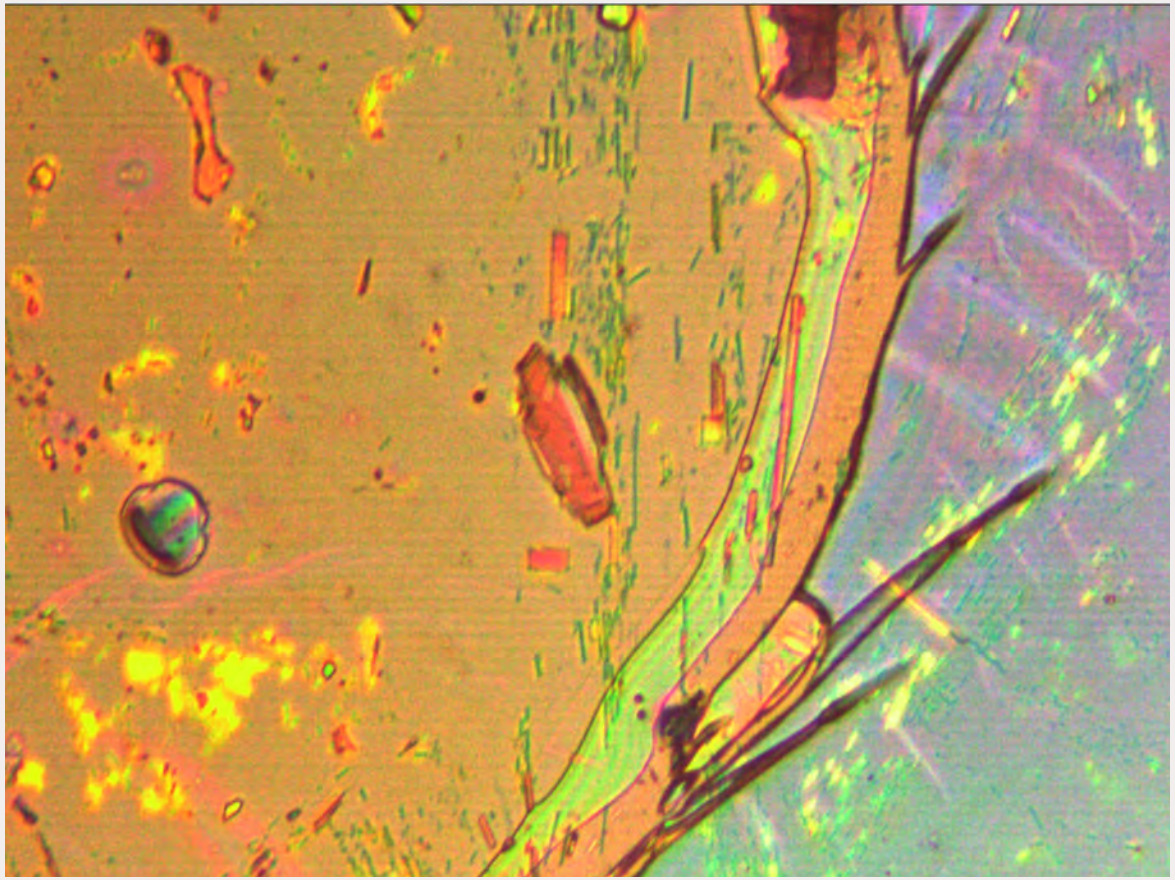


Results

In the process of stacking CrSBr on hBN.

Delamination

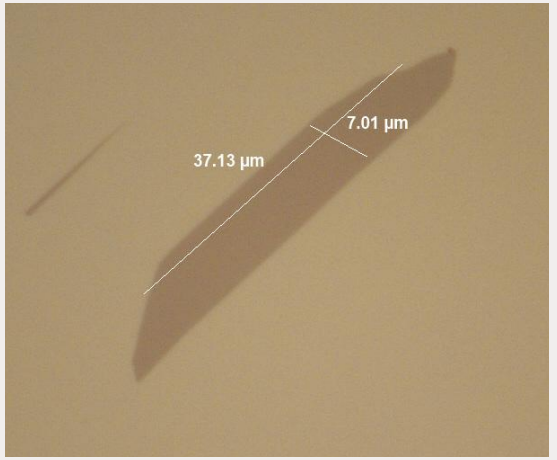




Summary

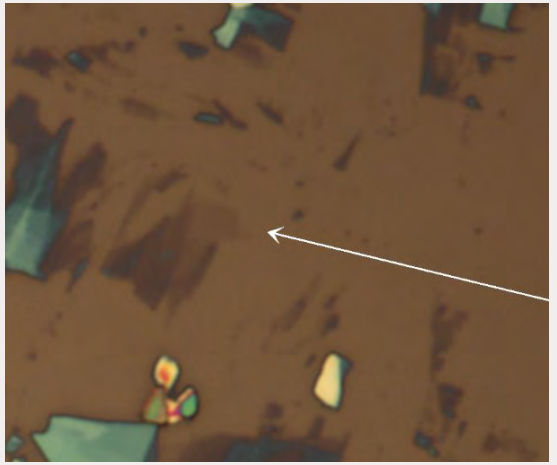
Graphite

- ☑ Cut 90 mm SiO2 wafer into 1 cm x 1 cm chips
- ☑ Exfoliate graphite crystal
- ☑ Learned to identify monolayers and bilayers
- ☑ Analyzed the structure of graphene flakes



Iron Oxychloride (FeOCl)

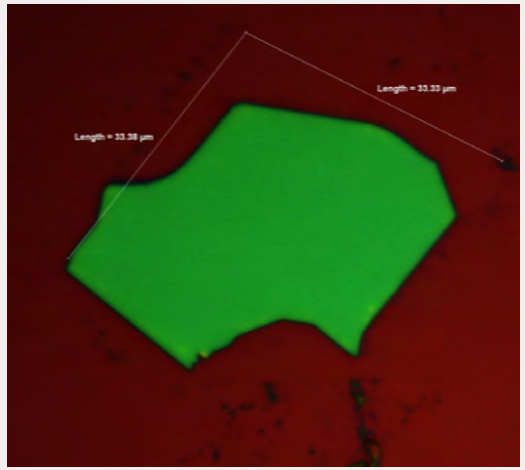
- ☑ Cut 90 mm SiO2 wafer into 1 cm x 1 cm chips
- ☑ Coat chips with Dodecanol
- ☑ Exfoliate CrSBr crystal
- ☑ Find and identify good quality flakes



Summary

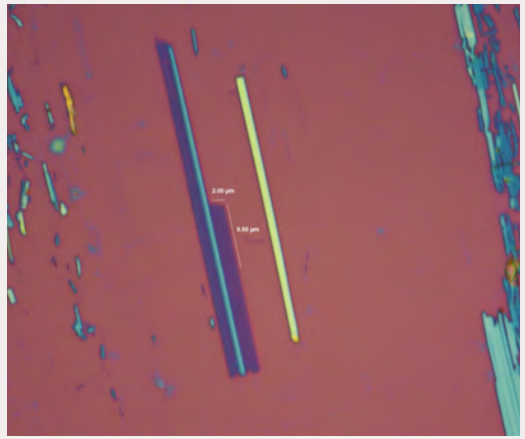
Hexagonal Boron Nitride (hBN)

- ☑ Cut 250 mm SiO2 wafer into 1 cm x 1 cm chips
- ☑ Exfoliate hBN crystal
- ☑ Find and identify good quality flakes
- ☑ Used stacker to pick up the flake we'd like to work with



Chromium Sulfur Bromide (CrSBr)

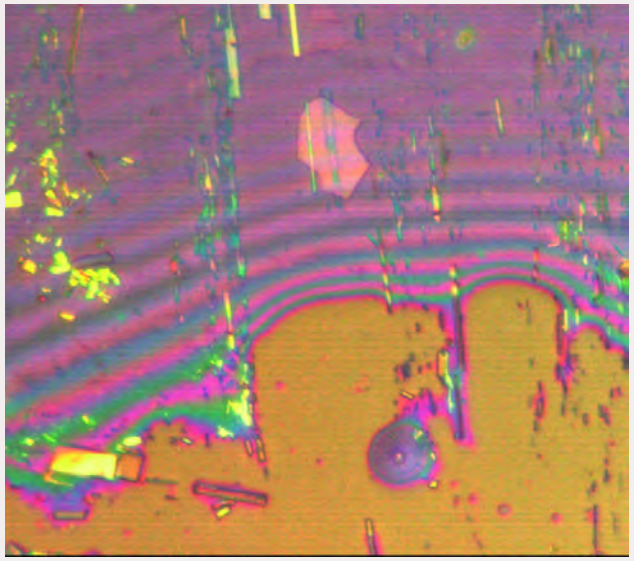
- ☑ Cut 90 mm SiO2 wafer into 1 cm x 1 cm chips
- ☑ Coat chips with PMMA
- ☑ Exfoliate CrSBr crystal
- ☑ Find and identify good quality flakes



Next Steps

Stacking

- Placing first CrSBr on hBN
- Placing second CrSBr on hBN at 90° relative to the first CrSBr



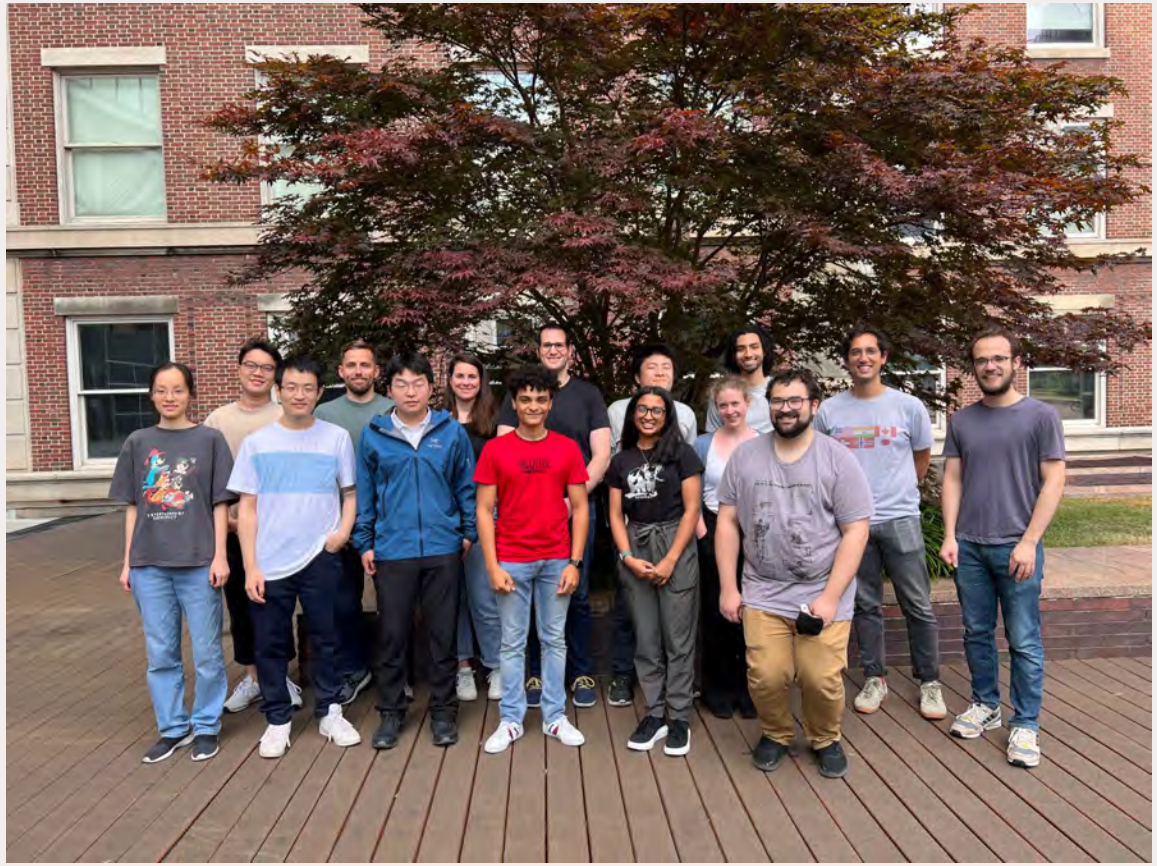
ENG Experience

Acknowledgements

Dean Lab, Columbia University

[redacted]

ENG Team



Engineering the Next Generation

COLUMBIA ENGINEERING FOR HUMANITY

Gravity Compensation of Robot Finger

[redacted]

Thursday, August 11th, 2022

[redacted]

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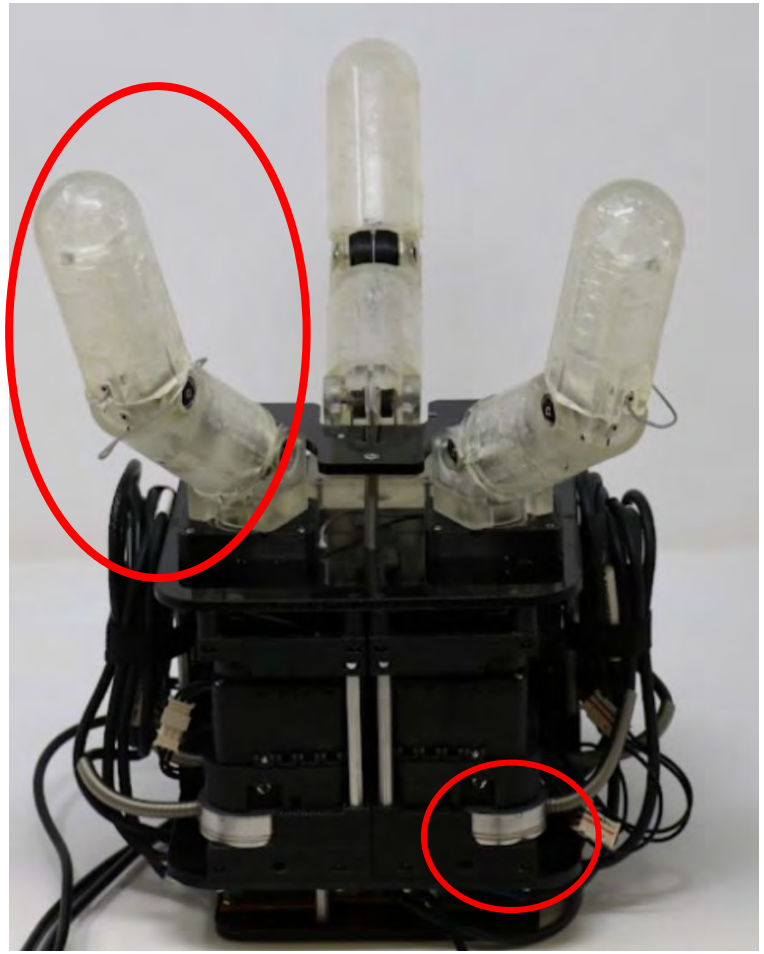
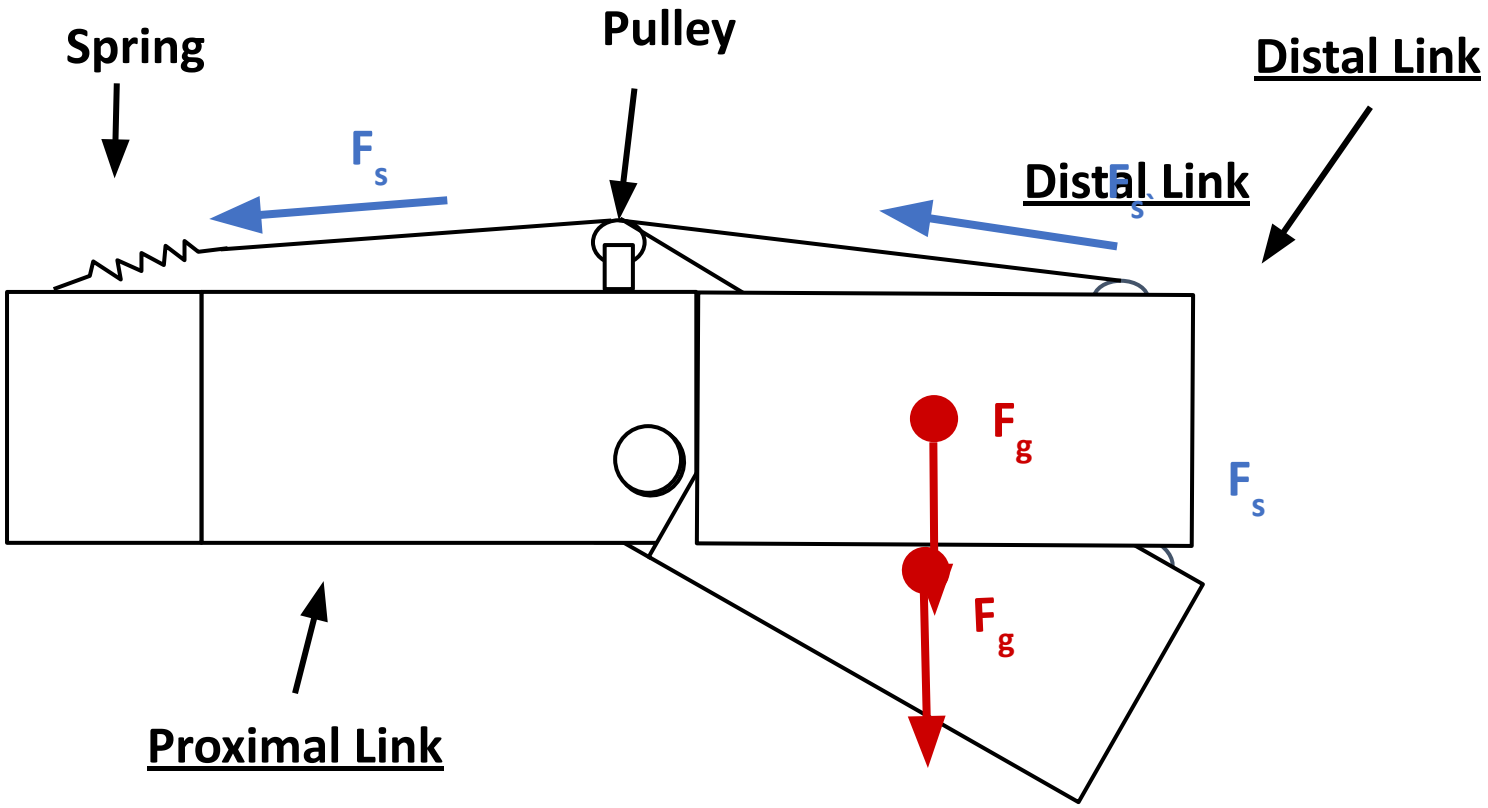
Actual ROAM Hand

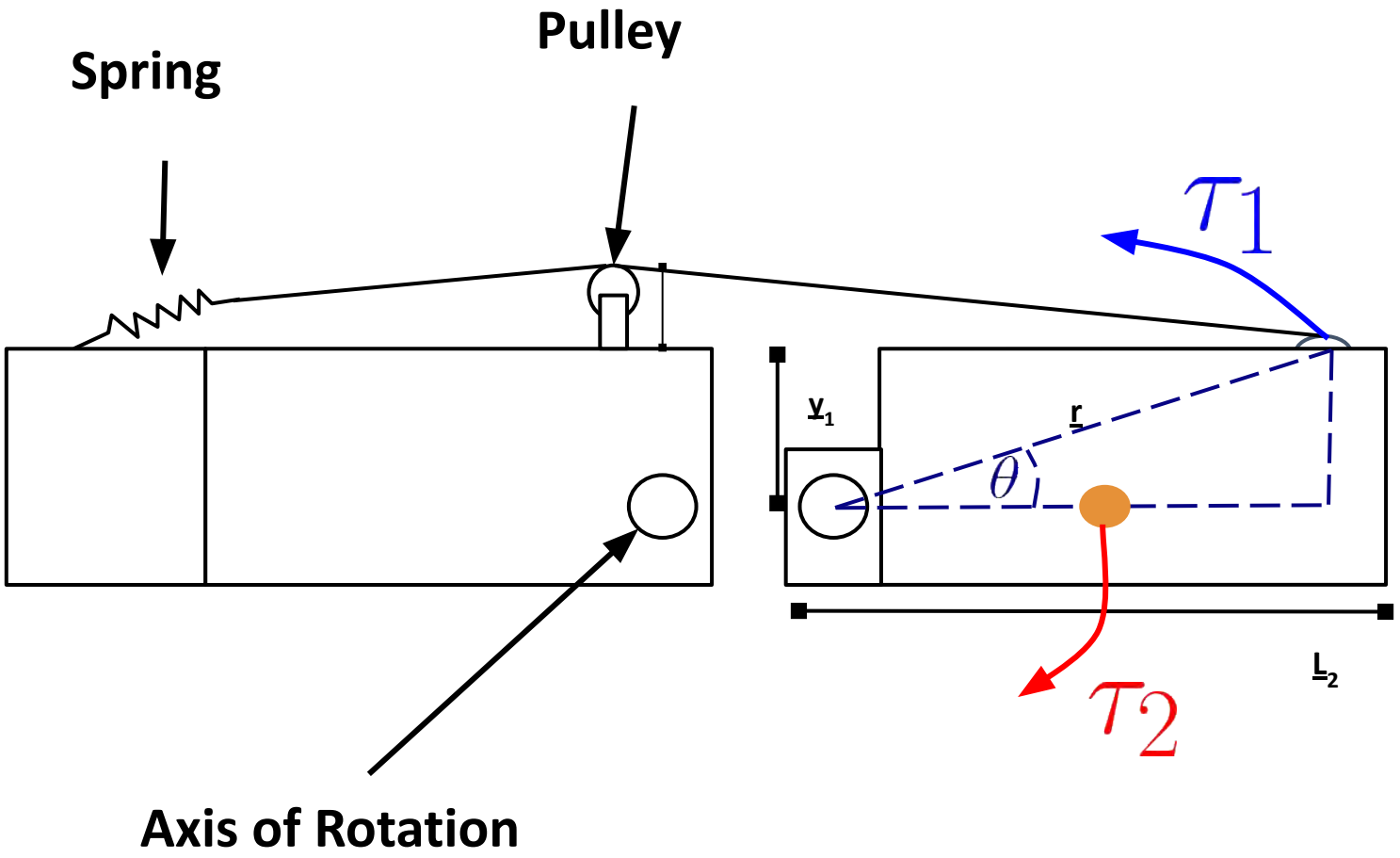


Islam, Design of Robot Hand for Variable Impedance Control to Achieve Dexterous and Robust Manipulation, 2022

- Impedance control: A method of dynamic control that links force and position
- Dexterous manipulation: Manipulators such as the ROAM Hand have highly sensorized fingers that can skillfully grasp objects

Free Body Diagram of Robot Finger





$$\Sigma\tau = \tau_1 - \tau_2$$

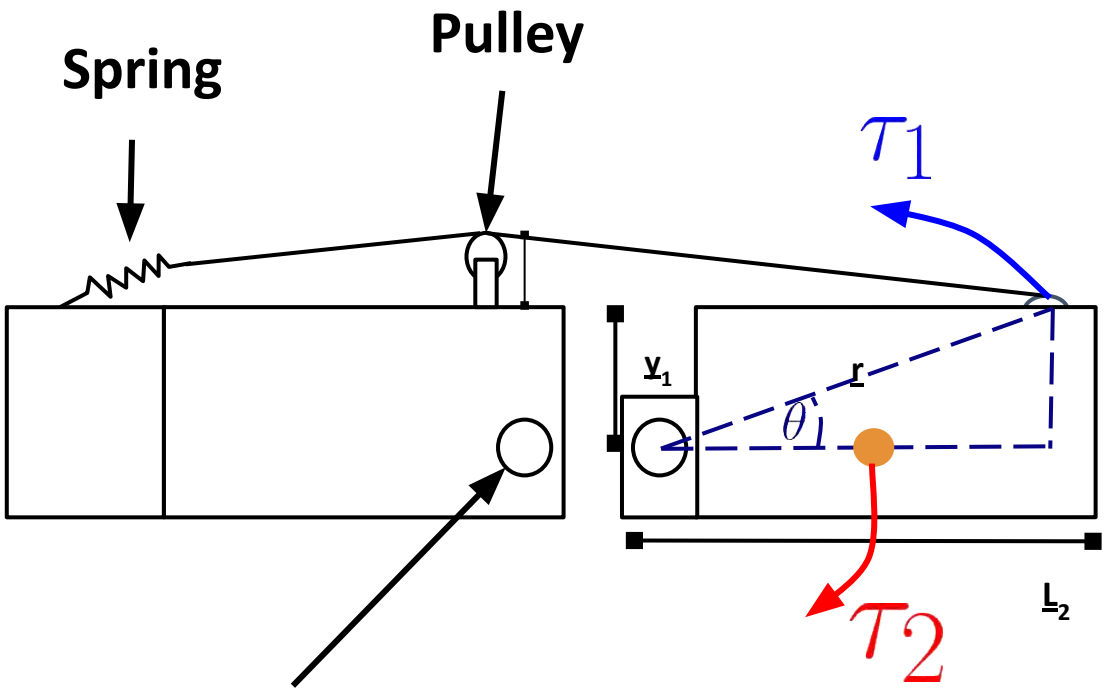
$$\Sigma\tau = I\alpha$$

$$\Sigma\tau = \tau_1 - \tau_2 = I(0)$$

$$\tau_1 - \tau_2 = 0$$

$$\tau_1 = \tau_2$$

= center of mass



● = center of mass

$$\tau_1 = \tau_2$$

$$\tau_1 = Fd \qquad \tau_2 = Fd$$

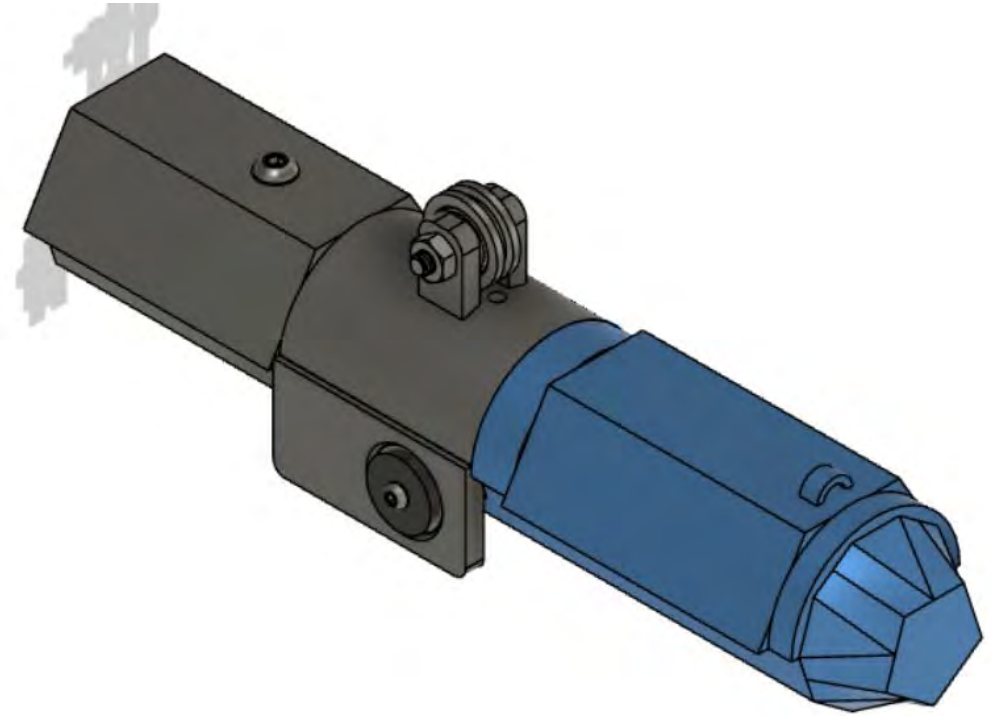
$$\tau_1 = (k\Delta x)(\frac{y_1}{sin\theta}) \qquad \tau_2 = (mg)(\frac{L_2}{2})$$

$$\boxed{(k\Delta x)(\frac{y_1}{sin\theta}) = (mg)(\frac{L_2}{2})}$$

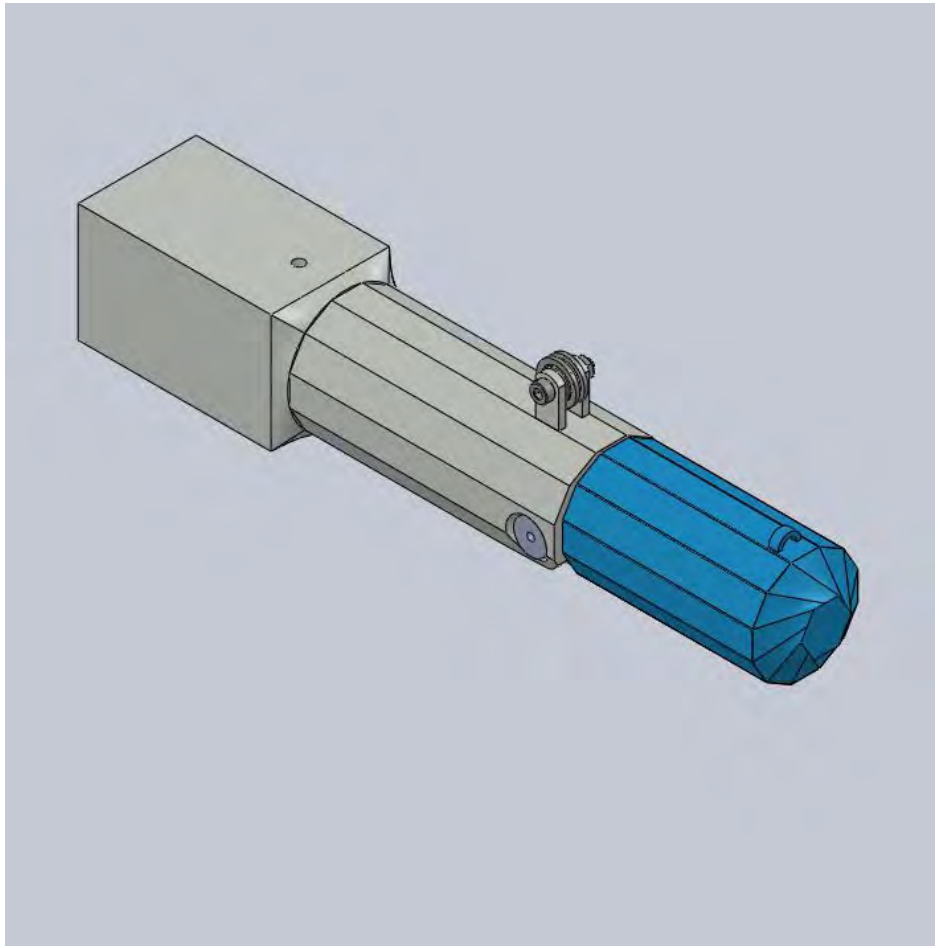
$$\boxed{\Delta x = \frac{(mg)(\frac{L_2}{2})}{(k)(\frac{y_1}{sin\theta})}}$$

*All values were assumed as known except for Δx

Ashley's 3D Model

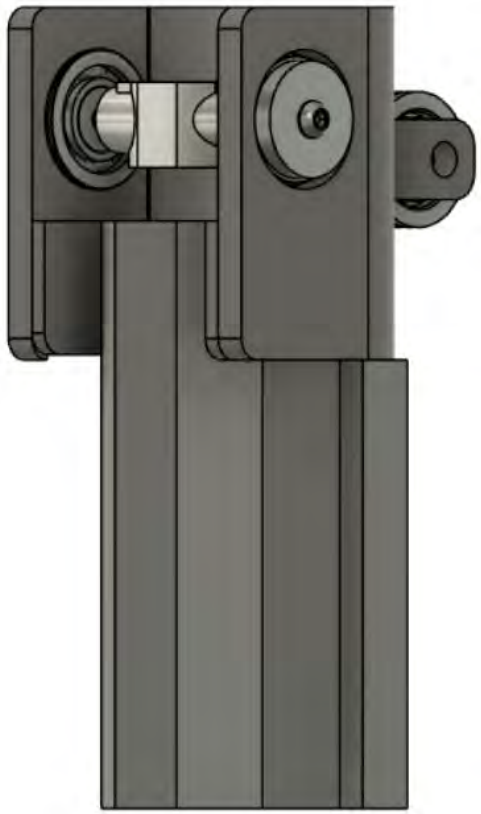


Brayan's 3D Model



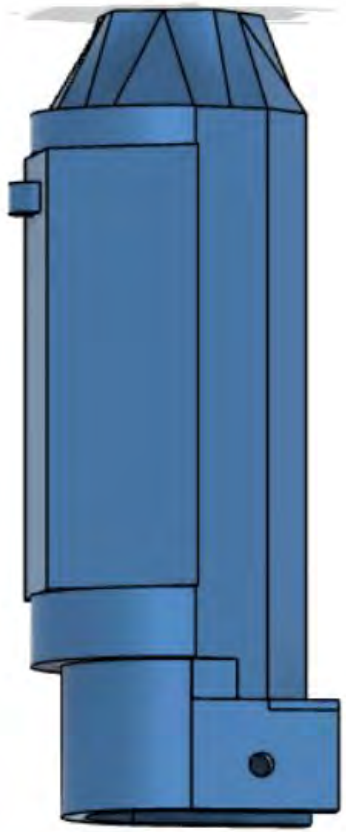
Proximal Link

Pulley

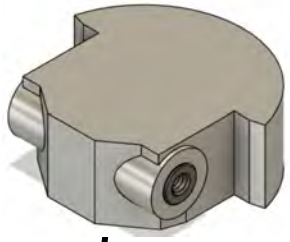


Thrust bearings

Distal Link

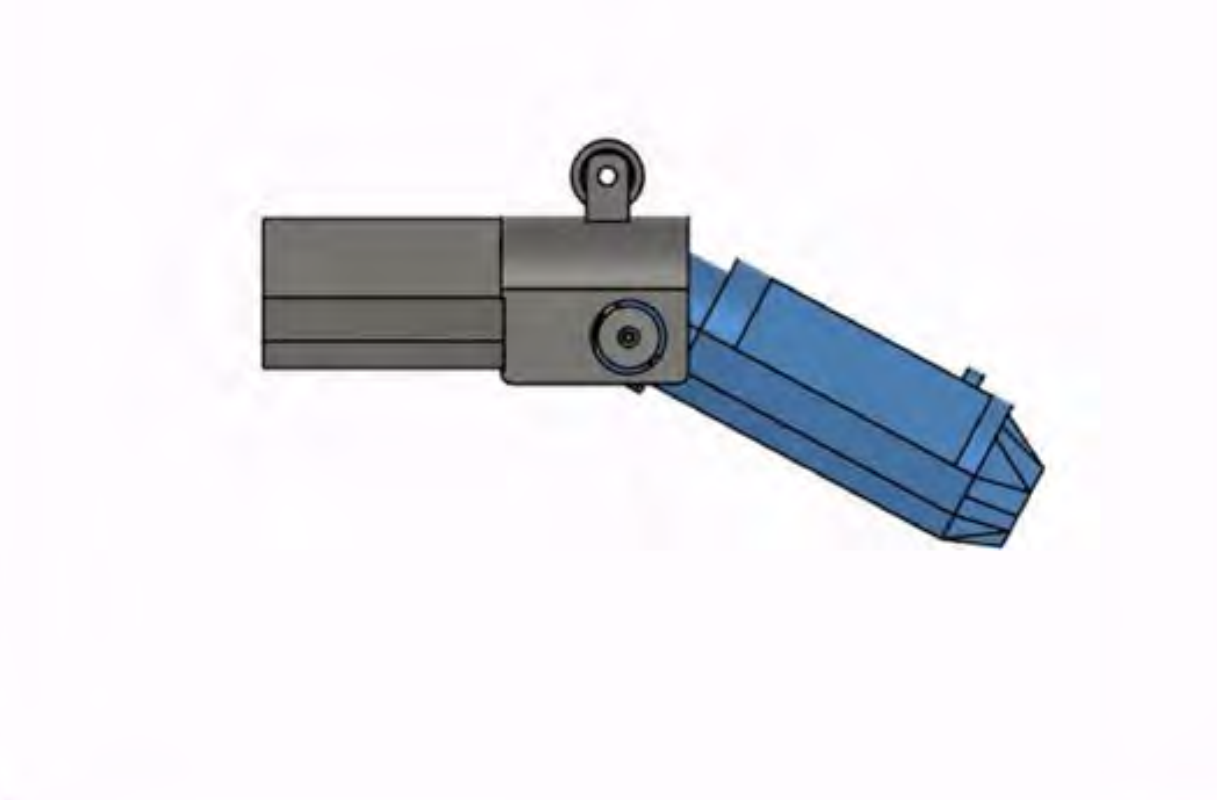


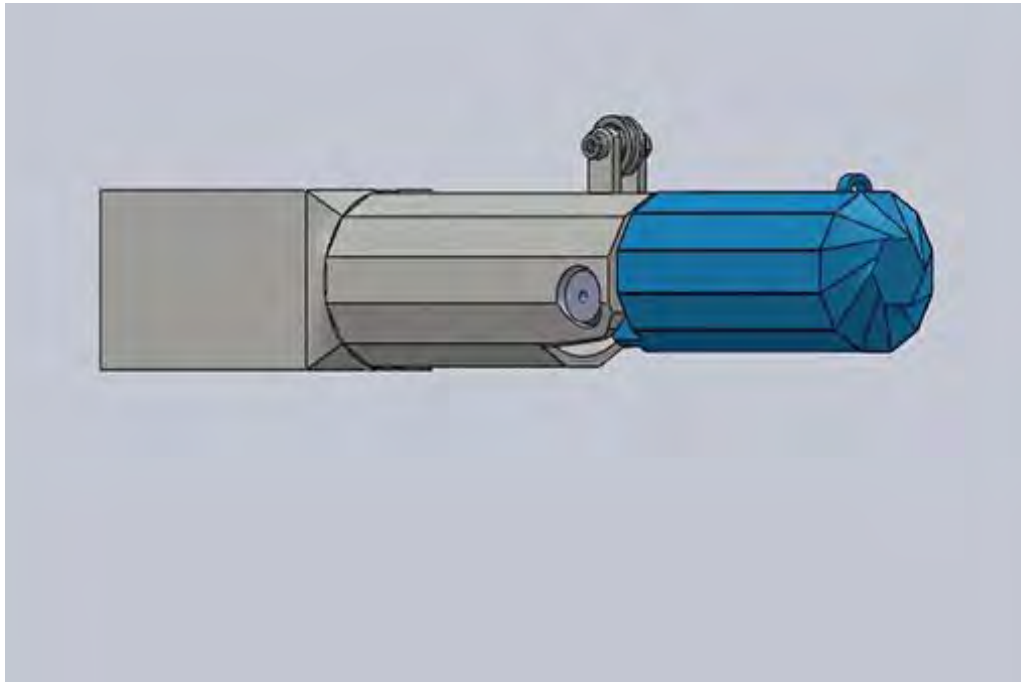
Nut



Heat inserts for plastic

Soldering Iron



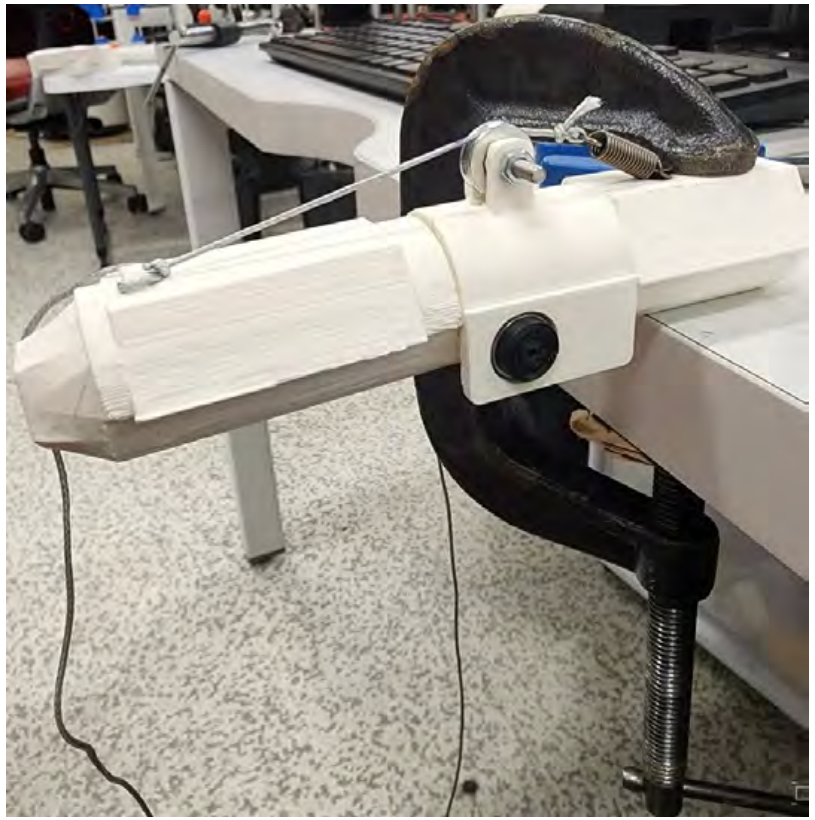


Experiment Procedure

marked section of string

Caliper

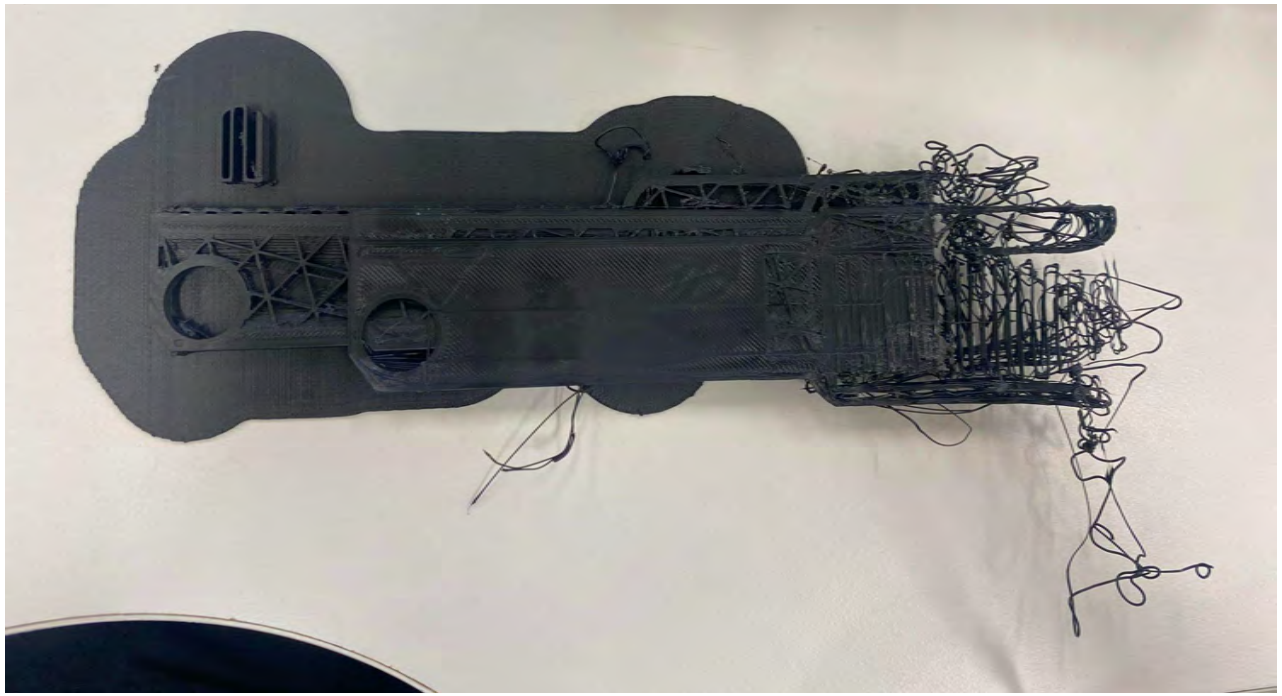
Results

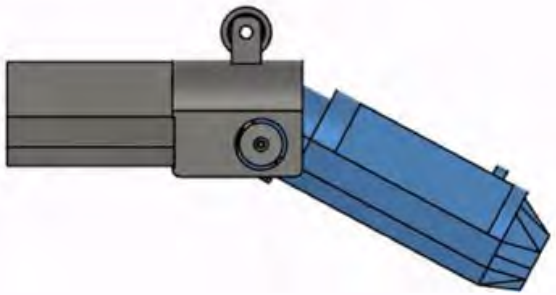


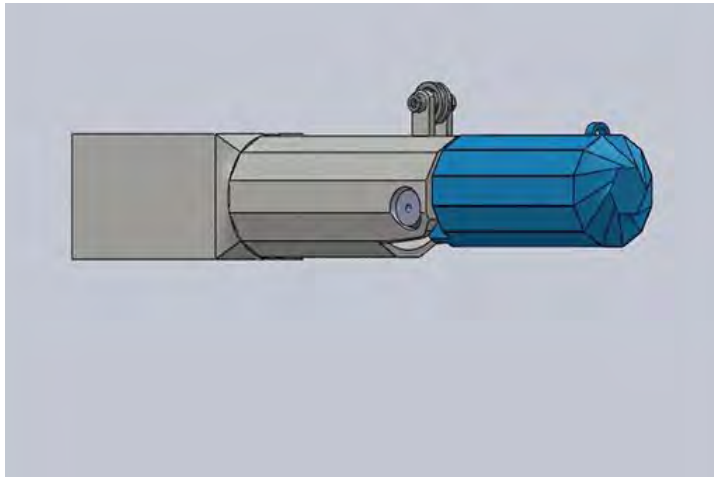
$$\Delta x = \frac{(mg)(\frac{L_2}{2})}{(k)(\frac{y_1}{sin\theta})}$$

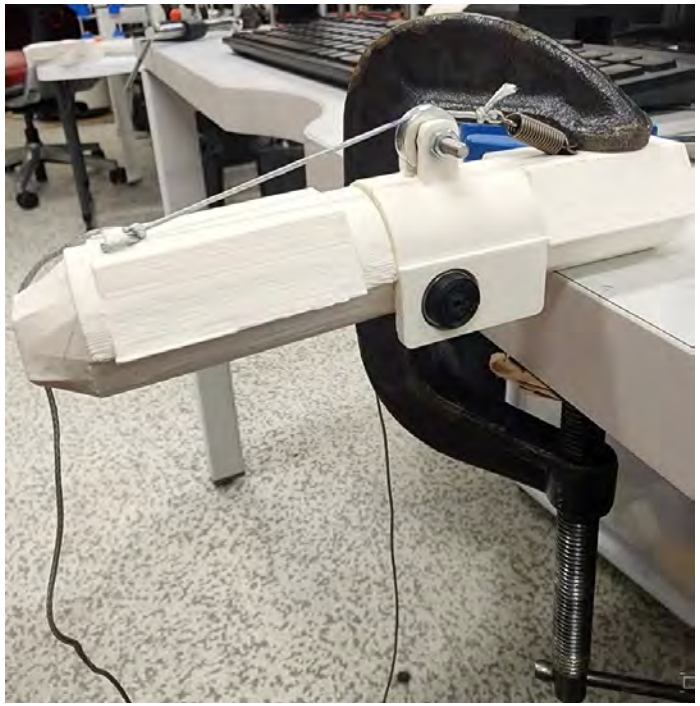
Extension of the spring(Δx)
= 1.77mm

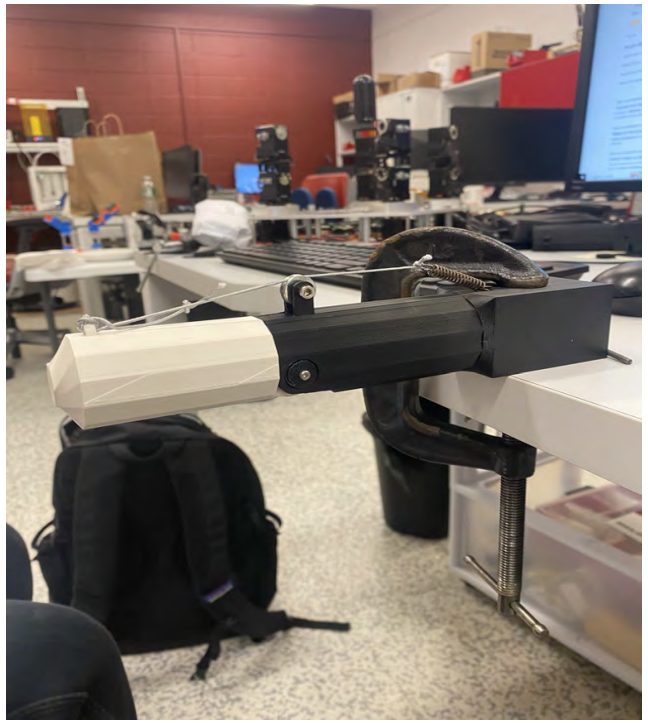
Extension of the spring (Δx)
= 0.37 mm











ENG Experience

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Acknowledgements

We want to thank our mentors

[redacted]

[redacted]

ENG Team

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Robotic Manipulation and Mobility Lab

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Engineering the Next Generation

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Thank You!

Any questions?

Engineering the Next Generation

COLUMBIA ENGINEERING FOR HUMANITY

The Effect of High Dimensionality and Noise on Machine Learning

[redacted]

Thursday, August 11th, 2022

Ab

[redacted]

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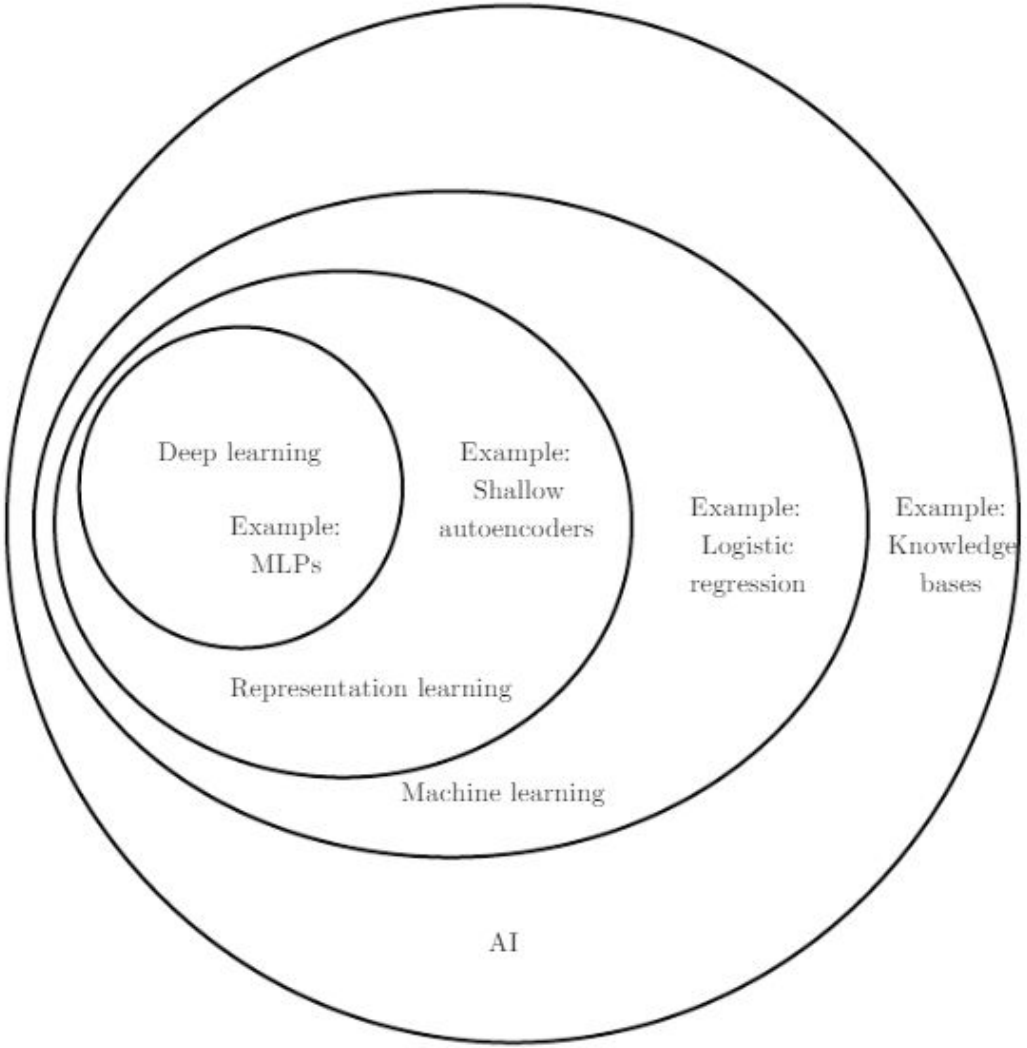
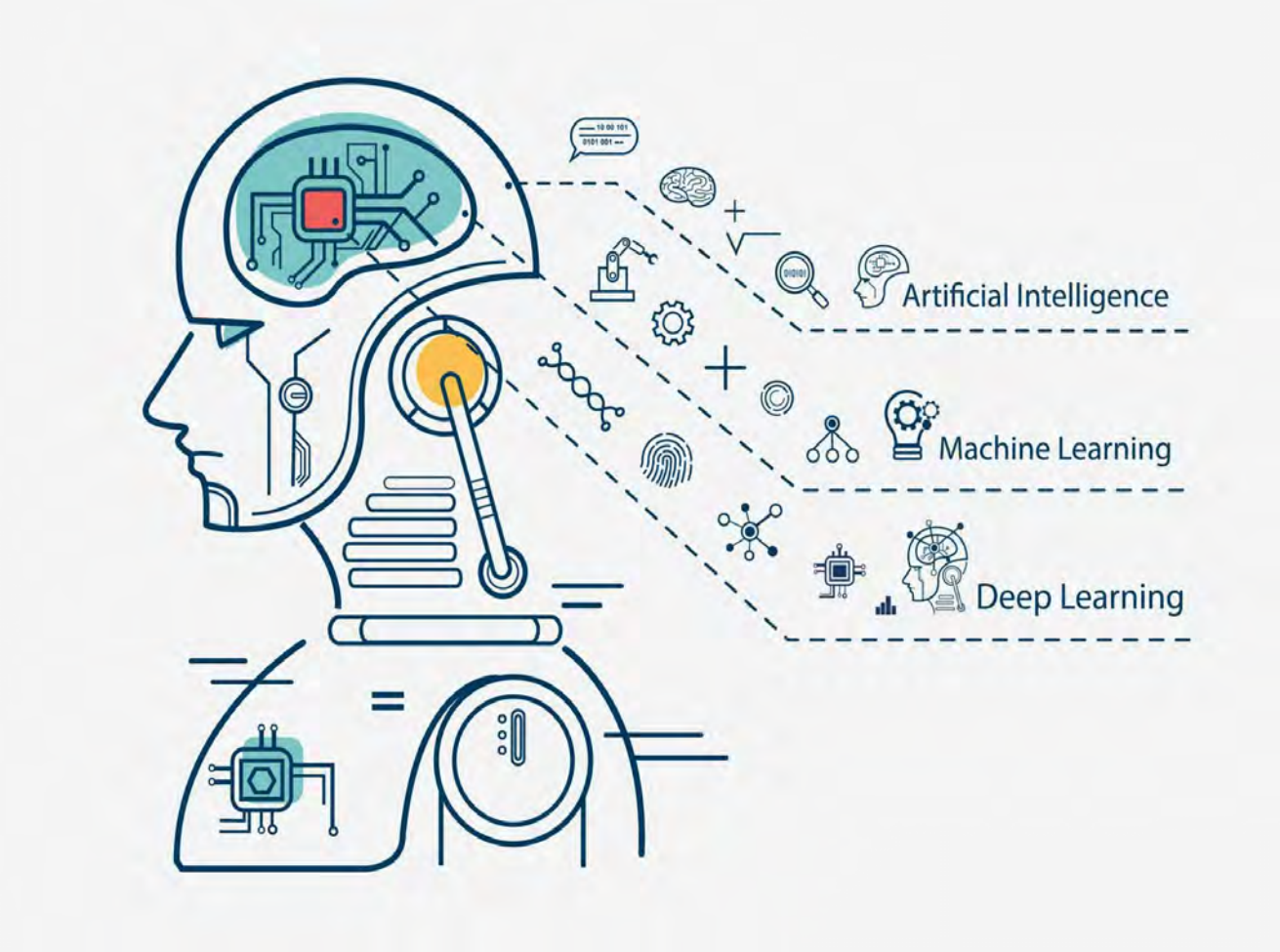
Introduction: What is Artificial Intelligence?

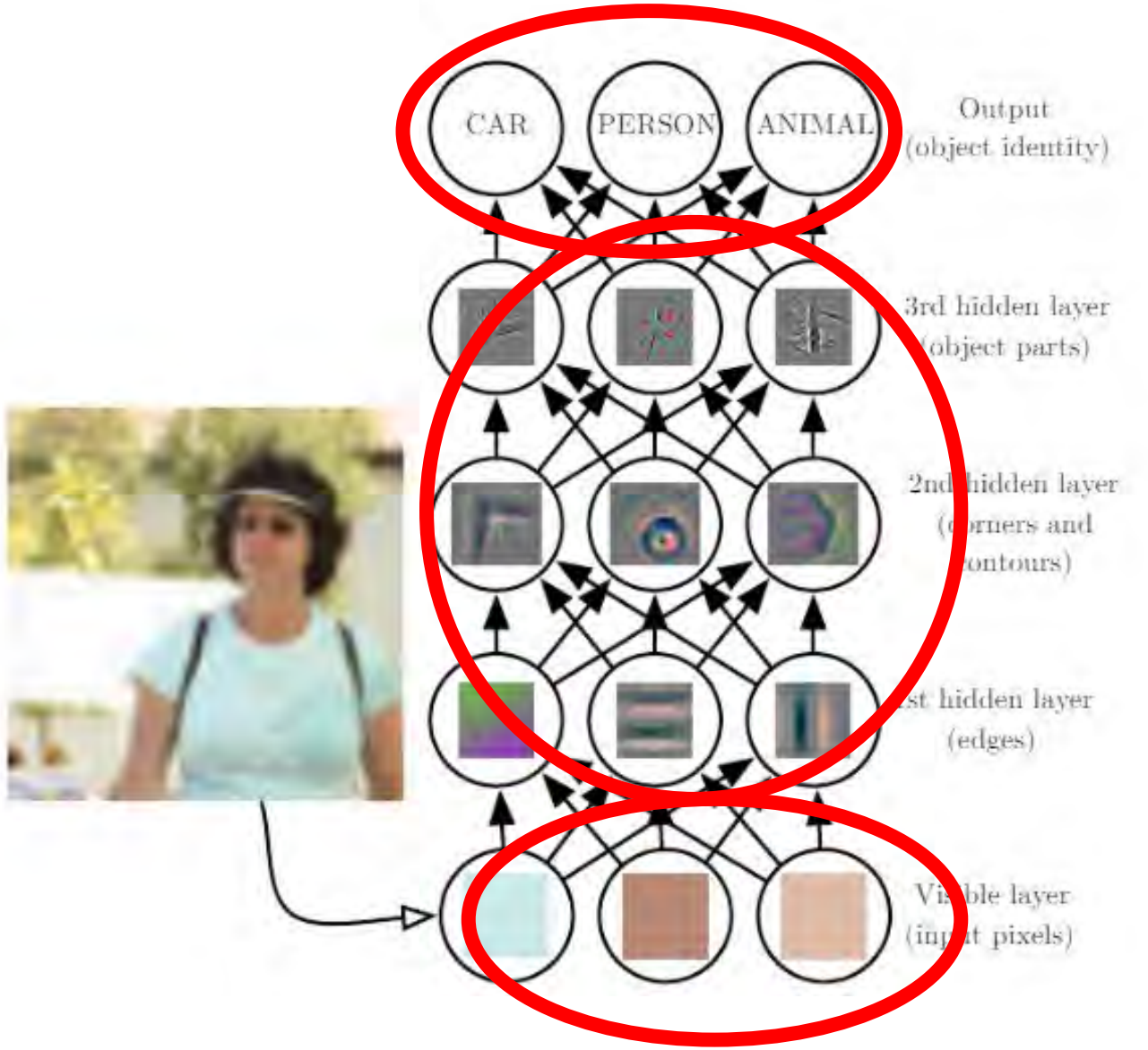
Artificial Intelligence: a field where intelligent software performs various tasks





Within Artificial Intelligence there is Machine Learning and Deep Learning

Introduction: What are Neural Networks?



Neural Networks can be used and designed to recognize patterns and solve common problems in the field of AI

- **We have three layers**
  - **Input**
  - **Hidden**
  - **Output**

Motivation

- We should care because improving these machines are the key to living in the future
  - Rather than wasting valuable personnel to do meticulous work, we can rely on machine learning

Problem

- **Using Neural Networks, we are trying to estimate Young's Modulus using many different elements.**

	atomic_mass	atomic_radius	electrical_resistivity	molar_volume	thermal_conductivity	bulk_modulus	youngs_modulus
Be	9.012182	1.05	3.800000e-08	4.85	190.0	130.0	287.0
Na	22.989769	1.80	4.900000e-08	23.78	140.0	6.3	10.0
Mg	24.305000	1.50	4.400000e-08	14.00	160.0	45.0	45.0
Al	26.981539	1.25	2.700000e-08	10.00	235.0	76.0	70.0
Ca	40.078000	1.80	3.400000e-08	26.20	200.0	17.0	20.0
Sc	44.955912	1.60	5.500000e-07	15.00	16.0	57.0	74.0

- **Young's Modulus: Material property indicating the stiffness of a material.**

features

observations

	Blood pressure	Heart rate	height	weight	...	...
Person 1						
Person 2						
Person 3						

High Dimensionality

What are its Risks?

High Dimensional datasets have major risks

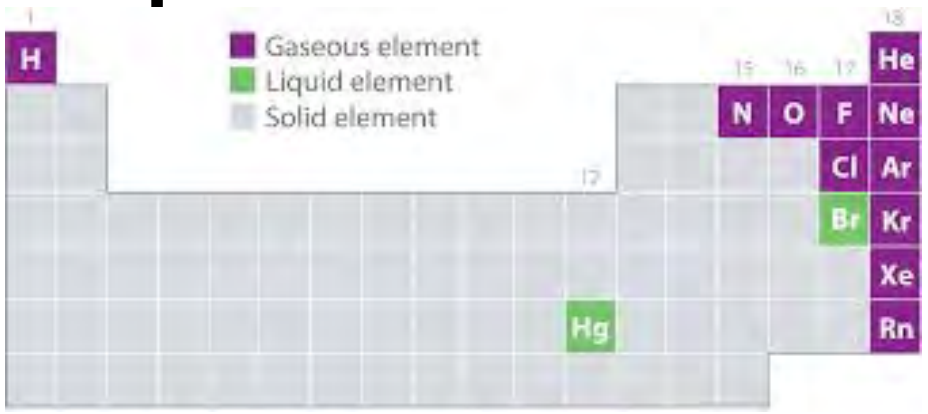
- there is never a deterministic answer
- We run the risk of overfitting the model, resulting in terrible sample performance
- The model becomes harder to cluster.
  - The computer cannot properly group various data points

Methods 1 (Anthen)

Step 1

mendeleev Mv

Step 2



Step 3

Dataframe: Full Values

	atomic_volume	boiling_point	en_pauling	evaporation_heat	heat_of_formation	lattice_constant	melting_point	specific_heat	atomic_radius	atomic_weight	density
Li	13.10	1118.15	0.98	148.0	159.3	3.49	553.69	3.582	145.0	6.940000	0.534
Be	5.00	3243.00	1.57	309.0	324.0	2.29	1551.00	1.825	105.0	9.012183	1.850
B	4.60	3931.00	2.04	504.5	565.0	8.73	2573.00	1.026	85.0	10.810000	2.340
Na	23.70	1156.10	0.93	97.9	107.5	4.23	370.96	1.228	180.0	22.989769	0.970
Mg	14.00	1363.00	1.31	131.8	147.1	3.21	922.00	1.023	150.0	24.305000	1.740
...	...	...	...	...	...	...	...	...	...	...	...
Tm	18.10	2220.00	1.25	232.0	232.2	3.54	1818.00	0.160	175.0	168.934220	9.321
Lu	17.80	3668.00	1.00	414.0	427.6	3.51	1936.00	0.154	175.0	174.966800	9.840
Ac	22.54	3470.00	1.10	292.9	406.0	5.31	1320.00	0.120	195.0	227.000000	10.000
Th	19.80	5060.00	1.30	513.7	602.0	5.08	2028.00	0.118	180.0	232.037700	11.700
U	12.50	4018.00	1.70	417.0	533.0	2.85	1405.50	0.116	175.0	238.028910	19.100

67 rows × 11 columns

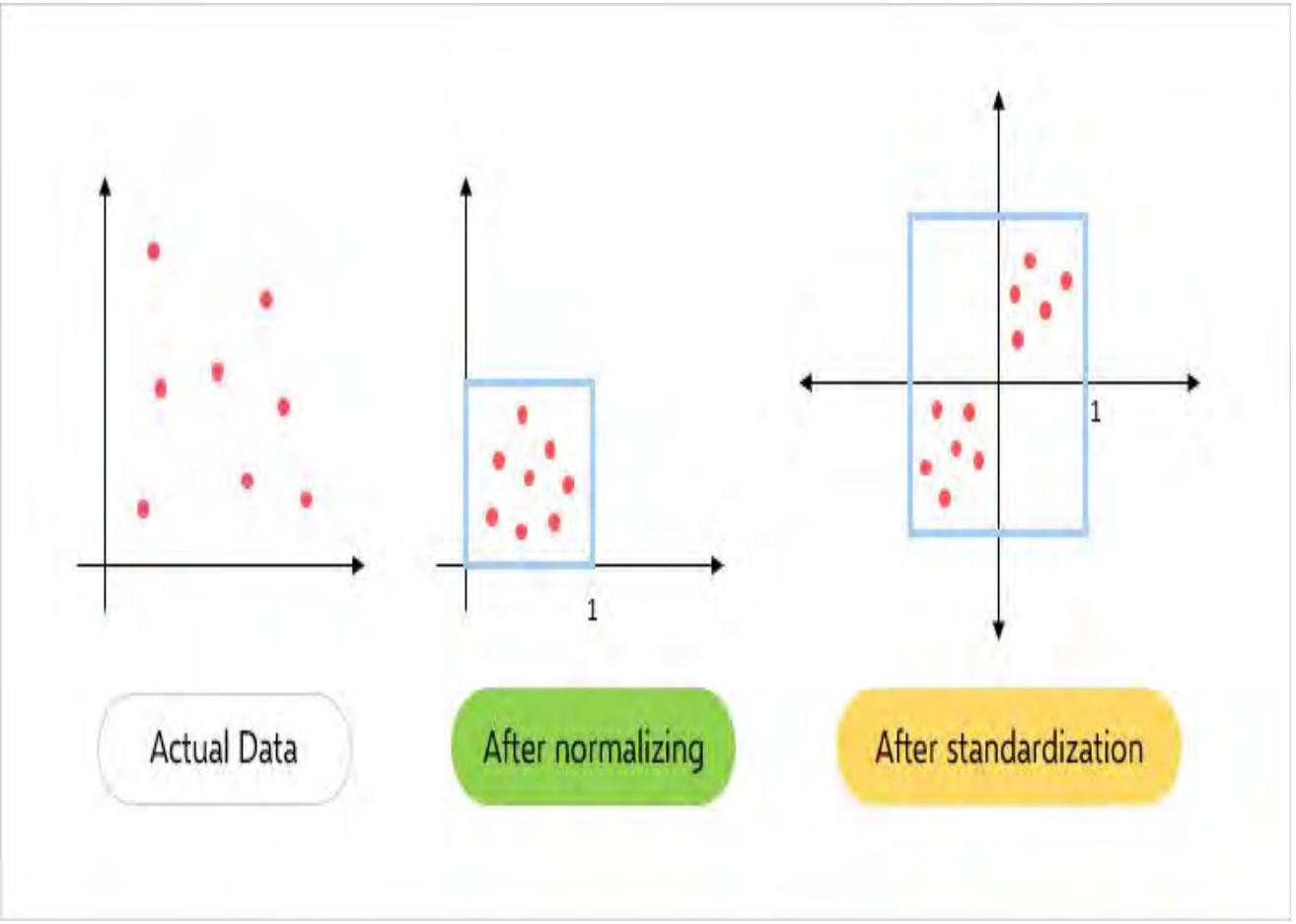
- We do this 2 more times due to the 3 split datasets

Step 4

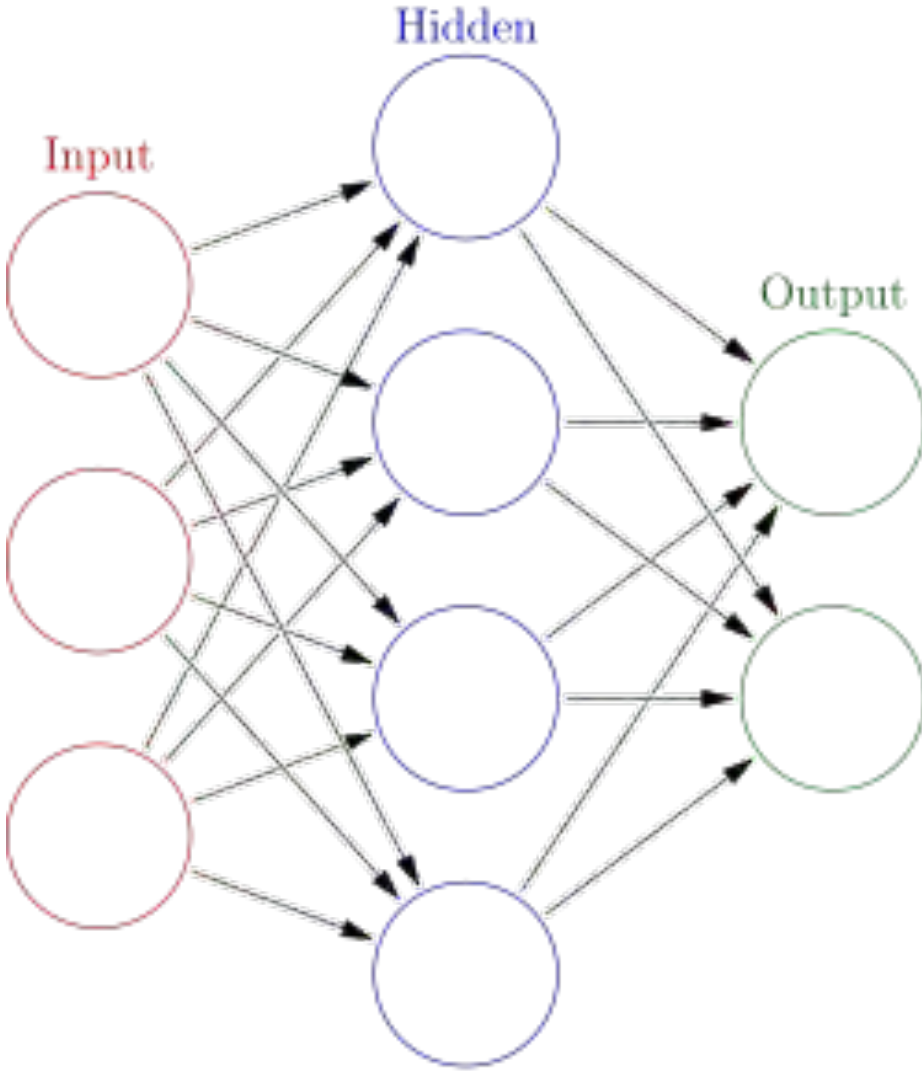
$$\overline{X}, \overline{Y}$$

Methods 1 (Anthen)

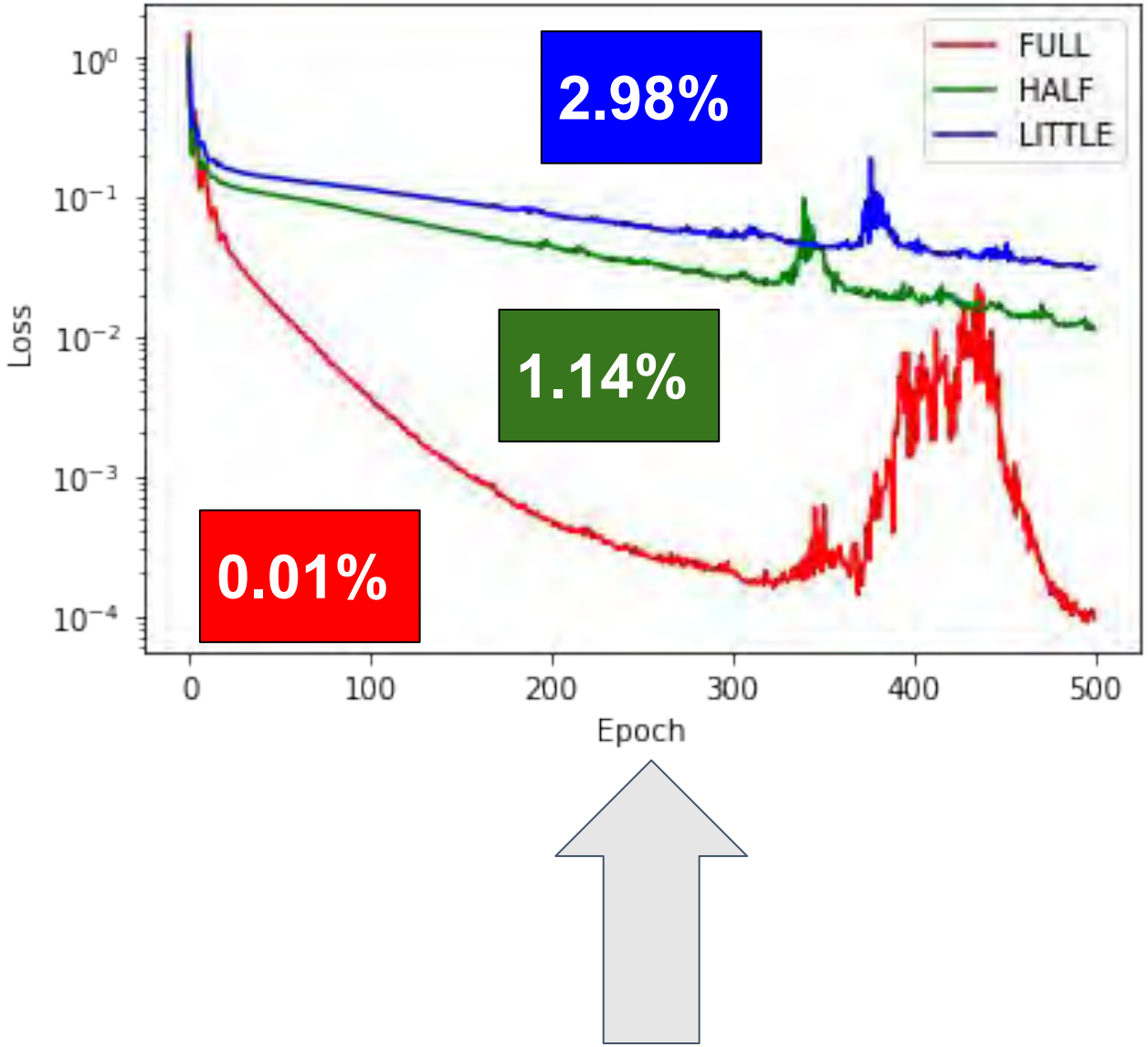
Step 5



Step 6

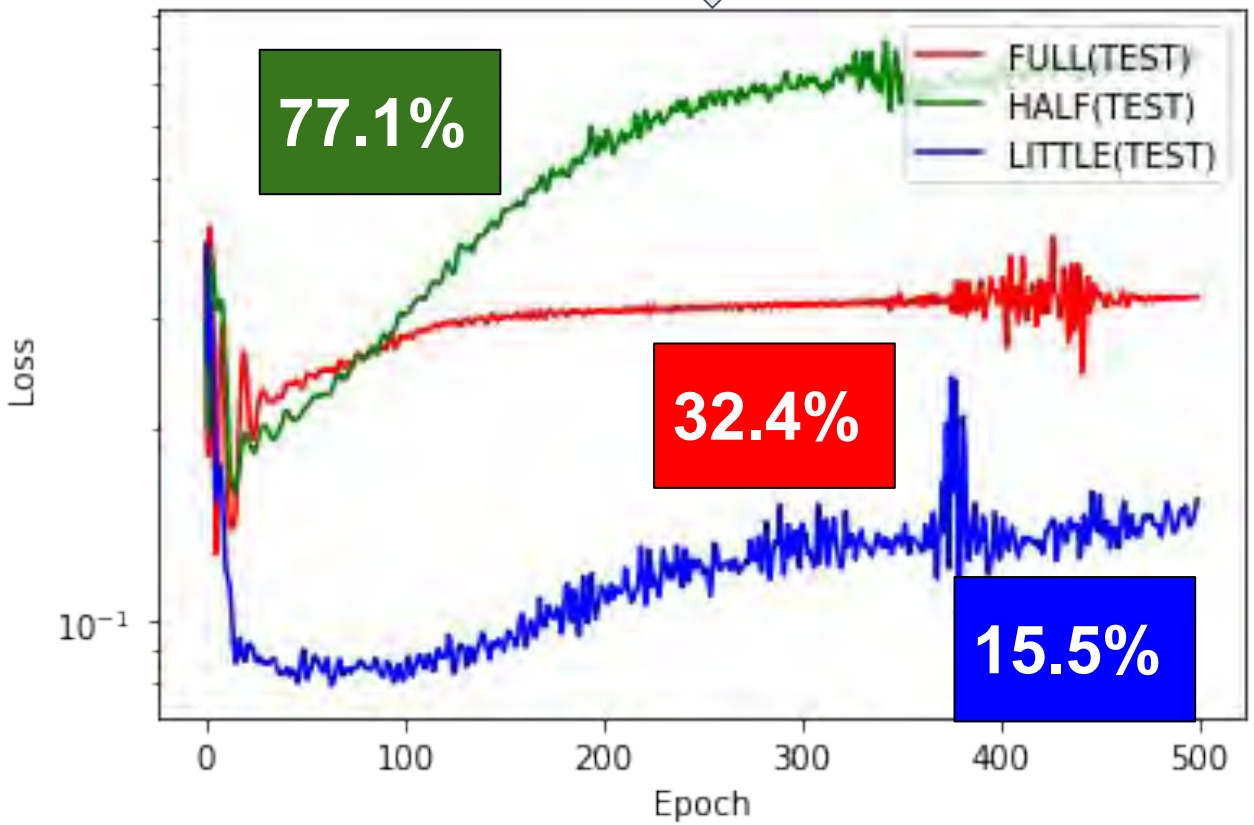


Results 1 (Anthen)



TRAINING DATA

TESTING DATA



Methods 2 (Sufyaan)

Noise

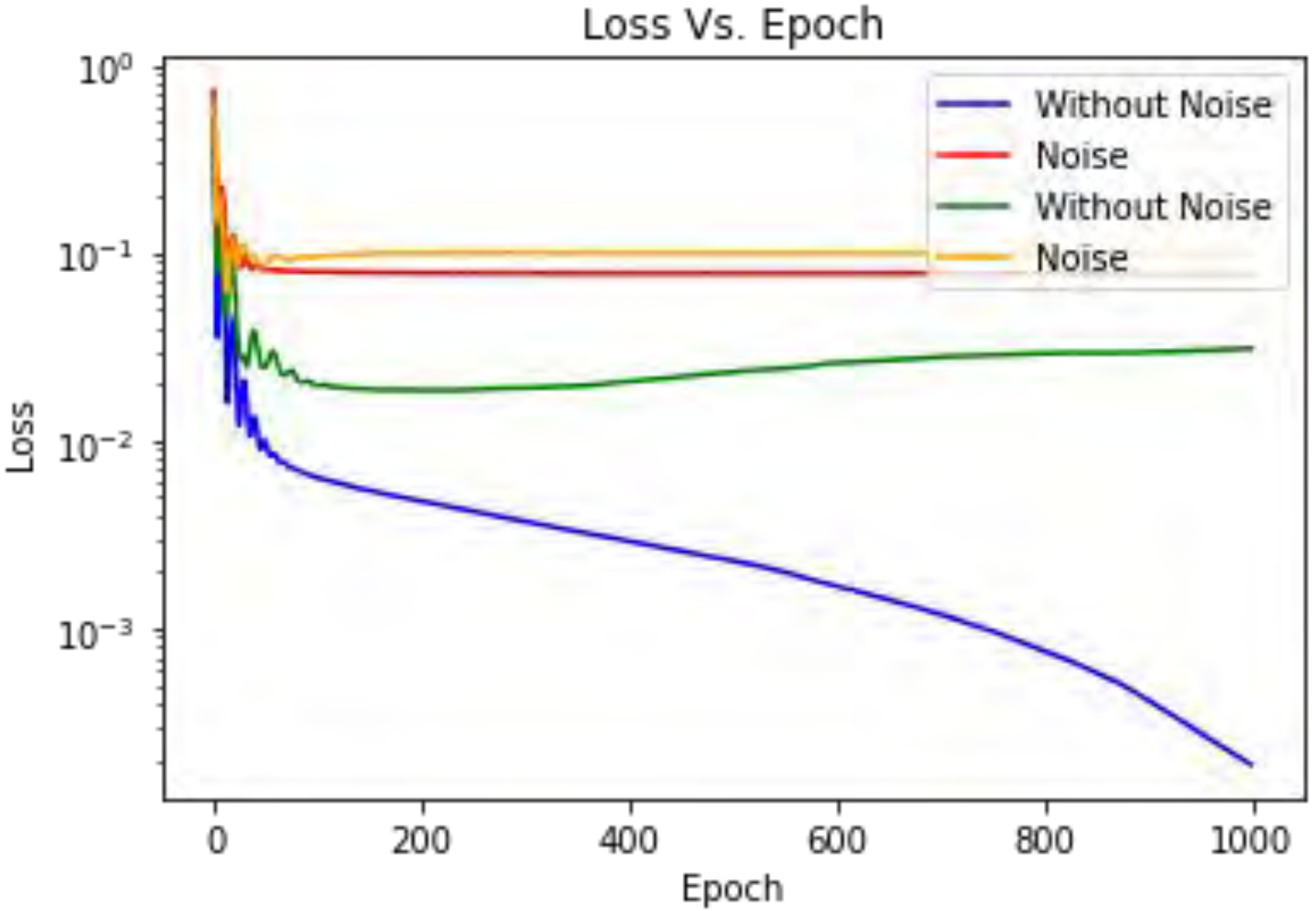
What Is It?

Noise is the act in which disruptions are added to data samples.

What are risks?

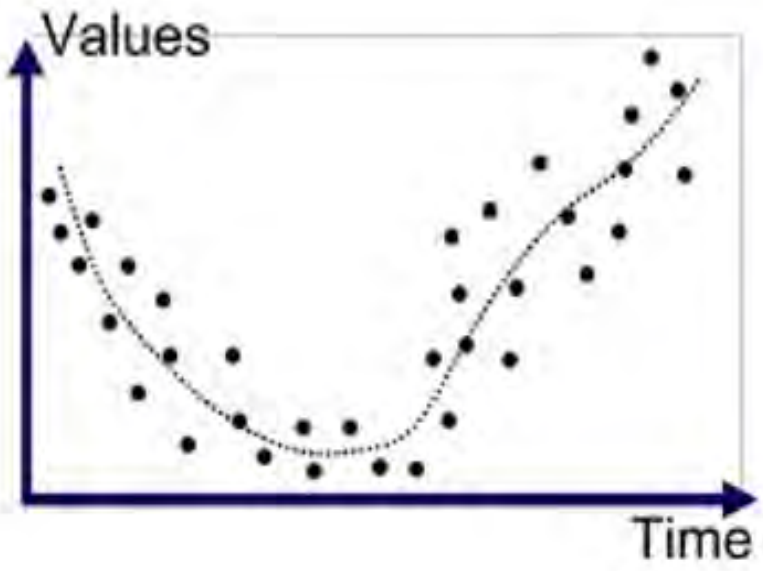
- Noise can either inhibit a Neural Network, or adjust it positively
- Noise can be used to reduce overfitting, but if not used properly can cause an increase

Results 2 (Sufyaan)

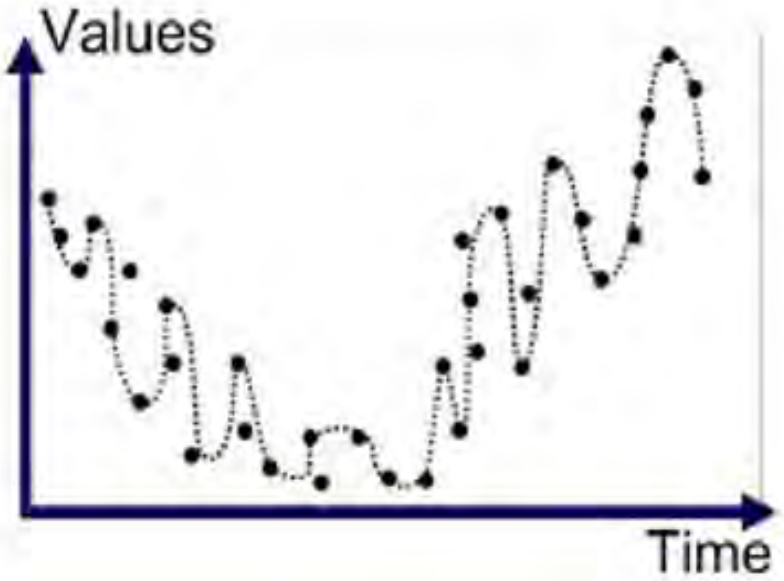


- **The yellow and red lines represent a decrease in overfitting because of how similar their points are.**

Summary



Good Fit/Robust



Overfitted

- As we remove more and more data, we see the effect of high dimensionality
  - A major problem being overfitted data

- To reduce the large loss caused by high dimensionality, we add noise to the neural network
  - We receive a lower loss and a machine that is more stable

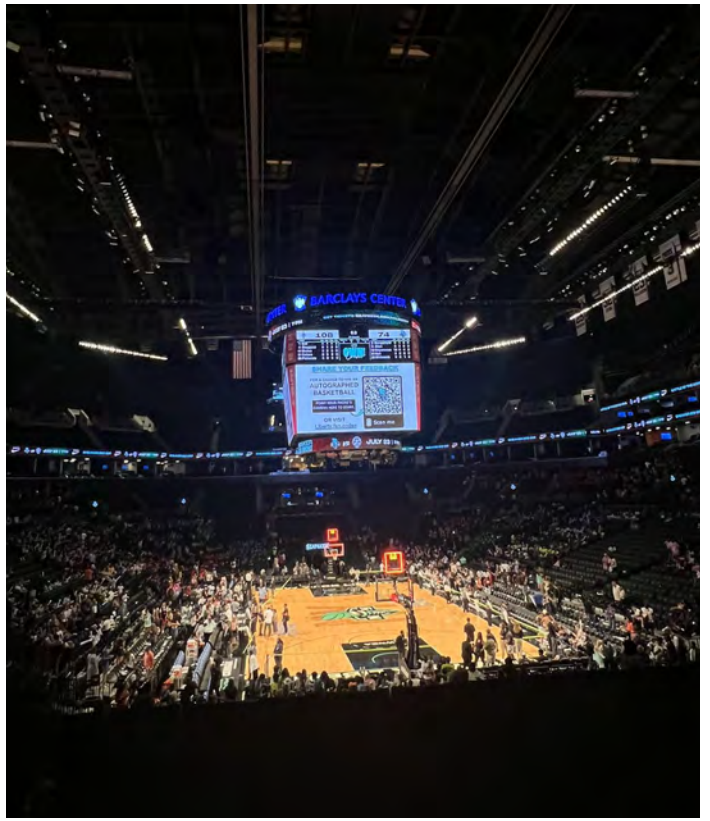
Limitations

- Small dataset leading to poor performance

Importance

- Improve future performance of computers within machine learning

The E.N.G. Experience



Acknowledgements

Computational Mechanics, Columbia University

E.N.G. Team
Columbia Engineering
Summer Youth Employment

Thank you!

Engineering the Next Generation

COLUMBIA ENGINEERING FOR HUMANITY

The Study of Hydrogen Combustion & Pathways of NOx Formation

[redacted]

Thursday, August 11th, 2022

COLUMBIA | ENGINEERING
The Fu Foundation School of Engineering and Applied Science

About Us

[redacted]

- Bronx, New York.
- Bronx Center for Science and Mathematics
- Software Engineer
- Computer Science, Thriller Shows/Movies, and Walks.

[redacted]

- Washington Heights, NY
- Columbia Secondary School
- Engineer
- Movies, math, science, and computer science

Introduction

Main Objective:

To study the significance of HNNO pathways in NO production during hydrogen combustion.

- Many engines use hydrocarbon fuels which contributes to global warming
- Global warming is a big threat to human society and our future.
- Hydrogen fuel is a lucrative alternative because it doesn't produce greenhouse gas.

Motivation

- Understanding NOx formation helps us understand hydrogen combustion.
- Having an understanding of hydrogen combustion may allow for use of hydrogen based fuel.

- No longer relying on hydrocarbon fuel means losing a big participant in global warming.
- We can use energy from renewables to make hydrogen fuel.

Key Vocabulary

- Combustion reaction - Process used to generate energy

- NOx - Sum of NO and NO_2

ppm:

$$NO_x\ [ppm] = NO\ [ppm] + NO_2\ [ppm]$$

- Equivalence Ratio - Represents the ratio of fuel to air, to the mole fraction.

$$\Phi = \frac{(A/F)_{Stoich}}{(A/F)} = \frac{(F/A)}{(F/A)_{Stoich}}$$

Complications of Hydrocarbon Fuels

- A large portion of combustion technology based industries are relying on hydrocarbon fuels (C_MH_N) like natural gasses, gasoline, or diesel to provide heat that can be used to generate electricity.

- These fuels are a considerable source for the mass production of carbon dioxide (CO2), a greenhouse gas that traps heat at the ground level.

- All these aspects play a significant role in the growing issue of climate change.

Alternative Fuel Methods

- Rather than using environment degrading fuel methods such as hydrocarbon, there has been a growing interest in using hydrogen as when chemically combined with oxygen, it produces H2O (water) rather than CO2.

- Unfortunately, there are undesired outcomes as a result of using hydrogen in combustion engines such as the formation of nitrogen oxides (NO) which can negatively impact the environment and our lungs.

Hydrogen as the fuel source

$$H_2 + 0.5\ O_2 \rightarrow H_2O$$

Hydrocarbon fuel

$$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$$

Complications of Hydrogen fuels (NO_x)

- These are the different species of nitrogen oxides produced in hydrogen combustion:

  A variety of different nitrogen oxides are formed during combustion:

  NO - Nitric Oxide - (No_X Production Rate (Flue Gas): 100-1000 mg/m^3)

  NO_2- Nitrogen Dioxide - (No_X Production Rate (Flue Gas): 10-100 mg/m^3)

  N_2O - Nitrous Oxide - (No_X Production Rate (Flue Gas): 1-10 mg/m^3)

- Nitric oxide and nitrogen dioxide are harmful for the environment for a myriad of reasons.

- Nitrous oxide is a greenhouse gas which also contributes to global warming.

4 Main Mechanisms in Which NOx is Produced

- Thermal (Zeldovich) :
  - $O + N_2 = NO + N$
  - $N + O_2 = NO + O$
- Prompt (Fennimore):
  - $CH_2 + N_2 = HCN + NH$
  - $CH + N_2 = HCN + N$
  - $C + N_2 = CN + N$
- N2O :
  - $O + N_2 (+M) = N_2O (+M)$
  - $N_2O + H = NO + NH$
  - $N_2O + O = NO + NO$
- NNH:
  - $H + N_2 (+M) = NNH (+M)$
  - $NNH + O = NH + NO$

The 5th pathway (HNNO Mechanism)

- $N_2O + H (+M) = HNNO (+M)$

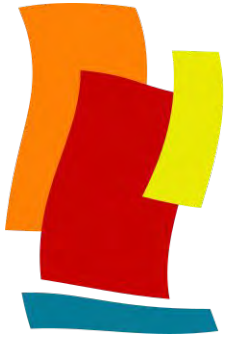
  $HNNO = NO + NH$
- This new pathway likely produces a significant amount of NOx.
  - It's also pressure dependent (the reaction occurs more rapidly as pressure increases).
  - The reactants are intermediate, meaning a molecular entity is formed from the initial reactants & intermediate reactants.
  - With further experimentation, we can estimate how much it produces to determine its significance.

Method(s)

Python IDE

- Used to retrieve our data and model them in a timely fashion
- Debugging code was easier as we were able to quickly retrieve values from the terminal.

Modeling Package(s)



Cantera

matplotlib

- Perform necessary chemical kinetic, thermodynamic, and transport calculations.
- Simulate the flame profiles and observe NO production.
- Created our own program to observe NO production with different conditions.

Method(s)

```
ideal_gas(name = "gas",
     elements = "O H N Ar He",
     species ="""  H2  O2  O3  H  O  OH  HO2  H2O  H2O2  NO  NH3  NH2  NH  N  NNH
                   N2H4  N2H3  N2H2  H2NN  NH2OH  H2NO  HNOH  HNO  HON  NO2  HONO  HNO2  NO3  HONO2
                   N2O  AR  HE  N2  t-ONNH  c-ONNH  ONHN  H2NNO2  t-HNN(O)OH
                   c-HNN(O)OH  """,
     reactions = "all",
     initial_state = state(temperature = 300.0, pressure= 101325.0)    )
```

Dataset Configuration

```
initial_temp = 300
T_f = 400
pressure_list = [1, 3, 10, 30]
width_list = [0.3, 0.1, 0.03, 0.01]
phi_list = [0.5, 1, 3.5]
X_list = ['H2:0.5, O2:0.5, N2:1.88', 'H2:1, O2:1, N2:4.25', 'H2:3, O2:0.5, N2:1.88']
fuel = 'H2'
unburned_flame_speed = []
```

Specie Data Properties

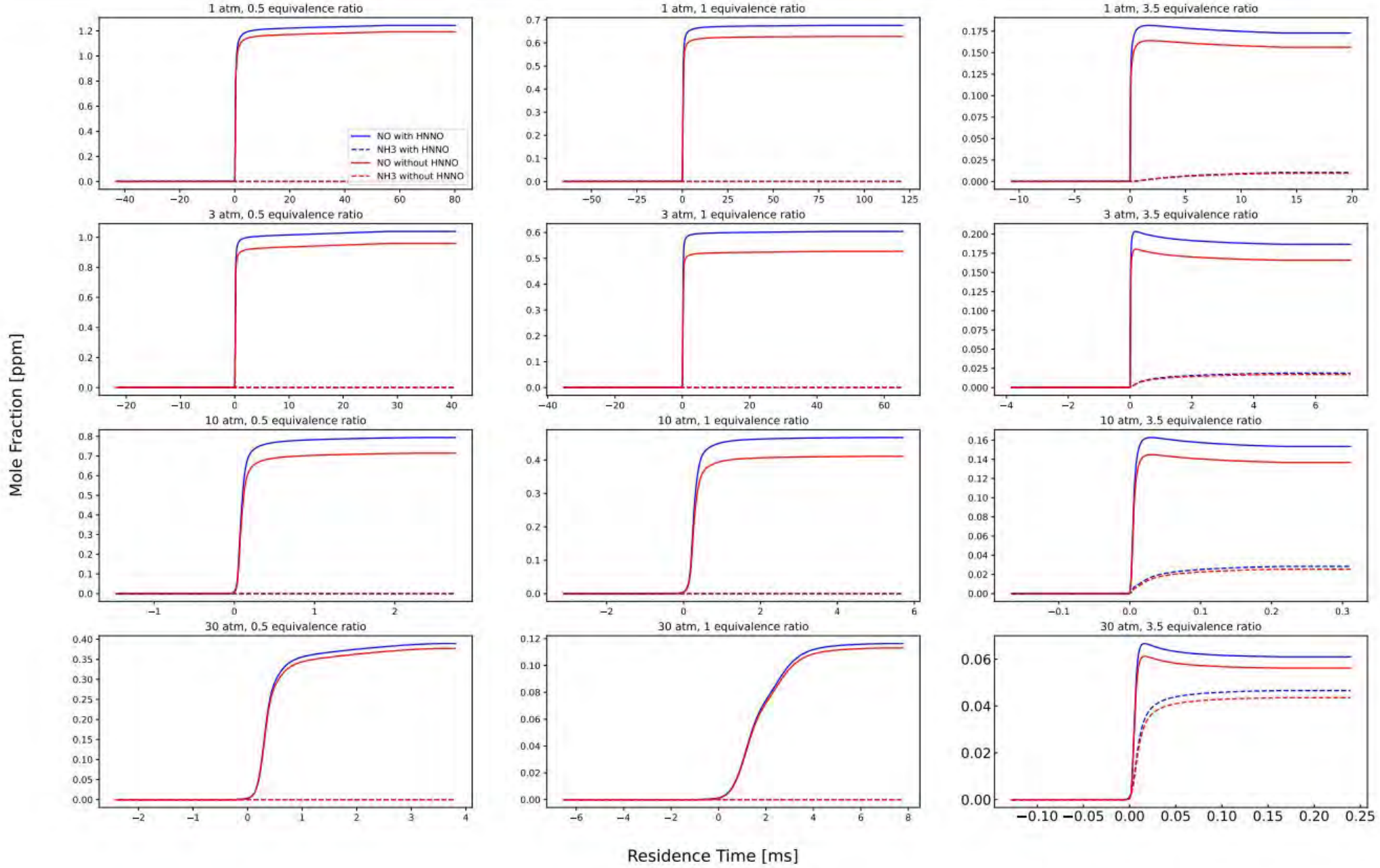
```
species(name = "H2",
    atoms = "H:2",
    thermo = (
       NASA(   [200.0, 1000.0], [2.376942040e+00, 7.739169220e-03,
                -1.887350730e-05, 1.955171140e-08,
                -7.170956630e-12,
                -9.211730810e+02, 5.471847360e-01]  ),
       NASA(   [1000.0, 6000.0], [2.902076490e+00, 8.689925810e-04,
                -1.658644300e-07, 1.908518990e-11,
                -9.311217890e-16,
                -7.979487260e+02,
                -8.455913200e-01]  )
              ),
    transport = gas_transport(
                   geom = "linear",
                   diam = 2.92,
                   well_depth = 38.0,
                   polar = 0.79,
                   rot_relax = 280.0)
```

```
e('.','p') + "_phi_" + str(er).replace('.','p') + ".csv"

ance', 'tau', 'T']

str(pres) + ' atm and phi = ' + str(er))

re = ' + str(pres) + ' atm and phi = ' + str(er))
gycon=True, soret=True)
me_results(pres, result, model)
```

Method(s)

```
    result = f.free_flame(ini_cond, er, fuel, gas, width_list[k], energycon=True, soret=True)
    T_list, velocity_list, mole_df, distance_list, net_rates = get_flame_results(pres, result, model)
    result_solution = result.solution
    result_solution['velocity'] = velocity_list
    result_solution['distance'] = distance_list
    for ii, rxn in enumerate(gas.reaction_equations()):
        result_solution['flux_rxn_'+str(ii)] = net_rates[ii]
    result_solution.to_csv(file_name, index=False)
S_b = list(velocity_list)[-1]
full_time = [(distance)/S_b for distance in distance_list]
distance_index = min(range(len(mole_df['NO'])), key=lambda i: abs(mole_df['NO'][i]-list(mole_df['NO'])[-1]*0.01))
tau_f = np.array(distance_list[distance_index]) / S_b
tau_list = [ft - tau_f for ft in full_time]
distance_f = np.array(distance_list[distance_index])
distance_list_new = [dl - distance_f for dl in distance_list]
color = 'red'
if(i == 1):
    color = 'blue'
linestyle = 'dashed'
if(obs == 'NO'):
    linestyle = 'solid'
axes[row, col].plot(np.multiply(tau_list,1000), mole_df[obs]*1e6, color=color, linestyle=linestyle, label = model_name)
plt.tick_params(axis = 'x', direction='in')
plt.tick_params(axis='x',labelsize=15)
plt.tick_params(axis = 'y', direction='in')
plt.tick_params(axis='y',labelsize=15)
axes[0, 0].legend(loc='lower right')
```

Results - Effects of Pressure and E.R. on NO and NH3 Formation



Summary

Conclusion:

- Inverse relationship between increasing pressure and equivalence ratio with the amount of NO and NH3 produced
- As pressure and equivalence ratio increase, the difference in the amount of NO and NH3 decreases.
- Whenever the equivalence ratio is at 3.5, the amount of NO and NH3 peak and then decrease afterward.
- When the pressure is at intermediate levels the difference between pathways with and without HNNO are the most significant

Looking Ahead:

- We can look at flux analysis simulations to observe NOx production rates in different conditions
- Communicate the information we've gathered to other industries so they can further their own research
- Information gathered here is part of a bigger picture that aims for a more sustainable environment.

The E.N.G Experience

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Acknowledgements

The Burke Lab, Columbia University

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Engineering the Next Generation

COLUMBIA ENGINEERING FOR HUMANITY

Modeling Chaotic and Structured Bubbling with Active Living Forces

[redacted]

Thursday, August 11th, 2022

THE SUMMER 2022 E.N.G. PROGRAM

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The Fu Foundation School of Engineering and Applied Science

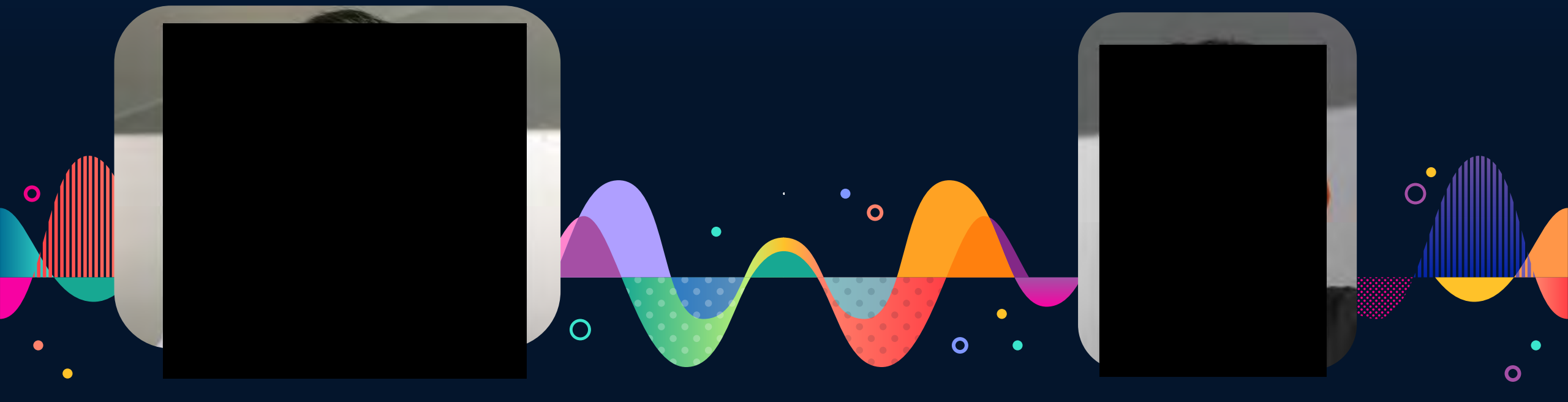
About Us

[redacted]

- Sunset Park, Brooklyn
- Brooklyn Tech
- Product Manager
- Ornithology and video games

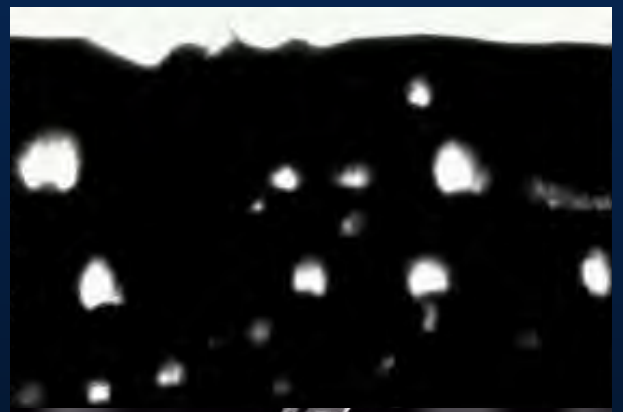
[redacted]

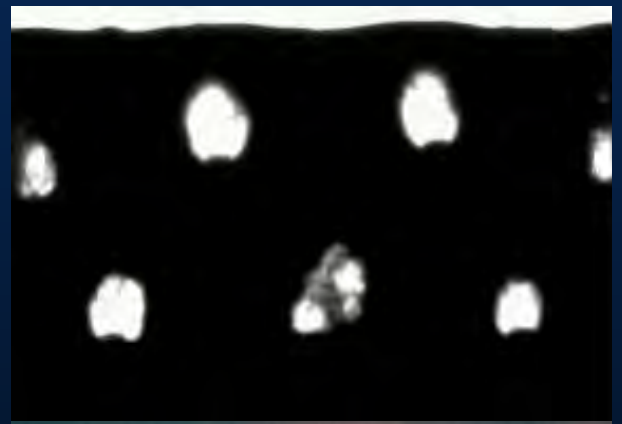
- Bronx, New York
- The Bronx Center for Science and Mathematics
- Software Developer
- Technology and basketball/football



Introduction

- Structured bubbling: Bubble patterns with consistent vibrations
- Free Bubbling: randomized buddle patterns





Introduction

- Granular particles can behave like solids, liquids, or gas, according to the different shears.
- Many hydrodynamic instability analogs have been also found in granular particles

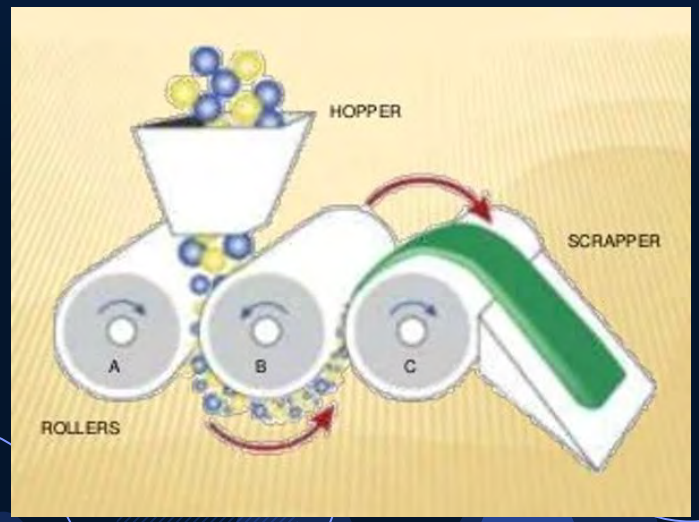
Motivation

- Reducing Food Waste with Soldier Fly Larvae

Motivation

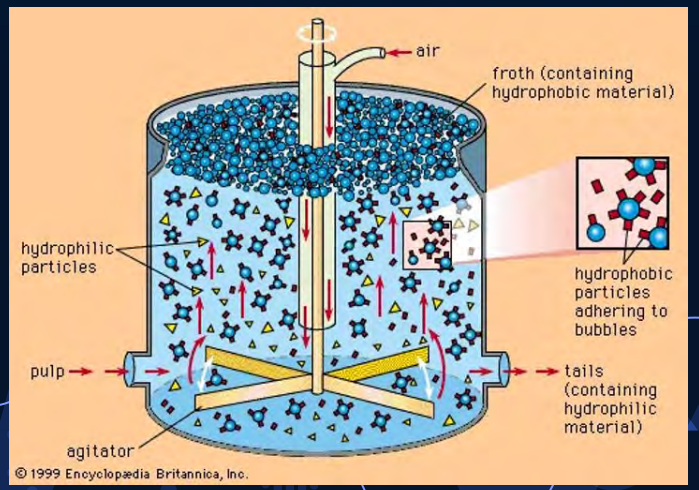
Pharmaceutical industry

- Pharmaceutical tablets require exact mixing of active and passive ingredients



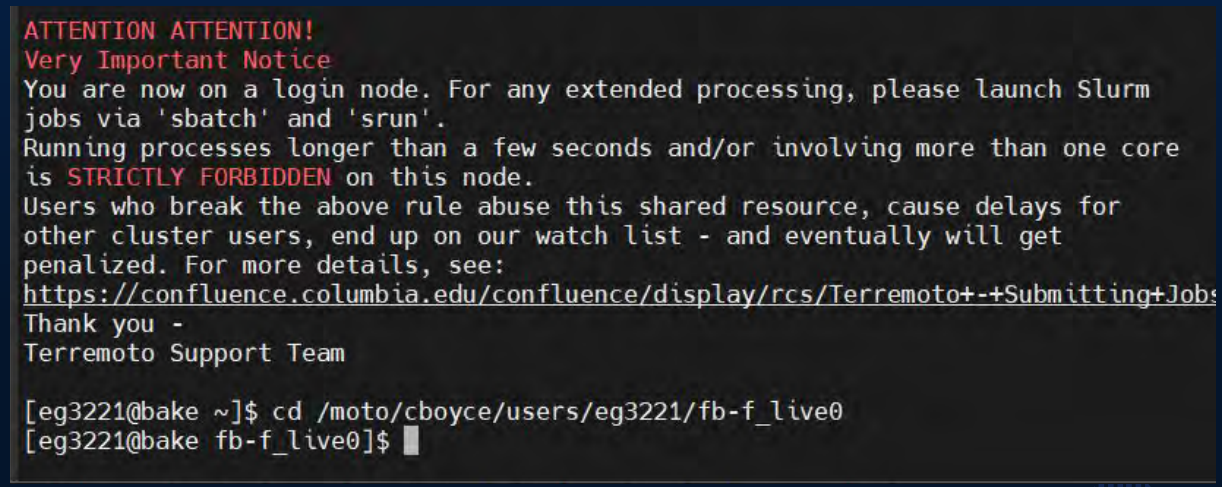
Mining industry

- Dry separation of granular particles on the basis of size, density and shape can reduce water and energy input to make mining more sustainable



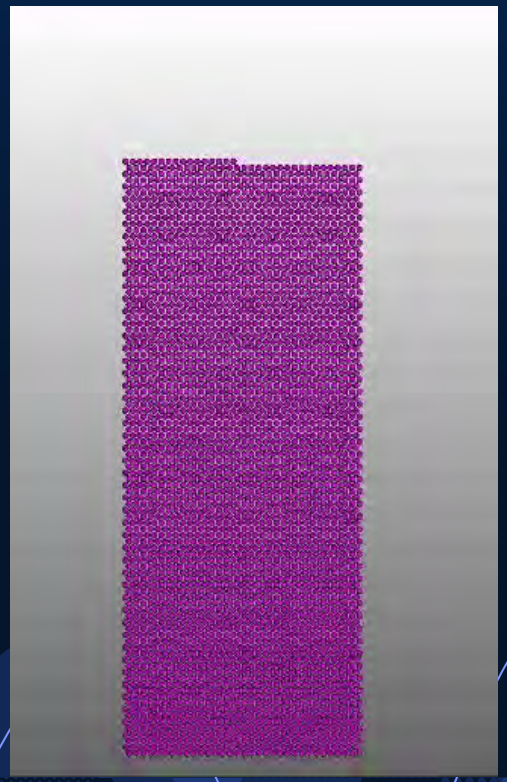
Methods

- Learned different softwares
  - Anaconda
  - MFIX
  - MobaXterm
  - WinSCP
  - Paraview
  - MatLab

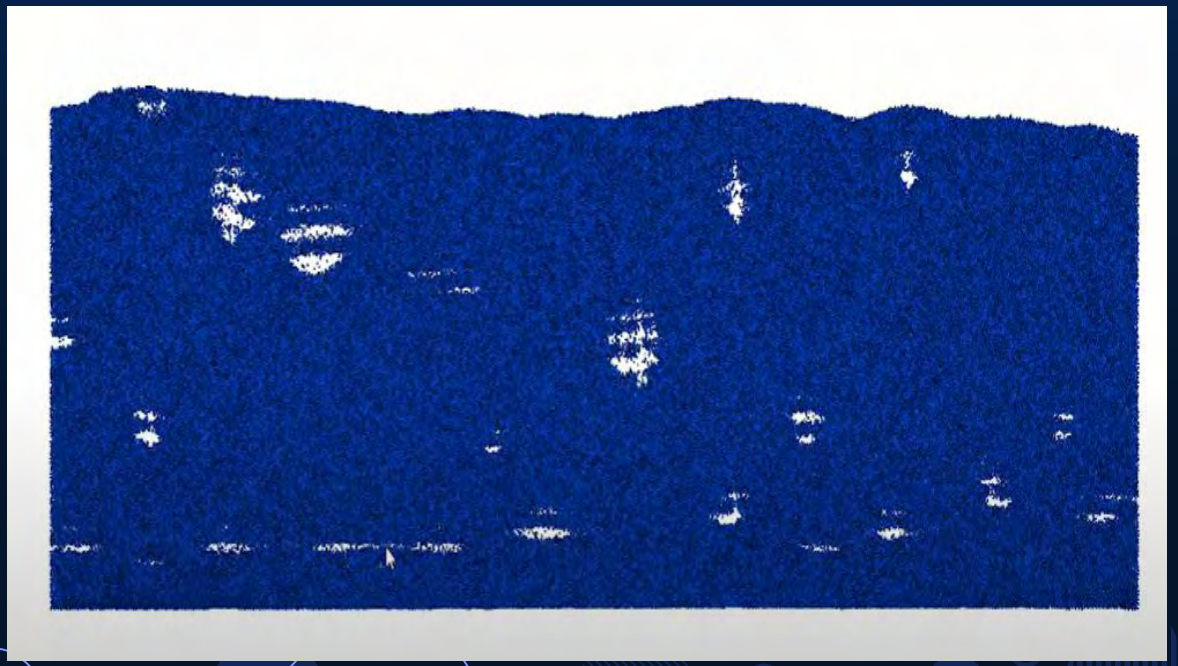


Software Methods

MFIX



Paraview



Software Methods

MatLab

videos.m

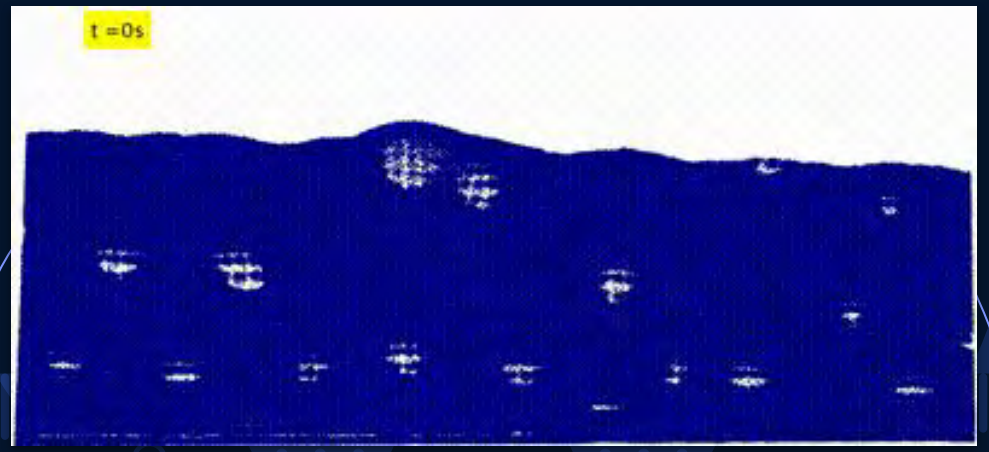
```
clc;clear all;close all;
cd = 'D:\eng\sb-f_live7\figures\';
position = [100 8];
outputVideo = VideoWriter(fullfile('sb7.avi'));
outputVideo.FrameRate = 2;
open(outputVideo);
for i=1:21
    im_ori_name=strcat(cd,num2str(1),' (',num2str(i),').jpeg');
    im_ori=imread(im_ori_name);
    im_crop = imcrop(im_ori,[49 80 1283 575]);
    text_str=strcat('t = ',num2str((i-1)*0.2),'s');
    RGB = insertText(im_crop,position,text_str,'FontSize',28,'BoxColor','yellow','BoxOpacity',1,'TextColor','black');
    writeVideo(outputVideo,RGB);
end
close(outputVideo)
```

Free Bubbling Cases Results

Std_L=1e-0 N

Std_L=1e-5 N

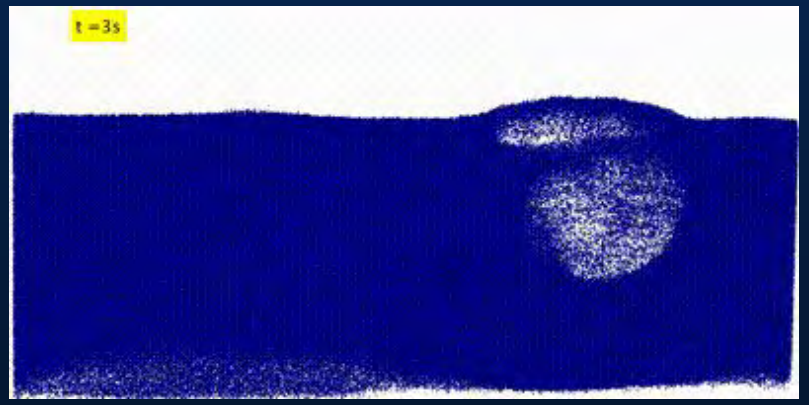
Std_L=1e-7 N



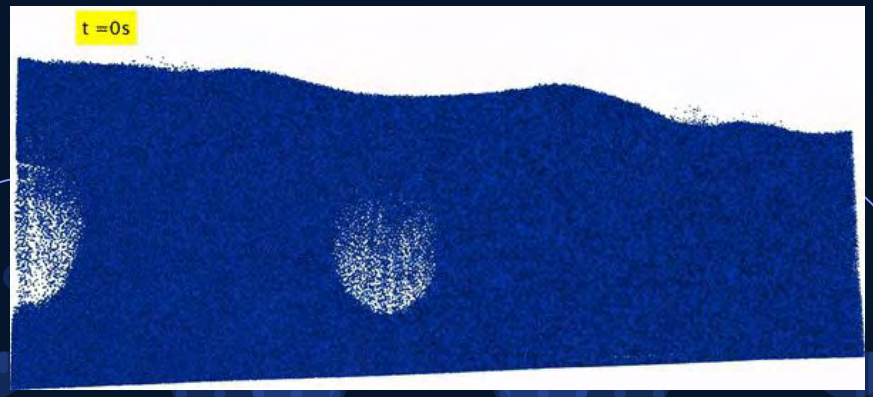
Structured Bubbling Cases Results

Std_L=1e-0 N

Std_L=1e-5 N



Std_L=1e-7 N



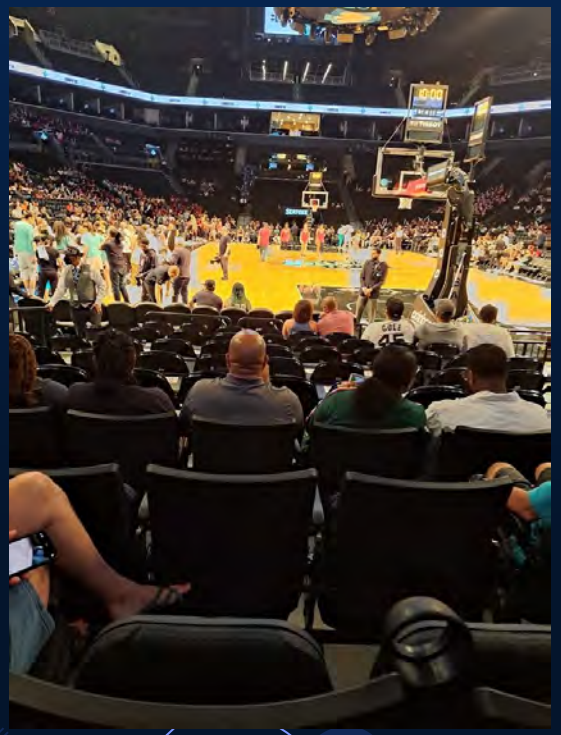
Summary

- CFD-DEM simulation can reproduce chaotic and and structured bubbling
- Living forces affect structured bubbling much more than chaotic bubbling. It doesn't affect free bubbling since it's already chaotic
- Larger living force can affect it more.

Next Steps

- For each active living forces, try more conditions (vibration and gasflow) to also produce similar bubbling patterns
- Do a force analysis to see the mechanism of the active living forces

ENG Experience



Acknowledgements

Boyce Lab, Columbia University

[redacted]

The ENG Team and Cohort

THANKS!

Any questions?

Engineering the Next Generation

Kasza Living Materials Laboratory

[redacted]

Thursday, August 11th, 2022

About Us

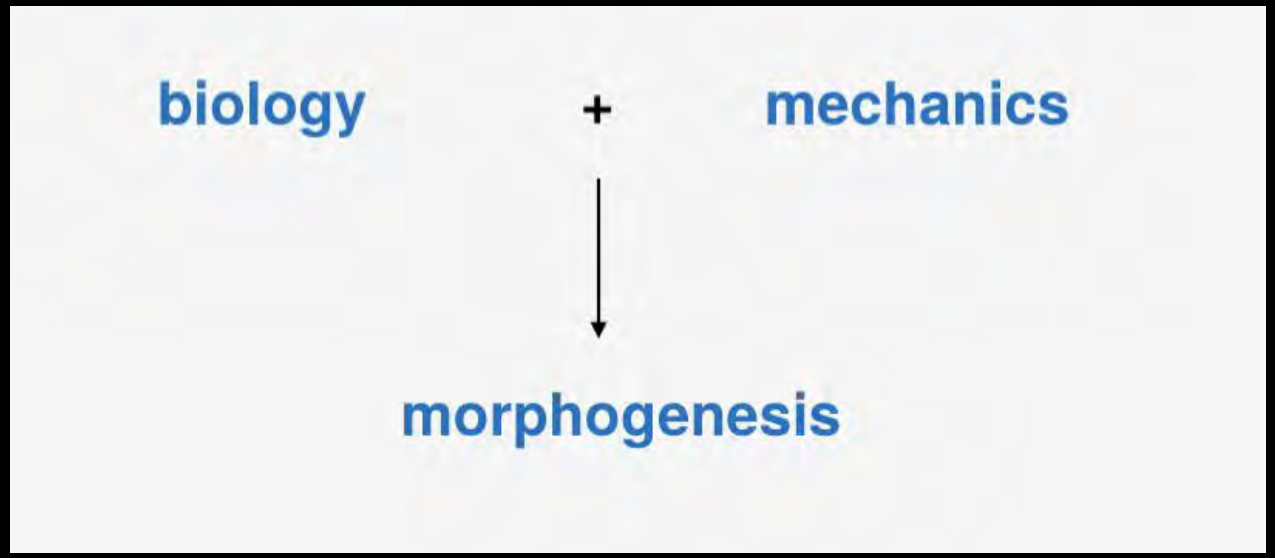
- Brooklyn, NY
- Stuyvesant High School
- Boxing, Chemistry, Economics

- Vietnam
- ELLIS Preparatory Academy
- Computer science
- Swimming and aikido

Motivation

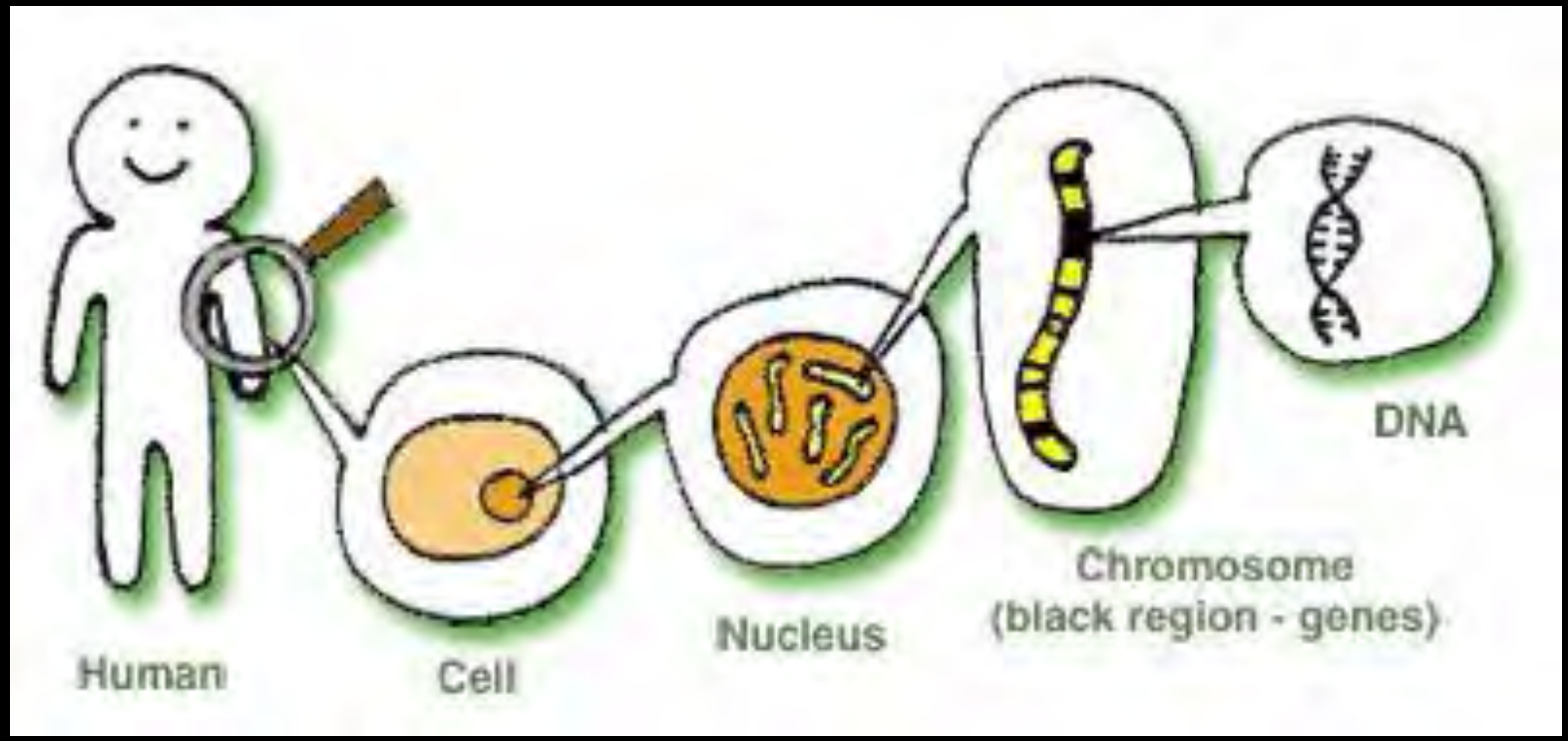
- We still do not how genes encode instructions to build tissues and organs
  - Lack of understanding regarding underlying causes of birth defects

- GOAL: Visualize and quantify how cells work together to build tissues and organs



The cell is the smallest unit that makes up all living organisms and the tissues of the body.

- Gene contains instructions that tell the cells to make molecules called proteins
- Application of cell work on animal meaningful and important influence on human



Why do we use *Drosophila* as a model organism?

Short life span

Easy

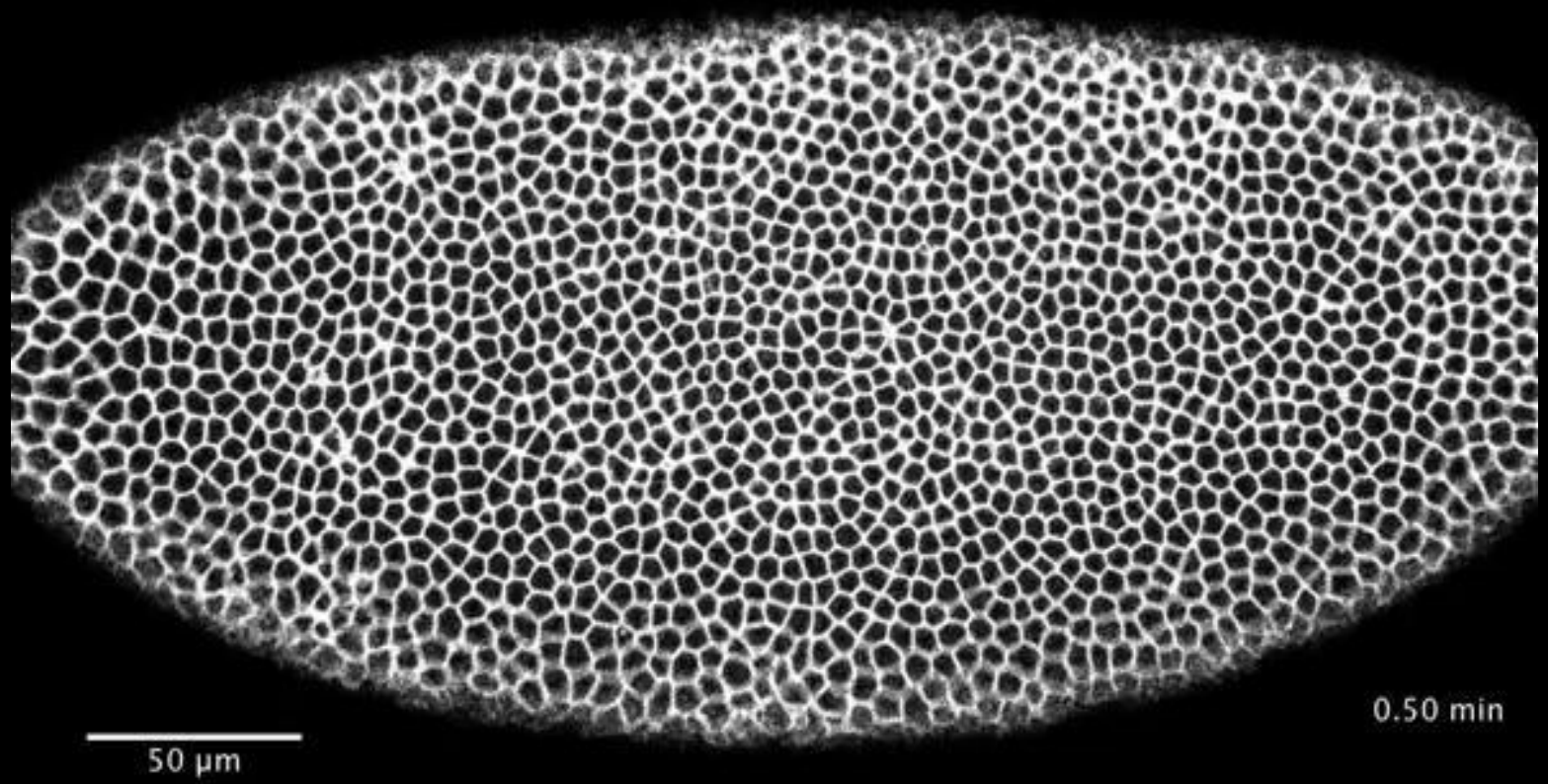
Large number of embryos

Inexpensive

Long history

Homologous gene to human

Objectives



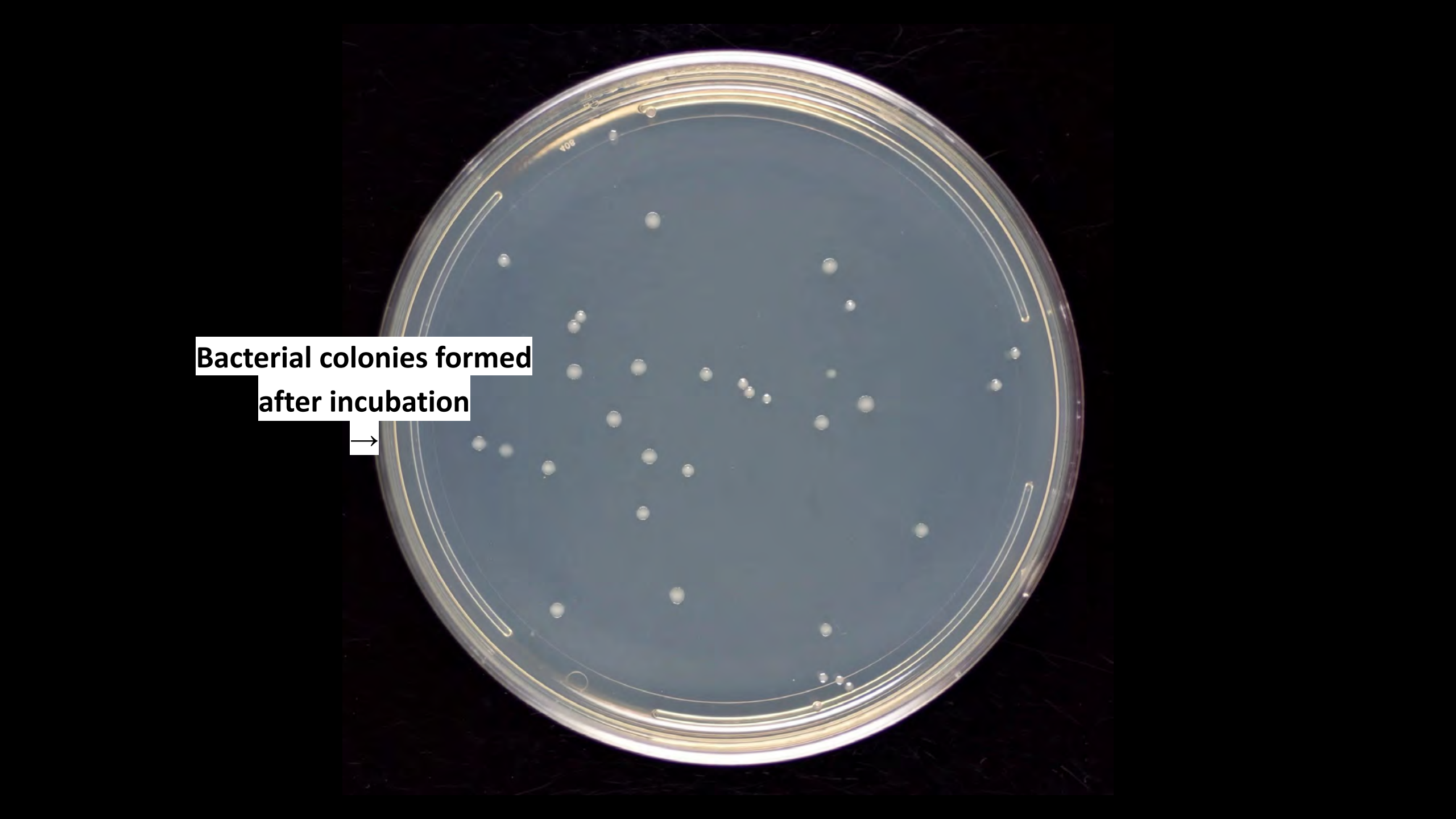
https://vimeo.com/386125858

Drosophila Use For Molecular Biology Work

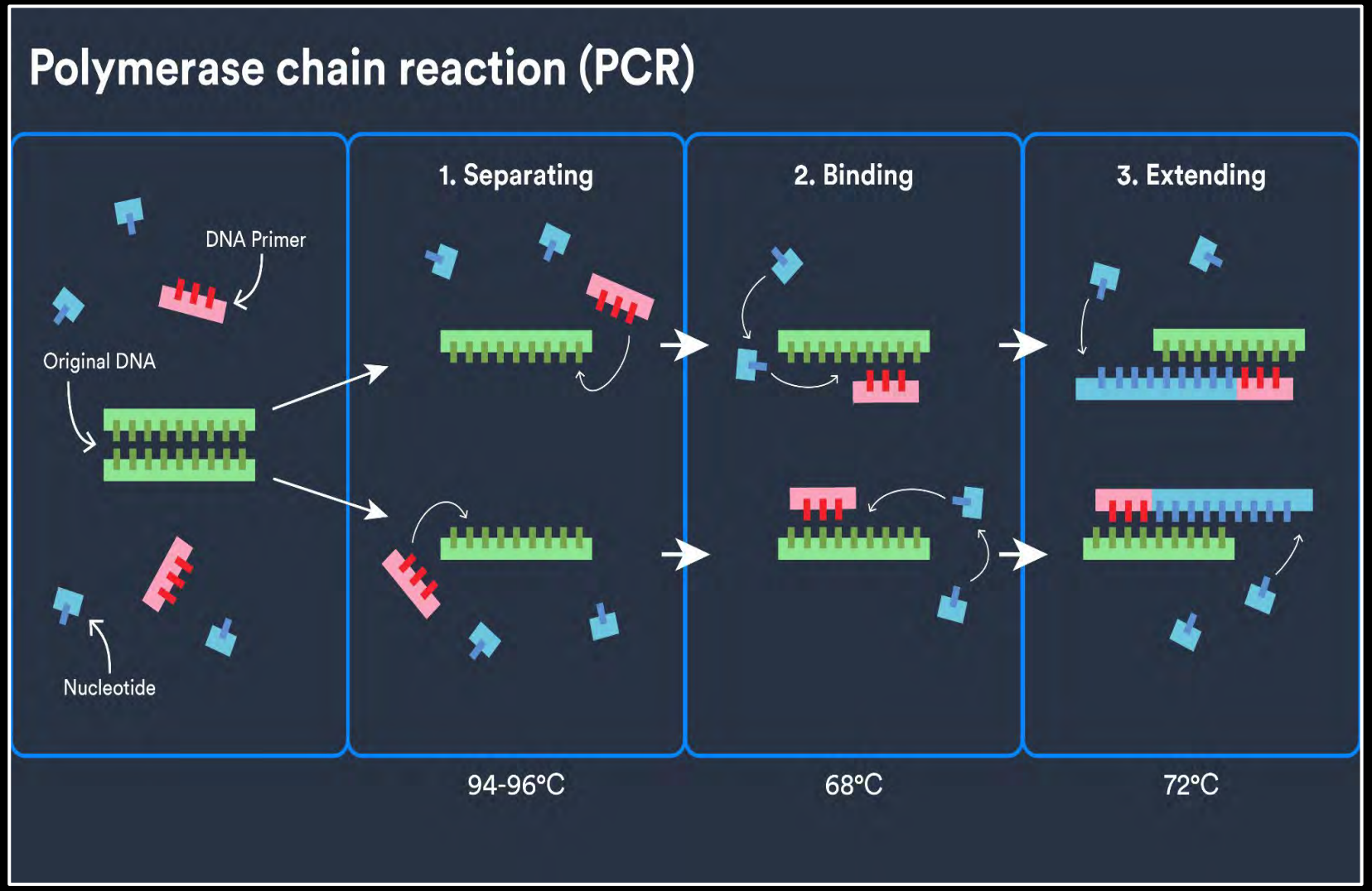
Goal: Purify and amplify desired DNA encoding four fluorescent proteins from bacterial hosts

1. Culture bacteria on petri dishes
2. Grow liquid cultures from individual colonies
3. Mini-Prep to extract DNA from cultures
4. PCR to generate fragments that are assembled into a complete plasmid

Centrifuge

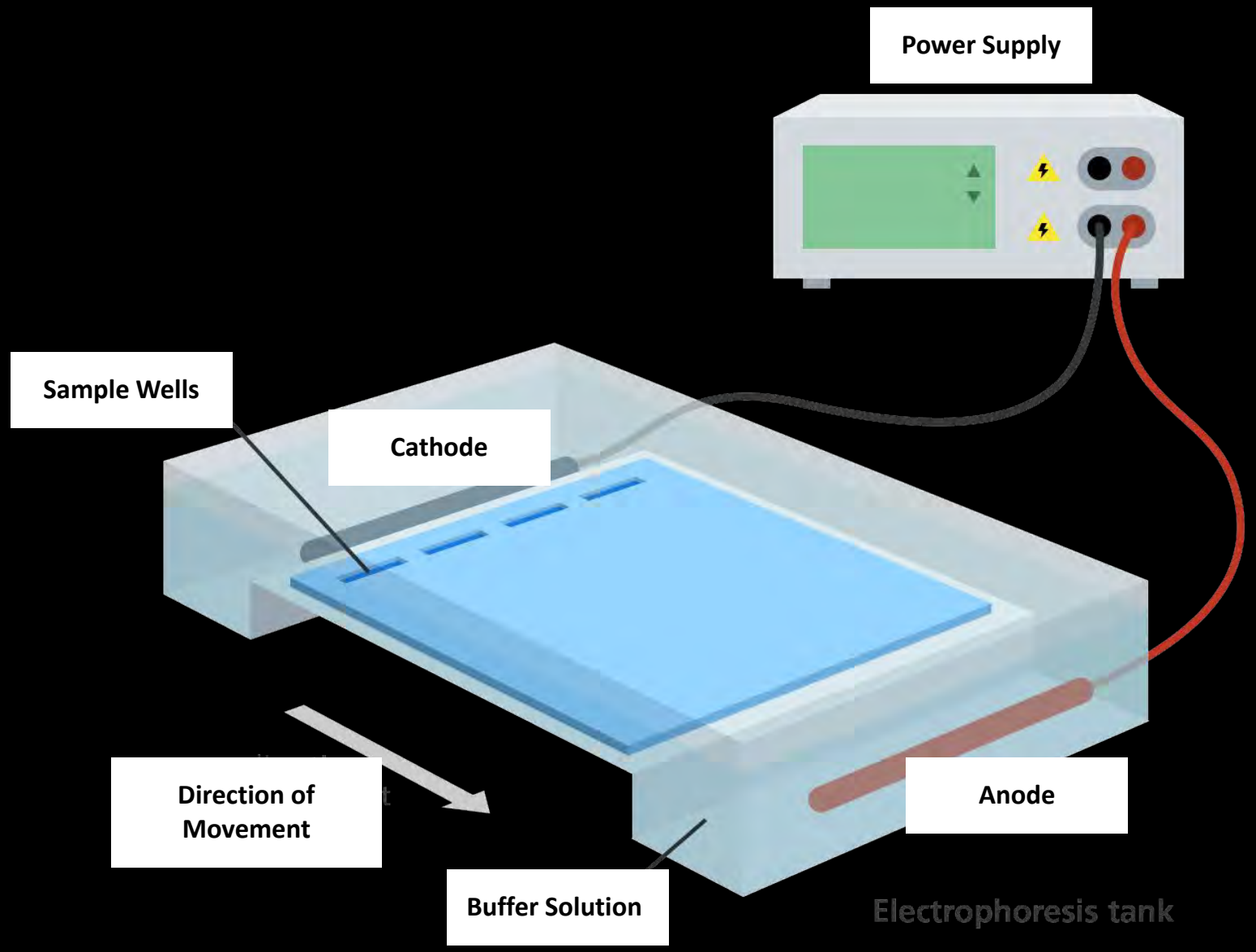

Bacterial colonies formed
after incubation
→

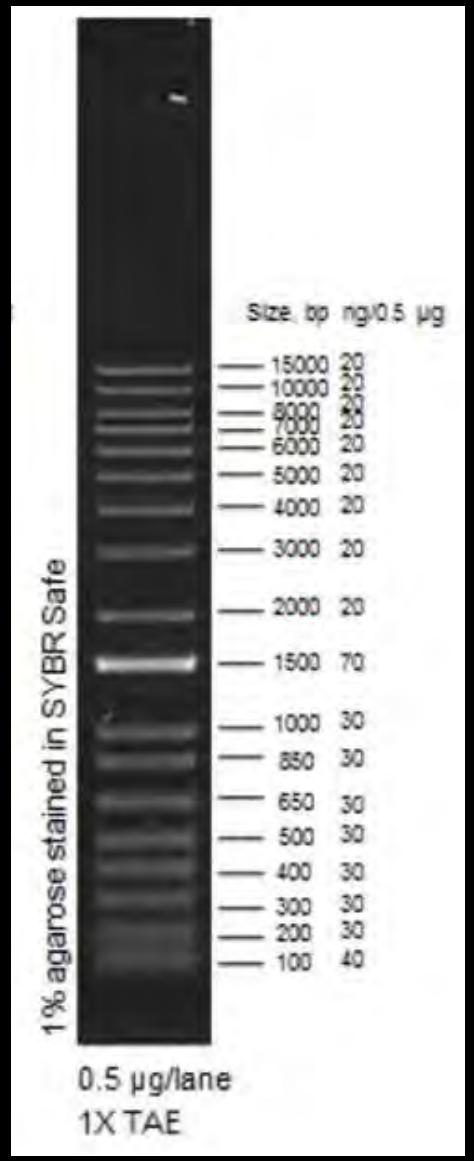
Polymerase Chain Reaction



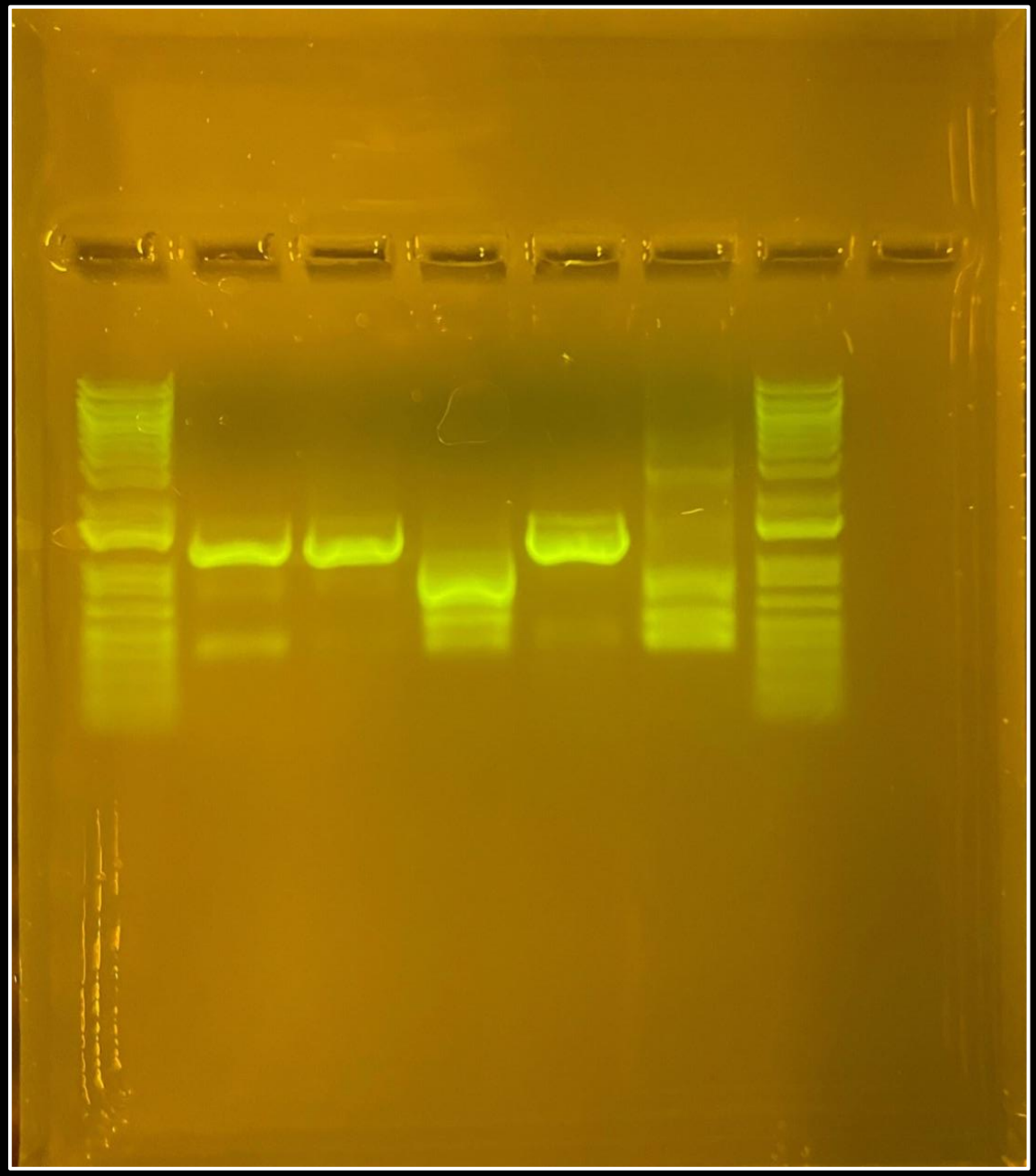
Thermal Cycler

Gel Electrophoresis



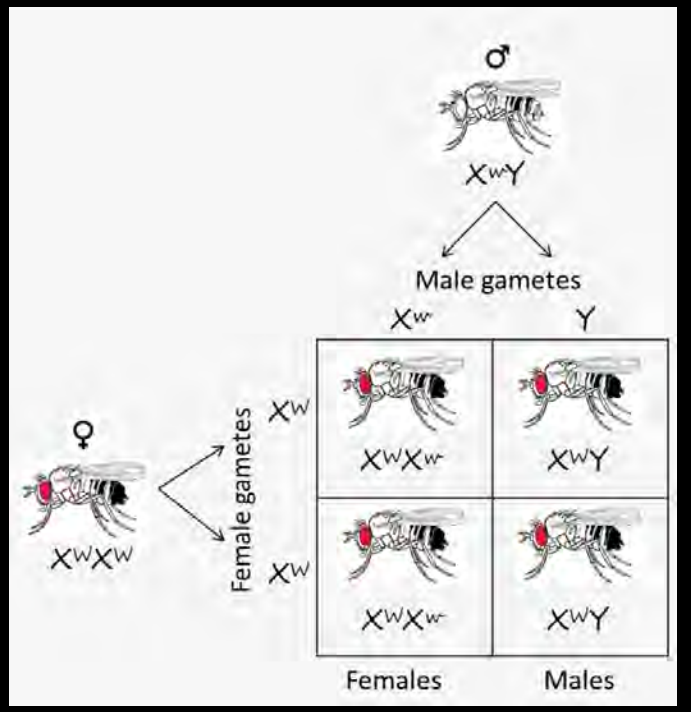


1500 bp →



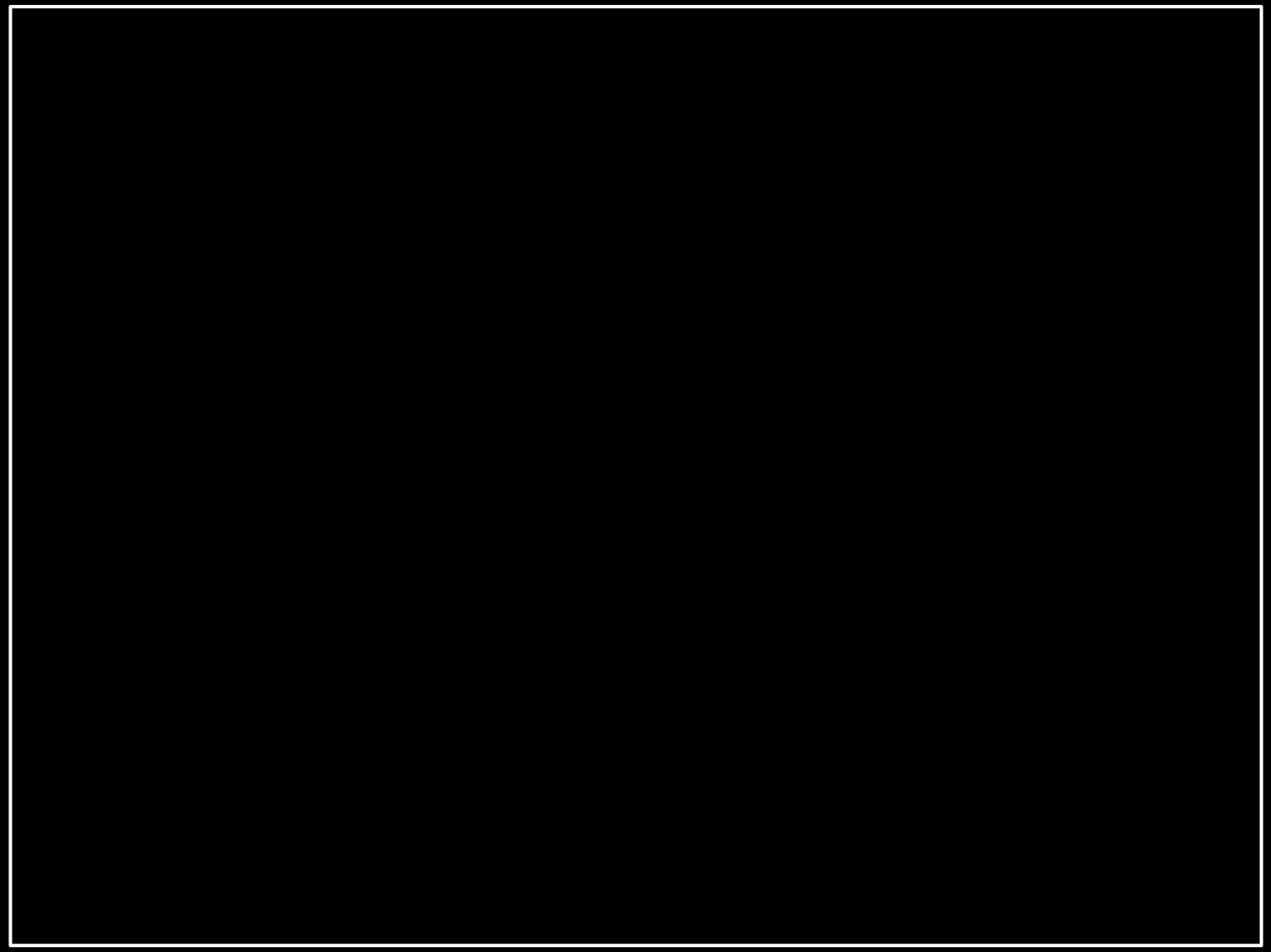
Predicting Offspring Eye Color Using Punnett Squares

- Eye color located on X-Chromosome
- White eyes recessive trait; red eyes dominant
- Version of white eye gene used to track mutated gene from bacteria
  - Phenotypic marker



Harvesting *Drosophila* Embryos In Cages

Placing Embryos Under Microscope To Track Movement

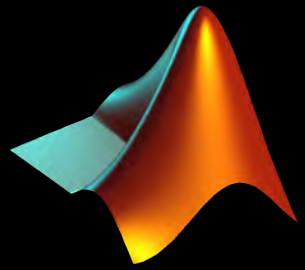


Method and procedure

Grow drosophila in vitro

Centrifuge

Matlab

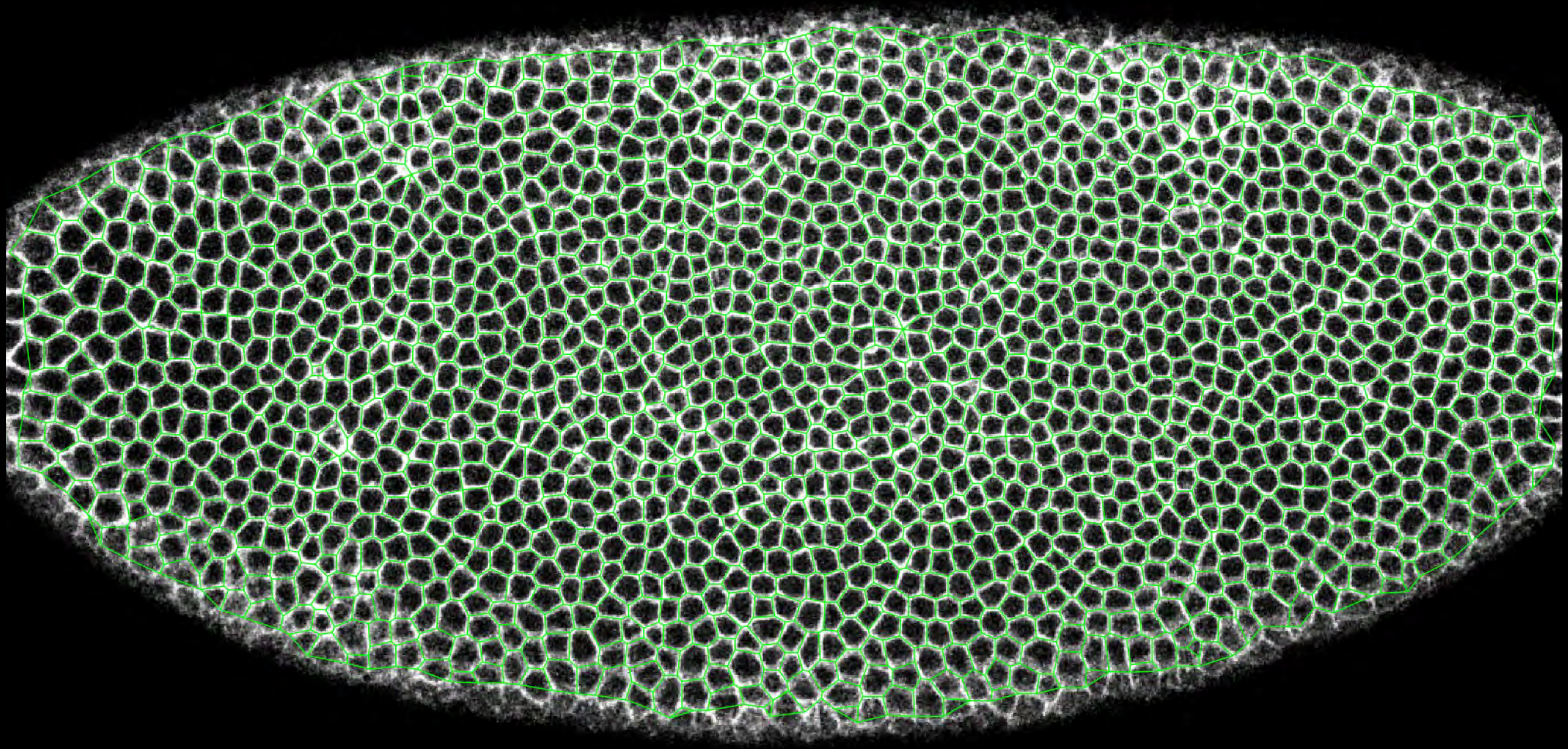


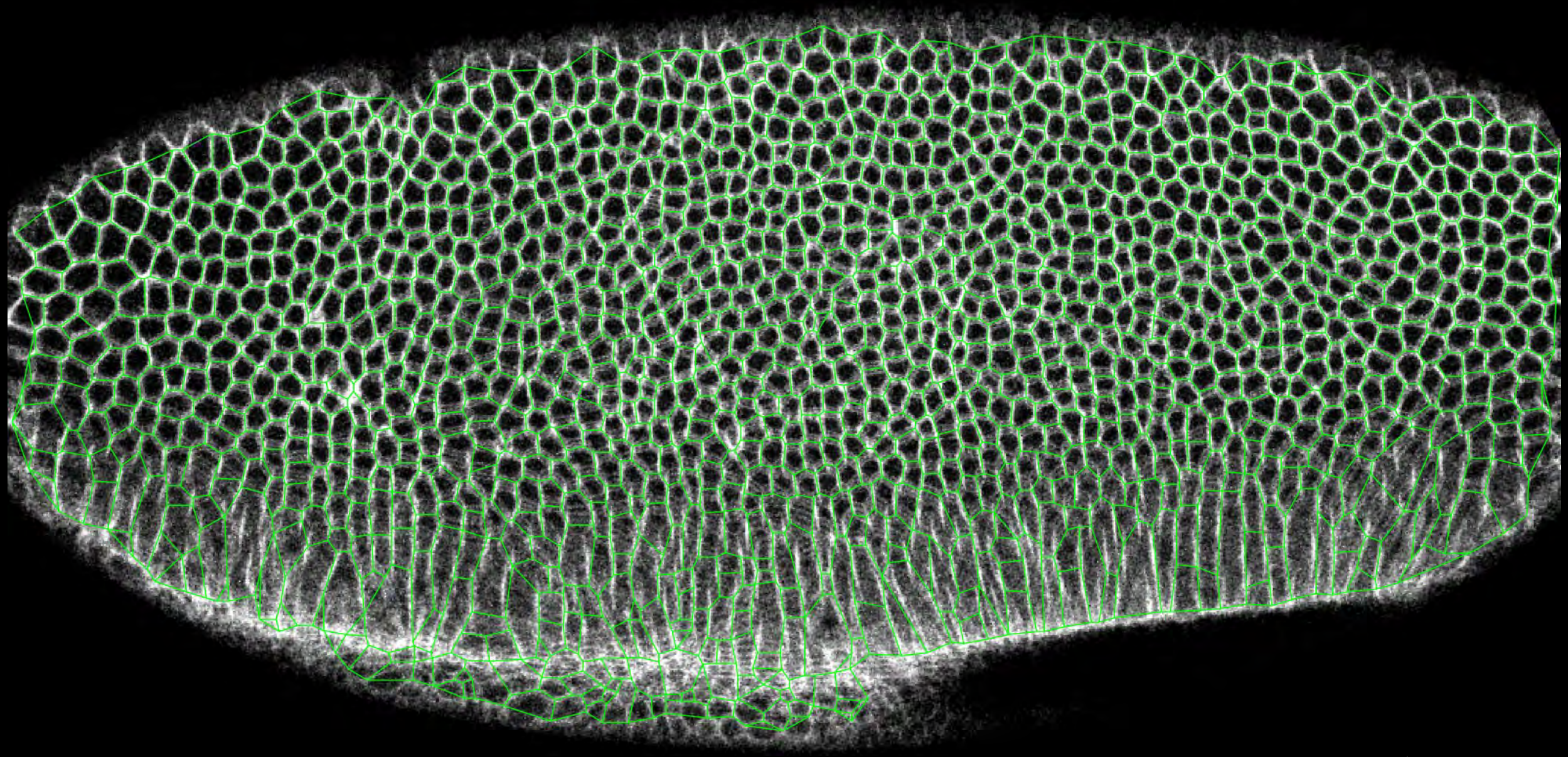
Thermal Cycler

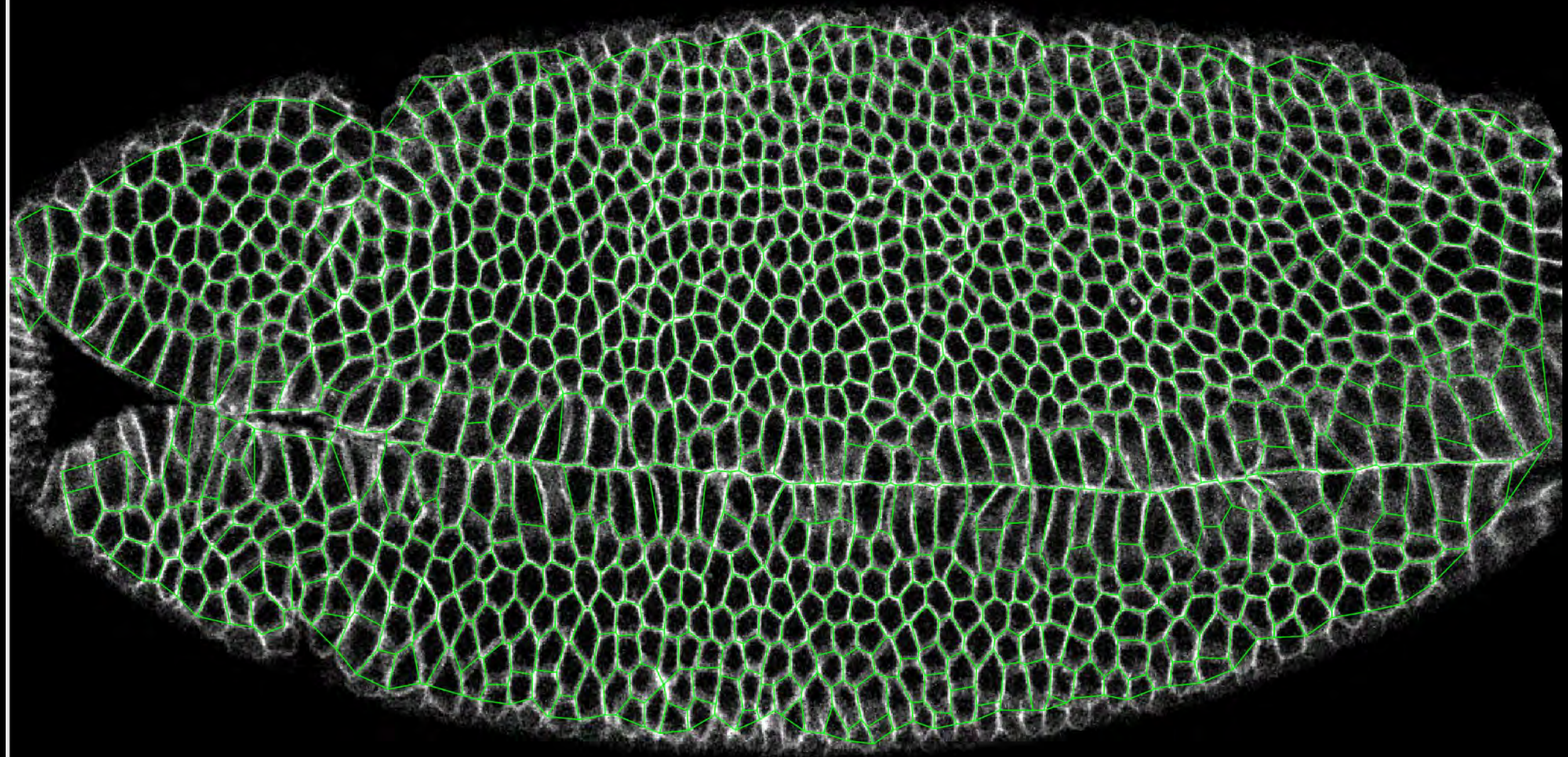
Fiji

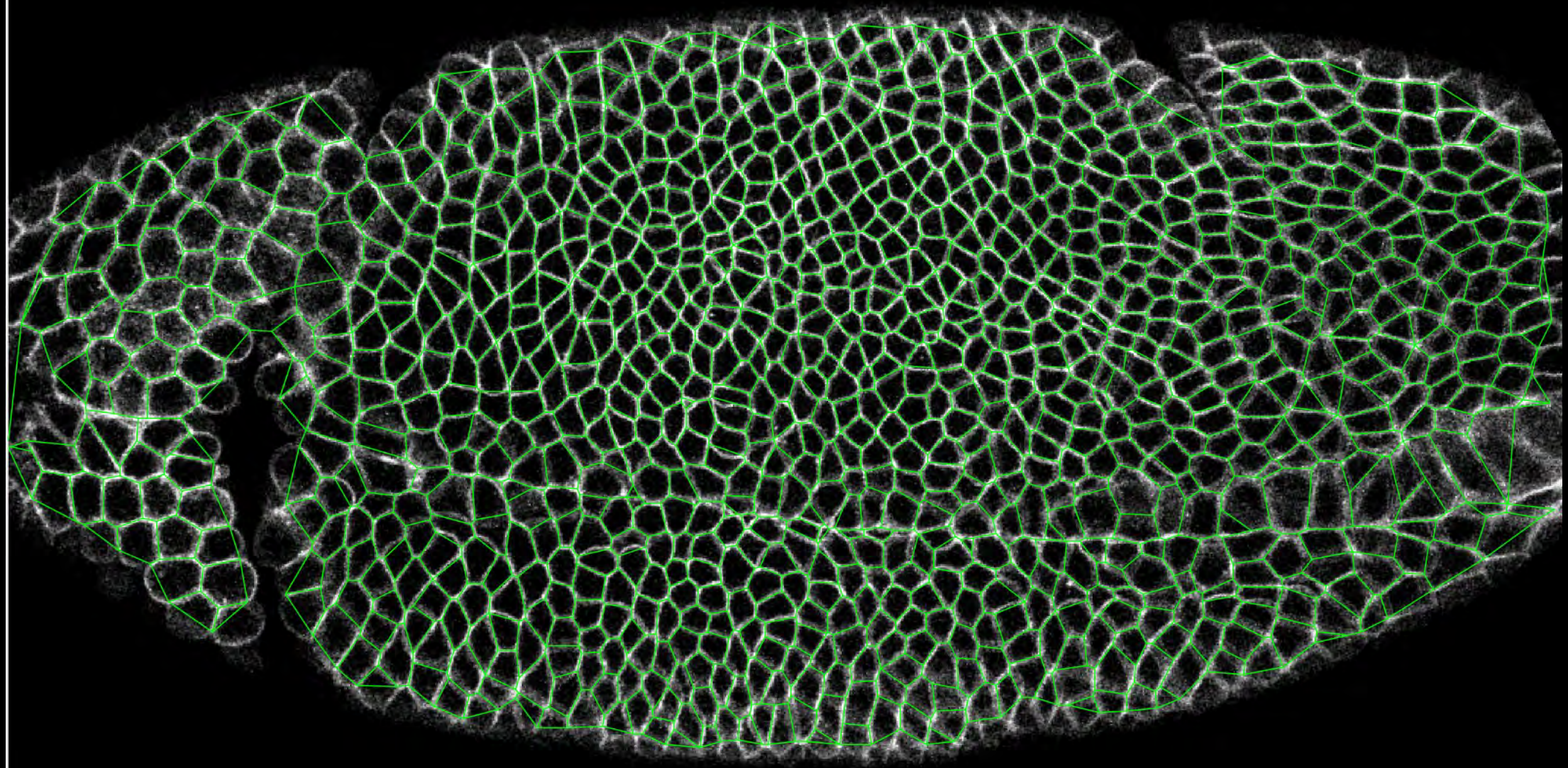
Fluorescence microscopy

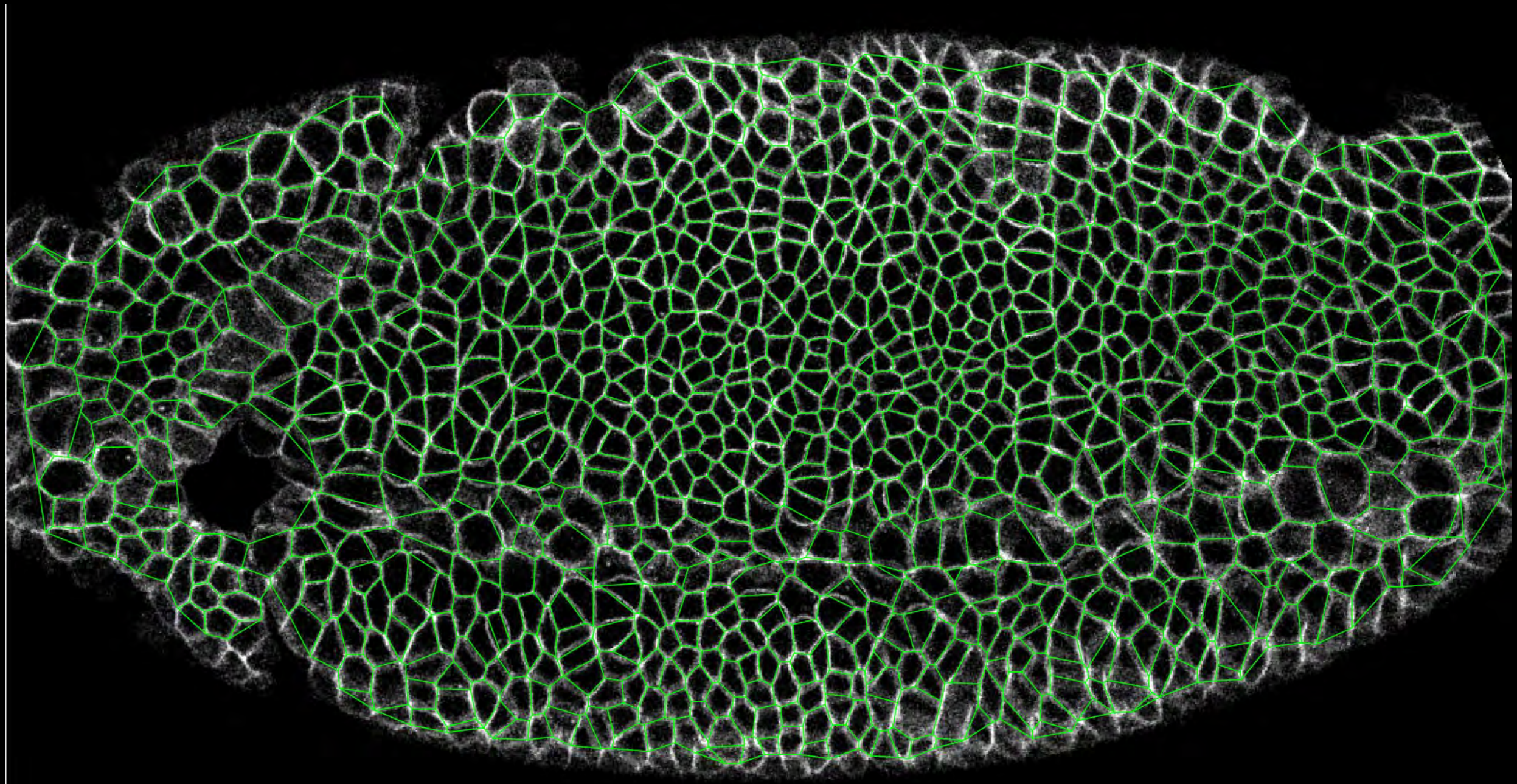
Sedation by CO2



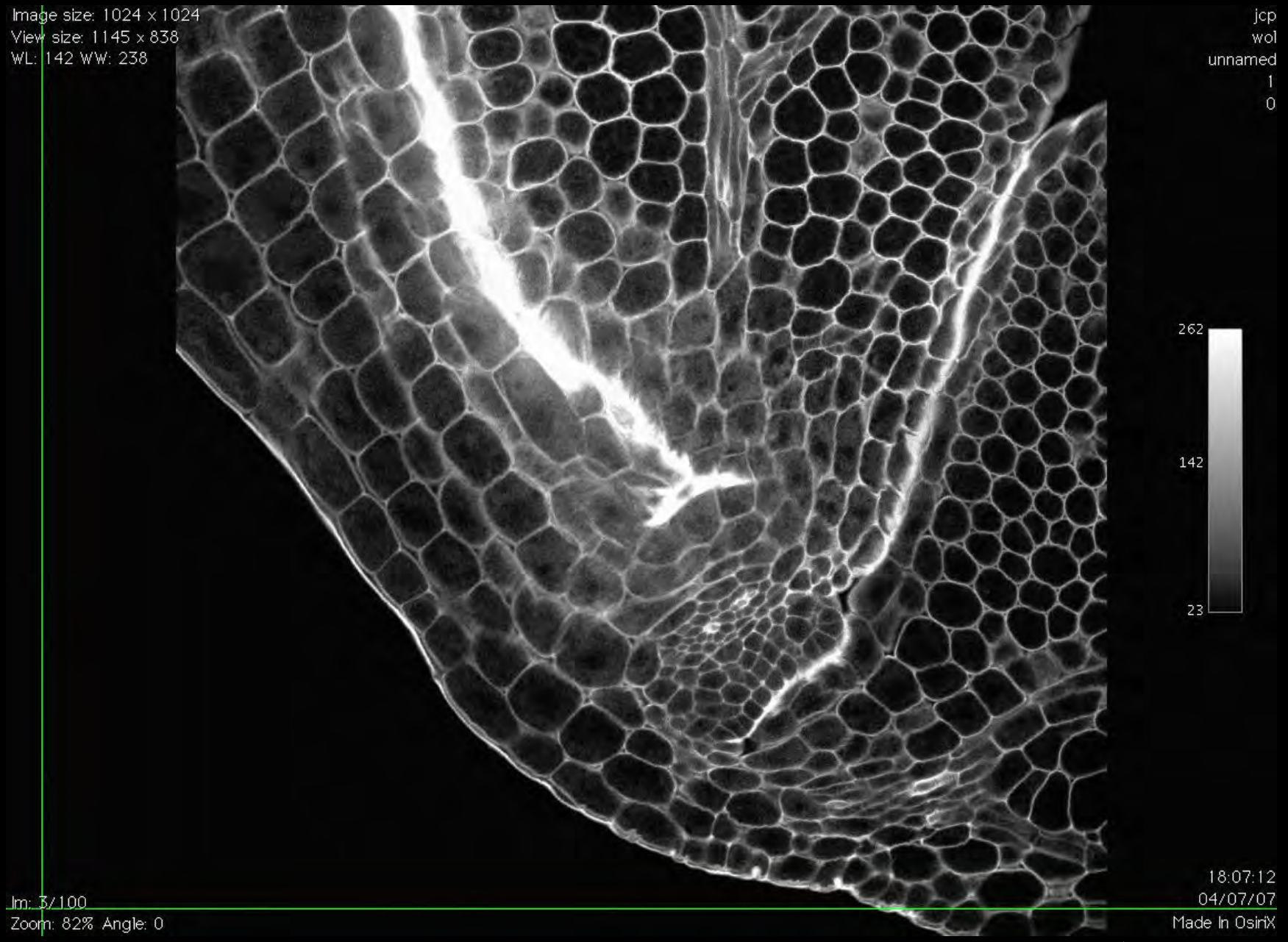




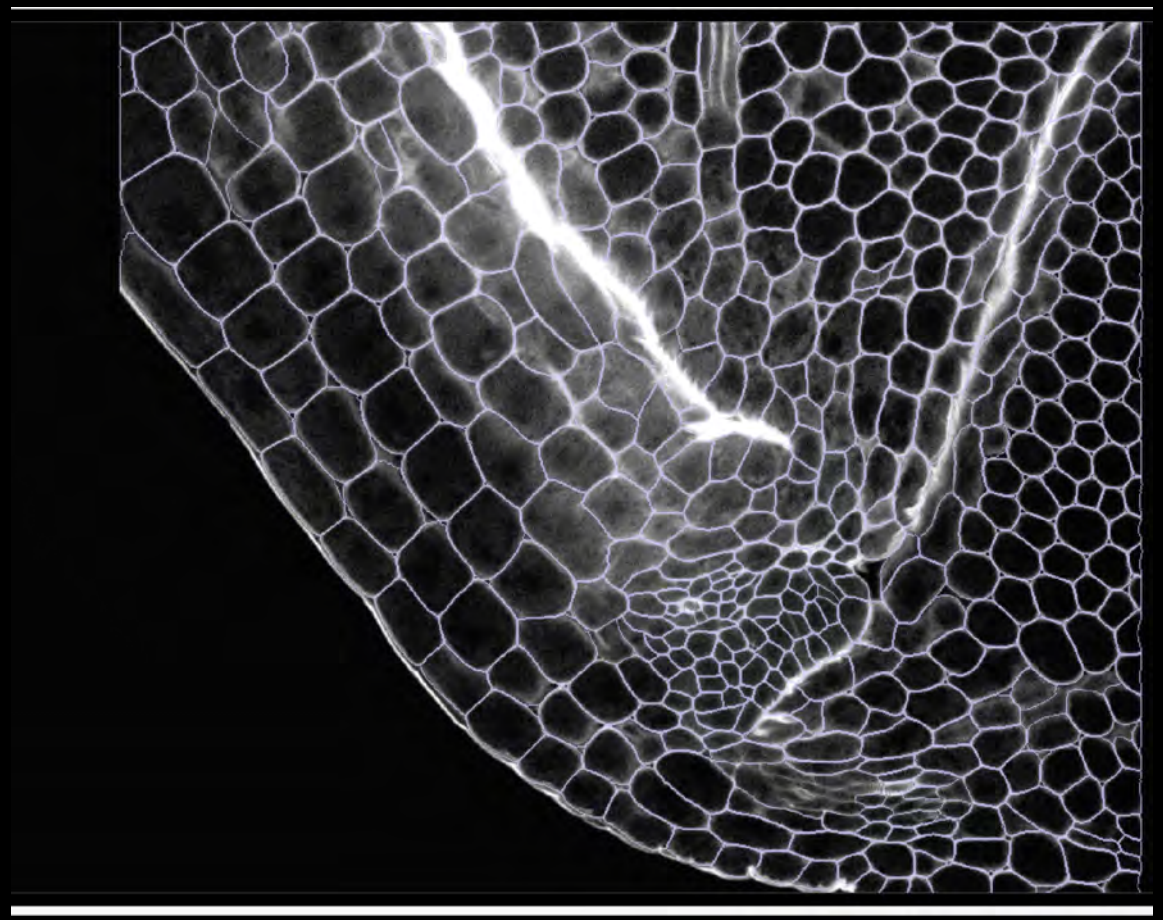


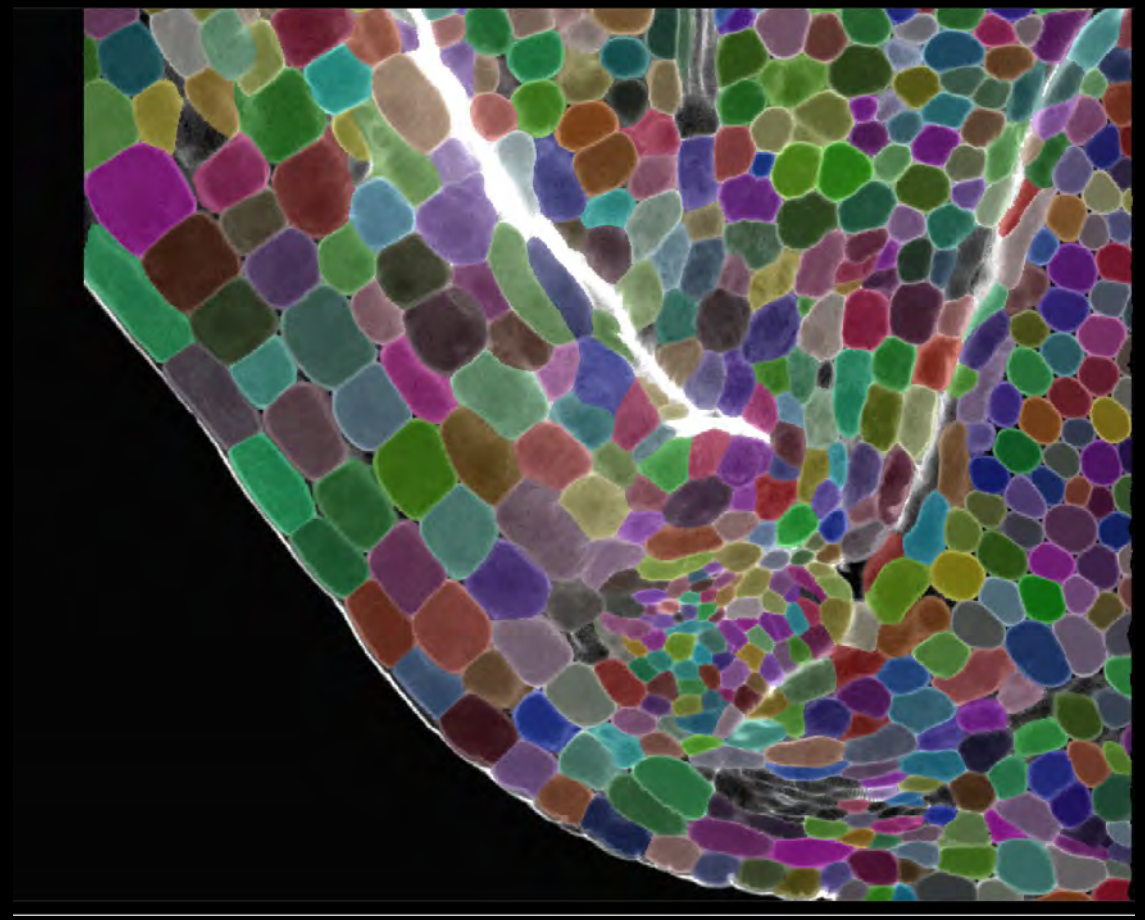


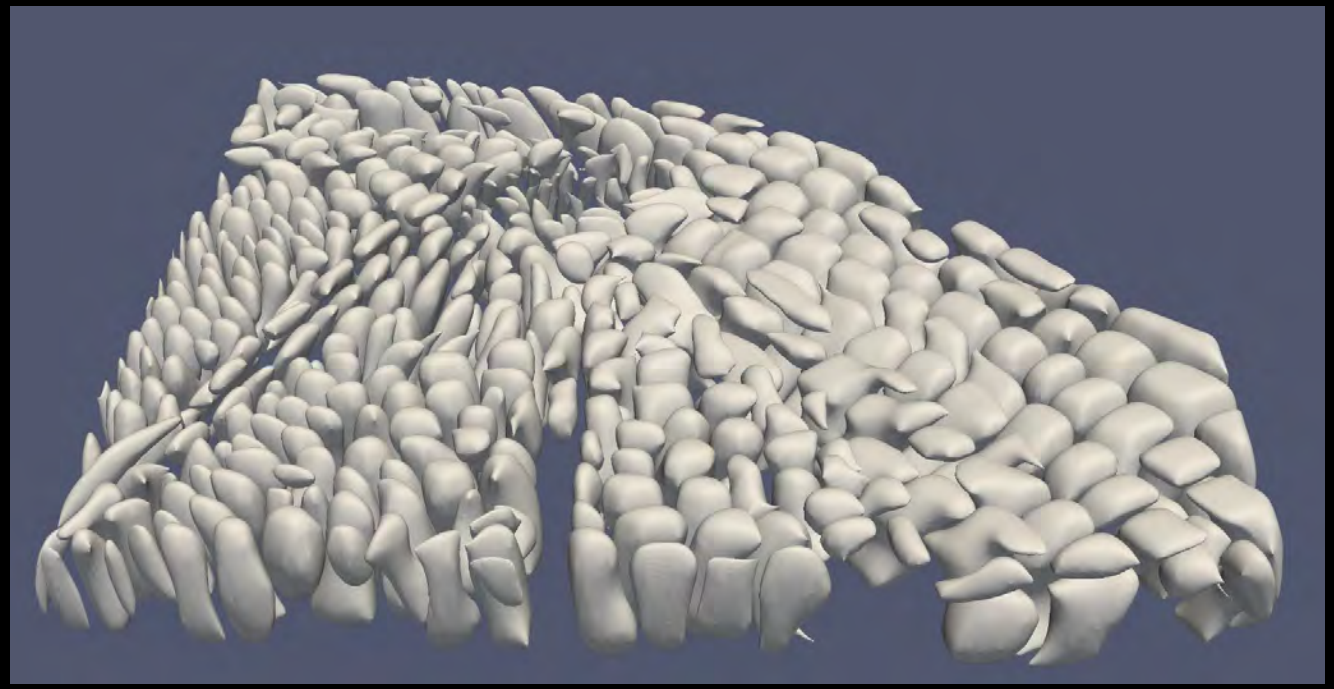
Plant Cell Segmentation Using Cell Pose

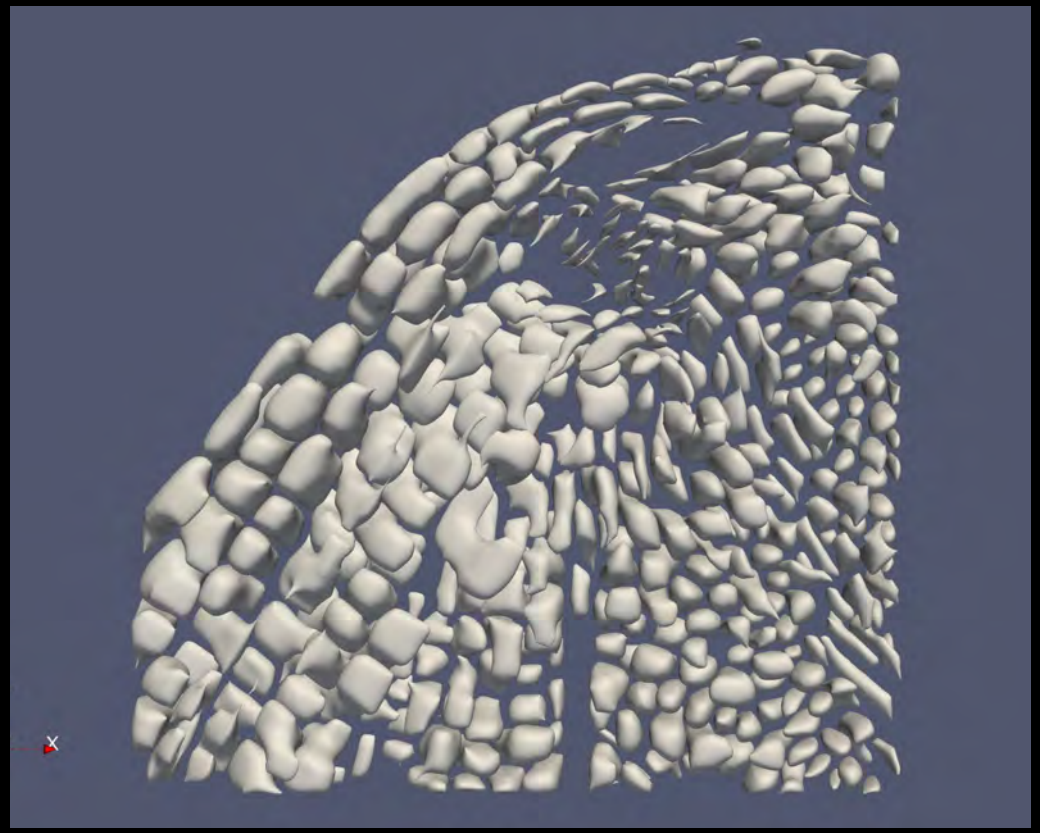


Using 2D Images To Create 3D Models of Tissues









Summary

- General Conclusions
  - Importance of model organisms in the world of developmental biology
  - Findings support Mendelian genetics (model of inheritance)
  - Bacteria are useful as DNA factories

- Obstacles faced
  - Organismal biology takes patience
  - Segmentation requires close attention to detail

- Final Remarks
  - Increased interest in pursuing science
  - Introduced many new lab skills

Acknowledgements

Kasza living materials laboratory, Columbia University

Engineering the Next Generation

COLUMBIA ENGINEERING FOR HUMANITY

Synthesis & Testing of Perylenediimide (PDI) Electron Storage Material

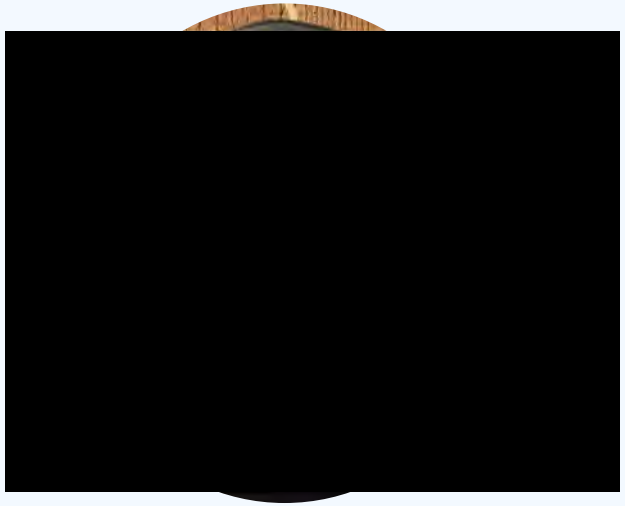
[redacted]

Thursday, August 11th, 2022

About Us

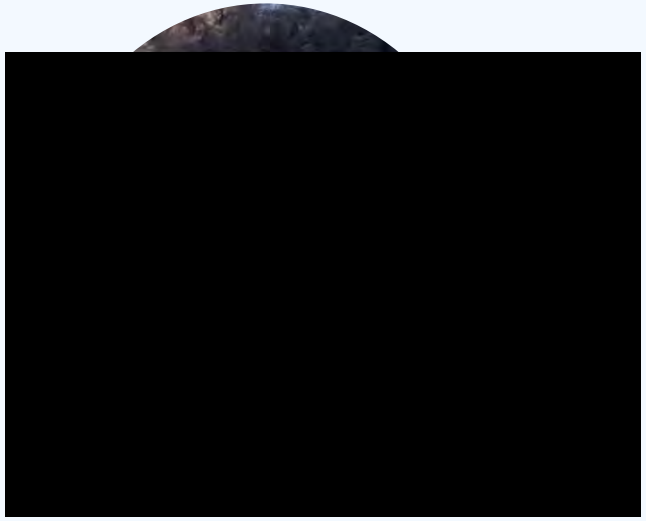
[redacted]

- Brooklyn
- Brooklyn Technical High School
- Data Science & Technology
- Traveling, Binge-Watching Shows



[redacted]

- Bronx
- Gregorio Luperon High School
- Research & Computer Science
- Music, Watching Films, and Walks



Introduction

Capacitors

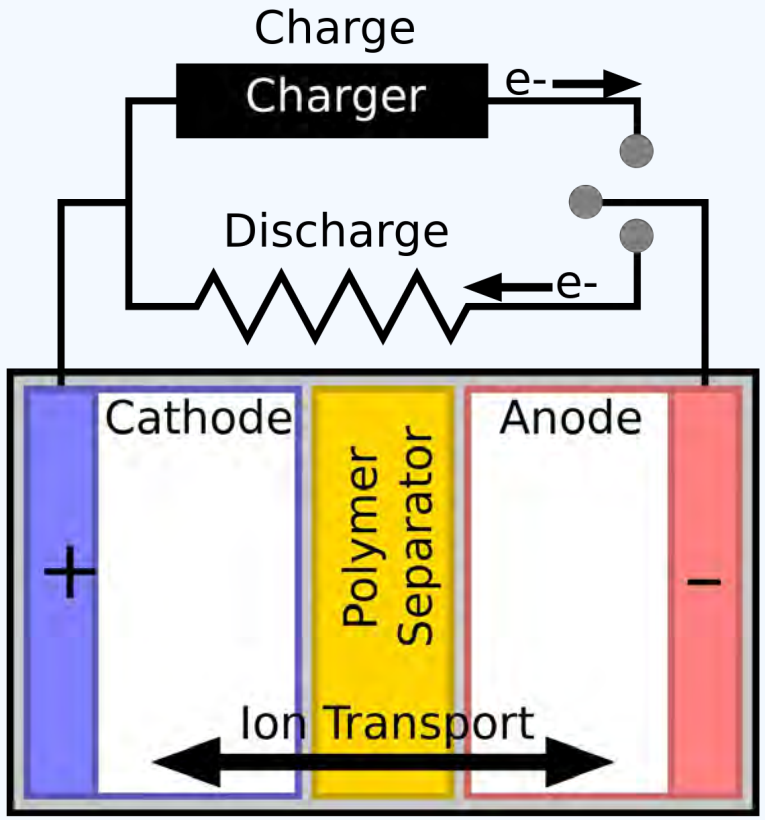
- short lifespan
- store electrostatic charge
- high power

Batteries

- long lifespan
- store charge faraidacally
- low power

HYBRID

Our Product



PDI Material **Lithium**

Motivation

Aim: Hybrid Electron Storage Material

Benefits

Made out of PDI

- Commercially available
- Non-toxic
- Cost-effective
- Environment friendly

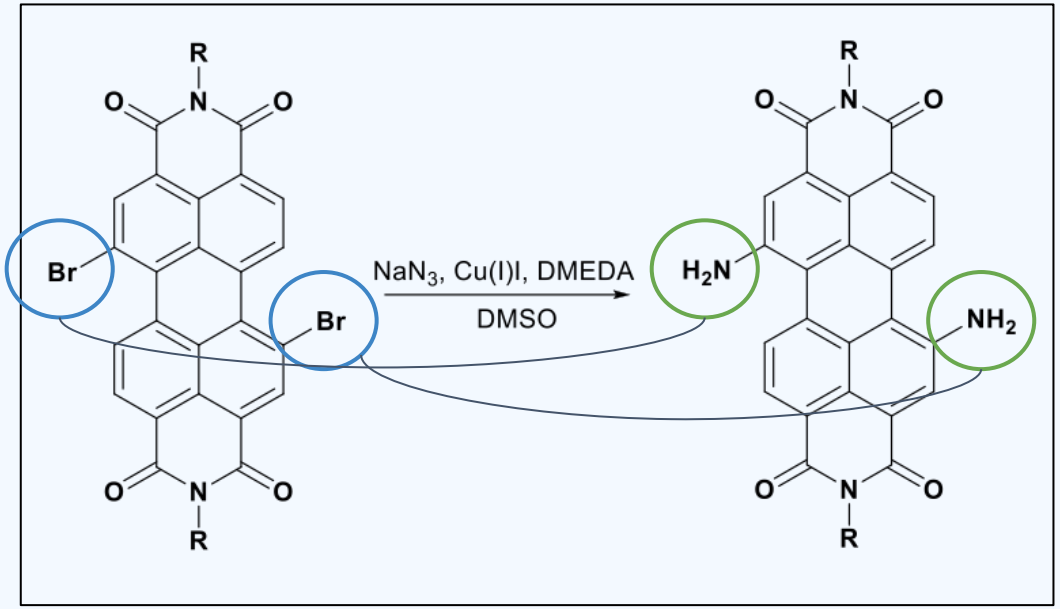
Examples of Use

- Power outage
- UPC to backup computers
- Regenerative braking
- Electric scooters

Methods

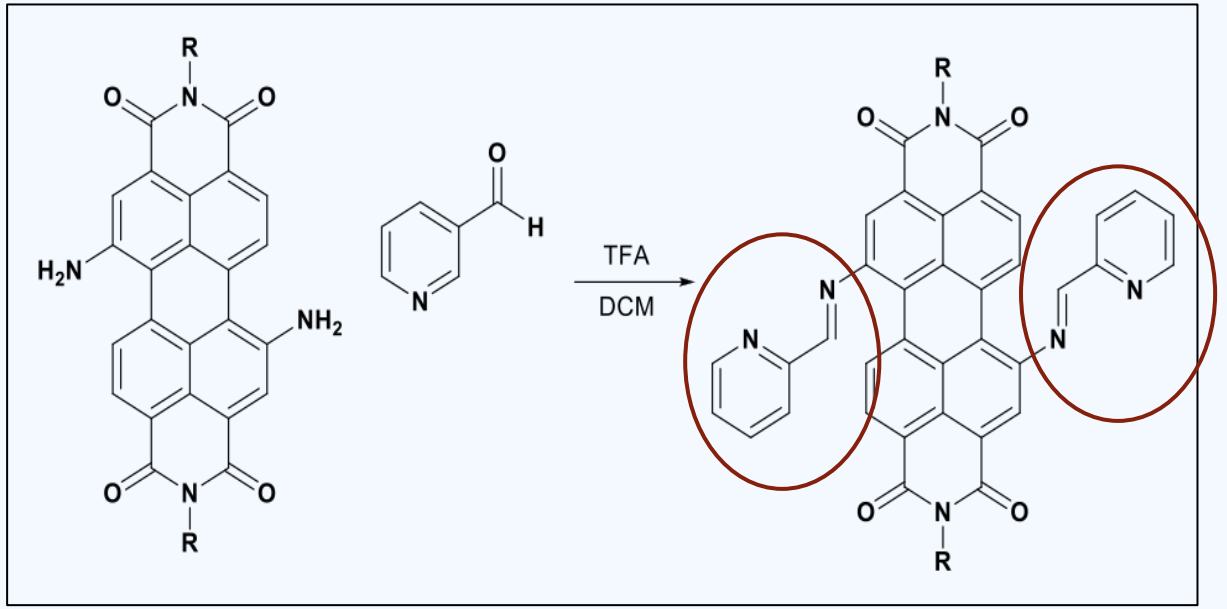
Creating Battery Material

Reaction #1: Substitution



diBromo-PDI → diAmine-PDI

Reaction #2: Addition

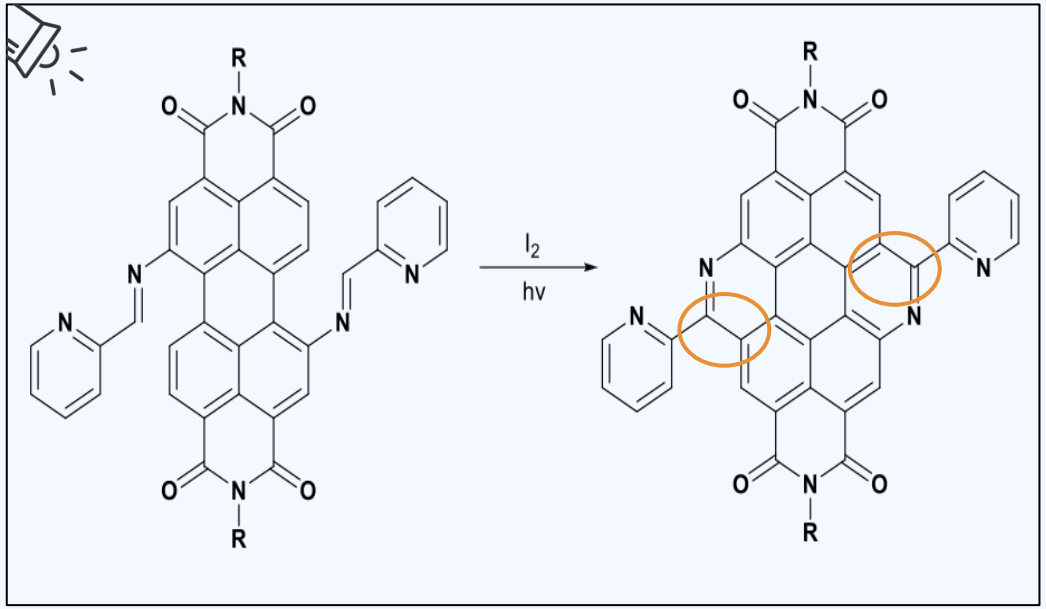


diAmine-PDI → PDI-n-Pyridine

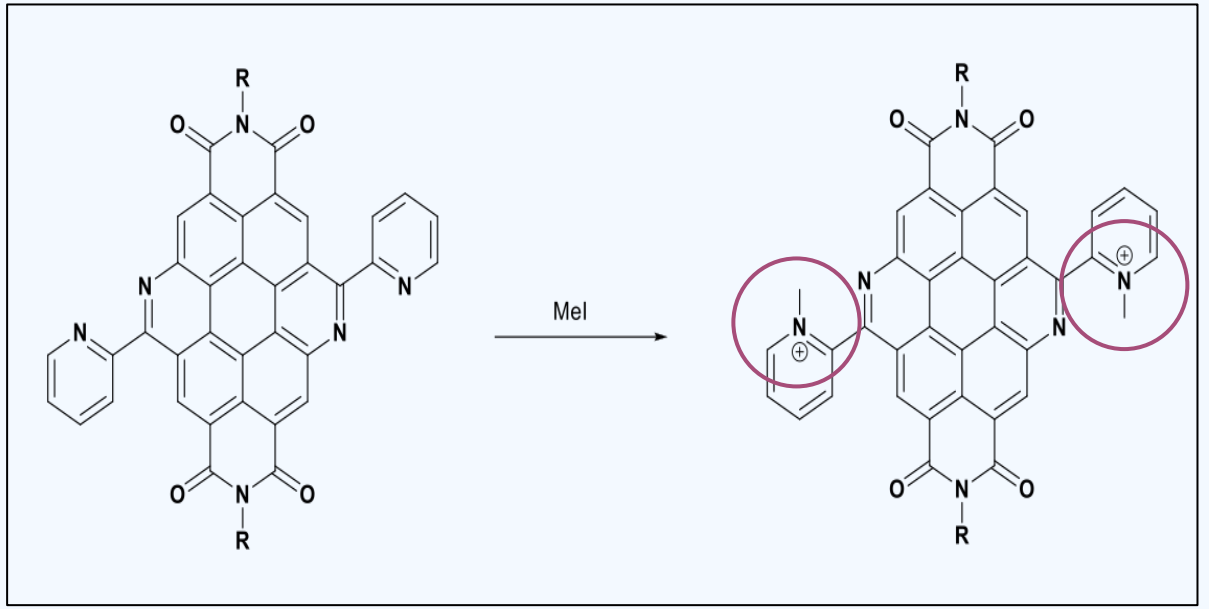
Methods

Creating Battery Material

Reaction #3: Light



Reaction #4: Methylation



PDI-n-Pyridine → PDI-n-Pyridine+

Methods

Building Batteries

Battery Parts

Positive case

Working electrode

Separator

Lithium metal

Spacer

Spring

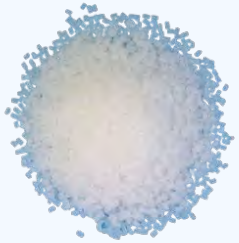
Negative case

Glove Box

Assembly of our batteries took place in an argon **glove box**:

- Oxygen-free
- Stable amounts of argon gas

Carbon Black



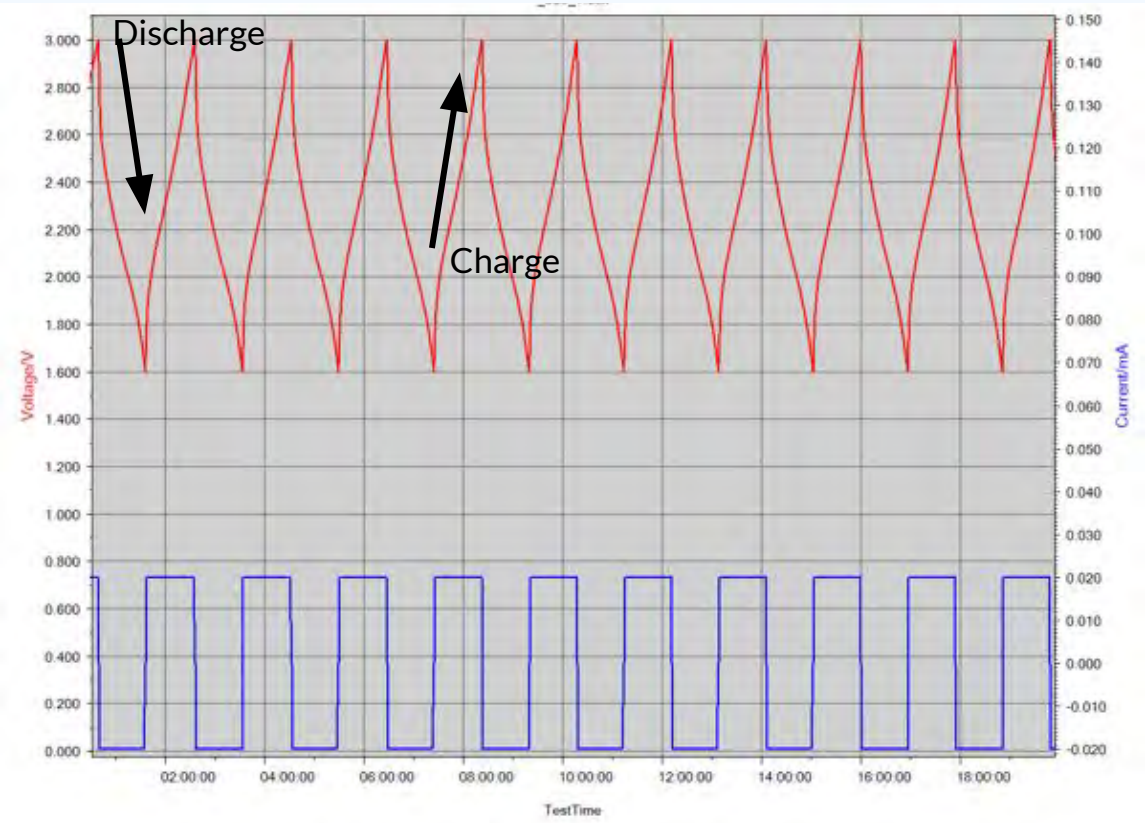
PVDF (Binder)

PDI-n-Pyridine/(+)

Results

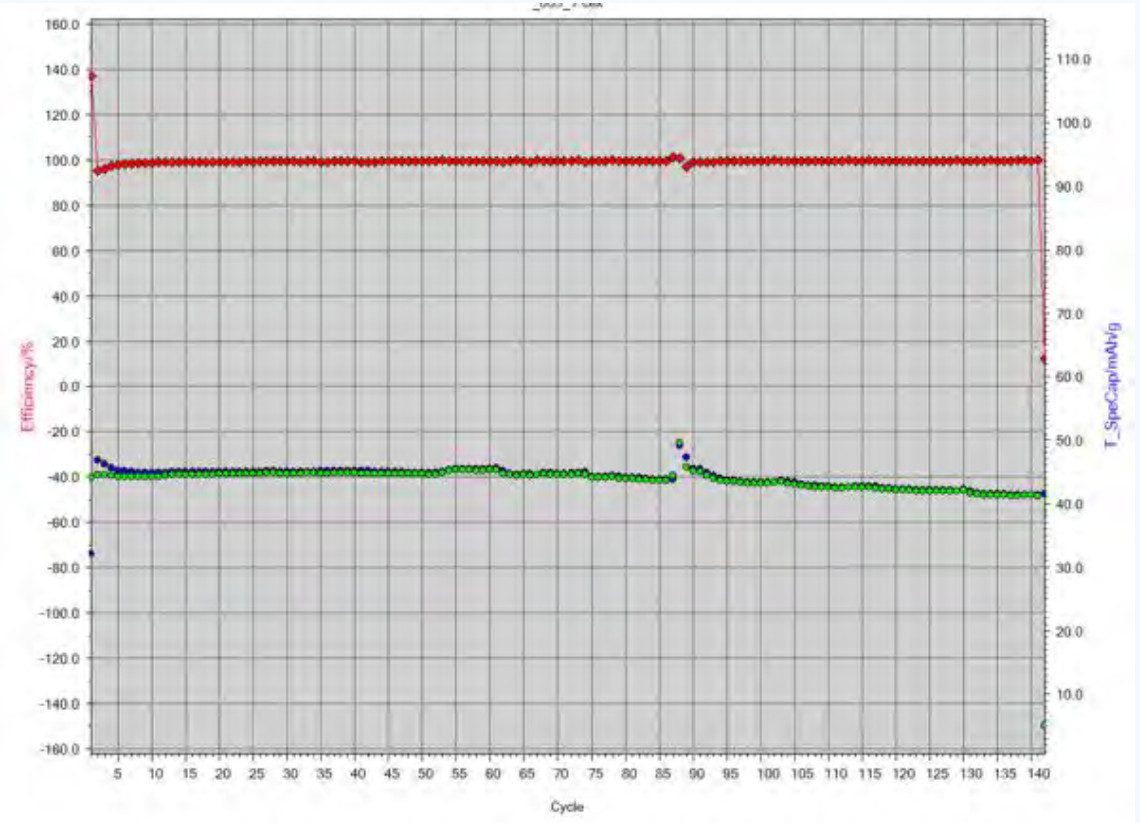
Battery Testing #1: PDI-n-Pyridine

Charge/Discharge



= Voltage = Current

Efficiency/Capacity

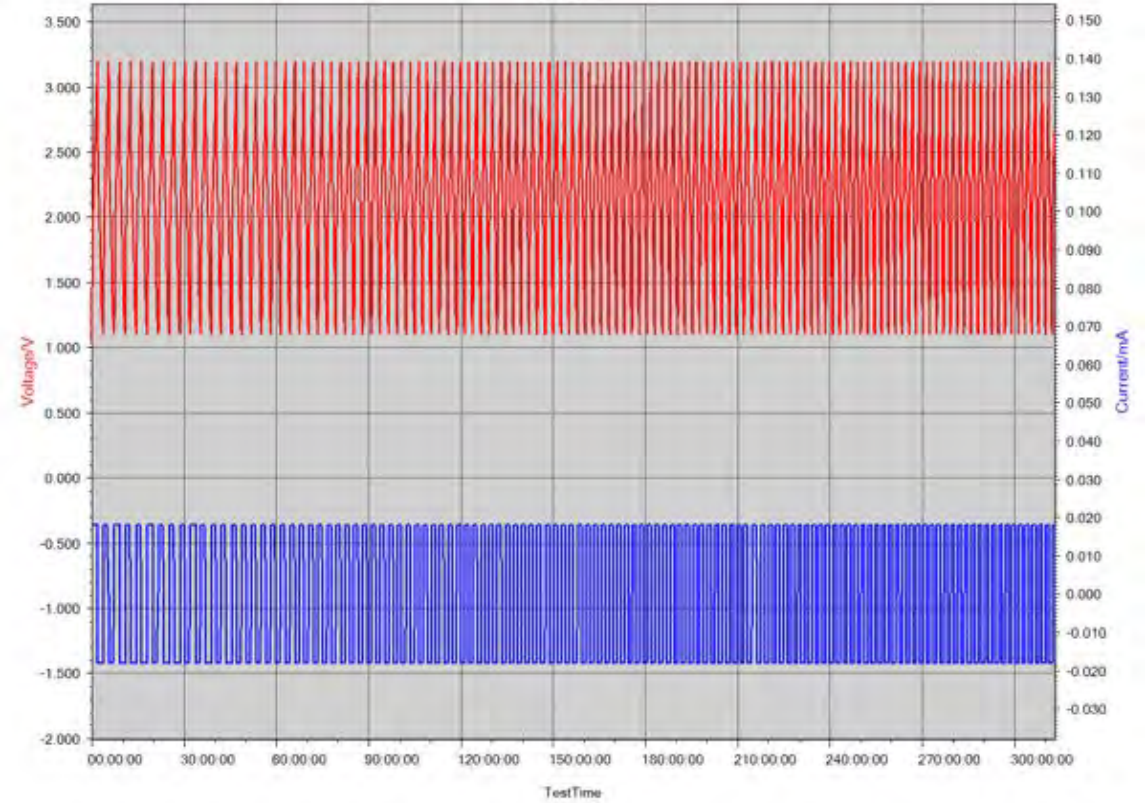


= Efficiency = Capacity

Results

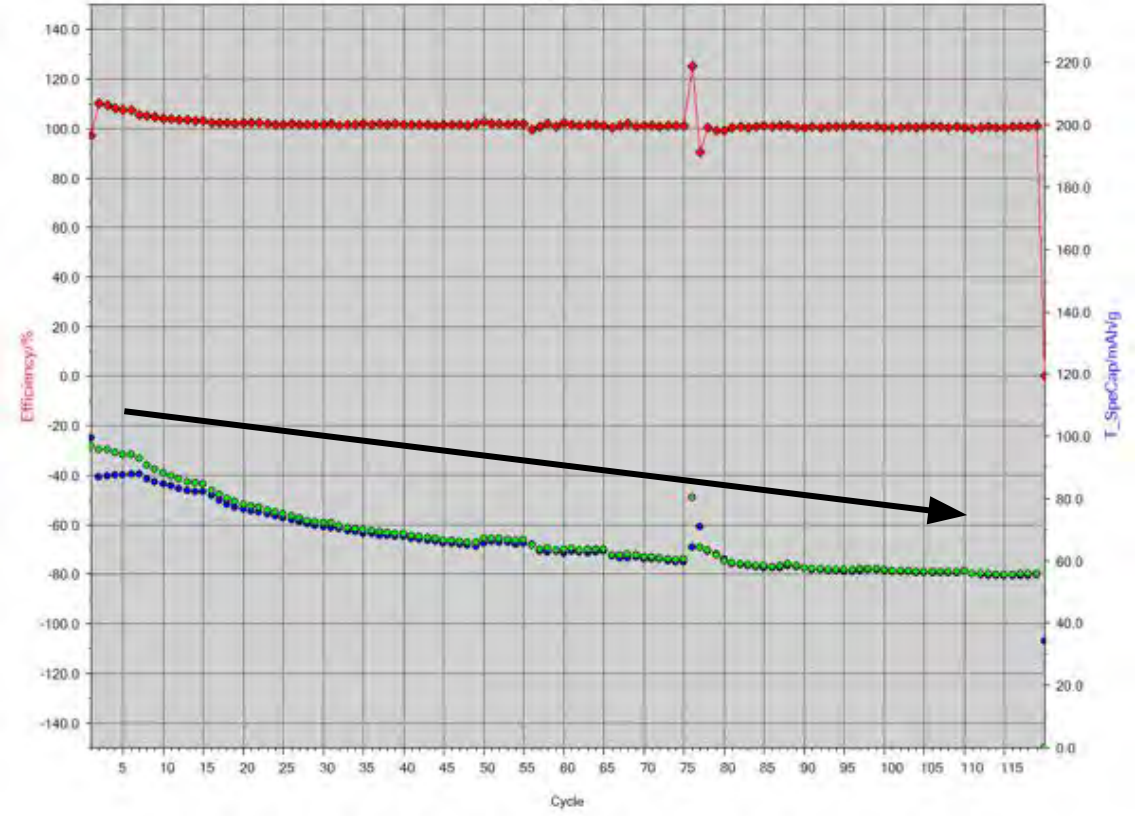
Battery Testing #2: PDI-n-Pyridine

Charge/Discharge



= Voltage = Current

Efficiency/Capacity



= Efficiency = Capacity

Summary

Created **Two Materials** for Battery Testing With the Aim of Producing PDI That Can Accept the Most Electrons

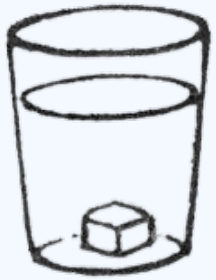
PDI-n-Pyridine	**PDI-n-Pyridine(+)**
• three-step reaction • greater than 99% efficiency • difference in cycling one electron versus two electrons	• four-step reaction • did not cycle • further testing needs to be done • has potential

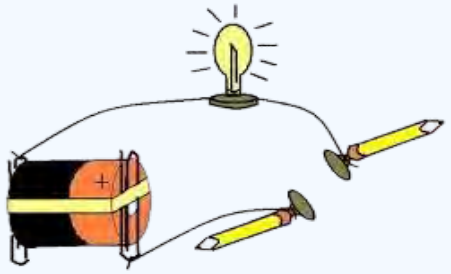
PDI-n-Pyridine **>** PDI-n-Pyridine(+)

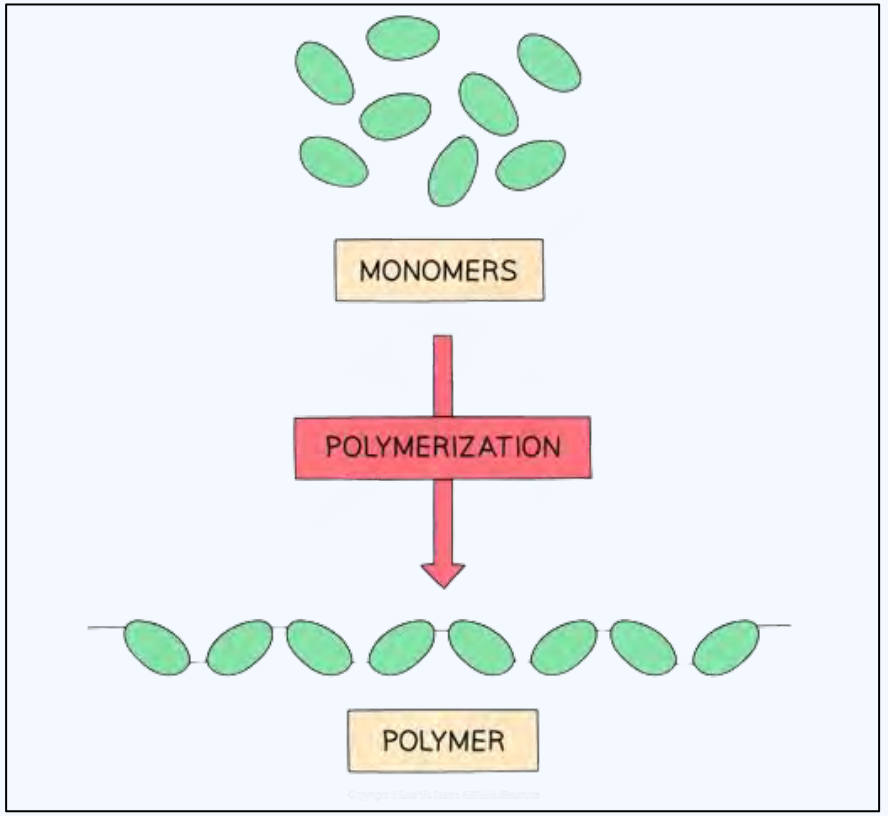
Future Direction

Next Step: Work Towards Creating a Functional Hybrid Commercial Battery Material

- Turn it into a **high storage** material
- **Polymerize** our product
  - increase molecular weight
  - more insoluble
  - greater conductivity







ENG Experience

We are really grateful for our experience the past six weeks!

Acknowledgements

Nuckolls Lab, Columbia University

[redacted]

Columbia Engineering Outreach

[redacted]

Thank You For Listening!

Any Questions?

Thanks for joining!

Follow up questions or comments:
engineeringoutreach@columbia.edu

Sign up for the monthly newsletter, on our website, to stay connected!

outreach.engineering.columbia.edu

engineeringoutreach@columbia.edu