



## **Book of Posters**

**Louis Stokes Alliances for Minority Participation (LSAMP) – Fall 2021**



# Fabrication and Assessment of a Flexible Graphene Thin film for Lightning strike protection

CRSP Program- New York City College of Technology, CUNY- Department of Mechanical Engineering Technology

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## Abstract

Lightning strike protection (LSP) have recently been a newly developing field particularly with the emergence of graphene thin film integration into carbon fiber composite structures. This technology has a widespread application in airplanes, wind turbines, and other instruments susceptible to frequent lightning strikes. This study will look at different methods for incorporating GTF (graphene thin film) into Carbon Fiber Reinforced Plastic and assess the electrical conductivity. through methods such as fabrication of a highly conductive functionalized nanosized GTFs, and combined use of carbon nanotubes (CNTs) and graphene nanoplatelets (GNPs). In the current study we will develop GTF using GNP impregnated polymer. Successful development of highly conductive blends could result in increased safety standards of aircrafts, reduced maintenance costs for wind turbines, and increased usage of wind energy.

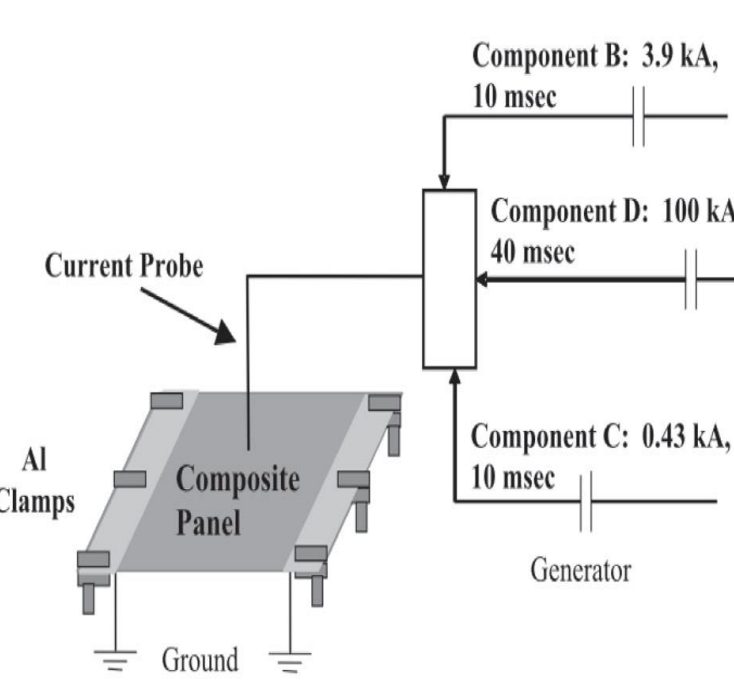
## Introduction

Lightning strike protection (LSP's) have recently been a newly developing field particularly with the emergence of graphene thin film integration into carbon fiber composite structures, particularly in airplanes, wind turbines, and other instruments susceptible to frequent lightning strikes. This study will look at different methods for incorporating GTF (graphene thin film) into Carbon Fiber Reinforced Plastic, and assess the electrical conductivity, through methods such as fabrication of a highly conductive functionalized nanosized GTFs, and combined use of carbon nanotubes (CNTs) and graphene nanoplatelets (GNPs). The following presentation compared three viable methods for graphene lamination- pristine graphene rolling, 3-D stitching, and carbon nanotubes (CNTs) and graphene nanoplatelets (GNPs) integration.

## Methods Adopted and Data Collection

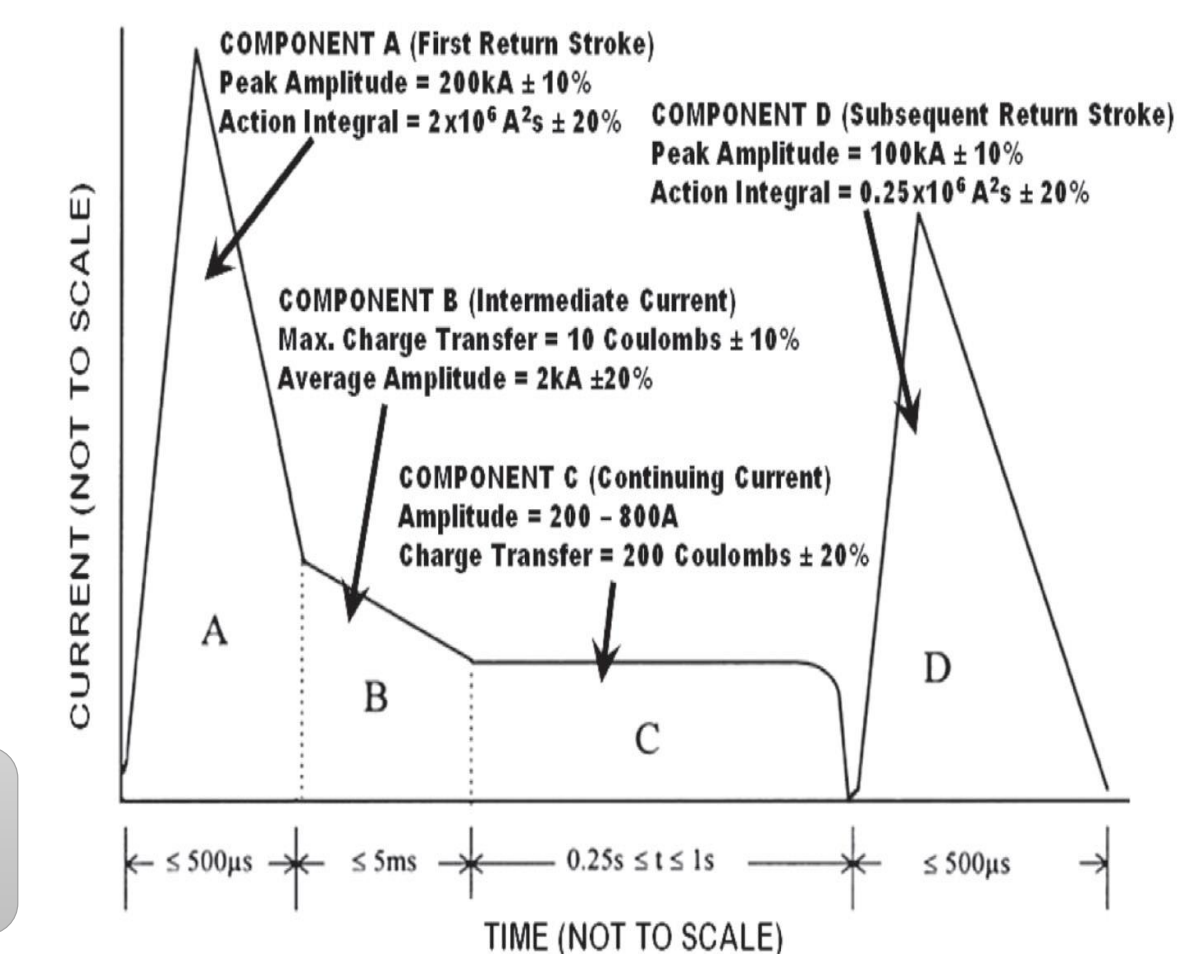
Three different methods were analyzed during the study. According to Zhang et al. (2017), flexible GTF's made of pristine Graphene were made using a process involving sonication. An input power of 50 W was applied on the test side and the energy was measured using open hole measurement of the reception side with a test panel. The difference between the open hole reference and the test-panel was considered as the shielding effectiveness of the material. On the other hand, the GTF fabricated by M Rahman et al. (2019) devised a method involving 3-D stitching of carbon fiber and GTF for the composite layups. The samples were neutralized and filtered. The third paper, Li et al. (2017) attempted to create synergistic effects by spray coating hybrid carbon nanoparticles on CFRP Laminates. Nanoparticles were sprayed using an airbrush system, and encapsulated with resin film, allowing much lower resistivity and increased electrical pathways.

Figure 1- Displays the impulse test applied by Zhang et al. (2017). High current was applied over very short periods of time



The Hybrid CNT/GNP were compared with reference CNT to measure surface electrical resistivity with reference to depth.

Figure 2- Displays the region-wise current test applied by Li et al. (2019).



## Test Data & Results

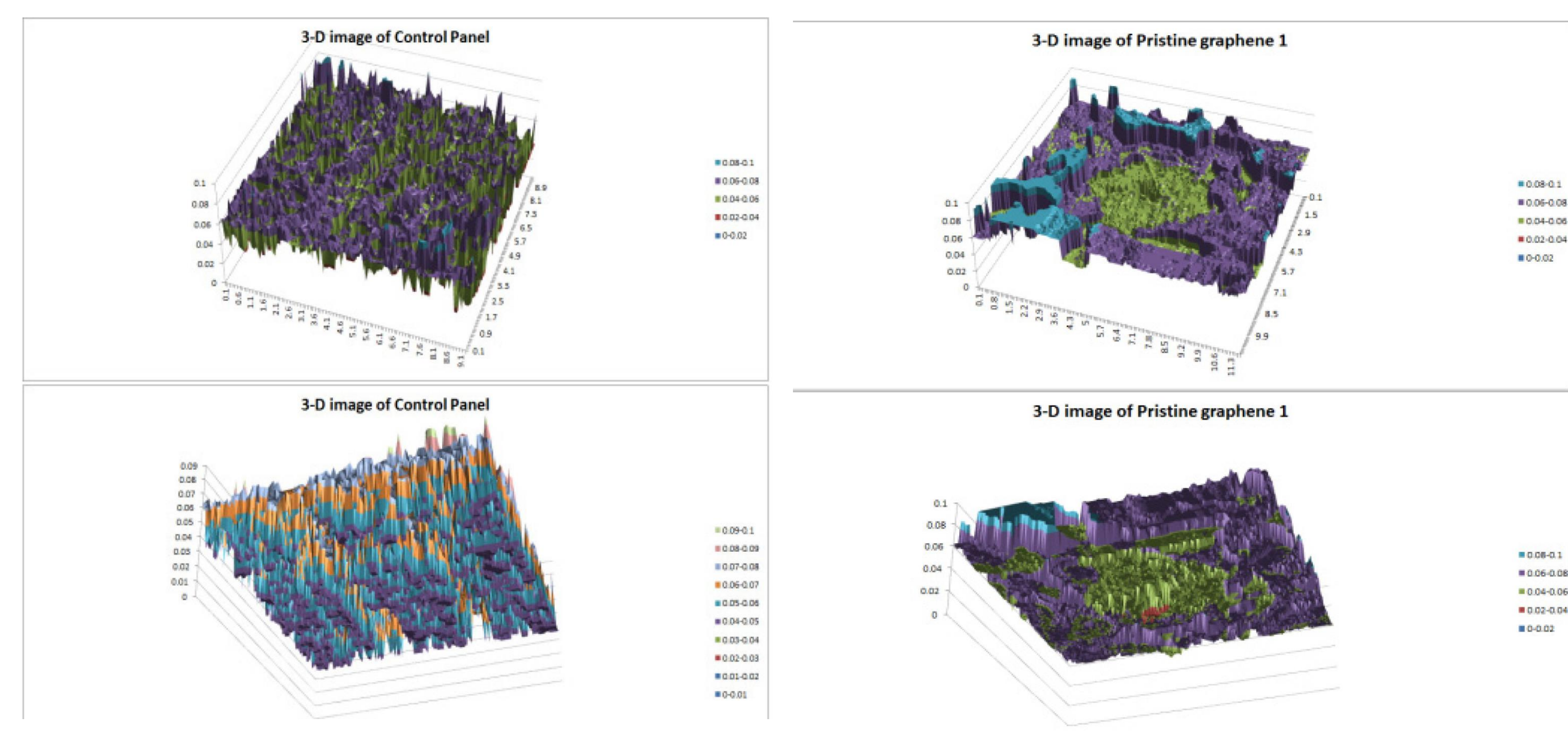


Figure 3- Demonstrates relative damage to the panel after impulse strike. The second diagram shows the area damaged by the impulse strikes. Zhang et al. (2017)

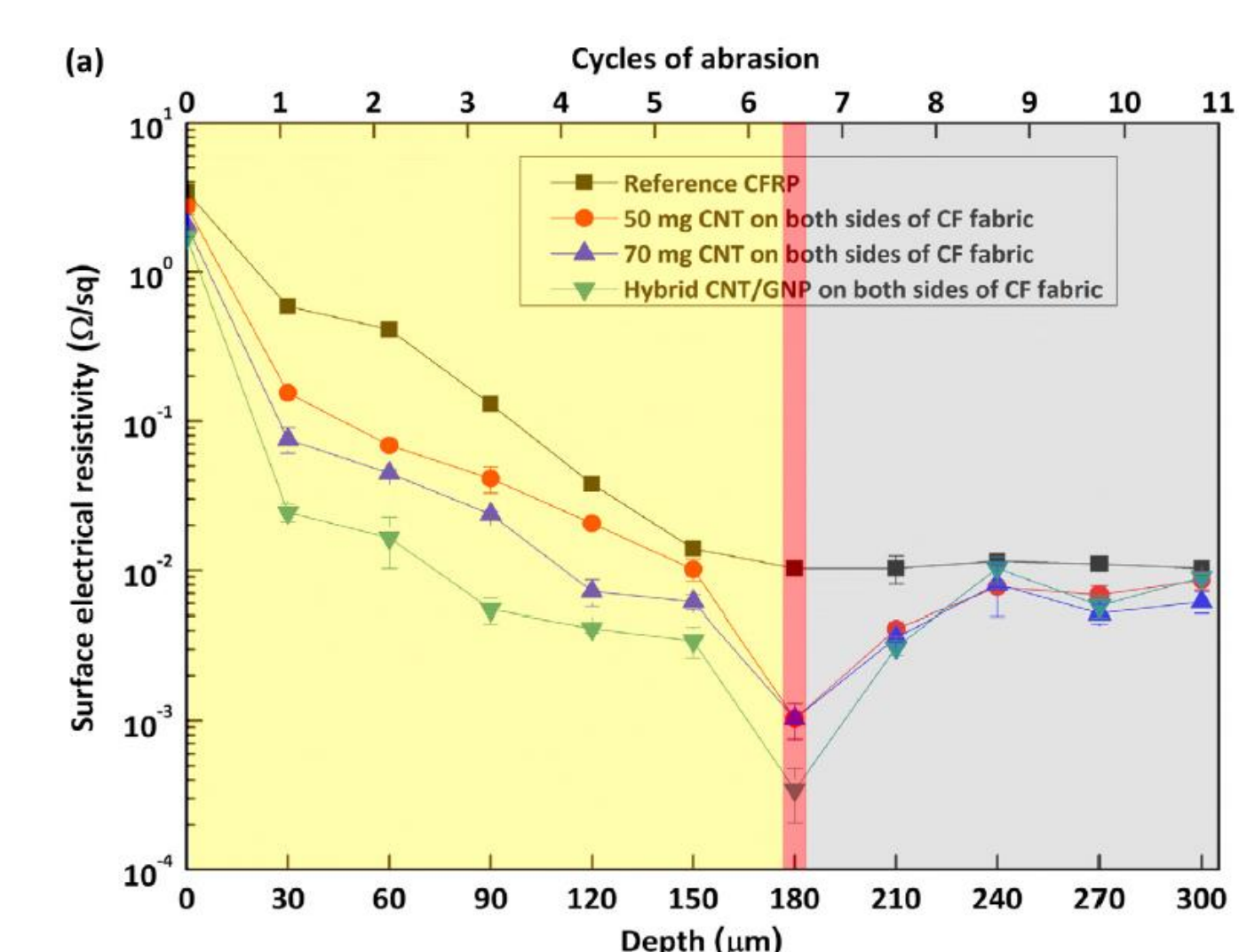


Figure 4- Displays Surface electrical resistivity of different nanocarbon modified CFRPs in relation to surface depth by Li et al. (2019).

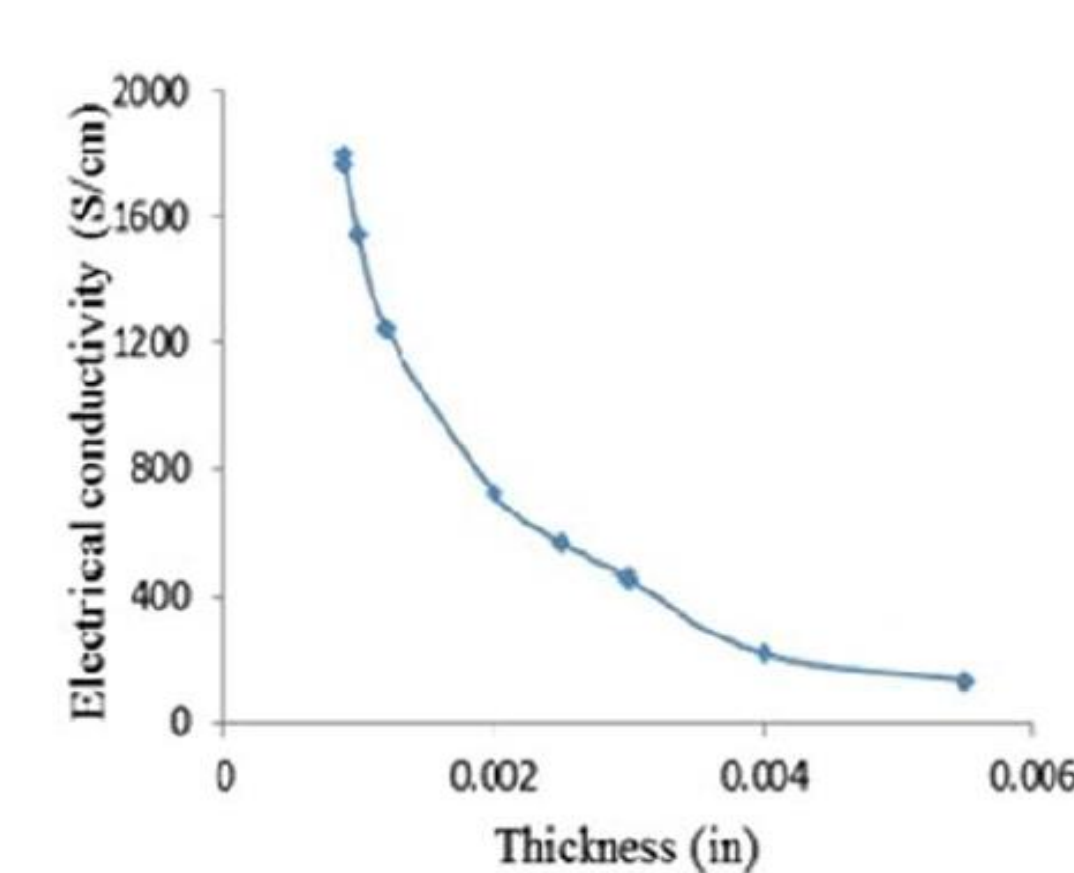


Figure 5- Illustrates how the 3-D stitched samples of varying thicknesses displayed with it's electrical conductivity. M Rahman et al. (2019)

	Control Panel (No Coating)	Panel Coated with Graphene Thin Film
Damage Area (mm <sup>2</sup> )	1.39 × 10 <sup>4</sup>	8.77 × 10 <sup>2</sup>
Fraction of Damage Area (%)	5.4	0.3
Damage Area Reduction (%)	-	94
Damage Volume (mm <sup>3</sup> )	7.07 × 10 <sup>3</sup>	3.06 × 10 <sup>2</sup>
Fraction of Damage Volume (%)	2.7	0.1
Damage Volume Reduction (%)	-	96

Figure 6- Demonstrate the Area and Volume Damaged by the GTF in comparison to the control. Zhang et al. (2017)

## Evaluation and Adaptation

From the data, we can clearly see that graphene in any form reduces the resistivity of the medium. Likewise, a larger depth of graphene also showed reduced resistivity, though, there was an optimum region. Readings higher than that resulted in higher resistivity meaning that the conductive pathways seemed to be hindered in some form. Another evaluation which could be drawn was that pristine graphene clearly created conductive pathways and reduced the volumetric damage to the material underneath the film. These properties examined would mean vital progress could be made to the aviation industry, and in large-scale wind turbines.

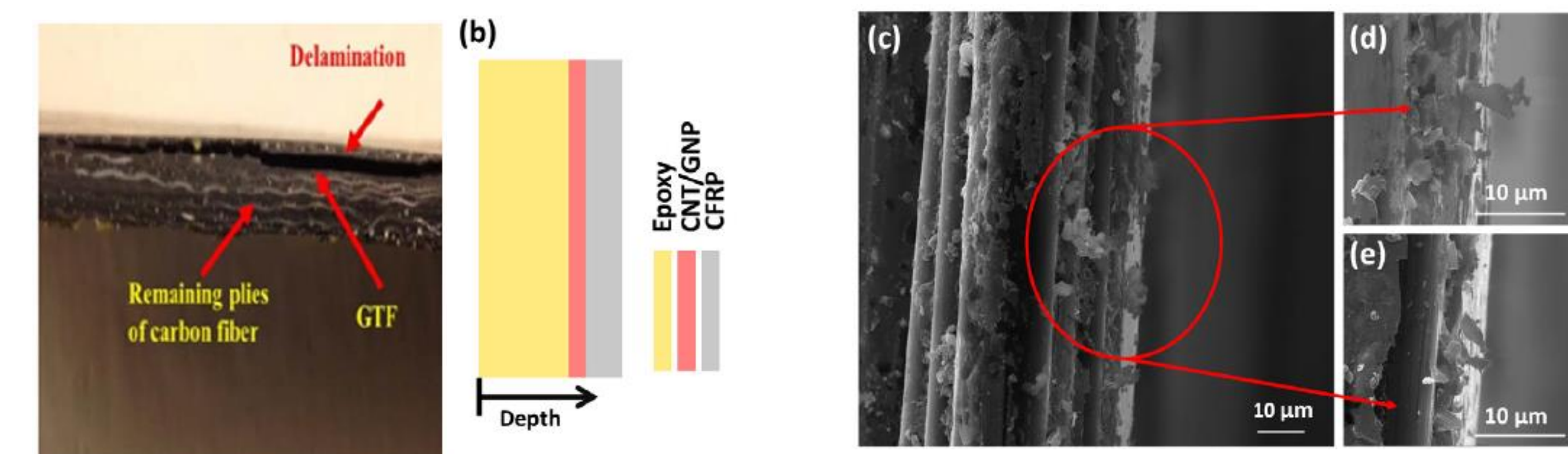


Figure 6 (Left) Demonstrates delamination without 3-D Stitching, while Figure 8 (Right) shows the synergistic GNP/CNT integration by Li et al. (2019)

A future extension of this would be understanding the synergistic relations between the CNT/GNP's, and its conductivity with relation to temperature. In reality, there are a lot of factors which determine materials for aircrafts/turbines. Thus, more intensive testing could be done on the temperature bearing ability, flexural strength testing, and others. Another aspect is the risk of delamination of the panel after repeated strikes. We would also need to study whether the conductive pathways created lead to safe discharge. It is vitally important, that the pathways generated do not risk the safety of passengers in the case of flights. A future extension could be an enhanced understanding of the large area shear crack and warpage of the film.

## Conclusion.

The purpose of the study and the subsequent experiment was to understand the impact of Graphene nanoparticles on CFRPs. This assessment should help us reduce the risks of Lightning Risks. In the case of wind turbines, this would hopefully encourage more people to take up wind-energy, since now there would be a reduced risk of lightning strikes.

## Acknowledgements

I would like to acknowledge Prof. Akm S Rahman for supporting me throughout, and the CBML Lab for its facilities.



# Development of dry sanitation systems with biodigester as a cleaner alternative to modern flush based plumbing system

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In a modern society, access to restrooms is a key indicator of human health and sanitation- yet 40% of the World's population has limited access to it. Furthermore, over 800,000 deaths worldwide are attributed to inadequate sanitation. In developed countries, where flush based sanitation systems are a standard, there are fundamental questions being asked about the restrooms being connected to both the water supply system and the wastewater infrastructure. The purpose of this paper is to evaluate the downfalls of the flush based sanitation system, and to develop decentralized dry restroom systems which potentially use a significantly lesser amount of water and could potentially provide a value-added product in the form of either energy or fertilizers. Restrooms in remote regions are often expensive to connect to the twin-circulation system, and environmentally unsustainable. We plan to design systems using a biodigester with anaerobic bacteria to decompose the fecal matter into treated water, and methane, which could then be potentially used as a fuel source. This would be expected to provide approximately 240KWh of energy for every metric tone of waste released in the restroom.

## Introduction

The flush toilet invented by modern civilization provides us a hygienic and comfortable life. However, the pollution problem brought about with the conventional waterborne sewage system has lately attracted considerable attention. The untreated sewage is polluting groundwater, rivers, lakes and coastal areas. Globally, the energies consumed in water utilization including the construction of water resource development facilities, the arrangement of water service and sewage, and the use of water service and sewage are 10900 trillion kcal. The electric power consumed in water service and sewage in 1997 is 137 hundred millions. Therefore, we are undertaking a double task of trying to improve the imperfections in sanitary condition of conventional toilet systems on one hand and protecting the environment against the waterborne sewage pollution on the other.

This has potential applications even in the US, where there is a shortfall of funding in maintaining public restrooms in remote areas, with 20 million \$ being allocated for the development and maintenance of restrooms in remote regions. Therefore, functionality, and portability of the system was also considered to ensure minimal parts and assembly was required for the system.

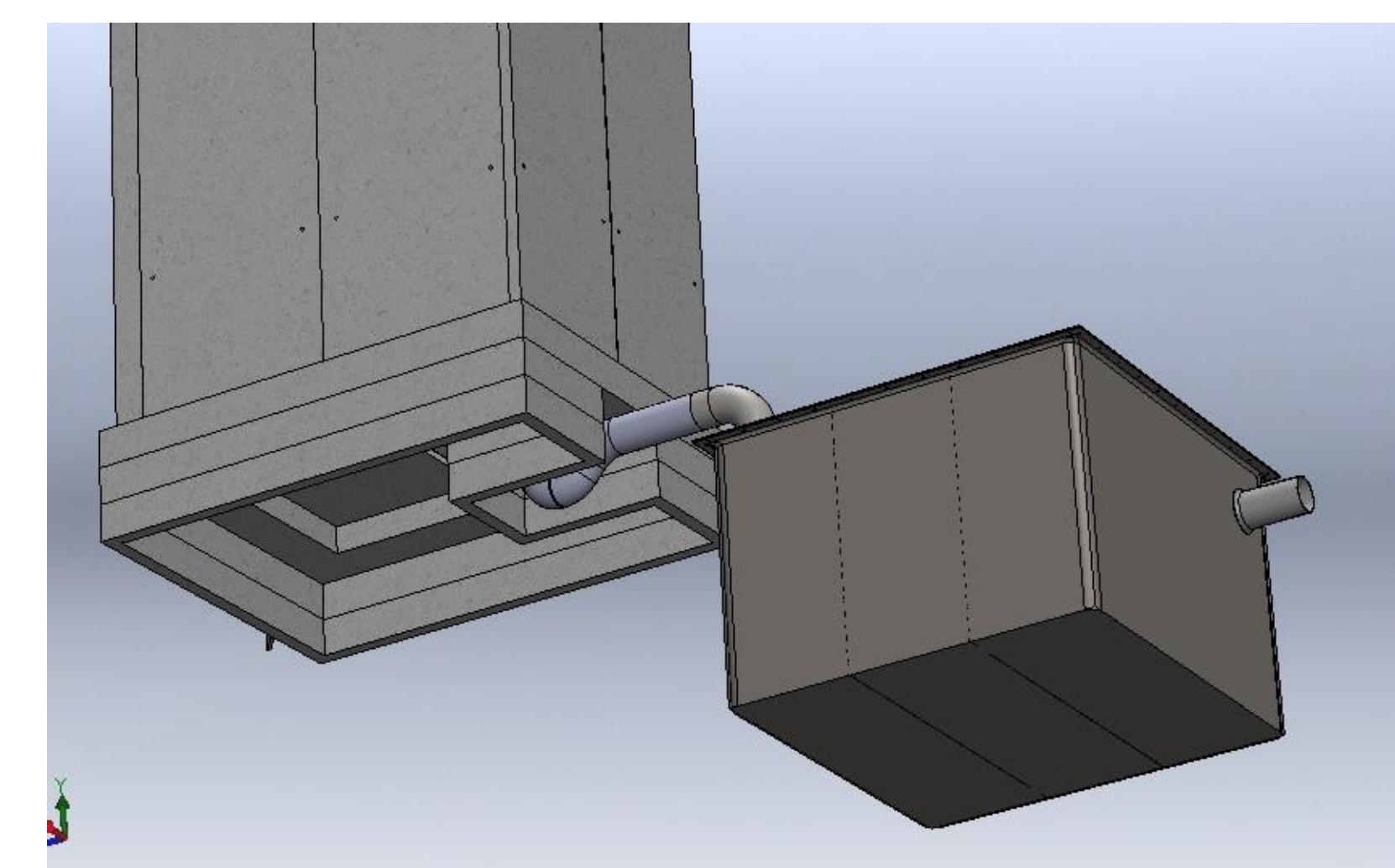
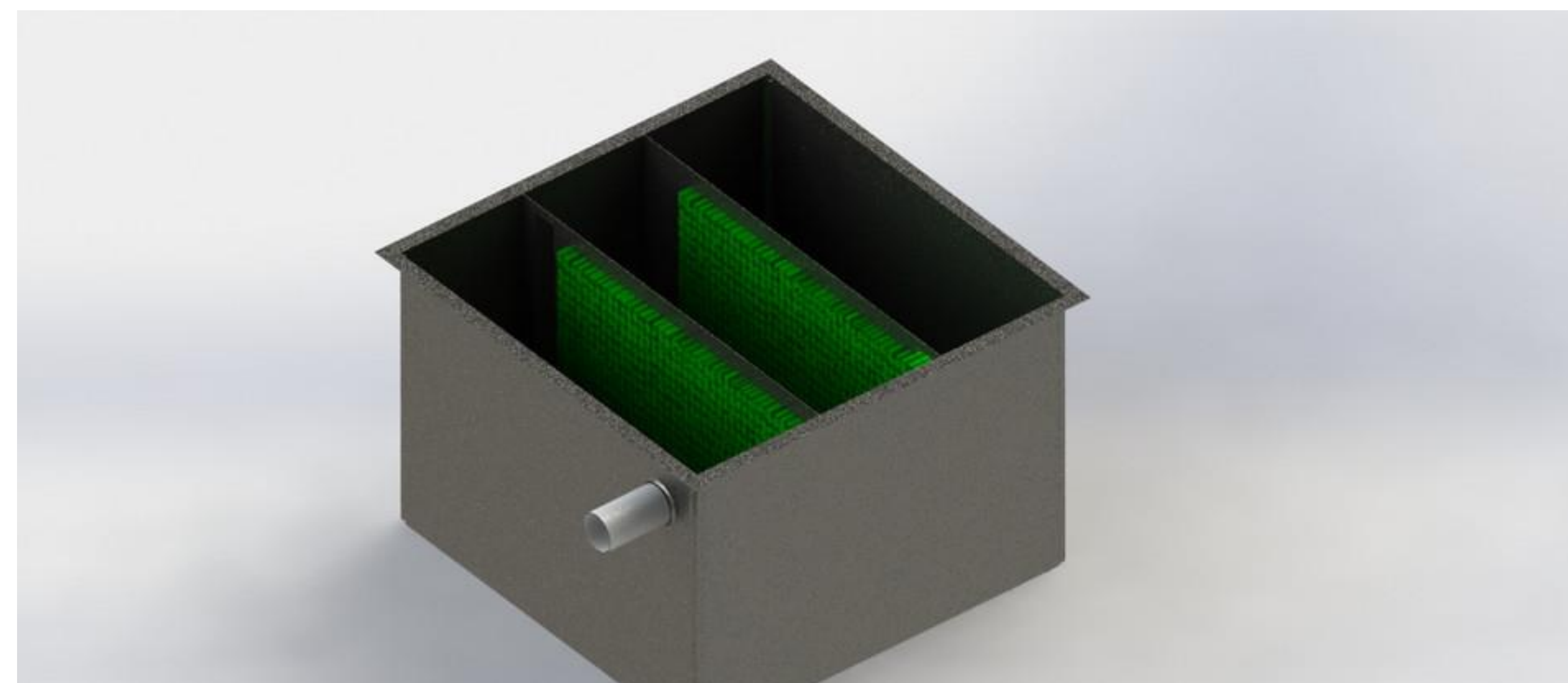


Figure 1 (Top)- Design of Bio-digester. The green area illustrates a wrinkled membrane for maximum interaction with the anaerobic bacteria.

Figure 2 (Left)- The plumbing system connecting the restroom to the underground biodigester

## Design Specifications

- The surface area to volume ratio has been minimized to improve the contact area for the anaerobic bacteria. This has been done by using surface wrinkling patterns. This will work optimally between 70-100 degrees F.
- 6 compartments have been created with 10 mm filters to allow the passage of processed water.
- Piping has been provided for the release of methane. With the use of a combustor, this could be converted to potential energy.
- The water released in the study was found to be gray water. This means that this is not drinkable. Ideally, this can be used for other miscellaneous purposes which do not require contact with the skin, such as irrigation. Alternatively, the water could be further processed to form higher quality of water.
- The size has been adjusted to meet the requirements of a single two-member household. The size could be adjusted with the same volume-surface area for a larger household.
- Mobility has been a key concern while designing this system. The design is set at 540 mm by 1140 mm. The idea that this can be reassembled easily, and that this design is portable means that this can be used in remote areas, and hiking sites. The design is mobile, so it can further be used for specific events, or for short-term housing projects.
- The design is not connected to the grid which allows for increased flexibility in usage.
- The wood chips don't need to be restocked, since they only act as a catalyst, so once this system is placed underground, it can stay without supervision for at least 3 years.
- The strain of anaerobic bacteria being used *Planococcus matriensis* and *Clostridium schirmacherense* is immune to most types of hard cleaning solvents, and detergents used in the restroom. Furthermore, the bacterial nature means that if the restroom is not used for a period of time, the bacteria is simply deactivated.

## Biological Principle

The principle and the structure of the bio decomposition toilet are the same as that of family garbage processing machine. Human waste is decomposed directly along with the slow rotation of the wood tips or sawdust in a box. This is further enhanced by adding anaerobic bacteria, to catalyze the breakdown of the waste. The anaerobic bacteria, in an ideal temperature of 80-90 degrees F should break down the domestic waste completely down to processed water and methane within a period of 48 hours. The anaerobic bacterium used (*Planococcus matriensis* and *Clostridium schirmacherense*) should be self replicating, and therefore the need for supervision and maintenance is avoided. The decomposition of the human waste is further catalyzed about by the microbe (mainly the soil bacteria) settled in the wood tips and the sawdust. A motor can be further used to stir the wood tips and the sawdust. It can further be designed to various sizes from a large toilet such as public toilets to a portable size for the use of nursing.

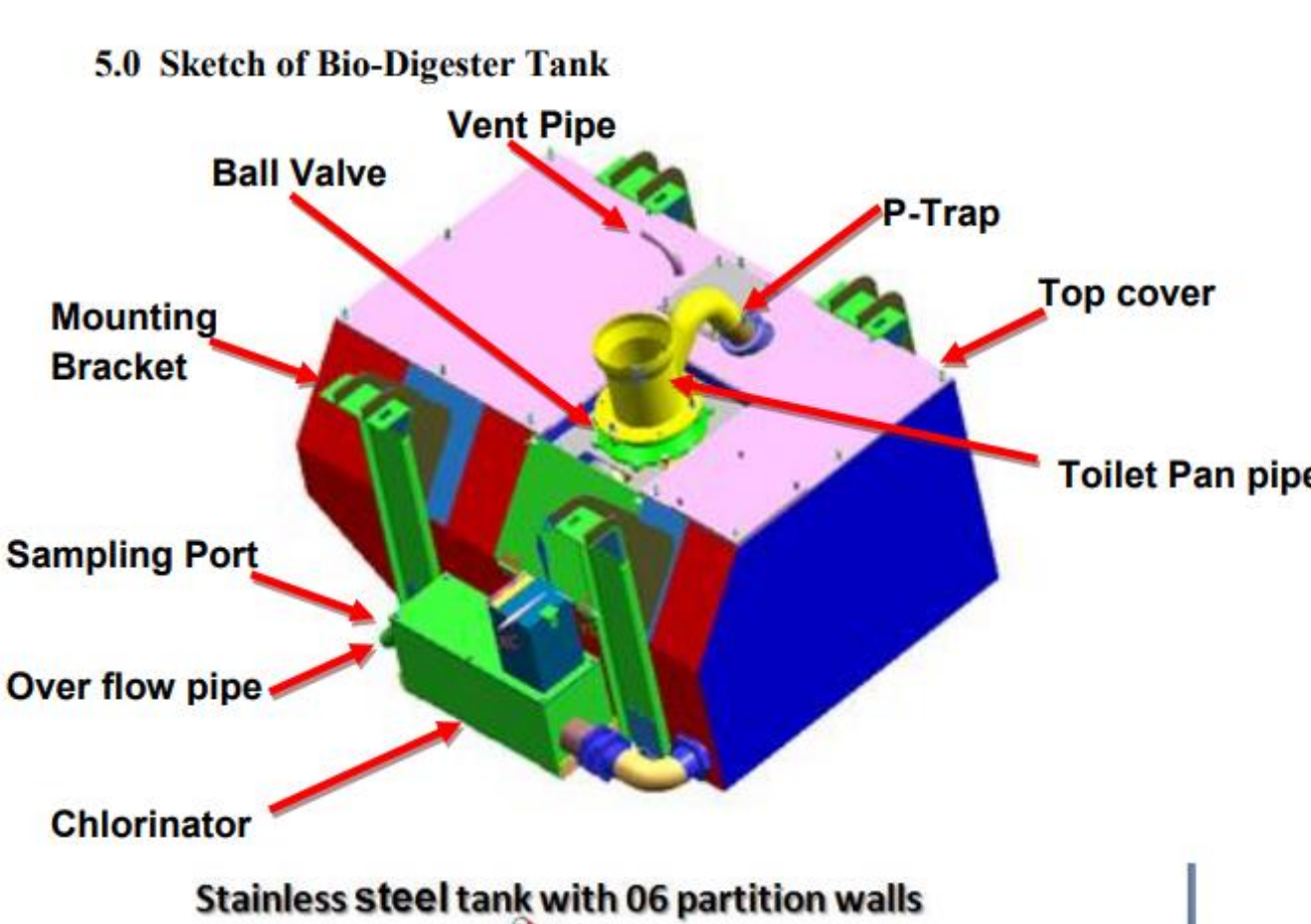
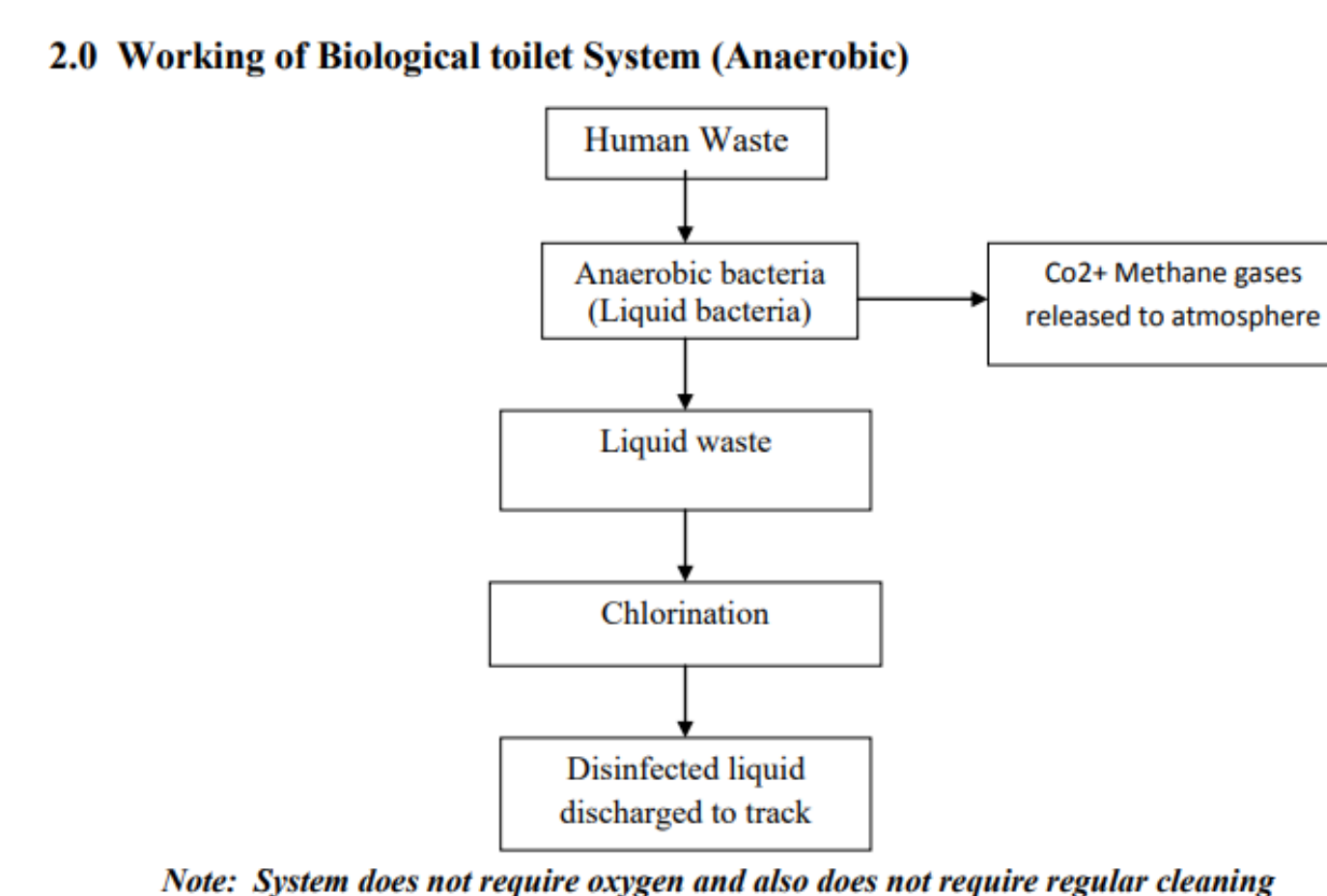


Figure 3 (Top)- Annotated design of the compartments in bio-digester.

Figure 4 (Top-Right) Steps for processing of fecal waste in bio-digester

Figure 2 (Right)- Portable nature of bio-digester and lack of connectivity means that this can be used in remote locations



## Environmental Impact

The environmental viability aspect was one of the primary focal points. The system would need to be decentralized and consume a significantly lower volume of water than existing systems. The treated water would also have to be safe to use for farming. Modelling and simulations have also been conducted to study the efficiency, carbon deposition and carbon embodiment of the system to ensure minimal environmental impact. The project is expected to release 20-50% carbon embodiment compared to a conventional flush based system, across its entire system life cycle.

## Conclusion

The purpose of this design is to examine how bio-digestors can be designed as a part of an integrated sanitation unit, or as a sanitation unit. The study examines design pitfalls and creates a design parameter that can be re-adjusted (depending on occupancy or usage), while retaining the original research on the microbes, and the surface area to volume ratio. This line of designs would provide us with an important innovation towards more environmental conscious designs.

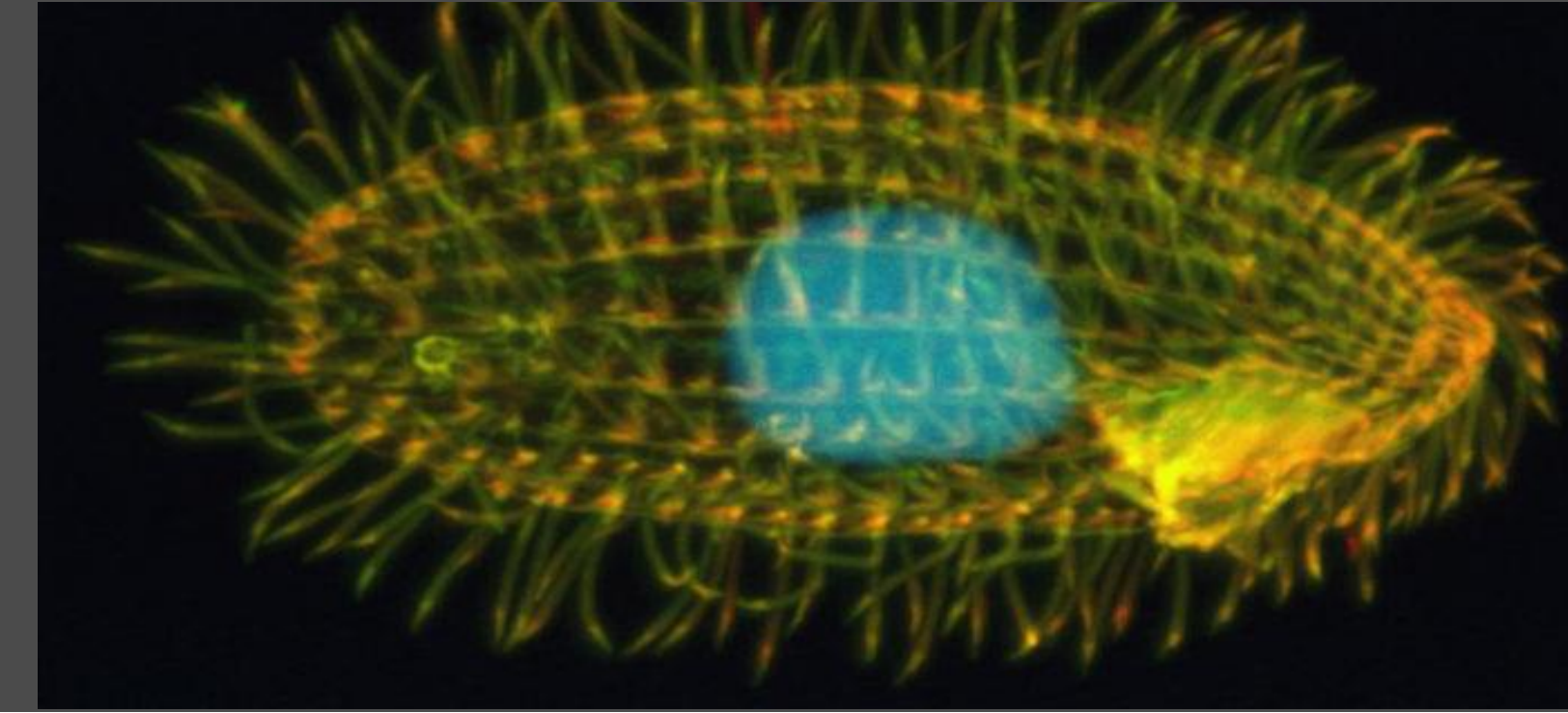






# Computational Characterization Of Calpains In *T. thermophila*

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## Abstract

Calpains are a set of calcium-dependent cysteine proteases that are found in almost every type of living organism, except archaeobacteria. Calpains share a set of common domains that help with their function as proteases. These domains are also used to classify the various Calpains. For example, in animals there are two classes of Calpains, classical and nonclassical calpain. Classical calpains contain C2L, PEF and CysPc domains while the non-classical calpains do not have C2L and or PEF domains. Calpains have been shown to play important roles in cell death, diabetes and neurological diseases such as Alzheimer's disease. Although calpains are being studied extensively, one are or cell model that has yet to be studied is in *Tetrahymena thermophila*.

*T. thermophila* is a ciliated protozoa which lives in lakes, ponds, and streams. These eukaryotic cells have two nuclei, a macronucleus and a micronucleus. The macronucleus is involved in vegetative growth while the micronucleus contains germline information. As a eukaryotic model, *T. thermophila* has been used to study many cellular structures and functions, including histones, cell cycle and cell motility. Although these cells have been studied extensively, they are yet to be exploited to examine the role of calpains. The genome of *T. thermophila* has been sequenced, but information on the thousands of genes in these cells is yet to be assigned. Therefore, the goal of this project was to use computational tools to begin examining the structure and function of THERM\_00898290, one of *T. thermophila* family members. This protein was selected from about 27 different calpain family members. Multiple alignment was done using MUSCLE, T-Coffee and MAFFT. Phylogenetic analysis was done using Phylogeny.Fr and MEGA. Protein structure was modeled using SWISS-MODEL and PHYRE2. Preliminary results suggest that THERM\_00898290 may be similar to human calpain 7 and 15. However, more analysis is needed to confirm which of these two human Calpains is THERM\_00898290 more related to.

## Objective & Hypothesis

The purpose of this research was to characterize human calpains of choice from Tetrahymna thempophila using bioinformatics tools. It can be predicted that THERM\_00898290 is more similar to one or more of human calpains.

## Methodology

### Using TGD to get the Gene of interest Protein Sequence

TGD stands for Tetrahymena Genome Database Wiki. It was utilized to obtain the THERM\_00898290 protein sequence in order to run various alignment.

### Multiple Sequence Alignments Tools

A multiple sequence alignment is a tool use to analyze closely related genes or proteins in order to determine their evolutionary relationships. Alignment tools like MAFFT, T-COFFEE, and MUSCLE were employed.

### Phylogenetic Trees

In order to see which human calpain is closely related to THERM\_00898290 MEGA, MAFFT, and Phylogeny.fr were used. They were employed to create phylogenetic trees in order to gather evolutionary data.

### Protein Structure Modeling

The three-dimensional structure of THERM\_00898290 was predicted using SWISS-MODEL software.

## Results

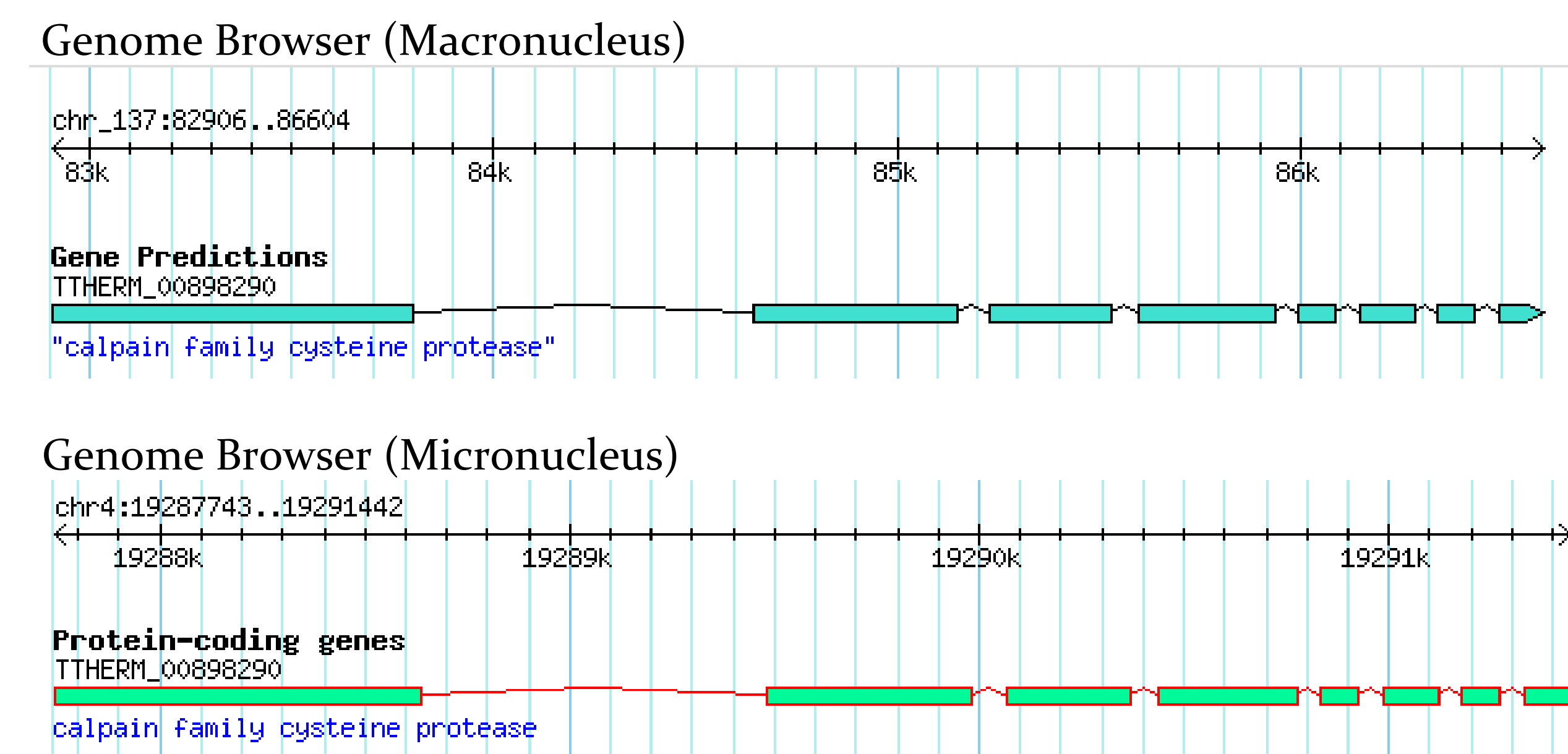


Figure 1: Shows THERM\_00898290 gene structure. Macronucleus and Micronucleus both have 8 exons.

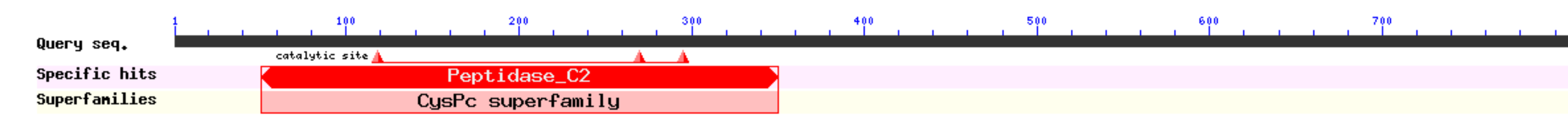


Figure 2: Graphic summary from BLASTp shows amino acid sequence of THERM\_00898290. It shows that CysPc conserve domain that is common to all calpains.

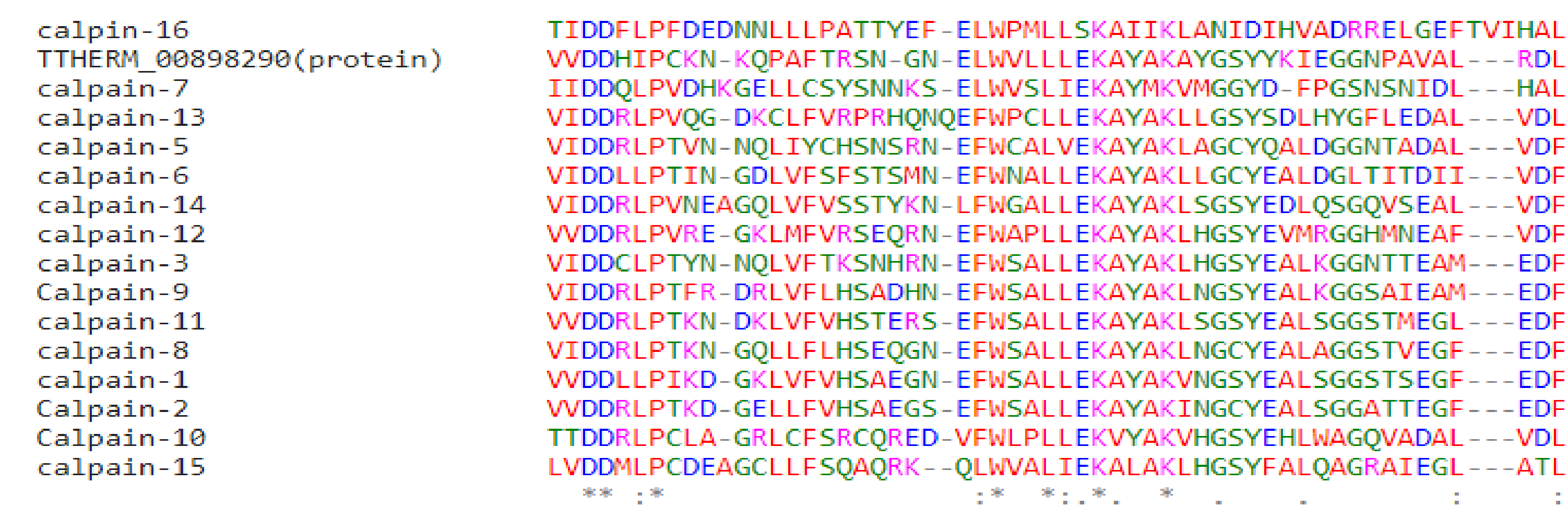


Figure 3: The alignment shown above is from Muscle, and it indicates that the nucleotides P, W, K, D, and L in the column are identical in all sequences in that alignment. "." indicates conservation between weakly similar property groups, ";" shows conservation between highly similar property groups, and "\*" indicates positions with a single, totally conserved property.

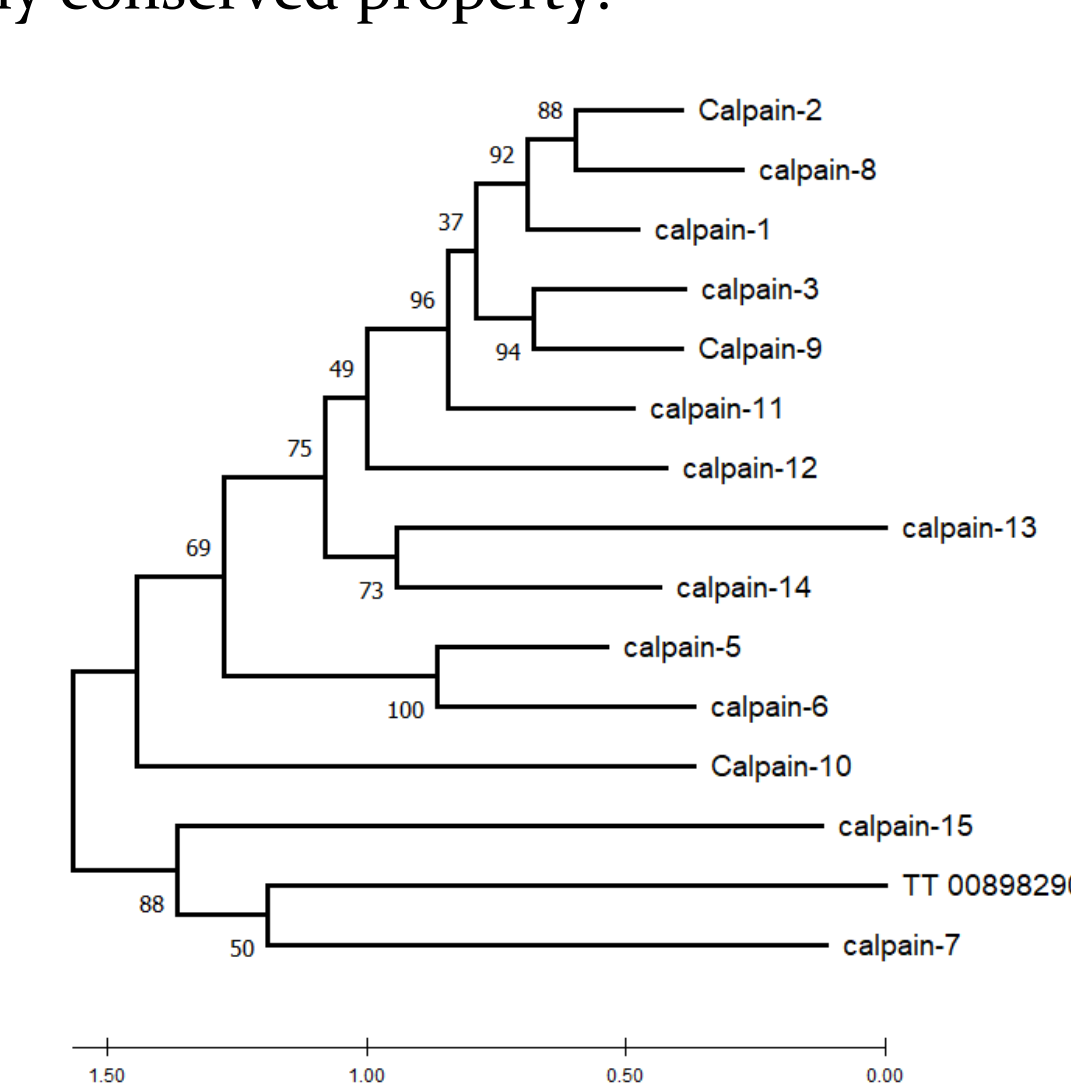


Figure 4: Phylogeny tree of human calpains and THERM\_00898290 from MEGA. Result shows THERM\_00898290 more closely related to Calpain-7. Tree was draw using Maximum Likely method.

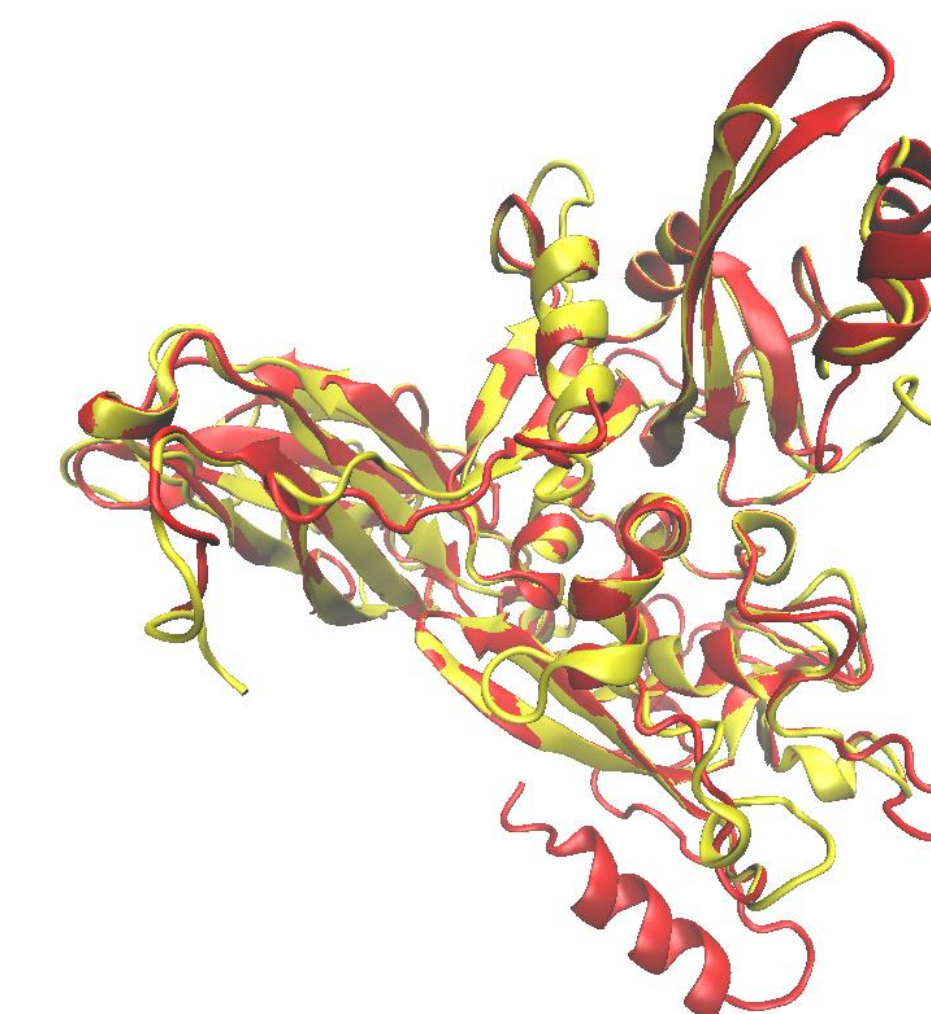


Figure 5: Proteins structure and alignment of calpain 7 (red) and THERM\_00898290 (yellow) using SWISS-MODEL. Many similar regions (blend of red and yellow) and dissimilar regions (separate red and light regions) are seen.

## Discussion

- THERM\_00898290 is one of the calpain family of *T. thermophila*.
- Both the macronucleus and the micronucleus genes are composed of 8 exons.
- Like other calpains, it has a cysteine protease domain.
- Different areas of the protein are conserved in both human calpains and THERM\_00898290.
- Based on phylogenetic and multiple sequence alignments, THERM\_00898290 seems to be more closely related to human calpain-7
- In addition to calpain 7, THERM\_00898290 is also more similar to Calpain-7 and Calpain-15 compared to the other calpains.

## Conclusion

THERM\_00898290 seems to be more closely related to human calpain 7, suggesting these two proteins may have some cellular functions in common.

## Future Directions

This is an ongoing research, and more illustrations can be done to explain why human Calpain-7 and Calpain-15 are so similar to THERM\_00898290.

## Acknowledgements

- I would like to thank Professor Ralph Alcendor for being my mentor for CUNY Research Scholars Program. I really appreciate all of his help.
- I would also like to thank the Undergraduate Research for giving me the opportunity to be a part of the CRSP Program.

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# Implication of Energy Loss Due to Natural Airflow Through Entrance Doors

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## Abstract

Infiltration through entrance doors and vestibules have had a major effect on calculating a building's heating and cooling loads; as natural airflow impacts climate. The purpose of this research is to: 1. Better understand air movement, heat dissipation, and energy consumption in building entrances; and 2. Find the main factors directly related to unwanted airflow through various types of entrance door; differential pressure, door usage frequency, airtightness, and wind profile around buildings. Some methods that were used in estimating door infiltration rates are qualitative analysis, a pre-experimental design survey, computer simulation, and tracer gas measurements. Future research is needed to design efficient high performing buildings, to reduce air infiltration, energy costs, maintaining indoor occupant comfort, and essentially lower its carbon footprint by decreasing greenhouse gas emissions responsible for climate change.

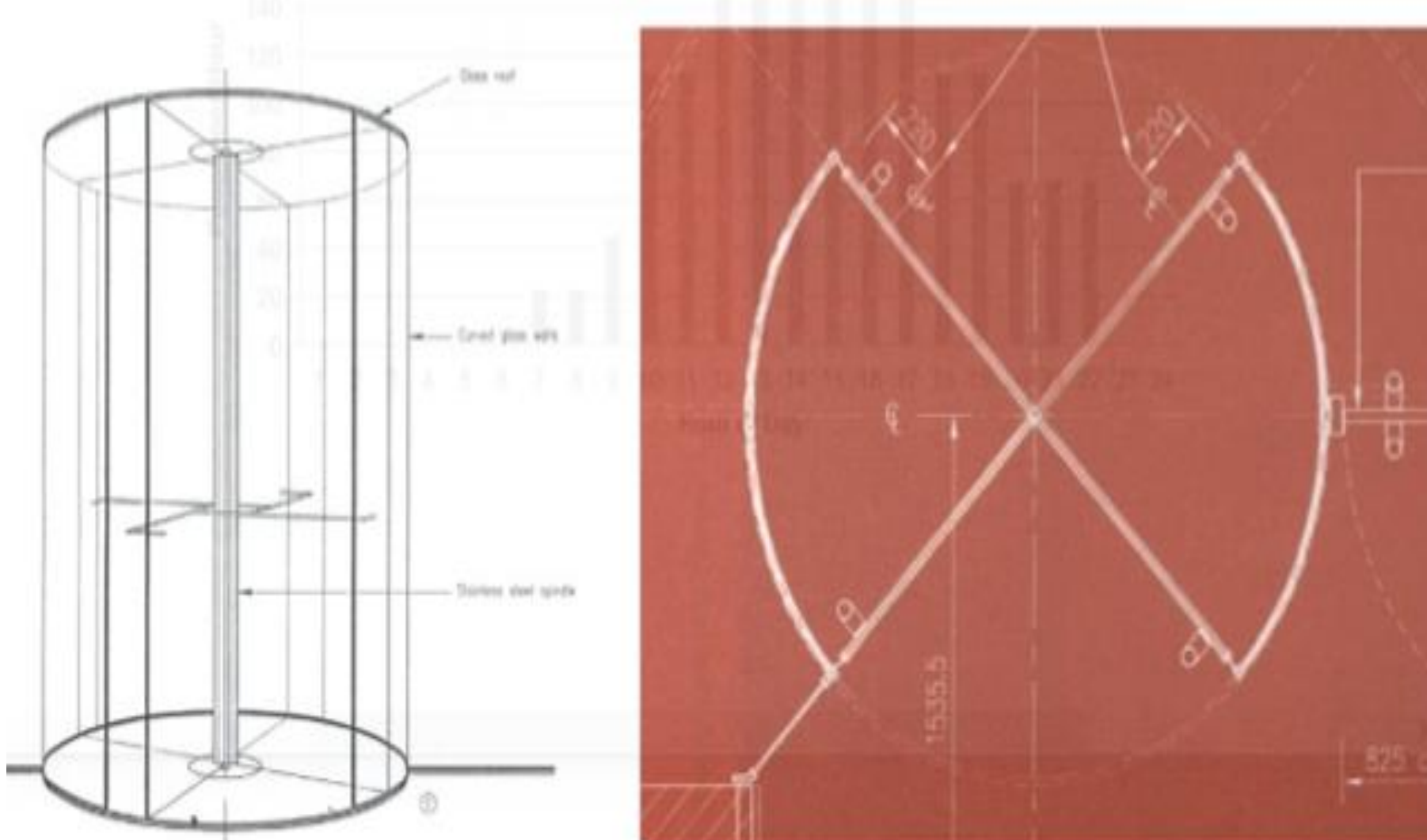


Figure 1. Two diagrams depicting a typical revolving door used today.  
(Adapted from 2)

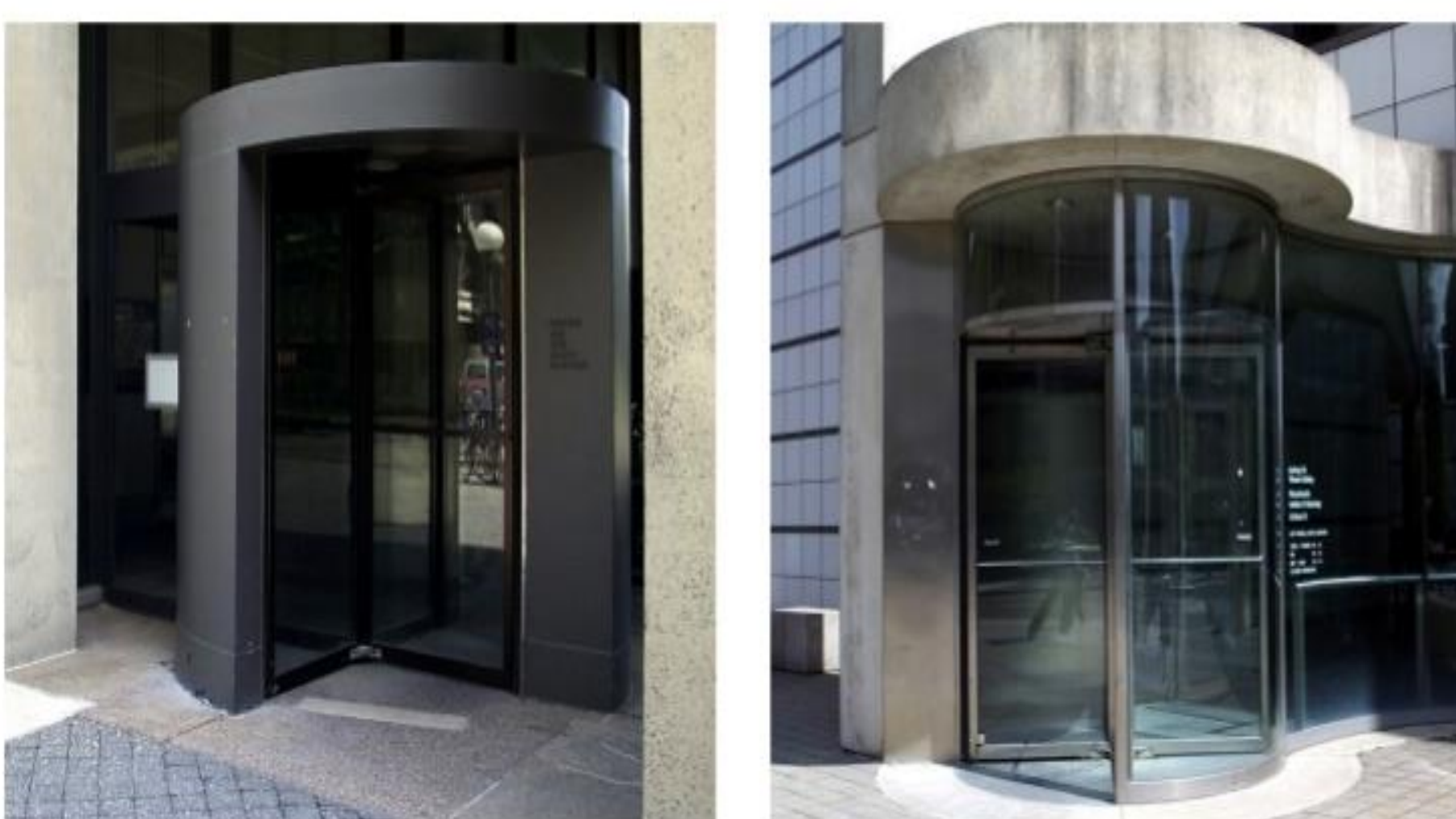


Figure 2. Revolving doors at MIT Campus with hidden swing doors.  
(Adapted from 2)

## Methods

### Empirical Analysis

- First, *ASHRAE RP-1596* studied infiltration rates of automatic doors in retail and supermarket stores were established using tracer gas measurements in intervals of 4 hours; sensors were connected to analyze pressure differentials across internal and external doors.
- Second, a pre-experimental design survey was conducted at MIT to determine if occupants preferred revolving or swinging door types when entering a university building. A controlled and uncontrolled Qualitative Analysis experiment using signage was piloted to observe occupant door movement and habits in buildings 9, 34, 39, 46, 54, 66, E15, E51, NE48, and NE49.
- Third, we examined indoor and outdoor vestibule, curtain type of doors, and a combination of both within different climate zones with all 4 seasons in commercial, residential, and government buildings.

### Numerical Analysis

- First, a computer simulation program and approximation equations were used to estimate values for Highrise office building entrance door areas airflow rates in relation to time of day and quantity of occupant usage.
- Second, we studied ASHRAE Standard 90.1's Modeling Strategy by measuring door use frequency, in peak and non peak hours, and simulating any savings to be gained with vestibules.
- Third, reviewed *ASHRAE Standard 1236-RP* which used *NFRC 100" (NRRC, 200a)* to examine heat loss using the *U factor* and *THERM* computer simulation on diverse types of commercial door entrances to understand their heat loss and find energy savings.
- Fourth, the *Whole Building Simulation Method* was used in calculating air infiltration rates simulation per hour, and pressure factor for retail stores with and without vestibule.

## Discussion

Continuous research and qualitative analysis is needed in finding new ways to calculate and simulate the effects of air filtration rate through different entrance door types and vestibules in regards to width, differential pressure, airtightness, and energy conservation to reduce the carbon footprint.

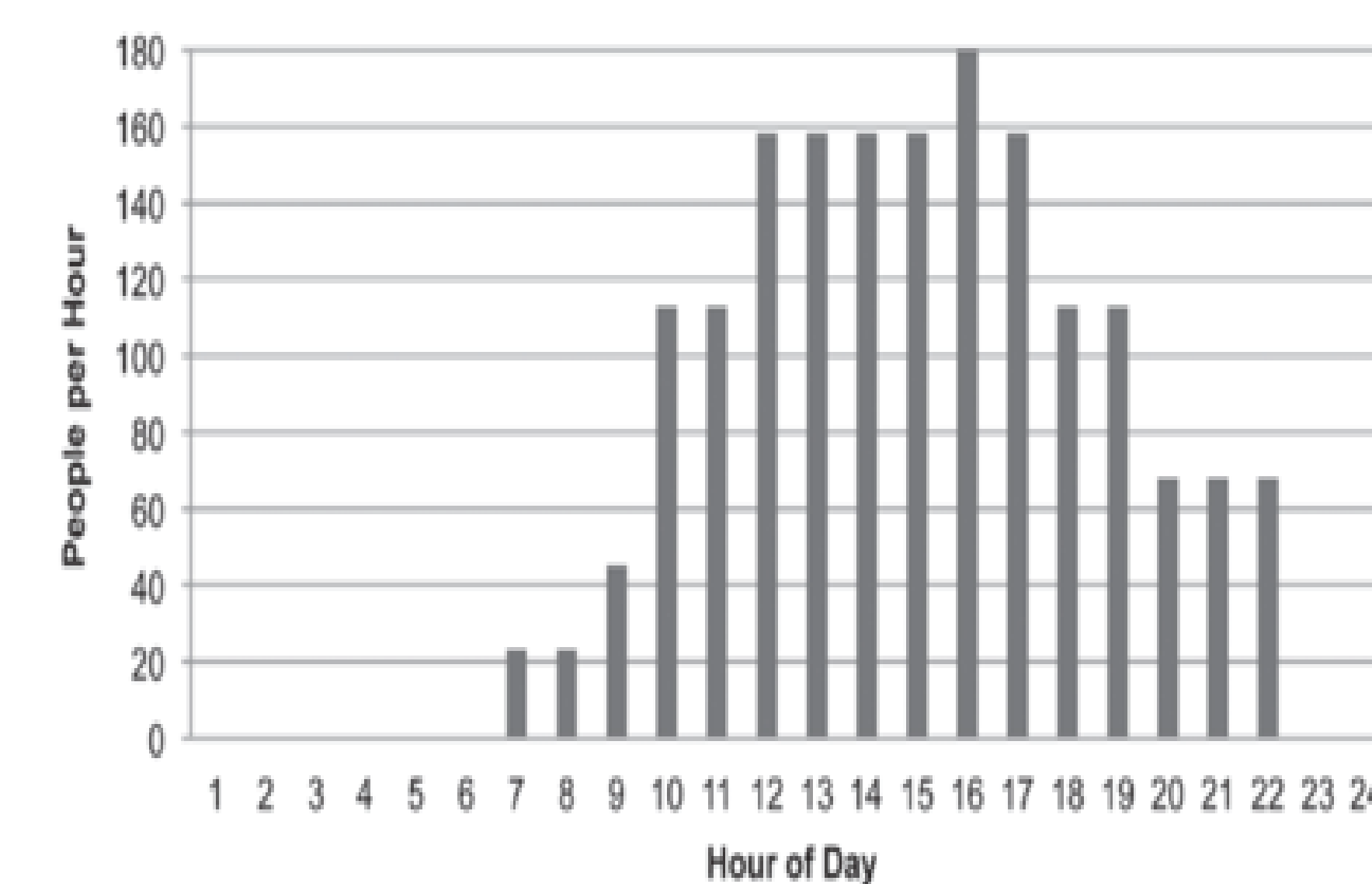


Figure 3. Rate of door traffic for each hour.  
(Adapted from 1)

## Results

### Door Type

- MIT occupants subconsciously used swing doors out of habit and efficiency, until revolving door signage educated energy conservation: revolver use rates of 77 +/-7% (Bldg. 54) and 84 +/- (E15). This compares to a control (unconstrained doors) average 23+/-2%. Recall, the self-revolving reported use rate was 33%".
- ASHRAE 1236-RP* computer simulation heat loss for uninsulated, 3-wing revolving door, and aircraft hanger commercial doors using the total U factor equation: **uninsulated-3-wing revolving door**- $0.77 \text{ Btu} \cdot \text{h}^{-1} \cdot \text{ft}^{-2} \cdot \text{°F}^{-1}$  and **aircraft hanger door**- $0.58 \text{ Btu} \cdot \text{h}^{-1} \cdot \text{ft}^{-2} \cdot \text{°F}^{-1}$ .

### Vestibule

- Combine together the vestibule and the curtain door work the best in keeping either the cold or the hot weather away.
- ASHRAE energy modeling strategy* found: Building floors with smaller areas are greater impacted by air infiltration than those with a larger square footage; Vestibules in colder climates have greater energy.

### Airtightness

- Findings for stationary door pressure differential range from 20-250 Pa was measured is: 1. When the door with the worn seal is in a closed, the air leakage measured at 75-Pa pressure change, was equal to 95 L/s. When the 4 wings point changed the air leakage was about 75 L/s at 75 Pa.

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# You Are Prepared: A Browser-Based Performance Using AI and ML

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Program of Emerging Media Technologies (MTEC), Department of Entertainment Technology

## Abstract

In today's age of rapidly expanding technology, people around the globe have resorted to extreme measures to "hack" their bodies through technological implants, ranging from NFC chips in fingers to entire hard drives in thighs. Led by Allison Berkoy, You Are Prepared is an interactive browser-based experience, exploring the similarities and intersections between human and machine self-optimization. In the first phase of my contributions, I have been researching content for examples of human biohacking, as well as training a machine-learning platform on AI image generation. The first core task has involved searching for video documentation of biohacking and human augmentation projects from recent years, putting focus on non-medical and more experimental, elective procedures. So far, I have found that humans are looking to self-augmentation as a method of seamlessly integrating technology into their bodies, eliminating the need for a separate or wearable device. The second research area involves Playform.io, a machine-learning platform. We have been training Playform's machine-learning software to generate image sets of flowers and animals based on assets we prepare, then comparing the original assets to the AI-produced images. This training is part of our ongoing image research, and we will conduct further tests to learn more about the particular machine-learning platform that Playform is making more accessible for artists. The final culmination of You Are Prepared will present a code-driven audiovisual experience on human and machine self-optimization.

## Video Research

When starting my video research, the first objective was to find which internet search terms would produce the most relevant results. I started with terms such as "consciousness hacking" and "biohacking." These searches led me to examples of extreme and experimental projects, many of which involved subjects performing surgical procedures in order to achieve their desired results of bodily optimization. Switching gears, I turned to more terms such as "human augmentation" and "transhumanism." This led me down a different path, finding many examples of the implanting of RFID chips to increase the ease-of-use for everyday objects. I was careful to not include examples of medical projects in my research, as our project is focused on the voluntary choice to augment the body in recreational ways. I found both examples from educational institutions like MIT, as well as "garage projects" from everyday people who are looking to change the limitations of the human body.

This preliminary research will be utilized in the final culmination of You Are Prepared as an informative piece of the performance, giving participants a taste of the ways humans have been developing ways to physically integrate technology into their bodies.



Fig. 5: Original asset



Fig. 6: Image generated by Playform



Fig. 7: Asset with BG removed



Fig. 8: Image generated by Playform

## Playform.io Testing and Results

Playform.io is a machine-learning (ML) software that "utilizes a particular class of ML systems called Generative Adversarial Networks (GANs), in which two artificial neural networks play a turn-based game with each other that teaches them the statistical attributes of the training data."<sup>1</sup> Specifically, we are utilizing Playform's Freeform process, which "interprets the [assets] and tries its best attempt to replicate its subject matter...all the shapes inputted will affect the shape of the amalgamated result."<sup>2</sup>

For the purpose of our research, we are experimenting with different assets and how to prepare those assets for testing in order to achieve optimal results. In our initial test, we ran images of flowers without any editing into Playform (Figure 5). The resulting set were images which often lacked distinction between the subject (flower) and the background of the image, as seen in Figure 6. We had the idea to remove the background of the images to include just the flower (Figure 7), hoping to assist the ML software in identifying only patterns and forms from the flower itself. As a result, the second image set showed much improvement in the AI's interpretation of the shape of a flower, as well as the most common colors and petal structures (Figure 8).

We carried this knowledge into testing of another set of assets, this time photos of various animals with their backgrounds removed (Figures 9-12). The resulting image set produced abstract-looking shapes which vaguely resemble animals, often managing to include the rough shapes of legs and a head (Figures 13-14). We decided to take this image set a step further, and ran a second test using the images from the previous iteration. This allowed the AI to continue work on the same images, which gave us much more detail in both the shapes and the patterns of the animal bodies (Figures 15-16). From this second training, we realized how much each stage of the image generation process helps the ML technology learn more about the assets, therefore giving greater details and specificity with each test.



Fig. 1: "AlterEgo is a wearable system that allows a user to silently converse with a computing device without any voice or discernible movements."

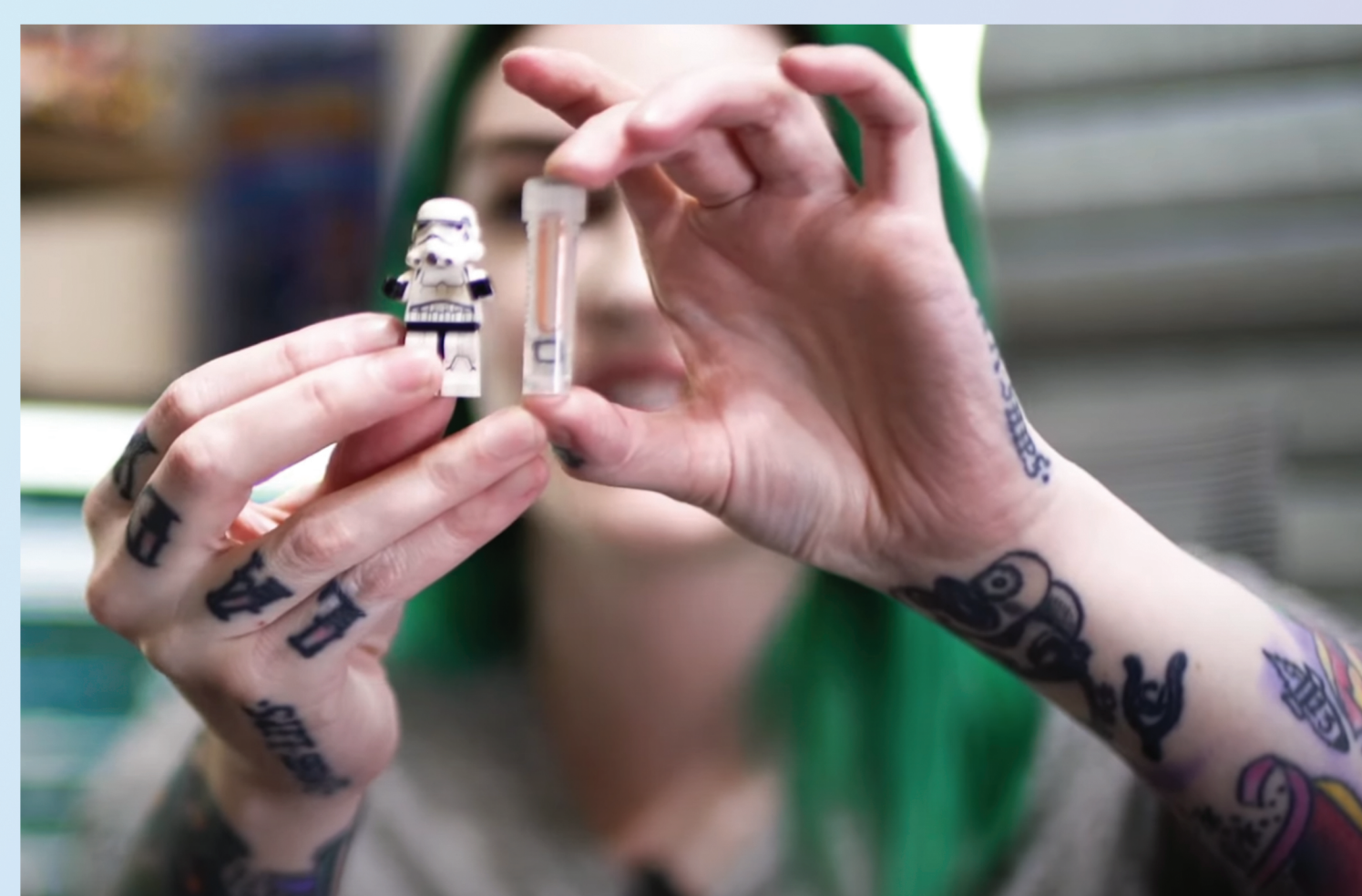


Fig. 2: Youtuber Amie DD shows the RFID chip that will be implanted into her hand. The chip will allow her to unlock her Tesla without using the vehicle's key card.

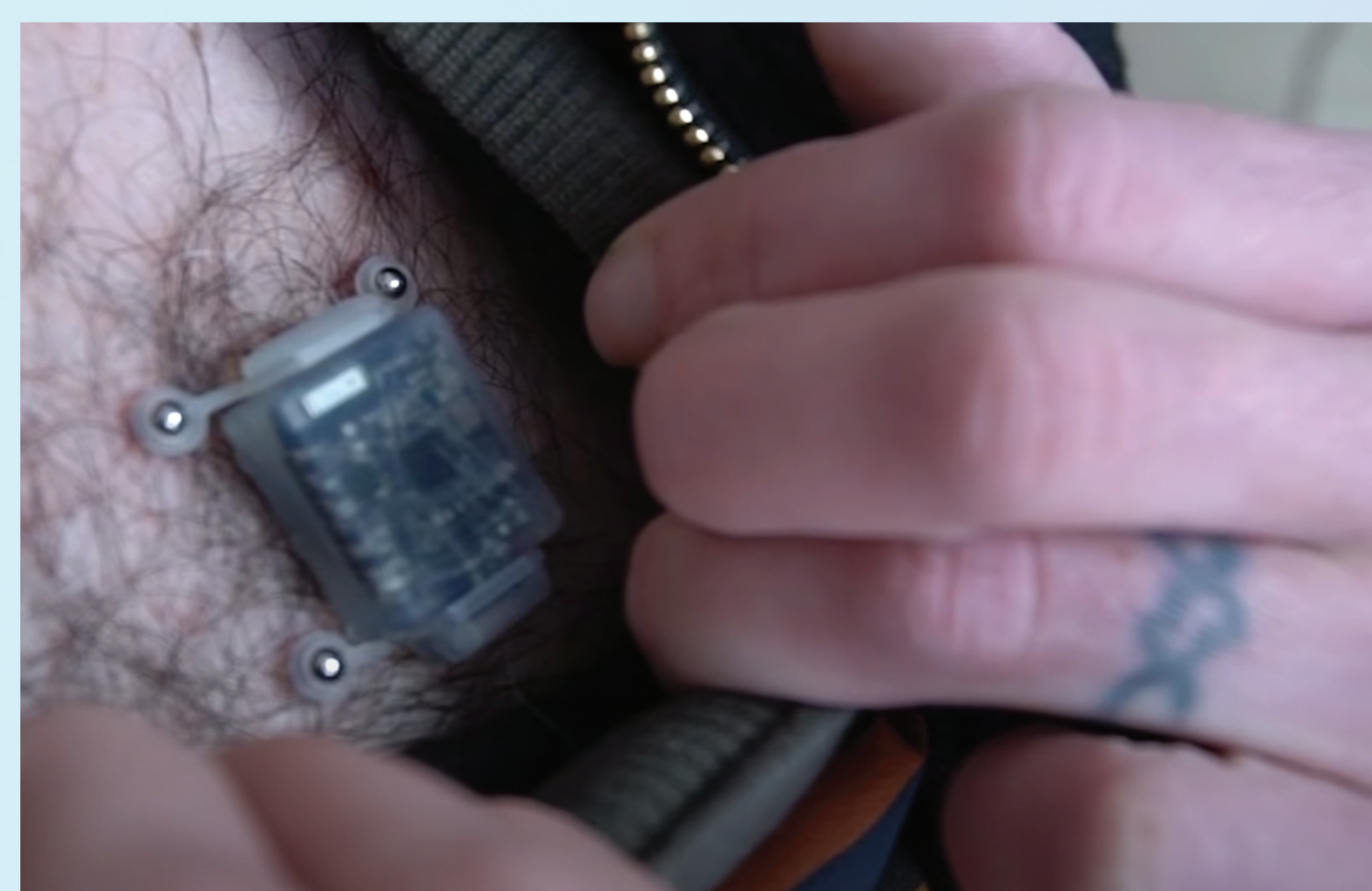


Fig. 3: "North Sense is a small biotech chip that attaches to people's chests with piercings and vibrates whenever they face north — creating a sixth sense — a sense of direction."

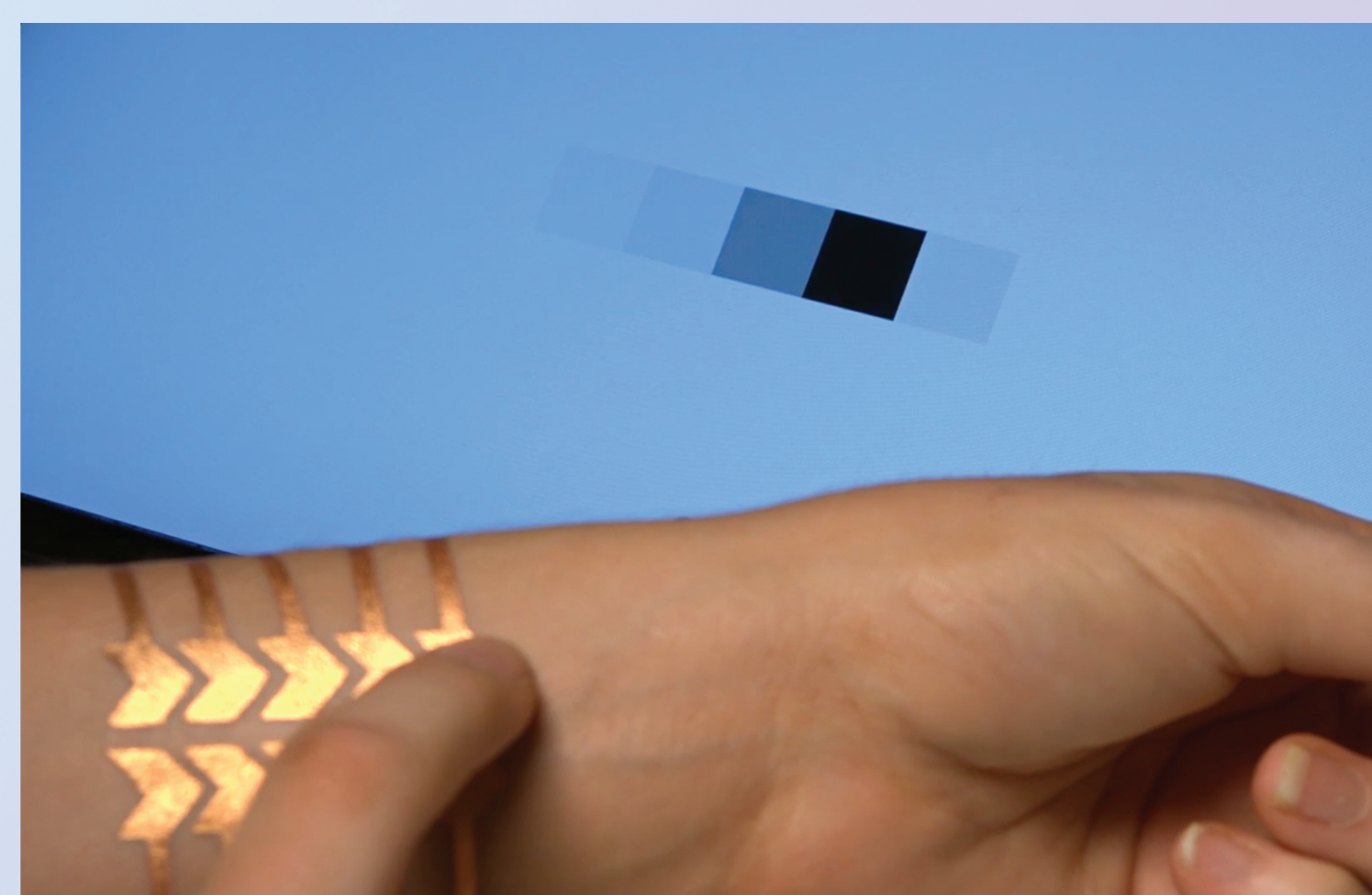


Fig. 4: DuoSkin is a wearable device that looks like a tattoo, while allowing users to control their mobile devices, display, and store information on their skin.



Figure 9



Figure 10



Figure 11



Figure 12

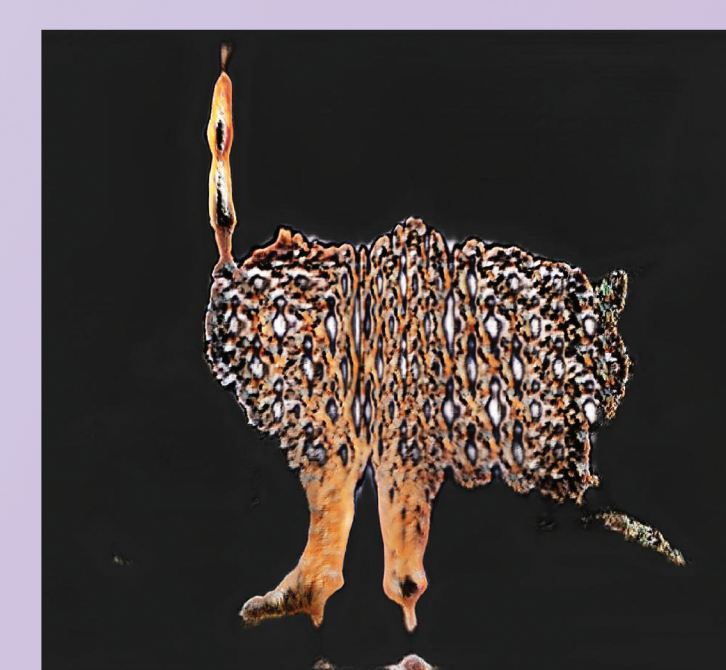


Figure 13



Figure 14



Figure 15

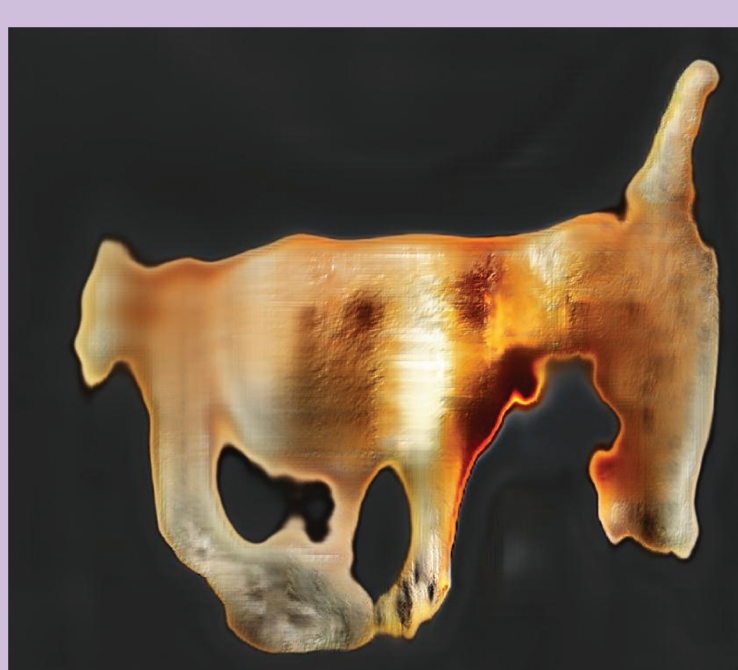


Figure 16

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<sup>2</sup>: All processes. Playform. (n.d.). Retrieved November 24, 2021, from <https://playform.gitbook.io/playform/faqs/results>.



# Polydimethylsiloxane (PDMS) Degradation Rate Studies

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## Abstract

In recent years, Tissue Engineering is utilized as an alternative approach for the organ transplantation. Success rate of tissue regeneration influenced by the biomaterials, cell sources, growth factors and scaffold fabrication. Design and precise fabrication of scaffolds are required to support cells to expand and migrate to 3D environment. At the SET Research Laboratory at City Tech, photolithography is used to fabricate the scaffolds. Main components of the photolithography are “photo-curable material” and an “elevator system”. In current scaffold fabrication set-up at SET, only 2D scaffolds are generated due to the lack of an elevator stage. In this research, to carry the scaffold fabrication from 2D to 3D, elevator stage is designed and fabricated. Our preliminary research showcased that scaffolds can be successfully fabricated with the use of elevator system.

## Introduction:

-Tissue Engineering also known as Regenerative Medicine is biomedical engineering that creates human tissues within a laboratory, and it is meant to be a cure rather than a treatment. Being able to repair/replace tissues in organs that fail due to disease, genetic errors, congenital abnormalities, or traumatic injury.

-Tissue engineering researched start in 1980s by an American bioengineering & scientist named Yuan-Cheng Fang. She submitted her proposal to the NSF(National Science Foundation)

-There are 4 important factors:

- The right cells to do the job.
- The right environment such as scaffold to support the cells.
- The right biomolecules for the growth factors to make those cells healthy and productive.
- The physical and mechanical forces to influence the development of the cells.

-To limit any rejections within the growth of the cells. Cells are harvested from the target organ ideally from the patient.

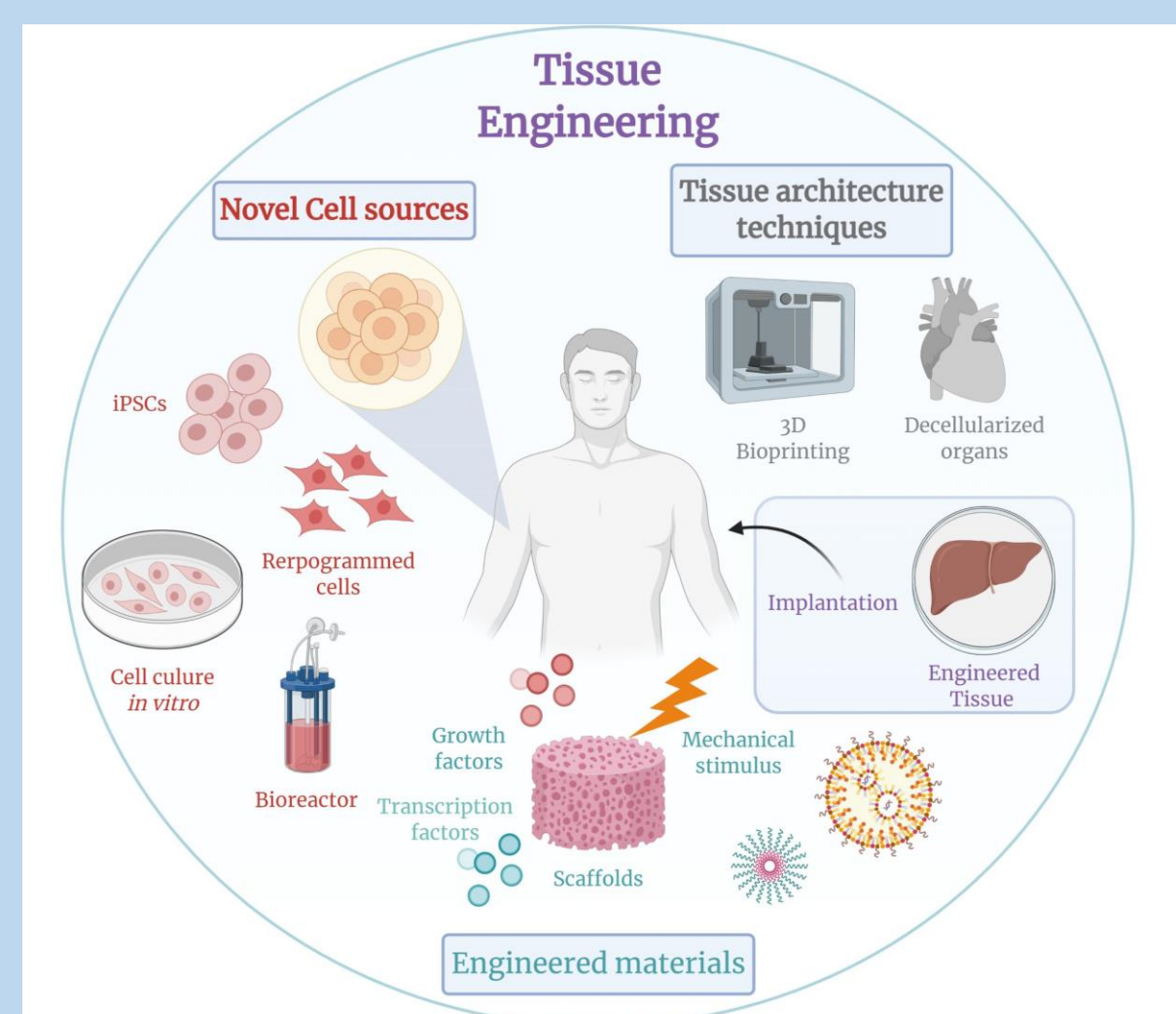


Fig 1. Tissue Engineering

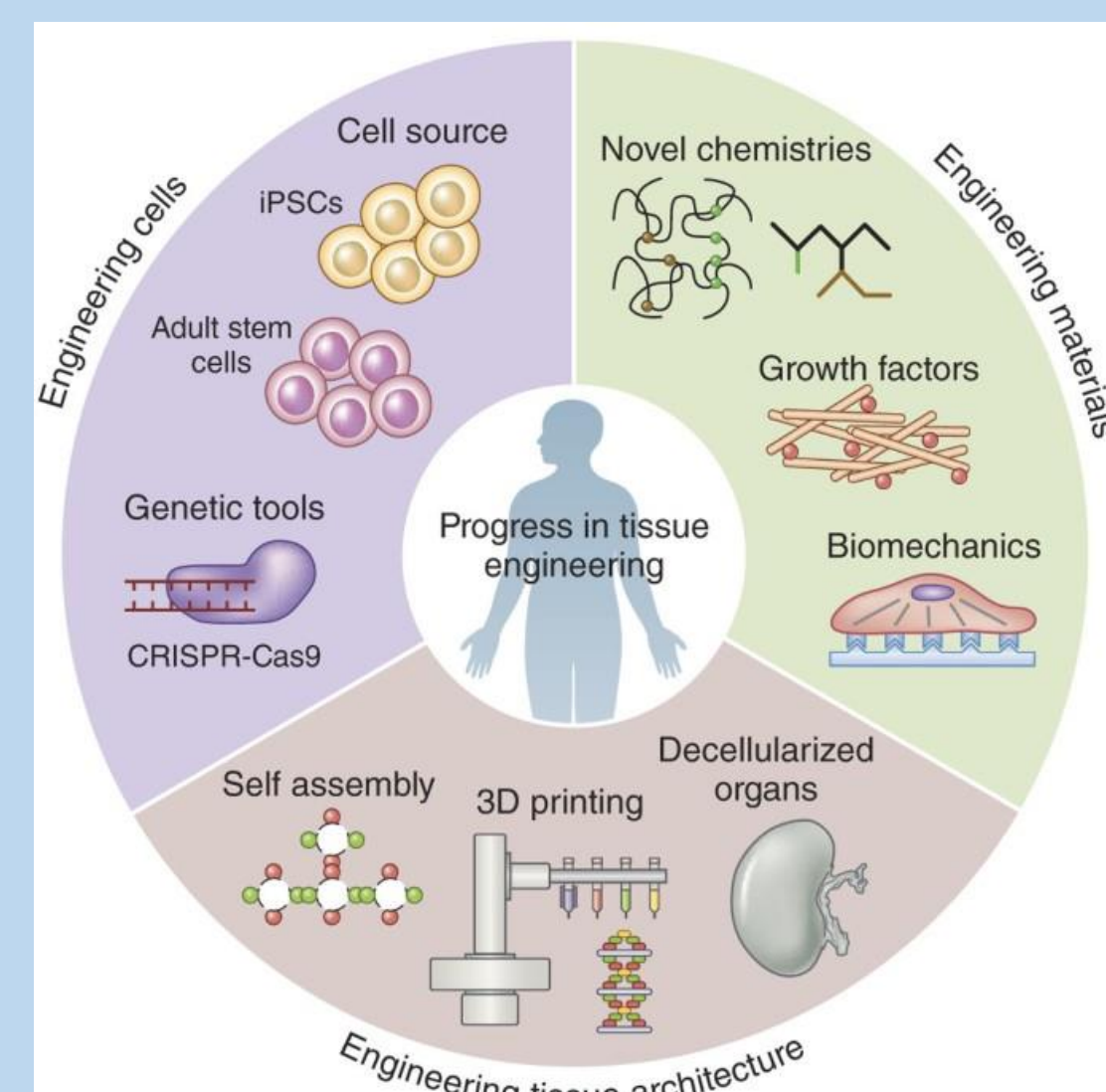


Fig 2. Progress in Tissue Engineering

## Results

In this work, our experiment results show that both single layer and multi-layer 3D structures can be design and can be fabricated with micro-molding. The core advantage of this process compared to other laser-based fabrication techniques is that the entire layers can be obtained simultaneously in a short period of temperature exposure.

Any biocompatible and photolithography biomaterials can be used for this fabrication technique. In our work, PEGDA was chosen to form the hydrogels. This system is also capable of fabricating complex shape structures.

## Conclusion

Tissue Engineering has achieved remarkable success and it has helped many people in repairing tissues for patients that need without having to rely on organ donors. However, precise fabrication of tissue scaffolds always has been a challenge. Our research showed that 100% PEGDA scaffolds has the lowest yield strength whereas 20% PEGDA has the highest yield strength. This is still expanding and still in progress on improving tissue engineering for more complicated body parts and organs.

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## Literature Review

Today in the research world many successful research institutes are working in this promising field Tissue Engineering. MIT, North Carolina University, Texas A&M, Drexel and many more universities are using different biocompatible materials for scaffold fabrication.

## Methods

### PDMS:

PDMS also known as Polydimethylsiloxane is widely used in biomedical research and technology. Mixing ratio of base polymer to curing agent or additives enables its mechanical properties to be manipulated and fit to mechanical properties of biological tissues.

In this research, 5 test tubes of 40ml capacity are filled with 5 PDMS mixture and then it is laid out in a think layer that was prepared by the mixing curing agent.

In the next step, PDMS were mixed with nanoparticles. Then they were baked in different temperatures.

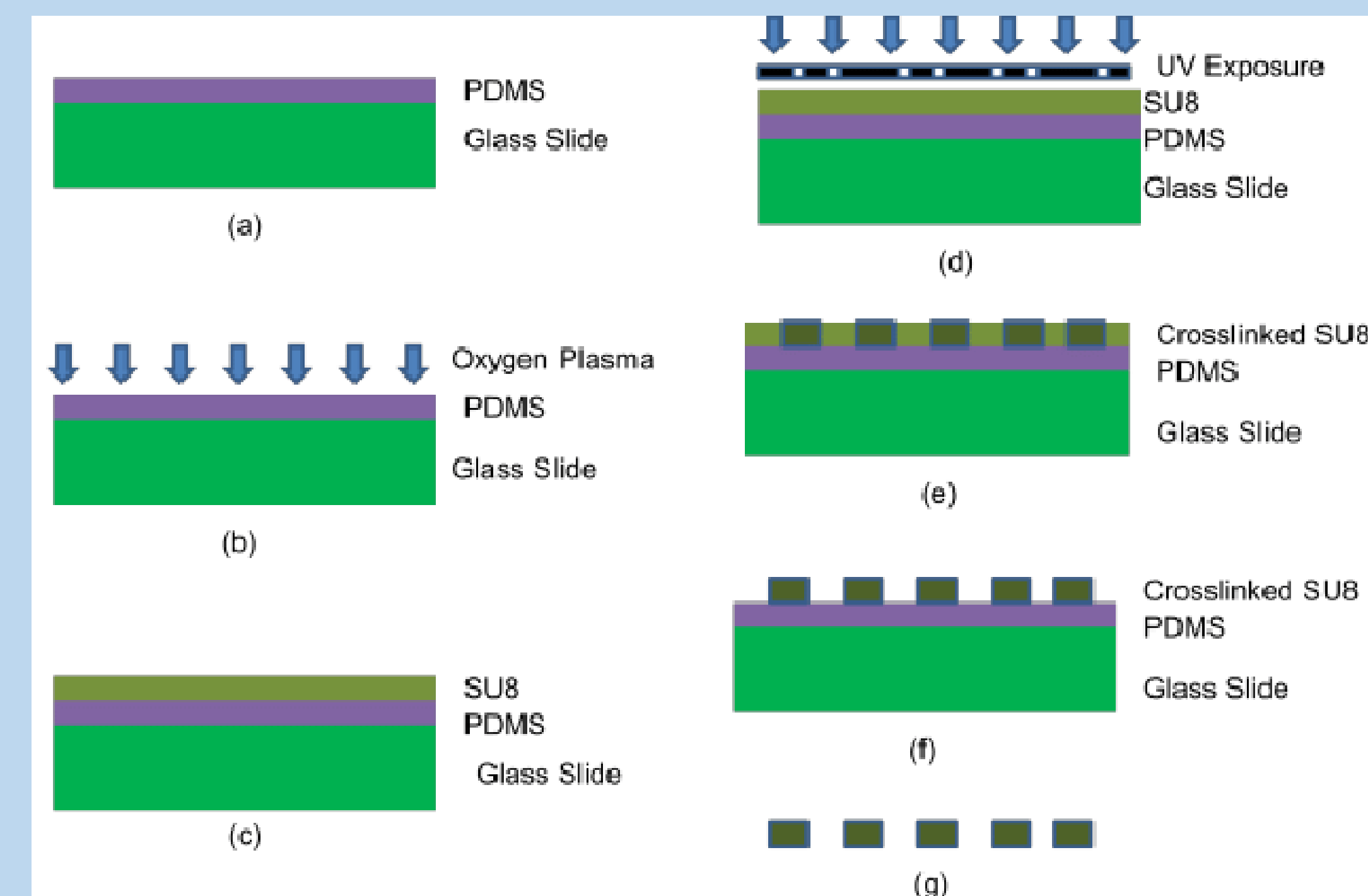


Fig 3. PDMS Substrates

Fully solidified PDMS samples will be studied to investigate the toxicity rates. Then, INSTRON Machine will be used to do the compressive tests for PDMS mechanical characterizations.

## Acknowledgment

The authors acknowledge the research support from Dean's Office, Research Scholars' funds and SET-CUNY





## ABSTRACT

The urban heat island (UHI) is a major environmental and public health issue in big cities. In order to study and better understand the phenomenon, high spatio-temporal land surface temperatures are required. However, there is no satellite that provides LST data with both high spatial and high temporal resolution. In this study, we use a linear regression model to downscale the Geostationary Operational Environmental Satellites – R series (GOES-R) LST data to the spatial resolution of Landsat observations (30 m) over New York City. The GOES-16 delivers land surface temperatures at a spatial resolution of 2 km but at a high frequency of every 5 minutes. On the other hand, Landsat 8 Thermal Infrared Sensor (TIRS) delivers land surface temperatures at higher spatial resolution of 30 m but at a lower frequency of 16 days. The downscaled LST data has spatial resolution of 30 m with a frequency of every 5 min. The downscaled estimates showed a reasonable agreement (-0.09 to 3.30 K) when they were validated against independent Landsat images. The results of this study could be applicable in any urban area in the world.

## MOTIVATION

- Available Satellite LST data are either a low spatial resolution and high temporal resolution or a high spatial resolution and low temporal resolution.
- Urban areas have a complex heterogeneous surface texture that can be lost in coarse resolution.

## STUDY AREA

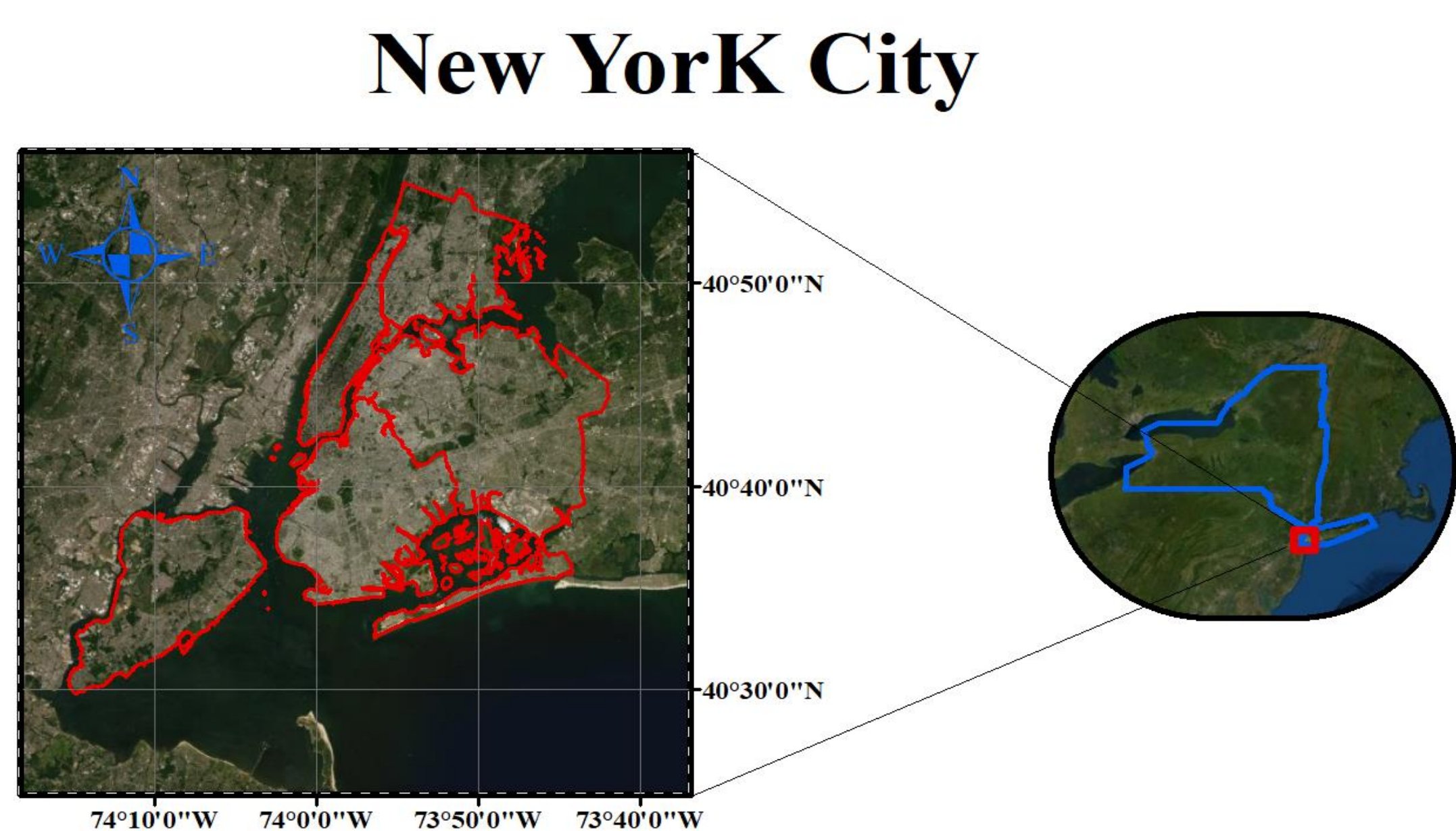


Figure 1. Study Area

## METHODOLOGY

- Dataset: daily land surface temperature over NYC from July 2017 to July 2020
- Obtain from Landsat 8 and GOES-R
- Time: 11:30pm EST
- Spatial resolution: 2 km to 30 m

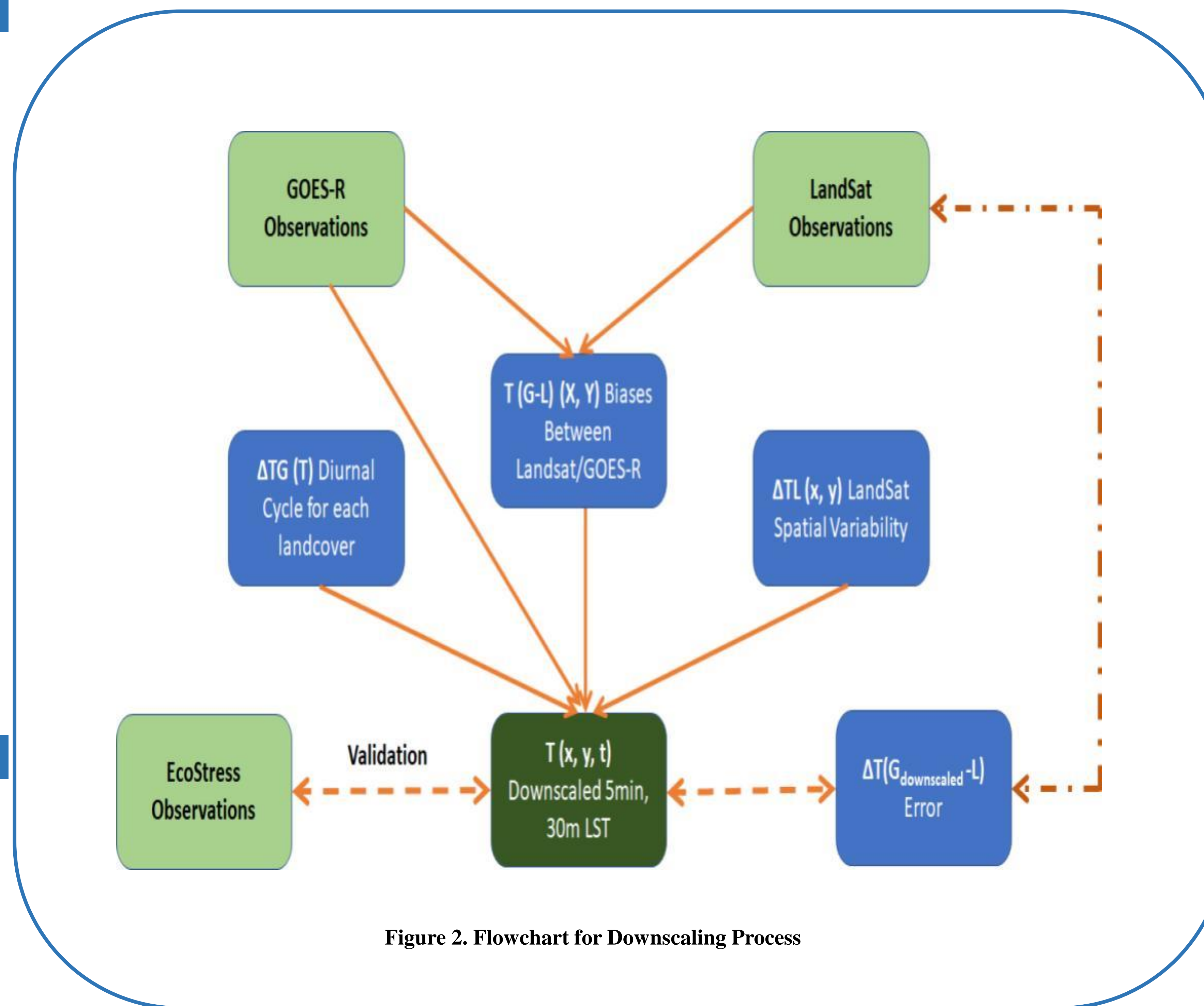


Figure 2. Flowchart for Downscaling Process

## RESULTS

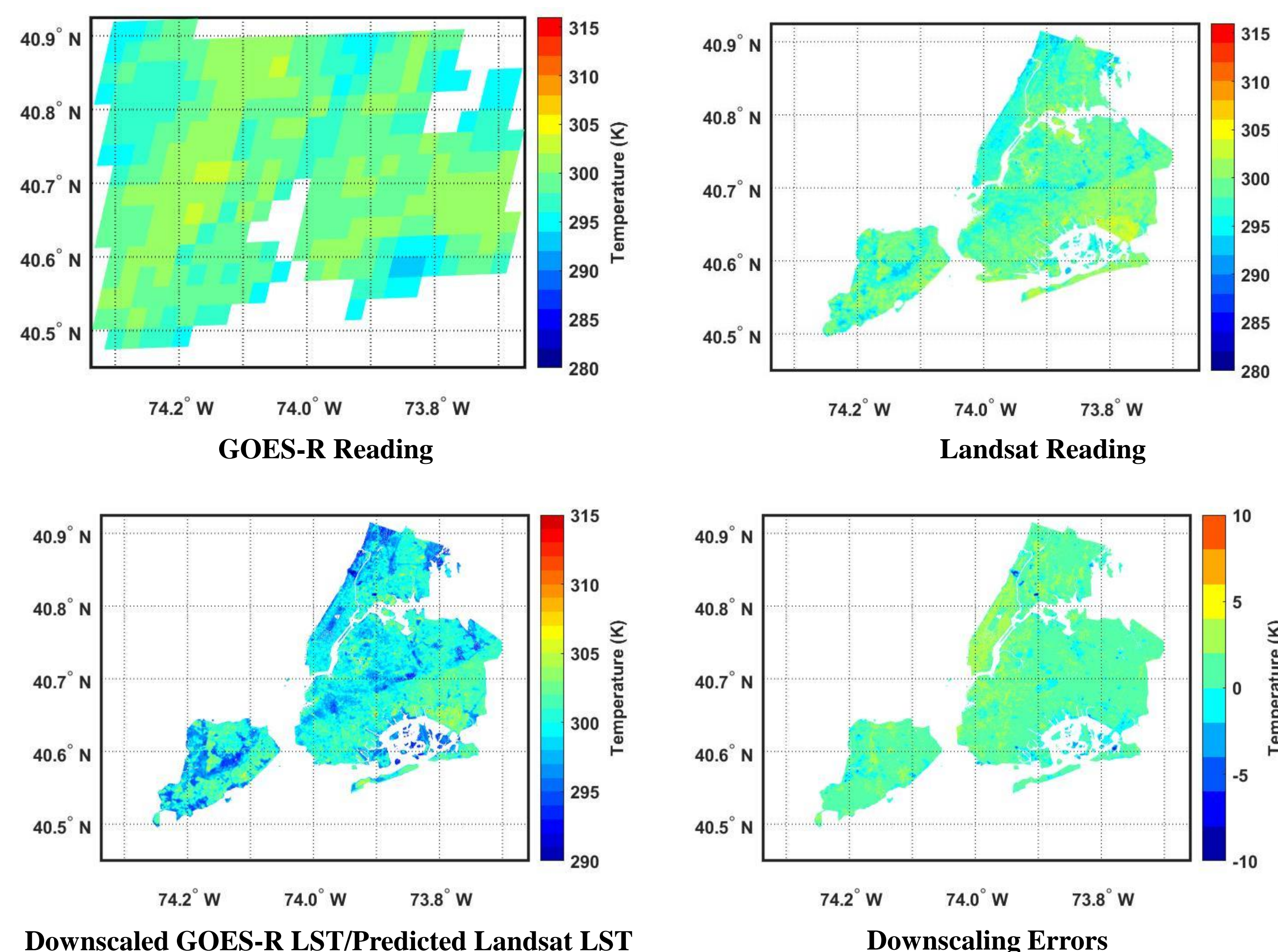


Figure 3. Downscaling GOES-R: October 2017

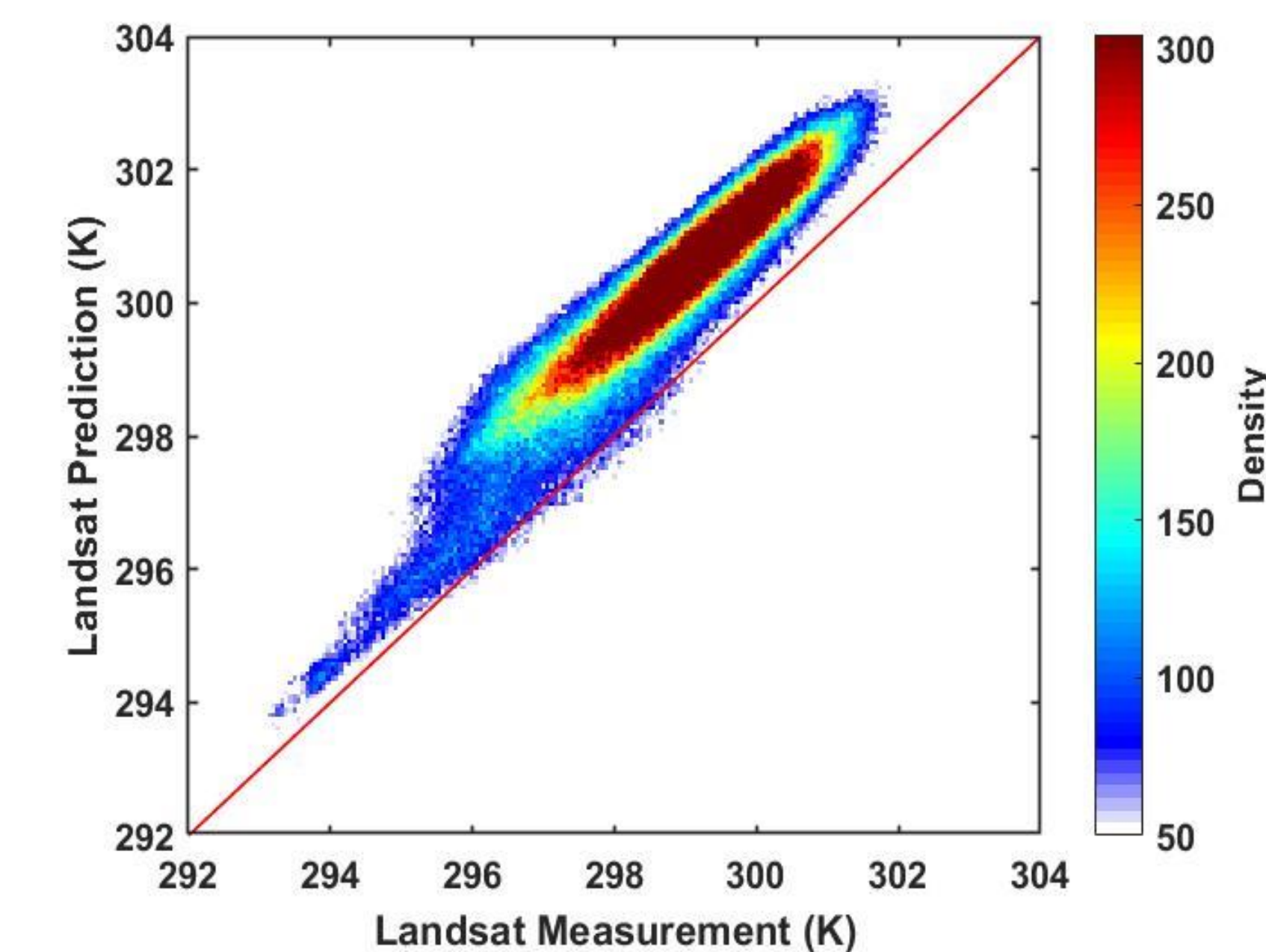


Figure 4. Measurement versus prediction scatter plot

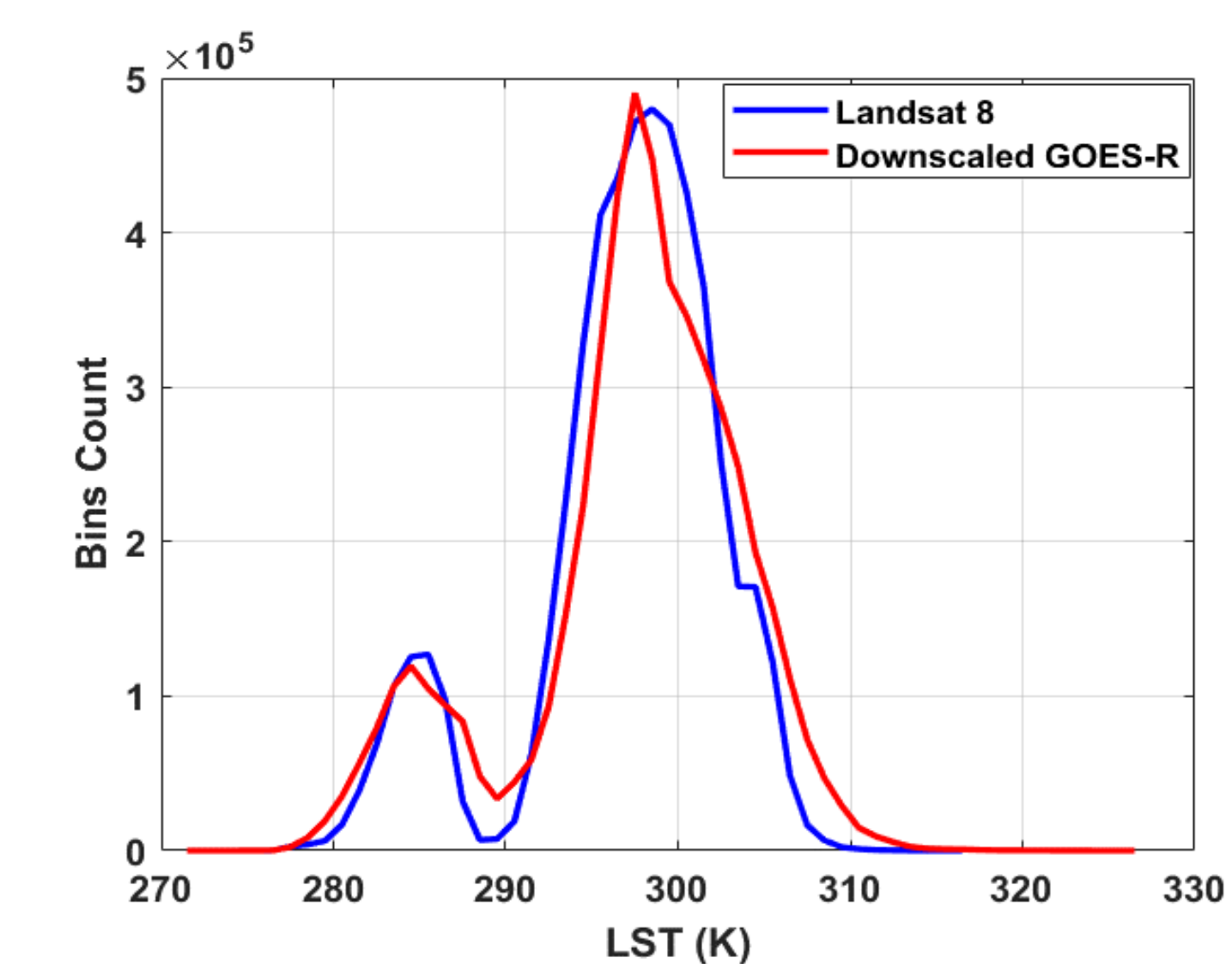


Figure 5. Distribution of Temperature for GOES-R and Landsat Readings

## CONCLUSION AND NEXT STEPS:

The differences between the Landsat LST measurements and predicted LSTs were between -0.09 to 3.30 K. The RMSE is less than 1.7 K. 60 – 80% of the variation are explained by the model. ECOSTRESS data and ground-based measurements from infrared cameras and drones will be used to validate the model.

## ACKNOWLEDGEMENT:

This study was funded by the Department of Defense (DOD) under Grant # W911NF – 18 – 0371. The statements contained within the manuscript/research article are not the opinions of the funding agency or the U.S. government but reflect the author's opinions. The authors also thank the Center for Remote Sensing and Earth Systems Science at the New York City College of Technology for resource assistance.



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