# Applicant’s Background and Goals for Fellowship Training

### A. Doctoral Dissertation and Research Experience

I was first captivated by science during my time conducting research in organic synthesis as a sophomore at Oberlin College under the direction of Dr. Albert Matlin. The work was difficult and we struggled to develop a reaction that was as enantioselective as we had hoped. Despite this, I was paired with another student who helped make our time in lab memorable regardless of the outcome. He joined me in a mission to learn the “reaction of the day”, and our shared value of curiosity and focus on performing better and better experiments made this research enjoyable. I spent six months in the Matlin Lab, but the ethos of learning the “reaction of the day” has stuck with me to the present, and I hope to impart this attitude upon my own students when I am an independent investigator.

##### Undergraduate Research:

I began my research career in the lab of Dr. Albert Matlin midway through my sophomore year at Oberlin College. I had decided to major in Biochemistry, and I had just completed organic chemistry. The course had been challenging but the I became fascinated with the subject matter, especially in mechanisms and synthesis. This prompted me to seek out a winter term project in the Matlin Lab and to take advanced organic chemistry courses in the spring semester of my sophomore year (CHEM 254 and CHEM 325). I was fortunate to learn advanced techniques in organic synthesis, enantioselective catalysis, chromatography, and NMR. CHEM 254 was taught by Dr. Duy Hua, a structural biologist. Her course connected organic chemistry and structural biology, emphasizing the biophysics of protein-protein and protein-drug interactions. Sheer interest in this subject matter drove me to turn a corner in my academic career, and I scored an A in both CHEM 254 and 325. Dr. Hua was a new professor, and sought to start a lab mentoring students in structural biology research, focusing on molecular dynamics and docking simulations of protein structures. I jumped at the opportunity and thus began my foray into computational research.

I spent the entirety of my Junior year at Oberlin working in Dr. Hua’s lab, taking the leap from chemistry and chromatography to the command line only. My research involved molecular dynamics (MD) simulations of human spleen tyrosine kinase (SYK) structures acquired from phosphorylated and dephosphorylated crystal structures. At Oberlin, we had remote access to a cluster computer with a handful of CPU and GPU nodes. I installed Linux Mint on my personal laptop and began learning bash and slurm scripting so I could submit MD simulations to the cluster. The ability to constantly tinker with and improve our workflow was addicting, and I taught myself how to use vim (command line text editor) and write my own scripts using a combination of online lectures.

During my time in Dr. Hua’s lab I was fortunate to develop UNIX programming skills as well as the ability to manage jobs on a supercomputing cluster. I also deepened my understanding of protein structural change and signaling. Through the opportunity to conduct research in her lab I became fascinated with molecular dynamics and sought opportunities to dive deeper into the mysteries of how biomolecular structure governed the biology of disease. Dr. Hua encouraged me to pursue molecular dynamics research and ultimately to apply to MD/PhD programs, and I think of the talk I gave in her lab as the moment I began to take ownership of my science communication in preparation for an academic career.

Throughout my junior year I reached out and applied to labs that performed similar research, and ultimately chose a position to work for Dr. Blanton Tolbert (see letter of reference) in the Department of Chemistry at Case Western Reserve University. I began my work in Dr. Tolbert’s lab during the summer after my junior year at Oberlin and began several projects performing molecular dynamics (MD) simulations of non-coding RNAs and RNA-protein complexes. In my first summer in the lab I was able to integrate NMR and small-angle x-ray scattering (SAXS) data into MD simulations to predict 3D solution structures of key regulatory RNAs in HIV-1. I presented my work that summer at the Meeting for Structural Biology Related to HIV/AIDS at the NIH, and I gave an oral presentation *Hacking the Viral Mechanisms of HIV with Molecular Dynamics Simulations* at Oberlin my senior year.

I completed and successfully defended an Honors thesis in Biochemistry during my senior year at Oberlin. My project focused on modulating the self-polymerization of polydopamine with a variety of small molecules in the lab of Dr. Jason Belitsky. This organic synthesis/materials chemistry project honed my skills in the wet lab and aptly supplemented my fcous in computational biochemistry. The challenging process of writing and defending an undergraduate thesis helped shaped me as an academic scientist and cemented my desire to work towards a PhD. I presented my Honors thesis research in an oral presentation at the ACS Meeting in Miniature (MiM) at John Carroll University and in two seminar talks at Oberlin College. My thesis defense was difficult, but the rewarding process of seeing the project to completion and learning from my many mistakes made me certain in my desire to pursue a career in science.

##### Postgraduate Research

I joined the Tolbert Lab as a Research Assistant upon graduation from Oberlin and continued my research on RNA 3D structure and its role in infectious diseases. In addition to continuing my work conducting MD simulations of non-coding RNAs in HIV, I also joined a project investigating RNA-drug interactions in enterovirus-71 (EV-71), a causative agent of hand, foot, and mouth disease. The lab collaborated with Dr. Amanda Hargrove’s Lab at Duke and together discovered that an amiloride-based small molecule could bind to a stem-loop structure within the virus and prevents transcription. I performed MD simulations that integrated NMR and SAXS data to reveal a binding site for a heterogenous nuclear ribonucleoprotein which ultimately blocked transcription of the virus. This work culminated in a paper published in Nature Communications, on which I am an author.

I also spent significant time in the Tolbert lab conducting molecular dynamics simulations of other non-coding RNAs that govern transcription in HIV-1. I translated NMR data such as residual dipolar couplings (RDCs) to constrain simulations and worked with other members of the lab to validate structures in the context of the molecular pathways they participate in. This work resulted in two other publications on which I am an author - one in the Journal of Molecular Biology and another in the Journal of Biological Chemistry.

Conducting research on RNA viruses and RNA drug interactions affirmed my desire to become a physician scientist. In the Tolbert lab, we constantly investigated dynamic structures for which we held only clues derived from experimental data. I became fascinated with the inference of conformational states and 3D structure, and it was through this work I was first introduced to challenge of statistical uncertainty. This curiosity laid the groundwork for my interest in the Silverman lab, and the familiarity of 3D structural research made the Cheng lab a great partner in my efforts to contribute to puzzle-solving in biology.

##### Doctoral Dissertation Research

My background in computational research, supplemented by synthesis work at the bench, led me to rotate in both labs that ultimately formed my co-mentorship team. I sought out a rotation with Dr. Cheng because of the unique imaging experiments conducted in the lab as well as the novel computational problems that arise in the analysis of these images. My project during the rotation focused building a pipeline for the automated segmentation of blood cells in micro-CT scans of Zebrafish. This project would allow researchers who study zebrafish models of disease and zebrafish genetics to computationally and quantitatively phenotype whole organisms based on the shape characteristics of their blood cells. This rotation in the Cheng Lab provided a strong foundation for my interest in micro-CT and continues to compel my affinity for computational problems. This project resulted in a paper published in eLife, of which I am one of the authors. I also presented aspects of this work in an oral presentation at the 2021 MD/PhD National Conference and in a poster at the 2023 Mid-Atlantic Regional Zebrafish meeting at the NIH.

I sought out a rotation in Dr. Silverman’s lab to gain exposure to a more theory-driven approach to machine learning. During my rotation, we decided to search for methods from topological data analysis and apply them to the classification of complex shapes in biomedical data. Dr. Silverman and I met a minimum of once per week and studied the methods I was learning at the whiteboard often for multiple hours at a time. I received hands-on training in the concepts underlying the computational methods we were studying. I first applied methods from persistent homology during this rotation, where I used the Vietoris-rips filtration to classify wild-type and mutant zebrafish blood cells based on shape. I believe that TDA has further untapped potential in image analysis, whereby it will contribute to the goal of quantifying phenotype based on cellular shape and location. The collaboration between Dr. Silverman and Dr. Cheng has continued into support for my thesis project, and has strengthened as we collect promising preliminary results. I have presented these results in my MSTP program seminar and in a poster at the American Society for Investigative Pathology (ASIP) Pathobiology conference in 2024.

### B. Training Goals and Objectives

##### 1. Career goals and research interests:

My long-term goal is to become a physician scientist leading a translational research lab applying novel measurement and computational methods to clinical problems. I plan to apply to a research track internal medicine residency possibly followed by a hematology-oncology fellowship with the aim of becoming a tenure-track faculty member at a top academic institution. I will work towards this goal in the short term by continuing to hone my clinical skills throughout my graduate years and by anchoring my thesis research in translational problems. Both of my co-mentors have a background in clinical medicine and are familiar with the training and experience required for effective medical training.

##### 2. Research training goals:

I have focused my PhD training on novel imaging technology and statistical methods, both disciplines that will facilitate the completion of the proposed work and prepare me for my future career as a physician scientist. Under the direction of Dr. Cheng, I will recieve training in experimental pathology and high-resolution imaging with a focus on both synchrotron and laboratory micro-CT methods. The micro-CT experiments conducted in our lab are motivated by histology and the diagnosis of human disease. I will work closely with Dr. Warrick (see letter of reference) to both develop my understanding of diagnostic medicine and guide our analysis of micro-CT images. In preparation for this proposal, I was able to work closely with Dr. Warrick to get IRB approval to perform an imaging study of prostate cancer tissue blocks. Dr. Warrick’s office is located in the same building as the Cheng Lab, and he maintains an open-door policy that sees us meet almost on a weekly basis and allows us to discuss data as soon as it is generated. This close partnership with Dr. Warrick directly contributed to preliminary data collection during a recent synchrotron trip I led to LBNL, a key role in my work with the Cheng Lab. Through my first two years in the lab I have participated in 3 synchrotron trips and taken a leadership role in one. My research goal for the continuation of this work is to further my understanding of high-resolution optics and their potential applications to the diagnosis and investigation of cancer. In pursuit of this goal I will also have several opportunities to develop my leadership skills in the setting of technically demanding experiments.

To analyze imaging results and complete aims 2 and 3 of this proposal, I will study statistical methods and machine learning with a focus on topological data analysis under the direction of Dr. Silverman. I have two goals for this phase of my research training. First, I aim to develop and optimize algorithms that will contribute to the analysis of complex 3D images, specifically aimed at methods applied to cancer biopsies. Aim 2 and especially aim 3 of this proposal will provide me with a unique opportunity to do so. Second, I strive to cultivate a skillset and understanding of data science and statistical methods that I will use throughout every facet of my career as a physician-scientist.

##### 3. Clinical training goals:

I will improve my clinical skills and specialty exposure throughout the duration of this award to prepare me both for success in medical school and my future career as a physician-scientist. The MD/PhD program at PSCOM has 3 main avenues of support for ongoing clinical training during the graduate years. First, students enroll in the BMS 802 course after they pass their comprehensive exams, during which they work with a clinical mentor in a hospital setting a minimum of 5 half-days per semester. Second, students also participate in clinical research conference (CRC) once every two months in which a physician-scientist and a group of three students prepare a presentation and lead the program through a real clinical case. This involves interactive building of a differential diagnosis, discussion of pathophysiology, and review of a relevant research article.

In addition to clinical exposure through the BMS 802 course and shadowing, I will also continue to volunteer in monthly free general medicine clinics at the Bethesda Mission in Harrisburg through the Lioncare student group at PSCOM. This will supplement the clinical training I receive in the pediatric emergency department with additional repititions of history taking, physical exams, and note writing in the setting of a different patient population. My goal is to become a well rounded medical student with experience treating a diverse patient base and consistent practice of the fundamentals of medicine.

##### 4. Career development goals:

I will improve my scientific writing, communication, and interpersonal skills and experiences throughout the duration of this award. I have sought out a co-mentorship that will provide unmatched training in these areas, as both co-sponsors of this grant hold MD and PhD degrees, and will have significant roles in shaping my development into a physician scientist. Dr. Silverman and Dr. Cheng each have a unique skillset that will both challenge and support me along my journey towards becoming an independent investigator. Their areas of research are independent but also complementary: Dr. Silverman is an expert in statistical methods and the analysis of biomedical data, while Dr. Cheng pathologist by training who has an extensive background in both imaging and genetics research.

The individual expertise of each of my co-sponsors will not only play crucial roles in mentoring me as I carry out the proposed work, but will also provide me with unmatched career development opportunities that will be unique to my co-mentorship. For example, on behalf of the Cheng lab and in close collaboration with Dr. La Riviere (see letter of reference), I am able to conduct highly specialized research in x-ray physics and interact with beamline scientists who support our work. With the guidance of Dr. Cheng and through collaboration with Dr. Warrick I will present my work to clinical pathologists who, in their daily practice, *directly encounter the problems defined in this proposal*, and I will integrate their feedback into my future experiments. To further pursue the input of pathologists I will apply to present this work at conferences such as the United States and Canadian Academy of Pathology (USCAP) Annual Meeting. Additionally I will present my work to an audience of computational researchers and statisticians. I will apply to present at meetings such as the SPIE medical imaging conference to improve my understanding of computational research relevant to this project. I will also apply to present my work on topological data analysis (A3) at JSM in 2026.

### C. Activities Planned Under this Award

##### Research Training Activities:

Through the experiments planned under this proposal and the guidance of my co-sponsors and broader mentorship team, I will accomplish my research goals and build on the research experience I have acquired to date.

* **Investigation of Tumor Heterogeneity:** Prostate cancer and other solid tumors exhibit multiple phenotypes that evolve under the selective pressure of chemotherapy, leading to treatment failure and disease progression. Improved detection of these phenotypes will directly advance cancer biology research and ultimately patient care. Thus far in my PhD I have worked to contribute to this field of cancer research by beginning with the first principles of histology and building towards a rigorous and reproducible 3D histopathological workflow. With a team that includes Dr. Cheng and Dr. Warrick we will be well-positioned to contribute advances in this space in the near future.
* **Applied Statistics:** Concomitant with imaging experiments, I have invested significant time in developing the ability to analyze complex data. Dr. Silverman’s lab consists of several students working on difficult but related problems, including 2 from the Bioinformatics and Genomics program and 2 from the statistics program. Lab meetings in which we present challenging problems to one another as well as one-on-one discussions with Dr. Silverman have honed my skillset in applied statistics. This will continue to accelerate under the proposed award as I complete additional coursework and allocate further time to data analysis upon completion of A1.
* **Synchrotron Micro-CT Imaging:** Imaging experiments in the Cheng Lab involve using micro-CT resources both on campus at Hershey Medical Center (HMC) and at Lawrence Berkeley National Laboratory (LBNL). I will gain experience with x-ray imaging in each setting. In service of aims 1 and 2 of this proposal I will lead 2 experimental imaging trips to beamline 8.3.2 of the Advanced Light Source at the LBNL.
* **Image Reconstruction:** Reconstruction and analysis of phase-contrast images requires programming experience and an understanding of the physics underlying micro-CT imaging. Throughout my training under this award I will build on the programming skills I have already acquired by continuing to perform and refine 3D image reconstructions in python. Additionally, I will work closely with Dr. Patrick La Riviere (see letter of reference, biosketch) from the University of Chicago in collaboration on phase-contrast experiments. Through this collaboration I will deepen my understanding of medical physics and the mathematics that govern x-ray imaging.
* **Statistical Methods and Study Design:** I have already spent time studying inference and probability using the *Statistical Inference* book by Casella and Berger in my first year in the Silverman lab. Under this proposal, I will also study non-inferiority trials, ANOVA, and mixed effects models in support of aim 2. This training will improve my literacy in statistical methods that will translate beyond basic science research. Completion of these aspects of my training will result in a robust foundation in statistical theory that will mold me into a well-rounded physician-scientist capable of contributing to both basic and clinical research.
* **Topological Data Analysis:** I first learned about topological data analysis and persistent homology during my rotation in the Silverman lab. I developed an interest in these concepts and continued discussing them with Dr. Silverman. This led to aim 3 of our proposal, the execution of which will leave me with an expertise in the applications of persistent homology and a skillset that will transfer to my career as an independent researcher. Morphology is an oft understudied characteristic of tumor phenotype and TDA represents a means of quantifying it, potentially contributing a wealth of untapped insight, particularly in complex cases.

##### Clinical Training Activities:

* **MSTP Clinical Exposure Program (CEP):** All MSTP students at PSCOM are required to participare in CEP. The CEP requires that these students join an advisor in clinic for a minimum of 6 half days each semester. Through this program, I am working with Dr. Lilia Reyes, a Pediatric Emergency Medicine Physician at Penn State Health. She will evaluate my clinical skills and note writing in preparation for clerkship training during the third year of medical school.
* **MSTP Clinical Research Conference:** The MSTP program hosts CRC once every two months, during which students are guided by a physician scientist through a presentation of a challenging clinical case, including detailed discussion of the pathophysiology and a pertinent paper. In 2023 I presented the pathophysiology of pre B-cell ALL. In 2024, I will present the paper related to a different clinical case.
* **Objective Structured Clinical Exams (OSCEs):** OSCEs are used to adjudicate the clinical skills of medical students throughout training at PSCOM. Students have the opportunity to enroll in OSCEs during the PhD portion of training, and I will participate in and pass one OSCE per semester throughout the duration of this award.
* **Lioncare Volunteering:** To supplement formal clinical training, I will continue my participation in the student-run Lioncare free clinic treating underserved populations at the Bethesda Mission in Harrisburg a minimum of once every two months.
* **Subspecialty Shadowing:** I will join Dr. Raymond Hohl (thesis committee member) for one full day in outpatient Hematology/Oncology clinic per semester to connect my clinical training to the subspecialty I hope to practice as an independent physician-scientist.

Roadmap of training experiences planned under this award

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| **Goal** | **Year 1 (G3-G4)** | **Year 2 (M3)** |
| Micro-CT Imaging | Lead additional imaging trip to Advanced Light Source at LBNL Lead experimental imaging trip to Argonne National Labs Present imaging data to pathologists and conduct non-inferiority trial | Develop image analysis pipelines during dedicated research time Draft, submit, and edit additional manuscripts |
| Statistical Methods | Complete coursework in machine learning (IST557) Longitudinal self-study in Linear Algebra and FDA Present applications of self-study and Data Mining to Silverman Lab | Apply methods to data analysis of translational data Present results of A3 at JSM conference |
| Topological Data Analysis | Begin self-study in TDA Consult with Dr. Silverman | Complete coursework in TDA Explore translational applications of TDA during research rotations |
| Professional Development | Present at Pathology conference Present at ALS users meeting | Gain experience in clinical and translational applications of thesis work within medical school research rotations |
| Clinical Training | Longitudinal clinical training (BMS802) in Pediatric Emergency Medicine with Dr. Lilia Reyes | Complete clinical clerkships and research rotations OSCE Exams |

##### Coursework/Seminars:

I have been fortunate to develop strong computational skills throughout my time at Oberlin and especially through research in the Hua and Tolbert Labs. Specifically, I wrote several programs in bash, zsh, and python to conduct and analyze MD simulations. I built on these skills through my coursework in the Bioinformatics and Genomics program at PSU, escpecially in BMMB 802, MCIBS 554, and STAT 555, all courses I was able to excel in. Through STAT 555 and my work in the Silverman Lab, I have also developed skills in R. Under the proposed work, I will bolster my background in statistical theory and mathematics to achieve the level of expertise I need to contribute from a data science perspective. I will build on my already strong background in machine learning and applied data science by taking Data Mining (IST557) this fall. IST557 takes material from *Pattern recognition and machine learning* by Christopher Bishop and *Deep Learning* by Ian Goodfellow, Yoshua Bengio, and Aaron Courville. Completetion of this course will give me expertise in complex algorithms across regression, classification, and clustering, expanding my toolbox and enabling me to carry out the FDA elements of aim 3.

Topological data analysis (TDA) requires a greater understanding of linear algebra (LA) than I currently have. Although IST557 involves significant content review of LA I will supplement this instruction by completing a guided self-study with Dr. Silverman. During this self-study I will utilize the texbook *Matrix Algebra from a Statistician’s Perspective* by David A. Harville. Upon completion of this material, I will take the Topology course in the statistics/math department at PSU. This will not only support Aim 3 of this proposal, but will also advance my skills as a data scientist and build a foundation for critical analysis of other biomedical research problems. To further supplement our learning and improve student writing skills, students in Dr. Silverman’s lab also conduct a self-study reviewing *The Sense of Structure: Writing from the Reader’s Perspective* by George Gopen.

I have completed the BMS 591 course in Biomedical Research Ethics at Penn State College of Medicine which has supplemented the training in medical ethics and humanities I received through the first two years of the medical curriculum. Penn State also emphasizes the Science of Health Systems (SHS) courses during the medical years of our training. During SHS courses, we continue to discuss ethical problems in the setting of hospital medicine and biomedical research while also delving into other topics such as quality improvement research and biostatistics. Discussion of quality improvement and systems approaches to care improvement have had influence in my research as we strive to build translational methods that will positively supplement the work of clinicians and scientists alike. This coursework will supplement my studies in data science and statistics and promote the application of my research experience to projects that improve the delivery of care to patients.

##### Professional Development:

I have sought out a unique co-mentorship that will also provide especially beneficial professional development opportunities. The Silverman Lab meets weekly, alternating between professional presentations given by students and open-discussion journal club. The lab has an expertise in statistical theory and methods applied to biological problems, and I will benefit not only from hands-on training from Dr. Silverman, but also from regular lunch meetings and close working relationships with other students in the lab. I meet with Dr. Silverman individually on a weekly basis and additionally when needed. The Cheng Lab also meets weekly in a different format, with each student presenting 45min individual updates alternating with student-led journal clubs. I also meet weekly with Dr. Cheng to plan projects and receive feedback. I have been fortunate to form a close relationship with both of my co-sponsors and have benefited greatly from their mentorship.

To support this co-mentorship efficiently, I commute to University Park (Penn State University main campus) on Wednesdays where I have a dedicated workspace in the Silverman Lab. The Cheng Lab meets every Wednesday morning at 9am, and then the Silverman Lab meets in person every Wednesday at 1:30pm. Dr. Silverman and I then typically meet in person at 4pm before I return to Hershey. To supplement our regular one-on-one meetings, Dr. Silverman also meets with me before and after each presentation I deliver, as he does with all of his mentees. Dr. Silverman and Dr. Cheng also will continue to have regular meetings both for their ongoing collaborations and the joint supervision of my project. We are able to meet monthly via zoom and additionally as needed. This has benefitted me as a student and supported both the publication of a paper on which I am an author as well as my successful completion of the PhD comprehensive exam in the Bioinformatics and Genomics program.

### Medical School (2 years - 1 supported under the proposed budget):

After successfully defending my PhD thesis, I will re-enter medical school for the third and fourth years of clinical training and this award. I will focus during this period of training on my clinical skills and prioritize my development into a well-rounded physician. I will continue to develop my research, leadership, and professional skills in addition to my clinical training throughout this award. During the third year of medical school (M3 in table 1) I will complete clerkships in all major specialties and select elective rotations in pathology and hematology/oncology. Upon completion of M3 I will sit for the USMLE Step 2 medical board exam.

During the fourth year of medical school (M4 in table 1) I will utilize at least 3 of my 12 4-week blocks to conduct research exploring the applications of the proposed work in digital pathology and malignant hematology. The expected balance of longitudinal professional development and research experiences under the award is summarized in Figure 2. The training the proposed work would provide will optimally prepare me for a career as an independent physician scientist. I am fortunate to collaborate with experts in biomedical imaging, histopathology, and statistical methods who will support this interdisciplinary project and shape me into a versatile early-career scientist. As I complete the final year of this award and complete medical school I will apply to a research-track internal medicine residency program with a combined fellowship in hematology-oncology.

Distribution of activities across stages of proposal

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| --- | --- | --- | --- | --- |
| **Year** | **Research** | **Coursework** | **Prof. Development** | **Clinical Training** |
| G3-G4 | % | % | % | % |
| M3 | % | % | % | % |

https://grants.nih.gov/grants/how-to-apply-application-guide/forms-h/fellowship-forms-h.pdf discuss the approval of your IRB - I have already submitted an IRB which was approved through Penn State ahead of our October trip to the LBNL synchrotron

\* Good table format:

Summary of Goals and Timelines

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| --- | --- | --- | --- |
| **Goal** | **Year 1** | **Year 2** | **Year 3** |
| Micro-CT Imaging | Set up imaging experiments Collect preliminary data | Analyze imaging data Optimize imaging parameters | Finalize imaging experiments Prepare for publication |
| Statistical Methods | Complete coursework in bioinformatics Learn statistical methods | Advanced coursework in statistics Apply methods to data analysis | Apply statistical methods to project Prepare for publication |
| Machine Learning | Introductory course in machine learning Self-study in Python | Advanced machine learning techniques Apply ML to imaging data | Implement ML models Analyze results |
| Topological Data Analysis | Begin self-study in TDA Consult with Dr. Silverman | Complete coursework in TDA Start project in FDA | Apply TDA to project Prepare for publication |

|l|X|X| **Goal** & **Year 1 (G3-G4)** & **Year 2 (G4-M3)**  
Lead synchrotron trip to LBNL to complete data collection (A1) Complete IST557 Data Mining fall course Analyze imaging data Optimize imaging parameters & Finalize imaging experiments Prepare for publication  
Statistical Methods & Complete coursework in TDA Present at JSM conference & Advanced coursework in statistics Apply methods to data analysis & Apply statistical methods to project Prepare for publication  
Machine Learning & Introductory course in machine learning Self-study in Python & Advanced machine learning techniques Apply ML to imaging data & Implement ML models Analyze results