The American Association *of* Physicists in Medicine

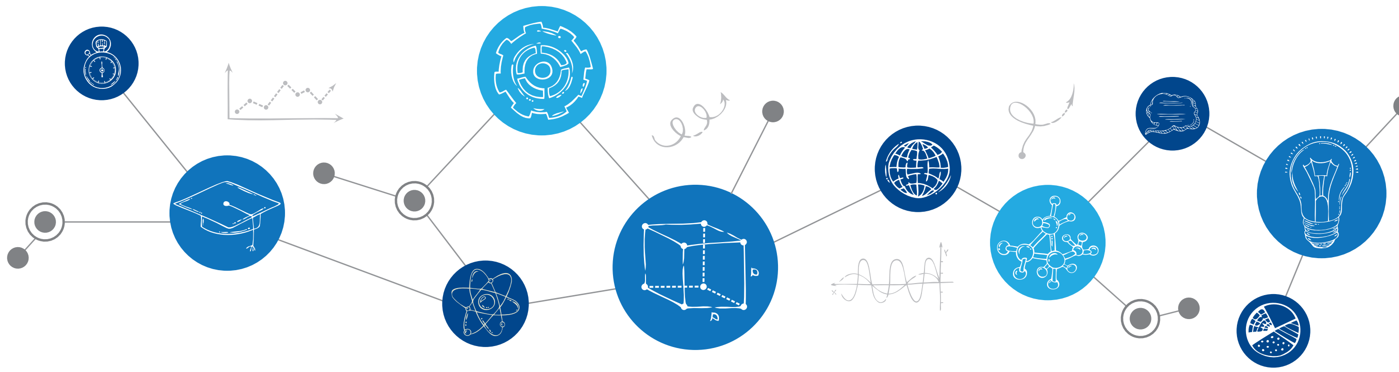
AAPM EDUCATION & RESEARCH FUND

2019 Annual Report

focus on our future

EDUCATION

RESEARCH



AAPM

Education & Research Fund Annual Report 2019

The AAPM Education & Research (E&R) Fund, established in 1990, supports the development of our vital medical physics profession by funding strategic education and research programs and awards. Research support includes seed grants for early-career researchers, a mentorship program, and travel grants. It also recognizes exceptional research through funding best paper awards for our AAPM journals.

Education support includes matching grants for clinical residency programs, fellowships for PhD students, and travel and tuition awards. It also funds an innovation in education award and distinguished lectureships. Of great significance, the Fund is used to attract undergraduates to medical physics and to promote diversity by supporting the Summer Undergraduate Fellowship Program (SUFP) and the Diversity Recruitment Through Education and Mentoring (DREAM) Program.

The Education & Research Fund receives its revenues primarily from member donations, donations from our local chapters and sister organizations, and the transfer of funds from the AAPM operations budget. As always, AAPM is extremely grateful for these generous gifts. Member donations, which are an essential component and provide the catalyst for other revenue sources, comprise both endowed and unendowed funds in the E&R Fund's portfolio of funds, many being named or memorial funds. In 2019, the AAPM E&R Fund supported just over $360,000 in programs.

In this report, recipients of the following grants, fellowships, and awards funded by the E&R Fund in 2019 will be described:

- **Research Seed Grants**

  Science Council, through its Research Committee, was funded $75,000 from the AAPM operations budget to support three $25,000 research seed grants for new researchers in medical physics.

- **Imaging Physics Residency Program Grants**

  In 2017, the AAPM Board of Directors approved $140,000 in funding for two new imaging physics residency positions, either in diagnostic, diagnostic with a nuclear medicine option, or nuclear medicine. Two institutions with such programs, selected in 2018, are receiving $35,000 per year for two years as matching support for one resident, which commenced July 2019.

- **Graduate Fellowships in Medical Physics**

  Earnings from the E&R Fund funded $36,000 to support the first of two years for the fellow selected for the 2019-2021 RSNA AAPM Graduate Fellowship in medical physics and the second of two years for the fellow selected for the 2018-2020 AAPM Graduate Fellowship in medical physics.

- **Summer Undergraduate and DREAM Fellowships**

  Education Council, through its Education & Training of Medical Physicists Committee (ETC), was funded $88,000 to support 16 undergraduate fellowships in the Summer Undergraduate Fellowship Program (SUFP) and another $38,500 to support seven undergraduate fellowships in the Diversity Recruitment Through Education and Mentoring (DREAM) Program. The seventh fellowship was funded by the AAPM Northwest Chapter.

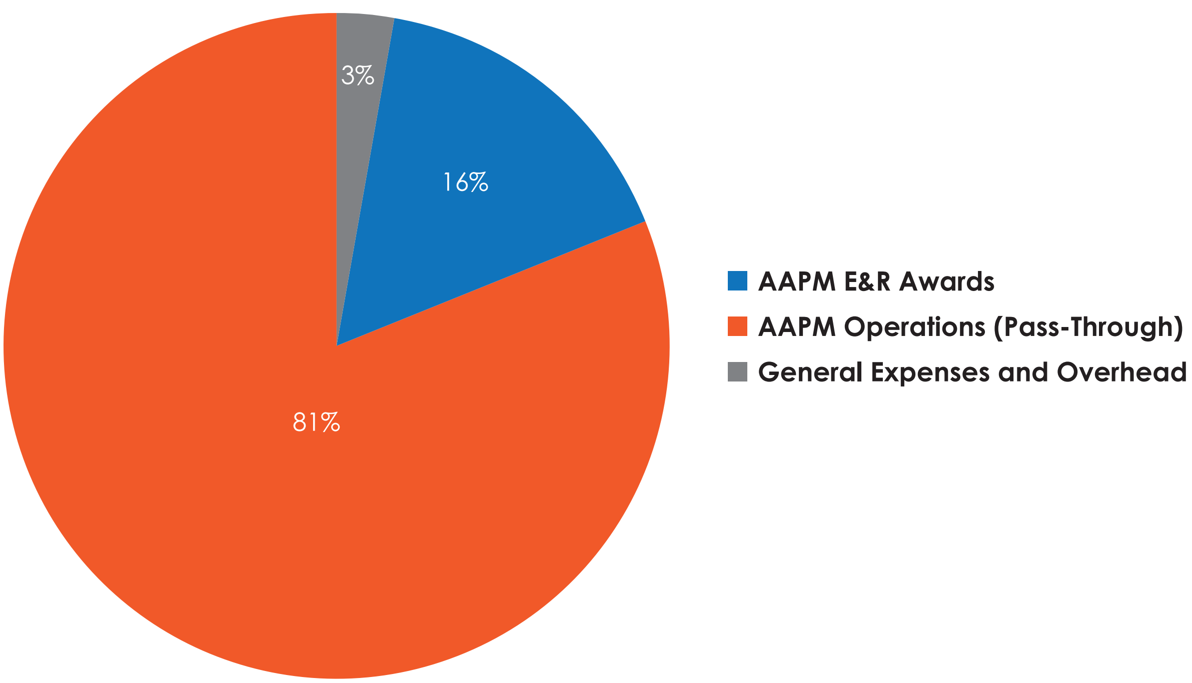
- **Journal Publication Awards**

  Endowed funds supported the 2019 annual *Medical Physics* awards for best papers in 2018 in the areas of radiation therapy and imaging, the Farrington Daniels Award and the Moses and Sylvia Greenfield Award. Recently endowed funds supported the inaugural 2019 annual *Journal of Applied Clinical Medical Physics* awards for outstanding articles in 2018 in four areas of medical physics in honor of its editors to date, Michael D. Mills, Peter R. Almond, George Starkschall, and Edwin C. McCullough.

- **Distinguished Lectureships**
  Our AAPM Annual Meeting benefitted from two endowed funds that each support distinguished lectures, the Anne and Donald Herbert Distinguished Lectureship in Modern Statistical Modeling, and the Carson/Zagzebski Distinguished Lecture On Medical Ultrasound.
- **Annual Meeting Awards**
  Earnings from the E&R Fund funded the Jack Fowler Junior Investigator Award, the Jack Krohmer Junior Investigator Award, the John R. Cameron Young Investigator Awards, and the Award for Innovation in Medical Physics Education at our 2019 AAPM Annual Meeting.
- **Other Awards**
  Other awards aimed at cultivating junior medical physics researchers and at providing medical physics education included: (1) the AAPM Science Council Associates Mentorship Program, (2) the AAPM Expanding Horizons Travel Grants, (3) the BEST/AAPM Travel Awards, and (4) AAPM Summer School Tuition Scholarships.

The benevolence of our members, chapters, and sister societies is greatly appreciated, without which these programs and awards would not be possible. The pages to follow detail 2019 award recipients and testimonials, which demonstrate the enormous value the recipients place on this support. As you read the reports, consider how these programs impact our medical physics profession by attracting bright, young people into our profession, encouraging development of quality graduate and resident medical physics education programs, and helping develop outstanding research scientists, all ***starting with your contributions to our AAPM E&R Fund.***

2019 AAPM E&R Fund Expenses
Total = $360,384



The Research Seed Funding Grant

Three $25,000 grants were awarded to provide funds to develop exciting investigator-initiated concepts, which will hopefully lead to successful longer term project funding from the NIH or equivalent funding sources. Funding for the 12-month grant period began July 2019. Research results are submitted for presentation at future AAPM meetings.

Sponsored by the AAPM Science Council through the AAPM Education & Research Fund (See AAPM website for more details, including eligibility requirements.)

Dante P.I. Capaldi, PhD
Medical Physics Resident
Stanford University
Department of Radiation Oncology

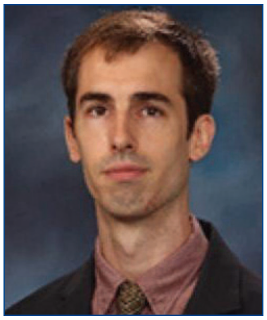
"An Integrated Quality Assurance Phantom for Frameless Single-isocenter Multitarget Stereotactic Radiosurgery"

I would like to express my sincerest gratitude for the opportunity to further my research that would have not been possible without the AAPM Seed Funding Grant. My project focused on the design and development of a quality assurance phantom to facilitate the translation of a frameless single-isocenter, multitarget cranial stereotactic radiosurgery program to improve work efficiency and patient experience. The funding support I received allowed me to purchase 3D printing technology and a computer to develop, prototype, and refine the design of a 3D printed quality assurance phantom to commission and perform acceptance testing of frameless single-isocenter multitarget stereotactic radiosurgery linear accelerators. The quality assurance phantom has not only been tested and refined to the point that we have implemented the phantom within our own clinic, but has been tested at multiple cancer centers, in an effort to truly translate this technology from the benchtop to the bedside. The work on the initial design and development of the quality assurance phantom is now submitted to the journal *Physics in Medicine and Biology*, and that demonstrating the clinical translation of this quality assurance phantom to multiple institutions has been submitted for this upcoming Annual Meeting.

Michele M. Kim, PhD
Medical Physics Resident
University of Pennsylvania
Department of Radiation Oncology

"Investigation of Spot Scanning Flash Radiation Using a Clinical Proton Beam"

Thanks to the AAPM Seed Funding Grant, I have been able to investigate a novel proton flash radiation technique. My two aims were (1) to apply use of a spread out Bragg peak in *in vivo* models to investigate its effects on therapeutic index and (2) to investigate effects of proton spot scanning on spatial variation of dose rate and biological effects of radiation. Proton flash irradiation at the Bragg peak created with a custom-made ridge filter, was compared to a shoot-through method using the entrance dose. Funding has allowed for the study of multi-spot proton flash irradiation to begin preliminary investigation of spot scanning for translation into clinically applicable larger field sizes. This has enabled generation of data to be presented at two conferences as well as preparation for a manuscript. The research opportunity has enabled me to pursue an academic position after residency and prepare preliminary data for a larger NIH application that will allow me to develop as an independent investigator initiating collaborative interdisciplinary projects.



Thomas R. Mazur, PhD
Washington University School of Medicine
Department of Radiation Oncology

"Margin Selection and Intra-fractional Feedback Techniques in MRI-Guided Radiotherapy"

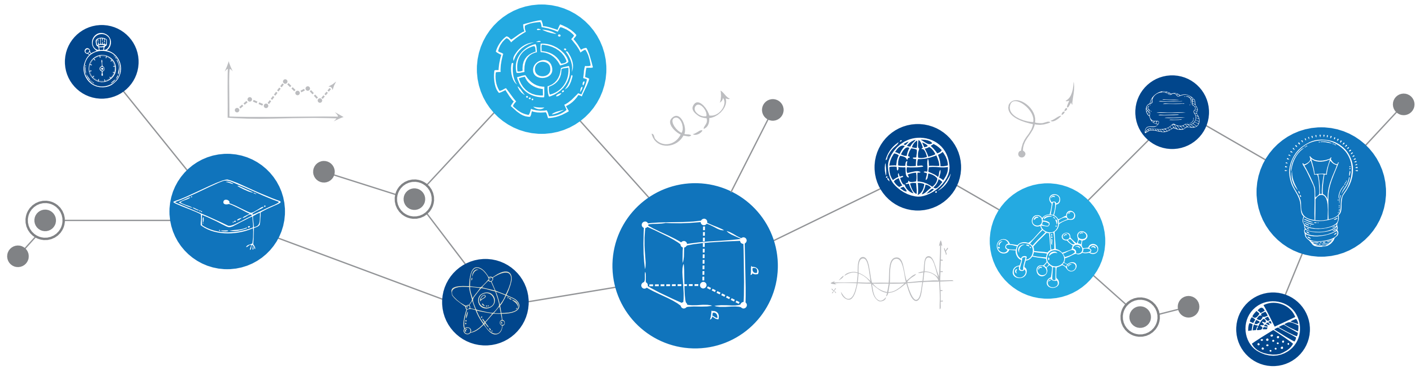
Resources from the AAPM Seed Funding Grant have supported me in synthesizing large amounts of imaging data acquired in MRI-guided radiotherapy treatments at our institution. From these imaging data, we have learned about variation in motion across patients and better understood the consequences of these variations in motion in terms of treatment efficiency and delivery accuracy and precision. Beyond just analyzing motion, this seed funding has enabled me to investigate more speculative hypotheses relating to improving imaging and treatment delivery in MRI-guided radiotherapy. I am very grateful to AAPM for providing this unique source of funding, which has enabled me to pursue research directions that I hope to continue to develop into projects that can contribute toward advancing our field.

AAPM Imaging Physics Residency Grants

On November 29, 2017, the AAPM Board of Directors approved $140,000 in funding for two new imaging physics residency positions in diagnostic radiology, diagnostic radiology with a nuclear medicine option, or nuclear medicine. With funding commencing July 2019, two institutions will receive $35,000 each per year for two years as matching support for one resident. Selected in 2018, the two program director recipients were:

Frederic H. Fahey, DSc
Boston Children's Hospital and Harvard Medical School
Diagnostic and Nuclear Medical Physics Residency Program

David Lloyd Goff, PhD
Medical & Radiation Physics, Inc.
Imaging Physics Residency Program



Graduate Student Fellowships

The AAPM Graduate Fellowship and RSNA/AAPM Graduate Fellowship are awarded in alternating years. Each fellowship is awarded for the first two years of graduate study leading to a doctoral degree in Medical Physics (PhD or DMP). Both BSc and MS holders are eligible to apply. A stipend of $13,000 per year, plus tuition support not exceeding $5,000 per year, is assigned to the recipient.

Sponsored by the AAPM Education & Research General Fund (See AAPM website for more details, including eligibility requirements.)

RSNA | AAPM Graduate Fellowship (2019–2021)

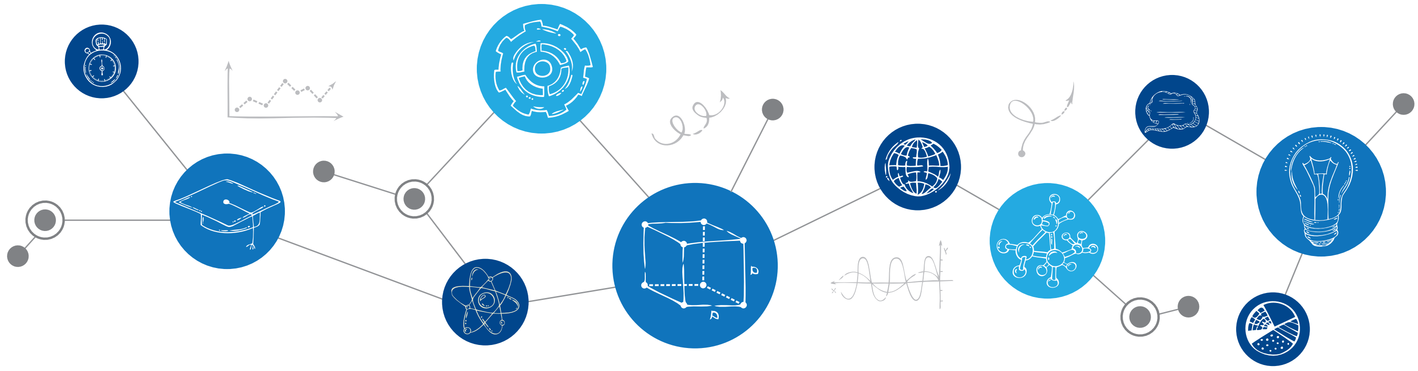
Hadley A. Smith, BSc
University of Chicago

I decided to study medical physics to make a positive impact on human health and wellbeing, by serving patients through a clinical career and researching ways to improve the efficacy and accuracy in diagnosing disease. The AAPM/RSNA Graduate Fellowship has given me financial freedom and opportunity to choose my research area based on those interests. Because of this freedom, I have realized my inherent interests in computational imaging and radiomics research. This fellowship has also furthered my professional development, by contributing to my financial freedom to attend conferences, present my research, and make professional connections. I am incredibly grateful for the AAPM/RSNA Graduate Fellowship — it has given me the best possible beginning to my graduate education and career.

AAPM Graduate Fellowship (2018–2020)

Kaelyn Seeley, MS
University of Wisconsin, Madison

I have completed courses in radiological physics and dosimetry, radionuclides in medicine and biology, physics of diagnostic radiology, medical imaging science, health physics, physics of radiotherapy, diagnostic ultrasound physics, magnetic resonance imaging, physics of radiotherapy, radiation physics metrology, pharmacokinetic modeling, and advanced treatment planning these past two years and have recently passed my qualifying exam to obtain my master's degree. Thanks to the AAPM fellowship, I have not had to worry about the financial burden of being in graduate school these past two years, and this has allowed me to spend more time in the cyclotron lab. My research has been focused on developing automated separation sequences to purify medical radioisotopes such as Ga-68 and Zr-89. I also have been working on fabrication of CaO targets to produce Sc-44 and Sc-43, two promising new PET radioisotopes.



Summer Undergraduate Fellowship Program

The Summer Undergraduate Fellowship Program is a ten-week (40 hours per week) summer program designed to provide opportunities for undergraduate university students to gain experience in medical physics by performing research in a medical physics laboratory or assisting with clinical service at a clinical facility. The mentor and fellow determine the exact ten-week schedule (May-September). In this program, AAPM matches exceptional students with exceptional medical physicists, many who are faculty at leading research centers. Students participating in the program are placed into summer positions that are consistent with their interest. Selected for the program on a competitive basis, summer fellows receive a $5,500 stipend from AAPM.

Sponsored by the AAPM Education Council through the AAPM Education & Research Fund
(See AAPM website for more details, including eligibility requirements.)

Elizabeth Brown
University of Nebraska at Omaha
Senior Physics Major

Mentor: Arash Darafsheh, PhD
Washington University
Department of Radiation Oncology

"Time Analysis of EBT3 Film"

My experience at Washington University was very rewarding. I made a lot of connections with the radiation oncology staff and learned more about what they do. The research that I was a part of gave me the opportunity to learn about a new part of medical physics that I had not been aware of going into this summer. At Washington University, I was encouraged to come up with research protocols and execute these plans. I learned how to be a part of a research team and how to design different experiments.

We did a time analysis of EBT3 Radiochromic Films. This analysis was performed under varying conditions such as regular irradiation, fractionated irradiation, and irradiation in the presence of a magnetic field.

This research of films is important because when a new model of film is produced, we need to be able to come up with a calibration curve for it. The best way to come up with the curve is to do a time analysis of the films irradiated at different doses and under different conditions.

We performed our project by cutting EBT3 films into 5x5cm squares and labeling them as to keep the same orientation during irradiation. We then subjected the films to different dose levels. After the films had been irradiated, we scanned the films at certain time intervals over the course of several days. After the measurements had been taken, we processed the optical densities of the irradiated films using Matlab. Once all the data had been processed, we were able to make our plots and draw our conclusions.

I helped with the irradiation of the films, scanning, data processing, plot making, and writing the paper.

This ten-week fellowship made me realize that there is a lot more to medical physics than I had originally thought. I plan on pursuing my PhD with hopes to make a difference in this field.

Madison Emily Grayson
Barrett, The Honors College, at Arizona State University
Senior Physics Major

Mentor: Radhe Mohan, PhD
The University of Texas
M.D. Anderson Cancer Center
Department of Radiation Physics

My summer fellowship with Dr. Radhe Mohan at M.D. Anderson Cancer Center was one of the most impactful experiences I have had as an undergraduate. The overall goal of my project was to generate normal tissue complication probability (NTCP) models for incidence of esophagitis following radiation treatment of the esophagus. In particular, I created a preliminary NTCP model that was able to be compared to previously generated models for proton data. I also had the opportunity to attend classes offered by the graduate school on proton therapy. This was valuable because I was able to learn more about a topic in which I am very interested, as well as experience a graduate-level course. I truly enjoyed this fellowship and believe that I have learned many skills that will be useful as I continue my research. Everyone with whom I worked was very welcoming and eager to guide me as I worked on my project and learned more about proton therapy. This fellowship has been an incredibly valuable experience and has further confirmed my passion for medical physics and research.

Tobey Haluptzok
University of Nebraska at Omaha
Senior Physics Major

Mentor: Andrea Ferrero, PhD
Mayo Clinic
CT Clinical Innovation Center

"Methods to monitor CT protocol compliance and radiation dose comparison across a large scanner fleet"

This summer internship was an amazing experience. I met a lot of great people and got to work on an interesting project. I also got to learn about what a medical physicist does on a day-to-day basis including both the clinical and research aspects. I also learned about how CT scanners worked and different techniques used to minimize radiation to the patient while still maintaining CT image quality. Some of these techniques were relatively new research papers that showed how patient size affects CT image readability. This along with other things really helped me understand what kind of research medical physicists do.

Some of Mayo Clinic's scanners don't take into account patient size when prescribing the noise tolerance. For a work around to this, patient size dependent technique charts were created. I created a software that monitors how well CT Technologists follow these technique charts and then compared the radiation from the technique charts to an example radiation curve.

The best CT image is one that minimizes radiation to the patient while maintaining diagnostically adequate image quality. What I did was create a tool to help physicists at Mayo to quickly and effectively monitor CT technologist compliance so they know where to concentrate their education/outreach efforts which in turn should help lower radiation to patients. This program also will help to modify the technique charts to optimize the noise tolerance parameters used for each patient size bucket.

I created a MATLAB program that is able to extract data from dicom headers, measure patient size in four critical places (AP top liver, AP largest width, laterally top liver, laterally largest width), and pull out data not found on the dicom headers from summary pages using optical character recognition. I then created intuitive plots to easily asses technologist compliance and compare radiation doses.

My program allows the medical physicists to monitor Tech compliance and compare radiation doses across different scanner makes and models. This will have an impact in the Mayo Clinic practice and help to improve patient care.

I now know what kind of an impact medical physicists have on patient care in medical institutions. With this knowledge I am even more excited and sure that I want to pursue a medical physicist graduate degree and someday be a medical physicist.

Benjamin Insley
Brown University
Senior Biological Physics Major

Mentor: J. Adam Cunha, PhD
University of California,
San Francisco
Department of Radiation Oncology

"Shielded brachytherapy applicator for nasopharyngeal carcinoma"

We designed and fabricated a novel radiation applicator with built-in shielding for intracavitary brachytherapy in the nasal canal. This new design allows for dose escalation on nasopharyngeal cancers while protecting nearby normal tissue such as the soft palate.

I also aided in improving brachytherapy treatment planning by incorporating biological dose models into the planning software.

My role was to take dose measurements of the applicator using radiochromic film to validate a Monte Carlo simulation of the radiation geometry. I then used this simulation to redesign the current nasopharynx applicator for better patient comfort and improve CT imaging.

For the treatment planning work, I redesigned the current algorithm to be faster and more accurate while taking into account the biology of cell irradiation.

Including shielding in brachytherapy protects the nearby organs so that the dose delivered to a target can be increased. This sort of dose escalation can lead to overall better patient outcomes, including higher remission rates without normal tissue toxicity.

The treatment planning software is important because accurate dose calculations can help us fully understand the space of possible treatment options.

I worked with my mentor and another lab at Berkeley to execute an appropriate film dosimetry procedure to validate the Monte Carlo. Once the simulator was found to be correct, I used AutoCAD to design a 3D-printed mold to make this new silicone applicator. The simulation was an important tool in measuring the shielding properties of each design.

For the treatment planning software I took over the code base from the previous students. I learned about biological dose models and how to interpret them for treatment planning. I then improved the algorithm's efficiency and accuracy.

I was able to design a new applicator for nasopharynx brachytherapy, as well as propose a shift in the treatment planning paradigm. These projects remain ongoing, and I hope to take them to publication.

Before this program I was sure I wanted to pursue a PhD in physics. My time at UCSF has given me even more direction in that I can see myself pursuing a job as a medical physicist. I have not felt as impactful in any other lab as I have here. It was very easy to see myself coming into the hospital and doing research, helping patients, and educating others. This program has definitely melted away some of the fog surrounding my future endeavors.

Brendan Koch
Lawrence Technological University
Senior Physics Major

Mentor: Arvind Rao, PhD
University of Michigan
Department of Computational Medicine and Bioinformatics

"Analyzing and extracting features from brain MRI to compile a database of information through machine learning"

During my experience at University of Michigan, I found myself working alongside graduate students working under Dr. Rao in his lab. Over the course of the ten weeks, I spent most of my time coding and researching on my personal laptop. This often took place within Dr. Rao's lab or in various neighboring parks.

There are currently multiple databases and processes used to help predictions and diagnoses, but having a single, well-formed database using our process will enhance the speed and predictability of brain MRI.

During my ten weeks of research, I spent the first couple of weeks familiarizing myself with research being conducted by Dr. Rao and his students along with general medical physics terminology and topics. I was then able to work on the coding process, building on previous work done by another student. Eventually, I had a working code that would extract features from any brain MRI. I finished at a point where the code could be fed any simulated brain MRI to extract certain features from the image itself.

Olivia Krieger
Allegheny College
Senior Physics Major

Mentor:
Åse Ballangrud-Popovic, PhD
Memorial Sloan Kettering Cancer Center
Department of Medical Physics

"Dosimetric evaluation of synthetic CT for brain radiation therapy planning"

I had a great experience with this project. It allowed me to learn about the process of treatment planning and get experience with a popular software used to treatment plan (Eclipse). I also gained understanding of various terminology and methods common for brain radiation therapy.

Within radiation therapy, there has been a push for an MR-only workflow by generating synthetic CT (sCT) images from MR images. Before I arrived, a post-doc had already developed sCTs for 14 patients that had already gone through successful radiation treatment. My job was to compare the sCT to the CT and evaluate its quality.

There are many advantages of MR-only workflows in radiation therapy. MR images have much greater definition of soft tissue. Also, the error introduced in treatment planning from the registration MR and CT scans will be eliminated. In addition, MR-only workflow will be easier on the patient because it will require one less scan, and MR scans don't expose the patient to extra radiation like CT scans do.

After being trained on Eclipse, the treatment planning software used at MSK Cancer Center, I performed various tasks and calculations on both the real and synthetic CT image. Then I pulled different metrics from dose calculations and put them into an excel file to perform various analyses in order to compare the results between the real and synthetic CTs. I performed dose calculations and analysis on 14 different patients. This allowed my mentors and I to examine differences in CT and sCT images and determine if larger differences between the two were because the sCT is not accurate enough. After performing various evaluations, we believe that the cases where there were larger differences in dose calculations arose because of errors when transferring treatment plans and structure sets, not because of the quality of the sCT image. The group I worked with plans to continue to work on publishing a paper that will include my results.

The fellowship allowed me to better understand how physicists contribute to clinical radiation therapy, both in planning for patients and performing research to advance the efficiency and quality of treatments. Also, I learned about the process of becoming a medical physicist and the options besides radiation physics that exist in the medical physics field. This knowledge has allowed me to better plan my next steps in building my career.

Sarah Lim
University of California, San Diego
Senior Biophysics Major

Mentor: Nataliya Kovalchuk, PhD
Stanford Hospital
Department of Radiation Oncology

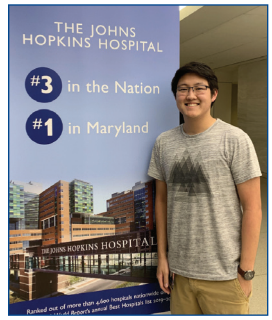
"Automated plan checking script"

My time at Stanford Hospital in the Department of Radiation Oncology was both educational and rewarding. Under the mentorship of Dr. Nataliya Kovalchuk, I saw firsthand the duties of a medical physicist. Thanks to her guidance, I gained experience both in the clinical and research areas of radiation oncology. It was rewarding to see the results of my work in use everyday in the clinic, something I had never experienced in the physics field prior to this. This fellowship also gave me a chance to experience working in the healthcare field, and provided me with a clearer idea of what I would like to pursue in the future.

My project was to improve and add to the Automated Plan Checking script used in the clinic. The script automates portions of the manual check which physicists perform for each treatment plan. This script reduces the time that it takes a physicist to do a secondary check on the treatment plan. It also allows dosimetrists to check their plans for errors prior to submitting them. The use of this script has reduced the number of errors made overall, ultimately decreasing the number of errors in patient treatment.

I first got familiar with the software and learned about the different aspects of medical physics. I then spent most of my time improving the script, adding checks to error prone processes, as directed by my mentor. I added numerous checks to the Automated Plan Checking script. These additions allow the clinic to run more efficiently while further decreasing the amount of errors in the clinic.

Through this fellowship, I learned about what medical physicists do, and how important they are to radiation therapy. I saw both the clinical and research sides of the profession, which has given me valuable insight as I consider my future.



David Martinus
Purdue University
Senior Radiological Health Science
Pre-Medical Physics Major

Mentor: Michael Jacobs, PhD
Johns Hopkins University
Department of Radiology and Radiological Science

"Investigating radiomics application to breast cancer diagnosis and evaluation of HIFU prostate surgery"

This summer I was able to learn about the diverse field of machine learning and neural networks. I initially started by reading numerous research papers on the history of machine learning. Then, I learned the history of how machine learning was applied to medical use early in the field. Once I understood the history, I began learning how Dr. Jacobs' research team applied machine learning and neural networks to advance modern diagnosis and treatment techniques. The most beneficial experiences I had were gaining practical knowledge of machine learning and advancing my coding skills.

My project involved validating a machine learning registration algorithm used to overlay and register multiple MRI images together. With this algorithm, the team could register many types of MRI images (T1,T2, ADC maps, etc.) into one image for radiomic analysis. Additionally, I used similar technologies created in-house to evaluate the effectiveness of a new type of ultrasound prostate surgery (HIFU). The ability of an algorithm to be able to synthesize many types of images into one combined image is important because this gives the image more information. If the image intrinsically has more information the machine learning and AI aspect of radiomics will have more data and information to train on. As with any type of machine learning, the more data the better. Additionally, AI presents the ability to extract data from images that would be invisible to the human eye. I started by researching the theories behind Machine Learning and AI. Then I was trained by a member of Dr. Jacobs' team and himself on how to use the in-house software. Once I understood the software I ran many tests to obtain data to test the validity of the registration algorithm. Data analysis was performed through excel which allowed me to figure out what aspects of the machine learning algorithm struggled as a whole. Once this determination was made I was able to find the "bugs" in the code and start to rewrite them. I was successfully able to perform quantitative analysis on all the patient data available to me and begin to incorporate changes in the code that lead to an overall increase in machine learning accuracy.

The fellowship really revealed to me how modern technology like computers, AI, neural networks, and machine learning will be incorporated to all fields, specifically medicine. This fellowship introduced me to a whole new side of Medical Physics, one that takes advantage of the technology available to us and maximizes its potential to aid in the development of life saving diagnostic and therapeutic practices.

Joshua Alexander Miles
University of Missouri-Columbia
Senior Physics and Economics Major

Mentor: David Fuentes, PhD
The University of Texas
M.D. Anderson Cancer Center
Department of Imaging Physics

"Molecular Dynamics Simulations Testing Suitability of EYKY for Nanoparticle Coating"

I did a ten-week research internship with M.D. Anderson's Department of Imaging Physics in Houston, Texas. My research project involved determining the suitability of a certain peptide to function as an agent for medical imaging. In this work, I used molecular dynamics (MD) simulation software to simulate peptide behavior, looking to determine the peptides' ability to aggregate and the shapes into which they might aggregate. Outside of my research, I also attended some presentations, lectures, and seminars organized through various programs at M.D. Anderson.

Completing the project required learning how to use the MD simulation software, learning theory concerning MD, and recording computer code used in the simulation. For my project, I used a software called GROMACS to model the behavior of a system containing EYKY (Glutamic acid-Tyrosine-Lysine-Tyrosine) peptides and water. My primary simulation used 100 EYKY peptides concentrated at approximately 80 mg/mL in water. I simulated the system for five microseconds total and collected metrics and visual representations of the system along the way.

If the EYKY peptides can be shown to aggregate into a certain shape or shapes, then EYKY might be useful as an imaging agent — a substance that carries another substance to a target site for medical imaging. My project could give an idea of the shape into which EYKY peptides aggregate and thus might help determine EYKY's suitability to function as an imaging agent.

My preparation for my work largely involved studying theory of molecular dynamics and studying how to use GROMACS software. My supervisors provided a couple of helpful MD simulation tutorials that helped me understand the simulation process holistically. I think that these tutorials guided the sequence of procedures that I used in my work.

I completed a simulation of a system containing EYKY peptides and water. While I think that more research would be necessary to obtain a knowledge of EYKY's aggregation tendencies that is sufficient for imaging purposes, I think that my work could give a preliminary idea of EYKY's usefulness as an imaging agent.

Through the Fellowship, I was able to further clarify my expectations about research work. Moreover, I now have more confidence that I can find satisfying research work, and I have an avenue of research to consider for graduate school and/or other future research endeavors.

Tarun Naren
Georgia Institute of Technology
Junior Nuclear/Radiological Engineering Major

Mentor: Atchar Sudhyadhom, PhD
University of California,
San Francisco
Department of Radiation Oncology

"Development of Pinpoint Accurate Proton Radiation Therapy Treatments"

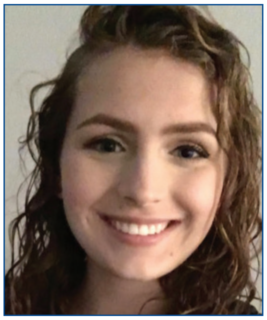
As part of my summer fellowship, I contributed to Dr. Sudhyadhom's project to develop more accurate proton radiation therapy treatments by creating tissue phantoms to test a method proposed by Dr. Sudhyadhom for more accurately determining mean ionization potential. In addition to the lab work, I also had the opportunity to shadow a few physicists in the radiation oncology department to gain more understanding of the daily roles and responsibilities of a medical physicist.

The goal of the research project was to improve the accuracy of proton radiation therapy treatments by accurately determining the mean ionization potential of tissue using MRI. MRI was used to determine the mass percent water and the mass percent hydrogen content in organic molecules which could then be used to calculate mean ionization potential. Proton radiation therapy treatments have a certain amount of uncertainty associated with them due to the variances in mean ionization potential in tissue. This can lead to tissue outside the intended treatment area receiving more radiation than desired. If we can determine the mean ionization potential of tissue accurately through MRI, we can reduce the uncertainty of proton radiation therapy treatments, thereby reducing the amount of unwanted radiation delivered to the patient.

My particular contribution to the project was creating tissue phantoms using substances such as water, coconut oil, gelatin, and bone meal powder to simulate the various compositions of human tissue. I tested a wide variety of compositions to determine which compositions were feasible to make and scan and the different types of tissue we could emulate. After scanning the phantoms, I analyzed them to determine electron density and stopping power ratio in order to compare them against calculated values from physical density.

I provided the necessary groundwork for testing the proposed method by creating phantoms of known composition and electron density. I also explored the boundaries of the possible tissue compositions that we could feasibly emulate to test. This helped move the project out of the theoretical phase.

My overall experience with Dr. Sudhyadhom and UCSF was very positive. I got to participate in cutting edge research about a topic that will help improve radiation therapy and learned quite a bit about the physics of MRIs and radiation treatments. I also now have a better understanding of the clinical responsibilities a medical physicist.



Megan Poremba
Siena College
Senior Physics Major

Mentor: Rao Khan, PhD
Washington University School of Medicine, Siteman Cancer Institute
Department of Radiation Oncology

"Effects of Extended Source to Surface Distance in Volumetric-Modulated Arc Therapy"

I worked on two projects at Washington University. My primary project was working with Dr. Rao Khan and his graduate student Shadab Momin on the effects of extended source to surface distance (SSD) in volumetric-modulated arc therapy (VMAT). I was able to work with Varian Eclipse™ to plan radiation therapy treatments for patients with large planning target volumes. My secondary project was with Dr. Khan as well as Dr. Arash Darafsheh, his graduate student Daniel Mulrow, and Elizabeth Brown, another AAPM Summer Undergraduate Fellow. This project was a time analysis of EBT-3 GafchromicTM film, which is commonly used in radiation dosimetry.

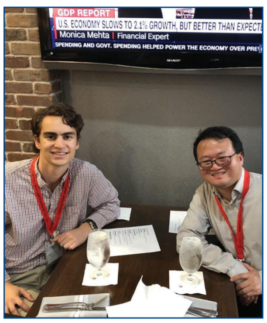
(Primary Project)
The source to surface distance (SSD) is typically less than 100 cm in a linear accelerator. By increasing the SSD, the radiation beam spreads out over a larger surface area allowing a larger area to be irradiated. The extended SSD technique can be useful in treatment planning in many ways. It can be used for total body irradiation for bone marrow transplant recipients. Extended SSD can also be used to target tumors that are too large to fit in the typical field size of a linear accelerator. By increasing the SSD, the radiation beam spreads out more and is able to reach the edges of bigger tumors that otherwise would have to be irradiated using two different fields.

In this project, we use extended SSD to target large tumors. Specifically, we work with a 22 cm planned target volume of the prostate, but in the future this could be applied to other large targets such as breast tissue. The potential advantages we look to achieve are reduced monitor units (MUs) and less leakage.

This project is important because innovating new and improved ways to treat cancer patients can significantly improve the quality of their life after radiation therapy. For instance, by treating the planned target volume while reducing the radiation exposure of the organs at risk, the healthy tissue surrounding the tumor can be spared and maintain better function.

(Secondary Project)
The purpose of this project is to investigate the optical response of the EBT-3 Model film over the course of a 120 hour period. The EBT3 Gafchromic™ films are used for their ease of use, high spatial resolution, and near tissue equivalency. EBT-3 is a well established and studied model of radiochromic film with an optimum dose range of 0.2-10 Gy. Despite the numerous characterizations of this film, a kinetic study has yet to be performed. This information is crucial in understanding the fundamental response of these films to clinical therapy beams and potential application in brachytherapy.

This project is important because EBT-3 Gafchromic™ films are commonly used around the world for radiation dosimetry, so it is important to understand how the films develop over time.



Noah Schweitzer
University of Wisconsin-Madison
Senior Nuclear Engineering-Radiation Science Major

Mentor: Dr. Yao Weiguang, PhD
University of Maryland Medical School
Maryland Proton Treatment Center

"Proton Range-Based Registration for Pelvis and Prostate Treatment with Intensity Modulated Proton Therapy: A Retrospective Study"

Overall, the project turned out great. The project allowed me to gain valuable experience and understanding in the clinical and research medical physics world. I developed stronger computational skills while also understanding medical physics and proton therapy at a much higher level. I analyzed eight prostate patients and ten pelvis patients' weekly QAs (a total of 82 QAs) in order to determine if there was an effect of gas in the rectum and of small and large bowels on the dose coverage, as well as analyzing the benefit of Range-Based Registration on the dose coverage.

The projects were important as the factors of gas and range-based registration can cause the protons to deliver a dose that is 3-5 mm away from the intended target. This can lead to healthy tissue being damaged. I performed my project by running simulations on Raystation for each QA. Furthermore, I used MATLAB and Dr. Yao's code to run the Range-Based Registration simulations.

I was able to show that there is a strong correlation between a change in gas in the bowels and rectum and a change in the dose coverage. Furthermore, I was able to show that range-based registration is able to decrease the margin of error to the target. These findings will be a significant portion of future papers that Dr. Yao plans to publish.

The fellowship allowed me to find a passion in medical physics, specifically medical imaging, and gave me clarity on what I wanted to do in the future.

Brian-Tinh Vu
University of Houston
Senior Physics Major

Mentor:
Raymond Acciavatti, PhD
Hospital of University of Pennsylvania
Department of Radiology

"Automation of virtual clinical trials used to evaluate efficacy of digital mammography and synthetic 2D mammography"

The project was about using the virtual clinical trial software created by the lab to evaluate the efficacies of the breast cancer screening modalities of digital mammography, digital breast tomosynthesis, and synthetic 2D mammography. About halfway into the program, an additional layer of work was added to the project: to automate the software pipeline to handle multiple experiments at once. We used virtual clinical trials (VCTs) developed by the Maidment X-ray Physics Lab to generate artificial mammograms for different breast cancer screening modalities (digital mammography, digital breast tomosynthesis, and synthetic 2D mammography). By using VCTs we were able to circumvent the associated time and cost of conducting regular clinical trials to evaluate efficacies of these screening modalities. We varied several lesion parameters (material, size, shape, position, etc.) and inserted lesions into the breast to create a virtual, artificial breast phantom. X-rays were projected onto this phantom and the resulting images were processed and evaluated for imaging quality.

Clinical trials for breast cancer screening are expensive, take up a lot of time, and possess an inherent risk because they expose patients to radiation. Virtual clinical trials hope to circumvent these downsides while providing the researcher finer control over the parameters of experiment, such as breast and lesion size, shape, and material composition. By testing digital mammography, digital breast tomosynthesis, and synthetic 2D mammography, we hope to determine how each screening modality performs in detecting lesions. By automating this process in Python, a high-level and open-source programming language, we hope to conduct several experiments at once without the need for human attention during the simulation, while making virtual clinical trials more accessible for other research groups around the world.

My project was to manage simulations and breast phantom and projection data, so it primarily took place at a desk in front of a computer, specifically a workstation with a high-performance graphics card capable of parallel processing. We were able to show that digital mammography performs better than digital breast tomosynthesis or synthetic 2D mammography in displaying calcifications. We did this by calculating the contrast-to-noise ratio for images of a breast with calcifications for each of these imaging modalities.

The fellowship provided me an opportunity to see how physics could be applied and be of use in a clinical setting. It also introduced me to an active and cohesive research group, the members of which were very supportive and encouraging. I am interested in pursuing medical physics as a career, particularly medical imaging and the development of novel and better imaging techniques and systems.

Trey J. Waldrop
Augustana University
Senior Physics Major

Mentor:
Gabriel O. Sawakuchi, PhD
The University of Texas
M.D. Anderson Cancer Center
Department of Radiation Physics

"Effects of BRCA1 Knockdown on Radiation Response in 4T1 Murine Cells"

This project examined the differences in survival following proton and photon irradiation between two cell lines: an unmodified 4T1 cell line and a 4T1 cell line that had the BRCA1 protein knocked down. BRCA1 has responsibilities in cell cycle arrest, transcriptional regulation, and DNA damage repair. Specifically, the protein is involved in a high-fidelity DNA repair pathway called homologous recombination (HR) that often competes with another DNA repair pathway that is far more error prone. Because protons and photons inflict varying degrees of DNA damage, we wanted to understand whether the knockdown of BRCA1 made cells more or less radiosensitive to one form of radiation over another.

My portion of the project was to perform clonogenic assays to generate survival curves following irradiation with varying doses of protons and photons. Additionally, I performed western blotting to verify that the BRCA1 protein was knocked down. This project is important because there are certain forms of aggressive breast and ovarian cancers that present with mutations in the BRCA1 gene. Understanding how cells deficient in BRCA1 respond differently to different types of radiation could allow physicians to better tailor treatment to patients with these mutations.

In a clonogenic assay, a certain number of cells are plated in a 6-well plate. The plates are then irradiated with different doses, incubated for a designated amount of time, and the number of colonies, or groups of cells, consisting of >50 cells are scored. The main idea is that each colony arose from a single cell that remained viable following irradiation. After scoring, the irradiated plates can be normalized by the plating efficiency of the control plate, and the surviving fraction can be plotted as a function of dose to determine the dose needed to achieve a certain fraction of cell death. Western blotting is a technique that uses gel electrophoresis and specific antibodies to determine the amount of a certain protein present in a sample of cells. I was able to perform a series of three clonogenic assays for these two cell lines, exposing with both protons and photons. Additionally, I was able to troubleshoot the western blotting process and gain insight into which antibodies work best.

This fellowship helped me to discover my interest in medicine and translational research. As a result of this fellowship, I hope to attend an MD/PhD program to perform similar research at the boundary between radiation biology and medical physics.

Alexander David Benson
Coe College

Mentor: Ahmet S. Ayan, PhD
The Ohio State University
Department of Radiation Oncology

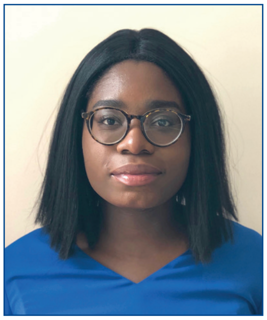
Eloise C. Lienert
Washington College
Senior *Physics Major*

Mentor: Ning Cao, PhD
University of Washington Medical Center
Department of Radiation Oncology

Diversity Recruitment Through Education and Mentoring Program (DREAM)

The Diversity Recruitment Through Education and Mentoring Program (DREAM) is a ten-week (40-hours per week) summer program designed to increase the number of underrepresented groups in medical physics by creating new opportunities, outreach, and mentoring geared towards diversity recruitment of undergraduate students in the field of medical physics. Students participating in the program are placed into summer positions that are consistent with their interest. Selected for the program on a competitive basis, DREAM fellows receive a $5,500 stipend from AAPM.

Sponsored by the AAPM Education Council through the AAPM Education & Research Fund, which included one fellowship funded by the AAPM Northwest Chapter. (See AAPM website for more details, including eligibility requirements.)



Ayobami Ayodele

Yale University

Nuclear Engineering & Radiological Sciences Major

Mentor: Jun Deng, PhD

Yale School of Medicine

Department of Therapeutic Radiology

"Determining Liver Cancer Risk through Personal Health Data"

I wasn't quite sure what to expect upon arrival. My faculty member Dr. Deng, who was quite kind, had me work on a project that was far more advanced than I was expecting, as it required some intense MATLAB coding, in which I had no experience. Thankfully, I figured out most of it by the end of the program, and I'm still working on finishing the final details.

A neural network that collects data from the National Health Interview Survey (NHIS) and the Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial (PLCO) was used to predict and stratify liver cancer based solely on personal health data, without having to undergo the conventional clinical procedures, but rather on demographic factors such as family history. One can hypothesize that the trove of data collected in the PLCO trial, enriched by both personal health data and known risk factors including staging, family history, socio-behavior, diet and lifestyle factors, can be used to train and validate a deep learning algorithm to improve liver cancer risk prediction. By creating an algorithm to determine one's risk factor of developing liver cancer, results can tell the patient their risk of developing a certain cancer over time, as well as being given the ability to avoid intrusive procedures to determine if the cancer is present.

I used the programming software Matlab to code the algorithm and variables I need for the designated task to run. I was able to tweak the code needed for the task; the likelihood of multiple patients developing liver cancer with the personal database NHIS and PLCO.

I am unbelievably grateful for this research opportunity. I witnessed firsthand the research topics that intertwine medical physics, radiology, medicine, computer science, etc. I also shadowed, and saw the tasks and duties expected of a medical physicist in a clinical setting.

Neha Bhatt

Yale University

Biomedical Engineering Major

Mentor: MingDe Lin, PhD

Yale University

Interventional Oncology Lab

"Lipiodol deposition in the liver: Comparing CT and CBCT imagine modalities"

I spent my summer fellowship working with the Interventional Oncology Research Lab at Yale University. My time at the lab has been full of intellectual rigor and social enrichment. This combination of enthusiasm and diverse perspective contributed to a fun environment that encouraged growth and curiosity. Additionally, I greatly appreciated my advisor being consistently supportive, insightful, and invested in my growth as a scholar and scientist.

My project centered around comparisons between computed tomography (CT) and cone beam computed tomography (CBCT) scans of patients with hepatocellular carcinoma (HCC) in an effort to use intra-procedural information to predict follow-up outcome by using a machine learning based approach. That way, real-time feedback can happen during the procedure rather than needing to wait weeks. The procedure is called transarterial chemoembolization (TACE), and it is a minimally invasive procedure often used to treat liver tumors, in which embolic materials and contrast agents are delivered locally to tumors along with chemotherapeutic drugs. Lipiodol is a radio-opaque drug delivery vehicle that is most used during the TACE procedure. Lipiodol retention is visualized using CBCT intra-procedurally and CT in follow-up scans.

We retrospectively analyzed a 15-patient cohort who were a part of a clinical trial that had both intraprocedural CBCT scans and 24-hour follow-up CT scans. CBCT images lack a calibrated scale, unlike CT images which have Hounsfield units and are largely viewed as a gold-standard. As such, our goal is to quantify and characterize lipiodol deposition in CBCT and measure its similarity to CT. Being able to demonstrate strong similarity would allow for physicians to make real-time changes during the TACE procedure using CBCT alone. In brief, we first developed a semi-automatic image processing pipeline using deterministic methods that included image intensity thresholding, filtering, and morphological enhancement to isolate lipiodol in both CT and CBCT. We then developed a nonlinear registration algorithm using robust point matching to register the two image sets. Finally, we computed DICE similarity coefficients (DSC) between the binary masks of lipiodol in CT and CBCT for each patient.

Our results yielded an average 0.54 DSC, a mediocre performance. To further improve upon the performance, we used a deep learning approach to observe what kind of results a Convolutional Neural Network (CNN) might yield. Specifically, we used the liver region of raw CBCT scans and the binary lipiodol mask of CT scans as inputs, training the model to learn similarities between these inputs, and outputting predicted CT binary lipiodol masks. We would then compute the DSC between these predicted masks and our actual patient masks. We have currently developed a CNN model. We are specifically using a Unet, which is a CNN created especially for use with biomedical image segmentation, and we are in the process of training the model.

This research is important because it greatly improves the efficiency of tumor treatment procedures. If CBCT could be formally related to the gold-standard, CT, then procedures could be adjusted in real-time using CBCT and therefore avoiding extra radiation exposure by also conducting a CT scan.

I performed my project using a multitude of software programs. I used a Yale biomedical engineering department program called Bioimage Suite to edit and process CT and CBCT scan images. I also used Matlab for basic codes involving image manipulation between regular and binary forms. Finally, I used Python to develop a machine learning processing pipeline. We were able to accomplish a significant amount. While we didn't pivot to a machine learning approach until about halfway through the ten-week fellowship period, we have gotten to a point where our machine learning model is set up and is currently training.

The 10-week fellowship was an incredible experience. I was able to expand my knowledge of clinical research, and I enjoyed engaging with rigorous coding and engineering methods in addition to clinical ideas. I also thoroughly enjoyed working with so many intelligent researchers from a variety of backgrounds and learning from them.

Matthew Daniel Hwang
Reed College
Physics Major

Mentors:
Clemens Grassberger, PhD/
Jennifer Pursley, PhD
Massachusetts General Hospital
Department of Radiation Oncology

"Machine Learning to improve Outcomes in Liver Cancer Patients treated with Radiation"

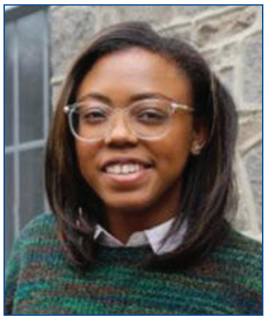
In the beginning of my fellowship, my experience consisted mainly of reading papers on machine learning (ML) and normal tissue complication probability (NTCP) models. These texts introduced me to the project and provided background knowledge and impetus for the research topic. Once my understanding of the subject became more solidified, I was given the task of translating some preexisting MATLAB code into Python to further deepen my knowledge and see firsthand how the NTCP model quantifies patient data. From here, I began work creating my own novel code, integrating different ML algorithms with anonymized patient data. This process demanded the bulk of my time at this fellowship. Providing guidance and checking my progress was my mentor, Professor Clemens Grassberger, whom I spoke with regularly and asked questions pertaining to the project and algorithms' results.

My project consisted of developing code that fed anonymized patient data to different ML models and comparing their predictive powers with that of a mathematical model to see which was more robust in predicting normal tissue damage as a side-effect of radiation therapy.

With the near-ubiquitous adoption of machine learning in medical physics research, realizing how ML and traditional models of radiation-induced toxicity compare and contrast grows ever more important due to the fact that oftentimes, creating and using ML algorithms is redundant and may be forewent in favor of preestablished models which offer equally compelling insight and higher interpretability.

I was able to complete the project's goal of developing custom code for the patient data, which in turn provided predictions for whether these patients would experience RT-related side-effects. These quantifiable results allowed us to directly compare the strength of the models. My contribution to the project will lead to a paper in the future and be used as a basis for further investigation and research.

Skill-wise, the fellowship bolstered my coding ability and taught me more about the process of research and developing code. More generally speaking, this research opportunity illustrated how interdisciplinary and cooperative the field of medical physics is, with its combination of topics such as statistics, biology, computer science, as well as physics, to develop new insights into radiation and the human body. Lastly, the program increased my confidence in working independently and showed me how research can undergo many unexpected twists and turns that guarantee one is always intellectually stimulated.



Erin Snoddy
Swarthmore College
Astrophysics Major

Mentor: Kenneth Bader, PhD
The University of Chicago
Department of Radiology

"Analyzing Histological Compositions of Ex Vivo Thrombi"

Chronic thrombi are less susceptible to thrombolytic therapy in patients with Deep Vein Thrombosis (DVT). In order to help create new methods of treatment, the structure of these blood clots must be better understood. My work involved developing a protocol that helped to categorize different components on histological stains of ex vivo thrombi.

Essentially, I wanted to find a way to take qualitative data (the histological stains) and analyze it to get qualitative results (percentages of the different components that make up the blood clots). I did this using the viewing software, ImageScope, which allowed me to separate and count the different pixels that were marked by several histological stains (trichrome, CD61, and HnE). With this method, the percentage of the clots that were made of collagen, platelets, as well as fibrin, can be determined.

Chronic thrombi contain fibroblasts, which secrete collagen. This has been known to affect thrombolytic efficacy. An in vitro model of a standard chronic blood clot will be essential in developing an effective histotripsy ablation treatment plan that particularly attacks chronic thrombi. Having an established protocol that allows one to differentiate and characterize the different components in blood clots will be important when confirming that the in vitro model is physiologically relevant. Using the histological composition protocol, composition of formed elements on the histological stains of the in vitro model will be compared with ex vivo thrombi so that the effectiveness of the in vitro model can be determined.

I spent a lot of time observing different histological stains in order to understand how the components needed to be distinguished. Using ImageScope, I manipulated hue and color saturation levels in order to achieve thresholding that was satis-factory for each of the three stains. By using these standards to analyze the data of numerous blood clot samples from a variety of patients, I was able to help create a standard protocol suitable for when data from the in vitro model must be analyzed.

With this project, I helped to construct a protocol that will be used for future analysis. My hope is that this work will become a small contribution to the larger area of work that is being done to design new methods that are more useful in treating patients with Deep Vein Thrombosis.

This fellowship taught me a lot about what is encompassed in medical physics, including what a possible career in the field would look like. I believe that I developed skills (including research, designing experiments, analyzing data) that will help me to become a better scientist. In addition, I gave a small presentation of my project's progress at a weekly lab meeting, which helped me to become better at communicating scientific ideas, as well as how to collaborate and work with others in a laboratory setting.

Rachel Trevillian

Lake Forest College
Physics Major

Mentor: Piotr Zygmanski, PhD
Brigham & Women's Hospital/
Dana Farber Cancer Institute/
Harvard Medical School
Department of Radiation Oncology

"Ion chamber arrays for real-time monitoring of linac fields" *(tentative title)*

My lab experience this summer at Dana Farber was valuable for my further advancement in the medical physics world, allowing me to expand my knowledge by talking with lab members, going to journal clubs, and learning the methodology to conduct radiation simulations. This experience allowed me to see future advancements in the medical physics career and what I have to look forward to in my future career.

The overarching objective was performing radiation transport Monte Carlo simulations with various detector array geometries to represent different detector designs and impact on radiation scatter effects. The importance of the project was to study radiation scatter effects in a high-definition ion chamber array and impact on absolute and relative dosimetry.

I conducted my research using Gate on virtual box and cluster where I programmed radiation simulations, first by defining the world function as well as the phantom geometries. Then, I included the physics and added detectors that measure the dose. Next, I defined the beam and started the simulation. We altered the phantom, ion chamber array, and individual ion chamber geometry, as well as materials.

The data I collected from the simulations allowed us to look at radiation scatter effects, especially, how different materials/electrodes affect the results. This allows those after me to continue the study on the affect and possibly implement them in an optimal design of the array

The fellowship enlightened me by allowing me to be exposed to one of the top cancer centers in the world, where I got to meet and learn about ground breaking ideas related to the cure of cancer and improvement of cancer techniques. It made me excited to continue my pursuit in medical physics to help the greater good. The individuals I met taught me many valuable skills and lessons that will be beneficial for the rest of my life.

Liyan Jacob

University of Memphis
Physics Major

Mentor: Maryellen L. Giger, PhD
The University of Chicago
Department of Radiology/ Medical Physics

Gabrielle Moss
Thayer School of Engineering at Dartmouth College
Biomedical Engineering Major

Mentor: Nima Kasraie, PhD
Children's Mercy Hospitals and Clinics
Department of Radiology

2019 REVIEW
Publication Awards

Medical Physics Journal Best Paper Awards

Farrington Daniels Award
This award is for an outstanding paper on radiation therapy dosimetry, planning, or delivery published in *Medical Physics* in 2018. Presented in 2019, the awardees were **Linh T. Tran, David Bolst, Lachlan Chartier, Dale Prokopovich, Susanna Guatelli, Alex Pogossov, Marco Petasecca, Michael Lerch, Mark Reinhard, Marco Povoli, Angela Kok, Vladimir Perevertaylo, Naruhiro Matsufuji, Tatsuaki Kanai, Michael Jackson**, and **Anatoly B. Rosenfeld** for their paper entitled "The relative biological effectiveness for carbon, nitrogen and oxygen ion beams using passive and scanning techniques evaluated with fully 3D silicon microdosimeters," *Medical Physics*, 5 (5): 2299 - 2308 (2018). *(Funded by the endowed Farrington Daniels Fund)*

Moses and Sylvia Greenfield Award
This award is for an outstanding paper on imaging, published in *Medical Physics* in 2018. Presented in 2019, the awardees were **James R. Scheuermann, Adrian Howansky, Marc Hansroul, Sebastien Léveillé, Kenkichi Tanioka,** and **Wei Zhao** for their paper entitled "Toward Scintillator High-Gain Avalanche Rushing Photoconductor Active Matrix Flat Panel Imager (SHARP-AMFPI): Initial fabrication and characterization," *Medical Physics*, 45 (2): 794 - 802 (2018). *(Funded by the endowed Moses and Sylvia Greenfield Fund)*

Journal of Applied Clinical Medical Physics (JACMP) Best Paper Awards

Michael D. Mills Editor In Chief Award
The Michael D. Mills Editor In Chief Award of Excellence recognizes an outstanding general medical physics article published in *JACMP* in 2018. Presented in 2019, the awardees were **Eric D. Morris, Joshua P. Kim, Paul Klahr,** and **Carri K. Glide-Hurst** for their paper entitled "Impact of a novel exponential weighted 4DCT reconstruction algorithm," *Journal of Applied Clinical Medical Physics*, 19(6): 217 - 225 (2018)." *(Funded by the endowed JACMP Editors' Fund)*

Peter R. Almond Award
The Peter R. Almond Award of Excellence is for an outstanding radiation measurements article published in *JACMP* in 2018. Presented in 2019, the awardees were **David E. Hintenlang, Xia Jiang**, and **Kevin J. Little** for their paper entitled "Shielding a high-sensitivity digital detector from electromagnetic interference," *Journal of Applied Clinical Medical Physics*, 19 (4): 290 - 298 (2018). *(Funded by the endowed JACMP Editors' Fund)*

George Starkschall Award
The George Starkschall Award of Excellence is for an outstanding radiation oncology physics article published in the *JACMP* in 2018. Presented in 2019, the awardees were **Rajesh Pidikiti, Bijal C. Patel, Matthew R. Maynard, Joseph P. Dugas, Joseph Syh, Narayan Sahoo, Hsinshun Terry Wu,** and **Lane R. Rosen** for the paper entitled "Commissioning of the world's first compact pencil-beam scanning proton therapy system," *Journal of Applied Clinical Medical Physics*, 19(1): 94 - 105 (2018). *(Funded by the endowed JACMP Editors' Fund)*

Edwin C. McCullough Award
The Edwin C. McCullough Award of Excellence is for an outstanding medical Imaging physics article published in the *JACMP* in 2018. Presented in 2019, the awardees were **Sebastian Ehn, Thorsten Sellerer, Daniela Muenzel, Alexander A. Fingerle, Felix Kopp, Manuela Duda, Kai Mei, Bernhard Renger, Julia Herzen, Julia Dangelmaier, Benedikt J. Schwaiger, Andreas Sauter, Isabelle Riederer, Martin Renz, Rickmer Braren, Ernst J. Rummeny, Franz Pfeiffer,** and **Peter B. Noel** for their paper entitled "Assessment of quantification accuracy and image quality of a full-body dual-layer spectral CT system," *Journal of Applied Clinical Medical Physics*, 19(1): 204 - 217 (2018). *(Funded by the endowed JACMP Editors' Fund)*

Each of the following, a competitive, prestigious award or lecture, which is connected to the AAPM Annual Meeting, is supported by a named, and in most cases, endowed E&R Fund:

Jack Fowler Junior Investigator Award

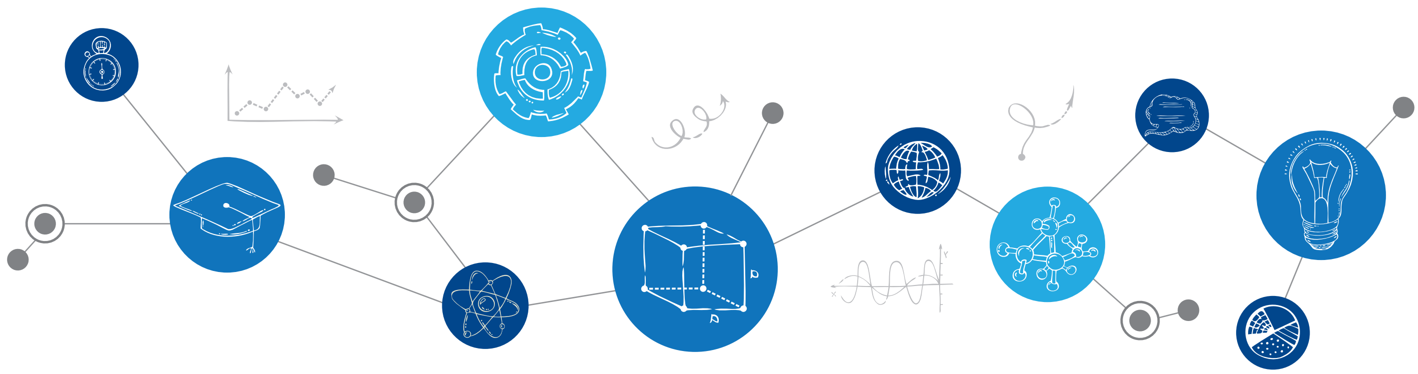
This award was established in honor of Jack Fowler, PhD, Emeritus Professor of Human Oncology and Medical Physics, University of Wisconsin. The award was presented to **Davide Brivio, PhD**, Brigham and Women's Hospital, for the top scoring abstract submitted by Junior Investigators who entered the competition, entitled "Self-Powered Thin-Film Multi-Layer Aerogel-Based X-Ray Detector Employing Fast Electron Current." *(Funded by the Jack Fowler Award Fund*)

Jack Krohmer Junior Investigator Award

This award was established in honor of Jack Krohmer, PhD, a pioneer in the medical physics community. The award was presented to **Xue Dong, PhD**, Emory University, for the best abstract submitted to the Scientific Program of the AAPM Annual Meeting, judged according to criteria of significance, innovation, and the potential for major scientific impact in an area of cutting-edge interest in medical physics. The abstract was entitled "Deep Learning-Based Self Attenuation Correction for Whole-Body PET Imaging." *(Sponsored by the AAPM Science Council through the AAPM Education & Research Fund)*

Award for Innovation in Medical Physics Education

This award is given for the best presentation at an Education Council session concerning innovative programs in medical physics education of physicists, physicians, ancillary personnel, and the public. Presentations can be concerned with scientific research, novel teaching strategies (team teaching or adult learning efforts), or novel educational materials (lectures, websites, or other innovations). This year's award went to **Andrea McNiven, PhD**, Princess Margaret Cancer Centre, Toronto, ON, for a presentation entitled, "Assessing the Feasibility and Utility of An Objective Structured Clinical Exam (OSCE) in Radiation Oncology Physics Residency Training." *(Funded by the Harold Marcus Fund)*



John R. Cameron Young Investigator Awards

(Funded by the endowed John Cameron Fund)

The Young Investigator's Symposium is a competition in honor of University of Wisconsin Professor Emeritus John R. Cameron, PhD. The 10 highest scored abstracts submitted for the Symposium are selected for presentation, from which the top three presentations receive awards. 2019 winners were:

1st place: Jessica Rodgers
Robart Research Institute at Western University
PhD Student in Biomedical Engineering (Imaging)
"Enabling 3D Ultrasound Needle Guidance During Implant Placement Procedures for High-Dose-Rate Interstitial Gynecologic Brachytherapy"

2nd place: Abdelkhalek Hammi, PhD
Massachusetts General Hospital and Harvard Medical School
Research Fellow in Radiation Oncology
"Modeling the Radiation Dose to Circulating Lymphocytes for Different Radiotherapy Modalities and Delivery Parameters"

3rd place: Eric Morris
Wayne State University and Henry Ford Cancer Institute
PhD Student in Medical Physics
"Cardiac Substructure Segmentation with Deep Learning for Improved Cardiac Sparing"

Carson/Zagzebski Distinguished Lecture On Medical Ultrasound

(Funded by the endowed Carson/Zagzebski Fund)

On Tuesday, July 16 at the AAPM 2019 Annual Meeting, invited lecturer **Kathy Ferrera, PhD,** Professor at Stanford University, delivered her lecture, "New Frontiers in Therapeutic Ultrasound: Transfection and Immune Modulation."

Anne and Donald Herbert Distinguished Lectureship in Modern Statistical Modeling

(Funded by the endowed Anne and Donald Herbert Fund)

On Thursday, July 18 at the AAPM 2019 Annual Meeting, invited lecturer **Matthew Schipper, PhD,** University of Michigan, delivered his lecture, "Individualized and Adaptive Radiation Therapy via Statistical Models."

AAPM Science Council Associates Mentorship Program

The program has been established to recognize and cultivate outstanding researchers at an early stage in their careers with the goal of promoting a long-term commitment to science within AAPM. The program uses the process of "shadowing" to integrate the Associates into the scientific activities of the organization. Science Council Associates participate in the program for one year, and are funded up to $4,000 per Associate (to cover travel costs including flight, hotel, and meeting registration) to attend two consecutive AAPM Annual Meetings, including the pre-meeting activities associated with each Committee.

Sponsored by the AAPM Science Council through the AAPM Education & Research Fund
(See AAPM website for more details, including eligibility requirements.)

- **Katelyn E. Hasse, PhD**
  Associate Professor
  Department of Radiation Oncology
  University of California, San Francisco

  Mentor: Kristy K. Brock, PhD, *Professor*
  The University of Texas M.D. Anderson Cancer Center

- **David M. McClatchy, III, PhD**
  Therapeutic Medical Physics Resident
  Department of Radiation Oncology
  Harvard/Massachusetts General Hospital

  Mentor: Andrew Jackson, PhD,
  Associate Attending Physicist
  Memorial Sloan-Kettering Cancer Center

- **Kristen A. McConnell, PhD**
  Assistant Professor
  Department of Radiation Oncology
  The University of Alabama at Birmingham

  Mentor: Martha M. Matuszak, PhD, *Associate Professor and Director of Advanced Treatment Planning*
  University of Michigan

- **Eenas A. Omari, PhD**
  Instructor
  Department of Radiation Oncology
  Loyola University Chicago

  Mentor: Neelam Tyagi, PhD,
  Associate Attending Physicist
  Memorial Sloan-Kettering Cancer Center

- **Lydia J. Wilson, PhD**
  Postdoctoral Research Associate
  Department of Radiation Oncology
  St. Jude Children's Research Hospital

  Mentor: Laurence Edward Court, PhD,
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  The University of Texas M.D. Anderson Cancer Center

- **Hao Zhang, PhD**
  Assistant Attending Physicist
  Department of Radiation Oncology
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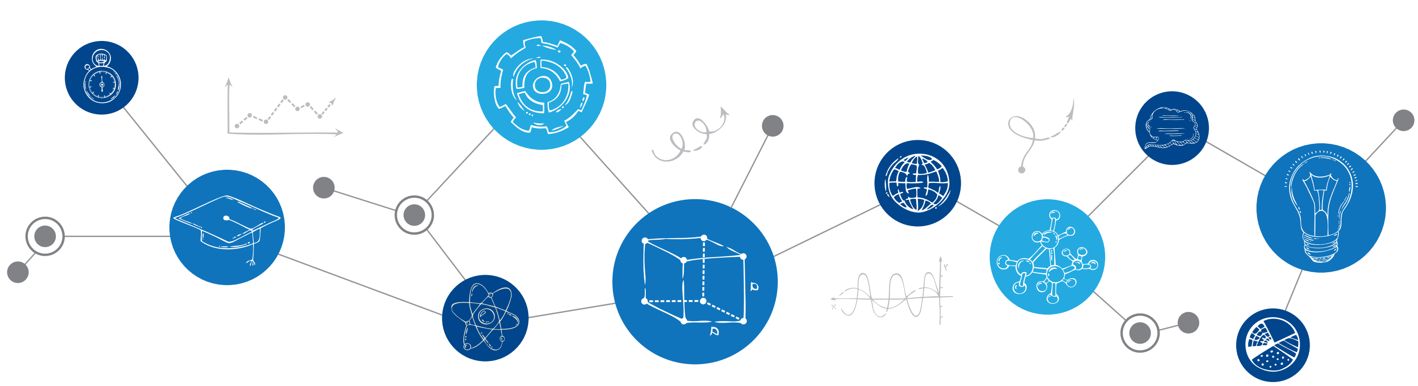

AAPM Expanding Horizons Travel Grant

Up to ten AAPM Expanding Horizons Travel Grants are awarded per year, each up to $1,000, for the purpose of providing additional support for student and trainee travel to conferences that are not specifically geared toward medical physics. The travel grant is designed to provide an opportunity to broaden the scope of scientific meetings attended in order to introduce students and trainees to new topics which may be of relevance to medical physics research and which may subsequently be incorporated into future research in order to progress the field in new directions. The grants are awarded twice annually. *Sponsored by the AAPM Science Council through the AAPM Education & Research Fund (See AAPM website for more details, including eligibility requirements.)*

Round 1 Awardees

- **Henry Chen, PhD**
  Fellow
  The University of Texas M.D. Anderson Cancer Center
- **Qihui Lyu**
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  University of California, Los Angeles
- **Allison Roth**
  Graduate Student
  University of Wisconsin-Madison
- **Suman Shrestha**
  Graduate Student
  The University of Texas M.D. Anderson Cancer Center

Round 2 Awardees

- **Qiyuan (Isabelle) Hu**
  Graduate Student
  University of Chicago
- **Brigid McDonald**
  Graduate Student
  The University of Texas M.D. Anderson Cancer Center
- **Emily Thompson**
  Graduate Student
  The University of Texas M.D. Anderson Cancer Center
- **Lydia Wilson, PhD**
  Fellow
  St. Jude Children's Research Hospital

Team BEST/AAPM Award

Team BEST provides funding for five fellowships in the amount of $1,000 each, to be used for travel, food and lodging expenses to attend the Annual Meeting. AAPM provides complimentary Annual Meeting registration for each recipient, including social functions. Team BEST also provides a plaque for each of the five fellowship recipients. *Sponsored by Team BEST through the AAPM Education & Research Fund*

- **Davide Brivio, PhD**
  Harvard University, Radiation Oncology
- **Jamison L. Brooks**
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- **Jina Chang, PhD**
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- **Esther M. Vicente, PhD**
  University of Maryland, Radiation Oncology
- **Chuang Wang, PhD**
  St. Jude Children's Research Hospital, Imaging Science

Summer School Tuition Scholarships

Summer School Tuition Scholarships were in the form of a full waiver of tuition fees for the entire AAPM 2019 Summer School. This award is available to applicants who are in the first five years of their careers in medical physics. *Sponsored by the AAPM Administrative Council through the AAPM Education & Research Fund (See AAPM website for more details, including eligibility requirements)*

- **Marc J.P. Chamberland, PhD**
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  University of Maryland, School of Medicine
  Department of Radiation Oncology
- **You Zhang, PhD**
  University of Texas
  Southwestern Medical Center at Dallas
  Department of Radiation Oncology

2019 REVIEW
Closing Statement

The AAPM Development Committee uses this report to convey the worthwhile activities supported by our Education & Research Fund and the value of your contributions. AAPM aims to continue growing our E&R Fund to support additional E & R Fund grants, fellowships, awards, and other activities. To that end, each member is encouraged to contribute to one of the many available options. In 2019, we improved our E&R Fund web site to better describe the multiple options a member has to give, whichever is best suited to your financial position. One popular option continues to be the 1:1 matching funds for gifts no less than $500 per year to our Five-Year Pledge Program (see Policy AP95).

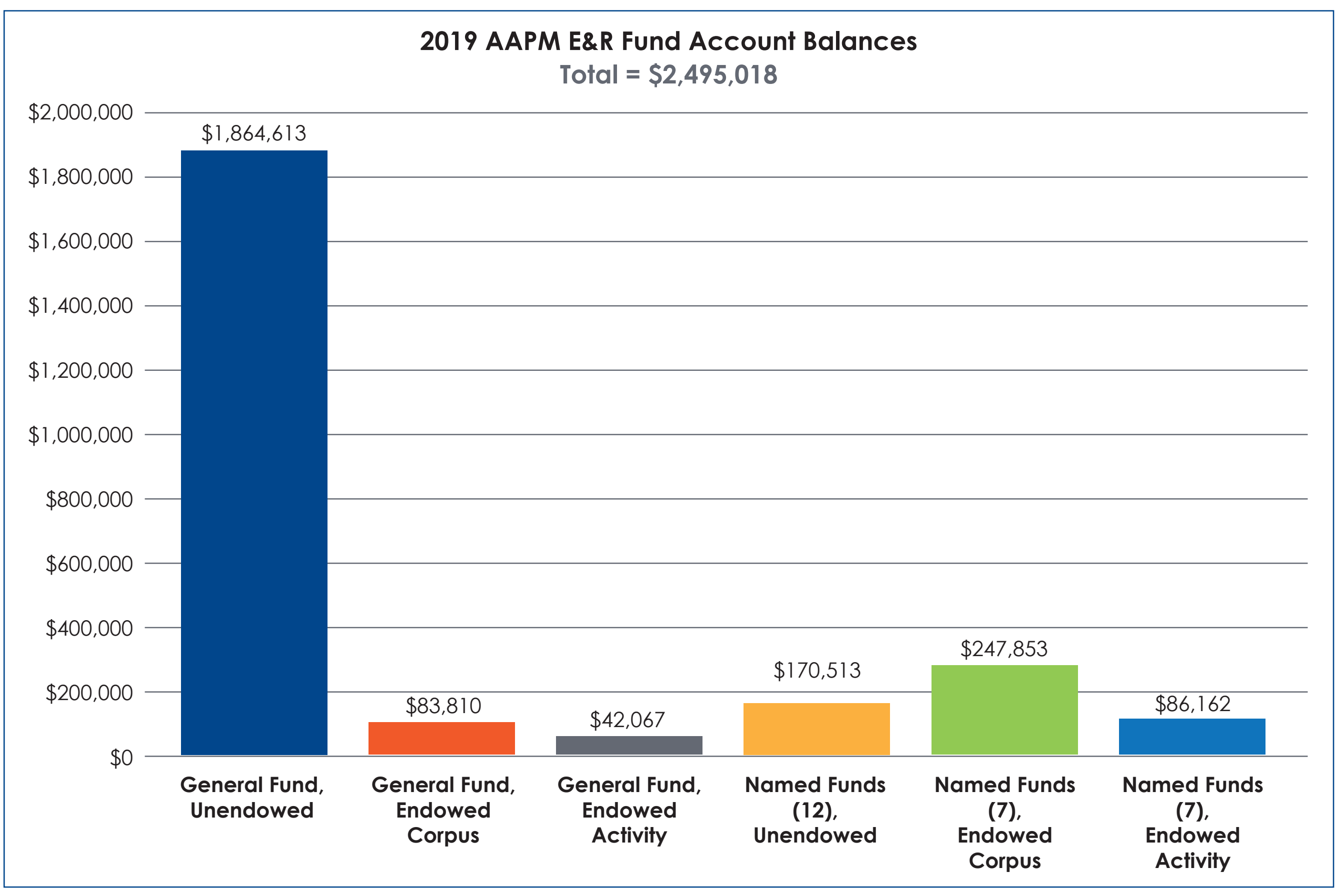
The current position of our E&R Fund is described in the bar graphs below for E&R Fund balances at the end of 2019, revenues for 2019, and member contributions for 2019.

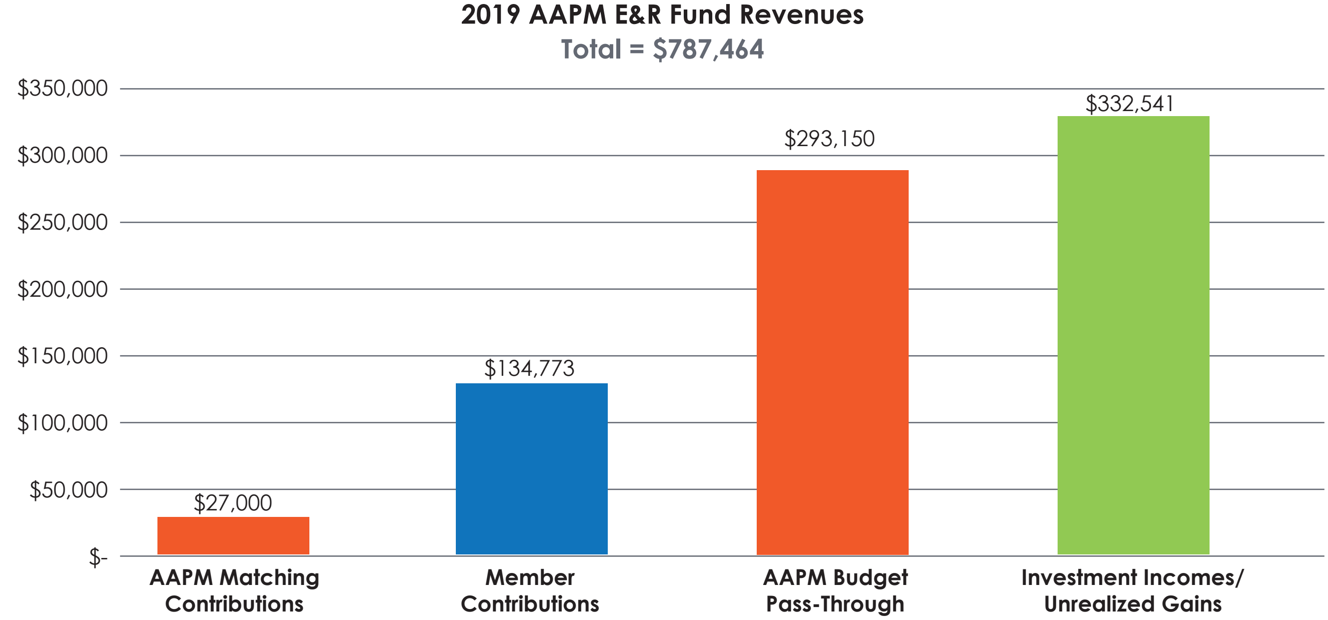
AAPM has also improved opportunity for its members to make legacy gifts by now providing a Planned Giving website, newsletters, and eNewsletters with the assistance of The Stelter Company. This information is not only intended to incentivize legacy gifts to AAPM, but also to provide members important information regarding their estate planning and wills. Also, AAPM continues to provide $5,000 to the E & R Fund for its first 60 members to notify AAPM of their Planned Gift commitment (see Policy AP18).

Your Development Committee continues to work on other ways to encourage gifts through memorial gifts and named funds. Please keep your AAPM in mind.

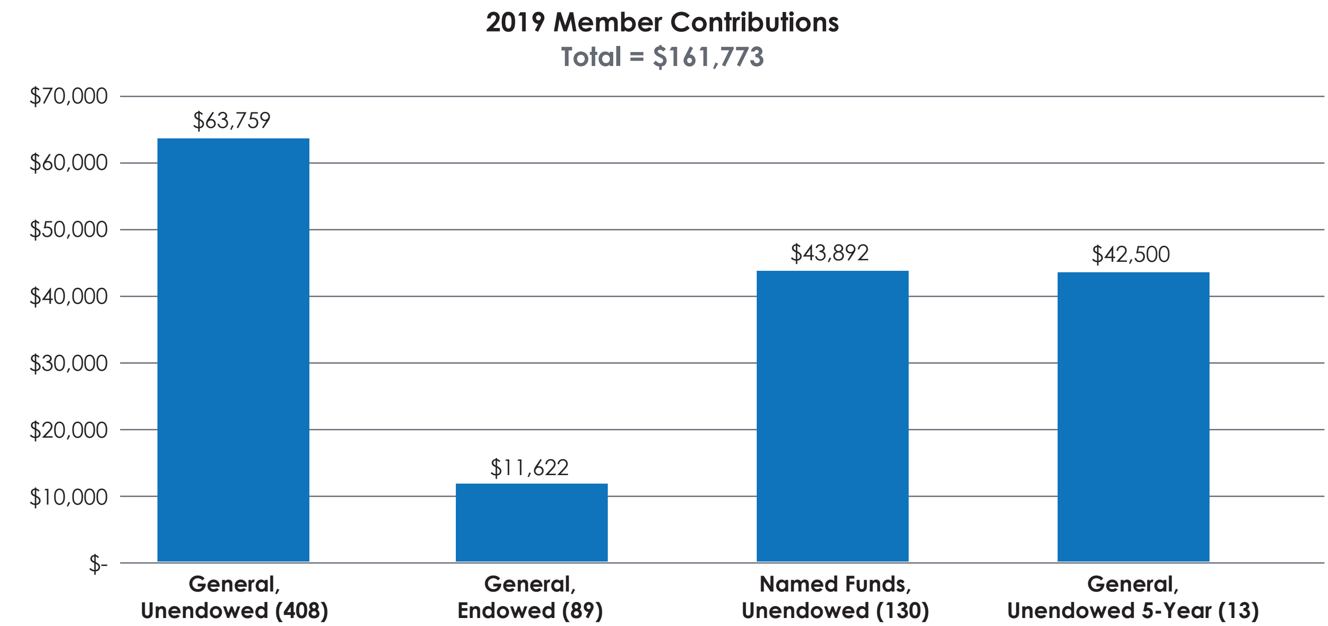
Our members and awardees truly appreciate and thank you for your support! On the following pages is a listing of the many who have given their support to our E&R Fund.

Kenneth R. Hogstrom, PhD
Chair, AAPM Development Committee





Origin of E&R Revenues used to fund 2019 awards. Revenues were up compared to 2018 due to higher investment earnings as well as pass-through from program areas.



Distribution of member contributions to different types of accounts of the E&R Fund in 2019. Numbers in parentheses represent the number of gifts. The General Unendowed 5-Year amount represents new pledges received during the year.

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THANK YOU
AAPM Staff

Our AAPM Development Committee receives dedicated support from our Headquarters team. Their assistance allows us to successfully operate our Education and Research (E&R) Fund and the many awards and honors it funds. Our annual report is a key publication that recognizes individuals and documents history of our Development and E&R programs. It is my pleasure to recognize some of the key staff that support our Development Committee and this *Education & Research Fund Annual Report*.

Sincerely,

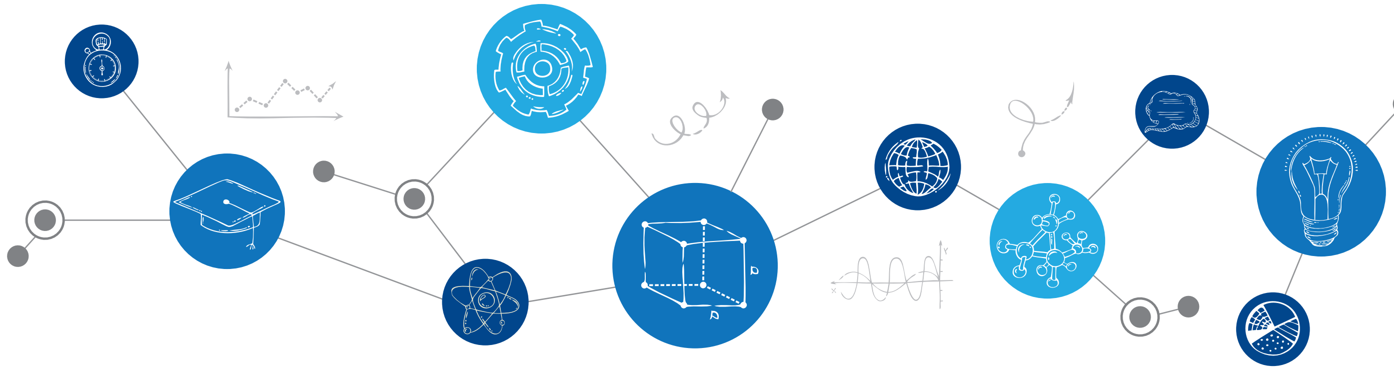
Kenneth R. Hogstrom, PhD
Chair, AAPM Development Committee

Justin Stewart
Programs Manager (Development)
Justin provides administrative support to the Development Committee and the Education and Research Fund programs.

Robert McKoy
Director, Finance
Robert serves as the Association's chief financial officer, overseeing all financial operations of the Development Committee and E&R Fund.

Abby Pardes
Graphic and Web Designer
Abby provides web design and graphics for Development Committee reports, web site, and communications.

Jacqueline Ogburn
Education Manager
Jacqueline provides support to committees that manage the Summer Undergraduate Fellows and Graduate Fellowship programs.

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