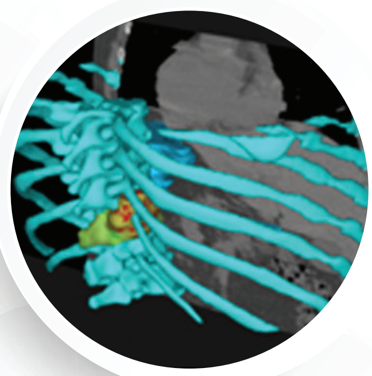
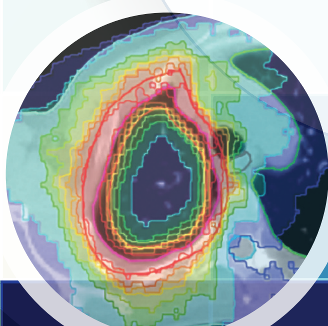
The American Association *of* Physicists in Medicine

AAPM EDUCATION & RESEARCH FUND

2015 ANNUAL REPORT

focus on our future





AAPM
Education & Research Fund Annual Report 2015

The AAPM Education & Research Fund supports the development of our great profession via the provision of seed money for research, fellowships for Ph.D. students, and support for clinical residencies, and our Future Graduate Program (added in 2014), which provides additional funding for Summer Undergraduate Fellowships and the Diversity Recruitment through Education and Mentoring (DREAM) program. In 2013 we started two new initiatives: An Endowed Distinguished Lectureships program by which members can contribute a lump sum sufficient to support an annual lectureship from the earnings accrued, and a Five-Year Pledge Program for which, in December 2015, AAPM agreed to provide matching funds. Without contributions from our generous members we would never have been able to provide the now over 100 grants, fellowships and residencies since the inception of the Fund over 20 years ago. As always, AAPM is extremely grateful for the generous gifts from our members.

The Education & Research Fund realized a 71% increase in contributions in 2015, although much of this increase was due to Distinguished Lectureship contributions. Without these we would have experienced a 35% increase in donations, which included contributions from 22 members who made five-year pledges, mostly at the end of the year after AAPM agreed to provide matching funds.

This generosity of our members is greatly appreciated and in the following paragraphs you will read testimonials from the graduate students, residents, fellows and undergraduates whom these contributions supported.

The Education & Research Fund also tracks funding for awards coming from within AAPM Councils and Committees, as well as support from outside organizations. The following awards were funded in 2015 through sources within and without AAPM itself:

- The Education & Training of Medical Physicists Committee (ETC) of the Education Council funded $50,000 in Summer Undergraduate Fellowships and $40,000 in DREAM program grants.
- The Awards & Honors Committee of the Administrative Council awarded $6,000 in scholarships for the Summer School.
- Science Council, under the sponsorship of the Research Committee, awarded three $25,000 research seed grants to new researchers in the field.

The Education & Research Fund independently funds two annual awards of $18,000 each. These grants are the AAPM Fellowship in Medical Physics and the AAPM/RSNA Fellowship in Imaging Medical Physics. This latter award recognizes the contributions made by RSNA in assisting to establish the AAPM Education & Research Fund in its infancy.

AAPM and RSNA partnered to support a total of eight new Commission on Accreditation of Medical Physics Educational Programs (CAMPEP)-accredited imaging physics residences over six years. The AAPM will provide $560,000 and the RSNA will provide $560,000. Each institution will receive $35,000 per year for four years in matching support for two residents. Three awards were approved in 2013 and the remaining five awards were granted in 2014.

AAPM is proud to include the following testimonials from the recipients of our 2015 awards programs. These demonstrate the enormous value the recipients place on the value of this support. Please read through the reports from the recipients to learn how the monies from the Education & Research Fund are aiding in the development of their careers.

2015 REVIEW

Grants & Fellowships

THE RESEARCH SEED FUNDING GRANT

Stephen S. Yip, PhD
Brigham and Women's Hospital, Boston

My research has resulted in two AAPM abstracts.

"One of the abstracts, entitled 'Associations Between Somatic Mutations and PET-based Radiomic Features in Non-Small Cell Lung Cancer' was selected as the winner of the Jack Fowler Junior Investigator Award for the 58th Annual Meeting of AAPM. We are currently preparing two manuscripts for journal submission."

John G. Eley, PhD
University of Maryland School of Medicine, Baltimore

The objective of my work is to investigate the ability of light-ion microbeams to spare CNS tissue in mice and to develop a biophysical treatment planning system that will be needed for later larger animal studies. The funds have so far been used to build a dedicated small animal irradiation table for use at the Maryland Proton Treatment Center in Baltimore, and to support new histologic investigations of mice exposed in a previous pilot study by our group to proton microbeams. A number of Monte Carlo investigations have been carried out during the past year and support the use of light ions, other than protons, such as He-4 and Li-7, which may spare CNS tissues to greater depths than protons due to less elastic scattering.

"The AAPM seed funds have been a great benefit and essential to the growth of our research. We have submitted early results to present at the upcoming 2016 Annual Meeting in Washington, D.C."

Ke Li, PhD
University of Wisconsin-Madison

In this AAPM Research Seed Grant-funded project entitled "High Quality and Sub-mSv Cerebral CT Perfusion Imaging," a four-dimensional (4D) cascaded systems model has been successfully developed to describe the noise transfer process in cerebral CT perfusion (CTP) imaging systems. The model covers both deconvolution- and nondeconvolution-based CTP systems, and includes cerebral blood volume (CBV), cerebral blood flow (CBF), time to peak (TTP), time to max (Tmax), and other parametric perfusion maps. It allows the noise characteristics of the three-dimensional (3D) perfusion maps to be *quantitatively* related to those of the 4D source CT images and postprocessing parameters, enabling the major contributors to the relatively poor imaging performance of the current CTP technologies to be pinpointed. The model also provides the needed scientific guidance for the development and optimization of source image acquisition, reconstruction, and postprocessing parameters of the CTP imaging system. A series of advances in CTP imaging technology have been galvanized by this cascaded system model: First, dedicated CT reconstruction algorithms were developed to reduce noise of CTP source images, as both the image quality and quantitative accuracy of CTP maps were found to be limited by the poor signal-to-noise ratio of the source images. To further reduce noise in the source images, a dedicated x-ray exposure control technique was developed, as the noise performance of CBV map was found to be limited by the unenhanced baseline time frames, while CBF and other maps are dominated by frames near the peak of contrast enhancement curve. Guided by these findings, the proposed exposure control technique repartitions the total radiation budget to reduce noise in the final perfusion maps. Last but not least, CTP postprocessing parameters (such as the weighting factor of the regularizer used in deconvolution and the strength of spatial-temporal filter) were optimized to maximize the detectability and quantification accuracy of perfusion deficits.

AAPM/RSNA IMAGING PHYSICS RESIDENCY GRANTS

UNIVERSITY OF OKLAHOMA

Matthew DeLorenzo MS, Senior Resident

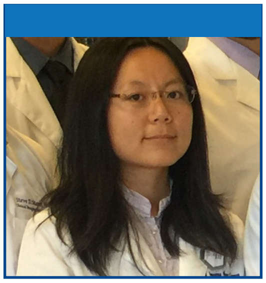
Our senior resident, Matthew DeLorenzo M.S., is approaching the end of his training and will be graduating at the of July. He has completed development of a software package for shielding based on NCRP 147 and *his research work has been accepted for an oral and a poster presentation at the AAPM Annual Meeting in July 2016.*

Josh McIlvain, MS Junior Resident

Our junior resident, Josh McIlvain, M.S., has made excellent progress in his first-year of training. He has started working on a research project on a low cost MCA design and characterization applicable to medical imaging energies.

The direct outcome of this Research Seed Grant Award include five conference presentations and four first-authored manuscripts.

DUKE UNIVERSITY



Yakun Zhang

Yakun Zhang entered the program in October 2013. She has successfully completed rotations in general radiography, MRI, CT, mammography, IT & displays, and ultrasound. Yakun has completed her clinical rotation in fluoroscopy and is scheduled to take the rotation oral exam in June. She is currently in progress with her final rotation, radiation safety. Her expected graduation is October 2016. Throughout the past year Yakun has made many meaningful and significant contributions to our clinical processes including the creation of a program to acquire clinical patient information from all Ultrasound examinations which is implemented into an Ultrasound 'dose' monitoring program. Yakun has also become an MQSA qualified physicist for FFDM and Hologic tomosynthesis units.

Tamar Chighvinadze

Tamar Chighvinadze entered the program in September 2015. To date she has successfully completed rotations in IT & displays, and mammography. Tamar is currently in progress with her radiation safety and MRI rotations. Tamar has already made many meaningful contributions to our clinical processes including creating detailed SOP documents for primary display evaluations and GE digital mammography unit evaluations.

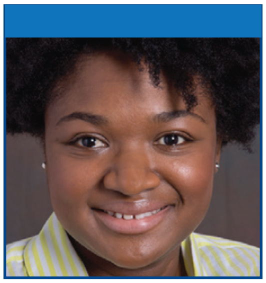
UNIVERSITY OF ALABAMA AT BIRMINGHAM

Ramses Herrera, MS

The University of Alabama at Birmingham (UAB) currently has one resident in our Diagnostic Imaging Physics residency program. The recipient of the AAPM/RSNA Imaging Physics Residency Grant is Ramses Herrera, MS. Mr. Herrera started his residency in mid-April, 2016. At the time of this update, he has been in the program for only a week and a half, but is already making good progress in his first x-ay rotation and has participated in annual surveys of both x ray and nuclear medicine equipment.

A two-year fellowship program in diagnostic imaging medical physics was initiated in 1978 at UAB. Now a residency program, trainees participate in clinical support, teaching and clinical research projects as training for a career in diagnostic imaging medical physics. Training is provided in all areas of diagnostic imaging including general x-ray, fluoroscopy, CT, MRI, nuclear medicine, PET, and informatics. The accreditation of our residency has been approved by the CAMPEP REPRC and is pending CAMPEP board approval in May, 2016.

EMORY UNIVERSITY



Ngoneh Jallow

Ngoneh Jallow will be completing her residency training on June 30th 2016. She is currently in her radiation safety rotation and her last rotation will be Ultrasound. *Dr. Jallow has successfully submitted two conference abstracts and first authored a research article on diagnostic reference levels for CT as conducted in PET/CT oncology studies.*

Shalmali Dharmashikari

Shalmali Dharmashikari will be completing her first year of training on June 30th 2016. She is currently in her CT and Mammography rotations. *She is working on research studying protocol adherence using our radiation dose tracking software and has co-authored an abstract submitted to RSNA.*

INDIANA UNIVERSITY

Our two-year residency program in diagnostic imaging medical physics is designed to provide clinical imaging physics training in areas of clinical quality assurance, clinical research and teaching. The program is administrated by the Department of Radiology within Indiana University School of Medicine (IUSM). The key characteristics of our program include the extensively leverage of resources from the IUSM/IU Health Partnership and their large clinical care, basic science and clinical research programs. We are at the final stage of completing our self-study documentation for CAMPEP application.

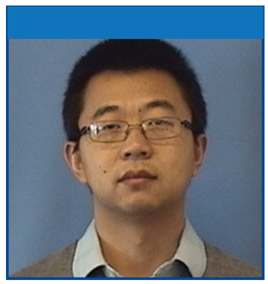
We currently have three residents:

Marcus Lamaster, MS

Marcus Lamaster, MS will be completing his residency training on June 30th 2016. He will have completed all his clinical rotations by the end of May. In June he will finish his clinical research project on multi-energy CT and practice ABR exams. He is also working on an abstract for the AAPM Spring Clinical Meeting.

Vijay Rana, PhD

Vijay Rana, PhD was recruited into the program in July 2015 via the Medical Physics Matching Program. He had successfully completed the first-round clinical rotations in digital radiography, fluoroscopy, ultrasound and CT before he was summoned to military service in January 2016. He will return to the program in March 2017. The IUSM GME has granted the extension of his residency which will allow him to resume and complete the 24 months training.



Xuandong Zhao, PhD was recruited into the program in February 2016 from the 2015 applicant's pool to fill the slot that was vacated by Vijay Rana's departure. He had previously worked in GE as a MRI system engineer. He is currently on a ultrasound rotation, and is working on a clinical research project to optimize the DRR (digitally reconstructed radiography) for radiotherapy treatment.

MEMORIAL SLOAN KETTERING CANCER CENTER

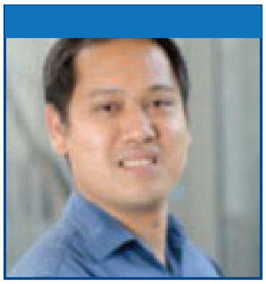
Our program at MSKCC is a four-year program in which those accepted perform research for the first two years as postdoctoral research fellows and then receive clinical training as imaging physics residents for the next two years. We currently have three residents:

Milan Grkovski, PhD, Edward K. Fung, PhD, and Sang Ho Lee, PhD

Dr. Lee is currently performing research. Both Dr. Grkovski and Dr. Fung are in full-time clinical training. Dr. Grkovski and Dr. Fung have received Limited Permits from NY State.

Milan Grkovski, PhD

Dr. Grkovski started in August 2013 and worked on a project entitled "Prognostic value of tumor hypoxia, as measured by ^{18}F-FMISO Breath Hold PET/CT, in Non-Small-Cell-Lung Cancer (NSCLC) patients" under the direction of Drs. Sadek Nehmeh and John Humm. *He made an oral presentation at the 2014 RAMPS Vacirca Young Investigator Symposium and at the 2014 SNMMI Annual Meeting. He submitted two abstracts which were accepted for oral presentation at the 2015 SNMMI Annual Meeting and one abstract for the 2015 AAPM Annual Meeting.*



Edward K. Fung, PhD

Dr. Fung started in November 2013 and worked on a project entitled "Compartmental Modeling of PET radiolabeled antibody uptake in tumors" under the direction of Drs. John Humm and Pat Zanzonico. *He made oral presentations at the 2014 AAPM 56th Annual Meeting, at the 2014 RAMPS Vacirca Young Investigator Symposium, and at the 2015 World Molecular Imaging Conference. He has submitted an abstract for presentation at the WMIC 2016, and has an oral presentation accepted at SNMMI 2016.*

Sang Ho Lee, PhD

Dr. Lee started in September 2015 and is working on a project entitled "MRI metrics to predict and monitor therapy response in mesothelioma and non-small cell lung cancer" under the direction of Dr. Neelam Tyagi. *He has submitted an abstract for the 2016 AAPM 58th Annual Meeting, and made an oral presentation at the 2016 RAMPS Vacirca Young Investigator Symposium.*

UNIVERSITY OF WISCONSIN, MADISON

We currently have three resident positions:

Nicholas Rubert

Nicholas Rubert started residency in January 2014, ended in November 2015 before completion of the residency. He then started a position as a Medical Imaging Physicist at Lurie Children's Hospital in Chicago. Since he applied for certification prior to 10/31/12, he was not required to complete the residency to be board certified.

Zhimin Li, PhD

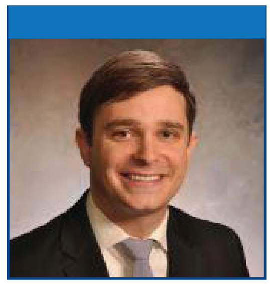
Zhimin Li, PhD started residency in April 2016.

Christina Brunnquell

Christina Brunnquell is scheduled to enter the residency program in July 2016, after finishing her PhD.

UNIVERSITY OF CHICAGO MEDICAL CENTER

Our program currently has two residents:



Kevin Little, PhD

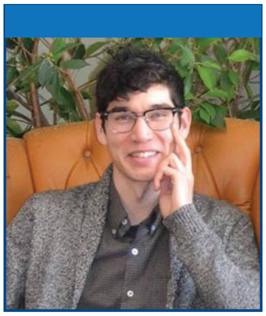
Kevin Little started in July 2014 and is expected to graduate in June 2016. He is on schedule to complete all the training elements as indicated in our self-study. He *passed ABR Part I in 2015. He has made presentations at the 2015 AAPM Annual Meeting and the 2016 AAPM Spring Clinical Meeting. His presentation at the 2015 AAPM Annual Meeting was chosen for "Best in Physics" award. He will also present at the 2016 AAPM Annual Meeting.*

Adrian Sanchez, PhD

Adrian Sanchez started in July 2015 and is expected to graduate in June 3 2017. He is on schedule to complete all the training elements as indicated in our self-study. He passed ABR Part I in 2015. He has been actively participating in PQI projects. *He will present his work at the 2016 International Pediatric Radiology meeting and the 2016 AAPM Annual Meeting.*

AAPM/RSNA FELLOWSHIP FOR THE TRAINING OF DOCTORAL CANDIDATES IN THE FIELD OF MEDICAL PHYSICS

UNIVERSITY OF ALBERTA (CROSS CANCER INSTITUTE)

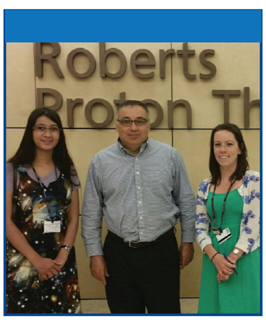


Dylan Breitkreutz

Dylan Breitkreutz is supported on an AAPM/RSNA Fellowship. The primary benefit of the AAPM/RSNA Graduate Fellowship has been financial security. This ultimately leads to a number of academic and personal benefits. First and foremost, the fellowship allows me to focus on academics without the stress associated with financial burdens. Furthermore, I plan on pursuing academic opportunities, such as workshops and conferences, that I might not normally consider attending due to their cost. I believe this will be crucial to my professional development. I am very grateful for the funding I am receiving from AAPM/RSNA.

DIVERSITY RECRUITMENT THROUGH EDUCATION AND MENTORING PROGRAM "DREAM"

UNIVERSITY OF PENNSYLVANIA



Mayisha Zeb Nakib

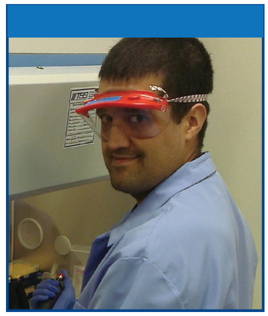
My summer project was on comparing intensity modulated photon therapy (IMRT) and double scattering (DS) plans to Rapid Arc (VMAT), intensity modulated proton therapy (IMPT), and single field uniform dose (SFUD) plans for thirteen past meningioma patients. The study compared the efficacy of normal tissue sparing while maintaining enough dose coverage to the treated volume for proton and photon plans in an attempt to find which plans would work better for the patient. A paper from my summer project with Dr. Kassaee among others is still in progress. I am also submitting an abstract to the PTCOG conference in May.

"I'm glad I happened to take a group photo before I left! I had pictures of random objects but none of them had me in them! Left to right is me, my mentor Dr. Ali Kassaee, and Maura Kirk who has helped me with several questions my entire summer."

I'm so glad I was able to be part of this program! I'd easily say this was my best undergraduate summer to date!

I learned so much from Dr. Kassaee! He is an awesome mentor and a great teacher! Whoever ends up with him as a mentor in future years is a lucky duck! Thanks Jackie for organizing all of this and running the program!

SAN DIEGO STATE UNIVERSITY



Adam Pruneda

I was able to study the radiobiologic effect of prostate cancer cells. Our goals were to see if when exposed to a specific medication if the cells would of been radiosensitized and a synergistic effect could be reached when the cells went through apoptoses. For my cell line we found that the cells were resistant to the treatment and kept a similar radio response to that of the control group. Further research would be needed for a comparative study to find the mechanism responsible for the null effect.

UNIVERSITY OF VIRGINIA SCHOOL OF MEDICINE

Brigid McDonald

This summer, I worked in Mark Williams' lab in the University of Virginia School of Medicine's Department of Radiology and Medical Imaging. My project was designed to compare the clinical performance of dual energy contrast enhanced (DECE) mammography with low energy x-ray mammography and breast-specific gamma imaging (BSGI) through a human reader study. Low energy mammography and BSGI are widely used clinical imaging modalities, but DECE is a new technique requiring further investigation.

Mammography uses low energy x-rays sent through breast tissue to produce a structural image of the breast. In BSGI, the patient is injected with a gamma-emitting tracer, which accumulates preferentially at the tumor site. A "hot spot" observed on a gamma image of the breast corresponds to an area of high uptake of the tracer.

In DECE, the patient is injected with an iodine-based contrast agent which accumulates preferentially at the tumor site. An x-ray source sends low energy x-rays through the breast to a detector, followed by high energy x-rays (above the K-edge of iodine, 33.3 keV). Due to the variation in the attenuation coefficient of iodine at different energies, an image produced by subtracting the low and high energy images highlights the areas of high uptake of the iodine contrast agent.

I showed radiologists images of each type from our lab's clinical trial. The radiologists would describe their findings in each image and assign each finding a probability of malignancy and recommended action (further imaging, biopsy, etc.) I'll continue collecting data from the last radiologist this semester. I will then compare the radiologists' assessments with the patients' biopsy reports to determine the sensitivity, specificity, and enhancement of these modalities.

UNIVERSITY OF FLORIDA

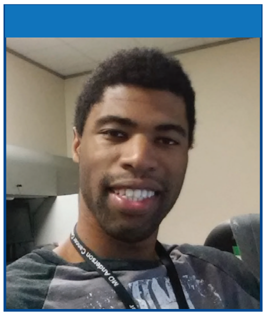
Catherine Carranza

I was able to join the Medical Physics team in the Radiology Department of Shands at the University of Florida for the summer of 2015 through the AAPM DREAM Undergraduate Fellowship. I collaborated in an ongoing project evaluating the effects of metal implants on organ doses utilizing an artifact reduction algorithm for pelvic CT examinations. We were able to measure the organ doses from clinical protocols by using optically stimulated luminescent dosimeters placed in organs of interest in post-mortem subjects. The metal artifact reduction algorithm proved to enhance image quality; we were also able to reduce doses by changing parameters in the scan acquisition.

Other projects that I was a part of included: measuring organ doses in post mortem subjects with pediatric CT protocols, assessing pediatric head CT image quality to reduce the doses in our clinical protocols, and investigating the effects of adipose tissue shielding on organ doses.

These projects led to the creation of a retrospective study to measure the organ doses for head and cervical spine trauma CT for adults in our Emergency Department. This study will aim to provide an idea of the organ doses associated with head trauma and C-Spine trauma CT. We hypothesize that the amount of trauma repeat scans can be reduced, with minimal trauma risk, by making radiologists aware of patient organ doses in order to minimize long-term radiation effects.

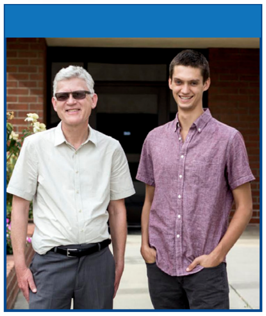
MD ANDERSON CANCER CENTER, HOUSTON



Davon Webb

During my summer at MDACC I had the pleasure of working with Dr. Julianne Pollard, a medical physicist, on two projects with the help of two other professors, Dr. Peter Balter and Dr. Laurence Court. My first project was creating a digital barometer website. The website gives frequently updated pressure readings that can be used by all of the physicists in the radiation department to calibrate their linear accelerators for clinical radiation therapy treatments. The second project that I worked on was using an in-house program called IBEX to analyze lung density changes in treated and untreated lungs of patients who have received radiotherapy to help make less toxic treatment plans for patients with multiple courses of radiation treatments. The main readings that we used for comparison were contrast and homogeneity. We also ended up looking at how their smoking history affected these values.

LOMA LINDA UNIVERSITY



Howard Heaton

During the summer of 2015, I worked under Reinhard Schulte to develop a new scheme for using data to reconstruct images in proton computed tomography (pCT). Due to multiple Coulomb scattering (MCS), the reconstruction problem in pCT is different from that in x-ray CT since the measured data yield path integrals not along straight lines, but along nonlinear paths. Here each path is approximated using a most likely path (MLP) formalism employing Bayesian statistics and a Gaussian approximation of MCS. Because MLP data is only available in discrete steps, it is computationally expensive to precisely estimate the intersection length of proton paths through individual voxels of the reconstruction space. However, these discrete steps may be adequate for estimating intersection lengths through a family of spherically symmetric basis functions commonly known as blobs. Thus, I developed methods to reconstruct images with blob basis functions. Experimental proton CT data was then used with these methods to successfully reconstruct images with blob basis functions. This work has opened the door for a comparative study of the efficacy of blob and voxel based image reconstructions in proton CT, which will soon follow.

"I have poster presentation on "Implementation of blob basis functions in proton CT reconstruction" at the Joint Mathematics Meeting in Seattle in January, 2015, and plan an article submission to Physics in Medicine and Biology, which should reflect well on this summer's fellowship."

SUMMER UNDERGRADUATE FELLOWSHIP

UNIVERSITY OF WASHINGTON MEDICAL CENTER

Marie Schwalbe

This summer, I worked with Eric Ford, Ph.D. at the University of Washington Medical Center Radiation Oncology Department in Seattle. My research was a continuation of a project investigating the effectiveness of EPID in-vivo dosimetry, an emerging quality assurance check for photon treatments. Using the EPIDs (electronic portal imaging devices) on the linear accelerators, one can perform in-vivo dosimetry by converting an EPID image taken during treatment into a gamma map comparing the dose delivered to the dose planned. One advantage of this method is that it provides information about changes in patient positioning or anatomy.

Throughout the summer I collected the data necessary for conducting an EPID analysis of qualifying patients and used specialized software to produce reports describing the dose agreement for the measured treatment fields. I investigated the sensitivity and specificity of this method by simulating errors in the treatment plans and comparing the modified plans to the dose that was delivered during treatment. I then produced ROC curves to reveal which errors were most detectable using this method.

This project gave me experience to various aspects of medical physics. I became familiar with using the treatment planning system, operating the linear accelerators, and analyzing imaging data. Additionally, I was able to shadow many healthcare personnel to gain an understanding of the workflow of radiation oncology and the various responsibilities of the therapeutic and diagnostic medical physicists. For example, I helped with the commissioning and monthly quality assurance testing of a linear accelerator; observed treatments and set-up at the nearby gamma knife facility; toured the Seattle Cancer Care Alliance Proton Center; and attended the testing of an MR scanner.

"The AAPM Summer Undergraduate Fellowship allowed more to explore medical physics, a field that I find important and fascinating. This was a wonderful opportunity for me to learn about the research and clinical aspects of medical physics."

UNIVERSITY OF CALIFORNIA SAN DIEGO

Megan Dagys

For my project, several phantoms were constructed using 3D printing and were used in 4DPET studies, gated radiation dose measurements, and cell survival assays for gated SBRT of NSCLC. The known size of the targets in the phantoms were used to test segmentation strategies in 4DPET, and enable the analysis of capillarity density effect. These phantoms are also able to hold ion chambers to perform dosimetric studies with a moving platform, and test tubes with NSCLC cells to test survival with high-dose rate, low-dose rate, and different gating windows.

During my time here, I learned to use Eclipse for treatment planning. I was able to constantly observe different aspects of the radiation therapy clinic and shadow different members of the team. I learned motion management concepts and came to understand the different areas of research that are encompassed under the field of medical physics. Nearing the end of my term I helped with phantom tests. During my stay I also attended the AAPM Annual Meeting with my mentor.

UNIVERSITY OF PENNSYLVANIA

Trevor Vent

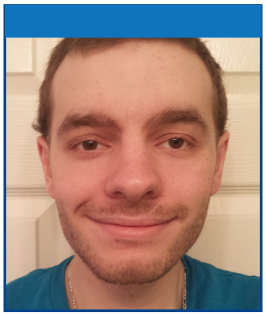
This summer has been the most rewarding educational experience that I have had to date. The x-ray physics lab in the department of radiology at the University of Pennsylvania welcomed me from the moment I set foot in their door. My mentor, Dr. Andrew Maidment, assigned me to work on two projects. I was given the opportunity to work one-on-one with my program mentor on the design and fabrication of a new-generation digital breast tomosynthesis system. This system provides multiple motions for the x-ray tube and the detector, allowing for further research in super resolution. By the end of the ten-week period, I was able to turn the ideas in Dr. Maidment's head, into a design. We have already built the frame of the mammography system, and designed the x-ray tube encasing and detector that are part of the c-arm in a digital breast tomosynthesis system.

The second project that I was assigned was research for multiplanar reconstructions in digital breast tomosynthesis. For this project I worked alongside the lab's postdoc, Dr. Acciavatti. I designed and built a phantom that houses a star test pattern and rotates to give any orientation. With this project, we verified that resolution depends on the star pattern's tilt relative to the breast support for multiplanar reconstructions in digital breast tomosynthesis. We also verified that super-resolution can be achieved along the direction that is parallel to x-ray tube motion in digital breast tomosynthesis.

On top of the two remarkable projects that I took part in, I was also introduced to proton therapy at the Robert's Proton Therapy Center at Penn's Perelman Center for Advanced Medicine. There, I was able to meet other medical physicists and was introduced to the physicists who calibrate the proton beams. As a part of the program, I attended talks given by radiology residents and other scholars in the field of diagnostic medical physics.

"I echo the sentiment with which I started this brief summary; this has truly been the most valuable educational opportunity of my life."

COMMUNITY HEALTH NETWORK, INDIANAPOLIS



Andrew Boria

During the ten weeks I was a part of the AAPM Summer Undergraduate Fellowship Program in 2015, I learned about the tasks and responsibilities of a clinical medical physicist with Cristina Medina Boswell at the Community Cancer Center South of the Community Health Network near Indianapolis, Indiana. I learned the clinical process for treating lung cancer via external beam therapy, discussed with my preceptor how to handle a multitude of ethical scenarios a medical physicist could be confronted with, performed daily and monthly quality assurance on a linear accelerator, created my own daily and monthly quality assurance protocols, and witnessed intraoperative radiation therapy. The knowledge that I gained was expressed in three reports, which discussed the clinical environment and process, the expected clinical conduct in a cancer center, and the daily and monthly quality assurance that is to be performed on a clinical linear accelerator. I learned so much during my time at Community Cancer Center South. It was an honor to be a part of this program, and my experience has reaffirmed my commitment to become a medical physicist in the future.

UNIVERSITY OF CHICAGO

Austin Patrick

As part of my AAPM Summer Undergraduate Fellowship, I researched medical image analysis techniques in Dr. Maryellen Giger's lab at the University of Chicago. As part of my research, I analyzed breast image data collected from high spectral and spatial resolution (HiSS) magnetic resonance imaging (MRI). HiSS MRI preserves spectral data that is not contained in conventional MRI. The spectral data contain fat and water peak information that was fed into a "fuzzy c-means" segmentation algorithm to distinguish the dense tissue portion of the breast from fat tissue. Since the spectral information is preserved, an analysis technique called dispersion-absorption (DISPA) analysis was used. This type of analysis plots the spectral information on imaginary vs. real axes, rendering a parametric curve. The total radial difference of these curves from a Lorentzian circle of radius one was then calculated. The goal of my research project was to compare the total radial difference of normal, dense breast tissue with data that was previously studied using DISPA analysis on benign and malignant breast lesions; this comparison may yield insight into the increased risk of breast cancer onset in patients with highly dense breasts.

UNIVERSITY OF CALIFORNIA LOS ANGELES

Caryn Geady

My project was focused on the development of a set of Java-based software plugins. Dr. Low and his team utilize a breathing motion model to predict the location of lung tumors during various breathing phases. The plugins, to be used in conjunction with MIM software, can implement the data provided by Dr. Low's model and redraw lung tumors [given said data] as well as provide feedback as to the accuracy of the data.

UNIVERSITY OF VERMONT MEDICAL CENTER

Fatimah Eashour

I selected a mentor at University of Vermont Medical Center where I experienced the clinical aspects of medical physics besides working on projects under the guidance of Dr. Matthew Deeley and other physicists in the Department of Radiation Oncology. I observed brachytherapy and stereotactic ablative body radiation therapy (SABR) QAs, simulations and treatments. I used measurements of temperature and relative humidity along with daily output measurement records for Infinity, Synergy and Platform linacs to investigate air conditioning parameters effects on photon and electron beams output constancy. I appreciated the opportunity to practice using the brachytherapy treatment planning system for cervical cancer cases. I also used the Pinnacle treatment planning system to compare absorbed dose delivered to a lung phantom calculated by different analytical algorithms, which I found relatively consistent with data from the literature of Monte Carlo calculated absorbed dose for an identical setup.

MASSACHUSETTS GENERAL HOSPITAL

Kimberley Lam

I had the privilege of being a participant in the American Association of Physicists in Medicine's 2015 Summer Undergraduate Fellowship Program. Through this program, I worked at the Radiation Oncology Department of Massachusetts General Hospital under the supervision of Dr. Jan Schuemann.

Our research focused on quantifying the differences between predicted proton beam dose ranges calculated by the clinically used dose-planning system (XiO) compared to the values obtained by Monte Carlo simulations (TOPAS). Because the clinical dose planner simplifies the proton beam interaction with tissue, XiO's predicted range tends to overestimate how far the proton beam will travel. Meanwhile, the Monte Carlo process simulates the step-by-step path of the protons through tissue, which provides a much more accurate model of the beam. I analyzed the extent of discrepancy between the two methods and the variation of their differences in multiple sites of the brain.

"This invaluable opportunity gave me the chance to work at a world-class research facility and to meet a variety of physicists and clinicians. I would like to thank AAPM for this experience and extend my deepest gratitude to the research group at Harvard Gardens for all of the wonderful memories."

WAYNE STATE UNIVERSITY

Rebecca Meerschaert

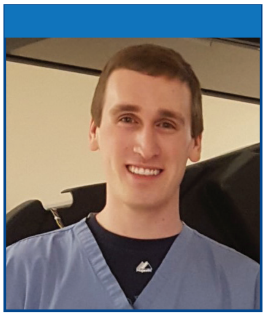
The AAPM fellowship provided me an incredible opportunity to participate in medical physics research at Wayne State University through the Karmanos Cancer Institute.

During this time, I conducted my own research under my mentor Dr. Zhuang relating to adaptive radiotherapy for cervical cancer patients. We compared the performances of two commercial external beam radiotherapy (EBRT) treatment plans created in Monaco and TomoTherapy Treatment Planning Systems (TPSs) for cervical cancer patients to determine if there was any variation of dose coverage to organs at risk and target volume. The TPSs were analyzed in terms of dose distributions, dose-volume parameters, and EUD to determine if the plans were comparable. This project provided the basis for analyzing doses for EBRT, which we will eventually combine and analyze with HDR brachytherapy treatment doses through the use of deformation vector fields.

We also investigated the variations of manual organ delineation during the multi-fractionation HDR brachytherapy of cervical cancer treatment. The HDR treatment is typically delivered to patients in 4 to 6 fractions and the presence of internal organ motion makes cervical cancer a clear candidate treatment site for adaptive strategy. By creating a program to rigidly register CT images from each HDR brachytherapy fraction and perform similarity calculations (Hausdorff distances, Dice Similarity Coefficients, etc.), I was able to analyze the extent of organ variation. Our future studies will involve applying deformable registration techniques to further understand organ motion in the pelvis leading to auto-segmentation evaluation. Through our better understanding organ motion in the pelvis, we can spare organs at risk around the target through adaptive radiotherapy and limit the labor-intensiveness and inter-observer/intra-observer variability.

"I have learned so much over the summer and gained invaluable hands-on experience."

UNIVERSITY OF WASHINGTON



Michael Headley

A good portion of my experience has been spent building context for what a Medical Physicist does. While I have certainly taken part in annual and acceptance testing of a variety of systems, I feel like it has been astonishing to observe the variety of hospital personnel and secondary/tertiary hospital systems with which they interact daily.

Throughout my Fellowship this summer I have accomplished many tasks independently and with oversight. The main project I have worked on thus far was acquiring and analyzing air kerma data from a collection of mobile C-arm units. While seemingly an easy task, putting systems in place to attain consistent and reliable data from a variety of different models and vintages of systems was quite complex. As well, I was able to see firsthand how the communication of dose information to physicians can drive the analysis and presentation approach. Based on this, I analyzed the data which was verified and then put into presentable form. The experience of analyzing data was a new process for me, as I had limited practical experience with Microsoft Excel. The data has been presented at a multi-disciplinary meeting, and has resulted in the establishment of a quarterly upper-level review of radiation dose on mobile c-arms.

Other accomplished tasks include researching luminance meters for the diagnostic physics section to test monitors in imaging rooms. Additional requirements by the ACR related to display devices has driven the need for more accurate luminance equipment. I researched performance and gathered quotes so that a reasonable future purchase can be made. I also, as well as shadowing, assisted in testing of DR, CR, MR, and PET-CT systems while attending various clinical and technical meetings. Further, I have had opportunities to observe activities in Radiation Oncology. Again, this has given me some good context for the different roles of a Medical Physicist in a hospital setting.

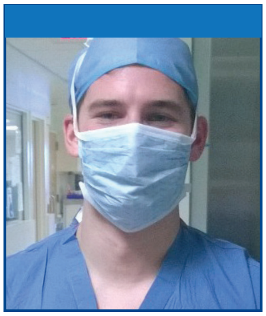
I still have three weeks remaining in my 10 week fellowship. In that time I plan on finishing two other projects including: 1) validating a measurement process of CTDI-vol for a GE state-of-the-art cone beam CT system; and, 2) implementing an automated phantom into CR, DR, and fluoroscopy testing. The purpose of implementing the automated phantom is to conduct the following tests: homogeneity, image distortion, image geometry, high contrast resolution, and dynamic range as well as taking a few other measurements while eliminating the need for the current cumbersome image analysis using a line-pair phantom.

UMASS MEMORIAL MEDICAL CENTER, WORCESTER

Jonathon Yuly

I worked on several projects at UMass Memorial Medical Center this summer. The most important project was a commissioning of the Monte Carlo electron beam simulation included with Eclipse, into the clinic's library of simulation techniques. This involved measuring depth doses and dose profiles at various beam energies using applicators of varying dimension. This data was compared with extensive simulation using gamma analysis. I also assisted with quality assurance work, audited a course in radiobiology taught by my mentor, and took the opportunity to participate in accelerator maintenance.

MASSACHUSETTS GENERAL HOSPITAL

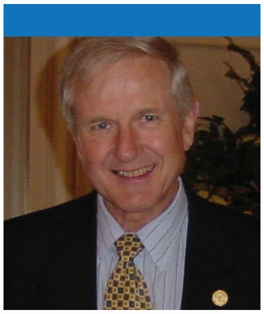


Nicholas Gabriel

This summer I had the opportunity to learn about proton therapy treatment of ocular melanoma at Massachusetts General Hospital under the direction of Dr. Alexei Trofimov. I learned about all aspects involved in this process, from diagnosis to patient outcomes and, in particular, clinical challenges and how to approach them. One of the challenges in treating ocular melanoma is intrafractional eye motion, as patients must maintain proper gaze voluntarily during proton therapy treatments.

To improve intrafractional monitoring of variations from the planned treatment setup, Dr. Trofimov and I prototyped a program in MATLAB to track eye motion during treatment and provide objective feedback on gaze variation. To accomplish this, the program would capture and process images of a patient's eye from a small camera mounted approximately 25cm in front of the patient and find the center of the pupil in each frame. After getting a sense of some possible methods for eye tracking, I migrated the tracking algorithms to OpenCV-Python, an open source computer vision library that is well suited for real time applications. To display eye motion data, we developed a user interface with a video of the patient's eye, as well as a continuously updating graph to display the variation of the patient's gaze in millimeters.

"Working in the physics research division at MGH was a rewarding experience and offered me a lot of insight into both the clinical and research activities of a medical physicist. I am now much more aware of the extent of the rich and vibrant field that medical physics is, and the incredible opportunities that it offers an aspiring physicist like myself. I absolutely look forward to pursuing Medical Physics in my graduate studies."



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We truly appreciate and thank you for this support. On the following pages is a listing of the many who have given their support to the Fund.

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Chairman, AAPM Development Committee

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