The American Association *of* Physicists in Medicine

AAPM EDUCATION & RESEARCH FUND

2013 ANNUAL REPORT

focus on our **future**

AAPM
Education & Research Fund

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 Minority Undergraduate Summer Experience (MUSE) program (renamed the Diversity Recruitment through Education and Mentoring (DREAM) program in 2014). Also in 2013 we started two new initiatives: a Five-Year Pledge Program and Endowed Distinguished Lectureships by which members can contribute a lump sum sufficient to support an annual lectureship from the earnings accrued. 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 20 years ago. As always, the AAPM is extremely grateful for the generous gifts from our members.

Even though the Education & Research Fund realized an increase in contributions in 2013, we continue to be well underfunded if we are to provide all the support necessary to maintain our programs at a desirable level. We desperately need more contributions from members. In 2013, only 133 members out of a total of over 8,000 contributed $100 or above. The profession is fortunate in that our average income exceeds $175,000. Asking for a $100 contribution to support the education and research endeavors of their professional society seems a meager amount to give to ensure the future of Medical Physics for the next generation.

We realize that many of you spread your philanthropy over numerous charities but support for the future of your own profession seems a worthy cause and one for which a meager donation of about 0.05% of your annual income is a reasonable contribution.

There are many AAPM members who give substantially more than the $100 request we make each year. For example, last year we received 60 individual contributions in the range of $200 to $12,000. This generosity is greatly appreciated and in the following paragraphs you will read testimonials from the graduate students, residents, fellows and undergraduates whom these contributions supported.

Included in the above were donations of over $27,000 to the Endowment Fund, which included $21,000 to a Distinguished Lectureship. These contributions remain permanently in the investment portfolio with only the earnings on the funds used to support educational and research activities. Also included in the above donations were contributions to our 'named' funds. These are donations to the Memorials of deceased members John Cameron, Hy Glasser, John Hale, Doug Jones, Jack Krohmer, John Laughlin, Bob Loevinger and Ted Webster. In total, these funds received $2,265.

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 2013 through sources within and without the AAPM itself:

- The Education & Training of Medical Physicists Committee (ETC) of the Education Council funded $40,000 in Summer Undergraduate Fellowships and additional contributions were received from the AAPM Northwest Chapter and an Anonymous Donor.
- The ETC also funded $32,000 in Minority Undergraduate Summer Experience grants. The ETC also

awarded two matching grants of $70,000 for the AAPM/RSNA Imaging Residency Grant Program. The RSNA contributed an additional $35,000 for total funding of three AAPM/RSNA Imaging Residency Program Grants.

- The Awards & Honors Committee of the Administrative Council awarded $5,000 in scholarships for the Summer School.
- Science Council, under the sponsorship of the Research Committee, awarded two $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.

The AAPM is proud to include the following testimonials from the recipients of our 2013 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.

2013 REVIEW

Grants & Fellowships

The Research Seed Funding Grant

Adam Wang, Ph.D.
Johns Hopkins University

"Low-dose C-arm cone-beam CT with model-based image reconstruction for high-quality guidance of neurosurgical intervention"

Our 2013 AAPM Research Seed Funding Grant was used to address the challenges of image quality, radiation dose, and reconstruction speed in intraoperative cone-beam CT (CBCT) imaging for neurosurgery by combining model-based image reconstruction (MBIR) with accelerated algorithmic and computational methods. In particular, fast MBIR methods advance C-arm CBCT image quality to a level suitable to soft tissue visualization approaching that of diagnostic CT of the head (e.g., gray and white matter, ventricles, and intra-parenchymal hemorrhage), as needed for guidance and verification of neurosurgical procedures and detection of complications.

We have additionally developed a novel "low-dose preview" method of CBCT images that prospectively depicts image quality for low-dose techniques, therefore enabling clinicians to confidently select patient-specific, minimum-dose protocols for subsequent scans. The method has numerous applications beyond neurosurgery, including in image-guided radiation therapy, where patients may receive upwards of dozens of CBCT scans.

> *"Thanks to the AAPM award, we have demonstrated that the significant improvement in image quality, new methods for dose reduction, and reconstruction time on the order of minutes will enable practical deployment of low-dose C-arm CBCT within the operating room."*

AAPM/RSNA Imaging Physics Residency Grants

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. Both Dr. Grkovski and Dr. Fung are currently performing research.

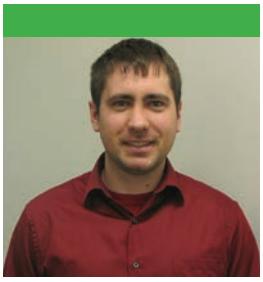
Milan Grkovski, Ph.D.
Department of Medical Physics, Memorial Sloan Kettering Cancer Center
New York, NY

Dr. Grkovski, who received his Ph.D. from the University of Ljubljana in Slovenia, started on August 26, 2013 and is working on a project entitled "Prognostic value of tumor hypoxia, as measured by 18F-FMISO Breath Hold PET/CT, in Non-Small-Cell-Lung Cancer (NSCLC) patients" under the direction of Dr. Sadek Nehmeh. Dr. Grkovski has become a member of AAPM and SNMMI and has submitted an abstract for the 2014 SNMMI Annual Meeting.

Edward K. Fung, Ph.D.
Department of Medical Physics, Memorial Sloan Kettering Cancer Center
New York, NY

Dr. Fung, who received his Ph.D. from Yale University, started on November 18, 2013 and is working on a project entitled "Compartmental Modeling of PET radiolabeled antibody uptake in tumors" under the direction of Drs. John Humm and Pat Zanzonico. Dr. Fung has submitted an abstract for the 2014 AAPM Annual Meeting and for the RAMPS Vacirca Young Investigator Symposium.

Both fellows/residents are also completing a course in Anatomy. Dr. Fung is taking a Radiobiology Course at Mt. Sinai Medical Center and will take additional courses at Columbia University in the Fall of 2014. They meet regularly with their research mentors and with Dr. Lawrence Rothenberg, the program director and Dr. Doracy Fontenla, the associate director to discuss their progress. In addition, they attend weekly sessions with our fellows and residents in our radiation therapy physics residency program. On alternate weeks there are Journal Club and Education Sessions. Both Dr. Grkovski and Dr. Fung have made presentations in the Journal Club. They also attend Medical Physics Grand Rounds, Molecular Imaging and Therapy Seminar, and other MSKCC educational sessions on a regular basis.



Nicholas C. Rubert, Ph.D.
University of Wisconsin School of Medicine and Public Health, Medical Physics Department

Dr. Rubert's residency began on February 2, 2014, after completing his Ph.D. in Medical Physics at the University of Wisconsin.

Gretchen Raterman, M.S.
University of Alabama in Birmingham

Ms. Raterman started her residency in January, 2014. She is making excellent progress in the short time she has been in our program, having completed her first rotation in x-ray and is now in her first nuclear medicine rotation. A two- year fellowship program in diagnostic imaging medical physics was initiated in 1978 at UAB. 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. Currently we are in the final stages of editing our self-study document for our application for CAMPEP accreditation.

AAPM/RSNA Fellowship

Xenia Fave

After receiving the 2013 AAPM and RSNA Graduate Fellowship, I began work on studying tumor texture features from NSCLC patients. Recent studies have identified correlations between tumor texture features and patient prognosis for a number of cancers including lung, prostate, and esophageal. However these features have been studied only at the beginning of treatment. We sought to determine whether and how substantially texture features change during the course of radiation therapy. The results when combined with patient prognostic information could have an impact on patient management and add to the growing amount of information available for adaptive therapy.

If texture features change during the course of treatment, monitoring a patient's values could be important for decision making on treatment and follow-up care. However additional clinical scans would be burdensome, time-consuming, and increase radiation exposure. To assess patients without altering the clinical work load, we also examined whether texture features could be measured from CBCT images.

Texture features were extracted from NSCLC tumors for thirty patients who had received weekly CT and CBCT scans. The change in normalized uniformity values was shown to increase for a subset of these patients. Additionally, CBCT texture values were successfully correlated to CT values indicating tumor texture may be obtained from these images. An abstract on our current research results was submitted to the 2014 AAPM Annual Meeting.

Future studies include investigating tumor features beyond uniformity, analyzing the impact tumor size and shape have on texture feature values, assessing the reproducibility of texture features in CBCT, identifying the effect of CBCT calibration on texture features, and correlating our data with patient outcomes.

2013 Minority Undergraduate Summer Experience Program (MUSE)

Miguel Conner

My experience last summer at the SCCA Proton Therapy Center in Seattle, WA, an opportunity sponsored by the AAPM MUSE fellowship, exposed me to the day to day life of a Medical Physicist. Across my 10-week stay, I spoke and worked with Medical Physicists, helped calibrate machinery, wrote a report, and gave a presentation on my research. A summary of my report is provided below.

Any sort of cancer irradiation treatment calls for accuracy and precision, and because the tumor position relative to each patient is not fixed, patient position must be readjusted for every treatment. A patient receiving proton therapy is told to lie down in a precise location on a specially manufactured couch. An x-ray "positioning" image of the reclined patient is then taken and is projected on top of an "ideal" image (a patient x-ray in the position where the proton beam is aimed at the tumor). The two images are then aligned, and the amount the "positioning" image has been shifted is translated into three-dimensional coordinate commands that shift the couch position. This process is repeated until the target area has been situated in front of the proton beam.

This report used patient data to examine the mean and the standard deviation of the displacement and rotation for the typical prostate patient, the skewness and kurtosis of patient position data, and the standard deviation of the rotation for the typical brain patient. This study hopes to find what the typical positions and rotations are for the "average" patient, and how these factors vary. This information can then be used to suggest procedure adjustments (specifically: override tolerance), and can serve as a comparison for future studies of a similar nature. The mostly Gaussian distribution of patient data suggested a reasonable, override tolerance setting, for prostate patients, of: Vertical: 0.7 cm, Lateral: 1.7 cm, and Longitudinal: 1.7 cm.

Summer Undergraduate Fellowship

Alexander Antolak

During the 10 week Summer Undergraduate Fellowship, I studied the effects of digital processing versus exposure on computed radiography (CR) and digital radiography (DR) images. This is a very important topic to study because of the increasing pressure to decrease patient doses in diagnostic screenings. To do this project, a phantom was imaged by CR and DR systems using underexposed, properly exposed, and overexposed techniques. The resulting raw images were digitally processed using current clinical parameters and then reprocessed with parameters that increased or decreased the amount of processing applied to the image. After processing, a computer program was used to analyze all of the final images for changes in image contrast and/or sharpness. By receiving this fellowship, I have gained experience in research being performed in multiple areas of medical physics and have discovered the areas of medical physics research that I am most interested in. This has helped me apply for graduate schools in medical physics with the goal of receiving a Ph.D.

Rachel Ger

Through the AAPM Summer Undergraduate Fellowship, for which I selected a mentor at University of California at San Francisco, I was able to experience the clinical aspect of medical physics. The physicists are an integral part within the system of doctors, therapists, and dosimetrists, all of whom I was able to work with to understand the inter-connected nature of the clinical medical physics field. At UCSF I was also able to learn from physicists on many different machines, including CyberKnife, GammaKnife, High Dose Rate Brachytherapy, different linacs, and intraoperative radiation therapy (IORT).

> *"As I aspire to be a clinical medical physicist who also does research, the fellowship allowed me to get a better understanding of my future and help propel me towards that goal."*

My primary project was with different quality assurance (QA) equipment, including the Daily QA3, ArcCHECK, and MapCHECK2. I checked how each device responded to different field sizes and how much the device reading differed from day to day. A daily output check was completed to make sure that the difference in readings was not due to a difference in machine output. For these devices, square and rectangular fields were used as well as plans than I had done on Pinnacle. The different devices were compared through the passing rates from the open fields and the plans from Pinnacle. My secondary project was with thermoluminescent detectors (TLDs). The TLDs were irradiated up to 2600MU in increments of 100MU, then read 24 hours post irradiation. From the raw data, a curve was fit for the nonlinear correction factor with respect to the uncorrected dose. This curve was used after I left to determine the out of field dose in a pediatric phantom on TomoTherapy.

This experience allowed me to observe clinical medical physics first hand and view the activities that are included in this field. I was also able to see the research that can be conducted in a clinical setting. As I aspire to be a clinical medical physicist who also does research, the fellowship allowed me to get a better understanding of my future and help propel me towards that goal.

Celeste Leary

Working at UCSF Comprehensive Cancer Center for the AAPM Summer Undergraduate Fellowship was a valuable and unforgettable experience. I learned how to use the Pinnacle and Tomotherapy treatment planning software, saw first hand the different duties a clinical medical physicist can have, and learned about all the types of radiation treatment UCSF has to offer. My most memorable experience at UCSF was when a treatment plan I created was used to treat a patient. I was practicing Tomotherapy planning with a head and neck patient, and made a plan that reduced radiation to the brain and was only one minute longer than the original plan. It felt great to know that a patient was getting a better treatment because of me.

During my 10 weeks at the Comprehensive Cancer Center, I did a research project that focused on minimizing dose to the thyroid in oropharynx cancer treatment plans. My study consisted of 14 head and neck cancer patients and, for each patient, I created three different IMRT treatments on the Pinnacle planning

> *"I know that this...clinical experience has helped me in applying to medical physics Ph.D. programs. I am so thankful that the AAPM's Summer Undergraduate Fellowship gave me this one of a kind experience."*

system. All of the Dosimetrists said that H & N treatments are the most complicated IMRT treatments to plan due to the small area and many tight dose constraints. I am very proud that I learned how to plan these treatments, and I know that the knowledge of these planning programs and my clinical experience has helped me in applying to medical physics Ph.D. programs. I am so thankful that the AAPM's Summer Undergraduate Fellowship gave me this one of a kind experience. This Fellowship provided me the means to live and work as a medical physics student researcher in San Francisco.

Erica Mason

I conducted my SUFP summer research at UCSF Radiation Oncology under the guidance of Dr. Lijun Ma, Ph.D., on the Gamma Knife Perfexion. My involvement included both research and clinical exposure in medical physics.

Utilizing the Gamma Knife database, I ran simulations on treatment plans, and gathered and analyzed the data.

> *"This award provided me the opportunity to gain hands-on exposure to the field of medical physics...I am truly grateful for the fellowship, and will carry the experience with me throughout my future in medical physics."*

For one study, I calculated dose distributions for cochlear volumes in treatments of vestibular schwannomas. For another, I developed radiation plans with independent-sector intensity modulation, which added a degree of freedom to the design of treatment plans. I tested these plans for improvements in conformality and plan quality. In a third, I simulated a fixed treatment on manually varied skull sizes to assess the relative normal brain sparing for pediatric cases, across multiple diagnoses. For volume-staged AVM treatments, I assisted by collecting isodose data by volume. Finally, I conducted a comparison of the integral dose transferred to normal brain during treatments of multiple metastases, and compared this radiation dose as it varies with number of mets.

I completed all calculations and gathered all data by the end of the summer, and each of these projects is presently in the writing and submission stages of the publication process. In addition to this research, I learned to design Gamma Knife treatment plans, and assisted in routine quality assurance testing of GK Perfexion. Gathering a breadth of clinical experiences, I shadowed procedures of radiation therapy and radiosurgery modalities at UCSF including Gamma Knife, Cyberknife, ARTiste, brachytherapy, and Tomotherapy, as well as MR imaging procedures and pre-brachytherapy surgery in the OR.

This award provided me the opportunity to gain hands-on exposure to the field of medical physics. This experience has greatly influenced my decisions regarding my graduate path and professional career. In addition, it allowed me to explore my interests, to conduct research, and to work toward publications. I am truly grateful for the fellowship, and will carry the experience with me throughout my future in medical physics.

Rachel Schmidt

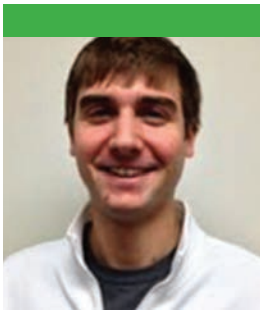
My name is Rachel Schmidt, and I was a recipient of the 2013 American Association of Physicists in Medicine (AAPM) Summer Undergraduate Fellowship Program. Through this fellowship, I was given the opportunity to travel to the University of California, San Diego to assist Dr. Kevin Moore with medical physics research. This work

comprised of a secondary study on the Radiation Therapy Oncology Group (RTOG) protocol 0126. The purpose of this work was to determine how often quality deficiencies occurred in intensity modulated radiotherapy (IMRT) treatment plans and the clinical severity at which it occurred. The IMRT treatment plans of 220 prostate patients from the high-dose arm (79.2 Gy) of the RTOG protocol were studied.

> *"Everything that I learned from participating in this research and working in a clinical environment resulted in an invaluable opportunity, which will extend far through my education into my own career."*

The clinical treatment plans were analyzed by a previously written computational program designed to produce predicted dose-volume histograms (pDVHs) attainable for each patient. This program uses mathematical methods to predict an achievable DVH for the patient-specific anatomy based off of a training set of previous plans. The clinical DVHs and pDVHs were then used for comparison of the clinically important parameters V40, V65 and V75 for organs-at-risk (OARs). The Lyman-Kutcher-Burman (LKB) normal tissue complication probability (NTCP) was also calculated for the clinical plan and the model-predicted plan, and the difference between these values was analyzed.

Overall, this project strives to ensure that quality control in patient treatment planning is constantly improving. To ensure optimal patient care, it is important to know how details in treatment planning affect the risk and presence of complications, and this work aims to do that. Aside from this, this fellowship allowed me to gain knowledge and hands-on experience in the field of medical physics. Everything that I learned from participating in this research and working in a clinical environment resulted in an invaluable opportunity, which will extend far through my education into my own career.



Andrew Shepard

Through the 2013 AAPM Summer Undergraduate Fellowship I was able to spend my summer working at the University of Wisconsin-Madison in the Medical Physics Department, under the supervision of mentor Bryan Bednarz. The summer fellowship allowed for me to gain vital experience in a laboratory, as well as in the clinic.

The bulk of my time this summer was spent working in Dr. Bednarz's lab group. I assisted Dr. Bednarz, and several of his current graduate students on multiple projects with a primary focus on modeling and Monte Carlo methods. Working on a wide range of projects allowed for me to gain a better understanding of different applications within medical physics. As the summer progressed I focused my research towards the development of a model for a low energy small animal irradiator to be used in preclinical trials. Through this

> *"This award allowed for me to gain invaluable experience in the field of Medical Physics, which is tough to come by for an undergraduate."*

work I was able to develop a greater understanding of the research process and some of the considerations which must be made. Ultimately, this work led to a presentation at the American Nuclear Society Winter Meeting in Washington D.C. in late October. Additionally, I was able to gain valuable experience within the clinic over the summer. Throughout the summer I was able to spend approximately 20-30 hours shadowing graduate students and Medical Physicists within the clinic. During my time spent in the clinic, I was able to participate in patient specific QA, monthly QA and a yearly QA of a linear accelerator. This work provided me with a chance to gain hands on experience in the use of a linear accelerator, and also provided a glimpse into some of the tasks associated with clinical medical physics.

Ultimately this award allowed for me to gain invaluable experience in the field of Medical Physics, which is tough to come by for an undergraduate. From the experience, I was able to gain a sense of understanding for what the field has to offer as a future career. Overall, I felt that this experience gave me a firm knowledge base of many different aspects of the field, which will benefit me immensely moving forward in my academic and career pursuits.

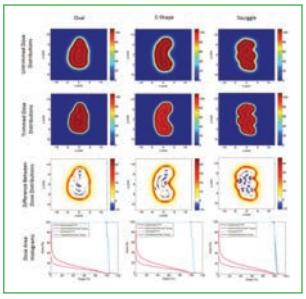
Blake Smith

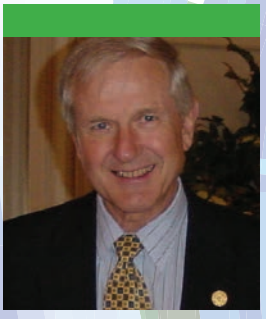
For the summer of 2013 I worked with a team of clinical medical physicists at the University of Iowa Hospital and Clinics Department of Radiation Oncology. Over the summer we developed a proof-of-concept project ascribed to an innovative, new dynamic collimation system consisting of two pairs of orthogonal trimmer blades which "trim" the edges of the proton beam in proton radiotherapy. Monte Carlo N-Particle Transport Code (MCNP) was used to simulate proton pencil beams incident on a water phantom at energies of 125 MeV. The energy deposition at the Bragg Peak was recorded for every orientation of the trimmer penumbra jaws in 2 mm increments. A weighted optimizer and dose placement algorithm was coded and implemented using MatLab. Dose distributions of trimmed kernels were then computed and compared to treatment simulations of homogeneous proton pencil beams unaffected by trimmer jaws. It was shown that the use of trimmer penumbra jaws in proton beam therapy significantly limits lateral dose fall off to healthy tissue and leads to an increase in dose conformity to the tumor region compared to conventional proton pencil beams used in proton beam radiotherapy.

During the summer I spent the majority of my time and energy adapting the weighted optimizer and developing the dose placement algorithms within the project described above. The first few weeks of my summer consisted learning the syntax and coding style of Matlab while simultaneously studying the physics and its applications in congruence to my project. Prior to my arrival, the medical physicists at the University of Iowa were running Monte Carlo simulations of dose distributions from the IsoTrim. We kept these simulations running over the summer with different parameters while I constructed the trimmer placement algorithm and adapted a weighted optimizer algorithm developed originally for Tomotherapy simulations. We then compared our trimmed results to simulated untrimmed results for various spot sizes and beam spread sigmas.

> *"At the end of my fellowship I contributed towards a paper that was submitted and accepted for publication in Medical Physics... This award has provided me with a research experience I could not have had without this fellowship...inspired me to pursue a doctorate in clinical therapeutic medical physics."*

Several dose area histograms were constructed to compare the dose distributions at the depth of the Bragg Peak for three arbitrary shapes (oval, "C" shape, and squiggle) between conventional untrimmed and trimmed deliveries. As shown in the figure below, our simulations suggest that the dose distribution delivered from the IsoTrim would retain the appropriate target coverage while simultaneously decreasing the dose delivered to normal tissue. At the end of my fellowship I contributed towards a paper that was submitted and accepted for publication in *Medical Physics* based upon our work over the summer. I would personally like to thank the American Association of Physicists in Medicine for this outstanding opportunity. This award has provided me with a research experience I could not have had without this fellowship. Furthermore, I have made numerous friends and mentors that have inspired me to pursue a doctorate in clinical therapeutic medical physics.





The AAPM Development Committee hopes that these testimonials to the value of your contributions will encourage greater support for the AAPM Education & Research Fund and the worthwhile activities the Fund supports.

As Chairman of the Committee I urge each and every AAPM member to contribute a minimum of $100 annually to support our educational and research activities. We must strive to obtain the level of contributions that will help to accomplish our mission of much-needed educational and research opportunities for our young professionals.

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.

Colin G. Orton, Ph.D.
Professor Emeritus

(A complete list of contributors at the various contribution levels follows.)

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