focus on our future

2010 Annual Report of the AAPM Education & Research Fund

There is growing emphasis within the medical community on the professional training and qualification of medical physicists. The AAPM Education & Research Fund supports residencies in medical physics as the pathway to professional qualification. The Association supports the American Board of Radiology (ABR) and the American Board of Medical Physics (ABMP) and recognizes Board Certification of medical physicists as a pre-requisite for becoming a Qualified Medical Physicist (QMP).

Our mission to advance the science, education and professional practice of medical physics is carried out in a major way by fostering high-quality training at the Graduate and Postgraduate levels through sponsorship of the Commission on Accreditation of Medical Physics Educational Programs (CAMPEP) and by awarding Training Grants and Fellowships through its Education and Research Fund.

The Education and Research Fund is overseen by the Development Committee, Chaired by Provost Paul M. DeLuca at the University of Wisconsin. The Committee would like to thank all who contributed in 2010, as well as all those who have supported the fund throughout its history. An appendix appears at the end of the report containing the names of all who have so generously contributed. Contributions in this and previous years, have supported scholarships, fellowships, residencies and other educational endeavors. Countless benefits have been derived by the professionals whose research and education have been supported by a grant from the Fund. This year we have added a new feature to your profile in our Membership Directory on **www.aapm.org**. Your level of contributions is now being recognized beneath your photo. Also, at the following link, **www.apm.org/education/edfunddonors.asp**, each member can view his/her contribution level to date and also learn what would be required to reach the next level. Check it out!

It is concerning to note that once again in 2010, the level of contributions was disappointing. A total of $22,592 was contributed. Based on the 2010 membership count of 7,341, the average member contribution was **$3.07**.

The members of the AAPM Development Committee are urging you to support these valuable research efforts by considering a minimum donation of **$100** annually. Without your contributions, the valuable efforts of this Committee are meaningless. Every AAPM member benefits from the work of the Association, and most especially in the area of education and training. Dues alone are insufficient to make significant gains in providing research and educational opportunities for new entrants into our profession.

The following testimonials and reports present just a short glimpse of the wonderful work being done under the auspices of the AAPM Education & Research Fund.

2010 Review

Grants and Fellowships

The Research Seed Funding Initiative

This award provides a $25,000 grant to a young/new investigator to assist with the development of exciting investigator-initiated concepts, which will hopefully lead to successful longer- term project funding from the NIH or equivalent funding sources. It is expected that funding will begin on July 1 of the year in which the award is made, and that subsequent research results will be submitted for presentation at future AAPM meetings.

The award in 2010 went to **Dr. Guillem Pratx** at Stanford University for his research entitled "X-Ray Luminescence Computed Tomography" Dr. Pratx describes his work with the following.

X-ray CT remains the modality of choice for imaging the anatomy with exquisite spatial resolution; however, it cannot probe subtle biological processes such as hypoxia and angiogenesis. X-ray luminescence computed tomography (XLCT) is a promising new approach that combines the high spatial resolution and deep-tissue imaging capability of X-rays and the capacity of optical imaging probes to sense subtle biological processes in vivo. XLCT is based on the X-ray excitation of injected radioluminescent nanophosphors (RLNPs) that act as light-emitting molecular reporters. Preliminary simulations suggested the feasibility of the approach, but an experimental validation was required.

With funding from the AAPM Research Seed Grant, we designed and built the first prototype of an XLCT system. Various components were purchased, including a highly-sensitive EM-CCD camera, a computer-controlled motion stage, a narrow tungsten collimator, and a data-acquisition computer. To test the system, several phantoms were built and imaged tomographically. The experiments were successfully conducted, and, for the first time, we were able to acquire and reconstruct XLCT images.

These groundbreaking results were published in *Optics Letters*.

Seed support from the AAPM filled a critical gap, and allowed us to move from preliminary computer-based simulations to important physical experiments. While use of CT is widespread, XLCT may introduce complementary molecular imaging capabilities in radiation therapy, helping clinicians to monitor treatment progress, hypoxia status or tumor apoptosis.

Fellowship for Graduate Study in Medical Physics

"My name is Dustin Jacqmin and I was the recipient of the 2008-2010 Fellowship for Graduate Study in Medical Physics. In Fall 2008, I began my PhD studies in the Medical Physics Department at the University of Wisconsin-Madison. I also have a BS in Nuclear Engineering and an MS in Medical Physics from Wisconsin. I have now completed all of my minor degree coursework and am working on my research full-time as a dissertator.

"I am carrying out my PhD research under the guidance of Professor Thomas R. Mackie. My research focuses on implementing a new proton radiation therapy dose calculation algorithm. The algorithm is based on the Macro Monte Carlo algorithms developed in the past for electron beam radiotherapy dose calculation but has been adapted to model the behavior of high energy protons. The project has challenged me to become better acquainted with the unique properties of proton therapy and to become a better computer programmer. I anticipate both of these skills will be valuable during my career as a medical physicist. At present, my research is proceeding smoothly and I will have an opportunity to present some early results at the European Medical Physics and Engineering Conference 2011 in Dublin, Ireland, this fall.

"Being selected as a recipient of the AAPM Fellowship for Graduate Study in Medical Physics was an honor and has been beneficial to me in a number of ways. As an important income source, the fellowship allowed me to spend one semester each year without teaching duties. While I enjoyed having a chance to serve as a teaching assistant for an engineering course, the job was quite time-consuming and my duties often interfered with my research. The AAPM fellowship allowed my department to support me as a

research assistant during one semester each year as well as during the summer. In addition to giving me much more time to focus on my research, the AAPM-funded research assistantship allowed me to participate in a number of other medical physics-related activities. This included volunteering at the University of Wisconsin Hospital Radiotherapy Clinic where I carried out delivery quality assurance for Tomotherapy patients on a weekly basis. I also participated in other activities like quality assurance for linear accelerators, film calibrations and monthly quality assurance for Tomotherapy. I have also found time to assist in setup and clean-up procedures for iodine radionuclide therapy at the hospital. My volunteering has been valuable work experience and a great opportunity to give something back to the medical physics community. It has also made me a more versatile student and physicist and provided me with skills I will use professionally.

"I would like to once again thank the AAPM for their generous contribution to my education! The fellowship has truly enhanced my learning experience as a student of medical physics."

The 2010-2012 Fellowship was awarded to Edward Wunder at the University of Wisconsin, Madison.

AAPM Imaging Residency

"Thank you for your interest in the progress of our resident, **Wendy Siman, M.S.**, who was the recipient of the AAPM Imaging Residency in 2010. He is a Resident at the University of Texas, M.D. Anderson Cancer Center. Thus far he has completed clinical rotations in *General Radiography, Angiography and Fluoroscopy, US, MRI, CT, Nuclear Medicine and PET, Breast Imaging, and Imaging Informatics*.

During his second year, the University, under the direction of Dr. Charles E. Willis, is expanding his clinical training in Nuclear Medicine, PET, and hybrid imaging modalities. He is

working on a clinical research project with Dr. Cheenu Kappadath, and they plan to submit their results to a peer-reviewed journal. He continues to perform mammography annual testing under direct supervision of MQSA medical physicists to achieve the requisite number of 10 devices and a stereotactic system within his two year training program. He will be participating in extramural clinical rotations in Cardiac Imaging, Pediatric Radiology, and Emergency Radiology and Community Medicine during his second year."

AAPM/RSNA Fellowship

The AAPM/RSNA Fellowship for the training of a doctoral candidate in the field of Medical Physics is awarded for the first two years of graduate study leading to a doctoral degree in Medical Physics. This award was established in recognition of Historical Contributions from the Radiological Society of North America (RSNA) and the American Association of Physicists in Medicine. Courtney Knapp at the University of Texas, San Antonio, was the recipient of the 2009-2011 award and her research was featured in the 2009 Annual Report.

Summer Undergraduate Fellowship Program

The American Association of Physicists in Medicine's Summer Undergraduate Fellowship Program is 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. In this program, the AAPM serves as a clearinghouse to match 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. Students are selected for the program on a competitive basis to be an AAPM summer fellow. Each summer fellow receives a stipend from the AAPM. The fellowship is for a period of 10 weeks during the summer academic period (May to September), which is mutually suitable to the mentor and fellow.

Several Summer Fellows in 2010 reported on how they spent their research opportunities.

Kate Turner
2010 AAPM Summer Undergraduate Fellow

"This past summer I was awarded the 2010 AAPM Undergraduate Fellowship. I spent ten weeks at Cleveland Clinic working with the head of medical physics, Dr. Ping Xia. I worked on two different research projects, while also shadowing in the clinical setting.

My first project was a study on the setup errors in patients with gynecological tumors and the relationship of larger setup errors to a higher body mass index (BMI). I retrieved patient data from past years, compiled the data, and analyzed it using various statistical tests and graphs. The second project I worked on involved comparing three types of image-guided radiation therapy and their efficacy in treating prostate cancer. The three modalities tested were the Clarity ultrasound system, the Calypso 4-D tracking system, and cone beam CT.

Overall, I really enjoyed my experience at Cleveland Clinic and couldn't have asked for a better summer. I was fortunate enough to conduct research, while also shadowing and seeing what medical physicists do in the clinical setting. I was able to network with medical physicists from all around the world, which was a major asset in the graduate school application process. I will attend Duke University in the fall to obtain my M.S. degree in medical physics."

Jami Johnson
2010 AAPM Summer Undergraduate Program Fellow

"This past summer, as an AAPM fellow, I worked as a research assistant at the University of Minnesota Medical Center in the Therapeutic Radiation Department. I worked closely with medical physicist Dr. Yoichi Watanabe and neurosurgeon Dr. Paul Sperduto on two main projects regarding Gamma Knife Stereotactic Radiosurgery. For the first project, we conducted a study that compared the distribution of brain metastases (BM) among different diagnoses and correlated that distribution with brain volume and blood flow. It was found that the distribution

of BM correlates directly with brain volume and blood flow for all diagnoses except for breast cancer and small cell lung cancer, which show a predilection for the cerebellum. This project was accepted for presentation at the 10th Biennial Congress and Exhibition of the International Stereotactic Radiosurgery Society in Paris, as well as the American Radium Society meeting in Palm Beach this May.

"Preliminary research suggests the location of brain metastases is not necessarily related to lobar brain volume or blood flow but rather molecular events such as tumor-specific cell surface proteins or receptors which may explain the homing process and preferential colonization of some parts of the brain. This study provides a basis for further research to explain and confirm these findings.

I was, furthermore, responsible for analyzing the MRI scans of former Gamma Knife patients whose treatments failed. We found that the dose given to a specific treatment volume did not directly correlate to the failure of a treatment. I was also given the opportunity to shadow the Medical Physicist on multiple occasions, and was therefore educated in radiation therapy and medical imaging technologies. I am attending graduate school next fall for biomedical engineering, therefore this experience has given me a strong background for research regarding cancer treatment modalities."

Mike Adams
2010 AAPM Summer Undergraduate Fellow

"I had the opportunity of being one of the recipients for the 2010 AAPM Summer Undergraduate Program. This program allowed me to participate in research and gain clinical experience. I was able to work in the radiation oncology department in the Center for Advanced Medicine at Washington University in St. Louis School of Medicine.

"This program allowed me to observe simulation, planning, external beam radiotherapy, and brachytherapy. I spent a lot of my time with the stereotactic radiosurgery gamma knife team.

My research consisted of learning about Graphical Processing Units (GPU's), Compute Unified Device Architecture (CUDA) and parallel computing. I worked to incorporate a NVIDIA Tesla GPU with the Gamma Plan Verification Tool (GPVT). GPVT is a program created in MATLAB that works alongside the Gamma Knife software and is used to double check and keep record of patient dose and shot information. I was involved in helping to make some modifications to the program to decrease run time. The current goal is to get GPVT to calculate isodose for 3-D matrix dose points for which the GPU would be useful.

"The AAPM summer program was a great experience for me. I was able to work with graduate students and medical physicists helping me gain an understanding of the necessary schooling and responsibilities for someone in this career. I was also able to gain some computational skills and put together a report and give multiple presentations on what I learned and accomplished over the ten week period. I am planning to attend a medical physics graduate program. The hands on experience this program provided would be very helpful to anyone seeking to work in the medical physics profession."

The **Minority Undergraduate Summer Experience Program (MUSE)** is designed to expose minority undergraduate university students to the field of medical physics by performing research or assisting with clinical service at a U.S. institution (university, clinical facility, laboratory, etc). The charge of MUSE is specifically to encourage minority students from Historically Black Colleges and Universities (HBCU), Minority Serving Institutions (MSI) or non-Minority Serving Institutions (nMSI) to gain such experience and apply to graduate programs in medical physics. The fellowship is for a period of 10 weeks during the summer academic period.

The following students were happy to share their summer experiences.

Rabi Alam
2010 Minority Undergraduate Summer Experience Fellow

The fellowship is for a period of 10 weeks, "I spent the past summer conducting outstanding research at the University of Chicago Medical Center Department Of Radiology. I was awarded a fellowship by the American Association of Physicists in Medicine, and had spent 10 weeks conducting research into medical imaging and computer-aided diagnosis of breast cancer.

"Together with my collaborators, including Maryellen Giger, professor of radiology at the University of Chicago, we published the results of our work in a paper titled "Exploring Deep Parametric Embeddings for Breast Computer Aided Diagnosis." We submitted the paper and were selected to present the findings at the International Society for Optics and Photonics Medical Imaging conference this past February (2011) in Orlando, FL. I was the second author of the paper.

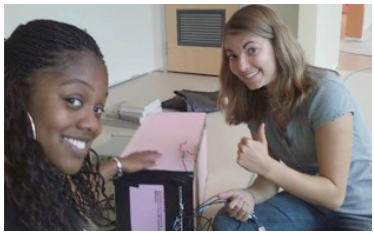
"Computer-aided diagnosis of cancer is a vital and relatively new field. It's so important because of how poorly we understand cancer. Cancer can be difficult even for trained radiologists to identify. While human vision has certain strengths, like the ability to view images holistically and make inferences, computer 'vision' has a different set of strengths. Chief among them is the ability to algorithmically identify patterns from images that are impossible for humans to identify, but which may present important data. Using computer-aided image analysis will yield practical benefits in the years to come by supplementing radiologists' attempts to identify and diagnose cancers.

"Using a variety of sophisticated techniques, myself and my collaborators essentially trained computers to analyze images from mammograms and other forms of medical imaging.

"Through my summer fellowship, I was able to examine, in practice, the capabilities and limitations of a computer's ability to learn. Aside from providing exposure to the world of applied

science, the experience has influenced my focus for my Senior Thesis, which will continue my investigation into machine learning and functional programming."

Danielle Nicholson
2010 Minority Undergraduate Fellowship (MUSE)



"There are a various methods used to perform neutron imaging. In my summer research, the objective was to isolate and detect a neutron signal in order to perform tumor spectroscopy analysis using secondary neutrons produced during proton therapy treatments. This will aid in determining tumor density and surrounding body formation. A detector was built with scintillating fibers to observe signals of secondary particles in the treatment room using an oscilloscope. Specifications for only a neutron signal were made using shielding. Preliminary data indicated a fairly good response of the detector to secondary radiation that follows basic expectations regarding energy and distance signal distribution behaviors.

"The first aspect of this project was to conduct extensive background research and preliminary simulations. This granted awareness of the behaviors and patterns of how protons and secondary particles behave in proton therapy. Using GEANT4 (Geometry and Tracking), a popular scientific software that specializes in particle tracking, both proton and neutron beam tests were run. Both beams were tested shooting 100,000 particles per run in a range of 0-200 mega electron-volts (MeV) in increments of 25 MeV. It was noted that the beam delivers all of the dosage to the target, and then comes to a complete halt. This is known as the Bragg Peak. The Bragg Peak moves further right with each increase in energy, while the neutron beam curve becomes higher and rounder with an increase in energy.

"The first phase of the experiment was to construct a detector. Using foam board a box was built with a black lining on the inside to seal all outside light from entering. Black flaps were also placed on each wall and the top to interlock and make the box completely "light

tight" despite having a removable top. The outer corners of the box were then sealed with black electric tape multiple times.

"Next, sixteen scintillating fibers were prepared by cleaning them with soap and polishing the tips of one end with 4 different grades of sand paper- starting with the most coarse and ending with a finer grade. The fibers were then spray painted one coat of white and two coats of black to keep the light from escaping the fibers and prevent outside light from neighboring fibers to interfere. Then, a photo multiplier tube or PMT, which amplifies the signal the fibers detect, was mounted to a side wall. The fibers were guided, organized and the non-painted end of the fiber was placed on the face of the PMT. The sixteen fibers were divided in half- eight short and eight long. The eight short fibers were run along a surface of the box in a straight path, while the long fibers were slightly turned into a 90^{o} degree angle. A preliminary test was needed to determine if our detector could receive a signal from a high voltage. The PMT was connected to the high voltage and the signals analyzed from an oscilloscope.

"The detector was then tested at the Hampton University Proton Therapy Center. Many trials were conducted from various distances. The conclusion that was drawn is that the back fibers picked up more signals due to secondary particles. The future objective is to specify the type of radiation being detected to isolate neutrons and carry out the goal of using them in tumor spectroscopy. This will aid the medical physics profession by allowing us to have an idea of exactly where the dosage was delivered via documented picture proof. It will aid me in the future as a medical physicist to be able to better serve and care for patients who have to suffer cancer.

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