

## **AC 2009-688: HISTORICALLY BLACK COLLEGES AND UNIVERSITIES EDUCATIONAL AND RESEARCH OUTREACH PROGRAM IN NUCLEAR SCIENCE AND ENGINEERING**

### **Sheldon Landsberger, University of Texas, Austin**

Dr. Landsberger is Coordinator of the Nuclear and Radiation Engineering Program and has primarily involved in the determination of heavy metals in environmental samples using nuclear analytical methods. In particular he has developed improved nuclear techniques to better determine the elements of critical importance in identifying regional sources of airborne particles, and characterizing solid waste leaching dynamics. His current research interests include low-level counting of natural radioactivity, corrosion studies, Compton suppression gamma-ray spectrometry and risk assessment in radioactivity handling. He is also involved in development of distance learning education.

### **Ofodike Ezekoye, University of Texas, Austin**

Dr. Ofodike Ezekoye is an expert in combustion and heat transfer in high temperature and reacting systems such as combustion engines, furnaces, and fire enclosures. He is currently the Graduate Advisor for the Mechanical Engineering Department and is an advisor for the National Society of Black Engineers University of Texas Austin Chapter.

### **David Hearnberger, University of Texas, Austin**

Dr. David Hearnberger is consultant for his own business Kaizen Innovations. He is a lecturer in radioactive waste management, health physics and health physics instrumentation in the Nuclear and Radiation Engineering Program at the University of Texas at Austin.

### **Rose Stiffin, Florida Memorial University**

Dr. Rose Stiffin is an Associate Professor in the School of Health and Natural Sciences and is responsible to teach nuclear and radiochemistry in the undergraduate radiochemistry technical option.

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Dr. Dimitri Tamalis is an Assistant Professor in the School of Health and Natural Sciences and is responsible to teach health physics in the undergraduate radiochemistry technical option.

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Dr. Michael Elliott is an Assistant Professor in the School of Health and Natural Sciences and is responsible to teach radioactive waste management in the undergraduate radiochemistry technical option.

### **Carlos Handy, Texas Southern University**

Dr. Carlos Handy is Chair of the Department of Physics at Texas Southern University. He established the only undergraduate health physics program in the Houston area. Dr. Handy continues his research in developing new ways of exploiting positivity constraints to computationally solve various quantum physics problems through the generation of rapidly converging lower and upper bounds to the physical parameters.

### **Elena Stefanova, Texas Southern University**

Dr. Elena Stefanova is a Visiting Professor at the Texas Southern University and has been involved in the newly developed health physics undergraduate program.

**Muchere Russ, Huston-Tilliston**

Dr. Muchere Russ is Associate Professor of Chemistry in the College of Arts and Sciences and is leading to establish a nuclear technical option in Huston-Tilliston.

# **Historically Black Colleges and Universities Educational and Research Outreach Program in Nuclear Science and Engineering from The University of Texas at Austin**

## **Abstract**

With the passing of the Energy Policy Act of 2005, the United States is experiencing for the first time in over two decades, what some refer to as the “Nuclear Renaissance.” Twenty-year operating license extension applications have been filed to extend the already approved 40-year operating period out to 60 years and some are already being approved. In addition, many utilities are filing a combined Construction and Operating License (COL) application to allow building new power plants within the existing restricted areas, while others are opting to build new power plants in different areas. The Nuclear Regulatory Commission (NRC) recognizes this surge in application submissions and is committed to reviewing these applications in a timely manner to support the country’s growing energy demands. Notwithstanding these facts, it is understood that the nuclear industry requires appropriately trained and educated personnel to support the growing needs of the nuclear industry and the US Nuclear Regulatory Commission. Equally important is the need to educate the next generation of students in nuclear non-proliferation, nuclear forensics and various aspects of homeland security for the national laboratories and the Department of Defense. From mechanical engineers educated and experienced in materials, thermal/fluid dynamics, and component failure analysis, to physicists using advanced computing techniques to design the next generation of nuclear reactor fuel elements, the need for new engineers, scientists, and health physicist has never been greater. To help existing and burgeoning academic programs succeed, we propose to work with Historically Black Colleges and Universities and other Minority Institutions (HBCU/MI) to increase enrollment at the graduate level to provide a higher better educated engineers and health physicists.

## **Goals**

In our program we will work closely with three HBCUs to make clearer the career opportunities in nuclear science and technology. We have chosen three distinct types of programs to work with of which two programs are in the state of Texas and one is in Florida. The two Texas programs are Texas Southern University and Huston-Tillotson University. The Florida school is Florida Memorial University. One of the PIs, Professor Landsberger, has done a considerable amount of work with Florida Memorial University and the relationship with FMU represents a template, of sorts, for the types of interactions that we will pursue with our other partner institutions. Texas Southern University, which is located in Houston, was chosen of its recently developed program in nuclear and radiological science. Finally, Huston-Tillotson University, which is located approximately 3 miles from the University of Texas at Austin, was chosen as a partner institution because of proximity to our program and opportunities for a very close working relationship between UT and HT faculty and students.

## **Interaction with Huston-Tillotson University**

Huston Tillotson University was formed in 1952 as a merger of Samuel Huston College and Tillotson College. Huston-Tillotson is a predominantly black college that has a proud tradition of educating African American leaders in the Central Texas area. Four year undergraduate degrees are awarded in a number of areas including science and technology. The University has an enrollment of approximately 750 students with all students required to take a number of science courses before graduating. The school has a number of biology and chemistry majors who are required to take a number of lab courses in these areas.

HTU has been quite aggressive in developing pipelines for middle and high school students to enter college in science majors through the successful Pre-Freshman Engineering Program (AusPrEP) summer program. The AusPrEP program is part of a \$238,000 grant to Huston-Tillotson from the U.S. Department of Education for math and science initiatives. This grant has initiated additional funding from industry. Applied Materials, a semiconductor equipment manufacturing company, awarded HTU \$20,000 to add to the AusPrEP program. We plan on leveraging on the success of this program to add modules to it specifically related to nuclear science and engineering issues. Funding will provide support for HTU faculty and students as well as UT National Society of Black Engineers (NSBE) students who will serve as group leaders in the summer program.

One of our PIs (Prof. Ezekoye) is the faculty adviser to the award winning University of Texas at Austin chapter of NSBE. Routinely, some UT-NSBE students will remain on campus during the summers to take courses etc. Additionally, a group of HTU science students will be in Austin during the summer. Through these student groups we will look for mentors interested and willing to serve as mentors for the AusPrEP group. The UT students who will work as AusPrEP mentors will take an Introductory Nuclear Engineering class the year before to be qualified to discuss and teach the modules developed for HTU students. We will develop a similar training module or some type of distance learning program for HTU students who will serve as mentors. We thus will create awareness of nuclear issues in UT and HTU students who might not have otherwise taken such courses, and we will also reinforce these learning concepts by having those students teach younger students about the value and importance of math and science related to nuclear science and technology.

We will help HTU better broadcast the AusPrEP program with a goal of increasing the number of students served by a factor of two. Funds will be used to accommodate this increase in number of students by hiring university level student mentors and supporting HTU faculty working on the program. We hope to be able to measure and document the impact of the program through the number of student mentors (undergrads) who eventually go to graduate school and of high school students who end up majoring in science and engineering.

### Goals:

- I. To increase awareness of and interest in nuclear science concepts for HTU students by incorporating specific nuclear science modules into existing science courses.
- II. Evaluate requirements and develop a feasible implementation plan for increasing the number of African-American in nuclear science related careers.

- III. To include an Introduction to Nuclear Science course in the Natural Science curriculum.
- IV. To encourage and prepare science majors to pursue nuclear science related experiences.
- V. To increase awareness of nuclear science related careers to HT students and minority groups in the community

Outcomes:

- 1 Adapt modules from University of Texas courses for inclusion in the following courses: Environmental Biology, Introduction to Biology, Physical Science, General Chemistry II, Organic Chemistry II, Physical Chemistry, and Physics II over a two year period
- 2 Plan developed and evaluated for HT nuclear science concentration
- 3 Implement alternate course in nuclear science as a second Physical Science options for HT students
- 4 Have at least three students participate in summer internships or complete a semester at Florida Memorial University or courses at UT
- 5 Prepare a nuclear science careers exhibit for presentation at career fairs

Huston-Tillotson University offers majors in Biology, Chemistry, and Mathematics. It graduates about 10 majors each year. While the predominant interest of most students is in health related careers, it will be advantageous to broaden the knowledge base of its students to include some of the fundamentals and applications of nuclear science. To this end the following activities are proposed

### **Activity #1 Curriculum Activities**

#### 1a - Course Modules

This activity will review currently available content modules in nuclear science and the syllabi for selected courses in natural science. Add modules to four science core courses, thus introducing nuclear science concept to every HT non-science module. Select and add modules to selected major courses. Develop nuclear science module evaluation survey to determine the information gained regarding nuclear science modules. Surveys will be administered at the end of each class with nuclear science module.

#### 1b – Introduction to Nuclear Science Course

This activity will get approval for the introduction of new non-majors course into the science general education core. Survey similar courses currently being offered at other institutions. Course design, development, and approval. Introduce course by Spring, 2010.

#### 1c – Nuclear Science Concentration Evaluation

Consult with Florida Memorial University regarding program introduction, requirements, and evaluation. Develop a strategy for HT. Implementation plan and cost evaluation.

## **Activity #2 Student Activities**

### 2a – Scholarship

Develop scholarship requirements and application. Recruit science majors to participate. Scholarship students will be required to participate in HT nuclear science courses, activities, and internship.

### 2b – Summer Internship/Visiting Semester or Courses

Identify potential nuclear science internships for HT students. Students apply, participate, prepare reports, and present work at professional conferences.

### 2c – Nuclear Science Careers Exhibit

Science and Education majors will develop a display/presentation/poster that focuses on nuclear science careers for presentation at high school and college career fairs to educate African-American students about nuclear science careers and concepts.

## **Activity #3 Faculty Activities**

### 3a – Part-time Faculty/ Consultant

Adjunct/masters level graduate student in nuclear science field to assist in module integration, faculty development, and nuclear science course development and delivery.

### 3b – Module Development

Review modules additions for courses and develop guided inquiry approach when appropriate.

### 3c – Nuclear Science Workshops

Participate in and possibly host at least two workshops to develop and increase knowledge of nuclear science knowledge base.

## **Interaction with Texas Southern University**

Texas Southern University, Department of Physics, located in Houston, Texas is uniquely situated to provide a line of coursework, (among other subjects) in physics, environmental radioactivity, radiation protection and dosimetry, and radiation detection. Currently, this is the only program that exists in the Houston area that can provide instruction at the undergraduate and graduate level in health physics. This is especially important considering the South Texas Nuclear Project, owned by NRG Services, is potentially the largest employer of health physicists in the region and their need will grow as two additional nuclear reactors are added to this site.

While this program is academically rigorous, the practical application of this knowledge base requires improvement.

The Physics Department (<http://www.tsu.edu/pages/2450.asp> or <http://physics.tsu.edu> ) at Texas Southern University (TSU), in Houston, Texas, has launched the only Health Physics program in Houston. This was initiated in August 2008. The program is a result of support received from the Nuclear Regulatory Commission (NRC). So far, all of the support has been for infrastructure development (i.e. approximately \$350K/two-year for faculty release time and equipment), and an additional \$100K (approximately) for faculty development. No support has been received for scholarships in health physics/nuclear physics related areas. This is an important concern since the availability of scholarship monies would allow us to recruit larger numbers of competitive students. Thus far, the few students in our program are being supported through monies from the National Science Foundation Louis Stokes Alliance for Minority Participation (LSAMP). Another grant awarded to the Biology department through a NASA-URI Center (focusing on radiation sciences, etc.) may also allow a combining of the requested resources.

The new Health Physics (HP) curriculum is very demanding, and delivered at an “honors level”. It places special emphasis on environmental radiation protection. The program is a comprehensive curriculum (nearly graduate level) and combines fundamental nuclear physics education with very practical skills that include courses like basic concepts of atomic and radiation physics (1 semester), environmental radioactivity (1semester), introduction to nuclear physics (2 semesters), radiation detection (3 semesters), nuclear radiation detection laboratory (3 semesters), radiation protection and dosimetry (2 semesters). Nuclear magnetic resonance laboratory and radiation biology course are currently presented as optional. The program website is: <http://physics.tsu.edu/Academics/BSHealth.php>. It should be emphasized that the curriculum is being updated on a continuous basis; however, the basic areas represented above are inherent to the program.

The core learning facility is the nuclear radiation detection laboratory presently introduced for 3 semesters. It is a basic nuclear physics laboratory, where students will become familiar with the principles of radiation detection before using more sophisticated and automated counting and spectroscopy systems. Few Universities have such laboratories. The laboratory starts the second semester of the third year and will involve a nuclear physics lab with Geiger Mueller counters to introduce the students to the physics of nuclear radioactivity. The subsequent semester’s laboratory will emphasize health physics and nuclear spectroscopy. The health physics oriented experiments will utilize ion chamber, GM counter, well detectors, proportional counter and scintillation detectors. Presently, the spectroscopy experiments involve alpha and gamma spectroscopy. The third semester laboratory is a nuclear electronics laboratory exploiting NIM modules running (at the moment) for half of the semester.

All of the above have been configured through support from the NRC. Presently, there are three students taking the specialized Health Physics courses targeting a degree in Health Physics. We received support from NRC to further develop our program by introducing a Radiochemistry course. This will be done close collaboration with UT Austin through Dr. Landsberger. Through this support we are purchasing a high energy resolution HPGe detector and introducing a Radiochemistry Laboratory and Radiochemistry course. The course is planned to be on-line at

UT Austin, but the Laboratory will be at TSU. We have a laboratory room with a hood for that purpose.

Two Summer schools are planned for our present students. One at Oak Ridge National Laboratory and one at UT Austin.

Other than support for a professional alpha spectrometer during year one, all the requested support is for student scholarships. We have included, below, the curricula that the various tracks would follow.

### **1. Bachelor of Science Degree in Physics: FOUR-YEAR DEGREE IN HEALTH PHYSICS**

This track has a semester load that varies from a minimum of 30 credit hours per academic year (AY) to 33/AY. The in-state tuition would vary from \$6,400 to \$7,500/student-per year. All nationally recruited students would be eligible for in state tuition. Various Online courses would be taught through UT-Austin/M.D. Anderson collaboration. All participants must show competence in advanced mathematics (i.e. one dimensional calculus) at the beginning of their freshman year. They must exhibit excellent intellectual maturity and drive.

### **2. Bachelor of Science Degree in Physics: FOUR-YEAR DEGREE IN PRE-RADIOPHARMACEUTICAL PHYSICAL SCIENCE**

This track has a semester load that varies from a minimum of 27 credit hours per academic year (AY) to 39/AY. The Instate Tuition would vary from \$6,040 to \$8,200/student-per year. All nationally recruited students would be eligible for Instate Tuition. Various Online courses would be taught through UT-Austin/M.D. Anderson collaboration. All participants must show competence in advanced mathematics (i.e. one dimensional calculus) at the beginning of their freshman year. They must exhibit excellent intellectual maturity and drive

### **3. Bachelor of Science Degree in Physics: POST-BACCALAUREATE 15-MONTH PROGRAM**

Four semesters (preferably two summers and one full academic year) would be offered to nationally recruited students with a B.S. in physics or a related discipline. Semester credit hours vary from 10, 12, 14, and 15. These represent an Instate Tuition cost of \$2,300, \$2,670, \$3,023, and \$3,200 each. Total cost is \$11,193-two years/student. This program will recruit, at the national level, outstanding students with a strong interest in nuclear related professions. They should have a strong GPA in physics, engineering, or chemistry. In addition, they must have a strong mathematics competency and have taken courses in linear algebra, differential equations, and calculus based physics at their originating institutions. GPA in these areas should be at least 3.0. Overall GPA can be at least 2.5.



#### **4. 10 Week Academic Year “Saturday Academy” Format Workshop for High School Students.**

TSU will conduct a combined /TSU-Physics/UT-Austin High School Workshop emphasizing advanced mathematics training (i.e. teaching rudiments of calculus), basic (Fortran) scientific programming, modern physics, and exposure to nuclear lectures/seminars, experiments, and demonstrations. The selected students will meet for ten Saturdays. Ten scholarships will be offered to exceptional Black American students at the rate of \$900/student. This will be done in order to attract exceptional students which otherwise might be forced to find minimum wage employment. The classes will meet every other Saturday. Recruited students will be made aware of the special opportunities in nuclear related fields. It is hoped that some of these students will decide to attend TSU and major in those areas identified above.

In order to implement the program as quickly as possible, we will seek out high achieving TSU undergraduates in various departments: physics, engineering technologies, chemistry, pre-pharmacy, biology. All such students must have taken calculus and demonstrate proficiency in it. We will also recruit students from the excellent Houston Community College network of campuses, including those campuses emphasizing science, engineering, and health sciences (i.e. HCC-Coleman campus).

During Year 1, only \$34,000 will be available in scholarships. Three current physics students (two U.S. citizens, the third a U.S. permanent resident) will be fully or partially supported. One of these is a post-baccalaureate student. Two of the students will have their scholarships enhanced through the current effort. The third, the post-baccalaureate, will be fully supported. The remaining funds will be used to attract other TSU students from the disciplines identified. There are some exceptional students within the biology program that would be attracted by the various programs identified. We would also advertise the program nationally through the newsletters for various professional societies including the National Society of Black Physicists, the National Society of Black Physics Students, the American Society of Physicists and its Student society, etc. We will try to maximize the scholarship funds by combining, where appropriate, with other scholarship programs such as those offered through NSF’s LSAMP program and the current NASA URI Center.

#### **Interaction with Florida Memorial University**

The University of Texas already has a strong interaction with the Radiochemistry Program at Florida Memorial University. In summer of 2007 two faculty members took a course in Nuclear Instrumentation and in the summer of 2008 a returning faculty member along with two undergraduate students spent one month on a ONR funded grant (through Argonne National Lab) in the characterization of uranium using prompt gamma activation analysis. As with Texas Southern University, students will have a unique opportunity to work in a research reactor environment.

Florida Memorial University is the only Historically Black University in South Florida and one of the few HBCUs with an established undergraduate Radiochemistry Program. This program, on its second year of inception, has four committed students in the program with an additional

four in the pipeline. In addition, two of the senior students participated in a summer internship this summer at the Nuclear Engineering Teaching Laboratory (NETL) with the University of Texas at Austin. Two faculty members have also taken an intense two week laboratory training program at the same site. It is our intention to use the funds available from the three year Naval Research grant to strengthen further this program through the following areas:

1. Undergraduate Scholarships
2. Travel (to attend/present at professional meetings)
3. Acquisition of additional equipment and supplies
4. Public relations to promote the program

Student scholarships are a cornerstone of our program. The vast majority of our students come from underprivileged backgrounds and sometimes has to work outside campus to make ends meet. This financial burden makes progress in their academic pursuits difficult even for students who excel academically, like the ones recruited in the radiochemistry program (GPA above 3.0). Other programs on campus also offer prospective students various scholarships; thus, to compete and make our program more enticing, we are in need of similar financial incentives for the students.

Travel to meetings and symposia plays a multifunctional role. Both students and faculty get to showcase their academic and research accomplishments. Moreover, the social networking that takes place enables students to establish contacts for future graduate work and employment. The faculty may expand their program through collaboration. It is our goal to increase our circle of colleagues through travel to meetings such as the “Seminar Activation Analysis and Gamma Spektroskopy (SAAGAS 22)” in Vienna Austria in February 2009 and the meeting in Hawaii in April 2009. Travel to UT at Austin during the summer will be required for two to three students and two of our faculty. During that time, students will do research using a nuclear reactor neutron beam and professors will have the dual task of supervising that work in addition to acquiring knowledge that will enable them to teach their respective radiochemistry courses at Florida Memorial University.

Currently, our Radiochemistry Laboratory is equipped with a hand held Geiger counter, radioactive sources, radiation monitors, a NaI detector, and a High Performance Germanium detector. All detectors and other equipment are functional and the faculty members have been trained to use them. These instruments are being used for educational purposes in the radiochemistry program laboratory courses. We will expand their usage to include research projects involving environmental contaminants in food, soil, etc. We are also in the process of acquiring an alpha spectrophotometer.

The Department of Health and Natural Sciences is actively involved and committed to the recruitment of students from high schools who have expressed an interest in science, and chemistry in particular. Faculty and students have visited numerous high schools in the past and wish to continue. Such a venture would need support in the form of printed brochures about the faculty and programs and other promotional items to distribute to students, teachers, and counselors.

## **Conclusions**

We have established a strong relationship with three HBCU's in promoting nuclear science and engineering in the academic classroom as well with collaborative research experience. Such a program will also allow the exchange of ideas between HBCU institutions and also allows for the recruitment of strong students in various graduate programs in the country.