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Northern Illinois Proton Center on the verge of major medical breakthrough

Partnerships proving highly beneficial in research

WEST CHICAGO, IL- Scientists and researchers from the Northern Illinois Proton Treatment and Research Center (NIPTRC) and Northern Illinois University along with their partners are developing a new imaging process using a proton beam that they believe will be a major medical breakthrough in the delivery of proton beam therapy for cancer patients.

Research Director and Chief Physicist George Coutrakon, Ph.D. says it demonstrates that NIPTRC and NIU are already fulfilling their goal to further cancer treatment for certain head and neck as well as difficult to treat pediatric cancers.

"By using a proton beam scan instead of an x-ray CT scan to image a patient prior to treatment, density maps would be more accurate and the proton beam would stop more precisely on the tumor," said Coutrakon. "This is advantageous for such tumors located at the brain stem and base of the skull because precision is absolutely essential in sparing healthy tissues. This is particularly important for tumors in children."

Currently, x-ray CT scans are used to develop an image of the cancer patient and simulate the radiation dose delivered by the proton beam to the tumor. Although x-ray CT scans have worked well for many years, they do contain an error margin that researchers believe could be reduced substantially through the use of proton beam scanning technology in imaging. The existing procedure of using x-ray CT scans causes the range of a proton beam to have a margin of error of about three percent. By using a proton beam scan instead, the margin of error would be reduced from approximately three percent to less than one percent thereby allowing greater dose sparing of healthy tissue.

The new innovation bears witness to NIPTRC's vital mission of advancement in cancer treatment research that will set it apart from any other proton treatment center. The discovery comes even as the northern Illinois center is still under construction.

"Even though we are not yet operational, there is a great deal of research activity taking place behind the scenes," said Executive Director John Lewis. "Our mission is to advance proton therapy to an even higher level in order to more effectively treat cancer patients around the

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world. This will continue and we anticipate more announcements like this one in the months and years to come."

Nearly 50 years ago, Nobel Prize winner Dr. Allan Cormack first proposed the idea of using protons for scanning instead of x-rays in a 1963 research paper. Two years ago, NIU and Loma Linda University in California took Cormack's theory and began work to develop proton scan technology for proton treatment imaging. Since then, the two institutes have partnered with Cal State San Bernardino, the University of California at Santa Cruz (UCSC), and even the University of Haifa in Israel. NIU's Physics and Computer Science Departments are making considerable research contributions to the project as well.

The University of California at Santa Cruz is building a prototype of the hardware detector needed to collect the data from the proton beam. This effort is being lead under the direction of Hartmut Sadrozinski of UCSC and Victor Rykalin from NIU. This prototype will be ready by the end of this month and used at Loma Linda to collect the first ever 3-D images of humanlike phantoms. Researchers will work three to four hours a night during three or four days each week on the project, and they will use the same proton beam that treats patients during the daytime. By September, data collection will be complete and ready to feed into computers to process.

The software and computer technology required to process the data presents unique challenges. Currently, it would take hundreds of hours to construct the 360 degree, 3-D images associated with proton scans using conventional computers. This needs to be shortened dramatically to under ten minutes. In order to develop the software needed to make this technical leap forward, a partnership has been formed that includes Drs. Nicholas Karonis and Kirk Duffin from NIU's Computer Science Department, Dr. Bela Erdelyi from NIU's Physics Department, Dr. Keith Schubert from Cal State San Bernardino's Computer Science Department, and Dr. Yair Censor in the Department of Mathematics at the University of Haifa in Israel.

"We are willing to partner with everyone that wants to advance the field of proton therapy, whether they are researchers, physicists, engineers, or doctors," said Lewis. "We believe establishing these types of collaborative efforts are the key to innovation and progress."

In fact, NIU is currently in discussions with longtime partner Argonne National Laboratory's Computer Science Division to use their cluster of 24 Graphical Processor Units (GPUs) to attain fast image reconstruction. GPUs are popularly associated with today's impressive video gaming technology, but their remarkable power is now needed to help in the fight against cancer.

"We are very grateful to all our partners and the spirit of cooperation everyone has showed to make this project possible," said Coutrakon. "I am excited to be involved and look forward to sharing the final results once we are complete."

While Coutrakon heads up this research project with west coast universities, radiation physicist Wayne Newhauser, Ph.D. is performing additional research at the University of Texas' MD Anderson Cancer Center in Houston. Since the beginning of NIPTRC's 2008 partnership with UT, Newhauser and his colleagues have published 16 peer-reviewed papers about proton therapy that result from support provided by NIPTRC in collaboration with NIPTRC's clinical partner

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Northwestern Medical Faculty Foundation's Department of Radiation Oncology. These have appeared in scientific, engineering, and medical journals. A complete listing is available on NIPTRC's website at www.niptrc.org.

"The knowledge gained about proton therapy from several of our applied clinical research projects has proven to be beneficial to our clinical practice," said Newhauser. "It is abundantly clear to me that NIPTRC's generous support is key to our collaboration and to the progression of the education of several of our best students and post docs. We will continue to strive to create new research and training opportunities for students, faculty, and staff in order to fulfill the mission of NIPTRC."

One research project examined the second cancer risk associated with whole-body exposure to stray neutron radiation from proton therapy. This risk is especially important to assess in pediatric cancer cases because they are highly susceptible to second cancers. Research has already established the overall risk of second cancers with traditional photon radiation at about 55 percent and IMRT photon radiation at 31 percent. Proton therapy brings this down to around 5 percent but questions remained about stray neutron radiation.

"Prior to our study, neutron exposures caused by proton therapy were not well understood, and previous publications speculated on the possible dangers of proton therapy, causing confusion as to its appropriateness for treating children," said Newhauser.

There are two types of proton therapy, passively scattered and scanned-beam, and Newhauser's research team concluded both techniques are barely distinguishable in terms of risk specifically from stray neutron radiation. Passively scattered proton therapy was estimated at 1.5 percent and scanned beam proton therapy was estimated at 0.8 percent.

"Our evidence now shows that the risk is lower following proton therapy, regardless of the technique used," said Newhauser. "Nevertheless, there still is risk and it is important to continue attempts to reduce stray radiation exposure as much as possible. Together with researchers from NIPTRC, we aim to produce a high-quality body of evidence to support clinical decision making on whether a patient receives proton or photon therapy."

Newhauser's graduate students and postdoctoral fellows in medical physics have garnered numerous awards and recognition for their research on proton therapy. In addition, as a result of the partnership, opportunities have been created for NIU, Northwestern University and UT faculty members to participate in several research initiatives.

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