View from the ground: A special crane—only one of the two in existence in the United States—hoists a major piece of the cyclotron shielding onto the 9th floor.

Particle Acceleration Reaches the 9th Floor

High Marks from UPMC in Cyclotron Upgrade

Over the course of the mid- to late-1990s, a team of researchers at the University of Pittsburgh Medical Center (UPMC) in the United States developed hundreds of compounds in an attempt to visually depict Alzheimer's disease and other neurological disorders in the brain. But they needed to do more. In light of the growing need for targets, UPMC opted to retire a particle accelerator in 2010 with the help of Siemens Customer Care program, and literally "elevate" their new system. The Eclipse HP Cyclotron from Siemens that took its place was an engineering feat that took place nine floors above ground.

By Clint vanSonnenberg

The UPMC PET Research Center is a mecca of nuclear imaging innovation, with more than 25 different compounds in the works, all of which are dedicated to research. Chester Mathis, PhD, Director of the PET Research Center, describes the Research Center faculty's decision to move to a higher-capacity cyclotron in Siemens' Eclipse HP.

What Goes Up Must Come Down

The PET Research Center at UPMC has differentiated its cyclotron research and defied skeptics since its founding. Strapped for space in 1991, UPMC decided to locate the PET Facility on the ninth floor of UPMC Presbyterian Hospital, a one and a half-floor space wedged between the MR Research Center and the hospital cafeteria. The installation of a cyclotron was viewed as impossible by many experts.

"No cyclotron was or is engineered to have anything underneath it—to my knowledge nobody else puts a cyclotron up this high," Mathis explains. This fact is especially relevant when what's below the magnetic system are one 1.5 T and three 3.0 T MRI scanners, within just 20 feet of the cyclotron. To the disbelief of many, the PET facility's cyclotron and hot cells worked not only problem-free, but with cutting-edge success. By 2010, with Mathis and the rest of the PET researchers hungry for more radioisotopes and the expansion of the facility's research program, Mathis opted to stay with Sie-

mens for the upgrade, a decision he characterized as straightforward. It was the clear option.

Mathis admits that he expected the installation to be "painful," as some people on the project estimated the facility to be without radioisotope production for as long as a year. Hastened by the pending retirement of the chief architect on the first cyclotron installation, Mathis applied for and won a $2.6 million National Institutes of Health (NIH) stimulus grant for the Eclipse HP and related projects, which he had to complete by February 2011. UPMC architects and researchers got together with the Siemens' team immediately, collaborating on a menu of cyclotron features and installment specifications.

By September 2010, the PET Facility had shut down its old system, removed the windows from one side of the ninth floor, demolished adjoining offices, ripped out 25 inches of borated polyethylene and jackhammered through one and a half feet of concrete floor shielding. Over a period of five months, the RDS-112 was torn apart and lowered to the ground by crane; hoisted up in eight main pieces was UPMC's new, 20-ton and 24-square foot Eclipse HP Cyclotron.

Smooth Sailing

"All in all it went smoothly," reflects N. Scott Mason, PhD, a radiochemist and associate professor of radiology at the Medical School of the University of Pittsburgh, who led the day-to-day project engineering. Mason considers several important aspects of the project as contributing to the successful installation.

"There are a couple of nice things about this system. For one, it's compact and relatively lightweight, much lighter than our previous machine. What was also a big deal for us was that the machine is self-shielded [from emanating radiation]. These aspects allowed us to put the new cyclotron on the ninth floor."

In less than half the time that many had expected—just five months—the Eclipse HP was spinning particles and bombarding the targets, with the system totally shielded from the MR center below and cafeteria above, electrical and water hooked back up, the floor renovated and the facility testing its new isotopes. Mathis doesn't neglect to point out one important detail, "Plus, I got a new office out of it."

More Radioisotopes, No Radiation

By mid-February of this year, the PET Facility had tested the new cyclotron and resumed *in vivo* human trials. Imaging continues to dominate UPMC's research portfolio, but the facility produces some 20 other compounds for research into Down's syndrome, drug abuse, depression and other neurologic and psychiatric disorders.

With more than 40 publicly and privately funded researchers vying for radionuclides from the cyclotron, UPMC saw an advantage to the Eclipse HP in an increase to eight targets, doubling its daily yield of radiopharmaceuticals. Researchers now produce two different compounds simultaneously by bifurcating the beam current to aim each portion at a separate target. Mathis also reports gains to operational efficiency from the entirely remote process and the quicker and superior computer technology.

"We have such a higher capacity for making radionuclides than we did before," Mason says. The facility now keeps two flurodeoxyglucose-18 (^{18}F) water targets, one ^{18}F gas target, an oxygen-15 target and a nitrogen-13 target. Moreover, these targets can be switched out for trials of novel or varied compounds, with the self-shielding protecting workers from all radiation.

Mathis cites several factors key components of UPMC's upgrade decision. "The honest answer is we had the experience with Siemens support after they took over CTI, and we had 99 percent uptime. We were confident the new machine would be equally reliable. There are so many users of this system in the world that when it comes to repair, Siemens is able to get there quickly because they have so many professionals in the field," Mathis explains.

Given the center's heavy and multifarious research program, upping the target capacity was equally essential. "Siemens has really put a lot of time into testing their targets, getting them right. Other companies have not put the time and effort into their targets that Siemens has. And with some of the smaller manufacturers out there, you really take a risk."

View from the top: Installation crew members keep a close eye on the crane while it lowers a concrete slab into the cyclotron facility on the 9th floor.

The PET Research Center has gotten regulatory approval for all but a few compounds since the cyclotron's February launch; they expect the list to be topped off by this month. "This system will allow us to do our production work, to support our clinical research program and to perform basic development research for applications and tracers, essentially at the same time. Whereas in the past we would have to work around the clinical schedule, whether on nights or weekends, to try to get faculty beam time and hot cell space, now we're able to work on these applications simultaneously," Mason notes.

Disassembling the RDS-112 and installing and launching the highest cyclotron in the world, all within five months, is no doubt a feat in itself. But with meticulous planning with long-term cyclotron partner Siemens, funding and support from the National Institutes of Health, the UP Cancer Institute, public and private foundations and the Bill and Melinda Gates Foundation, what is truly remarkable about the Siemens Eclipse HP are the UPMC research and clinical applications it supports.

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