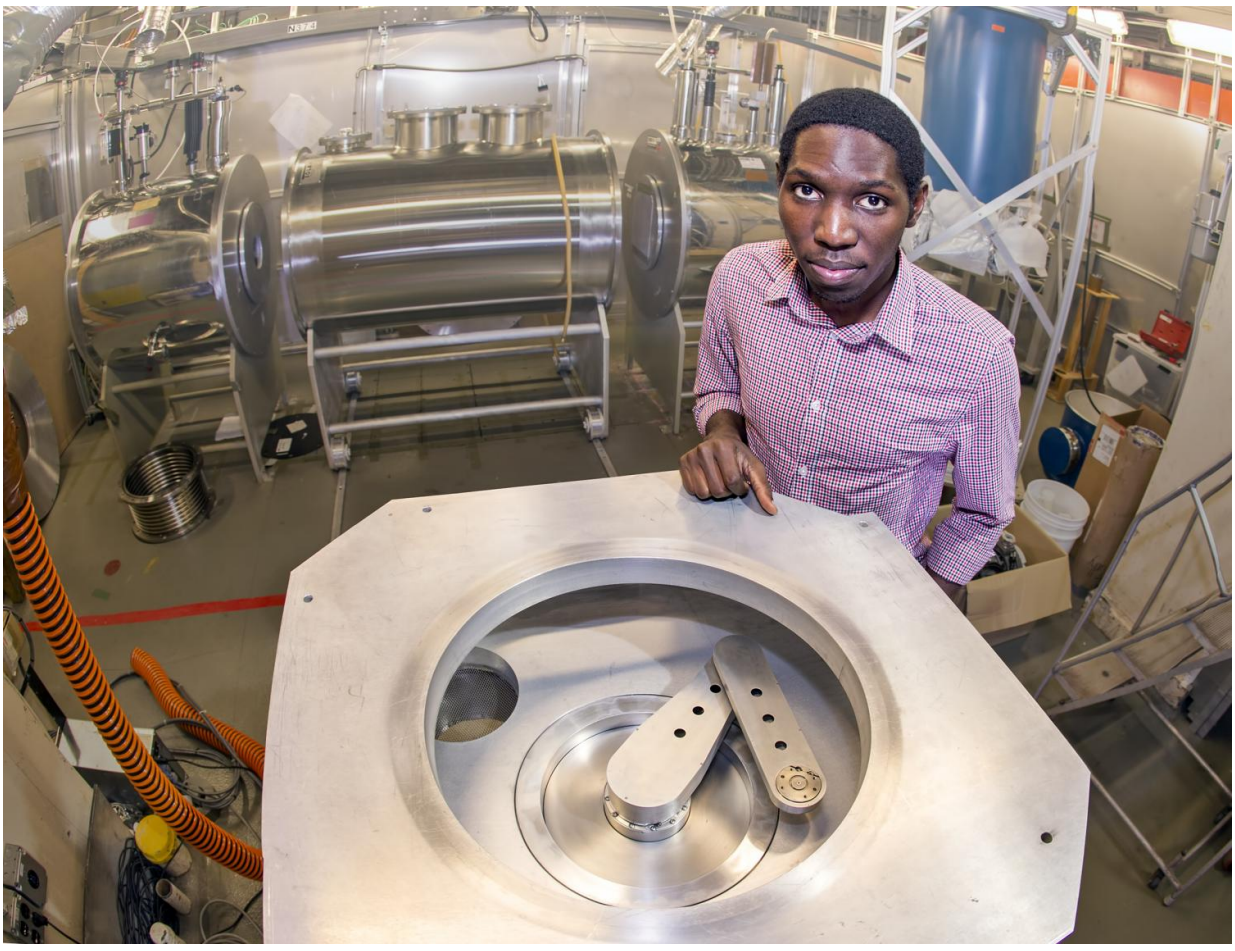
Intern helped get robotic arm on PPPL's PTOLEMY experiment up and running (Updated)

September 26 2016



PPPL intern Mark Thom with a device containing a robotic arm that will be used with PPPL's PTOLEMY experiment. Credit: Elle Starkman/PPPL Office of Communications

Deep in a laboratory tucked away in the basement of the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL), intern Mark Thom punched commands into a computer as two other students checked a chamber where a silver robotic arm extended from a small port.

The arm will allow scientists studying neutrinos that originated at the beginning of the universe to load a tiny amount of nuclear material into the device while still maintaining a vacuum in the PTOLEMY laboratory.

Thom, along with high school interns Xaymara Rivera and Willma Arias de la Rosa, worked closely with Princeton University physicist Chris Tully and PPPL engineers to get the robotic arm moving again. The crucial device will load tritium, a radioactive isotope of hydrogen, into PTOLEMY, the Princeton Tritium Observatory for Light, Early Universe Massive Neutrino Yield.

Tritium can capture Big Bang neutrinos and release them with electrons in radioactive decay. The neutrinos can provide a tiny boost of energy to the electrons, which PTOLEMY is designed to precisely measure in the darkest, coldest conditions possible. It is funded by the Simons Foundation and the John Templeton Foundation.

"For me it was just amazing that I actually got onto that project," Thom said. "It's exactly the kind of thing I thought I would like to do, being an engineer working on a high-energy physics project."

The robotic arm, together with the portable container and the computer program to operate it, were recycled from another experiment when Thom and fellow interns Rivera and Arias de la Rosa began the project. Thom was responsible for making the arm operational and altering it so it would fit PTOLEMY.

Handling delicate materials

Tully said the device can safely handle very delicate radioactive materials from DOE's Savannah River National Laboratory. Without the device, scientists would have to shut down PTOLEMY completely twice a day to change the tritium sample, he said. Maintaining a vacuum in PTOLEMY is also necessary for the extremely sensitive sensors that measure the energy spectrum of the electrons emitted from the tritium to function properly.

To make the robotic arm function again, Thom had to analyze why the coding was failing, which meant learning the code for the machine. He had to learn an unfamiliar program and then rewrite it to redirect the arm to handle tritium samples, without having worked on a device of that kind before, Tully said.

The students encountered a setback when the arm stopped working. At first, they thought the device would need a new motor, which would cost $20,000. It turned out that the culprit was a circuit that would cost just a few dollars to replace. While Tully fixed the computer, Thom took the arm apart and researched how to install magnetic shielding around the motors and sketched a design for that shielding, Tully said. "Mark was quite amazing," he said. "I was very impressed with him."

Thom also designed a cover for one of the ports that would need to be sealed for the robotic arm to work. Rivera and Arias de la Rosa helped him operate and test the robotic arm and wrote procedures for running it. Thom and the other interns also worked with PPPL engineers Charles Gentile and Mike Mardenfeld, along with senior mechanical technician Andy Carpe and lead technician Jim Taylor.

Gentile, who supervised Thom and other engineering interns, said Thom was one of the best interns he has seen in 25 years of supervising more

than 200 interns. "He's an excellent mechanical engineer," Gentile said. "He was a hard worker and he came up with innovative solutions to problems."

The arm connects to PTOLEMY through two ports equipped with valves. One valve connects to the experiment. The other connects to a loading chamber where scientists can insert a tiny sample of tritium on a graphene base.

Researchers would create a vacuum in the loading chamber and attach it to the vacuum chamber of PTOLEMY. The robotic arm could then collect the tritium and graphene sample and deposit it into PTOLEMY. Researchers would next retract the arm and close the valve connecting it to PTOLEMY.

Following parents' footsteps

Thom, who is in his final year of master's degree work at Howard University, is from Trinidad. The son of two engineers, he considered becoming a physician and briefly flirted with the idea of being an actor or music producer before choosing to follow in his parents' footsteps.

Thom studied engineering as an undergraduate at Howard. He learned about the internship when Andrea Moten, PPPL acting director of human resources, and engineer Atiba Brereton met him at National Laboratory Day at Howard University in February. The two passed Thom's resume along to Gentile as a candidate for the engineering apprenticeship program.

The graduate student recently celebrated his one-year anniversary with his wife, Sydney, who is also an engineer and is currently teaching at a Kipp DC Middle School in Washington, D.C. Thom commuted to Washington every weekend on Friday nights to see her and then headed

back to New Jersey on Monday mornings. "It was challenging at first," he said. "But after a while I got accustomed to it and I actually began to appreciate those drives because it gave me some time to think."

Thom said he enjoyed the laid-back atmosphere at PPPL. He was surprised when Gentile told him he was overdressed on his first day. But he most enjoyed talking to researchers about their work. "I met some really cool people – a bunch of physicists whom I was able to have certain conversations with, just talking about abstract theories. That's the kind of conversation I enjoy," Thom said. "Being able to interact with people like that in that atmosphere was really enjoyable."

The internship gave him a better idea of possible careers as he prepares to graduate, Thom said. "I had a limited view of the engineering world prior to going into this work," he said. "But now I have a better idea of the kind of environment I'd like to be in, so it gives me an idea of what I should do to prepare for that environment."

Provided by Princeton Plasma Physics Laboratory