University of Arizona grad student sends research into space and back; Earns top professional honors

January 23 2013

Not many students can say they had to wait for their research to come back from space before they could collect their doctorate degrees. And not many can say that along the way they earned the top award in their professional community. Meet UA's Brian Fox.

Most graduate students finish up in four or five years. Electrical and computer engineering graduate student Brian Fox has labored the better part of the last seven years, and waited. He saw his optical fibers launched into space aboard space shuttle Atlantis three years ago. Then he waited in the wings 18 long months—launch delay after launch delay—to see how the radiation-hardened fibers had fared in the harsh space environment on the Materials International Space Station Experiment-7, or MISSE-7. Finally, in May 2011, the test fibers arrived back aboard space shuttle Endeavour on its final mission, commanded by Capt. Mark Kelly (husband of former Arizona Rep. Gabrielle Giffords).

"MISSE is one of those rare opportunities that only come around once or twice in a lifetime," said Fox. "How many people get to send their research into space?"

Optical fibers are spun threads of glass, or silica, about the size of a strand of hair that are immune to electromagnetic interference and can transmit large amounts of data at very high speeds over long distances.

Fiber-optic lines carry voices over cell phones, information via the Internet, and high-definition video to televisions. Because of its low energy usage, light weight and high data integrity, optical fiber is ideal for space-based telecommunications.

Fox and his mentor, Kelly Simmons-Potter, a University of Arizona professor in the department of electrical and computer engineering and College of Optical Sciences, set out to see how optical fibers doped with the rare earth metals erbium and ytterbium would hold up a couple of hundred miles above the earth's protective atmosphere.

But finding out which hardening elements work best among all the sources of space radiation, such as X-rays or gamma rays, presents unique challenges, said Simmons-Potter, explaining that special testing facilities here on earth can duplicate some of those sources of radiation, but only one at a time.

Simmons-Potter—whose research group is one of only a few in the world, including NASA itself, working specifically on radiation-hardened optics for space—used her connections at Sandia National Labs and the Naval Research Lab to secure a spot on MISSE-7 for the fibers.

The arrival of the fibers back on Earth meant more weeks of waiting. Naval Research Lab staff did not know how to deal with the samples, so the fibers were the last of the payload unloaded from the space shuttle. By the time the fibers were returned, still in their metal open-suitcase-like tray with tracking sensors attached, Fox and Simmons-Potter were primed to get a look.

"I was extremely excited to see what we would find," said Fox.

Then hearts sank

The sheath containing the fibers had become rigid and brittle. The researchers did not think they would get good data.

"We gently cut the tubes off the fibers, and realized the optics fiber had maintained mechanical fidelity," Fox said.

A palpable collective sigh of relief, and the researchers were back in business. The world now knows more about the durability of optical fibers in space.

"By testing the optical fibers in a combined space environment," said Simmons-Potter, "we were able to identify fibers that exhibit better radiation-hardening and wavelength regions where the worst damage occurs."

Fox expects to graduate in May 2013. While he is mapping out his future, he can relish the fact that he is one of few graduate students ever to win the Outstanding Paper Award from the Hardened Electronics and Radiation Technologies, or HEART, Conference. More than 100 professional papers competed for the annual award in spring 2012.

"I believe this HEART award is the same award Professor Simmons-Potter received many years ago," Fox said. "I am very happy to be following in her footsteps and extremely fortunate she let me present our paper."

The HEART presentation, which capped an incredible journey, only lasted 15 minutes. The experience will last a lifetime. The paper will be published in multiple scientific journals next year, and Fox is more than ready for the next phase of his own mission.

"It is our job to produce students who are ready to hit the ground when they are done," said Simmons-Potter. "He is an incredibly accomplished

scholar, and I am proud of what we did together. It has been a joy to work with such a bright young man."

Fox, a U.S. citizen who lived for many years in Germany and transferred to UA after two years at Pima Community College, said he could not have chosen a better university for his graduate education. The good classes, fascinating research, inspiring professors and scholarship availability made the UA a perfect choice.

"The College of Engineering and the electrical and computer engineering department have been incredibly supportive of everything I have done," he said. "I am finished with the experiments, polishing my dissertation, and considering a job in a radiation effects niche field."

As for the future of optic fibers in space, the results of their research may well one day, in the not-so-distant future, result in fiber-optic lasers and amplifiers aboard space-based systems, even commercial spacecraft, to transmit information, said Simmons-Potter and Fox.

Provided by University of Arizona