

## MSU team sends computer into space

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*Photos by Chris Sandison. MSU Professor Brock LaMeres and his students created a radiation-tolerant computer that will be sent to the International Space Station next year.*

On Oct. 23, a computer built by MSU Professor Brock LaMeres and his research team of students was launched by a rocket from the New Mexico desert to an altitude of 77 miles above the Earth where it remained for three minutes, gathering data. After falling back to Earth the computer was retrieved and returned to MSU where the team is currently evaluating the data the computer collected during the flight.

For the past six years, the team has used funding from NASA to develop a computer that is tolerant to the damaging radiation of outer space. The October launch provided important data showing how well the computer system operates in the conditions of outer space which will help prepare the computer for its planned journey to the International Space Station in 2015. "Each time we do one of these demonstrations, there are successes, there are some failures, and things break. So we fix it; we make it a little better and do it again," said LaMeres, a professor in the Electrical and Computer Engineering Department.

LaMeres was unable to watch the launch in person. Although the team was able to load the computer into the rocket, bad weather delayed the launch from Monday, Oct. 20, to the following Thursday, by which time the team had returned home. Instead they watched the event on a live feed and on an online video uploaded thirty minutes after the launch.

According to LaMeres, the computer ran for a total of seven hours on launch day and collected data for the entire 12 minute flight. He said that there were holes in the data so the team is working to figure out what happened. So far, approximately 90 percent of the computer hardware was verified to be operational during the flight.

The computer system, designed to reduce radiation damage to computers in space, is based on TMR, Triple Modulo Redundancy, a three processor system which allows for a 'voting' function. As long as two out of the three processors used in a TMR system agree on a result, it can be assumed that that result is the correct one. The MSU team has improved on and expanded the TMR system. Their system is comprised of nine processors, three of which are always online and six that are held in reserve.

When one of the operational processors fails due to radiation, one of the spare processors is brought online and synchronized with the system while the faulted processor is repaired. This process takes place in milliseconds. "In real time systems, you wouldn't even notice it happened," LaMeres explained. By comparison, the traditional solution to processor failure of rebooting the processor or the entire system can take several minutes.

The idea of the computer system began as a senior design project. LaMeres's team wanted to create a radiation tolerant computer system that used commercial grade computer chips rather than expensive, custom built chips. This would create a higher performance system that would also be cheaper than the ones in use. The idea was developed until they received funding through the Montana Space Grant Consortium and later NASA.

Since then MSU has received five grants through NASA to fund LaMeres's research. Following next year's trial at the International Space Station, the computer will be placed on an orbiting satellite for final testing. 406 Aerospace, a local science and engineering company founded by an MSU research professor, has licensed the design and plans to commercialize the technology for use in small satellites.

LaMeres is positive about the impacts his team's research will have for MSU and for Bozeman: "It's kind of a win-win-win; there's a local company which can benefit from this . . . there's a new thread of research for MSU from my group that can look at all this computer technology . . . and then there's more MSU satellites and hardware in space, and that's always good for MSU because it gets students interested about coming here and working in our labs."

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