UK mini-laboratory catches up with double comet

August 5 2014

This week, on 6 August, a mini-laboratory developed and built at the UK's Science and Technology Facilities Council's (STFC) Rutherford Appleton Laboratory is due to rendezvous with a comet.

On board the European Space Agency's Rosetta orbiter is a lander named Philae, which houses a suite of instruments including Ptolemy, an award-winning evolved gas analyzer instrument the size of a shoebox and weighing 4.5 kg.

Designed by teams from STFC RAL Space and the Open University, Ptolemy will collect data to analyze the relationship between water ice on comets and the Earth's oceans. It will also study the nature of organic material on the comet and use this to investigate the relationship with similar materials from other solar system bodies.

Launched in 2004, the Rosetta spacecraft has the mission of reaching comet 67P/Churyumov-Gerasimenko. In January 2014, Rosetta awoke from its period of hibernation and now the €1bn spacecraft will close in on the comet, orbit around it and then send down the lander.

"This is an historic and hugely exciting moment for the Rosetta Mission," said Professor Richard Holdaway, Director of STFC RAL Space. "After 10 years of travel through space from Earth, Rosetta finally arrives at the comet and will land a unique shoe-box sized chemistry set designed and built by RAL Space and The Open University. We are very proud of our involvement and eagerly anticipate

receiving the first results."

Although the technology on the space orbiter is now ten years old, back here on Earth that technology has been developed further and is now being used to not only help diagnose cancers but to also improve the effectiveness of vaccinations.

The Rosetta mission is extremely ambitious and unique. It is the first spacecraft to undertake a long-term exploration of a comet at close quarters, and will be the first to attempt to land on a comet. As the orbiter closes in on the comet it will deploy the lander, which will attach itself to comet's surface so that the instruments can collect and analyze their data.

Dr. John Davies, an astronomer at STFC's UK Astronomy Technology Center in Edinburgh, said, "Once the orbiter arrives at the comet and examines from close proximity how a frozen comet is transformed by the warmth of the Sun, the next step is to place the mission's lander on the comet—that's likely to be in November. The lander is simply pushed away from Rosetta and falls towards the comet, so the tricky bit is dropping it at the correct moment so that it lands on the bit of the comet you most want to reach."

Once on the comet's surface, Ptolemy will be provided with just a few "grains" of solid sample which are then heated in miniature ovens. Once gaseous, the samples are fed into a sophisticated chemical analysis system and from here into an ion trap mass spectrometer. The gas is ionized by an electron-source and then a controlling high-voltage field is used to selectively eject ions of differing mass into a counter, enabling isotope ratios to be measured to very high precision.

The challenges for the project were the miniaturization of the mass spectrometer with its high-voltage control electronics, the many gas

valves and high temperature reactors of the complex chemical analysis system, and the supply of ultra-high purity helium to flush the evolved gases through the instrument.

The instrument control and data processing electronics required the design of several customized circuits. Overall, the severe constrains on the size, mass and power available for Ptolemy required the miniaturization and space-qualification of every component -either with significant evolution and modifications of existing components or the development of completely new technologies.

Professor Holdaway said, "We took a chemistry set the size of an average kitchen and shrank it down to fit into a shoebox. It had to be robust enough to survive the rigors of the launch and 10 years in space—and now, when it begins to take the measurements of the comet material, it's going to do that in incredible detail."

More than a year will pass before the mission draws to a close in December 2015, by which time the spacecraft and the comet will have circled the Sun and be on their way out of the inner solar system.

In the 10 years that Rosetta has been orbiting the solar system; the cutting-edge space technology developed specifically for its mission has evolved and is now directly benefiting people here on Earth. It has been developed by several small UK start-up companies for healthcare and medical applications.

Oxford Micro Medical is using technology originally developed for ESA's Rosetta Mission to develop a breath test for detecting stomach ulcers and a stomach infection linked to cancer.

Insect Research Systems Limited is developing technology for detecting and monitoring bed bugs in hotel rooms. The company is not using

technology directly applied to Rosetta but they are using many of the same philosophies and lessons learnt, such as the same requirements for portability, ruggedness, low power and limited user interaction.

Chilton Technology is developing micro-needles for use in vaccinations, so that a significantly smaller volume of liquid will be needed.

Provided by Science and Technology Facilities Council