# Empa mission in space

May 7 2014

Rosetta ROSINA DFMS (EQM) Credit: Contraves Space

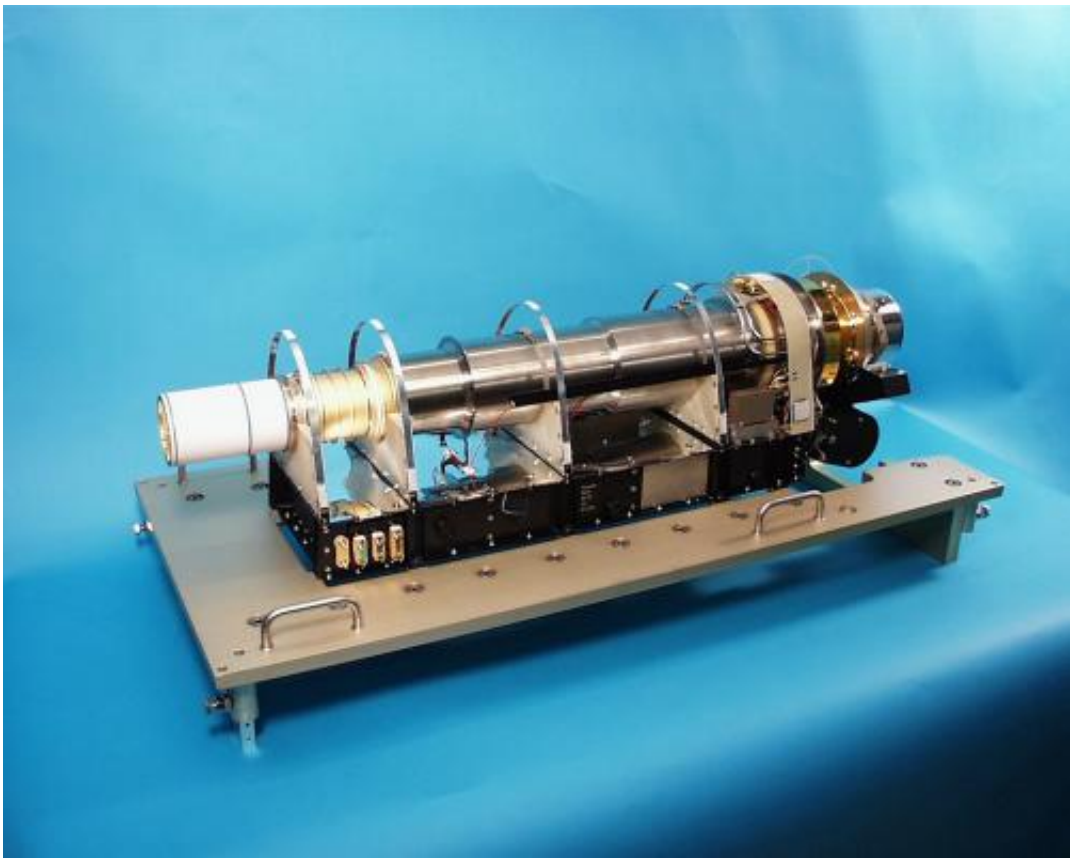
Little research has been done on comets and they still hold many secrets. One theory is that comets brought water (and thus possibly even life) to earth. Although space probes have been able to carry out isolated investigations, this has only been while the comets were flying past. At least until now. The European Space Agency (ESA) developed the Rosetta space probe in conjunction with numerous European institutions.

This will be the first probe not only to collect measurement data "en

passant" as it were, but to accompany the comet – and even to land on it. Various devices on board are measuring, mapping and analysing the comet and the gases and molecules in its environment over a period of two years. Even the interior of 67P/Churyumov-Gerasimenko will not be spared. A specially designed "lander" will - as its name implies - land on the surface of the comet and investigate its properties and its nucleus.

## How was our solar system formed?

Numerous institutions are involved in the project, including the University of Bern, which was responsible for developing ROSINA (the Rosetta Orbiter Spectrometer for Ion and Neutral Analysis). This group of instruments consists of two mass spectrometers and a pressure sensor. The researchers from Bern brought Empa on board to undertake the development and manufacture of the ion optical sensors for the two spectrometers. These not only had to be lightweight, but also had to withstand the harsh conditions of space. After its cosmic rendezvous with the comet, ROSINA will analyse ions and neutral gas particles in the (extremely "thin") atmosphere and in the ionosphere of 67P/Churyumov-Gerasimenko. This will enable conclusions to be drawn about how the solar system was formed. The DFMS (double focusing mass spectrometer) has two different operating modes, a gas mode for measuring neutral gas particles and an ion mode for analysing ionised particles. The RTOF (reflectron time-of-flight) mass spectrometer enhances the DFMS by increasing the sensitivity of the whole instrument. Mass analysis is carried out by means of the time-of-flight technique. This allows the combination of extremely high mass and time resolutions. This enables snapshots to be taken over the entire measurement range from 1 to 1000 amu (atomic mass unit).



Compact and lightweight: Rosetta's time-of-flight mass spectrometer with Empa ion sources (right) and reflector (left) is almost a metre long and weighs about 15 kilograms.

## Successful process development

The ion optical modules for the two mass spectrometers were developed and manufactured by a team led by Empa engineer Hans Rudolf Elsener. A major challenge was to translate the ideas and requirements of the astrophysicists into a multifunctional "space-grade" product capable of satisfying the highest demands: it had to be ultra-lightweight, mechanically robust, high-voltage resistant and very precise. In addition to making design modifications, Elsener also developed various processes to join "unusual" materials, such as metals and ceramics, to

each other. The individual components were not screwed together as would usually be the case, but instead were brazed in a vacuum furnace. During this process, the materials are chemically bonded using brazing materials. This requires a range of different coatings, all of which have to be tested beforehand. The parts to be joined are in a solid state - only the brazing material is fused and reacts with either the coating or the base material.

The methods and technologies developed at Empa were so successful that further space projects soon followed. Elsener and his team are currently developing a new ion optical sensor for an even smaller and lighter mass spectrometer for the Russian/Indian "LUNA" Moon mission, and Empa engineers also recently made highly complex modules and sensors for the European/Japanese "BepiColombo" mission to Mercury.

Part of the DFMS (double focusing mass spectrometer): the individual components were joined together by means of vacuum brazing and electron

beam welding.

## The devices are running – and Rosetta is ready

Although the probe will not reach the comet until August, the first measurements have already been taken. During the flight to the comet, the mass spectrometer analysed Rosetta's exhaust gases and the components of the calibration gases. The equipment tests carried out recently were also successful and nothing now stands in the way of the encounter with 67P/Churyumov-Gerasimenko. However, the approach manoeuvre in May is likely to be critical. If the probe misses the comet's orbit, it will drift too far away to "attach" itself to it and accompany it. Once Rosetta is in the comet's orbit, however, the "real" measurements can begin - and will start to reveal more about comets.

Provided by Swiss Federal Laboratories for Materials Science and Technology

Citation: Empa mission in space (2014, May 7) retrieved 12 September 2024 from https://phys.org/news/2014-05-empa-mission-space.html