

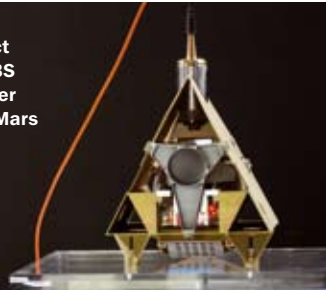
TNO's Berit Ahlers with the Raman / LIBS spectrometer.

Photo: Fred Kamphuis



The compact Raman / LIBS spectrometer for the ExoMars mission

Photo: Leo Ploeg / TNO



MINISTERIAL CONFERENCE

2008 is the year of space exploration. In November the Netherlands hosted the conference of ministers of the seventeen ESA member states, which include Norway and Switzerland even though they are non-EU countries, and not all EU member states are ESA members.

The conference decided that the ExoMars mission would definitely go ahead and be launched at the beginning of 2016. ESA will be determining shortly which instruments will definitely be making the journey. TNO has a good chance of building the so-called Raman spectrometer unit that will enable organic substances in the Martian soil to be analysed.



Photo: ESA

Artistic impression of the ExoMars robot rover

The search for life on Mars

MINISCALE, FEATHERLIGHT AND ROBUST

Has there been or is there life on the planet Mars? The answer mankind has been eagerly awaiting for centuries is likely to come after 2015, in part due to a precision instrument that has involved TNO since 2006. The European Space Agency (ESA) initiated the development of the 'Raman / LIBS Elegant Bread Board' for the ExoMars mission it is currently preparing.

'Given our expertise as makers of instruments that are miniscule in size and are able to perform in extreme conditions, ESA opted for TNO to develop a spectrometer with unique properties. This optical measuring instrument combines two techniques for accurately analysing Martian soil samples,' explain project manager Erik Boslooper and researcher Berit Ahlers of TNO.

ExoMars is ESA's second European mission to the planet. From data delivered by the Mars Express since 2003, researchers have discovered traces of water vapour and ice. It was initially Russian and American space probes that began to explore the geology and climate of Mars in the 1960s. Interest in Mars is mainly due to the fact that among all the other planets in our solar system it is the one that most resembles Earth. Mars spins around its own axis just forty minutes longer than the 24 hours the Earth takes, and there are seasons, though they last twice as long as they do on Earth, and the surface contains volcanoes, valleys, sand dunes and polar caps.

The moon is almost 400,000 kilometres from Earth; the distance to Mars varies between 75 and 375 million kilometres. Just once every two years conditions occur for a spacecraft to be launched to Mars using the minimum amount of energy. And as technology currently stands, the trip takes around a year.

'So all the deadlines for developing hardware and software are hard and fast. The launch was already delayed until 2013 some years ago but since 2006, when we got the order, the planning has been very tight indeed.'

Double scientific challenge

The Raman / LIBS Elegant Bread Board optical instrument is a prototype that will ultimately join other instruments on board a robot rover due to explore the Martian soil in 2015 and developed by scientific institutions, including TNO, and European specialist companies.

The TNO team regards the scientific challenge as not only ensuring that the instrument can comply with the extreme requirements in respect of volume, mass and power but also in the two entirely different technologies contained within it. 'Raman and LIBS are two entirely different technologies, and to merge them into a single instrument is unprecedented. It is certainly a compliment that ESA entrusts us with the task,' say Boslooper and Ahlers.

A spectrometer is an optical instrument that is able to capture and analyse light in a special way. The Raman spectrometer performs a molecular analysis of organic compounds and minerals, providing valuable information about the presence of water or ice. The powerful LIBS laser creates a plasma and makes a kind of fingerprint of the compound elements. Dust and weather influences are removed.

'Raman and LIBS complement each other nicely,' Ahlers adds. 'The little six-wheeled vehicle rides around the Martian surface collecting samples from the soil and these are analysed using the spectrometer. This will allow us to determine, together with the results from other instruments, whether or not there is, or has been, life on Mars.'

International network

For the development of the spectrometer the TNO experts received support from an international team of scientists from a variety of fields. Geology and chemistry professors at Amsterdam's Vrije University and different foreign universities worked on specifications on whose basis the instrument was developed. Furthermore, specialist companies in various European countries were selected to supply components.

Boslooper: 'TNO gave the suppliers the specifications. Our job was to assemble, integrate and test all the components in our cleanrooms, polish, glue and incorporate the most refined materials with the least possible permissible tolerance. That is our specialism. Rivalry? We operate internationally in a very small world in which everybody knows everybody and in which knowledge exchange both mutually and with industry is central.'

TNO researchers believe that the spectrometer will ultimately find other applications than just research on Mars: 'The instrument has to be able to function in space, regardless of the temperature differences and is highly shockproof. On Earth the spectrometer could therefore be used where extreme conditions prevail, such as on-site analysis of soil samples and rocks for the oil and gas industry. The strength of TNO lies in collaborative development – what we are developing here for space is a collaborative effort among colleagues from defence, ICT, building and construction or health – and the knowledge that is derived we exchange with scientists elsewhere in the world and with industry. It's also the rewarding part of the job: you are busy developing a small instrument now that in five years or so will land on Mars and perhaps show life there.'

The Elegant Bread Board was delivered to the customer in the summer of 2008 and now attention is turning to the flight model. Boslooper: 'The requirements and specifications will become even more stringent. The weight of the spectrometer will have to be reduced even further, though we won't know by exactly how much until some time next year. In the meantime, we can't wait. We have to push on reducing volume and weight. A technological challenge of the first degree.'

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