Proposal for new missions – **Denmark is in the forefront**

Through the development of the Ørsted satellite, and the use of data from him, Denmark has appropriated valuable experience in using satellites in different ways. That has led to several proposals for new missions. Common traits are that they are cheap, simple and can give valuable information for several purposes. ESA have selected three possible missions in the Earth Explorer Opportunity Missions programme among 27 proposals and out of these, two derive from Denmark. In addition, Danish researchers have proposed a simple, but very effective asteriode detector, the Bering mission.

Earth explorer missions

SVARM.
Figure: DSRI.

The two Danish proposals for missions, ACE+ and SWARM are similar in more ways than one. For both, the plan is to send a constellation of relatively small satellites in earth orbits and both missions are based on technology from the Ørsted satellite.

AEC+

The AEC+ (Atmosphere and Climate-Explorer) mission headed by the Danish Meteorological Institute (DMI) will consist of four identical satellites at around 135 kilograms. They are supposed to study the earth's atmosphere and detect how the climate develops on our planet. DMI has developed an advanced technique using GPS and radio equipment onboard to carry out pressure, humidity, and temperature in the atmosphere's different layers.

The principal goal of ACE+ is to measure variations and changes in global atmospheric temperature and water vapour distribution, in order to provide valuable data to monitor climate changes. ACE+ will also be used to improve weather forecasting. The mission will use four satellites in orbits between 650 and 850 km altitude. Each will carry an L band receiver for GPS/Galileo sounding, and a multi-frequency X-K band transmitter or receiver to cross-link satellite-to-satellite measurements.

The area coverage of the mission must be such that the profiles are globally and homogeneously distributed. The proposed constellation of four satellites will produce around 7000 humidity and temperature soundings per month, which will be appropriate for climate monitoring usage. Approximately 5000 refractivity soundings per day from GPS/Galileo radio occultation will also be produced and will be assimilated into weather forecasting systems.

SWARM

The SWARM mission, headed by the DSRI, is also going to use four satellites in orbit in order to investigate both how the earth's magnet fields vary in time and space, and how the field influences the environment around our planet. From the variations in the magnet field the scientists will be able to gain new knowledge about the earth's liquid core, the core that builds up the magnet fields.

The SWARM concept consists of a constellation of four satellites in two different polar orbits between 400 and 550 km altitude. Each satellite will provide high-precision and high-resolution measurements of the magnetic field. Together they will provide the necessary observations for the global high-precision survey of the geomagnetic field that is needed to model its various sources.

Magnetic fields play an important role in physical processes throughout the universe. The magnetic field exerts a very direct control of the electro-dynamic environment, on thermo-spherical dynamics, and possibly even on the evolution of the lower atmosphere.

SWARM will provide important new knowledge of the expanding and deepening South Atlantic Anomaly, with its serious implications for low-earth orbit satellite operations. Geographically, the recent decay of the earth's magnetic dipole is largely due to changes in the field in that region. The geomagnetic field models discovered on this mission will have practical applications in many different areas, such as space weather and radiation hazards, as well as furthering our understanding of atmospheric processes related to climate and weather.

Bering – an asteroid keeper

Asteroids, and especially the Near-Earth Asteroids, are bot exciting and dangerously frightening. Exciting, because they provide the scientists with valuable information about the dynamic for small objects in our own solar system, and when they fall down to earth as meteorites, they can be investigated in earth based laboratories. However, they are also dangerous because of the impact the asteroids at earth can cause our civilisation.

To detect, characterise and photograph small unknown asteroids in the asteroid belt the scientific community in Denmark has carried out a proposal for a small, but effective Deep Space Mission to fully automatically carry out the task. Bering, the Danish proposal for an asteroid searcher is named after the Danish explorer Vitus Bering, who in 1728 established the fact that America and Asia were two separate continents. Bering is relatively small, octagonal and with all sides and the bottom covered by solar cells, while the top is covered by a very effective insulation layer to hold the infrared cameras onboard sufficiently cold.

Bering is proposed with six star cameras, whose purpose is to locate asteroids while the satellite slowly rotates in space. Onboard computers detect at all times proper orientation, and compare pictures that have been taken with star catalogues onboard. Bodies that are moving among the stars are nearly always case asteroids, and will quickly be detected by the computer. This will be carried out wholly automatic, and is the key for an effective mission, and all the time the actual asteroid will be out of sight long time before a confirmation to follow it will come from earth. In addition, the satellite has both a miniature multi spectral imager that can give high-resolution colour pictures of the asteroid when it passes the satellite, and a powerful laser that measures the time and distance between Bering and the object. The satellite is also equipped with a magnetometer that provides a magnetic profile of some of the objects that pass.

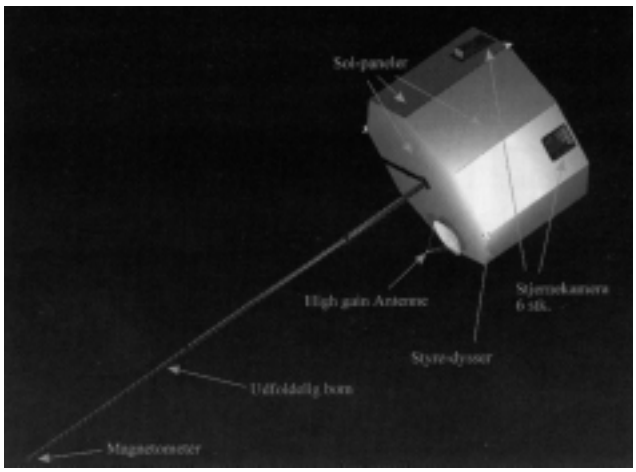
Another large advantage for the satellite is the possibilities to always direct the antenna toward earth. That prevents the antenna to be pointed in the wrong direction, and it ensures at the same time the most effectively energy transfer of data between the satellite and earth.

Danish student satellites.

In many countries, the construction of very small student satellites is used to make the study more interesting and it gives the students experience in how a scientific mission can be carried out. In addition, the data such satellites collect are also valuable and can be used to other student projects. At this point, Denmark is not an exception and in 2003 possibly two Danish micro satellites can be launched. The two satellites, built at Denmark Technical University (DTU) and Ålborg University, are both are built up in the CUBESAT structure and is a cube with the outward dimension of 100 millimetre in all directions, weighing not more than one kilogram.

Both satellites can take pictures of the same point from its 600 kilometres' high orbits the earth 6-7 times a day. The dissolution is not the best, with a pixel size of around a football ground, but high resolution of the camera is not essential, the primary goal is to develop and build a satellite that can operate in space.

In addition to the camera, the satellite from DTU will carry out an experiment with one kilometre long aluminium wire that will be rolled out when the satellite is in orbit. The wire will catch free electrons in space and the satellite will, aided by the electrons, provide electric current in the wire. The current will provide a magnetic field around the wire; a magnetic field that together with the earth's magnetic field possibly can move the satellite to lower or higher orbits. This technique can, in the future, if the results of the tests are positive, be used to bring a satellite to self-destruction in the atmosphere without the use of rocket engines.



Bering.
Figure: Niels Bohr Institute.

Prototypes of the two satellites will be ready within the first six months of this year. ■