AIRBUS DEFENCE AND SPACE USES CST STUDIO SUITE TO ANALYZE ANTENNA SYSTEMS ON BEPICOLOMBO

THE IDEA: RELIABLE DEEP-SPACE COMMUNICATIONS FOR FUTURE MERCURY SPACECRAFT

BepiColombo is a joint mission of the European Space Agency (ESA) and the Japanese Aerospace Exploration Agency (JAXA). The aim of the mission is to send two orbiters to Mercury in order to study its atmosphere, composition and magnetic field to help understand how the planet was formed, as well as to verify some key predictions of general relativity.

Airbus Defence and Space (Airbus DS) is the prime contractor for the ESA elements of the mission, including the Mercury Planetary Orbiter (MPO). The MPO includes multiple antenna systems – some of which are moveable – for telemetry, tracking and control (TTC) and scientific purposes, mounted on a single satellite bus, along with solar panels and instruments which can obstruct the antennas themselves (Figure 1). In order to ensure that the MPO functions as expected when it reaches Mercury's orbit, Airbus DS has to investigate any possible issues that could affect antenna performance across all of the spacecraft's different configurations.

THE CHALLENGE: ASSESSING INSTALLED PERFORMANCE AND EMC ON A LARGE, COMPLEX STRUCTURE

The TTC antennas on the MPO will operate in the deep-space X-Band, with a downlink frequency of around 8.43 GHz. At this frequency, the wavelength of the radiation is just 36 mm, while the spacecraft itself measures 2.4 m x 2.2 m x 1.7 m – not including the solar panels. In the Ka-Band, used for science data transmission at around 32 GHz, wavelengths are even shorter, being below 10 mm. Such electrically large simulations can be very demanding in terms of computing resources. While efficient ray tracing techniques are available, these didn't offer the accuracy required for the application, since the surface currents on the spacecraft were of interest. Instead, Airbus DS looked for a high-performance full-wave 3D solver, and turned to CST STUDIO SUITE®.

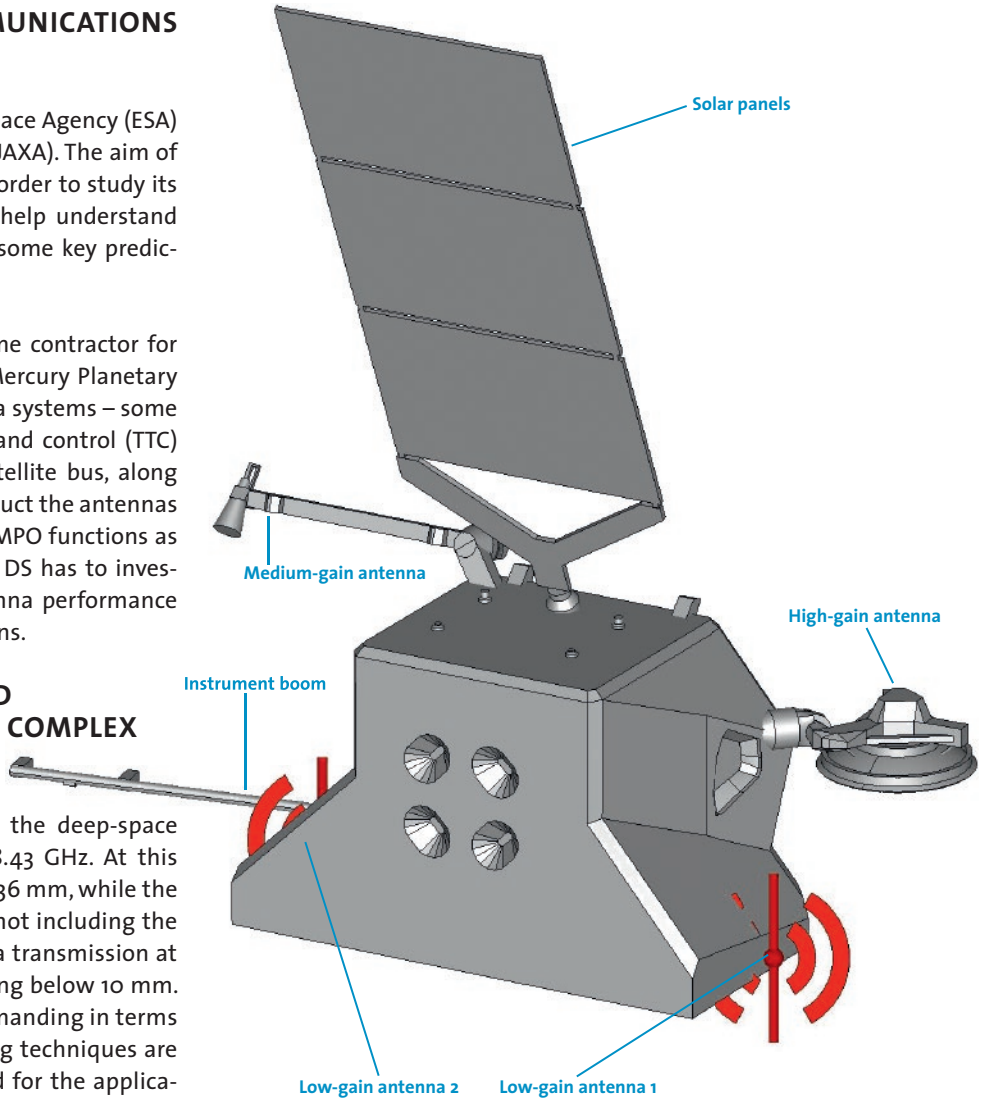

Figure 1 Antennas and major scatterers on the Mercury Planetary Orbiter. The low-gain antennas are represented as field sources (red symbols).

Using the integral equation solver, based on the multi-level fast multipole method (MLFMM), they were able to simulate fields around the entire spacecraft and calculate both the farfield radiation patterns and the fields on the surface of the spacecraft. Using the farfield patterns, they verified the antenna performance taking into account blocking by structural parts (Figure 2), while using the nearfield results they investigated worst case EMC scenarios and calculated the maximum field values around susceptible components.

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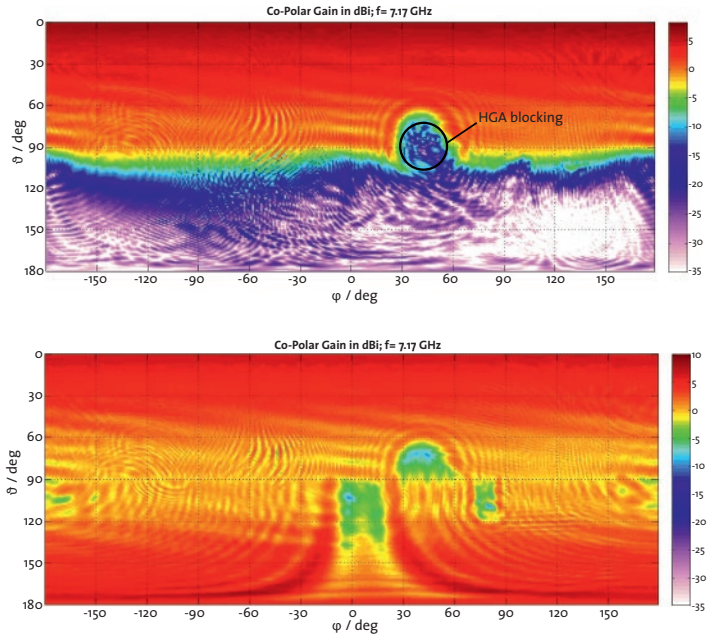

Figure 2 Radiation pattern for (top) low-gain antenna 1 and (bottom) both low-gain antennas combined, with the high-gain antenna (HGA) partially shadowing the antenna.

THE RESULT: AN EFFICIENT AND ROBUST SPACECRAFT ANTENNA SYSTEM

By using simulation in their development process, Airbus DS were able to identify potential EMC, coexistence and antenna accommodation issues for further analysis and test. The simulation results were used to prove the robustness of the chosen spacecraft design and antenna placement with respect to the customer requirements. With such a thorough simulation of the behavior of the antenna systems, Airbus DS and their customer ESA can have confidence in the performance of the spacecraft.

Figure 3 The fully assembled BepiColombo spacecraft. The MPO is the central element with the gold colored radiator. (Copyright Airbus DS GmbH 2012)

"With the help of CST STUDIO SUITE and the implemented high-performance solver techniques, we were able to verify the RF communications requirements and to establish reasonable EMC requirements for the various units and instruments on the spacecraft."

Dr.-Ing. Christian Imhof
Satellite Products, Airbus Defence and Space

About Airbus Defence and Space

Airbus Defence and Space is one of the three divisions of the Airbus Group and Europe's Number 1 defence and space company. It is the world's second largest space company and one of the top 10 defence companies globally, with revenues of around €13 billion per year and approx. 38.600 employees. The Chief Executive Officer of Airbus Defence and Space is Bernhard Gerwert. Airbus Defence and Space puts a strong focus on core businesses: Space, Military Aircraft, Missiles and related systems and services.

Airbus Defence and Space develops and engineers cutting-edge and peerlessly reliable products in the field of defence and space. Its defence and space technologies enable governments and institutions to protect natural resources, societies and individual freedom. The aircraft, satellites and services help to monitor climate and crops, and to secure borders. Airbus Defence and Space solutions guarantee sovereignty in foreign affairs and defence matters and its portfolio also ensures communication, mobility, the expansion of knowledge and the safeguarding of the environment.

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