Design and Performance of a Conduction-Cooled HTS Magnet in the Radio-Blackout Experiment COMBIT

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In the framework of the Helmholtz-Russia Joint Research Group (HRJRG) „COMBIT“ we developed a conduction-cooled HTS magnet to provide a high magnetic field for a radio blackout mitigation experiment in the arc-heated wind tunnel L2K at the German Aerospace Center in Cologne. The radio blackout phenomenon is well-known since the early days of space exploration. During hyper-sonic flights or during reentry in a planet's atmosphere a dense plasma layer can form at the surface of the space vehicle leading to mitigation or reflection of radio waves. As a consequence voice communication with ground stations and GPS data telemetry can be disturbed. The goal of “COMBIT” was to demonstrate that the radio blackout can be mitigated by a local reduction of the plasma density in the vicinity of senders and antennas by magneto-hydrodynamic effects using crossed electric and magnetic fields. In order to generate a high magnetic field in the plasma we developed a conduction-cooled HTS magnet and a cryogenic system that is able to withstand the high temperatures in the plasma. The HTS magnet was made with RE-Ba-Cu-O coated conductors and has an outer diameter of only 70 mm. Despite the small size which is a consequence of the experimental boundary conditions the magnet was able to generate a high and variable magnetic field outside the cryostat in the plasma. In several measurement campaigns, the magnetic field reached up to 2 T in the plasma, corresponding to a maximum magnetic field of 5.16 T at the conductor. Mitigation of the radio blackout could be demonstrated successfully.

After an introduction to the radio blackout phenomenon we present the design of the conduction-cooled HTS magnet and the cryogenic system and discuss their performance during the experimental campaigns.