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THE DESIGN AND DEVELOPMENT OF LOW FREQUENCY COMMUNICATION SYSTEM FOR LUNAR SURFACE OPERATIONS

Abstract

Widely used since 1930s for radio broadcasting in Europe, Asia and Northern Africa, the low radio frequencies (LF, longwaves; 30-300 kHz) possess signiffcant advantages in propagation on wide ranges and through different environments. High signal stability, country-wide range achievable with ground wave and almost-global range on ionospheric wave, lower signal's attenuation in comparison with shorter waves, as well as multiple available modes of modulation and transmission, present the longwaves as a reliable medium of communication not only for terrestrial purposes. A single LF transmitter and antenna set, installed on or below the surface (i.e. in a cave) of a small celestial body with the transmitter forward power of less than few kilowatts shall be able to cover the entire body with high quality signal, providing instant communication with surface instrumentation and crew, regardless of their position against the transmitting antenna (no antenna visibility needed). Highly sensitive receivers, based on multiple-ferrite or magnetometric technology, shall provide high signal readability and proper signal-to-noise ratio. The idea has been conceptualized and has been being developed in the GLACiER project in Warsaw University of Technology, Poland, as a part of the IGLUNA demonstrator project - aimed at supporting and accelerating the ESA Lab initiative; the Swiss Space Centre serves as coordinator for the events and main systems engineering activities. In IGLUNA, a lunar habitat and lunar surface operations had been organized on the Klein Matterhorn glacier in Switzerland in June 2019. The longwave part aimed to connect wirelessly the habitat, located up to 15 m inside the glacier, below the surface, with the surface instrumentation. The communication was established using two single-loop quarter-wavelenght antennas on the frequency of 270 kHz, sending impulse commands and AM-A3E messages (voice, directly to the astronauts). The entire system was implemented using low power due to EMC regulations in the glacier region - this however permitted for the longwave to penetrate the ice ceiling and provide data transmissions to and from the surface, also on large distances. The experiment, carried out in June 2019, have demonstrates the longwave technology for the use in future lunar missions, introducing the well-known low frequencies as a new, robust and reliable way of uncomplicated, safe and rapid communication in extraterrestrial environments.