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How much power is radiated by the BRAMS transmitter? And with what pattern?

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The Belgian RAdio Meteor Stations (BRAMS) network is a radio forward scatter system installed in Belgium with the goal to detect and characterize meteoroids. The BRAMS network is made of a dedicated transmitter located in the South of Belgium, and a network of around 35 receiving stations spread all over Belgium and neighbouring countries. The transmitter emits a pure sine wave at a frequency of 49.97 MHz with no modulation. The antenna is made of 2 crossed-dipoles and a ground plane made of an 8m × 8m metallic grid with the aim of emitting a circularly polarized wave in an isotropic way around the zenith. Due to inadequate adaptation of the two antennas, the radiation pattern is unfortunately very different from the theoretical one and in-situ measurements were necessary to determine the exact amount of power transmitted in a specific direction.

In 2019, a payload was designed to measure in-situ the radiation pattern of the transmitter. It comprises a pair of receivers located on a platform and connected to two short dipole antennas in order to measure both polarized components. The platform was hung below a captive weather balloon filled with Helium. Due to the proximity of the platform, the transmitter was only operating at a very small fraction of its nominal power. The platform was moved at a number of discrete positions in a horizontal plane to sample the far-field of the transmitting antenna. The platform also hosts an embedded Linux system, a camera, a three-axis accelerometer, a three-axis magnetometer, a battery and a GNSS receiver. Another GNSS receiver remains on the ground connected to a second embedded Linux system. This provides the necessary position and attitude information with sufficient accuracy.

In December 2019, the pattern was sampled in a single horizontal plane, 10 meters above the transmitter, and 57 usable samples were obtained. For each point, the power measured by each of the two receivers was recorded (the relative phase could not be retrieved as the receivers were not phase-locked to a common reference). During the run, accurate RTK-GPS positions could not be obtained because of poor signal-noise ratio of the GNSS signals. Instead the positions had to be determined from the images taken by the on-board camera. The data from the accelerometers, magnetometers and images were used to calculate the orientation of the receivers.

After compensating for the non-isotropic gain of the receiving antennas and normalizing the receiver gain, the power that would have been measured on standard orthogonal H and V dipoles can be computed. H and V are tangent to a sphere centered on the transmitter. H is horizontal, V is vertical (when at 0° of elevation). This is the radiation power pattern of the transmitter for elevations greater than 52° that is of interest to BRAMS.

In order to provide a base for comparison, the optimal radiation pattern of the transmitter (assuming ideal match and 90° phase difference at the feed points) was produced using the method of moments. The discrepancies between the two patterns are significant. Most notably, there is a 10° squint towards the West and the measured pattern severely departs from the intended circular polarization. The polarization issue is mostly explained by the poor performance of the power splitter and delay line used. Cross-coupling between the two dipoles and their respective tilts relative to the ground plane may contribute to the observed squint.

Improvements to the instruments and the measurement procedure are planned in 2021. They should reduce the dwell time at each position and thus allow taking many more measurements even in light winds (gusts severely affected the previous run, making the balloon platform unstable). Meanwhile, the BRAMS transmitter has been upgraded in June 2020.