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Initial Results from the Analysis of Sky Measurements by the MIST Global 21-cm Experiment

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The Mapper of the IGM Spin Temperature (MIST) is a new ground-based experiment trying to detect the sky-averaged, or global, redshifted 21-cm signal. This signal was produced by neutral hydrogen gas in the intergalactic medium (IGM) before and during the Cosmic Dawn, i.e., the period of formation of the first stars in the Universe. To detect this signal, MIST currently measures the radio spectrum in the range $25-105$ MHz, which approximately corresponds to redshifts $55 > z > 13$. MIST measures the spectrum using a single horizontal blade dipole antenna placed at a height of 0.5 m above the soil and does not use a metal ground plane to avoid potential systematic effects from the ground plane itself or due to its interaction with the antenna. In 2022, MIST conducted its first science-level sky observations at three remote locations: Deep Springs Valley in California, Death Valley in Nevada, and the McGill Arctic Research Station in the Canadian High Arctic.

In my talk I will present and discuss the latest results obtained from the analysis of the MIST sky observations. After applying a receiver calibration, an important part of this analysis corresponds to the determination of the ground loss and its removal from the observations. We do this by fitting a model for the soil conductivity and permittivity to measurements of the antenna impedance, which we conduct in parallel to measurements of the sky spectrum. After removing this effect, along with other losses in the measurement such as balun loss, and the loss due to sky blockage by mountains at the horizon, we produce the final sky radio spectra that we use for high-level analyses. In this process we average data while in parallel removing data affected by evident problems, such as strong ionospheric events, as well as those contaminated with radio frequency interference. This process results in a set of spectra corresponding to integrations within different ranges of local sidereal time (LST). We then implement several techniques to analyze these spectra. We use analytical models to verify the general quality of the data and to determine the basic parameters of the Galactic and extragalactic foregrounds across LST from our three observation latitudes. We also use simulated observations that include realistic models of our antenna beam, and compare them to the real spectra. These two approaches, in addition to new analysis ideas that we are beginning to test, enable us to identify the spectral structure that cannot be immediately interpreted as a contribution from the foregrounds, instrument, or environment. In my talk I will discuss this residual spectral structure and our current interpretations, including the possibility of unexpected instrumental effects and also a potential astrophysical origin.