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New Precision Measurements from GPS.DM Observatory for Exotic Physics Searches: Atomic Clock Phases every Second to <0.1 ns[1]
GEOFFREY BLEWITT, BENJAMIN ROBERTS, CONNER DAILEY, ANDREI DEREVIANKO, University of Nevada, Reno, GPS.DM COLLABORATION — We use the GPS satellite constellation as a 50,000 km-aperture sensor array, analyzing atomic clock phases for exotic physics signatures. In particular, we search for evidence of transient variations of fundamental constants that are either correlated with Earth's galactic motion through the dark matter halo, or with astrophysical events that generate multi-messenger signals. Recently we improved limits by orders of magnitude on certain couplings between atomic clocks and dark matter [1], using 30-s clock data archived by Jet Propulsion Laboratory (JPL). Now we generate our own 1-s clock data by analyzing carrier phase data every second from a global GPS station network. First, satellite positions published by JPL every 900 s are interpolated to 1-s epochs, then 1-s station data are modeled to account for (in order of decreasing magnitude) relativistic effects on clocks, ionospheric delay, neutral atmospheric delay, solid Earth tides, circularly polarized phase rotation, ocean tidal loading, spacetime curvature (Shapiro delay), and carrier phase ambiguity resolution. Relative phases between the most stable atomic clocks prove our precision is <0.1 ns, thus we are sensitive to the effects of exotic physics at this level across a 50,000-km aperture.

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