The Zpectrometer: an ultrawideband spectrometer for astronomical observations with the Green Bank Telescope

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We present design and performance properties of the Zpectrometer, a spectrometer for searches and observations of molecular lines from high-redshift galaxies with the NRAO 100 meter diameter Green Bank Telescope. The Zpectrometer covers 25.6–37.7 GHz, a 38% fractional bandwidth. This range of frequencies corresponds to $z = 2.06$–3.50 for CO $J = 1 - 0$, 5.12–8.00 for CO $J = 2 - 1$, 1.35–2.46 for HCN $J = 1 - 0$, and 3.70–5.92 for HCN $J = 2 - 1$.

The standard frequency resolution is 24 MHz, with frequency resolution constant across all bands. This corresponds to a linewidth of about 150 km s^{-1} at mid band. It is possible to push the frequency resolution to 18 MHz at the cost of modest increases in calibration and processing time. It is also possible to adjust channel center frequencies and the resolution element shape in steps of about 1/3 of the resolution width in post-processing, a step that can optimize the signal to noise ratio in line detections.

The spectrometer architecture is a correlation receiver with four independent subbands, each a WASP2 analog lag cross-correlator (Harris Rev. Sci. Inst. 76:054503-1, 2005; Harris & Zmuidzinas, Rev. Sci. Inst. 72:1531, 2001), following the GBT's Ka-band receiver.

A correlation receiver architecture can greatly improve receiver stability. High stability is needed for deep integrations with wide channels. We will discuss our experience with the instrument; a combination of the correlation receiver and subreflector switching allows deep integrations with nearly featureless spectral baselines. Some of our technical results have been summarized in the GBT Memo Series, (http://wiki.gb.nrao.edu/bin/view/Knowledge/GBTMemos; #254, #259, #249, #248). With excellent baseline stability, observations of planets and strong continuum sources give source spectral indicies across the entire band, producing both scientific results and diagnostics for antenna performance.

Detection of sub-mJy lines is straightforward with this instrument. We will show some of the Zpectrometer's spectra of high redshift galaxies to demonstrate its performance. The Zpectrometer is open for community use through the Green Bank proposal process.