Baseline Receiver Concept for a Next Generation Very Large Array
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The ngVLA will provide near-continuous frequency coverage from 1.2 – 116 GHz in multiple bands, with a gap at the atmospheric absorption band between ~50 – 70 GHz. Maximizing sensitivity for each band, while also minimizing the overall operating cost are the primary design goals. Therefore, receivers and feeds will be cryogenically cooled, with multiple bands integrated into a common cryostat to the greatest extent possible. Using feed designs that yield broad bandwidths and high aperture efficiencies are key to meeting these goals.

The proposed receiver configuration will be implemented as six independent bands, each with its own feed. The upper five bands will be integrated into a single compact cryostat, while the lowest-frequency band occupies a second cryostat of similar volume and mass. The lowest-band feed is cooled to 80K, while all other feeds are cooled to 20K.

For optimum performance at the higher frequencies, waveguide-bandwidth (~1.66:1) receivers are proposed to cover 12.6 – 50.5 GHz and 70 – 116 GHz in four separate bands, integrated into a single cryostat. Excellent LNA noise performance is readily achievable, and using waveguide throughout the signal chain reduces losses and their associated noise contributions, without adding undue size or weight. An axially-corrugated conical feed horn with wide flare angle (~50^0 half-angle), based on a design by G. Cortes and L. Baker, is being considered for these receivers.

For continuous coverage between 1.2 – 12.6 GHz, waveguide or even octave-bandwidth receivers are not cost-effective, given the > 10:1 frequency range. For these bands, wideband (3.25:1) receivers mated to a Caltech-designed quad-ridge feed horn (QRFH) are proposed. These feeds are highly compact and can be cryogenically cooled to reduce losses ahead of the LNAs. Aperture efficiency and LNA noise temperature may be somewhat less than optimum: however, there would be significant cost savings by effectively halving the number of receivers and cryostats required per antenna.