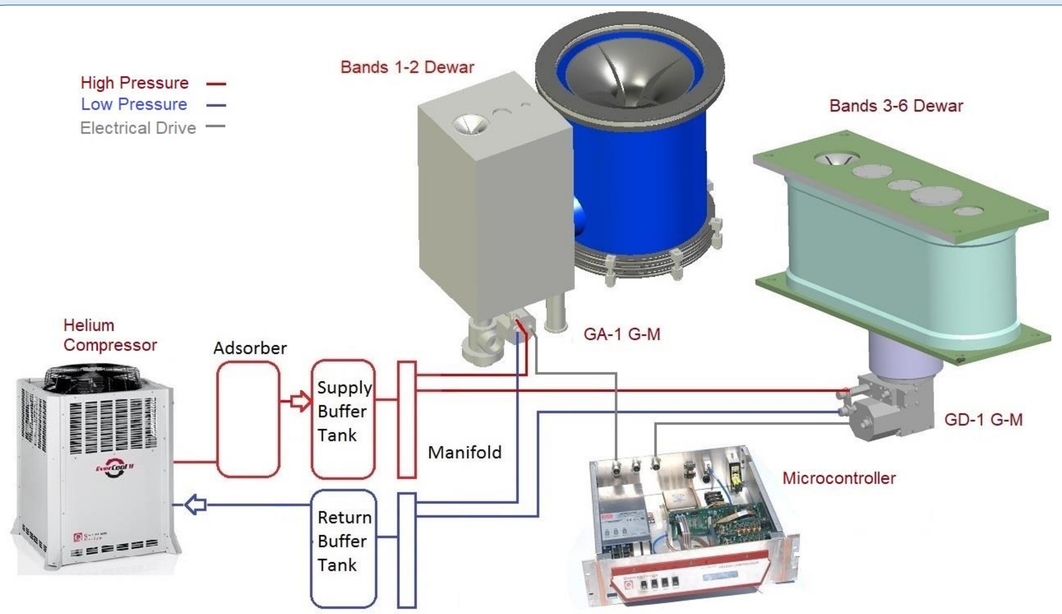
Smart Energy Cryo-Refrigerator Technology for the Next Generation Very Large Array

Jeff Gardiner, Jess Lawton, John Hamilton, Kyle Knight, Jeff Sloan, Stefano Spagna Quantum Design Inc., San Diego, CA 92121

Acknowledgments

Research supported in part by the ngVLA community study program through NSF grant AST-1519126.

We thank D. Urbain, K. Bukas, and D. Mertly of the VLA in New Mexico for evaluating the HAC 4500 and M. J. Britcliffe and E. Long at Jet Propulsion Laboratory for sharing their GA-1 load map data.

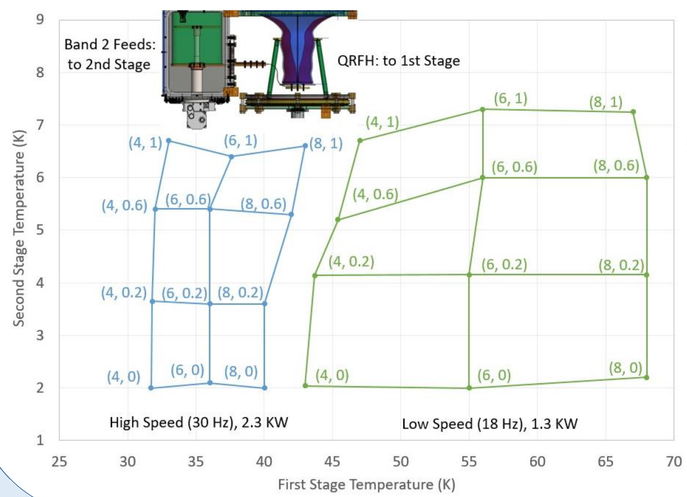


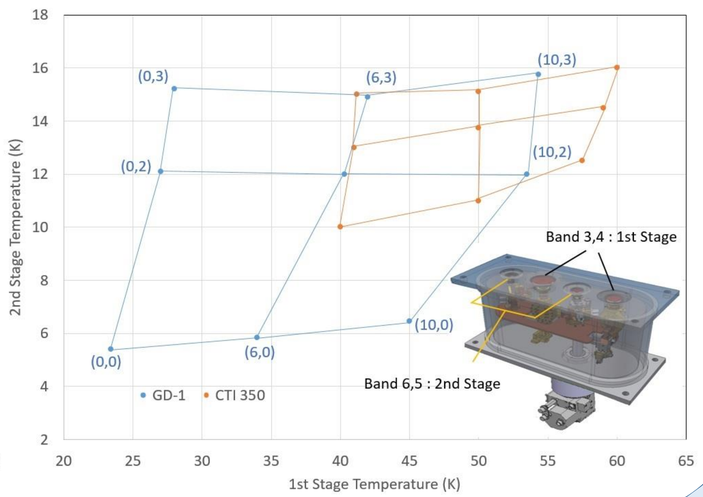
Cryogenic Concept

One of the most energy efficient configurations for the baseline design of the ngVLA from a power standpoint involves a single helium compressor and one 4 K and one 10 K class G-M cryo-refrigerators running at variable speed. The main components are: (1) a variable speed split-air helium compressor, (2) external adsorber, buffer tanks, high pressure lines and manifolds, (3) an intelligent microcontroller unit to independently control the speed of the compressor capsule and the speed of (4) two G-M cryo-refrigerators coupled to the two multi-band receivers.

Variable speed G-Ms

In this concept, a 4 K class GA-1 cryo-refrigerator cools the cylindrical band 1 Quad Ridge Feed Horn and the band 2 feeds. Data (left) shows high temperature load maps for the GA-1 at two speed indicating adequate cooling for the system. The second dewar is envisioned to house four high-frequency receivers bands. We propose these receivers to be cooled by a single 10 K class GD-1 cryo-refrigerator. Figure (right) below shows a favorable comparison of the cooling power of the GD-1 at high speed when compared to the CTI 350.





Power Draw Study

The HAC 4500 compressor was run with a static pressure of 1.5 Mpa at various speed while cooling down and at base temperature. This data shows substantial operational cost reduction for the antenna over systems that use constant power frequency compressor.