Improved power efficiency for cryogenics at the VLA

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The National Radio Astronomy Observatory (NRAO) recently completed a major upgrade to the electronics in the Karl Jansky Very Large Array (VLA) telescope, including all eight cryogenic Front End receivers. With the new systems now fully deployed and operational, the focus of development has shifted toward improving efficiency and reliability, in order to reduce operations and maintenance costs. In support of this objective, one of the VLA antennas has been selected as a test bed for experimenting with new instrumentation technologies and techniques to improve reliability, cut downtime and reduce power consumption. A particular area of focus is on the receiver cryogenic system, as it has largely gone unchanged for decades. The cryogenic system requires frequent maintenance on the array and in the lab by a crew of well-trained and skilled workers, and consumes a considerable fraction of the electrical power supplied to the array. Careful evaluation of the current system and preliminary tests of new techniques have demonstrated a significant power savings is possible, along with an overall reduction in maintenance.

These can be achieved via the introduction of variable-speed drives for the individual cryocoolers, in conjunction with upgrades to the receivers that reduce the required steady-state cooling power. Combined, the overall load on the Helium supply compressors will be reduced to a level which may allow one of the three compressors to be taken offline after the receivers have all cooled, reducing net power consumption by a third. A key to achieving this goal would be to combine the output of the three compressors on each antenna into a common supply tank, with a manifold feeding all eight cryocoolers. An enhanced intelligent monitor and control system for the cryocooler drives and compressors will be required.

The reduction in the number of compressors running continuously will not only reduce power consumption, but also the amount of maintenance required. Having a third compressor in standby mode allows built-in redundancy, and an automatic response to failures that could nearly eliminate unscheduled downtime. Similarly, the lower steady-state operating speed of the cryocoolers should proportionally extend the required maintenance interval, thereby lowering the overall maintenance cost.

This presentation will discuss the achieved cryogenic performance of the upgraded receivers when operated with a variable-frequency drive. It will also give the latest results on the effort to combine the outputs of up to three Helium compressors, and on the design of the new monitor and control system.