

Discoveries and Technical Developments in VLBI

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Abstract — The first very long baseline interferometry (VLBI) experiments, which started in 1967, involved 2 groups in the USA using digital recording and one group in Canada using analog TV recording. All three groups relied on rubidium and hydrogen maser atomic frequency standards along with Loran C and traveling clocks for time synchronization.

Early results included the measurement of the brightness temperature of quasars approaching the Compton limit of 10^{12} K, superluminal expansion of quasars and the ultra compact size of hydroxyl radical and water vapor emissions consistent with masers. Later VLBI was applied to making precise geodetic measurements leading to the first direct measurement of an increase in the distance between North America and Europe due to contemporary tectonic plate motion of about 15 millimeters per year.

Over the years since the 1960s the VLBI recording technology increased the data rates by about an order of magnitude per decade from a megabit/sec to over 10 gigabits/second. Other technical improvements include wider bandwidths and more accurate calibration for geodetic measurements and moving from centimeter to millimeter wavelengths for higher angular resolution. The data correlation in the early years used software and then moved to efficient correlation using specialized hardware. Now the hardware correlators are being retired as VLBI correlation goes back to software correlation using arrays of multiple COTS computer CPUs.