THE MARK IIIA CORRELATOR SYSTEM

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ABSTRACT. The Mark IIIA correlator system, developed at Haystack Observatory, is a second-generation version of the original Mark III correlator which adds significant new capabilities, such as double-speed operation, longer integration periods, and improved internal modelling. One Mark IIIA correlator is currently operational at the U.S. Naval Observatory in Washington, D.C., and another is being readied to replace the Mark III correlator at Haystack.

The Mark IIIA correlator can simultaneously process up to 10 baselines of 24-MHz BW data from 5 stations. Experiments including more than 5 stations may be processed with multiple passes through the correlator. The architecture of the correlator allows a future expansion to a maximum of 16 stations. Due to a simple modular design and the low cost of required computer-support equipment, expansion is straightforward and relatively economical.

Both astronomy and geodetic data processing are supported by the Mark IIIA system, including spectral line and pulsar gating. In addition, recent work has led to support of space-based VLBI observations; this capability was critical in supporting the first successful space-based VLBI astronomy observations between ground-based antennas and an orbiting satellite in August 1986.

1. INTRODUCTION

In 1984, four U.S. government agencies (NASA, NGS, USNO, NRL) contracted with Haystack Observatory to develop and build a next-generation Mark III correlator to replace the original Mark III correlator in service since 1979. This correlator, dubbed the Mark IIIA, was to have significantly improved capabilities in several areas, primarily in modelling and data-throughput improvements. This new correlator system was initially installed at the USNO in January 1986, and has since been expanded to 5-station operation.

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2. SYSTEM DESCRIPTION

The Mark IIIA processor, like the Mark III processor, is based on a straight-forward modular concept utilizing one hardware correlator module per baseline track-pair, where a tape track contains the data from a single RF "window". Thus 14 modules are required to process one baseline of 14 tracks. Each module operates as a completely autonomous unit, but all are controlled by a common overseeing computer (HP1000 minicomputer). The module performs the functions of de-coding the two data streams (one from each station forming the baseline), buffering and correctly aligning the data streams to remove the effects of recorder jitter. Each module can process continuous data streams up to 8 Msamples/second.

Each Mark IIIA correlator module incorporates an internal microprocessor to maintain a high-precision a priori model for several seconds, even under conditions of very high delay rates or acceleration. Sample-by-sample fringe-rotation and cross-correlation is performed over a specified number of lags (up to 32/module) for each of a number of several-second integration periods over the duration of an observation. The correlation results are then communicated to the control computer, which performs the necessary Fourier transforms to create cross-spectral and delay functions for each integration period. Data from all integration periods are then combined to make estimates of various observables (correlation amplitude, phase, group delay, phase-delay rate, etc.). Special algorithms are used for bandwidth-synthesis measurements, which typically span RF bandwidths of several hundred Megahertz.

3. CAPABILITIES

Up to 5-stations (10 baselines) of 14-track data may be correlated through the ensemble of 140 identical correlator modules. Software-selectable signal-path selection allows considerable freedom with regard to configuring the correlator for processing other types of data. For example, up to 5 baselines of 28-track data may be processed sumultaneously; or all polarization combinations from a 3-station 14-track (7 track/polarization) may be processed.

For spectral-line processing, 4480 available lags (140 modules times 32 lags/module) may be divided among one or more baselines as desired.

References:

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