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THE CANADIAN GEOPHYSICAL LBI SYSTEM: STATUS AND FUTURE PLANS

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ABSTRACT Emphasis in the design of the Canadian Geophysical LBI (CGLBI) system has been placed on economy, operational efficiency, and performance in geophysical applications. Unique features of the system include the use of modified VHS recorders to store digitized astronomical data and the capability to track delay and fringe rotation during observation. A prototype system has been completed and tested at L-band using the ARO-DRAO interferometer baseline. The prototype system converts a single fixed 12 Mhz wide IF channel to baseband. Since delay resolution with this system is not sufficient for modern geophysical applications a frequency switching capability is being designed to synthesize a wide IF bandwidth while still maintaining the economy of a single channel system. Further improvements include the design of a phase cal detector and an input module compatible with NASA geodetic S/X receivers. Finally, efforts are being coordinated with ISTS so that record terminals developed for the Radioastron project can be interfaced to the CGLBI system.

INTRODUCTION

The Canadian Geophysical LBI (CGLBI) system is being developed in response to the requirements of the geophysical community in Canada. Emphasis in the design is placed on economy and operational efficiency. Three main features of the system are intended to achieve these goals. The first is the use of VHS cassette recorders to store the large amount of astronomical data required by VLBI. Since VHS is a mature technology, the transports and tapes are inexpensive, robust and readily available. VHS data density is high and the cassettes are

easy to handle. Second, the interferometer geometric corrections are applied at the observatories prior to data recording. This results in a significant simplification in the design of the correlator. Third, the CGLBI system will use only a single baseband converter. This minimizes replication of modules both in the acquisition system and the correlator.

CGLBI STATUS

Two prototype CGLBI Data Acquisition and Recording Terminals (DARTs) have been completed and a single channel single baseline correlator is in operation. Prototype specifications are listed in Table I.

TABLE I CGLBI Prototype Specifications

IF input	26-38 MHz
Delay Tracking Resolution	1/8 sample interval
Phase Tracking Resolution	1/48 cycle
Baseband Converters	1
Baseband Channels	6 Mhz USB, 6 Mhz LSB
Sampling	2-levels at 12 Ms/s
Total Record Rate	24 Mb/s
Recorders	2 Modified VHS
Tape Duration	2 hours
Correlator	single channel, single baseline, real, 16 lags

System Tests

In addition to zero baseline tests, the prototype CGLBI system has been tested several times since 1987 on the interferometer baseline between the 46m antenna at the Algonquin Radio Observatory (ARO) and the 26m antenna at the Dominion Radio Astrophysical Observatory (DRAO). The observing frequency for the tests was 1668 Mhz and rubidium oscillators were employed as frequency references. The quality of the data is consistent with the use of a single fixed 12 Mhz baseband channel, rubidium reference oscillators, and the ionospheric instability associated with L-band observations.

CGLBI FUTURE PLANS

Worldwide, a number of radio antennas are currently parti-

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cipating in VLBI campaigns for geophysical purposes. In the majority of cases, the antennas have been outfitted to achieve a specific level of performance when used in conjunction with the Mark III system operated in standard geodetic mode. The CGLBI system will be upgraded to bring its performance to an equivalent level and to make its input compatible with the IF output of the standard NASA geodetic S/X receivers used at these sites.

Spanned Bandwidth

The primary VLBI observable in geophysical applications is the group delay. The ability to resolve this parameter is proportional to the spanned bandwidth. Since record rates are not high enough to sample a sufficiently wide IF bandwidth at the Nyquist rate, it has become a standard practice to acquire data from a number of narrow channels placed strategically within the band. The effect of the wide IF channel is then synthesized in postprocessing. The data can be acquired using either a number of separate channels operating in parallel or a single wider channel sequentially sampling the required frequencies. The latter approach has been selected for the CGLBI system because it attains the required delay resolution while maintaining the economy of a single channel system.

Sensitivity

Increased sensitivity allows a greater number of sources to be detected by a particular interferometer. This is extremely important in geophysical applications where schedule optimization has proven critical in enhancing the quality of VLBI baseline determinations.

There are a number of factors which determine the sensitivity of an interferometer, one of them being record rate. The prototype CGLBI system has a record rate of 24 Mb/s. Plans are being coordinated with the Institute for Space and Terrestrial Studies (ISTS) to interface record terminals being developed for the Radioastron Project to the CGLBI system. These record terminals are made up of 8 stacked S-VHS recorders, each capable of recording with acceptable error rates at 16 Mb/s for 6 hours.

Phase Stability

Phase wander in the receiver, cables, and VLBI signal processing system can be mistakenly interpreted as geometric effects. To avoid this possibility, a phase calibration capability will be included in the CGLBI system.

In conventional VLBI systems, phase and delay corrections are applied during correlation. The detection of phase cal tones is thus relatively simple since the frequency of the tones is fixed within the band. In the CGLBI system the geo-

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metric corrections are applied prior to recording the data by altering the frequency of the baseband LO. Since the frequency of the phase cal tones is correspondingly affected it is necessary to precisely control the phase of the tone detectors.

In the CGLBI system phase cal detectors will be placed in the acquisition system thus providing a powerful real time diagnosis of system problems. They will further track phase at any frequency within the baseband channel making it possible to calibrate the single channel group delay by detecting the phase of two tones within each channel. This allows the wide baseband channel of the CGLBI system to be used effectively to resolve group delay ambiguities.

TABLE II CGLBI Upgrade Specifications

IF input	4 inputs, 100-500 Mhz
Delay Tracking Resolution	1/8 sample interval
Phase Tracking Resolution	1/32 cycle
Phase Cal Detectors	2 tones at any freq
Baseband Converters	1
Baseband Channel	16 Mhz USB, 16 Mhz LSB
Sampling	4-level at 32 Ms/s
Total Record Rate	128 Mb/s
Tape Recorders	8 modified S-VHS
Correlator	single channel, 3 station, real, 32 lags

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