The Bonn Astro/Geo Mark IV Correlator

Arno Müskens, Walter Alef

Abstract

The Bonn MK IV VLBI correlator was officially opened on November 17th, 2000; it is operated jointly by the MPIfR (Bonn), the GIUB (Bonn) and the BKG (Frankfurt). The final installation will permit the simultaneous correlation of 16 channels of MK IV or VLBA formatted data for all baselines from 9 station playback units, in both cross- and parallel-hand polarizations.

1. History

Back in 1990 a "Prototype Next Generation Correlator" Project was initiated by a consortium of institutions on the East Coast of the United States. In 1993 the International Advanced Correlator Consortium (IACC) was founded and the construction of a completely newly-designed successor for the existing MK III(A) VLBI data acquisition and recording system was started at Haystack Observatory under the designation "MK IV Correlator Project". The aim of a working next generation VLBI correlator was achieved in 1999.

A MK IV correlator was installed by members of the Haystack Observatory at the *MPIfR* (Max-Planck-Institute for Radioastronomy, Bonn) in December 1999 [*Alef et al.*] shortly after the first operational correlator tests had been performed at the Washington VLBI correlation center at the *United States Naval Observatory (USNO)* [*Kingham and Martin*].

The Bonn MK IV correlator is jointly operated by the *MPIfR* for astronomical observations and by the *Bundesamt für Kartographie und Geodäsie (BKG)* in cooperation with the *Geodetic Institute of the University of Bonn (GIUB)* for geodetic applications.

Figure 1. Present MK IV VLBI Correlator at Bonn (MPIfR/BKG).

2. Status and Capabilities of the Bonn MK IV VLBI correlator

At the time of this report 6 playback drives can be used simultaneously with 15 baselines, 16 channels, and 32 lags. This limitation is caused by the current software which can only handle 2 of the 16 correlator boards. Other modes with fewer stations but more lags are also possible. Multiple passes have to be done for observations with more than 6 stations: e.g. 7, 8 or 9 stations have to be done in 3 passes, 12 stations in 6 passes. The next release of the software will handle 9 playback units with some limited set of correlator modes.

All tape drives can play back thick and thin tape; the equalizers of 5 playback drives are optimized for thin tapes at present.

Supported playback speeds are 80 ips for thin tapes and 135 ips for thick tapes, which is due to the tape drives having only one set of equalizers. Due to another software limitation the playback speeds have to be the same as the recording speeds (speed-up factor has to be 1). One playback is equipped with a newly-designed switchable equalizer board which has 3 sets of equalizers; at present it can switch between 80/135/270 ips playback.

The supported formats are MK IIIA, MK IV and VLBA, both MK IV and VLBA with 1- or 2-bit sampling. Fan-in modes are not supported while all the fan-out modes 1:1 and 1:2 and 1:4 are possible. Any number of up to 16 frequency channels can be used, both upper and lower sidebands.

Multiple passes as needed for modes with more than 16 channels are not supported by the present software release. Channel bandwidths of 2, 4, 8 and 16 Mhz are usable.

The different playback modes are: MK III modes B and C, and those shown in Table 1.

	128-16-1 128-8-2	128-16-2 128-4-1	128-8-1 128-4-2
thin tape only	128-2-2	256-16-1	256-16-2
thin tape only	256-8-1	256-8-2	256-4-2

Table 1. Overview MK IV correlator modes

The geometric correlator model is CALC 8.

Single-tone phase-cal extraction at 10 kHz is implemented. The possibility to extract other phase-cal frequencies as well as multi-tone phase-cal are planned. The pre-averaging time is flexible from 0.5 to 5 seconds.

Fringe-fitting is done off-line by the program fourfit. Dual frequency observations are done in a single execution of the program while dual/cross-polarization experiments have to be fringe-fitted in multiple executions.

The raw and fringe-fitted data is archived on DDS2 DAT cassettes. The archive contains the root, the raw correlator data (type 1 files), the fringe-fitted data (type 2), and the station-based files (type 3 files). All the processed geodetic data are also exported with the geodetic post-correlation software interface CALC/SOLVE.

3. Correlator Operations

Approximately 50% of the correlator time is allocated to IVS related tasks. It is used for setup and production processing of IRIS-S, EUROPE and CORE (Core-3, Core-OHIG) experiments.

The remaining 50% are used for astronomy correlation like the processing of millimeter-wave radio astronomy observations and other MPIfR-based VLBI observations. The total available processor time has to be reduced by 10% for such tasks as correlation fringe check, testing station performance, maintenance of processor software and playback recorder units and test experiments for geodesy and astronomy. Over the past year more than 25 geodesy sessions and test experiments were processed at Bonn MK IIIA / MK IV correlators.

4. Outlook

A new contract between GIUB and BKG was made to support IVS with the processing of about 50 experiments per year at the MPIfR/BKG correlator. At the end of 2001 it has to be reviewed if the commitment towards IVS can even be increased. This will also depend on further improvements of the MK IV processing software. Especially correlator post-processing software is still rudimentary and causes a lot of extra work.

5. References

Alef W, Graham D A, Zensus J A, Müskens A, Schlüter W (2000) The Bonn MK IV Correlator Project, Proceedings of the First IVS General Meeting, N.R.Vandenberg and K.Baver, Eds., NASA Center for AeroSpace Information, 7121 Standard Drive, Hanover, MD 21076–1320, Publ.No. NASA/CP-2000-209893.; p.210-214

Kingham K A, Martin J O (2000) Early Experiences with the Mark 4 Correlator, Proceedings of the First IVS General Meeting, NASA Center for AeroSpace Information, 7121 Standard Drive, Hanover, MD 21076–1320

Müskens A. et.al. (2000) Comparison of MK III and MK IV Correlation using a 4-station IRIS-S experiment, held at 14th Working Meeting on European VLBI for Geodesy and Astrometry at Castel San Pietro Terme (Italy) from Sept. 8 - Sept. 9, 2000, edited by P.Tomasi, F.Mantovani, M. Perez Torres, S125-136

Whitney, A. R. (1994) The Mark IV VLBI Data-Acquisition and Correlation System, In: Developments in Astronomy and Their Impact on Astrophysics and Geodynamics, edited by I.I Mueller and B. Kolaczek 151-157,1994.