

The Bonn Astro/Geo Mark IV Correlator

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Abstract

The Bonn Mark IV VLBI correlator is operated jointly by the MPIfR and the GIUB in Bonn and the BKG in Frankfurt. In 2005 the Bonn correlator was used to demonstrate phase correction during the 3mm-VLBI session using data from the Effelsberg Water Vapour Radiometer (WVR)¹.

1. Introduction

The Bonn Mark IV correlator is hosted at the Max-Planck-Institut für Radioastronomie (MPIfR)² Bonn, Germany. It is operated jointly by the MPIfR and by the Bundesamt für Kartographie und Geodäsie (BKG)³ in cooperation with the Geodätisches Institut der Universität Bonn (GIUB)⁴. It is a major correlator for geodetic observations and MPIfR's astronomical projects, for instance those involving millimetre wavelengths and astrometry.

2. Present Status and Capabilities



Figure 1. Left: Correlator rack in 2 crates. Middle: two station units with two rack-mounted Mark 5A playback units. Right: four Mark 5B units mounted in two racks.

The Bonn correlator (Fig 1) is one of the four Mark IV VLBI data processors in the world. It has been operational since 2000. A summary of the Bonn correlator capabilities is presented in Table 1.

¹<http://www.mpifr-bonn.mpg.de/staff/aroy/wvr.html>

²<http://www.mpifr-bonn.mpg.de/div/vlbicor/>

³<http://www.ifag.de/>

⁴<http://www.gib.uni-bonn.de>

Table 1. Correlator Capabilities

Playback Units

Number available:	9 Mark IV tape drives, 8 Mark 5A systems (interchangeable)
Tape types:	Thick, thin
Playback speeds:	80 ips, 160 ips (thin tapes); 135 ips, 270 ips (thick tapes) up to 1024 Mbit/s (Mark 5A)
Formats:	Mark III/Mark IV/VLBA (Mark IV/VLBA w/wo barrel roll, data demod.)
Sampling:	One bit; two bit
Fan-out:	1:1 1:2 1:4
Fan-in:	Not supported
No. channels:	≤ 16 USB and/or LSB
Bandwidth/channel:	(2, 4, 8, 16) MHz
Signal:	Mono, dual frequency; dual polarization
Modes:	128-16-1 128-16-2 128-8-1 128-8-2 128-4-1 128-4-2 128-2-2 256-16-1 256-16-2 256-8-1 256-8-2 256-4-2 512-16-2 512-8-2 1024-16-2

Correlation

Geometric Model:	CALC 8
Number of boards:	16
Phase cal:	Single tone extraction at selectable frequency
Pre-average times:	0.2 s to 5 s
Lags per channel:	32 minimum, 2048 maximum; 1024 tested and used
Maximum output:	9 stations: 36 baselines, 16 channels, 32 lags with autocorrelation function (ACF) without circular polarization (CP); 8 stations: 28 baselines, 16 channels, 32 lags with ACF with CP
Fringe-fit:	Off-line FOURFIT run
Export:	Data base, MK4IN to AIPS

The correlator is controlled from a dedicated workstation. Correlation setup, data inspection, fringe-fitting, and data export are done with a separate workstation. Per year about 300 to 400 Gbytes of correlated data are generated. The total disk space available for data handling at the correlator is more than 1000 Gbytes. Data security is guaranteed by using a file system with redundancy (RAID level 5) and by daily back-up of the data on a 120 Gbyte disk of a low-end Linux PC.

3. Staff

The people in the geodetic group at the Bonn correlator are

- Arno Müskens: group leader, overall experiment supervision, scheduling of T2, OHIG and EURO series.
- Alessandra Bertarini: experiment setup and evaluation of correlated data, media shipping.
- Alexandra Höfer: experiment setup and evaluation of correlated data, media shipping.
- 5 student operators for the night shifts and the weekends.

MPIfR staff supports IVS correlation with

- Walter Alef: correlator manager, correlator software maintenance and upgrades, and computer system administration.
- David Graham: technical development, consultant.
- Heinz Fuchs: correlator operator, responsible for the correlator operator schedule, daily operations, and media shipping.
- Hermann Sturm: correlator operator, correlator support software, media shipping.
- Michael Wunderlich: engineer, correlator, playback drives, Mark 5 support.
- Rolf Märten: technician, playback drive maintenance, Mark 5 support.

4. Status

In the course of 2005 the majority of the observations became disk-only. As a result the efficiency and throughput of the correlator could be increased by nearly a factor of two. The Bonn group correlated and released about 50 geodetic experiments: three T2, 39 R1, four EURO, five CONT05, and a Zelenchukskaya fringe test. No OHIG sessions were correlated in 2005 due to late arrival of the media from the Antarctic station Syowa.

The CONT05 sessions were an overall success, and after some analysis carried out at Bonn, IVS decided that the complete campaign should be fringe-fitted in one run with fixed parameters.

The new Water Vapour Radiometer (WVR) at Effelsberg was operated in parallel with two EURO sessions (EURO75 in March and EURO78 in December). The WVR data from EURO75 were compared with zenith wet delays estimated from VLBI: the offsets were found to have an RMS of about 9 mm.

The fringe-fitting program *fourfit* was modified to accept phase corrections obtained using the Effelsberg WVR to improve the phase coherence of astronomical millimetre VLBI observations. Further validation tests are in progress.

All astronomical projects correlated at Bonn including the two millimetre sessions have been disk-only since the beginning of 2005. This was partially possible with a huge investment by MPIfR in disks which helped to supply the VLBA antennas for those observations.

5. Outlook for 2006

MPIfR and BKG bought four Mark 5B units and four upgrades for the existing Mark 5A units. The aim is to upgrade the correlator to 12 stations by adding 4 Mark 5Bs to the system; at the

same time 2 tape units will be removed. Later the eight existing Mark 5As will be upgraded to Mark 5B depending on the number of Mark 5B recorders in the field. Bonn and Haystack are collaborating on Mark 5B hard- and software development required for the upgrade.

The tape drives and station units will still be maintained for some time because not all IVS and VLBA stations have been upgraded to Mark 5. But it is expected that tape-based correlation will cease towards the end of 2006.

The Bonn group is involved in the development of a digital Baseband Converter (dBBC) for the European VLBI Network (EVN). This unit is designed as a full replacement for the existing analog BBCs.

In spring of 2006 it is expected that the correlator will have Gbit connectivity to the Internet. The aim is to have an optically switched connection to the European Academic Network (Géant).