

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 IGGB in Bonn and the BKG in Frankfurt. In 2006 besides routine correlation, the first eVLBI transfer from some geodetic stations to Bonn correlator were made. A prototype software correlator was also installed at MPIfR.

1. Introduction

The Bonn Mark IV correlator is hosted at the Max-Planck-Institut für Radioastronomie (MPIfR)¹ Bonn, Germany. It is operated jointly by the MPIfR and by the Bundesamt für Kartographie und Geodäsie (BKG)² in cooperation with the Institut für Geodäsie und Geoinformation der Universität Bonn (IGGB)³. 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-most rack contains the two correlator crates. Rack second from left contains two station units with two rack-mounted Mark 5A playback units. Rack second from right contains from top to bottom three Mark 5B units and the eVLBI-dedicated linux computer. Right-most rack contains two Mark 5B units.

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/div/vlbicor/>

²<http://www.bkg.bund.de/>

³<http://www.gib.uni-bonn.de>

Table 1. Correlator Capabilities

Playback Units

Number available:	7 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) parallel-hand polarizations only; 8 stations: 28 baselines, 16 channels, 32 lags with ACF full pol.
Fringe-fit:	Off-line FOURFIT run
Export:	Database, 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, EURO series and eVLBI coordinator.
- Alessandra Bertarini: experiment setup and evaluation of correlated data, software correlator development, eVLBI commissioning tests and media shipping.
- Alexandra Höfer: experiment setup and evaluation of correlated data and media shipping.
- Christian Dulfer: eVLBI software support.
- 5 student operators for the night shifts and the weekends.

MPIfR staff supports IVS correlation with

- Walter Alef: correlator department head, correlator software maintenance and upgrades, software correlator development, eVLBI commissioning and computer system administration.
- David Graham: technical development, consultant and software correlator development.
- Alan Roy: deputy department head, water vapour radiometer (WVR), technical assistance.
- 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 maintaining correlator, playback drives, Mark 5 and development of the digital baseband converter.
- Rolf Märtens: technician maintaining playback drives and Mark 5.

4. Status

- Experiment Status:
In 2006 the Bonn group correlated 44 R1, six EURO, two T2, eight OHIG, which cleared the OHIG backlog from 2005, and about 20 astronomical projects. One K-band fringe test was correlated to measure the station coordinates of the Australian LBA antennas.
- CONT05:
After a trial re-fringe-fitting carried out at Bonn in 2005, all the CONT05 sessions were re-fringe-fitted with one *fourfit* control file. The aim of the re-fringe fitting was to reduce the number of clock breaks between the sessions due to differences in the *fourfit* control files and to ease the comparison between the VLBI-CONT05 data and measurements with other geodetic techniques. This operation took place in 2006 at the Bonn correlator with support of Brian Corey (MIT Haystack Observatory).
- Software Correlator:
In September 2006, Adam Deller (Swinburne University, Melbourne, Australia) visited the Bonn correlator and installed his C++ software correlator. The use of a software correlator has become possible recently due to the rapid increase of computing power in low-cost PCs. A couple of hours from an R1 were recorrelated using the software correlator and need now to be imported into AIPS for validation.

- **eVLBI:**
In the second half of 2006, the Bonn group started to conduct tests to establish and test the network link to Bonn and to get familiar with the various TCP- and UDP-based protocols. Some tests were conducted with Onsala and an entire geodetic session (EURO84, ~700 GB) was transferred from Onsala to Bonn using the big-block FTP-based (EGAE) software from Haystack. In addition the Tsunami (UDP-based) protocol was tested with Metsahovi and Onsala and a sustained data rate of about 800 Mbit/s was obtained.
- **Correlator Status:**
Two tape drives were decommissioned to make space for the Mark 5B racks, so the number of usable tape drives reduced to seven units in 2006.

5. Outlook for 2007

- **Correlator:**
The tape drives and station units (SU) will still be maintained in 2007 since a couple of antennas are still recording on tape. There will be a gradual change toward Mark 5B, which will further simplify the correlation process since the SUs will no longer be needed. The HP correlator control computer and the HP used for the correlation setup, data inspection and data export will be decommissioned and substituted by a linux file server with a RAID disk array with 10 TByte capacity and two high-end linux workstations.
- **Software Correlator:**
The software correlator output will be compared in detail with the hardware correlator output. A linux cluster is partly funded, more funds will be acquired in 2007 and 2008, provided tests are positive.
- **eVLBI:**
The eVLBI project will continue with more antennas and with some of them real-time transfers will be tested. The immediate aim is routine data transfer from the more remote stations.
- **Digital Baseband Converter (dBBC):**
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. Version I is already in production and a version II with broader bandwidth and lower cost is under development. Version II will be fully compatible with version I.