

The Bonn Astro/Geo Correlator

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Abstract The Bonn Distributed FX (DiFX) correlator is a software correlator operated jointly by the Max-Planck-Institut für Radioastronomie (MPIfR), the Institut für Geodäsie und Geoinformation der Universität Bonn (IGG), and the Bundesamt für Kartographie und Geodäsie (BKG) in Frankfurt, Germany.

1 Introduction

The Bonn correlator is hosted at the MPIfR¹ VLBI correlator center in Bonn, Germany. It is operated jointly by the MPIfR and the BKG² in cooperation with the IGG³. It is a major correlator for geodetic observations and astronomical projects such as VLBI at millimeter wavelengths, astrometry, RadioAstron⁴ VLBI observations, and pulsar VLBI.

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Bonn Correlator

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¹ <http://www.mpifr-bonn.mpg.de/>

² <http://www.bkg.bund.de/>

³ <http://www.gib.uni-bonn.de/>

⁴ <http://www.asc.rssi.ru/radioastron/>

2 Present Correlator Capabilities

The DiFX correlator⁵ was developed at Swinburne University in Melbourne by Adam Deller and other collaborators. It was adapted to the VLBA operational environment by Walter Brisken and the NRAO staff, and it is constantly updated by the worldwide DiFX developers group. In Bonn, the DiFX is running on a High Performance Compute Cluster (HPC cluster). Its technical specifications can be gathered from the most recent annual report.



Fig. 1 Gabriele, who is checking a Mark 6 unit before its usage.

⁵ DiFX: A Software Correlator for Very Long Baseline Interferometry using Multiprocessor Computing Environments, 2007, PASP, 119, 318

3 Staff

The people in the Geodesy VLBI group at the Bonn correlator are:

Arno Müskens - group leader and scheduler of T2, OHIG, EURO, and INT3 sessions.

Simone Bernhart - correlator support scientist and data analyst for geodesy, e-transfer support, Web site maintenance.

Alessandra Bertarini - correlator support scientist and data analyst for both astronomy and geodesy, digital baseband converter (DBBC) testing.

Laura La Porta - correlator support scientist and data analyst for geodesy and near-field VLBI observation, e-transfer support, DBBC testing, software developer.

The people in the astronomical group at the Bonn correlator are:

Walter Alef - head of the VLBI technical department, computers and cluster administrator.

Alan Roy - deputy group leader, APEX project manager, development of linear to circular polarization conversion software for phased ALMA.

Gabriele Bruni - support scientist and data analyst for RadioAstron, e-transfer support.

Sven Dornbusch - FPGA programming for DBBC. APEX.

Heinz Fuchs - correlator operator until the end of 2015 and media shipment.

David Graham - consultant (technical development and DBBC development).

Rolf Märten - technician maintaining cluster hardware and Mark 5/6 playbacks.

Helge Rottmann - cluster administration and developer for the ALMA phasing project.

Hermann Sturm - correlator operator and software developer.

Gino Tuccari - guest scientist from INAF, DBBC project manager and developer.

Michael Wunderlich - engineer, DBBC development and testing components.

4 Status

Experiments: In the two-year period 2015/16 the Bonn group correlated about 80 R1, twelve EURO, twelve T2, twelve OHIG, 100 INT3 experiments, and astronomical sessions (including 1 mm, 3 mm, RadioAstron and astrometric projects).

e-VLBI: The total disk space available for geodetic e-transfer data storage at the correlator is about 600 TB. On average $\geq 90\%$ of the stations do e-transfer. The average amount of e-transferred data per week is about 20 TB, considering only the regular INT3 and R1 experiments. Since September 2015 every second R1 is now observed at 512 Mbps; hence the increase in data transferred. Most transfers are done either using the UDP-based Tsunami protocol, or the Mark 5A/B/C control software “jive5ab”, which was developed at the Joint Institute for VLBI. Both systems can achieve data rates from 100 Mbps to 800 Mbps. In 2016 the University of Bonn made available an extra 1 Gbps Internet connection to use for e-VLBI transfers; hence now the total capacity toward Bonn is of 2 GB. The upgrade of the line to meet the requirements of VLBI Global Observing System (VGOS) has not been realized yet - still due to funding issues and apparently bureaucratic obstacles.

DiFX software correlator: The DiFX software correlator has been operated in Bonn since 2009 and is updated regularly. Since the second half of 2015 Bonn has a new cluster with more than 1,000 compute cores. In January 2015 the correlator’s playback unit included two Mark 6 recorders, now increased to five units.

The stable DiFX release 2.4 was installed in 2015.

Two other branch versions of the DiFX software correlator are available in Bonn: a DiFX version for RFI mitigation, developed by J. Wagner, now at KASI, and a DiFX version dedicated to RadioAstron, developed by J. Anderson, now at GFZ Potsdam.

DBBC: The Bonn group is involved in the development and testing of the most widely adopted VLBI backend: DBBC2 and its ancillary parts (e.g., FiLa10G) for the European VLBI Network (EVN) and geodesy. The DBBC2 is designed as a full replacement for the existing VLBI terminals and includes additional features. Stations like for instance APEX, Pico Veleta, AuScope (Australia), HartRAO (Africa), and a large part of the EVN have ordered one or more DBBC2s.

The FiLa10G, VLBI to 10GE interfaces have also been exported to Haystack and Korean stations.

The next generation DBBC (DBBC3-L) is being developed and two prototypes are being integrated and tested. The DBBC3-L can handle a larger bandwidth of 4 GHz for each IF/polarization. A maximum of eight IFs can be processed by a single DBBC3-L, so a dedicated variant of the modular system can also be used as complete VGOS backend at 32, 64, 128 Gbps covering the full RF range up to 16 GHz.

APEX: The Bonn VLBI group has equipped the APEX telescope for VLBI observations at 1 mm. In 2013 APEX conducted the first scientific observations by taking part in the Event Horizon Telescope (EHT) campaign. Observations were carried out at 4 Gbps, lasted about 50 hours and provided good detections for several sources including Sgr A* and M87.

RadioAstron: Data from ten global+RadioAstron experiments have been transferred to Bonn during AO-2 and AO-3 observing periods (July 2014–July 2016), plus another four from the ongoing AO-4. The corre-

lation of the three key science projects based in Bonn is regularly proceeding, and since AO-2 also experiments from single PIs are being processed. Eleven experiments were finalized in 2015/2016. Raw data are routinely transferred to ASC (Moscow) via Internet or HDD for backup purposes. The final version of the RadioAstron-dedicated DiFX is in use since September 2016, and also distributed on the official DiFX repository.

5 Outlook for 2017

First prototype for the prime focus for BRoad-baND (BRAND), the new wideband “digital” VLBI-receiver for the EVN, whose frequencies span from 1.5 GHz to 15.5 GHz.