Haystack Observatory VLBI Correlator

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Abstract

The Haystack correlator reports on its activities for the year. Mark 5B is in the final stages of development, and integration into the correlator is imminent. e-VLBI demonstrations linked to conferences were a major effort. Non-real-time e-VLBI transfers continue. Various other testing and development projects continue. An increased focus on R&D related activities rather than routine production will shape next year's correlator activities. Efforts to move operations to Linux-based systems continue.

Figure 1. Partial view of the Haystack Mark IV correlator, showing 2 racks containing 7 Mark 5A units and a decoder, correlator rack, 1 tape unit,and 1 rack containing 4 Station Units.

1. Introduction

The Mark IV VLBI correlator of the MIT Haystack Observatory, located in Westford, Massachusetts, is supported by the NASA Space Geodesy Program and by the National Science Foundation. The available correlator time is dedicated mainly to the pursuits of the IVS, with a small portion of time allocated to processing radio astronomy observations for the Ultra High Sensitivity VLBI (u-VLBI) project. The Haystack Correlator serves as a development system for testing new correlation modes, for e-VLBI, for hardware improvements such as the Mark 5B system, and for diagnosing correlator problems encountered at Haystack or at one of the identical correlators at the U.S. Naval Observatory and the Max Planck Institute for Radioastronomy. This flexibility is made possible by the presence on-site of the team that designed the correlator hardware and software. Additionally, some production correlator time is dedicated to processing geodetic VLBI observations for the IVS.

2. Summary of Activities

Once again, a variety of activities characterize the work for this past year.

On the technical side, e-VLBI and Mark 5B testing continued, with the Mark 5B system nearing implementation. Fringe products of e-VLBI real time correlations from Onsala, Westford, and GGAO at a data rate of 512 Mbps were displayed in real time at two major conferences: iGRID in September and Super Computing 2005 in November. Tangentially related to both of the above, Mark 5A testing, debugging, and repair continued in order to improve the stability of operations. In a continuing effort, non-real-time e-VLBI transfers of station data were copied onto disk packs at Haystack and shipped to the appropriate correlator; 26 experiments were transferred in 2005. The data sessions transferred came mostly from Tsukuba and Kashima, with a few sessions of Syowa data also transferred. Tests to measure directly the timing offset between the K5 and Mark IV systems were performed (see IVS NICT-TDC Newsletter No. 26, Sept. 2005). WACO and Bonn correlator support activities continued, with both hardware and software issues resolved (e.g. fixing the tgen program to support larger schedules, and replacing and repairing a failed station unit DMM at the Washington correlator). A major hardware improvement was the installation of heat sinks on the correlator input board's FIFO controller chips at Haystack and Washington. This modification has greatly reduced the failure rate of these chips, which has been an operations problem for years. Another item worthy of mention is investigation into a problem with station unit startup data creating spurious fringes in experiments without early-start recording. Also related to this was some re-investigation into the station unit's SUIM generation of valid zeros, a problem which dates back to the station unit's design.

On the organizational side, in July of last year correlator operations were partially melded with the Westford antenna in order to reduce costs. This joint operation involves remotely monitoring Westford observations while running correlator operations locally. Along with this change came a reduction in production correlator support from 30 to 24 hours per week. The focus of this support also changed, with an increased emphasis on R&D experiments and related work, and a reduction of routine production correlation.

3. Experiments Done

In 2005, 48 geodetic-VLBI experiments were processed at the Haystack correlator. This total consists of 9 R1s, 14 R&Ds, 2 CONTS, 1 APSG, and 22 test experiments. The test experiments covered an assortment of e-VLBI, Mark 5B, record format, and various station and equipment tests.

4. Current/Future Hardware and Capabilities

Currently, functional hardware installed on the system includes 6 tape units, 7 Mark 5A units, 7 station units, 16 operational correlator boards, 2 crates, and miscellaneous other support hardware. This represents an increase of 2 Mark 5A units from 2004. A minor rearrangement of correlator hardware took place mid-year, with one tape drive moved to an outer position. Its previous position was occupied by a new rack of three Mark 5As, with a keyboard/monitor integrated (see Figure 1). In order to reduce noise and save electricity, only three tape drives are kept powered up; even they have rarely been used in the past year. We have the capacity to process all baselines for 7 stations simultaneously in the standard geodetic modes, given that the aggregate recordings match the above hardware matrix. By early 2006, implementation of the Mark 5B may allow the correlation of more than 7 stations, due to the Mark 5B's independence from an accompanying station unit. We expect to remove more tape drives from the system as more stations move to recording exclusively on a Mark 5.

5. Staff

The addition of Chester Ruszczyk in support of e-VLBI is the one change in staff over the past year. Staff who participated in aspects of Mark IV, Mark 5, and e-VLBI development and operations include:

5.1. Software Development Team

- John Ball - operator interface; playback; Mark 5A/5B; e-VLBI
- Roger Cappallo - correlation software leader; system integration; post processing; Mark 5B
- Kevin Dudevoir - correlation; maintenance/support; Mark 5A/5B; e-VLBI
- Chester Ruszczyk - e-VLBI
- Jason SooHoo - e-VLBI
- Alan Whitney - system architecture; Mark 5/e-VLBI development

5.2. Operations Team

- Peter Bolis - correlator maintenance
- Brian Corey - experiment correlation oversight; station evaluation;technique development
- Dave Fields - playback drive maintenance; Mark 5 installation and maintenance; general technical support
- Glenn Millson - correlator operator
- Arthur Niell - technique development
- Don Sousa - correlator operator; experiment setup; tape library and shipping
- Mike Titus - correlator operations oversight; experiment setup; computer services; software & hardware testing
- Ken Wilson - correlator maintenance; playback drive maintenance;general technical support

6. Conclusion/Outlook

The integration of Mark 5B into the correlator will increase capabilities, as each Mark 5B that is integrated will allow either the retirement of a station unit or an increase in the number of stations that can be simultaneously correlated. Retirement of station units should increase efficiency and throughput due to a reduction in the need for reprocessing, due to routine use of a 32 MHz playback clock, and due to the smaller setup time required by Mark 5B. Upgrade of other correlators and stations to Mark 5B will follow. e-VLBI tests and experiments will expand to include more stations and will be more extensive. Non-real-time e-VLBI transfers will continue, possibly including more stations in the near future. Correlator operations will focus more on R&D and development work than on routine production. The effort to move operational correlator production tasks to more modern Linux-based systems over the next year will continue, possibly including the correlator run time software and control computer. Development in support of VLBI2010 is anticipated to increase next year. All the above work should result in a greatly improved data processing system as well as provide greater capability and a higher quality end-product to the IVS community.