

The VLBA Sensitivity Upgrade Project

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Basic Concept

Overall Theme

Apply modern technology to expand VLBA's performance.
... as well as flexibility and compatibility in observing modes.

Two Sub-Projects

Upgrade bandwidth of data path downstream from IFs.
... for ~6-fold increase in continuum sensitivity.

Upgrade selected receiver systems.
... for targeted increases in spectroscopic sensitivity.

Memo Series

<http://www.vlba.nrao.edu/memos/sensi/>

Science Drivers

Studies of AGN “jet launching regions”.

Blazars with gamma-ray flares.

Location and velocity of gamma-ray burst blast waves.

Mapping ionized gas in AGN cores.

Studies of Galactic “microquasars”.

Line absorption against compact continuum sources.

Cosmological distance scale.

Astrometry, parallax, proper motion of galactic objects.

Extragalactic astrometry.

Receiver Sensitivity Upgrades

Replace LNAs in Selected Receivers

Modern technology yields significant reduction in system noise.
Most advantageous at high-frequency observing bands.

22-GHz Upgrade Recently Completed

NRAO / MPIfR collaboration.

Completed January 2008.

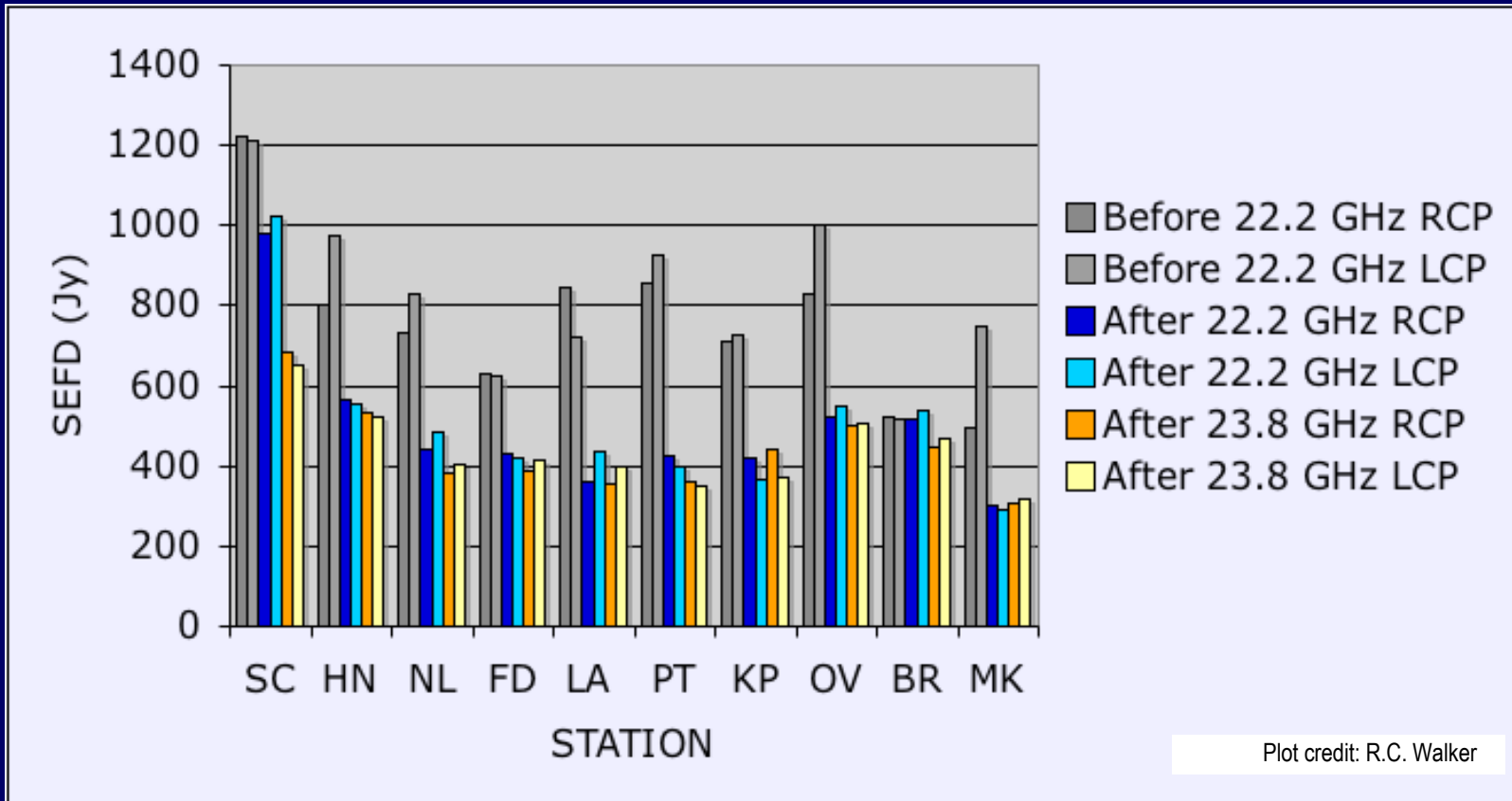
Original GaAsFET amplifiers replaced by InP devices.

Developed by NRAO CDL for WMAP, used in EVLA receivers.

Goal: 30% reduction in system noise.

Average actual reduction achieved in zenith SEFD: 38%.

Improvement in On-the-Sky Performance



VLBA 4-Gbps Data Path Upgrade

2 IFs @ 500 MHz BW @ 2-bit Nyquist Samples

4 Gbps bitrate bandwidth.

~6-fold increase in continuum sensitivity in most observing bands.

Target completion: 2011.

High-priority science could be supported as early as 2009.

Sustained 4-Gbps operation would require only additional recording and processing resources.

Three new components.

1. Digital Backend sub-band processor.
2. Mark 5C recording system.
3. DiFX software correlator.

1. “Digital Backend” Sub-Band Processor

Sample Directly in 500-1000 MHz IF.

All subsequent processing digital.

Filter Personalities

Digital down-converter (DDC).

4 independently tunable sub-bands per IF.

Bandwidths 0.5 – 256 MHz; Output sample precision: 1-8 bits.

Polyphase filterbank (PFB).

≥ 32 sub-bands spanning entire 500-MHz IF.

Firmware being developed in collaboration with Haystack Observatory.

Output

10G Ethernet; individual sub-band packet streams.

Maximum output rate 8 Gbps.

Digital Backend Hardware Platform

“ROACH” (formerly known as iBOB-2)

“Reconfigurable Open Architecture Computing Hardware”

CASPER / KAT / NRAO collaboration.

Introduced by Dan Werthimer (and others) yesterday.

Upgrade of UCB CASPER group’s successful iBOB.

New, higher-capacity Xilinx Virtex-5 FPGA.

10-Gigabit Ethernet output interface.

Status

Second prototype boards currently under test.

Order pending for production boards.

FPGA firmware for PFB personality data path largely implemented.

2. “Mark 5C” Recording System

Successor to Current Mark 5A/B/B+ Recorders

Joint development by NRAO / Haystack / Conduant Corp.
Introduced by Alan Whitney yesterday.

Requirements

Sustained recording at ≥ 4 Gbps.

Conduant’s “Amazon” disk array controller already capable of such data rates.

Preserve investment in existing Mark 5 disk-drive modules.

10G Ethernet input interface, in sub-band packet streams.

Mezzanine board for this interface is only new design required.

Output optimized for direct access from software correlator.

Status

Testing of mezzanine board (including FPGA code) nearly complete.

Delivery of first 3 units anticipated by end of February.

3. “DiFX” Software Correlator

NRAO Implementation

Software written by Adam Deller at Swinburne University.

Deller now a Jansky Fellow at NRAO/Socorro, speaking on DiFX later today.

Variety of peripheral software required to interface to VLBA.

Most already complete; international code-sharing consortium established.

Operator GUI, operations and archive interfaces still under development.

“Intermediate cluster” procured and installed.

20 Intel Xeon quad-core processors.

Expected to match throughput of existing correlator.

Status

Formal testing pending.

Expected to become available for immediate Exploratory Proposals for short observations, on a “shared risk” basis, in the near future.

Thank you