NRAO Status Report

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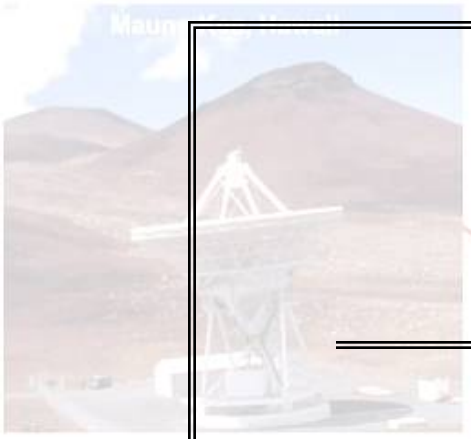
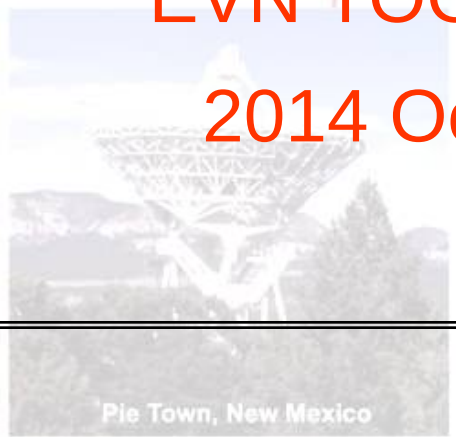
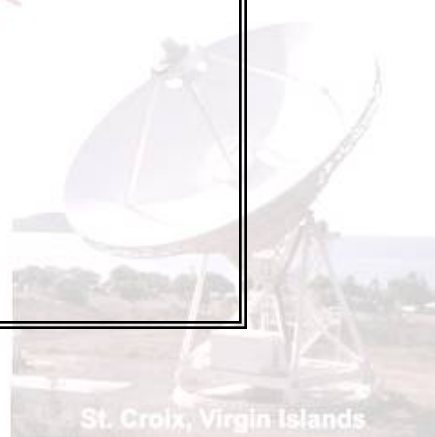
EVN TOG Meeting
2014 October 6





VLBA Sensitivity Upgrade

First Major Upgrade Since VLBA Inauguration in 1993.

Initial concepts developed 1999 – 2000.

Sensitivity Upgrade Memos #2 & #3

(science.nrao.edu/facilities/vlba/publications/memos/upgrade)

Many elements later cited in 2004 Taylor – Lonsdale report.

(www.vlba.nrao.edu/astro/VLBI_Future/future.pdf)

Project established 2007, with initial funding.

Overall concept:

Replace everything downstream from IFs with modern technology.

Match limits of existing IF system; sample directly in IF.

All further processing digital.

Goals & Status

Initial Project Goal: "4 Gbps by 2011".

- Instrumentation designed and built for 4 Gbps throughput.
  - Budget limited recording system to 2 Gbps.
  - Estimated cost of new units and media for 4 Gbps operation: 0.9 – 1.2 M$.
- Initial, limited 2-Gbps operation began February 2012.

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NOW FULLY OPERATIONAL

(… on the VLBA, + others detailed later.)
"Last bug" corrected more than three months ago.

You are the first audience to hear me say this publicly.

Two Basic Functional Modes

PFB (Polyphase FilterBank)

- Developed (primarily) by Haystack Observatory.
- Operates in second Nyquist zone; fundamentally LSB.
- Fixed 16 x 32-MHz channel configuration; requantized to 2 bits.
  - Only 15 channels of usable data.
  - Fixed 2048 Mbps output data rate, in mark5b emulation format.
- Channels selectable from 2 IF inputs; placeable in 32-MHz steps.
- Frequently used observing configurations:
  - **Compact dual-polar:** 8 contiguous channel pairs, centered in IFs.
  - **Spanned single-polar:** 16 contiguous channels spanning entire IF.
- Workhorse for wideband continuum observations.

Two Basic Functional Modes

DDC (Digital DownConverter)

- Developed by NRAO.
- Full capabilities require dual-RDBE configuration.
  - "Last Bug" occurred in this mode.
- Configurations
  - 1,2,4,8* channels; equal bandwidths of 128* / 64 / 32 / ◦◦◦ / 1 MHz.
    - Possible future upgrade to support varying-bandwidth channels.
  - Channels selectable from 4* IF inputs.
  - * 8-channel or 4-IF modes require dual-RDBE hardware configuration; maximum 8-channel bandwidth: 64 MHz (i.e., 2-Gbps recording).
- Frequencies settable in steps of 15.625 kHz.
  - But may not cross IF "zone boundaries" at 640 and 896 MHz.
- Requantized to 2 bits, VDIF format; possible future upgrade to >2 bits.

Beyond the VLBA — the High Sensitivity Array (HSA)

EVLA WIDAR correlator has operational RDBE-like modes; recording on a Mark 5C unit.

- Currently only available in non-subarrayed “Y27” configuration.

GBT is completely implemented as a VLBA station.

Effelsberg has developed scripts to operate RDBE / Mark5C from the Field System.

- All modes (PFB, DDC-4, DDC-8) operated correctly in a recent test.

Arecibo plans to adapt Effelsberg script approach.

- Has previously operated successfully in PFB mode.

Beyond the VLBA — the Global cm-Wave Network

Most EVN Stations Use DBBC-2 Units

Highly compatible with RDBE.

Differences in extremes of number of channels and bandwidth.

DBBC/PFB may produce 32 (or more) 32-MHz channels.

RDBE/PFB could also produce – but not record! – 32 channels.

DBBC/DDC supports 16 channels, but limited to 16-MHz channel BW.

Well-matched tuning quanta.

1024 MHz / 2^n : n = 32 => 238 mHz (DBBC).

n = 34 => 59.6 mHz (RDBE).

In both cases, requirement for integral number of cycles in 1 second dictates practical quantum of 15.625 kHz (5^6; n=16 above).

Also, if compatibility with legacy systems is required, both systems are limited to 250-kHz tuning steps.

Beyond the VLBA — the Global cm-Wave Network

"Hybrid Mode" May Resolve Most Mismatches

- FX correlators can process different numbers of data channels spanning the same total bandwidth.
  - Frequency resolutions per spectral point must match in cross-multiplier.
  - Easier (probably) to implement in a software correlator.
- Actually used in original VLBA correlator, for Mark 3(A) format.
- Recently demonstrated in JIVE / SFXC and MPIfR / DiFX.
- Concern about channel mapping of T_{sys} data in Socorro / DiFX.
  - Two user groups recently agreed to develop this capability.

Review of First-LO Standards May be Desirable

- New, wider observing bandwidths may make current standards unfeasible or sub-optimal in some cases.


NRAO
Owens Valley, California
Brewster, Washington
Hancock, New Hampshire
Los Alamos, New Mexico
Kitt Peak, Arizona
Pie Town, New Mexico
Fort Davis, Texas
St. Croix, Virgin Islands
Thank you