

Adaptation of DiFX

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Adapting DiFX for the VLBA

Features added to date

- * Native support for Mark5 modules
- * Conversion of output to fully compliant FITS-IDI
- * Improved model + *UVW* generator (Calc 9.1+)
- * Much more flexible correlator configuration
- * Multicast system for monitor and control
- * Graphical User Interface (nearing completion)
- * Basic support for subarrays
- * Profiling tools
- * Many tools to simplify operation

Better Baseline Vectors (1)

VLBI delay models typically include a host of physical effects

- * Earth orientation
- * Earth deformation
- * Plate tectonics
- * Atmospheric profiles

Baseline vectors are treated more poorly

- * Use simple geometry
- * Aberration/relativity typically ignored
- * Near field objects not handled properly

Wide-field VLBI requires better!

Better Baseline Vectors (2)

Define image plane

$$\phi = \frac{2\pi\nu}{c} (ul + vm) \quad (1)$$

Differentiate w.r.t. image coords

$$\frac{d\phi}{dl} = \frac{2\pi\nu}{c} u; \quad \frac{d\phi}{dm} = \frac{2\pi\nu}{c} v \quad (2)$$

Respect the wave eqn. $\frac{d\phi}{d\tau} = 2\pi\nu$

$$u = c \frac{d\tau}{dl}; \quad v = c \frac{d\tau}{dm} \quad (3)$$

To get better baseline vector

$$\vec{B} = (u, v, w) = c \left(\frac{d\tau}{dl}, \frac{d\tau}{dm}, \tau \right) \quad (4)$$

Some benchmarks

Hardware

- * 11× dual 4-core XEON 2.5 GHz CPUs (45 nm)
- * 18× Mark5A + 3× Mark5C
- * 48 port non-blocking 1 Gbps network switch

2 bits/sample, 128 spectral channel, half polar tests

- * $N=3$ stations $r=1485$ Mbps $\rightarrow Nr = 4454$
 - Note: PATA disk I/O is bottleneck; SATA tests soon!
- * $N=9$ stations $r=536$ Mbps $\rightarrow Nr = 4824$
- * $N=10$ stations $r=480$ Mbps $\rightarrow Nr = 4800$
- * $N=11$ stations $r=430$ Mbps $\rightarrow Nr = 4739$

Recent work at NRAO

vex-based correlation

- * Old `vex2config` and `vex2model` insufficient for VLBA and geodetic observations
- * New program `vex2difx` aims to support all vex based observations

Further development of multicast system

Operator GUI

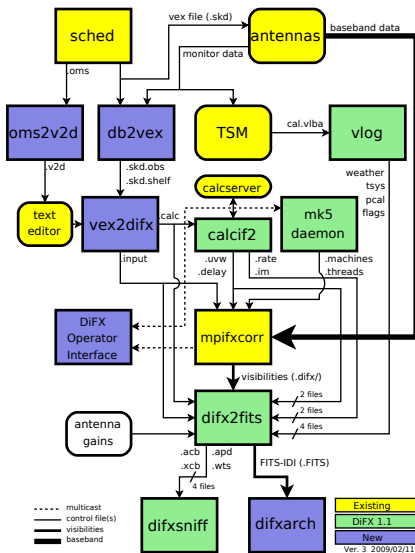
- * Graphically displays a queue of jobs to be run
- * Progress and failure monitoring for multiple jobs
- * High level control of correlator Mark5 units

Scalability test: 1.5+ Gbps / 3 station correlation

Development of operations plan

- * *See other talk...*

VLBA-DiFX block diagram



Upcoming features of `mpifxcorr` (mostly by A. Deller)

Mismatched/zoom band support

- * Independently specify recorded and correlation sub-bands
- * E.g., allows 2×4 MHz to be correlated against 1×8 MHz
- * E.g., allows high spectral resolution on a 125 kHz portion of 4 MHz

LO offsets

- * Initial implementation by J. Morgan
- * A. Deller adding formal support

New model infrastructure

- * `mpifxcorr` input files smaller
- * Use polynomials to describe model/ UVW over 2 min. intervals
- * To allow multiple phase centers

Phase Cal. Extraction

- * *See J. Morgan's talk*

Geodetic VLBI TODO list

Converter to write Mk4 output format

- * Much code can be lifted from `difx2fits` and `difxio`

Phase cal. extraction

- * In progress...

Mark5B+ support

- * Waiting on new `mpifxcorr` time infrastructure

Clean support for subarrays

- * `mpifxcorr` currently does a single subarray (sub-net)
- * `vex2difx` will produce multiple jobs to handle this now
- * Long term plan is to support this natively

Some advice

Expect a lot of work!

- * Correlation algorithm: \sim 100 lines of code
- * mpifxcorr: \sim 12000 lines of code
- * Deployed VLBA-DiFX: \sim 96000 lines of code
- * Much work of other adopters could be leveraged

Start adaptation development early!

- * Expect multiple FTE years of effort
- * Gain early experience with your hardware

You will want a system architect

- * You need somebody that is an expert in both correlation and your operations, or a close team
- * Plan for completely automatic operation but expect hands-on
- * Database integration?
- * Coordination of observing and correlation sites