



SFXC Software Correlator Developments

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Triggered Observations

- Proposal accepted: PI Anthony Rushton
- Intents to use AMI as trigger
 - AMI is being upgraded/refurbished
- Use VOEvents to trigger EVN observations
 - Filtering service at JIVE
- Filter VOEvents to meet criteria in proposal
 - Filtering approach to be discussed with PI (and PC?)
- Override based on relative priority (based on grade)
 - Relative priority already included in e-VLBI block schedule

VLBI data reduction in CASA



Two main components:

1. Fringe-Finder

- Python prototype (by Des Small): Matches AIPS
- CASA delay/rate calibration tables

2. Other a-priori calibration:

- Gain curves
 - System temperatures
 - Flagging
 - Opacity correction
-
- Data formats?
 - For now handle AIPS formats (ANTAB keyin)
 - Funded from BlackHoleCam and SKA-NL



SFXC Features

- FX software correlator
- Data formats: Mark4, VLBA, Mark5B, VDIF
- Delay model: CALC10 (same as Mark4@JIVE), or external
- WOLA: Hann, Hamming, Cosine, Rectangular
- VEX driven, with JSON configuration file
- Implemented using MPI
- Optionally uses commercial Intel IPP library



Paper

A. Keimpema, M.M. Kettenis et al, *The SFXC software correlator for very long baseline interferometry: algorithms and implementation*, *Experimental Astronomy*, Volume 39, Issue 2, pp.259-279

arXiv:1502.00467



2Gbit/s e-VLBI

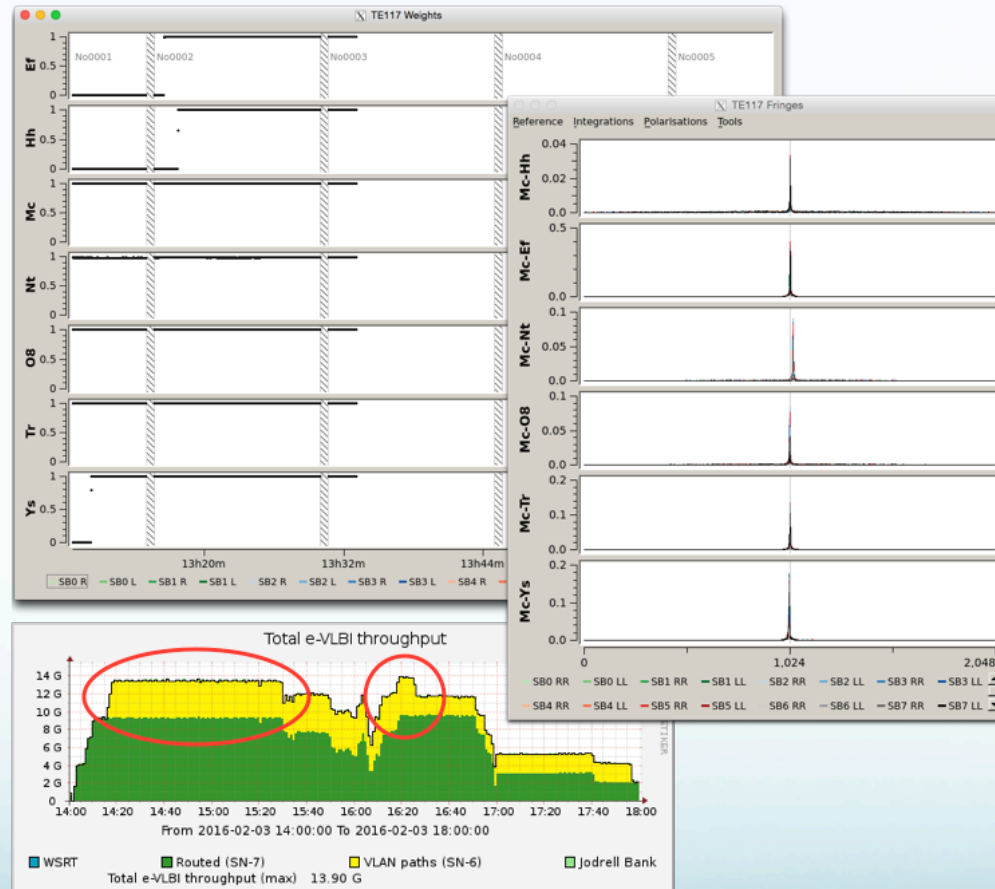
- Initial tests with Mark5B format
 - Successful in simulated environment
- Later tests with VDIF format
 - Initial attempt not so successful; lacked crucial optimizations
- Choice of VDIF flavours
 1. Single-thread, multi-channel, 8000 byte packets
 2. Multi-thread, single-channel, 2000 byte packets
- Optimizations needed for both flavours



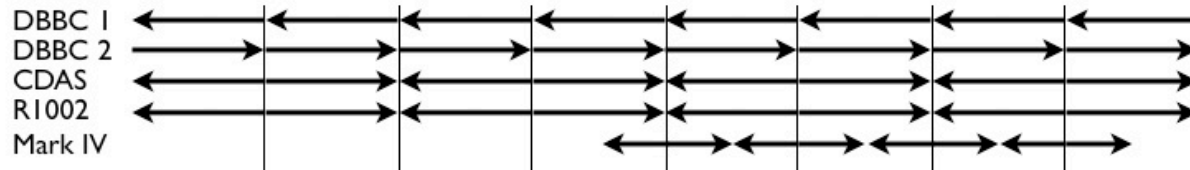
2Gbit/s e-VLBI

- SFXC uses TCP connections for bulk data transfer
 - Allows flexibility
- JIVE cluster has 1Gbit/s Ethernet and 40 Gbit/s (QDR) Infiniband
- Use IPoIB (IP over Infiniband):
 - Datagram mode
 - Connected mode
- Connected mode gives much higher throughput
 - Needed to make real-time 2Gbit/s e-VLBI work

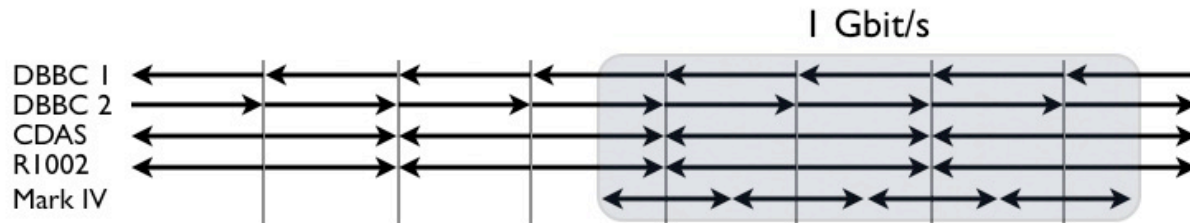
2Gbit/s e-VLBI



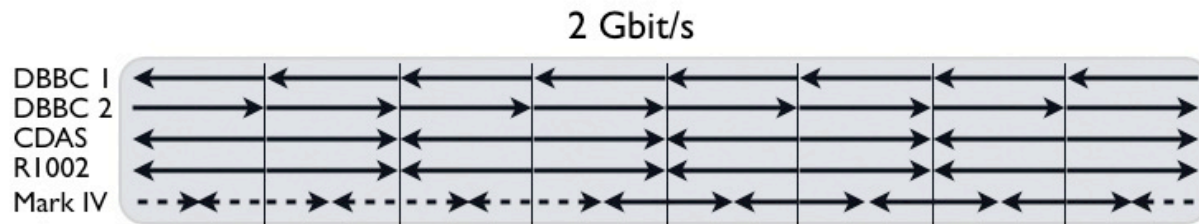
Mixed Bandwidth Correlation



Combined VEX file:



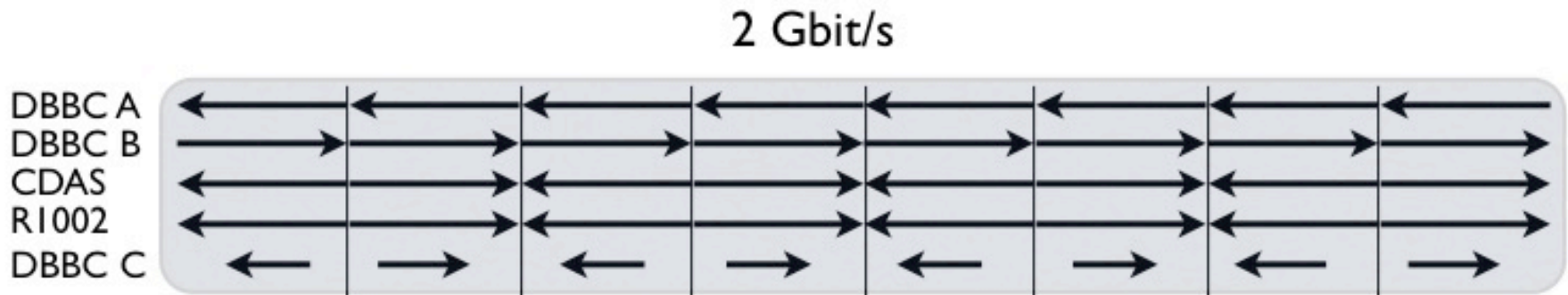
Edited VEX file (with fake 2 Gbit/s, 16 MHz station):



Mixed Bandwidth Correlation



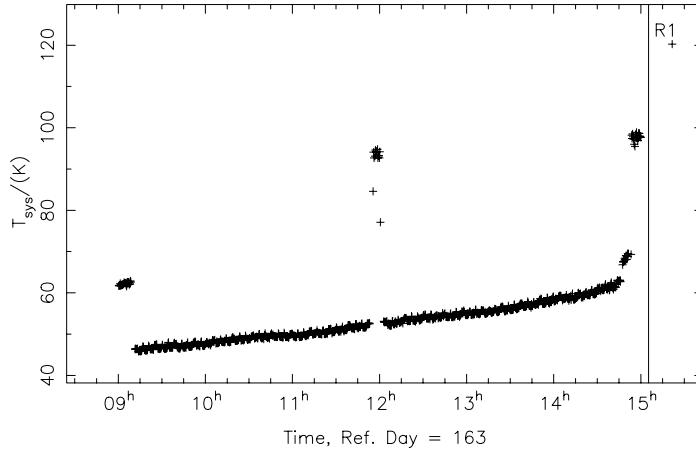
16 MHz Channels within 32 MHz channels



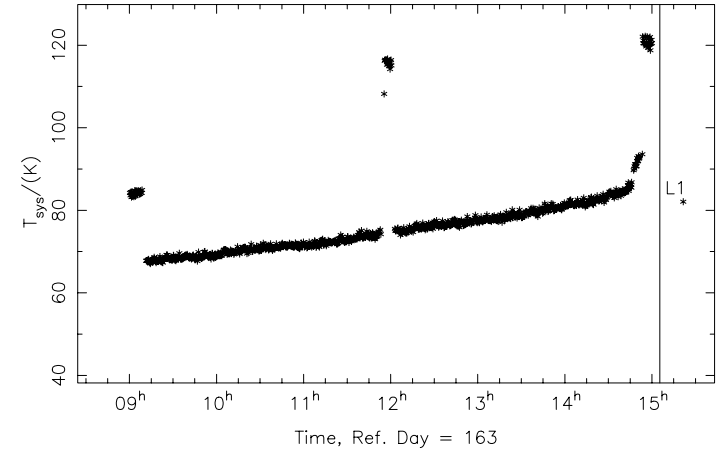
T_{sys} Measurements in SFXC

DBBC

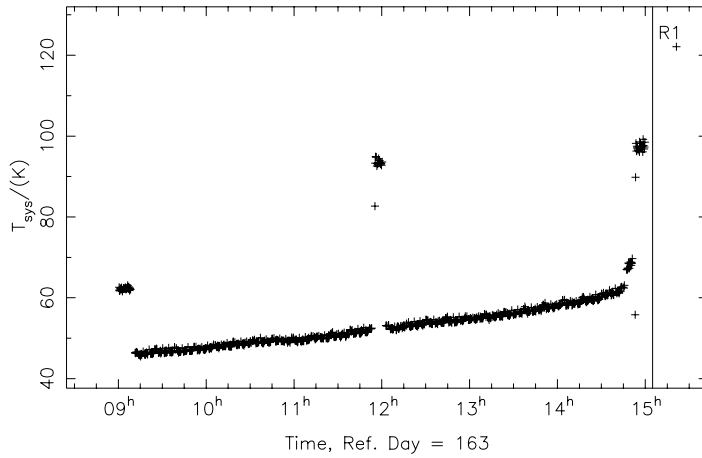
T_{sys} for EF in experiment GP051AEF R1



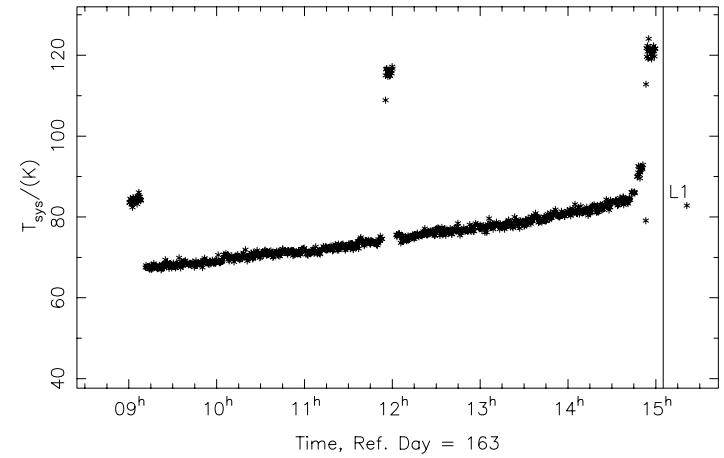
T_{sys} for EF in experiment GP051AEF L1



T_{sys} for EF in experiment GP051A R1



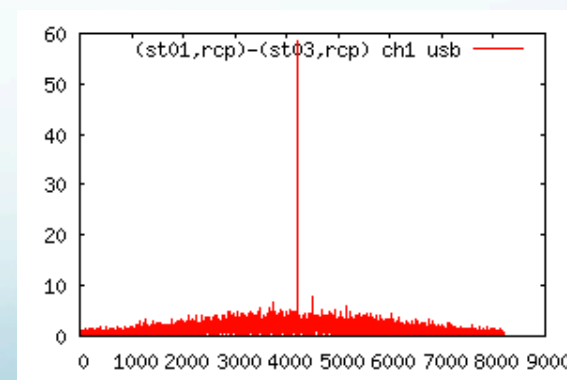
T_{sys} for EF in experiment GP051A L1



Correlator

Integer overflow!

- Single 4 GHz band from DBBC3
- 8 Gsamples/s doesn't fit in a 32-bit integer
- Fringes between On (DBBC3) and Ef (DBBC2), using mixed bandwidth correlation
- Needs changes to correlate output format





Scalability

- Parallelization axes:
 - Time (sub-integration) (SFXC, DiFX)
 - Frequency (sub-bands) (SFXC only)
- Data sub-integration/sub-band of all stations sent to single computer
 - Creates a data bottleneck
 - CPU's are not getting faster
 - 40 Gb/s is hard to sustain with small number of network streams
- Calibration of wide bands?
 - Nonlinear effects