JIVE

Joint Institute for VLBI ERIC

SFXC Introduction

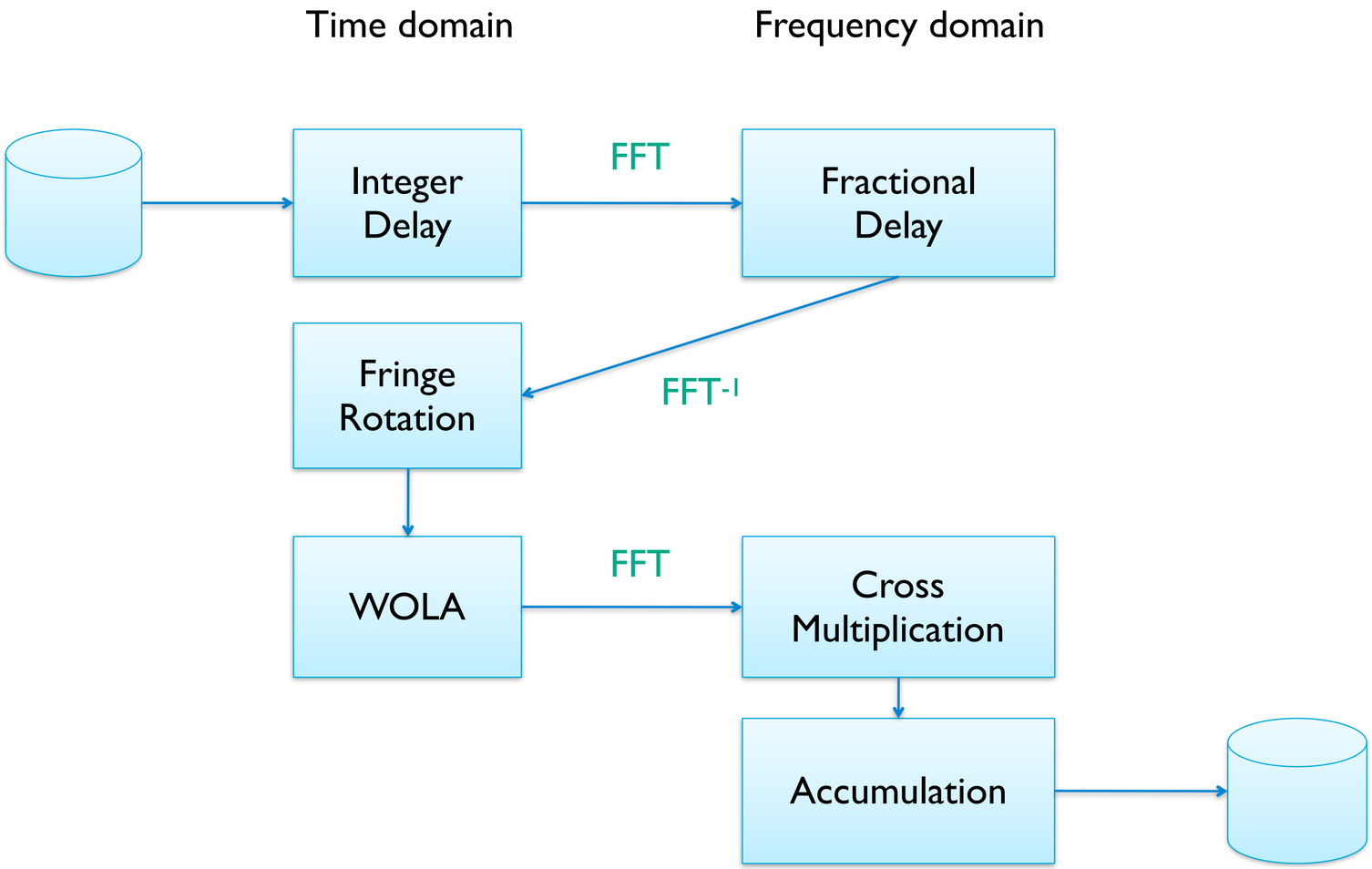
SFXC Workshop

Mark Kettenis, 22 September 2025

SFXC Features

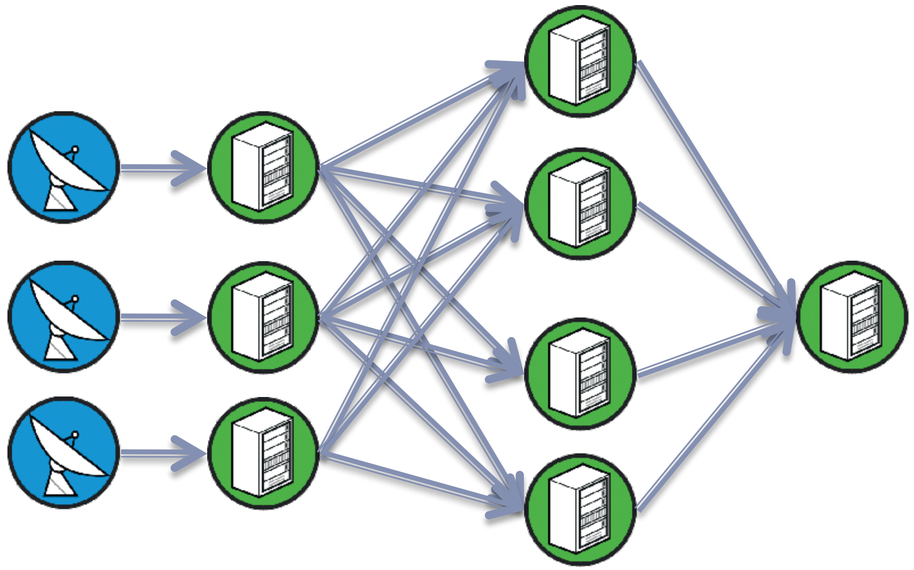
- FX software correlator
- Data formats: Mark4, VLBA, Mark5B, VDIF
- Delay model: CALC10 (same as Mark4@JIVE), or external
- **WOLA**: Hann, Hamming, Cosine, Rectangular
- VEX driven, with JSON configuration file
- Implemented using MPI
- Optionally uses commercial Intel IPP library
- Pulsar binning
- Incoherent or **coherent** de-dispersion
- Mixed bandwidth correlation / zoom bands
- **Phased array mode**

SFXC Algorithm



Parallelization

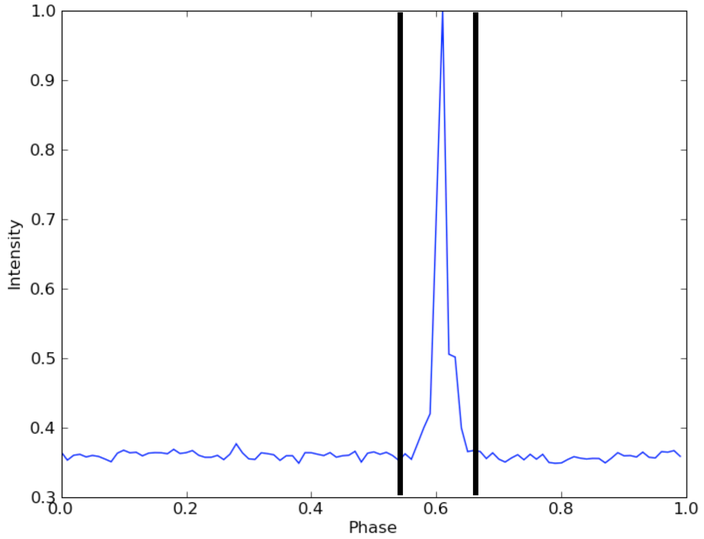
- Frequency axis
- Polarisation (only if no XPols)
- Time axis



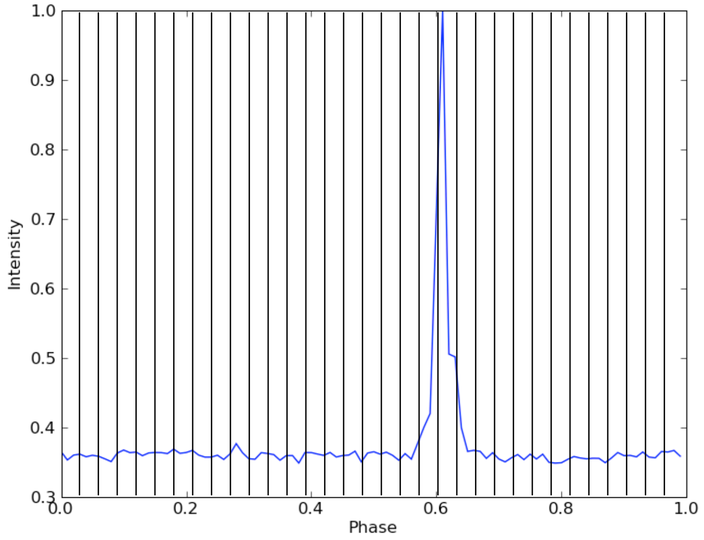
Space Science

- SFXC is a key ingredient of PRIDE:
  Planetary Radio Interferometry and Doppler Experiment:
  - High resoluton spectrometer (Guifre Molera)
    - Determines doppler shift
  - Near-field model (Dmitri Duev)
    - Replaces CALC10 for sources
      in solar system
- Used in Mars Express Phobos flyby
- Also used for processing RadioAstron observations

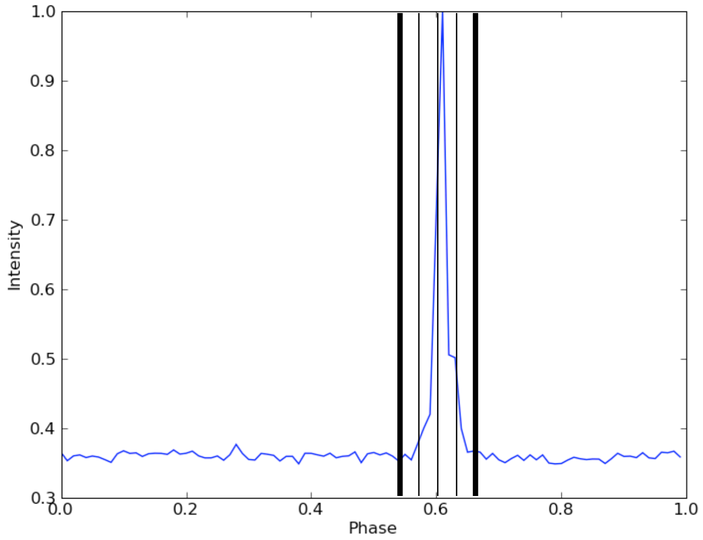
Gating



Binning



Gating + Binning



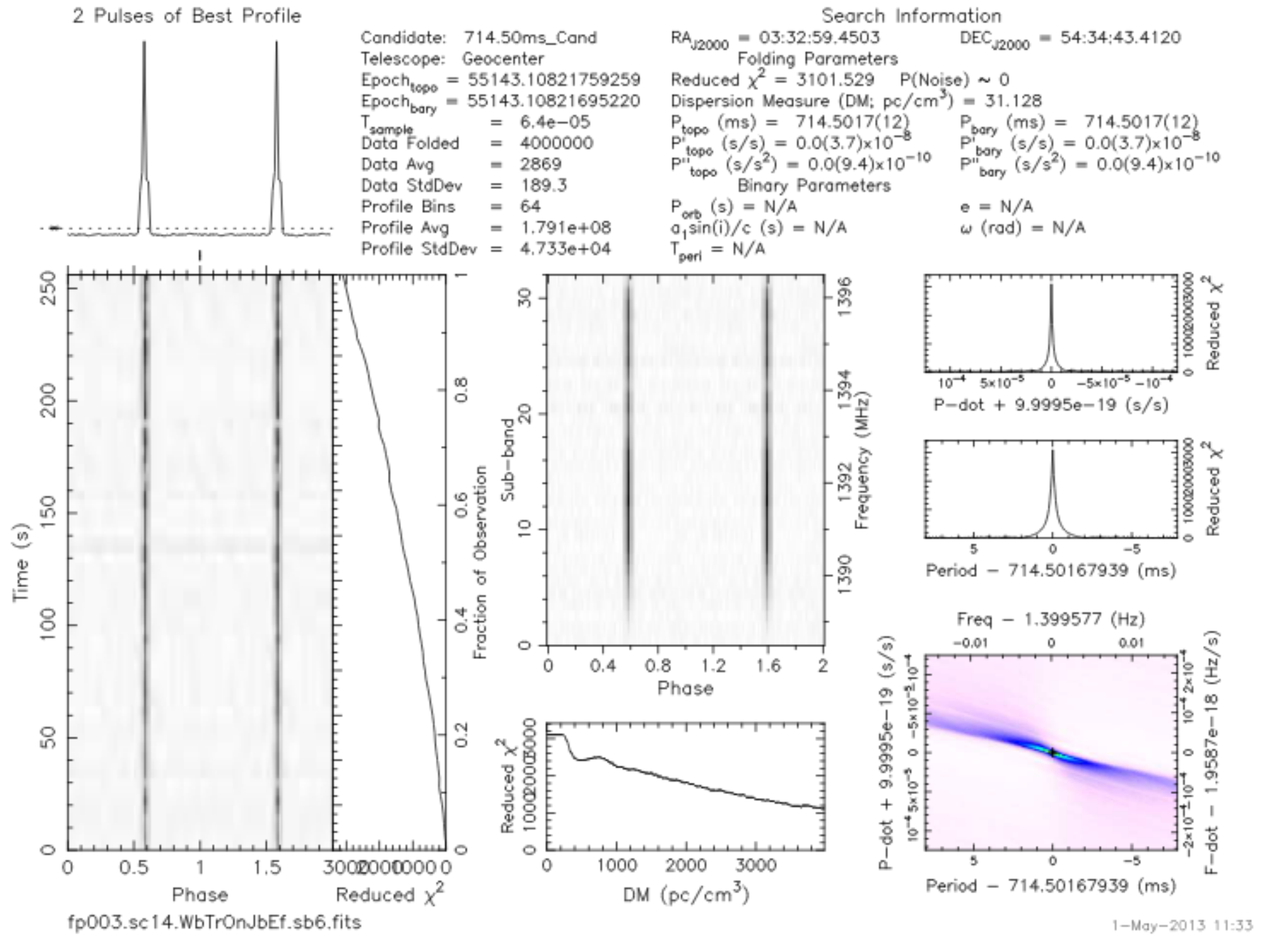
JIVE

Phased Array Mode

1. Apply AIPS calibration during delay compensation
2. Sum stations
3. Integrate total power per frequency bin
4. Resample
5. Convert to PSR FITS

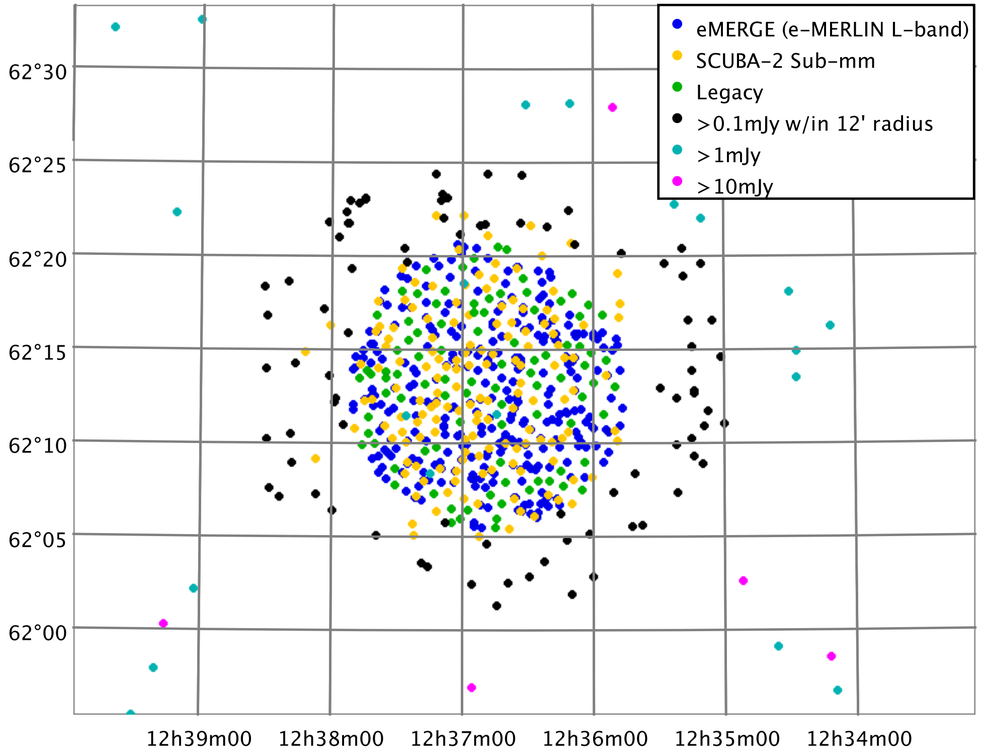
➡ Can be used as imput for standard Pulsar tools

Phased Array Mode



Pulse profile for B0329+54 summing Ef, Jb, On, Tr and Wb

Multiple Phase Centers



Radcliffe et. al.

699 sources in GOODS-N

Two areas:

- 15’ central area
- 20’ outer annulus

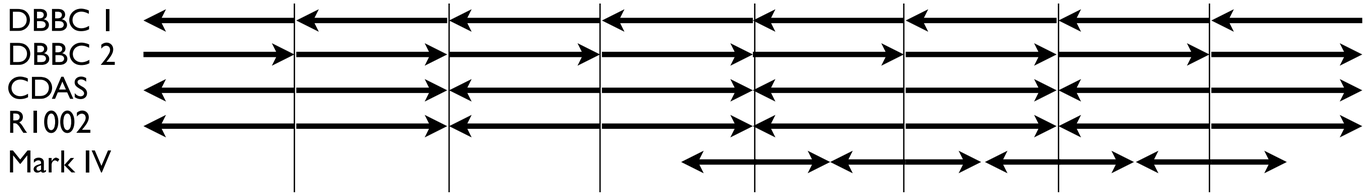
Multi-source Self Calibration

arXiv:1601.04452

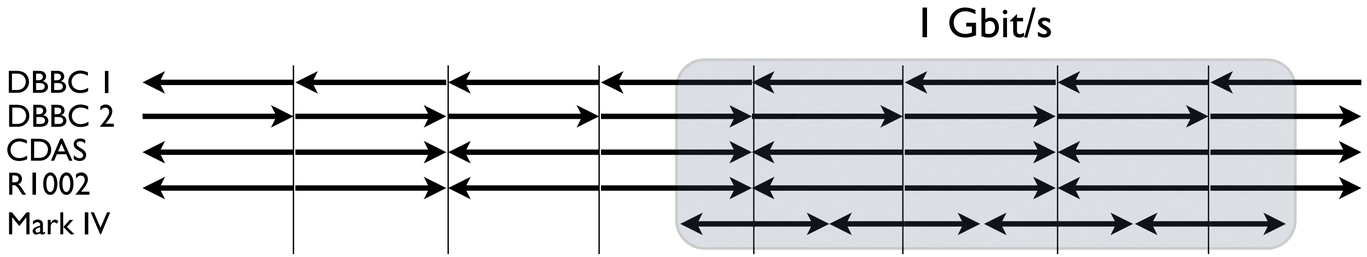
Mixed Bandwidth Correlation

- New digital backends are incompatible
- EVN: Offer 2/4 Gbit/s on selected baselines
  16 MHz with 32 MHz
- Global VLBI: RDBE in DDC mode
  16 MHz with 32/64 MHz
- Need to flip sidebandedness

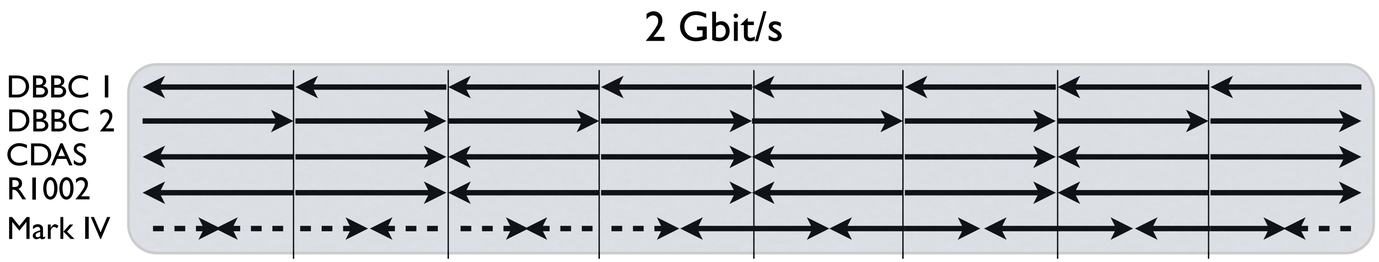
Mixed Bandwidth Correlation



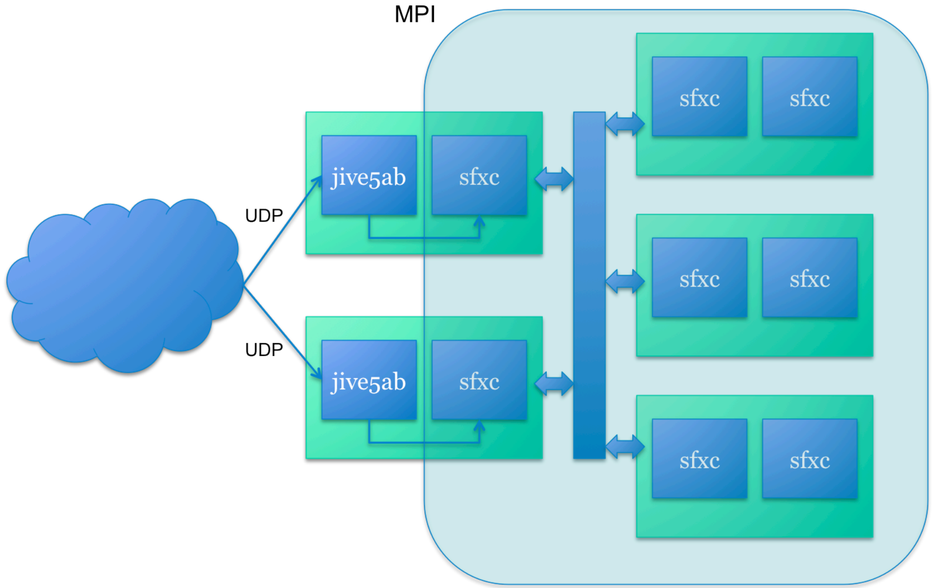
Combined VEX file:



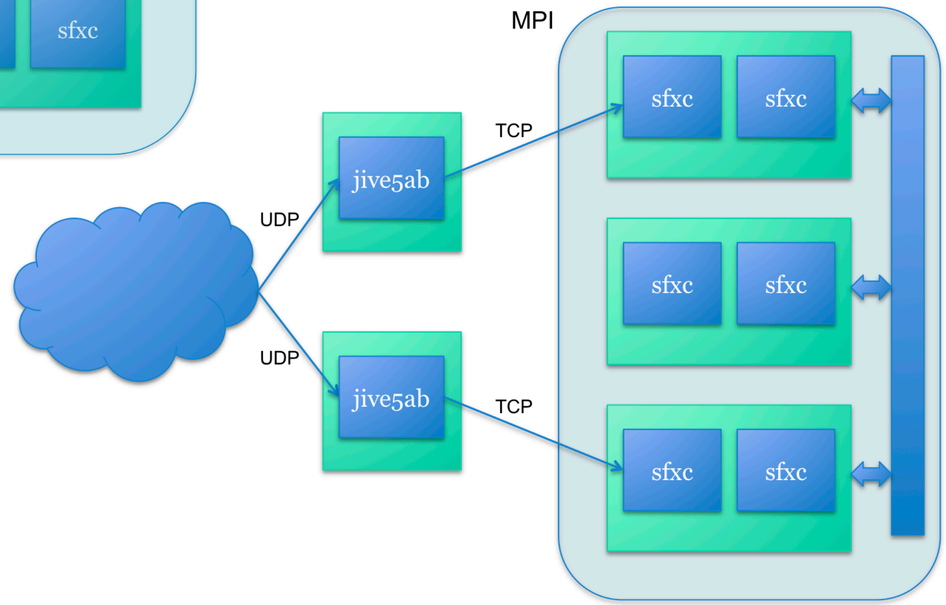
Edited VEX file (with fake 2 Gbit/s, 16 MHz station):



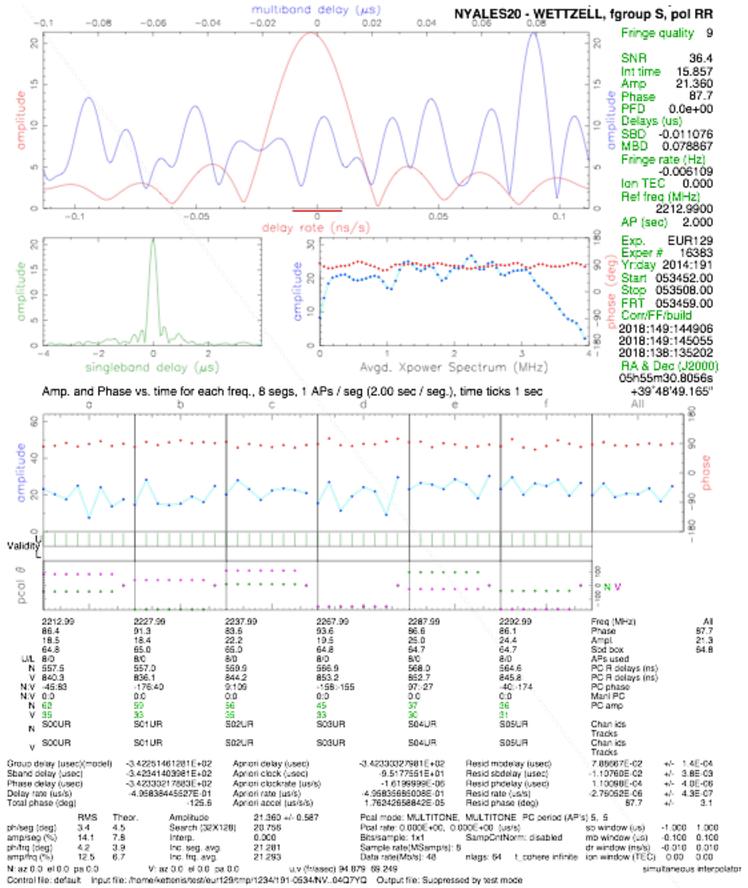
Real-time e-VLBI with SFXC



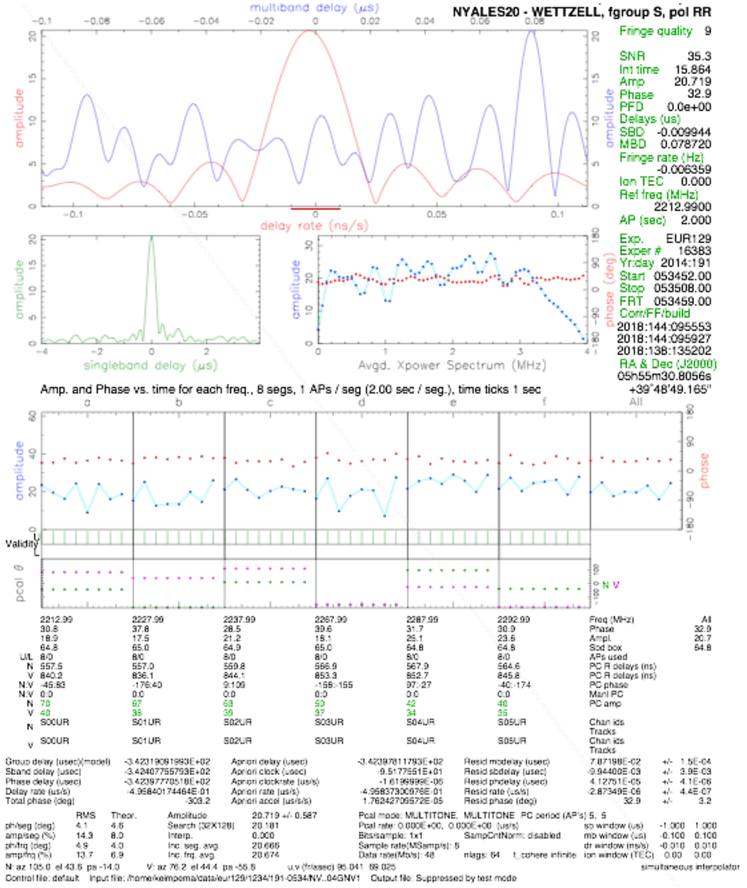
Using of bridge nodes for data input



Geodesy/Astrometry



SFXC



DiFX

Questions?