EXPReS FABRIC Kick-Off

JIVE's Expertise and Ambitions

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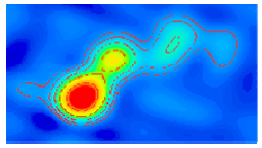
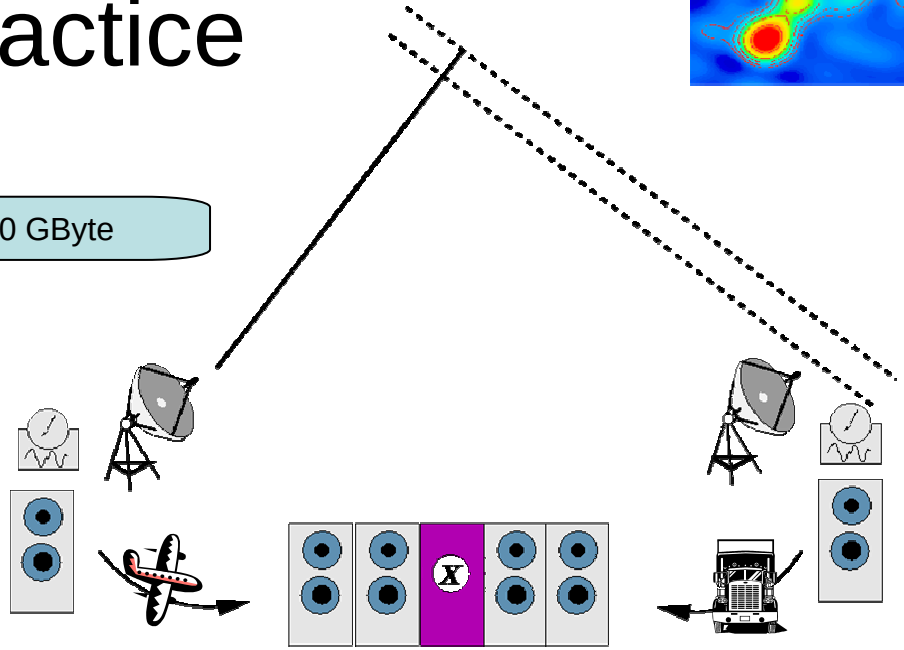
JIVE's Expertise and Ambitions

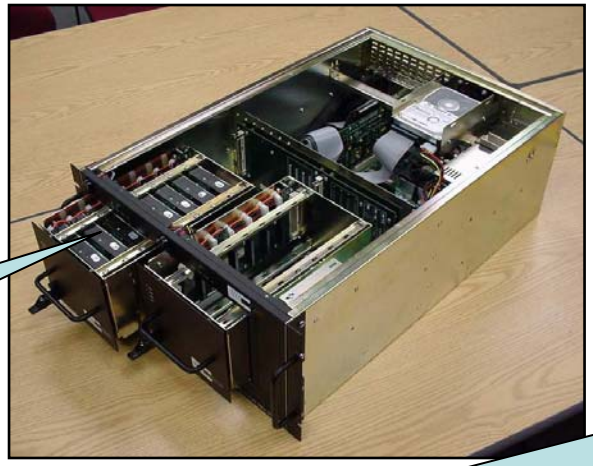
- Expertise
  - EVN Mk4 correlator operations
  - e-VLBI status
  - Ultra Narrow Band Correlation for Huygens on Titan
  - Broad band width software correlator
- Ambitions
  - Enable Software Correlator core to run on Grid nodes.
  - Variable Band Width correlator for special projects.

VLBI, today's practice



Tapes, 800 GBye



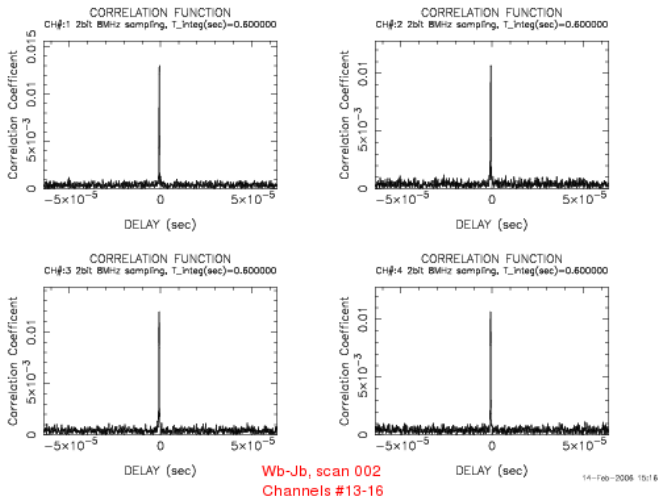


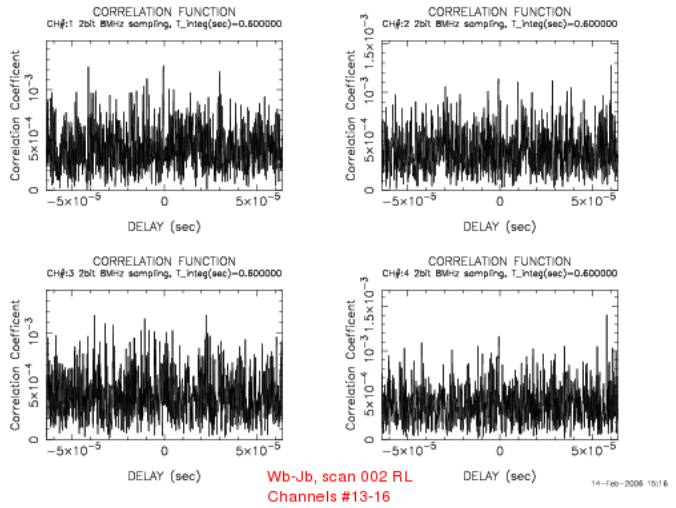
Mk5a disk arrays, 3.2TByte

EVN Mk4 correlator board, customs chips

Checking the VLBI observation system

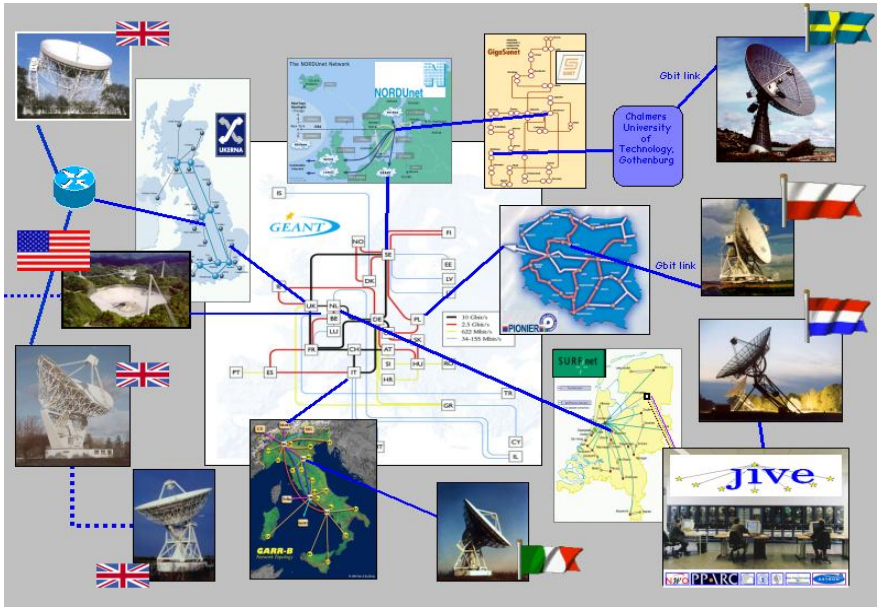
- VLBI requires coordinated/special set-up of telescopes and equipment.
- Fringe tests to check the system before start VLBI session absolutely necessary.
- 2003 and before:
  - a week before session tapes send to JIVE with test data, correlated on EVN Mk4 correlator. Fringe tests!
  - Very limited time to handle possible problems
  - Problems occurring during session, detected after session. Data loss!
- Present practice:
  - Short files ftp'ed to JIVE. Only a few seconds of data per station
  - Correlated using the K5 Software correlator (Kashima Space Research Center, NICT)
  - Detection problems during VLBI test possible

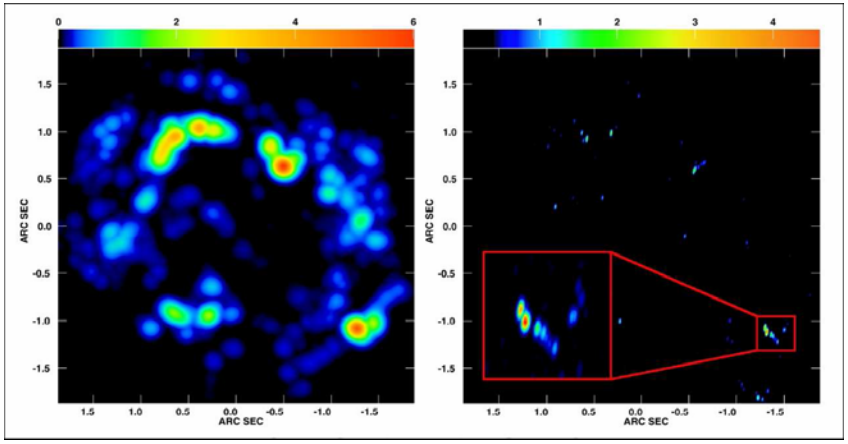




Current EVN e-VLBI network

- About 7 Telescopes
- Data rate 32 - 256 Mbps per telescope
- Excellent science already possible

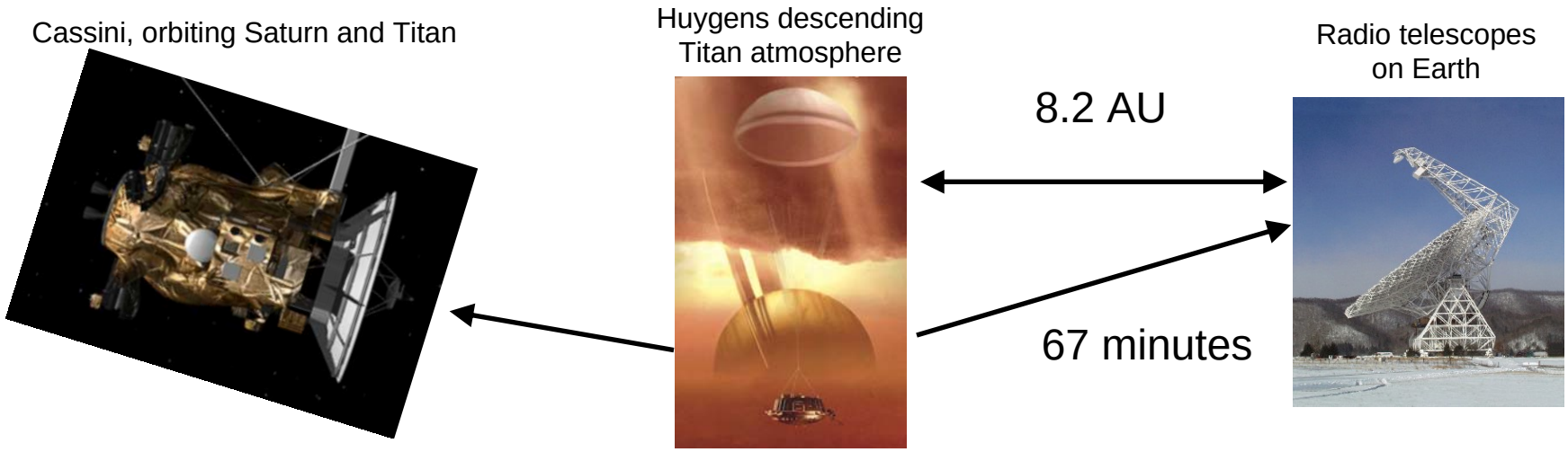




Super giant star IRC+10240, surrounded by shell of dust and gas

- Left image UK Merlin radio image
- Right EVN e-VLBI image, 32 Mbps. Finer structure because of higher resolution

Radio Measurements Huygens probe 2005

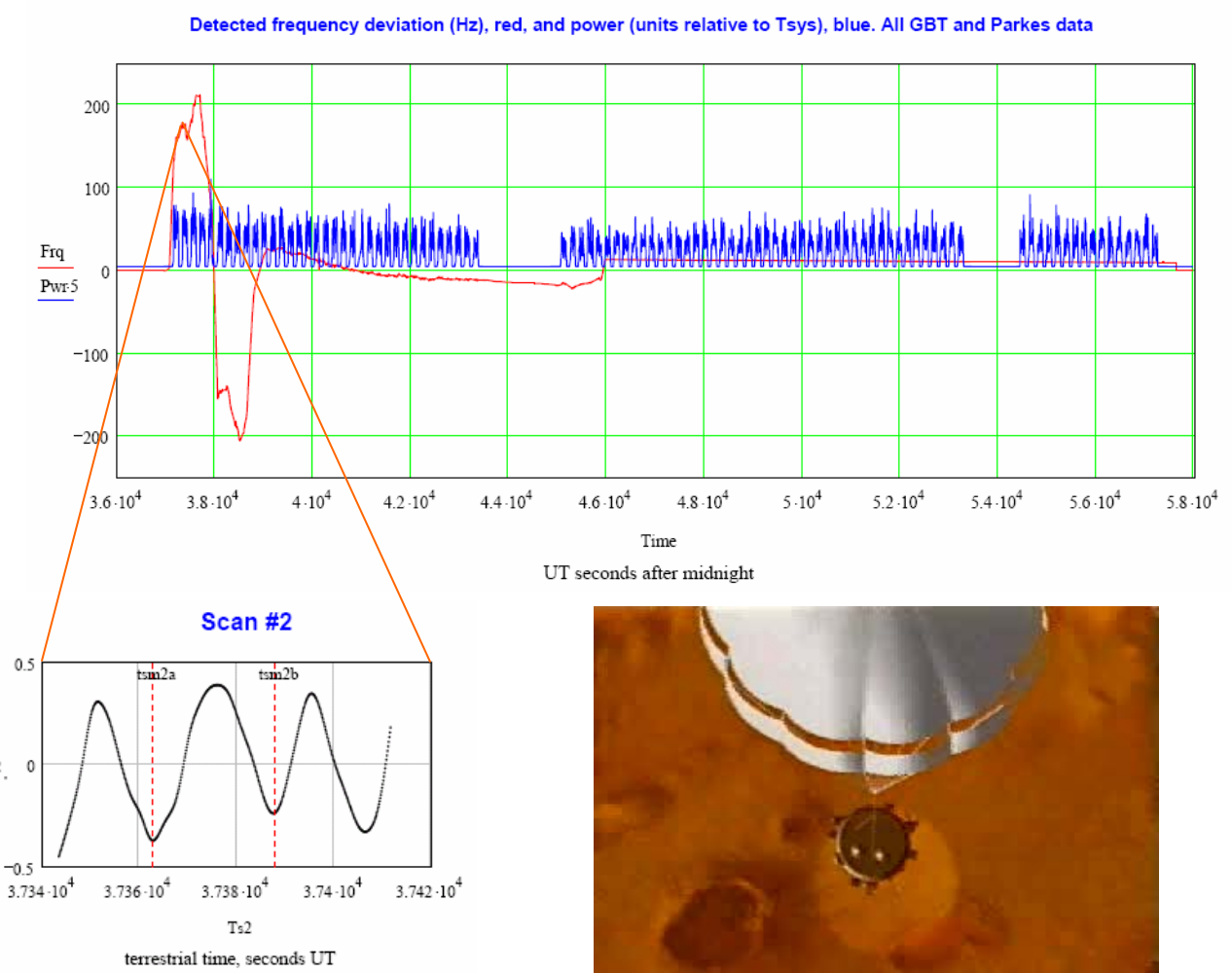


- Spacecraft tracking and navigation
- 14 January 2005 Huygens probe descents in Titan atmosphere
- Huygens transmitter only 3.5 W
- 17 radio-telescopes tracked Huygens. (JIVE)

Detected Huygens frequency and power

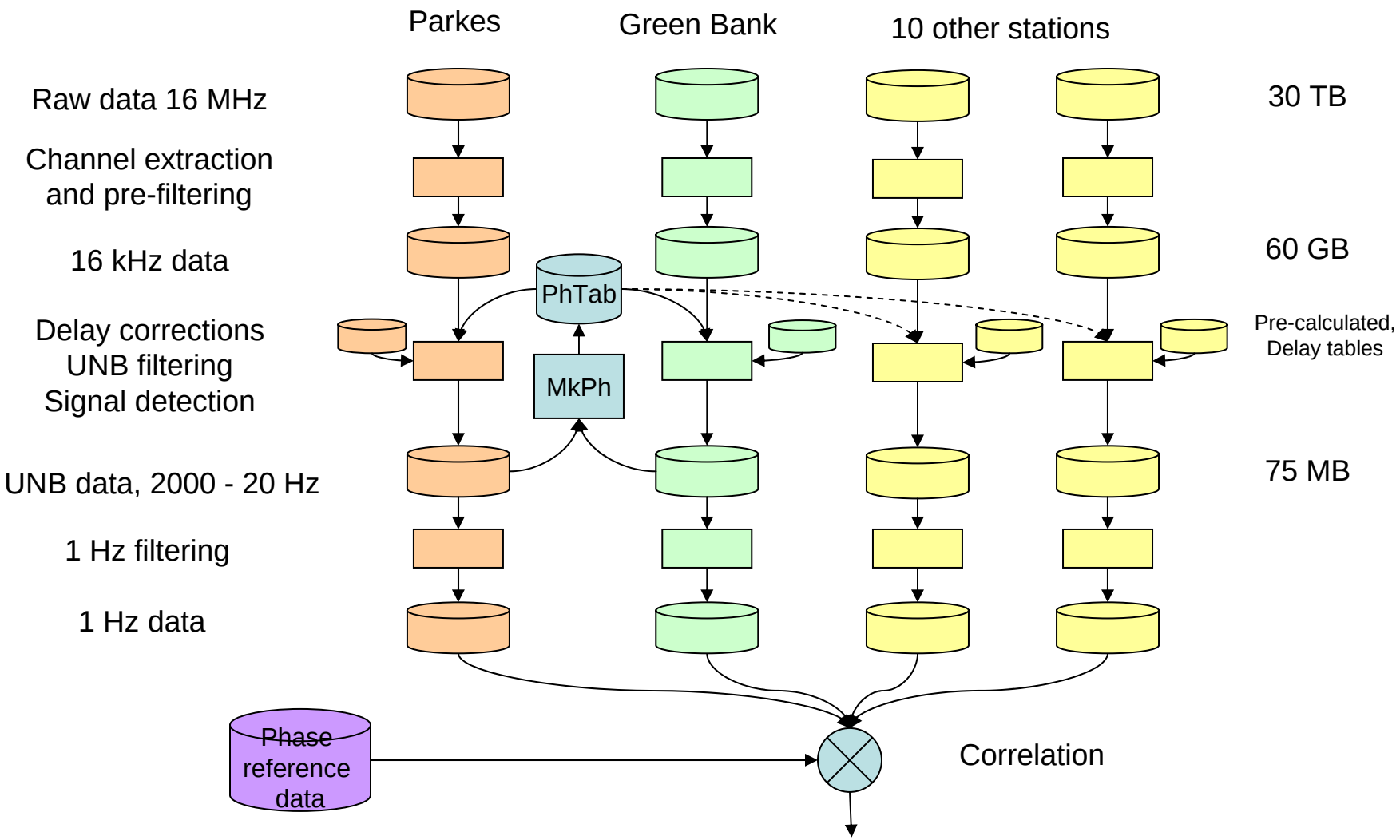
Green Bank (USA)

Parkes (Aus)

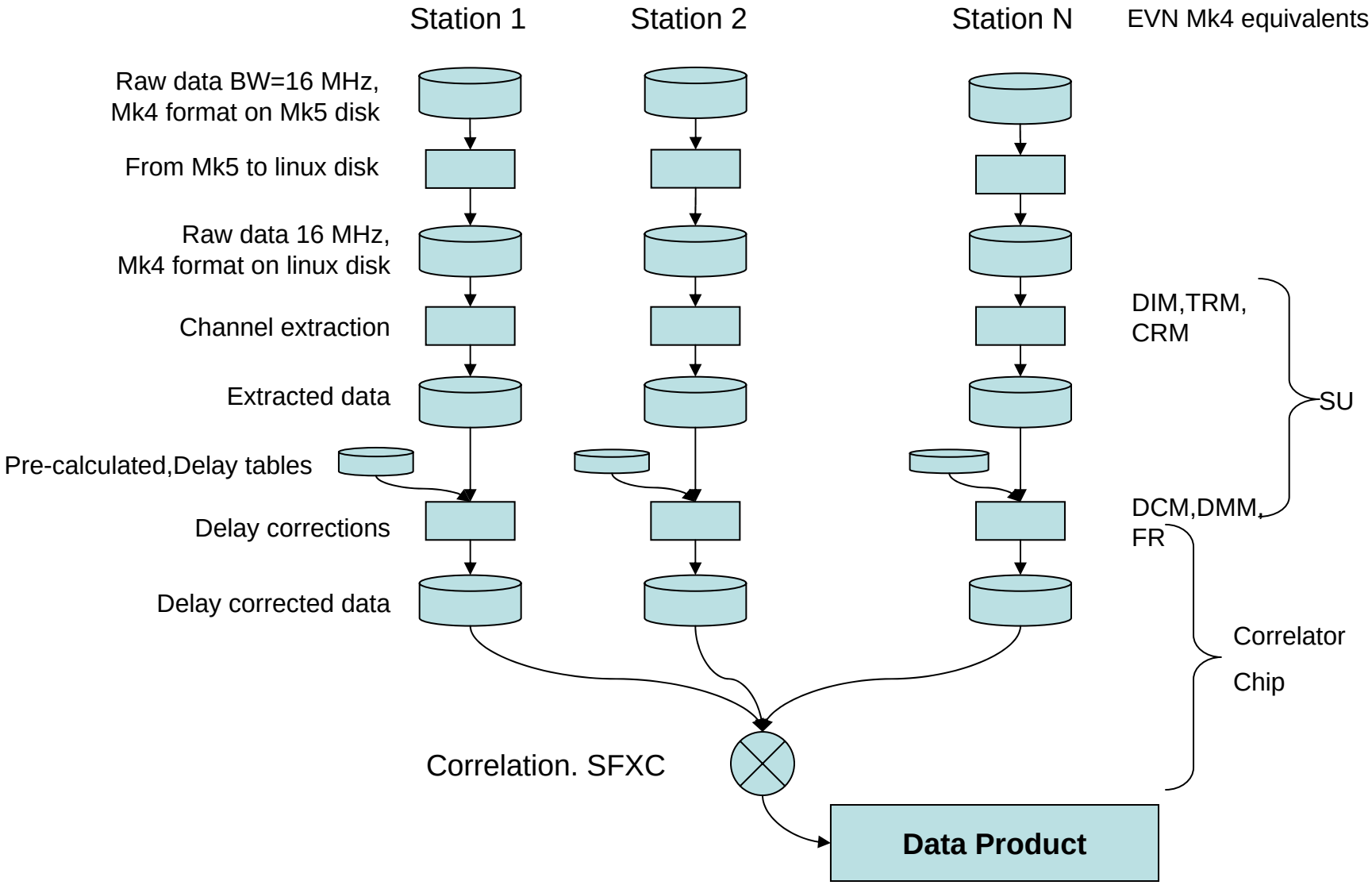


Huygens swinging under its parachute

Ultra Narrow Band correlation, Huygens on Titan

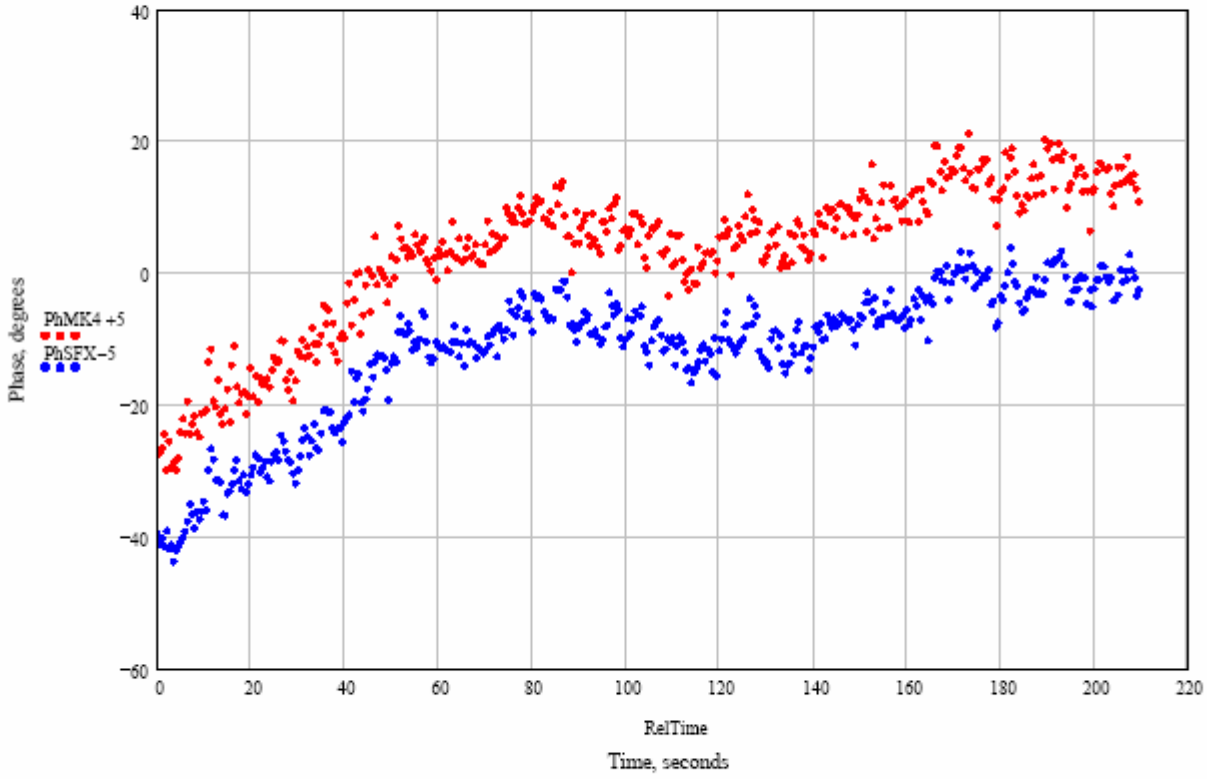


Broadband s/w correlator. SFXC



Comparison MK4 and SFXC correlator

Compare phases of MK4 and Huygens SW correlators, BW 16 MHz, Baseline GB-BR, Source DA193, S-band
210 seconds, 0.5 s integration per point,
64 spectral channels for MK4, 65 spectral channels SW. Bulk linear trend (common slope for both) removed,
10 degrees shift between curves applied for distinction. MK4 data - red, SFX data - blue

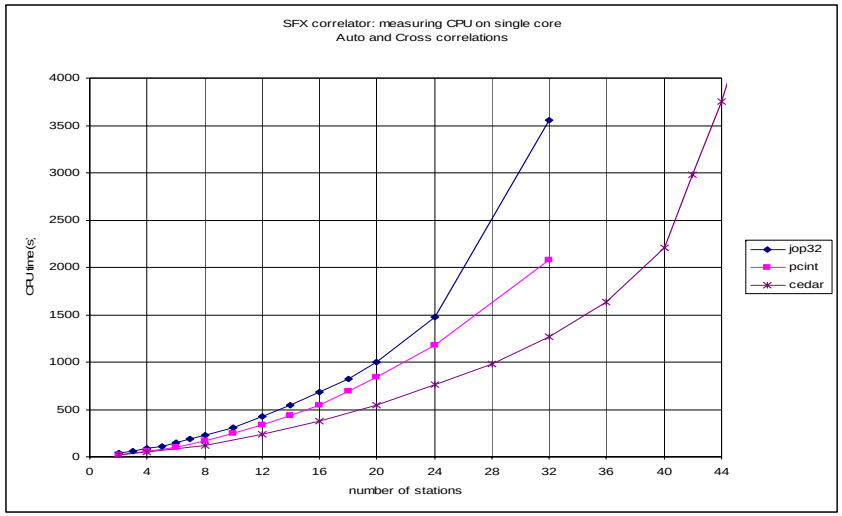


stdev(diffMK4) = 3.1874121493617644

stdev(diffSFX) = 2.2455567957849438

Scatter on SFX data is less than that on MK4

Benchmark Test Results SFXC (1)

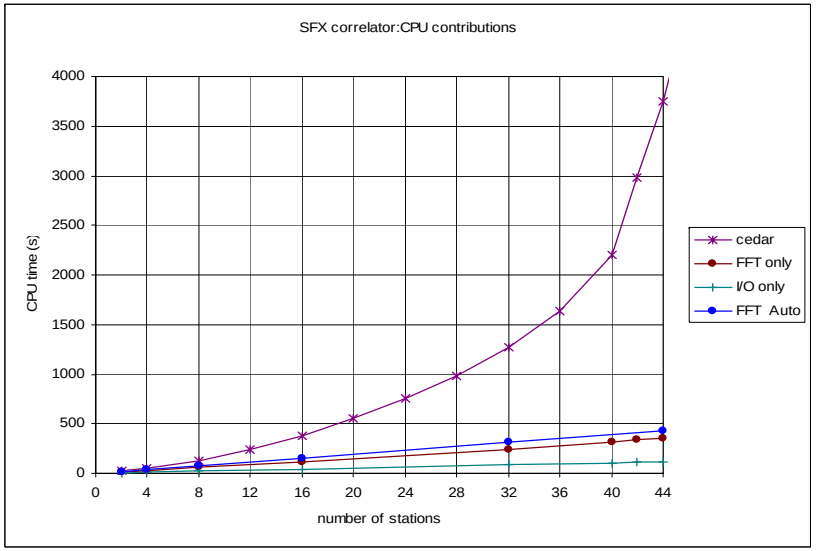


Comparison of single core processors

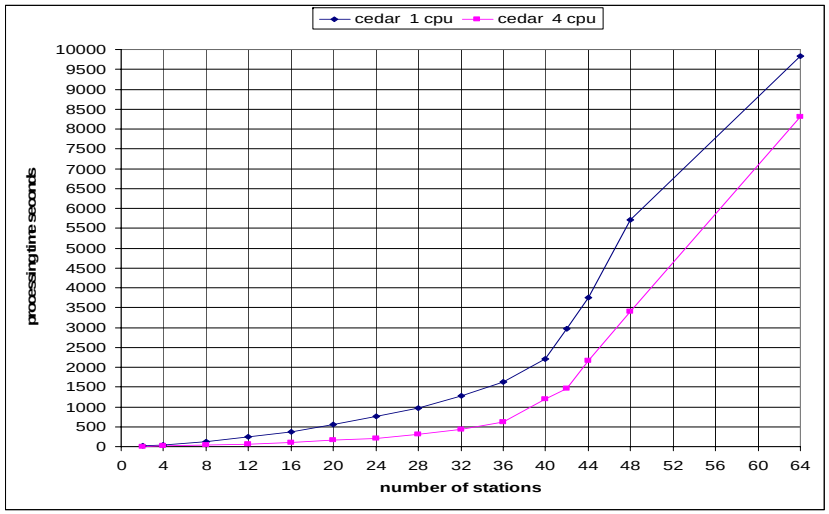
- 10 sec data, 16MHz BW one channel
- Jop32: Intel Pentium 4 3.0 GHz
- Pcint: AMD Opteron 244 1.8GHz
- Cedar: AMD Dual Core Opteron 270 2.0GHz. Using one core

CPU contributions

- Cedar: AMD Opteron 270, one core
- I/O, FFT, Autos: scale linear
- Cross correlations extremely non linear. Concentrate performance optimization efforts



Benchmark Test Results SFXC (2)

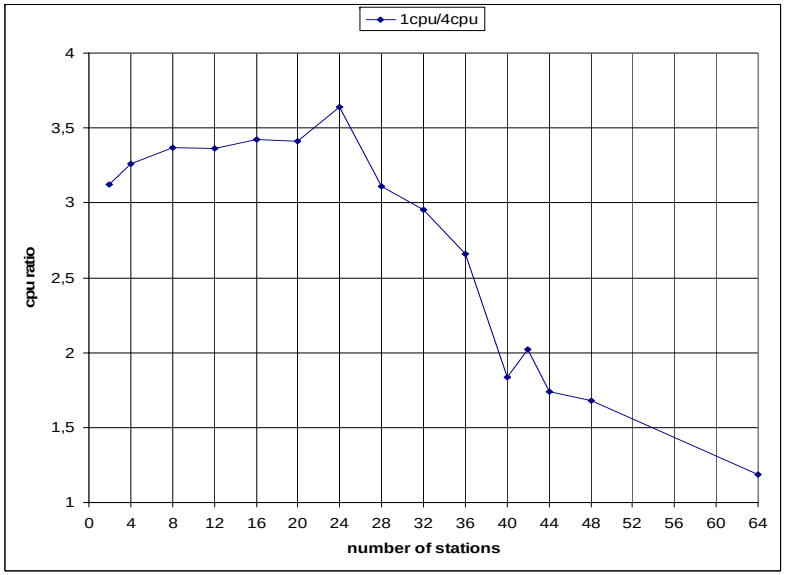


Using a single core and 4 cores on Cedar, a double dual core machine

- 4 stations, 10 sec data takes 46 sec CPU using 1 core
- 4 stations, 10 sec data takes 14 sec CPU using 4 cores

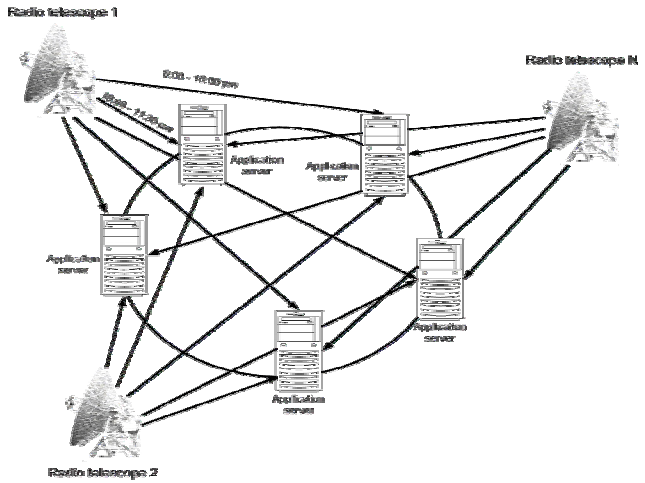
CPU ratio on Cedar

- Running 4 processes gives max 3.6 times a single CPU performance. (Amdahls law)
- Beyond 24-28 stations strong performance drop
- Optimizing performance requires thorough knowledge of hardware architecture



Future Correlators

- Current practice:
  - Centralized processing
  - Custom made hardware
  - Synchronous processing
- Issues
  - Computing power
  - Connectivity
- Possible future practice
  - COTS hardware and software, e.g. CELL CPU IBM
  - Software correlator
  - Grid computing
- Projects
  - EXPReS FABRIC (EU funded)
  - SCARI (NWO funded). Partners: SARA, UvA, NLgrid



Software Correlator Requirements/Issues

- Speed up current code SFXC
  - Parallelization?
  - Vectorisation SIMD (SSE) ?
- I/O Interface standardization
  - Output format FITS
  - Geometrical model (delay)
  - Control file(s) with set up parameters
  - Observational data
- Portability: test on various platforms
- Enable variable (ultra narrow) band width correlation for special projects like:
  - Space craft tracking
  - Cosmic water masers