Impact of Operations on Data Analysis

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Formatter Clock Jumps

- The Mark IV correlator does not handle arbitrary formatter offsets
  - If sub-second portion (available from gps-fmout or fmout-gps) of the clock offset exceeds about ±30 milliseconds it must be reset.
  - If the integer second portion (available normally from “sy=run setcl &”) of the clock offset exceeds about ±5 seconds it must be reset.
  - Correct as soon as possible
- Smaller offsets should **not** be removed.

Extra Cable delay

- Avoid interrupting 5 MHz to the Cable Calibrator antenna unit
  - If you leave the cable extender for the cable measurement in the line by accident, don't take it out once the experiment has started unless you believe there is something wrong with the extender.
  - Likewise, do not make the cable measurement during the experiment. If you forget to make it beforehand, please wait until the end.
- Please note: phase meter must be in the middle half of the range

Sensitivity Effects

Geodetic Precision is roughly proportional to observation sigma σ

$$\sigma \propto \frac{1}{SNR} \propto \sqrt{\frac{SEFD_1 SEFD_2}{T_{\text{int}}}} \Big/ S_c$$

- σ is the precision of the observation (sigma) or how good a measurement we are making (the smaller the better)
- SNR is the signal-to-noise ratio, or how much stronger the signal is than the noise (the larger the better)
- $SEFD_1$ is SEFD at antenna 1 (the smaller the better)
- $SEFD_2$ is SEFD at antenna 2 (the smaller the better)
- T_{int} is the integration (recording time) of observation (the larger the better)
- S_c is the correlated source flux (the larger the better)
- Observation sigma σ is inversely proportional to *SNR*
- Observation sigma σ is proportional to square root of product of SEFDs
- Observation sigma σ is inversely proportional to square root of T_{int}, recording time

Effect of a Warm Receiver

- If one station's receiver is warm, that station's SEFD might typically go up by a factor of 3.
  - Then the average sigma would go up a factor of or about 1.7, a station position estimate that would have been precise to about 5 mm would instead be precise to about 8.5 mm.
  - Warm receiver with SEFD 3 times normal is the same as observing 1/3 of the time
  - Target (minimum) SNR values are typically 20 at X-band, there are no fringes of SNR falls below about 7.
    - With an SEFD 3 times normal, the equivalent target SNR becomes 11, the result is not fatal and many observations still exceed the target.
  - A warm receiver at one station usually won't destroy an experiment as is.
    - However, it may prevent fringes to a high SEFD station if it was scheduled with a lower SNR target. For example baselines to O'Higgins are typically scheduled with a target of 15. If Hobart warms-up the SNR is reduced below 9 and the Hobart-O'Higgins baseline will be marginal at best.
- Stopping and re-cooling is not the automatic solution
  - Suggestion: only re-cool if
    - The RX is warm at the start of the experiment
    - You have high confidence you can re-cooling quickly, say in 6 hours or less
  - Not re-cooling is acceptable

Other effects that increase SEFD

- Pointing off by one half of a full-width-half-maximum (FWHM)
  - Drops the response of the antenna by a factor of two and so doubles the SEFD and the sigma is increased by sqrt(2)
- If the focus is off, the same rule applies.
  - If the response is down half, the SEFD is doubled and the sigma is increased by sqrt(2).
- Poor image rejection:
  - Front-end, doubles the noise level in all channels, so increases sigma by sqrt(2).
    - also does bad things to phase-cal: adds spurious signals
  - VC/BBC, doubles the noise level in that channel, so increases the sigma by about a small amount, but is bad in other ways

Other issues

- Missing channels
  - Each lost channel reduces data yield by about 7%
  - It can compromise the delay resolution function, please see the accompanying write-up in the notebook by Axel Nothnagel
- Phase-cal
  - Should be about 1% in power
    - Too strong reduces sensitivity and produces spurious signals
    - Phase-cal too weak and existing spurious signals can be a problem

Station Performance 2004

- Results for 153 Sessions (29 not included)
- 966 Sessions Days (about 80%)
- 121 Days Data Lost ~ **12.5 %**
  - For 2003 ~ 14.2%
  - For 2002 ~ 12.2%
  - For 2001 ~ 11.6%
  - Subset of 1999-2001 ~ 11.8%
- This loss is expressed in observing time, overall data loss is about twice as much, or about **25%**

Data Loss by Sub-system 2004

Sub-system	2004 Loss %	2003 %
Antenna	32.9	17.8
Receiver	18.0	25.2
Recorder	11.2	10.9
Unknown	10.1	12.6
Miscellaneous	8.0	6.0
Rack	6.8	5.0
Operations	6.1	3.6
RFI	5.1	9.3
Shipping	1.4	6.1
Clock	0.5	3.4
Software	0.0	0.1
Total	100.0	100.0

Litany Of Problems (compiled by Mike Titus)

- TIGO X band problem.
- Spurious signals in phase cal (sometimes requiring manual pcal refourfit).
- RFI - often S4 at Westford, Medicina and occasionally Wettzell - and various other channels at other stations (nothing systematic sticks out though - unless TIGO's problem is really RFI!).
- Manual phase cal used at Kokee (will this ever be fixed?).
- Processing in two passes due to late arrival of Hobart disk (occasionally others too).
- Various antenna failures (often drive motors, sometimes pointing or pointing computers, hydraulics, mounts/rails).
- Mark5A hangs, or bad modules having to be switched out (causing missed scans).
- One bad disk in Mark5A disk pack.
- Seshan upper X band rolloff.
- Gilcreek pass overwriting.
- Low fringe and phase cal amplitude in individual channels, sometimes requiring deletion of said channel.
- Warm receivers.
- Fortaleza poor playback.
- Ionospheric disturbances.
- Fortaleza low amplitude in upper X band channels (WACO only mentioned).

Reduced Channel Amplitude

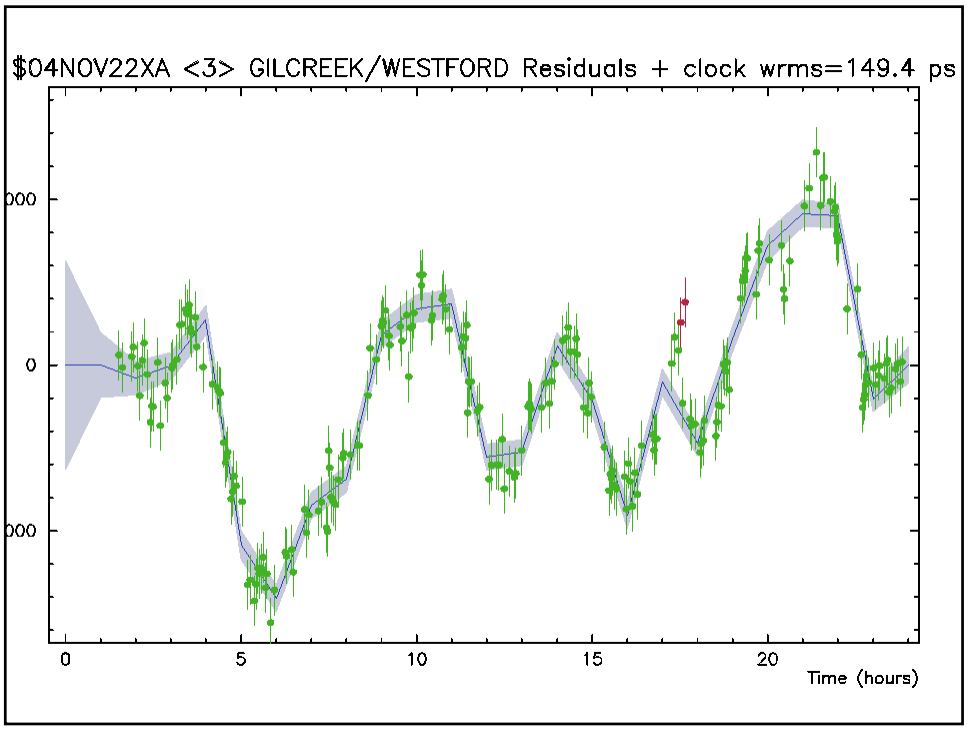
- Caused by Spurious Signal, RFI, bad channels, etc.
  - Sometimes channel must be deleted
  - See accompany fringe plots:
    - HartRAO autocorrelation: strong spur, channel deleted
    - Matera-Wettzell S Band & Matera autocorrelation: strong spur at Matera
    - Gilcreek-Westford S-band, bad BBC at Gc, RFI at Westford, note: sidelobes of MBD high
    - TIGO-Wettzell, Upper X-band problem at TIGO
    - Gilcreek-Hobart S-band, Hobart noisy LO in VC14
    - Seshan-Wettzell X-Band: Seshan roll-off in upper channels, all four channels deleted

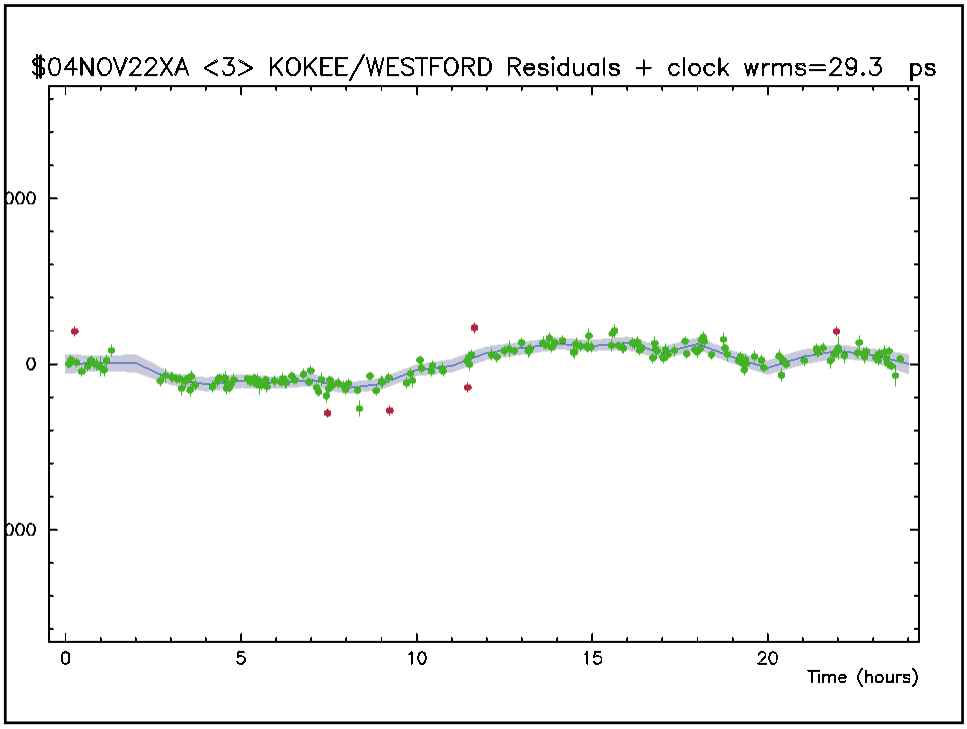
Tape Overwriting

- See Gilcreek-Hobart Fringe Plot with significant data loss

Gilcreek Maser Problem, Fall/Winter 2004-2005

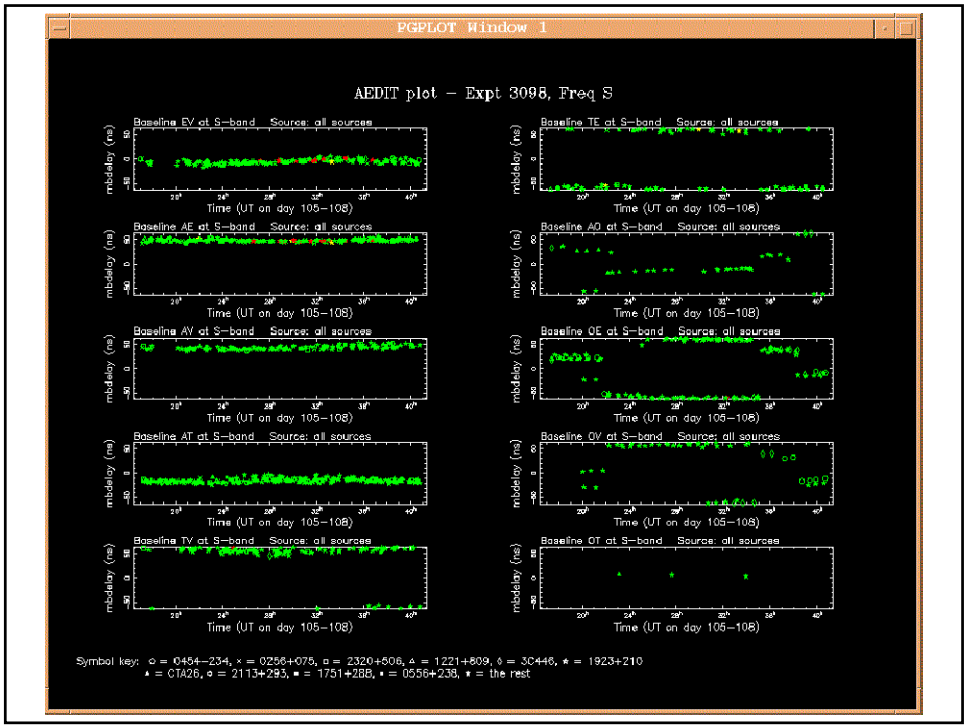
- See accompany fringe plots from R1154
  - Phase jump at X and S at Gilcreek
- See accompany clock/residual plots from R1150:
  - Problem: Gilcreek versus Westford, wrms=149 pico-seconds
    - Normal: Kokee versus Westford, wrms=29 pico-seconds
- Very roughly the effect was to double Gilcreek's coordinate sigmas
  - Corresponds to losing about 75% of the data





Phase-cal epoch jumps

- AEDIT plot for R1171, see Station O
  - S-band MBD delays jumps
    - S-band ambiguity spacing is no longer 200 nanoseconds
  - If Phase-cal 5 MHz is interrupted there is 4 out of 5 chance the epoch will change
  - Possible causes:
    - Disconnecting and reconnecting Phase-cal 5 MHz cable
    - For example: Removing cable sign check extension cable during session, please don't.
    - Bad connectors
    - Bad power supplies
    - Anything else that can cause the epoch of Phase-cal pulse to change


PGPLOT Window 1
AEDIT plot – Expt 3095, Freq S
Baseline EV at S-band Source: all sources
Baseline TE at S-band Source: all sources
Baseline AE at S-band Source: all sources
Baseline AO at S-band Source: all sources
Baseline AV at S-band Source: all sources
Baseline OE at S-band Source: all sources
Baseline AT at S-band Source: all sources
Baseline OV at S-band Source: all sources
Baseline TV at S-band Source: all sources
Baseline OT at S-band Source: all sources
mbdelay (ns)
Time (UT on day 105–108)
Symbol key: ○ = 0454–234, × = 0256+075, □ = 2320+508, △ = 1221+809, ◇ = 3C446, ★ = 1923+210
▲ = CTA26, ● = 2113+293, ■ = 1751+288, ♦ = 0556+238, ▼ = the rest