Impact of Operations on Data Analysis

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(past lectures by Ed Himwich)

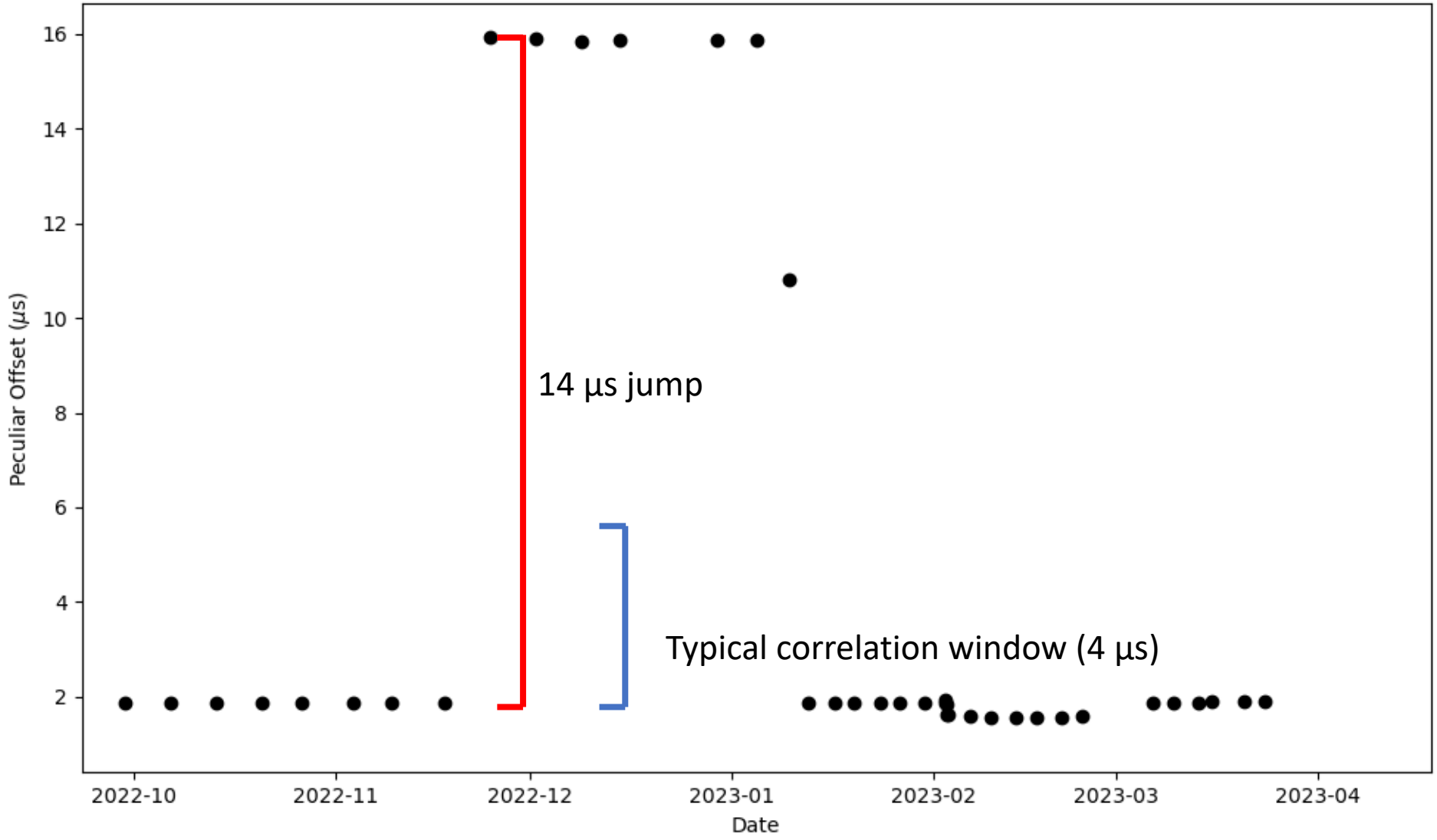
Peculiar Offsets

- Roughly speaking, they represent the signal path delay from the antenna to the sampler at each station
  - They are “Peculiar” (unique) for each station
  - They are “Offsets” because they are added to the stations’ `fmout-gps` values to get the final (`used-offset`) correlation clocks.
  - They are necessary because the VLBI data has to be related to the VLBI reference point, not the time-tags of the recording, i.e., we want the time-tags to be for the VLBI reference point.
- Any errors in the “Peculiar Offsets” (or the `fmout-gps` data) directly affect our estimates of UT1-UTC, one of our most important products.
  - A +1µs error in the time-tags makes a -1 µs error in UT1-UTC
- For more details see the article in the April 2019 IVS Newletter, “Why is my Offset so Peculiar?”
  - https://ivscc.gsfc.nasa.gov/publications/newsletter/issue53.pdf

Peculiar Offsets

- Correlators only have `fmout-gps` and historical peculiar offsets to help them find fringes
  - If a peculiar offset changes enough (2-4 µs or more) then no fringes are found and the correlator must start guessing
- This is usually recoverable but takes extra correlator time

Peculiar Offsets - A Practical Example



Peculiar Offset and YOU (correlators)

+CLOCK

st	epoch	used-offset	used-rate	raw-offset	raw-rate	comment
Ht	2022-363-1830	9.619	-5.580000e-14	6.667979	-2.010234e-13	
Is	2022-363-1830	0.370	-1.570000e-13	0.148675	2.491744e-14	
Kk	2022-363-1830	7.903	-2.545000e-13	7.346932	-5.665280e-14	
Ns	2022-363-1830	23.987	6.884000e-13	8.110163	8.358000e-13	
Ny	2022-363-1830	-63.386	1.259000e-12	-65.667153	1.259166e-12	
Ny	2022-363-1830	0.000	1.259000e-12	-65.667153	1.259166e-12	clock-break
Wz	2022-363-1830	-4.385	-1.070000e-13	-6.541582	-1.070275e-13	
Ys	2022-363-1830	53.621	1.257000e-12	55.416536	1.391239e-12	

* st 2-char station ID
* epoch time coordinate of offsets and clock model segment start time
* used-offset (usec) station clock minus offset used in correlation at epoch
* used-rate drift rate of station clock minus offset used in correlation
* raw-offset (usec) station clock minus reference clock offset at epoch
* raw-rate drift rate of station clock minus reference clock offset
* comment clock-break, reference station, or other notes

Peculiar Offsets – What to Report

- Please report to the correlators any change in signal path from the antenna to the formatter, for example:
  - IF cables
  - Change of formatter
  - Electronics inserted into the data path
    - e.g., adding FiLa10G to path to Mark 5B recorder
- Also any change in:
  - GPS receiver or its setup or cabling
  - `fmout-gps` counter, cabling, or setup (triggering)

fmout-gps

- Offset of the recorded time tags from UTC
- Critical for finding fringes
- Labeling
  - `fmout-gps` if formatter leads GPS: `fmout` should start counter
  - `gps-fmout` if GPS leads formatter: `GPS` should start counter
- Stable triggering
- Good cables/connectors
- Correct impedance termination
- Do not use processing of 1 Hz measurements
  - e.g., No “1-x” to correct for wrong label
- Do not use averaging
- For more details, see “Got ‘fmout-gps’ right?” article
  - In April 2017 IVS Newsletter: https://ivscc.gsfc.nasa.gov/publications/newsletter/issue47.pdf

NTP

- Strongly recommend that the FS PC runs on NTP
  - See `/usr2/fs/misc/ntp.txt` for set-up recommendations
- Use up to 10 stratum 1 servers
  - Some local: TAC, CNS Clock II, Symmetricom
  - Some remote
  - NTP likes to have at least three servers available
  - Use `iburst minpoll 4` server options
- Set `time.ctl` to use `computer` model
- Do not start FS operations until NTP is synced
- Place `check_ntp` procedure in `station` library
  - Use manually at any time
  - Call `check_ntp` at end of `initi`
  - Call `check_ntp` at start of `exper_initi`

check_ntp

- Procedure contents
```
sy=popen 'uptime 2>&1' -n uptime &
sy=popen 'ntpq -np 2>&1|grep -v "^[- x]" 2>&1' -n ntpq &
```
- Output example
```
ntpq/=====================================================================
ntpq/+192.5.41.209 .PTP. 1 u 4 1024 367 89.534 0.267 14.599
ntpq/+18.26.4.105 .CDMA. 1 u 36 1024 377 25.581 0.561 0.209
ntpq/+192.12.19.20 .GPS. 1 u 1009 1024 377 65.842 0.159 0.192
ntpq/+164.67.62.194 .GPS. 1 u 690 1024 377 65.516 0.242 2.145
ntpq/+204.123.2.72 .GPS. 1 u 1003 1024 377 72.726 0.174 0.207
ntpq/*128.227.205.3 .GPS. 1 u 217 1024 377 29.554 0.030 0.267
ntpq/+128.59.0.245 .GPS. 1 u 145 1024 377 9.523 0.409 25.274
uptime/ 17:35:21 up 10 days, 2:42, 14 users, load average: 0.03, 0.05, 0.00
```
- `ntpq` output
  - To be sync'd, one server must have * in the first column after /
  - Next to last column is offset in milliseconds, Should be small, less than ±100
- `uptime` output
  - Just a record of how long since boot, to help troubleshoot

Formatter Clock Jumps

- The DiFX correlators can handle arbitrary clock offsets IF they are documented
- Generally it is not necessary (and not desirable) to correct clock jumps unless the jump is large, greater than:
  - ±500 milliseconds for fmout-gps (or gps-fmout)
  - ±5 seconds for setcl/time.
- Mark 5B `syncerr_gt_3` does not mean a re-sync is needed if `fmout-gps` is stable
- This does not mean we want arbitrary clock offsets
  - Start experiments with correct time in the formatter and a small offset (microsecond level)
  - If the offset is not stable at the microsecond level, some other corrective action is needed
  - Fix small jumps after experiments

Other Issues

- Performing the pre-checks from the class is strongly recommended
  - Really helps increase the likelihood of success
- Send logs as soon as you have completed post-checks/experiment
  - Especially important for Intensive experiments
  - Consider using `push_log` SNAP procedure to automate pushing logs
    - See FS change item #12 in FS 9.13 update notes.
- Once observing is complete, send stop message to ivs-ops with any issues that you encountered during the session
- Please be pro-active in troubleshooting your station, look for potential problems:
  - Plot ancillary data with `plotlog` for every experiment
    - Examine plots for problems, jumps, noisy data, etc.
  - Examine IVS experiment web pages for plots, correlator, and analysis reports
  - IVS can provide assistance in troubleshooting problems

Mark IV VC power levels

- Set attenuators for minimum power level above 0.1 volts in all recorded channels (USB &LSB as appropriate) at zenith in clear weather
- If this approach is used, it should not be necessary (hopefully) to change levels during an experiment because of rain or other events
  - please don't change the level if possible, it can causes problems for correlator diagnostics if you do
- `ifadjust` command can be used for this if there is not too much RFI. It is worth a try anyway:
  - Point to zenith in clear weather
  - Set frequencies etc with mode set-up command
  - then try `ifadjust`

Mark 5 Issues To Be Aware Of

- Follow module check-out instructions (from pre-check class) before using
  - Verifies module is in working order
  - Verifies electronic VSN in module is correct
- Write SDK version on module field label, e.g.:
  - SDK 8.2
- Contact IVS and EVN before upgrading SDK version

Missed Experiments

- If you don’t observe send e-mail message to ivs-ops
- Important so that correlators don’t delay correlation waiting for data that will never arrive
- Bottom line: send message to ivs-ops

When to re-cool

- Generally we prefer you NOT stop the schedule to re-cool, except in some specific circumstances:
  - There is not enough time after this experiment and before the next to re-cool
  - The experiment requires the highest sensitivity and is useless without a cool receiver, you will receive special instructions for the experiment in this case
  - You have personnel or equipment constraints that will not allow re-cooling after the session and before the next
  - Other situations as appropriate

Extra Cable delay

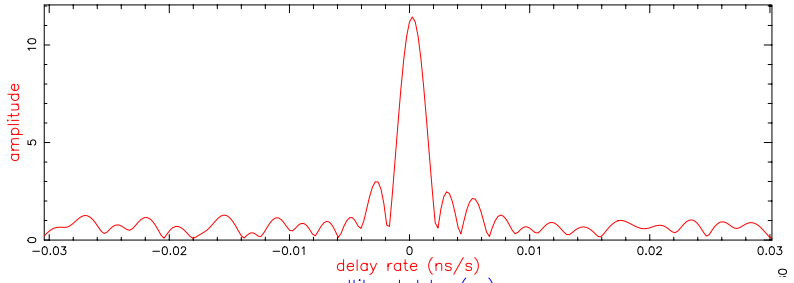
- If you leave the cable extender for the cable measurement in the line by accident, don’t take it out once the experiment has started unless you believe there is something wrong with the extender.
- Likewise do not make the cable measurement during the experiment. If you forget to make it beforehand, please wait until the end.
- Phase meter must be in the middle half of the range

Missing Channels

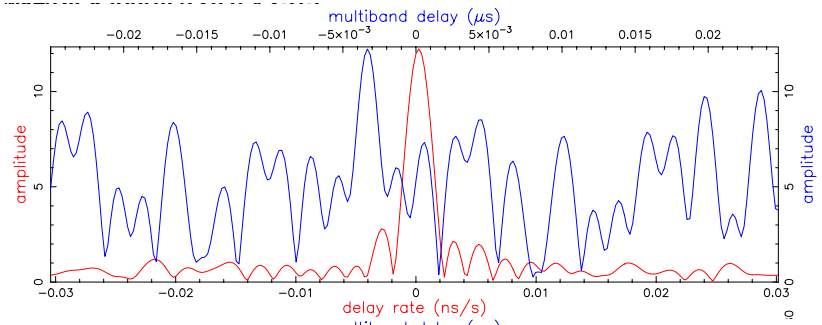
- Each lost channel reduces data yield by about 7%
- In addition it can compromise the multiband delay function
  - Each lost channel makes the function more ambiguous
- Order to drop to channels if not enough VCs/BBCs
  - Stations should follow the same order to minimize impact
  - Sequences with 8 BBCs (RDV) should always have enough working converters.
  - 14 BBC/VC sequences: drop order is 6, 11, 7, 2, 5
    - That is: one bad converter, drop #6, two then drop #6 and #11, and so on

Losing Channels and The Multiband Delay Function

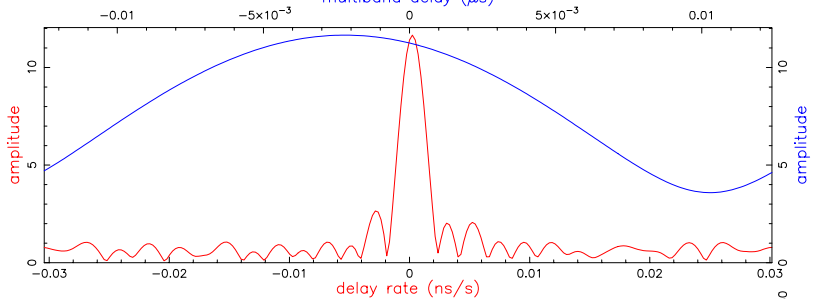
1 channel
0 spacings



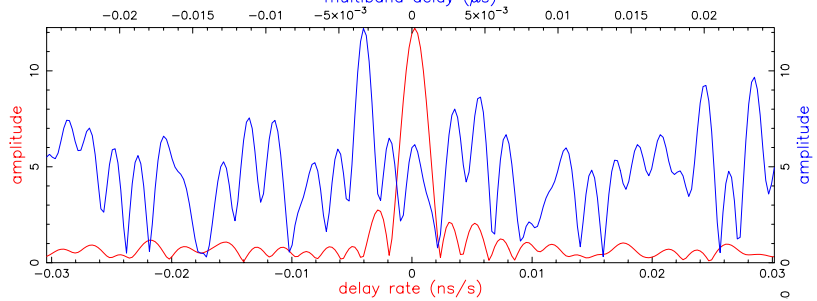
5 channels
10 spacings



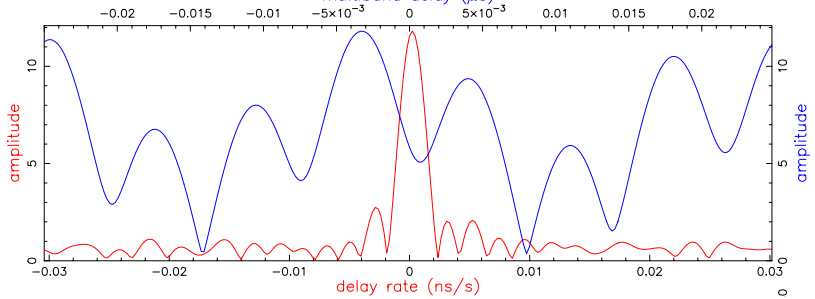
2 channels
1 spacing



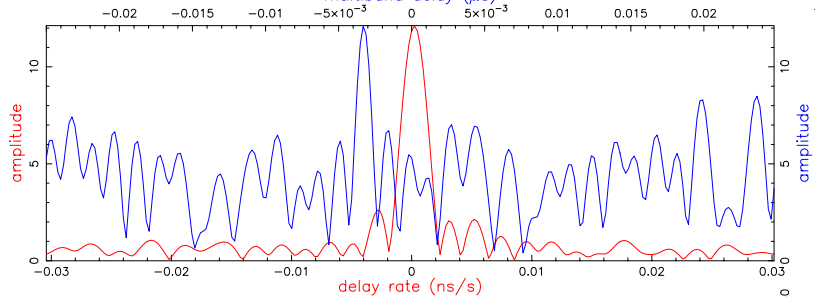
6 channels
15 spacings



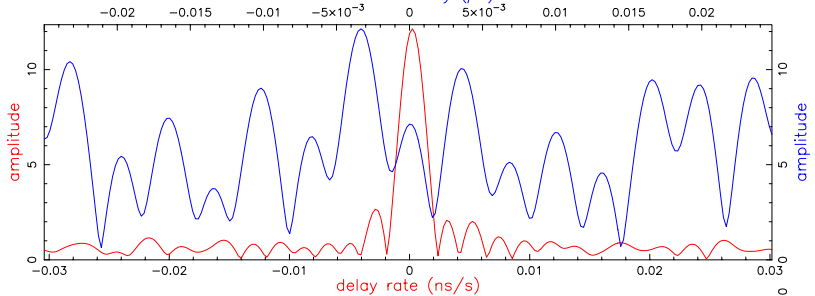
3 channels
3 spacings



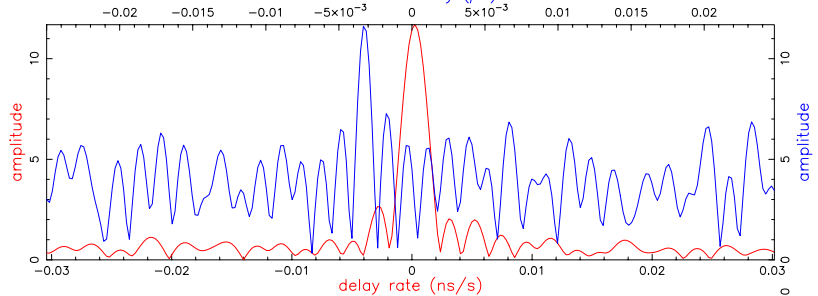
7 channels
21 spacings



4 channels
6 spacings



8 channels
28 spacings



PLEASE Inform Coordinating Center about Changes in Station Status

- Typical Problems
  - Increased SEFDs, e.g., warm receiver
  - Antenna slewing problems
  - Staffing Problems
  - Station not operational, i.e., “down” or unreliable
  - Observing conflicts
  - Insufficient media
  - Any other issues that impact station performance or experiments that can be supported
- Report expected duration
  - One day, One week …
  - If expected duration is unknown any estimate is helpful, particularly a minimum duration
- Send messages to ivs-urgent@lists.nasa.gov
- This information will help the coordinating center determine how to handle the situation and get the best data possible.
- Please also tell us when a situation is resolved and other good news too!

Four Primary Ways for Coordinating Center to Deal with Station problems

- Change Master Schedule
  - Mostly for observing conflicts and extended periods when a station may be “down”
- Modify scheduling parameters
  - Used for problems that limit station performance, e.g., warm receiver, antenna slewing degraded, temporarily or permanently
- Change scheduling status to “Tag-along”
  - Works well for temporary situations that may prevent observing or make station unreliable
  - Allows a station to contribute to network if it can observe, but limits bad consequences if it is unable to observe
- Help organize repair and troubleshooting