

## Occasional problems and workarounds

VGOS Correlation Workshop

MIT Haystack Observatory

May 9, 2019

## Data issues, continued.



- Phase-cal issues
- Missing network-reference station
- Parallactic angle and polarization-swaps

# Phase-cal issues



Issues that occasionally crop up:

- Weak, corrupt, or missing tones

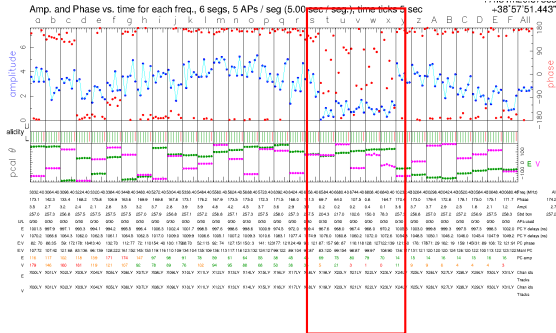
- P-cal. missing altogether

# Phase-cal issues



Issues that occasionally crop up:

- Weak, corrupt, or missing tones
- Multi-tone p-cal can tolerate some weak tones in a channel. Can temporarily change h-code threshold with `pc_amp_hcode`.
- Default value should be discussed with analysis centers. `pc_tonemask` can be used to discard a fixed set of problematic tones.
- Can sometimes delete problematic channels.
- P-cal. missing altogether



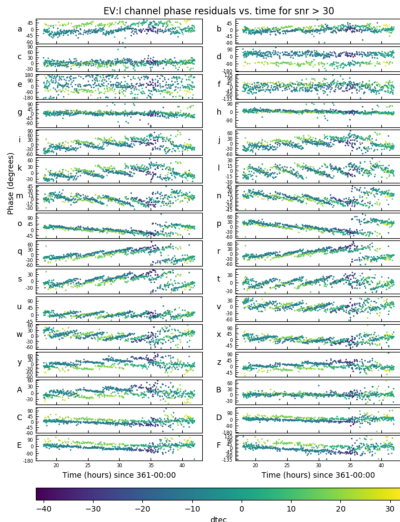
Bad p-cal tones.

# Phase-cal issues



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  - Default value should be discussed with analysis centers. `pc_tonemask` can be used to discard a fixed set of problematic tones.
  - Can sometimes delete problematic channels.
- P-cal. missing altogether
  - Do not process data from this station. Manual p-cal. is not sufficient.



Phase residuals when missing p-cal.

# Missing the network phase/delay-reference station



- Previous VT-sessions have used GGAO X-polarization as the phase/delay reference station, whenever possible.
- Sometimes the network reference station is not present or has hardware problems
- When should it be disqualified?
  - Missing a large fraction of scans  $> 80\%$  in a 24-hr session.
  - Missing a band from the reference polarization.
  - Missing channel(s) for the entire experiment.
  - Other hardware issues: warm receiver, p-cal loss, etc.

# Choosing an alternate network-reference station



Need to consider:

- Number of scans with all other stations during a session.
- Alternate network-reference station should share as many scans as possible with other stations.
- The alternate should not have any hardware problems itself (specifically with the X-polarization).

When running the post-processing with an alternate network-reference:

- Proceed as normal, substituting in the alternate station's site-code.
- Ensure that the a-priori `pc_phases_x/y` that are applied are made w.r.t to the original reference station, and that these corrections are also applied to the alternate in the initial control file.
- This ties the alternate network-reference station back to the original preserving continuity of `pc_phases_x/y` values between sessions.

# Parallactic angle

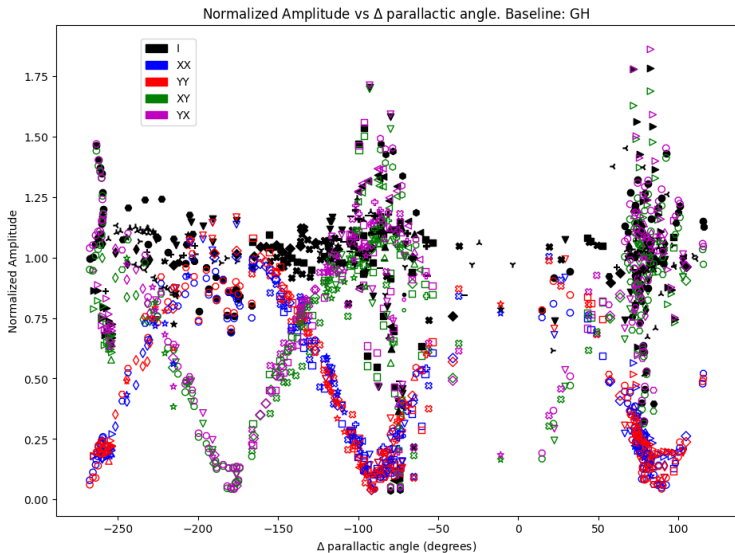


Some things to note:

- VGOS antennas are linear-polarization with alt-azimuth mounts  $\Rightarrow$  the orientation,  $\phi$ , of the feed as projected on the sky changes as Earth rotates.
- Consider two stations observing an unpolarized source, with parallactic angles  $\phi_1$  and  $\phi_2$ , and differential parallactic angle  $\Delta = \phi_1 - \phi_2$ .
- The cross-power amplitude in the polarization products XX, YY is  $\propto \cos(\Delta)$  while XY, YX  $\propto \sin(\Delta)$ .
- This is why we use pseudo Stokes-I which is independent of  $\Delta$  to first order.
- Important to keep in mind when looking at individual polarization products on a fourfit plot. It can be confusing.



# Parallactic angle: relative cross-power



# Station polarization-swaps



- On rare occasions hardware work at a station can introduce a  $Y \longleftrightarrow X$  polarization swap.
- Absolute polarization determination is difficult, but we can spot when/if a change happens at a station.
- If the station in question has a nearby partner where  $\Delta \sim 0$  for most scans/sources. Then we can see if the majority of the power shifts from the  $XX$ ,  $YY$  products to  $XY$ ,  $YX$ .
- This situation can be more difficult to detect if there are no nearby partners and  $\Delta \neq 0$  the majority of the time.
- However, during post-processing this problem can be spotted if a large change or sign-flip is noticed in the  $Y$ - $X$  phase/delay offsets of a station.
- The simplest (non-hardware) fix for this scenario is to re-correlate with the polarization/ $IF$  labels of the problematic station reversed in the `.vex` file.

# Keep an eye out...



- Additional data issues that may crop up include pointing-problems, clock breaks, or RFI.
- There is a large space of problems which can appear. We cannot categorize them all.
- Experience in recognizing when something is wrong is best obtained by regularly processing sessions with good data.