# Investigations

To do-
- Search aLOGs to see if PcalY irises were changed
  - Can't find any, think this was never done
  - Jeff says (on 29-Jun) this later turned into concern about clipping on entrance into integration sphere; need to look for this
  - aLOG from Evan (30877) states that steering mirrors were realigned on October 25th but irises were not changed (but "apertures" were installed at Tx output and Rx input)

- Look at potential curvature of Rx PD Out before realignment in October
  - Did this, see analysis above prior to October 25 realignment

- Sum of Tx/Rx PDs from 5/13 to 5/17, and whole data range
  - This number won't make sense, these have separate ground circuits

- Build X/Y of PD vs Temp and Ratio vs Temp for whole data range
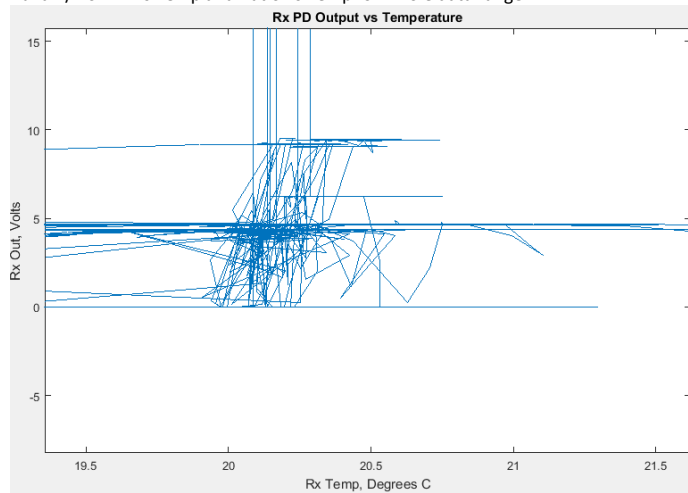


Some wide ranging swings from early data but steps in voltage create multiple regions:
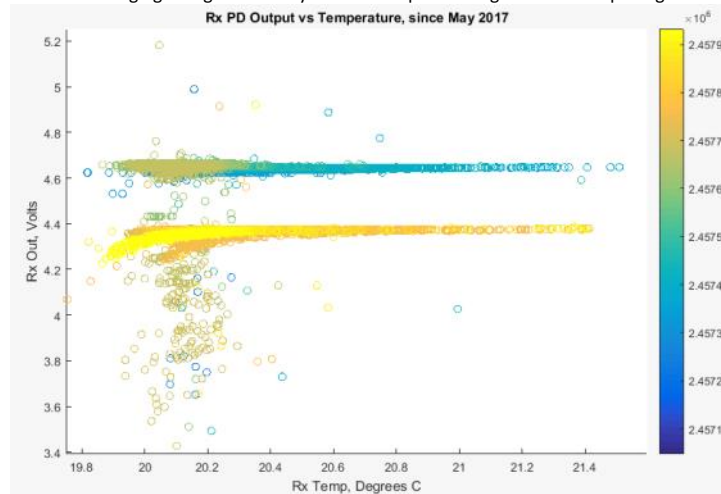


Color scale is time scale. Higher is newer.
Lower static offset is more recent so let's look at that:

Rx PD Output vs Temperature, since May 2017
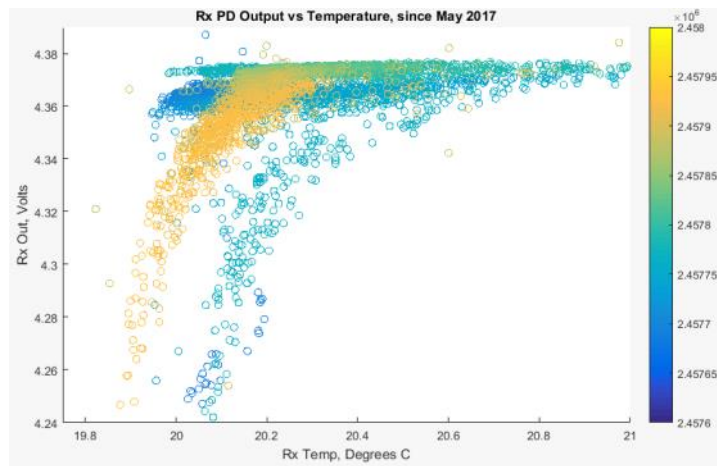
In the plot above, 'warmer' colors correspond to newer data points. This is interesting for a number of reasons; first, there are clear delineations in "periods" of interactivity between the channels. Second, while the degree of interactivity doesn't increase linearly with time, the last few weeks have most certainly had the highest correlation. Looking at with some extra info:
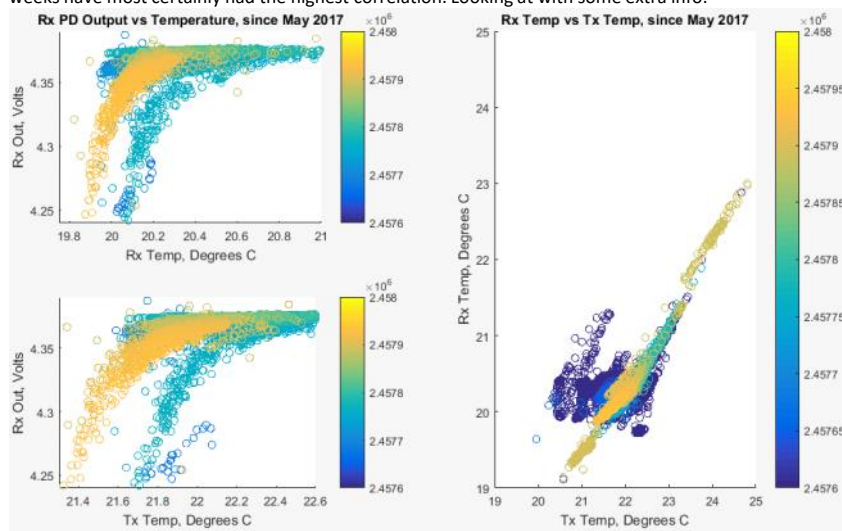


Clearly, the relationship stands regardless of which temperature it's compared to. There is a small temperature offset between the temperature sensors but, overall, they appear to have parity. Tx is also 'regional':
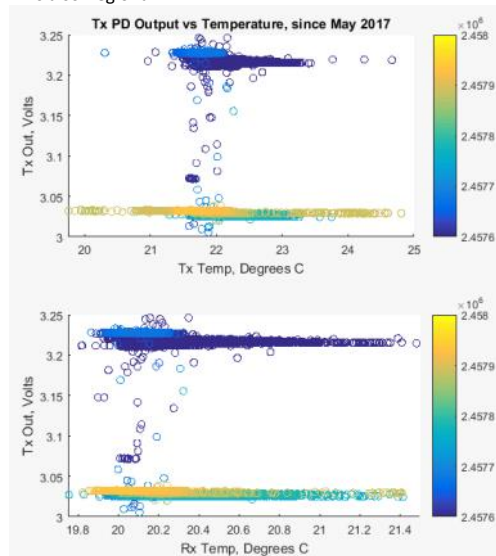


Zooming in on newest period:

Tx PD Output vs Temperature, since May 2017
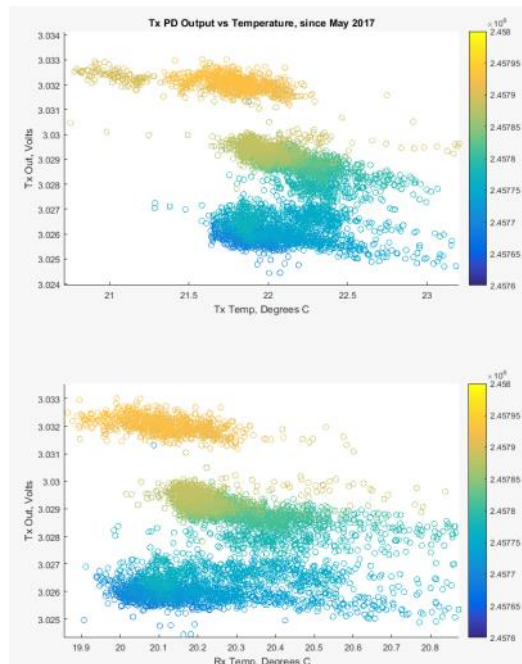


So Tx doesn't have the same temperature correlation that Rx does.

- Check ratio of Tx:Rx across events this year
  - Actually, need to do this? Have shown that Rx is temp dependent but Tx isn't.

- Calculate "sliver overlap" for x amount power loss

- Run BruCo thru SSH between Rx PD Out and other channels. Correlation with temperature may not be only one and doesn't indicate obvious issue. Given that multiple corrections since October only seem to temporarily correct issue, there may be some long running correlation here.
  - Did so on June 30, for random period (GPS time 1182885000, or 19:09:42 UTC on June 30). Most of correlated channels are other PcalY channels and EY ISI channels, which make intuitive sense. Should probably run BruCo for more targeted segment where I know issue was occurring.
  - Found targeted segment (shown is one day of PCalY Rx PD out, 10min trend on left and second trend on right):
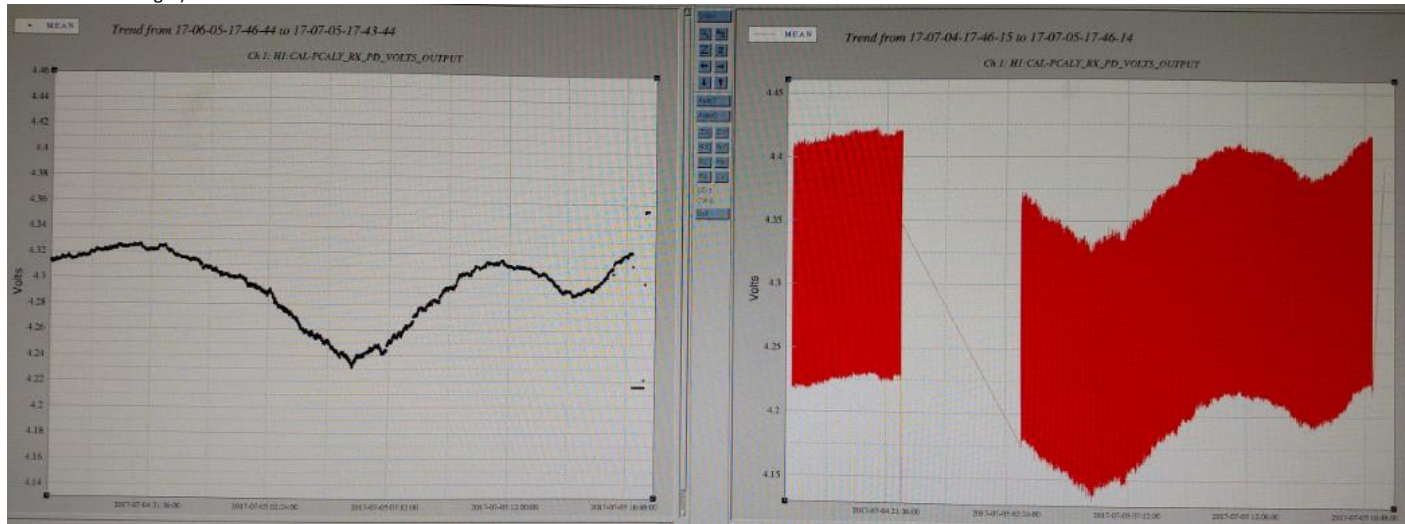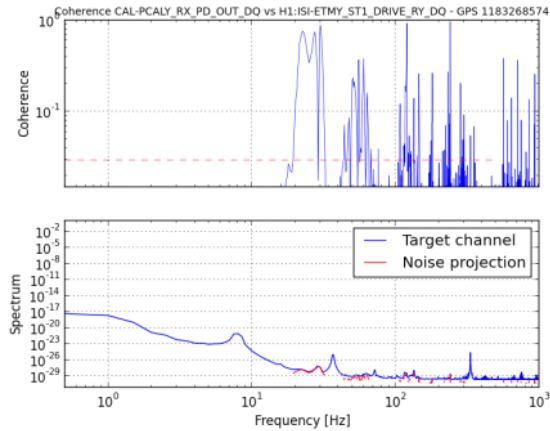


  - Problem with this segment is that it's ~16 hours long so no way BruCo can handle that, will need to select channels and run DTT; which channels? Or how about BruCo right when signal turns around?
  - Ran BruCo on window right around turn around but it only finds higher frequency coupling to ISI/HPI and other PCal channels out at EndY, which makes sense and isn't helpful. Went through a number of time series over 2yrs data with BruCo designated channels and aren't seeing the ~12 hr (0.00001 Hz) cycling that the Rx PD power is seeing.

## Top 10 coherences at all frequencies

### GPS 1183268574 + 360 s

| | | | | |
|---|---|---|---|---|
| 7.00 | CAL-PCALY_OFS _PD_OUT _DQ (1.00) | CAL-PCALY_TX _PD_OUT_DQ (1.00) | CAL-PCALY_OFS _AOM_DRIVE _MON_OUT _DQ (1.00) | CAL-PCALY_OFS _ERR_OUT _DQ (0.98) |
| 7.50 | CAL-PCALY_TX _PD_OUT_DQ (1.00) | CAL-PCALY_OFS _PD_OUT _DQ (1.00) | CAL-PCALY_OFS _AOM_DRIVE _MON_OUT _DQ (1.00) | CAL-PCALY_OFS _ERR_OUT _DQ (1.00) |
| 8.00 | CAL-PCALY_TX _PD_OUT_DQ (1.00) | CAL-PCALY_OFS _PD_OUT _DQ (1.00) | CAL-PCALY_OFS _AOM_DRIVE _MON_OUT _DQ (1.00) | CAL-PCALY_OFS _ERR_OUT _DQ (1.00) |
| 8.50 | CAL-PCALY_TX _PD_OUT_DQ (1.00) | CAL-PCALY_OFS _PD_OUT _DQ (1.00) | CAL-PCALY_OFS _AOM_DRIVE _MON_OUT _DQ (1.00) | CAL-PCALY_OFS _ERR_OUT _DQ (1.00) |
| 9.00 | CAL-PCALY_TX _PD_OUT_DQ (1.00) | CAL-PCALY_OFS _PD_OUT _DQ (1.00) | CAL-PCALY_OFS _AOM_DRIVE _MON_OUT _DQ (1.00) | CAL-PCALY_OFS _ERR_OUT _DQ (0.96) |

Example:



Coherence CAL-PCALY_RX_PD_OUT_DQ vs H1:ISI-ETMY_ST1_DRIVE_RY_DQ - GPS 1183268574

- See HVAC upgrade in person

- Compare to alignment channels? Want to differentiate between physical clipping in X/Y due to alignment and also beam spot size growth due to distance changes

- What about HEPI/ISI position channels? Anything on periscope? Rick was curious about tipping due to extra metal, or perhaps some slip. Long term stress relaxation along with CTE differences? Perhaps convolved issues.
  - Jeff says periscope design has been the same since before O1, so he doesn't believe material change is issue. What about stress relaxation? Or improper pre-tension torque at installation? Or embedment at installation?

- Find out why 1.08 kHz cal line is used

- Think about concrete top pad for breadboard supports

- Think about which components could see contaminant buildup and what that might be; would it have to be something that gives a frequency (and wavelength) dependent scattering? Why does it keep coming back and/or changing range of variation?

- Think about electrical issues; power supply? PD on Rx?
  - Wouldn't be electronics on Tx side since that side's PD hasn't been varying