

# CHIRON Quality Analysis

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# 1 Log of CHIRON Major Events

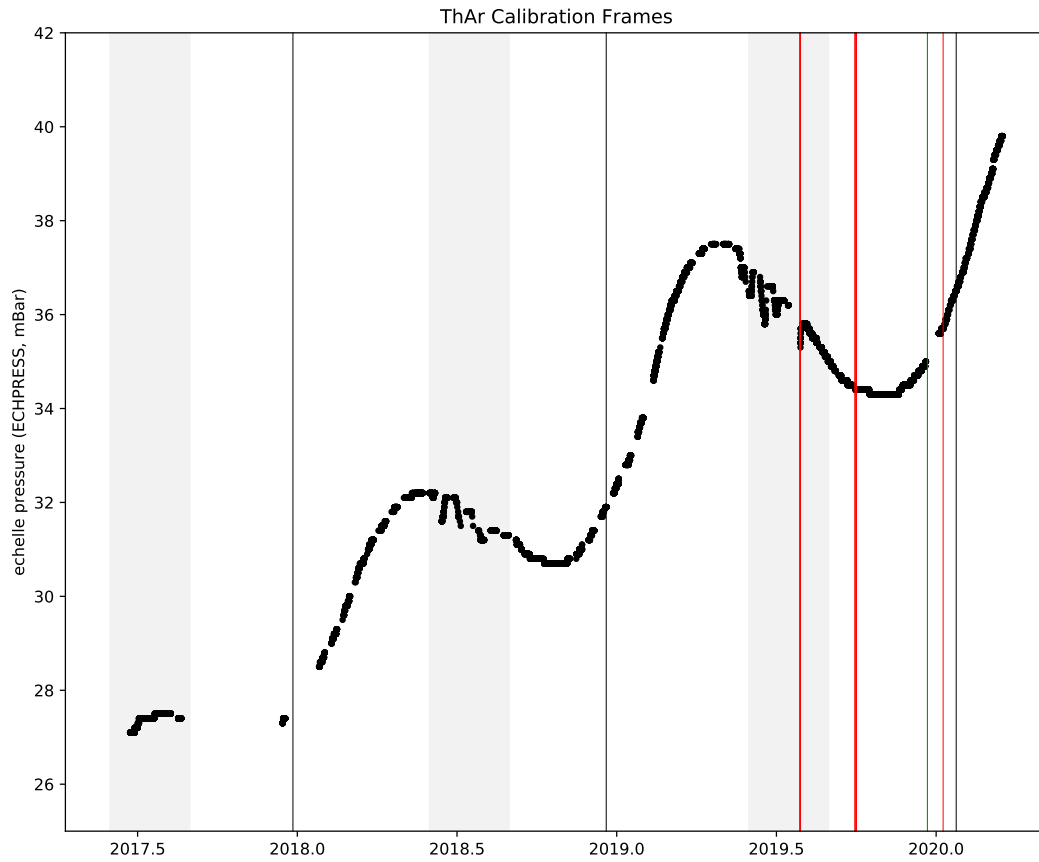
| Date        | Events   | Solution   |
|-------------|--|--|
| 8-Mar-2017  | dirty mirror   | CLEANED  |
| 27-Dec-2017 | dirty mirror   | CLEANED  |
| 20-Dec-2018 | dirty mirror   | CLEANED  |
| 29-Jul-2019 | <p>Todd: You (Andrei) might have seen that the ThAr lamp for CHIRON stopped working last week. <b>It was removed and replaced with a different lamp.</b></p> <p>Andrei: I found that ThAr frame chi190729.1002 (slit) is horribly out of focus. Things to do: switch on the focus motor, make the focus sequence, set correct focus. The FITS headers say focus=0 on July 14 (the focus motor was off) and focus=10.341 on July 28. Apparently, someone switched on the focus motor in CHIRON and set it in the incorrect position. Supposedly, the lamp change did not affect CHIRON in any way, but in fact it did!</p> <p>Andrei: CHIRON has a problem with the fiber/slicer adjustment. Someone has moved something.</p> | <p>The fiber alignment done by Andrei and Rodrigo today produced a major improvement.</p> <p><b>The motor focus light was turned ON.</b></p>   |
| 30-Jul-2019 | Lamp issue continues   | <p>Andrei: I think that changing the lamps is counter-productive. The increase in counts could be caused by a slightly different lamp position (changes w.r.t. calibration fiber), so after changing the lamps you might get different fluxes, and it will be unreproducible: going back to the same lamp will not give the same result. <b>Do we ever change the lamp back to the old one?</b></p>  |
| 30-Sep-2019 | <ul style="list-style-type: none"> <li>* Lower counts in ThAr slicer. Indicating either fiber misalignment or slicer misplacement.</li> <li>* ThAr taking too long to expose. Indicating slicer not responding, can be checked on the debug window too.</li> <li>* Error messages, usually displayed in chiron gui, and debug console windows.</li> </ul>  | <p>Slicer motor is ok and working.</p> <ul style="list-style-type: none"> <li>- <b>The fiber has been realigned by Andrei. It was also not plugged completely.</b></li> <li>- <b>A female connector loose was plugged back in.</b></li> <li>- Focus motor was "homed", now is back to its last good value.</li> </ul>  |
| 1-Oct-2019  | Exposure meter's power supply and motherboard are dead   | <p><b>New EM computer is rebuilt.</b></p> <p>Marco: Humberto took the disks of the original machine and use them to build a "new" expmeter machine, that is currently sitting there and could be used as spare. We tested it yesterday and works fine.</p>   |
| 2-Oct-2019  | focus motor light was ON   | <p><b>The motor focus Light was turned OFF.</b></p> <p>Andrei 07/23/2020: The ThAr plot shows that CHIRON was slightly out of focus between 2019-07-29 and 2019-10-02. During this period, the focus motor was left switched ON, and a light apparently emitted by its stage (likely in IR) produced the "glow" in the blue part of the spectrum. ThAr is by itself not a stable light source, neither is quartz.</p>  |
| 22-Dec-2019 | molecular sieve  | <p><b>Marco: The molecular sieve was replaced on December 22 due to a very bad vacuum.</b> Although the dewar was not taken out, the sieve was replaced right there, in place, it is possible that there may have been some slight movement that could have caused an issue.</p>   |
| 9-Jan-2020  | DEWPRESS keyword   | <p>Marco: The pressure gauge on chiron was regularly kept OFF because for some reason it generated sometimes an increased "dark current" - which of course is not dark current but probably some back-light produced by the gauge high voltage cathode. The problem is that we did not have automatic reading of the pressure. Sometimes the person filling the dewar would turn it on manually, take a look, and the shut it off, but we had no regular telemetry.</p> <p>So the change I did -which I probably did not tell you cause I thought it would be irrelevant for the science-, was to plug the gauge on a ethernet power outlet, and then make a script that would turn it ON at 11:30 a.m., and then turn it OFF at 3 p.m. In that way we could get lots of pressure readings daily (1 every 10 minutes) without affecting the observations or the calibrations. This is why you may see values for the pressure, likely the last value read by the script before turning it off.</p> |
| 24-Jan-2020 | dirty mirror   | CLEANED  |
| 23-Oct-2020 | dirty GAM mirror   | GAM mirror was cleaned after the reopening on 10/23/21   |

## 2 Data Analysis

The CHIRON data have been used for various topics, including finding exoplanets, discovering spectroscopic binaries, determining stellar activities, or measuring radial velocities. Users often apply their in-house pipelines to extract the information they need from their data. For each program, the data are mostly acquired within a short time, so users are lack of a broader picture of the stability of this instrument. In order to help users to assess their data qualities, we prepare this document to show the data stored in the headers from frames acquired since July 2017.

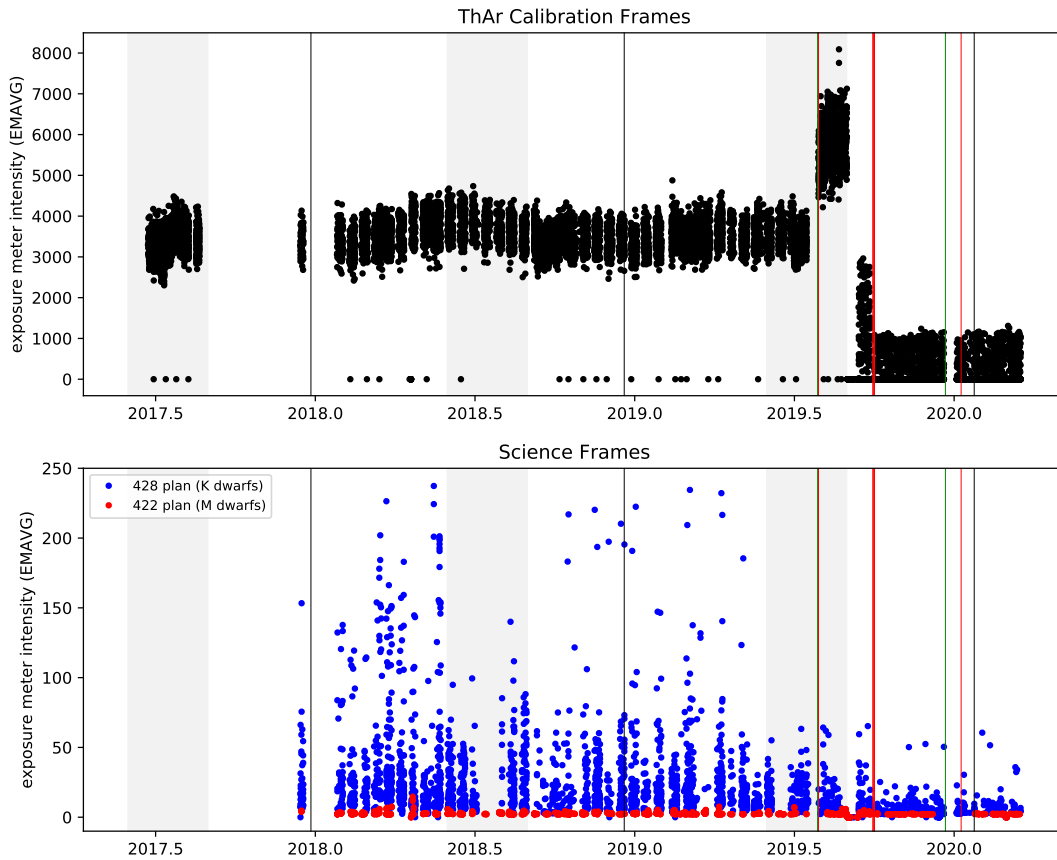
Most plots in this report are created using header parameters in ThAr calibration or science frames in slicer mode. Major events noted in the table are plotted as thin vertical lines. Black lines indicate mirror cleaning, green lines indicate fiber realigning, and red lines indicate others. Gray boxes indicate dates between June 1 and August 31, which is winter. The header keywords used to make this plot are given in the Y axis title, i.e, ECHPRESS, EMAVE, etc. The guiding data are given in section 10 to 13. The lost photons problem is discussed in section 14.

### 3 Echelle Pressure



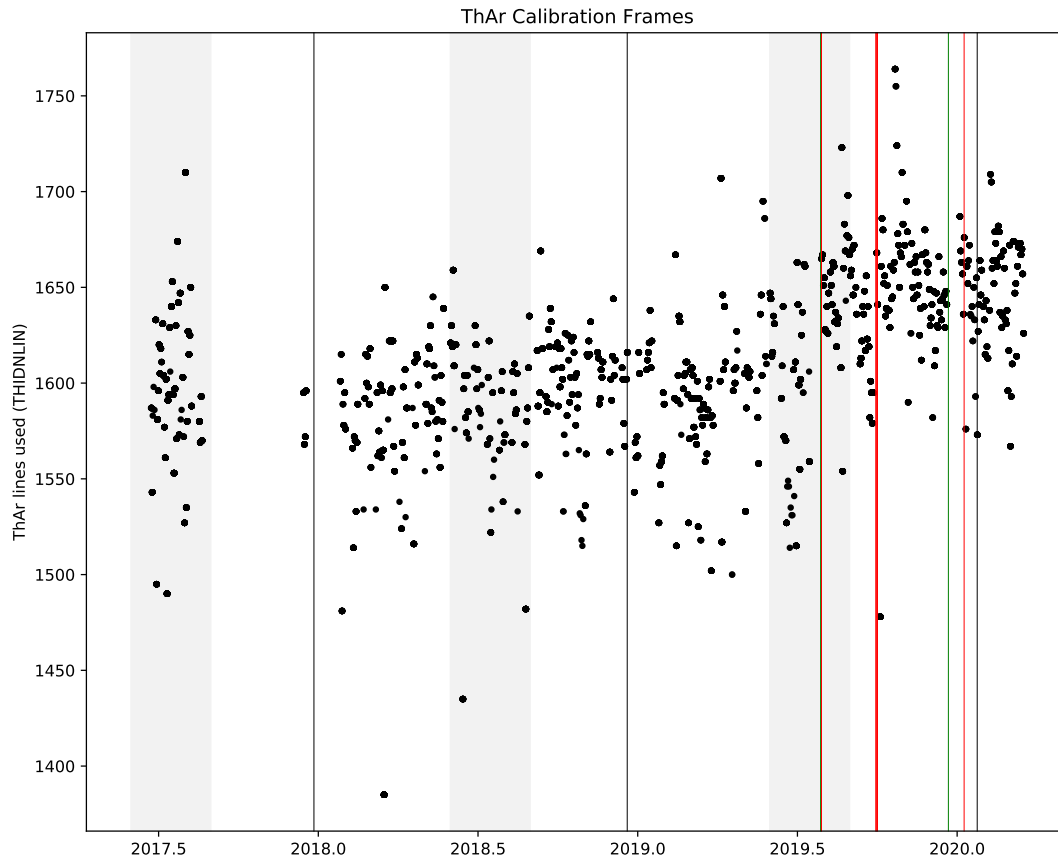
The echelle pressure steadily increases since 2017. Black lines indicate mirror cleaning, green lines indicate fiber realigning, and red lines indicate others.

## 4 EMAVG



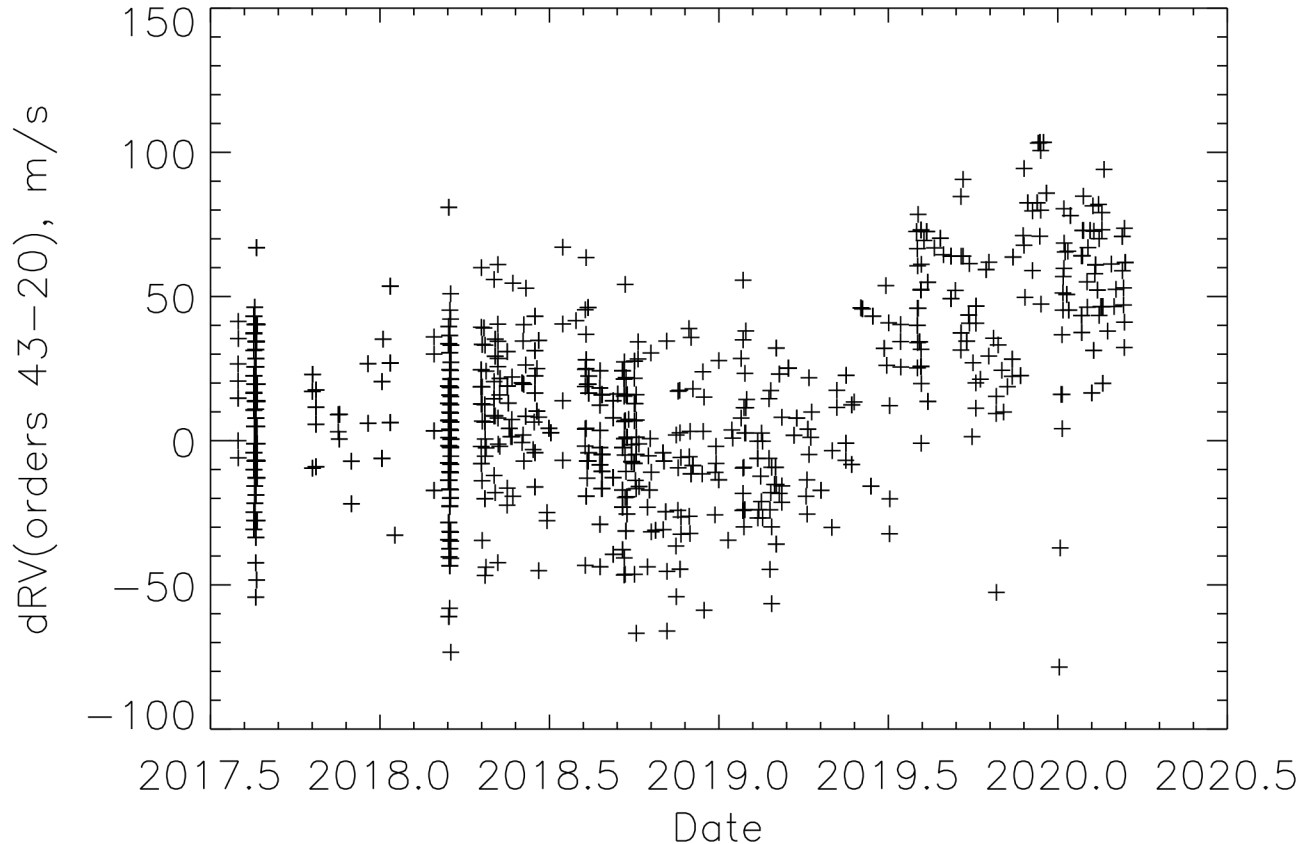
Data from both ThAr frames and science frames are shown here. Exposure meter counts increase sharply on July 29 2019 because the focus motor light was turned on, and the counts drop sharply in mid September 2019, a few weeks before the light was turned off on September 30 2019 and stay steady since. Notice that a few ThAr frames have 0 count since 2017.. Two science programs using the slicer mode are plotted as examples for bright stars (blue points for K dwarfs) and faint targets (red points for M dwarfs). Black lines indicate mirror cleaning, green lines indicate fiber realigning, and red lines indicate others.

## 5 ThAr lines, Part 1



The number of ThAr lines used to calibrate wavelengths increase gradually since early June of 2019. Black lines indicate mirror cleaning, green lines indicate fiber realigning, and red lines indicate others.

## 6 ThAr lines, Part 2

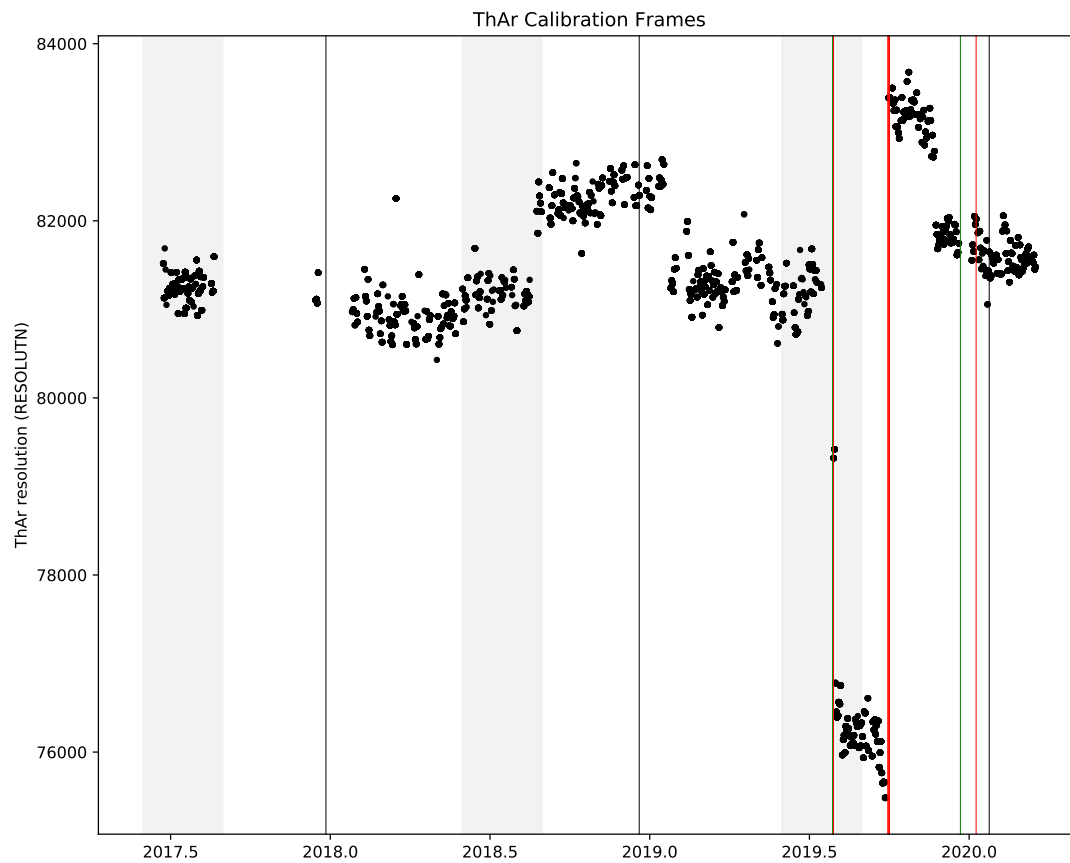


A similar increasing trend as the ThAr line plot in section 5 is seen here plotted by Andrei using a different method.

(07/25/2020 by Andrei): Shifts of the central wavelength w.r.t. the first spectrum are interpreted as RV shifts. The comparing is done using the wavelengths of the central pixels in orders 20 (blue, 5500A) and 43 (red, 7060A). They strongly correlate between orders and, naturally, reflect the faults of temperature control in winter months and the increasing echelle pressure. The \*difference\* of RV shifts between those two orders (see the plot) suggests a creep of 50  $\text{m/s}$  that started around 2019.5, superposed on the large scatter and occasional spikes. The plot characterizes the wavelength calibration in the slicer mode, common to all programs.

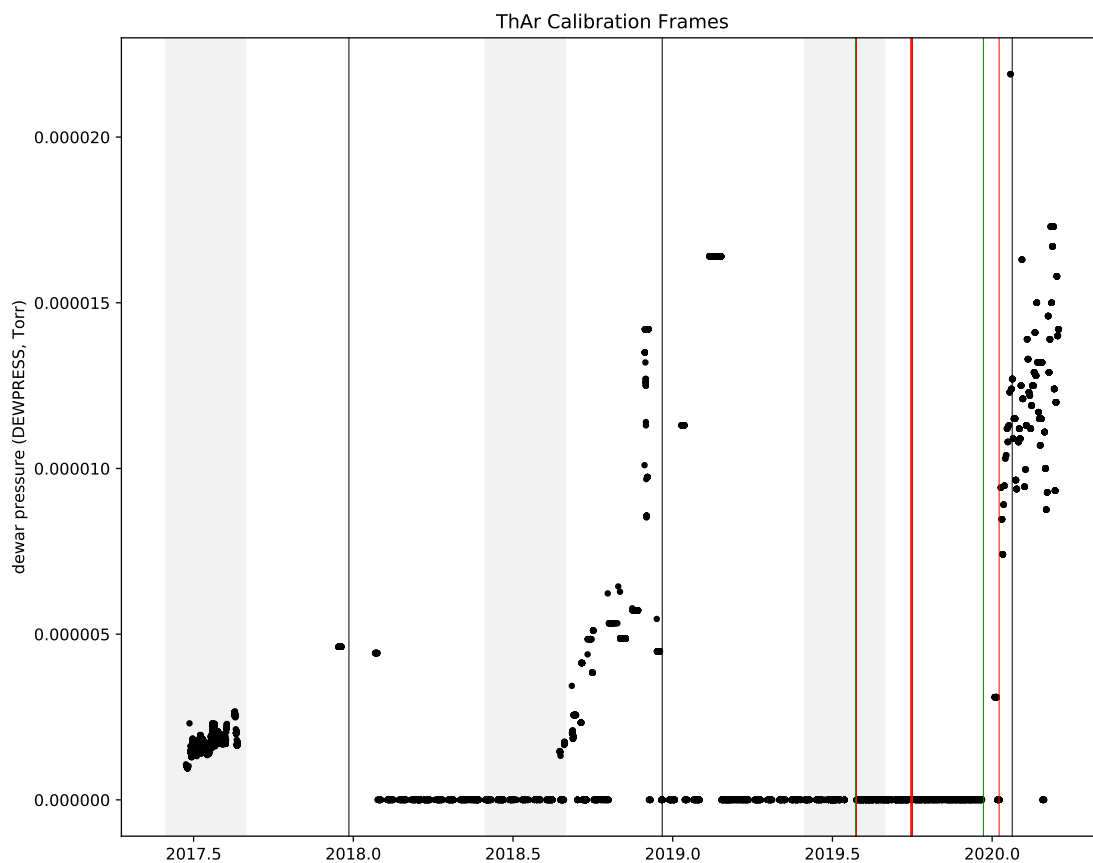


## 7 ThAr Resolution



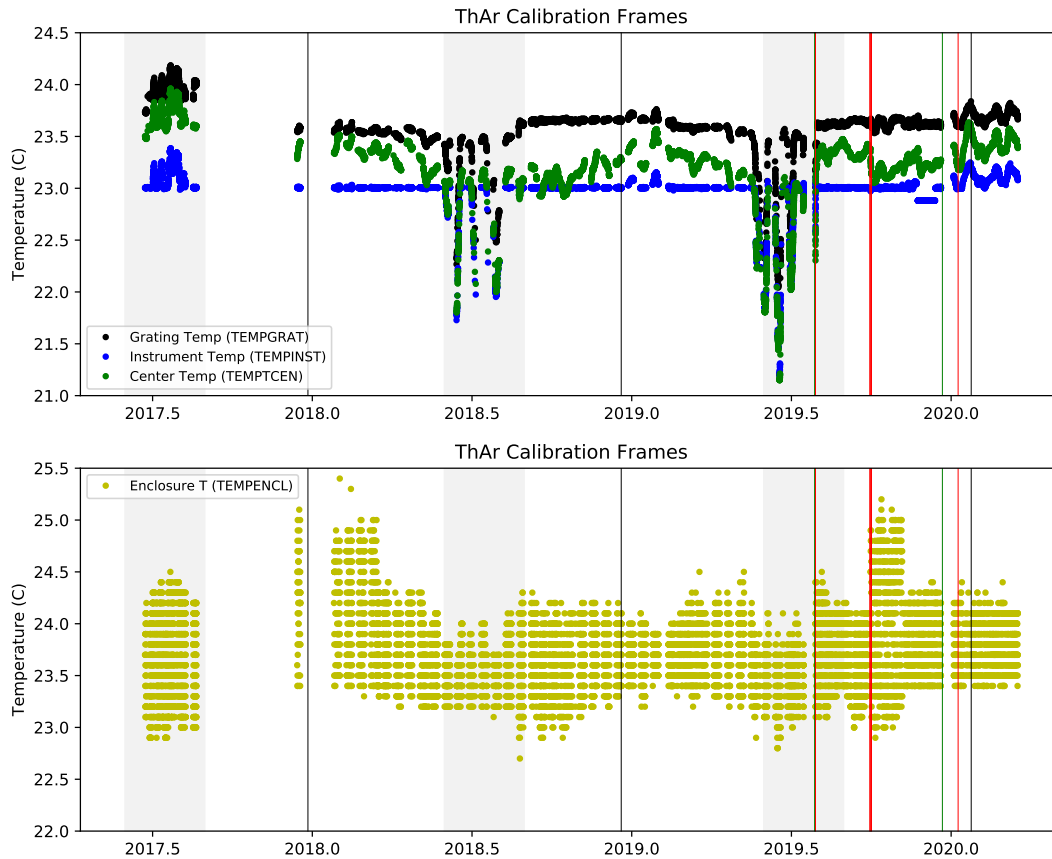
A sudden drop of the ThAr resolution is seen when the focus motor light was turned on. Black lines indicate mirror cleaning, green lines indicate fiber realigning, and red lines indicate others.

## 8 Dewar Pressure



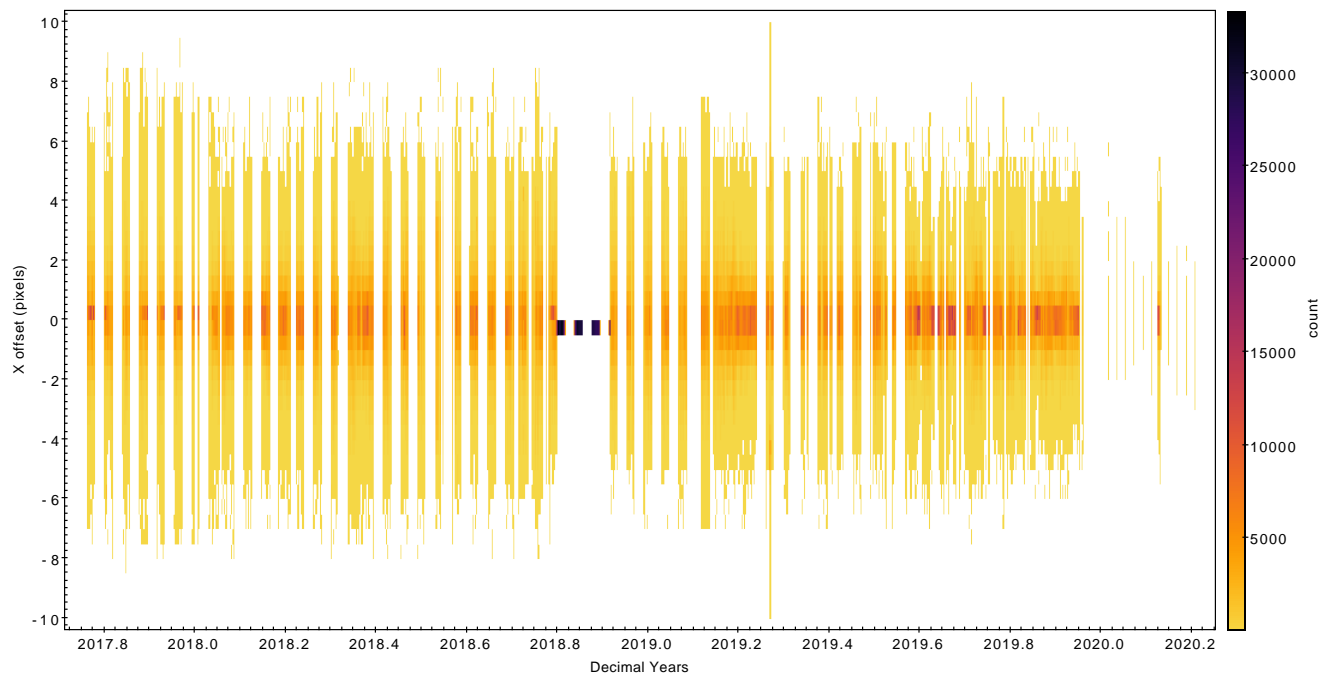
The "DEWPRESS" keyword was modified by Marco on Jan 09 2020 and please see section 1 for details. No record is shown for the increasing dewar pressure in late 2018. Black lines indicate mirror cleaning, green lines indicate fiber realigning, and red lines indicate others.

## 9 Temperature



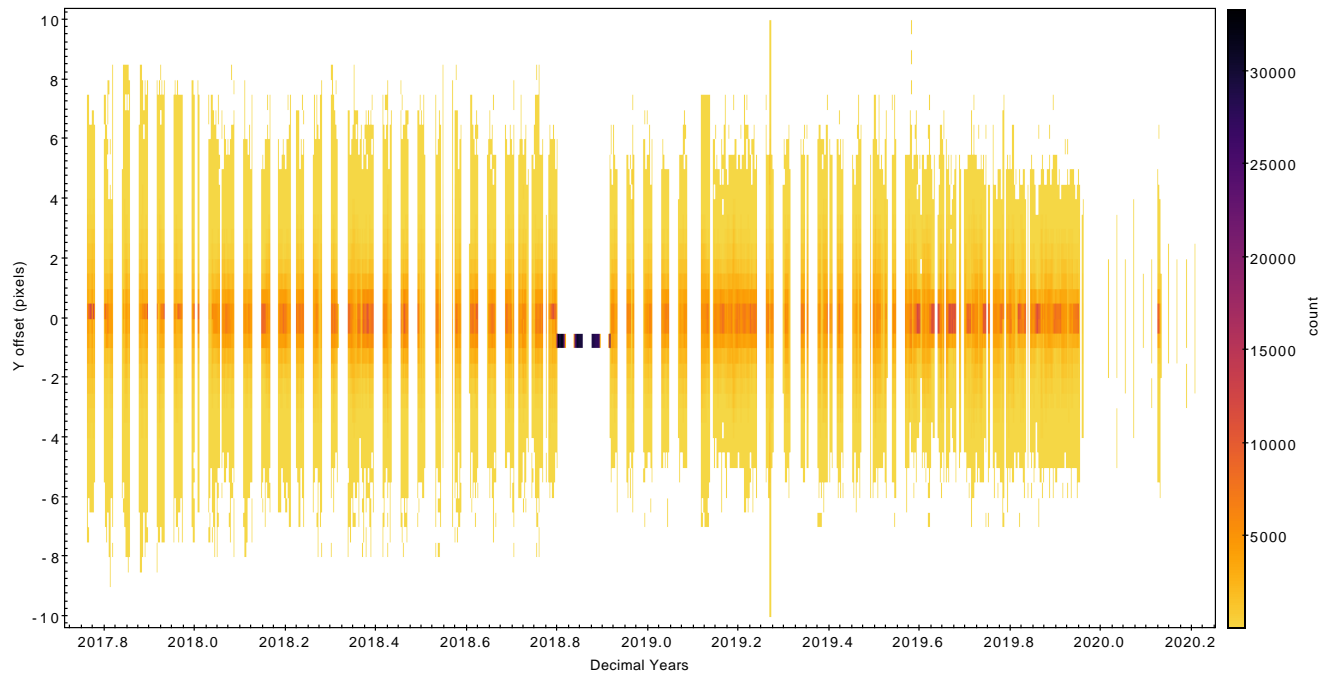
The top figure shows recorded temperatures from three different keywords, TEMPGRAT, TEMPINST and TEMPCEN and all three curves have a similar trend. The temperature dips coincide with winter season in CTIO. The temperatures recorded inside the enclosure (TEMPNCL) can be fluctuated up  $2^{\circ}\text{C}$  on a given night. Black lines indicate mirror cleaning, green lines indicate fiber realigning, and red lines indicate others. Three gray boxes indicate dates between June 1 and August 31.

## 10 Guiding Data/X offset

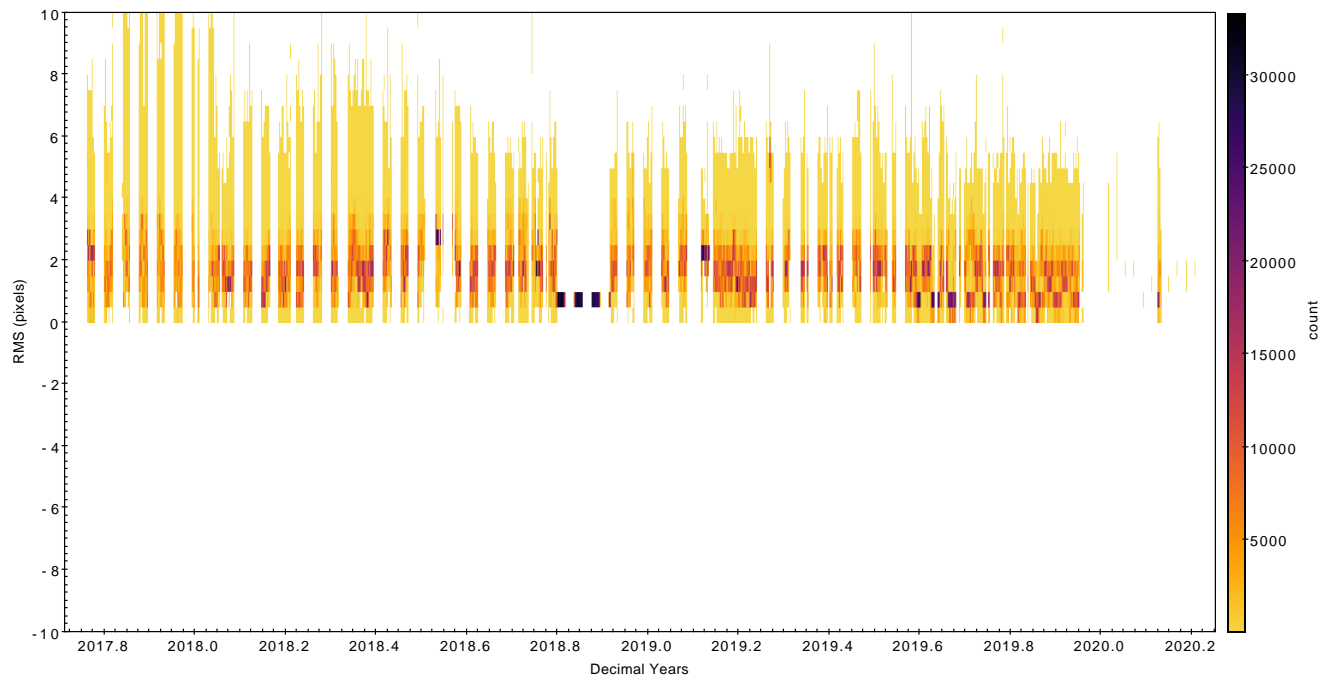


The guiding data, which contain 14 million entries, are parsed by Marco. A density plot is generated here to see the distribution of X offset. The next three figures are for Y offset, RMS and FWHM.

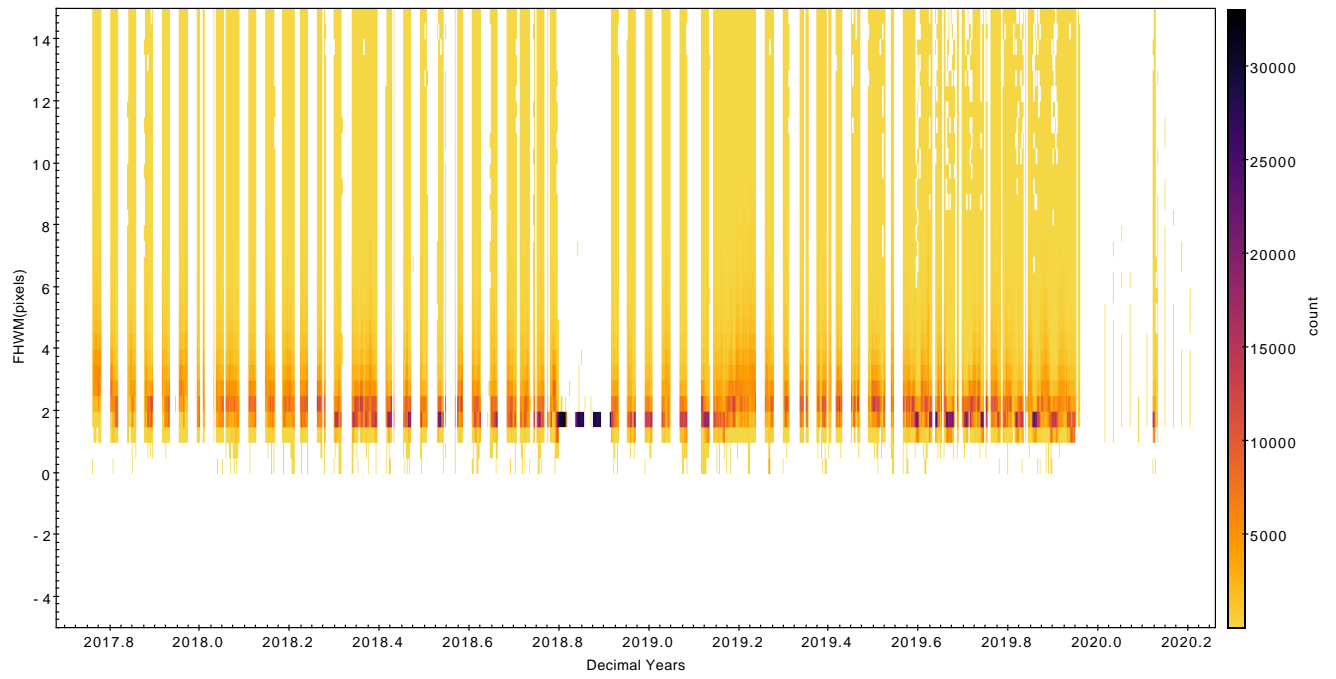
# 11 Guiding Data/Y offset



## 12 Guiding Data/RMS

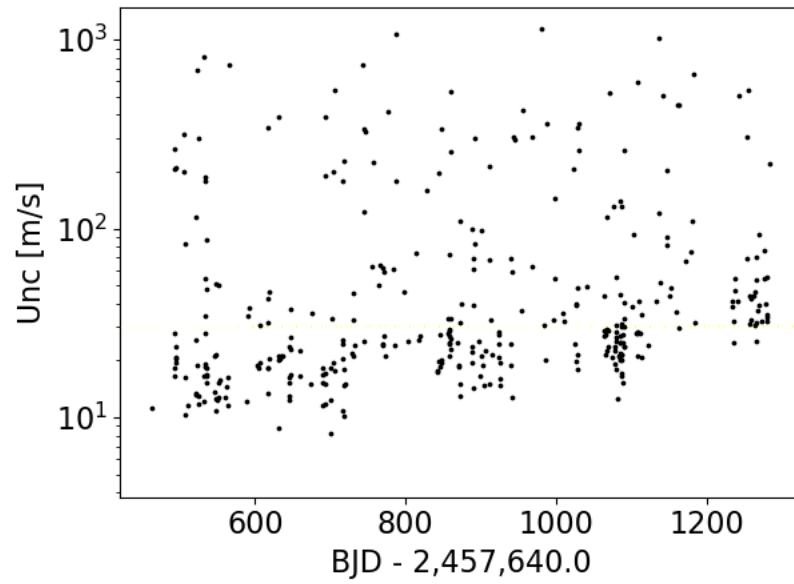


## 13 Guiding Data/FWHM



## 14 Lost Photons Problem

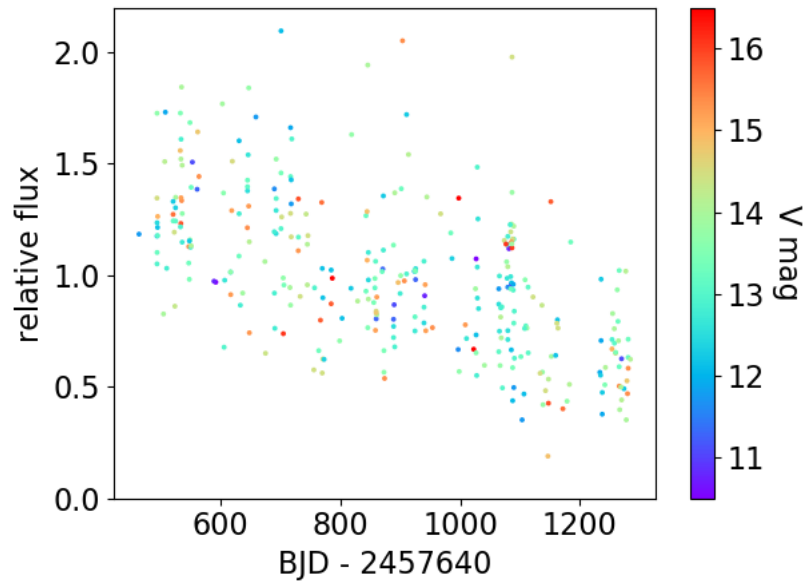
This problem was first identified by the Harvard's RV project for M dwarfs. They notice their RV precision is degraded with time (See figure below).

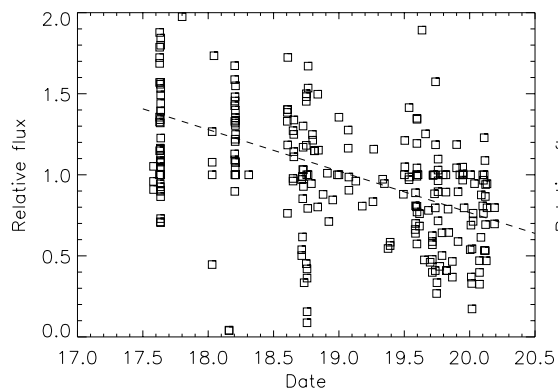




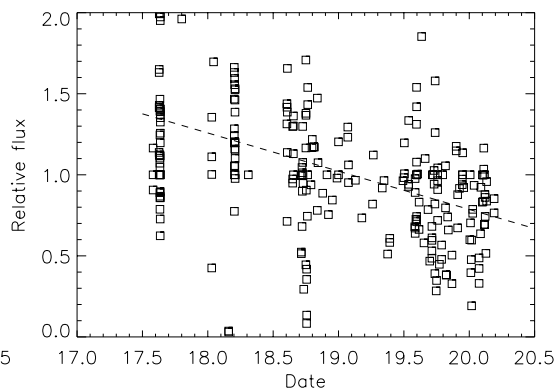
Later, the fluxes relative to the mean are plotted to show the lost light problem using the Harvard's data (see below). The same plots using data from A. Tokovinin's targets and two RV standards also show this downward trend. Therefore, all plots show the trend of losing photons. This problem will be investigated after the CTIO 1.5-m is reopened after the COVID19 shutdown.

(UPDATE Oct/23/20) The GAM mirror was cleaned on Oct/23/20. The initial results show photons counts have been regained. More analysis will be conducted.

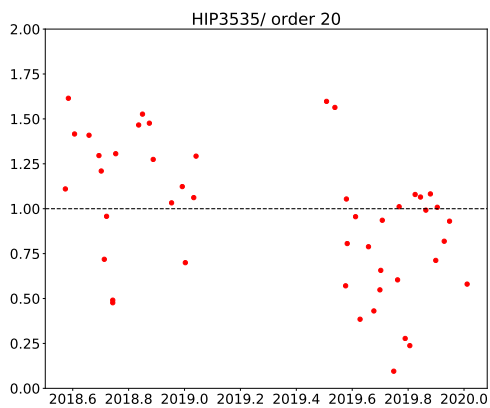




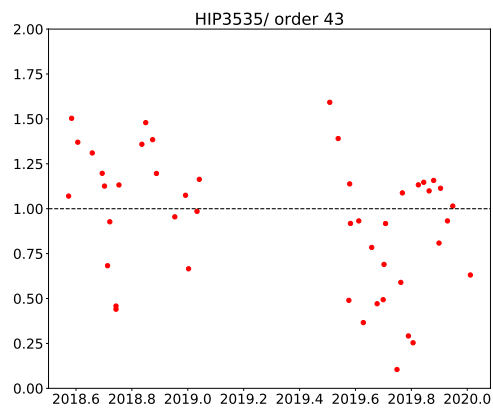
(a) order 20 by A. Tokovinin



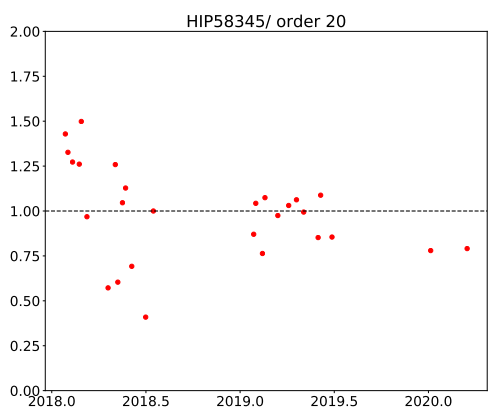
(b) order 43 by A. Tokovinin



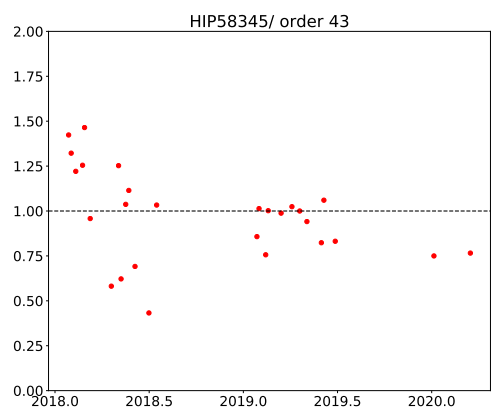
(c) order 20 for HIP3535



(d) order 43 for HIP3535



(e) order 20 for HIP58345



(f) order 43 for HIP58345

## 15 RV offset

The RV data show a systematic offset since the reopening the telescope on Oct/23/20. We are analyzing RV standard stars and SB2 with known orbits to determine the systematic offset.