The In-Dome DIMM Project
(IDD)
March 2010 Version 1.5

Vicki Riley, Chevo Terrazas, Amy Westfall, Amber Armstrong, Matthew Shetrone

Procedure

- The outside DIMM was set up as usual on a suitable target available all night. It is located in a twenty foot tower some 100 yards south and slightly west of the HET.
- The interior dome DIMM was located on the platform in front of the primary and placed on an equatorial wedge set on top of a steel pier anchored to the truss platform and reinforced against vibration.
- Observations were done at four specific HET structure azimuths during the night: north-east, north-west, south-west, and south-east. The dome was maneuvered as required to find suitable stars. Both structure azimuth and dome azimuth were recorded for each data set. Louvers were manipulated only as full-open or half-open as dictated primarily by the wind speeds and the louver position then also recorded.
- Data for a specific structure direction would be taken for fifteen to twenty minutes on a target.
- Data through several full cycles of all four structure azimuths was taken each night.

Data Collection

- DIMM seeing data is automatically logged and timestamped when the software is in the “Take Seeing Measurements” mode. Recorded are the zenith zero FWHM value in arcsecs, the telescope time and the exposure time. Exposure time for all data points in this study is 0.01 seconds.
- Weather data (outside temperature, wind direction, wind speed) is logged in five-minute interval averages; the truss temperature is also available in a separate timestamped database.
- A spreadsheet was compiled nightly containing all pertinent information re structure and dome azimuths, louver position, observer, time and weather in order to later time correlate the various logs for the data collection time periods.
- The weather archives were then mined for the outside temperature, wind direction and wind speed for the same time periods.
- The truss temperature was obtained from the truss temperature database.

Data Processing

- The DIMM and IDD logfiles were compared with the observer spreadsheet and correlated to Universal Time. Only data for which all desired pertinent data (weather, IDD, DIMM2, truss temperature, etc.) was accepted.
- The zero zenith FWHM from both IDD and outside DIMM was corrected to zenith 35 for the HET observing zenith.
- The first two nights data included in this report had a camera plate scale set at 0.79 arcsecs/pixel. The remaining data have the correct plate scale of 0.444 as calculated by Phillip MacQueen 19 April 2009, just prior to the start of this experiment. Thus the first two nights' data has been corrected to the 0.444 value as this is a scalar property for a camera.

- Telescope operators are denoted by their initials in the charts plotted by time data sequence
  - AA Amber Armstrong
  - CT Chevo Terrazas
  - VR Vicki Riley
  - AW Amy Westfall
- The data sequence is divided into the nights (UT) as observed. There were a total of 1000 points of data over the eight nights.
- A second data set was taken in 2010 while with the HET was simultaneously observing to look for the impact the heat load on the tracker might have on the IDD results.

Calibration

- The Calibration for the IDD was done by setting DIMM2 up next to DIMM1 on the tower. DIMM2 was located outside the DIMM enclosure and at the top of the stairs but at the same elevation as DIMM1.
- The Calibration tests involved observing the same stars with both telescopes and also observing two different stars to determine the impact of not being on the same star.

Summary:

- DIMM1 (in the DIMM tower) and DIMM2 yield very similar seeing values (-0.04 with RMS ~0.15”; see Figure 1) when on the same star and side by side but can result in 0.2” differences when on different stars (See Figure 2).
- The in dome DIMM tracks the outside dimm very closely over good seeing and bad seeing events.
- The louvers were either open completely or open half way based on what the TO felt the wind speed required. Figure 3 puts the louver position as different colored points. There does not seem to be any influence on the difference between the inside and outside DIMMs based on louver position.
- There is a very weak trends between the difference between the inside and outside dimm and the difference between the inside and outside temperature. If the inside dome temperature is higher than the outside temperature then the inside DIMM tends to be slightly higher than the outside DIMM.
- Earlier trends seen with wind direction (Figure 9) do not hold up in the later data set from February 2010 (Figure 15).
- The results from the IDD vs. DIMM are that the IDD matches and occasionally beats the DIMM seeing values, there is no dome seeing problem that the DIMM telescope can detect. The residual IQ of the HET is on the order of 0.7”.

Future Tests:

We may have a dome seeing problem that is undetectable by the DIMM, e.g. seeing cells larger than can be detected by the DIMM which may cause image motion (not differential motion). Such dome seeing will have to be tested with a high speed camera, perhaps while the IDD is running. We may also have dome seeing problems that would be detectable with the IDD but were not present on the nights sampled.

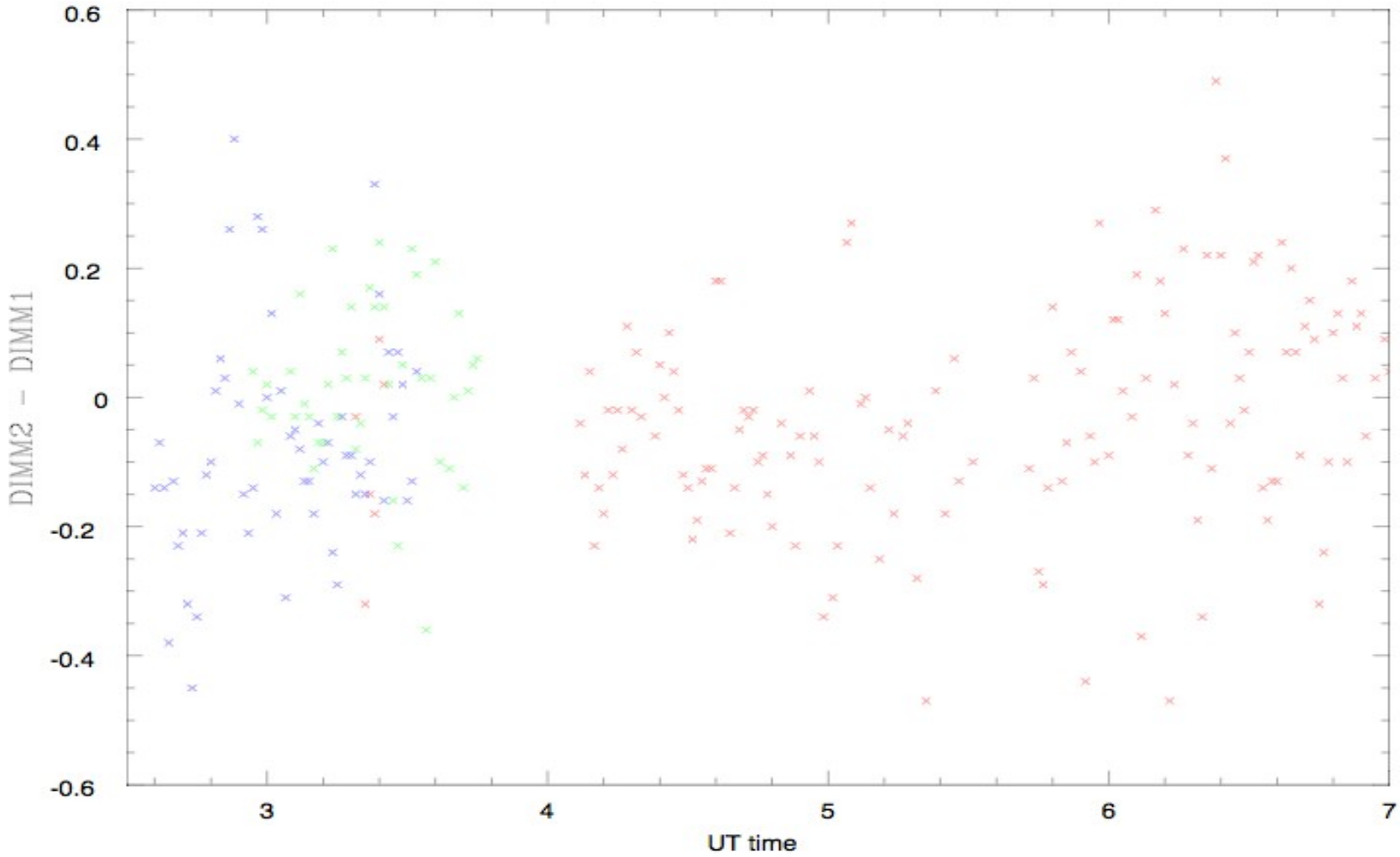

Figure 1: Results from the Side by Side Test on the Same star for the two DIMMs from three nights: red Nov-25-2009, blue Jan-16-2010, and green Jan-25-2010. The Standard Deviation is 0.15".

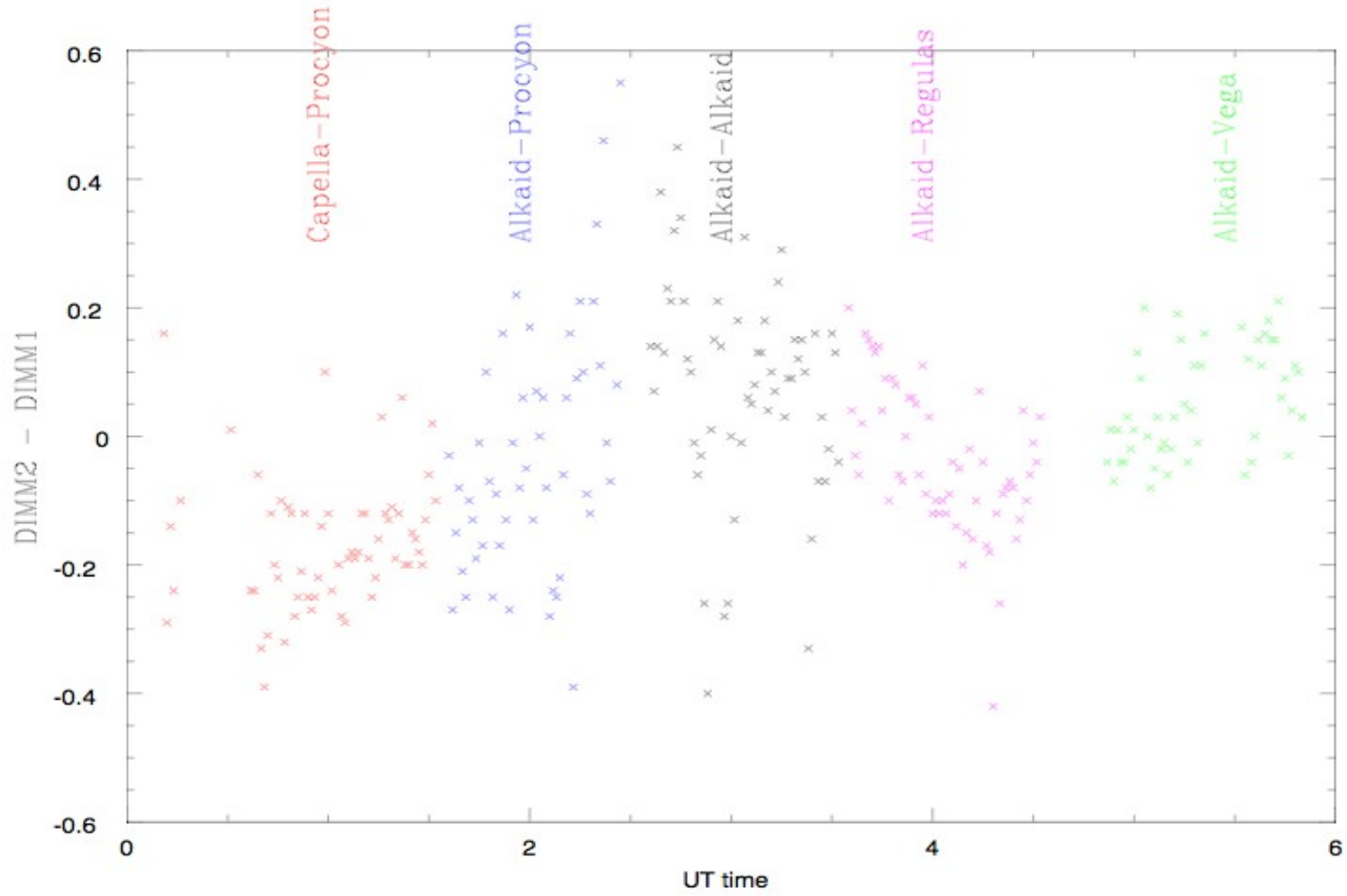

Figure 2: Results from the Side by Side Test on different stars for the two DIMMs from the night: Jan-16-2010. The Standard Deviation is 0.16". Each color respresent different star pairs. The black points were on the same star.

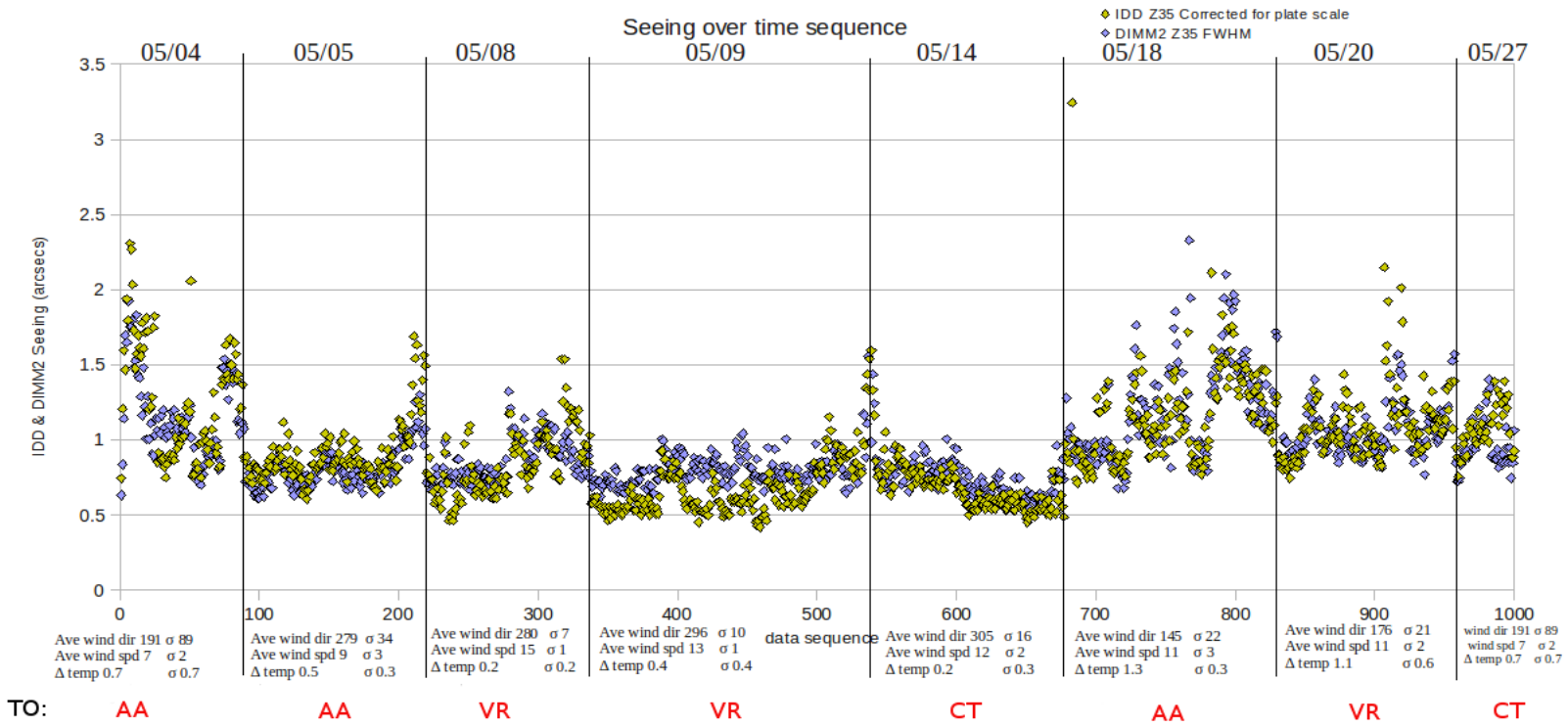

Figure 3: The IDD and outside DIMM2 values for each night that could be time correlated. Below each night the initials of the TO and the average wind direction and speed are given along with the average difference in temperature between the dome and the outside temperatures.

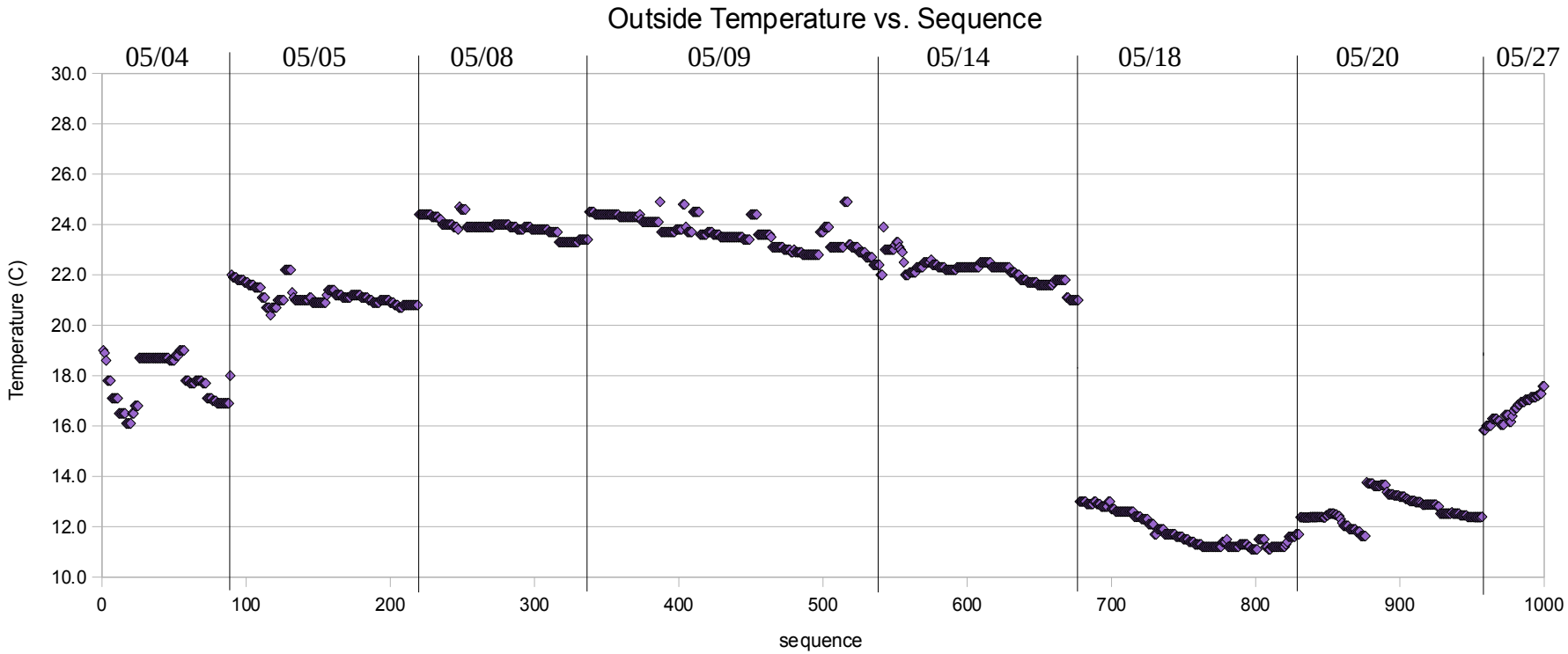

Figure 4: The outside temperature for each data point for the nights in which the time could be correlated. The dates are indicated by vertical lines drawn to separate the different nights.

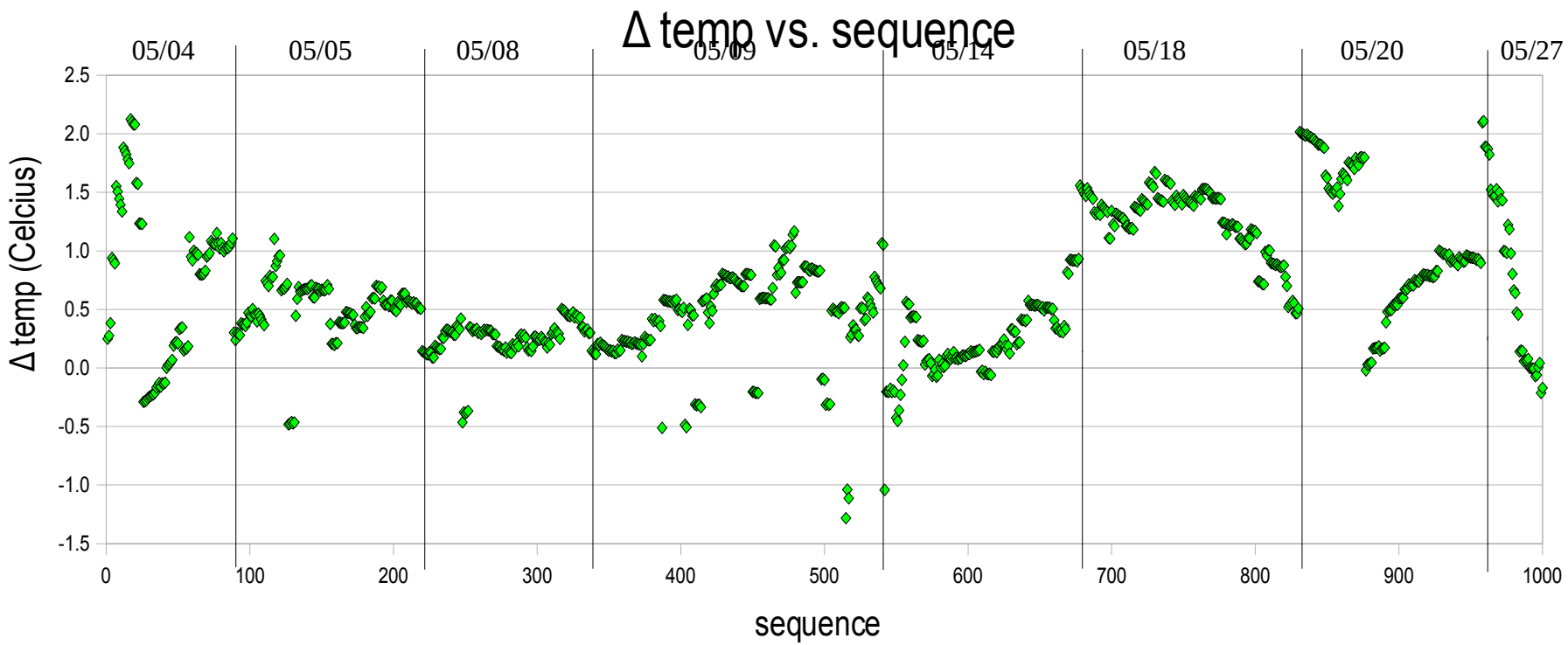

Figure 5: Difference between the inside and outside temperatures for each data point for the nights in which the time could be correlated. The dates are indicated by vertical lines drawn to separate the different nights.

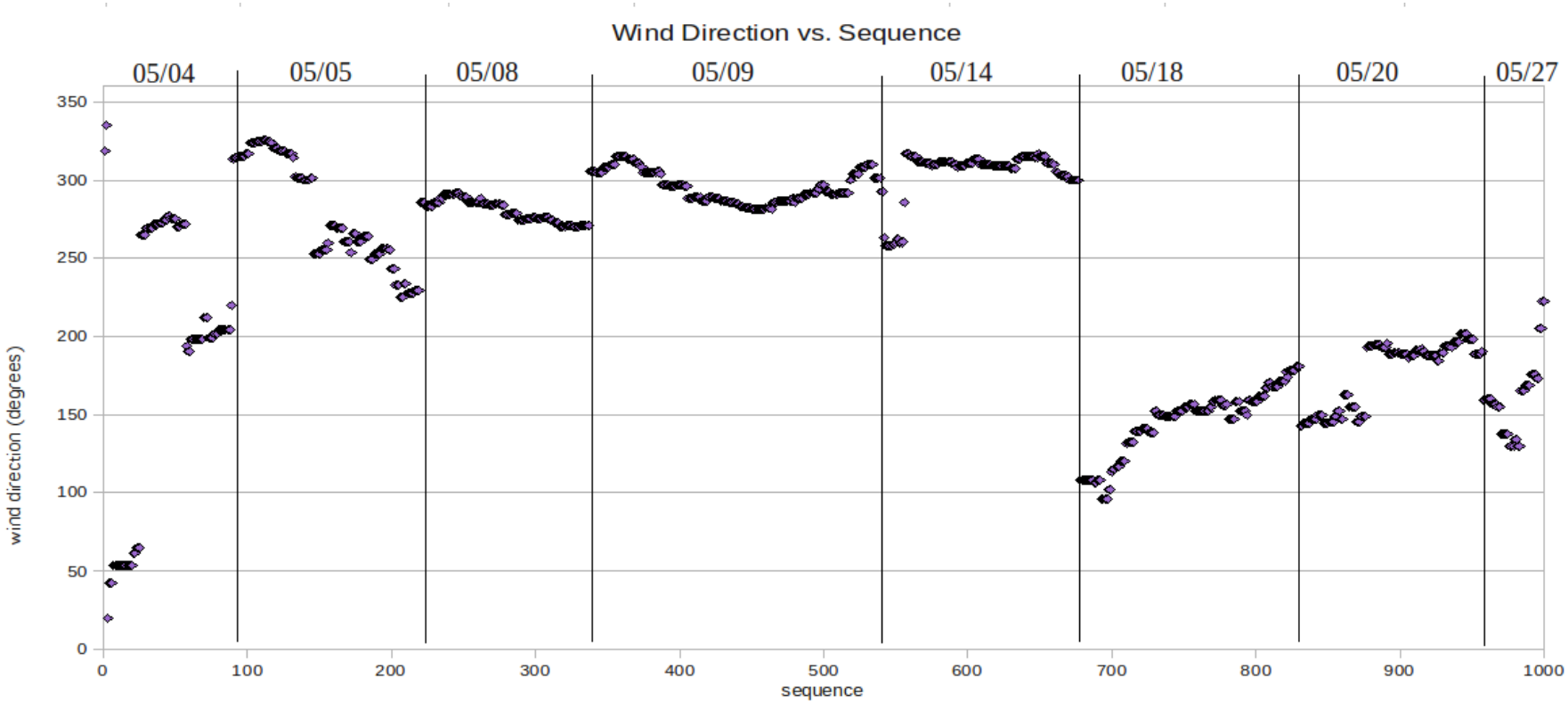

Figure 6: Wind direction for each data point for the nights in which the time could be correlated. The dates are indicated by vertical lines drawn to separate the different nights.

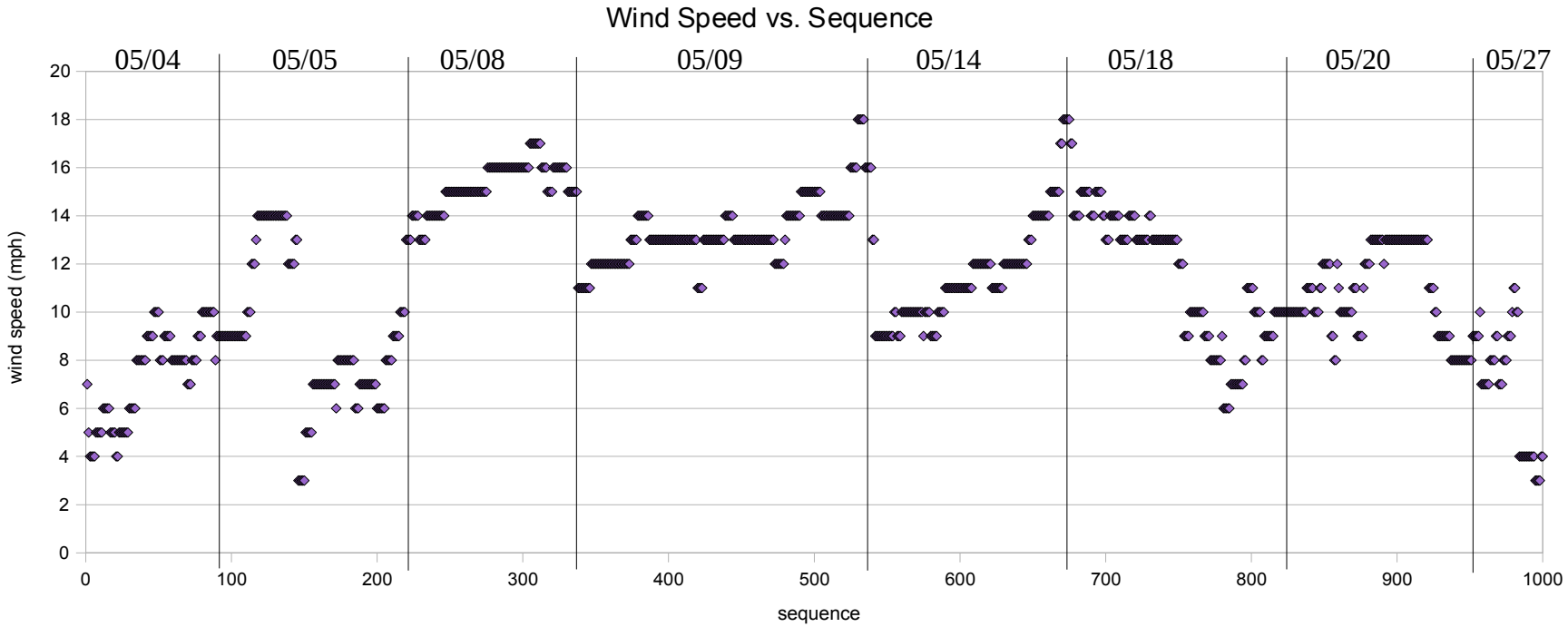

Figure 7: Wind speed for each data point for the nights in which the time could be correlated. The dates are indicated by vertical lines drawn to separate the different nights.

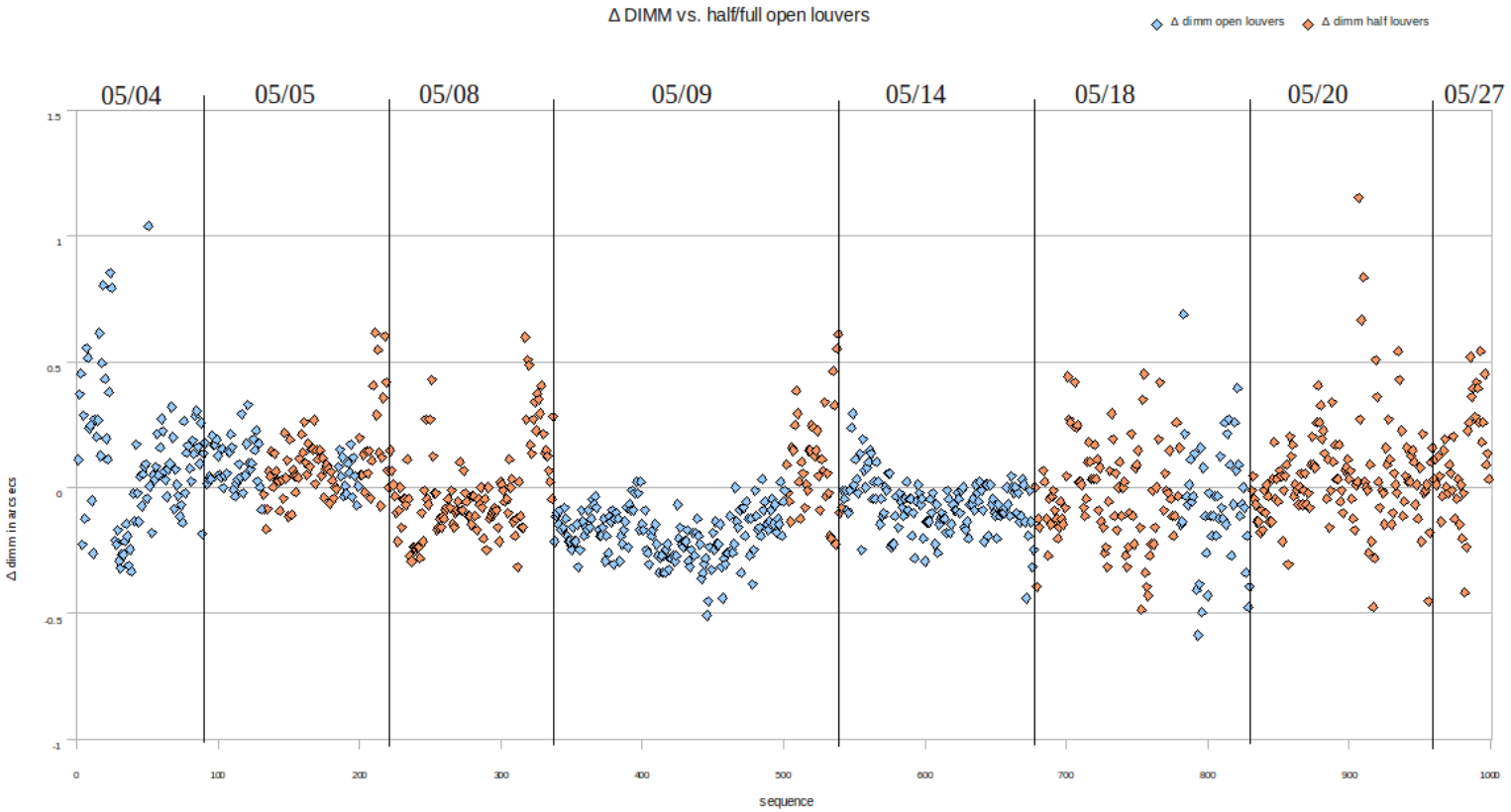

Figure 8: The difference between the IDD and the DIMM2 are shown. The copper colored points are the periods when the louvers were feathered to 45 degrees and the blue points are when the louvers were fully open.

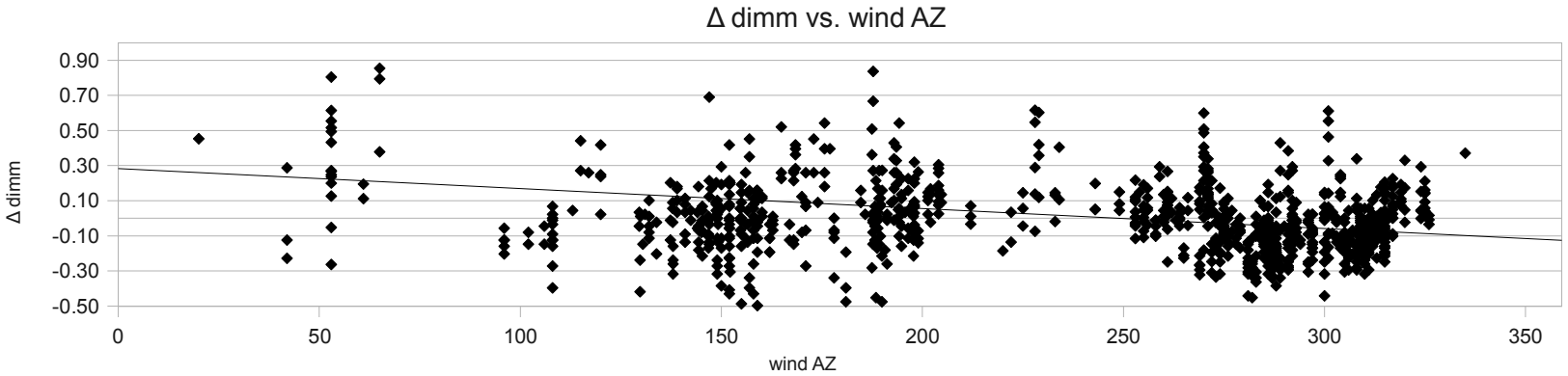

Figure 9: The difference between the IDD and the DIMM2 as plotted against the wind azimuth in degrees.

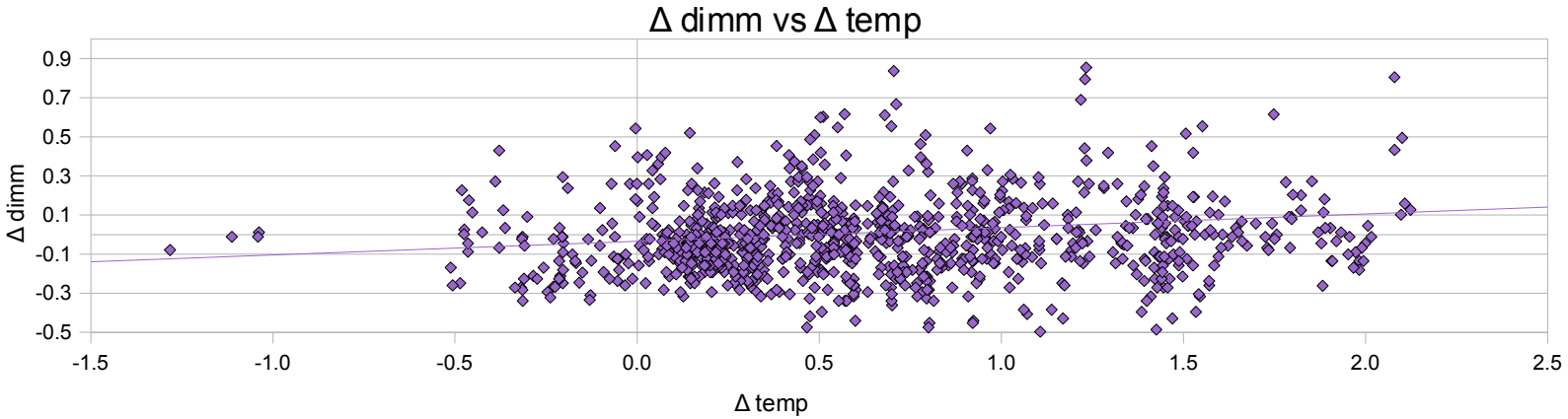

Figure 10: The difference between the IDD and the DIMM2 as plotted against the difference in temperature (°Celsius) as recorded at the IDD and the DIMM2 respectively.

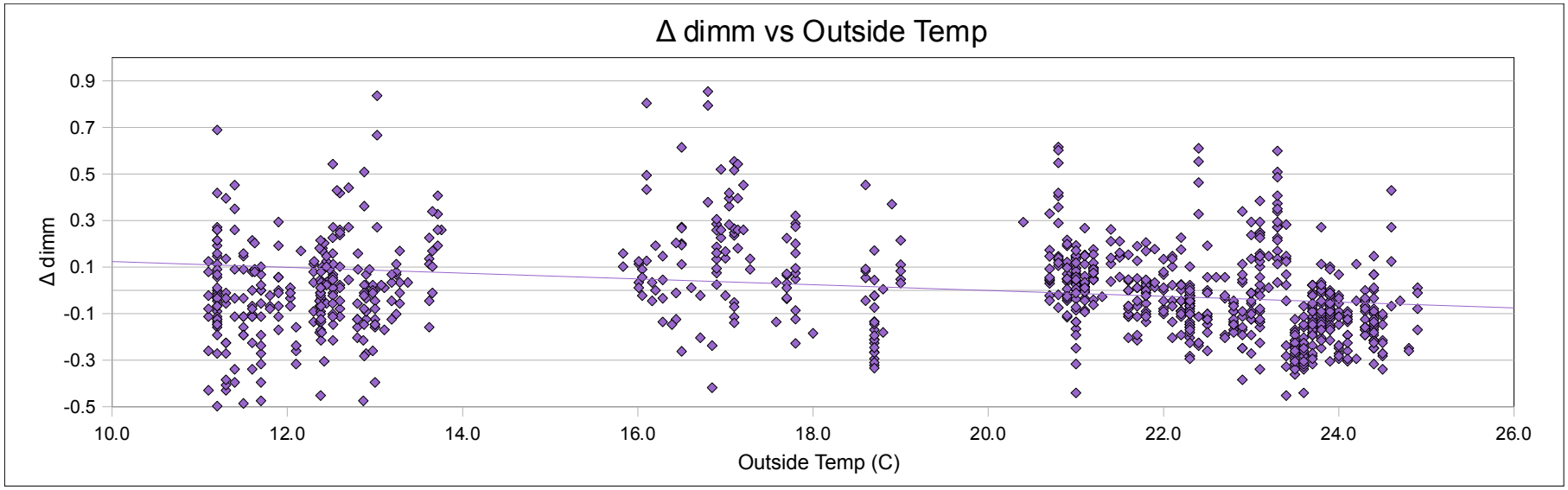

Figure 11: The difference between the IDD and the DIMM2 as plotted against the difference in temperature (°Celsius) as recorded at the IDD and the DIMM2 respectively.

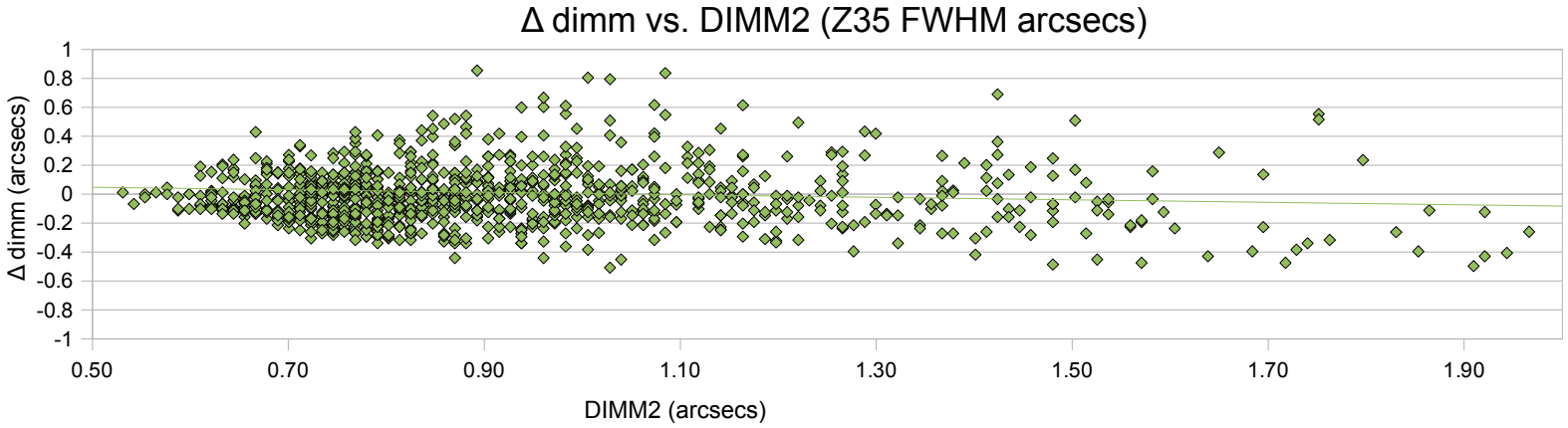

Figure 12: The difference between the IDD and the DIMM2 as plotted against the DIMM2 value. All seeing values in arcsecs.

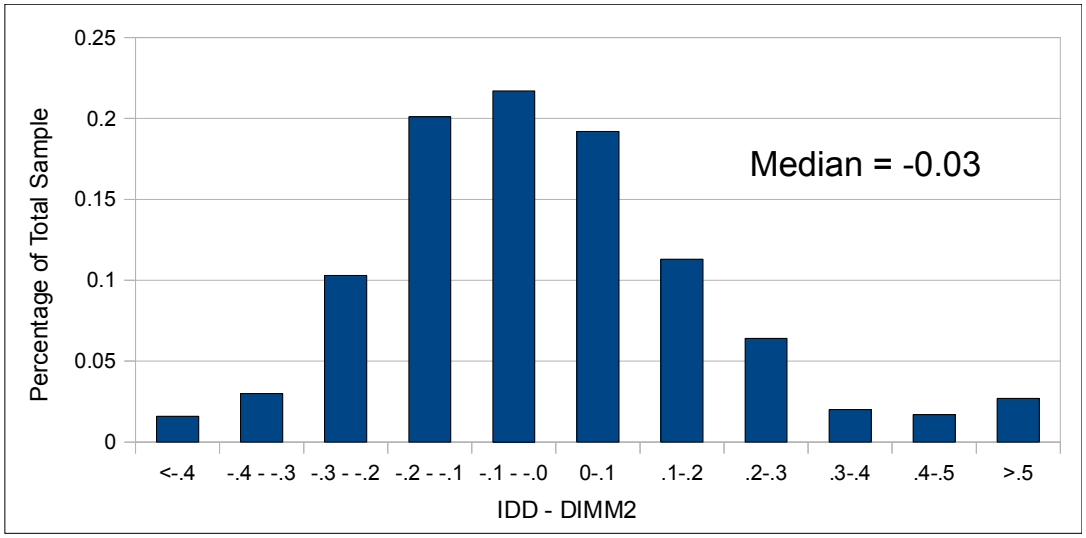

Figure 13: A histogram of the difference between the In Dome Dimm and the outside DIMM (DIMM2).

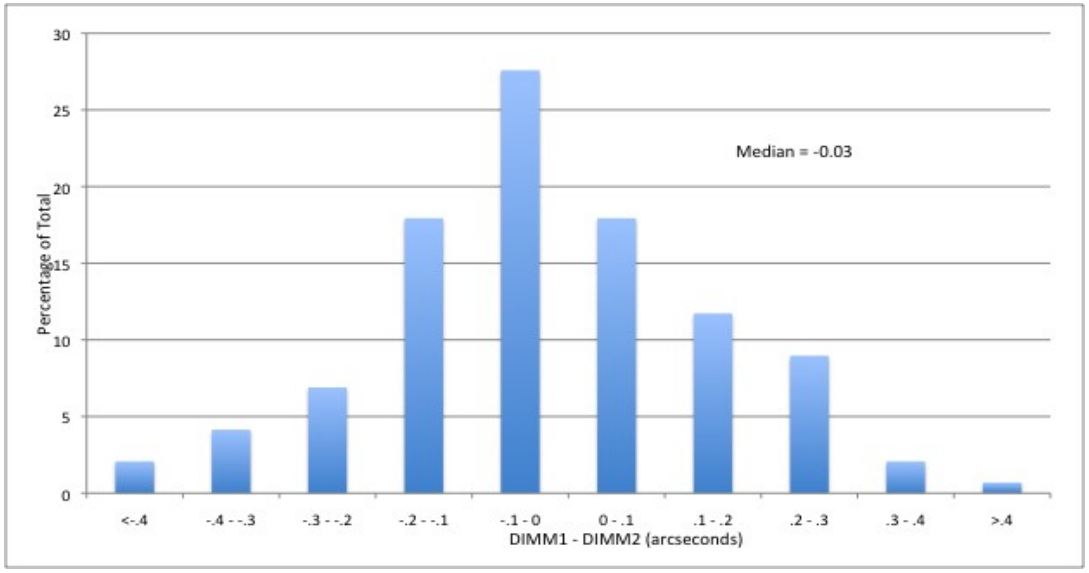

Figure 14: Similar to the previous figure, but with the IDD setup on the outside DIMM tower and sampled over only 140 data points. This should measure any systematic differences between the two DIMM telescopes.

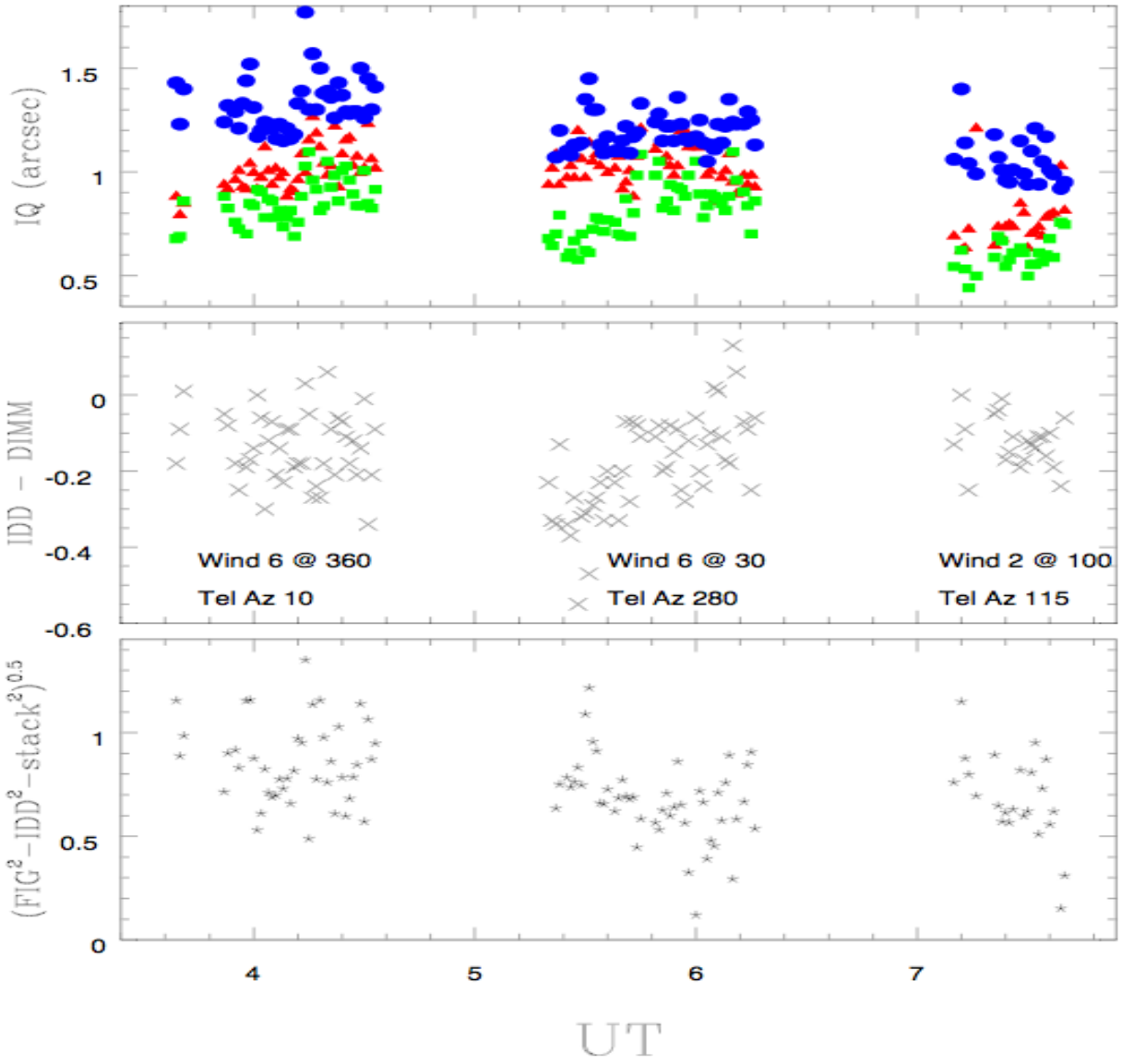

Figure 15: The top pane shows data from the fiber guider with direct mirror feed (blue), the DIMM (red) and the IDD on the HET structure (green) from the night Feb-27-2010. The middle pane shows the difference between the IDD and the DIMM along with the direction the HET and the smaller telescopes were pointed. The bottom pane shows the residual image quality after the IDD and stack were subtracted off in quadrature.