# Have aCyg R: PEP Monitoring of Deneb

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Submitted December 9 2025

**Subject Keywords**

Photometry, PEP; Alpha Cygni Variables; stars: individual (Deneb)

**Abstract**

Alpha Cygni variables generally exhibit photometric variations of only 0.1 magnitude or less. A successful photometry campaign with multiple observers must achieve high internal consistency with low uncertainties. With preliminary data on Deneb, we show that the AAVSO Photoelectic Photometry (PEP) group can produce such data.

## 1. Introduction

Deneb is among the most studied of the Cygni variables, but its great brightness and small range of variation make it a challenging photometric target. Old-school PEP is well suited to the study of this star. During the 2025 apparition (June to October) nine AAVSO PEP observers obtained 154 V band data points.

## 2. Observations

### 2.1 Method

The AAVSO PEP group operates Optec SSP photometers almost exclusively. For this project the model SSP-3 was used, its photodiode sensor being well suited to such a bright target. Telescopes of aperture 8 to 12 inches were employed. The brightness of Deneb was measured differentially in respect to HD 199629, an A0 giant. The PEP observing sequence typically samples the program star three times, each time bracketed by samples of the comparison star. The reduced magnitude is taken from the mean of the three differential measurements.

Historically, AAVSO PEP has reported uncertainties as the standard error of the samples. That metric overstates the precision achieved. In this study those

uncertainties have been multiplied by 1.73, approximately converting the standard error to a standard deviation of the sample.

The comparison star was chosen to minimize transformation, the Δ(B-V) being 0.070 (Mermilliod, et al, 1997). Observers would typically apply transformations of only a few millimagnitudes. Alpha Cygnis undergo only slight color changes so the transforms were based upon the catalog BV colors rather than two-band measurements. The comparison is 5° away from Deneb so an extinction correction was applied. Some observers measured nightly extinction, others used a fixed estimate. The extinction corrections are not readily available from most observers, but the second most prolific observer (32 data points) applied median absolute corrections of 0.006.

## 2.2 Results

Figure 1 presents the 2025 PEP light curve with the expanded uncertainties. The median uncertainty was 0.005 magnitudes. On 41 nights there were 2, 3, or 4 measurements reported. This permitted 107 same-night pairwise comparisons between observations. In 96 cases, the pairs agreed within their uncertainties for a 90% rate of consistency. In only two cases were both magnitudes reported by the same observer.

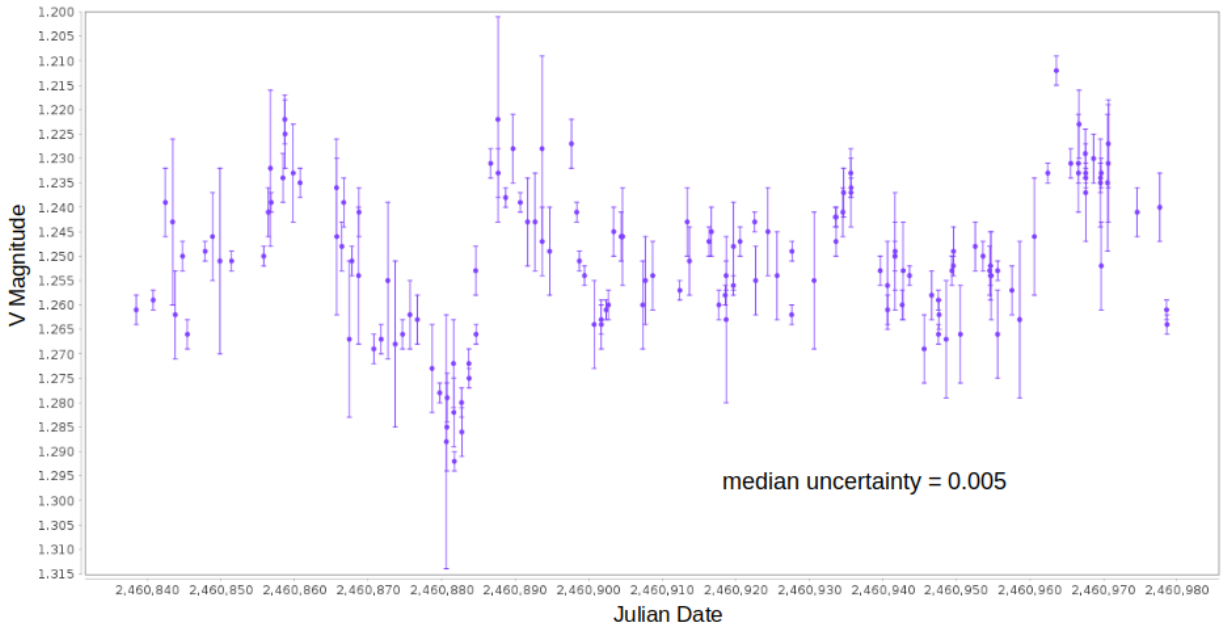


Figure 1. Deneb V band light curve, June-October 2025.

## 2.3 New uncertainties

With some admittedly limited data it is possible to illustrate that the new uncertainty metric is appropriate. The AAVSO International Database (Kloppenborg, 2025) contains some stars that were once thought variable but are now considered constant. Such stars, for which data may still be submitted, become convenient test targets. Figure 2 shows a light curve for HD 127700 with 27 data points from four

observers. The weighted mean of the observations (V=4.244) is marked with the dashed line. Only four data points fail to have their uncertainties straddle the mean, missing by 2, 10, 14, and 18 mmag. The worst of these is known to have been acquired on a night with challenging sky conditions; the other large outliers are still under investigation.

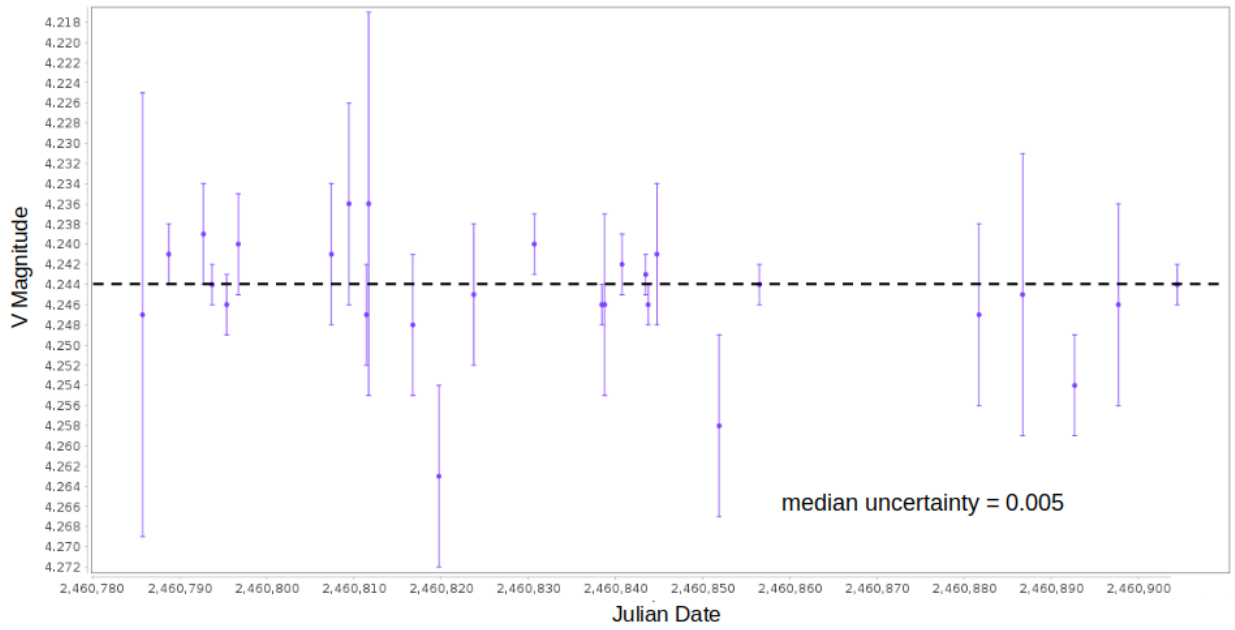


Figure 2. V band light curve of constant star HD 127700.

The comparison (HD 136726) was chosen for its very close BV color match. Some observers took data only in V band, others took BV data and inferred the color difference. The comparison is about 5° from the target star; extinction was compensated for.

Light curves like this can be used to diagnose problematic sources of photometry. We have already employed such a curve to identify an observer reporting systematically too-bright magnitudes. Constant stars can be found in the International Variable Star Index (Watson, et al, 2006) by searching for "non-variables." It would be instructive for CCD observers to undertake an exercise like this!

## 3. Conclusions

The consistency and precision of PEP make it well-suited to the study of low amplitude variables by multiple observers. We plan a multi-year project to follow Deneb and other alpha Cygni stars. In the future AAVSO PEP will make standard deviation of the sample the default metric for uncertainty.

## Acknowledgements

We gratefully acknowledge support from the late Gerald Persha, founder of Optec and designer of the SSP photometers.

**References**

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