Transform Generator User's Guide

(TG – Version 6.9)

1. Introduction

The Transform Generator (TG) program provides an easy way to calculate photometry transformation coefficients. The program reads text file(s) containing instrument magnitude measurements of standard stars in reference fields (currently M67, NGC 7790, M11, NGC 1252, NGC 3532 , Mellotte 111 and the Landolt Fields) and calculates the standard transformation coefficients. Plots of the instrument magnitudes used to compute each transform are displayed allowing users to deactivate bad data points whereupon the transforms are immediately recalculated. Deselected data points can be reactivated. Transform sets can be saved for future use. Results from multiple transform sets can be compared and averaged together to obtain a final set of coefficients. An export file can be created containing the transform coefficients in a format compatible with the AAVSO Transform Applier tool and for printing.

The program works with standard export files from VPhot, AIP4WIN and MaxIm. Screen captures in this user's guide sometimes show previous version numbers. Other than the version number, those screens have not changed.

2. System Requirements and Installation

TG requires the use of Python along with several additional libraries. Detailed installation instructions can be found at http://www.aavso.org/tg. Following these procedures will ensure the necessary software is installed on your computer.

TG requires an active Internet connection.

3. Program Operation

TG allows users to compute and maintain transformation coefficients for multiple telescopes. Using TG, users proceed through the following steps to generate coefficients:

3.1 Start program using the start-up icon.

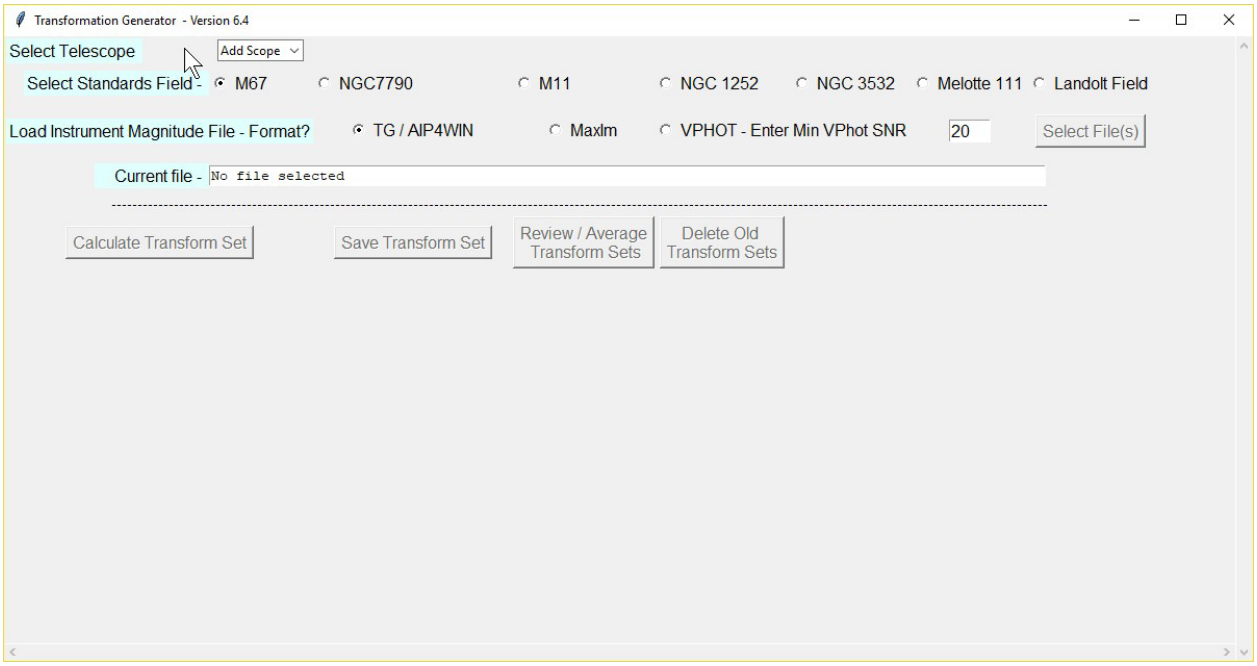
(See installation instructions at www.aavso.org/tg.) Launch time for the program depends on how TG was installed. This is explained on the website with the installation instructions.

3.2 Select telescope name –

"Add Scope" if it's the first time you enter data from that scope. (To use the demonstration file, enter T17 as a scope name)

3.3 Select the standards field used.

Currently M67, NGC 7790, M11, NGC 1252, NGC 3532, Melotte 111 and the Landolt Fields are available. (Select M67 to use the demonstration file.)



3.4 Create the Instrument Magnitude Files

The first step is to observe the standard star field and create the standard star instrument magnitudes. ***VPhot is recommended to identify stars and generate instrument magnitude files. It can save a lot of time greatly simplifying the selection of standard reference stars. It also has a rapid way to generate the instrument magnitudes for all filters. If using VPhot, skip to section 3.4.3. You won't need to understand the details of the instrument magnitude file formats described in the following two sub-sections.)***

If you are using AIP4Win, MaxIm, or you own software, match the reference field stars to the VSP data (https://app.aavso.org/vsd/stdfields , using the AUID's to identify the stars.

3.4.1 TG and AIP4WIN Instrument Magnitude File Format:

The format for this file is a standard CSV file – the delimiter may be either a semicolon or comma.

Three types of lines in the file are processed - all other lines in the file are ignored.

3.4.1.1 Filter identification line -

A filter identification line identifies what filters were used and which fields of subsequent star measurement lines respectively contain which filter measurements. The first key word of this line must be "Filt" – case sensitive. Subsequent fields contain u,b,v,r, and/or i (upper or lower case). Fields may be skipped (e.g. many

programs output error data in between machine magnitudes) by entering successive delimiters.

Two examples:

Filt,b,v,i

Filt;;u;;b;;I;;v;;r (note, this is a standard AIP4WIN output format)

3.4.1.2 Date of observation line -

This is optional, but is included in the program output to help identification. The first key word is "Julian_Day", and the second field contains the Julian date.

Example:

Julian_Day; 2456628.19110; (again, this is part of a standard AIP4WIN format)

3.4.1.3 Star instrument magnitude measurement lines-

These lines contain the filtered instrument magnitudes for each star. The filter sequence and spacing are defined by the earlier Filter identification line.

The first field of a star instrument magnitude measurement line contains the star id.

M67 ids may be either those in Appendix A (with "Boulder" star ids 1-63) or the current AUID. NOTE: The most recent standard reference magnitudes are retrieved from the AAVSO VSP tool independent of whether one uses the original Boulder ID's or current AUID's. (Users of the original "Boulder" numbers should know some of those stars are no longer reference stars. A message will be displayed by TG indicating which stars were not used in the calculation.)

NGC 7790 ids may be either those in Appendix B (with "Boulder" star ids 1-31) or current AUID's.

The second and subsequent fields in the star instrument magnitude measurement line have the magnitudes defined in the earlier Filt line.

Examples 1:

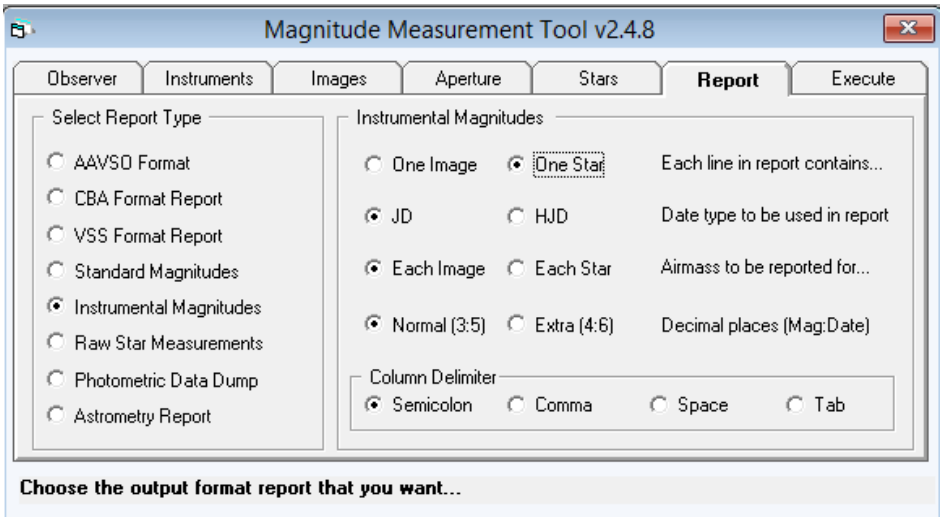
Filt; B;; V;; R;; I;;
1; 9.063; 0.001; 9.047; 0.001; 8.784; 0.001; 9.375; 0.001;
2; 10.711; 0.002; 9.325; 0.001; 8.408; 0.001; 8.369; 0.001;

Example 2:

Filt,b,snr,v,snr,r,snr
112,-7.747,258,-9.436,411,-9.475,415
117,-7.9,282,-9.002,332,-8.7,235

3.4.1.4 Users of AIP4WIN can generate this file using the MMT (Magnitude Measurement Tool) and selecting the Instrumental Magnitudes report format with the “One Star” in “Each line in report contains…”

AIP4WIN MMT Window:



3.4.2 MaxIm Format

The MaxIm instrument magnitude report format from MaxIm v. 6 is used. Star id’s are the numbers immediately in front of the “:Instrument Magnitude (Centroid)” text.

Instructions for MaxIm v. 6

1. Go to analyze - photometry
2. Go to add files
3. Select your U, B,V,R,I images (or filter subset)
4. Make sure you highlight the image that you intend to identify your stars
5. On the match tab, select auto-star matching
6. Go to identify tab
7. Right click and tag new object for the stars that you want to identify in the image. Tag all of your stars as new objects. You must tag one star as a reference star but you do not have to input any magnitudes.
8. Go to the graph tab. At the bottom, select CSV export options. Magnitude is selected by default. The only other field that is needed is Instrumental magnitude.
9. Save file as CSV

10. You can go into excel and delete the magnitude column but it is not necessary because the TG will read the file with or without the magnitude column there.

11. In TG select MaxIm as file type and select the file and click on calculate transform set.

Example file format:

Timestamp (JD), Filter, 21 : Instrument Magnitude (Centroid), 21 : Magnitude (Centroid), 17 : Instrument Magnitude (Centroid), 17 : Magnitude (Centroid), 11 : Instrument Magnitude (Centroid), 11 : Magnitude (Centroid), 13 : Instrument Magnitude (Centroid), 13 : Magnitude (Centroid), 5 : Instrument Magnitude (Centroid), 5 : Magnitude (Centroid), 8 : Instrument Magnitude (Centroid), 8 : Magnitude (Centroid), 18 : Instrument Magnitude (Centroid), 18 : Magnitude (Centroid), 9 : Instrument Magnitude (Centroid), 9 : Magnitude (Centroid), 26 : Instrument Magnitude (Centroid), 26 : Magnitude (Centroid)

2456849.8309953702, B, 14.979, 14.826, 14.899, 14.745, 12.895, 12.742, 14.003, 13.850, 14.426, 14.273, 11.667, 11.514, 13.918, 13.764, 14.072,
13.919, 15.921, 15.768

2456849.8324421295, I, 12.437, 11.771, 12.247, 11.582, 12.194, 11.528, 13.281, 12.615, 13.754, 13.088, 11.457, 10.791, 13.164, 12.498, 13.207,
12.542, 13.819, 13.153

2456849.8295486113, R, 12.287, 12.531, 12.115, 12.359, 11.662, 11.907, 12.741, 12.986, 13.146, 13.390, 11.006, 11.251, 12.599, 12.843, 12.673,
12.918, 13.576, 13.820

2456849.8272453705, V, 13.351, 13.342, 13.231, 13.222, 12.148, 12.139, 13.252, 13.243, 13.694, 13.685, 11.330, 11.321, 13.185, 13.176, 13.281,
13.272, 14.528, 14.519

3.4.3 VPHOT Format

An efficient method to create transform coefficients is to use VPhot to process your images and create the file(s) used as input to TG. There are two methods. The first method is the quickest; it was recently developed (April, 2023) and is referred to below as the "AIP file format method". The second method requires the creation of multiple files and was the original approach. It is referred to below as the "VPhot file format method". It remains for those who prefer to continue using that earlier approach.

In both cases, the first step is to log into VPhot. If you have not used VPhot before, you'll need to be an AAVSO member, have an observer code and register a VPhot account. Instructions are on the page -https://app.aavso.org/vphot/. The initial time you register, take the time to read the ***VPhot Users Guide*** and become familiar with its operation.

The initial steps to creating an instrument magnitude file for use by TG are the same for either method:

1. Select the standards field you plan to use (a full list is at https://app.aavso.org/vsd/stdfields.)
2. Make observations with each of your filters. It's recommended you take three images with each filter in a cadence such as BVRIBVRIBVRI or BBBVVVRRRIII (less filter wheel movement).
3. Use filter exposures that provide suitable SNR.
4. Upload the images to your VPhot account.
5. Select/display one of your images (typically your "V" image).
6. Create an observing sequence containing the reference stars you will utilize to generate transform coefficients –
    - Select the Catalog dropdown box on the upper right of the screen, and select "Load AAVSO Standard Stars"
    - Review the image. Remove stars that are too close together with overlapping apertures or have too low an SNR.
    - Alternatively, one may want to accept/save all standard stars. Overlapping stars, saturated stars or very faint stars can be removed/deactivated later as obvious outliers in TG.
    - Select any two stars and tag them by clicking on the star in the image and selecting "Fixed Target" or "Check Star". These two stars are not used in the analysis but are required for the Time Series tool used below.
    - Save the sequence.

The next steps differ based on which VPhot method you use.

AIP File Format Method

- Go to the images page and select all the standard field images you are using from every filter. If you have taken multiple images with the same filter, you may select all of them.

- Select "Time Series" from the list of options across the top of your image list. The time series tool is used to create a single file containing all the instrument magnitude measurements for all the images from all different filters.
- Select the sequence you prepared earlier. Typical settings for other options are - Aperture set on automatic with radius 1.5 time FWHM, and Min SNR set to 20.
- Select "Start the Analysis", and on the subsequent "analysis is complete" page, select "Continue to the result page"
- Select "General Export" from the options across the top of the table.
- At the bottom of the resulting page, select "Save to AIP fmt for TG" and be sure to note the location of this saved file. This is the file you will import to TG.

VPhot file format method – this method remains active, but requires a few additional steps/effort for each filter group.

- In VPHOT, view one filter image at a time.
- Select your saved sequence.
- Select "View Photometry Report".
- Select "Download" option (towards the top of the screen).
- Save the file on your computer.
- Repeat this process for each image. For example, if you have a full UBVRI set of images, you will have 5 separate files. (You can also have multiple images for any filter(s) creating multiple files for the same filter. TG will average the measurements from all the files.) This process can be less tedious if multiple filter images are stacked to create one stacked image for each filter.

You now have generated the instrument magnitude file(s) needed by TG.

3.5 Loading Instrument Magnitude Data Files and Calculating Transforms Coefficients

(If you just now starting TG, remember if TG was installed using the "single file" method, it may take 30 seconds for the program to start as it initializes the Python environment. If this is the first time you've used TG, add your scope name (click add scope twice and enter name).

The next step is to load the instrument magnitude file. Select the format of your file.

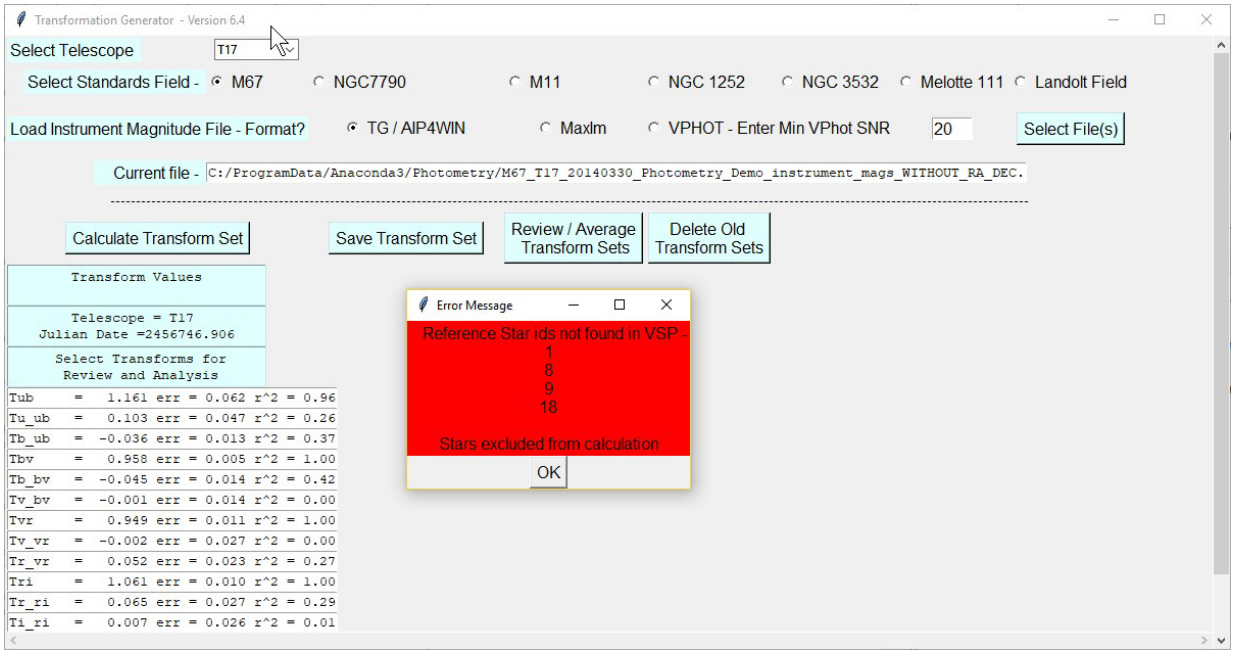
- If you used the VPhot AIP File Format method, select the AIP/TG format.
- If you used the VPhot File format method, select VPhot format and enter a minimum SNR you want used in the calculation. (For the best results, set SNR >100, but note that SNR>20 often yields similar results. The most important objective is to ensure that many stars with extreme colors are present in each plot.)
- If you created AIP/TG or MaxIm files, select that format

Click "Select File(s)" and, if multiple files, (e.g. one for each filter in the VPhot File Format Method) select/copy ALL THE DOWNLOADED VPHOT FILES and insert/paste them all at one time.

Click "Calculate Transforms" – and the data appears in 10 – 15 seconds. If any of the stars contained in the instrument measurements file are not found in VSP, an error message appears listing those id's. Transforms are

created using all valid measurements.

The number of stars used for each transform varies – based on the minimum SNR entered and which stars VPHOT downloaded. Numbers of standard stars exceeding 50 generally provide more reliable coefficients, especially if highly colored stars are present.
As an example, you can use the test TG file you downloaded with the program (M67_T17_20140330_Photometry_Demo_instrument_mags) by naming a scope T17, loading that demo file, and selecting the TG/AIP4WIN format. Selecting "Calculate Transform Set" produces the screen below. Using your own instrument file will produce similar results.



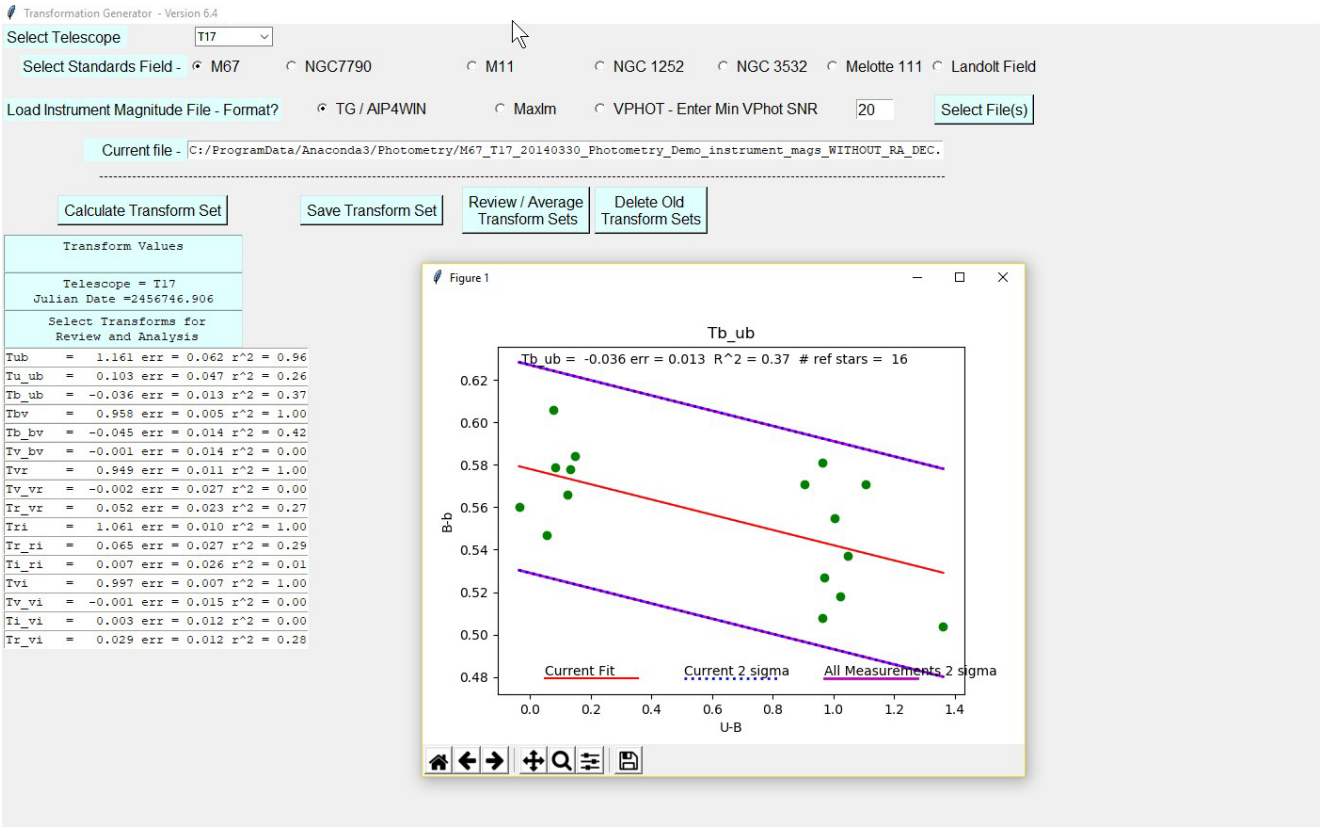
Note the display shows the current file name, the JD of observations (if it was provided), transform values, one sigma error estimate, and "r squared" measure indicating the "goodness" of the linear fit to the measured data.

The r^2 value gives some indication of the goodness of the linear fit, but is not reliable when data has a slope near zero, which occurs with the magnitude coefficients (i.e. Tx_xy). In fact, an exact fit to a slope zero line will actually exhibit a r^2 value=0 not 1!

The Error Message box displays any id's which could not be found in VSP.

3.6 Plotting of transformation coefficients –

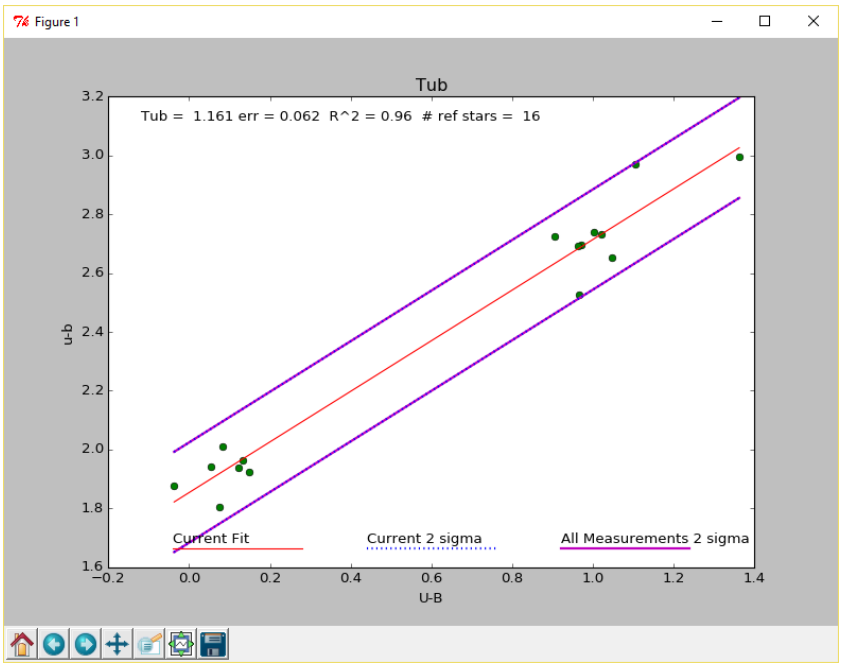
Point at any individual transformation line in the table. The field will turn red. On selecting the field, a plot is generated –

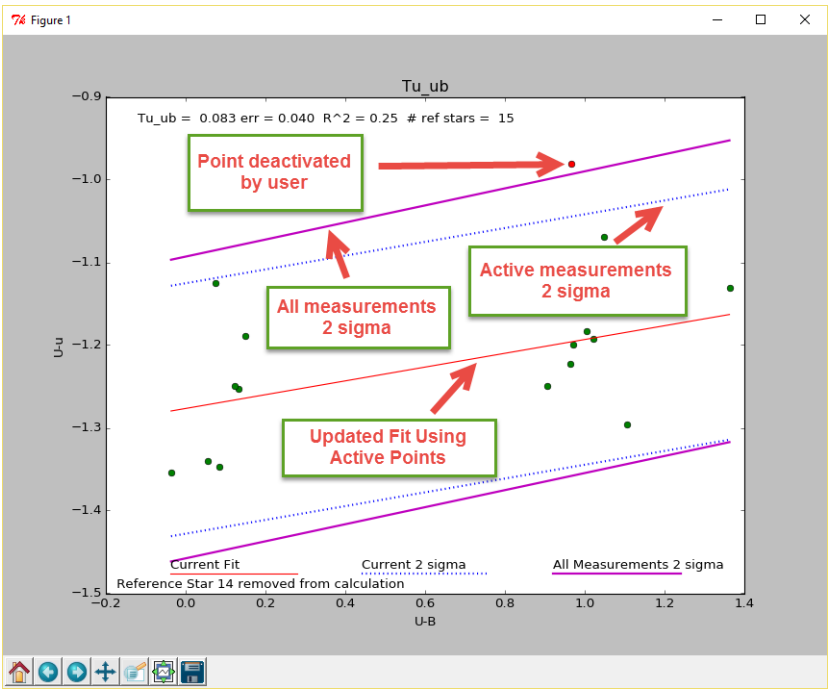


3.7 Analysis of transformation coefficients –

The red line shows the plot resulting from the calculated transform. Two sigma error lines calculated using all observations are shown in purple. These 'all measurements' 2-sigma lines remain static during subsequent analysis and deletion/addition of data points.

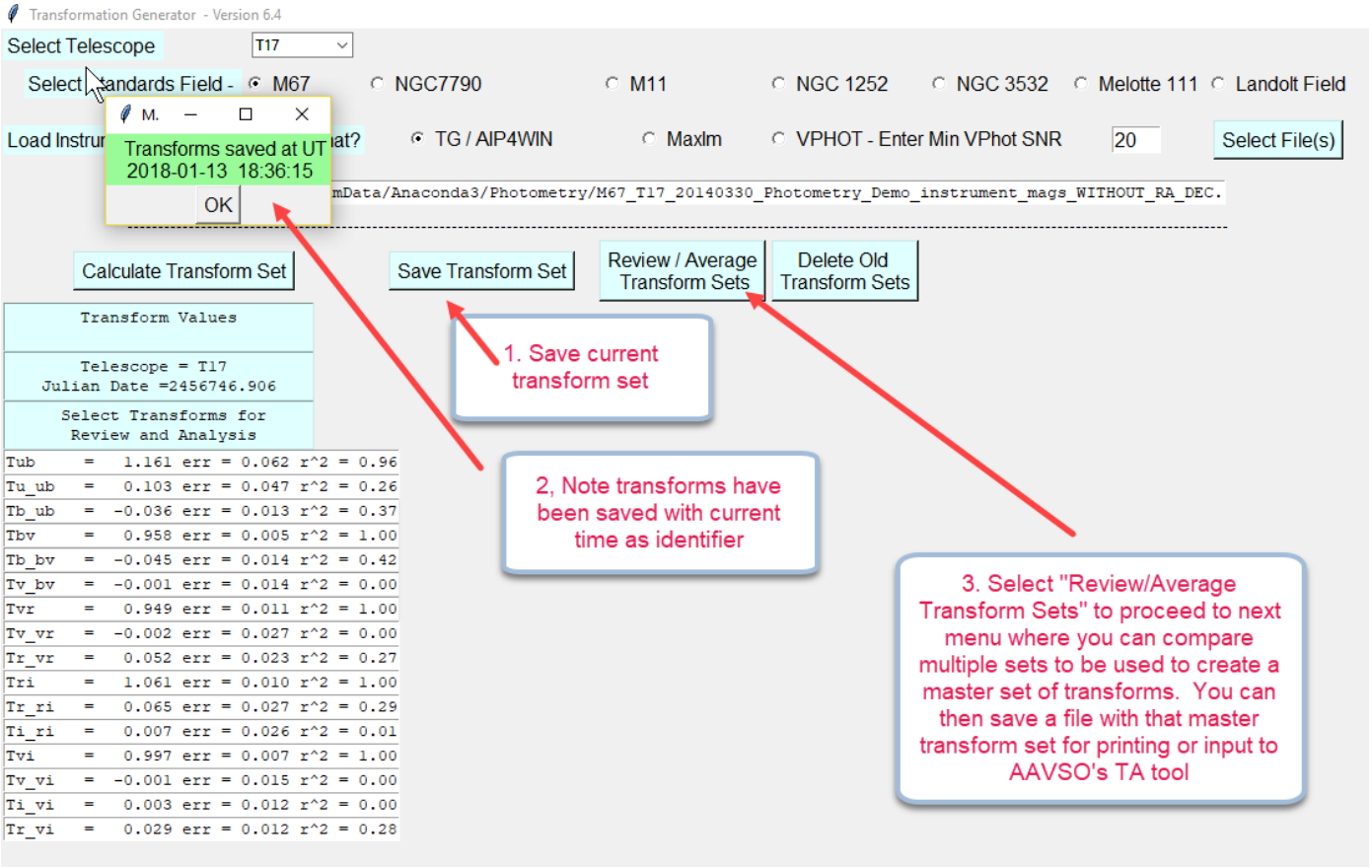
The user may select any individual observation measurement/outlier to deactivate it from the calculation. Deactivated observations switch from green to red in color, and the transform value is immediately recalculated, an updated fit line redrawn in red, and new "Current 2 sigma" lines are **drawn in dotted blue.** The deactivated star id and the number of active reference stars used in the current calculation are shown. Users can deactivate additional stars and also, by reselecting a deactivated star, re-activate it for use in the calculation.





3.8 Saving the displayed transform set –

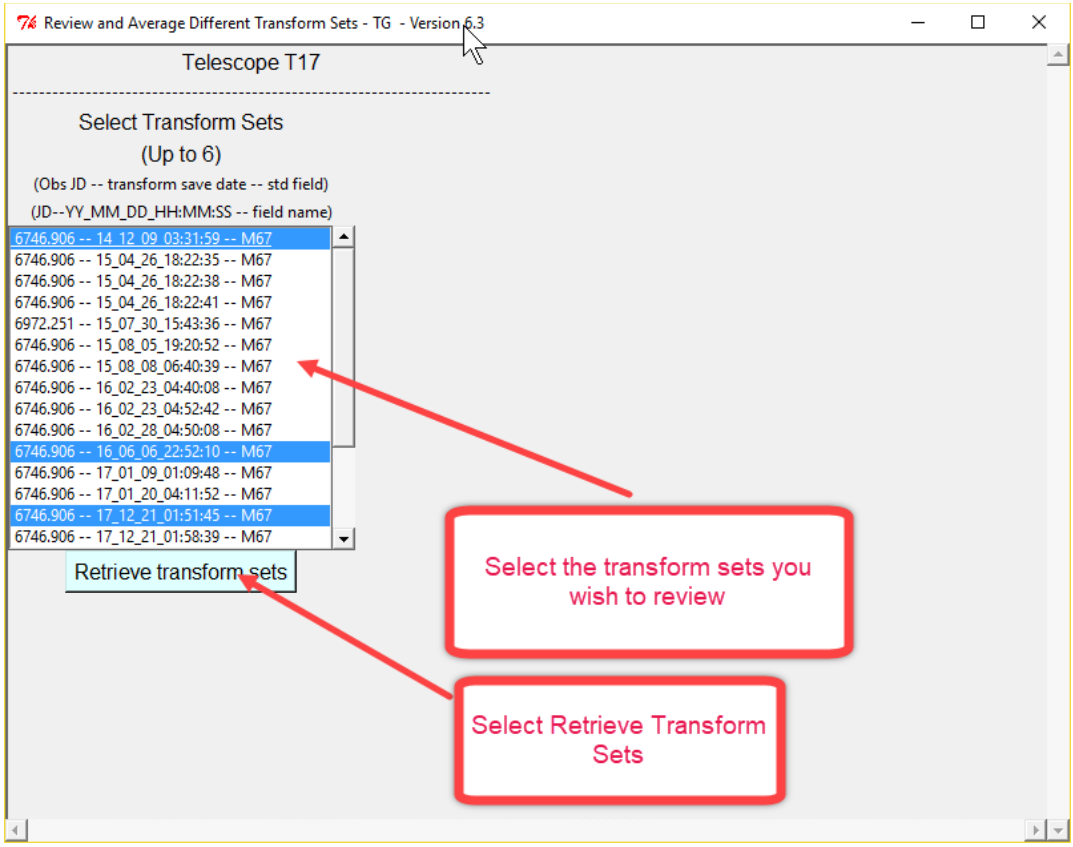
After reviewing all the transform coefficients, select the "Save Transform Set" box on the main menu. A message box appears displaying the time the transforms were saved. This time is used to label the transform set for future use. NOTE: This is NOT the file used for TA. The user MUST proceed to the next steps (5 and 6.) to create the file used by TA. (Caption 3 below)



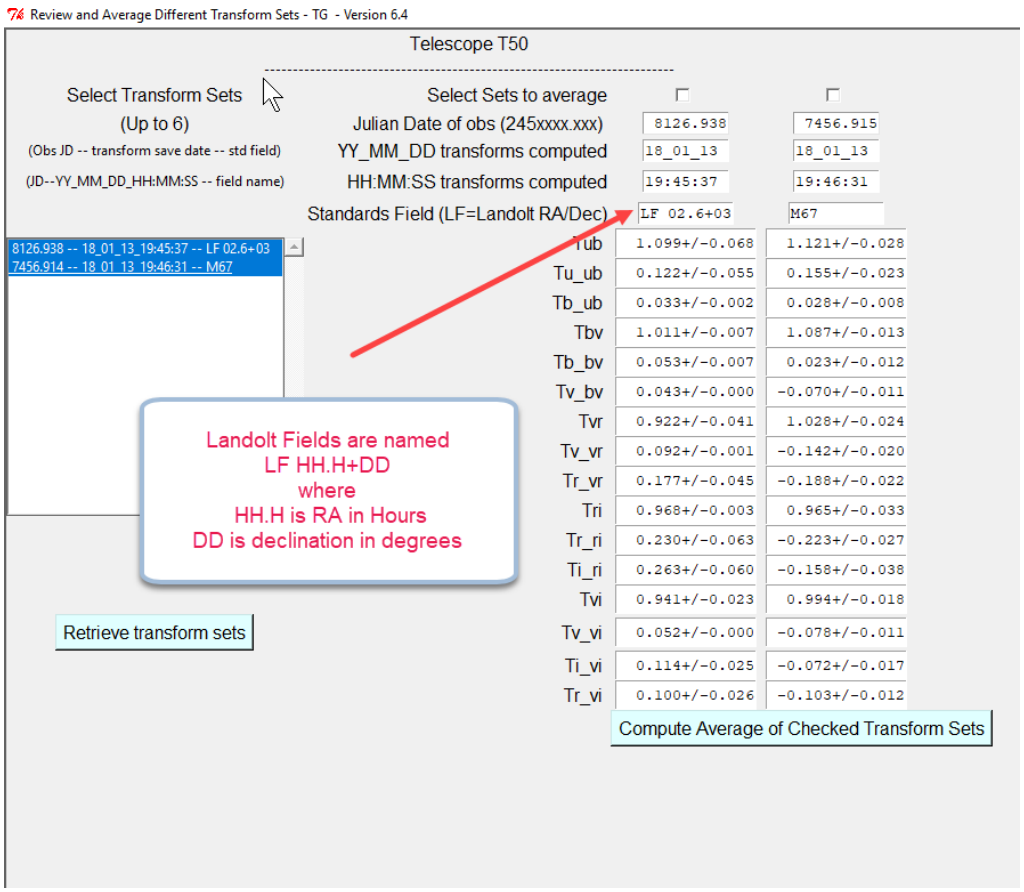
3.9 Reviewing and combining existing transform sets –

Select the “Review / Average Transform Sets” box (above figure step 3) to see a list of your saved transformation coefficients. A new window appears. Select the transform sets you want to compare, and click “Retrieve transform sets”.

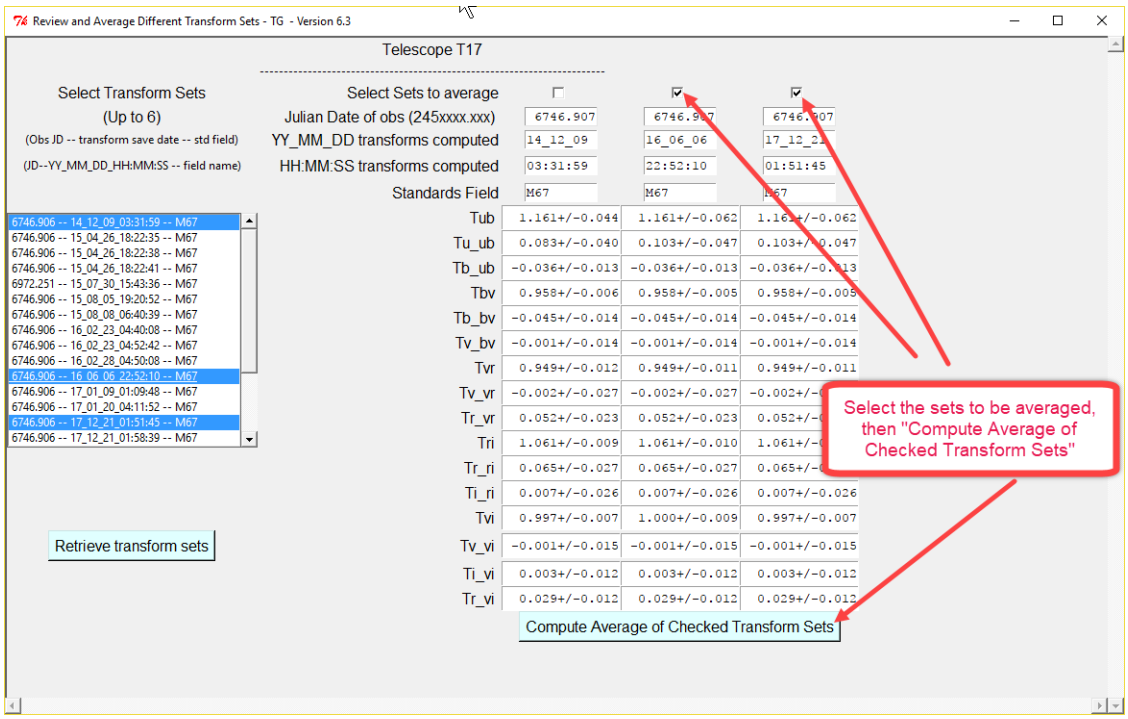
The first time many users use TG, they want to quickly create a TA file with the first saved set of coefficients. That’s easy – the “Select Transform Sets” box will only contain one line showing the first saved set. Just highlight that one line, click “Retrieve transform sets”, and that set will appear in a single column. See below on selecting the column and saving the TA output file.

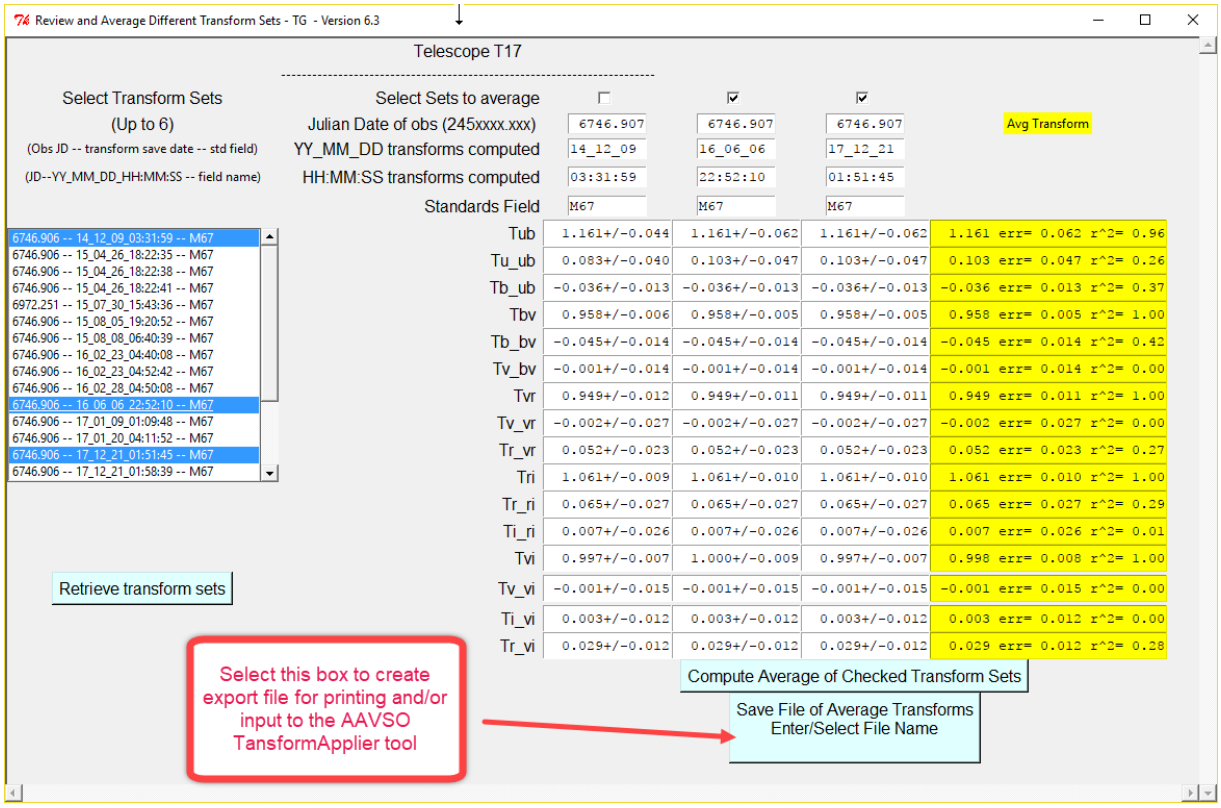


Note that if Landolt Fields are used, the field name is LF HH.H+DD where HH.H is the RA hour angle and DD is the declination.



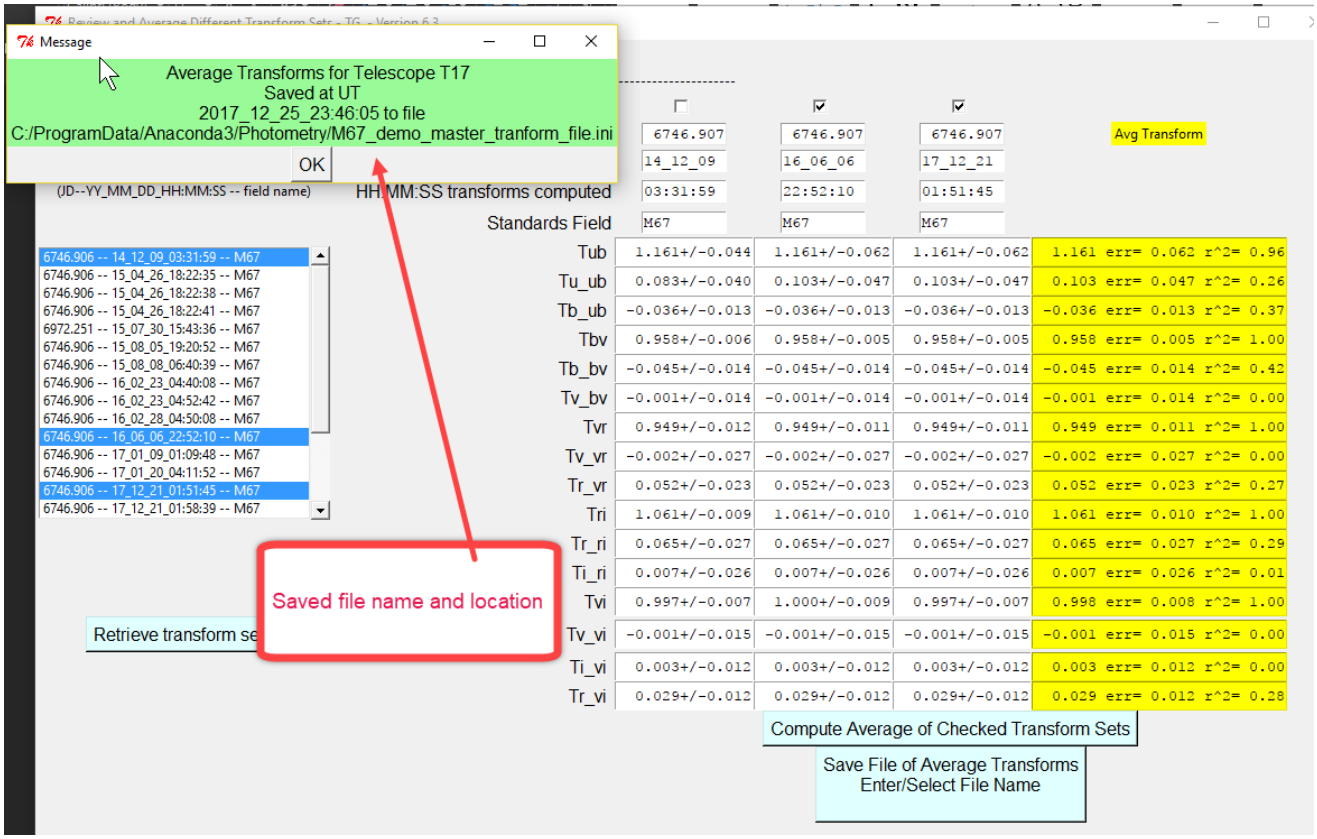
After reviewing the data, select the sets you want averaged together by clicking on the check boxes at the top of each column. Then select "Compute Average of Checked Observation Sets" – (you may need to scroll down to see the "Compute" box.)





3.10 Save the Transform Export File –

To save a file with this final averaged set of transforms, click the "Save File of Average Transforms – Enter/Select File Name" box. A message appears with the full file name when saved. This file is an "ini" format compatible with the AAVSO Transform Applier tool. It can also be printed as a text file. It contains the transform values, one sigma error estimate, and r-squared values. There is no need to add an extension to the file name. ini will be attached automatically.

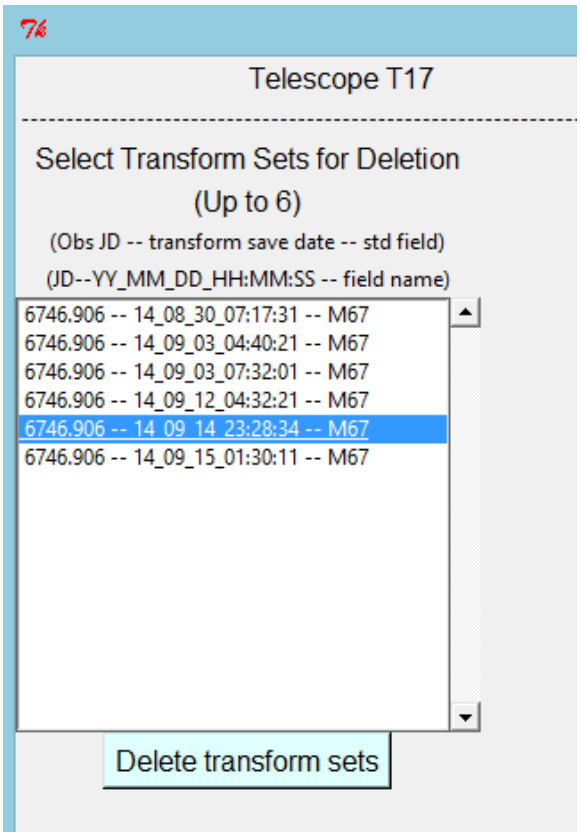


Output File Example (can be printed or directly imported into the AAVSO TransformApplier tool):

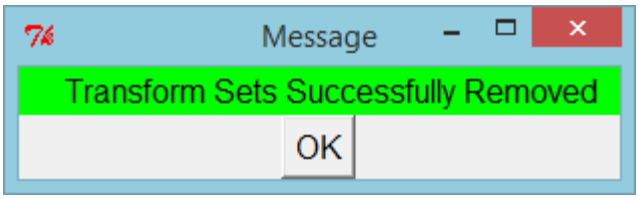
[Setup]
description= TG - Version 5.6, Telescope= T17, Time created (UT) = 2015_03_03_06:58:03
[Coefficients]
Tub= 1.161
Tu_ub= 0.103
……
[Error]
Tub= 0.044
Tu_ub= 0.047
…….
[R Squared Values]
Tub= 0.965
Tu_ub= 0.256
Tb_ub= 0.365

3.11 Transform Set Deletion:

To delete existing transform sets, select “Delete Old Transform Sets” button. A new window appears –



Select the set(s) to delete, click on the Delete transform sets button. A success message will appear –

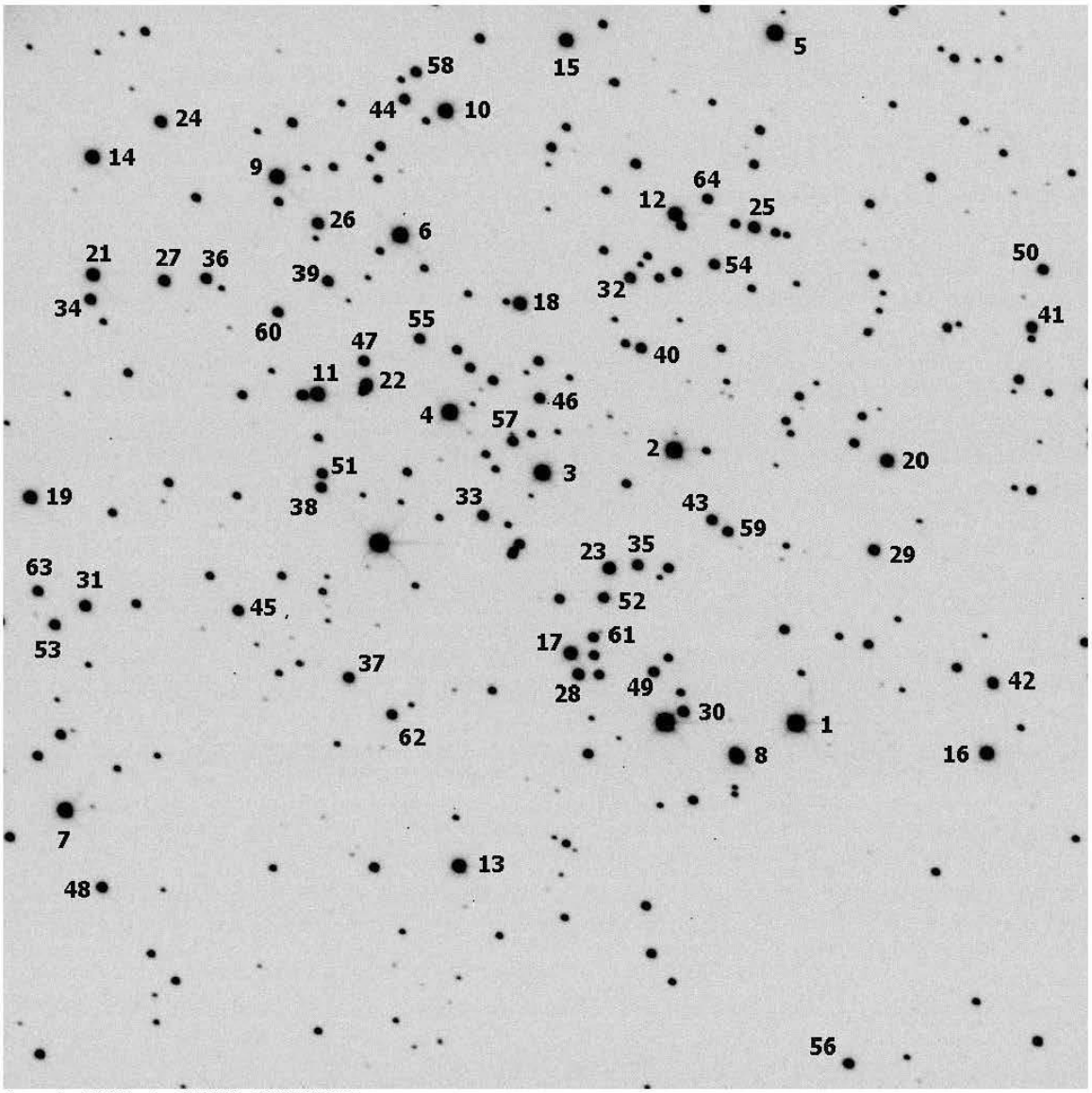


4. Transform Generator Support

Questions and suggestions can be emailed to: gordonmyers@hotmail.com

Appendix A – M67 field showing original Boulder star id's

M67 Standards Field



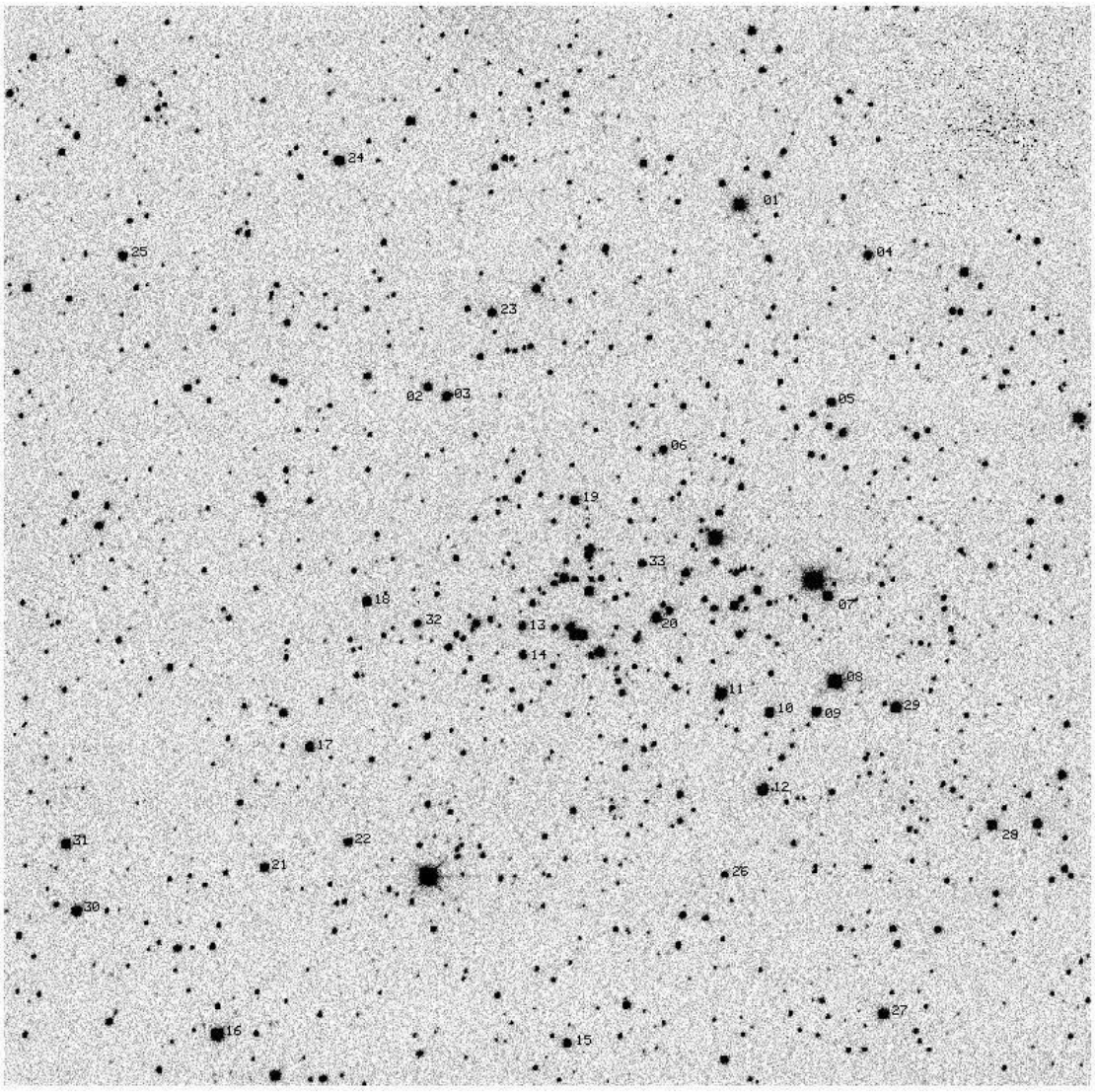
Approximate field center: 08:51:20 +11:47:00 J2000

Arne's UBVRcIc data for the numbered stars in the image above

Arne's full set of M-67 calibration data

Arne's full writeup on the M67 experiment

NGC 7790 Standards Field



Calibration data from Arne:

NGC7790 Standard Field
Update 14 October 1999
field center approximately star 20 at
23:58:23.20 +61:12:25.0 J2000
4 Observations

ID	RA (J2000)	DEC	V	B-V	U-B	V-R	R-I	verr	bverr	uberr	vrerr	rierr
1	359.566634	61.280182	11.659	0.567	0.130	0.349	0.346	0.005	0.006	0.044	0.002	0.014
2	359.681309	61.247799	13.518	0.458	-0.047	0.316	0.366	0.005	0.012	0.014	0.006	0.003
3	359.674397	61.246143	13.135	0.537	0.271	0.323	0.354	0.006	0.007	0.019	0.008	0.013
4	359.519403	61.271313	13.469	0.428	0.209	0.255	0.280	0.006	0.003	0.051	0.006	0.007

Appendix C: Details for using AIP4WIN data with TG

This note was posted on the AAVSO web site in response to a member's question:

Using AIP4WIN with TG

mgw

Online

Joined: 2010-08-01

Posted: March 10, 2015 - 3:19pm

Keith,

You don't need all the magnitude information on the M67 stars. TG automatically retrieves it from the AAVSO web site's VSP tool.

What you do need is a comp list with the 64 ids (1-64) so you can select those stars in AIP4WIN and get the right Boulder identifier. (The TG Users guide V 5.6 has a new appendix A that shows an image of the M67 field with the 1-64 star ids).

To help get the right comp star ids I created an AIP4WIN "STAR" file that contains all 64 M67 standard stars. It is attached to this post. (NOTE: When you download it, remove the _.txt at the end of the file name. I had to add _.txt to be able to post the file on this blog. AIP4WIN is looking for the file to end in .STAR".) Copy this M67_Henden_Field_Comps.STAR file into the AIP4WIN/Data directory (usually C:\Program Files (x86)\AIP4Win\Data).

Now start MMT. On the MMT Images tab load all your M67 images for all the filters. Select one image to locate the comps (I ususally select one of the V filter images). Go to the MMT Stars tab and click "Recall..." to load that M67 file containig all the comps.

Select any star as the M67 target (i.e. AIP4WIN's "V" star - which again, is not used). Now select the comp stars - you'll see the comp number matches the boulder id. Once all the comps are selected, go to the AIP4WIN Report tab and select the options shown in the TG Users Guide section 4.4.1.5. Then go to the AIP4WIN Execute tab, pick a good guide star and "Run Photometry". Because you have different filter images, AIP4WIN will usually ask you reconfirm the guide star between images.

AIP4WIN will find all the stars in each image. Sometimes stars in one band won't have adequate SNR for AIP4WIN, but that's OK. AIP4WIN indicates the error in the output report file and TG handles it.

The AIP Instrument Magnitudes file created this way can be directly loaded into TG.

FYI, TG goes to the AAVSO web site to retrieve the current standard star magnitudes from VSP, so don't worry about the magnitudes in the STAR file.

One other suggestion - if you want to ease the star selection burden and only identify the first 30 standard stars, edit the STAR file (in Notepad) by deleting all stars above 30.) Pragmatically I find the results are very good.

Another point - when you run TG you will get an error message that some of the Boulder id do not have an AUID counterpart. That's true - some of the original stars are no longer in the standards field. Don't worry, TG will generate the transforms based on the other stars.

Again, think about using VPHOT to identify the stars - it saves a lot of work