

# Guidelines for Creating and Updating Sequences

## Overview

The AAVSO maintains a web page where a member may request a sequence when none exists for a specific target:

<https://www.aavso.org/request-comparison-stars-variable-star-charts>

The requests are currently automatically directed to a team member, Tim Crawford. Tim then assigns some of them to other active team members.

If an observer has a problem with an existing sequence, they can go to the following AAVSO web page and submit a CHET:

<https://www.aavso.org/apps/chet/>

Team Leader Tom Bretl currently monitors the CHETS which are all accessible from the above web page.

## Procedure for creating a new sequence/chart

1. Check VSP, <https://www.aavso.org/apps/vsp/>, to see whether or not a sequence already exists. It is usually best to display a DSS chart with all variable stars marked. For compatibility with Seqplot, the orientation should be “north up” and “east left.” An E or F scale is best for faint variables, but a C or D scale may be needed for brighter ones. If the name of the variable is not recognized, use coordinates.
2. Check VSX, <https://www.aavso.org/vsx/>, to determine whether or not the target exists and has an AUID. Observations cannot be reported without an AUID, nor will Seqplot or VSP bring up a chart for a variable without an AUID. If the AUID is missing, sign into VSX and request one. While waiting for an AUID you can simply use coordinates to access Seqplot and VSP. Check VSX remarks to make sure that the target is actually variable, and to see if potential contamination from a nearby star needs to be taken into consideration. Based on what you find, you may want to discuss the situation with the observer who made the request. Make a note of the constellation for entry into the team tracking spreadsheet.
3. Check the AAVSO Sequence Team Update List to make sure that another team member is not already working on the same target. Then make your own entry, but leave the date blank until your work is completed. Enter “in progress” in the Work Performed column. The URL for the Update List is long - <https://docs.google.com/spreadsheets/d/1mR4I7bEIFYZI5lwkVwByCNXwiKCMzIP-S1IAx0QvQ/edit?hl=en&hl=en#gid=1172236228>, so be sure to bookmark it!

4. It is important to understand that more than one source may be needed to complete a sequence. However, do not intermix different sources unnecessarily. Typically, when more than one source is needed, it will occur at either the brighter or fainter end of the sequence; when this happens, try to insure that there is a smooth transition from one source to the next, with no more than a 0.04 magnitude difference between the sources for a comp star at the transition point.

On rare occasions, there may also be no single source that supplies photometry at all the desired filter bands. In such cases, you can combine sources for individual comp stars. Do this by either a) making a manual entry of the missing filter data directly into VSD, or b) ordering your sequence upload to VSD in a way that appropriately combines the data. (Note that actual data replaces NA's, but NA's do not replace actual data.)

5. Use the seqplot tool, <https://www.aavso.org/seqplot>, to look for suitable comp stars.

- Enter the star name and press the Find RA & Dec button.
- Choose an appropriate source catalog. APASS is a good place to start.
- Enter the desired Field Size and Limiting Mag. It may help to at first set a fairly bright limit, look for suitable bright comps, and then gradually choose fainter limits as you look for fainter comps.
- Press Get Plot.
- Use the Online Help to learn more about how seqplot works. Pay particular attention to the filepath structure used by the program. You'll want to know where "send to file" actually sends the file!
- Select Options to alter your preferences as desired. Changing the dot size often makes it easier to spot potential comps of an appropriate magnitude.
- Depending on the magnitude of your target, consider other seqplot source catalogs.
- Seqplot allows you to plot several different sources at the same time. Overlapping dots will then appear. Clicking in slightly different spots will reveal data from the different sources. Dragging a small box around the dots will zoom in and make it easier to do this.
- You can also download a table that contains all of the data from all of the selected sources for all of the stars within seqplot's field of view.
- Be sure to follow the **Sequence Selection Guidelines** below (following step 9).

## Sources used by seqplot

Source	Filters	Range	Notes
APASS	Johnson BV with Sloan gri (converted to RclC)	~10 - 16.5 V	Range of 10.2 - 15.9 appears most useable. Brighter data down to ~7.5 for some limited fov's.
BSM	BVRclC	~ 6.3 - 13 V	For some fields good down to 13.7. Excellent uncertainty data for range.
GCPD	UBV	~.01 - 6.5 V	Superior source for bright stars, but replace inaccurate coordinates with Tycho-2.
NOFS	UBVclC	~13 - 18.7 V	Excellent first choice within given range. Sometimes okay up to magnitude 10.2.
SRO	UBVRI	~10.3 - 17 V	Can go as faint as 17.9 in some fov's. Check it before using APASS.
Tycho-2	BtVt (converted to BV)	~ 6.5 - 10.2 V	Reasonable source for brighter targets when no GCPD or BSM data is available.
W30		~10 - 16 V	My be able to go as faint as 17, but available in few fov's.

6. If fainter data than what is available within Seqplot is needed, the best available outside source data is available using VizierR, <http://vizier.cfa.harvard.edu/viz-bin/VizieR>. SDSS is the first choice, Pan-STARRS is the second choice, and GaiaDR2 is the third choce. Note that SDSS has limited coverage, and GaiaDR2 does not allow for B filter conversion. All three of these sources require convsion to the Johnson-Cousins system (BVRI), and this can be done by using the spreadsheets available for download from the Sequence Team website. Step by step instructions are included.

Hint: not all target names are recognized by VizieR, so it is suggested to always enter the coordinates of the target instead of the name. Try a 6 arcmin search radius for fainter stars.

Avoid other variable stars when using VizieR data. This can be done by keeping your eye on a VSP chart which will show all other variables within the fov.

Again, be sure to follow the **Sequence Selection Guidelines** below (following step 9).

## Sources outside of seqplot

Source	Filters	Range	Notes
CMC15	r'JK (converted to BVRc)	~10 - 14.4 V	B filter conversions may have larger uncertainty than NOFS. Used less now.
SDSS	griz (converted to UBVRc)	~14.8 - 18.7 V	Best faint option if range is appropriate and no NOFS data is available.
Pan-STARRS	gri (converted to BVRc)	~14.5 - 19.5 V	Some fov's go as faint as 20.9. Converted B filter data may have larger uncertainty when compared with NOFS data.
ASAS-3	V	~ 8 - 12.5 V	Both APASS and BSM have almost eliminated the need to use this data.
GaiaDR2	G/BP/RP (converted to VRc)	~10 - 19.5 V	No known B conversions reduce the frequency of used for this source.
Survey of the Magellanic Clouds	UBVRc	~12 - 16 V	Decent SH survey with good uncertainty values. Worth consideration, especially if no APASS data is available.
UCAC4	BVri (ri converted to RCc)	~10 - 16.5 V	This is simply APASS DR9 data with small portion from 1 night only. Useful if there is no usable DR10 data in seqplot.

- Upload or modify the sequence using the VSD Admin portal. Then check VSP to make sure that it is displaying correctly, and that the comps added or modified display in the requested field of view and associated sequence table. Notify the person requesting the sequence that the sequence has been created or updated. (This is done automatically when a CHET is marked as completed.) If working on multiple sequences in response to a single non-urgent request, you may delay the notification until all of the sequences have been completed, provided that they are all completed within a day or two.

8. Notify the sequence team that the sequence has been uploaded via email to the team list. Attach a copy of the file you uploaded to VSD, and include any relevant information about why the sequence was created. Title the email as either <name of variable> “new sequence” or <name of variable>”revised sequence.”
9. Complete your entry in the Sequence Team Update List.

## Sequence Selection Guidelines

The guidelines used to select sequences were established by the International Chart Working Group in July 2002 and were updated in October 2019. It is important to emphasize that these are guidelines, not absolute rules. Often one guideline may seem in conflict with another. Each sequence is considered on a case by case basis.

- Utilize photometry whose uncertainty is within .05V with a preference for .02V or less.
- Utilize comparisons of known color only. (B-V, or its equivalent in the sequence color index.)
- Choose comp stars that range between  $0.3 < B-V < 1.0$  , (or its equivalent in the sequence color index), with a conscious effort to limit the range to  $\sim 0.7$ . [For further discussion, see the pdf: Color Guidelines Revisited.]
- Try to avoid color differences between successive comps that result in one comp being brighter in V while the other comp is brighter in B (aids visual observers).
- Steps between comps should be no larger than 0.5V, whenever possible; try to avoid 0.1V steps.
- The sequence range should not exceed a + or – 2.5V of the target.
- Do not intermix two different surveys within a sequence; however, when two different surveys are required for the full range of the sequence, find a suitable transition point where both surveys closely agree.
- Do not select comps that result in duplicate labels in the same field of view. But keep in mind that the definition of “field of view” may vary depending upon the existence of other nearby variables.
- Exclude close doubles as comp stars.
- Identify close companions to the variable as comp stars (if possible), to aid in identification.
- Choose comp stars as close to the variable as possible. As a general rule, the fainter the comp star the closer to the variable.
- Avoid large spatial distances between comps in the same magnitude range.
- For visual charts, take position angle effect into account. Endeavor to pick comps along a line running E and W of the variable if there is a choice.
- Avoid high proper motion stars.
- When no better alternatives exist, micro-variables with an amplitude of 0.03V or less are acceptable to use for visual sequences, but should be noted as variable in the comments field.

## Revising Existing Sequences and Responding to CHETs

All of the guidelines for new sequences also apply to revisions and CHET responses, but there are few additional things to keep in mind. Some existing sequences were created years ago, when the photometry was less accurate or more incomplete, so it makes sense to update them using more current sources. CHETs are often requests to extend or fill a gap in a sequence, but they, too, provide an opportunity to review the entire existing sequence and make changes when appropriate. Resist the temptation to make wholesale changes in a sequence, however, unless there is a very good reason to do so. Check with other team members when in doubt.

When updating an existing sequence, keep as many comps from previous versions of the sequence as are appropriate, but take advantage of the opportunity to:

1. Eliminate redundancies and duplications.
2. Eliminate stars of extreme color, falling significantly outside the  $0.3 < B-V < 1.0$  range.
3. Eliminate variables. Check with Sebastian Otero if the variability is in doubt.
4. Eliminate close doubles.

When responding to a CHET:

1. Change the CHET's status to "in progress" and (as usual) make an entry in the Update List.
2. Pay close attention to the requested field of view.
3. Update the status when you are finished. Resolved CHETs are automatically reported back to the submitter. For unresolvable CHETs you may want to email the submitter directly yourself.
4. Use the comment field to report what you have done. Include the date and your initials.

## Sequences for Exoplanets

Arne Henden (2012)

Exoplanet sequences are a little different. First, notice the range - this is purely CCD. Second, almost all stars are variable once you get down into the millimagnitude level, so picking just one comp star of just the right brightness and color would be great - if you could guarantee that it was constant. APASS and any 2-3 night calibration won't tell you the definitive answer regarding variability at this level.

So what I would recommend:

See if there is something within one magnitude of the target with similar color, preferably spatially close. If so, that is the first choice. Make your choice based on the color of the target and its similarity to the color of the comp. Then pick up to a half dozen other stars within a couple of magnitudes of the target, either brighter or fainter. At  $V=9.75$ , you will be hard-pressed to get a good comp star. I often use an ensemble of 6-12 fainter stars, using the large number of comps to reduce the noise. If I have a choice, I find comps so that they don't end up with the same tenth-magnitude label. If the nearest 10th magnitude star is 20-30 arcmin distant or more, the observer is going to have a hard time doing this target!

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Tom Bretl  
Tim Crawford