SpectroCalc 2

User Manual

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Prefacing

I am working with a Shelyak LHires III spectrograph with 2400 lines/mm. Sometimes I take many images for a spectrum to get a better signal/noise ratio (S/N) and sometimes I have to monitor the lines over several hours to see a change of the line shapes (for example to analyse the pulsation of a star).

With my equipment, I got the experience that the wavelength can move more than 10 pixels over the night, caused by temperature shift. For that reason, I take always before and after each image of the spectrum a reference lamp image (except I decide to calibrate with water lines).

That is the reason I cannot add all spectra stripes before calibration without losing resolution! The better way is to scan each single image to a 1D spectrum and align it before add them to a result image.

2018 I started to develop SpectroCalc (Version 1) to build up my complete workflow. 2019 I presented it on the VEGA 2019 spectroscopy symposium.
After that, I started to develop SpectroCalc 2, with better processing, more flexibility and more features. The new version needs more resources, but for computers with fewer resources, SpectroCalc-1 is still available.

Copyright

My main concern is that spectroscopy is spread in the amateur field and that amateurs achieve reliable results for science.

Credits

Many thanks to my spectroscopic mentor and teacher Ernst Pollmann!
Many thanks to Roland Bücke for the algorithm of heliocentric correction!
Many thanks to Hartmut Bornemann for the FITs-IO library!

Content

Hardware and software requirements

- Windows 7 **64-Bit** or higher
- 4 GB RAM, better 6 or more
- 1200 x 800 pixels screen resolution, better 1920 x 1080 or more
- Internet connection: only for Simbad requests or the software update feature

Input file format

Input files have to be 2D images in FITs format or still scanned spectra in 1D FITs or DAT format!

Output file format and directory structure

Master dark:
A new directory under the folder where the single darks are stored, is created: “SpectroCalc”
MasterSpecDark.fit Master dark for spectra
MasterRefDark.fit Master dark for reference lamp files
MasterFlatDark.fit Master dark for flat field images

Master flat:
A new directory under the folder where the single flats are stored, is created: “SpectroCalc”
MasterFlat.fit Master flat field image

Uncalibrated scanned and aligned spectra:
The first step of processing is the scanning and aligning of the single spectra. If you go to the next processing step “Calibrate” or if you press “Save”, the spectra will saved under a new created directory under the folder, where the single 2D images are located: “SpecUncal”

Uncalibrated scanned and aligned references:
In the first step of the processing the single reference images will assigned to the time corresponding spectra images and will scanned with the same parameters as the spectra. If you go to the next processing step “Calibrate” or if you press “Save”, the scanned references will saved under a new created directory under the folder, where the single 2D images are located: “RefUncal”

Calibrated spectra:
The second step of the processing is the wavelength calibration of the aligned spectra. The calibrated spectra will saved under a new created directory under the folder, where the single 2D images are located: “SpecCal”

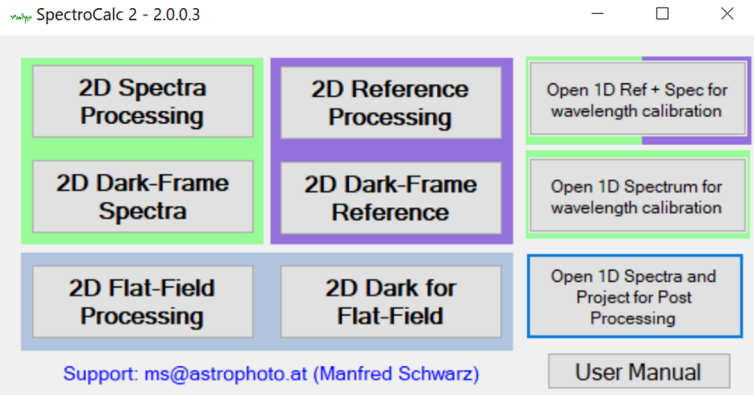
Calibrated references:
The calibrated references will saved under a new created directory under the folder, where the single 2D images are located: “RefCal”

Instrument response:
If you correct in the third step (post processing) the instrument response, the response curves will saved under a new created directory under the folder, where the single 2D images are located: “InstResp”

Continuum remove:
If you remove in the third step (post processing) the continuum, the continuum curves will saved under a new created directory under the folder, where the single 2D images are located: “Continuum”

Result:
The result images from post processing are stored in a location, which can be defined by yourself. Additional a project file is stored with the extension “.sc2”, which includes user defined texts and window configurations.

Main Window



2D Spectra Processing: load 2D spectra for 2D-calibration, scanning and aligning

2D Dark-Frame Spectra: load 2D dark images for generating a master-dark for the spectra

2D Reference Processing: load 2D reference images for 2D-calibration, scanning and aligning

2D Dark-Frame Reference: load 2D dark images for generating a master-dark for the reference images

2D Flat-Field Processing: load 2D flat field images for generating a master-flat for spectra and/or reference images

2D Dark for Flat-Field: load 2D dark images for generating a master-dark for flat images

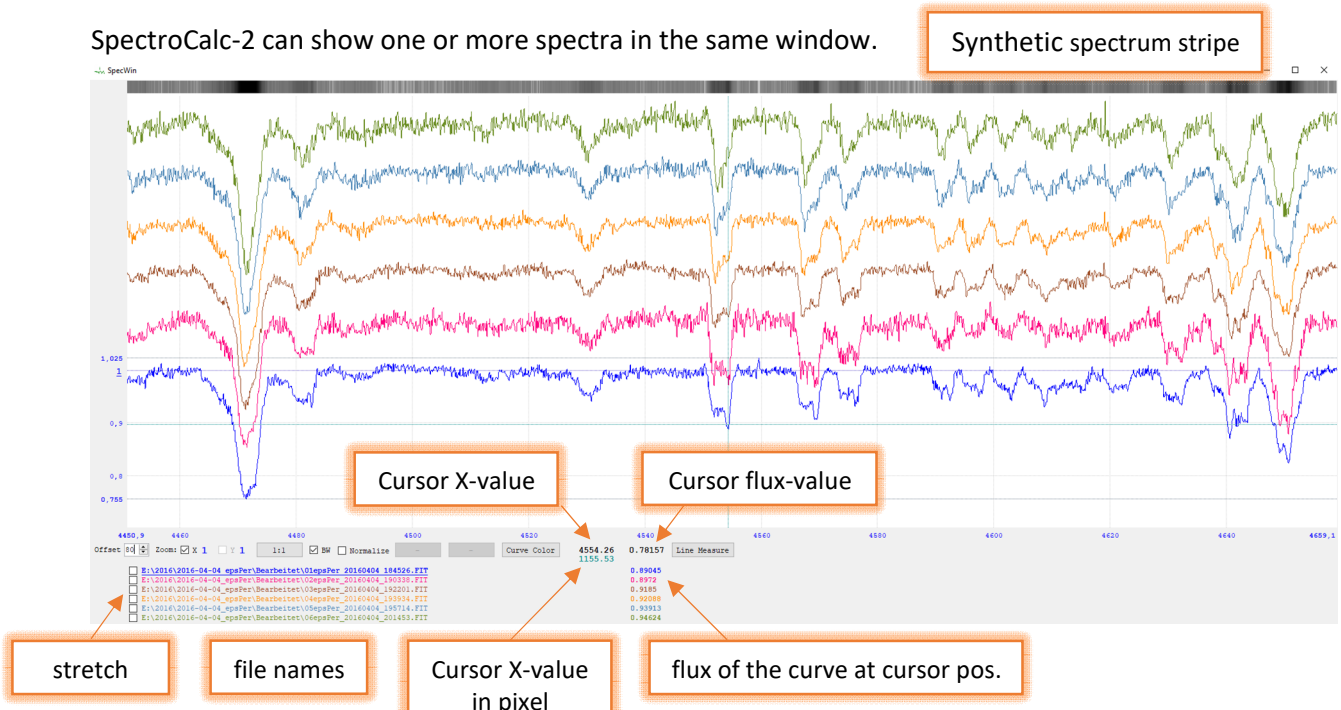
Open 1D Ref + Spec for wavelength calibration: If you have an already scanned and averaged spectrum and a reference image, you can skip the first step and start directly with the wavelength calibration.

Open 1D Ref + Spectrum for wavelength calibration: If you have an already scanned spectrum without a reference images and you want to calibrate with telluric or internal lines, you can skip the first step and start directly with the wavelength calibration.

Open 1D Spectra and Project for Post Processing: If you have already wavelength calibrated spectra or a previous stored project, you can skip the first two steps and go directly to the post-processing feature.

Graphical Representation of Spectra

SpectroCalc-2 can show one or more spectra in the same window.



Grid:
The grid is always assigned to the spectrum, which is selected. If you click on another file name, the grid will change to this curve.

Stretch:
Normally the highest flux of all curves is the top of the window and the lowest value the bottom. If you check the box on the left side of the file name, this curve will stretched to the whole Y area.

Offset:
Normally all curves are overlaid. If you want to see the single curves separated, you can define an offset in pixel, like in the example above. If you have an offset defined, a zoom in Y-axis is not possible.

Zoom:
It is possible to zoom into the curve with the mouse wheel. Zoom level: 1:1 up to 16:1. You can also zoom in with a right mouse-click. Right mouse double-click sets the zoom back to 1:1.
You can disable the zoom of X and Y-axis separate. Example: X and Y are checked and you zoom to 4:1. Then you uncheck Y and zoom further until X = 16:1 and Y = 4:1.
With the 1:1 button, you can always zoom out to 1:1 level.

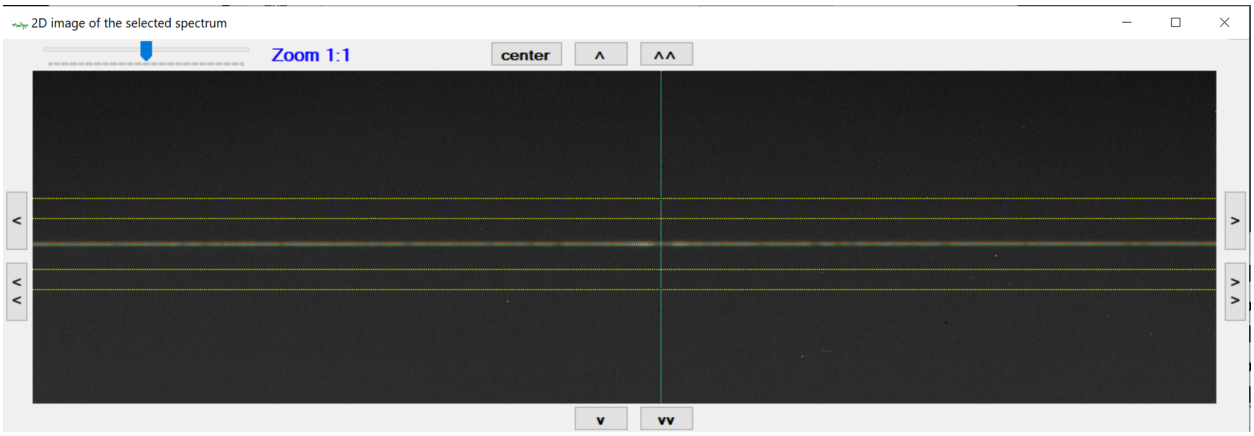
BW:
If this box is checked, the synthetic spectrum stripe is in black and white. Otherwise, it is in colour according the wavelength of the X-value. This makes only sense, after the wavelength calibration.

Normalize:
For several reasons (compare of different spectra, estimation of peak values, etc.) it makes sense to normalize the spectra. If you check this box, only the display shows normalized values, the real data will not modified! You can define the left and the right value for normalizing by mouse click.

Curve Color:
Each spectrum has another colour. With this button, you can redefine the colours.

Line Measure:
Simple line measure between 2 user defined points on the x-axis.

Image Window



< shift the image a little bit to left
<< shift the image completely to left
> shift the image a little bit to right
>> shift the image completely to right
^ shift the image a little bit higher
^^ shift the image to the top
v shift the image a little bit lower
vv shift the image to the bottom
center centre the image. If a spectrum stripe is recognized, the Y position is on the centre position of the stripe

The blue slider changes the brightness of the image.

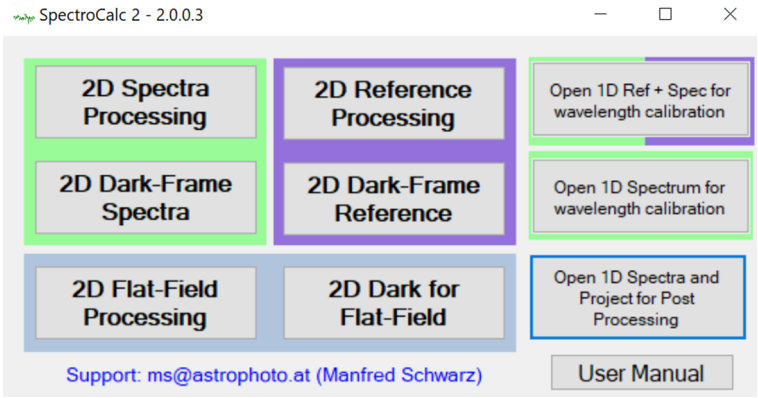
Press and hold down the left mouse key and move the mouse: move the image position

Mouse wheel: zoom in and out. Right mouse click: zoom in. Right mouse double-click: 1:1

Step 1 - 2D Processing

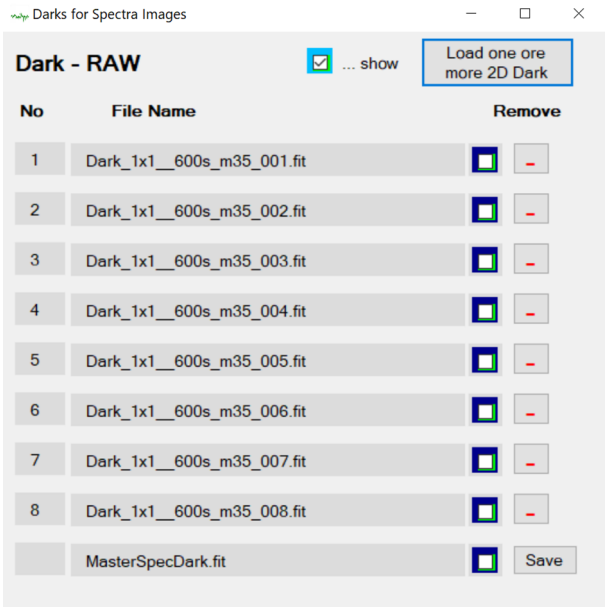
The 2D images from your camera has to be calibrated with dark frames and flat-fields, depending on your camera system.
Dark frames are very important, because the ratio of peak to continuum is changing after dark frame correction. Dark current is additive!

The order of loading the files is not important. That means, it is equal, if you load at first the dark frames and then the spectra or vice versa.



2D Dark-Frame for Spectra

Select one or more dark frames for the calculation of the master dark. Multi-selection is possible.



With “Load one or more 2D Dark”, it is possible to load further darks.
With “-“, you can remove a file from the list.
If you check the box beside of the file name, an image window appears with the selected dark frame.

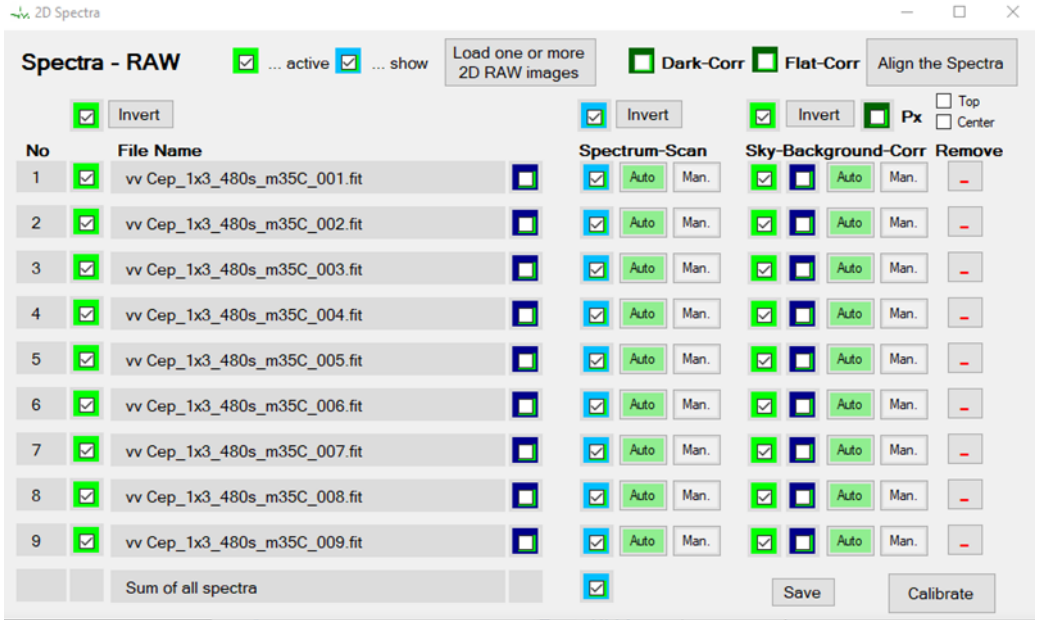
The MasterSpecDark.fit is the average of all images.
If you have only one dark file or a master dark of a library, the master-dark is a copy of the loaded file.

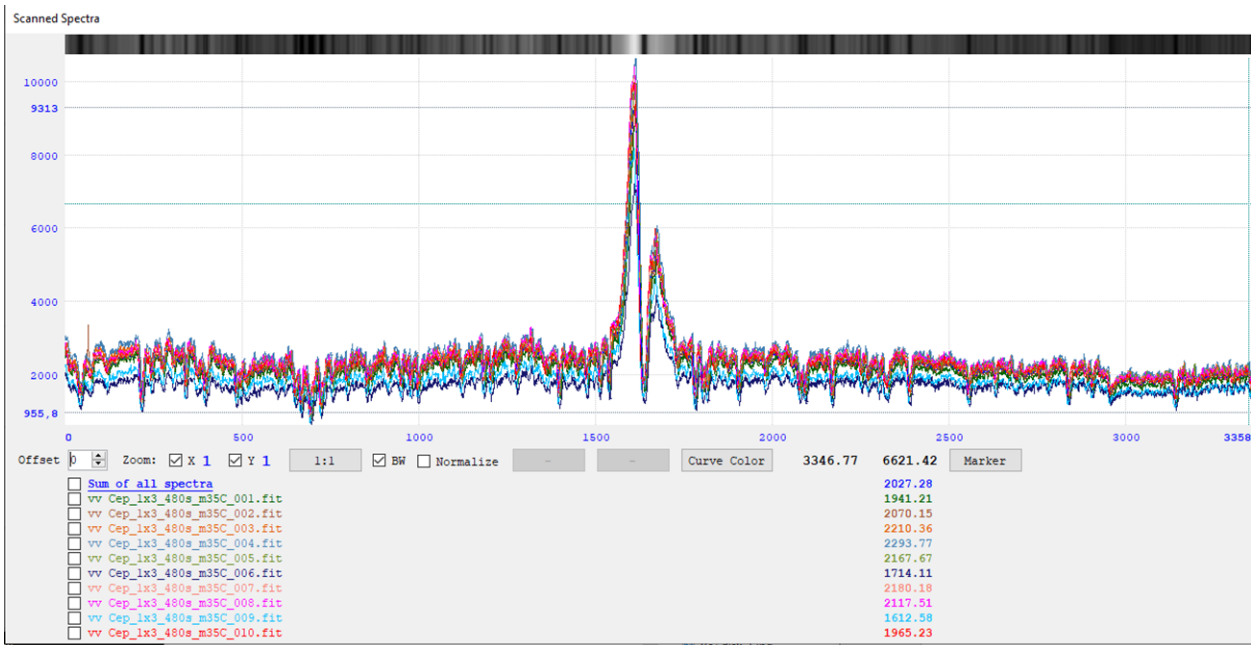
Press save, to store the master dark. The Dark-Raw window will minimized and the master-dark is ready to use it for the spectra.

If you close the Dark-Raw window with “X” on the right upper corner, the master-dark will discharged and it is possible to start this procedure again by pressing “2D Dark-Frame Spectra”.

2D Spectra Processing

Select one or more spectrum images. Multi-selection is possible.



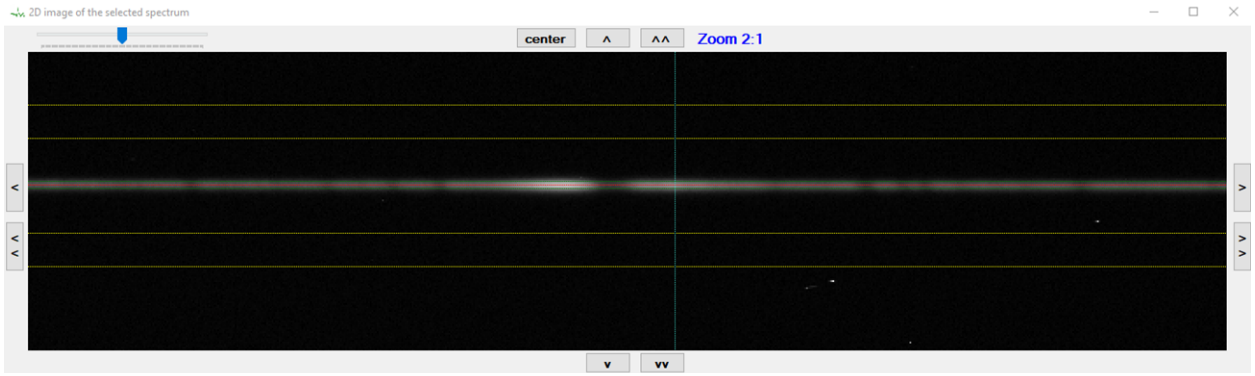


Disable/Enable an image:

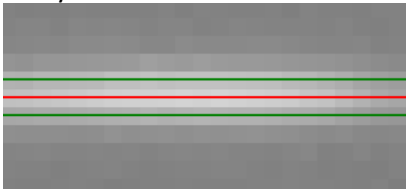
Uncheck the box to disable the image from the processing. With this feature, you can see in real-time the influence of an image to the result spectrum “Sum of all spectra” (to see only the result, you can unselect all views of spectra, except the summarized spectrum – look below under *View the spectrum in the graphic window*).

View the image:

Check the blue box to open the view of the image.



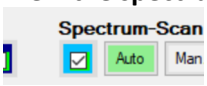
The yellow horizontal lines are the automatic calculated sky-background areas.



Between the green lines is the scan area.
The red line is the centre line of the automatic calculated spectrum stripe.

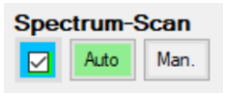
The turquoise vertical line is the X-axis centre line.

View the spectrum in the graphic window:



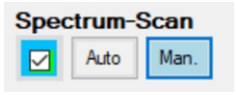
Check or uncheck the blue box to display or hide the spectrum in the graphic window.

Automatic scan of the spectrum stripe:

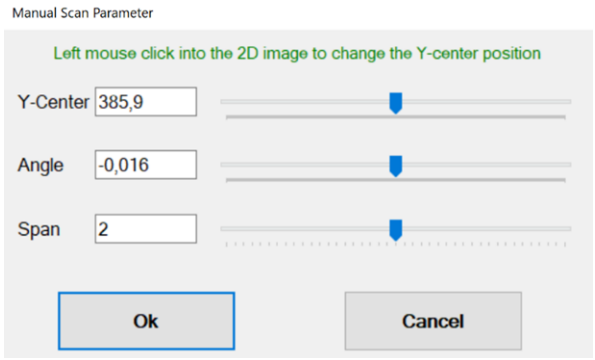


After loading an image, the automatic scan is activated (green button “Auto”).

Manual scan of the spectrum stripe:



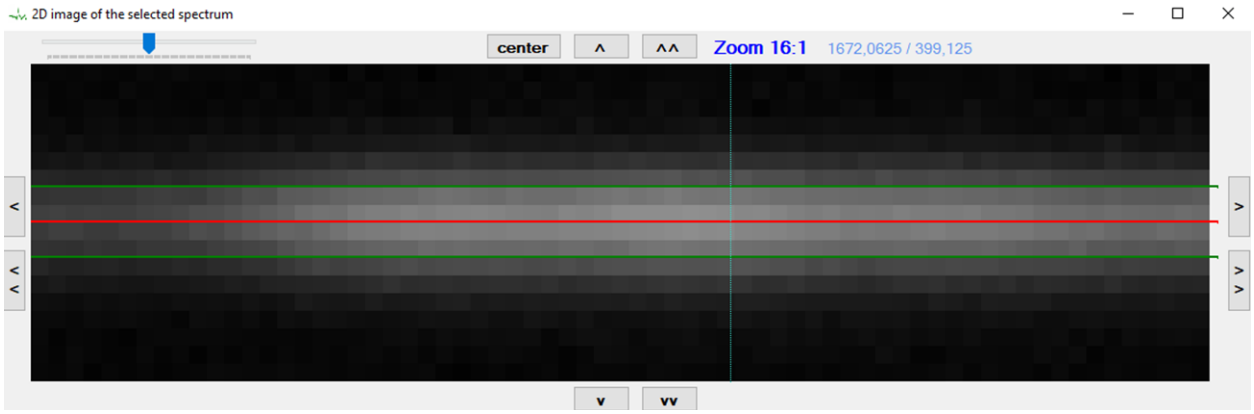
If the brightness of the spectrum stripe is very low over the background, it is possible that the software cannot scan automatically. In this case, you should press “Man.” To define the scan parameter manually. Anyway, you can press “Man.” to control and/or correct the result of the automatic scan.



Y-Center: Y-value of the centre line in the middle of the X-axis.

Angle: angle of the centre line

Span: Height of the scan area in pixels



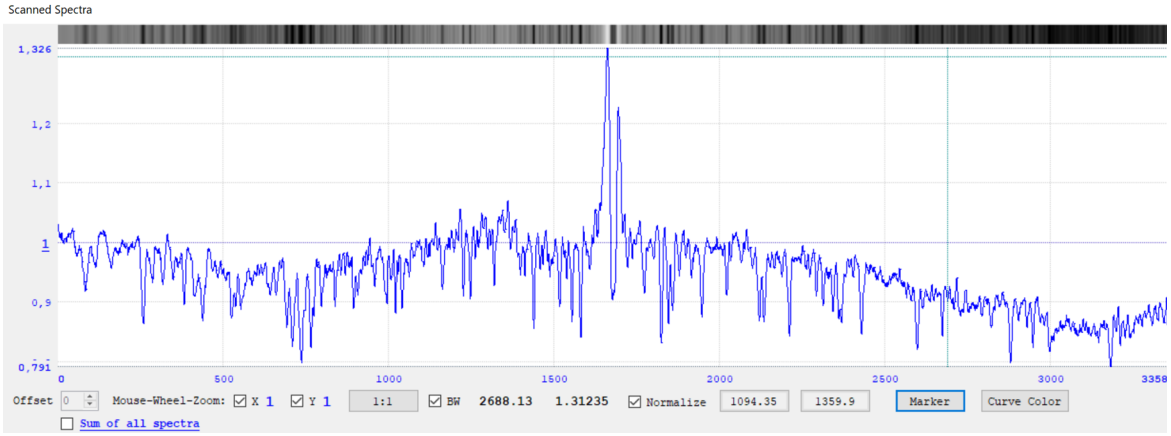
You can enter the desired values directly, or you can move the sliders to change the values.
A click into the image window, defines the center of the stripe per mouse-click. Before you define the centre per mouse-click, you should press the “center” button, to be sure, that you are in the middle of X-axis!

Activate Sky-Background correction:

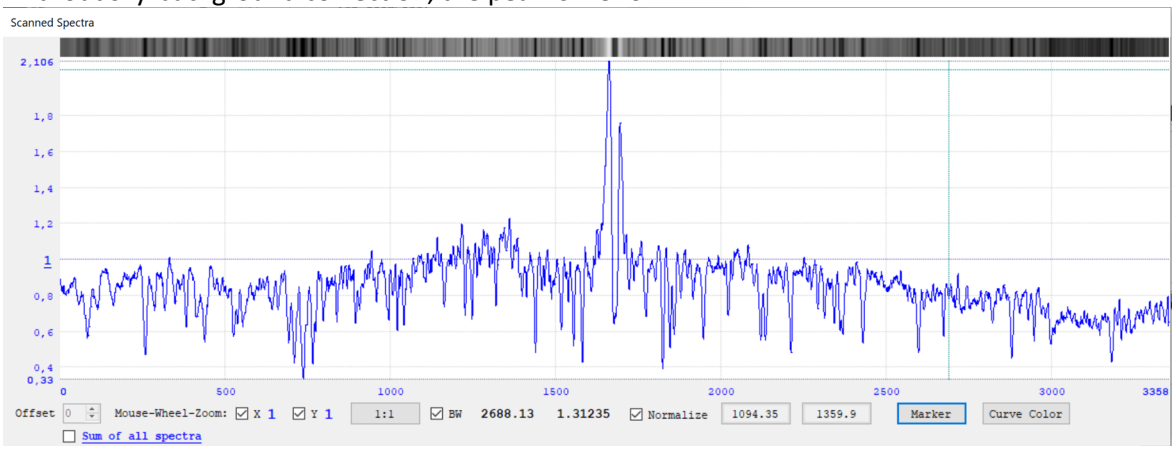
Check the green box to activate the sky-background correction of this image.

ATTENTION: the sky background is also an additive signal. It is important to correct it, because the ratio of peak to continuum is changing after sky background correction! Without the correction you get a too low ratio!

Example:

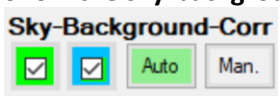


Without sky-background correction, the peak is 1.326

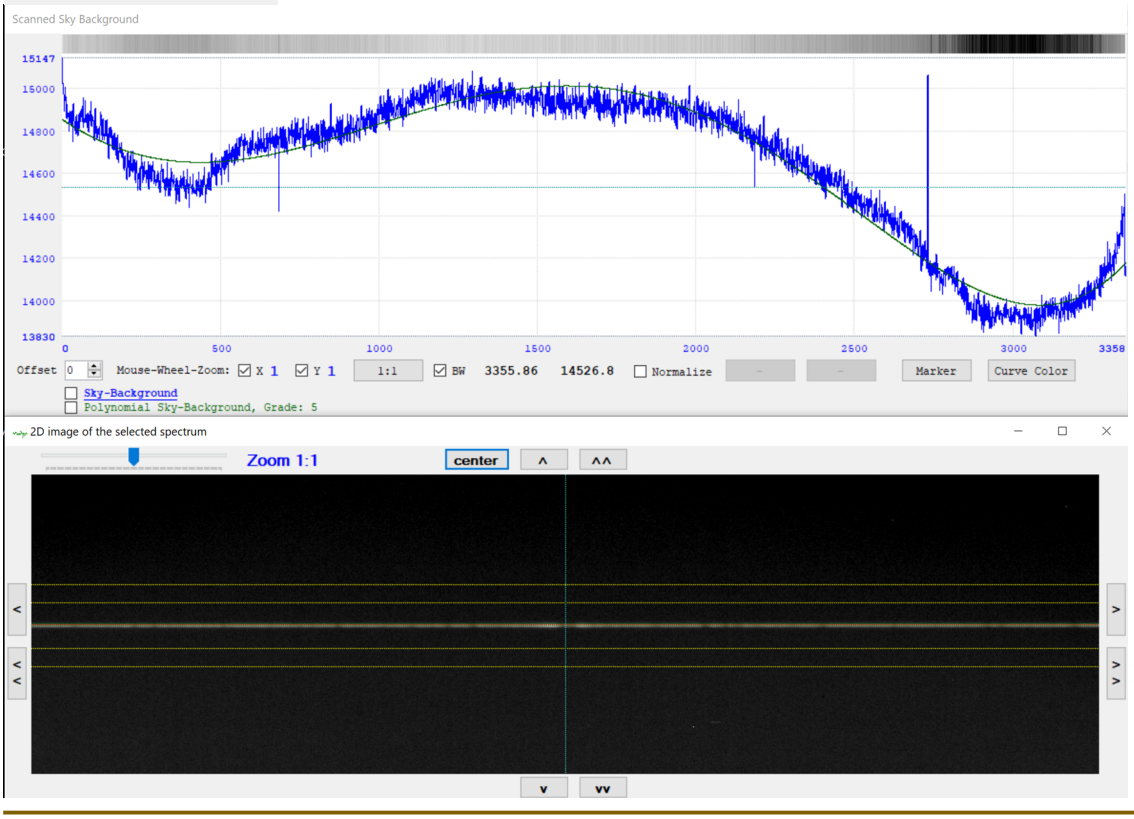


With sky-background correction, the peak is 2.106

Show the sky-background:

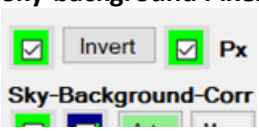


Check the blue box to show the calculated sky-background.



The software scans the upper and the lower background stripe and calculate an average of it (blue curve in the example). A polynomial with grade 5 is the correction curve (green curve in the example).
The correction is a subtraction of the scanned spectrum minus the correction curve.

Sky-background Pixel by Pixel:

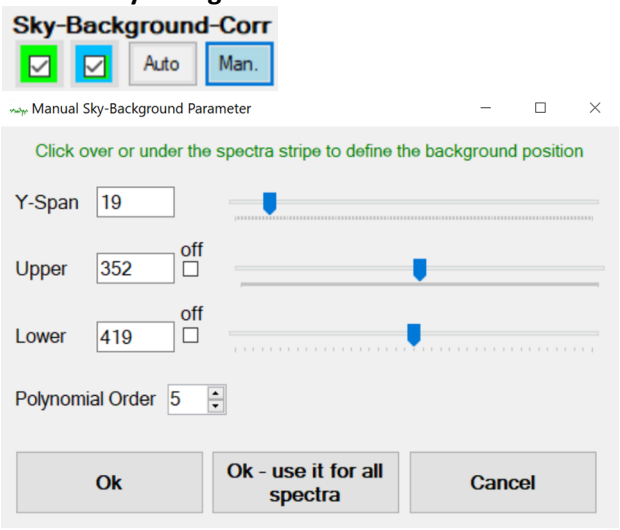


Normally SpectroCalc is using a polynomial function for the background to avoid additional noise. But if you have a light pollution with emission lines in the background, you can check the box “Px” to use the background pixel by pixel.
In this case I recommend to use the manual sky-background calculation and define a very narrow Y-Span (e.g. 2). Try to set the scan area near the spectrum stripe (but not too near to avoid to substract spectrum information). Mostly it is better to use only one background stripe, the upper or the lower.

Automatic sky-background calculation:

After loading an image, the automatic sky-background calculation is activated (green button “Auto”).

Manual sky-background calculation:



Following parameter can changed manually:

Y-Span: Height of the scan area (minimum 1)
Upper: Y-centre of the upper area
Lower: Y-centre of the lower area
Polynomial Order: order of the polynomial (only if “Px” is not checked)

Click in the image window with the left mouse key to set the centre of upper or lower area (depends if you click above or below of the spectrum stripe).

With the check boxes, it is possible to disable one of the background areas.
With this feature, you can easily find the beginning of the background position:

- Disable one of the areas
- Set Y-Span to 1
- Move the centre of the enabled area in the direction of the spectrum stripe

If the spectrum appears in the background graphic, you are too close to the spectrum stripe.

Ok: use the parameter for this spectrum

Ok – use it for all spectra: Use the parameters for all spectra

Cancel: Cancel the changes of the parameters.

Remove an image:

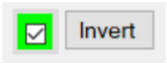
Here you can remove an image from the list.

Flat and Dark correction:

If you have already generate a master-flat and or a master-dark, you can disable or enable the correcting by uncheck or check these boxes. You see immediately the change in the graphic window.

Load one or more 2D RAW images:
With this button, you can load additional spectra to the processing area.

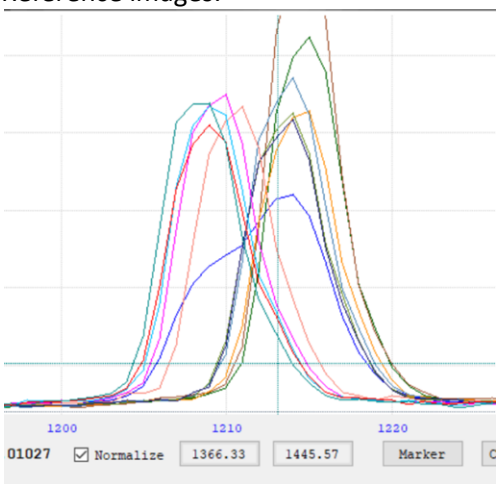
Enable/disable all or invert the selection:



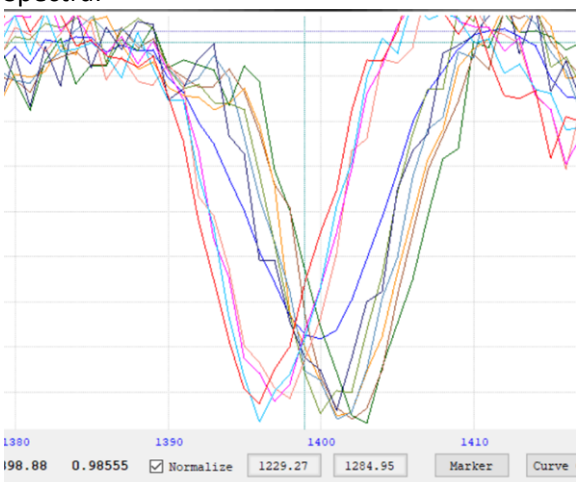
If you check this box, all images will enabled, if you uncheck it, all images will disabled.
Press “Invert” to invert the selection.

Align the Spectra:
If you have more than one spectrum loaded, it will mostly be necessary to align the spectra in the x-axis. For a better possibility to compare the different curves, you should use the “Normalize” feature (see at *Graphical Representation of Spectra*). Zoom into the graphical window(s) on a line to see the misalignment.
In following example, spectrum and reference images are loaded:

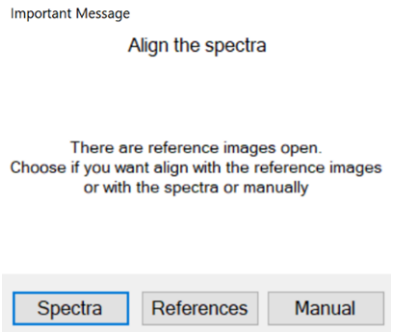
Reference images:



Spectra:



Press “Align the Spectra”.



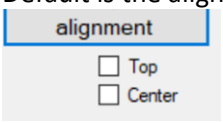
You can automatically align on the lines of the spectra.

You can automatically align on the lines of the references.

You can manually align on the lines of spectra or references.

You can always reset the alignment by pressing the same button (text has changed to “Remove Alignment”). Therefore, you can try which result is the best.

Default is the alignment with the bary-centre. You can also try with the “top” or “center” method:



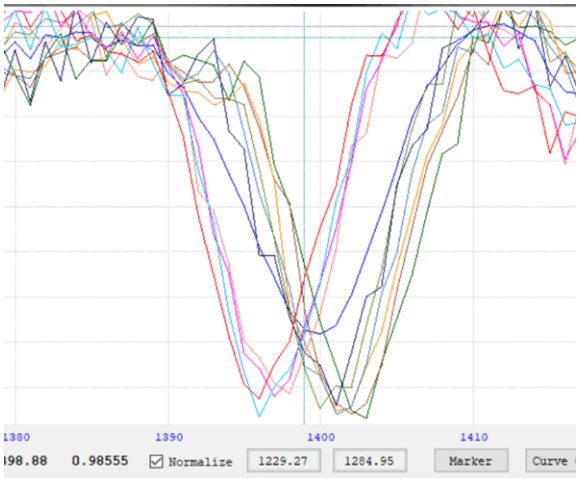
Check one of this boxes before you press “Align the Spectra”

All spectra and reference images will be aligned to the first image of the spectra or references, depending if you have chosen “Spectra” or “Reference” for the alignment.

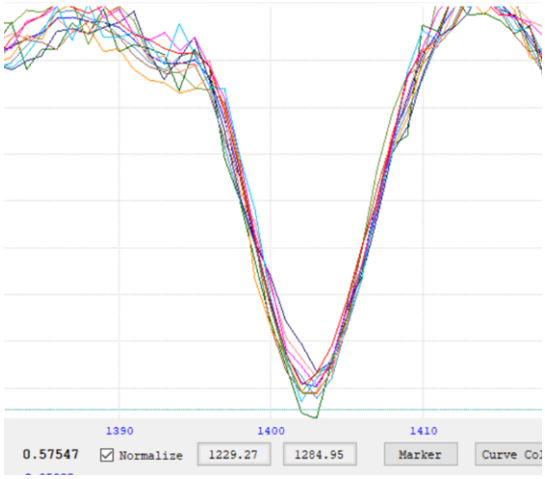
The alignment is working in sub-pixel mode with a resolution of 1/100 of a pixel.

Result of the example above:

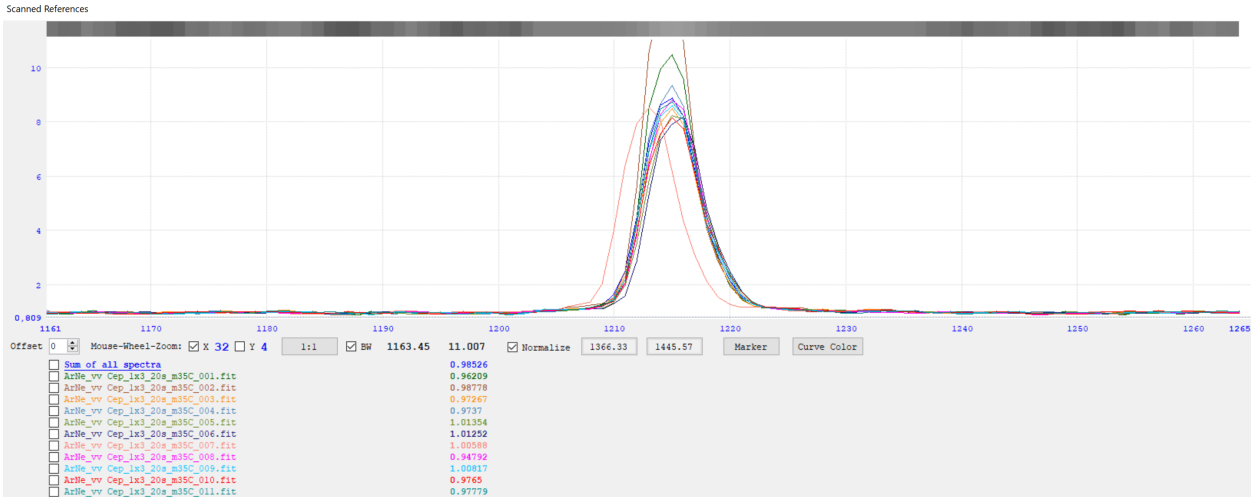
Before alignment:



After alignment:



In this example, I have aligned with the spectra lines. The graphic of the aligned references shows that one reference image is completely wrong aligned. For some reasons (maybe a mechanical problem), this image was shifted against the others.



In this case, you should remove the bad image from the reference list.

Save:
If you do not want to calibrate after the processing step 1, you can save the results of each single spectrum and reference image to calibrate it on a later time.

Calibrate:
All single spectra and references will be stored and the processing step 2 starts – Wavelength calibration.

2D Dark-Frame Reference

Select one or more dark frames for the calculation of the master dark for the reference images. Multi-selection is possible.
This process is similar to ***2D Dark-Frame for Spectra***

2D Reference Processing

Select one or more reference images. Multi-selection is possible.

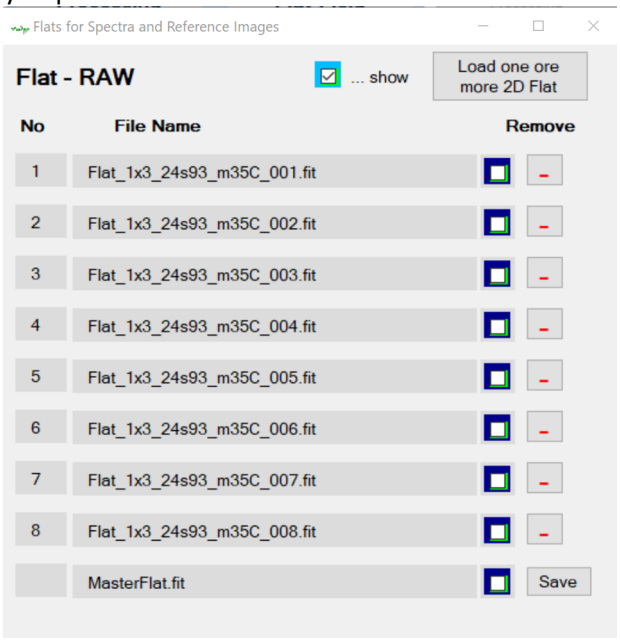
You can disable reference images from the processing. You can show it in an image window.
You can show or hide it in the graphical window and you can remove an image.

2D Dark for Flat-Field

Select one or more dark frames for the calculation of the master dark for the flat-field images. Multi-selection is possible.
This process is similar to ***2D Dark-Frame for Spectra***

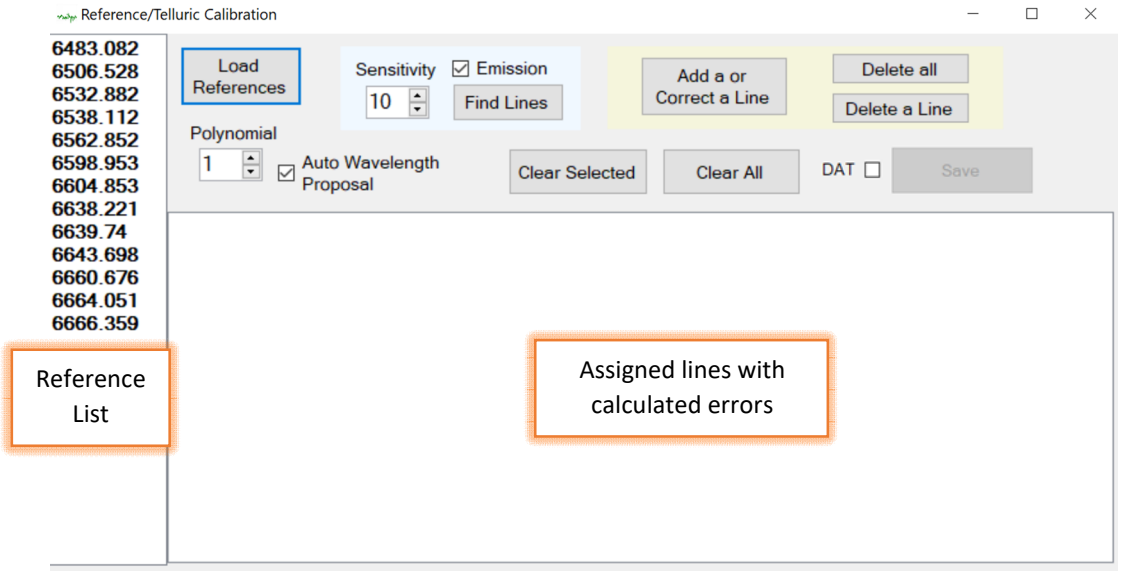
2D Flat-Field Processing

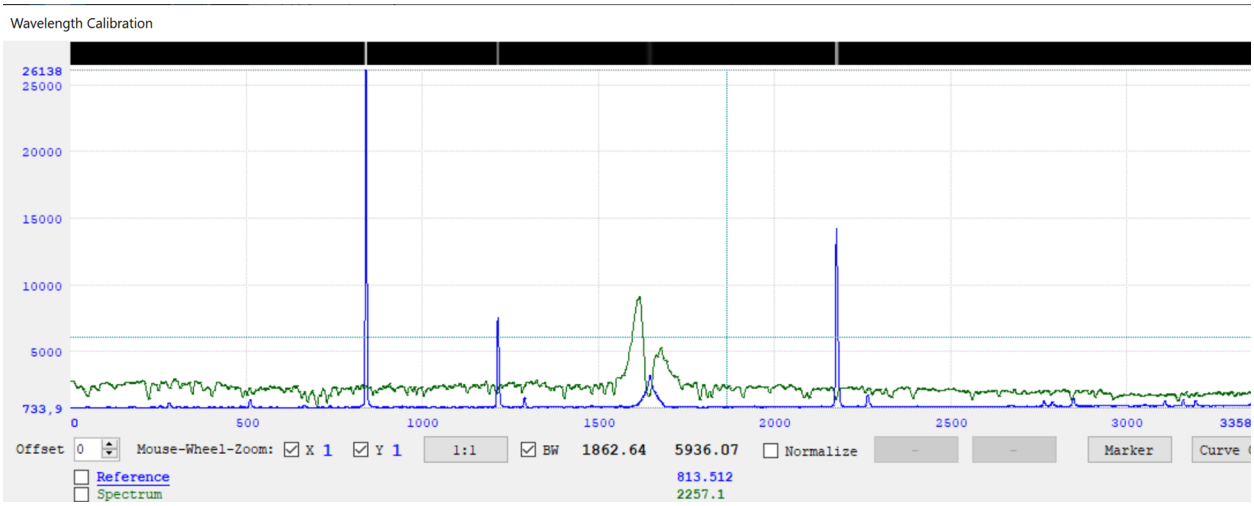
Select one or more flat-field images for the calculation of the master flat. Multi-selection is possible.
If you want to correct the flat-fields with darks, you have to proceed the “2D Dark for Flat-Field” before you press “Save” in the Flat-Raw window.



Step 2 – Wavelength Calibration

From Step 1 you come directly to the wavelength calibration process, if you press “Calibrate”.





If you have more than one images processed in step 1, you will only see the averaged result of all images here, but the calibration is done for all images.

If you have no reference images and want to calibrate with telluric lines or internal lines, you will see only the averaged result of the spectra.

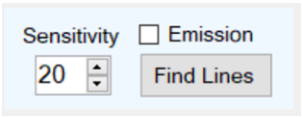
Load References

Load a text file with the wavelength of the reference lines.
SpectroCalc delivers four sample reference files:

- ArNe_Ha Argon Neon emission lines in the area of H-alpha
- ArNe_SiIII Argon Neon emission lines in the area of the Si-Triplett about 4550 Å
- Telluric_Ha Telluric absorption lines in the area of H-alpha
- Elements A huge list of elements. You can take it as base for creating lists for your Equipment
- Neon_5852_7438 Neon emission lines in the range of 5852 to 7438 Å

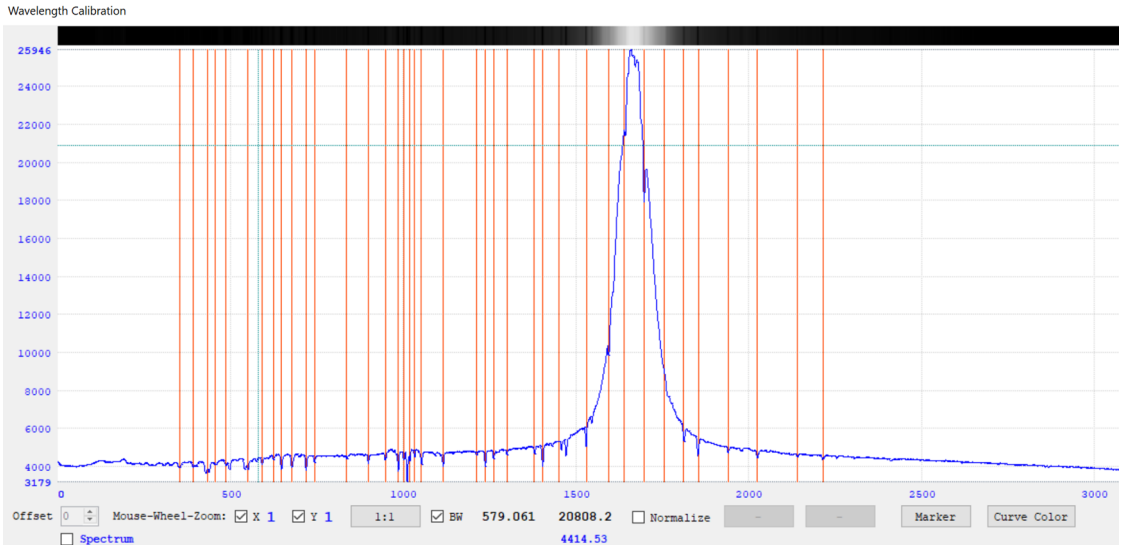
For the most reference files exists a help-image, which is opened automatically. You can resize it for a better view.

Find Lines

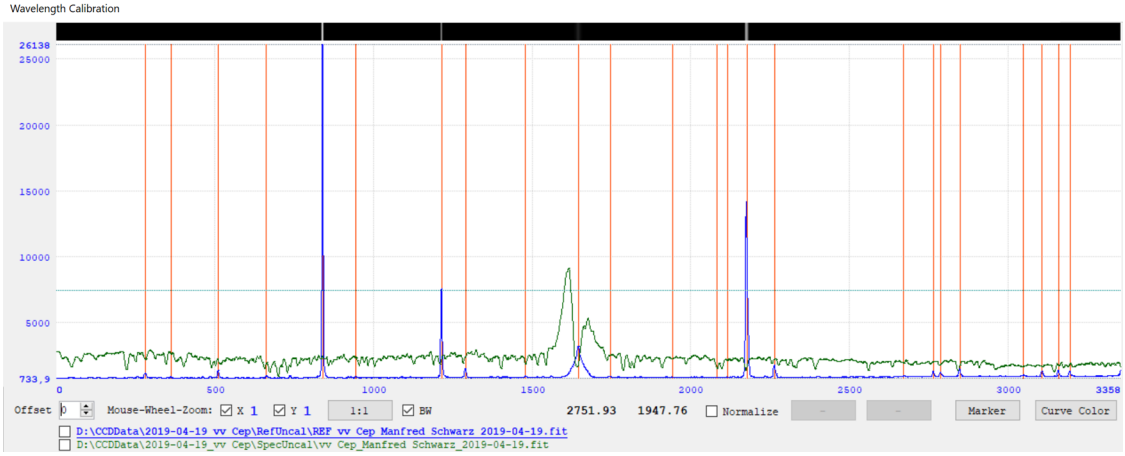


Emission: the software selects in case of reference images “Emission” and deselect this box in case of spectra only. If you want to change this parameter for any reason, you can change it.
Sensitivity: higher values create a higher sensitivity for finding lines
Find Lines: Press it to generate a new calculation of reference lines

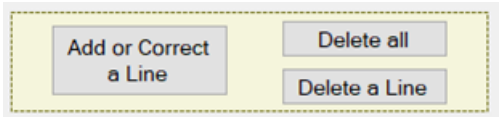
Example without reference images:



Example with reference images:



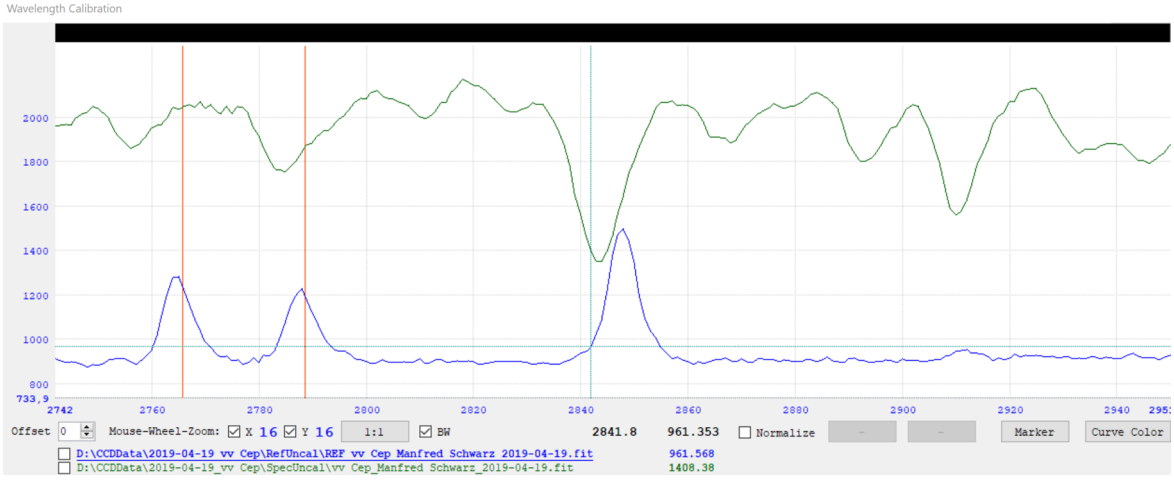
Add, delete or modify lines



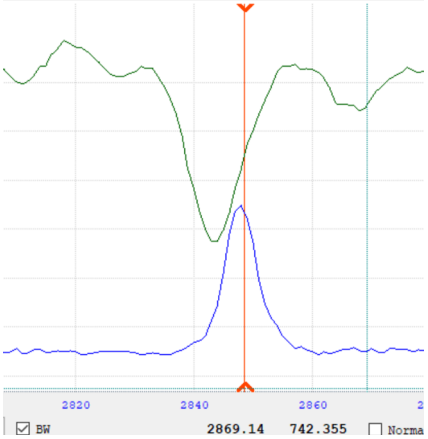
You can define all the lines by yourself, or you can add lines, if the automatic search has not found all desired lines.

Add a line:

Zoom in to have a good view on the desired line. Press “Add or correct a Line”.



Click on the left wing, where the line rises from the continuum, and then click on the right wing, where the line sinks into the continuum.



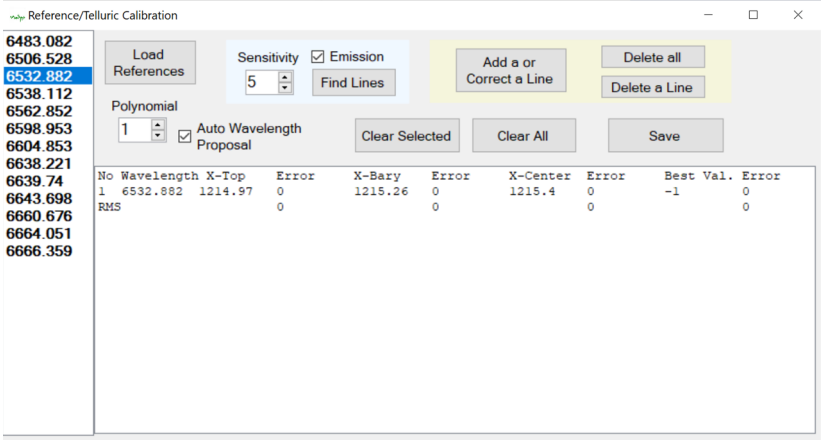
Modify a line:
You can modify a line, if you click on “Add a or correct a Line” and use a line, which has already a vertical marker line.

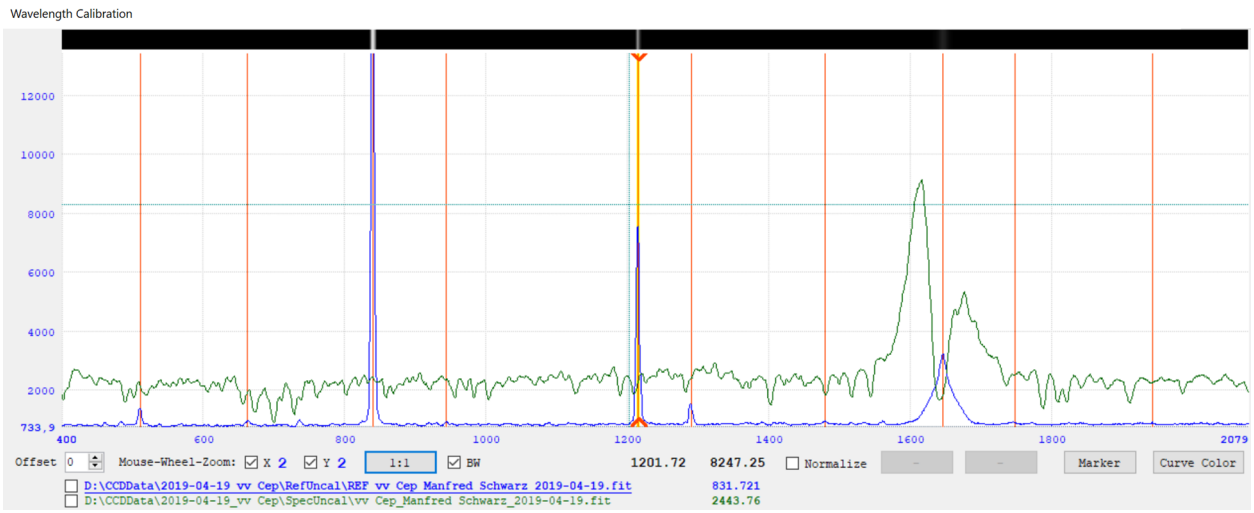
Delete all lines:
Remove all marker lines.

Delete a line:
Remove the selected line (marked on the top and bottom of a marker line)

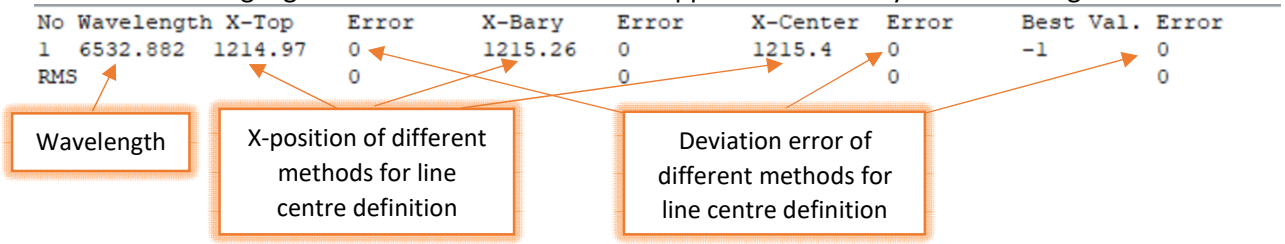
Take a line in the calibration list and assign a wavelength

Select a line by left mouse click on a marker line, and then select a wavelength in the reference list.





The line is now highlighted and in the calibration list appears a new entry with following information:

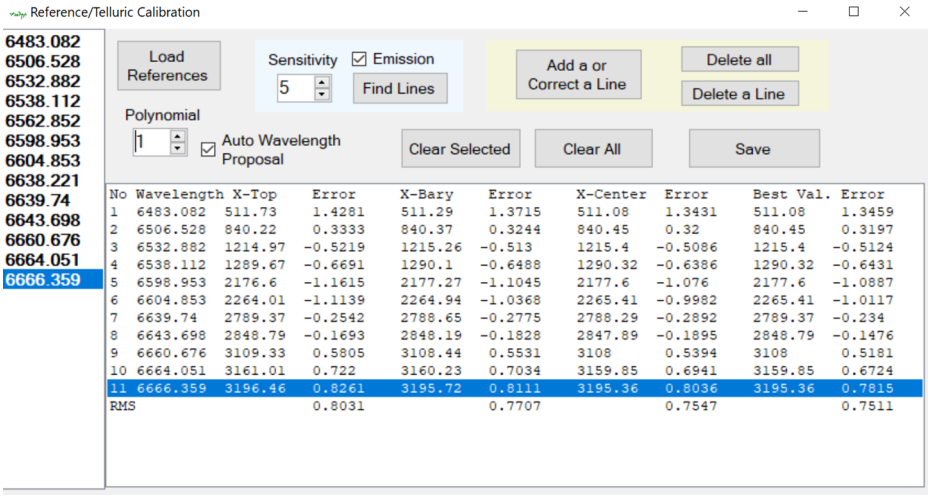


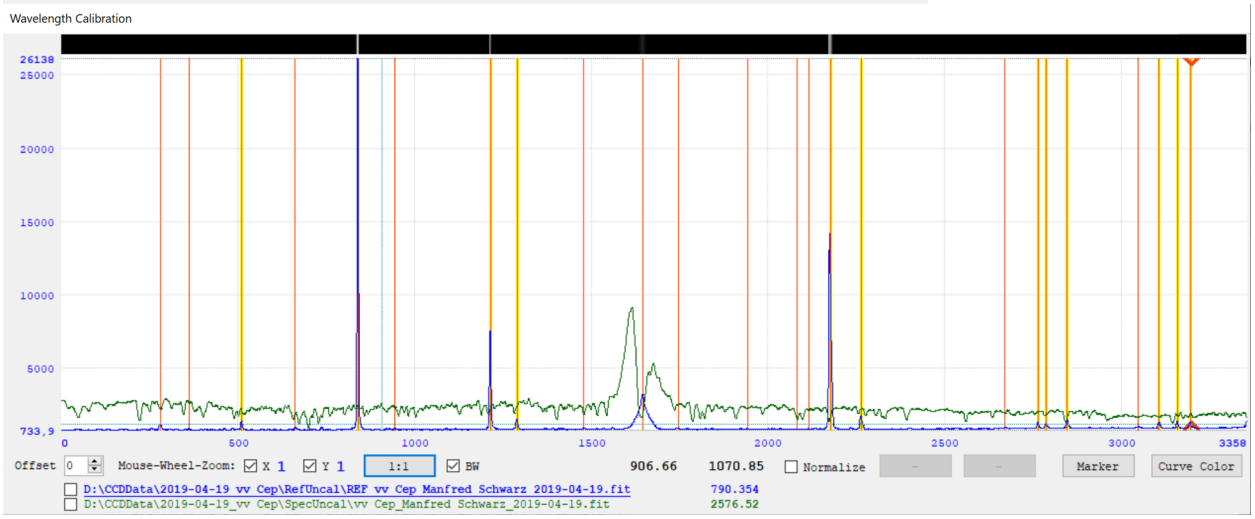
The same procedure is to do for the second line. Choose the first and second line with a big X-distance to get a better result by finding the next wavelength automatically.

Auto Wavelength Proposal

If this box is checked, all further wavelength will be assigned automatically by selecting a line (only possible, if two lines already defined manually).

After assigning the desired lines, you will get following:

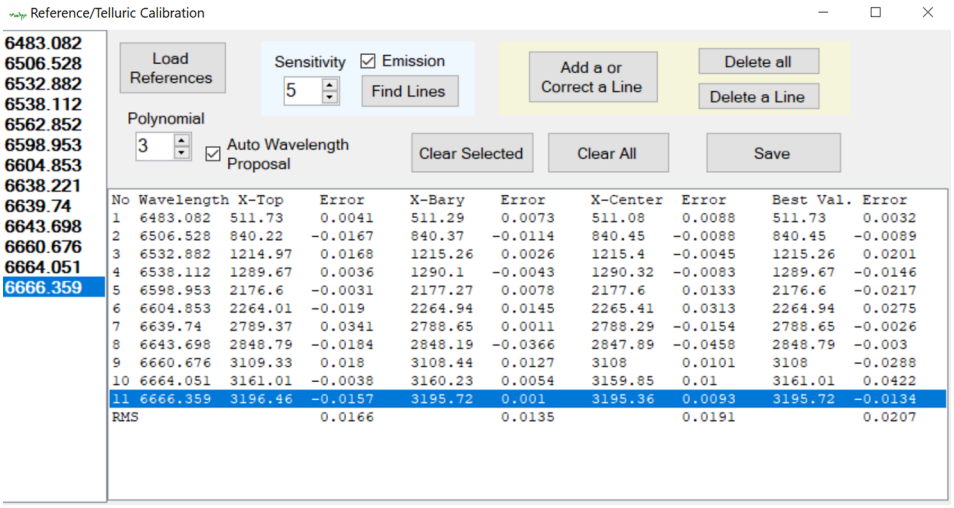




If the automatic has assigned a wrong wavelength, you can select the line and choose another wavelength in the reference list.

Polynomial

Change the polynomial to generate a non-linear correction curve for your spectral grid.
The polynomial value should be at maximum two times lower as the number of used lines!



Clear All

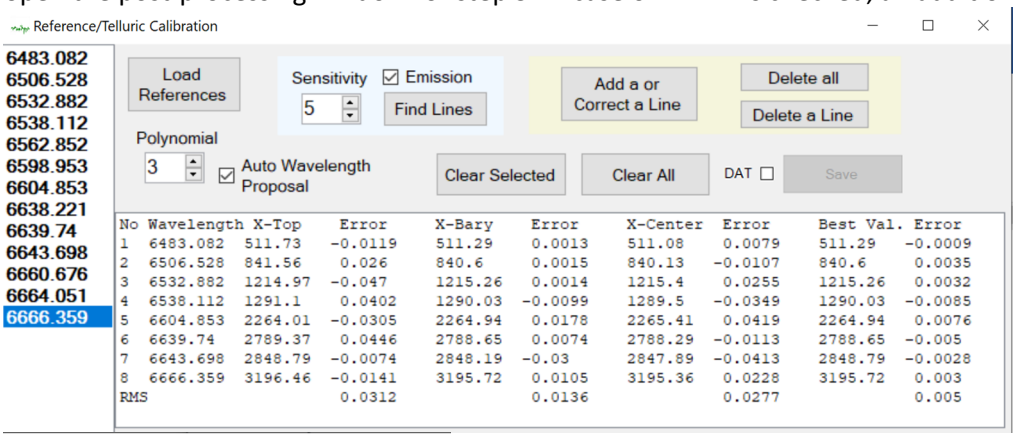
Remove all assignments and clear the calibration list.

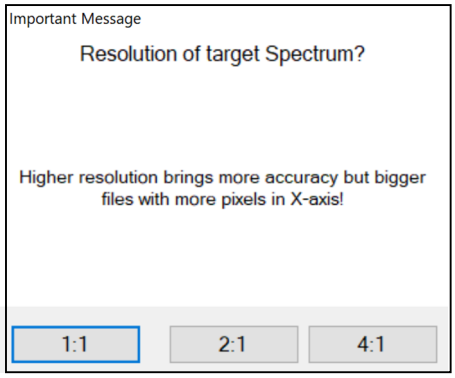
Clear Selected

Remove the selected line. If you see a big deviation error on a line, you can clear it from the list or you can try to modify the marker line with “Add or Correct a Line”.

Save

If you are satisfied with the result, press “Save” to save all calibrated spectra and reference images and open the post-processing window for step 3. In case of “DAT” is checked, an additional .dat file is stored.





The software has to linearize the data with the calibration curve. In this step, you can lose precision.

1:1 save the linearized data with the same resolution as the original data (most time sufficient)

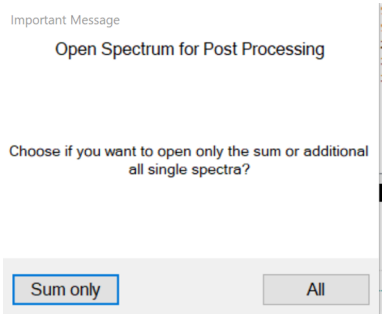
2:1 save the linearized data with two times resolution as the original data

4:1 save the linearized data with four times resolution as the original data

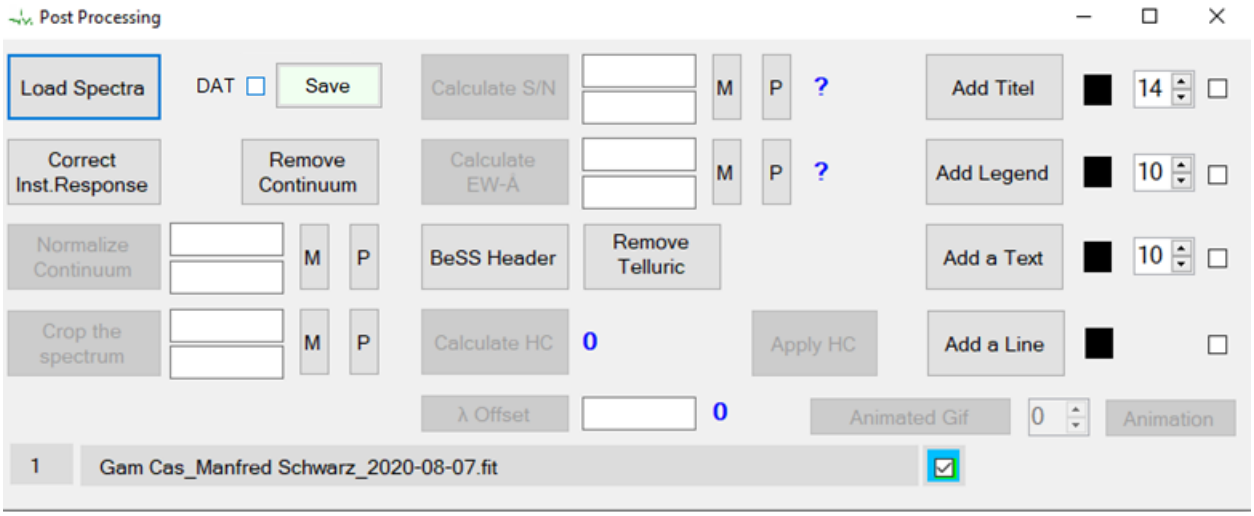
4:1 is the best result, but with four times bigger files

Step 3 – Post Processing

If you enter this step from the calibration step, the system ask you if you want to process the averaged result only or all spectra.



If you want to show the changes in the lines during a time-period, you have to select “All”.
If you are interested on the averaged result spectrum, press “Sum only”.



Load Spectra

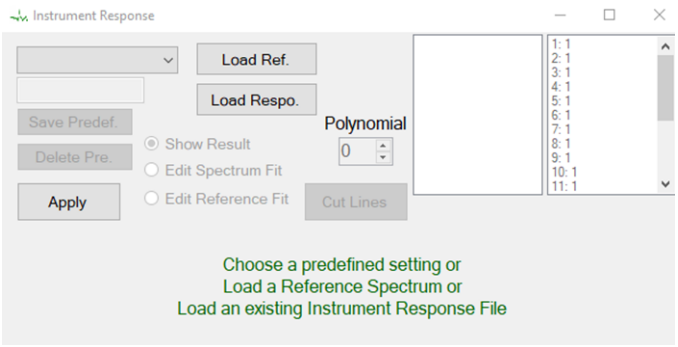
Load additional spectra into the working area.

Correct Instrument Response

Each instrument setting (telescope, spectrograph, and camera-chip) has a non-linear geometrical influence to the flux (Y-axis) over the X-axis.
The first step should always to correct the instrument response to get the natural shape of the continuum of the spectrum.

The best and most precise way to do that, is to make an image of a reference star in the near of your object and very close in the time of the exposure of your object. The best reference stars are some with less absorption lines and without emission lines. Calculate the instrument response of the reference star with this feature and use the result to correct your spectrum.

Mostly you will not have the possibility to image a reference star. In this case, you can correct the instrument response directly on your object spectrum with a similar reference star of one of the reference catalogues.

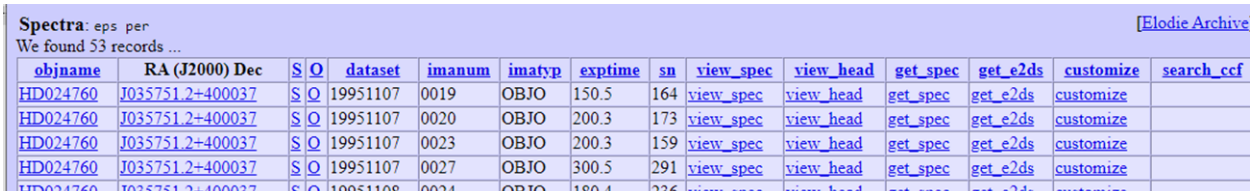


Load Ref.:
Load the spectrum of a reference star.

SpectroCalc2 try to connect to my web-server to look at the reference star libraries.
If you have not already downloaded the libraies, you get a message if you want to download it.
This can take up to an hour, if you have a very slow internet connection.
If you have already downloaded the libraries, SpectroCalc2 is looking, if there are new stars added and download it automatically.

In the moment 3 libraries are supported:

Elodie (OHP observatory France): **absolute recommended, if you need accurate results**!
You can use the exact same star as you have imaged as reference. Elodie spectra are very well flux-corrected and you can be sure that you get the better fit as with a general star type spectrum.
I have added only few spectra in this library, but I will add from time to time more spectra.
However, it is very easy for you to add your own Elodie spectra by visiting following web page:
http://atlas.obs-hp.fr/elodie/index.html
Enter the star name (Simbad compatible name) and press get spectra.



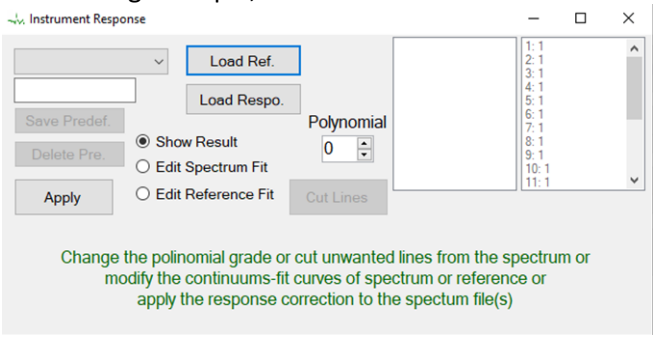
Choose a spectrum and press get_spec.
I recommend to add the spectra in an own created folder to avoid that SpectroCalc overwrite it by a library update.

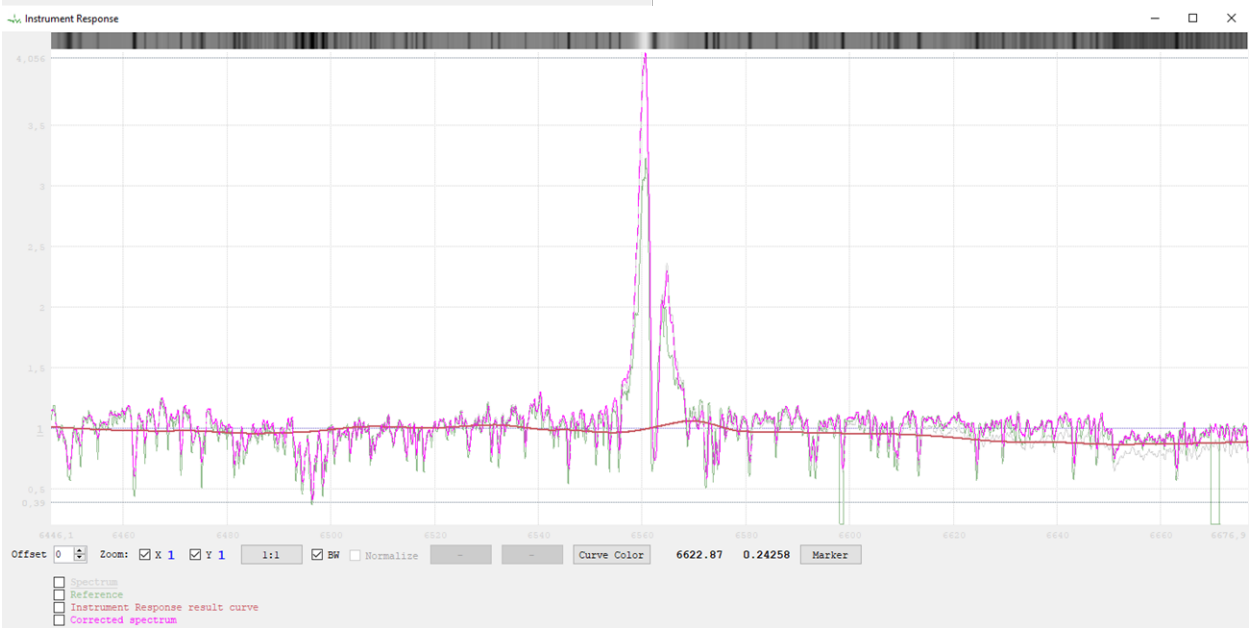
Miles:
Reference stars from Miles catalogue (http://miles.iac.es/pages/stellar-libraries.php)

There are also high-resolution spectra, but mostly for stars, which are not used by amateurs. For that reason, you have mostly to use a similar star type. I recommend it only, if you do not find your star in the Elodie database.

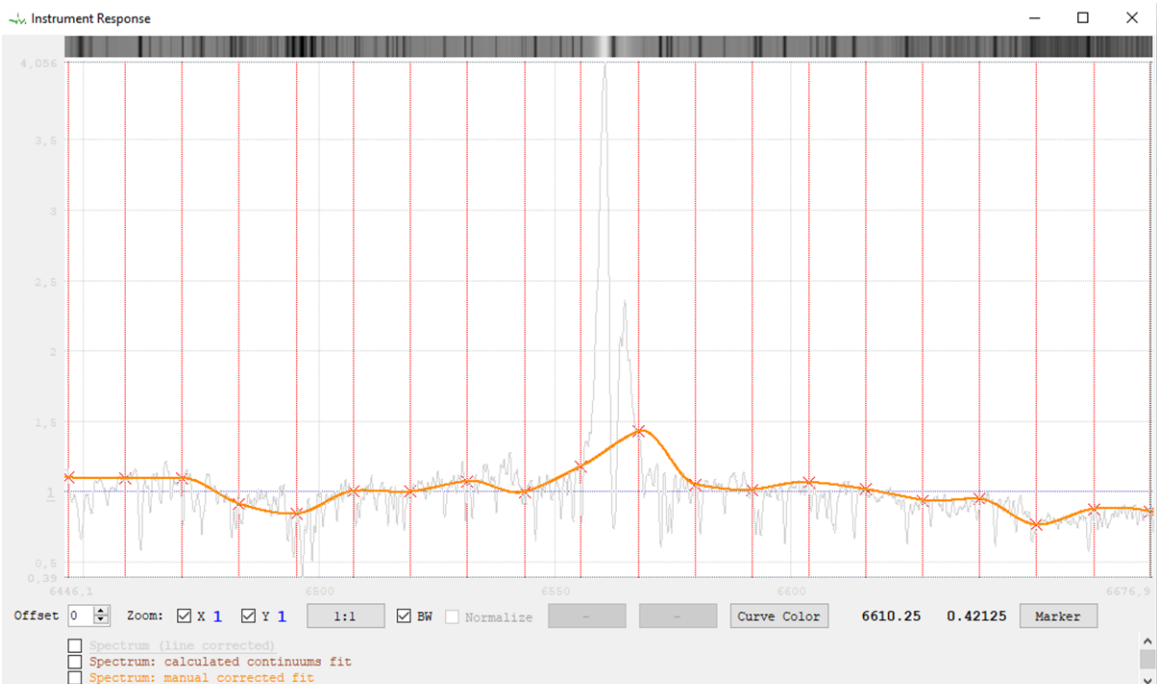
Low-Resolution:
This is a short list of standard stars with low-resolution.
I recommend it only, if you want to find the temperature of a star, but not for equivalent width calculations.

In following example, I used the Elodie folder with the star “Cep vv - M2epIa-Iab.fits”.

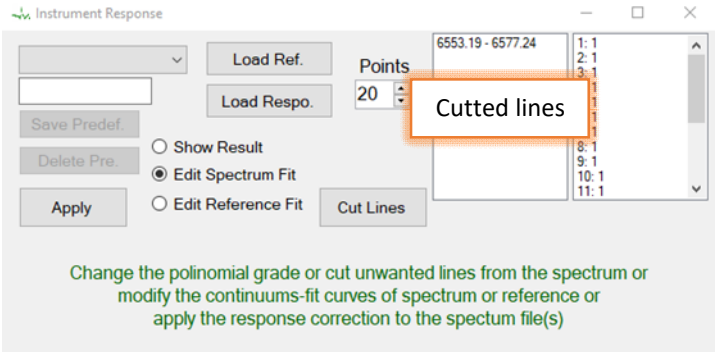


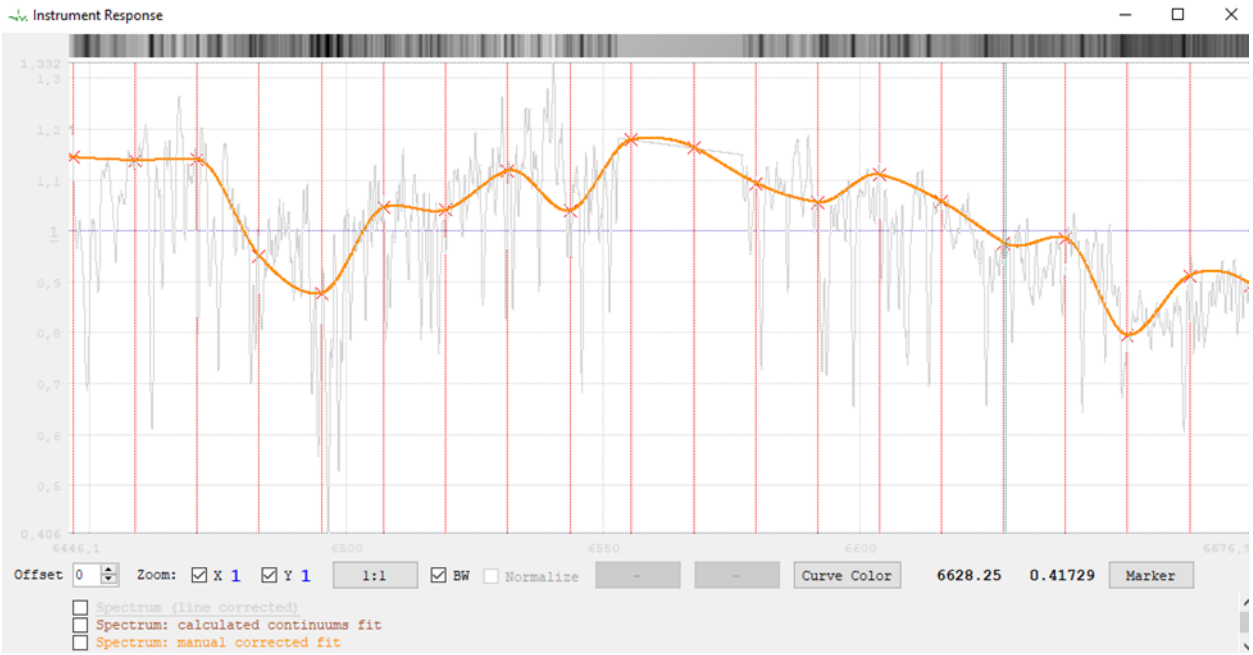


Select “Edit Spectrum Fit”.



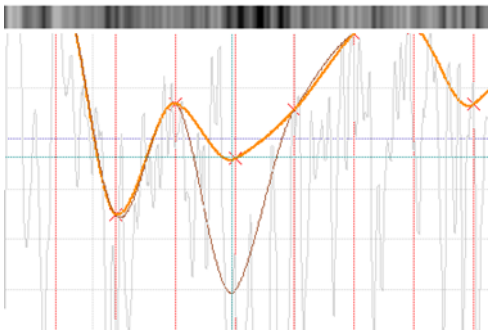
Now you see the calculated curve of the continuum-fit.
You can change the numbers of edit-points (default = 20).
As you see in this example, the emission of the B-companion disturbs the shape of the calculated continuum.
Cut the emission by pressing “Cut Lines” followed by clicking left and right from the emission:



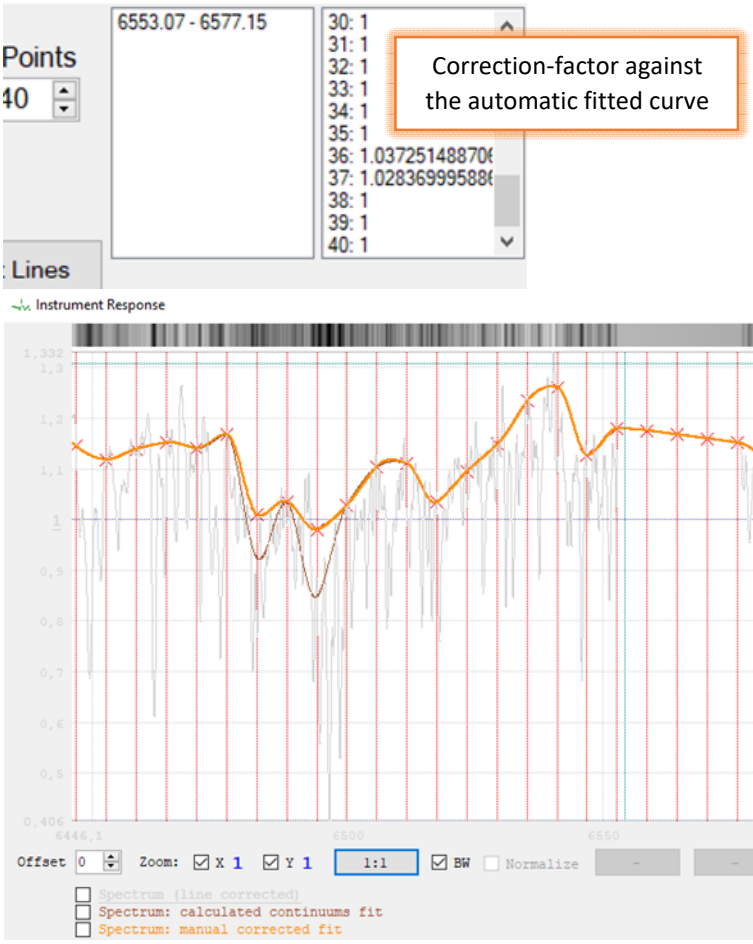


You always have the possibility to zoom in and out to work with more precision.

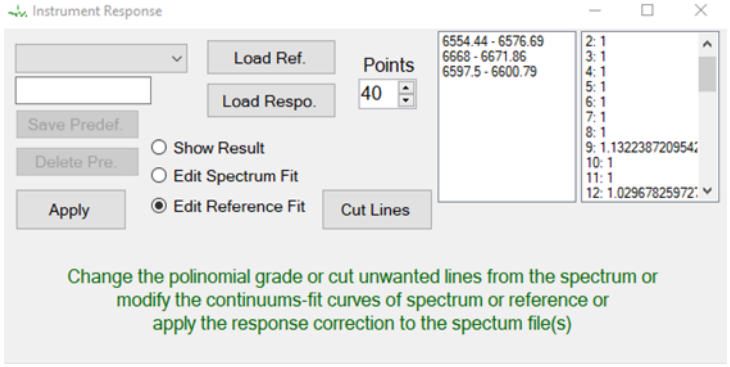
In my case, I increased the number of points to 40. Click on a point to select it. Correct the Y-position of it by hold down the left mouse button and move the mouse up- or downwards. If the movement is too small to get a result, zoom more in or move the point on a wider false position and move it then back to the desired position.

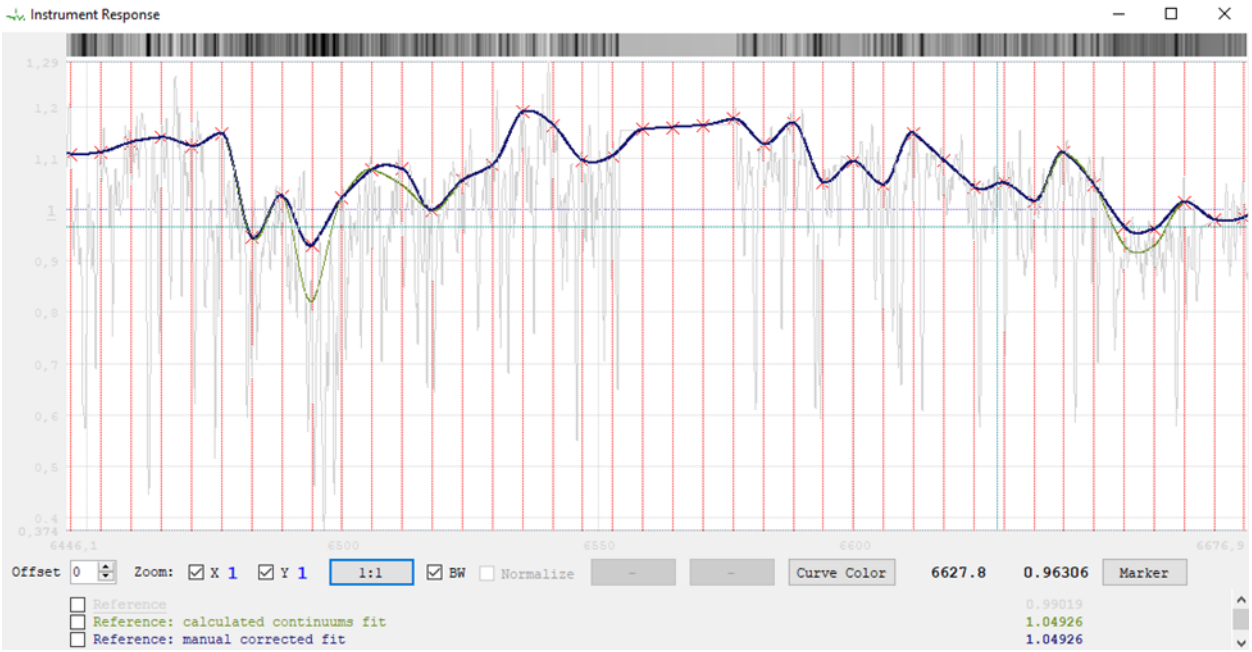


You should try to define the shape of the continuum of the shown spectrum.

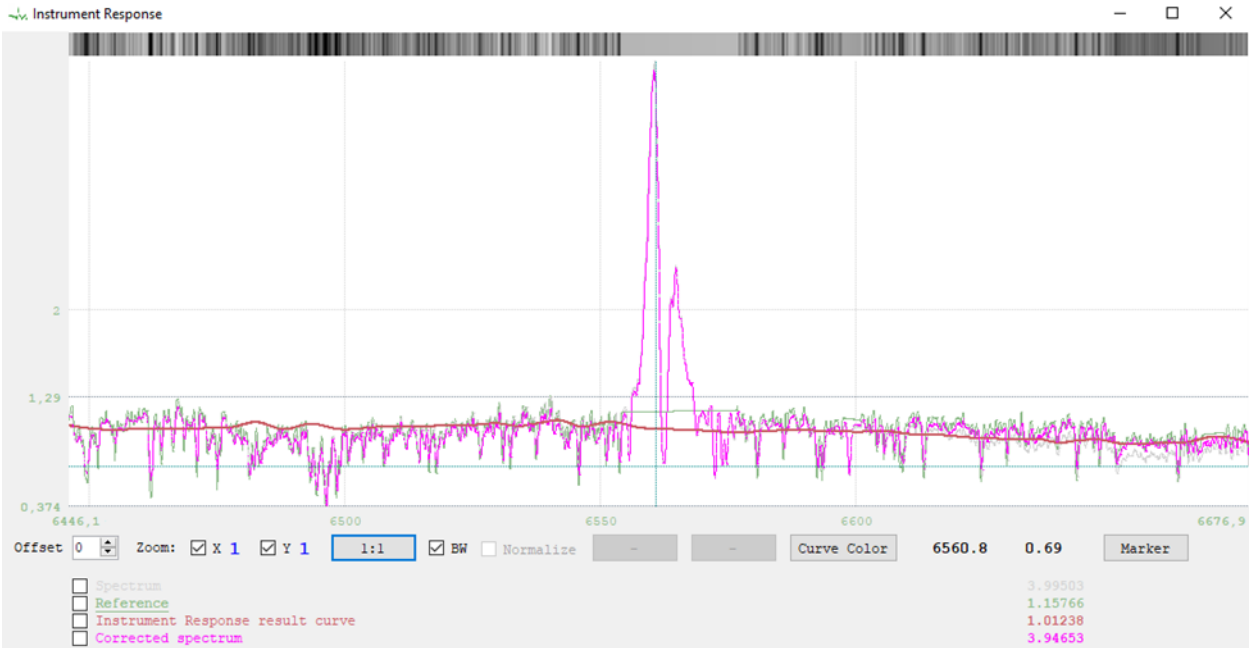


Select “Edit Reference Fit” and edit the continuum fit in the same way as for your spectrum before. In my example, I have also increased the number of points to 40.



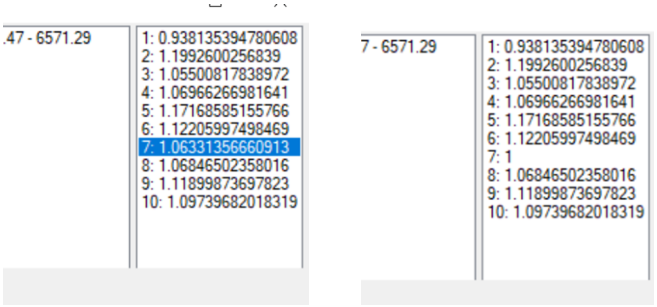


Select “Show Result” and you will see a grey curve as original spectrum, a green curve as reference spectrum, an orange curve as instrument response curve (continuum shape of spectrum divided by continuum shape of reference) and the pink shape is the corrected spectrum (original spectrum divided by instrument response).

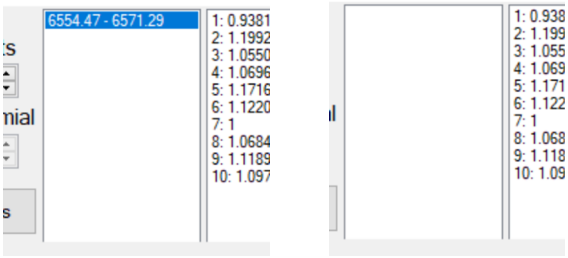


If the polynomial value is 0, you get the exact calculated instrument response curve. If you change the polynomial value, you can smooth the curve.

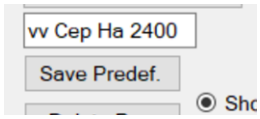
Reset a corrected point:
Click on the point in the list and press “DEL” or “Backspace”.



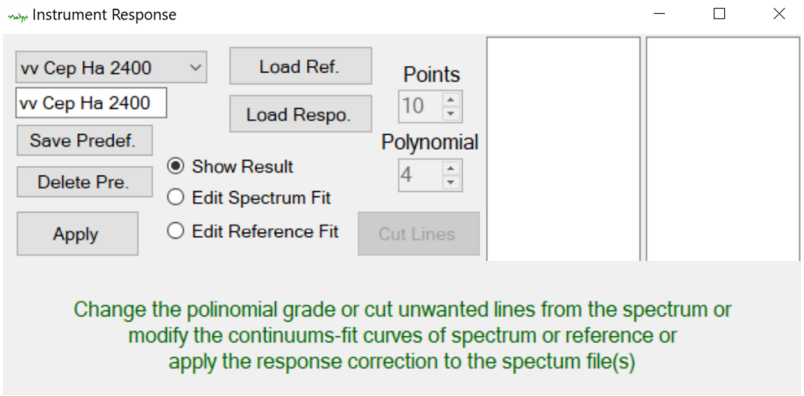
Delete a line cut:
Click on the line cut value in the list and press “DEL” or “Backspace”.



Save the parameters for future processing’s:
You can save many steps for processing the next spectrum of this object, by saving the parameters in your pre-sets.
Enter a name in the text field above “Save Predef.” button and press “Save Predef.”.



Use pre-set parameters:
If you have already stored a pre-set for this object and for your settings, you can choose the pre-set from the drop-down-box.



Please control the “Edit Spectrum Fit” and “Edit Reference Fit” curves and if it is necessary correct it for the current situation.

Delete pre-set parameters:
Select the desired pre-set and press “Delete Pre.”

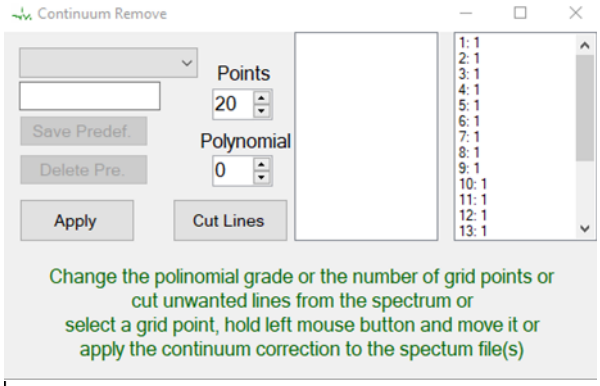
Load an instrument response curve:
Press “Load Respo.” If you already have an instrument response curve for the correction.

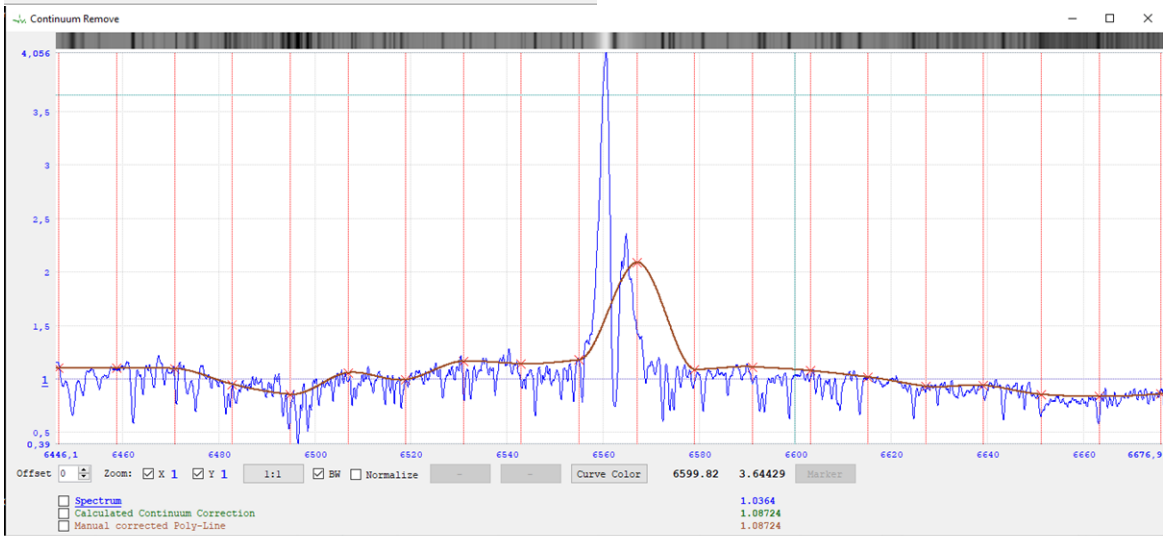
Apply:

The instrument response correction will applied to the spectrum. If you have loaded more than one spectrum, the instrument response curve is calculated for each single spectrum extra, with the same parameter-set and all curves will be corrected.

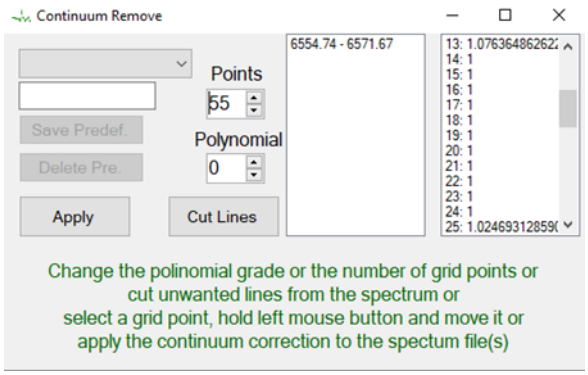
Remove Continuum

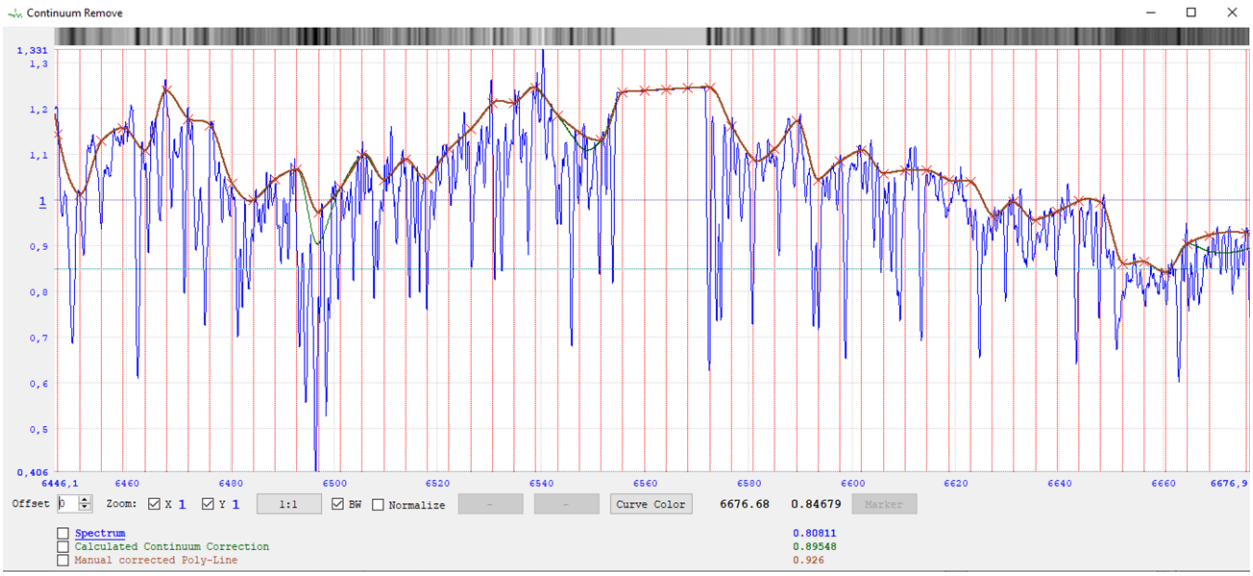
For some measurements, it is necessary to remove the continuum (for example to compare peaks of emission lines).



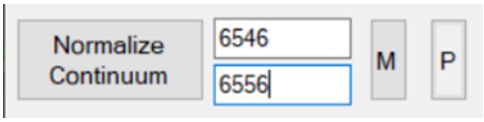


The continuum remove feature is very similar to the instrument response correction.
You can cut lines, edit point, etc.





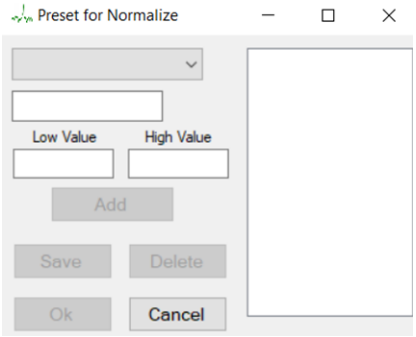
Normalize Continuum to 1



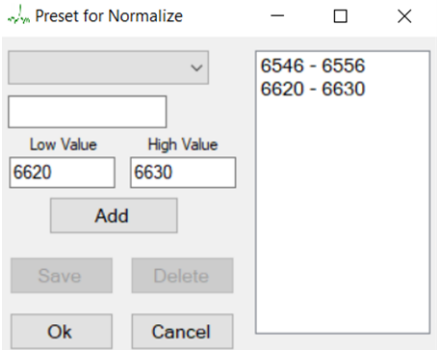
Normalize on an entered wavelength area:
Enter the low value of the wavelength area in the upper field and the high value on the field below and press “Normalize Continuum”.

Normalize with a mouse-defined area:
Press “M” and click with the left mouse key on the lower X-axis point and then on the higher X-axis point.

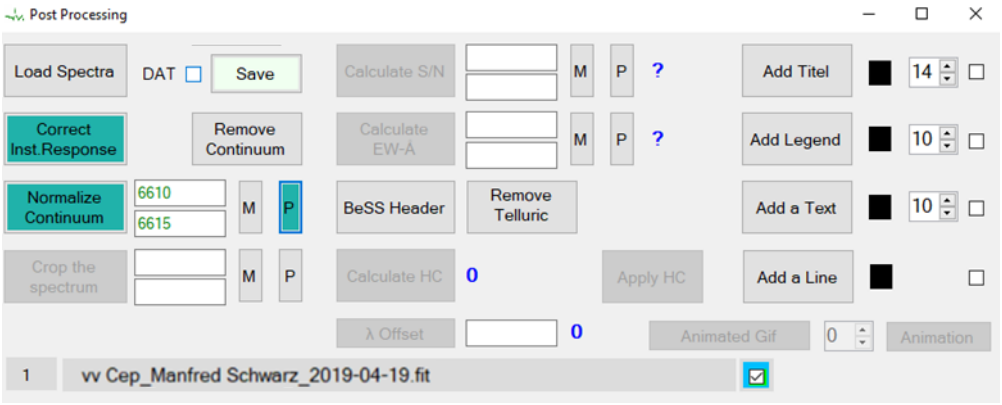
Normalize with pre-defined values or with more then one areas:
Press “P” and the pre-set window opens.

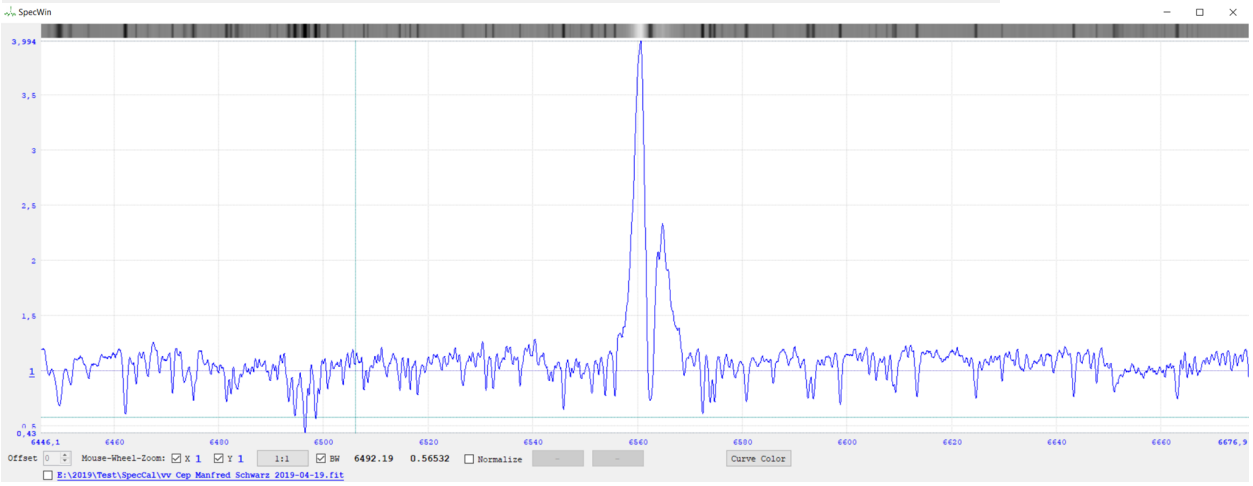


Enter the low and the high value of the wavelength area and press “Add”. The range is displayed on the right white box. You can define more than one areas. In this case, SpectroCalc uses an average of all calculated values.
You can save this setting as pre-set values. Enter a name for the setting in the text field above of the wavelength fields and press “Save”.
If you want to delete an area of the list on the right side, select the entry and press the “DEL” or “Backspace” key.
You can select an already stored pre-set with the drop-box.
If you have select an already pre-defined setting, you can delete it by pressing “Delete”.



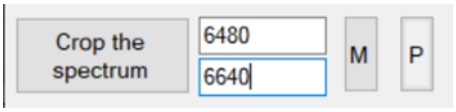
Press Ok to take over the value and calculate the spectrum data.



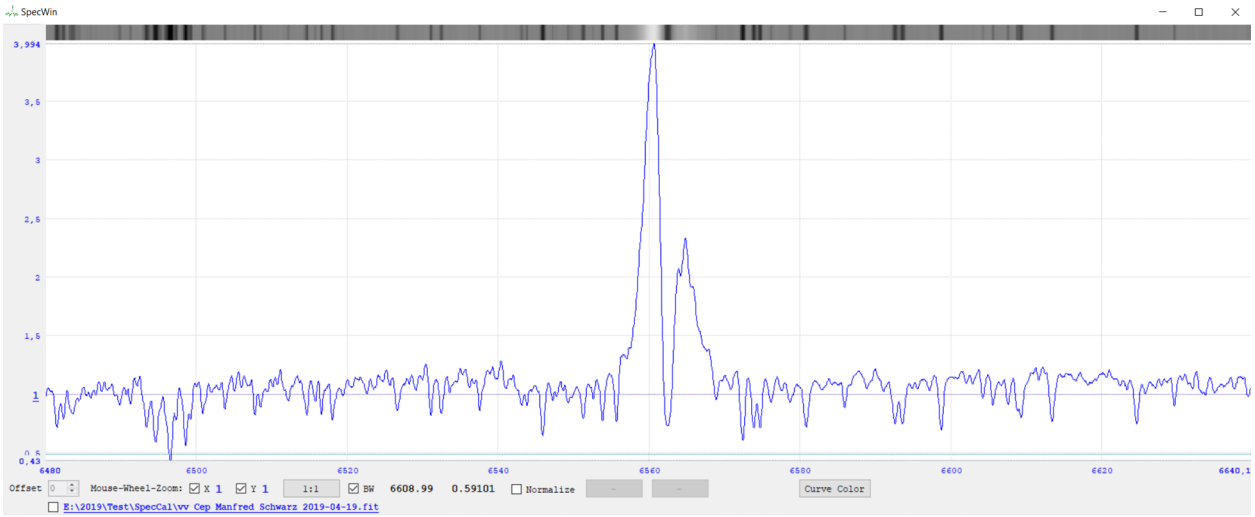


The values beside the “Normalize” button can have different colours:
Black: manual entered value
Blue: entered with “P” or pre-defined setup – one area only
Green: entered with “P” or pre-defined setup – more than one areas

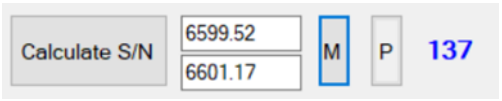
Crop the X-axis



The using of this feature is structured exactly in the same way as the normalisation feature before.
The only one difference is that for crop, you can define one area only.

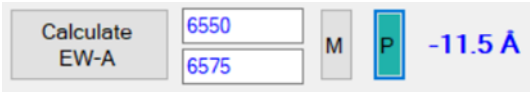


Signal to Noise Ratio



The using of this feature is structured exactly in the same way as the normalisation feature before.
You can also define more than one areas. In this case, you get the average of the calculated S/N values.

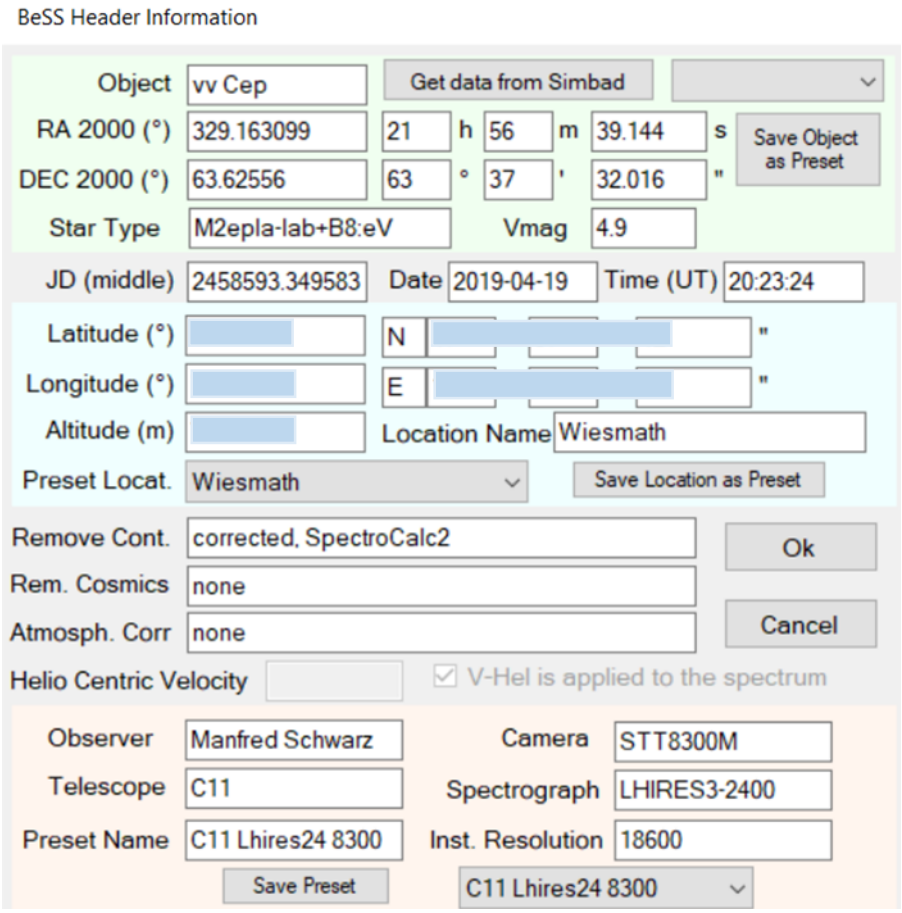
Equivalence Width in Ångström [Å]



The using of this feature is structured exactly in the same way as the normalisation feature before.
You can also define more than one areas. In this case, you get the average of the calculated EWÅ values.

BeSS Header

If you want to store your spectrum to the BeSS data base: http://basebe.obspm.fr/basebe/, you have to fill out all relevant data which are necessary. Anyway, you should fill out this data, because it is a good documentation for you or other people, which want to work with your spectra. Also for the heliocentric correction calculation, it is necessary to define the most of these parameters. All the data will stored into the FITs header of the output files.



Get data from Simbad:
The program look at the Simbad database and download the data from this object. Please configure your firewall that SpectroCalc2 has access to internet.
Sometimes the response of Simbad is missing. Mostly if you try it a second time, it works.

Pre-sets are also possible for:

- Object data
- Location
- Instrument settings

Press Ok, to take over the changes, Cancel to exit without changes.
Remove Continuum:
If you used the remove continuum feature of SpectroCalc, it is filled out automatically.
If you used another software, enter the method of normalization.
If the continuum is not removed, enter: **none**.

Remove Cosmics:
If you have removed cosmics, enter the method.
If you have removed cosmics but you don't know the method, enter: **corrected, no indication of method**
If you have not corrected the cosmics, enter: **none**

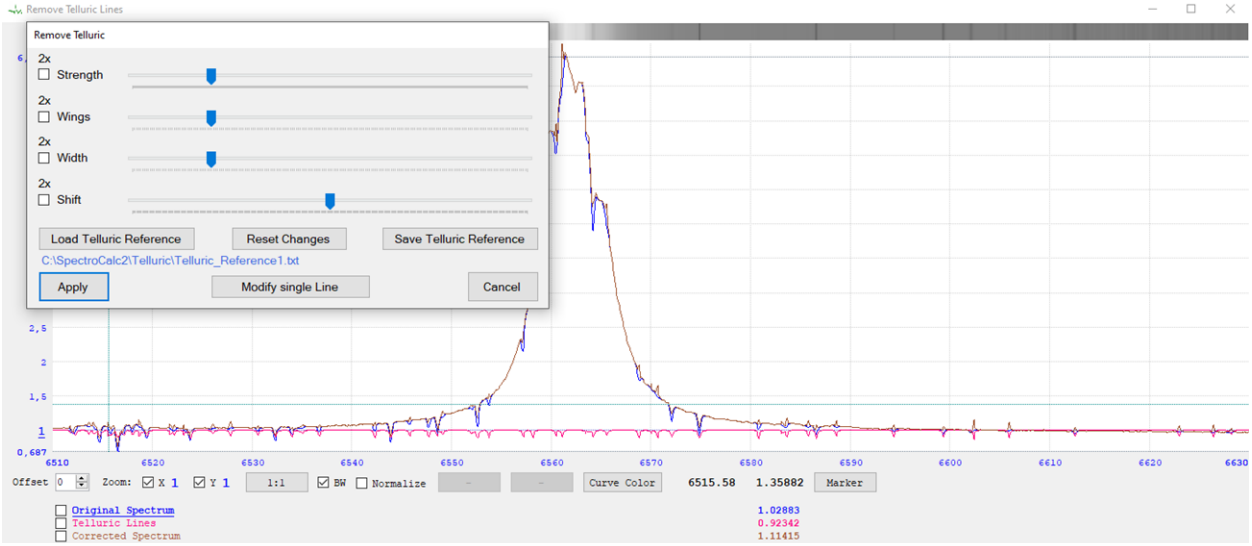
Atmospheric correction:
If you have removed the atmospheric lines (telluric), enter the method.
If you have removed it but you don't know the method, enter: **corrected, no indication of method**
If you have not corrected it, enter: **none**

Helio Centric Velocity:
If you have calculated the HC with SpectroCalc, it is filled out automatically.

Instruments and observer:
Please attend by the instrument resolution, that this value depends on the monitored wavelength.
It is a higher value in red areas und a lower value at blue area.
Example for my LHires III with 2400 l/mm grade:
6562 Å: instrument resolution = 18600
4600 Å: instrument resolution = 11000

Remove Telluric

Especially in the area of Hα, there are many telluric lines of our atmosphere. If you want to have a precise EW measurement of the Hα line, you should remove the telluric lines from your spectrum.



A new graphic window appears with 3 curves:

- Original spectrum
- Telluric lines
- Corrected spectrum

SpectroCalc2 supplies 2 different telluric reference files. You can change it with “Load Telluric Reference” button click.
It is also possible to design you own reference file or you can copy one of the existing files under another name and modify it (add new lines or change the parameter of the existing lines).

Following drawbars exists for changing the parameters of the telluric reference:

- Strength: deepness of the lines
- Wings: curve of the left and right wings
- Width: width of the lines
- Shift: wavelength shift (should be not necessary to change it for the complete telluric reference, if your spectrum is well wavelength calibrated)

If one of the parameters are too weak, you can check “2x” to double the effect.

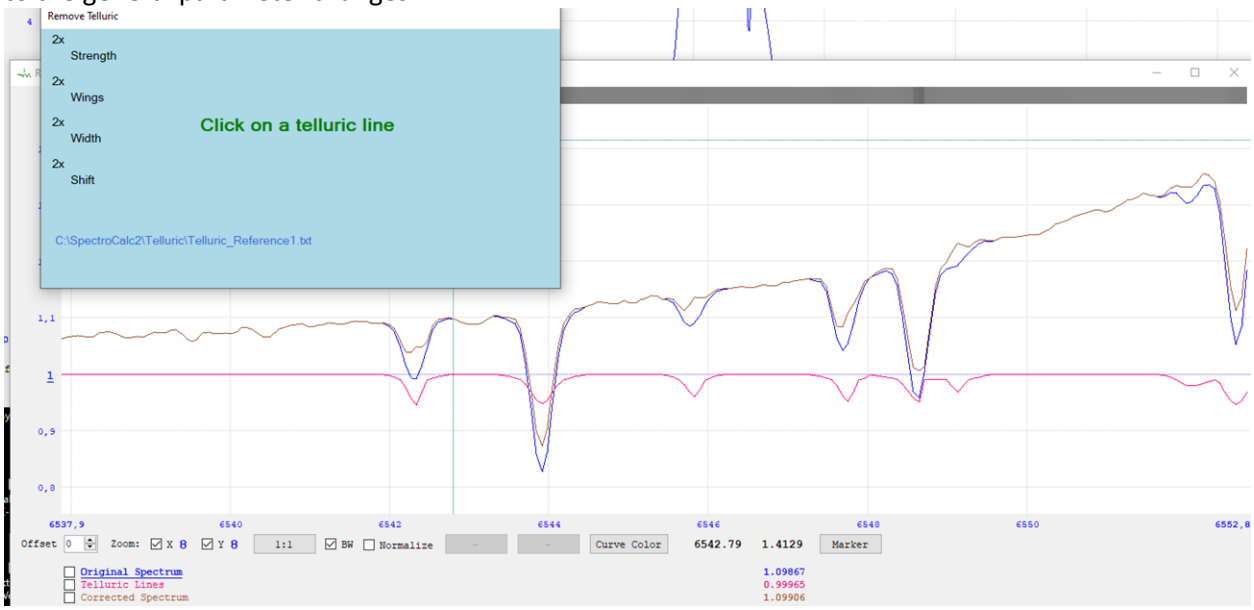
“Reset Changes” change the parameters back to the start parameters.

“Save Telluric Reference” saves the file name of the chosen reference file and all parameter changes you have done in a file with the extension “.tel”. Next time, you can load the saved file with “Load Telluric Reference”, the original reference file will be loaded, and all changes will be done.

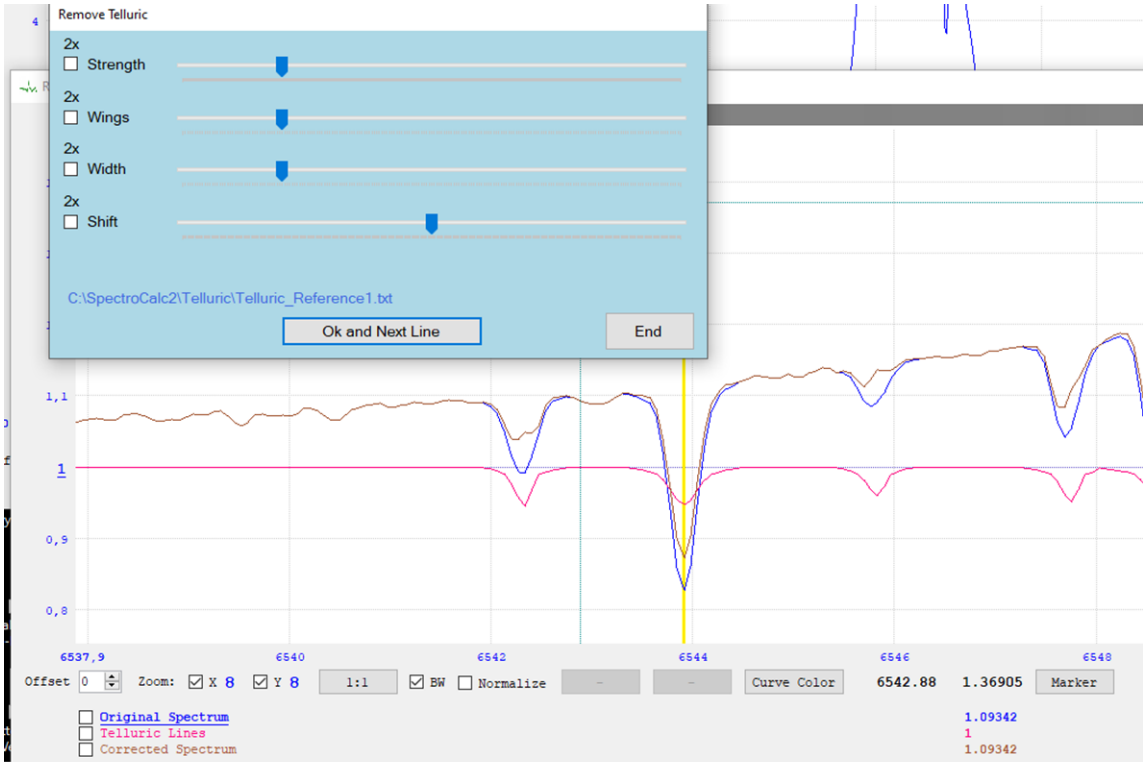
“Apply”: applies the correction to the spectrum/spectra.

“Cancel”: doesn’t apply the correction and close the remove-telluric-section.

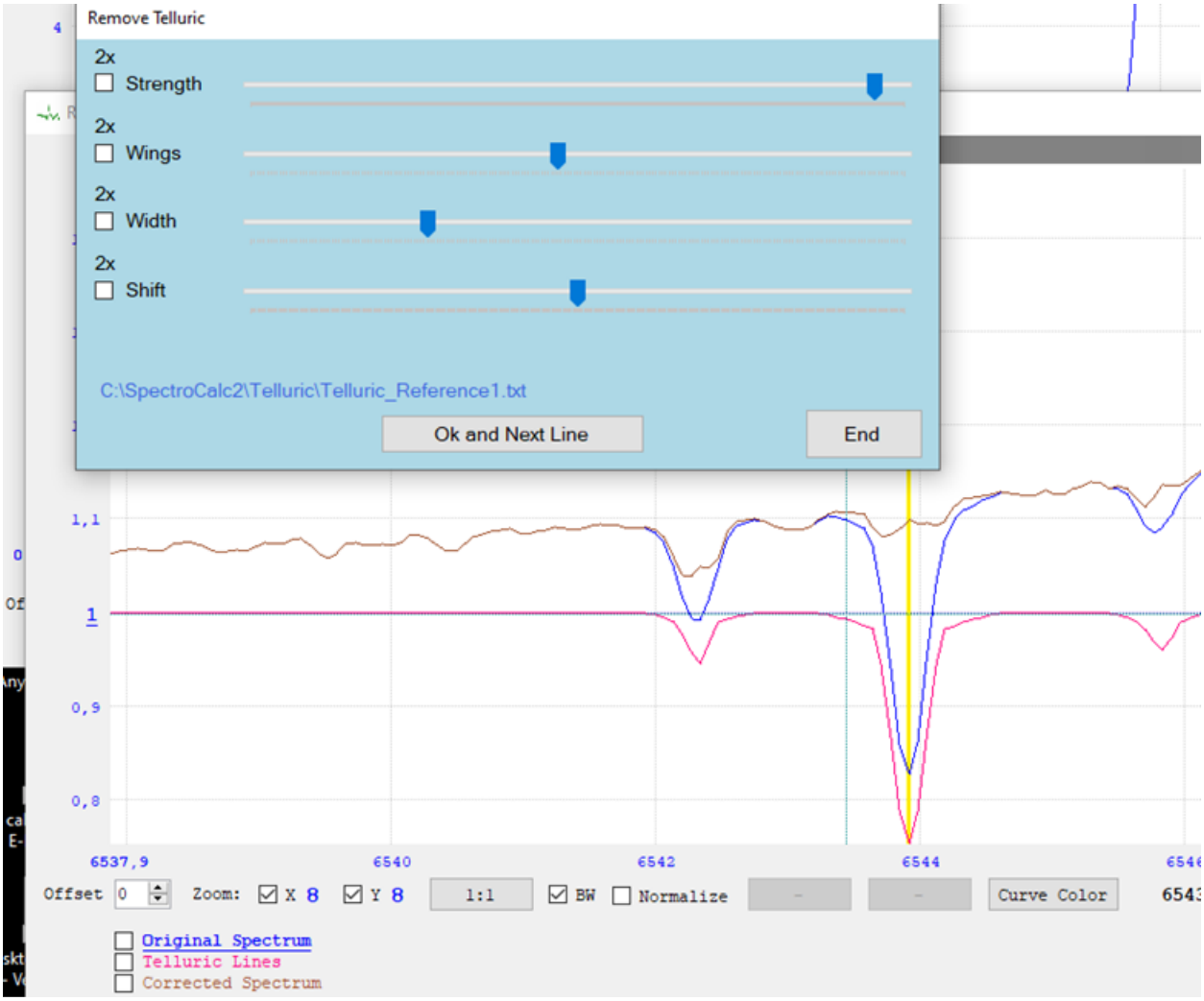
“Modify single Line”:
Often, the intense, the shape or the wavelength of one or more single telluric lines are different of the telluric reference data. In this case you are able to change the parameters of each single line in addition to the general parameter changes.



Click in the near of a telluric line to select it



Now you can change the parameters and all these changes are only for the selected line.



“Ok and Next Line”: after the parameter are Ok, you can finish the line and select another one

“End”: if all lines are corrected, you change back to the main correction mode.

λ Offset

If you have different sources of star spectra and they have a small wavelength shift, you can correct this by adding a positive or negative offset.

Attention: This is only a linear shift of the whole spectrum. The original wavelength values are lost!

Calculate the heliocentric correction

This feature is only possible, if you have entered the object area and the location area in the BeSS header area.
SpectroCalc compute the heliocentric correction value of the middle Julian Date of the exposure in km/s.

The calculation includes following influences:

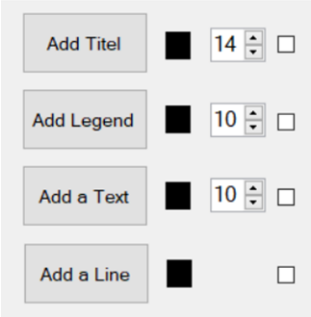
- Orbit of earth at the entered JD
- Rotation of earth depending of the observe location and entered JD
- Influence of moon at the entered JD

Apply the heliocentric correction

Applies the calculated HC value to the loaded spectra.

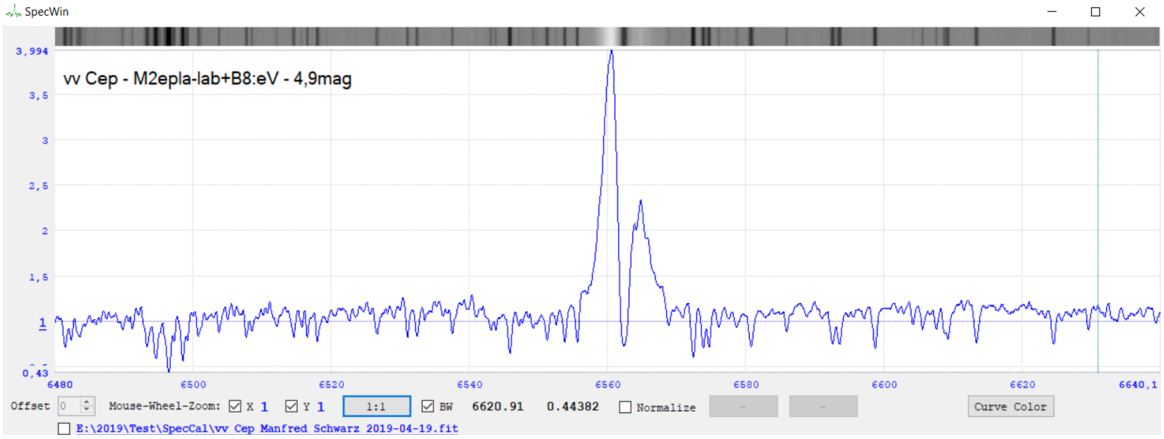
Text and Lines

You can create a documentation for your spectrum.

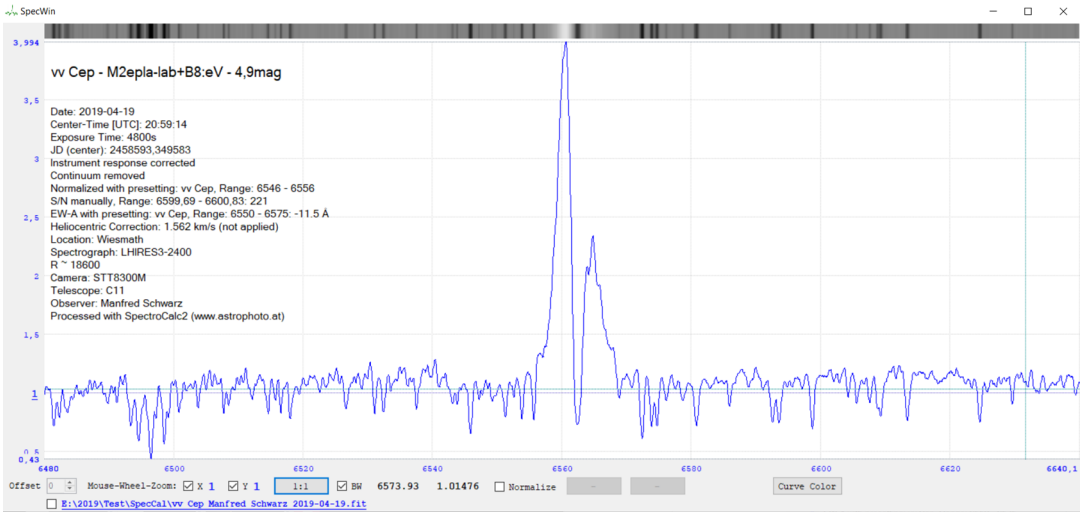


The black coloured boxes are to change the colour of the text/line.
The number is the size of the text.
The check-box is to set the text/line to bold.

Add Titel:
With this button, you create a normal text, but the text is automatically the main data of the object.

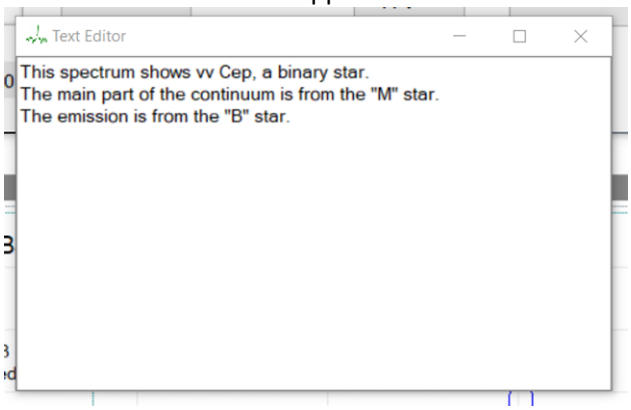


Add Legend:
With this button, you create a normal text, but the text is automatically filled out with the data of interest.



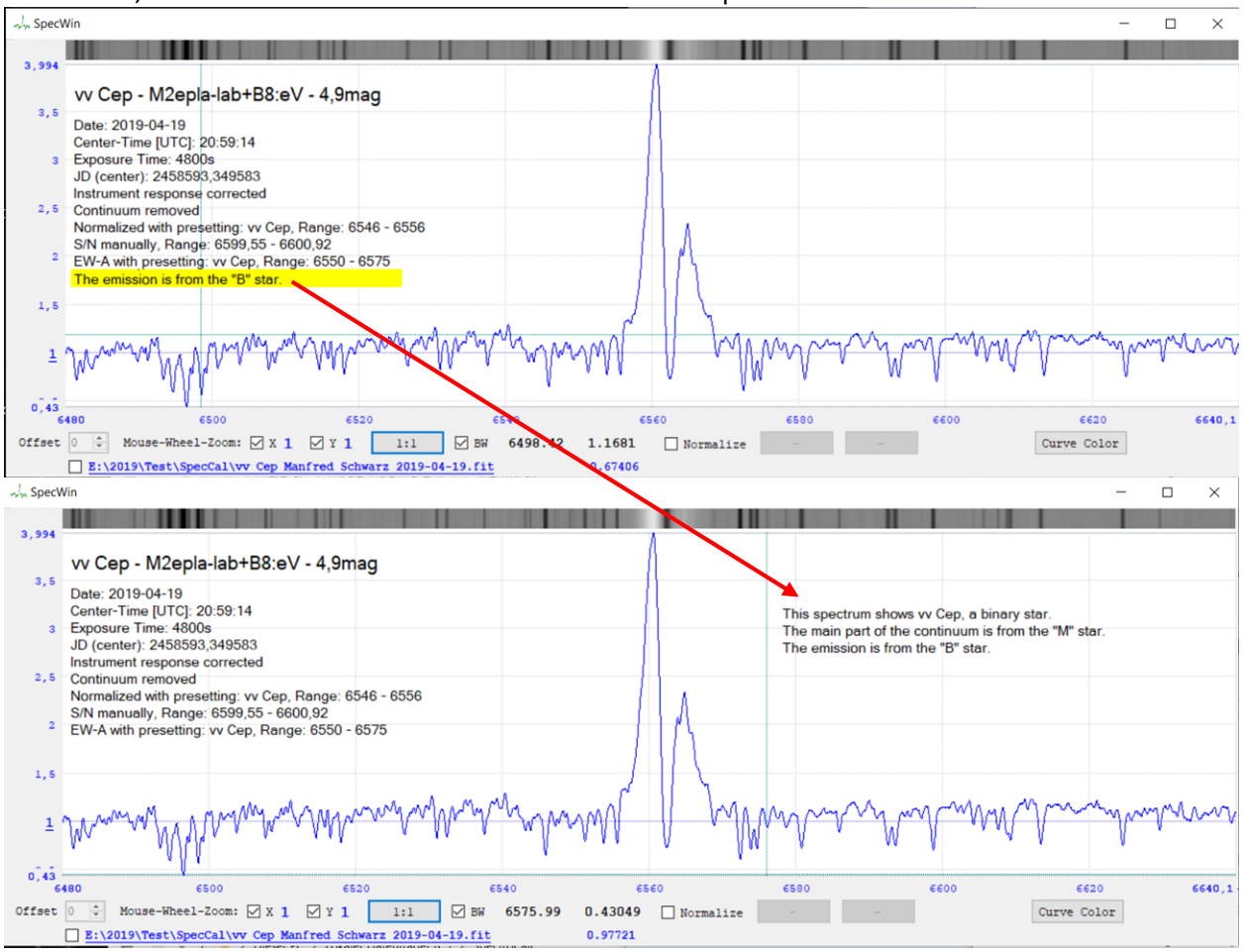
Add Text:

A new text-edit window appears. Enter the desired text and close the window by clicking on “X”.



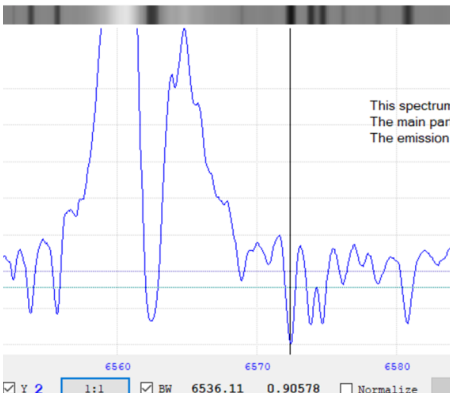
It is possible, that several texts are overlapped.

In this case, click on the text to select it and click on the new position.

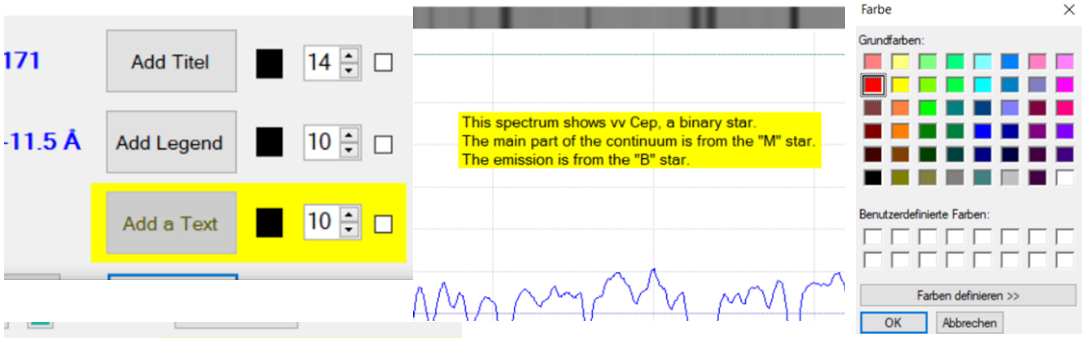


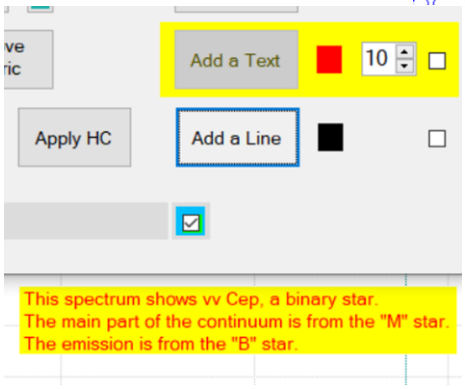
Add a Line:

You can also add a vertical line by clicking in the graphic window.



Change the colour of a text or line:
Select a text or line (yellow highlighted) and press into the colour box to change the colour.





Click again to the text to deselect it.

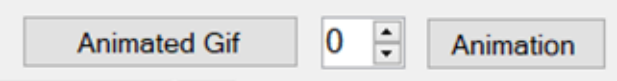
Set a text or line to bold:
Select a text or line (yellow highlighted) and check the bold box.
Click again to the selected text or line to deselect it.

Move a text or line to another position:
Select a text or line (yellow highlighted) and click on the new desired position.
Click again to the selected text or line to deselect it.

Delete a text or a line:
Select the text or the line and press “DEL” or Backspace”.

Edit a text:
Select a text and press “Enter”. The text window opens and you can edit the existing text. Close the text window with “X”.

Animation



If you are working with more than one single spectra, you can animate it.
The number field is the delay between two images in seconds. The value 0 is with 0.5s defined.

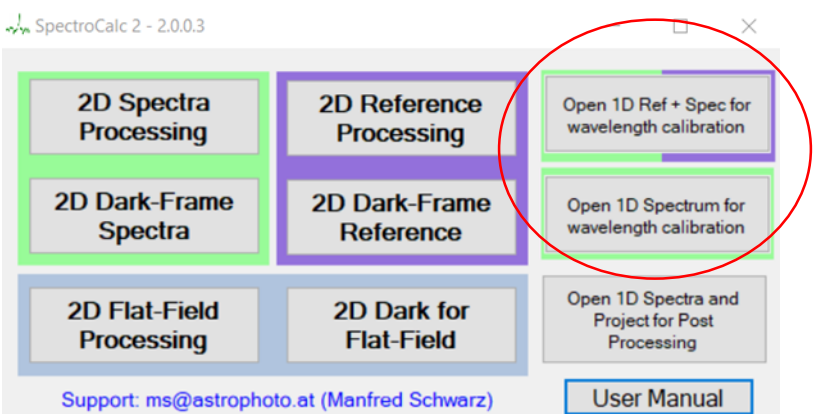
“Animated Gif” creates an animated GIF file.

“Animation” animates the spectra in the graphic window.

Save the spectrum / spectra

Press the “Save” button. You can choose the file name, as example: “20200128_vvCep.fit”
If you have loaded more than one spectrum, the first one is stored under the chosen name. All others get a number behind: “20200128_vvCep_001.fit”, etc.
A project file with the extension “.sc2” is also stored: “20200128_vvCep.sc2”
This file includes the texts, lines, loaded file names and the graphical window size. It will automatically load, if you open the main file (in this example: “20200128_vvCep.fit”) at the next time.
In case of “DAT” is checked, an additional .dat file is saved or if you have more than one spectra loaded, each single file is also stored as a .dat file.

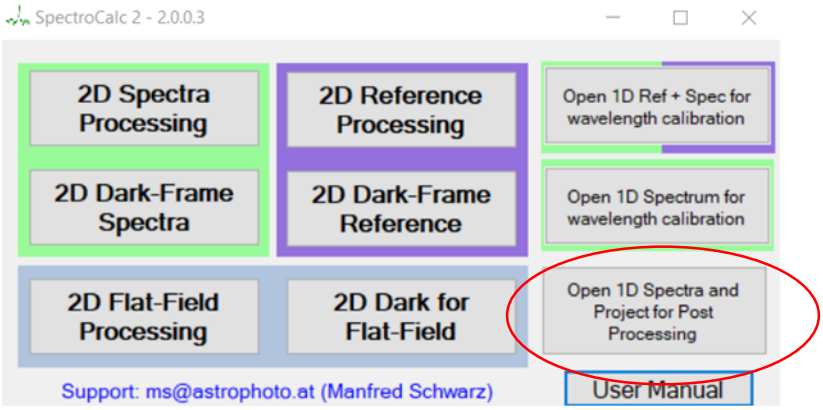
Calibrate already scanned spectra



If you have already scanned spectra and reference files, press “Open 1D Ref + Spec for wavelength calibration”. At first, you should select the reference files, and then select the spectra. You can go further with **Step 2 – Wavelength Calibration.**

If you have already scanned spectra without reference files, press “Open 1D Spectrum for wavelength calibration”. You can go further with **Step 2 – Wavelength Calibration.**

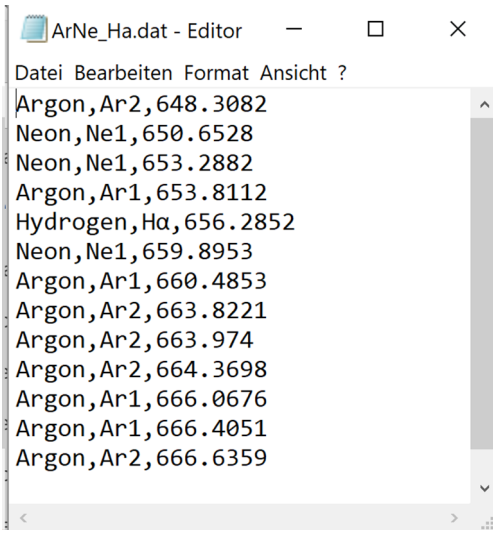
Post processing of already calibrated spectra or open a Project



If you have already wavelength-calibrated spectra, press “Open 1D Spectra and Project for Post Processing”. You can only select one file.
If it is a previous stored project, all files of the project opens automatically and all texts and lines appears.
If it is only a calibrated spectrum and you want to load more spectra, you have to use the “Load Spectra” button (here it is a multi-selection possible).
You can go further with the **Step 3 – Post Processing.**

Define a Wavelength-Reference-File

There are different reference files included, like ArNe_Ha.dat or Telluric_Ha.dat, etc.
Folder: c:\SpectroCalc2
You can define your own reference file. The file extension has to be .dat.



You can see the structure on this example.

First value of a line is the element name.
It follows a “,” as separator.
Second value is the element sign with the ionisation state.
It follows a “,” as separator.
Third value is the wavelength in nanometre (nm)!

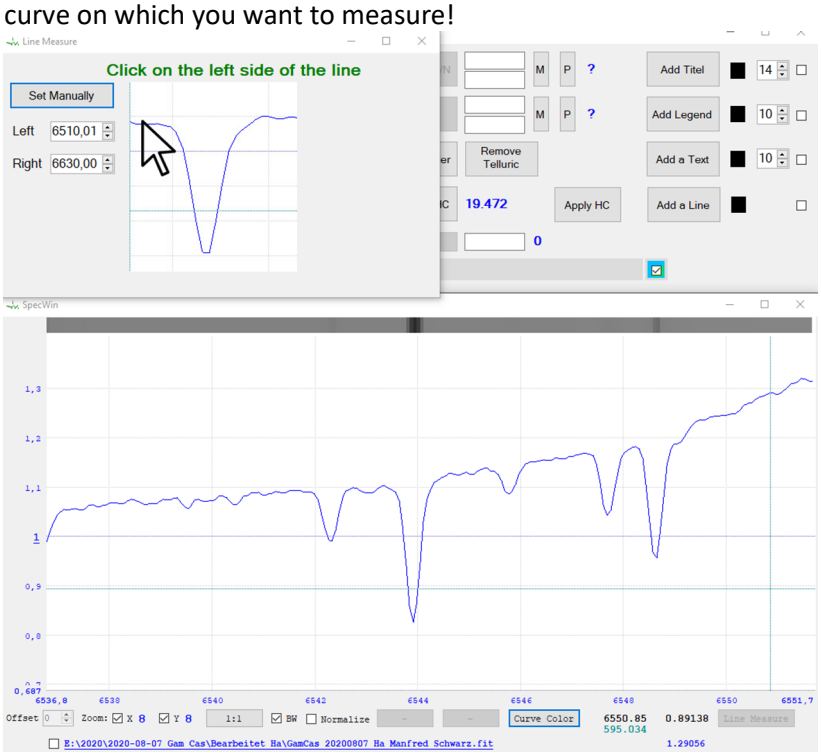
There is also included the file C:\SpectroCalc2\elements.dat. You can use this as base for a new reference file. You should use the desired lines only.

If you define a new reference file, you can add a help-image in JPG format with the same name, but with the extension .jpg.
Example:

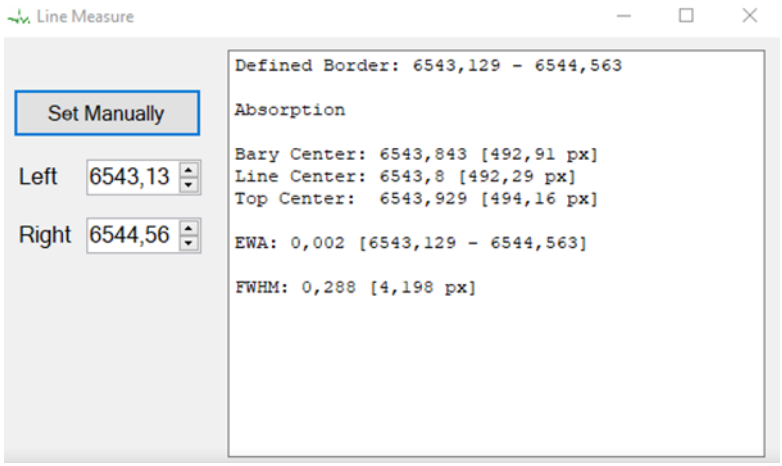
- ArNe_Hb.dat
- ArNe_Hb.jpg

Line Measure in a spectrum graphic window

In each spectrum graphic window it is possible to measure some parameters of absorption or emission lines of the spectrum.
Important: if you have more than one spectra in a graphic window, you have previously to select the curve on which you want to measure!



Click on the left side (not too close to the line) and then click on the right side (not too close to the line) of the desired line.



You get the result into an editable text field. You can select the text and copy it to the clipboard, for example to insert it as text into the project.
In the moment, you will find 3 different values of line-centre findings, equal to the wavelength calibration feature. The EWÅ, the Full-Width at Half-Maximum (FWHM) value is shown and if it is an absorption or an emission line.
The measure tool removes the continuum in the selected area before measuring. For that reason it is possible that the EWÅ value is different to the Post-Processing EW-Å measurement.

If you want to measure another line, click on “line Measure” again.

Alternative to define the area with the mouse-click, you can enter the desired left and right values and press “Set Manually”.

Conclusion

It is a matter of my personal concern, to bring more amateurs in the direction of science.
One important part is the education of the basics of physics and spectroscopy, which is done for example from my friends Ernst Pollmann, Michael Winkhaus and Bernd Koch more times in the year in Wuppertal/Germany. Another part are workshops or amateur conferences like the OHP in France each year in the summer time or the VEGA conferences each second year in Austria.
With SpectroCalc, I hope to add another part, to give you an easy to handle tool to get the best and accurate results of your exposed spectra.

For all bugs and your proposals, please contact me: ms@astrophoto.at

Software Installation and Updates

Environment: look at **Hardware and software requirements**

SpectroCalc2 is available at https://www.astrophoto.at

The software is looking on each start, if an update is available. If it is, you get a message, if you want to install it (internet access is necessary for this feature).

Software Version Release Notes

V2.0.3.3 - 2022-02-24

- Bug-fix: in case of deleting the last used reference file, there is no crash after loading a spectrum into the wavelength calibration area
- possibility to store an additional .DAT file in the area “Wavelength Calibration” and “Post Processing”

V2.0.3.2 - 2021-04-17

- Bug-fix: shut-down by full screen of graphic

V2.0.3.0 - 2021-02-11

- New post-processing feature: Animation of single spectra
- Bug-fixes

V2.0.2.1 - 2020-12-14

- Calibration wavelength list shows now additional the elements
- Bug-fix: download of reference files was corrupted since one of the previous versions

V2.0.2.0 - 2020-12-13

- Sky-Background correction is now possible in “pixel by pixel” mode to remove emissions of light pollution

V2.0.1.18 - 2020-12-12

- Improvement of automatic find of spectrum stripe algorithm

- Bug-fix: Add a line without reference lamp images is now looking at the “Emission” checkbox. Before it looked always at absorption lines
- Bug-fix: on open an un-calibrated 1D image from a previous project

V2.0.1.17 - 2020-10-23

- Add of the “Line Measure” feature

V2.0.1.15 - 2020-10-04

- Add of the “Remove Telluric” feature

V2.0.1.14 - 2020-06-24

- bug-fix: heliocentric correction apply was in the opposite direction

V2.0.1.13 - 2020-05-11

- λ Offset in post processing

V2.0.1.12 - 2020-05-10

- Zoom factor of spectrum graph increased from 32 to 64
- bug-fixes

V2.0.1.11 - 2020-04-08

- Scanning with super-resolution (blow up each pixel 5 times) to avoid artefacts on tilted spectra-stripes
- bug-fixes

V2.0.1.8 - 2020-03-29

- Add Elodie library. And new organization of the libraries.
- bug-fixes

V2.0.1.4 - 2020-03-22

- improve continuum fit for instrument response and continuum remove functions
- bug-fixes

V2.0.1.3 - 2020-03-08

- add help-images for reference lines

V2.0.1.1 - 2020-03-02

- max. calibration polynomial now number of values – 2 (instead of – 4)
- right mouse click = zoom, double click right = 1:1
- bug-fixes

V2.0.1.0 - 2020-02-16

- First Beta-Test Version