

Reference Manual
For Windows®

Spectrography data processing software

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CHAPTER 1

Introduction

Welcome to Visual Specs, a user-friendly software for analysis of astro-CCD spectral images in a Microsoft Windows environment.

The Visual Specs software gives you a powerful and extensive toolbox for processing spectral data.

Visual Spec is not an image processing software neither an acquisition software. It assumes that the input data is a 2D image of a spectrum, with all the pre-processings complete (Bias, dark, flat, registration and stacking). To perform these processings the user will need to use an image processing like the freeware IRIS, from Christian Buil.

Using Visual Specs you can fully exploit your spectral images.

- Creating spectral profile files from 2D astronomical images with either automatic or manual extraction of the spectral profile – Format supported are the native format of Iris software and fits for black and white images
- Wavelength calibration
- Specific processing: extraction of continuum, correction of instrumental response, filtering, composition
- Analysis and quantification: calculation of full width at half-maximum, signal-to-noise ratio, calculation of equivalent line width
- Comparison of profiles: superposition, recalculation in wavelength, animation, exporting to *.bmp or text-compatible tables
- Identification of chemical elements by referring to a database of wavelengths per atomic elements
- Access to a library of standard spectra from different spectral types
- If you have Excel, search for the spectral type of a star in the Bright Star Catalog
- Export into fits format for professional database BeSS
- Productivity tools like assistants and scripts
- Window style User interface for external freeware: graphics (gnuplot), spectral modelling (spectrum), internet link to CDS professional database

This first chapter shows how to install Visual Specs on your computer, introduces other sections of the document, and describes some fundamental processing of spectral analysis.

Installation

Visual Spec uses the standard Windows installation method.

Before installation

Before installing Visual Specs, ensure that your computer meets the minimum configuration required.

Verifying hardware and system compatibility

To run Visual Specs you should have a certain hardware and system configuration installed on your computer. The system configuration includes:

- Windows 2000, XP, Vista (for W98 see website)
- Optional: Microsoft Excel for exporting data in Excel format and for access to the Bright Star Catalog
- Internet connection for direct access to professional database like the BeSS Be Star and Simbad atlas.
- Does not support multibyte language like Korean, Japanese, chinese – only western window regional settings

Installing Visual Spec

To install Visual Spec, launch “Setup.exe”. Follow the instructions given during installation.

In addition to the executable, Vspec will install:

Element.txt

Database of atomic lines for which the atomic number is lower than that of Iron

Sun.txt

Database of Sun lines

Pic.xls

Excel document for exporting image areas

Brscat2.xls

Bright Star Catalog in Excel format

Help.pdf

Help document in *.pdf format, readable using the free Acrobat reader software

(www.adobe.com/acrobat)

Libspec directory

Contains standard spectra of different spectral types, from Pickles et.al.

H20.dat

ASCII File Intensity-wavelength of the earth atmosphere to eliminate atmospheric lines in spectral profile

Gnuplot package

GnuPlot application files for graphics generation. This application is an open source application.
Copyright 1986 - 1993, 1998, 2004 Thomas Williams, Colin Kelley.

Spectrum package

Sub directory Spectrum: Spectrum application from R.O. Gray to generate theoretical spectra based on stellar atmosphere model. Those models are in a sub-directory “models”

BeSS_VO

Empty directory for cache. It will contain the files which results from the query to the BeSS database on internet.

How this manual is organized

The chapters of this manual can be grouped as:

- Chapter 1: Introduction and installation
- Chapters 2-4: Basic concepts of Visual Spec
- Chapter 5: Spectral series – how to create, save-to-file, and modify spectra
- Chapters 6-9: Process and analyze the data

Examples of applications

On the Vspec site you can find a package with some examples.

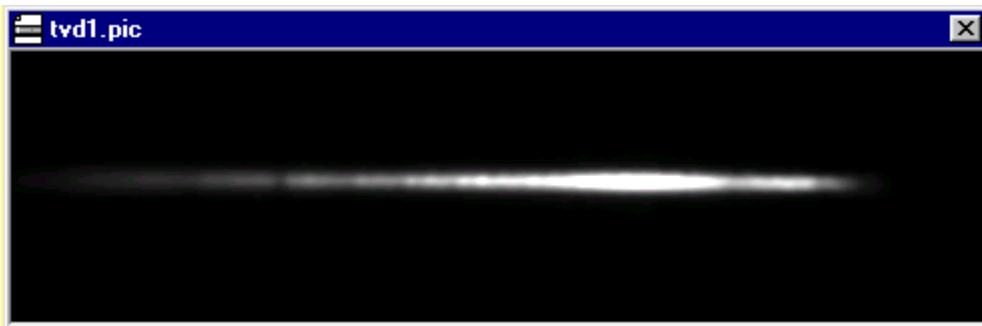
- Spectral images obtained of T60 from the Pic du Midi Observatory (France) with the “Bardin” spectrograph
- Spectral images obtained by C.Buil and Morata's family
- Spectral images sent by Jack Martin (UK) et Dale Mais (USA)

Spectral Image Concepts

Spectral imager processing consists in reducing then analyzing the spectrum of an object. The input data of Visual spec is a 2D image which contains preferably only one spectrum. This software and manual will not describe how to acquire spectra and the image processings required to get the final 2D spectrum images. The purpose of Visual Spec is to process the spectral profile, reduced the data and analyze them.

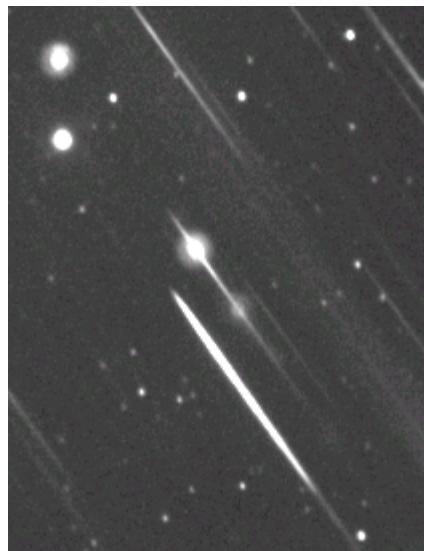
The spectral profile is a graph representing the intensity of the spectrum by pixel. Starting from the spectral profile, one carries out the analysis. The first operation consists of calibrating the profile in wavelength. One can then carry out various operations of identification or correction.

Spectral Image

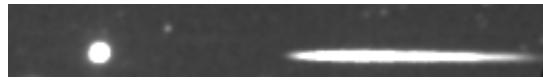


A spectral image of an object usually contains:

- The spectrum of the object
- The background
- Some surrounding stars in the case of a assembly “without slit”.



The spectrum of an object should be extended along the horizontal axis. It is strongly recommended to align the spectral lines with columns of the CCD matrix before acquisition. Otherwise, one can rearrange the image by rotating, using an appropriate image-processing software.



The spectrum of an object is generally distributed among several image lines. This vertical dispersion is eliminated with the conversion into a spectral profile.

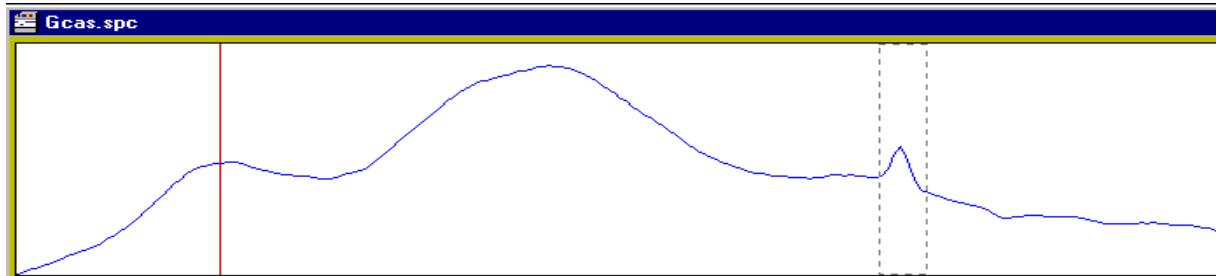
The background of an image contains spectra of the background of the object, most often the background of sky. If lines are present, one can obtain their spectral profile and subtract it from the

spectral profile of the object, or does the operation using a n image processing software which includes spectral 2D processings, like Iris.

Visual Spec assumes that the blue region of the spectrum is on the left and the red part on the right.

The spectral profil

The spectral profile is the distribution of luminous intensity as a function of “color”, or wavelength. It is presented in the form of a series of data points (intensity per pixel) and can be represented as a curve, each pixel being thereby associated with a wavelength by calibration.



The transformation of a spectral image into a spectral profile is accomplished by “binning”, or summing line-by-line the spectral image of the object. This operation increases the signal-to-noise ratio and condenses the spectral image into an intensity curve called a series, which can then be saved in a document called a **profile** document.

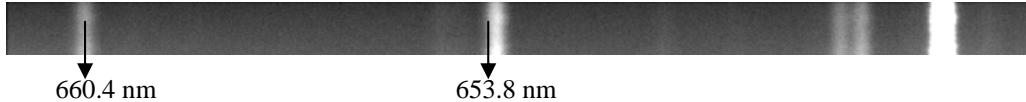
A profile document includes several spectral series intensity curves so-called **series** which can be saved in one profile document under the “.spc” proprietary format.

Distribution of intensity by pixel is decomposition of the luminous intensity by wavelength. One can then associate each intensity value, calibrated by pixel, with a wavelength and establish a law of dispersion. Vsual spec will handle non-linear calibration law and will convert it into a linear one on the observed spectral region A pixel represents the same quantity of wavelength no matter what its position. To establish the “Pixel-Wavelength” relationship, at least two points of reference must be defined, or one point and the dispersion if it is already known.

tdztau-1.pic



adztau-2.pic



The association of a pixel to a wavelength is accomplished with the help of these lines of reference. To do this, one identifies two points in the spectrum corresponding to lines of known wavelength, then by applying interpolation one can continue with the calibration itself.

The calibration is done using a spectrum called the reference; this spectrum can be one of a known set (calibration lamps) or could be spectrum of the object if its lines are easily identifiable although this latter method is less precise.

Spectral Analysis

Spectral analysis of an object includes several categories of operations

- Identification of the lines
- Modification of the spectral response, scaling, correction of the continuum, Planck's Law, atmosphere lines correction, atmospheric extinction, heliocentric speed correction
- Measurements: center of the line, equivalent width, full width at half-maximum

Identification of the lines is done based on their wavelengths. Each chemical element produces a unique set of lines (its spectrum) of wavelengths, of which each line is the result of an atomic transition between two energy levels characteristic of the atom under consideration. One who is interested can consult the literature for an explanation of the physics of this phenomenon.

The resolution of a spectrum is defined as the smallest domain of wavelength associated with a pixel. An insufficient resolution impedes determination of the chemical elements having lines in this area. To help identify lines, Visual Spec includes a database of spectral lines between 3000 and 11000 angstroms.

The intensity of a spectrum is affected by:

- The spectral response of the CCD
- Its own continuum, distribution of energy into wavelength as a function of temperature (Planck's Law)
- Atmospheric extinction

One can correct for the spectral response of a CCD by using the spectrum of one of the library of standard spectral type spectra included with Visual Specs. Comparing experimental intensity with standard normalized intensity of same spectral type provides the curve of the spectral sensitivity of the equipment used. This response curve can then be used for correcting spectra obtained under the same conditions of observation.

To determine the spectral type of a star, the Bright Star Catalog database is available if one has previously installed Excel. Or the user can connect to the CDS internet database to get the star spectral type.

One can also simply carry out the elimination of the continuum by approximating the continuum of the profile by a continuous law. This operation yields a "flat" spectrum despite the response of the CCD, but also eliminates the physical continuum of the object which is a function of the temperature of the object (Planck's Law).

To obtain the "Planck profile" of an object the instrumental response as to be carried out and the continuum shall not be removed.

Additional processing can be carried out like: atmospheric extinction correction, earth Doppler shift correction (heliocentric correction), atmosphere lines elimination

Finally, it is always possible to normalize or "scale" a spectrum with respect to a spectral area that contains no lines. Normalization removes variations in intensity due to different exposure times by calculating only the relative intensity compared to the same spectral domain. This simple operation is often sufficient for profiles having little variation of continuum during extended spectral recording.

The following measurements can be made on spectral lines:

- Center of the line
- Full width at half-maximum
- Equivalent width

The center of the line is determined with precision by calculating the barycenter. It is important to be careful with the selection of the line to avoid introducing error into the measurement.

The Full Width at Half Maximum (FWMH) of a line can be used to determine the speed of expansion or rotation of the body under observation. It can also be used as an indication of the resolution of the instrument, if it is taken on a reference line of a body under known physical conditions (calibrated lamp).

The equivalent width of a spectral line is a spectroscopic measurement that can characterize the “power” of the line. This measurement allows one to precisely follow the development of a line over the course of time for the same object as it presents variations.

Must-do spectral processings

The spectral processing can be splitted into 2 sets:

- Processings which are instrumental or observational dependant: they cannot be carried out without additional data linked to the night of observation or linked to the instrument. Those processings are the mandatory set of processings which has to be applied before sharing data with community, like uploading the spectrum into the professional database Bess.
- Processing or data reduction which can be independently conducted by a user which has not acquire the spectra.

Intrumental dependant processings

- Wavelength calibration
- Instrumental response curve correction

In addition to those minimum processing, for sharing data the user shall record the time of observation, the celestial coordinates or the name of the object. Additional informations for scientific usage may be also required as described in the BeSS format conversion section.

CHAPTER 2

Your first spectral profile

It will take you several minutes to obtain your first spectral profile from a pre-processed digital image. You open a *.pic or *.fit file, the image will be displayed, you can adjust the thresholds of visualization and obtain information about the intensity of the pixels. Then, you extract and visualize the spectral profile, which you can save as a “Profil” document. You continue by preparing wavelength calibration based on a reference image, and you finish by filling in the document header.

This chapter provides an overview of these operations, describes the necessary documents and knowledge you will need to use Visual Specs

Examples

You can download the set of examples from the web site..

An example from a spectrum obtained as Spectrum of T60, Picture of the Day of the star Dzeta Tau, is included with the application. You can find it in the application folders. It consists of:

Dztau-1.pic – spectral image

ADztau-2.pic – reference spectral image, Argon lamp

Dztau-1.spc – spectral profile calibrated in wavelength

Launching Visual Specs

To execute Visual Specs, double-click on the Visual Specs icon

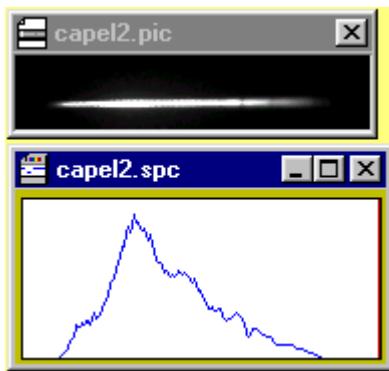
Visual Specs files

The Visual Spec application manages two types of documents through Windows windows:

Images: read-only files in *.pic or *.fits format, black and white 2D image.

Profiles: files in *.spc format, created only from image files by the Visual Specs application; an ASCII file containing one or more spectral intensity curves called series – or a fits 1D file format (one spectrum, linear dispersion).

VSpec can also read simple “ascii” files as “.dat” format. The file shall contain two columns. First one shall be the wavelength column, with values equally spaced (linear). The second column will contain the intensity values.



Manipulation of Visual Spec document windows follows usual Microsoft Windows standards. One will find the traditional classical window menus for documents in an application.

Image Documents

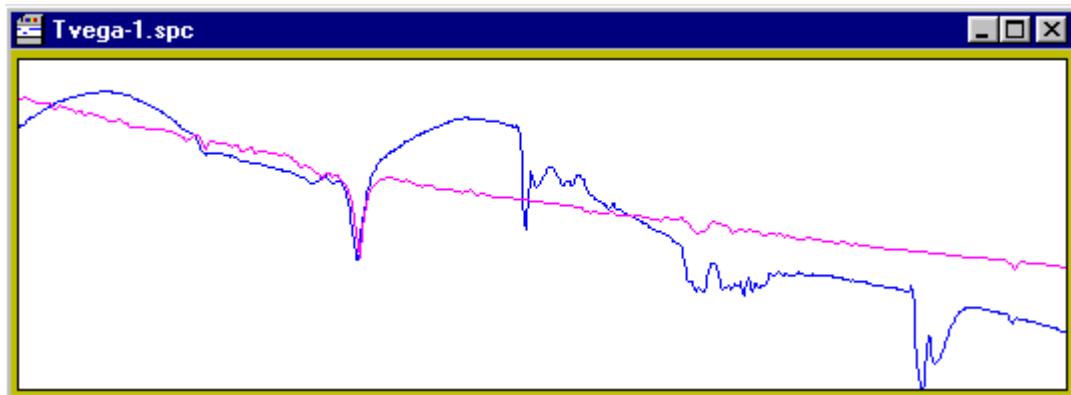
The image document allows one to view the image file. The intensities of the pixels of a CCD image are displayed using 256-level grayscale, with thresholds that can be set by the user.

The image document has a fixed size corresponding to the size of the binary image.

Profil Document

The profile document allows one to view the profile file, which contains the spectrum. Spectra are represented in the form of a graphical curve, called a series, of which the Y values are the intensity of the spectrum as a function of X, X being either the pixel number or the wavelength once the spectrum has been calibrated in wavelength.

A Profile document can contain, in addition to the spectra of an object, some associated series such as the result of a division, an instrumental response, a reference spectrum, all associated with the same calibration in wavelength.



The document profil has an adjustable size.



Note:

It is recommended to associate a document with an object spectrum, even though the document may contain associated series serving as references or intermediate results of processing.

Informations windows

A certain number of windows are created during execution of the application but are not considered to be documents; unless otherwise indicated these windows cannot be saved.

Graphic window for quickly showing a cut from the intensity of a line image

Information windows containing results of different calculations done on profiles - the contents of these windows can be saved in the format of a text file “infos.txt”.

Image window of a synthesized spectrum

Console window for entering command-line commands

Other documents generated by the application

Three other sub-types of documents may be generated but are not directly generated by the application:

Excel file, containing the values of the pixels of a sub-image

Bitmap file *.bmp: graphical copy of a profile file

Text file *.txt: exported values from a profile file, following formatting rules for an Excel table so the file can be read using this application

Activation of a document

To make a document active, click one time within the document, preferably in the bar at the top of the window.

Selection of a profil region

To select a region of a profile, the region can be a spectral line or a section of the continuum:

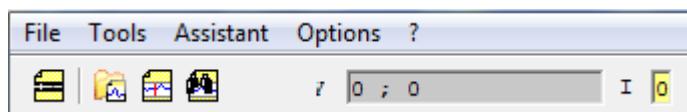
- Activate the document where the profile is
- Activate the serie which contains the profile where the selection has to be done (by clicking on the profile curve or selecting the serie name in the drop-down list of the toolbar – see the serie section)
- Click with mouse left button at the beginning of the desire selection
- Move the mouse while maintaining the button pressed
- End the selection at the desired location by releasing the mouse button

Interface elements

The Visual Specs interface is in the Microsoft Windows style, with menus, document windows, and toolbars.

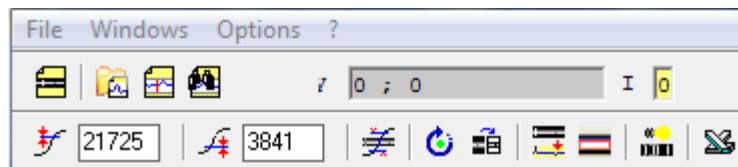
Four toolbars give access to functions depending on the type of document or the operations chosen by the operator.

Main toolbar: always present

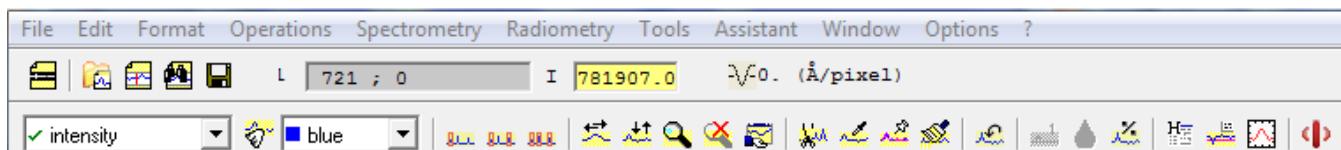


The text area contains information relating to the position of the cursor, depending on the type of document displayed

Image toolbar: appears only when an Image document is on the screen



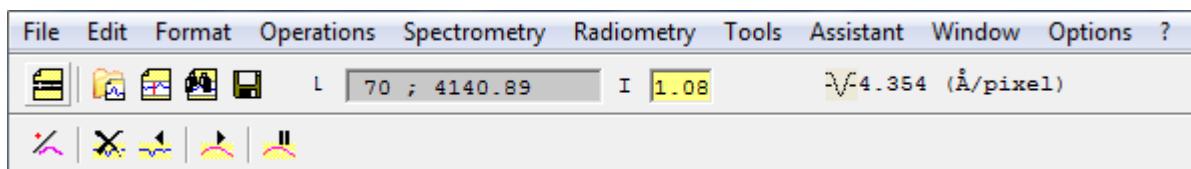
Profile toolbar: appears only when a Profile image is on the screen



- Calibration toolbar: appears only when the operator wants to perform a calibration in wavelength of a profile.



- Continuum toolbar: appears only when the operator wants to perform an approximation of the continuum



Preferences

Visual Specs permits the user to save a certain number of configuration parameters for Visual Specs.

The configuration parameters for Visual Specs are:

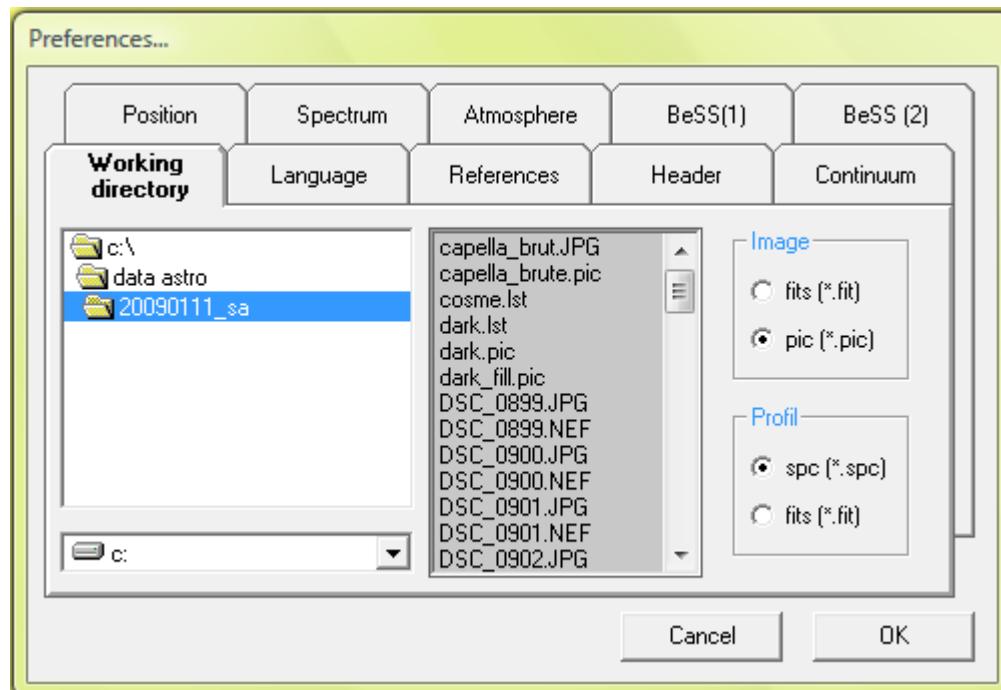
- Default folder for image and profile files

- Reference wavelength of spectral lines for calibrating in wavelength
- Spectral area for continuum calculation
- Default comments
- Geographic position
- Language selection: French or English
- Path to get acces to external software SPECTRUM
- Atmospheric line file setting
- Export to fits format for BeSS database pre-filled keywords

These configuration parameters are used by Visual Specs while it executes. They are saved in the Registry.

To access them, click on the Options menu and choose Preferences.

Preferences dialog box



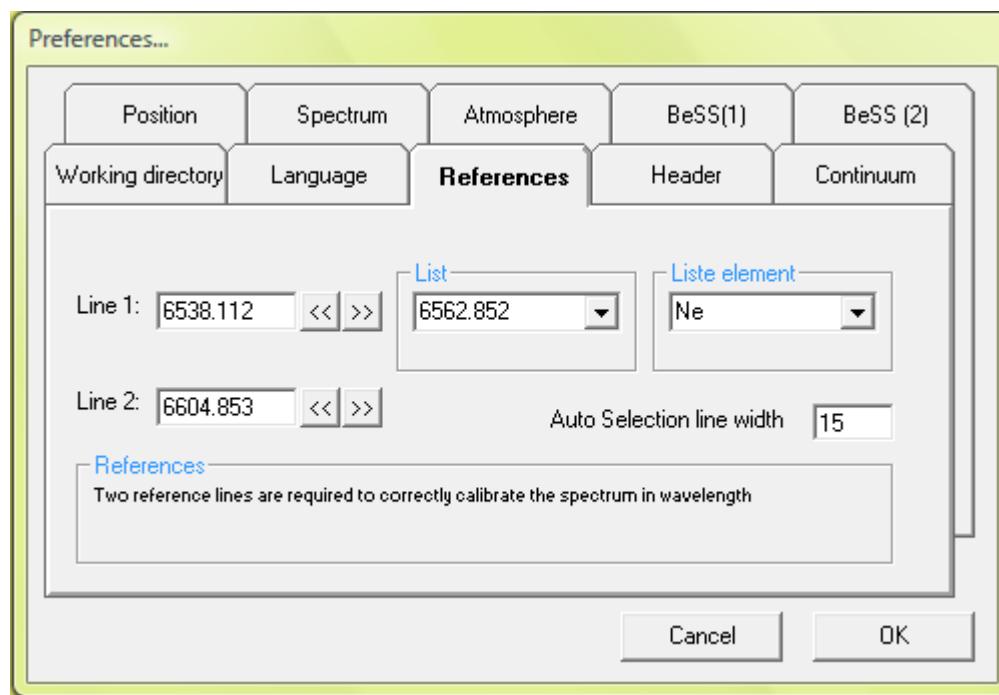
Default working directory

Select the folder to be the default folder for the “open image” and “open profiles” commands.

Select the default type of the Image file. You have the choice between the standard "fits" format and the proprietary format "pic" of the software Iris/Pisco of C.Buil.

Select the default type of the profile file. You have the choice between the standard "fits" format and the proprietary format "spc" of Visual Spec.

Wavelength of spectral reference lines



Wavelengths are in angstroms. Two reference wavelengths are needed to correctly calibrate the spectral profile using a linear law.

The wavelength “Line 1” will be used to correspond the barycenter of the line selected within the frame during the Calibrate mode of the Spectrometry menu when one clicks on the “Raie1” (“Line1”) button.

The wavelength “Line 2” will be used to correspond the barycenter of the line selected within the frame during the Calibrate mode of the Spectrometry menu when one clicks on the “Raie2” (“Line2”) button.

The “List” listbox contains a list of the common reference lines.

- Select from the listbox the reference wavelength to be a reference for the calibration
- Click on the button “<<” next to the corresponding textbox to automatically fill in the value

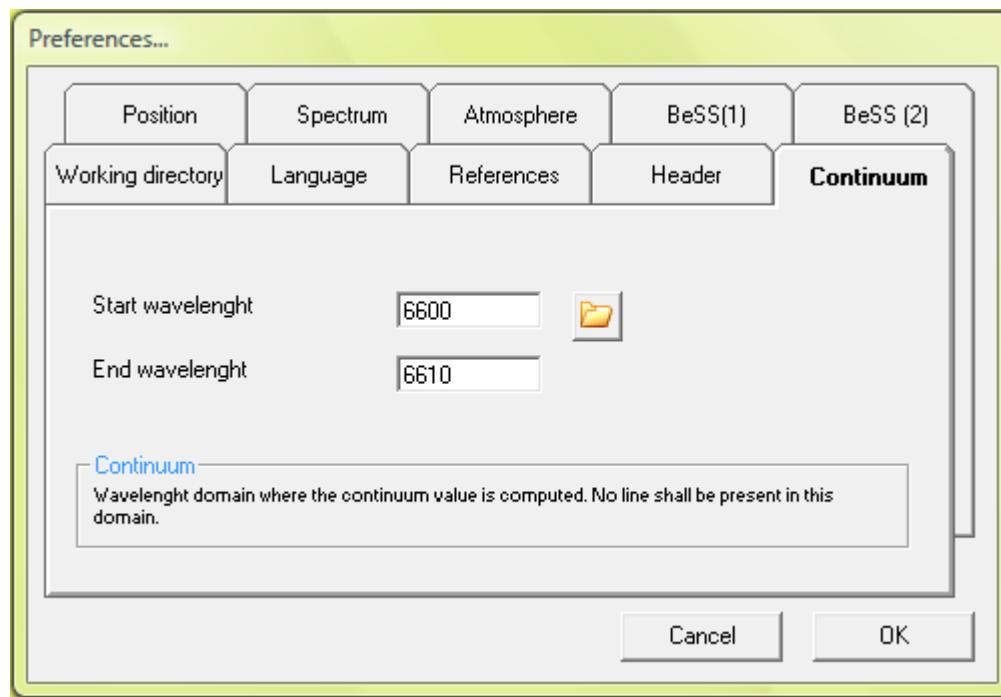
To add an entry to the listbox, click on the button “>>” and the value in the corresponding textbox will be added to the list.



Note: These additions to the list are not saved. When the program is launched, only the values listed in the appendix will be present.

The Auto Selection line width is a line width parameter in pixels which shall correspond to the average width of the spectrum lines in pixel. It is used in automatic algorithms to ease the detection of a spectral line in specific function.

Spectral area of calculation of continuum



Wavelengths are in angstroms. Two wavelengths delimit the area over which the average will be taken for calculating the relative intensity.

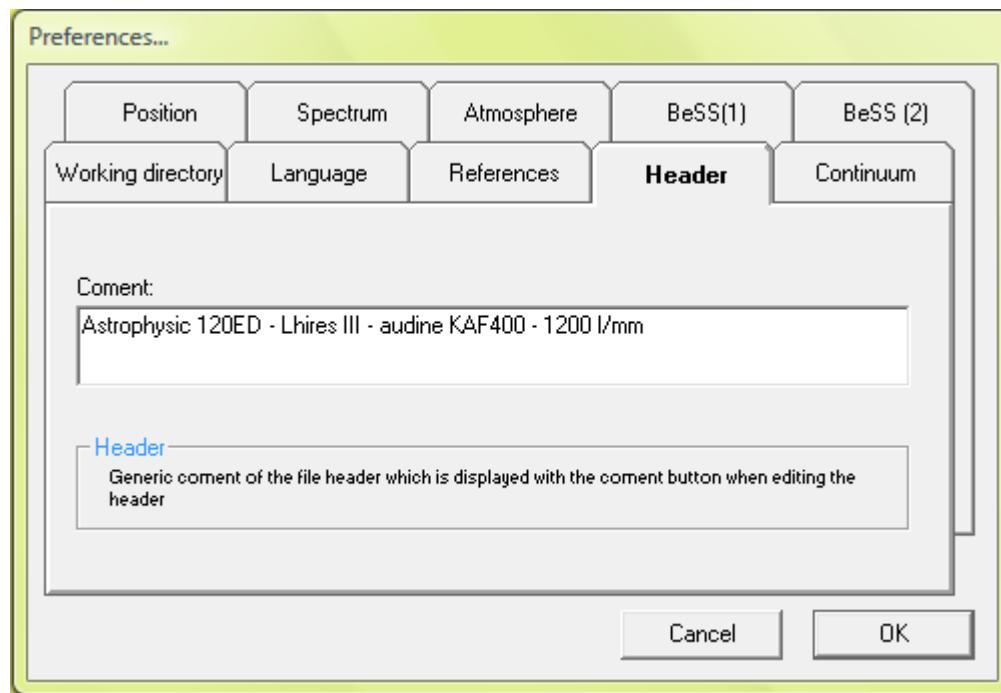
During the normalization operation, the set of spectra will be divided by this average.

This area should not contain spectral lines since it must represent the spectral continuum

The directory icon button open the working directory to read a text file which can includes the 2 wavelength separated by a coma as below:

6600, 6610

Default Comments



The entered text is displayed in the comment area while editing the header of a "Profile" file, when one clicks on the button "Preset" in the header dialog box.

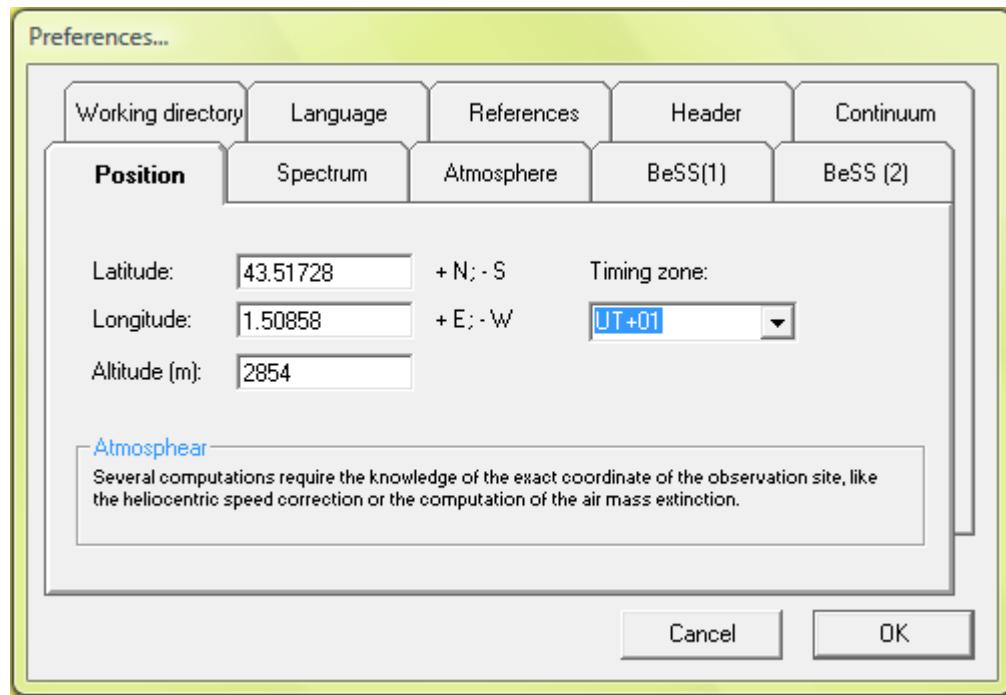
Geographic position

In some occasion, where very accurate computation is needed, it is required to know observation site coordinates.

The coordinates shall be entered under the decimal format: dd.mmss

In this version the altitude is not used.

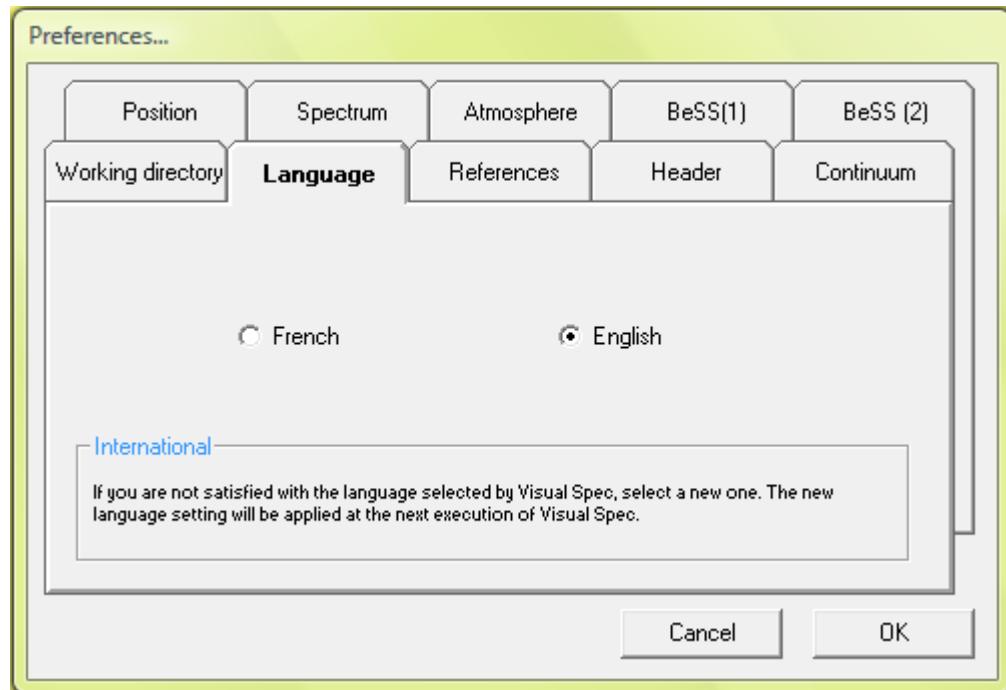
The UT value in the timing zone drop down list is used in the computation of the time of a sequence if the exposures have been acquired with a PC not set at UT time.



Language

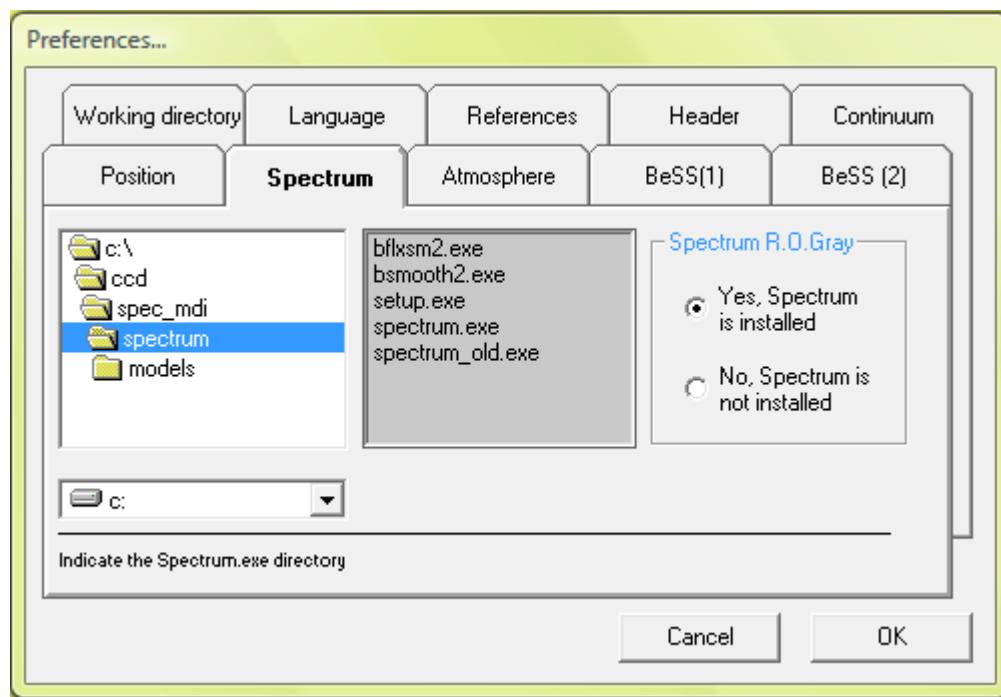
If you do not like the default language, you can change it in the tab "Intl" by clicking in the language of your choice.

This preference will not be applied until you quit and re-launch the application.



Link with SPECTRUM

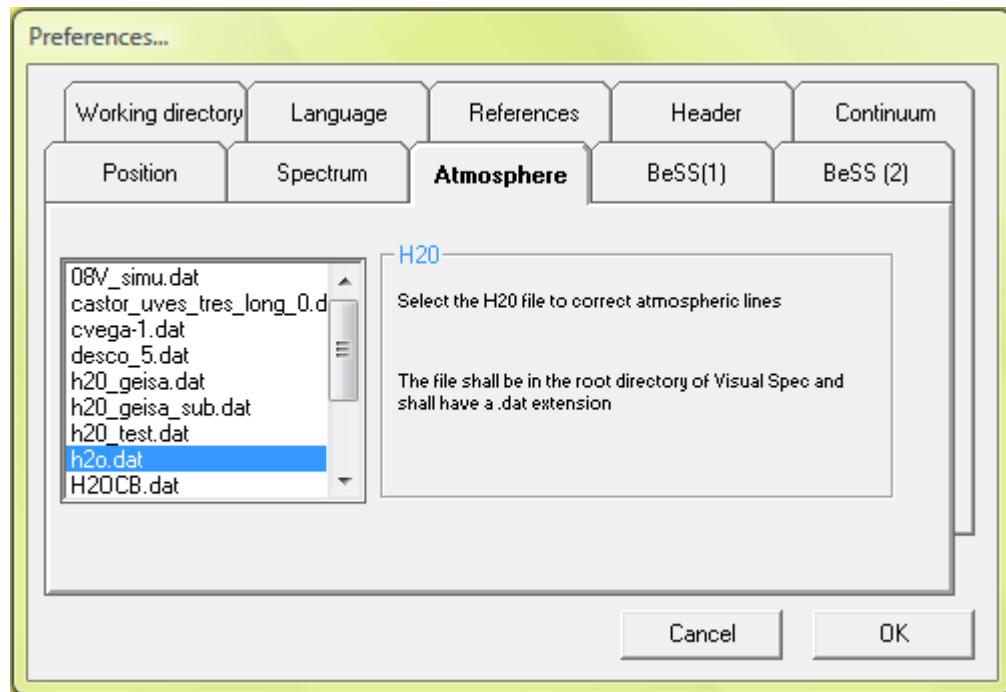
Spectrum software is a free software written by Richard Gray. It generates synthetic spectrum from diverse physical parameters and stellar atmosphere model. To have Visual Spec automatically send parameters to SPECTRUM and get displayed spectrum results, you need to configure the directory path.



Atmosphere

To remove the atmospheric lines from an object spectrum, a file containing the wavelength and the intensity of the atmospheric lines shall be used. This file shall be present in the root directory of the Visual Spec application.

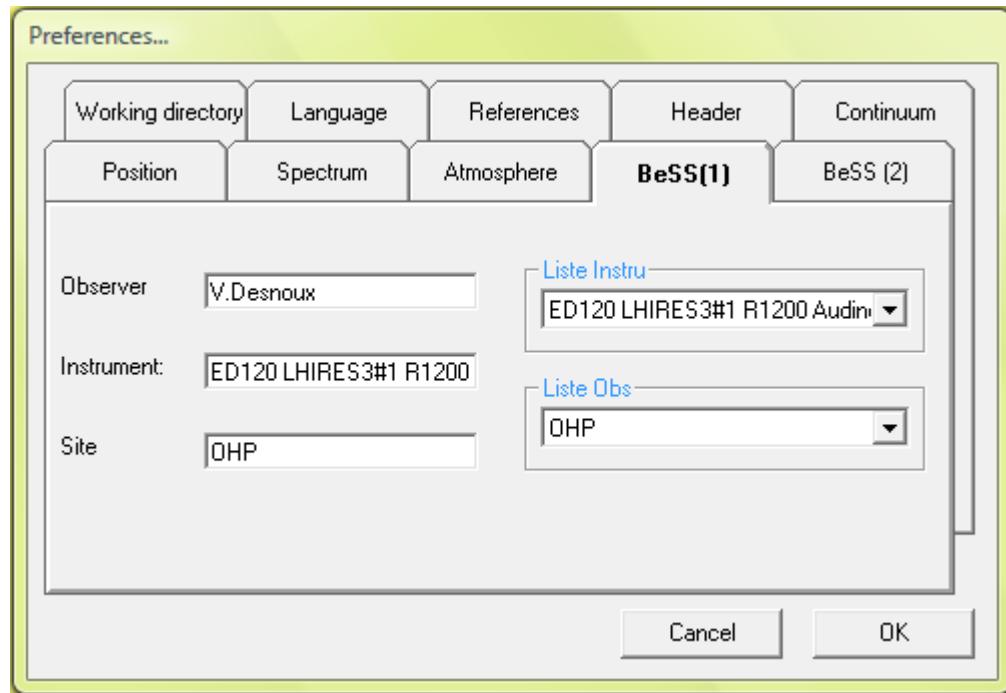
If you have different atmospheric file, this tab allows you to select the one you want to use by default.



All the file having a .dat extension in the root directory of the application are listed here. Select the appropriate one. Visual Spec proposes a default file created by Christian Buil from various source of data.

BeSS(1)

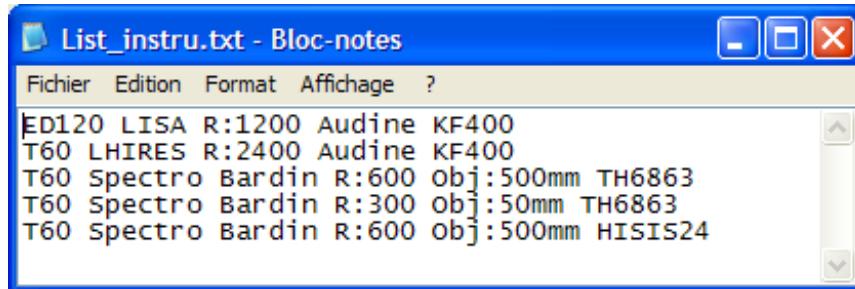
This tab allows you to pre-filled key words used to fill the Fits header and BeSS additional key words.



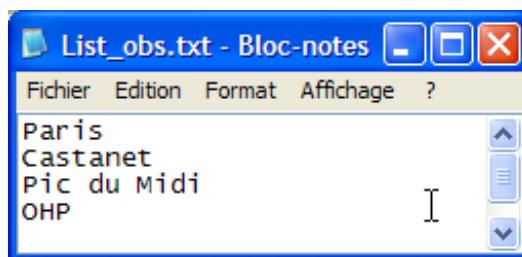
- **Observer:** (Fit keyword) Name of the observer(s) – limited to 68 characters. Names shall be delimited by coma if multiples. They shall correspond to the BeSS alias of the observer profile when registered to BeSS.
- **Instrument:** (BeSS fits keyword) Title of the instrumental configuration. It will allow the database to classify your spectrum. The instrumental profile shall refer to an existing profile in BeSS or at upload you will have to fill a new instrumental profil.
- **Site:** (BeSS fits keyword) Observation site. Same as above for its declaration in BeSS.

BeSS database do check the exact name of those keywords. So if one character or word is not exactly the same which is recognized by the database, a new profile will be prompted to you for filling. As it can be painful to keep track of the exact syntax of your configurations, Vspec offers you to use two text files to keep track of them. Two files are used:

- **List_instru.txt:** Each line shall be instrumental configuration title. See the example below



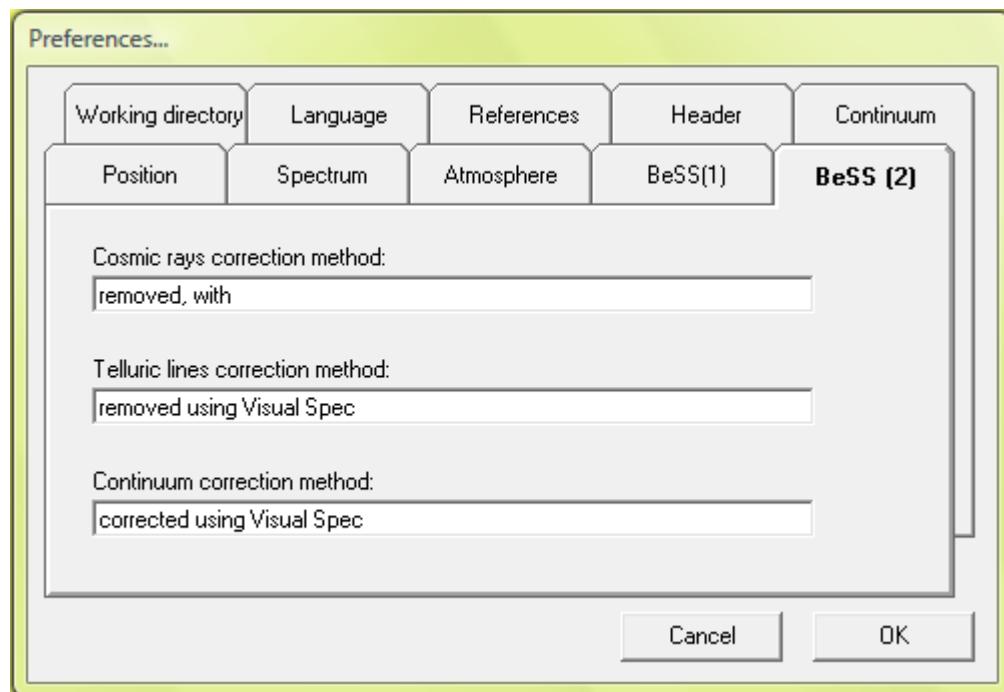
- **List_site.txt:** Each line shall be the name of your observation sites. See the example below
-



Lines of those file are displayed in the drop-down list. List Instru and List Obs. If the files do not exist or are empty, the drop-down list are empty. You will have to keep those files in the root directory of Vspec.

BeSS(2)

This additional tab is for BeSS keywords which described the method used for standard corrections in the fits header.



Each text field shall not include more than 40 characters and shall not include special characters to be compatible with the fits standard.

VisualSpec Help

The on-line VisualSpec help file is in a *.pdf format, which necessitates installation of the Acrobat Reader.

Acrobat Reader is available free and can be obtained via the Internet from www.adobe.com/acrobat.

To access the help file, refer to the Acrobat Reader documentation.

The help file Aide.pdf is also contained in the document Vspcman.doc available in the form of a Microsoft Word97 file.

To access help on-line:

- Click on the menu ?, and choose Help



Note: Verify that the file type .pdf is associated with the Acrobat Reader application to automatically read the file using this application.

Anotated profiles

A spectrum profile annotated is a profile where the lines are identified with their respective wavelength.

To access the diagrams

Click in the menu "?", subitem Diagrams

The following annotated spectra are available – see in appendix the copy of these diagrams

- Telluric lines 6470-6590

- Telluric lines 6500-6600
- Neon 3000-7000
- Vega 3800-8000

Steps for creating a profile

Display an image

Displaying an image is done by choosing Open Image from the File menu, then using the standard “open...” dialog.

The size of the window will depend on the size of the binary image and cannot be changed.

Dztau-1.pic

Open the file Dztau-1.pic in the root folder of the application. The image has been processed as is commonly done for a CCD image, offset, black, and the spectrum is horizontal



aDztau-2.pic

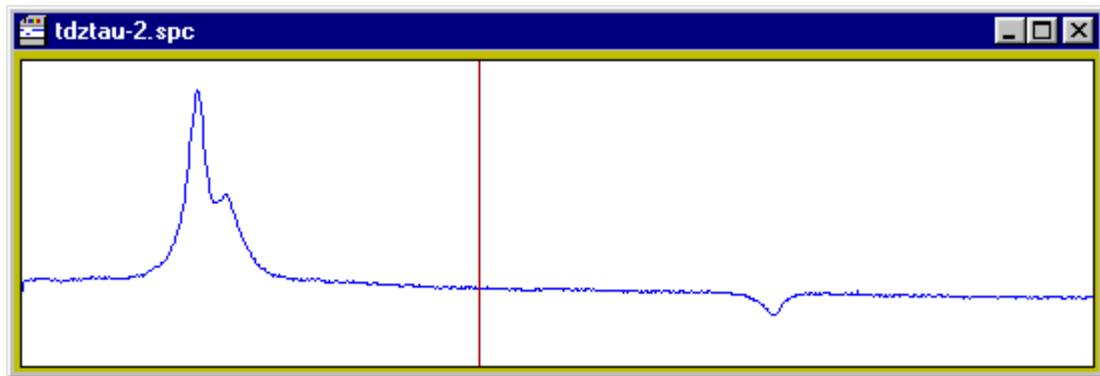
Open the file aDztau-2.pic in the root folder of the application. The image is the spectrum in the same domain of wavelength obtained with an argon calibration lamp.



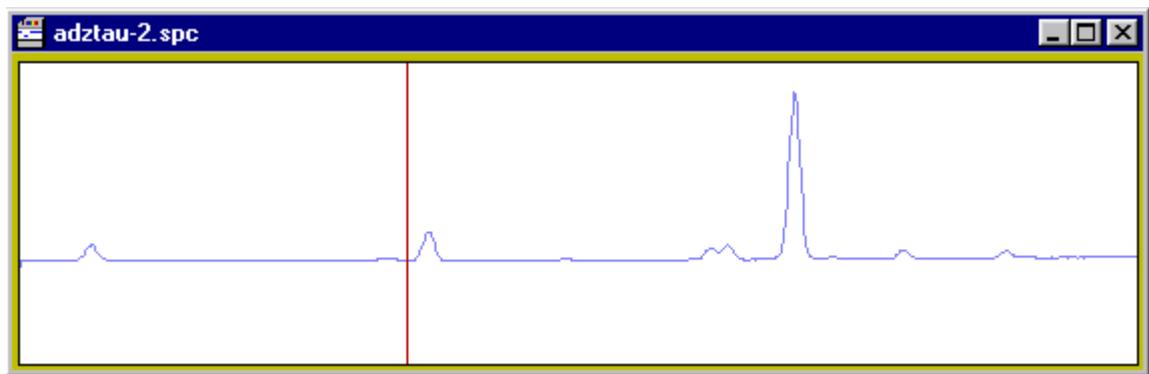
Extract the spectral profile

The creation of a spectral profile from an image is done by clicking on the “Object Binning” button  of the “Image” toolbar.

A new Profile window is created and the result of binning is displayed in the form of a spectral profile.

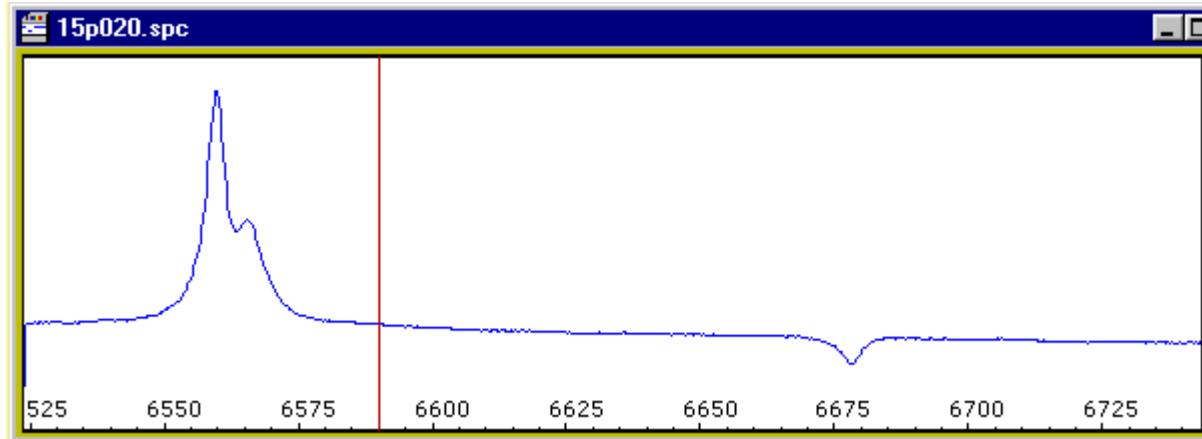


Spectral profile of the image aDztau-2.pic, reference spectrum for calibration:



Dztau-1.spc

Open the file Dztau-1.spc in the root folder of the application. The profile was calibrated in wavelength. Compare it with the spectrum that you have obtained from the raw image Dztau-1.pic and the image of the reference spectrum aDztau-2.pic.



Fill in the Header

The header of a profile file contains some useful information related to the exposure and the conditions of observations. Some of these values, such as the exposure time, are needed for certain operations such as flux calibration.

File name

Date and starting time of exposure: they are updated automatically by the application during the creation of a spectral profile by binning.

Date and finishing time of the exposure

Duration of exposure: it is entered automatically by the application during the creation of a spectral profile by binning.

Alpha: right ascension of the object, entered by the operator. Used to calculate the zenithal height of an object for correcting for atmospheric absorption and for heliocentric speed in accurate Doppler measurements.

Delta: declination of the object, entered by the operator. Used to calculate the zenithal height of an object for correcting for atmospheric extinction. It is used also in heliocentric speed correction for accurate doppler measurements.

Comment: textbox. There is a function for searching for “Profile” documents containing a specified search-string within these comments. It is advisable to include, for example, the name of the star.

Save the profile

Save the profile document by using the File menu, then choose Save or Save As...

CHAPTER 3

Image

Document

The Image documents contains the spectral image to be analyzed. These documents are used to create the Profile document that contains their spectral profile.

Image Format

The Image files accessible by this application are limited to format “.pic” generated by the program Pisco and Iris © or “.fit”, “.fts”, “.fits” traditional FITS format.

The thresholds of visualization by default are those that are entered in the header of the .pic or .fit file.



Note: If the automatically-provided thresholds from the header of the image do not give anticipated results, adjust the thresholds manually.

Image Folder

The default folder to contain “Image” files can be set in the “Preferences...” dialog box.

Open and close an image

Open an image

To access the dialog box for opening an Image document:

- Click on the menu File, choose Open Image

Or

- Click on the “Open Image” button  in the main toolbar of the application.

The standard Microsoft dialog box will be displayed. It is possible to select several documents using the SHIFT or CTRL buttons.

It is possible to select the image file format in the filter area of the dialog box:

- Qmips (*.pic)
- Fits (*.fit)

Close an image

To close an Image document:

- Click on the File menu, chose Close

Or

- Click on the close symbol in the frame of the document window.

To temporarily close a Image document, click on the “Minimize Window” symbol in the frame of the document window. The minimized document will be placed at the lower left of the application.

Search for a reference image

In the case where a calibration lamp or other source of external calibration (standard lamp) is used, before or after each spectrum, a reference spectrum will have been created to calculate the law of dispersion of the set in the same configuration.

If the user saves the reference image which is used for the wavelength calibration using the convention: name of image = prefix “a” + name of spectral image of the object, and if the reference image is in the same folder, this function will automatically find files corresponding to the criteria:

- Name of active displayed image, with the prefix “a”

To recover the reference images identified by the prefix “a”:

- Click on the File menu and choose Find References...

Example: if the image “Dztau.pic” in the Image folder is active, the search function will select all files aDztau*.pic which are present in the Image folder.

Obtain information about the image

Position of cursor

The cursor placed within the image area takes the shape of a cross.

The x,y position and the intensity of the image pixel under the cursor are indicated in the main toolbar of the application.

Change the Thresholds

The thresholds of an image, high threshold and low threshold, define the “contrast” of the rendering of the image, also called scale of visualization.

All the pixels whose values are included between the low and high threshold are rendered using a 256-value grayscale.

A smaller scale augments the contrast of the image, but reduces the visualization of the total dynamics of the image.

A larger scale diminishes the contrast of the image.

To find the optimal thresholds:

Search, by moving the cursor, for the maximum values of the image where a signal is present.

Use a value slightly higher than this value as the high threshold.

Search, by moving the cursor, for the minimum values of the image, values of the black areas of the image.

Use a value slightly lower than this value as the low threshold.

To increase contrast, gradually tighten the thresholds around the average value of the image.

The thresholds are modifiable by manually entering values for “high threshold” and “low threshold” in the text area of the Image toolbar (directly editing)

Or

By using the cursor.

Change the thresholds by direct editing

The area for directly editing the rendering thresholds is located in the Image toolbar.

To edit a threshold

- Click in the edit area of the threshold
- Enter a value between 0 and 32000
- Click on the “apply threshold” buttons  so the value is accepted.

One can return to the original thresholds of the Image file by clicking on the button “original thresholds”. 

Change the thresholds by using the cursor

To modify the thresholds using the cursor, move the mouse while holding the left mouse button.

- Moving upward: the high threshold will be increased
- Moving downward: the threshold will be decreased
- Moving rightward: the low threshold will be increased
- Moving leftward: the low threshold will be decreased

The new thresholds are not applied until the mouse button is released.

The thresholds are limited to values between -32000 and 32000, and the difference between the two thresholds cannot exceed 32000. Visual Spec corrects them automatically.

One can return to the original thresholds of the Image file by clicking on the button “Original threshold”. 



Note:

The mouse may move outside the document window.

Select an image area

Selecting of an image area is done by moving the mouse while holding the right mouse button.

The image area selected can be used for either creation of a spectral profile or for exporting the values of the pixels to an Excel file.



To make the selection indicator disappear, right-click on the image area without moving the mouse.

Export to Excel

The application can export a previously selected image area to Excel. This function is not available if Excel has not been installed.

- Select an image area
- Click on the “Excel” button 

The values of the pixels are placed into an Excel file “Pictemp.xls”.

If the image area is too large, the time needed for exporting can be significant. The hourglass cursor will seem to disappear, but until the Excel application appears the transfer is still proceeding.

When the export operation is completed, Excel will become active. A worksheet containing the values of each pixel in the cells of the Excel document is created under the filename “picTemp.xls”.

To return to Visual Specs, close Excel.



Save the file PicTemp.xls under a different name if you don't want to overwrite preceding values.

CHAPTER 4

Profile

Profile Document

The Profile documents of the Visual Spec application contain one or more spectral intensity curves, called a series in the application. They are the fundamental documents of the application with which most of the processing and analysis operations will be done.

Profile Format

It is valuable to make the distinction between the format of a *.spc file and a Profile document.

The Profile document is the window of the application that allows one to visualize, process, and compare spectra. A spectrum is a graphic visualization of intensity as a function of pixel number, or of wavelength after the spectrum is calibrated. The graph of a spectrum in a profile document is represented by a spectral series. These spectral series are graphic profiles constructed from a table containing:

- The wavelength of the point or, if the series has not been calibrated, the sequence number of the pixel
- The intensity at each point

Each profile document has the capacity to contain four spectra or basic spectral series which are saved by the application, identified by the symbol , and an unlimited number of “temporary” series, which are not saved, identified by the symbol  in the Select Series control box of the Profile toolbar. These spectra share the same spectral sampling.

The files Profil.spc accessible to and created by this application are in “.spc” format, a proprietary format of Visual Spec but based on ASCII format.

When saved as a “Profile” file, along with the four basic series are recorded:

- the sequence number of each pixel
- the wavelength in angström of each pixel
- an index which invalidates the value of the pixel of the profile if the index value is -1 (otherwise the index value is 0)

Profile Folder

The default folder containing the Profile files in format *.spc is defined using the “Preferences...” dialog box.

Create and open a profile

Create a profile

The creation of a profile is always done from an image, by the operation of binning.

Binning is a simple summation by column of the pixels selected within the image area. It increases the quality of the spectrum as compared to a simple extraction by line of the image.

Two types of binning are suggested:

- Object binning: summation of lines containing the spectral signal, by clicking on the button  of the Image toolbar.
- Reference binning: summation of a sub-set of lines, by clicking on the button  of the Image toolbar. This reference notion is useful when working with calibration lamp as a spectral reference.



Note: It is advisable to rectify any spectral image having tilted lines using Qmips 32. It is also required that the spectrum beeing oriented in the direction from blue to red (from left to right).

Object binning

The Objec binning creates a profile in the basic serie "Intensity" of profile document. The binning can be done according to two strategies: Automatic or by user zone selection. In this last case, two methods are proposed to select the zone before clicking the binning button.

Automatic Binning

The automatic binning do not requires user actions. It extracts the lines of the image which contains the spectral signal signal and add them. The algorithm of lines selection is based on the mean signal comparison to the added noise. If the signal level is superior to the added noise then the line is added. In the contrary, the line is not added as it probably contains only sky background. This algorithm can added not necessarily contiguous.

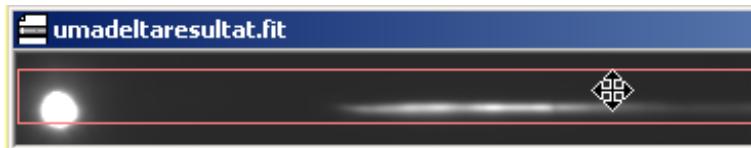
The binning constraint is that no other signal than the one from the spectrum or its background shall be present in the image. If another spectrum or a star are present, the algorithm will not make any difference and will add the high signal lines whether it belongs to the spectrum or not.

Semi-manual binning

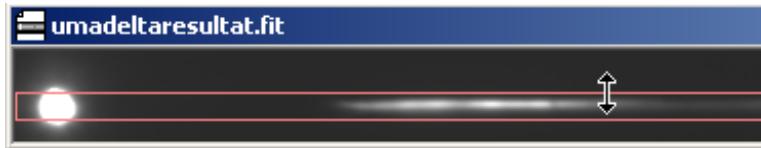
The semi-manual binning allows the user to display a pre-defined box to define the binning zone. The box extend on the entire width of the image. The user can move the box up and down and change the height.

The box zone is displayed by clicking on the button the  button of the Image toolbar. It is then possible to move the area vertically using the cursor.

- Vertical move of the entire box: put the cursor over the binning box. The cursor looks like a cross. Click and drag by hitting the mouse left button.



- Height modification: put the cursor on the upper border. Click and change frame height by hitting the mouse left button.



The upper border position (Y) and the box height (H) are displayed in the lower right corner of Vspec. This allows a reproducible positioning of the binning from image to image if required.

Y 21 - H 15

Manual binning

If only a small zone contains the spectrum, it is more easy and fast to do the direct selection using the mouse.

- Select the zone by hitting the right mouse button (the left button is used to modify contrast and brightness) and drag around the desired zone.



Reference binning

Reference binning is done by a simple summation by column on the total image .

Reference binning generates a basic "Ref1" series in the Profile document.

A manual or semi-manual selection is possible before starting the binning using the "reference

binning" button



Note:

Warning: a profil file shall always contain a valid profile in the "intensity" serie. If you do only a "reference binning" Vspec will not allow you to save the document. You shall have perform an "Object binning" or moved the "ref" serie into the "intensity". See the move a serie section.

Creation of a profile

When the binning is completed the profil is created. Several options are available depending whether a Profile document is already open.

If no profile document is displayed a new profile document is created. It is positioned under the Image window and takes the name of the image with the *.spc extension.

If a Profile document is already present, a dialog box is displayed:

- If the operator answers “yes” to the question “Do you want to recover the file from existing and lose your changes?” then the binning will replace the preceding values.
- If the operator answers “no” then a new Profile document will be created with the same name as the active profile document to which a letter “n” is appended.

Open a profile

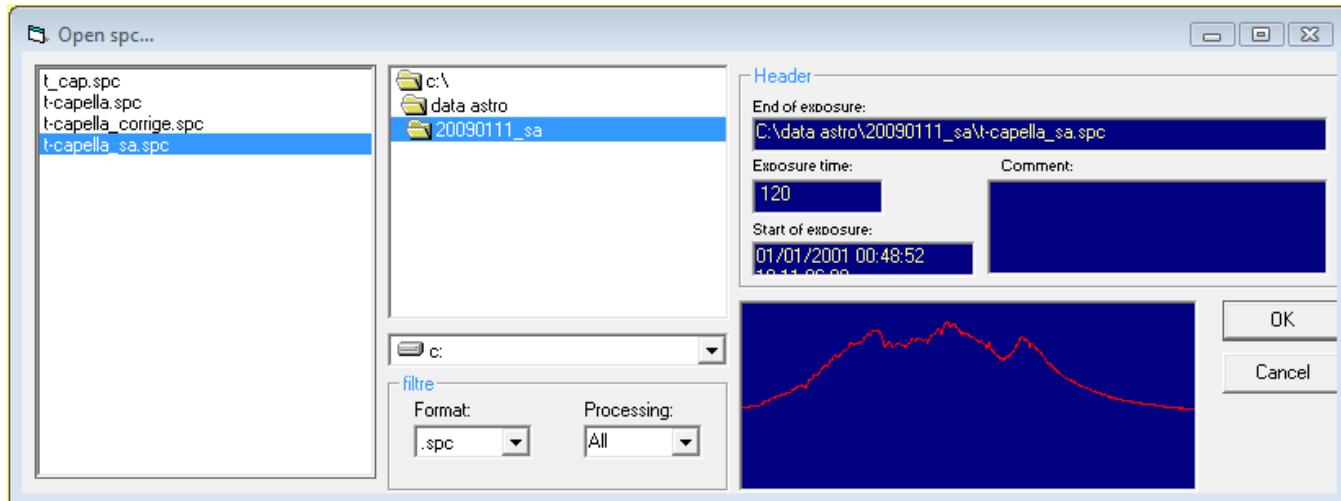
To open a Profile document

- Click on the File menu and choose Open Profile

Or

- Click on the “Open profile” button  of the main toolbar of the application.

“Open Profile...” dialog box



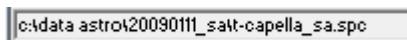
- Select the disk
- Select the folder
- Select the document type among three options:
 - Spc format: original format inherited from A.Klotz software for compatibility
 - Dat format: text format with two columns (wavelength and intensity) and no header
 - Fits format: the one for spectro with multiple axis
 - UVS file format: from the the UVES database from ESO
 - All: will display spc, dat, fit files.



Once the file downloaded from the ESO database, make sure it has the .uvs extension and not any .txt extension.

- Select if a Processing filter shall be applied on the processing postfix as defined by Christian Buil on his site. Those postfixes are used in some assistants of Vspec.
- Select the document in the *.spc file list presented
 - Select a continuous set of files by holding the SHIFT key
 - Select a non-continuous set of files by holding the CTRL key
 - When a file is selected, the information contained in the file header is displayed in the fields to the right of the folder list.
- Click on the Cancel button to cancel the operation.
- Click on the OK button to close the dialog box and display the file.

This dialog box can be resized. When a profile document is opened and active its name is displayed in the bottom status bar.

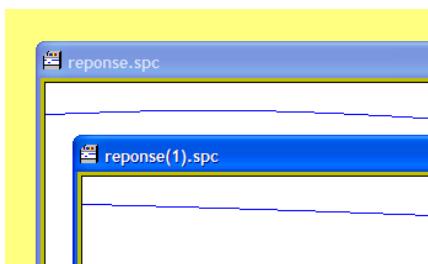


Drag and Drop

You can also open one or multiple profile documents by simply dragging the fits or spc files from Windows Explorer.

Open file with same name but from another directory

When a file with the same name than a file already opened but from a different directory is opened, the profile window is displayed with an index added to the file name in the caption section.



You can verify from which directory is coming from in the status bar, at the bottom of the application



Search for a profile

The Search function allows one to find the set of files in a set of folders, whose “comments” header field contains the search-string specified in the search criteria area (see section “Fill in the header”).

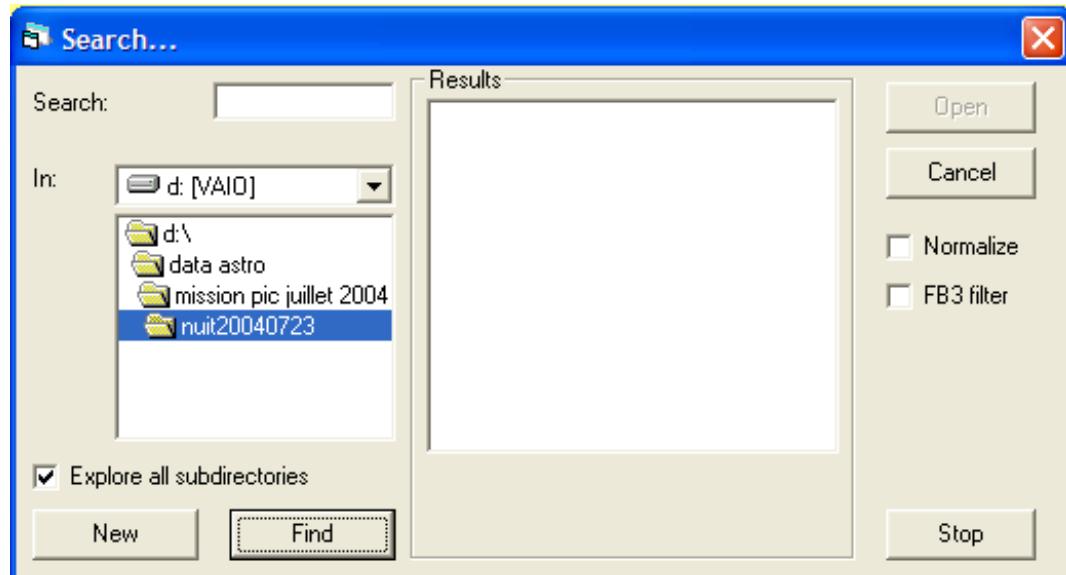
To search for a Profile document

- Click on the File menu, choose Find...

Or

- Click on the Find button  of the main toolbar of the application

“Search...” dialog box



- Edit the search criteria: in the search string, the character “*” replaces a set of undefined characters
- Select the root folder
- If the “Explore all subdirectories” checkbox is chosen, the set of folders under the root folder will be included in the search
- To clear the search criteria and start a new search, click the “New” button
- Click the “Find” button. The list of files whose ‘comment’ field corresponds to the search criteria will be displayed at the right
 - Click on a folder in the list; the contents of the file's comment field will be displayed below the list
 - Press the DEL key on the keyboard; the file will be removed from the list
- Click "Open" to close the dialog box and open the set of files contained in the list
 - If the “Normalize” checkbox is checked, upon opening the “Intensity” series will contain the normalized spectral profile starting from the continuum area that has been preset in the “Preferences...” dialog box.
 - If the “FB3 filter” checkbox is checked, upon opening the “Intensity” series will contain the spectral profile filtered by a third-order low-pass filter.
 - If both boxes are checked, filtering is done after normalization.
- Click on the Cancel button to cancel the operation.
- Click on the Stop button to stop search operation.

Open zip files

You can drag and drop zip files on the yellow section of Visual Spec.

If the zip files contains files with format compatible with Vspec: fits, spc they will be automatically opened in the application.

This feature is specifically appropriate to open files downloaded from the BeSS database.

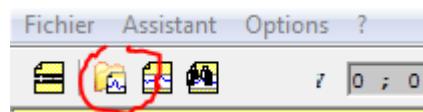
To run this function you need to have the dll vbuzip10.dll in the system32 directory

VisualSpec Explorer

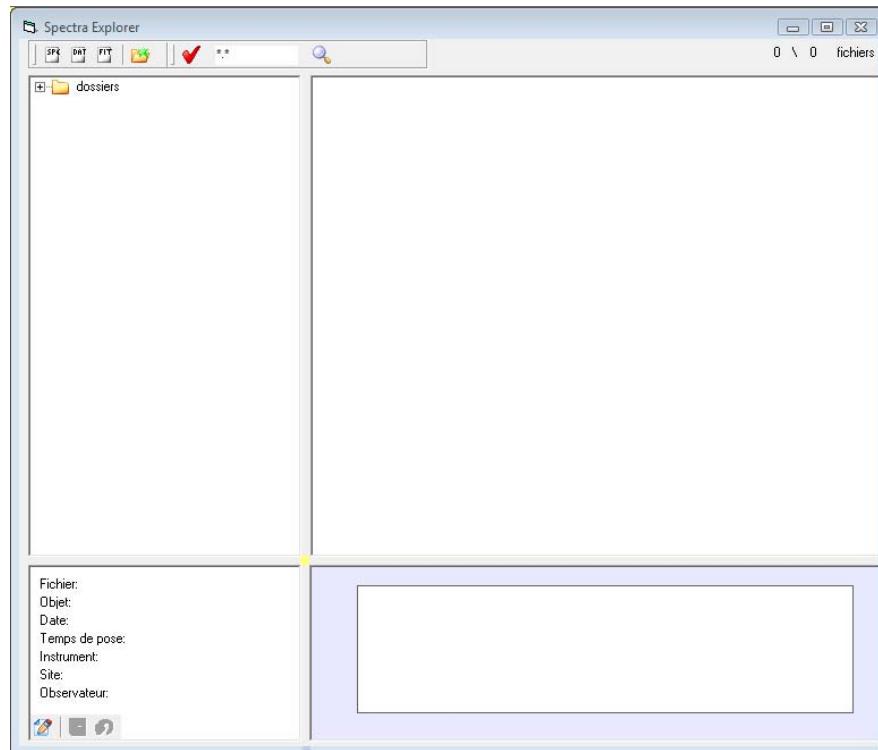
Visual Spec has another profile files opening interface in Windows Explorer style to manage and visualize with thumbnails the profile files.

The supported formats are the native format “.spc » but also fits 1D files ((1D, V0 table) and *.dat

To launch the new interface, click on the button in the principal toolbar.



A window of Explorer type will open in Visual Spec.



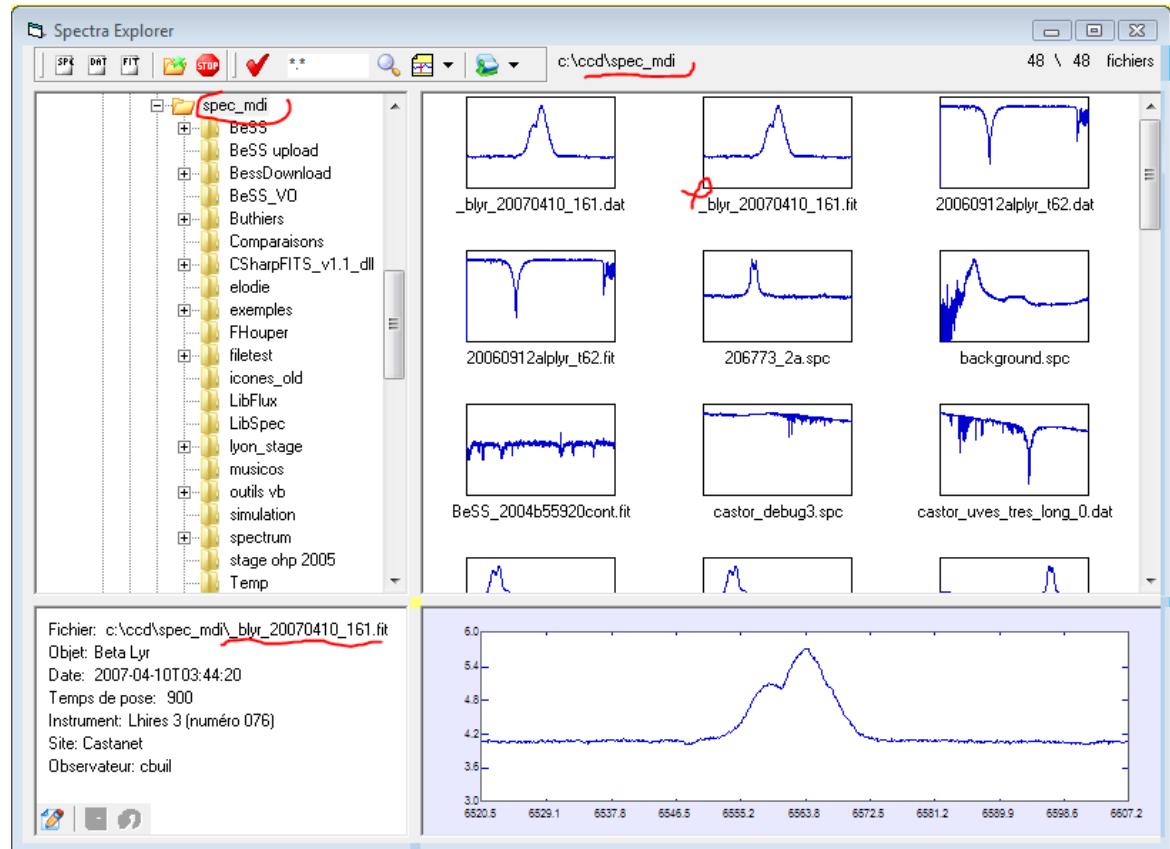
- The first top left section is the directories treeview.
- The second top right section will display the thumbnails.
- The bottom left section will display information from the file selected header.
- The bottom right section will display a graphic with graduated axis of the selected file.

Reach a directory which contains profile files by clicking on the nodes to develop the trees.

We can directly reach the default working directory defined in the preferences of Visual Spec by clicking on the icon  of the top toolbar.

Click on a thumbnail to display the information from the header and the graphic. The header information will not exist for a .dat file as it does not have any header.

To stop the generation of the thumbnails in a directory, click on the button 



Copy – move – delete

To get access to the contextual menu, select a thumbnail and make a right click with the mouse.

Pour accéder au menu contextuel, sélectionner un fichier et faire un click droit avec la souris.

- Open with Visual Spec – this menu item will directly open the file in Visual Spec application.
- Copy – copy the file, to paste it in another directory.
- Paste – select the destination directory and paste it
- Delete – delete the file on the hard disk. Ask for confirmation.

The following short-cuts are available:

To move a file from one directory to another one, click on the thumbnail with the left mouse button and drag it to the destination directory in the treeview section.

To copy a file from one directory to another, click on the thumbnail as for a move but maintain the Ctrl key pressed as well.

To delete a file, use the “Del” key

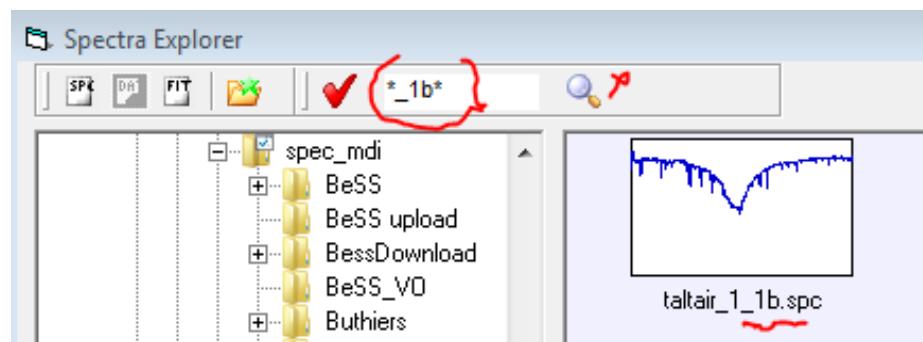
Filter – search

There are three filters based on the file formats: *.dat, *.fit, *.spc which can be enabled with the buttons in the top toolbar.



An enabled icon means that the format is included. A grey icon means the format, here the .dat format is excluded from the display.

Search based on free criteria in file name can also be done, on the name of the file if the drop down menu is selected.



Wildcard characters are indicated by « * » - to run the search click on the icon with the mag glass.

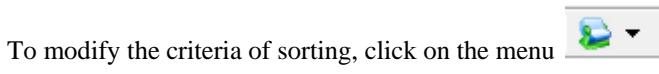
To explore sub-directories, click on the icon . The background of the thumbnails section will become blue if it shows search results.



If the menu is selected, the search will be done on the keyword OBJNAME in the fits header. In this case, only if the object name exactly matches the search string the file will be considered. No "*" character is permitted.

Sorting

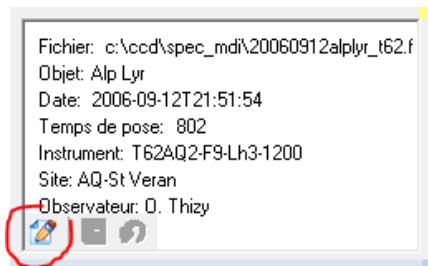
The files are sorted by alphabetical order.



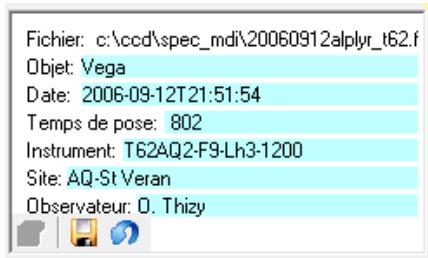
To modify the criteria of sorting, click on the menu to apply a sorting by date or object name, only for fits files.

Editing

You can edit the header of the file in the file info section.



Click on the icon to turn into the edit mode



The editable fields are in blue – when all the changes are made, click on the save icon or undo the change with no saving with the undo icon

Close and Save a profile

Close a profile

To completely close a Profile document

- Click on the File menu, choose Close

Or

- Click on the close symbol of the document window frame

To temporarily close a Profile document, click on the minimize symbol of the document window frame. The minimized document will be placed at the lower left of the application.

To close all the Profile documents:

- Click on the File menu, choose "Close all"

If a document was modified since it was last saved, a confirmation dialog is displayed.

Save a profile

To save a Profile document

- Click on the File menu, choose "Save..."

Or

- Click on the button in the principal toolbar

The .spc file will be saved in the working directory.

If the file was modified, a confirmation dialog is displayed.

Save under a different name

To save a Profile document under a different name

- Click on the File menu, choose "Save As..."

The "Profile Save As..." dialog box will be displayed

This is a standard Microsoft Windows dialog box.

If the file already exists, a notification will be displayed to the screen.



Note:

You can save the file under the dat format, change the type of the file in the standard dialog box

The spectral series

A spectral series is a spectrum for which the intensity of each point is associated either with an order number for the point, or with the wavelength once the series is calibrated. The wavelengths are regularly spaced, the interval defining the spectral sampling.

Each Profile document contains four spectra or series, each having the same sampling. In addition to the basic series "Intensity", one can save the reference spectrum in the series "Ref1", the relative spectral intensity compared to the continuum in "standardized" and a second reference spectrum in "Ref2".

For the benefit of the application, one can create and superposition temporary series, but can only save them by using them to replace one of the four basic series. These temporary series are created by the application after certain operations such as filtering, cut/paste, division, calculation of a Planck profile, addition of a chemical spectrum or one of the library of spectra. A temporary series may not have the same spectral sampling as the base series.

There is always one series active in a Profile document, this is the series whose name is displayed in the "series" listbox of the Profile toolbar.



Display a series

When a Profile document is opened, the series displayed and active by default is the "Intensity" series.

To display a different series:

- Use the cursor in the "series" listbox in the Profile toolbar to select the name of the new series

The new series displayed will become the active series.

To change the color of a series:

- Use the cursor in the "color" listbox in the Profile toolbar to select the new color from the list of colors provided.

To change the display mode to by-point of a series, click on the Format menu and choose Plot.

To change the display mode to histogram of a series, click on the Format menu and choose Histoplot.

To return the display mode to by-line-segment, click on the Format menu and choose Line. A submenu is available to change the thickness of the line.



To clear the display, click on the “Erase graphic” button of the Profile toolbar.

Selecting a serie

To select a new series:

- Place the cursor in the area of the “series” listbox in the Profile toolbar and select the name of the new series

Or

- Place the cursor over the graphic of the new series and click. When the cursor is correctly positioned, the cursor changes to arrow-shaped. The newly selected series will flash one time.

Or

- Move from one active series to another in the series listbox of the profile document by pushing the Tab key or Shift-Tab key of the keyboard. Each series in the list will in turn become active.

Selecting a series makes it the “active” series; that is to say that its spectral profile is displayed and when one moves the cursor along the profile, the position, the wavelength, and the intensity of the pixel are displayed in the upper toolbar. The spectral sampling is displayed in the area of the main toolbar:



Many functions are performed on the active series.



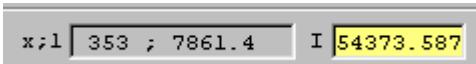
Note: The name of the file, the date and the time of the file where the serie belongs is displayed in the bottom status bar. This is useful after a copy/paste of a serie from another file to keep track of the informations.

Cursor position

This function applies to the active series.

On a profile document, only the X position of the cursor is changeable. The cursor takes the shape of a hand holding a red line.

Each new position is displayed in the main toolbar:



- the pixel number
- the wavelength, if it was previously calibrated
- the spectral intensity



Note:

To temporarily display the “comments” field of the document header, left-click on the yellow border around the image and hold the left mouse button; the comments will appear in a yellow rectangle at the cursor position. It will disappear when the mouse button is released.

Selecting a spectral area

This operation applies to the active series.

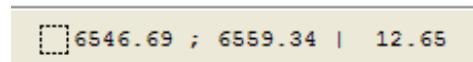
To select a spectral area:

- Position the cursor at the start of the area to be selected
- Drag the mouse holding the left mouse button
- Release the button at the end of the area to be selected. The selected area is framed by a gray dotted rectangle.

Selecting a spectral area defines:

- The spectral area to enlarge
- The spectral domain on which calculations will be effective
- The spectral domain of the database of wavelengths

The zone of selection in the toolbar displays: the starting wavelength of the selection, the ending wavelength and the distance bewteen the two

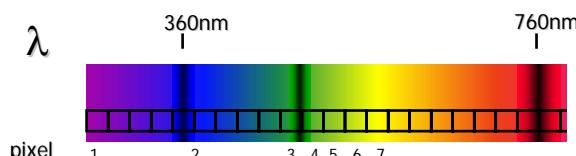


Spectral calibration

Spectral calibration consists of establishing the dispersion relationship of Pixel to Wavelength of the profile. Without this operation, it is impossible to analyze the results obtained.

To establish the Pixel-wavelength relationship, several methods are available, the most precise using empirical reference spectra based only on instrumentation parameters defined by the user.

To calculate the law of dispersion, Visual Spec assumes that the law is linear. Whatever the domain of wavelength, the spectrum always has the same calibration.



Pixel n°5 raie $\lambda=360\text{nm}$
 Pixel n°638 raie $\lambda=760\text{nm}$

$$(638-5) = \text{Echx} * (760-360)$$

$$\text{Echx} = 400 / 633$$

$$\text{Echx} = 0.632 \text{ nm}$$

A database of wavelengths of simple elements is available to help in identifying the lines.



Note:

It is not always necessary to calibrate a spectrum in wavelength to identify some simple lines, such as the Balmer lines of hydrogen. But this operation is needed to make possible the corrections, calculations and comparisons of the spectral processing

Calibration using reference

To calibrate a spectrum in wavelength, one uses a Reference spectrum. This spectrum should contain one or two spectral lines of which the wavelength is previously known.

This reference spectrum can come from:

- A calibration lamp, standard lamp, or lamp of known composition such as argon
- A star of which one knows the lines, and whose spectrum was obtained under the same experimental conditions
- The spectrum itself, if it contains identifiable characteristic lines

In each step of preliminary research for identification of reference lines, one can also perform a manual calibration from a simple reference point and a preliminary knowledge of the sampling of the device (see section “Calibration without reference”).

Visual Spec requires that the reference spectrum be included in the profile document, in the form of the basic series “Ref1”.

Add an external reference spectral profile

To add a reference spectrum based on an image as the “Ref1” series:

- Open the profile document of the spectrum to calibrate. If the document does not exist, create the spectral profile as indicated in the section ‘Create a Profile’ in the chapter ‘Profile’.
- Open the reference spectrum image
- Click on the button “Reference Binning”. Refer to the section ‘Create a Profile’ in the chapter ‘Profile’.

The reference spectral profile will be placed automatically in the series “Ref1” of the document. The four basic series share the same calibration.



Note:

This function calculates the spectral profile from a simple sum on the whole image or on a predefined zone (see section “Reference Binning”). In the case of a spectrum obtained from a calibration lamp, the spectral image extends throughout the image, and binning with extraction is not useful.

Create a spectral reference profile from a star spectrum

It is not always possible to have access to a reference spectrum whose elements are simple and known.

One can, in certain cases, use the spectrum of a star obtained under the same experimental conditions and from which one can identify at least two lines with precision. The spectrum of the object itself can thus be used for its own calibration.



If one calibrates a spectrum based on its own lines, no calculation of Doppler shift is possible because it is not absolutely calibrated by an external reference.

Some useful wavelengths of spectral lines are given in the appendix.

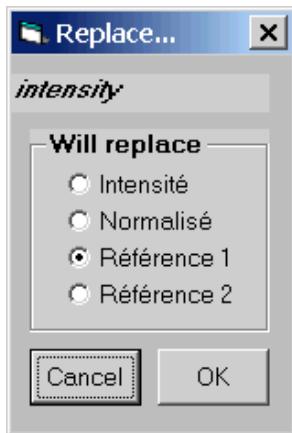
To use the spectrum of an object itself for calibration:

Select the “intensity” series of the document:

- Click on the Edit menu, choose Replace

Or

- Click on the button of the Profile toolbar. The “Replace...” dialog box will be displayed



- Click on “Reference 1”
- Click on OK

This operation permits duplication of the series “Intensity” to the series “Ref1”, which is the basic series used for calibration.

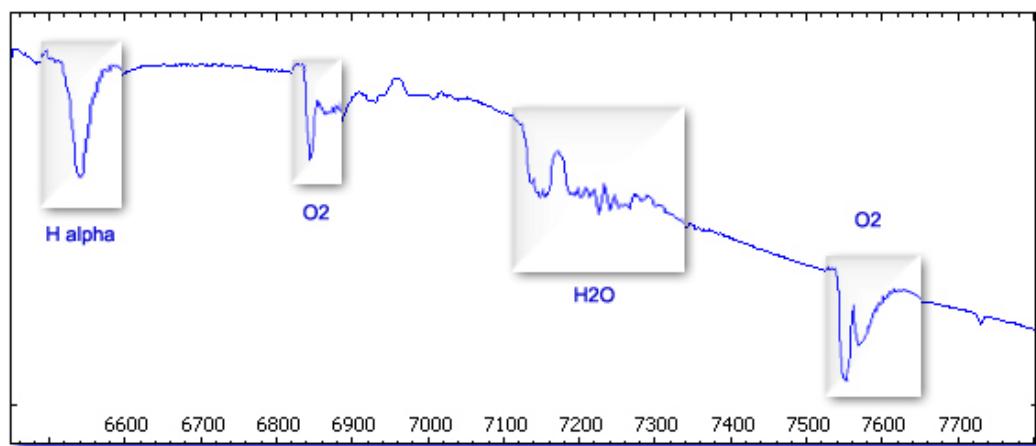
It is possible to let the application do the job itself by clicking in the menu Spectrometry, sub menu Calibration. To the question "do you want to use the current serie?", click on "yes" and the "Intensity" serie will be automatically copied in the "ref1" serie.



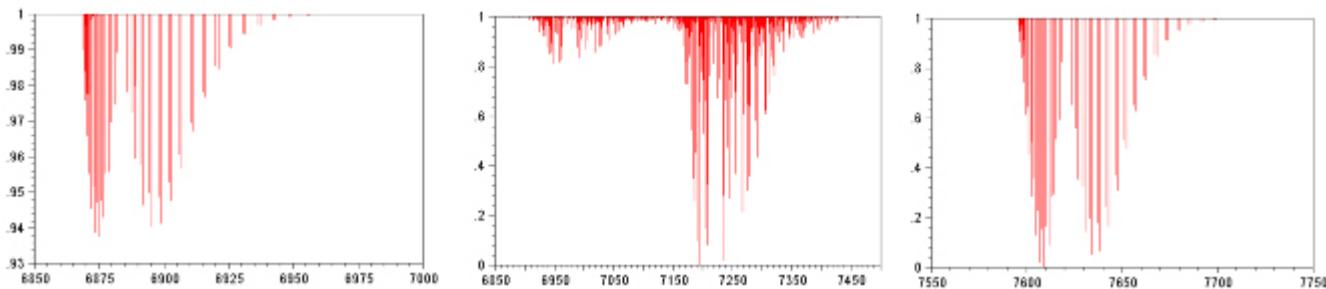
It is also possible to copy a series from a different document, as long as the spectrum was obtained under the same experimental conditions...

Atmospheric lines

If the spectrum contains atmospheric lines contained between 6875 and 7604 angstroms, these can be easily used to calibrate the spectrum because they are easily recognizable.



02 Line	6875 angstroms
H2O Line	large line, can specify 6950 and 7250 angstroms
02 Line	7590 angstroms



Calibrate in wavelength with 2 lines

Once the “Ref1” series is filled, activate “Calibration” mode.

- Click on the Spectrometry menu, choose "Calibration 2 points..."

Or

- Click on the  button of the profile toolbar

The Calibration toolbar will replace the Profile toolbar, and the active series will become the “Ref1” series.

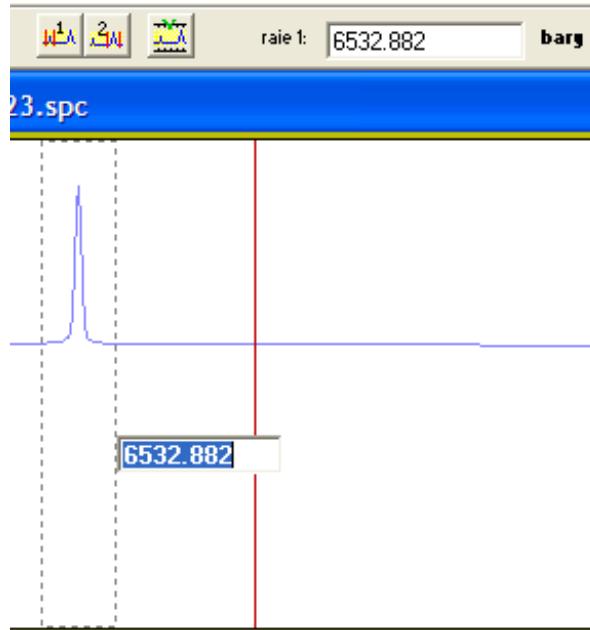
- Verify the reference wavelengths in the fields "raie 1" ("line 1") and "raie 2" ("line 2"). By default, they contain the values that were predefined in the “Preference” menu.
- Edit these values directly if the default values are not OK.
- Using the cursor, select the line that is identified as the first reference line. Its wavelength will correspond to the absolute wavelength shown in the field “raie1” (“line1”).



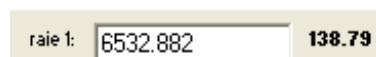
Note:

Calculation of the barycenter is very sensitive to the selected area. It is recommended to select an area balanced around the minimum and maximum of the line, and not including other neighboring lines.

- Select with the mouse the first line identified as the first reference line. Its wavelength will correspond to the absolute wavelength of the field "line1" of the toolbar. At the end of the selection operation, a text box is displayed close to the selection. It contains by default the value of the "line2" field from the toolbar.



- Type "Enter" from the keyboard to validate the value or double click with the cursor inside the text field. You can edit it before validating. Once validated, the barycenter position is displayed next to the line1 field in the toolbar.



- Select the second line the same way, enter or keep the displayed value which corresponds now to the second line "line2" field. Validate
- If you don't know in advance the exact wavelength of the identified line, you can be helped by the element database. Display the Element wavelength list and click on the wavelength you want to have automatically displayed in the edit box. Just then type enter to have the value validated. See the section "Elements" later in the manual
- Done! – as long as you have validated the second wavelength, Visual Spec calibrates the spectrum, exits the calibration mode and displays the "intensity" series.

The linear interpolation calculations will associate to each point in the series a wavelength based on the two reference points thus calibrated. The X position of the cursor now gives access to the wavelength for each data point.

To facilitate selection of the reference lines, it is possible to:

- Zoom on an area
- Change the scale of the X and Y axes
- Display the database of atomic lines (refer to the section “Elements”)



Note: At any time it is possible to quit Calibration mode and return to the “Line” menu by choosing the “Calibration...” sub-item on the “Spectrometry” menu.

Calibration without reference

Only one line is needed to calibrate the spectrum along with the knowledge of the linear dispersion of the spectrograph.

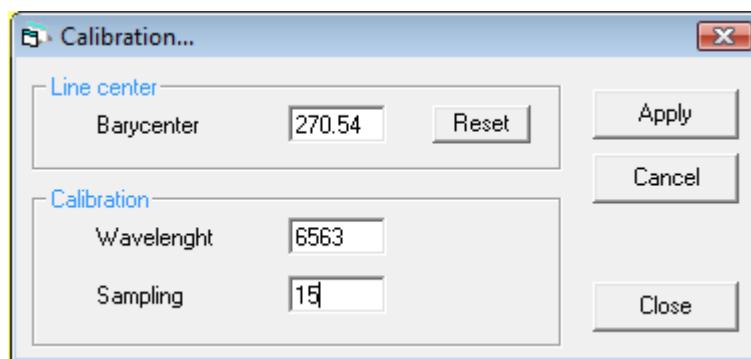
This calibration operation is described by the section title. It is not recommended. It can, however, contribute to identification of the reference lines before performing the complete calibration, or make it possible to use the data in the absence of any access to a reference spectrum.

This method is based on identifying only one point in the profile and on assuming the device sampling in angstroms per pixel.

- Select the reference line
- Click on the Spectrometry menu, choose "Calibration 1 line..."

Or

- Click on the button  of the profile toolbar



A dialog box will appear. The pixel position of the barycenter is indicated.

In the Barycenter textbox, the barycenter of the selection area is automatically calculated and displayed. To change this value, click in the textbox and enter the new value of the barycenter of the selection.

- Enter in the “Wavelength” textbox the wavelength of the reference line
- Enter in the “Sampling” textbox the assumed calibration of the device, in angstroms per pixel.
- Click on the “Apply” button. The X axis will immediately be calibrated in wavelength. Without clicking in the profile window, drag the mouse over the profile and verify the coherence of the wavelengths of the lines.

- Redo the operation, adjusting the values, until a satisfactory result is obtained. Do not change the selected line.
- Click on the button “Close” to save the new calibration and close the dialog box.
- Click on the button ““Cancel” to return to the original calibration.



Note: For this method it is not necessary to create a reference profile.

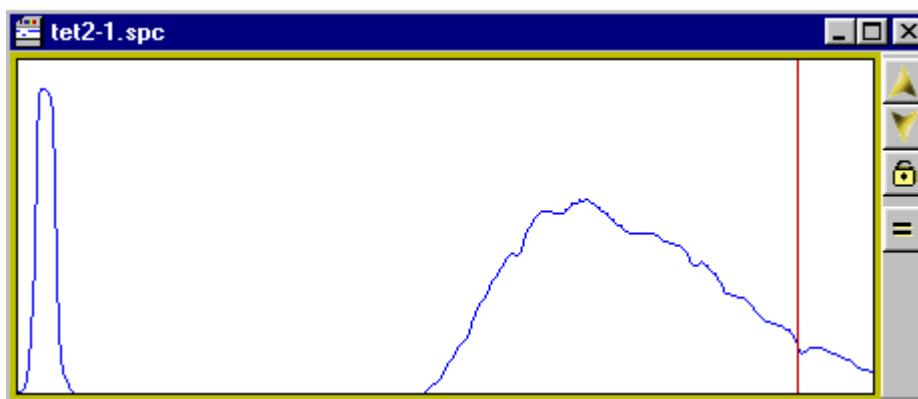
To restart using a different line, exit by clicking on “cancel” then “close”.

Application to an image containing a star.

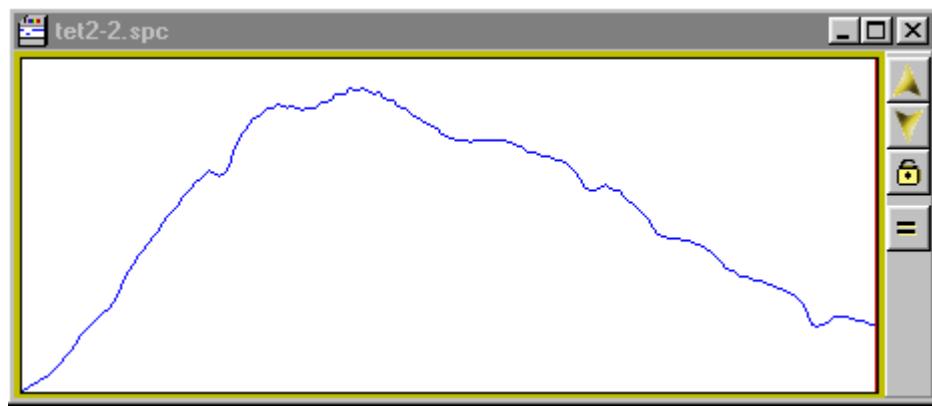
In case one has obtained a spectrum using an assembly without a slit, the star and its spectrum are present. If one knows the dispersion of the device in angstroms per pixel, it is then possible to use the position of the star to calibrate its spectrum.

Display the image containing the star and its spectrum.

Perform Object Binning, or manual binning by framing. The base series “Intensity” then contains the spectrum.



1. Replace the base series “Ref1” with the series “Intensity”
2. Select by framing the line which indicates the position of the star
3. Click on the Spectrometry menu, select ““Define...””
4. Enter 0 in the “wavelength” area; the dispersion will start from the star
5. Enter the number of angstroms per pixel of the device in the “sampling” area
6. Click on the “Apply” button
7. Drag the mouse over the document; the wavelengths will be displayed in the main toolbar
8. Change the value of calibration as needed
9. To save the calibration, click on the button “Close”
10. Select the useful area of the spectrum
11. Click on the Edit menu, choose “Crop”
12. Save the result



Non linear calibration

Non linear calibration is useful when the dispersion system used does not shift the wavelength of the same pixel-length quantity. Up to now, all the proposed method was assuming that each pixel was seeing the same wavelength quantity.

To proceed with a non linear calibration, one can cut the spectrum into small pieces, small enough to have the linear assumption being correct.

Visual Spec proposes a more powerfull interpolation function on the entire spectrum based on a multiple reference lines identification. This function still permit the linear calibration if wanted.

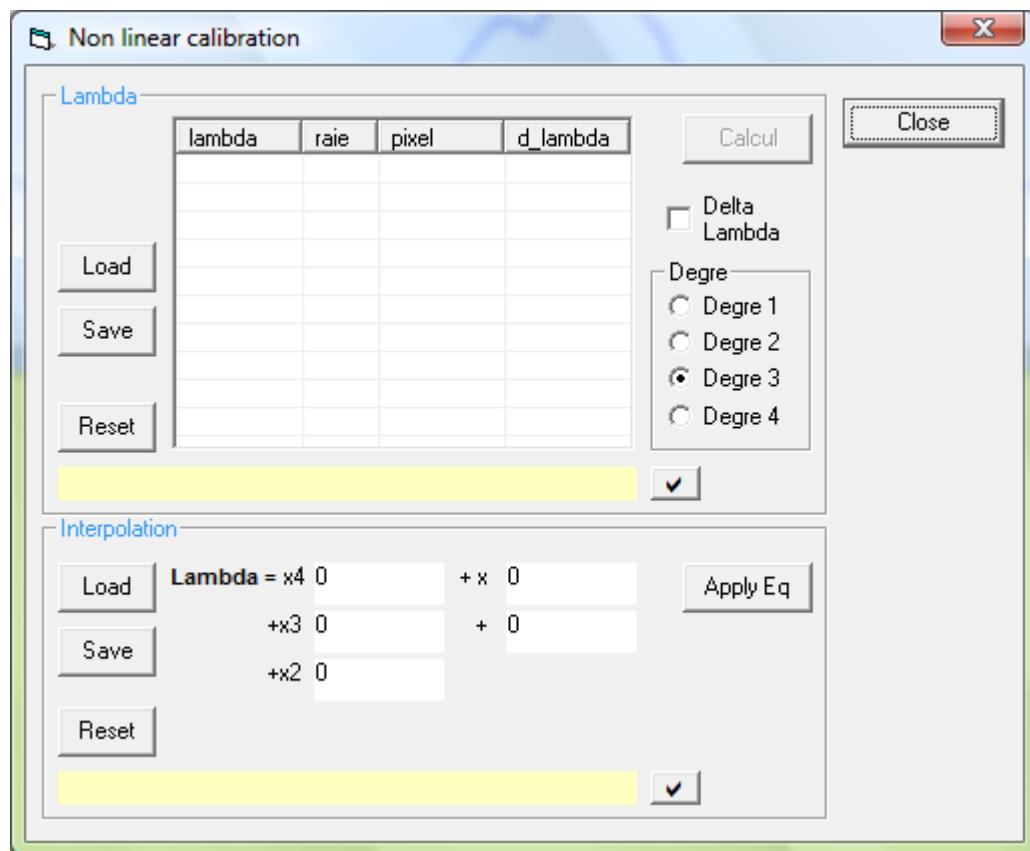
- Click on the menu Spectrométry, choose Calibration multi-lines

Or

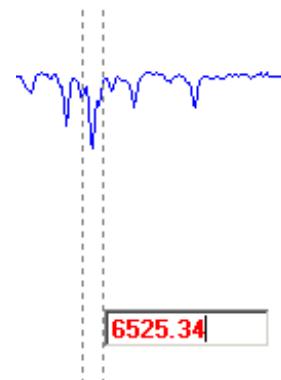
- Click on the button  of the profile toolbar

A dialog box appears to enter the reference wavelengths.

Dialog box non linear calibration

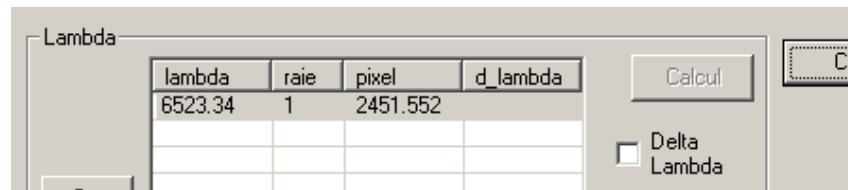


- Select the first line by click-drag on the serie to calibrate.

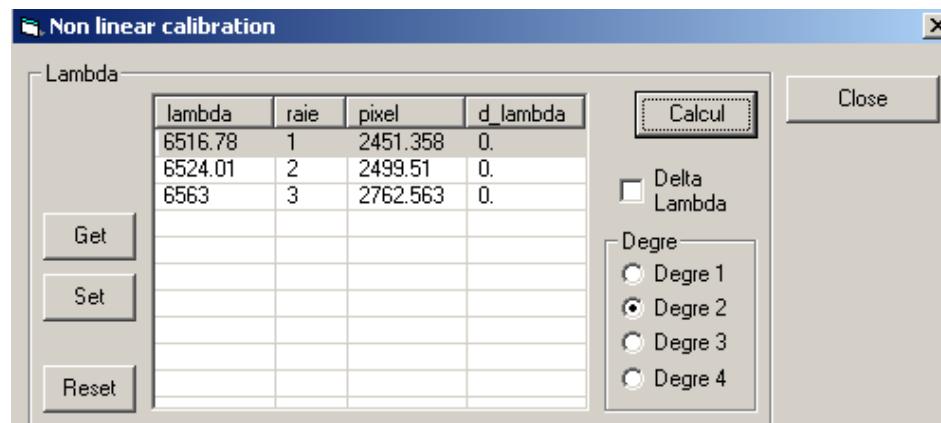


- A small text box appears close to the cursor. Enter the wavelength value of the line. Validate by hitting the Enter keyboard key.
- Instead of entering data with keyboard, you can directly use the element database from Visual Spec.
 - For this, you need to have displayed the "Element" window and have selected the appropriate database. See the Element section later in this manual.
 - In the Element window, click on the line from which you want to copy the wavelength
 - The value will automatically be set in the text box

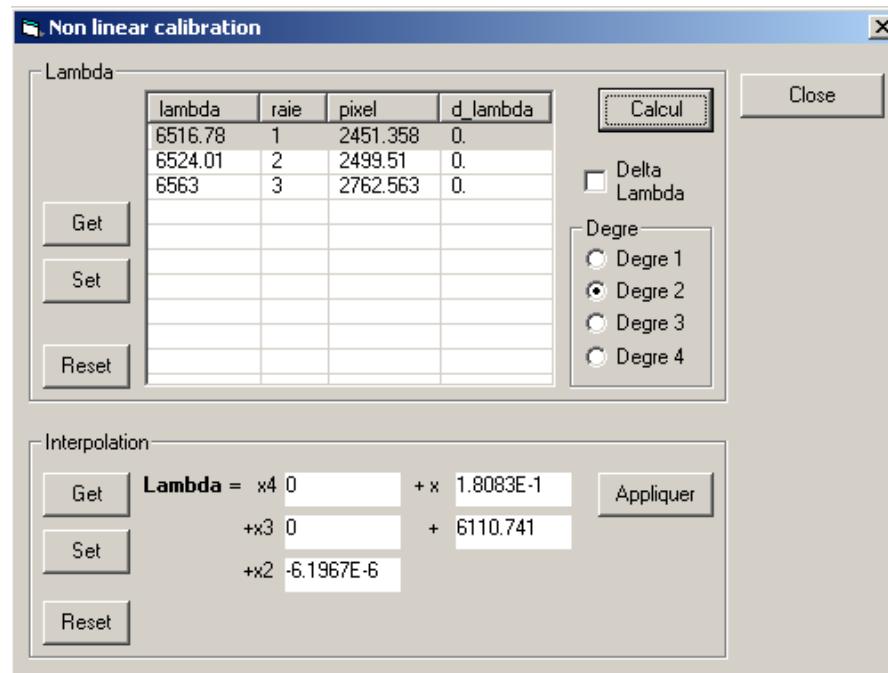
- Click back on the text box and press Enter



- In the dialog box, the wavelength table is filled with the wavelength and the position of the barycenter, along with a reference ID
- Repeat the line identification operation for each known lines



- Select the polynome degree
- Click on the "Calcul" button. The interpolation of the wavelength law are displayed in the bottom of the dialog box and the profile is calibrated. The profile is linearly re-sampled with a sampling factor close to the linear coefficient of the equation.



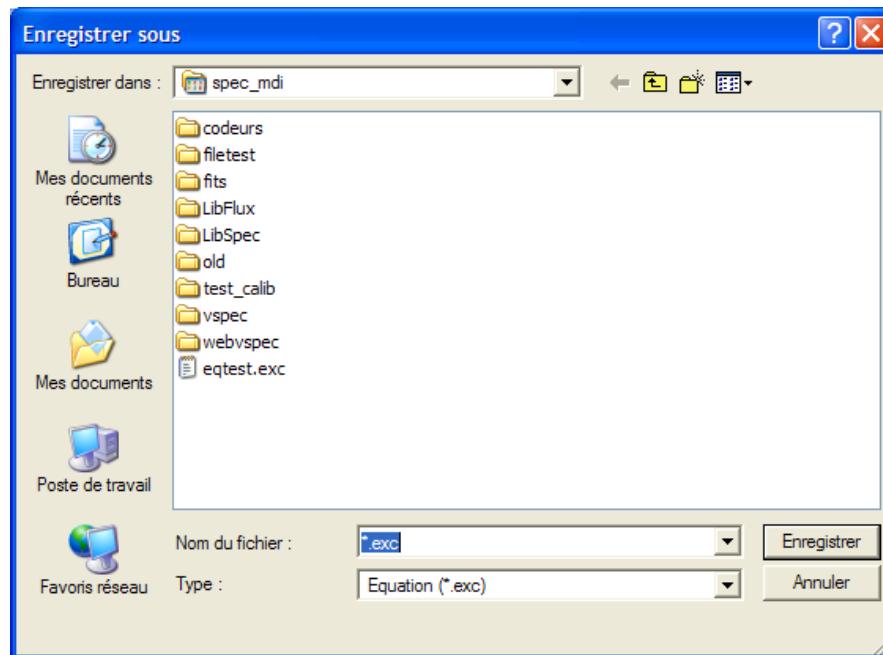
- If the number of lines is not enough to match the interpolation degree selected, the lower order is automatically selected and applied.

Degree	Minimum number of lines	Interpolation equation
Degree 1	2 lines	$\lambda = ax + b$ ($x = \text{cursor position}$)
Degree 2	3 lines	$\lambda = ax^2 + bx + c$
Degree 3	4 lines	$\lambda = ax^3 + bx^2 + cx + d$
Degree 4	5 lines	$\lambda = ax^4 + bx^3 + cx^2 + dx + e$

- The equation coefficient are displayed in the bottom frame

Save an equation

- To save the equation coefficient , click on the button "Save" in the Interpolation bottom section. A dialog box will appear to allow the user to enter the file name.



The interpolation equation coefficients are mainly function of the dispersion system used. They do not vary from one spectrum to another if no change is made on the instrumental configuration. Only the constant (wavelength domain offset) will have to be re-computed.

To re-use the interpolation coefficients:

- Load the spectral profiles, enter the non-linear calibration mode.
- Load the coefficient by clicking the "Load" button in the interpolation section. The coefficients are updated.
- Enter "0" in the constant field box
- Select one line in the spectral profile and fills the wavelength

- Click on Apply – the calibration is made and the cursor position on the profile references the wavelength.
- To reset all coefficients, click on the "Reset" button



Note:

The "Apply" button in the interpolation section recompute the calibration if one of the coefficient is changed, like the constant. If one on the wavelength table value is modified, the "Calcul" shall be hitted again to re-compute the interpolation law.

Load an equation

Load the set of coefficient of the equation which defines the relationship between the pixels and the wavelength by using the Load button. When loading a file, its name and path is kept int he yellow section. Next time you'll use this function, you can just click on the checkmark button on the side of the yellow field to reload the file in the list area.

Save a list of wavelength

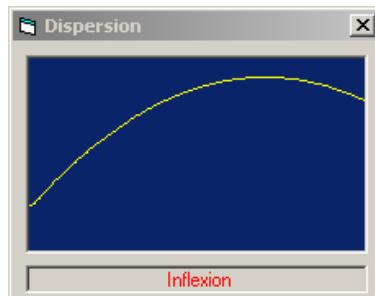
List of wavelengths can be saved and then re-loaded if a set of lines are used regularly to calibrate the spectrum. As for the equation, use the button LOAD and SAVE on the side of the wavelength list frame. The file extension is .lst

Load a list of wavelength

Load a list by using the Load button. When loading a file, its name and path is kept int he yellow section. Next time you'll use this function, you can just click on the checkmark button on the side of the yellow field to reload the file in the list area.

Inflexion point

If the dispersion law has an inflection point, Visual spec inhibits the calibration . A sound is emitted and the word "inflexion" is written in red under the graphical representation of the dispersion law. Inflexion point are an indication of something wrong in the process as for one pixel position only one wavelength shall correspond.



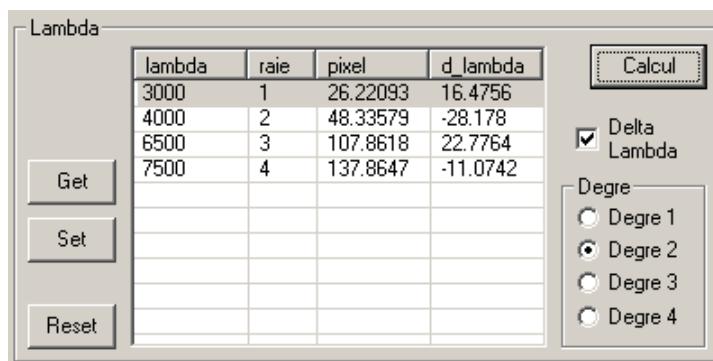
To modify values in the wavelength table:

- Click one time on the line to edit the wavelength
- Click two times to edit the barycenter (pixel position)

dλ dispersion law

For a greater accuracy in the calibration, more reference lines than the minimum required by the interpolation degree can be added. For each line, the difference between the calculated value and the observed value is displayed.

The differences are listed in the d_lambda column.



The Lambda frame contains a table with four columns: lambda, raié, pixel, and d_lambda. The data is as follows:

lambda	raié	pixel	d_lambda
3000	1	26.22093	16.4756
4000	2	48.33579	-28.178
6500	3	107.9618	22.7764
7500	4	137.8647	-11.0742

Below the table are three buttons: Get, Set, and Reset. To the right of the table is a 'Calcul' button and a checkbox labeled 'Delta Lambda'. A vertical stack of radio buttons is labeled 'Degre' with options: Degre 1 (unchecked), Degre 2 (checked), Degre 3 (unchecked), and Degre 4 (unchecked).

In order to take those differences into account in the final dispersion law:

- Check the box "delta lambda" in the "Lambda" frame



- Click on the button "Calcul" to compute the dispersion law

The dispersion computation applies a linear interpolation between each difference and adds it to the lambda computation.



Note: The lambda differences are not saved with the interpolation law coefficients. They shall be recomputed at each time.

Changing the appearance of a profile document

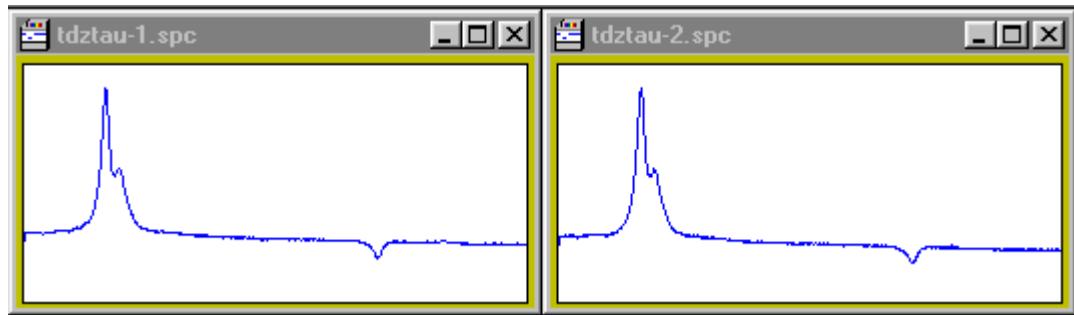
Enlarging, reducing a window

The Profile document has an adjustable size. Adjustment of the size is done as for standard Microsoft windows. To maximize the window, click on the “maximize” symbol of the window.

Thumbnails

To view a collection of profile documents, it is possible to reduce all the windows to a small thumbnail format.

- Click on the “Windows” menu, choose “Small Windows”.



Adjusting Format

One can automatically put the document window into the format of its original image.

- Click on the “Windows” menu, select “Adjust”.

Or

- Click on the "Medium Size" button  of the Profile toolbar



Note: A pixel in the graphic area of the profile will correspond to a pixel of the original image if the series is viewed in its entirety, from first to last pixel.

Pre-defined Format

It is possible to define and apply a particular size, different from the Small or Adjusted size, to a profile document.

To apply a pre-defined size:

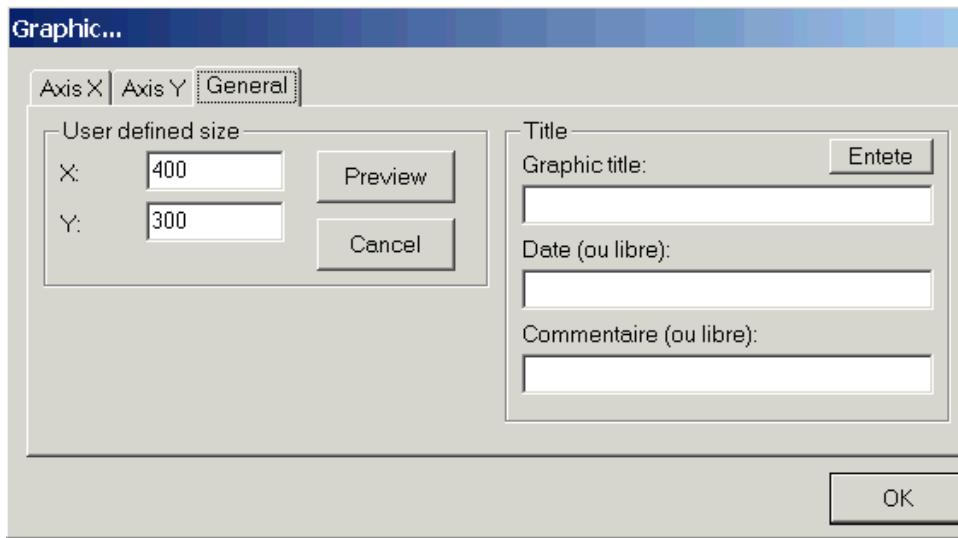
- Click on the "User Defined Size" button  in the Profile toolbar

Or

- Click on the “Windows” menu, select ““Predefined”

The default size can be modified by using the “General” tab in the “Graphic” dialog box.

- Click on the Format menu, select "Graphic..."



- Select the “General” tab
- Edit the X and Y size fields, in units of pixels
- View the results by clicking on the “Preview” button
- Click on the button “Cancel” to return to the original size
- Click on the button “OK” to close the dialog box.

Display graduated axes and a title

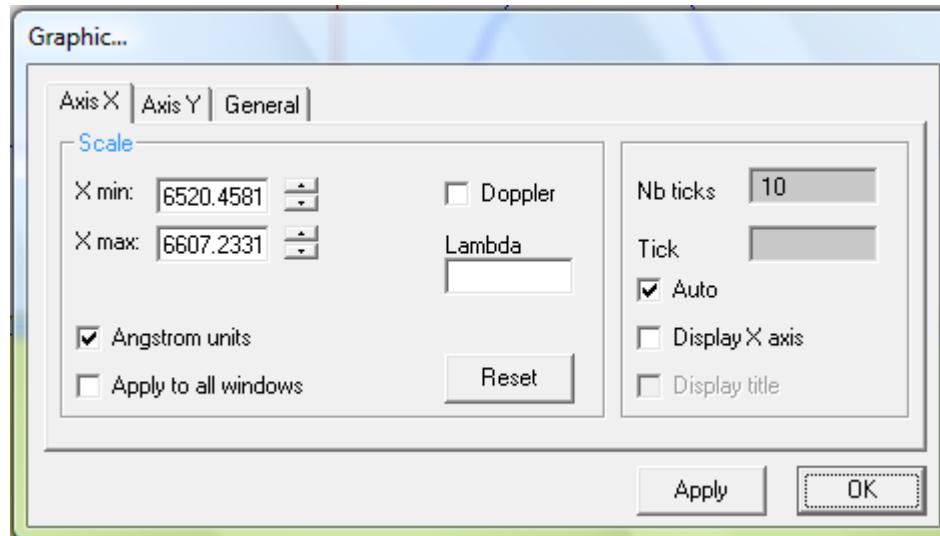
To display the graduated axes of the active series of a profile:

- Click on the Format menu, select "Graphic..."

Or

- Click on the buttons  in the toolbar

The "Graphic..." dialog box is displayed



Tab Axis X

- Click on the tab "Axis X" and check the checkbox "Display X Axis" to view the X axis graduations

Or

- Click on Auto checkbox. The application will define automatically the best combination of ticks and graduations
- Check the checkbox to "Display title" so the title of the graph will be displayed in the predefined corner of the application. The title of the graph is entered in a textbox on the General tab

Tab Axis Y

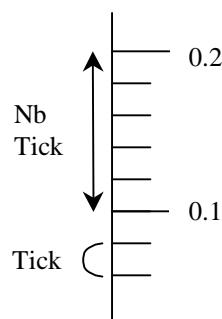
- Click on the tab "Axis Y"

Or

- Click on Auto checkbox. The application will define automatically the best combination of ticks and graduations
- check the checkbox "Display Y Axis" to view the Y axis graduations.
- Check the checkbox "Display gridlines" to view the grid in horizontal dashes for each major graduation

The axes display two types of graduations:

Simple graduations or "ticks" are displayed by plain dashes. The distance between two simple graduations is defined by the value of the tick. If no value is entered into the textbox "tick" then this value will be automatically calculated.



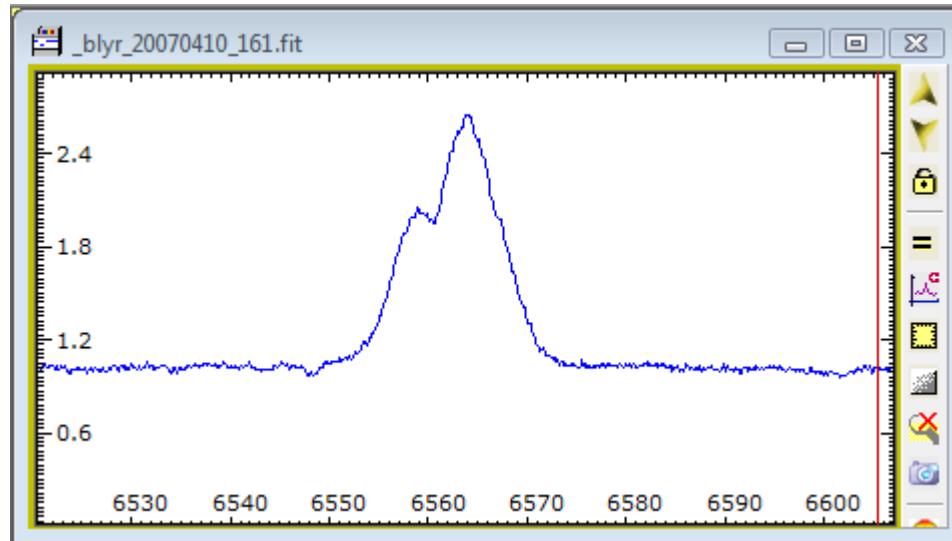
Labeled graduations are defined by the number of simple graduations or “ticks” separating them, and are displayed using a longer dash and the X or Y value.

If no value is present in the “Tick” text area, the application automatically determines the most suitable value.

The graduations apply to a document and not to a series. If one selects a different series, the graduation of the axes may give less desirable results. Then adjust the graduations to display.

On the Y axis, if the application detects a difference too large between the value automatically proposed by the application and that entered by the user, it will use the automatic value.

- Click on “Apply” to view the result
- Click “OK” to close the dialog box and save the result.



Short-cut "graduations on"

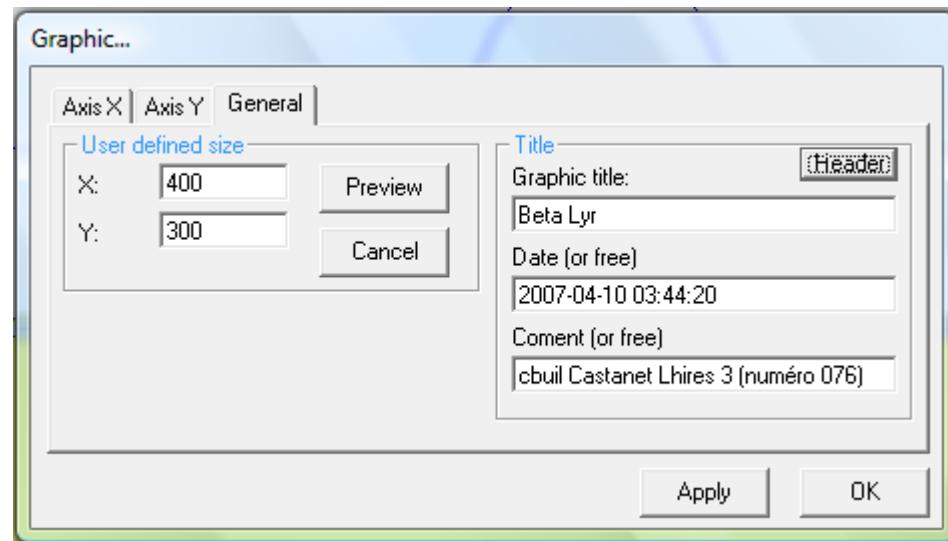
When clicking on the "display graph" button  on the profile document side toolbar the auto function is also activated

The function to display the graduation will update the display everytime the window is resized. For better performances, switch off the graduation display when resizing the window.

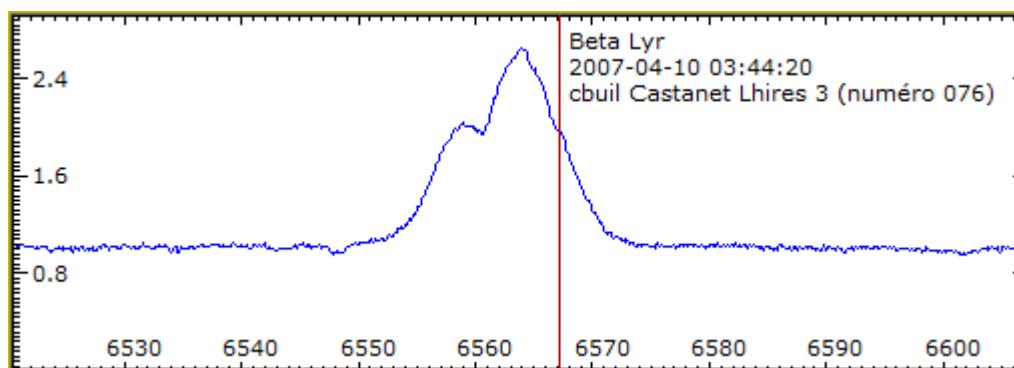
Graph title

Visual Spec offers the possibility to add a title and two lines of comment superimposed onto the image

- Click on the “General” tab



- Enter the graph title in the field “Graphic title”
- To automatically display the date or comments from the header, click on the button “Entete” (“Header”).
- Freely edit, as needed, the date and comments lines, which will be displayed underneath the title.
- Check the checkbox “Display title” in the tab “Axis X”.



Once the title is displayed, it is possible to move it within the image.

- Place the cursor in the area of the title, and the cursor will become cross-shaped
- Click and hold the left mouse button while moving the title to the desired place.

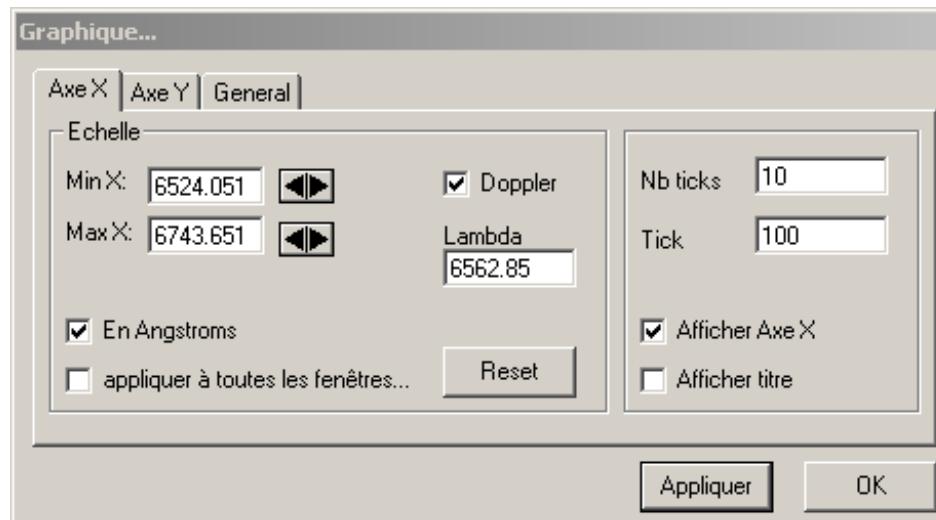


Note: After resizing, the title will always return to the upper right corner.

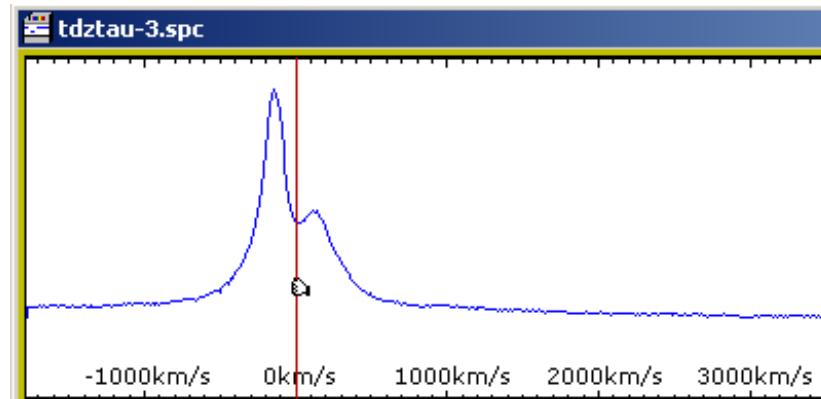
Doppler shift scale

To graduate the profile in Doppler shift (km/s) relative to a given wavelength on the X axis:

- In the tab "Axis X", mark the Doppler box and enter the wavelength value in the lambda text field.



- Click on Apply to check the result. Adjust the ticks and Ticks Nb if needed.



The doppler shift values are computed versus a reference wavelength λ following the equation formula $((\lambda - \lambda_{\text{ref}}) / \lambda_{\text{ref}}) * c$, c being the light speed in km/s – 300000km/s

The document is not modified, only the display takes into account the new X values. To save the serie along with the Doppler shift export the current document in .dat format. (Doppler shift – intensity").

- Click on menu File, choose Export .dat

A .dat file will be created with the same name but the .dat extension in the current directory.

Changing the color and font

To change the background color of the Profile document

- Click on the Format menu, select “Background color...”

The “Color” dialog box will be displayed.

Click on the color to display as the background of the document

Click on “OK” to close the dialog box and apply the selection

As needed, also change the colors of the series by selecting from the color control of the Profile toolbar to apply a new color to the active series.



The color is specific to the active document. Redo the operation to change the background colors of the other Profile documents.

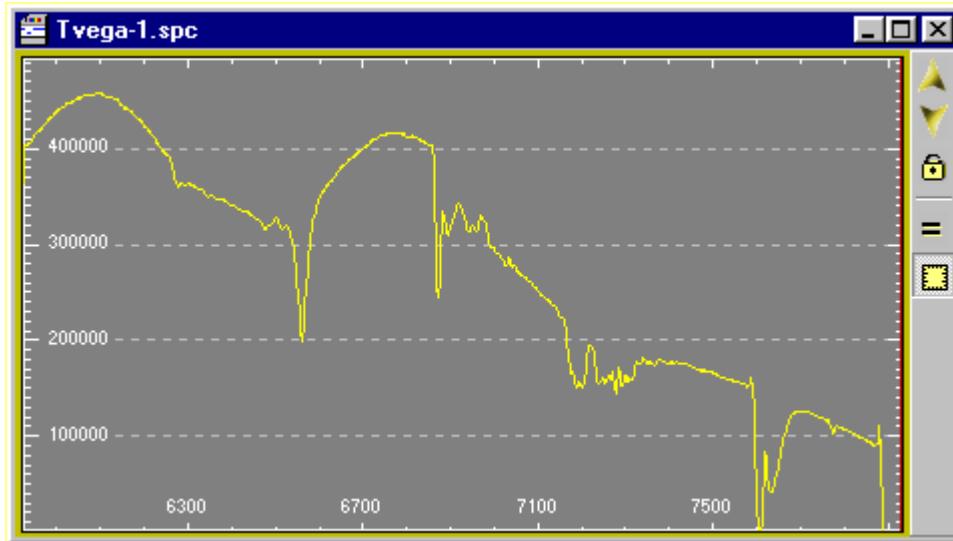
To change the text font

- Click on the Format menu, choose Font...”

The “Font” dialog box will be displayed

- Select the font and font style options
- Click on “OK” to close the dialog box and apply the selection

The text font applies to the axis graduations or line labels.

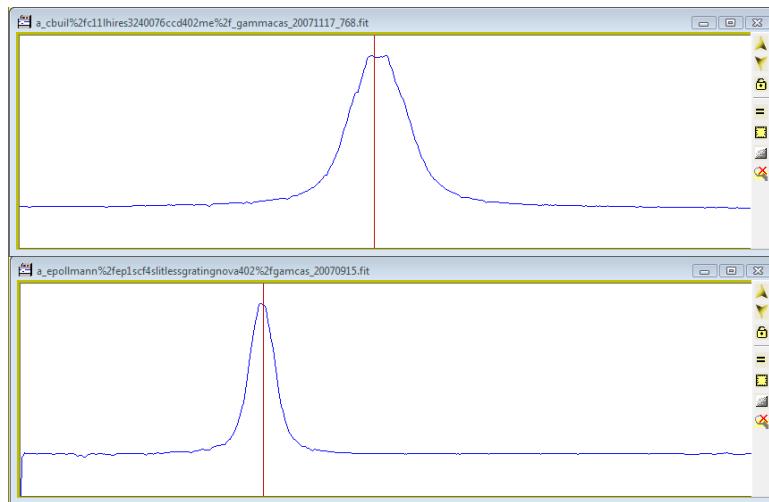


Cursor synchronization

Synchronize the move of the cursor on all the opened profiles.

Activate the mode with the button

The cursor of all the open profiles will move at the wavelength of the cursor of the active profile.



Export to other applications

The Visual Spec application offers a certain number of links to standard applications by generating files compatible with the formats used by these applications. These formats are:

- .fit format with BeSS keywords
- .bmp files, for saving the spectral profile
- .txt file, compatible with spreadsheets, for exporting values from .spc files to other applications for data processing.
- .dat file, text format that contains only the active series in the form of two columns.

Exportation as fits "BeSS"

To export a file in the fits format, Vspec offers you to format the fits file required parameters and update the Fits BeSS new keyword to make the fits file directly compatible with the BeSS database. This database is operated by the GEPI team, at Paris-Meudon observatory, and is dedicated to Be Stars. See the base at <http://basebe.obspm.fr/basebe/Accueil.php>

To configure your BeSS parameters, default settings can be updated in the preferences, tab "BeSS(1)" and "BeSS(2)".

Profile exportation

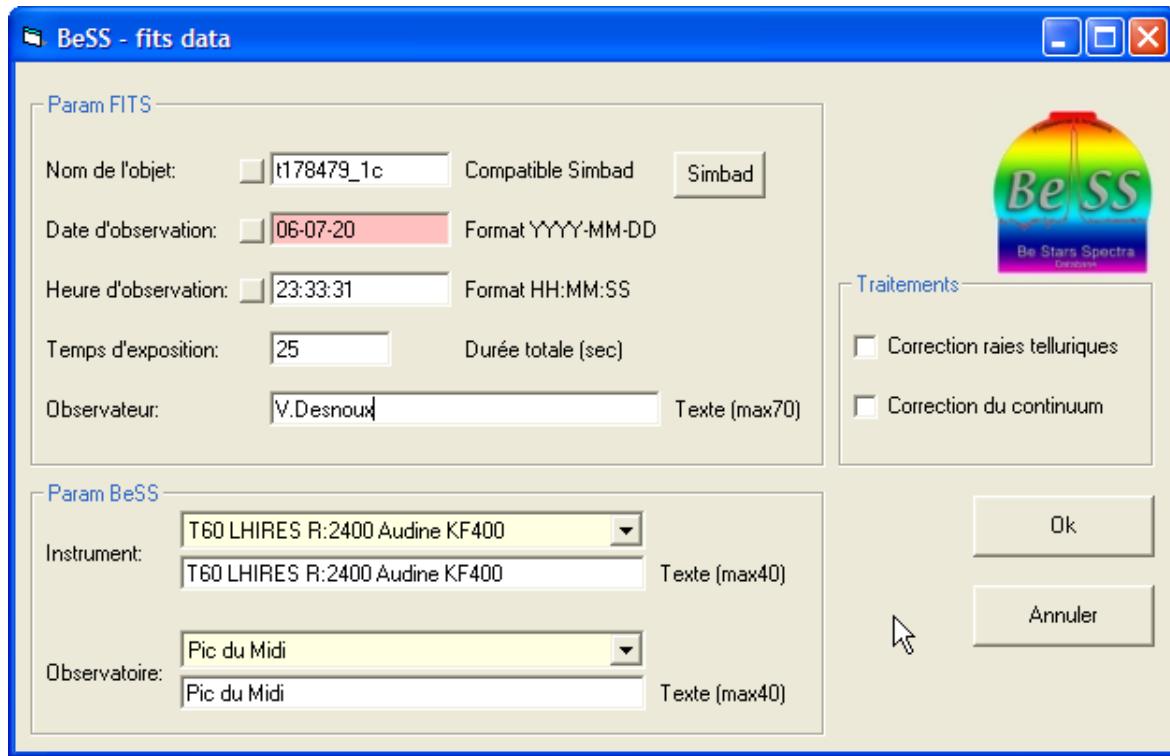
To convert the active profile:

- click on menu "file", sub-menu "Fit export"



A dialog box is displayed

Dialog box "BeSS – fits data" - description



Visual Spec automatically extract parameters from the spc file header. So, it is your interest to fill it and to update the default settings in the preferences

- **Object name:** By default, Vspec takes the name of the file without its extension. The object name shall be recognized as one of the official name of the object. You can check it by checking the "Simbad" database: <http://simbad.u-strasbg.fr/sim-fid.pl>

- To check the object name, you can make a "Simbad" search by clicking the "Simbad" button. Vspec will prompt for the name and launch internet for a Simbad request.
- **Observation date:** date of the beginning of the observation, extract by default from the header.
- **Observation time:** the time of the beginning of the observation, extract by default from the header spc.
- **Exposure duration:** This shall be the total duration of the observation, extract by default from the spc header. From the BeSS specification, it is not only the cumulated time of the exposure, but the total length of the observation. Date and time of the last exposure + its exposure time minus the date and time of the beginning of the first exposure.
- **Observer:** by default, extract from the preferences, tab Bess, Observer.
- **Instrument:** by default, extract from the preferences, tab Bess, Instrument – or can be chosen in the drop-down list above
- **Site :** by default, extract from the preferences, tab Bess, Observation site – or can be chosen in the drop-down list above
- The BeSS database expect to receive spectra with minimum processings: wavelength calibrated and response corrected. But in some case, other processings could have been applied like atmospheric lines correction, then check the option box, or continuum corrected, then check the option box accordingly.

To export the file in fits format, click on OK. The dialog box is closed and a new one appears to ask for the directory and the file name to be saved.

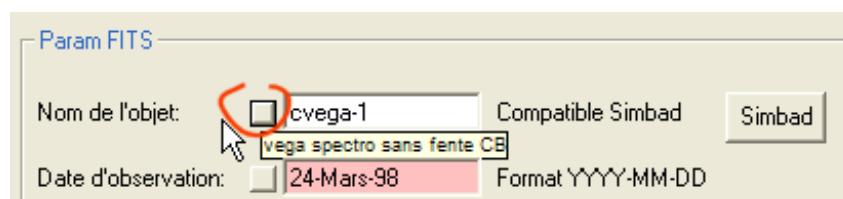
Vspec is able to read fits file which are 1D spectral profile. (not echelle spectrum). But for the best performances of Vspec it is recommended to convert it into spc format for all the spectral functions. You'll have to export it again if you want to stay with the fits format.

To ease the data typing and to avoid errors which will be found by the BeSS verifier, Vspec has some helps and warnings included:

- If you move the cursor over the labels, a tip window is displayed with information on the parameter to enter, like format of meaning.



- If the small square button is clicked, a tip window is displayed with the original entry of the spc header



- In some text field, as long as the entry does not meet the expected format, the background is in light pink.

.bmp Image

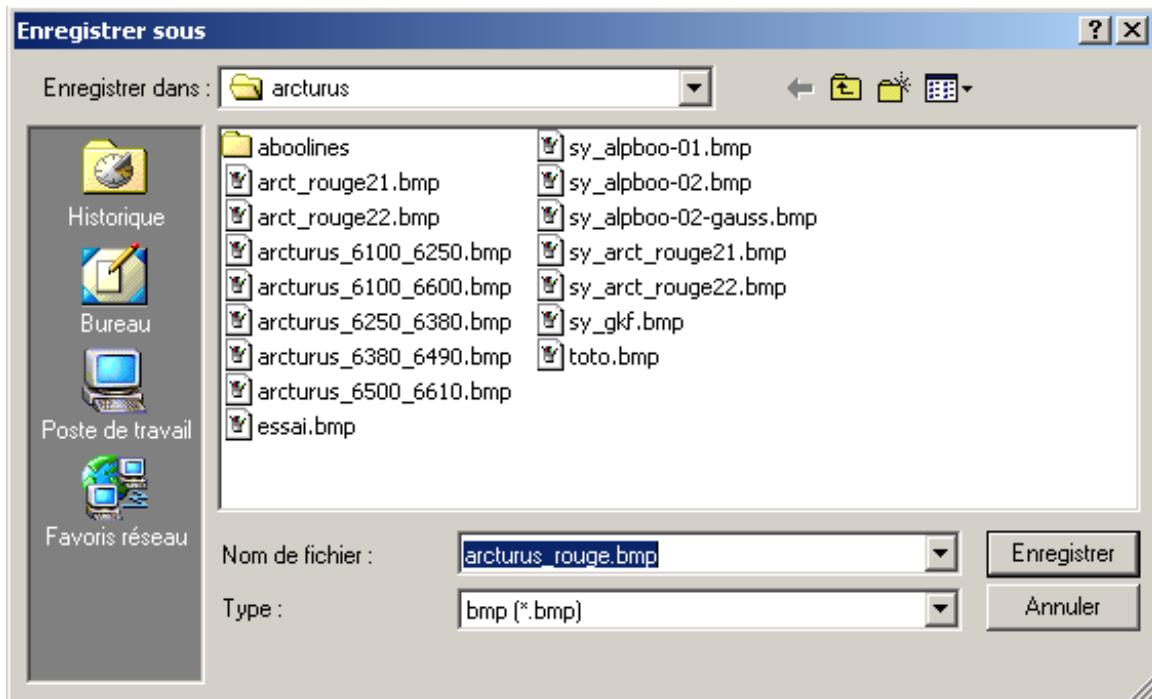
To create a .bmp image of the active Profile document:

- Click on the "File" menu, select "Export bmp"

or

- Click on the side button  in the document side toolbar

A dialog box to enter the file name will appear.



By default, the .bmp file will take the name of the .spc document with the .bmp extension, and will be saved in the working directory.

The saved image is a copy of the image area of the active document, graduations, cursor and color included.

.txt Profile

To create a .txt file from the active Profile document:

- Click on the "File" menu, select "Export txt"

The .txt file will take the name of the .spc document with the .txt extension, and will be saved in the working directory.

The text file contains the set of values of each series of the .spc document, each line being formatted in the following manner:

0	<i>number of pixels in the series</i>
768	<i>value that is not used</i>

```

22/04/1998 00:09:45.84      date and time of start of pose (exposure)?
22/04/1998 00:09:51.84      date and time of end of pose
6                           times de pose in seconds
SpectroCB Véga            comments
0                           value not used
.spc                        extension of original file
pixel tab angström tab intensité tab Ref1 tab Ref2 tab normalise tab repère cr      series name
1 tab 5925.349 tab 29612.8163 tab 10733710 tab 0 tab 0 tab 0 cr      values by pixel
2 tab 5927.968 tab 32720.3065 tab 10733710 tab 0 tab 0 tab 0 cr
...

```

The tab characters **tab** and line-returns **cr** are placed to facilitate reading of the .txt file by a spreadsheet application such as Excel. Each cell will contain one value for the set of lines.

.dat File

to create a .dat file from the active Profile document:

- click on the “File” menu, select “Export dat”

The .dat file will take the name of the .spc document with the extension .dat, and will be saved in the working directory.

The format of the .dat file is ASCII, comprised of two columns. The first column contains the wavelength, the second column contains the spectral intensity of the active series.

.gif or .png file

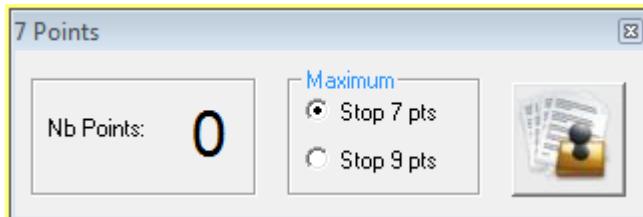
See the "GnuPlot" section later in this manual.

Points list

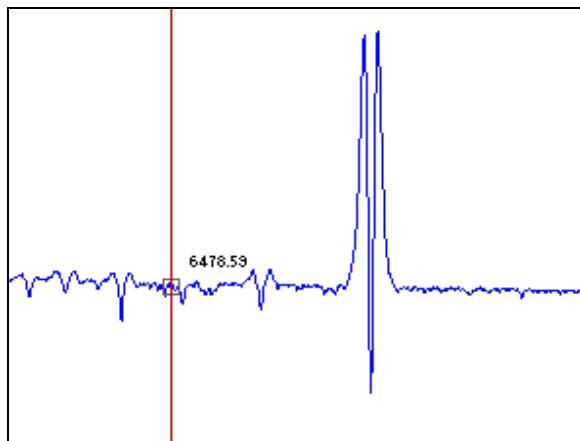
It is possible to point and store a liste of wavelength and intensities up to 7 or 9 points clicked in a profile.

- Click in the menu Tools, sub-menu 7pts

A new window is displayed



Move the cursor over the profile on the values (point) you want to memorize. Click on it.

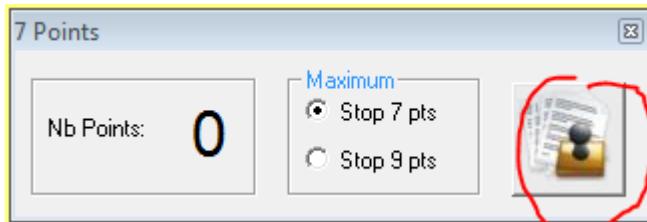


A small rectangle is displayed around the point selected. When the cursor is moved over this rectangle, the wavelength is displayed on the top-right.

To cancel a point, click on the rectangle you want to remove, then press "Suppr" or "Del" to remove it.

The window displays the number of points to reach the upper limit of 7 or 9 points. You can change the upper limit with the radio button.

To finish and export the list in the file liste7pts.txt, click on the big button on the right.

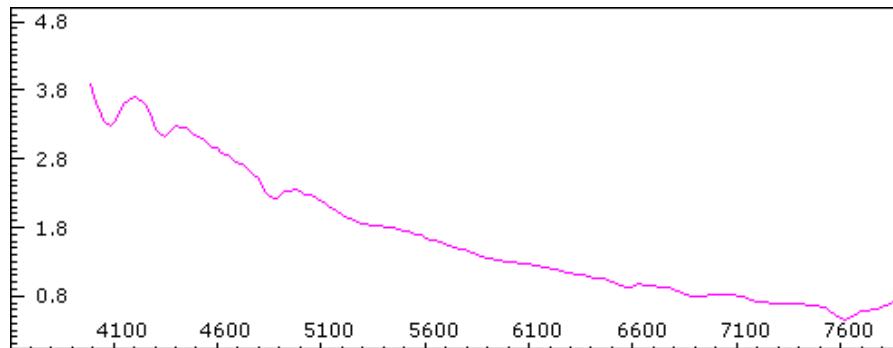


Clipboard

To rapidly copy the image window of a profile document, one can use the Clipboard.

- Click on the Edit menu, select Copy
- Select an application that supports the image-copying function of the Clipboard
- Paste the contents of the Clipboard; a .bmp image of the active profile document is pasted.

To display an image frame, display the graduated axes.



CHAPTER 5

Spectral Series

The creation of a spectral series is at the base of the set of functionalities of Visual Specs.

A spectral series is a curve representing spectral intensity as a function of wavelength.

One can modify their format: scale in X and Y, zoom to an exact area, clear the display of a series, display the wavelength of a selected line. These operations only modify the way in which the series is viewed.

It is also possible to add series by copy/paste, to suppress a temporary series, or to replace one of the basic series with one of the temporary series.

One can modify a series by applying transformation operations such as translation or by applying simple arithmetic operations with a constant. One can combine several series to achieve a re-sampling or a composite.

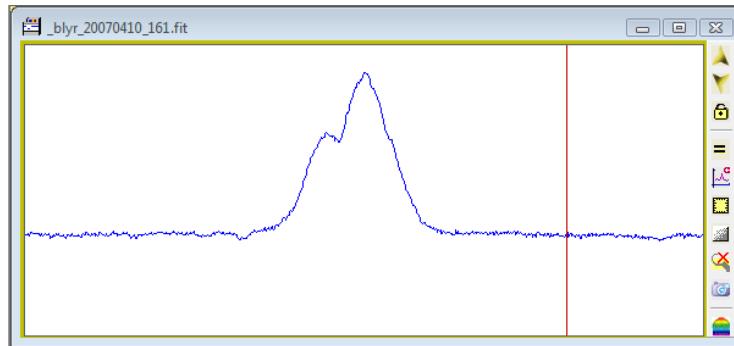
One can create temporary series as a result of an operation applied to the selected series, such as filtering, normalization, derivation, calculation of a Planck profile, and some operations such as division that combine the active series with another series. It is possible to save a temporary series by replacing one of the four basic series with the temporary series to be saved.

One can modify, pixel by pixel, the intensities of a series.

A toolbox dedicated to measurement of an area of the spectrum, such as a line or a continuum, contains the basic calculations of spectrometry or statistics: full width at half-maximum, signal-to-noise ratio, center of a line, equivalent width, average, standard deviation.

Format

It is possible to modify the scale of the series displayed in the profile document using the vertical toolbar of the document.

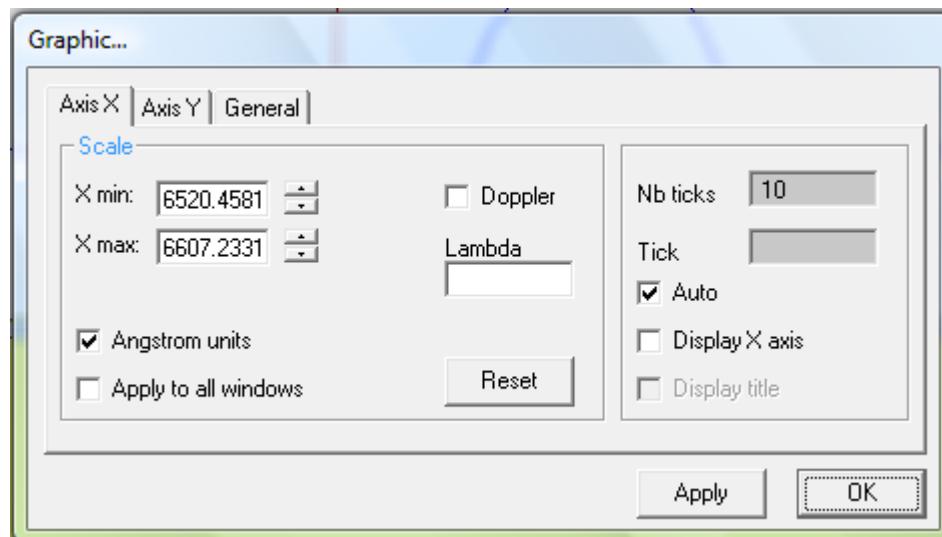


Or, by using the "Graphic..." dialog box.

- Click on the Format menu, choose "Graphic..."

Or

- Double-click in the graphic area



Modify the scale

This operation concerns, needless to say, the active series.

The scales of the series are:

In X: min and max value of the domain in wavelength, or min and max pixel number

In Y: min and max value of the intensity of the profile

The Y axis of a series is scaled automatically when it is displayed, starting from the maximum intensity of the profile multiplied by 1.1 (the min value being fixed at 0).

The X scale of a series is scaled automatically when it is displayed, based on the min and max wavelengths or pixel numbers of the profile.

If the min and max values of these scales are modified, the new values are used.

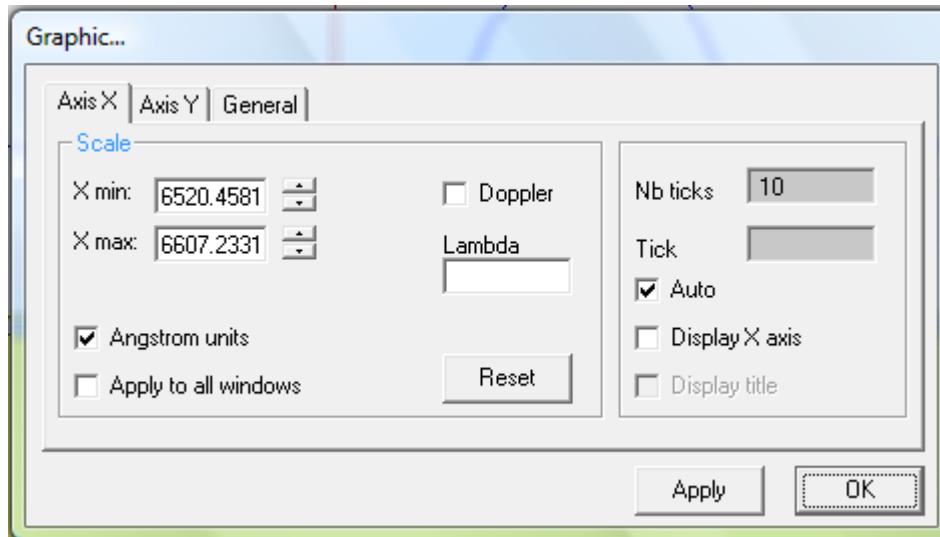
Modification of the min and max values of these scales is done using the "Graphic..." dialog box.

- Click on the Format menu, choose "Graphic...", and click on the tab "Axis X" or "Axis Y"

Or

- Click on the buttons "Scale X"  or "Scale Y"  in the profile toolbar.

X Axis Scale



- Click on the tab “Axis X”
- Enter the new thresholds "X min" and "X max" for the X scale of the profile into the editable fields

Or

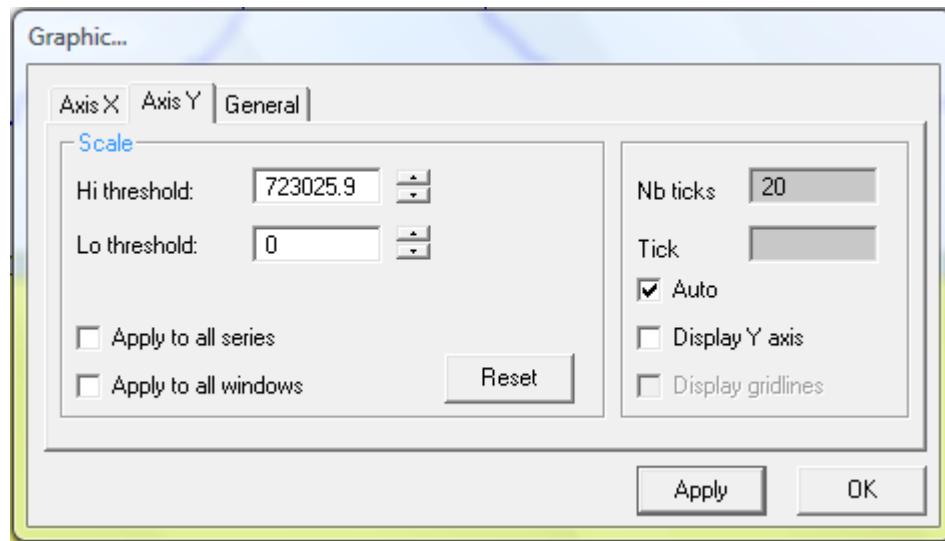
- Click on the Right/Left control arrows to increase/decrease the value by ten percent.
- Click on the checkbox “Angstrom units” to edit the thresholds in Angstroms. By default, the min and max values represent the pixel number in the profile or the coordinates of the min and max pixel.
- Click on the checkbox “Apply to all windows” to make the change in scale apply to all displayed profile documents.
- Click on the button “Apply” to instruct the application to apply the scaling.
- Click on the button “Reset” to return to default values
- Click on “OK” or in the close symbol of the dialog box to make it disappear.



Note:

When the min and max values of the X scale are lower, higher than the real min and max values of the profile, cursor movement is limited to the effective area of the spectral profile.

Y Axis Scale



Enter the new high and low thresholds Y scale of the profile into the editable fields

Or

- Click on the Right/Left control arrows to increase/decrease the value by ten percent.
- Click on the checkbox “Apply to all windows” to make the change in scale apply to all displayed profile documents.
- Click on the checkbox “Apply to all series” to make the change in scale apply to all the series
- Click on the button “Apply” to instruct the application to apply the scaling.
- Click on the button “Reset” to return to default values
- Click on “OK” or in the close symbol of the dialog box to make it disappear.

Vertical toolbar of the profile document

It is also possible to make adjustments to the Y scale very quickly using the vertical toolbar of each Profile document.



Decrease the max threshold of the active series by 10%

Increase the max threshold of the active series by 10%

Apply the changes to all series 'Lock'

Apply the max threshold of the active series to all the series

Find the max of all the series displayed and apply it to all all series

Display the graduated axes

Erase all overlayed graphics like label lines

Unzoom



Note: It can happen that the changes or equalization of thresholds does not permit viewing certain series in the document. To return to the original display, select the invisible series in the control listbox of the Profile toolbar, then display the "Graphic..." dialog box and click on Cancel.

Zoom

A more direct method for changing the X scale is available using the zoom function.

- Select a spectral area
- Click on the button “Zoom” of the Profile toolbar

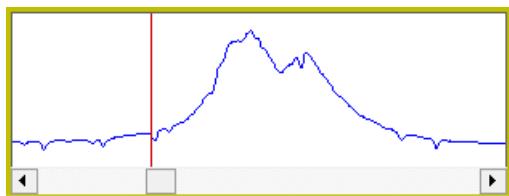
The X scale will be automatically adjusted to the lower and upper borders of the selected spectral area.

To cancel the zoom, click on the "Cancel zoom" button of the Profile toolbar.

To immediatly make a zoom on a profile region, maintain the "Maj" key while clicking and dragging on the region.

Horizontal sliding bar

If the profile displayed is longer than the section the section displayed, you can slide along the profile whilae maintainaing the same zoom factor. Move the cursor toward the bottom of the graphic zone to make the horizontal sliding bar appear.

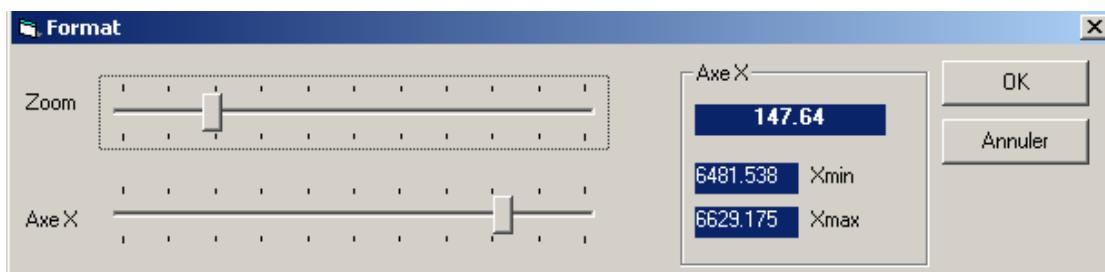


Interactif zoom

This function of zooming and translating the spectrum ease the visual correlation between to spectra or to simply explore a large spectrum.

- Click on the menu Format, choose Zoom...
- or
- Use the shortcut Ctrl+Z

A dialog box appears



Move the zoom slider to modify real time the zoom factor of the current profile document.

The same way, move the Axe X slider to translate the display of the spectrum;

The Xmin and Xmax values represents the start and end values (either wavelength if calibrated or pixel number is not). Above the spectral extent is displayed .

Applying the same format

This function is an alternative to the option "Apply to all windows" of the Axis X dialog box with in addition the setting of all the windows size to the active window size

To apply the X scale and the window size of the active window to all the windows:

- Select the window from which one would like to extend the format to the other windows
- Click on the Edit menu, choose "Apply format"

Or

- Click on the "Paste format" button  of the Profile toolbar

Clear a series

Clearing a series makes it disappear from the display, but does not remove it from the listbox of series.

To clear a series:

- Select the series to clear
- Click on the Edit menu, choose Clear

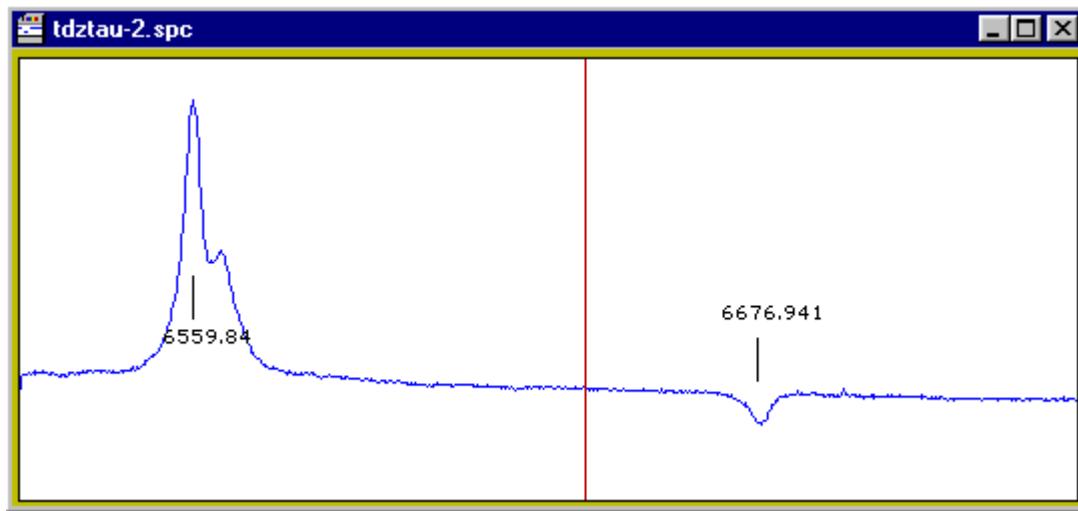
Or

- Enter Ctrl+D at the keyboard

Label the wavelength of a line

Labeling a line consists of displaying, under the barycenter of the line, a label indicating the wavelength of that line.

- Select the line to label
 - Click on the menu Tools, choose Label
- Or
- Right-Click in the selected area. The pop-up menu will be displayed. Select the item Label



Note: The line label will disappear each time the window is refreshed. Refreshing a window happens when one changes its size, displays a new series, or activates a new window.

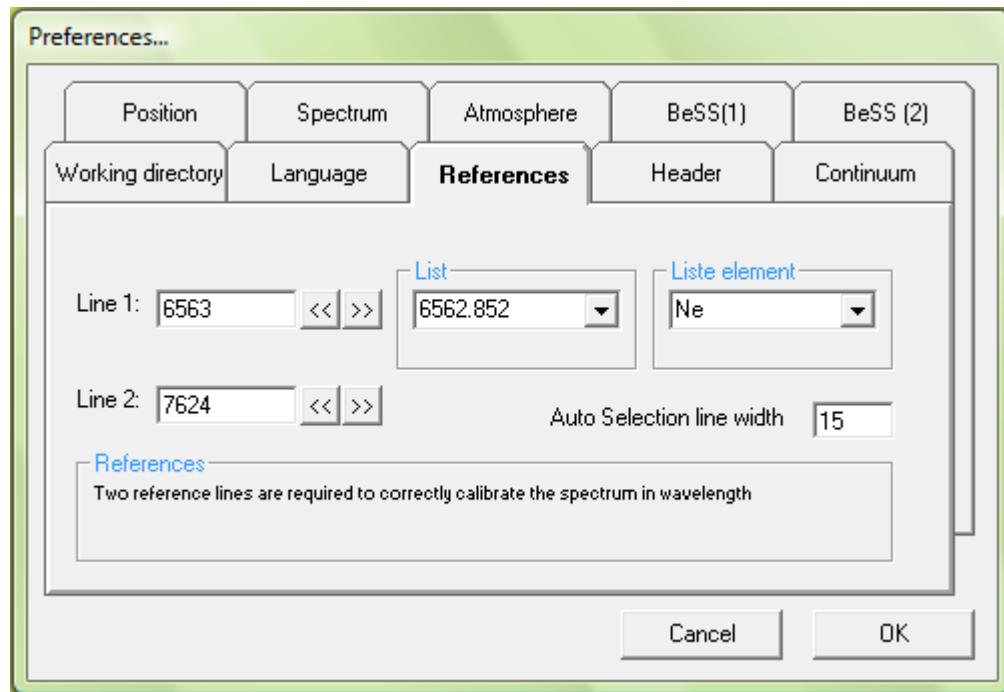
Automatic selection of a spectral line

To select a line in a profile, the standard method is to click-drag the mouse around the line. Whatever the profile is, the selection will be what is inside the gray rectangle.

If the spectral line are about the same (a constant driven by the spectrograph design), a short-cut is available:

- Click on the line while maintaining the Ctrl key

Visual spec will first detect the max (or the min if absorption lines) around the cursor position with a range specified in the Auto Sel Line specified in the preferences.



Once the max (or min) is found, the selection start and stop are defined by the Auto Sel Line width.

Crop a serie

The crop function allows for keeping only a section of the profile

- Select the spectral zone to keep
- Click on the menu Edition, Choose Crop

or

- Click on the button  in the profile toolbar

 Note:

Caution: this operation is not reversible. It definitively invalidates non-included pixels after saving.

Adding, replacing, and deleting

Copy a series

To copy a series:

- Select the series to copy
- Click on the Edit menu, choose Copy

Or

- Click on the Copy button  of the Profile toolbar

Or

- Enter Ctrl+C on the keyboard



Note: The copy operation can also copy a bitmap of the document to the Clipboard. Open an application that will accept a bitmap image and paste into it the contents of the Clipboard.

Paste a series:

To paste a series:

- Select the document to which the series will be added
- Click on the menu Edit, choose Paste

Or

- Click on the button Paste  of the Profile toolbar

Or

- Enter Ctrl+V on the keyboard

The series will be added to the list of series in the Profile document and become the active series. It will have a generic name “SerieX” where X is an incremented number.

If both the series to be pasted and the Profile document to receive the series are calibrated in wavelength, it will be resampled using the wavelength calibration of the “intensity” series of the destination document.

If the destination Profile document is not calibrated in wavelength or if the series to be pasted is not calibrated, and if the serie to be pasted has the same number of pixels as the destination document, then it will be displayed without scaling as a function of the number of pixels. If the number of pixels is different, the operation is not possible and a warning message will announce that the series are not compatible.

When no series is copied, the Paste button is inactive.

In the bottom status bar, the origin of the serie and the date of its file will be displayed. This helps to know where the paste serie comes from.

Replace a series

To replace a basic series with the active series:

- Click on the Edit menu, choose Replace

Or

- Click on the Replace button  of the Profile toolbar

The “Replace...” dialog box is displayed.

Only the active series of a document can replace a basic series within the same document.

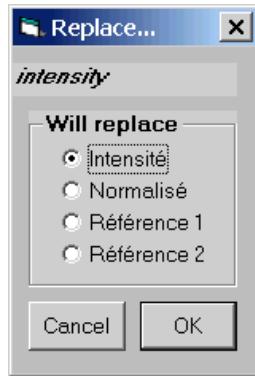
The series is resampled using the calibration of the “Intensity” series.



Note: To replace a series by a series from a different document, use Copy/Paste between the two documents.

“Replace...” dialog box

- First select the active series that will replace one of the basic series. (See section “Selecting a Series”.)



- Click on the radio button corresponding to the basic series whose values are to contain the values from the active series
- Click on the “OK” button to close the dialog box and replace the series
- Click on the “Cancel” button to cancel the operation

Delete a series

During execution, certain temporary series are generated and added to the list of series of a document. To delete a temporary series

- Select the series to delete
 - Click on the Edit menu, choose Delete
- Or
- Press the DEL key on the keyboard

Modifying a series

Arithmetic operations

To apply a simple calculation using a constant:

- Click on the Operations menu, choose "Arithmetic Operation"
- A dialog box is displayed



- Select the arithmetic operation to perform
- Enter the parameter
- Click on the button Apply to view the result
- Click on the button Cancel to cancel the operation
- Click on the button Close to close the dialog box.

Low-pass Filtering

Low-pass filtering consists of replacing the value of the pixel by the average of the n pixels surrounding it. To apply a low-pass filter to a series:

- Select the series to filter
- Click on the Operations menu, choose Low-Pass Filter

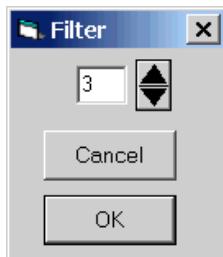
Or

- Click on the “Filter” button  in the Profile toolbar

Or

- Enter Ctrl+F at the keyboard

A dialog box for selecting the order of the filter is displayed. The cursor is positioned automatically on the OK button.



- Change the order of the filter by clicking on the Up/Down control arrows. The value will always be odd. The value area is not manually editable.
- Click on Cancel to cancel.
- Click on OK to apply the filter and close the dialog box.

The new series that was created by filtering the active series will be added as a temporary series to the list of series of the document.

Its name is composed of the initial name of the active series to which a prefix Fb+<filter order> is prepended. This operation can be repeated several times; each time a temporary series is added and becomes the active series.

Example:

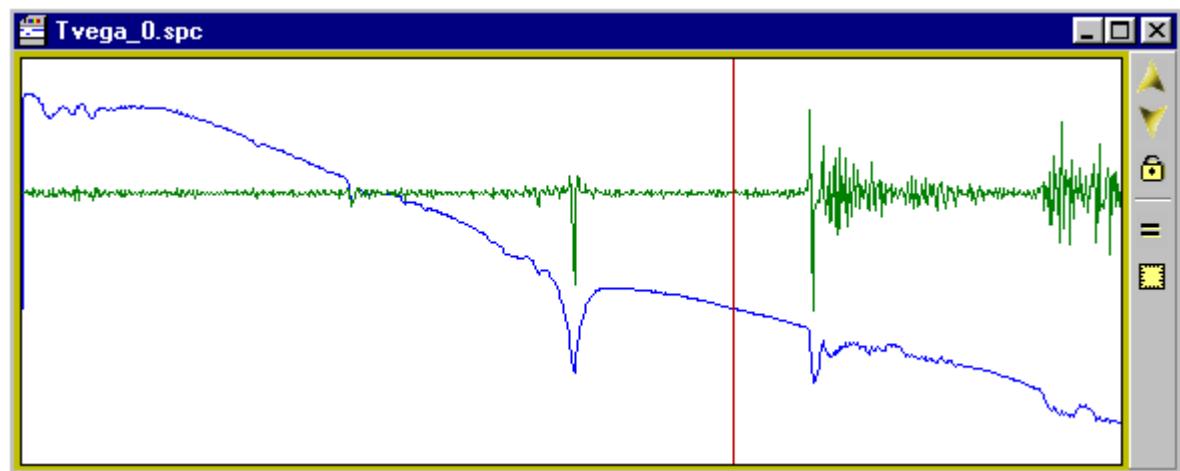
```
Fb3.intensity
Fb3.fb5.Ref1
```

High-pass Filtering

To better highlight the area where lines are present, it is possible to eliminate slow modulation from the spectral profile by dividing the spectrum by its spectrum filtered by a low-pass filter. The function OptiDiv applies this type of automatic filtering.

- Click on the Spectrometry menu, choose OptiDiv

The application will automatically apply a low-pass filter of order 3 to the active series, and then divide the original series by the filtered series. The result is a new temporary series of the name Division which is added to the list of series. The series fb3.<series name> is also added to the list.

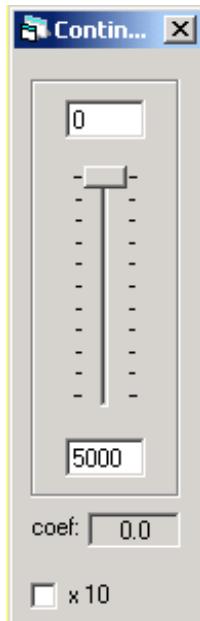


Spline Filtering

Spline Filtering interpolation is a powerful filtering which initially calculates the Spline coefficients and then rebuilds the profile starting from these coefficients with a softening factor.

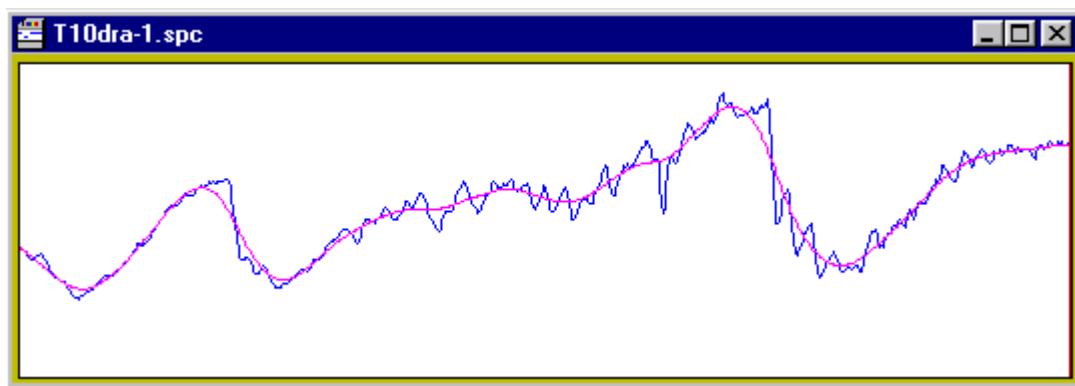
- Click on the Operations menu, choose "Spline Filter"

The rebuilt profile is displayed in violet, superimposed. A control for adjusting the softening parameter is displayed.



- Drag the slider with the mouse to modify the softening coefficient. The value of the coefficient is displayed in the control's header area. The affect on the series is visible in real-time in the document window.
- You can edit the adjustment bounds of the coefficient by entering the new values in the editable textboxes above and below the slider.
- If you click on “Enter” while the cursor is in one of the editable areas, the slider and the softening parameter itself will be automatically adjusted to the new value.
- Click on the Page Up and Page Down keys to move from one tabulated value to the next.
- If the max value of 30000 is not strong enough to correctly smooth the profile, click in the x10 box to multiply by 10 all the slider values
- Click on the Up and Down keys to move from one tabulated value towards the next by increments.
- Click on the close symbol of the control to save the adjustment.

The new filtered series based on the active series will be added as a temporary series to the series list of the document.



Its name is made of the initial name of the active series preceded by the prefix Sp.

Example:

Sp.intensity

Gaussian filter

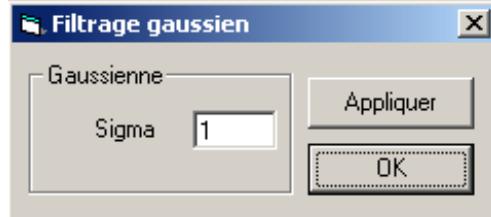
The gaussian filter is another type of filtering which attenuates the noise of the spectrum by smoothing with a gaussian.

To apply the filter

- Select the series to filter
- Click on the Operations menu, choose Gaussian Filter

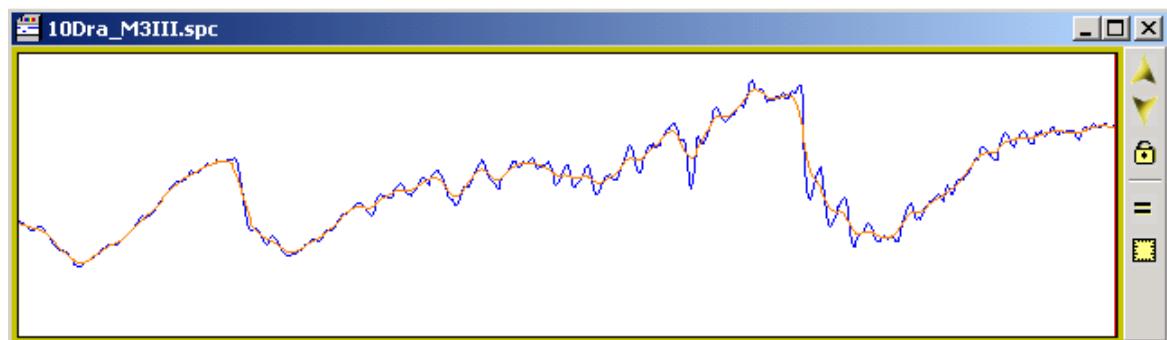
A dialog box for selecting the power of the filter is displayed

Dialog box Gaussian filter



- Enter the sigma value as a non-decimal value defining the strength of the filtering.
- Click on Apply – *Appliquer* to apply the filter

The new series that was created by filtering the active series will be added as a temporary series to the list of series of the document under the name serie.<g>



- Click on OK to apply the filter and close the dialog box.

Mmse filter

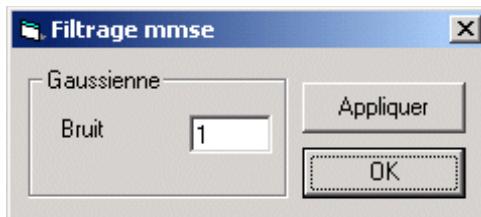
The mmse filter is another type of filtering which attenuates the noise of the spectrum

To apply the filter

- Select the series to filter
- Click on the Operations menu, choose Gaussian Filter

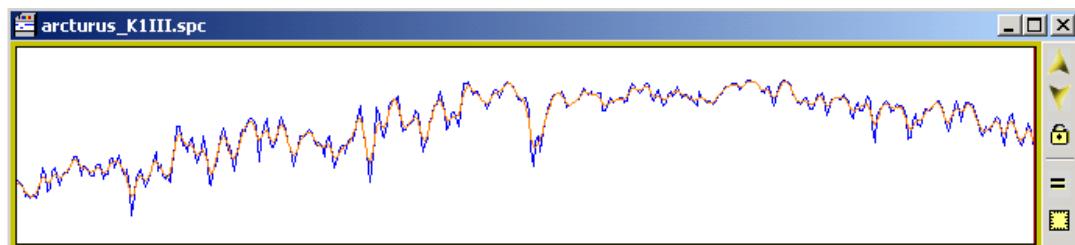
A dialog box for selecting the power of the filter is displayed

Dialog box mmse filter



- Enter the sigma value as a non-decimal value defining the strength of the filtering.
- Click on Apply – *Appliquer* to apply the filter

The new series that was created by filtering the active series will be added as a temporary series to the list of series of the document under the name serie.<m>



- Click on OK to apply the filter and close the dialog box.

Note:

If the coefficient is not strong enough the orange serie covers entirely the original serie

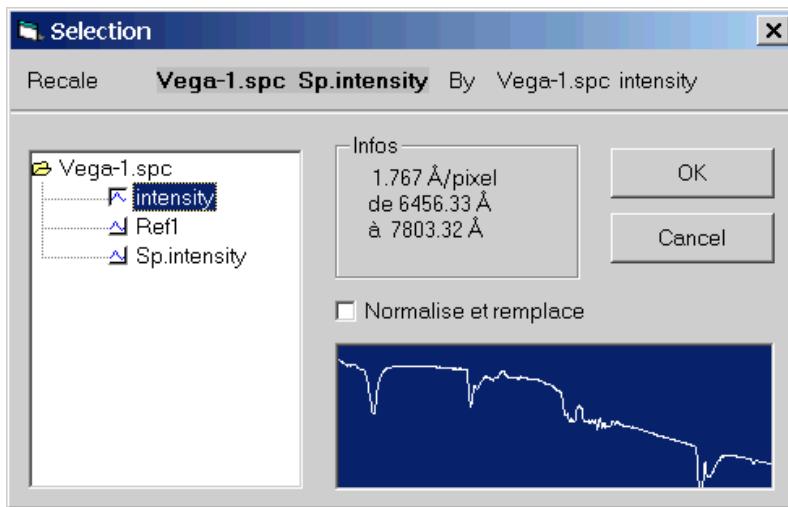
Resample a serie

Resampling a series with respect to another allows the two series to share the same calibration in wavelength. This operation consists of resampling the active series by Spline interpolation based on calibration of another series.

To readjust a series with respect to another:

- Select the series to re-sample
- Click on the Operations menu, select Recalibrate profil by a profil...

A dialog box for selecting the series to be used for recalibration is displayed.



Each Profile document open in the current session is listed in the left area. The available series are displayed here. Only the series that are calibrated in wavelength are listed. The selected series is viewed in the graphic area and information on its spectral extent and sampling are displayed in the "Infos" area

- To select a document, click on the document icon. The list of series will appear
- To select a series, click on the series icon. Its profile will be displayed in the graphic area and the "Infos" will be updated.
- To perform the recalibration with respect to the spectral calibration of the selected series, click on OK.
- To cancel the operation, click on Cancel.



Once started, the operation cannot be cancelled. To return to the original profile, reload the document. The option "Normalize and replace" is inactive.

Binning 1:1 horizontal

When a spectrum has a poor signal to noise ratio, this operation increase the signal at the expense of the resolution. It combines the values of two adjacent pixels into one by addition.

Operations on two series

Divide two series

To divide one series by another:

- Select the series to divide
- Click on the Operations menu, choose "Divide profile by a profile..."
- Or
- Enter Ctrl+D on the keyboard

A dialog box will appear to select the series by..." (See section "Selection Dialog Box".)

The new series, corresponding to the result of the point-to-point division of the active series by the series selected in the dialogue box, is added as a temporary series to the list of the series of the document under the name "Division", and becomes the active series.

Multiply two series

To multiply one series by another:

- Select the series to multiply
- Click on the Operations menu, choose "Multiply profile by a profile..."

Or

- Enter Ctrl+D on the keyboard

A dialog box will appear to select the series by..." (See section "Selection Dialog Box".)

The new series, corresponding to the result of the point-to-point multiplication of the active series by the series selected in the dialogue box, is added as a temporary series to the list of the series of the document under the name "Multiplication", and becomes the active series.

Add two series

To add one series to another:

- Select the series to add
- Click on the Operations menu, select "Add profile by a profile ..."

Or

- Enter Ctrl+D on the keyboard

A dialog box will appear to select the series by..." (See section "Selection Dialog Box".)

The new series, corresponding to the result of the point-to-point addition of the active series to the series selected in the dialogue box, is added as a temporary series to the list of the series of the document under the name "Addition", and becomes the active series.

Subtract two series

To subtract one series from another:

- Select the series to subtract
- Click on the Operations menu, choose "Subtract profile by a profile ..."

Or

- Enter Ctrl+D on the keyboard

A dialog box will appear to select the series by..." (See section "Selection Dialog Box".)

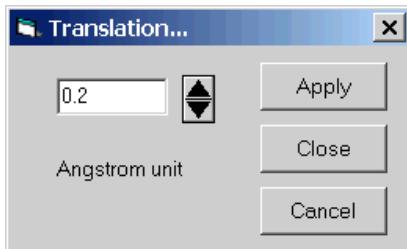
The new series corresponding to the result of the point-to-point subtraction of the active series from the series selected in the dialogue box is added as a temporary series to the list of the series of the document under the name "Subtraction", and becomes the active series.

Translate a series

This operation shifts the absolute value of pixels or angströms of all the data points in the series.

- Click on the Operations menu, choose "Translate..."

The dialog box for adjusting the translation will be displayed



- Enter the amount of the shift into the text area
 - If the profile is calibrated in wavelength, the shift will be displayed in angstroms
 - If the profile is not calibrated in wavelength, the shift will be displayed in pixels
- Click on the "Apply" button to display the result

Or

- Click on the Up/Down control arrows to increase or decrease the translation. The absolute shift is then immediately applied.
- Click on the "Cancel" button to cancel the operation, close the dialog box, and return to the values of the series before the start of the operation.
- Click on the "Close" button to save the translation and close the dialog box.



Note:

To enter a decimal value less than 1, enter 0.2 and not .2.

Normalize a series

Normalization of a profile allows one to obtain the relative intensity of the profile with respect to a reference continuum of 1. This continuum is calculated based on the average of the area of the profile whose boundaries in angstroms are defined :

- If no profil selection is in progress; by the values defined in the “Preferences...” dialog box, “Continuum” tab. (See section “Preferences” in chapter “Introduction”.)
- if a profil zone is selected (gray visible rectangle), by the limit of the selection.

To normalize a series:

- Select the series to normalize
- Click on the Operations menu, choose Normalization

Or

- Click on the button “Normalise”  in the Profile toolbar.

The intensity serie is automatically replaced by the normalized values.

This step of normalization is needed to calculate the equivalent width of a line or to compare two spectra of the same object taken at different times without requiring a spectro-photometric calibration. (See section “Comparison of Profiles”.)

The information window is displayed with the exact boundaries of the spectral zone where the average signal has been computed.

If you do not want to discard the original intensities values, save the file under a new name.

You override the preset continuum values from the preferences by selecting a profile zone with the mouse on which you want the average computation being performed.

Derive a series

To derive the active series

- Select the series to derive
- Click on the Operations menu, choose “Derive”

The new series corresponding to the result of derivation performed on the active series is added as a temporary series to the list of series of the document with the name “derivee.<active series>”, and it becomes the active series.



Note: If the series does not appear in the window, verify that the scale in X is correct.

Stack several series

Stacking permits addition of several series of the same object in order to increase the final signal-to-noise ratio. The operation is performed starting from the “Intensite” series of each document.

If the spectral sampling is different, rescale the spectra before adding.

To stack a set of spectral profiles:

- Open the set of documents to stack
- Ensure that each has been calibrated in wavelength
- Click on the Operations menu, select Compose

Each “intensity” series of the displayed documents will be rescaled in wavelength with respect to the “intensity” series of the active profile and added to it.

The active document then contains in its “intensity” series the result of stacking the set of profiles.

- Save the new profile under a different name



Note: You can then verify that the signal-to-noise ratio has been improved with respect to that of similar non-stacked profiles.

Join two series

Joining two series creates a new Profile document whose “intensity” series contains the two joined series, normalized over the area of overlap. This operation is only possible if one of the series was calibrated in wavelength.

To join two series

- Select the first series
- Click on the Operations menu, select Join

A dialog box for selecting the series “by...” allows the choice of the second series. (See section “Selection dialog box”.)

A new Profile document is created under the name “newspc”. The “intensity” series contains the results of the operation.

The reconciling of the two series is done in the following manner:

- The overlapping area of the two series is detected
 - If there is no overlapping area, the operation is cancelled. The message “no area of overlap” is displayed.
 - If one series is completely included within the other, the operation is cancelled. The message “series a includes series b” is displayed.
 - If the two series overlap strictly, the operation is cancelled. The message “the two series are super-imposable” is displayed.
- The normalization of the two series is carried out starting at the area of overlap. Each series is normalized at the start of the area to be joined.
- The first points of the new series will contain the first points of one series until the start of the area of overlap is reached. The subsequent points will be those of the other series.

To save the result, save the new Profile document with the command “Save” or “Save As...”.

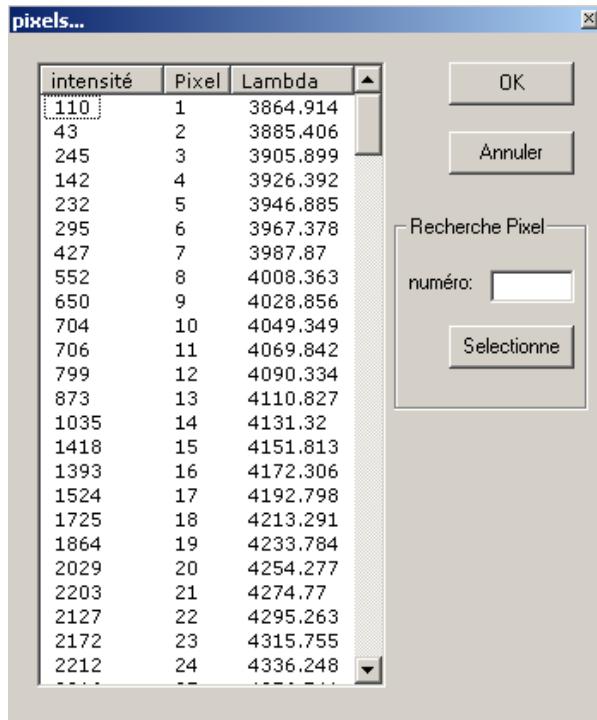
Modify the intensity of a pixel

Aberrant points may interfere with correct execution of the automatic processing of Visual Spec. For this reason, it is possible to individually modify the intensity of each pixel.

To modify the intensity of a pixel:

- Click on the menu Edit, choose Pixel

A window appears. It contains the complete table of pixels and their intensity.



To modify the value of an individual pixel:

- Click twice on the pixel to modify, the intensity is highlighted and is then editable.
- Modify the value.
- Repeat as needed for other pixels.

To more easily find a pixel whose order number one knows:

- Enter the pixel number in the search area
- Click on “Select”

To terminate the operation

- Click on OK to save the modifications. The series will be updated automatically.
- Click on Cancel to cancel all modification.

Measurements

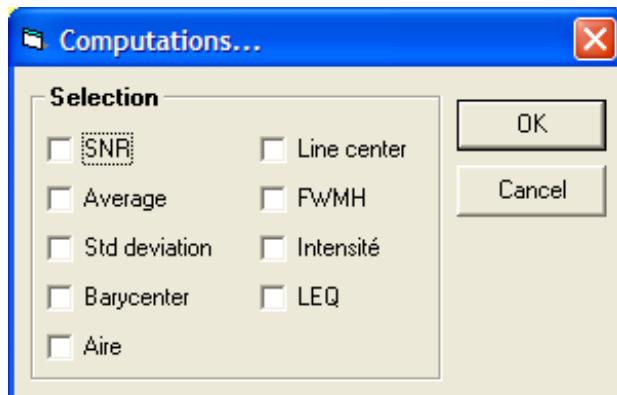
A certain number of simple measurements are possible on a spectrum calibrated in wavelength. These measurements can be used to characterize the quality of the spectrum or to identify and/or measure the spectral lines.

The measurements are made on the spectral profile area selected with the cursor.

To select the type of measurements to execute:

- Click on the menu Spectrometry, choose Computation preferences

The dialog box that allows the selection of measurements to perform will be displayed.



- Check each checkbox corresponding to the measurement whose result is desired.
- Click on the button Cancel to cancel.
- Click on OK to save the list of measurements and make the dialog box disappear.

To change the list, redisplay the dialog box by clicking on the menu Spectrometry, choose Computation

To execute the list of calculations and view the results:

- Click on the Statistics button  on the Profile toolbar

The list of measurements to perform is reused each time the operator requests measurements on a profile zone using the Statistics button 

The results are displayed in the “Infos...” window, which appears if it was not already displayed.



Note:

By default, no measurement is active in the list; if one requests measurements then the dialog box of calculations will be automatically displayed.

Infos... Window



The Info window permits viewing and tracing the results of measurements made on a spectral profile. It is possible to modify the size of the window with the mouse.

The name of the document on which measurements were taken is noted in red. Then the result of each measurement is displayed.

- Click on the “Reset” button to clear all displayed results.

- Click on the “Header” button to display the ‘date’, ‘pose’ (exposure), and ‘comments’ field of the active document.
 - Click on the button “Save” to save the results in the text file “Infos.txt”. This file will be found in the application directory.
 - Click on the close symbol of the window to hide the window
- Or
- Go in the tools menu and select the sub-menu "infos" to hide the window
 - Use the scrollbar to access preceding results, if they were not cleared.

Signal to Noise Ratio

Calculates the signal-to-noise ratio over the selected spectral area. The signal-to-noise ratio is the report of the standard deviation of the average.

Average

Calculates the average over the spectral area.

Std deviation

Calculates the standard deviation of the average over the spectral area.

Line center

Calculates the wavelength that corresponds to the barycenter of the selected area. This wavelength defines the wavelength of a spectral line.

FWMH

Calculates the full width at half-maximum over the spectral area.

The half-maximum of a line is defined as (the maximal intensity of a line with respect to a reference taken on the points on each side of the line) divided by two.

The full width at half-maximum of a line is defined as the deviation in wavelength (or in pixel if the series is not calibrated) between the two borders of the lines at mid-height.



Note:

This measurement is only possible on an area with a minimum of three points. The reference of the continuum is the average between the first and last point in the selection.

This calculation is fragile if the first and last points are those of the line itself, if the selection is too tight, or if other lines are present at the borders of the line to measure.

Barycenter

Calculates the barycenter in pixels of the spectral area

The barycenter is defined as the sum of the points multiplied by their index divided by the area of the zone.

The area of the zone is delimited by the spectral profile and a straight line joining the first to the last point.

Intensity

The line intensity is the line surface.

Equivalent width (LEQ)

To calculate the equivalent width of a line, it is necessary to normalize the profile. Otherwise the results make no physical sense.

The Width Equivalent is a computation of the line surface normalized to the background.

The calculation takes place over the spectral area delimited with the cursor in the active series.

An equivalent width of the line will be displayed in the “Infos...” window, expressed in angstroms. It characterizes the power (calculation of area) of a line with respect to the continuum.

Surface

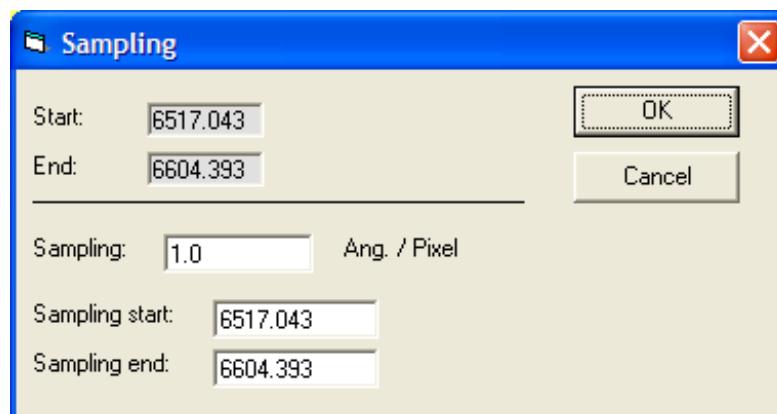
Surface computation of the profil included in the selection. The surface computation is a simple sum of the intensity of the pixel.

Resampling

To resample the profil, you need to define the new sampling step and the starting limit

- Click on the menu Spectrometry, select "Resampling"

A dialog box "sampling" is displayed



The current value of the beginning and end of the profil are displayed in gray

- Enter the new value of the sampling step
- Modify or not the start and end limits
- Click on OK to execute
- Click on Cancel to quit without executing or exit

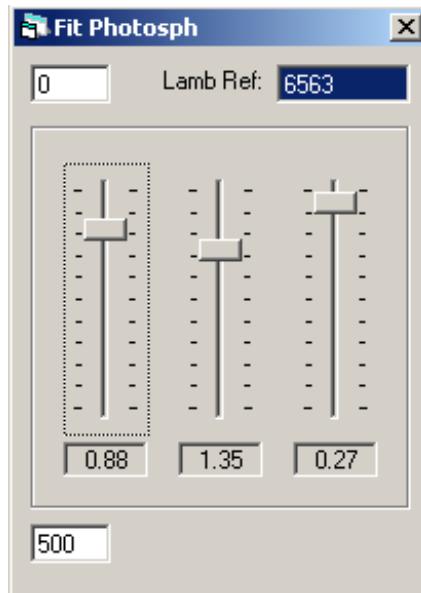
The intensity serie is replaced by the new resampled serie. If you want to keep the result, save the file under the same name or change the name by doing a "Save As...".

Fit Photosphere

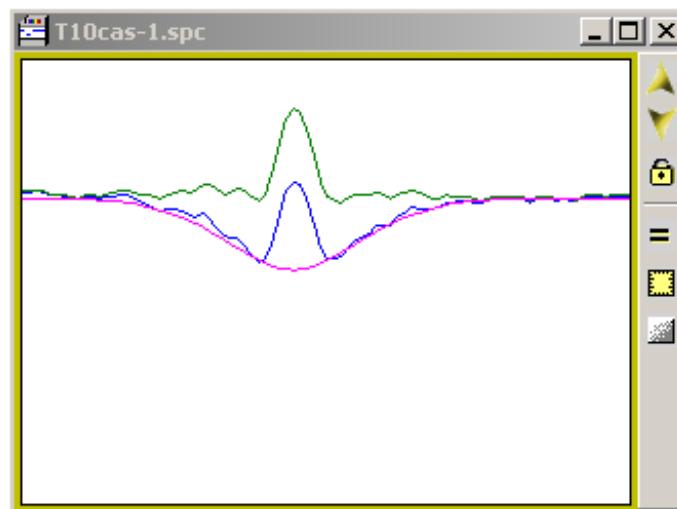
In some rare occasion, it can be of interest to suppress the contribution of the photosphere in a line profile.

- Click on the menu Spectrometry, choose "Fit Photospher"

A dialog box "Fit Phosotospher" appears



By adjusting the different sliders, it is possible to generate a gaussian profil centered to the Lamb Ref field value which is subtracted to the current serie.



The purple profile is the gaussian profile and the serie Fphot.intensity is added to the serielist.

The green profile is the result of the correction and is added in the serie list as Soustnorm serie.

To exit the function, click on the close box in the dialog box.



This function shall be applied on a significant line profile.



There is no modification of the current serie. To suppress the added serie, just select it and press the delete button

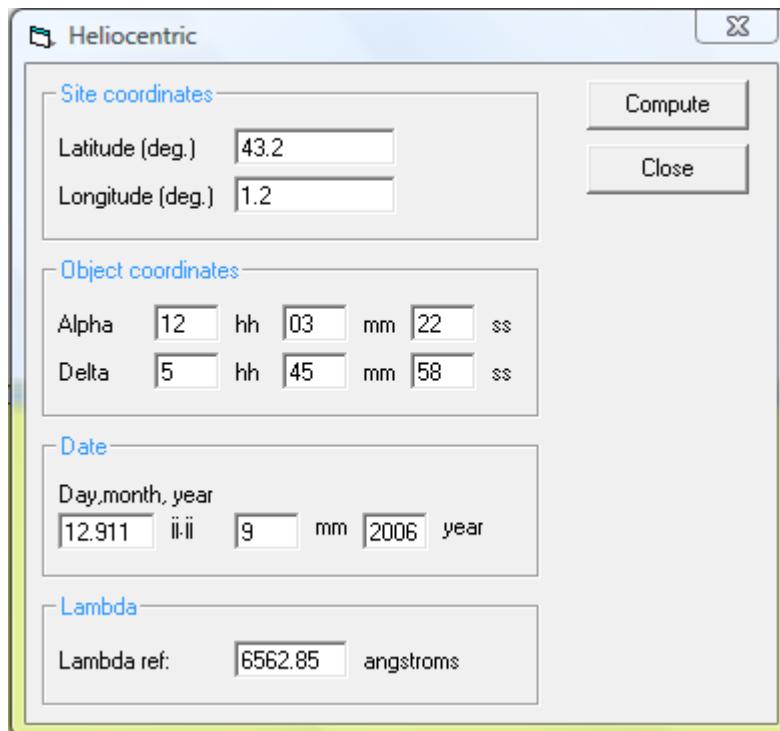
Heliocentric Speed

To produce accurate measurements of Doppler Shift, the Doppler Shift of the Earth around the Sun in the direction of the object has to be taken.

Visual Spec computes this shift by taking into account the observation site coordinates, the date and time of the observation and the celestial coordinates of the star, alpha and delta.

- Click on the menu Spectrometry, choose " Helio Correction"

A dialog box appears



- Enter the latitude and longitude coordinates of the observation site in decimal degrees.
- In case of a fits file, if the Lat and Long data are present in the Fits header, they will be automatically displayed.
- If not, or in case of an spc file, the coordinates preset in the preferences dialog box will be automatically loaded.

- Enter the Right ascension and the declinaison of the star – if the coordinates have been entered in the header of the spc document, those values will be displayed automatically.
- Enter the date and time of the observation in day, month year. The day is a decimal value which will take into account the time of the observation.
- The computation requires the longitude convention being positive toward East and negative toward West. It is the opposite of the convention of some planetarium software or Iris, but in accordance with BeSS convention.

Example:

```
Date = 9 Sept 2001
Time (Heure) = 3h 32 mn 5s
```

```
Month (Mois)= 9
Year (Année)=2001
    Day (Jour) non-decimal part = 9
    Day (Jour) decimal part = (3 + 32/60 + 5/3600 )/ 24 = 0.147
Day (Jour) = 9.147
```

- Enter the reference value of the wavelength to compute the doppler shift which shall be applied to offset the Earth moving.
- Click on "Calcul" to display the results in the Infos... window

Or

- Click on "close" to temporarily hide the dialog box without losing the data entered: alpha, delta, and date/time.

or

- Click in the close box of the dialog box to definitively close it and allow at next loading an automatic update of the alpha, delta, date/time of the current spc document.
- The results are displayed in the Infos... window, which can be then saved. See the Infos... Window section.



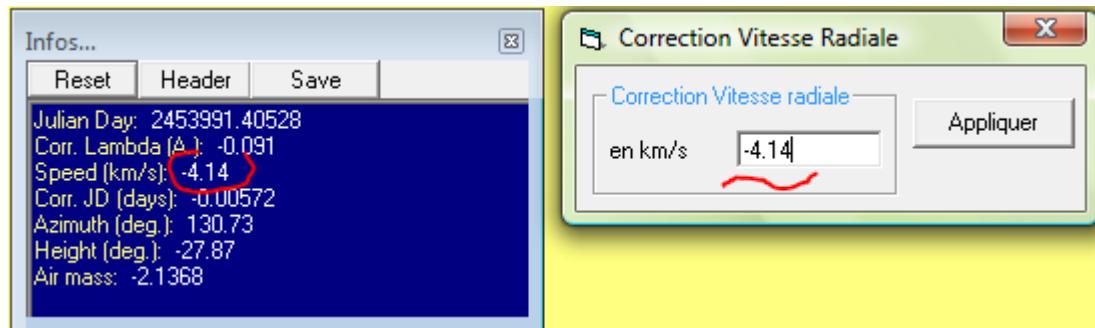
- Julian Day - *Jour Julien*: date and time transformed in Julian Day – *for info*
- Corr. Lambda (Angstrom): Angström shift due to the Earth moving doppler shift.
- Speed - *Vitesse*: Speed motion in the direction of the object, to be corrected
- Corr. JJ: Time correction equivalence – *for info*
- Azimuth: azimuth of the object during the observation – *for info*

- Heighth - Hauteur: heighth of the object during the observation – *for info*
- Air section - Masse d'air: Air section crossed by the light of the star during the observation – useful to correct from the atmospheric extinction.. See Extinction section in Radiometry.

Heliocentric speed correction

To correct the speed due to the earth computed with the heliocentric speed function above, click on the menu Spectrometry, sub-item Heliocentric speed correction.

A dialog box is displayed



Enter the speed value read from the infos window, then click apply

CHAPTER 6

Radiometry

Radiometry concerns processing that corrects the intensity of the spectral profile.

The raw intensity of a spectral profile is not only a function of the physical characteristics of the object observed. It includes also local attenuation caused by the equipment used, spectral sensitivity of the capture device, and even attenuation caused by the atmosphere. To compare spectra from different equipment, to reconstruct the physical continuum of the object, it is often necessary to first carry out a radiometric correction. This correction is the equivalent of a Flat Field in direct imagery.

To correct a raw spectrum it is necessary to determine the instrument response curve. This instrument response can be obtained in several ways:

- From the spectrum of one of the 24 stars calibrated photometrically within Visual Spec
- From a standard spectrum of the sample spectral type, from the library
- Once the spectrum has been corrected radiometrically, one can eliminate its physical continuum by synthesizing the Planck profile at the temperature of the object.

Spectral library

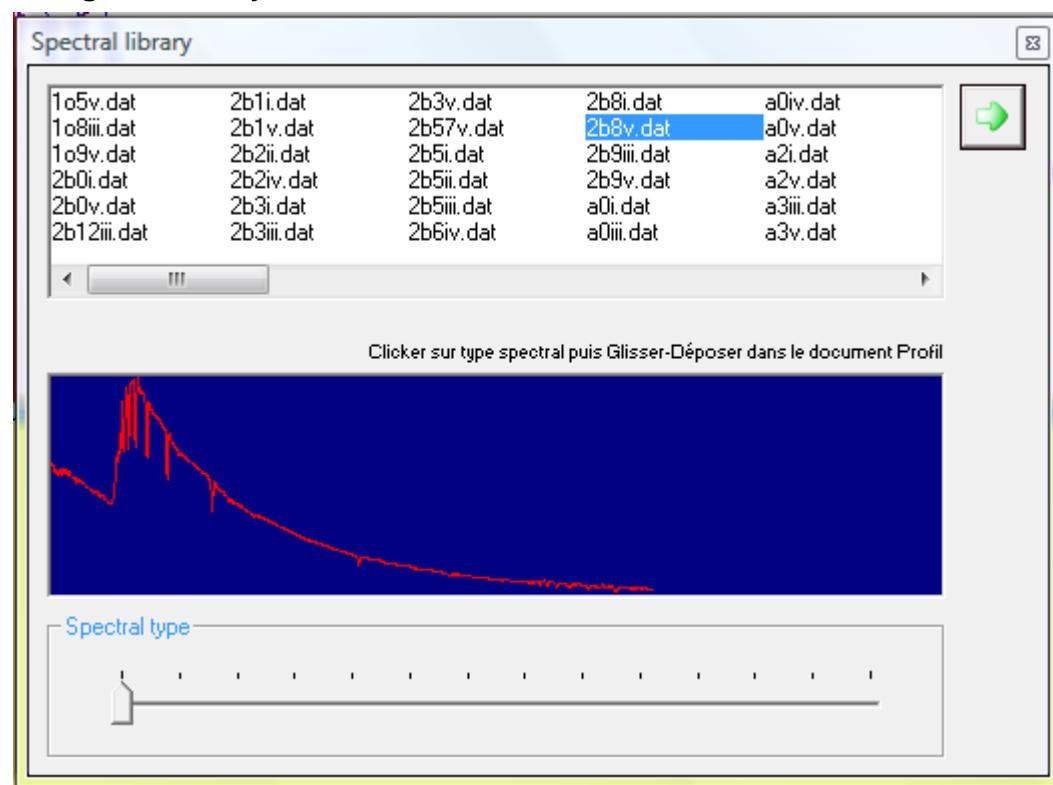
Visual Spec provides a database of 131 spectra corresponding to different spectral types. This database comes from the Centre de Données Stellaire of Strasbourg. The 131 spectra are in the folder libspec. The files are in “.dat” text format and extend from 1200 to 10600 angstroms. The intensity is normalized from 1 to approximately 5550 angstroms.

To access the library:

- Click on the Tools menu, choose “Library...”

The “Spectral library” dialog box will be displayed.

Dialog box Library



- Select a spectrum by its spectral type. It will be displayed in the graphic area at the bottom.
- Drag the name of the spectrum to the active profile document to add the profile to the list of series.

Or

- Click on the green bouton arrow on the right side
- To enlarge part of the spectrum in the graphic area, right-click near the part of the spectrum to be enlarged.
- To quickly scroll through the spectral types, use the “Spectral type” slider.
- To end the operation, click on the close symbol of the dialog box.

The spectrum is added in the form of a temporary series whose name is that of the spectrum in the dialog box. These series keeps its original sampling which is 5 angstroms. To resample the spectrum to the sampling of the document, perform a resample (see section “Resampling”).



Note: It is impossible to add a spectrum from the library to a document which is not calibrated.

Spectral type

This function is only available if the Excel application is installed.

To determine the spectral type of a star:

- Click on the Tools menu, choose “Spectral type...”

Or

- Enter Ctrl+T using the keyboard

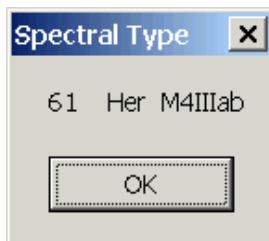
A dialog box is displayed which asks for the name of the star to search for in the Bright Star Catalog.



The syntax to be followed when entering the name of the star to search for is the following:

- Three first letters of the Greek designation: Gam, Alp, Omi, Ome ... or star number followed (without a space) by the three-letter constellation abbreviation .

The result of the search is displayed in the Type Spectral (Spectral Type) dialog box.



Note: The Bright Star Catalog is available in the form of an Excel file “brscat2.xls” in the application folder. In addition to spectral type, it contains other information such as the coordinates, magnitude, HD reference.

Continuum

To more easily read the spectrum, it is sometimes useful to “flatten” its profile. If one cannot suppress the “continuum” using a Planck profile, nor calculate the instrumental response from one of the reference stars in Visual Spec, it is still possible to calculate an artificial continuum by interpolation on some points of the raw profile.

- Click on the Radiometry menu, “Extract Continuum...”
- A new toolbar will replace the Profile toolbar.

To leave continuum mode at any time:

- Click on the Stop button

Or

- Click on the Radiometry menu, choose “Extract Continuum...”. The checkmark on the menu will disappear

Two methods are provided to obtain the continuum. To toggle between them, click on the point/curve button .

Continuum by area suppression

The continuum toolbar will change to look like this:



- Select the area of the spectrum containing lines to eliminate.
- Click on the eliminate zone button  of the toolbar to eliminate the selected area.
- Repeat the operation to eliminate additional areas.
- Click on the annule button  to replace the areas that were eliminated.
- Click on the execute button  to activate reconstruction of the profile.

The temporary series “Fit.<active series>” is added to the list of series and is displayed in the window in orange color. The eliminated areas are interpolated by a straight line. The dialog box for adjusting softening is displayed. Once the adjustment is made, click in the close symbol of the control. (See section “Filtering by Spline”.) The toolbar disappears and is replaced by the Profile toolbar.

Continuum by points

To access this mode, click on the point/curve button .

The continuum toolbar will change to look like this:



- Place the mouse on the profile and left-click on the profile to place an input point.
- Continue this operation until all input points have been placed.
- Click on the Cancel button  of the toolbar to eliminate all points and restart.
- Click on the execute button  of the toolbar to activate the reconstruction of the profile.

The temporary series “Fit.<active series>” is added to the list of series and is displayed in the window in cyan color. The toolbar disappears and is replaced by the Profile toolbar.



Note:

Interpolation between points is by Spline interpolation. It automatically uses the first and last point of the series. If these points are aberrant, it is possible to edit them manually using the function Edit Pixel, or by cutting them from the Profile.

- It is possible to save the list of points by clicking on the “Enregistre liste” (“Save list”) button . The coordinates of each point are saved into the file “liste.txt” in the root folder of the application. The list is used by the “Extraire...” (“Extract...”) function.

Extraction

This continuum extraction is done based on the list of wavelengths. Each of the wavelengths must correspond to a place in the spectrum where it is assumed that no line is present.

- Click on the menu Radiometry, choose “Extract...”

From this list, Visual Spec calculates an interpolation by spline and displays the new spectrum in the series extract_ followed by a sequence number.

The list of points comes from:

- A text file “liste.txt”, if it is present in the root folder of the application.

You can easily build this list if you first click on the points you need in a manual continuum extraction in "point" mode. This list will be saved if you click on the save icon in the continuum toolbar.

Or

- One of the pre-defined lists if the file “liste.txt” is not found. These lists contain the following wavelengths:

3390, 3448, 3509, 3571, 3636, 4032, 4167, 4255, 4464, 4566, 4785, 5000, 5263, 5556, 5882, 6055, 6370, 6800, 7100, 7530, 7850, 8080, 8400, 8805, 9700, 9950, 10250, 10400, 10800

It is possible to manually edit the file “liste.txt” with a simple text editor, following the format of a wavelength in angstroms per line. If one or more wavelengths are outside the domain of wavelengths, the value is ignored. If all the values are ignored, the default list is used.

Extract from zone

The continuum will be computed on the active serie but excluding the zone specified in the listzone.txt file. These zones are supposed to contain spectral lines.

The file will contain the last zone selection made in manual continuum extraction. Or you can edit the file. The format is each line contains the limit of a zone

5860.037, 5994.185

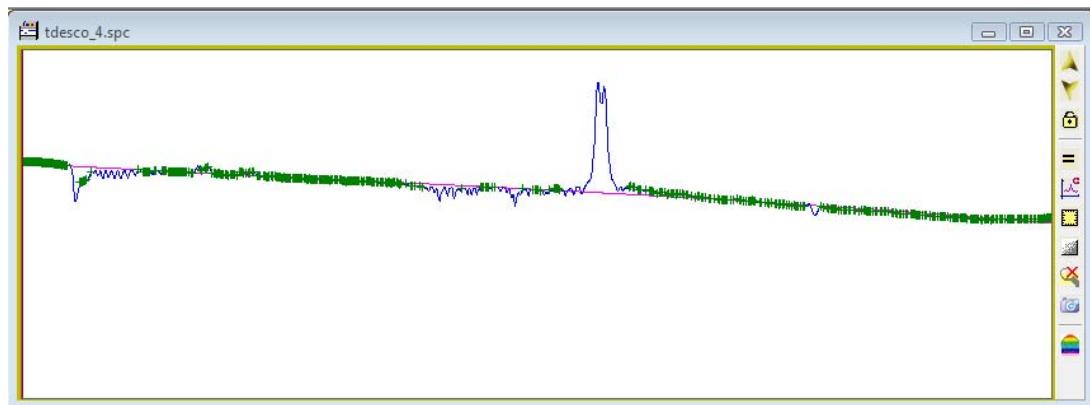
Automatic continuum

Robustness of automatic function shall always be questioned

Visual Spec offers the capability to automatically detect the continuum.

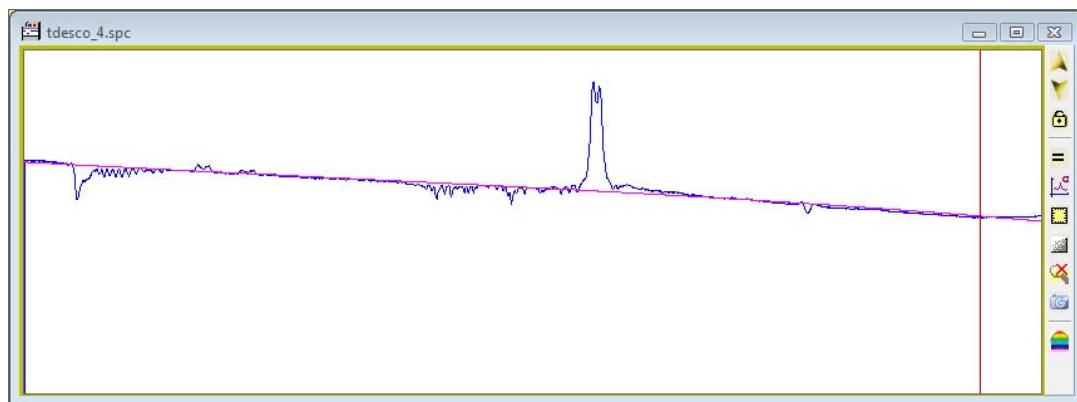
- Click on Radiometry menu, sub-item automatic continuum

A purple serie is added as the result of the detection of the continuum. The detection algorithm shows which points have been selected to fit the continuum using a spline function.



Note: This function is very intensive in term of computation. If you performed it on profile which has a large number of points, it can take a long time...

If you resize the document, the green crosses will disappear.



Compensation of the continuum

By dividing by the continuum

In only one operation it is possible to remove the continuum of a spectral profile.

- Click on the Radiometry menu, choose “Continuum division”

The continuum toolbar is displayed

- Perform the operations on the continuum (see the section “Continuum”).

Once the artificial continuum is calculated, the intensity series is automatically divided by this continuum.



The intensity series is automatically replaced by the result of the operation. If you don't want to overwrite this series, copy it into a different basic series or save the document under a different name.

By subtracting the continuum

It is mandatory that the serie has been normalized

- Click on the menu Radiométrie sub-menu Continuum Subtraction...

Same as above for the division. but the continuum is subtracted the intensity serie and a value of 1 is added to avoid negative values.

Suppression of atmospheric lines

Two functions are proposed:

- Synthesis of an atmospheric spectrum from a file containing the atmosphere lines which has been defined in the preferences. The file included in the Vspec package covers a wavelength range from 6408 to 6628 angströms.
- Correction by using a real spectrum of the atmosphere extracted from a star observation during the night

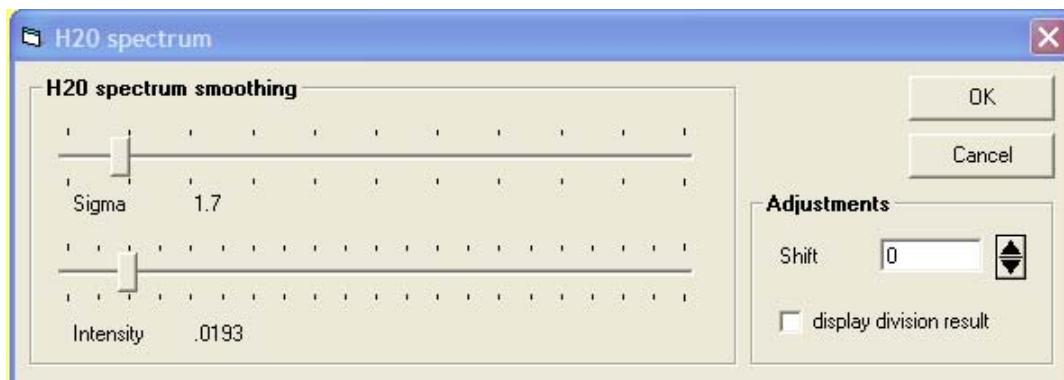
Synthetic atmospheric correction

The goal of this function is to reduce or suppress completely the water atmospheric lines in the spectral extent 6400- 6600 angstroms

- Click on the menu Radiométrie, choose H20

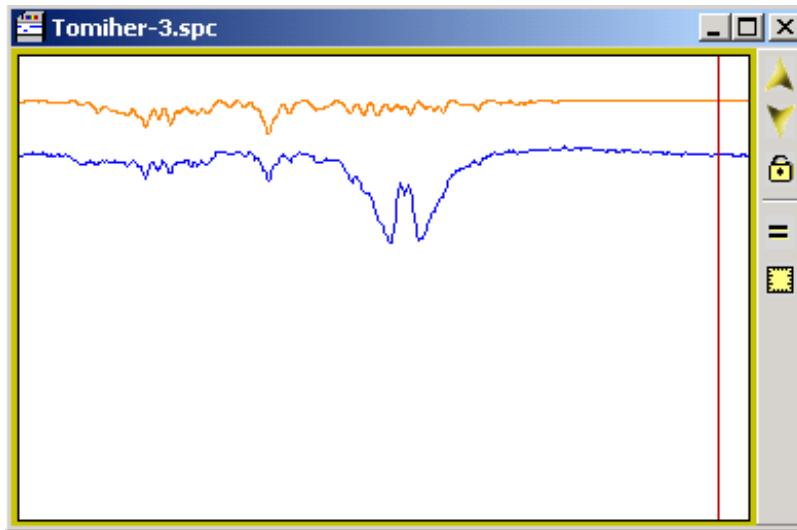
To proceed with the interactive adjustment a diaoog box is displayed

Dialog box H2O

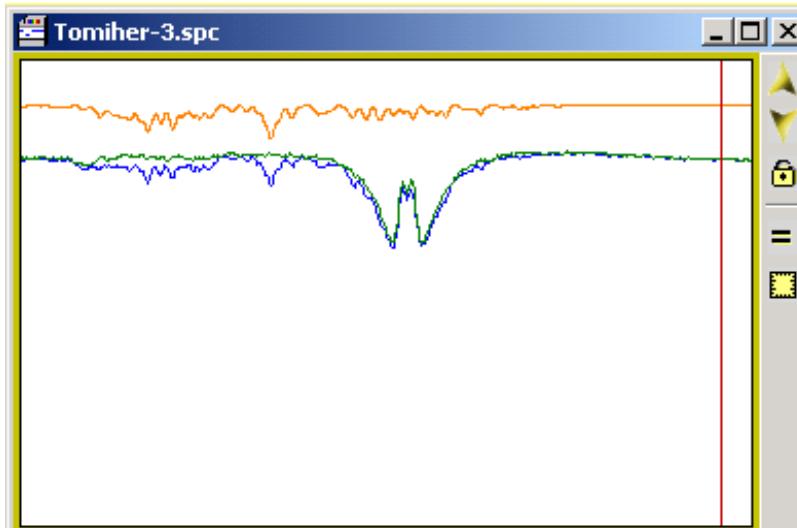


- Start by moving the Sigma slider to make appear the base line of the H20 profile
- Follow by moving the instensity slider to increase the intensity of the lines
- Adjust agin the sigma slider to more or less filter the lines. The H20 lines shall meet the spectrum lines to be corrected

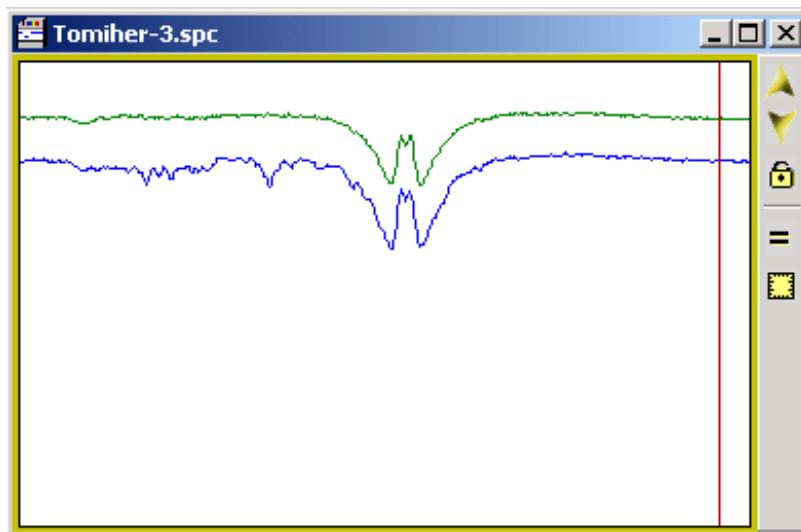
Compare the two profiles, you shall be in position to match the two profiles. Repeat the process until satisfaction is reached.



- In some cases, a slight shift in wavelength can be visible. In this case, adjust the shift in the shift section of the dialog box. The shift is applied on the original spectrum, not on the H₂O spectrum.
 - Click on the up/down arrow box to change value by 1
 - One can enter directly decimal value and press enter to validate and apply the shift
- To fine tune the overall matching process, check the "display division result" – "Afficher résultat division" box. A green series is added as the result of the division of the two spectra. The interactive process shall drive to the elimination of the H₂O lines.



- Click on cancel to cancel the operation and come back to the original document
- Click on OK to keep the result and come back to the original document



The corrected serie is added under the form of a temporary serie with name Division in the serie list.

Note:

From one use to the next one, the parameters "sigma" and "intensity" are kept in memory. If the intensity value has to be adjusted during the night, the "sigma" value is quite often the same for a given night and configuration

Real spectrum atmospheric correction

The goal of this function is to reduce or suppress the atmospheric lines created by the water from a real spectrum of the atmosphere of the night of observation. This spectrum is extracted from a star which has not a lot of lines.

Before running this correction, the atmospheric spectrum shall have been computed and displayed.

To extract the atmospheric spectrum:

Acquire a spectrum of a star which has not a lot of lines (type A, like Altair, or Vega) and for whom you have an already corrected spectrum. See in the ELODIE database from the Haute-Provence Observatory at <http://atlas.obs-hp.fr/elodie/>.

Normalise, then divide the real object profile by the ELODIE profile: the resulting profile is the atmospheric profile

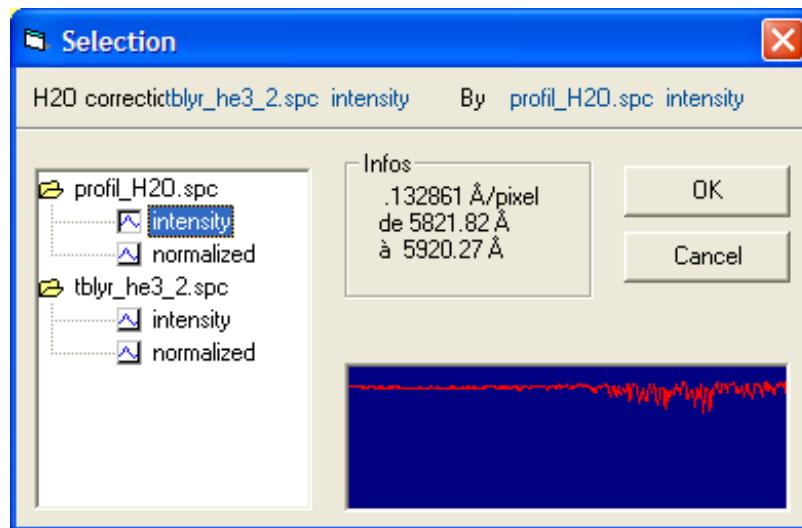
Move this profile into a series which will be saved, like the "intensity" series, and save the document, like "profile_atm_x". Keep the document open

Go back to the profile to be corrected

- Click on the menu Radiométrie, choose H₂O correction real spectrum...

A dialog box to select the real atmospheric spectrum is opened

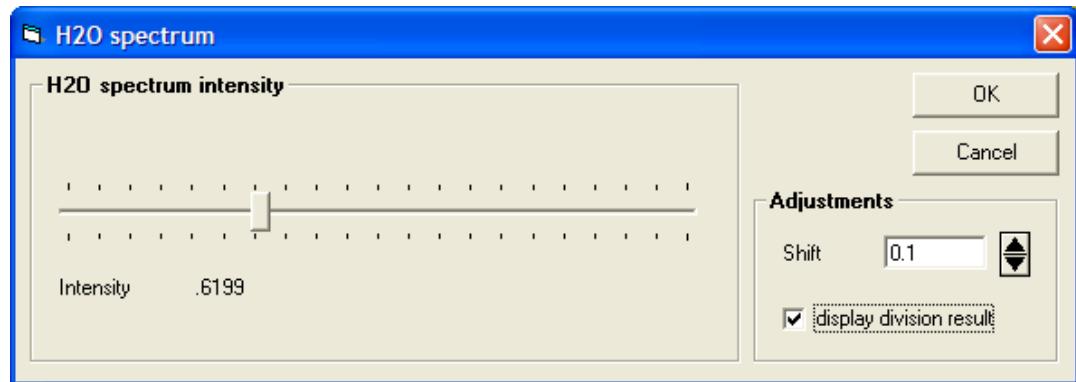
Boîte de dialogue sélection de profil réel



- select the document and the serie which contain the atmospheric spectrum
- click OK la série qui contient le spectre réel de l'atmosphère

The function will proceed with the interactive adjustment, a dialog box is displayed

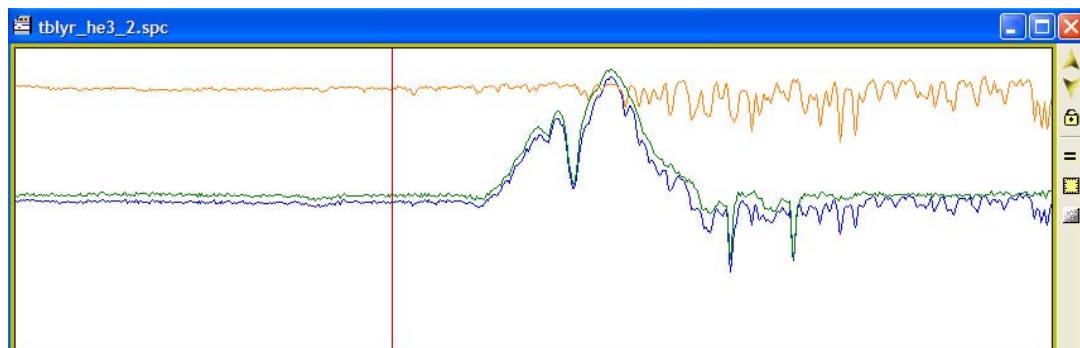
Dialog box H2O intensity adjustment



The intensity level of the real atmospheric spectrum can thus be adjusted. The result of the correction can be seen real time by checking the "display division result" box. wavelength shift can also be adjusted.

Report to the previous section on the synthetic correction for a more detailed description of the all controls.

Once the parameters adjusted, the serie "division" in green, contain the corrected profile. To save it, replace one of the non-temporary serie (like the "intensity" serie) by the result with the "replace" fonction, and save the file.



Instrumental response correction

The intensities of the raw spectrum acquired are the combination of the real intensities of the star spectrum and the multiple absorption which have happened before it gets stored. The main source of spectral intensities "modification" is the sensor used in the acquisition process. In Digital Camera, CCD camera or webcam, the sensors used does not have the same spectral response. Some have a very response in the blue region, some have very good detection in the red regions. To get back to the star intensities, this instrumental spectral response curve has to be determined.

This process is in 2 steps:

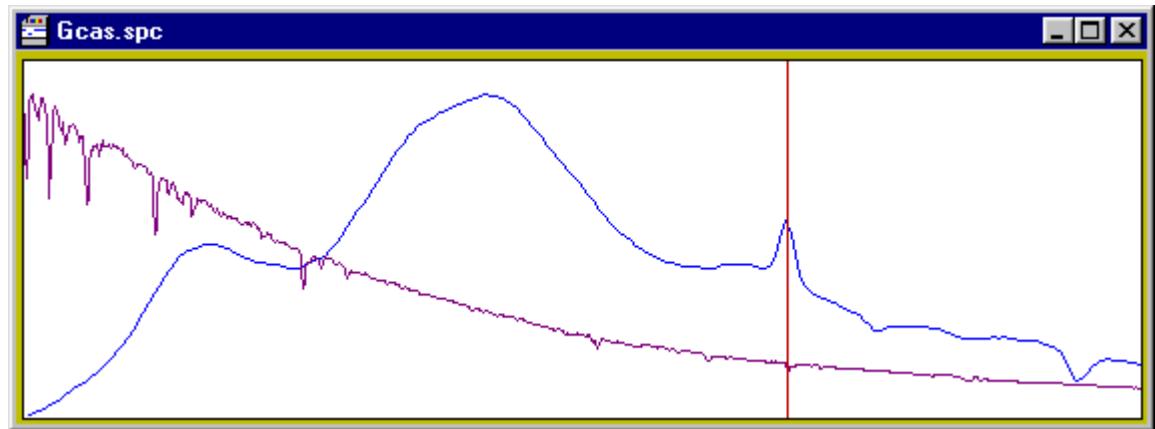
1. Get the instrumental response from a spectrum taken from a well-known star, a reference star or calibration star
2. Use this instrumental response to correct all the profiles acquired during the night

How to get the Instrumental response

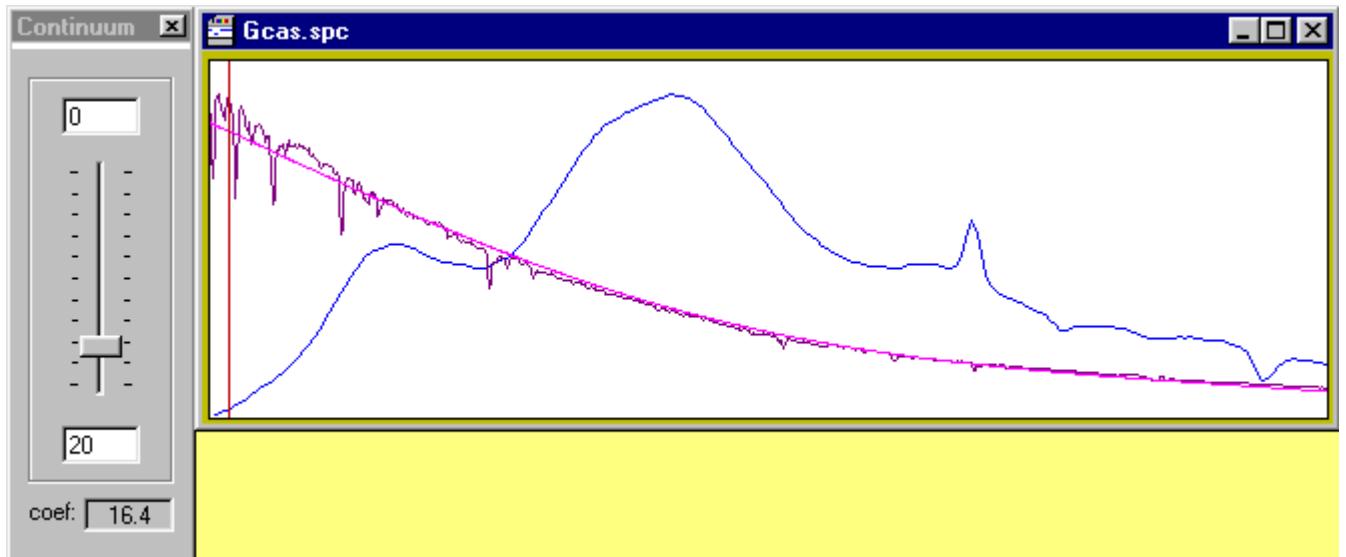
You need to obtain the spectrum of a "non-variable", bright star, from a spectral type closest to the 1-type as possible. The A-type spectrum exhibits a very limited number of spectral lines, which is recommended as we are looking at the continuum profile in this operation. A star such vega is very well appropriated.

To correct the active series radiometrically by using a spectrum from the library:

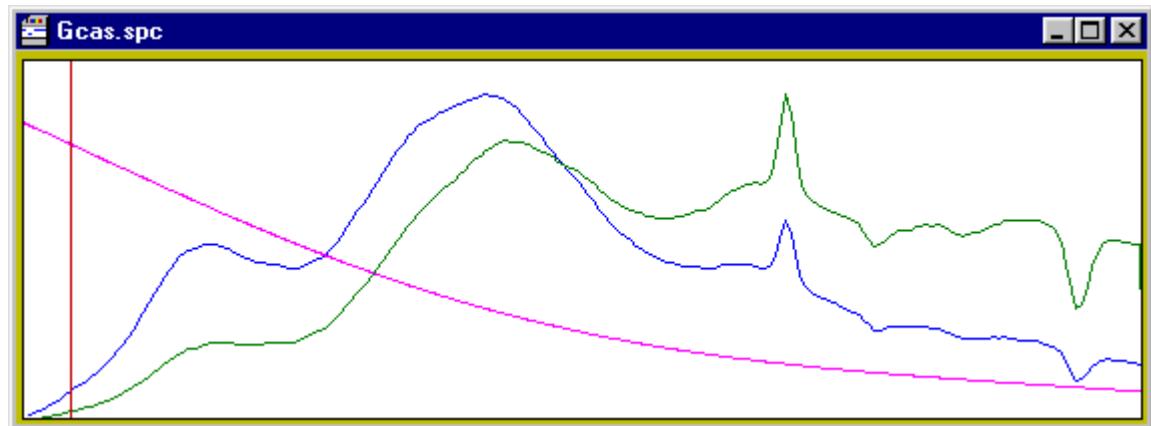
1. Obtain the spectral type of the reference star. For Vega it is A0V
2. Add the standard spectrum from the library which corresponds to the spectral type of the object



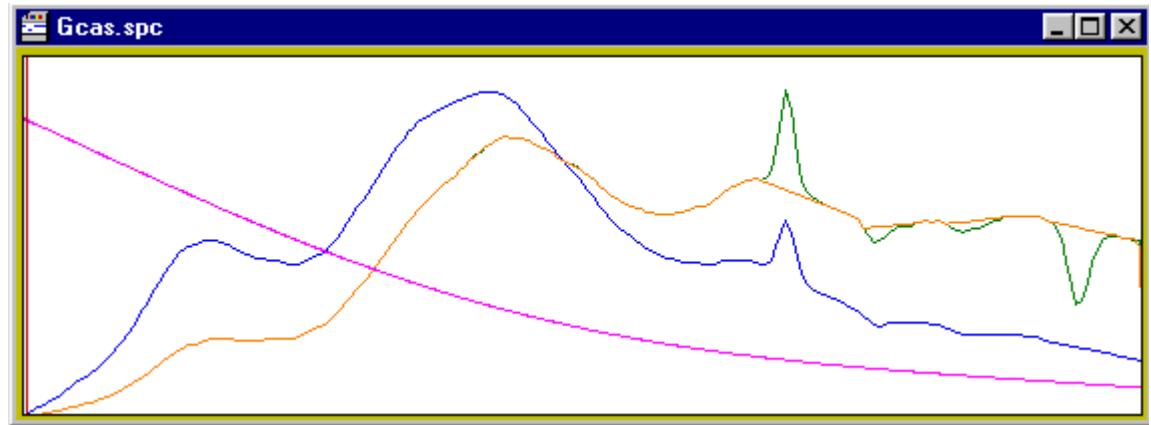
3. Extract the continuum of the standard spectrum, either by Spline filtering or by using the continuum function, in violet. (This step is not mandatory, the lines will be eliminated during the step 6 also).



4. Select the series “intensity”.
5. Divide the “Intensity” series by the series “Fit.spectre_standard”. One thereby obtains the instrumental response in the serie “Division”, in dark green.



6. To eliminate the spectral lines, perform a Spline filtering or apply the Continuum function on the series "Division". The new series "Fit.division" will be added, containing the instrumental response, in orange.
7. The orange serie is the instrumental response.



At this step, the orange serie is the instrumental response curve. To save it, move it into the "intensity" serie and save the document under a new name like "response".

This profile will be the instrument reponse of the night.

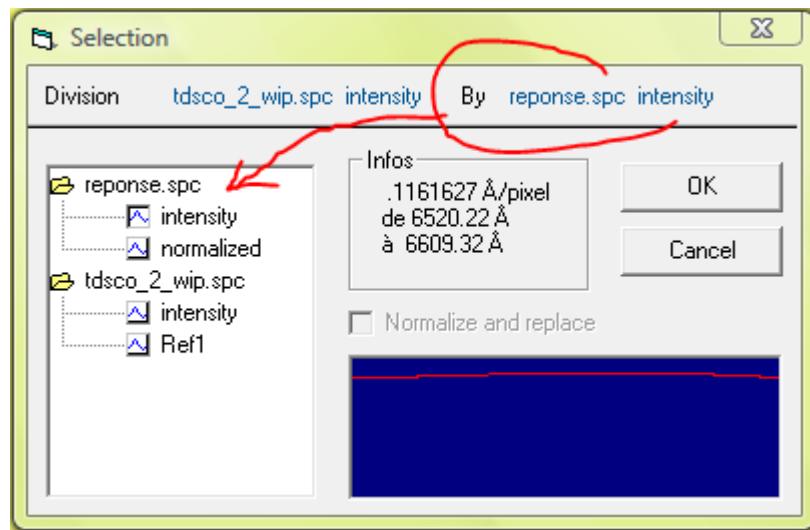
Correct the profiles with the instrumental response

The second step is to perform the correction. Load a spectrum of the night. Keep the response profile document opened.

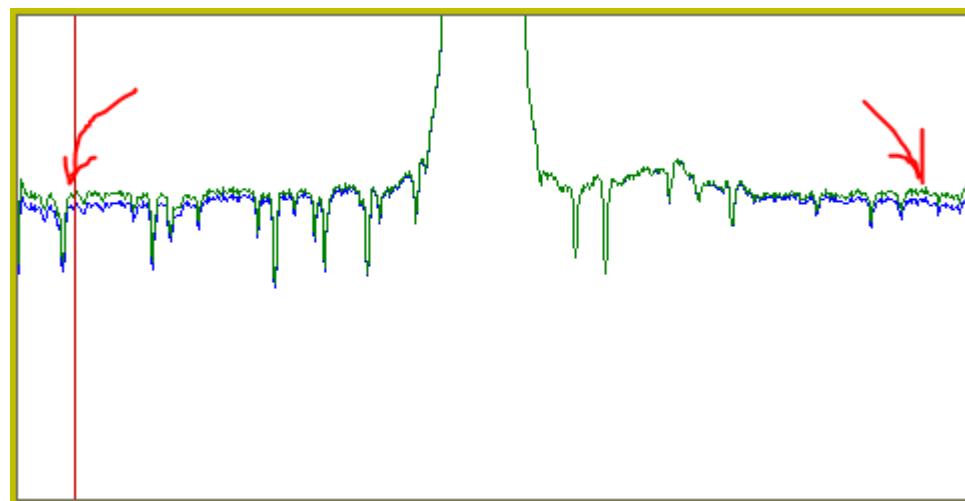


1. Select the serie of the dicument you want to correct

2. Divide the series “intensity” by the instrumental response “intensity” from the document response. The series “division” then contains the radiometrically-corrected spectrum, in dark green.



3. To save the series, replace one of the basic series by the series “Division”.



The intensities obtained are not the absolute intensities of the object. For an absolute spectrophotometric calibration, it is necessary to use a real spectrum of one of the 24 stars calibrated in Flux. (See section “Flux Calibration”).

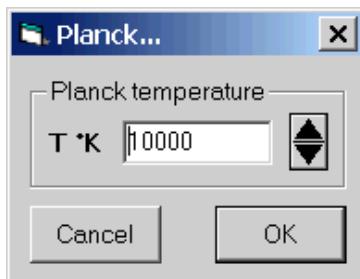
Planck Profile

The absolute intensity profile of a spectrum follows a law which is a function of the temperature of the star (dark-body temperature, Planck's Law). Based on this law, and thus on a temperature, it is possible to calculate the theoretical profile of energy per unit of wavelength this star would have.

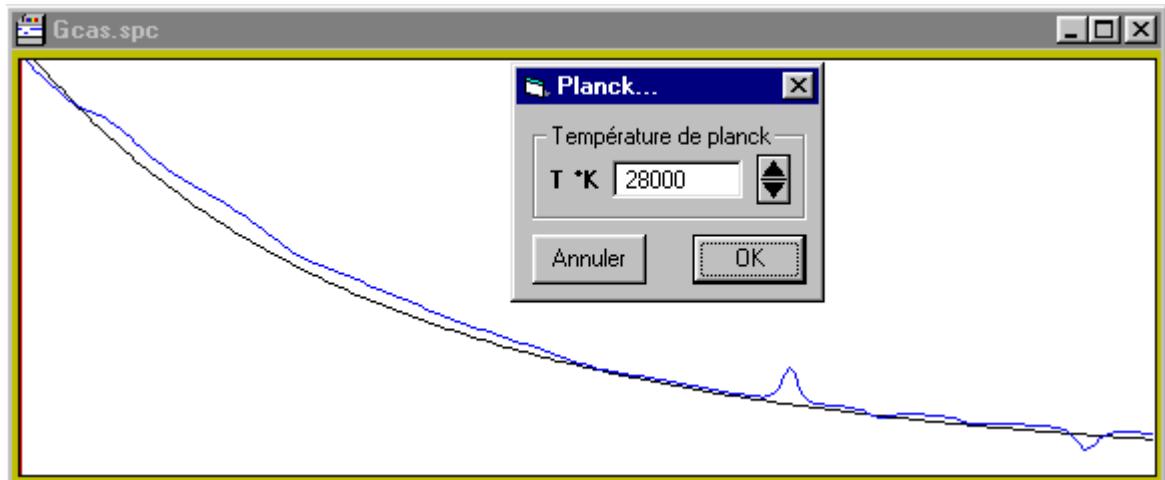
To display the Planck profile of a star of temperature T:

- Click on the Radiometry menu, choose “Planck...”

A dialog box is displayed.



- Enter the desired temperature, or increment/decrement the temperature by clicking on the Up/Down control arrows.
- Click OK to display the theoretical profile; a temporary series “P_<temp>”, where <temp> is the temperature, is added to the list.



- Click on Cancel to cancel the operation.

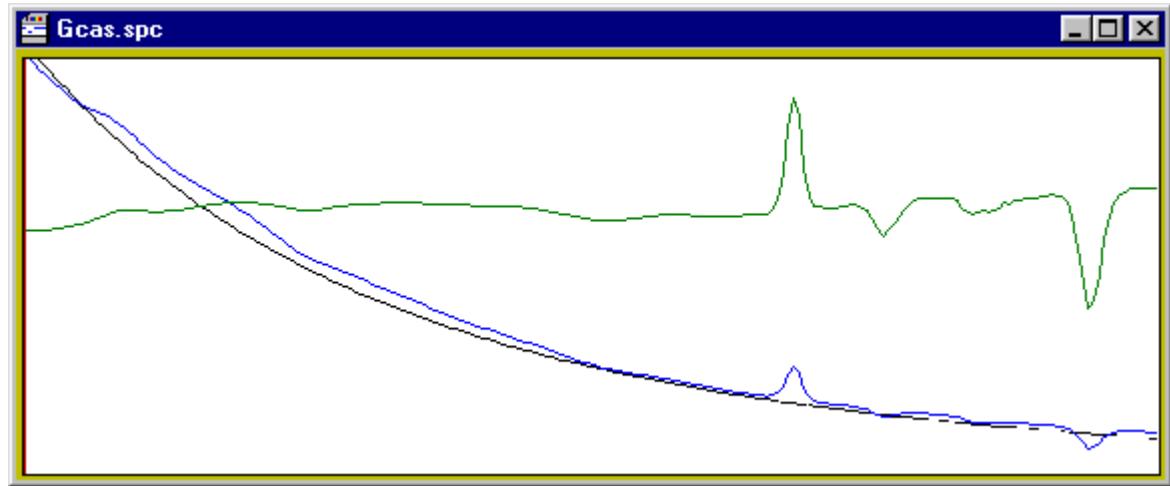
To determine the Planck temperature of a body

Correct the intensity of the profile in order to obtain the theoretical intensity.

Superpose the Planck profile for different temperatures until the two profiles have the same slope. To do this one can adjust the respective scales of each of the series.

Note which temperature gives the best match with the continuum – this is the temperature of the body observed ...

One can then “flatten” the spectral profile by dividing by the Planck profile, which then suppresses the “continuum”.

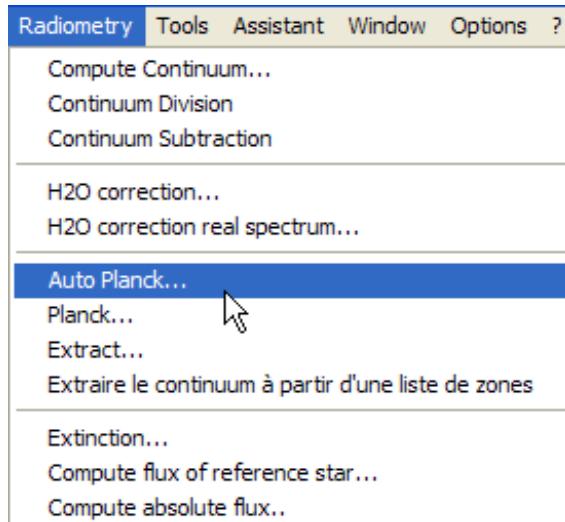


To save the Planck series, replace one of the basic series with the series "P_<temp>".

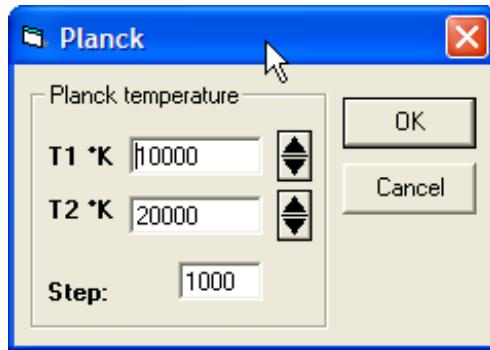
Automatic Planck law

This function will find the best temperature which fit the Planck law until it matches the profile continuum.

- Click on the menu "radiometry" sub-menu "Auto Planck..."

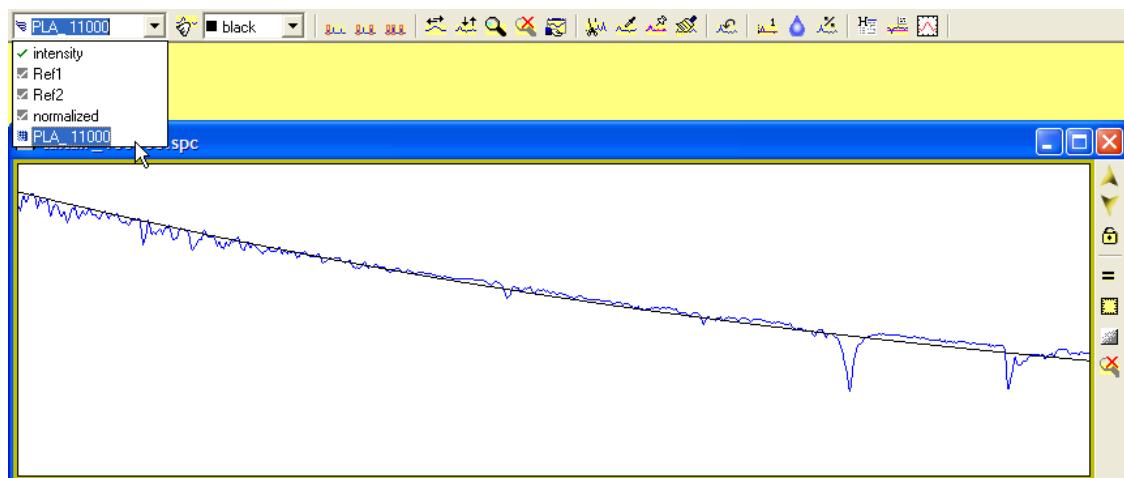


A dialog box is displayed



- Enter the limits max and min into which Vspec will iterate to find the best value which fit the continuum using the mean square method.
- Enter the step of the iteration. A small step will drive a better accuracy but the iteration will take longer. It shall be noted that in any case the result shall be considered as an indication and not a real scientific exact value. This method is not accurate enough, but the result is a good astrophysics indication and can be an interesting educative exercise.
- Click ok to run the computation

A black curve is displayed as the best Planck profile fit as an additional series. To know the temperature, go in the drop-down series list and look at the name of the added series. It will have the name P_ + the temperature of the best fit in Kelvin.

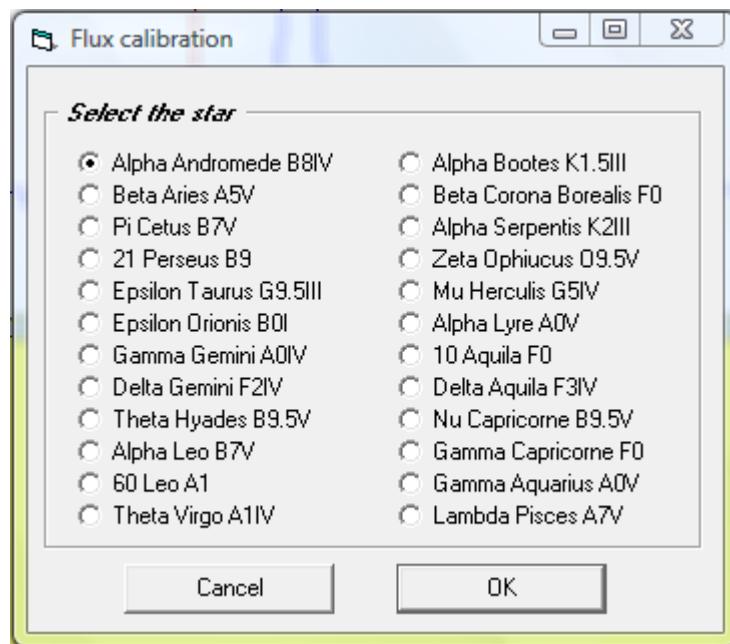


Absolute flux instrumental response

If you use the standard spectra from the Vspec library, the intensities of those spectra are not calibrated in absolute flux. What you'll get is relative intensities. In most cases, this is largely enough. In some applications, you may be interested in getting into the absolute flux. These will imply as well that your process for acquiring spectra is well under control (excellent guiding, good sky conditions).

To get to absolute flux, you'll need to build the instrumental response from a reference star from which you'll know the absolute flux spectrum.

Visual Spec includes a library of absolute flux for 24 stars.



It is suggested to re-determine the spectral response of the instrument each time it may be necessary: setup/breakdown, changing wavelength domain ...

1. Acquire the spectrum of one of the stars in the Visual Spec library.
2. Process the spectrum like any spectrum, up to calibration in wavelength (needed).
3. Click on the Radiometry menu, choose “Response...”
4. Select the star in the list of proposed stars.
5. Click on OK.
6. The instrument response is added as the temporary series “RepInstru”.
7. To save the series, replace one of the basic series with the series “RepInstru”.



Note:

The instrumental response is obtained by interpolation of the profile in equivalent theoretical flux divided by the observed flux.

The continuum fit is calculated automatically, but only in the range [4000 – 9000] – you'll need to have a wavelength range larger than 500 Angström or the application will not have enough points on the continuum to compute it

The “absolute” instrumental response can then be used to correct raw intensity profiles obtained under the same conditions.

Flux calibration

To correct the raw intensity of a spectral profile in order to determine the absolute intensity, it is necessary to calculate the instrument response following the method in the section “Absolute flux Instrumental Response”.

Calculate the instrument response.

Select the “Intensity” series.

Divide the series by the series “RepInstru”.

The temporary series “Division” is added to the list of series; it contains the contents of the intensity series corrected by the instrumental response.

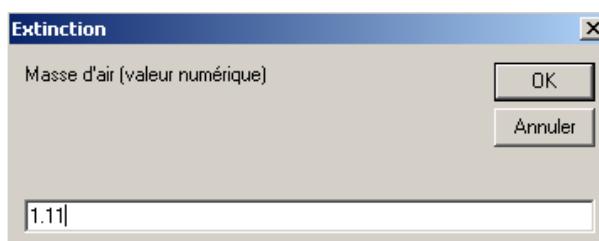
To save the series, replace one of the basic series by the series “Division”.

Atmospheric extinction correction

This correction only makes sense for excellent quality spectra and for very accurate measurements. It can only be performed once the instrumental response has been corrected. This correction has anyway small effect on the intensities.

- Click on the menu Radiometry, choose Extinction

A dialog box appears



- Enter the Air section (Masse d'air)
- Click on OK

To obtain the Air section value, one can get it from the Speed Heliocentric calculation. See section Speed Helio.

The Air section value is listed in the infos... window.



CHAPTER 7

Tools

A certain number of tools are provided to facilitate spectral analysis.

To compare spectra, several methods are available:

- An animation function allows viewing of changes over time of a set of profiles
- Synthesis of the spectral image for comparison with the original image
- Mosaic and batch formatting
- Generation of a graph with superposition and shifting

To identify different lines present, one can use a database of atomic lines of chemical elements. Some prohibited lines of oxygen and nitrogen are also included, as well as the position of the principal molecular bands of Titanium Oxide TiO.

In some cases, it can be useful to compute the parameters of the best Gaussian fit to a spectral line.

The open source Gnuplot application can be used to generate advanced plot of the profiles and be combined in the generation of a web page.

For those who prefer keyboard commands, a special command-line console is available.

It is also possible to get the coordinate of an object from the on-line Brigh Star Catalog.

Animation

Animation of a set of profiles allows viewing of the evolution of the same profile over time.

Time scaled animation

This animation function requires that date and time of the spectrum are correctly entered in the document profil header.

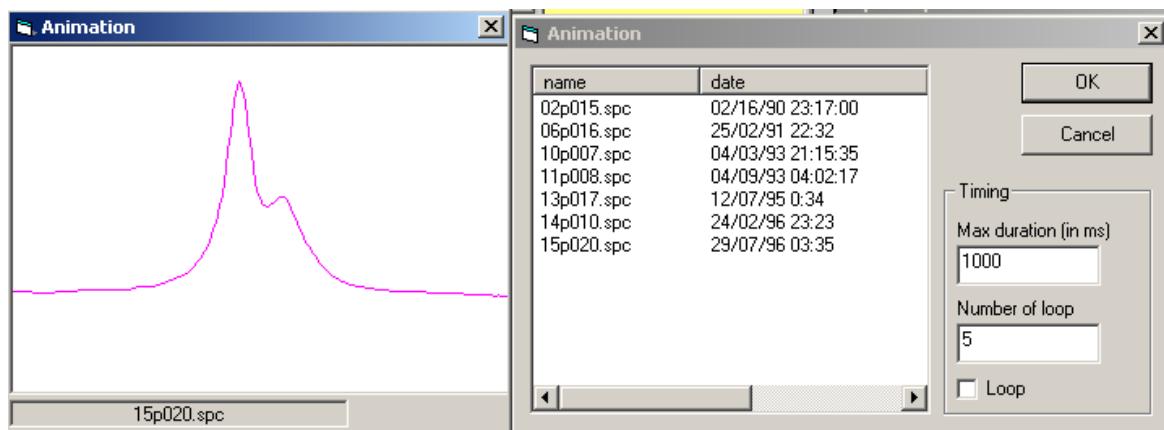
Open the set of profiles containing the spectra of the same object, saved at different times.

Normalize the profiles in order to compare the profiles using the same relative scale.

Put all of the profiles into the same format, using the function “Apply Format” (on the Edit menu) and as needed using the function Y-Scale (menu Format, choose “Graphic...”, use tab “Axis Y), applied to all windows.

Open the animation dialog box – the date and time will be read from the document header

Click on the OK button to run the animation



Click on the close box to close the windows and go back to the application

The files will be arranged by increasing time in the list before the animation starts. The overall animation time will be the time in the "max duration" field. The number of loop in case of loop selection can also be modified.

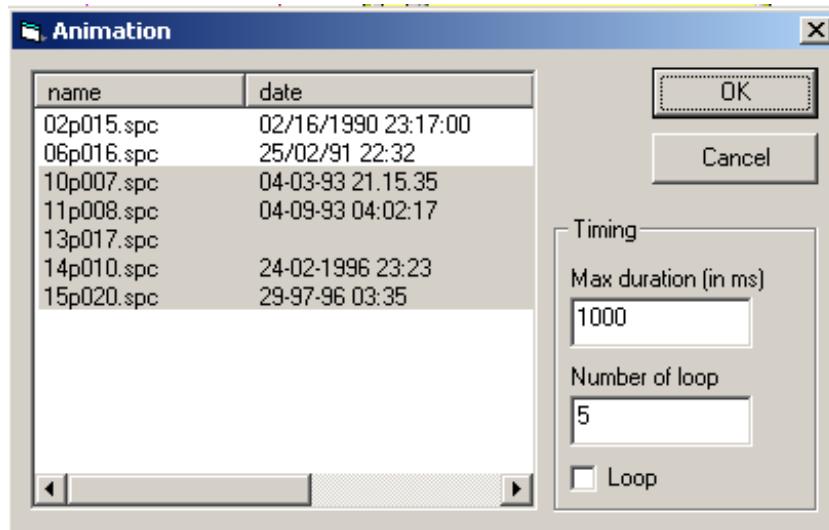
The animation is displayed in a separated window. The name of the file currently displayed is shown in the bottom of the animation window.

You can run again the animation by clicking again the OK button.

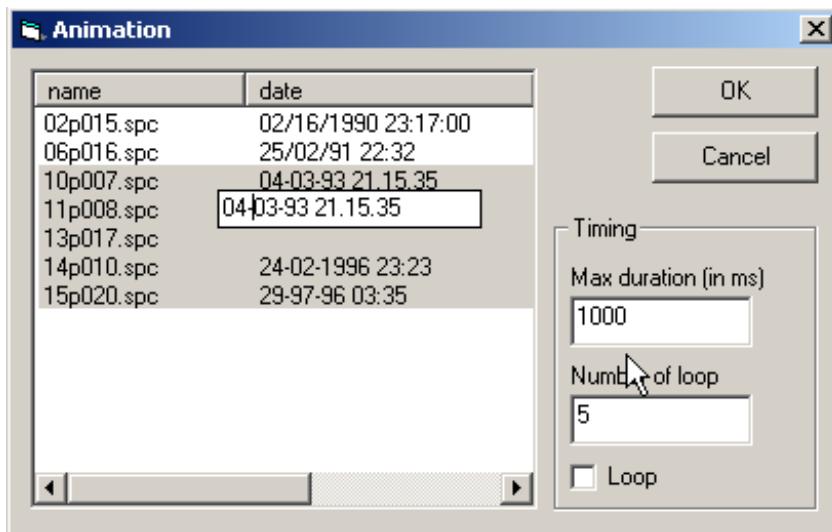
Date and time formatting

The date and time shall have the following format: dd/mm/yy hh:mm:ss

If the format is not recognized by Vspec, the files will be highlighted in gray in the dialog box after you clicked on the OK button



To edit the date and time, select the file and double-click with the right mouse to make appear the edit field.

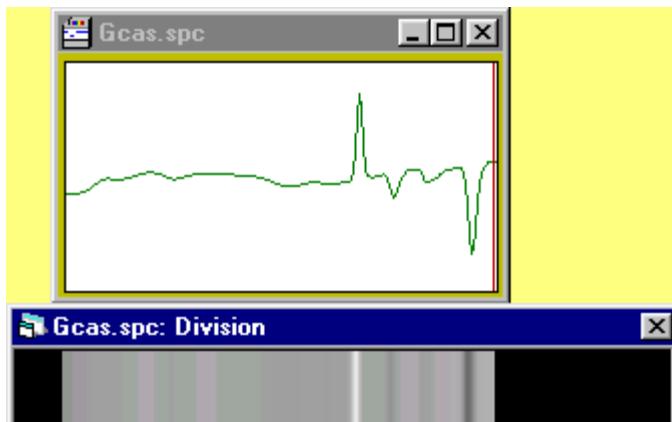


Edit the data and press the enter keyboard button to validate the data.

None of the updates will be saved in the header of the file. If you want to save time the next time, it is much better to edit the file header directly with the header function in the Edit menu.

Synthesis of spectral image

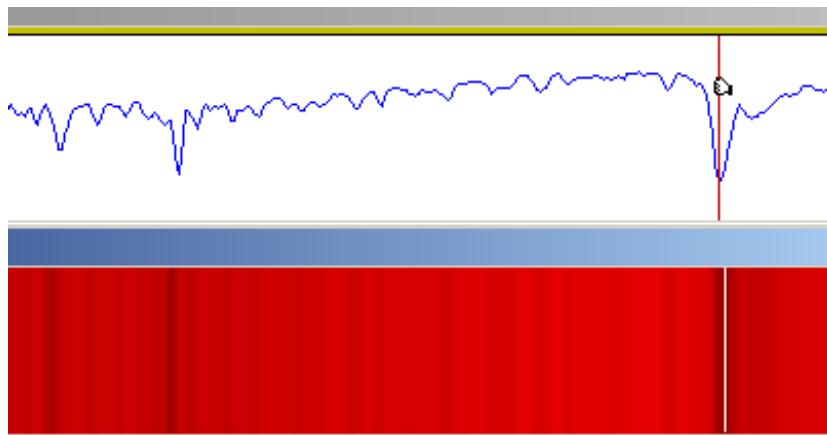
Synthesizing a spectral image is creating an image reconstructed from the active spectral series, which may be the result of several processes such as composition or filtering a set of profiles of the same object.



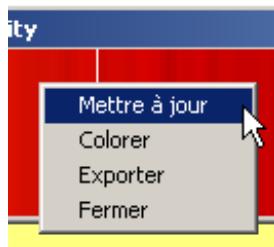
The grayscale values are determined directly from the Y scale of the series. Several attempts are sometimes needed to obtain a synthesized image with good contrast. The image can be resized din width.

This image can be then compared to one of the raw images that was used to create the spectral profile.

When moving the cursor on the document profil spectrum, a white cursor will move on the spectral image at the corresponding position



To export, display the spectrum with colors corresponding to wavelength, or update the scale, display the popup menu by clicking on the right mouse button while the cursor is over the image.



- Select the popup menu item Colorer (Color) to display the colors.



- Select the popup menu item Exporter (Export) to save the image in the form of a .bmp. A dialog box allows you pick the directory and the file name. By default, the file will have the name of the profile document followed by the suffix “-s.bmp”.

It is now possible to match the scale of the spectral image to the wavelength domain of the spectrum.

- Select the popup menu Update (Mettre à jour) to update the image display scale after a change in the spectrum profil scale change like a zoom.
- Select the popup menu Close (Fermer) to close the window or click in the close box in the window itself.

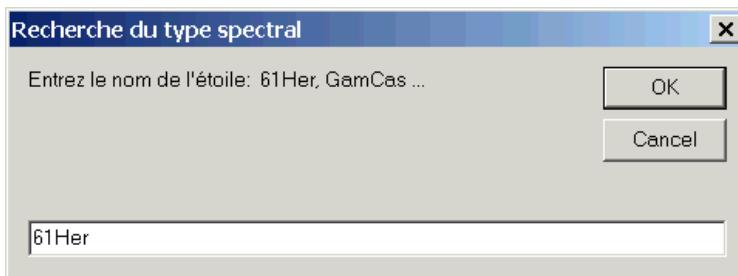
Coordinates

This function is only available if the Excel application is installed.

To find the coordinates of a star:

- Click on the Tools menu, choose Coordinates

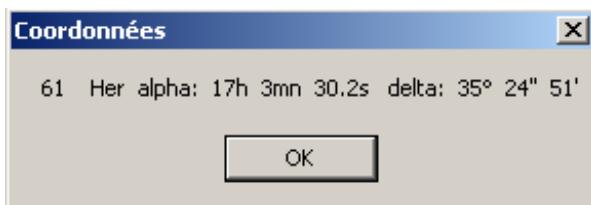
A dialog box is displayed which asks for the name of the star to search for in the Bright Star Catalog.



The syntax to be followed when entering the name of the star to search for is the following:

- Three first letters of the Greek designation: Gam, Alp, Omi, Ome ... or star number followed (without a space) by the three-letter constellation abbreviation .

The result of the search is displayed in the Coordinates dialog box.



Note:

The Bright Star Catalog is available in the form of an Excel file “brscat2.xls” in the application folder. In addition to spectral type, it contains other information such as the coordinates, magnitude, HD reference.

The profile file header is automatically updated with the values. If you want to keep the values recorded in the header, you'll have to save the file again.

Comparison

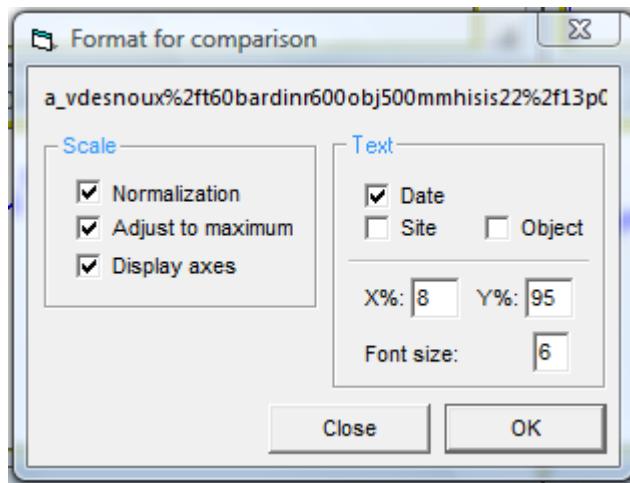
This function is used to apply same formatting to the entire profiles load for an easier comparison.

Load in Visual Spec all the spectra to be compared. We suggest using the command **Tile** in the menu **Windows** to automatically arrange the spectra in the Visual Spec application.

Select the profile from which you want all the profiles to have the same format – mainly teh wavelength domain.

- Click in menu **Tools**, sub-menu **Comparison**

A dialog box is displayed if more than one prfile is opened in Visual Spec.



The name of the profile which will serve as the reference is displayed at the top of the box

Select the type of formatting to be applied

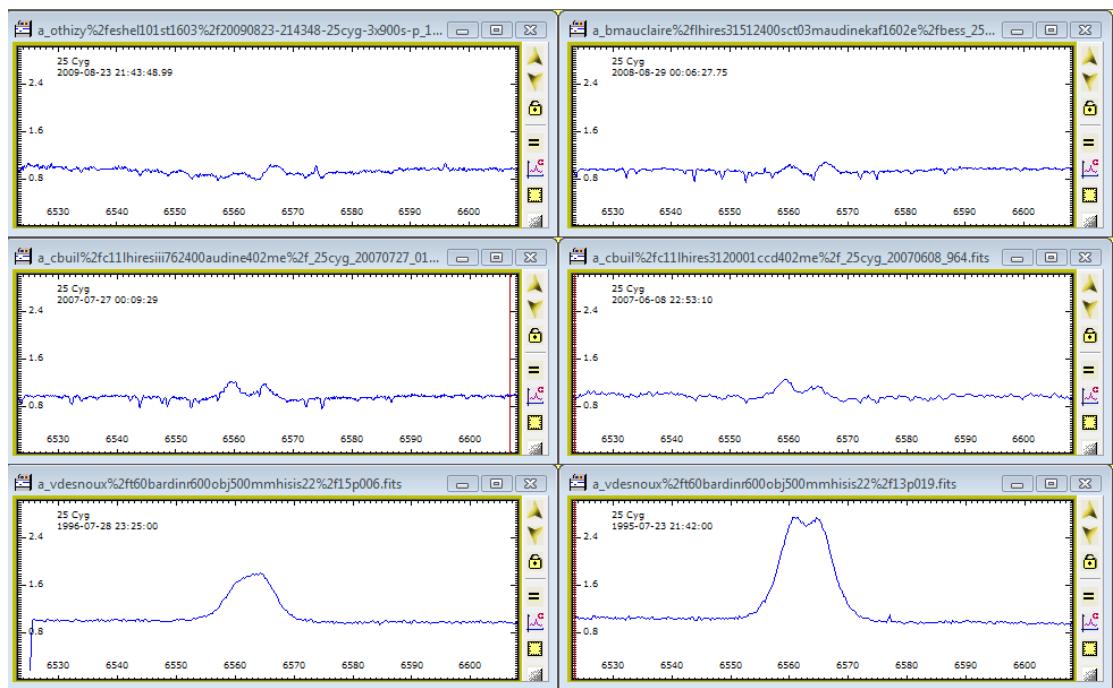
- Normalisation: this will scale to 1 the continuum on the wavelength range defined in the preset – if the domain is out of the coverage of one the profile, Visual Spec will prompt the dialog box to enter new set of values. But will not change the previously adjusted profile. In this case it is better to repeat the process.
- Adjust to maximum: look to the maximum value of each profiles. Align the max of the Y-axis of the each profile to this value plus 10% - all profiles will thus be displayed with comparable scale
- Display axes: turn on the display of the graduations for both axis

In addition the user can select text to be displayed in each graphic zone

- Date: display the date of the observation, from the header
- Site: displayed the site of the observation, from the fits header , or nothing if not a fits file with BSS_SITE keyword filled
- Object: display the object name, from the fits header, or nothing if not fits file with OBJNAME filled
- X%, Y%: value in percentage of the X or Y width where the text shall be displayed
- Font size: size of the font to be used

Hitting the OK button will format all the profiles according to the dialog box settings

Hit Close to close the dialog box.



This function is very well suited with BeSS query function to compare spectra evolution of a same object from the BeSS Database

Superposition diagram

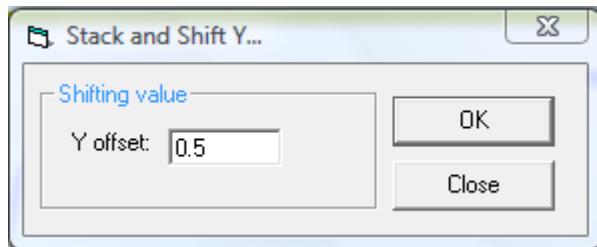
Another way to compare spectra is simply to superpose them and to shift them along the Y-axis.

This can be done manually with the functions of Visual Spec but this function allows to automatically copy-paste and shift of a constant value each of the series.

Before launching this function, it is recommended to proceed with the comparison function first. As described in the previous section, the comparison function can normalize each profile.

- Click on the menu Tools, sub-menu Stack and Shift Y...

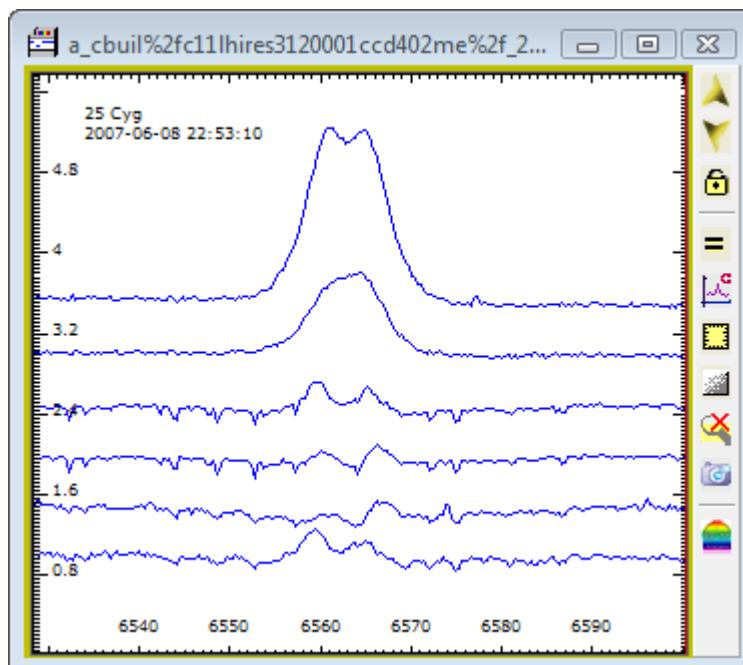
A dialog box appears, if more than one profile is opened in Visual Spec.



- Enter the shifting constant which will be added to each copied serie for the stacking process
- Click on OK to proceed

Or

- Click on Close to quit the function with no action



You can export the graph as bmp with the capture button on the right side or plot each series with gnuplot with the checked box "multi-serie" activated.

Identification of chemical elements

Identification of a chemical element based on wavelength is facilitated by the presence of a database included with Visual Spec.

- Element.txt

This a short version of the CRC Handbook of Chemistry & Physics - only lines from element up to Iron is reproduced.

VI/16 Line Spectra of the Elements (Reader+ 1980-1981)

Reader J. & Corliss Ch.H. <61st ed., CRC Handbook of Chemistry & Physics (1980--81)>

- lineident.txt

This a formatted version of a catalog of lines in stellar objects

VI/71A Revised version of the ILLSS Catalogue (Coluzzi 1993-1999)

COLUZZI R: 1993 < Bull. Inf. CDS 43, 7>

- sun.txt

This a formatted version of the sun lines catalog

J/A+AS/131/431 Accurate wavelengths in the Sun spectrum (Allende Prieto+ 1998)

Allende Prieto C., Garcia Lopez R.J. < Astron. Astrophys. Suppl. Ser. 131, 431 (1998)>

- Hires

The newly added "Hires" database if the transcription of the luke.lst file from Richard Gray's SPECTRUM software. It includes 38 text files and requires the 3.0.4 Vspec version at a minimum to be read as well as the separated zipped database file to be downloaded

- Atmos

The file atmos.txt has been made by Christian Buil from various source of data: national weather forecast tables, observatories tables, and personal data from the professional Coralie Neiner.

At the exception of Atmos and Hires database, all database are available from the Centre de Données Stellaire of Strasbourg, the CDS. By default, the database is the element list of the “Chemical Handbook”. It includes only the wavelengths of the atomic elements for which the wavelengths are included between 3000 and 11000 angstroms.

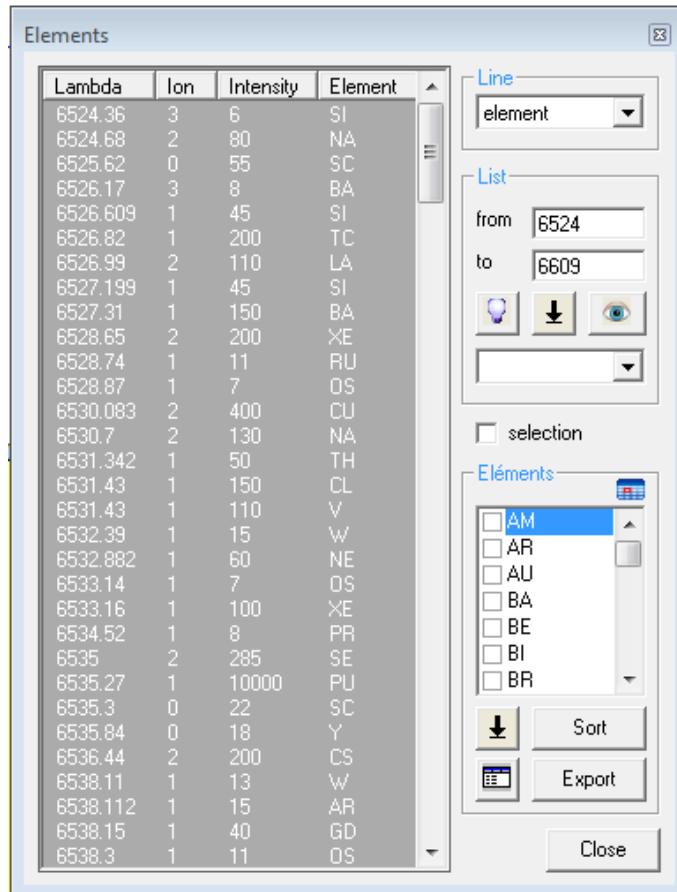
It is possible to add to the elements in this list by editing the file “Element.txt”. It is suggested to follow the format of the database.

To display the databases:

- Click on the menu Tools, choose “Elements...”
- or
- Click on the button  from the toolbar

A dialog box "Elements" appears

Dialog box "Elements"



The lines of chemical elements whose wavelengths are included in the entire spectral area of the profile appear in the list.

- The column “lambda” gives the wavelength in angstroms of the line
- The column “ion” indicates the ionization state of the atom.
- The column “intensity” gives the laboratory intensity of the line.
- The column “element” gives the chemical symbol of the atom.

To close the dialog box, click on the “close” symbol of the window frame.

You can click on one line and the cursor will move on the spectrum at the position of the element wavelength. If you do not see any move, click on the profil document and then again on the element window. You can also use the "up" and "down" arrows.

Identification by element

To view the spectral lines by element, click on the column header “Element”. The elements will be rearranged in alphabetical order.

To return to a list ordered by wavelength, click on the column header “Lambda”.

Identification over a defined domain

To view the lines included in a defined spectral domain, enter into the textboxes “from” and “to” the values in angstroms of the first and last wavelength in the list. Then click on the button “Find”.

To return the all set of wavelength, click on the button  from the frame "list"

Automatic identification

Automatic identification allows automatic selection of the line whose wavelength is that defined by the cursor position.

For this, it is necessary to:

- Click on the selection box Selection in the list frame from the element window
- Select a spectral area
- Click on the database window to display the selection of elements in the list
- To suppress the automatic identification mode, unselect the selection box

When the cursor is within the selected area, between the gray dashed lines, the closest line to the cursor position whose wavelength is included in the wavelength domain plus or minus the sampling factor is automatically selected in the list.

Multiple lines can be highlighted. This is due to low resolution of the spectrum which prevent the accurate determination of one unique line.



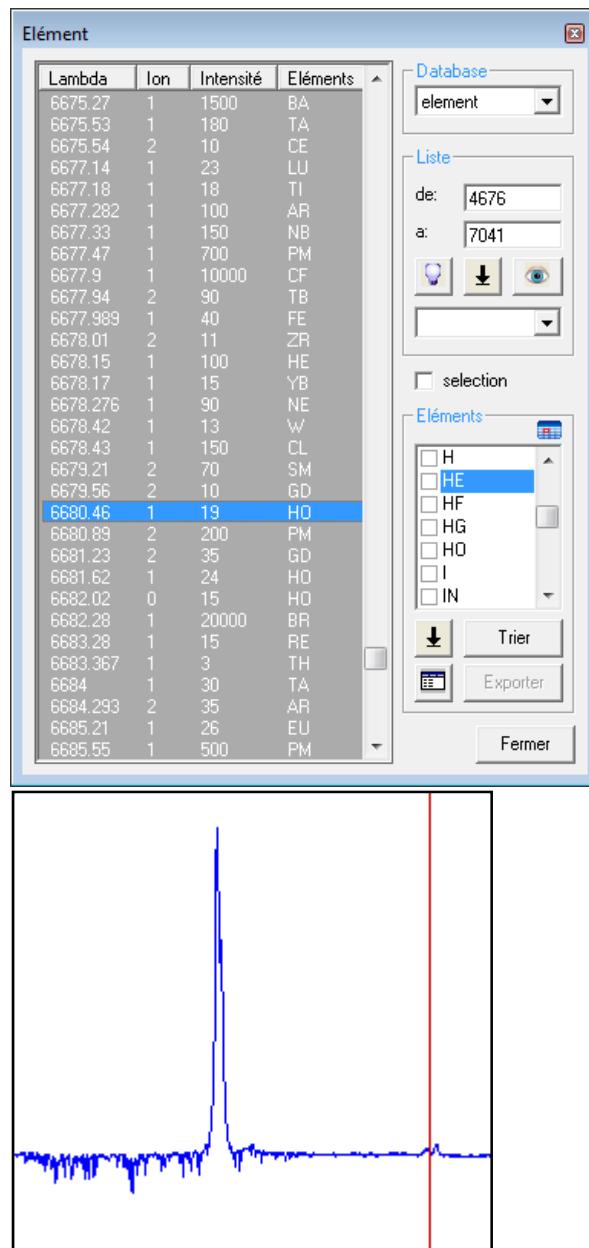
This automatic identification is only an indication, and is highly sensitive to imperfections of calibration and resolution of the equipment.

Spectral line link

If the profile is calibrated in wavelength, and the user click at a specific wavelength, the cursor in the element list will move toward the line closest to the wavelength of the cursor in the profile.

This function is given for indication, to move in the list in the “wavelength range” of the profile cursor. It shall be used to identified spectral lines. The resolution of a spectrum does not allow to get to the required accuracy to pick the line with certitude. The atomic element can be not present in this type of object and the sampling will probably encompass multiple lines.

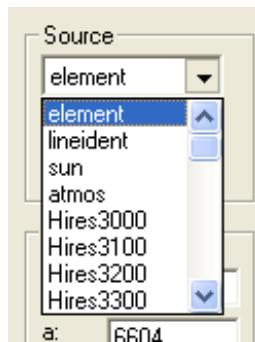
In the following example, clicking at the cursor position, the spectral line 6680.6 HO is highlighted. In reality, the line is the Helium line: 6678.15 HE located above.



Changing database

To pick another database:

- Select the database name from the dropdown list in the source frame



Element sorting

To only see some of the lines of certain chemical elements:

- In the “Elements” area, click the symbol of the element that one wishes to see.
- Click on the button “Sort”.

It is possible to select multiple entries in order to view a set of elements from the list.

To re-display all the elements

- Click on the “Reset” button 

Exporting a synthetic spectrum

It is possible to only display the lines of one or several chemical elements, then to synthesize the spectrum of corresponding lines in order to superimpose it on existing series. To accomplish this:

- In the Elements area, click the checkbox in front of the elements illustrated in the list
- Click on the button “Sort”
- Once the list is created, click on the “Export” button to export it

The synthetic spectrum is added as a temporary series named “spc.<chemical element symbol>” of the selected element.



Note: Verify and modify, as needed, the spectral extent of the list.

Exporting a synthetic spectrum as a new document

If the calibration process is not certain, it is possible to export the synthetic spectrum of a chosen element on the all spectral extent defined in the from/to fields in a separated profile document.

- Click on the button  to export the list of lines of the element list as synthetic emission spectrum

A new profile document is created under the name "Newspc-<id>.spc"

It is then very convenient to pick the interactive zoom and to search for evident correlation between lines pattern.

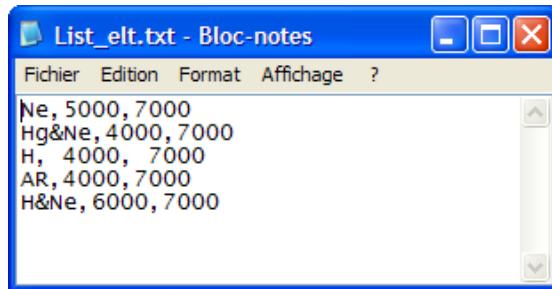
Fast access to spectral lamp profile

This can be useful to have a quick access to a pre-defined list of elements over a range of wavelength. The suggested usage is to list the wavelength of lines of a calibration lamp or the H Balmer lines. User can define multiple preset of lines wavelength and get quick access to them by using text files.

List_element.txt file

To configure the fast access, the text file List_elt.txt shall be edited by any word editor like notepad. This file shall be kept in the root directory of Vspec.

The file will look as below



Each line contains the name of the atomic element the user wants to see the lines wavelength and a wavelength range, each parameter separated by a comma

Example:

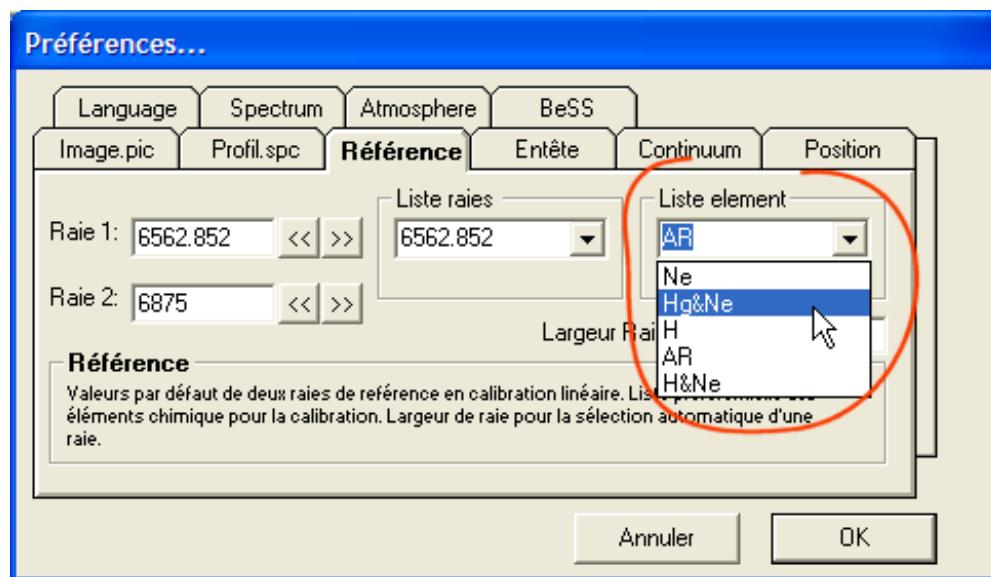
Ne, 5000, 7000

will display the lines wavelength of the Neon element over the range 5000 to 7000 angströms

To combine more than one element, the symbol & shall be used

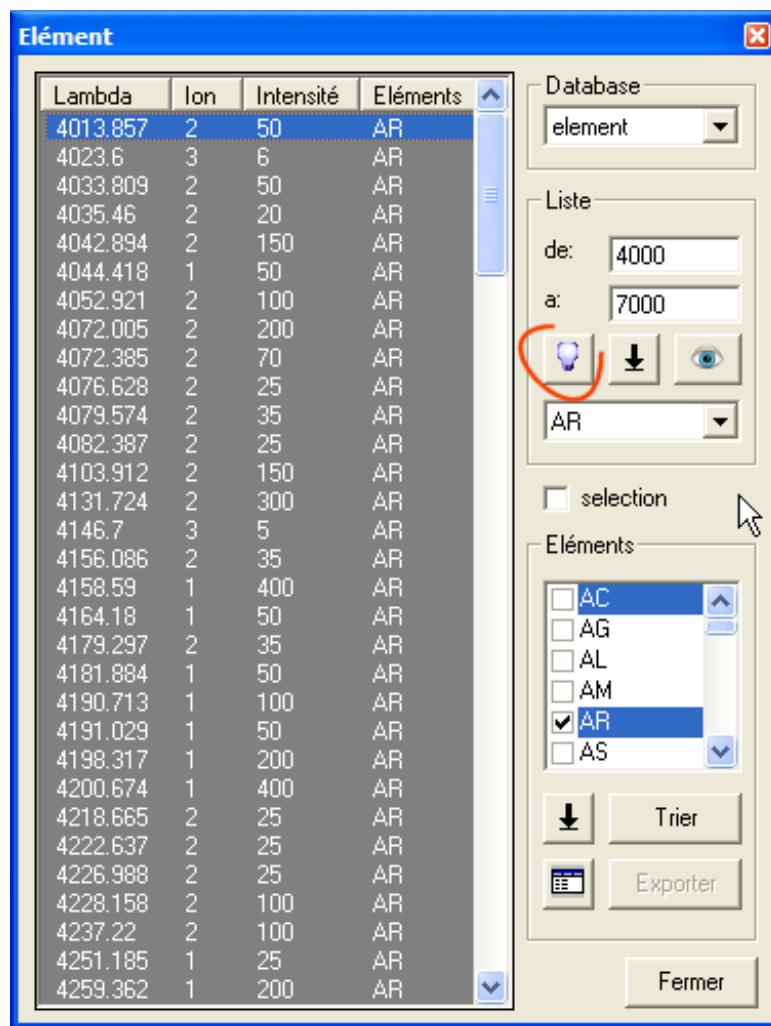
Symbols to identify the atomic element are the standard format in chemistry, as in a Mendeleiv table. Na for sodium, H for hydrogen, He for Helium, etc...

dialog box préférences – Tab Reference



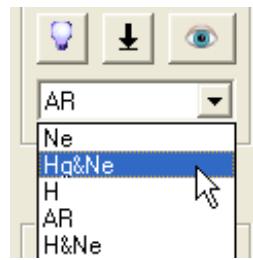
Each lines of the list_elt.txt texte file will the items of the drop-down list in the tab References. By selecting one will assign the configuration to the "lamp"  button which appears in the dialog bow "Elements"

Quick access in the Element dialog box



Click on the lamp icon to display the lines wavelength associated in the preference menu.

To change configuration, go in the drop-down list and pick another one of listed in the list_elt.txt file.



To come back to the full list, over the wavelength domain of the current profile, click on

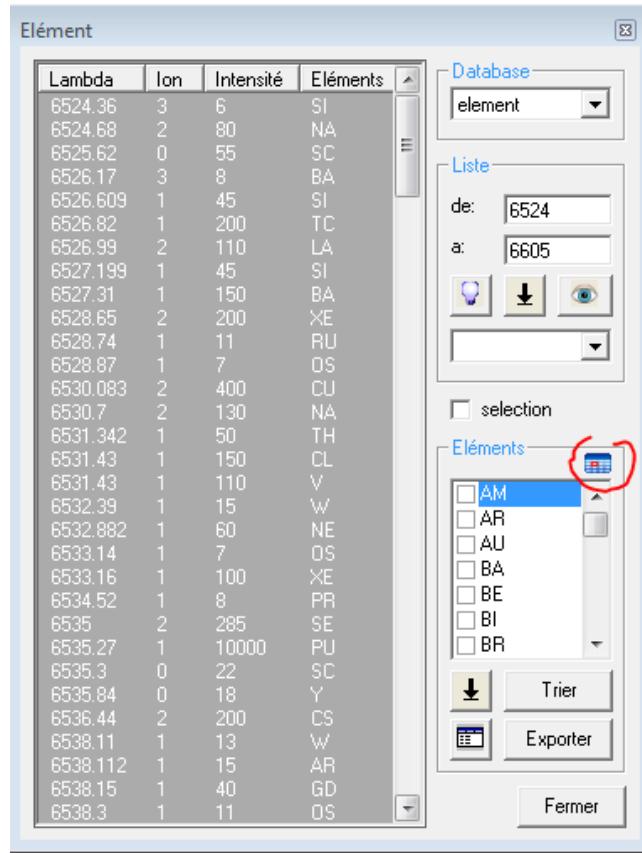
To modify wavelength domain, type the new wavelengths "from:" "to:" and click on

If the list_elt.txt file does not exist or if it is empty, then drop-down list will be empty.

Mendeleïev table

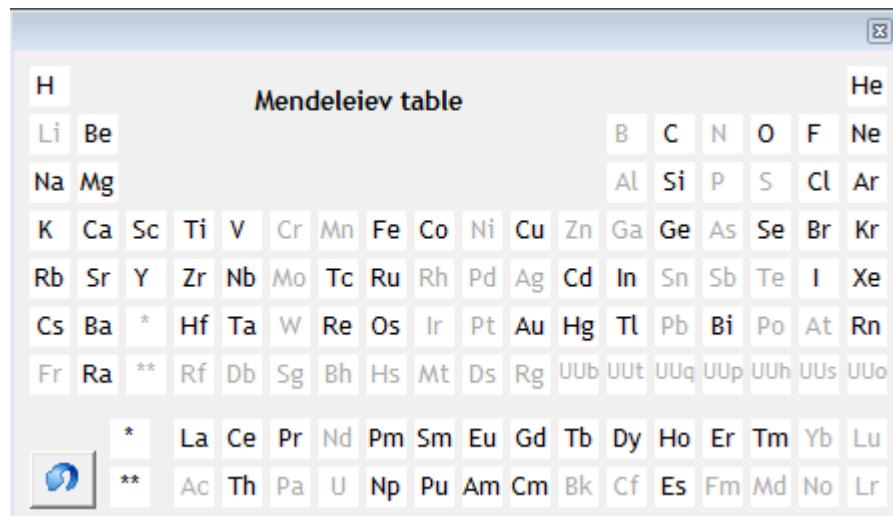
Display the spectral lines of an atomic element from the Mendeleïev periodic table interface.

This interface is displayed clicking on the  button.



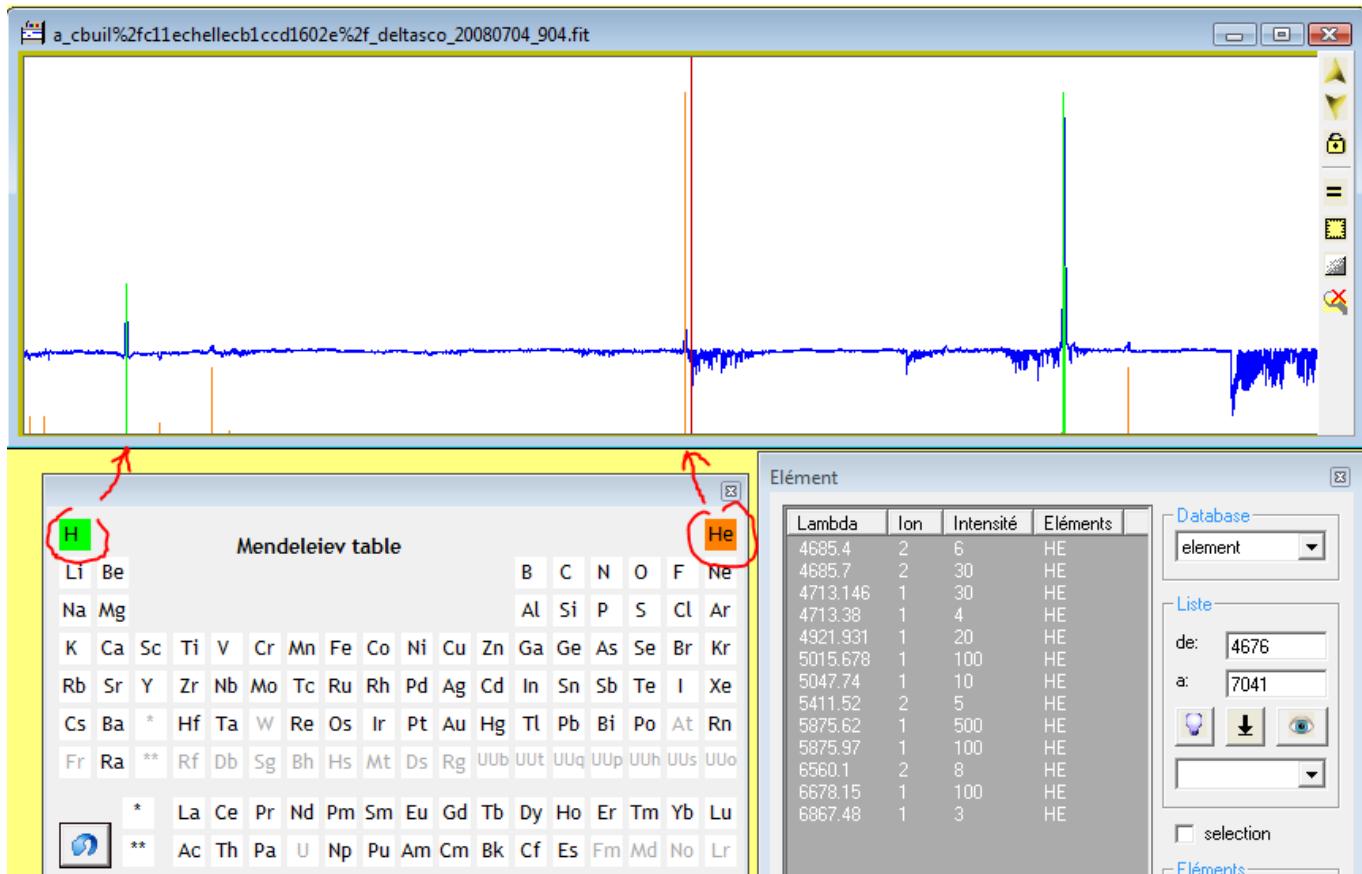
The screenshot shows a software interface titled "Elément". On the left is a table with columns: Lambda, Ion, Intensité, and Éléments. The table lists various spectral lines with their corresponding values. On the right side, there is a "Database" dropdown set to "element", a "Liste" section with fields for "de:" (6524) and "a:" (6605), and a "selection" checkbox. Below these are two lists: "Éléments" and "Trier". The "Éléments" list contains a scrollable list of elements, with "AM" selected and highlighted by a red circle. At the bottom are "Exporter" and "Fermer" buttons.

A new window is displayed. It represents the Mendeleïev periodic table. Only the atomic elements which have spectral lines in the selected wavelength range are enabled. Other elements are in gray and disabled.



The screenshot shows the Mendeleiev table interface. The table is a grid of elements. Most elements are in blue text, while some are in gray, indicating they are disabled. The rows and columns are labeled with element symbols: H, He, Li, Be, Na, Mg, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Kr, Rb, Sr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe, Cs, Ba, *, Hf, Ta, W, Re, Os, Ir, Pt, Au, Hg, Tl, Pb, Bi, Po, At, Rn, Fr, Ra, **, Rf, Db, Sg, Bh, Hs, Mt, Ds, Rg, UU_b, UU_t, UU_q, UU_p, UU_h, UU_s, UU_o. Below the table is a toolbar with icons for search, export, and other functions.

To display the spectral lines of an element, click on it. A color will be assigned and will correspond to the color of the synthetic spectrum superposed to the profile spectrum. Multiple selections can be made.



To cancel selections, click on the button

The superposition of the spectral lines on the profile is not performed if no profile is displayed or if the profile is not calibrated in wavelength.

To revert to the unsorted list of element, click on

Hires lines database

This database is extracted from the luke.lst file from SPECTRUM software. It includes all the lines retained by Richard Gray to generate theoretical spectrum. As this database is huge, it has been splitted in several sub files with 100 angstroms domain wavelength.

You have to select the Hiresxxx file where xxx correspond to the domain wavelength of your study.

If you did not have installed the hires.zip package, you will not see the files in the dropdown list.

Other aids to identification

While the program is running, other calls to the database of atomic spectral lines can be made using the button containing the question mark. The chemical handbook database is used by default.

- When calibrating in wavelength. Then only the lines corresponding to the chemical body of calibration are displayed
- During manual calibration. Then the whole database is displayed in the list

Gaussian fit

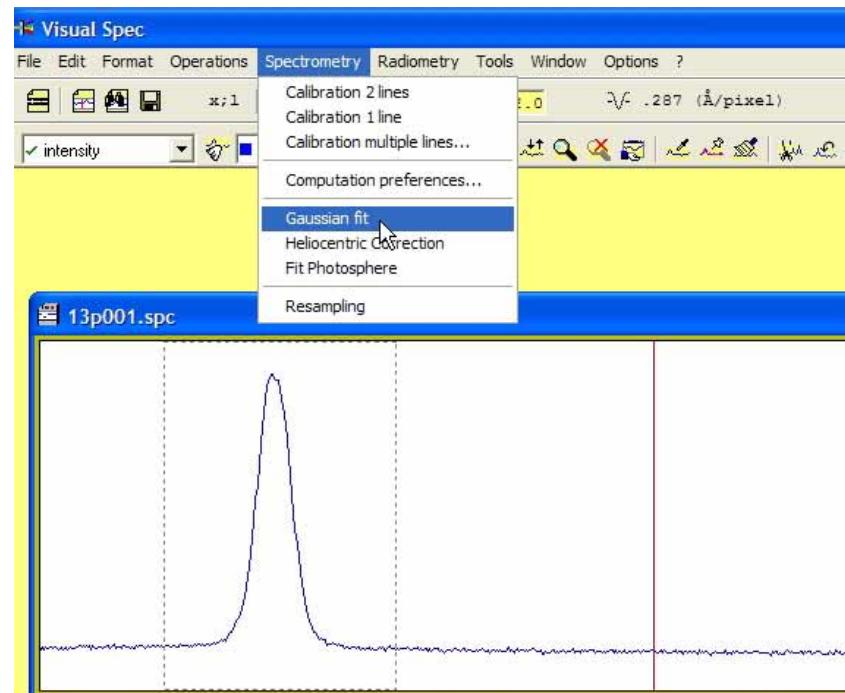
In some occasion, it can be of interest to fit a gaussian with spectral line. Visual Spec can compute the gaussian parameter which will best fit the spectral line selected.

Spectral line shape are defined by physics law. A gaussian profile is an approximation. The real profile is a combination of several physics process which can drive to more complex profile like Lorentz profile, Voigt profile combination, function of the energy level of the transition, the pressure, temperature, turbulence. Line can be also non-symmetrical, modified by Doppler effect of the matter. So computing some key parameters like Full Width mid-Height that way is not always relevant and drive to errors

Simple extraction of a gaussian profile

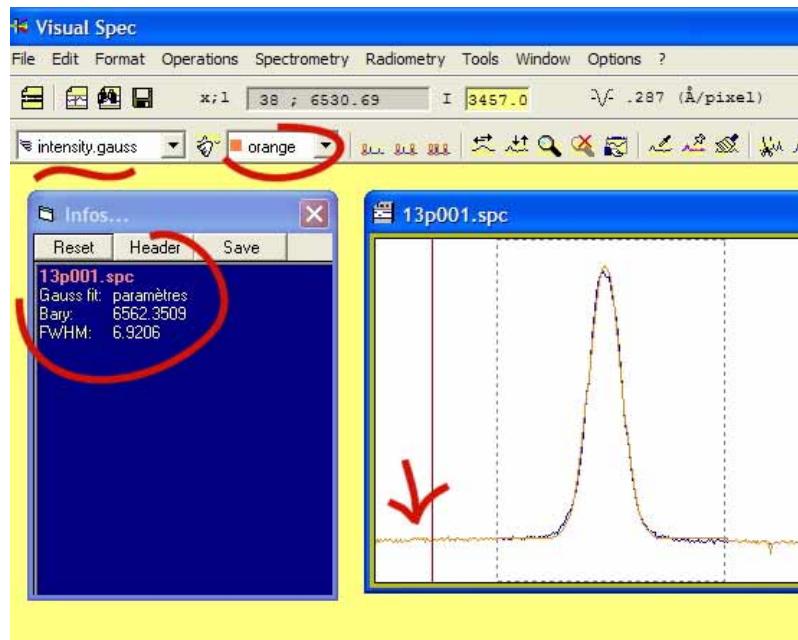
Open the profile and display the line you want to model - With the cursor select the portion of the profile you want to model with the gaussian fit

- Go in the spectrometry menu and pick the gaussian fit item



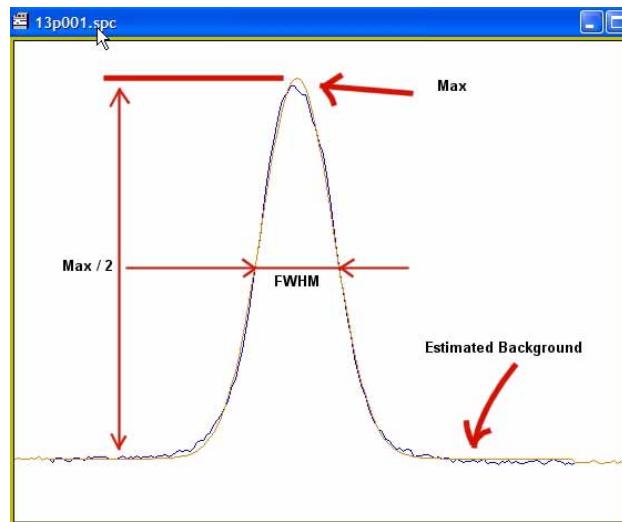
The gaussian fit will be computed and displayed as a new serie "serienname.gauss" with the orange colour

The parameters of the best fit gaussian are displayed in the infos window



Outside the selected zone the profile is the same than the original profile

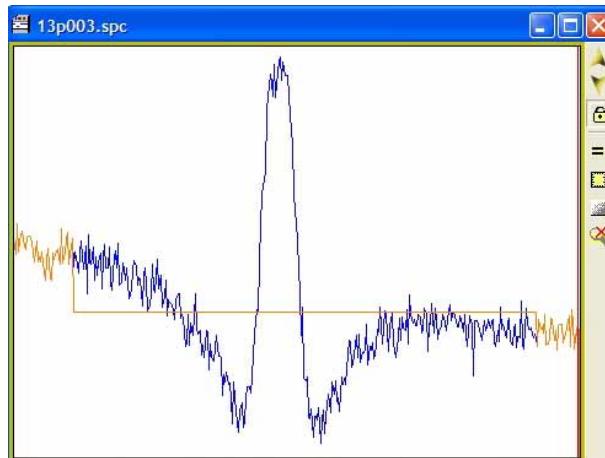
The "bary" is the centre of the gaussian, the "FWHM" is the Full Width at mid height of the gaussian



The modelization can also be applied to an absorption line



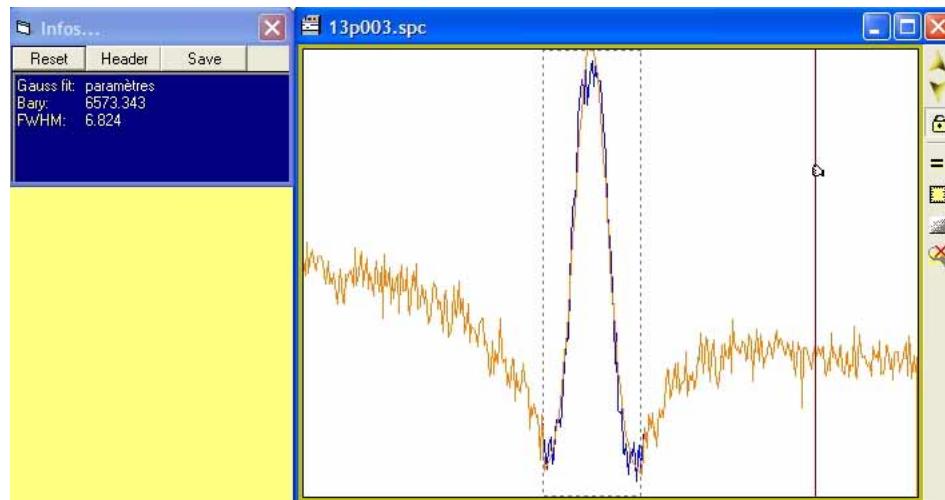
In some cases, the algorithm will fail to get to the right gaussian. It can just display a continuous profile of an error message in the infos windows like "no convergence" or "MS=0", MS for mean square



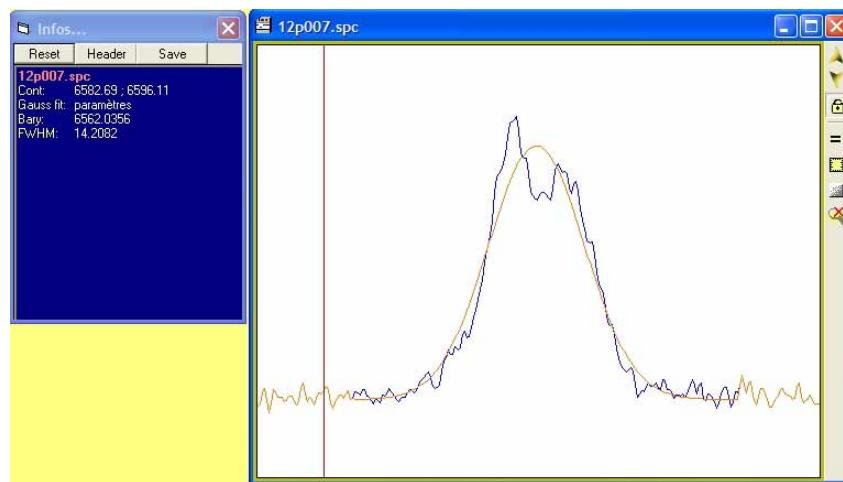
The fail can often be driven by the base of the line not being at the same level. One option is to "flatten" the profile with a continuum correction or to move to a more complex model, by sub-range as explained below

Zone modelisation

The user can choose to fit only a portion of the line profile, which is closest to a gaussian curve like in the example below



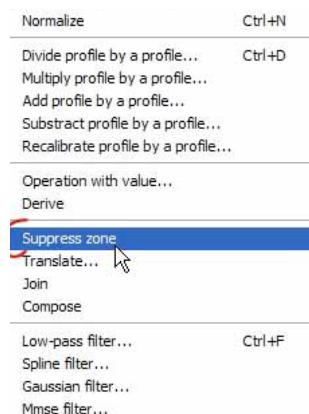
Let's take a combined profile



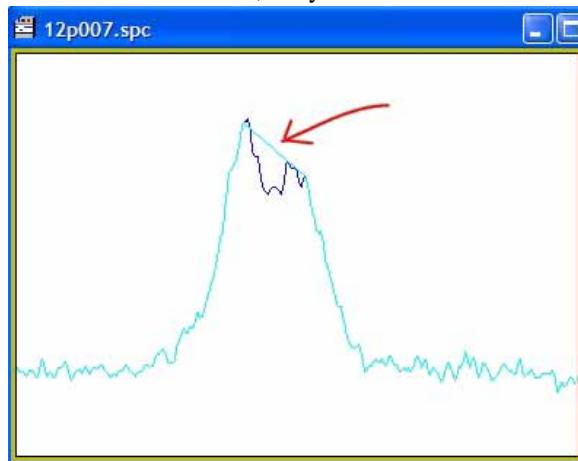
Due to the absorption centre in the line the best fit takes it into account and the overall fit is an average which does not exactly model the line shape.

For a better fit, the user shall indicates to the function that a portion of the profile shall be eliminated.

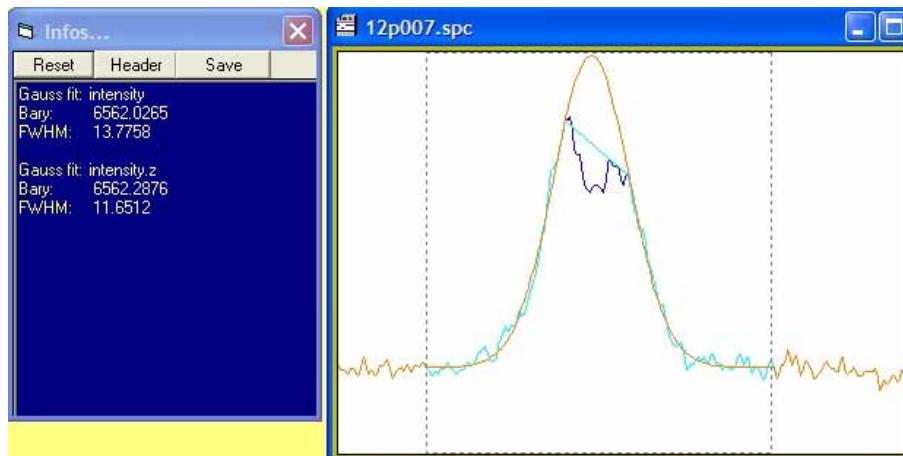
- Select the portion of the line you want to eliminate and click in the menu "operations", sub-menu "zone elimination"



The portion of the profile will be removed and a direct line will connect the two border points - A new serie will be added, in cyan color. Its name will be the previous working serie name + ".z"

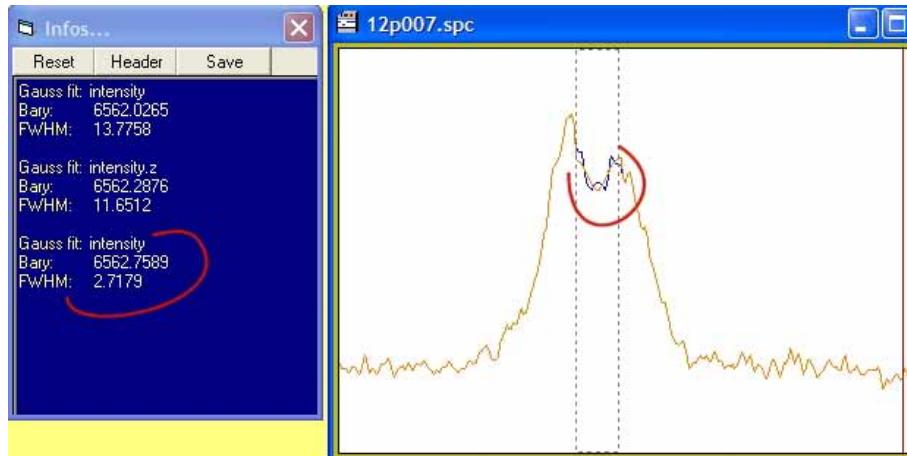


Keep selected this serie - select the overall line profile and perform now the gaussian fit



You can see that the gaussian modeled profile fits much better the main line profile - you can have a better estimate now of the line centre and its FWHM

If you want, you can perform another fit on the central portion, but pay attention of the border of the selection



GnuPlot

The GnuPlot application is a "grapher", a free software running on Linux and Windows. To fully benefit from the powerful GnuPlot function, please refer to the website <http://www.gnuplot.info/>

You can also simply use the version which is installed by Visual Spec during its installation.

```
* Copyright 1986 - 1993, 1998, 2004 Thomas Williams, Colin Kelley
*
* Permission to use, copy, and distribute this software and its
* documentation for any purpose with or without fee is hereby granted,
* provided that the above copyright notice appear in all copies and
* that both that copyright notice and this permission notice appear
* in supporting documentation.
***
* This software is provided "as is" without express or implied warranty
* to the extent permitted by applicable law.
```

Visual Spec uses the possibility to run GnuPlot by a command file and a script.

Visual Spec distributes the Version 4.0 but with only the mandatory file to run batch mode. To use the full application, one needs to get the official package from the official website. The Vspec distribution also includes specific files required by Vspec to run correctly GnuPlot like the command file "Gnutest.txt" and a script file "std.gnu".

The style file "* .gnu" are in fact the GnuPlot scripts. It is a text file. You can edit and create other files, but shall give them the .gnu extension to be recognized by Vspec.

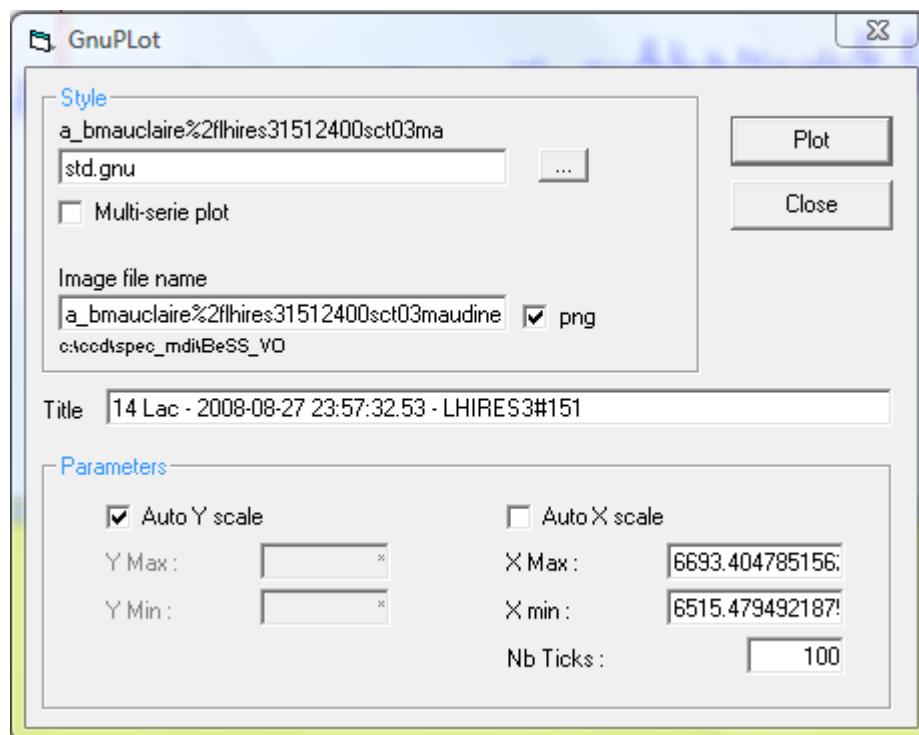
- Click on the menu Tool, sub-item "Run Gnuplot"

or

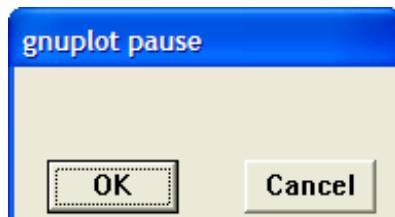
- Click on the button  in the toolbar

A dialog box is displayed

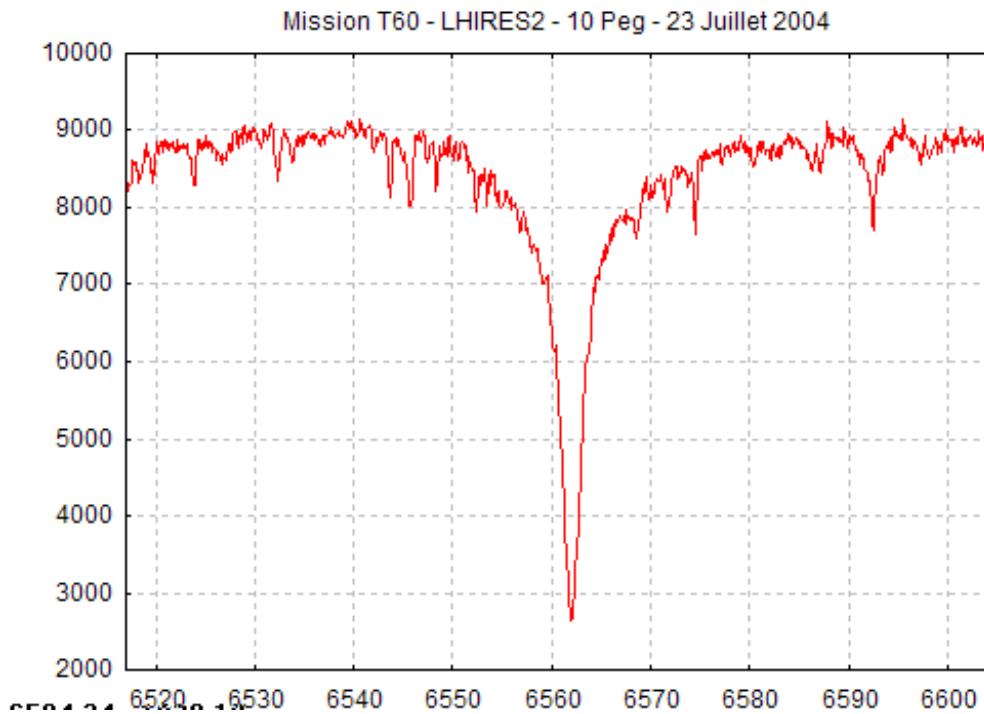
GnuPlot Dialog box



- GnuPlot use the .dat file format to create the graph. If a profil with the .spc format is currently displayed, the .dat format will be automatically created and displayed. If the serie to plot is not the intensity serie, you need to replace the intensity serie by the desired serie before launching GnuPlot.
- The style file is displayed in the frame "Style". If you want to select another file, click on the button to open the "open file..." dialog box.
- If you click on the check box multi-serie plot, all the displayed series will be plot in GnuPlot. Otherwise, only the Intensity serie will be plotted.
- The image file name is indicated in the field "Image file name". The name can be edited. It is not required to add extension. The extension is automatically added by Visual Spec (.gif) or (.png) if the check box png is checked.
- The field Title contains the text to be displayed at the top of the graph.
- The frame parameters manage the limits and the graduations of the graph.
 - You can let GnuPlot select the best scale parameters by checking the check box Auto Y scale and/or Auto X scale
 - If these checkboxes are not checked, you have to specifies the Y and X limits. For X axis, the graduations spacing can also be specified.
 - If your script forces the X and Y values, these values will have no effect.
- Once the parameters are defined, click on the button "Plot" to create the graph.
- When GnuPLot has completed the script execution, a Pause dailog box is displayed



This box is managed by GnuPlot. It allows to keep the display on your screen, if your script is using it as a terminal. To close the GnuPlot window, click on OK



- To close the Visual Spec GnuPlot window, click on the Close button

File style "std.gnu"

Visual Spec proposes a script file by default: "std.gnu" – it creates both a graph on the screen and record it under a .gif file in the same directory than the profile file.

```
#=====
# Script de trace GnuPlot des profils spectro de Visual Spec
#=====

# Paramètre 1 : nom du fichier
# Paramètre 2 : intitul, du titre
# Paramètre 3 : valeur min en Y
# Paramètre 4 : valeur max en Y
# Paramètre 5 : valeur min en X
```

```

# Paramètre 6 : valeur max en X
# Paramètre 7 : valeur ticks en X
# Paramètre 8: nom du fichier png
#
# Exemples :
#  call "std.gnu" "140699.dat" "88Her" 6500 7000 .2 1.8
#  call "std.gnu" "140699.dat" "88her" * * * (echelle automatique)
#=====

set terminal windows "Arial" 9 -> display the graph on the screen
set xlabel "" -> defines the x label, here, none
set ylabel "" -> defines the y label, here, none
set yrang [ $2:$3 ] -> defines the limits of the Y axis
set xtics $6 -> defines the space between X axis graduations
set xrange [ $4:$5 ] # zone libre -> defines the limits of the X axis
set tmargin 2 -> defines the margin around the graph
set grid -> Display a grid in the back of the graph
set title '$1' , -0.5 -> display the title of the graph
plot "$0" notitle with lines -> plot the graph from the file
#and now the file
set terminal gif small size 640,480 -> display the graph in a gif file format
set output '$7' -> save the file under the name $7
set xlabel ""
set ylabel ""
set yrang [ $2:$3 ]
set xtics $6
set xrange [ $4:$5 ] # zone libre
set tmargin 2
set grid
set title '$1' , -0.5
plot "$0" notitle with lines

```



The Gif format is more or less yet in the public domain. If you have difficulties, you need to check the png checkbox and modify the script std.gnu to replace set terminal gif by set terminal png

Required files

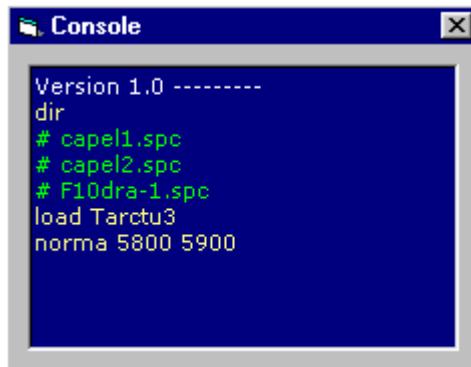
Here are the files that Vspec needs to launch gnuplot. All these files shall be in the root directory of Vspec.exe

- Gnu.bat, DOS script file to launch script
- Gnup.text, generated by Vspec, contains the directory path of the files to graph and the axis values
- Pgnuplot.exe, Wgnuplot.exe, wgnuplot.mnu, executables
- Std.gnu, style file for a single plot
- Page.gnu, thumbnail style file for web page generation by Vspec

Console

The console (menu Tools, choose “Console”) permits execution control by command-line.

The console is only accessible if the spectrum has been calibrated in wavelength.



How to use the command-line

To enter a command

- Click in the console window
- Enter the name of the command with or without associated parameters
- To execute the command, press “Enter”

If the command is not known, the error message “syntaxe inconnue” (“unknown syntax”) is displayed.

If the command is not followed by the needed number of parameters, the message “nombre d’argument incorrect” (“number of parameters is incorrect”) is displayed.

If one of the parameters violates syntax, the error message “Erreur syntaxe” will be displayed.

To display the list of commands, enter “help ?”.

List of available commands

The command-line commands currently available are:

Command	Parameters	Description
Help	?	Display the list of commands
Help	name of a command	Describe the command
Dir	<none>	List the .spc files in the current directory
Cd	Directory name or .. to go up one level	Change the directory path
Load	filename	Open the file <filename>.spc (the suffix .spc is automatically appended)
Select	windowname	Make the open document in the window named "windowname" active. If the document isn't open the message "Erreur de syntaxe" is displayed
Affichserie	seriesname	Make the series <seriesname> in the active document the active series. If a series named <seriesname> does not exist in the active document the message "Erreur de syntaxe" is displayed
Formatx	real value L1 real value L2	Display the series of the active document between wavelengths L1 and L2
Allformatx	real value L1 real value L2	Apply the L1 to L2 wavelength domain to all open documents
Norma	real value L1 real value L2	Normalize the active series with, for area of continuum, the area included between L1 and L2
Leq	real value L1 real value L2	Calculate and display in the info window the equivalent width included between L1 and L2. This calculation is only valid if the series is normalized
Decoupe Crop	real value L1 real value L2	Eliminate from the series the points outside the wavelength area included between L1 and L2 If one limit is unchanged, use the "*" character as for Crop *, 6600 or Crop 6200, *
Comp	Operation: one character a:surface b:barycenter c:center of the line f:Fwhm i: intensity l:Equivalent Width m:mean s:snr I1: real value I2: real value	Execute the operation between the value I1 and I2. Example: comp b I1 I2 Compute the barycenter entre between the value I1 and I2.
Plot	<none>	Call the gnu_plot dialog box – no parameter, plot the current active profile
Loadim	Image_name	Load an image. If not extension is set, the default extension is the one defined in the preferences.
Bin	<none>	On the active image, bin the image and create the 1D profile
Binz	Integer Y1 Integer Y2 Binz Y1 Y2	On the active image, bin the image on the zone between Y1 and Y2 Binz Y1 Y2
Crop_pix	Integer X1 Integer X2 Crop_pix X1 X2	On the active profile, crop the profile between the pixel value X1 and X1 Crop_pix X1 X2
S_rep	Filename Filename_response_instrumental	Divide the intensity serie of the file filename by the intensity serie of the file filename_response_instrumental. It is not required to specify the complete path of the files. The response file shall be located in the same directory than the filename. The resulting file is saved under the name "filename_1c".
gaussfit	I1: wavelength	Fit a gaussian to the profile section comprise between I1

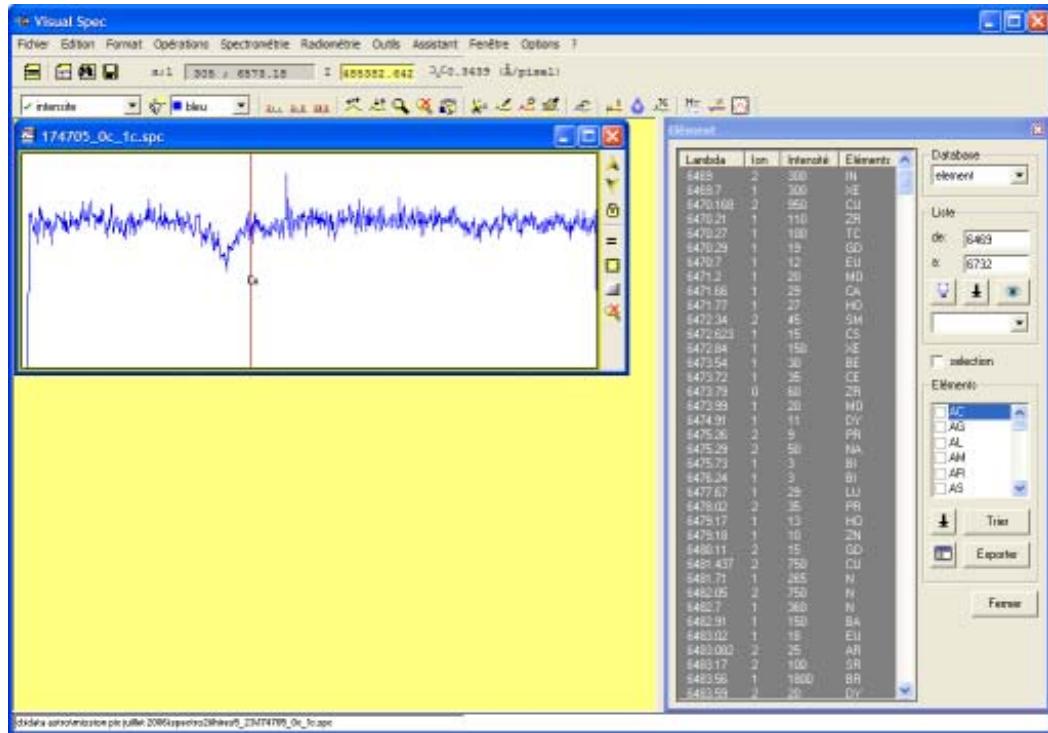
	I2: wavelength	and I2
serie_sel	s1:integer	Select the serie by its number s1 Serie number s1 are coded as followed: - Intensity: 3 - Ref1:4 - Ref2:5 - Normalise:6 - added temporary series, incremented as they are added, first add start at 8
div	s1:integer	Divide the current active serie by the serie of number s1
div_sel	Nomfenetre: string	Divide the current serie of the current profile by the serie active of the profile in the window name nomfenetre
cont_l		Compute the continuum from point list stored previously in the Liste.txt file
cont_z		Compute the continuum by eliminating zone from the list stored previously in the Listezone.txt file
smooth	P1:integer	Smooth by spline function the current active serie, the smooth coefficient is p1
replace	S1: integer	Replace the serie of serienumber s1 by the current active serie
run	nomprog.pgm: string p1:param p2:param p3:param	Run the script nomprog.pgm, can support 3 parameters
Zone_sup	I1: wavelength I2: wavelength	Suppress from the profile the intensities between the wavelength I1 and I2
Serie_del	S1: integer	Delete the serie by its number s1 Serie number s1 are coded as followed: - Intensity: 3 - Ref1:4 - Ref2:5 - Normalise:6 - added temporary series, incremented as they are added, first add start at 8
Vhcor		Get the Vhcor value from the fits header of the VO table file. Apply this speed correction to the whole profile. If the keyword is not present, display 0km/s and does not modify the profile
Corratm	Nothing I1: wavelength I2: wavelength	If no parameter is following, then corratm iterated a theroretical atmospheric profile to fit the object profile on the wavelength domain 6540;6553 anströms If 2 wavelength are listed, then the iteration is done on this domain. The result is a changed intensity profile corrected from the atmospheric lines.
7pts		Launch the 7pts "point and store" function, as if clicked from the menu
Comp7		Same a comp but used the first and the last wavelength values from the list7pts.txt file
Save_infos	Filename	Save the data displayed in the infos windows under the file named filename and replacing breakline by tab character to have all data on one line
W_bk		Write and force a break_line character in the infos text
Write	String	Write a string on the infos text – do not use space in the string
w_jj		Write the date in Julian days in the infos text
W_samp		Write the sampling factor in the infos text
Line1		Generate and display a line which Y axis is one

Windows docking

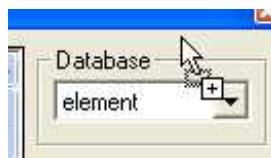
User can dock the following windows on the right side of the application

- Window element
- Window infos
- Window console

The application interface will look like:

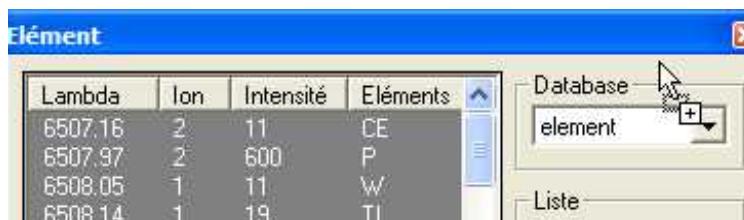


To dock windows, click and keep push on the left mouse button until the cursor will look as below.



The "drag-and-drop" docking mode will be activated if clicked in the window gray area, outside of frames. Exemple of location to click are shown for each window

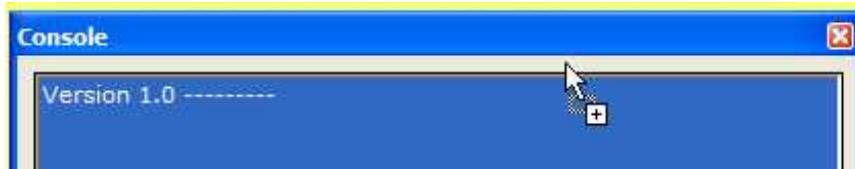
- Window element



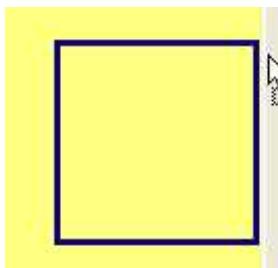
- Window infos



- Window console



Drag-and-drop the cursor on the new grey side of the Vspect application. When drop is allowed, a black rectangle appears close to mouse location.



To un-dock the windows, click and drag-and-drop them on the yellow part of Vspect interface.

If your computer screen is too small, dock only the useful windows. Make a test.

Sequence timing

In BeSS database, the exposure duration definition is not the total exposure of the spectrum as the sum of the individual exposure of each image in the sequence.

The BeSS exposure duration is defined as the overall time period where the images were recorded. It is computed as the date & time of the end of the last image – date & time of the beginning of the first exposure. This has to be in Universal Time.

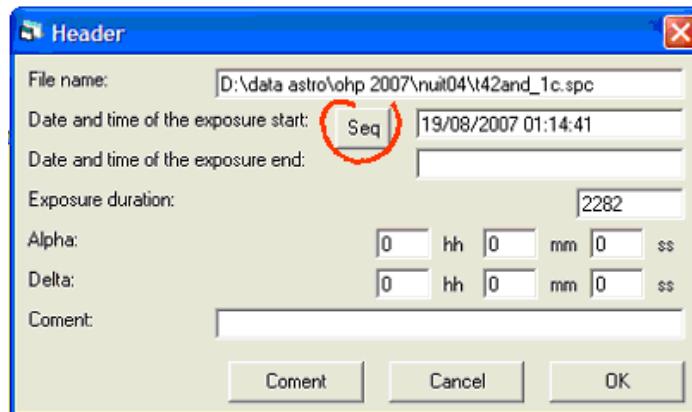
To facilitate this operation, the user can now select the list of the images of the sequence and let Vspect extracts and compute the timing and date.

The functions works with Pic or Fits format file. It does not work with dat, as the .dat format does not have any header informations.

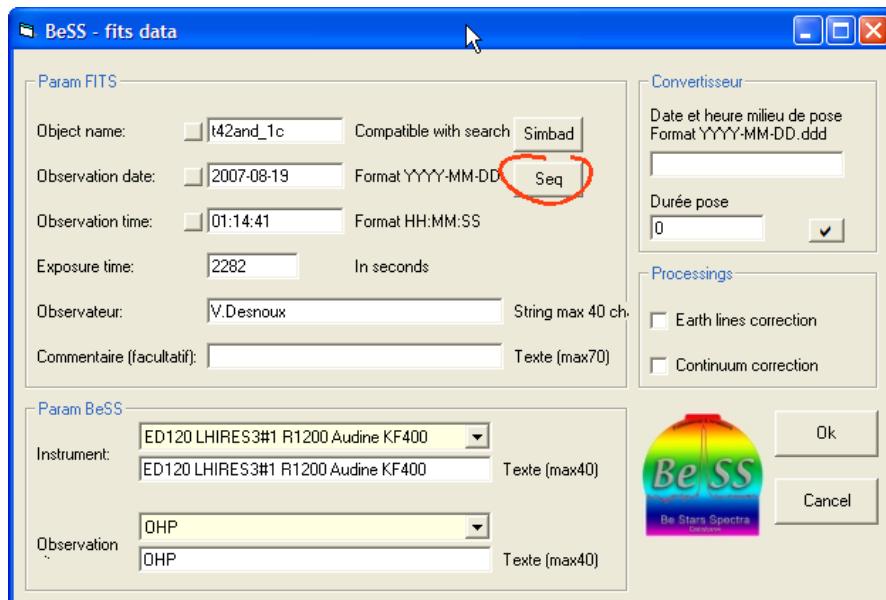
Get to the function

To access the function:

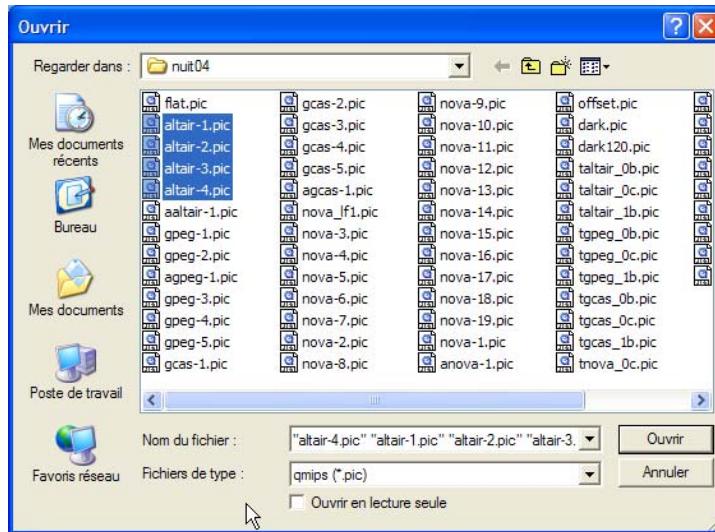
- Menu Edit, sub-menu Header – in the header dialog box, button Seq



- Menu Export fit – in the BeSS format diaolog box, button Seq



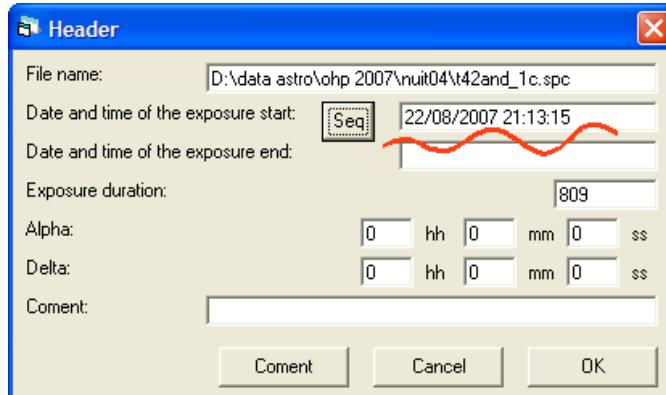
When clicking on the Seq button, the Open Image Dialog box opens:



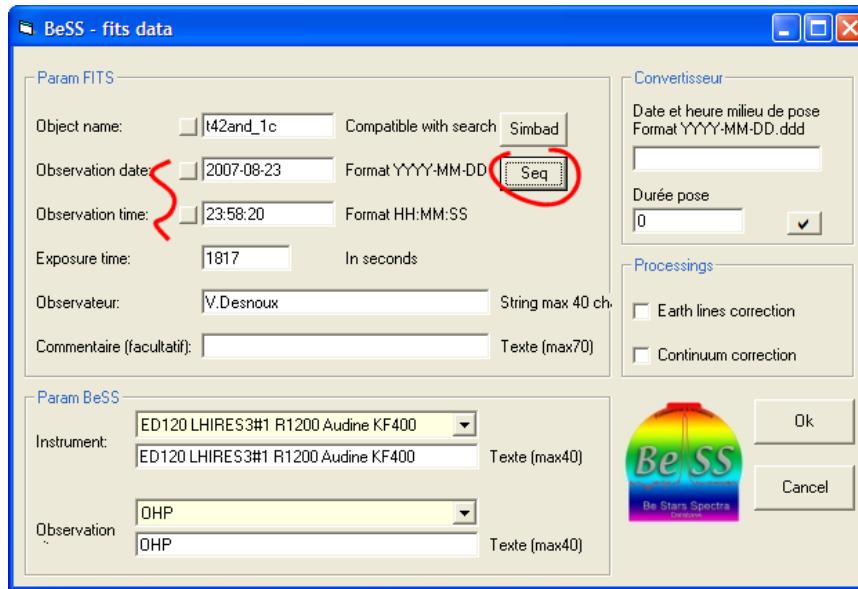
- Select the images which belong to the sequence of observation
- Click on the "Open" button

The dialog box will close

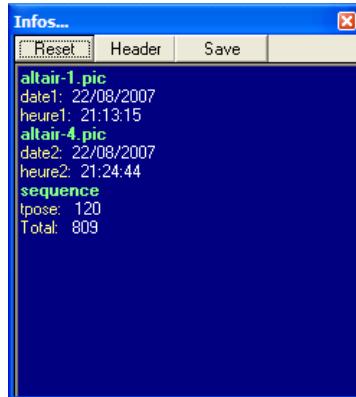
- The result of the computation is automatically updated in the header dialog box



- Or in the BeSS dialog box



- Result and details are displayed also in the Infos window



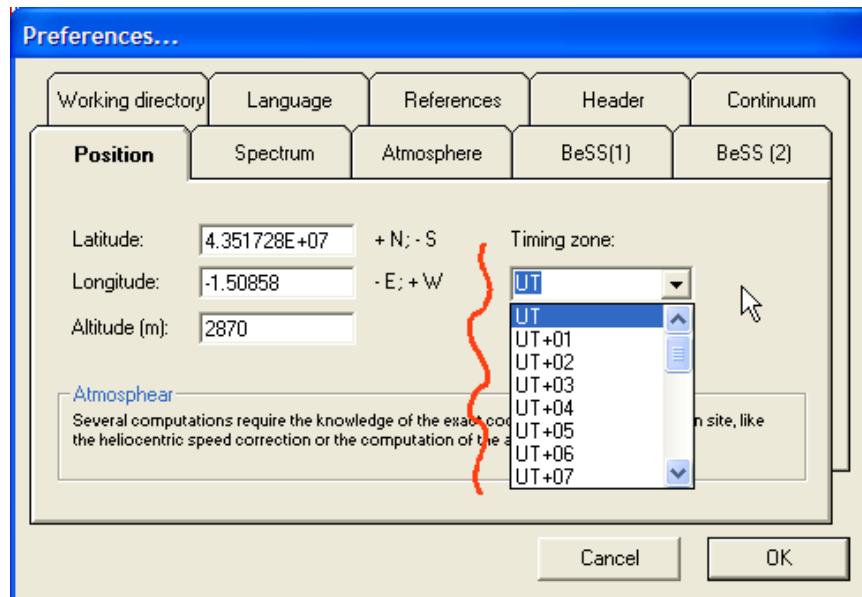
The name/date/time of the first image and the name/date and time of the last image of the sequence are displayed – First and Last are found based on the exact date and time from the image header.

The date/time of the first image, in Universal Time is computed and the total overall exposure duration is computed following the definition of the BeSS specification.

You'll have to make sure that your list effectively includes the first and last image of the observation sequence

Preset the UT time

To define the local time, you'll have to define in the Preferences what's the time difference Vspec will have to add to your images time flag. If you have set-up your images acquisition process in Universal Time, set UT+0 – if not, then select your offset in the preference "position" tab.

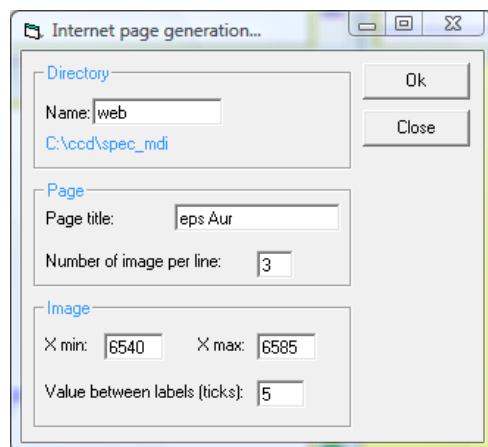


Internet page generation

This function is a tool to generate a web page with all the spectra of the currently opened documents as gnuplot graph.

- Click on menu Tools, sub-item Page...

Dialog box Internet Page Generation



- Enter the name of the sub-directory in Vspec directory. If the directory does not exist, it will be created. If the directory exists, the content will be replaced by this new page generation
- Enter the title which be printed at the top of the page, in blue, larger font
- Enter the number of graph per line.

The size of the graph generated will not change. They will also be as described in the style file "page.gnu" – by default it is:

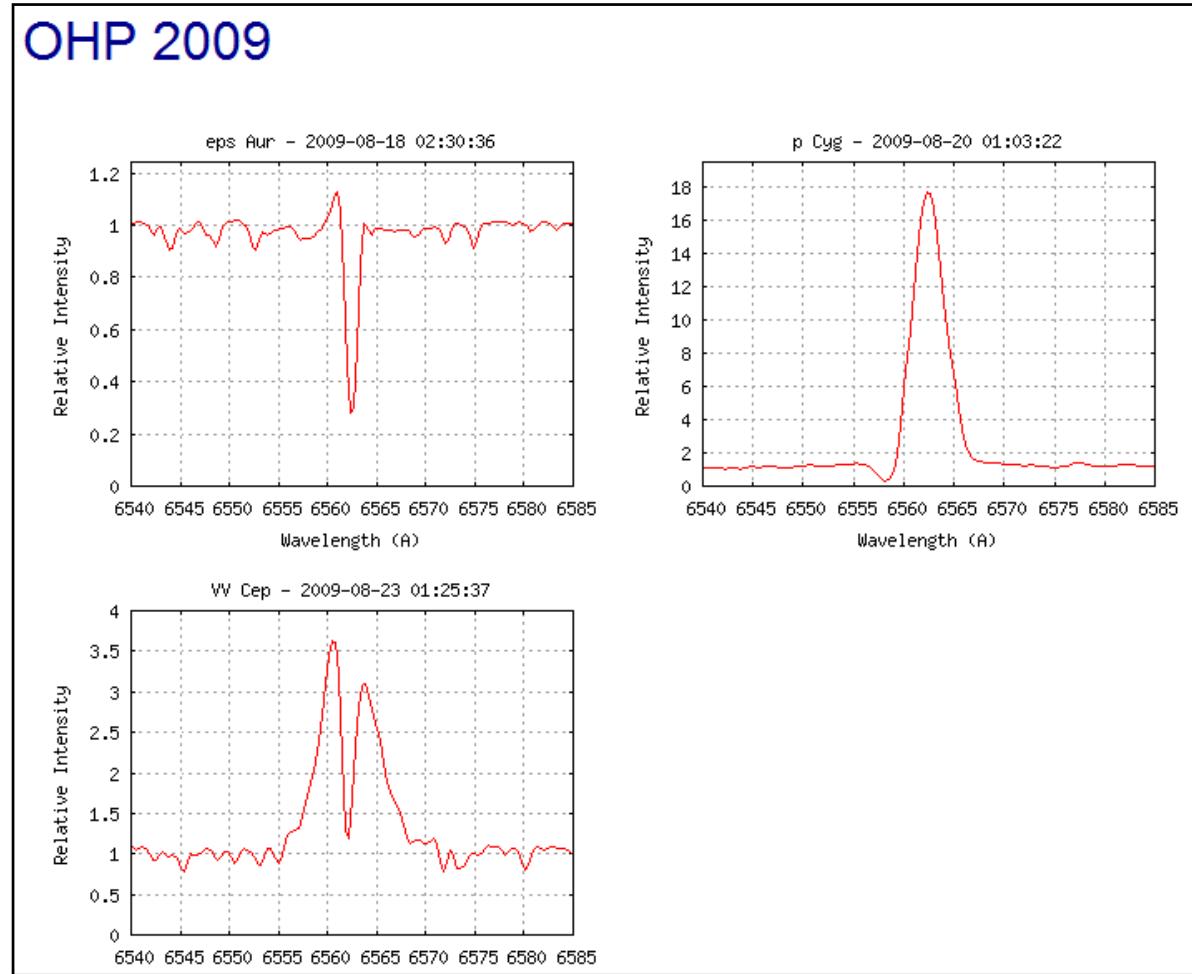
```
set terminal png small size 340,260
```

To modify the style of the graph generated by gnuplot, directly edit the file "page.gnu" which contains the batch list of gnuplot commands. The file "page.gnu" has to be found in the same directory as Vspec.exe.

- Enter the wavelength range for all the graphs and the number of ticks between labeled ticks

In the created sub-directory, the generated page is named vspec_objet.htm. All the documents will be converted into dat files and will be stored in this directory. All the images will also be generated and stored there, with generic names img x.png

The directory can be moved at anyplace on the hard disk. If not moved, next call for new page generation will erase the previous one if directory name is not changed.



The html page can be edited for customization.

This function is powerful if combined with the comparison tool, and the BeSS query. In few clicks, it can generate a web page with the spectra of a star over time with same format and scale for quick visual comparison.

CHAPTER 8

Assistants

The assistants are evaluated functions or link to external applications to assist the user in performing a sequence of processings in a more automated way or to get access to additional informations through internet connections to public database.

Lhires based assistants

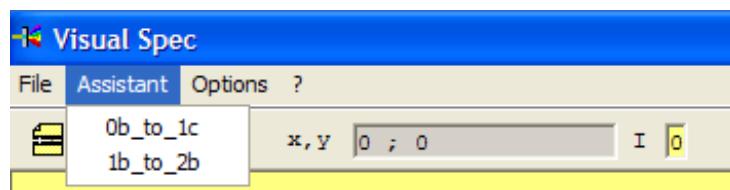
Those assistants have been developed to fulfil the need for Lhires spectrograph users, but can be used also with images acquired with other devices, as long as some rules are respected, as explained all along this section.

The Vspec assistants follow the convention of file naming suffix which describes the level of processings, defined by Christian Buil in his tutorials (see <http://astrosurf.com/aras/tutorial1/pipeline.htm>)

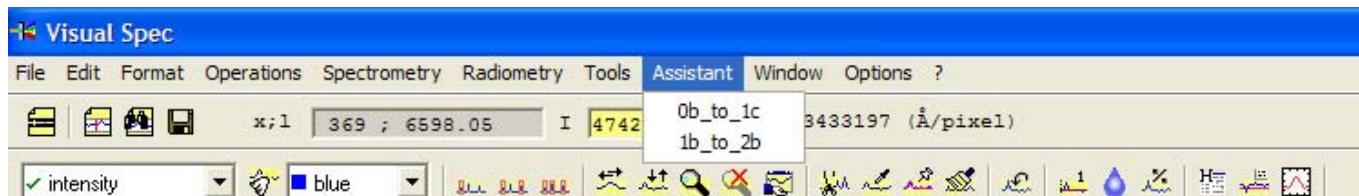
- 0b, 0c: Image file, one spectrum per image, all pre-processings done, ready for the 1D profile extraction
- 1b: profile file, wavelength calibrated
- 1c: profile file, 1b + correction of the instrumental response
- 2a: profile file, 1c + correction of the atmospheric lines
- 2b: profile file, 2b + continuum correction

The two assistants can be found in a new menu "Assistant"

- if no profile file is opened



- if a profile file is opened



0b_to_1c – starting with the image

This assistant extracts the spectral profile, calibrate it in wavelength and corrects it from the instrumental response of the sensor. The resulting profile has the level of processing required and sufficient to be converted into fits format. (ready to be load in the BeSS database in case of a Be Star)

The assistant load the object image, the calibration lamp image and the response curve of the device. It detects the spectral lines of the calibration lamp and calibrates the profile using a pre-written list of wavelength from a text file

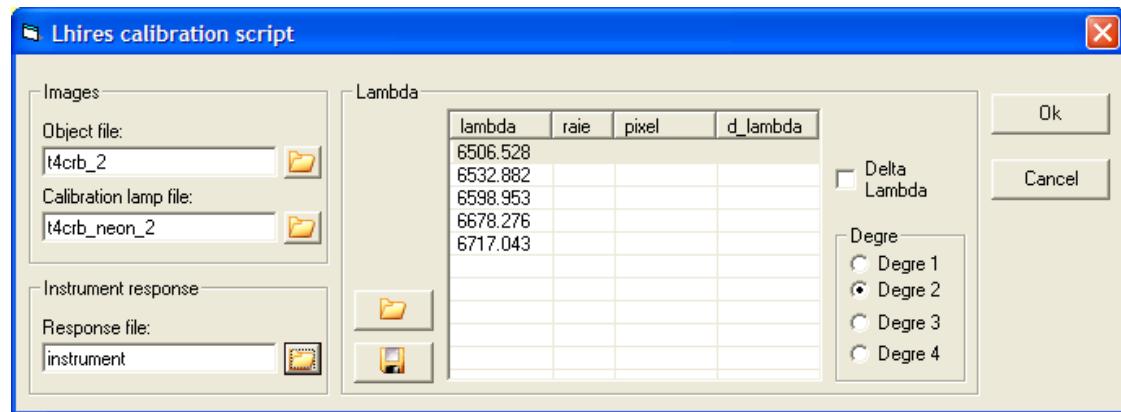
The response curve shall have been pre-established and saved as a spc file with the response profile in the intensity serie.

The wavelength list is read from a text file that the user shall specified

This function has been developed for spectra acquired with a Lhires spectrograph. It can be used with any other spectrograph as long as the following conditions are met:

- the calibration process uses a calibration lamp
- one spectrum per image
- The response curve of the instrumental behaviour has been processed and the wavelength of the lines in the lamp spectrum are identified

Dialog box "Calibration script Lhires" - description



- Object file: name of the image file, without its extension – click on the icon on the right to select the file if required
- File lamp calibration: name of the file of the calibration lamp, without its extension - click on the icon on the right to select the file if required
- The extension is the default extension defined in the preferences

The degree of the polynome is forced to 2, whatever the user selection is

The directory is the default directory or working directory chosen in the preferences.

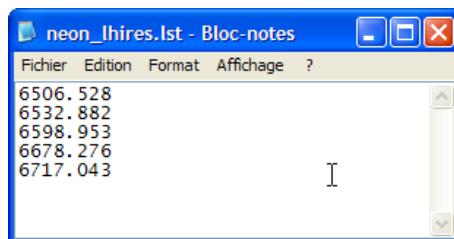
- Instrumental response: name of the profile file of the instrumental response, without extension - click on the icon on the right to select the file if required

This profile file shall be a spc file, and the first serie intensity shall contain the response curve. This response shall cover the wavelength range of the profile to correct.

- Lambda: Wavelength list of the calibration lamp spectrum – this list shall be load with the xx bouton – it calls for a dialog box to select the .lst file which resides in the vspec root directory

The wavelength list shall correspond to the spectral lines visible on the lamp spectrum. They shall be ordonated from the blue to the red. (increasing wavelength)

To create this list, it can be done with the multi-lin function, editing the wavelength (or selecting them from the element window if displayed) then by saving the list in a .lst file. This file can also be directly edited with a text editor like notepad. See the Vspec manual and the example below.

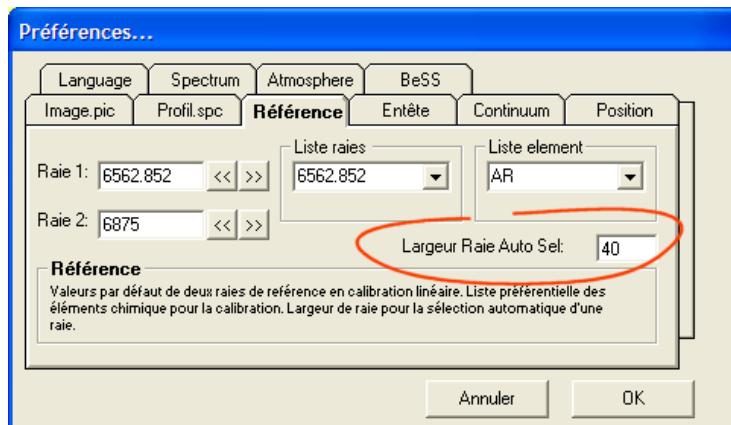


Operations description

Vspec will first load the two images. It will extract the 1D profile with the automatic binning function and the result is put in the intensity serie.

It will then do the "lamp binning" on the lamp image and put the result in the "Ref1" profile.

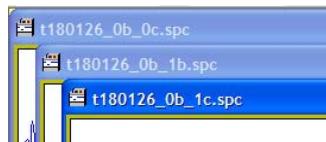
Vspec then detects the lines of the lamp profile. The assumption is made that all lines are emission lines (detection of maximum) and that the width is around the one defined in the preferences, as shown in the image below.



Once the lines are detected, Vspec assign the corresponding wavelength in the same order from the .lst file. Line 1 is associated to the first wavelength, line 2 with the second, up to the last line. The calibrated profile is saved with the "_1b" extension.

Vspec will then load the instrumental response and divide the object profile by this response, and will replace the intensity serie by the division result. This new file will be saved with the extension "_1c"

The profile files will be kept displayed for a check. It is not necessary to save them again. Except if you make modifications.



The wavelength and their corresponding barycentre with the coefficients of the calibration law are displayed in the infos window.



Console mode

This assistant is also accessible through the console with a command line.

A wavelength list shall be previously created which will contain the wavelength of the lines of the lamp spectrum, as in the menu assistant. This file shall have as above the .lst extension.

The command is the following:

```
s_calrep nom_image nom_image_neon nom_profile_instrumental
nom_fichier_liste
```

None of the file name need to be written with its extension. The extension is by default the one selected in the preferences.

All the files shall be present in the working directory, specified in the preferences with the exception of the list file which shall reside in the root directory of Vspec

Example

In the working directory, the following files are:

t4Crb_2.pic for the image of the object

t4Crb_neon_2.pic for the image of the calibration lamp, here a neon lamp

Instrument.spc for the previously computed instrumental response

neon_lhires.lst for the wavelength list of the neon lamp

6506.528

6532.882

6598.953

6678.276

6717.043

The line command is:

```
S_calrep t4crb_2 t4crb_neon_2 instrument neon_lhires
```

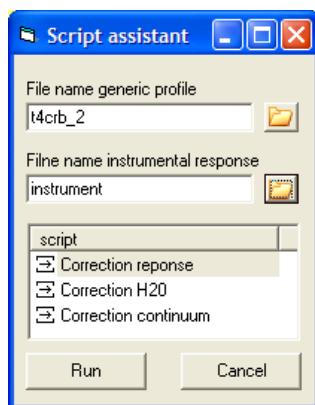
1b_2b – Starting with a calibrated profile

This assistant links the following processings starting from a calibrated profile (wavelength calibrated "_1b")

- correction of the instrumental response "_1c"
- correction of atmospheric lines "_2a"
- correction of the continuum "_2b"

These processings requires user intervention, but are linked automatically the stand-alone processings. The assistant saves all the files with the appropriate extension corresponding to their level of processing.

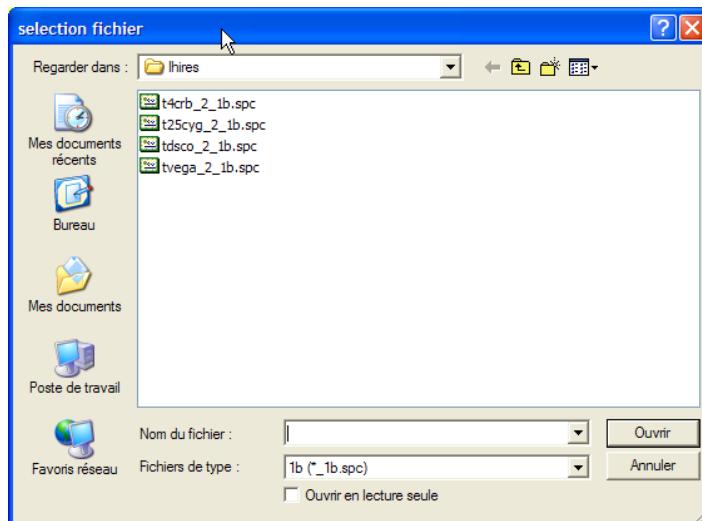
Dialog box "assistant script" - description



It is possible to deactivate one of the processing in the chain by clicking on the icon facing the processing name in the list script.

- **generic profile file name:** select the file from the directory with the right button or type the name without suffix "_1b"

In the open file dialog box, only file with extension ".spc" are listed.



- **Instrumental response file name:** select the file from the directory with the right button or type the name without the extension .spc
- Click on Run

Visual Spec will automatically launch the processing listed. Some of them requires user actions. Refer to the stand-alone description of the processing in Vspec manual

Operation description

Vspec opens the file "generic_name_1b.spc" and corrects it with the profile from "response_name.spc". Result is saved with the extension "_1c.spc"

Vspec launches the atmospheric line correction processing. Refer to Vspec manual. Once the correction adjusted, click on ok in the atmospheric dialog box. The result will be saved with the extension "_2a.spc"

If the atmospheric line correction has required a shift in the wavelength, then at closure, Vspec applies the shift to the instrumental response profile and redo the response correction. (and save again the "-1c.spc" file).

Finally, Vspec will launch the continuum correction, which will divide the profile by its own continuum. Refer to Vspec manual for continuum correction user actions description. Vspec will save the result in a file with the extension "_2b.spc"

If one of the processing is disabled by the user, Vspec link the next enabled processing based on the suffix of the last executed valid processing.

Vspec also automatically crop the profile by detecting values close to zero.

At the end of the assistant execution, All the files "_1b.spc", "_1c", "_2a", "_2c" are displayed for checking

If files are not found, or errors occur, information messages are displayed. There is no command line in the console mode available for this assistant

Console script mode

The console allows you to enter command lines. It is now possible to link them into a text file and run this as a script to automatize some processings.

Automatization of spectral processing shall be done with care. Make sure your results are consistent and as accurate as the manual process.

How to build / run a script

- Test your command sequence first in the single command mode in the console
- Open a text file, edit the command list, one command by line, up to 3 parameters \$1, \$2, \$3 can be used
- Save the text file with a .pgm extension - the file shall be stored in the vspec.exe directory
- Run the script from the console by typing run nompgm (without .pgm) and the parameters if you have included them

Script example

In this example, the script will load the \$1 file, perform a zone continuum correction followed by a spline smooth with \$3 smooth coefficient, select the intensity serie and divided it by the serie "8" which is the added serie "continuum.fit". It then normalize the profile, move the current serie in the intensity serie, save the file under the \$2 name and reload it to display the result

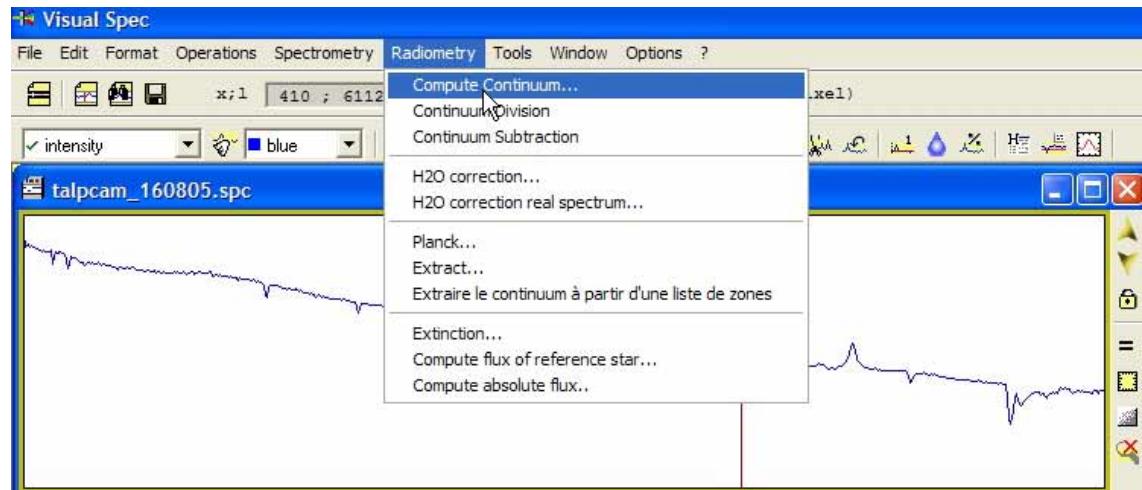
```
load $1
conti_z
smooth $3
serie_sel 3
div 8
norma 6590 6640
replace 3
save $2
load $2
```

Define the extraction continuum zone

The most important to know here is to have previously stored the list of profile zones to eliminated before the continuum fit on a previous profile, this having being done the traditional way. The same way, the smooth coef \$3 would have been determined from another similar object processed manually. It may not be absolutely the same from one profile to another one... that's the limitation of automatisation.

Pick the profile which exhibits the highest number of lines, to make sure all the zones where lines can be present are captured and eliminated.

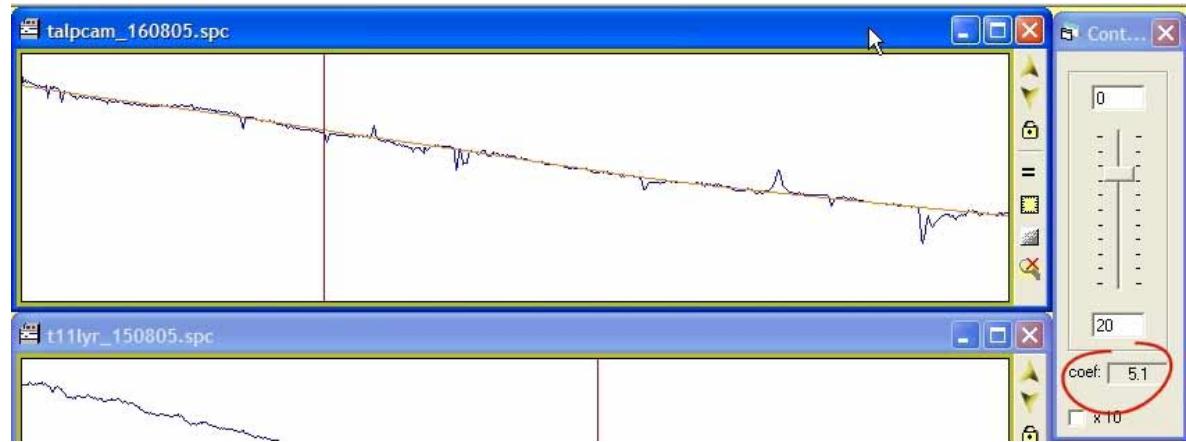
This profile is then processed "manually" - first, extract the continuum



Then, eliminate the zone where there are lines



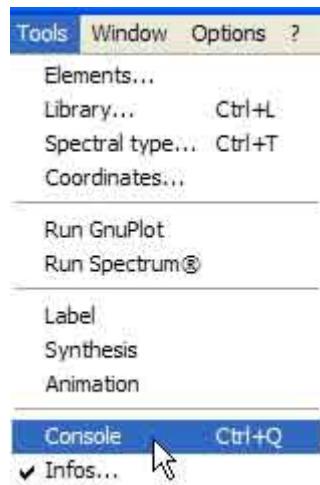
When done, just run the continuum extraction, and get the smooth box displayed - pick and note the smooth coefficient



Stop here, or go up to the end, just to check that your process will be ok

Run the script

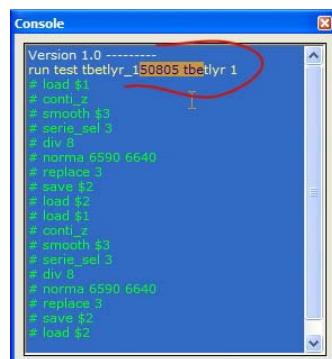
Display the console



Enter the command to run the script with the name of the file to process as parameter 1, the name of file under you want to save the result as the second parameter and the smooth coefficient, which is 5 (the highest it is the smoother it will be). Run... and observe the sequence, at the end, the file with the resulting processed spectrum is saved and displayed. The list of commands executed are printed in green in the console.



You can repeat the script entering new object names - you can just edit the names on the same line, then select only few characters of the line and hit enter - the command will be run again.



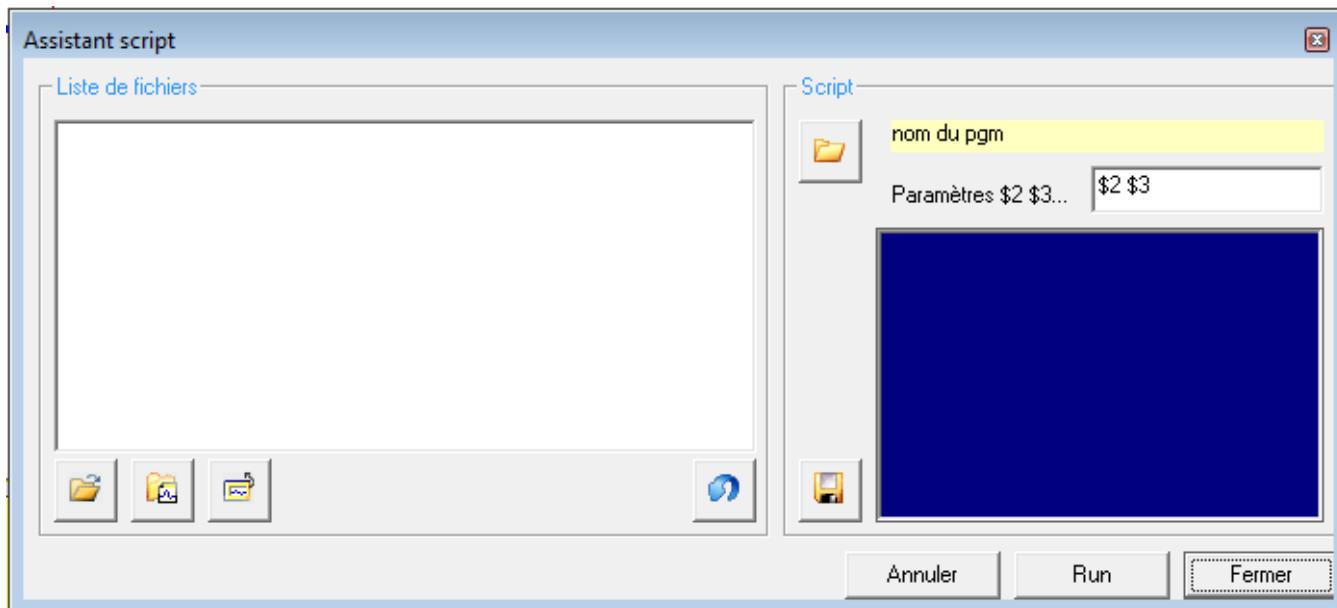
You can also cut and paste to repeat the same script in a long text file with the different names of the object you want to process. And run just once

Script box

This allows running a script on a list of files from different directory, dropped in the list box.

Click on the menu "assistant" sub-item "Script-box"

Script box dialog box

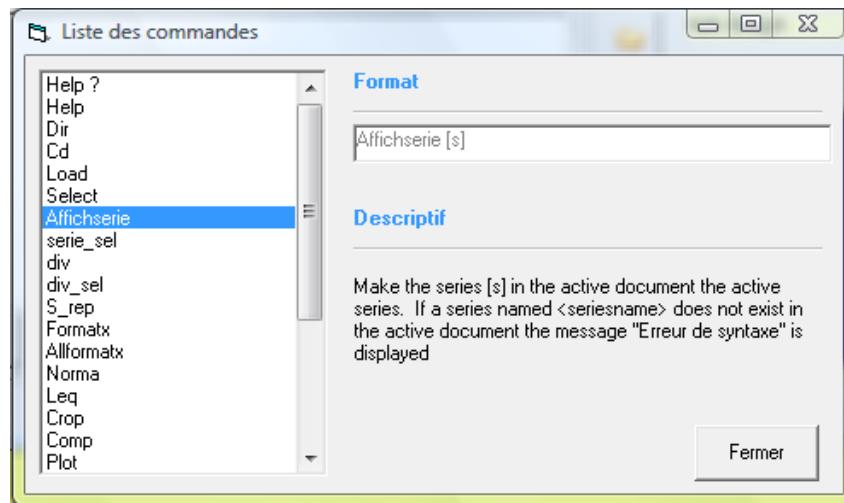


- The left white box shall show the files to be processed by the script
- Windows Explorer : open Windows Explorer. The user can select the directory and the files to be processed by the script. Drag and drop them in the file section of the dialog box.
- VisualSpec Explorer : open the Visual Spec Explorer interface. Drag and drop the thumbnails of the files to be processed by the script.
- If profiles are already opened in Visual spec, click on the button to add them all to the list of files to be processed.
- The open file icon is to open the directory of the script .pgm file to run on each file in the list box
- When the .pgm file is loaded the script is displayed in the blue section
- If the script requires parameters, enter them in the parameter text field
- Click on Run to execute the script on the files
- Always start a script with the command Load \$1

In addition

- you can save back the script if you edited it
- Clear the list of files with the blue arrow button

- Get a description of the command line available with the button , then click on the command to have the description in the dialog box



Examples

Script to link the plot gnu_plot feature and generate the png graphics

```
load $1
plot
```

Script to compute the Equivalent Width on a pre-defined wavelength zone

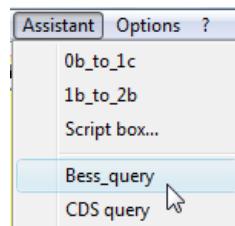
```
load $1
norma 6590 6600
comp l 6547 6577
```

BeSS queries

Visual Spec includes a tool to query and import spectra from the professional database « BeSS », for Be Stars from the Paris-Meudon – GEPI observatory.

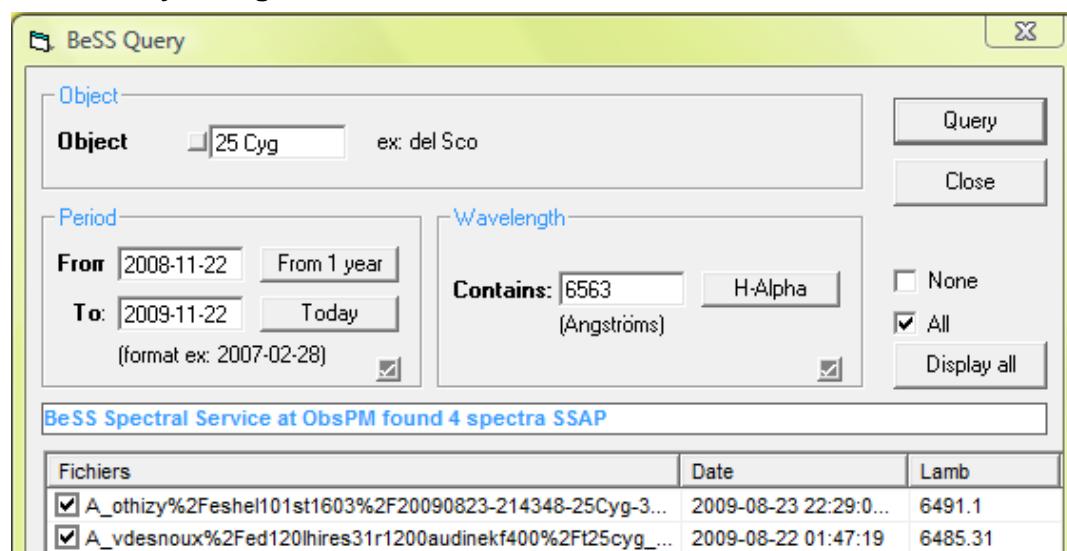
You need an internet connection.

To make a query go in the « Assistant » menu, item « BeSS query ».



A dialog box is displayed

BeSS Query dialog box



Enter the name of the star which you are looking for spectra in BeSS. The name format shall meet the BeSS format and shall respect the use of lower/upper case.

- For an HD star, enter HD followed by its number
- For a name like bet Cyg : the first three characters of the greek letter are in lowercase, then a space, then the abbreviation of the constellation name with always the first one in uppercase and some followings: ups Sgr, kap UMa, bet CMi.
- If a fit file is already open and you want to search spectra from the same star, click on the small button next to the object text field.



- Launch the query by clicking on the « query » button.

BeSS database returns a message showing the number of spectra found.

BeSS Spectral Service at ObsPM found 2 spectra SSAP

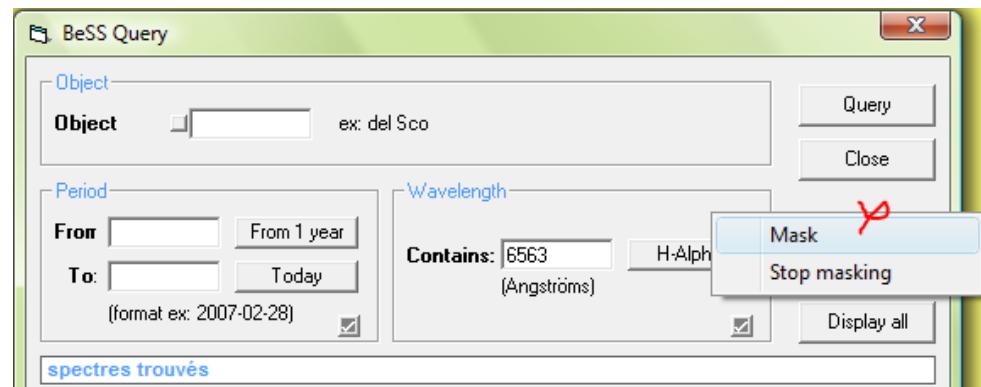
If this number exceeds 1000, no spectra are returned, the list stays empty. You need to reduce for example the time period of the search, using the “period” section or change the wavelength.

- Fills the text fields, or use the predefined button “from one year” or “today” to quickly reduce the time range.
- To get only spectra which contains a specific wavelength, enter the wavelength in the text field.
- A button "H-alpha" allows a quick fill of the H-alpha wavelength at 6563 angström
- To erase data in all the text fields, click on the buttons

The files found in BeSS are listed in the list zone.

- Click on one of the spectra to open it directly in Visual Spec.

- To open all the listed spectra, click on the “display all” button.
- To not open some files, unclick the selection box in front of the file name
- To unselect all the files in the list, click on the "none" button, then only select the files you will want to open with the "display all" button
- To reselect all the files, click the check box "All"
- To display the files by date ascending order or descending order, click on the date column.

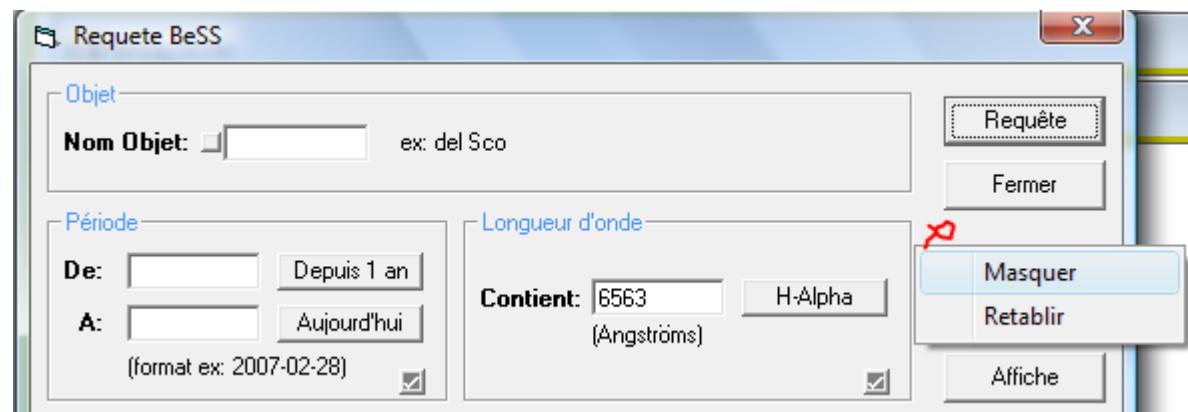


BeSS files are stored in the BeSS_VO directory – clear this directory from time to time.
Fits file are in fits VO table format. This is the standard format defined by the “Virtual Observatory” group and are not largely supported by other software. Applets can be found on the net.

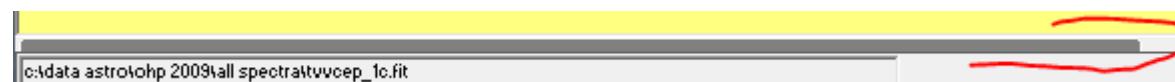
Hiding – sliding

Instead of closing the window, you can simply mask it and put it at the bottom of the application, where it will be easy to recall only by passing the mouse over the remaining border.

To mask the window, click with the right mouse button inside the BeSS VO dialog box, not on a control



A context pop-up menu will appear, click on "mask". Each time the cursor will move on the yellow section of the application the dialog box will move down to the application and appears with just a grey border.



Move the cursor over the grey line and the query box will slide vertically and re-appear.

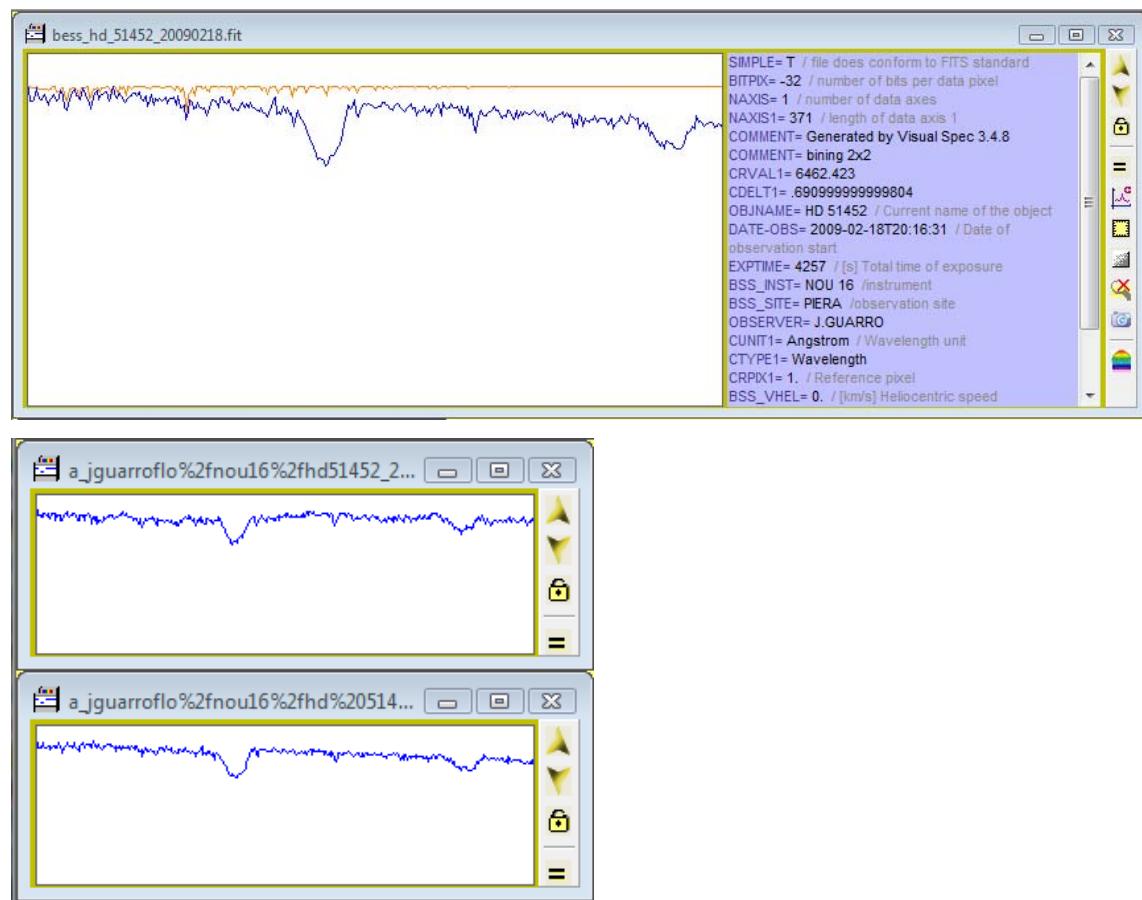
BeSS spectrum validation

The validation of a spectrum for its acceptance in the BeSS database, requires several operations to be performed. This command linked them to speed up the validation process for spectra centered on the h-alpha line.

- Click on the  button on the side toolbar of the document.

The application will perform the following operations:

- Superimpose the atmospheric spectrum, to check for concordance of the telluric lines with the observed spectrum
- Display the fits header, to check the validity of the date, time and other key words
- Zoom on the region between 6440 and 6700 if the spectrum is going beyond those limits
- Read the fits keyword OBJNAME and use it to query the BeSS database
- Display the last 2 spectra from this object load in the BeSS database in smaller windows



If no spectra from BeSS are displayed, this may indicate that there is no spectrum of this object in the BeSS database.

If the objname is not meeting the VO query rules, no object will be found. Check the Objectname format – the first letter of the constellation name shall be uppercase.

Edit Vspec txt files

Visual spec uses several text files for saving pre-settings or configuration or styles. This command allows the user to open directly the text file for editing without going out of visual spec and open the file from the Vspec directory.

- Click in the menu Assistant, sub-item Edit... A list of files as new subitems list is displayed.
Pick the one you want to read or edit. Will launch notepad.

The files which are editable are:

- Std.gnu: style file to generate gnuplot graph
- Page.gnu: style file to generate the thumbnails of the Vspec web page tool
- Infos: open infos.txt, the file which contains the data displayed in the infos windows, when user has click on the save button
- Liste: open liste.txt which contains (if any) the latest saved wavelength points list to extract continuum
- Liste7pts: open liste7pts.txt file which contains the wavelength and intensity of the memorized points with the 7pts command
- Continuum: open the continuum.txt which contains the 2 wavelength which delimits the average computation of the profile to be used as scaling factor
- List_instru: open the list_instru.txt file which contains your list of instrument for BeSS
- List_obs: open the list_obs.txt file which contains your list of preset observatory site names for BeSS

CDS queries

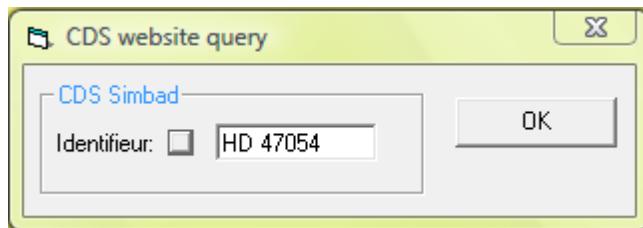
To directly check the Simbad database to get more information about an object, use the CDS query command.

- Click in the menu Assistant, sub-item CDS query

Or

- Short-cut F3

A dialog box is displayed



If the name is correct, the internet browser will display the request result. If the name is not recognized as an official identifier, the web page will indicate an error. As recognized identifier, one can enter the bayer name like alpha lyre, or bet Cas, or the HD number format or for the brightest star their popular names like antares or vega ...

Object query : simbad search hd178479
 =====> Your identifier (hd178479) is translated into : HD 178479

Available data: Basic data Identifiers Plot & image tools Bibliography Measurements External archives Notes

Basic data : HD 178479 -- Be Star

ICRS 2000.0 coordinates 19 08 25.1716 +09 08 00.764 [11.57 8.44 92] A [1997A&A...323L..49P](#)
 FK5 2000.0/2000.0 coordinates 19 08 25.17 +09 08 00.8 [11.57 8.44 91]
 FK4 1950.0/1950.0 coordinates 19 06 01.63 +09 03 11.1 [68.85 49.77 90]
 Galactic coordinates 42.99 +0.42
 Proper motion (*mas/yr*) [error ellipse] -1.47 -3.30 [1.33 .98 92] A [1997A&A...323L..49P](#)
 B magn, V magn, Peculiarities 9.24, 8.92
 Spectral type B9V
 Parallaxes (*mas*) 2.64 [1.26] A [1997A&A...323L..49P](#)

Click on the small square button to recall the objname of the active fits file if one is displayed into the application

Link with SPECTRUM software

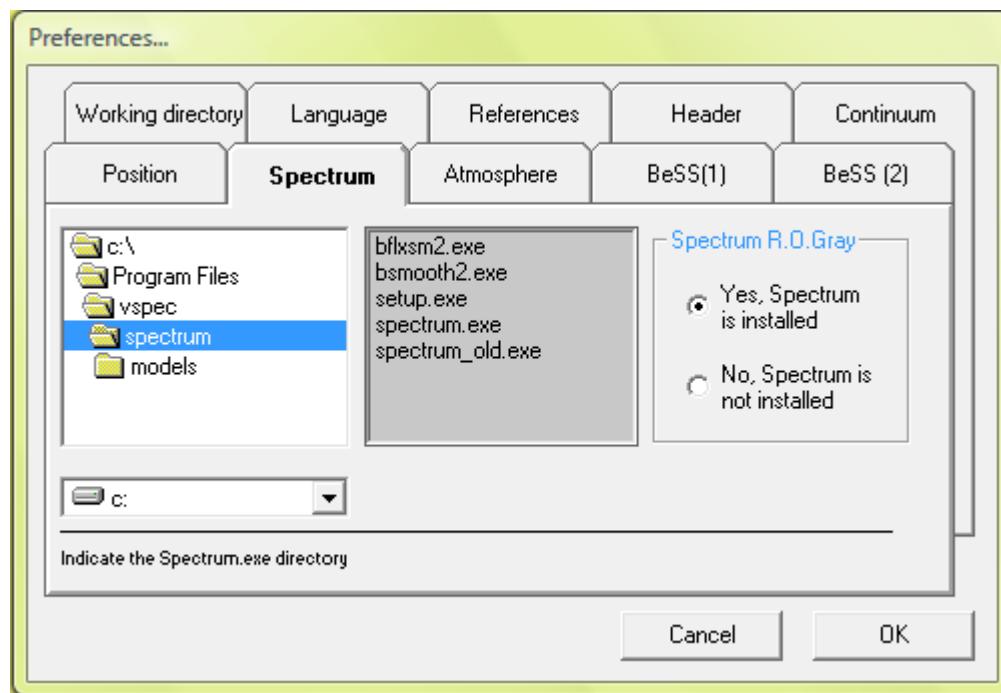
Visual Spec allows you to directly use the SPECTRUM software by providing a user-friendly interface using the script facility of the SPECTRUM software. R.O. Gray, the author has accepted that Visual Spec get linked to his application.

Refer to the section on Spectrum on Visual Spec website
<http://astrosurf.com/vdesnoux/spectrum.html>

Also this link will provide more explanations on the models name format and the bibliographic references: <http://astrosurf.com/vdesnoux/models.html>

This requires that you have correctly installed SPECTRUM and declared it in the preference dialog box, if it was not correctly installed automatically by Vspec at its installation.

Preference settings for SPECTRUM



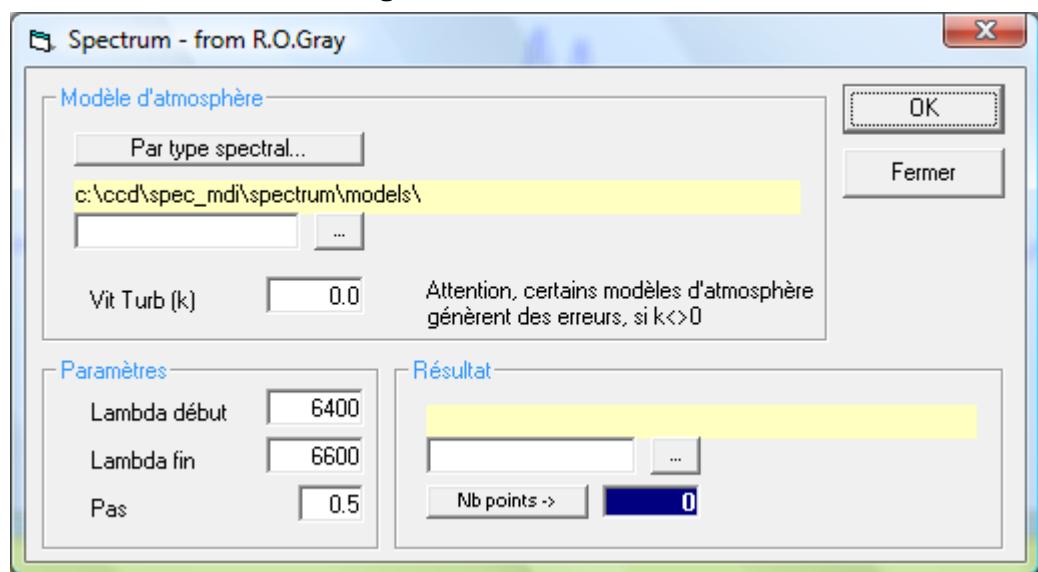
- Select the tab "spectrum"
- Select the harddrive and the directory where spectrum.exe is installed
- Click the option button "Yes, Spectrum is installed" on the right frame

This will become the referenced path for Visual Spec to find the executable of SPECTRUM. If you change this directory, make sure you update the preferences settings in Vspec again.

If you did not have installed Spectrum and not selected the installation path, the Run Spectrum sub-menu will not appear in the Options menu.

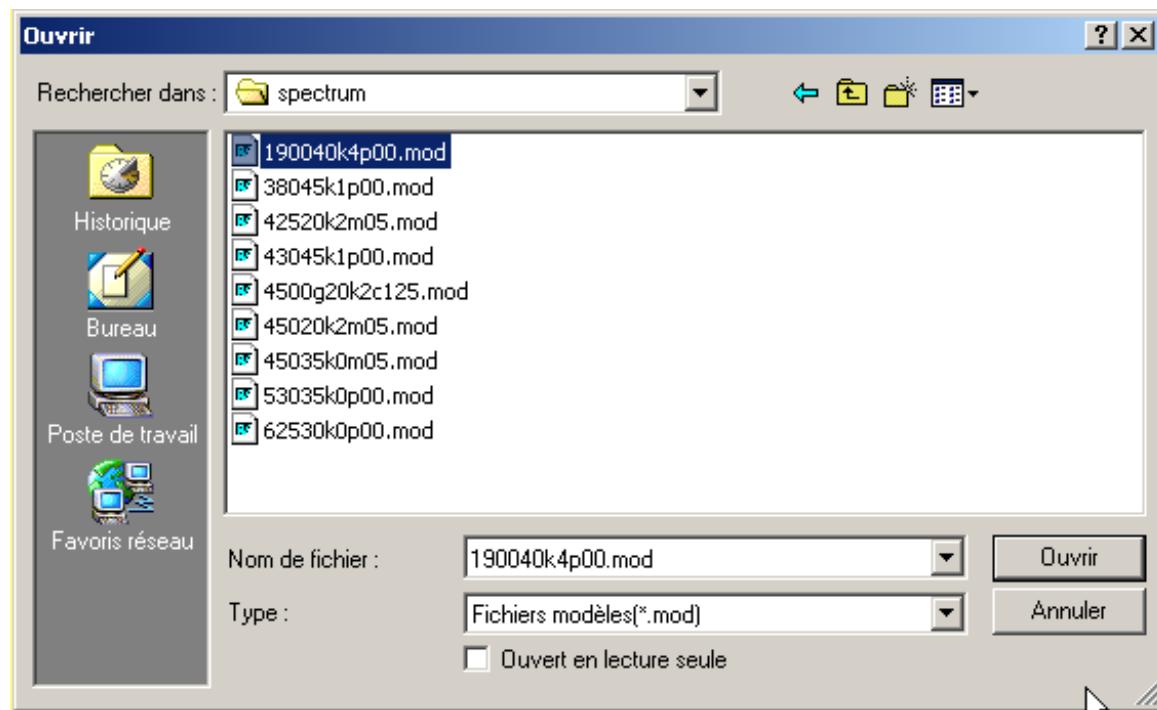
- Click on the Run Spectrum sub-menu in the Options menu to get access to the SPECTRUM interface and run SPECTRUM

SPECTRUM interface dialog box



You have to enter the parameters required by SPECTRUM to run correctly.

- Enter the Atmosphere model. Either you type directly the file name or you click on the side button to open a "open dialog" box



Only the files with extension *.mod will be listed. They shall meet the SPECTRUM atmosphere file format as described on its web site.

- Enter the turbulence velocity – usually this value is known from the name of the model you picked

Usual convention for model file names

45045k4p00.mod
 450: 4500°K temperature
 45: log(g) 4.5cm/sec²
 k4: 4km/s turbulence velocity
 p00: metallicity [M/H]=0.0 (solar abundance)
 m05: [M/H]=-0.5 (0.32 x solar abundance)
 p05: [M/H]=0.5 (3.2 x solar abundance)

The model files shall be find on the web, mainly from Kurucz site. (See Vspec site).

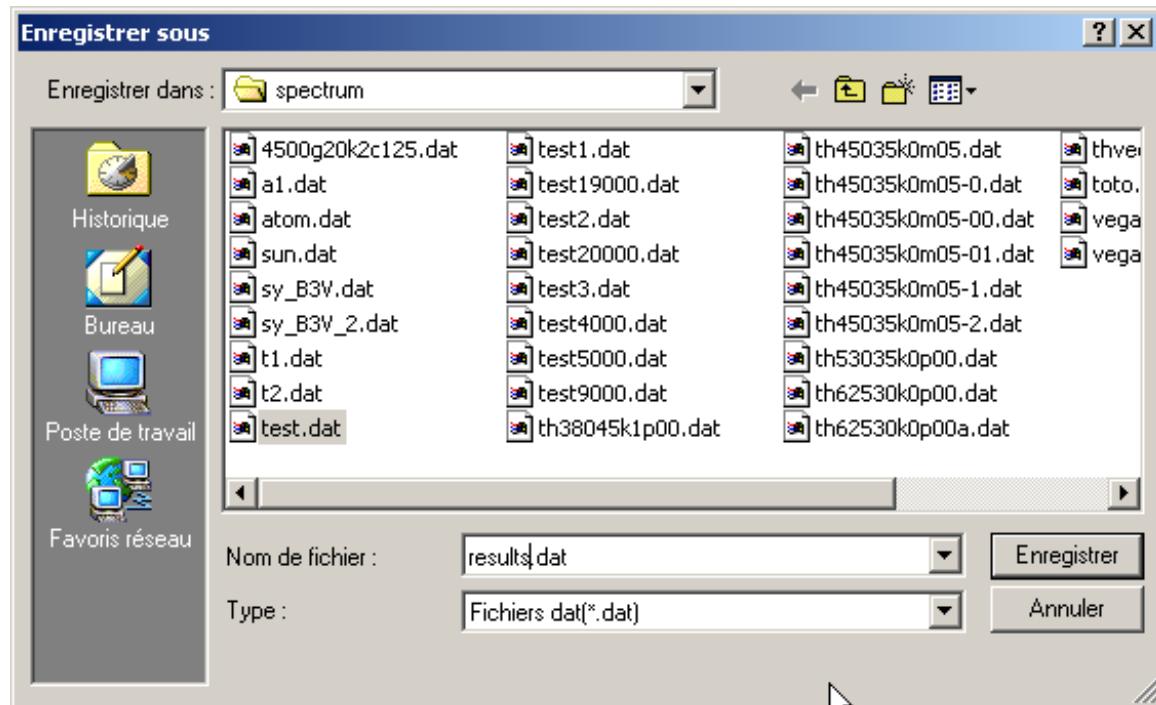
- Enter the start and end wavelength
- Enter the wavelength steps – use 0.01 angström as a minimum value

You can compute the number of points in the output files by clicking on the "Nb points" button. This is useful to prevent too huge file generation.

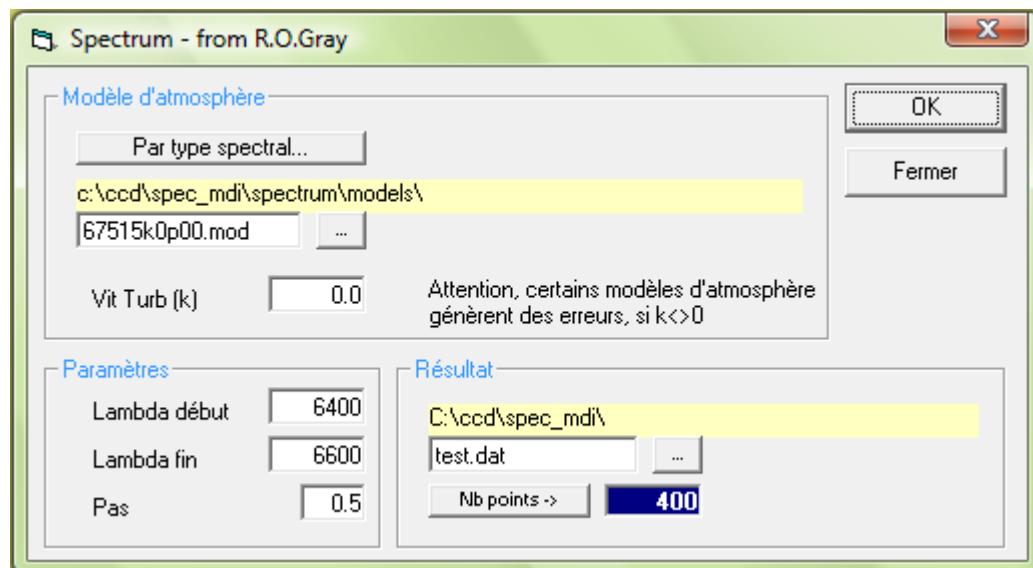


Vspec can only manage 16382 points spectrum file.

- Enter the name of the output file – the file format will be a "dat" file (two columns: wavelength, intensity) – You can select the directory and the file name by clickling the side button.



Here is an example of the window correctly filled



- Click on the OK button to launch SPECTRUM

A small script is written on the hardisk and then executed by SPECTRUM. The DOS windows of SPECTRUM execution is temporary displayed over Vspec

```

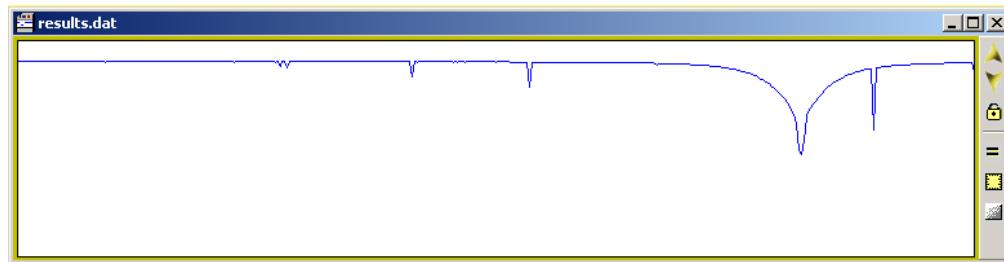
Visual Spec
File C:\WINNT\System32\cmd.exe
C:\cccd\spectrum 0Kb.rsp
SPECTRUM, an IBM-PC and UNIX-based Stellar Spectral Synthesis
Program <C> Richard O. Gray 1992 - 2002 Version 2.48
April 24, 2002
Integrated Disk mode <normalized Intensity>

Enter name of stellar atmosphere data file > Teff = 19000 log(g
= 0.00

Enter name of line list file: Default = line.adj >
Enter name of output file >
Enter microturbulence <km/s> >
Enter beginning and ending wavelengths >
Enter wavelength step >
Calculating Partition Functions for all species for all levels
Completed level 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54
59 60 61 62 63
Calculating Number Densities
Completed Level: 0 1 2 3 4 5 6 7 8 9 10 11 12 13
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33
38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53
58 59 60 61 62 63
Calculating Ionization ratios for all atoms at all levels
Completed atomic number: 3 4 5 6 7 8 9 10 11 12
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
57 58 60 63 64 80
Calculating Reference Opacities
Entering Main Loop

```

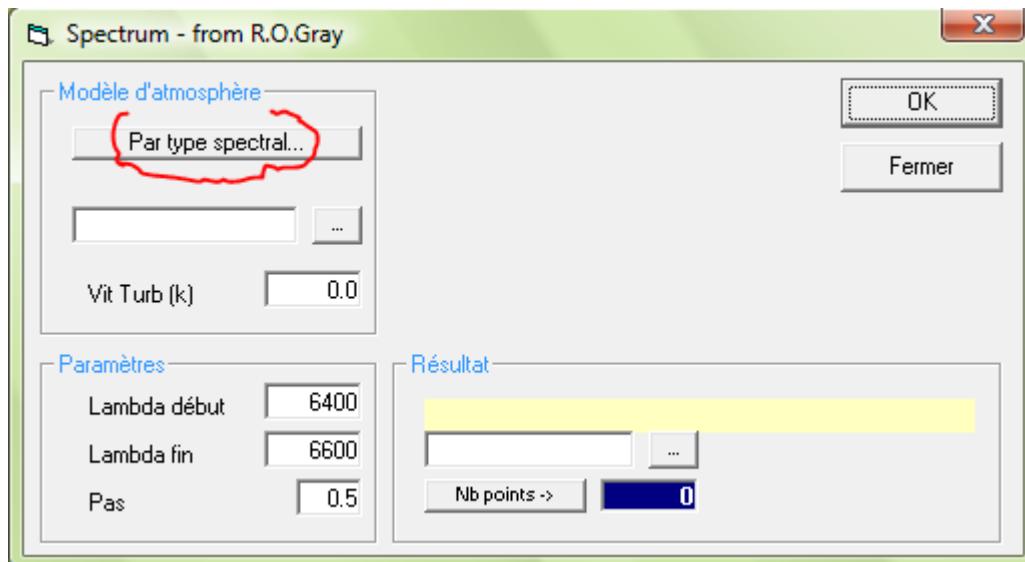
Once the execution is completed, the synthetic spectrum is automatically displayed in Visual Spec and saved as a "dat" file.



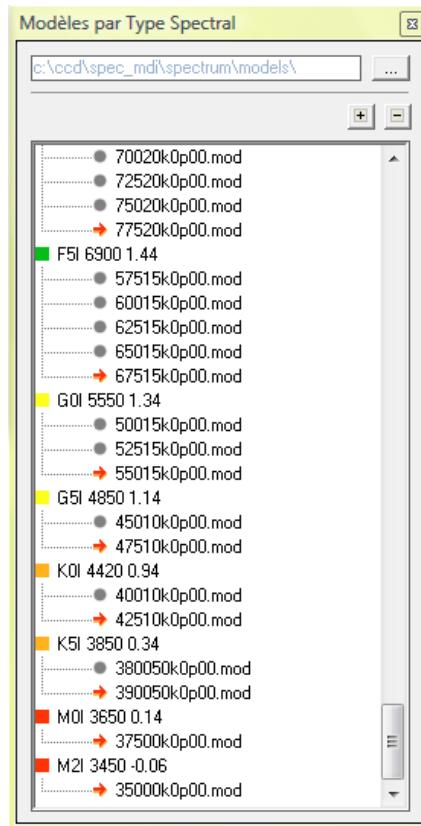
A great Thanks to Richard Gray who wrote SPECTRUM free software with adequate documentation and script function...

Spectrum and models linked to spectral type

The interface of Spectrum also includes a link to a table which will make easier the correspondence between models and spectral types, pointing the effective temperature and density. Click on the “by spectral type” button.

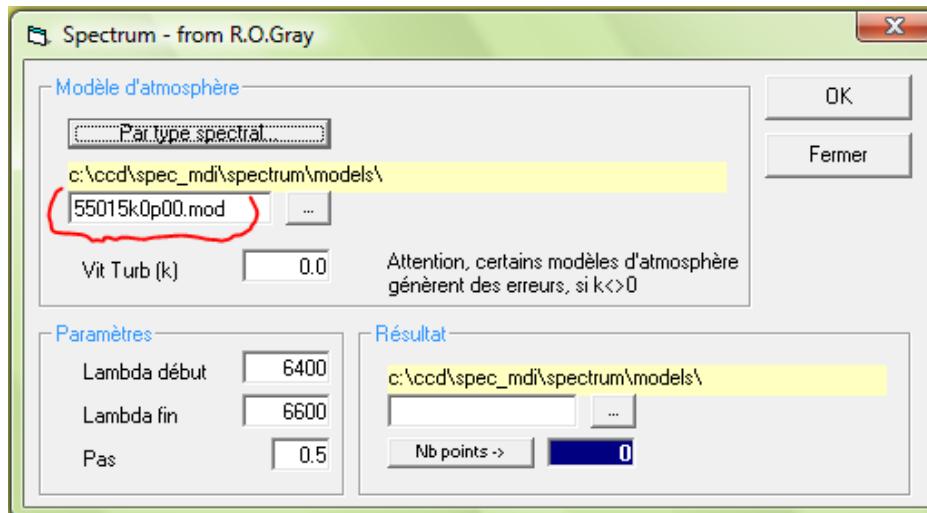


The spectral type models window is opened:



For a given spectral type, the corresponding model is highlighted by a red arrow. If intermediate spectral types are looked for, pick one of the closest models which are available (with gray circle) based on their temperature.

Click on the desired model. Its name will be automatically put in the text field of the Spectrum dialog box.



Complete by entering the other parameters.

CHAPTER 9

Spectral Analysis

Spectral analysis consists of processing the data of a profile calibrated in wavelength in order to extract significant spectroscopic information. This chapter describes various strategies for processing and spectral analysis.

The first application consists of comparing spectra with each other, or with spectra of the same object having changed over time. These comparisons are qualitative.

A second application consists of a quantitative comparison of certain measurements such as equivalent width or Doppler shift.

Finally, it is always interesting to try to identify different spectral lines of an object a posteriori.

To complete the analyses, Visual Spec provides use a user friendly link to the SPECTRUM software from Richard Gray. This software can be download from the web site xxx. SPECTRUM allows you to generate theoretical spectrum of a star knowing physical parameters like temperature, pressure... To have an extensive description of SPECTRUM usage, please refer to Vspec web site in the "theoretical spectrum" section.

Comparison of spectra

To compare spectra with each other, it is necessary to first perform operations of correction and normalization so the spectra are really comparable with each other.

These corrections are:

1. Calibration in wavelength: needed
2. Radiometric: suggested if the spectrum extends over a spectral domain sensitive to the difference of the sensitivity to wavelength of the sensor.
3. Normalization with respect to the continuum: done so that the calculation of the continuum is carried out on the same wavelength domain of both spectra and to ensure that no lines are present in this area

One can compare several spectra:

- By simple superposition, by Cut/Paste, even if the samplings are different (see section "Cut/Paste of a spectral series").
- By animation, after having applied the same format all spectra to be compared.
- By division, the signature of a difference having resulted in a line outside the noise in the vicinity of the difference.

Quantitative parameters

If the spectra are sufficiently resolved that the shape of a line is not solely dependant on the characteristics of the equipment, it is possible to measure and compare:

- Equivalent widths of lines
- Doppler shift
- Speed of expansion

Equivalent width

To follow the evolution of the same line over time, calculating the equivalent width gives an indication of the power of the line. If the equivalent width changes, this indicates changes in the physical conditions of the layers that produced the line.

An example of evolution of the line H α of 28 Tau (B8Ve)

1. Search with the File|Find function for all the profile documents containing “28Tau” in their comment area.
2. Open the documents.
3. View the set of spectra using the function Window|”Small Windows”
4. Select one of the spectra, and apply the same format to the others (Format|”Graphic...”|”Axis X” and check “Apply to all windows” and then click “Apply”).
5. Verify the predefined area for calculating the continuum in the “continuum” tab of the Options|“Preferences...” dialog box. This area should be common to all the spectra and should not contain lines.
6. Normalize each of the spectra (Operations|Normalize).
7. For each spectrum, select the line to measure and choose the menu item Weq (Equivalent Width) in the Spectrometry menu. The result is displayed in the “Infos...” window below the name of each document.
8. Click on the “Save” button of the “Infos...” window.
9. Open the file Infos.txt in a text editor.

```
LEQ: 37.91  
15p004.spc  
LEQ: 34.68  
14p005.spc  
LEQ: 32.54  
12p009.spc  
LEQ: 31.66  
11p007.spc  
LEQ: 30.55  
09p021.spc  
LEQ: 22.92  
06p015.spc
```

Doppler shift

Measuring the Doppler shift requires a bit of care because it is based on the measurement of deviation in wavelength of a line with respect to its theoretical position.

It is impossible to perform this measurement if the spectrum was calibrated in wavelength based on its own lines.

The Doppler shift to be measured must also be from 2 to 3 times more significant than spectral sampling.

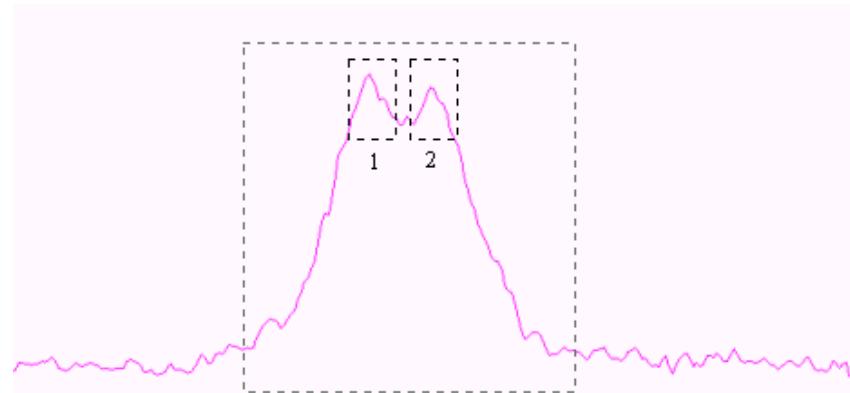
For very accurate measurements, correct the spectrum from the doppler shift from Earth moving. See the section "Helio Speed correction"

It is also possible to graduate the X axis in doppler shift (km/s) centered around a reference wavelength value.

To measure a Doppler shift:

1. Calibrate the spectrum carefully using an external reference spectrum.
2. Select the line to measure.
3. Calculate the center of the line; the position is given in angstroms.
4. Calculate the ratio: Measured Position – Theoretical Position / Theoretical Position.
5. Multiply by $c=3,000,000$ km/s to obtain a shift in km/s.

Example of a detail of the line H α of 59 Cyg (Ble)



```

center1: 6559.47
center2: 6564.61
center: 6562.33 theoretical position at 6562.852
FWHM: 12.76
12p010.spc Ech= 0.286 A/pixel

```

Yields:

- Shift 1 = $(6559.47 - 6562.852) / 6562.852 * 300000 = -154.6$ km/s
- Shift 2 = $(6564.61 - 6562.85) / 6562.852 * 300000 = 80.6$ km/s
- Resolution = $(0.286) / 6562.852 * 300000 = 14$ km/s



Note: A precise measurement should take into account the Doppler shift due to movement of the Earth in its orbit. This calculation is available with the heliocentric speed correction function.

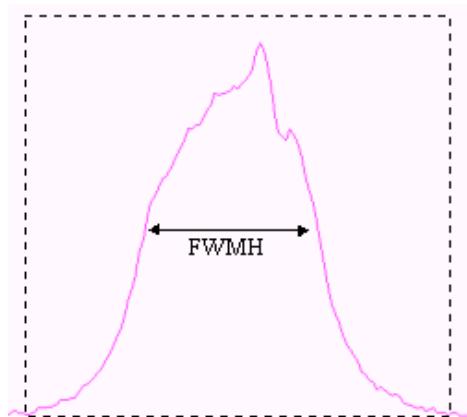
Speed of expansion

As for calculation of Doppler shift, this measurement demands the same precautions for calibration and resolution.

The measurement of speed of expansion or rotation is defined by increase in the line caused by the Doppler effect.

1. Calibrate the spectrum carefully using an external reference spectrum.
2. Select the line to measure.
3. Measure the center of the line, the position is given in angstroms
4. Measure the full width at half-maximum of the line: FWMH.
5. Calculate FWMH/center
6. Multiply by $c=3,000,000$ km/s to obtain shift in km/s

Example of the nova Cygnii 1995



center: 6562.75
FWMH: 43.92
tnvcy-48.spc

Yields:

- Speed = $(43.92) / 6562.852 * 300000 = 2008$ km/s

Identification of elements

The identification of element is a difficult exercise. It is not a question here of discovering new elements, but to recognize well the original chemical elements of the lines observed.

Ability to identify with precision which chemical element produces which line depends largely on the resolution. Indeed, a great number of lines of various elements are possible in a very small domain of wavelength, such as shown below in an area of 10 angströms / 1 Nm.

Elements

Lambda	Ion	Intensity	Element
5797.859	1	100	SI
5799.914	1	45	CL
5800.47	2	150	SI
5801.33	4	250	C
5801.75	1	17	K
5803.78	1	140	HG
5804.26	1	65	TI
5804.45	1	12	NE
5806.74	2	200	SI
5807.14	1	35	V
5809.84	0	70	SC
5810	0	100	TiO
5811.6	0	70	SC
5811.98	4	200	C
5812.15	1	15	K
5814.96	0	21	TI
5816.84	1	7	MN
5817.06	1	23	V
5817.44	3	10	TI
5817.53	1	35	V
5819.2	2	450	S
5820.156	1	40	NE
5823.71	1	40	TI
5826.42	3	150	C
5827.8	2	30	SI
5829.54	1	265	N
5830.72	1	55	V
5831.89	1	17	K
5833.93	3	18	FE
5834.263	1	5	AR
5839.02	2	10	HG

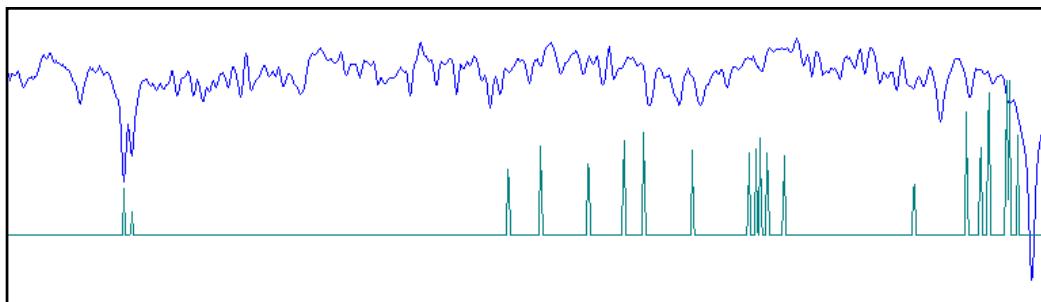
It is necessary to research, referring to the literature, to gain preliminary knowledge of the physical conditions of the object of study, with reference to its spectral type.

A useful technique consists of superimposing the theoretical spectrum of the presumed elements in order to verify whether they correspond to the lines.

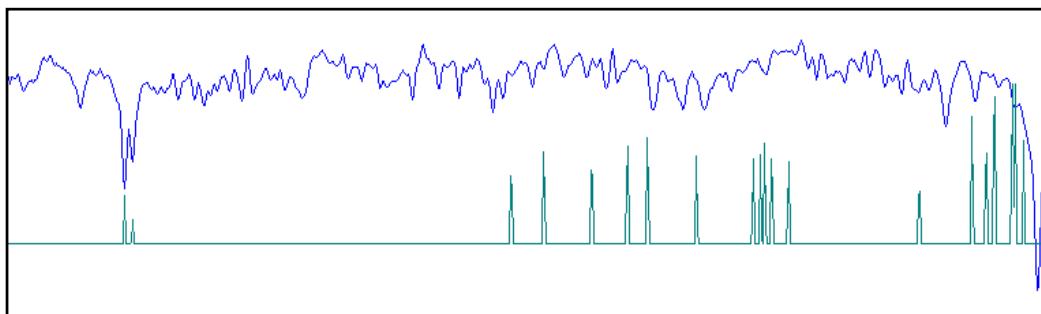
Click on one the line to see the profile document cursor moving at the line wavelength on the active serie. If no move is observed, click on the profile document then come back in the element list. You can also move the line selection by using the up and down keyboard arrows.

Solar spectrum

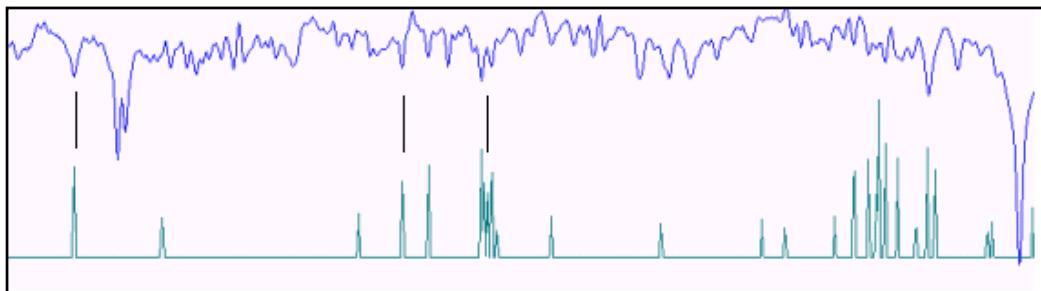
Example: Solar spectrum and lines of Sodium, Na. One can recognize the doublet of Sodium, at the left.



Superposed with the lines of Iron, one sees some correspondence.

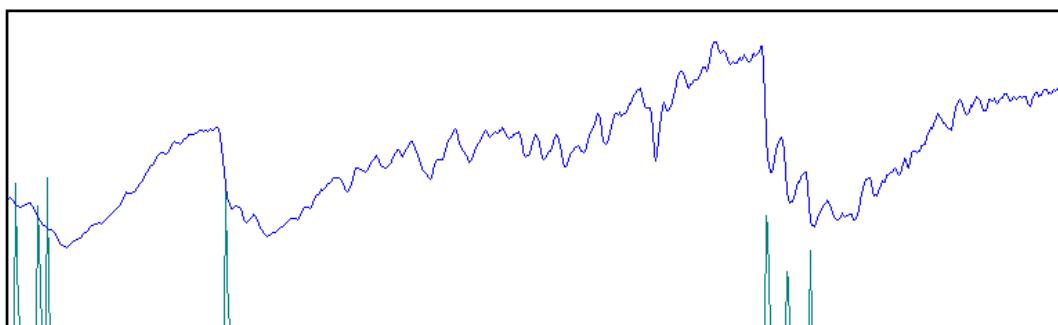


Superposed with the lines of Calcium.



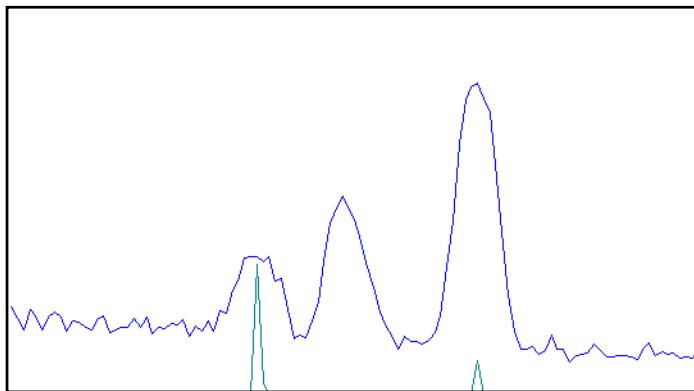
Stars of spectral type M

Example of a spectrum of an M star, 10 Dra (M3.5III) with the start of lines of TiO



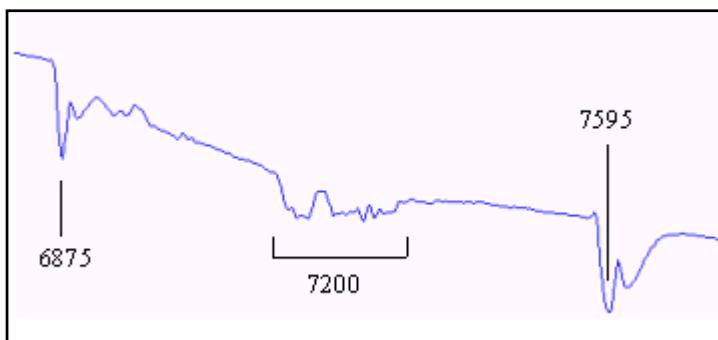
Planetary nebula

Example of the spectrum of a planetary nebula M57 and missing lines (NIII).



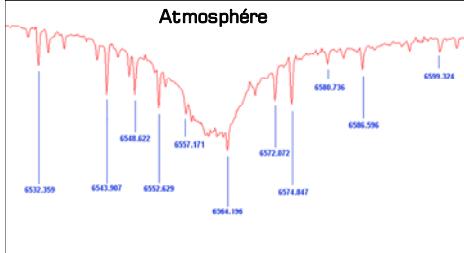
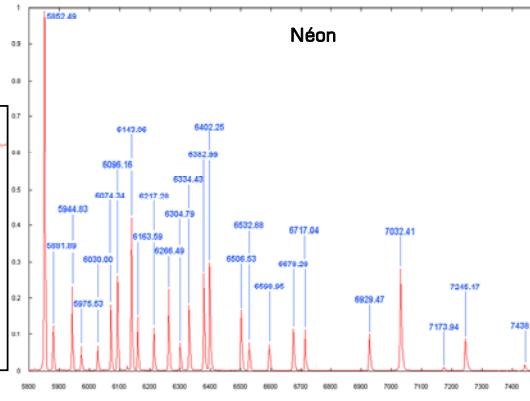
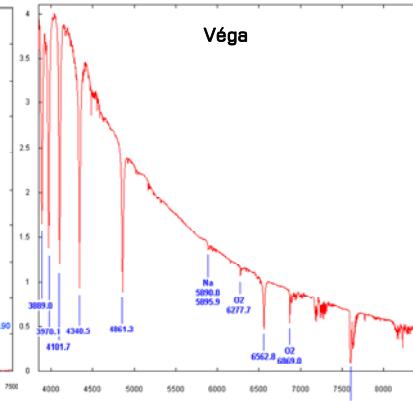
Atmospheric lines

Atmospheric lines have a characteristic profile and are easily identifiable. They can be used for spectral calibration.

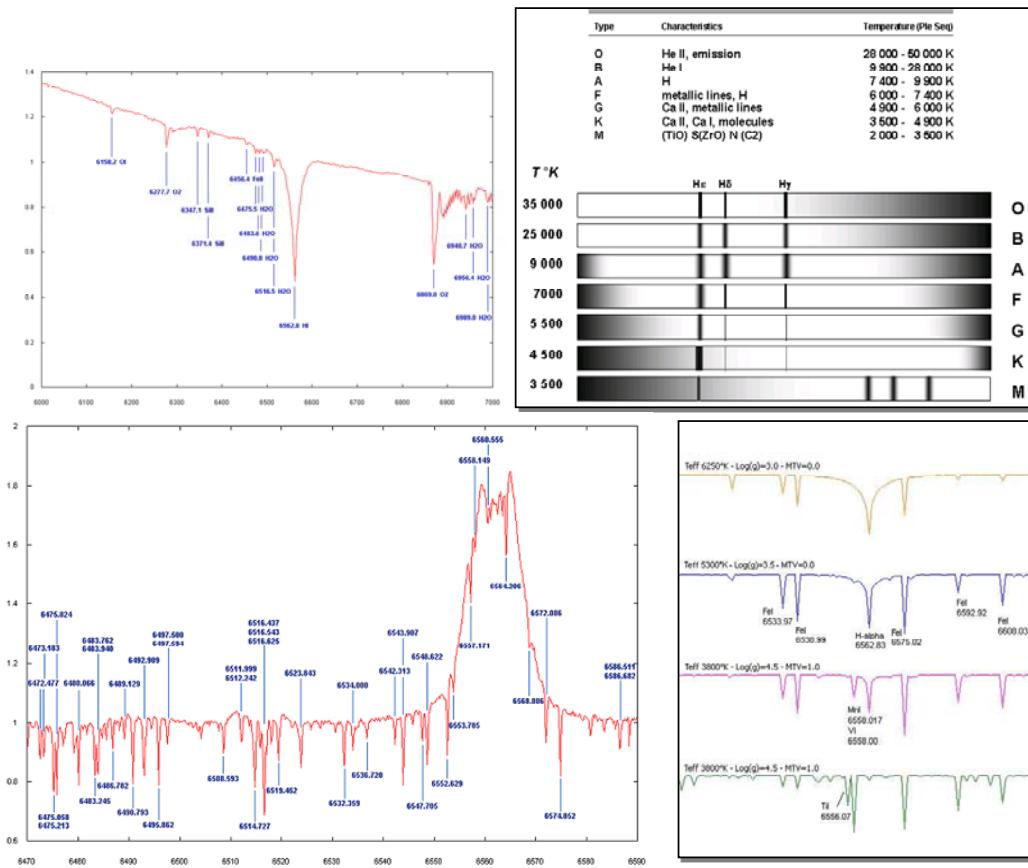


APPENDIX 1

Quick Reference Guide**Quick reference card****Visual Spec - Quick Reference Card**

 Open Image  Open Profile  Reset image thresholds  Reverse Right/Left image  Binning object  Binning calibration lamp  Calibration 2 lines  Calibration 3 lines and +	 Calculation on selection, calculations defined in the preference measure  Correction of atmospheric lines  Call grapher GnuPlot  Display database of elements  Decrease max value of Y axis  Increase max value of Y axis  Link series  Apply same scale to all serie  Display axis graduations  Erase all except series	Short-cut Del/Suppr Delete the active serie, if temporary serie Ctrl+D Divide the active serie by another one Ctrl+E Database of element wavelength Ctrl+Q Console mode Ctrl+W Convert into fits "BeSS" Ctrl+T Spectral Type Ctrl+R Move serie Ctrl+I Window Infos.. Ctrl+G Manage scale & graduations Ctrl+Z Interactive zoom Ctrl+L Spectra library Ctrl+F Smoothing filter "Low-Pass" Ctrl+C Copy Ctrl+V Paste Ctrl+B Paste format of the active profile Ctrl+N Reference the continuum to 1 Alt+selection profil Zoom on selection Ctrl + click sur série Automatic selection of line close by
Formules Doppler: $\Delta V = c \cdot \Delta \lambda / \lambda$ Rep: lobs/theo + Extraction continuum Icorrinstru: lobs/Rep		
 Atmosphère <p>This plot shows the atmospheric spectrum with several absorption lines labeled in blue. The x-axis represents wavelength from 5800 to 6200 Å, and the y-axis represents intensity from 0 to 1.</p> <ul style="list-style-type: none"> 6532.359 6543.907 6552.429 6557.171 6572.872 6584.196 6598.847 6598.596 6599.324  Néon <p>This plot shows the Neon spectrum with numerous sharp emission lines labeled in blue. The x-axis ranges from 5800 to 7000 Å, and the y-axis ranges from 0 to 1.</p> <ul style="list-style-type: none"> 5944.83 5975.53 6001.39 6030.00 6074.34 6142.06 6162.59 6171.26 6204.49 6304.47 6352.89 6505.53 6532.88 6599.95 6679.29 6717.04 6929.47 7037.41 7173.94 7246.17 7439.90  Véga <p>This plot shows the spectrum of Vega with several absorption lines labeled in blue. The x-axis ranges from 4000 to 8000 Å, and the y-axis ranges from 0 to 3.5.</p> <ul style="list-style-type: none"> 3800.0 3978.1 4101.7 4348.5 4864.3 5095.8 5895.9 6277.7 6562.8 6803.8 O2 7605.0 		

Visual Spec - Quick Reference Card



Type	T_{eff}	$\log g$
O3V	52500	4.14
O5V	44500	4.04
O6V	41000	3.99
O5I	40300	3.34
O6I	39000	3.24
O8V	35800	3.94
O8I	34200	3.24
B0V	30000	3.9
B0III	29000	3.34
B0I	26000	2.84
B3V	18700	3.94
B5V	15400	4.04
B5III	15000	3.49
B5I	13600	2.44
B8V	11900	4.04
A0I	9730	2.14
A0V	9520	4.14
A5I	8510	2.04
A5V	8200	4.29
F0I	7700	1.74
F0V	7200	4.34
F5I	6900	1.44
F5V	6440	4.34
G0V	6030	4.39
G0III	5850	2.94
G5V	5770	4.49
G0I	5550	1.34
K0V	5250	4.49
G5III	5150	2.54
G5I	4850	1.14
K0III	4750	2.14
K0I	4420	0.94
K5V	4350	4.54
K5III	3950	1.74
K5I	3850	0.34
M0V	3850	4.59
M0III	3800	1.34
M0I	3650	0.14
M2V	3580	4.64
M2I	3450	-0.06
M5V	3240	4.94

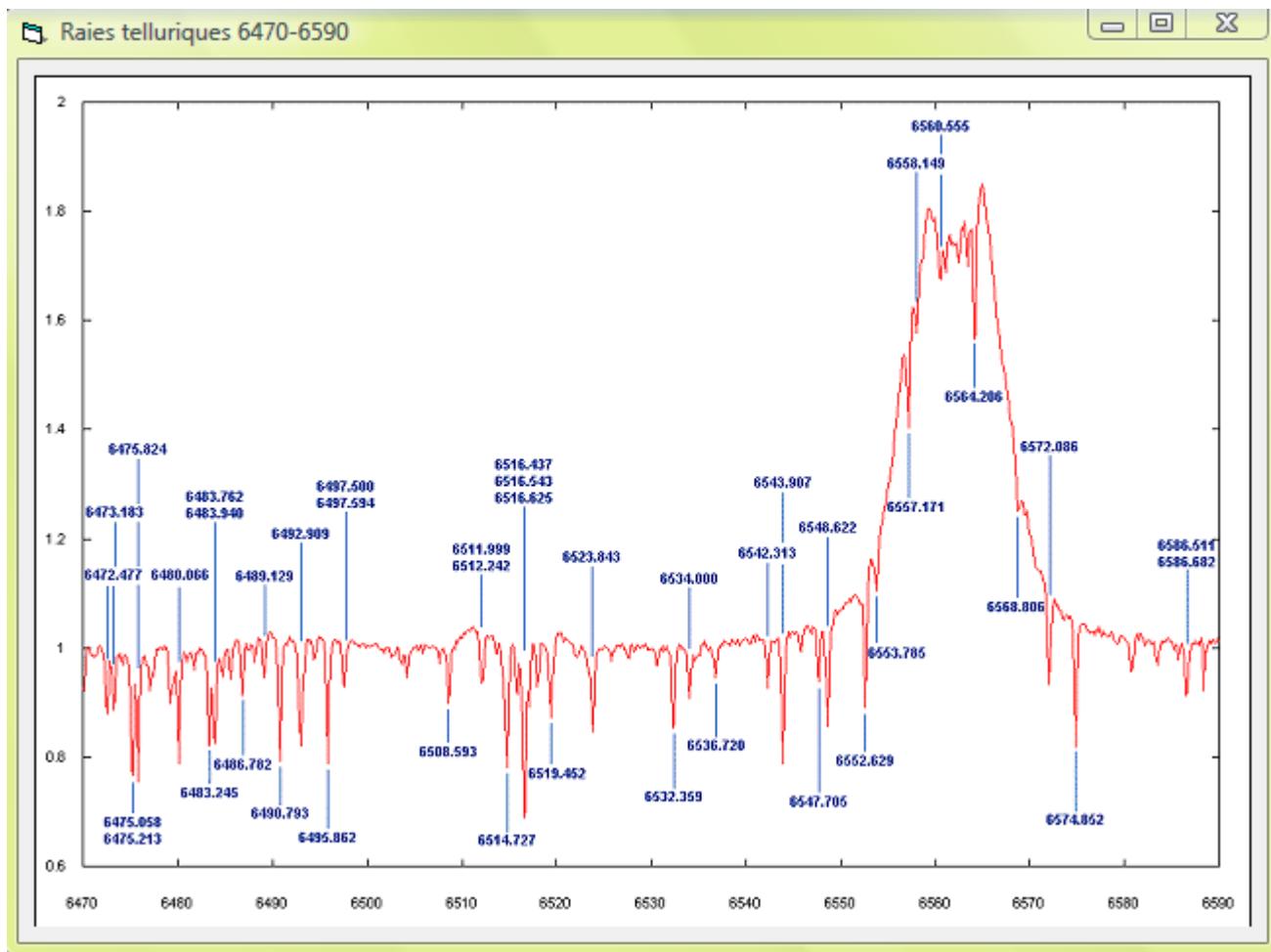
Stellar Model Star Atmos file name coding
- 450 is for the temperature, 4500*K
- 45 if the gravity $\log(g)=4.5 \text{cm/s}^2$
- k4 is the microturbulence velocity, 4km/s
- p00 is the metallicity ratio [M/H] which 0.0 for solar abundance or m05 for [M/H]=-0.5 for 0.32 times solar abundance or p05 for [M/H]=0.5 for 3.2 times solar abundance

This reference guide can be found on the website in a power-point format.

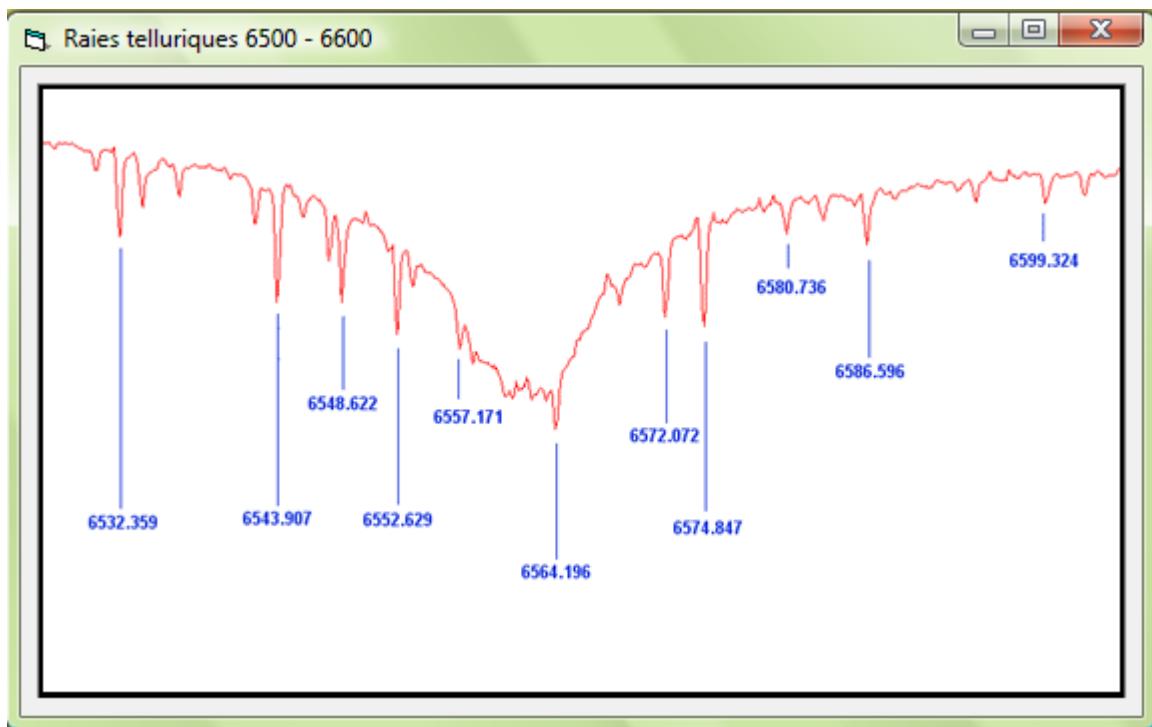
Annotated diagrams

All annotated spectra are from Christian Buil

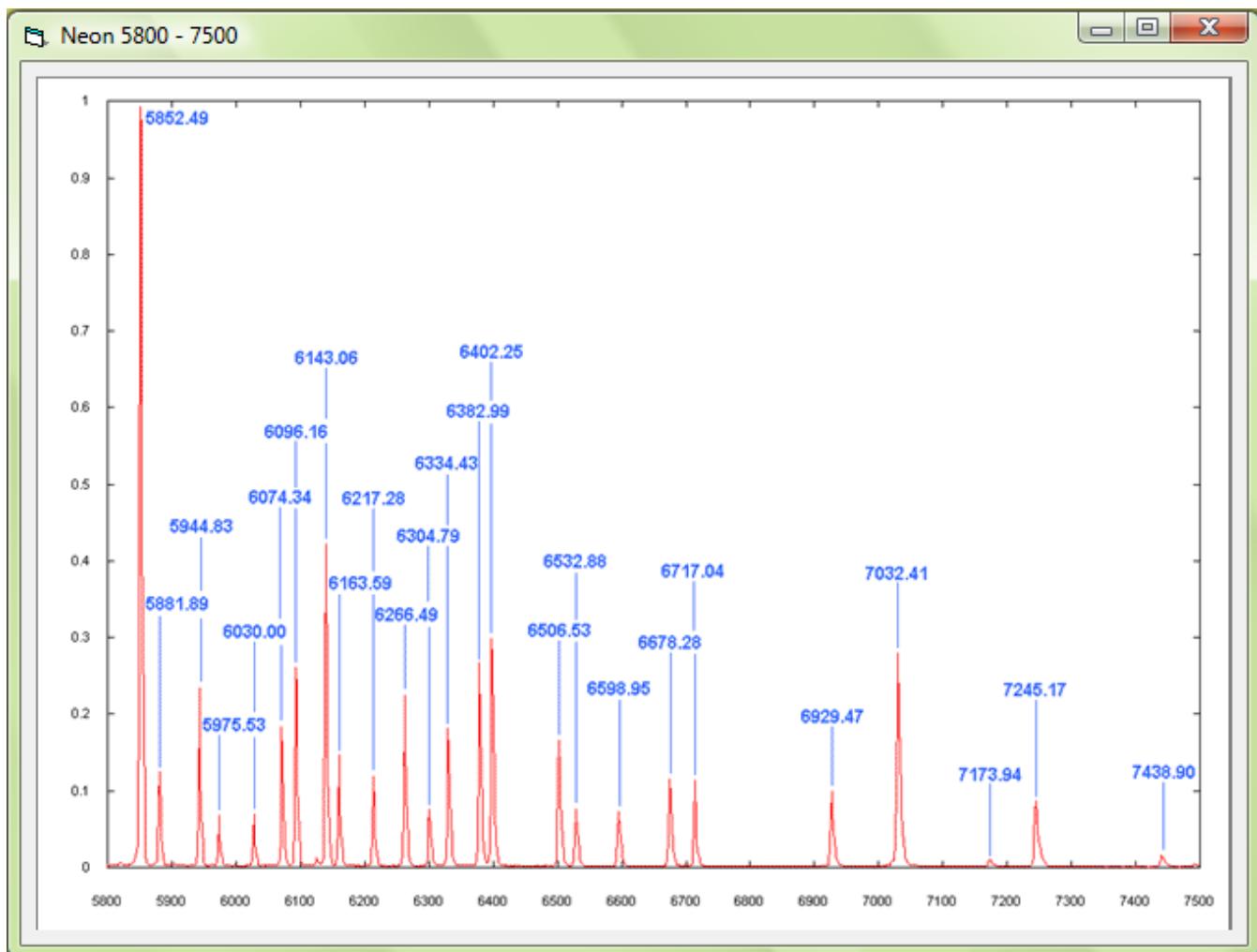
Telleruc lines 6470-6590



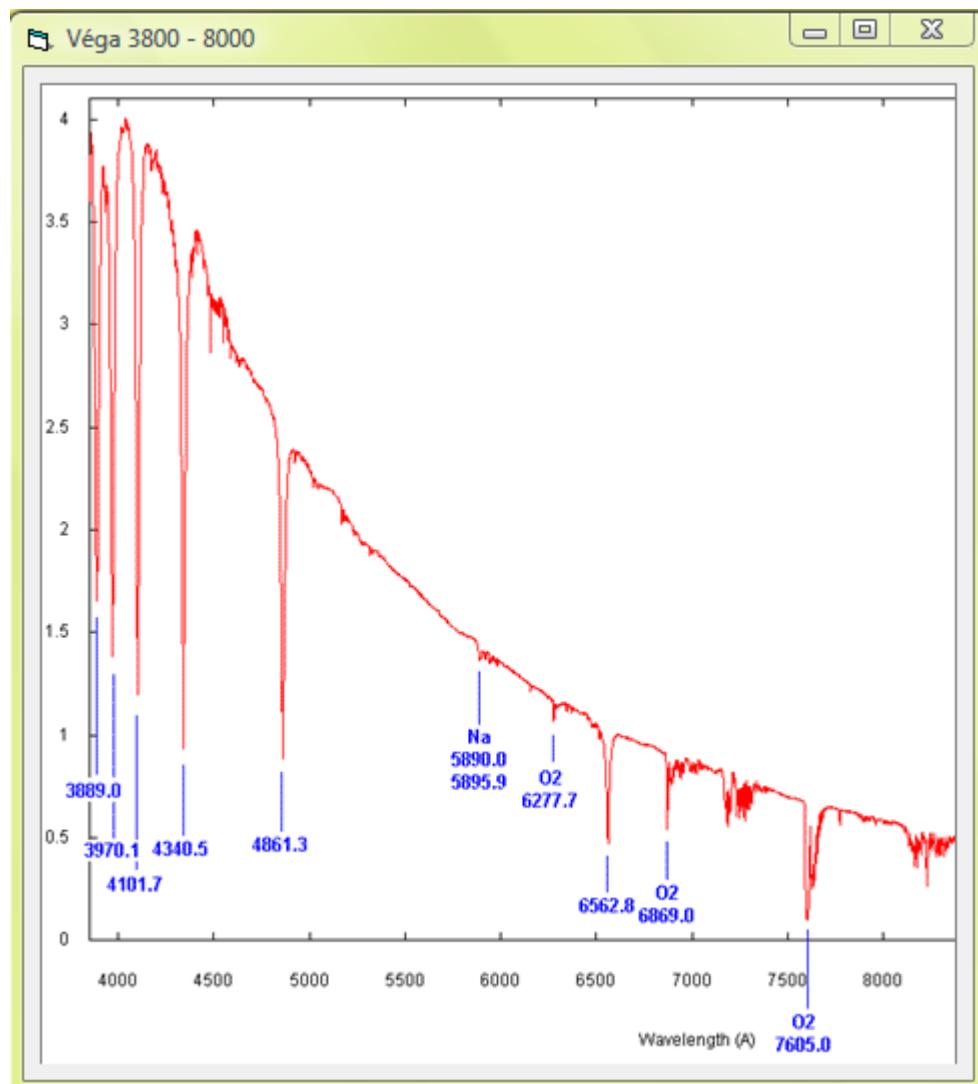
Telluric lines 6500 - 6600



Neon spectrum 5800 - 7500



Vega spectrum 3800 - 8000



APPENDIX 2

Buttons**Principal Toolbar**

-  Open a .pic or .fit image
-  Open Visual Spec Explorer
-  Open a .spc Profile file
-  Display a search window for all profiles which contain the search string

Image Toolbar

-   Apply a new low threshold, new high threshold to the visualization image
-  Apply new thresholds to the visualization image
-  Reset the thresholds to default values
-  Mirror the image to revert the left-right side
-  Extract a spectral profile
-  Display a box to limit the binning on this area
-  Extract a reference profile
-  Export a sub-image to Excel

Calibration Toolbar

Display the list of lines of the reference element (Argon)

-   Display a dialog window for applying new thresholds in Y, in X

Continuum Toolbar

-  Toggle the method of calculation of the continuum between area-suppression mode and point-mode
-  Eliminate the selected area from the profile of the continuum
-  Reset the areas eliminated from the continuum
-  Execute interpolation of the continuum
-  Reinitialize the list of intake points of the continuum
-  Execute interpolation of the continuum by points
-  Leave continuum mode
-  Save the list of continuum points

Profile Toolbar

-   Display a dialog window for applying new thresholds in X, in Y
-   Zoom on scale X of the profiles in the area selected using the cursor
-  Erase all displayed series
-  One line calibration
-  Two lines calibration
-  Multi-lines calibration
-  Redimension the profile document to a predefined format
-  Cut the profil according to the selection
-  Copy the active series
-  Paste the series previously copied
-  Apply the X format of the active series to all windows
-  Display Element window
-  Normalize the active series
-  Atmosphere spectrum correction
-  Divide a profile by another profile
-  Display a dialog window to add a series containing a theoretical profile of the Planck temperature
-  Display a selection window of calculations to be carried out on a selected area
-  Replace one of the base series with the active series
-  Launch Gnuplot application



Synchronise curseur on the profiles opened

Button on the side of a profile document



Decrease the value of the upper bound of the Y axis



Increase the value of the upper bound of the Y axis



Lock the upper and lower Y axis boundes of the active serie to all the series



Apply the current Y axis scaling of the active serie to all the series



Among all series find the Y-max value and take it to scale all the series



Display graduated axis



Refresh the graphic display



Unzoom



Take a quick screen capture in a bmp format



Apply a validation scenario for BeSS spectrum

APPENDIX 3

Reference list of menus and functions**Visual Spec**

Menu	Function	Description
File	Open image...	Open a .pic or .fit image
	Sequence duration	Get a list of the image files of a sequence to compute the overall exposure and time
	Profiles Explorer	Open Visual Explorer interface to open profiles document
	Open profile...	Open a .spc document
	Find	Search for a .spc document whose header contains the search-string
	Quit	Quit the application
Tools	Elements	Display the dialog box to search for element spectral lines
	Console	Open the console to enter command-line commands
Assitant	0b_to_0c	Call the assistant for Lhires calibration: wavelength & response
	1b_to_2b	Call the assistant for Lhires calibration: response, H2O, continuum
	Scriptbox	Call the scriptbox to run script on a list of documents
	Run Spectrum	Launch Spectrum interface
	BeSS query	Interface panel to query BeSS database
	CDS query	Name enter box to query Simbad database
Options	Preferences...	Display the Preferences dialog box
?	About...	Display the window "About Visual Spec"
	Help	Launch the Acrobat Reader to display the help file Aide.pdf

Image

Menu	Function	Description
File	Open profile...	Open a .spc document
	Open image...	Open a .pic or .fit image
	Display header	Display the header of the image file
	Find references...	Search for an associated .pic image beginning with the prefix "a"
	Export bmp	Export the Image document into a bmp file under name<-I>.bmp in the same directory
	Close	Close the current document
	Close All	Close all image windows
	Quit	Quit the application
	Arrange	Cascade the windows
	Mosaic	Tile the windows
Window	Align	Align the windows at the left of the screen one over another
	Preferences	Display the Preferences dialog box
	About...	Display the window "About Visual Spec"
?	Diagrams	Can display different spectral profile with lines indentified
	Help	Launch the Acrobat Reader to display the help file Aide.pdf

Profile

Menu	Function	Description
File	Open image...	Open a .pic or .fit image
	Sequence duration	Get a list of the image files of a sequence to compute the overall exposure and time
	Profiles Explorer	Open Visual Explorer interface to open profiles document
	Open profile...	Open a .spc document
	Find...	Search for a .spc document whose header contains the search-string
	Save	Save the document without changing its name
	Save As...	Save the document, asking for a new name
	Export fits	Convert and export the .spc file into a fits 1D document
	Export txt	Export the .spc document as a .txt document
	Export bmp	Export the active window as a .bmp document
	Close	Close the current document
	Close All	Close all image windows
	Quit	Quit the application

Edit	Copy	Copy the series
	Paste	Paste the series
	Apply format	Apply to all windows the X format of the active series
	Clear	Clear the active series from the window
	Suppress	Suppress the active series from the list, if it is a temporary series
	Replace	Dialog box: replace one of the predefined series with the active series
	Crop	Eliminate areas outside the selected area from the active series
	Pixel...	Dialog box: edit the intensity of the pixels
	Header	Dialog box: edit the .spc document Header
Format	Graphic...	Dialog box: Modify the graphic format, scale and graduations
	Zoom...	Interactive zoom and translation controls
	Line	Display the spectral profile as a line
	Dot	Display each pixel with a symbol
	Bar	Display the spectral profile in a small rectangle
	Font...	Dialog box: Modify the font of the Graph
	Background color	Dialog box: Modify the color of the graphic background
Operations	Normalize	Normalize the series with respect to a predefined continuum
	Divide profile by a profile...	Divide the active series by a series in memory
	Multiply profile by a profile ...	Multiply the active series by a series in memory
	Add profile by a profile ...	Add the active series to a series in memory
	Subtract profile by a profile ...	Subtract the active series from a series in memory
	Recalibrate profile by a profile	Recalibrate the active series based on calibration of a series in memory
	Binning 1:2 horizontal	Digital binning: add the intensities of 2 adjacent pixel
	Operations with values...	Dialog box: Arithmetic operations with constant
	Suppress zone	Exclude temporary a spectral zone for a computation
	Translate...	Dialog box: Translate series in X
	Join	Concatenate two series to form one series
	Compose	Add the displayed profiles to the active series
	Low-Pass Filter	Dialog box: apply a low-pass filter
	Spline Filter	Dialog box: apply a spline filter
	Gaussian Filter	Dialog box: apply a gaussian filter
	MMSE Filter	Dialog box: apply a mmse filter

Spectrometry	Calibration 1 lines...	Display the one line calibration toolbox
	Calibration 2 lines...	Toolbar: manual calibration based on instrumental parameters
	Calibration multi-lines lines...	Dialog box non-linear calibration
	Computation preferences	On a selection of lines, dialog box: measurement
	Heliocentric correction	Dialog box: compute the heliocentric correction due to the Earth moving
	Heliocentric speed correction	Dialog box: apply the heliocentric speed correction
	Gaussian fit	Fit a Gaussian curve on the selected region
	Fit Photosphere	Dialog box: Adjustement and subtraction of a gaussian profil to suppress the photospheric contribution (Work in Progress...)
	Resampling	Dialog Box: resample the profil
Radiometry	Compute Continuum...	Display the Continuum toolbox to compute the continuum
	Extract	If list of wavelength is not empty, extract the continuum from this list
	Extract from zone list	If list of wavelength region to exclude is not empty, extract the continuum
	Auto continuum	Automatic detection of continuum
	Continuum division	Call the function Continuum then replace the intensity series by its division by a continuum
	Continuum subtraction	Call the function Continuum then replace the intensity series by its subtraction by a continuum
	H2O correction	Dialog box: suppress the atmospheric lines of the water
	H2O correction real spectrum...	Dialog box: select the atmospheric profile then link with the intensity adjustment dialog box
	Auto Planck	Dialog box: compute the best fit of planck curve varying the temperature
	Planck...	Dialog box: calculate the Planck profile for a temperature
	Extinction	Dialog box: correct the atmospheric extinction
	Compute flux of reference star...	Dialog box: Calculate the instrumental response for a reference star
	Absolute Flux calibration	Correct the active series from the instrumental response
Tools	Elements...	Dialog box: display the database of elements
	Library...	Dialog box: display the database of standard spectra
	Spectral type	Dialog Box: search for the spectral type of a star
	Coordinates	Dialog Box: search for coordinates of a star
	Run GnuPlot	Dialog Box: launch the GnuPlot application
	Comparison	Dialog box: format parameters to be applied to all opened profiles
	Page...	Dialog box: parameter for the web page generation with the gnuplot graphs of the opened profiles
	Stack and Shift Y...	Dialog box: parameters to stack all the profiles series on the same graph with an offset

		along Y axis
	Label	On the selection of lines and calibrated profile: display the wavelength
	Synthesis	Display the spectral image reconstructed from the active series
	Animation	Dialog box: temporal animation of the displayed profiles
	Console	Display the command-line window
	Infos...	Display the calculation windows on the lines
Assitant	Ob_to_0c	Call the assistant for Lhires calibration: wavelength & response
	1b_to_2b	Call the assistant for Lhires calibration: response, H2O, continuum
	Run Spectrum	Launch Spectrum interface
	BeSS query	Interface panel to query BeSS database
	CDS query	Name enter box to query Simbad database
Window	Small windows	Reduce the set of windows to “thumbnail” size
	Adjust	Enlarge the set of windows to normal size
	Arrange	Cascade the windows
	Tile	Tile the windows
	Align	Align the windows at the left of the screen one over another
Options	Preferences	Display the Preferences dialog box
?	About...	Display the window “About Visual Spec”
	Diagrams	Display a list of spectra with lines identified
	Help	Launch the Acrobat Reader to display the help file Aide.pdf

APPENDIX 4

Acknowledgements

This software was created after having extensively used the software "Spec" by Alain Klotz, which runs under DOS. Some functions were reproduced here, but unfortunately not all of them since the objective were to develop a mainly "Visual" interface for the most-often-used functions.

Since then, many functions were added, with the arrival of data of various "spectroscopists" of the Aude list, in particular C.Buil, the Morata family and the members of Astroqueyras with Jacques Boussugues, Oliver Thizy and the CALA - A special mention to Dale Mais for his patience and tenacity. The database of standard spectra comes from Pickles et.al. and was found at the Centre de Données Stellaire de Strasbourg: <http://cdsweb.u-strasbg.fr>

The atmos file is derived from personal data of Coralie Neiner, Observatoire Paris-Meudon, GEPI. They are thanked here for it.

A special thanks to those who have done the complete translation and production of this manual in English (Thanks to Barbara...). This opens a door to VisualSpecs and we are very happy if this software, through this initiative, allows a lot of amateurs all around the world to have fun with Spectroscopy

APPENDIX TO THE ENGLISH TRANSLATION

Translation Notes

The translator of this document is not export in either spectroscopy or French/English translation. Mistakes are undoubtedly present. If something seems wrong, the user may find that a better translation will provide better help.

Some useful French-English vocabulary:

La longueur d'onde = wavelength
Raie = line (spectral line)
Étalonnage = calibration
Calibrer = gauge
Repartition = distribution
Recaler = readjust
Decaler = shift
Affiché = displayed
Bascule = toggle
Seuil = threshold
Onglet = tab
Cocher = check (a checkbox)
Enregistrer = save (record)
Visualiser = view
Decalage = shift
Barycentre = barycenter
Pose = exposure

A useful site for translating words and phrases (don't forget that human language does not follow strict syntax, so automatic translation is not completely reliable):

<http://translator.go.com/>