

## FTS Manual (May 2015)

The aimed of this manual is to introduce the tools that will permit the control and the setting of the instrument (§I) and a quick visualization of the data by computing a photoabsorption spectrum out of the recorded interferograms (§II). Very often, multiple events are associated with the various interacting buttons, but you don't have to fill up your memory, as most of these buttons carry an information flag that will popup when you drag the mouse over. Only a few commands are necessary to run the FTS and compute the data, so not all of the information below is crucial, although it is useful to know somehow the basic principles in order to interact with the beamline staff if necessary. The various FTS software shortcuts are located in the same folder "Softs-STF" onto the desktop. Running "VerinMicos.vbp" will start the control software, "spectroEUV-v??" is for the spectra computation and visualization.

### I. FTS control & settings (VerinMicos.vbp shortcut) :

There are two different **control windows** (Fig 3 & 4). Basically, the first one allows only the control onto the translation stage. "Current position" is the position of the translation stage regarding the zero optical path difference position (near the 0 value). The speed of the movement can be set to any value typically in the range [0 - 0.5 mm/s], but the standard scanning speed is 150  $\mu\text{m/s}$ . So as to start a scan, one must click on the "**Move to....**" Button in order to shift to the second control window (fig 4). This second control panel is the main interface for setting the FTS.

#### 1. **Beam-line set-up:**

- Synchrotron beam energy selection: Three currents (PS1, PS2, PS3) are necessary to fully adjust the undulator parameters (polarization state and working energy). The undulator white beam bandwidth which feeds the FTS is  $\Delta E/E \sim 6-7\%$ . An example of the undulator background continuum at 24 eV is shown in FIG 1. The FTS works more efficiently in the vertical polarization state, which means that the PS2 and PS3 currents must be kept to 0. See Table I for the PS1 Vs Energy FTS calibration data (which is slightly different from the monochromator branch calibration). In the vertical polarization mode, the FTS can cover the range 6.2 up to 30 eV. In order to work at lower energies (limit at  $\sim 4.1$  eV), the undulator must be set in an exotic polarization mode, working with PS1 and PS3 simultaneously. The undulator energy position is directly controlled by using the dedicated popup window that can be called pressing (Ctrl-Left Click) the button labeled **-2-** on figure 4. Select the new energy on the popup window (figure 5), and then press "GO".
- Front-end control & the two main valves of the FTS branch : Global Screen panel (Left screen) on the beamline post control (figure 2)

#### 2. **Acquisition procedure.**

- a. The "p" parameter : All the operations regarding "p" are localized in the "fan parameter" window. This parameter is related to the sampling interval in the

interferogram, and therefore the Nyquist energy in the spectrum.. This will be the upper limit energy that will appear in the spectrum scale. In practice, we choose this value not too far from the working energy set by the undulator parameters. Typically, Nyquist Energy  $\sim$  Undulator Energy + 2eV. Always keep in mind that there is a relation between the Nyquist energy, the p parameter and the ultimate resolution achievable (see table II). The p parameter is not a user parameter, please ask the beamline staff if you need to change p. At the end of the “change p” procedure, the new value is automatically inserted in the **-1-** text box.

If there is a doubt about the written value, one can check it by doing the following operation: press CTRL+Left pointing the mouse arrow onto “real p” box **-1-**. The program will process an automatic small scan in order to measure the value. After a few seconds, a pop-up window will appear with the experimental p parameter.

- b. The next step is the selection of the acquisition filename **-3-**. The typical format is: **date-letter??-PS1current-“freeText”**. The date and the PS1 current are set automatically. In order to work below 6eV, a PS3 contribution is necessary, in this case the **-PS1current-** field will display automatically the value PS1+PS3 when selecting the undulator energy. One must choose the **letter** of the current acquisition. An acquisition is composed typically of several scans in order to increase the S/N ratio by co-adding several interferograms. Each interferogram will be recorded and referenced by the letter followed by a number (the two question marks). The number will be incremented automatically from scan to scan. For example if you decide to record 50 interferograms on the 25<sup>th</sup> February 2012 with 500 Amps on PS1 labelled “D” scan, one will get at the end of the experiment, 50 interferograms with the following names : from **120225-D01-500A-“freeText”.int** up to **120225-D50-500A-“freeText”.int**. The interferograms file extension is **.int** The upper value is 99 which means that an acquisition with more than 99 interferograms must be recorded in two steps, but in practice it is quite unusual. “free text” can be any data concerning the acquisition, for example: nature of the sample, pressure, etc...,
- c. Select the number of scans **-4-**.
- d. Select the number of samples recorded per scan **-5-**, a list of choices will popup. The basic adjustment works with  $2^N$  samples in order to process the Fourier computation. Table II gives the theoretical resolution for 1024K samples ( $2^{20}$ ) and for different “p” parameters, you can also press the “**Choose scan parameters**” button in order to display a more complete table. Of course, if you choose 512K samples, you decrease the resolution by a factor 2. We can go a little further by selecting the checkbox “Max” **-6-**. Therefore, one will get the maximum resolution that can be achieved by the instrument (see Table II). In this case, the number of samples will not be a power of 2.
- e. Setting up the ADC card gain. A shutter is present near the FTS entrance slit in order to preserve the optics from the beam, out of the scan. One can have access to the open/close button of the shutter by clicking on the “**=>shutter**”

button **-11-**. This will open a new window with the shutter **“open/close”** button. Then, one can check the VUV DC signal level on the scope. This signal is proportional to the machine current, and it is also related to the undulator beam energy. This means that the signal could be quite different from an experiment to another (typically, it should be in between 1V and 6 V).

- f. Left click on **-7-** to see the “code – gain” relation and set a value about twice the value seen on the scope into the text field **-8-**. This is because the signal near the zero optical path difference (OPD) is higher than the average DC signal seen on the scope. For example if you see a 0.8 DC value on the scope, you can select gain code 4 which means a 2.5V scale on the 16bits of the ADC card. Now, you can close the shutter and the pop-up window.
- g. Setting the scan speed **-9-**: in order to work properly, the scan speed must be set between 0.100 and 0.160 mm/s. The typical value is 0.150 mm/s.
- h. We are now ready to start the acquisition. Click the button **“Go to Start”**. Click the red **“Confirm”** button, and that’s it .....

### Miscellaneous :

- The two checkbox **-10-** must be selected in order to transfer the data to the server, and to open automatically the shutter of the beamline when the scan starts.
- If you need to mark a pause during an acquisition. Click the **“pause”** button, and after a few seconds the button will turn to pink. This action will pause the current scan **at the end of the displacement**, so be patient. Then, you will have two options :
  - If you press the **“pause”** button again, the acquisition will resume.
  - A CTRL+Left action pointing the mouse arrow onto the **“pause”** button will stop the current acquisition. This means that the translation stage will go back to its starting position ”0”, and the increment will be set directly at its maximum value.

## **II. FTS software ( SpectroEUV-v???.exe – shortcut)**

Basically, to get a spectrum from an interferogram, you only need to compute a Fourier calculation on the recorded interferogram. In fact, it is a little more complicated. The procedure includes several steps: first, the retrieve of the exact zero optical path difference position, then a correction of the phase error in the spectrum, next, a calculation of the average spectrum and finally the spectrum is put on an absolute scale and one can export the file to an ascii format.

Here, I will describe how you can proceed the acquisition by yourself, and check the spectrum using the tools of the software viewer.. The “rough” spectrum will be good enough in order to have a first idea of the final result. A deeper treatment will be done after the run to check for possible extra phase error or/and set a more precise energy scale. All the process is done automatically in the frame of a batch window. So you will only need to perform a few operations in order to see the “rough” result.

Note that the computation/viewer software (SpectroEUV-v???.exe – shortcut) can be launched several times in parallel (figure 7). This is useful to keep displayed one or several particular spectra on the screen, while computing others.

## 1. Acquisition Computation

The interferograms will be automatically transferred to the server (see §I), and then directly to a dedicated folder in the laptop located inside the hutch where the files will be computed. The interferograms will appear with an **.int** extension in the acquisition folder of the FTS control computer. All the files are in a binary format.

You are now ready to start the computation process :

- a. CTRL+Right with the mouse pointer in the “**Calcul TF Cos**” button (figure 7). A new window appears with two separated columns. Open the folder where the interferograms are localized. All the “**.int**” files will appear in the right column. Select the ones that you need to compute and click the transfer button. The files are transferred to the left column (figure 8).
- b. Make sure that the two checkbox “**Sampl. prof. correct.**” and “**Merge RP316**” are selected.
- c. Use the arrows in order to set the spectrum interpolation coefficient. Usually we choose “4”.
- d. Press “**calcul TF cos**” button. The process will start. The spectra will be computed into the interferograms folder with a “**.stC**” extension. You should see on the right side three different windows. During the process you will see the calculation progress for each interferogram :
  - Display of the interferogram near the zero OPD.
  - Display of the phase error profile.
  - Display of the current individual spectrum.

When all the interferograms have been computed, you are ready to calculate the average spectrum:

- a. Press the red “**CLOSE**” button with the checkbox “**average**” selected. The averaging window tool will be opened targeting the current folder, with again two separated lists for the averaging process. The spectra (**.stC** extension) are displayed on the right.
- b. You select the spectra that will be co-added on the right list and you transfer these spectra to the left side by pressing the green button “**ADD**”, pressing the red button “**REMOVE**”, will take out, the selected spectra.
- c. Press “**COMPUTE**” button, the average file spectrum will be written in the current folder with the automatic name **date-Lmoy??-PS1current.freeText.stC**, where *L* stands for instance to the current spectrum series letter, and ?? is the number of spectrum to be averaged. It is possible to average files with different letters. In this case the letter in the average name is the letter relative to the first spectrum of the list. However, spectra already averaged i.e. with names including the term “**moy**” will not be processed. So, when you need to co-add spectra with more than one series-letter, be sure to make the averaging process apply to all the desired spectra and never on partial averaged ones. Note that the average spectrum name is proposed, not imposed: you can modify it before to trigger averaging, but we suggest to keep

the same structure: date-Letter(s)moy??-PS1current-freetext . When more than one letter is involved, simply add the 2<sup>nd</sup> , 3<sup>rd</sup> etc to the name.

Comment: There are two checks (**RP stats** and **Jitter Stats**) that are not really required at this step of the process but could be useful in order to diagnostic internal problems. Ask the beamline staff for details.

## **2. Spectrum viewer:**

You can display any computed spectrum by a right click on the “**VOIR spectre**” button (figure 7). Just select the averaged spectrum you have just computed to display it. If you select more than one spectrum, a new window will appear with a list of the selected spectra (figure 6), it is the easiest way to handle many spectra, many lists can be displayed, saved etc.... A lot of tools are present on the tool bar (right side of the spectrum window. The main ones are:

- a. The **arrows**, the **zoom** and the **window selection** buttons allow the selection of a region in the spectrum.  
**Arrows** proceed by field width (L-click) or by half-field (R-click).  
Enter/exit **zoom** mode by clicking Zoom button..Zoom by clicking the spectrum window at the place to become the center of the next display.  
Zoom in by L-click. Zoom out by CTRL+L-click  
Enter/exit the **range selection** mode by clicking the button, then select the spectral range (a subset of the currently displayed range), by depressing right button, then move pointer across the spectral window, then release.
- b. You can switch the spectral unit between nm, cm<sup>-1</sup> or eV .
- c. The **vertical scale** must be set manually : text field “**y<sub>max</sub>**”,end with ENTER to refresh the display. There is also a drag tool if you double click onto the vertical axis values to set more quickly the scale, but it is still manual
- d. “**T**” button displays the full scale spectrum. Useful, whenever you are lost.
- e. “**B**” button: pressing “B” displays the full undulator bandwidth spectrum.
- f. The U pink button is a very useful toll in order to help selecting the different overlapping undulator positions when a large spectral range has to be covered. Pressing the right mouse button and dragging onto the main screen will display a virtual undulator shape that will be seen when the button is released.
- g. You can mask the command part (upper part) of the screen by clicking the upper button of the tools bar (toggle restricted/full display). Useful to manage simultaneous viewer screens.

Pressing down the right mouse button and dragging the cross-like mouse pointer across the spectral window, shows the coordinates at the cross position. Abscissa is given as an index value, but also in the current spectral unit.

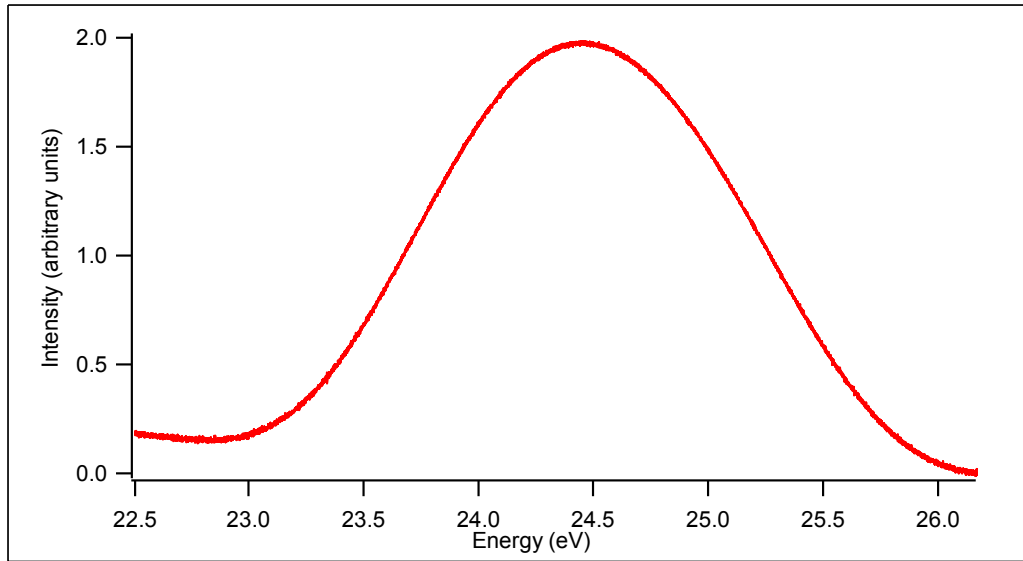


FIG.1

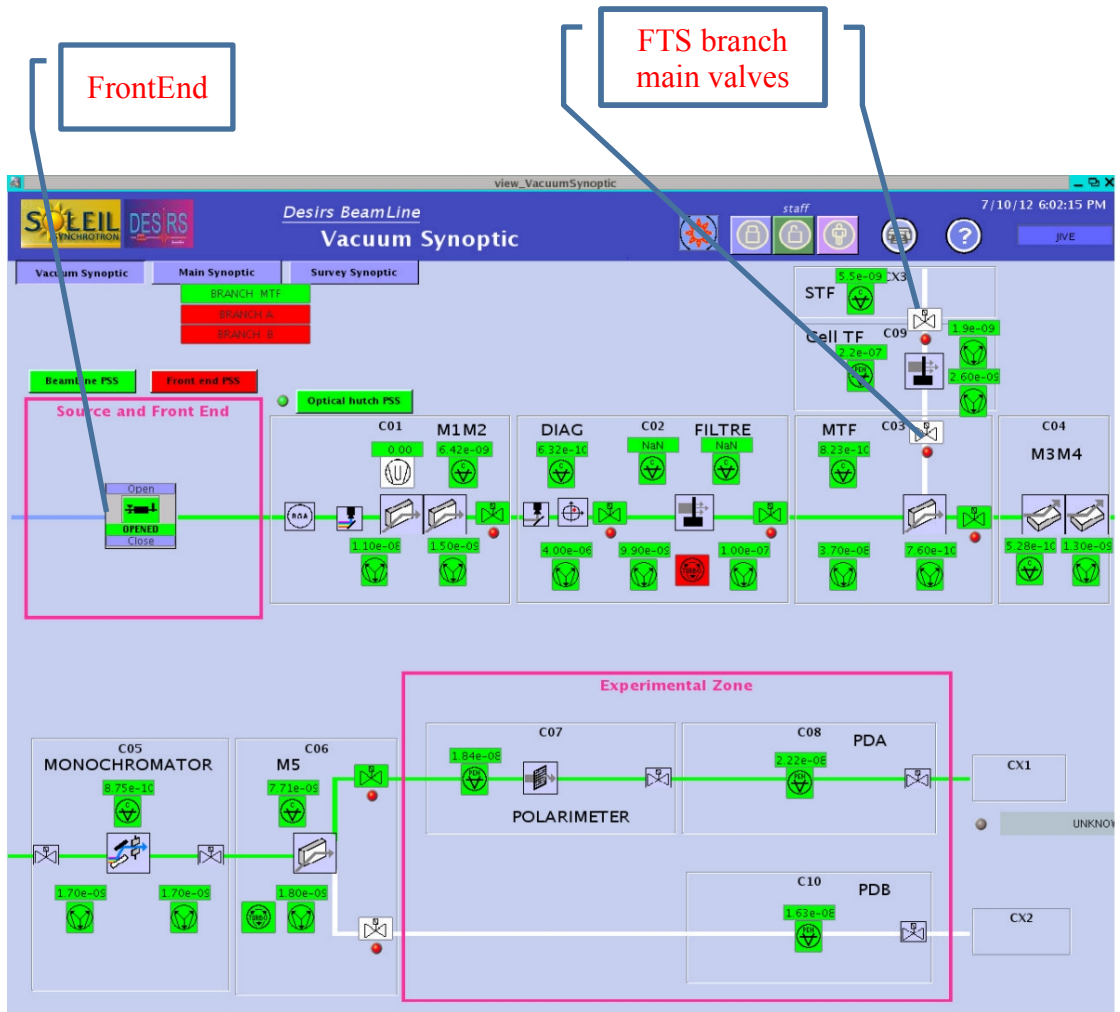


FIG.2

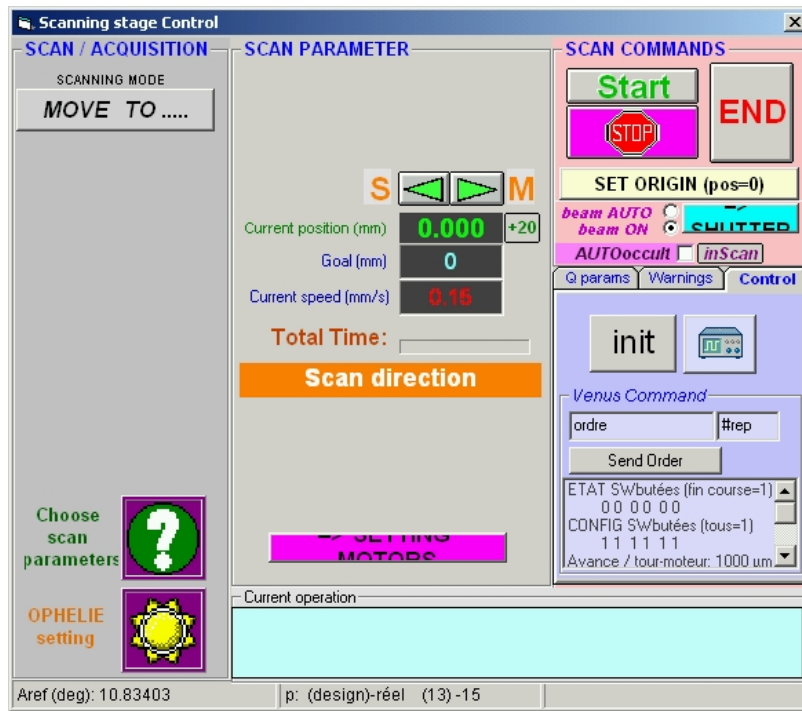


FIG.3

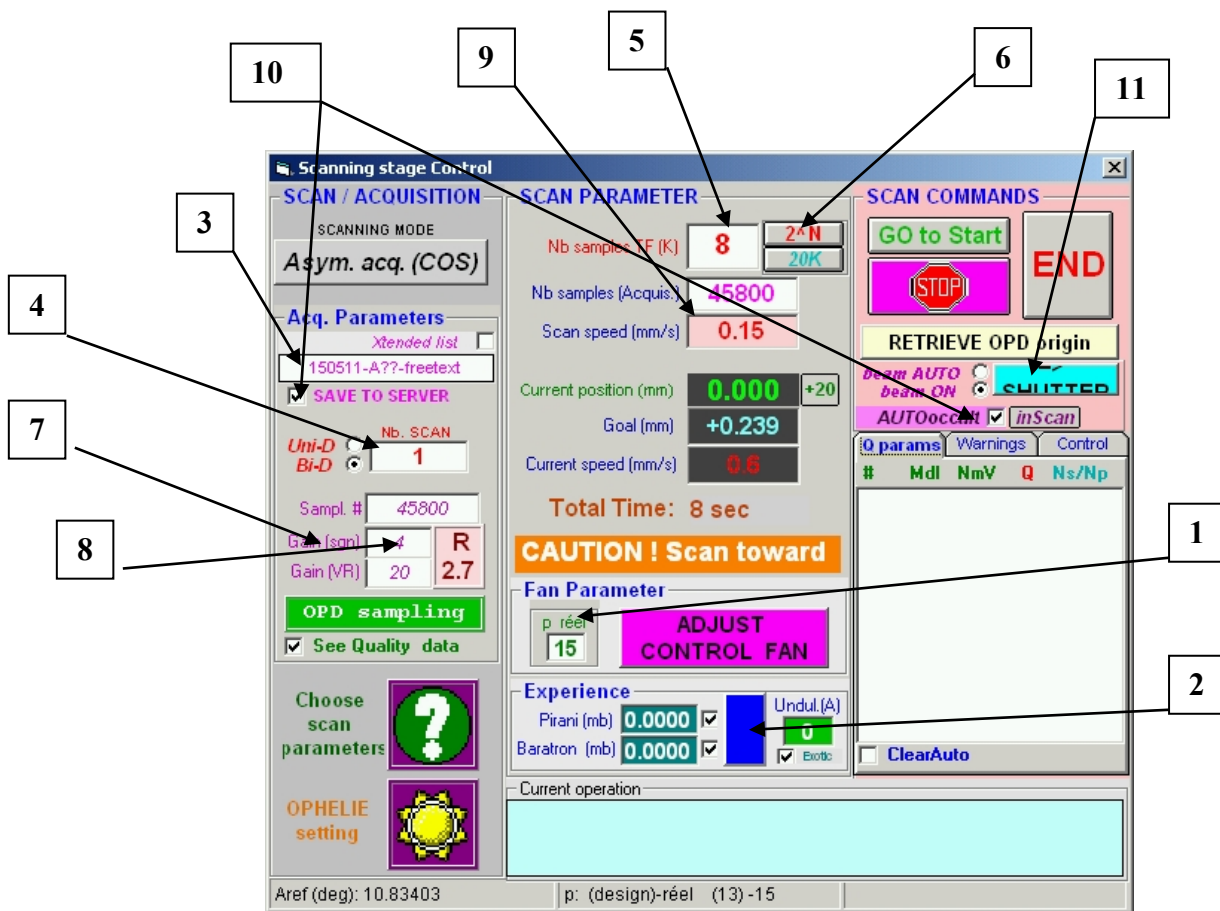


FIG.4

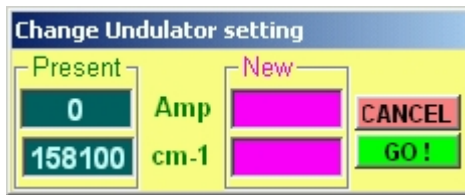


FIG.5

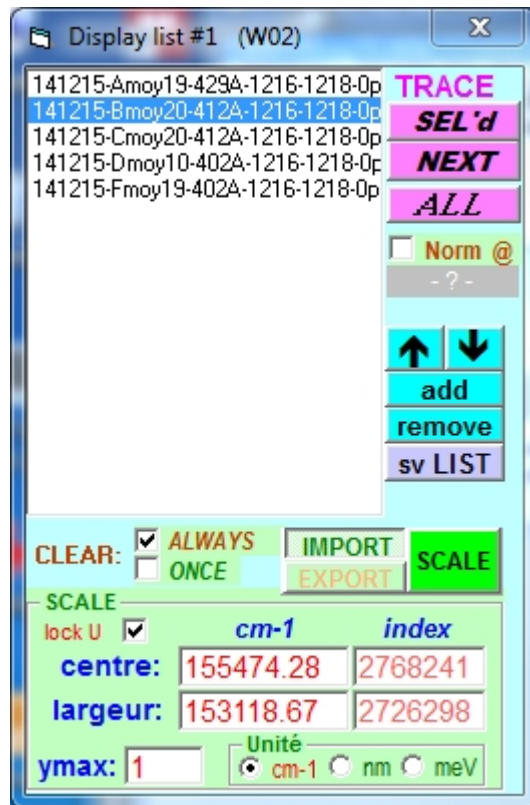


FIG.6



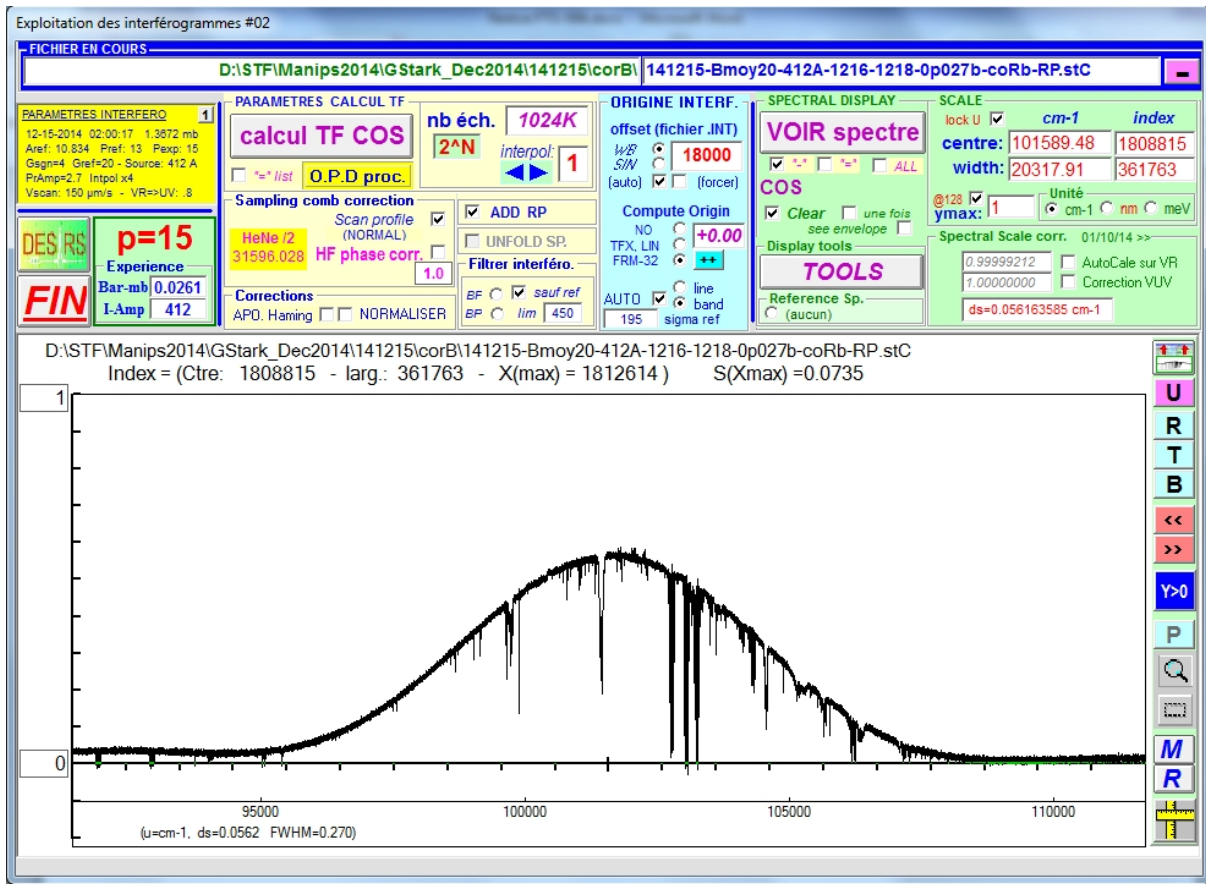


FIG.7

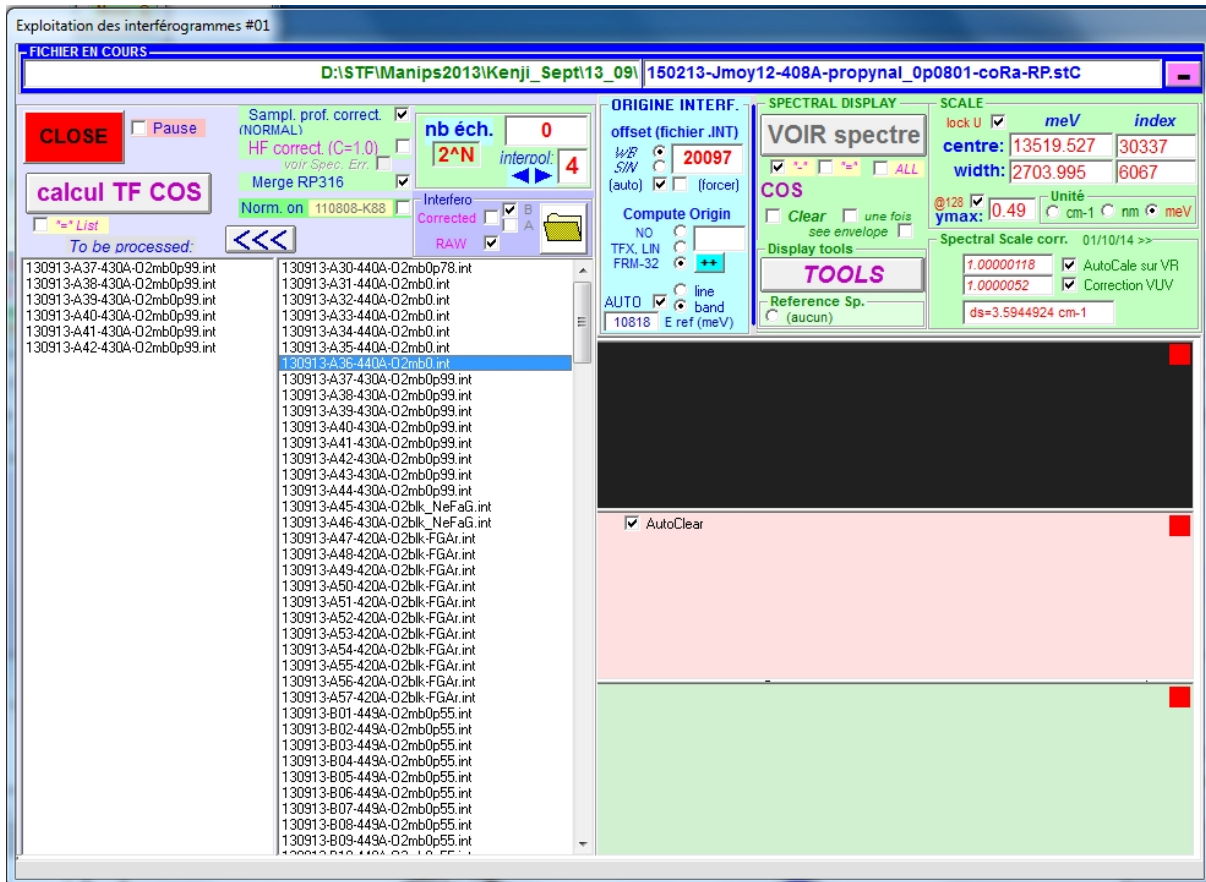


FIG.8

**TableI**

PS1(A)	E(cm-1)	E(nm)	E(eV)
276	196300	51	24.3
300	174100	57	21.6
312	164800	61	20.4
325	153300	65	19.0
337	145500	69	18.0
350	136500	73	16.9
365	127500	78	15.8
375	121800	82	15.1
386	115700	86	14.3
395	109700	91	13.6
400	108700	92	13.5
406	105300	95	13.1
415	100100	100	12.4
425	97700	102	12.1
450	87700	114	10.9
475	78500	127	9.7
500	71200	140	8.8
550	60100	166	7.5
600	51500	194	6.4

**TableII**

p	E Nyquist (16/06/08)			Résolution Ultime		Résolution 1024Ks	
	$\lambda$ (nm)	$\sigma_{max}$ (cm-1)	E(eV)	FWHM		FWHM	
	$\lambda$ (nm)	$\sigma_{max}$ (cm-1)	E(eV)	$\delta\sigma$ (cm-1) FWHM	PR (Nyquist)	$\delta\sigma$ (cm-1) FWHM	PR(Nyquist)
5	127.36	78517.63	9.8			0.090	873813
7	90.96	109933.09	13.7	0.074	1492500	0.126	873813
8	79.59	125638.81	15.6	0.075	1684167	0.144	873813
9	70.75	141343.78	17.6	0.090	1567500	0.162	873813
10	63.67	157051.28	19.5	0.108	1450833	0.180	873813
11	57.89	172752.32	21.5	0.129	1338333	0.198	873813
12	53.06	188456.40	23.4	0.154	1221667	0.216	873813
13	48.98	204159.68	25.4	0.185	1105000	0.234	873813
14	45.48	219863.31	27.3	0.222	992500	0.252	873813
15	42.45	235566.36	29.3	0.269	875833	0.270	873813
16	39.80	251271.32	31.2	0.329	763333	0.329	763333
17	37.46	266972.57	33.2	0.413	646667	0.413	646667