temDM CumulativeEELS 3.0

Installation: The plugins „temDM CumulativeEELS.gtk“ and „temDM extFrames .gt3“ should placed in some plugins folder of DigitalMicrograph.
The script „find plugins folders.s“ included in the distribution package will help you to localize such folders. Open „find plugins folders.s“ in DigitalMicrograpgh and run it by pressing „execute“ or by pressing ENTER with holding the CNTR key. Read the list of available plugins folders. The first folder in the list is most appropriated for placing the temDM plugins.

Some folders can be hidden in Windows. If you do not see all folders, make them visible in Windows explorer:
Windows 7: „Organize“ tab – „Folders and search options“ – „View“ tab – click „show hidden files, folders and drivers“ checkbox.
Window 10: „View“ tab – click „hidden items“ checkbox.

Drop the plugins into the choosen Plugins folder.
Restart DigitalMicrograph.

To update the version, just overwrite the plugin of the previous version in the Plugins folder. This is needed to avoid confusion of DigitalMicrograph with loading ambiguous commands.

Alternatively, you can install the script manually in DigitalMicrograph.
Having “extended frames classes.s” frontmost click: “File” – “Install script”- “Library”-”OK”
Having “CumulativeEELS interface.s” frontmost click: “File” – “Install script”- “Library”-”OK”
Having “CumulativeEELS functions.s” frontmost click: “File” – “Install script”- “Library”-”OK”
Having “CumulativeEELS positioning.s” frontmost click: “File” – “Install script”- “Library”-”OK”
Having “CumulativeEELS.s” frontmost click: “File” – “Install script”- “Menu command”-”OK”

In this way, you can modify the code of the script.

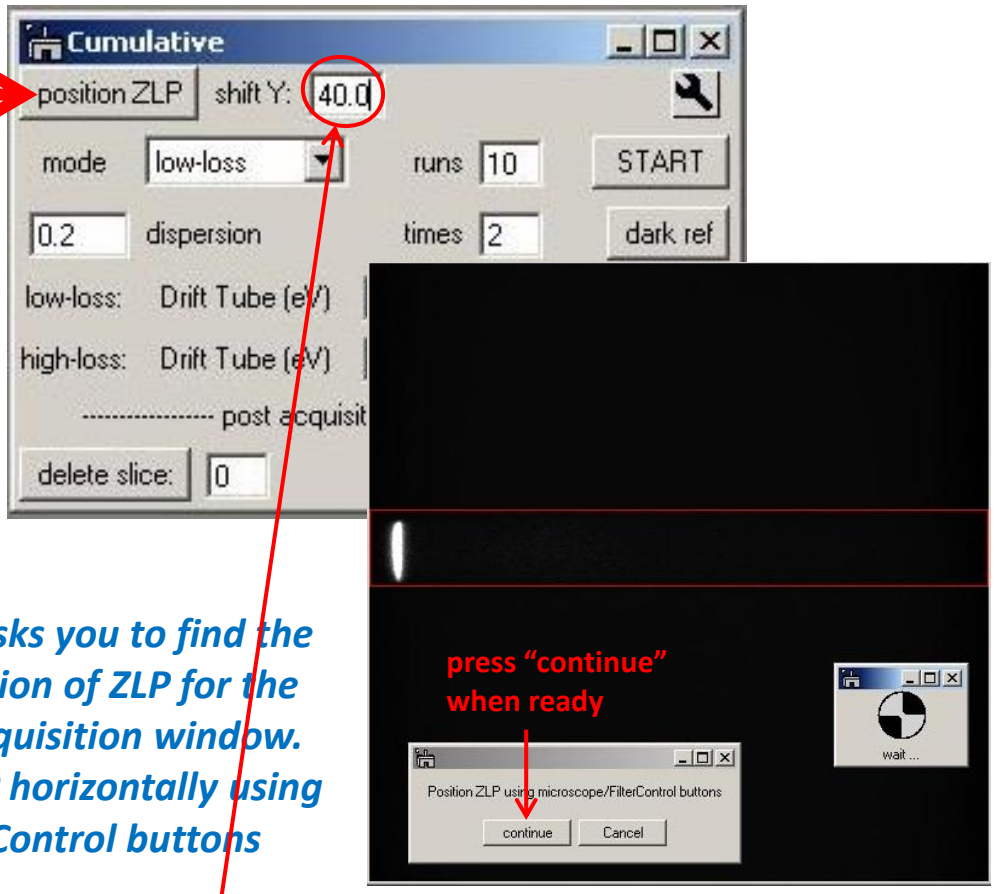
Why cumulative multi-run acquisition is needed

EELS spectra are often noisy. The noise can be reduced by applying the long acquisitions. However, the primary energy of incoming electrons varies continuously. It can suddenly jump, say, 1eV up or down with every second. Therefore, a long EELS acquisition would be unavoidably "smeared out" over the energy axis. Instead, it is much better to accumulate a lot of relatively short (not longer than few seconds) acquisitions and then sum them up cleverly.

Additionally, spectra suffer of unequal gain over the camera. The best way to strike with that is smearing the gain, i.e. averaging of many spectra where the same spectral feature is intentionally placed at different energy channel. This is realized by a small random electrostatic shift applied at each partial acquisition. Of course, this random shift should be properly taken into account during the final clever summation of partial acquisitions.

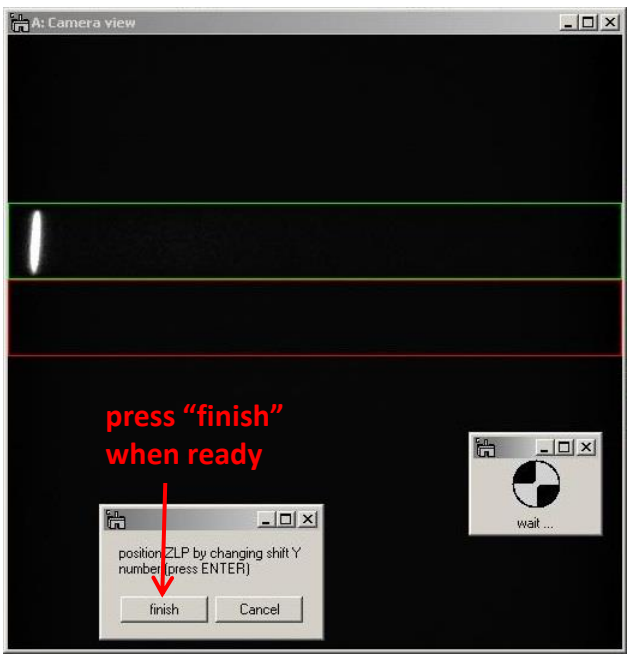
Before starting acquisitions , ensure that the beam hits the right window at the camera

click to position ZeroLossPeak



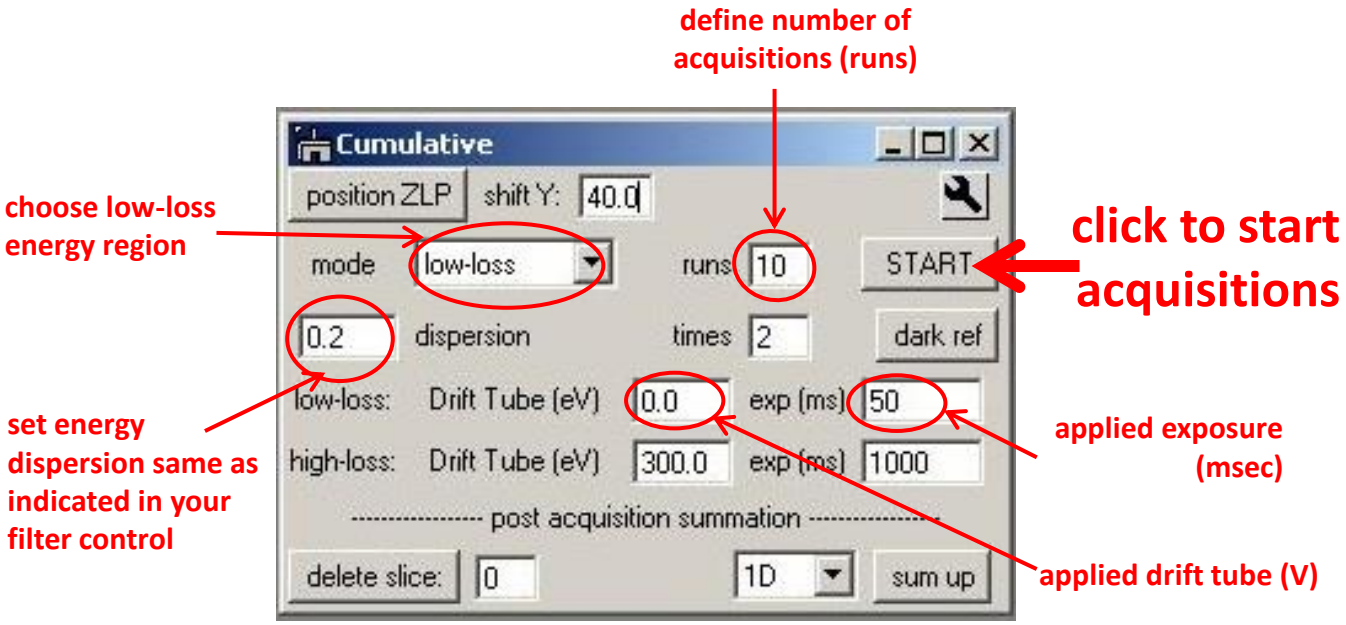
First, script asks you to find the right Y-position of ZLP for the "normal" acquisition window. You move ZLP horizontally using the Filter Control buttons

Then, you need to set your "shifted" window needed for a kind of dual-EELS acquisition. move ZLP horizontally by changing the "shift Y" value in the script frame.

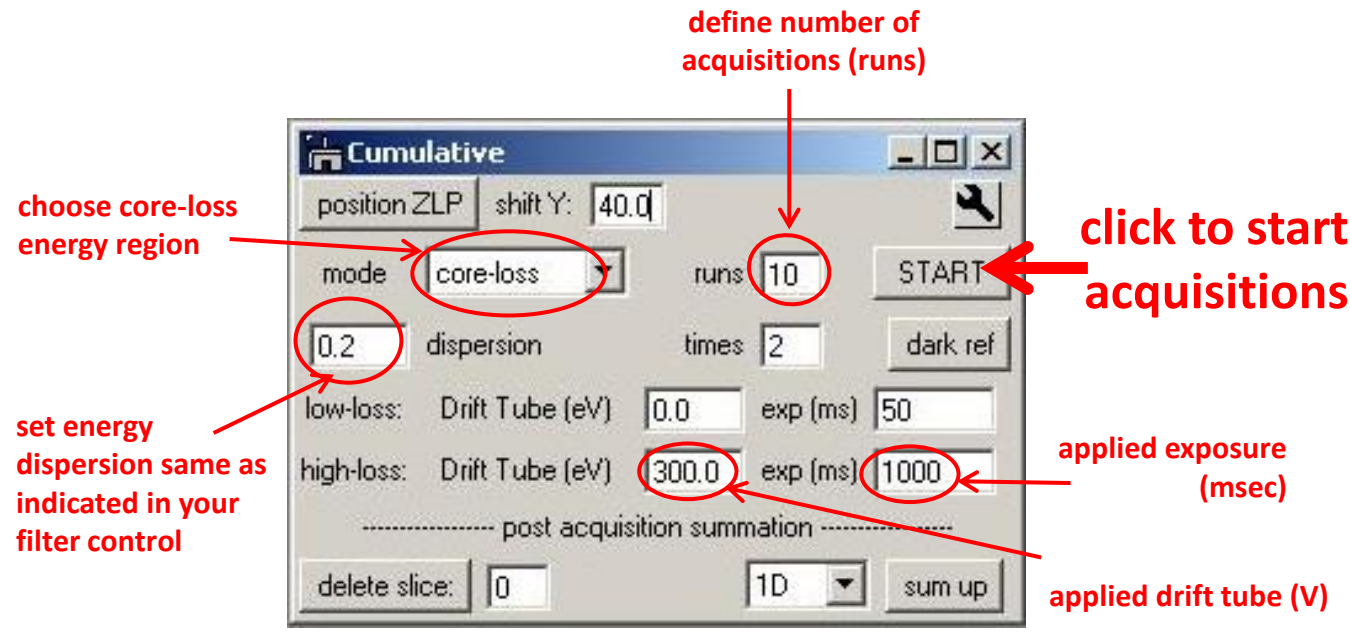


How to do cumulative acquisition

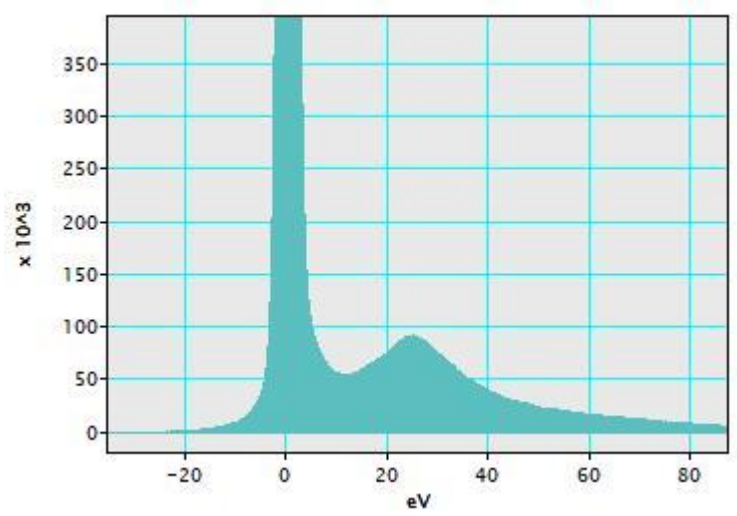
You can set conditions for your low-loss and core-loss acquisitions and run any of your choice without much changing of parameters.



(Attention: dispersion is not automatically read from the microscope. You should specify it manually)



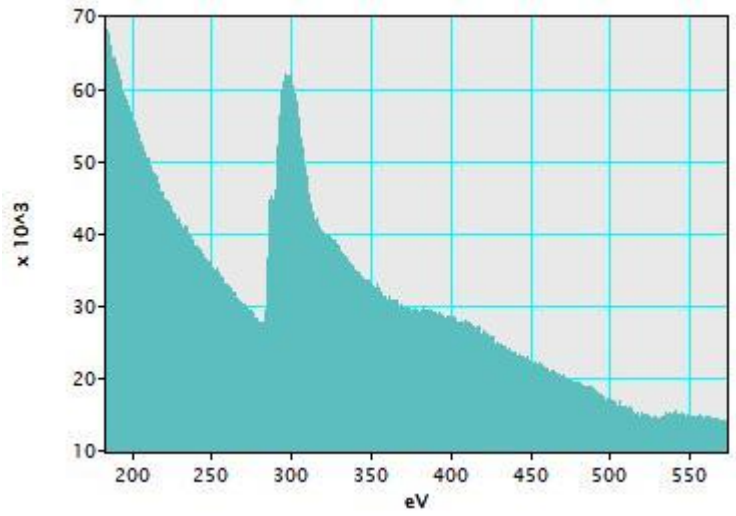
After acquisitions start you are watching at life-updated 1-D cumulative spectrum.



The scripts stops after the specified number of runs. However, you can stop it anytime by pressing ENTER.

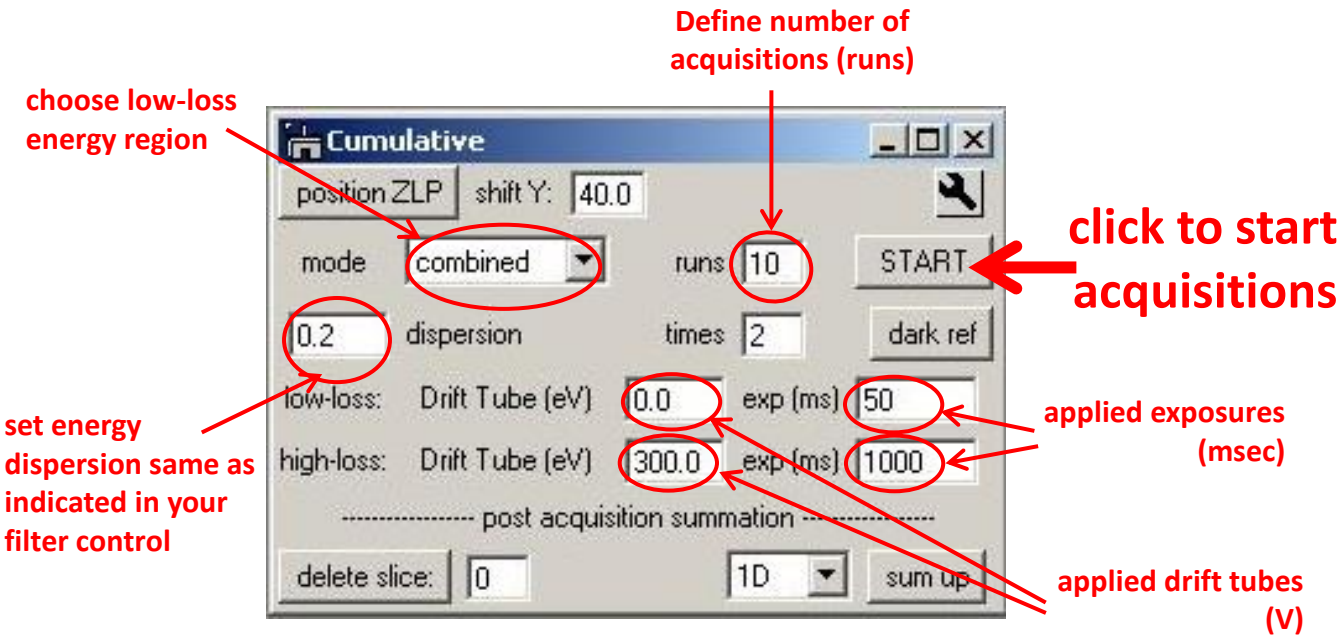
Finally you get the cumulative 1-D spectrum as well as the raw data in the form of 2D spectra stack. This is in fact the data cube – you might scroll the slices and check the individual acquisitions.

Same for core-loss cumulative acquisition.



Finally you get the cumulative 1-D spectrum as well as the raw data in the form of 2D spectra stack of your core-loss spectrum .

You can also do combined acquisition

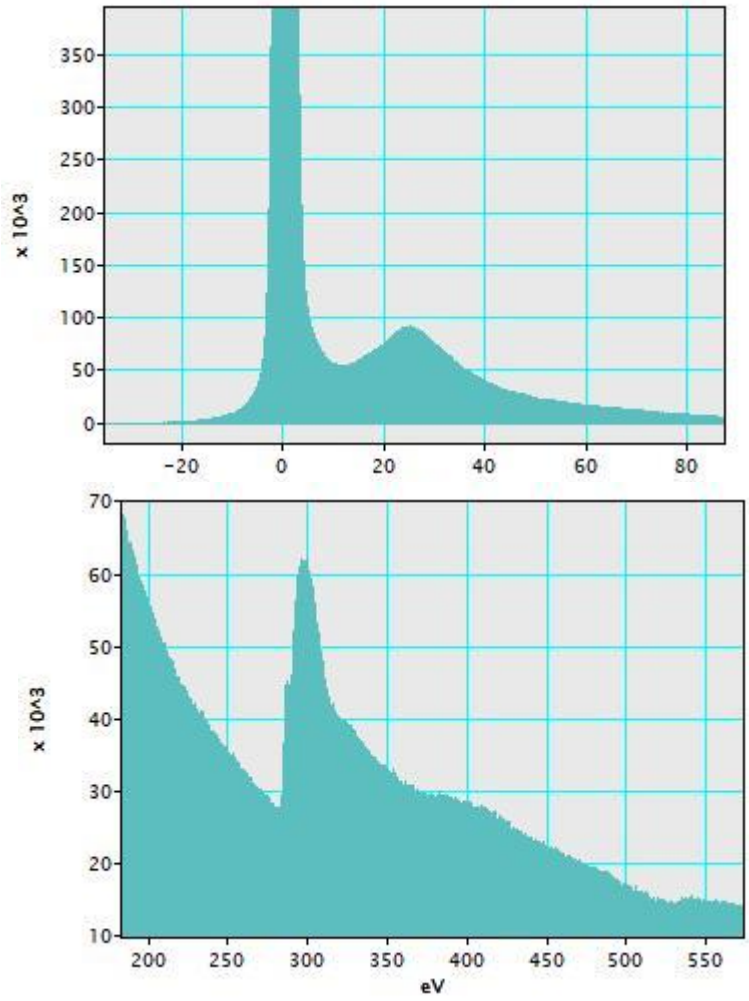


This is low-loss plus core-loss acquisitions in a sequence:
low-loss … core-loss … low-loss … core-loss.
The position of the zero-loss peak in each low-loss acquisition is used to determined the energy reference in the core-loss one.

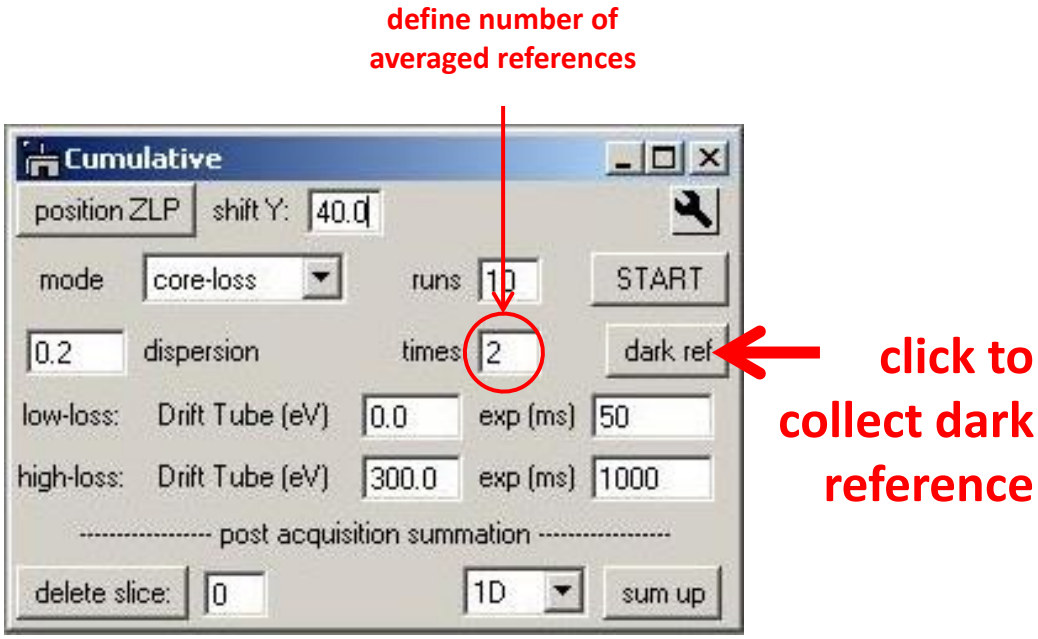
This regime is a close analogue of the Gatan dual-EELS option, although it works slower than the hard-code programmed dual-EELS.

at the end you get:

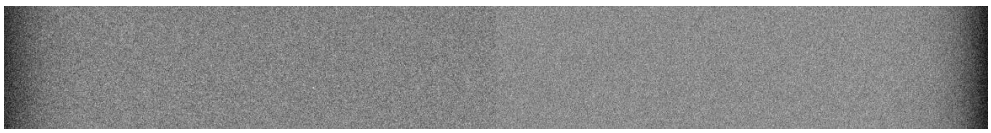
- *Cumulative 1D spectrum for low-loss*
- *Cumulative 1D spectrum for core-loss*
- *Raw datacube for low-loss acquisitions*
- *Raw datacube for core-loss acquisitions*



You can use you life-accumulated spectrum but for more accurate results you might do a posteriori processing of the raw data. For that you need an accurate dark reference. Several acquisition can be averaged for better accuracy



You get 2D reference image



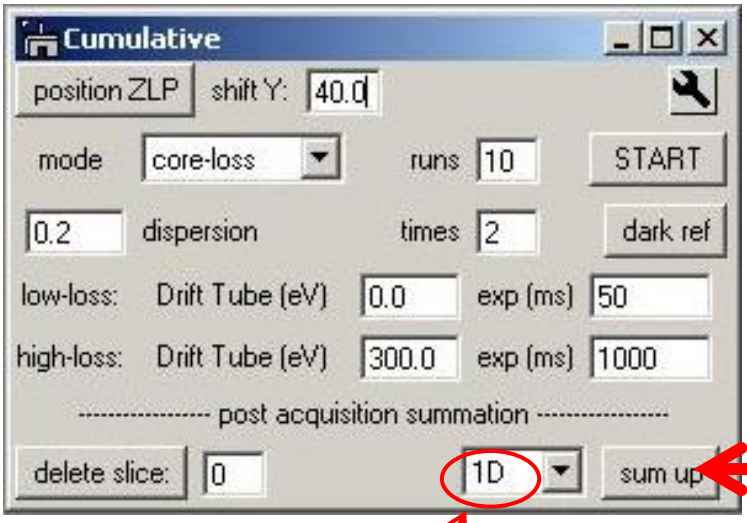
Advantages of a posteriori correction:

- ***Artefacts from inadequate dark reference (for example, due to after-glow) are avoided.***
- ***You may control quality of dark reference. If it suffers of after-glow, recollect the dark references after the sufficient pause. If it too noisy, accumulate many dark references.***

Disadvantages :

- ***You should take care manually of collecting dark current reference and their storing.***

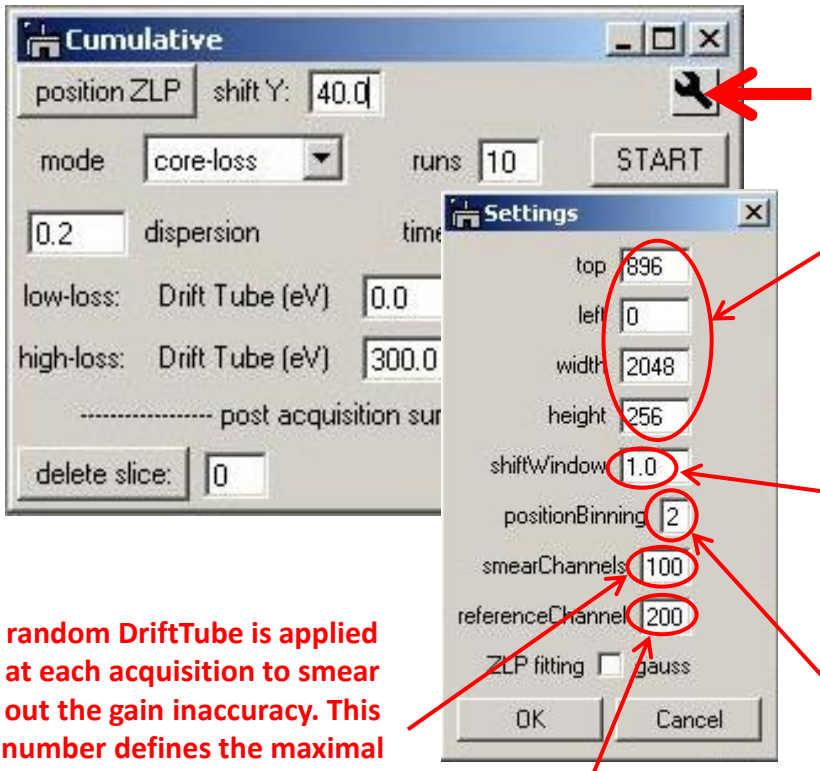
Finally you might wish to treat the collected raw data a posteriori with accurate accounting for dark reference and fine ZeroLossPeak positions



click to sum up raw data

You can choose if your final image appears as a 2D or as a projected 1D spectrum

Lets look at settings…



EELS acquisition area at the camera

this defines the position of the shifted window for dual-EELS acquisition (+1 shifted up, -1 shifted down)

random DriftTube is applied at each acquisition to smear out the gain inaccuracy. This number defines the maximal range (in channels) for random variation

when finding ZLP position at camera, continuous readout with a certain binning is executed (binning 4 fastest readout, binning 1 most accurate positioning)

a channel where ZLP is expected to be at DriftTube =0 (this is needed for approximate calibration of core-loss spectra in core-loss mode)