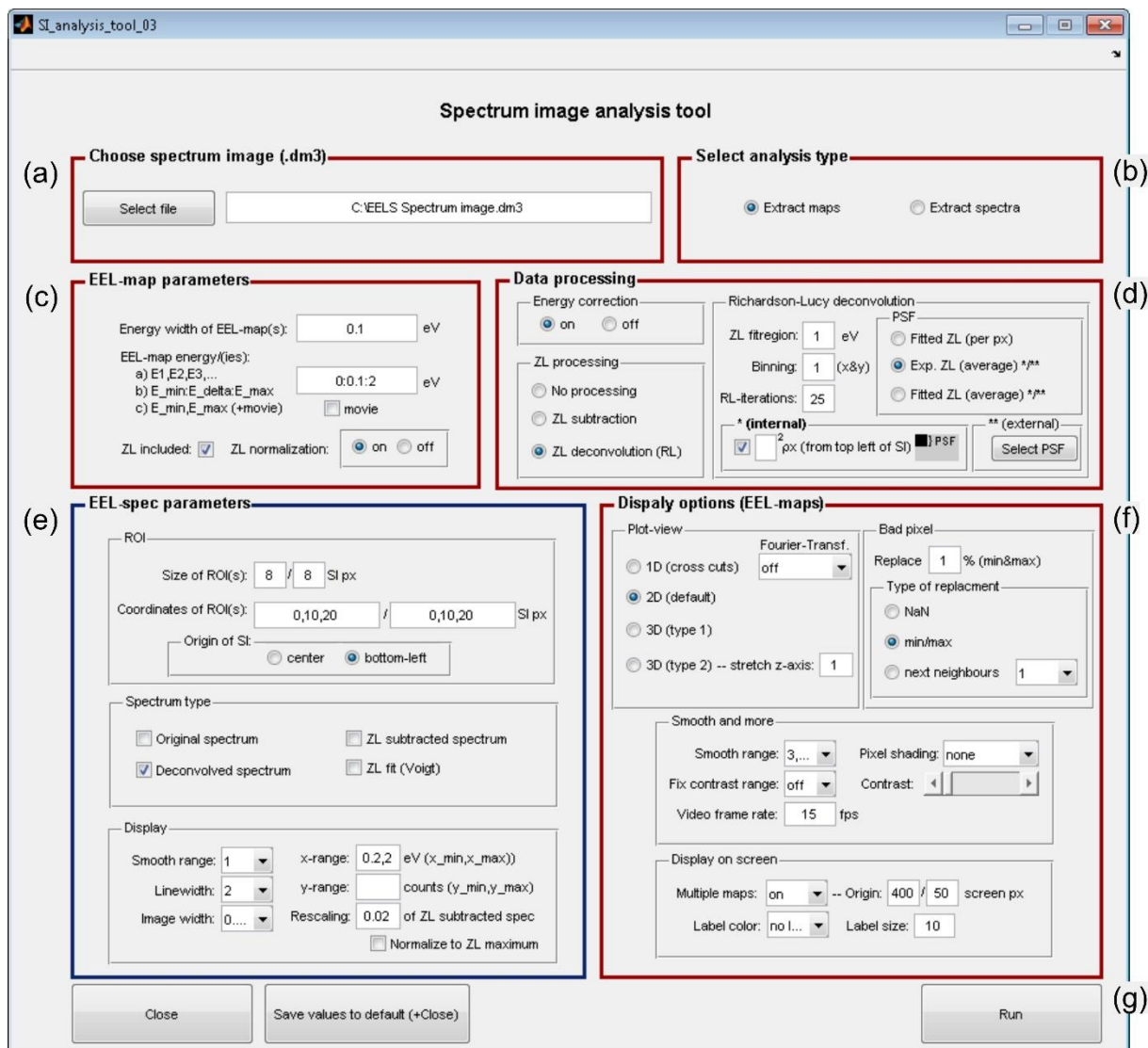


Spectrum Image Analysis Tool

Install instructions + How to use

Basic steps

- Download „SI_analysis_tool_03“ from <http://www.felmi-zfe.at/general/downloads/> and save the folder on your hard drive.
- For use in MATLAB (recommended):
 - Unzip and open folder „SI_analysis_tool_03“ and run m-file „SI_analysis_tool_03.m“
→ a user interface as shown below will be opened
 - Select spectrum image file (.dm3)
 - Select analysis type
 - Depending on the analysis type select your desired parameters
 - Press run
 - EEL-map(s) or EEL-spectra (+ROI position(s) in the SI) will be displayed on screen
- For use without MATLAB (not recommended):
 - Open folder “exe” within the folder „SI_analysis_tool_03“
 - If MATLAB is not installed on your system, download and install MATLAB Runtime R2016a, freely available at <https://www.mathworks.com/products/compiler/mcr/> – this enables to run compiled MATLAB applications (exe) without installing MATLAB.
 - Double click on “SI_analysis_tool_03.exe”
 - The same GUI as shown below is opened (this can take some time)
 - Follow the same procedure as explained above



Features

- Extraction of maps and spectra from EELS or CL spectrum images
- Flexible choice of a multitude of parameters such as:
 - Maps:
 - Energy position(s) and width
 - Energy correction, Zero-Loss normalization
 - Display in „1D“, 2D and „3D“
 - Replacement of “bad pixel” with different algorithms
 - Contrast adjustments
 - Data smoothing
 - Automated adjustment of simultaneously displayed EEL-maps on the screen
 - Automated saving capabilities (pngs)
 - Creation of EEL-map-movies (avi)
 - Spectra:
 - ROI-size, ROI-position(s)
 - Display and comparison of original spectra (raw data) with deconvolved and/or Zero-Loss subtracted spectra and/or fit function
 - Data smoothing

- Data range + rescaling
- Deconvolution (Richardson-Lucy algorithm)
 - Flexible choice of the point spread function (PSF)
 - per pixel vs. average PSF
 - experimental vs. fitted PSF
 - internal (=included in SI) vs. external PSF
 - Further parameters:
 - Number of iterations
 - Fit range for fitted PSF (=Voigt-profile)
 - Binning in lateral dimensions (before deconvolution!)
- Automated analysis of multiple SIs due to attached loop function “loop_input.m”

Good to know

- To save/export EEL or CL map(s) for external use, run the program with the display option “Multiple maps = off” (therefore the display of each map is optimized) and all displayed maps are saved as pngs by just one click (Prompt window will ask to save) in the subfolder “maps”.
- If movie is activated an avi movie in the subfolder “movie” is produced showing the EEL/CL maps from the lowest to the highest loss energy (for movies the plotview “3D (type2)” is recommended).
- Low loss (including the Zero-Loss) as well as high loss (no Zero-Loss) EEL spectrum images can be analyzed. Do not forget to select “ZL included” on or off.
- For analyzing CL spectrum images only set “ZL included” to off (the data are recognized as CL data, as soon the spectral scaling in the dm3 file tags is set to “nm”).
- If a spectrum image is processed for the first time, an energy corrected spectrum image (“filename_(aligned).dm3”) and a Zero-Loss normalized spectrum images (“filename_(aligned)_ZLnorm.dm3”) is produced and saved as dm3-file in the folder of the original SI file.
- If you choose “ZL subtraction” or “ZL deconvolution” in the “Data processing” panel two or three dm3 files are produced:
 - Deconvolved spectrum image (filename_deconv_XXiter.dm3)
 - ZL subtracted SI (filename_sub.dm3)
 - SI with the fitted ZL(s) (filename_ZL_fit.dm3) – only if a fitted psf is used for deconvolution (“Fitted ZL (per px)” or “Fitted ZL (average)”)
- For the deconvolution the Richardson-Lucy algorithm is used. The following parameters in “Richardson-Lucy deconvolution” may improve the results:
 - Optimize the fit region of your PSF (“ZL fitregion”).
 - Bin your SI for better SNR and therefore better deconvolution results (“Binning”), but loosing spatial resolution.
 - Adapt the number of iterations (“RL-iterations”).
 - Optimize your PSF (per pixel vs. average PSF, experimental vs. fitted PSF, internal (=included in SI) vs. external PSF).
- To reuse the selected set of parameters in the next session push “Save values to default (+Close)”.
- For data analysis of large data sets (many spectrum images), additional scripts can be found in the folder “scripts to loop”:

- (1): For automated data analysis of several spectrum images (e.g. deconvolution of multiple SIs) open “loop_input.m”. Here parameters can be defined, which you would like to loop (e.g. filenames). This script iteratively calls the function “function_input.m”, which does exactly the same as the GUI. Set all parameters, which you don’t like to loop to their desired fixed values in the “Default parameter list” of “function_input.m” (P1 – P53). Adapt the input parameters of the function (transfer parameters) as desired.
- (2): If you have previously generated several pngs of EEL-maps with the GUI you can plot a selected number maps in one new figure together using the function “function_plot_maps.m” with up to 11 input parameters (see “Default values”). Again, as in (1), use the script “loop_plot_maps” to call the function (iteratively) using selected transfer variables.

Parameter list

(a) Panel “Choose spectrum image (.dm3)”

- Filename of spectrum image (.dm3)

(b) Panel “Select analysis type”

- Extract whether EEL/CL maps or EEL/CL spectra of spectrum image?

(c) Panel “EEL-map parameters”

- Energy width of EEL/CL map(s)
- Selected energy/(ies) (=center energy) to extract particular EEL/CL-map(s)
- Create movie of EEL-maps and save as .avi (on/off)
- Tick/untick “Zero-Loss included” (lowloss EELS vs. highloss EELS or CL)
- Zero-Loss normalization (on/off)

(d) Panel “Data processing”

- Energy correction (on/off) - 'off' for SIs w/o Zero-Loss included (core-loss spectra, CL data)
- Data processing (0/1/2)'
 - No processing
 - Zero-Loss subtraction of fitted (Voigt) or experimental Zero-Loss
 - Richardson-Lucy deconvolution using a fitted (Voigt) or experimental Zero-Loss as point spread function
- Fit region to be used for Zero-Loss fitting (in eV, [ZL-fitregion, ZL+fitregion])
- Binning of spectrum image in "image" direction (in x/y direction)
- Number of iterations for Richardson-Lucy deconvolution (see deconvlucy.m)
- Type of point spread function
 - Fitted ZL (per px): ZL of SI is fitted (Voigt profile) for each pixel of the SI and used as PSF for pixel wise deconvolution of the SI
 - Exp. ZL (average): An averaged experimental ZL, extracted whether from the top left region of the SI itself or loaded from an external dm3 file is used for pixel wise deconvolution
 - Fitted ZL (average): The same as before, but the averaged ZL is fitted by a Voigt profile.

- Internal PSF: Set size S of ROI (= SxS px) of spectrum image, from which spectra are extracted. The ZL, which has to be included in the spectrum image, acts as PSF (origin of ROI = left, upper corner of SI). If no value is entered or the check box is not selected, a spectrum summed over the whole SI is chosen as PSF.
- External PSF: Select a dm3-file including an EEL-spectrum. This spectrum is used as PSF for RL deconvolution.

(e) EEL-spec parameters

- Size of region, from which spectra are extracted (px in x-direction)
- Size of region, from which spectra are extracted (px in y-direction)
- Region(s) of interest: Shift(s) in x direction from center or bottom-left position of spectrum image (in pixel)
- Region(s) of interest: Shift(s) in y direction from center or bottom-left position of spectrum image (in pixel)
- Original spectrum
- Richardson-Lucy deconvolved spectrum
- Zero-Loss subtracted spectrum
- ZL fit (Voigt)
- Smooth spectra (arithmetic mean of next neighbours): Smooth region in px (+/- "span", odd number)
- Linewidth of plotted spectra
- Width of SI Survey image in units of the normalized display area
- x-range of plotted spectra (in eV) (if empty, range is set automatically)
- y-range of plotted spectra (in eV) (if empty, range is set automatically)
- Rescaling of ZL subtracted spectrum (no ZL and therefore no ZL normalization of spectrum possible)

(f) Display options (EEL-maps)

- Display of plotted EEL-map (1/2/3/4):
 - 1 ("1D", side view, (=cross cuts of EEL-maps summed in y-direction))
 - 2 ("2D", top view)
 - 3 ("3D", view-angle=(-60°,40°))
 - 4 ("3D", 2D slice in 3D coordinate system)
- Fourier transformation of cross-cuts (only with plotview=1))
- Stretch z-axis (for plotview=4)
- percentage of min/max value to be excluded/replaced
- Type of replacement of "bad" pixel (nan, min/max, next neighbours)
- next neighbour elements (1/2/3 for 8/24/48 next neighbours which are used to replace excluded pixel)
- Smooth range ([x,y,z] in px), over which data are smoothed ('box', next neighbour smoothing)
- Pixel shading ('interpolate'/'none'), pixel values are not changed!
- Set same contrast range for all EEL-maps (on/off)
- Adapt contrast range
- Video frame rate (frames per second)

- Decide, whether multiple EEL-maps should be displayed and arranged on the screen at once or not('on'/'off')
- Display area: Origin (x-coordinate), measured from left/lower corner of screen (in px)
- Display area: Origin (y-coordinate), measured from left/lower corner of screen (in px)
- Color of label text (black, white, yellow, etc.)
- Set font size of EEL-map legend