



Technical brochure

MetalloBox software

Metallographic images analysis

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I. Modules presentation

The **MetalloBox** software proposes several metallography modules. Natively, the software provides a complete set of functionalities for interactive or automatic measures for **phase ratio** calculation or **grain size estimation**.

Thanks to its Python implementation, MetalloBox is an adaptive tool, allowing the Reactiv'IP development team to complete this software with additional norms or measures.

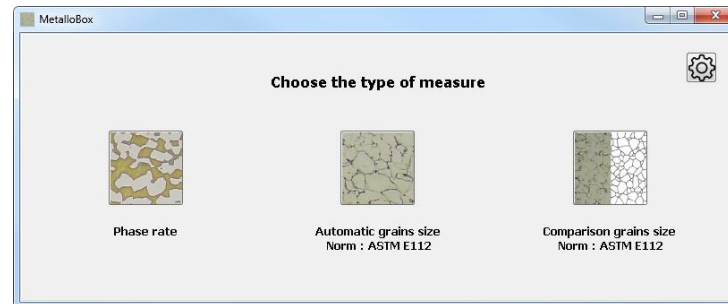


Figure 1: First MetalloBox window

II. Generic visualization tools

II.1. Visualization

MetalloBox offers a complete image visualization toolset. Among other functionalities, the user can zoom/unzoom the image, change the contrast, the lightness or the display dynamic. Moreover, the user can move the view in the main viewer, with an additional miniature overview of the entire image.

MetalloBox supports all classical image file formats: tif, jpg, bmp.

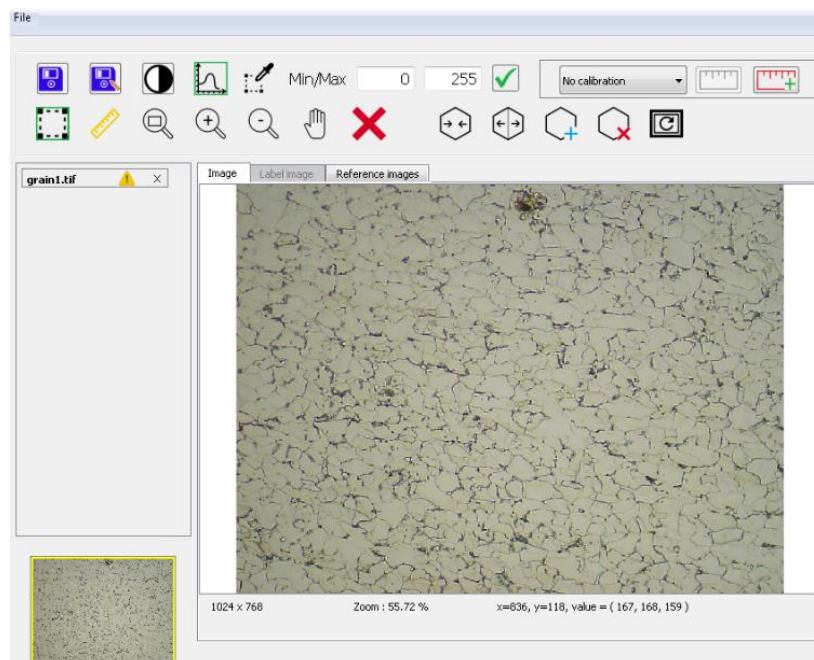


Figure 2: Image visualization within MetalloBox.

II.2. Calibration

In order to compute measures, **MetalloBox** provides a functionality to define calibrations. These calibrations can directly be entered by the user if the image resolution is known. The user can also extract that calibration from targets.

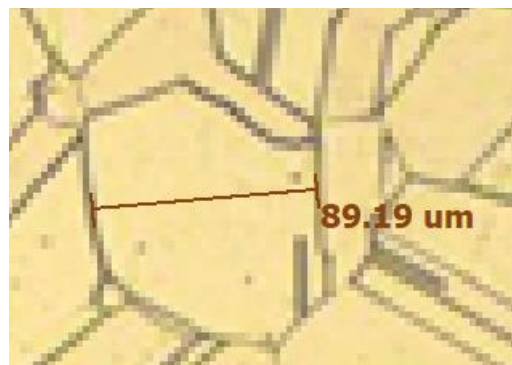


Figure 3: Positioning the calibration tool (in red) on the target displayed on the image.

II.3. Interactive measures



MetalloBox allows to manually measure lengths directly on images according to the calibration defined by the user.



III. Grains size measurement (ASTM E112 norm)

The grain size measurement module segments the grains in the image. Once the segmentation is calculated, the grains are measured according to the ASTM E112. This index is computed thanks to

both the planimetric and the intercepts procedures. In addition to the ASTM index, the module provides an accurate granulometry of the identified grains.

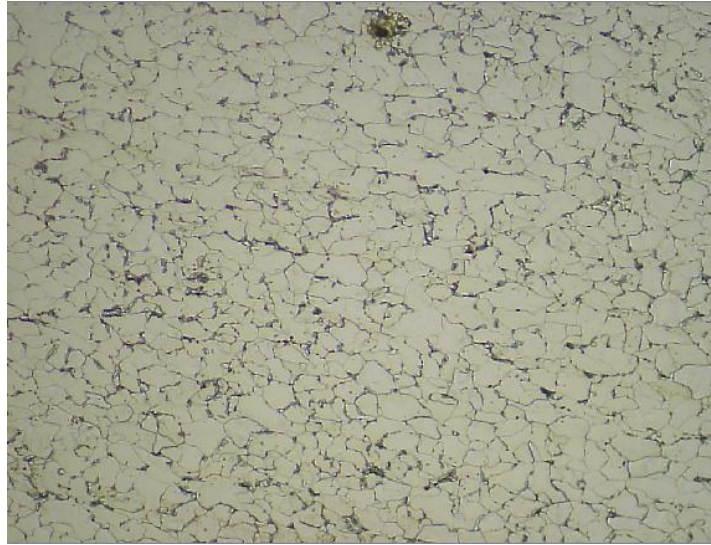


Figure 4: Example of an image containing grains to analyze.

III.1. Interface

A simple and user-friendly interface helps to detect and measure the granulometry and the grain sizes.

Grains size (ASTM E112)

Pre Processing

Automatic correction of lighting

Delete points

Threshold

Type de joints

Light

Dark

Scale

Minimum

Maximum

Joints threshold

16

254

Catch

Carbides threshold

0

77

Catch

Filtering

Minimal grains diameter

2

um

Disaggregation

Grains disaggregation

MEDIUM

Once the detection parameters are adjusted, **MetalloBox** presents the detected grains in overlay.

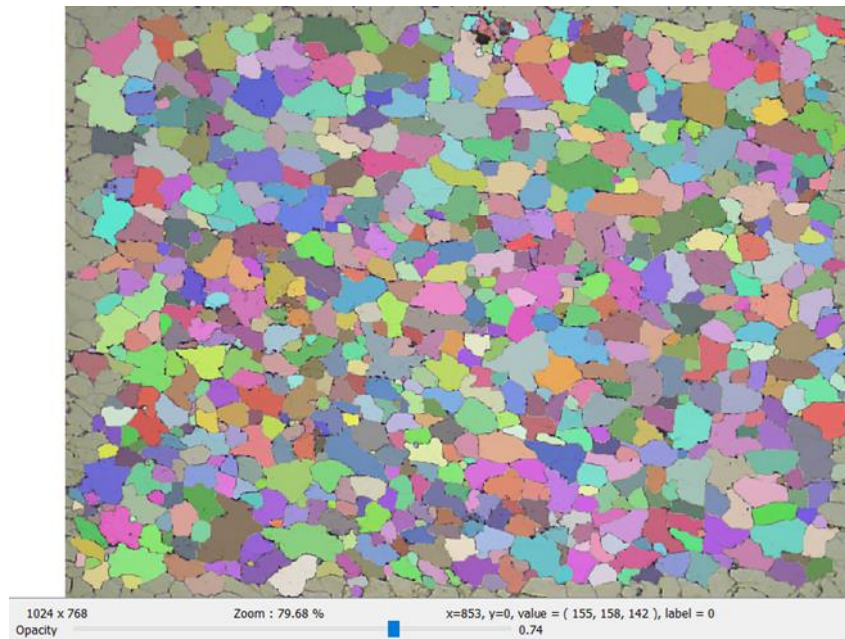


Figure 5: Overlay of segmented grains.

The slider below the image allows to change the overlay opacity.

III.2. Manual modifications



Figure 6: Options for grains segmentation modifications.

With **MetalloBox**, the user can manually modify the segmented grains. The proposed options are:

- Merge grains,
- Split grains,
- Draw and add a new grains,
- Remove grains

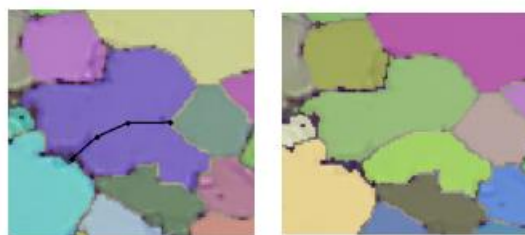


Figure 7: Left, drawing a separation line between two grains (black).
Right, result of this grains separation.

Once the segmentation is modified, the user can compute the measures on this new segmentation image.

III.3. Displaying the results

MetalloBox can accumulate measures for several images. The following table shows the analyzed surface, the ASTM index computed from the planimetric and the intercepts procedures, as well as the number of grains.

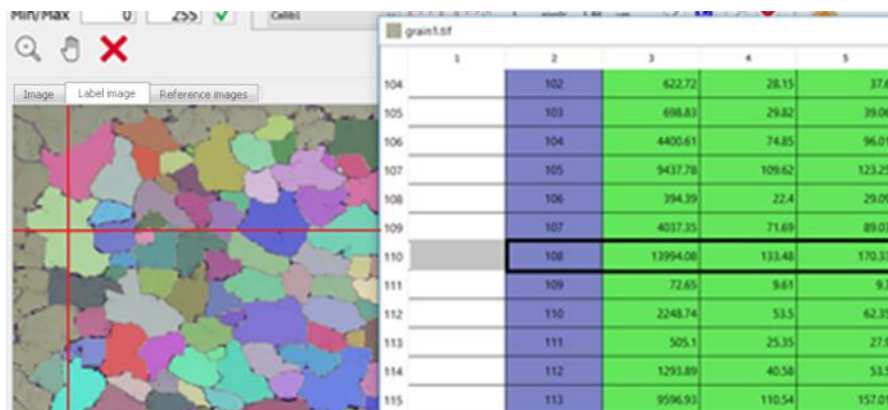
N° image	Image name	Surface analyzed (um ²)	Planimetry	Intercept	Grains number		
1	grain1.tif	786432	7.25	7.09	812		



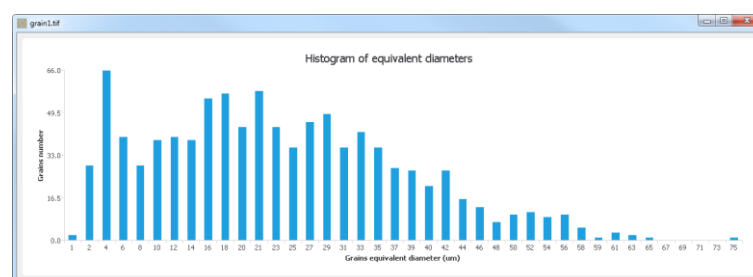
MetalloBox offers a way to visualize a complete measurement table as well as the associated statistics. Each line presents the measures applied on a segmented grain (surface, average diameter, perimeter, orientation, etc.):

Index	Area (um ²)	EqDiameter (um)	Length (um)
1	84	10.34	17.67
2	786	31.63	37.33
3	311	19.89	21.83
4	596	27.54	37.99
5	236	17.33	23.92
6	74	9.7	10
7	201	15.99	17.07
8	234	17.26	19.58
9	730	30.48	44.21

The table can interact with the image so that a grain is connected with its measures.



It is also possible to represent these results with histograms. For instance, the figure below illustrates the distribution of average diameters.



III.4. Visual comparison

Once the ASTM index is calculated, **MetalloBox** can display the reference board of this index, with an equivalent magnification, so that the user can validate the result produced by the software. The user can also visualize other index reference boards for a more accurate comparison.

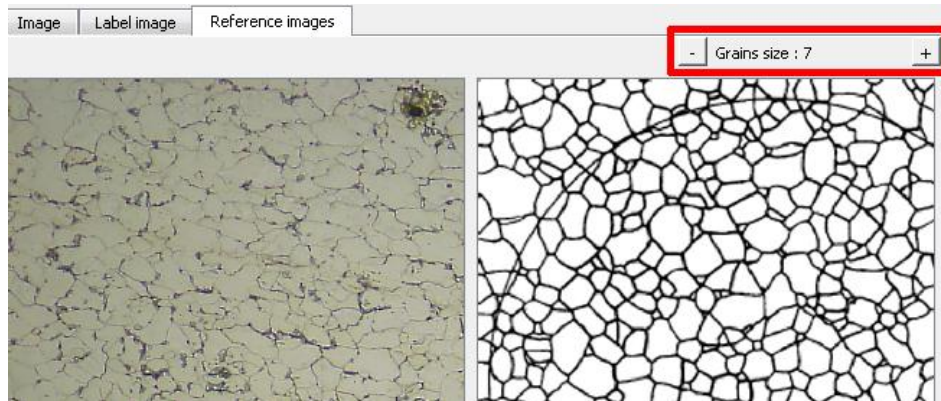


Figure 8: Visual comparison from reference boards.

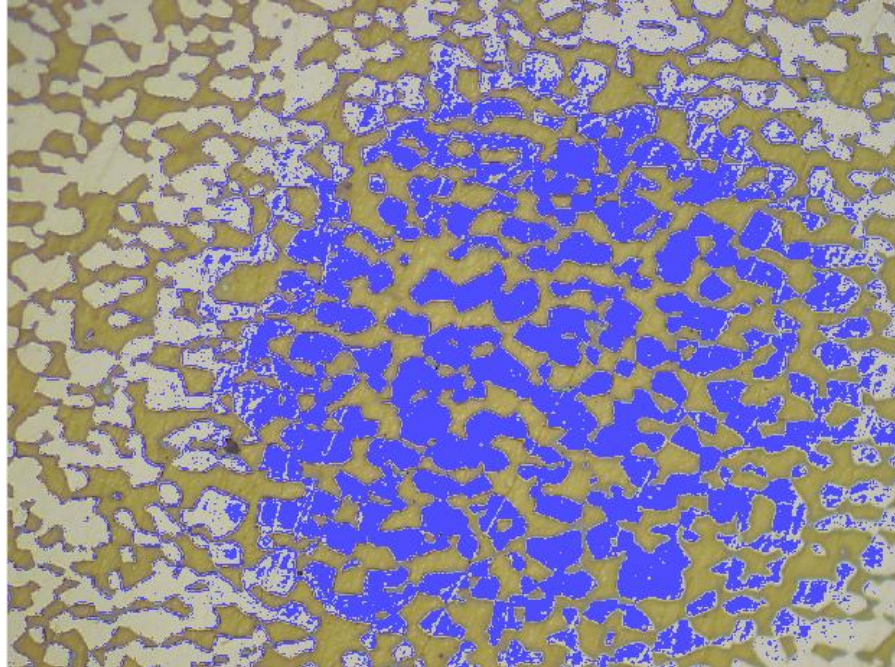
IV. Phases rate

The phase rate module allows to characterize various materials on an image. Once identified, these phases are measured and accumulated in a table

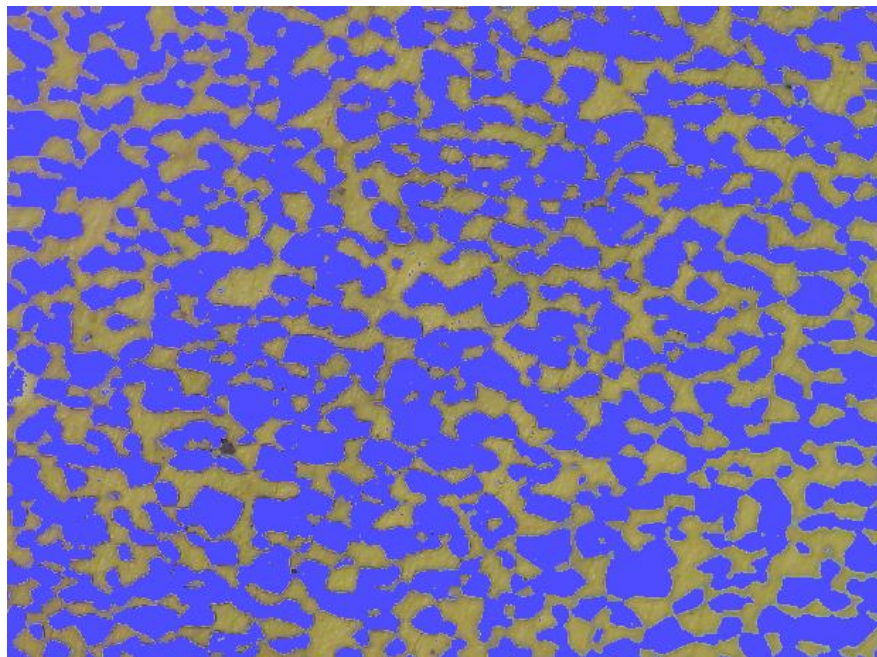


IV.1. Pre-process: Homogeneity correction

In several cases, a shading correction pre-process is needed. The lightning issue is particularly obvious in the following image.



Subtracting the background image allows to automatically smooth the intensities.



IV.2. Interface

A simple and user-friendly interface helps the user to define the phases and to quantify them for an image set.

Phase rate

Pre Processing

Automatic correction of lighting ☒

Threshold

Automatic threshold ☐

Number of phases 2 phases

	Name	Minimum	Maximum	
phase 1	Ferrite	170	254	Catch
phase 2	Austenite	0	170	Catch

Low spots closing 3

Post processing

Width of transitions to delete

MetalloBox can handle up to ten different phases.

IV.3. Displaying the results



The buttons under the configuration interface allow to launch the process either on the current image or on all the images opened in the software.

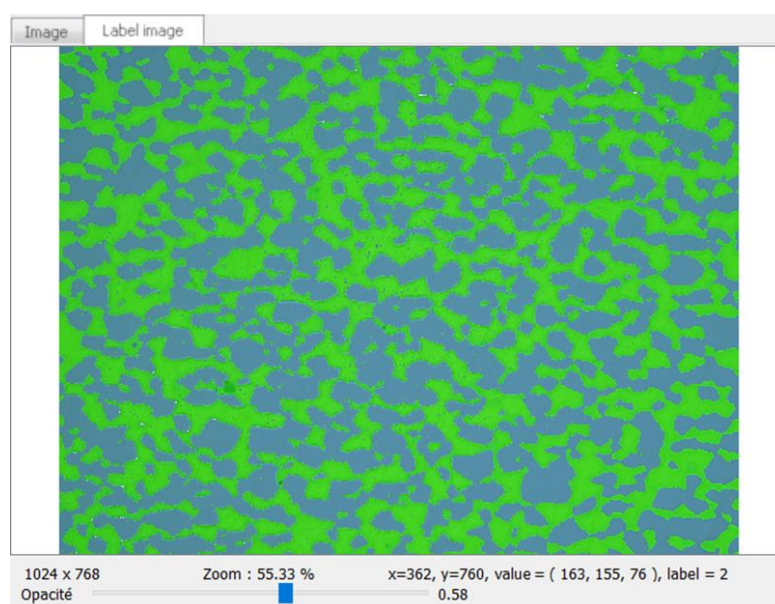


Figure 9: Example: detection of the two phases in the image.

MetalloBox can cumulate measures calculated for each image. The following table displays the analyzed surface for each phase:

N° image	Image name	Surface analyzed (um ²)	Ferrite		Austenite	
			Surface (um ²)	Percentage (%)	Surface (um ²)	Percentage (%)
1	fer_aust2.tif	3333492.04	1722320.32	51.66	1610747.83	48.32

If several images are processed, the statistics are automatically displayed in the table.

N° image	Image name	Surface analyzed (um ²)	Ferrite		Austenite	
			Surface (um ²)	Percentage (%)	Surface (um ²)	Percentage (%)
1	fer_aust2.tif	3333492.04	1722320.32	51.66	1610747.83	48.32
2	fer_aust3.tif	3333492.04	1895952.42	56.87	1428248.26	42.84
Min		3333492.04	1722320.32	51.66	1428248.26	42.84
Max		3333492.04	1895952.42	56.87	1610747.83	48.32
Mean		3333492.04	1809136.37	54.26	1519498.04	45.58
Sum		6666984.08	3618272.74	108.53	3038996.09	91.16

V. Complete management of a study

V.1. Multi-images management

MetalloBox can work either on independent images or with a project mode. In this latest situation, it is possible to load an entire set of images in order to process them within a same study. This makes it possible to easily reach the cumulated surface to fit each norm.

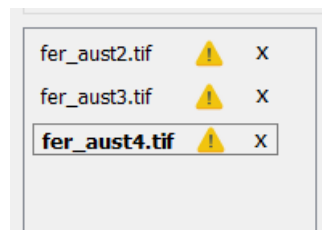
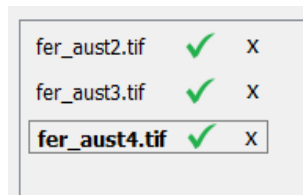


Figure 10: List of loaded images waiting to be processed.

V.2. Measures automation

Several process modes are available, particularly to impose the use of the same parameters for all the images, or, on the contrary, to allow a customized configuration.



A small window titled 'List of processed images' showing a table with three rows. Each row contains a filename, a green checkmark, and an 'X' in a box.

fer_aust2.tif	✓	X
fer_aust3.tif	✓	X
fer_aust4.tif	✓	X

Figure 11: List of processed images.

V.3. Saving the results

Once the measures are calculated, **MetalloBox** can save the entire study as a project. In this situation, all the resulting images are saved in a sub-directory in order to possibly control them in a second phase.

