



HADI – BGA

Operation Manual

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Contents

1. Introduction.....	4
1.1. Introduction	4
1.2. Basic Features	4
1.3. HADI Products Comparison.....	5
1.4. System Requirements.....	6
2. HADI Settings.....	7
2.1. Global Settings - General.....	7
2.2. Global Settings - Calibration	9
2.3. Template-based Inspection.....	10
3. Toolbars	11
3.1. Toolbar - FILE	11
3.2. Toolbar - VIEW.....	17
3.3. Toolbar - MEASURE	19
3.4. Toolbar - IMAGE	22
3.5. Toolbar - FILTERS	24
4. Inspection	34
4.1. BGA DETECTION.....	34
4.2. VOID INSPECTION	37
5. Getting Started	45
5.1. General	45
5.1.1. Working with Scenes	45
5.1.2. Multi-View Display	47
5.1.3. Image Loading Assistant	49
5.1.4. Exporting.....	49
5.1.5. Supported file formats.....	50

5.1.6.	HADI Terminology	50
5.1.7.	Improve Performance	50
5.2.	Automated and Template based Inspection	51
5.2.1.	Automated BGA Inspection	51
5.2.2.	Automated Void Inspection	55
5.2.3.	Create Template	57
5.2.4.	Image Calibration	58
5.3.	Dock Panels	60
5.3.1.	Templates	60
5.3.2.	Images	64
5.3.3.	MT Info	68
5.3.4.	MT Usage	71
5.3.5.	Histogram	76
5.3.6.	Voids	77
5.3.7.	Void Statistics	80
5.4.	Measurements	81
5.4.1.	Measurement Tools	81
5.4.2.	Closed Shapes	82
5.4.3.	Non-Closed Shapes	85

1. Introduction

1.1. Introduction

HADI-BGA is a Template-based inspection software.

You can use HADI - BGA as an Automated BGA Detection and Automated Void Inspection software.

It supports the following inspection features:

	Inspection Functions	Support
1	Template Management	YES
2	Automated BGA Detection	YES
3	Automated Void Inspection	YES
4	Inline Void Inspection	NO
5	Inline PCB Inspection	NO
6	Batch Processing Simulation	NO

Check for more information: [products comparison](#).

1.2. Basic Features

- Support various image formats to load and save. (GIF, BMP, JPG, TIF, TIFF, PNG, etc.)
- Support to load and save the image/scene.
- Support 16-bit images and Window/Level adjustment.
- Support image calibration.
- Support image histogram and profile.
- Support multiple languages. (Korean, English, Japanese and Chinese)
- Support up to 25 measurement tools.
- Support up to 14 images filters.
- Support command line invoke with various parameters.
- Advanced template management.
- Powerful reporting and printing functions.
- Support windows explorer integration.

1.3.HADI Products Comparison

Functions	HADI Inspection	HADI BGA	HADI Inspection Pro	HADI iBoard	HADI iBoard Pro
Image Import / Export	√	√	√	√	√
Scene Import / Export	√	√	√	√	√
Print Images	√	√	√	√	√
Image / Screen Cap- ture	√	√	√	√	√
Multiple Language Support	√	√	√	√	√
Measurement Tools	√	√	√	√	√
Image Filters	√	√	√	√	√
Image Calibration	√	√	√	√	√
Histogram and Profile	√	√	√	√	√
Multiple Image Display	√	√	√	√	√
16-bit image support	√	√	√	√	√
Image Conversion	√	√	√	√	√
Image Alignment	√	√	√	√	√
Command Line Support	√	√	√	√	√
Void Inspection	√	√	√		√
BGA Detection		√	√	√	√
Batch Processing Simulation			√	√	√
UDP Communication Support			√	√	√
PCB Inspection				√	√

1.4. System Requirements

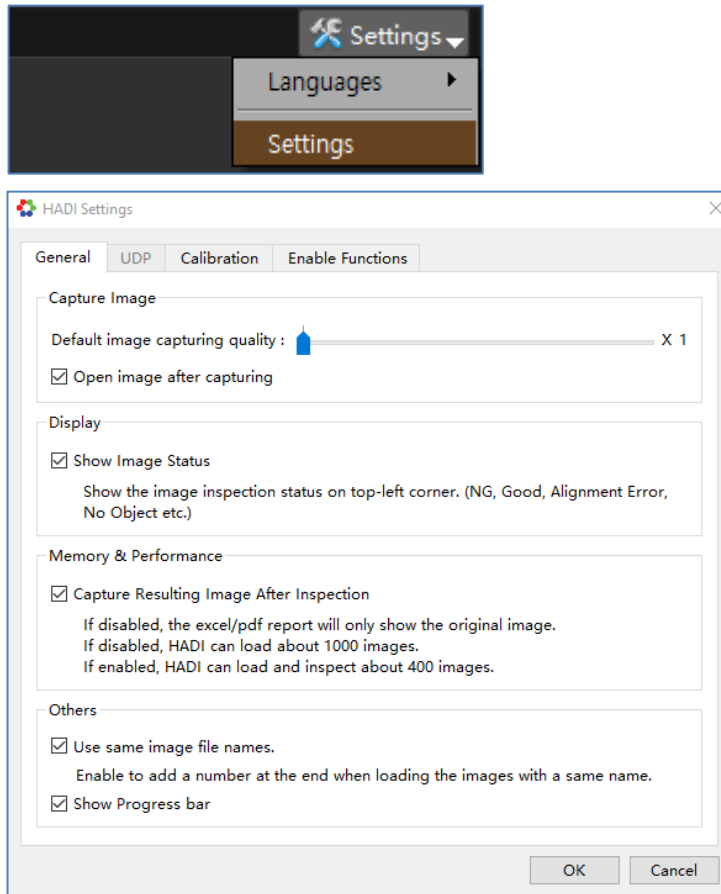
	Minimum	Recommended	Inline Inspection ^{*1}
OS	Windows 7 Windows 10 Pro	Windows 7 Windows 10 Pro	Windows 7 (64-bit) Windows 10 Pro (64-bit)
HDD	20GB	200GB	500GB or higher
SSD	None	128GB	128GB or higher
CPU	Intel i5	Intel i7	Intel i7 3.40 GHz or Higher
RAM	2 GB	4 GB	8 GB
GPU	none	extra GPU required	extra GPU required
Display Resolution	1920 x 1080	1920 x 1080	1920 x 1080
3 rd party applications	none	Microsoft Excel PDF Reader	Microsoft Excel PDF Reader
Network	none	required	required

^{*1}) Only for HADI-InspectionPro, HADI-iBoard, HADI-iBoardPro

2. HADI Settings

2.1. Global Settings - General

Click on top-right menu "Settings" -> "Settings" -> "General".



Capture Image

Default image capturing quality

Set the image capturing quality.

For example, "X3" means the captured image resolution is 3 x 3 = 9 times of original resolution.

Higher quality image capturing takes more time.

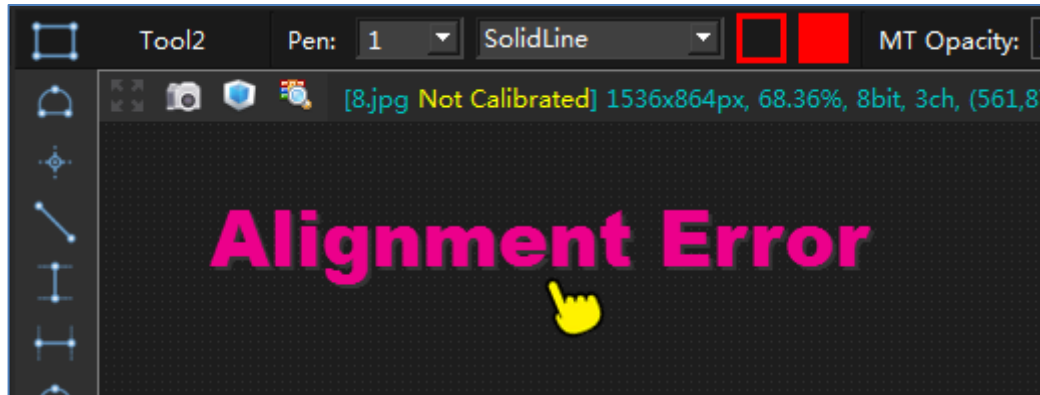
Open Image After Capturing

Open the captured image after capturing.

Display

Show Image Status

Show or hide the image status that appears on the top-left corner of main view.



Memory & Performance

Capture Resulting Image After Inspection

Set whether to capture the resulting image or not.

See the link "Improve Performance" for more information.

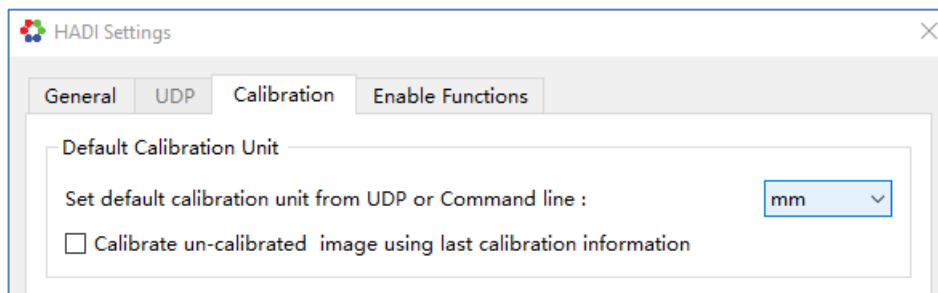
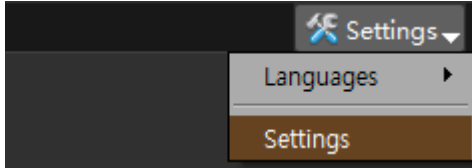
[Clear All] function

[Clear All] Function

If you set this option, the [Clear All] button will also clear the inspection result of the image.

2.2.Global Settings - Calibration

Click on top-right menu "Settings" -> "Settings" -> "Calibration".



Calibrate un-calibrated image using last calibration information

If you set this option, the last used calibration information will be used for calibration.

Default Calibration Unit

In UDP mode, you can send the UDP command for calibration from other application to HADI. It will be applied to the calibration setting of HADI. The default unit is millimeter. You can change the default unit using the unit combo box. Please see the following example for more information:

For example:

Suppose that you send the UDP (calibration) command "**image_name; 1.5**" to HADI.

- "1.5" means "1 pixel = 1.5 millimeter". (default unit = millimeter)
- If you change the default unit from "millimeter" to "**centimeter**", then "1.5" means "1 pixel = 1.5 **centimeter**"

2.3.Template-based Inspection

All HADI products support Template-based inspection.

Template Saves

The purpose to use template is to

- save all parameters of the image or the Measurement Tools.
- save the image alignment information.
- apply all saved parameters and Measurement Tools to a new image (to be inspected).

Template Auto Saving

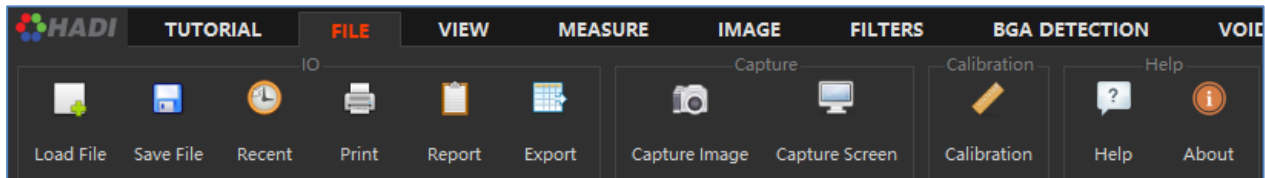
In a Template, all changes will be saved automatically, including

- Measurement Tool changes.
- Window/Level changes (for 16-bit image).
- Void Inspection parameter changes.
- BGA Detection parameter changes.

3. Toolbars

3.1. Toolbar - FILE

Click on the "FILE" tab to display the following toolbar:

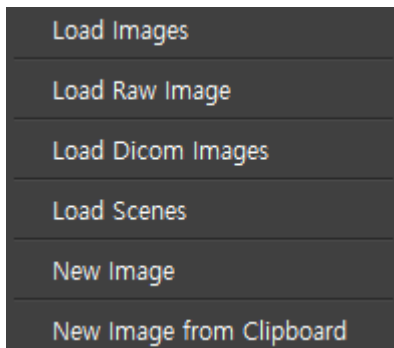


IO

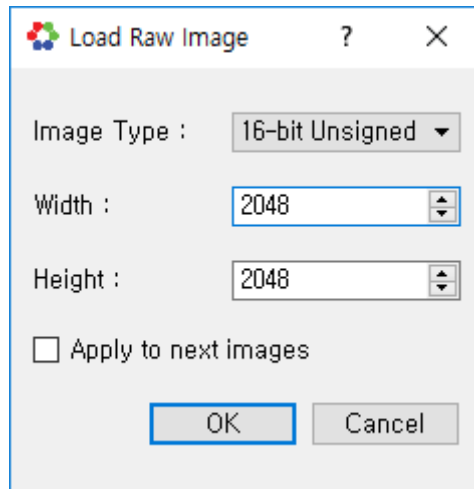
Load File

You can load image files into HADI using several ways.

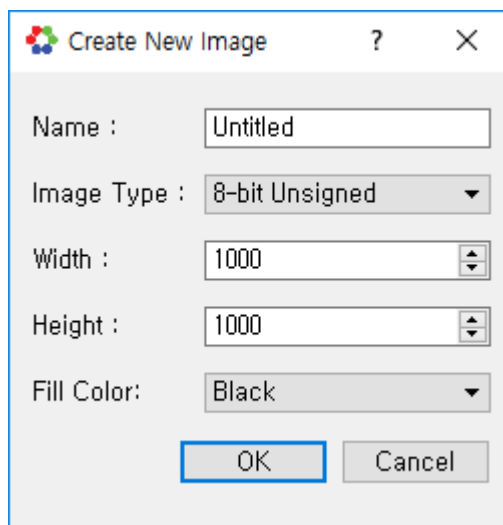
HADI maintains the path to the last used folder for images and scenes.



- **Load Images**
Load images such as PNG, XPM, JPG, BMP, GIF, TIF and TIFF.
- **Load Raw Image:**
Load a RAW format Images.
The following parameters will be shown in the next dialog window:
 - Image Type:** specify image types.
 - Width:** specify image width.
 - Height:** specify image height.
 - Apply to next images:** If you check this option, all of the above parameters apply to the next image when loading multiple raw images.



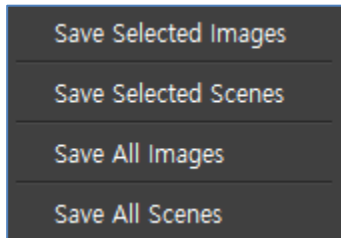
- **Load Scenes:**
Load a scene file.
You can save current scene as a XML file, and load it using this menu.
- **New Image**
Create a new image with the specified parameters.



- **New Image from Clipboard**
Create a new image from Clipboard.

Save File

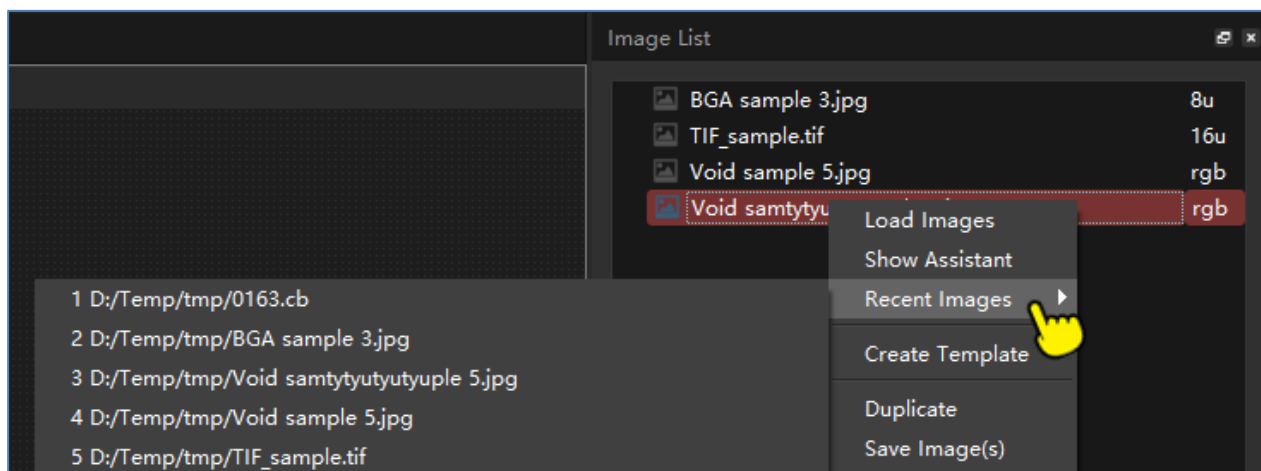
You can save images and scenes as files.



- **Save Selected Images**
Save selected Images in the image list panel.
- **Save Selected Scenes**
Save the selected images in the image list panel as scenes.
- **Save All Images**
Save all Images in the image list panel.
- **Save All Scenes**
Save all images in the image list panel as scenes.

Recent

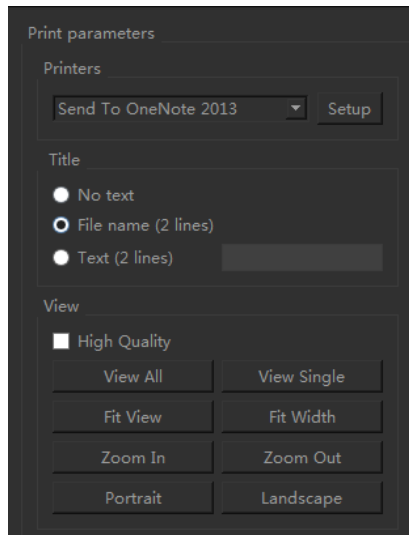
Displays recently used images and folders.



Print

Print the selected images.

You can insert the title of the image and print it in high quality.



Print parameters

Printers

Send To OneNote 2013 Setup

Title

☐ No text

☐ File name (2 lines)

☐ Text (2 lines)

View

☐ High Quality

View All View Single

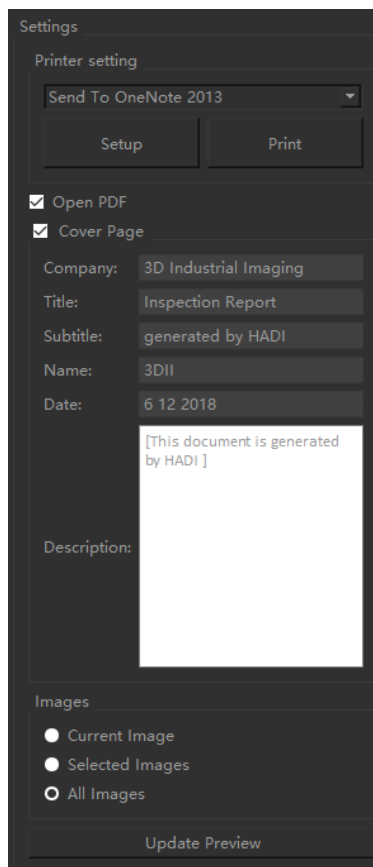
Fit View Fit Width

Zoom In Zoom Out

Portrait Landscape

Report

Generate a report for selected images.



Settings

Printer setting

Send To OneNote 2013

Setup Print

☒ Open PDF

☒ Cover Page

Company: 3D Industrial Imaging

Title: Inspection Report

Subtitle: generated by HADI

Name: 3DII

Date: 6 12 2018

Description:

[This document is generated by HADI]

Images

☐ Current Image

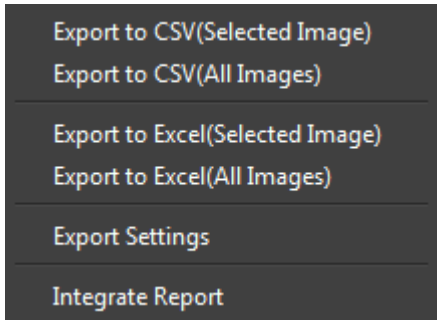
☐ Selected Images

☐ All Images

Update Preview

Export

Export information from images to a CSV or Excel file.



- **Export to CSV(Selected Image)**
Export the information of selected images to CSV file.
- **Export to CSV(All Images)**
Export the information of all images to CSV file.
- **Export to Excel(Selected Image)**
Export the information of selected images to MS-Excel file.
- **Export to Excel(All Images)**
Export the information of all images to MS-Excel file.
- **Export Settings**
See "Export Settings" in "MT Info" dock panel.
- **Integrate Report**
Display the report integrator dialog window.
- **Load**
Load the Excel files to integrate.
- **Save**
Integrate the loaded Excel files into one file.
- **Up**
Move up the selected rows in the file list.
- **Down**
Move down the selected rows in the file list.
- **Remove**
Remove selected files.
- **Clear**
Remove all files.

Capture

Capture Image

It saves the current image displayed in the view window.

- Click "Capture Image" in the Capture panel.
- Click the camera icon  on the top-left corner of any view.

You can also capture high-quality images.

Go to "Settings" -> "General" -> "Capture Image" to adjust the default image quality.

Capture Screen

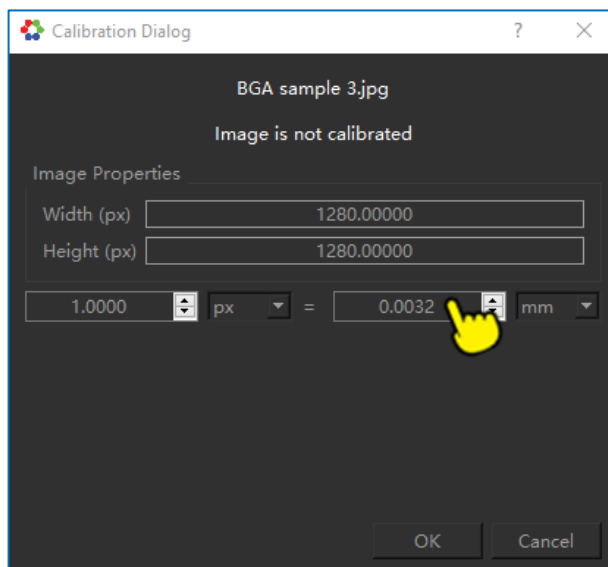
It captures the whole or part of the screen.

You can save the captured image or copy the captured image to the clipboard or HADI.

Calibration

You can calibrate the pixel unit to the actual unit.

See "Image Calibration" for more information.



Help

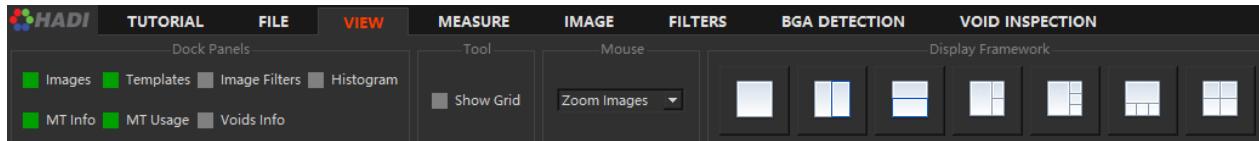
Open the operation manual.

About

Show the information such as product version, download link, etc.

3.2.Toolbar - VIEW

Click on the "VIEW" tab to display the following toolbar:



Dock Panels

Images

Shows or hides Images dock panel.

Templates

Shows or hides Templates dock panel.

Image Filters

Shows or hides Image Filters dock panel.

Histogram

Shows or hides Histogram dock panel.

MT Info

Shows or hides MT Info dock panel.

MT Usage

Shows or hides MT Usage dock panel.

Voids Info

Shows or hides Void Info dock panel.

Tool

Show Grid

Shows or hides a grid on the image.

Mouse

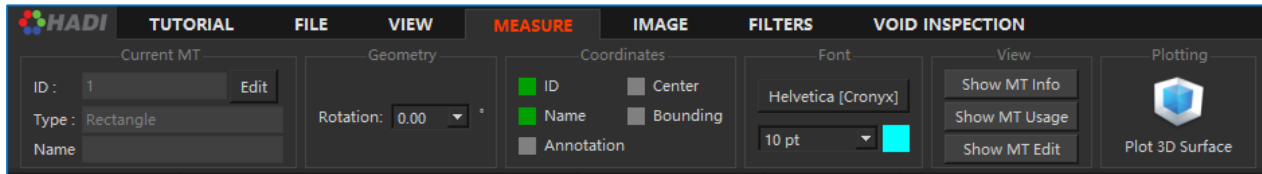
Set the function of the mouse wheel: "Zoom Images" or "Switch Images".

Display Framework

Set the display framework in the main workspace.

3.3.Toolbar - MEASURE

Click on the "MEASURE" tab to display the following toolbar:



[Note]: All the parameters apply to the selected Measurement Tools

Current MT

ID

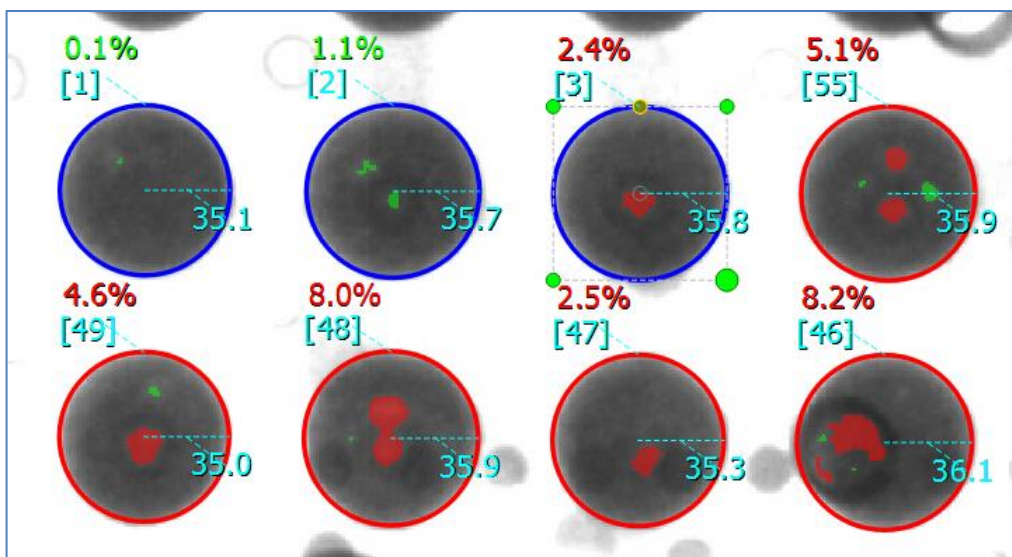
Identification (ID) of the selected Measurement Tool (Hereinafter referred to as "MT").

Edit

You can change the ID of Measurement Tools.

1. Select a MT in the active view.
2. Click "Edit" button, then the MT color changes to red.
3. Click MT in the order in which you want to reassign the ID number. The IDs are reassigned sequentially from 1. The MTs that have been assigned are displayed in blue.
4. Once you have clicked on all MTs, the editing will automatically end.

To finish editing on the way, click the "Finish" button to finish editing.



Type

The type of MT you have selected, such as lines, rectangles, circles, polygons, and so on.

Name

The name of MT you have selected.

The default value is empty. Type a name and press "Enter" key.

Geometry

Rotation

The rotation angle to rotate the MTs you have selected.

You can select multiple MTs and rotate them simultaneously.

The range of angle: -180° (counterclockwise) $\sim 180^{\circ}$ (clockwise).

Coordinates

Set to show or hide the coordinate information and label of the selected MT.

ID

Set to show or hide the ID of the selected MT.

Name

Set to show or hide the name of the selected MT.

Annotation

Set to show or hide the default annotation of the selected MT.

Center

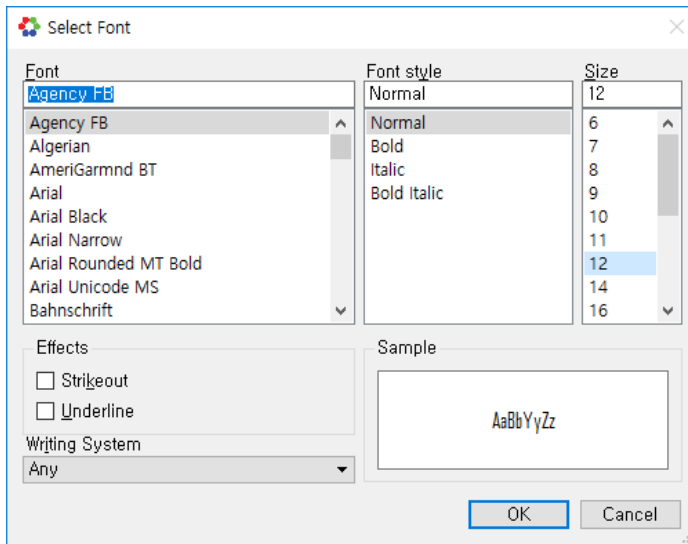
Set to show or hide the center coordinates of the selected MT.

Bounding

Set to show or hide the vertex coordinates of the selected MT.

Font

You can set the font type, size, and color for the selected MT.



View

Show MT Info

Show Measurement Tool Info dock panel.

Show MT Usage

Show Measurement Tool Usage dock panel.

Show MT Edit

Show Measurement Tool Edit dock panel.

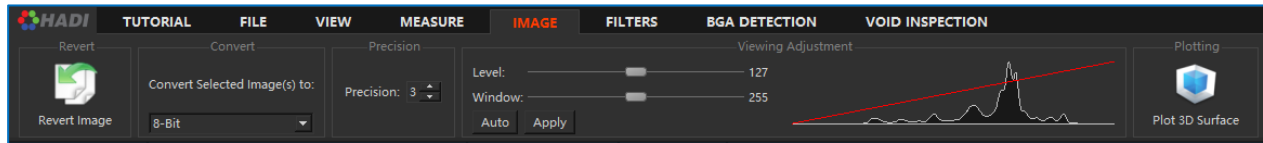
Plotting

Plot 3D Surface

Display the 3D plotting window of the selected closed-shape Measurement Tools.

3.4.Toolbar - IMAGE

Click on the "IMAGE" tab to display the following toolbar:



Revert

Revert Image

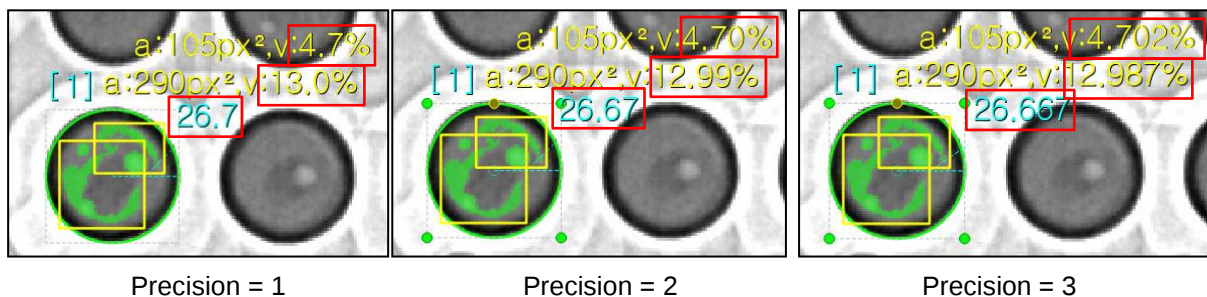
Reload the image from the original file and all changes are discarded.

Convert

Same as Conversion filter. You can use this to convert images to 8-bit, 16-bit, or RGB.

Precision

You can set the number of decimal places for the selected MT.



Viewing Adjustment

Level

Adjust the view level of the current image.

Window

Adjust the viewing window of the current image.

Auto

Automatically adjust the level and window of the current image.

Apply

Apply the current value of level and window to the current image.

Histogram

Display the histogram of the current image.

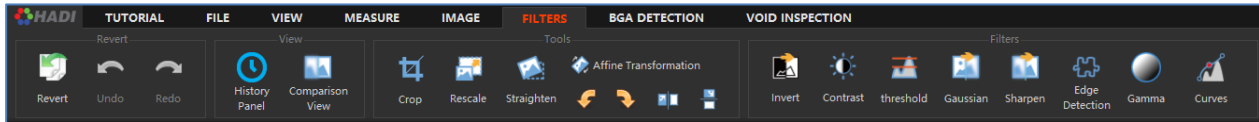
Plotting

Plot 3D Surface

Display the 3D plotting image of the current image.

3.5.Toolbar - FILTERS

Click on the "FILTERS" tab to display the following toolbar:



Revert

Revert

Reload the image from the original file and all changes (Undo/Redo history) are discarded.

Undo

Undo and revert the previous user action.

Redo

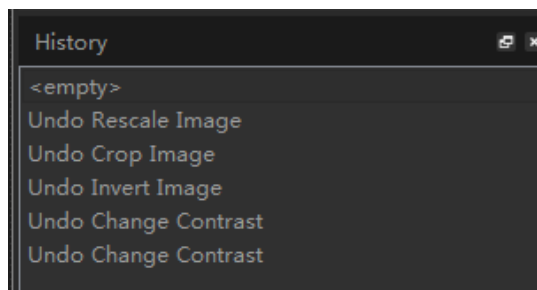
Run the previous undo operation again.

View

History Panel

HADI records the operation history of the image filters.
You can roll back to previous state using "History" panel.

Click one of the history states in the "History" panel to roll back.



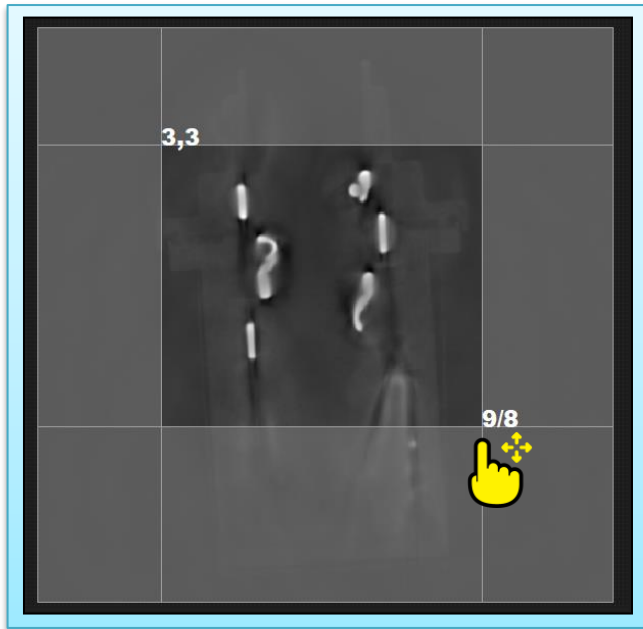
Comparison View

When you click this button, half of the current image is applied to the image filter.
Therefore, you can compare the previous and future images.

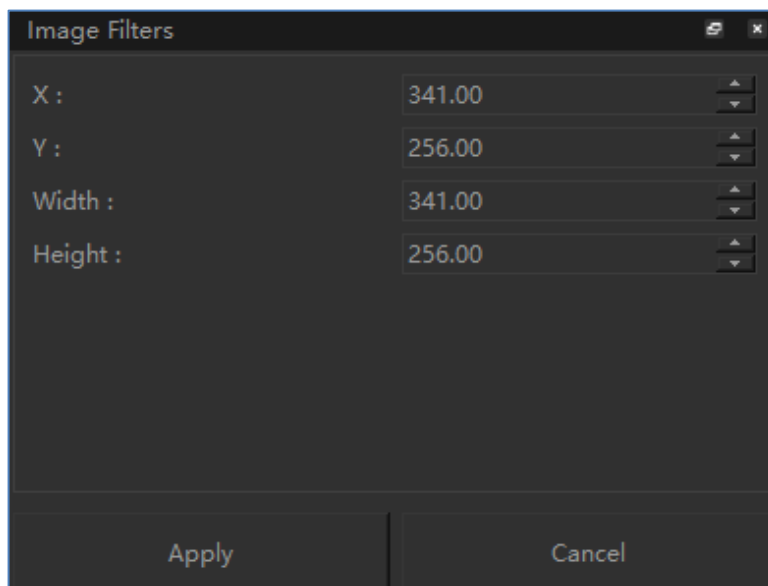
Size

Crop

This tool crops the image.



You can crop the image using the mouse drag or by entering coordinate values, width, and height.



- You can set a new top-left position by clicking around the current top-left position.
- You can set a new bottom-right position by clicking around the current bottom-right position.

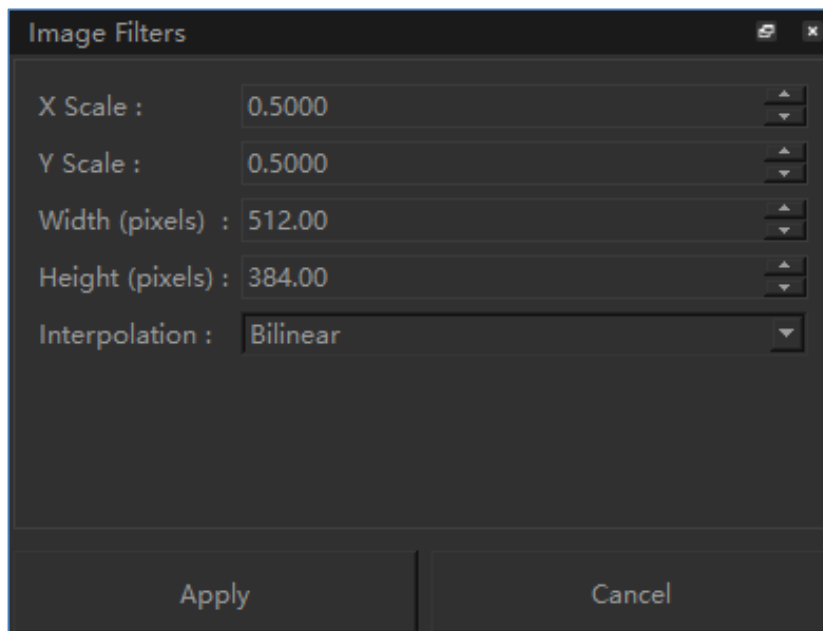
Rescale

This tool rescales the image.



The rectangle area shows the preview image when rescaled.

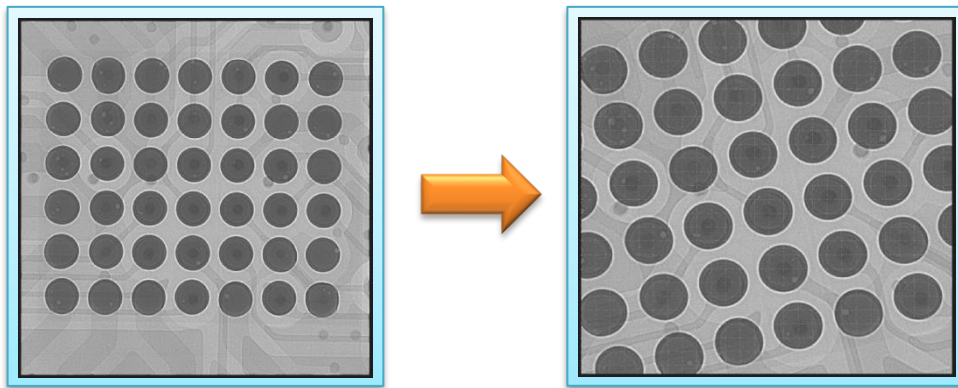
- You can rescale the image using the mouse at the hover points.
- You can rescale the image by entering scale ratio, width, height and interpolation.



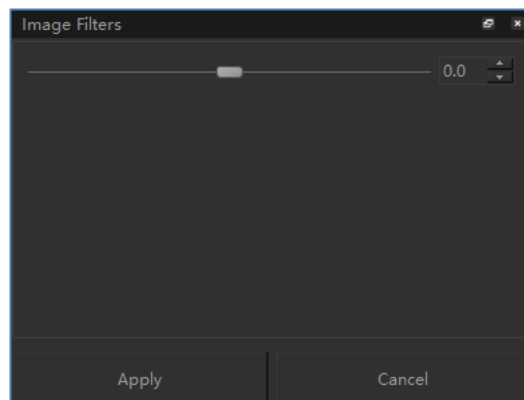
Adjustment

Straighten: the rotation and scale change slightly.

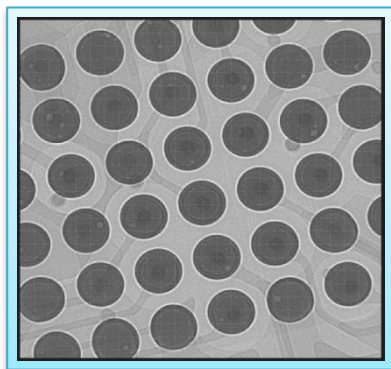
This function slightly changes the rotation and scale of the image.



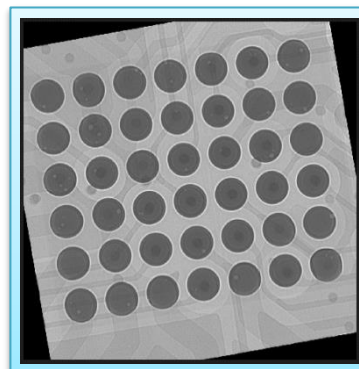
- You can use the weight parameter to straighten the image.



The difference between "Rotation" and "Straighten" is that "Straighten" rotates the image and slightly rescale it to avoid the black border area.



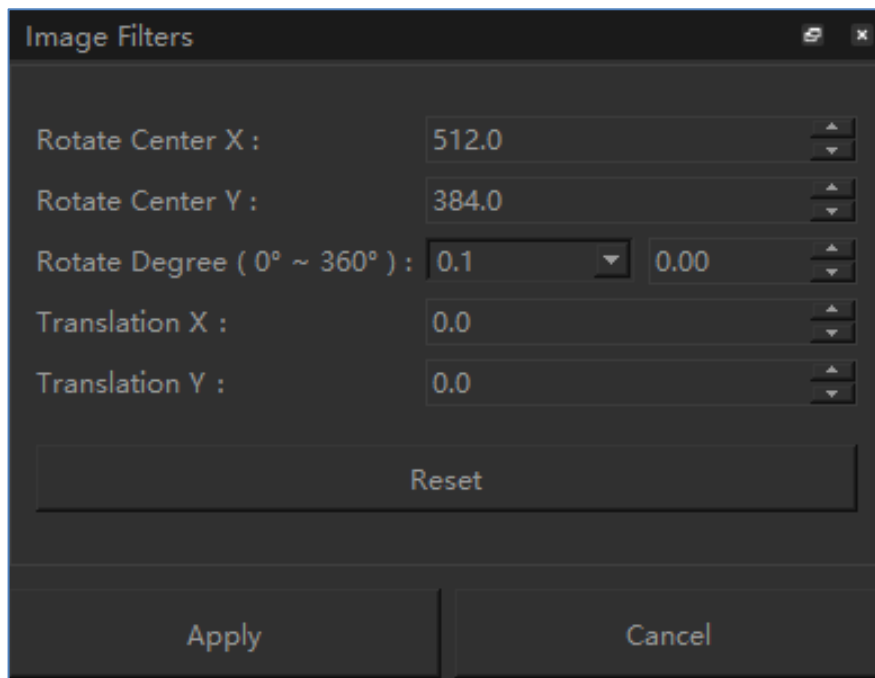
Straighten



Rotation

Affine Transformation

You can use several parameters for “Affine Transformation” as shown below:

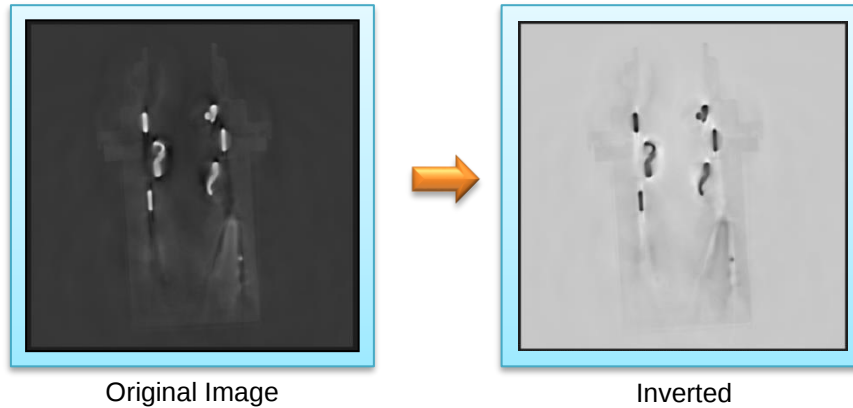


- You can rotate the image 90 ° clockwise or counterclockwise.
- You can define the axis of rotation by adjusting the “Rotate Center X” and “Rotate Center Y”.
- You can rotate the image by setting the “Rotate Degree”.
- You can zoom in and out the image by adjusting the “Image Scale”.
- You can use "Translation X" and "Translation Y" to move the image in the x or y direction for a specified number of pixels.

Filters

Invert

This filter inverts the current image.

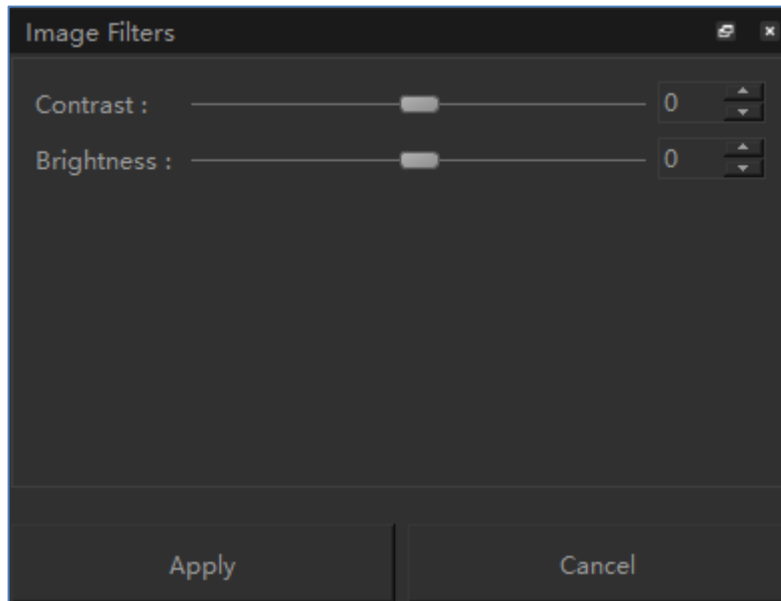


Contrast

Auto Contrast: automatically adjust the contrast and brightness of the current image.

Contrast: adjust the contrast of the current image.

Brightness: adjust the brightness of the current image.



Threshold

This filter applies the threshold to the current image.

The "Threshold value" adjusts the pixel value of the current image by converting the value to a black or white value. Pixel values smaller than "Threshold value" are changed to 0 (=black).

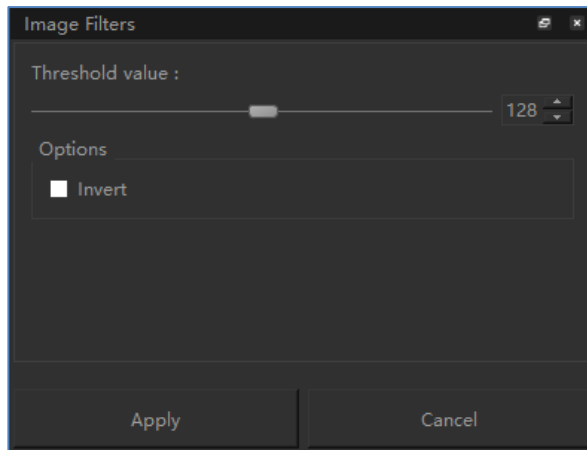
The "Thresholded value" is used together with the "Binary" option (checked):

- If the pixel value is smaller than "Threshold value", the pixel value will be changed to 0 (black).
- If the pixel value is larger than "Threshold value", the pixel value will be changed to "Thresholded value".

"Binary": This changes the current image to binary image (black and white).

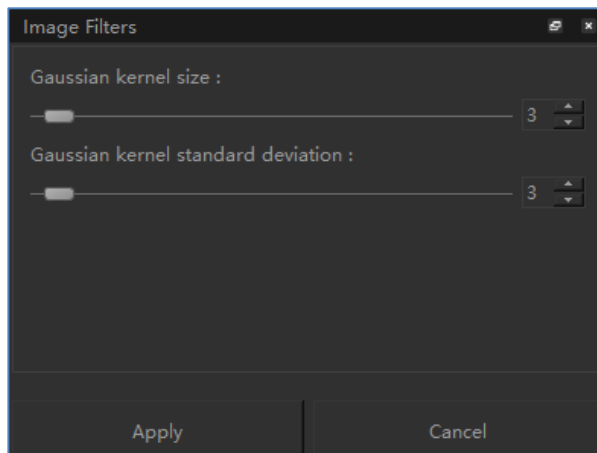
This is used together with the "Thresholded value".

"Invert": Inverts the current image.



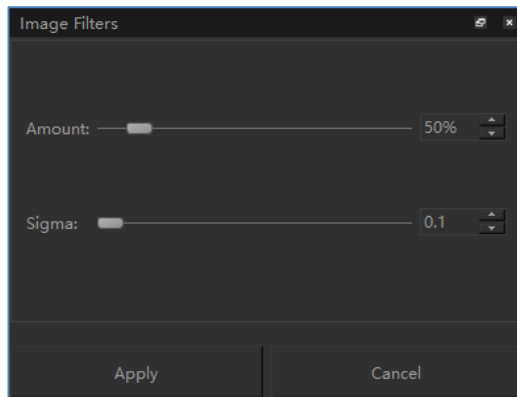
Gaussian

Use the Gaussian filter to blur the current image.



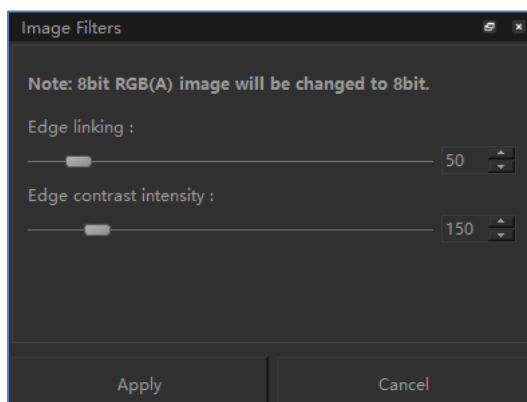
Sharpen

Sharpen the current image.



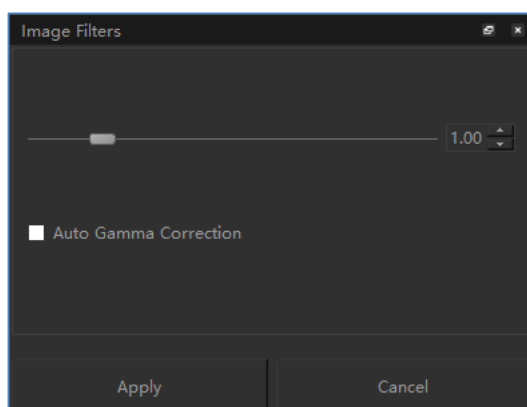
Edge Detection

Find edges in the current image.



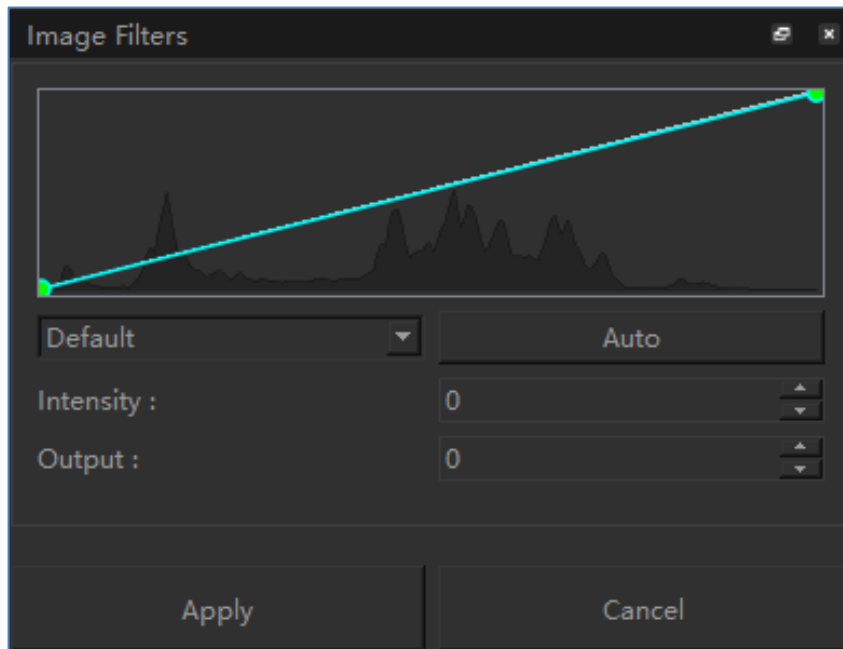
Gamma

You can adjust how an image is displayed on the monitor.
This filter adjusts only the dark tones.



Curves

You can use the curved brightness control as shown below:

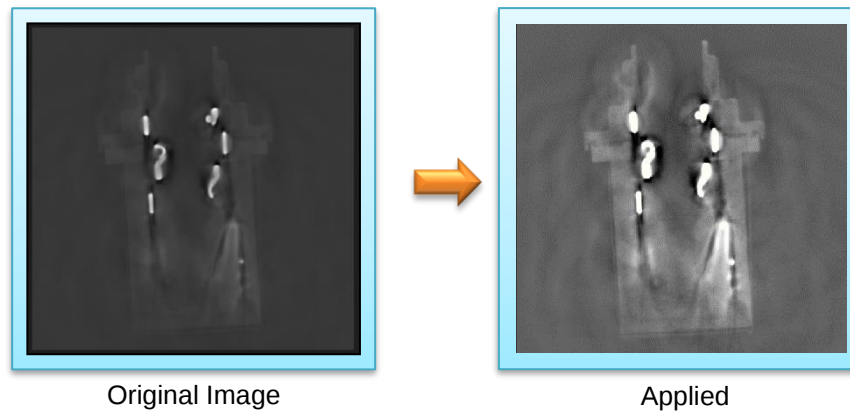


Initially, the intensity of the image is displayed on a graph with a straight diagonal line.

- You can select various image processing algorithms.
- When you click a line, the adjustment point is added to the line. If you move the adjustment point to change the shape of the curve, the image changes.
 - ✓ Moving the adjustment point at the top of the curve adjusts the bright area of the image.
 - ✓ Moving the adjustment point in the middle of the curve adjusts the middle area of the image.
 - ✓ Moving the adjustment point at the bottom of the curve adjusts the dark area of the image.
 - ✓ To darken the bright area, move the adjustment point at the top of the curve down.

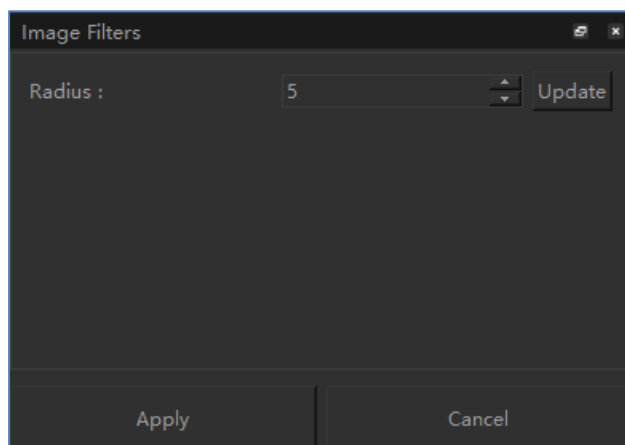
Auto Contrast

This filter automatically adjusts the contrast and brightness of the current image.



Local Thresholding

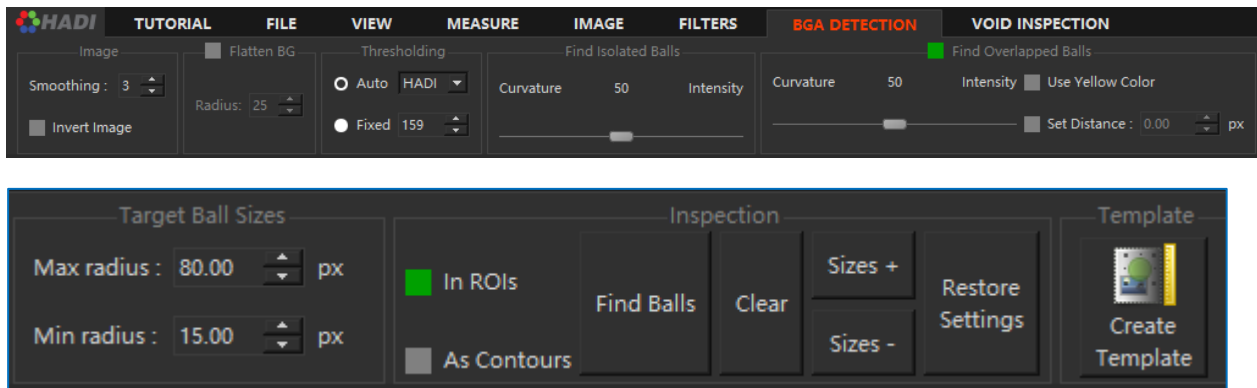
You can set the radius of the local domain over which the threshold will be applied. This filter does not support the 16bit an RGB(A) format.



4. Inspection

4.1. BGA DETECTION

Click on the "BGA DETECTION" tab to display the following toolbar:



Image

Smoothing

Set the number of Gaussian smoothing iterations. The default value is 3.

Invert Image

In general, HADI detects black balls on white background.

Check this option if you want to detect white balls on black background.

Flatten BG

If the background is not flat, use this option.

Radius

The radius is usually set to twice the diameter of the ball.

Thresholding

Auto

HADI: Default value. You can use this option in most cases.

OSTU: You can use this option in some cases.

Fixed

The value of "Auto" may not be operated correctly in a noisy image.

You can set a value of thresholding using this option.

If you change this parameter, the image gets an overlay to show the segmentation area.

Find Isolated Balls & Find Overlapped Balls

Two slider bars in the "Find Isolated Ball" and "Find Overlapped Ball" are designed for finding balls as contour.

The contour shape will be changed slightly depending on the curvature and intensity values.

Normally, you don't need to change these parameters (default value=50).

For more information, see the tutorial "BGA Detection".

Target Ball Sizes

You can use this option to define the radius size of the ball you are finding.

It is very important to define the radius range of a BGA ball to get more accurate result.

Set the minimum and maximum radius size of the ball.

Default values:

Minimum radius = 15 pixels

Maximum radius = 80 pixels

If the radius of ball to find is greater than 80 pixels (default), you must change the value of "Max radius".

To measure a size of ball, you can use Line Tools.

Inspection

In ROIs

Insert a rectangle tool in the image and set it as "Tool3 (BGA Detection)".

Check "In ROIs" option.

HADI will find balls only in the ROI.

As Contours

If you check this option, HADI will show you the balls as Polygon (Contour).
If you uncheck this option, HADI will show you the balls as Circle.

Find Balls

Click this button to find the balls.
It will first remove all the detected balls, and then find out balls with current parameters.

Clear

Click this button to remove all the detected balls.

Size+

Increase the radius size of all balls selected in the ROI by one.

Size-

Decrease the radius size of all balls selected in the ROI by one.

Restore Settings

Restore all parameter settings to their default values.

Template

You can create a template with current image and its parameters.

For more information, see the tutorial "Template".

Selected MTs

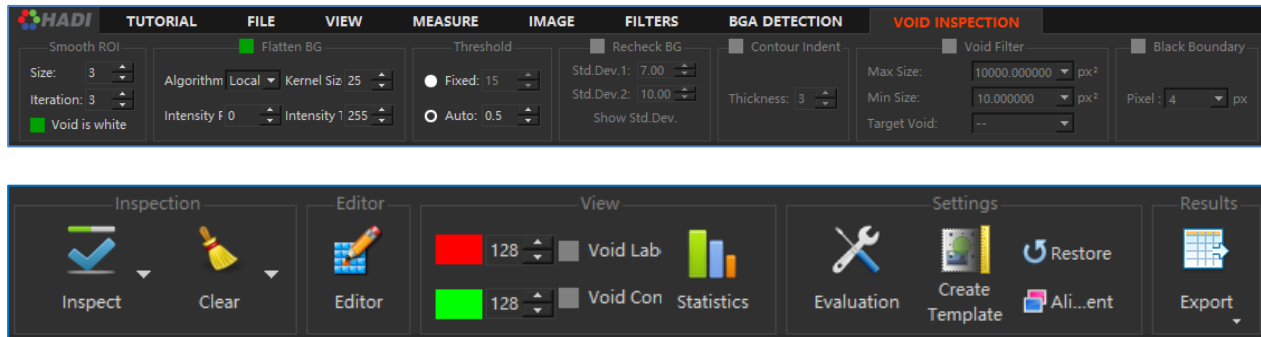
Insert measurement tools (rectangles, polygons, and circles) as ROIs in the image.

Check "Set as Mask Area" option, and then HADI will set all selected ROIs as mask areas.

HADI will not find the ball in these masks ROI.

4.2.VOID INSPECTION

Click on the "VOID INSPECTION" tab to display the following toolbar:



Note: Only the closed-shape Measurement Tools can be used for "Void Inspection".

Smooth ROI

Smooth the ROI with Gaussian smoothing algorithm.

Size and Iteration:

Set the Gaussian kernel size and smoothing iteration.

Void is white

By default, HADI looks for void objects that are brighter than the background. Disable this option to find void objects that are darker than the background.

Flatten BG

Flatten BG (background) makes the background flat.

Kernel Size

Set the maximum width or height of a void.
At the maximum void of the ROI, the larger of the width and height is the **Kernel Size**.

Intensity From

The start value of intensity to which the void inspection is applied.
HADI ignores surrounding pixels whose intensity value is less than "Intensity From".

Intensity To

The end value of intensity to which the void inspection is applied.
HADI ignores surrounding pixels whose intensity value is greater than "Intensity To".

Threshold

The threshold process is used to separate the foreground and background of an image.

Fixed

You can define a fixed value.
When "Flatten BG" is applied to an image, the range of pixel values starts at zero and the threshold is applied to the flattened image.
Normally, values between 4 and 20 are used.

Auto

Dynamic threshold values are applied to each ROI. A floating-point value is used.
If you increase "Auto" value, it fine-tunes the segmentation more.
If you decrease "Auto" value, the segmentation areas are expanded.

Recheck BG

Recheck BG is used to detect the void of the outer part connected to the outside.

Show Standard Deviation

The standard deviation value of the selected ROI is displayed.

Standard Deviation 1

Usually set to a value less than the standard deviation.

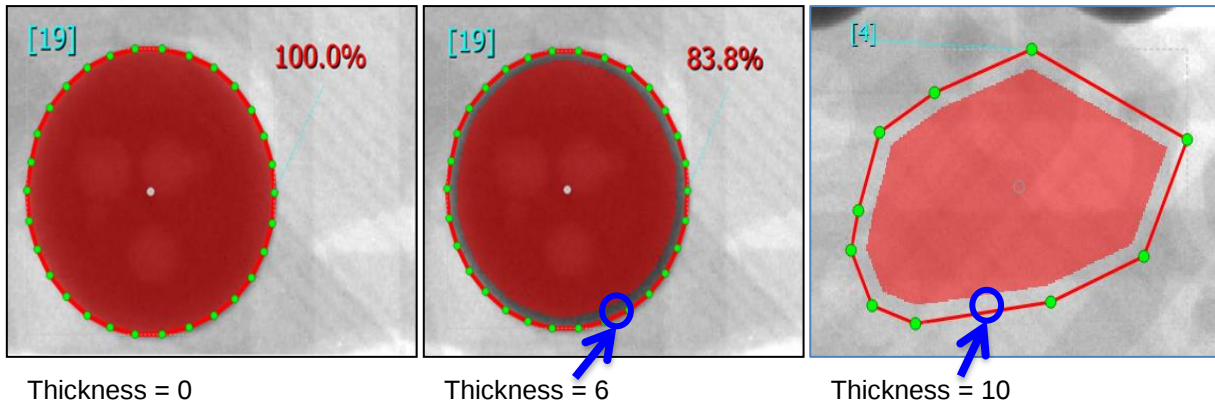
Standard Deviation 2

Usually set to a value greater than the standard deviation.

Exception: If the area of the outer pore is large, the standard deviation 2 is gradually decreased.

Contour Indent

You can define areas to exclude from the inspection.
The "Thickness" option is the pixel indented at the boundary of the MT (measurement tool).
The indented area is excluded from the inspection.



Void Filter

You can specify the size of the void you want to find in the ROI.

Max Size

Set the maximum void area in the selected MT (measurement tool).
If a void area is greater than this value, the void is excluded.

Min Size

Set the minimum void area in the selected MT (measurement tool).
If a void area is less than this value, the void is excluded.

Black Boundary

You can use this option if the void in the ROI is not in the form of a closed curve.



Example:

The gray area of the ROI is a void, but it is not a closed curve.

Inspection

Inspect

Run a void inspection on the current image.

Clear

Clear

Clear inspection results and ROIs in the current displayed image. [Keeping the alignment result]

Clear All

Clear inspection results and ROIs in the current displayed image. [Going back to the original image]

Clear Result

Clear inspection results in the current displayed image. [Keeping the alignment result]

Editor

Editor

You can edit voids in the ROI.
When you click this, the popup window is appeared.

View

The void inspection will result in "Defect (NG)" or "Non-Defective (GOOD)" depending on the evaluation settings.

Defects Color

You can set the colors and transparency value for "Defect (NG)" state.

Non-Defects Color

You can set the colors and transparency value for "Non-Defect (GOOD)" state.

Void label

Click this button to display the information of void.

Void Contour

Click this button to display the void as outline.

Note: This option applies to all voids of the entire ROI in the current image.

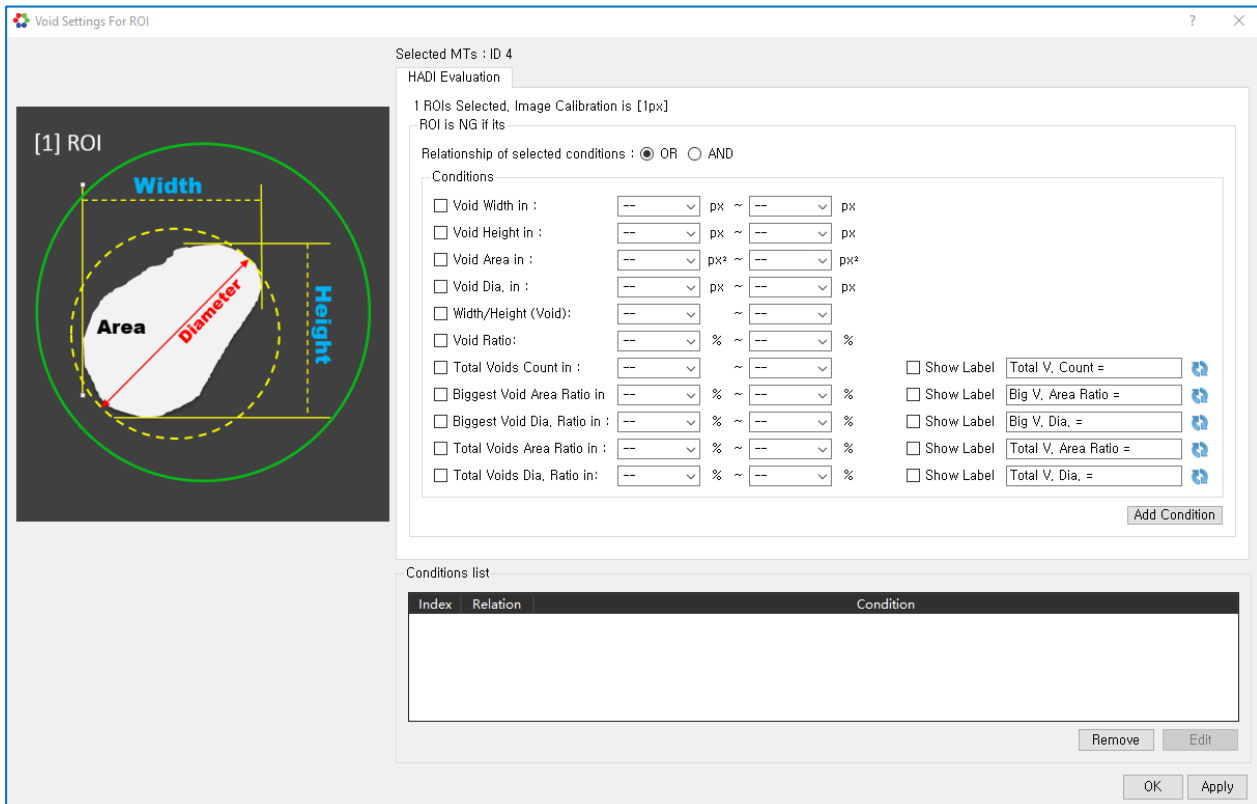
Statistics

Display the Void Statistics Plotting dock panel.

Settings

Evaluation

You can define the NG conditions of a ROI for void inspection.
The setting applies to all selected MTs (measurement tool).
There are several conditions for NG.



Void Width in

If the void width is within this range, the selected tool and current image are NG.
The void is indicated by Defect Color.
The border line of the tool is indicated by Defect Color.

Void Height in

If the void height is within this range, the selected tool and current image are NG.
The void is indicated by Defect Color.
The border line of the tool is indicated by Defect Color.

Void Area in

If the void area is within this range, the selected tool and current image are NG.
The void is indicated by Defect Color.
The border line of the tool is indicated by Defect Color.

Void Dia. in

If the void diameter is within this range, the selected tool and current image are NG.
The void is indicated by Defect Color.
The border line of the tool is indicated by Defect Color.

Width/Height (Void)

If the value of void width/height is within this range, the selected tool and current image are NG.
The void is indicated by Defect Color.
The border line of the tool is indicated by Defect Color.

Void Ratio

If the void ratio is within this range, the selected tool and current image are NG.
The void is indicated by Defect Color.
The border line of the tool is indicated by Defect Color.

Total Voids Count in

If the total void count of the selected ROI is within this range, the selected tool and current image are NG.
The border line of the tool is indicated by Defect Color.

Biggest Void Area Ratio in

If the area ratio of the biggest void in the selected ROI is within this range, the selected tool and current image are NG.
The biggest void is indicated by Defect Color.
The border line of the tool is indicated by Defect Color.

Biggest Void Dia. in

If the diameter of the biggest void in the selected ROI is within this range, the selected tool and current image are NG.
The biggest void is indicated by Defect Color.
The border line of the tool is indicated by Defect Color.

Total Voids Area Ratio in

If the area ratio of the total void in the selected ROI is within this range, the selected tool and current image are NG.
The border line of the tool is indicated by Defect Color.

Total Voids Dia. in

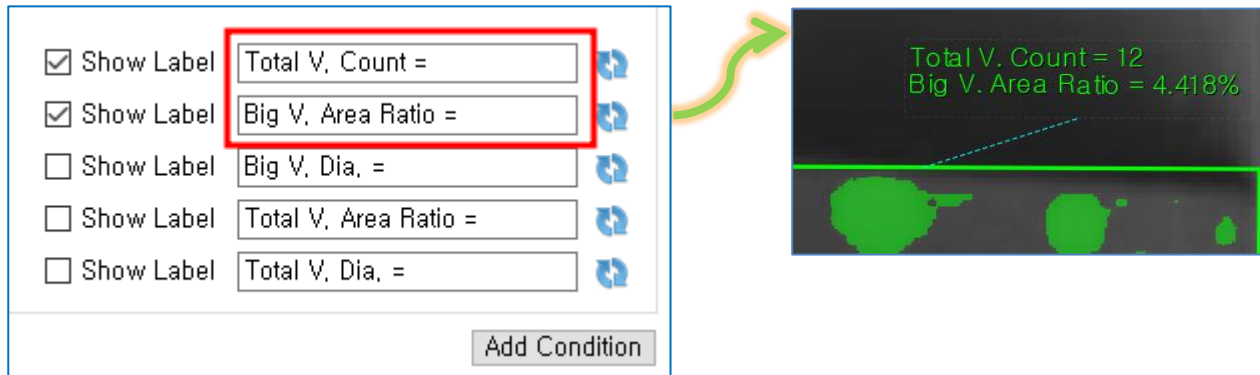
If the diameter of the total voids in the selected ROI is within this range, the selected tool and current image are NG.
The border line of the tool is indicated by Defect Color.

Conditions

After setting the evaluation condition, click the **[Add Condition]** button and it will be added to the condition list.
You can add more than one condition.
The relationship between the added conditions is OR.
To remove a condition from the condition list, click the **[Remove]** button.

Show Label

Display the annotation prefix of the condition in the MT (measurement tool).



Reset "Show Label"



If you want to re-enter the default values for the "Show label", click this button to bring up the original values.

Create Template

Create a Template using the currently displayed image.

Alignment

The "Image Alignment" dialog is displayed.

Show the Alignment settings for the selected template.

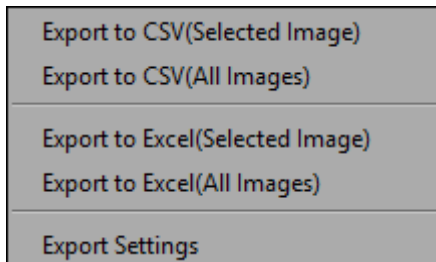
Restore Parameters

Restore the void inspection parameters of the selected MT to their default values.

Results

Export

Exports information about all or selected images.



- Export to CSV format (Selected Image)
- Export to CSV format (All Images)
- Export to Excel (Selected Image)
- Export to Excel (All Images)
- Export Settings

See "Export Settings" in the "MT Info" dock panel.

5. Getting Started

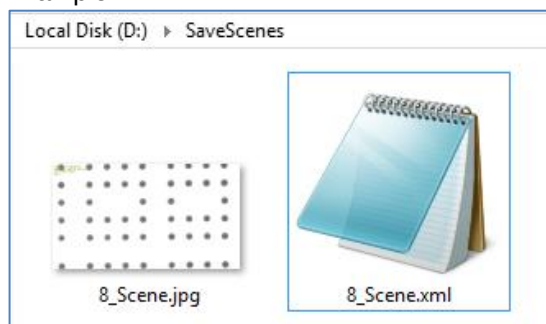
5.1.General

5.1.1. Working with Scenes

You can save current scene as a XML file, and load it in the HADI later.

The image is saved with the same name as the XML file.

Example:



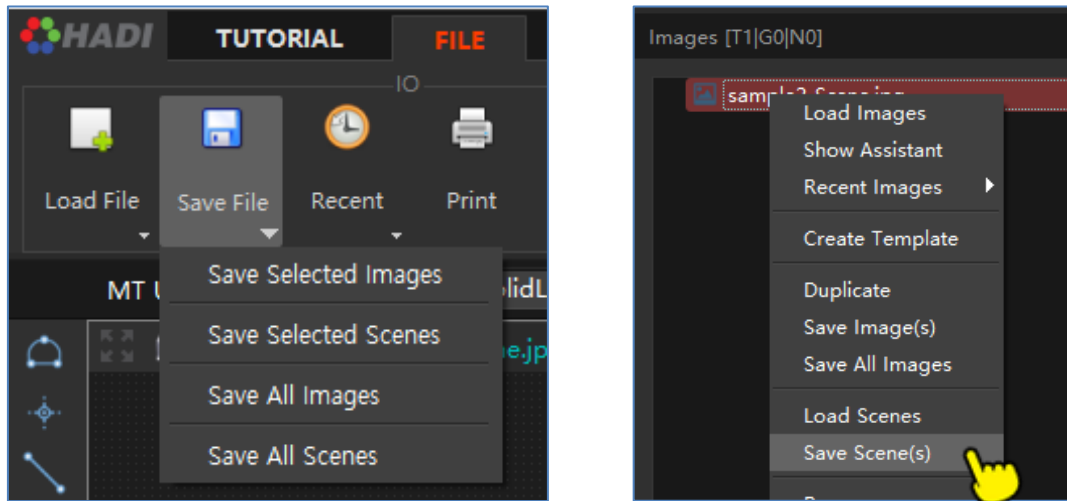
The XML file contains:

- All measurement tool (MT) and their properties (e.g. position, color, pen, etc.).
- All parameter of MT.
- All parameter of the image.

Save Scenes

You can save the scene using one of the following menus:

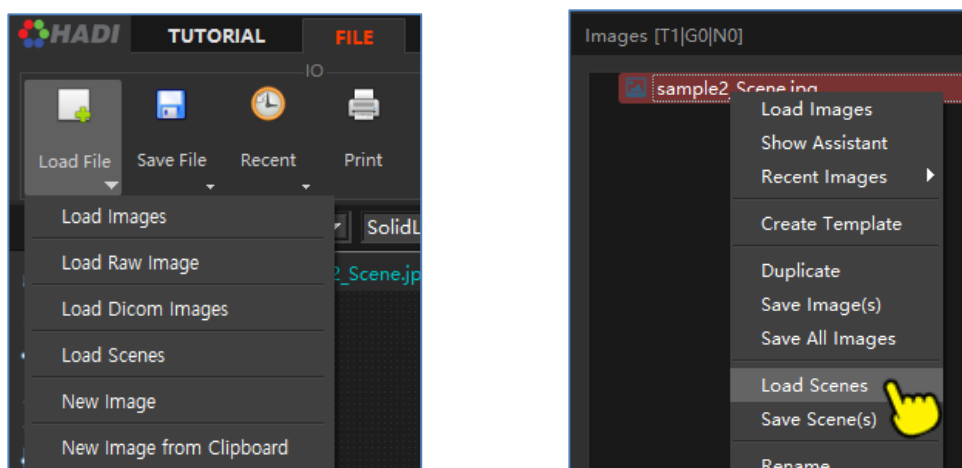
- **[FILE]** tab → "Save File" → "Save Selected Scenes" menu
- **[FILE]** tab → "Save File" → "Save All Scenes" menu
- Right-click the image in the image dock panel → "Save Scene(s)" in the popup menu



Load Scenes

You can load the scene using one of the following menus:

- **[FILE]** tab → "Load File" → "Load Scenes" menu
- Right-click the image in the image dock panel → "Load Scenes" in the popup menu

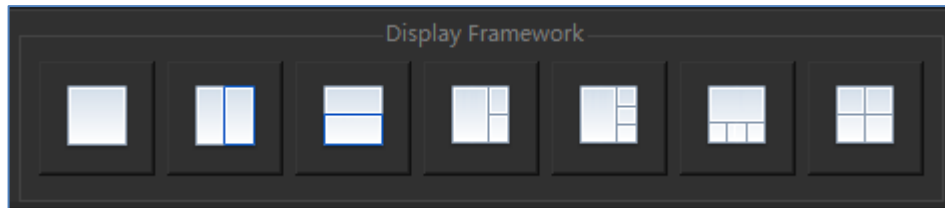


5.1.2. Multi-View Display

HADI supports multiple view windows. You can view up to 4 images at the same time.

By default, HADI displays a single image view.

You can change the display framework in the **[VIEW]** tab → "Display Framework".



Single view



Two vertical views



Two horizontal views



One main view and two small vertical views



One main view and three small vertical views



One main view and three small horizontal views

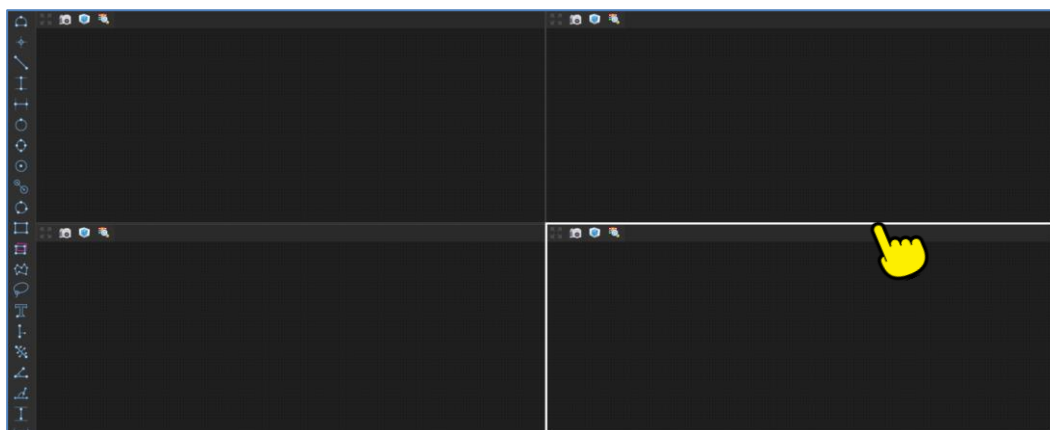


Four views

Activated View

The active view has a white border that is different from other views.

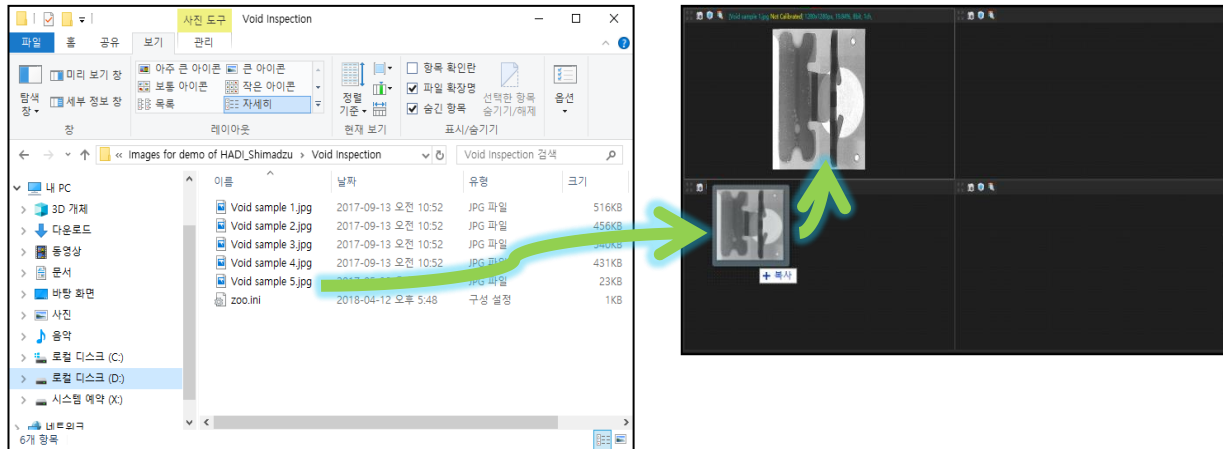
You can click a view to activate it.



How to display images in the multiple views

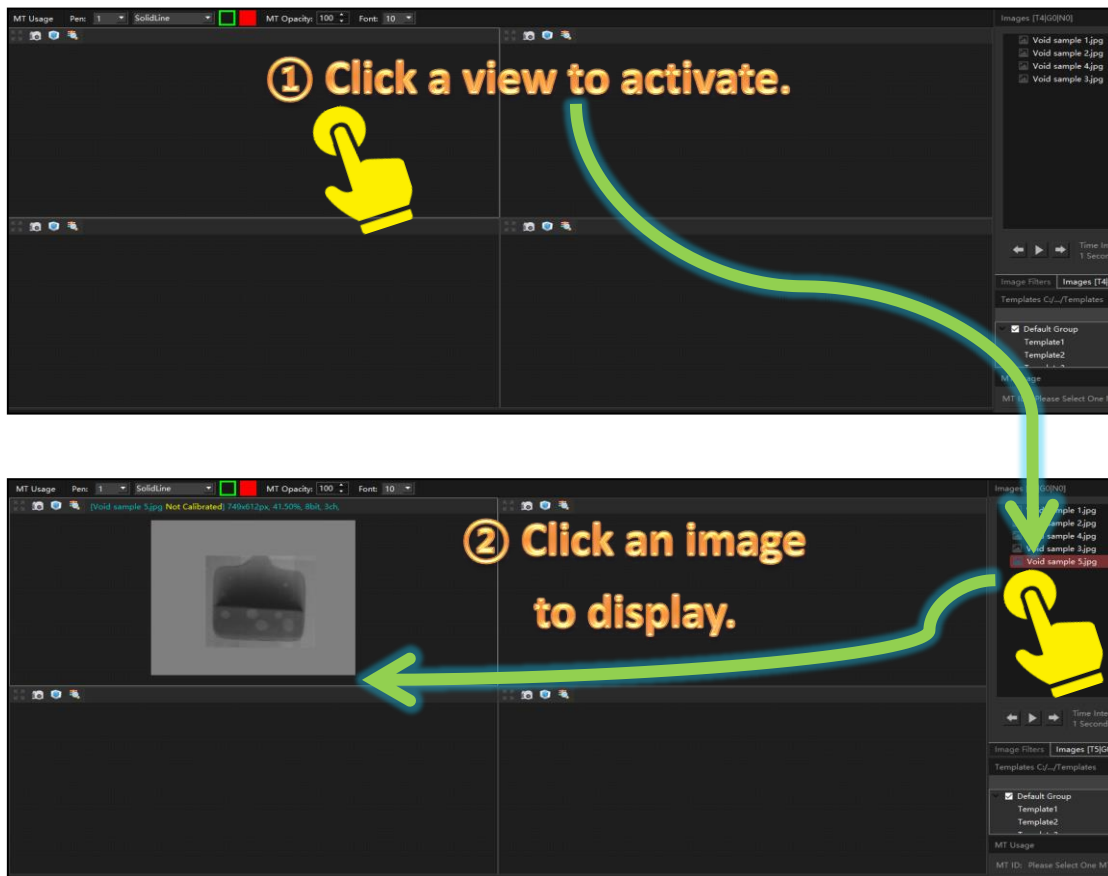
Method 1

Loading images using a mouse drag from Windows explorer into a view.



Method 2

First, click the view you want to activate, and then click the image name in the Image List panel. The image will be displayed to the activated view.



5.1.3. Image Loading Assistant

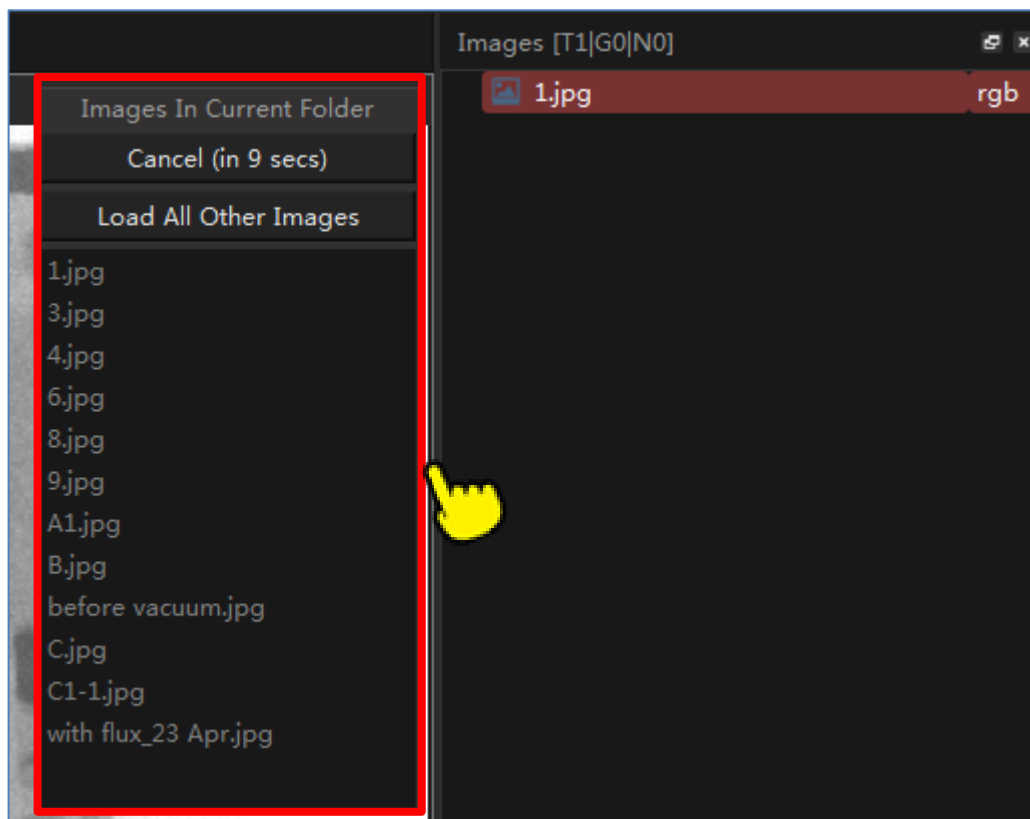
When you load images, "Assistant" window will be appeared.

It shows a list of all images in the same image folder.

You can click on an image file name in the list to load it.

If you don't click anything, this window will be disappeared after 10 seconds.

- **[Cancel]** button: Close the Assistant window.
- **[Load All Other Images]** button: You can also load all other images that are not loaded.



5.1.4. Exporting

HADI provides the following functions for exporting information:

- Save Images
- Save Working Scenes
- Capture Image
- Capture Screen
- Print Images
- Export Inspection Results to PDF file
- Export Inspection Results to CSV/Excel file

5.1.5. Supported file formats

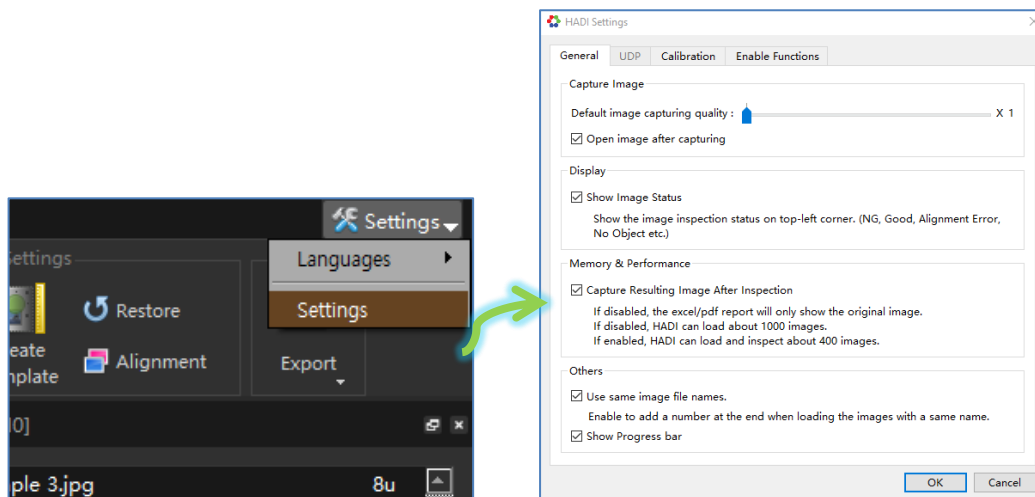
HADI supports various image formats such as PNG, XPM, JPG, BMP GIF and TIFF.
 The TIFF file can be 16-bit.
 HADI also support to load RAW image files.
 HADI saves the working scene as a XML file. You can also load XML scene files.

5.1.6. HADI Terminology

Name	Description
NG	Not Good. Used for inspection and evaluation
GOOD	Good. Used for inspection and evaluation
Void Inspection Tool	Measurement Tool whose MT usage type is Void Inspection.
Measurement Tool	HADI supports 25 measurement tools. It can be assigned to different MT usage type.
Closed-Shape MT	Measurement Tools such as Circle, Rectangle, and Polygon are MTs with closed shapes.
Non-Closed-Shape MT	Measurement Tools such as Angle, Line, and Distance are MTs with non-closed shapes.
Image Alignment	Image Alignment is used for Template.

5.1.7. Improve Performance

You can improve performance with HADI settings.



Memory & Performance

HADI maintains the inspected image after inspection and this image is used for the Report.
 To disable it, use "Global Settings" → "General" → "Memory & Performance" menu.

5.2. Automated and Template based Inspection

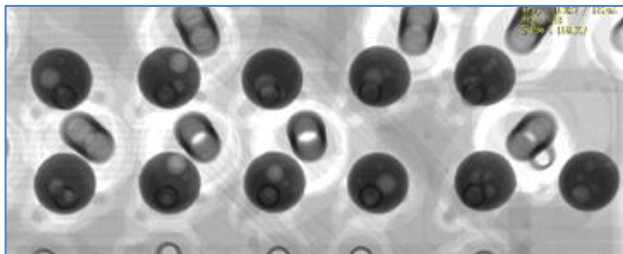
5.2.1. Automated BGA Inspection

Click on the "BGA DETECTION" tab to detect balls in the BGA image.

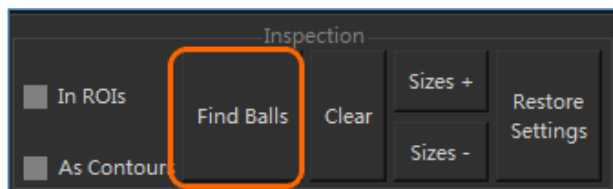
- General BGA Detection Procedure
- If failed...
- Ball Representations
- Advanced BGA Detection
- Find Overlapped Balls
- Set Mask Area

General BGA Detection Procedure

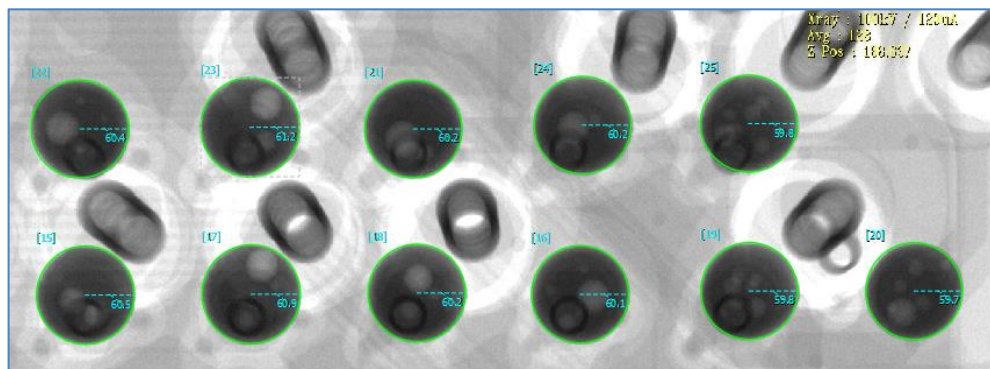
1. Load a BGA Image.



2. Click on "Find Balls" button.



In general, BGA of images is detected and displayed as the following image. Balls are indicated by a Circle MT and the ball radius by a label.



If failed...

Please follow the steps below:

- **Reset Parameters**

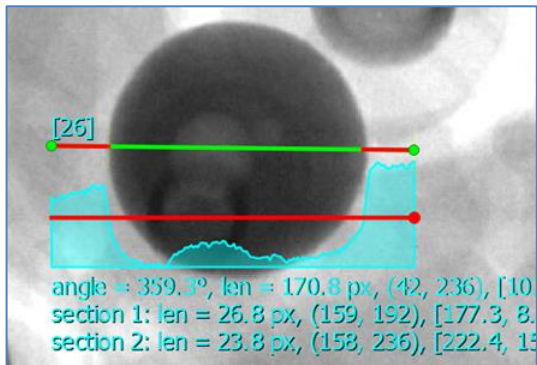
Click "Restore Settings" button to reset all BGA detection parameters to the default values. Then run the "Find Balls" button again.

- **Change "Target Ball Sizes"**

HADI only detects balls that match the defined range (default: 15px ~ 80px).

Therefore, it is very important to set the appropriate ball size.

You can define the target ball size by measuring the radius of the ball using the Line Tools.



- **If the Ball is White**

In general, HADI detects black balls on white background.

Check "Invert Image" option if you want to detect white balls on black background.

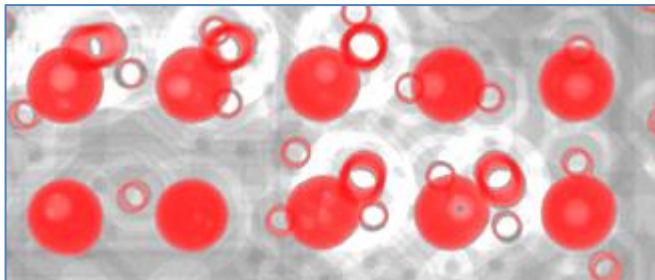
- **Use Fixed Threshold**

HADI uses automatic thresholds ("Auto" option) to distinguish balls by default.

If the background is very complex, automatic thresholds may not work.

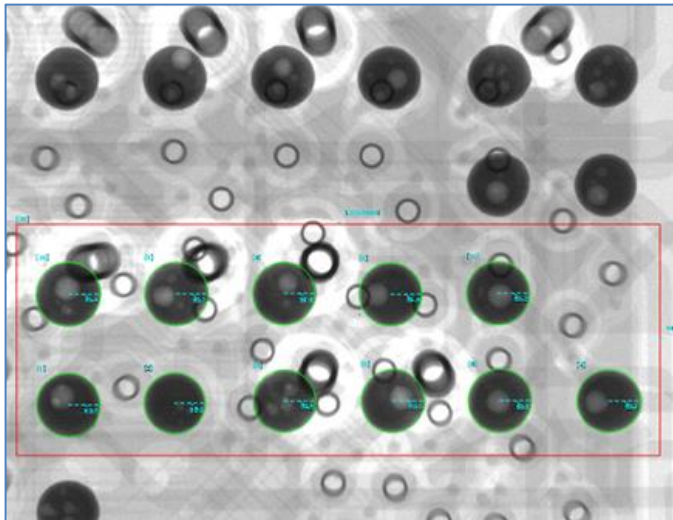
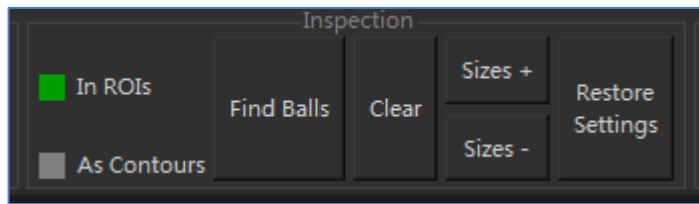
In that case, you can use a fixed threshold value to correctly distinguish balls.

If you set a fixed threshold value, HADI represents the overlaid ball segments.



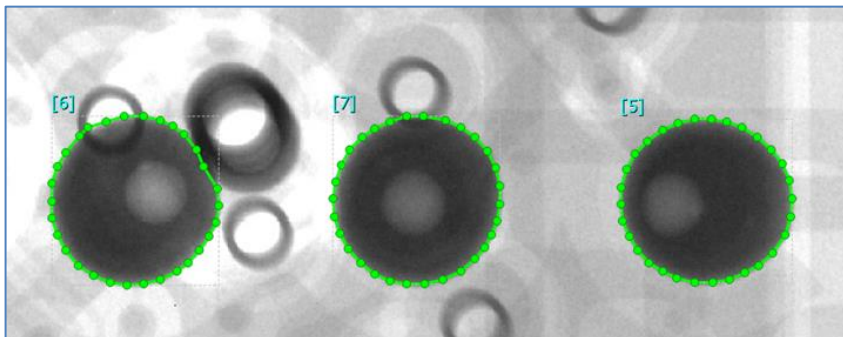
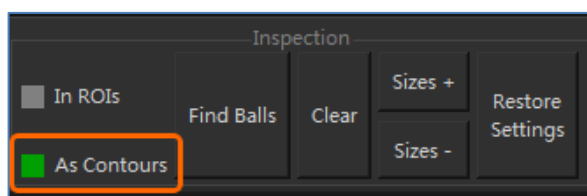
- Try to find balls in ROIs

Insert a rectangle tool in the image and set it as the MT usage "Tool3 (BGA Detection)".
HADI will find balls only in the ROI.



Ball Representations

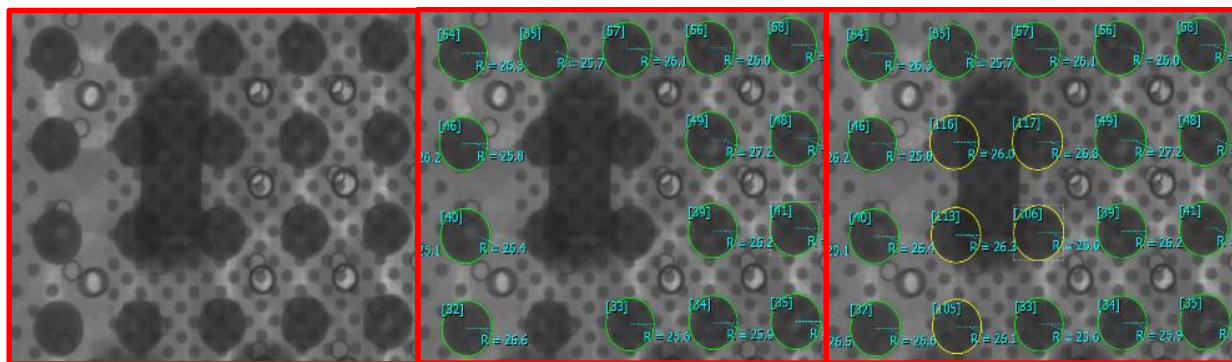
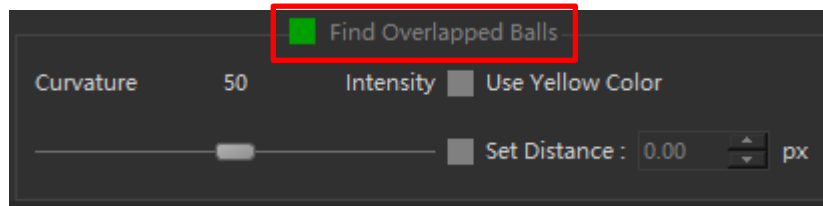
If you check "As Contours" option, HADI will show you the balls as polygon not as circle.



Advanced BGA Detection

Find Overlapped Balls

If you check “**Find Overlapped Balls**” option, HADI will detect balls that are overlapped with other objects.



Original image

Finding isolated balls

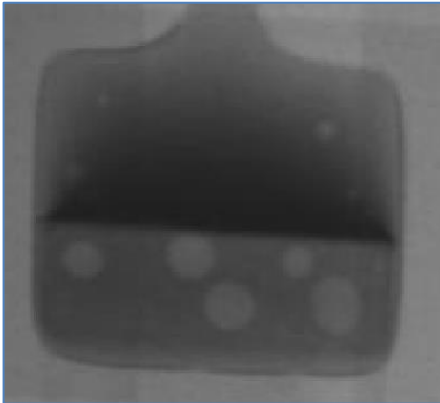
Finding isolated balls
and overlapped balls

5.2.2. Automated Void Inspection

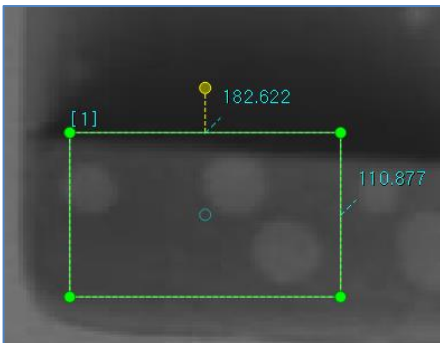
Click on the "VOID INSPECTION" tab to inspect voids in the image.

General Void Inspection Procedure

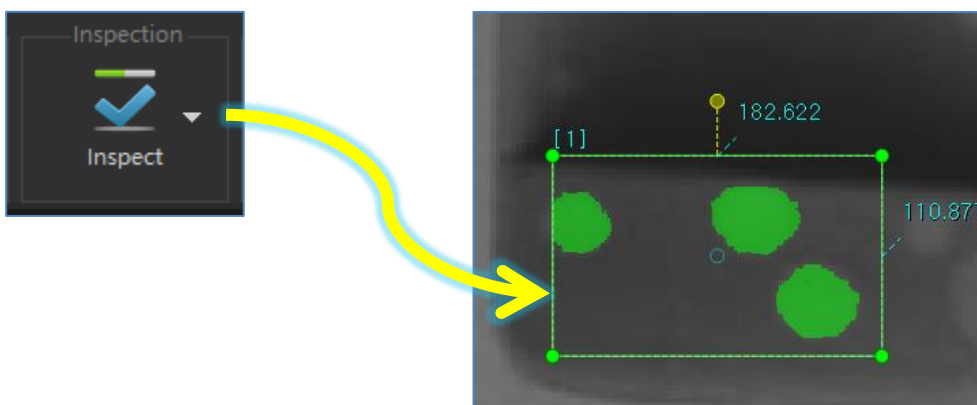
1. Load an Image.



2. Insert a closed-shape MT in the Image.



3. Click [Inspect] button



If failed...

Please follow the checkpoints below:

1. Check whether the tool is closed-shape or non-closed shape.
Void Inspection works only on a closed-shape MT.
2. Check the usage type of the tool in the "MT Usage" dock panel.
Void Inspection works only in the "Tool2 (Void Inspection)" type.
3. Check the Void Color:
 - By default, HADI looks for void objects that are brighter than the background.
 - Disable **"Void is white"** option to find void objects that are darker than the background.
4. Check the "Flatten BG" parameters.
5. Check the "Threshold" parameters.
6. Check the "Void Filter" parameters.

Show Voids as Contour

Check "Void Contour" option to display the void as outline.

Void Evaluation

You can define the NG conditions of a ROI for void inspection.
Click on "Evaluation" button to open the evaluation settings for selected MTs.

Create a Template with Current Image

You can use "Template" to inspect multiple images with the same ROI setting.
The image to be inspected should be like the image in the template.
You can create a template by clicking the "Create Template" button.

Export Results

[Method 1]

To export the results as a PDF file, click the "Report" button on the "FILE" tab.

[Method 2]

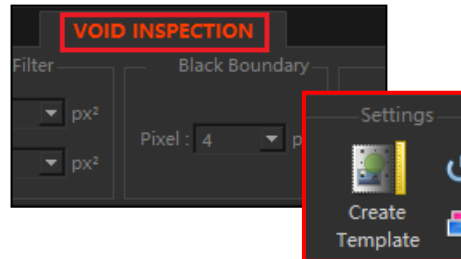
To export the results as an Excel file, click the "Export" button on the "VOID INSPECTION" tab.

5.2.3. Create Template

Create a Template from the current image

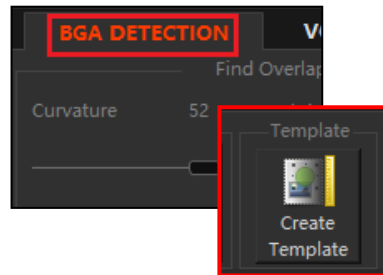
[Method 1]

Go to [VOID INSPECTION] tab → "Create Template" button.



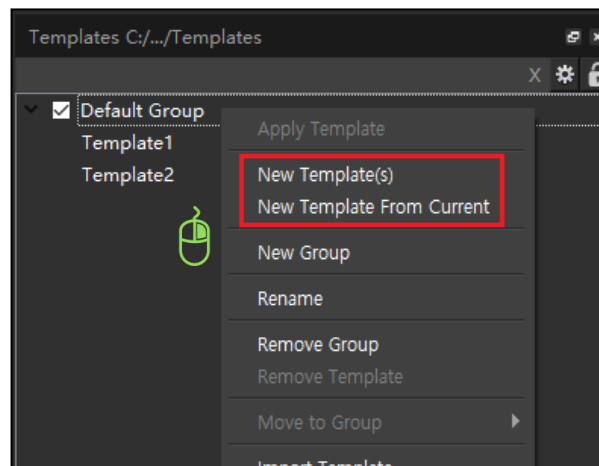
[Method 2]

Go to [BGA DETECTION] tab → "Create Template" button.



[Method 3]

Go to "Templates" dock panel → Right-click on the panel
→ "New Template From Current" popup menu.



Create a Template from the image selection dialog window

[Method 1]

Go to "Templates" dock panel → Right-click on the panel
→ "New Template(s)" popup menu.

5.2.4. Image Calibration

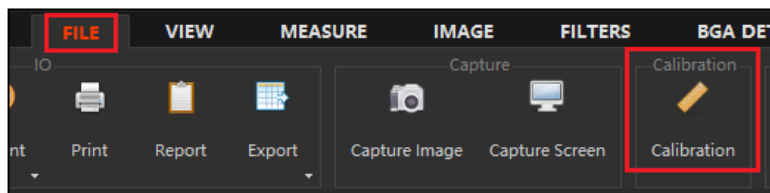
Use the Calibration menu to calibrate the pixels to their actual size.

- Open Calibration Window
- Remove Calibration Information

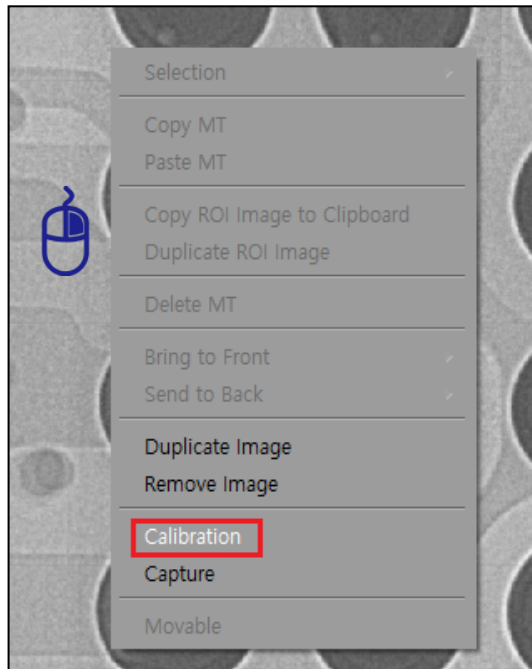
Open Calibration Window

To calibrate the current image, do one of the following:

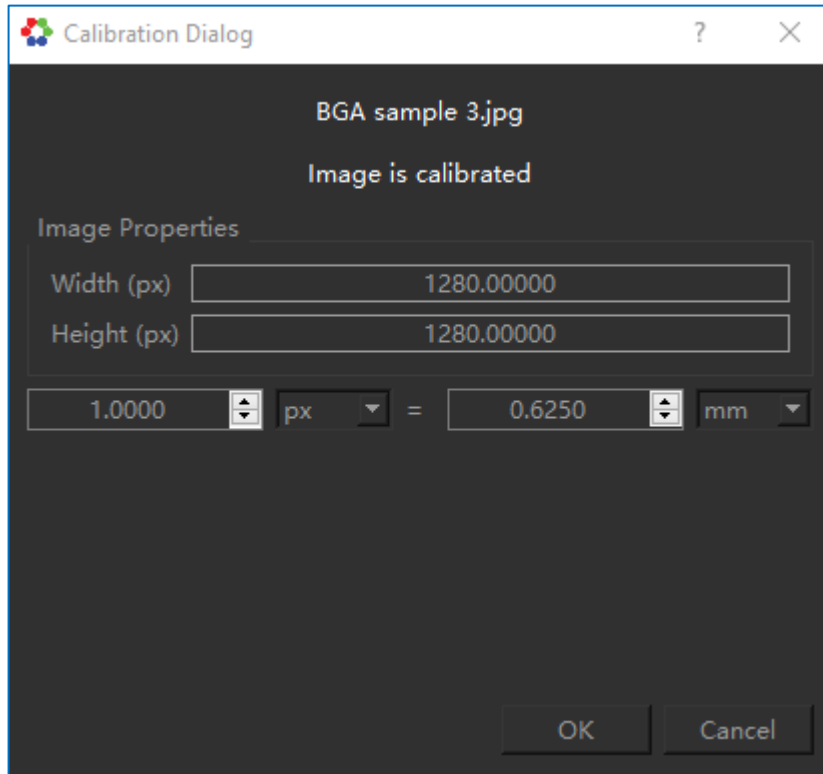
- Click the "Calibration" button in the **[FILE]** tab.



- Click the "Calibration" menu from the popup menu on the image.
(Right-click on the image)



Then the calibration dialog window appears.



- If you right-click on the image, the image properties section displays the properties of the whole image.
- If you right-click on the measurement tool (MT), the image properties section displays the properties of the ROI (MT) area.

HADI supports the following units:

- centimeter
- millimeter
- micrometer
- nanometer

Remove Calibration Information

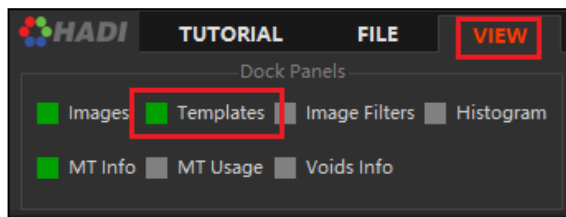
To remove the calibration setting of an image, set "Pixel = Pixel" without changing the value or "1 pixel = 1 pixel".

5.3. Dock Panels

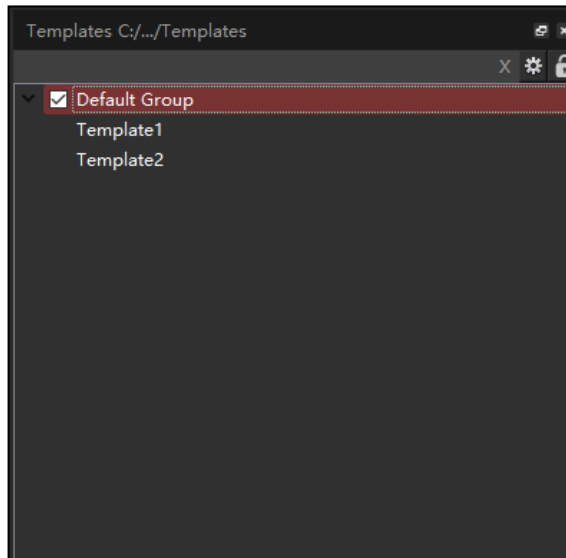
5.3.1. Templates

Show Templates Dock Panel

To display the Templates dock panel, select the **[VIEW]** tab and enable the “Templates” option in the “Dock Panels” menu.



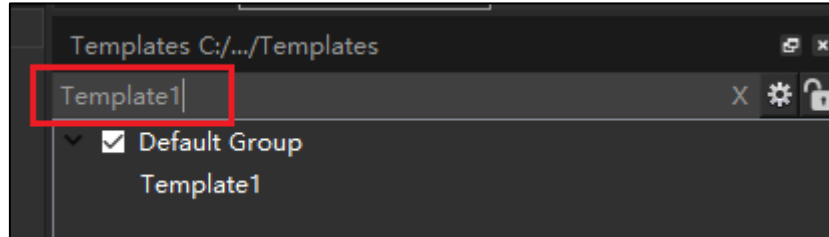
The Templates panel is displayed on the lower right corner of the screen.



UI elements and Mouse behaviors

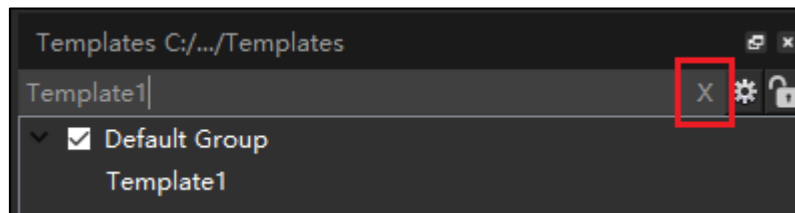
- **Search Window**

Search for a template by keyword.



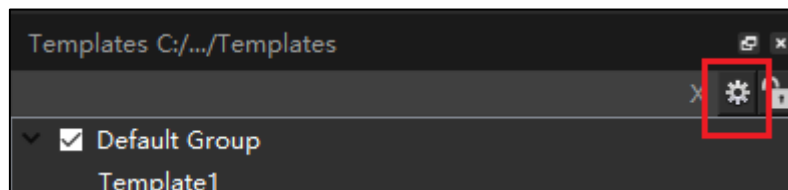
- **Clear Search Text**

Clear a keyword text from the search window.



- **Settings**

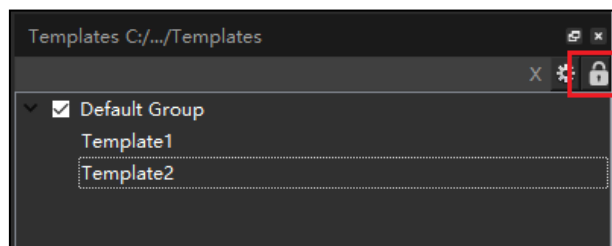
You can change the path of template folder.



- **Lock**

To edit the template, click the "Lock" button and enter the password to unlock it.

The default password is "3dii".

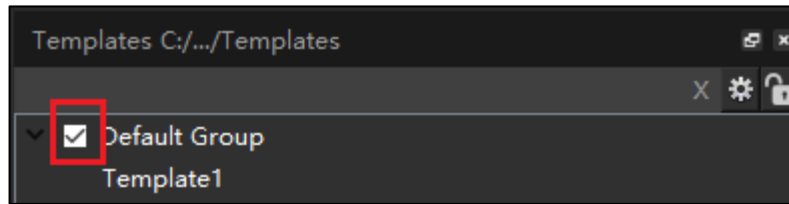


- **Check a Group**

When you restart HADI, all templates in that group are loaded.

- **Uncheck a Group**

When you restart HADI, all templates in that group are not loaded.



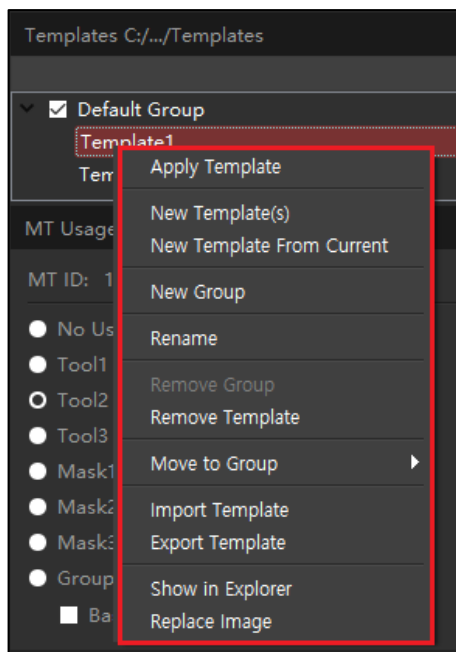
- **Mouse click on the template**

Single click → select a template

Double click → display a template image

Context Menu

Right click on the template dock panel to display the context menu.



- **Apply Template**

Apply the template to the current image to be inspected.

- **New Template(s)**

The Select Image File dialog window opens.

You must select an image to use for the template.

- **New Template From Current**

Create a new template with the currently loaded.

All Measurement Tools and their parameters are copied to the template.

- **New Group**

Create a new group.

You can manage templates with groups.

- **Rename**

Rename a group or a template.

- **Remove Template / Remove Group**

Remove selected template(s) or remove selected group(s).

- **Move to Group**

Move selected template(s) to another group.

- **Import Template**

Import the template (XML file) into HADI.

The template is copied to the current template folder.

- **Export Template**

Export the template to your hard disk.

- **Show in Explorer**

Run Windows Explorer to display the Templates folder.

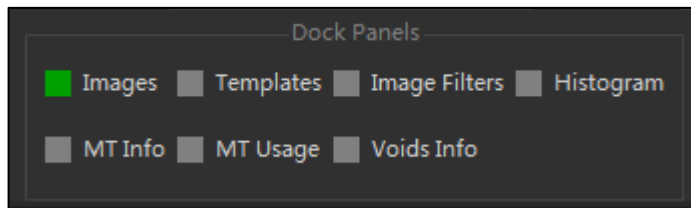
- **Replace Image**

Replace the current template image with another image.

5.3.2. Images

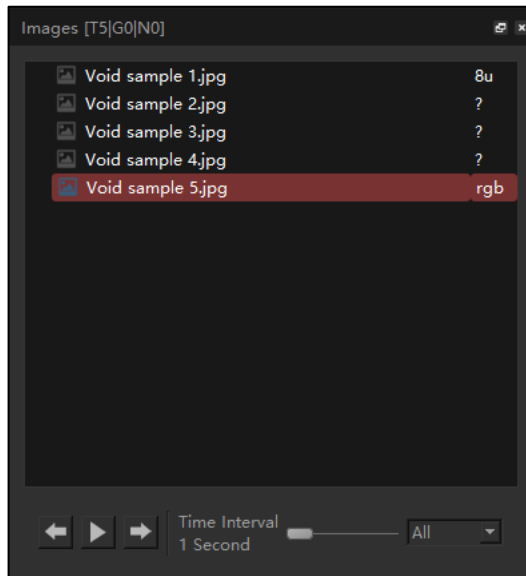
Show Images Dock Panel

To display the Templates dock panel, select the **[VIEW]** tab and enable the "Images" option in the "Dock Panels" menu.



When multiple images are loaded into the image dock panel, not all images are loaded simultaneously into memory. Only the image you click on will be loaded into memory. This is to improve performance.

- The images you didn't click are indicated by "?" in the type of column of the image dock panel. When you click on these images, they are loaded into memory and "?" changes to the actual format.
- The images you clicked are indicated by their image format such as "8u", "rgb", "rgba" and "16u".



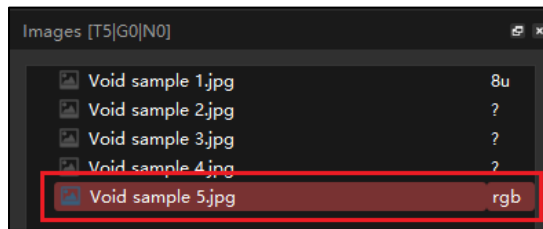
UI elements and Mouse behaviors

- Title

Images [T5|G0|N0]

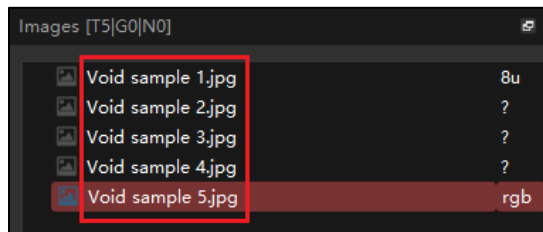
T = Total Images, G = Good Images, N = NG Images

- **Red color item**



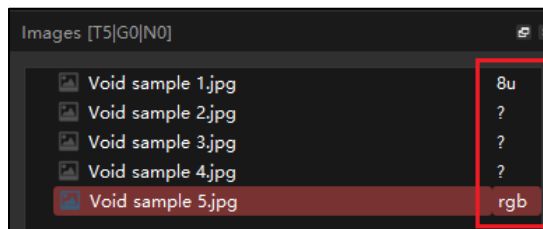
Current selected image. The selected image is displayed in the main view.

- **First Column**



The name of the image file.

- **Second Column**



The image formats.

- **Click and Drag**

Select multiple images at once.

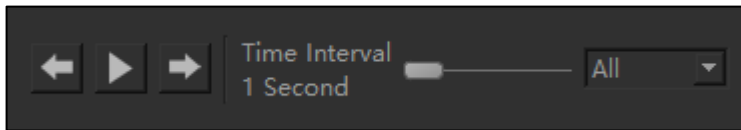
- **[Ctrl] + Click**

Select multiple images individually.

- **[Shift] + Click**

Select multiple images at once.

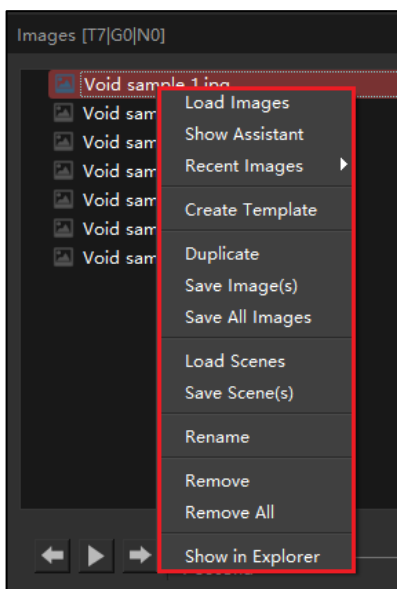
Bottom Toolbar



1. Click to view previous image.
2. Click to play a slideshow of images.
3. Click to view next image.
4. Set the time interval for the slideshow.
5. Set the target of the slideshow. "All images", "Good image" or "NG image".

Context Menu

Right click on the images dock panel to display the context menu.



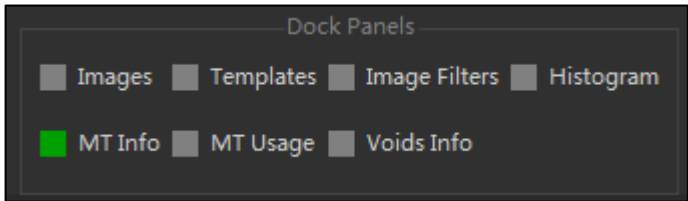
- **Load Images**
Load images into the images dock panel.
- **Show Assistant**
Display the image assistant window.
- **Recent Images**
Load recently used images or folders.

- **Create Template**
Create a template from the selected image.
- **Duplicate**
Make a copy of the selected image.
- **Save Image(s)**
Save selected image(s).
- **Save All Images**
Save all images in the images dock panel.
- **Load Scenes**
Load a scene file.
- **Save Scene(s)**
Save selected images as scenes individually.
- **Rename**
Rename the selected image.
- **Remove**
Remove the selected image(s) from HADI.
- **Remove All**
Remove all images in the images dock panel from HADI.
- **Show in Explorer**
Run Windows Explorer to display the folder that contains the selected image file.

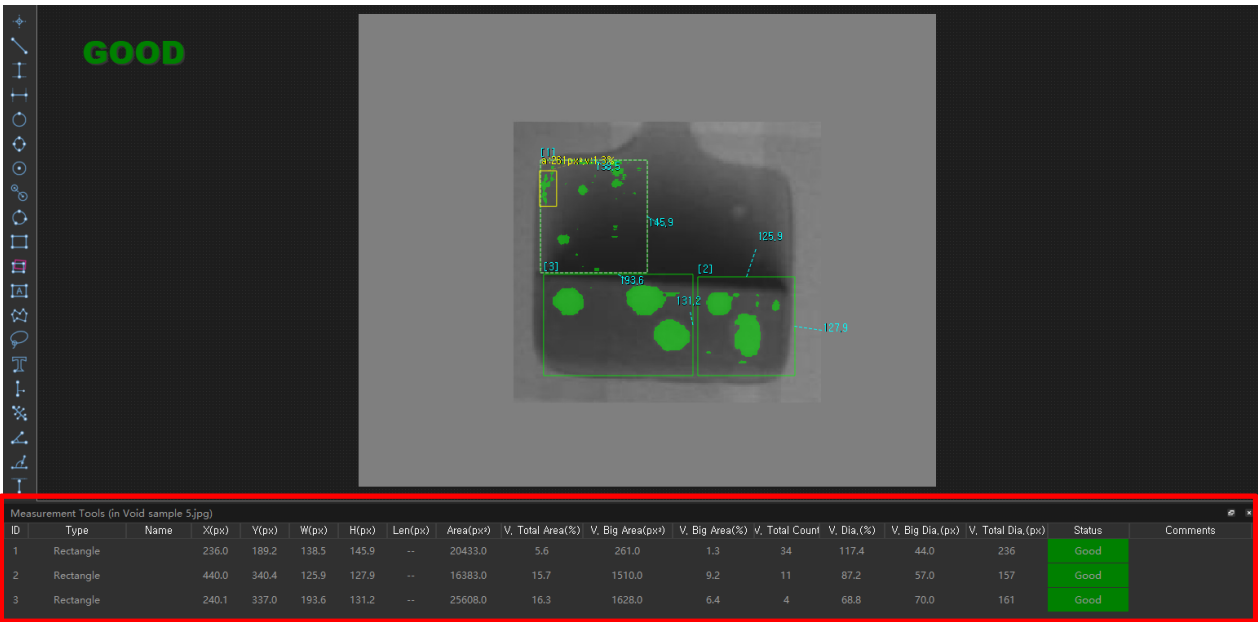
5.3.3. MT Info

Show MT Info Dock Panel

To display the MT Info dock panel, select the **[VIEW]** tab and enable the “MT Info” option in the “Dock Panels” menu.



The MT Info panel displays the information and properties of the measurement tools for the current image in the main view.

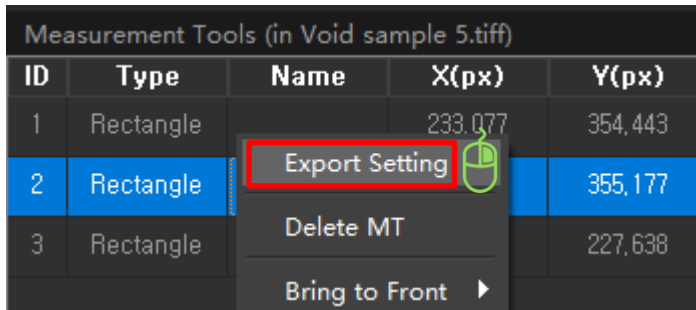


- **ID**
ID of a measurement tool.
- **Type**
Type of a measurement tool.
- **Name**
Name of a measurement tool.
- **X**
X coordinate of the upper left position of the measurement tool.

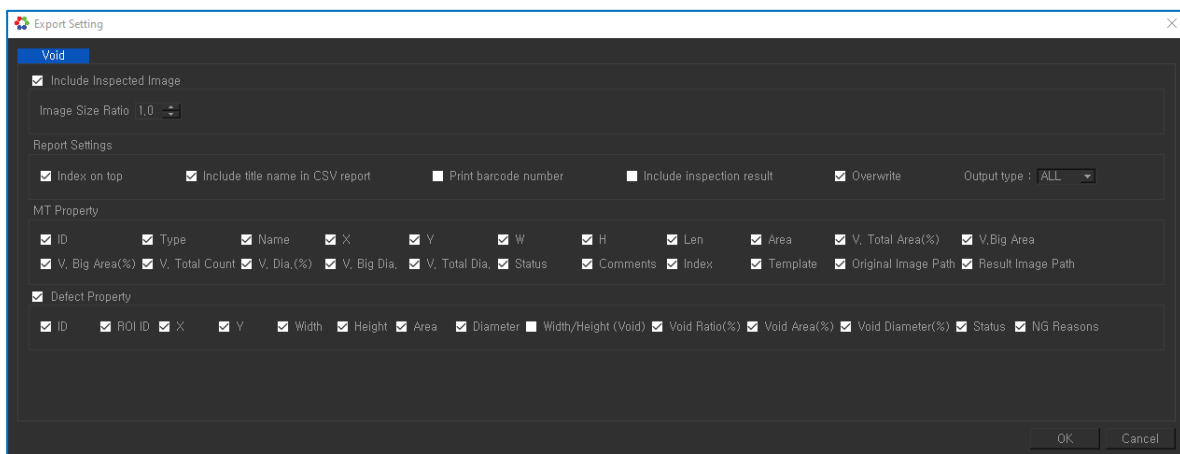
- **Y**
Y coordinate of the upper left position of the measurement tool.
- **W**
Width of a measurement tool.
- **H**
Height of a measurement tool.
- **Len**
Length of a non-closed shape measurement tool.
- **Area**
Area of a closed-shape measurement tool.
- **V. Total Area (%)**
The percentage of the total void area ratio of the measurement tool.
- **V. Big Area**
Area of the biggest void of the measurement tool.
- **V. Big Area (%)**
The percentage of the biggest void area ratio of the measurement tool.
- **V. Total Count**
The number of voids in the measurement tool.
- **V. Dia. (%)**
The ratio of “sum of each void’s diameter” to “measurement tool’s diameter”.
- **V. Big Dia.**
The diameter of the biggest void of the measurement tool.
- **V. Total Dia.**
The total diameter of voids of the measurement tool.
- **Status**
The evaluation status of a measurement tool.
 (“Good” = Good, “NG” = NG, “Pending” = Not Inspected, “--” = Not Inspectable).
- **Comments**
Additional comments (or properties) of a measurement tool.
(e.g. start and end points of a Line Tool)

Export Settings

Right click on the MT Info dock panel and click “Export Setting” menu.



The “Export Setting” include the following options:



Void

- **Include Inspected Image**

Select this option to include a screenshot of inspected image in the exporting file.

- **Report Settings**

Select this option to include inspection results in the exporting file.

- **MT Property**

Select the column of properties you want to show or hide in the MT information panel.

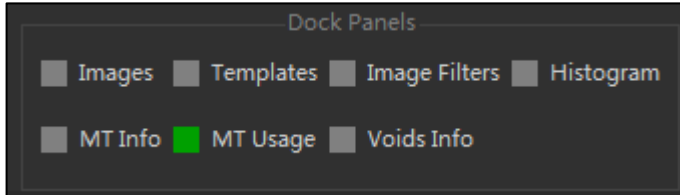
- **Defect Property**

Select the column of “Void Info” you want to show or hide in the MT information panel.

5.3.4. MT Usage

Show MT Usage Dock Panel

To display the MT Usage dock panel, select the **[VIEW]** tab and enable the "MT Usage" option in the "Dock Panels" menu.

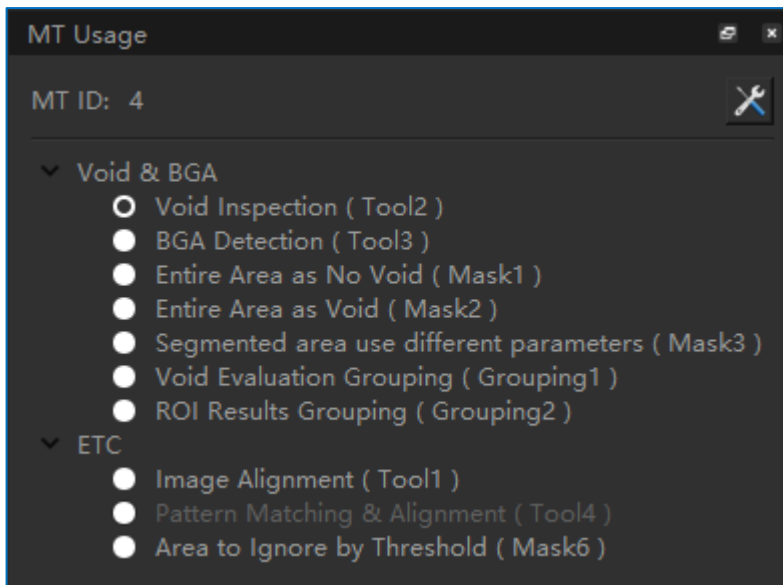


By default, when you create a MT in the Measurements panel, it is set to one of the following:

- "Tool2 (Void Inspection)" for closed-shape MT.
- "No Usage" for non-closed shape MT.

MT Usages

HADI supports several "MT usage" and varies depending on the product type of the HADI series.



- **Tool1 (Image Alignment)**

Set the selected MT to the image alignment tool in the template.

If you don't use this option, HADI will use the entire image area as the basis for image alignment.

In some cases, it takes time to perform image alignment depending on the image resolution. To improve performance, you can define a specific area as the basis for image alignment. In this case, you can apply this option to the selected MT in the template.

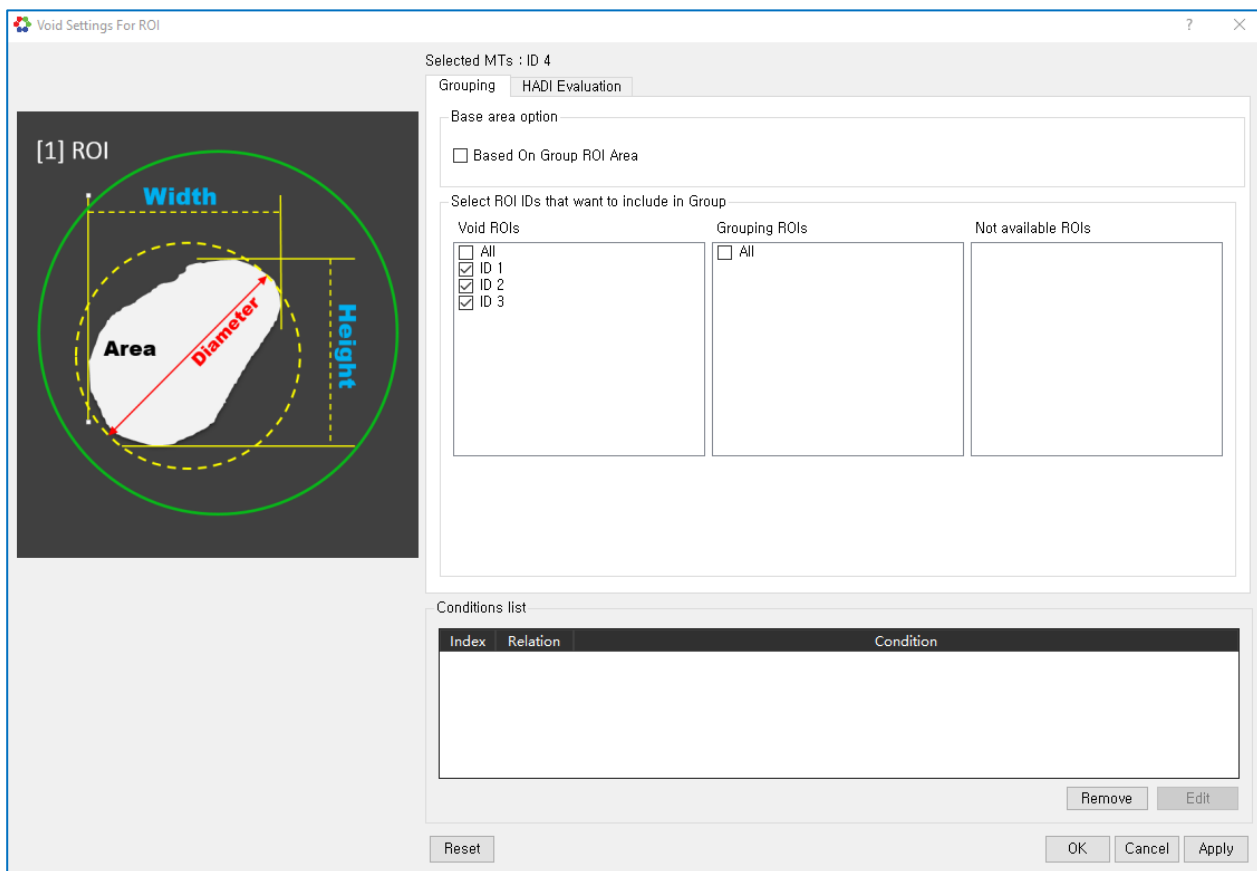
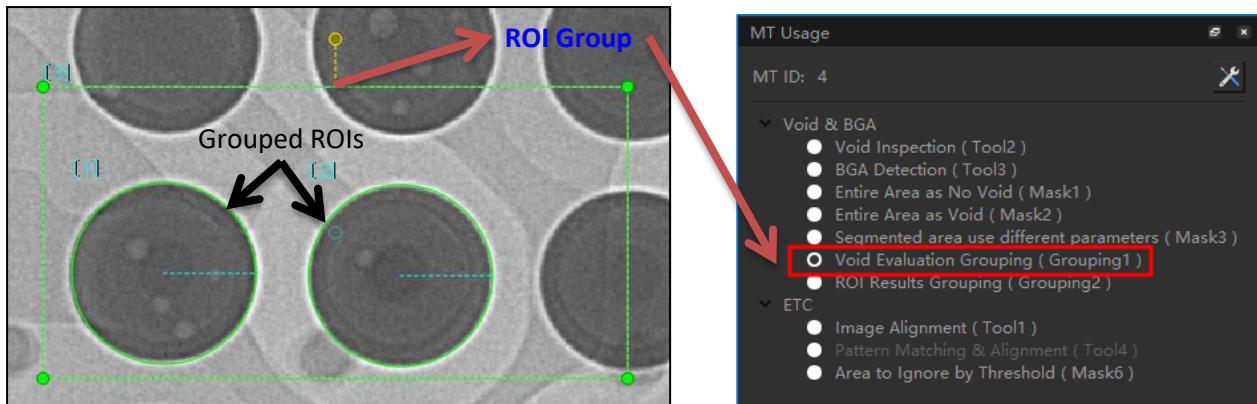
[Notice]

- The size of the MT should not be too small.
 - A template image can have only one image alignment tool. Using more than one will result in unexpected image alignment.
-
- **Tool2 (Void Inspection)**
Set the selected MT to the Void Inspection tool. The MT must be a closed-shape MT.

 - **Tool3 (BGA Detection)**
Set the selected MT to the BGA Detection tool. The MT must be a closed-shape MT.

 - **Mask1 (Entire Area as No Void)**
Set the entire area of the selected MT to the “No Void” area.
 - **Mask2 (Entire Area as Void)**
Set the entire area of the selected MT to the “Void” area.
 - **Mask3 (Segmented Area as Void)**
Set the segmented area of the selected MT to the “Void” area.

 - **Grouping1 (Void Results Grouping)**
Set the selected MT to the Void Results grouping tool.
This MT must contain other regular MTs for grouping.
-
- . “Based On Group ROI Area”: if you select this checkbox, ROI Group evaluates only the area of grouped MT, not all area of ROI Group.

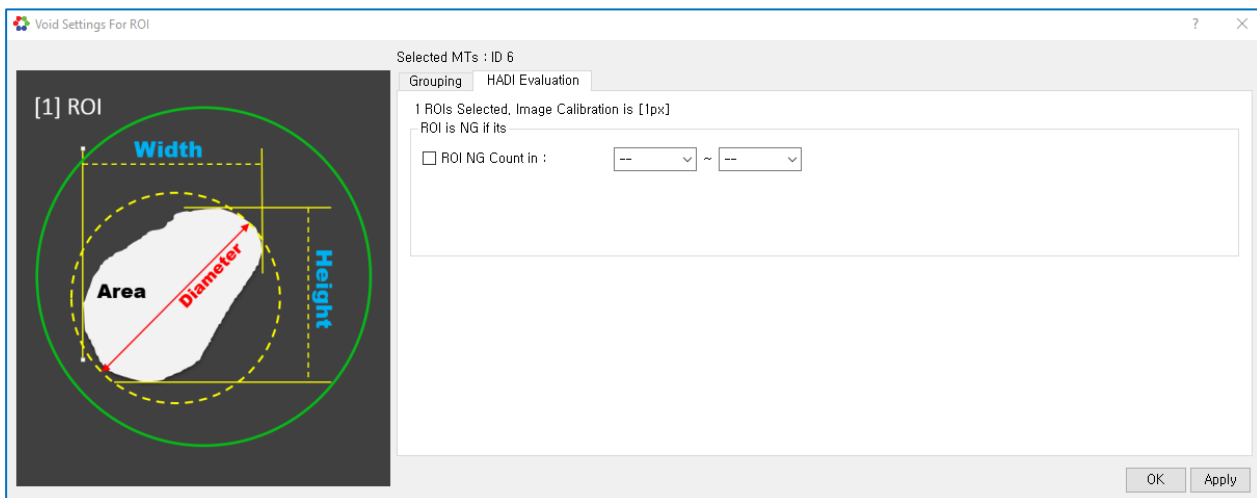
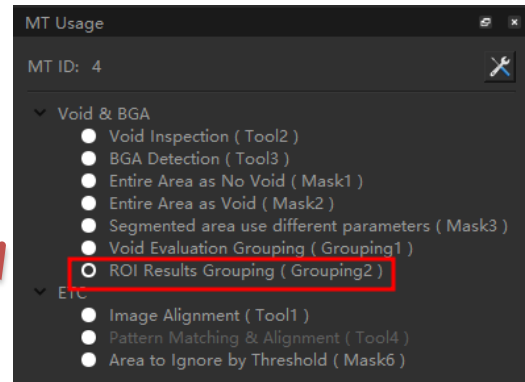
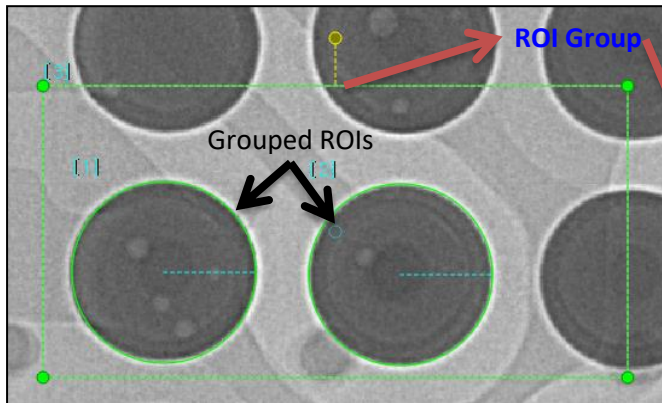


- **Grouping2 (Select ROI)**

Set the selected MT to the Select ROI grouping tool.

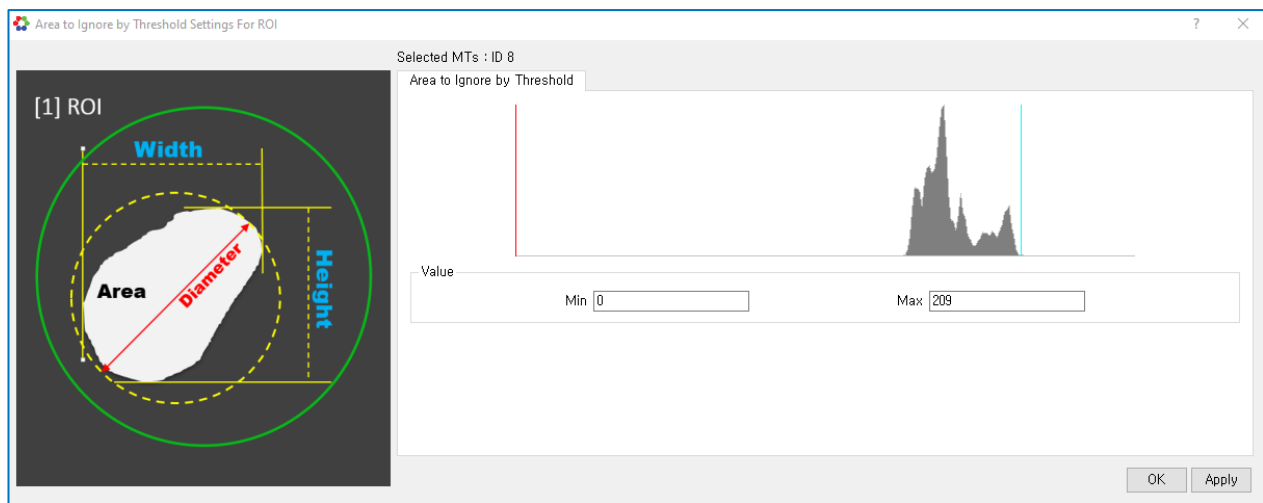
This MT must contain other regular MTs for grouping.

- . You can select only the ROIs to set conditions for evaluation.



- **Mask6 (Area to Ignore by Threshold)**

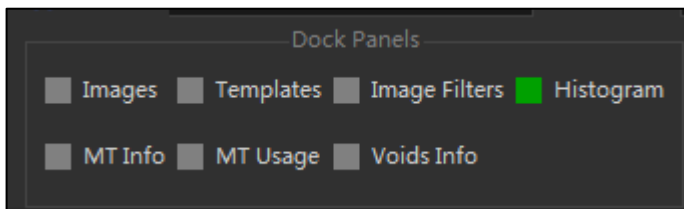
Set the selected MT as the tool that sets the exclusion area by the reference value for the ROI.



5.3.5. Histogram

Show Histogram Dock Panel

To display the Histogram dock panel, select the **[VIEW]** tab and enable the "Histogram" option in the "Dock Panels" menu.



Histogram and Profile

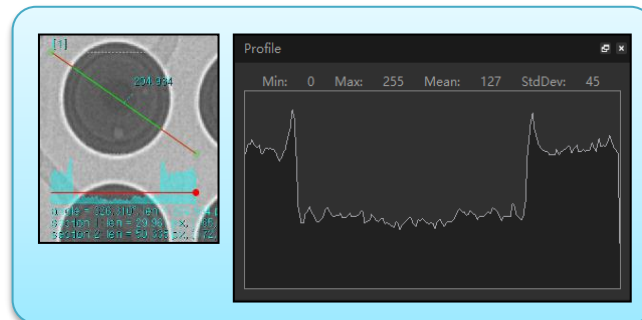
The histogram panel is then displayed on the right side of the screen.

If no ROI is selected, a **histogram** of the entire image is displayed.

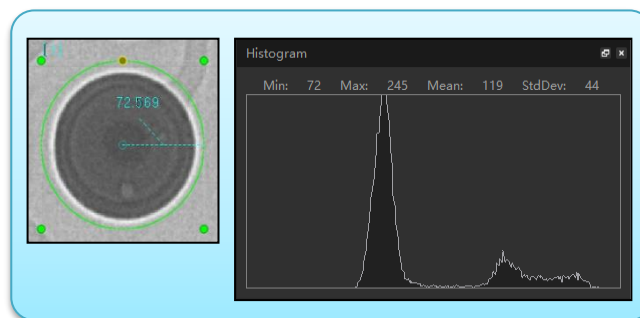
If a ROI is selected,

- ROI is a closed shape (e.g. Circle, Polygon or Rectangle):
A **histogram** of the ROI is displayed on it.
- ROI is a non-closed shape (e.g. Line):
A **profile** of the ROI is displayed on it.

The top label of the histogram or profile shows the minimum, maximum, average, and standard deviation values of the images within the ROI.



Profile for a Line ROI (non-closed shape)

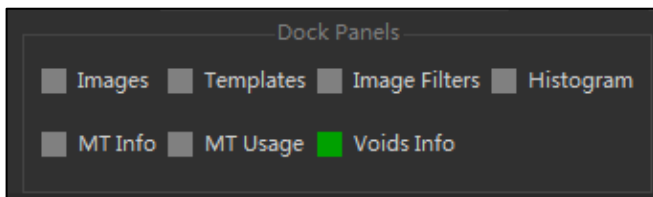


Histogram for a Circle ROI (closed shape)

5.3.6. Voids

Show Voids Info Dock Panel

To display the Voids Info dock panel, select the **[VIEW]** tab and enable the "Voids Info" option in the "Dock Panels" menu.



The "Voids Info" dock panel displays the void information for the selected measurement tool (ROI).

The title of dock panel: it shows the ID and the evaluation conditions of the selected ROI.

The screenshot shows the 'Voids Info' dock panel. The title bar is highlighted with a red box and contains the text 'Voids in ROI [ID:1, Total:181] Area(1~1000)px²'. A green arrow points to this title bar. Below the title bar is a table with the following data:

ID	ROI ID	X(px)	Y(px)	W(px)	H(px)	Area(px²)	Dia.(px)	V. Area(%)	V. Dia.(%)	Status
9	1	1055.5	935.0	95.0	86.0	3362.0	101.0	0.8	9.5	Good
10	1	1142.0	958.0	84.0	90.0	3653.0	92.0	0.8	8.6	Good
11	1	1053.5	928.5	23.0	15.0	128.0	25.0	0.0	2.3	NG
12	1	1039.0	932.0	2.0	4.0	4.0	4.0	0.0	0.4	NG
13	1	1043.5	943.5	13.0	17.0	58.0	20.0	0.0	1.9	NG

- **ID**
ID of the void.
- **ROI ID**
ID of the ROI to which the void belongs.
- **X**
X coordinate of the upper left position of a void.
- **Y**
Y coordinate of the upper left position of a void.
- **W**
Width of a void.
- **H**
Height of a void.
- **Area**
Area of a void.
- **Dia.**
Diameter of a void.

- **Width/Height**

Value of dividing width by height of Void.

- **Void Ratio**

The percentage of the total voids area ratio in ROI.

- **V.Area**

The percentage of the void area ratio.

- **V.Dia**

The percentage of the void diameter ratio.

- **Status**

The evaluation status of void inspection.

- **NG Reasons**

Shows the NG reasons if its evaluation is NG.

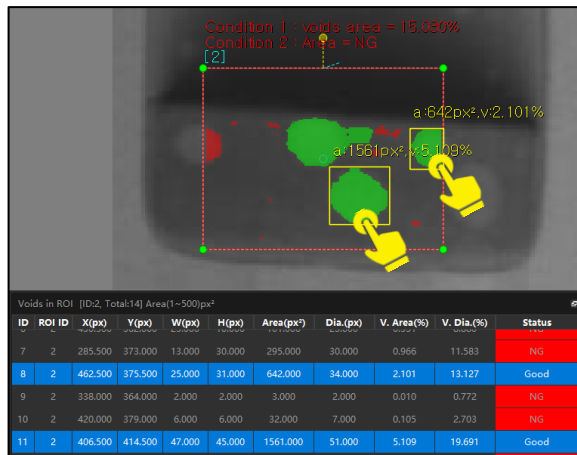
Mouse Actions

When you click any cell in the “Voids Info” panel, the selected row is highlighted and the corresponding void in the image is also selected.



If you click any void in the image, the corresponding row in the “Voids Info” dock panel is also selected.

Multiple selections are also supported.



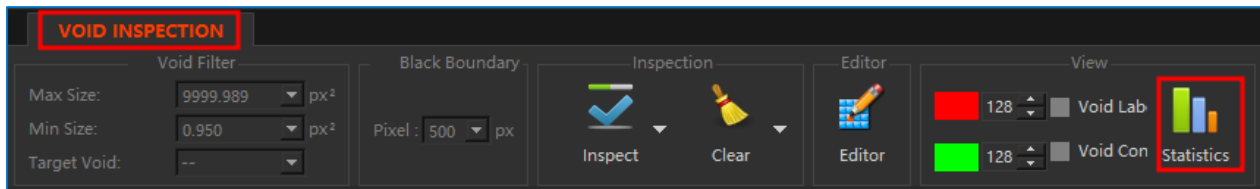
Export Settings

See "Export Settings" in the "MT Info" dock panel.

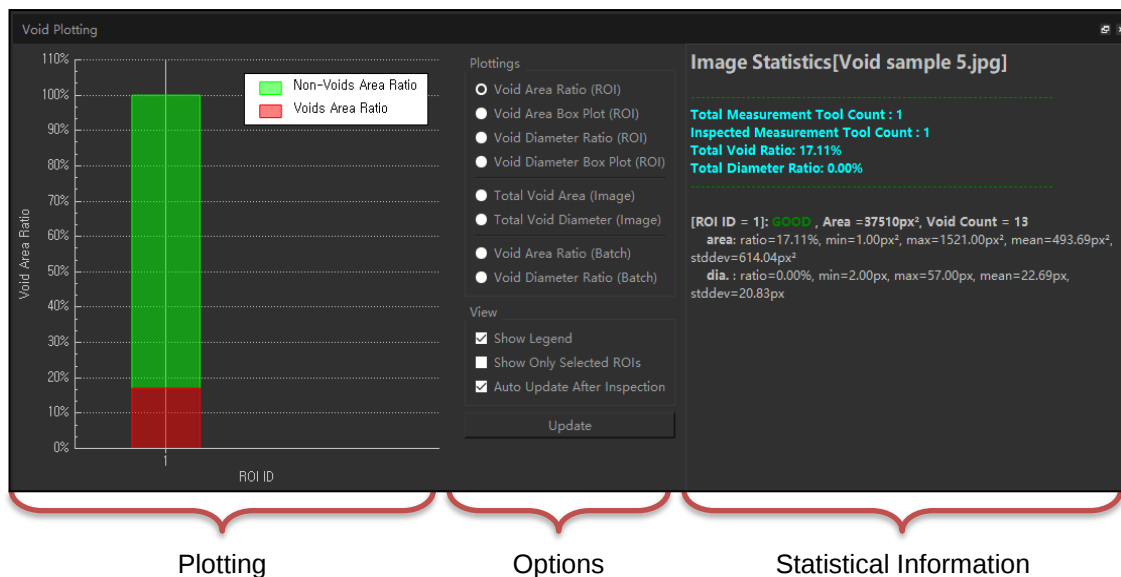
5.3.7. Void Statistics

Show Void Statistics Plotting Dock Panel

To display the Void Statistics Plotting dock panel, select the **[VOID INSPECTION]** tab and click the "Statistics" button in the "View" menu.



The Void Statistics Plotting dock panel appears as follows.
It supports various plotting graphs:



Void Area Ratio (ROI based bar plot)

This option plots the void area ratio of each ROI.

X-axis: ROI ID

Y-axis: void area ratio

Bar graph:

- Green: Non-Void area ratio.
- Red: Void area ratio.
- Void area ratio + Non-Void area ratio = 100%

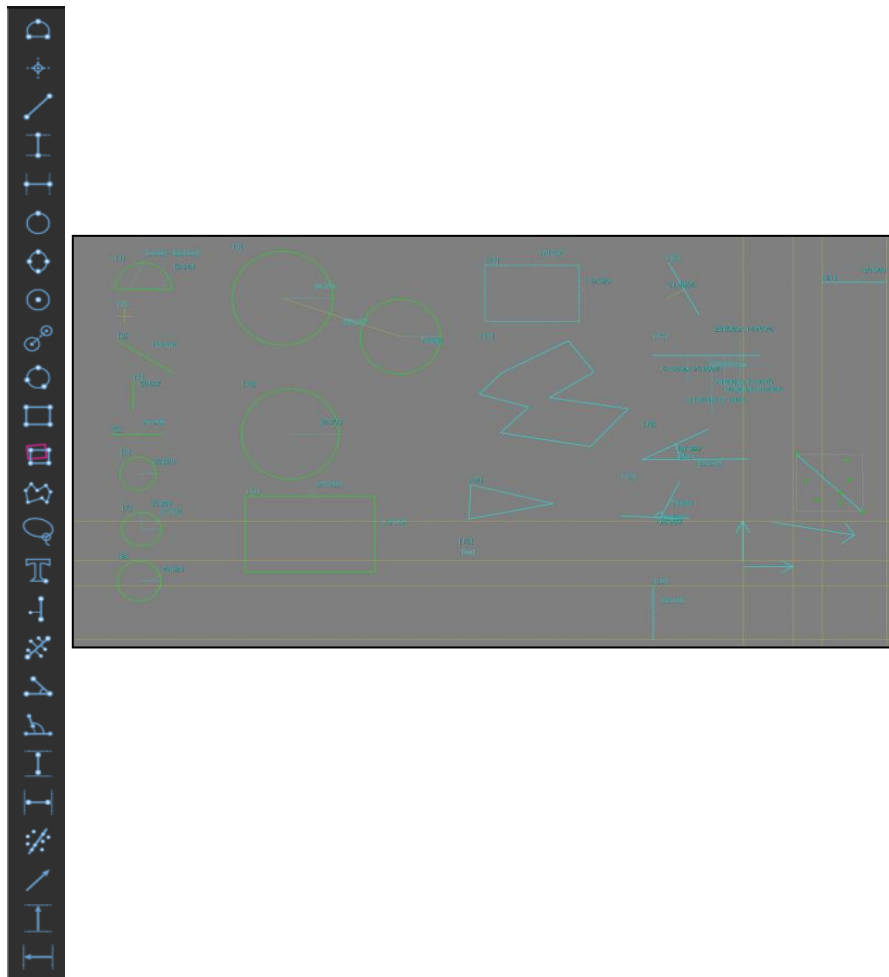
5.4. Measurements

5.4.1. Measurement Tools

HADI supports 25 measurement tools (MT).

Click on a MT in the MT panel and insert it into the current image.

- | | |
|------------------------|----------------------------|
| - Chord | - Point |
| - Free Line | - Vertical Line |
| - Horizontal Line | - Circle |
| - Ellipse | - Circle from center |
| - Circle to Circle | - Circle from three Points |
| - Rectangle | - Alignment Tool |
| - Polygon | - Lasso |
| - Text | - Solder fill tool |
| - Perpendicular tool | - Angle from three Points |
| - Angle from two lines | - Vertical Ruler |
| - Horizontal Ruler | - Fit Points |
| - Arrow | - Vertical Arrow |
| - Horizontal Arrow | |



5.4.2. Closed Shapes

Chord



Usage

Usually used for void inspection.

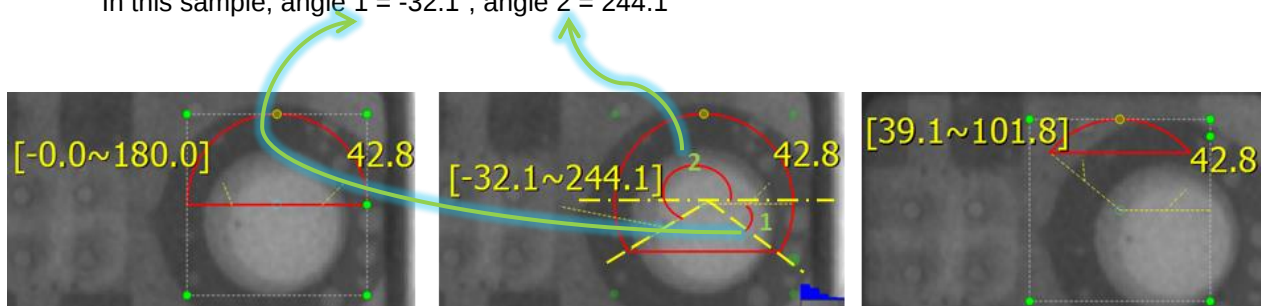
Annotation Example

Radius: 42.8

In this sample, 42.8 means the radius of the potential circle.

Angle: $[-32.1^\circ \sim 244.1^\circ]$

In this sample, angle 1 = -32.1° , angle 2 = 244.1°



Circle



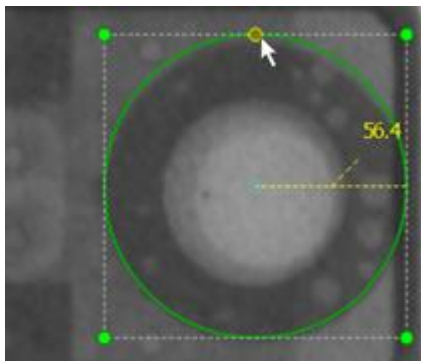
Usage

Usually used for void inspection.

Annotation Example

Radius: 56.4

In this sample, 56.4 means the radius of the circle.



Circle to Circle



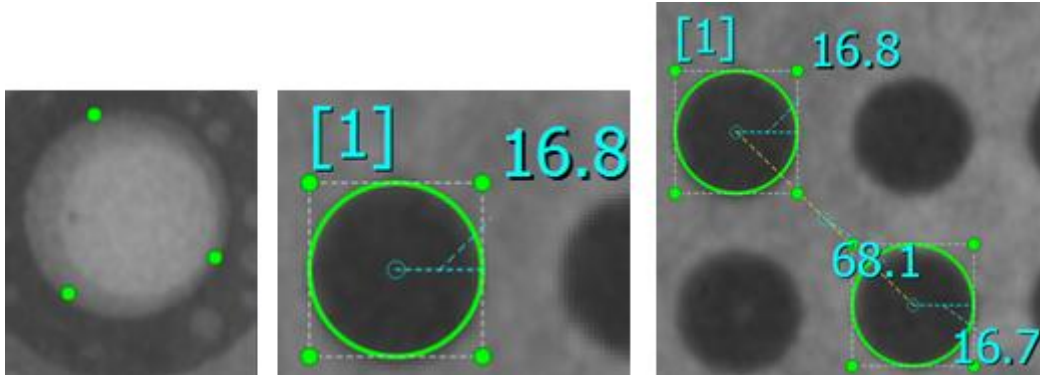
Usage

Usually used for void inspection.

Annotation Example

Radius: 16.8 and 16.7 mean the radius of the two circles.

Distance: 68.1 means the distance between the two circles (from center to center).



Ellipse



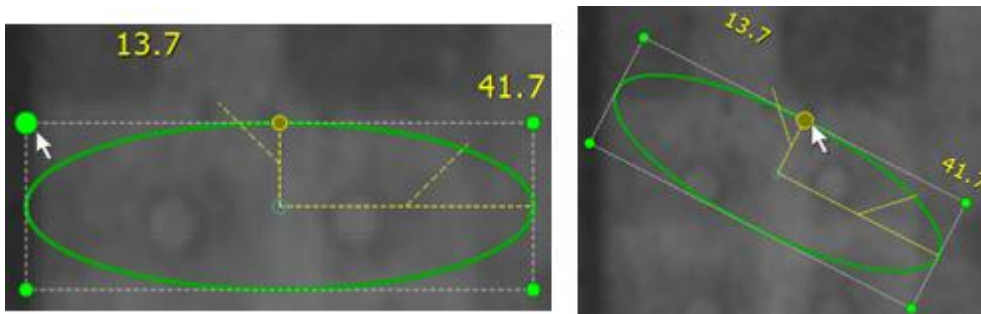
Usage

Usually used for void inspection.

Annotation Example

Major radius & Minor radius:

In this sample, 41.7 means the major radius and 13.7 means the minor radius of the ellipse.



Rectangle



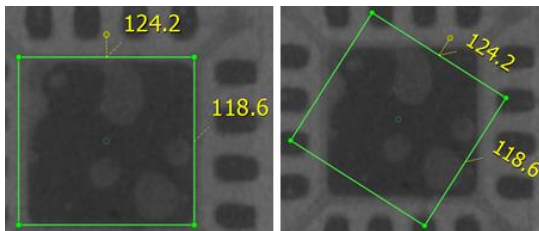
Usage

Usually used for void inspection.

Annotation Example

Length: 124.2 means the length of the rectangle.

Width: 118.6 means the width of the rectangle.

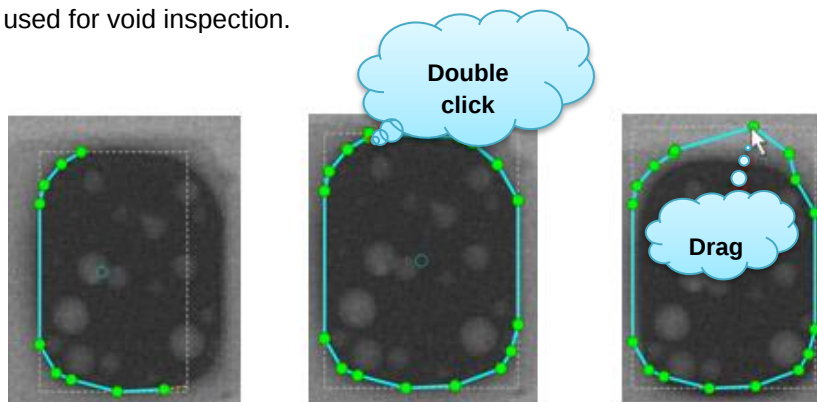


Polygon



Usage

Usually used for void inspection.

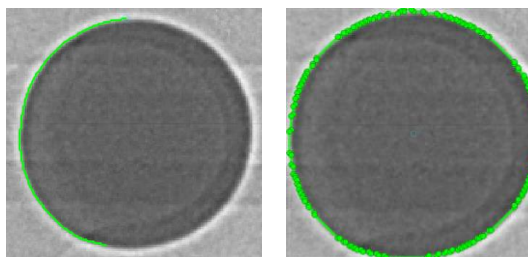


Lasso



Usage

Usually used for void inspection.



5.4.3. Non-Closed Shapes

Line Tools



Usage

Usually used to measure length or height.

[NOTE]

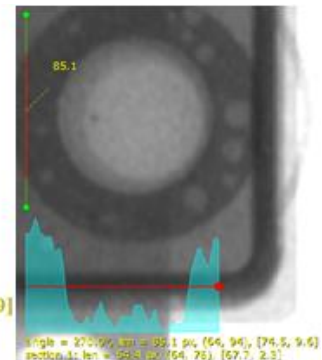
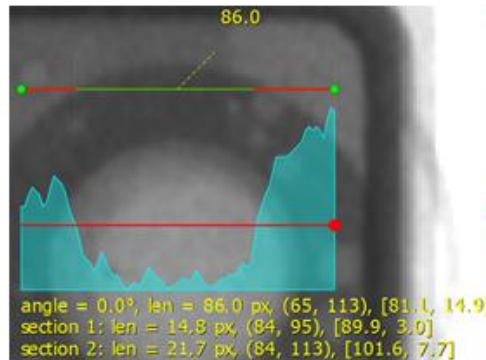
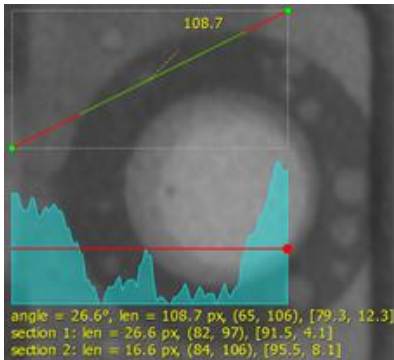
HADI uses **red** and **green** colors to separate lines into sections based on profile thresholds. If you cannot distinguish between sections, change the measurement tool border color to a different color (not red).

Annotation Example

1. Angle: the angle between the horizontal and free line (counterclockwise)
2. Length: displayed in pixels or calibrated unit.
3. Intensity Value:
(65,106) and [79.3, 12.3] = (min, max) and [mean, variance] intensity value of the line.
4. Section: length and intensity values for each red section.

[NOTE]

1. Double-clicking the line changes the measurement part (indicated by **red**).
2. Only the measurement (**red part**) information is displayed in the annotation.



Text Tool



Usage

It is typically used to insert information about measurement tools.



Ratio Tool

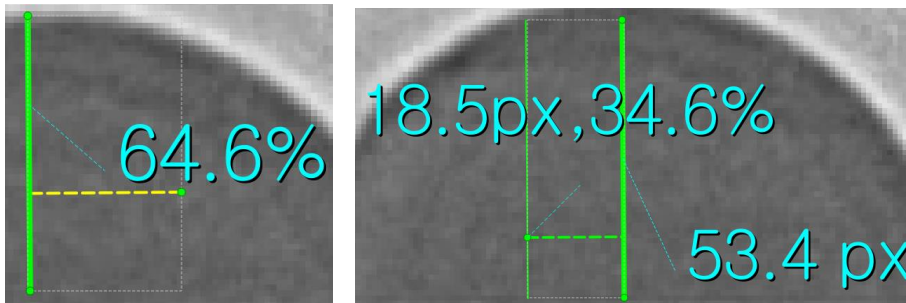


Usage

It is typically used to measure the ratio of the length of a vertical point to a set criterion (length).

Annotation Example

Ratio: the ratio of the length of a vertical point to a set criterion (length).



Distance Tool

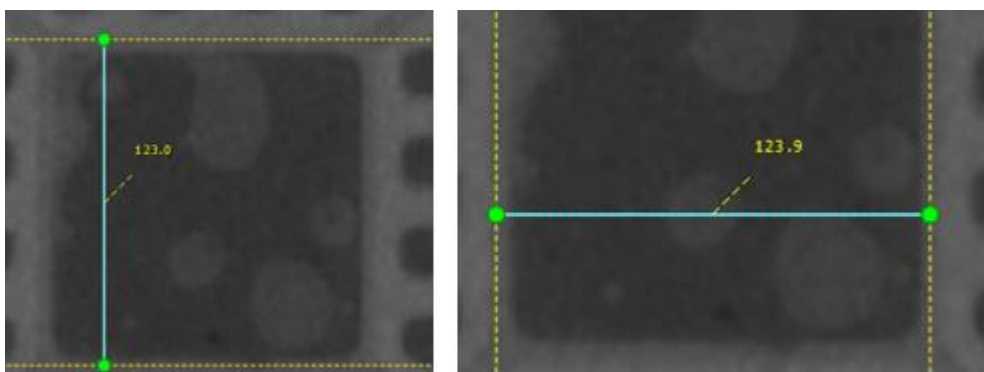


Usage

It is usually used to measure the length or width of the chip.

Annotation Example

Length: The length from the start point to the end point of the ruler.
It is displayed in pixels or calibrated unit.



Angle Tools

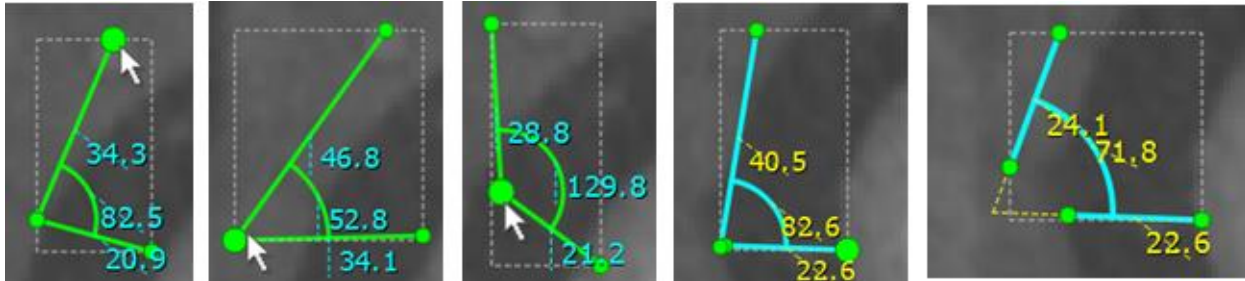


Usage

It is usually used to measure the angle between two lines.

Annotation Example

Angle: The angle between two lines.



Others



Usage

Usually used to mark a specific part.

Annotation Example

Length: The length from the start point to the end point of the ruler.
It is displayed in pixels or calibrated unit.

