

Self Tuning

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1 Self Tuning Overview

Self tuning feature is for automatic inspection data optimization. Based on selected criteria Self Tuning feature sets tolerances for given algorithm sample value's based on data collected on one or multiple PCBs

2 Operating Environment

BF2 for 3Di Machine.

3 Self Tuning Function Activation

- 1) Open *BF2 Options* - section *System – Plugin*.
Confirm *Com.Sakicorp.BfCore.Autotuning* plugin is enabled. If not please enable and restart BF2.

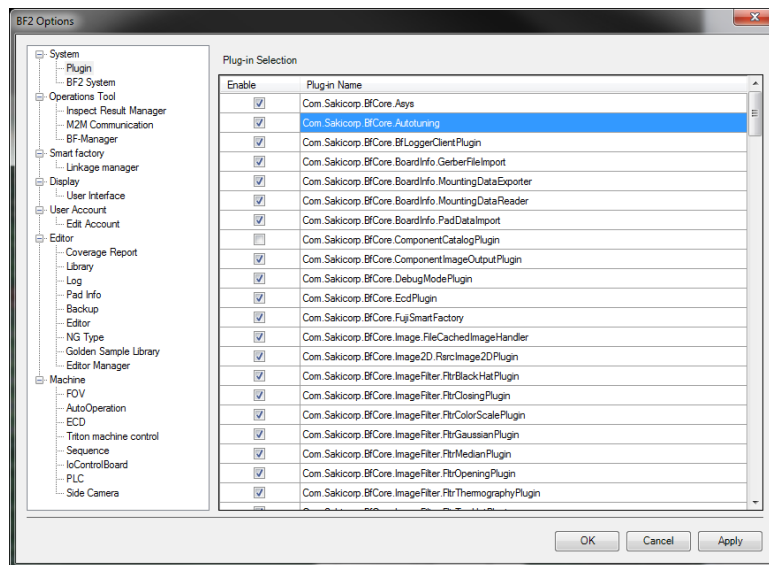


Figure 1 Plugin setting

- 2) Open *BF2 Options* – section *User Account – Edit Account*
Confirm *Menu.Autotuning* is allowed. Restart BF2 or log out current account.

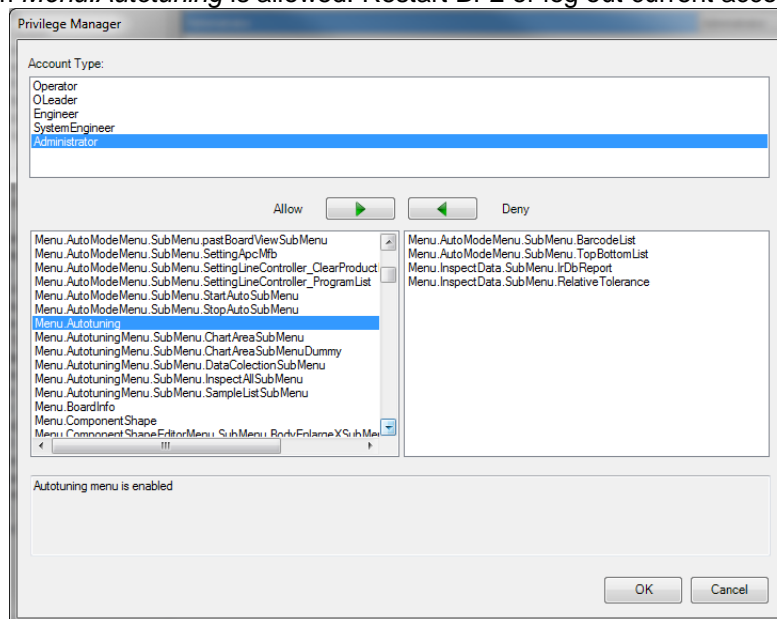


Figure 2 Privilege settings

3) After restart of BF2 Self Tuning tab is visible in main BF2 ribbon menu.

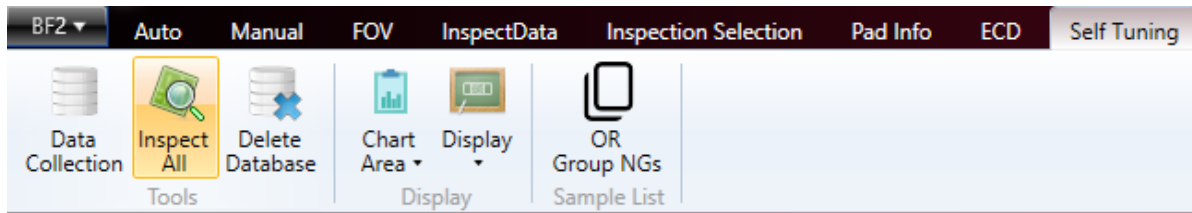


Figure 3 Self Tuning Tab

4 Features

The tools and function of Self tuning are implemented in separated “Self Tuning” tab structured to several functional sections. Self Tuning tab works only with the data of currently loaded inspection program.

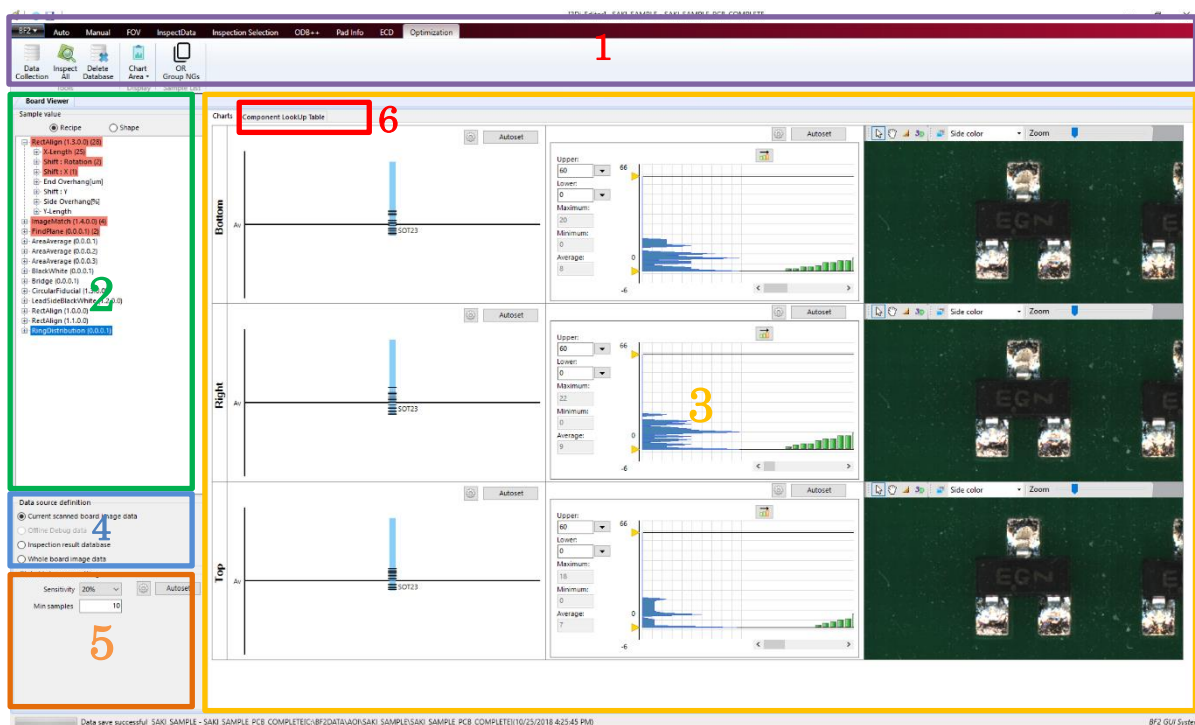


Figure 4 Self Tuning tab

4.1 List of functional sections

Sections	Detail
1. Top ribbon	Ribbon with basic functions and tools: “Data Collection” to collect data & images in automated mode, “Inspect All” to refresh inspection results, “Delete Database” to delete one or more databases if required, “Chart Area” enabling different sorting of Chart section, “OR Group NGs” enabling to show/hide NG counting for sample values exceeding tolerance in case they are in OR group with other algorithm.
2. Sample value	Showing list of algorithms used in loaded inspection program with three structure up to specific sample values and NG types with appropriate count of sample values exceeding given tolerance. By setting Recipe or Shape “Charts” section graphs are organized by particular Recipes or grouped into Shapes.
3. Charts	Section is showing bar charts and histograms of sample values for selected algorithm on Sample value section.
4. Data Source Definition	Enables to define from which source Self Tuning function takes current results and count of NG sample values. Section enables to take data from: <ul style="list-style-type: none"> • Current board image loaded in operation memory • Inspect Result Database values for related recipes and algorithms. (Data are valid only until change of input parameters for given recipe) • Whole board image data enable loading into Self Tuning tab sample values inspected on several whole board images for given program stored previously • <i>Offline Debug data – currently not available!</i>
5. Global Tolerances Settings	Section enables to set criterias for setting of lower tolerance level (LTL) and upper tolerance level (UTL) for given algorithms, sample values, ng kinds. Autoset button applies UTL & LTL corrections for all sample values defined in criterias according to particular definition. Sensitivity parameter is defining ratio of corrections applied to current tolerances from calculated correction factor. Min samples enable applying correction tolerance correction factor only for sample values where number of samples is greater than Min samples.
6. Component Lookup Table	Additional tab listing up all sample values deployed into related recipes with their current tolerances and information about last Self Tuning adjustment

Table 1: List of sections

4.1.1 Detail of Top Ribbon

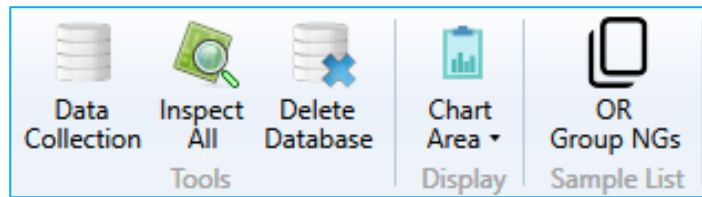


Figure 5 Top Ribbon

Data Collection

Data collection function allows to collect multiple board images in automated loop

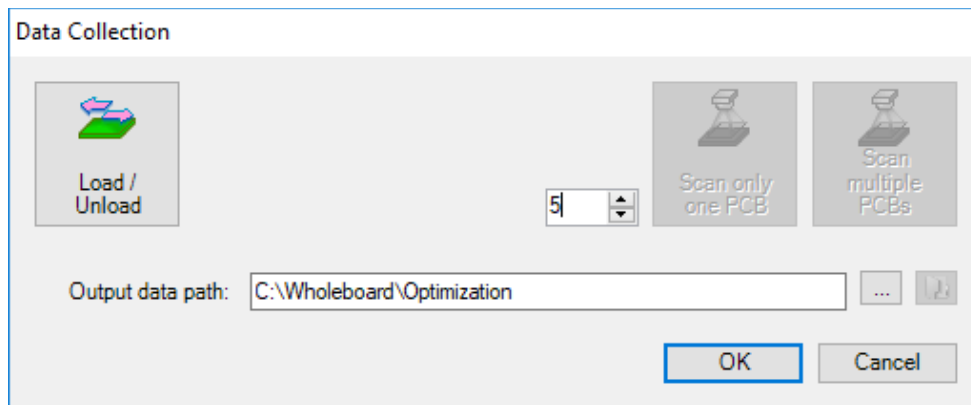


Figure 6 Data Collection window

Output Data path – specify path used to save whole board images by Data Collection. Path is also used to Load&Inspect whole board images once “whole board image data” is used in Data source definition.

Inspect all

Function is performing inspection based on selection made in “Data Source Definition” and fills sample values to Chart section.

Delete Database

Function allows to delete an existing inspect result database of loaded inspection group.

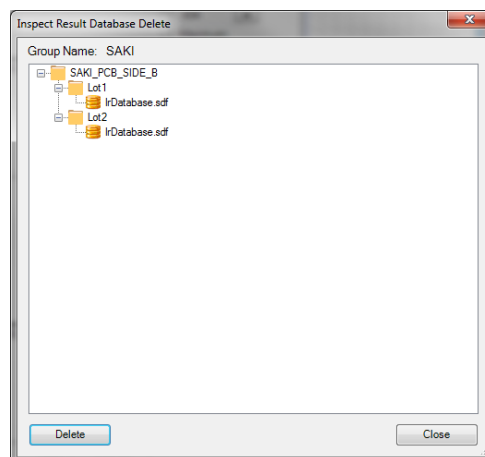


Figure 7 Inspect result database delete dialog

Chart Area

Allows to sort bar graphs of recipes resp shapes in Chart section by

- Ng count – recipes resp. shapes with highest number of excessive sample values will be displayed first
- Name – recipes or shapes are sorted alphabetically
- Sigma – sorting is performed from the largest standard deviation of acquired sample values to the smallest (helps to determine recipes resp. shapes where input values of related algorithm should be checked due to high spread of sample values)

Note:

Self tuning Chart area is listing all recipes/shapes with given algorithm/sample value. Various sorting of the Chart area helps programmer and program optimizer to focus on tolerance adjustments at first or to focus first on recipes/shapes where values measured has widest range (sigma) and are likely candidates for algorithm input values optimization.

OR Group NGs

Function allows to hide or show sample values on “Sample value” section exceeding tolerances in case given algorithm is in OR group with another algorithm. Recipes resp. shapes where given algorithm is in OR group are visualized with bars without filling in “Charts” section.

Example:

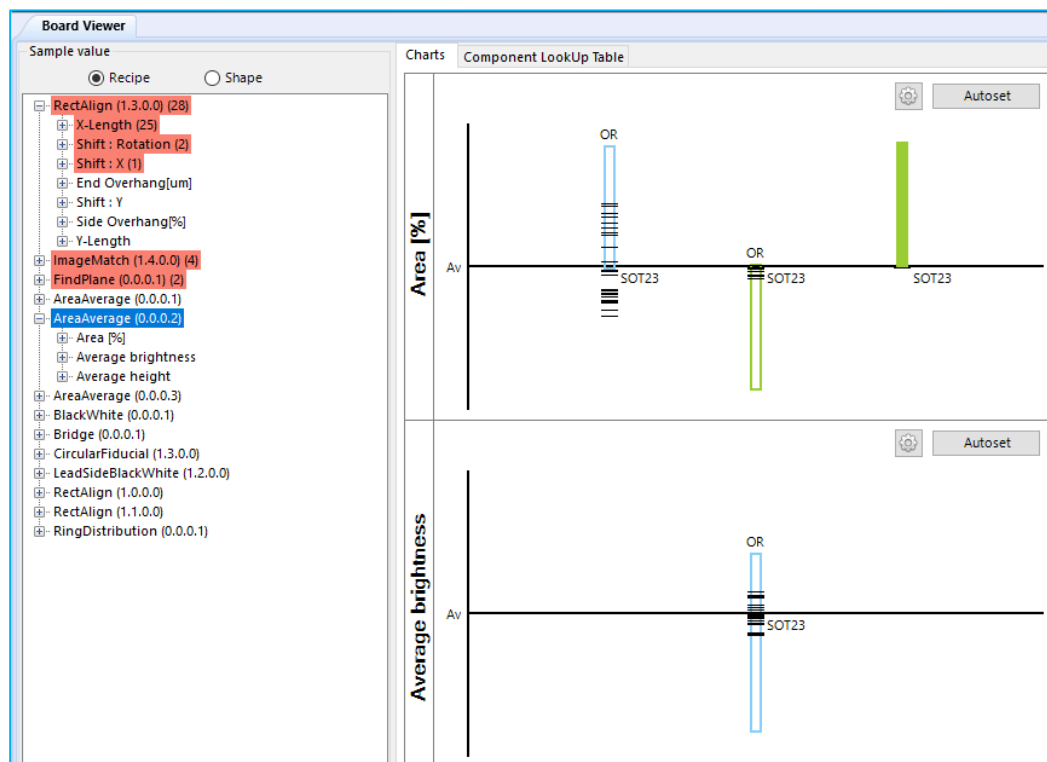


Figure 8 Example of Recipe with hidden OR group results

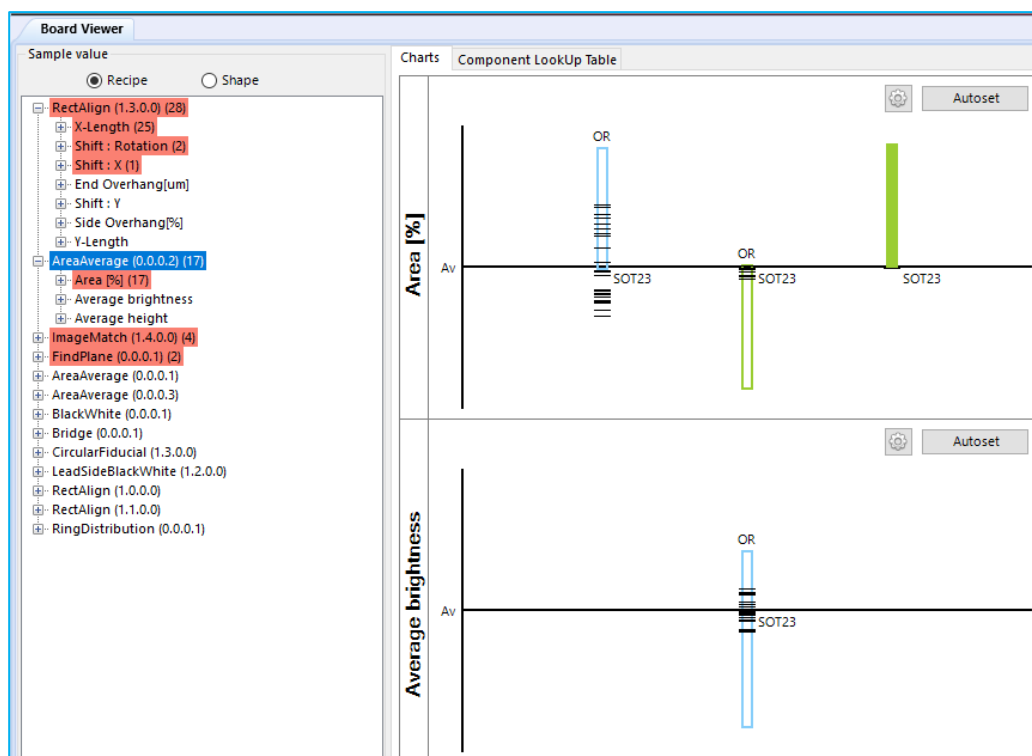


Figure 9 Example of Recipe with shown OR group results

4.1.2 Detail of Chart section

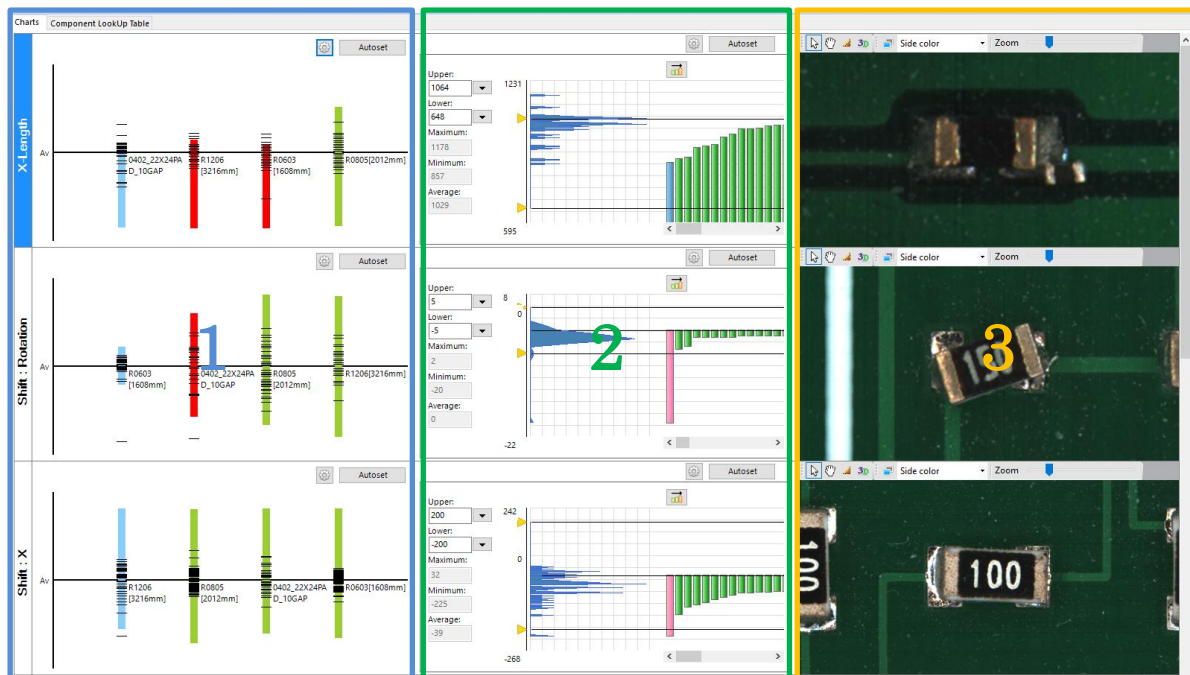


Figure 10 Chart section of Self Tuning tab

The Chart section contains

- 1) Bar graphs showing sample values and tolerances for different recipes resp. shapes having particular algorithm selected in Sample value.
- 2) Histograms of sample values for first or selected bar graph in the “Bar graph” of “Chart” for given sample value.
- 3) Component image of first or of selected reference position in the histogram part of the “Chart” is displayed. By double mouse click Recipe Editor is called in order to adjust parameters on specific part in recipe editor.

4.1.3 Detail of Data Source Setting

Enables to define from which source Self Tuning function takes current results and count of NG sample values. Section enables to take data from:

- Current board image loaded in operation memory
- Inspect Result Database values for related recipes and algorithms. (Data are valid only until change of input parameters for given recipe. Data should be dumped manually in case tuning is performed on input parameters)
- Whole board image data enable loading into Self Tuning tab sample values inspected on several whole board images for given program stored previously
- Offline Debug data – currently not available!

Once Inspect all is pressed and in case “Whole board image data” is selected, system will search load and inspect the images stored under the folder specified in “Data Collection” function setup window and put all result into the Self Tuning for further processing until next “Inspect All” is initiated.

4.1.4 Detail of Global Tolerance Setting

Enable to set edit Global tolerance table setting, initiate Autoset function for all involved Recipes/Shapes at once and to set "Min samples" to disable Autoset function for all Recipes/Shapes where Self Tuning tab has less than Min samples sample value of particular kind to optimize and Correction "Sensitivity".

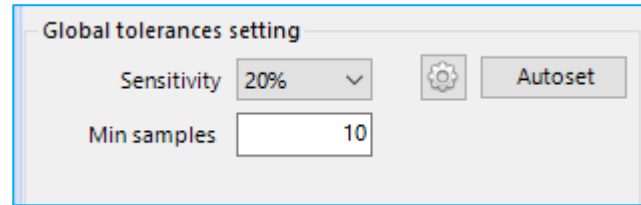
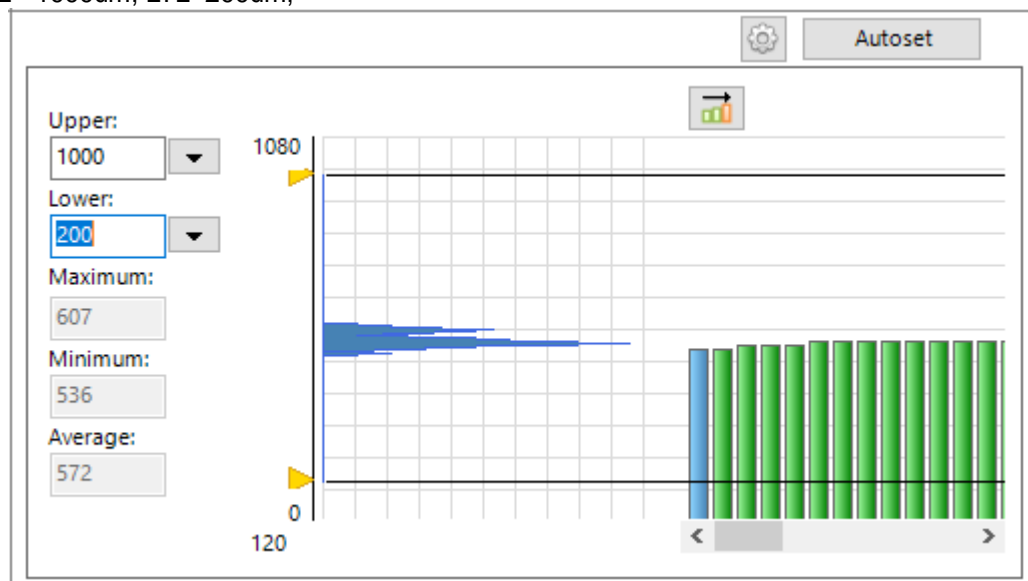


Figure 11 Global Tolerance Setting Section

Note: Sensitivity parameter example

Algorithm: FindPlane
Sample: Height
NG kind: N/A

Average height of related Recipe =572um,
 UTL= 1000um, LTL=200um,



Correction criteria: UTL -> +10% of average height, LTL -> -10% of average height
 Calculated correction factor: $UTL = 1000 - (572 + 0.1 \cdot 572) = 371^1$

Sensitivity parameter: set to =20%
 Applied correction factor for UTL is $= 0.2 \cdot 371 = 74$

Resulting UTL = $1000 - 74 = 926$

Setting of Global Tolerance table

Global tolerance table can be opened from *Setting* button on Global tolerance setting section

¹ Values are rounded

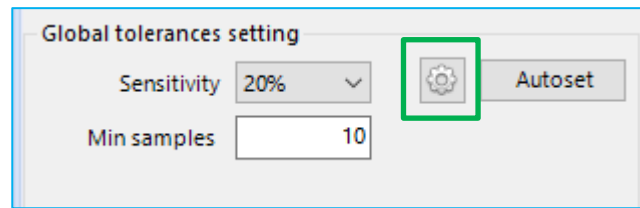


Figure 12 Global tolerance table setting

Global tolerance table enables to set particular correction requirement for upper tolerance level and lower tolerance level for any algorithm\sample value\Ngtype involved in inspection on given program.

Note:

System does not differentiate between different algorithm versions. If the same Sample value exist in various algorithm versions correction is applied.

Algorithm	Sample	NG Type	Lower	Upper
AreaAverage	Area	All	Av-3σ	Av+3σ
AreaAverage	Average height	All		
AreaAverage	Sample value[%]	All		
AreaAverage	Volume [um3]	All		
Black White	Sample[%]	All		
Bridge	BridgeHeight	All		
CircularFiducial	Circle Match	All		
CircularFiducial	Inside average	All		
CircularFiducial	Inside avg. - outside avg.	All		
CircularFiducial	Location : Rotation	All		
CircularFiducial	Location : X	All		
CircularFiducial	Location : Y	All		
CircularFiducial	Location : Z	All		
CircularFiducial	Shift : Rotation	All		
CircularFiducial	Shift : X	All		
CircularFiducial	Shift : Y	All		
CircularFiducial	Shift : Z	All		
FindPlane	Area	All		

Figure 13 Global Tolerance Table

4.1.5 Detail of Component Lookup table

Component lookup table provide overview of currently used tolerances and giving information if tolerances for given sample value had not yet been modified, had been modified by user manually or had been modified by Autoset correction.

Charts Component LookUp Table									
Shape	Recipe	LinkID	Algorithm	Sample Name	Tolerance Low	Tolerance High	Modified	Autotune	
R0805[2012mm]	R0805[2012mm]	0805_50X48PAD_22GAP	AreaAverage (0.0.0.3)	Area [%]	36	103	Automatically	<input checked="" type="checkbox"/>	
R0805[2012mm]	R0805[2012mm]	0805_50X48PAD_30GAP	AreaAverage (0.0.0.3)	Area [%]	36	103	Automatically	<input checked="" type="checkbox"/>	
R0805[2012mm]	R0805[2012mm]	0805_50X48PAD_18GAP	AreaAverage (0.0.0.3)	Area [%]	36	103	Automatically	<input checked="" type="checkbox"/>	
R0805[2012mm]	R0805[2012mm]	0805_50X48PAD_10GAP	AreaAverage (0.0.0.3)	Area [%]	36	103	Automatically	<input checked="" type="checkbox"/>	
R0805[2012mm]	R0805[2012mm]	0805_50X48PAD_38GAP	AreaAverage (0.0.0.3)	Area [%]	36	103	Automatically	<input checked="" type="checkbox"/>	
R1206[3216mm]	R1206[3216mm]	1206_70X40PAD_60GAP	FindPlane (0.0.0.1)	InclinationX	-219	100	Manually	<input checked="" type="checkbox"/>	
R0603[1608mm]	R0603[1608mm]	0603_35X20PAD_30GAP	RectAlign (1.3.0.0)	Shift : Rotation	-5	5	None	<input checked="" type="checkbox"/>	
R0603[1608mm]	R0603[1608mm]	0603_35X20PAD_30GAP	FindPlane (0.0.0.1)	Area	30	100	None	<input checked="" type="checkbox"/>	
R0603[1608mm]	R0603[1608mm]	0603_35X20PAD_34GAP	BlackWhite (0.0.0.1)	Sample value[%]	35	100	None	<input checked="" type="checkbox"/>	
R0603[1608mm]	R0603[1608mm]	0603_35X20PAD_30GAP	FindPlane (0.0.0.1)	Height	365	565	None	<input checked="" type="checkbox"/>	
R0603[1608mm]	R0603[1608mm]	0603_35X20PAD_30GAP	RectAlign (1.3.0.0)	Side Overhang[%]	0	25	None	<input checked="" type="checkbox"/>	
R0603[1608mm]	R0603[1608mm]	0603_35X20PAD_30GAP	RectAlign (1.3.0.0)	Y-Length	619	919	None	<input checked="" type="checkbox"/>	

Figure 14 Component Lookup table

Column “Autotune” enables to make exception for specific Recipe in order not to be involved in correction by Autotune parameters.

5 Operation with Self Tuning tab

Self Tuning tab allows to correct tolerances for related Recipes

- Manually
- By “Autoset” function

Manual correction

Manual tolerance setting is done by mouse dragging of respective bar on bar graph section of “Charts” up or down or by resizing the bar by upper or lower end.

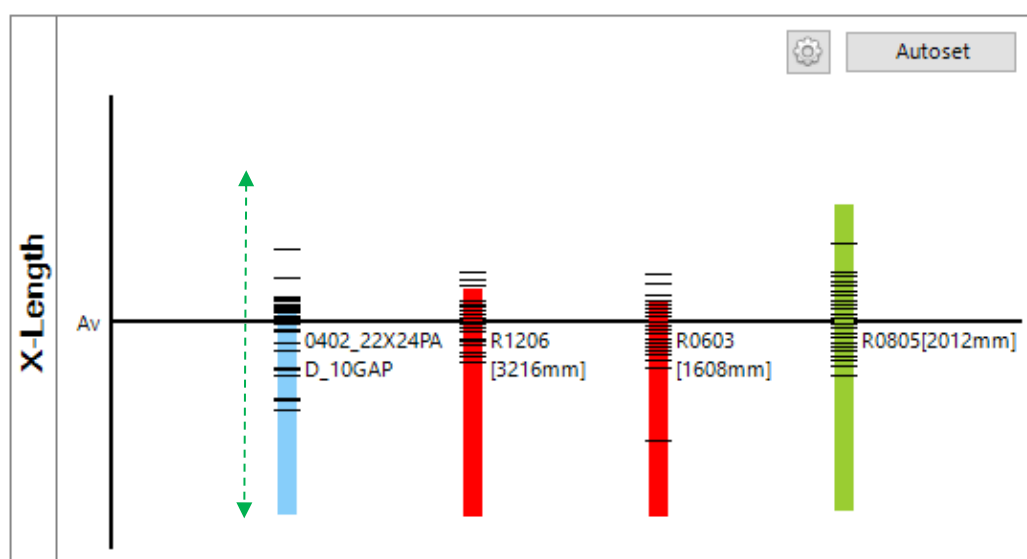


Figure 15 Bar graph adjustment

Tolerances for given Recipe/Shape can be adjusted also on Histogram chart of “Charts” section by selecting appropriate Upper or Lower tolerance by mouse dragging or by selection of specific criteria.

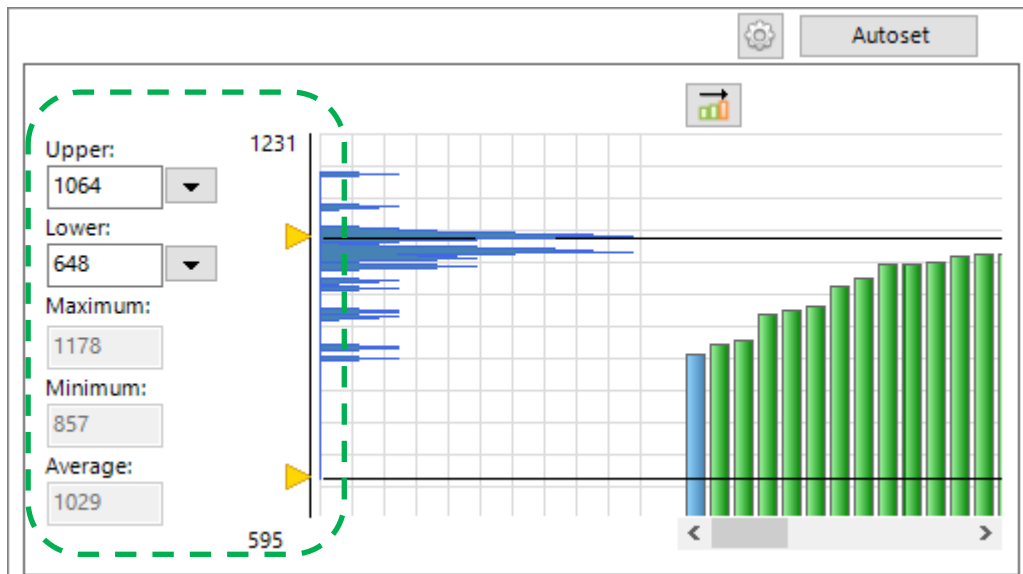


Figure 16 Histogram Setting

Correction by "Autoset" function

By pressing Autoset button, tolerances are corrected according to specific criteria listed in Tolerance Setting list.

Tolerance correction is applied for all sample values of all listed algorithms respectively for all Recipes/Shapes with one specific sample value, respectively for one Recipe/Shape only.

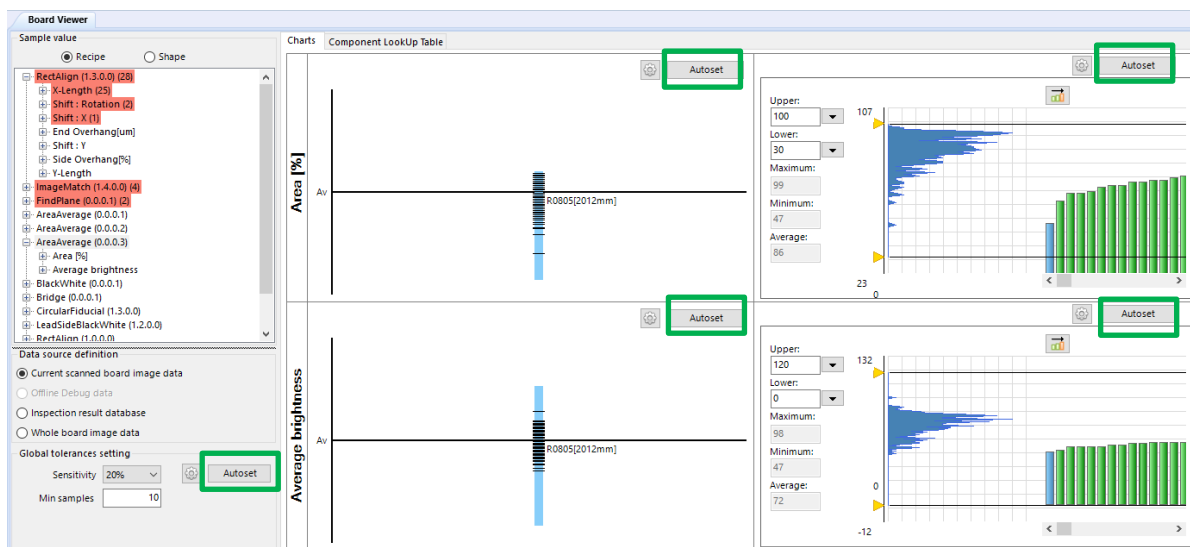


Figure 17 Autoset buttons for respective corrections

Note:

Autoset function always considers **Sensitivity** parameter and **Min Samples** (minimum allowable amount of samples) in "Global Tolerance Setting" section for correction of tolerances.

Operation Example:

- 1) Load program and board image and go to Self Tuning tab
- 2) Fill in/ check required tolerance correction target into the “Global Tolerance Table” Chapter 4.1.4 Detail of Global Tolerance Setting for particular Algorithm & Sampel Value & NG Kind I.e. algorithm RectAlign, sample X-lenfgth, Y-length set tolerance level to +/-10% from average.

Algorithm	Sample	NG Type	Lower	Upper
AreaAverage	Area	All	Av-3σ	Av+3σ
Rect Align	X-Length	All	Av-3σ	Av+3σ
Rect Align	Y-Length	All	Av-3σ	Av+3σ
AreaAverage	Volume [um3]	All		
Black White	Sample[%]	All		
Bridge	BridgeHeight	All		
CircularFiducial	Circle Match	All		
CircularFiducial	Inside average	All		

Figure 18 Example of setting of correction target

- 3) Press “Inspect All” button from top ribbon of Self Tuning tab
- 4) Set Sensitivity on 50% on 4.1.4 Detail of Global Tolerance Setting
- 5) Press Autoset on 4.1.4 Detail of Global Tolerance Setting
- 6) Tolerances on all Recipes using Rect Align algorithm are corrected respectively for each Recipe for 50% of correction between original tolerance levels up to Av +/-3σ.

6 Operation with Offline Debug data

Offline debug data added to *Self Tuning* tab.

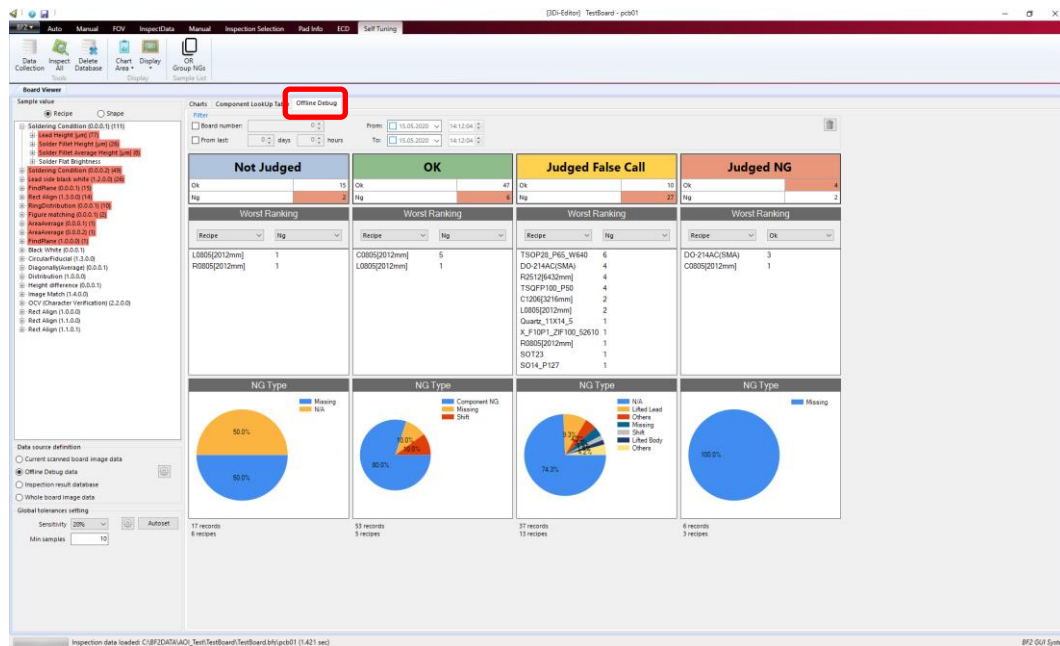


Figure 19 Offline Debug Data display in the Self Tuning tab

To display the *Offline Debug Data* on the *Self Tuning* tab, it is necessary to select *Offline Debug Data* option. The user needs to set which components should be used, if NJ, OK, FC and/ or NG data. Afterwards, click on *Inspect All* to view the data provenient from the *Offline Debug Data*.

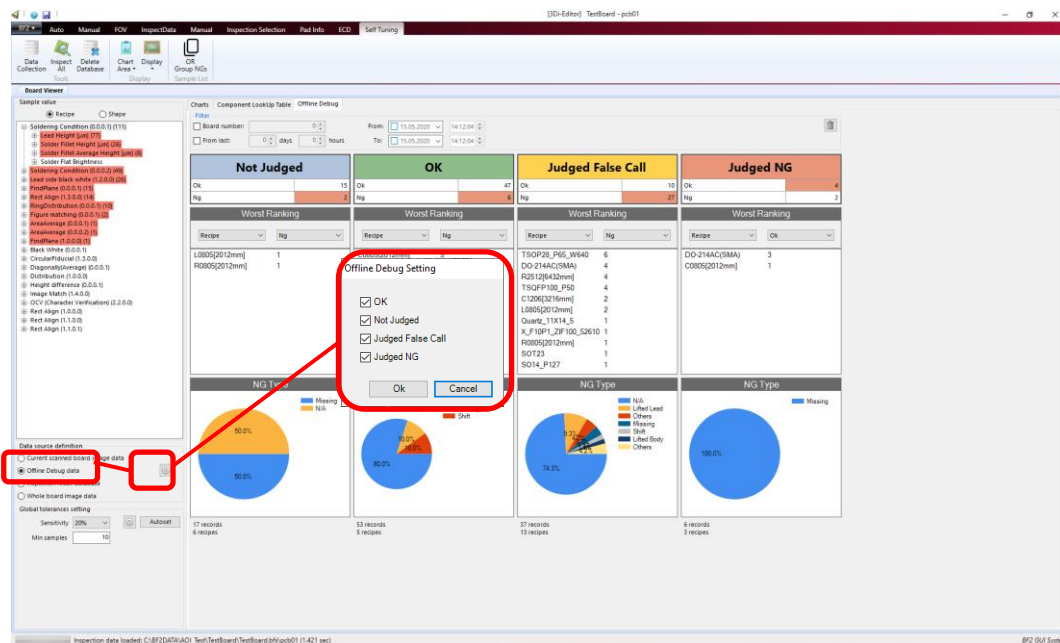


Figure 20 Offline Debug Data setup

Not Judged	Records with no judgement set by the operator
OK	Records seen by the machine as OK, or judgment set as OK by the operator through the recipe editor interface
Judged False Call	Records with judgement set as false call by the operator, either through real time judgement or through the recipe editor interface
Judged NG	Records with judgement set as NG by the operator, either through real time judgement or through the recipe editor interface

The worst ranking displays the recipes with most OK or NG results, according to the operator's selection.

The pie chart displays the percentage of NG types responsible for the NG components.

The *Offline Debug Data* used for the *Self Tuning* can be filtered based on the number of boards starting from the last board; the number of days and hours relative to the current date and time; or by setting a time interval.

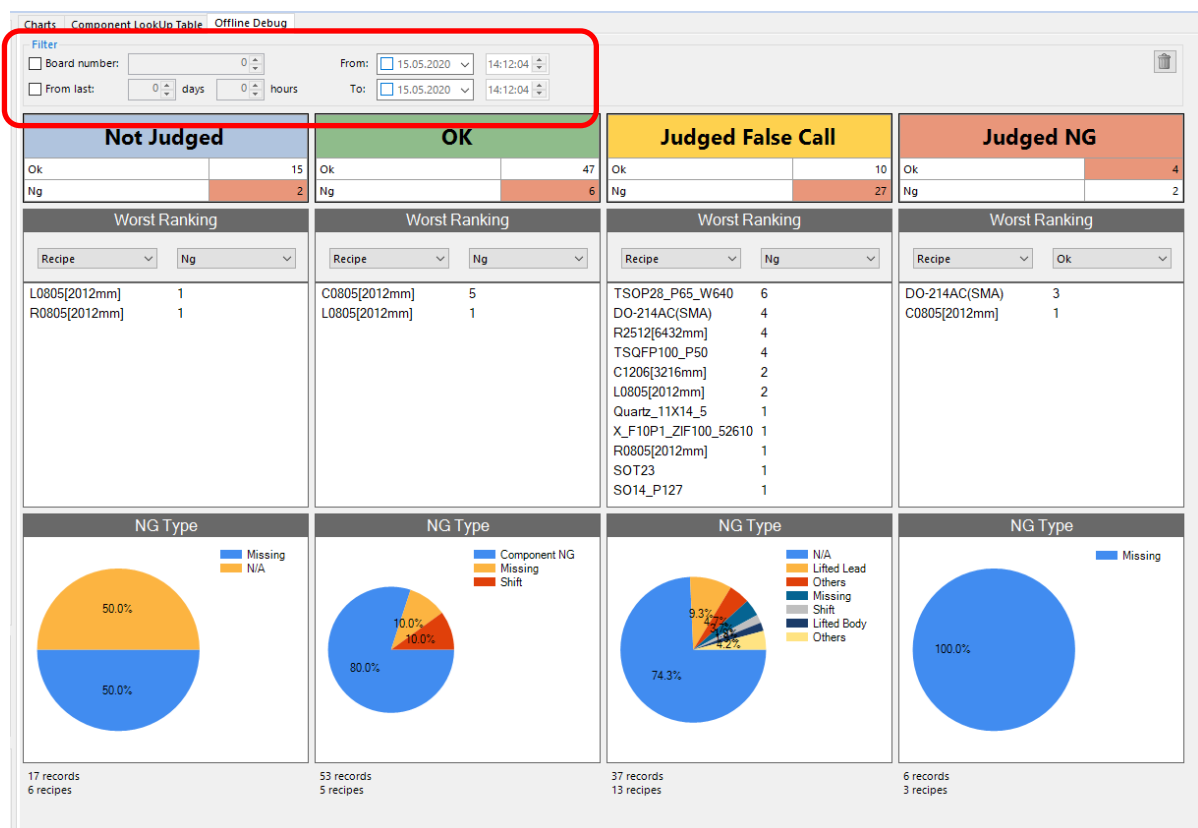
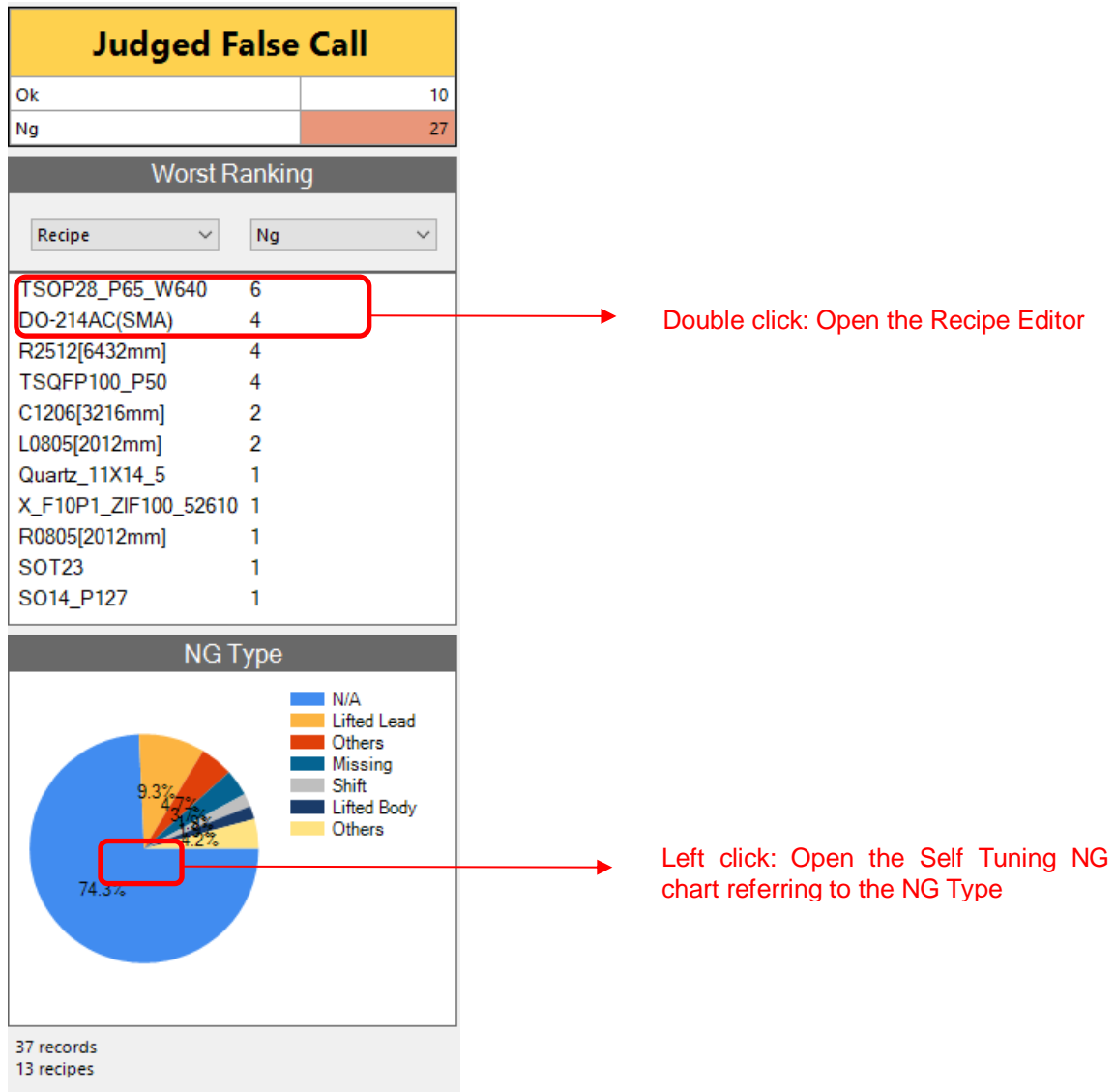


Figure 21 Offline Debug Data filtering

By double clicking on one recipe from the recipe list, the recipe editor for selected recipe will be opened.

By single clicking the target slice of the pie chart, the self tuning chart for the selected NG type will be opened.



The background colors of the *Ok* and *Ng* cells will change accordingly to their position:

- In the *Ok* column, the cells will turn green when the number of OK components is equal to the number of registered components, and red otherwise;
- In the *Judged False Call* column, the cells will turn green when the number of OK components is equal to the number of registered components, and red otherwise;
- In the *Judged Ng* column, the cells will turn green when the number of NG components is equal to the number of registered components, and red otherwise.
- In the *Not Judged* column, the cells will remain red while the number of registered components is bigger than zero.

Not Judged		OK		Judged False Call		Judged NG	
Ok	15	Ok	47	Ok	10	Ok	4
Ng	2	Ng	6	Ng	27	Ng	2

Figure 22 Result header with colors

7 Revision History

Revision	Date	Description	Written by
00	2018/10/23	Document skeleton created	B. Benda
01	2018/10/26	Document updated	M.Kostadinov
02	2018/10/29	Review	B. Benda
03	2019/03/13	Document updated	P. Votruba
03	2019/03/13	Review, formal changes.	B. Benda
04	2020/05/19	Document updated	A. Corte
05	2020/06/16	Modified Chap 4.1.1 / Chart Area	M. Kostadinov