

Application Note

AWB20060321

How to create a simple “AutoLearn” Recipe?

FEATURES

Process Surface Distribution

Process Step

Process Signature

Filter – k-NN Using Min-Max

Train

Document the recipe

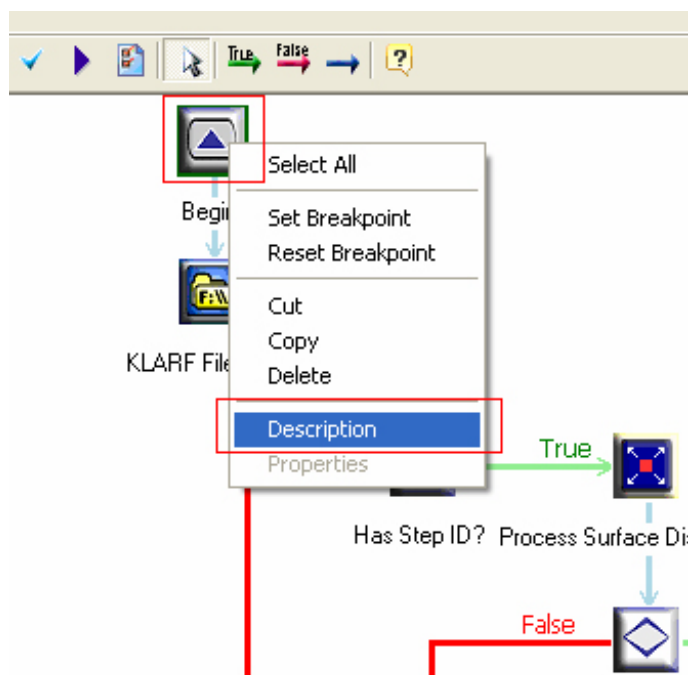
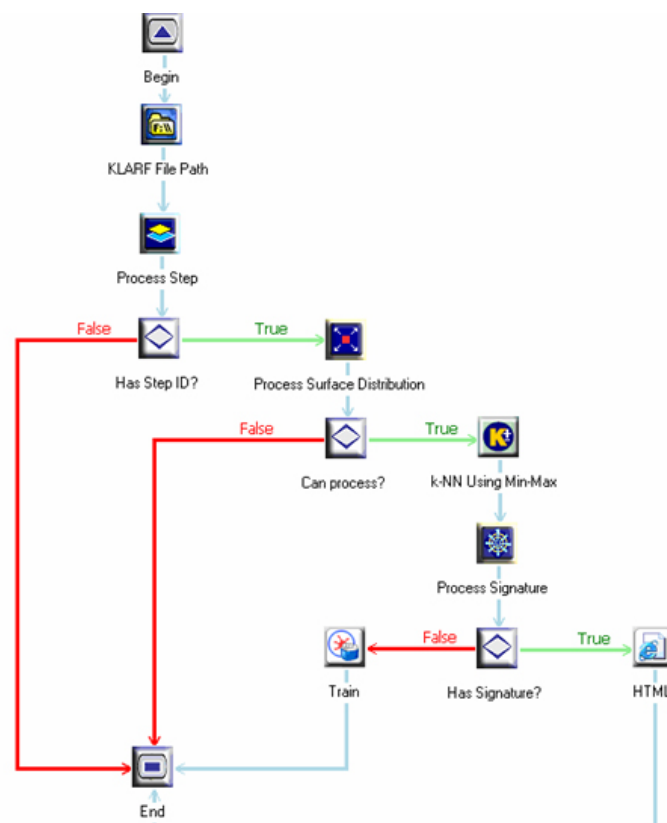
Dynamic Signature Library



Introduction

The new function, called *AutoLearn*, automatically trains previously unknown spatial signatures into its dynamic defect signature library. If the signature repeats on any subsequent results file, the recipe with *AutoLearn* function, see Fig. 1, the recipe will automatically recognize it, classify it and notify the user by email or publish the signature to a *Web Portal*. This application note describes how to use the *Automation Workbench (AWB)* to create a recipe or program flow to monitor a KLARF's folder for previously unknown spatial signatures, with an average k-NN distance less than 500 microns.

Figure 1 Recipe with AutoLearn Library ▶▶▶



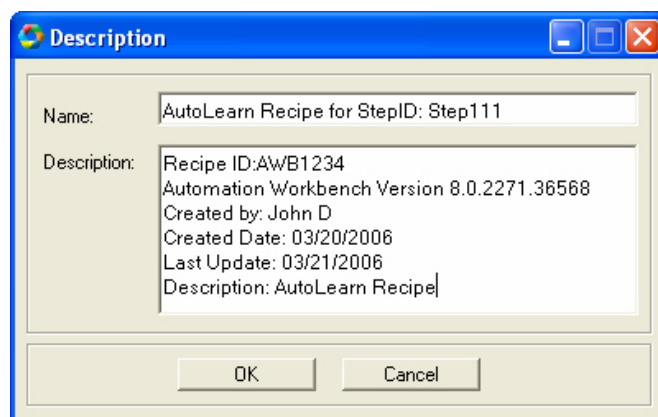
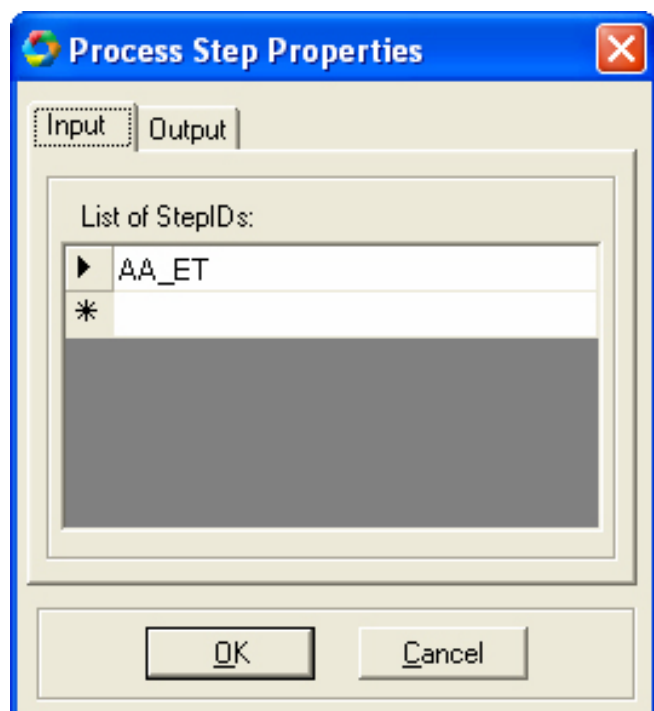
Begin

The recipe in Figure 1, starts with the “*Begin*” node, and it is considered a good practice to document the recipe, using the “*Description*” note. See Figure 2.

◀◀◀ Figure 2 Choose “*Description*” in “*Begin*” node

Point the cursor to the “Begin” node, right-click on the mouse button and choose “Description” to start to document the recipe. See Figure 3.

Figure 3 Document the recipe ►►



Process Step

To obtain the best accuracy for signature recognition, SiGlaz recommends that input KLARFs are selected by Step ID in order to have a consistent level of background (random) defects. When creating a new recipe, it is usually a good practice to start by monitoring a single step in the fabrication process. Additional process steps with similar background levels and similar signatures can be added to the list of Step IDs once the recipe proves to be reliable for the initial process step. Use the “Process Step Properties” dialog to enter the *StepID* which you like to monitor. See Figure 4.

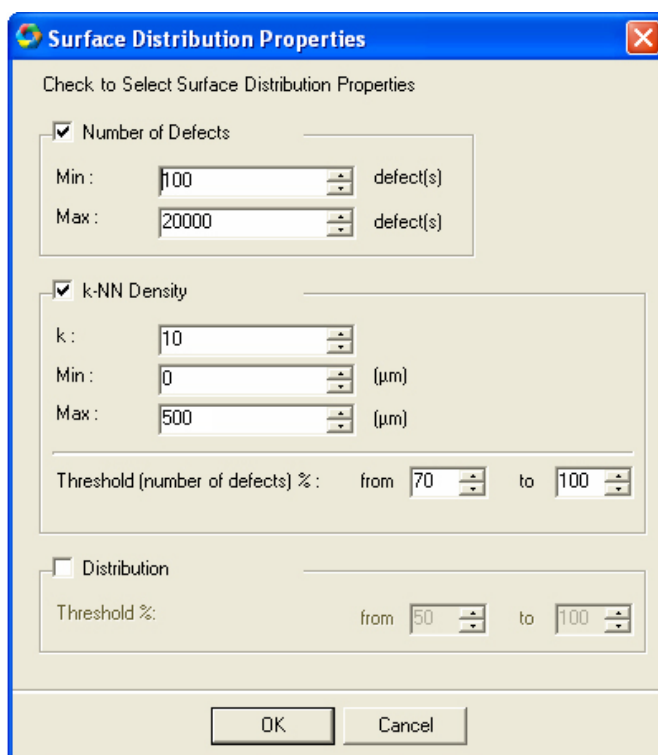
◀◀ Figure 4 Choose a StepID

Process Surface Distribution

Use *Process Surface Distribution* node to determine when the defect density distribution of the wafer meets the criteria for a defect signature. This function allows users to determine if the distribution of defects on the surface of the wafer is consistent with normal conditions. The user may input maximum and minimum values for defect count, k-NN distance and distribution percent. The function analyzes the distribution of defects on the wafer surface and determines if the distribution characteristics meet the specified parameters.

In this example, see Figure 5, we are looking to identify signature with defects that have proximity to their neighbors of approximately 500 microns and that have a defect pattern that constitutes more than 70% of the entire defects on the wafer.

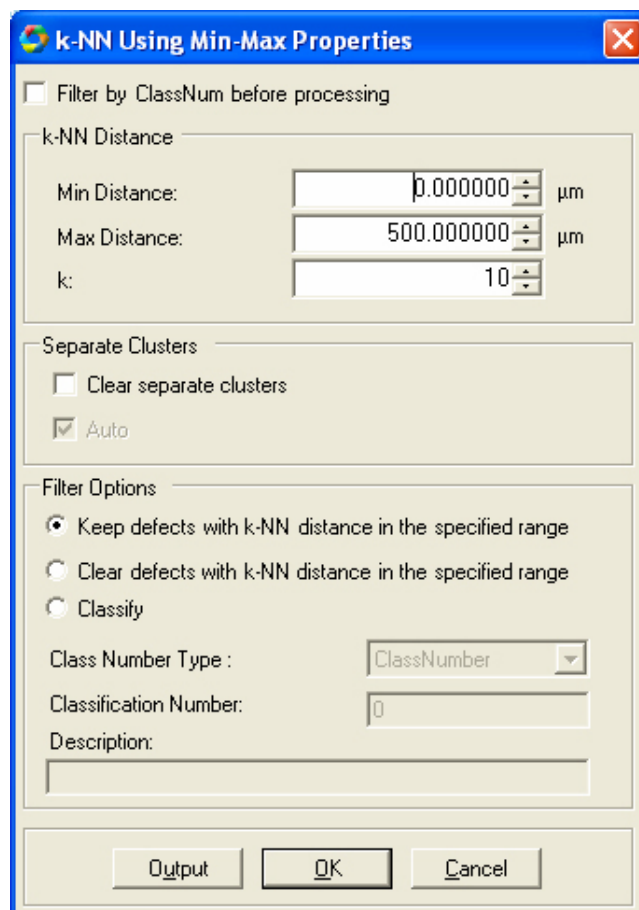
Figure 5 Surface Distribution Properties are selected to identify dense defect patterns ►►



K-NN using Min-Max

Use *k-NN using Min-Max* node to eliminate background defect that are not part of the defect pattern. See Figure 6. All defects that have k-NN distance above 500 microns will be filtered out. Note that it is also possible to classify defects in the desired density range and to use a "Filter by Classification Attributes" function to analyze only those defects.

Figure 6 Clear background defects from KLARF file ►►



Process Signature

Use *Process Signature* node with *Dynamic Library* option. Click on "Settings" to define the dynamic library. See Figure 7 and 8.

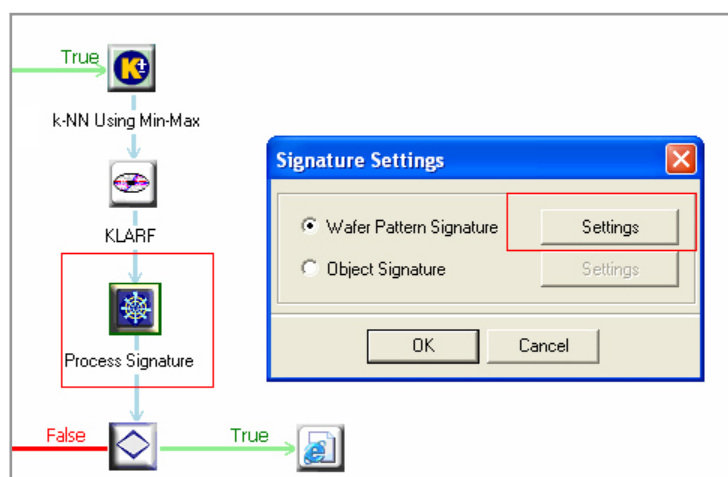


Figure 7 Click "Settings" to define dynamic library ▲▲

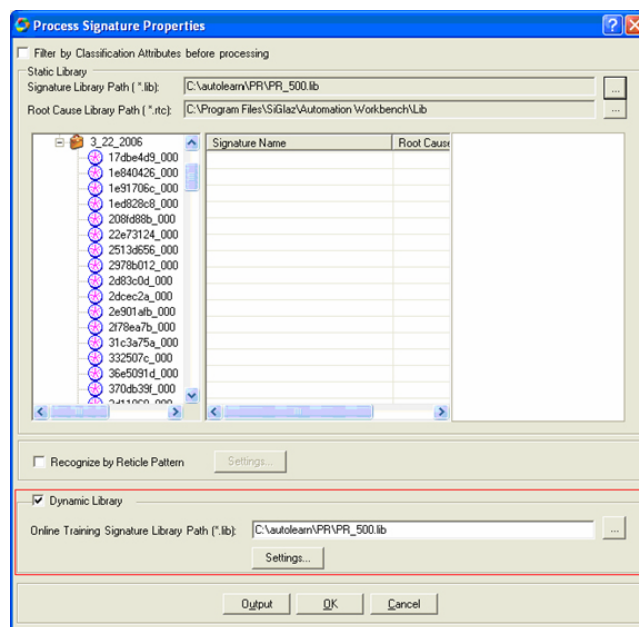
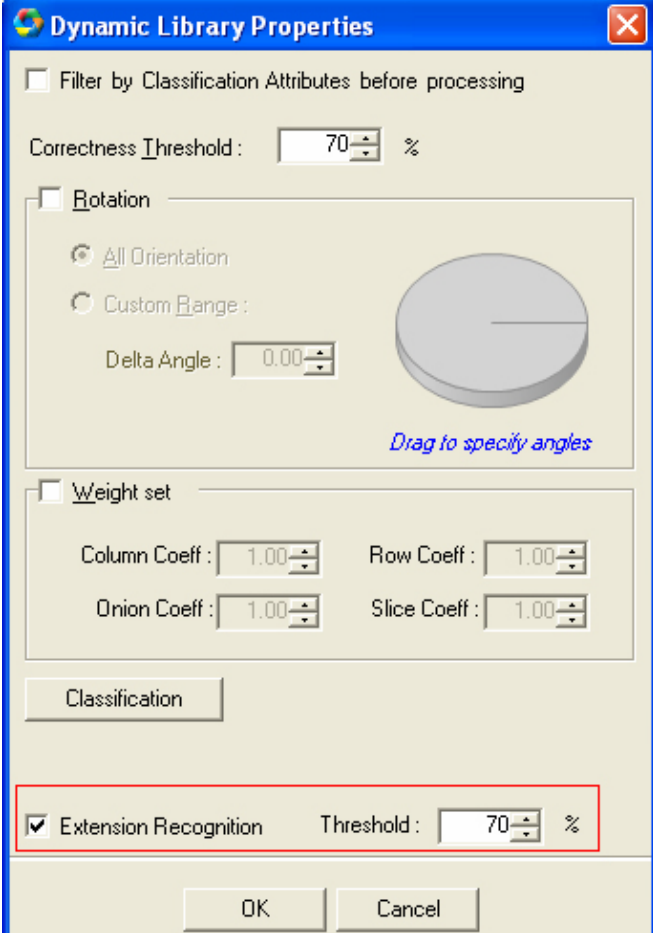


Figure 8 Define the "Dynamic Library" ▲▲

Click “Settings” to define pattern recognition properties using the dynamic library. See Figure 9. Use the Pattern Recognition Extension function to further define spatial attributes relating to the defect signature for detail pattern discrimination.

Figure 9 Use Pattern Recognition Extension ►►



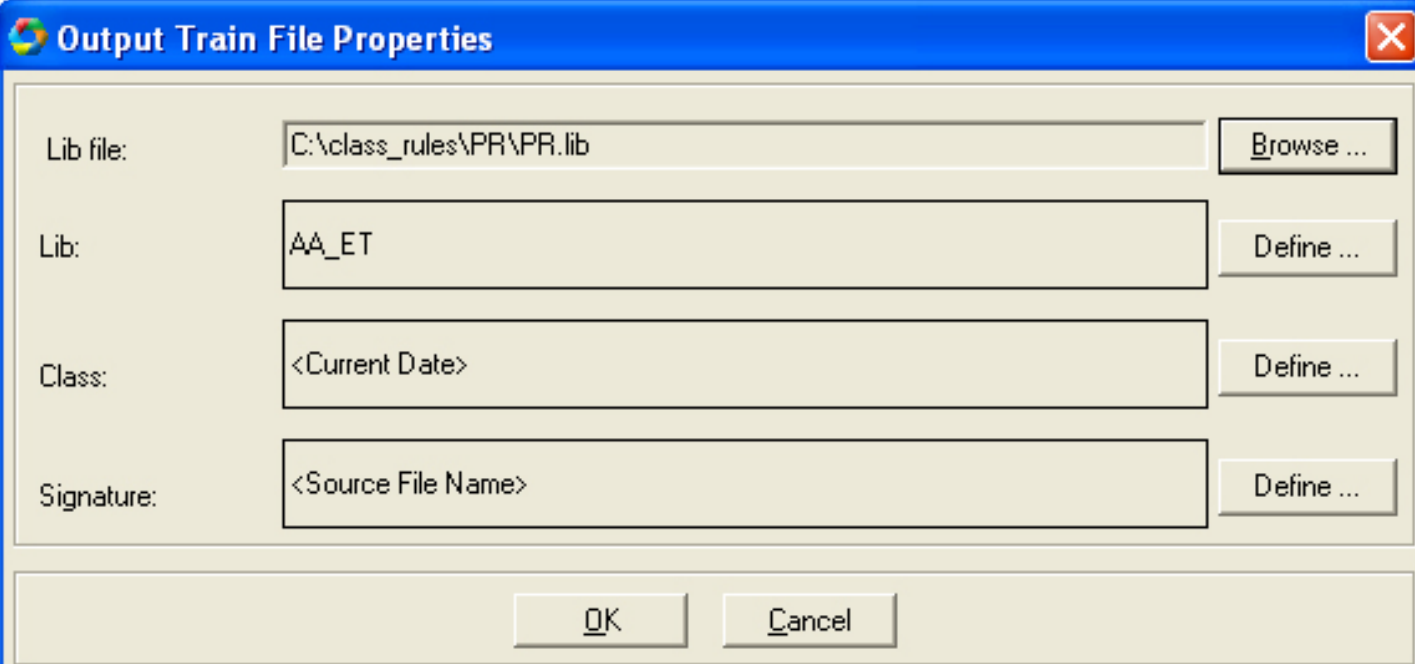
The **Dynamic Library Properties** dialog box is shown. It has a blue title bar with a close button. The main area is divided into several sections:

- Filter by Classification Attributes before processing**: A checkbox that is unchecked.
- Correctness Threshold**: A numeric input field set to 70, followed by a percentage sign.
- Rotation**: A section with two radio buttons: **All Orientation** (selected) and **Custom Range**. Below the radio buttons is a **Delta Angle** input field set to 0.00. To the right is a 3D pie chart with a line indicating an angle. Below the chart is the text *Drag to specify angles*.
- Weight set**: A section with four input fields: **Column Coeff** (1.00), **Row Coeff** (1.00), **Union Coeff** (1.00), and **Slice Coeff** (1.00).
- Classification**: A button.
- Extension Recognition**: A checkbox that is checked, with a **Threshold** input field set to 70 and a percentage sign. This section is highlighted with a red border.

At the bottom are **OK** and **Cancel** buttons.

Train

Use this option to define library name and file path and how the classes and signatures of the dynamic library will be named. See Figure 10



The **Output Train File Properties** dialog box is shown. It has a blue title bar with a close button. The main area contains four rows of input fields, each with a corresponding button on the right:

- Lib file**: Input field contains `C:\class_rules\PR\PR.lib`, button is **Browse ...**.
- Lib**: Input field contains `AA_ET`, button is **Define ...**.
- Class**: Input field contains `<Current Date>`, button is **Define ...**.
- Signature**: Input field contains `<Source File Name>`, button is **Define ...**.

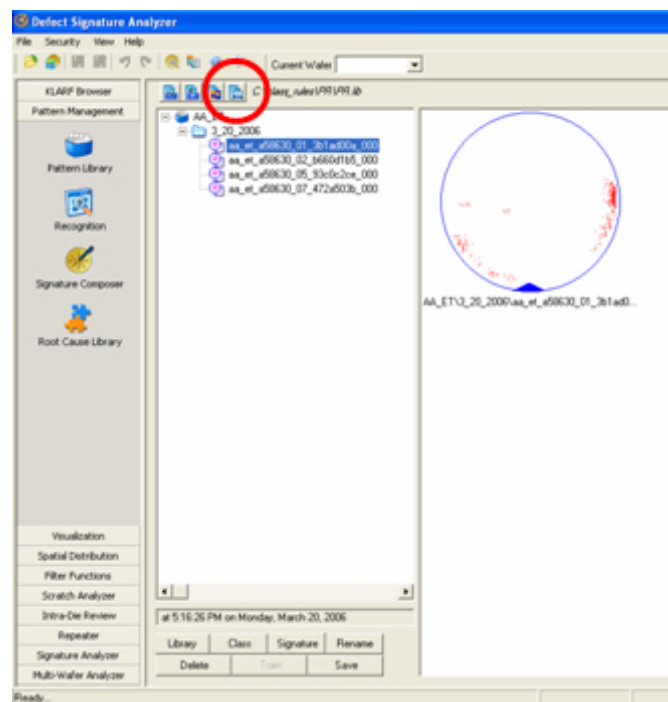
At the bottom are **OK** and **Cancel** buttons.

Figure 10 Dynamic Library ▲▲

Dynamic Library

You can use the *Defect Signature Analyzer* to view and manage the dynamic library. Use the “Merge Library” function (see red circle in Figure 11) to add the Dynamic Library to the existing DSA Library. The result of the dynamic library is shown in Figure 11.

Figure 11 Dynamic Library ►►►



HTML Results

The followings are samples of defect signatures that were not initially in the signature library. After AutoLearn trained the initial signature into the dynamic library, subsequent occurrences of the signature were recognized by the recipe.

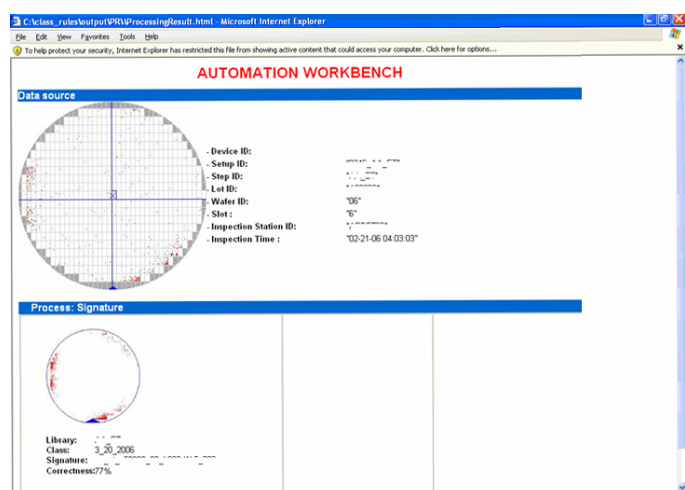


Figure 12 Edge Shading ▲▲

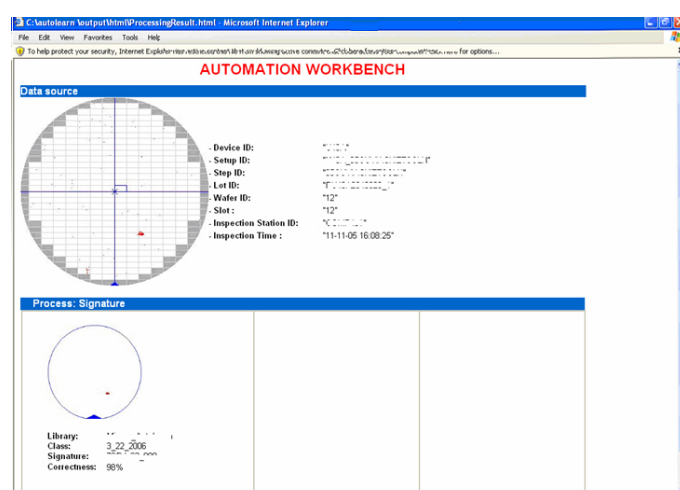


Figure 13 Blob ▲▲

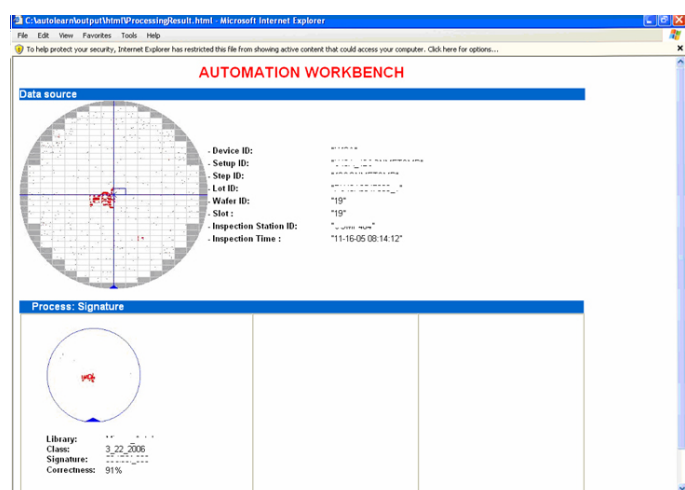


Figure 14 Center Large Blob ▲▲

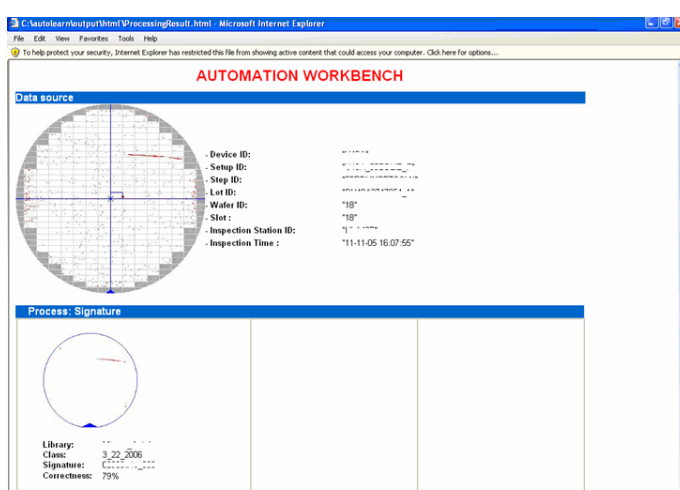


Figure 15 Scratch ▲▲

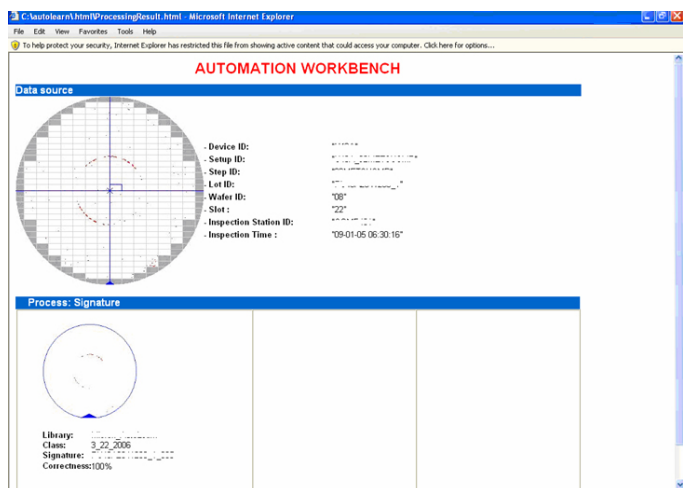


Figure 16 Circle

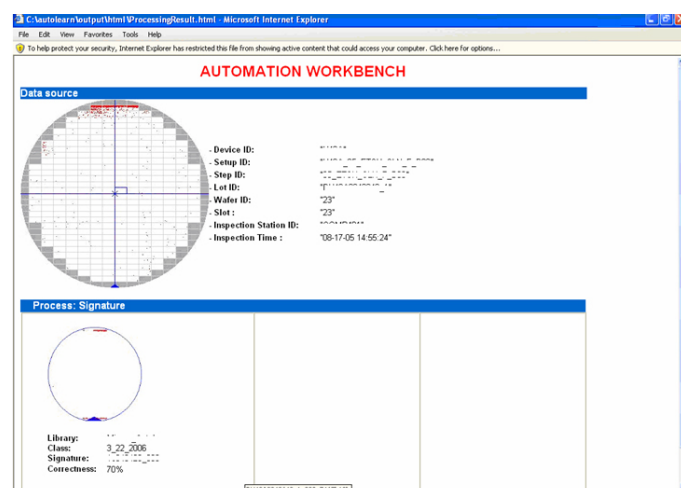


Figure 17 Edge Blob

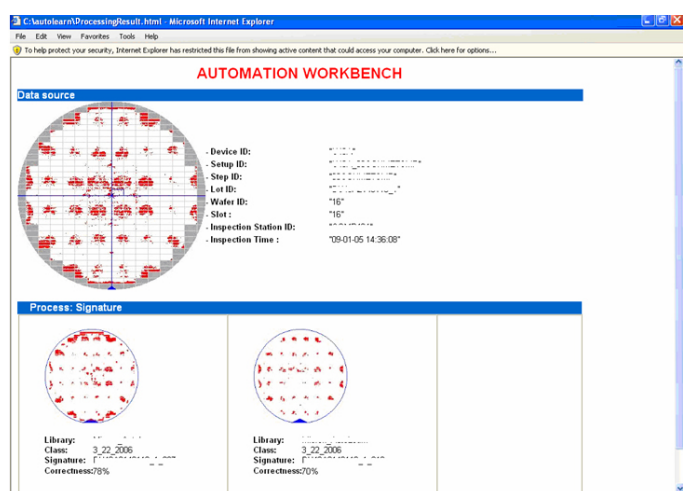


Figure 18 Focus Spot

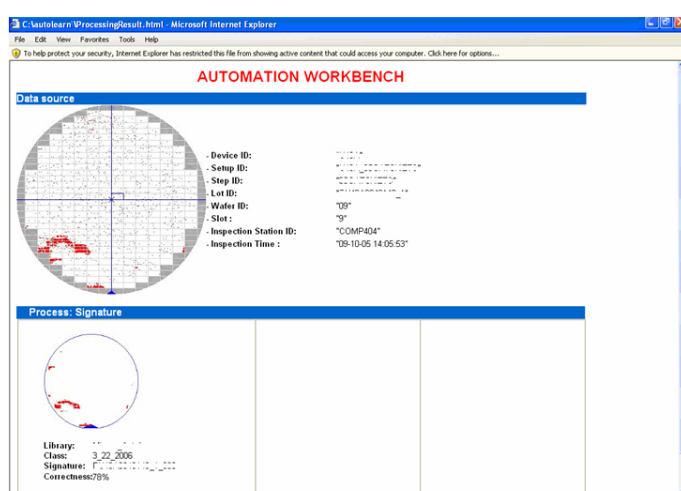


Figure 19 Streaks

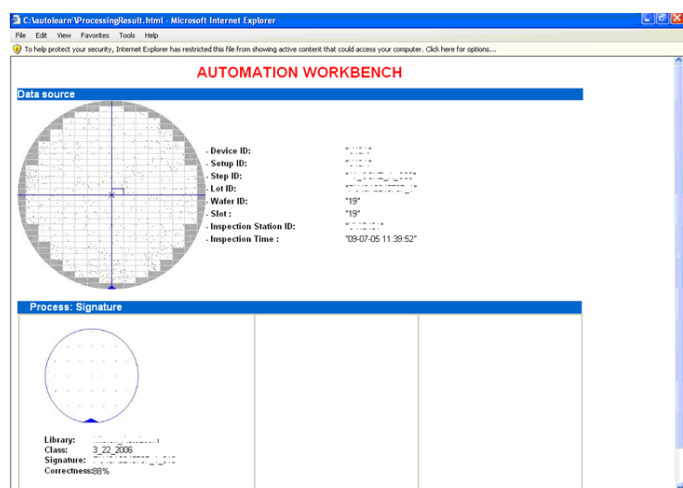


Figure 20 Repeaters

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