Practical Approach to Further Reducing False Alarms in Dynamic Fault Detection

Tom Ho / Gabe Villareal / Weidong Wang / Joe Lee
tomho@bistel.com / gabevillareal@bistel.com / wiedongwang@bistel.com / joelee@bistel.com
BISTel America, Inc.
3151 Jay Street, Suite 201, Santa Clara, CA 95054, USA
Phone: +1 -408-855-8212 Fax: +1-408-855-8213

Background

At the ISSM event in 2016, we introduced a new concept in real-time fault detection called Dynamic Fault Detection (DFD). The solution utilizes full sensor traces from neighboring wafers as references to detect abnormalities and to uncover issues in real-time. This unique approach allows the system to intelligently adapt to process changes with minimal effort to set up. This greatly reduces the time required to deploy and virtually eliminates maintenance of an FDC system. Furthermore, by using the full sensor trace for analysis, a more accurate fault detection can be achieved. Another key advantage of using DFD is its ability to significantly reduce false alarms. With fewer false alarms, engineers can work more efficiently by focusing on the real issues at hand.

False Alarm Reduction in DFD

Recent data from one of the DFD installation sites showed that their overall monthly alarm rate was reduced by 10X to 100X when compared to their previous traditional FDC system, all the while maintaining or improving the quality of the alarms. Even with this dramatic improvement, we continue to see opportunities to improve the intelligence of the alarming system and to fine tune DFD to further reduce false alarms.

Approach

There are common events in a semiconductor manufacturing process which often result in unwanted alarms. This is mainly because traditional FDC systems do not have the intelligence to distinguish these expected occurrences from the true characteristics of a process failure. In the updated version of Dynamic Fault Detection (DFD), more intelligence has been incorporated into its algorithms to reduce these types of false alarms. Here are 3 examples of such alarms:

Alarm Type #1	False glitch alarms
Description	A stray data point in the streaming data that causes an unexpected spike or dip
False Alarm Reduction Approach	Algorithm was improved to enable DFD to intelligently examine and validate glitches caused by a true process issue before alarming (see Figure #1)

Alarm Type #2	First wafer effect alarms
Description	Abnormal sensor reading during the processing of the first few wafers in the process lot before the chamber/equipment has reached operation steady state
False Alarm Reduction Approach	Added intelligence to detect sensor behavior pattern based on events. In this case, DFD looks for short-term changes at a chamber “cold start” and examines the sensor behavior pattern to determine whether it warrants an alarm (see Figure #2)

Alarm Type #3	Alarms after PM events
Description	Sensor behavior changes as a result of a maintenance event
False Alarm Reduction Approach	Like the added intelligence used to detect first wafer effects, the approach here is to expand pattern detection over a long period to study sensor behavior over multiple sub-events (see Figure #3); in this case, to recognize the sensor behavior pattern after each PM event

Results

While traditional FDC systems are widely used and are deemed effective as a monitoring tool, the excessive number of false alarms issued by these systems remain a big challenge for engineers. Dynamic Fault Detection (DFD) version 1.0 has been proven to dramatically reduce false alarms by up to 90+% using its adaptive fault detection capability. New techniques are being implemented in an updated version of DFD which can help to further reduce false alarms by another 20 to 50% (see Figure #4).

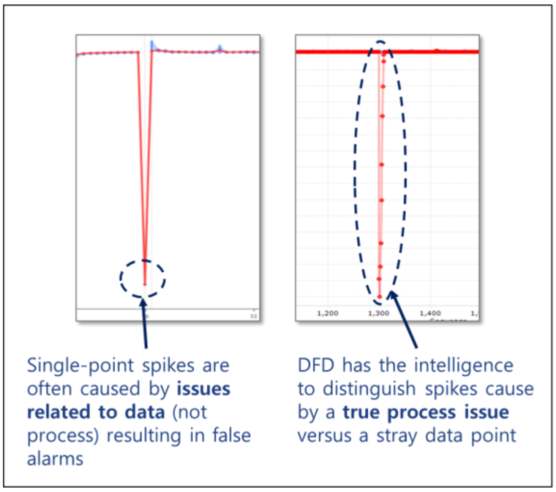

Figure #1 – Example of a false glitch and a glitch caused by a true process issue

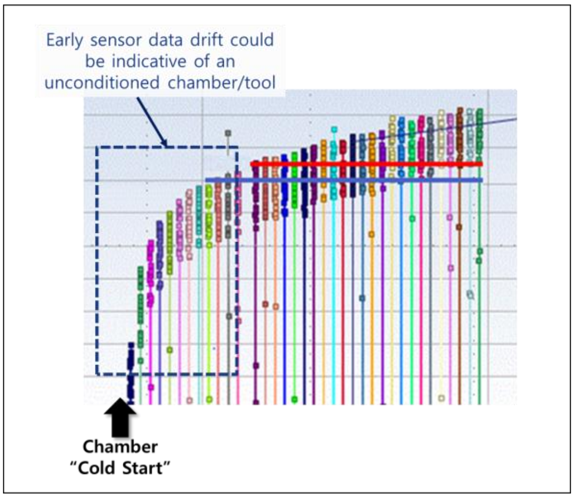

Figure #2 – DFD recognizes the sensor behavior pattern after a "Recipe Start" event. The early sensor drift is the result of a chamber that has not reached operation steady state.

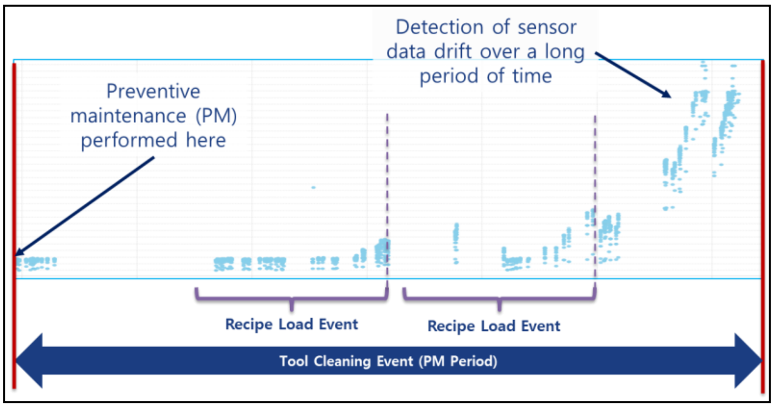

Figure #3 – DFD recognizes the sensor behavior pattern after a "Recipe Start" event. The early sensor drift is the result of a chamber that has not reached operation steady state.

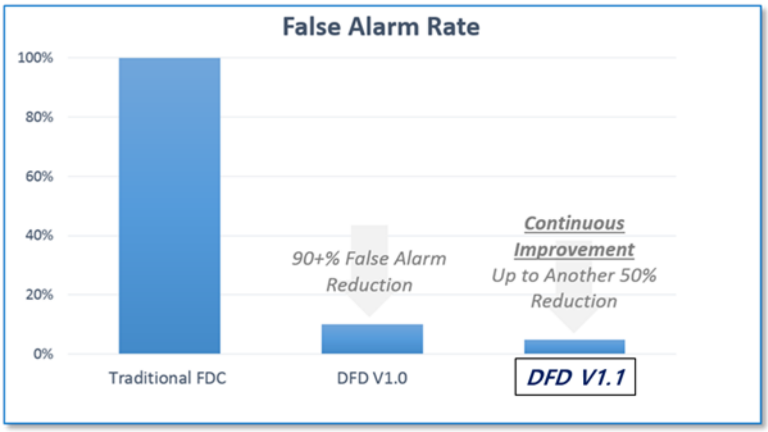

Figure #4 - Continuous improvements in DFD allow the solution to further reduce the number of false alarm