Implementing FDC in the Wafer Dicing Process to Improve Product Quality

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Henry Hsu, Joe Hung, Sophia Lin, Vincent DiFilippo

Rudolph Technologies

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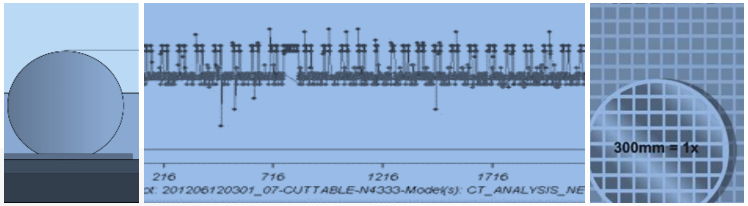
Agenda

- Introduction
- Wafer dicing issues and impact
- Kerf solutions approach
- FDC as a tool for monitoring the dicing process
- Correlation of FDC and kerf metrology
- Typical Use Case
- Identifying critical parameters
- Closing the loop with FDC monitoring
- Conclusion

Introduction



A tool-based FDC system can collect extensive tool sensor data from a dicer saw, generate meaningful statistical data, and store these in a database.

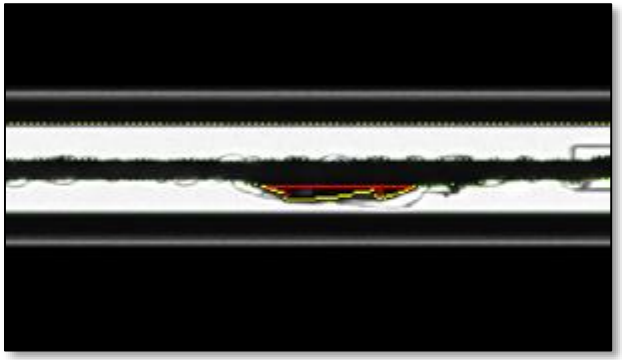
This FDC data can then be correlated by lot and wafer to measured wafer metrology data.

Advanced statistical techniques can then be used to identify which tool signals most influence die chipping.

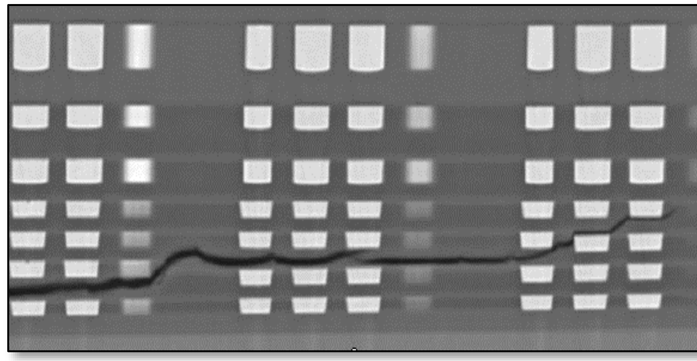
These signals can then be monitored by FDC models, completing the circle to improve product quality.

Wafer Dicing Issues and Impact

Typical Process Issues…

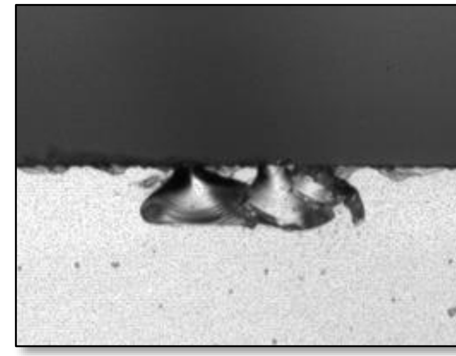


Side Wall Cracking



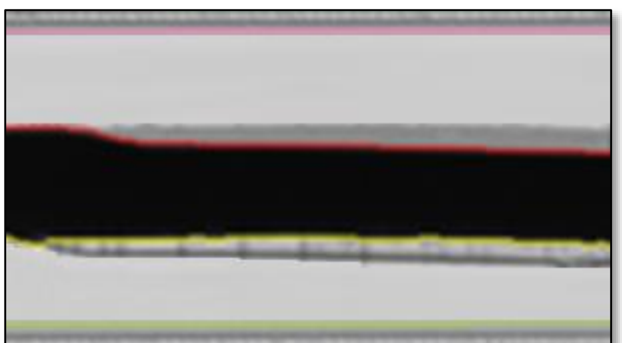
Impact: Yields, Increased escape rates

Backside Chipping



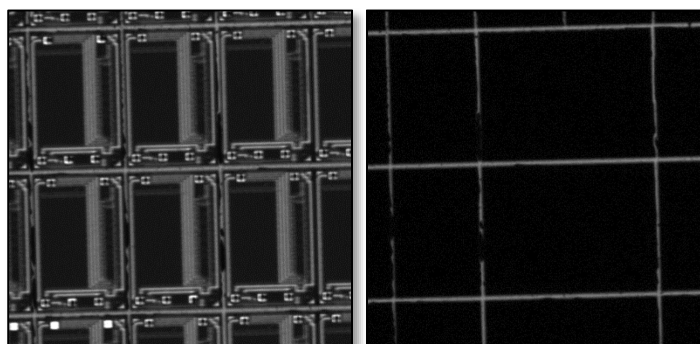
Impact: Yield, Escape rates

Front Side Delamination



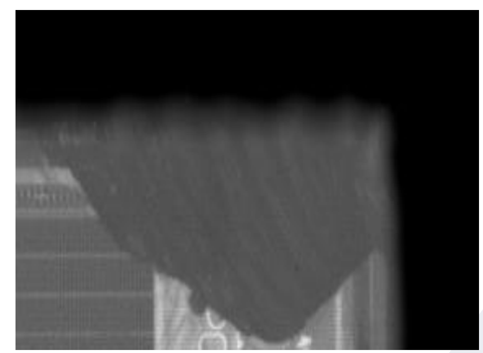
Impact: Yield, Increased escape rates

Bridged Dies



Impact: Process issues, Yield Impacts

Layer Delamination

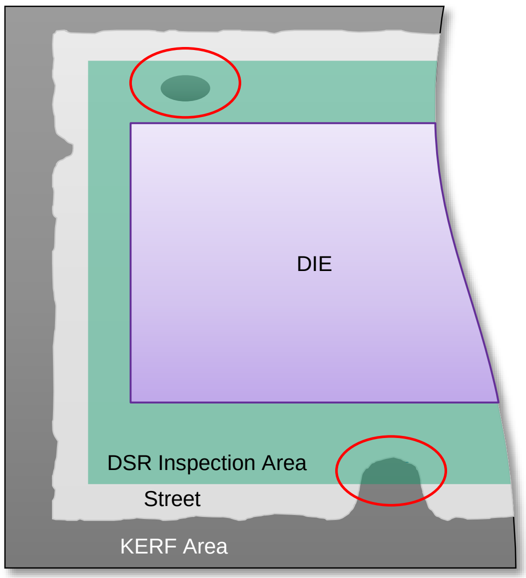


Impact: Yield, Performance

Rudolph Kerf Solutions Overview

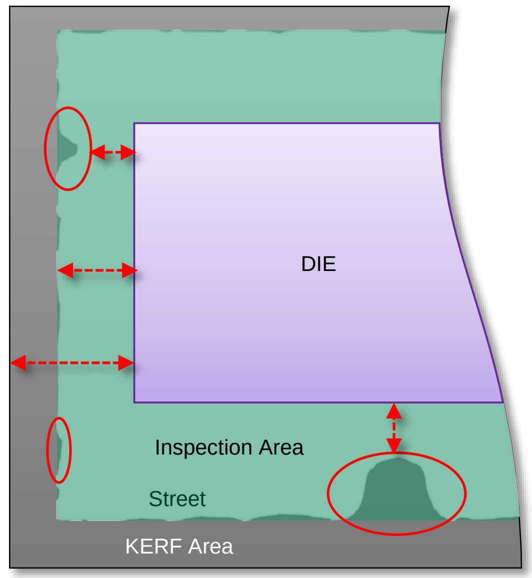
Multiple levels of SAW Analysis and Process Control

Die Seal Ring Inspection



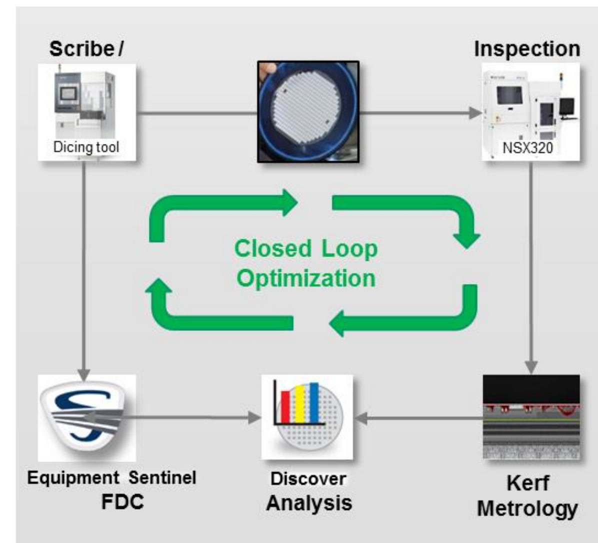
- ✓ Defect present verification
- ✓ Die disposition
- ✓ Reticle-based setup
- ✓ Same pass as 2D inspection

KERF Metrology Inspection



- ✓ Adv. metrology measurements
- ✓ Cut quality feedback
- ✓ Adv. die disposition
- ✓ Process monitoring
- ✓ Increased process understanding

KERF Metrology Inspection & SAW Control



All of the Kerf Metrology & …

- ✓ Dicer process monitoring
- ✓ Adv. FDC / Metrology correlations
- ✓ Ideal for process development
- ✓ OEE improvements
- ✓ Excursion root cause understanding

Rudolph KERF Solutions

KERF Metrology & SAW Process Control

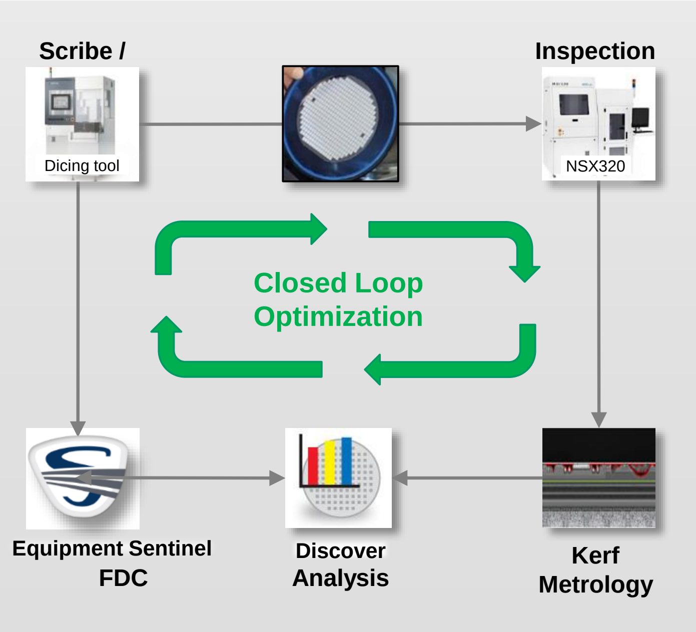
Enabling SAW process control, yield improvements, and escape reduction !!

SAW PROCESS

- ✓ Process Monitoring
- ✓ Faster Process improvement
- ✓ Predictive Yields

INSPECTION / METROLOGY

- ✓ 100% Inspection Control
- ✓ KERF Metrology
- ✓ Die Classification / Binning
- ✓ Escape Reduction



FDC PROCESS CONTROL

- ✓ High speed data collection
- ✓ 100+ signals recorded
- ✓ Fleet Process Control

DISCOVER ANALYSIS

- ✓ Complete SAW Visibility
- ✓ Metrology to FDC correlation
- ✓ Process Improvements
- ✓ Closed Loop Correlation

Wafer Saw Process for Advanced Packaging

- ✓ Automated manufacturing reports
- ✓ Dynamic metrology and defect sampling
- ✓ Fleet management: tool matching and performance rating

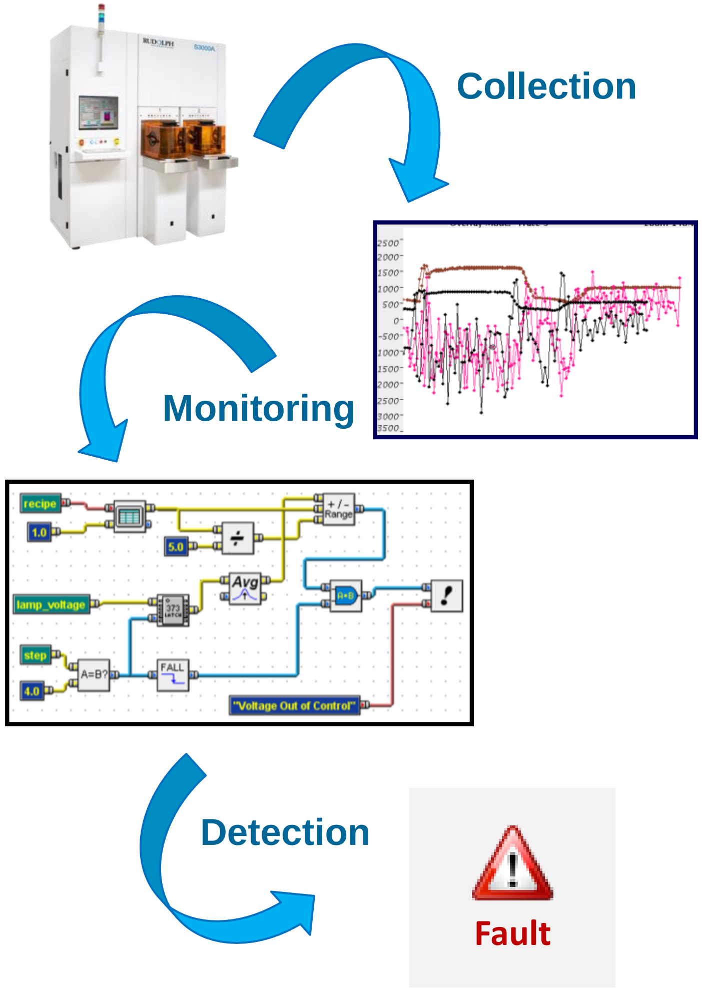
- ✓ Stop saw mid-wafer during groove or saw
- ✓ Optimize recipe settings for quality and throughput
- ✓ Reduce scrap and rework, detect issues early in process

- ✓ Focus on reliability defects
- ✓ Monitor Pass/Fail and quality metrics for metrology

Rudolph provides process control at advanced nodes.

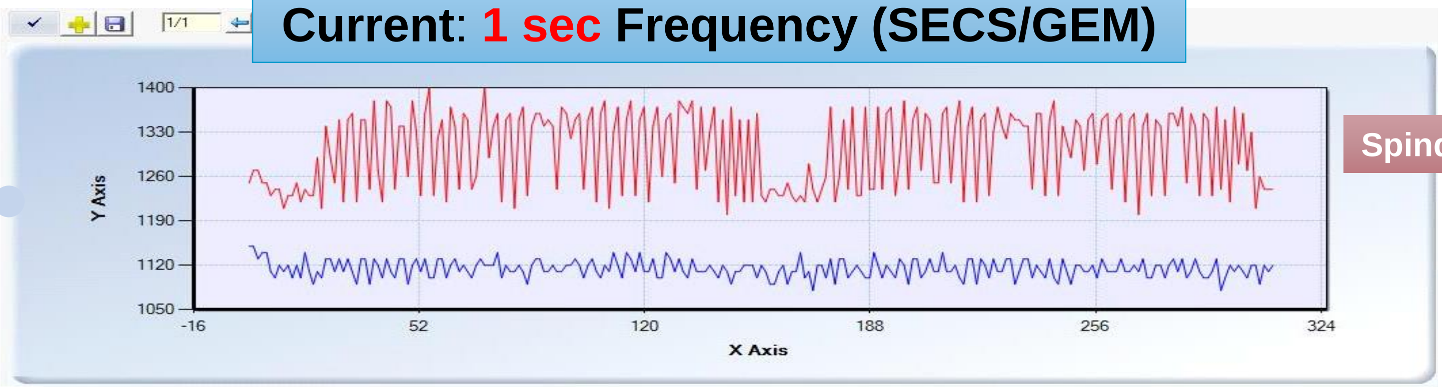
What is FDC (Fault Detection and Classification)?

- Detects an abnormal status of the equipment or the process running on it.
- Monitors key parameters as defined by fab engineering (such as low chamber pressure or low RF reflected power)
- Identifies the detected failure, such as a leak in the chamber or a faulty RF power supply
  - Knowledge-based
  - Statistical
- Acts to alarm or shut the tool down prior to misprocessing



Higher Data Sampling = More Sensitivity

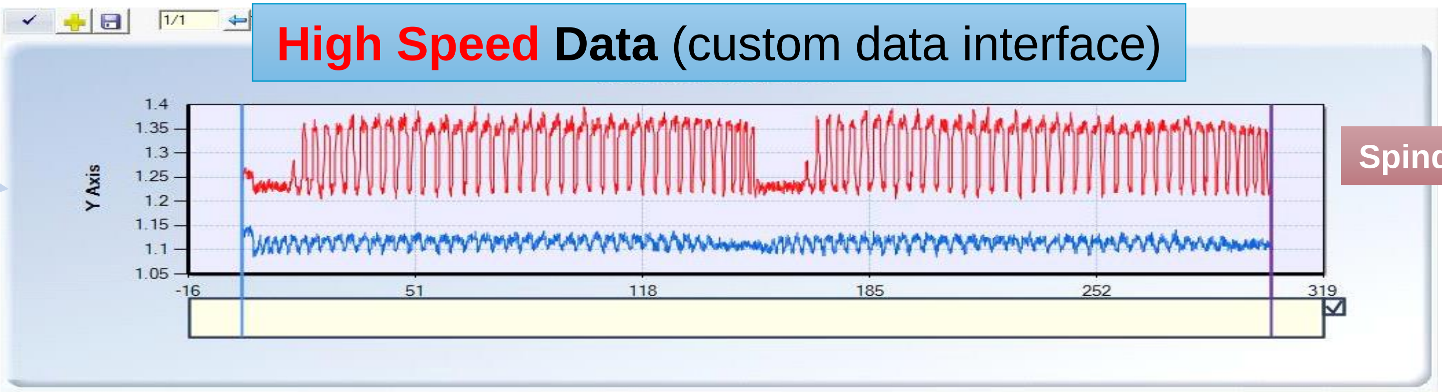
Current: 1 sec Frequency (SECS/GEM)



Spindle Current

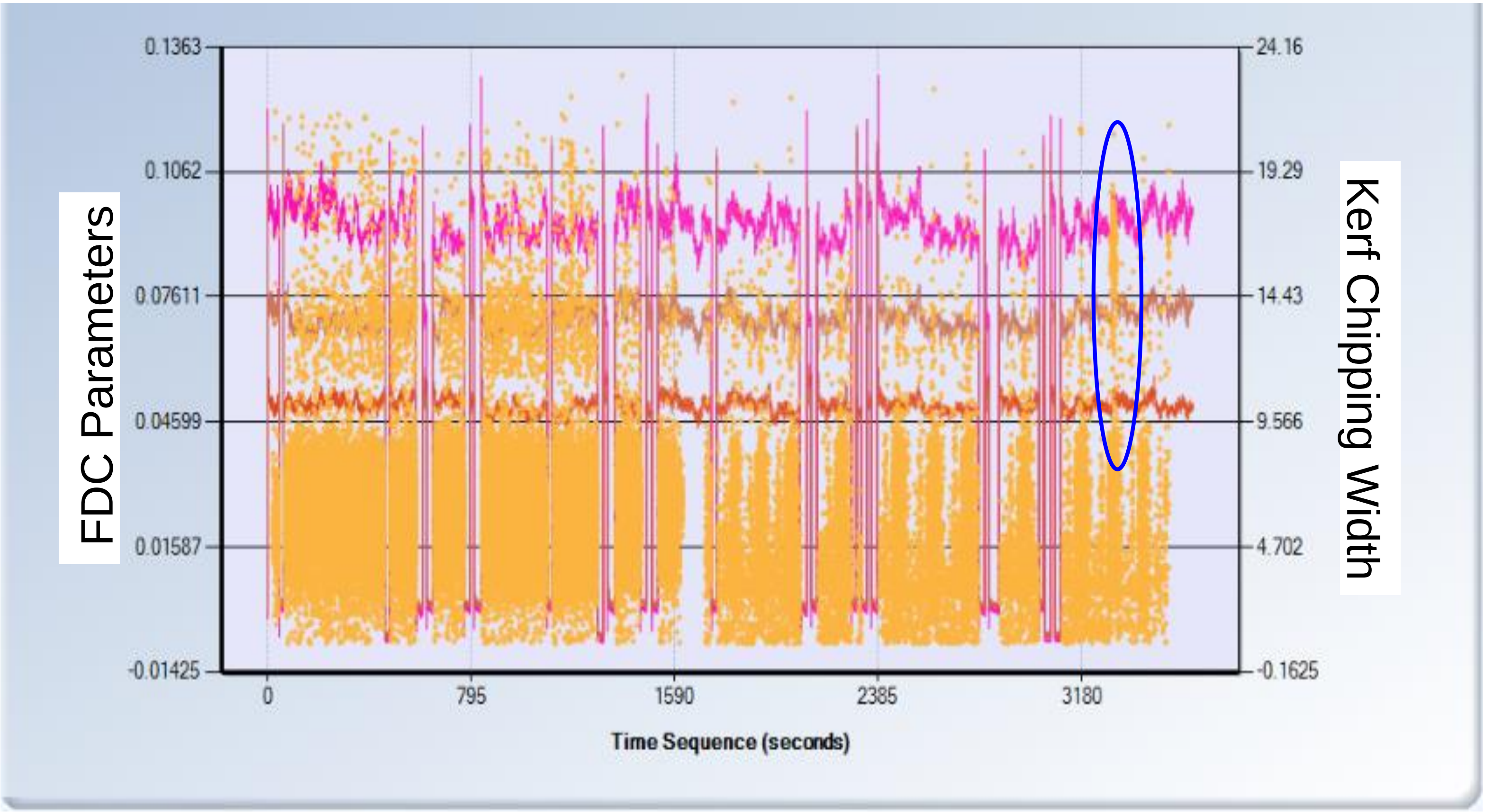
Same process

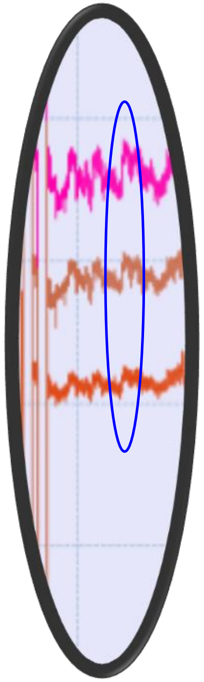
High Speed Data (custom data interface)



Spindle Current

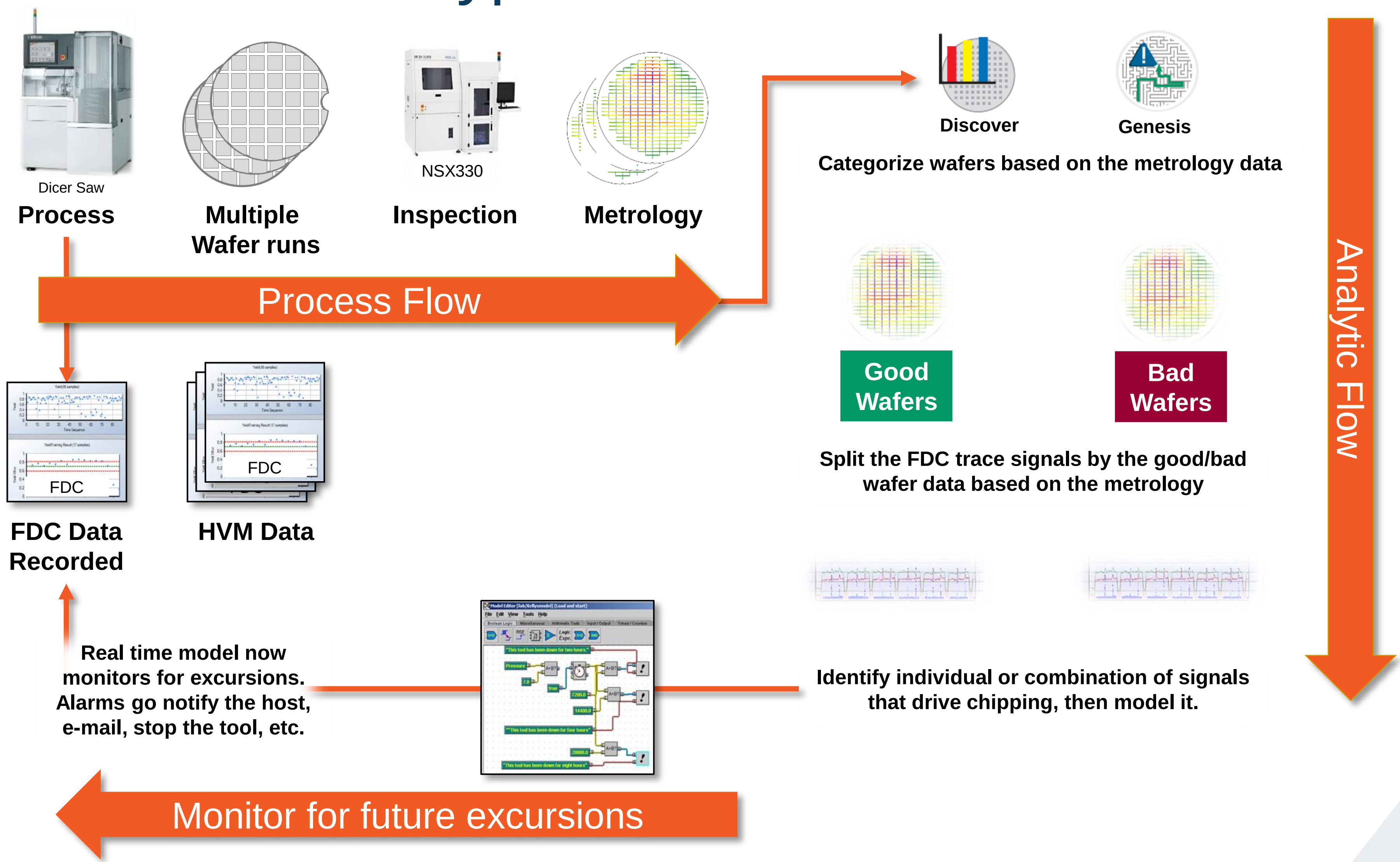
FDC and Inspection Data Alignment



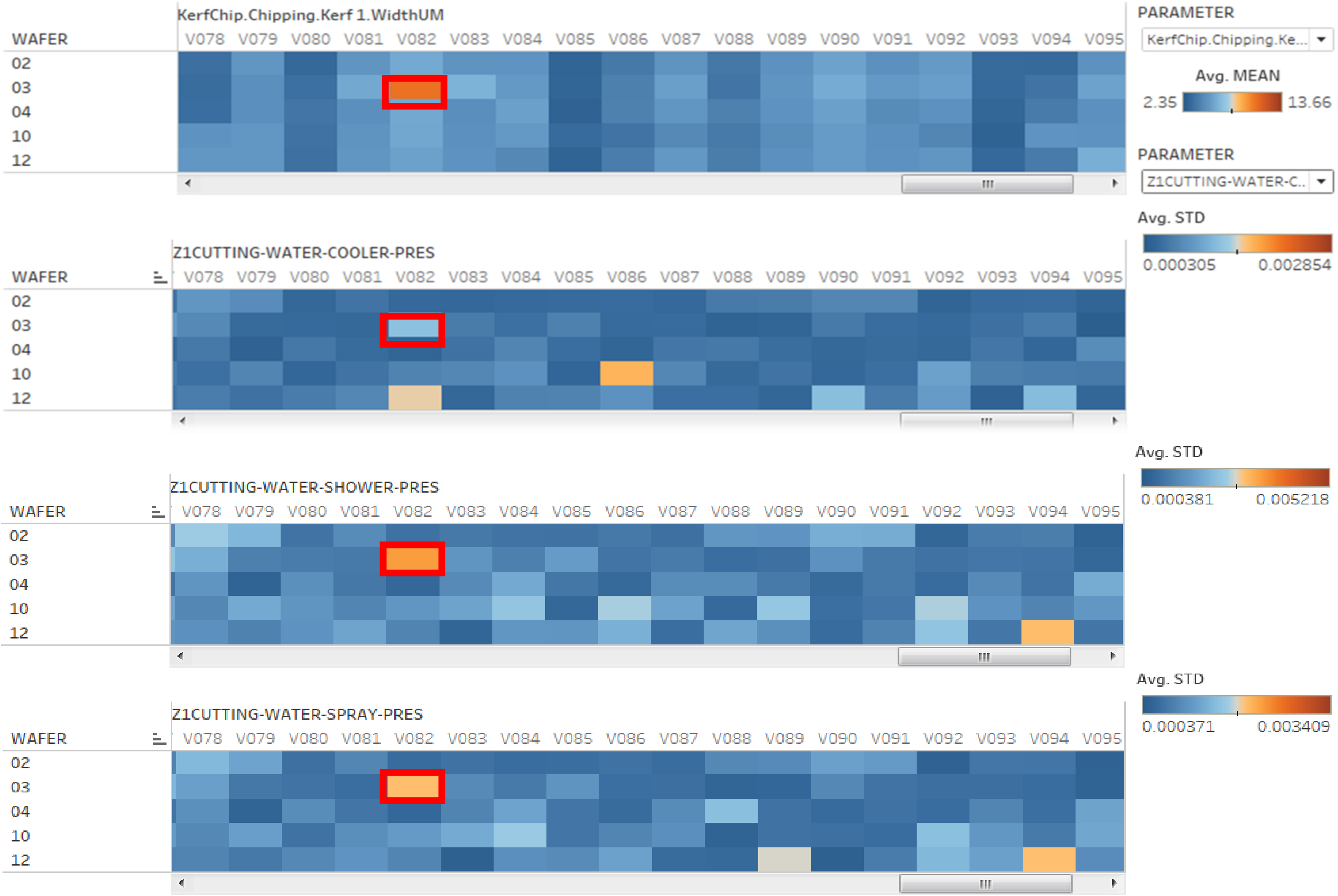


Raw data of FDC parameters and inspection tool measurements of kerf width. Collected across a wafer, these data were collected separately on a dicer and an inspection tool then automatically aligned in the Discover database.

Typical Use Case…



Identifying Critical Parameters – Visualization



Identifying Critical Parameters – Analysis

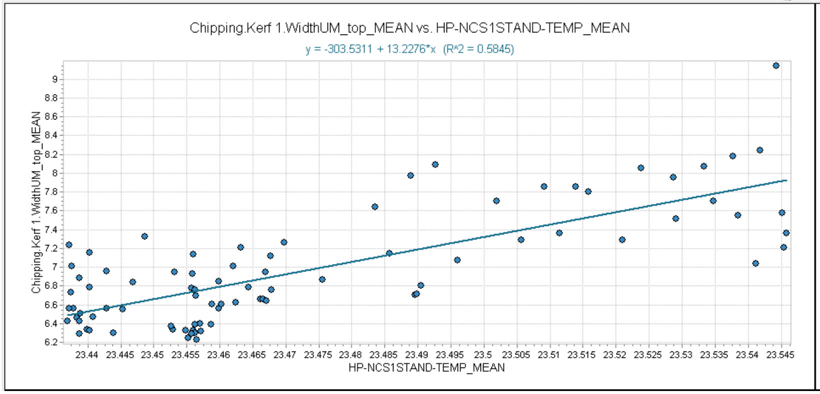
Align FDC and metrology data to generate statistics

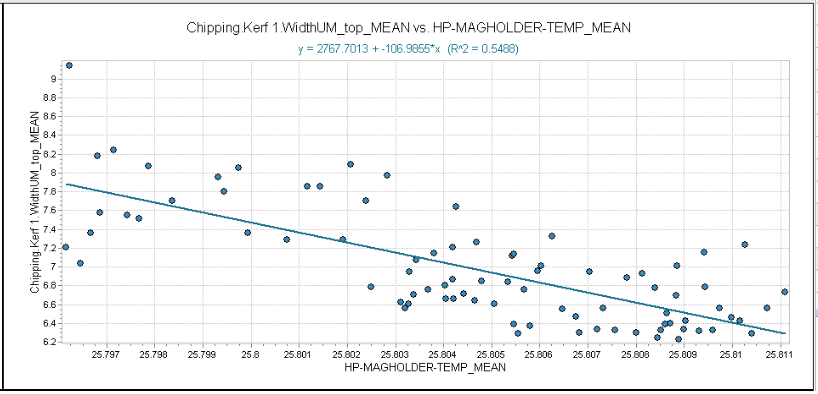
THEN

correlate summary data against kerf metrology data using multivariate methods, such as PLS in the Genesis analysis package.

PLS Regression Report

X Parameter	Coefficient	Standard Regression Coefficient	VIP	Regression Model Parameter
	Chipping.Kerf 1.WidthUM_top_MEAN	Chipping.Kerf 1.WidthUM_top_MEAN		
Constant	1028.7500	-	-	
HP-NCS1STAND-TEMP_MEAN	2.4744	0.1430	2.3133	°
HP-MAGHOLDER-TEMP_MEAN	-20.1968	-0.1399	2.2447	°
TMOTOR-TORQ_MEAN	0.0622	0.1106	2.0031	°
Y1MOTORFULLCLOS-DEV_MEAN	-0.0139	-0.0708	1.5123	°
TMOTOR-DEV_MEAN	0.1166	0.0714	1.4909	°
XMOTOR-TORQ_MEAN	-0.2954	-0.0942	1.4280	°
C/T-VAC_MEAN	-0.4481	-0.0670	1.3485	°
C/T-WORK-VAC_MEAN	-0.4352	-0.0670	1.3239	°
SPINDLE1-CURRENT_MEAN	-4.5100	-0.0626	1.2483	°
HP-COOLINGWATER-TEMP_MEAN	-65.9377	-0.0507	1.2299	°
HP-C/TBASE-TEMP_MEAN	0.6605	0.0490	1.1914	°
HP-ROOMTEMP_MEAN	14.6418	0.0640	1.0755	°
SPINDLE1-AIR-IN-FLOW_MEAN	-1.1657	-0.0586	0.9909	
HP-CUTTINGWATER-TEMP_MEAN	-21.6960	-0.0349	0.7218	
XMOTOR-DEV_MEAN	-0.0041	-0.0396	0.7010	
XMOTOR-SPD_MEAN	18.9447	0.0273	0.6205	
CONFIG_CUTSPEED_MEAN	0.0405	0.0111	0.5790	
HP-Z1CUTTING-WATER-SPRAY_MEAN	7.7330	0.0423	0.5552	
MAIN-AIR-PRES_MEAN	63.8257	0.0267	0.5130	
SPINDLE1-AIR-IN-PRES_MEAN	30.5750	0.0215	0.4742	
Z1CUTTING-WATER-SPRAY-PRES_MEAN	76.4064	0.0339	0.4662	
HP-Z1CUTTING-WATER-SHOWER_MEAN	5.5544	0.0281	0.4441	
TMOTOR-SPD_MEAN	-35.9697	-0.0305	0.4384	
Z1CUTTING-WATER-SHOWER-PRES_MEAN	27.2040	0.0217	0.4141	
SPINDLE1-REV_MEAN	0.0282	0.0193	0.4017	
HP-Z1CUTTING-WATER-COOLER_MEAN	4.3233	0.0262	0.3686	





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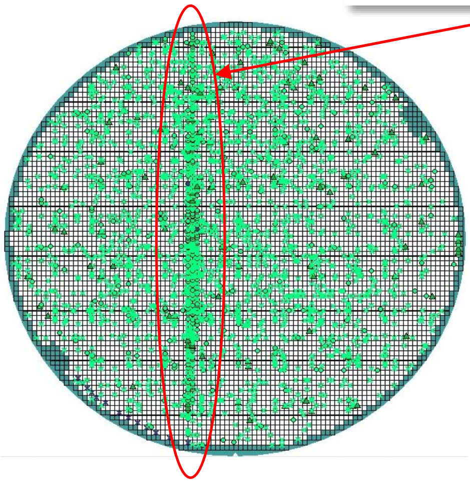
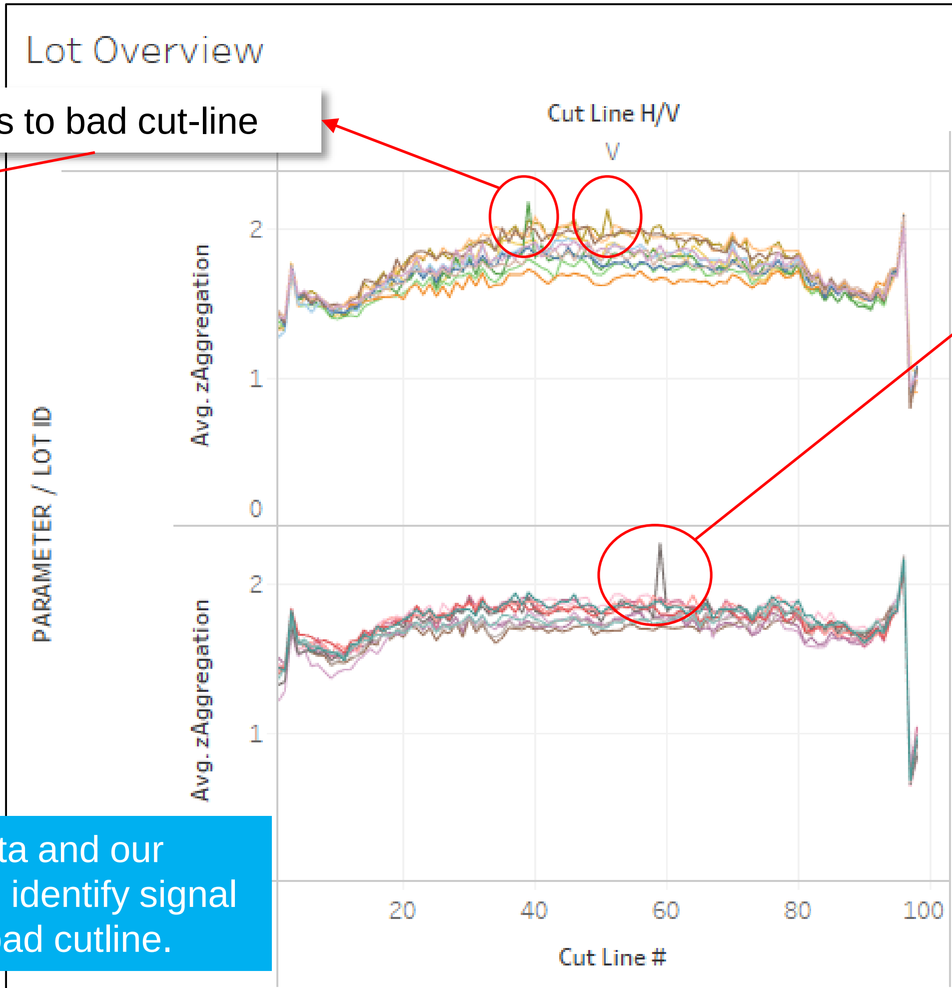
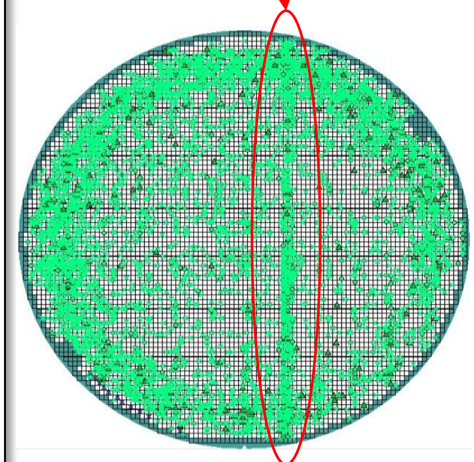
Identifying Critical Parameters - Bad Cutlines

Relates to bad cut-line





Relates to bad cut-line



By using summarized data and our visualization tool, we can identify signal peaks correlated with a bad cutline.

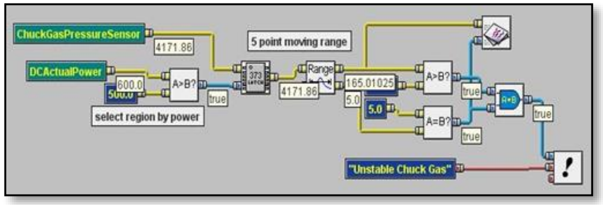
FDC Monitoring

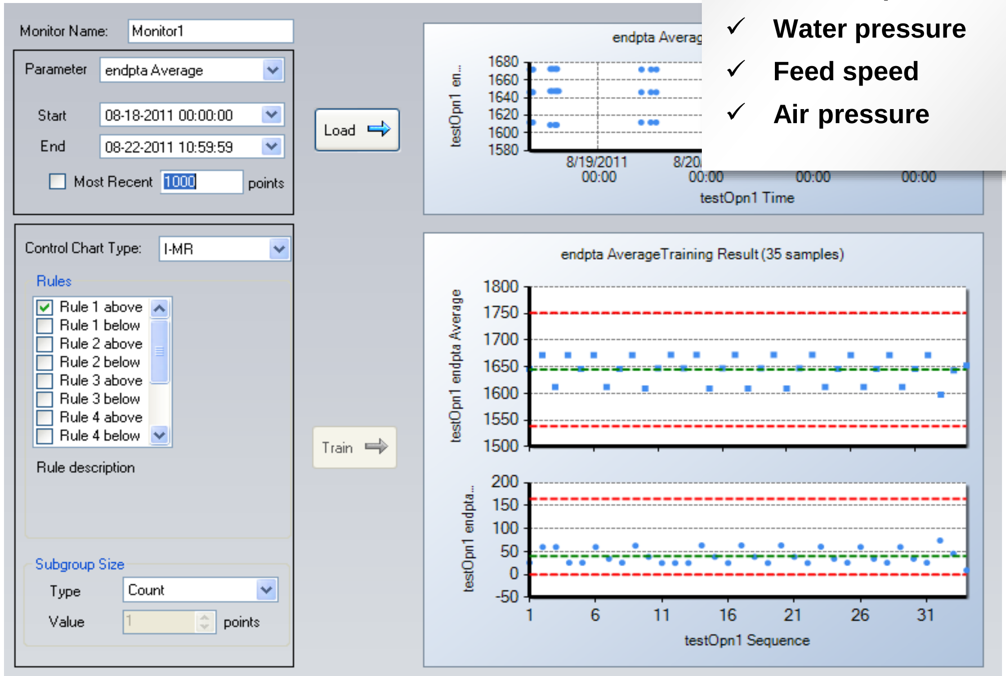
Dicer

Key Parameters

- ✓ CT and ST vacuum
- ✓ Spindle speed
- ✓ Blade exposure
- ✓ Water pressure
- ✓ Feed speed
- ✓ Air pressure

Equipment Sentinel





Key parameters can be monitored by user-created models:

- Real time monitoring
- SPC monitors
- Golden trace
- Multivariate monitors

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Conclusion

TO IMPROVE DIE QUALITY…

Align FDC and kerf metrology data to allow correlation of tool signals to kerf parameters.

Create FDC heuristic models to monitor newly identified process parameters for future excursions.

Monitor key dicer signals with FDC to reduce kerf chipping.

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obrigado

Thank you!

info@rudolphtech.com
www.rudolphtech.com