

Dynamic Neural Controller™ As an E-diagnostic Tool

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Agenda

- Background
 - Dynamic Neural Controller™ (DNC)
- E-diagnostic Application
- Results:
 - E-diagnostic result:
 - Failure forecast on lamp subsystem
 - Uniformity of Set-up parameters settings
 - Model accuracy
 - Cost saving benefits
- Conclusion

Dynamic Neural Controller (DNC)



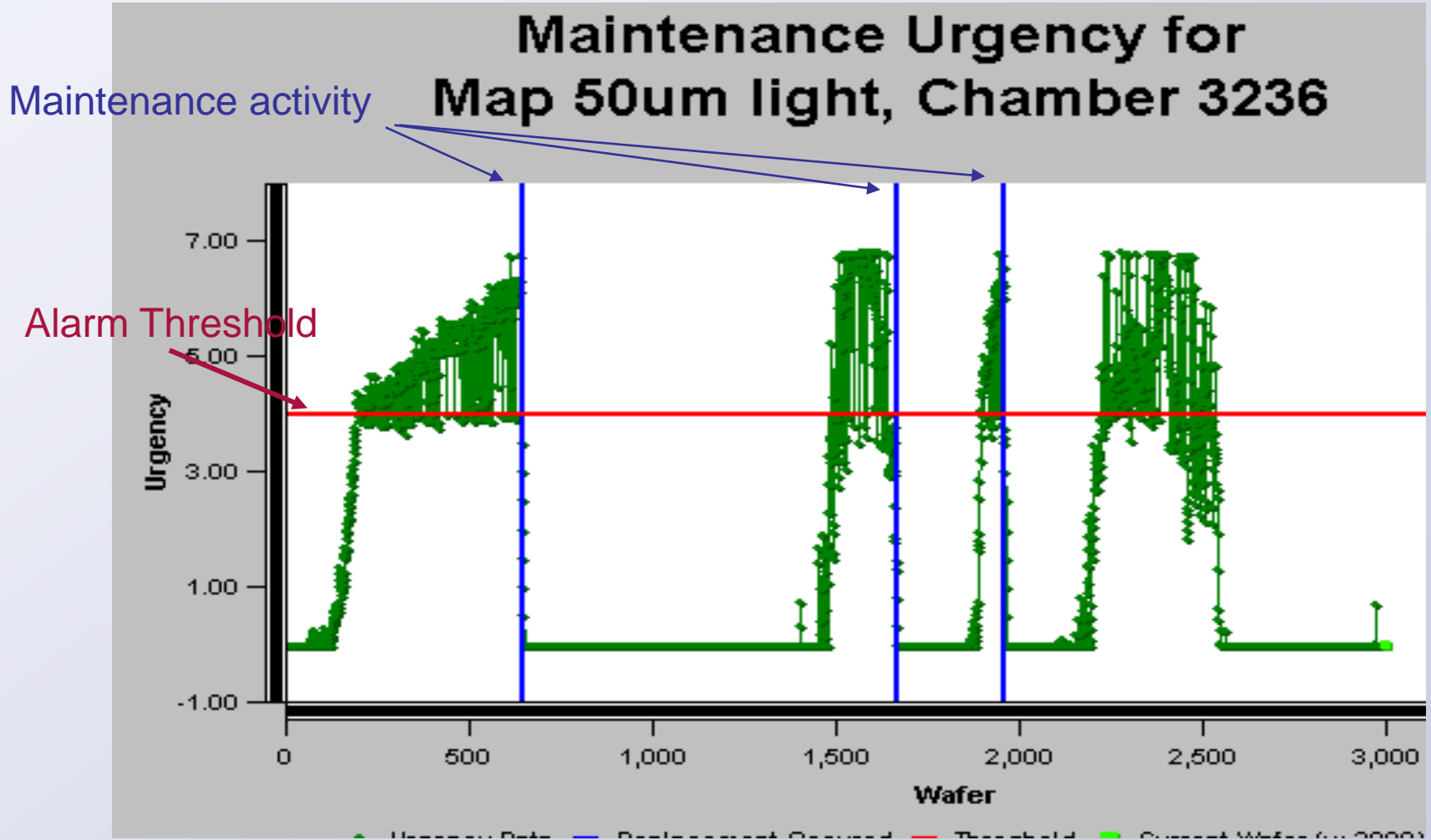
- Originally designed as a model-based wafer to wafer controller/advisory for process recipe and equipment control
- Unique features that monitors *tool health* along with process health
 - Tool health monitor can be used directly as an e-diagnostic tool
- Based on adaptive neural network and artificial intelligence technologies.

DNC Recommendations



- Aims at finding the least costly solution
 - Cost may come from material & labor, machine down time, operational cost, etc.
 - Find optimal solution from multiple solutions
 - Will not recommend solutions that incur more cost than benefit.
- Based on Urgency concept
 - Alarm before the problem occurs
 - Alarm at a customer-defined threshold

Example of DNC Urgency Plot



Dynamic Neural Controller™ as an E-diagnostic tool

DNC E-diagnostic Application



- Two goals:
 - Forecast/diagnose tool health problems
 - Give customer service lead time to intervene
 - Serve as an Expert System on optimal solutions

⇒ Cost Savings!
 - Uniform set-up parameter settings
 - Provide fairly uniformed settings during set-up
 - Offer “best guess” on settings based on tool performance in the field
 - Avoid lengthy individual tuning

⇒ Cost Savings!

DNC E-diagnostic Applications



- Application site:
 - KLA-Tencor
 - Customer service organization
- Application tools:
 - On lamp subsystem of optical overlay metrology Archer tools
 - 4 tools used
 - 2 parametric inputs (Halogen PS current and voltage), 4-5 maintenance inputs
 - Data range from 07/20/04 to 07/06/05

Lamp Subsystem E-diagnoses



- Separate models are trained for each of the 4 tools.
- Results:
 - Model fitting is very accurate.
 - Avg. accuracy 86% (examples follow).
 - Model recommendations are accurate.
 - Able to forecast tool health problems
 - Using “urgency” plots

Inputs Variable to the Models

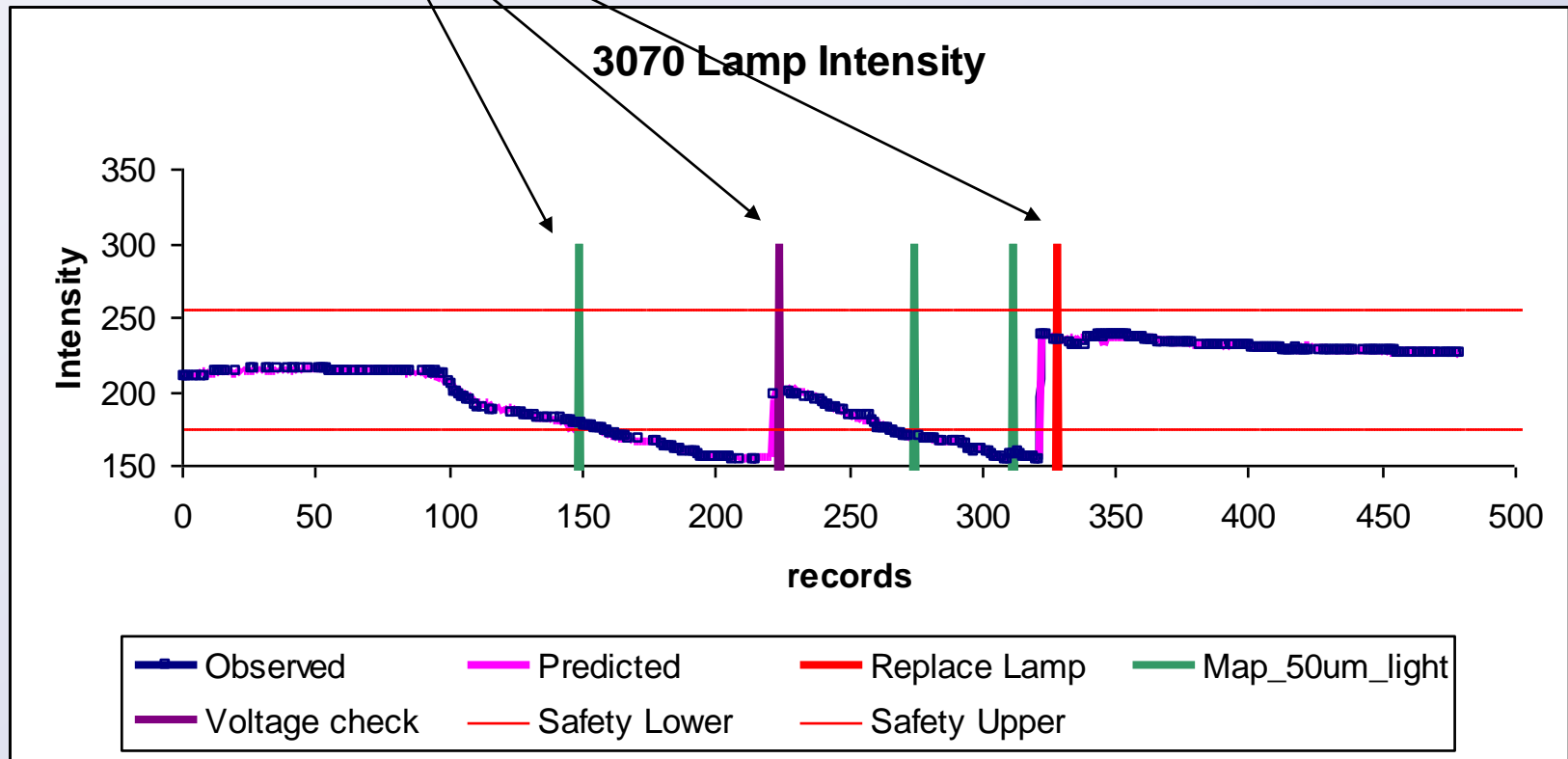


3009	3070
Halogen_PS_current	Halogen_PS_current
Halogen_PS_voltage	Halogen_PS_voltage
Replace_Halogen_LampHLS_1	Archer_10_Halogen_Lamp_Power_Supply__Voltage_Check__Adjustment_1
Map_50um_light_1	Replace_Halogen_LampHLS_1
Archer_10_Shutter_Adjustments_1	Map_50um_light_1
	Archer_10_Shutter_Adjustments_1
3071	3236
Halogen_PS_voltage	Halogen_PS_voltage
Halogen_PS_current	Halogen_PS_current
Archer_10_Halogen_Lamp_Power_Supply_Voltage_Check_Adjustment_1	Replace_Halogen_LampHLS_1
Replace_Halogen_LampHLS_1	Map_50um_light_1
Map_50um_light_1	Archer_10_LINNIK_Light_Hardware_Reference_Point_Adjustment_1

Model Fitting Example on 3070



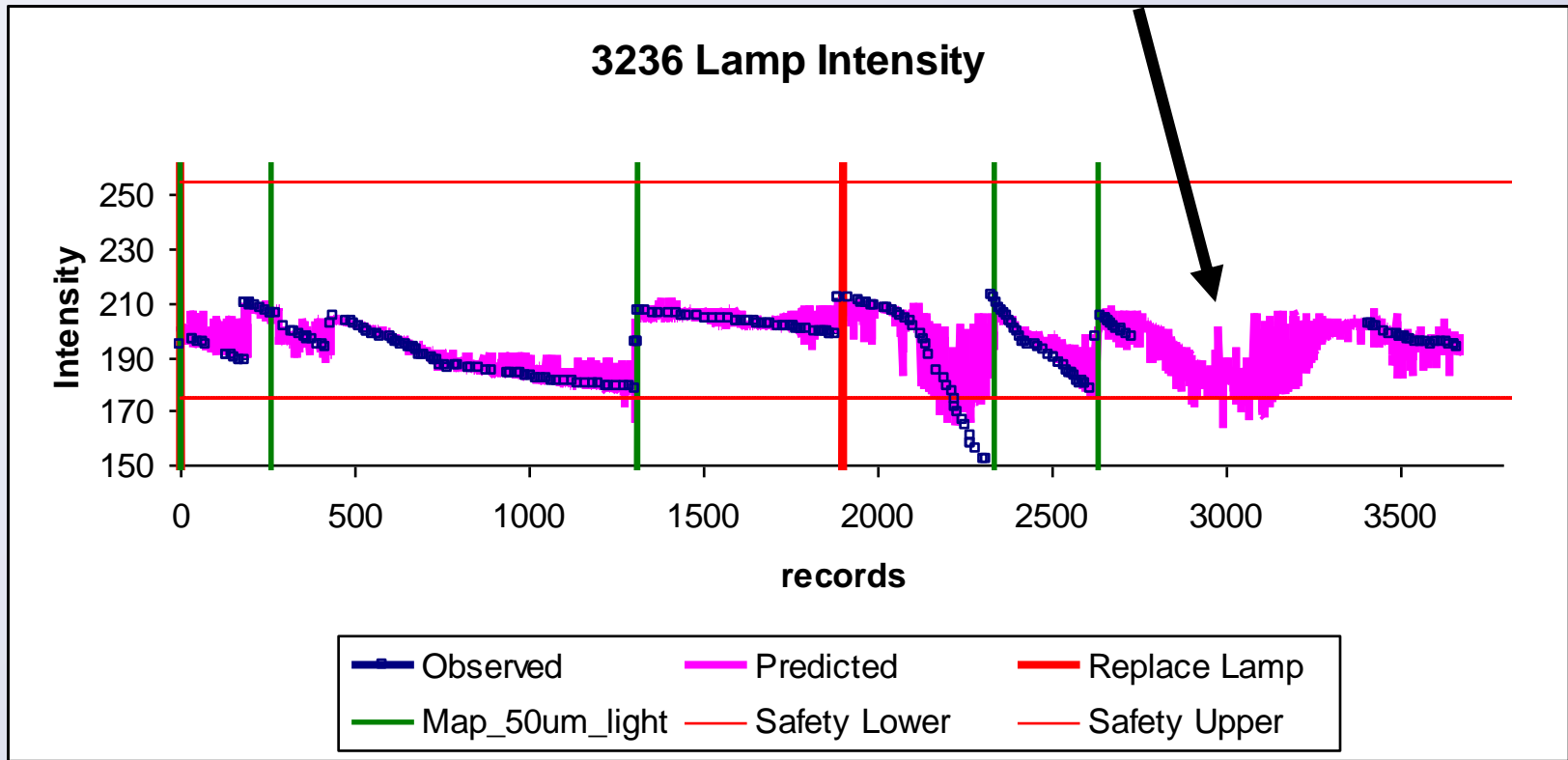
Maintenance activities known as potential fixes to lamp intensity problems



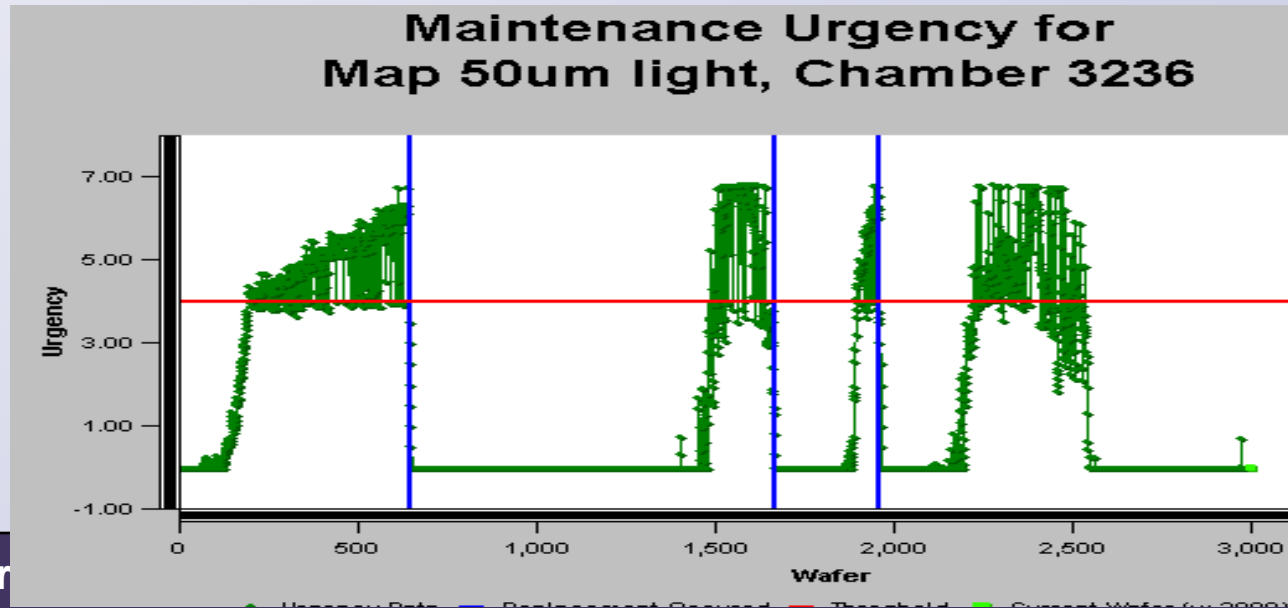
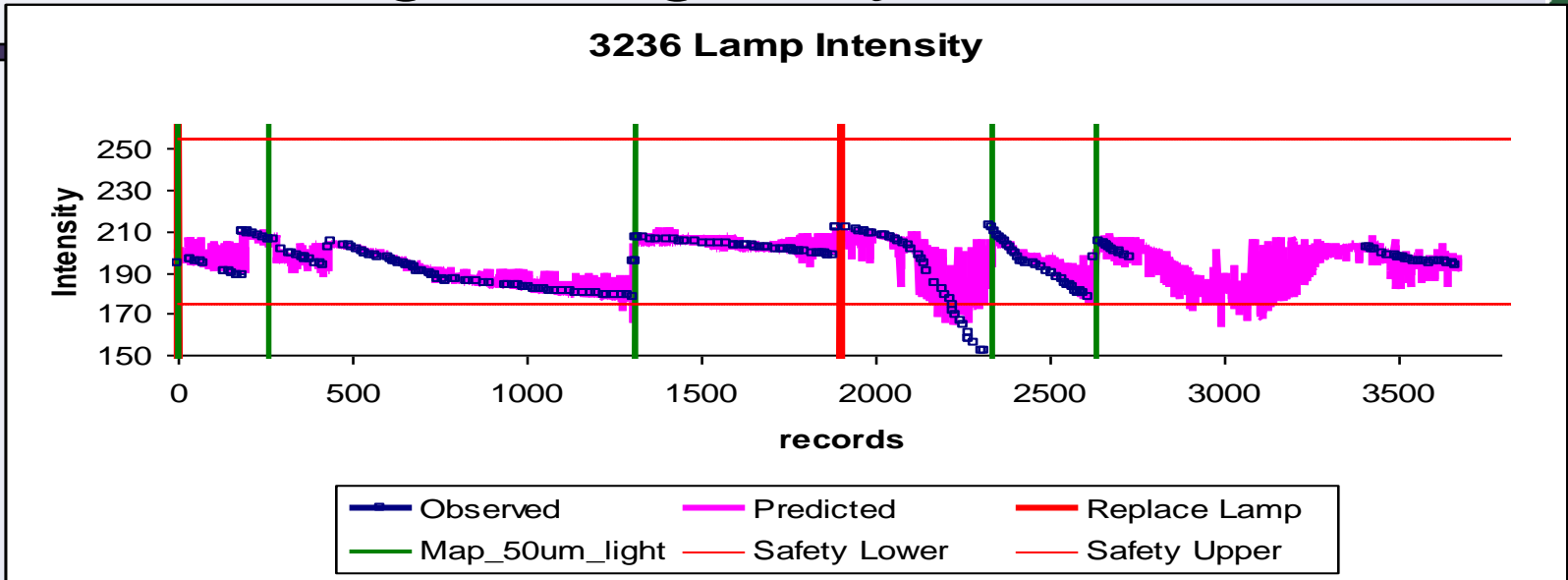
Model Fitting Example on 3236



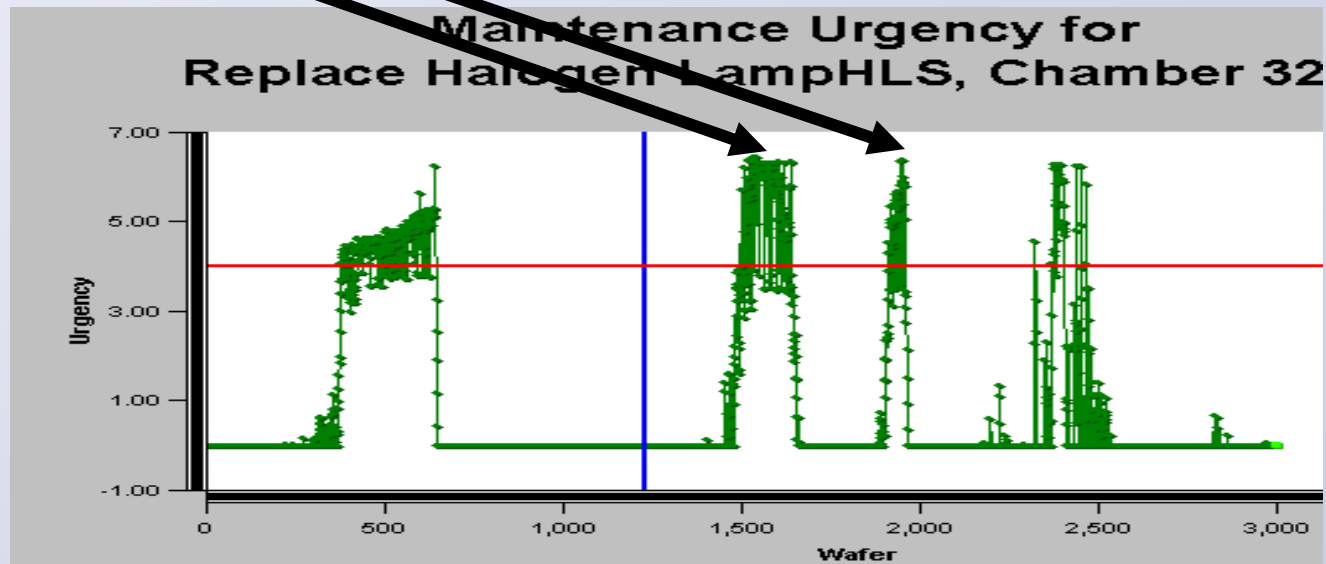
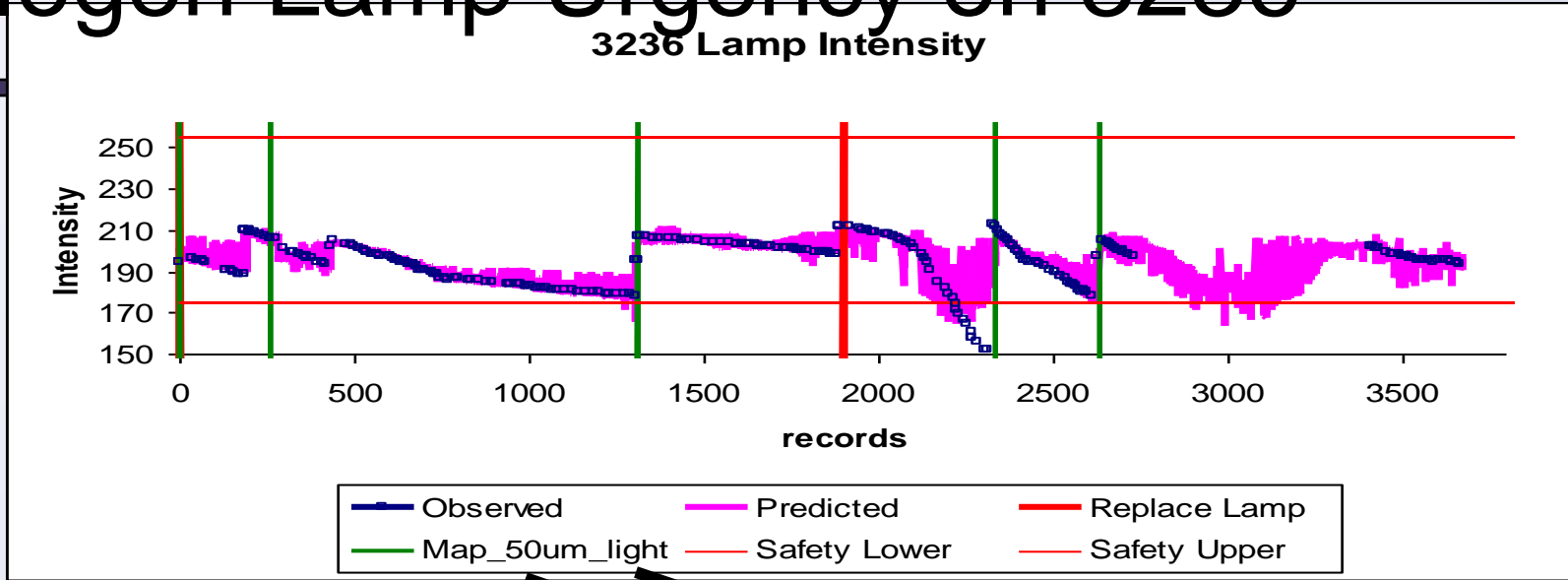
Model predicts a decay on lamp intensity, which is reasonable



Map 50um light Urgency on 3236



Halogen Lamp Urgency on 3236

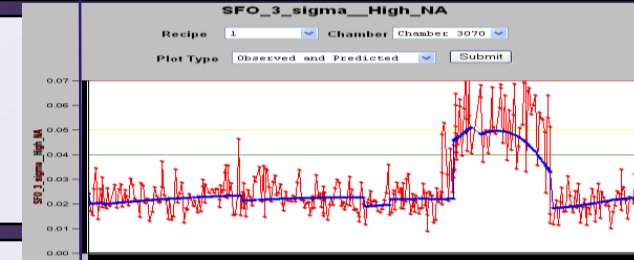
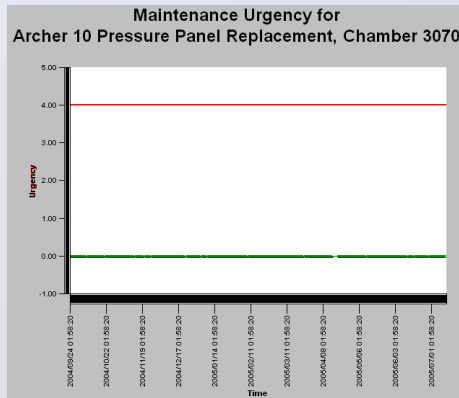


Dynamic Neural Controller™ as an E-diagnostic tool

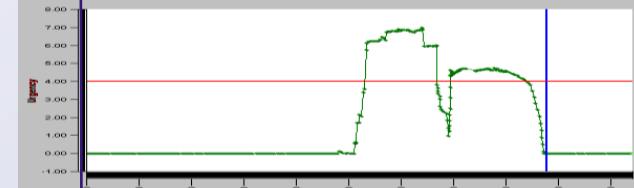
3070 SFO_3_sigma_High_NA



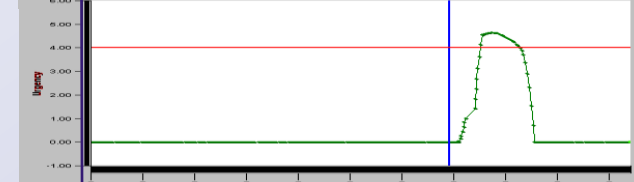
When an output is outside the soft limit, the Urgency index is high for some of the inputs



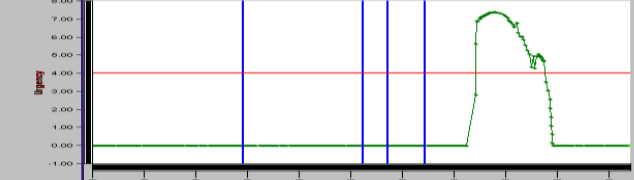
Maintenance Urgency for Archer 10 Shutter Adjustments, Chamber 3070



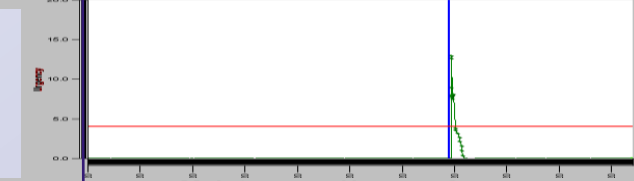
Maintenance Urgency for Perform system focus offset calibration, Chamber 3070



Maintenance Urgency for Replace shutter valve, Chamber 3070



Maintenance Urgency for Archer 10 Pneumatic Inlet Panel Replacement, Chamber 3070



3236 Request For Maintenance


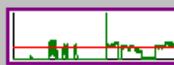

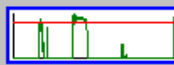

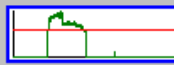

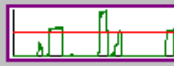




IBEX Dynamic Neural Controller

<< >> Main Menu Performance Recipe Health Tool Health Detailed Analysis Utilities Help

Request For Maintenance

Process Module 3236

Maintenance Action	Urgency Count			Urgency	Combinations (Original Risk 171.934)				
	Current	History	Recipe Count		1	2	3	4	5
Replace_Shutter_piston	288 	(1022)	1 / 1		✓	✓	✓	✓	✓
Backup_and_Restore_parameters_and_results	7 	(344)	1 / 1		✓	✓	✓	✓	✓
Map_750um_light	0 	(841)	1 / 1		✓	✓			✓
Replace_Halogen_LampHLS	0 	(648)	1 / 1		✓		✓		✓
Archer_10_PZT_P_Z_GainOffset_Adjustment	0 	(222)	1 / 1						✓
New Risk					161.553	161.714	161.771	161.932	164.446
Percent Improvement					6.038	5.944	5.911	5.817	4.355

Need Shutter Piston

Recommendations Screenshot





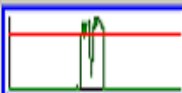
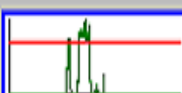
main menu Performance Recipe Health Tool Health Wafer Analysis Utilities Help

2004-07-20 to 2005-07-06

Request For Maintenance

3662 Wafers Displayed

Process Module 3071

Maintenance Action	Urgency Count			Urgency	Combinations (Original Risk <u>96.6645</u>)		
	Current	History	Recipe Count		1	2	3
Map_50um_light	471 	(471)	1 / 1		✓	✓	✓
Replace_Halogen_LampHLS	0	(269)	1 / 1			✓	
Archer_10_Halogen_Lamp_Power_Supply_Voltage_Check_Adjustment	0	(190)	1 / 1				✓
				New Risk	86.2144	91.6396	91.9547
				Percent Improvement	10.811	5.198	4.872

Dynamic Neural Controller™ as an E-diagnostic tool

Summary on DNC Recommendations

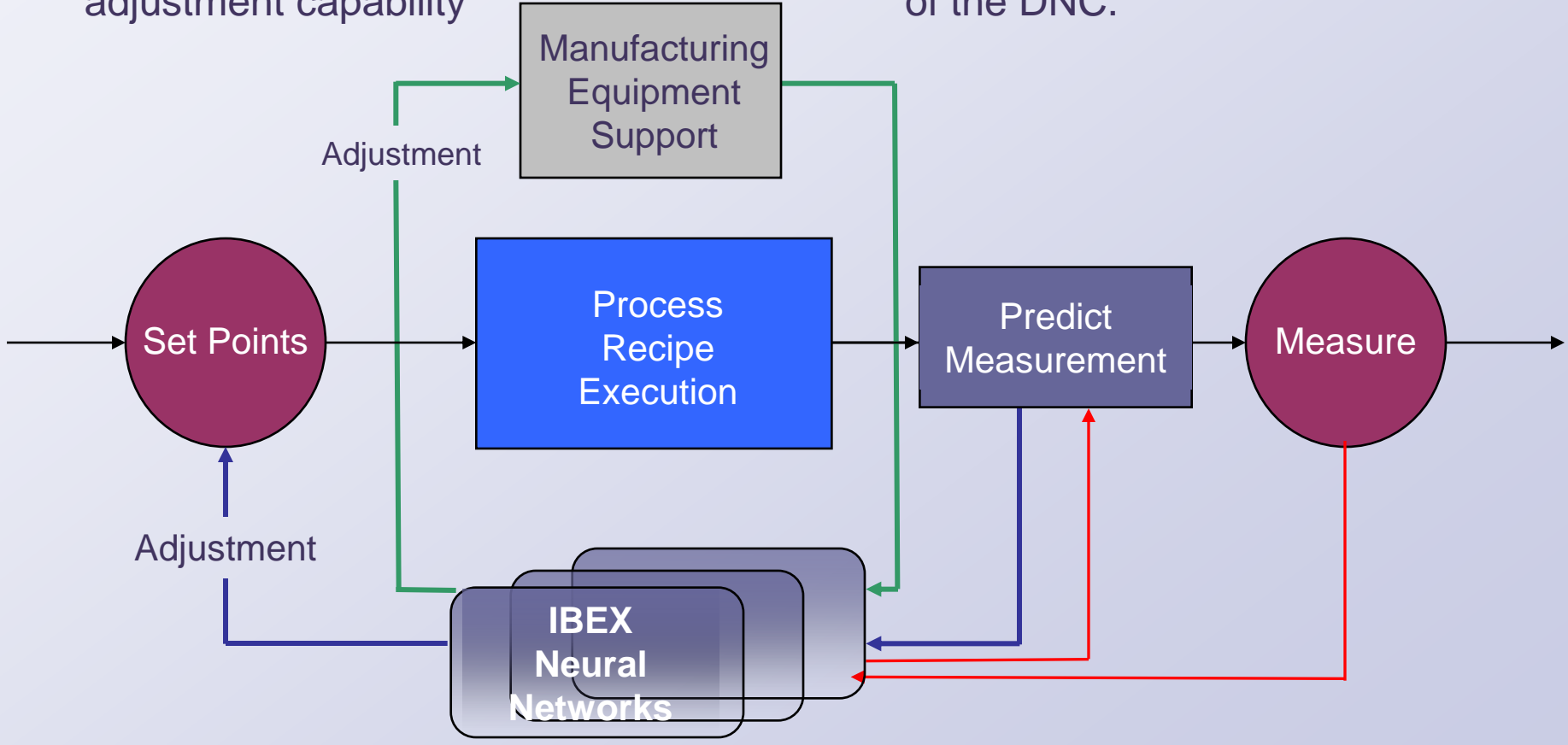


- The results demonstrated DNC's capability as an E-diagnostic tool
- The recommendations showed possible cost saving by eliminating unnecessary maintenance actions.
- Additional cost saving came from the ability to forecast catastrophic failures and avoid unscheduled down time.



DNC Optimization

Two type of recommendations can be advised by DNC: Maintenance actions and input adjustments. Next application relies on the input adjustment capability of the DNC.



Dynamic Neural Controller™ as an E-diagnostic tool

Uniformity of Setup Variables



- **Exact parameter settings are unknown at set-up time**
 - Extensive individual tuning at set-up
 - Hard to compare different tools
 - Post-maintenance Calibration issues
 - Highly trained engineers are required
- **How DNC can help**
 - Use information from *multiple* tools *in field*
 - Identify the best setting for tools that are physically similar
 - Tuning a set of variable *simultaneously* (multivariate) instead of treating them as independent.
 - ⇒ *Reduce set-up time;*
Make the knowledge more transferable

DNC Application for Setup Uniformity

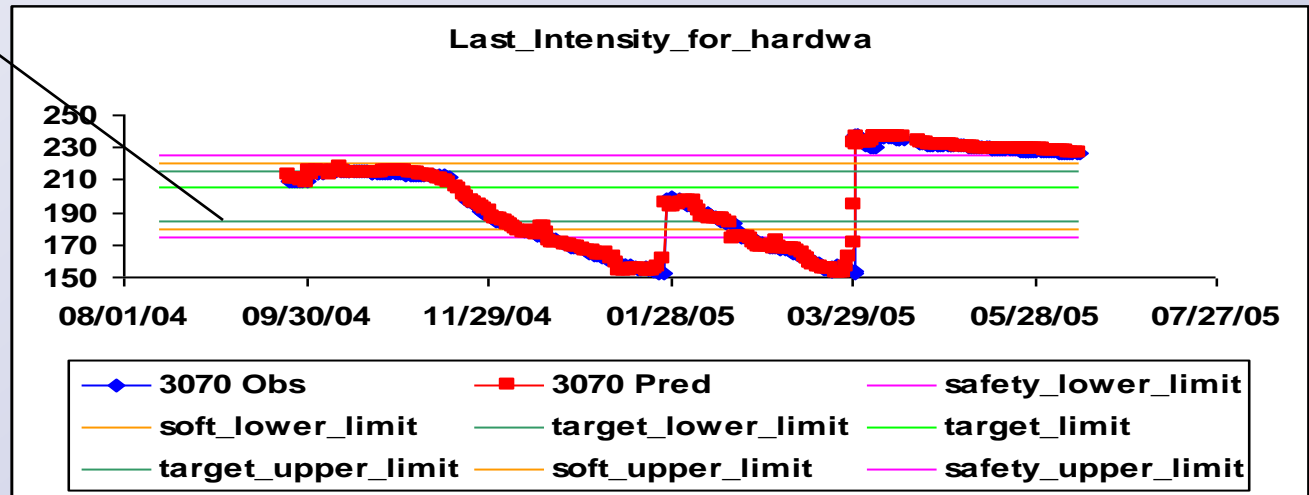
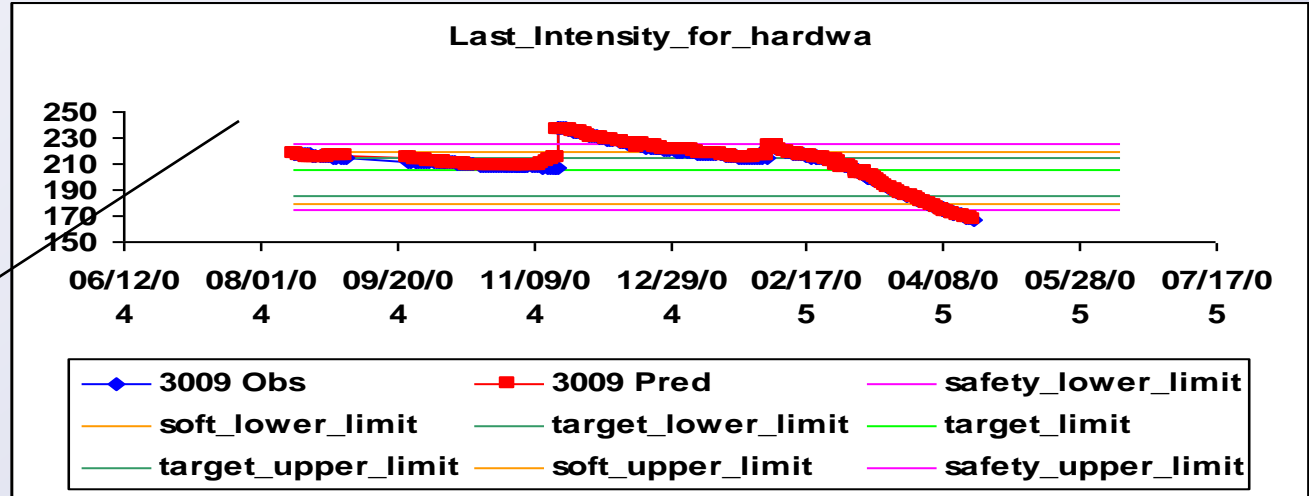


- Using archer as an example,
 - A single model was trained for 2 tools (3009 and 3070)
 - High model accuracy observed
 - Tools have to be physically similar enough
 - 9 month of training data
 - Parametric setting changed uniformly across 2 machines
 - Results in overall cost reduction for tool 3070

Model Accuracy



Note that the two tools are running at different level, and the model fits each tool accurately

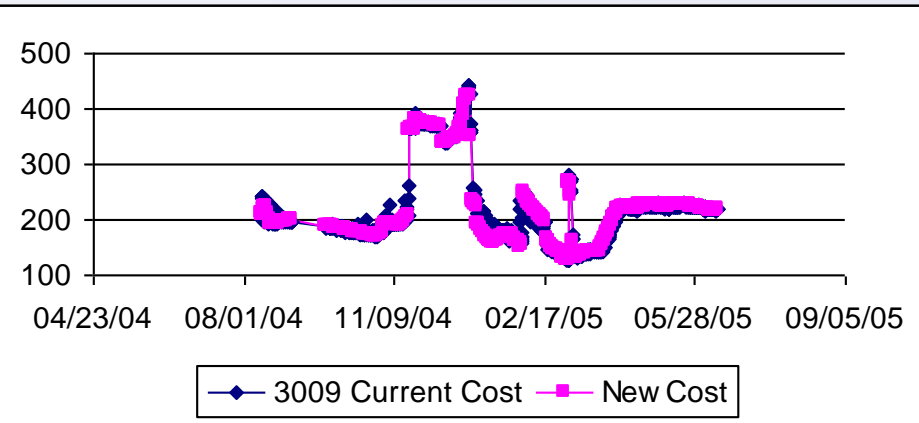


Set-up Parameter Adjustment

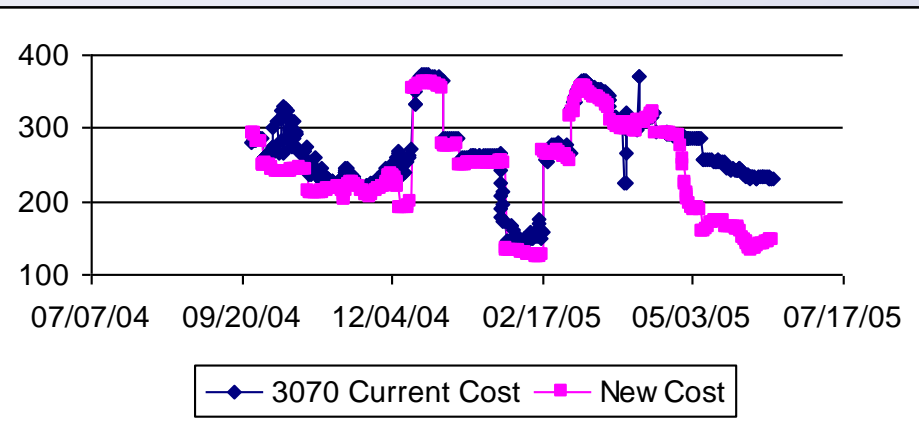


- Following variables included in setup adjustment:
 - AMS_BF_light_12mm_FOV
 - AMS_BF_light_750_um_FOV
 - Phase_plot_autocalib
 - PZT_P_gain
 - PZT_P_offset
- After the optimal settings were found, DNC simulated the tool performance
 - New settings led to 10% cost reduction on 3070

Cost Reduction in Setup Uniformity



	Average	StdDev	Min	Max
3009	1%	5%	-16%	36%



3070	10%	14%	-46%	43%
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Conclusions



- Results on the Archer lamp subsystem demonstrated DNC's ability to as an E-diagnostic tool
- DNC applications can lead to significant cost saving:
 - By forecasting/monitoring tool health
 - By providing uniformity of set-up parameters
- Direct Application does not require major modifications of DNC.
- DNC can serve as a centralized controller
 - seamlessly combine both e-diagnostic and process control.