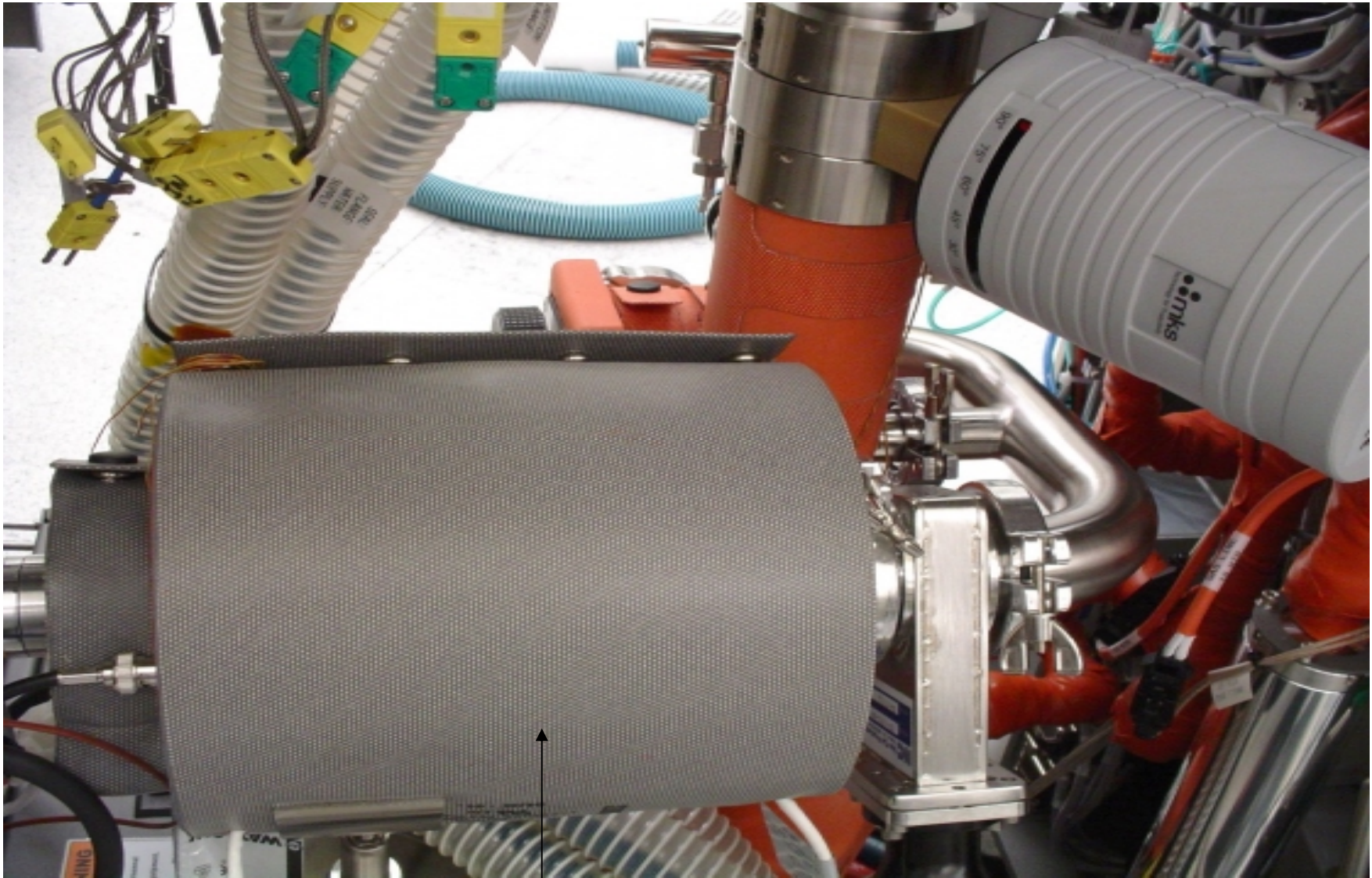


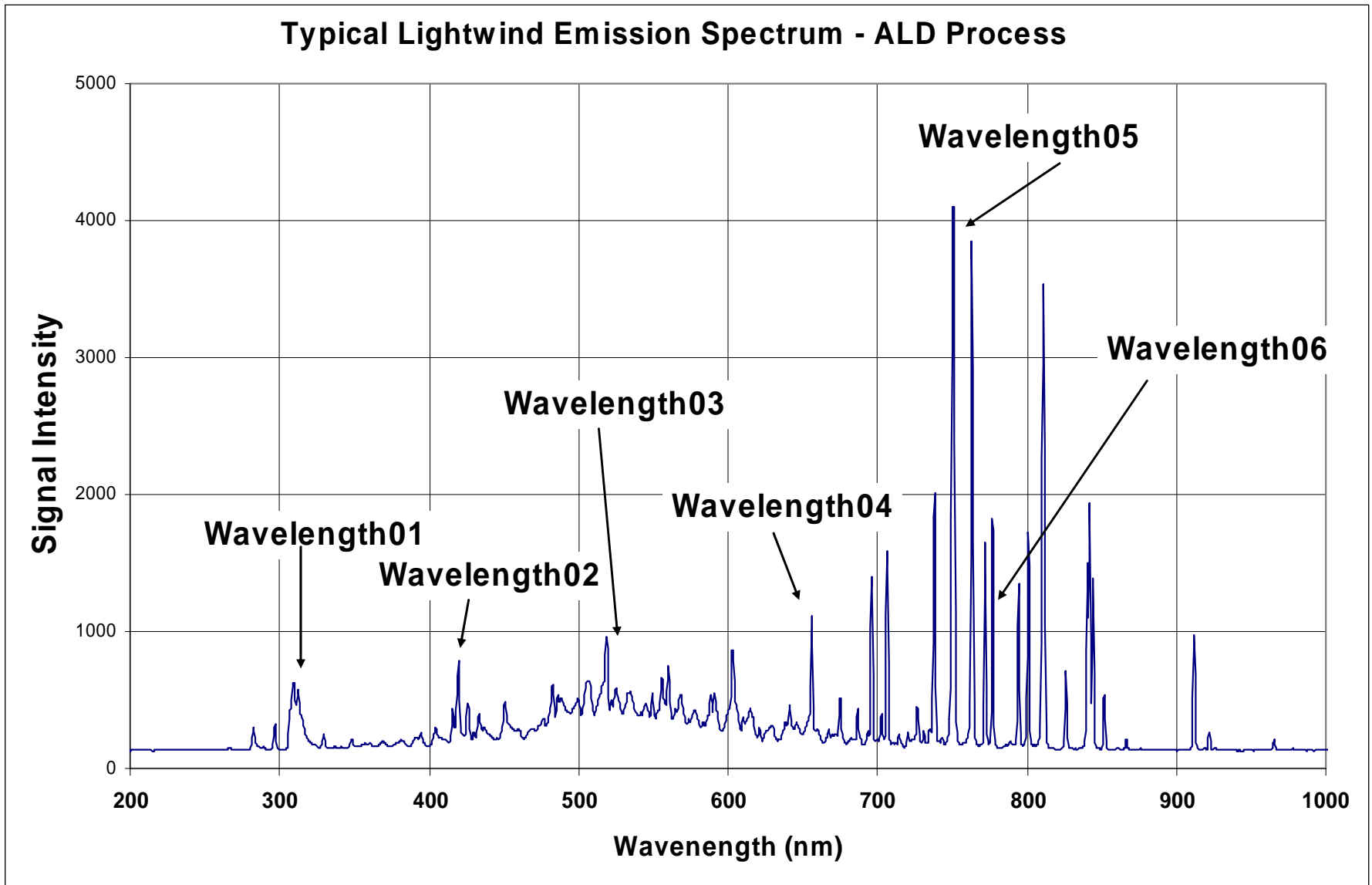
USING OPTICAL EMISSION SPECTROSCOPY TO IMPROVE EQUIPMENT UPTIME FOR AN AL₂O₃ ALD PROCESS *

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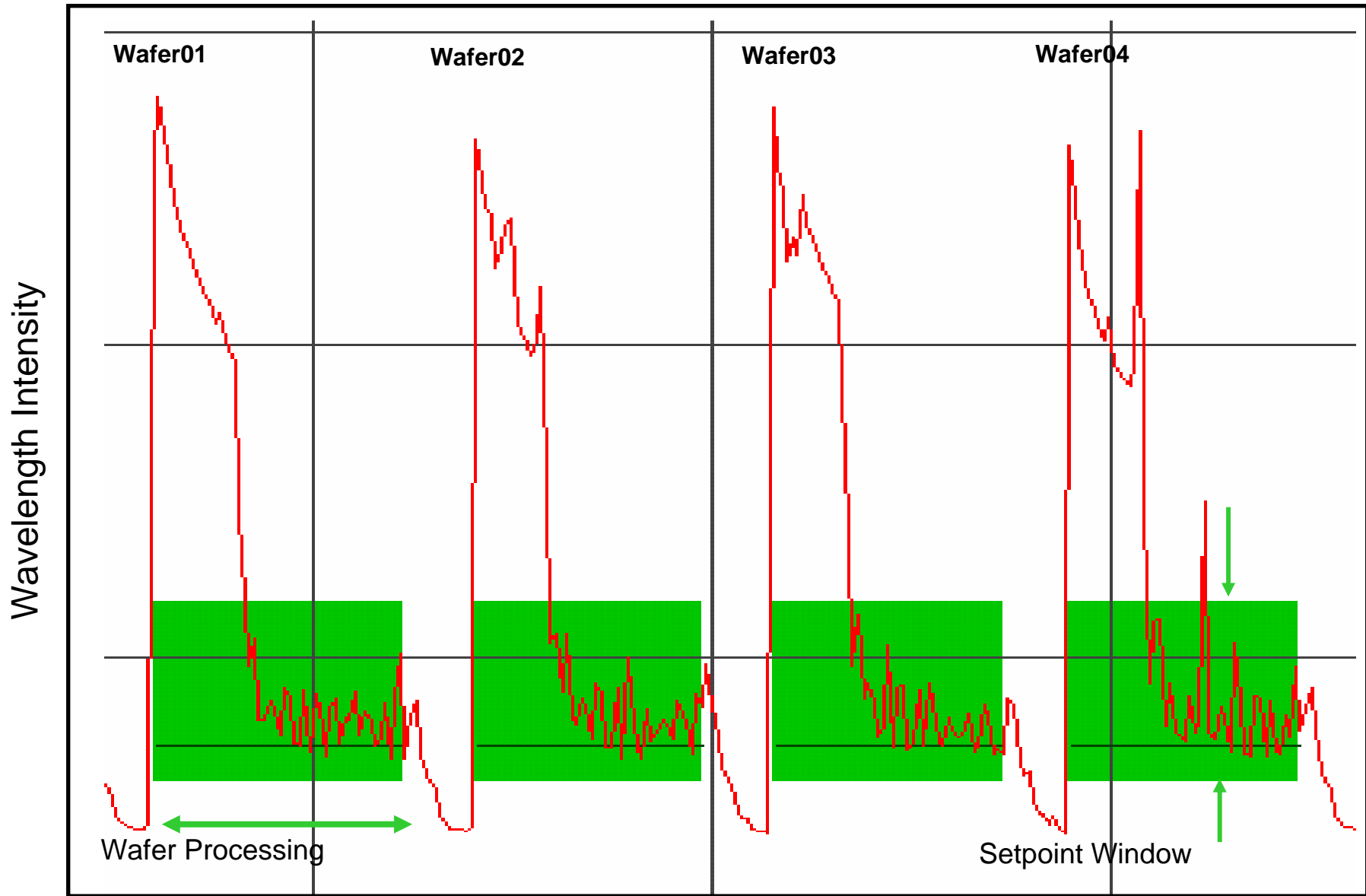
* Presented at the AVS 5th International Conference on Atomic Layer Deposition
August 8-10, 2005, San Jose California



Installed OES unit with heater blankets

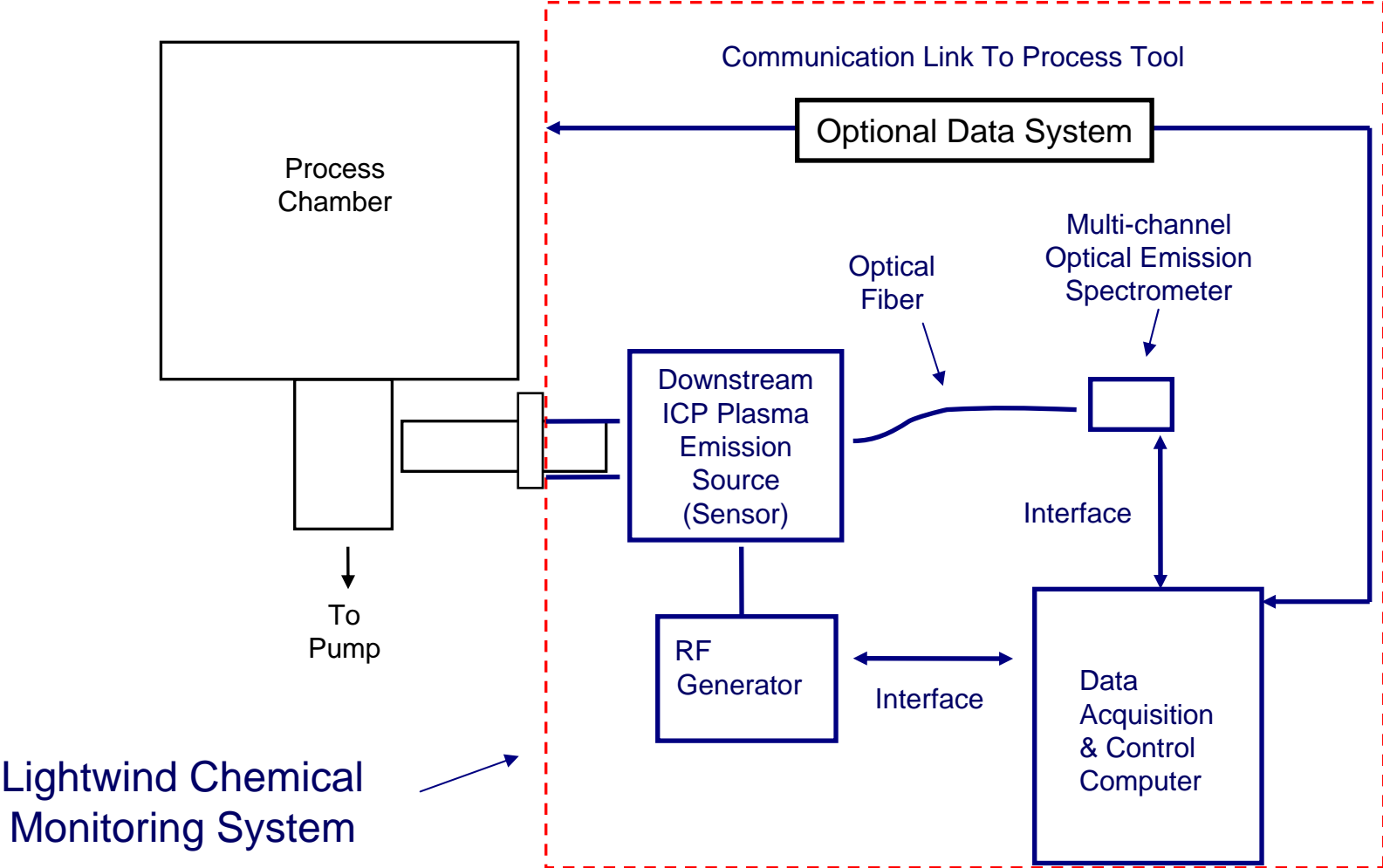


Typical emission spectra of an Al₂O₃ ALD process

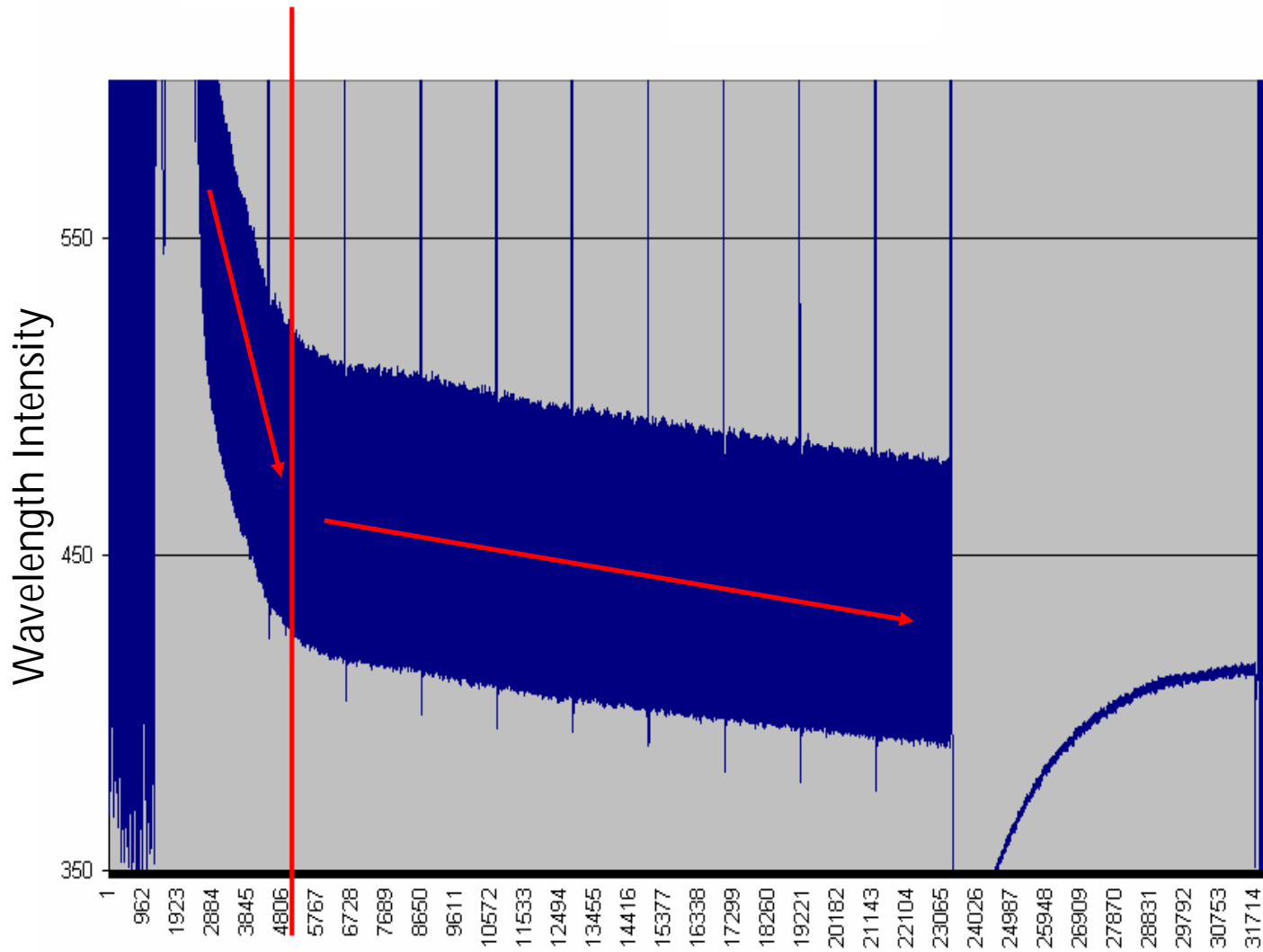


Typical monitoring of chamber affluent wavelength

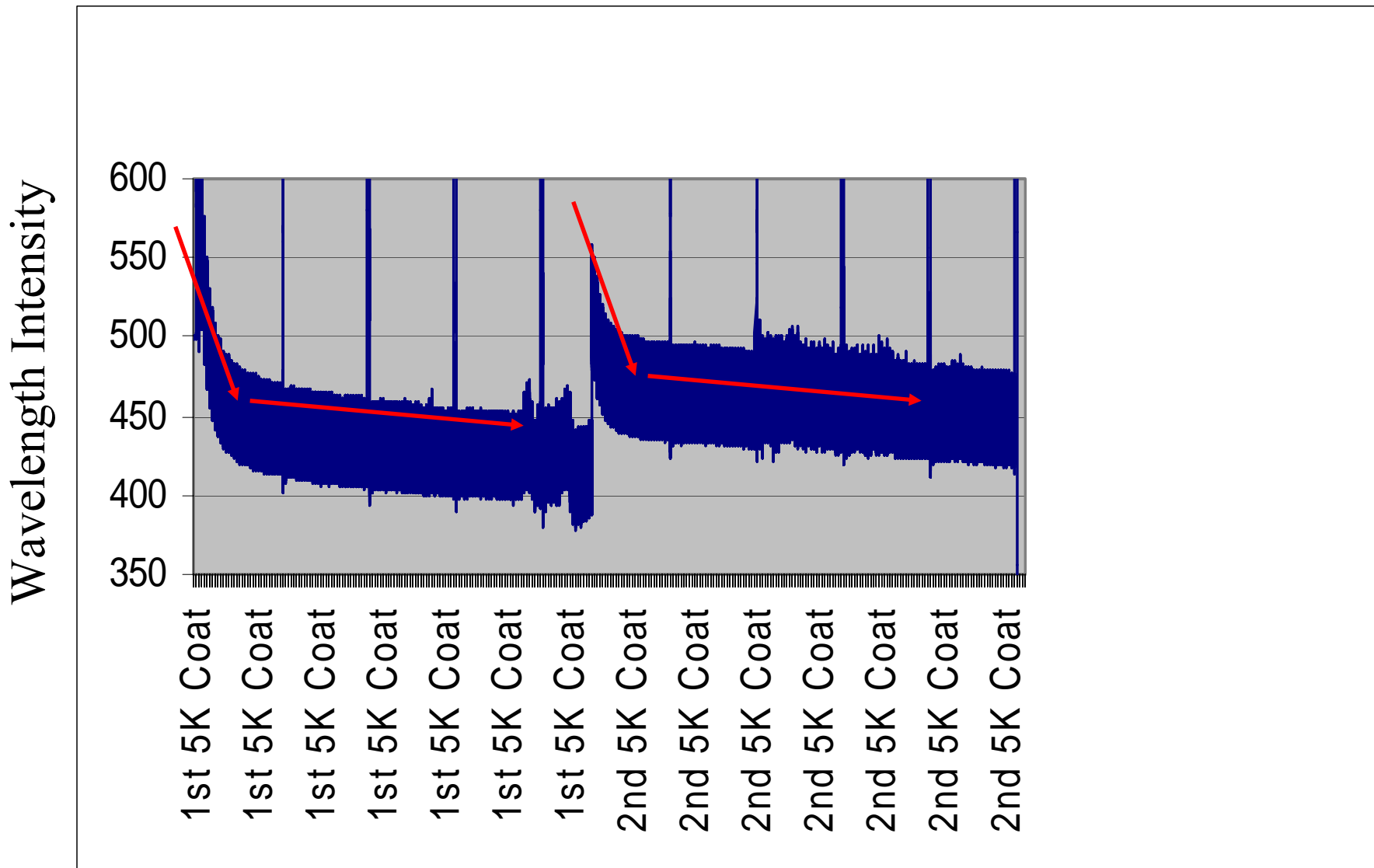
SYSTEM INFORMATION



The Lightwind system monitors process chemistry via plasma-induced Optical Emission Spectroscopy (OES).



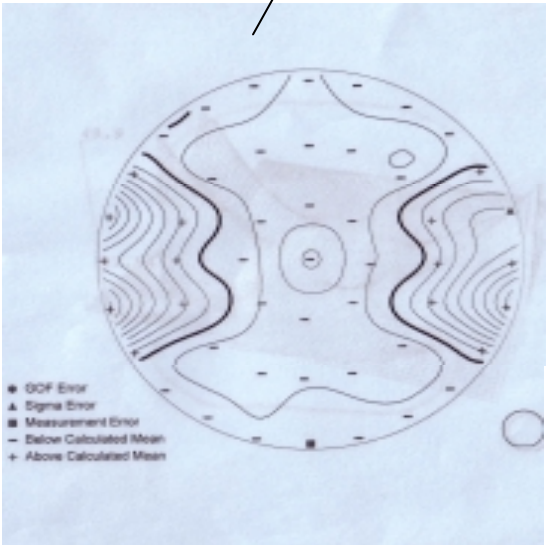
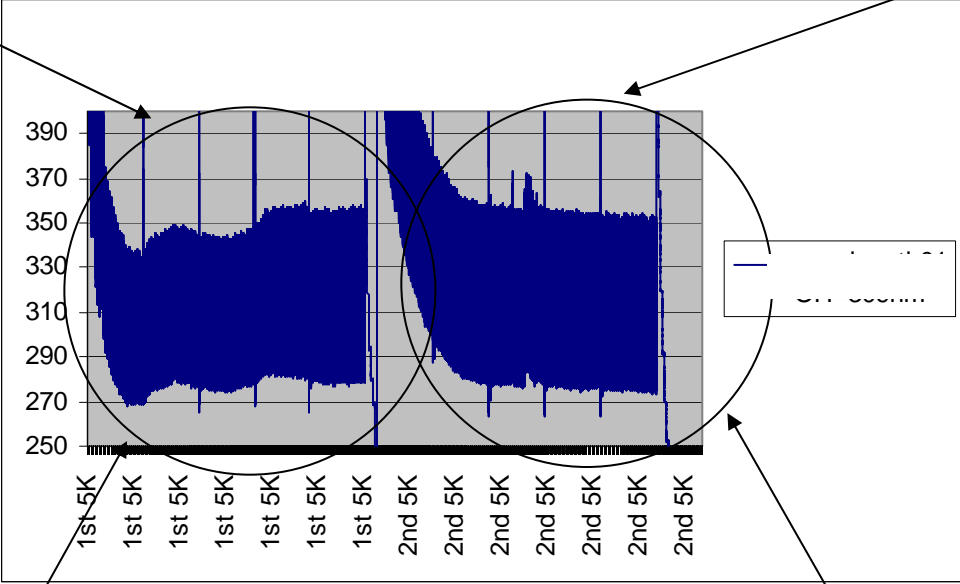
Wavelength time trend of a long chamber coat. There is a distinct shape of the trend which indicates that the chamber is ready for post chamber maintenance release.



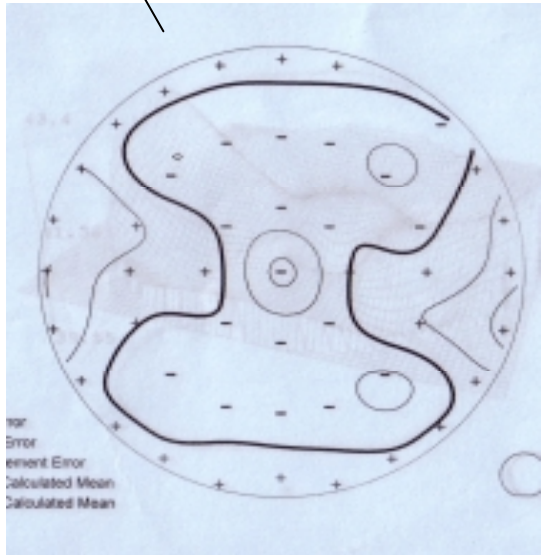
Wavelength time trend of two successive short coats ($\frac{1}{2}$ the time of the long coat). This shows a repeatable “seasoning” curve in the same process chamber. Keeping this signature in mind a higher gas flow coat was attempted.

Improper trend indicating seasoning did not properly occur

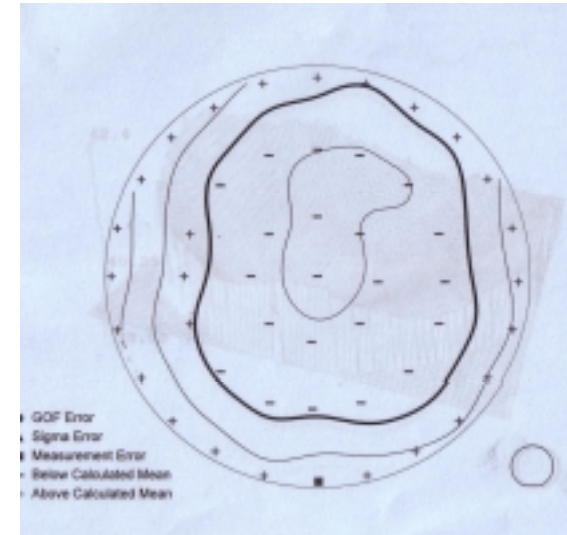
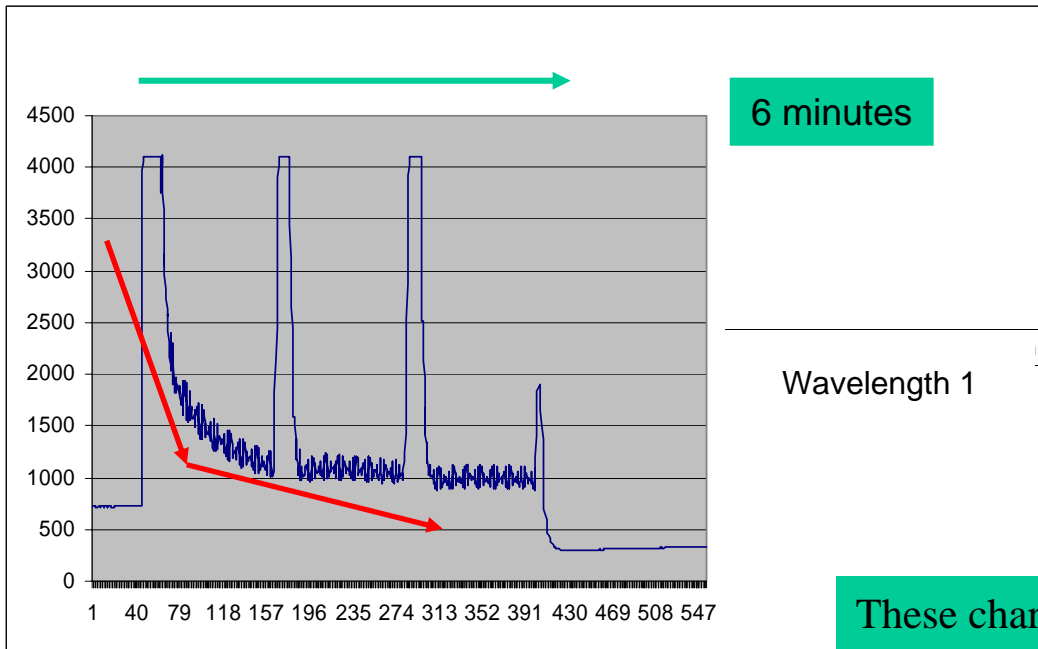
Proper trend indicating seasoning is complete



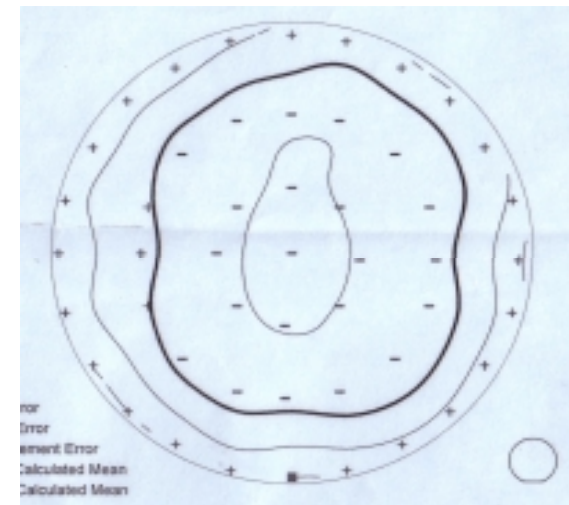
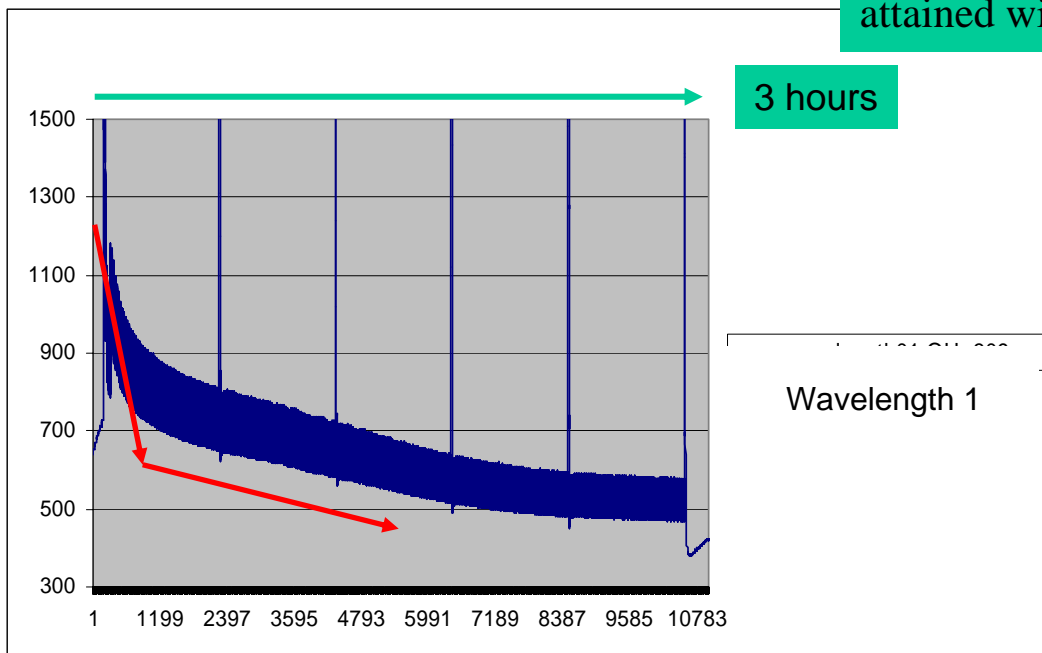
49pt Contour Map performed after coating

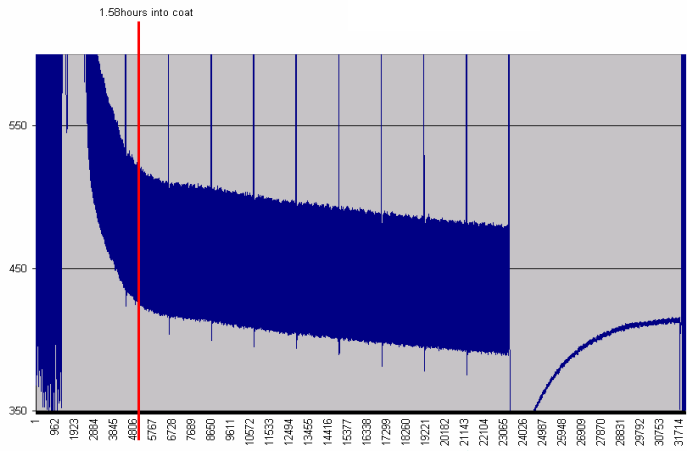


49pt Contour Map performed after coating

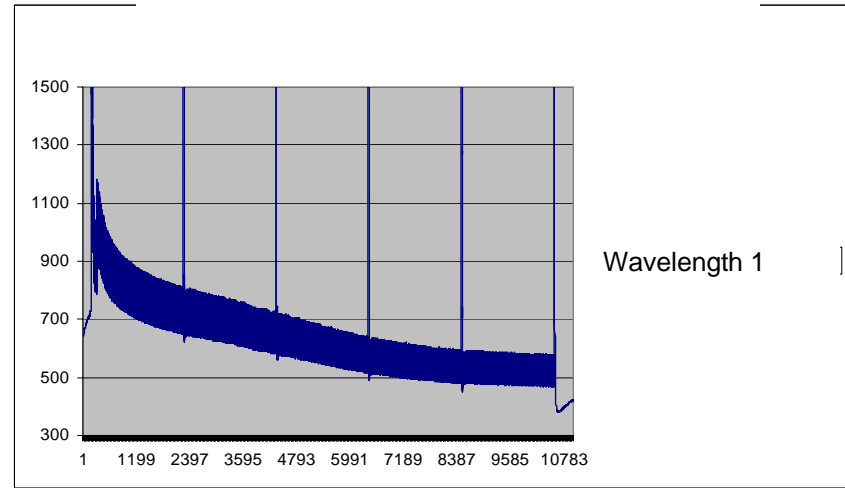


These charts indicate that the same seasoning curve can be attained with a simple change to the coating recipe.

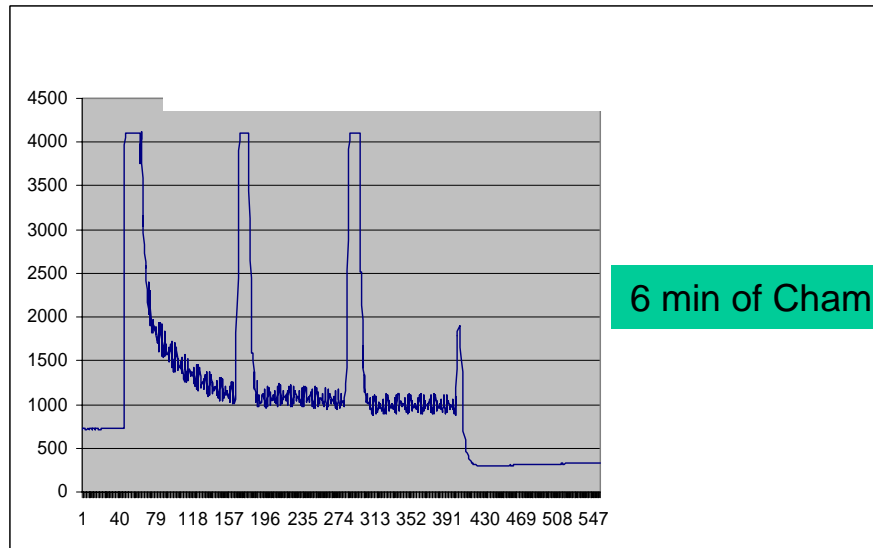




6 hours of Chamber Coating

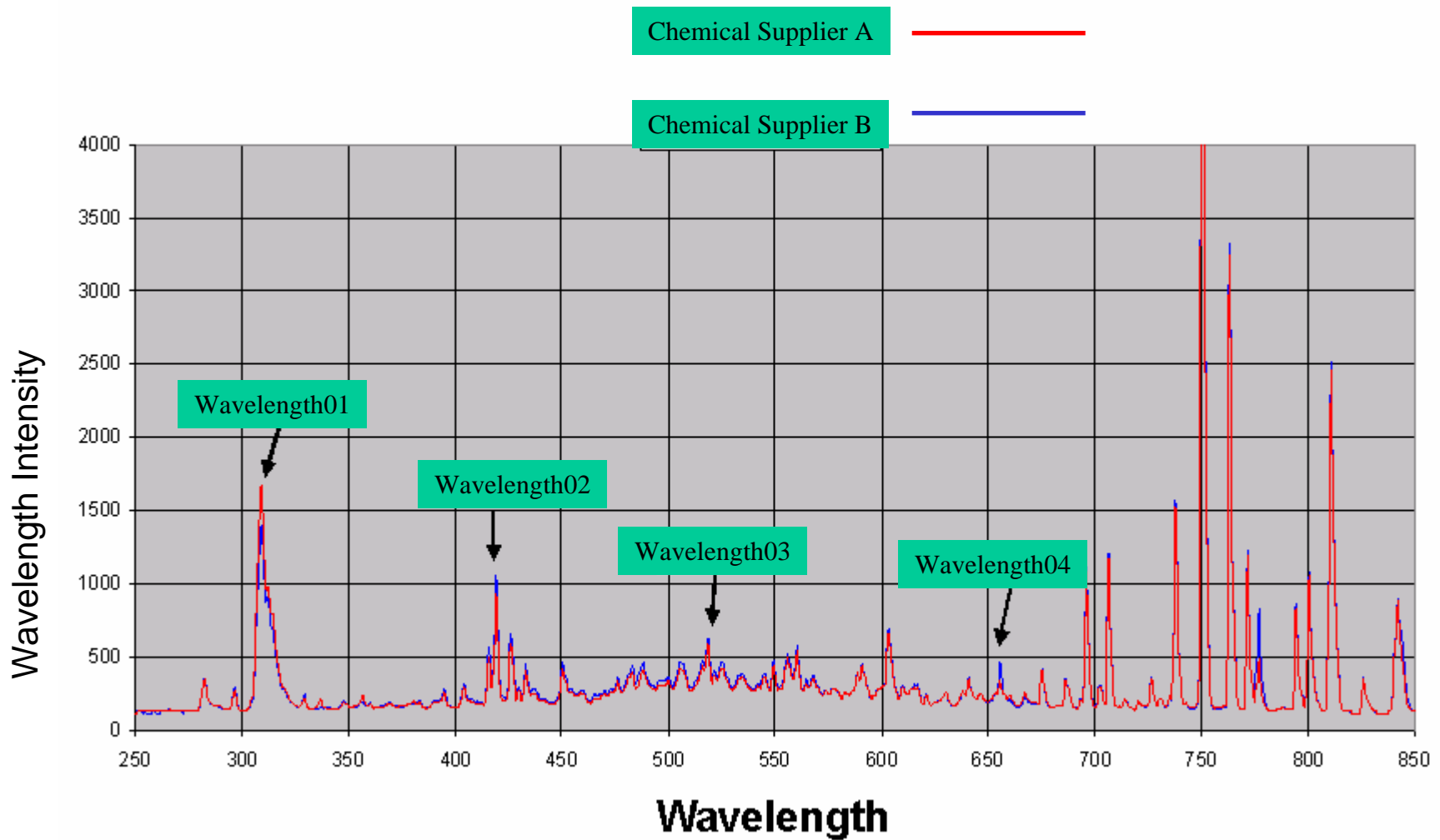


3 hours of Chamber Coating



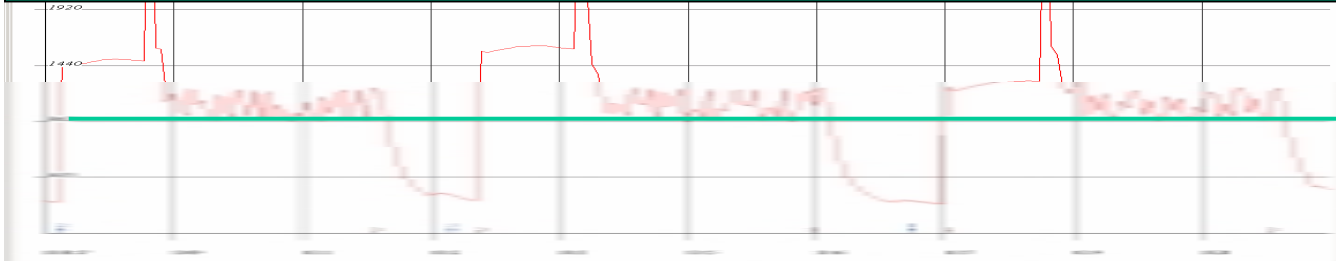
6 min of Chamber Coating

By understanding the response from the chamber affluent during chamber coating , qualification time (time required to prepare a processing chamber for production material processing) can be reduced from 6hours to 6min.



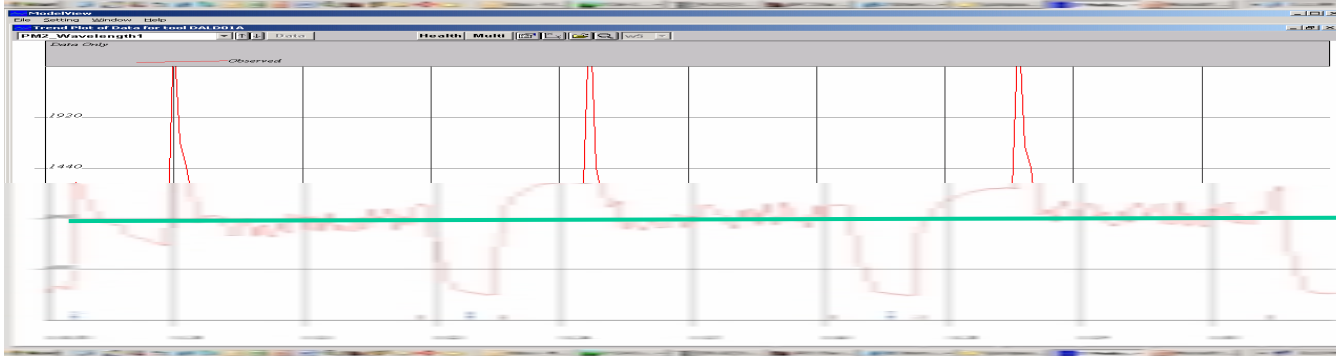
In this example, precursor chemical suppliers were compared by overlapping full spectra. Critical wavelengths were previously identified as shown above. Using OES provided additional information regarding the precursor chemical composition from both suppliers.

These charts show how OES monitoring of chamber affluent can detect changes to the reaction liquid fill level. As the bottle level drops, the wavelength intensity decreases.

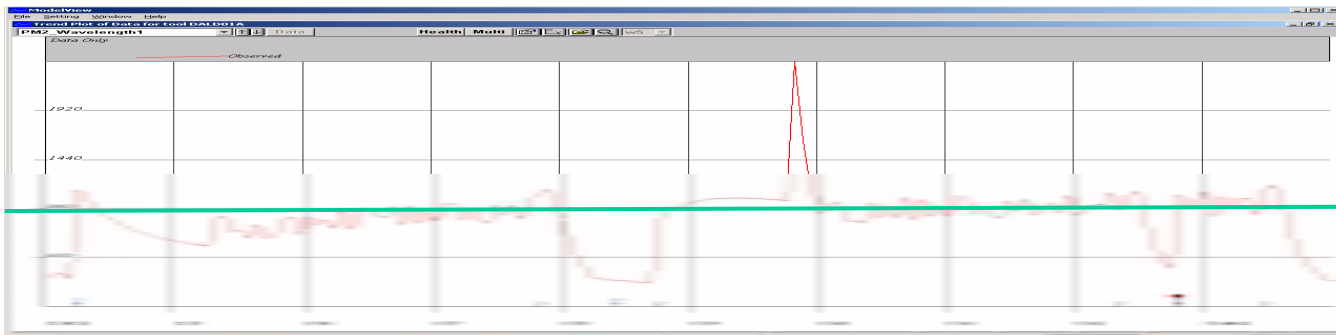


Bottle Fill = 100g

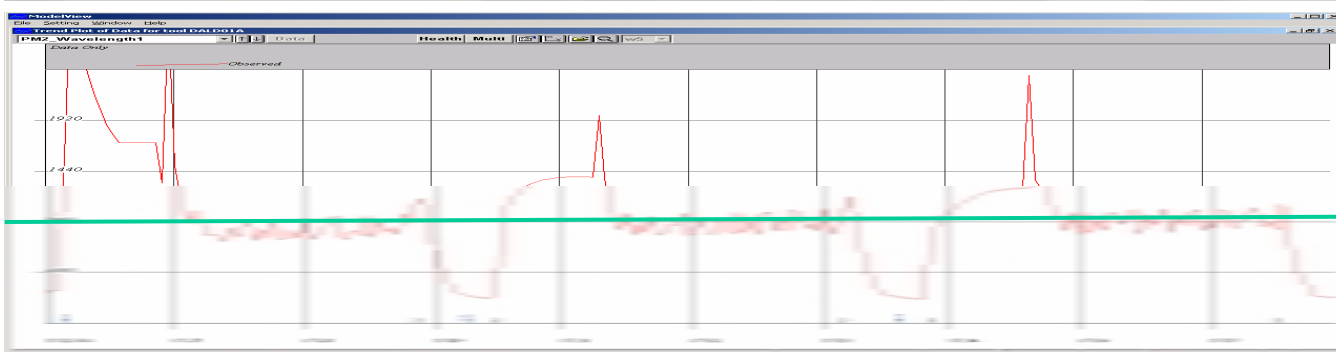
Reference Line



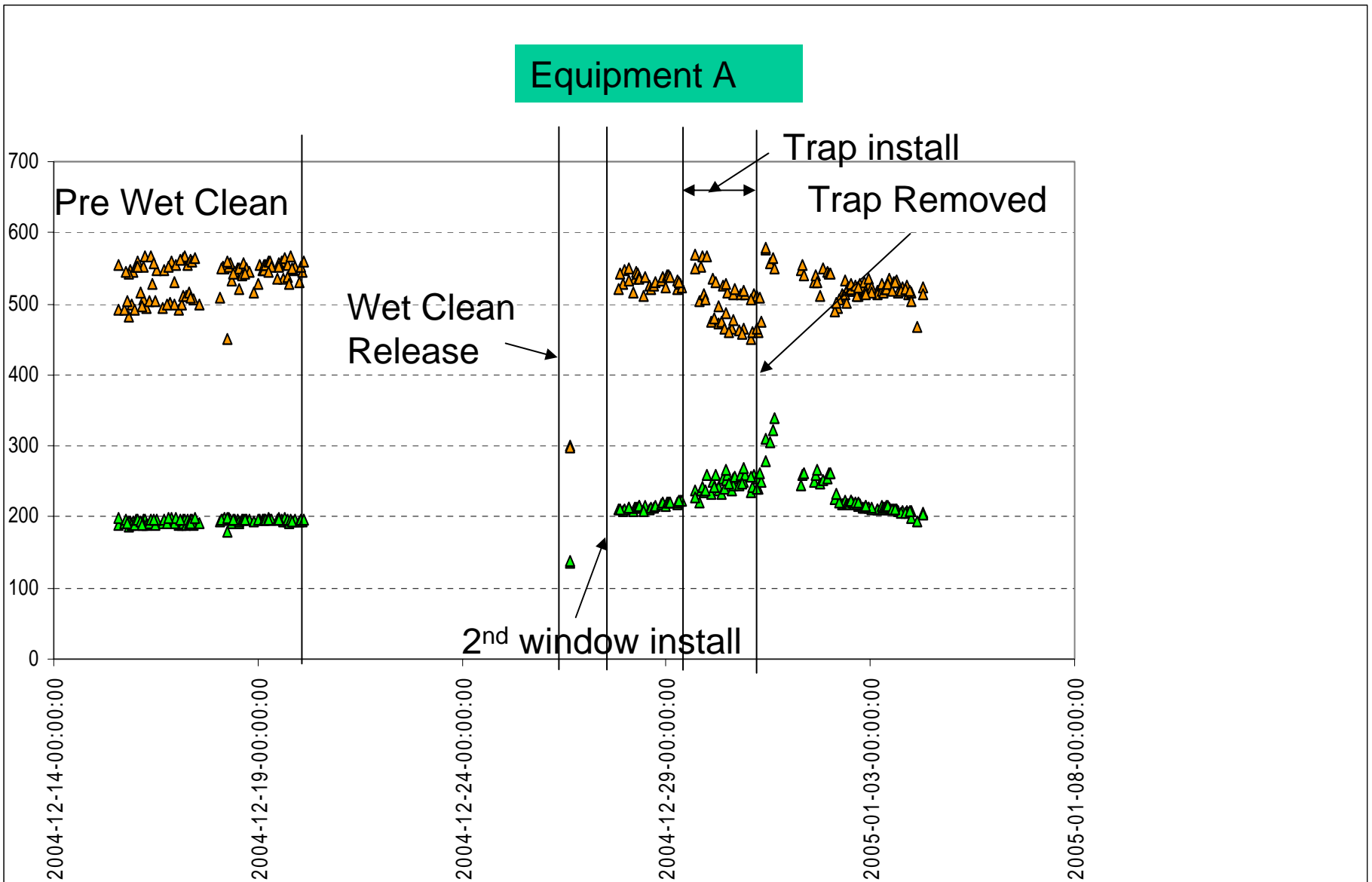
Bottle Fill Level = 63g



Bottle Fill Level = 43g



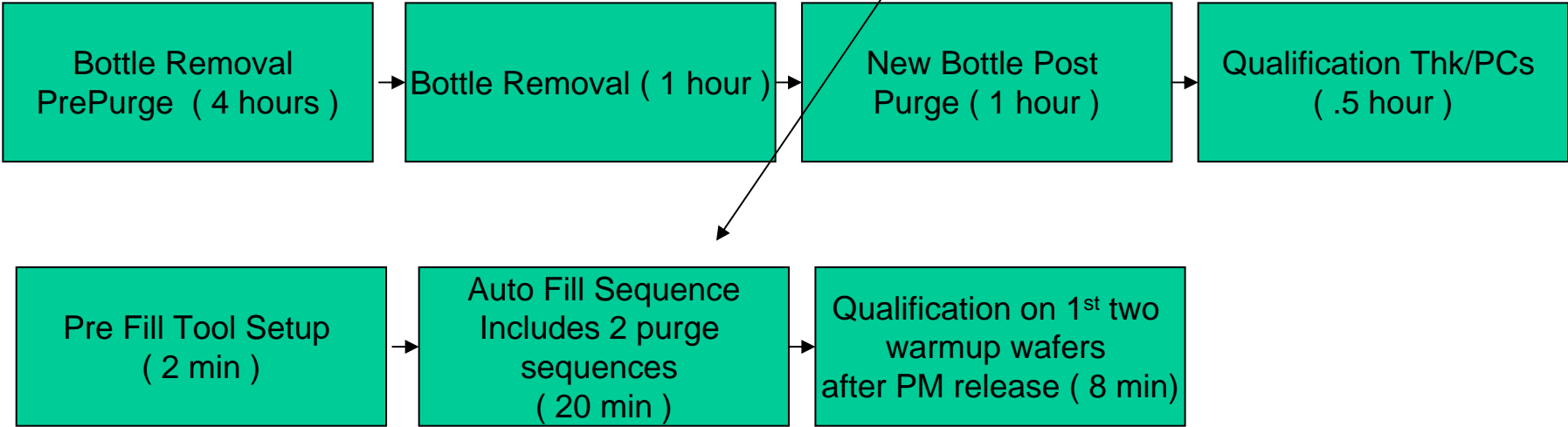
Bottle Fill Level 20g



Here OES monitoring was used to evaluate a new pump trap design. Shortly after installation, the intensity of the monitored wavelength decreased leading to an early detection of a trap failure.

The use of OES provides critical information regarding processing system integrity before and after a schedule maintenance. Here is an example whereby OES data was utilized after a precursor bottle fill. This coupled with an in-situ precursor fill system drastically reduced the total time required.

Precursor Bottle Replacement/Fill Maintenance and Qualification Time	Original Total Time per Tool	New Total Time per Tool	Added Uptime per Tool
	6.5hours	.5hours	6.0hours



By switching to an AutoRefill System and then confirming chamber integrity post the maintenance with OES data, total time reduced by 6 hours.