



CI SEMI

On-line real time Monitoring

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CI Systems and CI Semi

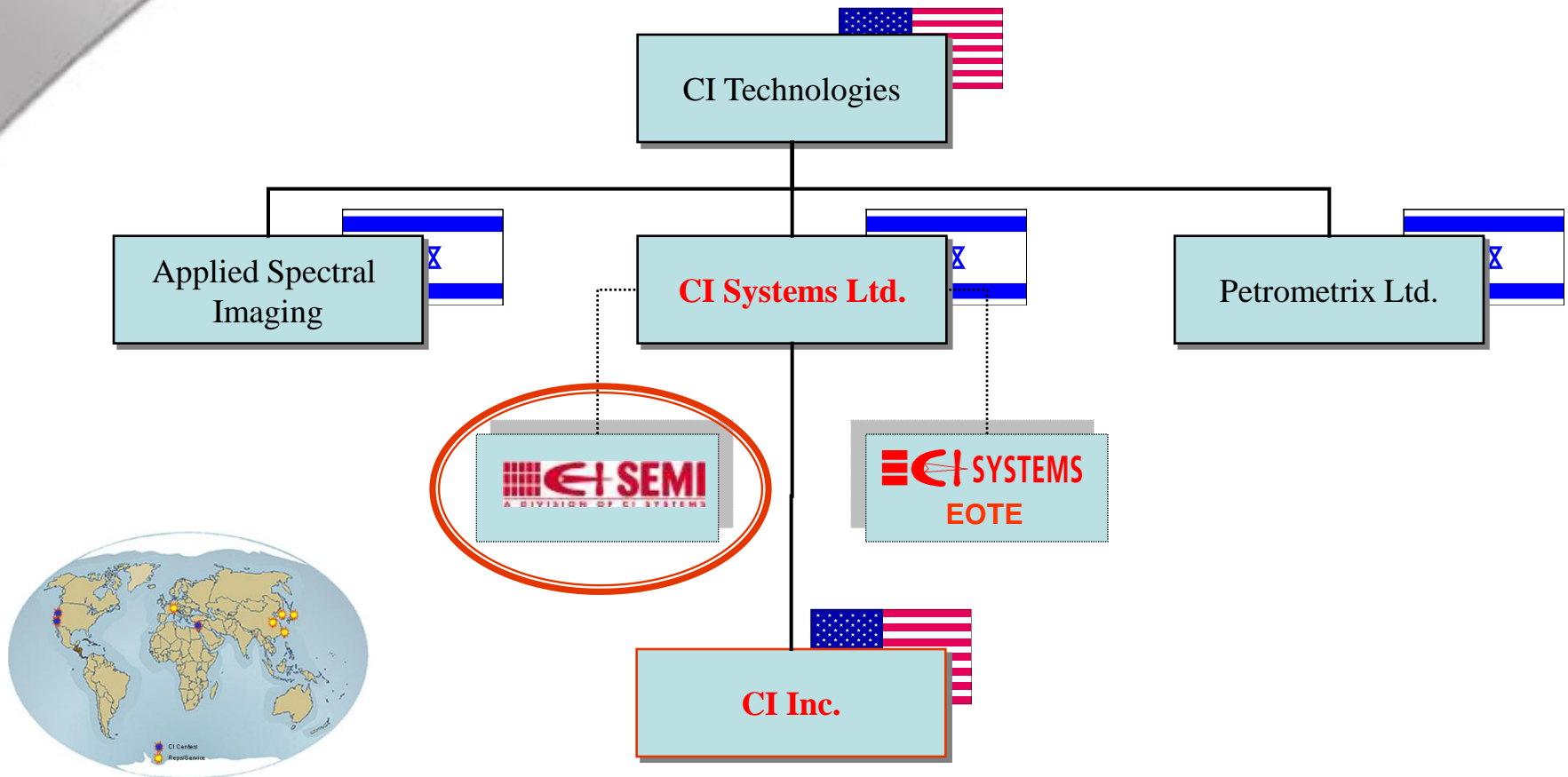
CI Systems LTD founded in 1977, is a pioneer in a wide array of IR electro-optic (E-O) products for scientific, industrial and military applications.



CI Semi is a division of CI Systems, which develops, manufactures, and markets in-line and in-situ monitoring solutions for the **semiconductor, solar, and FPD** manufacturing industry.



CI Group – Organization chart



25 years of excellence in IR spectroscopy and radiometry

Key Facts

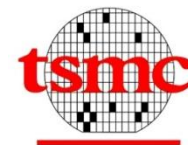
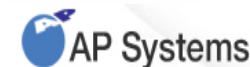
- Public company in TASE since 1993
- Israeli main Facility
 - R&D / Production / Q.A. / Service / Marketing
 - 110 employees, (35% engineers)
 - 45,000 sq. ft.
- U.S. subsidiaries (L.A and the Silicon Valley)
 - Applications / Assembly / Service / Marketing
 - 10 employees
- ISO9001-2000 / CE certified / ANSI Z540 part-II

Our Customers (Partial list)

Monitoring solutions *for the Semiconductor industry* for more than 15 years

OEM's: Novellus, Applied Materials, TEL, Ulvac, etc.

End users: Samsung, TI, IBM, Cypress, Renesas, Micron, AMD, Elmos, CMO, AUO, DongBu, More....



Main Product Lines

■ NTM: In-Situ wafer Temperature Monitor

Non-contact, real-time, same-point emissivity measurement compensation



■ In-Line Wet process analyzers

Broad line of monitoring solutions for real-time wet chemistry monitoring

➤ WetSpec200/201

➤ WetCon100

➤ WetRad-2



Product Selector

Chemical Mix	Number of components to measure	Model	Technology
Single Component	1	WetCon100	Conductivity (by inductance)
Multi Component	1	WetRad-2	NDIR (Vis/NIR , dual wavelength)
	>1	WetSpec200/201	NIR Spectroscopy

Product Selector (continued)

WetSpec200/201: The only tool for measuring multi components in one mix

WetRad-2: a SELECTIVE one component (in a multi components mix) sensor. The selectivity by: wavelength is pre-selected per the component you want to measure

WetCon100: High sensitivity single component sensor

WetSpec200

Wet Chemistry Analyzer – **Best Product 2009**



The WetSpec200 – NIR Spectrometer

- The WetSpec200 is an in-line monitor of chemical composition of liquids.
- It measures the near-infrared (NIR) optical transmission spectrum
- It determines the values of the fluid's properties by chemometric means.

Advanced Features

- Near-infrared (NIR) optical transmission spectrum measurement
- Real-time, in-line chemistry monitoring
- Proprietary novel pre-processing & chemometrics algorithms
- Simultaneous measurement of multi-component chemistries
- Up to eight channels
- Advanced communication through Ethernet

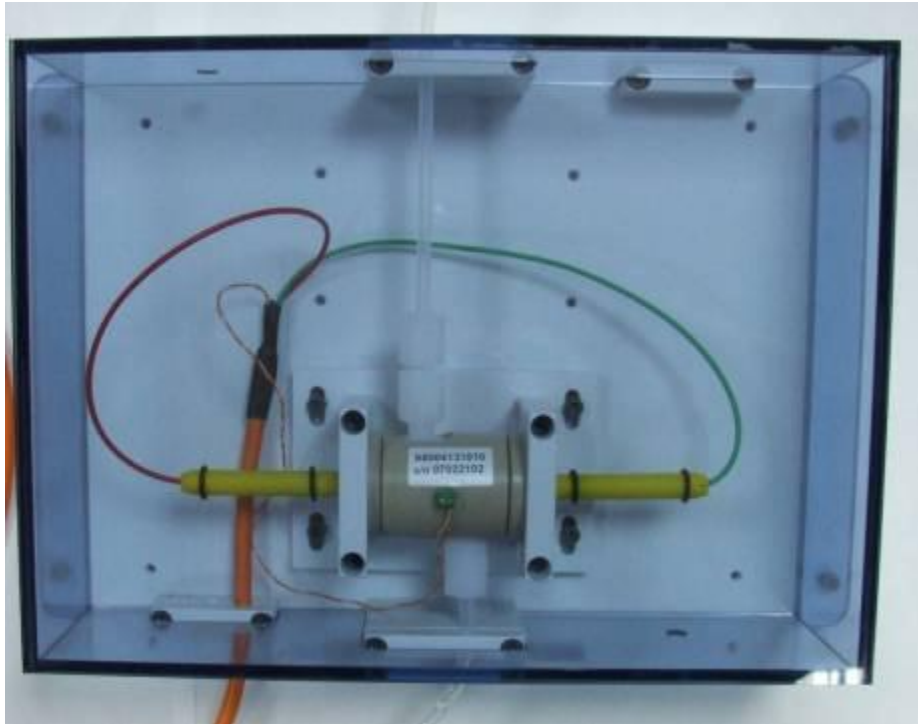


Back side view with fiber connected



Front side view with service door open

Flow cell

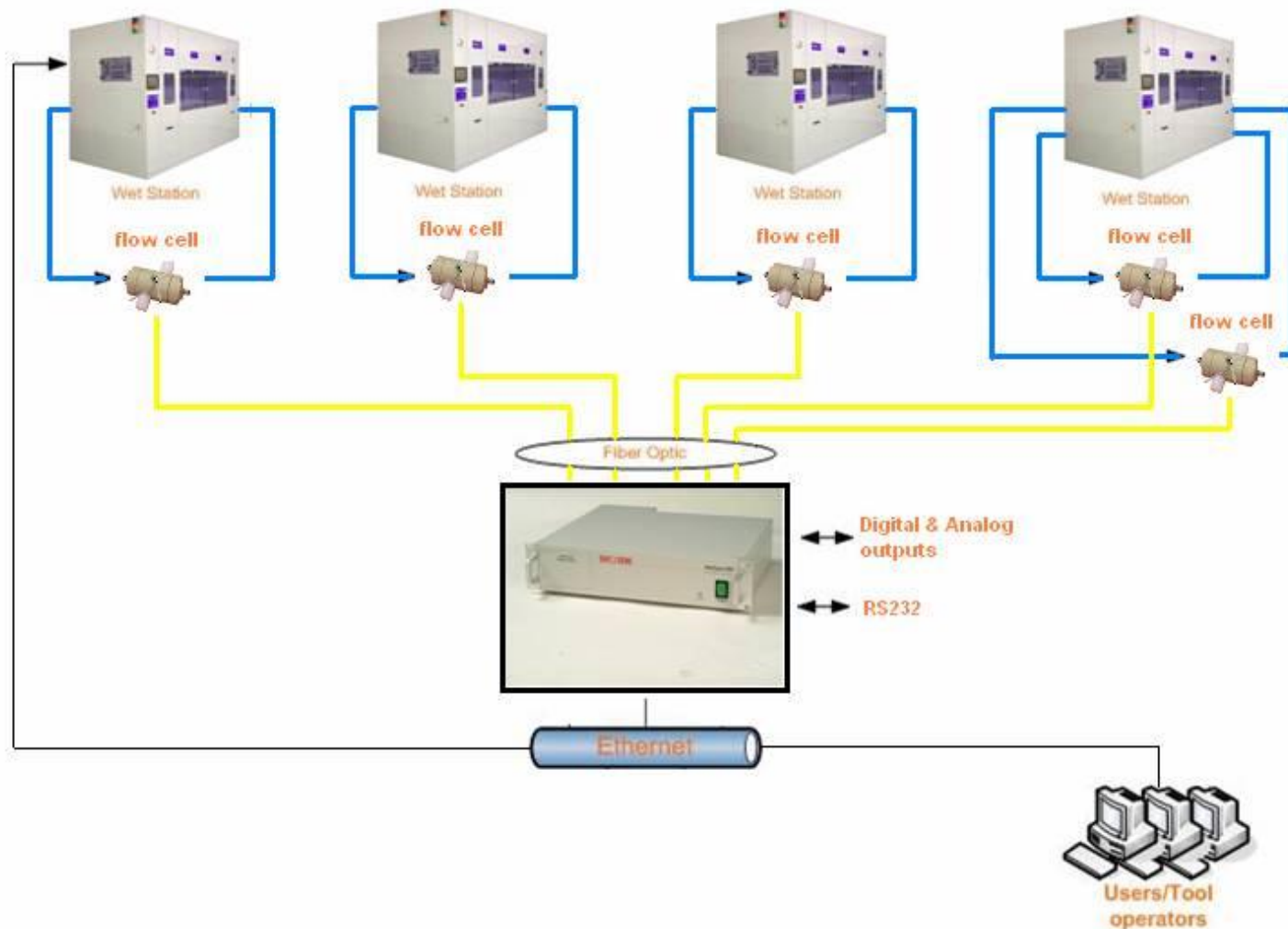


The new WetSpec201

- Single channel
- Small footprint
- Same performance as the WS200



WetSpec 200 Typical Configuration



Typical Applications: Etching

Application	Component	Range (*)	Accuracy (*)
			(RMS Error)
HF/HCl	HF	0-1.2 wt%	0.04 wt%
	HCl	0-1.2 wt%	0.05 wt%
HF	HF	0-1.2 wt%	0.04 wt%
		1.2 - 30	0.1 wt%
Hydrofluoric Peroxide	HF	22-27 wt%	0.1 wt%
	H2O2	13-17 wt%	0.1 wt%
Buffered Oxide Etch	HF	0.5-5 wt%	0.1 wt%
	NH4F	16-40 wt%	0.3 wt%

(*) Typical values only. Real range and accuracy is per specific definitions

Typical Applications: Cleaning

Application	Component	Range (*)	Accuracy (*)
			(RMS Error)
SC1	NH4OH	0-5 wt%	0.10 wt%
	H2O2	0-15 wt%	0.10 – 0.20 wt%
SC2	HCl	0-8 wt%	0.20 wt%
	H2O2	0-6wt%	0.20 wt%
DSP (Dilute Sulfuric Peroxide)	H2SO4	0 - 25wt%	0.20 wt%
	H2O2	0.5-5 wt%	0.10 wt%
H2O2 in water	H2O2	10-33 wt%	0.5 wt%
NH3 in water	NH3	20-27 wt%	0.25 wt%

(*) Typical values only. Real range and accuracy is per specific definitions

Typical Applications:

PR removal and CMP

Application	Component	Range (*)	Accuracy (*)
			(RMS Error)
SPM 50-100C	H2SO4	70-100 wt%	0.2 wt%
	H2O2	0-6wt%	0.2 wt%
ACT 970	Water	14-18 wt%	0.15 wt %
ST 250	Water	34-40 wt%	0.15 wt%
ST 26	Water	5-20 wt%	0.5 wt%
ACT AS65	Water	8-20 wt%	0.25 wt%
EKC 265	Water	8-28 wt%	0.20 wt%
Peroxide in Slurry	H2O2	0-5 wt%	0.05 wt%

(*) Typical values only. Real range and accuracy is per specific definitions

Typical Applications – FPD/PV

Application	Component	Range	Accuracy (RMS Error)
HF/HNO ₃	HF	4-12 wt%	0.2 wt%
	HNO ₃	10-25 wt%	0.45 wt%
	H ₂ SiF ₆	0-6 wt%	0.1 wt%
Si Etch	KOH	0-5wt%	0.20 wt%
	IPA	0-5 wt%	0.20 wt%
Al etch	HNO ₃	3-6wt%	0.10 wt%
	CH ₃ COOH	3-6wt%	0.10 wt%
	H ₃ PO ₄	65-70 wt%	0.50 wt%
Nitric/Acetic Acid	NHO ₃	1-4 wt%	0.15wt%
	CH ₃ COOH	8-12 wt%	0.2 wt%
MAE (Mix Acids Etch) #1	HF/HNO ₃ /H ₃ PO ₄ /H ₂ SO ₄ /H ₂ O	*	*
MAE (Mix Acids Etch) #2	HNO ₃ /HCl/CH ₃ COOH	*	*
MAE (Mix Acids Etch) #3	HNO ₃ /HF/CH ₃ COOH	*	*
HF/HCl	HF	0-1.2 wt%	0.04 wt%
	HCl	0-1.2 wt%	0.05 wt%
KOH	KOH	0-50 wt%	0.2 wt%

The WetSpec200 Key Benefits

- Real-time concentration monitoring
- Fast measurement enabling closed loop control
- Increases tool throughput
- Flexibility of use:
 - Modular measurement channels – Up to 8
 - Same analyzer can measure different chemistries
 - Software switch between different chemistries
- Fast ROI (Return On Investment)
 - Savings on chemical usage and disposal
 - Savings on testing
 - Improved yield through better control
 - Avoid excursions



High sensitivity Conductivity Meter **WetCon100[®]**

- The **WetCon100[®]** monitor has been developed in cooperation with Thermo-Scientific in order to provide the best Cost-Performance solution for the strict demands of the semiconductor manufacturing process.
- The **WetCon100[®]** couples *CI Semi* extensive knowledge of semiconductor wet process monitoring together with *Thermo-Scientific* expertise in conductivity and induction sensing solutions for various industrial markets.

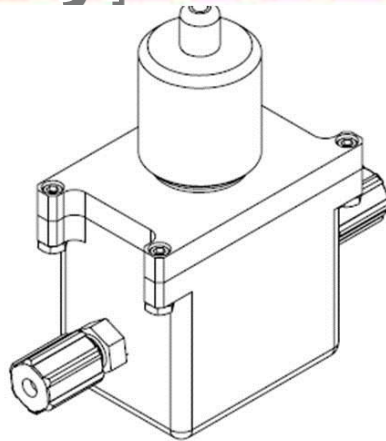
Main Features:

- ❖ **Measurement Method:** By using *electromagnetic induction* method, the *WetCon100* is superior to any electrode base conductivity meter.
- ❖ **Real time HF concentration :** The *WetCon100* determines the chemical concentration in real time by measuring the induction current of the solution and comparing it to a pre-set calibration curve
- ❖ **High Accuracy:** The *WetCon100* measurement range of 0-2000 mS/cm, provides an accurate and effective measurement solution for practical process concentrations including diluted chemicals
- ❖ **Durability:** The *WetCon100* sensor is built from PVDF/PTFE which provides excellent resistance to all levels of acids and eliminates any danger of metal ion contamination of the solution.
- ❖ **Temperature Compensation:** the *WetCon100* has a built-in temperature sensor which detects the solution temperature and provides automatic compensation for temperature changes.

Specifications

<i>WetCon100</i>		
Range		0 to 49%
Repeatability		±2% of Full Scale
Concentration step Response time		4 sec (to 90% of step)
Power Requirements	Voltage	24VDC or 100-240VAC, 0.25 A
	Power	6W
Display	Resolution	4 Digits
Output	HF Concentration	4-20 mA DC
	Alarm	Low/High
Sample	Temperature variation	± 3°C
	Pressure	3 ATM

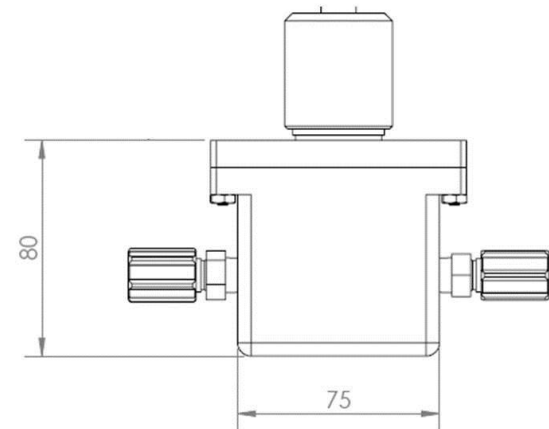
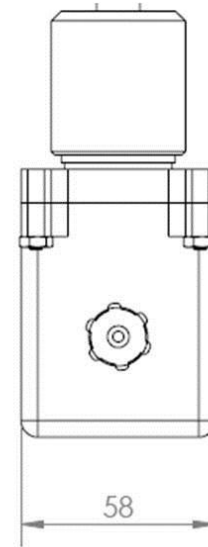
Flow type Sensor



Features and Benefits:

- High resolution measurement
- Factory-calibrated (no field calibration required upon installation).
- Recommended calibration interval – 2 years.
- Standard $\frac{1}{4}$ " to $\frac{3}{4}$ " Flaretek® or Flowell fittings for easy installation *(Other sizes and fittings type are available)*
- Wetted materials: PVDF, PTFE and Viton - Full acids compatibility and no risk of contamination *(Other O-rings materials are available)*

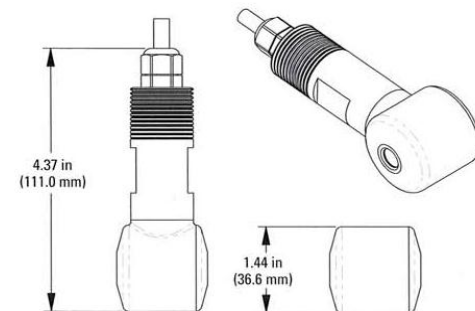
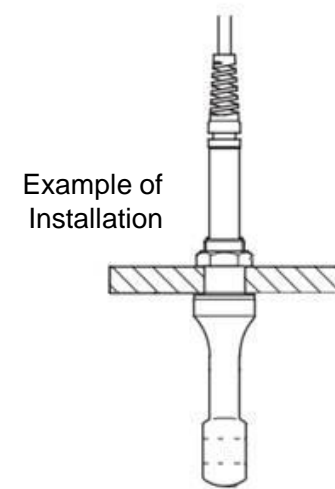
optional: space saving configuration – extension cable



Submersible type Sensor

Features and Benefits:

- Can be submerged directly into the Hydrofluoric tank
- Compact size
- High resolution measurement
- Factory-calibrated (no field calibration required upon installation).
- Recommended calibration interval – 2 years.
- Wetted materials: PVDF, PTFE and Viton (Other O-rings materials are available) - Full HF compatibility and no risk of contamination



Features and Benefits:

Mounting Options

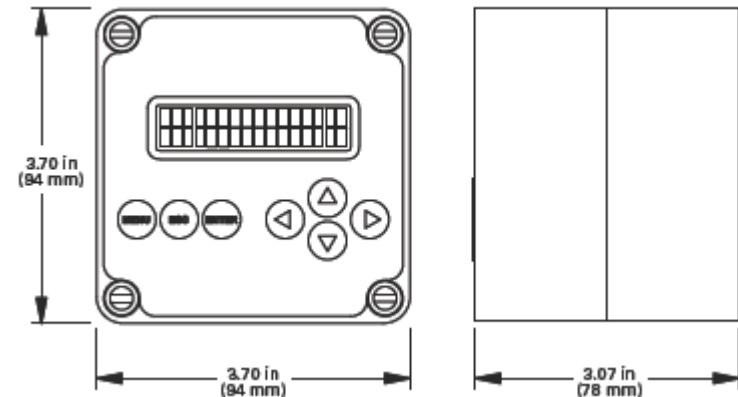
- Enclosure, NEMA 4X
- ¼ or ½ DIN NEMA 4X panel mount

Interface

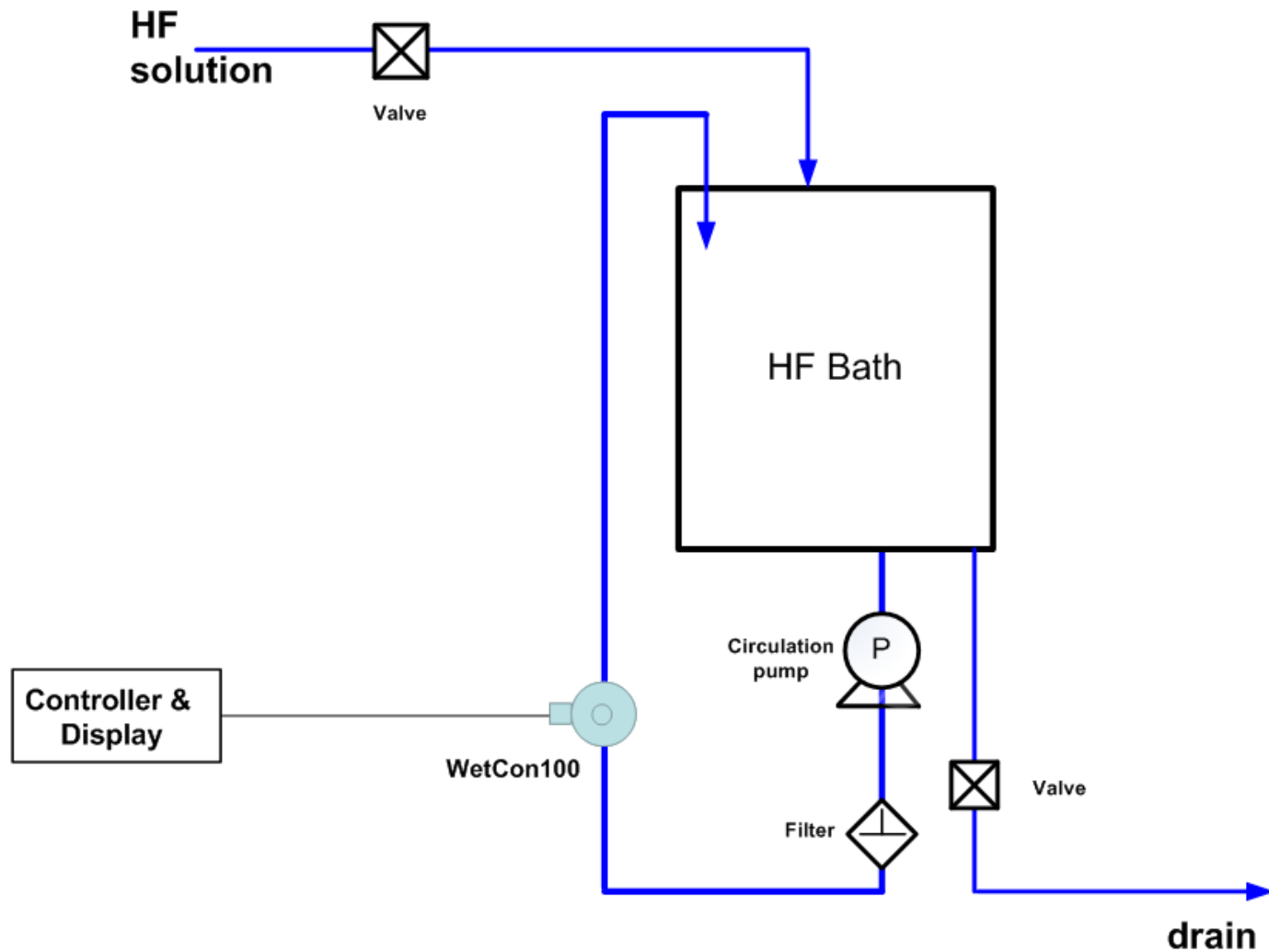
- Display: 2 line by 16 character LCD
- Backlight: High contrast green
- Keypad: 4 directional arrows, MENU, ESCAPE and ENTER

Environmental Conditions

- Ambient Operating Temperature Range: – 20 to 65 °C
- Maximum Relative Humidity: 95% non-condensing
- Meets CE requirements for heavy industrial use



Typical Installation Layout





WetRad

- The **WetRad** is a selective sensor for a specific component in a complex mix
- The **WetRad** is based on CI's core technology and uses the NTM DeLTA platform

WetRad

- The WetRad is an In-Line fiber-optic based chemical concentration monitor.
- The WetRad is based on the NTM-Delta a well established OEM product with thousands of units installed in the field on semiconductor manufacturers tools .
- It is available in several models, each dedicated to a particular application (chemistry).
- Principle of operation: Optical transmission measurement



WetRad

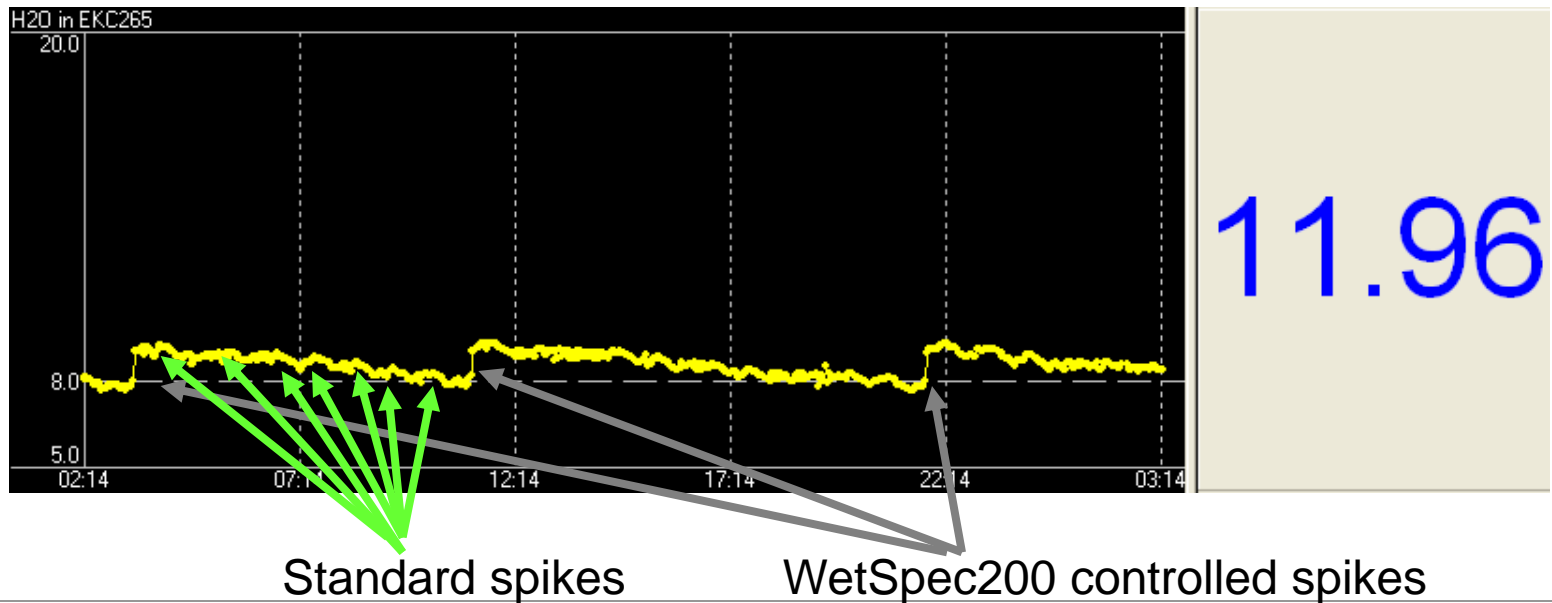
- **Major advantages:**
 - Accurate and repeatable in-line measurements
 - High stability (by continuous monitoring of temperature and light source intensity)
 - User friendly data logging and display software
 - Fast response: Typically 1sample/sec
 - High Cost /Performance
 - Reliability:
 - No moving parts
 - No replacement parts (no lamps)
 - Inert Flow cell: Chemistry sees only Teflon, sapphire and Kalrez
 - Compact size (Controller - 100x200x50mm)



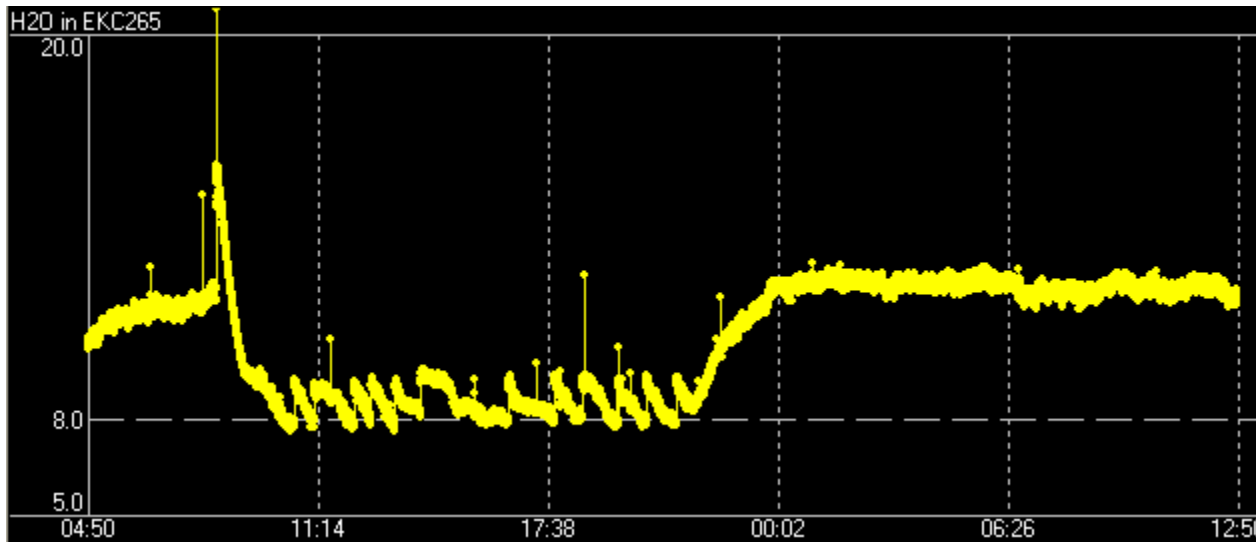
Typical test-cases

EKC265 - Change of working conditions

- Customer changed working conditions to 80C.
- Spiking was not enough to maintain 8wt% H₂O.
- Customer added bigger spikes each time the WetSpec200 showed 8wt%



- After working for a while at 80C, returned to 70C, and standard spikes were enough.
- This graph shows two weeks, one new process and the second standard process.



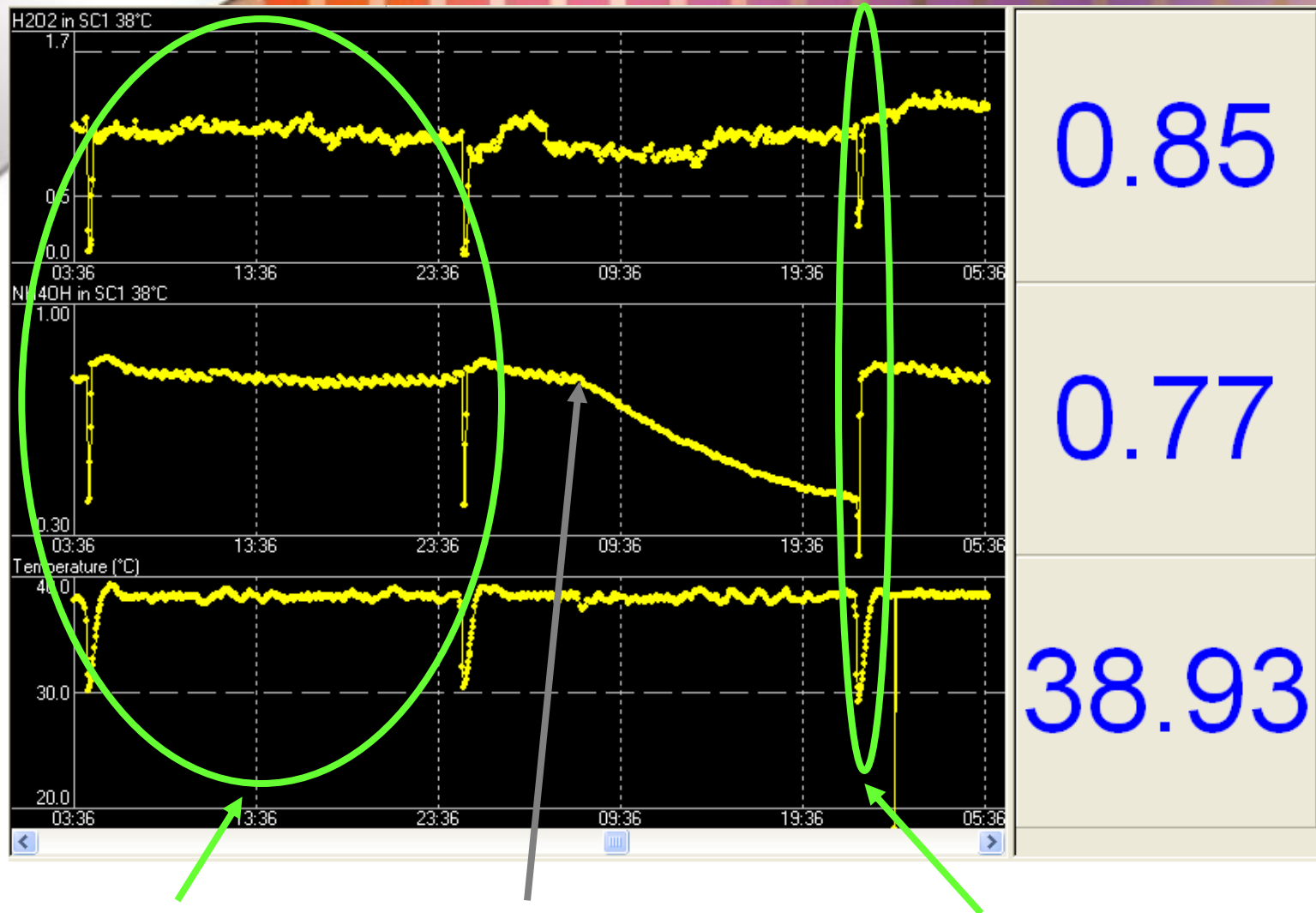
11.96

SC1 spiking

- Customer running SC1 at 38C.
- Bath is being replaced every ~20 hours.
- Small spikes of NH_4OH during process.

Spiking system malfunction

- During normal operation of tool, the spiking system stopped working.
- WetSpec200 identified the NH_4OH level going down below normal levels.
- Tool stopped, and spiking system fixed.

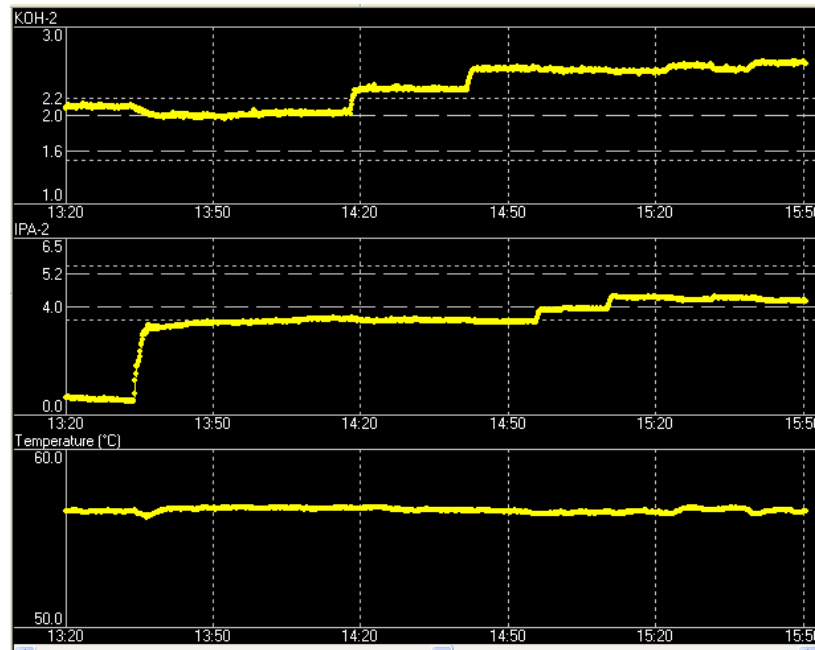


Standard bath, full cycle.

Spiking System Spiking System fixed, bath failure. replaced. Back to normal.

KOH/IPA/(K₂SiO₃)

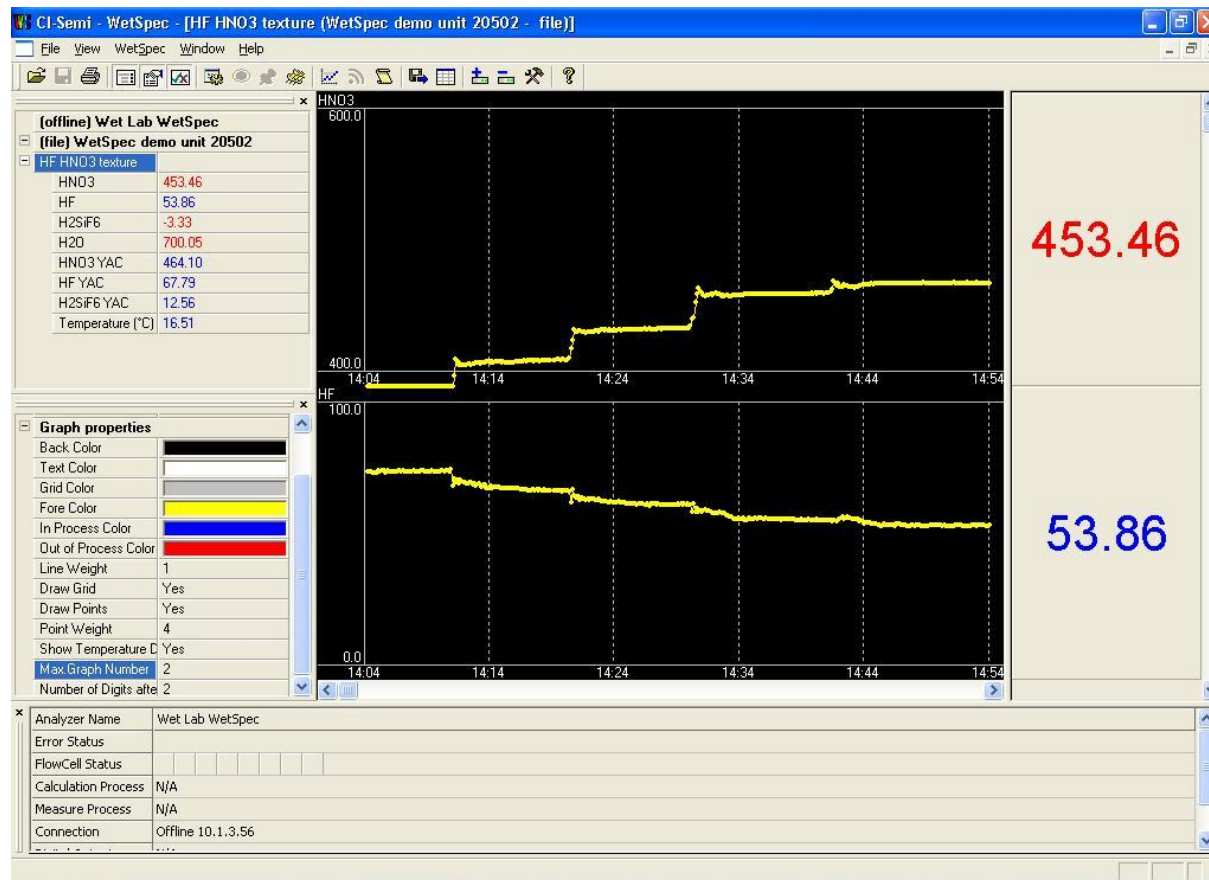
- Measuring KOH & IPA at ~60C
- The WS200 is capable of monitoring the Si by-product as well!
- The system was qualified by two OEMs (as of June 2011) for this specific application



One day's test, including spiking as monitored by the WetSpec200

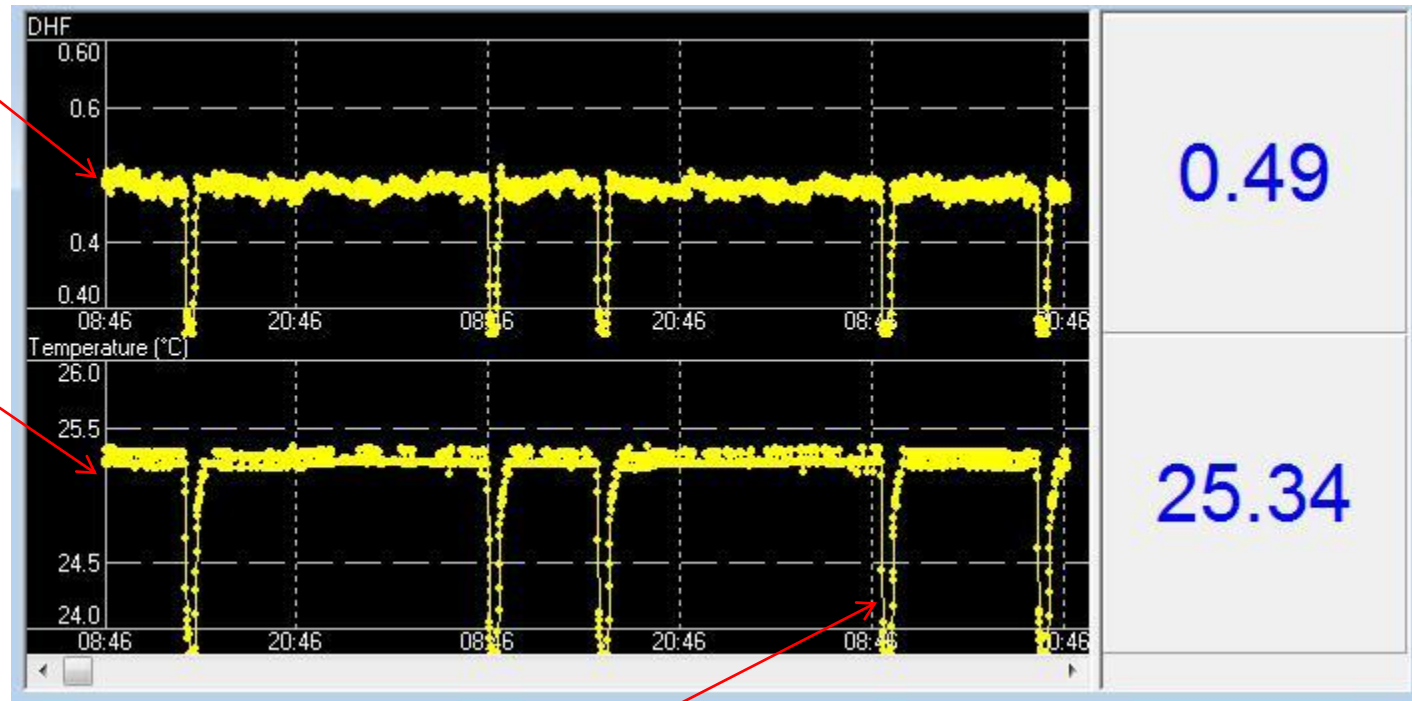
HF/HNO₃- monitoring bath changes

- Monitoring the etch product - H₂SiF₆
- HNO₃ spiking every 10 min.
- Units in g/liter



DHF (0.5%)- monitoring bath changes

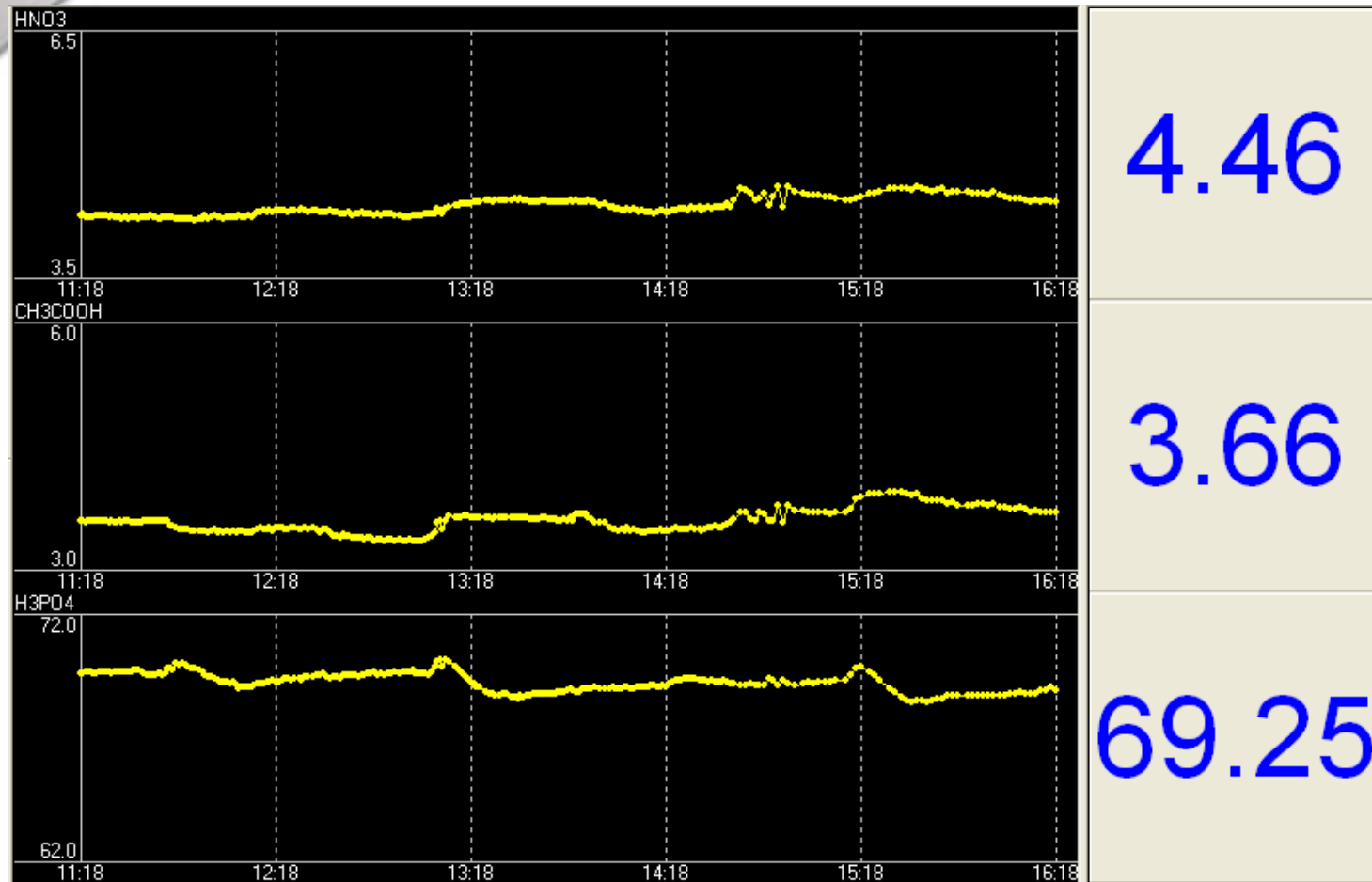
- Continuous 2.5 days data monitoring .
- Bath change every 6/12/18 hours
- STD. = 0.004%



Al etch (Mixed acids etch)

- Al etch is done using three acids:
 - HNO_3
 - CH_3COOH
 - H_3PO_4
- WetSpec200 monitors each acid separately.

■ 5 hours normal process, steady measurements.

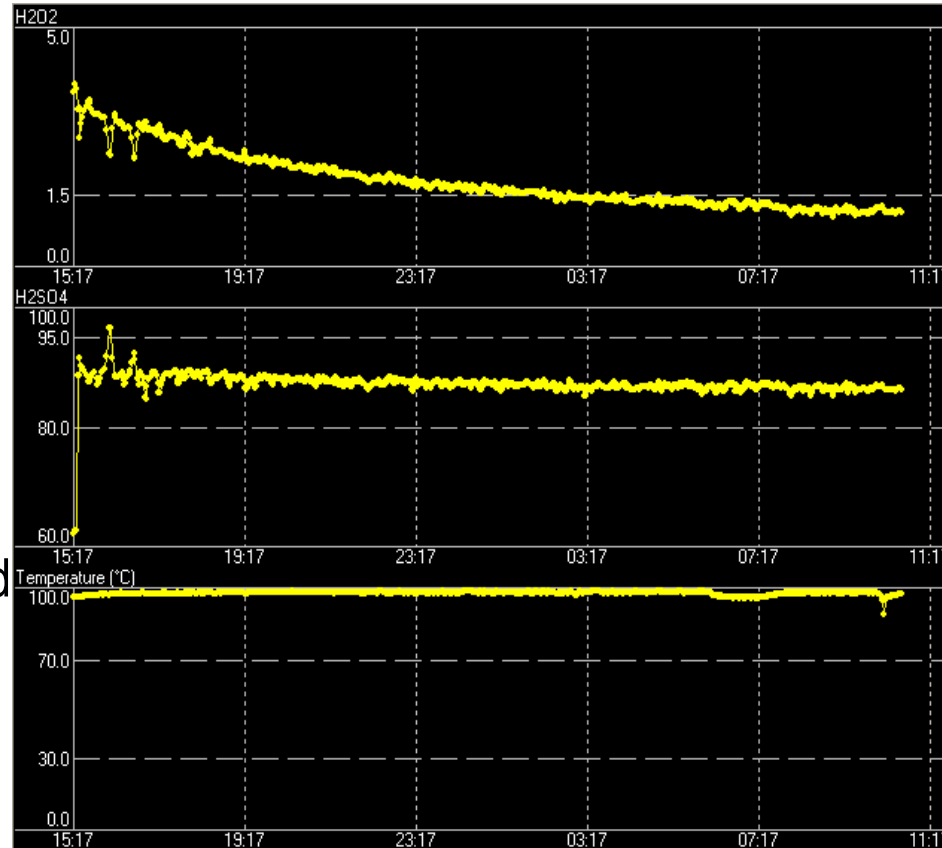


Piranha process

- Piranha process is a mix of sulfuric acid and peroxide.
- The process is usually done at 120C and above.
- The WetSpec200 can monitor the process inline and at real time.

Piranha at 100C

- New bath is mixed, and process start.
- H_2O_2 wt% drops during bath life.
- Customer confirmed sulfuric wt% at 87 wt%
- After monitoring with WetSpec200, bath is now replaced every 5 days. Instead of every 15 hours.



1.16

86.44

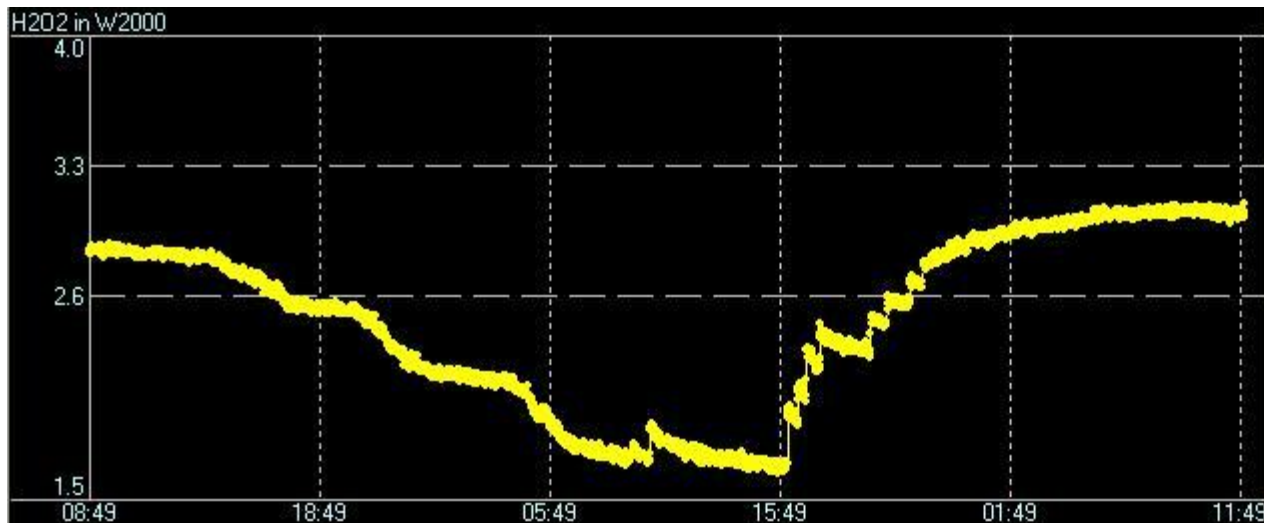
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H₂O₂ in W2000 slurry

- W2000 slurry is used for Silicon oxide CMP process.
- An amount of ~3 wt% of H₂O₂ is added to the slurry for best results.
- The customer has a tight control of 2.6-3.3 wt% of H₂O₂.

Process out of control

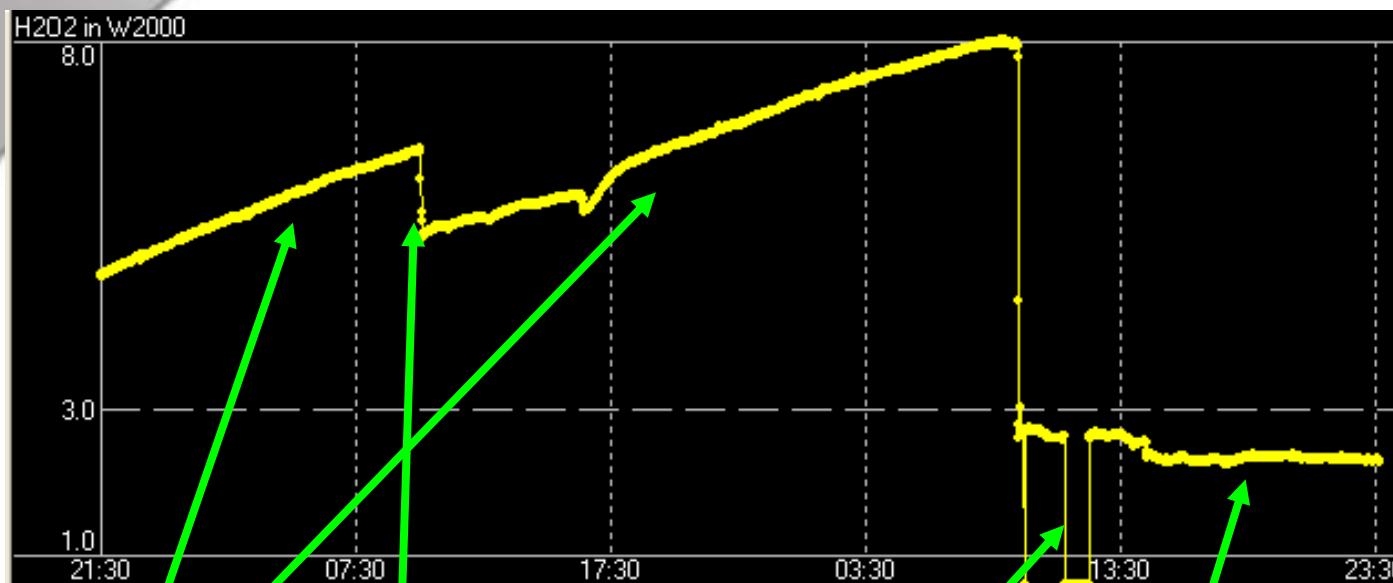
- The H_2O_2 wt% dropped below process limits.
- Using the wetSpec200 small amounts of H_2O_2 were added until higher limit of H_2O_2 was reached.
- Process then returned to normal conditions.



2.66

W2000 – another customer

- Customer needs between 1-3 wt% of H_2O_2 in the slurry.
- After mixing WetSpec200 identified H_2O_2 wt% drifting up.
- After investigating the problem, customer found a leak in the H_2O_2 supply, the result was that H_2O_2 was added continuously.
- Leaking valve was fixed, and process returned to normal.



1.16

**Drift of
 H_2O_2 wt%**

**Slurry
added**

**Leak fixed, and
system cleaned**

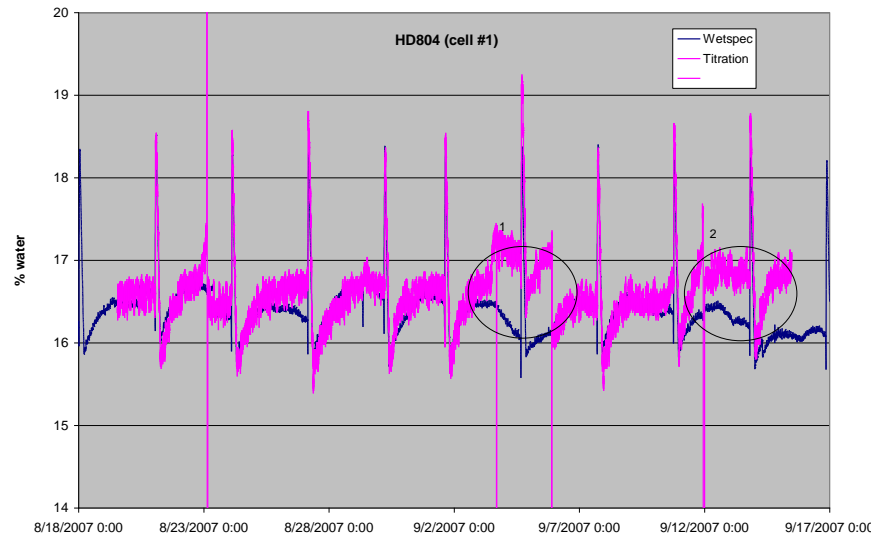
**Normal process
under control**

H₂O in ACT970

- ACT970 is a solvent with ~20% H₂O.
- The customer start working with ACT970 when water wt% reaches 17.
- The customer is spiking with water to maintain level of water.
- In this case a titration was done every 30 minutes before the WetSpec200 was bought.

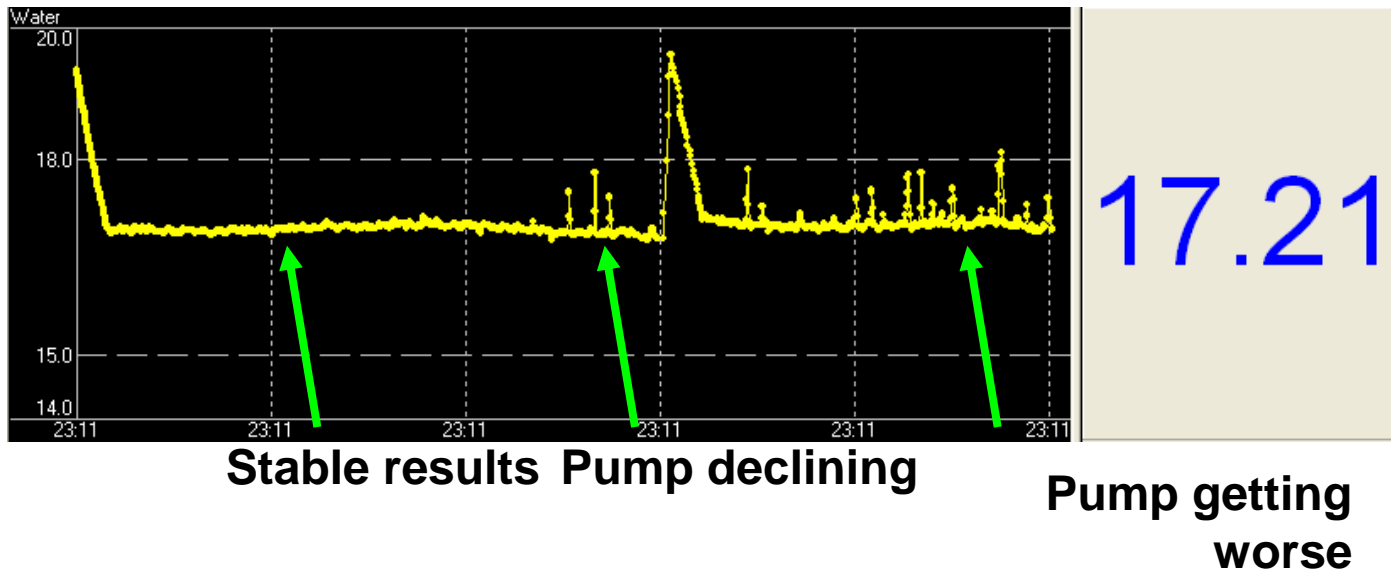
Titrator out of order.

- WetSpec200 results and titration results usually are almost identical.
- Customer observed a jump in titrations, while no change in WetSpec200 results.
- After a while, titration results return to be like WetSpec200 results.
- WetSpec200 results have better repeatability as well.
- Customer started using WetSpec200 for control, and removed the titrator from the line.

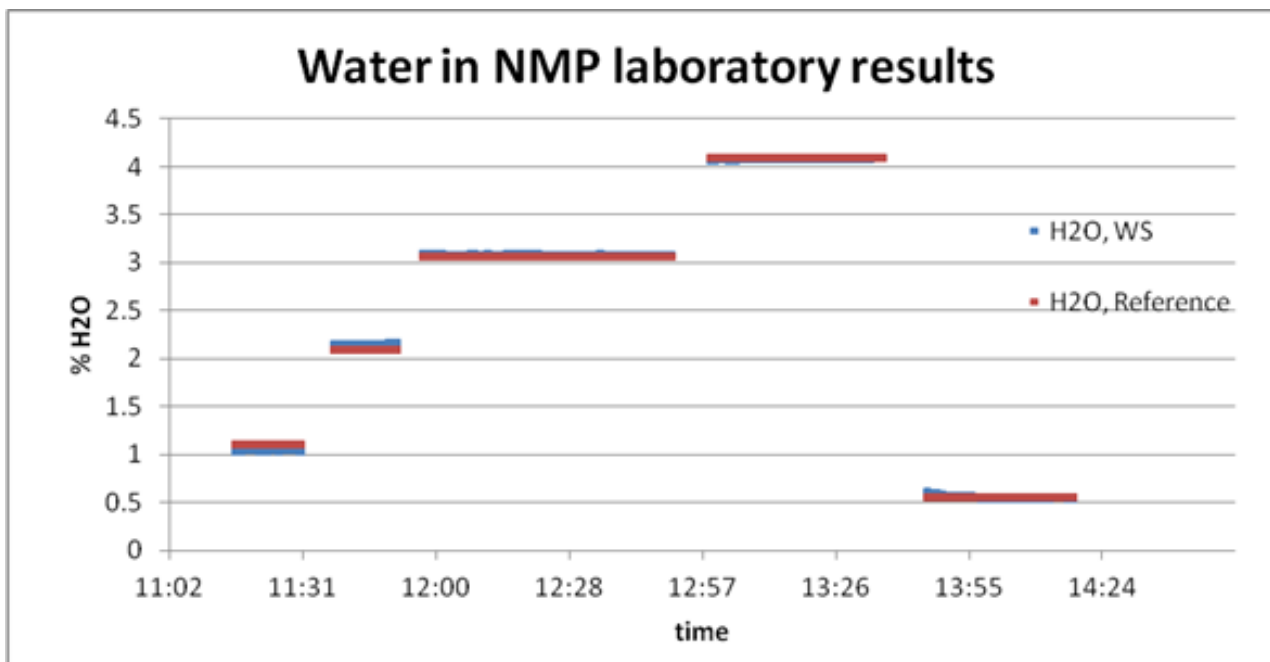


Pump is declining

- Customer normally sees very stable WetSped200 results.
- WetSpec200 result start looking unstable.
- Customer found pump was not working properly, so liquid flow was very unstable. Pump was fixed, and results were, again, stable.

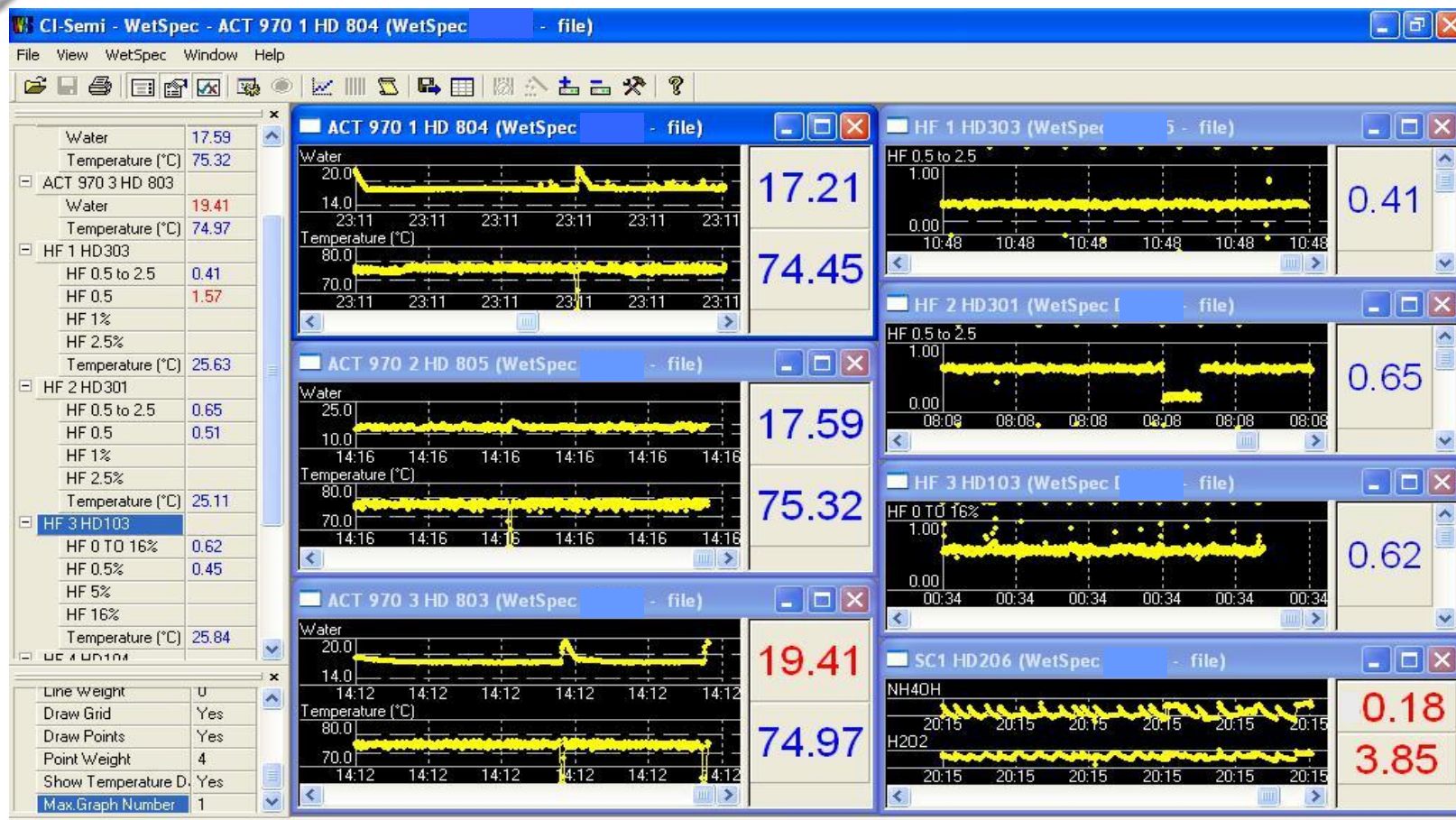


H2O in NMP



Component	Measurement range, wt%	Accuracy (RMSEP – Root Mean Squared Error of Prediction), wt%
EKC265	0 to 2	0.1
EKC265	0 to 1	0.05

Multi channels system





Solvents for Photoresist Removal

January 12, 2012

WetSpec Solvents measurements

- Provides a powerful tool for real time process monitoring and control
- Allows bath life extension and material saving
- Applications includes EKC265/270/580, ACT927/935/970, ST250 and many others.
- Close cooperation with solvents material manufacturing
- Ability to monitor ALL solvent components if needed.
- Ability to monitor in the presence of the process by-products.

The WS200 – The selected choice for OEMs

❑ Because of its cost-performance superiority, the WetSpec200/201 is a preferable choice for solvent tools vendors.

❑ The WetSpec200 was selected as the default monitoring solution for Akrypton's Gamma platform



PRODUCT ENHANCEMENTS
OCTOBER 2010

GAMA, V3, E200, 94xx Platforms

Chemical Analyzer for Solvents

Applications: All GAMA, V3, E200 & 94xx Solvent Strip Wet Stations

Features & Benefits:

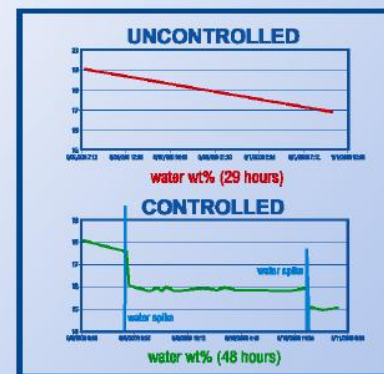
- CI Semi WetSpec 200 provides closed loop real time chemical concentration control
 - Monitors and controls DIW content
 - No chemical sampling or dilution required
 - Short measurement time and low operational costs
- One analyzer can monitor several measuring cells: up to eight different chemicals
- Complex chemistries (multi-component) analysis: up to four chemical components per individual chemical stream
- Location convenience: up to 20 meters distance between analyzer and measuring cell
- Unique Flow Cell with sapphire windows
 - Software with Windows based GUI
 - Chemical model for current chemistries
 - Eight channel multiplexer
 - Ethernet connectivity/RS 232 Communications
 - Digital Output
- Meets all current safety standards including CE compliance



Upgrade Kit:

- CI Semi WetSpec 200 NIR Spectroscopic Analyzer
- Flow Cell (chemistry specific)
- Fiber Optic Bundle
- Plumbing and Electrical Kits

**Extends Bath Life
reducing chemical costs &
increasing system uptime**



General Information

- Equipment Down-time during installation (estimated): Approximately 24 hours per tank
- Resources required to install: 1 Regional Field Service or Factory Technician
- Production lead-time from order to shipment: (subject to factory production availability): 12 – 14 weeks

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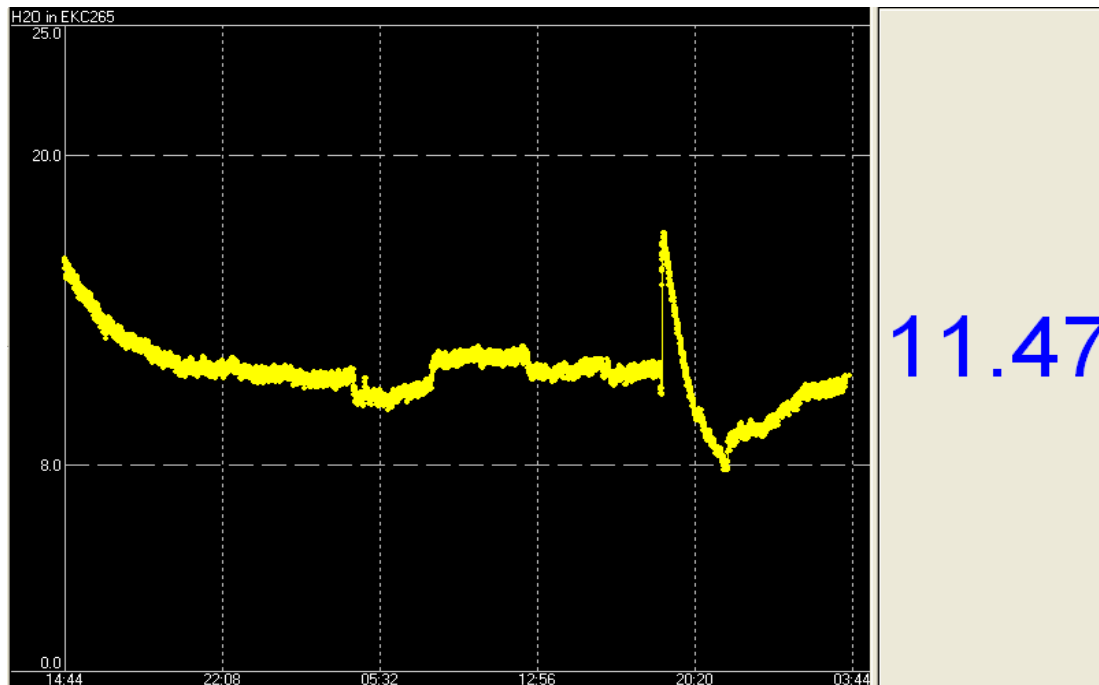
EKC Measurements

EKC265 General

- EKC265 is used for post metal resist removal.
- EKC265 is Du-Pont material, and is a mix of four chemicals:
 - H2O
 - HDA
 - Comp. B
 - Comp. C
- EKC265 is used at hot temperatures, 70C-85C.
- The performance of EKC265 is influenced by the wt% of all chemicals, and therefore, all chemicals should be stable.
- Usually the HDA and water concentrations are more critical- the rest are less important .

Wet Spec Results Process

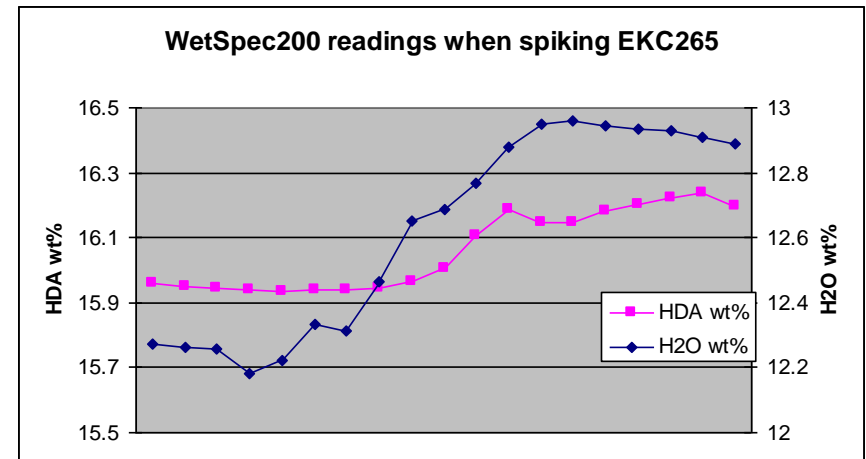
- When spiking with EKC265, bath life can be extended.
- During the process, residues accumulate in the bath, and reach levels that can not be ignored.
- These residues do not effect WetSpec200 readings.



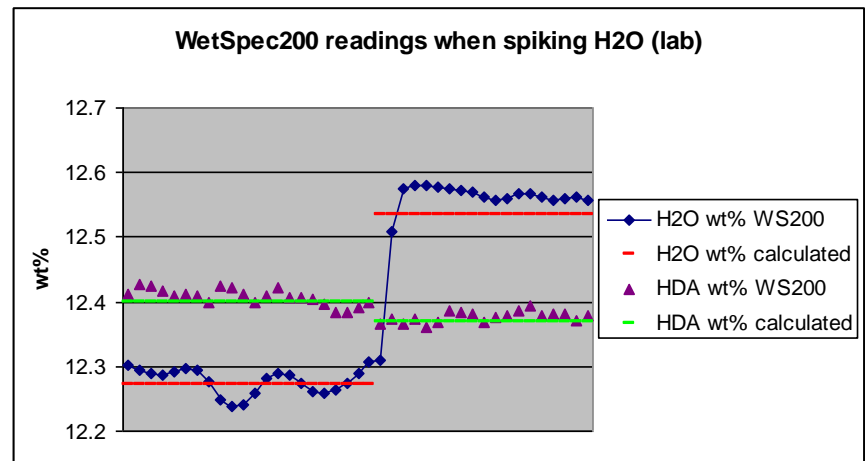
In this graph - a bath running for one month, and one bath replacement is shown.

Samples for WS200 results

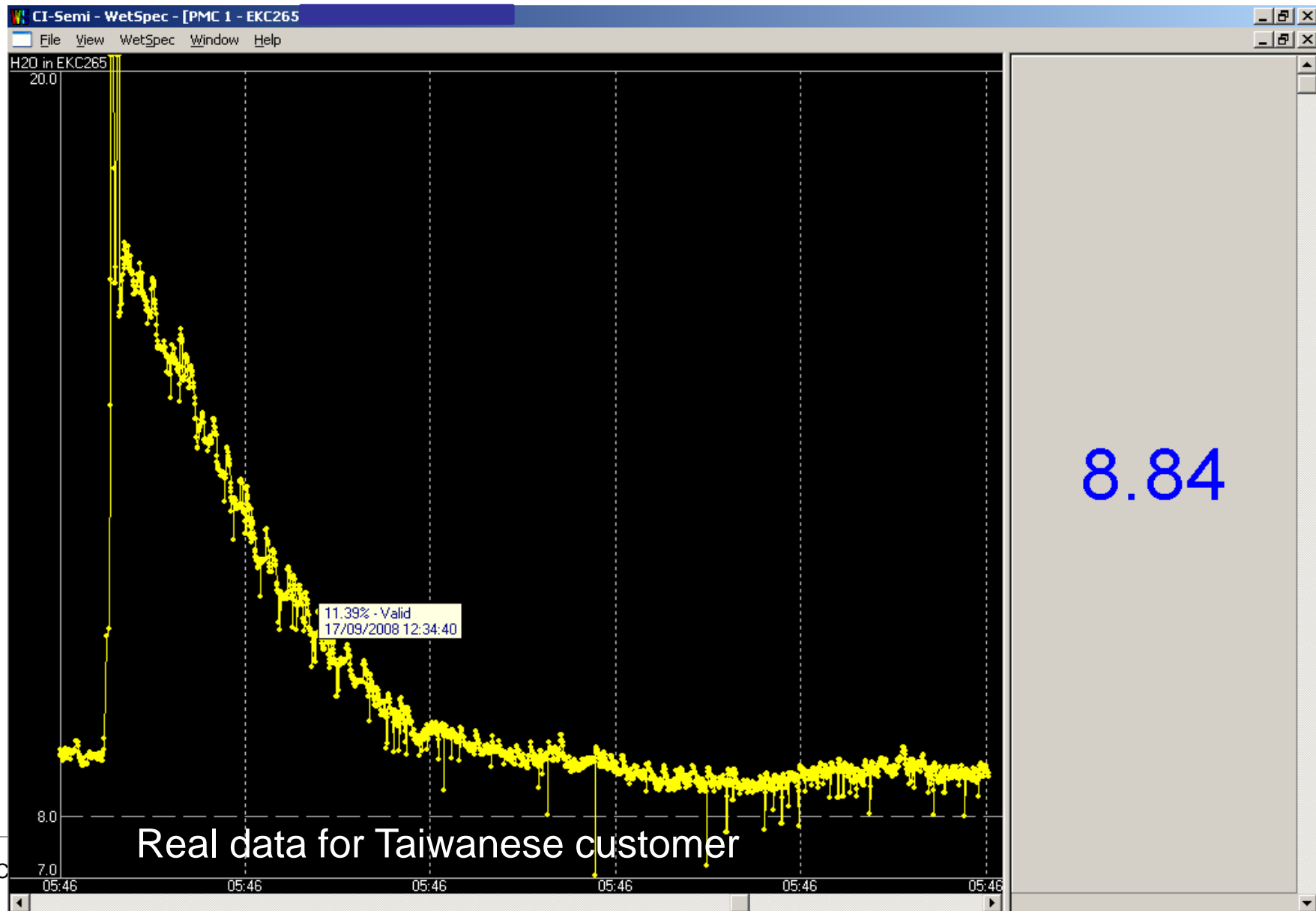
- WetSpec200 can identify small spikes of EKC, as demonstrated in this graph.



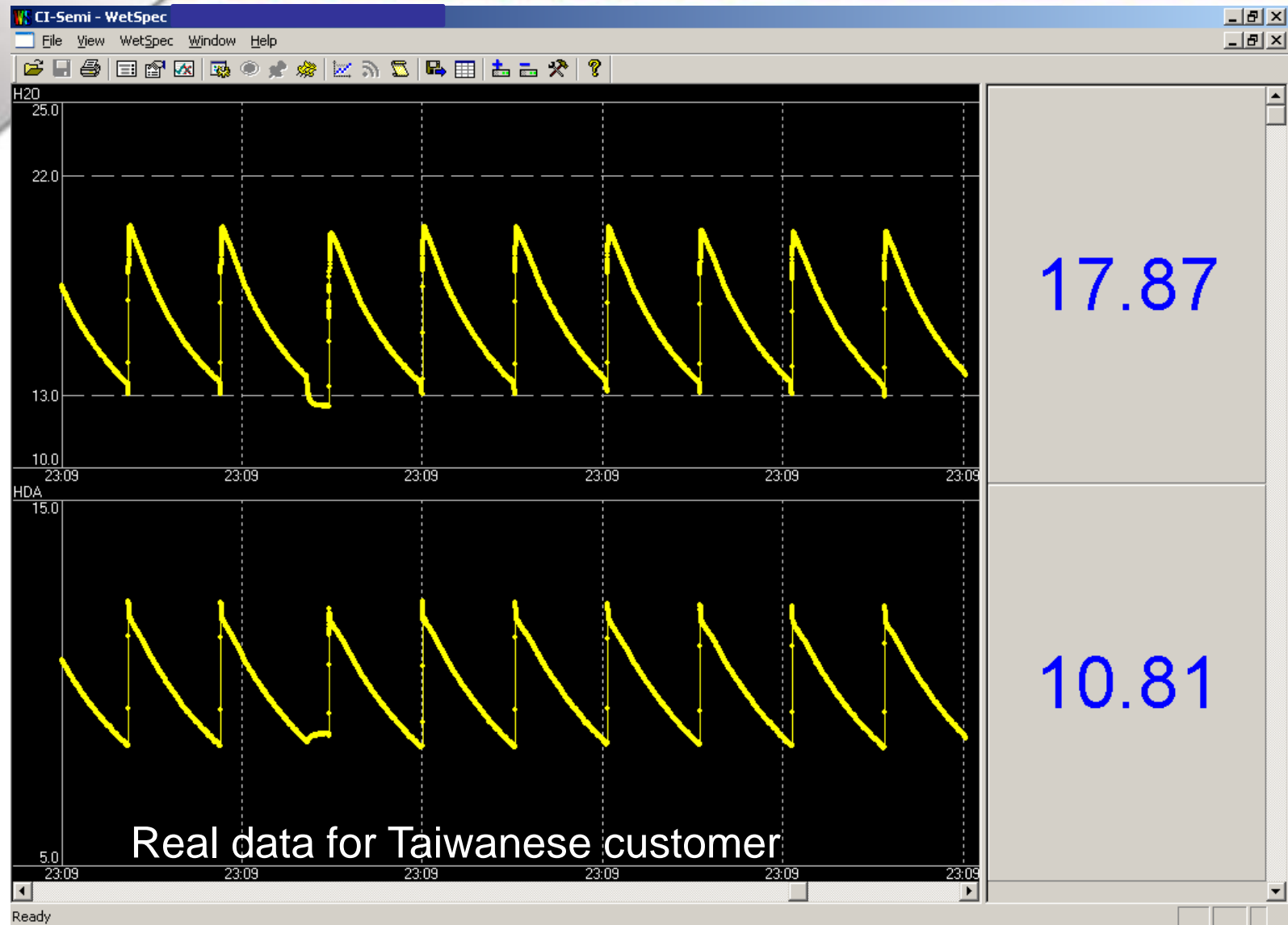
- WetSpec200 can also identify small spikes of H2O with the same models.



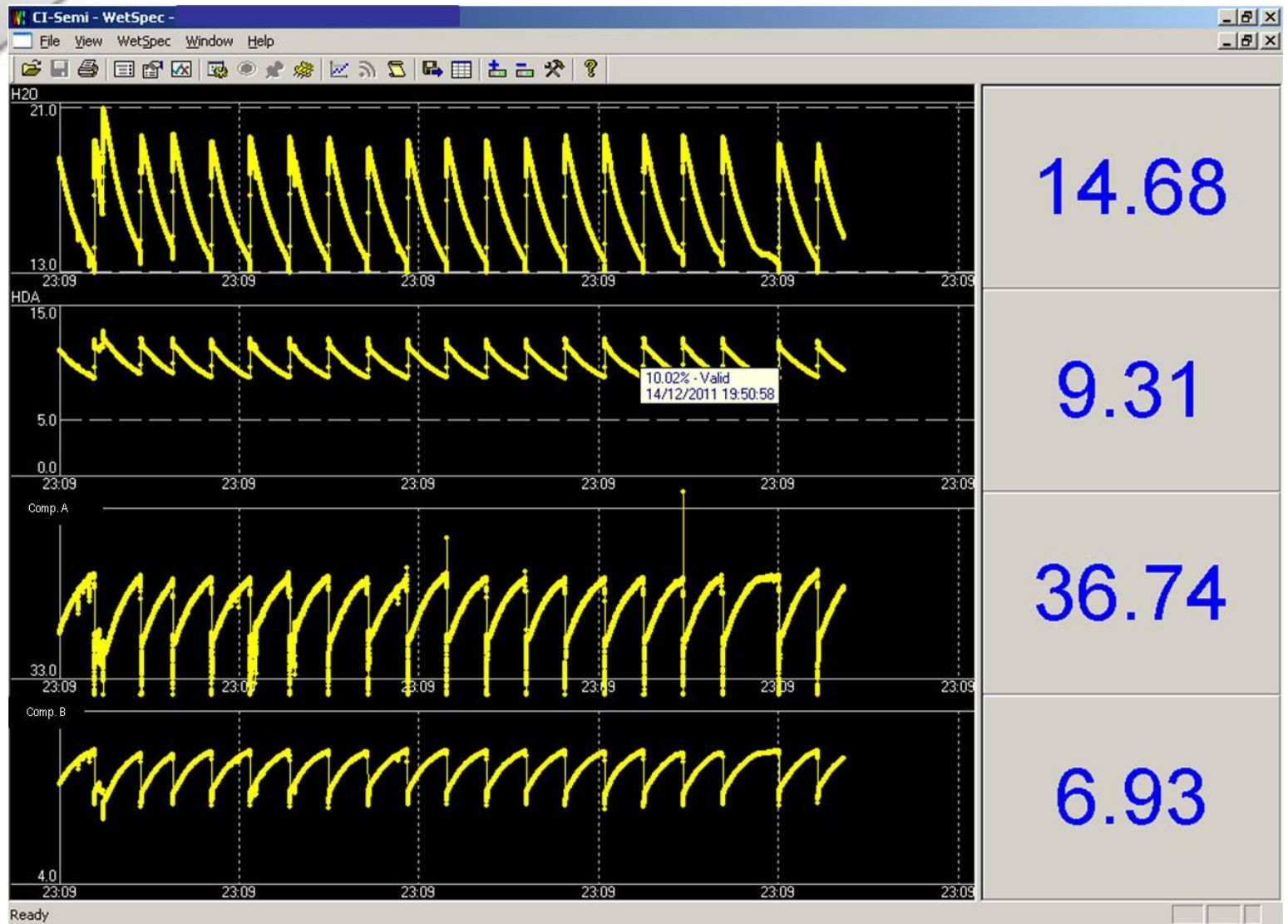
Water in EKC Measurement



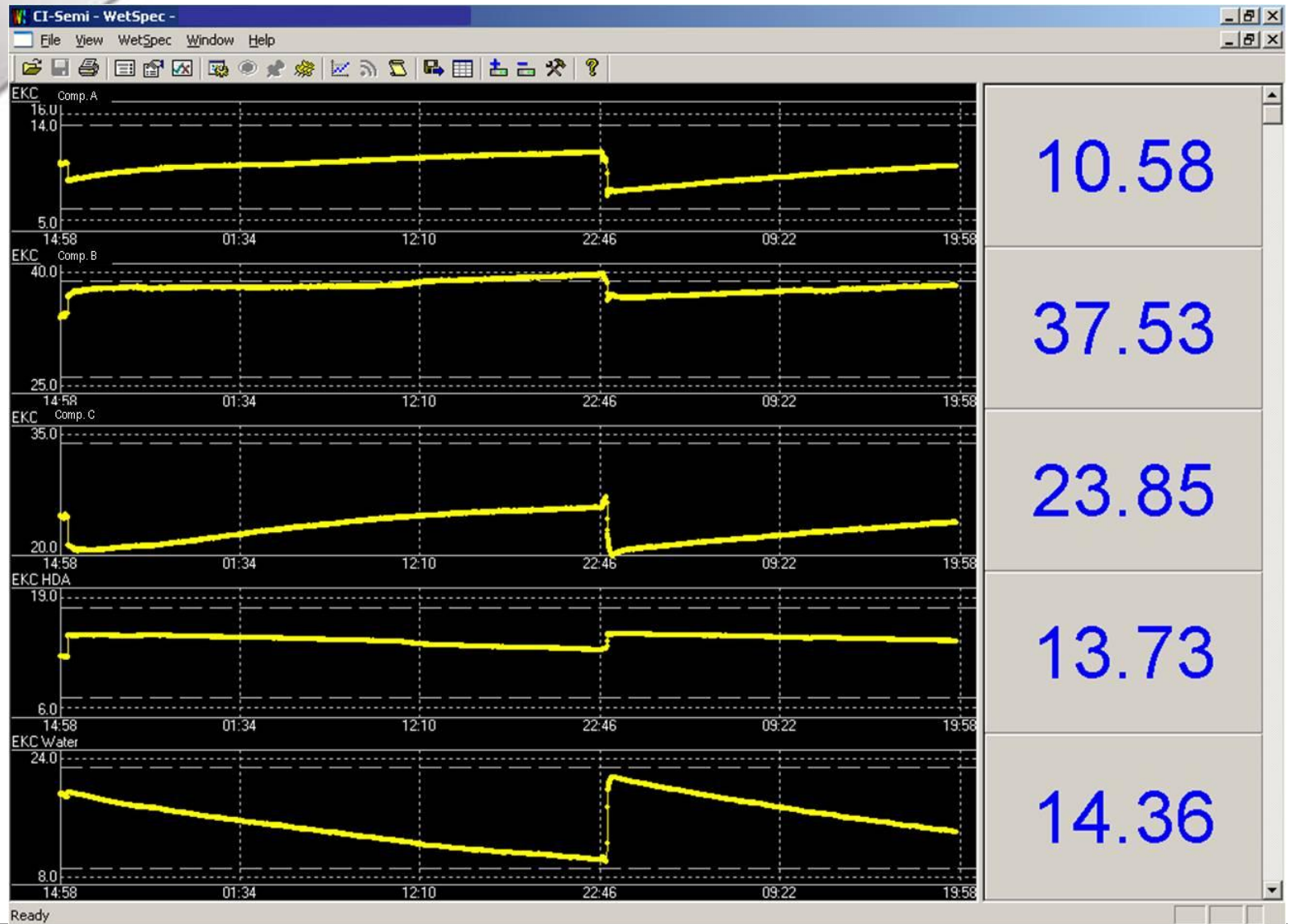
EKC270: Water and Hydroxylamine



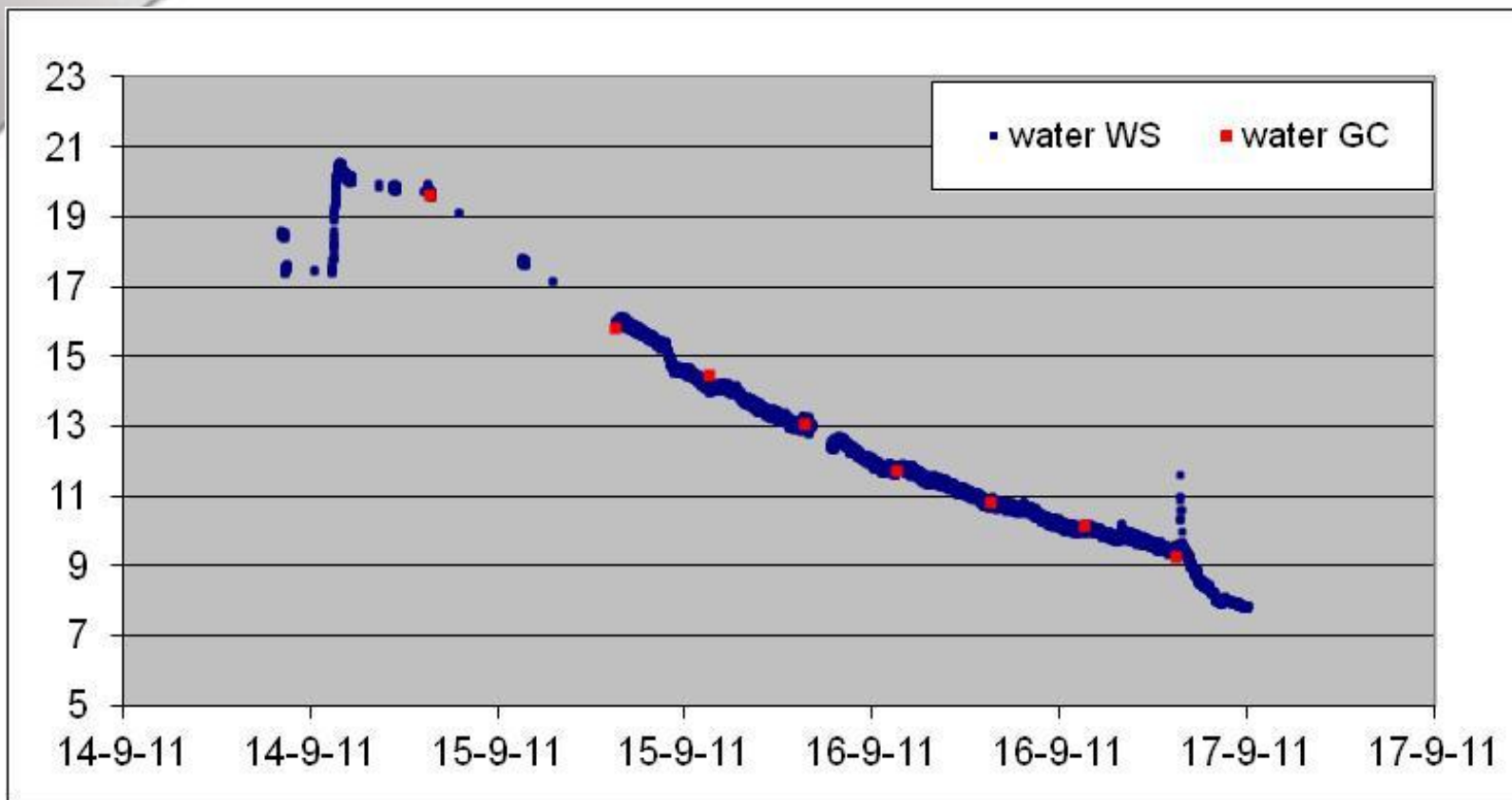
EKC 270: 3 Components & Water



EKC270: All 5 components

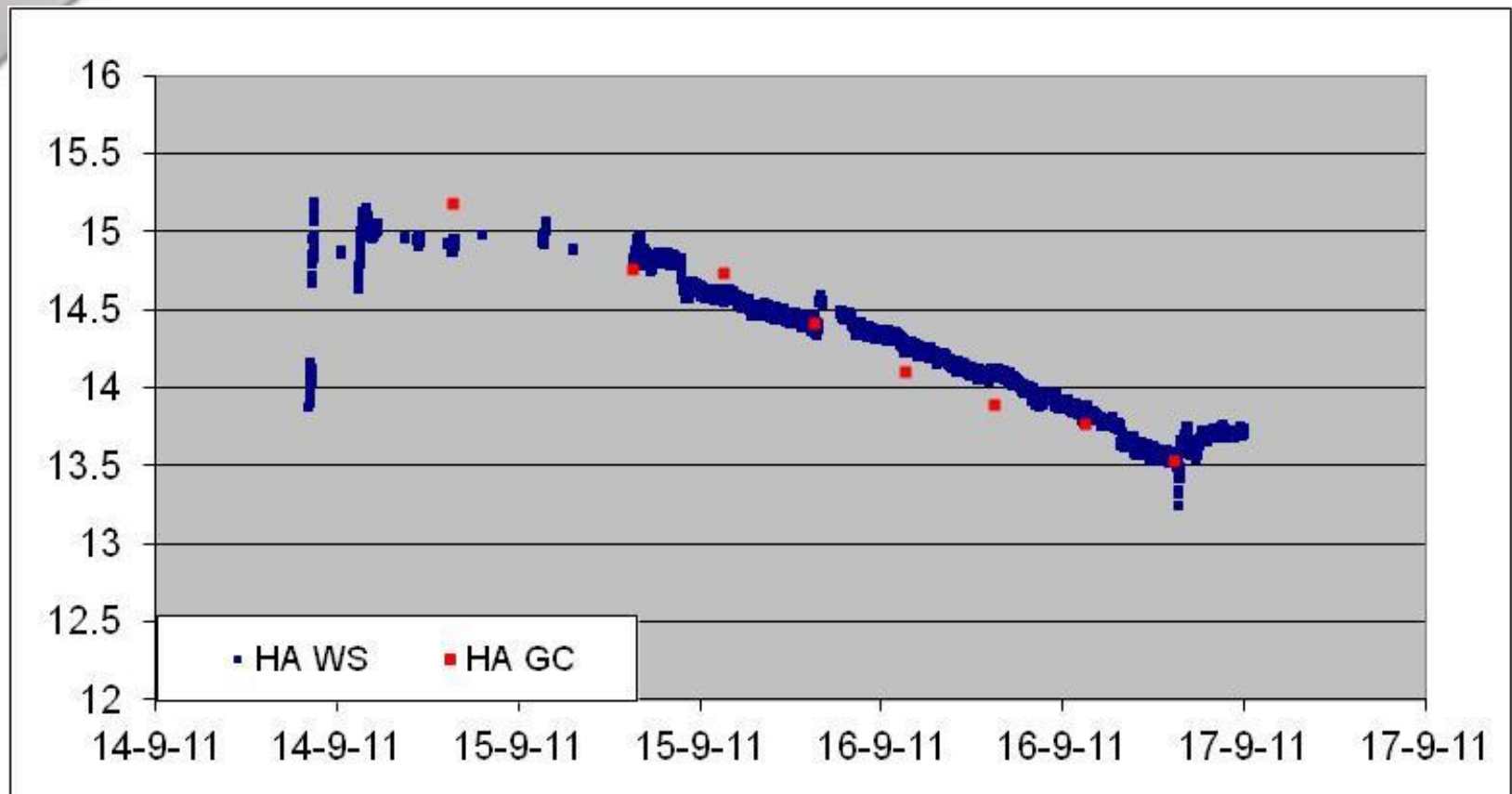


Water in EKC Validation by GC*



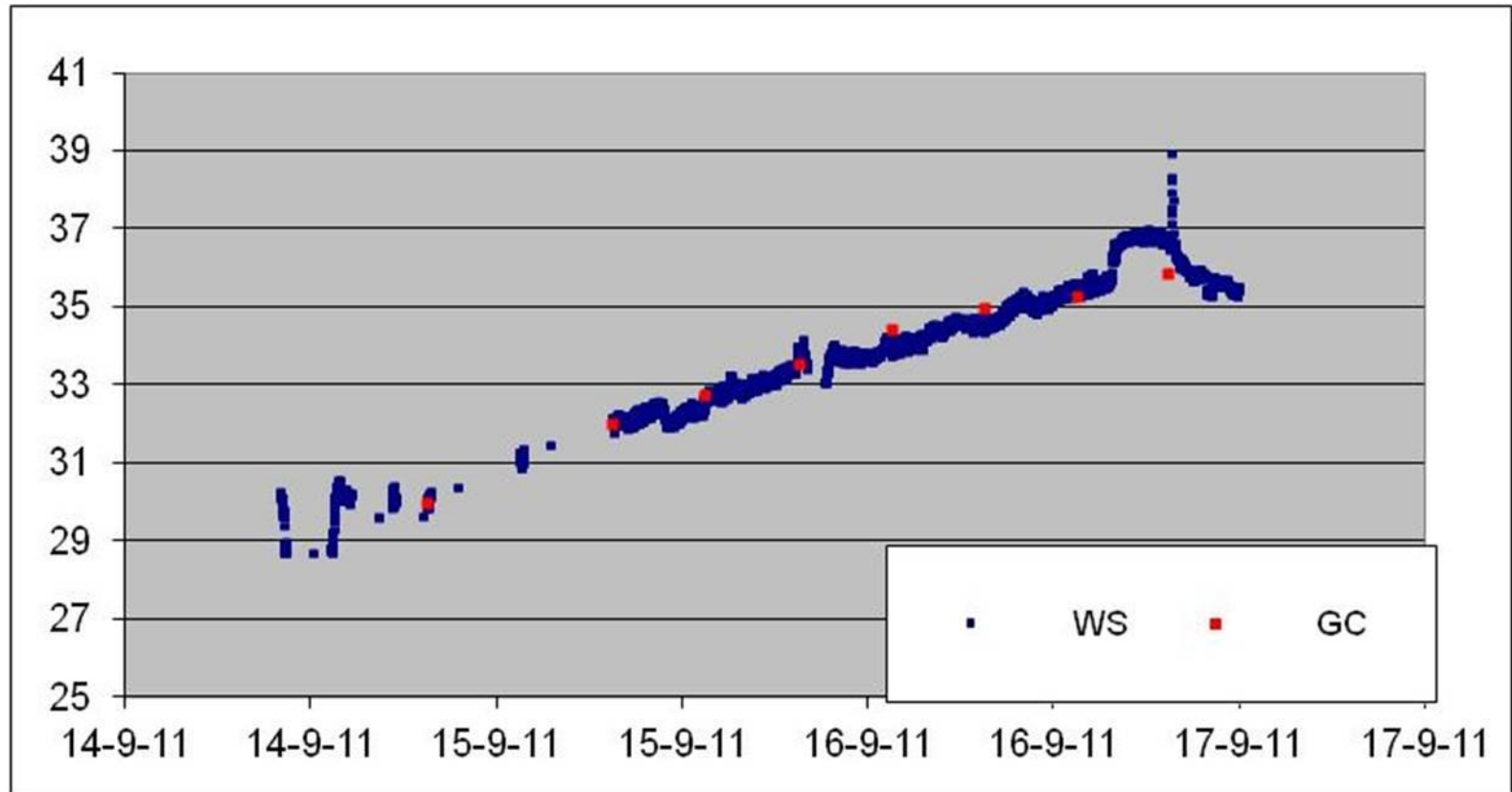
RMS error 0.17 wt%

Hydroxylamine in EKC 270 Validation



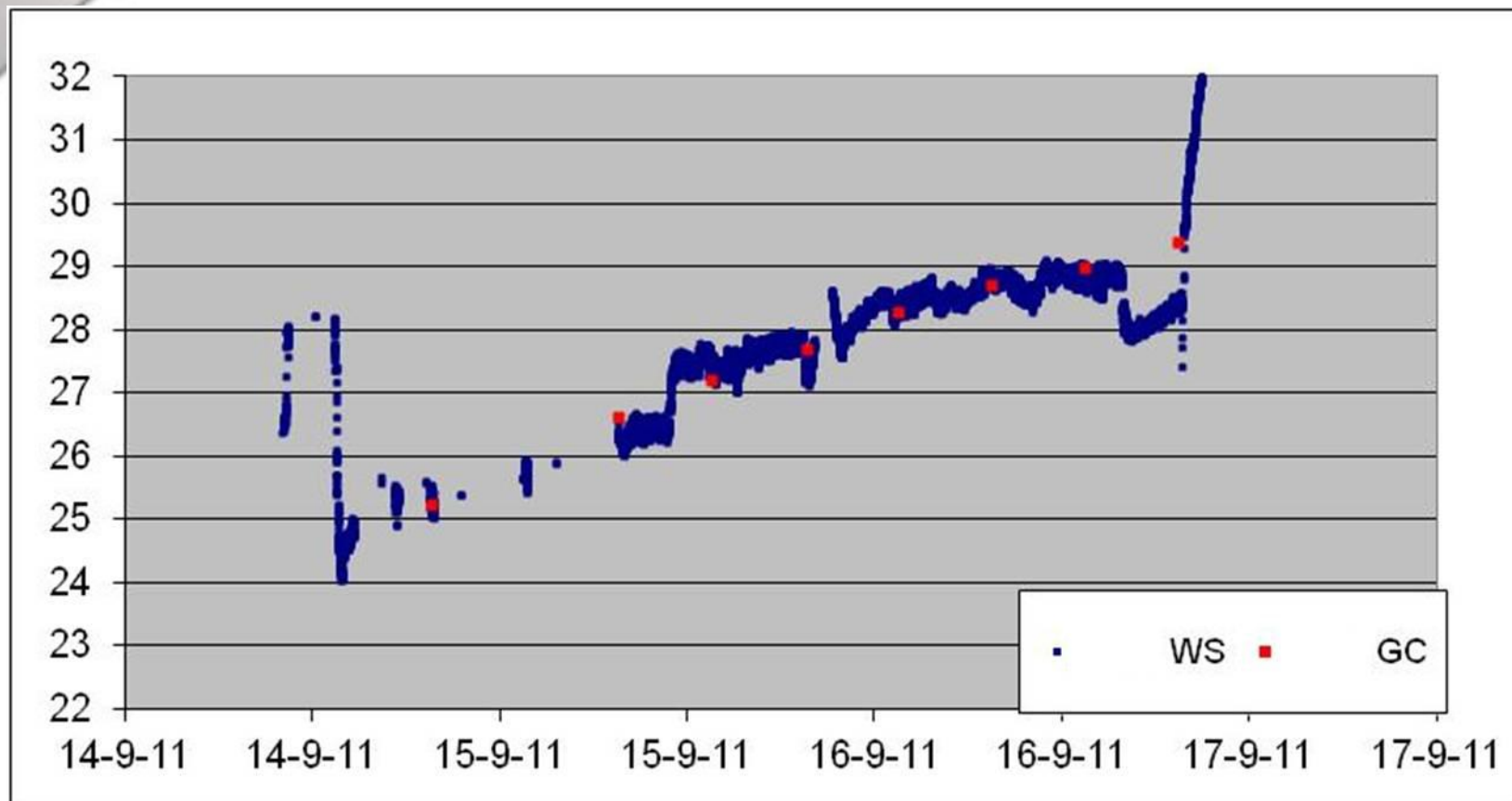
RMS error 0.14wt%

Comp. A in EKC270: validation



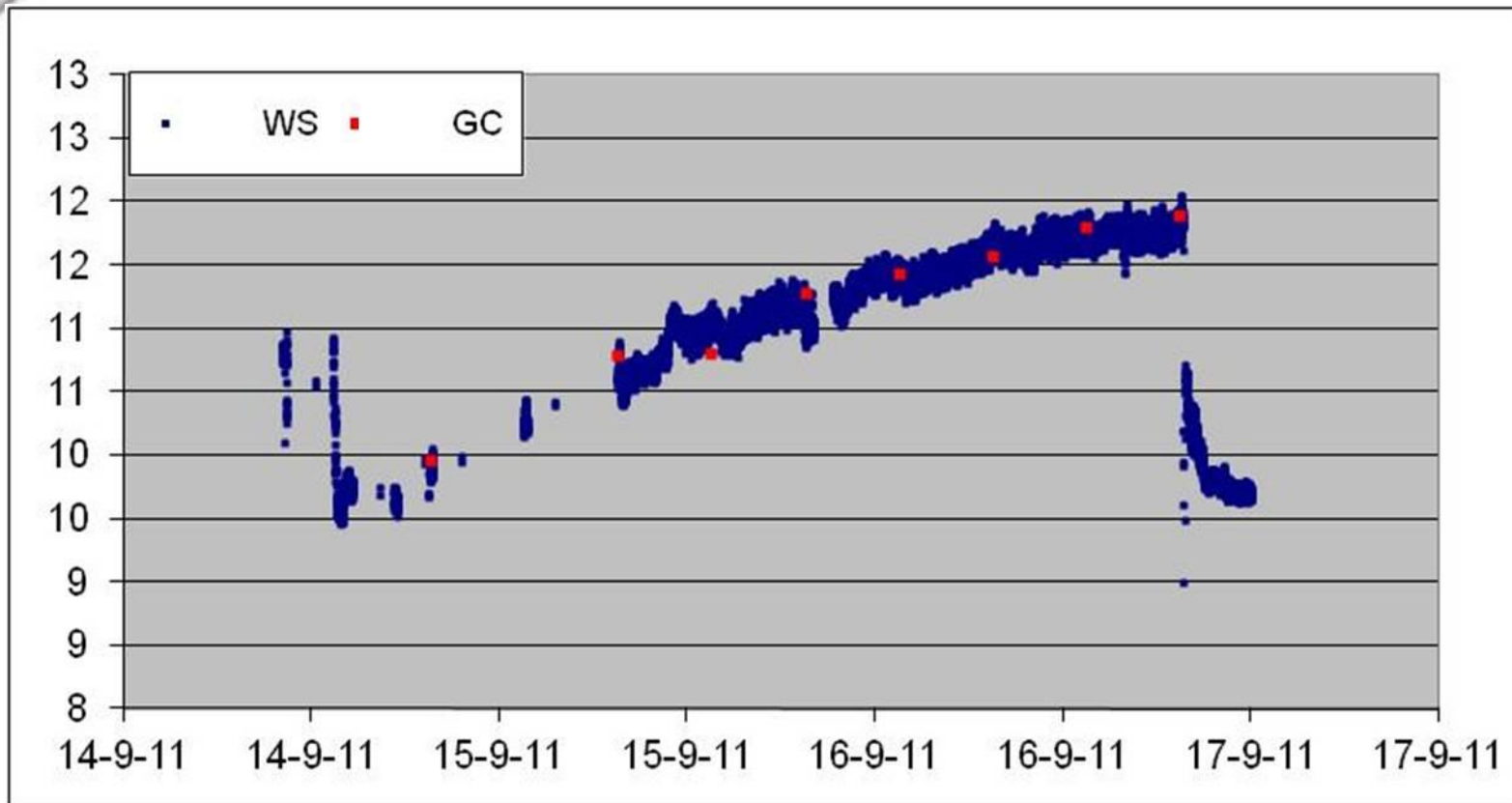
RMS error **0.38wt%**

Comp. B in EKC 270 validation



RMS error 0.2 wt%

Comp. C in EKC 270 Validation



RMS error **0.16 wt%**

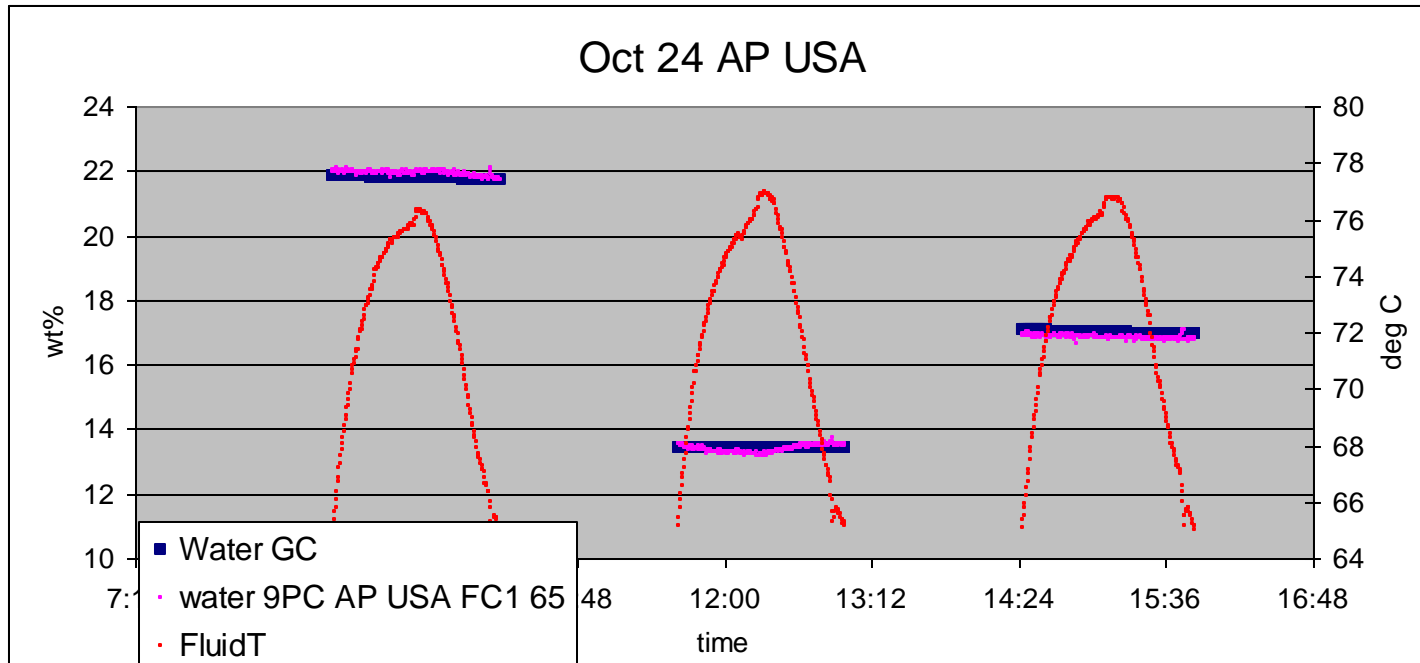


EKC Measurements Insensitivity to temperature

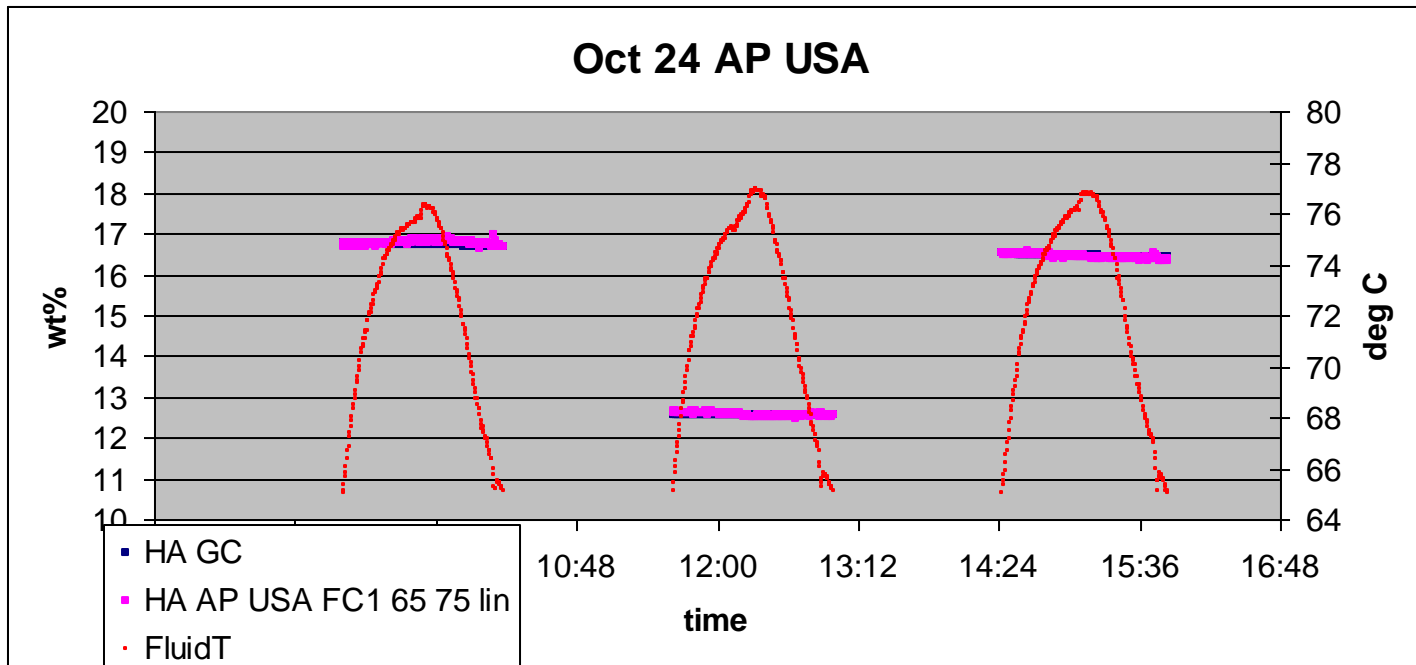
Temperature Effect

- The models, when tested between 65 and 75 °C, are insensitive to temperature change
- RMS errors, in weight %:
 - Water 0.16
 - HDA 0.07
 - Comp. A 0.29
 - Comp. B 0.27
 - Comp. C 0.19

Water Temperature Insensitivity



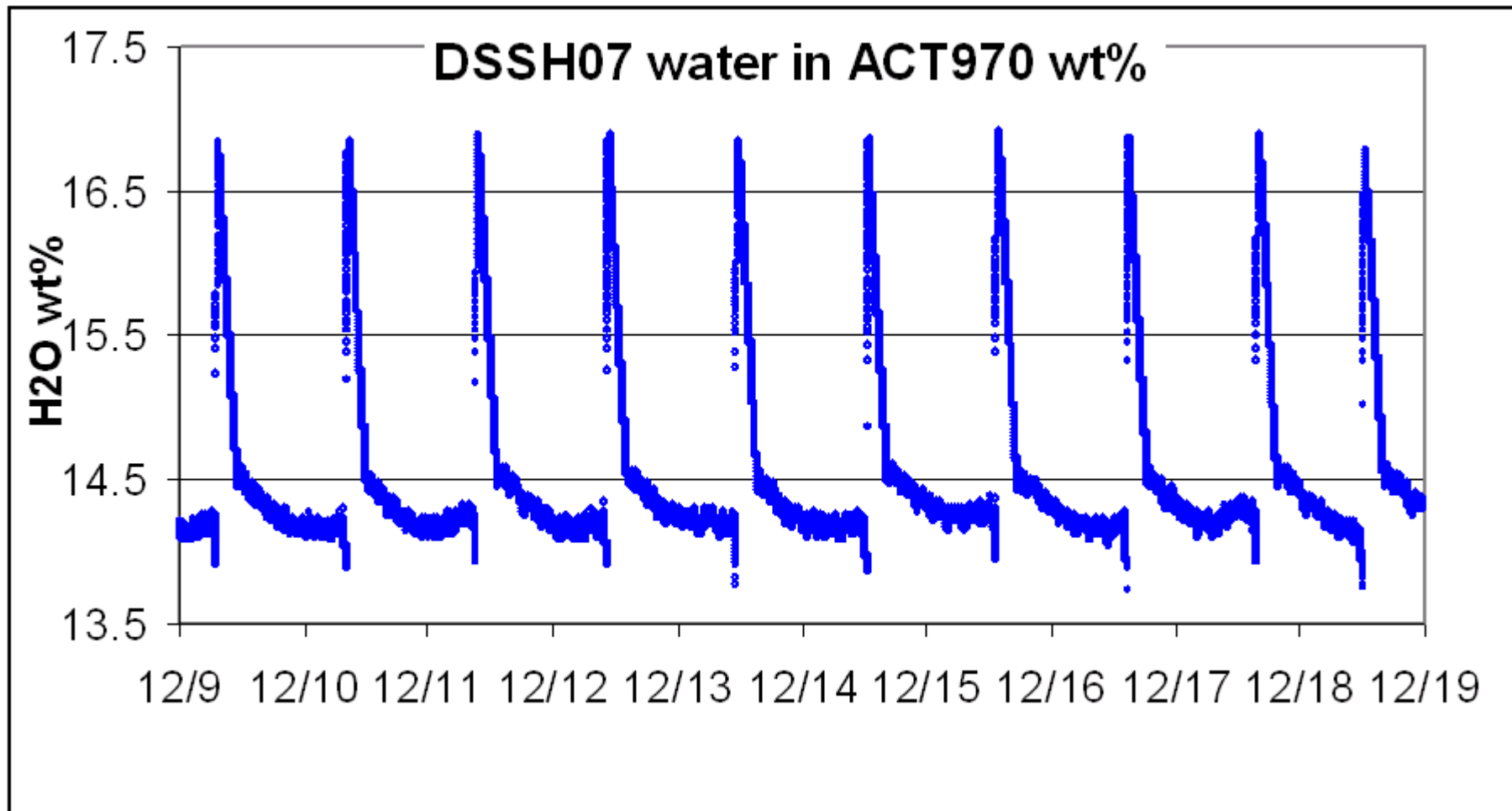
HDA Temperature Insensitivity



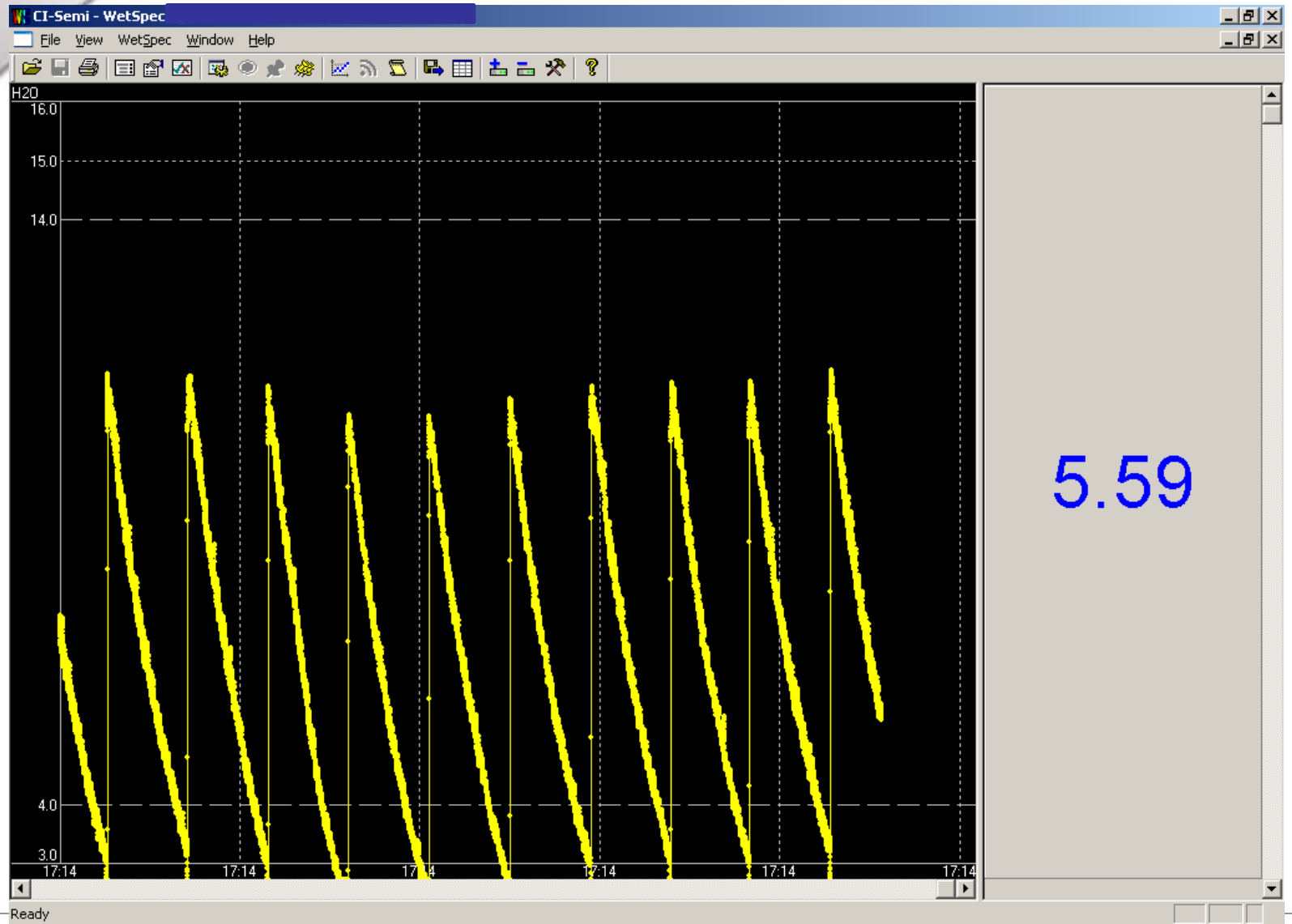


ACT measurements

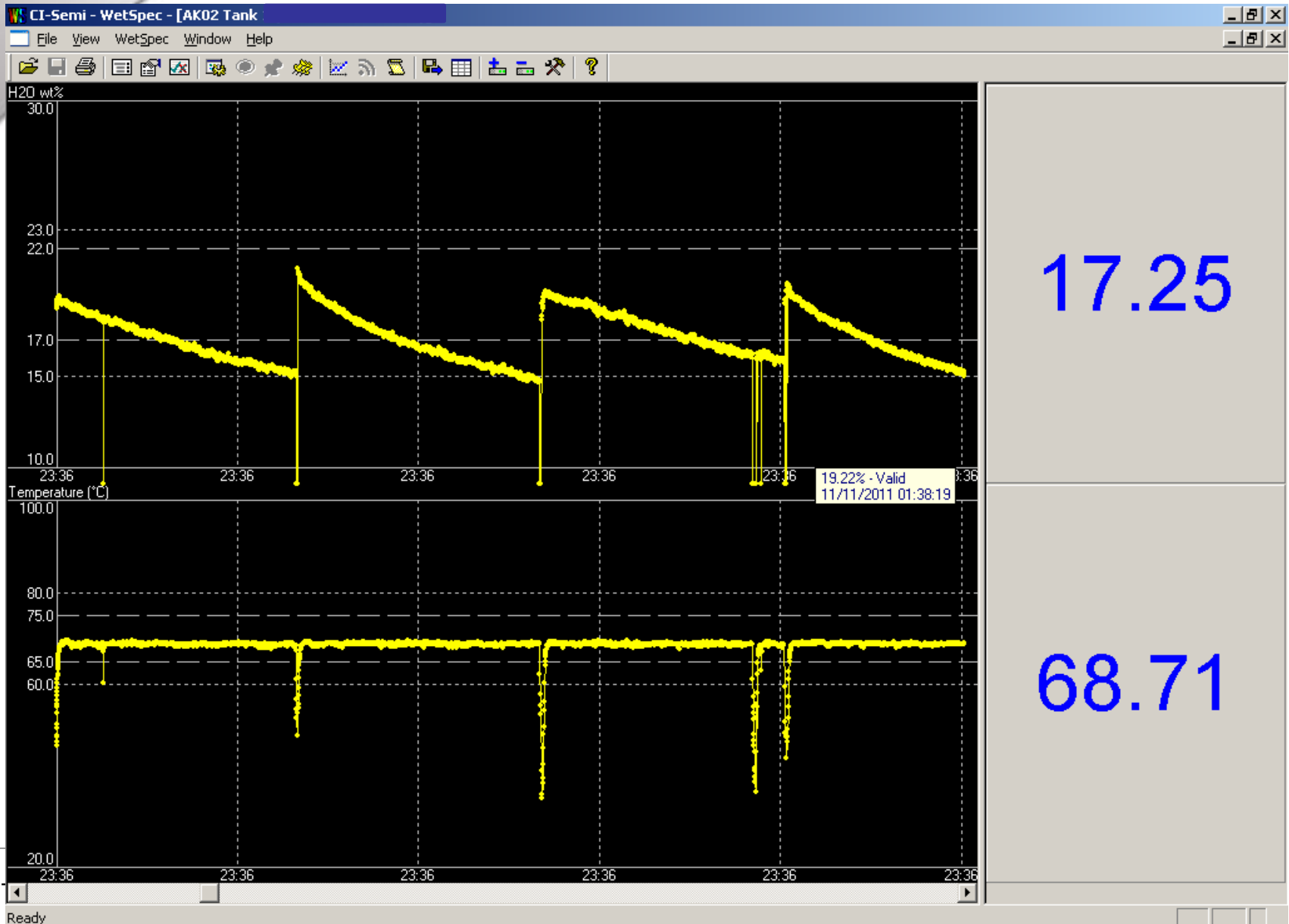
Water in ACT970, Korea



Water in ACT 935, Taiwan



Water in ACT970, USA





Thank you
