FIA Lab

Fluidics Intelligently Automated

Lachat Replacement: Advancements over Traditional FIAs 2/25/2025

FIAlab Instruments, Inc.

FIA Lab

HELLO!

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FIA Lab

SPRING

Some would say
Spring symbolizes renewal, growth,
and hope, representing
a time for new beginnings

Nowadays, water pollution has become a global issue affecting most countries in the world. Water quality should be monitored to alert authorities on water pollution, so that action can be taken **quickly**.

Accurate Nutrient Management: Soil testing helps identify nutrient deficiencies and excesses, allowing farmers to apply fertilizers more **efficiently**

Content

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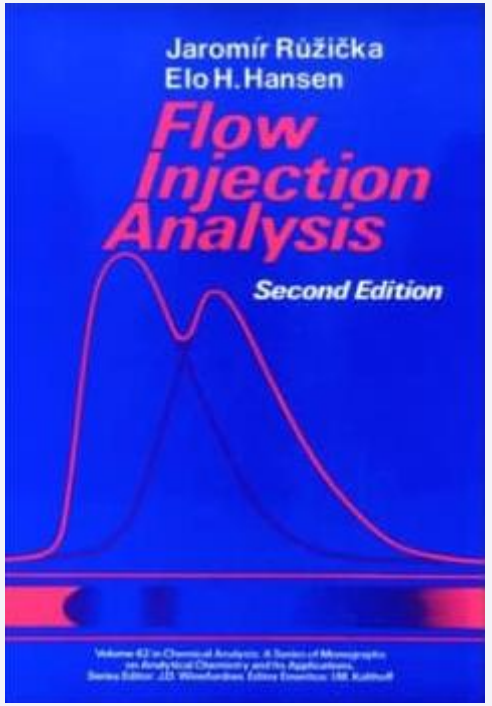
Flow Injection

Why did the market choose Flow Injection vs. SFA or Discrete

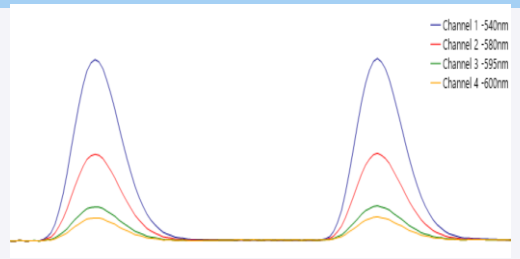
WE LOVE FLOW INJECTION

FIAlab Instruments has the strongest roots in flow injection out there. **The inventor of these techniques (Jarda Ruzicka) founded FIAlab in 1987**. For over 30 years now, we have remained on the cutting-edge of these techniques and have significantly improved these technologies. The latest technological break through Sequential Injection was also founded by FIAlab.



WHY DID FIA BECOME MARKET LEADER

- Speed
  - Whole Calibrations ~5 min from start PEAK IN LESS THAN 60 SECONDS
- Carryover
  - **complete** return to baseline between injections



- Use of plastic (Teflon) capillary tubing
  - Actually, much more inert than glass and cost is significantly reduced to change or replace tubing vs. glass
- Wider Dynamic Ranges
  - Less Reruns/dilutions needed (Compared to SFA/Discrete)
- Lowest Cost of Operation-Highest Cost is OPERATOR TIME

WHY DID FIA BECOME MARKET LEADER

- Troubleshooting
  - Know what you did wrong can be corrected quickly
- Does it all
  - Low Level of Detection
  - Various Matrices
  - Amperometric detection (CN), Direct Voltage (Fluoride for example)
- Simultaneous Determinations
  - This was a downfall of discrete (sequential) productivity (Ammonia/NOx), (OP/NO2)
- Gas Diffusion
  - Ammonia inline Distillation via GD
- Sample Prep automation (Inline TN/TP/CN/Phenol/MBAS)

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Flow Injection

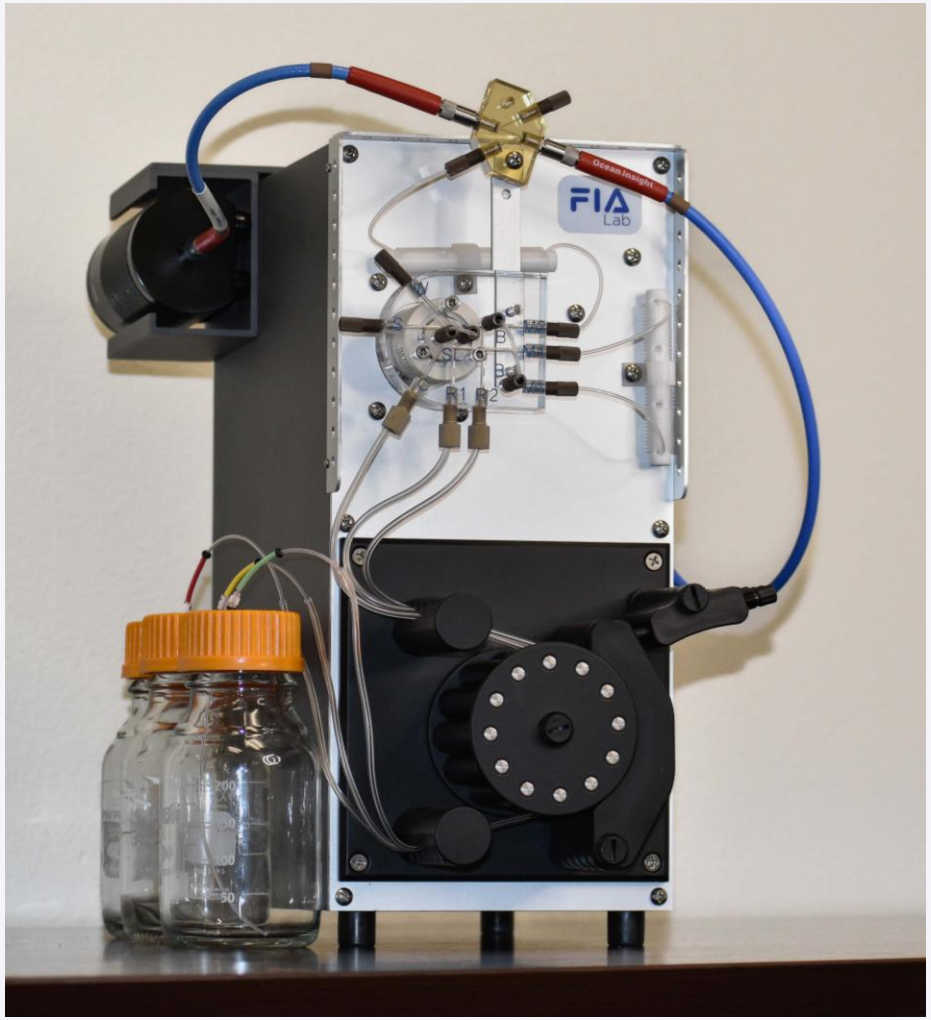
Hardware Advancements

FIA-FLEX vs. FIA-1000

FIAlyzer-FLEX	FIAlyzer-1000
	
Suggested Platform for Labs Who Need: • Easy Switchover Between Chemistries • Integrated Low-noise Detector • In-line Method Compatibility • Small Batches of Multiple Chemistries	**Suggested Platform for Labs Who Need:** • Dedicated Workstations • High Throughput • 100% Visible Manifold • Greater Compatibility with Multiple Detection Types

HARDWARE ADVANCEMENTS

- Size-Bench Space Critical
- Backup for Lab (redundancy)
- Full Array Spectrometer
- Pump Control (FIA)
- Lower cost of operation over Lachat
- No O-Rings
- Improved Cadmium Column
- Metal not plastic
- Flexibility

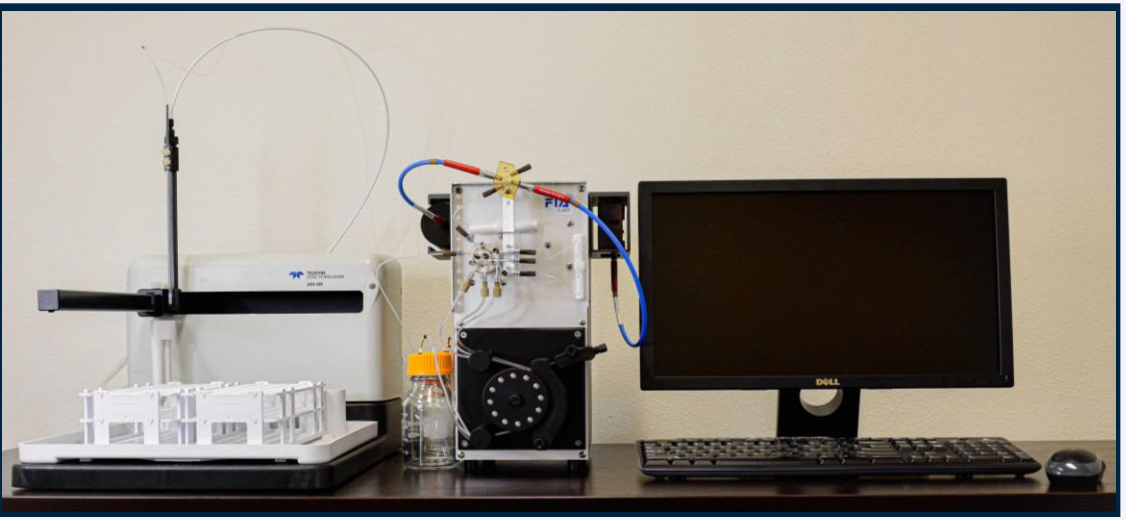


UNIQUE FLEXIBILITY WITH LITTLE ADDED COST

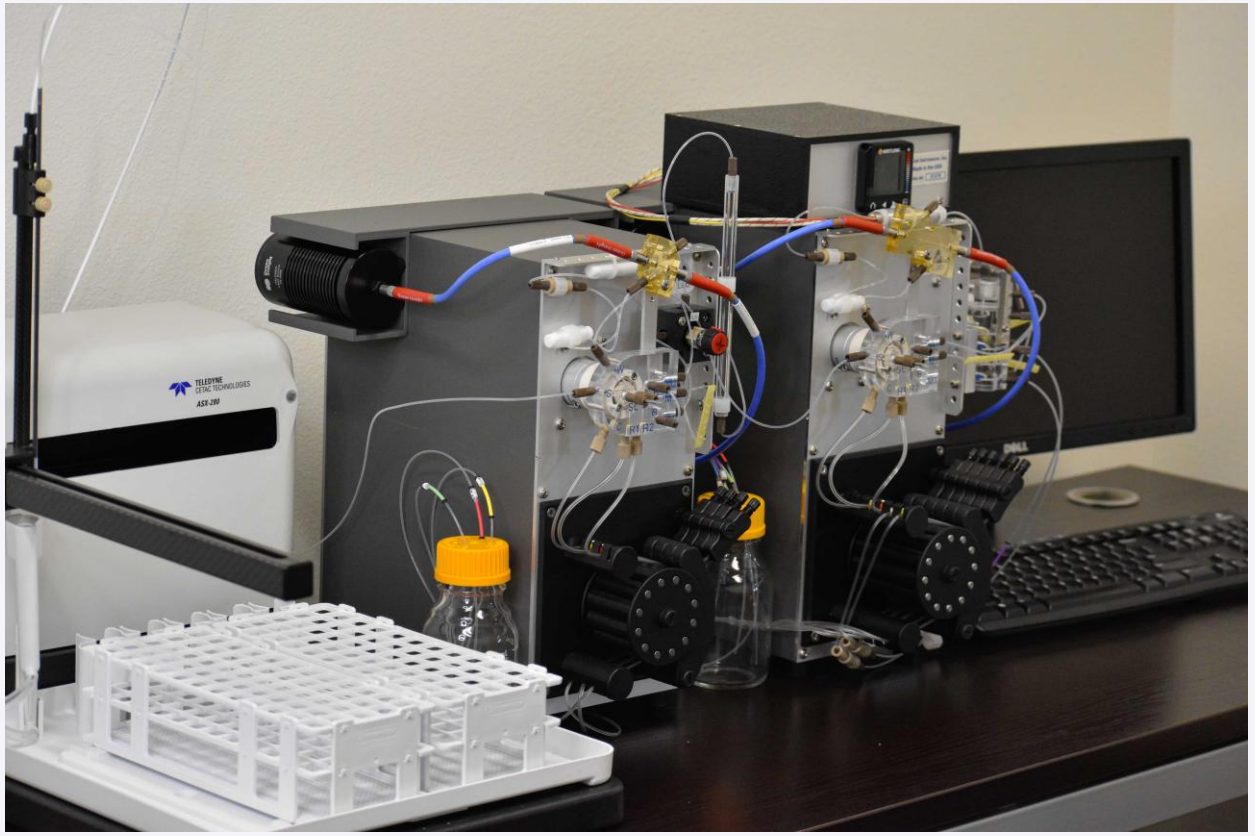
- FLEXIBILITY
  - Add Autosampler and Software license
- TWO WORKSTATIONS

No other FIA does configure this way

MULTICHANNEL FLOW INJECTION SETUP



EXTREMELY SMALL SIZE
60 cm x 25 cm x 50 cm
(actual space 10 cm)

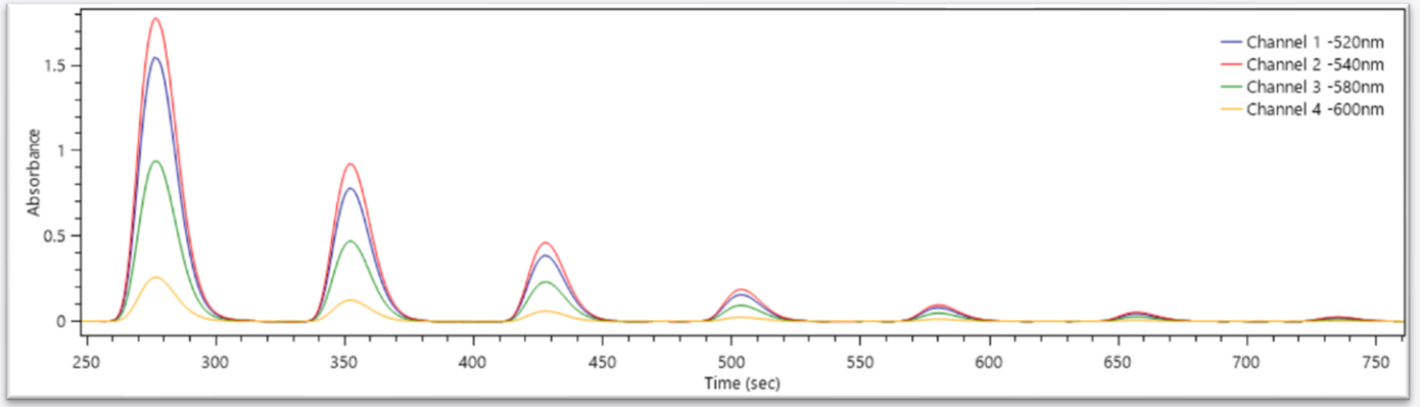


2-channel setup, Nitrate+Nitrite and Ammonia

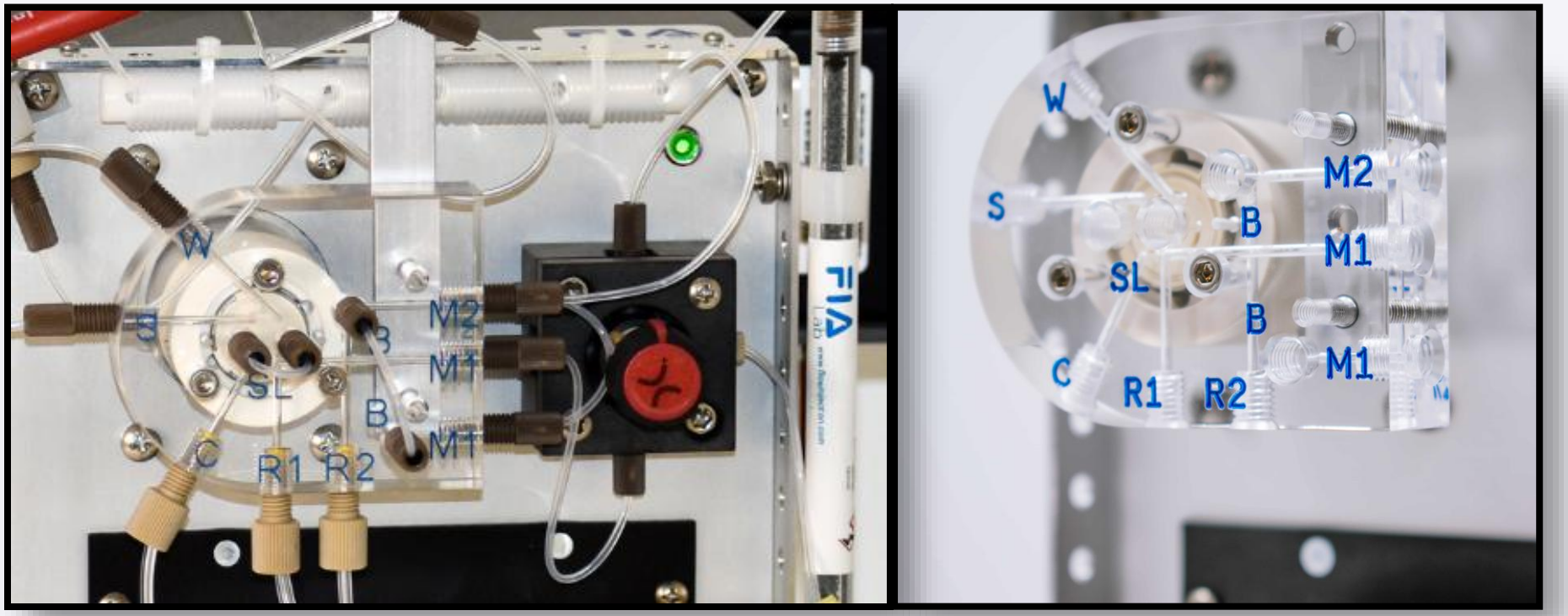
HIGH END FULL ARRAY SPECTROMETER

- All Wavelengths Simultaneously
  - Linear Range Extension
  - Colorimetric interference identification

No More FILTERS!



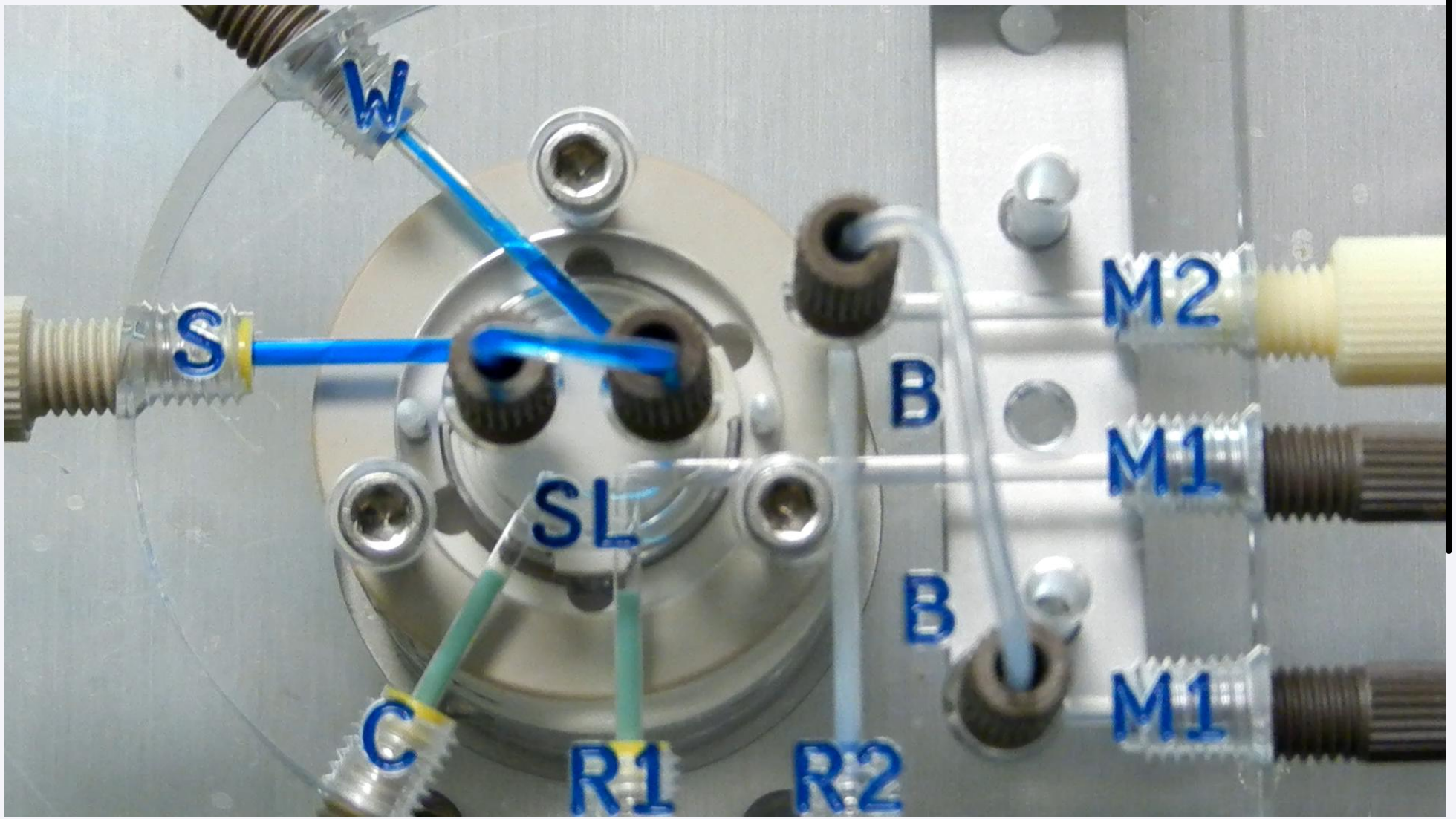
LAB-ON-VALVE (LOV) DESIGN



FIA-1000 LOV

- FIAlab Design – wide channels to prevent clogs
- Transparency of valve operation
  - Valve no longer a black box for customer
  - Easy Troubleshooting
- Fluidic organization (labeled ports)
- Easy Maintenance

LAB-ON-VALVE (LOV) DESIGN

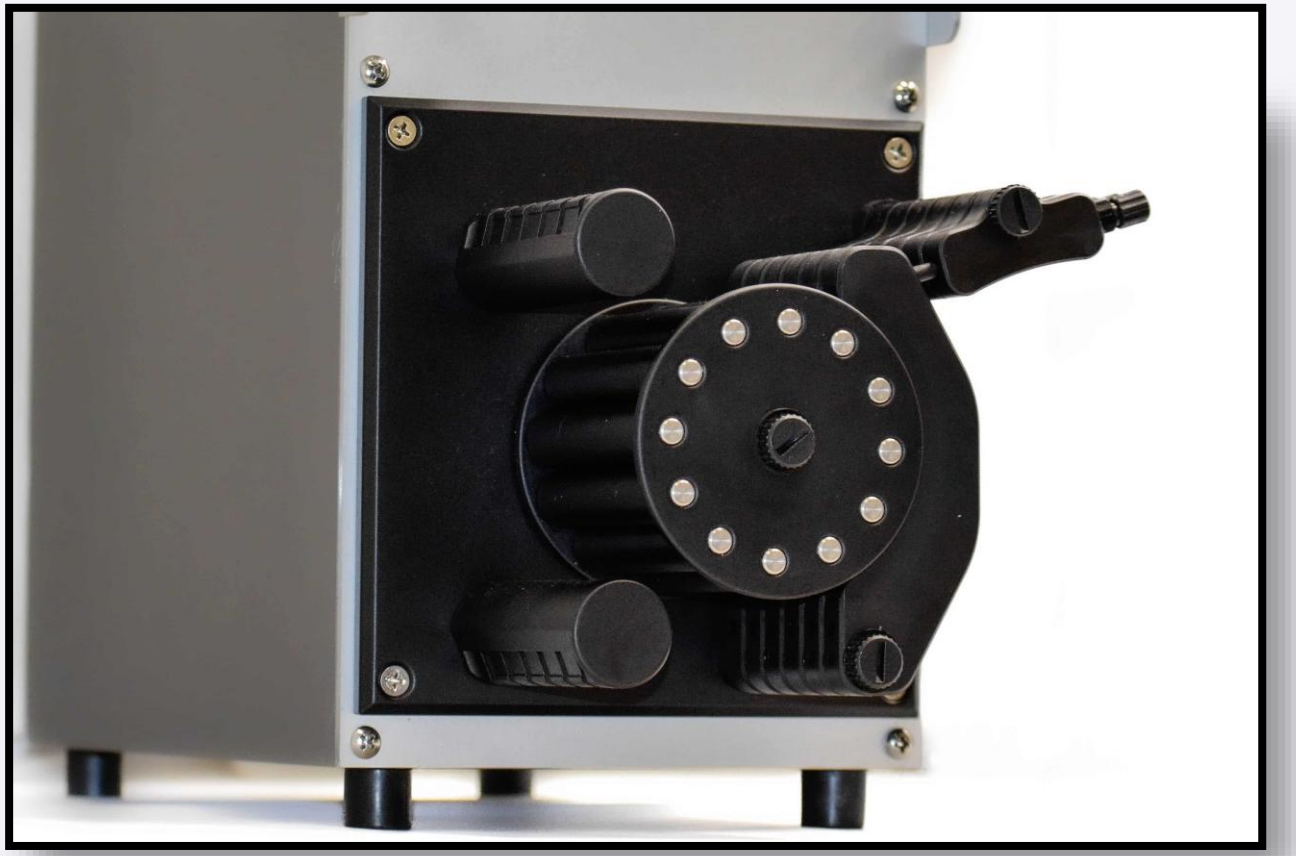


Blue-dye injection on LOV

SOFTWARE CONTROLLED PUMP

Peristaltic Pump

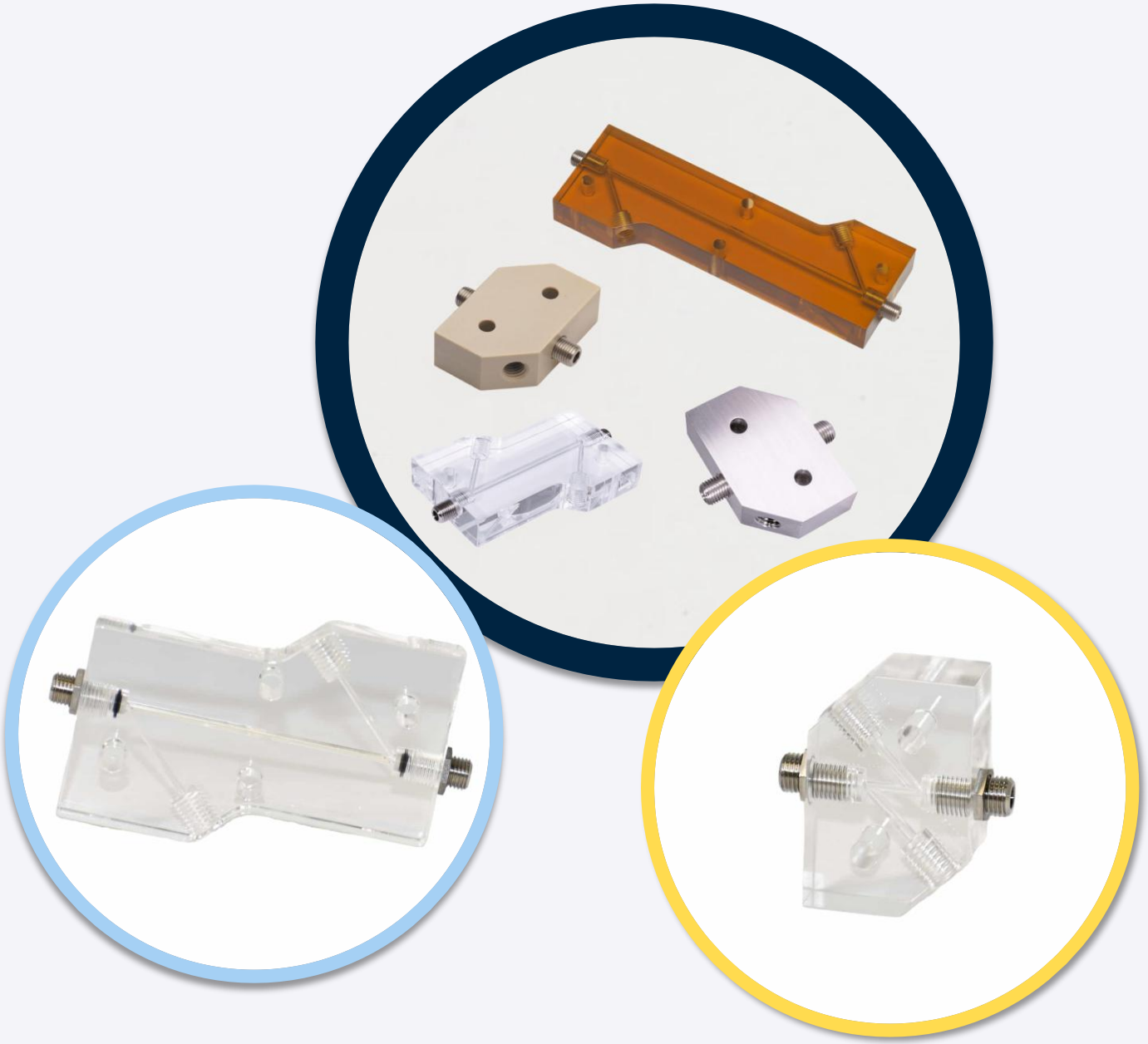
- Smooth rotations and precise liquid flow
- Software control for ease of use, overnight run capability with ‘slowdown’ mode
- 6-channel capability on each channel
- Built in for FIA-1000, External for FIA-FLEX



FLOW CELLS

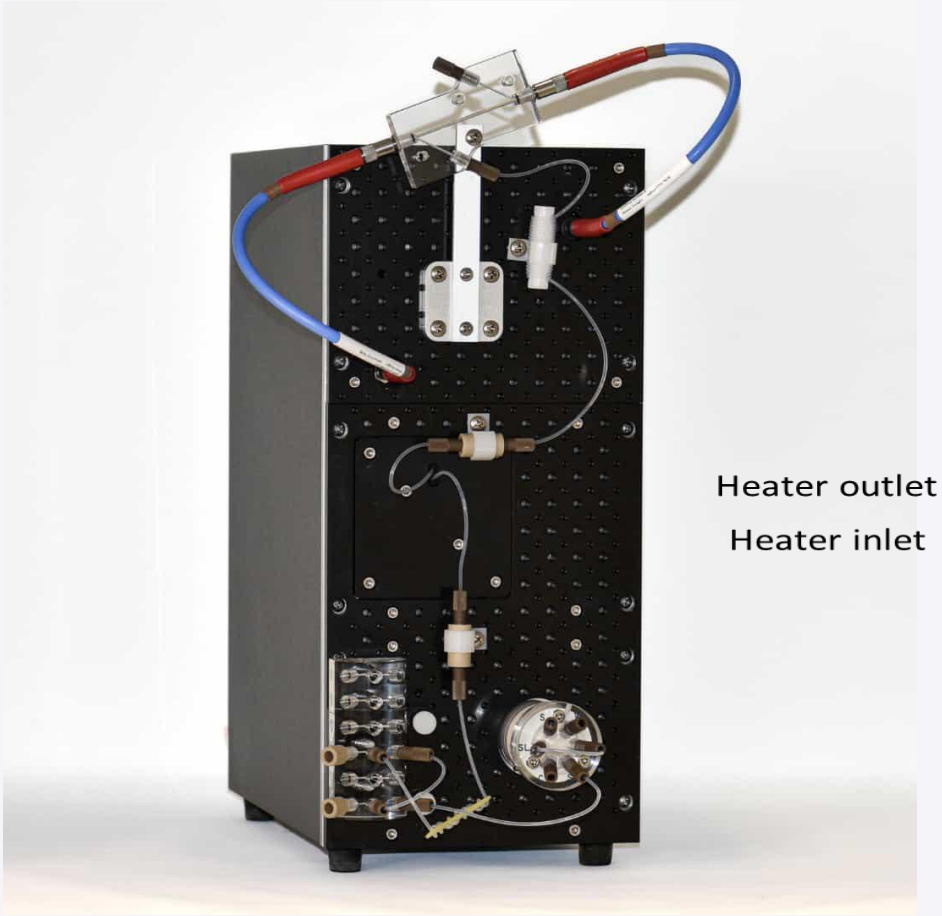
Flow cells for in-line absorbance measurements

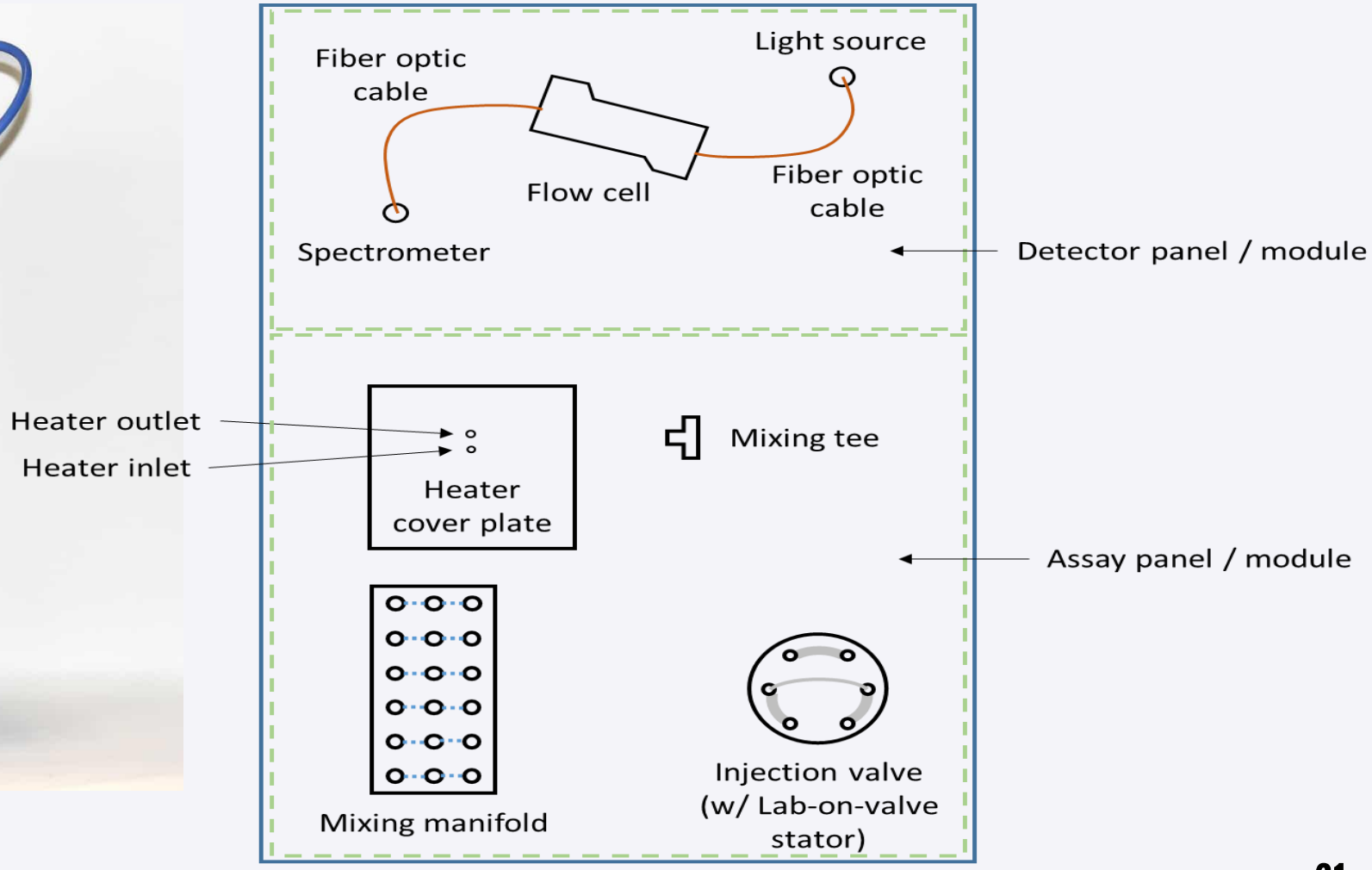
- 2.5 – 100 mm path lengths
- Variety of materials for different method applications



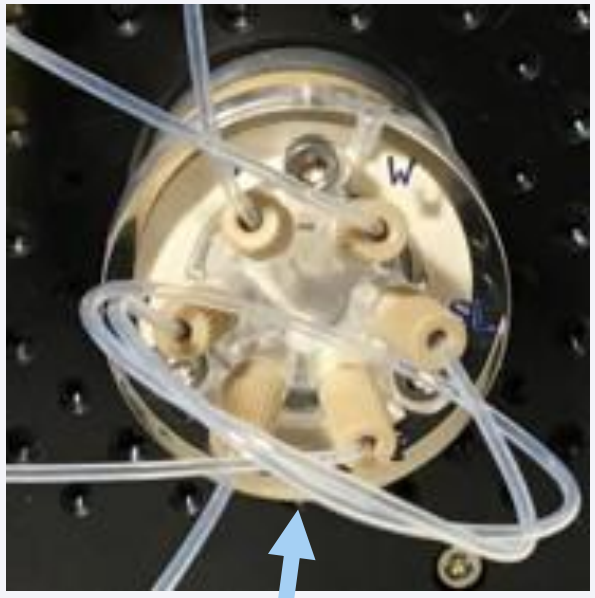
FIALYZER-FLEX SERIES

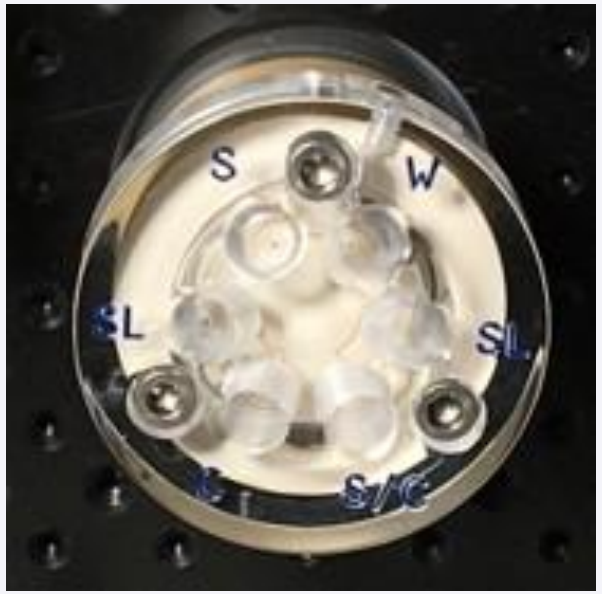
FLOW INJECTION ANALYZER





FLOW INJECTION ORGANIZATION





Sample Loop

- Lab-on-Valve (LOV) manifold
  - Replaces traditional injection valve stator
  - Transparency of valve operation
    - Valve no longer a black box for customer
    - Tremendous help in troubleshooting
  - Fluidic organization (labeled ports)

MULTICHANNEL FLOW INJECTION

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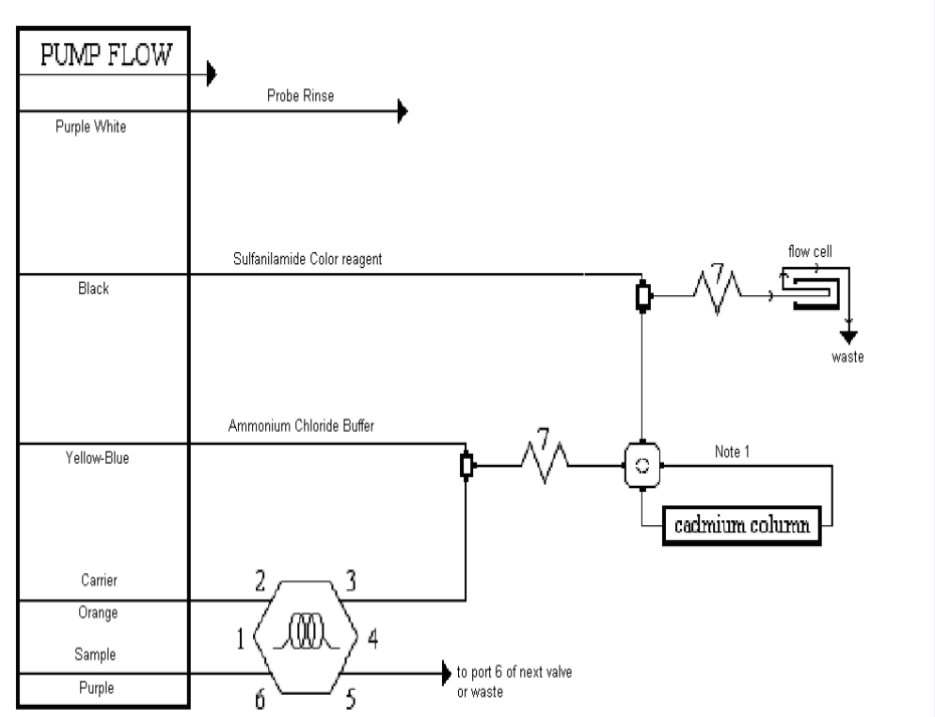
Chemistry Advancements

Comparison to some Lachat Methods

CHEMISTRY FLOW DIAGRAM

Example Method: Colorimetric Nitrate+Nitrite



Lachat Method Diagram

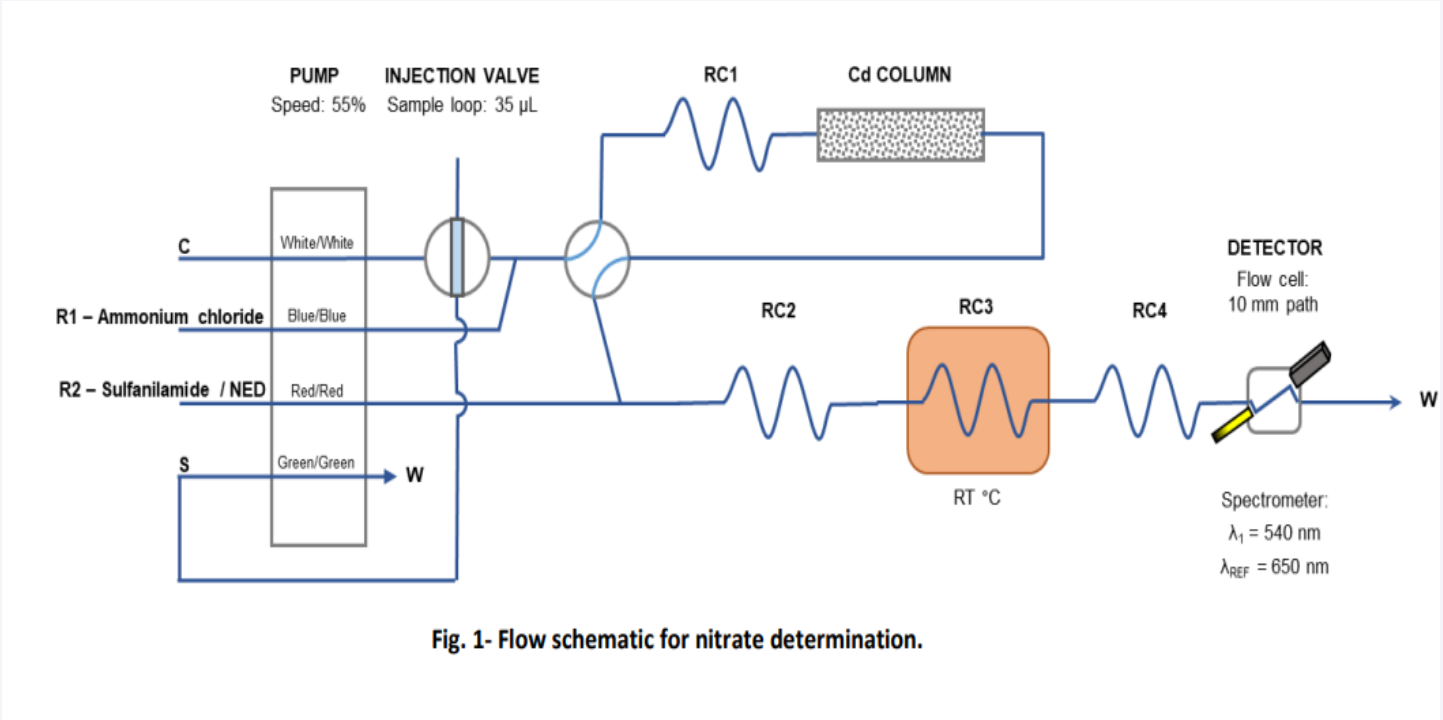


Fig. 1- Flow schematic for nitrate determination.

New FIA Method Diagram

Flow Rates New FIA VS Lachat

Pump Tubing Type, Internal Diameter and Flow Rate Table

Pump Tube Type	Internal Diameter (inches)	Flow at 40% (ml/min)
Orange/Blue	0.010	0.03
Orange/Green	0.015	0.10
Orange/Yellow	0.020	0.18
Orange/White	0.025	0.25
Black/Black	0.030	0.32
Orange/Orange	0.035	0.41
White/White	0.040	0.56
Red/Red	0.045	0.71
Gray/Gray	0.051	0.84
Yellow/Yellow	0.056	1.01
Yellow/Blue	0.060	1.12
Blue/Blue	0.065	1.35
Green/Green	0.073	1.57

Flow rates applicable to Cole Parmer Ismatec pumps only.

Part Number (Tygon)	Part Number (Duraprene)	Color	Inner Diameter (mm)	Measured Flow Rate* (mL/min.)
53403	54403	Orange-Blue	0.254	0.16
53404	54404	Orange-Green	0.381	0.23
53405	54405	Orange-Yellow	0.508	0.49
53406	54406	Orange-White	0.635	0.76
53407	54407	Black-Black	0.762	0.94
53408	54408	Orange-Orange	0.889	1.28
53409	54409	White-White	1.016	1.45
53410	54410	Red-Red	1.143	1.75
53411	54411	Gray-Gray	1.295	2.47
53412	54412	Yellow-Yellow	1.422	2.95
53419	54419	Yellow-Blue	1.524	3.07
53413	54413	Blue-Blue	1.651	3.44
53414	54414	Green-Green	1.854	4.23

LESS REAGENT CONSUMPTION & WASTE GENERATION

Chemistry	Lachat Method	Standard Method	FIAlab Method	Low	High	Units
Nitrate/Nitrite	10-107-04-1-C	4500-NO3-I	NO3-W-20-2	0.2	2.0	mg/L

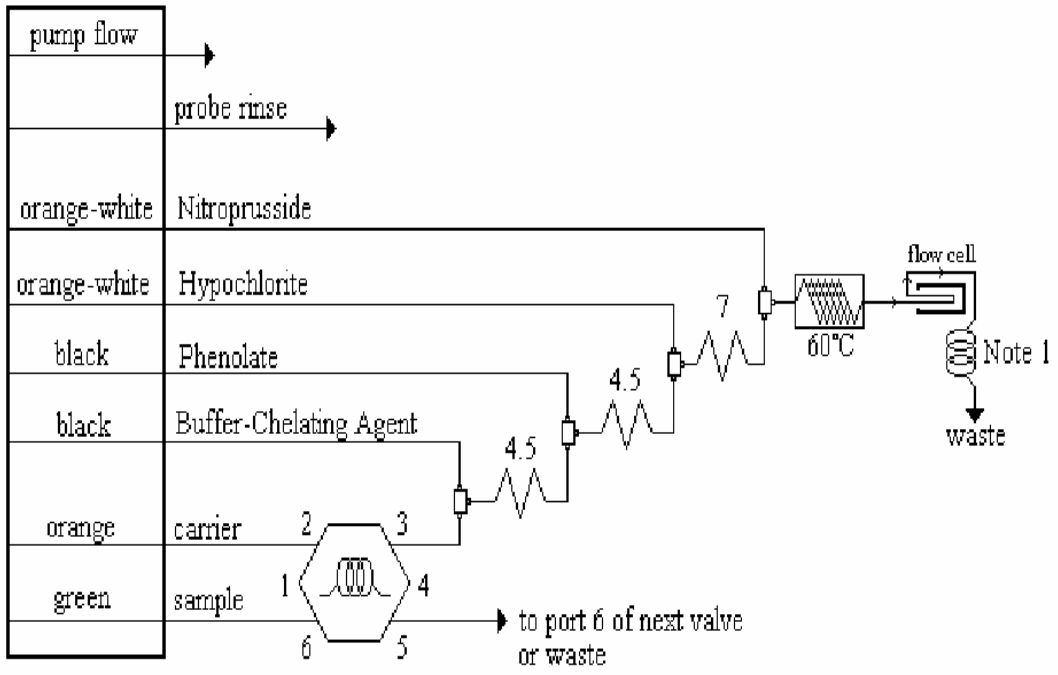
Reagent Name	Stability	Lachat	FIAlab
1.6M Ammonium Chloride Buffer (1L)	3 months	3.07 mL	1.925 mL
Sulfanilamide Solution (1L)	Monthly	0.94 mL	0.94 mL
Carrier (i.e. D.I. Water)		1.28 mL	0.77 mL
Total (mL) / minute		5.29 mL	3.635 mL

Reduction of waste approximately 30%

$$f(x) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos\frac{n\pi x}{L} + b_n \sin\frac{n\pi x}{L} \right)$$

0.04 cents/sample X # of samples (30,000/year)
$360 reduction in Reagent Cost

AMMONIA LACHAT VS New FIA



Carrier: **DI water or Reagent 7 (preserved samples)**
Manifold Tubing: **0.5 mm (0.022 in) i.d.** This is **2.5 µL/cm**.
AE Sample Loop: 125 cm x 0.022 in. i.d.
QC8000 Sample Loop: LR = 125 cm x 0.022 in. i.d.
HR = 13 cm x 0.022 in. i.d.
Interference Filter: 630 nm

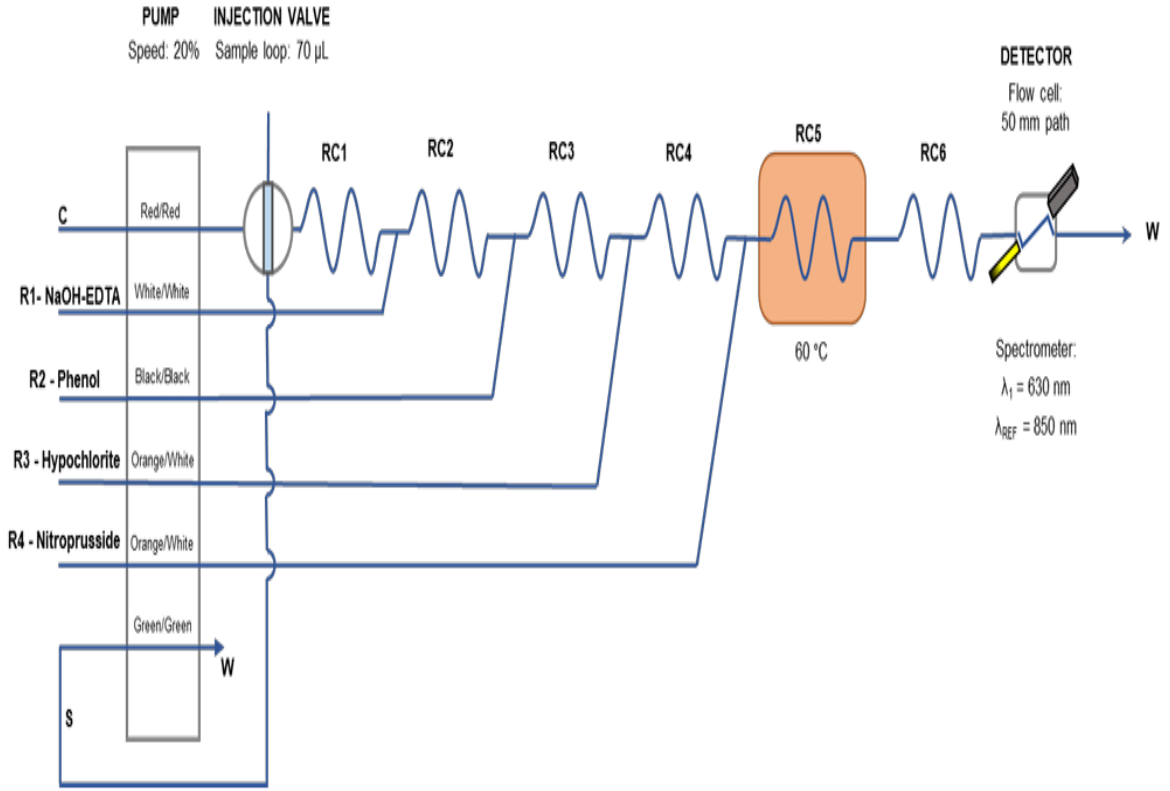
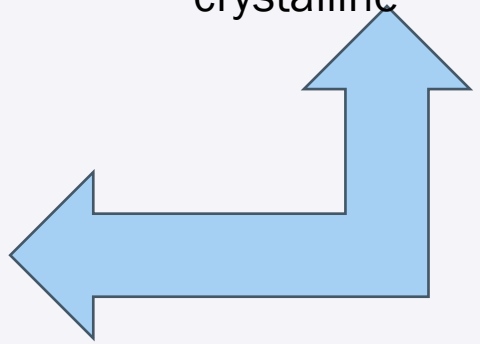


Fig. 1- Flow schematic for ammonia determination.

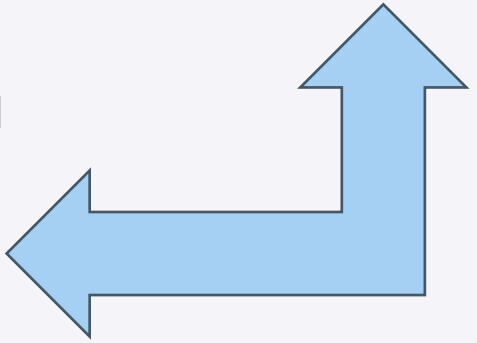
Ammonia New FIA VS LACHAT

- Reagent 2: Phenol solution (200 mL) □ Add 35 mL of 8.6% NaOH stock solution to 157 mL deionized water. □ Add 8.2 mL of 90% phenol (or 7.9 g solid phenol). □ Stir to mix. □ Store in a brown glass bottle.

41ml of liquefied phenol or 39.5 g crystalline



88ml of liquefied phenol or 83g crystalline

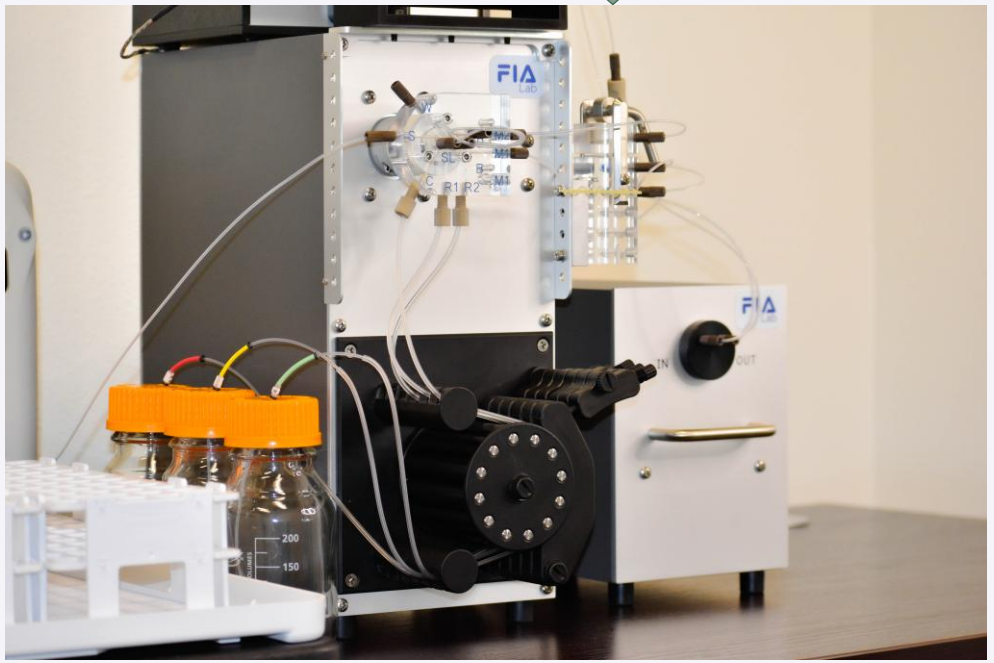


Reagent 1. Sodium Phenolate -By Volume: In a 1 L volumetric flask, dissolve 88 mL of 88% liquefied phenol or 83 g crystalline phenol (C_6H_5OH) is approximately 600 mL DI water. While stirring, slowly add 32 g sodium hydroxide (NaOH). Cool, dilute to the mark, and invert to mix. Do not degas

BEST AMMONIA/TKN METHOD

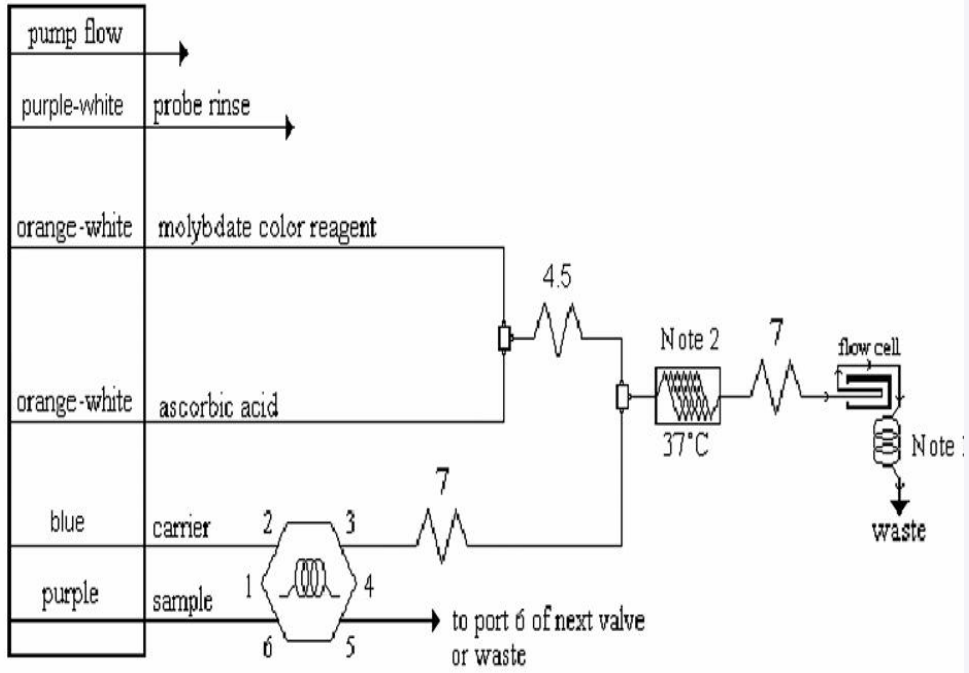
Ammonia								
Method number	Lower	Upper	MDL	Units	Sample / Hour	Matrix	Compliant With	Notes
NH3-S-1-1	0.02 0.075	0.5 50	0.006 0.025	mg N / L as NH3	120	Soil extracts	N/A	Salicylate method for soil extracts.
NH3-W-1-2	0.5	20	0.1	mg N / L as NH3	60	Waters	EPA 350.1	Salicylate method with gas diffusion, can also be used for TKN analysis.
NH3-W-1-4	0.5	20	0.1	mg N / L as NH3	60	Waters	SM 4500-NH3 H.	Salicylate or phenate method with gas diffusion.
NH3-W-2-1	0.01	0.5	0.003	mg N / L as NH3	60	Waters	EPA 350.1	Salicylate or phenate method with gas diffusion, utilizing low-noise detector, can also be used for TKN analysis.
NH3-W-2-3	0.01	0.5	0.003	mg N / L as NH3	60	Waters	SM 4500-NH3 H.	Salicylate or phenate method with gas diffusion, utilizing low-noise detector, can also be used for TKN analysis.
NH3-W-2-5	0.003	1	0.001	mg N / L as NH3	60	Waters	SM 4500-NH3 H.	Salicylate or phenate method, utilizing low-noise detector.
NH3-W-2-6	0.003	1	0.001	mg N / L as NH3	60	Waters	EPA 350.1	Phenate method, no gas diffusion.
NH3-W-3-2	0.015	10	0.005	mg N / L as NH3	60	Waters	EPA FIAlab 100	OPA method with gas diffusion, utilizing fluorometric detector, can also be used for TKN analysis.
NH3-W-3-3	0.015	5	0.005	µmol NH3 / L	60	Waters	N/A	OPA method, utilizing fluorometric detector, no gas diffusion, for seawater matrices.

•APPROVED JULY 19th 2021



SOIL OP LACHAT VS New FIA

12-115-01-1-N ULTRA HIGH THROUGH Bray or Mehlich



Carrier: DI Water*
Manifold Tubing: 0.8 mm (0.032 in) i.d. This is 5.2 µL/cm.
QC8000/8500 Sample Loop: Microloop
Interference Filter: 880 nm

Fast-Phosphate Determination – PO4-S-1-2

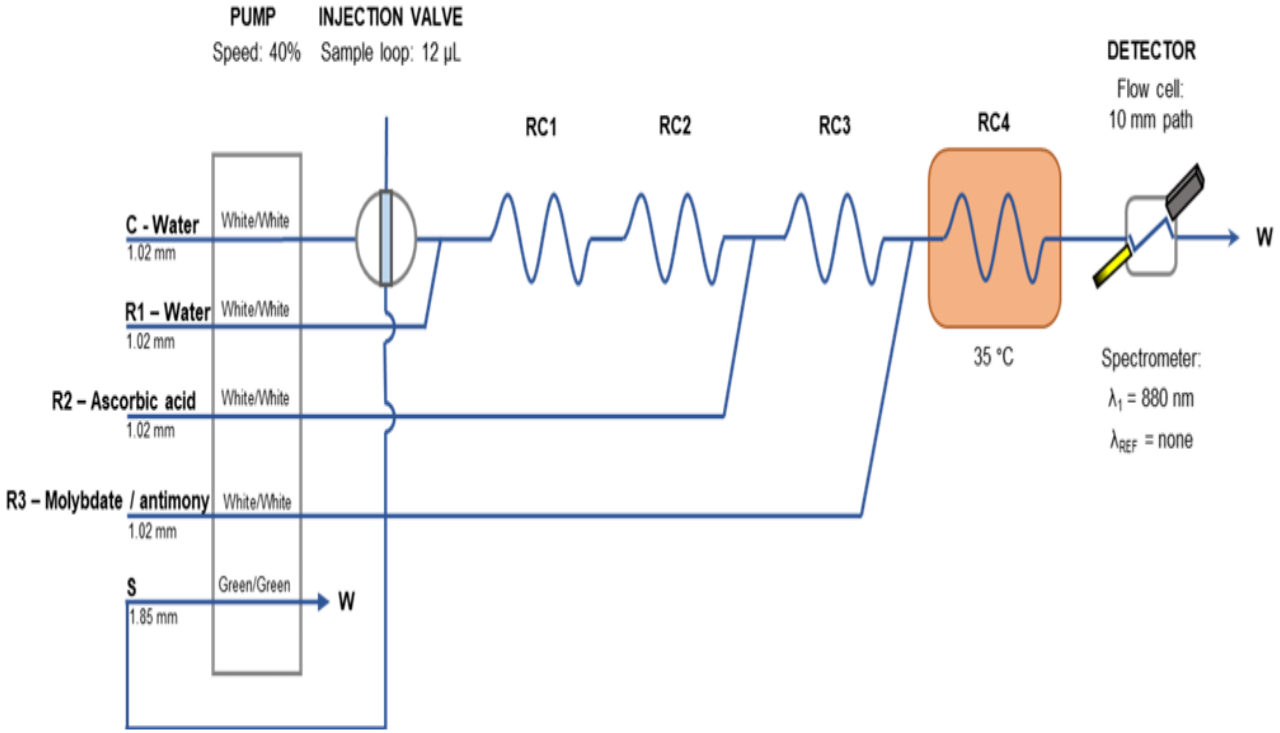


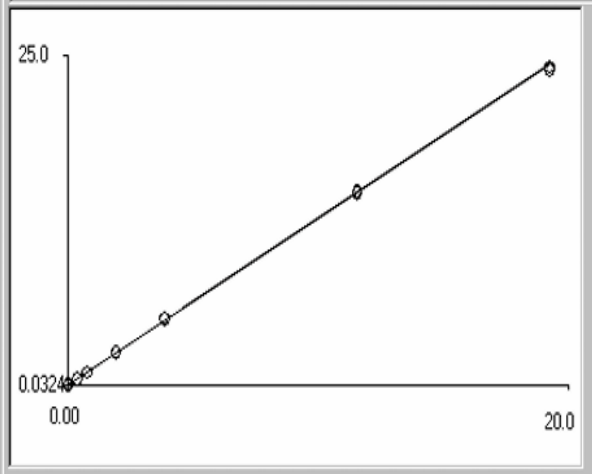
Fig. 3- Flow schematic – high range

Flow Injection Soil Advancement

Calibration Results

PO4

	Known Concentration (mg/L)	Rep	Area (V.s)	Height (V)	% RSD	% Residual	Unused	Det. Conc (mg/L)	Date	Time
1	20.0	1	25.0	2.46	0.6	0.7	☐	19.9	9/4/2007	10:03:50 AM
2	20.0	2	24.8	2.44	0.6	1.5	☐	19.7	9/4/2007	10:04:20 AM
3	12.0	1	15.1	1.50	0.4	0.0	☐	12.0	9/4/2007	10:04:49 AM
4	12.0	2	15.2	1.51	0.4	-0.5	☐	12.1	9/4/2007	10:05:19 AM
5	4.00	1	5.30	0.526	1.3	-4.3	☐	4.17	9/4/2007	10:05:48 AM
6	4.00	2	5.20	0.517	1.3	-2.4	☐	4.10	9/4/2007	10:06:18 AM
7	2.00	1	2.65	0.261	0.8	-3.2	☐	2.06	9/4/2007	10:06:47 AM
8	2.00	2	2.62	0.257	0.8	-2.1	☐	2.04	9/4/2007	10:07:17 AM
9	0.800	1	1.05	0.101	0.5	0.8	☐	0.793	9/4/2007	10:07:46 AM
10	0.800	2	1.04	0.100	0.5	1.5	☐	0.787	9/4/2007	10:08:15 AM
11	0.400	1	0.550	0.0515	0.2	0.7	☐	0.397	9/4/2007	10:08:45 AM
12	0.400	2	0.549	0.0515	0.2	1.0	☐	0.396	9/4/2007	10:09:15 AM
13	0.00	1	0.0324	3.11e-3			☐	-0.0147	9/4/2007	10:09:45 AM
14	0.00	2	0.0380	3.36e-3			☐	-0.0103	9/4/2007	10:10:14 AM



Area = 1.26 * Conc + 0.0513
Conc = 0.795 * Area - 0.0405
Correlation Coefficient (r) = 0.99998

1/x weighting

Settings

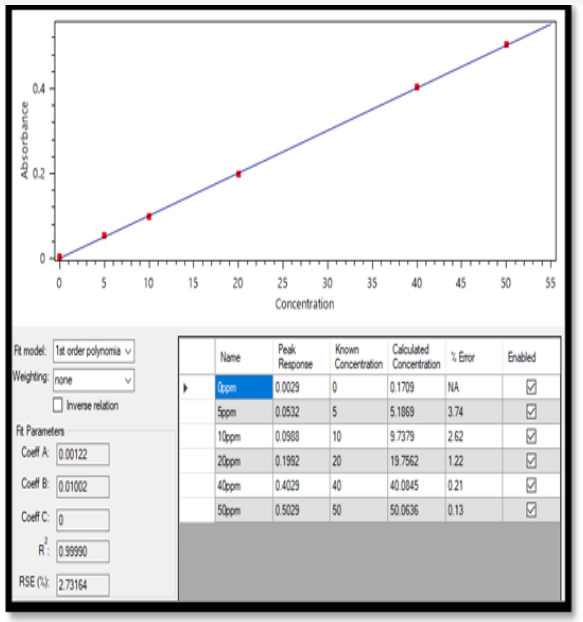


Fig. 4 – Example calibration data – high range

- Lower limit of detection: 0.3 mg P/L – $9.7*10^{-6}$ mol/L
- Lower limit of quantification: 1.0 mg P/L – $3.2*10^{-5}$ mol/L
- Upper limit of detection: 50 mg P/L – $1.3*10^{-3}$ mol/L
- Sample throughput: 135 samples / hour
- Startup + Calibration: 10 minutes
- Shutdown: 5 minutes

3

Software Advancements

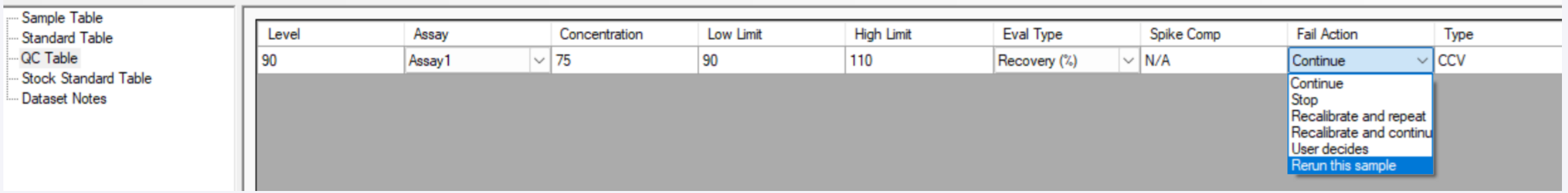
Lachat Omnion 4.0 Direct Comparison

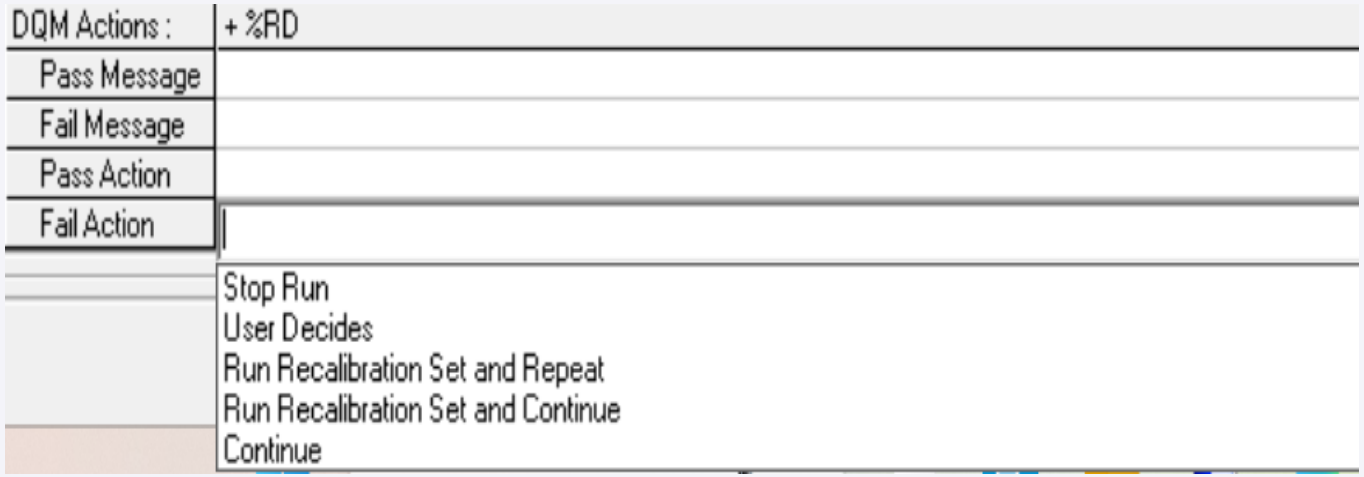
OMNION 4.0 VS FIASOFT

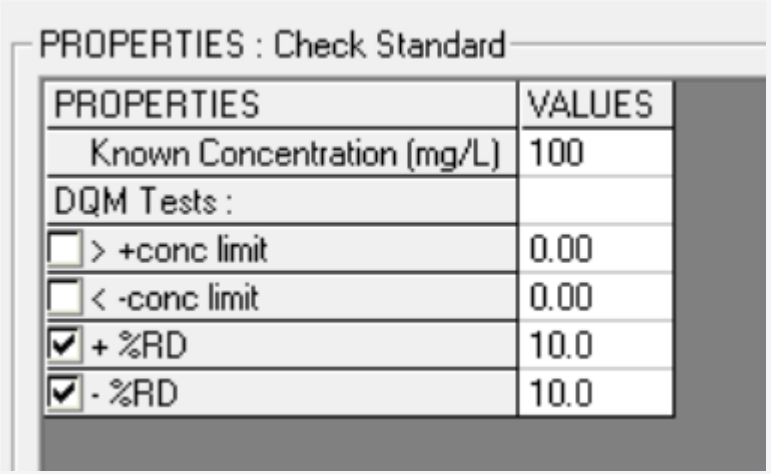
Sample No.	Cup No.	Sample ID	Sample Type	Reps	ADF	Trigger OFF	MDF	Weight	Units
1	S1	CalStd A	Calibration Standard	2	☐	☑	☐	☐	
2	S2	CalStd B	Calibration Standard	1	☐	☑	☐	☐	
3	S3	CalStd C	Calibration Standard	2	☐	☑	☐	☐	
4	S4	CalStd D	Calibration Standard	1	☐	☑	☐	☐	
5	1	Sample1	Unknown	1	☐	☐	☐	☐	
6	2	Sample2	Unknown	1	☐	☐	☐	☐	
7	3	Sample3	Unknown	1	☐	☐	☐	☐	
8	1	Sample8	Unknown	1	☐	☐	☐	☐	
9	1	Sample9	Unknown	1	☐	☐	☐	☐	
10	1	Sample10	Unknown	1	☐	☐	☐	☐	
11	1	Sample11	Check Standard	1	☐	☑	☐	☐	
12	1	Sample12	Unknown	1	☐	☐	☐	☐	
13	1	Sample13	Unknown	1	☐	☐	☐	☐	
14	1	Sample14	Unknown	1	☐	☐	☐	☐	
15	1	Sample15	Unknown	1	☐	☐	☐	☐	
16	1	Sample16	Unknown	1	☐	☐	☐	☐	
17	1	Sample17	Unknown	1	☐	☐	☐	☐	
18	1	Sample18	Unknown	1	☐	☐	☐	☐	
19	1	Sample19	Unknown	1	☐	☐	☐	☐	
20	1	Sample20	Unknown	1	☐	☐	☐	☐	

Status	Injection No	Sample Name	Rack Position	Sample Type	Level	MDF	ADF	Weight	Comment	Autodilute?	Remove
Done	1	Std 300	RS1	Standard	01	1	1	1		☐	Remove
Done	2	Std 200	RS2	Standard	02	1	1	1		☐	Remove
Processing	3	Std 100	RS3	Standard	03	1	1	1		☐	Remove
Pending	4	BLK	RS8	Standard	04	1	1	1		☐	Remove
Pending	5	Unkown	RA1	Unknown	00	1	1	1		☐	Remove
Pending	6	Unkown	RA2	Unknown	00	1	1	1		☐	Remove
Pending	7	75	RA3	QC	00	1	1	1		☐	Remove
Pending	8		RA4	Unknown	00	1	1	1		☐	Remove
Pending	9		RA5	Unknown	00	1	1	1		☐	Remove
Pending	10		RA6	Unknown	00	1	1	1		☐	Remove
Pending	11		RA7	Unknown	00	1	1	1		☐	Remove
Pending	12		RA8	Unknown	00	1	1	1		☐	Remove
Pending	13		RA9	Unknown	00	1	1	1		☐	Remove
Pending	14		RA10	Unknown	00	1	1	1		☐	Remove
Pending	15		RA11	Unknown	00	1	1	1		☐	Remove

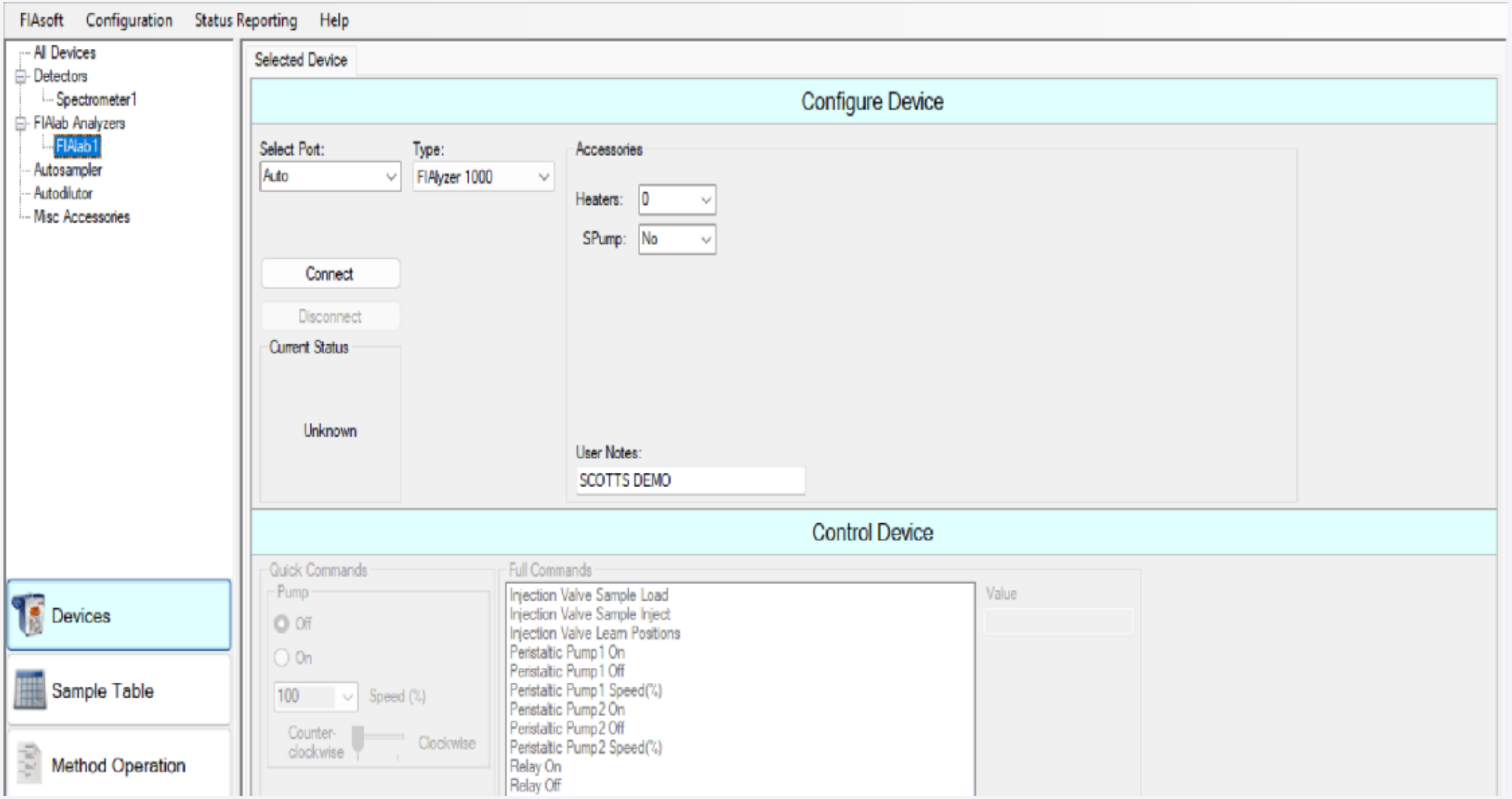
Flow Injection Software



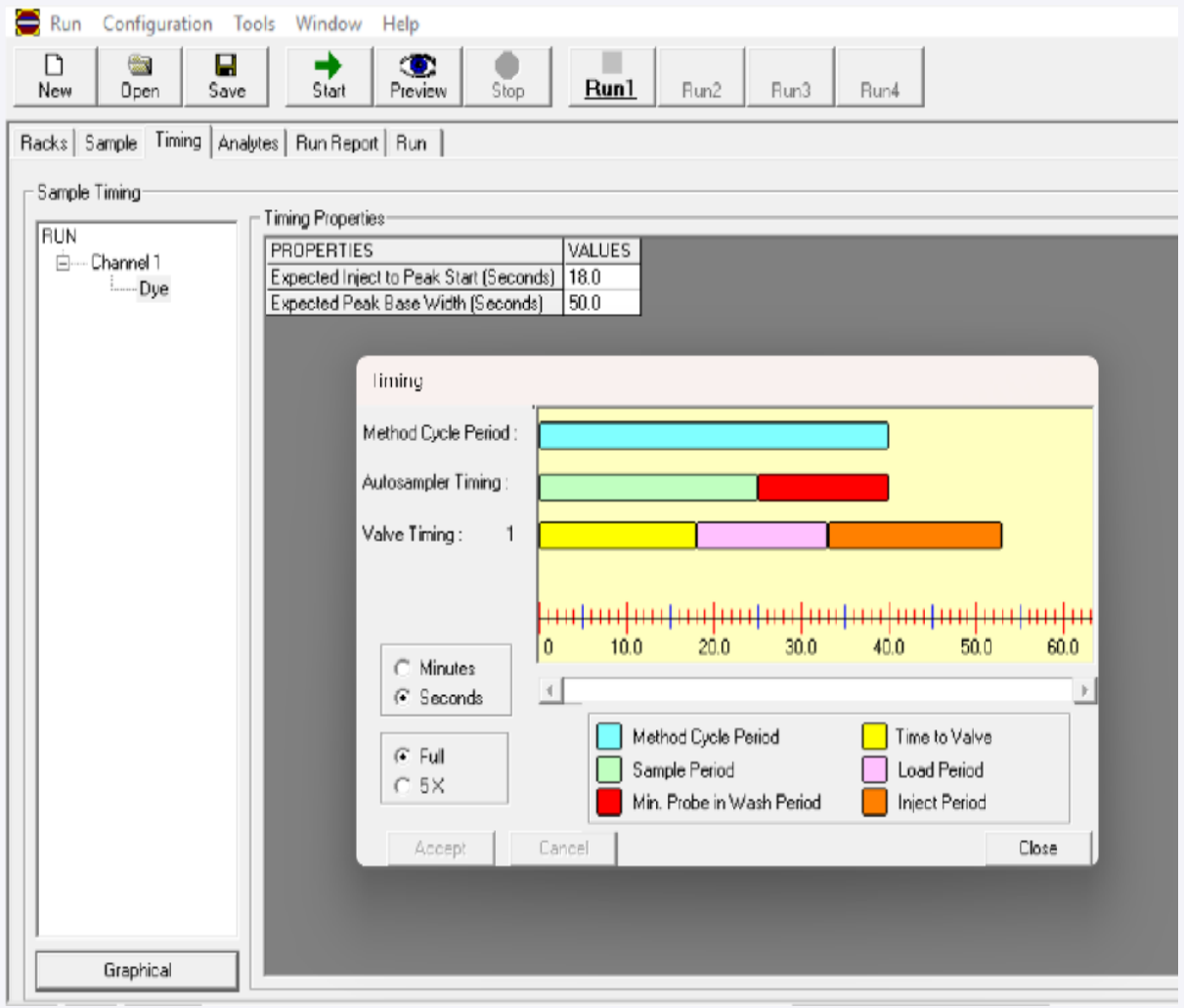


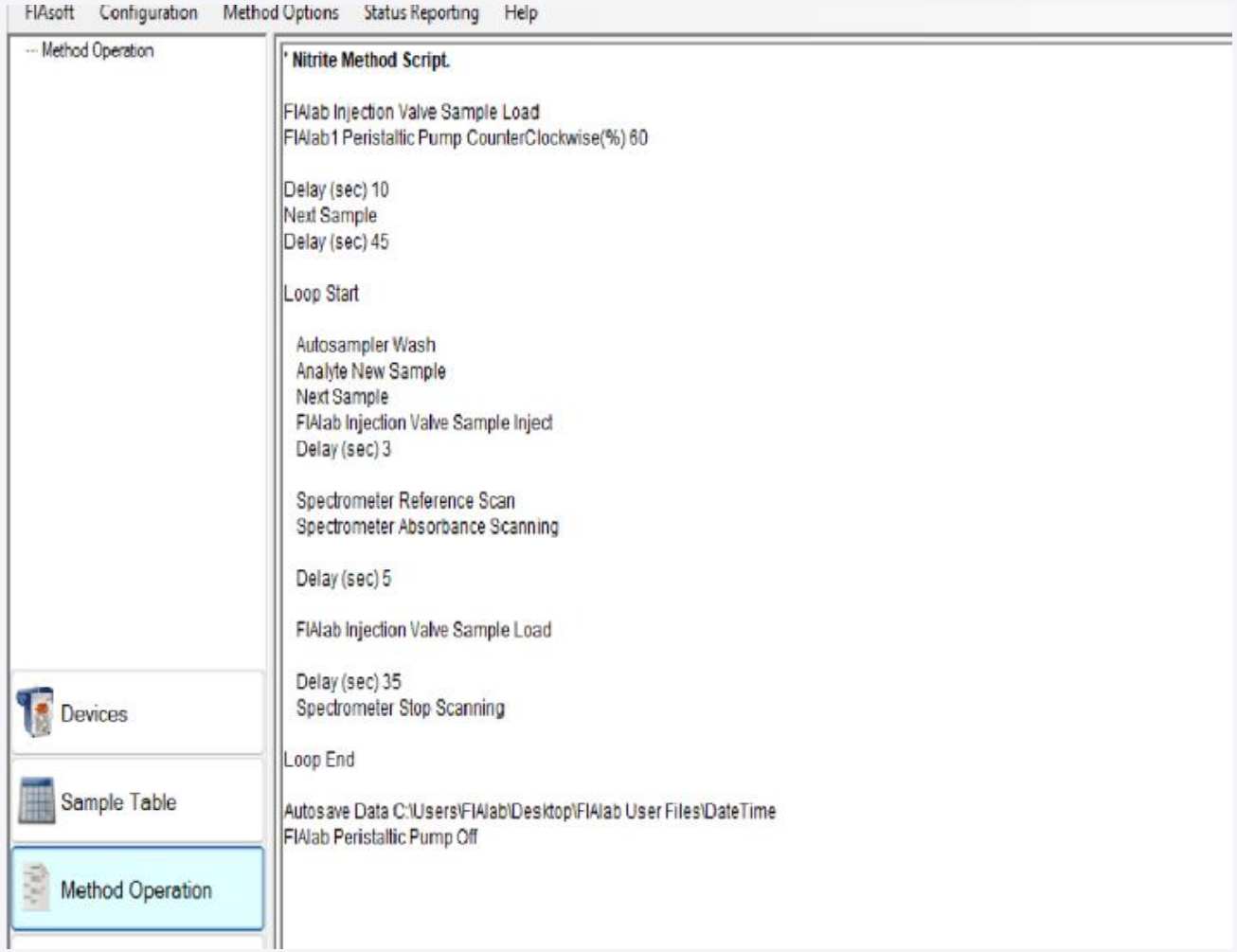


HARDWARE CONTROL



Modern Software

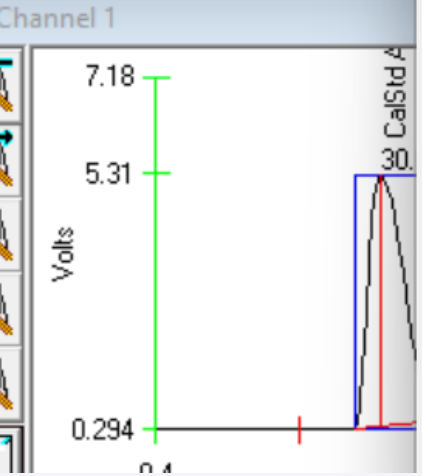


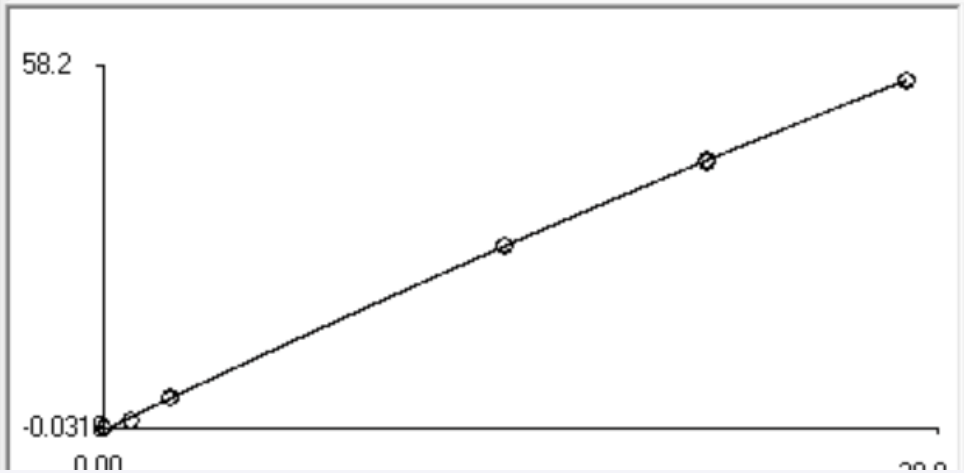


First Delete Standard in curve

S1	CalStd A
S2	CalStd B
S3	CalStd C
S5	Sample1
S6	Sample2
S7	Sample3

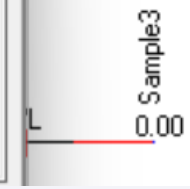
	Known Conc. (mg/L)	Rep.	Peak Area (V.s)	Peak Height (V)	% RSD	% Resid.	Unused	Det. Conc (mg/L)	Date	Time
1	30.0	1	58.0	4.91	0.2	0.1	☐	29.9	9/17/2001	3:33:19 F
2	30.0	2	58.2	4.94	0.2	-0.2	☐	30.0	9/17/2001	3:33:19 F
3	22.5	1	44.5	3.78	0.3	0.3	☐	22.5	9/17/2001	3:33:19 F
4	22.5	2	44.7	3.79	0.3	-0.1	☐	22.5	9/17/2001	3:33:19 F
5	15.0	1	30.5	2.58	0.3	0.0	☐	15.0	9/17/2001	3:33:19 F
6	15.0	2	30.6	2.59	0.3	-0.4	☐	15.1	9/17/2001	3:33:19 F
7	7.50	1	30.6	2.59			☑		9/17/2001	3:33:19 F
8	7.50	2	30.7	2.60			☑		9/17/2001	3:33:19 F
9	2.50	1	5.03	0.412	1.0	0.0	☐	2.49	9/17/2001	3:33:19 F
10	2.50	2	5.10	0.416	1.0	-1.4	☐	2.52	9/17/2001	3:33:19 F
11	1.00	1	1.44	0.113	4.3	21.5	☐	0.821	9/17/2001	3:33:19 F
12	1.00	2	1.35	0.105	4.3	26.1	☐	0.782	9/17/2001	3:33:19 F



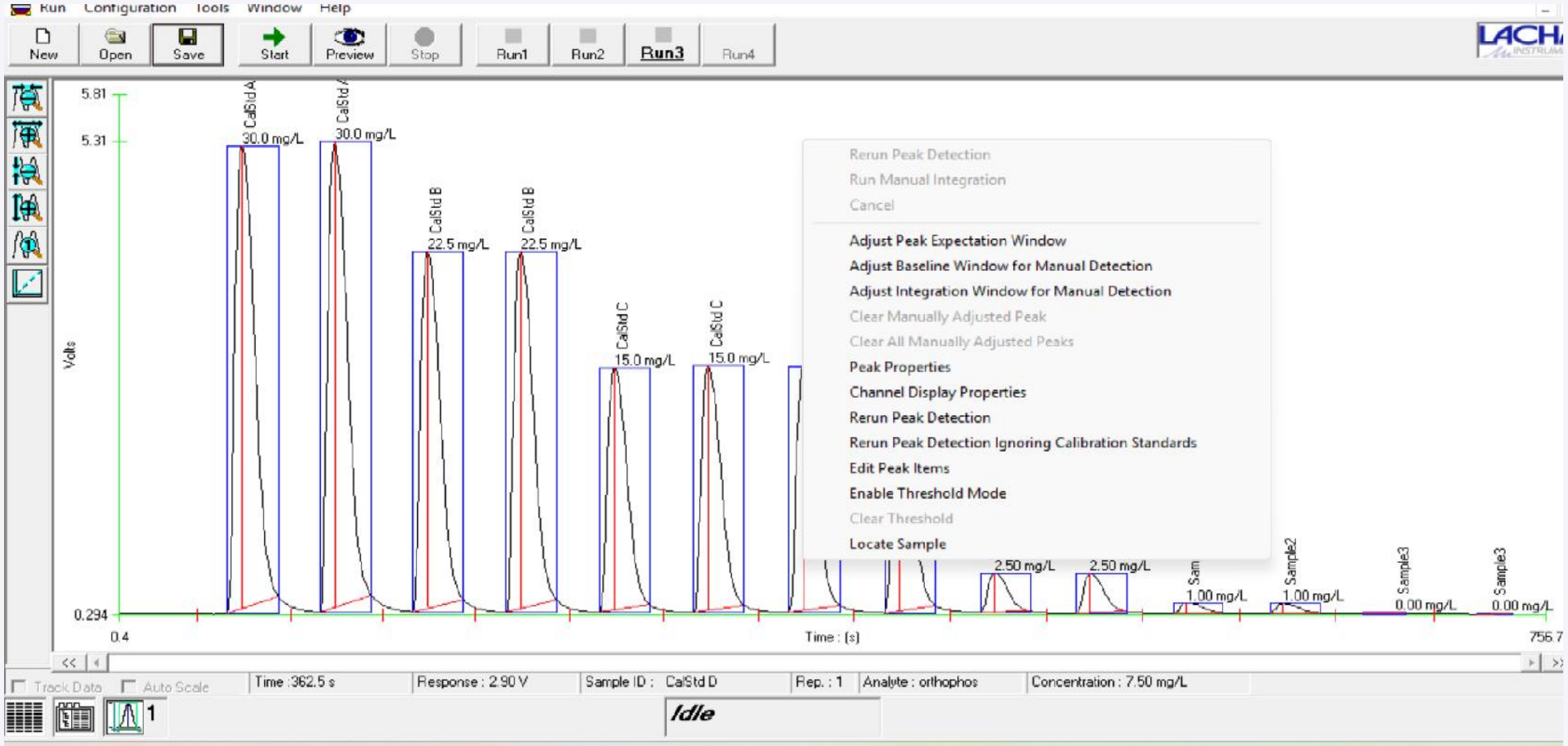


Area = - 6.84e-3 * Conc^2 + 2.15 * Conc - 0.313
Conc = 9.55e-4 * Area^2 + 0.458 * Area + 0.160
Correlation Coefficient (r) = 0.99994

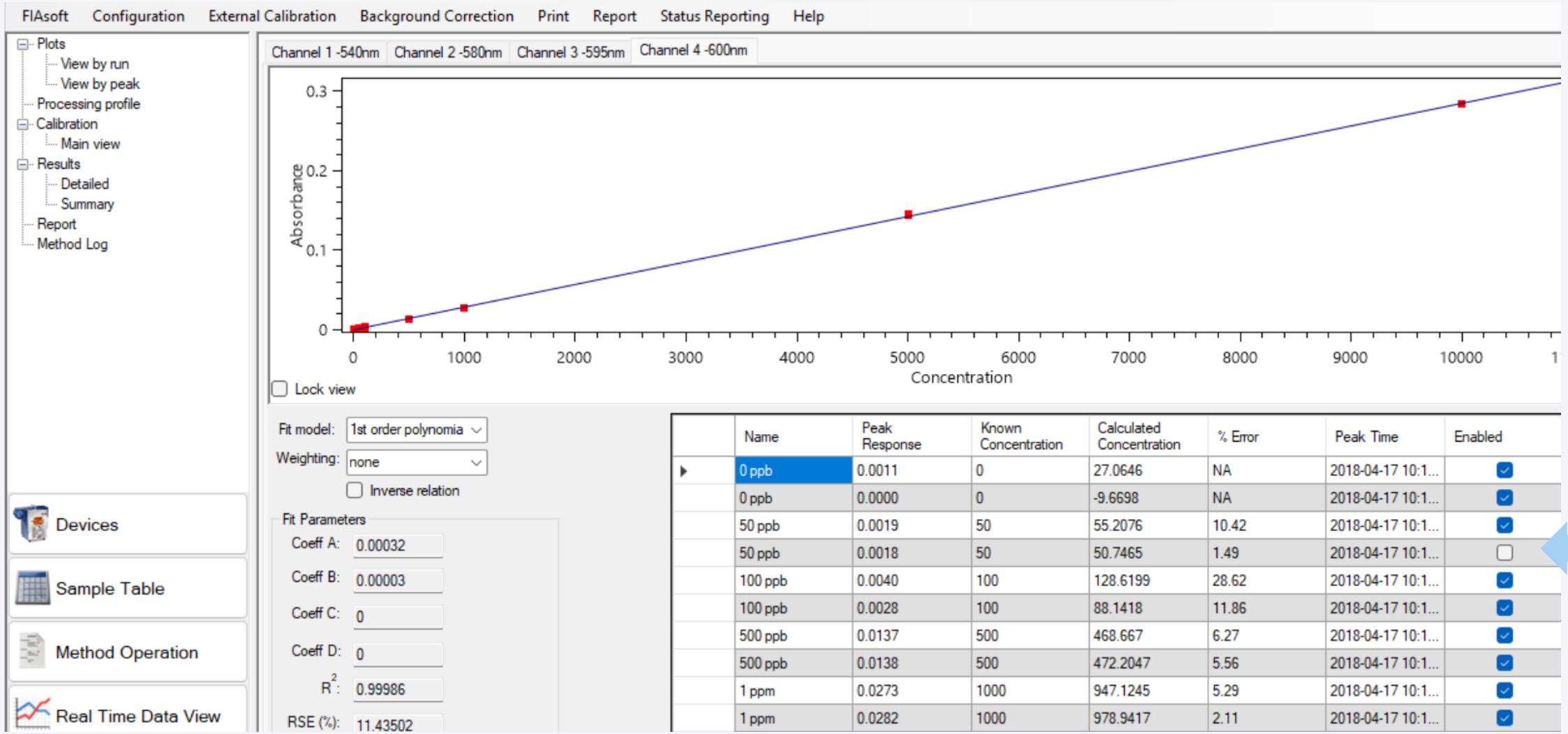
Weighting : None



Rerun Peak Detection

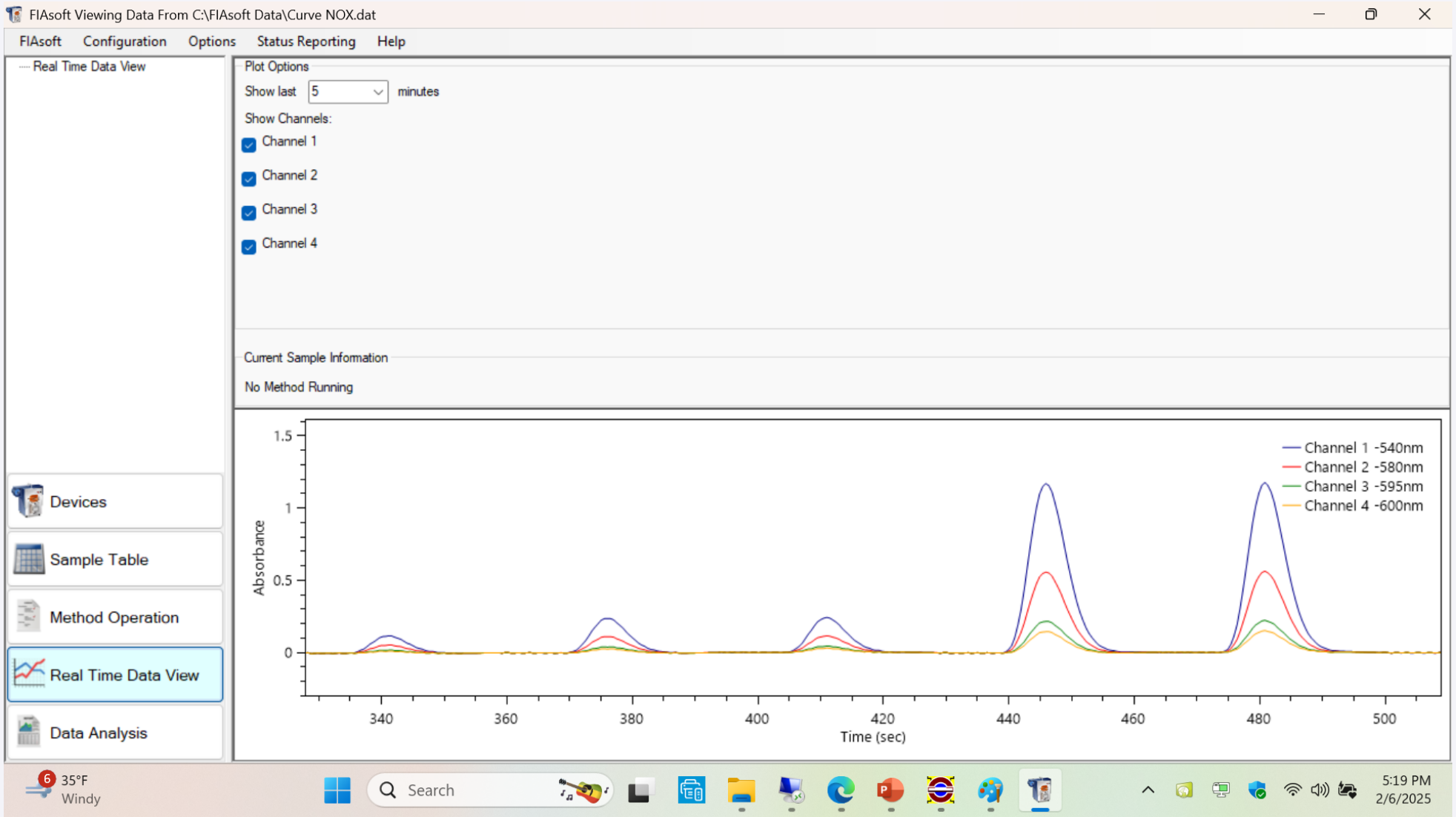


Click –While running

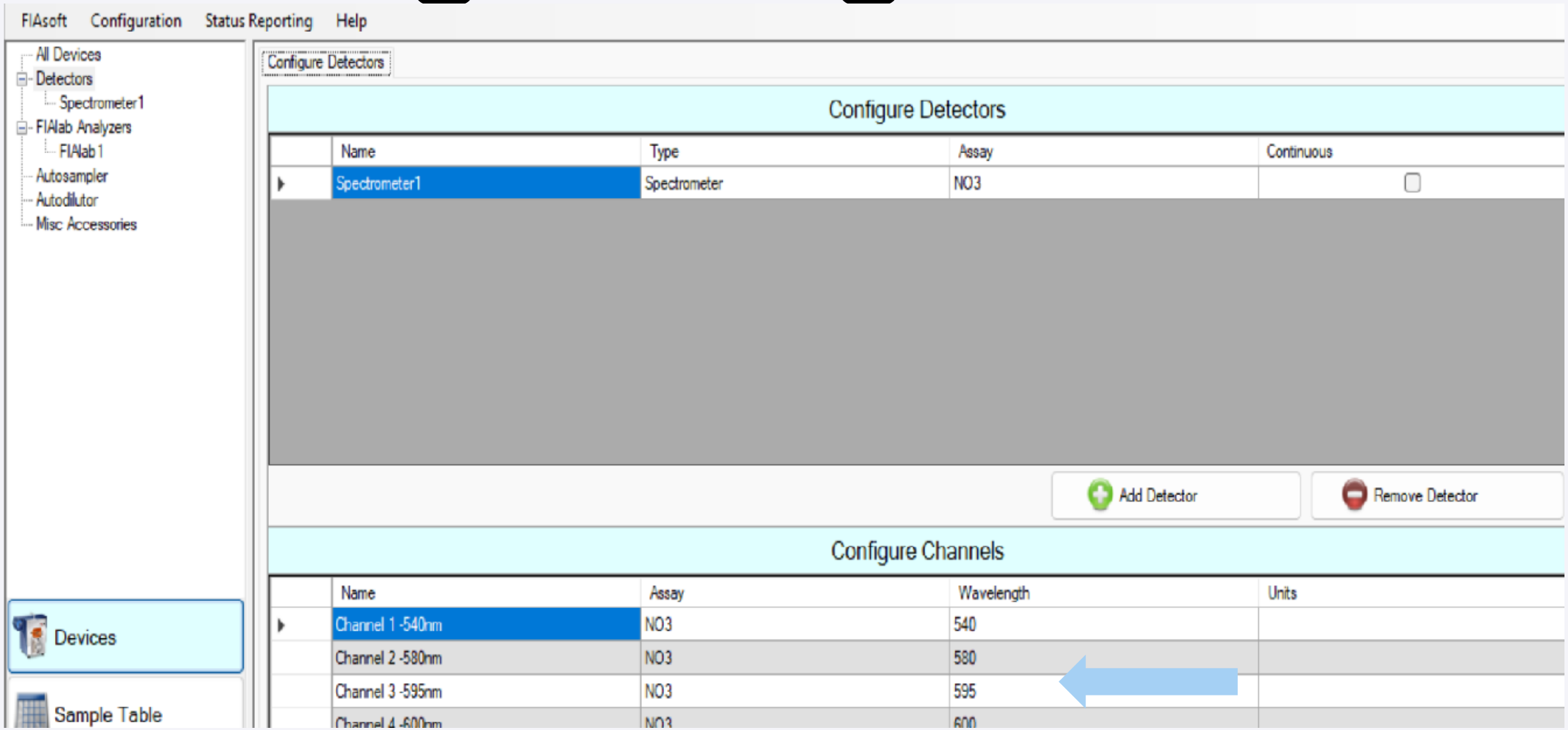


Name	Peak Response	Known Concentration	Calculated Concentration	% Error	Peak Time	Enabled
0 ppb	0.0011	0	27.0646	NA	2018-04-17 10:1...	☑
0 ppb	0.0000	0	-9.6698	NA	2018-04-17 10:1...	☑
50 ppb	0.0019	50	55.2076	10.42	2018-04-17 10:1...	☑
50 ppb	0.0018	50	50.7465	1.49	2018-04-17 10:1...	☐
100 ppb	0.0040	100	128.6199	28.62	2018-04-17 10:1...	☑
100 ppb	0.0028	100	88.1418	11.86	2018-04-17 10:1...	☑
500 ppb	0.0137	500	468.667	6.27	2018-04-17 10:1...	☑
500 ppb	0.0138	500	472.2047	5.56	2018-04-17 10:1...	☑
1 ppm	0.0273	1000	947.1245	5.29	2018-04-17 10:1...	☑
1 ppm	0.0282	1000	978.9417	2.11	2018-04-17 10:1...	☑

Wavelength Change



Wavelength Change-While running



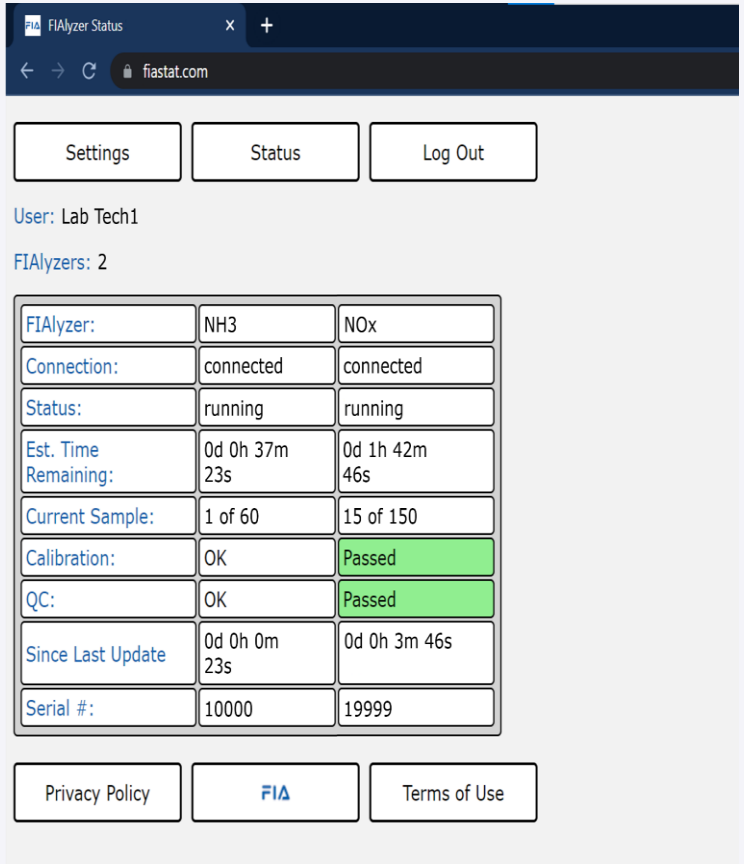
SOFTWARE

FIAsoft

- In house managed software by PhD chemists
- Easy load-in software configurations for chemistry switchovers
  - On-the-fly Analysis
  - Intuitive Quality Control
  - Full Spectrum Range
  - Compatible Data Management and Integration
  - Multilingual feature

FIAstat

- Free status webpage to link your run to a web browser
  - See runtime, if calibration/QC are passing
  - **Not available from any other competitor!**



FIASTAT-Real Time Monitoring

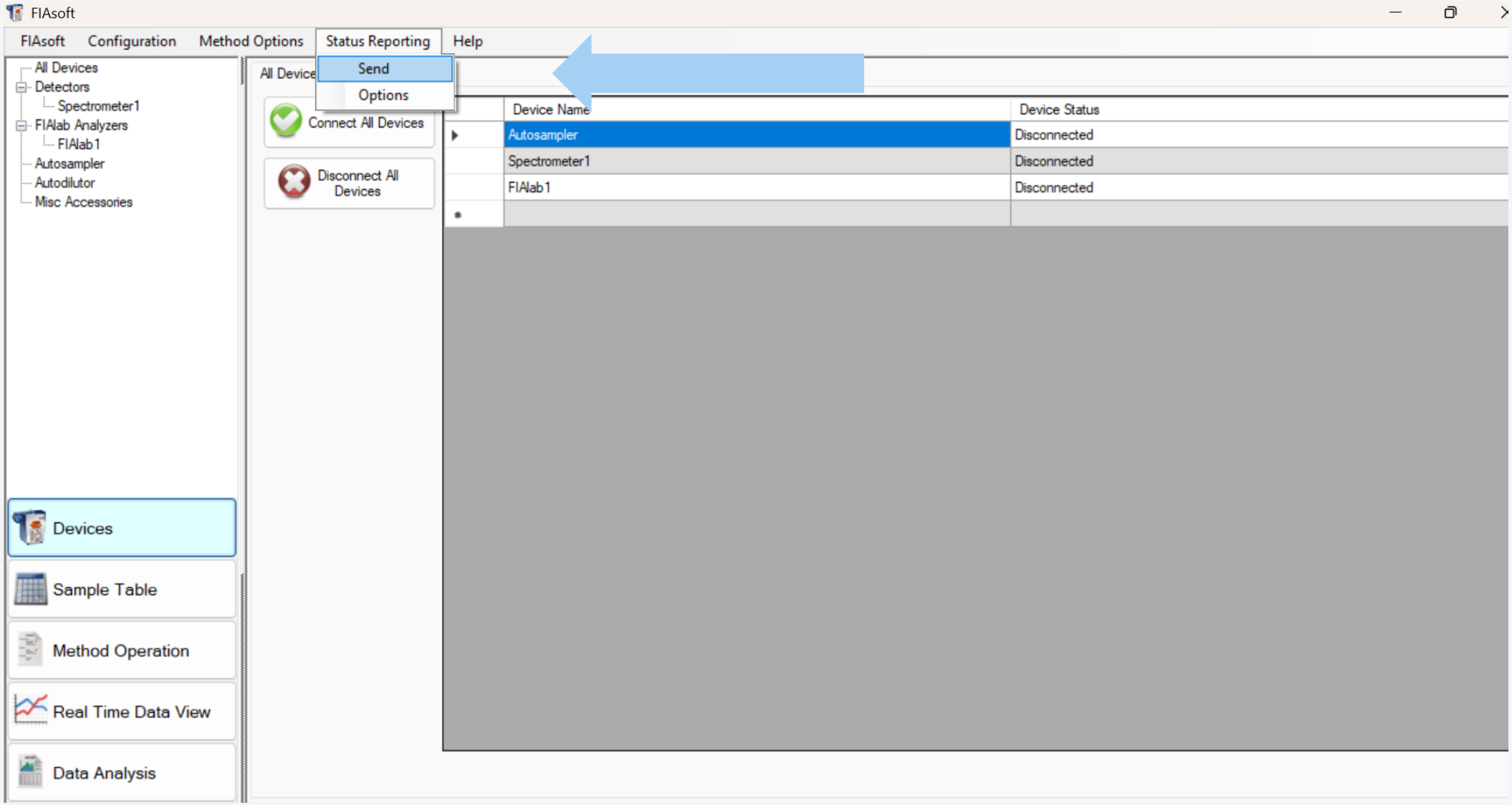
Settings | Status | Log Out

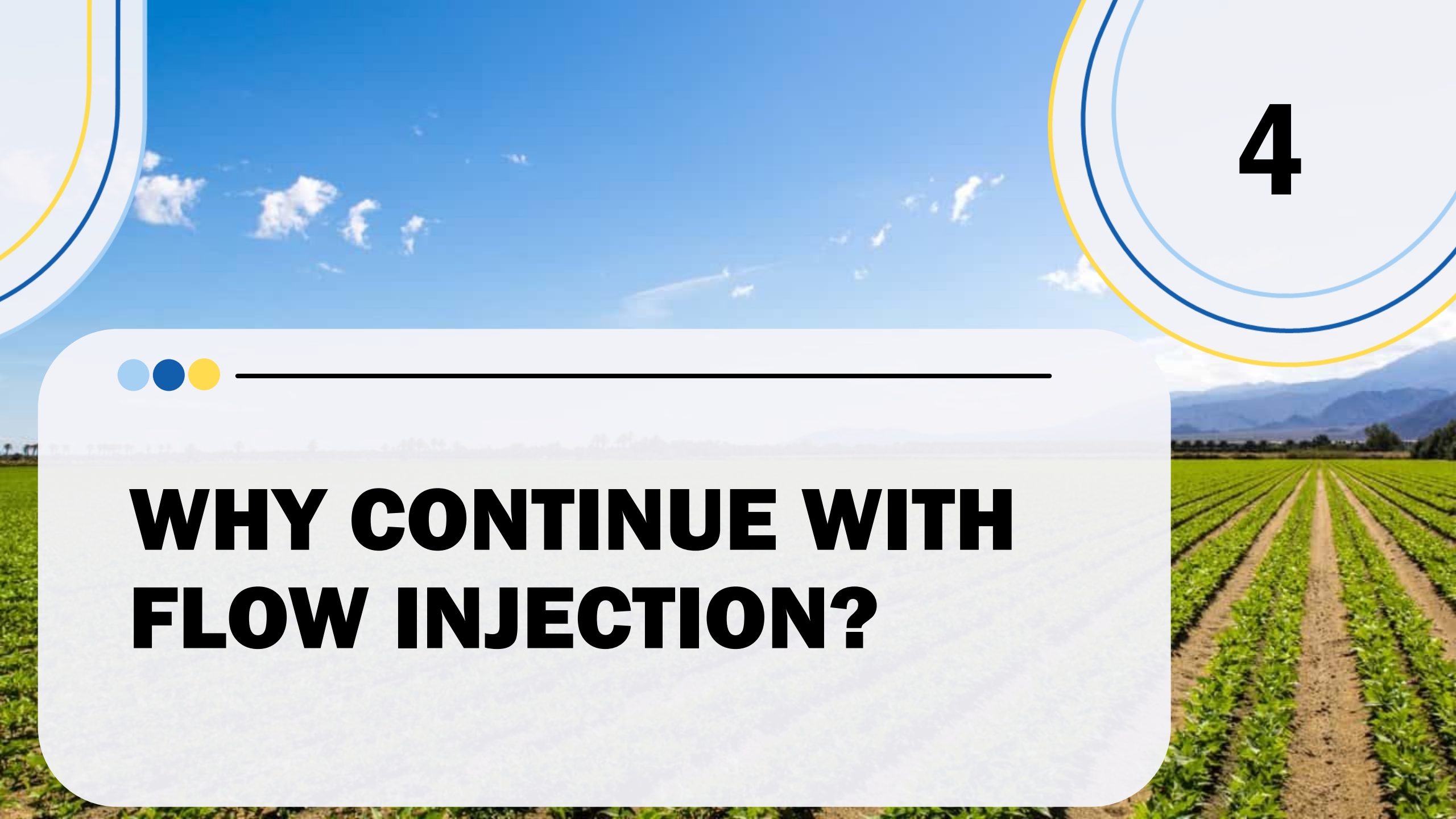
User: Demo

FIAlyzers: 6

FIAlyzer:	Demo	SCOTTS DEMO		Bens Demo		
Connection:	connected	connected		not connected		
Status:	idle	running		not connected		
Est. Time Remaining:				not connected		
Current Sample:	0 of 480	2 of 7	of	0 of 63	of	of
Calibration:	OK	OK		not connected		
QC:	OK	OK		not connected		
Since Last Update	0d 0h 0m 13s	11d 6h 35m 41s	11d 6h 27m 42s	0d 0h 0m 7s	346d 14h 52m 2s	346d 14h 51m 52s
Serial #:	29012	31563	31541	31609	30817	31022

FIASTAT-Real Time Monitoring



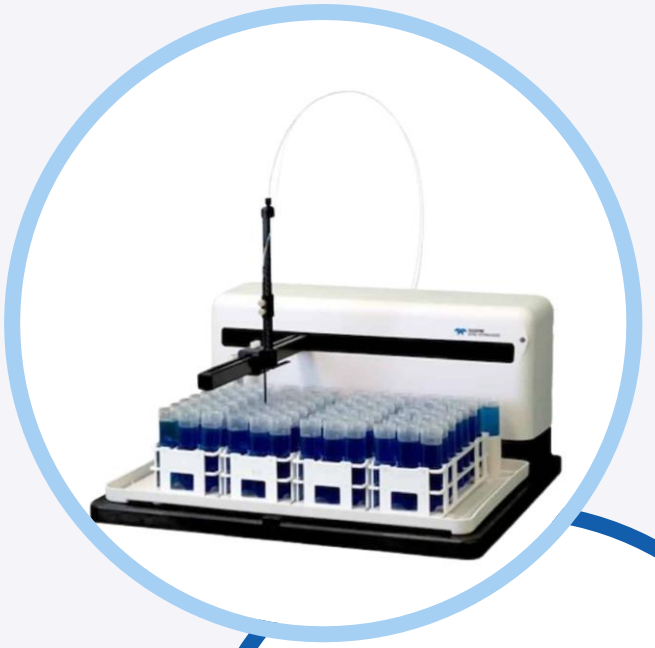


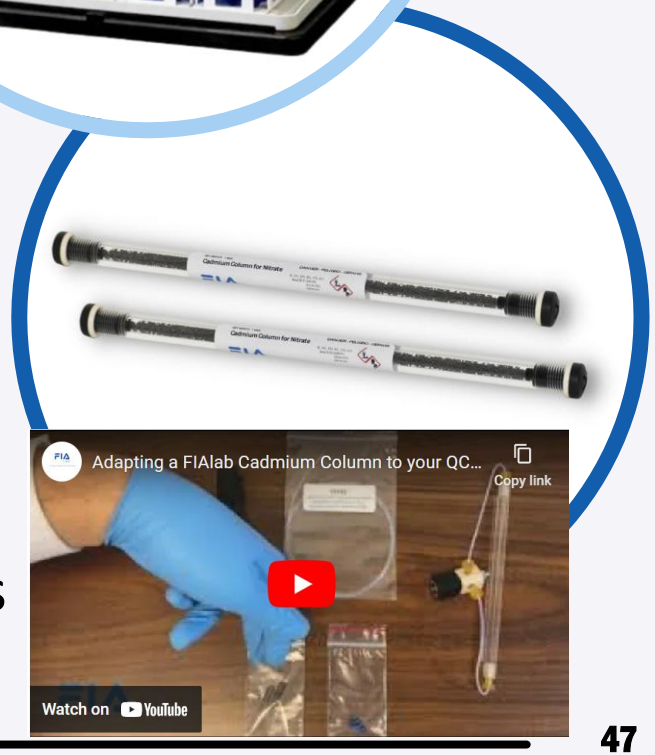
WHY CONTINUE WITH FLOW INJECTION?

Flow Injection Upgrade Path

SAVE from Loss of Investment

- Trade in on whole unit
- Autosamplers (AIM or CETAC)
- Cadmium Columns cross-compatible with QuikChem series
  - Add-on Lachat Adaption kit
  - Improved lead time and lower cost & longer shelf life
- Similar SOPs
  - NOx has almost identical reagents as QC 8500 methods





Flow Injection Advancements

1. Footprint
2. Spectrometer
3. Remote Troubleshooting-Online Applications
4. No O-rings
5. Software on current platform (C#)
6. Lab On Valve Design
7. Can buy and replace the rotor and align with software (LEAST MOVING PARTS AND LOWEST COST TO MAINTAIN)
8. Fastest up to 211 samples/Hour on our Fast Soil Phosphorus method in real time 1 channel

Flow Injection Advancement

1. Better Modular Design-KISS (keep it smart & simple) Less Failure & Less Clogs
2. Built High-Quality materials (not plastic QC8500 like the days of the QC8000)
3. Every Channel is a unique instrument which means redundancy 3X in a 3 channel (less down time to customer)
4. Flow Cells customize 1-10 cm (Lachat only had 1 & 2 cm)
5. LESS CLOGS! And easier to see if they happen in valve and fix
6. Selling Solutions - Service & Support Essential


THANK YOU