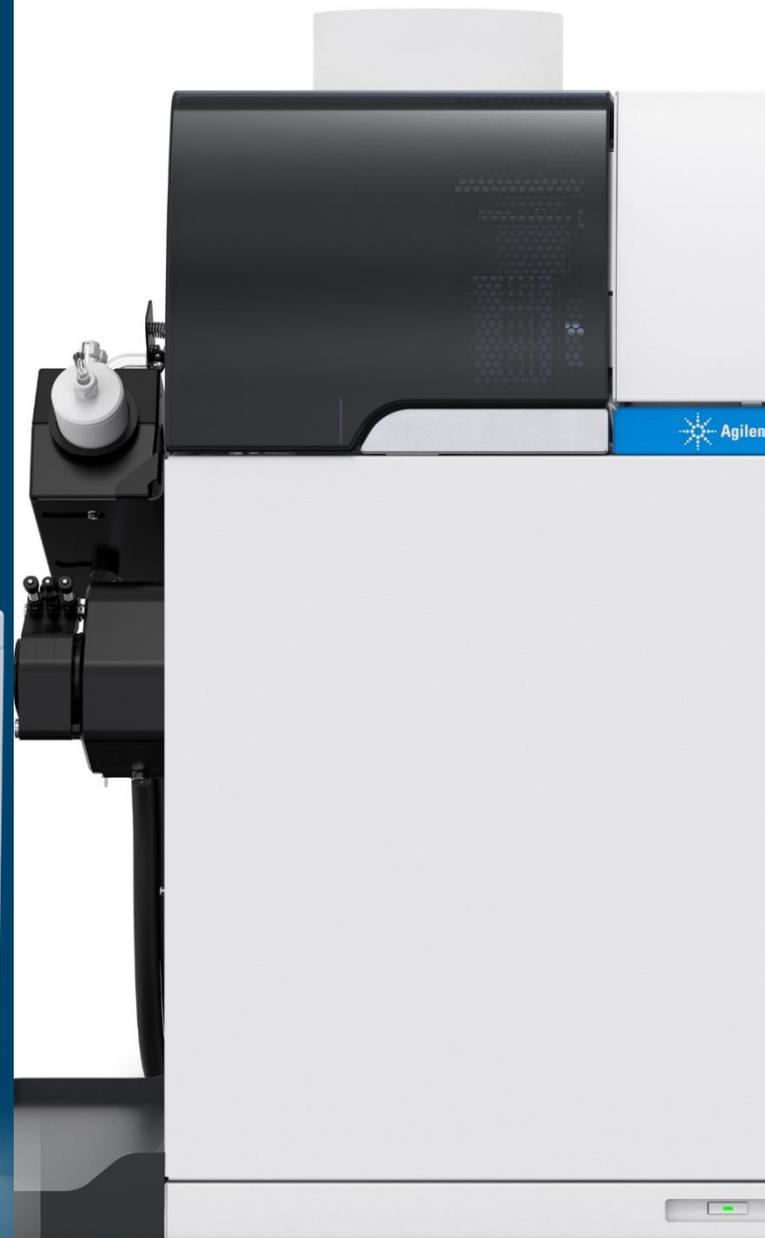


Improving Sample Throughput for Metals Analysis with Intelligent Automated Standard & Sample Introduction

Agilent Auto-Diluter System

Yan Cheung
Application Scientist, ICP-MS

DE24839864



Agilent ICP-MS Workflow

- Clamp tubing and make sure ventilation duct is turned on.
- Start Plasma.
 - This will turn on the chiller, start the plasma and run startup autotune.
- Create batch from template (or from existing batch).
- Edit sample list.
- Add the batch to the queue (start run)
 - This will optimize lenses, generate EPA tune report, analyze calibration standards, linearize the detector and analyze samples.
- Review data and print/export results.

Agilent ICP-MS Workflow

- Preparation of Calibration Standards !!!
- Calibration duct is turned on.
- Plasma and run startup
- (from existing batch).
- Edit sample list.
- Add the batch to the queue (start run)
 - This will optimize lenses, generate EPA tune report, analyze calibration standards, linearize the detector and analyze samples.
- Review data and print/export results.

Agilent ICP-MS Workflow

- Preparation of
- Calibration
- Standard
- Dilution of Samples Prior to Analysis!!!
- Edit sample
- Add the batch
 - This will optimize lenses, generate EPA tune report, analyze calibration standards, linearize the detector and analyze samples.
- Review data and print/export results.

lation duct is turned on.

run startup

batch).

Agilent ICP-MS Workflow

- Preparation of Calibration Standards
- Dilution of Samples Prior to Analysis
- Re-Analysis of Samples that Over-range!!!
- Edit sample parameters (e.g., dilution factor, integration time, etc.)
- Add the batch (e.g., sample name, concentration, etc.)
- This will optimize intense calibration standards, ICP-MS.
- Review data and print reports

lation duct is turned on.

run startup

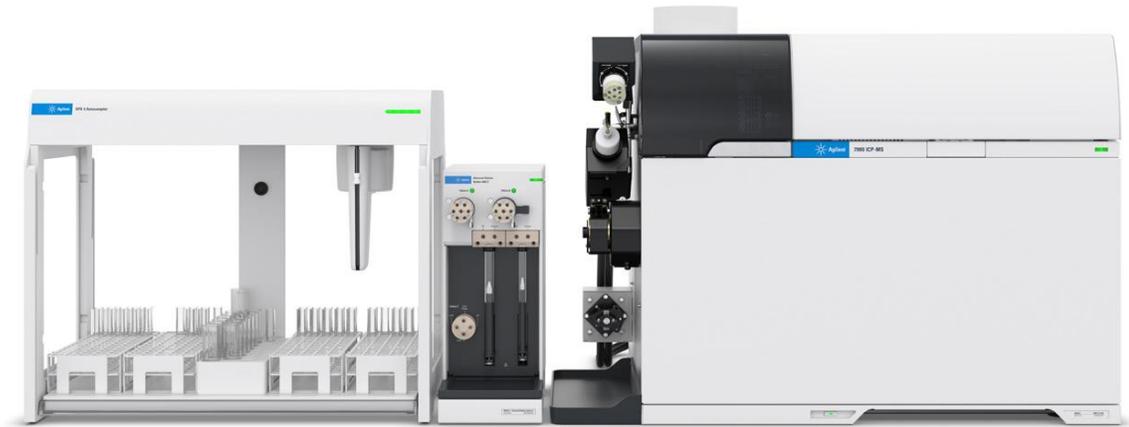
batch).

s.

Introducing the ADS2 Automatic Dilution System For Agilent ICP-OES and ICP-MS

- **Preparation of cal standards from cal stocks**
- **Pre-dilution of samples**
- **Auto-dilution of samples over cal range**

- **Free from human errors**
- **Kept from contaminations**
- **Traceability**
- **Single Vendor Solution/Support**



Agilent ICP-MS Automation System



Agilent ICP-OES Automation System

Less work. More flow.

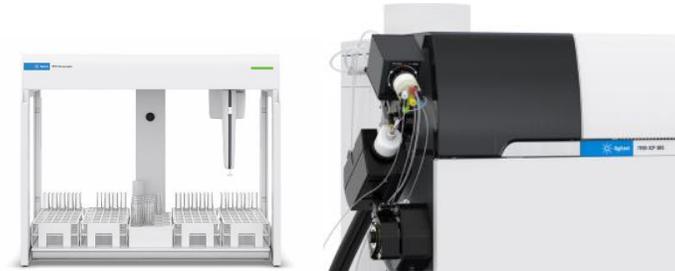
The Agilent ICP Workflow Automation Solution

- Addition of ADS 2 adds a new industry standard
 - Boosts throughput & free's up the Operator's time
 - Automates analysis dilution tasks
 - Further reduces TAT, cost/sample & human error



Agilent ICP-OES/-MS + SPS 4 + ADS 2

- High throughput labs have standardized on switching valve technology
 - AVS increase sample throughput – improves key metrics of Turn-Around Time (TAT) and cost/sample



Agilent ICP-OES/-MS + SPS 4 + AVS/AVS-MS

- Most routine labs are using autosamplers to introduce sample to the ICP

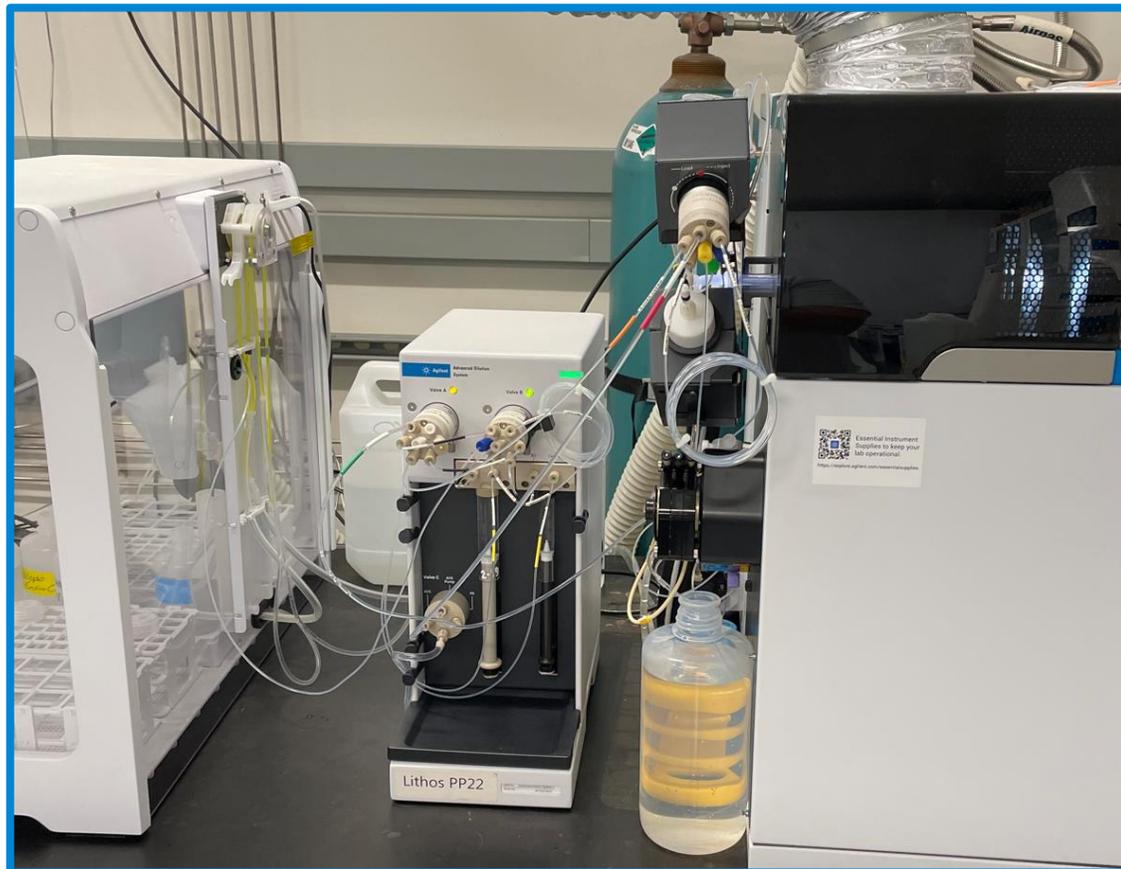


Agilent ICP-OES/-MS + SPS 4

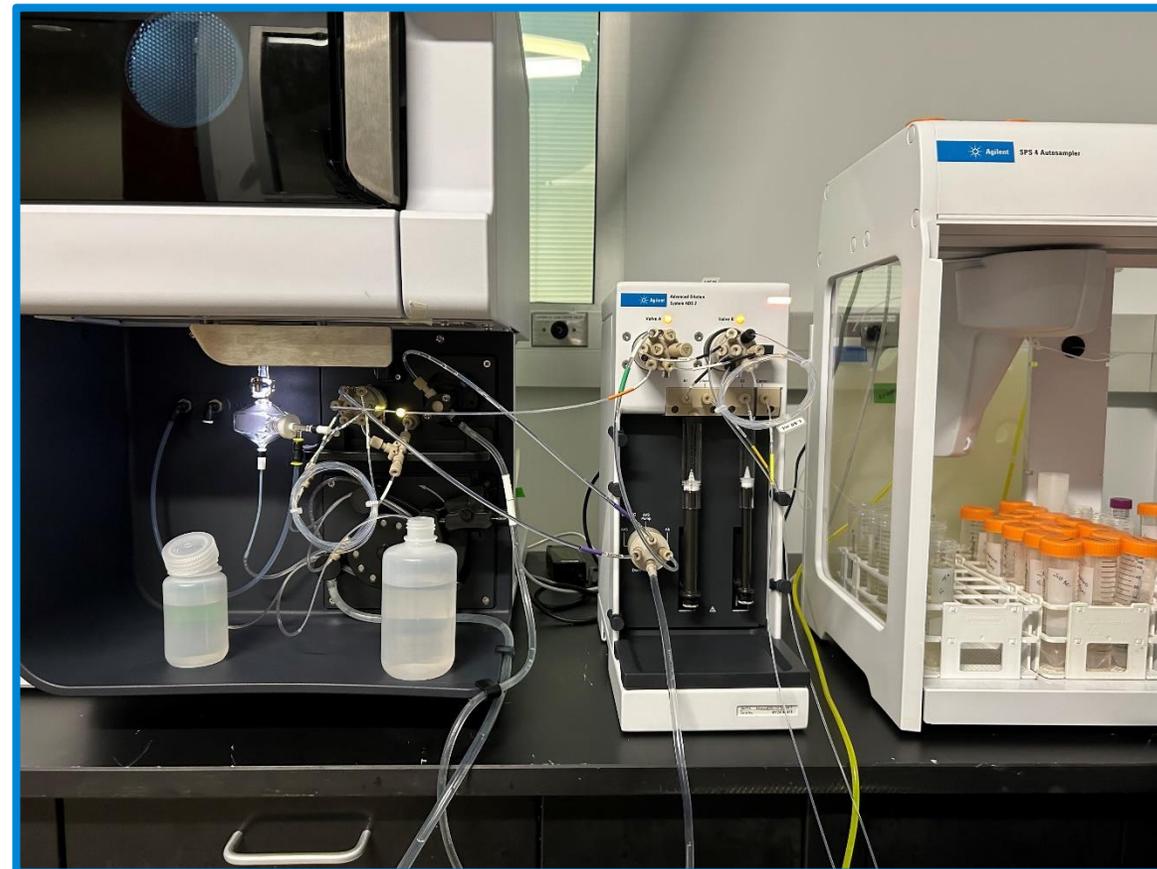
Increasing Level of Automation

ADS2 in Agilent Labs

Agilent 7850 ICP-MS + SPS4 + ADS2



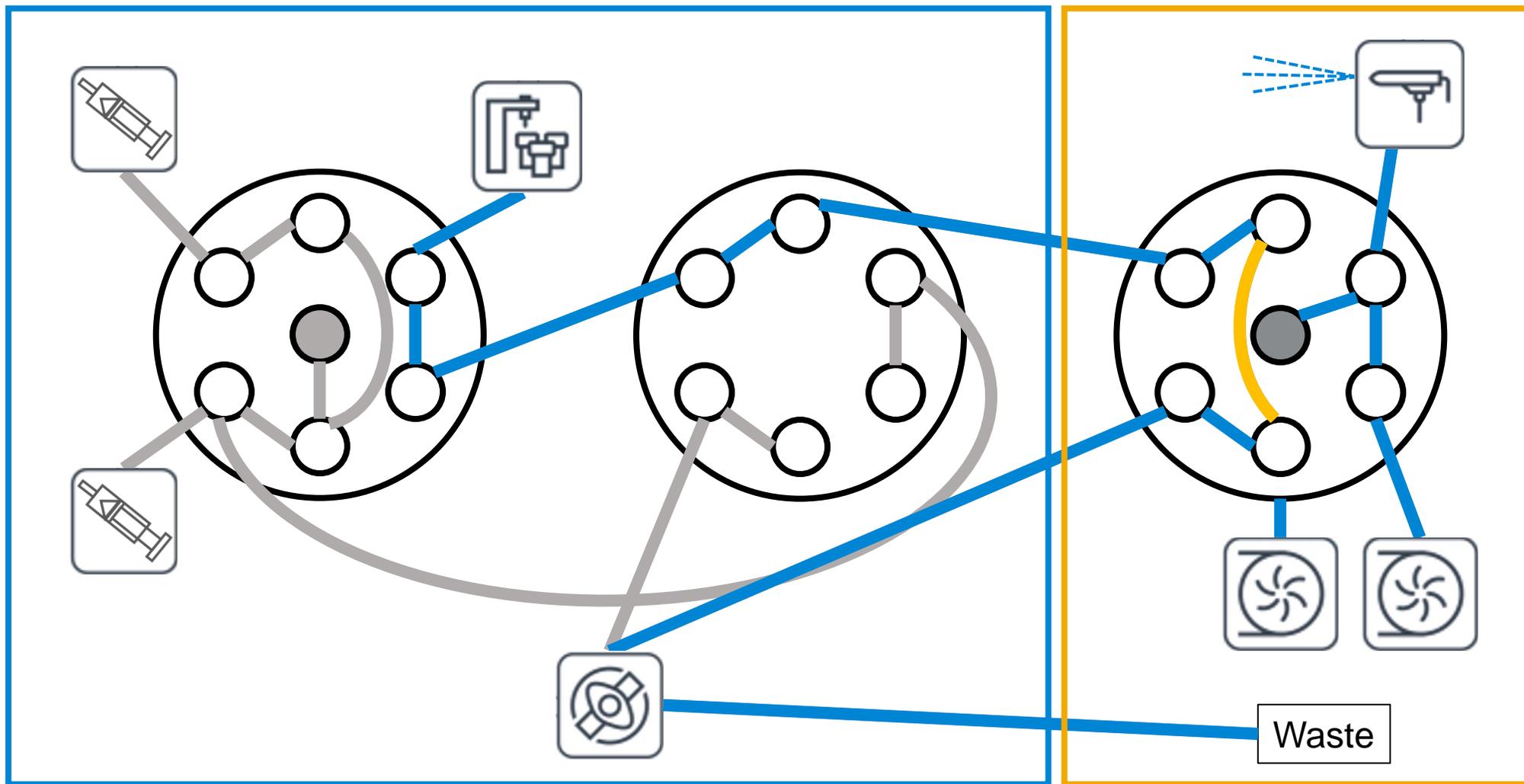
Agilent 5900 ICP-OES + SPS4 + ADS2



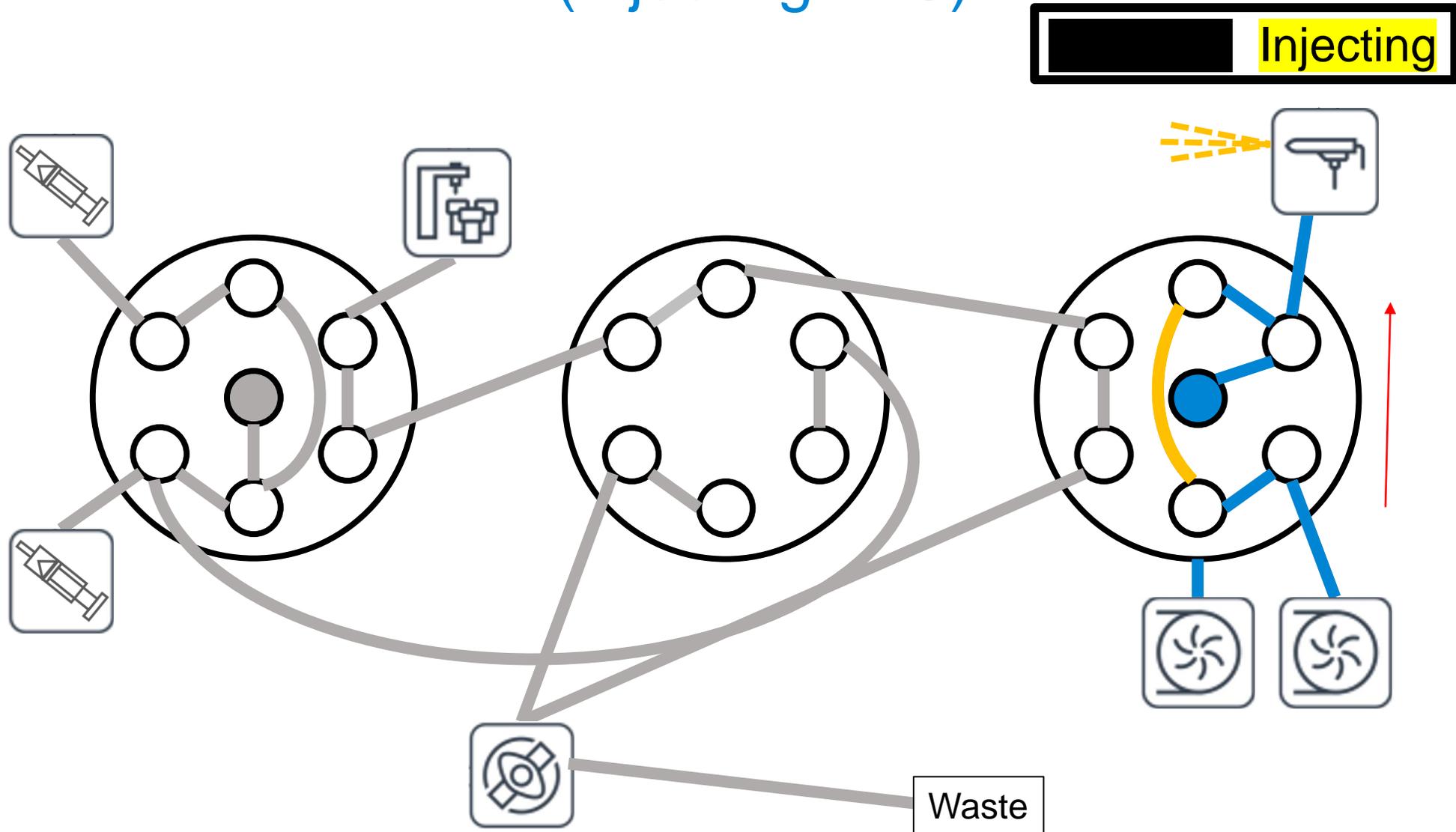
Simple Flow Diagram

ADS2

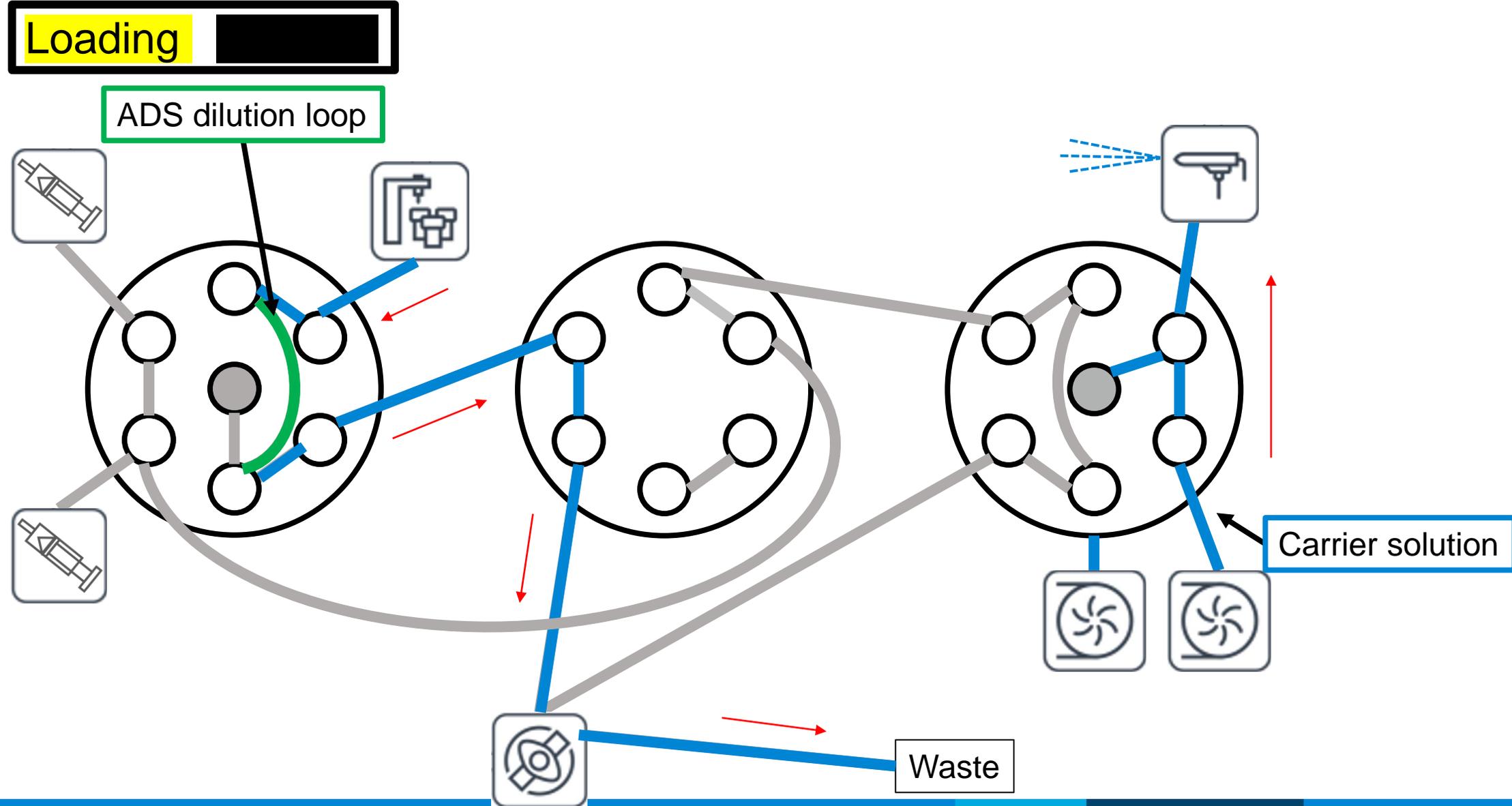
AVS-MS



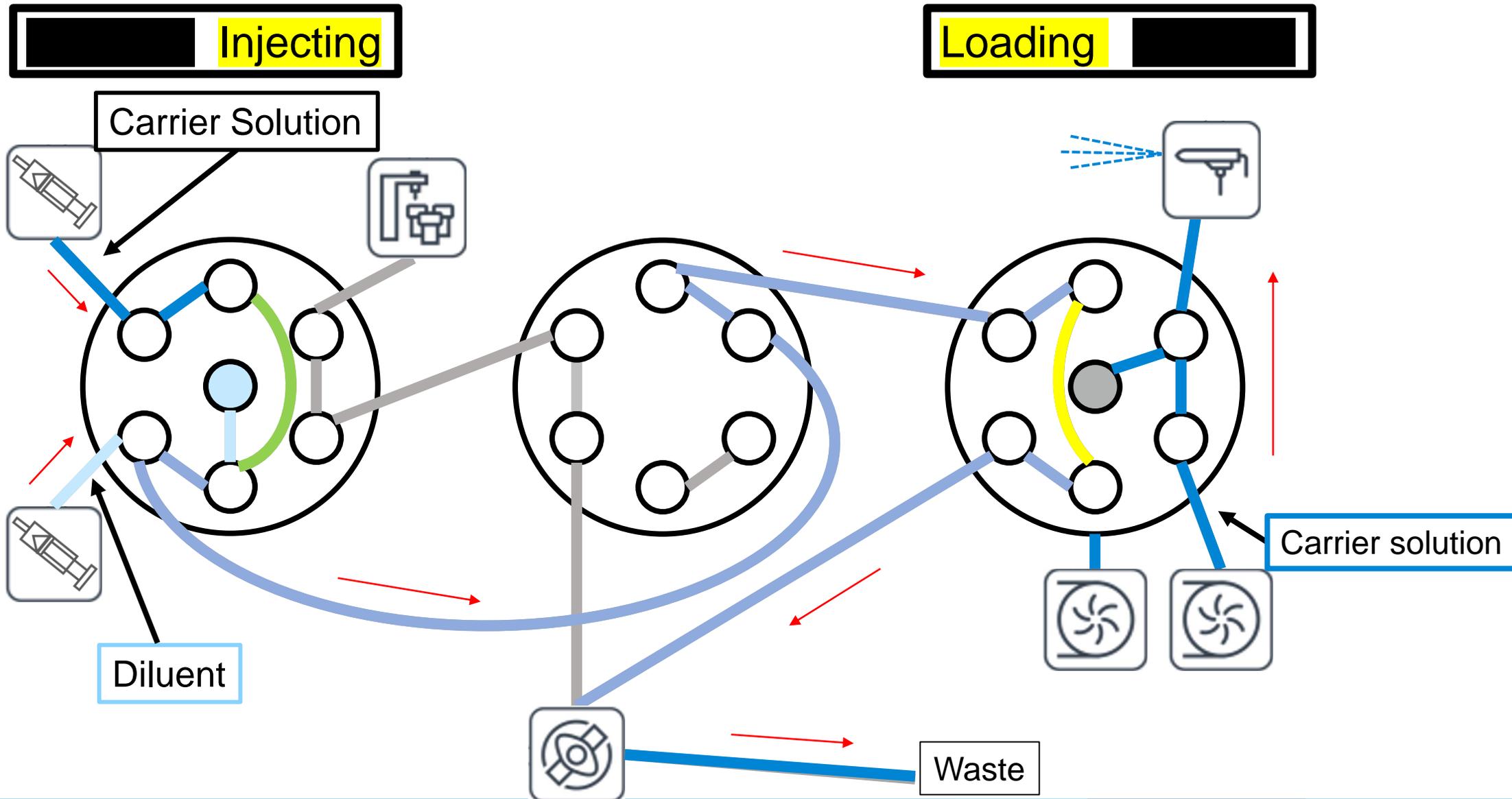
No Dilution Mode (Injecting AVS)



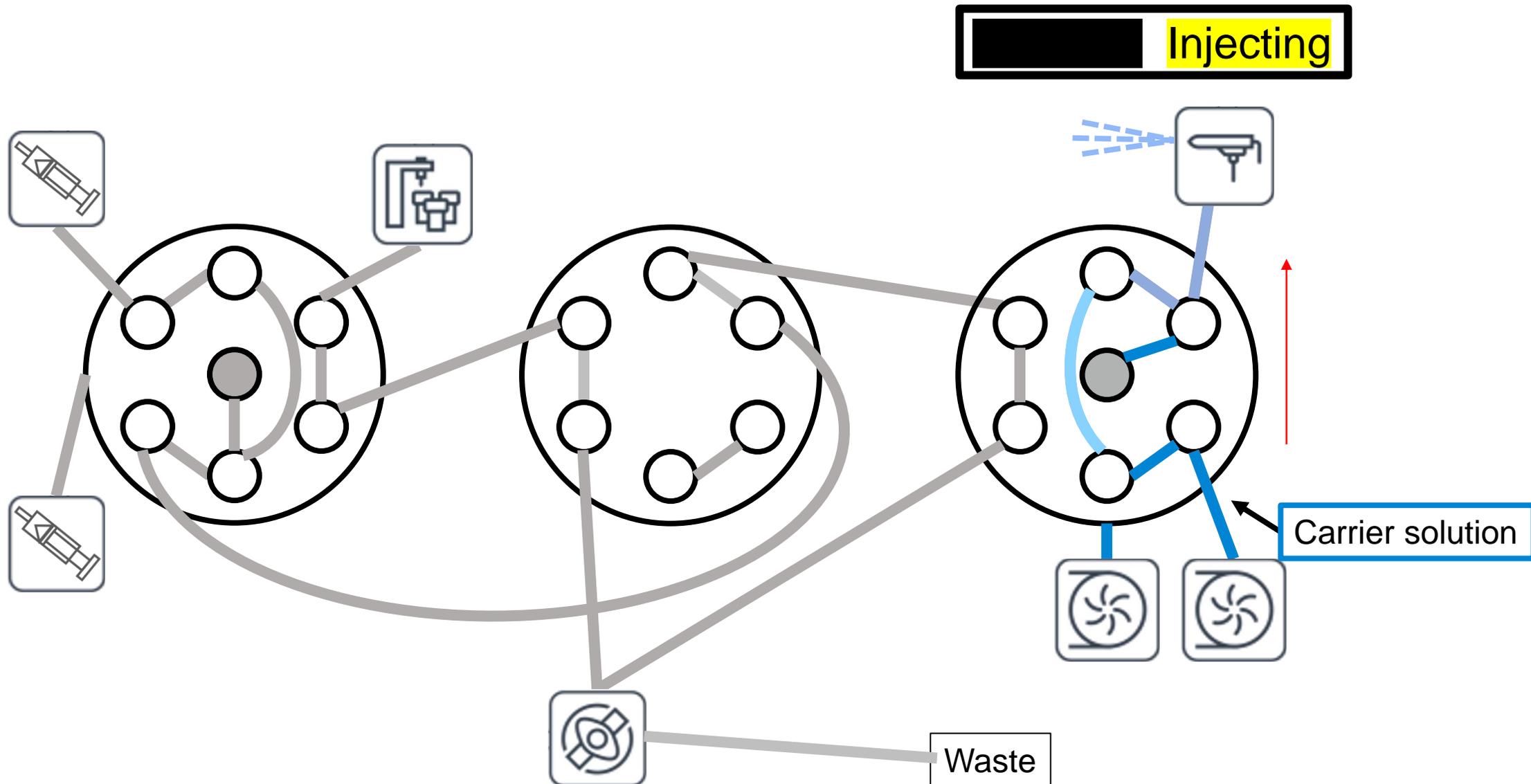
Dilution Mode (Loading the ADS dilution loop)



Dilution Mode (Diluting the sample and loading AVS loop)



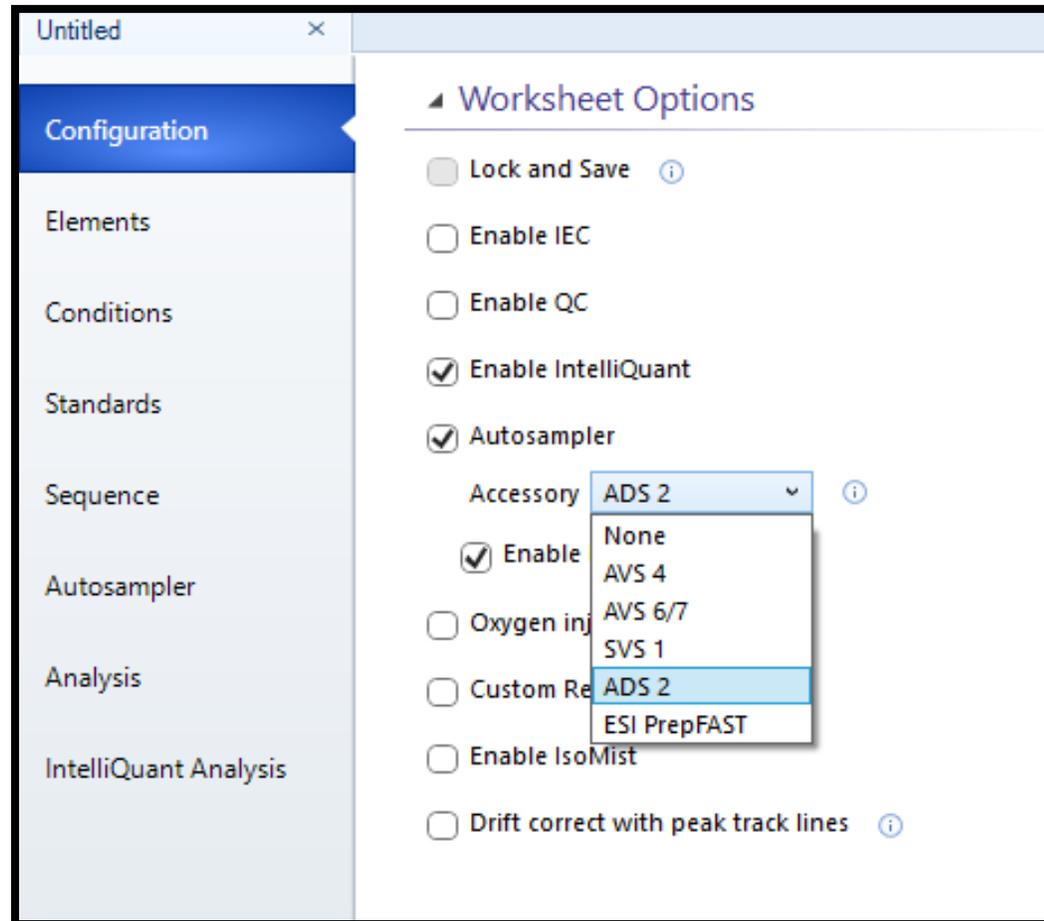
Dilution Mode (Injecting the diluted sample)



ADS2 Software Fully Integrated with Agilent Atomic Instruments

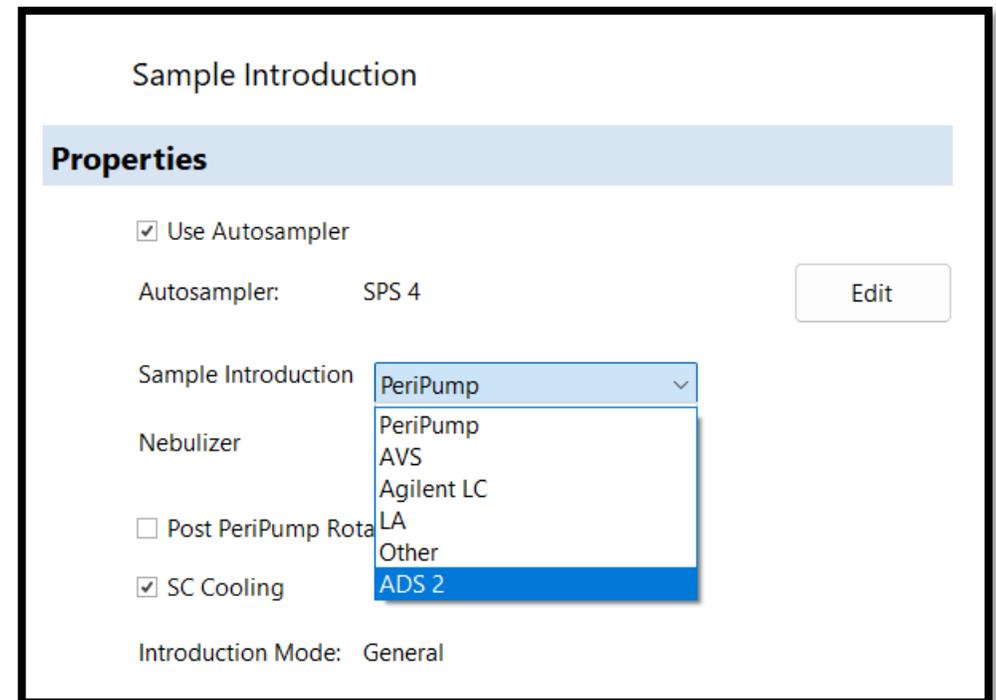
ICP Expert 7.7

MassHunter 5.3



The screenshot shows the 'Configuration' window in ICP Expert 7.7. The left sidebar contains a menu with the following items: Configuration (selected), Elements, Conditions, Standards, Sequence, Autosampler, Analysis, and IntelliQuant Analysis. The main area is titled 'Worksheet Options' and contains several settings:

- Lock and Save ⓘ
- Enable IEC
- Enable QC
- Enable IntelliQuant
- Autosampler
 - Accessory: ADS 2 ⓘ (dropdown menu is open showing: None, AVS 4, AVS 6/7, SVS 1, ADS 2, ESI PrepFAST)
 - Enable
- Oxygen inj
- Custom Re
- Enable IsoMist
- Drift correct with peak track lines ⓘ



The screenshot shows the 'Sample Introduction' window in MassHunter 5.3. The 'Properties' section is active and displays the following settings:

- Use Autosampler
 - Autosampler: SPS 4 (with an 'Edit' button)
- Sample Introduction: PeriPump (dropdown menu is open showing: PeriPump, AVS, Agilent LC, LA, Other, ADS 2)
- Nebulizer: (dropdown menu is open showing: PeriPump, AVS, Agilent LC, LA, Other, ADS 2)
- Post PeriPump Rota
- SC Cooling
- Introduction Mode: General

Batch - Atomic talk ADS2 4-19.b

DA Method Task: Advanced Calibration Setup Autocalibration Assistant Reload Elements Load List From Acquired Data Add Analyte Remove Analyte Add/Remove Columns

Calibration Parameters			
Calibration Title	Calibration Method	Edit ISTD Conc	Virtual ISTD Correction
▶	External Calibration	<input type="checkbox"/>	<input type="checkbox"/>

	Tune Mo...	Ma...	N...	Curve Fit	Analyte					Level								QC1	QC2	
					Origin	ISTD	Min Conc.	Units	Outlier	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8			
1	▶ 1: He	7	Li	Linear	Blank offset	6	<None>	ppb	<input checked="" type="checkbox"/>	0	0	0	0	0	0	0	0	0		
2	1: He	23	Na	Linear	Blank offset	45	<None>	ppb	<input checked="" type="checkbox"/>	0	25	100	1000	10000	0	0	0			
3	1: He	24	Mg	Linear	Blank offset	72	<None>	ppb	<input checked="" type="checkbox"/>	0	25	100	1000	10000	0	0	0			
4	1: He	27	Al	Linear	Blank offset	72	<None>	ppb	<input checked="" type="checkbox"/>	0	0.25	1	10	100	0	0	0			

ISTD				
	Tune Mo...	Ma...	N...	Outlier
1	▶ 1: He	6	Li	<input checked="" type="checkbox"/>
2	1: He	45	Sc	<input checked="" type="checkbox"/>
3	1: He	72	Ge	<input checked="" type="checkbox"/>
4	1: He	115	In	<input checked="" type="checkbox"/>
5	1: He	159	Tb	<input checked="" type="checkbox"/>
6	1: He	209	Bi	<input checked="" type="checkbox"/>

Autocalibration Assistant

Autocalibration Assistant

Solution: 5183-4688 Concentration Unit: mg/L

Stock Name	Ag	Al	As	Ba	Be	Ca	Cd	C
5183-4688	10	10	10	10	10	1000	10	10
Envr Cal Int	0.1	0.1	0.1	0.1	0.1	10	0.1	0.1
Hg stock	0	0	0	0	0	0	0	0

Dilution Factor to Level

	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
Dilution Factor		400	100	10	1	400	200	100
Stock Solution	CalBIK	Envr Cal Int	Envr Cal Int	Envr Cal Int	Envr Cal Int	Hg stock	Hg stock	Hg stock

Apply Cancel

Set up calibration stocks
(only need to perform once)

Autocalibration Assistant

Solution: 5183-4688 Concentration Unit: mg/L

Stock Name	Ag	Al	As	Ba	Be	Ca	Cd	C
5183-4688	10	10	10	10	10	1000	10	10
Envr Cal Int	0.1	0.1	0.1	0.1	0.1	10	0.1	0.1
Hg stock	0	0	0	0	0	0	0	0

Dilution Factor to Level

	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
Dilution Factor		400	100	10	1	400	200	100
Stock Solution	CalBIK	Envr Cal Int	Envr Cal Int	Envr Cal Int	Envr Cal Int	Hg stock	Hg stock	Hg stock

Apply Cancel

Set up calibration Levels
(only need to perform once for each batch)

Batch - Atomic talk ADS2 4-19.b

DA Method Task: Advanced Calibration Setup | Autocalibration Assistant | Reload Elements | Load List From Acquired Data | Add Analyte | Remove Analyte | Add/Remove Columns

Calibration Parameters			
Calibration Title	Calibration Method	Edit ISTD Conc	Virtual ISTD Correction
▶	External Calibration	<input type="checkbox"/>	<input type="checkbox"/>

	Analyte									Level								
	Tune Mo...	Ma...	N...	Curve Fit	Origin	ISTD	Min Conc.	Units	Outlier	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	QC1
17	1: He	107	Ag	Linear	Blank offset	115	<None>	ppb	<input checked="" type="checkbox"/>	0	0.25	1	10	100	0	0	0	
18	1: He	111	Cd	Linear	Blank offset	115	<None>	ppb	<input checked="" type="checkbox"/>	0	0.25	1	10	100	0	0	0	
19	1: He	123	Sb	Linear	Blank offset	115	<None>	ppb	<input checked="" type="checkbox"/>	0	0.25	1	10	100	0	0	0	
20	1: He	135	Ba	Linear	Blank offset	115	<None>	ppb	<input checked="" type="checkbox"/>	0	0.25	1	10	100	0	0	0	
21	1: He	201	Hg	Linear	Blank offset	159	<None>	ppb	<input checked="" type="checkbox"/>	0	0	0	0	0	0.25	0.5	1	
22	1: He	205	Tl	Linear	Blank offset	209	<None>	ppb	<input checked="" type="checkbox"/>	0	0.25	1	10	100	0	0	0	
23	1: He	206	[Pb]	Linear	Blank offset	209	<None>	ppb	<input checked="" type="checkbox"/>	0	0.25	1	10	100	0	0	0	
24	1: He	207	[Pb]	Linear	Blank offset	209	<None>	ppb	<input checked="" type="checkbox"/>	0	0.25	1	10	100	0	0	0	
25	1: He	208	Pb	Linear	Blank offset	209	<None>	ppb	<input checked="" type="checkbox"/>	0	0.25	1	10	100	0	0	0	

Calibration table is auto-populated
(only need to perform once for each batch)

Batch - Atomic talk ADS2 4-19.b

Use Block List Import Sample List Add/Remove Columns

Estimated Time for Batch Acquisition: 1361.000 sec

	Skip	Sample Type	Sample Name	Vial#	Level	Total Dil.	Autodilution
1	<input type="checkbox"/>	Sample	Rinse	1			
2	<input type="checkbox"/>	CalBlk	Cal blk	1	Level 1	1.0000	
3	<input type="checkbox"/>	CalBlk	Cal blk	1	Level 1	1.0000	
4	<input type="checkbox"/>	CalStd	Std 0.25 ppb	4	Level 2	400.0000	400.00
5	<input type="checkbox"/>	CalStd	Std 1 ppb	4	Level 3	100.0000	100.00
6	<input type="checkbox"/>	CalStd	Std 10 ppb	4	Level 4	10.0000	10.00
7	<input type="checkbox"/>	CalStd	Std 100 ppb	4	Level 5	1.0000	1.00
8	<input type="checkbox"/>	CalStd	Hg 0.25 ppb	1101	Level 6	400.0000	400.00
9	<input type="checkbox"/>	CalStd	Hg 0.5 ppb	1101	Level 7	200.0000	200.00
10	<input type="checkbox"/>	CalStd	Hg 1 ppb	1101	Level 8	100.0000	100.00
11	<input type="checkbox"/>	Sample	Rinse	1			
12	<input type="checkbox"/>	Sample	Unknown 1ppm	4104		9.0000	9.00
13	<input type="checkbox"/>						

Add cal blanks and calibration levels

Batch - Atomic talk ADS2 4-19.b

Use Block List Import Sample List Add/Remove Columns

Estimated Time for Batch Acquisition: 1361.000 sec

	Skip	Sample Type	Sample Name	Vial#	Level	Total Dil.	Autodilution
1	<input type="checkbox"/>	Sample	Rinse	1			
2	<input type="checkbox"/>	CalBlk	Cal blk	1	Level 1	1.0000	
3	<input type="checkbox"/>	CalBlk	Cal blk	1	Level 1	1.0000	
4	<input type="checkbox"/>	CalStd	Std 0.25 ppb	4	Level 2	400.0000	400.00
5	<input type="checkbox"/>	CalStd	Std 1 ppb	4	Level 3	100.0000	100.00
6	<input type="checkbox"/>	CalStd	Std 10 ppb	4	Level 4	10.0000	10.00
7	<input type="checkbox"/>	CalStd	Std 100 ppb	4	Level 5	1.0000	1.00
8	<input type="checkbox"/>	CalStd	Hg 0.25 ppb	1101	Level 6	400.0000	400.00
9	<input type="checkbox"/>	CalStd	Hg 0.5 ppb	1101	Level 7	200.0000	200.00
10	<input type="checkbox"/>	CalStd	Hg 1 ppb	1101	Level 8	100.0000	100.00
11	<input type="checkbox"/>	Sample	Rinse	1			
12	<input type="checkbox"/>	Sample	Unknown 1ppm	4104		9.0000	9.00
13	<input type="checkbox"/>						

Only three vials needed!

Batch - Atomic talk ADS2 4-19.b

Use Block List Import Sample List Add/Remove Columns

Estimated Time for Batch Acquisition: 1361.000 sec

	Skip	Sample Type	Sample Name	Vial#	Level	Total Dil.	Autodilution
1	<input type="checkbox"/>	Sample	Rinse	1			
2	<input type="checkbox"/>	CalBlk	Cal blk	1	Level 1	1.0000	
3	<input type="checkbox"/>	CalBlk	Cal blk	1	Level 1	1.0000	
4	<input type="checkbox"/>	CalStd	Std 0.25 ppb	4	Level 2	400.0000	400.00
5	<input type="checkbox"/>	CalStd	Std 1 ppb	4	Level 3	100.0000	100.00
6	<input type="checkbox"/>	CalStd	Std 10 ppb	4	Level 4	10.0000	10.00
7	<input type="checkbox"/>	CalStd	Std 100 ppb	4	Level 5	1.0000	1.00
8	<input type="checkbox"/>	CalStd	Hg 0.25 ppb	1101	Level 6	400.0000	400.00
9	<input type="checkbox"/>	CalStd	Hg 0.5 ppb	1101	Level 7	200.0000	200.00
10	<input type="checkbox"/>	CalStd	Hg 1 ppb	1101	Level 8	100.0000	100.00
11	<input type="checkbox"/>	Sample	Rinse	1			
12	<input type="checkbox"/>	Sample	Unknown 1ppm	4104		9.0000	9.00
13	<input type="checkbox"/>						

Autodilution factors are auto-populated once levels are entered

Batch - Atomic talk ADS2 4-19.b

Use Block List Import Sample List Add/Remove Columns

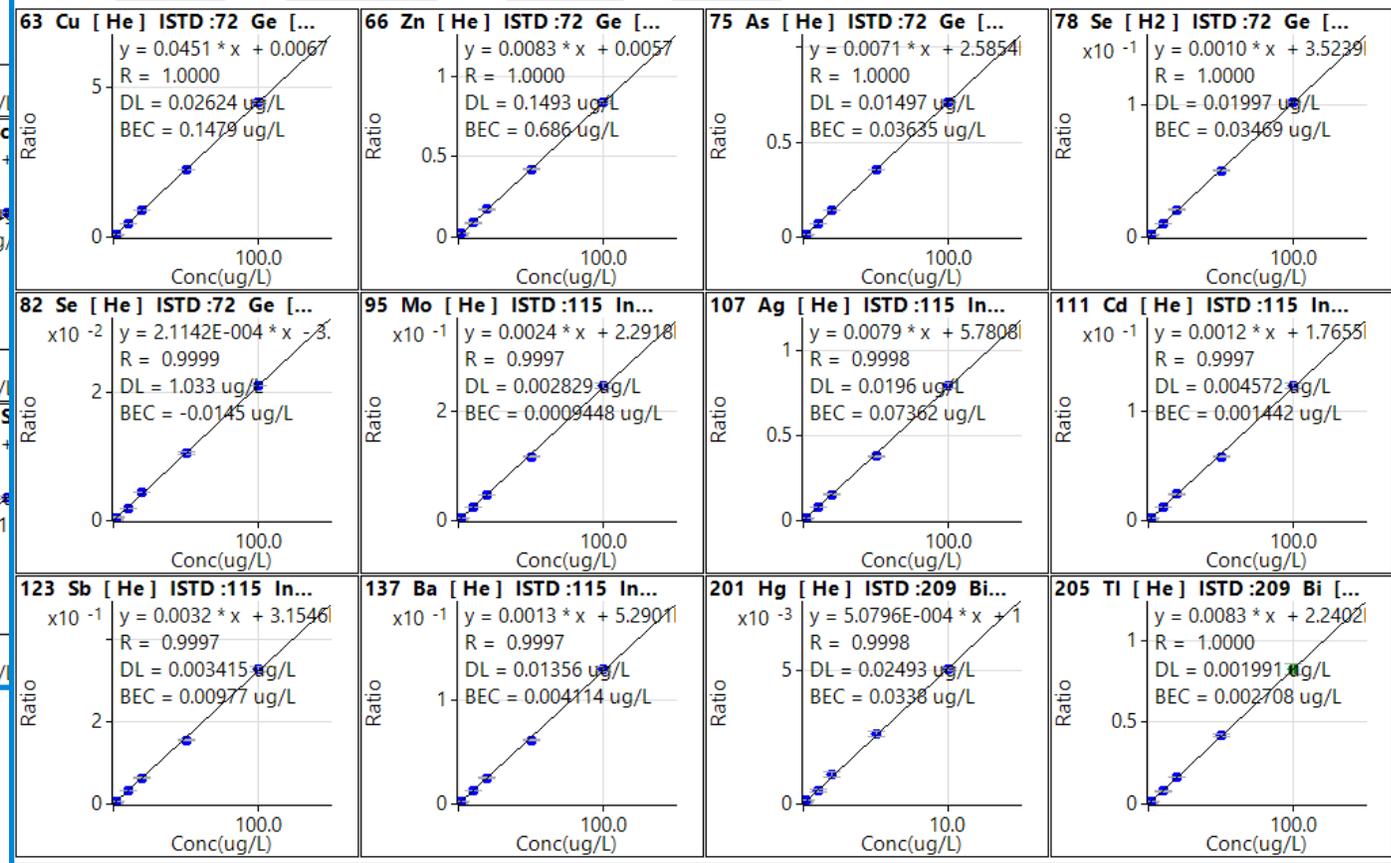
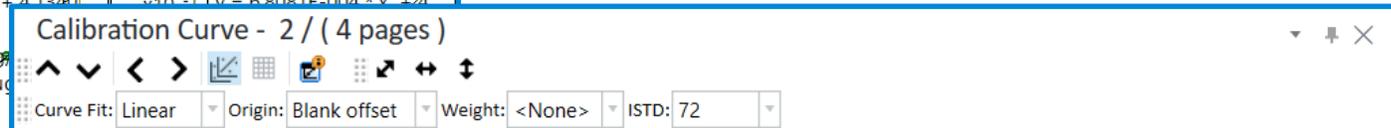
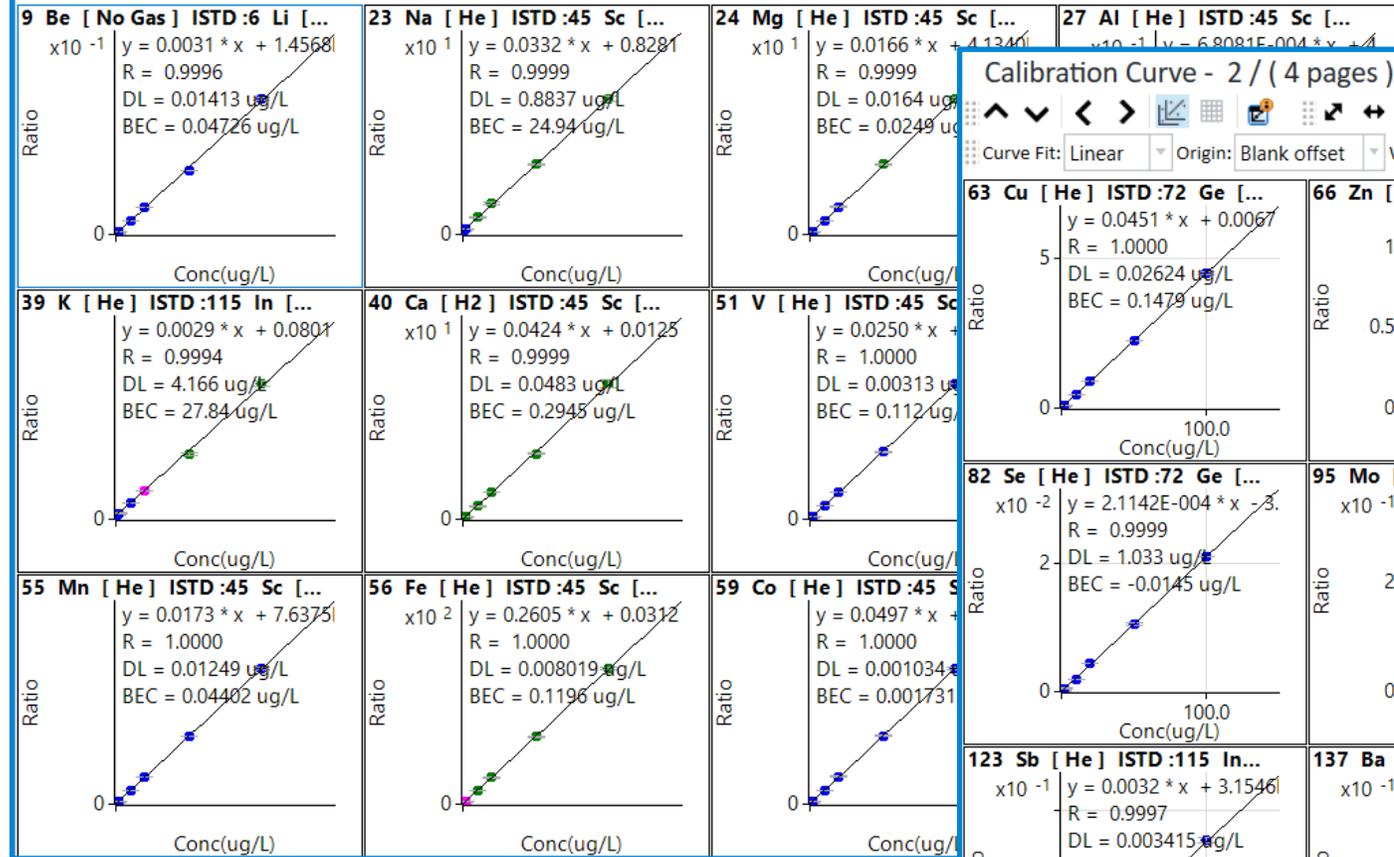
Estimated Time for Batch Acquisition: 1361.000 sec

	Skip	Sample Type	Sample Name	Vial#	Level	Total Dil.	Autodilution
1	<input type="checkbox"/>	Sample	Rinse	1			
2	<input type="checkbox"/>	CalBlk	Cal blk	1	Level 1	1.0000	
3	<input type="checkbox"/>	CalBlk	Cal blk	1	Level 1	1.0000	
4	<input type="checkbox"/>	CalStd	Std 0.25 ppb	4	Level 2	400.0000	400.00
5	<input type="checkbox"/>	CalStd	Std 1 ppb	4	Level 3	100.0000	100.00
6	<input type="checkbox"/>	CalStd	Std 10 ppb	4	Level 4	10.0000	10.00
7	<input type="checkbox"/>	CalStd	Std 100 ppb	4	Level 5	1.0000	1.00
8	<input type="checkbox"/>	CalStd	Hg 0.25 ppb	1101	Level 6	400.0000	400.00
9	<input type="checkbox"/>	CalStd	Hg 0.5 ppb	1101	Level 7	200.0000	200.00
10	<input type="checkbox"/>	CalStd	Hg 1 ppb	1101	Level 8	100.0000	100.00
11	<input type="checkbox"/>	Sample	Rinse	1			
12	<input type="checkbox"/>	Sample	Unknown 1ppm	4104		9.0000	9.00
13	<input type="checkbox"/>						

Unknown sample auto-predilution

Calibration Curves from Blank Solution & Calibration Stock(s)

MassHunter 5.3



Count RSD %		5	>= 10000 cps	Ignore and Continue
Blank Conc Level % [use 'BlkVrfy' Sample]		100	BlkVrfy	Ignore and Continue
Out of Calibration Curve Concentration Range %		100		Dilute and Re-Run

Setup preferred actions under QC setup

Sample Name	Total Dil.	Vial Number	Autodilution %	39 K [He]		44 Ca [He]	
				Conc. [ppb]	Meas. Conc. [ppb]	Conc. [ppb]	Meas. Conc. [ppb]
Std 1	100.0000	4	100.00	102.404	102.404	98.190	98.190
Std 10	10.0000	4	10.00	1022.460	1022.460	990.832	990.832
Std 100	1.0000	4	1.00	9997.738	9997.738	10000.939	10000.939
Rinse	1.0000	1		-2.622	-2.622	0.871	0.871
Unknown 1ppm	9.0000	4104	9.00	100283.458	11142.606	97942.385	10882.487
Unknown 1ppm	20.0000	4104	20.00	100392.589	5019.629	96810.712	4840.536

Active smart re-dilution of overrange samples

Sustainability

The automation of manual tasks with the ICP workflow automation systems

- Increases Productivity
- Reduces Energy Consumption
- Reduces Waste of single-use plastic including:
 - Pipette Tips
 - Sample Vials
 - Gloves

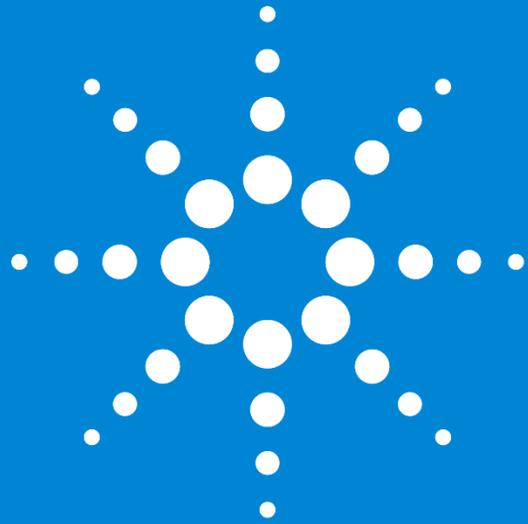


Agilent's ICP Workflow Automation Systems will **lower the cost-of-analysis** and **reduce the environmental impact** of analysis, helping labs to become **more sustainable**.

The Integrated, All-Agilent ICP Automation System

Increasing productivity





Agilent

Trusted Answers

Yan.cheung@agilent.com