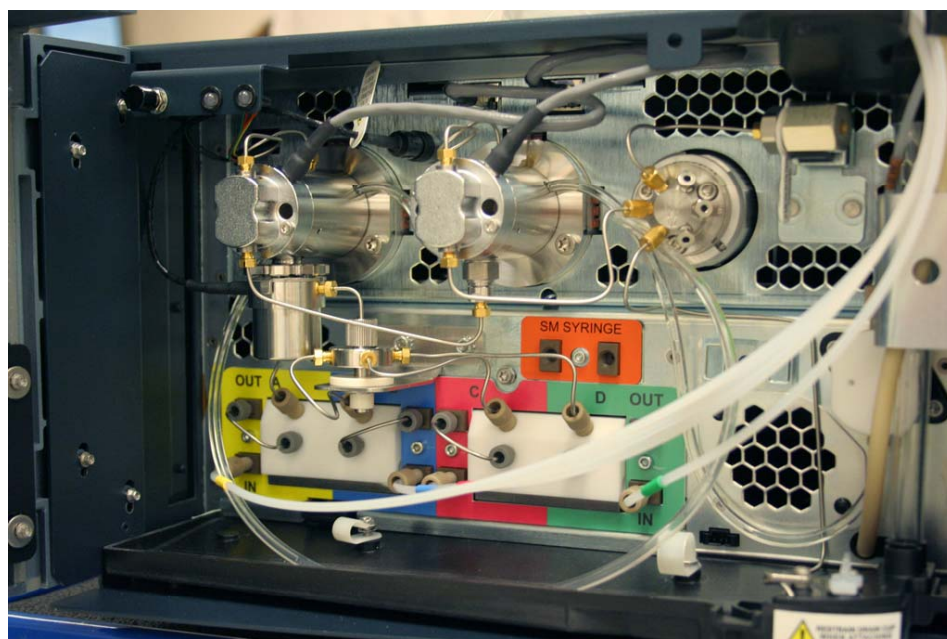




ACQUITY H-Class QSM Overview

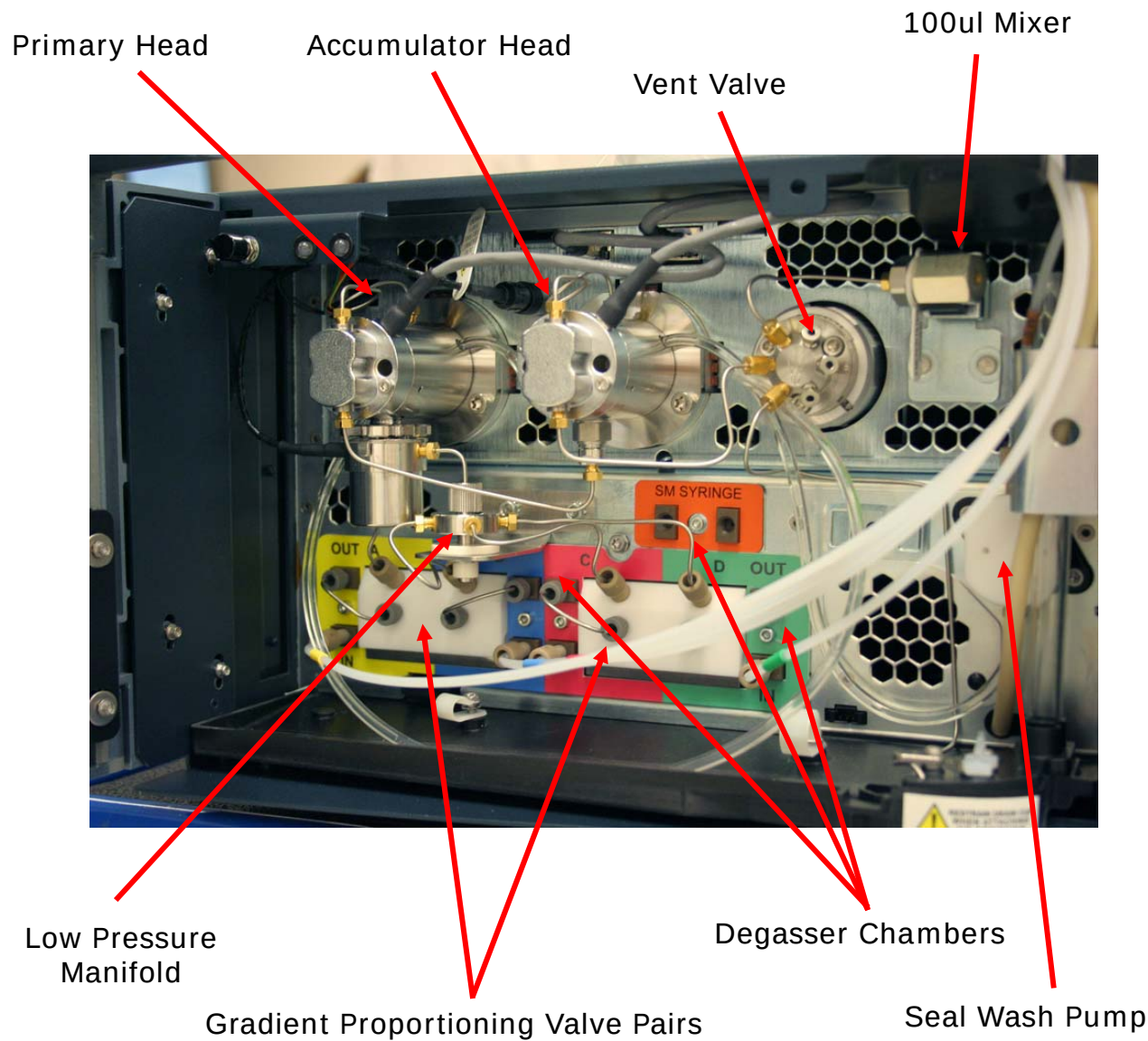


QSM Design Philosophy

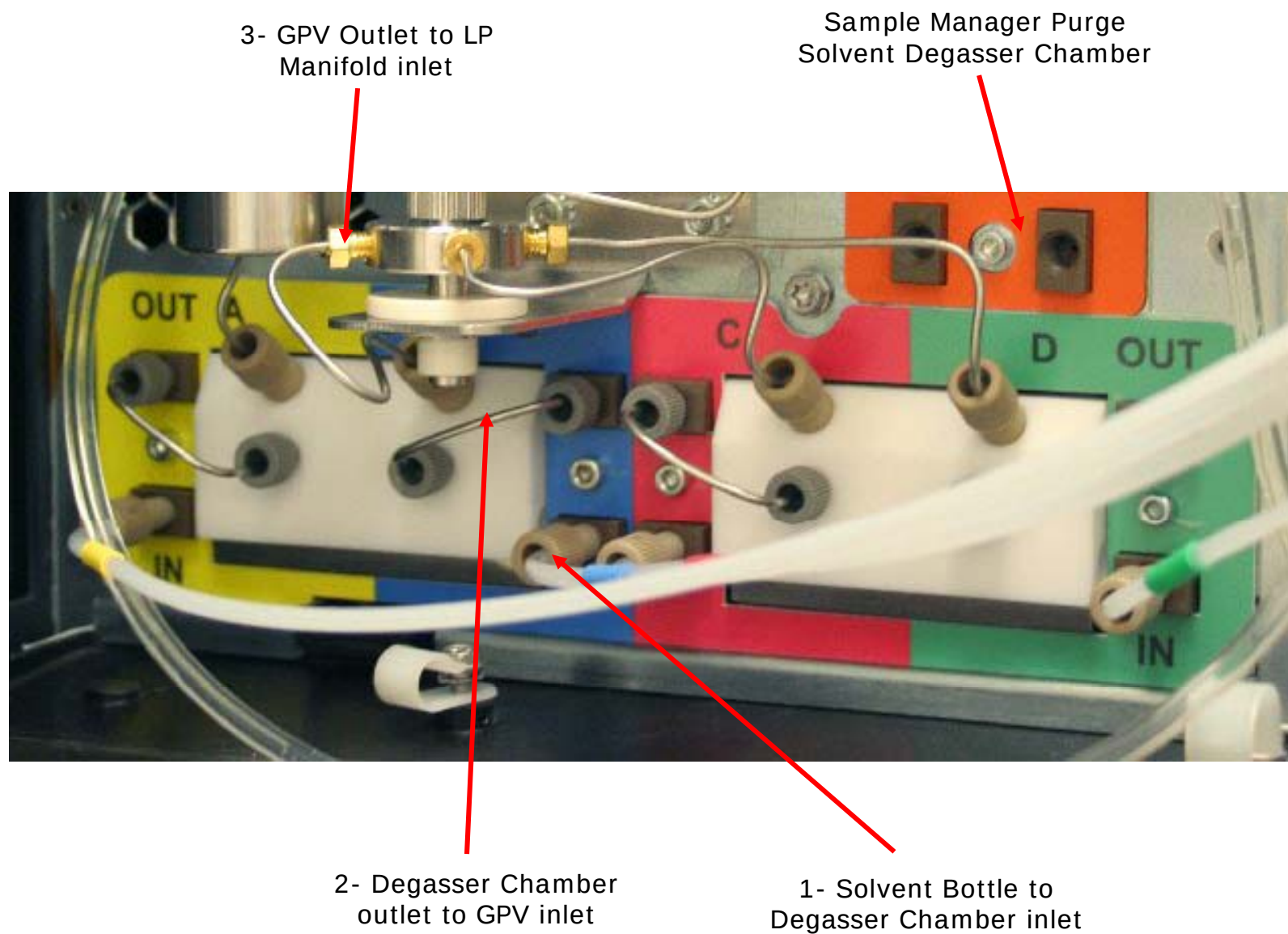


- Adapt the best, most proven design aspects from both ACQUITY and Alliance to create a UPLC capable quaternary solvent manager
 - Based on state of the art low pressure mixing technology
 - Keeping system dwell volume as low as possible
 - Supporting the full UPLC pressure range
 - Using already proven ACQUITY fluidics, electronics and software where appropriate
- Make it cost competitive
 - Only need one pump, CPU and personality card
 - Degasser functionality added to personality card
- Proven reliability

QSM Fluidics-Front View



QSM Degasser / GPV Flow Path



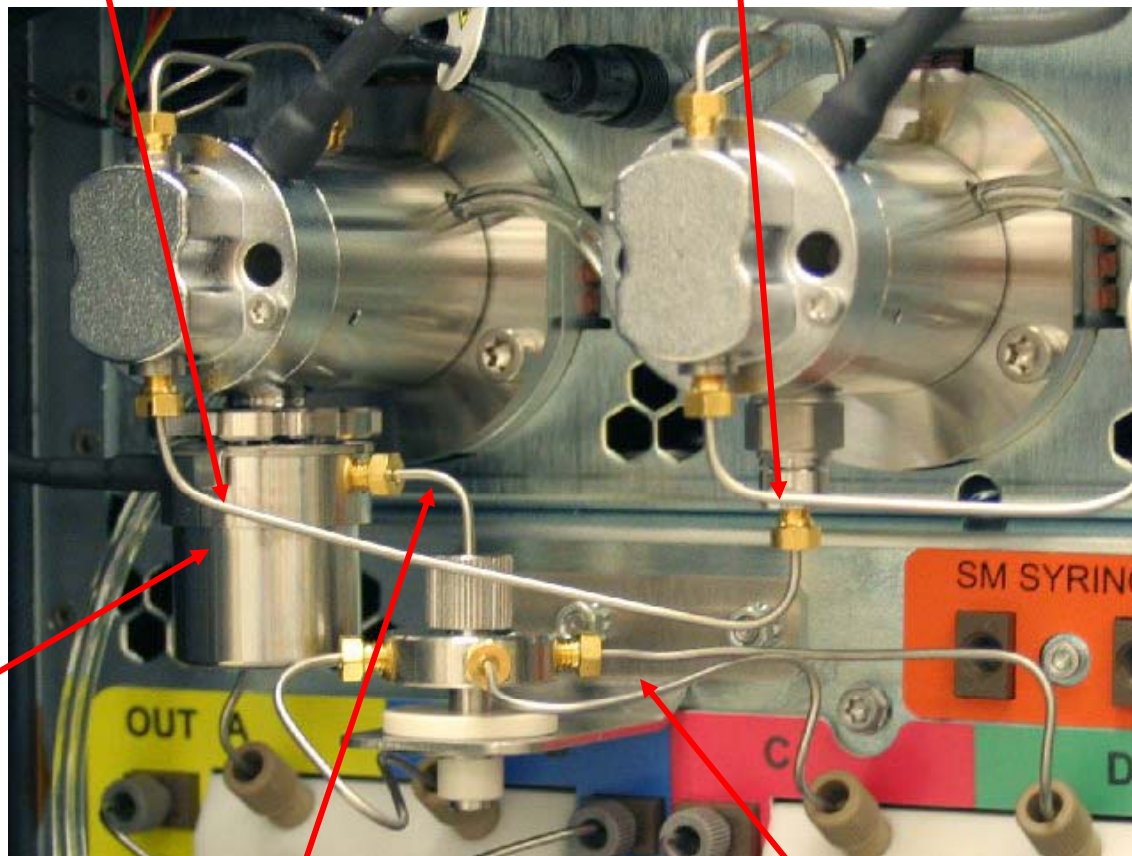
QSM Pump Head Flow Path



3- Primary Head Transducer to
Accumulator Check Valve

4- Accumulator Head Transducer
to Vent Valve

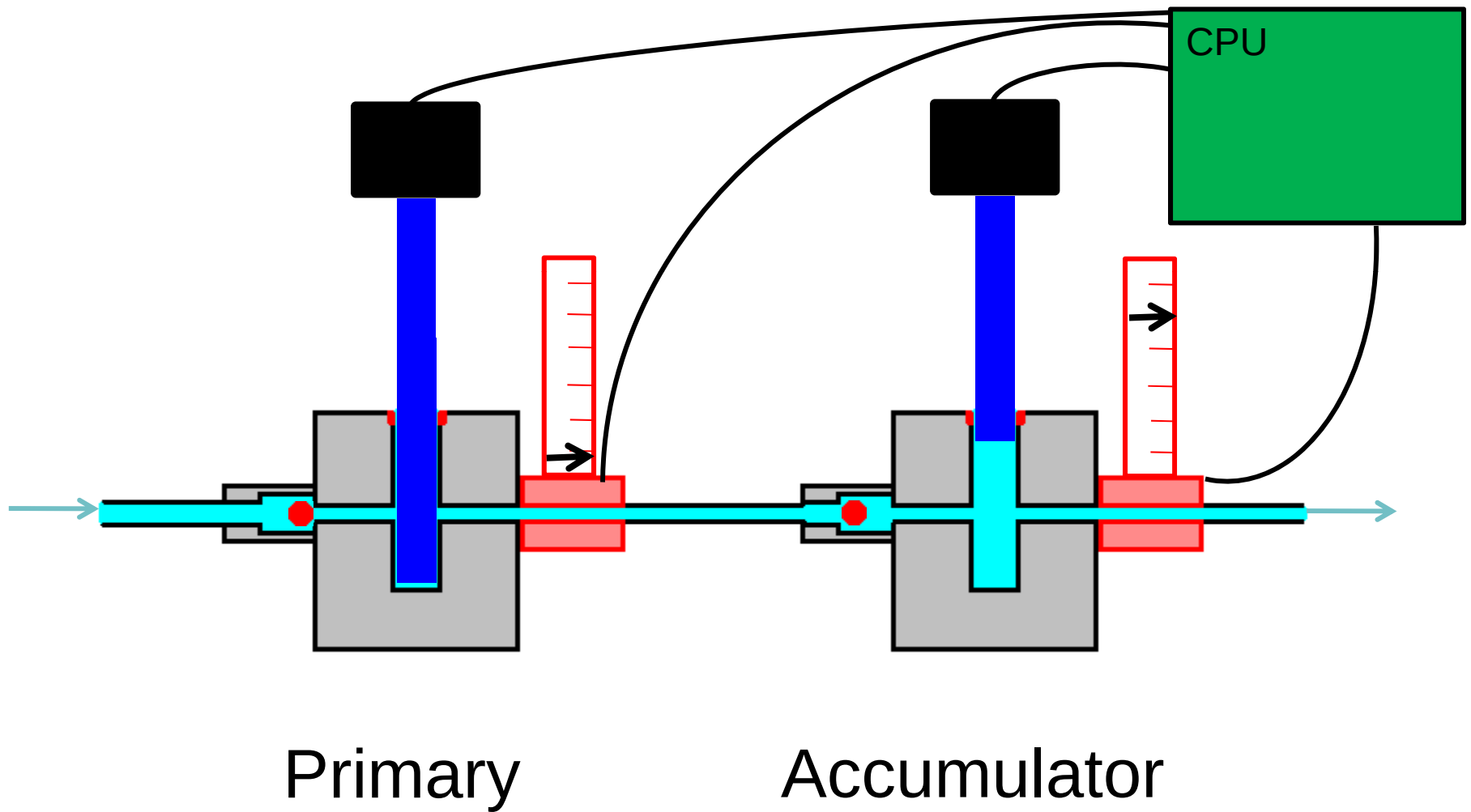
I2V Actuator



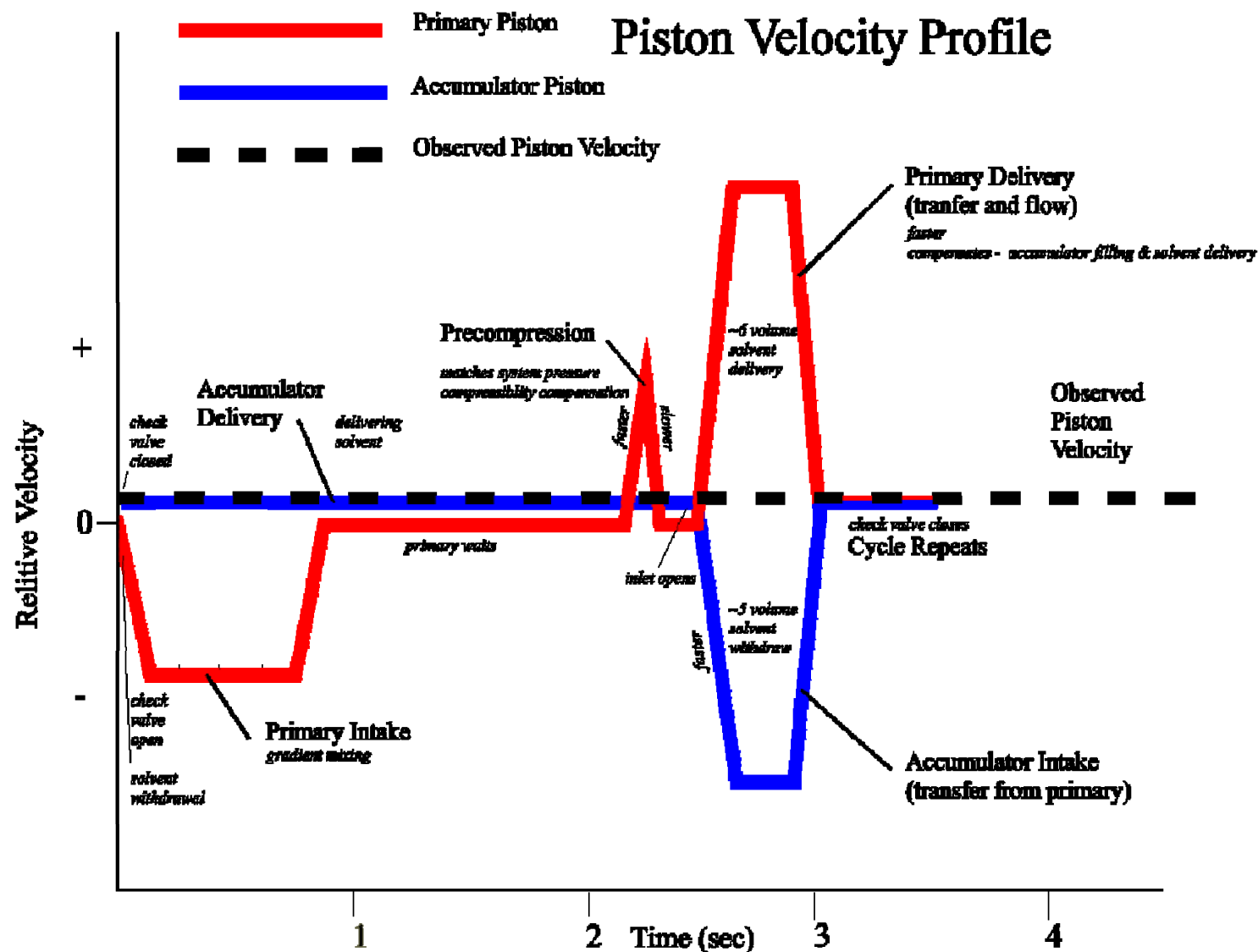
2- LP Manifold to Primary
I2V

1- GPV Outlet to LP
Mixing Manifold

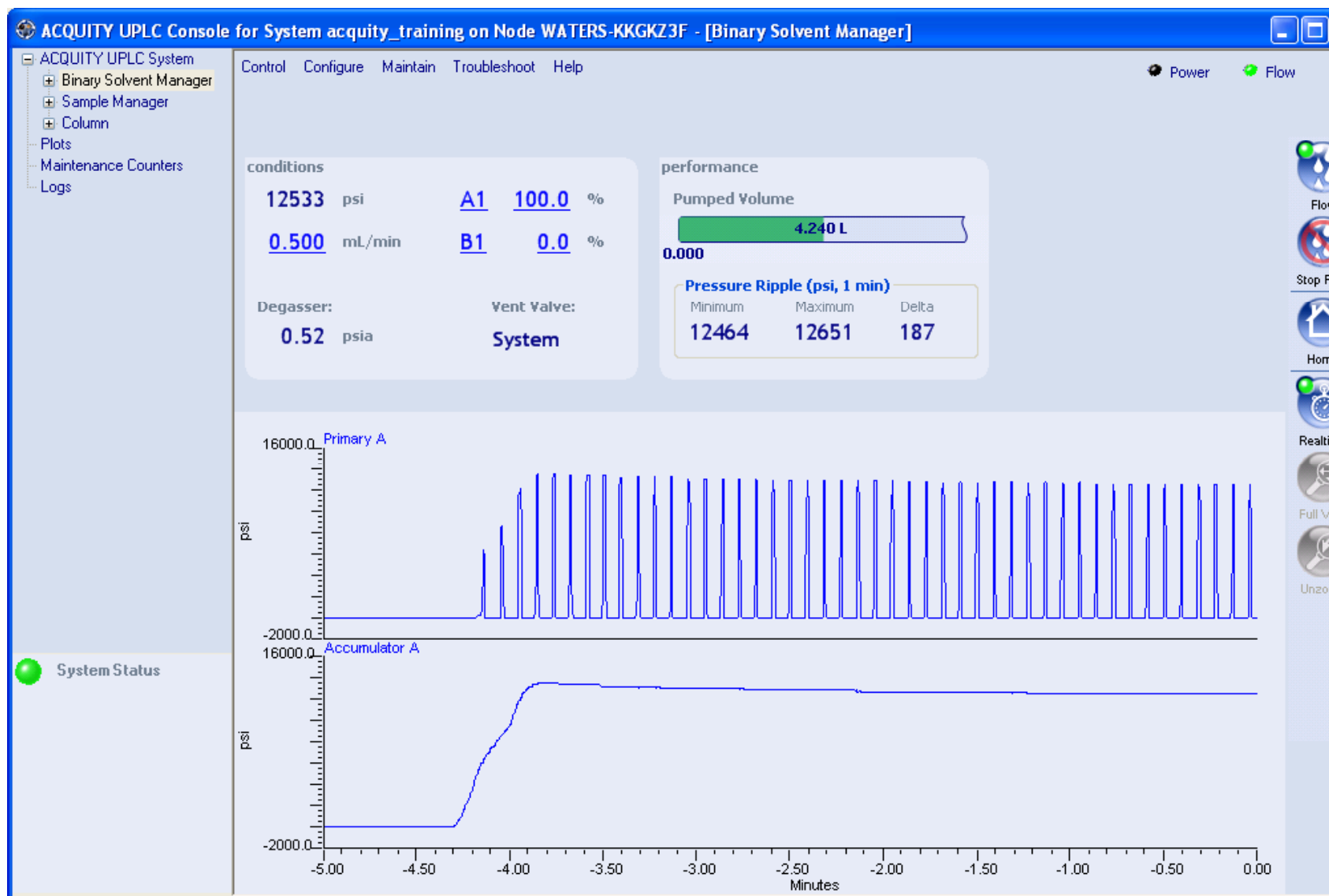
BSM/QSM- Movement of Pistons



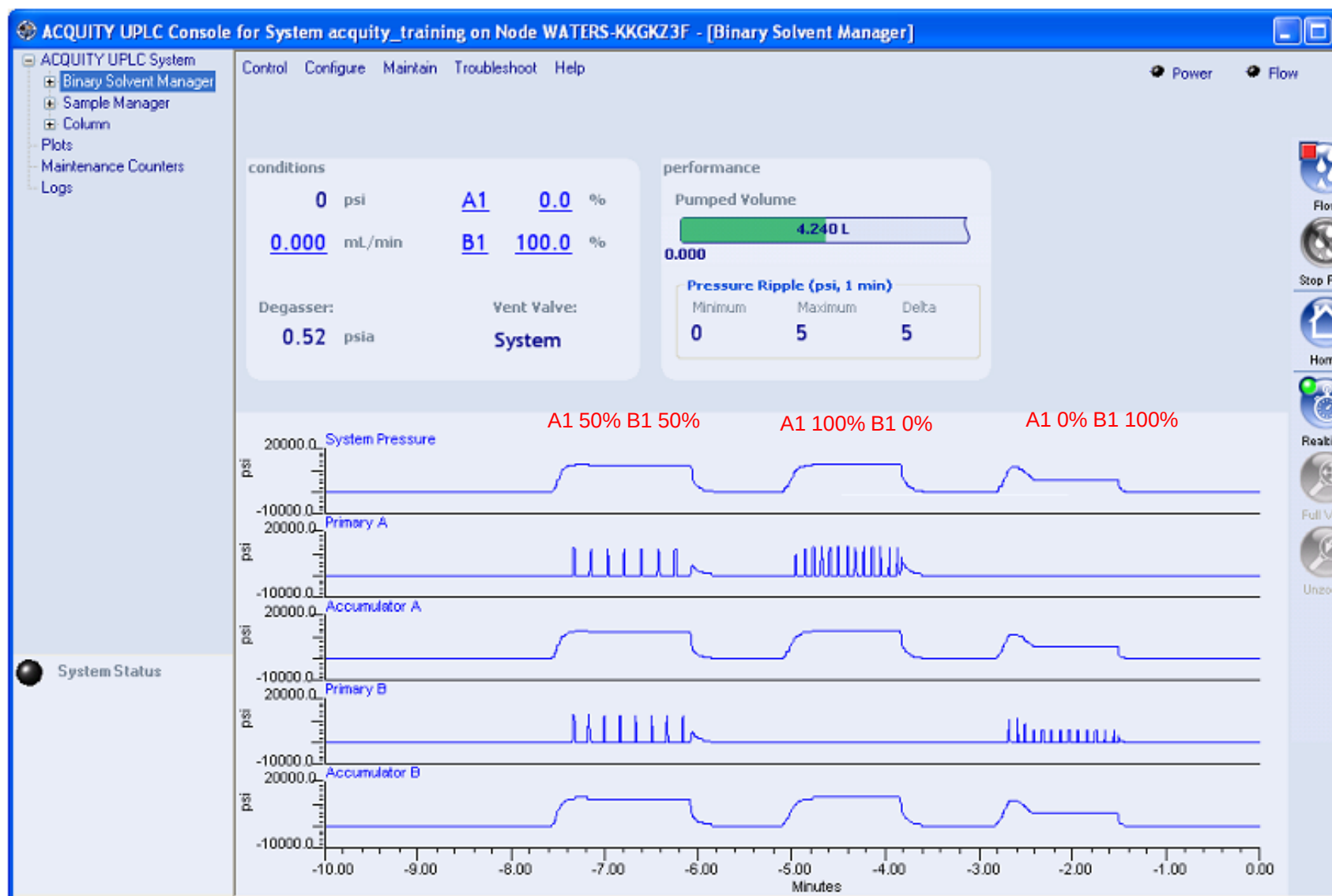
Single Pump Velocity Profile



Single Pump Pressure Example



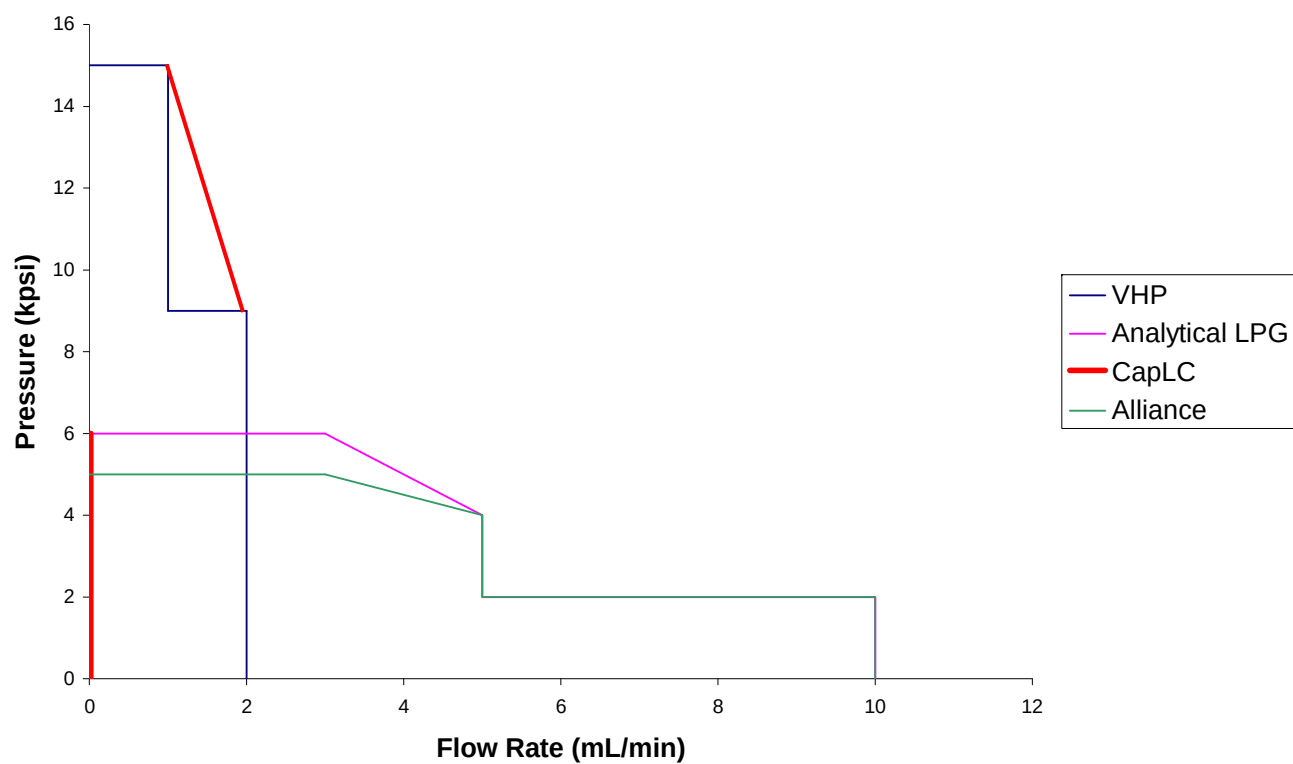
Monitoring all pressure traces



Pump Performance



Performance Envelope



High Pressure Limit Adjusts



Acquity Binary Solvent Manager
Ultra Performance LC

General | Data | Analog Out | Events

Solvents:
A1 * Water
B1 * Water

Pressure Limits:
Low: 1000 psi
High: 15000 psi
Seal Wash: 5.0 min

Gradient:

	Time (min)	Flow (mL/min)	%A	%B	Curve
1	Initial	2.000	95.0	5.0	Initial
2					
3					
4					
5					
6					

Attention

The flow and composition profile of this gradient requires that the system pressure be limited to 9600 psi.

The high pressure limit will be adjusted.

OK Cancel

Binary Solvent Manager

Analog Out | Events

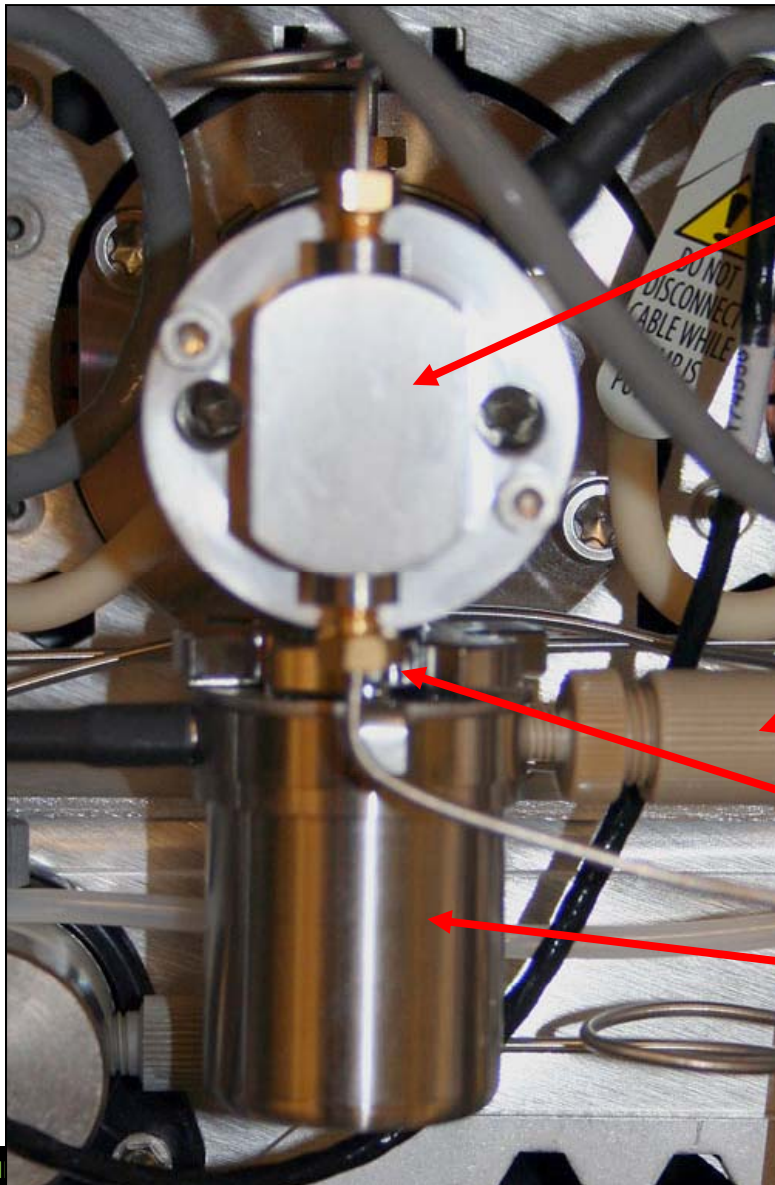
Pressure Limits:
Low: 1000 psi
High: 9600 psi
Seal Wash: 5.0 min

Flow (mL/min) %A %B Curve

2.000	95.0	5.0	Initial

Comment:

Intelligent Intake Valve (I2V)



Pressure Transducer

Inlet Filter

I2V Check-valve cartridge

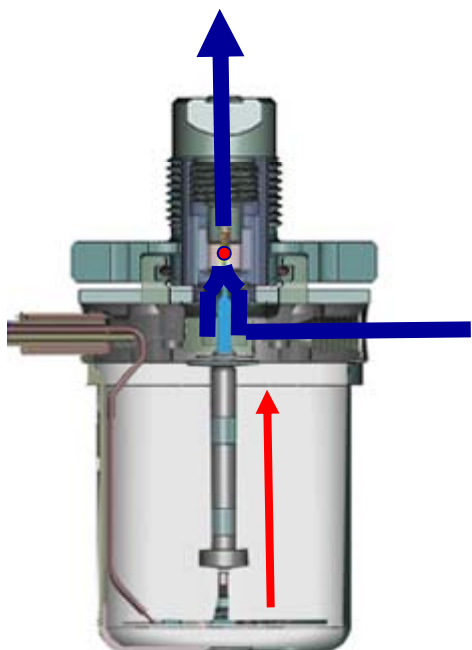
I2V Actuator

I2V Operation

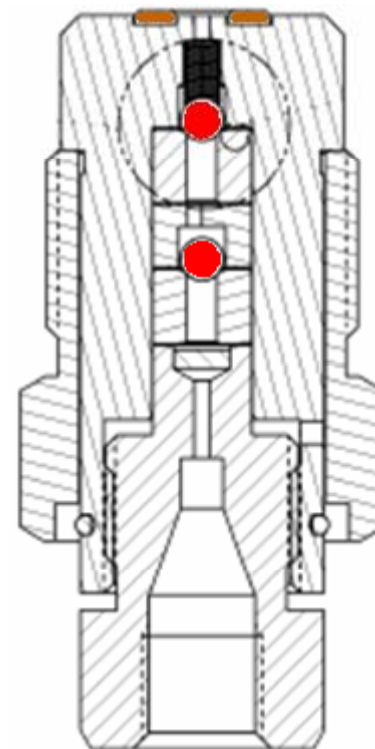


- An applied current generates a force, timed with the motion of the pump plungers, that pushes the ball off its seat.
 - In the case of traditional passive check valves the ball is lifted off the seat by the force of the solvent flow
- Faster system priming and startup times
- More robust operation
- Continued highly repeatable system performance

QSM Check valve

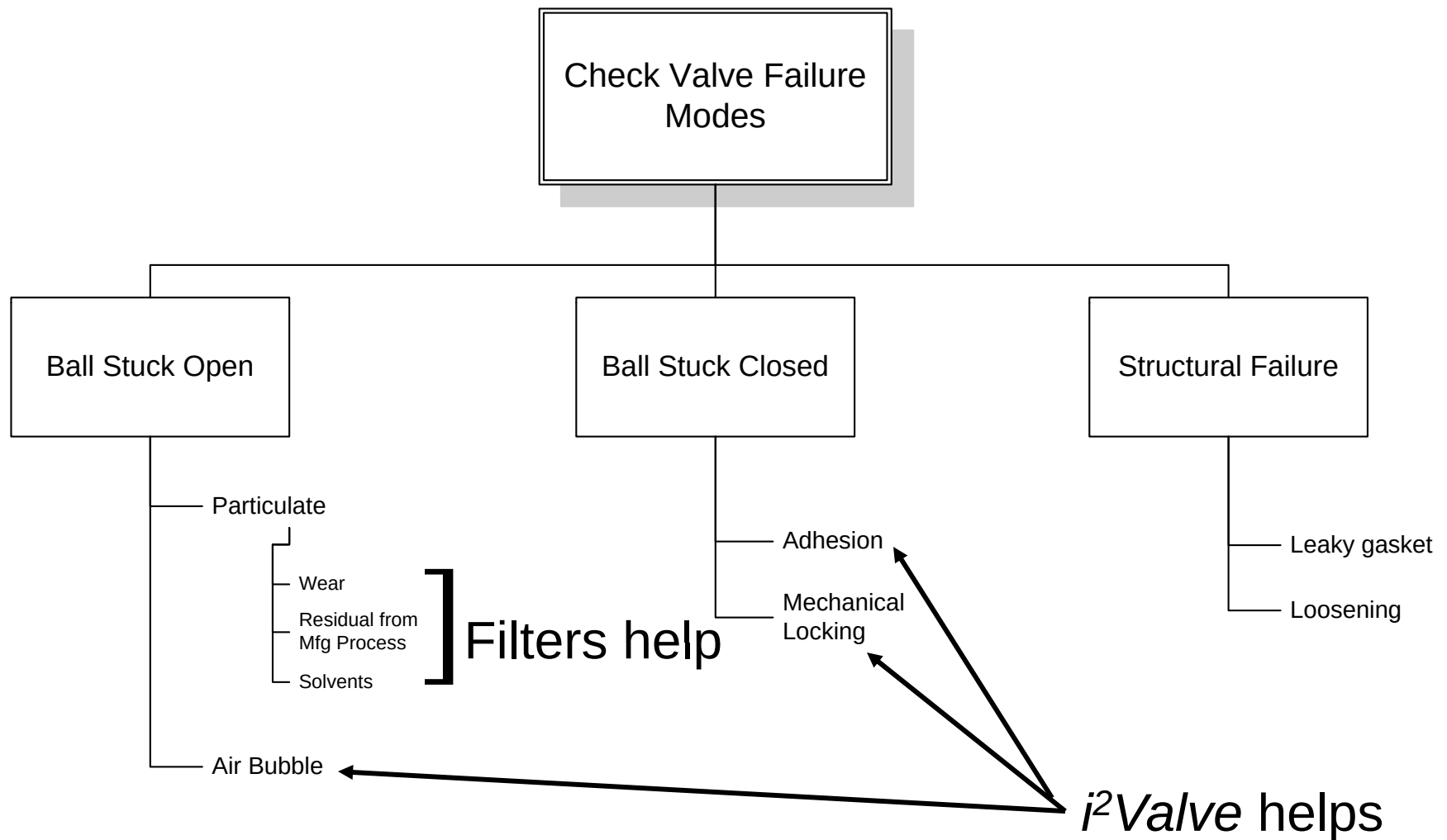


Primary



Accumulator

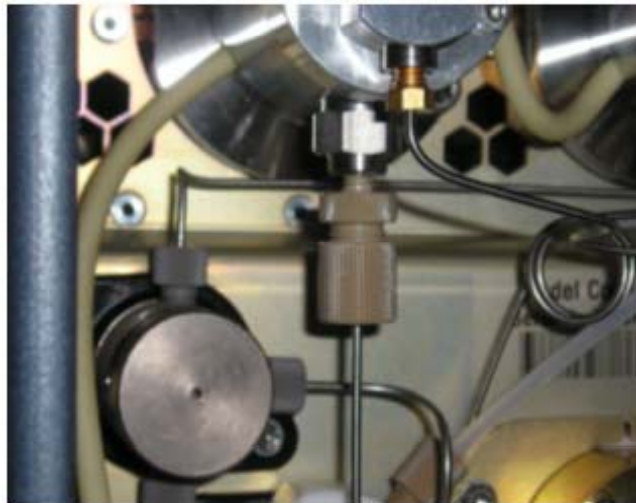
Check Valve Failure Modes



ACQUITY UPLC BSM Inlet Filters



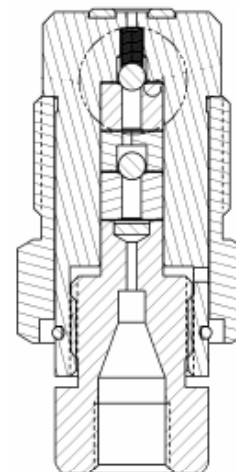
- Primary Check Valve Inlet Filters (Implemented Mar 2006)
 - Protects inlet check valve from particles
 - Thus, increases the robustness of the ACQUITY UPLC™ system
 - Part Number 700002912
 - Remain integral to ACQUITY UPLC BSM



ACQUITY UPLC BSM Dual Ball and Seat Check Valves Accumulator



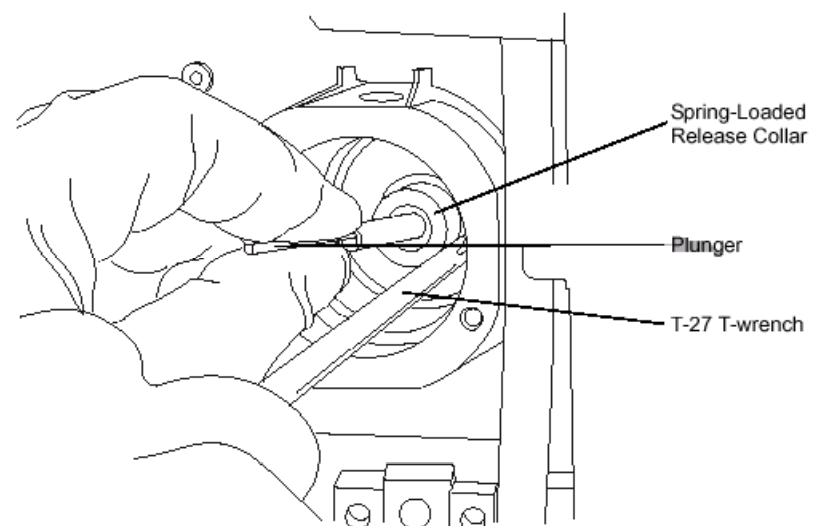
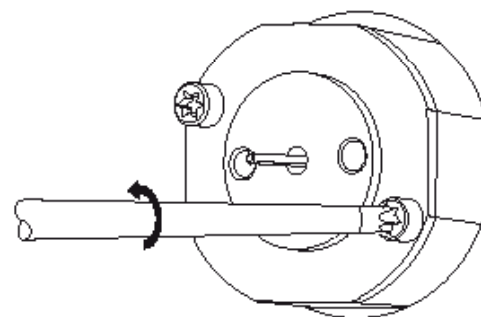
- Dual Ball and Seat Outlet Check Valve (added May 06)
 - Used on the Accumulator Head
 - Protects outlet check valve from particles
 - Increases the robustness of the ACQUITY UPLC™ system
 - Built in redundancy
 - Part Number 700002968



Plunger and Head



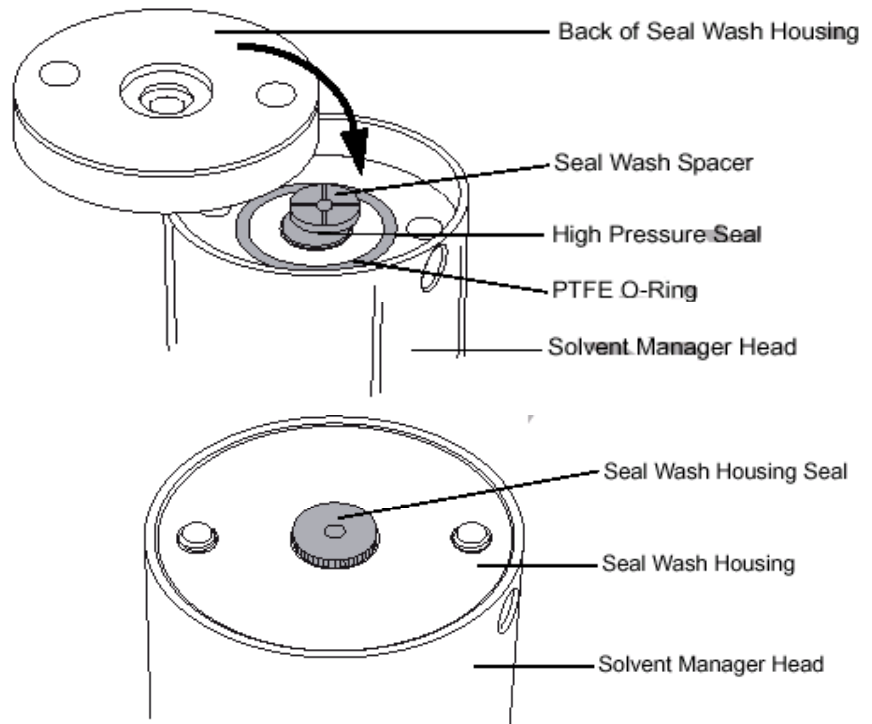
- 700002600
 - 2 per package
- 2mm Plunger Assembly
- Head Volume = 54uL



Pump Head Seals



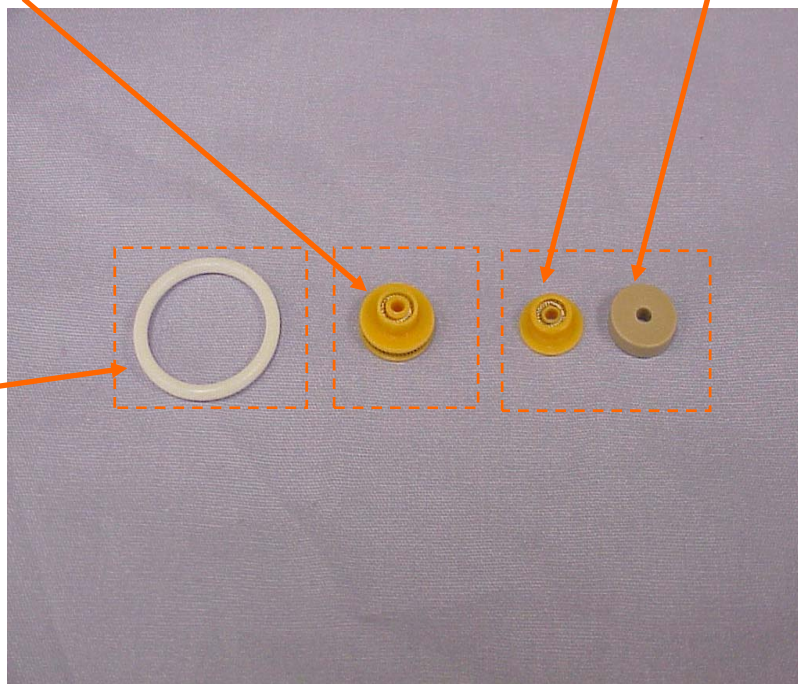
- High Pressure Seal
- PTFE O-Ring
- Seal Wash Spacer
- Seal Wash Housing
- Seal Wash Housing Seal



Head Seals



- 700002598
 - 2 per package
- Seal Wash Housing Seal
- WAT076152
 - 1 per package
- O-Ring
- 7000002599
 - 2 per package
- Head Plunger Seal
- Seal Wash Spacer



GPV Degasser Assembly- Original



From Vacuum Pump

To Vacuum Gauge PCB

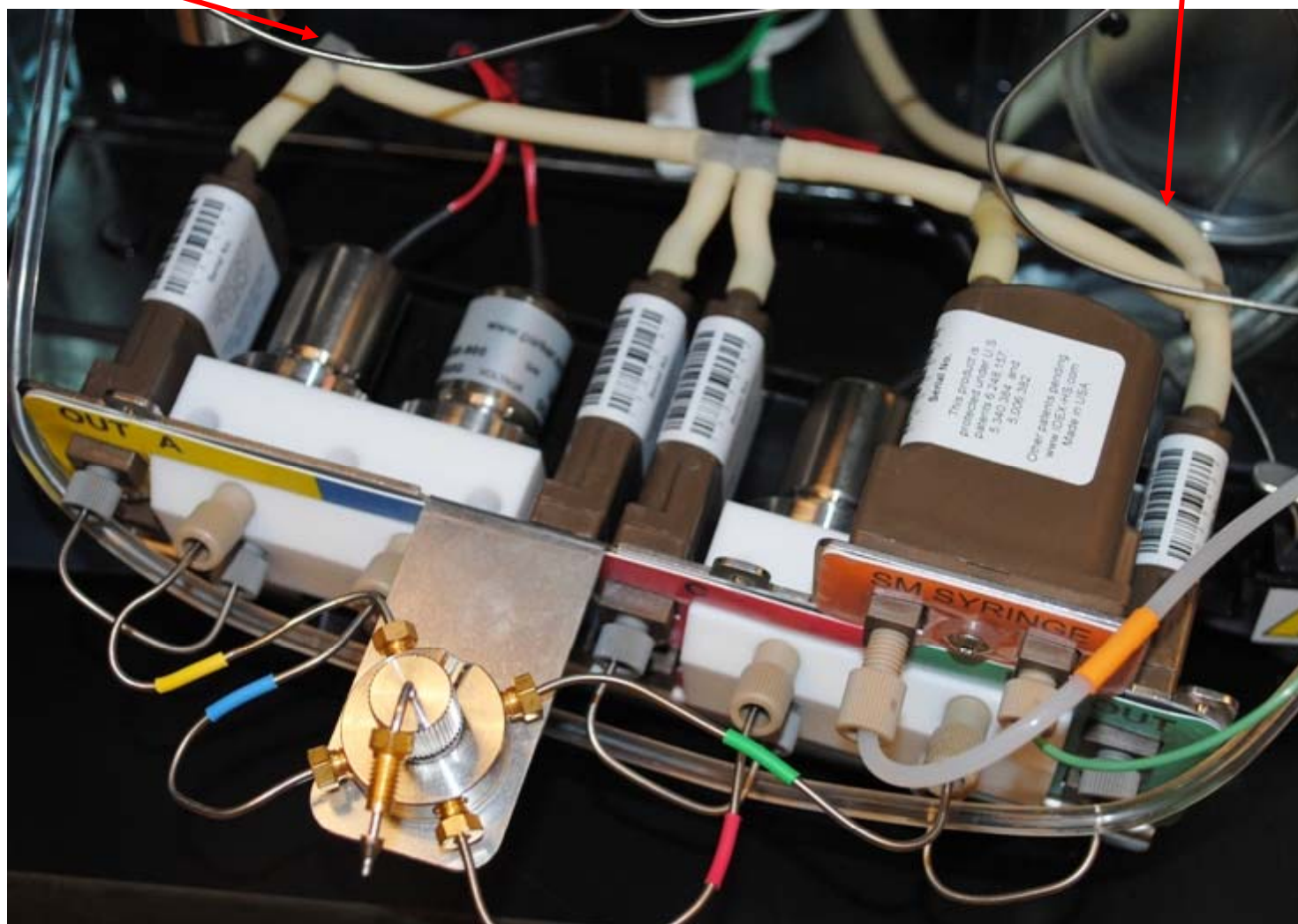


GPV Degasser Assembly New Style

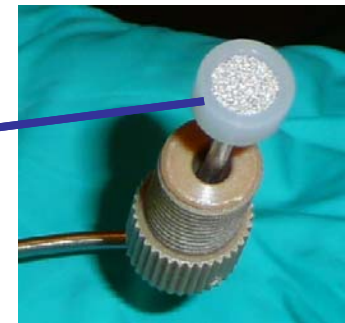
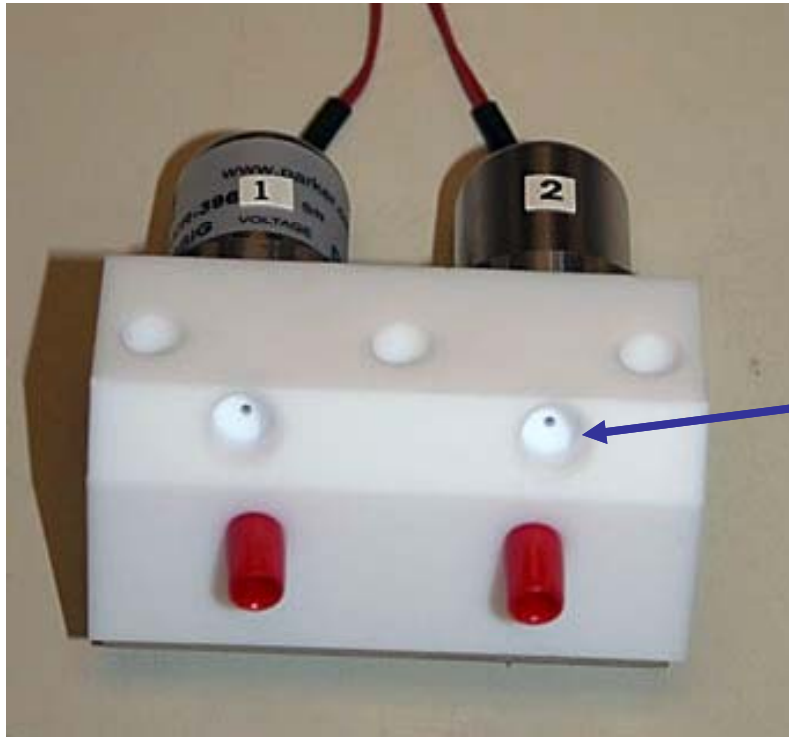


Plugged

To Vacuum
Pump and
Gage PCB



GPV Valve Pair and Filter



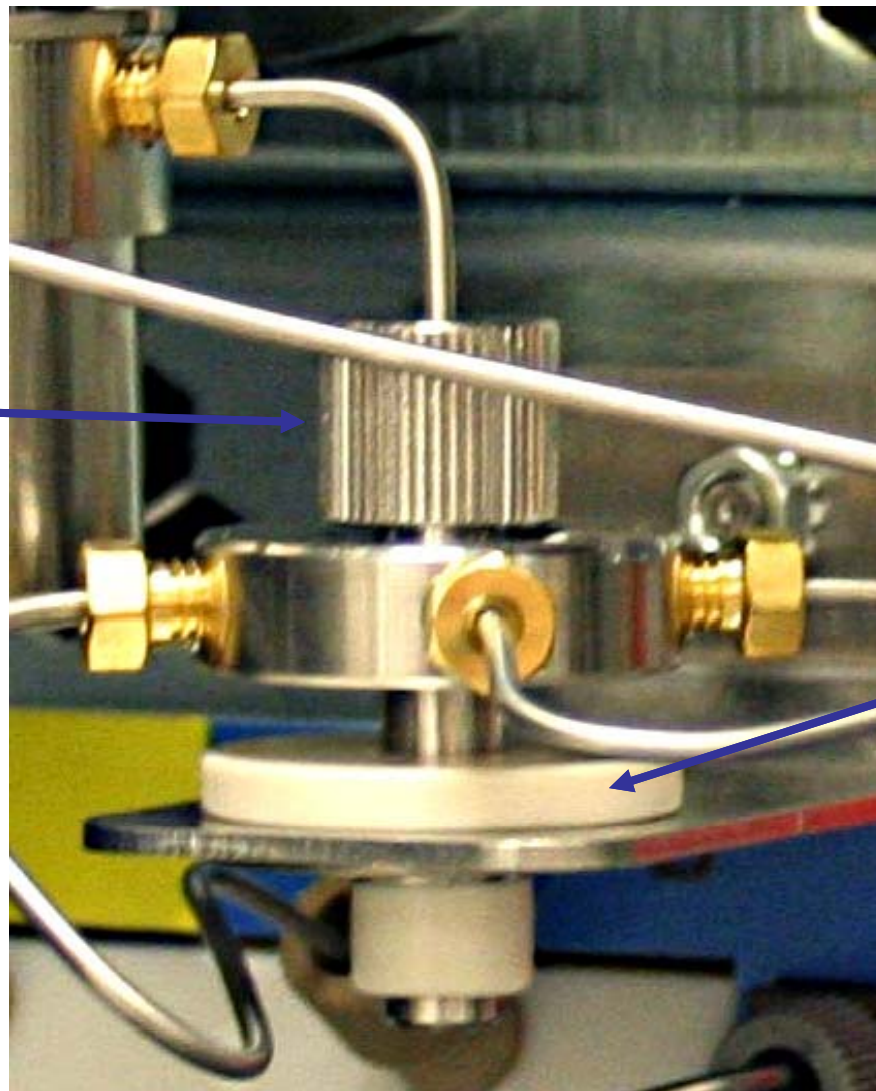
GPV FILTER
(20 MICRON FRIT)
All 4 are changed at PM

- Same proven Alliance type GPV valve
- Located closer to the head to keep dwell volume down
- Can be replaced as a pair for lower maintenance costs

LP Manifold

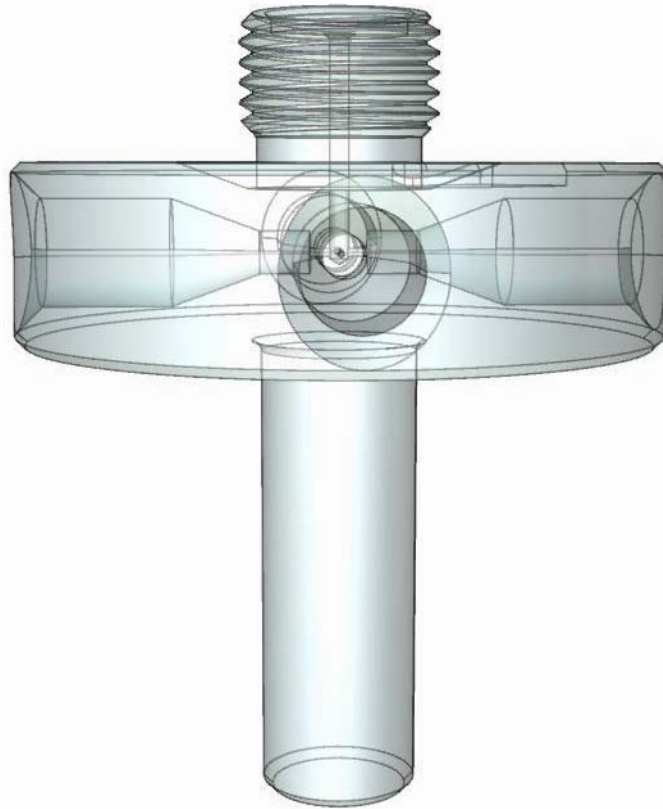


Knurled Knob
SS Fitting

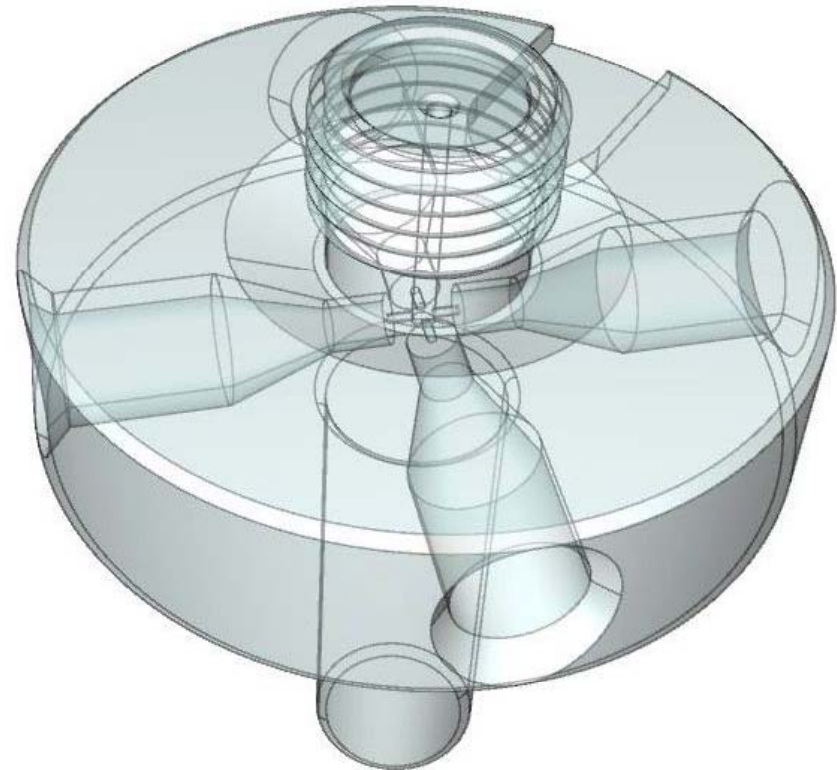


Support
Bracket

LP Manifold

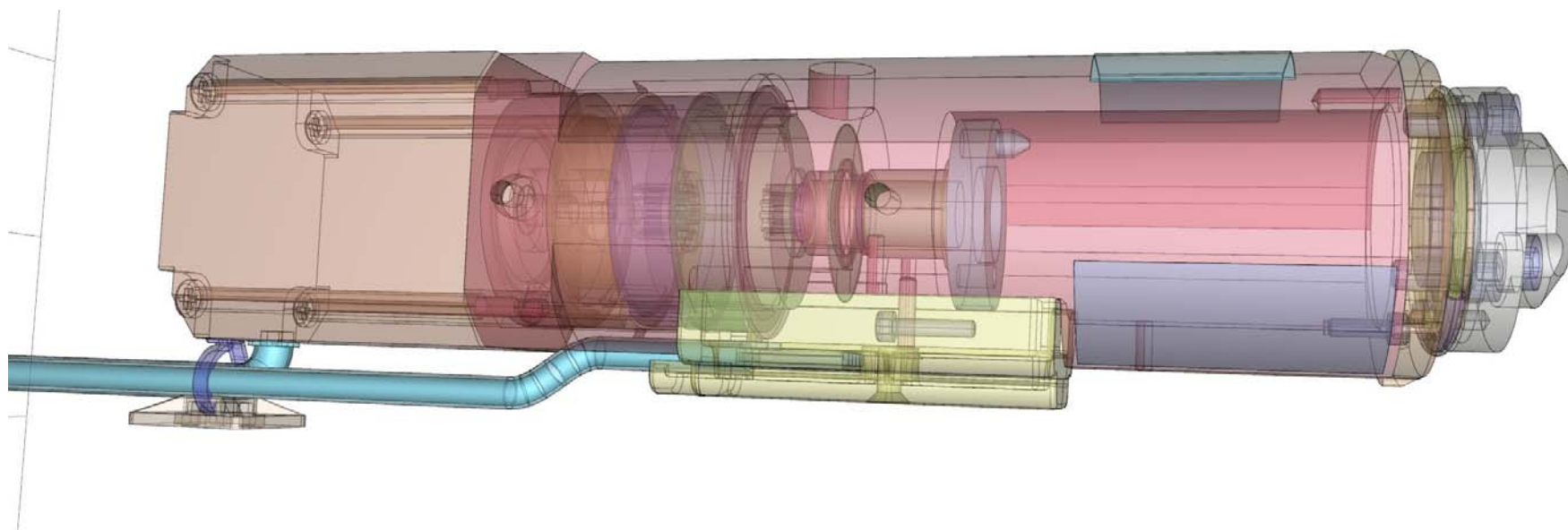


Side View



Top View

QSM Internal Components



QSM Internal Components- Top View



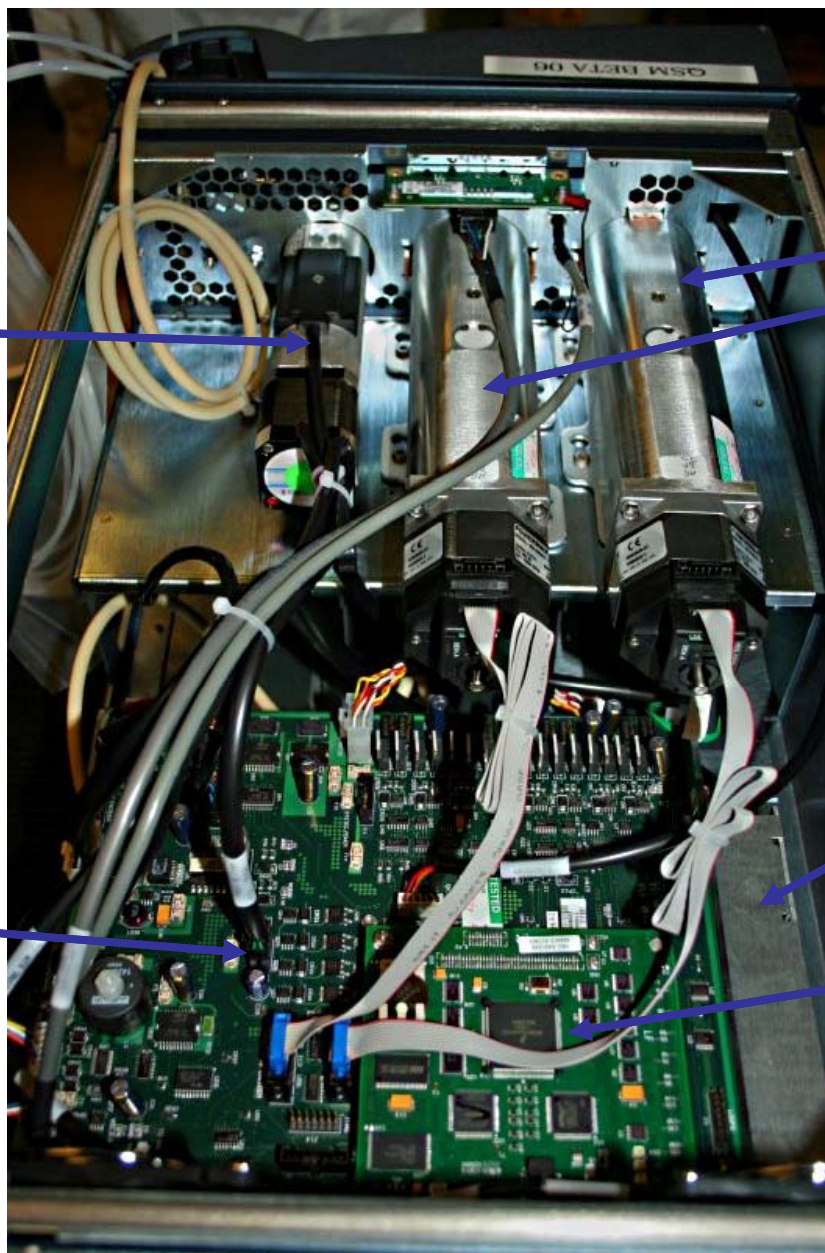
Vent Valve

Primary and
Accumulator
Actuators

Personality
Card

Power Supply

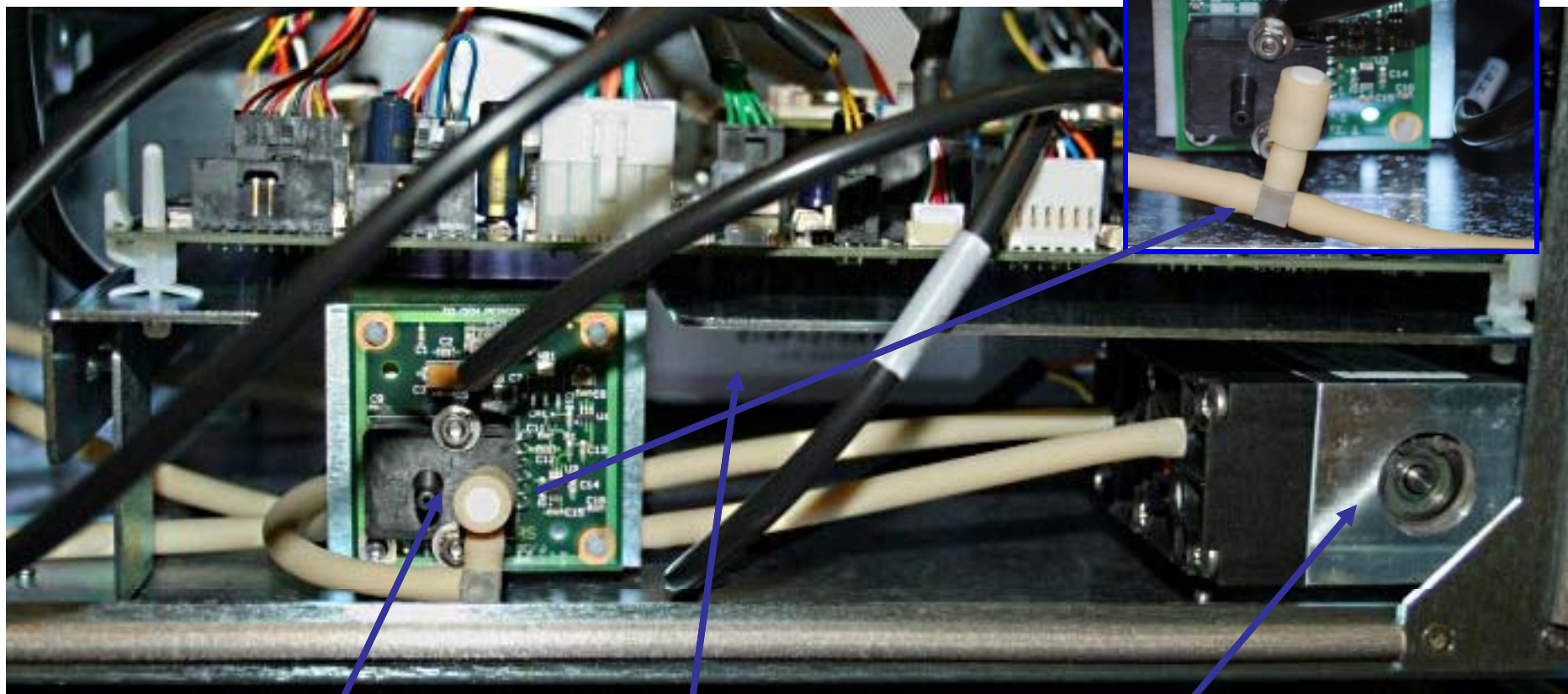
CCPU2K3V



QSM Right Side View



New Tubing Connections



Degasser
Gauge PCB

Power Supply

Degasser
Pump

QSM Rear Panel

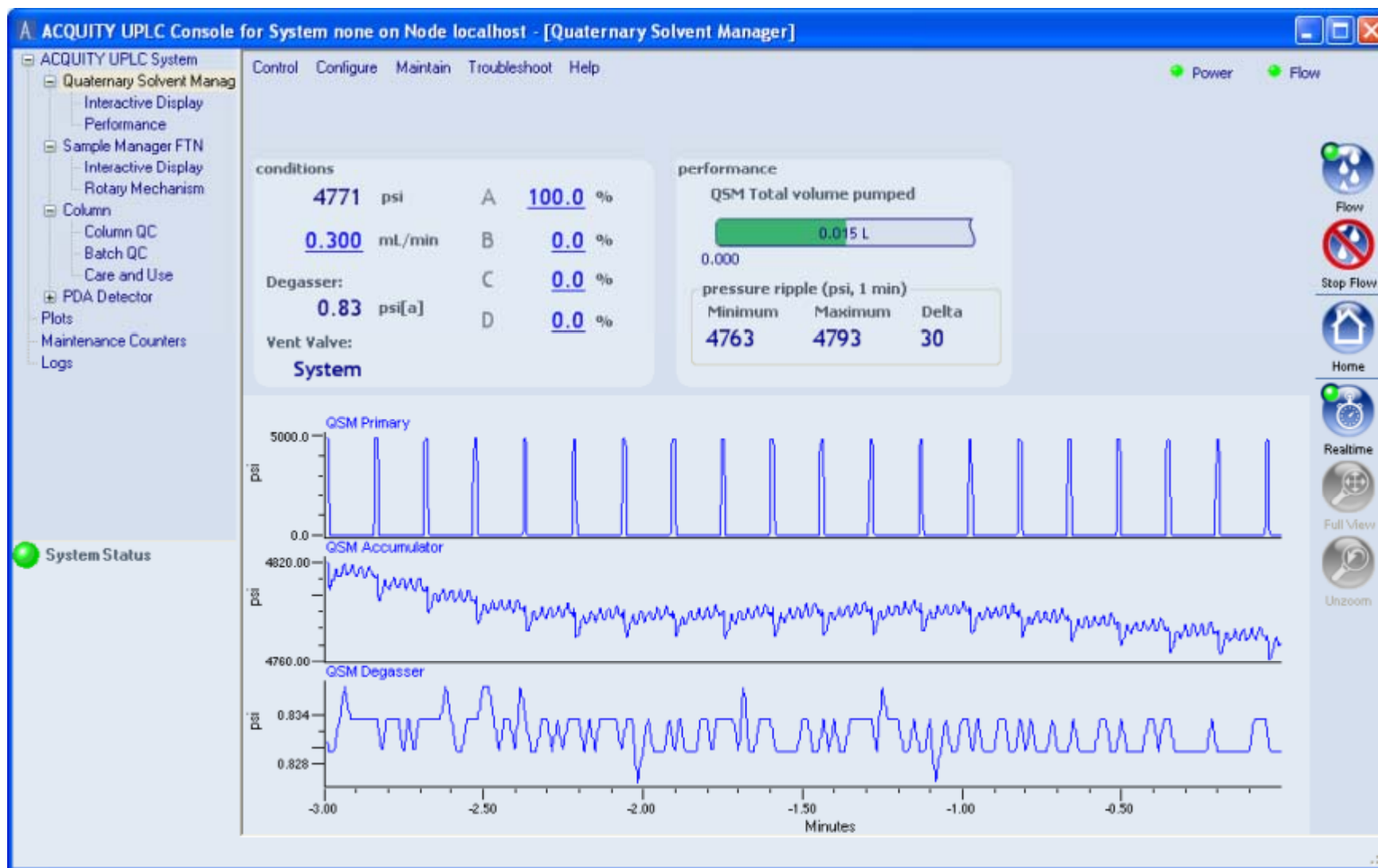


Vacuum Pump
Attachment
Screws

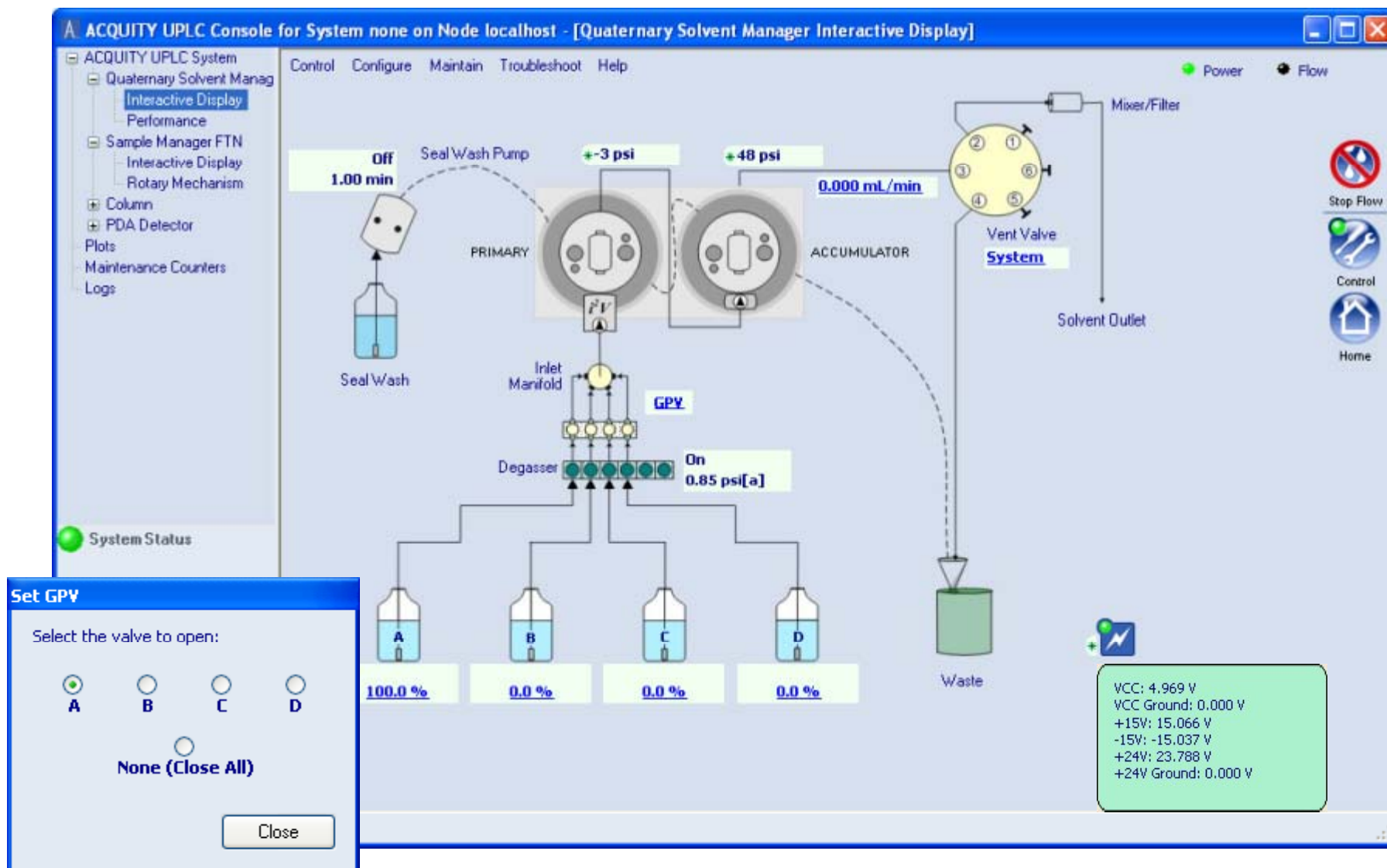
ENET and
RS232
Connectors

Power Supply

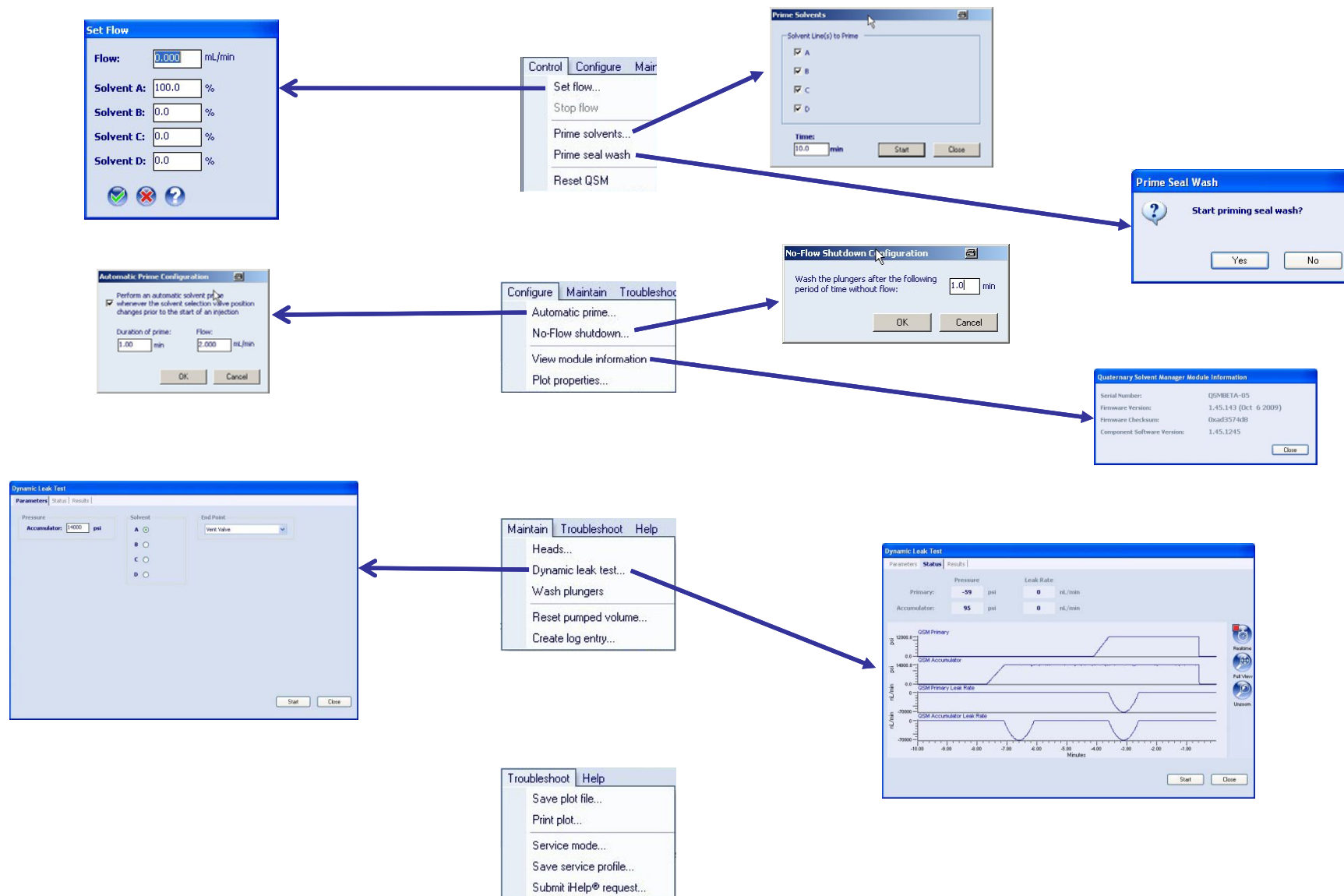
QSM Console Top Level Menu



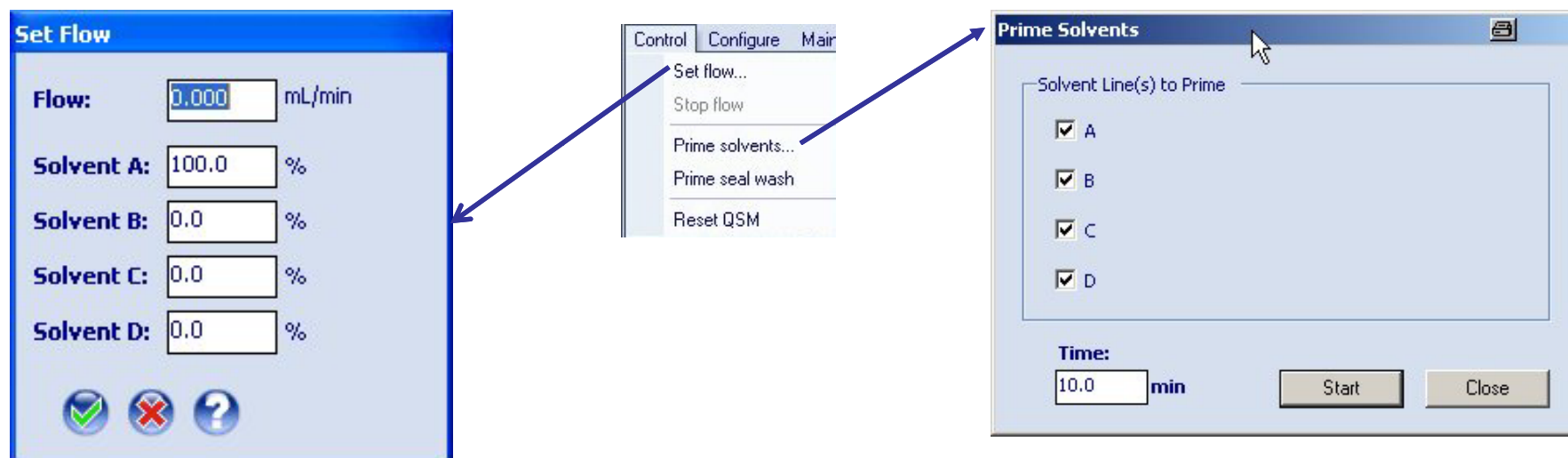
QSM Console Interactive Menu



QSM Console- New Pull-Down Menus



Set Flow and Priming Menus



New QSM Console Functions



Automatic Prime Configuration

☒ Perform an automatic solvent prime whenever the solvent selection valve position changes prior to the start of an injection

Duration of prime: min Flow: mL/min

Automatic Prime Configuration
Used with the Solvent Select Valve. Allows the user to automatically run a prime when they switch to a different "D" solvent line while running samples.

No-Flow Shutdown Configuration

Wash the plungers after the following period of time without flow: min

No-Flow Shutdown Configuration
Runs the Wash Plunger function automatically after the specified period without flow.

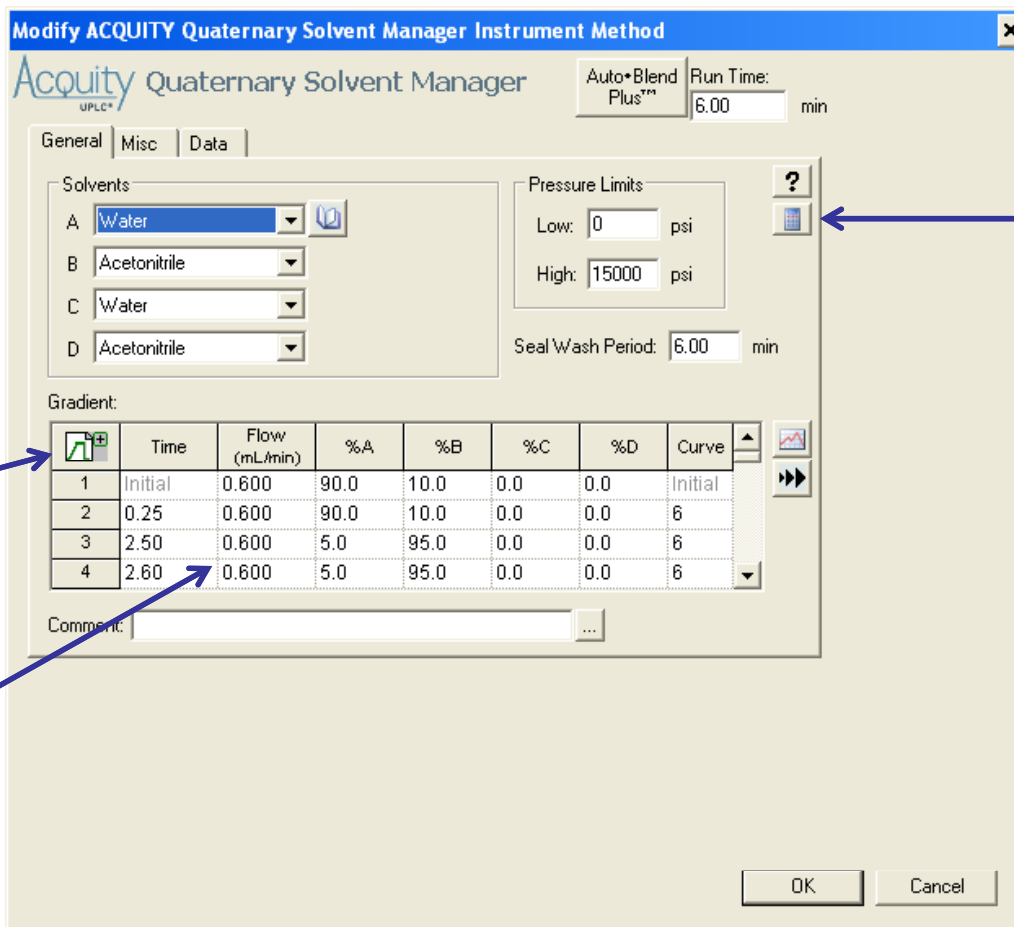
QSM Instrument Method-General Tab



Solvent Descriptions here form the pull-down menus. Descriptions can be added by clicking the edit button.

Drag and drop the Gradient Table to the ACQUITY Calculator via this icon.

Gradients or isocratic conditions are entered in the Gradient Table. Binary to Quaternary gradients may now be specified. Standard Waters gradient Curves apply.



The dialog box is titled "Modify ACQUITY Quaternary Solvent Manager Instrument Method". It has tabs for "General", "Misc", and "Data". The "General" tab is active. At the top right, there are fields for "Auto-Blend Plus™" and "Run Time: 6.00 min". Below the tabs, there are sections for "Solvents", "Pressure Limits", "Seal Wash Period", and "Gradient".

Solvents: A list of four solvents (A, B, C, D) with pull-down menus. A is "Water", B is "Acetonitrile", C is "Water", and D is "Acetonitrile". There is an edit button (a small icon with a plus and minus) to the right of the list.

Pressure Limits: Fields for "Low: 0 psi" and "High: 15000 psi". There is a help icon (?) to the right.

Seal Wash Period: A field for "6.00 min".

Gradient: A table with columns: Time, Flow (mL/min), %A, %B, %C, %D, and Curve. There is a small icon with a plus and minus to the left of the table, and a help icon (?) to the right.

	Time	Flow (mL/min)	%A	%B	%C	%D	Curve
1	Initial	0.600	90.0	10.0	0.0	0.0	Initial
2	0.25	0.600	90.0	10.0	0.0	0.0	6
3	2.50	0.600	5.0	95.0	0.0	0.0	6
4	2.60	0.600	5.0	95.0	0.0	0.0	6

At the bottom, there is a "Comment:" field and "OK" and "Cancel" buttons.

The ACQUITY Calculator can be accessed by clicking the Calculator button or alternately from the ACQUITY console top-level menu.

QSM Method- Solvent Catalog



Modify ACQUITY Quaternary Solvent Manager Instrument Method

Acquity Quaternary Solvent Manager

Auto-Blend Plus™ Run Time: 6.00 min

General Misc Data

Solvents

A: Water B: Acetonitrile C: Water D: Acetonitrile

Pressure Limits

Low: 0 psi High: 15000 psi

Seal Wash Period: 6.00 min

Gradient

	Time	Flow (mL/min)	%A	%B	%C	%D	Curve
1	Initial	0.600	90.0	10.0	0.0	0.0	Initial
2	0.25	0.600	90.0	10.0	0.0	0.0	6
3	2.50	0.600	5.0	95.0	0.0	0.0	6
4	2.60	0.600	5.0	95.0	0.0	0.0	6

Comment:

OK Cancel

Solvent Catalog

View

Filter by:

All

1% FA in Water
90/10 Water/ACN
Acetic Acid
Acetonitrile
Ammonium Acetate
Ammonium Bicarbonate
Ammonium Formate
Butanol-1
Butanol-2
Chloroform
Dibasic Sodium Phosphate
Dimethyl sulfoxide
Dimethylformamide
Ethanol
Ethyl Acetate
Formic Acid
Hexane

Add... Copy... Remove

Detail... Rename...

OK Cancel

A solvent catalog can be created and accessed for use in the solvent descriptions.

QSM Method- Gradient Table

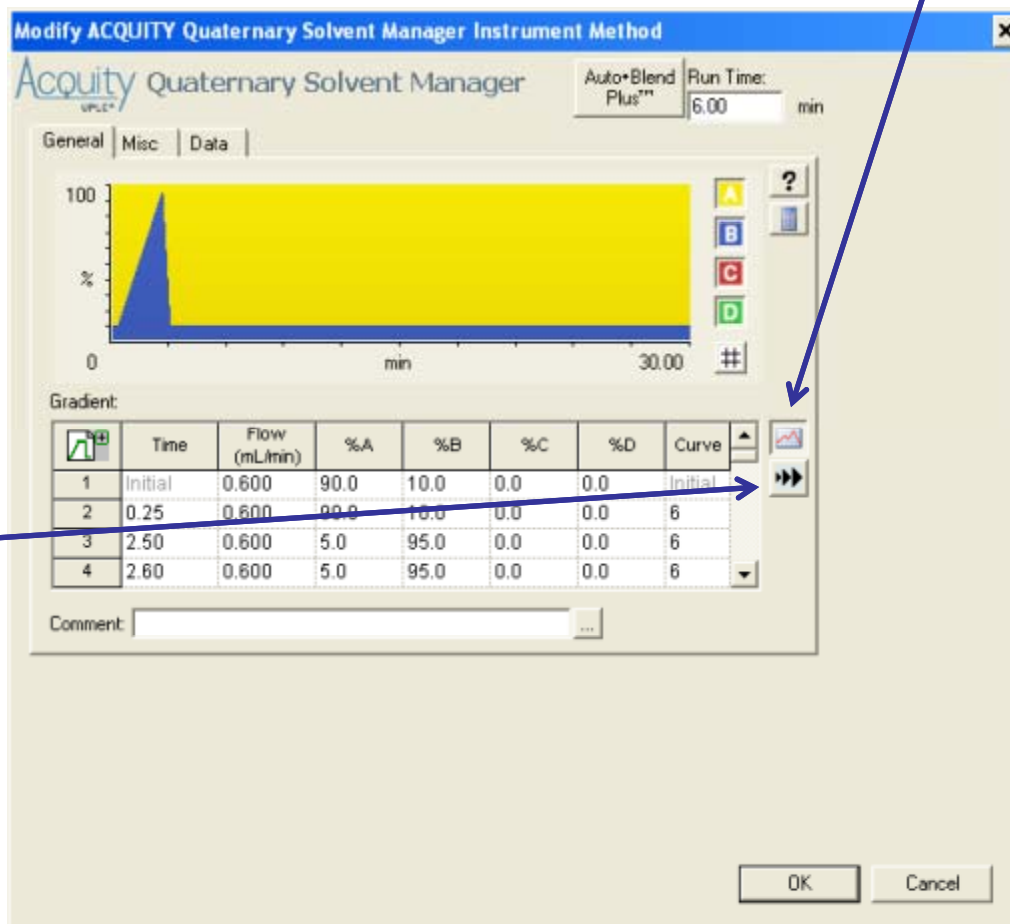


Gradient

	Time	Flow (mL/min)	%A	%B	%C	%D	Curve
1	Initial	0.600	90.0	10.0	0.0	0.0	Initial
2	0.25	0.600	90.0	10.0	0.0	0.0	6
3	2.50	0.600	5.0	95.0	0.0	0.0	6
4	2.60	0.600	5.0	95.0	0.0	0.0	6
5	3.00	0.600	90.0	10.0	0.0	0.0	6
6	30.00	0.000	90.0	10.0	0.0	0.0	11
7							
8							
9							
10							
11							
12							
13							
14							
15							

OK Cancel

The entire gradient table can be viewed in one window (as shown above) by clicking this button.



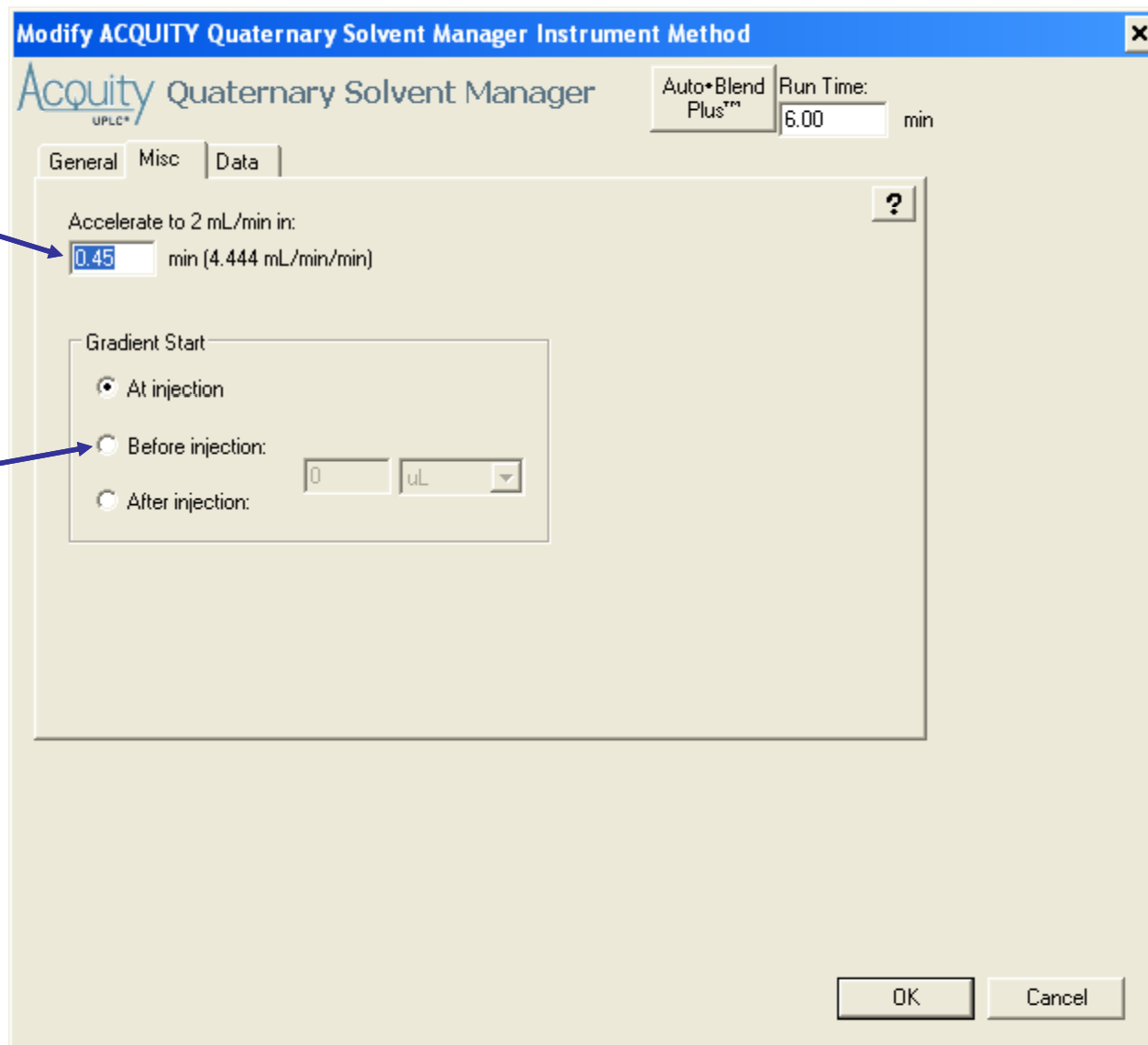
The gradient table can be viewed in graphical format (as shown) by clicking this button.

QSM Instrument Method-Misc Tab



A flow acceleration rate can be entered in this field. Once downloaded to the QSM the flow rate will ramp up at the prescribed rate.

Gradient Start- Specifies the volume the injection will be delayed (Before Injection) or the initial conditions held (After injection) The ACQUITY Calculator will recommend a value if the proper parameters are specified. Field was formally known as Pre-InjectionVolume.



The screenshot shows the 'Modify ACQUITY Quaternary Solvent Manager Instrument Method' dialog box with the 'Misc' tab selected. The 'AutoBlend Plus™' button is visible. The 'Run Time' is set to 6.00 min. The 'Accelerate to 2 mL/min in:' field is set to 0.45 min (4.444 mL/min/min). The 'Gradient Start' section has three radio buttons: 'At injection' (selected), 'Before injection:', and 'After injection:'. The 'Before injection:' field is set to 0 uL. The 'OK' and 'Cancel' buttons are at the bottom right.

Modify ACQUITY Quaternary Solvent Manager Instrument Method

Acquity Quaternary Solvent Manager

AutoBlend Plus™ Run Time: 6.00 min

General Misc Data

Accelerate to 2 mL/min in: 0.45 min (4.444 mL/min/min)

Gradient Start

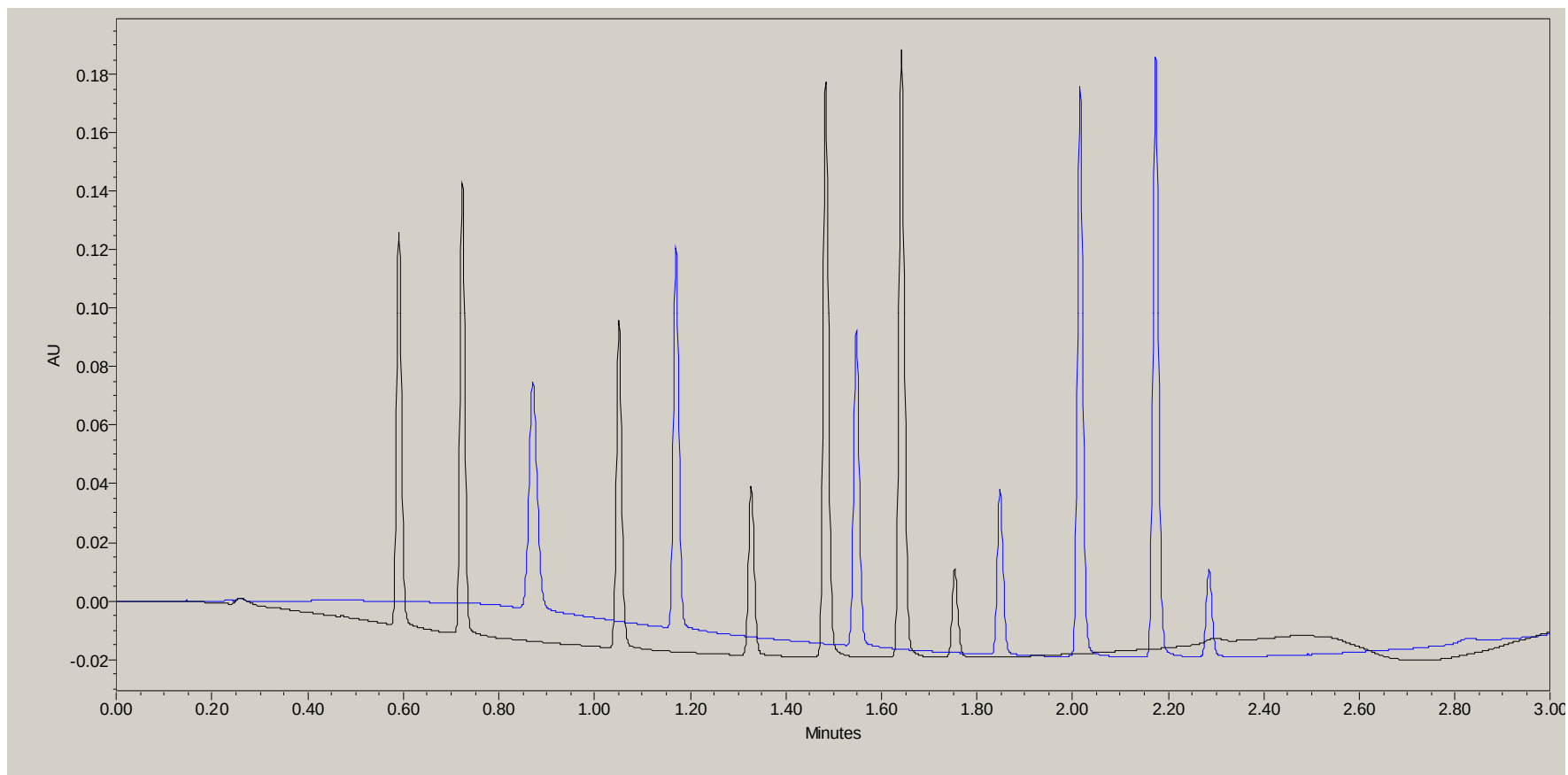
☒ At injection

☐ Before injection: 0 uL

☐ After injection:

OK Cancel

Effect of the Pre-Injection Volume Field



Blue Chromatogram- No PI Delay

Black Chromatogram- 300ul PI Delay

QSM Instrument Method-Data Tab



Modify ACQUITY Quaternary Solvent Manager Instrument Method

Acquity Quaternary Solvent Manager

Auto-Blend Plus™ Run Time: 6.00 min

General Misc Data

Select data channels to acquire: ☒ Show diagnostics ?

Channel	Description
☐ System Pressure	Overall solvent pressure (psi)
☐ Flow Rate	System flow rate set point (mL/min)
☐ % A	% composition setting of solvent A
☐ % B	% composition setting of solvent B
☐ % C	% composition setting of solvent C
☐ % D	% composition setting of solvent D
☐ Primary	Primary (left head) (psi)
☐ Accumulator	Accumulator (right head) (psi)
☐ Degasser	Solvent degasser pressure (psi[a])

OK Cancel

Select the QSM diagnostic data channels to acquire. These will be saved as independent channels in Empower or MassLynx. Note: some of the above channels are enabled for beta testing only and will not be available in the released product.

QSM Dynamic Leak Test



Leak Test

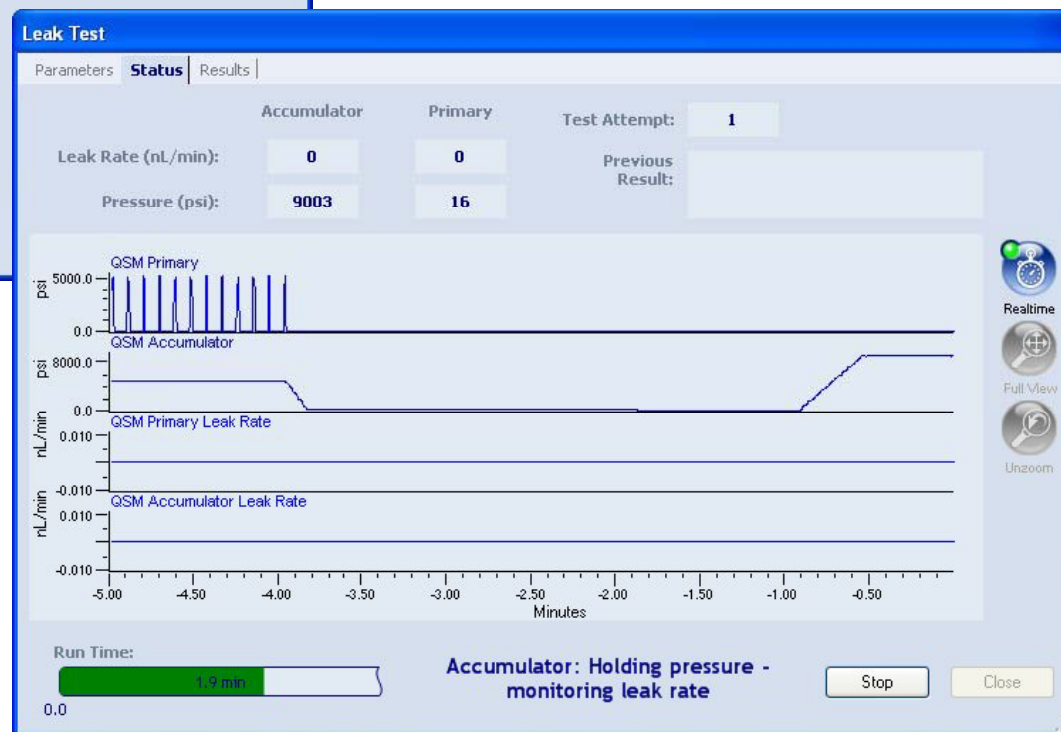
Parameters | Status | Results

Pressure
Accumulator: psi
Primary: 12000 psi

Solvent
A ☒
B ☐
C ☐
D ☐
☒ Prime

End Point
☒ Vent Valve
☐ Column (Active Pre-heater Outlet)
☒ Include Sample Manager Needle and Seal

Retry the test if it fails, up to a maximum of additional attempts.



QSM Dynamic Leak Test Results



Leak Test		
Parameters Status Results		
	Accumulator	Primary
Result:	Passed	Passed
Leak Rate:	20 nL/min	16 nL/min
Maximum Pressure:	9161 psi	7027 psi
Percent of Stroke:	9 %	8 %
Compressed Volume:	5 uL	4 uL
Compression Attempts:	1	1
Test Attempts:	1	

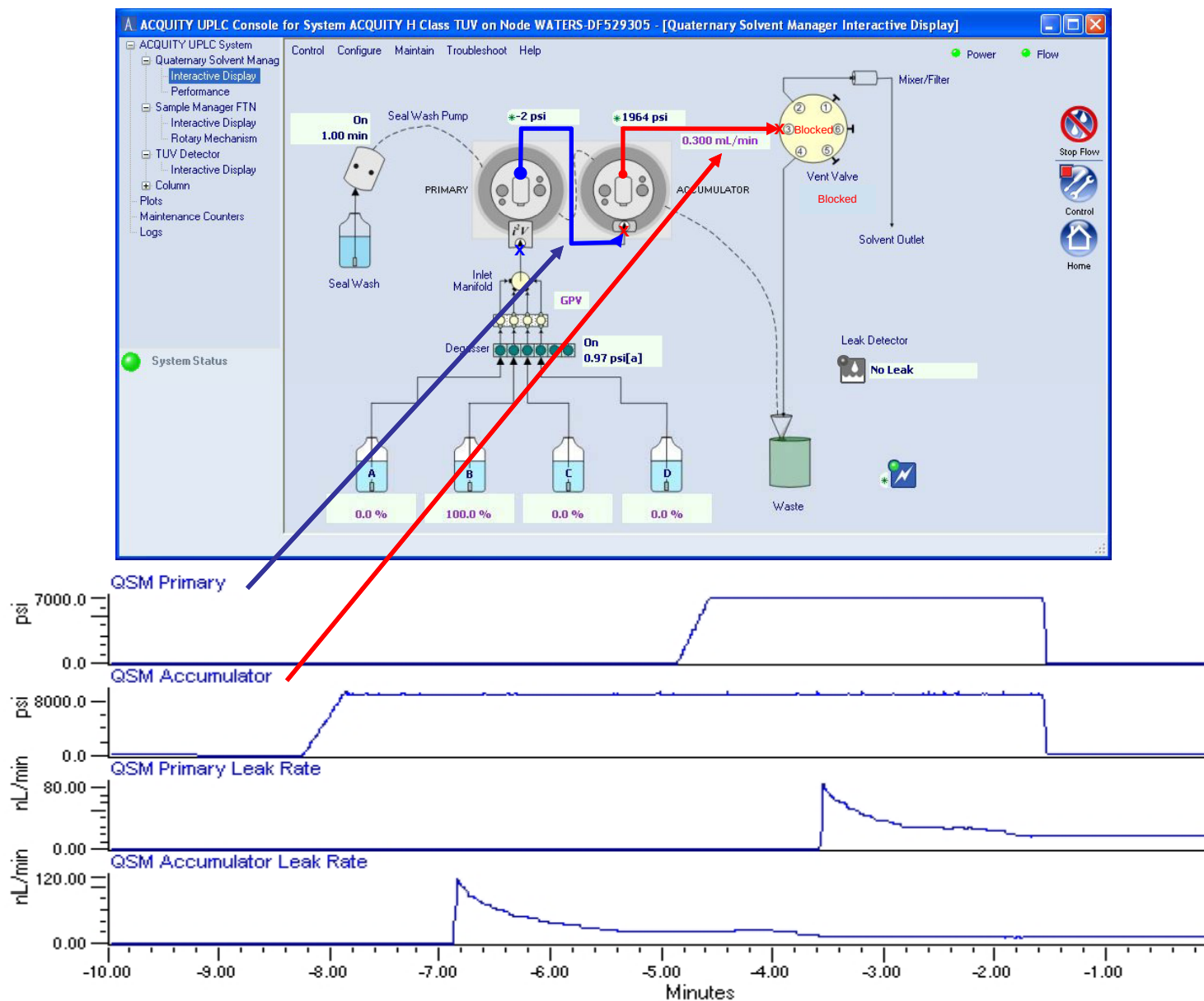
Print

Start Close

The criteria for passing the leak test is a leak rate less then **150nl / min** when testing to the QSM Vent Valve.

When testing to the column, the criteria for passing the leak test is a leak rate less then **300nl / min**.

QSM Dynamic Leak Test Plot



QSM Dynamic Leak Test Results



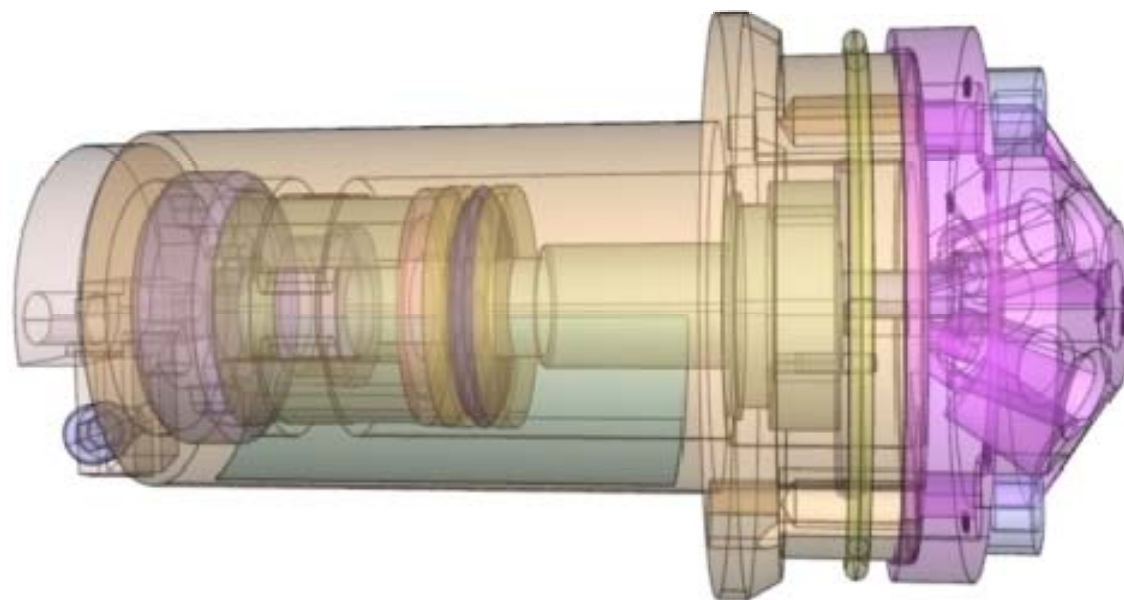
	Accumulator	Primary
Result:	Passed	Passed
Leak Rate:	20 nL/min	16 nL/min
Maximum Pressure:	9161 psi	7027 psi
Percent of Stroke:	9 %	8 %
Compressed Volume:	5 uL	4 uL
Compression Attempts:	1	1
Test Attempts:	1	

Print Start Close

The criteria for passing the leak test is a leak rate less then **150nl / min** when testing to the QSM Vent Valve.

When testing to the column, the criteria for passing the leak test is a leak rate less then **300nl / min**.

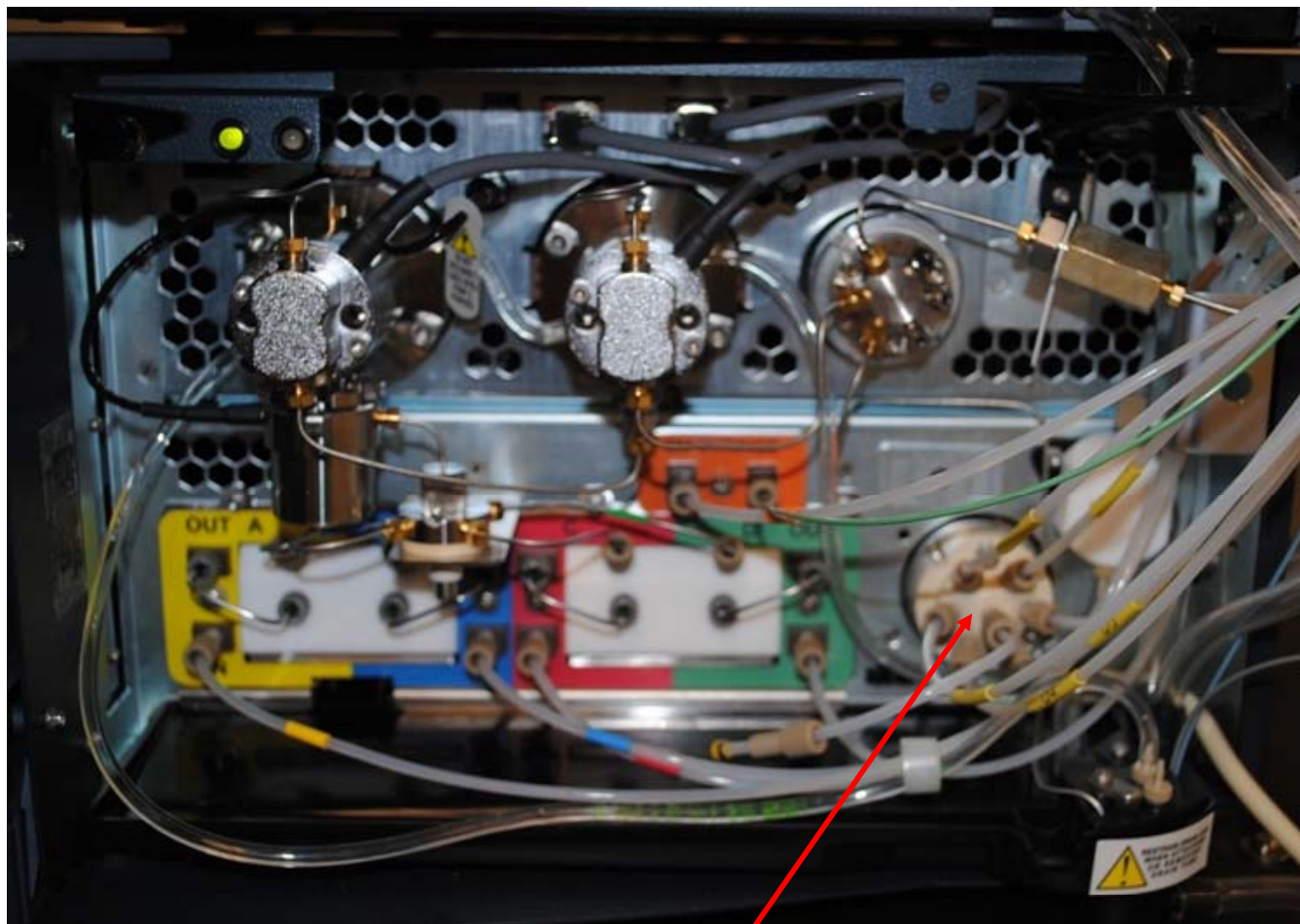
Solvent Select Valve Cartridge



Optional Solvent Select Valve



The optional Solvent Select Valve provides the ability to select between 5 different solvents for the “D” line. It has the same components as the Vent Valve. The pod assembly is of course different.

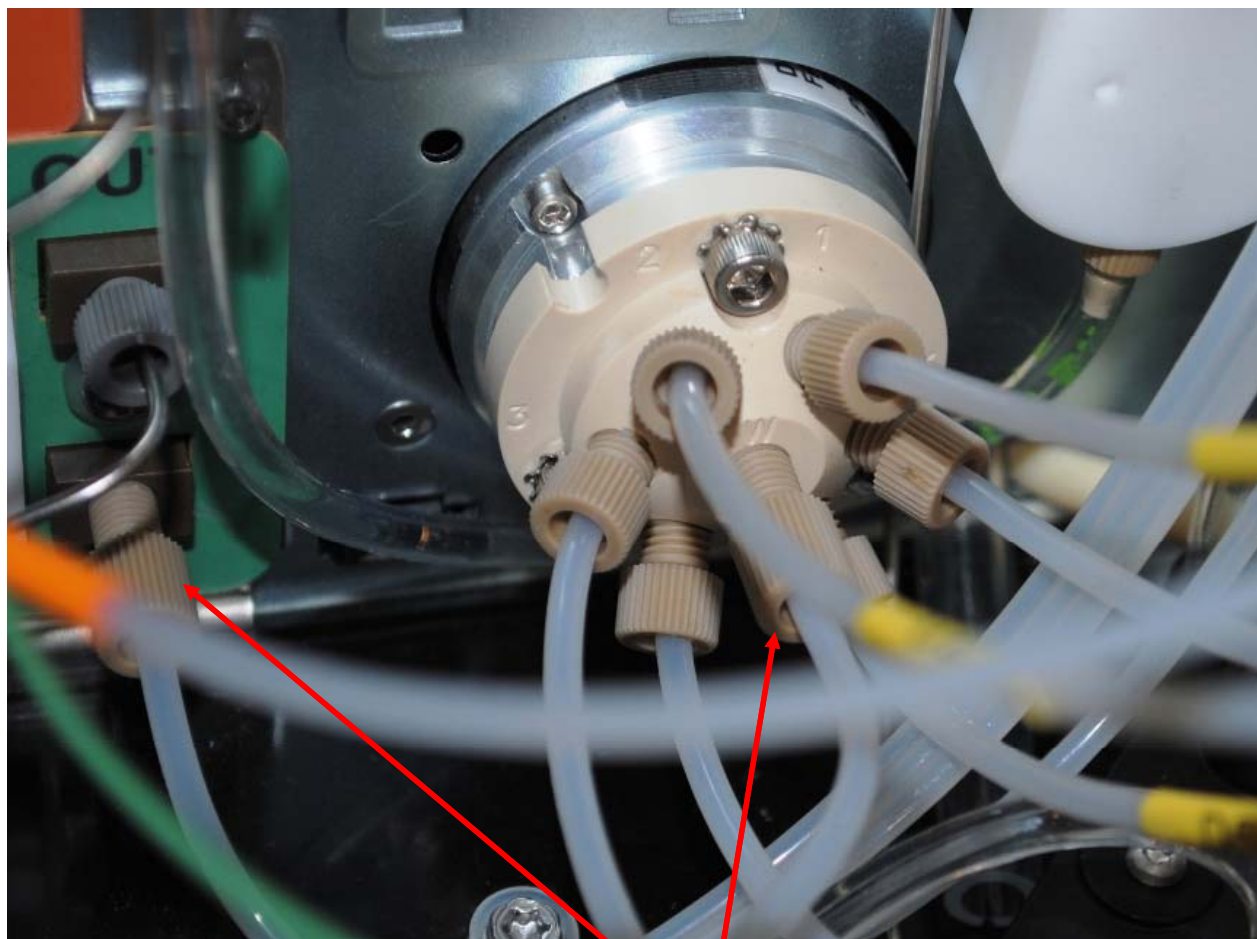


Solvent Select Valve

Solvent Select Valve



The solvents are switched before entering the degasser assembly.



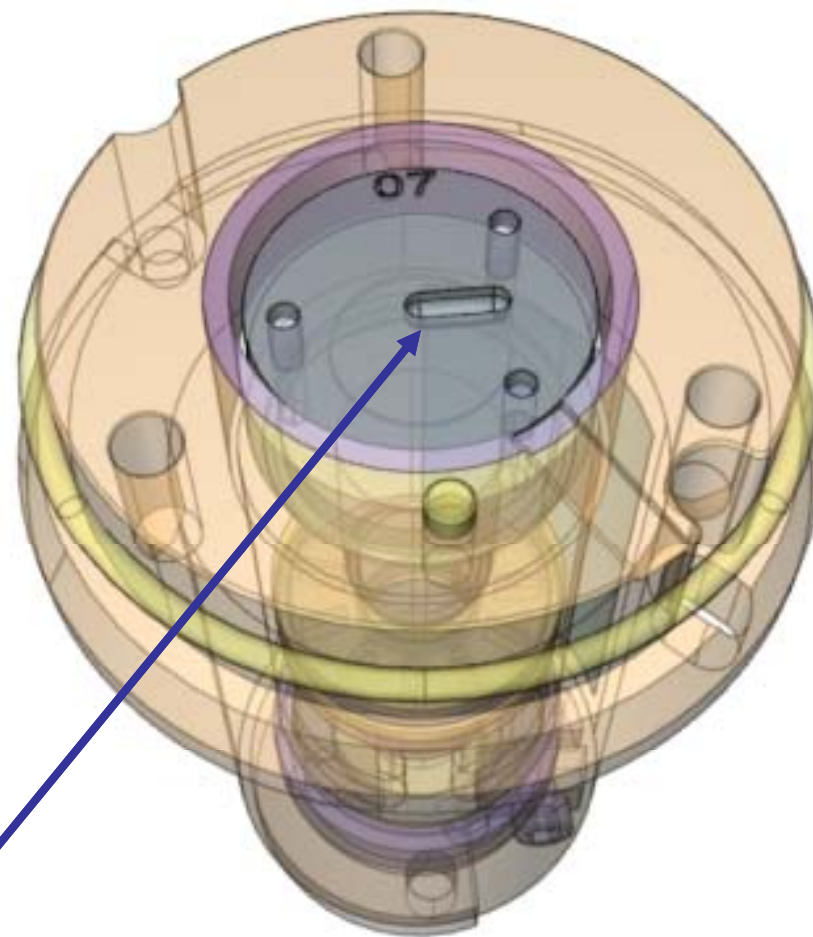
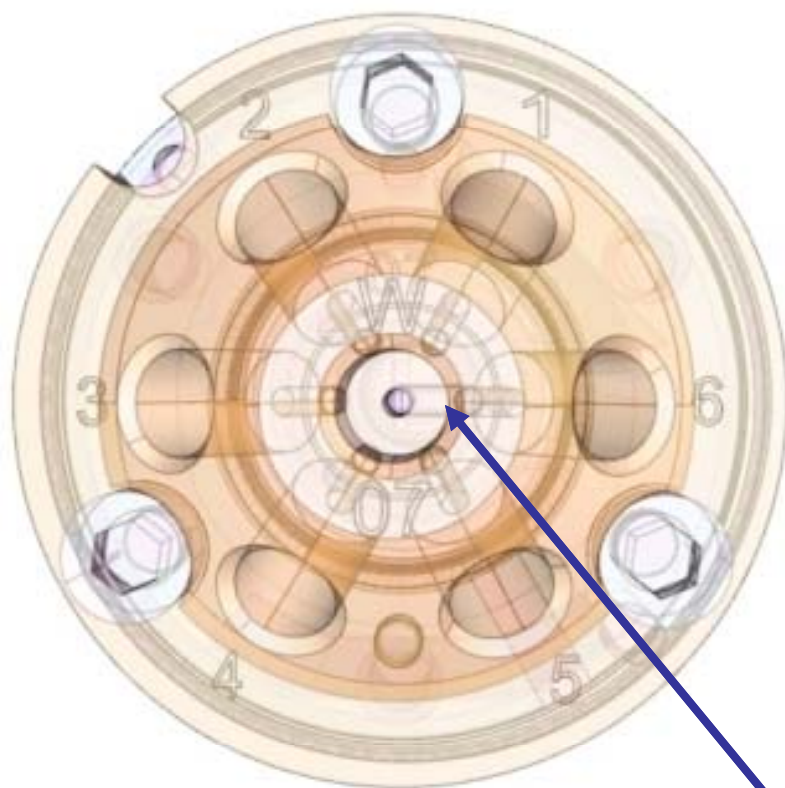
To D Line Degasser

Solvent Select Valve Cartridge



Rotor and Stator
(Transparent View)

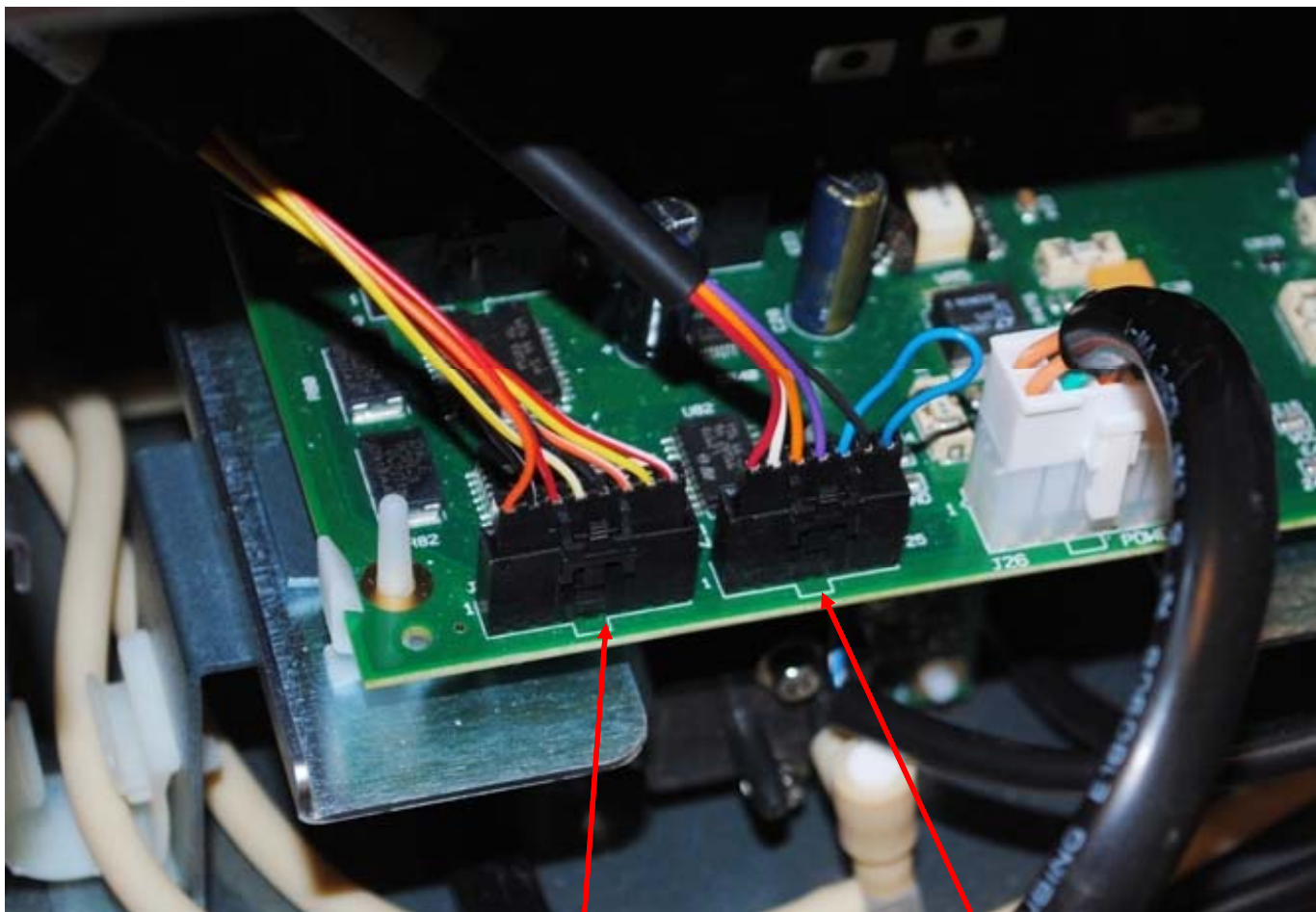
Rotor
(with Stator removed)



Rotor Channel

The clock style rotor channel connects one solvent at a time to the center port.

Solvent Select Valve PCB Connections



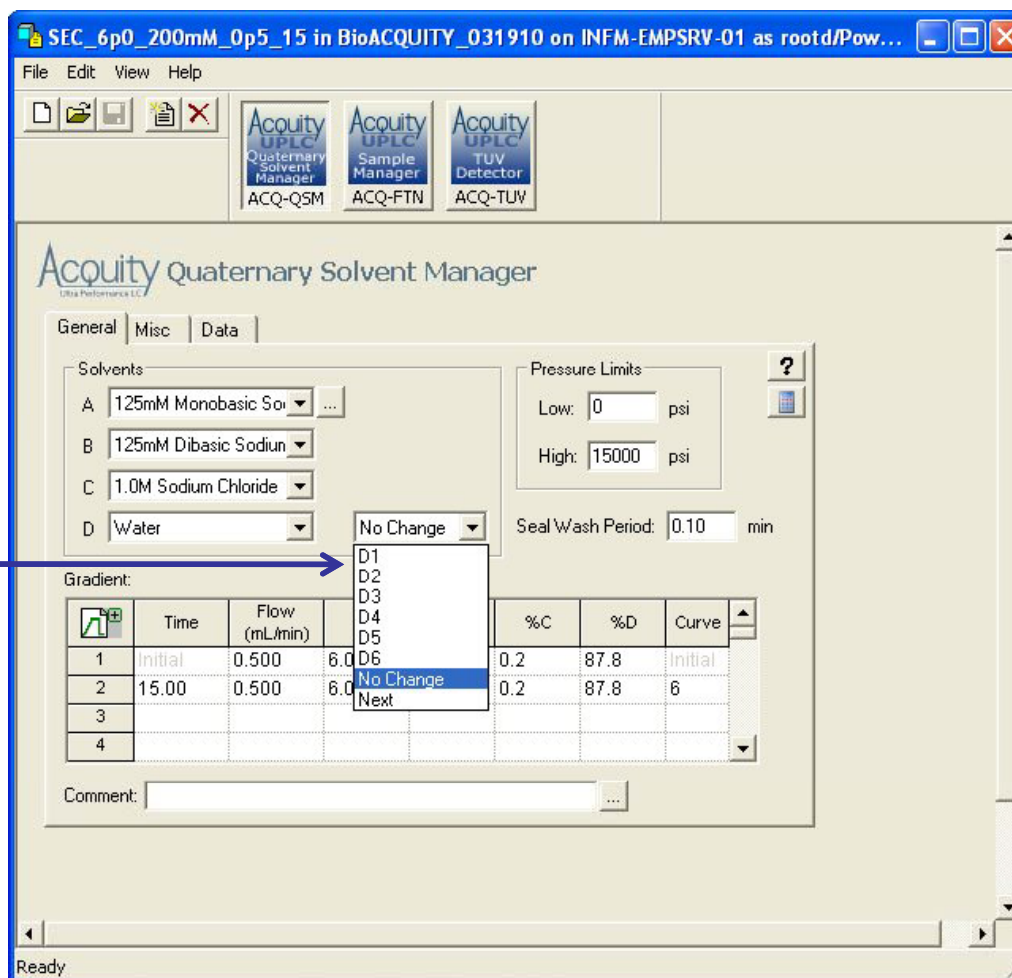
SSV Motor Connection

SSV Encoder Connection

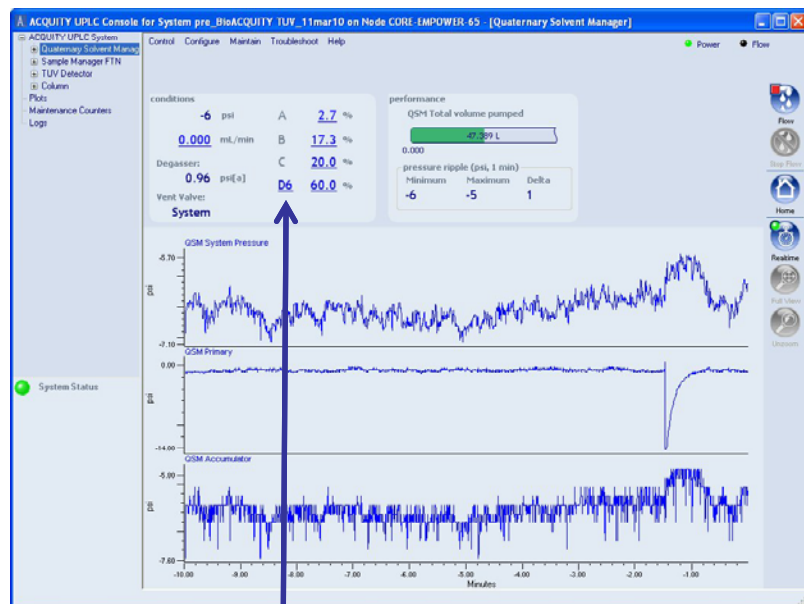
QSM Instrument Method- SSV Enabled



“D” Solvent Selection Menu
This menu becomes active when the optional SSV is installed and detected by the QSM. Once selected, the solvent will be used for the D line until another method is loaded or it is switched in the console.

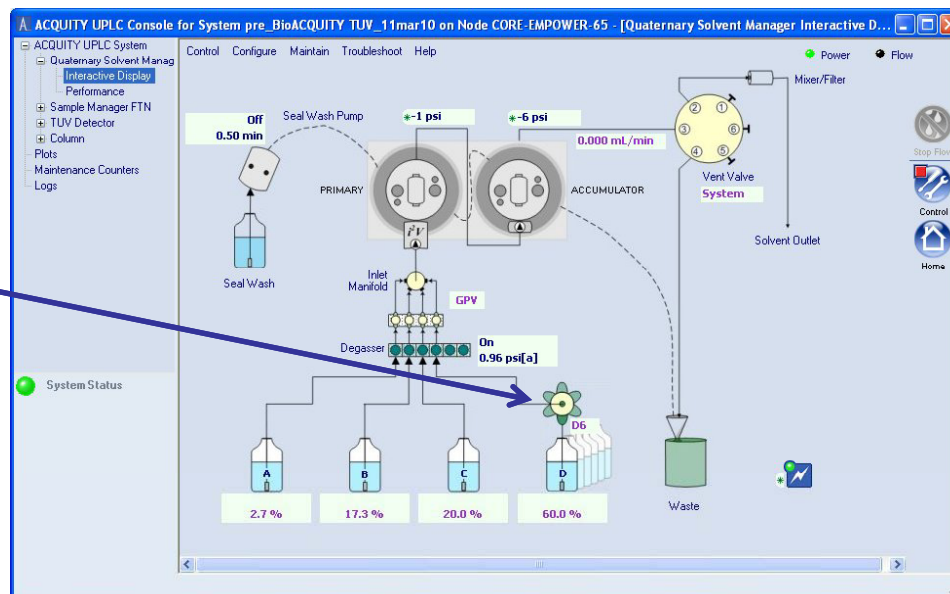


QSM Console Menu- SSV Enabled

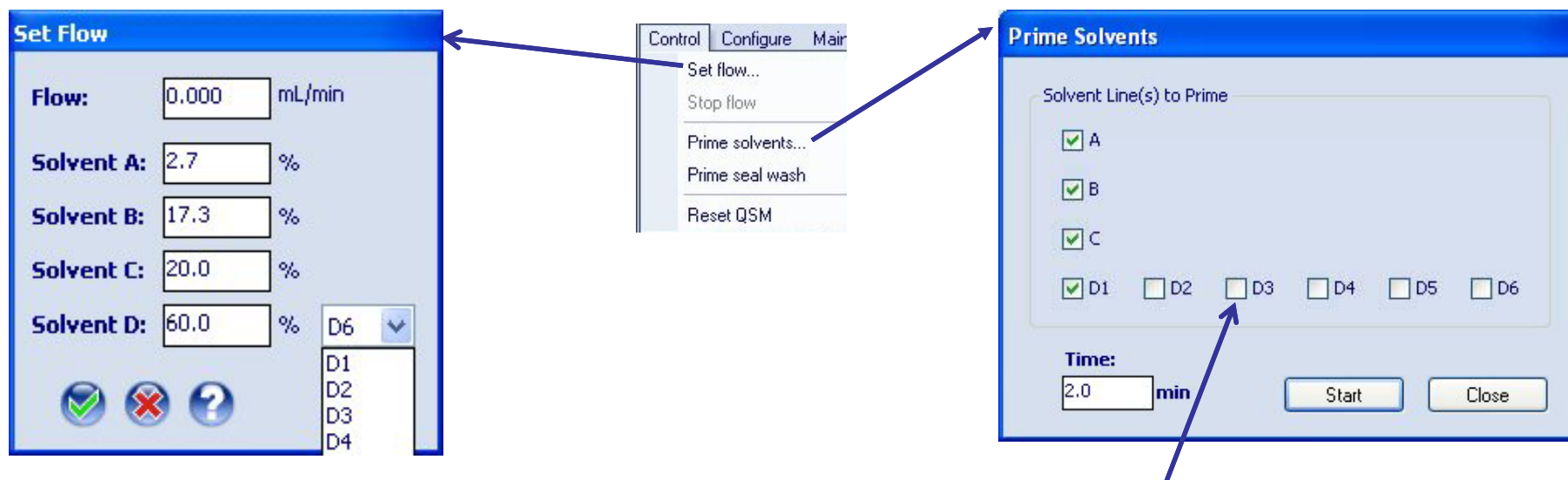


"D" Solvent Status Indicators

The current D line selected is indicated in the QSM top level and Interactive console menus.



Set Flow and Prime Solvents- SSV



"D" Solvent Selection Checkbox
In addition to lines A,B and C, each D line checked will be individually primed for the time specified in the menu above.

QSM Workbook Section



- Familiarize yourself with PM procedures
- Perform key new service procedures
- Disassemble the unit as desired
- Reassemble and run diagnostics
- **Cautions**
 - Do not take apart individual degasser chambers
 - Be careful not to cross-thread the GPV outlet fitting