

Binary Solvent Manager



BSM Overview

Waters
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- Low volume flow path
 - ~150 ul
- UPLC™ pressure capabilities
 - Up to 15,000 PSI
- Serial/parallel Flow Path
- 50ul Zirconia Bead Mixer
- Full console user diagnostics



- Fluidics
 - Inlet filters
 - Two Serial solvent managers
 - Pressure Transducers
 - Filter-Tee-Mixer
 - V-detail fittings
 - Waste Management System Solvent Degasser
- Six Channel Degasser Chamber
 - Pump, control board and transducer
- Electronics
 - Electronics control
 - Power distribution
- Software

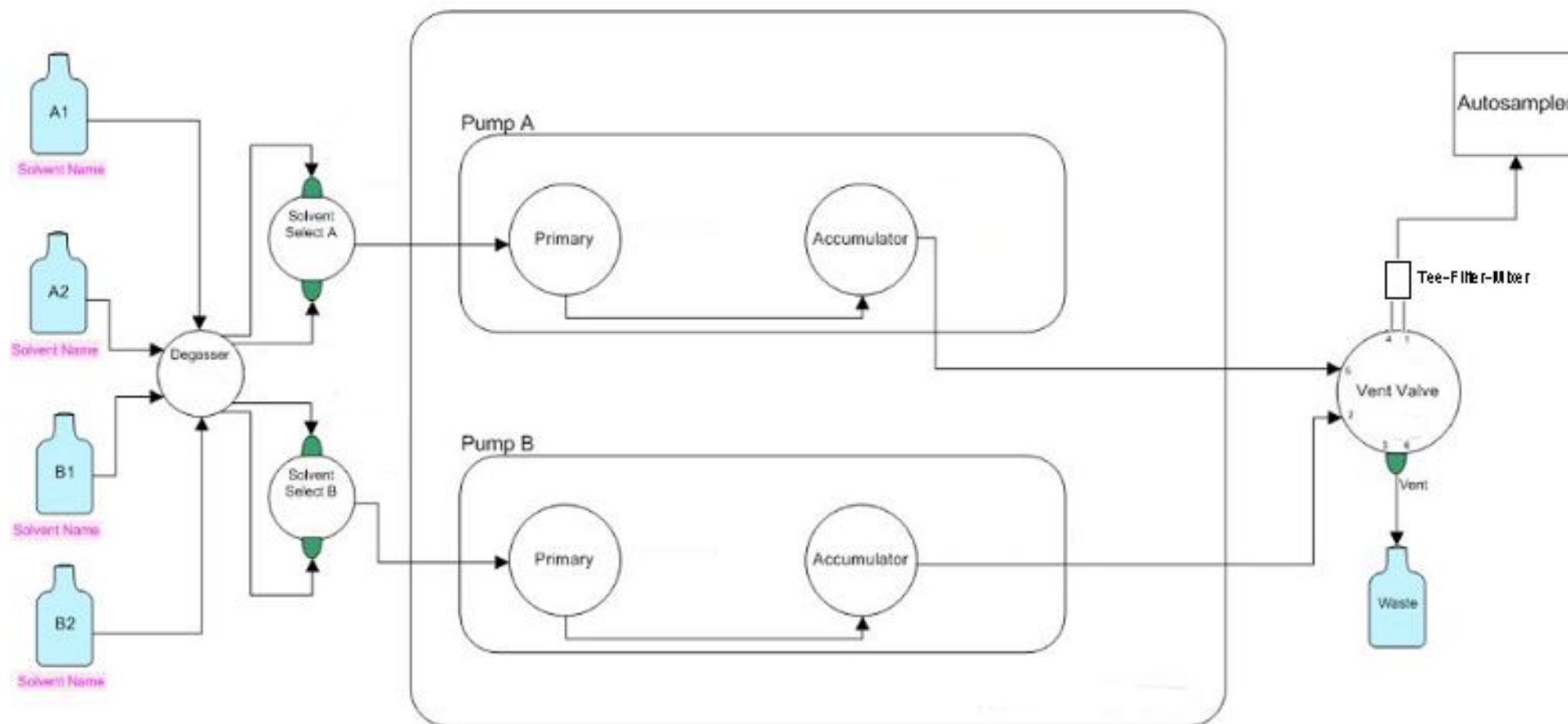
Serial Pumps Plumbed in Parallel

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- Two independently driven **primary** and **accumulator** piston drives plumbed in parallel
- Four Solvents Capability
 - A1 or A2 and B1 or B2
 - **Two solvents per gradient**
- Six Channel Degasser
 - 4 chromatographic eluents
 - 2 solvents for Sample Manager
 - Strong & weak wash

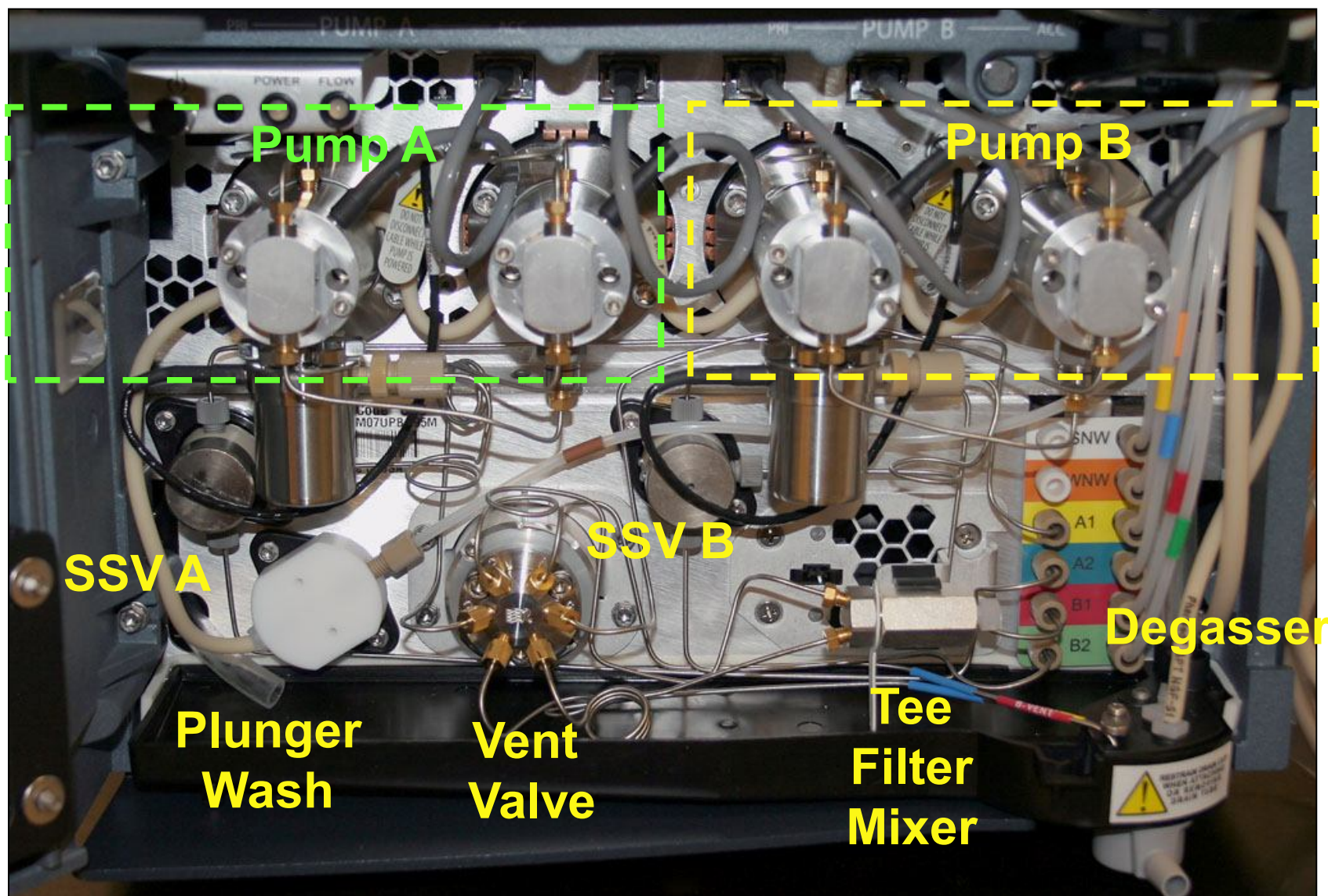
Binary Solvent Manager Flow Path

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BSM- Front View

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Single Pump Velocity Profile

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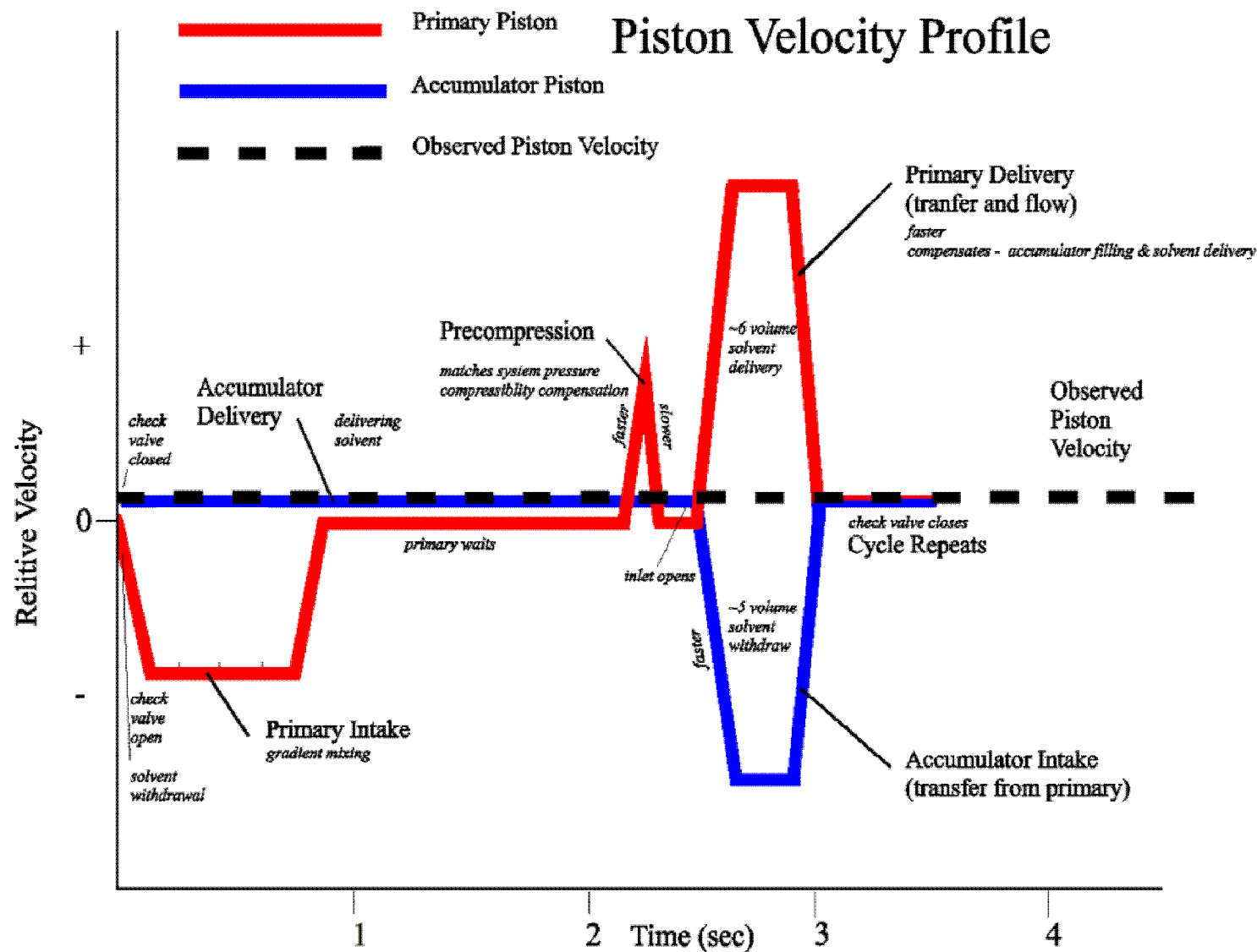
Single Pump Velocity Profile

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Single Pump Velocity Profile

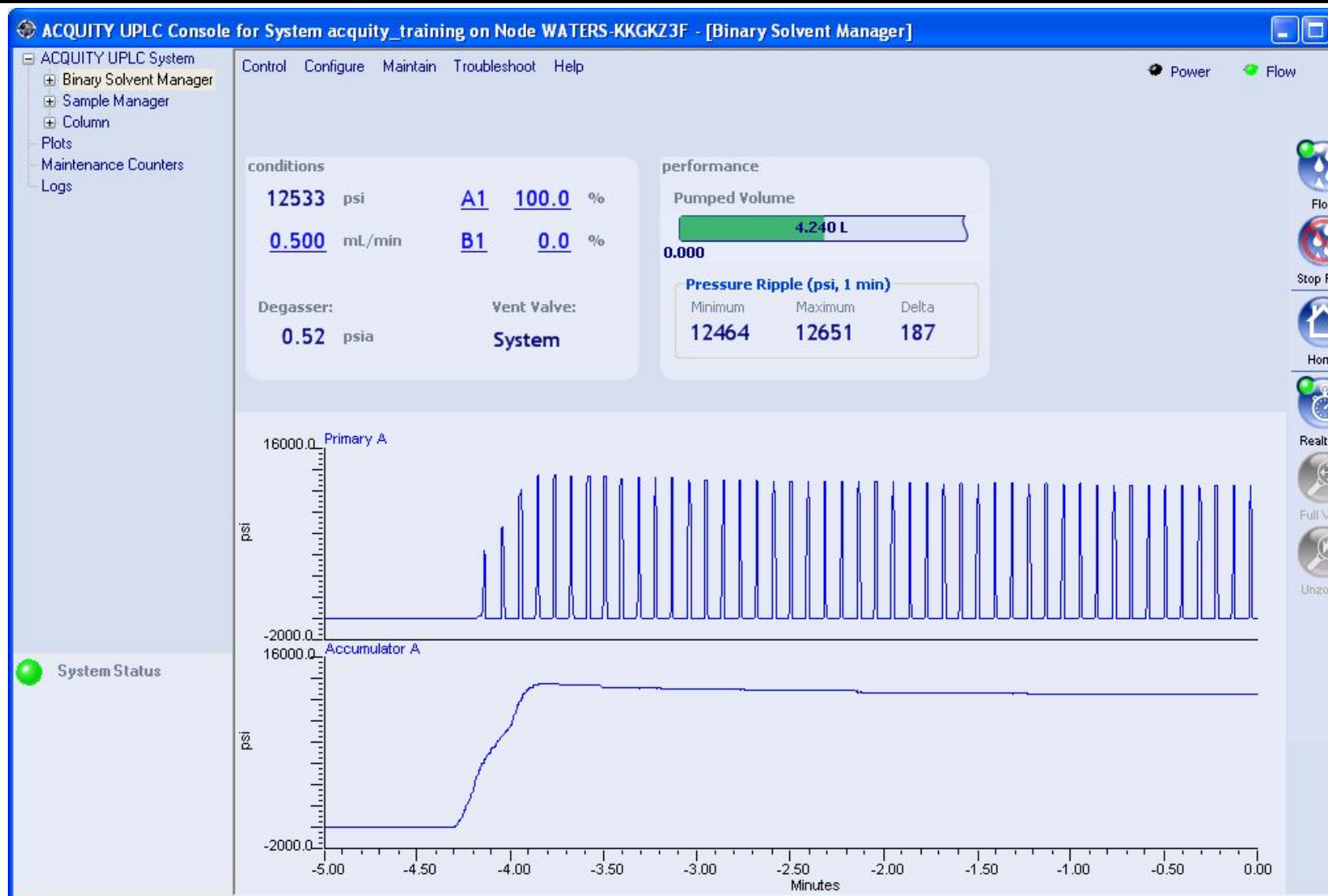
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- 1. Solvent is degassed by the inline vacuum degasser.
- 2. The solvents (A1 or A2 and B1 or B2) flow through the inlet check valve into the primary piston chamber while the accumulator piston delivers solvent under pressure to the system pressure transducer.
- 3. Just before the accumulator chamber empties, the solvent in the primary piston chamber is pre-compressed to a pressure slightly less than that indicated by the system pressure transducer.
- 4. When the accumulator piston chamber is empty, the primary piston delivers solvent under pressure through the primary pressure transducer, refills the accumulator piston chamber, and delivers solvent under pressure through the system pressure transducer, while maintaining a constant flow through the system. The cycle repeats, beginning at step 2.
- 5. The system pressure transducer measures the operating pressure. A software algorithm compares the primary head pressure and the system pressure readings and regulates the pre-compression step to balance the pressures, providing a smooth, ripple-free flow.
- 6. Flow continues from the system pressure transducer outlet to the vent valve and into an the filter/mixer/tee assembly where the solvents are mixed.
- 7. The solvent flow proceeds to the sample manager.

Single Pump Pressure Example

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Monitoring all pressure traces

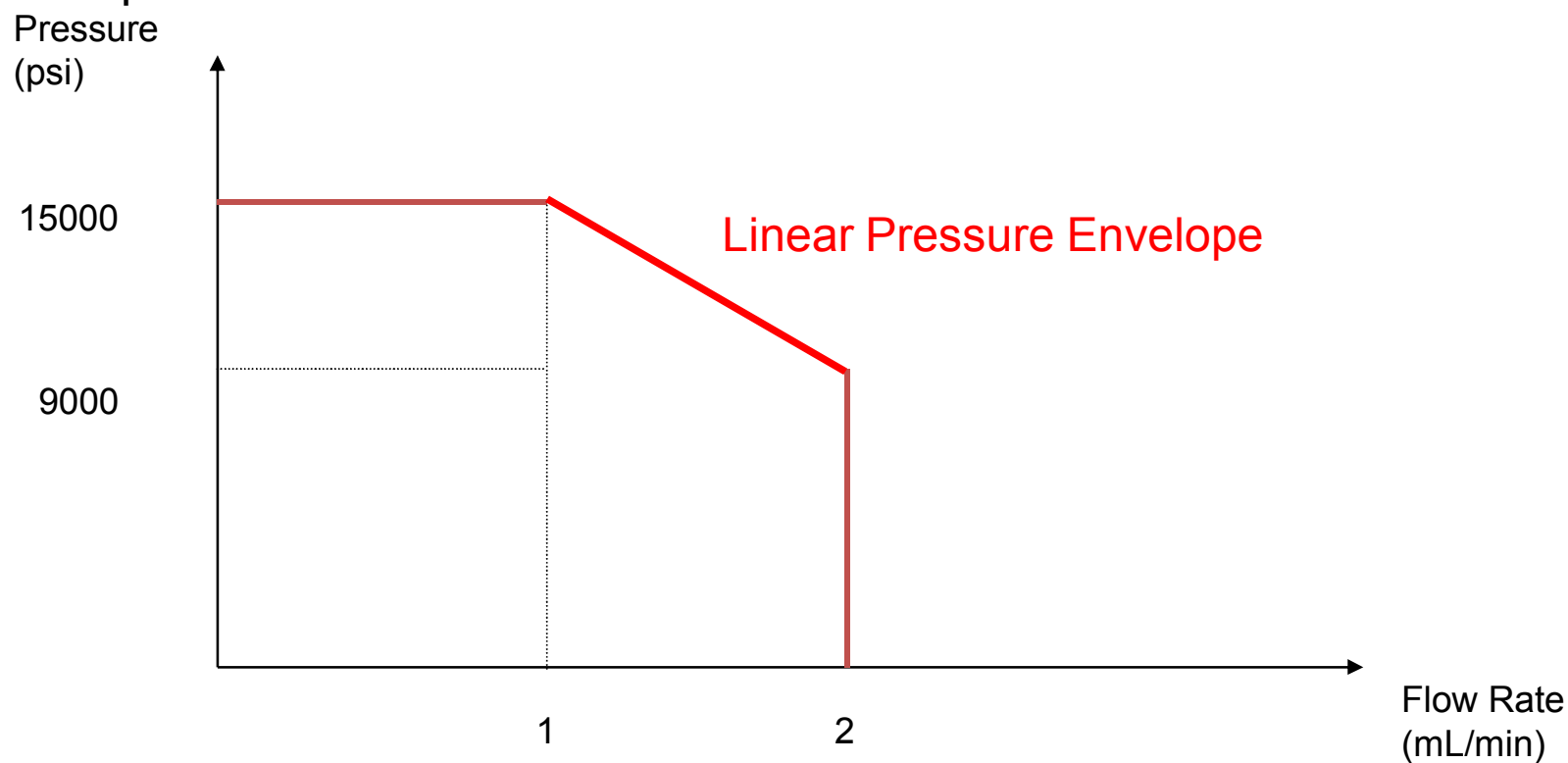
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Pump Performance Envelope

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- UPLC™ auto-adjusts pressure limits from 1 – 2mls/minutes
- Fluidic components optimized to support the pressure demands of UPLC™ separations
 - Seals, head, bolts, check valves, fittings, tubing, mixer, pressure transducers



High Pressure Limit Adjusts

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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					

Comment:

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

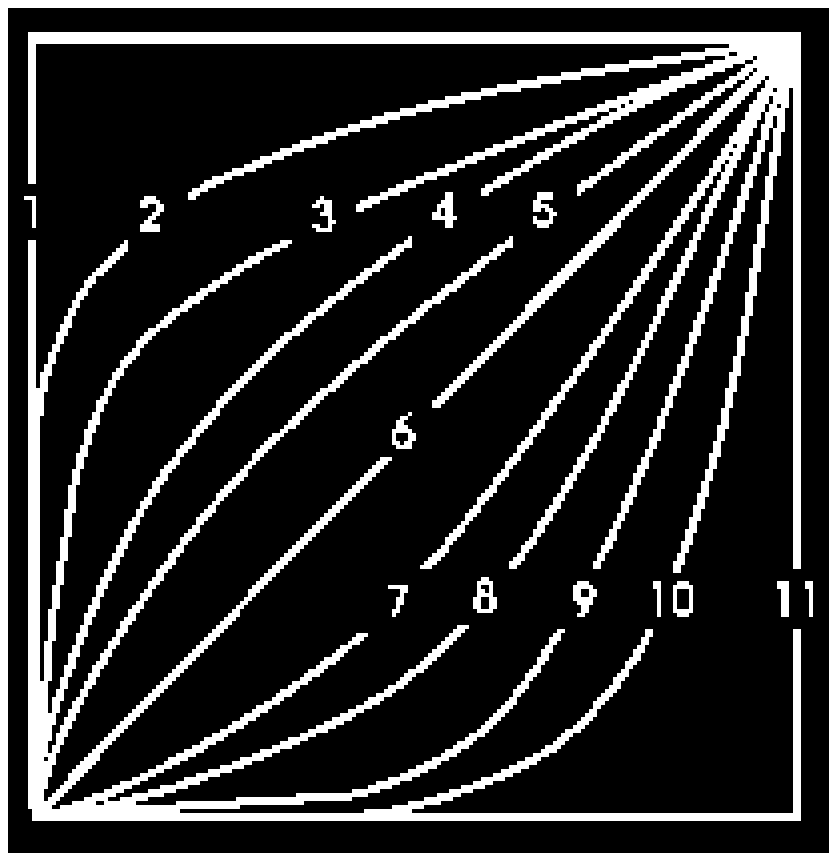
2.000	95.0	5.0	Initial

Comment:

ACQUITY UPLC™ Non-Linear Gradient Capability

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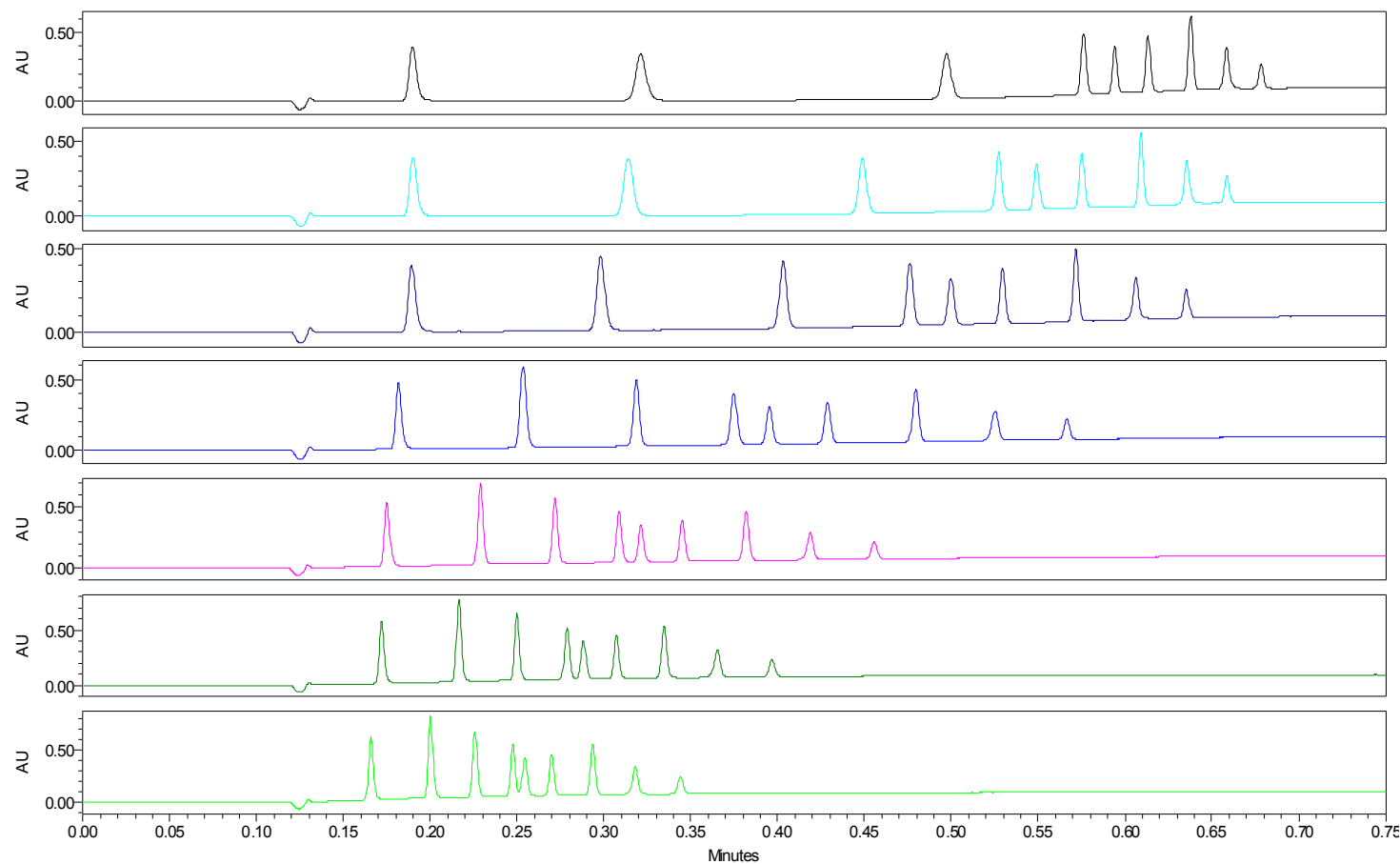
Gradient Profiles on ACQUITY UPLC™



Curve #	Effect
1	Immediately to specified condition
2 to 5	Convex
6	Linear
6 to 10	Concave
11	Maintain start conditions

Gradient Curves Have a Big Effect

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Curve 9

Curve 8

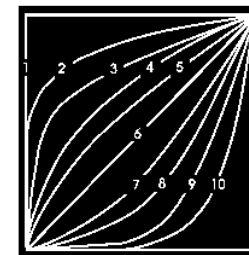
Curve 7

Curve 6

Curve 5

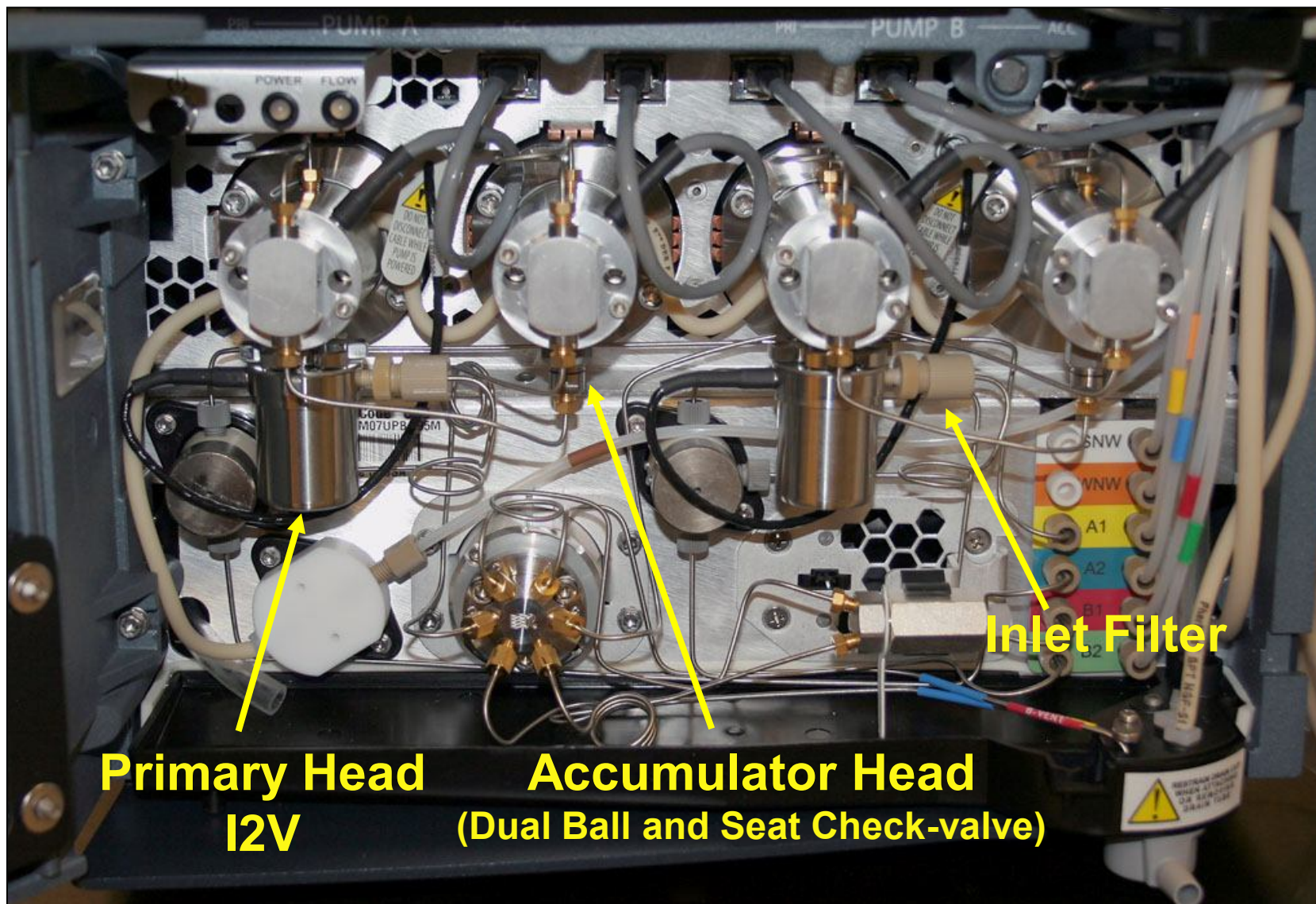
Curve 4

Curve 3



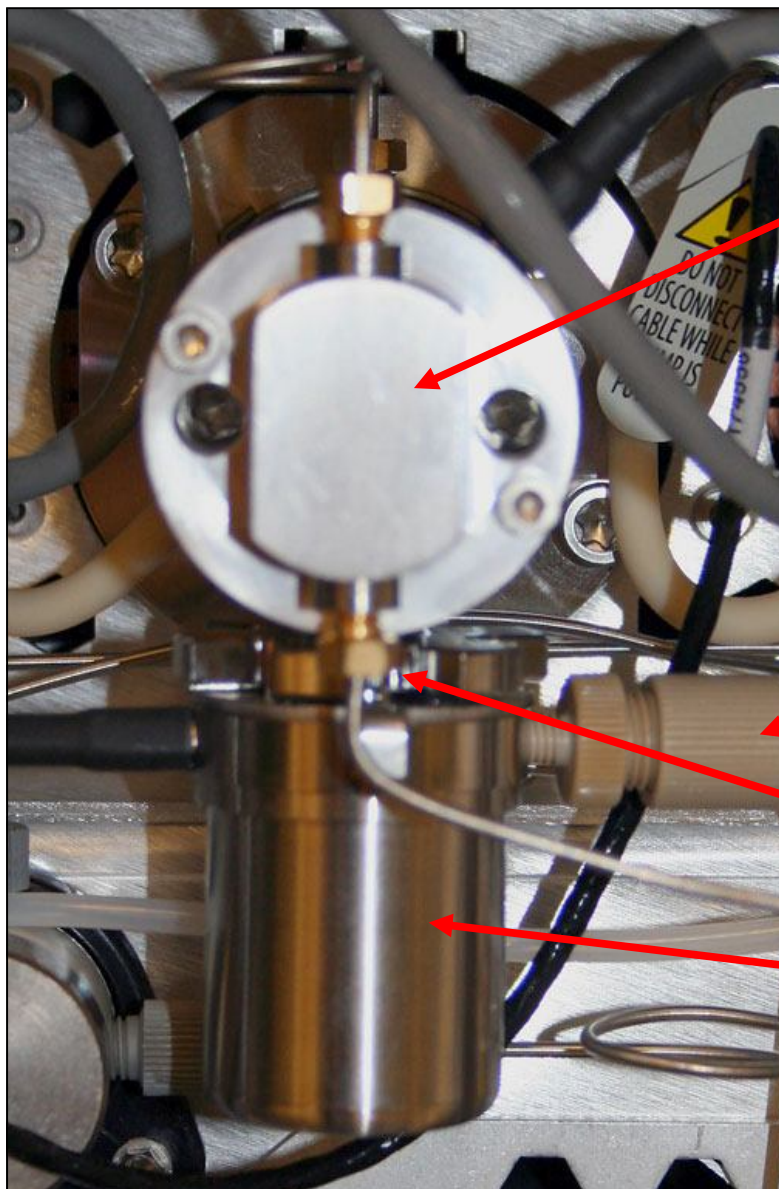
BSM- Front View

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Intelligent Intake Valve (I2V)

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Pressure Transducer

Inlet Filter

I2V Check-valve cartridge

I2V Actuator

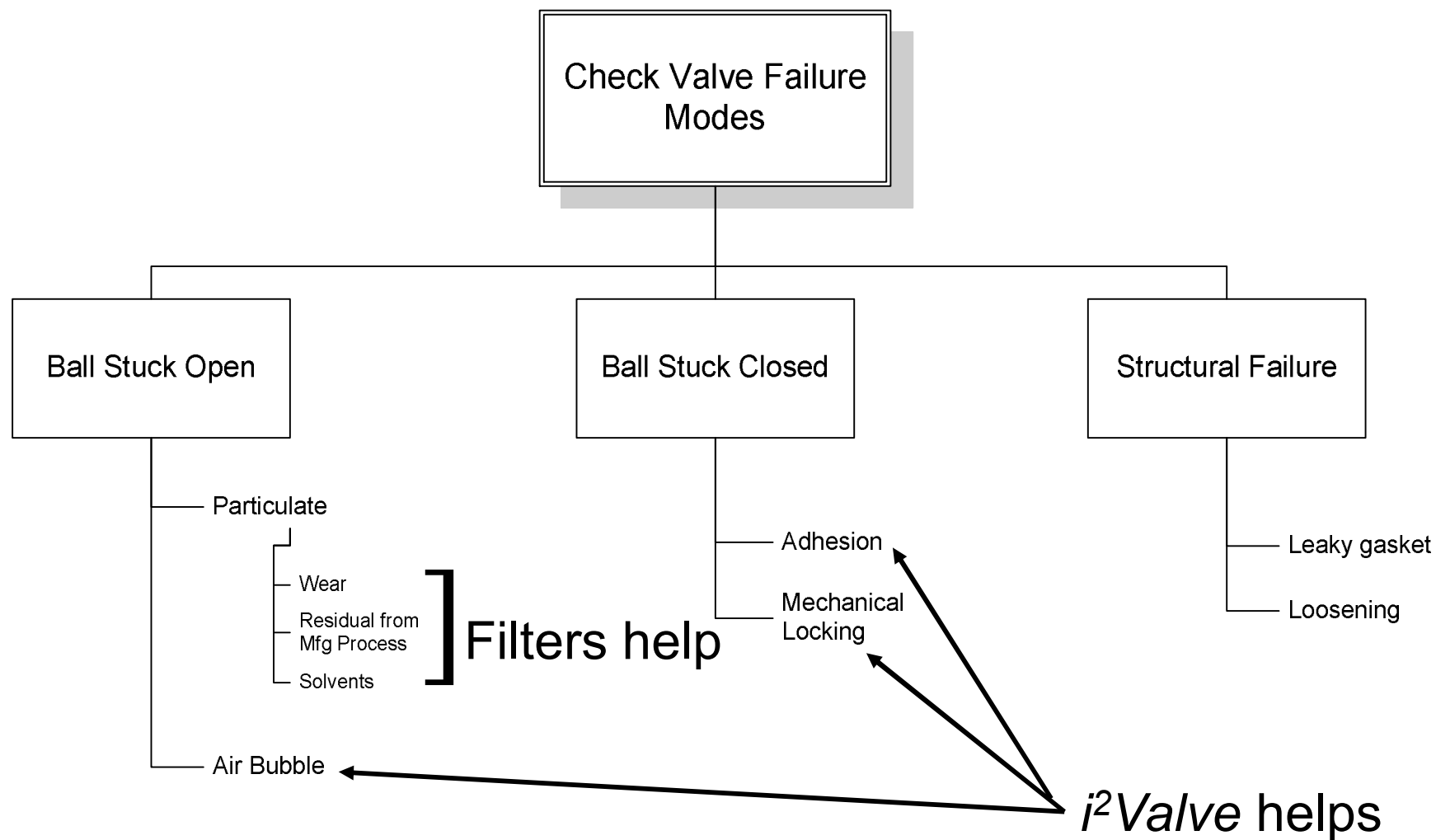
I2V Operation

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- 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

Check Valve Failure Modes

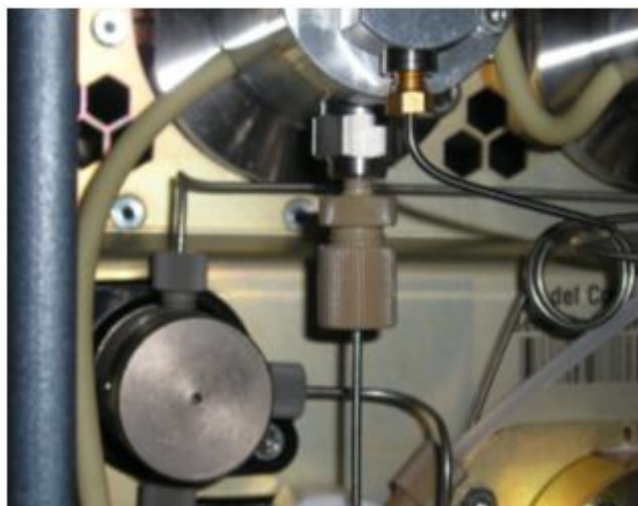
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ACQUITY UPLC BSM Inlet Filters

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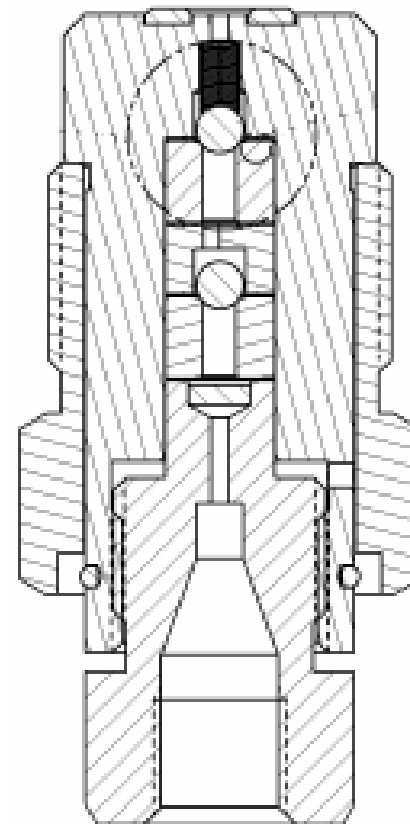
- Primary Check Valve Inlet Filters (Implemented Mar 2006)
 - Protects inlet check valve from particles
 - Thus, increases the robustness of the ACQUITY UPLC™ system
 - Part Number 700002912
 - Remain integral to ACQUITY UPLC BSM



ACQUITY UPLC BSM Dual Ball and Seat Check Valves- Accumulator

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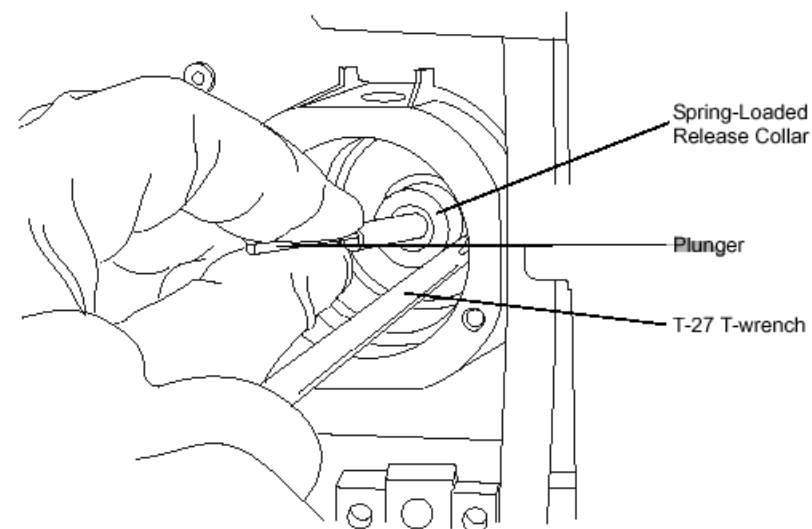
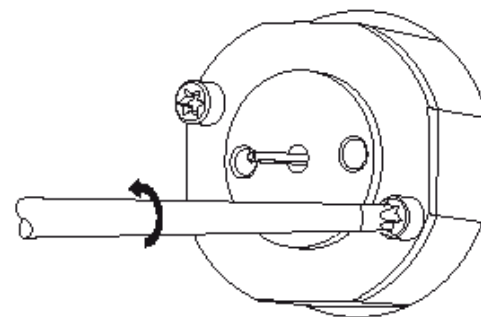
- Dual Ball and Seat Check Valve (added May 06)
 - Used on the Accumulator Head
 - Protects check valve from particles
 - Increases the robustness of the ACQUITY UPLC™ system
 - Built in redundancy
 - Part Number 700002968



Plunger and Head

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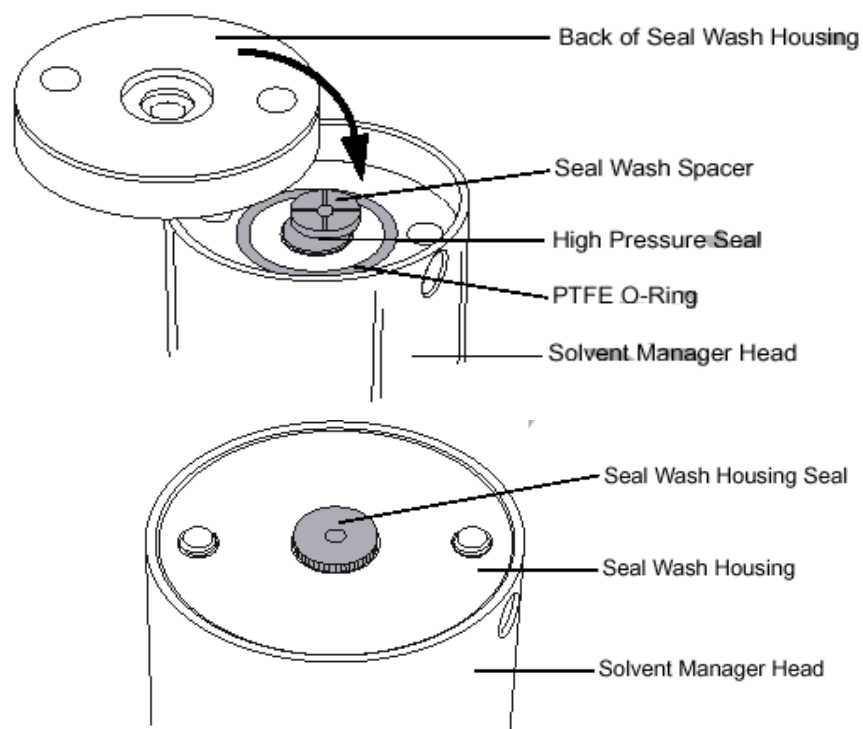
- 700002600
 - 2 per package
- 2mm Plunger Assembly
- Head Volume = 54uL



Pump Head Seals

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



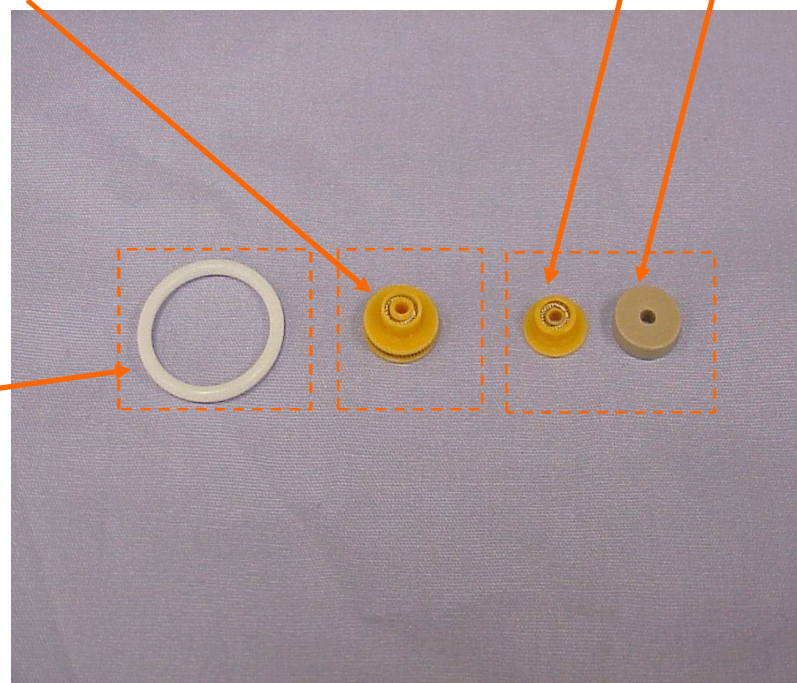
Head Seals

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- 700002598
 - 2 per package
- Seal Wash Housing Seal

- 7000002599
 - 2 per package
- Head Plunger Seal
- Seal Wash Spacer

- WAT076152
 - 1 per package
- O-Ring



Closed Waste Management System

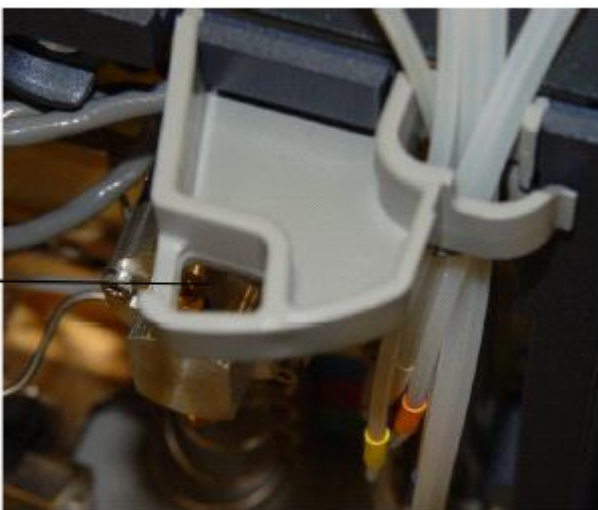
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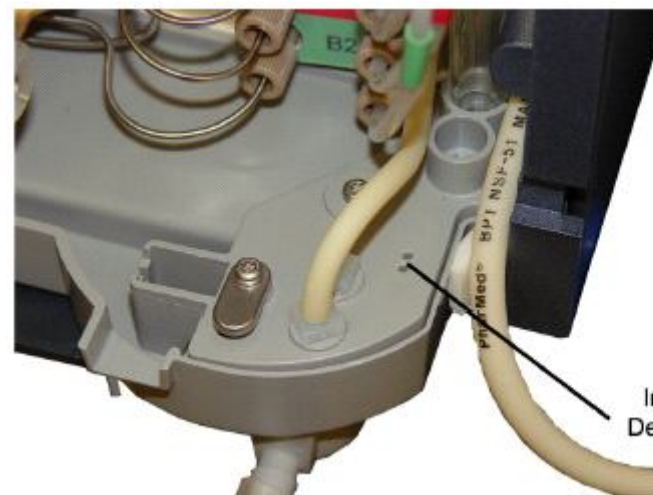
Process Waste from Sample Manager

NCS Drainage Waste

Drip Tray



Pass-through in BSM Upper Drip Tray



Insert PEEK Detector Outlet Tubing

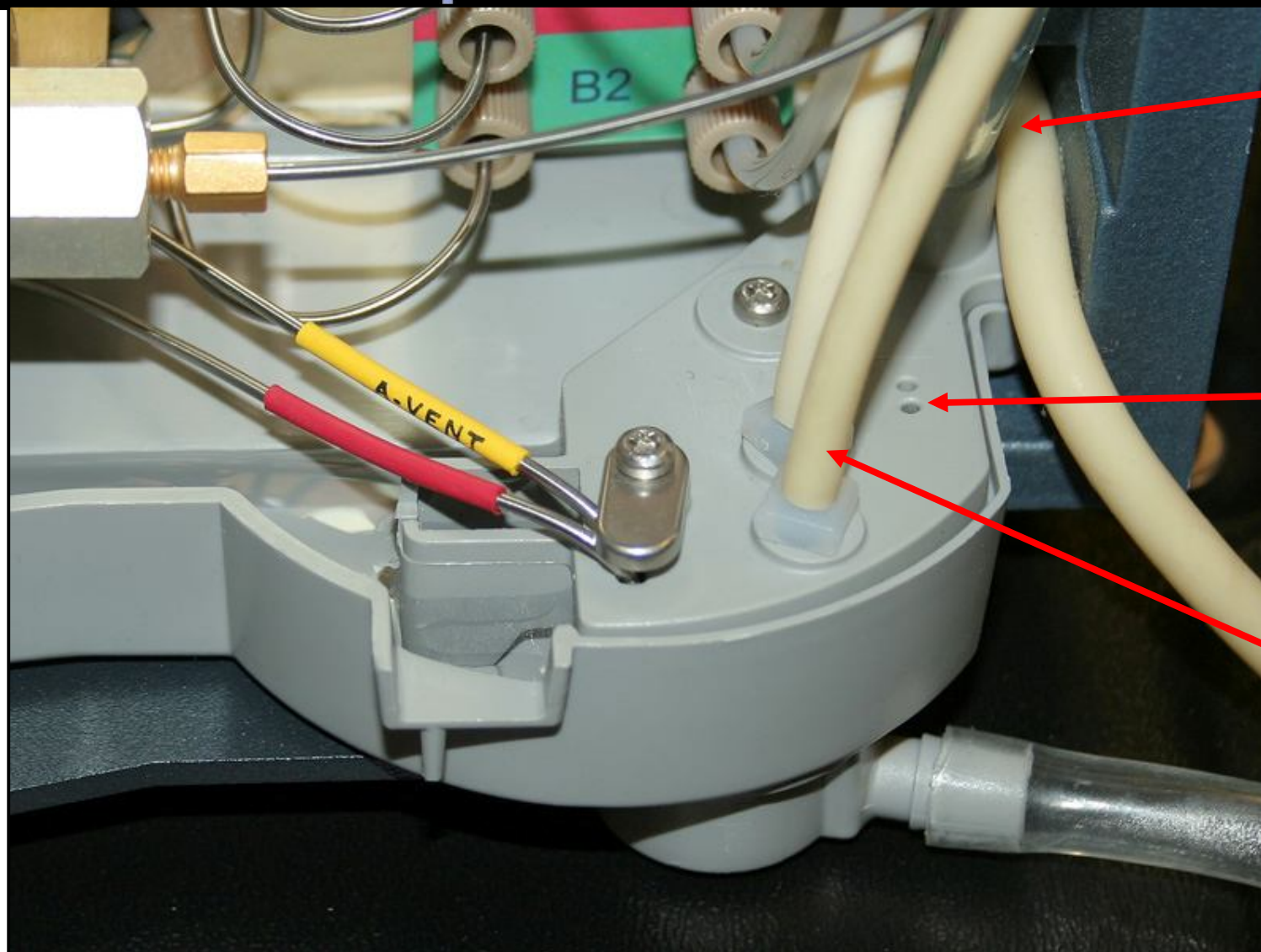
Closed Waste Management

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Closed Waste Management

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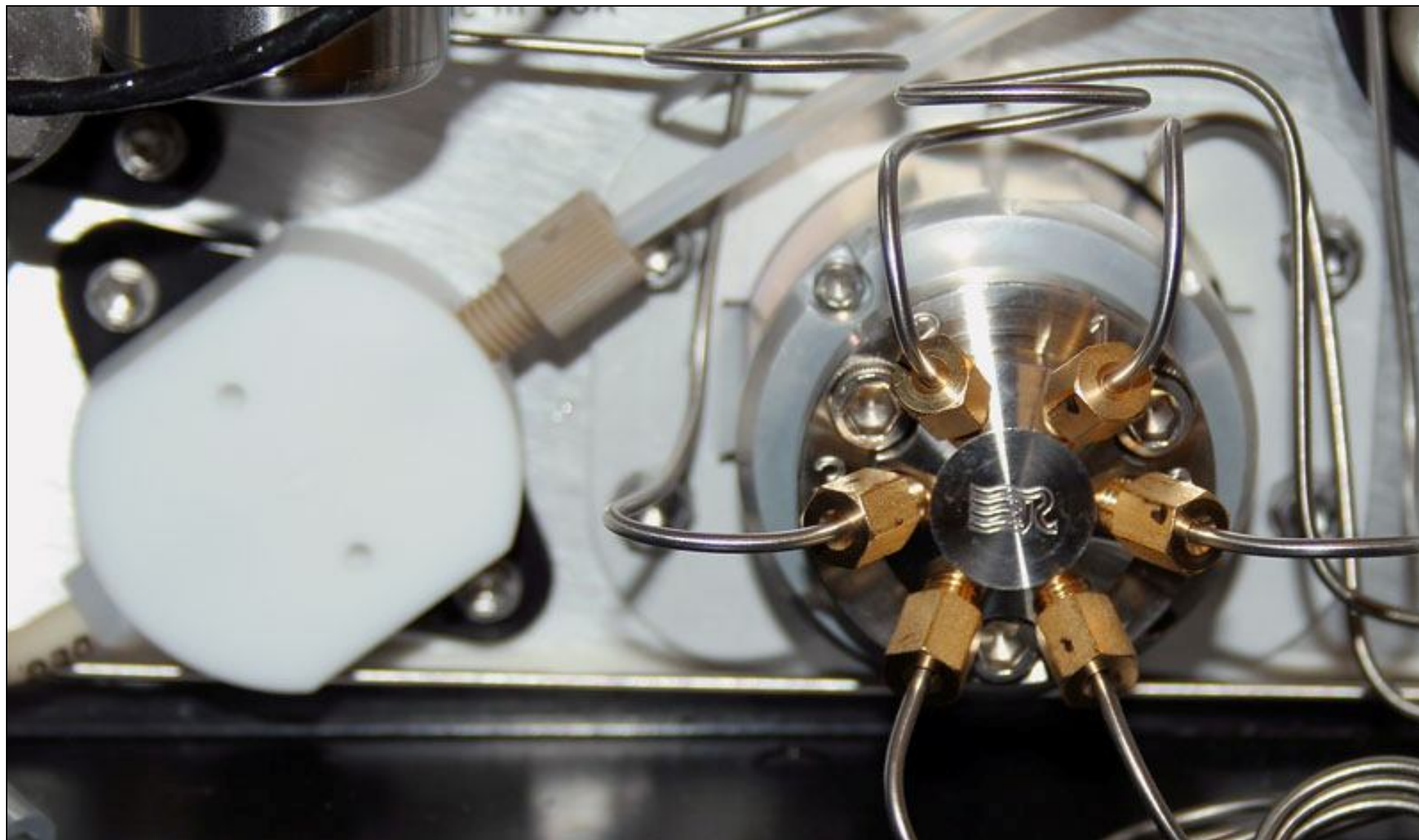
Process Waste
from SM

Detector Outlet
Tubing

Needle-clean
System waste

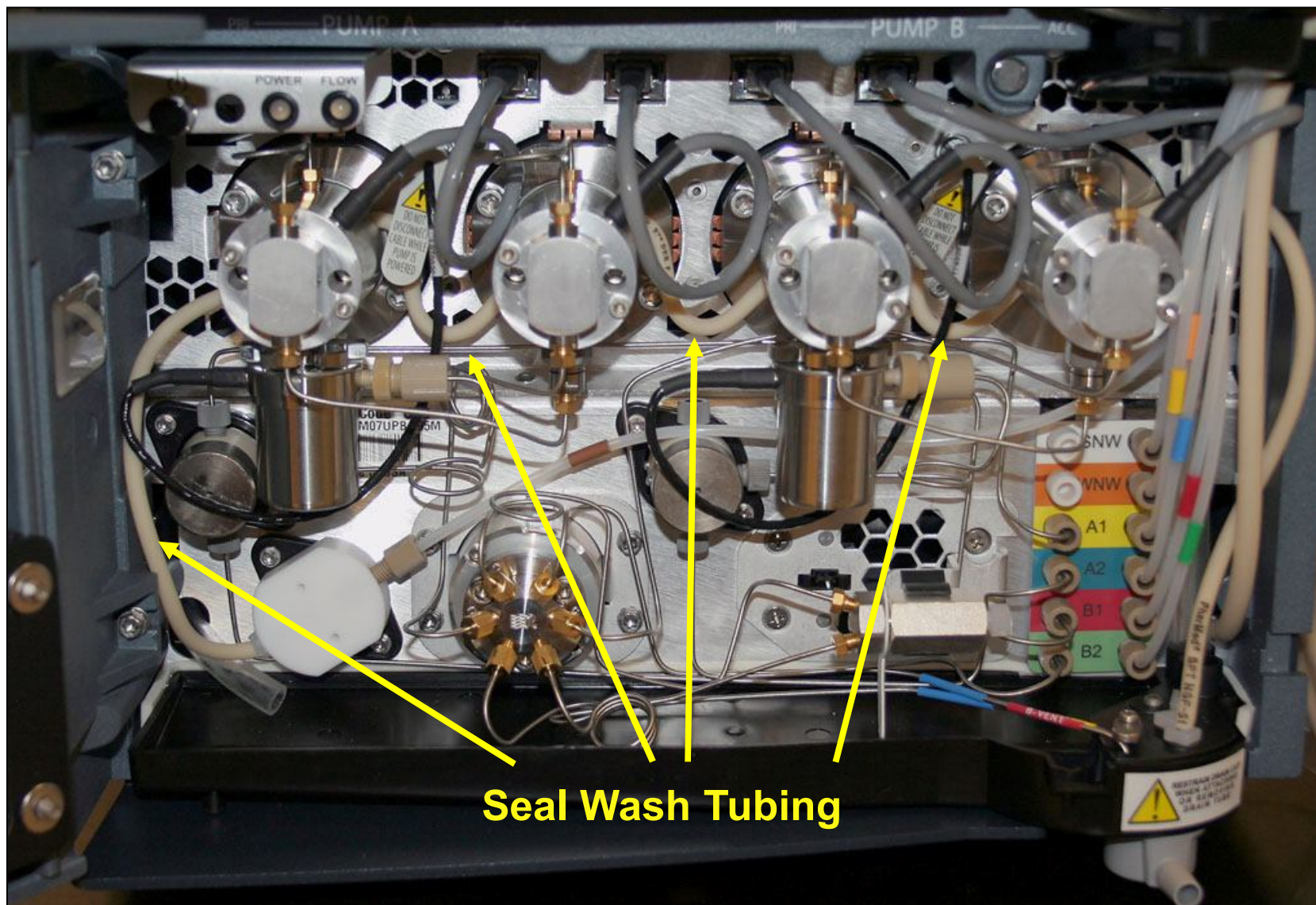
Vent Valve and Seal Wash

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Seal Wash System

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Seal Wash Guidelines

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- Lubricates the plungers
- Flushes away solvent or precipitated buffers that have made it past the high pressure seals
- Seal Wash should contain 10% Organic
- Re-prime Seal Wash when
 - BSM has been idle for more then a few hours
 - After using buffered mobile phases

Vent Valve Assembly

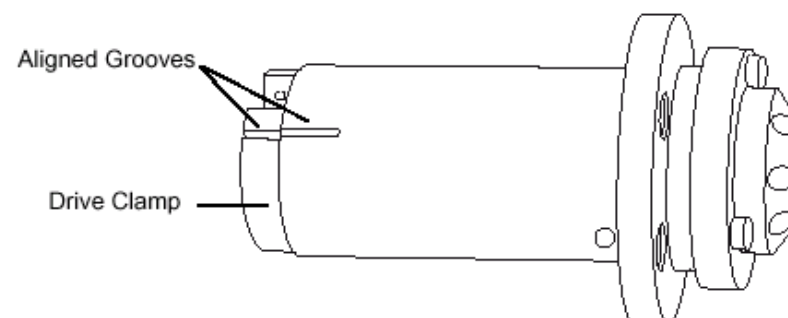
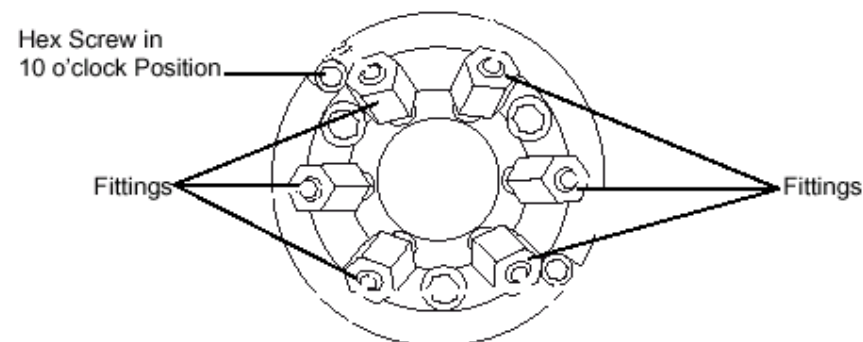
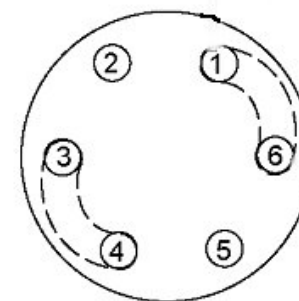
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Vent Valve Cartridge

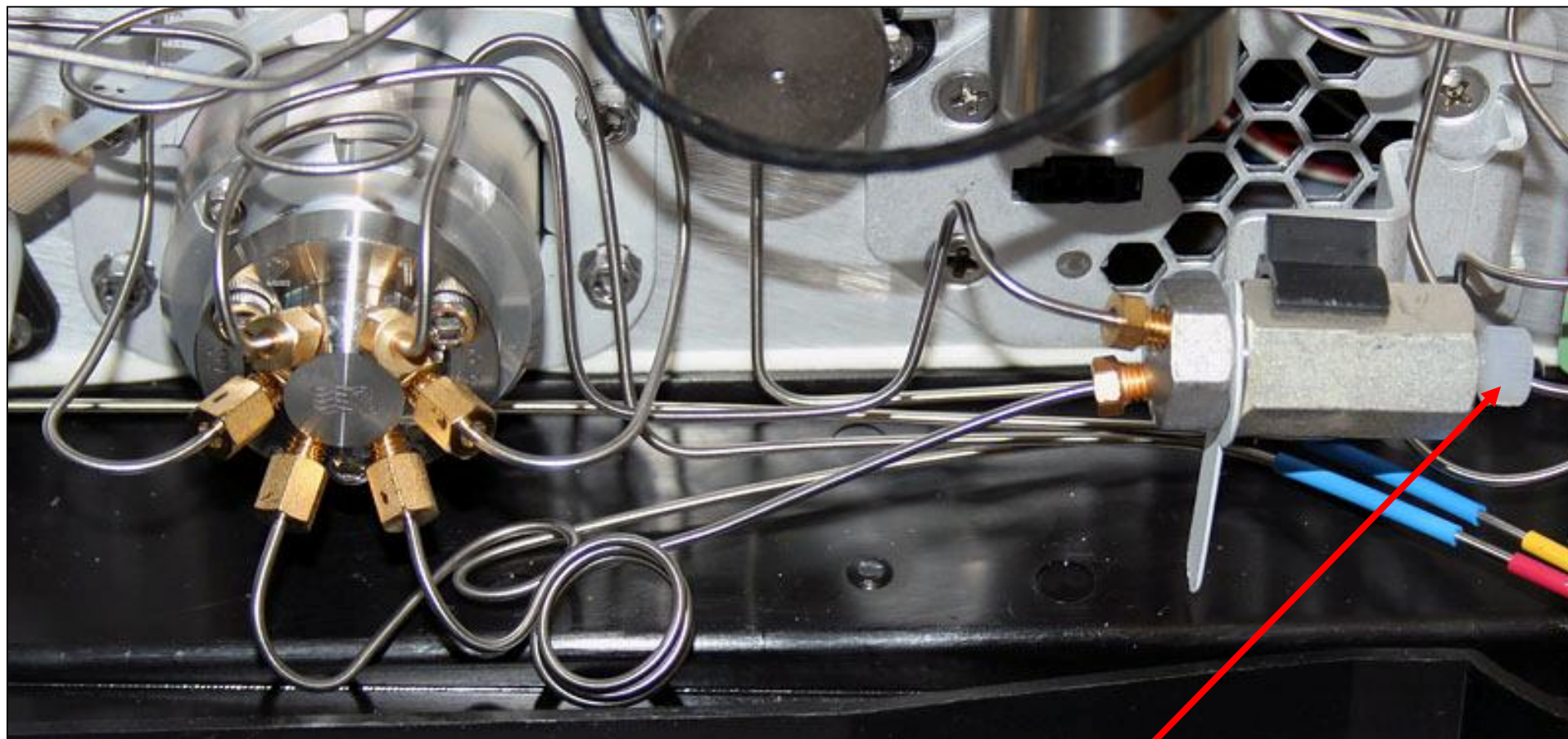
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- Two position valve
 - System flows to SM and column
 - Vent for priming
 - Blocked for static leak test
- Removal
 - Loosen tube fittings
 - Remove the Hex Screw
 - Remove Vent Valve Cartridge
- Installation
 - Note the alignment groove and clamp on rear of assembly for proper installation into drive housing



Vent Valve and Tee-Filter-Mixer

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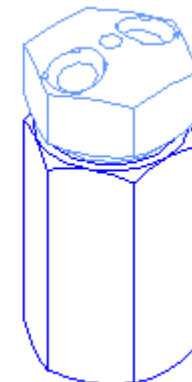
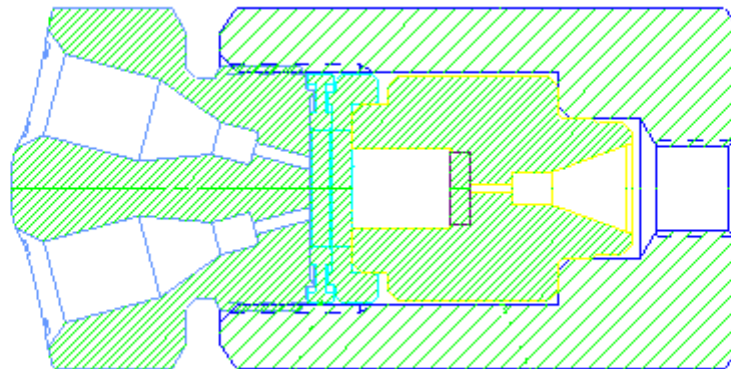
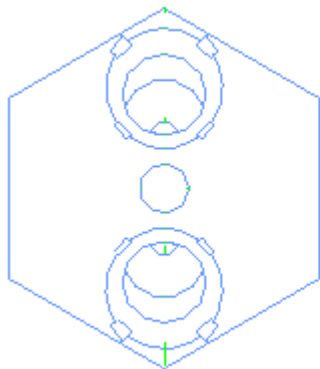
Pump Outlet to Sample Manager

Tee / Filter / Mixer Assembly

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AQCUITY Tee / Filter / Mixer

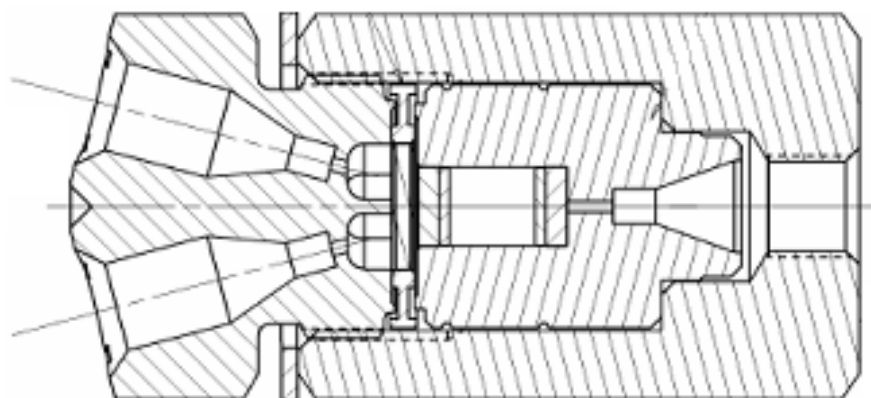
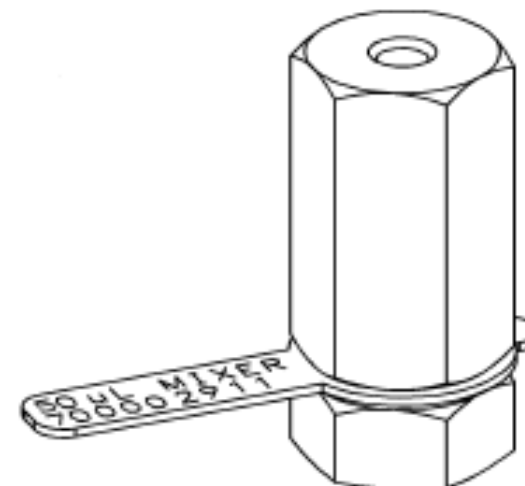
ALLIANCE Filter



Tee / Filter / Mixer Assembly

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- 700002911
- Zirconia Mixing Beads
 - Non destructive beads
 - Will not fracture
 - Impervious to High PH



Tee/Filter/Mixer

- Standard 50 μ L mixer – Optional 100 μ L Mixer
 - Zirconia beads (200 μ m)
 - Eliminates particulate from fractured glass beads
 - Eliminates concern of high pH mobile phases

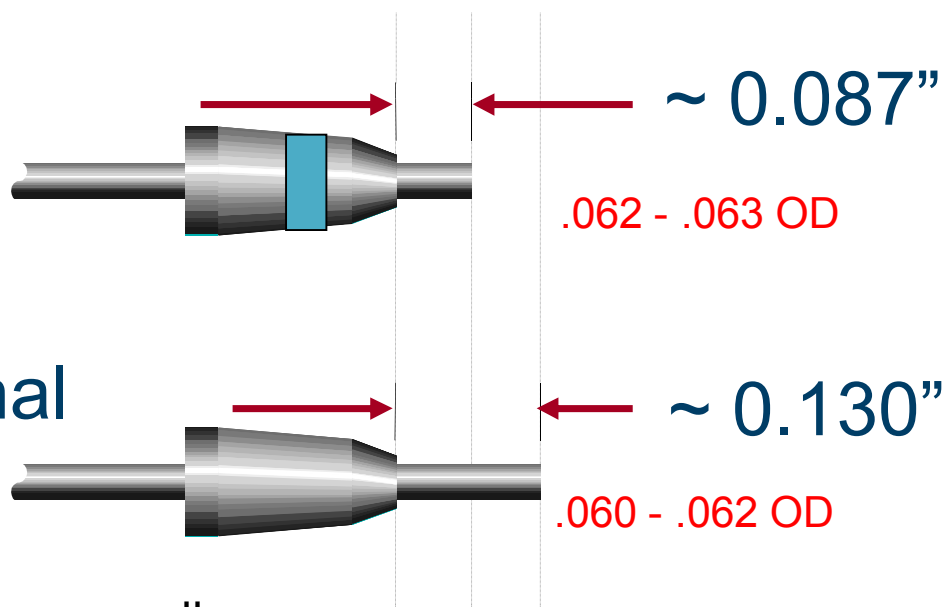
- Column based gradient mixer
 - Also useable for other peptide applications up to 10000 psi
 - Manages baseline noise with TFA to the 100 micro AU range
 - Volume about 425 μ L
 - Uses Zirconia beads (800 μ m)
 - Part Number 205000403

Fittings, V Detail vs. Waters Normal

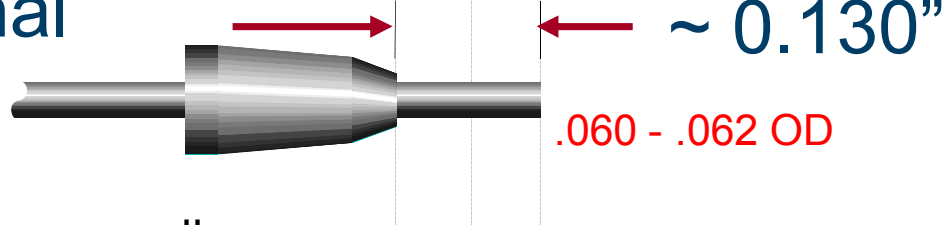
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- Standard tubing O.D. with tighter size & finish tolerances
- Optimized for UPLC

ACQUITY



Waters® Traditional



- Classic Waters tubing uses smaller O.D. with standard size and finish tolerances
- HPLC compatible

New Tubing & Fittings

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- HPLC Fittings

- Traditional drawn tubing



- Traditional Waters Fittings



- UPLC™ Fittings

- Center-less ground tubing



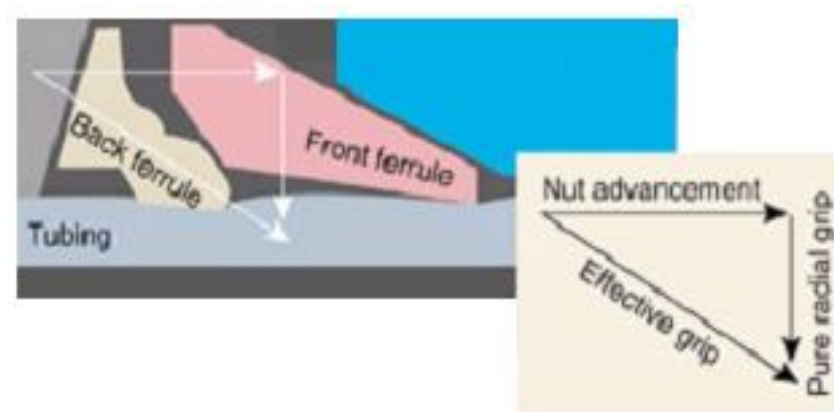
- Gold Compression Screw
- 2 Piece Swagelok Ferrules



2 Piece Swagelok Ferrule

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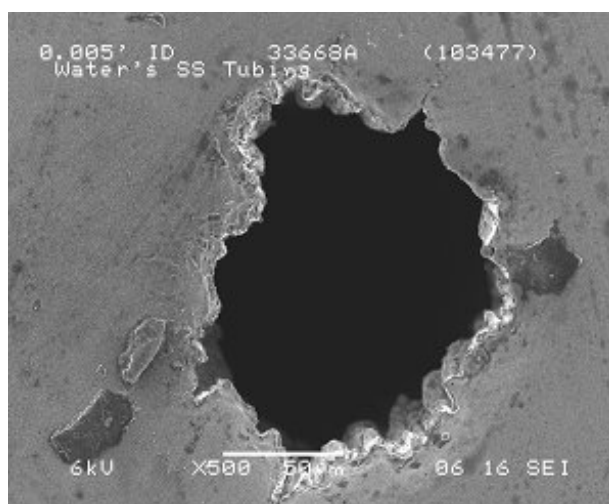
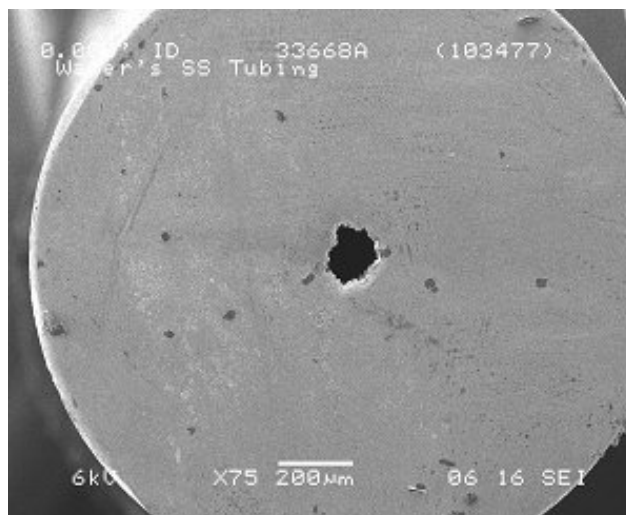
- Back Ferrule
 - Provides forward pressure, effective and radial grip
 - Allows for forward advancement of front ferrule without rotational movement
 - Eliminates tube destruction



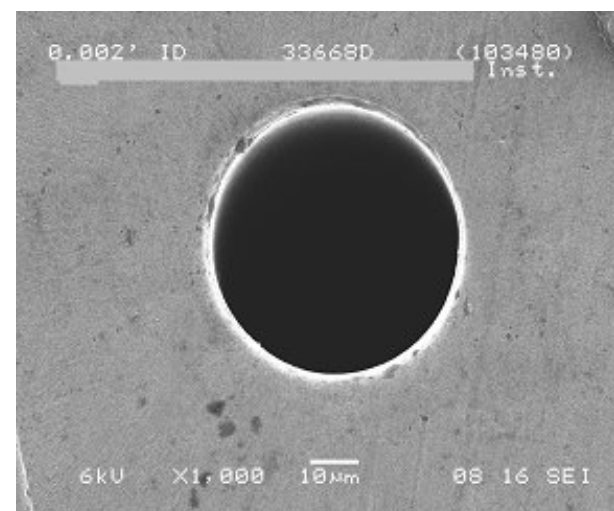
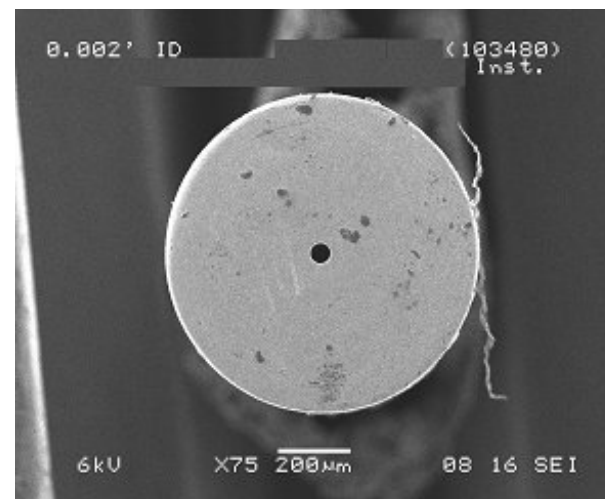
Tubing Comparisons

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Traditional HPLC Tubing

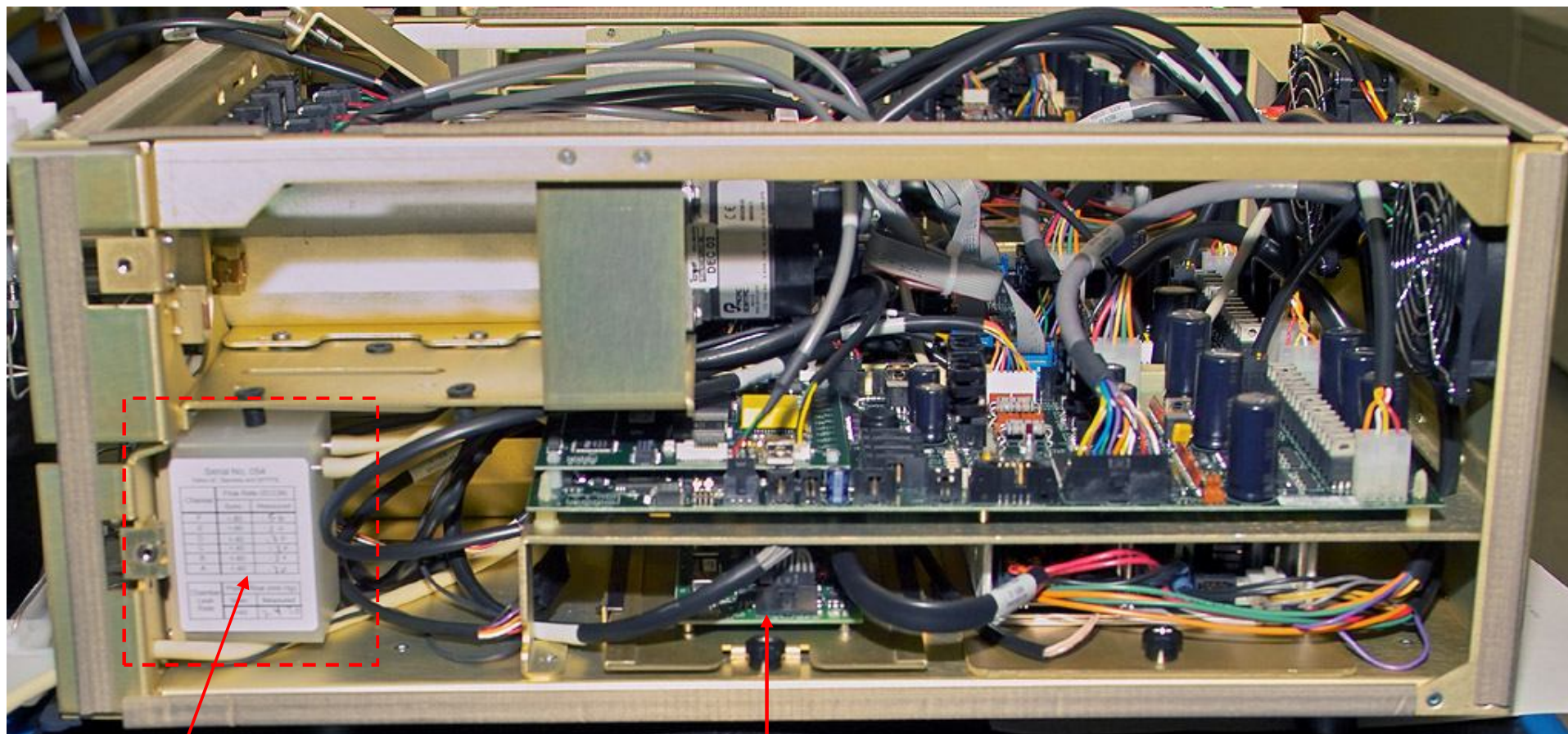


Acquity Tubing



Degasser Components

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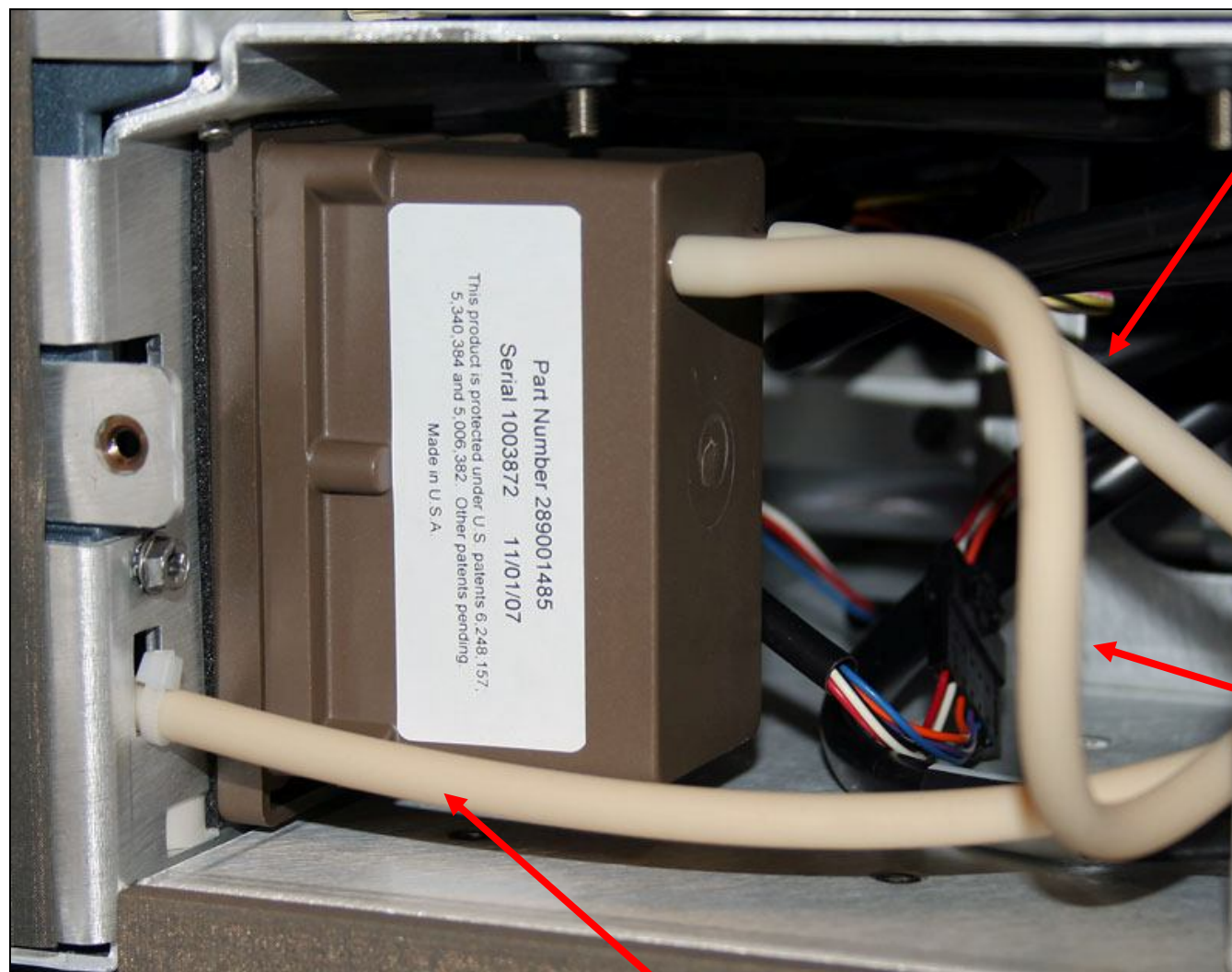


Degasser Chamber

Degasser Assy

New Style Degasser Chamber

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To Degasser Pump
Vacuum Inlet

To Vacuum Gage on PCB

Degasser Exhaust (to vent line or Waste)

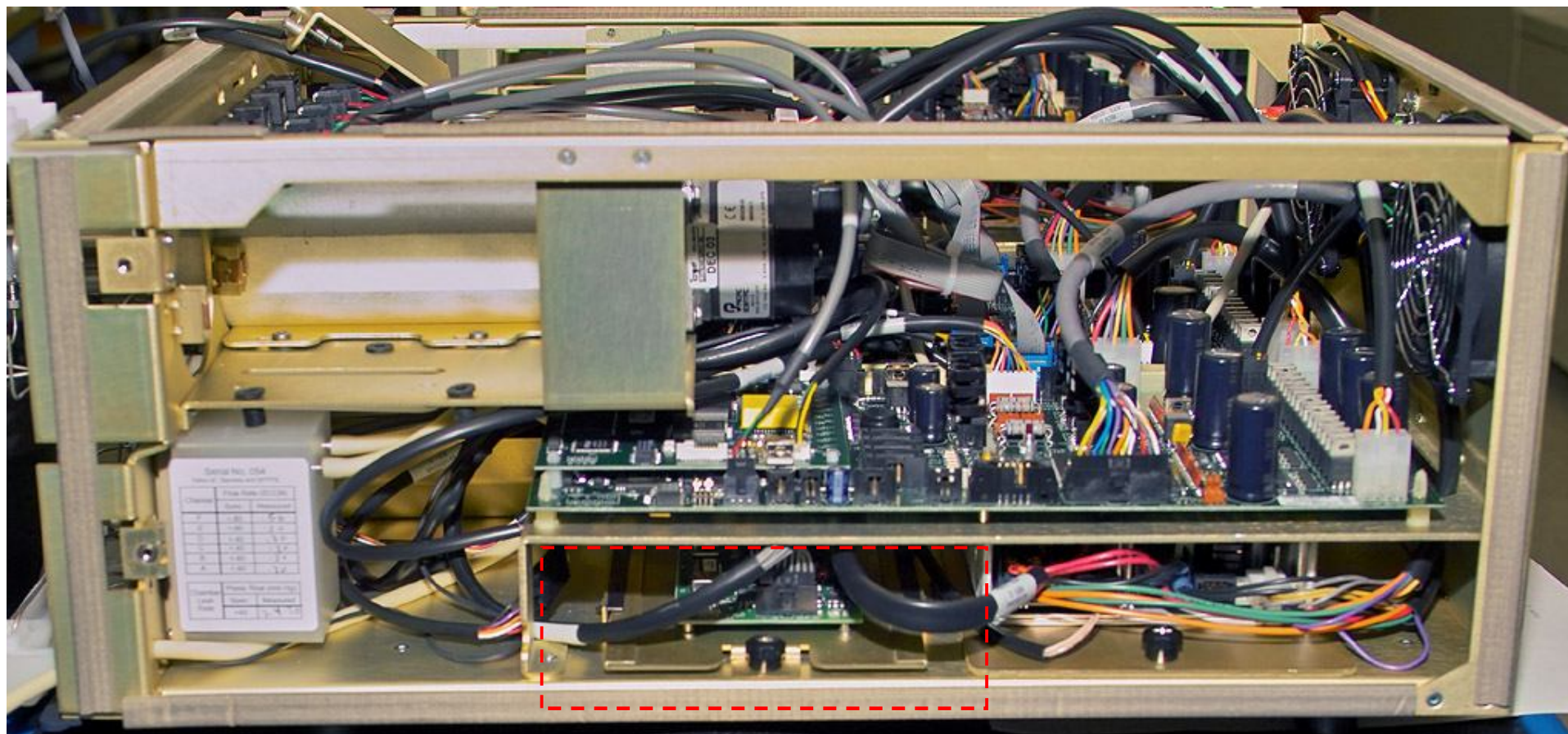
Old Style Degasser Chamber

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Degasser Components

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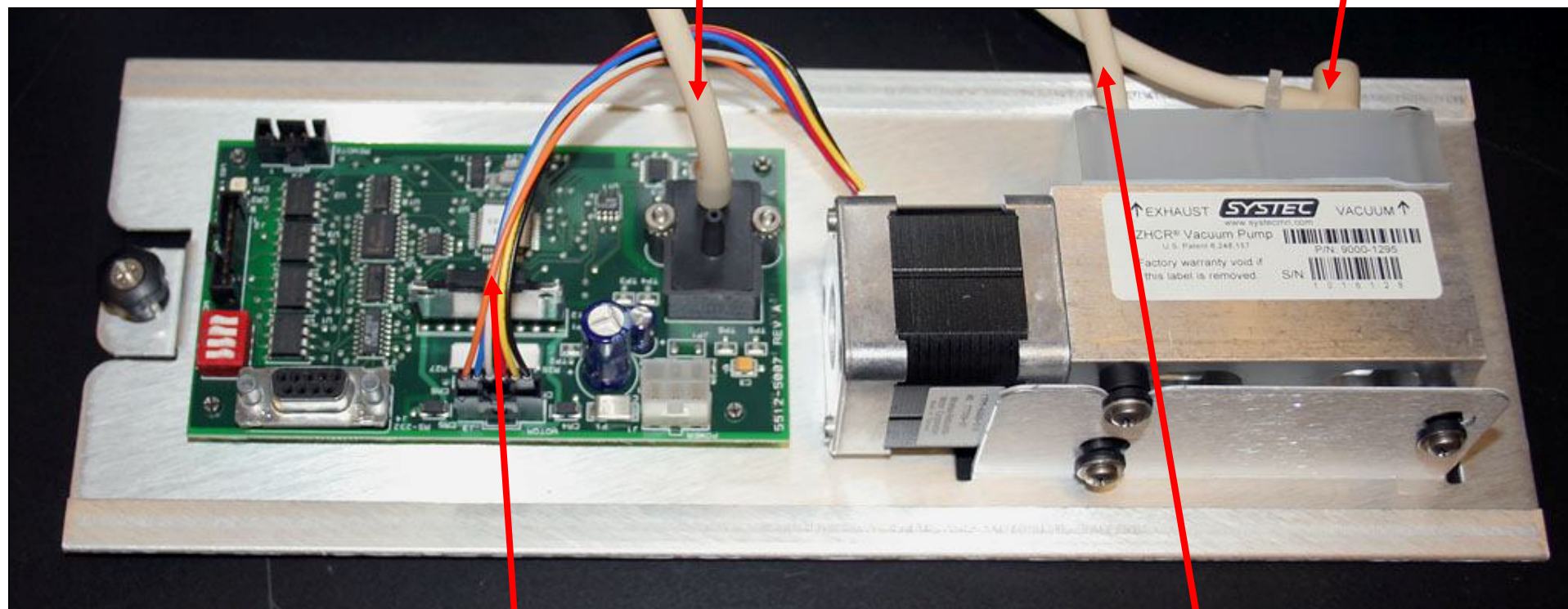
Degasser Assy

Degasser PCB and Pump Assy.

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To Vacuum Gage Line

Degasser Pump
Vacuum Inlet



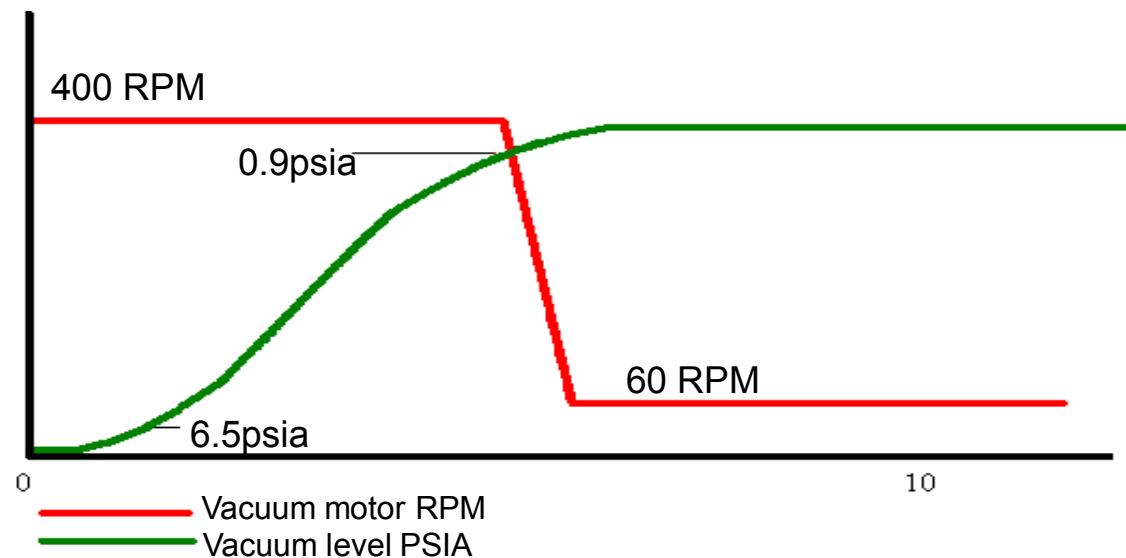
Degasser PCB ASSY

Degasser Exhaust (to Waste)

Current Degasser

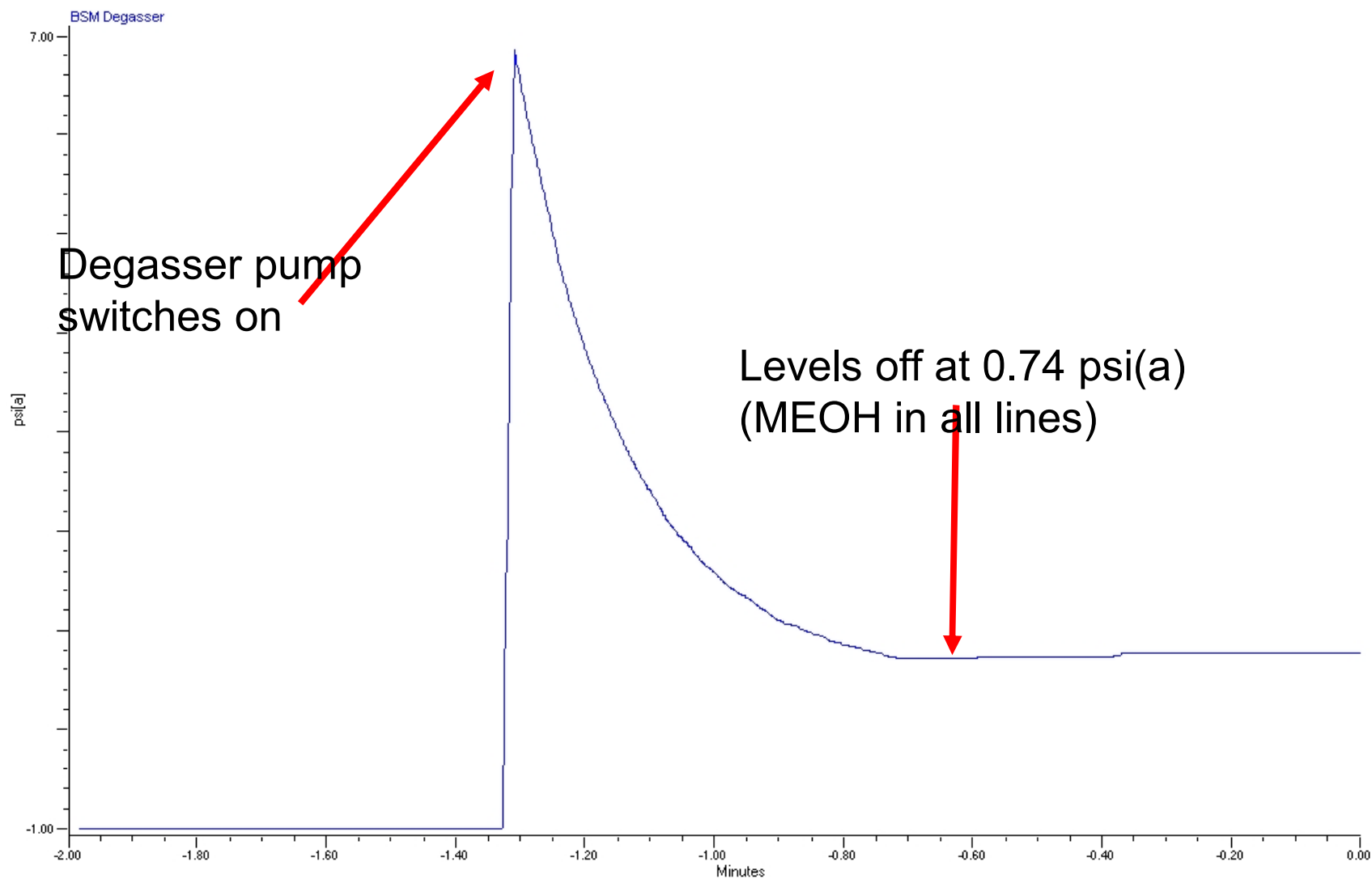
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- Vacuum Pump runs at High Speed (400 RPM) until a vacuum level of 0.9psia is reached.
 - Once 0.9 is reached within 3 minutes, then the speed drops down to 60 RPM



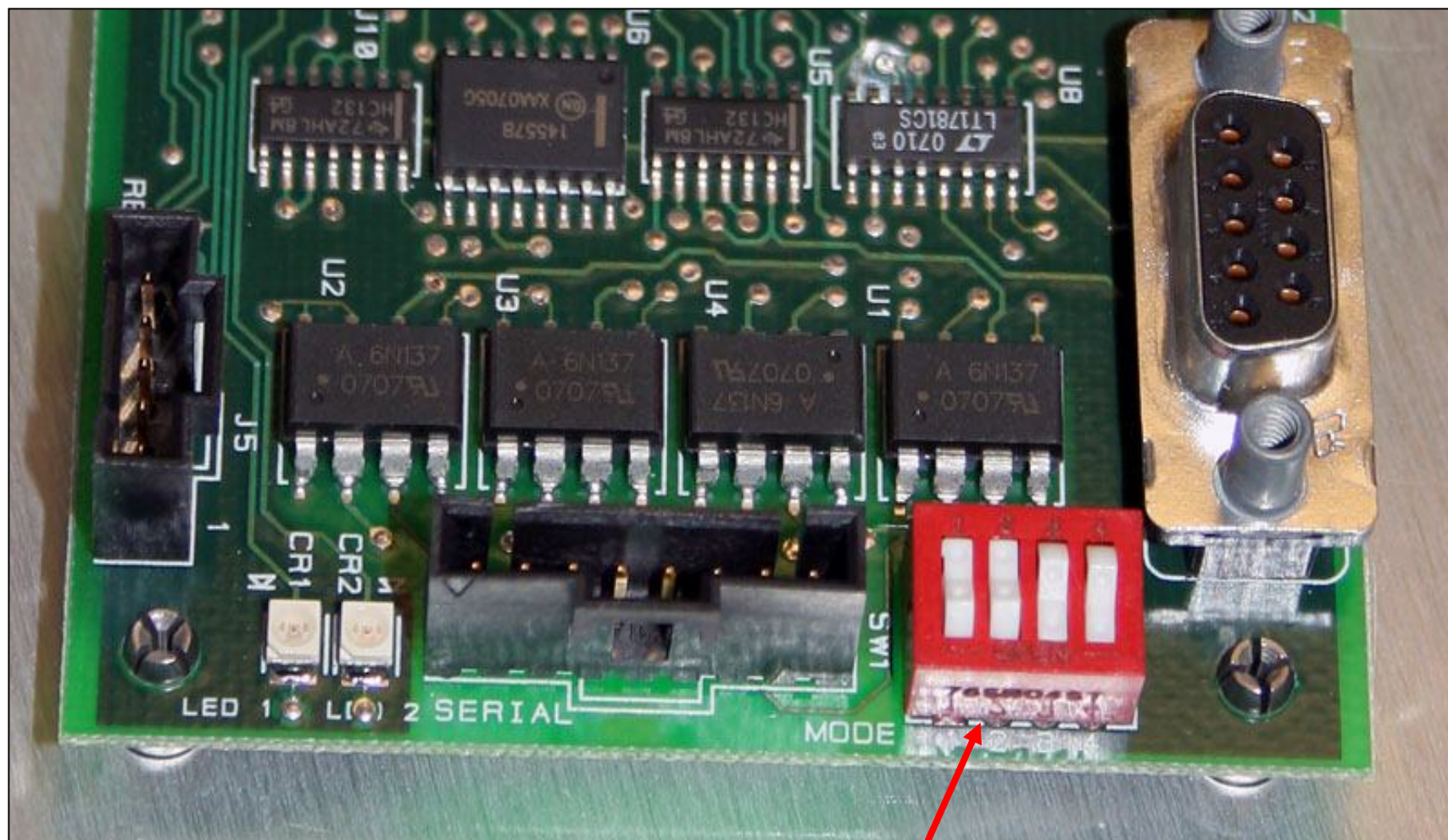
BSM Degasser Plot Startup

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Degasser Switch Settings

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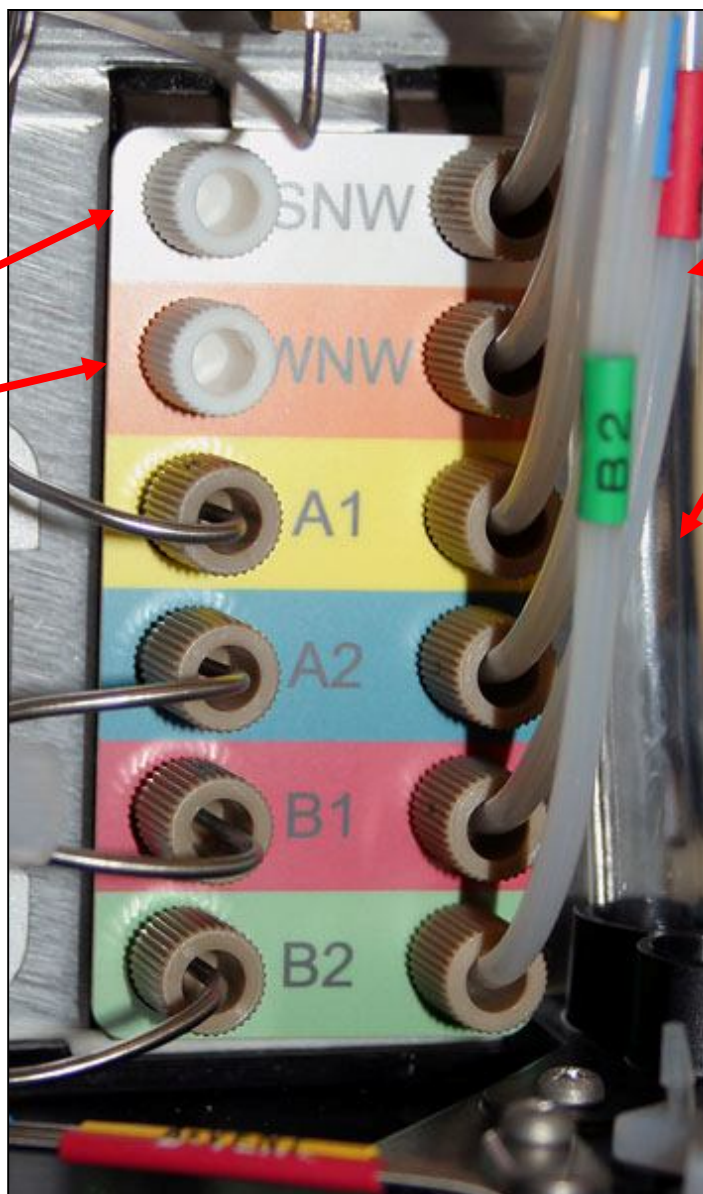
Switches Properly Set for ACQUITY

Degasser Front Panel Connections

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Outlet Lines

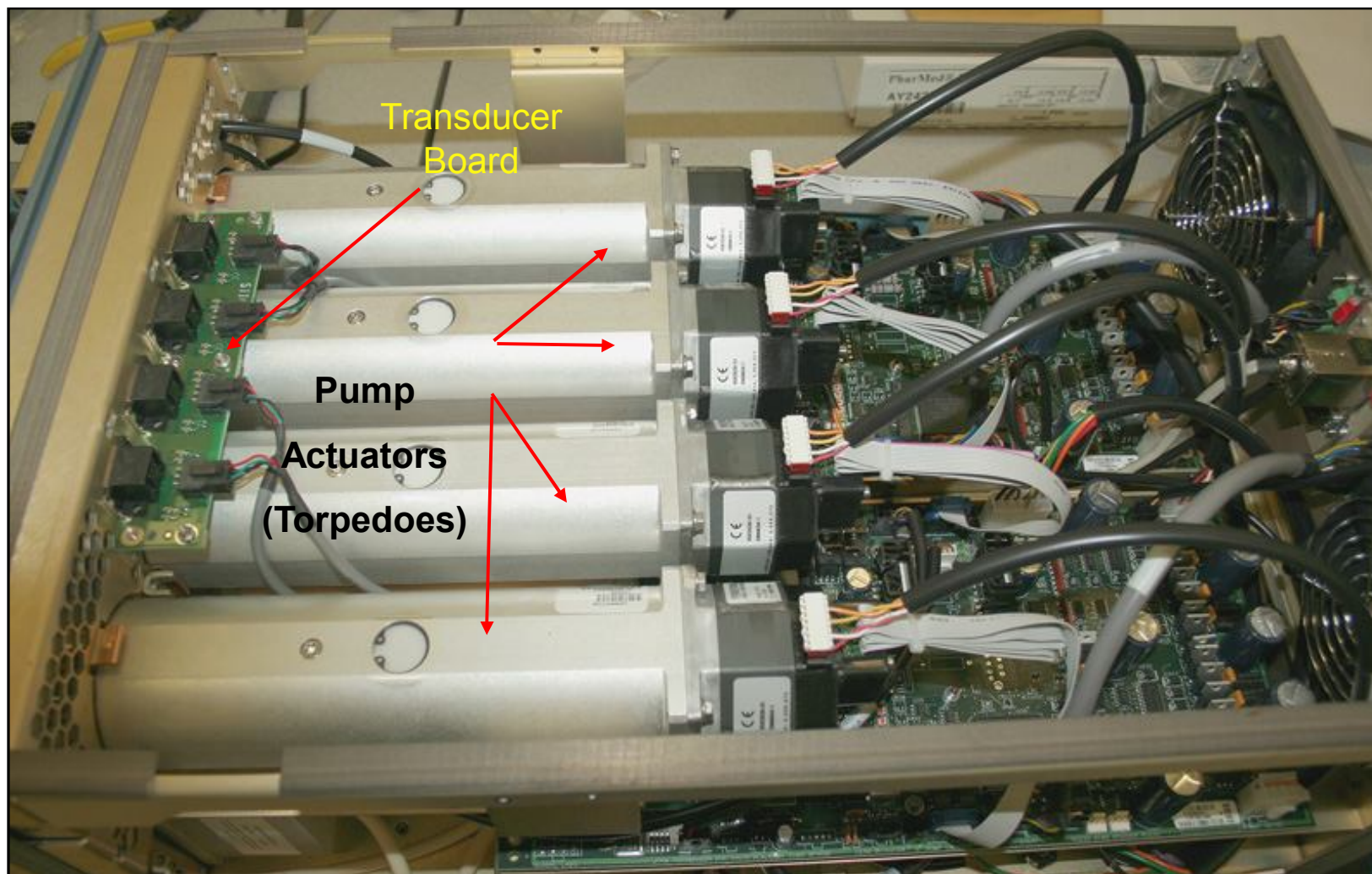
Sample Manager
Strong Wash
Weak Wash



Inlet Lines
from
Solvent Bottles

BSM Top View

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Reference Material

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- ACQUITY Parts Locator
 - On the Knowledge Center
 - All service procedures
- Operators Guide (71500082502)
 - Usage Guidelines and Customer maintenance procedures
- PM Protocol (715001008)

Components Changed at PM

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- Plunger Seals
- Seal Wash Seals
- Plungers
- Solvent Filters
- Check Valves
- Inline Filter
- Air filters
- Tubing and Fittings

Lab Exercise

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- Section 3 of the course manual
- Diagnostics and common service procedures
- PM Practice on BSM

Electronics and Power Distribution

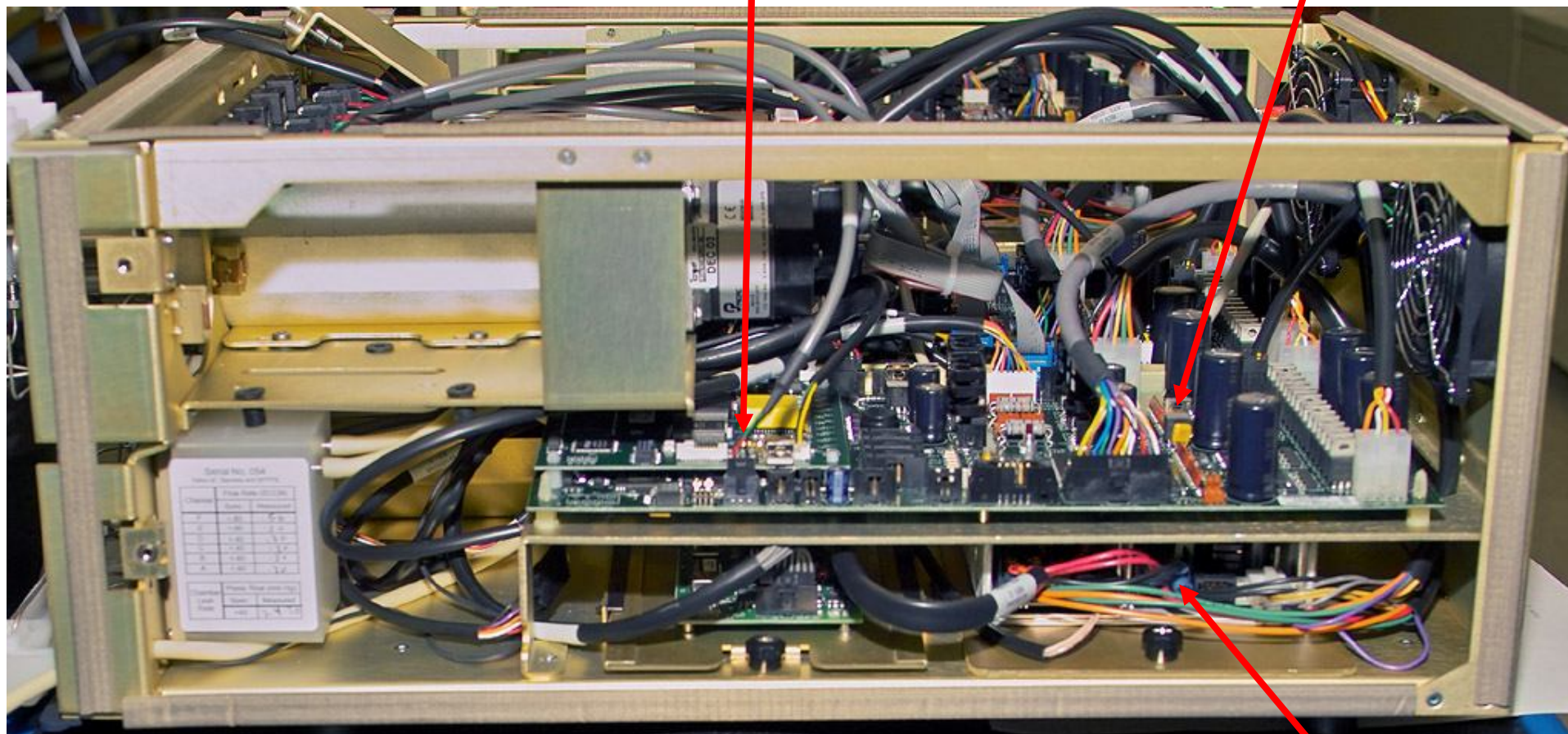


BSM- Side View

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CPU 2000

Personality PCB

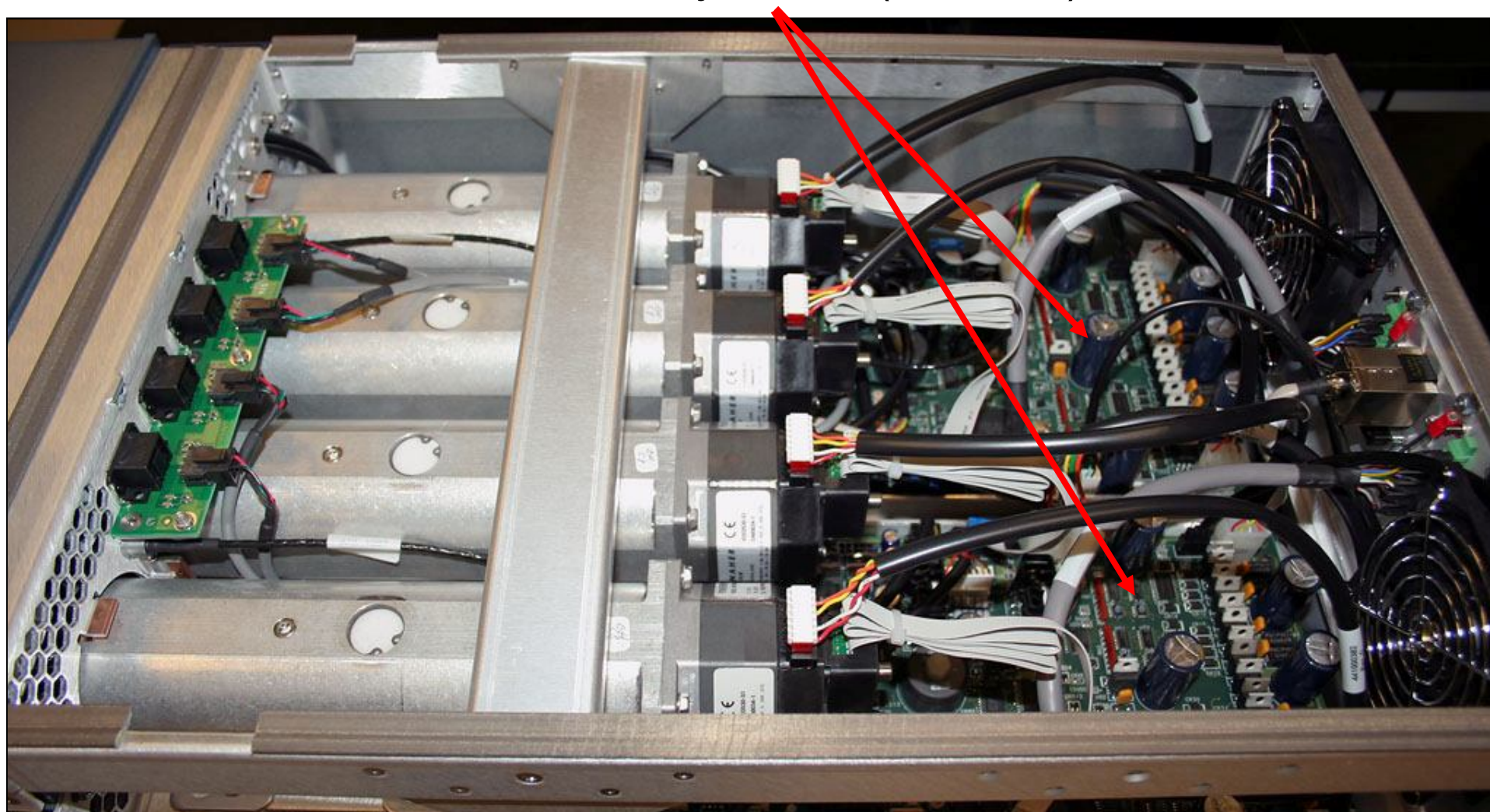


Power Supply

BSM- Inside Top View

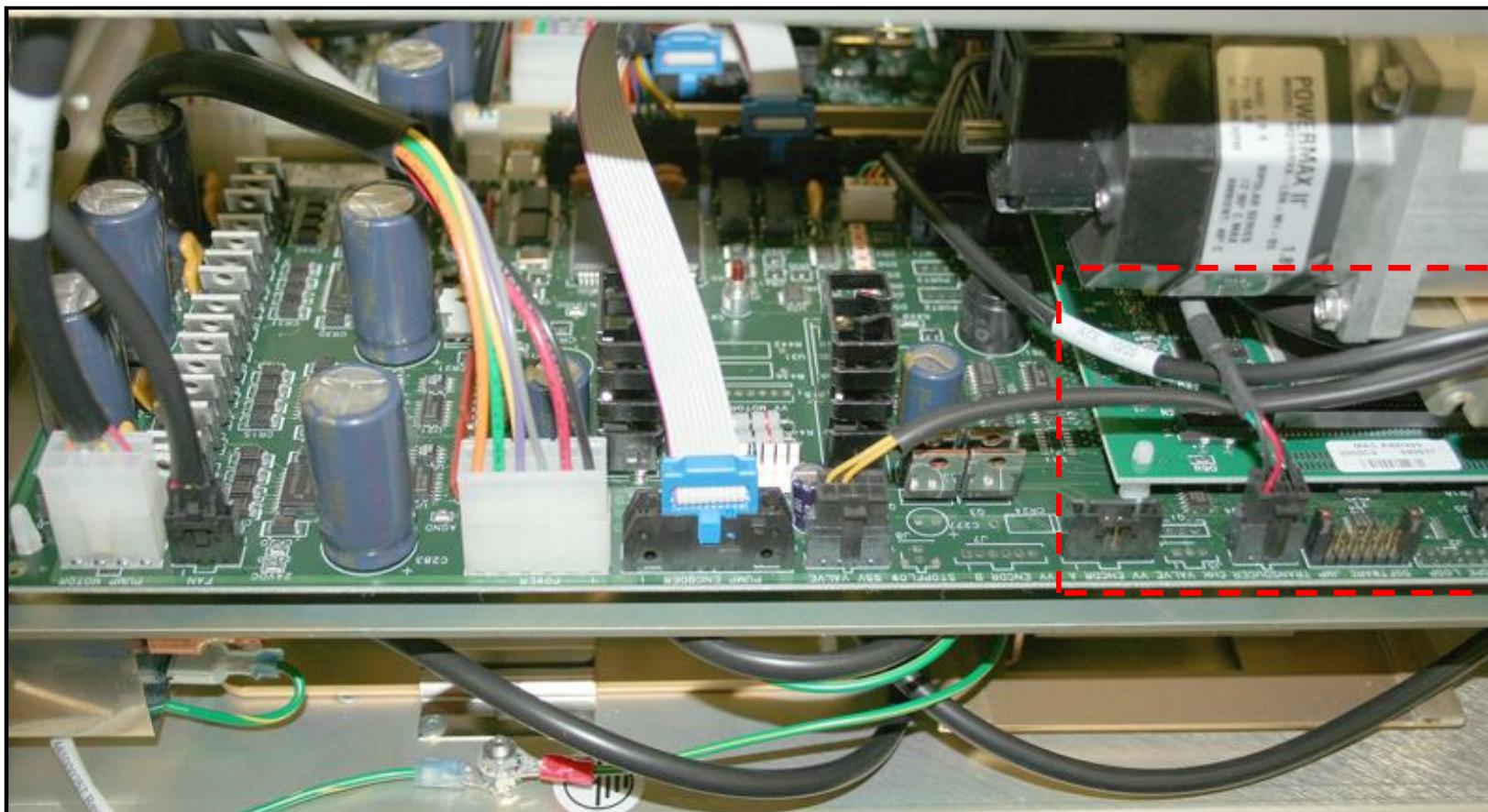
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Dual Personality PCBs (A and B)



Personality Board

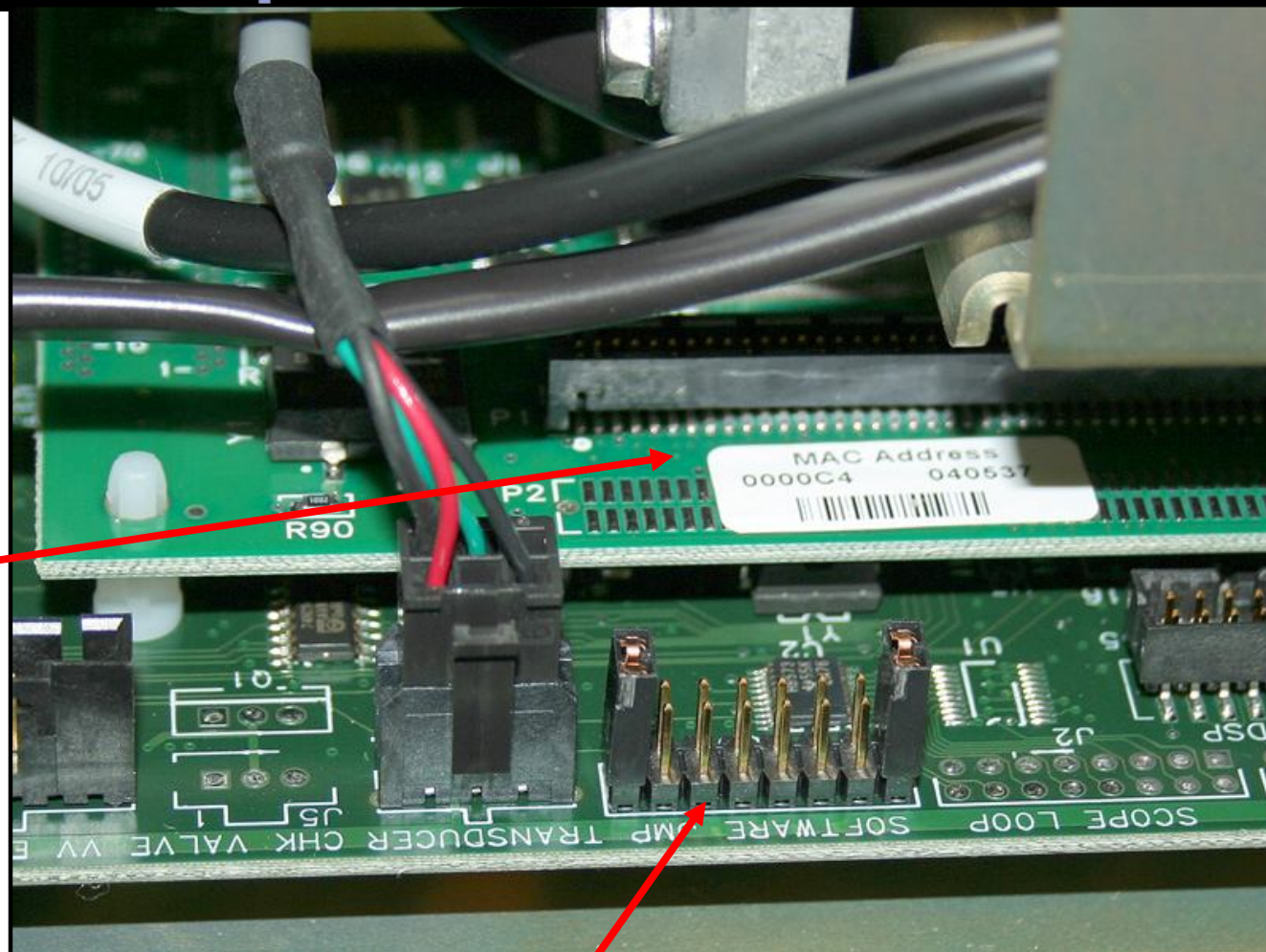
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Personality Board Jumpers

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CPU 2000



Jumpers Settings

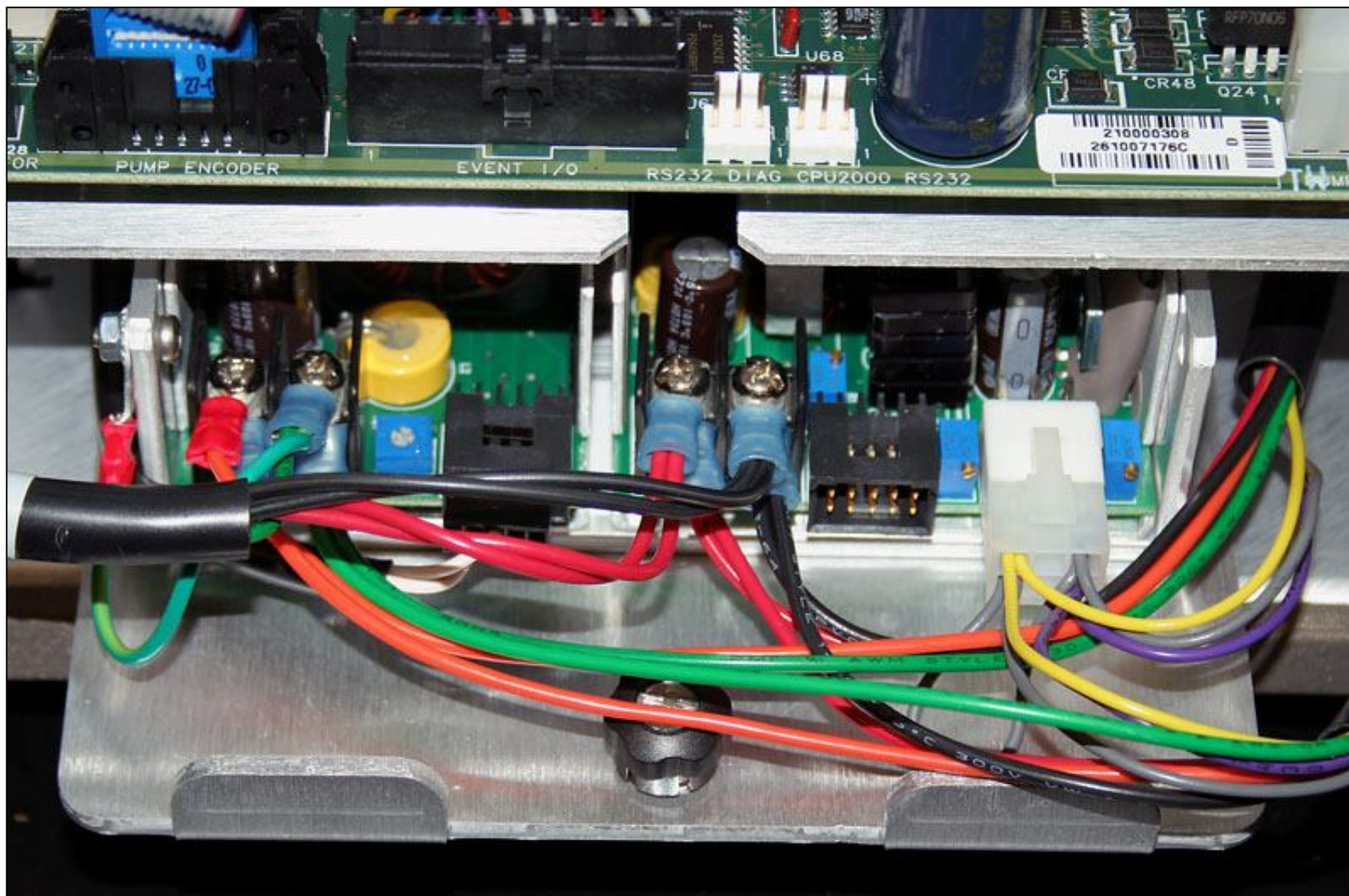
A Board- 1, 8

B Board- 8

Jumpers Set for A board

BSM Power Supply

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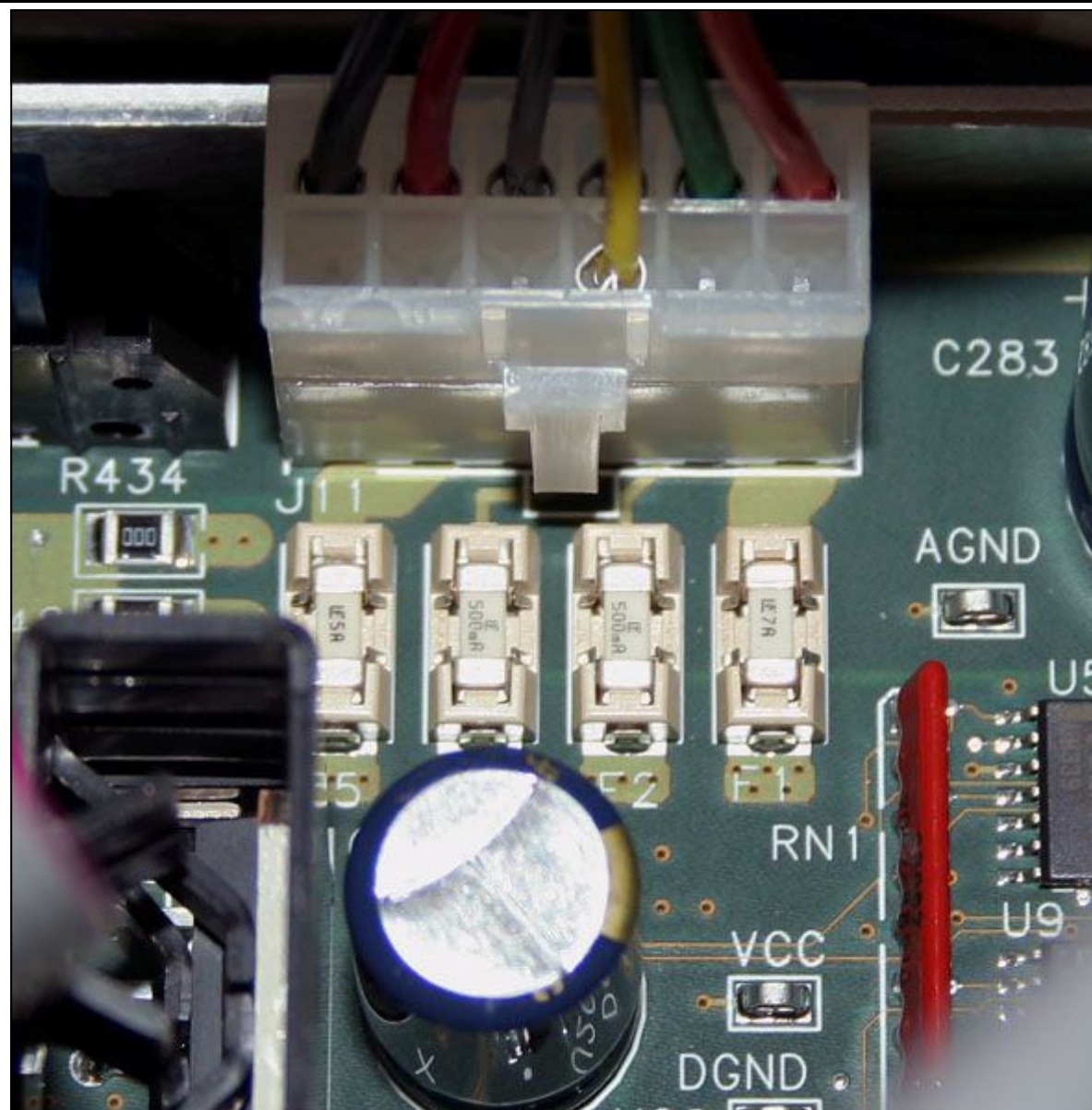
BSM- Top Rear View

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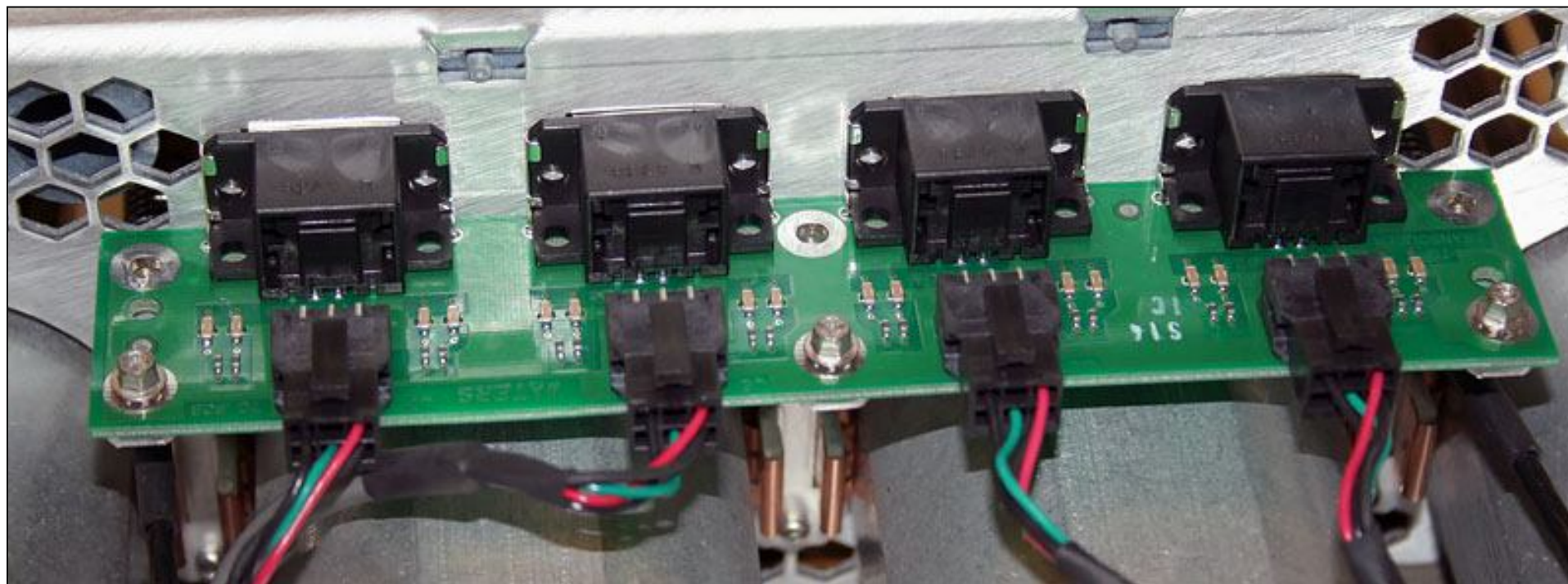
Micro-Fuses on Personality PCB

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Transducer PCB

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Front Panel LED's

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- Visual indicators
- Power LED (left)
 - ON GREEN
 - Instrument is on, has power
- Flow LED (right)
 - OFF
 - Currently idle, not flowing, appears in good health
 - ON GREEN
 - Pump is currently flowing, in good health
 - FLASHING RED
 - Pump has stopped on error, no longer flowing
 - ON RED
 - Serious system failure prevents further operation



Lab Exercise

Waters
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- Section 3B of the course manual
- Electronics sub-systems
- Service procedures
- Common faults and remedies
- Bugging and troubleshooting as time allows