



ACQUITY H-Class SM-FTN Overview



CPSM Design Philosophy



- Adapt the best, most proven design aspects from ACQUITY to create a new UPLC common platform sample manager
 - Implement direct injection technique supporting the full UPLC pressure range
 - Simpler operation
 - Great sample recovery
 - Excellent carryover specifications
 - Using already proven ACQUITY fluidics and software where appropriate for high reliability
 - Simplify sample pickup by designing a new R-Theta movement algorithm
 - Keeping system dwell volume and bandspreading as low as possible
- Make it cost competitive
 - Use common platform for both FTN and Fixed Loop versions
 - Use molded rigid foam panels to insulate and hold components in place

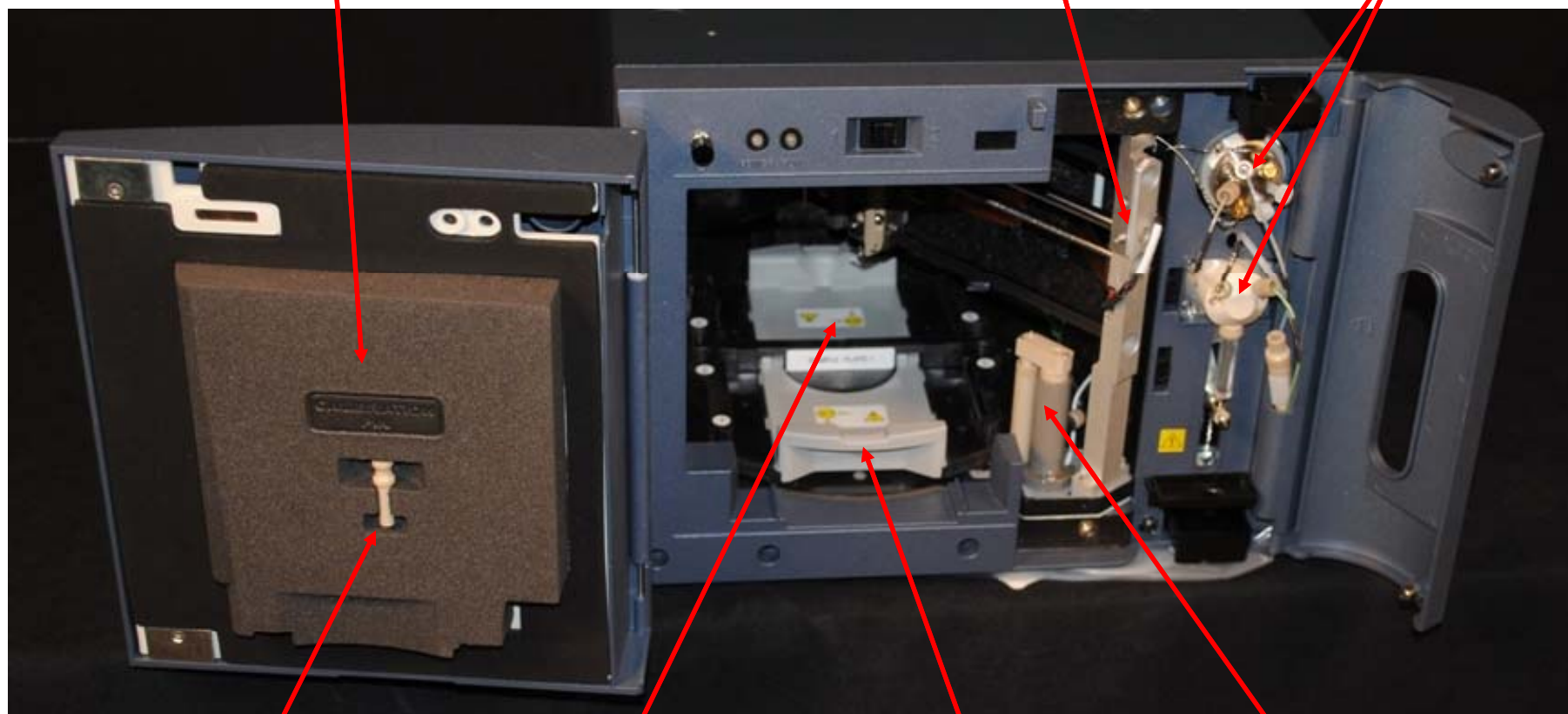
SM-FTN Component Overview



Sample Compartment Door
Insulating Foam

R-Carriage
Assembly

Inject Valve and
SM Syringe



Rotary Tray
Calibration Pin

Sample
Compartment

Rotary Tray

Injector Seal /
Needle Wash
Housing Assy.

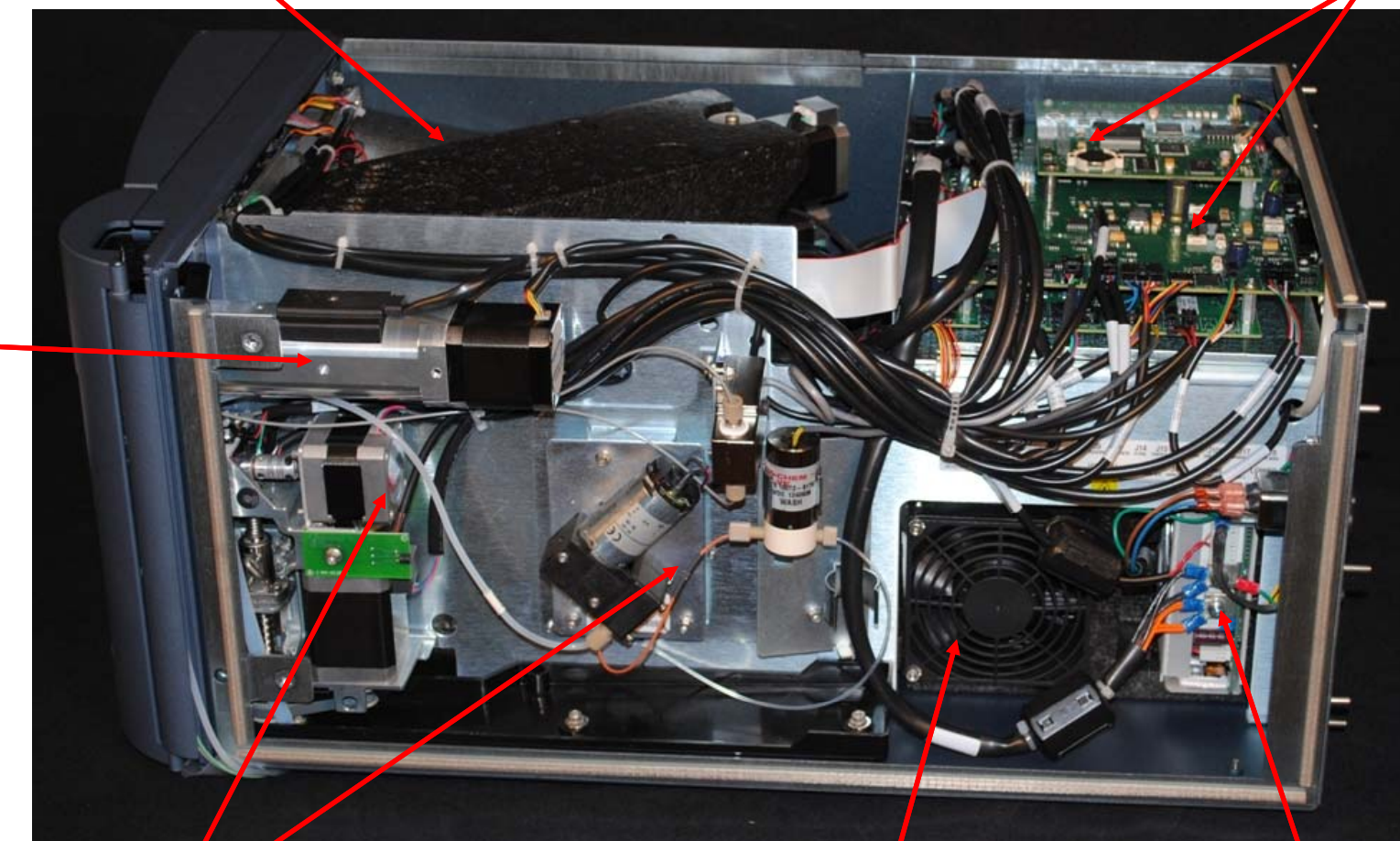
SM-FTN Component Overview



Sample Compartment
Top Insulating Foam

CPU2000, Control
and Driver PCB

Inject
Valve



Internal
Fluidic
Components

Heater/Cooler
Engine Fan

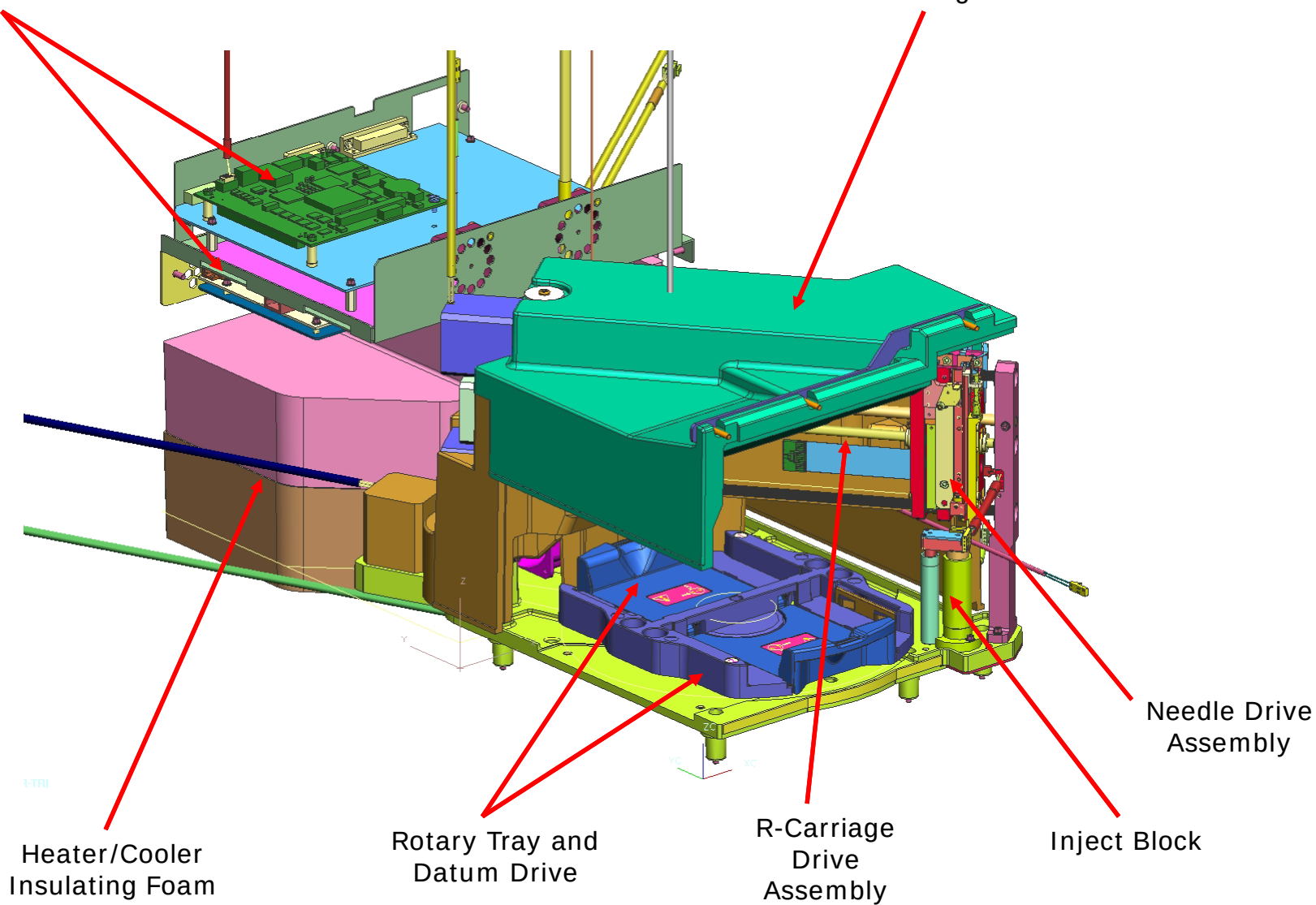
Power Supply

SMDI Component Overview



CPU2000, Control
and Driver PCB

Sample Compartment
Insulating Foam



Major Assemblies

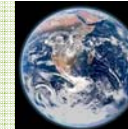


- Fluidics
- R-Theta Drive Assembly
- Sample Heater/Cooler Assembly
- Electronics
- Software Components

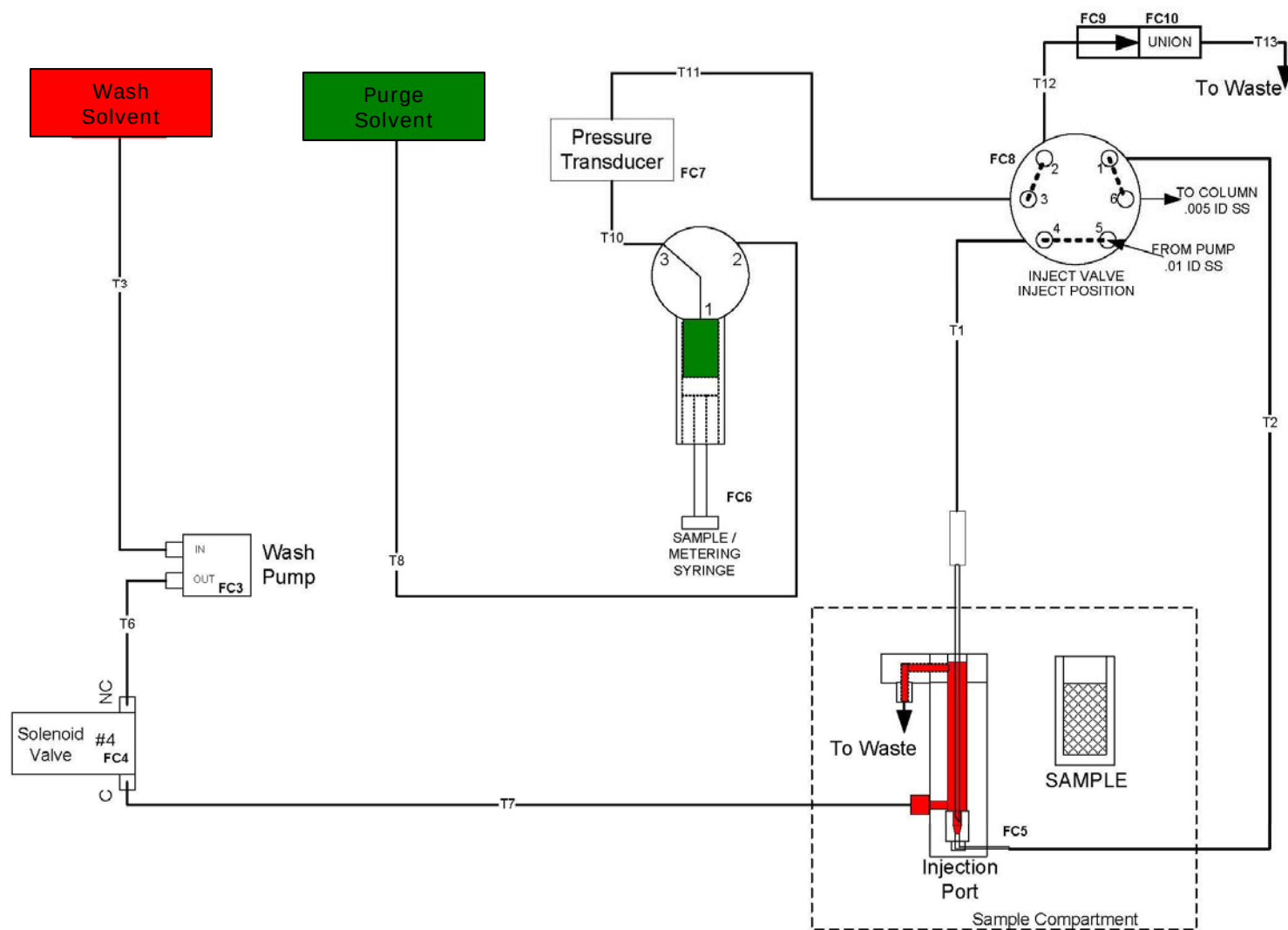
Fluidics



SM-FTN Flow Diagram



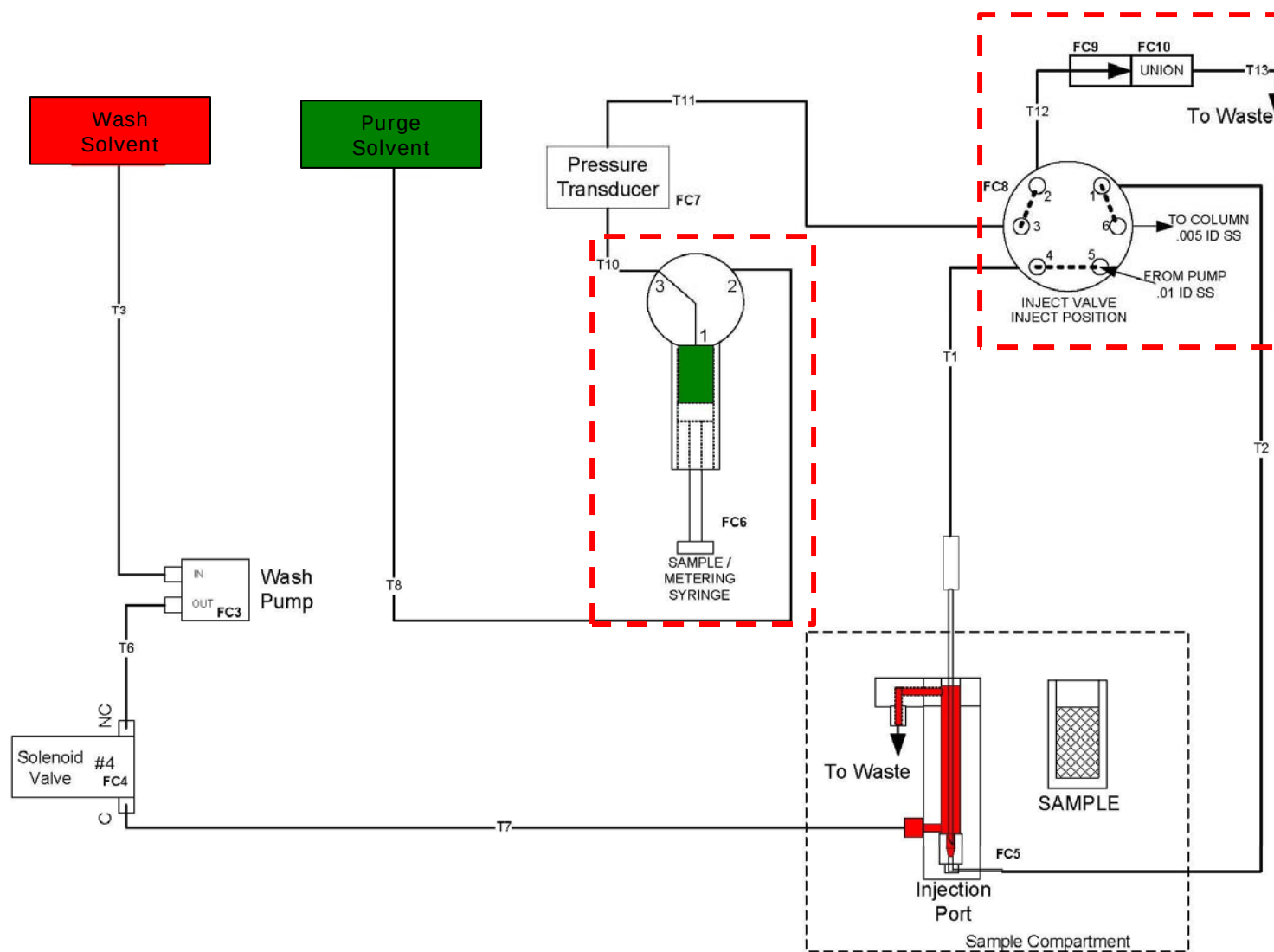
Global Training
& Development



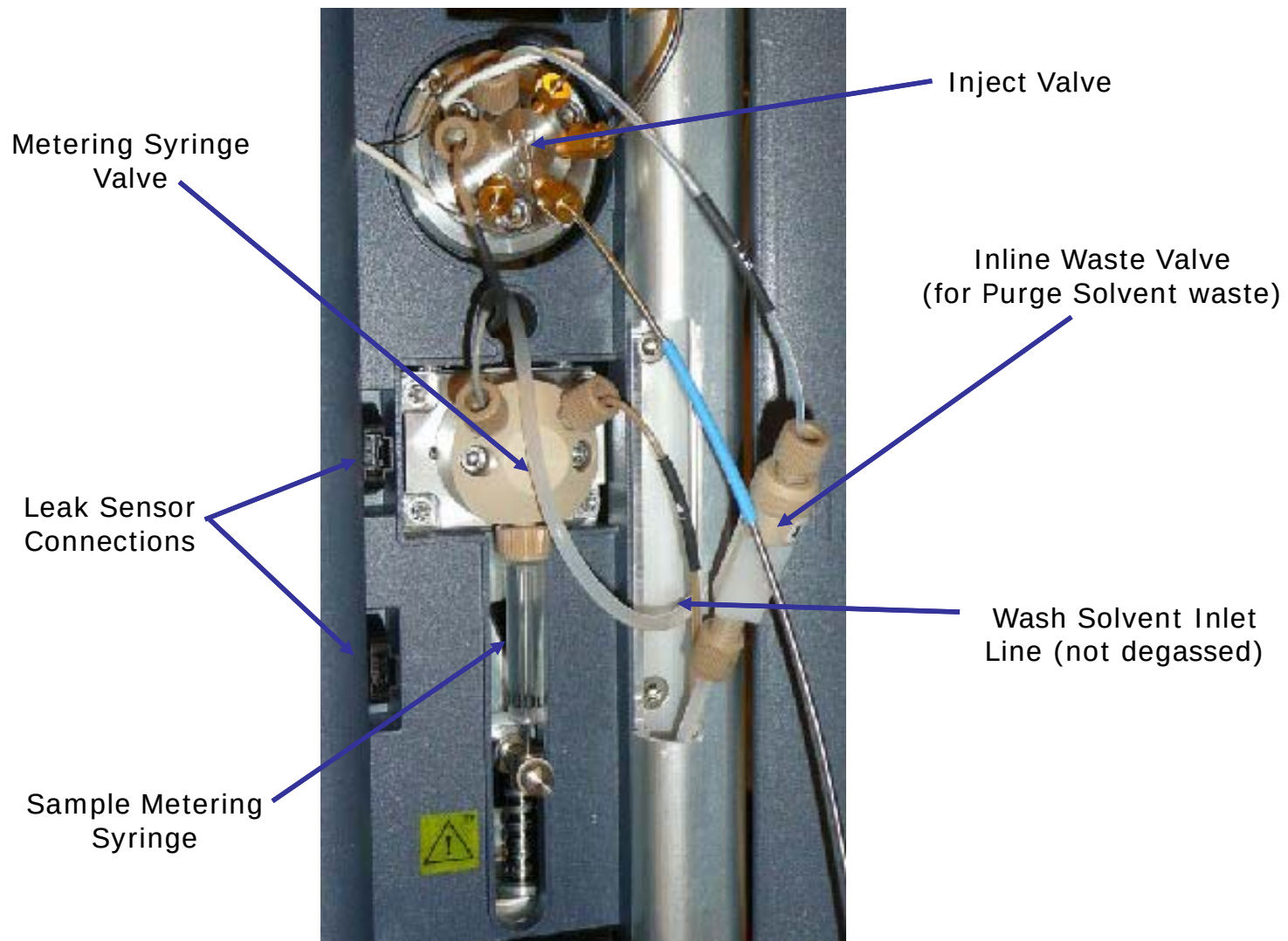
SM-FTN Flow Diagram



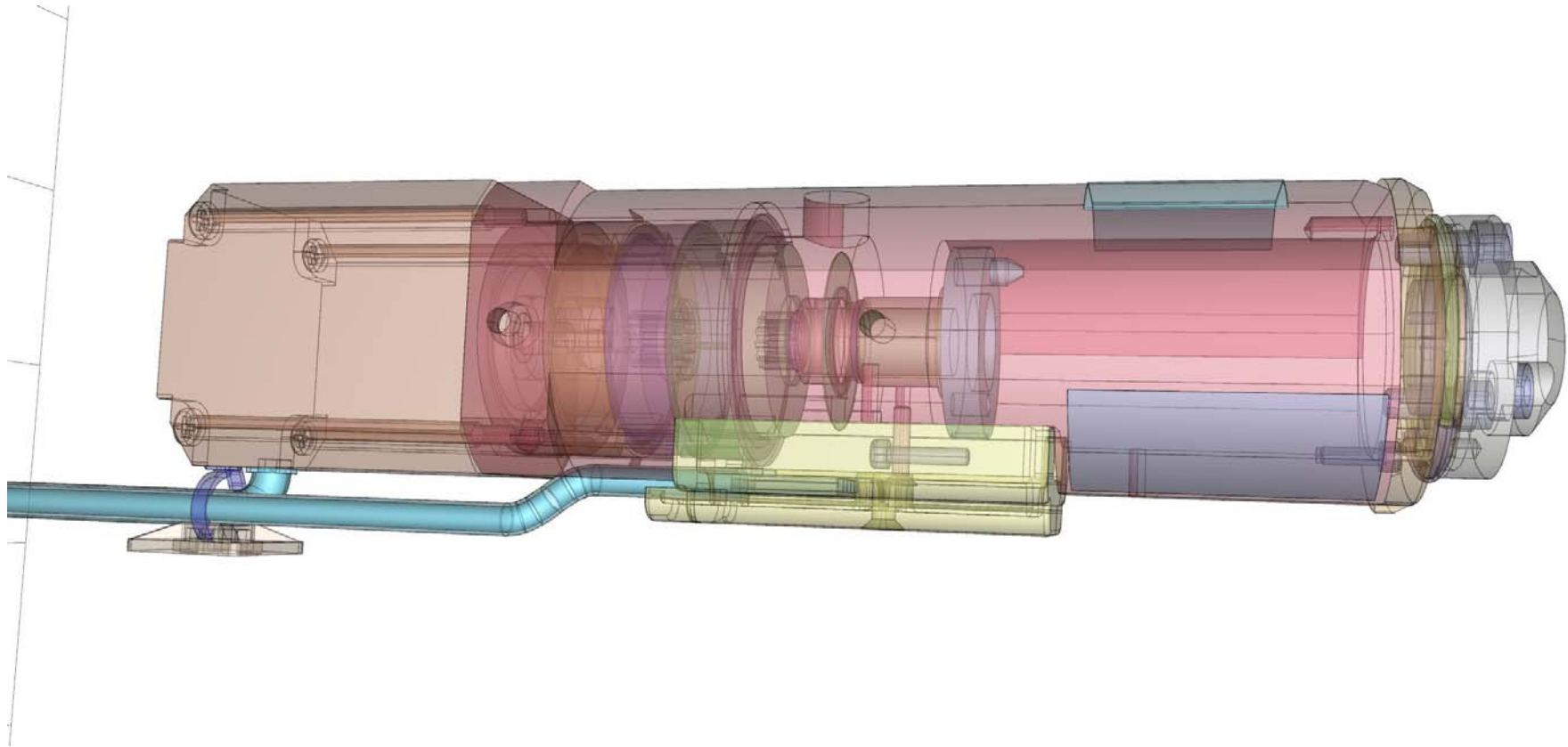
Global Training
& Development



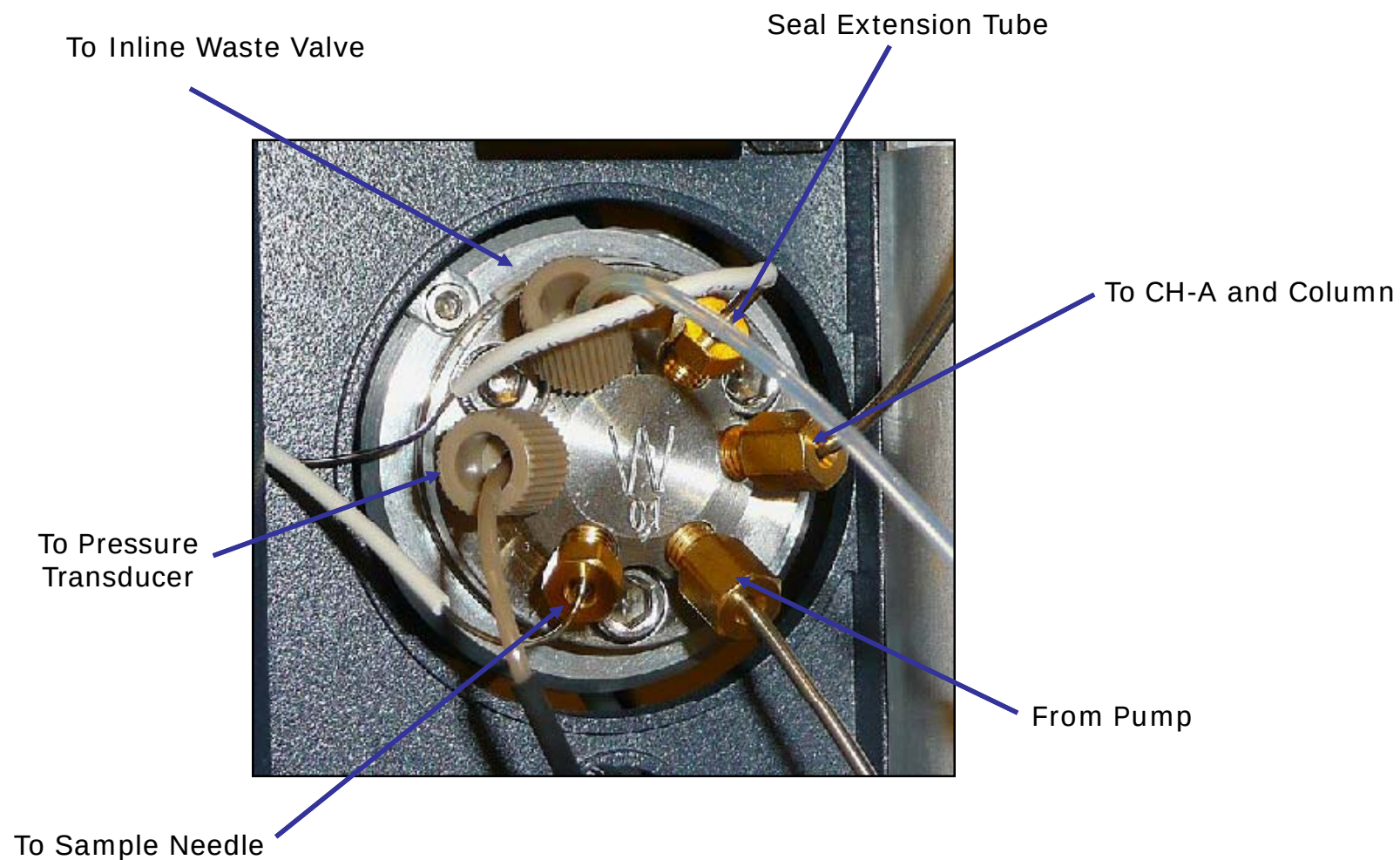
SMDI Front Panel Fluidics



Inject Valve Assembly



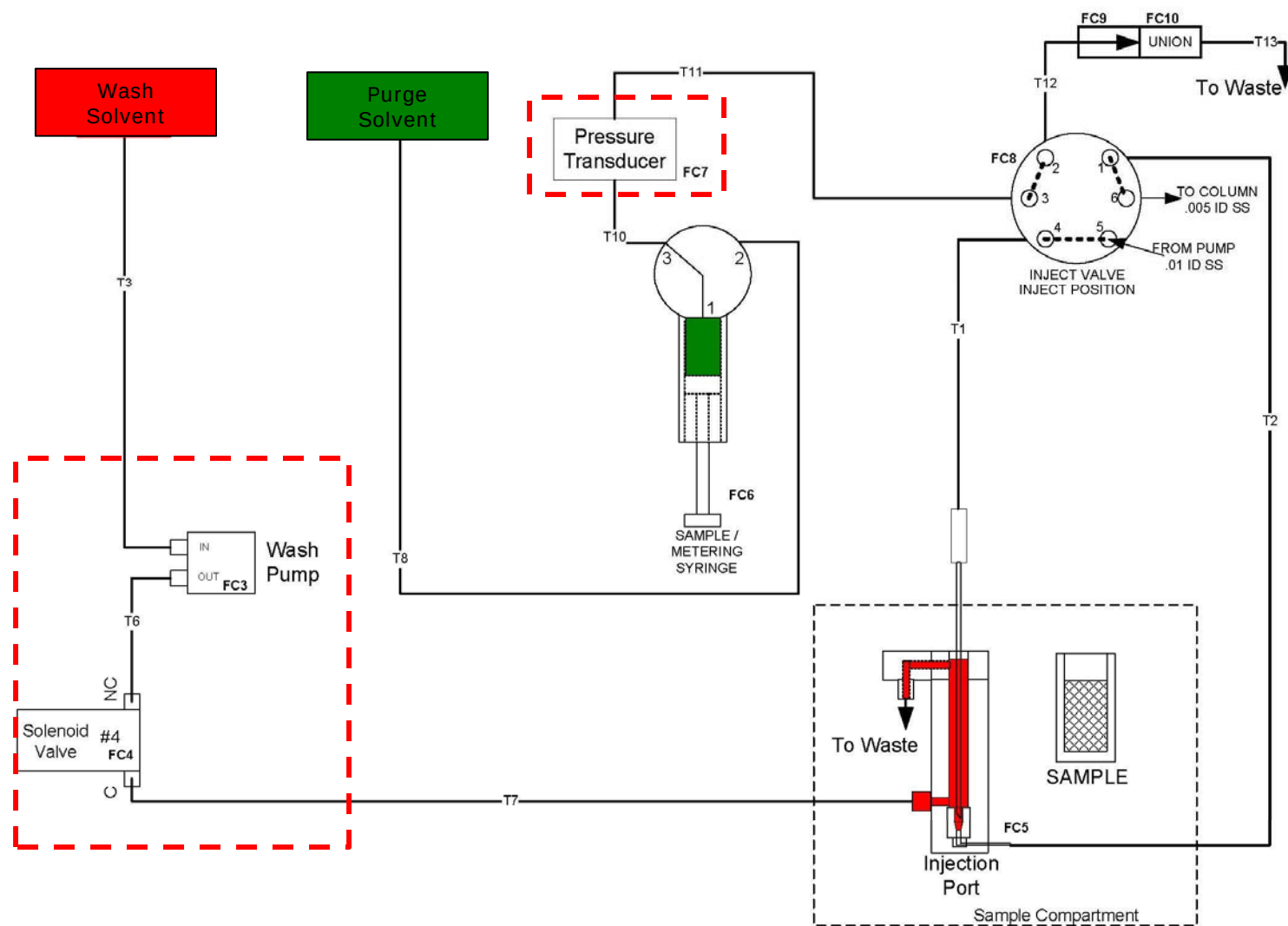
SDMI Inject Valve Connections



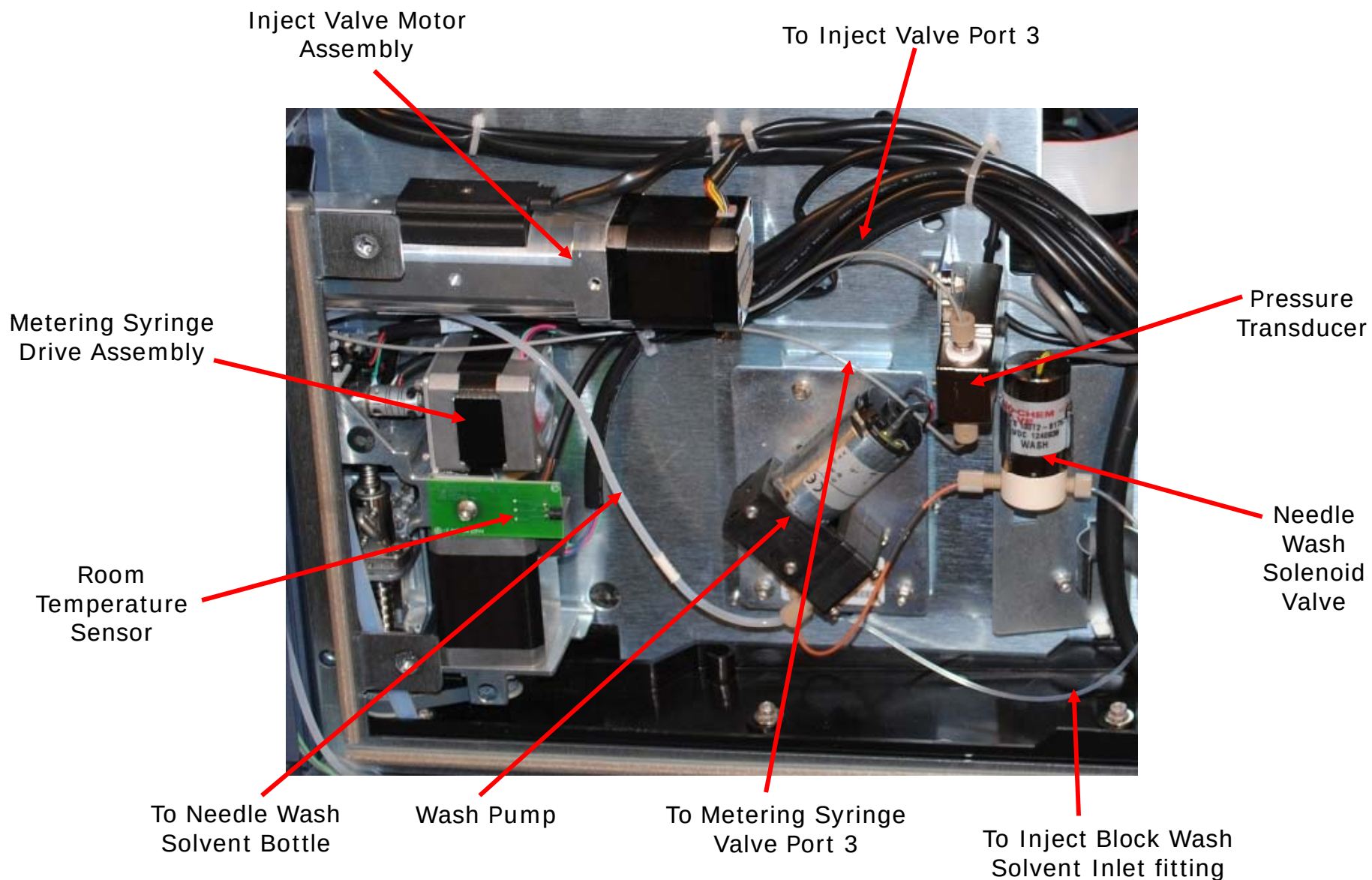
SM-FTN Flow Diagram



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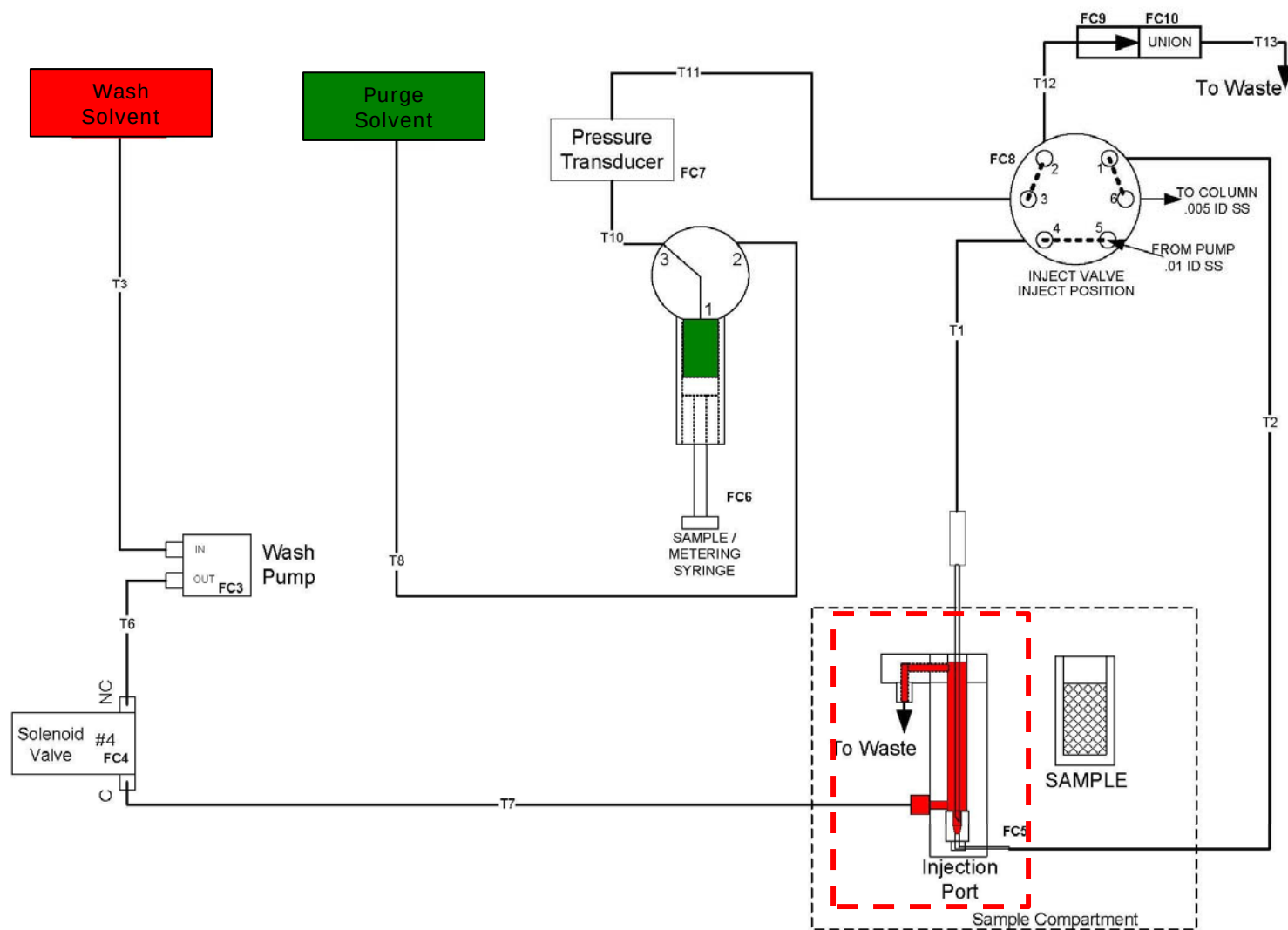
Internal Fluidic Connections



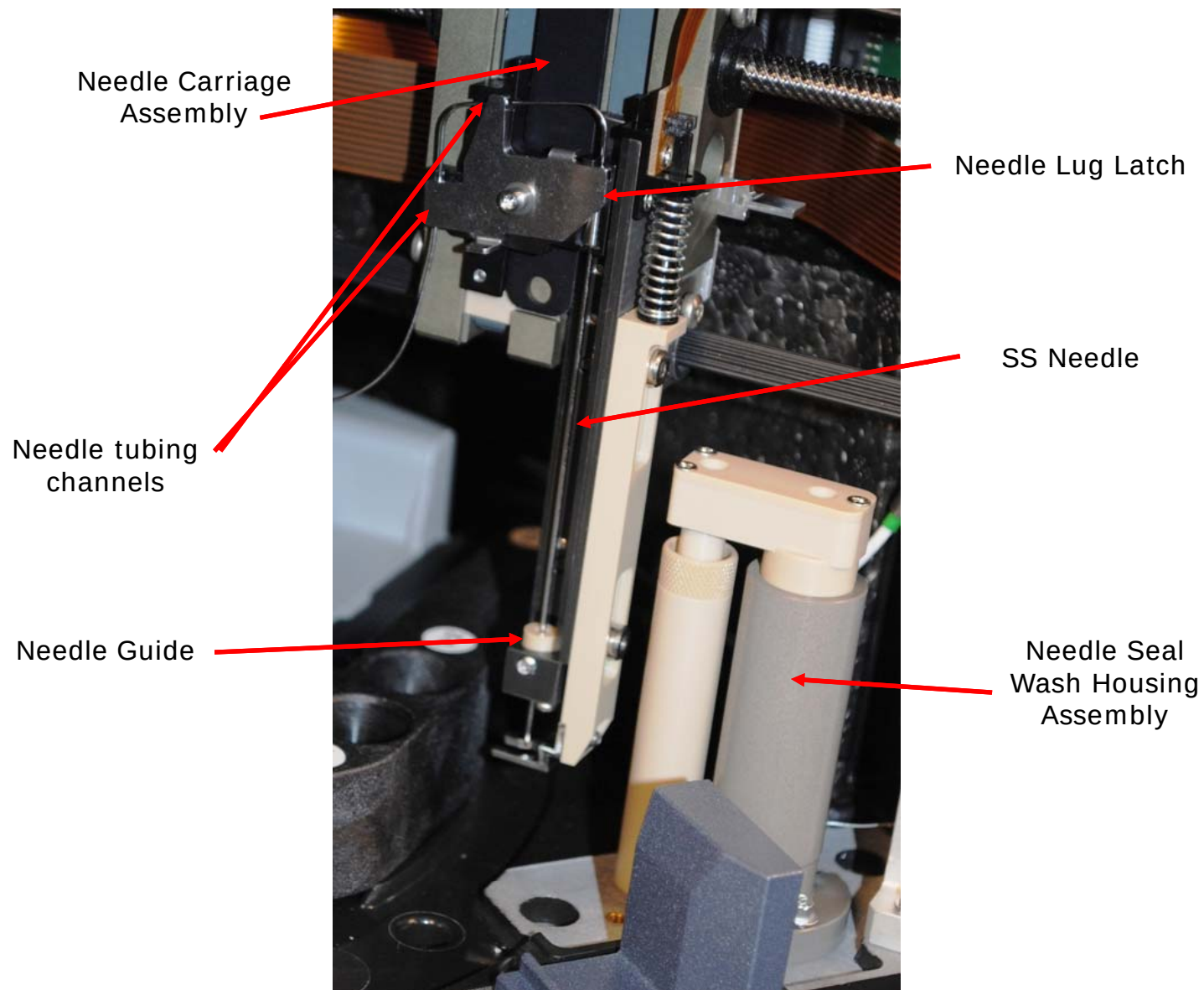
SM-FTN Flow Diagram



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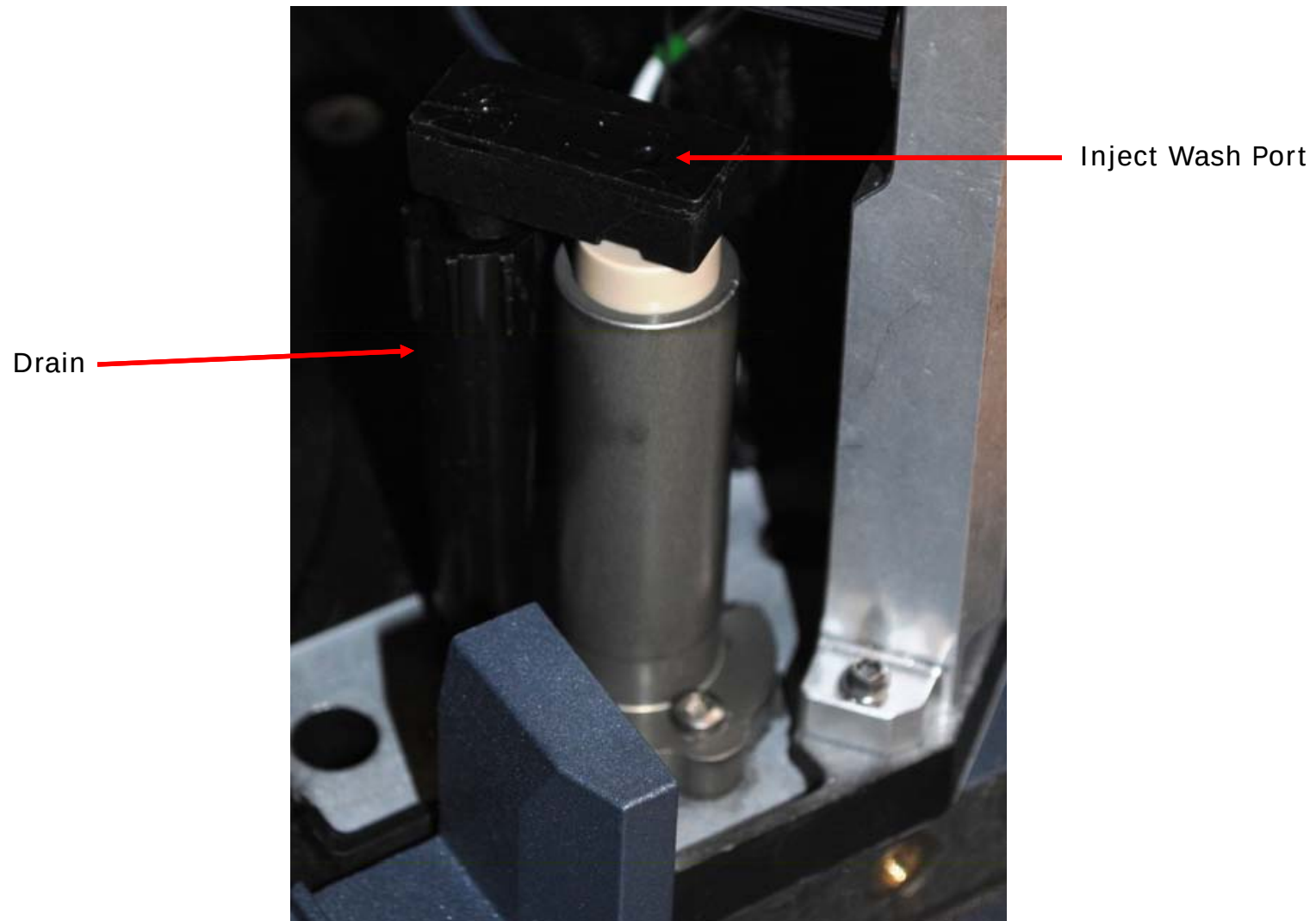
Internal Fluidic Components



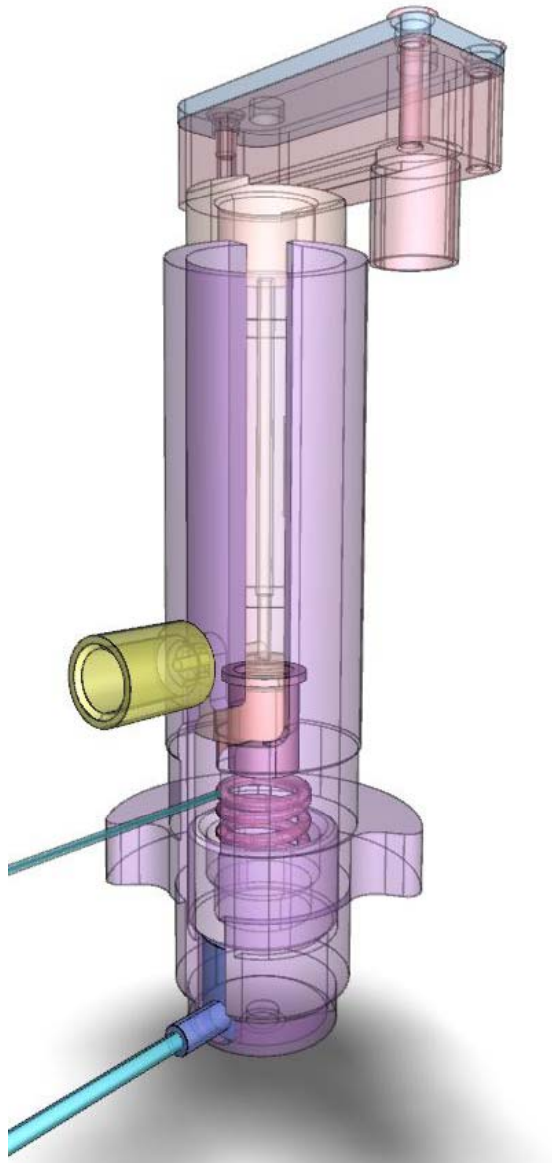
New Needle Seal Wash Housing Assembly



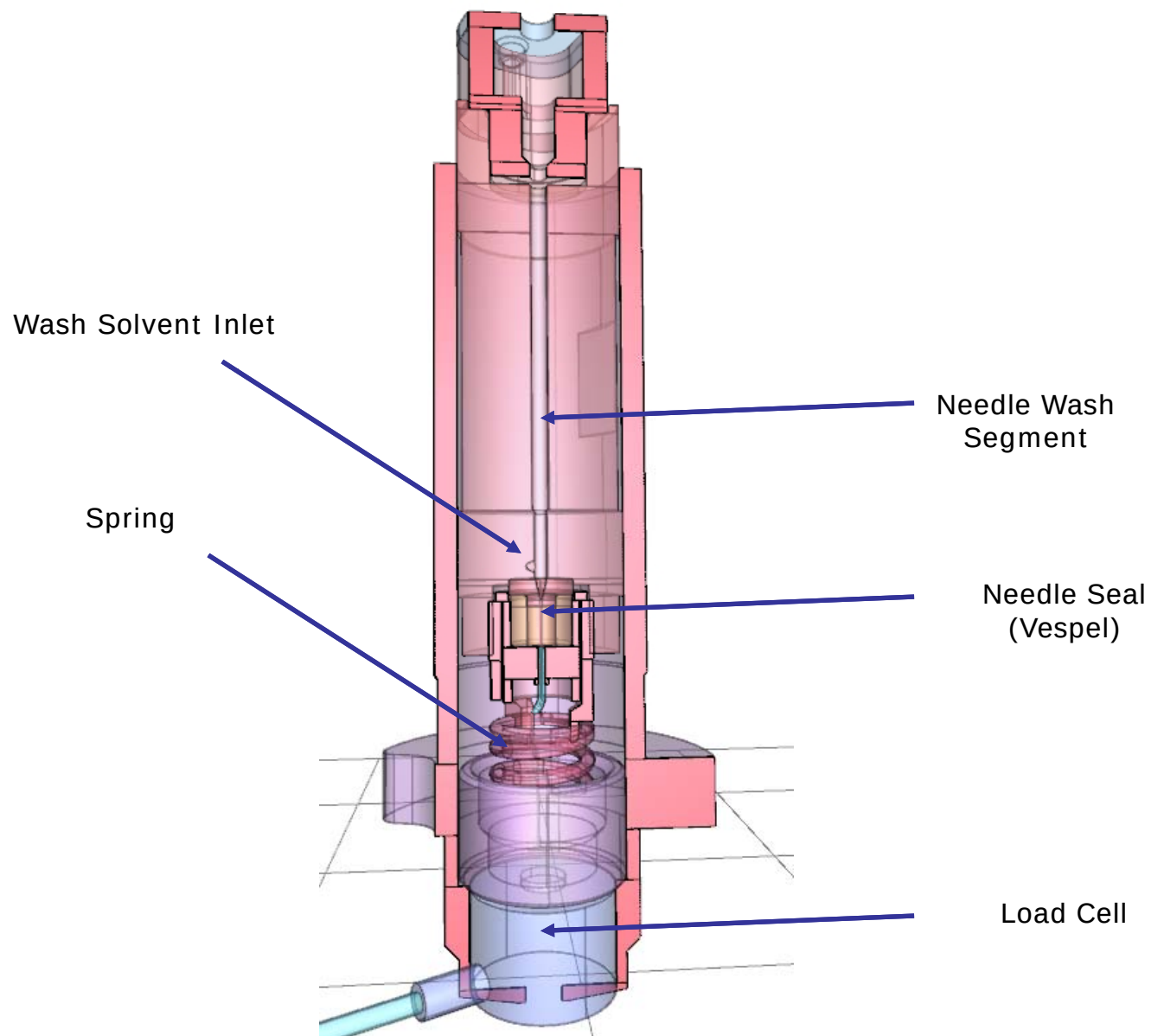
Global Training
& Development



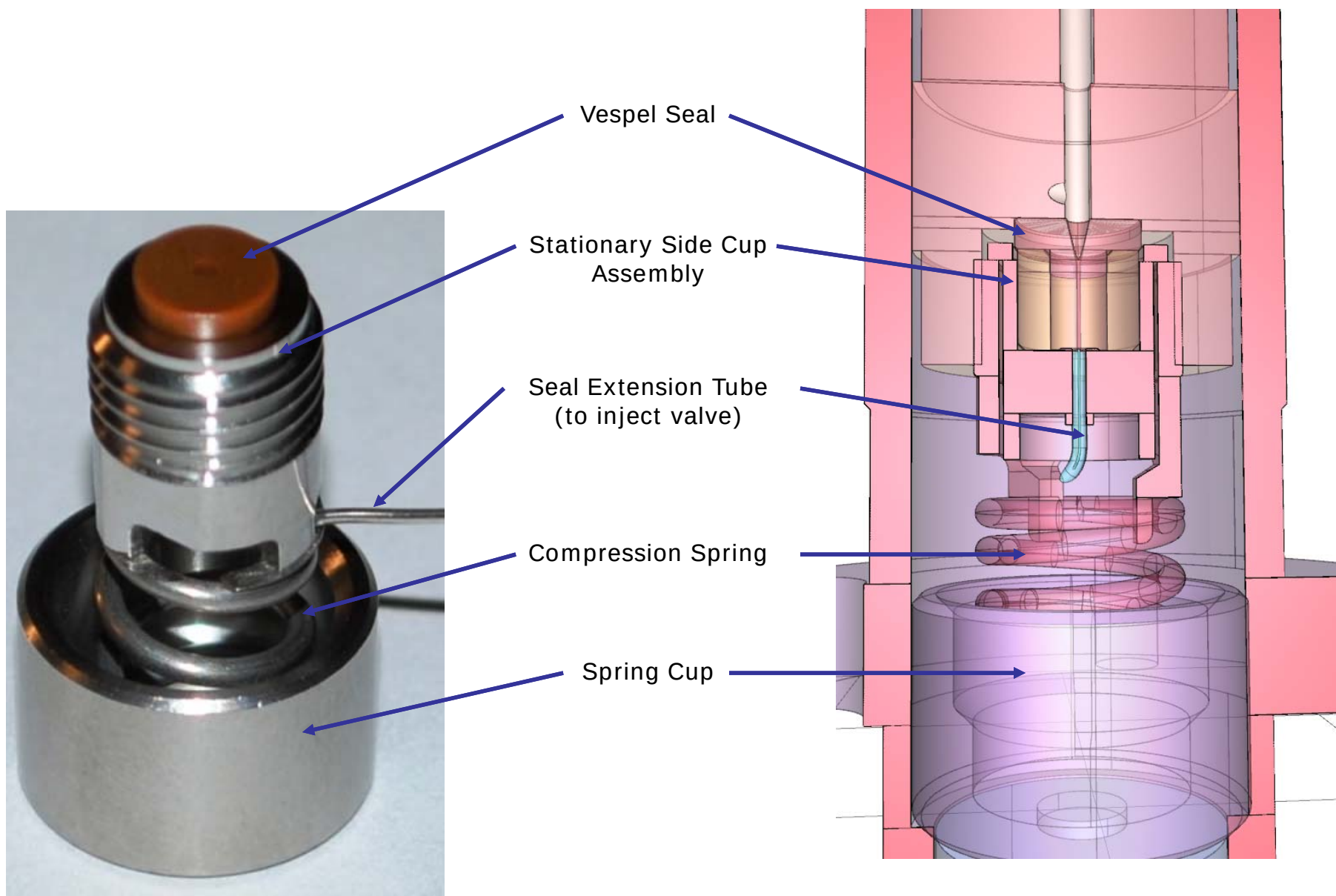
Needle Seal Wash Housing Assembly



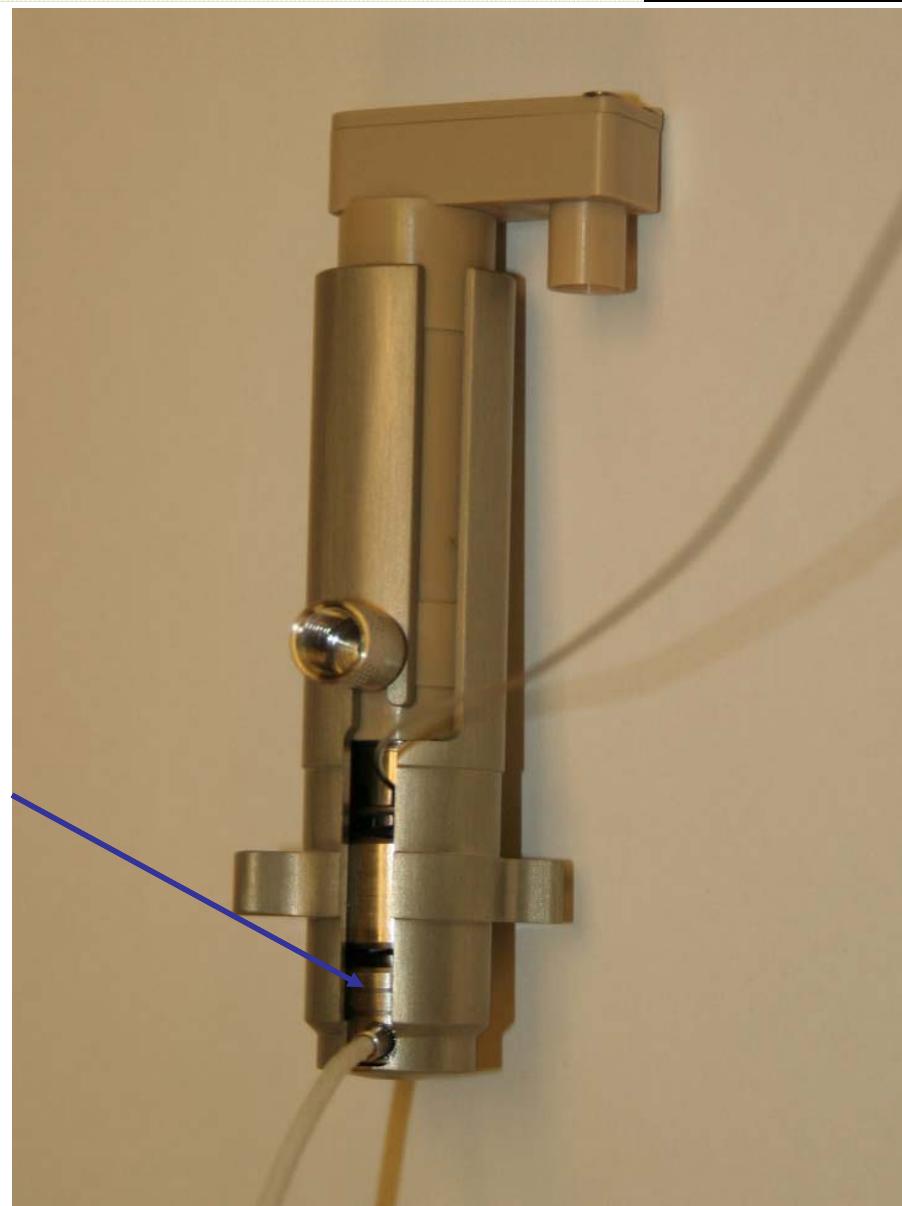
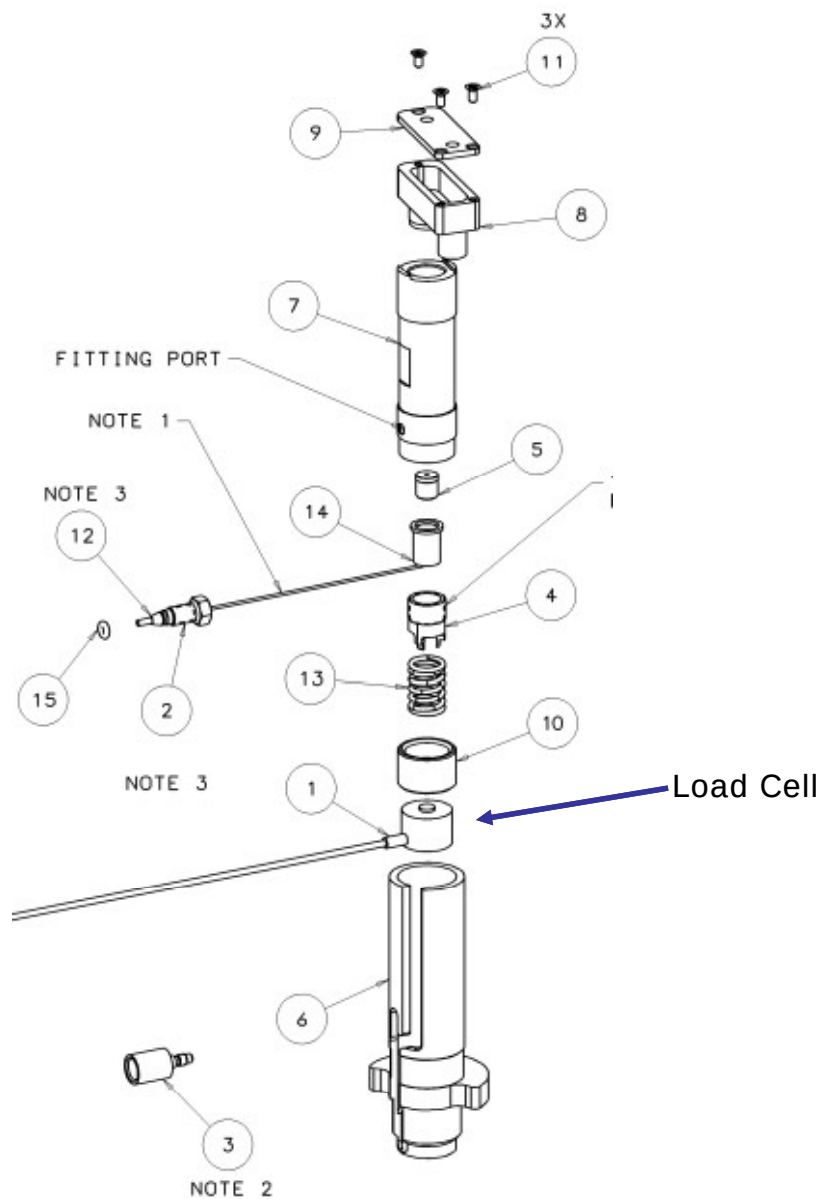
NSW Assembly- Transparent View



Stationary Side Seal Assembly



Needle Seal Wash Housing Assembly



Needle, Loop and Syringe Options



Volume Configuration

Extended Loop Size: 0.0 μL

Needle size: 15.0 μL

Sample syringe size: 100.0 μL

OK Cancel

Volume Configuration- Default Values and drop-down menu options

Volume Configuration

Extended Loop Size: 0.0 μL

Needle size: 0.0 μL

Sample syringe size: 1000.0 μL

OK Cancel

Volume Configuration

Extended Loop Size: 0.0 μL

Needle size: 15.0 μL

Sample syringe size: 30.0 μL

OK Cancel

Volume Configuration

Extended Loop Size: 0.0 μL

Needle size: 15.0 μL

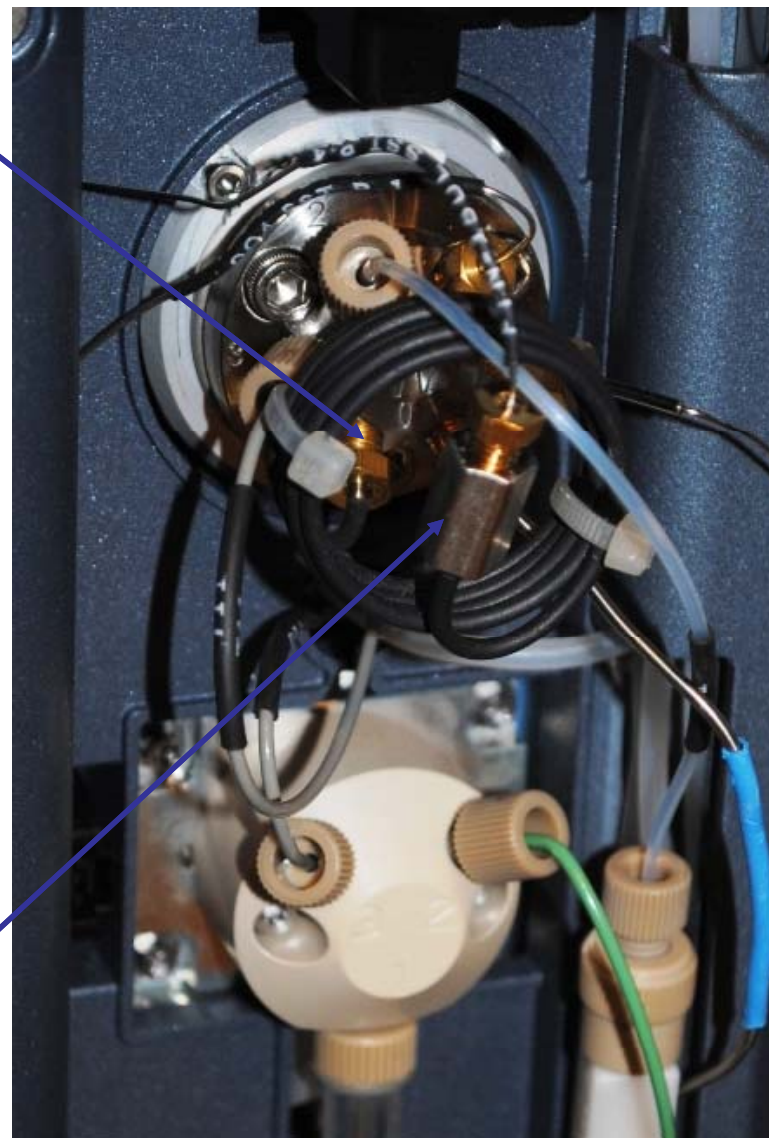
Sample syringe size: 100.0 μL

OK Cancel

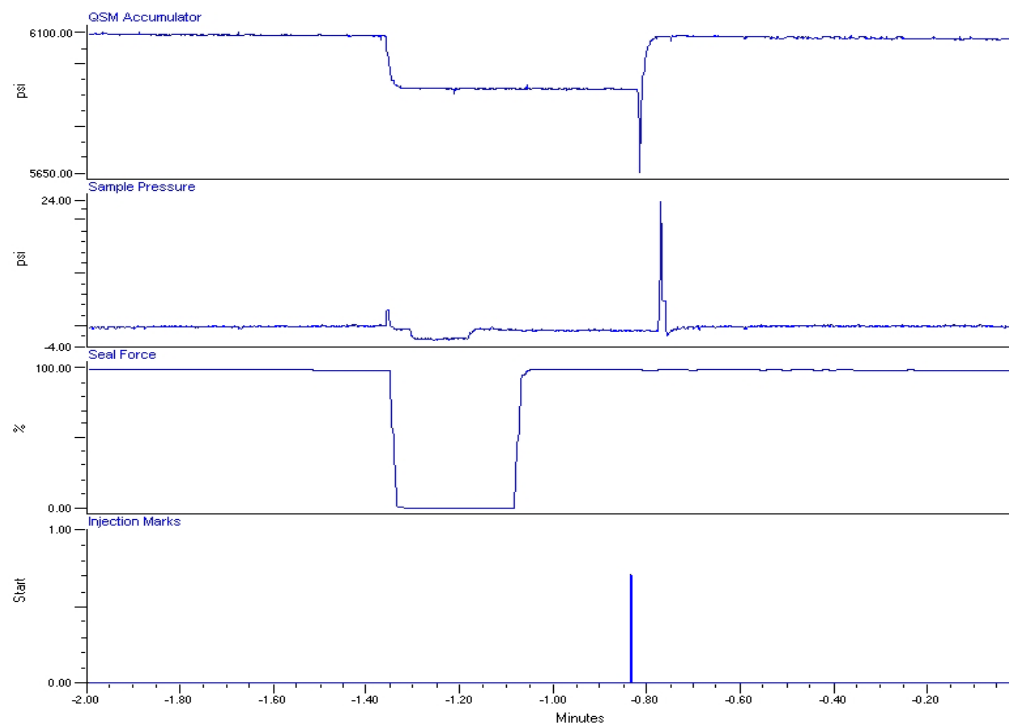
Extended Loop



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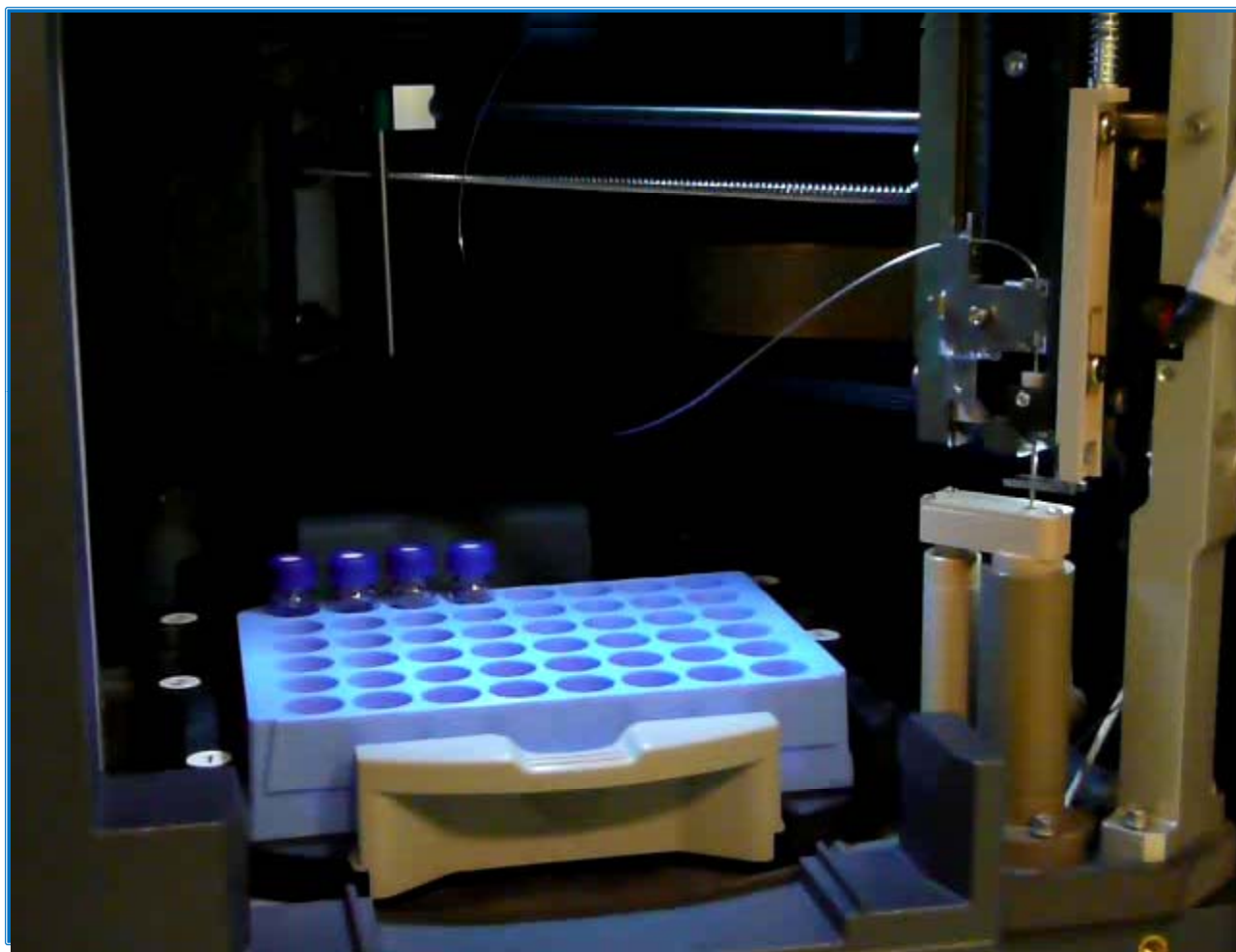
SM-FTN Injection Sequence



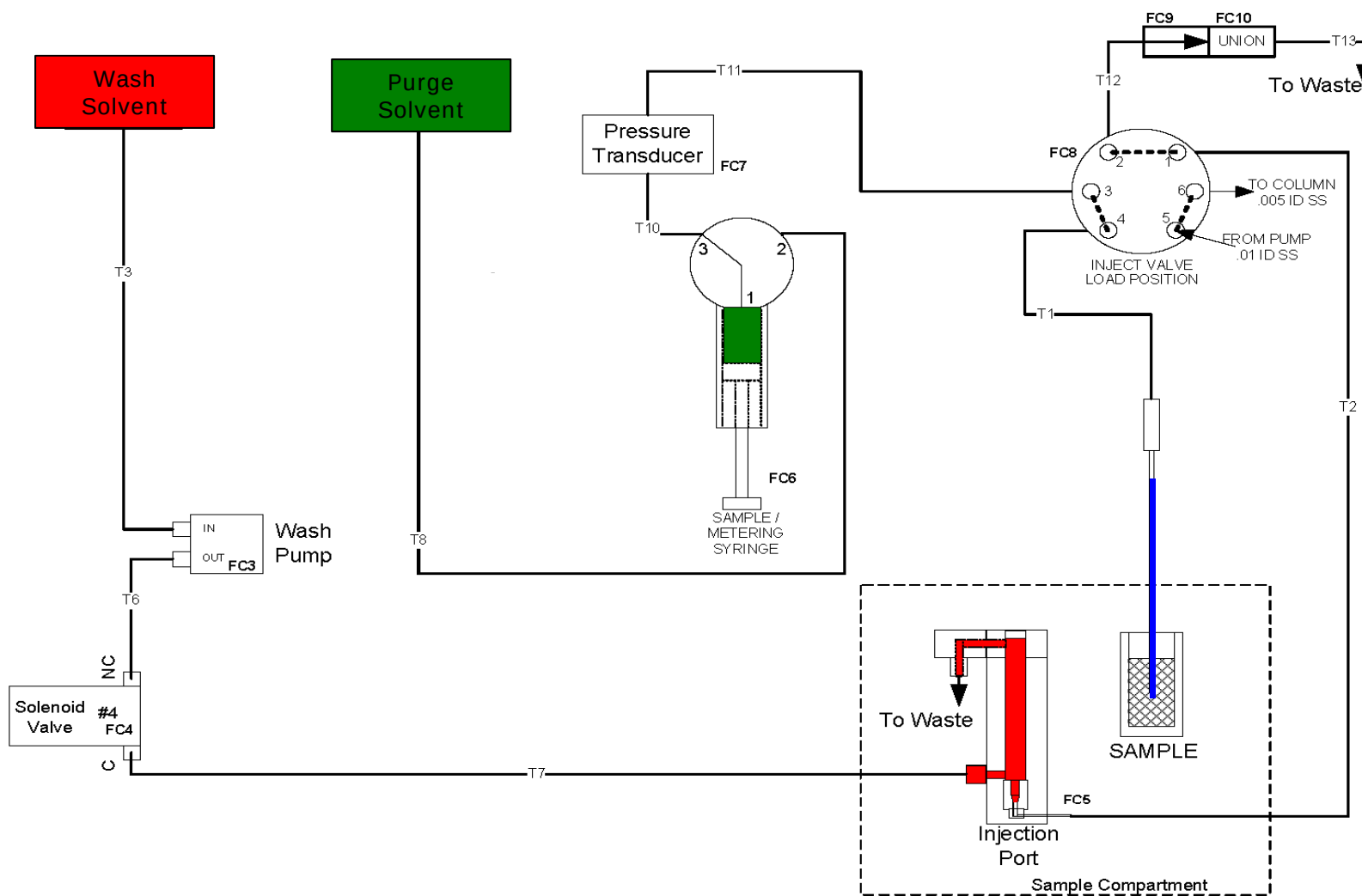
Sample Withdrawal Sequence



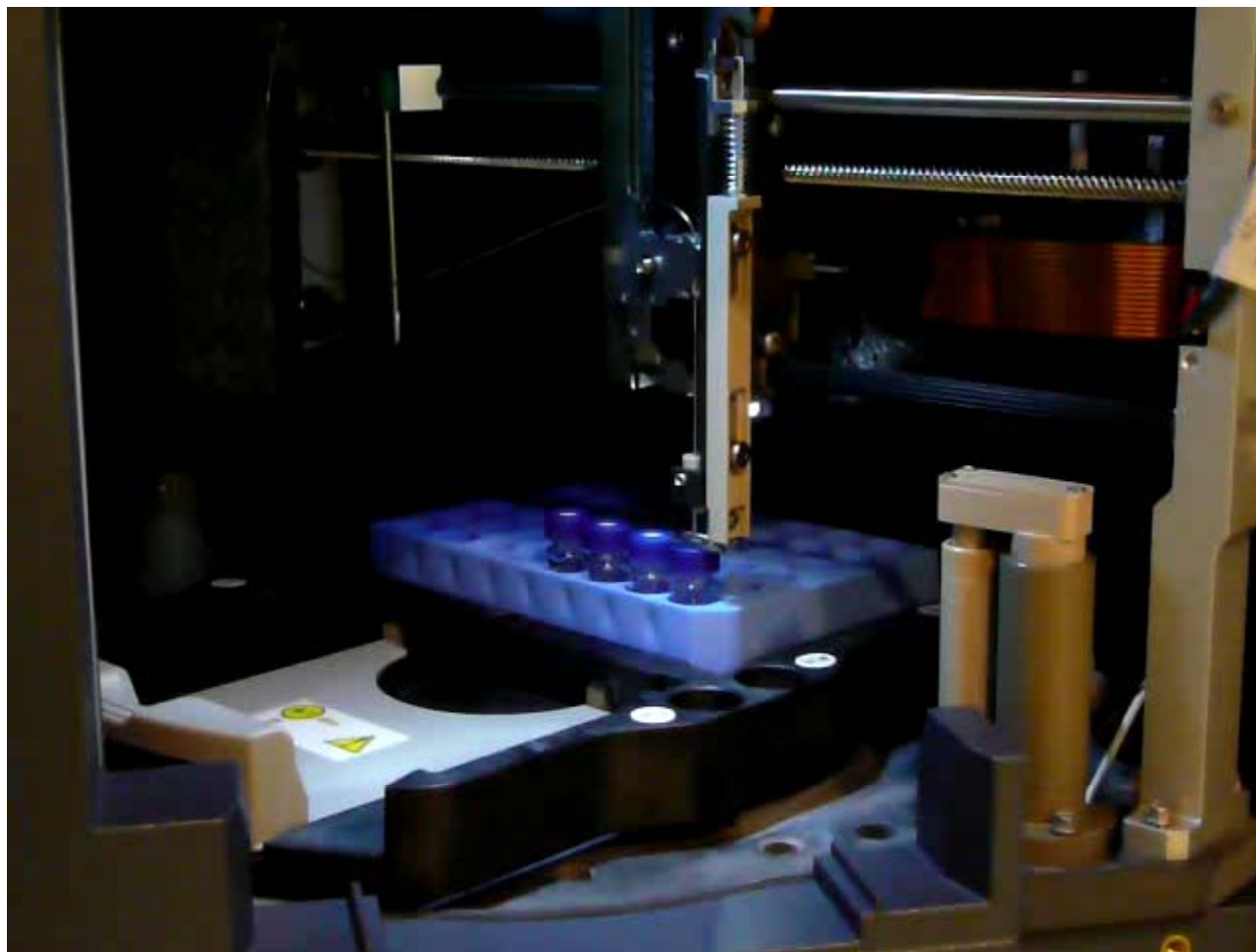
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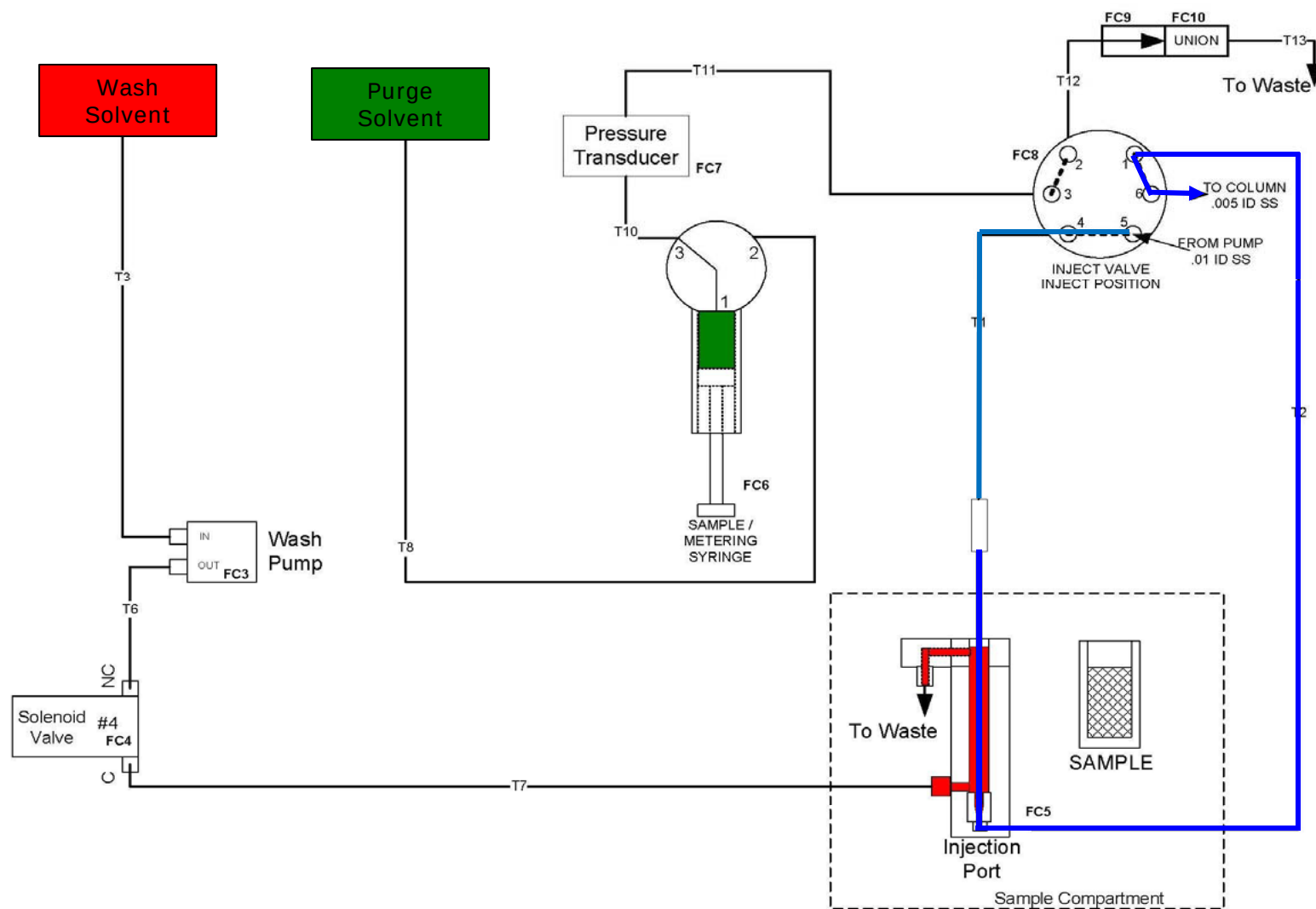
Flow Diagram- Sample Withdrawal



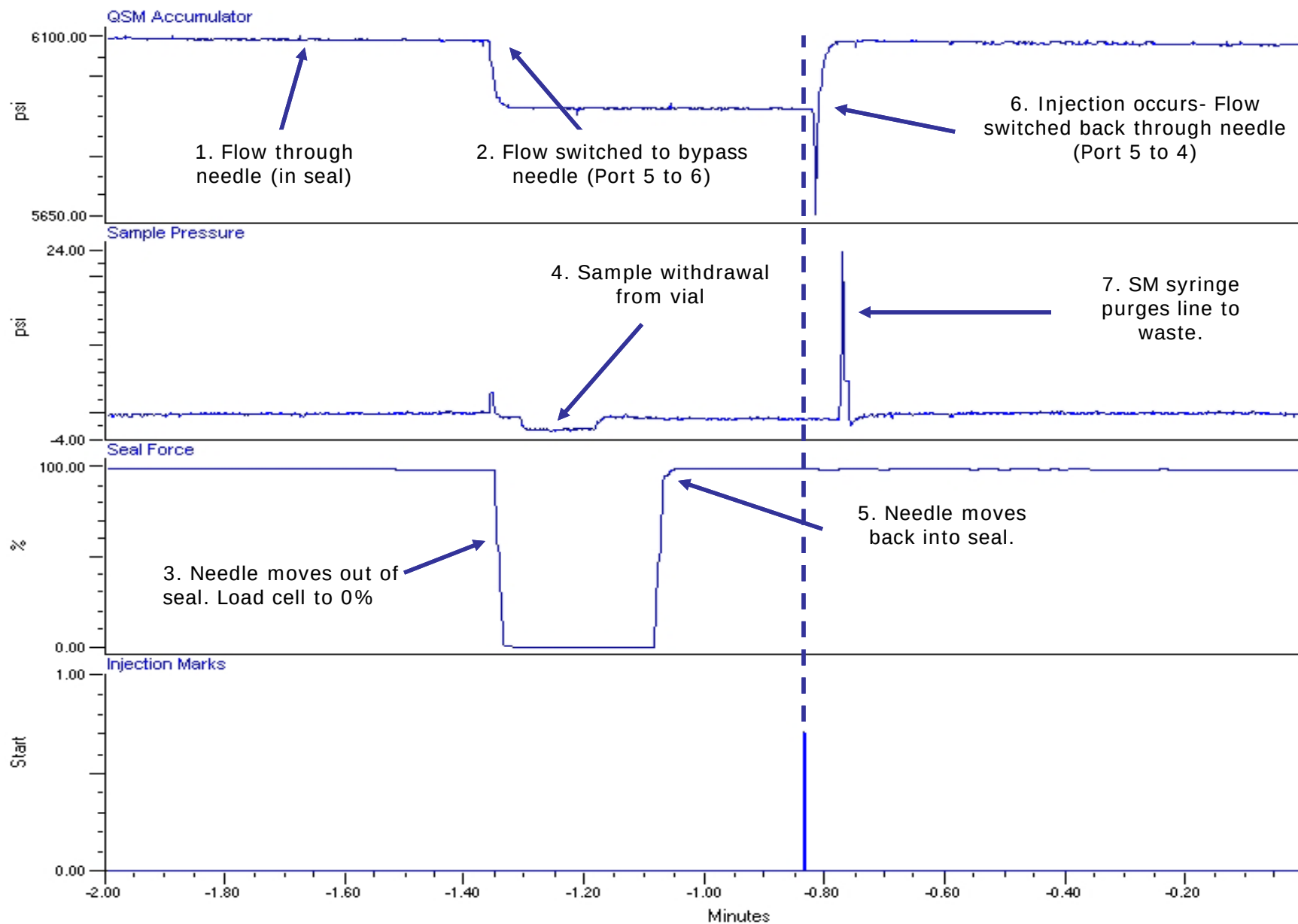
Sample Injection Sequence



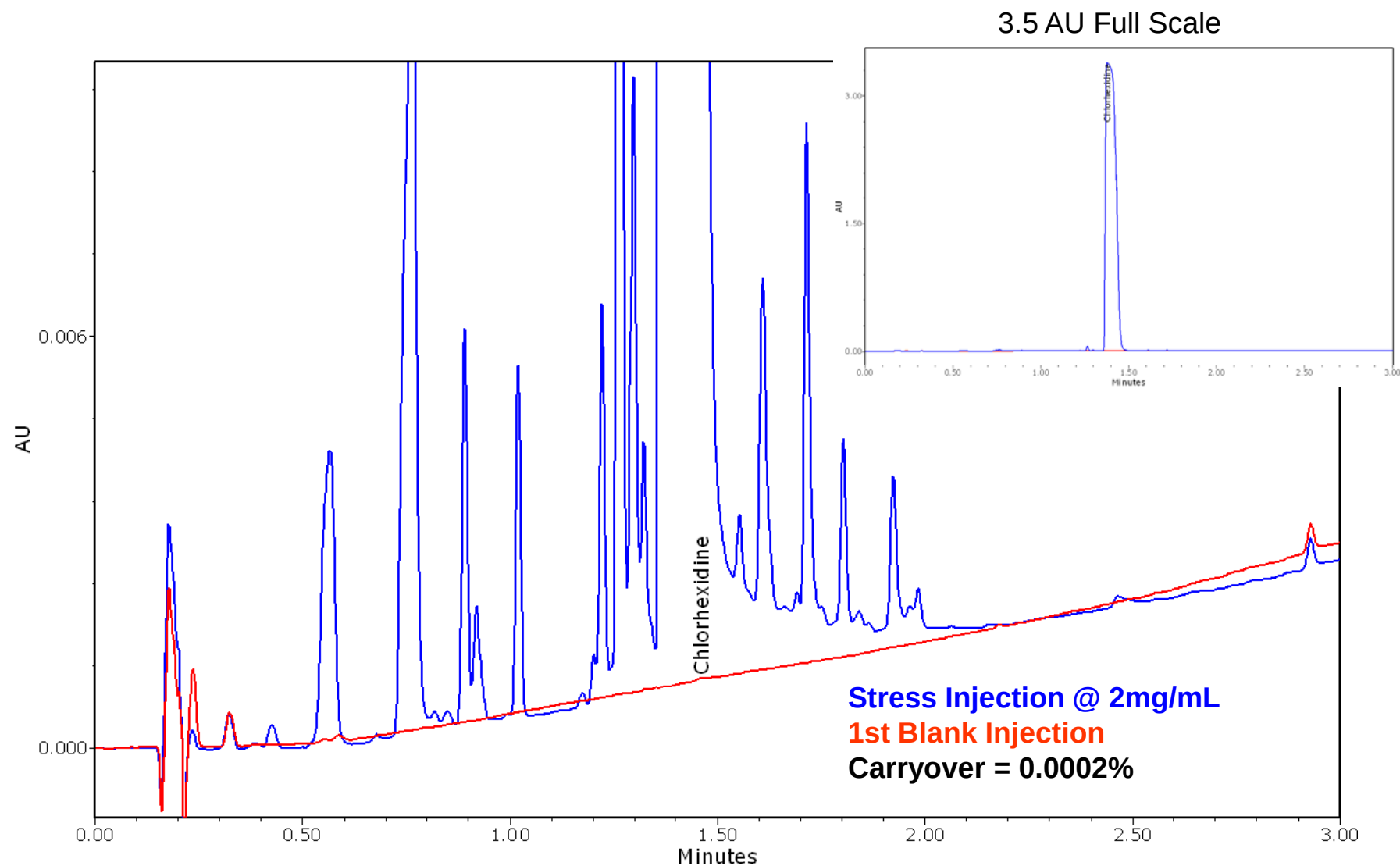
Flow Diagram- Inject Mode



Injection Sequence Pressure Trace

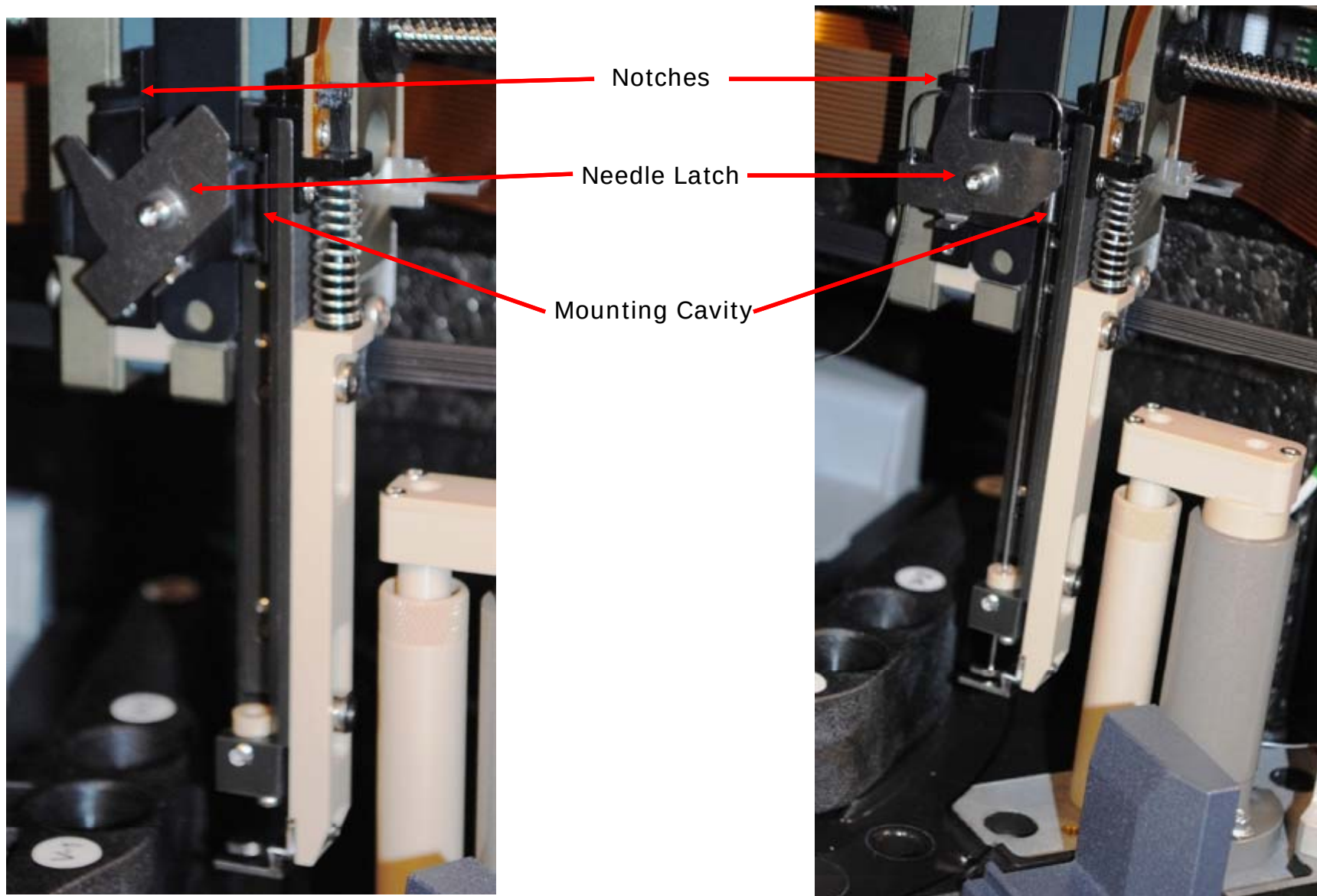


Carryover with UV Detection

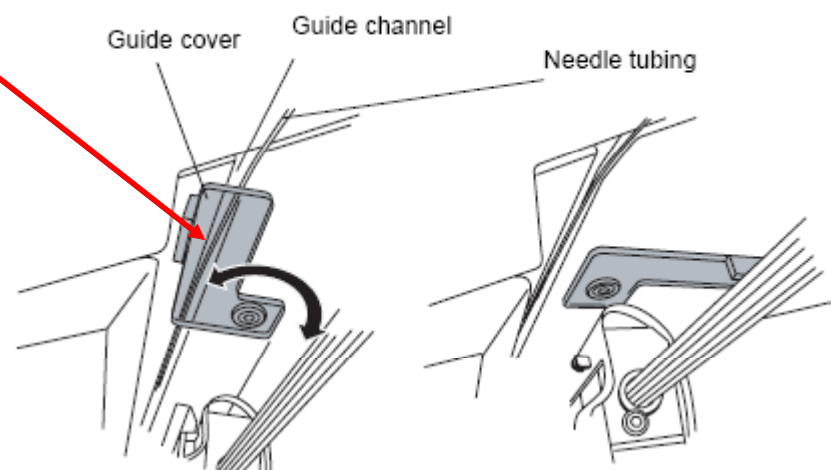
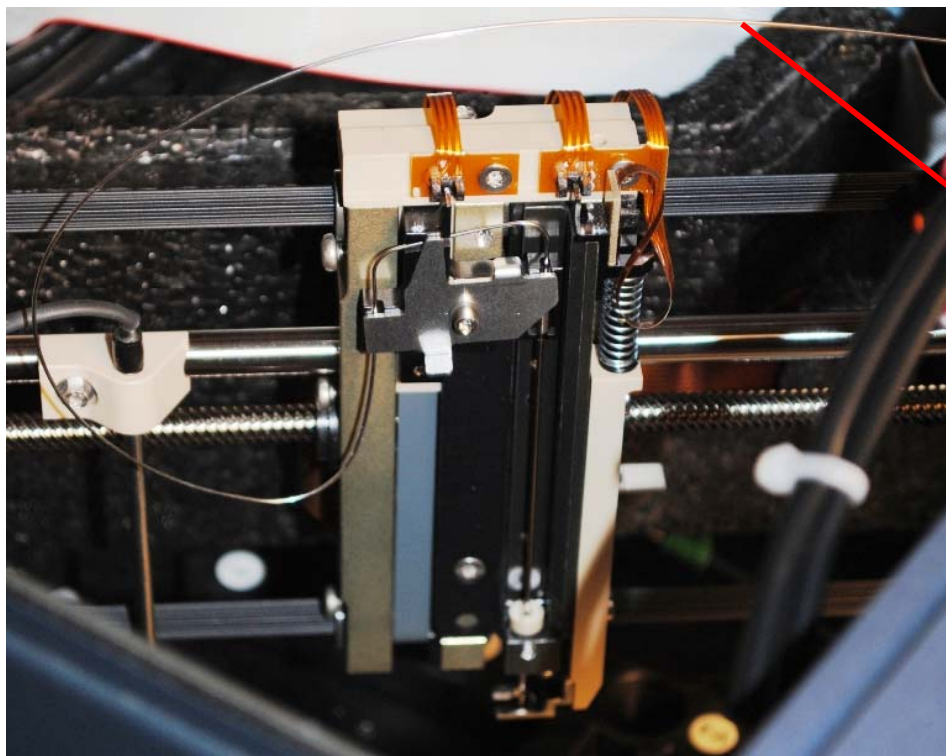


Excellent carryover performance @ 0.0002% was achieved for Chlorhexidine (a basic and difficult-to-remove compound) flow-through-needle (SM-FTN) design.

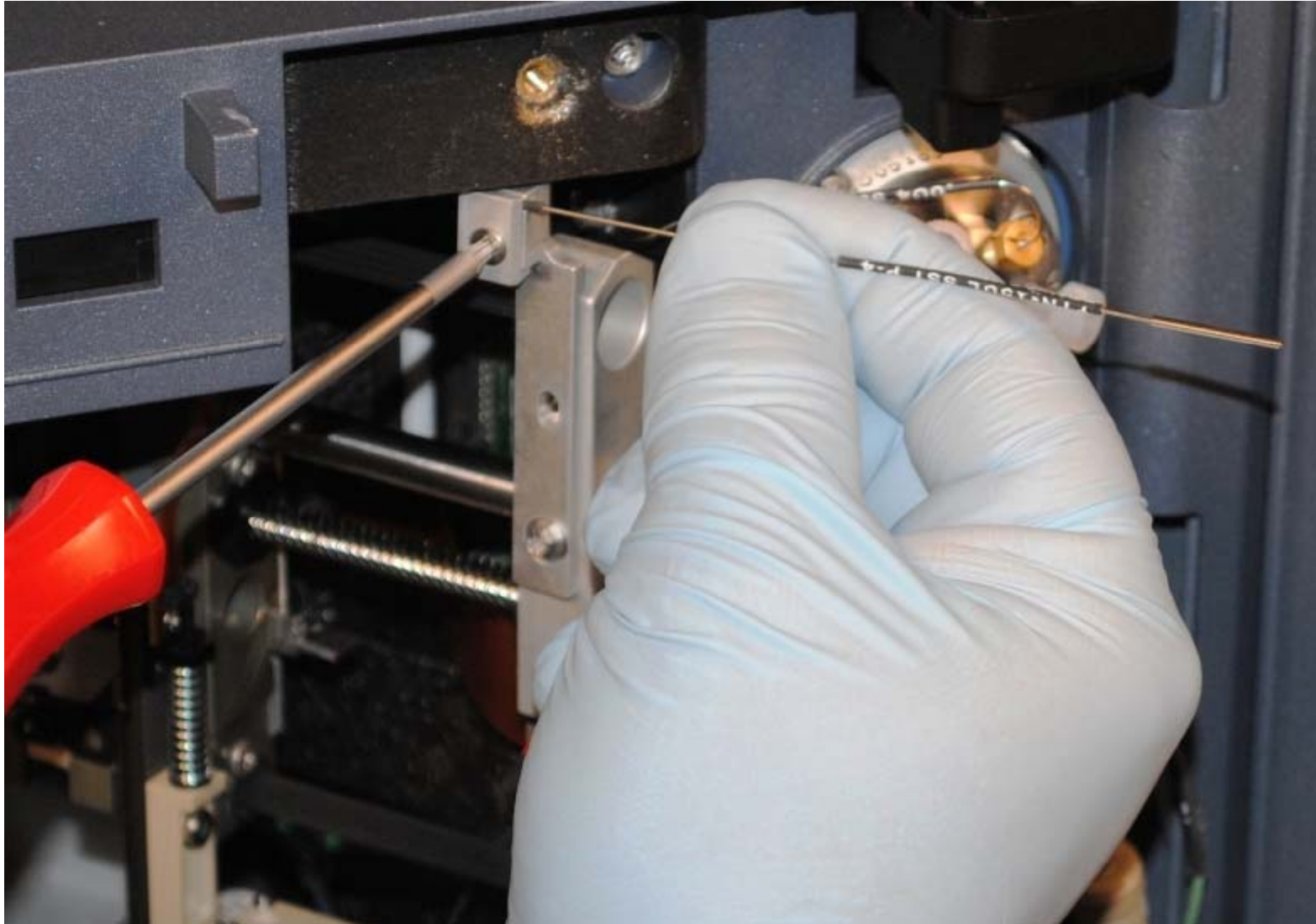
Needle Installation- Production Units



Needle Routing- Production Units



Needle Routing- Production Units



SM Performance



Injection Volume Recommendations



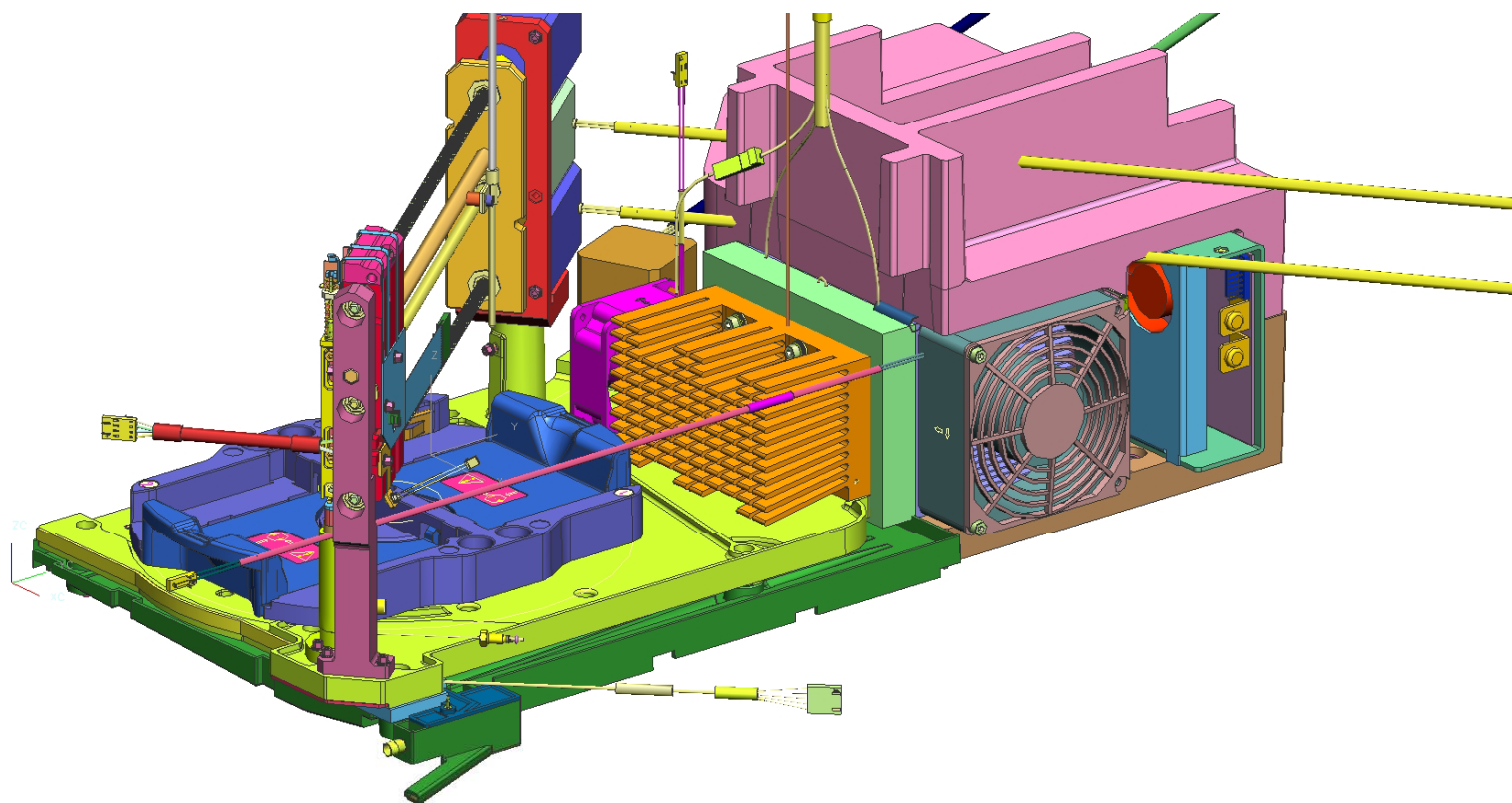
Configuration	Extension Loop	Injection Volume	R ² 0.999
15µL needle		0.1 to 10µL	0.2 to 10µL
30µL needle		0.1 to 25µL	0.2 to 25µL
Any needle	50µL	Up to 50µL	2 to 50µL
Any needle	100µL	Up to 100µL	10 to 100µL
Any needle	250µL	Up to 250µL	25 to 250µL



Sample Compartment Internals

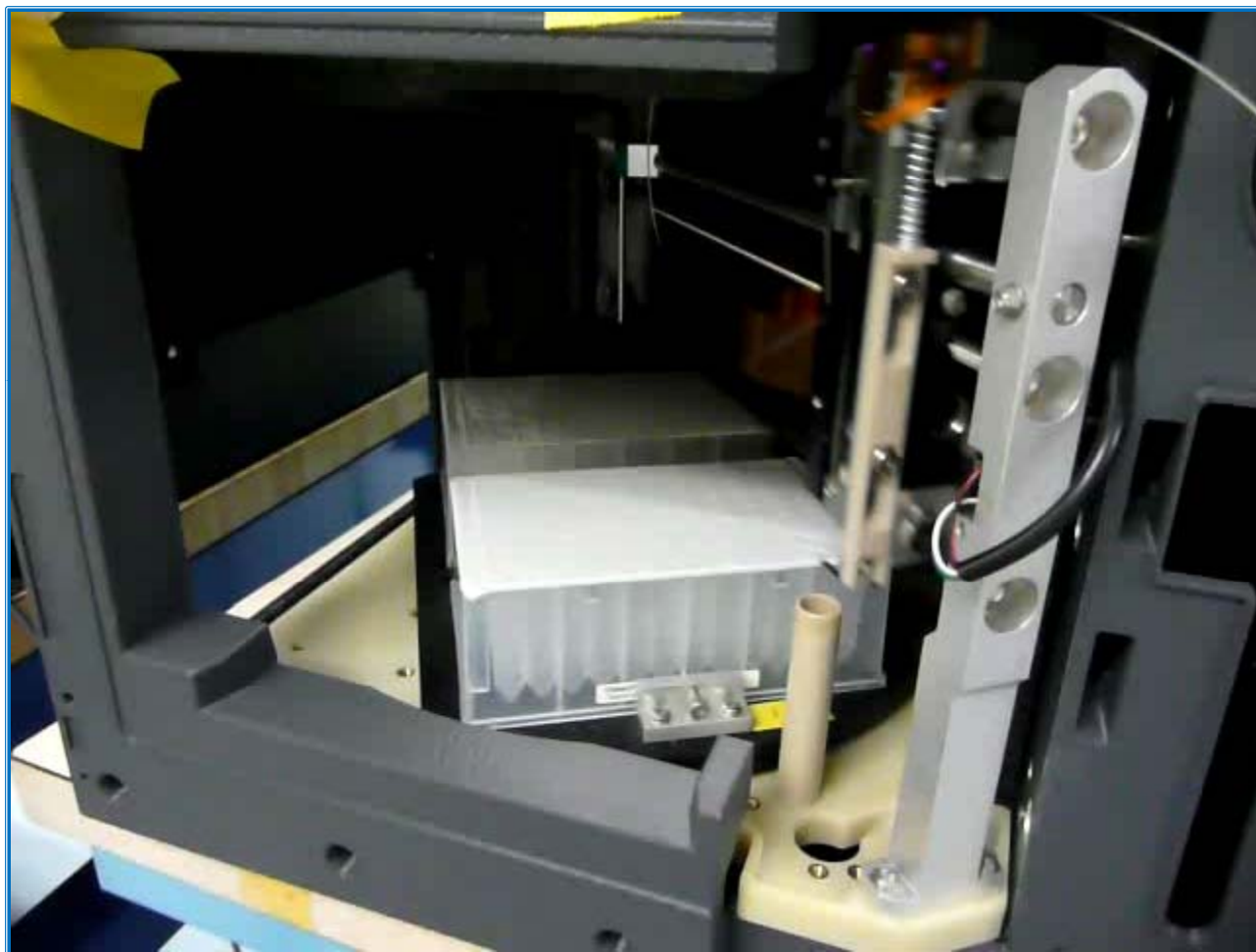


R-Theta Drive Assembly

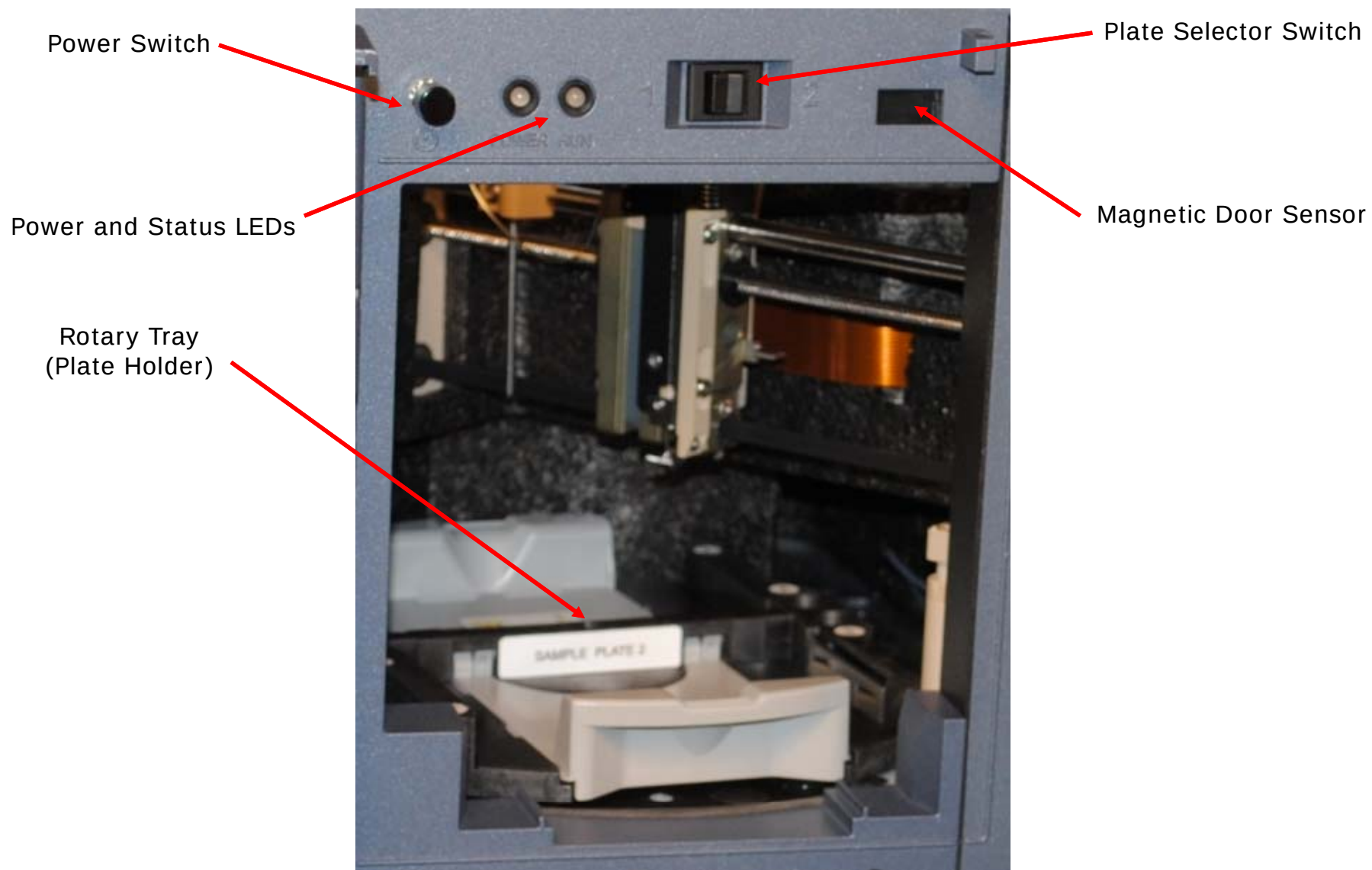


TF11-TR1 Work Camera TF11-TR1

R-Theta Coordinated Movement



Sample Compartment



Rotary Tray

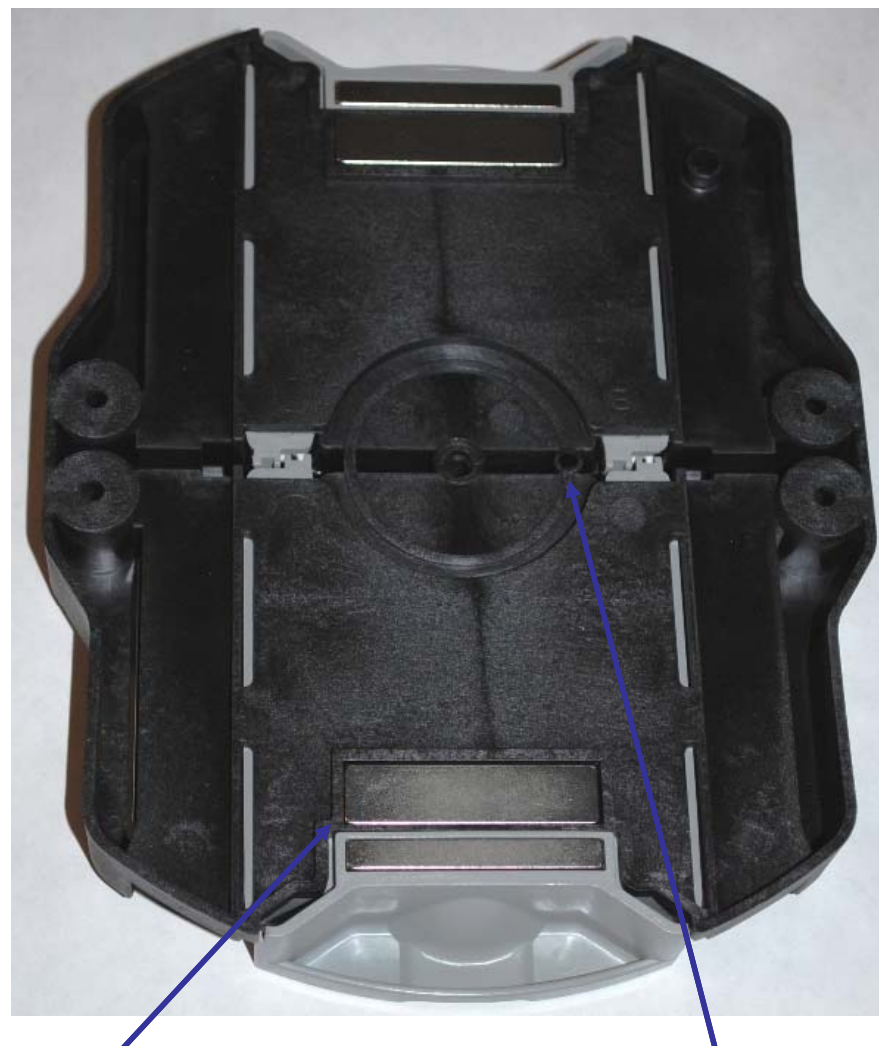


Top View



T20 Torx Screw

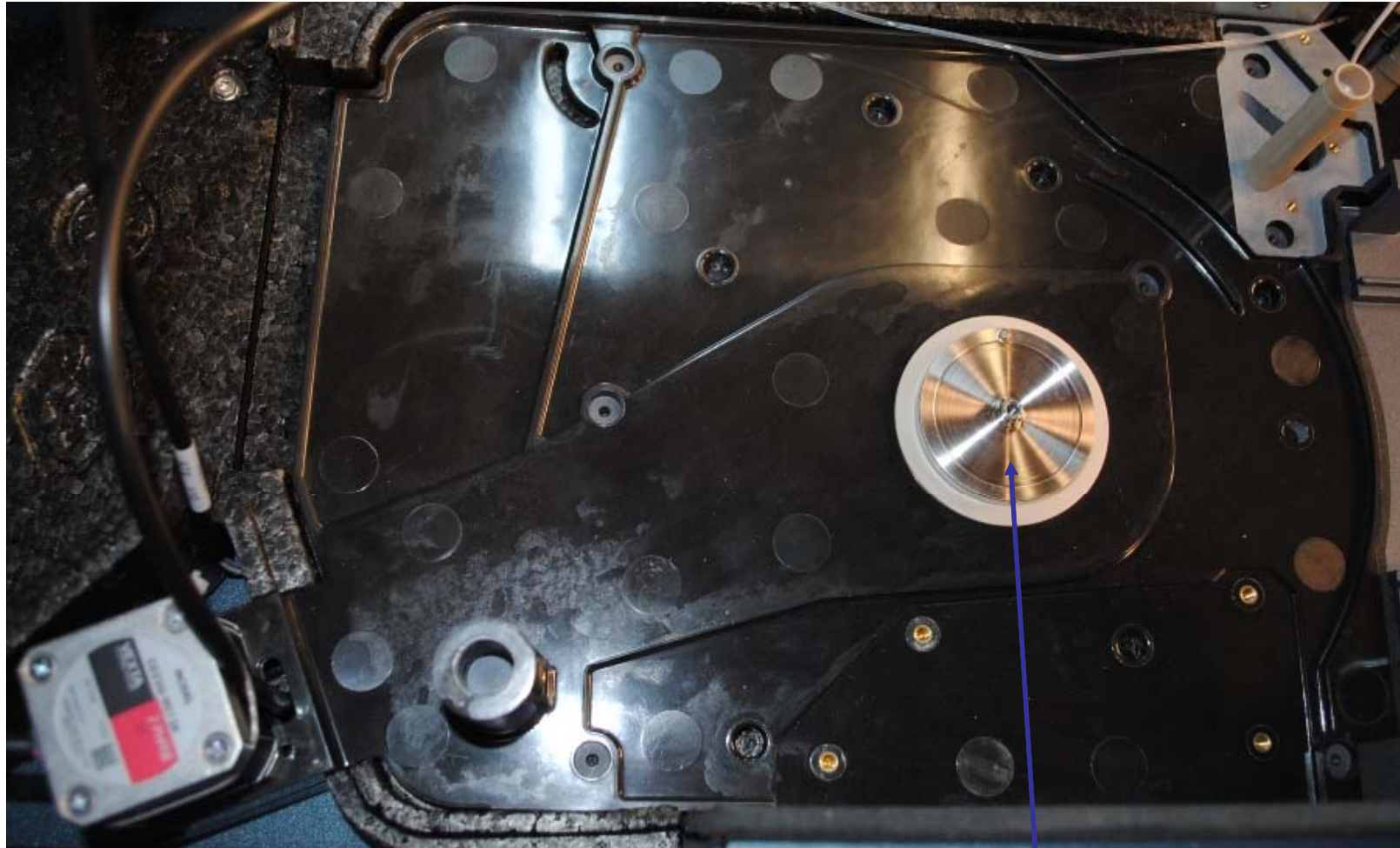
Bottom View



Magnets (to secure plates)

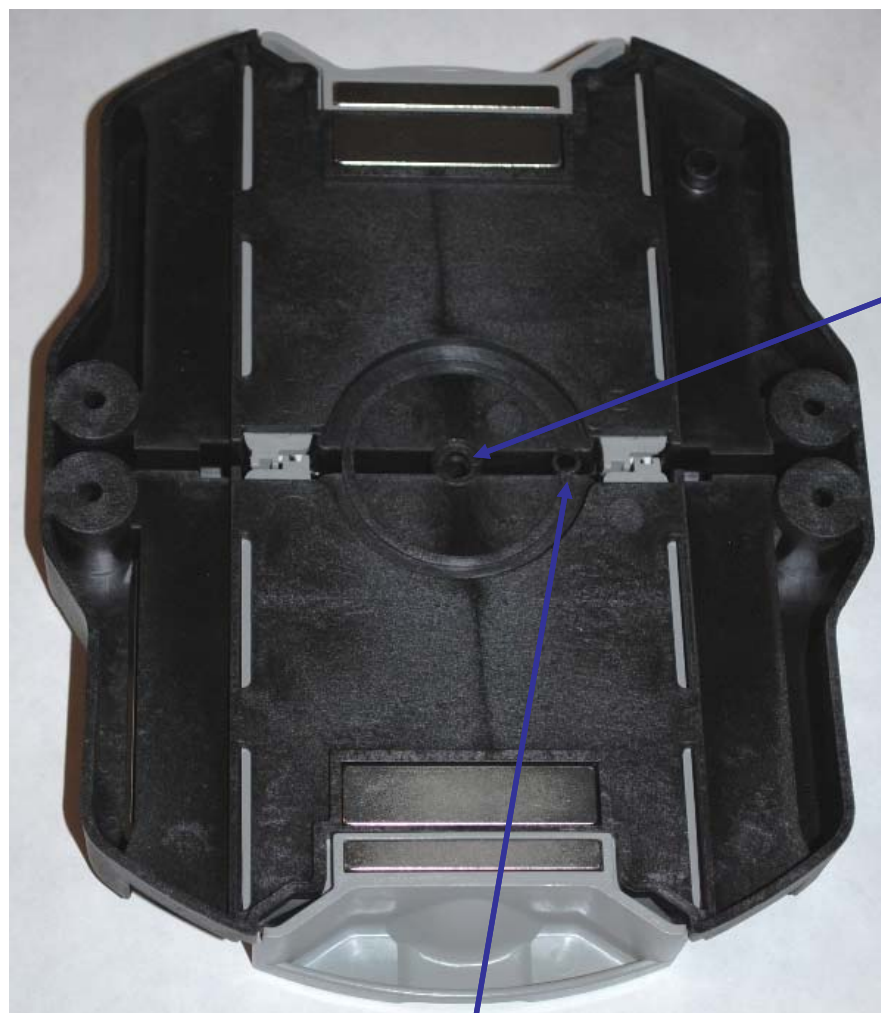
Guide Pin Hole

Theta Drive Assembly (Top View)

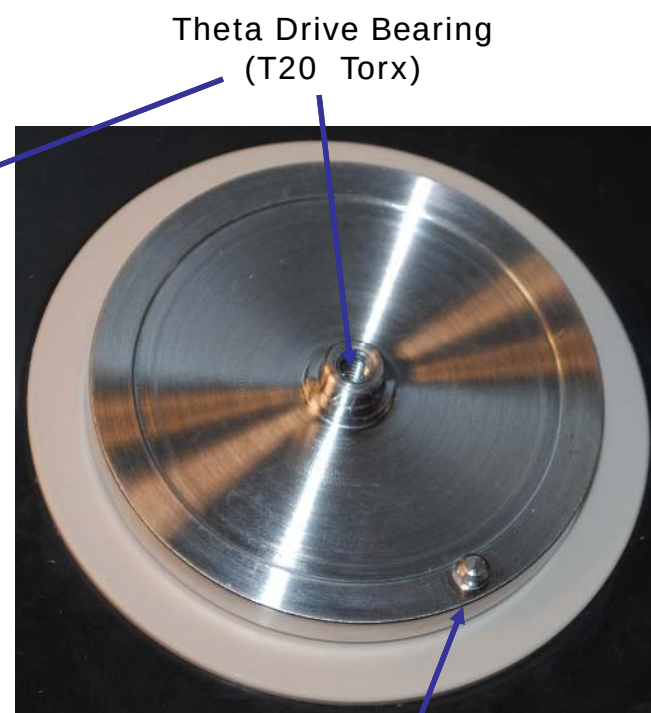


Rotary Tray Drive Bearing

Rotary Tray and Theta Drive Bearing

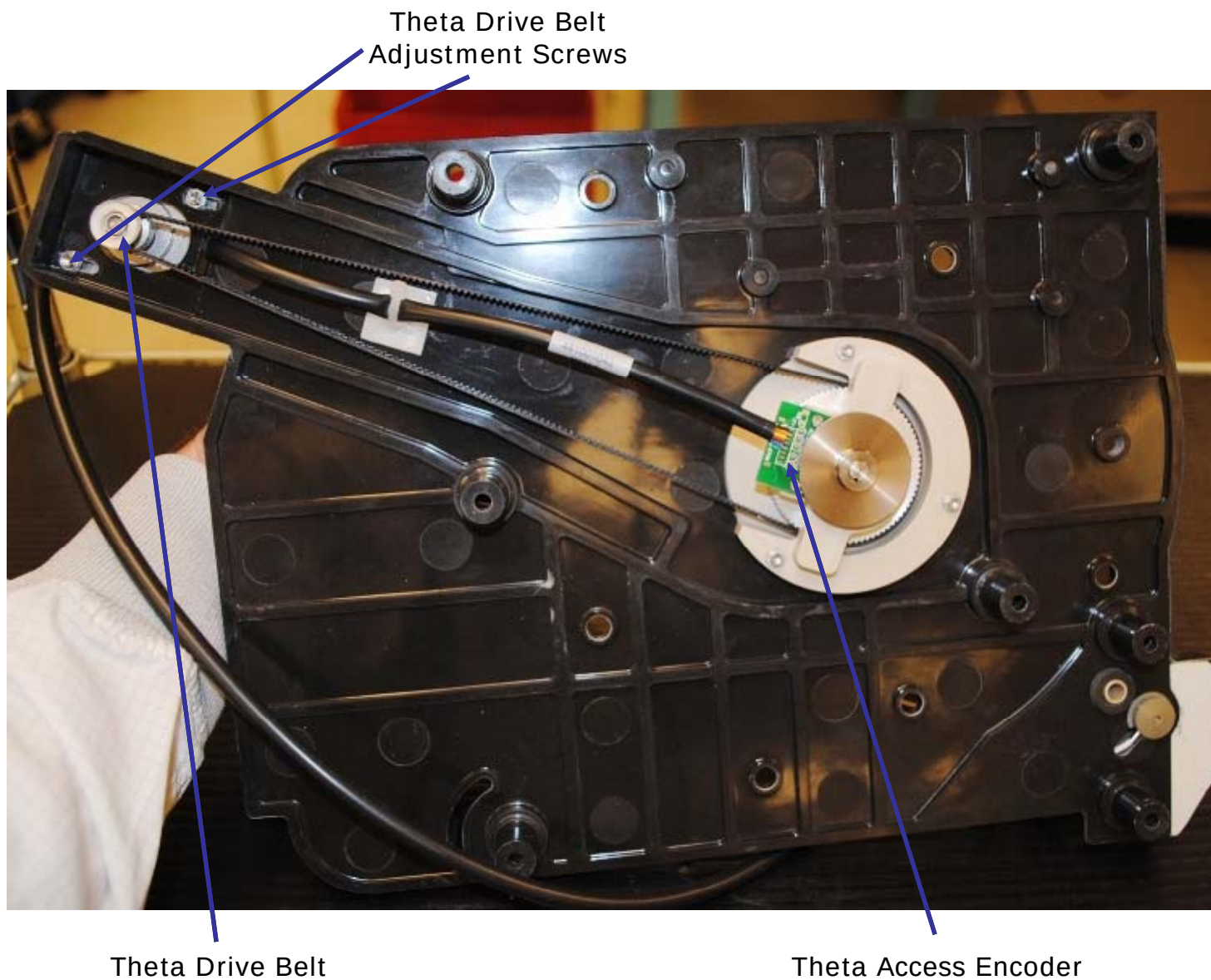


Guide Pin Hole



Guide Pin

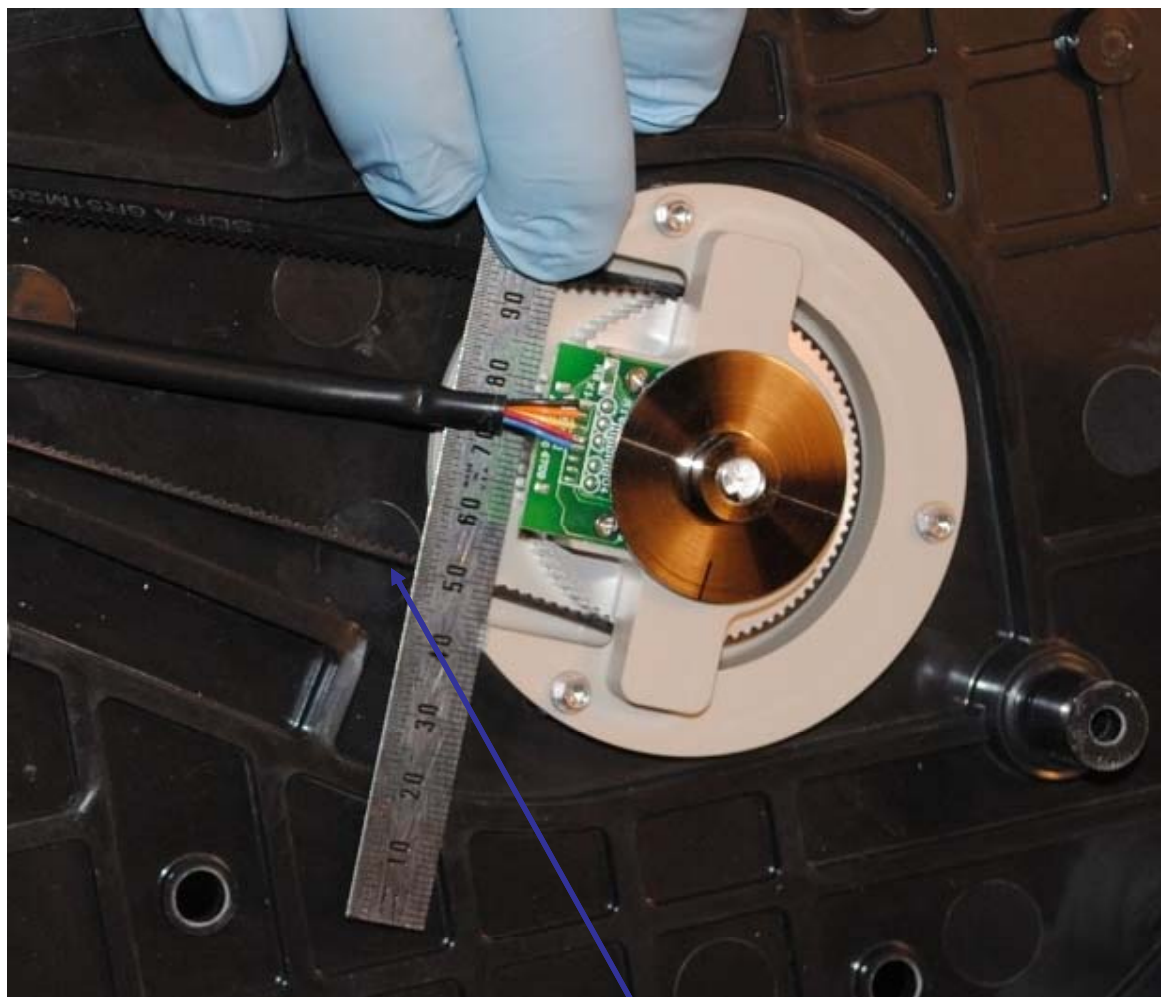
Theta Drive Assembly (Bottom View)



Theta Drive Belt Adjustment

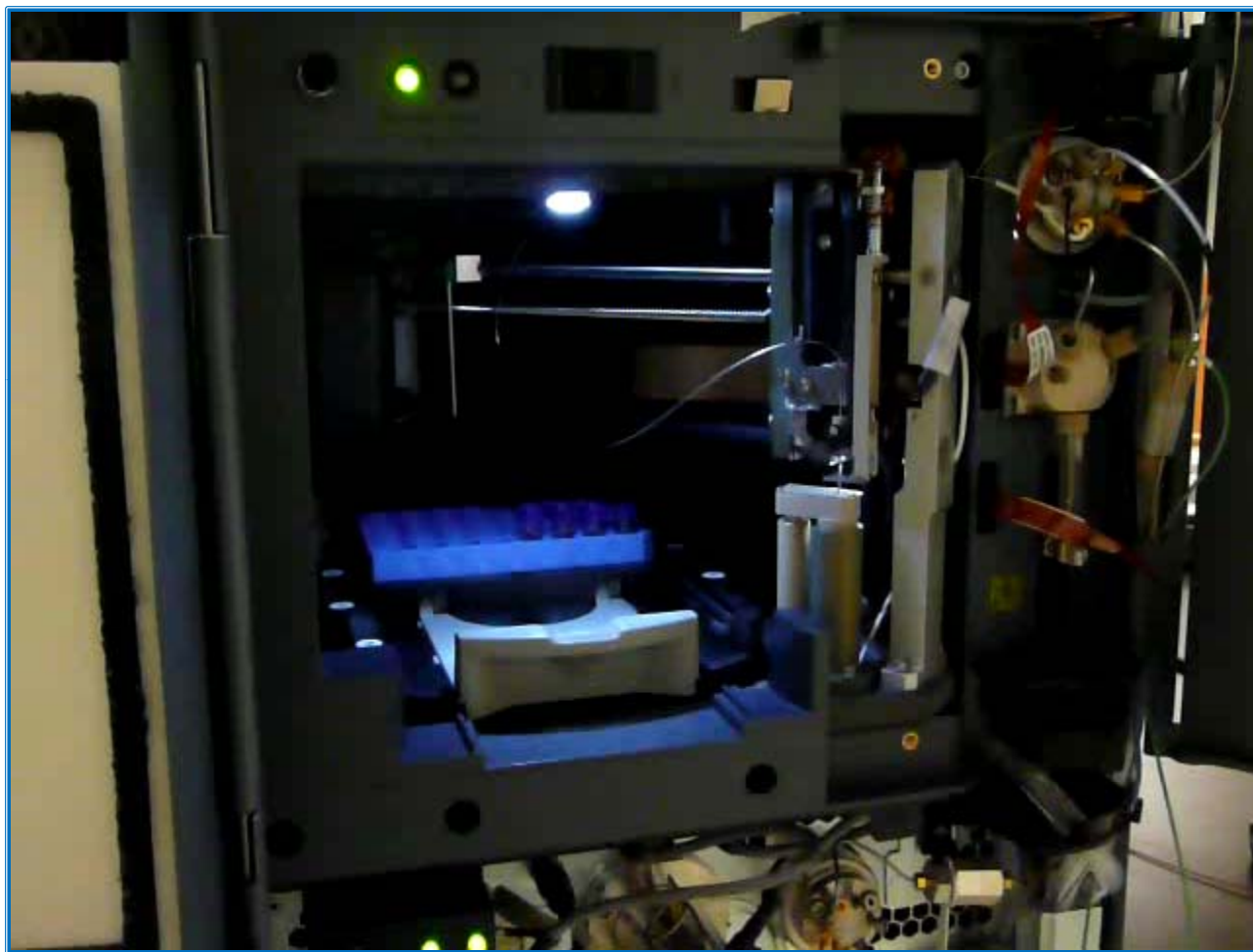


Adjust Theta Drive Belt
tension to 7 lbs force.

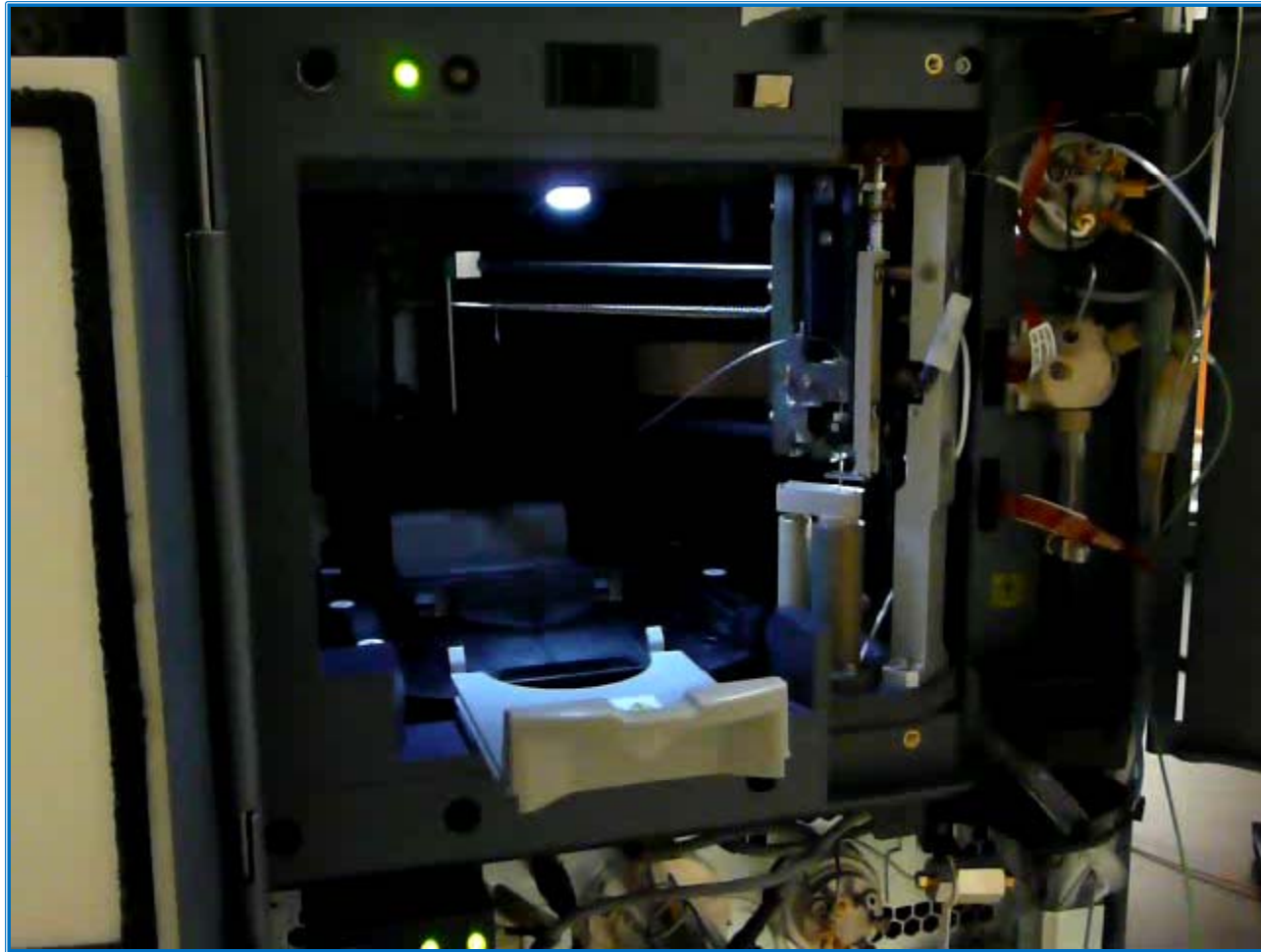


Alternate adjustment is 3mm displacement with
finger tension here.

Removing Sample Plates



Loading Sample Plates



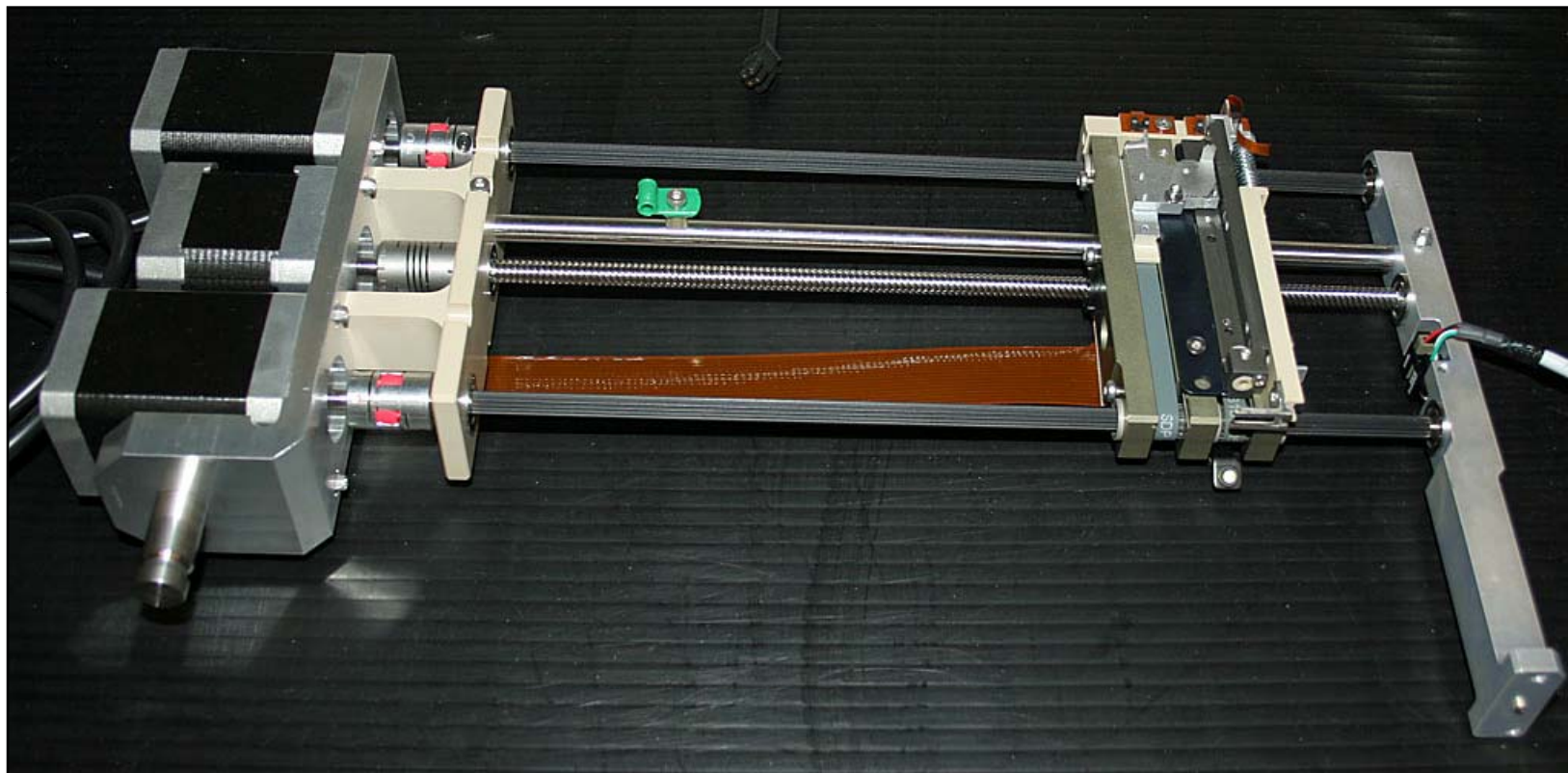
Sample Compartment Top Foam Cover



Sample Compartment Top View



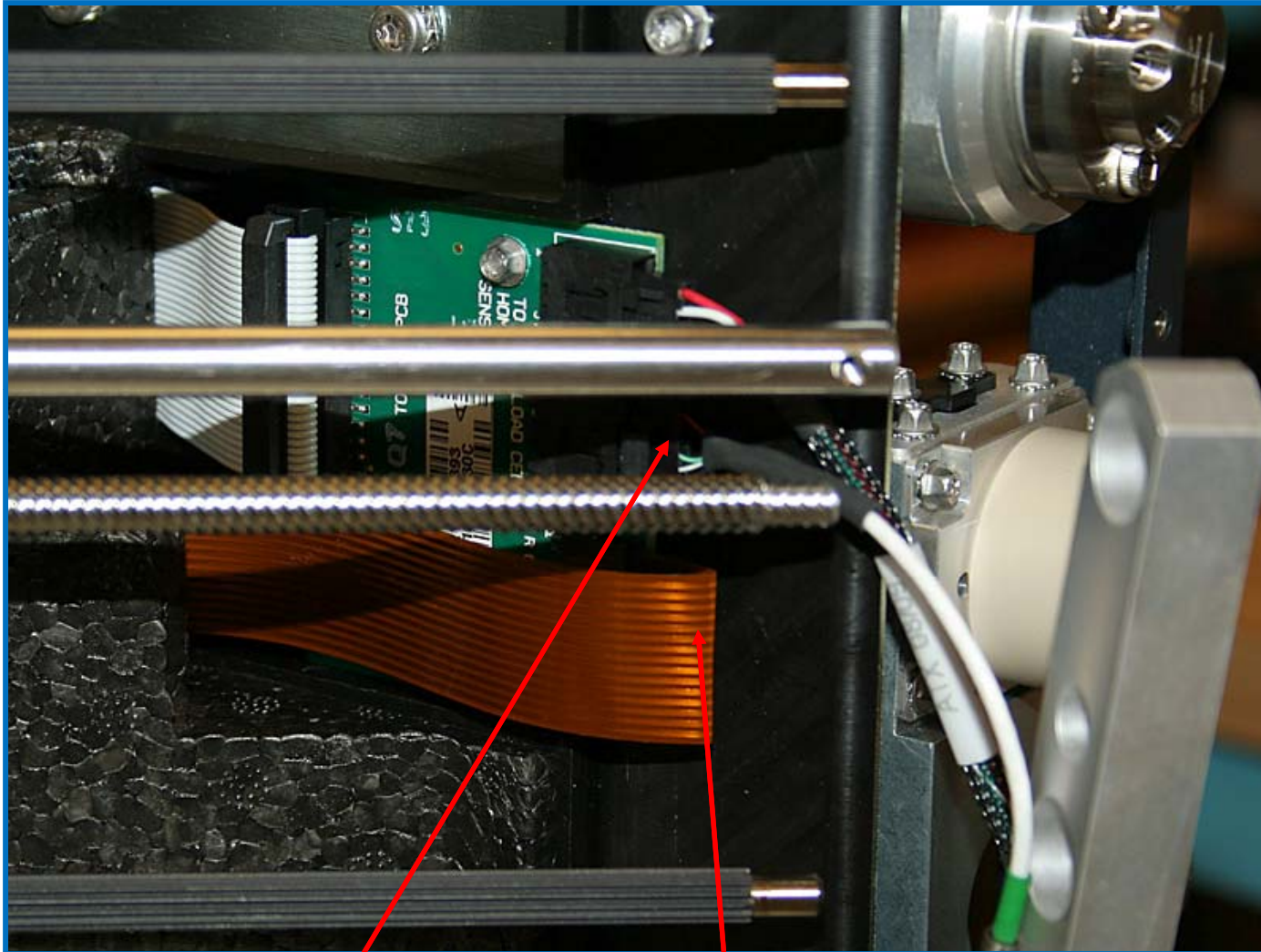
R-Carriage Assembly



Interface PCB



Interface PCB with Cable Connections



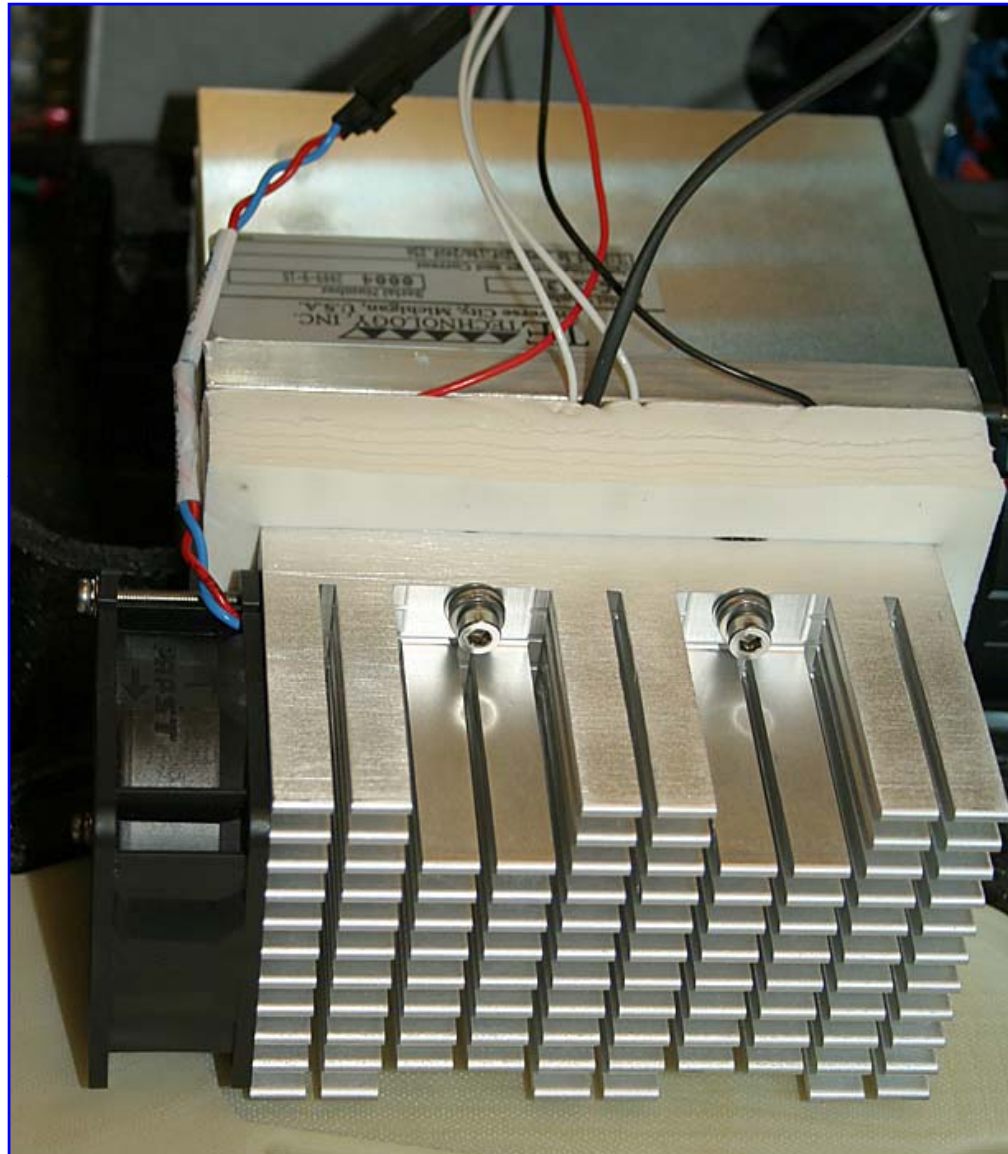
Warning: Load Cell wires and Flex Cable Connector are fragile. Handle with care!



Sample Heater / Cooler Assembly



Heater / Cooler Engine



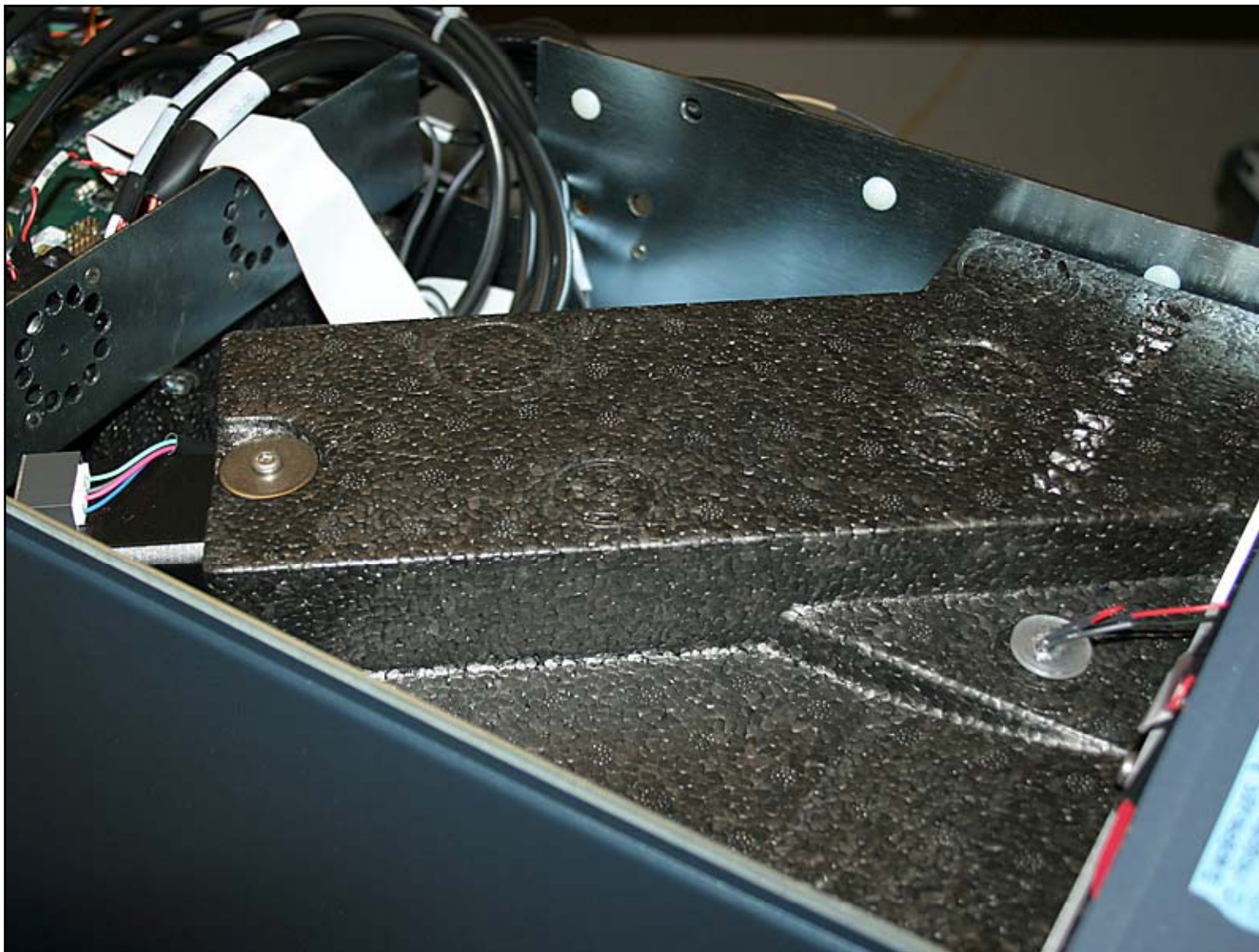
Heater / Cooler Engine in Foam Support



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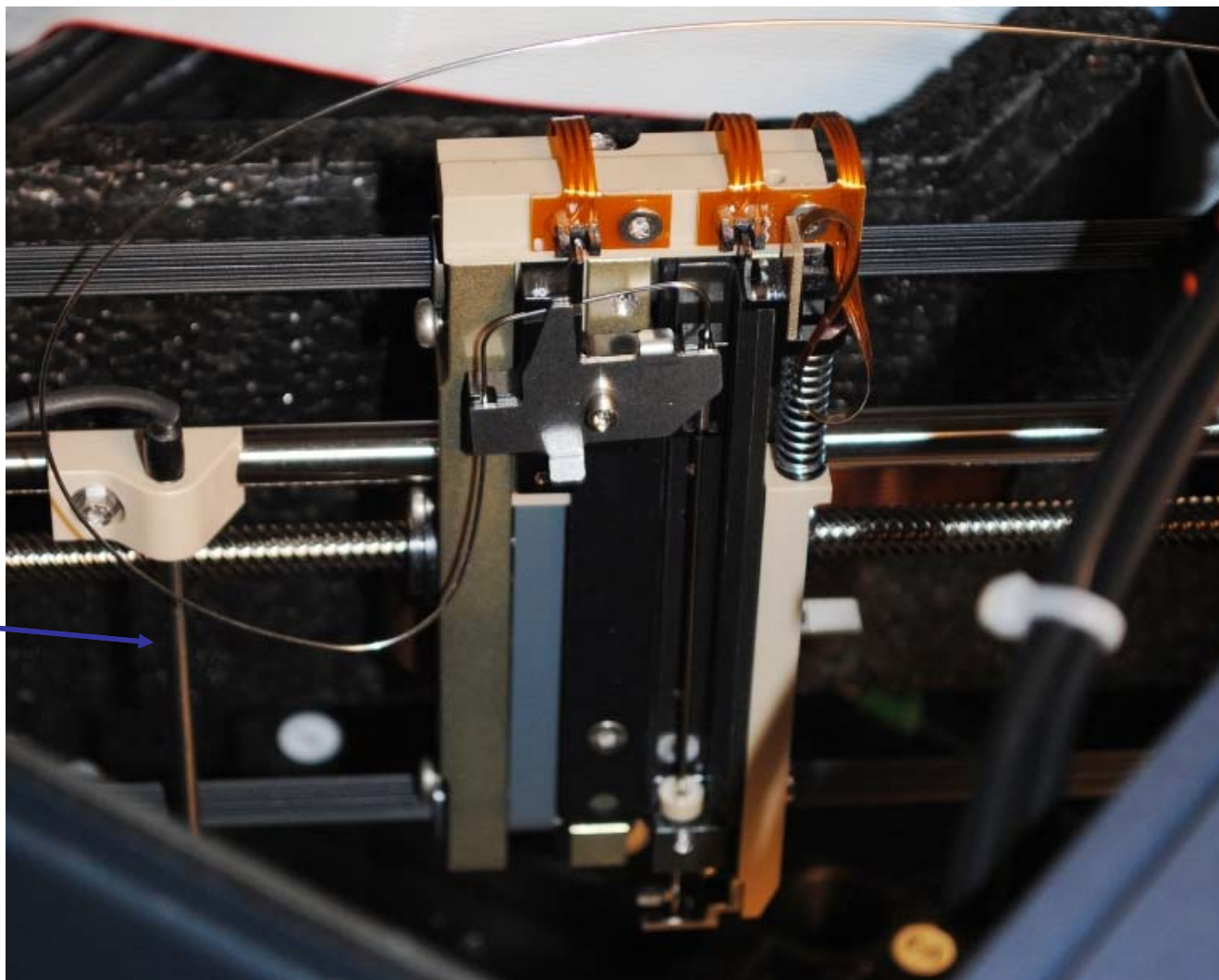
Sample Compartment Foam Cover



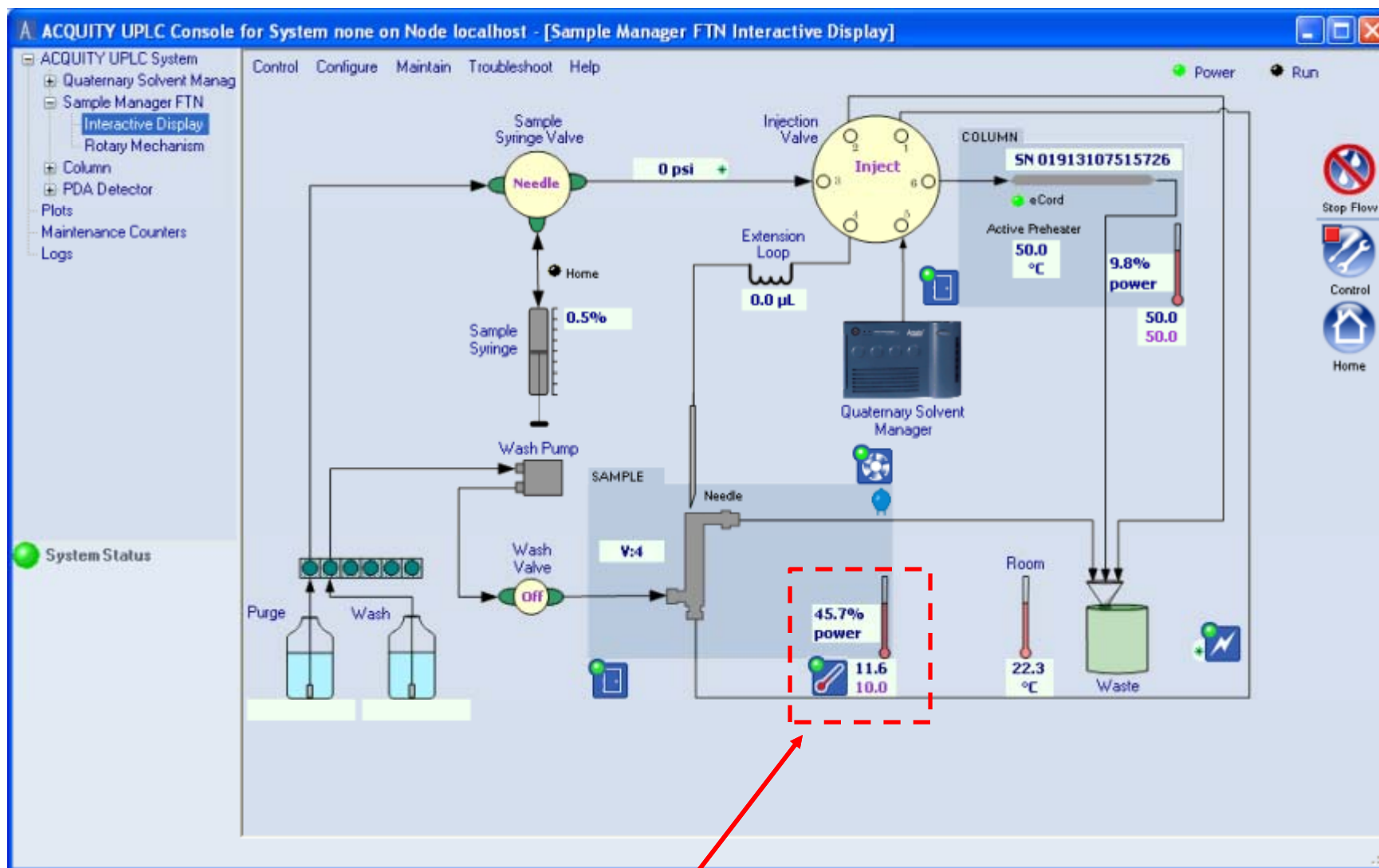
Sample Compartment Temperature Probe



Temperature
Probe

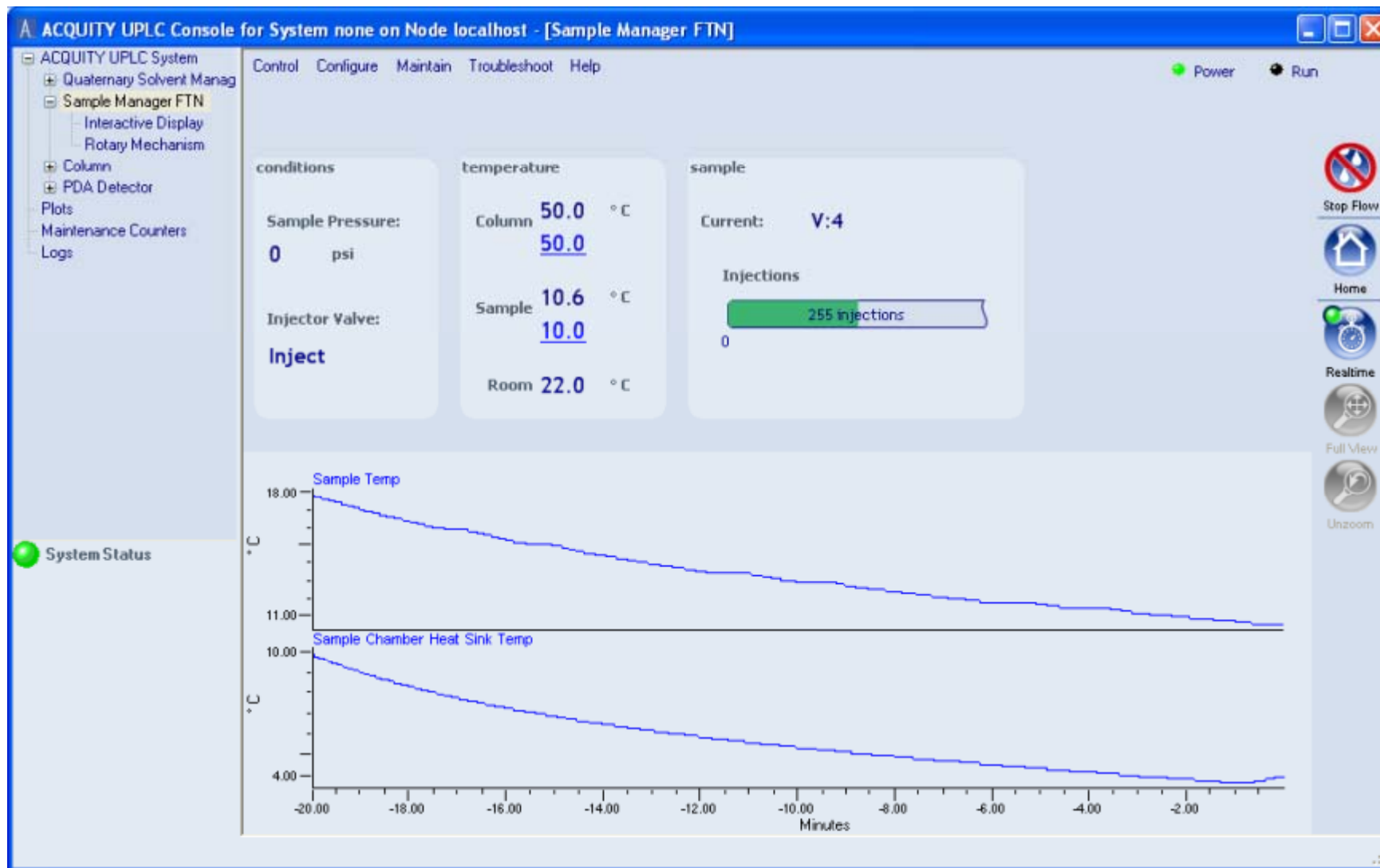


Checking Heater / Cooler Engine Health



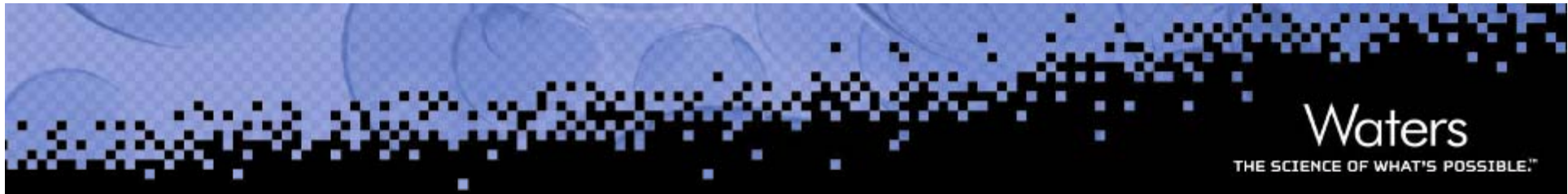
Heater/Cooler Engine power and temperature

Checking Heater / Cooler Engine Health



Checking Heater / Cooler Engine Health





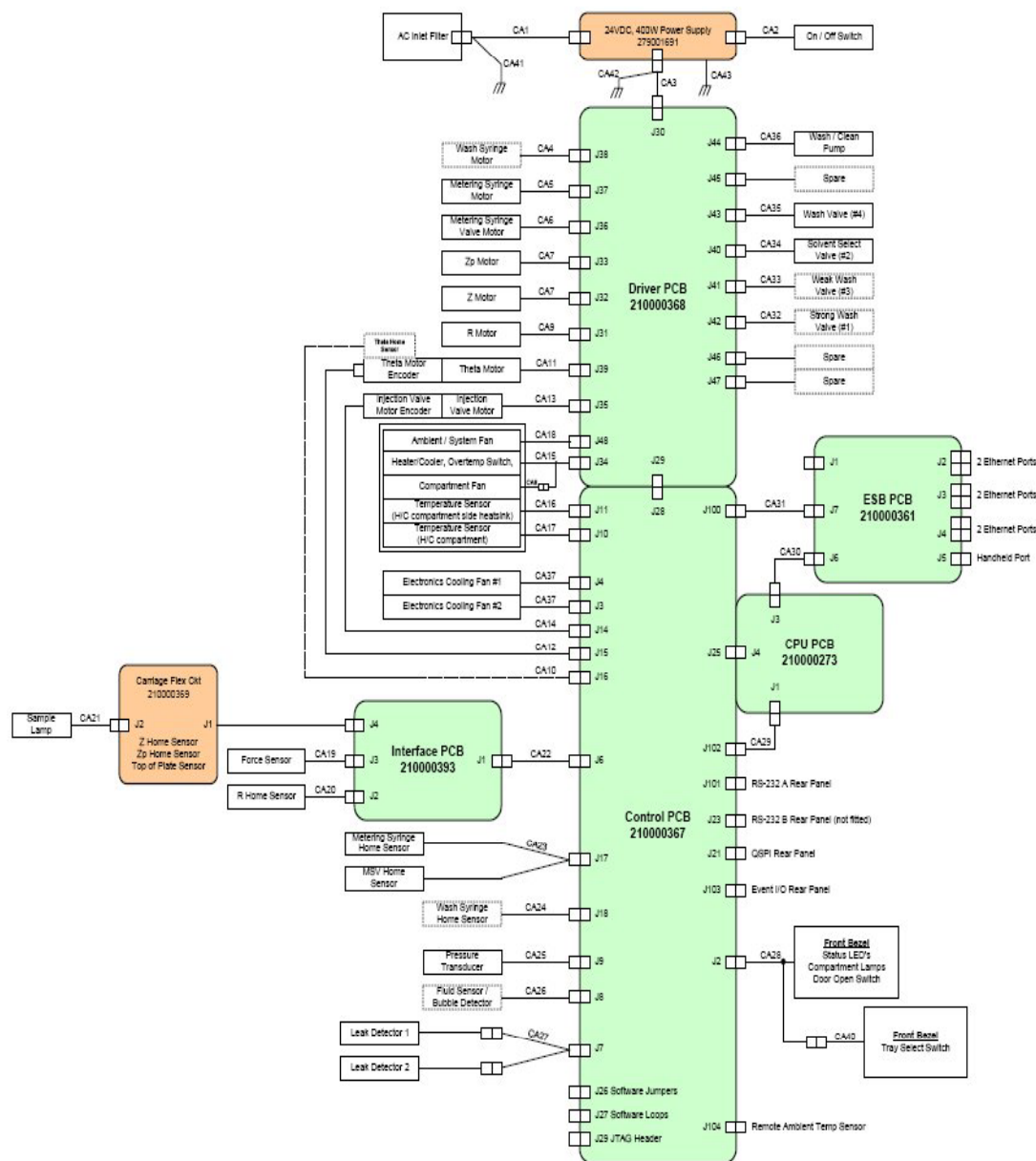
Electronics



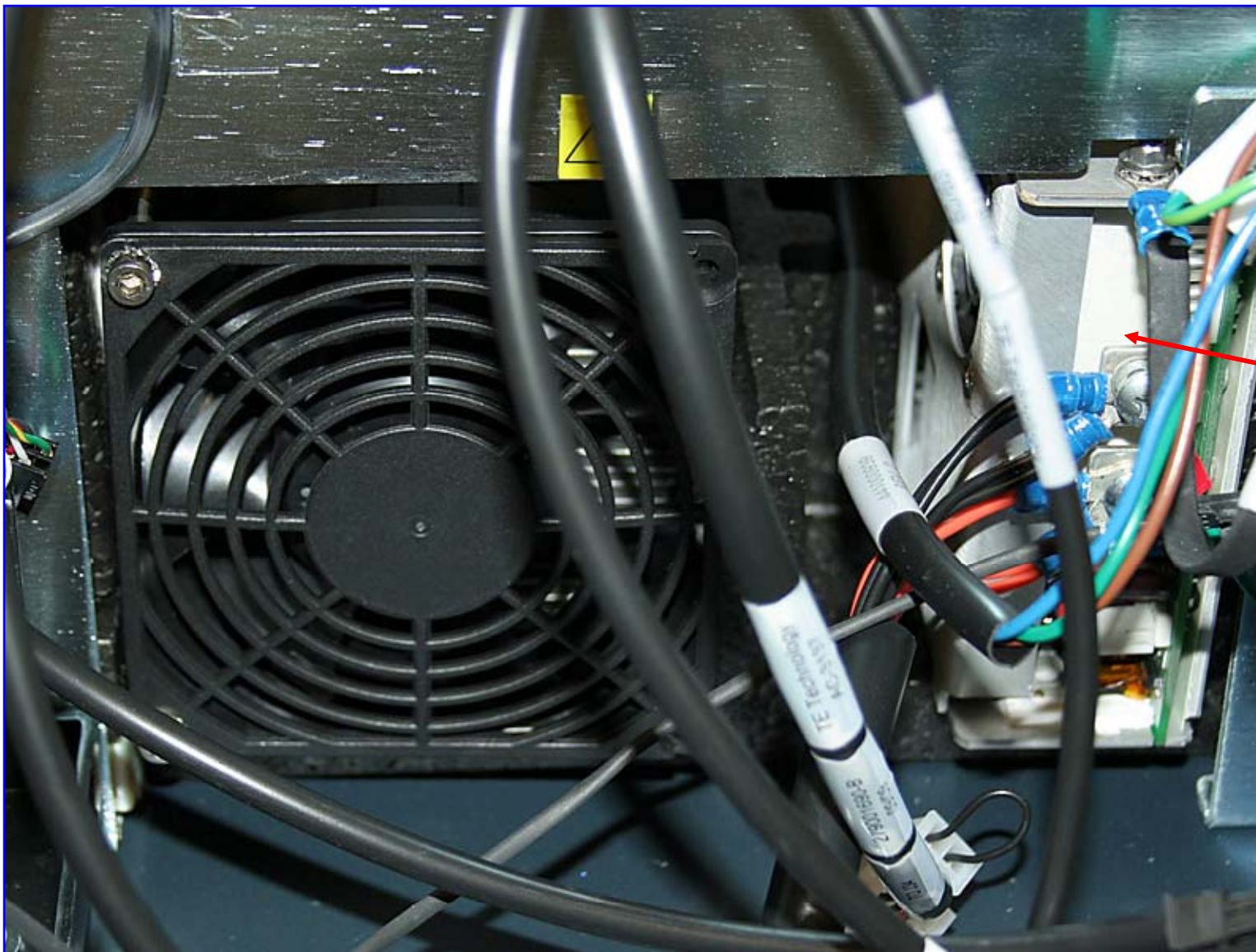
Electrical Interconnect Diagram



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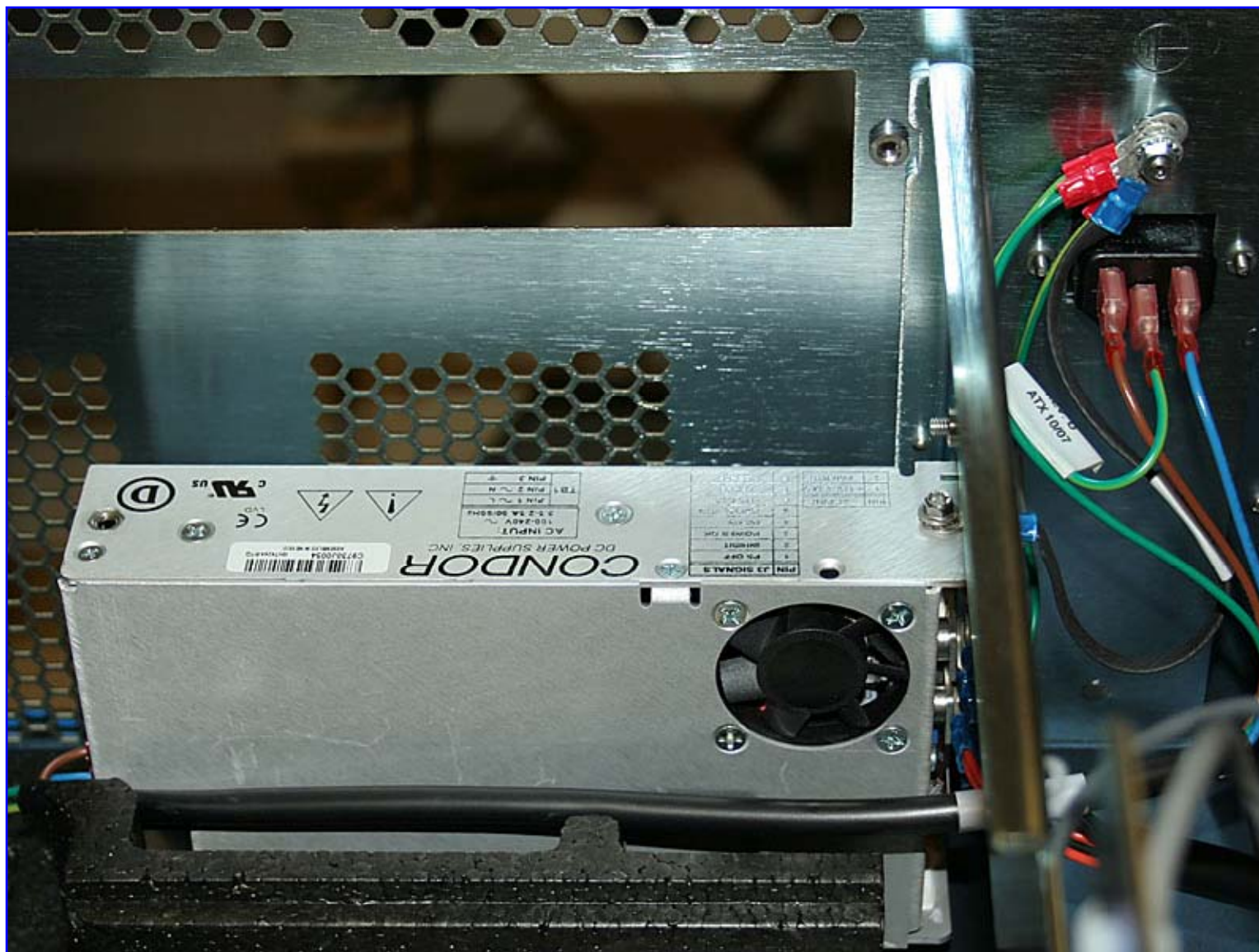


Power Supply

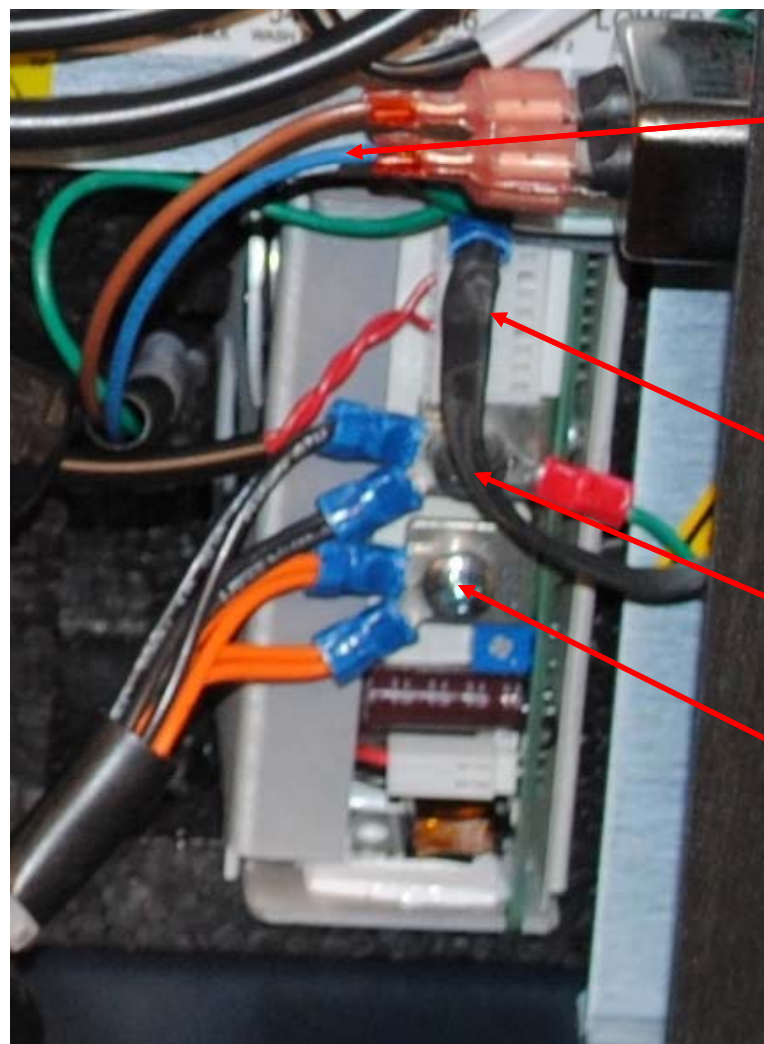


Power Supply

Power Supply



Power Supply



AC Line Input

Front Panel Power
Switch
(contact closure)

Ground

+24 volts

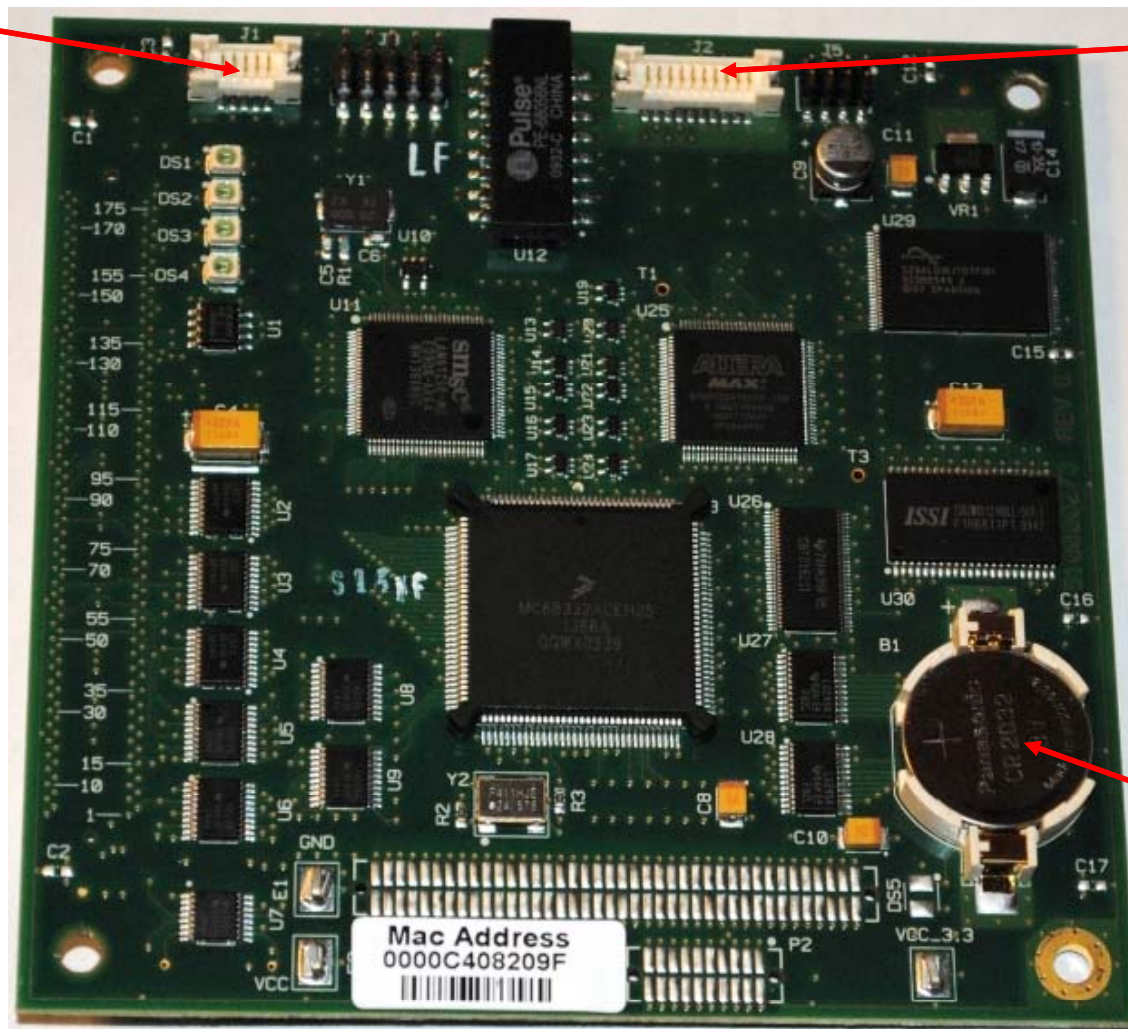




CPU2000 3V



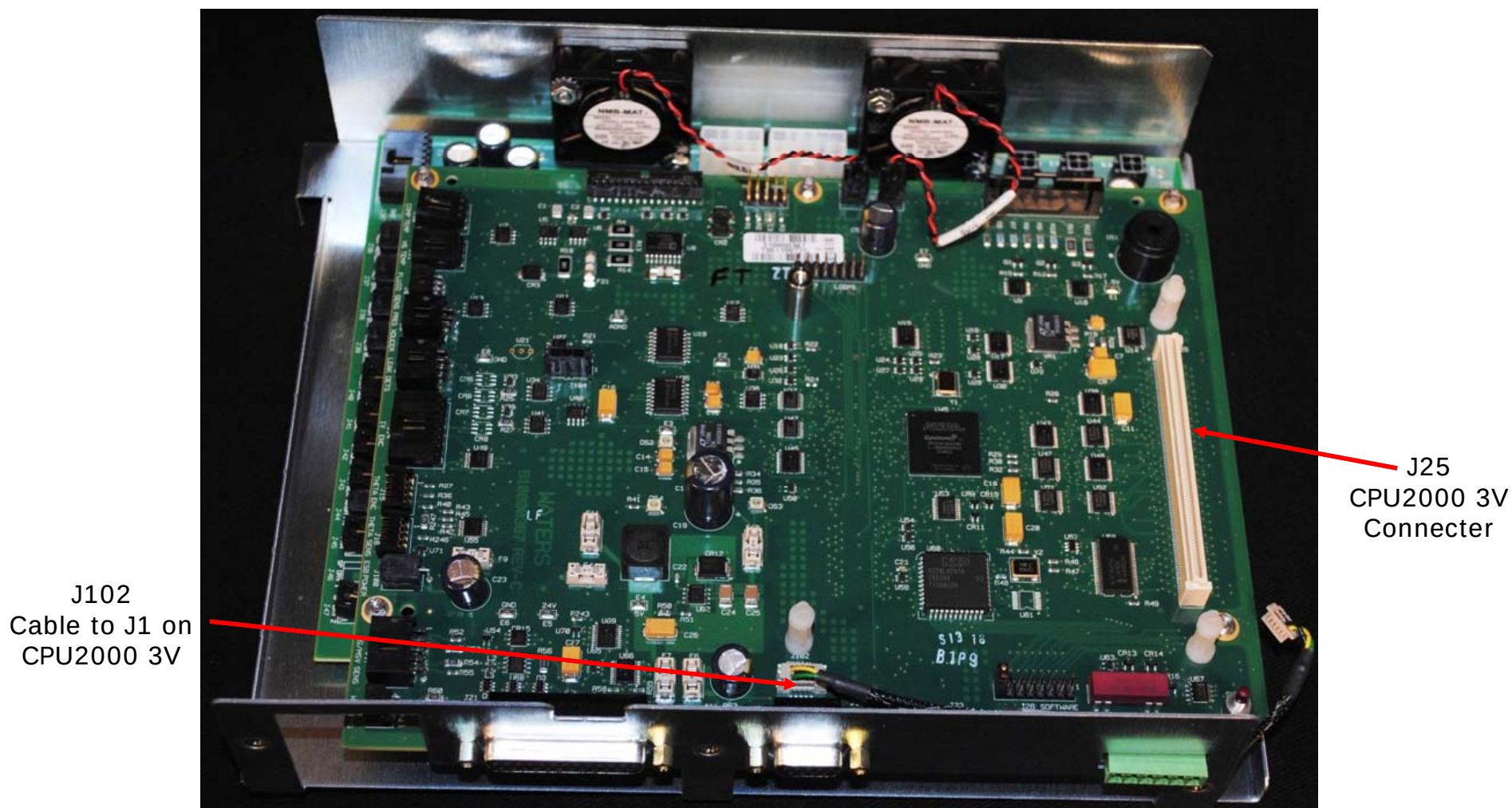
J1
Cable to J102 on
Control PCB



J3
To Ethernet
Switch PCB J6

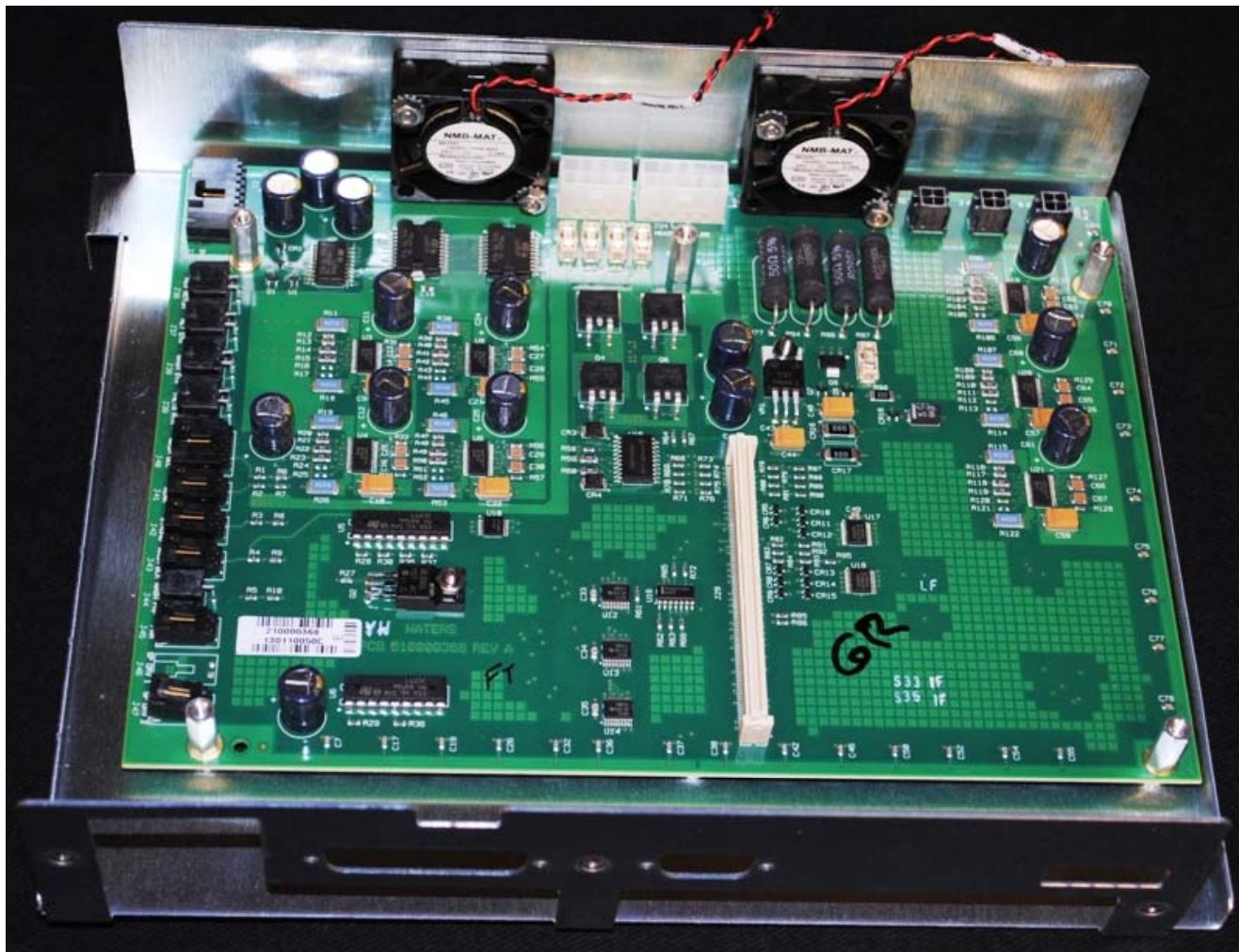
Panasonic
CR2032
3V Battery

Control PCB



The function of the Control PCB is to Monitor the sensors and encoders in the SM-FTN. The Control PCB also drives the CHA via the QSPI connector as well as providing event and RS232 support.

Driver PCB



The function of the Driver PCB is to drive most of the motors in the SM-FTN. Examples of some of the motors are: the Wash Syringe, Metering Syringe, Metering Syringe Valve Zp, Z and Theta drive motors.

Cable Connections



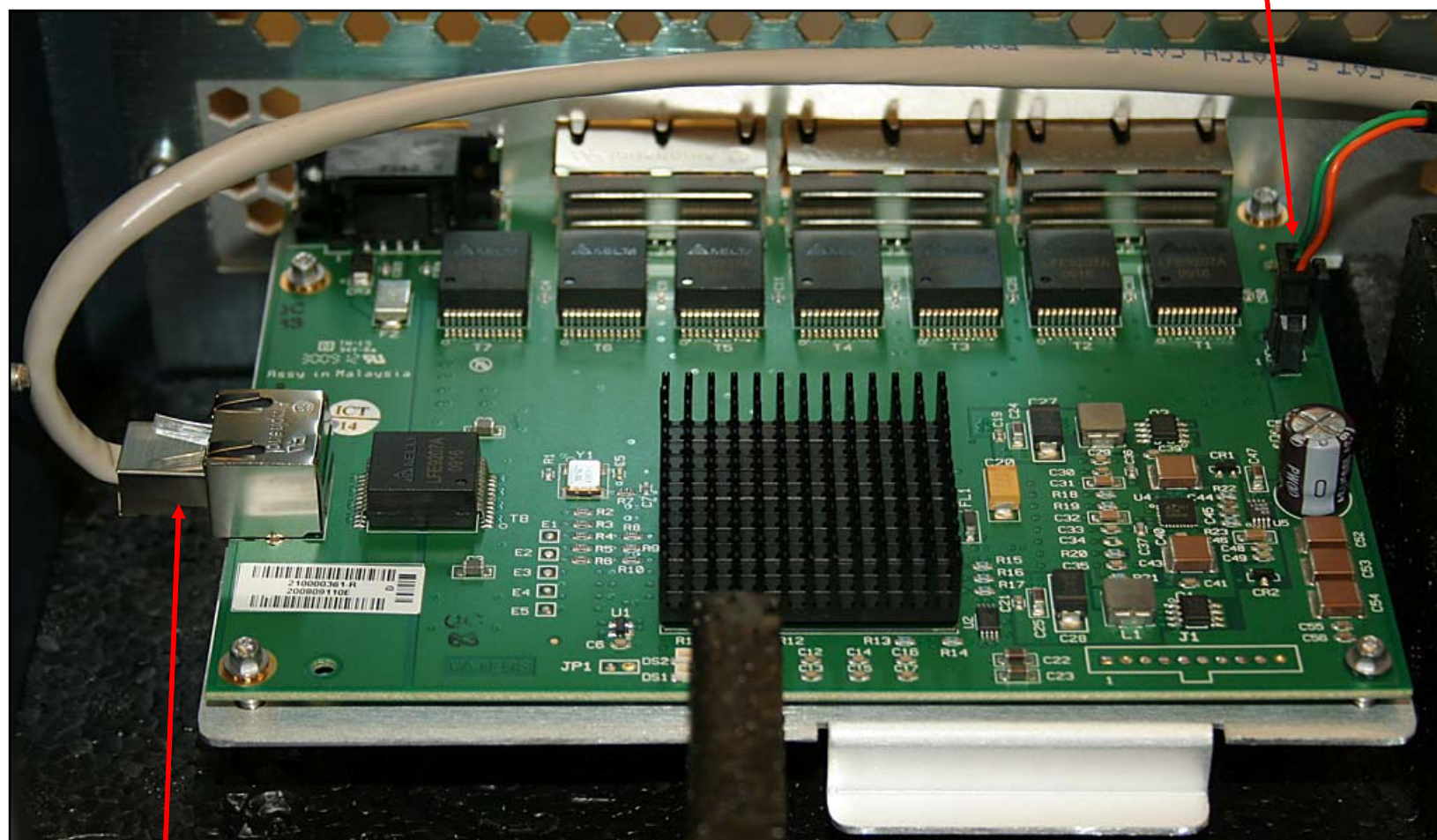
UPPER PCB	J10 COMP TEMP	J11 HS TEMP	J8 FLUID SENS	J9 XDUCE	J7 LEAK DETS	J14 IV ENC	J15 THETA ENC	J16 THETA SENS	J100 ESB POWER	J17 MS/MSV SENS	J18 WS SENS		
J35 INJ VLV MTR	J36 MSV MTR	J37 MET SYR MTR	J38 WASH SYR MTR	J39 THETA MTR	J40 WASH SEL	J41 WEAK	J42 STRONG	J43 WASH BLK	J44 WASH PMP	J45 FAN	J46 SP DRV 1	J47 SP DRV 2	LOWER PCB

Cable Connections Key
Located below PCB
connectors

Ethernet Switch PCB

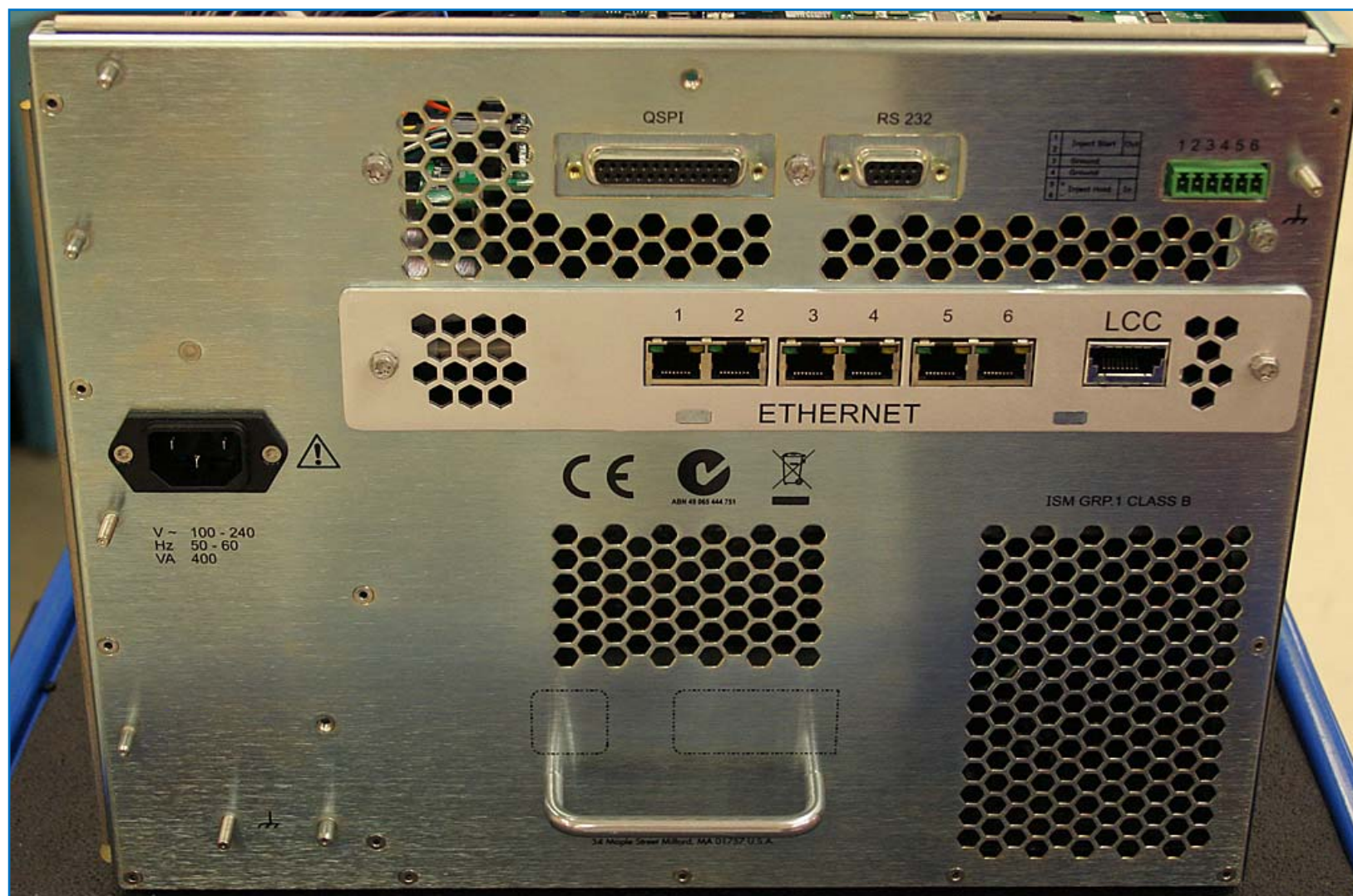


J7- +24 volt supply from
J100 on Control PCB



J6- Ethernet Connector
to J3 on CPU 2000

Ethernet Switch PCB

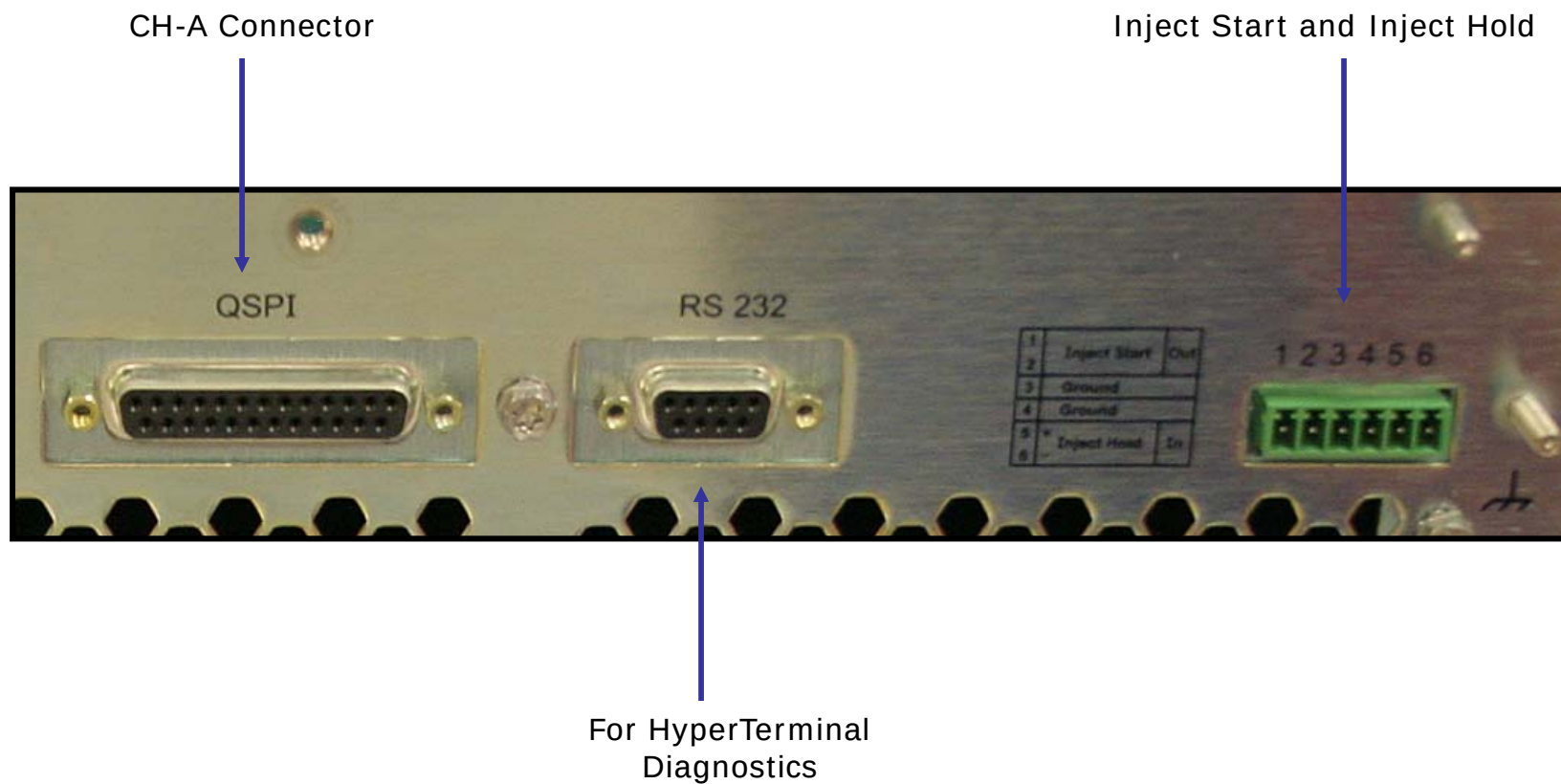


Removing the Ethernet Switch

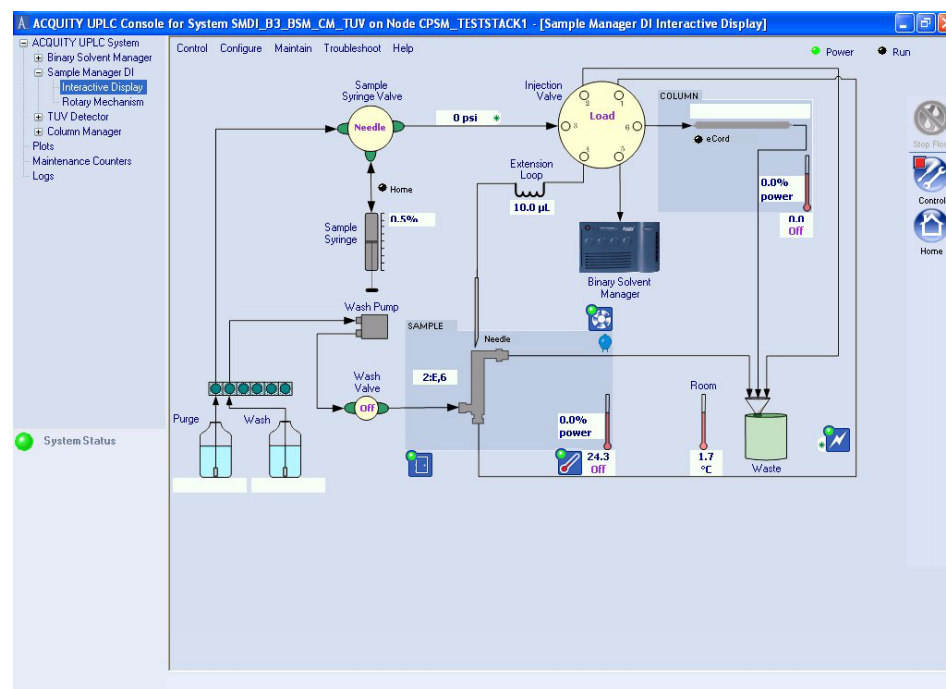


The PCB Ethernet Switch PCB can easily be removed and replaced from the rear of the SM-FTN by removing the two T20 Torx screws.

SM-FTN Rear Connections



SM-FTN Software Components



Software Components



- Instrument Method Menus
- ACQUITY Console Diagnostics and Control

SM Instrument Method- General Tab



Modify ACQUITY Sample Manager Instrument Method

Acquity Sample Manager FTN

Run Time: 6.00 min

General | Data | Dilution | Events

Solvents

Wash Solvent Name: 90/10 Water/ACN

Purge Solvent Name: Water

Pre-Inject Wash: 0 sec

Post-Inject Wash: 6 sec

Temperature Control

Column: 40.0 °C Alarm Band: ± 5.0 °C

Sample: Off °C ± 5.0 °C

☐ Loop Offline: Automatic min

☐ Load Ahead

Comment:

Advanced...

OK Cancel

Advanced Settings

Enable any of the following options to override the automatic behavior.

☐ Syringe Draw Rate Automatic

☐ Needle Placement (from bottom) Automatic

☐ Air Gaps pre-aspirate Automatic post-aspirate Automatic

☐ No Injection

OK Cancel

No Injection

This parameter supports advanced separations such as high throughput, trapping, and 2D separations.

The sample manager does not inject sample from the requested vial, but it performs all other system operations, including triggering system modules.

SM Instrument Method- Dilution Tab



- Sample Dilution Tips
 - Use only previously dissolved samples, without particulates or solids.
 - Avoid nonvolatile or salt buffers as purge or wash solvents.
 - Ensure the purge solvent is similar or identical to your isocratic or initial gradient solvent conditions, excluding buffers.
 - Match the wash solvent to the sample diluent.
 - Ensure purge solvent and sample solutions or buffers are miscible and soluble.

The screenshot shows the 'Modify ACQUITY Sample Manager Instrument Method' dialog box with the 'Dilution' tab selected. The 'Run Time' is set to 6.00 min. The 'Dilution' tab contains the following settings: 'Enable' is checked, 'Needle placement (from bottom)' is 4.0 mm, 'Dispensed Purge Solvent' is 50 uL, and 'Post Dilution Delay' is 30 sec. There is a '?' icon in the top right corner of the main settings area and 'OK' and 'Cancel' buttons at the bottom right.

Modify ACQUITY Sample Manager Instrument Method

Acquity Sample Manager FTN

Run Time: 6.00 min

General | Data | Dilution | Events

?

☒ Enable

Needle placement (from bottom)

4.0 mm

Dispensed Purge Solvent

50 uL

Post Dilution Delay

30 sec

OK Cancel

SM Instrument Method- Data Tab



Modify ACQUITY Sample Manager Instrument Method [X]

Acquity Sample Manager FTN Run Time: 6.50 min

General | **Data** | Dilution | Events

Select data channels to acquire: ☒ Show diagnostics ?

Channel	Description
☐ Sample Pressure	Pressure of sample loop (psi)
☐ Sample Temp	Temperature of sample manager compartment (°C)
☐ Column Temp	Temperature of column heater compartment (°C)
☐ Room Temp	Temperature of air intake of sample manager (°C)
☐ Seal Force	Seal Force (%)
☐ Preheater Temp	Temperature of active preheater, if present (°C)

OK Cancel

SM Instrument Method- Events Tab



Modify ACQUITY Sample Manager Instrument Method

Acquity Sample Manager FTN UPLC*

Run Time: 6.00 min

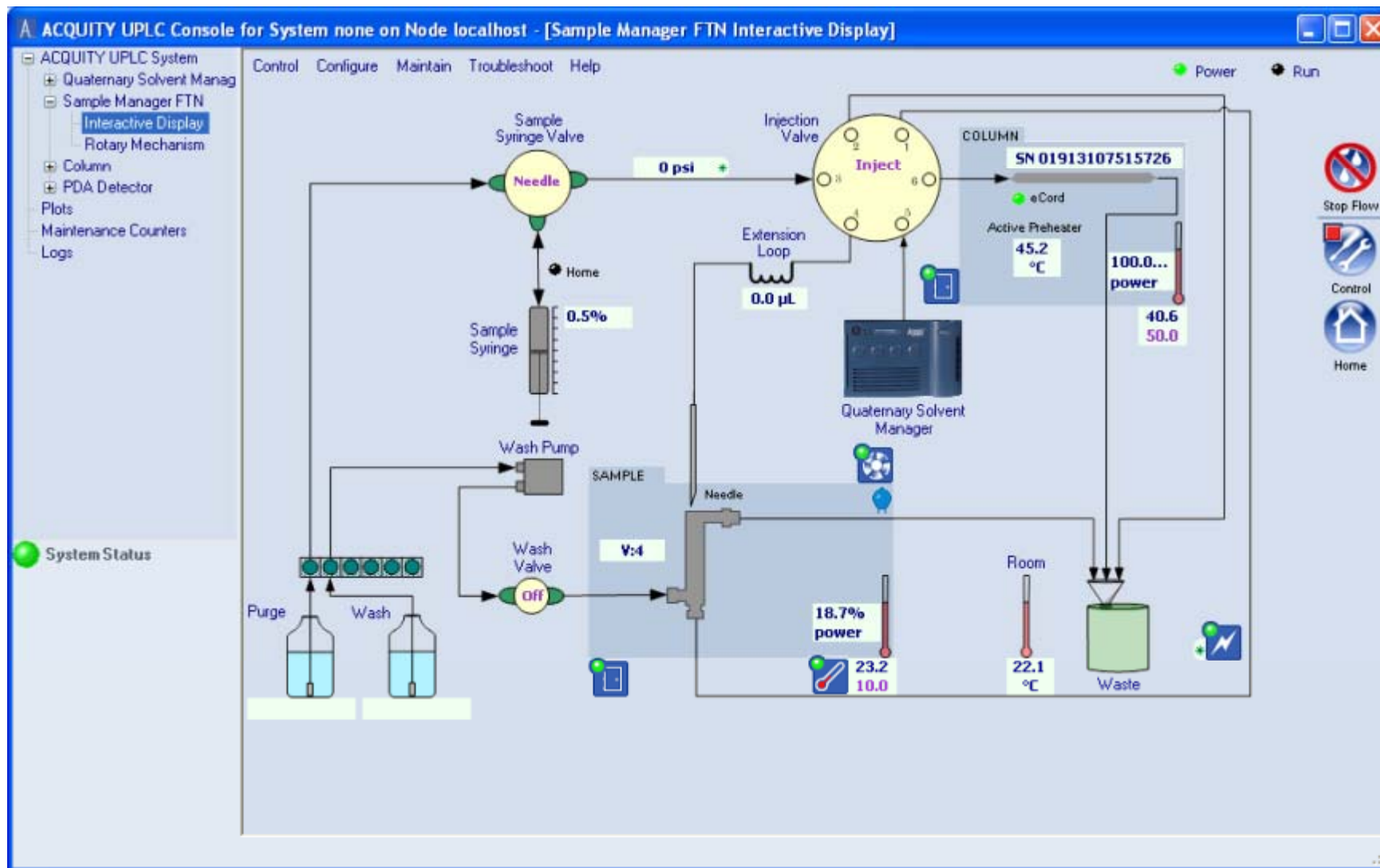
General | Data | Dilution | Events

☒ Run Events

	Time (min)	Event	Action
1			
2		Sample Temperature	
3		Column Temperature	
4		Sample Temperature Off	
5		Column Temperature Off	
6			
7			
8			
9			
10			

OK Cancel

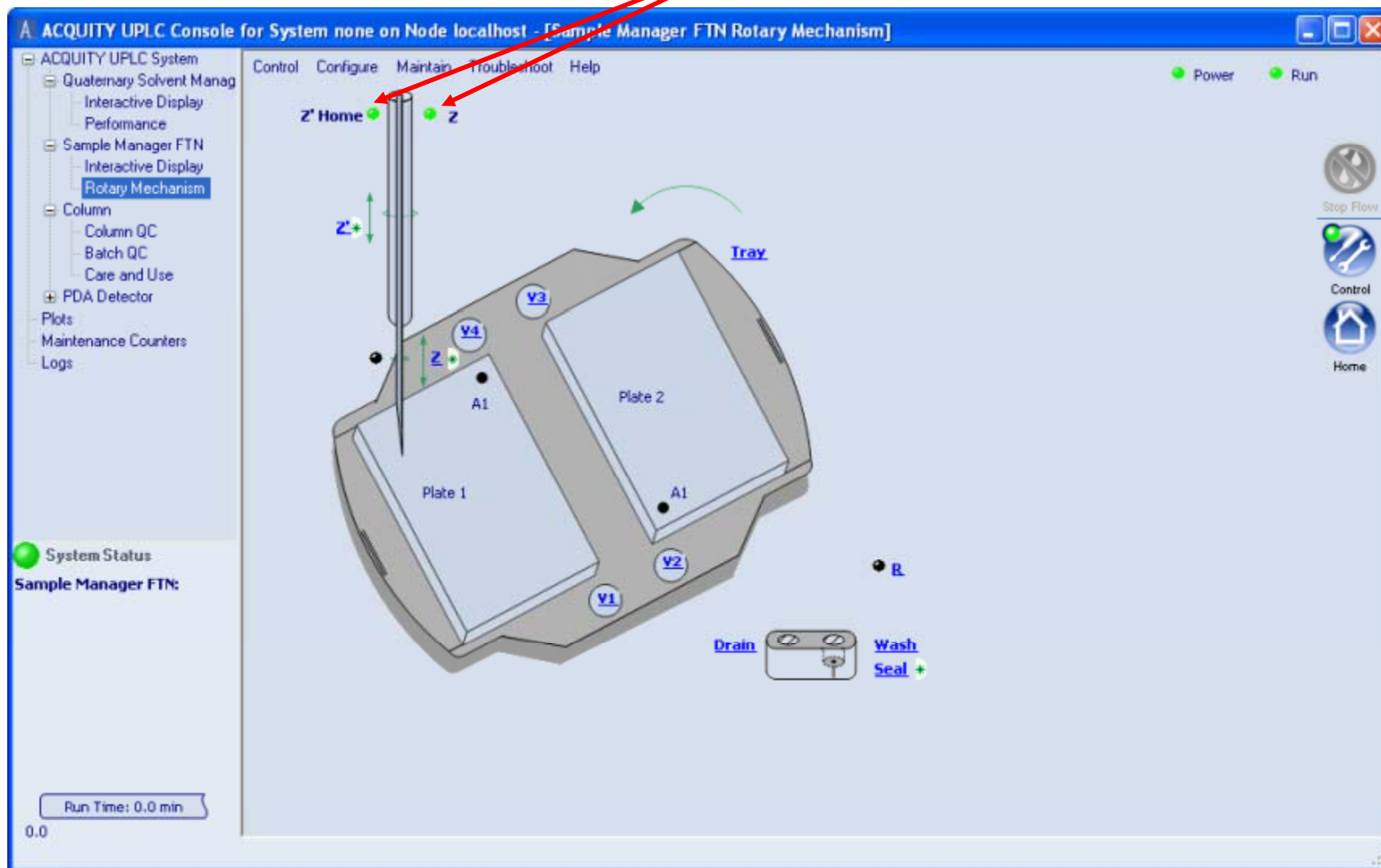
SM-FTN Interactive Display Menu



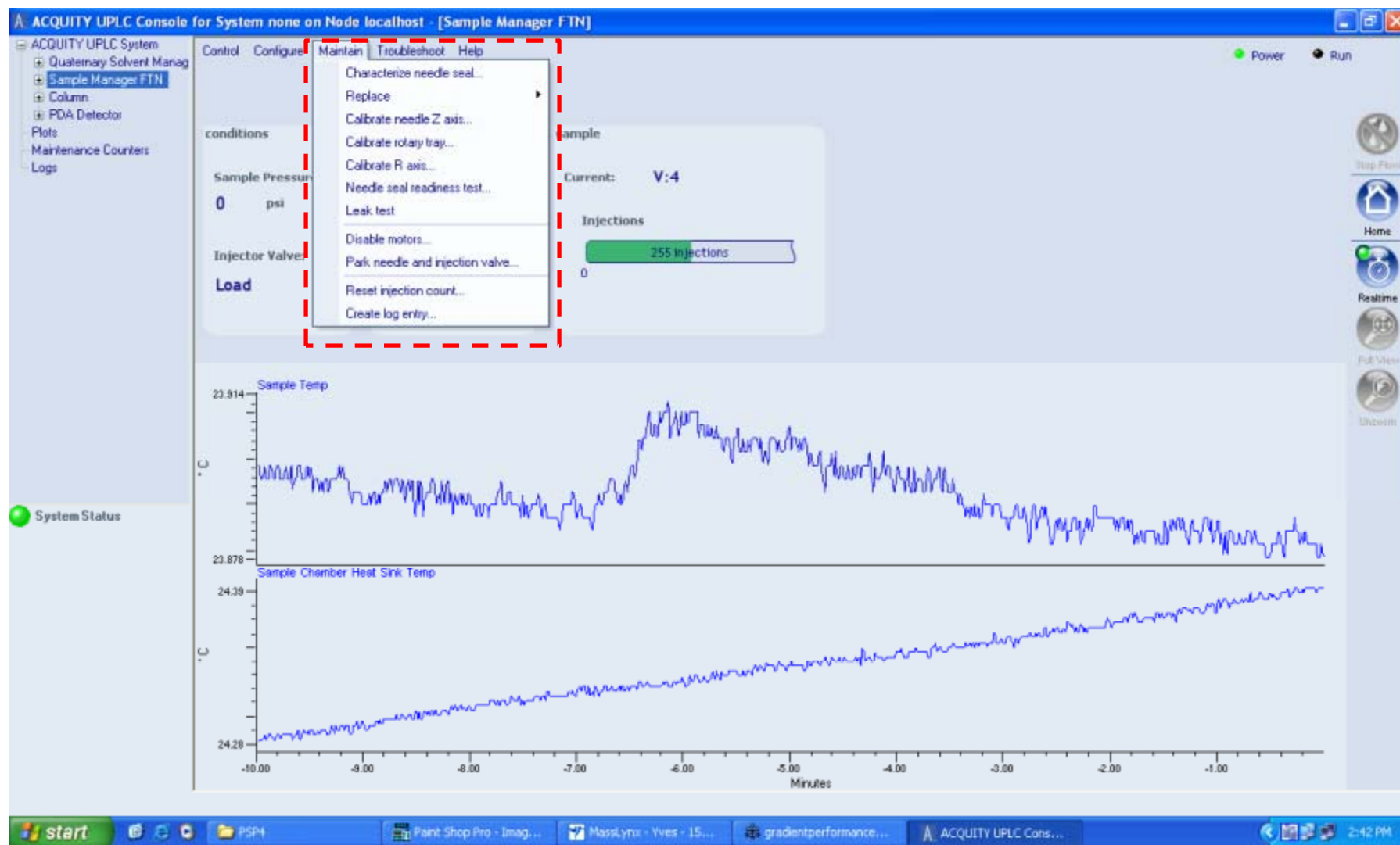
SM-FTN Interactive Display Menu



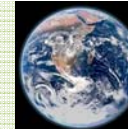
R-Carriage Sensor Indicators



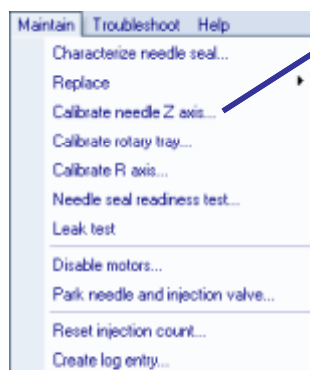
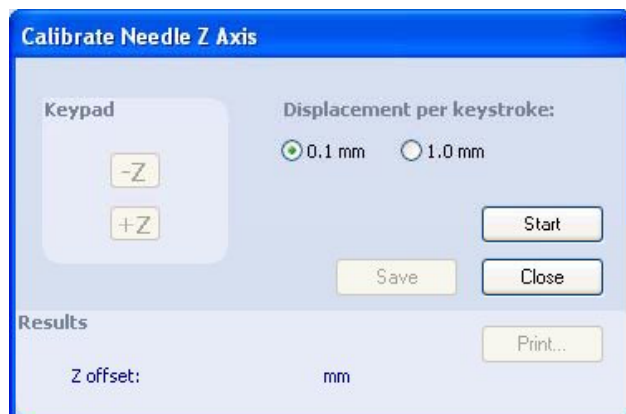
SM-FTN Maintain Menu



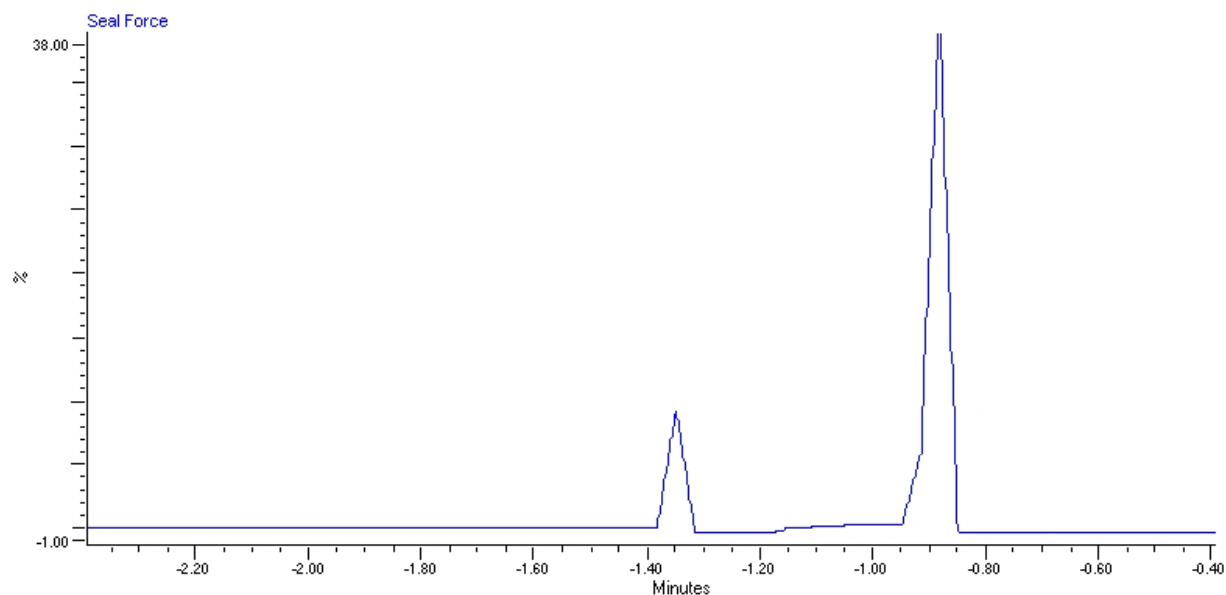
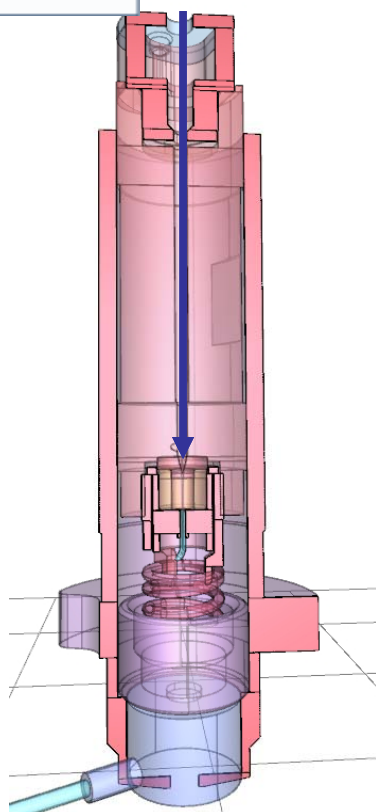
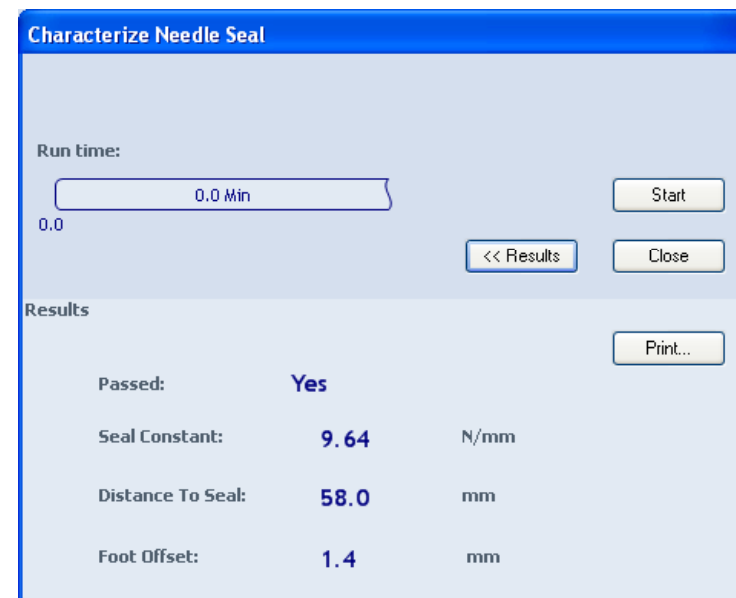
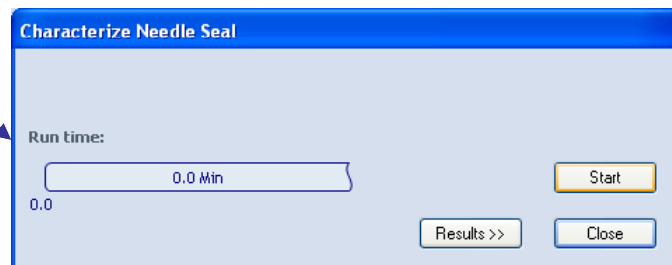
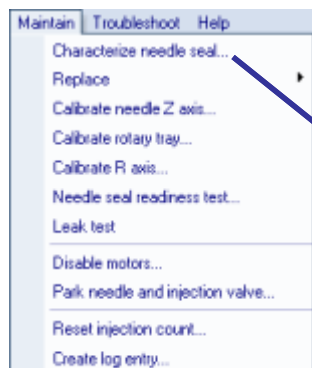
Z-Needle Calibration



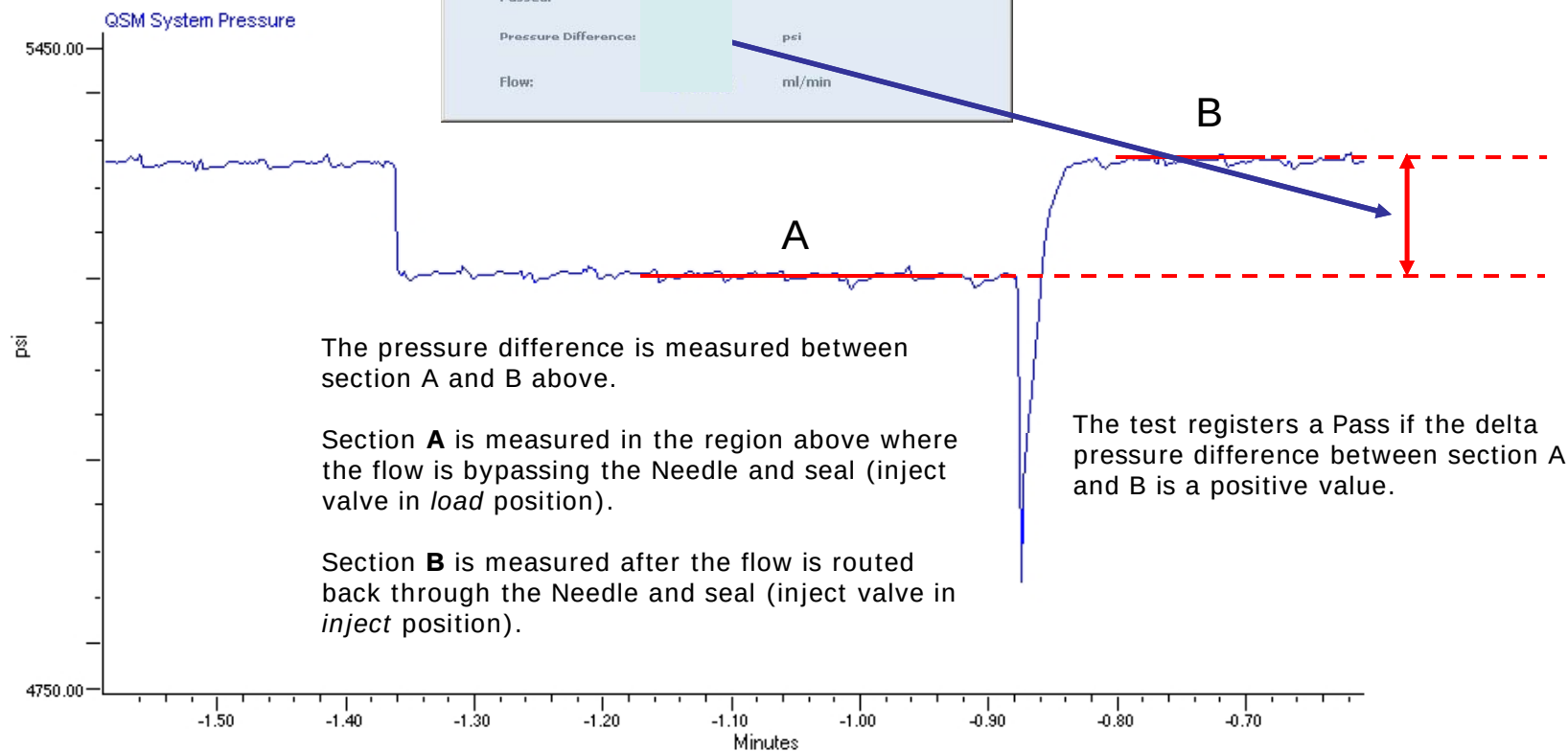
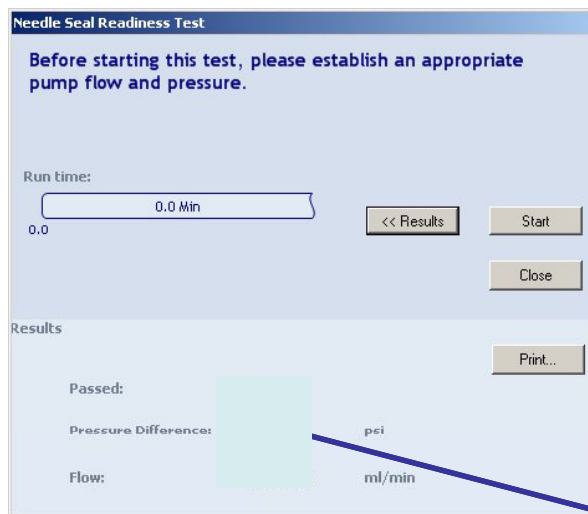
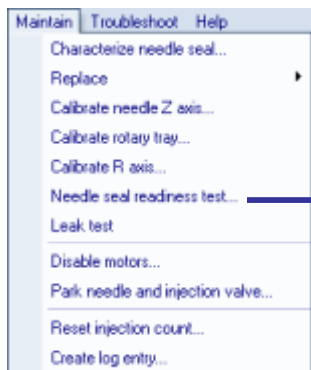
Global Training
& Development



Characterize Needle Seal



Needle Seal Readiness Test



Needle Seal Readiness Test- Failed



Needle Seal Readiness Test

Before starting this test, please establish an appropriate pump flow and pressure.

Run times:
0.0 0.0

<< Results Start

Close

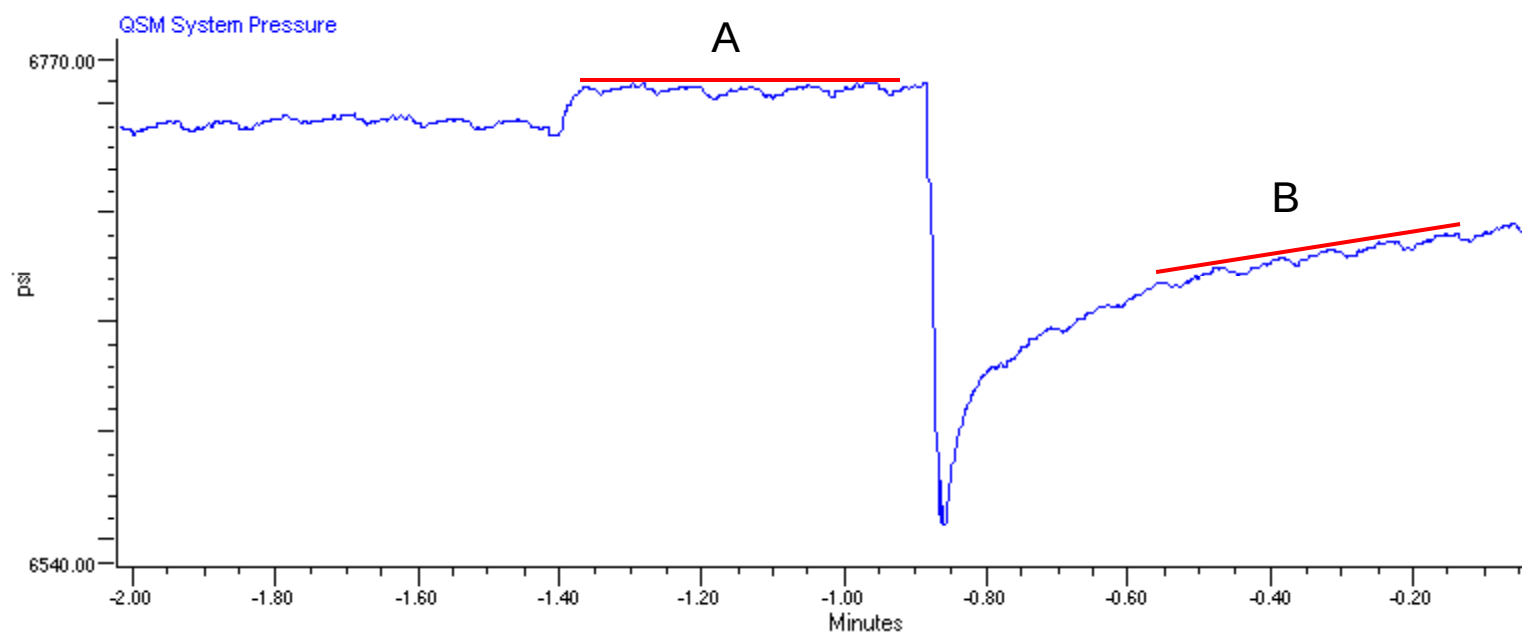
Results

Print...

Passed: **No**

Pressure Difference: **-136** psi

Flow: **0.60** ml/min



Needle Seal Readiness Test- Bad Fail



Needle Seal Readiness Test

Before starting this test, please establish an appropriate pump flow and pressure.

Run time:
0.0 Min

<< Results Start
Close

Results

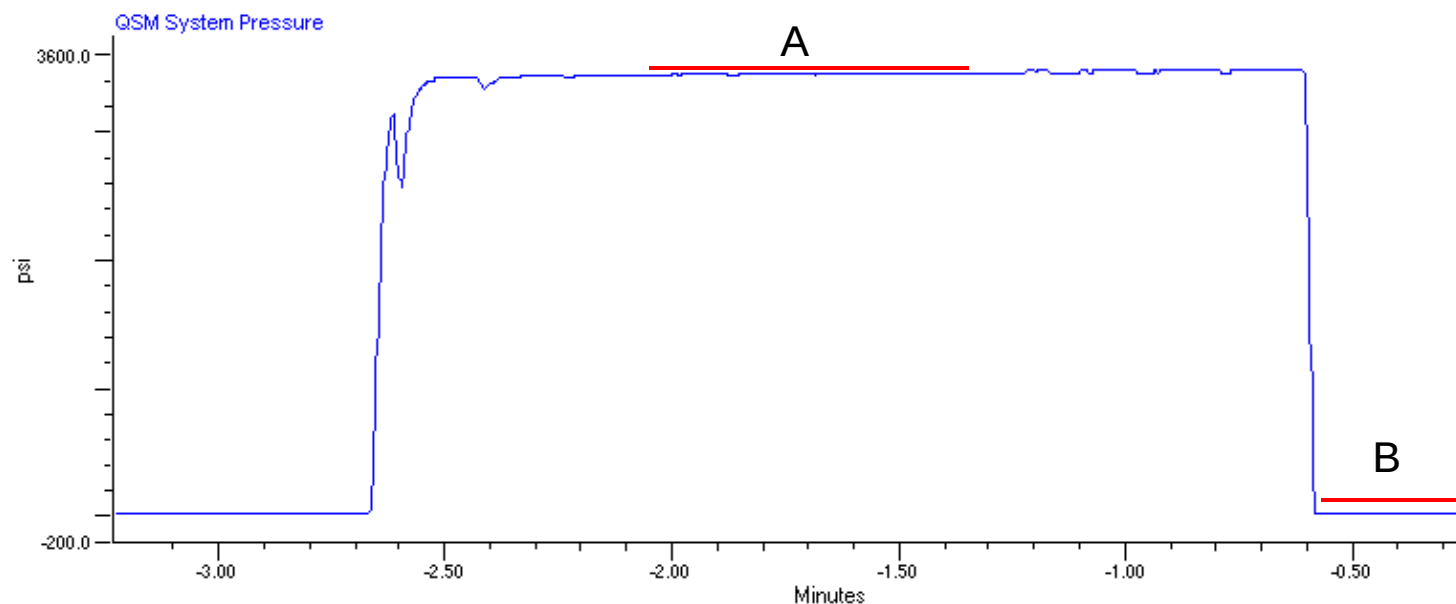
Print...

Passed: **No**

Pressure Difference: **-3467** psi

Flow: **0.30** ml/min

This is a symptom of a broken Seal Extension Tube or failed needle seal among other possibilities. There is virtually no back pressure being generated in the system until the inject valve is switched to the load position.



Running the System Leak Test



Leak Test

Parameters | Status | Results

Pressure
Accumulator: 9000 psi
Primary: 7000 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 0 additional attempts.

Attention
Please plug the outlet of the active pre-heater, then press OK.

OK Cancel

Start Close

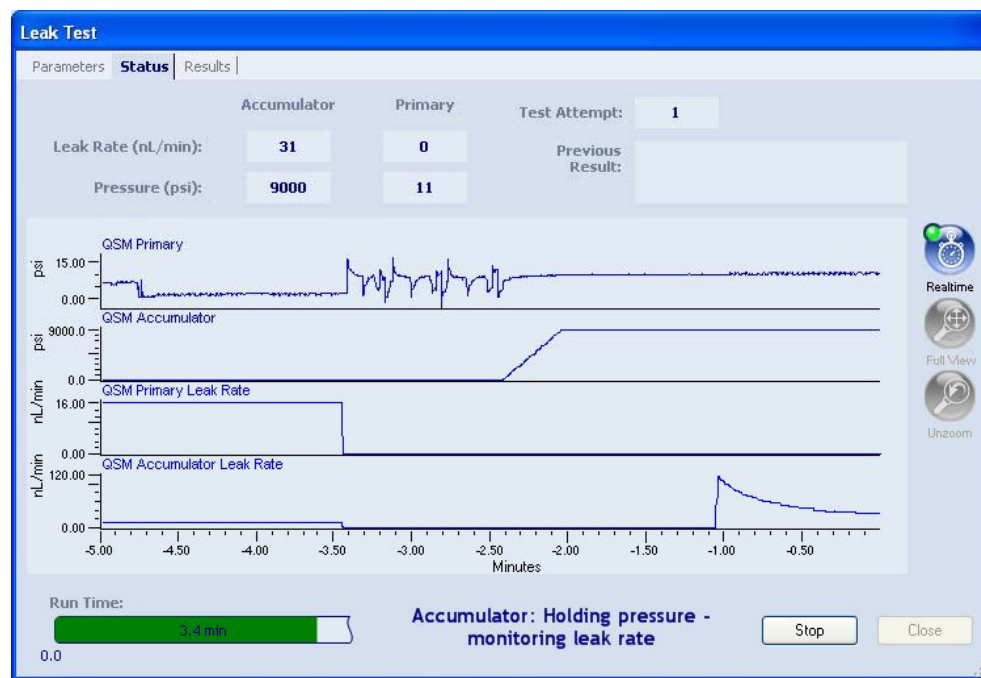
Leak Test

Parameters | Status | Results

	Accumulator	Primary
Result:	Passed	Passed
Leak Rate:	15 nL/min	18 nL/min
Maximum Pressure:	9017 psi	7022 psi
Percent of Stroke:	12 %	8 %
Compressed Volume:	7 uL	4 uL
Compression Attempts:	1	1
Test Attempts:	1	

Print

Start Close



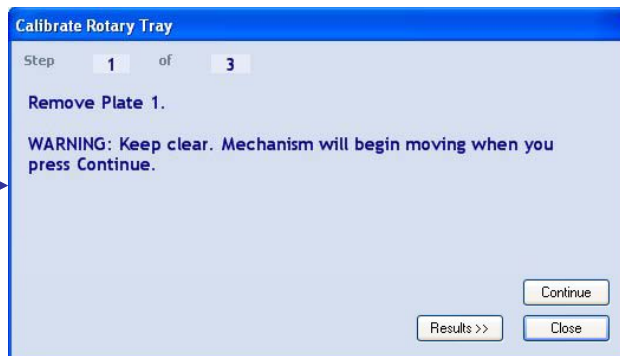
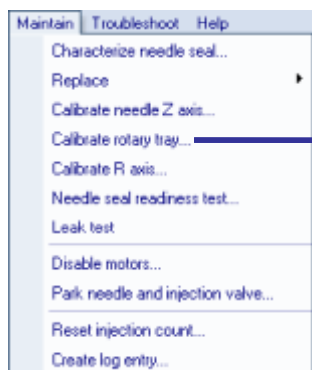
Rotary Tray Calibration Pin



Calibration Pin
is located in
SM door foam



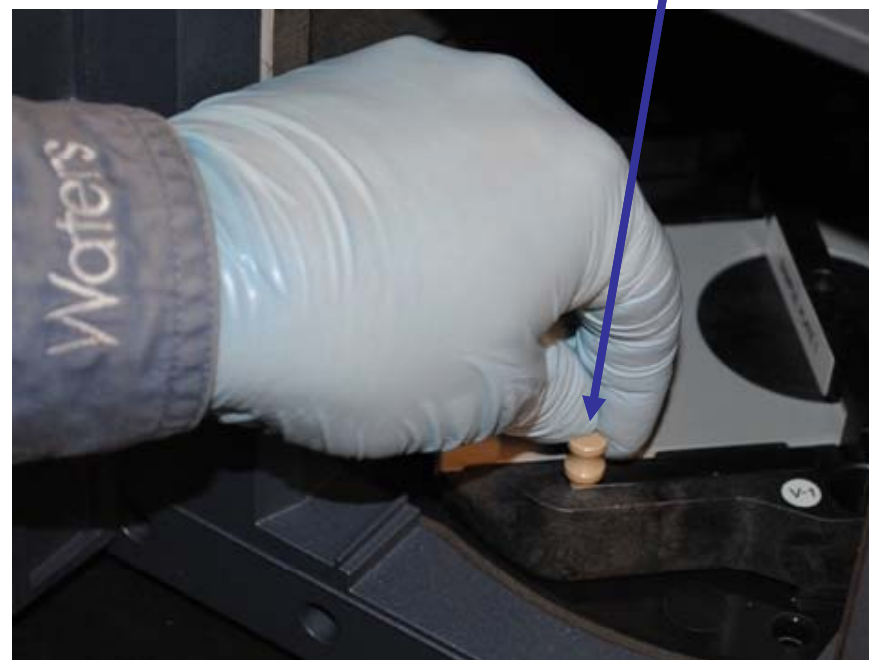
Calibrate Rotary Tray



Tray is moved manually until these holes line up.



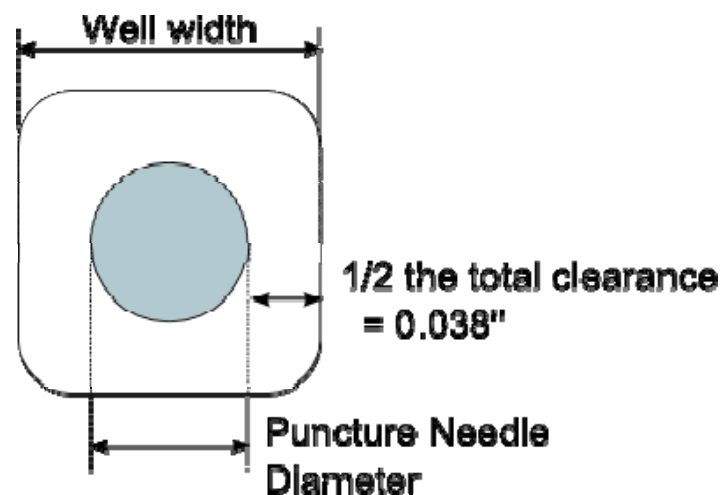
Calibration Pin is inserted into the lined up holes to lock the location.



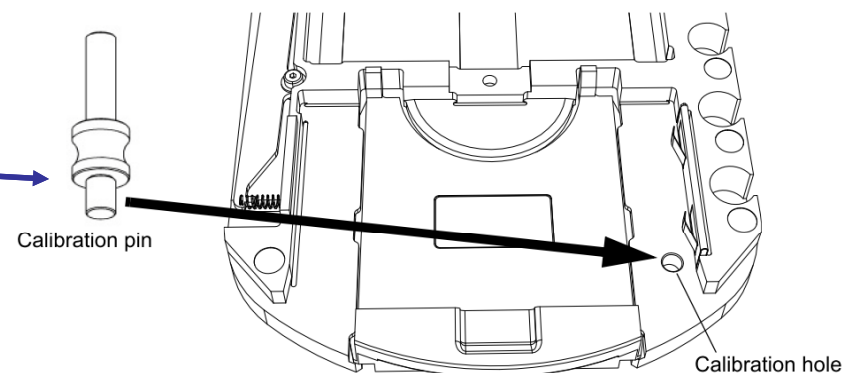
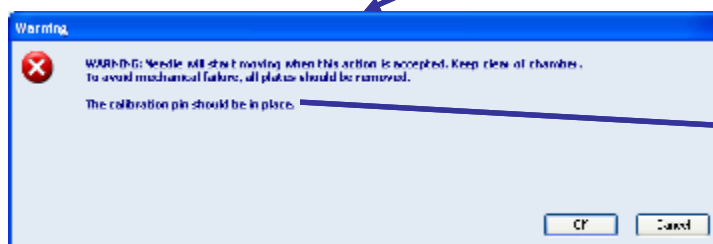
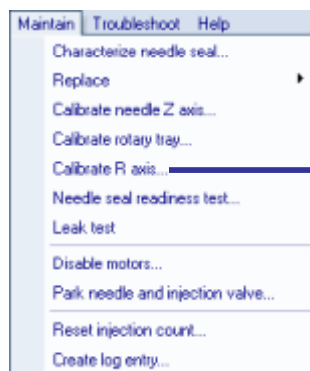
Implementation of R-Calibration



- Compensated for accurate needle positioning with 384 wellplates
- R-Calibration
 - Analogous to the X-Y calibration of the ACQUITY Sample Manager
 - But only one axis
- Calibration in user diagnostics
- Basic description of routine:
 - Insert calibration pin in calibration hole on platter as shown
 - The calibration pin has a small hole in the tip
 - Using diagnostics controls, move the needle back and forth until it lines up with the hole
 - Save calibration



Implementation of R-Calibration



Implementation of R-Calibration

