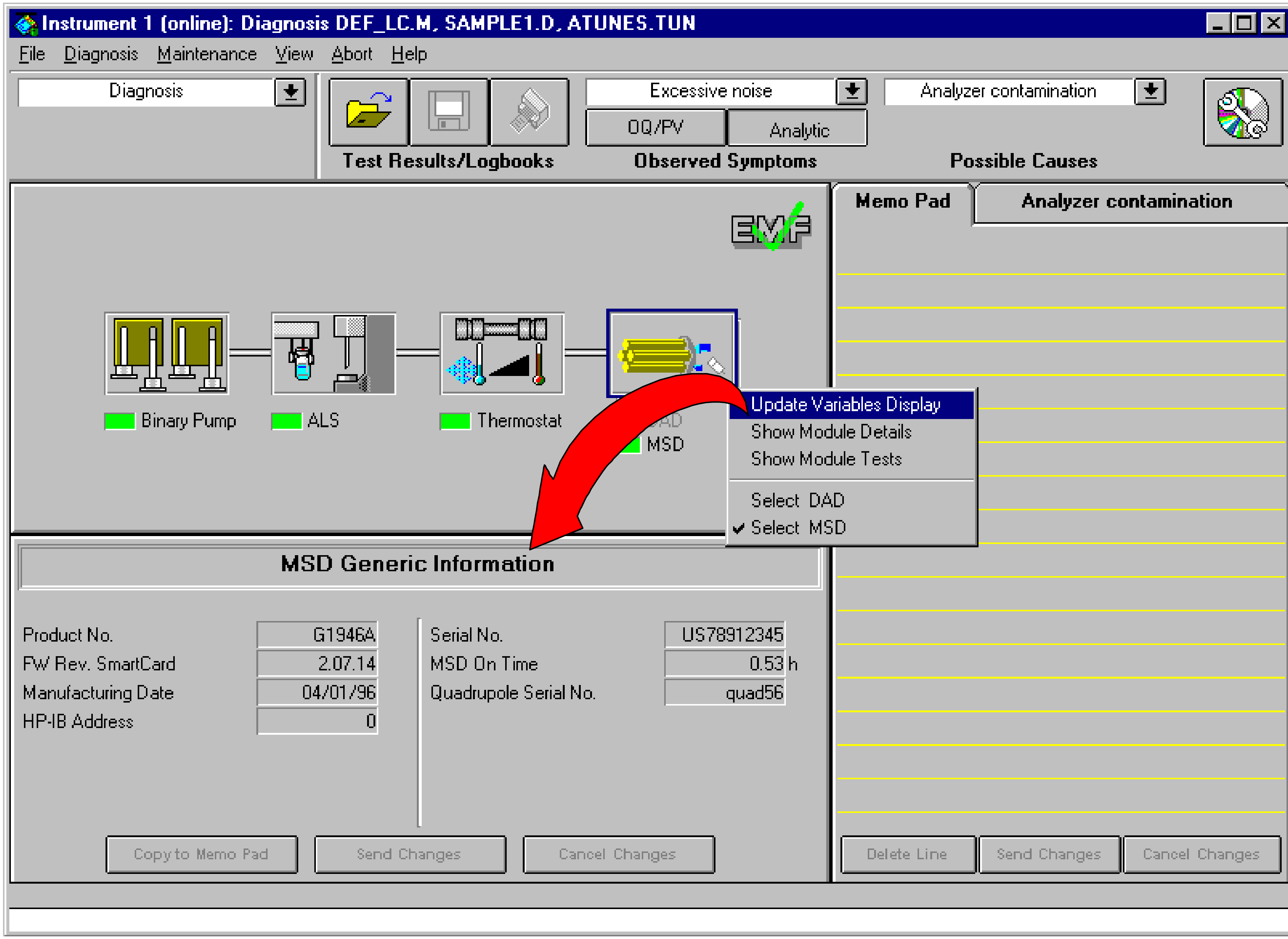
Diagnostics and Troubleshooting

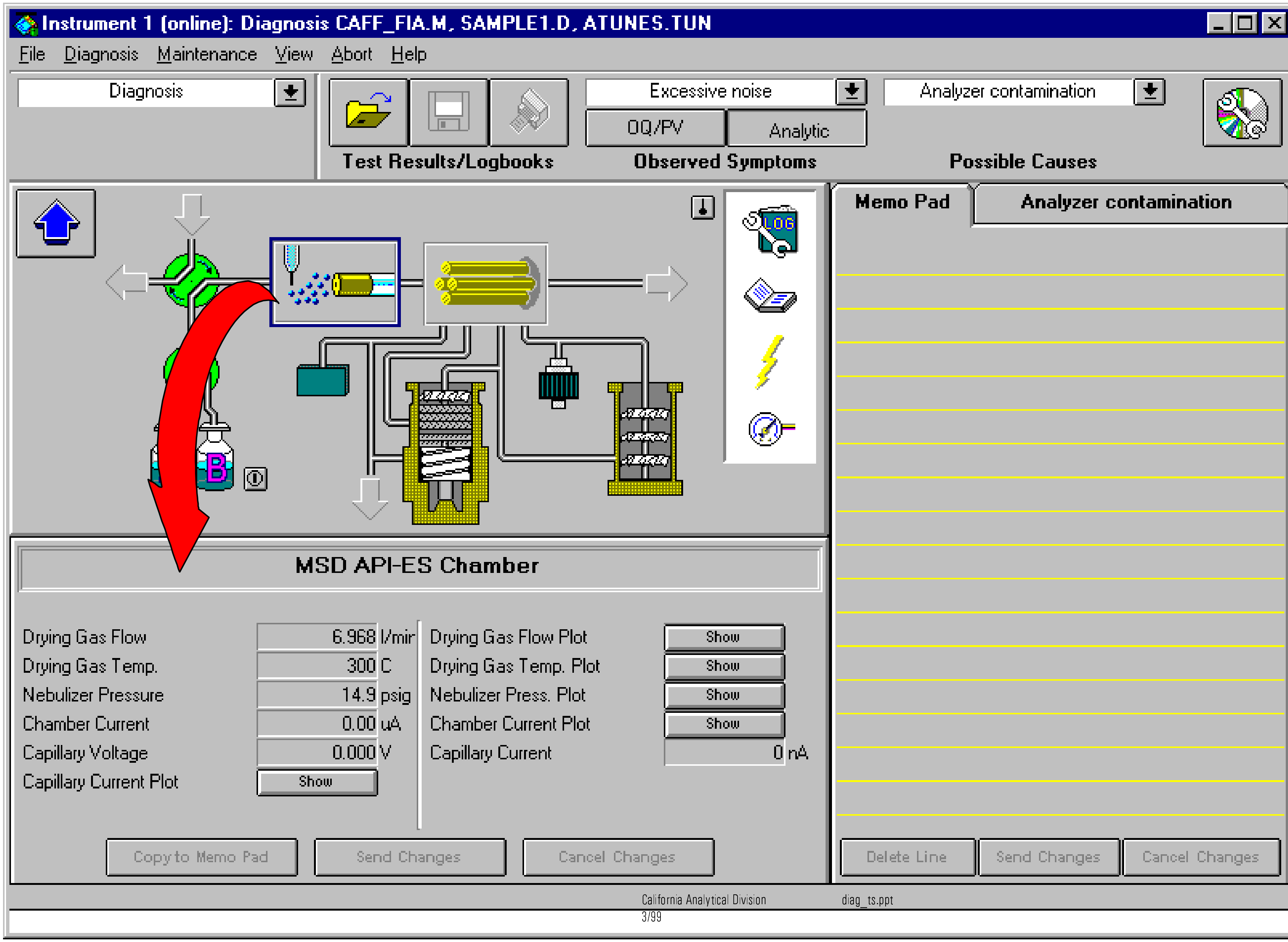
Objectives

- Recognize a “problem situation” on the system
- Know the utilities available for diagnosing a system problem
- Diagnose the instrument using the calibration (tune) report
- List the MS faults that the can be generated by the MSD and know their possible causes
- Develop and outline a repair strategy for the various functional groups, including applications, of the system
- Successfully troubleshoot and repair specific system problems

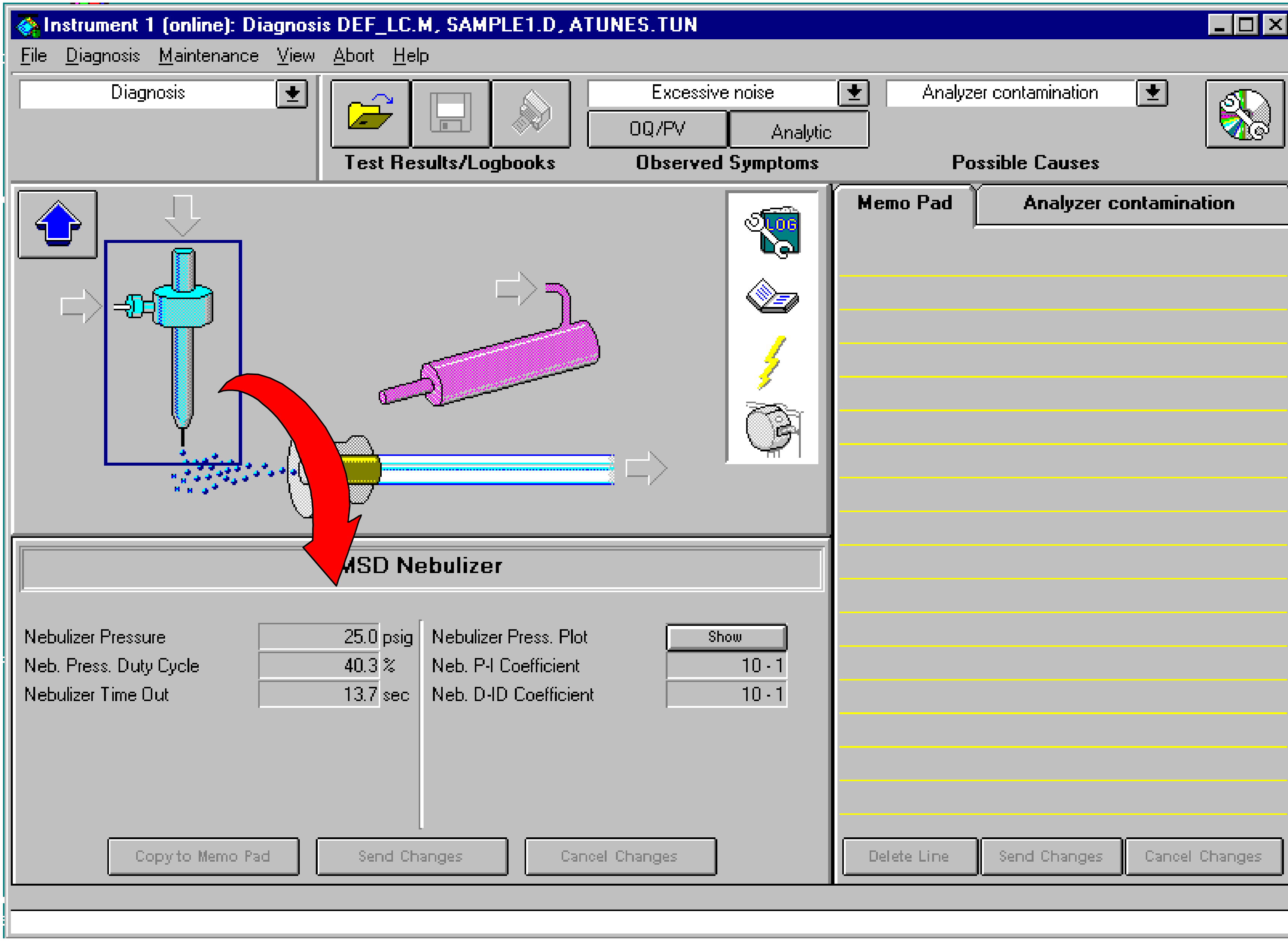
MSD Module / Update Variables Display



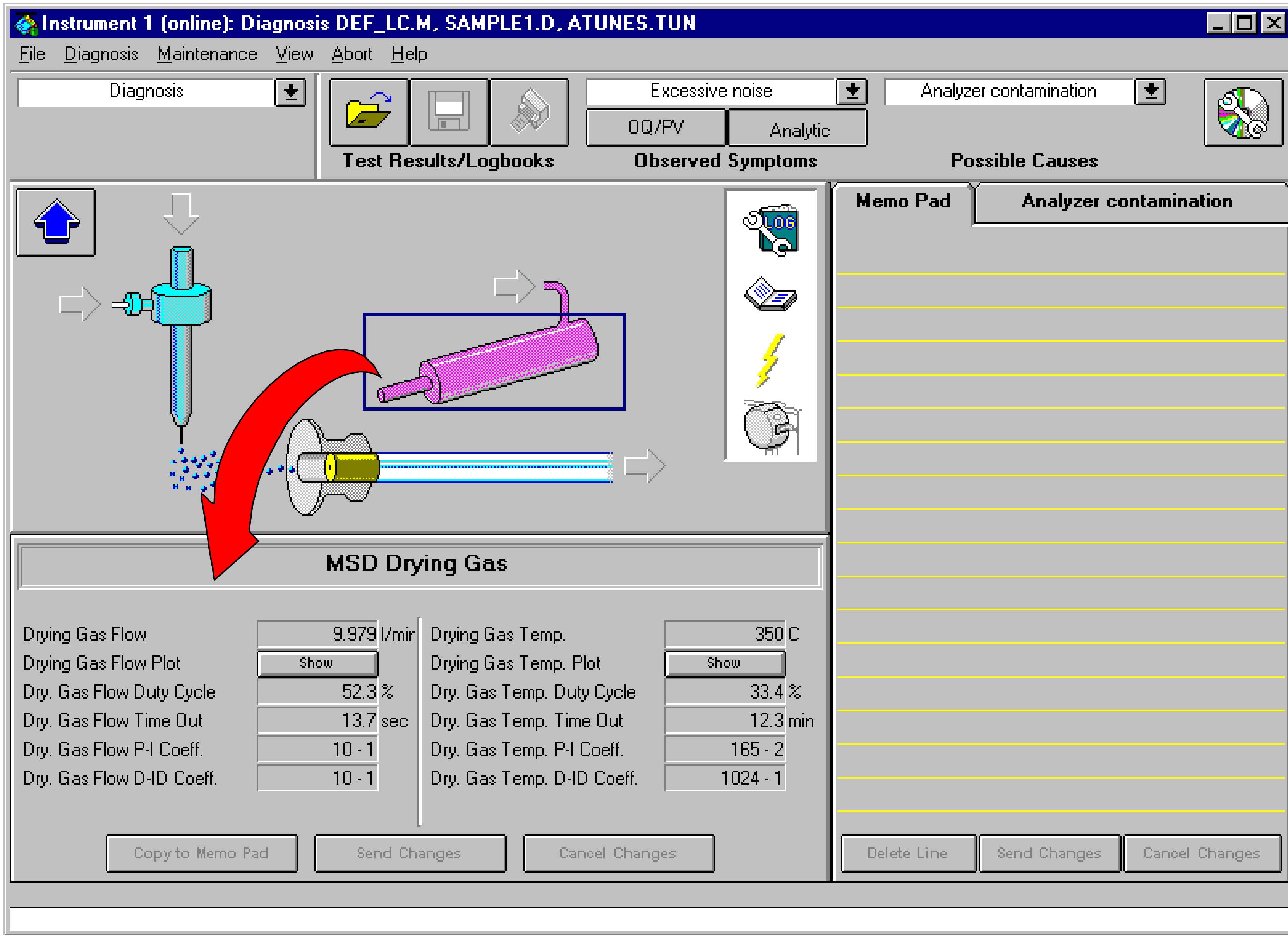
MSD Module Details -- API-ES Chamber



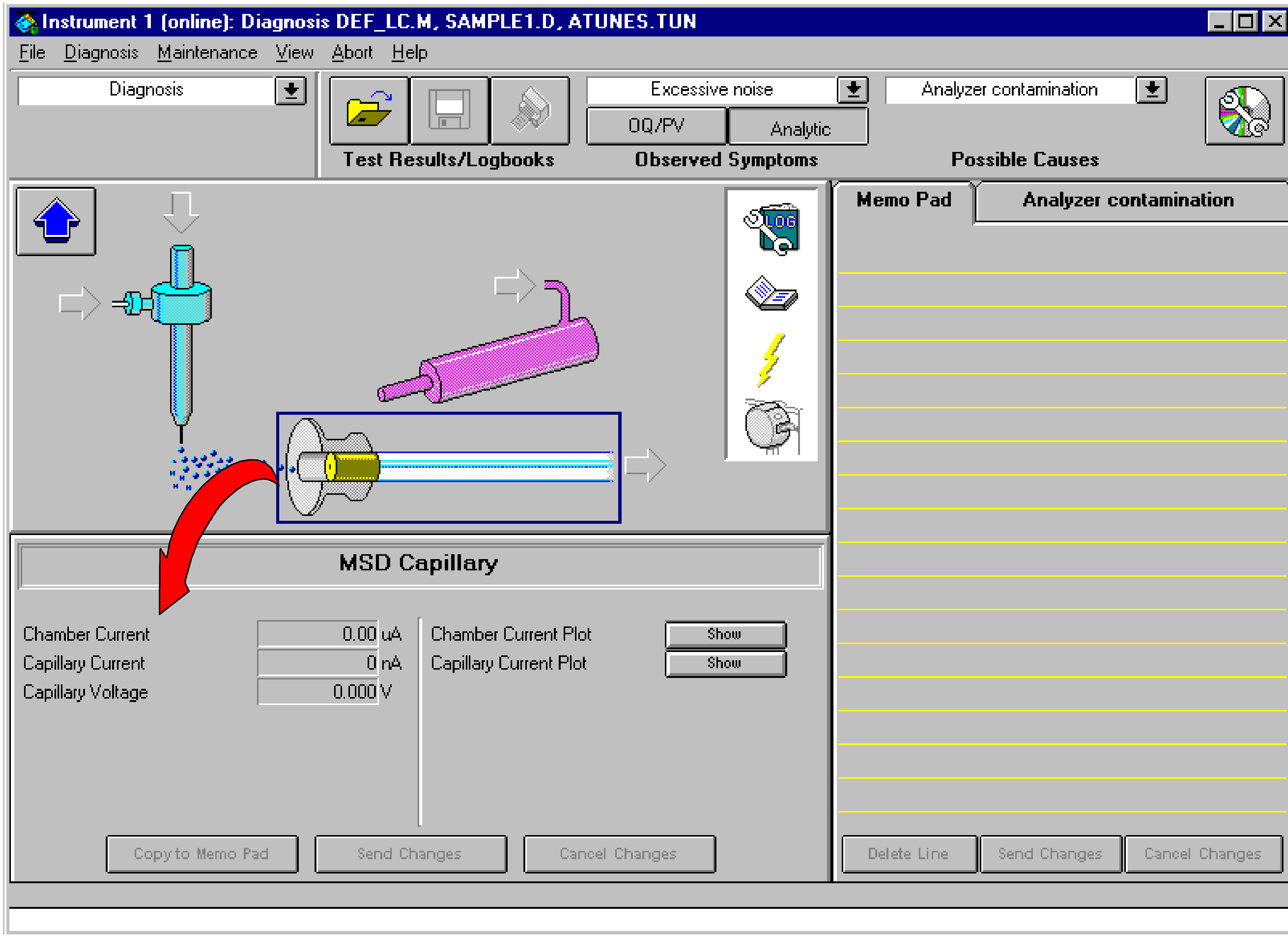
MSD Spray Chamber Details -- Nebulizer



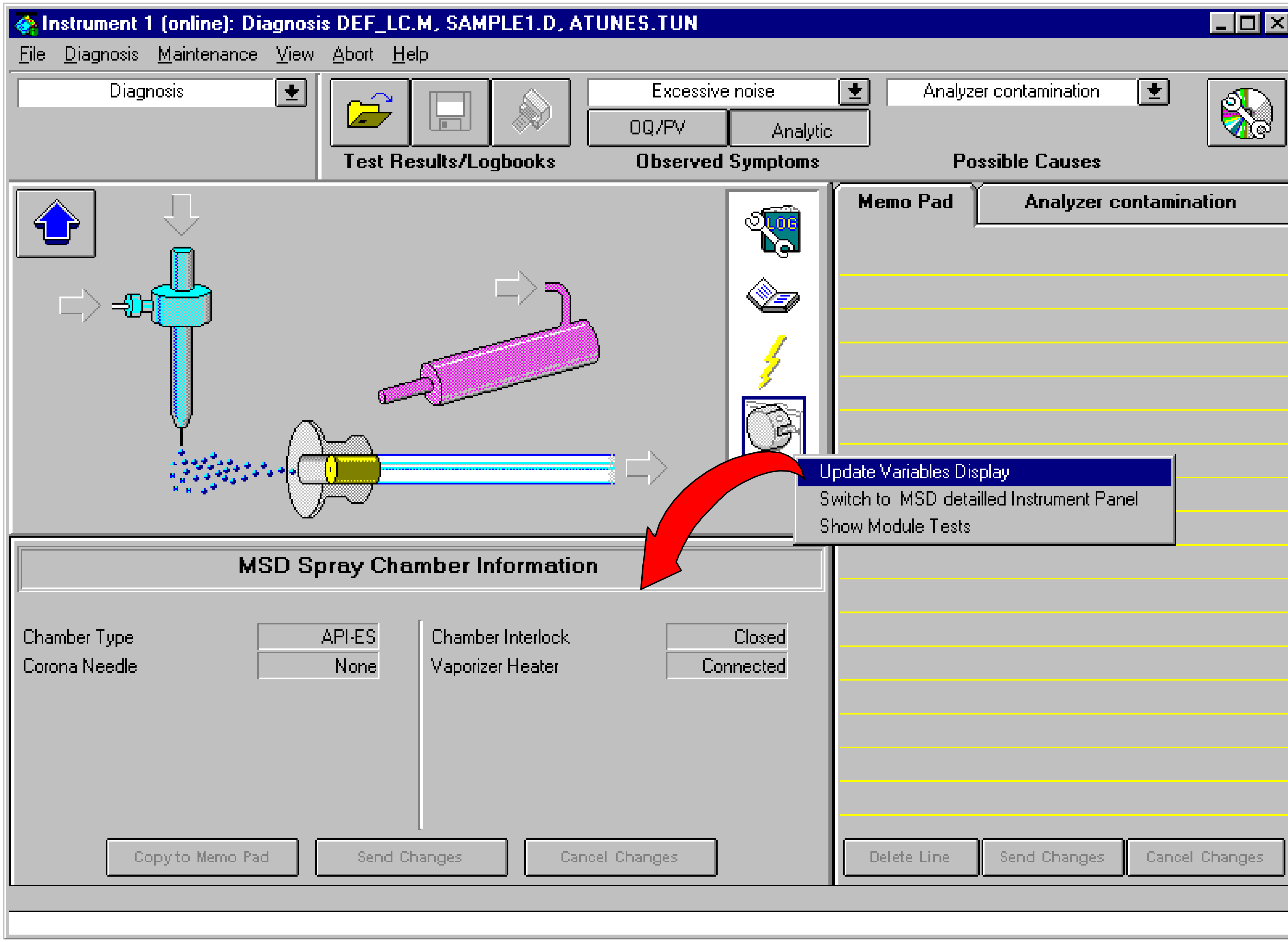
MSD Spray Chamber Details -- Drying Gas



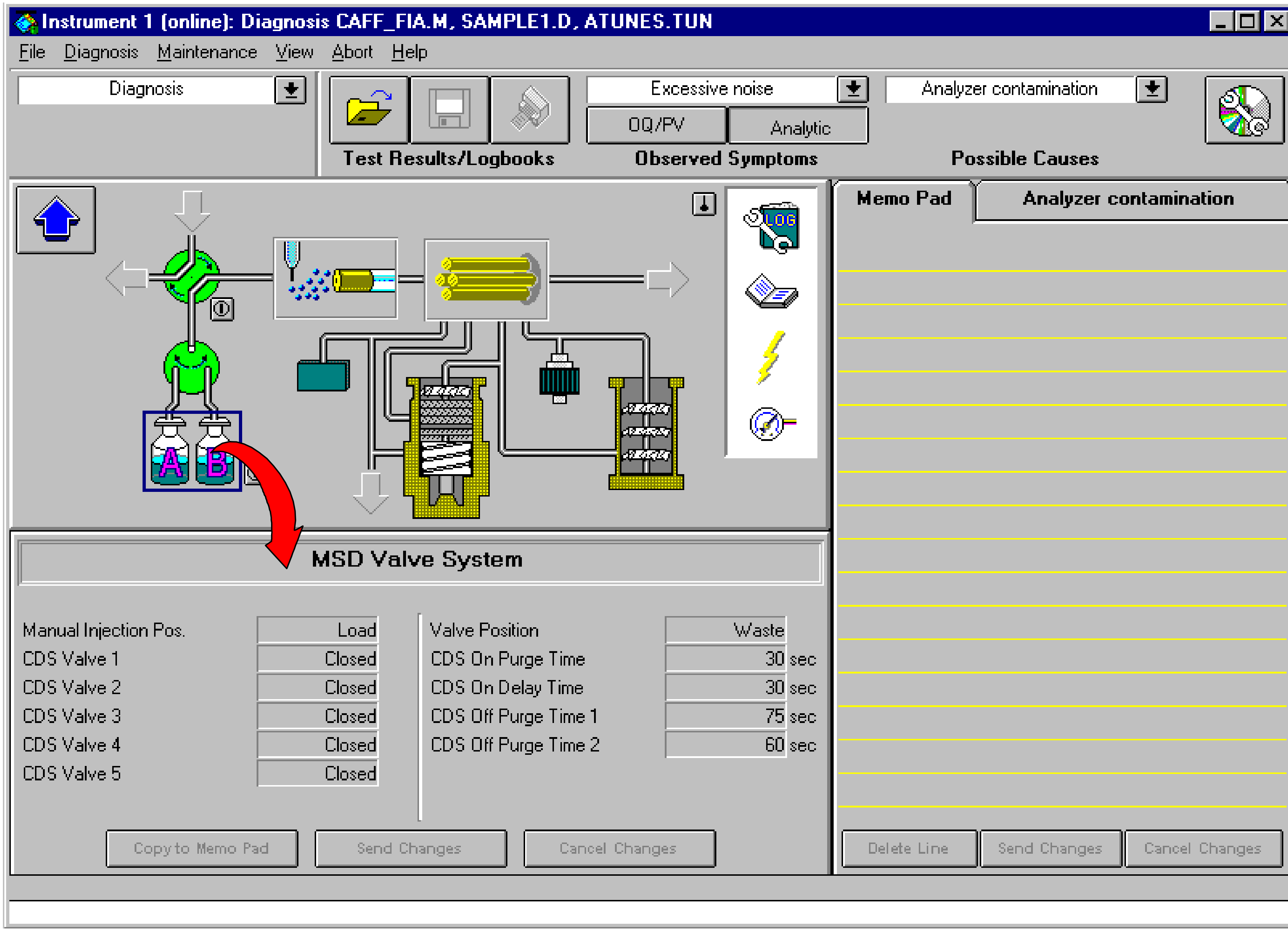
MSD Spray Chamber Details -- Capillary



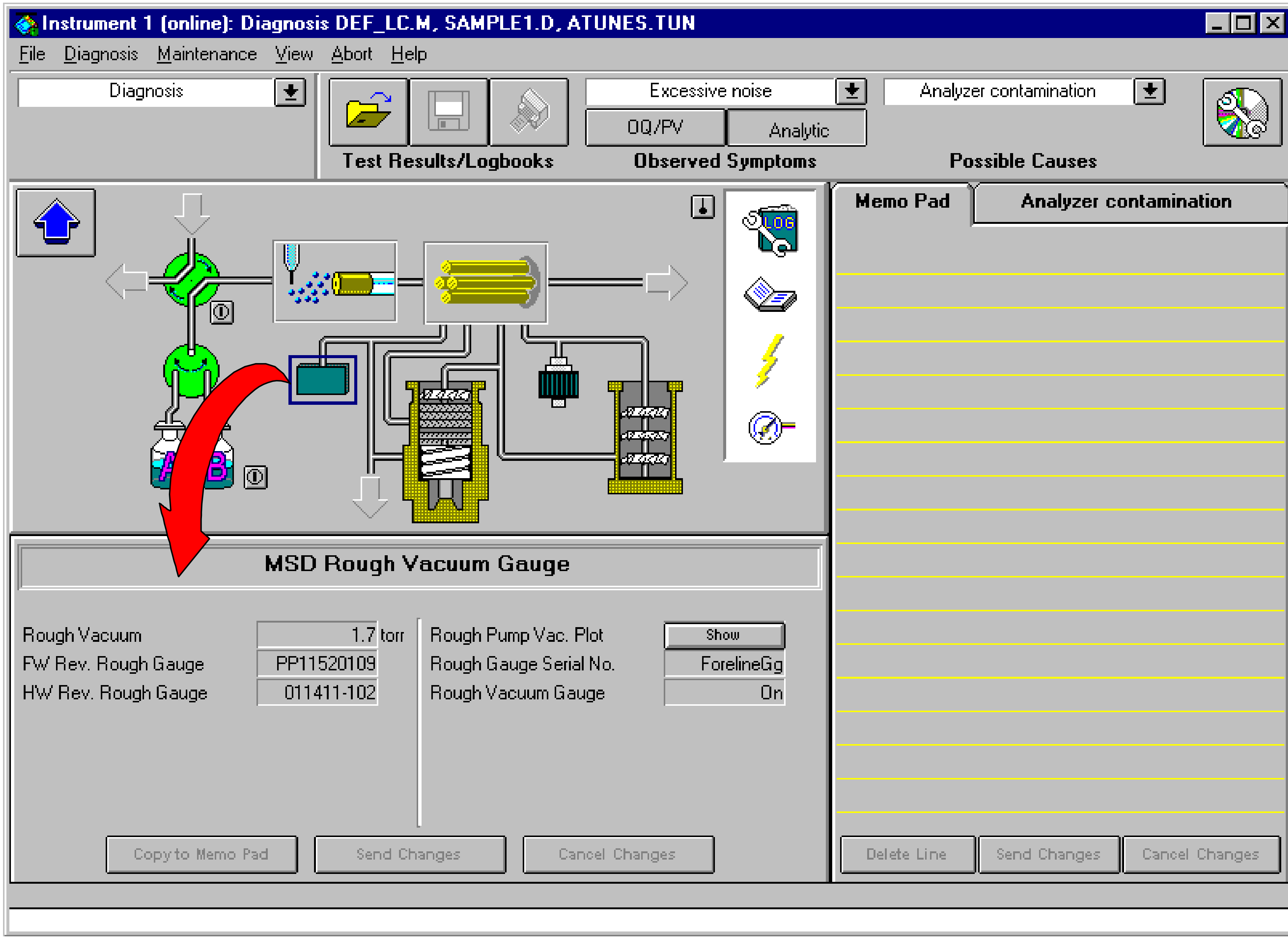
MSD Spray Chamber Information



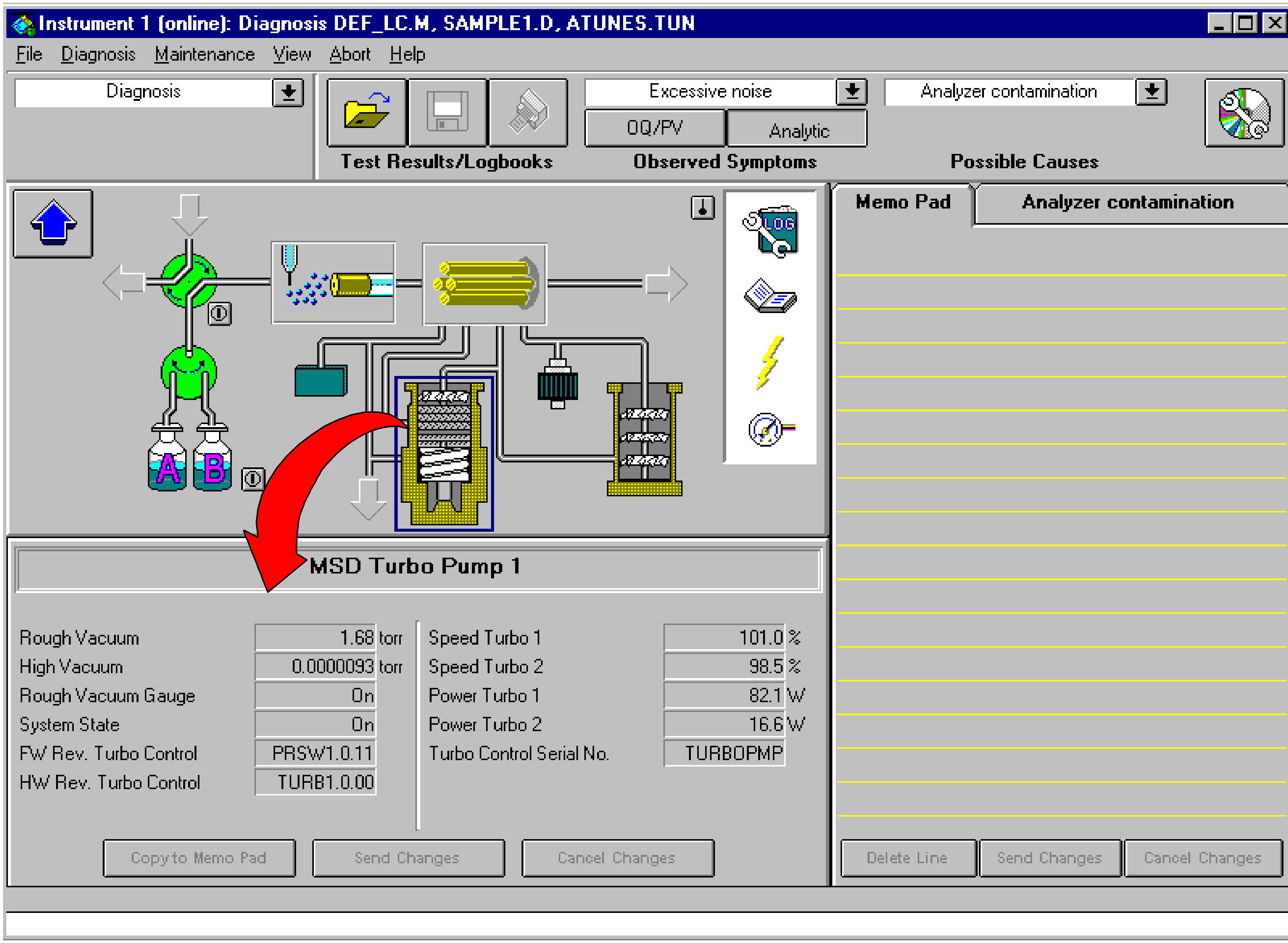
MSD Module Details -- Valve System



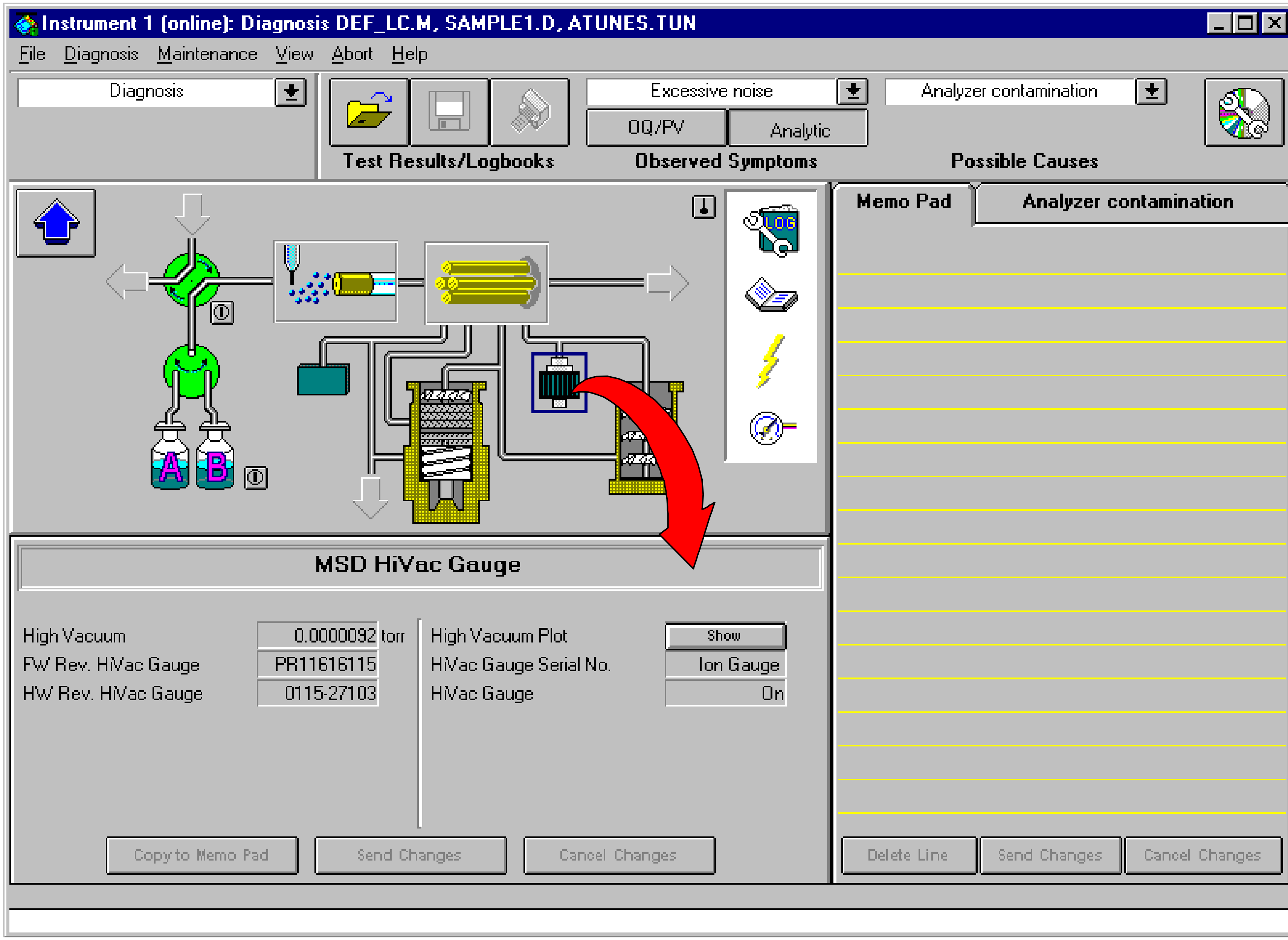
MSD Module Details -- Rough Vacuum Gauge



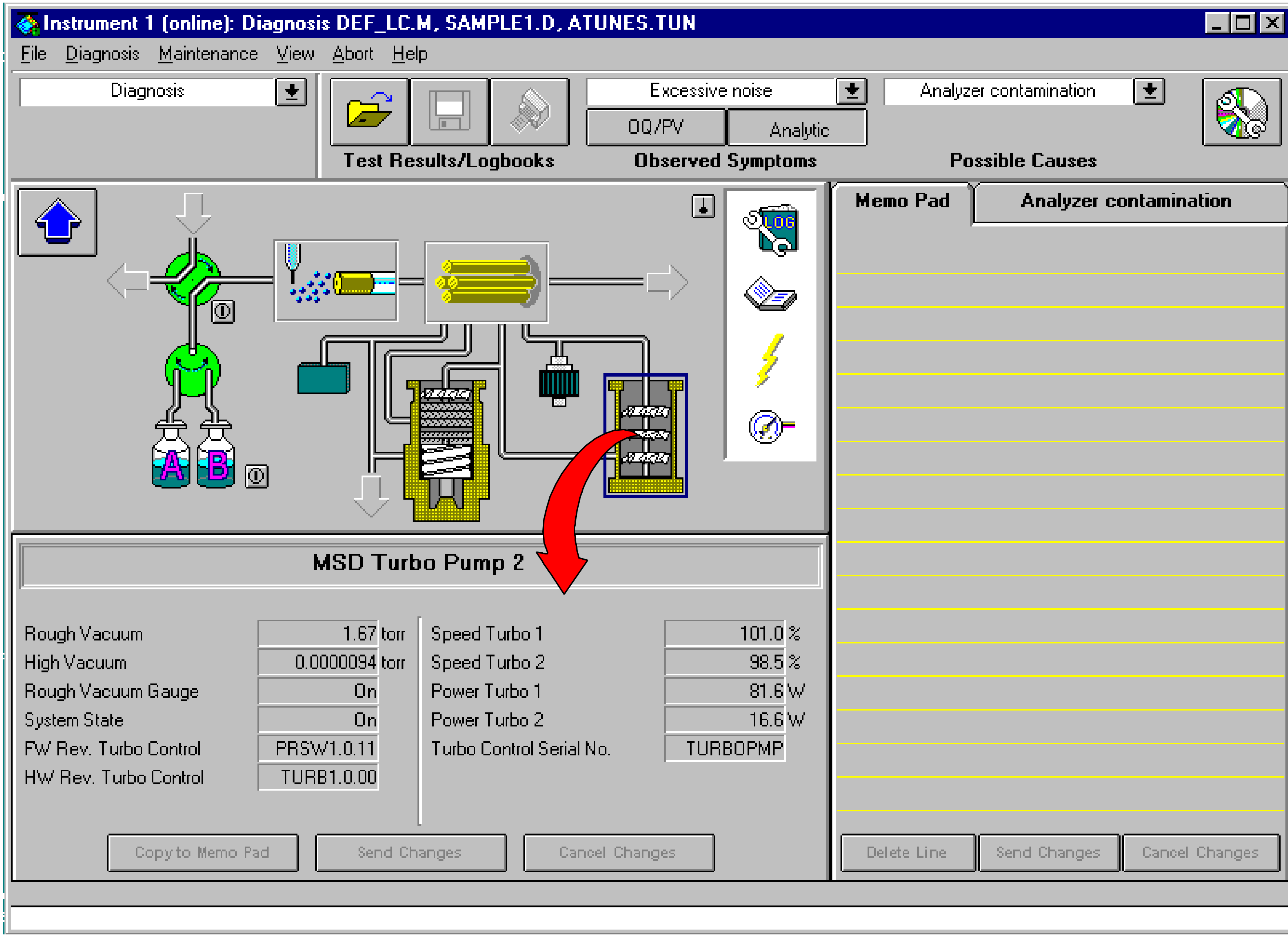
MSD Module Details -- Turbo Pump 1



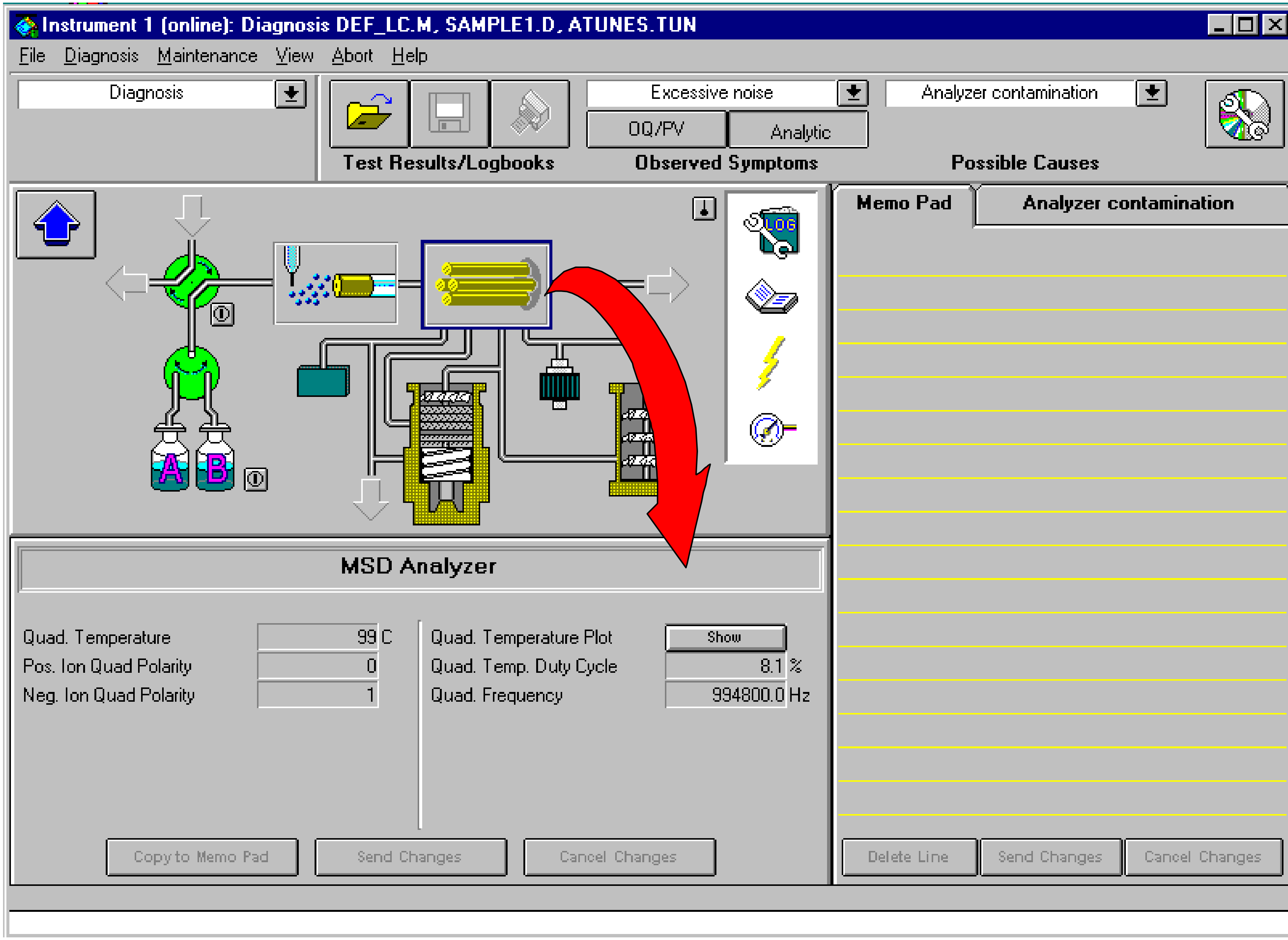
MSD Module Details -- HiVac Gauge



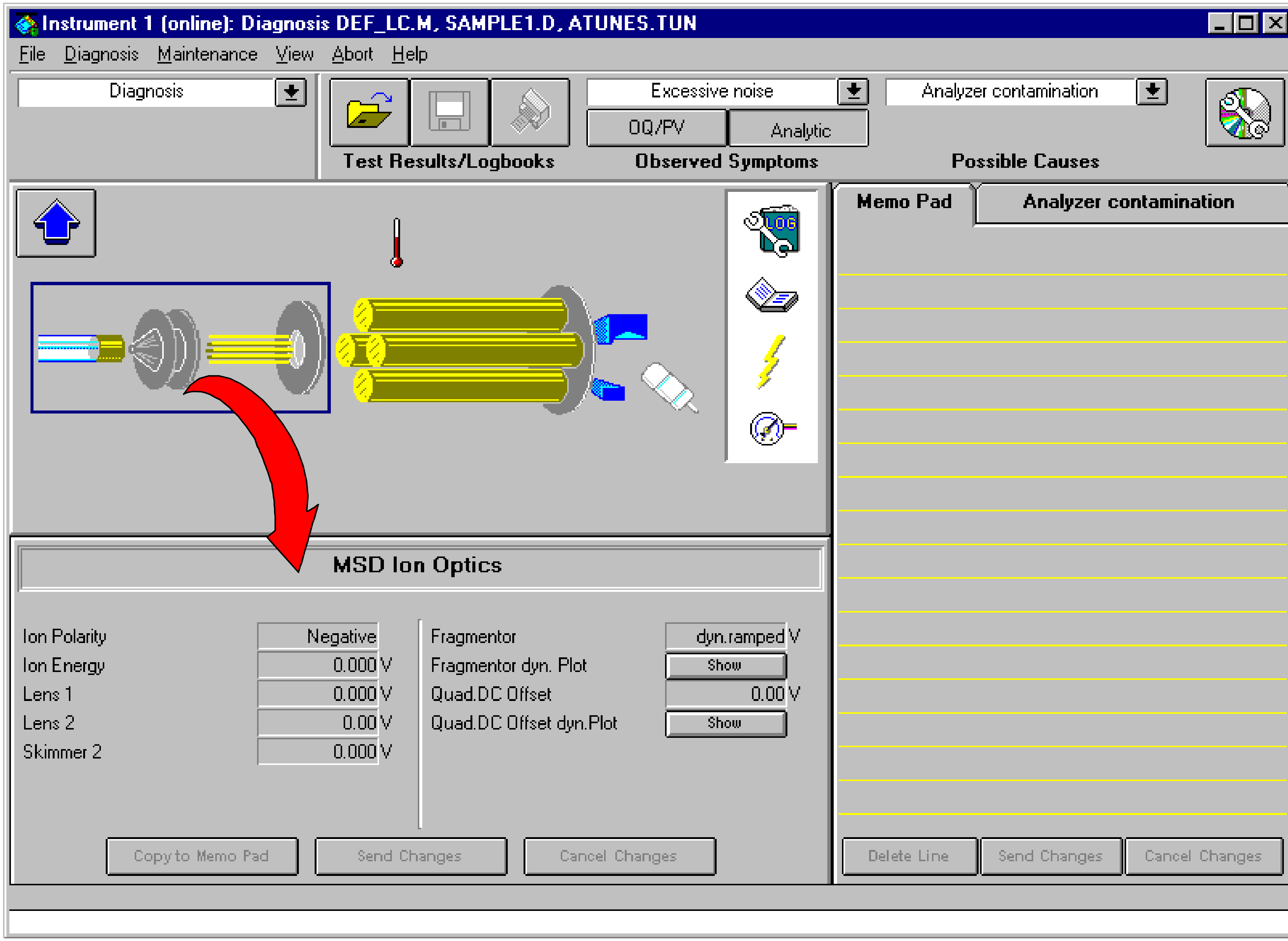
MSD Module Details -- Turbo Pump 2



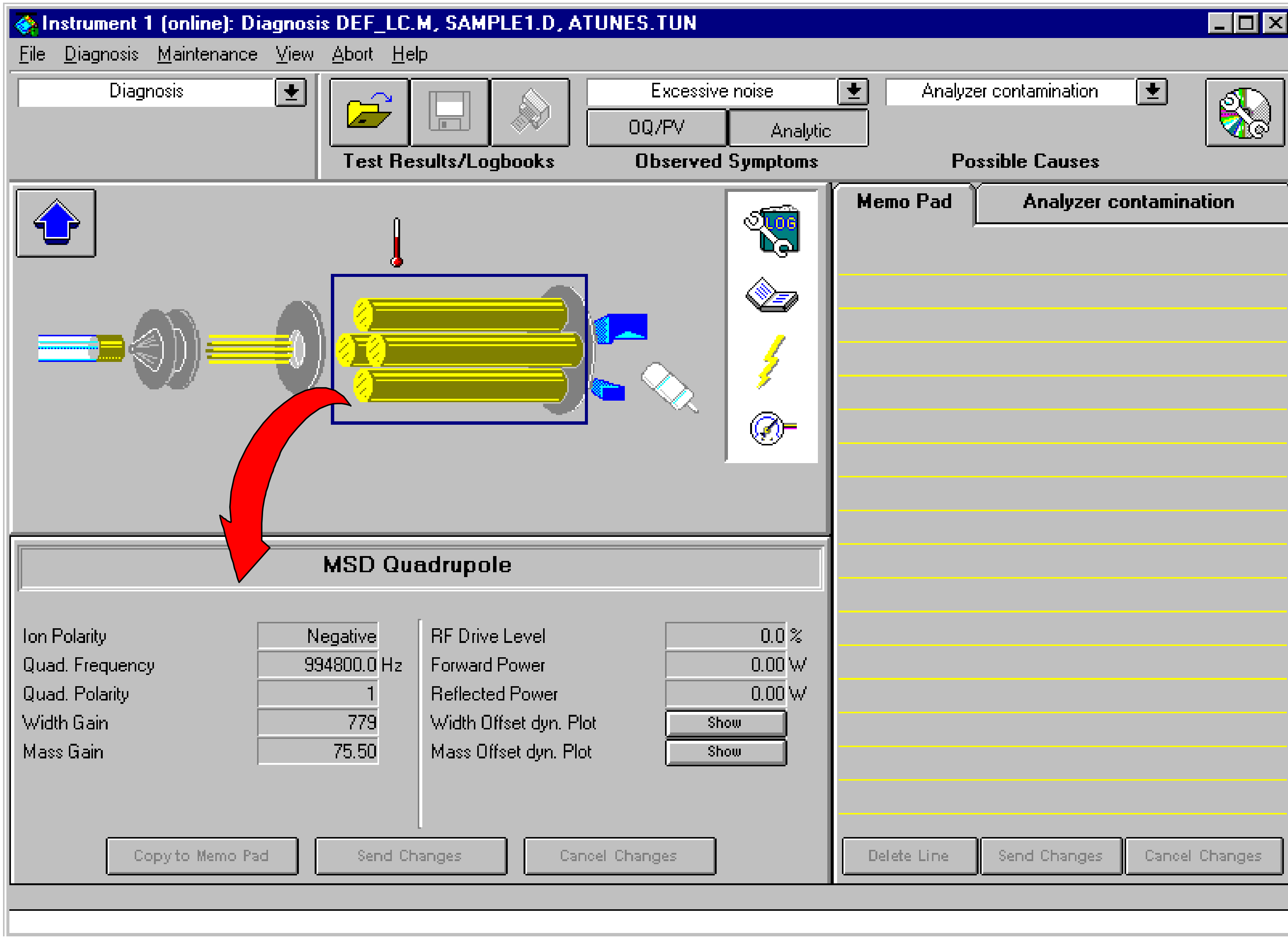
MSD Module Details -- MSD Analyzer



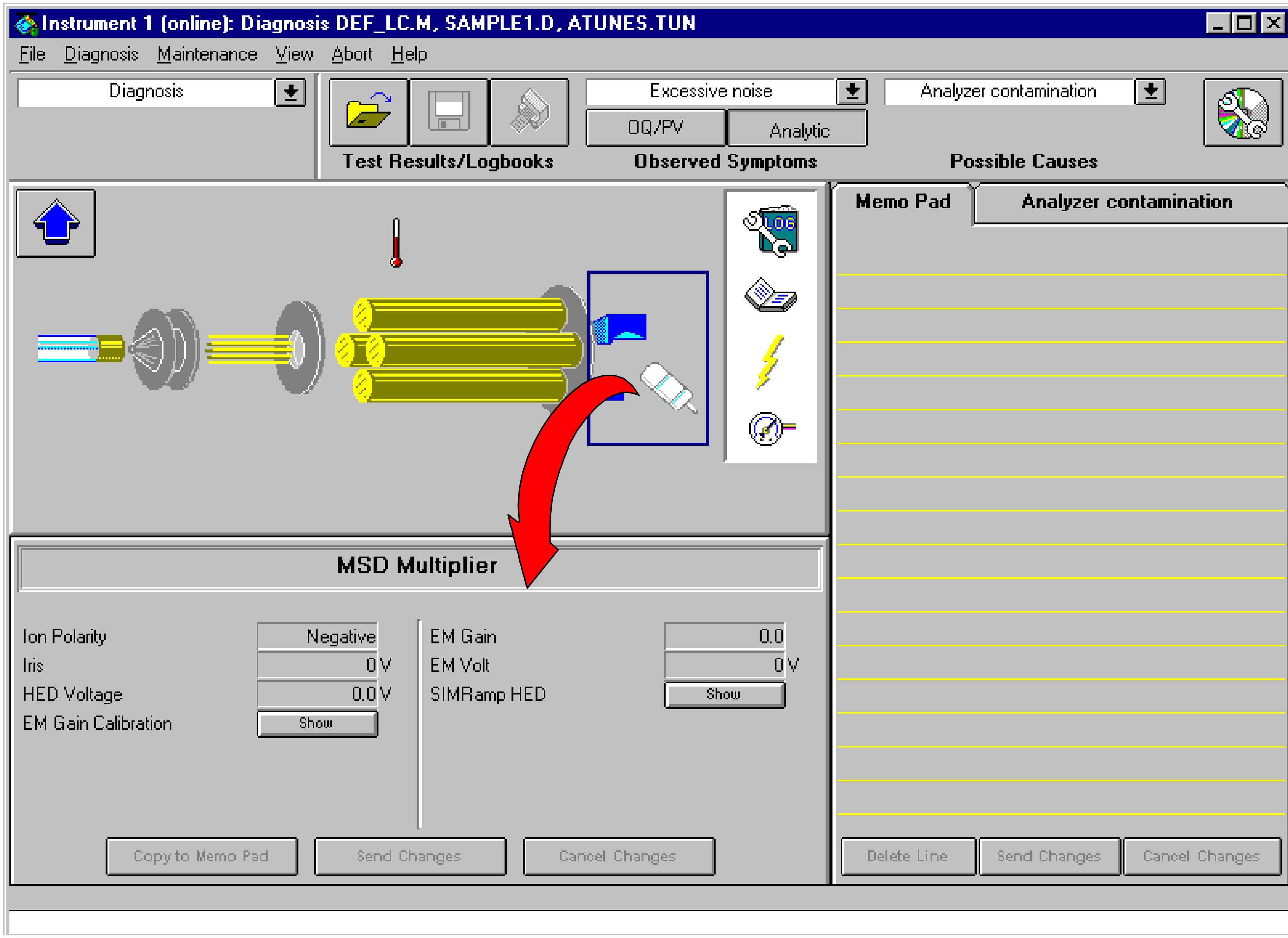
MSD Analyzer Details -- Ion Optics



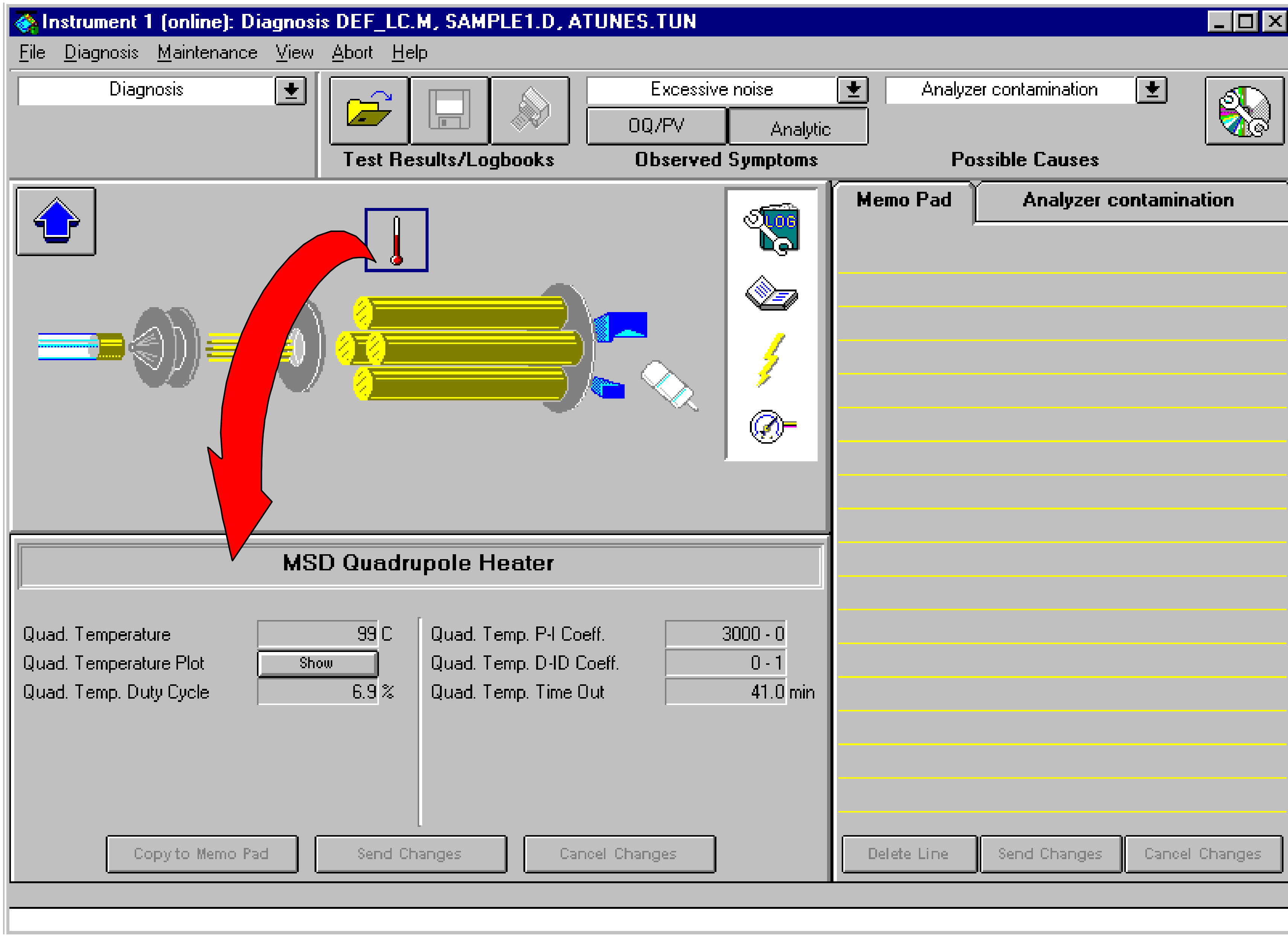
MSD Analyzer Details -- Quadrupole



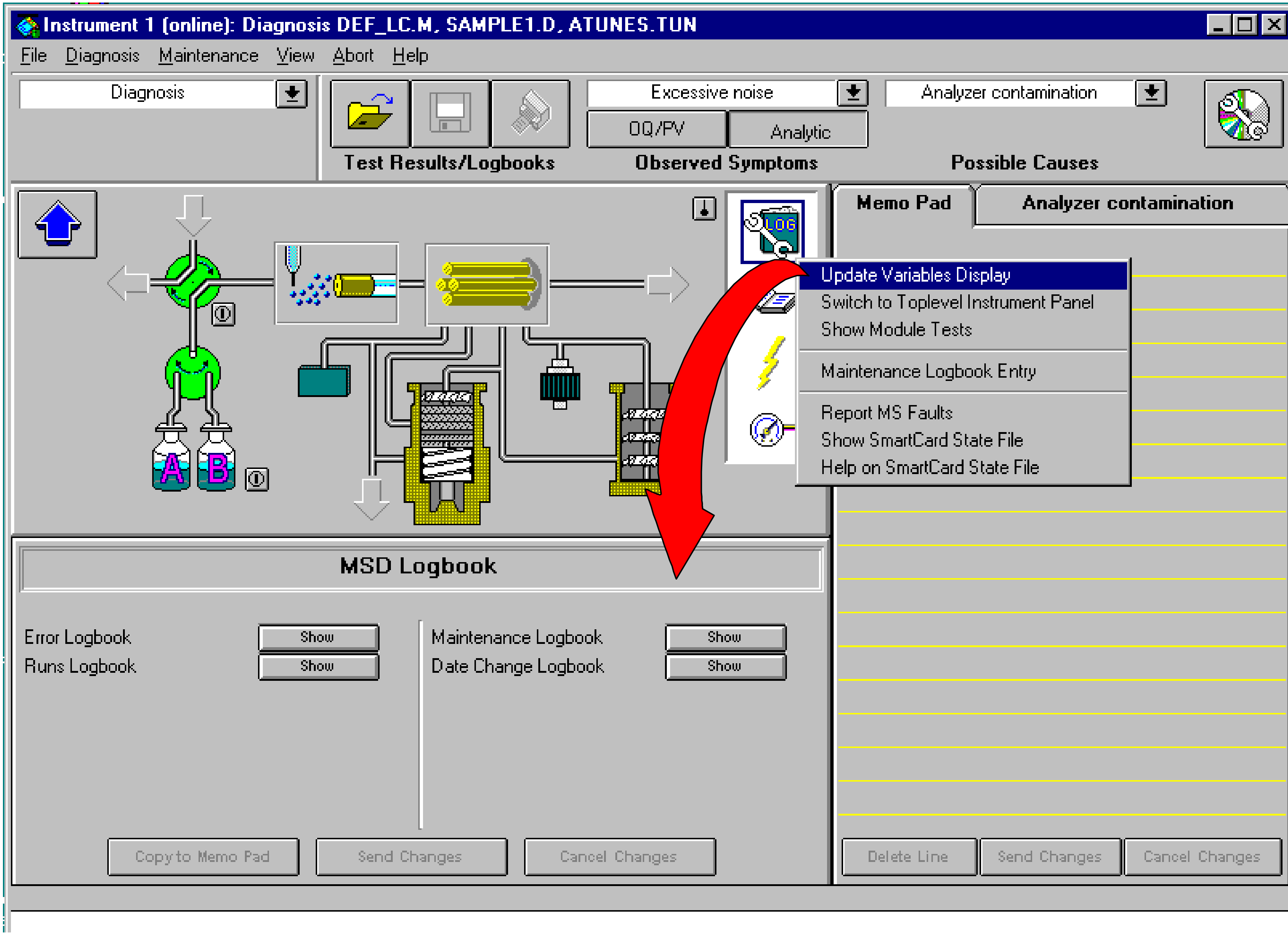
MSD Analyzer Details -- Multiplier



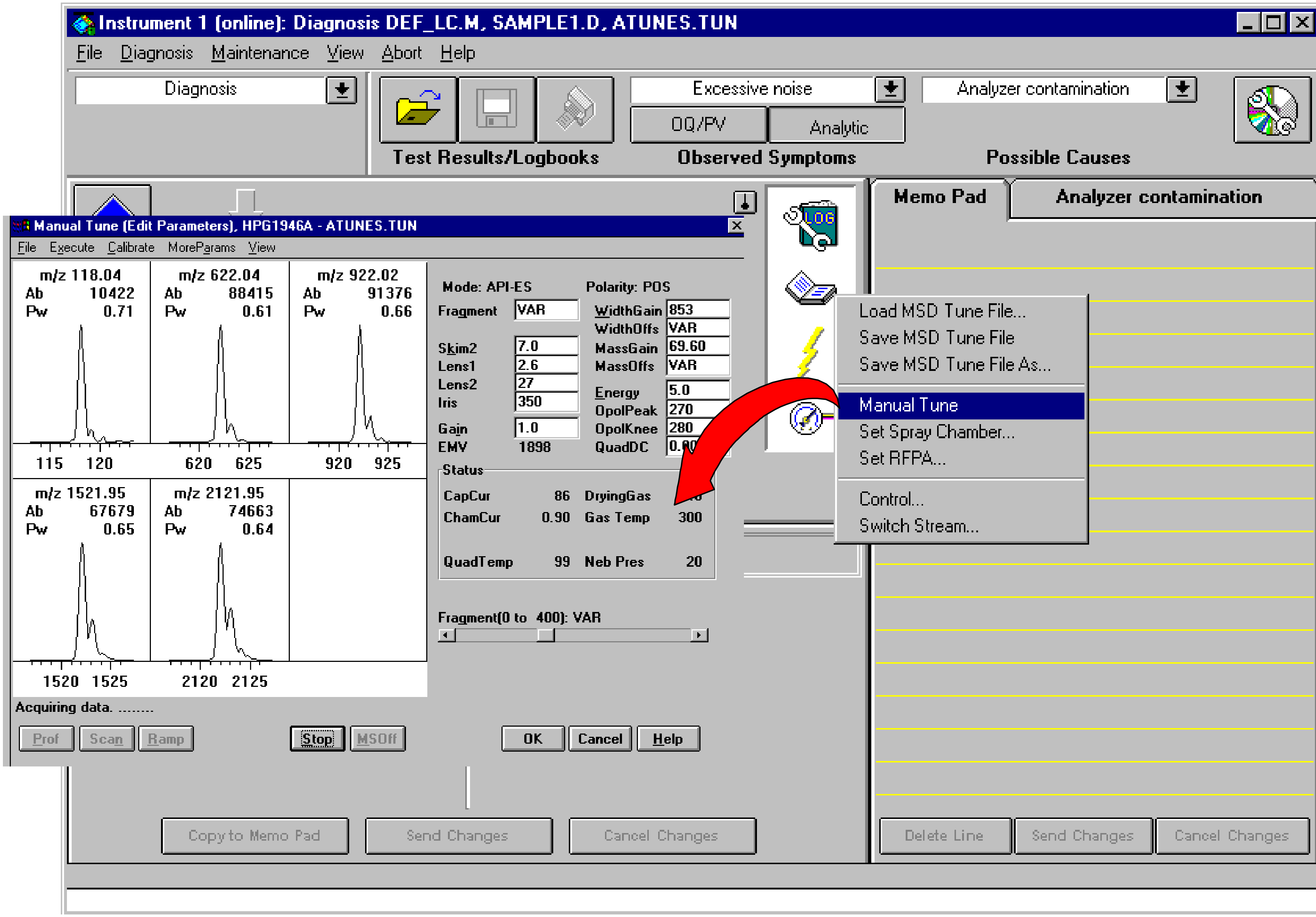
MSD Analyzer Details -- Quadrupole Heater



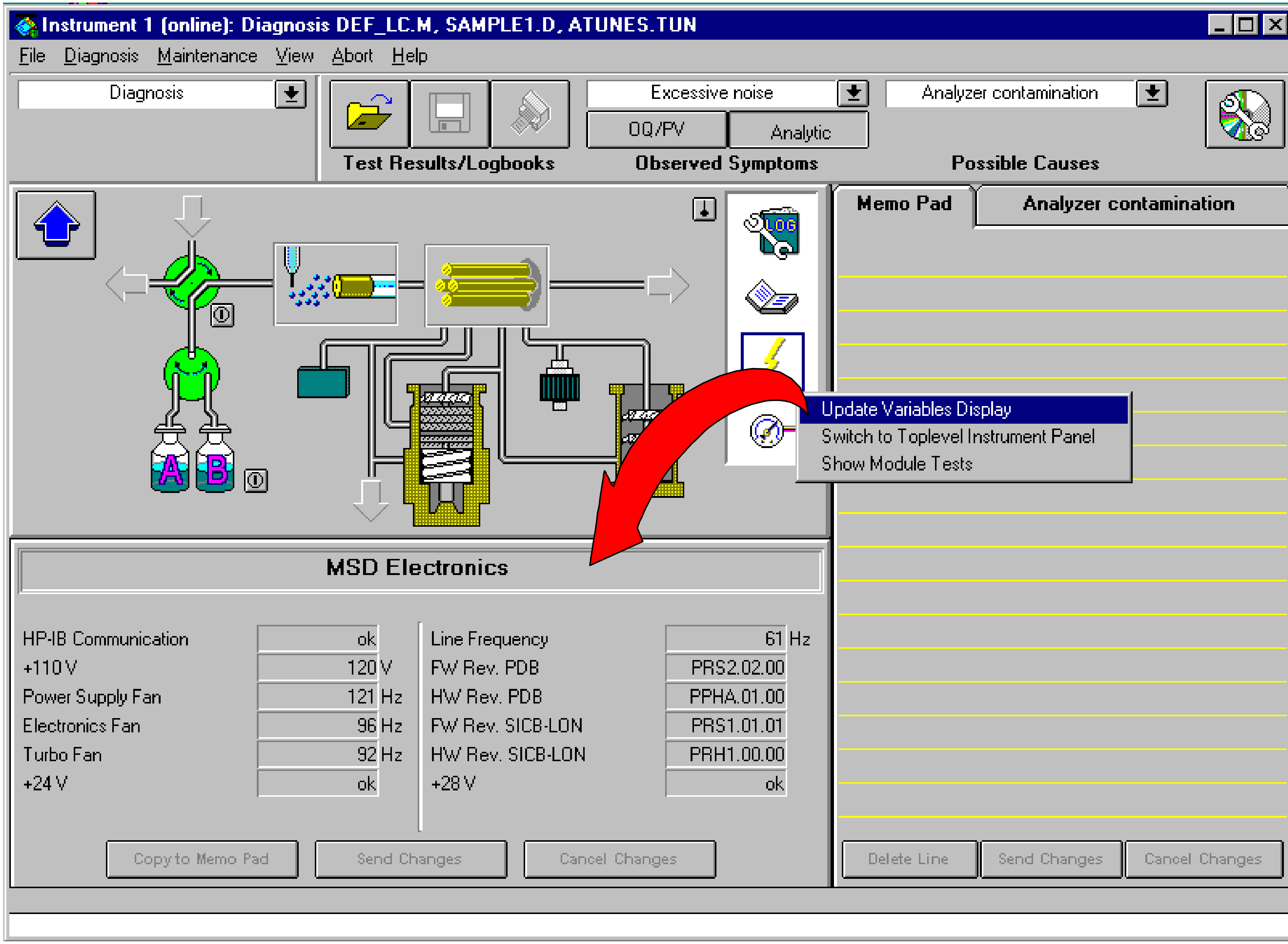
MSD Logbooks



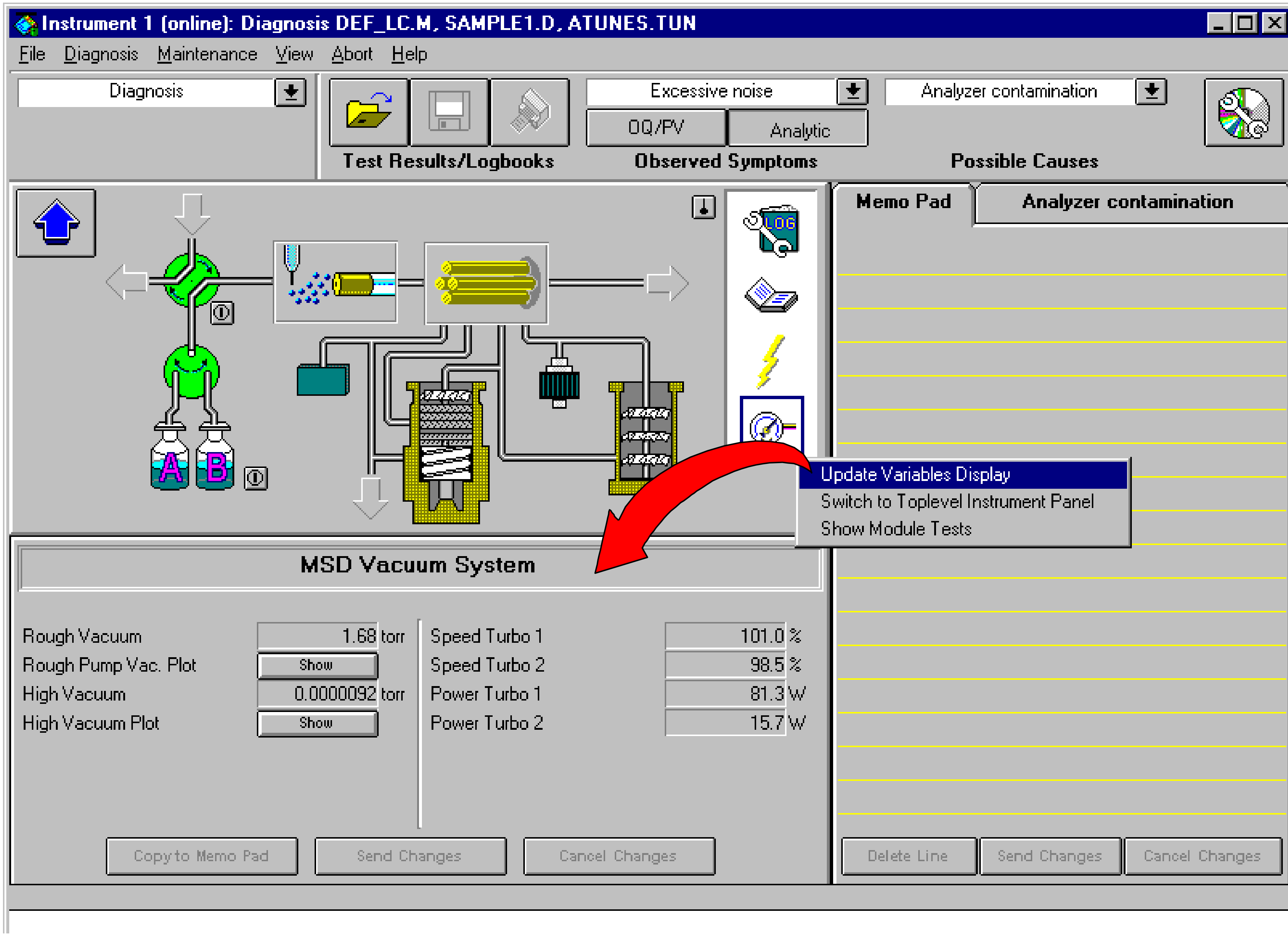
Accessing Manual Tune from Diagnosis



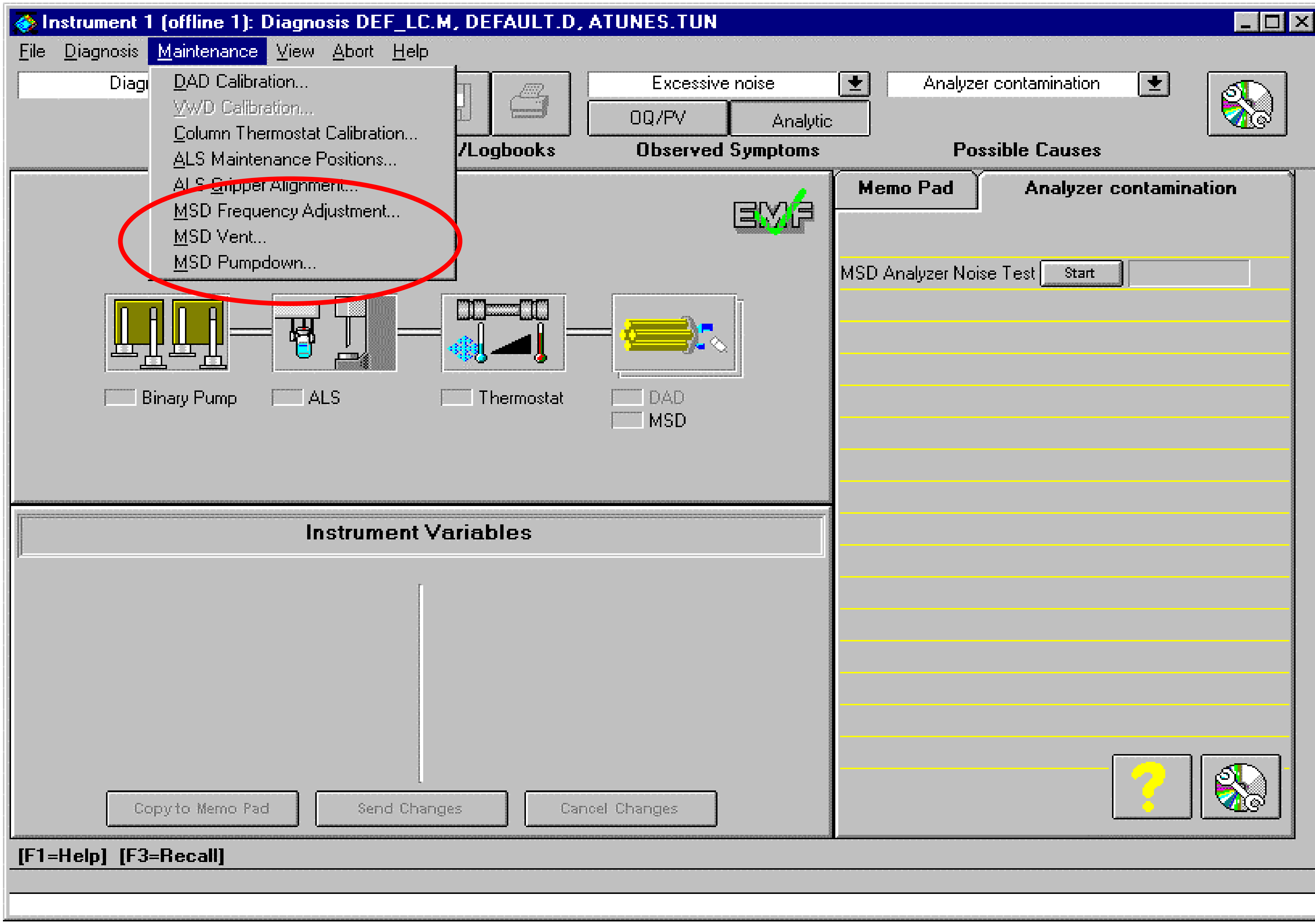
MSD Electronics Variables Display



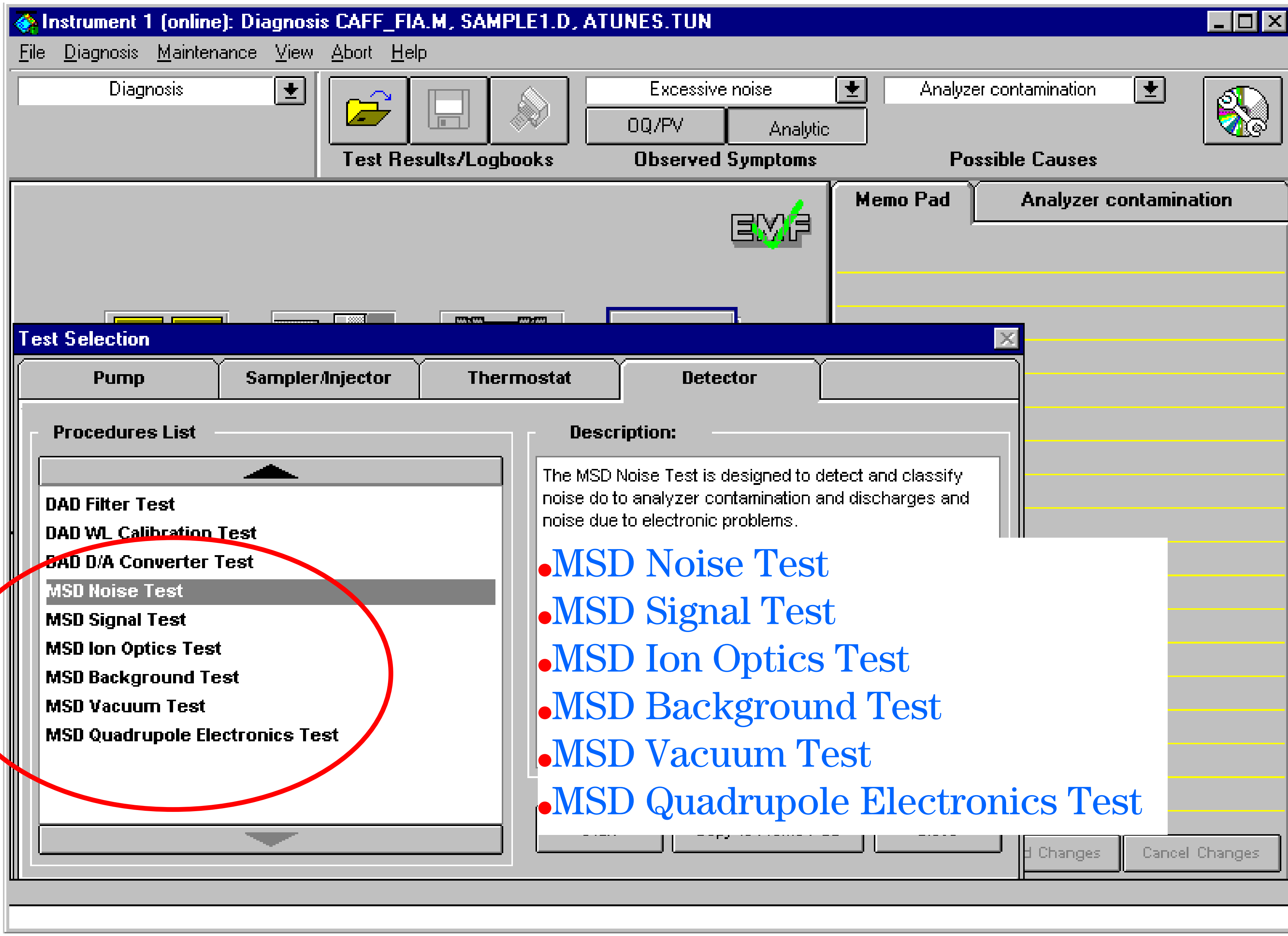
MSD Vacuum System Variables Display



Maintenance Menu



MSD Module Tests

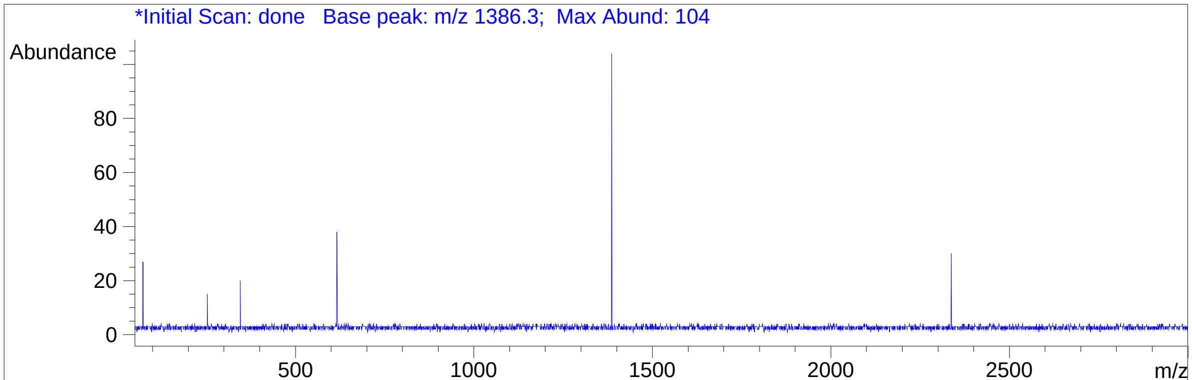


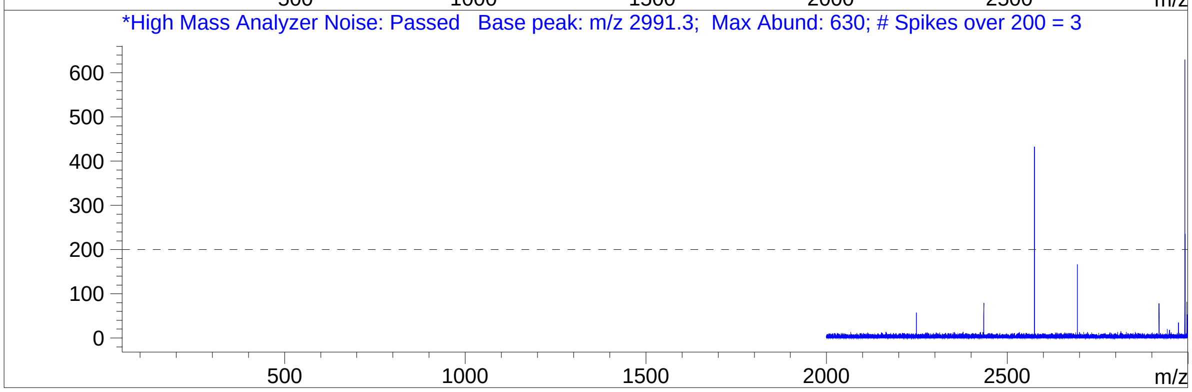
- MSD Noise Test
- MSD Signal Test
- MSD Ion Optics Test
- MSD Background Test
- MSD Vacuum Test
- MSD Quadrupole Electronics Test

MSD Noise Test Report

Instrument:	MSD	
Tune File:	ATUNES.TUN	API_ES Negative Ion
Quad Polarity	1	
Serial No:	US80100069	
Operator:	none	
Date:	9/12/98	
Time:	7:07:29 PM	

MSD Noise Test Charts





MSD Noise Test Results	Result
Initial Scan	done
High Mass Analyzer Noise	PASSED

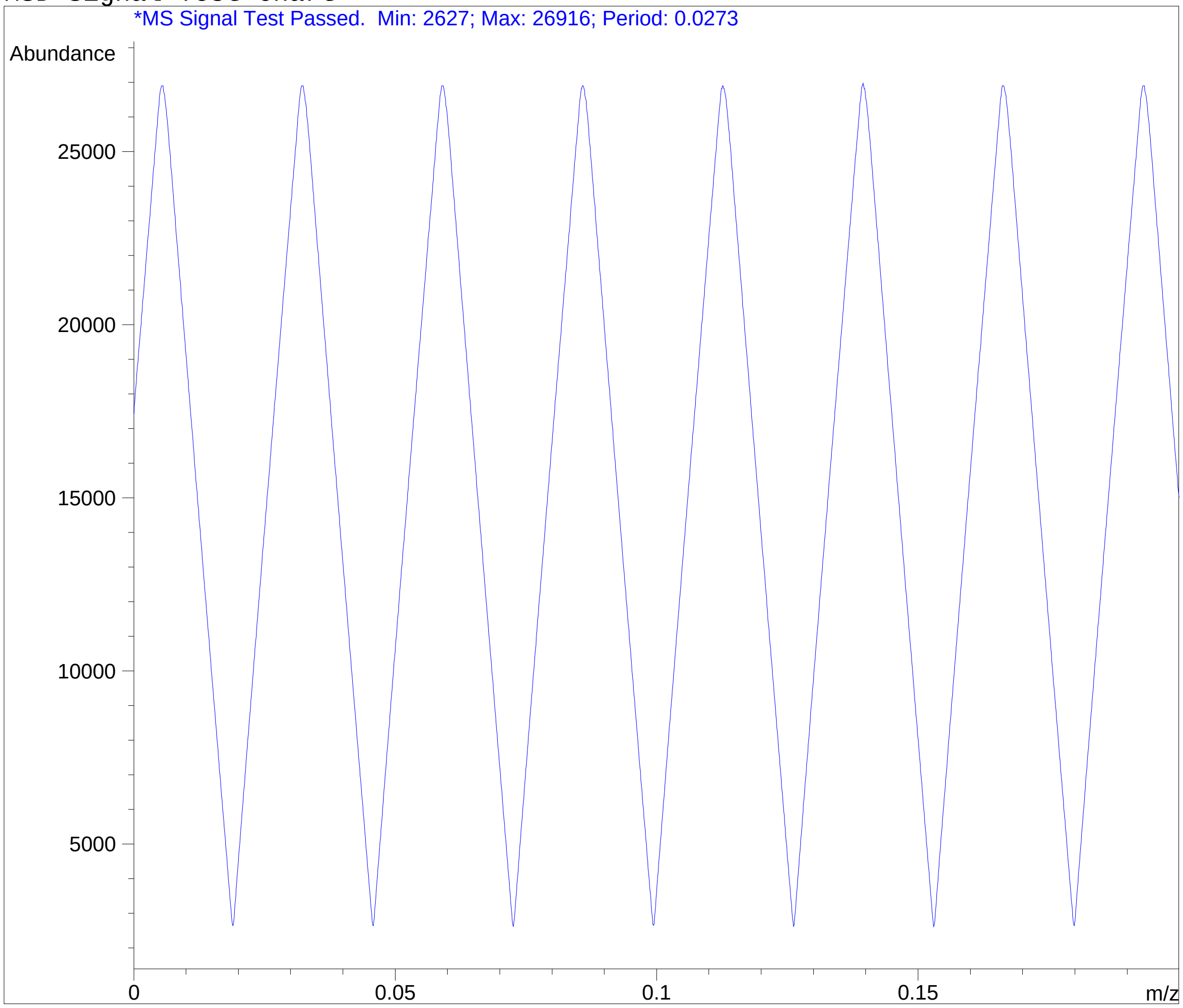
Passing Criteria:

Analyzer Noise	Max Abund. < 1000
	# Spikes over 200 < 10
Electronic Noise	Max Abund. < 50

MSD Signal Test Report

Instrument:	MSD
Tune File:	ATUNES.TUN
Serial No:	US80100069
Operator:	none
Date:	9/12/98
Time:	7:00:49 PM

MSD Signal Test Chart

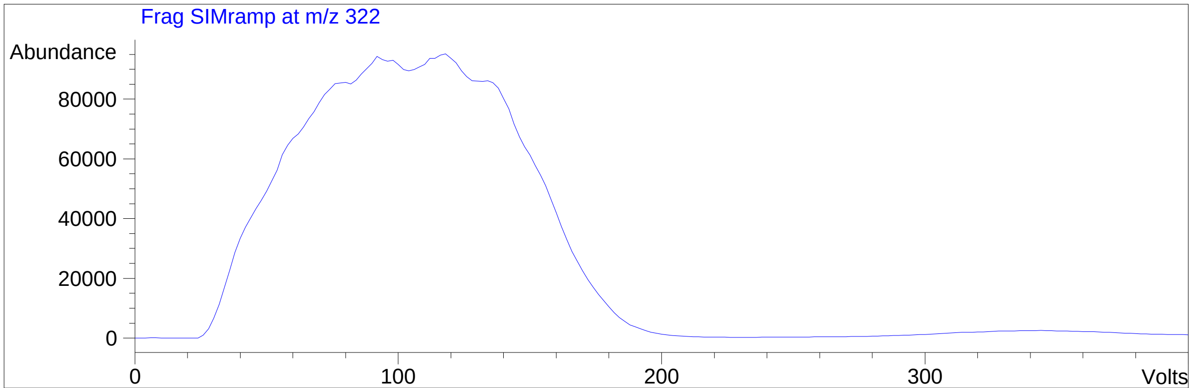


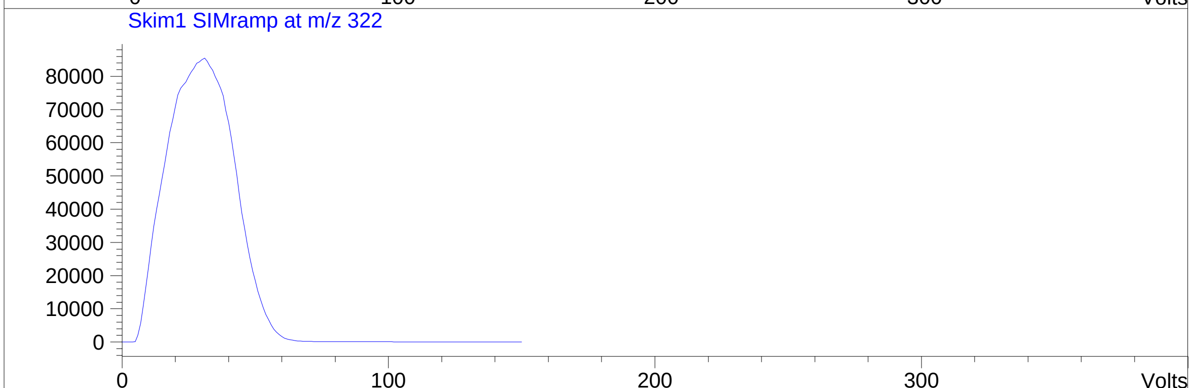
MSD Signal Test Results	Specification	Measured	Result
Minima rel. Std. Dev.	< 2.0	0.5	Passed
Maxima rel. Std. Dev.	< 2.0	0.1	Passed
Period rel. Std. Dev.	< 2.0	0.4	Passed
Mean Minima	< 1800cts ; 4200cts >	2627.0 cts	Passed
Mean Maxima	< 20000cts ; 30000cts >	26916.2 cts	Passed

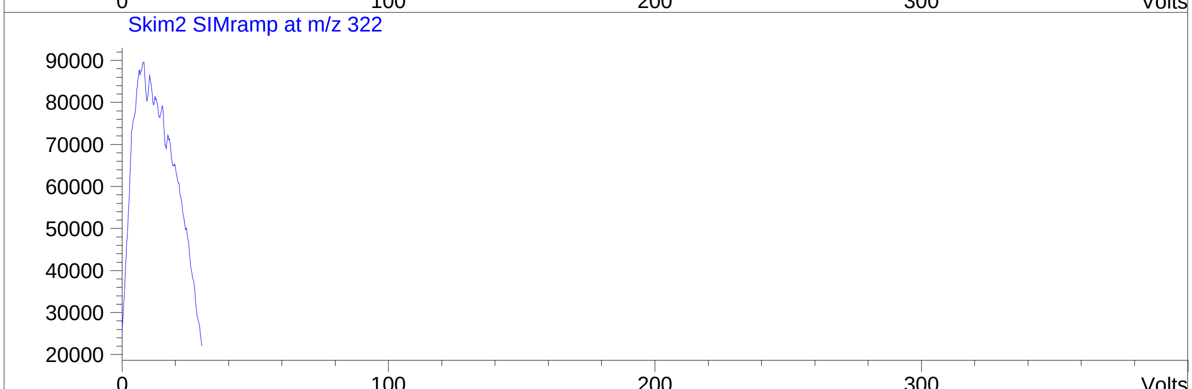
MSD Ion Optics Test Report

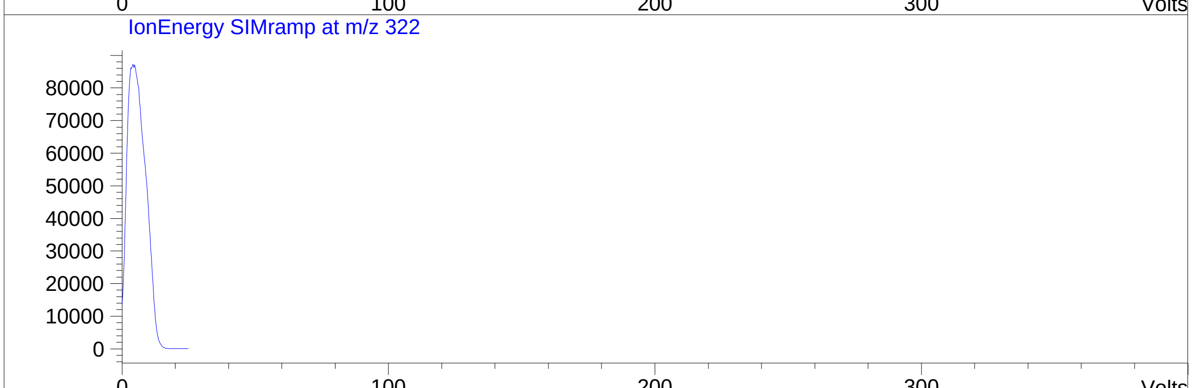
Instrument:	MSD	
Tune File:	ATUNES.TUN	API_ES Pos
Serial No:	US80100069	
Operator:	none	
Date:	9/12/98	
Time:	7:16:48 PM	

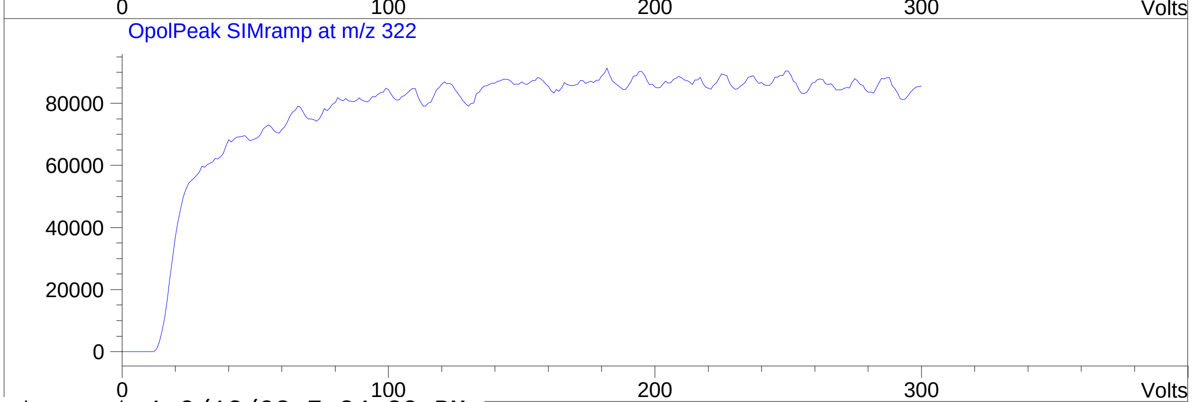
MSD Ion Optics Test SIMRamp Chart

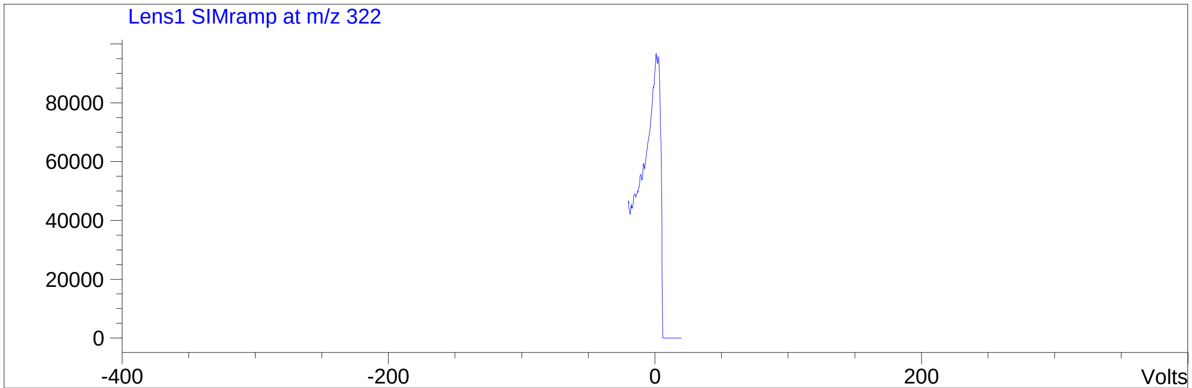

Frag SIMramp at m/z 322
Abundance
80000
60000
40000
20000
0
0
100
200
300
Volts

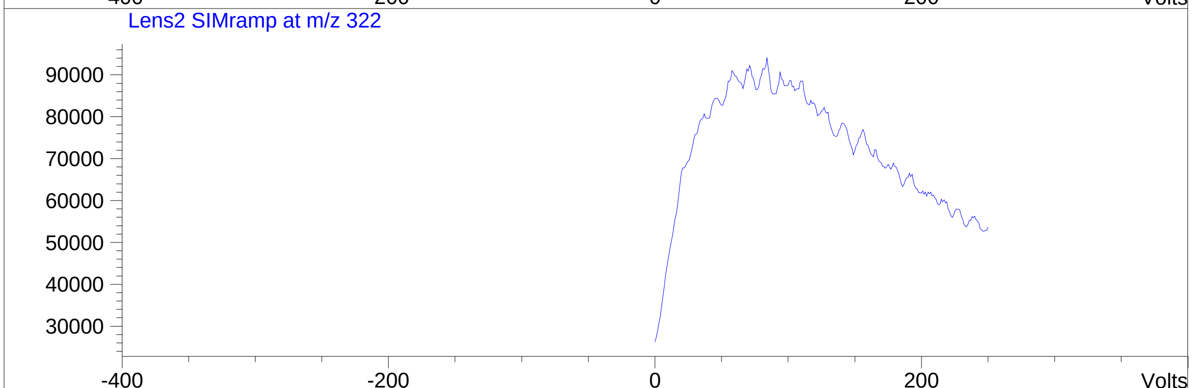

Skim1 SIMramp at m/z 322
80000
70000
60000
50000
40000
30000
20000
10000
0
0
100
200
300
Volts

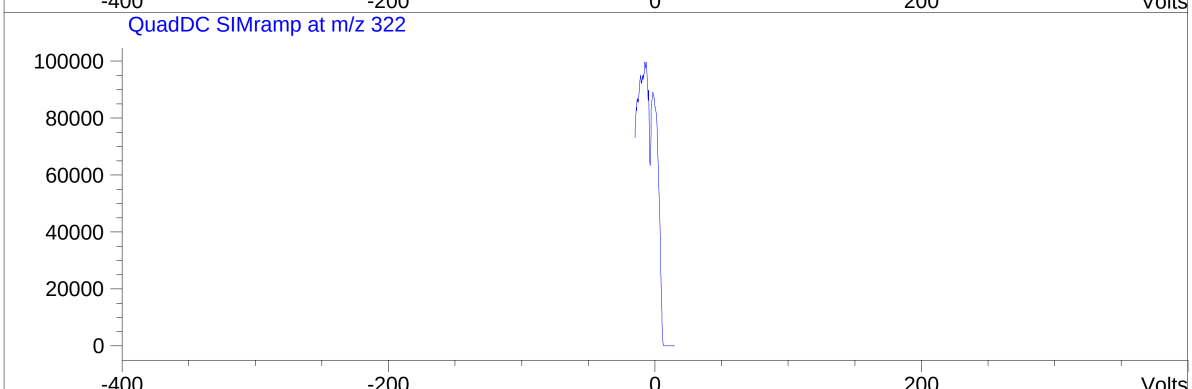

Skim2 SIMramp at m/z 322
90000
80000
70000
60000
50000
40000
30000
20000
0
100
200
300
Volts

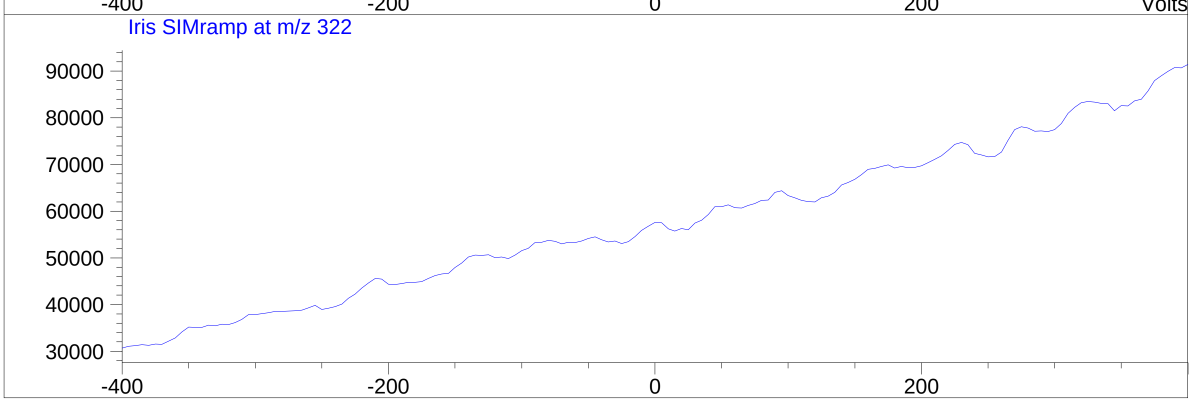

IonEnergy SIMramp at m/z 322
80000
70000
60000
50000
40000
30000
20000
10000
0
0
100
200
300
Volts


OpolPeak SIMramp at m/z 322
80000
60000
40000
20000
0
0
100
200
300
Volts


Lens1 SIMramp at m/z 322
80000
60000
40000
20000
0
-400
-200
0
200
Volts


Lens2 SIMramp at m/z 322
90000
80000
70000
60000
50000
40000
30000
-400
-200
0
200
Volts


QuadDC SIMramp at m/z 322
100000
80000
60000
40000
20000
0
-400
-200
0
200
Volts


Iris SIMramp at m/z 322
90000
80000
70000
60000
50000
40000
30000
-400
-200
0
200

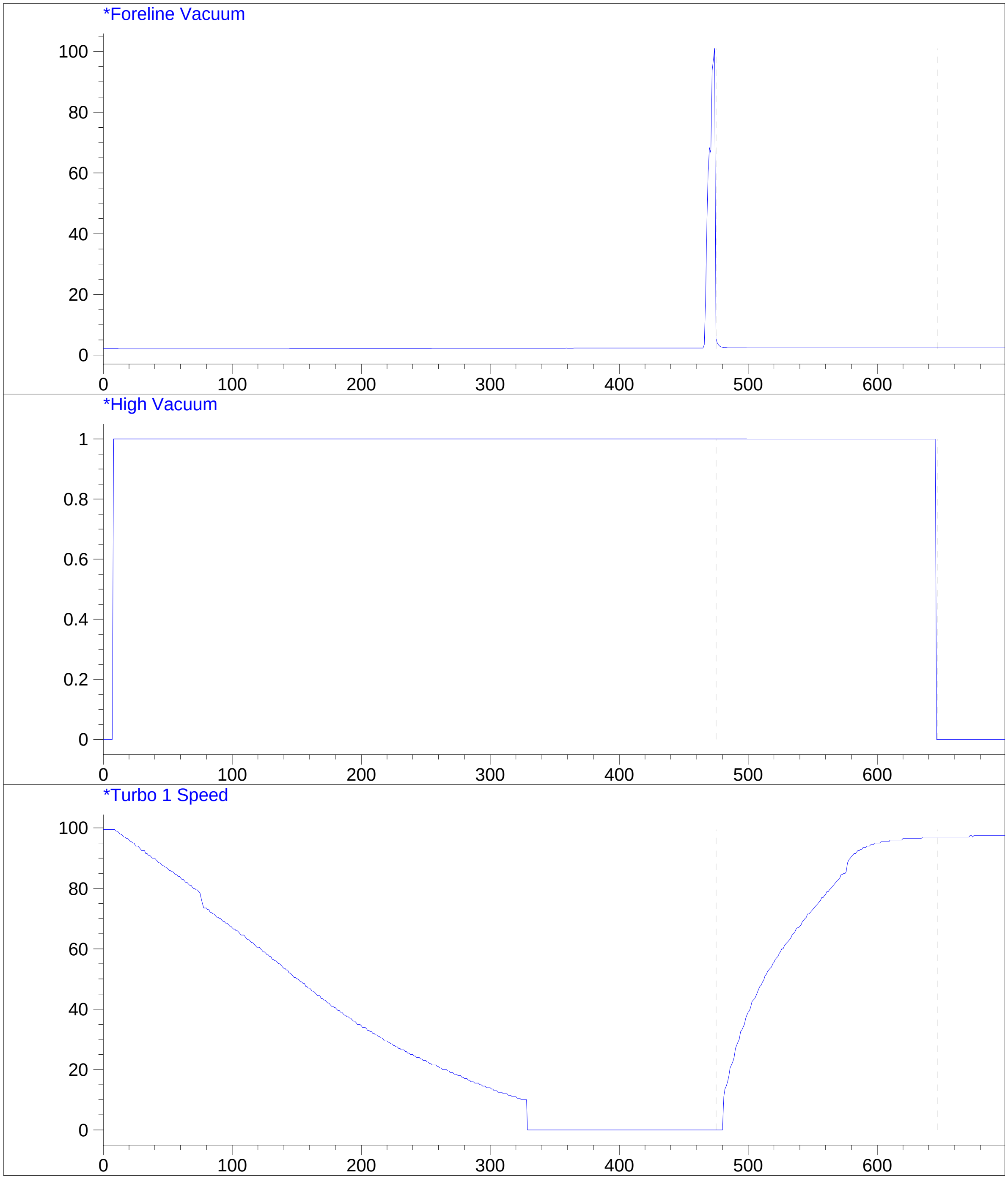
MSD Ion Optics Test Report

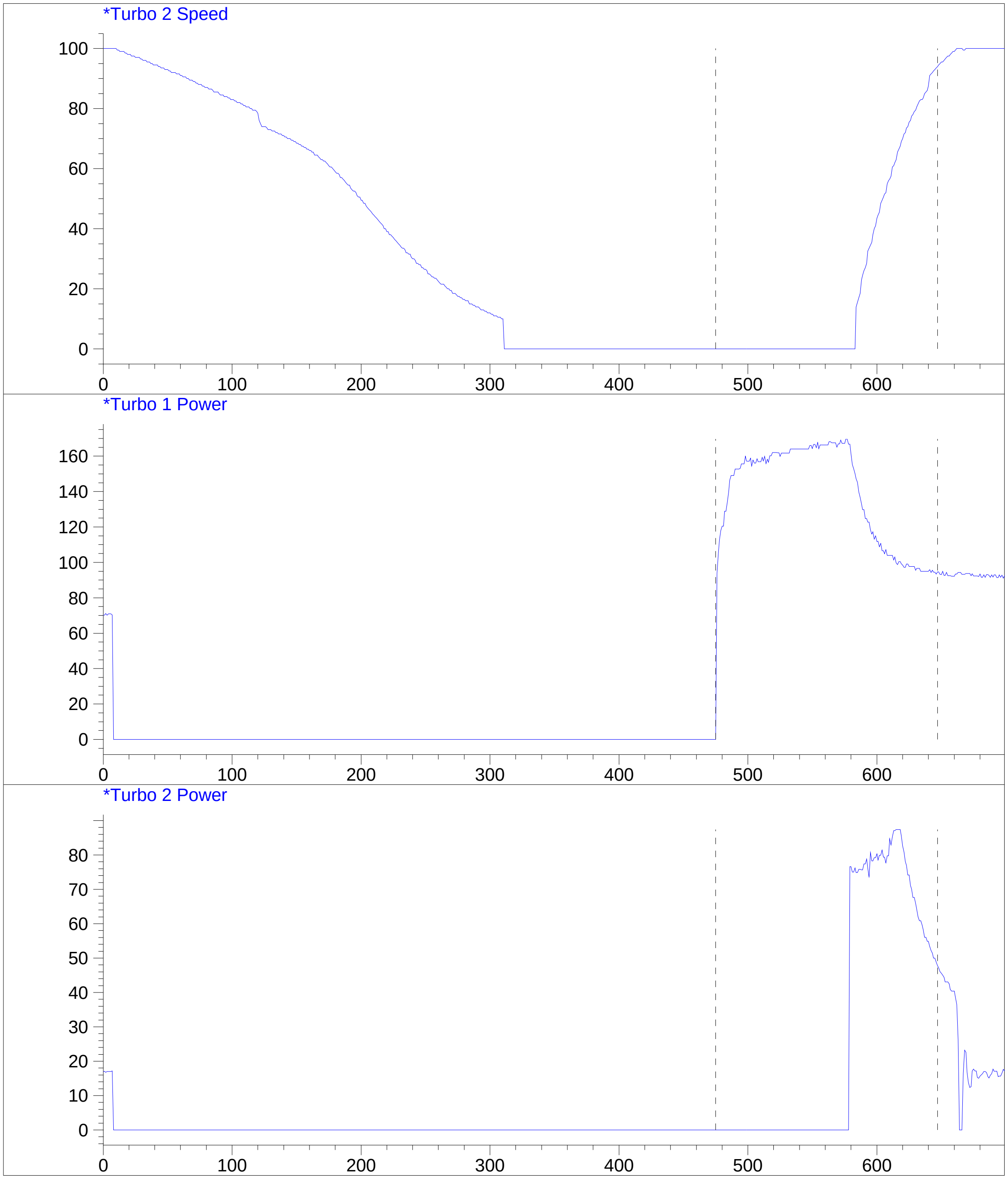
MSD Ion Optics Test Result

Initial Scan (Pos.)	Passed
Turned off (Pos.)	Passed
On Maximum (Pos.)	Passed
On Maximum (Neg.)	Passed
Ramping Test	Passed (m/z 322)

Instrument: MSD
Tune File: ATUNES.TUN
Serial No: US80100069
Operator: none
Date: 9/12/98
Time: 7:46:19 PM

MSD Vacuum Test Chart





MSD Vacuum Test Results	Specification	Measured	Result
Vent Time	< 420 sec	475 sec	Failed
Pump Down Time	< 300 sec	172 sec	Passed

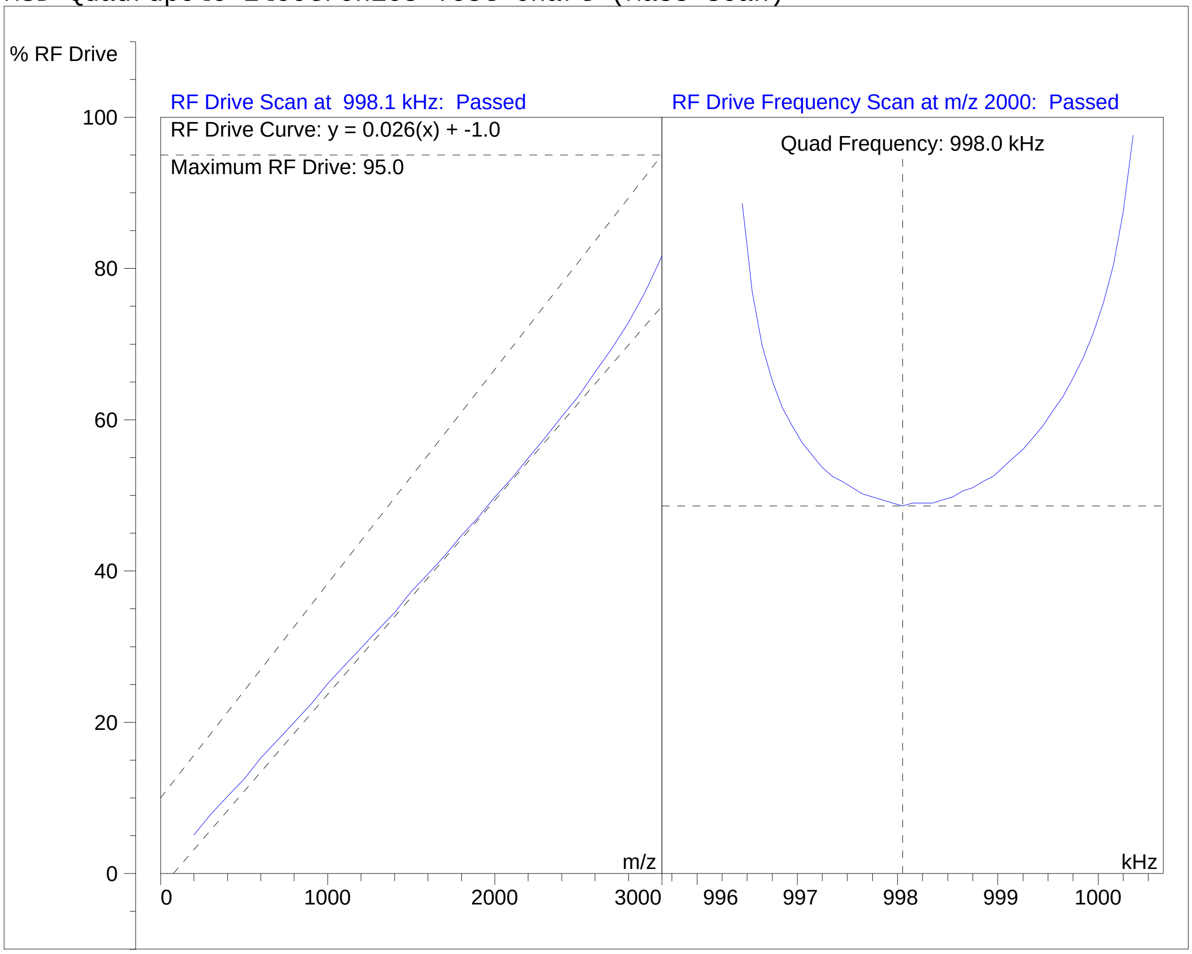
MSD Vacuum Report

MSD Vacuum Test Results	Specification	Measured	Result
Rough Vacuum Time	< 10 sec	0 sec	Passed
Rough Vacuum Steady State	< 3 torr	2.43 torr	Passed
High Vacuum Time	< 300 sec	171 sec	Passed
High Vacuum Steady State	< 0.00002 torr	0.000015 torr	Passed
Turbo 1 at 90% Speed	< 180 sec	130 sec	Passed
Turbo 1 Peak Power	> 150 W	169.7 W	Passed
Turbo1 Power Steady state	< 100 W	94.3 W	Passed
Turbo 2 Peak Power	> 60 W ; 120 W <	87.4 W	Passed
Turbo2 Power Steady state	< 24 W	38.6 W	Failed

MSD Quadrupole Electronics Report

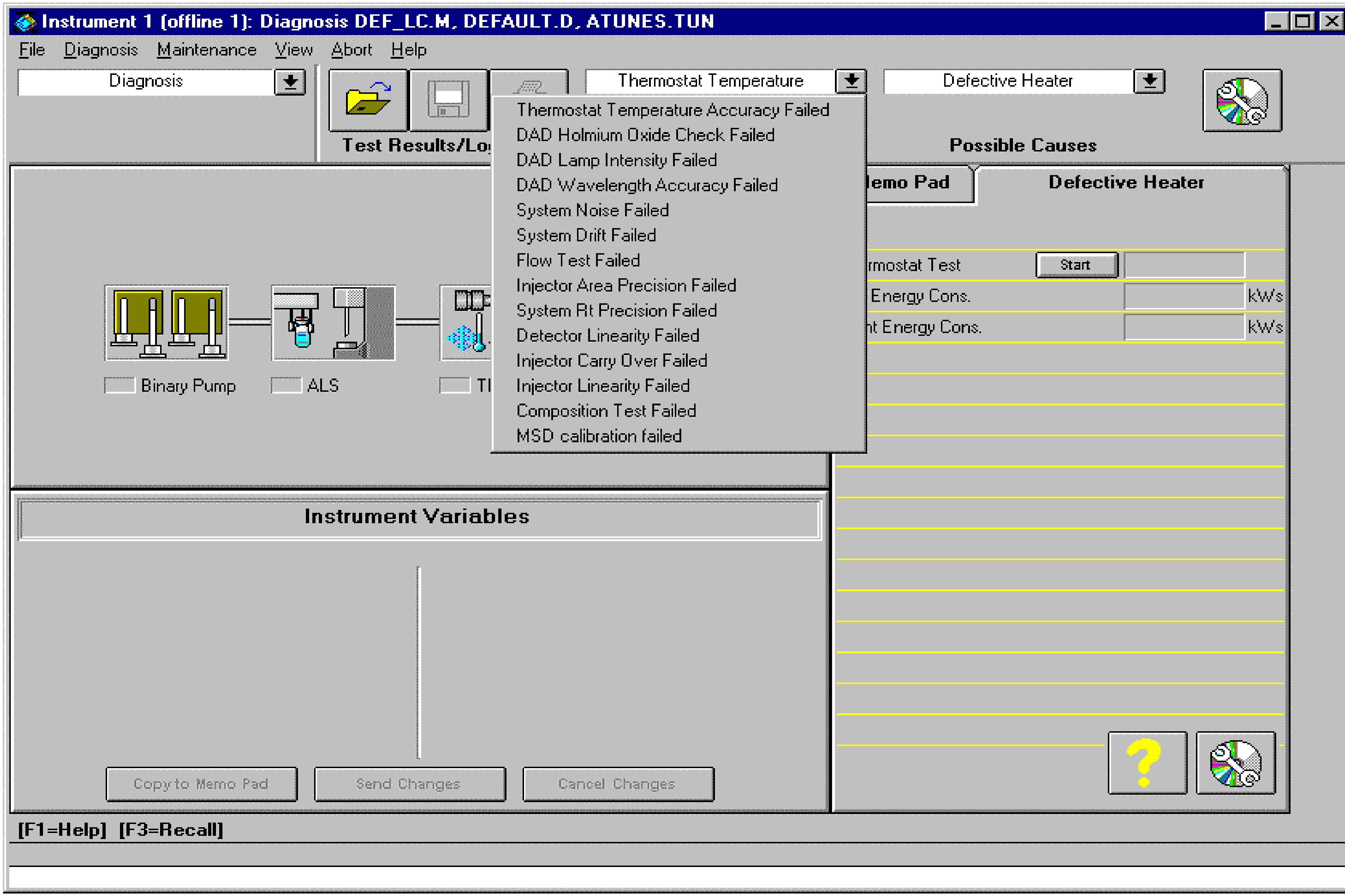
Instrument:	MSD	
Tune File:	ATUNES.TUN	API_ES Positive Ion
Serial No:	US80100069	
Operator:	none	
Date:	9/12/98	
Time:	7:01:42 PM	

MSD Quadrupole Electronics Test Chart (Mass Scan)

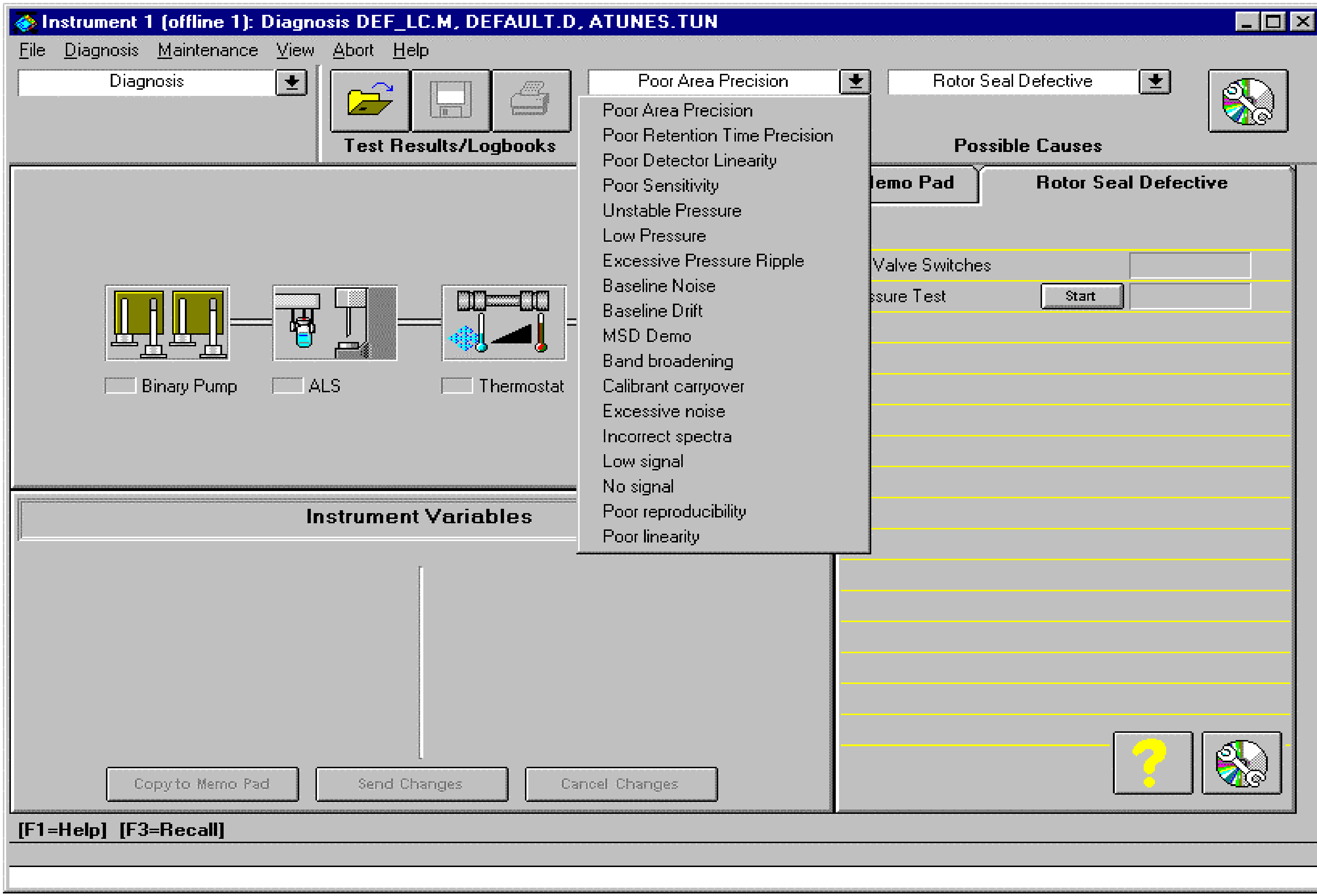


MSD Quad. Elec. Results	Specification	Measured	Result
Max RF Drive, mass scan	< 95.0	81.6	Passed
RF Drive slope, mass scan	< 0.02 ;0.03 >	0.026	Passed
RF Drive intercept, mass scan	< 10.0; -2.0 >	-1.0	Passed
Min RF drive, frequency scan	< 63	48.6	Passed
Quad. frequency delta	< 1000 Hz	100 Hz	Passed

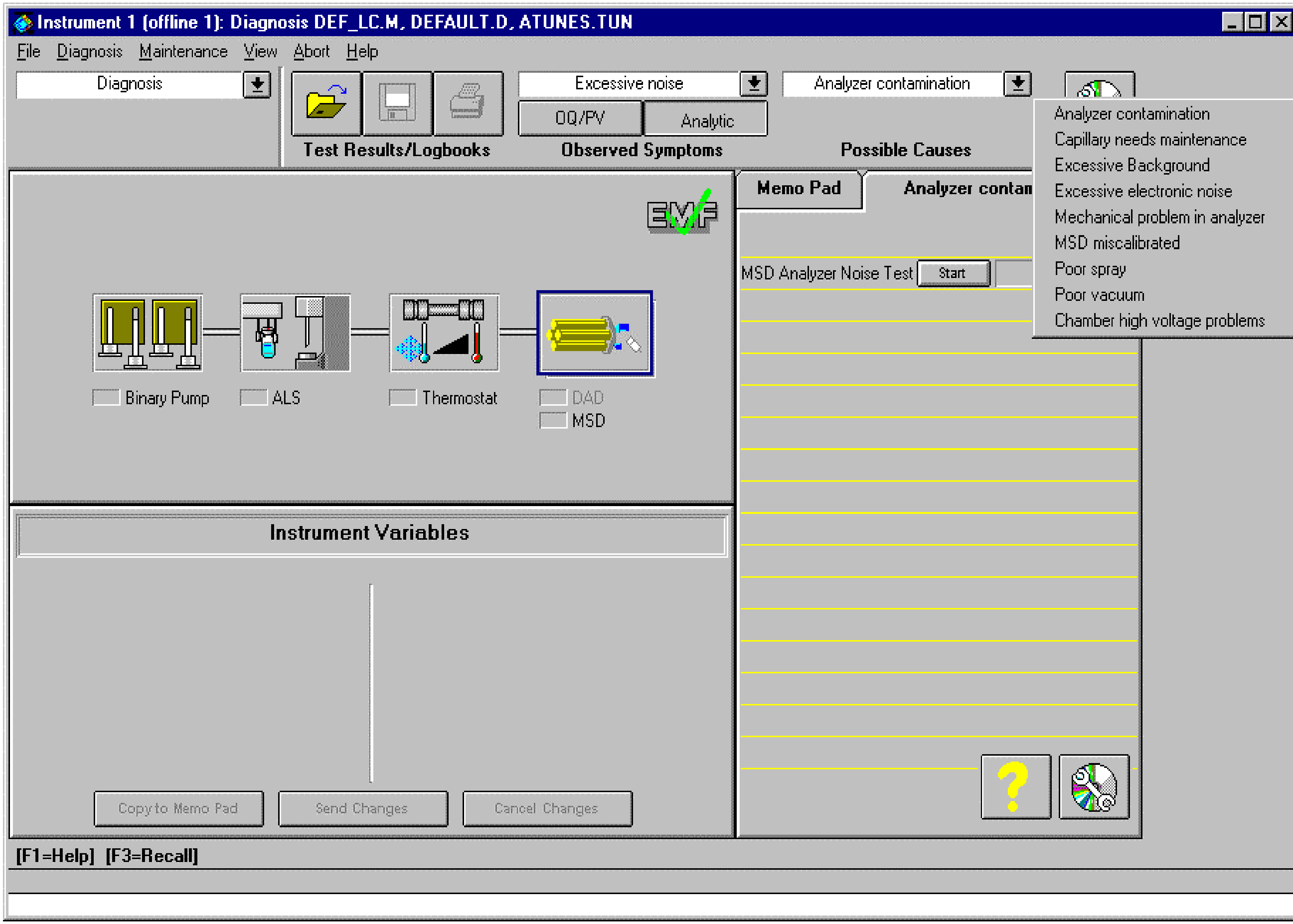
List of Symptoms - "OQ/PV" Failures



List of Symptoms - "Analytical" Problems



Possible Causes of Currently Selected Symptom



MSD Faults

Sprite Smartcard Fault Word Bits
Jan. 30, 1997

Some notes on the source column in the table below.

<SCFW> = Filled in by Smartcard firmware.
MSSn:bb = Bit bb of MSE MS Status word n.
lll:w:bb = Bit bb of word w of LON node lll.
where lll = CG for Convectron Guage
IG for Ion Guage
TPC for Turbo Pump Controller
PDB for Power Distribution Board
SB for master SICB<->LON converter node
w = <stat> for the current node state value
W for the current node warning status word
S for the current node shutdown status word

SC Bit	Description	Source
0	Party Fault Historically set if any of the other bits are set.	<SCFW>
1	Difficulty with spray chamber electronics.	
	0 APCI corona current could not be maintained.	MSS1:01
	1 Capillary/Chamber voltage could not be maintained.	MSS1:00
2	Difficulty with ion optics electronics.	
	0 LV Lens Fault	MSS1:02
	1 Ion Energy Fault	MSS2:06
	2 Fragmentor Fault	MSS2:04
	3 Skimmer 1 Fault	MSS2:00
	4 Skimmer 2 Fault	MSS2:01
	5 Octopole RF voltage could not be maintained.	MSS1:07
	6 Lens 1 Fault	MSS2:02
	7 Lens 2 Fault	MSS2:03
	8 Quad DC Fault	MSS2:07
	9 <unused>	
	10 Iris Fault	MSS2:05
	11 Mass axis DAC required recalibration.	MSS1:03
3	Difficulty with detector electronics.	
	0 HED Fault	MSS1:14
	1 CDEM Fault	MSS1:13
4	Difficulty with spray chamber gas flows.	
	0 Drying gas pressure zone timeout.	PDB:F:09
	1 Drying gas pressure zone control high.	PDB:W:06
	2 Drying gas pressure zone control low.	PDB:W:07
	3 Drying gas pressure sensor open.	PDB:F:10
	4 Drying gas pressure sensor shorted.	PDB:F:11
	5 Nebulizing gas pressure zone timeout.	PDB:F:12
	5 Nebulizing gas pressure zone control high.	PDB:W:08
	6 Nebulizing gas pressure zone control low.	PDB:W:09
	7 Nebulizing gas pressure sensor open.	PDB:F:13
	8 Nebulizing gas pressure sensor shorted.	PDB:F:14

MSD Faults (cont.)

5 Difficulty with calibrant delivery system.

0 Calibration delivery system leak occurred.	PDB:F:15
1 Difficulty switching stream selection valve. (> 5 seconds between change and PDB:S:1,2,3)	<SCFW>
2 Difficulty controlling CDS valve #1. (> 5 seconds between change and PDB:S:4)	<SCFW>
3 Difficulty controlling CDS valve #2. (> 5 seconds between change and PDB:S:5)	<SCFW>
4 Difficulty controlling CDS valve #3. (> 5 seconds between change and PDB:S:6)	<SCFW>
5 Difficulty controlling CDS valve #4. (> 5 seconds between change and PDB:S:7)	<SCFW>
6 Difficulty controlling CDS valve #5. (> 5 seconds between change and PDB:S:8)	<SCFW>

6 Difficulty with vacuum system gauges.

0 CG pressure reading below calibrated range.	CG:W:00
1 CG pressure reading above calibrated range.	CG:W:01
2 CG pressure conversion did not complete in time.	CG:W:02
3 CG ADC reading too low (indicates under voltage).	CG:S:00
4 CG ADC reading too high (indicates over voltage).	CG:S:01
5 IG pressure reading below calibrated range.	IG:W:00
6 IG pressure reading above calibrated range.	IG:W:01
7 IG pressure conversion did not complete in time.	IG:W:02
8 IG ADC reading too high during calibration.	IG:W:06
9 IG pressure reading too high during calibration.	IG:W:07
10 IG ADC reading too low (indicates under voltage).	IG:S:00
11 IG ADC reading too high (indicates over voltage).	IG:S:01
12 IG hardware detected under voltage condition.	IG:S:03
13 IG hardware detected emission control shutdown.	IG:S:04

7 Difficulty with vacuum system pumps.

0 Turbo pump #1 shows no power or speed after turn on.	TPC:W:
1 Turbo pump #2 shows no power or speed after turn on.	TPC:W:
2 Turbo pump #1 showed power but no speed after turn on.	TPC:S:1
3 Turbo pump #2 showed power but no speed after turn on.	TPC:S:1
4 Turbo pump #1 did not reach 50% speed in time.	TPC:S:(
5 Turbo pump #2 did not reach 50% speed in time.	TPC:S:(
6 Turbo pump voltage supply problems.	TPC:W:
7 Turbo pump did not slow down after turn off.	TPC:S:1

8 System not at vacuum.

0 IG pressure reading too high to keep guage on.	IG:S:02
1 IG turn on requested with high foreline pressure.	IG:S:06
2 IG tube is off.	IG:<sta
3 IG tube is in dgas mode.	IG:<sta
4 Rough pump is off.	PDB:<s
5 Turbo pumps are disabled.	TPC:<s
6 Foreline pressure too high to turn on turbo pumps.	TPC:S:1
7 Turbo pump #1 is not at full speed.	TPC:W:
8 Turbo pump #2 is not at full speed.	TPC:W:

MSD Faults (cont.)

9 Difficulty controlling temperature zones.	
0 Quadrupole temperature zone timeout.	PDB:F:00
1 Quadrupole temperature zone control high.	PDB:W:00
2 Quadrupole temperature zone control low.	PDB:W:01
3 Quadrupole temperature sensor open.	PDB:F:01
4 Quadrupole temperature sensor shorted.	PDB:F:02
5 Drying Gas temperature zone timeout.	PDB:F:03
6 Drying Gas temperature zone control high	PDB:W:02
7 Drying Gas temperature zone control low.	PDB:W:03
8 Drying Gas temperature sensor open.	PDB:F:04
9 Drying Gas temperature sensor shorted.	PDB:F:05
10 Vaporizer temperature zone timeout.	PDB:F:06
11 Vaporizer temperature zone control high.	PDB:W:04
12 Vaporizer temperature zone control low.	PDB:W:05
13 Vaporizer temperature sensor open.	PDB:F:07
14 Vaporizer temperature sensor shorted.	PDB:F:08

10 The mass spectrometer is not properly calibrated.	
0 Mass axis DAC could not be calibrated.	<SCFW>
1 Log amplifier is not properly calibrated.	<SCFW>
2 Electron multiplier gain is not calibrated.	<SCFW>
3 Mass assignments are not calibrated.	<SCFW>
4 Mass peak widths are not calibrated.	<SCFW>

11 Difficulty with instrument power supplies or fans.	
0 The power distribution board 110VAC relay is off.	PDB:F:16
1 The power distribution board 28V supply is off.	PDB:F:17
2 The power distribution board 28V supply is too high.	PDB:F:18
3 The power distribution board 28V supply is too low.	PDB:F:19
4 The power distribution board 24V supply is too high.	PDB:F:20
5 The power distribution board 25V supply is too low.	PDB:F:21
6 The power distribution board 60Hz zero cross missing	

12 Difficulty with quadrupole RF electronics	
0 Quadrupole RF voltage could not be maintained.	MSS1:10

13 Difficulty with internal instrument communications.	
- MSE Comm. Error	
- <none defined yet>	
- LON Node Comm. Error	
0 - CG update interval > 1 minute requested.	CG:W:03
1 - CG update delay > 1 minute requested.	CG:W:04
2 - CG event beyond queue length requested.	CG:W:05
3 - CG invalid mode requested.	CG:W:09
4 - IG update interval > 1 minute requested.	IG:W:03
5 - IG update delay > 1 minute requested.	IG:W:04
6 - IG event beyond queue length requested.	IG:W:05
7 - IG invalid mode requested.	IG:W:09
8 - IG invalid mode change requested.	IG:W:10
9 - IG foreline pressure update timeout.	IG:S:05
10 - TPC foreline pressure update timeout.	TPC:S:14
- PDB ...	
- SB ...	
- SICB Comm. Error	
- Error communicating with the SICB<->LON converter.	<SCFW>

MSD Faults (cont.)

14 An LC/MS shutdown has occurred. <SCFW>
0 This is set whenever Smartcard sends or receives an
APG Remote Control Loop SHUTDOWN signal.

15 The spray chamber is not ready for operation.
0 Spray chamber is open.
1 APCI needle detected with AP-ESI spray chamber.
2 APCI needle not correctly installed.
.
15 Spray chamber configuration problem. .

HEWLETT PACKARD

Troubleshooting Problems

The problems listed below give the symptoms of actual failures on the LC/MSD and how to troubleshoot these failures. The problems are organized in the general functional areas of the LC/MSD.

Vacuum System

- Bad Rough Pump
- Turbo #2 Frozen
- Large Leak in Vacuum System
- Bad Turbo LON Interface Assembly
- Bad LON Connection or Cable

Calibrant Delivery System & Manual Injection Valve

- Bad CDS Valve #5
- Wrong Calibrant in Bottle

Gas Flow & Temperature Control

- Low Nitrogen Tank Pressure
- Bad 110 Vac Fuse on PDB
- Open Quad Heater

Source & Ion Optics

- Bad Vcap/Vchamber Supply
- Disconnected Octopole Leads

Mass Filter

- No U+/U- from Analyzer Board
- Bad RF Coil Box
- RFPA output adjusted too low
- RFPA output adjusted too high

Detector

- Bad or Disconnected Signal Cable
- No HED Voltage to Detector

Communication

- Bent pin on bottom of Adapter board

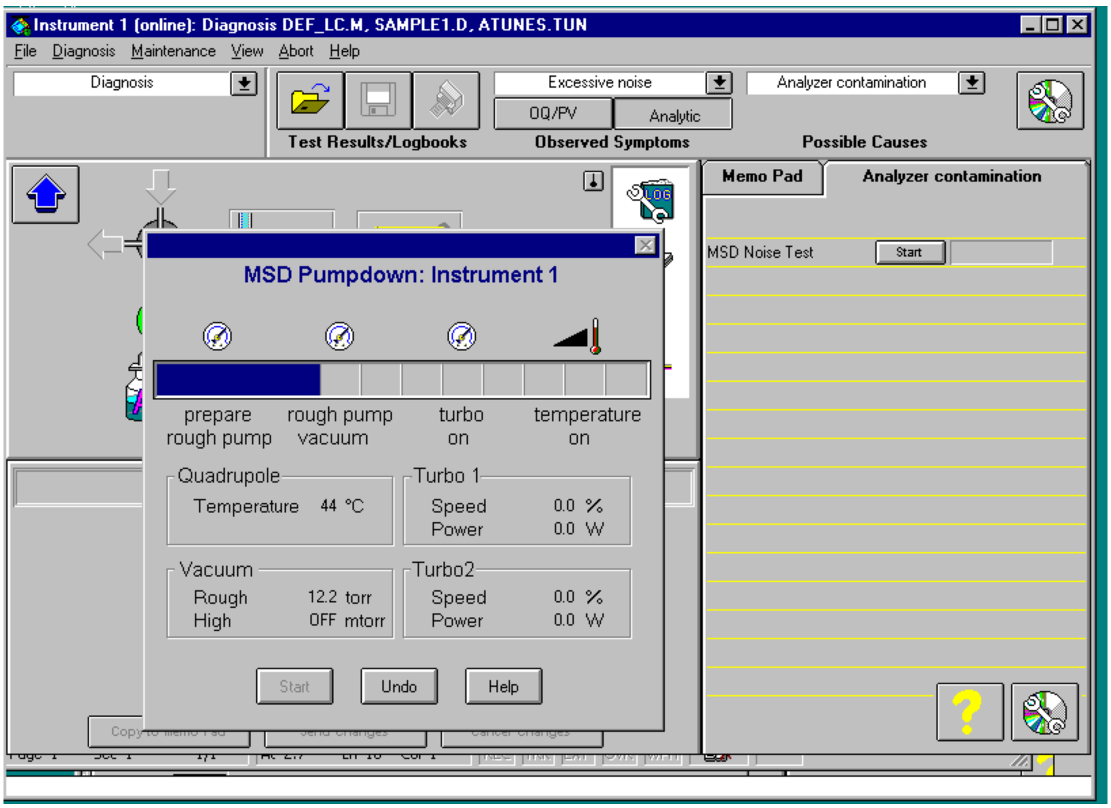
Power Supplies

- Bad +15 Volts on PDB
- Cover Interlock Switch is Open

Bad rough pump

Symptoms:

When you start a pumpdown, the pumpdown panel indicates that the foreline pressure cannot go below 12 torr (see Fig. 1).



(Fig. 1)

How to Troubleshoot:

This symptom is caused by either a bad rough pump or a massive leak. Even a sizeable leak will allow the rough pump to pull foreline pressure below 5 torr, so the symptom points more to a bad rough pump.

To isolate the rough pump, you can disconnect the 4-way adapter and and use rubber stoppers to plug off the port that would be connected to stage 1 and the outlet of turbo #1. Leave the Pirani gauge connected. Then turn select MSD Pumpdown and monitor the foreline pressure. If the rough pump is functioning properly, the pressure should quickly (within 15 seconds) go below 2 torr. If it doesn't then either the rough pump is bad or there is a leak in the vacuum hose, the connections at the pump, the Pirani gauge, or the 4-way adapter. Check for a leak in those places. Also make sure that there is no restrictions on the exhaust. Remove the oil mist filter temporarily to make sure that a restriction on the exhaust is not causing the problem. If there is no restriction or leak in the hose or connectors, then you need to replace the rough pump.

If when you stopper off the 4-way connector and then pumpdown and the foreline pressure rapidly drops to below 2 torr, then stop the pumpdown immediately so that the turbo pumps don't turn on, reconnect everything, and look for a massive leak.

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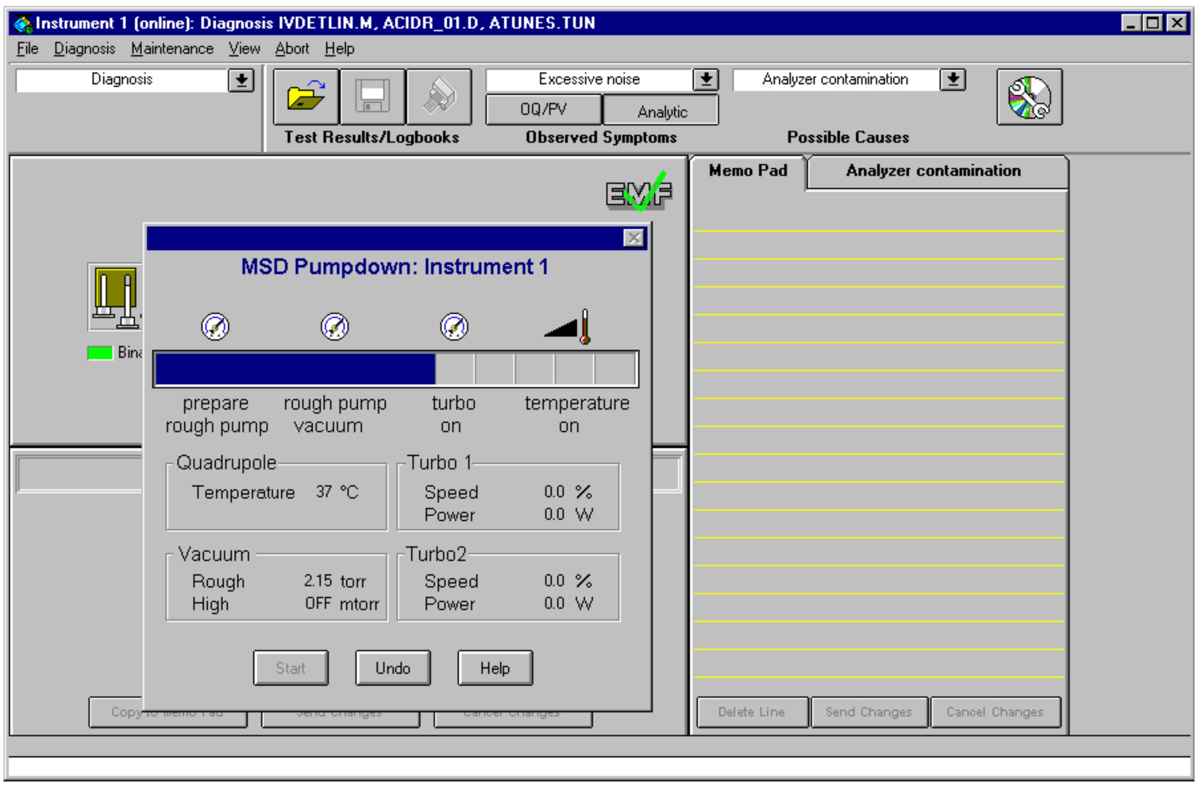
Turbo #2 Frozen

Symptoms:

The following are symptoms of a frozen turbo #2:

When the power to the LC/MSD is turned on, the rough pump starts to pump and the rough vacuum quickly goes to below 5 torr. If you are monitoring the vacuum status while the system is pumping down, you will see that when the rough pump gets below 5.7 torr turbo #1 will get full power (approx. 180 W) and will start to spin up. You can also see the three red LEDs on turbo #1 controller cycle indicating turbo #1 is getting power. When turbo #1 gets to 90% speed and power starts to be applied to turbo #2, turbo #1 power will shut off and turbo #1 speed will decrease to 0% (see Fig. 1).



(Fig. 1)

How to Troubleshoot:

With these symptoms, you don't know if turbo #2 is bad or if turbo #2 controller is bad. To determine which component is bad, turn off the LC/MSD power and make sure that the main cicuit breaker on the left side of the instrument is off, then swap the turbo controllers at the turbo pumps. Turn the power back on. The LC/MSD will initiate a pumpdown.

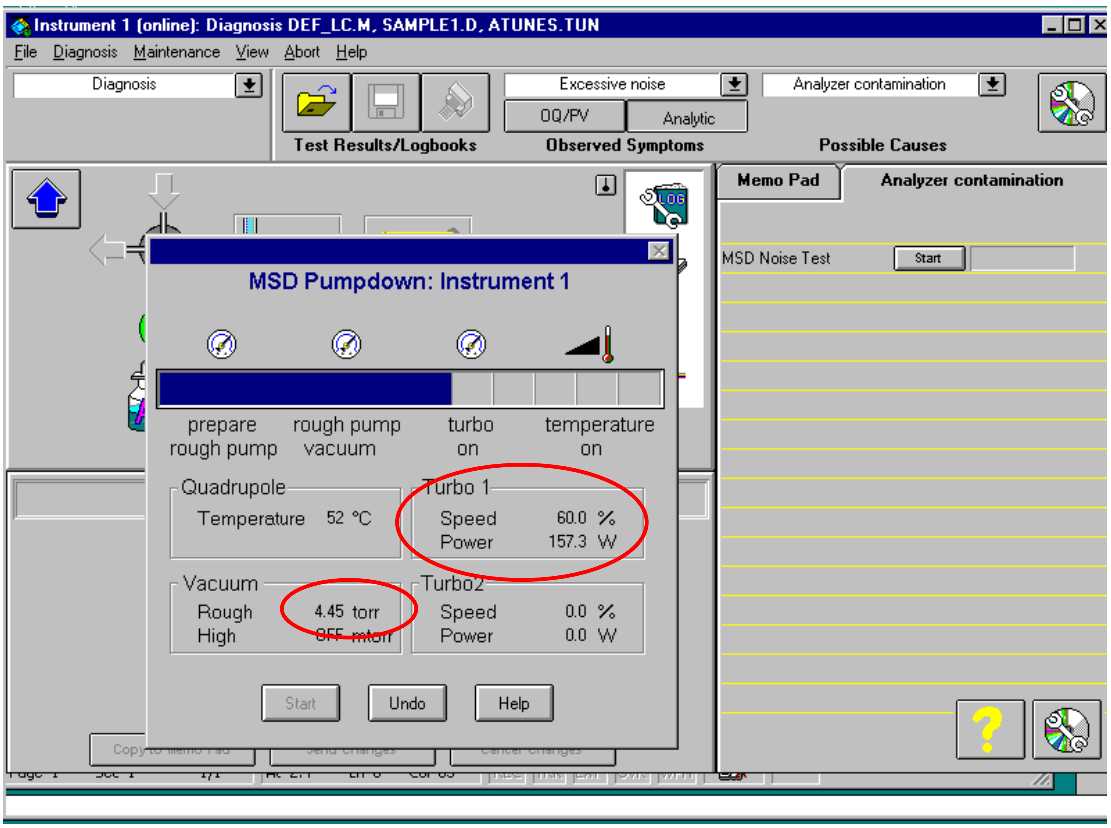
When the rough vacuum gets down to 5.7 torr, power will be applied to turbo #1 controller, which is now connected to turbo #2. If the speed on turbo #1 (which is actually turbo #2) on the MSD pumpdown screen stays at 0%, then you know that the problem is a bad turbo #2. On the other hand, if the speed on turbo #1 starts to increase to at least until 80%, then you know the problem is a bad turbo #2 controller.

Before replacing either the turbo pump or turbo controller, check for bent pins on the turbo pump and on the turbo controller cable where it connects to the turbo LON interface assembly.

Large leak in vacuum system

Symptoms:

When you start a pumpdown, the pumpdown panel indicates that the foreline pressure cannot get below 4.5 torr. Turbo #1 has high power, and it takes a long time just to get to 60-70% of speed. (See Fig. 1)



(Fig. 1)

How to Troubleshoot:

This symptom can be caused by either a bad rough pump or a vacuum leak.

To isolate the rough pump, you can disconnect the 4-way adapter and and use rubber stoppers to plug off the port that would be connected to stage 1 and the outlet of turbo #1. Leave the Pirani gauge connected. Then select MSD Pumpdown and monitor the foreline pressure. If the rough pump is functioning properly, the pressure should quickly (within 15 seconds) go below 2 torr. For this problem, you would find that the foreline pressure would rapidly drop to below 2 torr. This would then point to a leak in the vacuum system.

To troubleshoot a leak in the vacuum system, you can use isopropanol solvent and squirt it into potential locations of a leak while monitoring the vacuum pressure. When you squirt the solvent at a spot that leaks, you should see the pressure jump momentarily. If the vacuum leak is small enough that the high vacuum pressure gauge turns on, then you will be able to easily see the jump in pressure on the high vacuum gauge: the pressure should jump more than a decade. However, if the vacuum leak is so massive that only the foreline gauge is on, it is harder to notice a jump in foreline pressure. It might only momentarily increase by .1 or .2 torr. If you cannot detect a change in foreline pressure when you squirt the isopropanol solvent, then your only other way to find and correct a leak is to remove, clean and reconnect all the possible connections or seals where a leak might occur.

The possible location of a vacuum leak on the LC/MSD are:

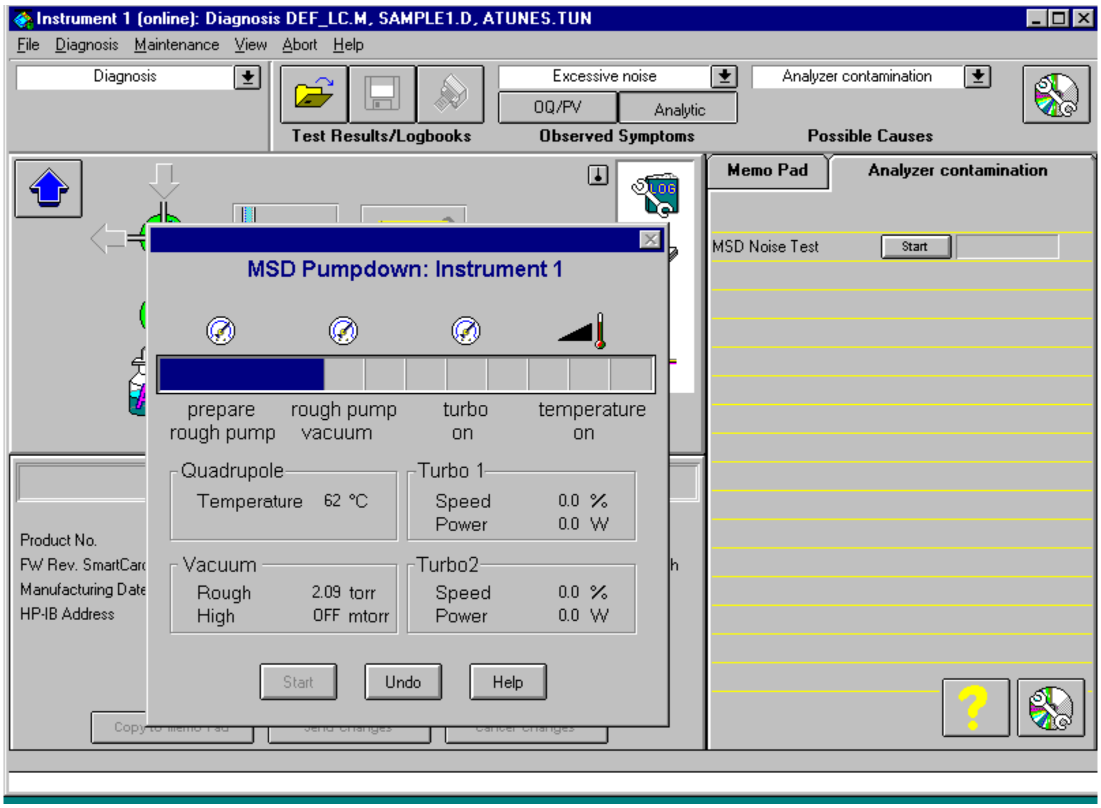
- The manifold o-rings that seal the manifold at stage #3 and stage #4 to the top plate
- The connections at each end of the hose between the Turbo #2 and stage #3.
- The connections at the end of the hose between stage #2 and the bottom drag pump stage of Turbo #1.
- The seals on blank flanges at the blanked off ports on the front of the vacuum manifold.
- The seals between the turbo pumps and the vacuum manifold.
- The rubber boot between stage #1 and the 4-way connector to the rough pump hose.
- The o-ring between the desolvation assembly and the front of the vacuum manifold.
- The HED, EM, iris, and signal feedthroughs.
- The three quad feedthroughs.
- The ion optics cable and octopole feedthroughs.

The leak used to generate this problem was a massive leak across the main manifold o-ring.

Bad turbo LON interface assembly

Symptoms:

When you start a pumpdown, the rough vacuum will go to approximately 2 Torr, but the turbo #1 will not turn on (power and speed = 0) (see Fig. 1).



(Fig. 1)

None of the LEDs on the turbo controllers are lit.

How to Troubleshoot:

These symptoms can either be a frozen turbo pump #1, a bad turbo controller #1, or a bad turbo LON interface assembly.

To check to see if the problem is with the turbo pump or turbo controller, turn off the LC/MSD main circuit breaker on the left side panel and swap the turbo controller cables at the connections on the turbo LON interface assembly. Now turn the circuit breaker back on and power on the LC/MSD. The system will now try to start turbo pump #2 as soon as the rough pressure gets below 5.7 torr. If turbo pump #2 (turbo pump #1 on the pumpdown screen) starts to spin up, then the problem is in either turbo pump #1 or turbo controller #1.

For this problem, however, you would find that the turbo pump #2 would not spin up. This indicates that the turbo controller/LON interface assembly is bad. You should replace the assembly.

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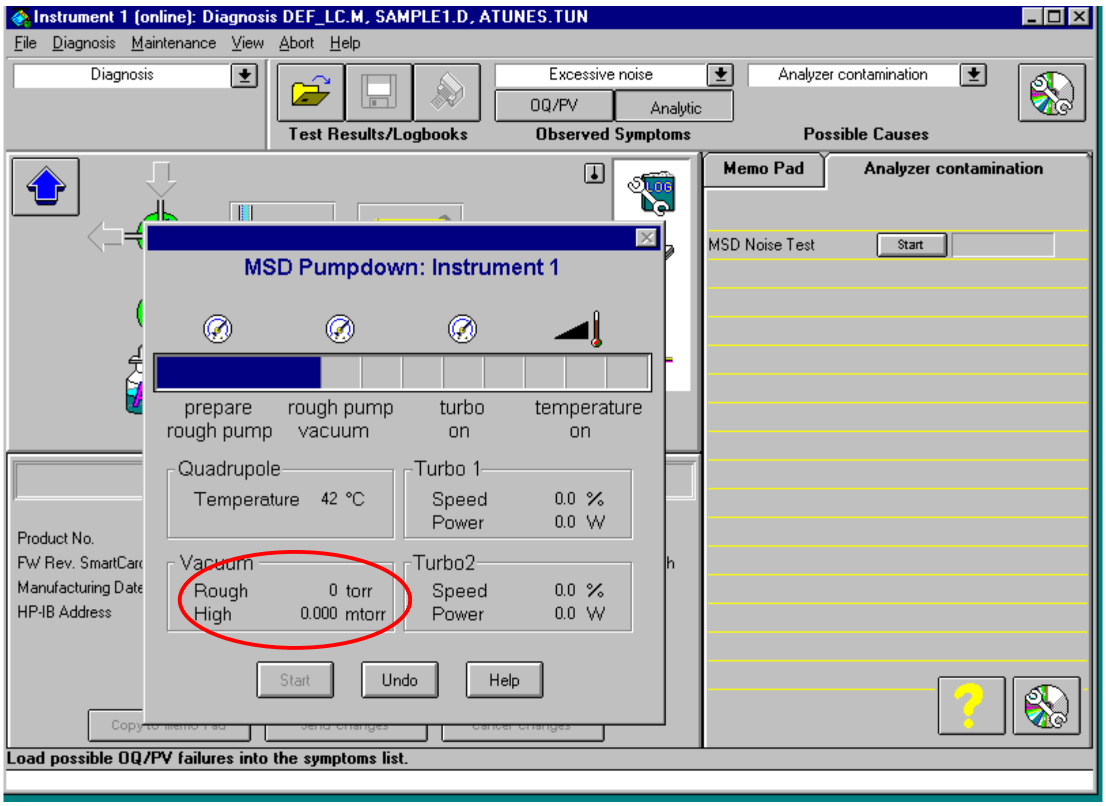
Bad LON connection or cable

Symptoms:

When you start a pumpdown, the pumpdown panel has “0” readings for rough vacuum and high vacuum (see Fig. 1). The system will not complete the pumpdown.



(Fig. 1)

How to Troubleshoot:

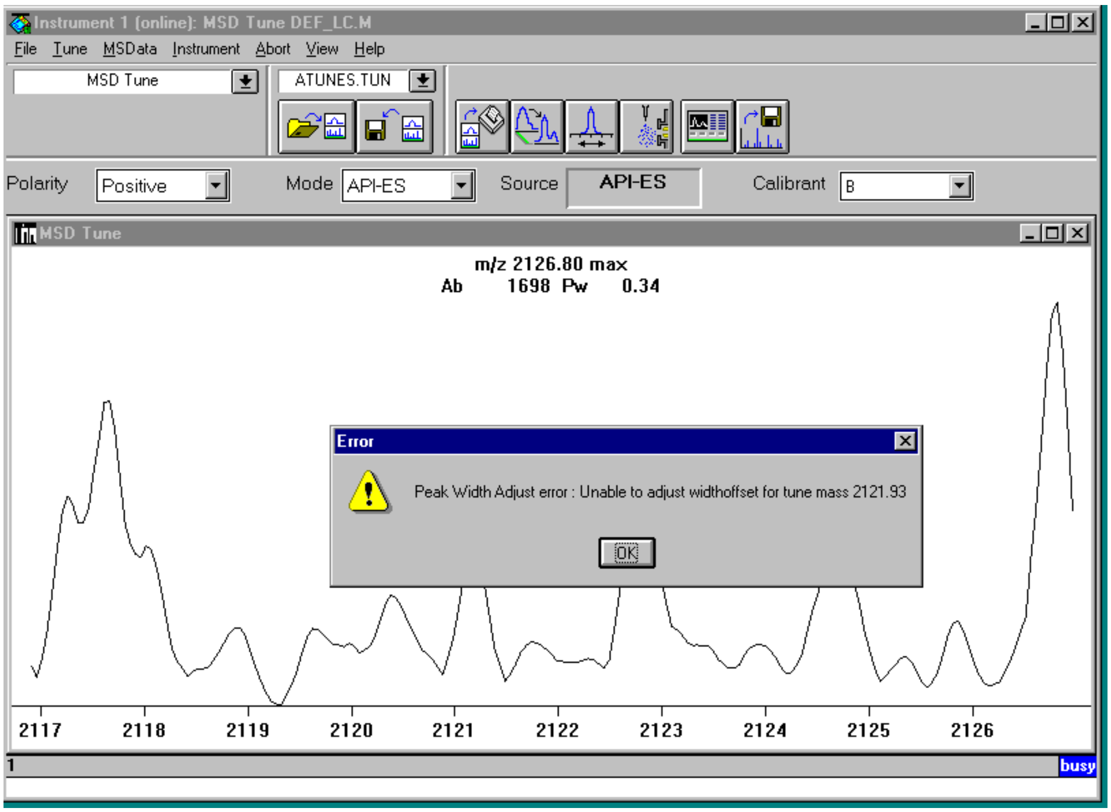
If the rough pressure reads 0 torr, then either the Pirani gauge is bad, the LON communication between the PDB board and the LON interface PCA is bad, or the communication between the LON interface PCA and the Pirani gauge is bad. Since the high vacuum is reading 0.000 mtorr with the Turbo 1 speed at 0%, this points to bad LON communication between the PDB and the LON interface PCA (the high vacuum reading should indicate “Off” if the LON communication was good).

First, check to see if there is +24 volts on the LON interface PCA. The +24 volts is required to power the LON components. If there is no +24 volts, make sure there is +24 volts on the PDB. If it is on the PDB and not on the LON interface PCA, then plug the LON cable into a different connector on the LON interface PCA, in case there is just a bad connector. If that doesn’t correct the problem, then replace the LON cable or replace the LON interface PCA.

Bad CDS valve #5

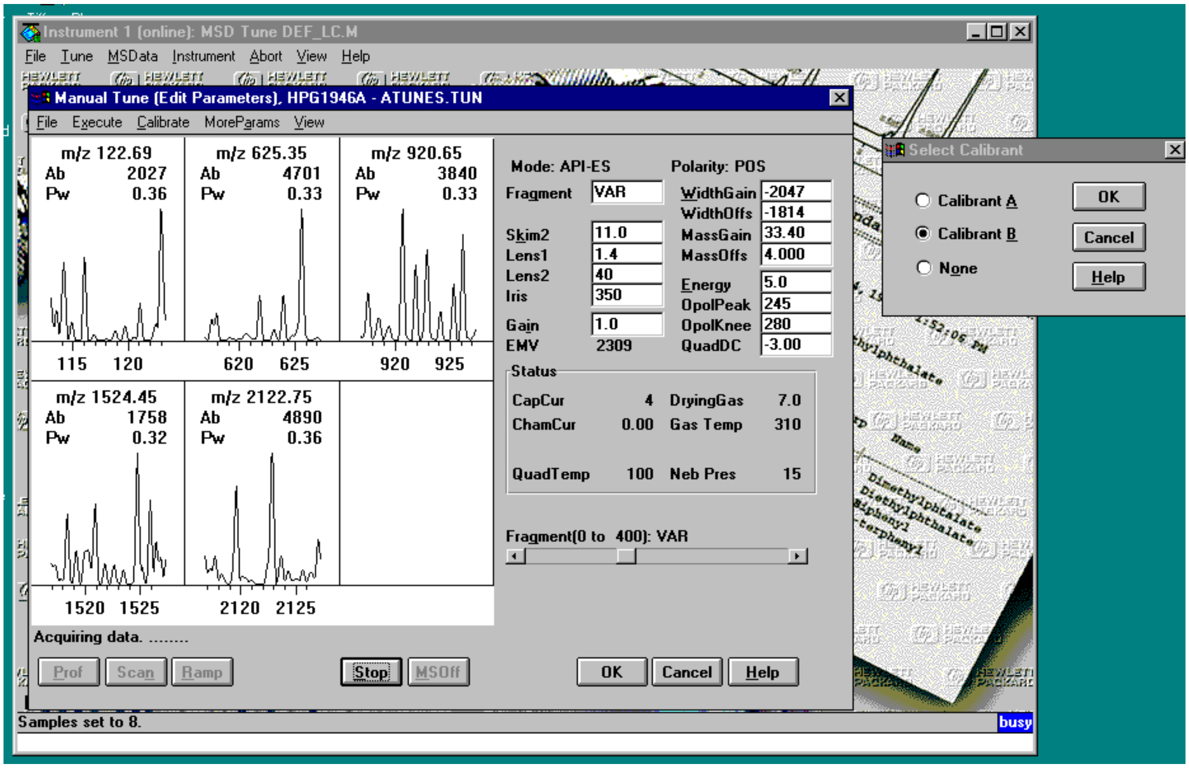
Symptoms:

Autotune will eventually give the error “Peak Width Adjust error…Unable to adjust widthoffset for tune mass 2121.93” (see Fig. 1).



(Fig. 1)

If you go into manual tune and do a repeat profile scan, you should notice that the capillary current and chamber current is close to 0 (see Fig. 2).



(Fig. 2)

How to Troubleshoot:

With the system still in repeat profile scan and the calibrant B selected, remove the nebulizer from the spray chamber and point it against one of the black magnets and check for spray. You would find that there is no spray. This can either be caused by a clogged nebulizer, misadjusted nebulizer needle, plugged lines from the CDS to the nebulizer, one or more bad CDS valves, no voltage control of the CDS solenoids, no nitrogen pressure to the CDS, or no calibrant solution.

First do a quick check to make sure you have enough calibrant.

To check for a plugged nebulizer, set the LC flow to 100 ul/min and set the Switch Stream selection for the LC/MSD to go to “MSD”. Check the spray out of the nebulizer. You should see that you have spray, so that would indicate the nebulizer is not plugged.

Next, go back into manual tune and start a repeat profile again with the calibrant B selected. Disconnected the PEEK tubing line at the top of the nebulizer and check for calibrant flow. You should get a drop every 5-7 seconds. For this problem you would not see any drops.

Next disconnect the PEEK tubing line that goes from the CDS valve #5 to the selection valve. Disconnect it at the selection valve and check for flow. For this problem you would still not see and flow.

Next disconnect the PEEK tubing line at the exit of valve #5. Again you wouldn’t see any flow. This means that there is a problem with one of the CDS valves or the control of the valves. You can use the flow diagrams given in the “CDS and Manual Injection Valve” section of the LC/MSD CE Training CD-ROM to troubleshoot the CDS valve. In particular, look at the page titled “Calibrant B delivered to MSD”.

Check that you have calibrant coming through the line from bottle B to the front of valve #5. Disconnect the teflon tubing at the front of valve #5. For this problem you would have a lot of flow through that line. Reconnect the line.

Next check that the voltage control is good for valve #5. From the diagram you can see that valve #5 should be energized when calibrant B is delivered to the MSD. When the valve is energized, there should be a 8.5 volt drop across the two solenoid leads for the valve. You can measure this voltage drop by putting your voltmeter test probes on the solder spots for the solenoid leads on the back of the valve board. There are three solder spots at the connector for each valve. When viewed from the back of the valve board, the right two solder spots are the two connections for solenoids. You can either measure the voltage drop across those two points, or you can just measure the center solder spot. When a valve is energized, the voltage on the center solder connections will drop to 0 volts (the right solder connection will stay at +8.5 volts, thereby giving a voltage drop across the solenoid). For this problem you would find that the voltage control was okay.

This all then leads to a problem with valve #5. As a temporary fix, you can swap valve #1 or #2 with valve #5, as long as the customer is not also using APCI.

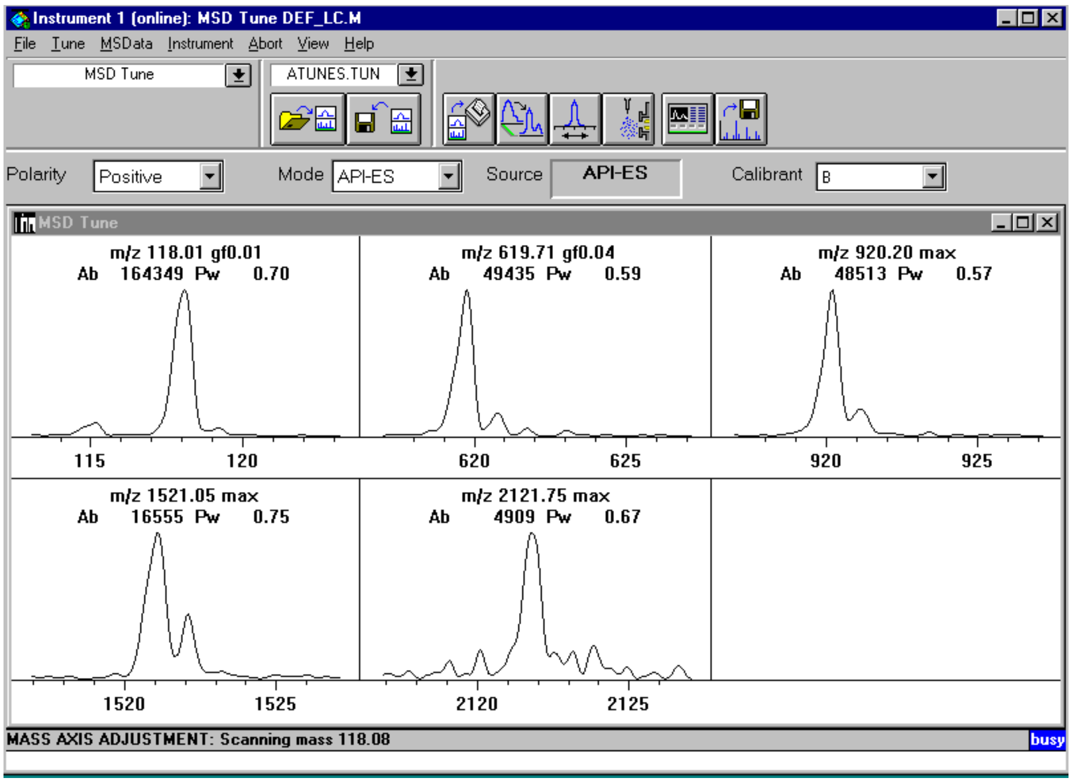
To fix the problem, replace the valve.

Note: send all bad CDS valve to the support engineering group at CAD for failure analysis.

Wrong calibrant in bottle

Symptoms:

When you run an autotune in electrospray mode, the peaks will have good peak shape but mass assignments will be off. Mass #1 will initially be at 121 m/z (expected m/z = 118). As the system adjusts the mass gain and offset, mass #1 and mass #5 will be calibrated properly, but mass #2 will be at too low of a m/z (see Fig. 1).



(Fig. 1)

In the tune report for positive mode, the mass offset ramp will go to very negative values for the middle three masses. In negative mode, the mass offset ramp will have very high positive values.

In either mode, the tune peaks will not have good shape.

How to Troubleshoot:

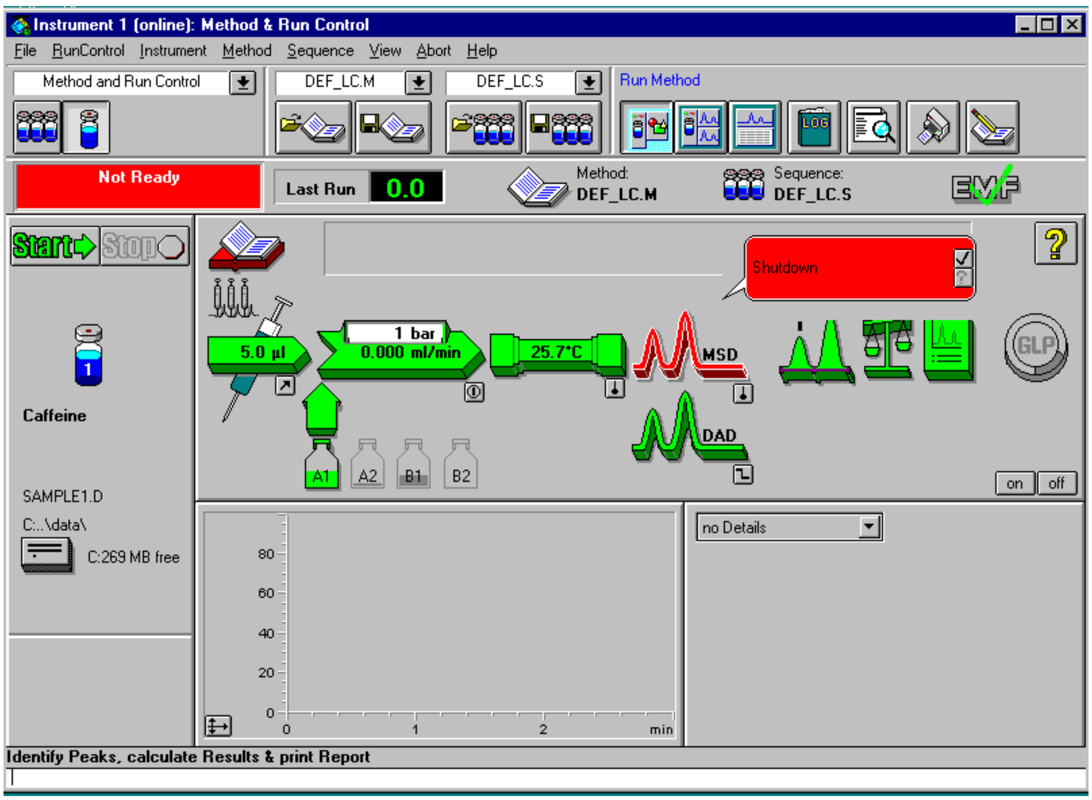
These symptoms indicate either bad mass axis control from the analyzer board or wrong calibrant. But notice that with reasonable mass gain and mass offset values (60 and 0, respectively), masses #2-5 are pretty close to the expected mass assignment, but mass #1 is closer to m/z 121. Since mass #1 is the primary difference between the APCI and electrospray calibrant in positive mode, you should suspect wrong calibrant. Replace the calibrant with fresh calibrant.

Low nitrogen tank pressure

Symptoms:

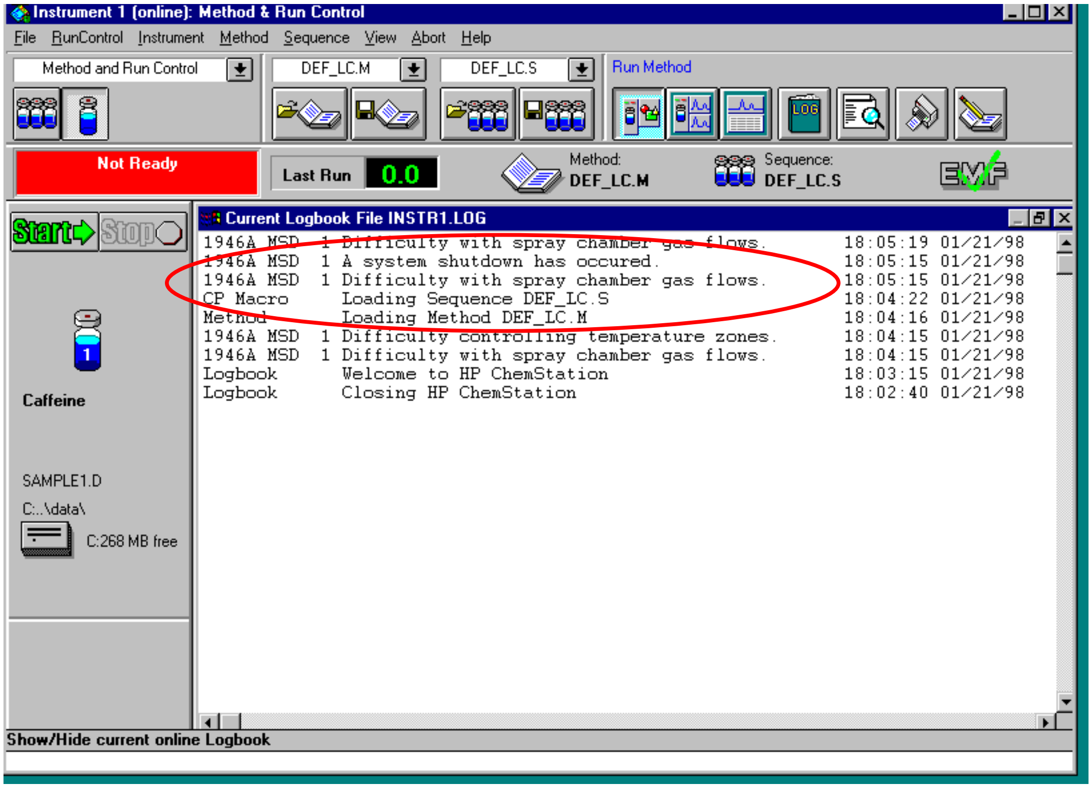
(In this example, the nitrogen supply pressure was set to 20 psi.)

If the nitrogen supply pressure drops below the pressure required for the nebulizer or the drying gas flow, a shutdown error will be generated for the MSD (see Fig. 1).



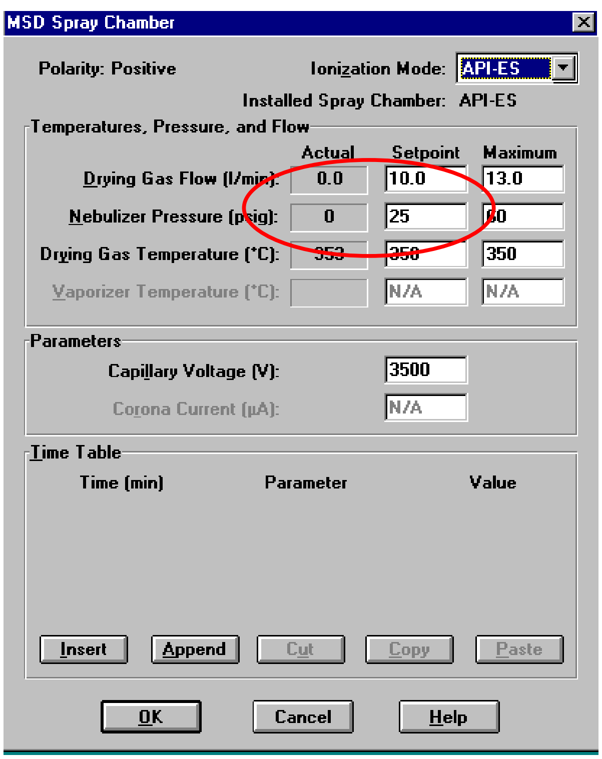
(Fig. 1)

If you access the instrument log book, it will indicate Difficulty with spray chamber gas flows (see Fig. 2).



(Fig. 2)

If you access the spray chamber parameters, it will indicate that the drying gas flow and nebulizer pressure has shut off (see Fig. 3).



(Fig. 3)

How to Troubleshoot:

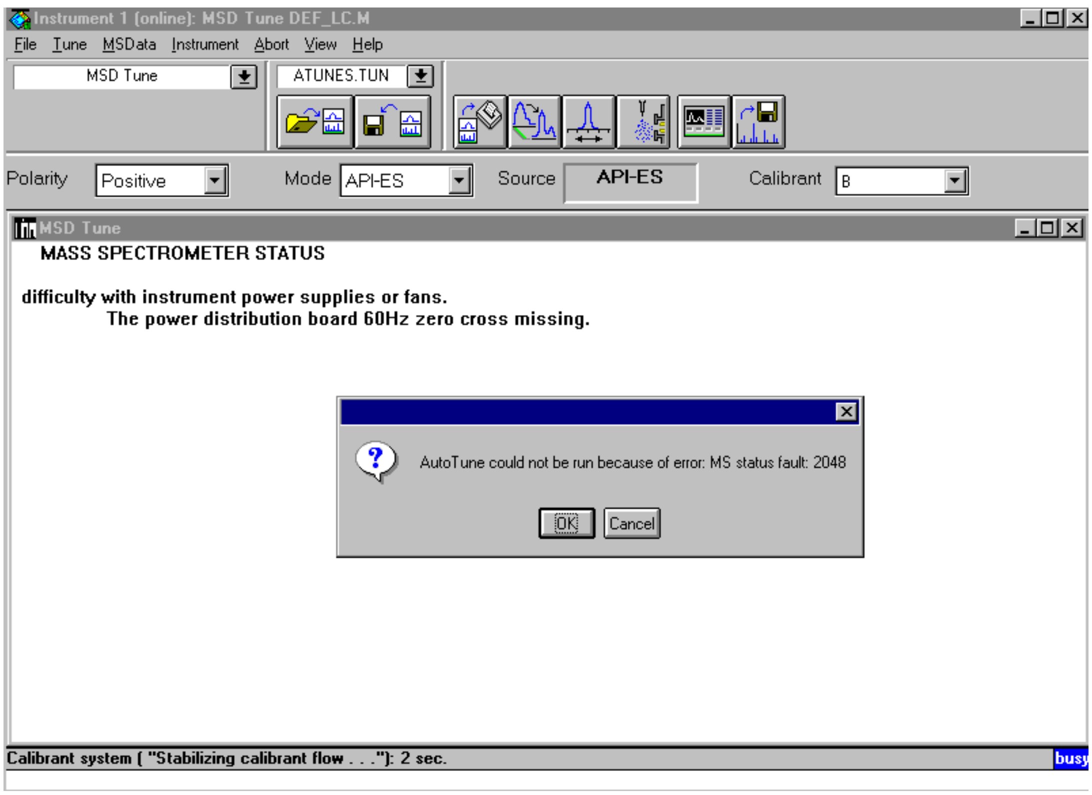
These symptoms can be caused by either low nitrogen supply pressure, a bad gas flow control module, or bad control signals for the gas flow control module from the PDB board. The most common cause and the first item to check is low nitrogen supply pressure. You should also check the pressure on the downside of the nitrogen gas filter, just in case the filter is plugged. If you cannot get a pressure gauge on the downside of the filter, at least loosen the connection at the nitrogen inlet on the side of the MSD and make sure that you have a high gas flow at that point.

Bad 110 Vac fuse on PDB

Symptoms:

When you start an autotune, during the autotune initialization period, the message line at one point will indicate "waiting 130 secs, while temperature reaches setpoint and stabilizes" and will proceed to count down the time. After it gets to 0 sec, the autotune program will purge the calibrant. After it has completed that, you will get the error message:

MS Status Fault 2048
Difficulty with instrument power supplies and fans
The power distribution board 60Hz zero cross missing



How to Troubleshoot:

This error indicates a problem with the 110 Vac used for the heated zones. The error is generated on the PDB board. The first item to check is the fuse for 110 Vac at the top of the PDB board. For this problem, if you checked the fuse you would find that it was open. There might be a cause for the blown fuse, however. If you put in a new fuse and it also blows, check the resistance on all the heated zone heaters, and also check for shorts to ground. Refer to the Functional Diagram in the Gas Flow & Temperature Control section of the LC/MSD CE Training CD-ROM.

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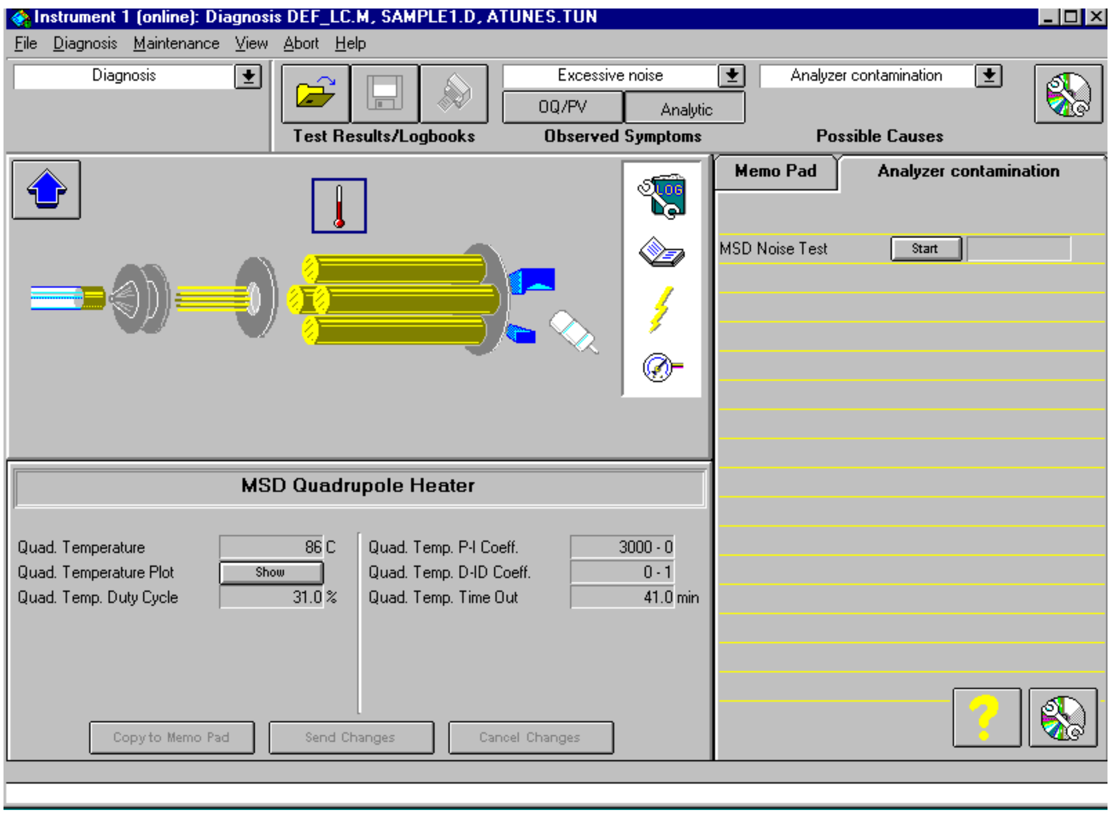
Open Quad Heater

Symptoms:

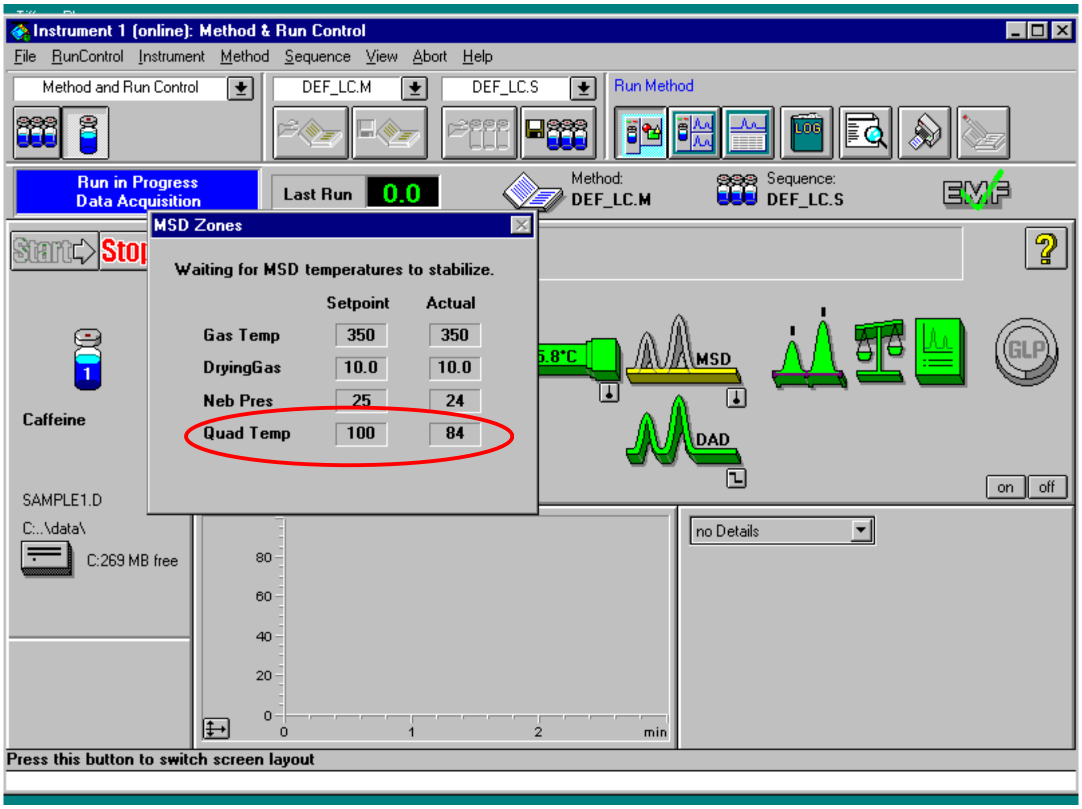
Autotune runs without a problem, but if you run a Checktune you might notice that the mass assignments have drifted.

If you go into diagnostics and update variables display for the quad temp, no errors are displayed, but the quad temp will not be at the 100 C setpoint (see Fig. 1)



(Fig. 1)

When you start a run, you will get a display box that will indicate that the quad temp cannot reach its setpoint, while the other zones (drying gas temp, drying gas flow, and nebulizer pressure) are already at their setpoints. It will wait for the quad temp to come up indefinitely (see Fig. 2).



(Fig. 2)

How to Troubleshoot:

This problem can be caused by either a bad quad heater, a bad PDB board which doesn't deliver the 110 Vac for the quad heater, a bad quad temp sensor, or a bad quad temp setpoint in non-volatile RAM.

Since the quad temperature is giving a reasonable value (84 C), then the quad temp sensor seems to be working okay (if the sensor was bad, it would either give very high temperature readings, ~450 C, or a zero reading).

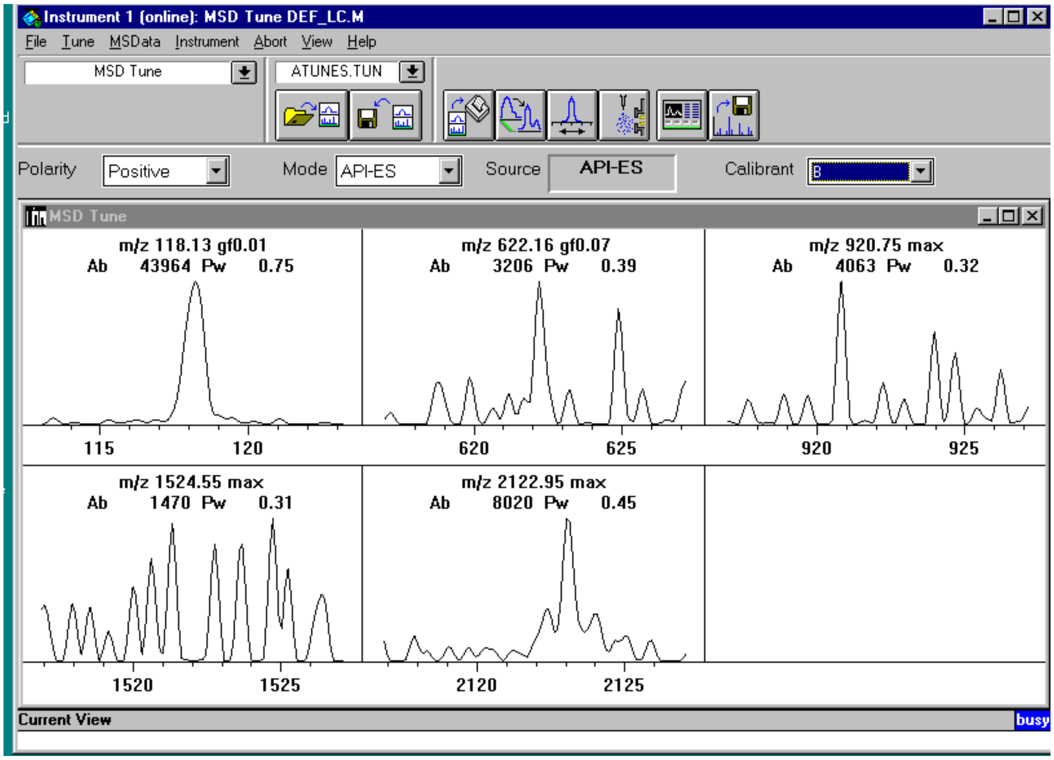
Next disconnect the quad heater lead on the cable that comes from the PDB board where it connects to the leads that go through the vacuum manifold. Measure the resistance on the leads on the quad heater side, and check each lead for a short to ground. The resistance should be approx 110 ohms. Use the Functional Diagram in the Gas Flow & Temperature Control section of the LC/MSD CE Training CD-ROM for testpoints and expected values. On the other connector you can check for the 110 Vac from the PDB board. For this problem you would find that the resistance on the quad heater was infinite, which would indicate a bad quad heater.

If you wanted to make sure that the quad temp setpoint was correct in non-volatile RAM, you could execute the command 'shownvr' to get a listing of all the non-volatile RAM parameters. To make sure it is set properly, execute the commands 'qt 100' and 'burnqt 100'.

Bad Vcap/Vchamber supply

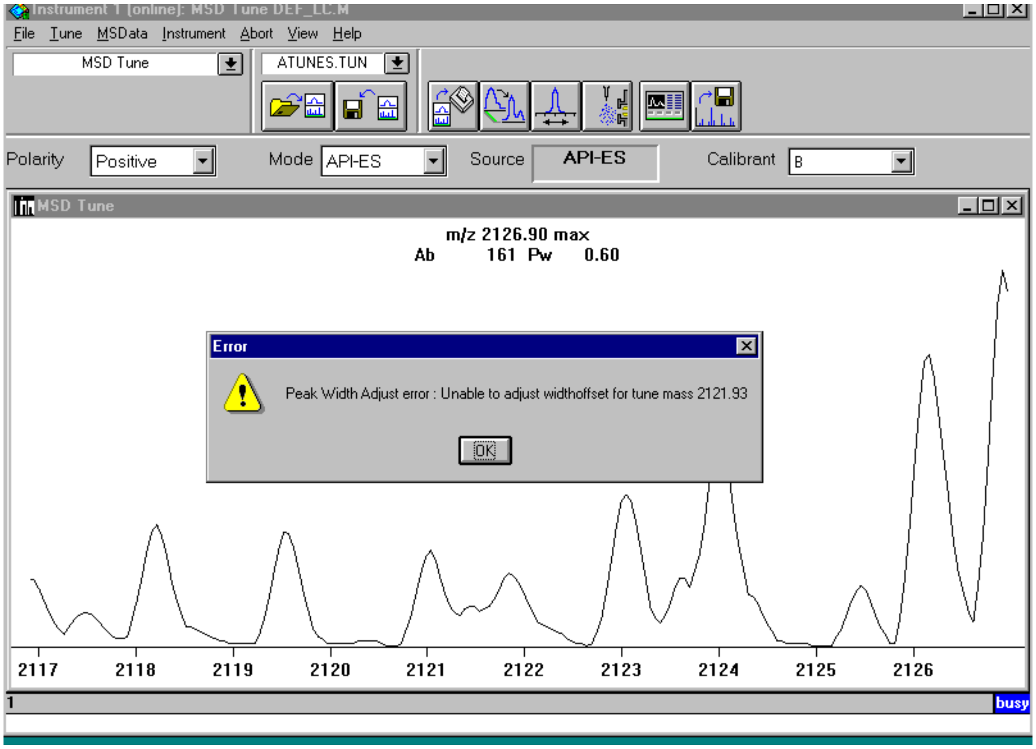
Symptoms:

The beginning of autotune shows a noisy response with low signal, especially at mid to high mass (see Fig. 1).



(Fig. 1)

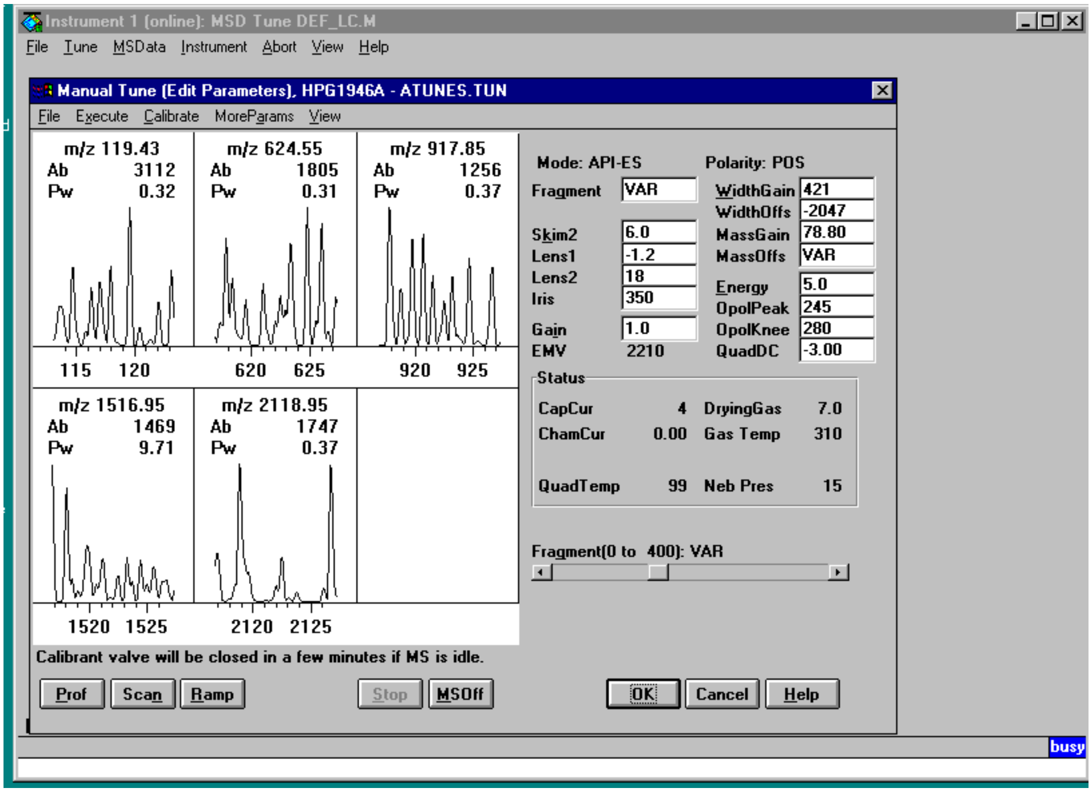
Autotune will fail with “Peak Width Adjust Error, Unable to adjust WidthOffset for 2122” (see Fig. 2).



(Fig. 2)

How to Troubleshoot:

The first step in troubleshooting this problem is to make sure that the spray chamber is generating ions. Go into manual tune, make sure that calibrant B is open, then start a repeat profile. Check the CapCur and ChamCur values. They should be approx. 100nA and 1uA, respectively. For this problem, you would see that they are both close to 0 (see Fig. 3).



(Fig. 3)

The zero CapCur and ChamCur can be due to either no nebulizer spray or bad Vcap/Vchamber voltages. To check the nebulizer spray, remove the nebulizer from the spray chamber while the instrument is in repeat profile (with calibrant B open) and point the nebulizer against one of the blank magnets. Check for a constant, uninterrupted spray and a circular wet spot. For this problem you would find that the spray is good.

Since the spray is good, this would indicate bad Vcap or Vchamber voltages. Because of the safety interlocks on the spray chamber, you cannot safely measure the voltages directly at the spray chamber elements. So first you should check that the Vcap and Vchamber signal lines are continuous. Disconnect the Vcap and Vchamber leads at the Vcap/Vchamber power supply, then open the spray chamber, and check for continuity from the leads to the capillary (check to the capillary cap) and chamber (check to the end cap) elements. (While the spray chamber is open, also check the resistance of the elements to ground, to make sure that are not shorted to ground.) If there is continuity, then you can suspect that either the Vcap/Vchamber power supply is bad, or the analyzer board is bad since the analyzer board drives the Vcap/Vchamber. You can confirm this by measuring the Vcap or Vchamber voltage directly off of the power supply by setting the Vcap voltage to 1000 V and then starting a repeat profile.

Before replacing either the Vcap/Vchamber power supply or the analyzer board, make sure that the ribbon cable between the Vcap/Vchamber power supply and the analyzer board is connected properly and that the pins on the connectors are not bent.

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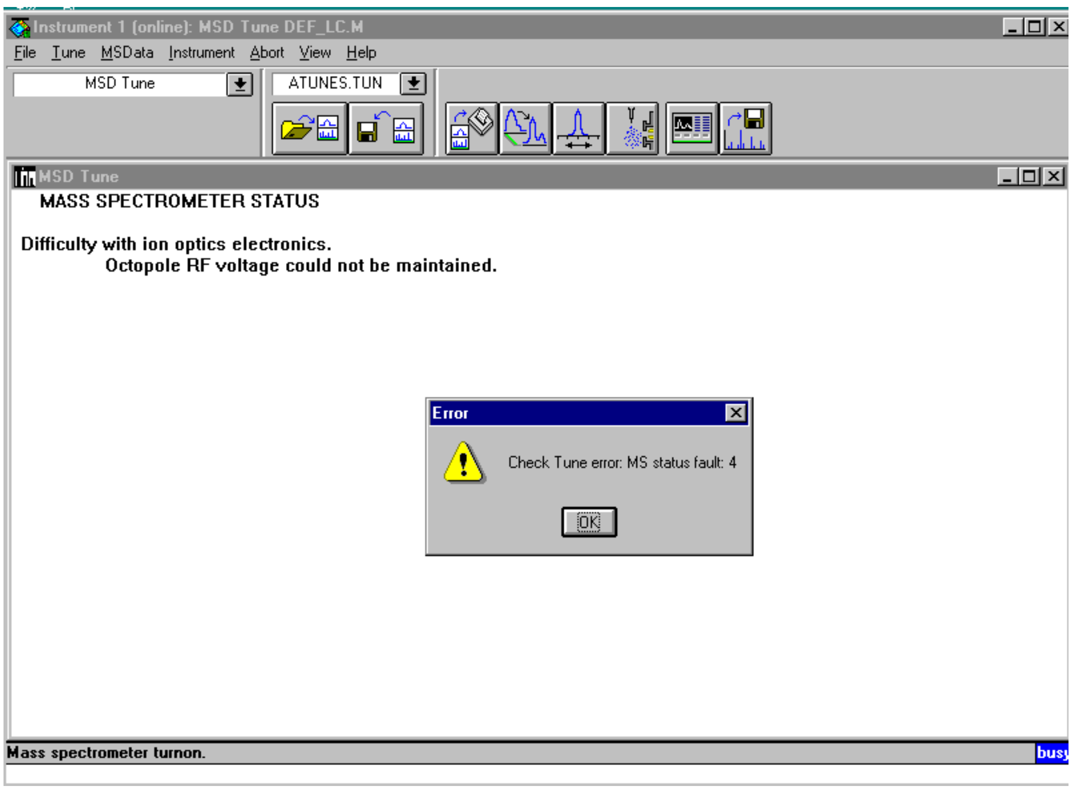
Disconnected Octopole Leads

Symptoms:

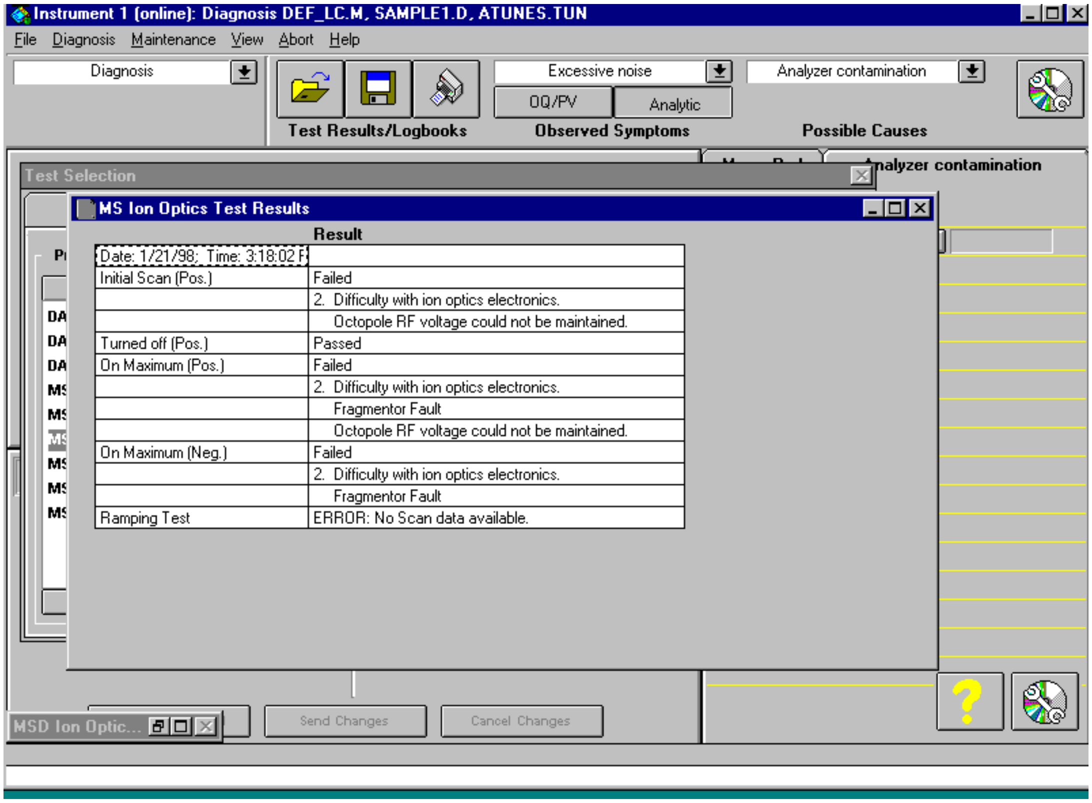
When you run an autotune, you get the message:

> MS status fault: 4
> Difficulty with ion optics electronics
> Ocotople RF voltage could not be maintained



(Fig. 1)

When you run the MSD Ion Optics test in Diagnosis, you will also get the error “Difficulty with Ion Optics/Octopole RF voltage cannot be maintained” in every result field (see Fig. 2).



(Fig. 2)

How to Troubleshoot:

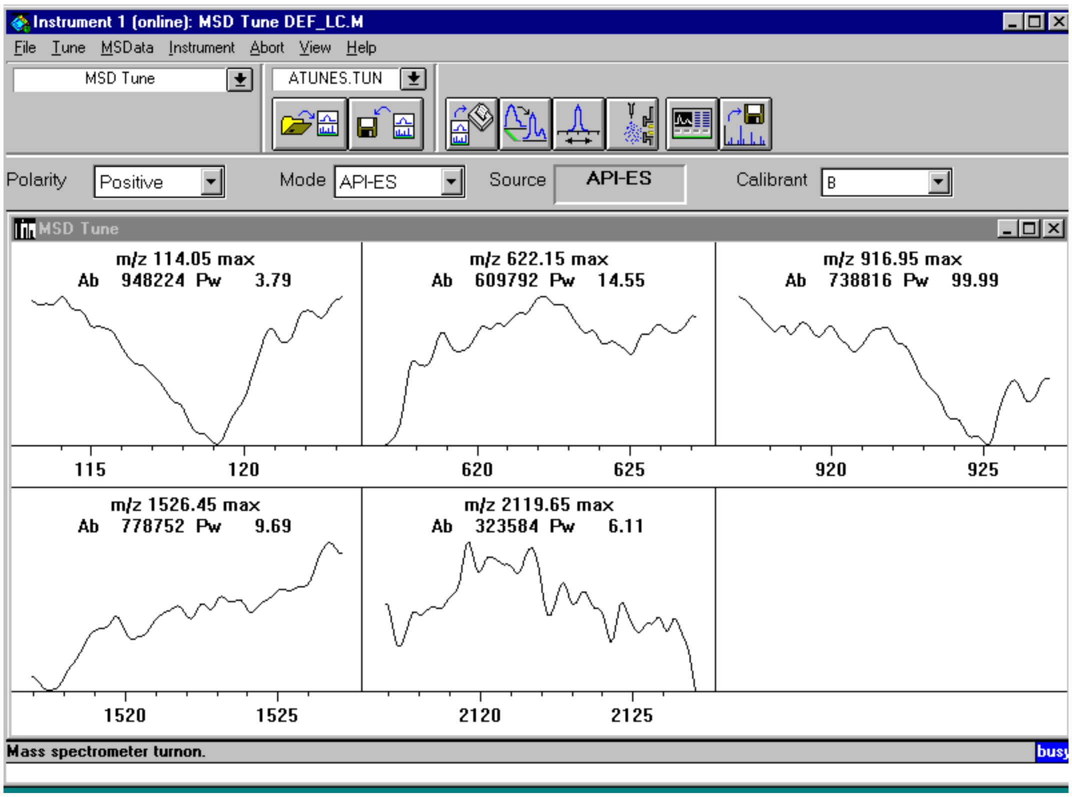
This error indicates a problem with the octopole board, the octopole leads, or the octopole itself. The first thing to do is to vent and check that the octopole leads are connected properly, and also check for continuity between the connections on the octopole board and the connections on the octopole or the octopole rods themselves. Also check to make sure that the octopole rods are not shorted to ground or to each other, and make sure that the octopole rods are not damaged or have come unsoldered.

For this problem, you would find that the octopole leads were not connected properly.

No U+/U- from Analyzer board

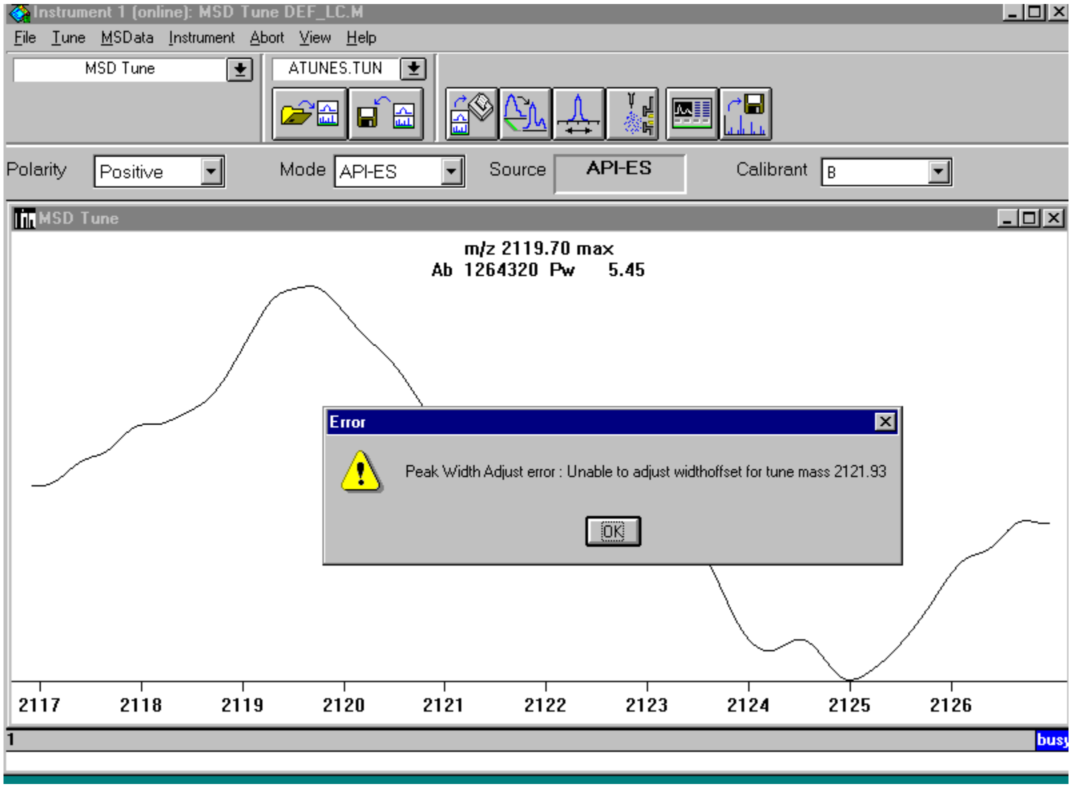
Symptoms:

When you run an autotune, the profile scans will give very wide peaks without a definite gaussian peak shape but with relatively high abundance (see Fig. 1).



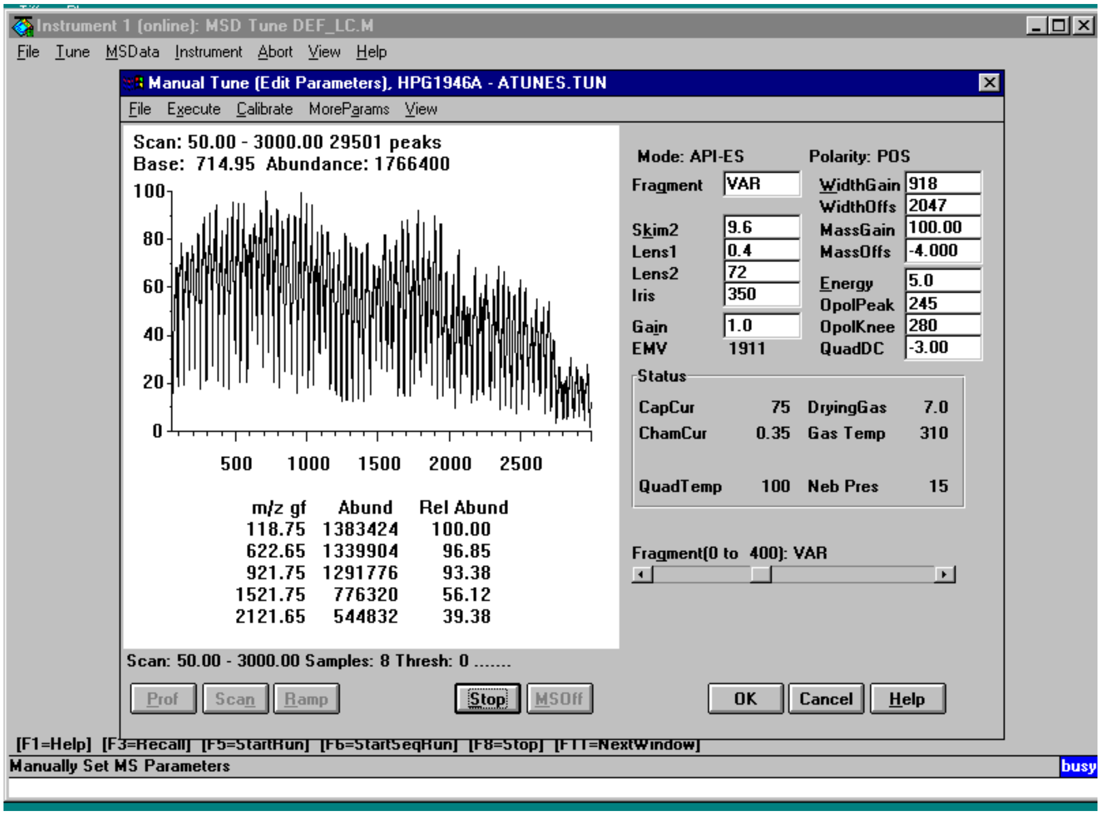
(Fig. 1)

After the autotune tries for a while, it will stop with the error message “Peak Width Adjust Error: Unable to adjust width offset for tune mass 2121.93” (see Fig. 2).



(Fig. 2)

A spectrum scan will give a band of noise across the whole mass range, decreasing in abundance at the higher masses (Fig. 3).



(Fig. 3)

How to Troubleshoot:

Since there is plenty of abundance (over 1,000,000 counts), then that means that ions are being produced in the spray chamber, that the ion optics are allowing the ions to pass through, and the detector is detecting the ions. But the mass filter is not filtering those ions.

If the RF was not working properly, you would either get an RF fault or no signal. So this points to the U+/U- not working properly, specifically being too low. The first thing to do is to measure the U+ and U- at the connector where it connects to the back of the RF coil box. Going into manual tune and select Edit Acquisition Parameters from the MoreParms menu. Uncheck all boxes except for mass 118, then start a repeat profile. Measure the U+ and U- signals. Repeat this for masses 622, 922 and 1522. The expected readings are as follows:

Mass	U+	U-
118	+30V	-30V
622	+151V	-151V
922	+223V	-223V
1522	+369V	-369V

For this problem you would find that all reading are 0. This would indicate either that the U+/U- is not being generated on the Analyzer board or that the cable from the Analyzer board to the RF coil box is bad. If Analyzer board has a fault detection circuit such that you will get a 'Quad DC' fault if the U+/U- is not generated. So this would lead to a bad or disconnected U+/U- cable.

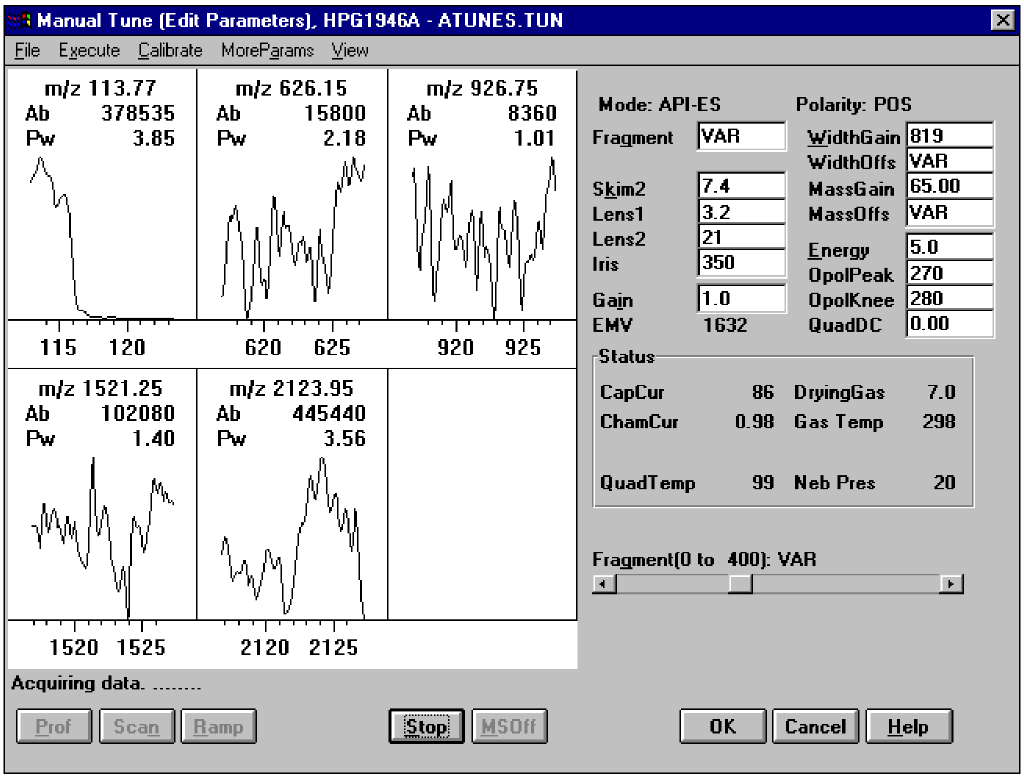
If the U+/U- measurement was good at the cable, then the problem might be in the RF coil box. The U+/U- signal is combined with the RF signal in the coil box, and the circuit to combine the signals might be bad.

HEWLETT PACKARD

Bad RF Coil Box

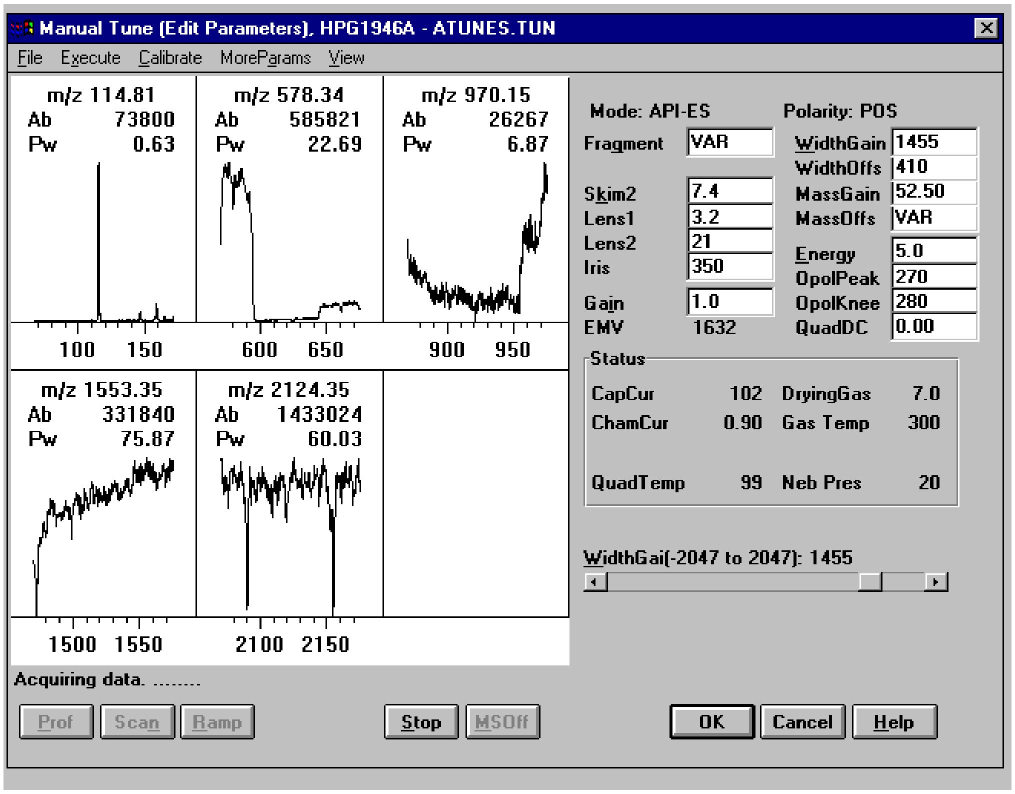
Symptoms:

When you start a profile scan with typical width gain and offset values, you will see that there is high abundance for the tune peaks, but there is just noise, especially at high mass (see Fig. 1).



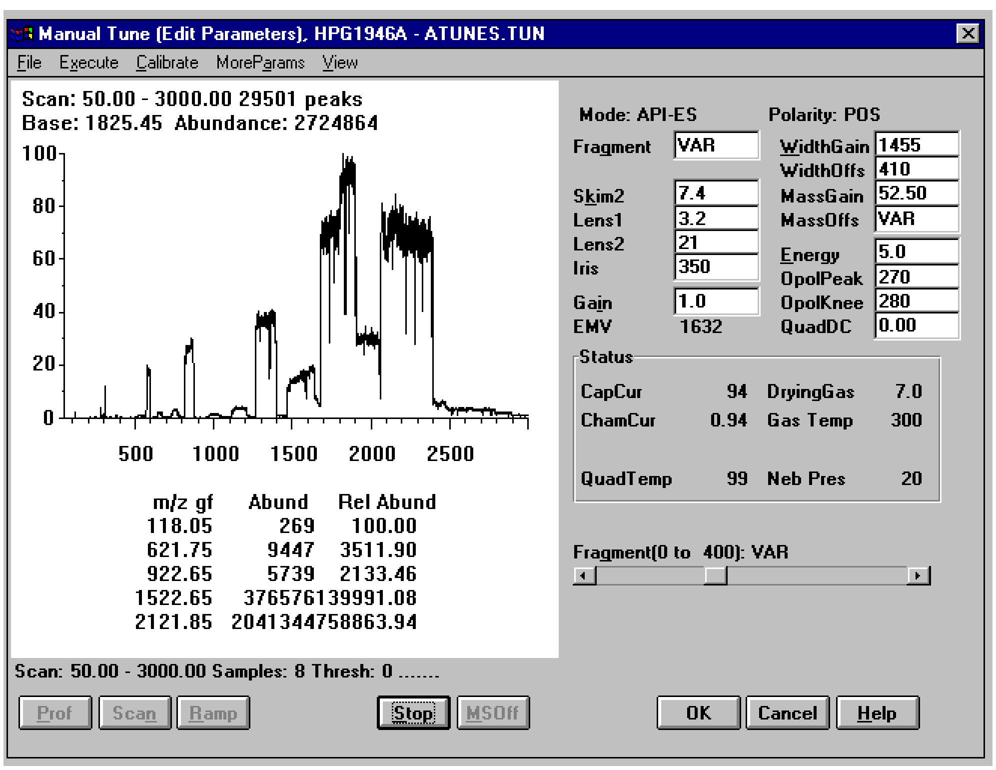
(Fig. 1)

You can increase the width gain and width offset to adjust the 118 ion width, but the mid and high mass tune peaks will still be too wide (see Fig. 2).



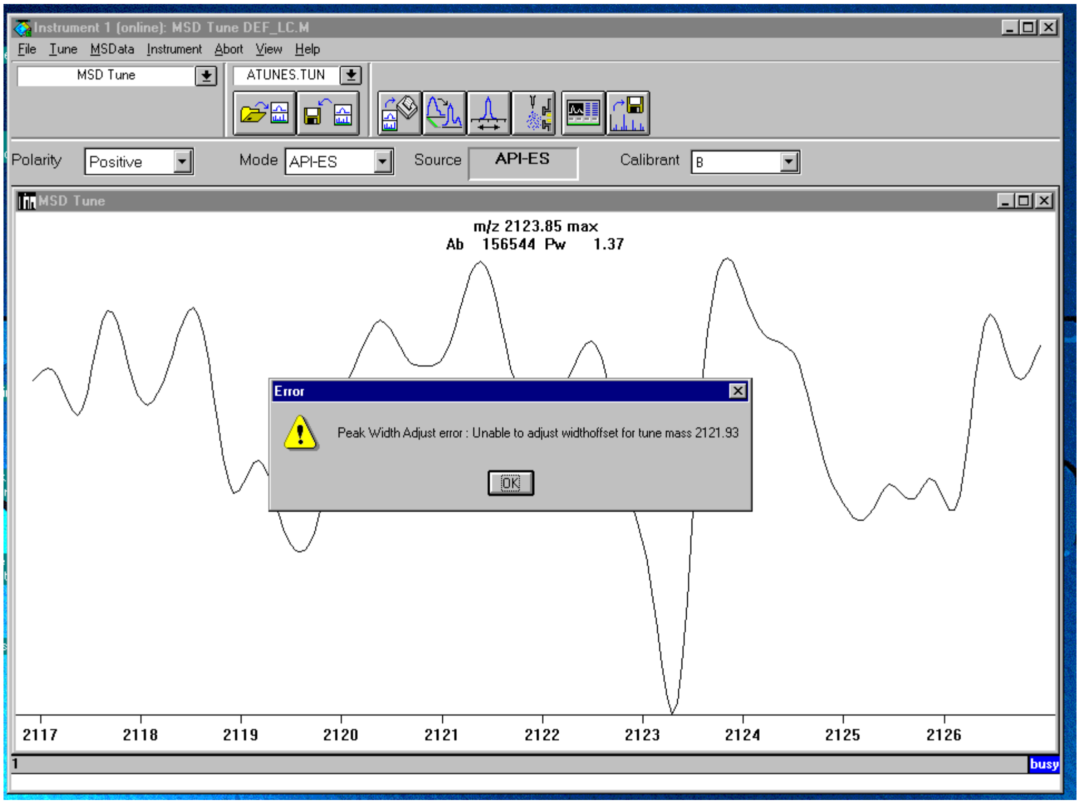
(Fig. 2)

A spectrum scan will show very wide and noisy peaks at high mass (see Fig. 3)



(Fig. 3)

If you run an autotune, it will fail with the error: “Peak Width Adjust error: Unable to adjust widthoffset for tune mass 2121.93” (see Fig. 4).

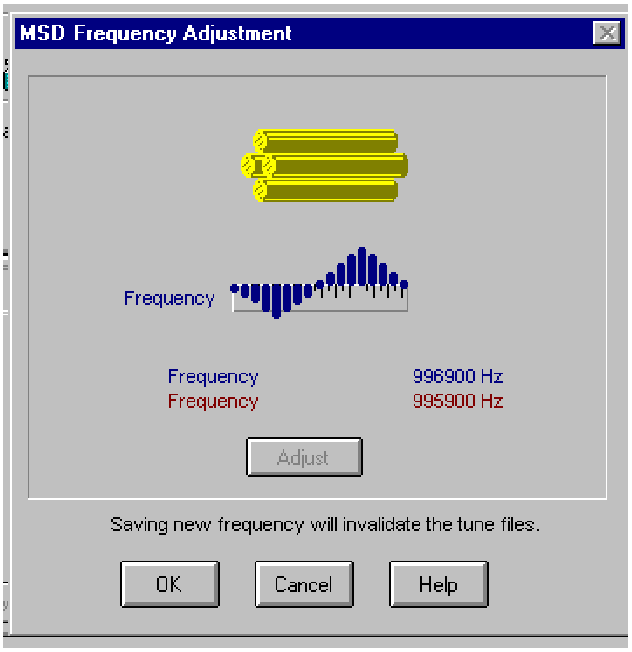


(Fig. 4)

How to Troubleshoot:

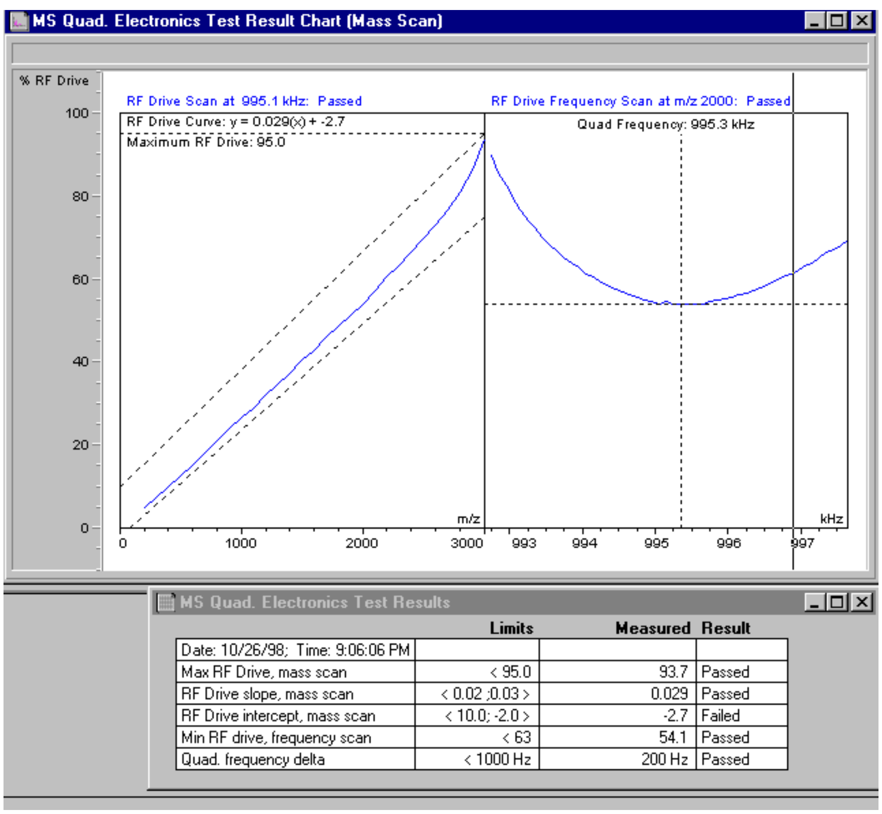
Since there is plenty of abundance, this indicates that the source is generating ions, that the ion optics is properly focussing the ions into the mass filter, and that the detector is detecting the ions, but the mass filter is not filtering the ions properly.

If you perform a quad frequency adjustment, the quad frequency adjustment will properly adjust (see Fig. 5). This verifies that the analyzer board is generating the 1MHz signal and the proper RF drive, that the RF signal is delivered from the RFPA to the coil box, that the connections from the coil box to the quad are good, and that the RF feedback signal from the coil box to the analyzer board is good. However, it doesn’t verify that the RF output from the RFPA is good, or that the circuit in the RF coil box is good.



(Fig. 5)

If you ran the quad electronics test, the test will pass except for the RF drive intercept (see Fig. 6). This doesn't directly point to the problem, however it does verify that the RFPA is performing properly since it is generating the properly RF output voltage throughout the mass range.



	Limits	Measured	Result
Date: 10/26/98; Time: 9:06:06 PM			
Max RF Drive, mass scan	< 95.0	93.7	Passed
RF Drive slope, mass scan	< 0.02 ;0.03 >	0.029	Passed
RF Drive intercept, mass scan	< 10.0; -2.0 >	-2.7	Failed
Min RF drive, frequency scan	< 63	54.1	Passed
Quad. frequency delta	< 1000 Hz	200 Hz	Passed

(Fig. 6)

Since the quad circuit signals (1 MHz clock, RF drive, RF output, and RF feedback) seems to be good, and since the symptoms is wide peaks at high mass, this points to a problem with the RF coil box, in particular bad sampling diodes on the coil box.

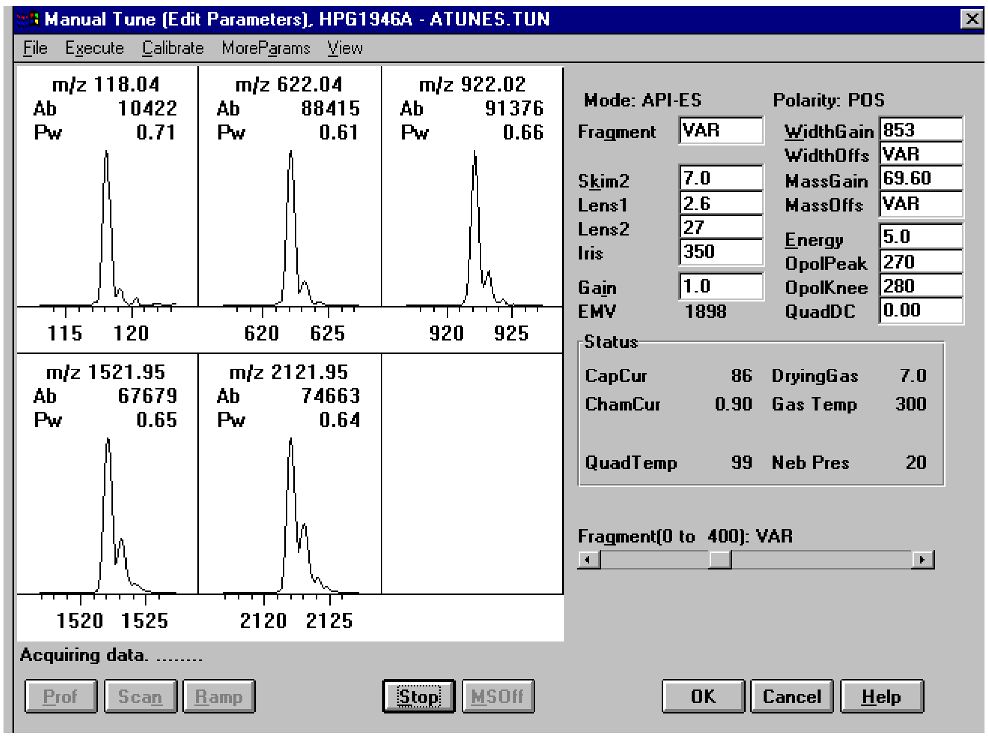
Replacing the RF coil box would fix the problem.

RFPA output adjusted too low

Symptoms:

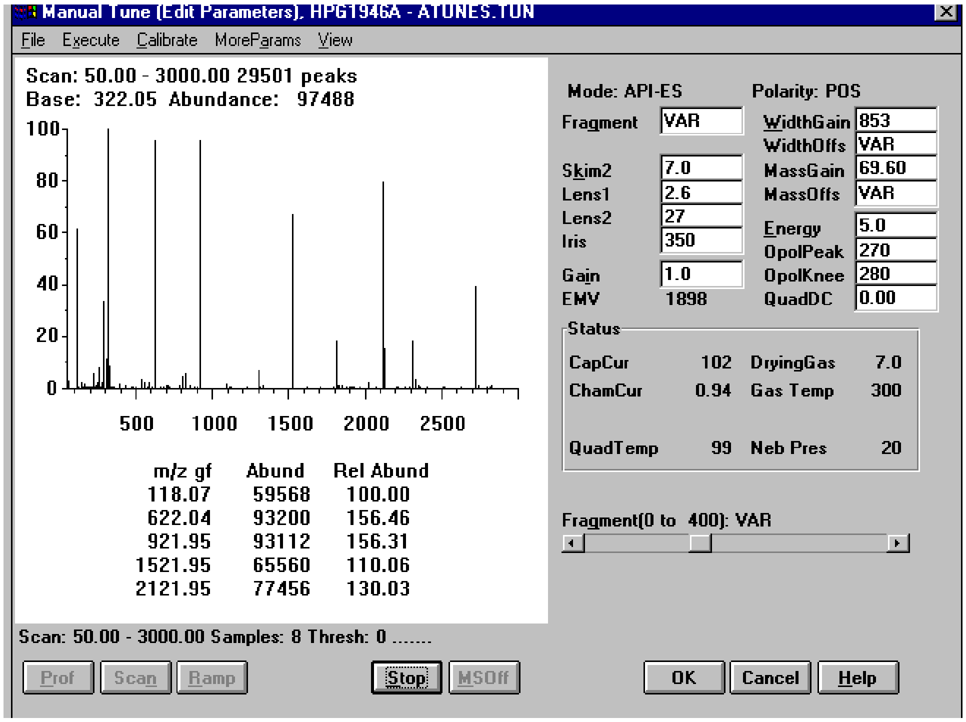
(RFPA output was adjusted such that RF drive = 31.8% at 3000 amu—the pot on the RFPA was turned all the way clockwise until it clicked).

Repeat profile in manual tune does not show any significant effects (see Fig. 1).



(Fig. 1)

A spectrum scan doesn't show any significant effects, either (see Fig. 2).



(Fig. 2)

How to Troubleshoot:

Since there isn't an obvious problem symptom, this problem might be difficult to recognize. You might see peak stability problems at low mass.

Running electronics test will give you a failure on the RF drive level.

To correct the problem, adjust the RFPA output by typing 'showrf [mass], [repetitions]' and adjust the RFPA output to 80-85% at 3000 amu.

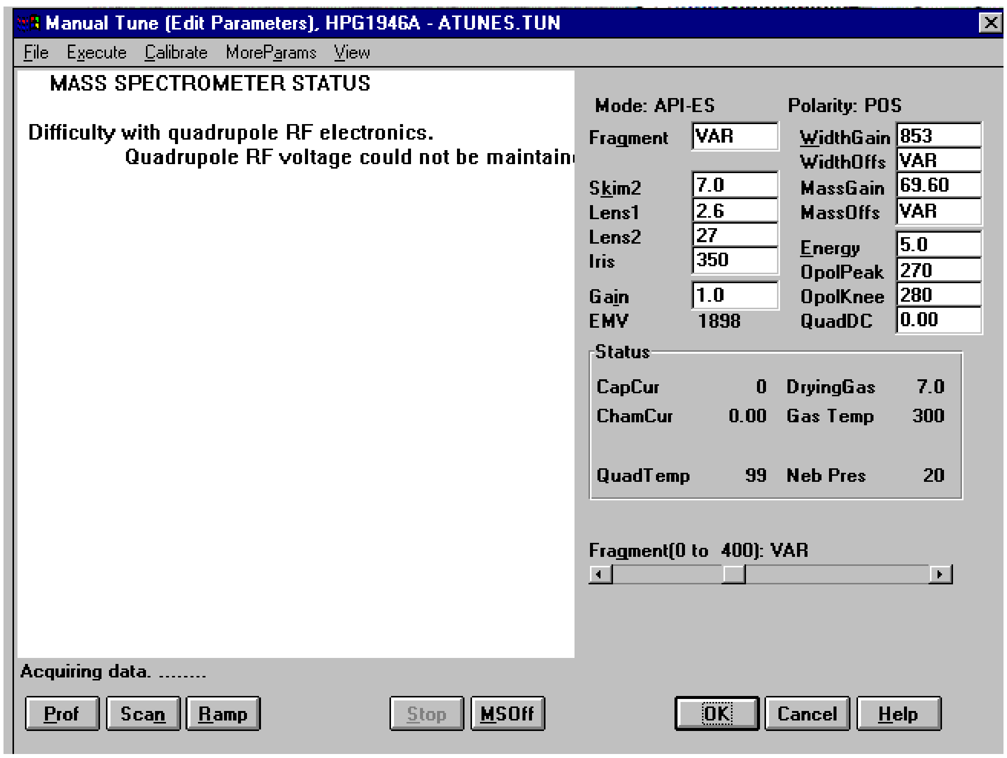
HEWLETT PACKARD

RFPA output adjusted too high

Symptoms:

(RFPA output was adjusted such that RF drive = 56.9% at 1000 amu—the pot on the RFPA was turned all the way counter-clockwise until it clicked).

Repeat profile in manual tune will give a fault when it is trying to profile mass 2122 with the error: “Difficulty with quadrupole RF electronics… Quadrupole RF voltage could not be maintained”(see Fig. 1).



(Fig. 1)

How to Troubleshoot:

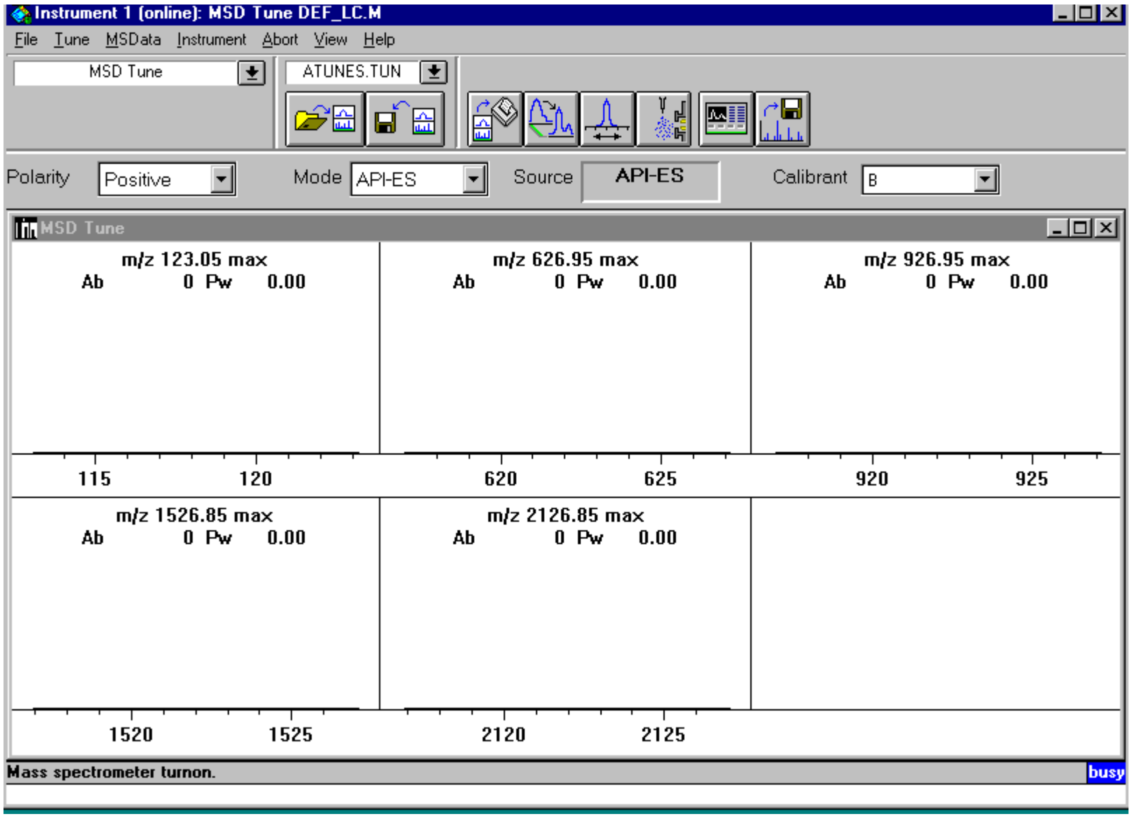
If you run the quadrupole electronics test, the quadrupole RF frequency adjustment would pass, but the RF drive level test would indicate a problem that the RF drive level is too high. This could either be a problem with the RFPA or that the RFPA output is adjusted too high. The first thing to do is to try to adjust the RFPA output.

To adjust the RFPA output, type ‘showrf [mass], [repetitions]’ and adjust the RFPA output to 80-85% at 3000 amu. This would then correct the problem.

Bad or disconnected signal cable from EM dynode to feedthrough inside vacuum manifold

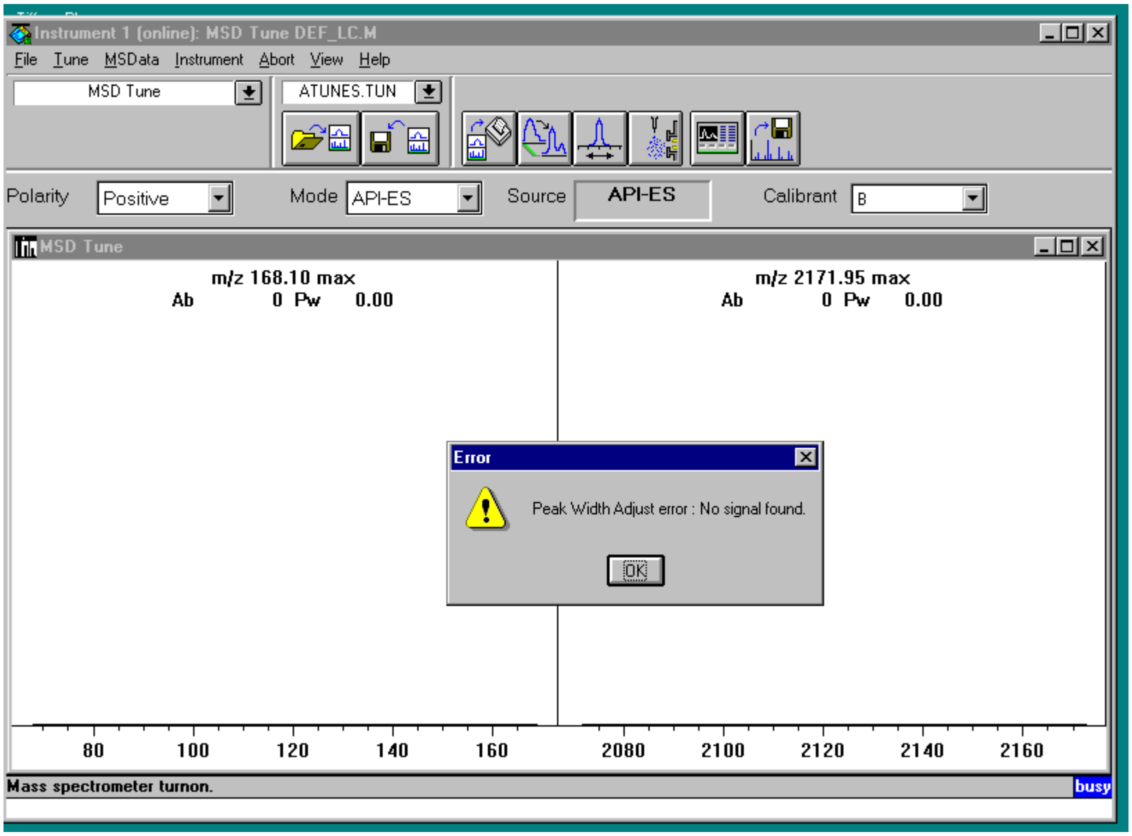
Symptoms:

When an autotune is performed, the profile scans will give low level noise or no abundance (see Fig. 1).



(Fig. 1)

After the autotune tries for a while, it will stop with the error message “Peak Width Adjust Error: No signal found” (see Fig. 2).



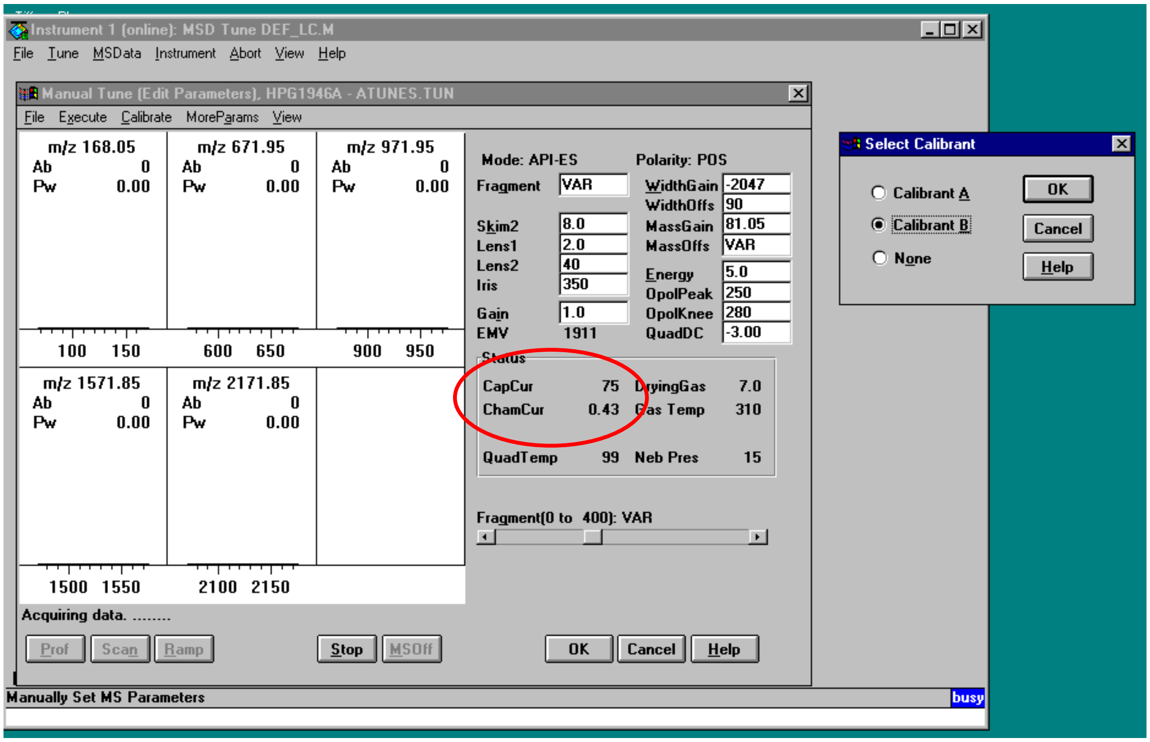
(Fig. 2)

How to Troubleshoot:

This symptom can be caused by any of the following:

- No calibrant flow
- No ions being created in the spray chamber
- The quads not functioning properly and filtering out all masses
- No HED voltage
- No EM voltage
- A bad EM dynode
- Bad or disconnected cables for the HED or EM voltage
- Bad or disconnected signal cable from the EM dynode
- Bad signal cable from the signal feedthrough in the vacuum manifold to the log amp
- Bad log amp or detector board

For this problem, you can go into Manual Tune and do a repeat profile, and you will notice that the Cap Current and the Chamber Current have typical readings, indicating that calibrant is flowing to the source and the source is generating ions (see Fig. 3).



(Fig. 3)

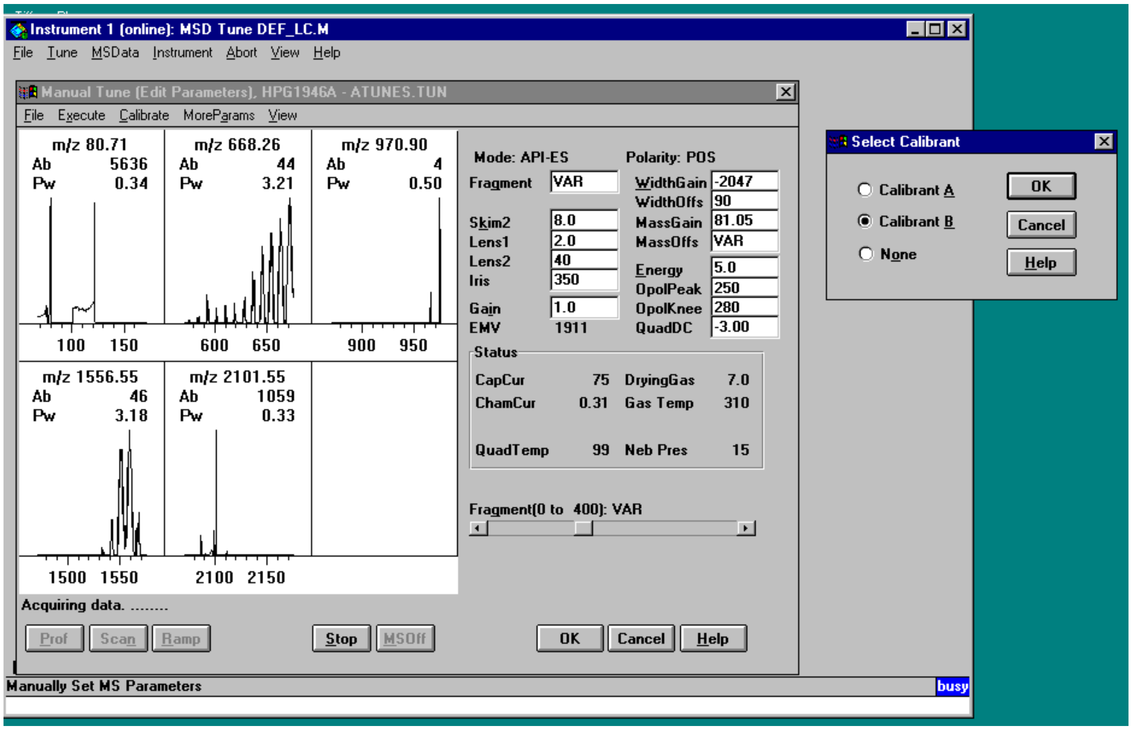
To check to see if the quad is functioning properly, first do a quad electronics test in Diagnosis. This will verify the proper quad frequency and RFPA adjustment, so indirectly it will verify that the quad RF electronics are functioning properly. It doesn't check the U+/U-, but if there is a problem with those voltages it is usually that they are too low or are missing--in that case you will either get a Quad DC fault, or you will get tune peaks that are too wide.

Another problem with the quad that could cause the tune peaks to disappear is if the WidthGain and/or WidthOffset are set too high, and therefore you are overresolving the tune masses. To check this, set the WidthGain and WidthOffset values to their maximum negative settings (-2047). If you now have wide peaks, then the problem might be that you need to properly adjust the WidthGain and WidthOffset. If the peaks are still missing, then the problem is likely not in the quads or quad circuit.

Next, you should verify that the EM and HED voltages exist. To check the EM volts, remove the EM voltage cable (black cable that plugs straight onto feedthrough) from the feedthrough at the vacuum manifold, set the EM gain to a value such that the EMV is in a range that your voltmeter can measure (you can set the EM gain down to a minumum of 0.1), then start a repeat profile. Measure the DC volts at the pin on the inside of the connector at the end of the cable.

To measure the HED voltage, first do an MSOFF to turn off the voltages, then remove the HED cable (white cable that plugs straight onto feedthrough) from the feedthrough at the vacuum manifold, then use the command 'HED 1000' to set the HED to 1000 volts, then start a repeat profile. Measure the DC volts at the pin on the inside of the connector at the end of the cable.

After you verify that the EM and HED voltages are good, you should verify that the signal cable is good and log amp is functioning. To do that, remove the signal cable at the feedthrough, start a repeat profile, and then press your finger on the center pin of the signal cable. You should see noise generated in profile scan (see Fig. 4). This indicates that the signal cable, log amp and detector circuit are working.



(Fig. 4)

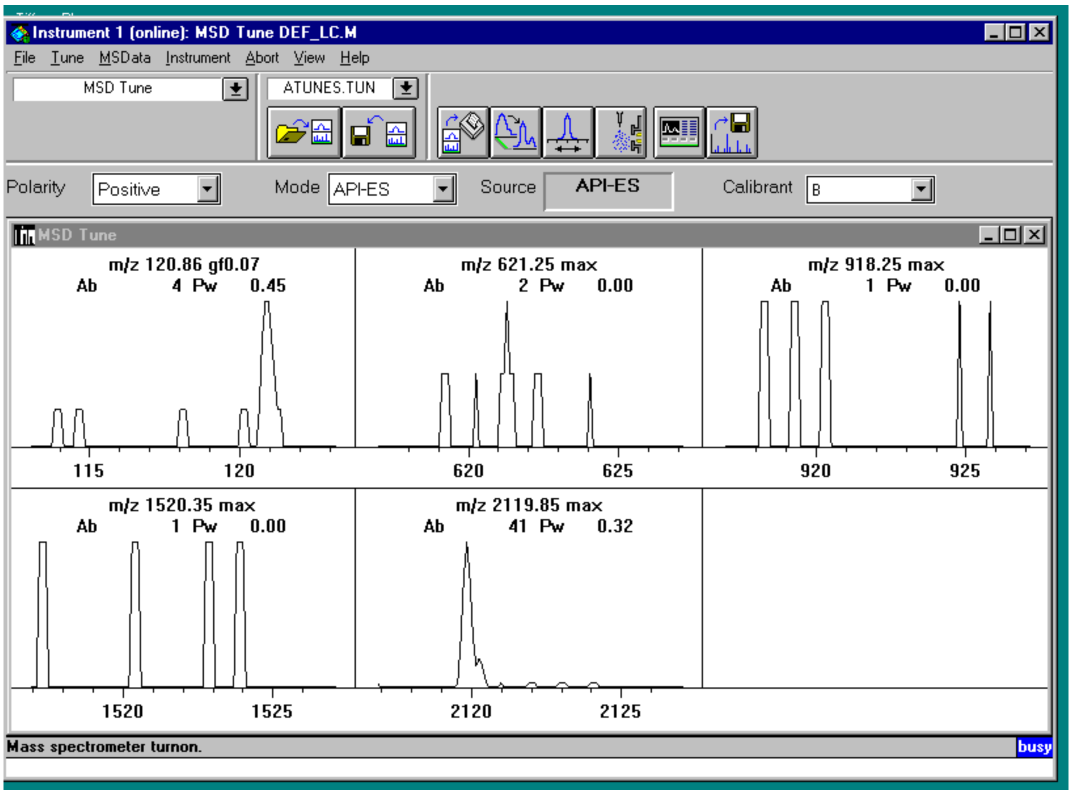
These test narrow the problem down to either a problem with the cables to the detector inside the vacuum manifold or a bad EM dynode. First check the cables by venting the LC/MSD and checking the cables (EM, HED, Iris, and signal) to make sure that are connected properly, then ohm out all the cables and feedthroughs to check for continuity and to make sure that that are not shorted to ground. For this problem you would find that the signal cable from the EM dynode to the signal feedthrough was bad or disconnected.

If the cables and feedthroughs were okay, then you would need to replace the EM dynode.

No HED voltage to detctor

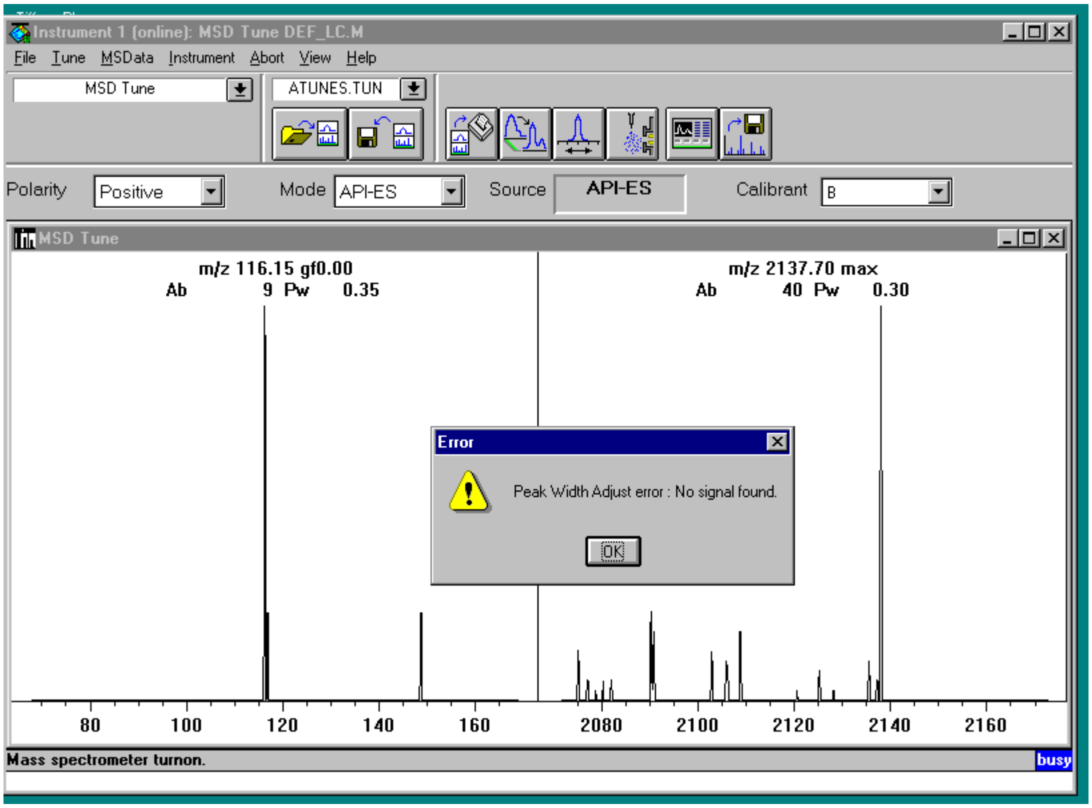
Symptoms:

When you run an autotune, the profile scans will give very low level noise (see Fig. 1).



(Fig. 1)

After the autotune tries for a while, it will stop with the error message “Peak Width Adjust Error: No signal found” (see Fig. 2).



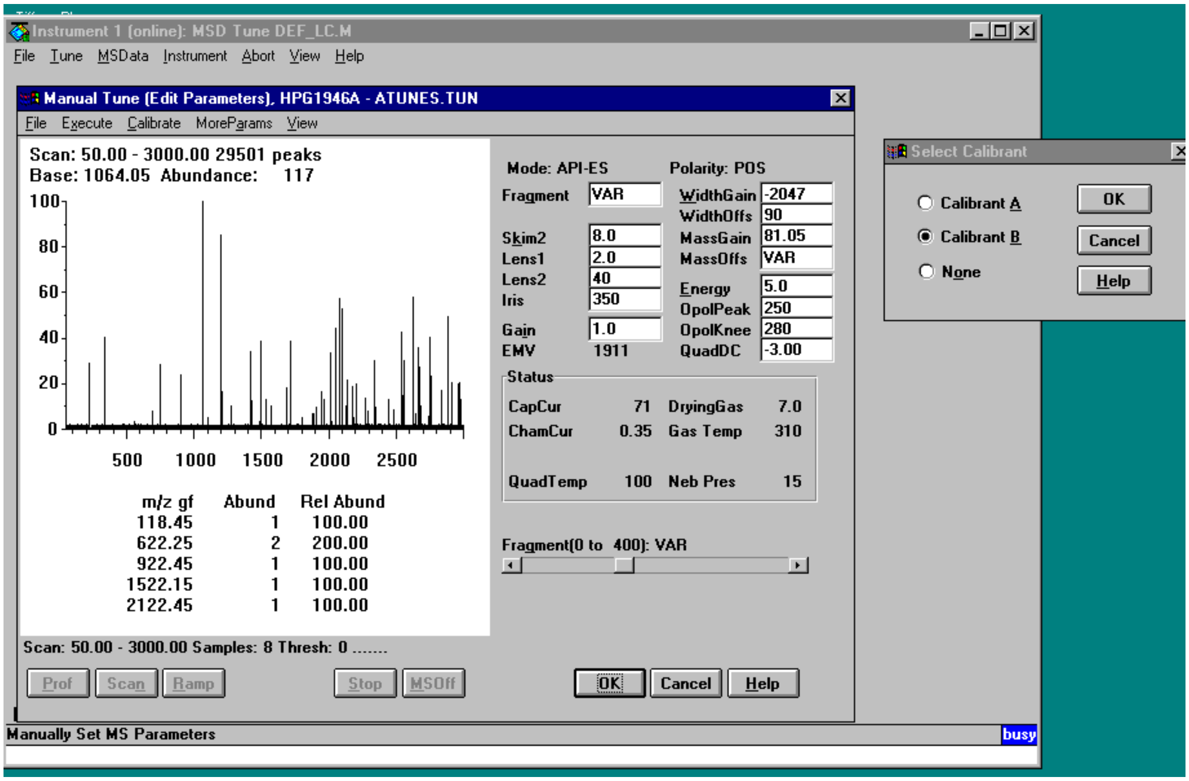
(Fig. 2)

How to Troubleshoot:

This symptom can be caused by any of the following:

- No calibrant flow
- No ions being created in the spray chamber
- The quads not functioning properly and filtering out all masses
- No HED voltage
- No EM voltage
- A bad EM dynode
- Bad or disconnected cables for the HED or EM voltage
- Bad or disconnected signal cable from the EM dynode
- Bad signal cable from the signal feedthrough in the vacuum manifold to the log amp
- Bad log amp or detector board

For this problem, you can go into Manual Tune and do a spectrum scan, and you will notice that the Cap Current and the Chamber Current have typical readings, indicating that calibrant is flowing to the source and the source is generating ions. Also, the spectrum shows some noise peaks (see Fig. 3).



(Fig. 3)

To check to see if the quad is functioning properly, first do a quad electronics test in Diagnosis. This will verify the proper quad frequency and RFPA adjustment, so indirectly it will verify that the quad RF electronics are functioning properly. It doesn't check the U+/U-, but if there is a problem with those voltages it is usually that they are too low or are missing--in that case you will either get a Quad DC fault or you will get tune peaks that are too wide.

Another problem with the quad that could cause the tune peaks to disappear is if the WidthGain and/or WidthOffset are set too high, and therefore you are overresolving the tune masses. To check this, set the WidthGain and WidthOffset values to their maximum negative settings (-2047). If you now have wide peaks, then the problem might be that you need to properly adjust the WidthGain and WidthOffset. If the peaks are still missing, then the problem is likely not in the quads or quad circuit.

Next, you should verify that the EM and HED voltages exist. To check the EM volts, remove the EM voltage cable (black cable that plugs straight onto feedthrough) from the feedthrough at the vacuum manifold, set the EM gain to a value such that the EMV is in a range that your voltmeter can measure (you can set the EM gain down to a minumum of 0.1), then start a repeat profile. Measure the DC volts at the pin on the inside of the connector at the end of the cable.

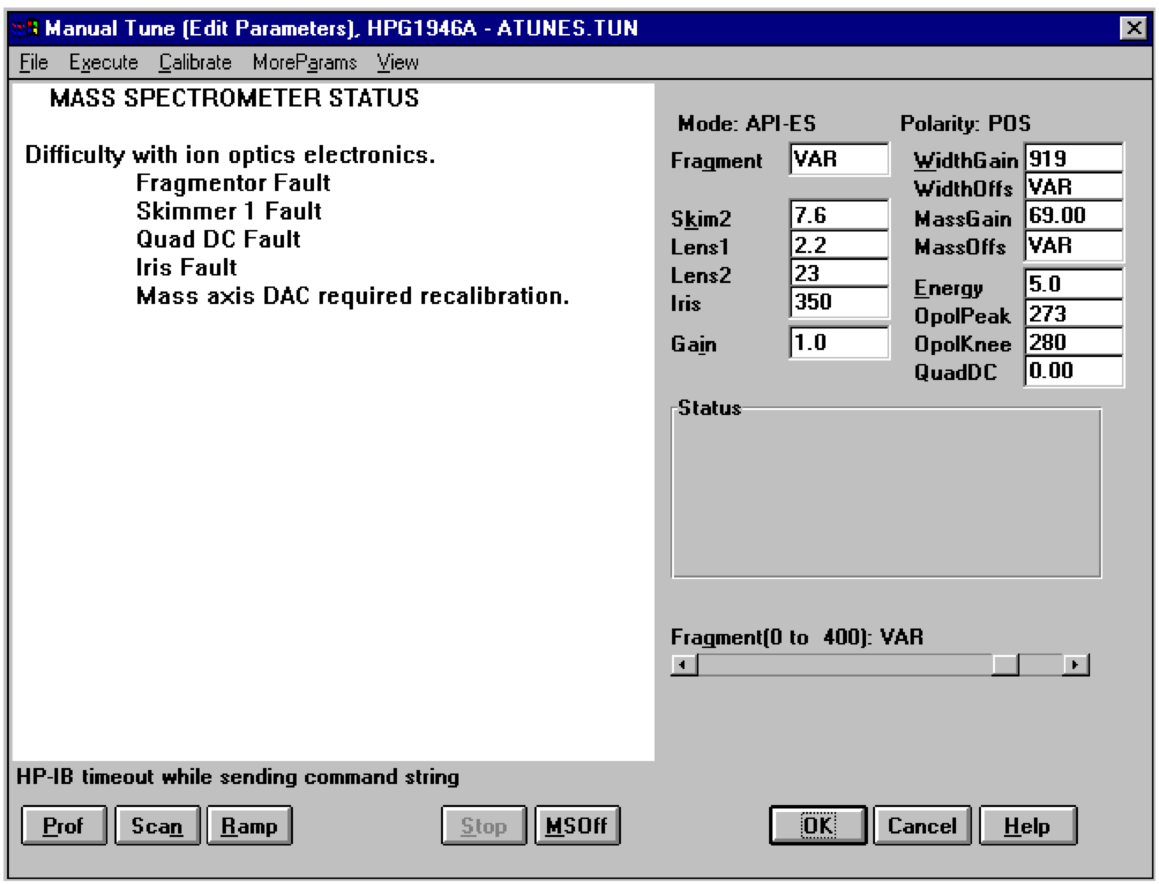
To measure the HED voltage, first do an MSOFF to turn off the voltages, then remove the HED cable (white cable that plugs straight onto feedthrough) from the feedthrough at the vacuum manifold, then use the command 'HED 1000' to set the HED to 1000 volts, then start a repeat profile. Measure the DC volts at the pin on the inside of the connector at the end of the cable. For this problem you would measure no voltage. You should make the same measurement at the connector on the HED supply itself. If there is still no voltage there, then it is either a bad HED supply, a bad detector card which drives the HED supply, a bad ribbon cable between the detector card and HED supply, or a bad connection with the ribbon cable. Before replacing the detector card or HED supply, check the ribbon cable, check the pins at the connectors for the ribbon cable at both the detector card and the HED supply, and then make sure that the ribbon cable is connected properly at both the detector card and HED supply.

Bent pin on bottom of adapter board

Symptoms:

When you attempt a repeat profile scan in manual tune, you will get a series of errors (see Fig. 1):

"Difficulty with ion optics electronics…
    Fragmentor Fault
    Skimmer 1 Fault
    Quad DC Fault
    Iris Fault
    Mass axis DAC required recalibration"



(Fig. 1)

If you attempt to acquire data, you will get a "Shutdown" error when the MSD turns on, and the MSD icon in Method and Run Control view will turn red.

How to Troubleshoot:

All the faults are related to the analyzer board, however it is unusual to get all the faults generated together at once. This indicates that there is either a problem with the analyzer board, or a bent pin on the connector at the bottom of the analyzer board, or a bent pin on the connector at the bottom of the adapter board. Especially the error "Mass axis DAC required recalibration" cannot be generated by any instrument fault condition, only by a failure of the fault circuit on the analyzer board or by a bent pin at the connectors.

To troubleshoot this problem, you could disconnect the fragmentor, skimmer 1 and iris cables from the analyzer board, then try a repeat profile again. You would see that you would still get faults associated with those lens elements. This would further confirm that either the analyzer board was bad or there was a bent pin on a connector connecting to the backplane.

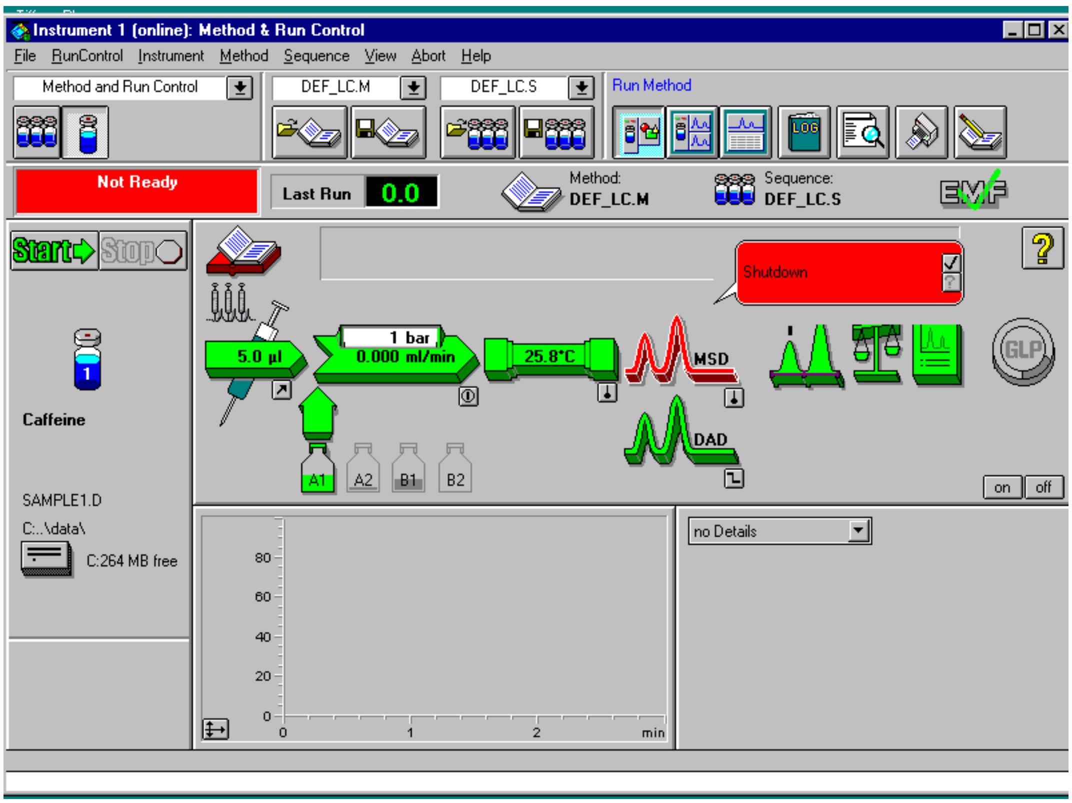
Before replacing the analyzer board, you should remove both the analyzer board and adapter board and inspect the connectors. If you did that, you would find a bent pin on the adapter board (pin #1). You can straighten the pin to correct the problem.

A bent pin on the adapter board will give you these series of errors because all of the data that is sent to and received from the other boards in the backplane goes from the backplane, through the adapter board, and then to the SmartCard. If there is a bent pin on the adapter board, the data, including fault status data, will not be delivered properly to the SmartCard, and the SmartCard might interpret the faulty data as an instrument fault.

Bad +15 Volts on PDB

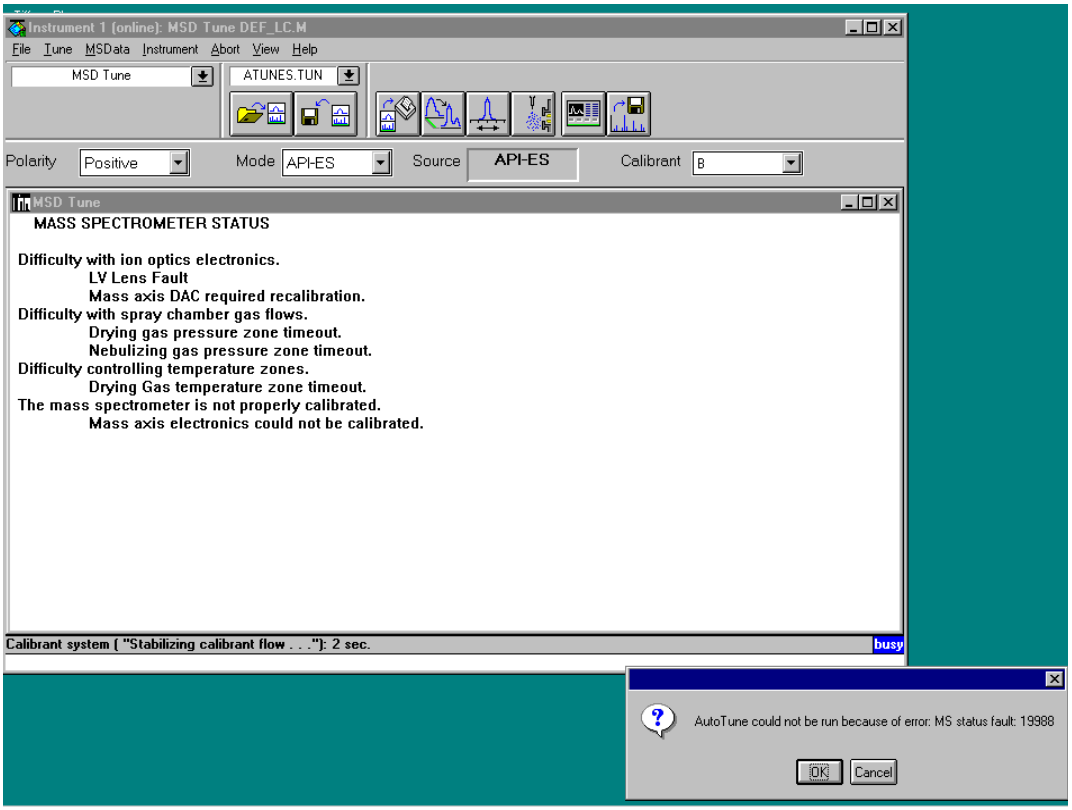
Symptoms:

When you start up the ChemStation and go into Method and Run Control view, the MSD comes up “red” and indicates a “Shutdown” error (see Fig. 1).



(Fig. 1)

When attempting to autotune, a temperature equilibration timeout occurred and lengthy status message was reported (see Fig. 2).



(Fig. 2)

How to Troubleshoot:

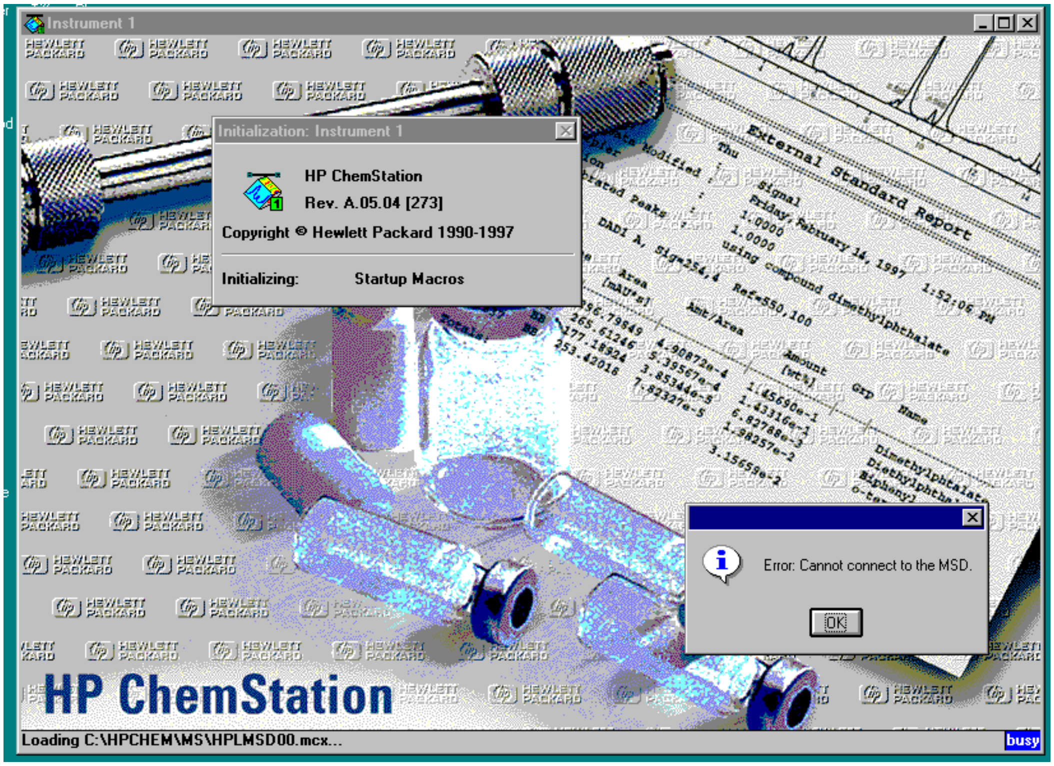
Because of the variety of error messages when attempting to autotune, you should suspect a power problem.

Measure the DC voltages off the octopole board. You can measure +5, +/-15, and +24 V. For this problem you would find that the +15 V was missing. You should then check the +15 volts on the PDB board with the electronics tubs magnetic switch open (to disconnect the voltage supply from the load of the other boards in the electronics tub). You would find that the +15 volts was missing on the PDB board. This would then mean that either the PDB board was pulling down the +15 volts or the main power supply was not generating the voltage. To isolate it further, you can check the resistance of the +15 V test point to both digital ground and chassis ground. Do this with both the board installed and removed from the electronics tub. If you don't find a short to ground, then the problem is with the main power supply not generating the +15 V, so replace the main power supply. If you find a short, and it still exists with the PDB board removed, then the problem is with the PDB board.

Cover interlock switch is open

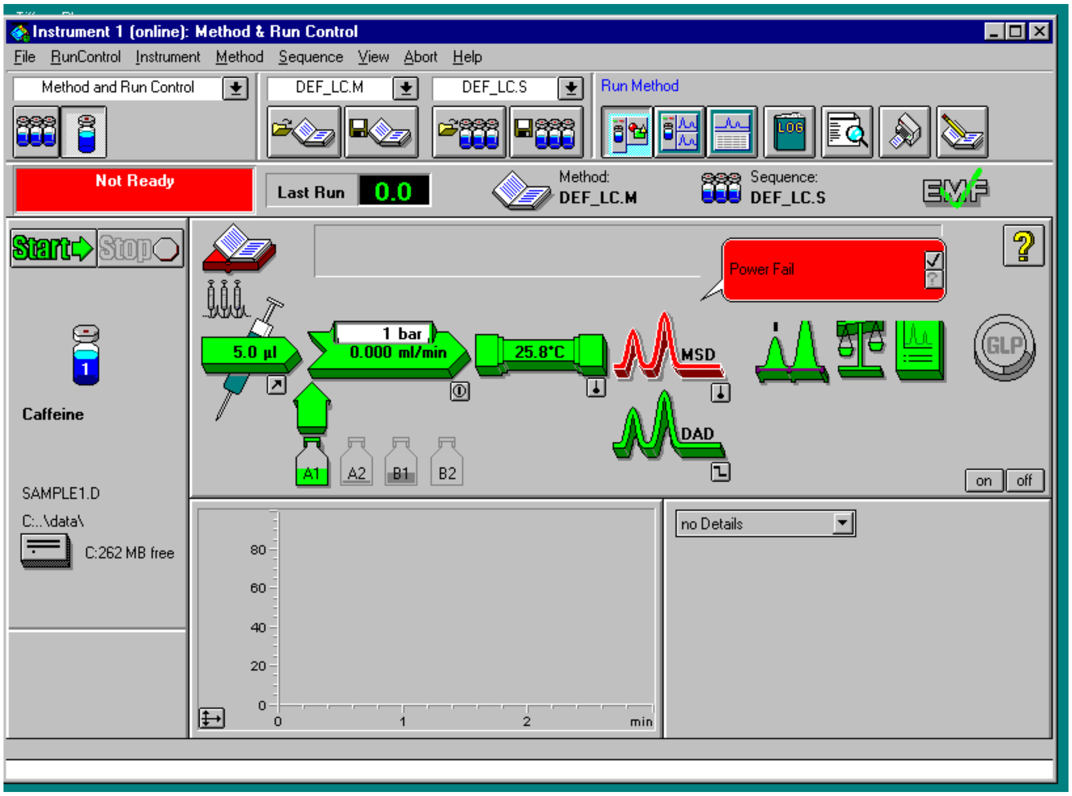
Symptoms:

When you start up the ChemStation, you will get the error: “Cannot connect to MSD” (see Fig.1).



(Fig. 1)

When you go into the Method and Run Control view, MSD will be red and in a “Power Fail” condition (see Fig. 2).



(Fig. 2)

How to Troubleshoot:

The power fail condition means that either there is no +5 volts to the SmartCard or the computer cannot communicate with the SmartCard. Since the LC modules come up green, that means that the computer can communicate with the LC, so it is either a problem with the SmartCard or the power.

The first thing to do is to measure the DC voltages on the octople board. Measure the +5, +/-15, and +24V. You would find that all voltages measure 0. Next you should measure the voltages at the PDB board. You would find that all the voltages are present on the PDB board. This means that there is either a problem with the cover interlock switch, or the flex cable connection between the PDB board and the adapter board, or a problem with the adapter board.

MS Utilities Help

Description

The MS utilities macros can be grouped into several categories, as follows:

Gain Utilities

- **Gain**
- **CalibGain**
- **PrintGain**
- **ShowGain**
- **ResetEMGain**
- **BurnGain**
- **PlotGain**
- **ShiftGain**
- **ClearGain**

Quad Frequency Utilities

- **QF**
- **SetQF**
- **DipQF**
- **BurnQF**

Quadrupole Temperature Utilities

- **QT**
- **SetQT**
- **BurnQT**

Quad Polarity Utilities

- **QP**
- **BurnQP**

Firmware Identification Utilities

- **MSID**
- **SCID**
- **PDBID**
- **SBID**
- **TCID**
- **LONversion**
- **CheckVer$**

General Utilities

- **ShowRF**
- **Recapture**
- **HED**
- **RampHED**
- **Set_Lag**
- **Flt**
- **MSLight**
- **Set1946A**
- **Set1946B**
- **PSDelay**
- **BurnPSDelay**
- **MStnPrintError**
- **ShowRamp**

MS Non-Real Time Subsystem macros

Power Distribution, flow and temperature control

Gain Utilities

Gain

Description

This macro is used to determine whether the gain measurement is likely to be valid or not by measuring gain and ion current with two different mass peak widths. If the gain measurement is valid (not compromised by error due to noise), then the gain should be the same in both measurements and the abundance and ion current measurements should increase by the same amount.

Returns a gain number with confirmation. Also returns ion current data.

Syntax:

```
Gain [massnum] default=622
```

GUI:

None. Values returned on message line.

CalibGain

Description

Runs a gain calibration using default parameters.

Syntax:

```
CalibGain
```

GUI:

There will be a menu item in MS Tune View and Diagnosis View to run a calibration. This utility will display a pass or fail message on the status line.

PrintGain

Description

Displays and prints the requested gain calibration curve. If the requested calibration does not exist, an error message is printed. If the gain calibration register and the gain calibration file don't exist, new, default gain calibration register and files are created.

Syntax:

```
PrintGain [WhichCalib], DisplayLevel
```

Default calibration to be printed is #1 (most recent).

DisplayLevel controls the level of detail used when displaying the gain calibration evaluation.

0: no evaluation data
1: typical evaluation criteria
2: maximum display

Default calibration to be printed is #1 (most recent).

GUI:

None. User should type listmessages on, or turn on logging, to view error output.

ShowGain

Description

Displays the requested gain calibration curve. If the requested calibration does not exist, an error message is printed. If the gain calibration register and the gain calibration file don't exist, new, default gain calibration register and files are created.

Syntax:

```
ShowGain [WhichCalib] ], DisplayLevel
```

Default calibration to be printed is #1 (most recent).

DisplayLevel controls the level of detail used when displaying the gain calibration evaluation.
0: no evaluation data
1: typical evaluation criteria
2: maximum display
Default calibration to be displayed is #1 (most recent).

GUI:
None. User should type listmessages on, or turn on logging, to view error output.

ResetEMGain

Description
Sets the EM gain coefficients in the LC/MSD memory to defaults.
Syntax:
`ResetEMgain`

GUI:
Dialog boxes ask the user for confirmation and whether to display the new instrument calibration curve (dgMSshowGain).

BurnGain

Description
Sets the EM gain coefficients in the LC/MSD memory using a specified gain calibration. By default, the latest passing calibration is used.
Syntax:
`BurnEMgain [WhichCalib]`
If WhichCalib is specified on the command line, that calibration is burned. If that calibraion is failing, an error dialog is presented.
GUI:
The latest passing calibration is presented in a dialog box for confirmation. If a failing calibration is requested, a warning dialog box is presented.

PlotGain

Description
Displays the current instrument's EM gain curve as a graph of EMV vs. gain.
Syntax:
`Plotgain [PrintOut]`
If PrintOut is set to 1, a printout is generated. Default is 0 (no printout)

GUI:
The gain calibration curve is displayed in a window on screen. If PrintOut is 1, then a printed copy is generated.

ShiftGain

Description
Gain compensation: shifts gain curve by the specified voltage delta.
The new StdEMV will be clipped to 1600 (min) and 2700 volts (max).
Syntax:
`Shiftgain [deltaEMV] default=0`
GUI:
Excecuted by command line only. May also be called by Autotune program. In this case, a dialog box will alert the user that ShiftGain was performed.

ClearGain

Description

Clears the EM gain calibration register. The user is prompted to back up the existing register if desired.

Syntax:

```
ClearGain
```

GUI:

Executed by command line only.

Quad Frequency Utilities

QF

Description

Displays the current quad frequency and the power-on quad frequency. They are usually the same, unless the quad frequency has been adjusted but not stored.

Syntax:

```
QF
```

GUI:

None. Output is to the status line.

SetQF

Description

Sets the quad frequency, in Hz. No range checking is performed, so if the number is not close to correct, quadrupole electronics faults will occur. The new quad frequency and the power on quad frequency are reported.

GUI:

None. Output is to the status line.

Syntax:

```
SetQF [QuadFreq]
```

If no frequency is specified, an error message occurs and the
Quad frequency is not changed.

Global Variables:

```
None
```

DipQF

Description

Determines the optimal quadrupole frequency. The power on quad frequency is not changed. To store the new quad frequency, use **BurnQF**.

Syntax:

```
QF
```

GUI:

None. Output is to the status line.

BurnQF

Description

Stores the current quad frequency in the LC/MSD's non-volatile memory as the power-on quad frequency..

Syntax:

```
QF
```

GUI:

None. Output is to the status line.

Quadrupole Temperature Utilities

QT

Description

Displays the current quadrupole temperature, current quadrupole temperature setpoint, and the power-on quadrupole temperature setpoint.

Syntax:

```
QT
```

GUI:

None. Output is to the status line.

SetQT

Description

Sets the current quadrupole temperature setpoint. If no temperature is specified, an error message is displayed.

Syntax:

```
SetQT [NewTemp]
```

There is no default newTemp. If no temperature is specified, an error occurs.

GUI:

None. Output is to the status line.

BurnQT

Description

Sets the power-on quadrupole temperature setpoint. If no temperature is specified, an error message is displayed.

Syntax:

```
BurnQT [NewTemp]
```

There is no default newTemp. If no temperature is specified, an error occurs.

GUI:

None. Output is to the status line.

Quad Polarity Utilities

Glossary: Quad polarity refers to the orientation of the DC voltages applies to the quadrupole mass filter. These polarities are given the designations 0 or 1. For a given quadrupole, there is a favored quadrupole polarity for positive ion and another for negative ion. These are stored ("burned") in the instrument's non-volatile memory. If the original quad polarity settings for the LC/MSD are lost or mis-set, there can be a severe degradation in instrument performance.

QP

Description

Sets or displays the current quadrupole polarity for the current ion polarity. If no polarity is specified, the current setting is displayed. Note that this does not change the power-on quadrupole polarity setting.

Syntax:

```
QP [NewQP]
```

There is no default newQP. If no quad polarity is specified, the current quad polarity is displayed.

GUI:

None. Output is to the status line. A messages is printed to remind the user that the new setting is not stored.

BurnQP

Description

Sets the power-on quadrupole polarities. Changing the quadrupole polarity incorrectly can seriously affect the performance of the mass spectrometer.

Syntax:

```
BurnQP [PosIonQP], [NegIonQP]
```

There are no default quad polarity settings.. If no quad polarities are specified, an error message is displayed.

GUI:

None. Output is to the status line.

Firmware Identification Utilities

MSID

Description

Sets or displays the LC/MSD serial number. If no serial number is specified, the current serial number is displayed. Any text string, up to 10 characters long, will be stored in the LC/MSD's non-volatile memory.

Syntax:

```
MSID
```

GUI:

None. Output is to the status line.

SCID

Description

Displays the current HP-IB identification string for the mass spectrometer. This text identifier consists of four fields:

Manufacturer, Model number, Serial Number, Firmware Revision.

Syntax:

```
SCID
```

GUI:

None. Output is to the status line.

PDBID

Description

Displays the LC/MSD Power Distribution Board firmware revision.

Syntax:

```
PDBID [verbose]
```

If verbose is 0, output is suppressed. Verbose is set to 1 by default. Sets the global variable PDBID$.

GUI:

None. Output is to the status line.

SBID

Description

Displays the LC/MSD SICB/LON Board firmware revision.

Syntax:

```
SBID [verbose]
```

If verbose is 0, output is suppressed. Verbose is set to 1 by default. Sets the global variable SBID$.

GUI:

None. Output is to the status line.

TCID

Description

Displays the LC/MSD Turbo Controller Interface firmware revision.

Syntax:

```
TCID [verbose]
```

If verbose is 0, output is suppressed. Verbose is set to 1 by default. Sets the global variable TCID$.

GUI:

None. Output is to the status line.

LONversion

Description

Displays firmware revisions for the various LON (local operating network) nodes in the LC/MSD. Will report communication errors if any of the revision strings can't be read. Note: To positively verify communication, it may be necessary to execute the MSSCINIT 1 command first.

Syntax:

```
Print CheckVer$()
```

Returns:

"completed" or "failed: communication error"

GUI:

None. Output is to the status line. The macro opens the listmessages window to display its output.

CheckVer$

Description

Displays LC/MSD serial number, revision strings for the ChemStation software and all LC/MSD firmware, including SmartCard, Power Distribution Board (LON and 8332), SICB-LON Board, Turbo Controller Interface, Ion Gauge and Convectron Gauge.

Syntax:

```
Print CheckVer$()
```

Returns:

"completed" or "failed: communication error"

GUI:

None. Output is to the status line. The macro opens the listmessages window to display its output.

General Utilities

ShowRF

Description

Executes the MSSetRFPA command at the specified m/z value while displaying the RF drive value. The number of readings of RF drive is specified by the count parameter. RF drive represents the % output of the quadrupole RF electronics. If the RF drive value exceeds about 95%, high mass transmission may be reduced or quadrupole faults may occur. See Quadrupole Electronics Test for more information.

Syntax:

`ShowRF [mz], [count]`

`mz` is the m/z value that the quadrupole electronics are set to (default is 1000).
`Count` is the number of repetitive readings to be taken. (default is 3)

GUI:

None. Output is to the status line.

Recapture

Description

Executes the MSCapture command at the specified m/z. The quadrupole mass filter is set to the specified m/z value and the raw signal from the multiplier is collected and displayed. This can be useful for estimating signal stability or for detecting fast noise events such as droplet noise or flow dropouts. The MS Tune window will display the signal, with mean, min, max and standard deviation. The status line will display %RSD (Standard deviation/mean).
This macro will repeat until the Abort menu item is selected.

Syntax:

`Recapture [mz], [CapPer], [do_prof], [nPts]`

`mz` is the m/z value that the quadrupole electronics are set to (default is 622.03).
`CapPer` Is the sampling rate in milliseconds. The allowable range is 25 to 250 µsec. (default is 100)
`Do_Prof` executes an MSProfile before beginning the capture. This ensures that all of the voltages to the entire MS are on. If set to 0, no MSOn occurs and the signal with all voltages off can be viewed. (Default is 1 (on))
`NPts` is the number of samples per capture. The allowable range is 10-10,000. (default is 10,000).

GUI:

None. Displays the MSCapture signal in the MS Tune window. Output is to the status line.

HED

Description

Reads or sets the High Energy Dynode (HED) voltage, which is typically set to 10 kV. Changing the HED voltage is usually only done for diagnostic purposes. For example, setting it to zero volts and comparing the results can indicate whether the HED voltage is having an effect.
If a voltage is not specified or is less than zero, the current setting is displayed. If the new voltage is above the maximum (10 kV), then the HED setting will be 10 kV.

Syntax:

`HED [newVoltage]`

If newVoltage is not specified, the current setting is displayed on the command line.

GUI:

None. Output is to the status line.

RampHED

Description

Executes a SIMramp of the HED. This can be useful for diagnostic purposes. Note that ramping the HED can take much longer than ramping other tuning parameters. By default, only one ion (#3) is ramped. Other ions can be selected by their number. If ion number 0 is specified, all selected ions will be ramped.

Syntax:

```
RampHED [massNumber]
```

massNumber: which ion to ramp. Default is 3.
If massNumber is between 1 and 6, that ion will be ramped
If massNumber is 0, all selected ions will be ramped.

GUI:

None. The SIMramp is displayed in the MS Tune window. Output is to the status line.

Set_Lag

Description

Calculates and sets the mass assignment lag factors for the LC/MSD. Mass #2 is scanned at a range of scanning speeds to calculate the lag factors, which are then stored in the LC/MSD's non-volatile memory. If there is insufficient signal at mass #2, Set_lag will abort with an error. If the mass peak width is too great (> 0.80), the new lag factors may be unreliable.

Syntax:

```
Set_Lag [massNumber], [Threshold]
```

MassNumber specifies the ion to be used for calibrating the mass assignment lag factors. (Default: #2)

Threshold specifies the minimum signal required to calculate the lag factors. (Default: 10,000 counts)

GUI:

None. The new mass assignment lag factors are displayed in a dialog box.

Glossary: Mass assignment lag factors are used to correct for changes in mass assignment due to scan speed differences. If these are not set, there may be consistent mass assignment errors when scanning at sampling rates of < 4.

Flt

Description

Generates an MS Fault Report, which will report errors from three sources:

Tune - the last MS fault that occurred in the MSD tune view or during Manual Tune from the diagnosis view

LogBk - The last MS Fault that was recorded in the error logbook

Actual - Any MS Fault that is currently being reported. Note that MS Faults are latched, which means they will be held in the MSD until they are reported or until the MSD is scanned again.

The MS Faults dialog box contains a print button if a paper copy of the fault report is desired.

The MS Fault Report is also available by selecting the the log book icon the MSD Instrument panel in Diagnosis view

Syntax:

```
flt
```

GUI:

A panel displaying the decoded error messages with print and exit buttons.

MSLight

Description

Tests the LC/MSD status display light, found on the upper right-hand corner of the instrument's front panel. The light is set to off, green, yellow and red and the user is asked to note whether the expected color is being displayed.

Syntax:

```
MSLight [PrintReport]
```

If PrintReport is set to 1, then the results of each comparison are printed. Default is 0. (No printed report).

GUI:

Interaction is via dialog boxes. The macro declares pass or fail.

Set1946A

Description

Configures SmartCard for a G1946A

Syntax:

```
Set1946a
```

GUI:

Executed from command line only.

Set1946B

Description

Configures SmartCard for a G1946B

Syntax:

```
Set1946b
```

GUI:

Executed from command line only.

PSDelay

Description

Sets the polarity switching delay. Default is 300msec.

Syntax:

```
Psdelay [NewPSDelay] default= -1
! by default, only reports the delay
! Use burnPSDelay to change power-on default
```

GUI:

Executed from command line only

BurnPSDelay

Description

Stores a new polarity switching delay value to non-volatile RAM

Syntax:

```
burnpsdelay [NewPSDelay] default= -1
! must follow with msscinit to load burnpsdelay value
```

GUI:

Executed from command line only

MStnPrintError

Description

Formatted error message to the status line. Used in error traps by many of the MS utilities.

GUI:

None. If the error is replaced by other output on the status line, the user can type listmessages on, or turn on logging, to view the output.   Also, the last error message can be redisplayed by typing MStnPrintError

Syntax:

```
MStnPrintError
```

SIMramp report `(macro file: enutnrmp.mac)`
ShowRamp

Description

Generates a report of SIMramps for all rampable parameters. This report can be used in a diagnostic situation to help determine whether the ramps are typical or not. Very often, an atypical ramp can be a useful indicator of a specific problem.

The report contains the following information:

Page 1: Fragmentor, Skim1, Skim2 (unlinked) SIMramps
Page 2: Fragmentor, Skim1, Skim2 (linked) SIMramps
Page 3: Octopole Peak, Lens 1, Lens 2 SIMramps
Page 4: Quad DC Offset, Iris, and HED SIMramps
Page 5: Profile and scan
Page 6: Tune file parameters

Note that only four ions are ramped, namely ions 1,2,4, and 5 if five tune masses are selected, or 1, 2, 4, and 6 if six tune masses are selected.

GUI:

None.

Syntax:

```
ShowRamp IonIndex, TuneFile$

      IonMode specifies which ion polarity to use:
           0: positive ion.
        1: negative ion.
        2: both pos and neg ions.
        9: current ion. (default)
```

By default, the current tune file and current ion polarity are used

MS Non-Real Time Subsystem macros

Power Distribution, flow and temperature control

PDBfault

Description

PDBfault displays the status of the portions of the LC/MSD controlled by the Power Distribution Board, which include power distribution, flow and temperature control and Calibrant Delivery System (CDS) control.
Whenever there is a change in PDB status or a PDB fault occurs, an event is logged in the non-volatile memory on the PDB. There is room for up to 10 events, numbered 0-9. These can be retrieved by specifying the event number, for example:

```
PDBfault 3
```

PDBfault output is time-stamped using GMT or Universal time.
To see the full output, set `listmessages on`.

See PDBlog to generate a report with current status information and all logged events.

See PDB Status and Fault Information

Syntax:

```
PDBfault [Event number]
```

If the event number is not specified, the current state is displayed.
The allowed range for event number is 0-9. Any number greater than 9 will display event number 9 with no warning message.

GUI:

None. Output is to the status line. To see the full output, the user must first type:

```
listmessages on
```

PDBlog

Description

PDBlog generates a report of the current PDB fault and status information and all available PDB fault events (10 maximum). The report is stored in the Tune directory with the name pdblog.txt. To clear previous logs, type PDBlog 1.
PDBlog output is time-stamped using GMT or Universal time.

See PDB Status and Fault Information

Syntax:

```
PDBlog [Overwrite]
```

By default, the log is appended to earlier files. To overwrite the log, use PDBlog 1.

GUI:

None. Output is to a file, _tunePath$ + "pdglog.txt", which is displayed in the ChemStation viewer.

PDB Status and Fault Information

The HP 1100 LC/MSD Power Distribution Board (PDB) monitors the following status and fault items:

Status Information

- Rough Pump State [On or Off]

This refers to the state of the relay that powers the rough pump. If the rough pump is not plugged into the LC/MSD or the rough pump power switch is off, the rough pump will not be controlled by the LC/MSD.

- SSV stepper [Clockwise or Counter-clockwise]
  The Stream Selection Valve directs the flow from the LC inlet to the spray chamber (LC to MSD) or to waste (LC to Waste). The clockwise position corresponds to LC to MSD and the counter-clockwise position corresponds to LC to Waste. This item refers to the logical state of the valve. If the limit switch state (below) does not agree, there will be a fault. See MSD Stream Selection Valve.
- SSV Counter-clockwise limit switch Active
- SSV Clockwise limit switch Active
  The Stream Selection Valve has two limit switches to confirm that the valve is in the expected position. If neither or both are active, there is a problem with the valve.

- CDS valve 1 On
- CDS valve 2 On
- CDS valve 3 On
- CDS valve 4 On
- CDS valve 5 On
  If any of the CDS valves are off, the valve will not be listed. Note that this refers to the logical state of the valve, not the actual state, which cannot be sensed. See CDS Valves.

- Manual injector in Inject position
  The optional manual injector has a switch to detect when it is in the Inject position. If the inject position is not sensed, this item will not be listed.

Fault Information
These faults are monitored and reported by the MS Fault system whenever the LC/MSD is actually acquiring data or tuning. The PDB fault logs can be used to detect events that occurred in the past or when the LC/MSD is not acquiring data.

- 110V relay [Disabled or Enabled]
  If a fault is detected in any of the temperature control zones, the 110 Vac power supply is disabled to prevent a possible temperature runaway.

- 28V supply voltage [Too High or Too Low]
  The 28V power supply is used by the RF power amplifier. If the voltage is within the limits, no message is displayed. Note that if the vacuum system is in a fault or not ready state (foreline pressure too high), the 28V power supply is shut down to prevent a quadrupole electronics turnon. In this case, the 28V supply will be reported as being too low.

- 24V supply voltage [Too High or Too Low]
  If the 24V power supply voltage is within limits, no message is displayed.

- 110V zero cross Not Detected
  If the 110V relay is not disabled, the 110V fuse may have blown, or there may be a connection problem with the 110V transformer.

- Drying gas thermal runaway
- Quad thermal runaway
- APCI vaporizer thermal runaway
  The measured temperature is above the measurement range.

- Quad Timeout (too long at full power)
- Drying gas Timeout (too long at full power)
- APCI vaporizer Timeout (too long at full power)
  A thermal runaway is detected whenever the a heater circuit is at 100% duty cycle (temperature has not reached setpoint) for a defined period of time. The timeout period can be seen in the Diagnosis view, or by using the MSZoneTimeout command.

- Quad sensor Open
- Drying gas temp sensor Open
- APCI sensor Open
  A temperature sensor has an open circuit. This may be due to a connection problem or a hardware failure.

- Quad sensor Shorted
- Drying gas temp sensor Shorted
- APCI sensor Shorted
  A temperature sensor has a short circuit.

- Drying gas flow Timeout (too long at full power) - Check Gas Supply
- Nebulizer flow zone Timeout (too long at full power) - Check Gas Supply
  The setpoint for flow or pressure has not been reached within the timeout period. This is most commonly due to having low inlet gas pressure, and may only occur at high drying gas flow rate and/or high nebulizer gas pressure.

- Drying gas flow sensor Open
- Nebulizer flow sensor Open
  A pressure sensor has an open circuit.

- Drying gas flow sensor Shorted
- Nebulizer zone sensor Shorted
  A pressure sensor has a short circuit.

- Leak detected
  There is a leak sensor in the CDS assembly which can detect liquid leaks from the CDS valves, the stream select valve or the manual injection valve. A leak may be erroneously reported if the leak sensor is not properly calibrated. See LeakCal and GetLeakCal.

- Vacuum shutdown Active
  This condition is reported when the ion gauge is not turned on. This is most likely to occur when the turbo pumps are not both above 90% speed, when the pressure in stage 4 is very high (> 3 * 10^{-3} Torr), when there is a communication problem between the gauge and the Power Distribution Board, or when there is an ion gauge hardware failure.

Clearing PDB faults

Some PDB faults, such as a runaway state, must be cleared manually. To clear all PDB faults, use PDBreset or MSSCinit 1**.** MSSCinit 1 will also reset all the other instrument functions, while PDBreset will only clear power distribution board functions.

MSZoneTimeOut

Description

Each of the flow and temperature control zones has an associated timeout value. If the heater temperature, gas flow or gas pressure is not reached within the timeout period, a fault is declared and the zone is shut down.
The timeout values are stored in the LC/MSD's non-volatile memory. They can be seen in the Diagnosis view in the variables display.
The timeout values should only be changed if directed by Hewlett-Packard service or support personnel. If the timeout is set too short, unnecessary faults will occur; if it is set too long, gas may be wasted or thermal damage may occur.

Zone_id	Zone Name	Default Timeout
1	Drying Gas Flow	13.7 sec.
2	Nebulizer Gas	13.7 sec.
3	Drying Gas Temp	12.3 min
4	Quad Temp	88.0 min
7	APCI Vaporizer Temp	4.4 min

Syntax:

`MszoneTimeout zone_id, [value]`

Valid zone_id values are 1 through 4 or 7. If no `zone_id` is specified, an error message occurs.
If `value` is not specified, the current value is displayed. Value is in seconds for drying gas flow and nebulizer pressure, and in minutes for heated zones.

GUI:

None. Output is to the status line.

MSZonePID

Description

Each of the flow and temperature control zones has temperature control constants that are tuned for that specific zone. These PID values are stored in the LC/MSD's non-volatile memory. They can be seen in the Diagnosis view in the variables display.
The PID values should only be changed if directed by Hewlett-Packard service or support personnel. If these are mis-set, temperature or flow problems may occur.
The default values are shown in the table below.

Zone_id	Zone Name	P	I	D	ID
1	Drying Gas Flow	10	1	1	1
2	Nebulizer Gas	10	1	10	1
3	Drying Gas Temp	165	2	1024	1
4	Quad Temp	3000	0	0	1
7	APCI Vaporizer Temp	512	2	0	1

Syntax:

`MszonePID zone_id, [P], [I], [D], [ID]`

Valid zone_id values are 1 through 4 or 7. If no `zone_id` is specified, an error message occurs.
If no P, I, D or ID values are specified, the current values are displayed. If one or more P, I, D or ID values are specified, only those are changed.

GUI:

None. Output is to the status line.

Vacuum System Control

VacInfo

Description

Displays vacuum system status and fault information, turbo pump speed and power, foreline pressure and high vacuum pressure. To see the full output, set `listmessages on`.

Syntax:

`vacinfo`

By default, the log is appended to earlier files. To overwrite the log, use PDBlog 1.

GUI:

None. Output is to the status line. To see the full output, the user must first type:

```
listmessages on
```

TPCfault

Description

TPCfault displays status and fault information for the turbo pump controller (TPC) interface. Whenever there is a change in TPC status or a TPC fault occurs, an event is logged in the non-volatile memory in the TPC interface. There is room for up to 10 events, numbered 0-9.

These can be retrieved by specifying the event number, for example:

```
TPCfault 3
```

TPCfault output is time-stamped using GMT or Universal time.

To see the full output, set `listmessages on`.

See <u>TPClog</u> to generate a report with current status information and all logged events.

See <u>TPC Status and Fault Information</u>

Syntax:

`TPCfault [Event number]`

If the event number is not specified, the current state is displayed.

The allowed range for event number is 0-9. Any number greater than 9 will display event number 9 with no warning message.

GUI:

None. Output is to the status line. To see the full output, the user must first type:

```
listmessages on
```

TPClog

Description

TPClog generates a report of the current TPC fault and status information and all available TPC fault events (10 maximum). The report is stored in the Tune directory with the name pdblog.txt. To clear previous logs, type TPClog 1.

TPClog output is time-stamped using GMT or Universal time.

See <u>TPC Status and Fault Information</u>

Syntax:

`TPClog [Overwrite]`

By default, the log is appended to earlier files. To overwrite the log, use TPClog 1.

GUI:

None. Output is to a file, _tunePath$ + "pdglog.txt", which is displayed in the ChemStation viewer

TPC Status and Fault Information

The HP 1100 LC/MSD Turbo Pump Controller interface (TPC) monitors the following status and fault items:

Status Information

- Vacuum state is [Off, Low, High, On]
  The vacuum system states are defined as:

State	Condition
Off	Both turbo pumps are in the Off state.
Low	Turbo 1 or Turbo 2 is not in the Off state.
High	Turbo 1 is On, Turbo 2 is not in the On state.
On	Turbo 1 and Turbo 2 are both in the On state.

- Turbo 1 state is [Off, Low, Med, High, On]
- Turbo 2 state is [Off, Low, Med, High, On]
  The turbo pump states are defined as:

State	Condition
Off	The turbo pump is commanded off and speed is < 10%.
Low	The turbo pump is commanded off and speed is < 50%
Medium	The turbo pump is in diagnostic mode (no interlocks)
High	The turbo pump is commanded on and speed is > 50%.
On	The turbo pump is commanded on and speed is > 90%.

- Turbo supply voltage is [Low, OK]
  If the turbo supply voltage is low, the LC/MSD will not pump down. Contact a Hewlett-Packard Customer Engineer.

- Turbo Controller is in diagnostic mode
  When the turbo controller is in diagnostic mode, all interlocks are disabled. To clear the diagnostic mode, the LC/MSD must be vented and turned off using the circuit breaker on the service panel.

- Turbo Pump 1 is not plugged in
- Turbo Pump 2 is not plugged in

- No communication with ion gauge
  This is most likely due to a connection problem or an ion gauge failure.

Fault Information

These faults are monitored and reported by the MS Fault system whenever the LC/MSD is actually acquiring data or tuning. The TPC fault logs can be used to detect events that occurred in the past or when the LC/MSD is not acquiring data.

- Foreline pressure too high

If the foreline pressure is too high, the turbo pumps will turn off. This will generally happen only in cases of rough pump failure or if there is a very large leak.

- No communication with foreline gauge
  If there is no communication with the foreline gauge, the vacuum system will shut down.

- Turbo LON Interface fault
  The turbo pumps have been commanded off, but are not slowing down.

- Turbo pump 2 fault
- Turbo pump 1 fault
  Power is being applied to the turbo pump but speed is not increasing. This could occur if a turbo pump rotor is frozen or if a turbo pump controller has failed.

- Turbo pump 2 pumpdown timeout
- Turbo pump 1 pumpdown timeout
  The turbo pumps do not reach 50% speed within 10 minutes.

Vacuum System Sensors

- Turbo 1 speed (%) and power (W)
- Turbo 2 speed (%) and power (W)
- Foreline pressure (mBar)
  Note that the pressure gauges report in mBar. To convert to Torr, use the following conversion: Torr = mBar * 0.76

TPCinfo

Description

Displays turbo pump speed, power, hardware and firmware revisions from the turbo pump controller.

Syntax:

`TPCinfo`

GUI:

None. Output is to the status line. To see the full output, the user must first type:

`listmessages on`

TurbosOn

Description

Commands the turbo pumps to go on. Note that they will only turn on if the foreline pressure is below the threshold, which is approximately 5 Torr. This command must be used if the turbos are turned off using TurbosOff.

This command is for diagnostic purposes only. For routine use, use the Pumpdown panel in the Diagnosis view, or turn the LC/MSD power switch on.

Syntax:

`TurbosOn`

GUI:

None.

TurbosOff

Description

Commands the turbo pumps to turn off. This indirectly turns off the high vacuum gauge, which only operates if both turbo pumps are above 90% speed.
This command is for diagnostic purposes only. For routine use, use the Vent panel in the Diagnosis view, or turn the LC/MSD power switch on.

Syntax:

```
TurbosOff
```

GUI:

None.

RPOn

Description

Commands the rough vacuum pump to go on. This may indirectly turn on the turbo pumps if they have been commanded on. This command must be used if the rough pump was turned off using RPOff.
This command is for diagnostic purposes only. For routine use, use the Pumpdown panel in the Diagnosis view, or turn the LC/MSD power switch on.

Syntax:

```
RPOn
```

GUI:

None.

RPOff

Description

Commands the rough vacuum pump to turn off, which will also turn off the turbo pums and the high vacuum gauge. It is highly recommended that the rough pump not be turned off while the turbo pump are turning faster than 50% speed.
This command is for diagnostic purposes only. For routine use, use the Vent panel in the Diagnosis view, or turn the LC/MSD power switch on.

Syntax:

```
RPOff
```

GUI:

None.

ForePres

Description

Displays the current rough vacuum pressure (in Torr) to the status line.

Syntax:

```
ForePres
```

GUI:

None.

HighPres

Description

Displays the current high vacuum pressure (in Torr) to the status line.

Syntax:

```
HighPres
```

GUI:

None.

Leak Sensor Utilities

LeakCal

Description

Calibrates the LC/MSD leak sensor. This may be necessary if spurious leaks are being detected, if no leaks are being detected, or if any of the leak sensors, CDS, or Power Distribution Board are replaced.

The leak sensor must be correctly positioned in a dry leak tray when the calibration is performed.

There is no way to set the leak sensor calibration value other than to run the calibration routine or to set it to zero (ClearLeakCal).

Syntax:

```
LeakCal
```

GUI:

None. Output is to the status line. If a value of 0 is reported, the leak sensor is disabled.

GetLeakCal

Description

Displays the calibration value for the LC/MSD leak sensor. If a value of 0 is reported, the leak sensor is disabled.

Syntax:

```
GetLeakCal
```

GUI:

None.

ClearLeakCal

Description

Clears the calibration value for the LC/MSD leak sensor, effectively disabling leak sensing.

Syntax:

```
ClearLeakCal
```

GUI:

None. Output is to the status line. If a value of 0 is reported, the leak sensor is disabled.

MS Non-Volatile Memory Macros

ShowNVR

Description

Reads all the values in non-volatile memory and generates a text file report, which is displayed in a viewer. (Example appended to file).

Syntax:

`ShowNVR [FileName$]`

FileName$: the report will be saved using the supplied file name.
Default: MSDNVRAM.TXT

GUI:

Output is directed to the ChemStation viewer.

SetNVR

Description

Input certain instrument identification information, including serial number, manufacturing date, quadrupole number, and presence of manual valve.

Syntax:

`SetNVR [Snum$], [QuadNum$], [MfgDate$], [MSValveP], [DONTASK]`

Snum$: Serial number, maximum length 10 characters
QuadNum$: Quadrupole serial number, maximum length 6 characters
MfgDate$: Manufacturing date, maximum length 8 characters.
MSValveP: 1 if manual injection valve is present, 0 if absent.
DONTASK: if set to 1, set only parameters provided on the command line.

GUI:

Dialog box interface.

BackupNVR

Description

Saves all instrument non-volatile memory values in the MSDNVR register. These values will be stored until the next BackupNVR operation. The user will be asked whether to read the values from the instrument first. If no is selected, the previously read values will be backed up. In offline mode, the instrument values are not read. See also RestoreNVR.

Syntax:

`BackupNVR [ReadFirst]`

ReadFirst: 1 – Read instrument values first
0 – Don't read from instrument.

GUI:

Command line interface

RestoreNVR

Description

Set all instrument configuration values using the values stored in the MSDNVR register.

```
!See BurnNVR for a description of the precedence rules used when restoring values.
!See also BackupNVR.
```

Syntax:

BackupNVR
ReadFirst: 1 – Read instrument values first
0 – Don't read from instrument.

GUI:

Command line interface

GetNVR$

Description

Reads a specified parameter from the LC/MSD.
Returns:

Syntax:

```
GetNVR Parameter$
```

Returns:
Formatted text display of the selected variable, as displayed in the ShowNVR report. See the Instrument Parameters list for allowed parameters

GUI:

Command line interface

Instrument variables list

This list includes settable non-volatile memory items as well as read-only instrument configuration information.

Description	Parameter Name
Instrument Name	instname
Serial Number	serialnum
Product Number	prodnum
Manufacture Date	mfgdate
Quad Serial Number	quadnum
MS Inject Valve Present	msvalvep
ChemStation Rev	swrev
SmartCard Rev	Idn
PDB HW Rev	pdbhwrev
PDB FW Rev	pdbswrev
PDB 68332 FW Rev	pdb332rev
SICB-LON HW Rev	sbhwrev
SICB-LON FW Rev	sbbswrev
Turbo Pump Ctrl HW Rev	tpchwrev
Turbo Pump Ctrl FW Rev	tpcswrev
Convect. Gauge HW Rev	cghwrev
Convect. Gauge FW Rev	cgswrev
Ion Gauge HW Rev	ighwrev
Ion Gauge FW Rev	cgswrev
Log Amp ID	logampid
Quad Frequency	quadfreq
Pos Ion Quad Polarity	quadpolp
Neg Ion Quad Polarity	quadpoln
Stdby Quad Temp	quad
Stdby Drying Gas Temp	dgas
Stdby Drying Gas Flow	dgasflow
Stdby Nebulizer Press	nebpres
Stdby Vaporizer Temp	vapor
Quad Temp PIDs	quadpid

Drying Gas Temp PIDs	dgaspid
Vaporizer Temp PIDs	vaporpid
Drying Gas Flow PIDs	dgasflowpid
Nebulizer Pres PIDs	nebprespid
Quad Temp Timeout	quadTO
Drying Gas Temp Timeout	dgasTO
Vaporizer Temp Timeout	vaporTO
Drying Gas Flow Timeout	dgasflowTO
Nebulizer Pres Timeout	nebpresTO
CDS Leak Sensor Calibration	leakCal
CDS On Purge Time	cdsdonps
CDS Off Purge Time 1	cdsdofp1
CDS Off Purge Time 2	cdsdofp2
CDS On Delay	cdsdoncd
Mass Axis Lag D Coeff 0	mald0
Mass Axis Lag D Coeff 1	mald1
Mass Axis Lag D Coeff 2	mald2
Std EMV	stdemv
EMV Gain Coeff 0	emvgain0
EMV Gain Coeff 1	emvgain1
EMV Gain Coeff 2	emvgain2
EMF limit: Calibrant A hrs	emf_cexa
EMF limit: Calibrant B hrs	emf_cexb
EMF limit: Pump Oil hrs	emf_poil
EMF limit: Gas Conditioner hrs	emf_gasc
EMF limit: Ion Optics hrs	emf_iono
EMF limit: SSV Cycles	emf_ssv
EMF limit: EM Current	emf_emul
Last Backup Date	backup
Last Restore Date	restore

BurnNVR

Description

Stores (burns) a value in the LC/MSD non-volatile memory. The provided must be a text string. If no value is specified, the most likely correct value is supplied, determined as follows:

- The most recently backed-up value (set by BackupNVR)
- If no backup is available, the most recently read value (set by ShowNVR)
- The default value, if one exists and is appropriate.

To set a given parameter to default, use the keyword “default” to specify the value.
If rowNum is specified, then Parameter$ is ignored, and the parameter to be burned is specified by its row number in the NVRAM table.

For manual entry of certain parameters, it is recommended to use the following macros:

Instrument identification:	SetNVR
Zone timeouts:	MSZoneTimeout
Zone control constants:	MSZonePID
Quad polarity:	BurnQP

Leak calibration value: LeakCal

Syntax:

```
BurnNVR Parameter$, [NewValue], [rowNum]
```

Parameter$: specify the parameter name as listed in the LC/MSD Non-volatile Parameters List.

NewValue: A text string containing the new values to be burned.
If no value is specified, the backup value will be used.
If "default" is specified, and a valid default value exists, it will be burned.

RowNum: If a rownum is specified, the parameter at that position in the MSDNVRAM table is burned and Parameter$ is ignored.

GUI:

Command line interface

LC/MSD Non-volatile parameters:

Description	**Parameter Name**
Instrument Name	Instname
Serial Number	serialnum
Product Number	prodnum
Mfg Date	mfgdate
Quad Serial Number	quadnum
MS Inject Valve Present	msvalvep
Quad Frequency	quadfreq
Pos Ion Quad Polarity	quadpolp
Neg Ion Quad Polarity	quadpoln
Stdby Quad Temp	quad
Stdby Drying Gas Temp	dgas
Stdby Drying Gas Flow	dgasflow
Stdby Nebulizer Press	nebpres
Stdby Vaporizer Temp	vapor
Quad Temp PIDs	quadpid
Drying Gas Temp PIDs	dgaspid
Vaporizer Temp PIDs	vaporpid
Drying Gas Flow PIDs	dgasflowpid
Nebulizer Pres PIDs	nebprespid
Quad Temp Timeout	quadTO
Drying Gas Temp Timeout	dgasTO
Vaporizer Temp Timeout	vaporTO
Drying Gas Flow Timeout	dgasflowTO
Nebulizer Pres Timeout	nebpresTO
CDS Leak Sensor Calibration	leakCal
CDS On Purge Time	cdsdonps
CDS Off Purge Time 1	cdsdofp1
CDS Off Purge Time 2	cdsdofp2
CDS On Delay	cdsdoncd
Mass Axis Lag D Coeff 0	mald0
Mass Axis Lag D Coeff 1	mald1
Mass Axis Lag D Coeff 2	mald2
EMV Gain Coeff 0	emvgain0
EMV Gain Coeff 1	emvgain1

EMV Gain Coeff 2	emvgain2
EMF limit: Calibrant A hrs	emf_cexa
EMF limit: Calibrant B hrs	emf_cexb
EMF limit: Pump Oil hrs	emf_poil
EMF limit: Gas Conditioner hrs	emf_gasc
EMF limit: Ion Optics hrs	emf_iono
EMF limit: SSV Cycles	emf_ssv
EMF limit: EM Current	emf_emul

Example NVR Report

```
G1946 LC/MSD Instrument Configuration
    5:31:25 PM    2/27/98
    ------------------------------------------------------------------------------
    Instrument Name               : Qu'Apelle
    Serial Number                 : 3627A00017
    Product Number                : G1946A
    Mfg Date                      : 01/01/97
    Quad Serial Number            : 007
    MS Inject Valve Present       : 0
    ------------------------------------------------------------------------------
    ChemStation Rev               : Rev. A.05.04 [273]
    SmartCard Rev                 : 2.07.14
    PDB HW Rev                    : PPHA.01.00
    PDB FW Rev                    : PRS2.02.00
    PDB 68332 FW Rev              : 1.58
    SICB-LON HW Rev               : PRH1.00.01
    SICB-LON FW Rev               : PRS1.01.01
    Turbo Pump Ctrl HW Rev        : TURB1.0.00
    Turbo Pump Ctrl FW Rev        : PRSW1.0.11
    Convect. Gauge HW Rev         : 011411-102
    Convect. Gauge FW Rev         : PP11520109
    Ion Gauge HW Rev              : 0115-27103
    Ion Gauge FW Rev              : PR11616115
    Log Amp ID                    : LOG01,CAL
    ------------------------------------------------------------------------------
    Quad Frequency                : 1001230.0000
    Pos Ion Quad Polarity         : 0
    Neg Ion Quad Polarity         : 0
    ------------------------------------------------------------------------------
    Stdby Quad Temp               : 100
    Stdby Drying Gas Temp         : 300
    Stdby Drying Gas Flow         : 3.000
    Stdby Nebulizer Press         : 20.0
    Stdby Vaporizer Temp          : 325
    ------------------------------------------------------------------------------
    Quad Temp PIDs                : P=3000;I=0;D=0;ID=1
    Drying Gas Temp PIDs          : P=165;I=2;D=1024;ID=1
    Vaporizer Temp PIDs           : P=512;I=2;D=0;ID=1
    Drying Gas Flow PIDs          : P=10;I=1;D=1;ID=1
    Nebulizer Pres PIDs           : P=10;I=1;D=10;ID=1
    ------------------------------------------------------------------------------
    Quad Temp Timeout             : 88.8
    Drying Gas Temp Timeout       : 12.3
    Vaporizer Temp Timeout        :  4.4
    Drying Gas Flow Timeout       : 13.7
    Nebulizer Pres Timeout        : 13.7
    ------------------------------------------------------------------------------
    CDS Leak Sensor Calibration   : 0                        Exp <> 0
    CDS On Purge Time             : 30
    CDS Off Purge Time 1          : 75
    CDS Off Purge Time 2          : 60
    CDS On Delay                  : 30
    ------------------------------------------------------------------------------
    Mass Axis Lag D Coeff 0       : -0.0147929
    Mass Axis Lag D Coeff 1       : 5.79334e-05
    Mass Axis Lag D Coeff 2       : 1.12859e-08
    ------------------------------------------------------------------------------
    Std EMV                       : 1820
    EMV Gain Coeff 0              : -15.272984
    EMV Gain Coeff 1              : 0.011282
    EMV Gain Coeff 2              : -1.6021e-06
    ------------------------------------------------------------------------------
```

```
EMF limit: Calibrant A hrs     : 0
EMF limit: Calibrant B hrs     : 0
EMF limit: Pump Oil hrs        : 0
EMF limit: Gas Conditioner hrs : 0
EMF limit: Ion Optics hrs      : 0
EMF limit: SSV Cycles          : 0
EMF limit: EM Current          : 0
-----------------------------------------------------------------------------
Last Backup Date               : 2/27/98 9:37:47 AM
Last Restore Date              :
NVR Macro Revision             : 0.9
```

This document describes how to use MSMask.mac to troubleshoot fault states on the LC/MSD. MSMask.mac is u
sed to generate a FAULT MASK, which causes SmartCard to ignore certain faults.

NOTE: To jump directly to Applying MSMask.mac, search the document for "applying".

Overview

The Fault Mask has the following format:

```
    MaskStr$ = "0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0"
```

The Fault Mask string is a 16-bit representation of the 256-bit fault string which is reported by SmartCar
d in the SCTRACE.TXT report:

```
faultStatus: returning 0x0a00
0x0000000000000000000000000000000000000000000000000000000000000000
  ^15 ^14 ^13 ^12 ^11 ^10 ^9  ^8  ^7  ^6  ^5  ^4  ^3  ^2  ^1  ^0
```

Summary Faults
Each of the Fault Bits, 0 through 15, represents a Summary Fault. The 16 summary faults are:

0 Party Fault
1 Difficulty with electrospray source electronics
2 Difficulty with ion optics electronics
3 Difficulty with detector electronics
4 Difficulty with electrospray source gas flows
5 Difficulty with calibrant delivery system
6 Difficulty with vacuum system gauges
7 Difficulty with vacuum system pumps
8 System not at vacuum
9 Difficulty controlling temperature zones
10 The mass spectrometer is not properly calibrated
11 Difficulty with instrument power supplies
12 (unused)
13 Difficulty with internal instrument communications
14 An LC/MS shutdown has occured
15 The mass spectrometer is not properly configured

Summary Fault Sub-Bits
Each of these summary faults has 16 sub-bits which represent the specific fault detected. For example, su
mmary fault 9, Difficulty controlling temperature zones, has the following sub-bits defined:

0 Quadrupole temperature zone timeout
1 Quadrupole temperature zone control high
2 Quadrupole temperature zone control low
3 Quadrupole temperature sensor open
4 Quadrupole temperature sensor shorted

5 Drying gas temperature zone timeout
6 Drying gas temperature zone control high
7 Drying gas temperature zone control low
8 Drying gas temperature sensor open
9 Drying gas temperature sensor shorted

10 Vaporizer temperature zone timeout
11 Vaporizer temperature zone control high
12 Vaporizer temperature zone control low
13 Vaporizer temperature sensor open
14 Vaporizer temperature sensor shorted

Instead of listing all 16 sub-bits in the Summary Fault, the sub-bits are represented by a four digit hexa
decimal number. For example, a 'Vaporizer Temperature Sensor Open' fault is represented by fault bit 13.
 This would be represented by a hexadecimal value of 2000, which represents the following binary string:

0010000000000000 or 0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0

Where the sub-bits are reported left to right from 15 to 0.

Applying MSMask.mac

1. Generate the fault message. Most faults are only reported when the LC/MSD is active. Usually it is sufficient to type "MSON" on the command line to generate a fault. However, if an MSON is not sufficient, type "MSPROFILE 1" and allow the system to profile until the fault is generated.

2. After the fault is generated, generate an SCTRACE report, by typing "MSSCTRACE 1" on the command line. This will generated an SCTRACE.TXT report. This report can be called from Diagnosis View, or by searching for the file name. It should be located under the directory:

C:\...\HPCHEM\<Instrument Number>\1946tune\

3. Scroll through the SCTRACE.TXT report and locate the 256-bit fault string:

```
faultStatus: returning 0x0a00
0x0000000000000000000000020000000000000000000000000000000000000000
  ^15 ^14 ^13 ^12 ^11 ^10 ^9  ^8  ^7  ^6  ^5  ^4  ^3  ^2  ^1  ^0
```

In this case, we will again use the 'Vaporizer temperature sensor open' fault as an example.

4. Launch the calculator from the Accessories group on the computer. Change the view to Scientific. Select 'Hex' and type the value(s) from the 256-bit fault string (or '2000' for this example).

5. Select the 'Dec' button on the calculator to convert the hexadecimal value into a decimal number. For our example, '2000' converts to '8192'.

6. Launch Notepad, and open the macro MSMASK.MAC, which is located in the directory:

C:\...\HPCHEM\CORE\

7. Type the decimal value into the Fault Mask at the appropriate Summary Fault location. Note that the order of the Summary Bits is reported from 0-15. This is the reverse of the order in the SCTRACE.TXT report. For our example, this would be:

MaskStr$ = "0,0,0,0,0,0,0,0,0,8192,0,0,0,0,0,0"

8. To apply this new fault mask, type "macro msmask.mac" on the command line (no quotes). The new mask will be displayed.

The MSMask.mac macro follows with a "clean" mask (no faults masked):

```
!MSMASK.MAC

! This macro is for G1946A LC/MSD PROTOTYPES ONLY
!
! if msMask is run with no parameter, a default fault mask is set
! to enable reporting of all faults.  This macro can be modified
! to provide a temporary workaround to disabe reporting of certain faults.
!
! If MaskOn is 0, then all masks are cleared.  This is for diagnostic
! use only.
!
! If the MS electronics are turned off, or an MSSCInit is executed, then
! msMask should be executed again.
!
! This macro is executed when the file msMask.mac is loaded.
! December 20, 1996 (Erik)
!
! Added MS command set check to allow also a LC only instrument
! configuration. Jan 6,1997 (Dani)
!
! Now be called in acqinit. Jan 14,1997 (Stefan)
```

```
! Irene is the owner of the file and has to be notified for any changes!


!***********************************************************************
name MSMask
parameter MaskOn default 1
! Set MS fault mask.  If MSMask = 0 all fault masking is turned off,
! otherwise the fault mask is set.
!***********************************************************************
LOCAL MaskStr$, MSMaskVer$

  MSMaskVer$ = "030397"

  if CHECK(COMMAND, MsScQuery) =1 then
    MaskStr$ = "0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0"

    if MaskOn = 0 then  ! clear mask
      msscwrite "msc:flt:mask:full 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0"
      msscquery "msc:flt:mask:full?", MaskStr$
      print "MSMask OFF (Ver. " + MSMaskVer$ + ")"
    else
      msscwrite "msc:flt:mask:full " + MaskStr$
      msscquery "msc:flt:mask:full?",  MaskStr$
      print "MSMask set to " + MaskStr$ + "  (Ver. " + MSMaskVer$ + ")"
    endif
  endif

endmacro   ! MSMask

! Direct execution
MSMask 1
remove MSMask
```