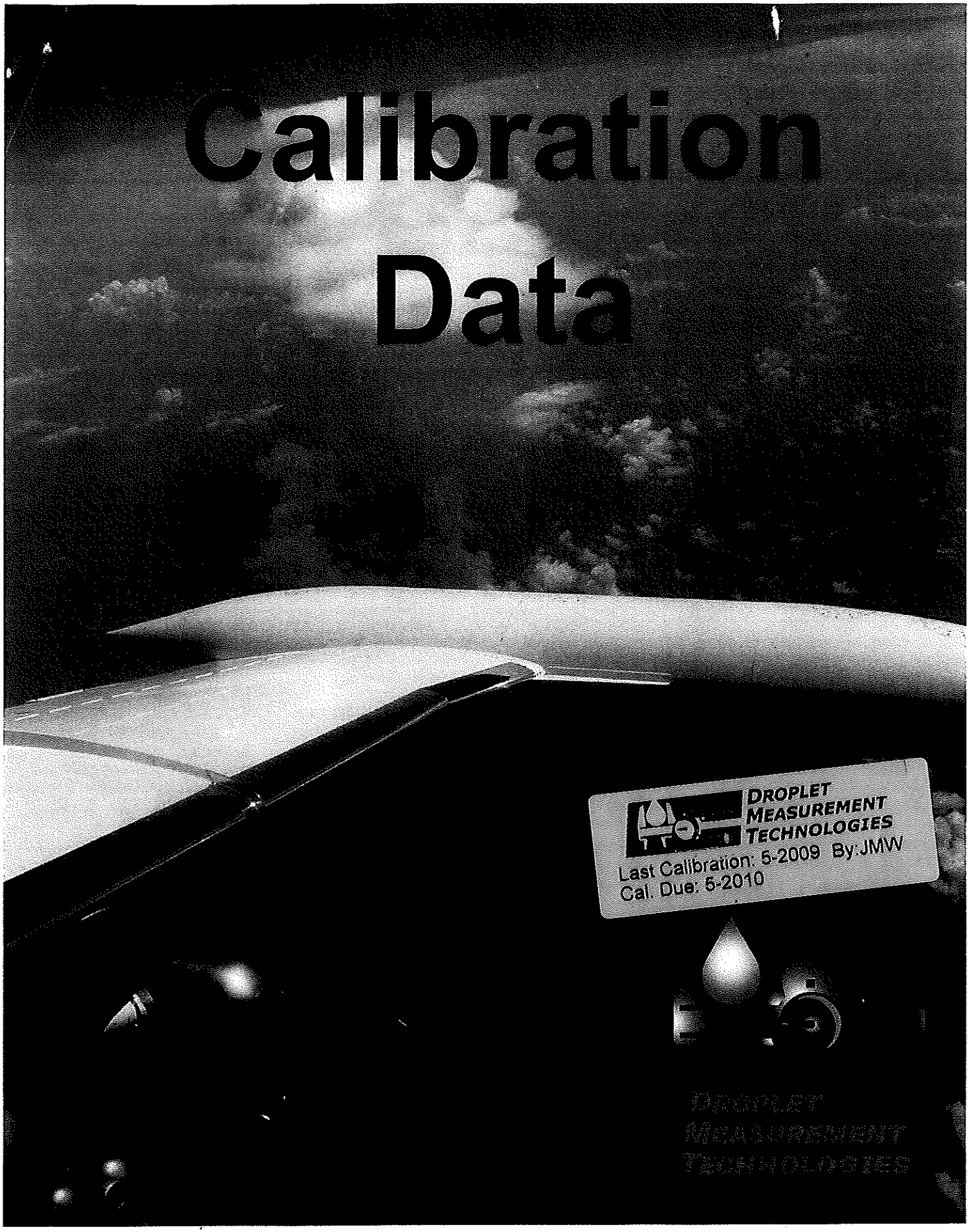
Calibration Data



5710 Flatiron Parkway Suite B, Boulder CO 80301, ph. 303-440-5576, www.dropletmeasurment.com

May 2009 WMI PCASP-200 SN 0102

DROPLET MEASUREMENT TECHNOLOGIES

5710 Flatiron Parkway Suite B
Boulder, CO 80301
www.dropletmeasurement.com

Calibration Certificate

Customer: WMI		Instrument Model: PCASP 100X	
Serial Number: 0804-0102		Calibration Date: 5/6/2009	
Condition Received			
In Tolerance:		Operational Failure:	
Out of Tolerance:	X	Physical Damage:	
New:		Comments:	
Condition Shipped			
Meets DMT Specifications:	X	Other:	
Calibration Done By:		James Wiggins	
Recommended Re-Calibration Date:		5/6/2010	

NIST-Traceable Particles

Size	Tolerance	Lot No.	Material	Manufacturer	Exp. Date
.12um	<=12%CV	28964	PSL	Duke	10/08
.144um	<=12%CV	28625	PSL	Duke	7/08
.222um	<=3%CV	33078	PSL	Duke	3/11
.43um	<=3%CV	34155	PSL	Duke	10/11
.82um	<=3%CV	33176	PSL	Duke	3/11
2.001um	+-.025um	25785	PSL	Duke	3/05

Technician Signature: Date: 5/6/2009

DROPLET MEASUREMENT TECHNOLOGIES, INC.
5710 Flatiron Parkway, Suite B
Boulder, Colorado 80301
(303) 440-5576

PCASP Calibration Report

DMT Order Number:	0901096	Client/Probe Owner:	WMI
Date:	4/8/2009	Model Number:	PCASP 100X
Work Performed by:	James Wiggins	Serial Number:	0804-0102
Other information:None			

PRE-CALIBRATION BEFORE CLEANING

Preliminary Visual Inspection	
General Condition of the Exterior:	Ok
General Condition of the Interior:	Potentiometers on Analog Mux and Baseline Restoration Module had been adjusted after calibration.
Other information:	

Working Status Of Probe Prior To Cleaning		
Condition and general appearance of the laser firing:	Good	
Vibrational sensitivity of the laser:	OK	
Heater Status:	Power Rating (watts):	215
	Voltage Rating (volts):	28
	Calculated Heater Resistance R = V^2/P (ohms)	3.65
	Actual Measured Heater Resistance (ohms)	3.8
+5 V Power Supply:	5.02 VDC	200 mVAC noise
+15 V Power Supply:	15.2 VDC	152 mVAC noise
-15 V Power Supply:	-15.2 VDC	120 mVAC noise

INITIAL CALIBRATION PROCEDURES

A precision bead pre-calibration, using the DMT aerosol generator, was performed on the probe, the results of this pre-calibration are attached to this report.

Our technician's comments about this calibration are as follows:
No particles were peaking and the ambient distribution looked terrible. I checked the laser output coupler and it was filthy but the instrument was still reading above 9 VDC on reference. I cleaned the output coupler and the laser reference immediately went to 10.5VDC which is the maximum value for this housekeeping parameter. I found that someone had adjusted the potentiometer on the multiplexer module to make it look like the probe was okay. After cleaning the particles started to bin correctly and ambient distribution started looking normal.

The sample flow and the sheath flow were measured using pneumatic flow meters and the results are tabulated below. The probe was adjusted for the proper flow rate and the rates were measured and tabulated again.

Time of Measurement	Sample Flow in cc/sec	Sheath Flow in cc/sec
Before Adjustments	1.04	12.54
After Adjustments	1.26	15.2

Additional comments made by the technician performing this procedure are:

The reference voltage was measured to be(See notes above) volts, in a properly operating probe, this voltage should be greater (in magnitude) than six (6) volts.

The signals GAIN1, GAIN3 and GAIN4 were measured and then adjusted to be within the manufacturer's specification. The results of these measurements are tabulated below.

Signal Name:	GAIN1 (mvolts) (Signal-3, Low Gain)			GAIN3 (mvolts) (Signal-2, Mid Gain)			GAIN4 (mvolts) (Signal-1, High Gain)		
	Low Peak	High Peak	Average	Low Peak	High Peak	Average	Low Peak	High Peak	Average
Before Adjustment	274	294	284	232	266	249	-58	68	.05
After Adjustment	328	376	352	320	374	347	-44	328	142

Our technician's comments concerning this procedure are:

CLEANING

A thorough cleaning was performed on the probe, the following table summarizes the steps that were performed.

Electrical Contacts	
Contact Description	Status and/or Service Performed
Amphenol Connector	Checked
Card Seating	Cleaned
Card Edge Connectors	Cleaned
Optical System Components	
Component Description	Status and/or Service Performed
Aspheric Collector	Cleaned
45 Degree Mirror	Cleaned
Parabolic Mirror	Cleaned
Laser Output	Cleaned

Additional comments made by the technician performing this procedure are:

ALIGNMENT

The reference voltage was measured and various adjustments were performed to make it come into specification. Laser Reference Voltage: 9.1

Using the DMT aerosol generator, the probe's inlet jets were adjusted to provide the strongest signal possible to the in coming aerosols.

The desiccant was replaced with fresh royal blue desiccant.

Our technician's comments concerning this procedure are:

CALIBRATION

A final calibration, using the DMT aerosol generator, was performed on the probe, the results of this final calibration are attached to this report.

Our technician's comments about this calibration are as follows:

During final calibration the transformer / voltage regulator combo that drove the laser died. Since it was 24 years old I doubt the laser caused this failure. This coupled with the fact that the probe has ran for several days with the new driver supports that assumption.

Additional comments made by our technician:
I was in contact with the end user a few months ago when he initially had trouble with the probe. He and I spoke and emailed each other to try and troubleshoot the probe in the field. I suggest that the next time the instrument returns from the field that all potentiometers are inspected for tampering. There are four that need to be checked. The three on the baseline restoration module, one on the analog multiplexer, and one on the high voltage power supply near the pump relay.

DMT Particle Analysis and Display System

Program Configure

Sample | Read a File

Current Data File: 20090506114322

Manual Slow Medium Fast

11:43:23 12:30:00 12:57:50

00 d 11:46:12 (42372sec)

(0) SPP_200 Setup Debug

Pump Relay Control

ON OFF

This light indicates that PADS thinks it has turned the relay on. There is no direct feed-back from the probe.

Relay On

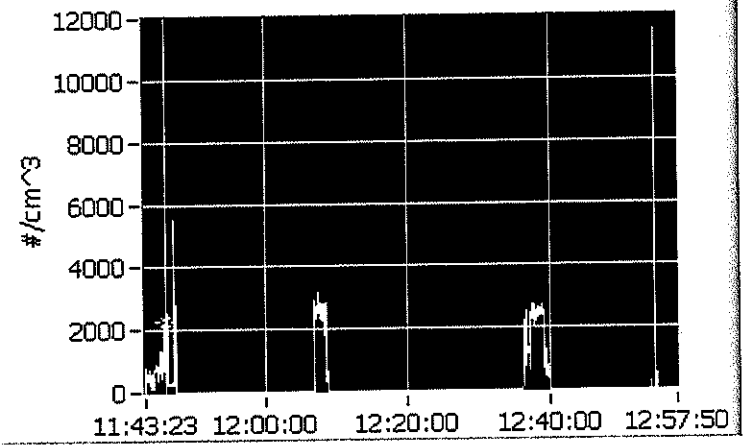
#Conc/Vol Conc | Selectable Charts

Enable Enabled COM Port 5 No Fault v2.7.2

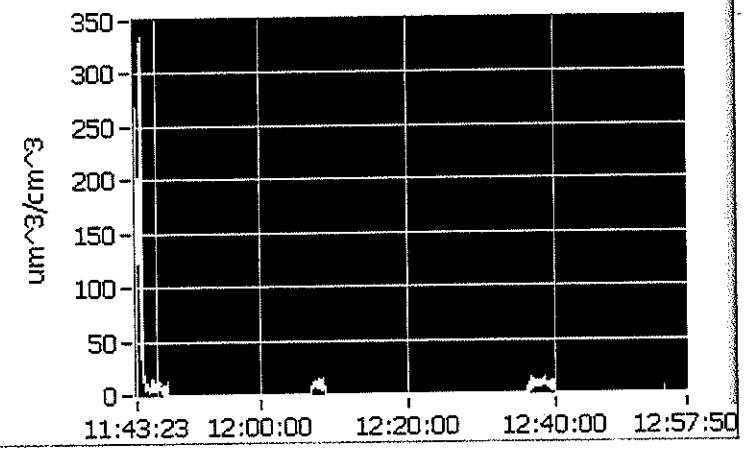
SPP_200 Data

Number Conc (# / cm^3)	Sample Flow (vol cm^3/s)
2250.25	1.26
Volume Conc (um^3 / cm^3)	Sheath Flow (vol cm^3/s)
7.17	14.19
MVD (um)	Laser Ref (V)
0.24	9.04
ED (um)	Electronics Temp (C)
0.21	39.1
Aux Analog 1	Avg Transit
0	228
Hi Gain Baseline (V)	ADC Overflow
0.1	0
Mid Gain Baseline (V)	Pump Flow
0.34	OK
Lo Gain Baseline (V)	
0.34	

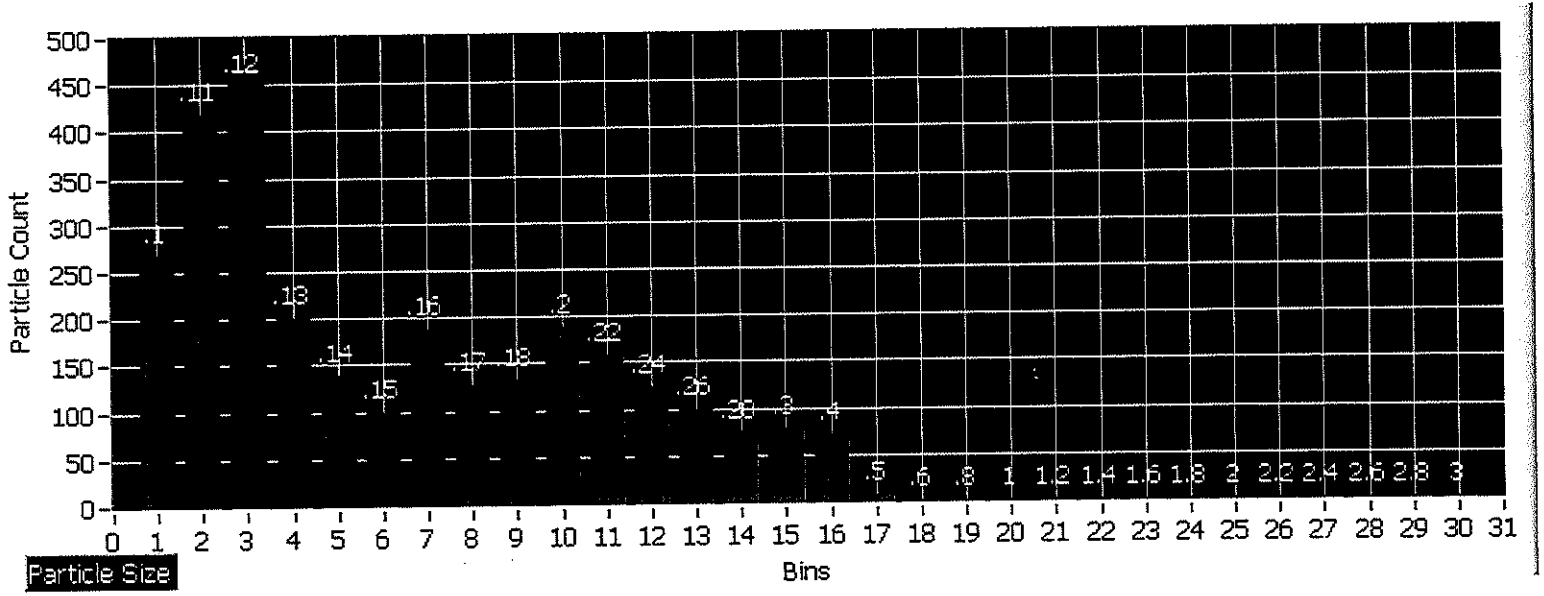
SPP_200 # Conc (#/cm^3)



SPP_200 Volume Conc (um^3/cm^3)



X-Axis Auto-Scale



Y-Axis

Auto-Scale Log-Scale Normalized

DMT Particle Analysis and Display System

Program Configure

Sample Read a File

Current Data File: 20090506114322

Manual Slow Medium Fast 11:43:23 12:30:00 12:57:50

00 d 11:45:54 (42355sec)

(0) SPP_200 Setup Debug

Pump Relay Control

ON OFF

Relay On

This light indicates that PADS thinks it has turned the relay on. There is no direct feed-back from the probe.

#Conc/Vol Conc | Selectable Charts

Enable Enabled COM Port 5 No Fault v2.7.2

SPP_200 Data

Number Conc (# / cm^3)	Sample Flow (vol cm^3/s)
1809.69	1.26
Volume Conc (um^3 / cm^3)	Sheath Flow (vol cm^3/s)
7.61	14.15
MVD (um)	Laser Ref (V)
0.25	9.08
ED (um)	Electronics Temp (C)
0.23	39.1
Aux Analog 1	Avg Transit
-0.01	251
Hi Gain Baseline (V)	ADC Overflow
0.07	0
Mid Gain Baseline (V)	
0.34	Pump Flow OK
Lo Gain Baseline (V)	
0.34	

Y-Axis

Auto-Scale Log-Scale Normalized

SPP_200 # Conc (#/cm^3)

#/cm^3

12000 10000 8000 6000 4000 2000 0

11:43:23 12:00:00 12:20:00 12:40:00 12:57:50

SPP_200 Volume Conc (um^3/cm^3)

um^3/cm^3

350 300 250 200 150 100 50 0

11:43:23 12:00:00 12:20:00 12:40:00 12:57:50

X-Axis Auto-Scale

Particle Count

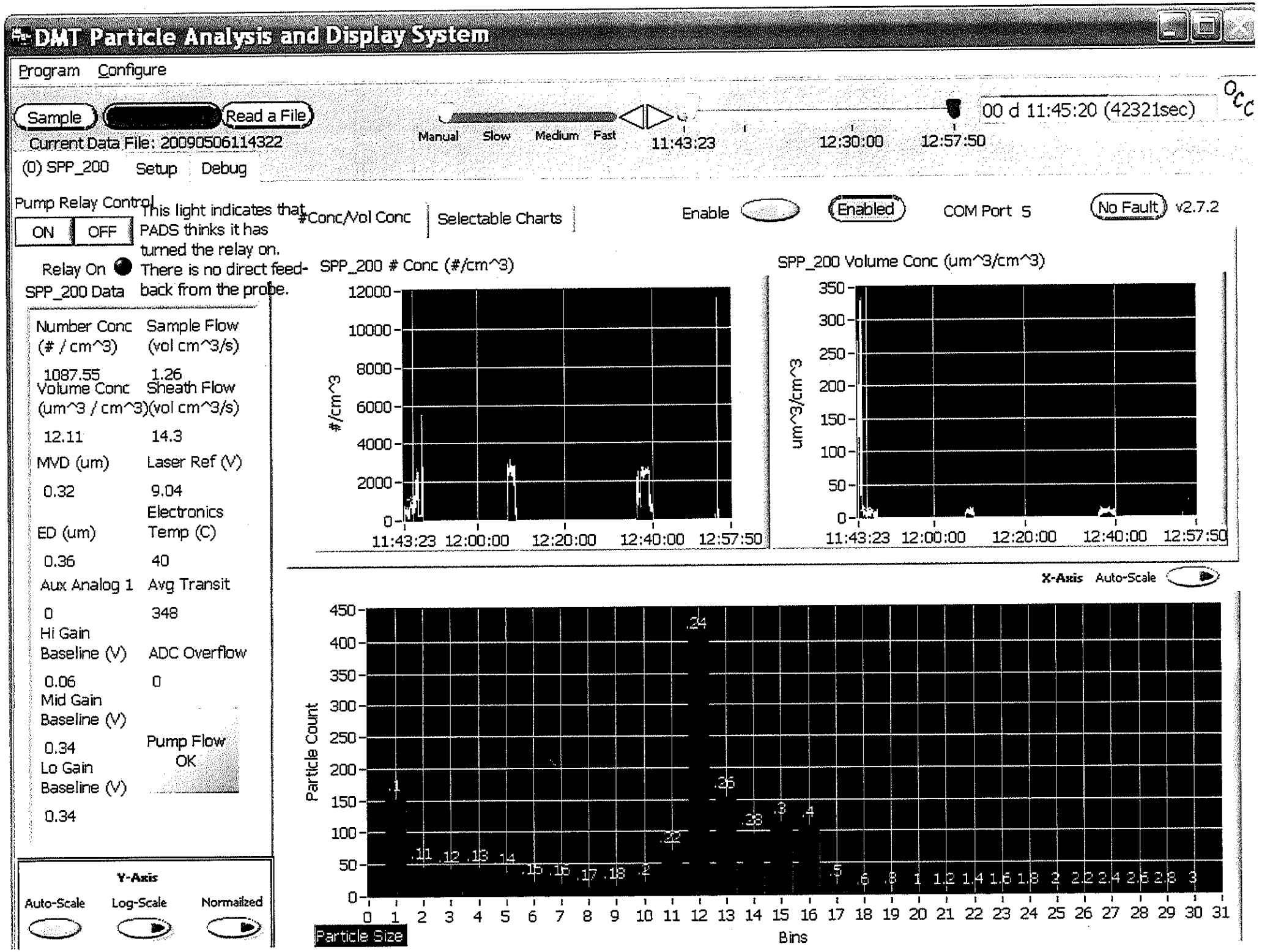
450 400 350 300 250 200 150 100 50 0

.1 .11 .12 .13 .14 .15 .16 .17 .18 .2 .22 .24 .26 .28 .3 .4 .5 .6 .8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

Particle Size

Bins


DMT Particle Analysis and Display System
Program Configure
Sample
Read a File
Current Data File: 20090506114322
Manual Slow Medium Fast
11:43:23
12:30:00
12:57:50
00 d 11:45:20 (42321sec)
(0) SPP_200 Setup Debug
Pump Relay Control
ON OFF
Relay On
This light indicates that PADS thinks it has turned the relay on. There is no direct feed-back from the probe.
#Conc/Vol Conc
Selectable Charts
Enable
Enabled
COM Port 5
No Fault
v2.7.2
SPP_200 Data
Number Conc (# / cm^3)
1087.55
Sample Flow (vol cm^3/s)
1.26
Volume Conc (um^3 / cm^3)
12.11
Sheath Flow (vol cm^3/s)
14.3
MVD (um)
0.32
Laser Ref (V)
9.04
ED (um)
0.36
Electronics Temp (C)
40
Aux Analog 1
0
Avg Transit
348
Hi Gain Baseline (V)
0.06
ADC Overflow
0
Mid Gain Baseline (V)
0.34
Pump Flow
OK
Lo Gain Baseline (V)
0.34
Y-Axis
Auto-Scale
Log-Scale
Normalized
SPP_200 # Conc (#/cm^3)
#/cm^3
12000
10000
8000
6000
4000
2000
0
11:43:23 12:00:00 12:20:00 12:40:00 12:57:50
SPP_200 Volume Conc (um^3/cm^3)
um^3/cm^3
350
300
250
200
150
100
50
0
11:43:23 12:00:00 12:20:00 12:40:00 12:57:50
X-Axis Auto-Scale
Particle Count
450
400
350
300
250
200
150
100
50
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Particle Size
Bins

DMT Particle Analysis and Display System

Program Configure

Sample [redacted] Read a File

Manual Slow Medium Fast

11:43:23 12:30:00 12:57:50

00 d 11:44:37 (42278sec)

Current Data File: 20090506114322

(0) SPP_200 Setup Debug

Pump Relay Control

ON OFF

This light indicates that PADS thinks it has turned the relay on. There is no direct feed-back from the probe.

Relay On

SPP_200 Data

#Conc/Vol Conc | Selectable Charts

Enable [redacted] Enabled COM Port 5 No Fault v2.7.2

Number Conc (# / cm^3)	Sample Flow (vol cm^3/s)
611.27	1.26
Volume Conc (um^3 / cm^3)	Sheath Flow (vol cm^3/s)
5.53	14.23
MVD (um)	Laser Ref (V)
0.29	9.04
ED (um)	Electronics Temp (C)
0.3	40
Aux Analog 1	Avg Transit
-0.01	276
Hi Gain Baseline (V)	ADC Overflow
0.04	0
Mid Gain Baseline (V)	
0.34	Pump Flow OK
Lo Gain Baseline (V)	
0.34	

Y-Axis

Auto-Scale Log-Scale Normalized

SPP_200 # Conc (#/cm^3)

#/cm^3

12000 10000 8000 6000 4000 2000 0

11:43:23 12:00:00 12:20:00 12:40:00 12:57:50

SPP_200 Volume Conc (um^3/cm^3)

um^3/cm^3

350 300 250 200 150 100 50 0

11:43:23 12:00:00 12:20:00 12:40:00 12:57:50

X-Axis Auto-Scale

Particle Count

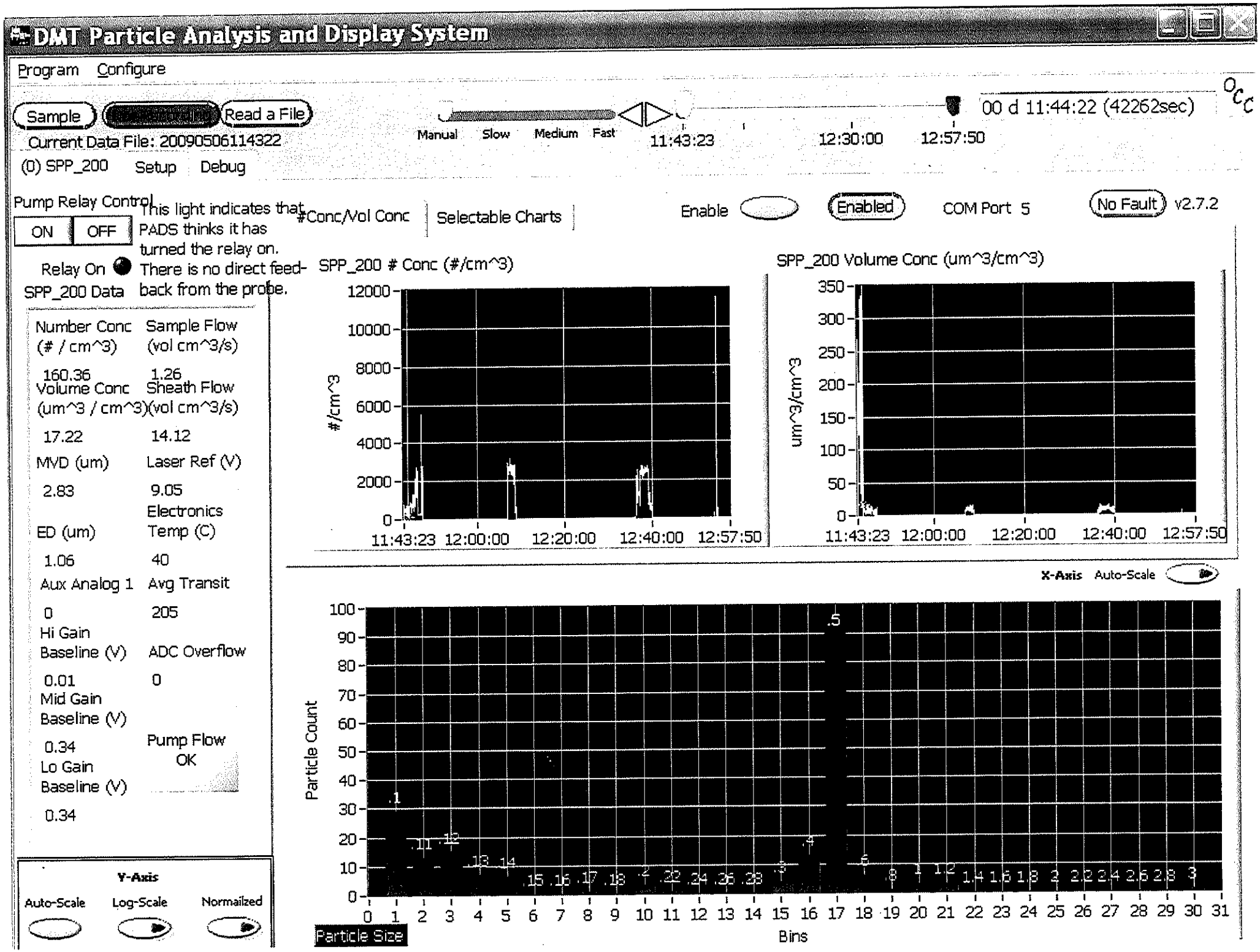
250 225 200 175 150 125 100 75 50 25 0

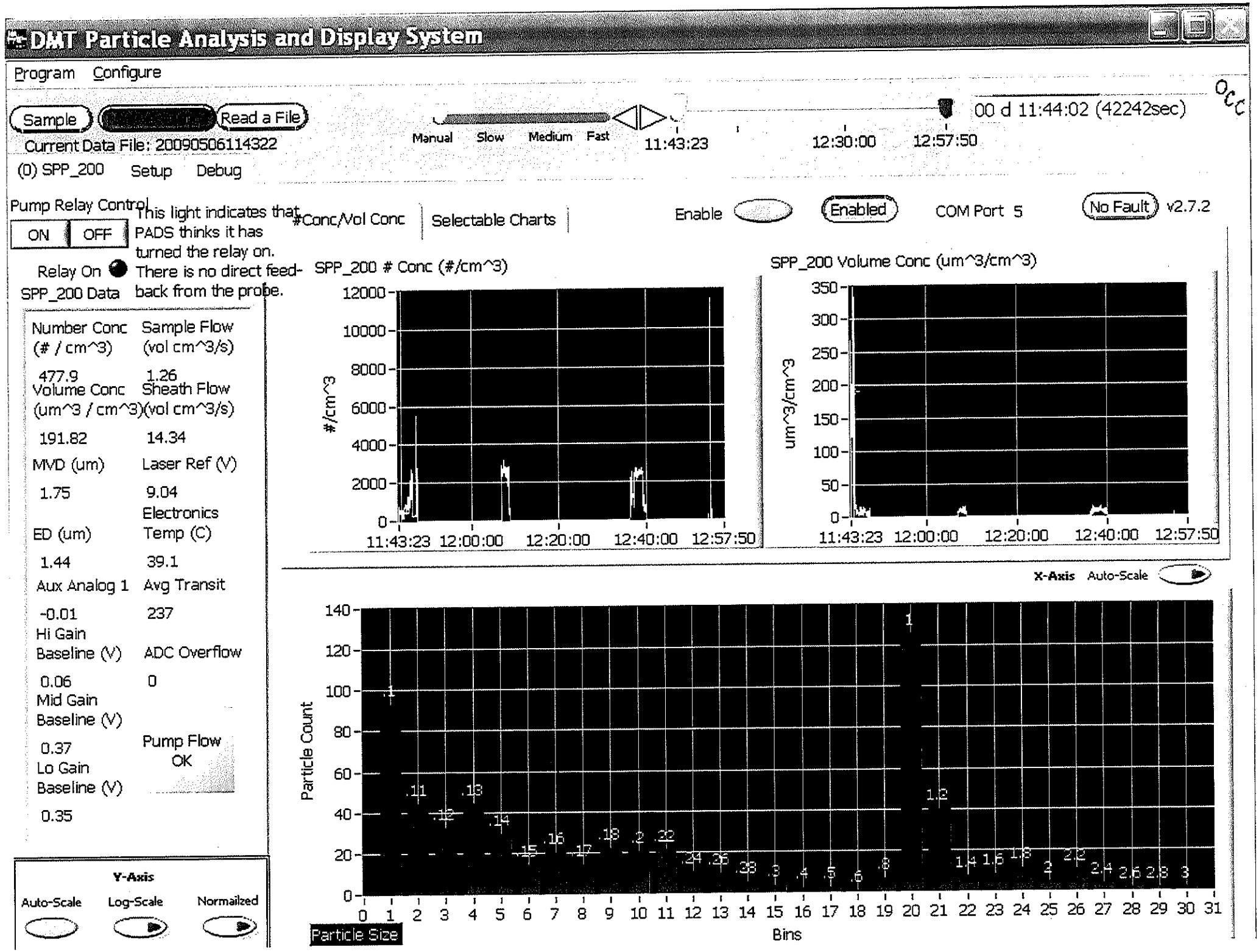
.1 .11 .12 .13 .14 .15 .16 .17 .18 .2 .22 .24 .25 .28 .3 .4 .5 .6 .8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3

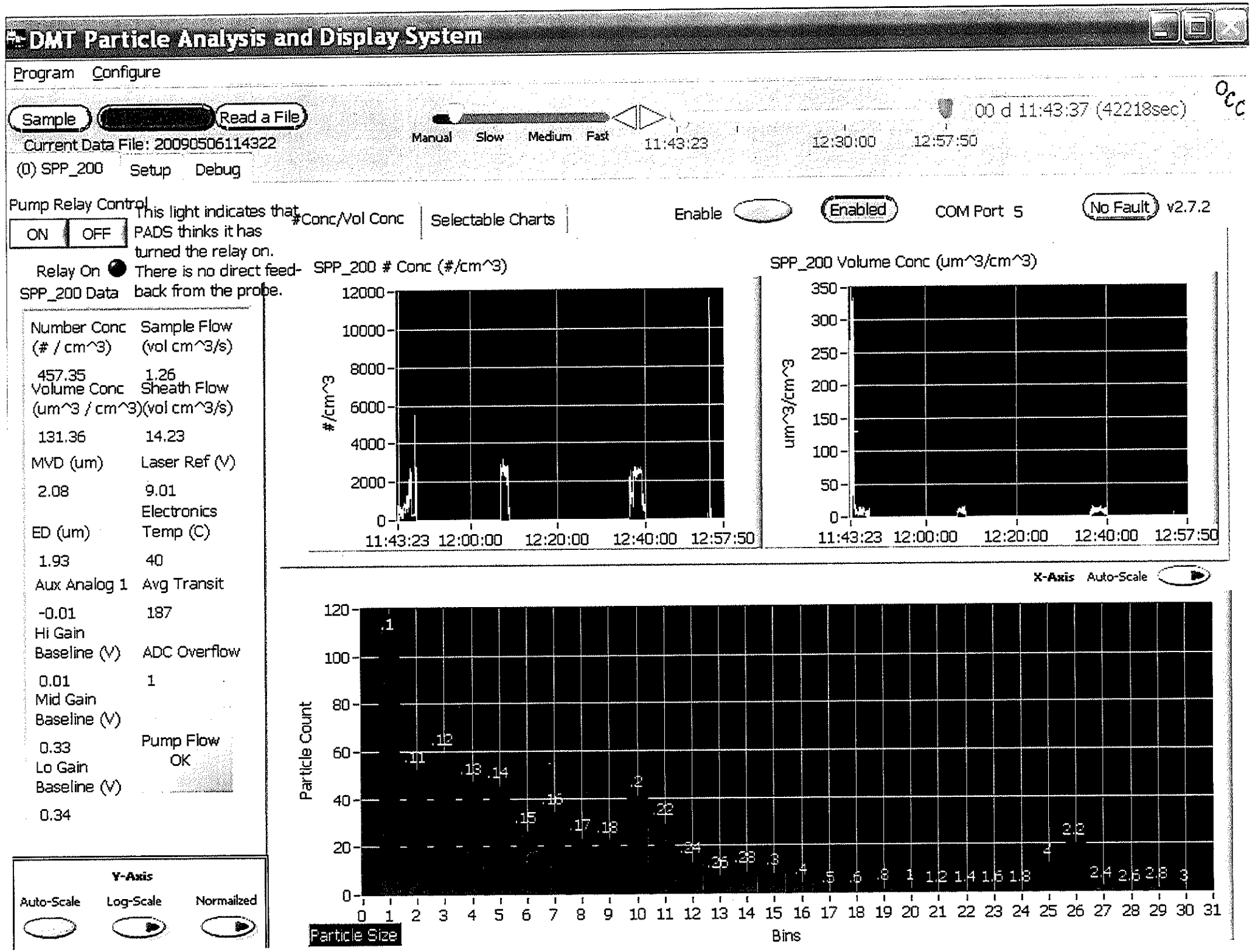
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

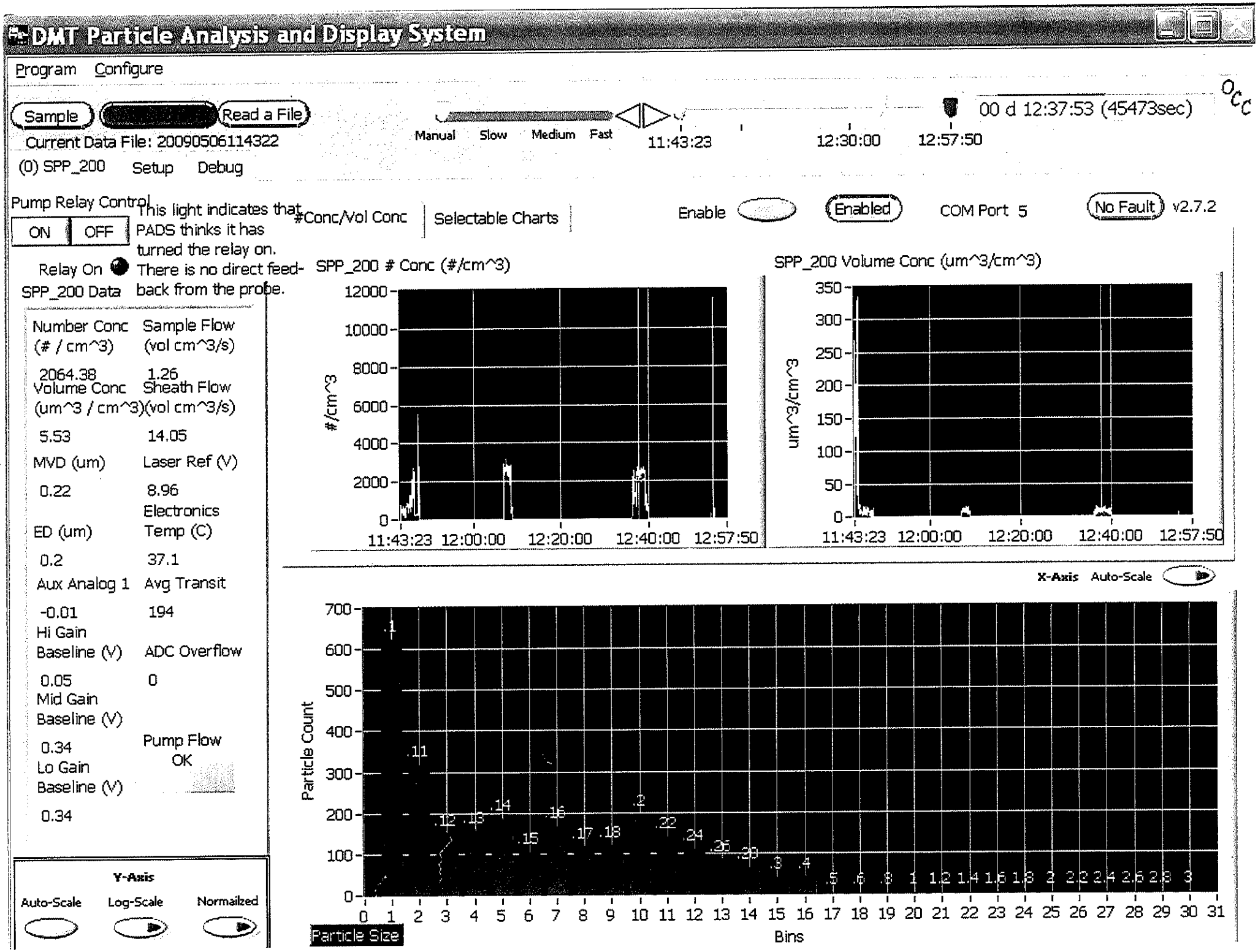
Particle Size

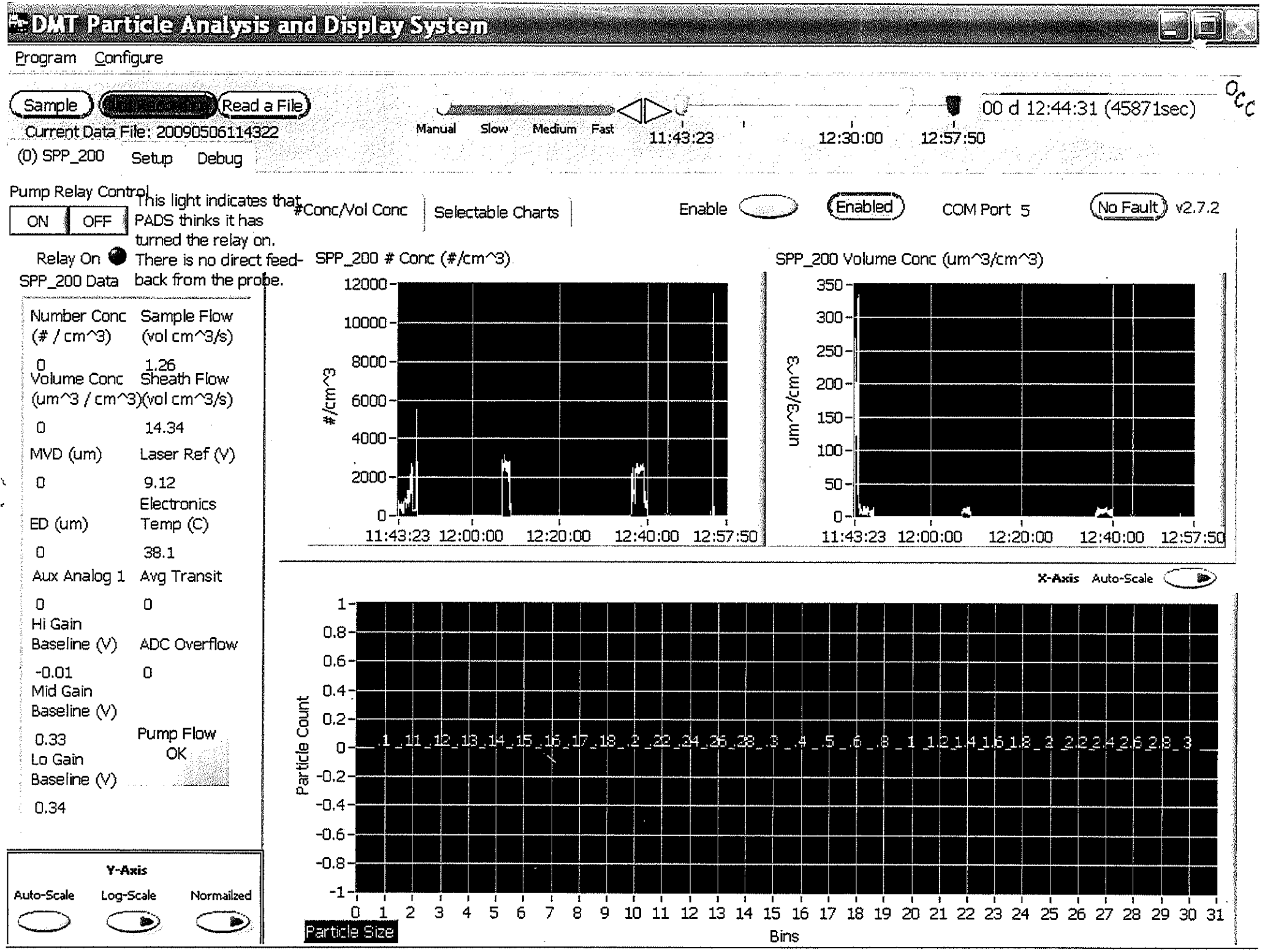
Bins


DMT Particle Analysis and Display System
Program Configure
Sample Read a File
Current Data File: 20090506114322
Manual Slow Medium Fast
11:43:23
12:30:00
12:57:50
00 d 11:44:22 (42262sec)
(0) SPP_200 Setup Debug
Pump Relay Control
ON OFF
Relay On
This light indicates that PADS thinks it has turned the relay on. There is no direct feed-back from the probe.
#Conc/Vol Conc
Selectable Charts
Enable
Enabled
COM Port 5
No Fault
v2.7.2
SPP_200 Data
Number Conc (# / cm^3)
160.36
Sample Flow (vol cm^3/s)
1.26
Volume Conc (um^3 / cm^3)
17.22
Sheath Flow (vol cm^3/s)
14.12
MVD (um)
2.83
Laser Ref (V)
9.05
ED (um)
1.06
Electronics Temp (C)
40
Aux Analog 1
0
Avg Transit
205
Hi Gain Baseline (V)
0.01
ADC Overflow
0
Mid Gain Baseline (V)
0.34
Pump Flow
OK
Lo Gain Baseline (V)
0.34
SPP_200 # Conc (#/cm^3)
#/cm^3
SPP_200 Volume Conc (um^3/cm^3)
um^3/cm^3
X-Axis Auto-Scale
Y-Axis
Auto-Scale Log-Scale Normalized
Particle Count
Particle Size
Bins


DMT Particle Analysis and Display System
Program Configure
Sample
Read a File
Current Data File: 20090506114322
(0) SPP_200 Setup Debug
Manual Slow Medium Fast
11:43:23
12:30:00
12:57:50
00 d 11:44:02 (42242sec)
Pump Relay Control
ON OFF
Relay On
This light indicates that PADS thinks it has turned the relay on. There is no direct feed-back from the probe.
#Conc/Vol Conc
Selectable Charts
Enable
Enabled
COM Port 5
No Fault
v2.7.2
SPP_200 Data
Number Conc (# / cm^3)
477.9
Sample Flow (vol cm^3/s)
1.26
Volume Conc (um^3 / cm^3)
191.82
Sheath Flow (vol cm^3/s)
14.34
MVD (um)
1.75
Laser Ref (V)
9.04
ED (um)
1.44
Electronics Temp (C)
39.1
Aux Analog 1
-0.01
Avg Transit
237
Hi Gain Baseline (V)
0.06
ADC Overflow
0
Mid Gain Baseline (V)
0.37
Pump Flow
OK
Lo Gain Baseline (V)
0.35
SPP_200 # Conc (#/cm^3)
#/cm^3
SPP_200 Volume Conc (um^3/cm^3)
um^3/cm^3
X-Axis Auto-Scale
Particle Count
Particle Size
Bins
Y-Axis
Auto-Scale
Log-Scale
Normalized


DMT Particle Analysis and Display System
Program Configure
Sample Read a File
Current Data File: 20090506114322
Manual Slow Medium Fast
11:43:23
12:30:00
12:57:50
00 d 11:43:37 (42218sec)
(0) SPP_200 Setup Debug
Pump Relay Control
ON OFF
Relay On
This light indicates that PADS thinks it has turned the relay on. There is no direct feed-back from the probe.
#Conc/Vol Conc
Selectable Charts
Enable
Enabled
COM Port 5
No Fault
v2.7.2
SPP_200 Data
Number Conc (# / cm^3) 457.35
Sample Flow (vol cm^3/s) 1.26
Volume Conc (um^3 / cm^3) 131.36
Sheath Flow (vol cm^3/s) 14.23
MVD (um) 2.08
Laser Ref (V) 9.01
ED (um) 1.93
Electronics Temp (C) 40
Aux Analog 1 -0.01
Avg Transit 187
Hi Gain Baseline (V) 0.01
ADC Overflow 1
Mid Gain Baseline (V) 0.33
Pump Flow OK
Lo Gain Baseline (V) 0.34
SPP_200 # Conc (#/cm^3)
#/cm^3
SPP_200 Volume Conc (um^3/cm^3)
um^3/cm^3
11:43:23 12:00:00 12:20:00 12:40:00 12:57:50
X-Axis Auto-Scale
Particle Count
Particle Size
Bins
Y-Axis
Auto-Scale Log-Scale Normalized


DMT Particle Analysis and Display System
Program Configure
Sample
Read a File
Current Data File: 20090506114322
(0) SPP_200 Setup Debug
Manual Slow Medium Fast
11:43:23
12:30:00
12:57:50
00 d 12:37:53 (45473sec)
Pump Relay Control
ON OFF
Relay On
This light indicates that PADS thinks it has turned the relay on. There is no direct feed-back from the probe.
SPP_200 Data
#Conc/Vol Conc
Selectable Charts
Enable
Enabled
COM Port 5
No Fault
v2.7.2
SPP_200 # Conc (#/cm^3)
#/cm^3
SPP_200 Volume Conc (um^3/cm^3)
um^3/cm^3
11:43:23 12:00:00 12:20:00 12:40:00 12:57:50
Number Conc (# / cm^3)
2064.38
Sample Flow (vol cm^3/s)
1.26
Volume Conc (um^3 / cm^3)
5.53
Sheath Flow (vol cm^3/s)
14.05
MVD (um)
0.22
Laser Ref (V)
8.96
ED (um)
0.2
Electronics Temp (C)
37.1
Aux Analog 1
-0.01
Avg Transit
194
Hi Gain Baseline (V)
0.05
ADC Overflow
0
Mid Gain Baseline (V)
0.34
Pump Flow
OK
Lo Gain Baseline (V)
0.34
X-Axis Auto-Scale
Particle Count
Particle Size
Bins
Y-Axis
Auto-Scale
Log-Scale
Normalized


DMT Particle Analysis and Display System
Program Configure
Sample Read a File
Current Data File: 20090506114322
Manual Slow Medium Fast
11:43:23
12:30:00
12:57:50
00 d 12:44:31 (45871sec)
(0) SPP_200 Setup Debug
Pump Relay Control
ON OFF
This light indicates that PADS thinks it has turned the relay on. There is no direct feed-back from the probe.
Relay On
SPP_200 Data
#Conc/Vol Conc
Selectable Charts
Enable
Enabled
COM Port 5
No Fault
v2.7.2
Number Conc (# / cm^3)
0
Sample Flow (vol cm^3/s)
1.26
Volume Conc (um^3 / cm^3)
0
Sheath Flow (vol cm^3/s)
14.34
MVD (um)
0
Laser Ref (V)
9.12
ED (um)
0
Electronics Temp (C)
38.1
Aux Analog 1
0
Avg Transit
0
Hi Gain Baseline (V)
-0.01
ADC Overflow
0
Mid Gain Baseline (V)
0.33
Pump Flow
OK
Lo Gain Baseline (V)
0.34
SPP_200 # Conc (#/cm^3)
#/cm^3
12000
10000
8000
6000
4000
2000
0
11:43:23 12:00:00 12:20:00 12:40:00 12:57:50
SPP_200 Volume Conc (um^3/cm^3)
um^3/cm^3
350
300
250
200
150
100
50
0
11:43:23 12:00:00 12:20:00 12:40:00 12:57:50
X-Axis Auto-Scale
Particle Count
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Bins
Particle Size
Y-Axis
Auto-Scale
Log-Scale
Normalized