Measuring light hydrocarbon gases in the Hydrocarbon Processing Industry (HPI)

Introducing the PGC1000 – Field Mounted Process Gas Chromatograph

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PGC1000 Product Platform

- An economically priced, field mounted PGC using 1 – 2 analytical trains per analyzer to measure C1 thru C9+ hydrocarbons, inert gases and H2S in various HPI streams.
- Ideal for measuring light hydrocarbon gases where minimal space is available and a simple, reliable, low cost measurement is required.
- Servicing the analyzer requires minimal effort to gain access to the modular analytical hardware that is easily removed for replacement.

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PGC1000 Product Platform

- Excellent choice for most Gas Processing Industry applications.
- Excellent choice for monitoring fuel gases such as natural gas, syngas, methane and/or bio-gas required for the efficient operation of process equipment and plant wide systems in the HPI.
- Simple, reliable, easy to service, low cost measurement!

Analytical Train Concept

- Analytical Train Definition
  - An analytical train is designed to separate and measure a specific series of chemical compounds.
- Applications often require different chromatographic columns, or trains, for the measurement requirements.

- One or two analytical train solution

- Three or four analytical train solution

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Pre-engineered Column Trains

Available Column Trains	
BBC	C3+, Air or H2, C1, CO2, C2=, C2, C2*
BBF	C3+, Air or H2, C1, CO2, C2=, C2
BBH	C1+, He, H2, O2, N2, CO
BBJ	C5+, C3, C3= and C2*, IC4, NC4, H2S, B-1 and IC4=, tB-2, cB-2, 1, 3-BD
BBK	C6+, C3, IC4, NC4, Neo-C5, IC5, NC5
BBR	H2S in fuel gas
BBT	C9+, C6s, C7s, C8s
BBV	H2
BBX	C4+, CYC3, PD, MA
BBZ	C4+, C3, C3=
BCJ	Air+, H2
BCB	C3+, Air or H2, C1, CO2, C2, CO2, H2S, H2O
BBM	C6+, C3, IC4, NC4, Neo-C5, IC5, NC5 and H2S
Note: Many of the trains identify similar components but will have differing cycle times dependent upon the carrier gas being used.	

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Application Engineering – GC Module

- Some applications require only two trains to identify the components of interest. Some applications may require three or four column trains.
- Depending on the application, a GC module will be employed with some combination of the pre-engineered column trains.
  - For example, if your application is C6+ your GC module must employ two column trains; the BBF and the BBK. If your application were C9+ three column trains would be needed; the BBT, as well as the BBF and BBK would be required.

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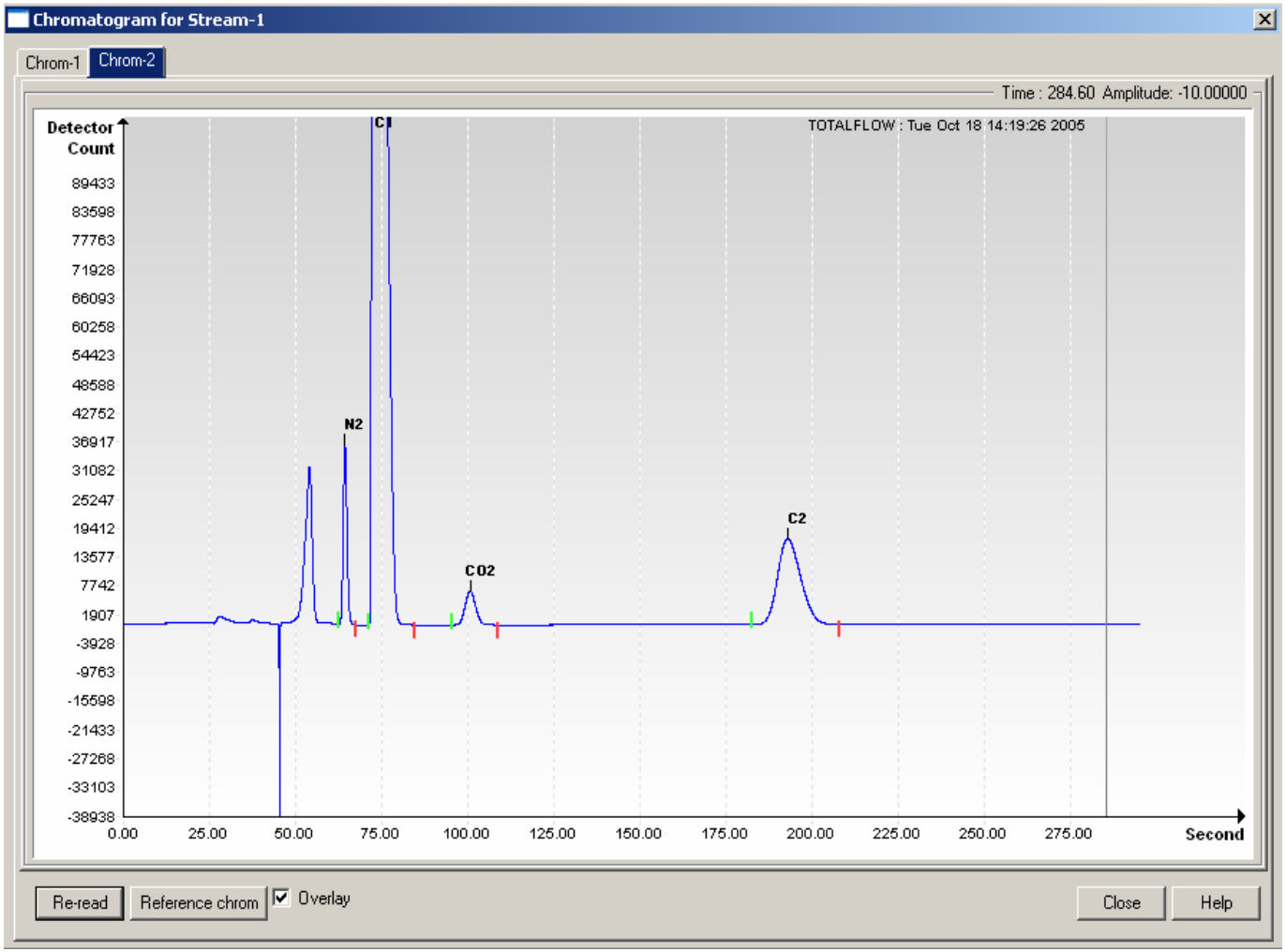
BBF Train – The Lights



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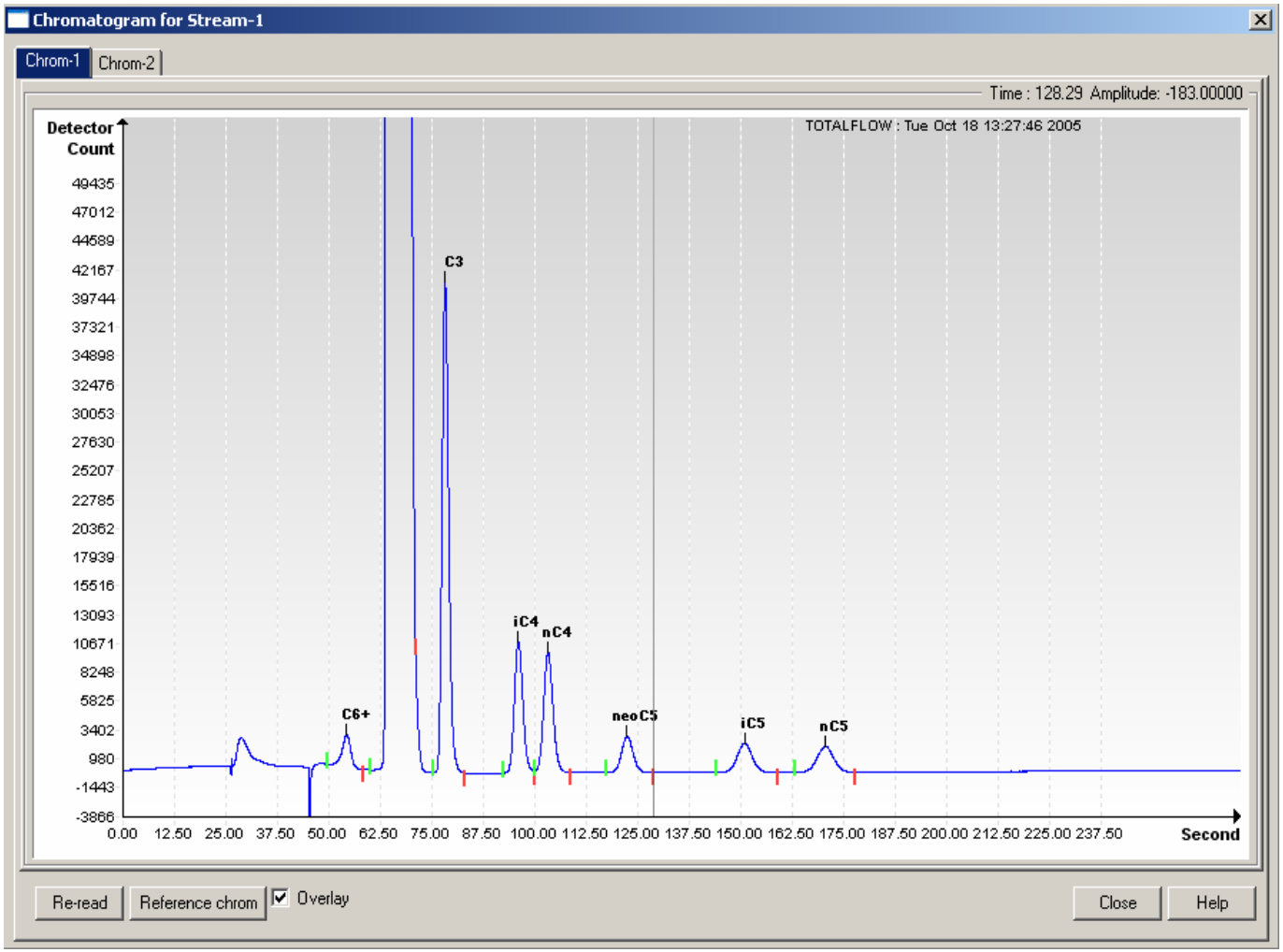
BBK Train – The Heavies



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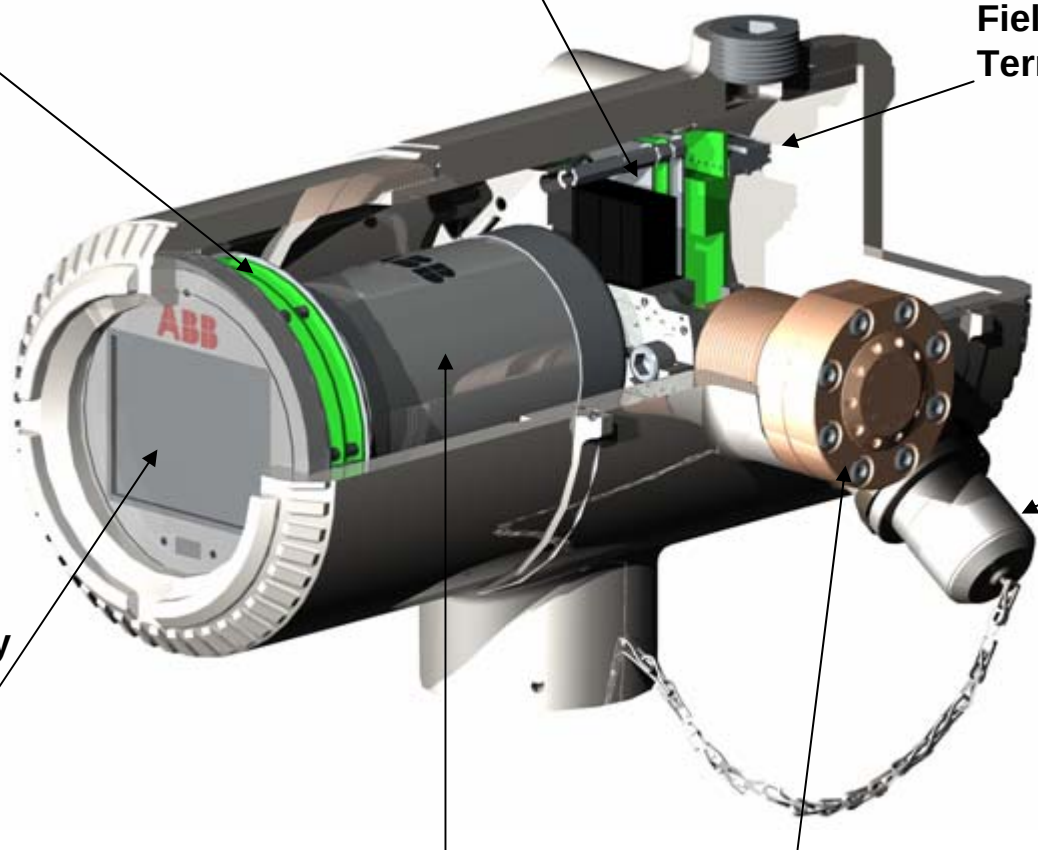
Compact Modular Design Concept



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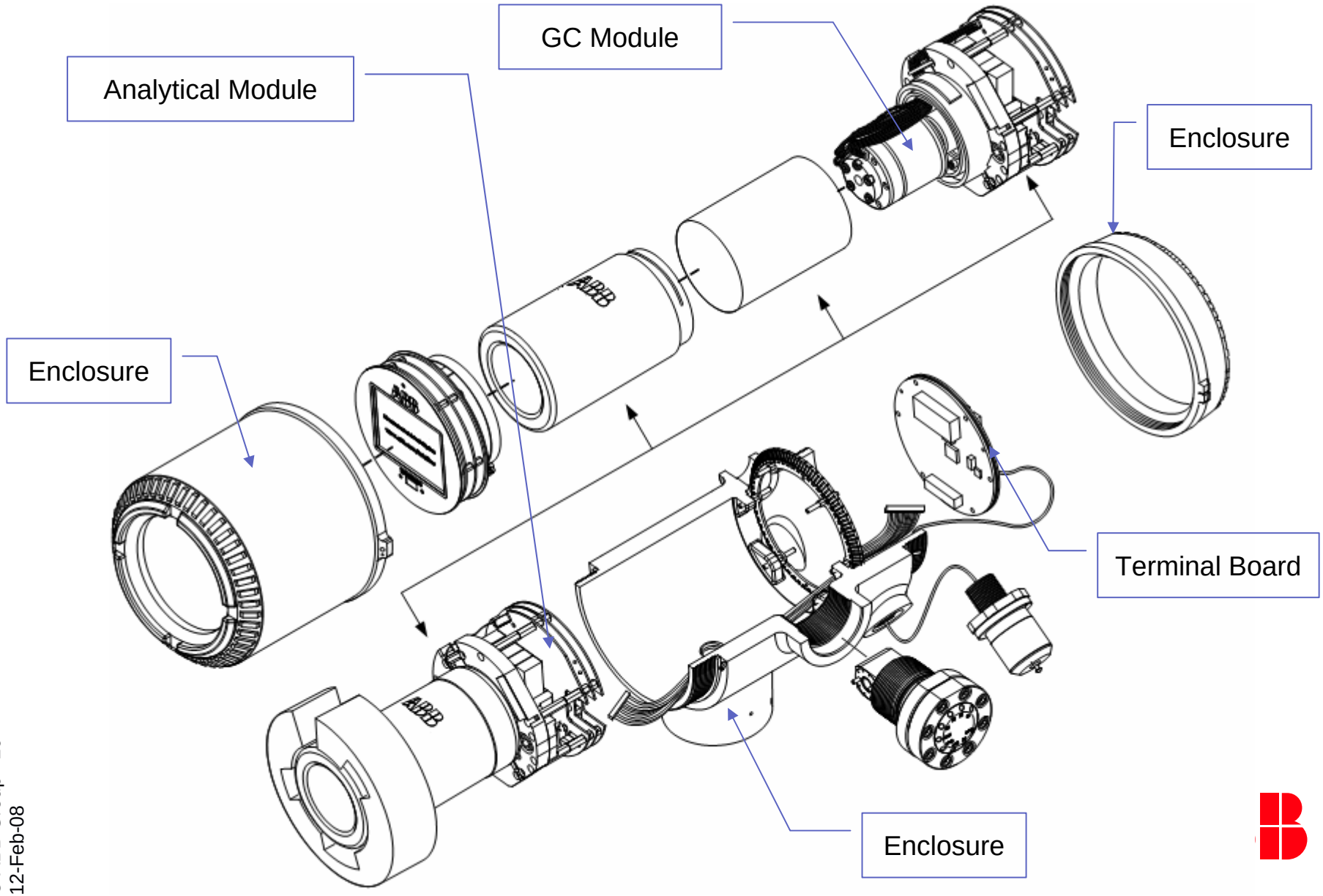
Modular Concept



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Analytical Module

- Core analytical components are all on one simple to remove GC module
- Single GC module in each PGC1000 enclosure
- Each GC module can be equipped with 2 analytical trains

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PGC1000 Innovations

- Compact footprint – 16” front to back, 28 pounds
- Conventional analytical components, not a GC on a chip
- Windows CE operating system
- Interactive graphical display actuated by magnet contact
- Economically priced

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PGC1000 General Specifications

- Four streams with manual calibration or three streams with auto calibration
- Dual calibration streams capability
- Operating temperature range -17.8° C to 54° C (0° F to 130° F)
- Low power consumption – 6 watts nominal, 45 watts start up

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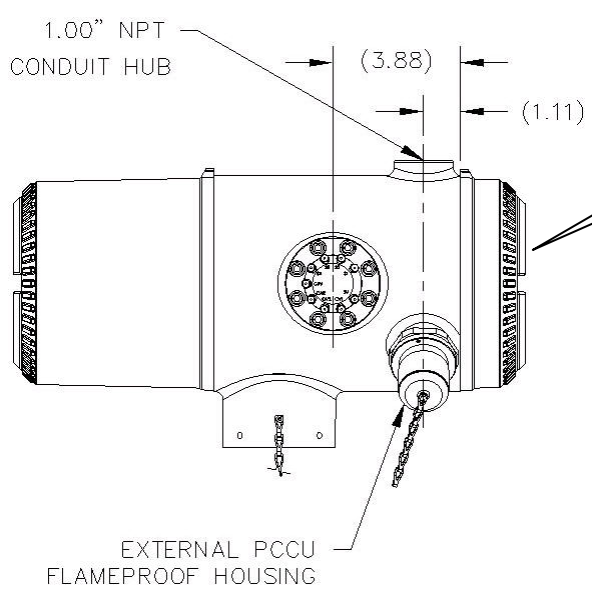
PGC1000 Dimensions



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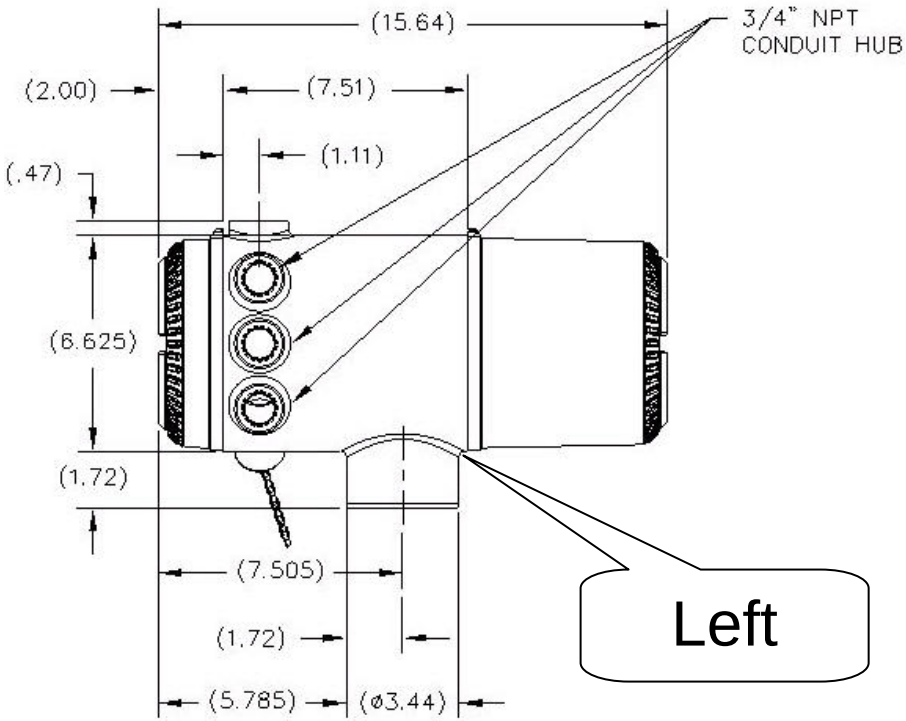

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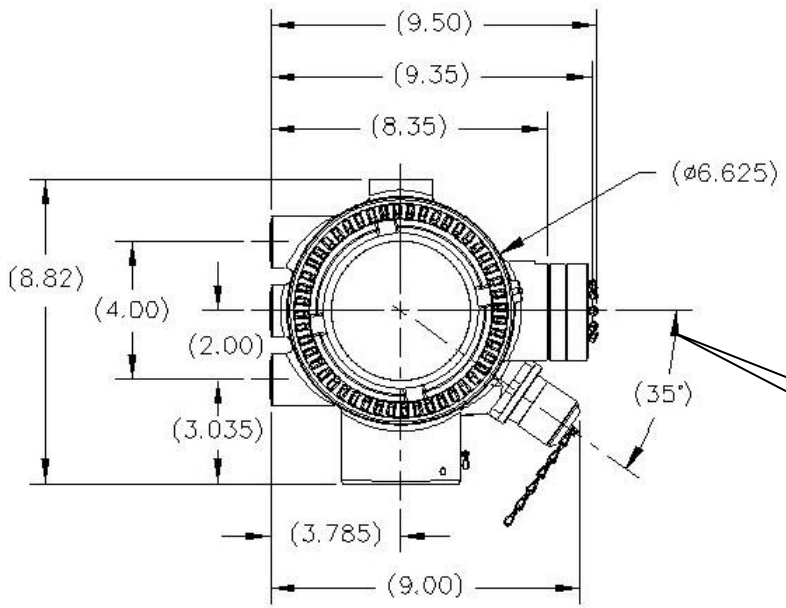

Front

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Hazardous Area Certifications

- Certifications:
  - NEC & CEC Class I, Div. 1, Groups B, C, and D, T6
  - CFR 47, Part 15
  - CE
    - ATEX Ex II 2G : Ex d, IIB+H2 T6; Zone 1
    - EMC - EMI/RFI:
      - EN 55022, EN 61000-6-1, EN 61000-4-2, 4-3, 4-4, 4-6, 4-8
      - CISPR 22-2004
  - IECEx Exd IIB + H2 T6; Zone 1

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Utility and Sample Requirements

- Power required is 10.5 to 16 VDC @ 7 Watts (45 Watts to start)
- Carrier required is 20 CC/min chromatographic grade helium: 99.995% pure
- Calibration blend concentrations should fit the gas stream, but should contain all measured components
- The sampled gas should be a clean, dry gas free of particulate contamination and free of liquids (condensate and water) at about one bar (15 PSIG) with a minimum flow of 33 cc/min

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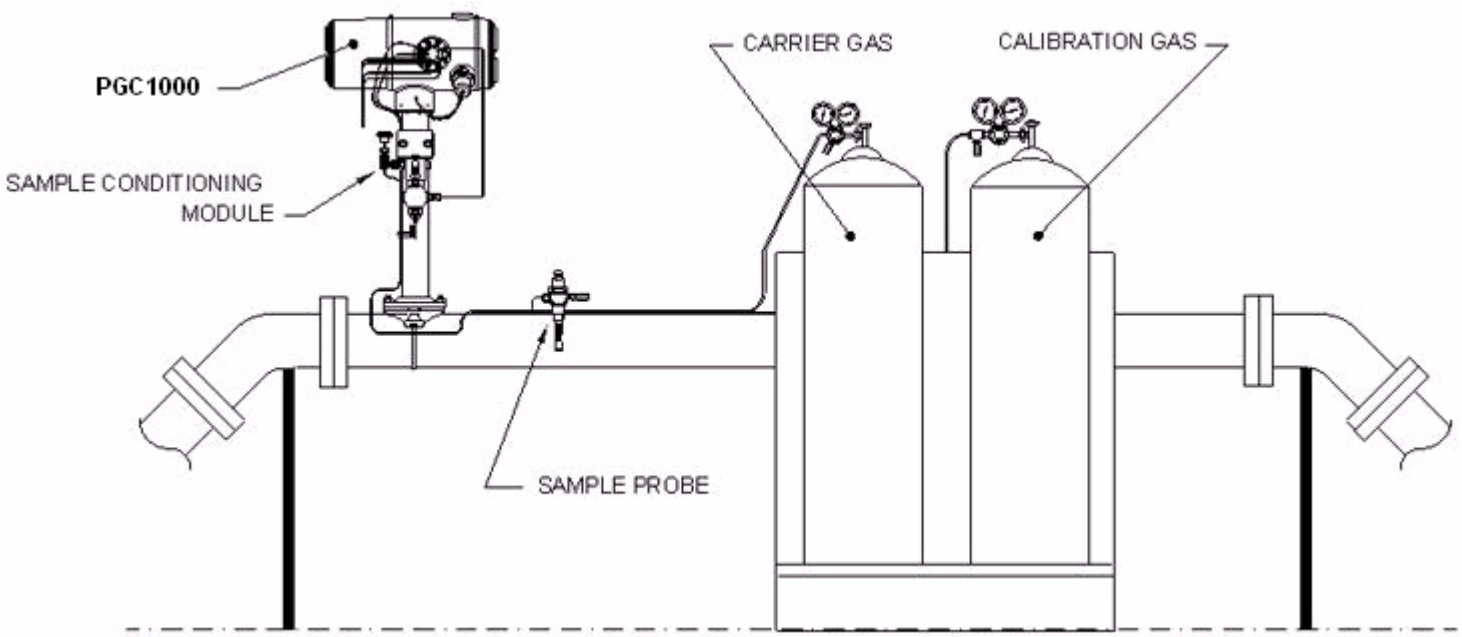
Installation – Direct Pipeline



- Pipeline Installation
  - As close to the sample tap as possible

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Installation Procedures – Pipeline Mount

- Sample Probe Installation
- Pipe Saddle Installation
- PGC Installation
- Sample Conditioning Module Installation
- Sample Line Connections
- Carrier/Calibration Bottle Rack Installation
- Carrier Gas Regulator with Low Pressure Switch Installation
- Calibration Gas Regulator with Low Pressure Switch Installation
- Carrier Gas and Calibration Gas Connections
- DC Power Installation

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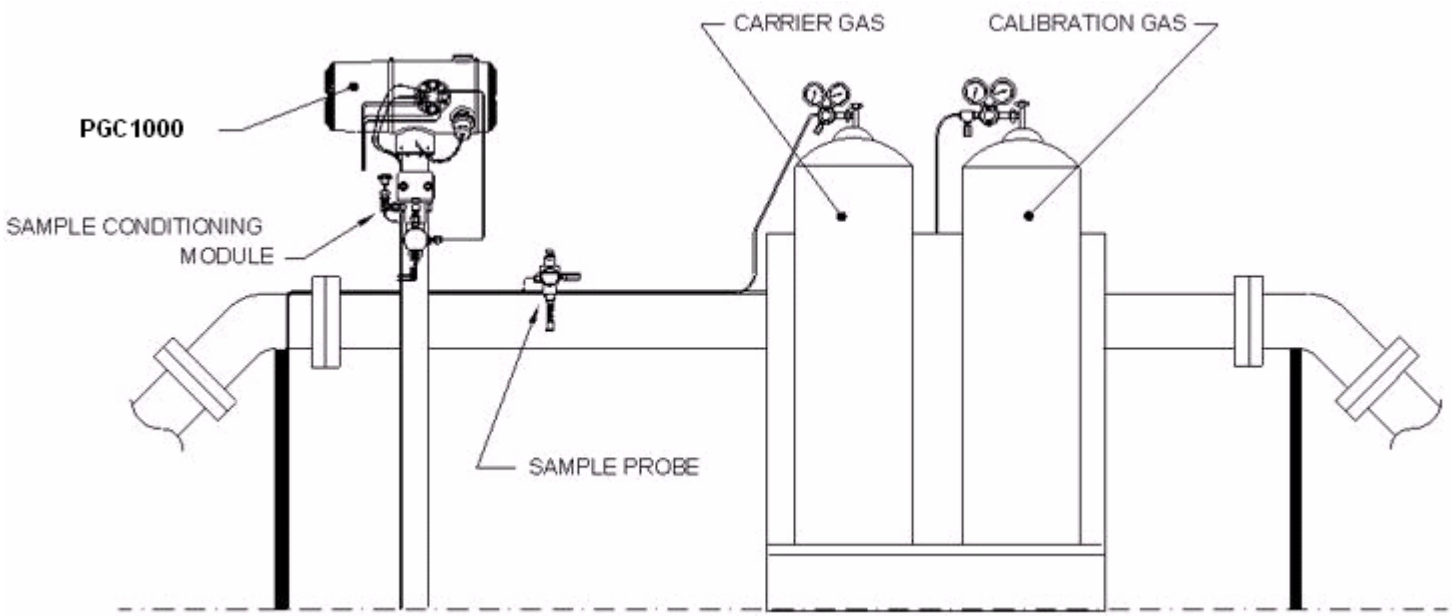
Installation – Free-standing Pipe



- Pipeline Installation – Free-standing Pipe
  - As close to the sample tap as possible

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Free-standing Pipe Installation Procedures

- Sample Probe Installation
- Free-Standing Pipe Installation
- PGC Installation
- Sample Conditioning Module Installation
- Sample Line Connections
- Carrier/Calibration Bottle Rack Installation on Meter Run
- Carrier Gas Regulator with Low Pressure Switch Installation
- Calibration Gas Regulator with Low Pressure Switch Installation
- Carrier Gas and Calibration Gas Connections
- DC Power Installation

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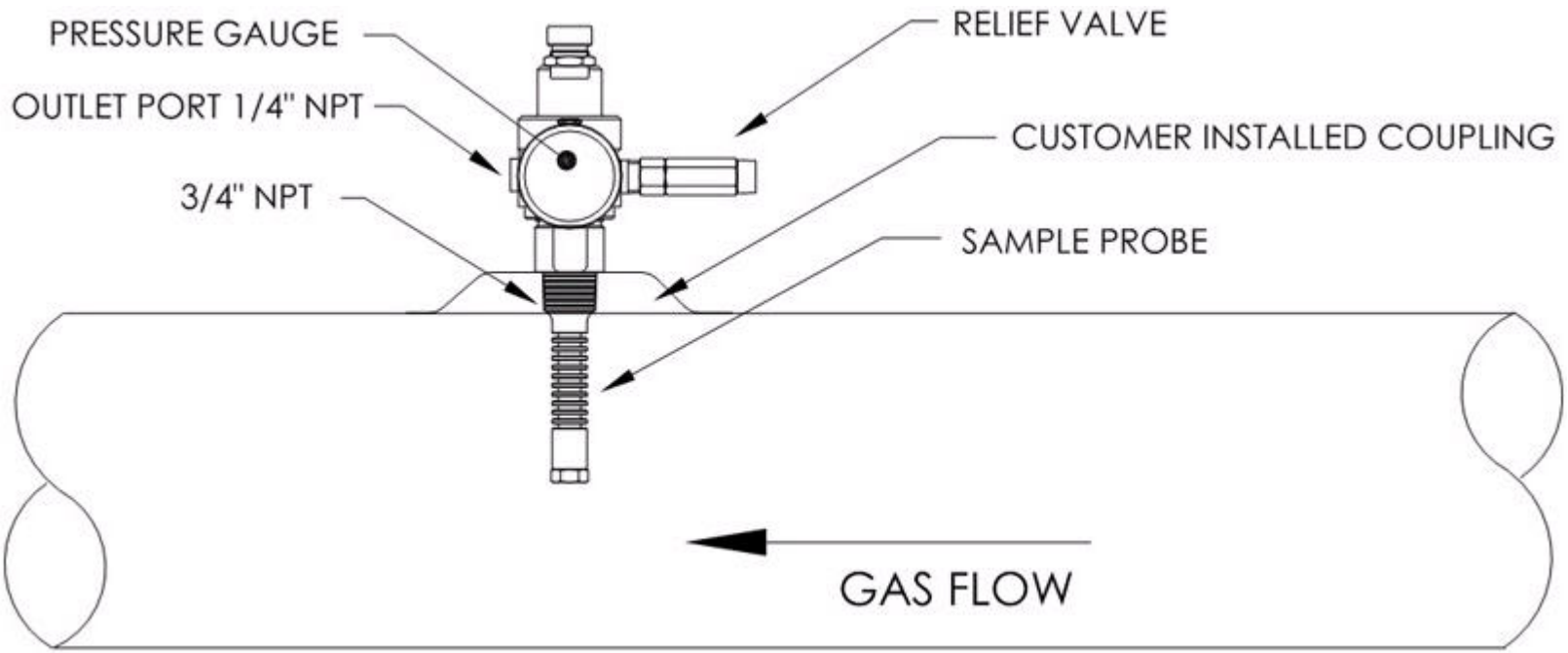
Integration – Sample Probe

- Sample probe installation
  - a sample probe regulator needs to be installed to extract the gas sample from a pipeline



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Integration – Sampling Probes

- Standard probe
  - These sample probes are provided so that a clean, dry, representative sample can be withdrawn from the flowing gas stream.
  - The Genie and Welker probes provide pressure reduction and temperature compensation without the use of external utilities.
  - The probes can be fixed or retractable.
  - These probes are designed to work with the Genie liquid rejection probe whenever hydrocarbon liquids are present.

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Integration – Sampling Probes

- Electrically Heated Probes
  - Prevents condensation of hydrocarbons.
  - Can be used if AC power is available.
  - A GO regulator provides pressure reduction.
  - Supplied with an explosion proof electric heater to counter the auto refrigeration due to the pressure drop.

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Integration – Sampling Probes

- Auto Insertion Probes
  - Same purpose as the standard probes.
  - Used for larger lines or lines that cannot be shut-in and blown-down for installation and/or inspection.
  - Have the capability for using the pipeline pressure to assist in the insertion into a flowing gas pipeline.

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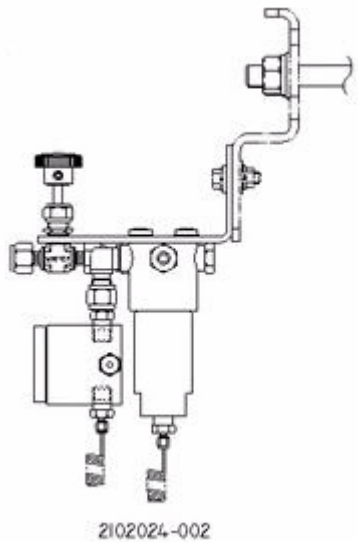
Integration – Sample Conditioning Module

- Sample conditioning systems
  - Protects the PGC from particulates and liquids and if not installed damage could result to the PGC



  - For each analytical stream measured, a standard sample conditioning module is provided with the PGC1000

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Standard Sample Conditioning Modules

- For use with stable gas samples
- Sample point is more than 10’ (3m) and less than 150’ (50m) from the chromatograph
- Sample could have particulate and liquid contamination with possibility of line flooding in upset conditions
  - Pipe scale and other solid contaminates
  - Liquid contamination or liquid carry which could damage the chromatograph if it was introduced as a sample
- This model contains a liquid shut off to protect the GC
  - Welker ALS-2

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Miscellaneous PGC1000 Accessories

- Accessories
  - Cold weather enclosure
    - Ambient temperature from 0° F to -40° F
  - Tool kits for PGC
  - Installation and maintenance kits
- Benefits
  - Protect analytical equipment
  - Efficient and proper analyzer maintenance activities
  - Most complete installations

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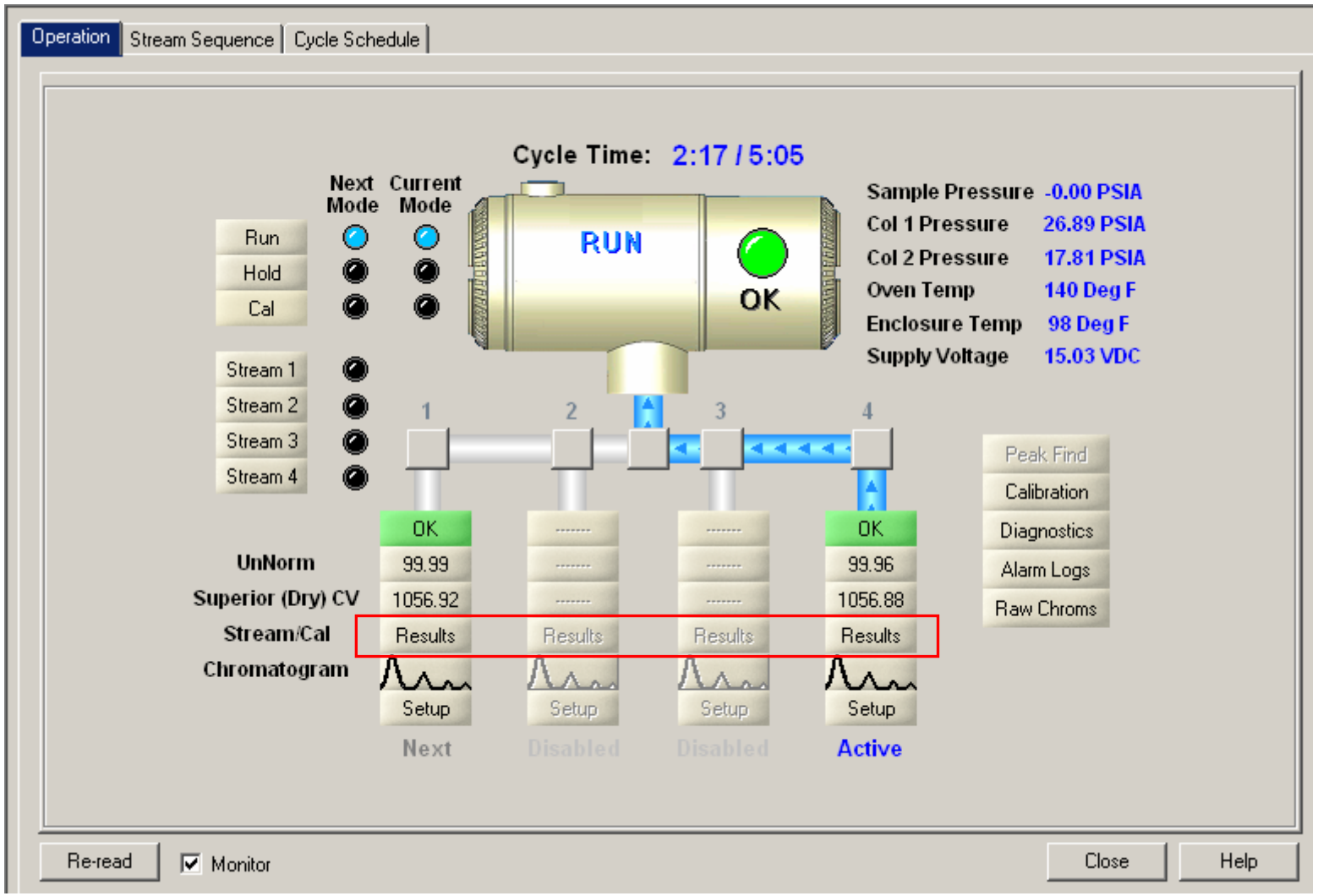
Powerful Graphical User Interface



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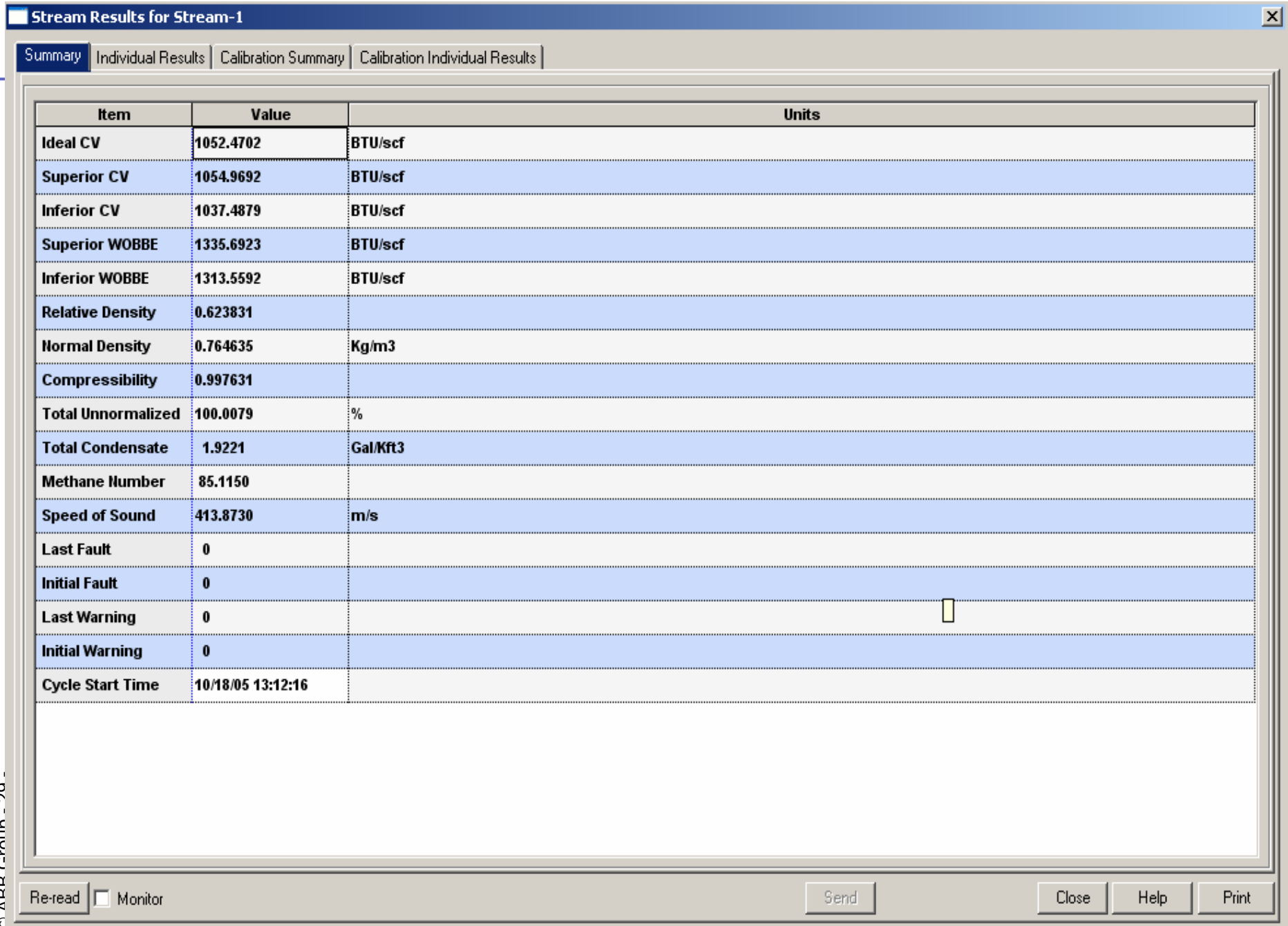
Stream Results for Stream-1
Summary
Individual Results
Calibration Summary
Calibration Individual Results
Item
Value
Units
Ideal CV
1052.4702
BTU/scf
Superior CV
1054.9692
BTU/scf
Inferior CV
1037.4879
BTU/scf
Superior WOBBE
1335.6923
BTU/scf
Inferior WOBBE
1313.5592
BTU/scf
Relative Density
0.623831
Normal Density
0.764635
Kg/m3
Compressibility
0.997631
Total Unnormalized
100.0079
%
Total Condensate
1.9221
Gal/Kft3
Methane Number
85.1150
Speed of Sound
413.8730
m/s
Last Fault
0
Initial Fault
0
Last Warning
0
Initial Warning
0
Cycle Start Time
10/18/05 13:12:16
Re-read
Monitor
Send
Close
Help
Print

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Stream Results for Stream-1

Summary | Individual Results | Calibration Summary | Calibration Individual Results

Component	Factor	Unnormalized Percent	Normalized Percent	Area	Height	Time	Liquids	Ideal	Density
Propane	3.26453	1.00002	0.99994	3063276	41154	77.93	0.274678	25.1604	0.015226
IsoButane	2.81139	0.29791	0.29789	1059661	10860	95.72	0.097209	9.6873	0.005979
Butane	2.79288	0.29851	0.29849	1068821	9959	102.90	0.093881	9.7366	0.005991
NeoPentane	2.54093	0.09983	0.09982	392880	2878	122.08	0.036444	3.9937	0.002487
IsoPentane	2.48833	0.10027	0.10026	402972	2287	150.60	0.036606	4.0115	0.002498
Pentane	2.52858	0.10011	0.10010	395917	1998	170.13	0.036170	4.0128	0.002494
Heavies	1.06576	0.02801	0.02801	38.8.5	3054	54.03	0.000000	0.0000	0.000000
Nitrogen	12.83018	2.38048	2.38030	1855379	36359	64.00	0.000000	0.0000	0.023025
Methane	15.49696	89.70054	89.69349	57882658	418278	72.43	0.000000	905.9043	0.496875
CarbonDioxide	10.25231	0.99940	0.99933	974809	6785	100.30	0.000000	0.0000	0.015187
Butane+	0.00000	0.00000	0.00000	0	0	0.00	0.000000	0.0000	0.000000
2ndPropane	0.00000	0.00000	0.00000	0	0	0.00	0.000000	0.0000	0.000000
Ethane	9.26514	5.00277	5.00238	5399563	17305	192.43	1.334905	88.5271	0.051940
Hexane	0.00000	0.00000	0.01400	0	0	0.00	0.005744	0.6660	0.000417
Heptane	0.00000	0.00000	0.01400	0	0	0.00	0.006444	0.7705	0.000485
Octane	0.00000	0.00000	0.00000	0	0	0.00	0.000000	0.0000	0.000000
Nonane	0.00000	0.00000	0.00000	0	0	0.00	0.000000	0.0000	0.000000
Decane	0.00000	0.00000	0.00000	0	0	0.00	0.000000	0.0000	0.000000
	0.00000	0.00000	0.00000	0	0	0.00	0.000000	0.0000	0.000000
	0.00000	0.00000	0.00000	0	0	0.00	0.000000	0.0000	0.000000
	0.00000	0.00000	0.00000	0	0	0.00	0.000000	0.0000	0.000000

Re-read | Monitor | Send | Close | Help | Print

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Stream Results for Stream-1

Summary | Individual Results | Calibration Summary | Calibration Individual Results

Item	Value	Units
Ideal CV	1052.5399	BTU/scf
Superior CV	1055.0396	BTU/scf
Inferior CV	1037.5569	BTU/scf
Superior WOBBE	1335.7241	BTU/scf
Inferior WOBBE	1313.5905	BTU/scf
Relative Density	0.623884	
Normal Density	0.764700	Kg/m3
Compressibility	0.997631	
Total Unnormalized	100.0000	%
Total Condensate	1.9225	Gal/Kft3
Methane Number	85.0976	
Speed of Sound	413.8517	m/s
Cycle Start Time	10/18/05 13:38:06	
Calibration Mode/Command	Auto	

Re-read | Monitor | Send | Close | Help | Print

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Stream Results for Stream-1

Summary | Individual Results | Calibration Summary | Calibration Individual Results

Component	Factor	Old Response Factor	New Response Factor	Response Factor % Difference	Unnormalized Percent	Normalized Percent	Area	Height	Time	Liquids	Ideal	Density
Propane	3.26757	3.26453	0.00000	0.09302	1.00000	1.00000	3060379	0	0.00	0.2747	25.1620	0.015227
IsoButane	2.81386	2.81139	0.00000	0.08773	0.29800	0.29800	1059045	0	0.00	0.0972	9.6910	0.005981
Butane	2.79642	2.79288	0.00000	0.12691	0.29900	0.29900	1069224	0	0.00	0.0940	9.7534	0.006001
NeoPentane	2.54435	2.54093	0.00000	0.13459	0.10000	0.10000	393028	0	0.00	0.0365	4.0009	0.002491
IsoPentane	2.49481	2.48833	0.00000	0.26045	0.10000	0.10000	400832	0	0.00	0.0365	4.0009	0.002491
Pentane	2.53015	2.52858	0.00000	0.06200	0.10000	0.10000	395234	0	0.00	0.0361	4.0087	0.002491
Heavies	1.07425	1.06576	0.00000	0.79638	0.03000	0.03000	279264	0	0.00	0.0000	0.0000	0.000000
Nitrogen	12.83969	12.83018	0.00000	0.07418	2.38000	2.38000	1853627	0	0.00	0.0000	0.0000	0.023022
Methane	15.50795	15.49696	0.00000	0.07087	89.69300	89.69300	57836802	0	0.00	0.0000	905.8993	0.496872
CarbonDioxide	10.27180	10.25231	0.00000	0.19013	1.00000	1.00000	973539	0	0.00	0.0000	0.0000	0.015197
Butane+	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0	0.00	0.0000	0.0000	0.000000
2ndPropane	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0	0.00	0.0000	0.0000	0.000000
Ethane	9.27034	9.26514	0.00000	0.05614	5.00000	5.00000	5393543	0	0.00	1.3343	88.4850	0.051915
Hexane	0.00000	0.00000	0.00000	0.00000	0.00000	0.01500	0	0	0.00	0.0062	0.7134	0.000446
Heptane	0.00000	0.00000	0.00000	0.00000	0.00000	0.01500	0	0	0.00	0.0069	0.8254	0.000519
Octane	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0	0.00	0.0000	0.0000	0.000000
Nonane	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0	0.00	0.0000	0.0000	0.000000
Decane	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0	0.00	0.0000	0.0000	0.000000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0	0.00	0.0000	0.0000	0.000000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0	0.00	0.0000	0.0000	0.000000

Re-read | Monitor | Send | Close | Help | Print

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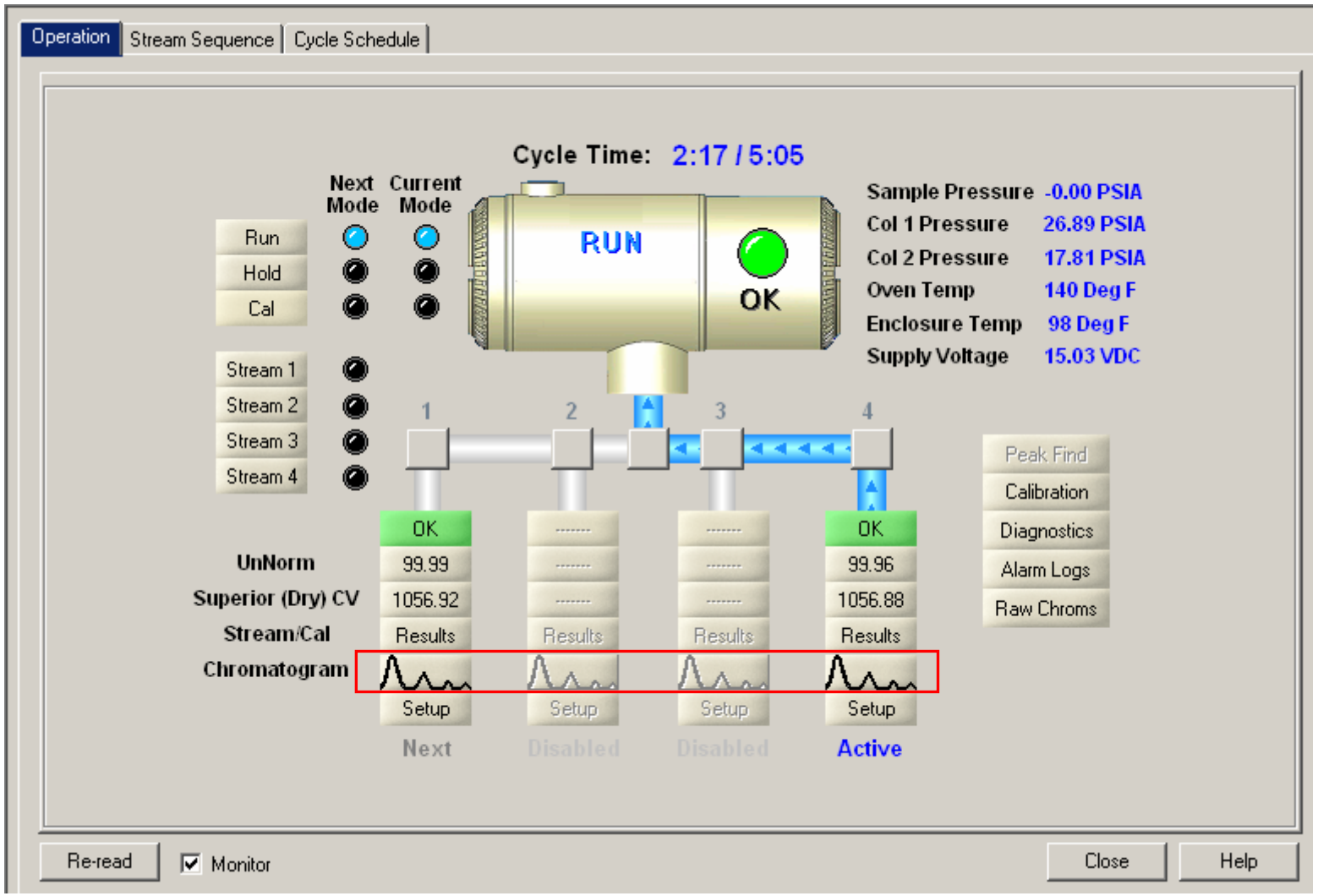
Powerful Graphical User Interface



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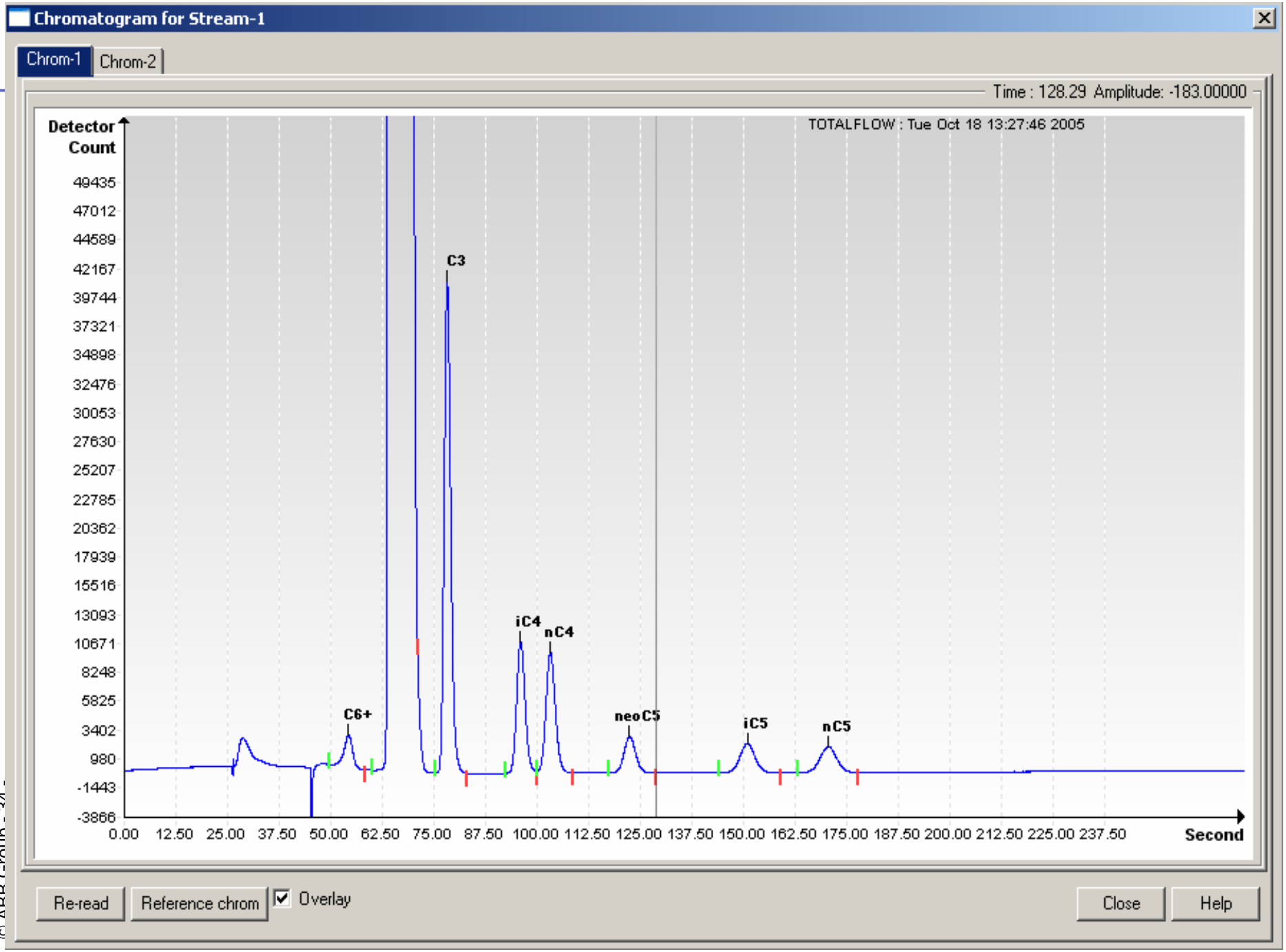
Chromatogram for Stream-1
Chrom-1
Chrom-2
Time : 128.29 Amplitude: -183.00000
TOTALFLOW : Tue Oct 18 13:27:46 2005
Detector Count
49435
47012
44589
42167
39744
37321
34898
32476
30053
27630
25207
22785
20362
17939
15516
13093
10671
8248
5825
3402
980
-1443
-3866
C6+
C3
iC4
nC4
neoC5
iC5
nC5
0.00 12.50 25.00 37.50 50.00 62.50 75.00 87.50 100.00 112.50 125.00 137.50 150.00 162.50 175.00 187.50 200.00 212.50 225.00 237.50
Second
Re-read
Reference chrom
Overlay
Close
Help

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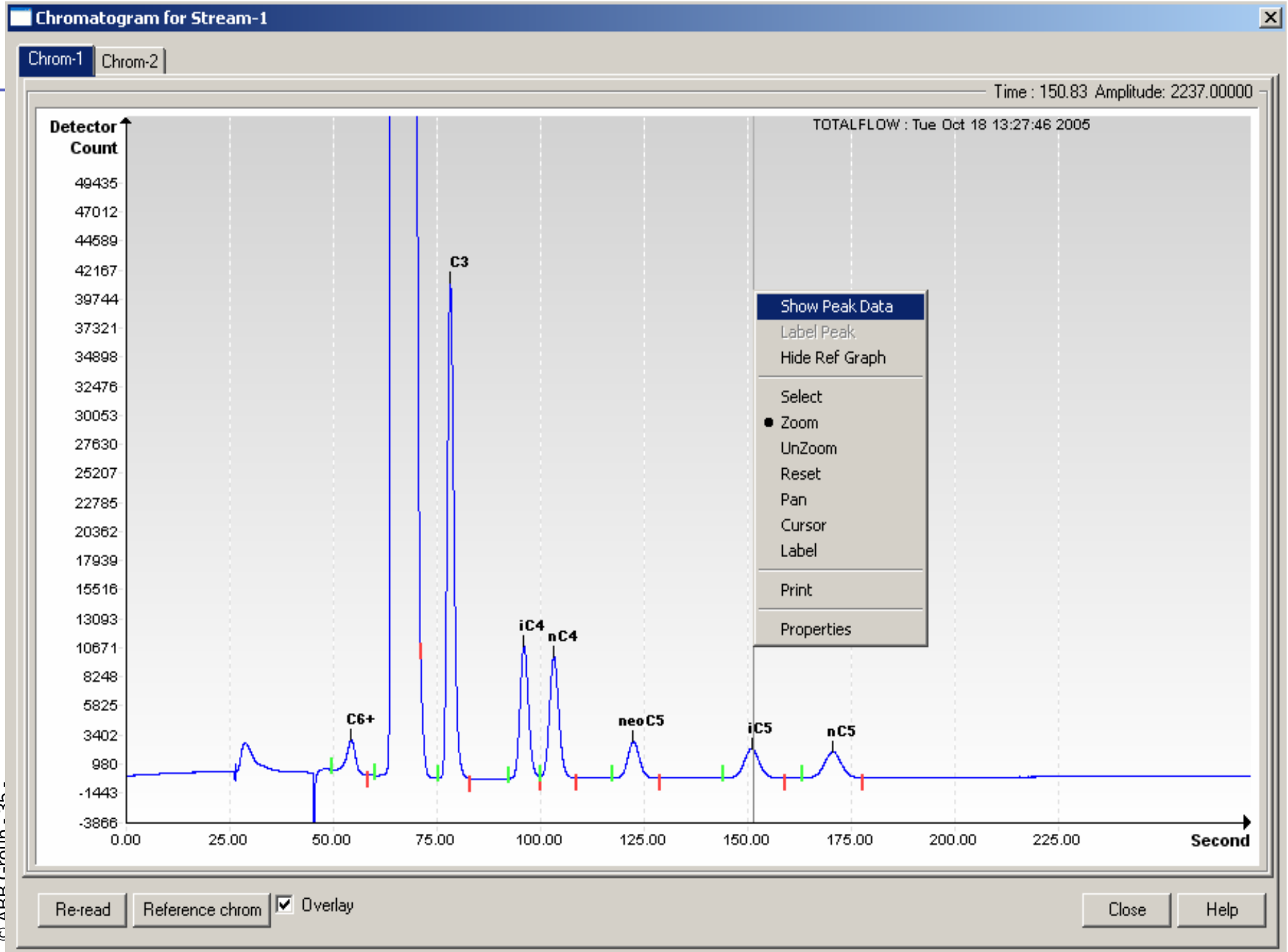
Chromatogram for Stream-1
Chrom-1
Chrom-2
Time : 150.83 Amplitude: 2237.00000
TOTALFLOW : Tue Oct 18 13:27:46 2005
Detector Count
49435
47012
44589
42167
39744
37321
34898
32476
30053
27630
25207
22785
20362
17939
15516
13093
10671
8248
5825
3402
980
-1443
-3866
C6+
C3
iC4
nC4
neoC5
iC5
nC5
0.00
25.00
50.00
75.00
100.00
125.00
150.00
175.00
200.00
225.00
Second
Show Peak Data
Label Peak
Hide Ref Graph
Select
Zoom
UnZoom
Reset
Pan
Cursor
Label
Print
Properties
Re-read
Reference chrom
Overlay
Close
Help

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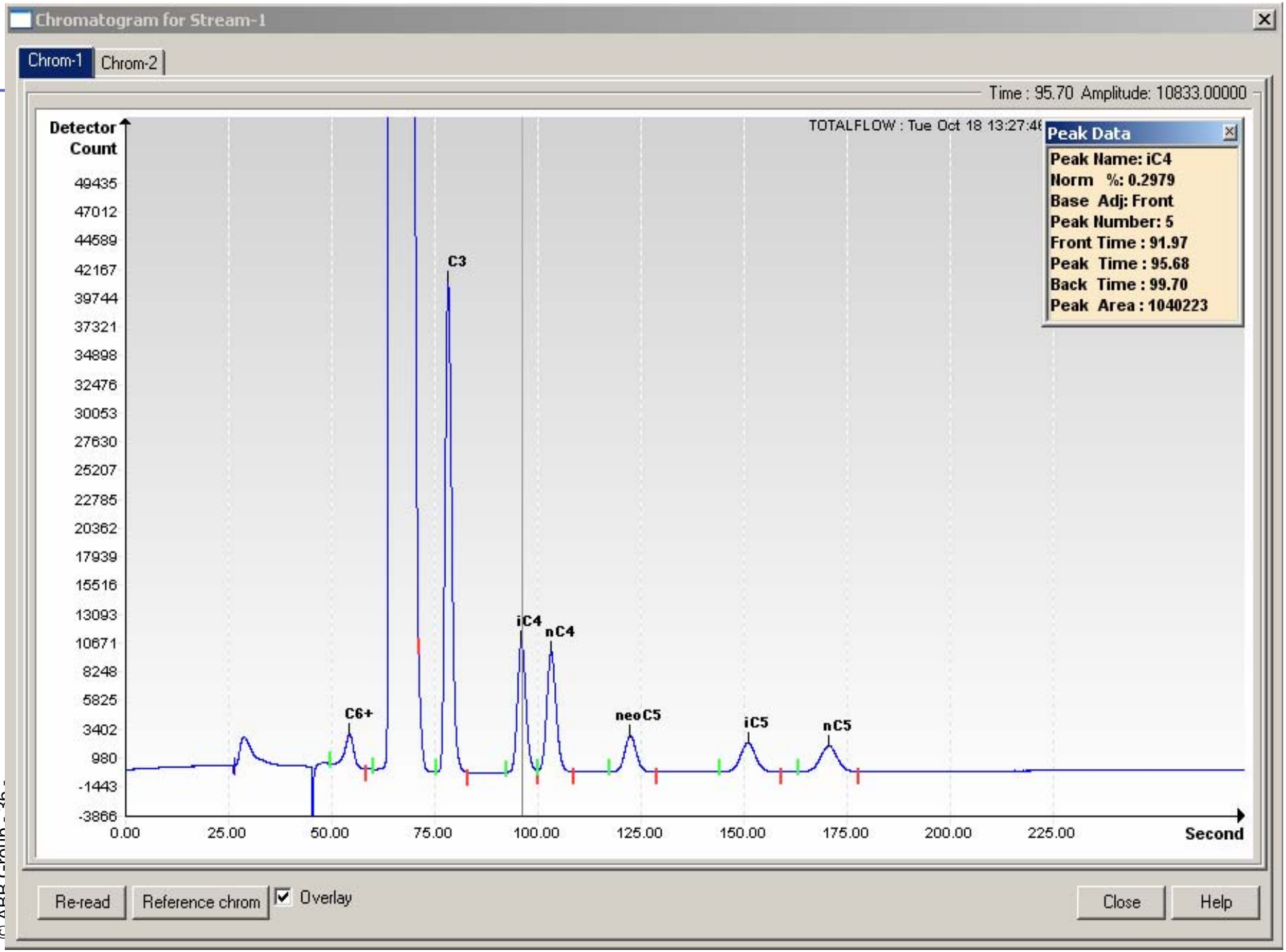
Chromatogram for Stream-1
Chrom-1
Chrom-2
Time : 95.70 Amplitude: 10833.00000
TOTALFLOW : Tue Oct 18 13:27:46
Peak Data
Peak Name: iC4
Norm %: 0.2979
Base Adj: Front
Peak Number: 5
Front Time : 91.97
Peak Time : 95.68
Back Time : 99.70
Peak Area : 1040223
Detector Count
49435
47012
44589
42167
39744
37321
34898
32476
30053
27630
25207
22785
20362
17939
15516
13093
10671
8248
5825
3402
980
-1443
-3866
C6+
C3
iC4
nC4
neoC5
iC5
nC5
0.00
25.00
50.00
75.00
100.00
125.00
150.00
175.00
200.00
225.00
Second
Re-read
Reference chrom
Overlay
Close
Help

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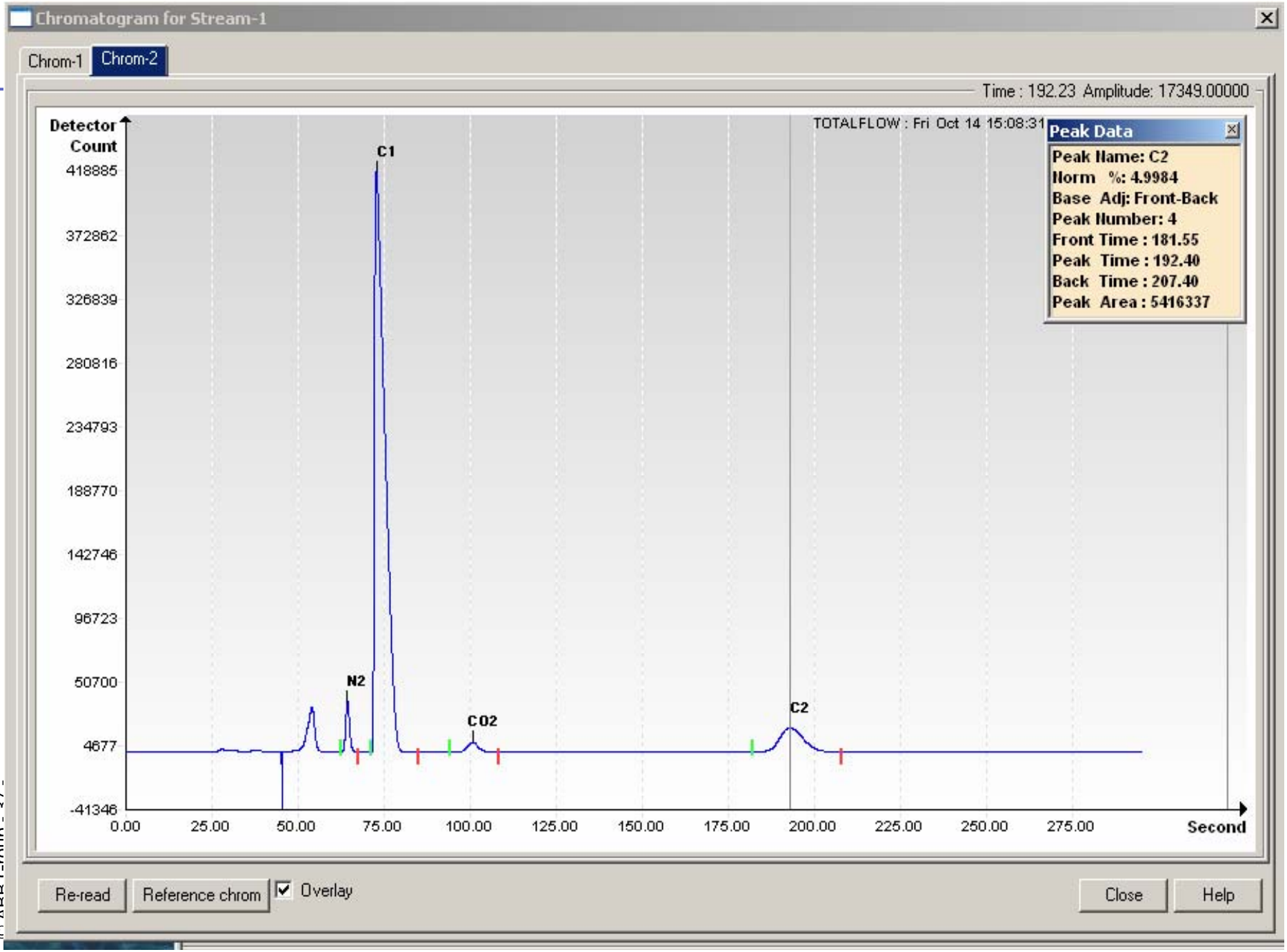
Chromatogram for Stream-1
Chrom-1
Chrom-2
Time : 192.23 Amplitude: 17349.00000
TOTALFLOW : Fri Oct 14 15:08:31
Peak Data
Peak Name: C2
Norm %: 4.9984
Base Adj: Front-Back
Peak Number: 4
Front Time : 181.55
Peak Time : 192.40
Back Time : 207.40
Peak Area : 5416337
Detector Count
418885
372862
326839
280816
234793
188770
142746
96723
50700
4677
-41346
C1
N2
CO2
C2
0.00
25.00
50.00
75.00
100.00
125.00
150.00
175.00
200.00
225.00
250.00
275.00
Second
Re-read
Reference chrom
Overlay
Close
Help

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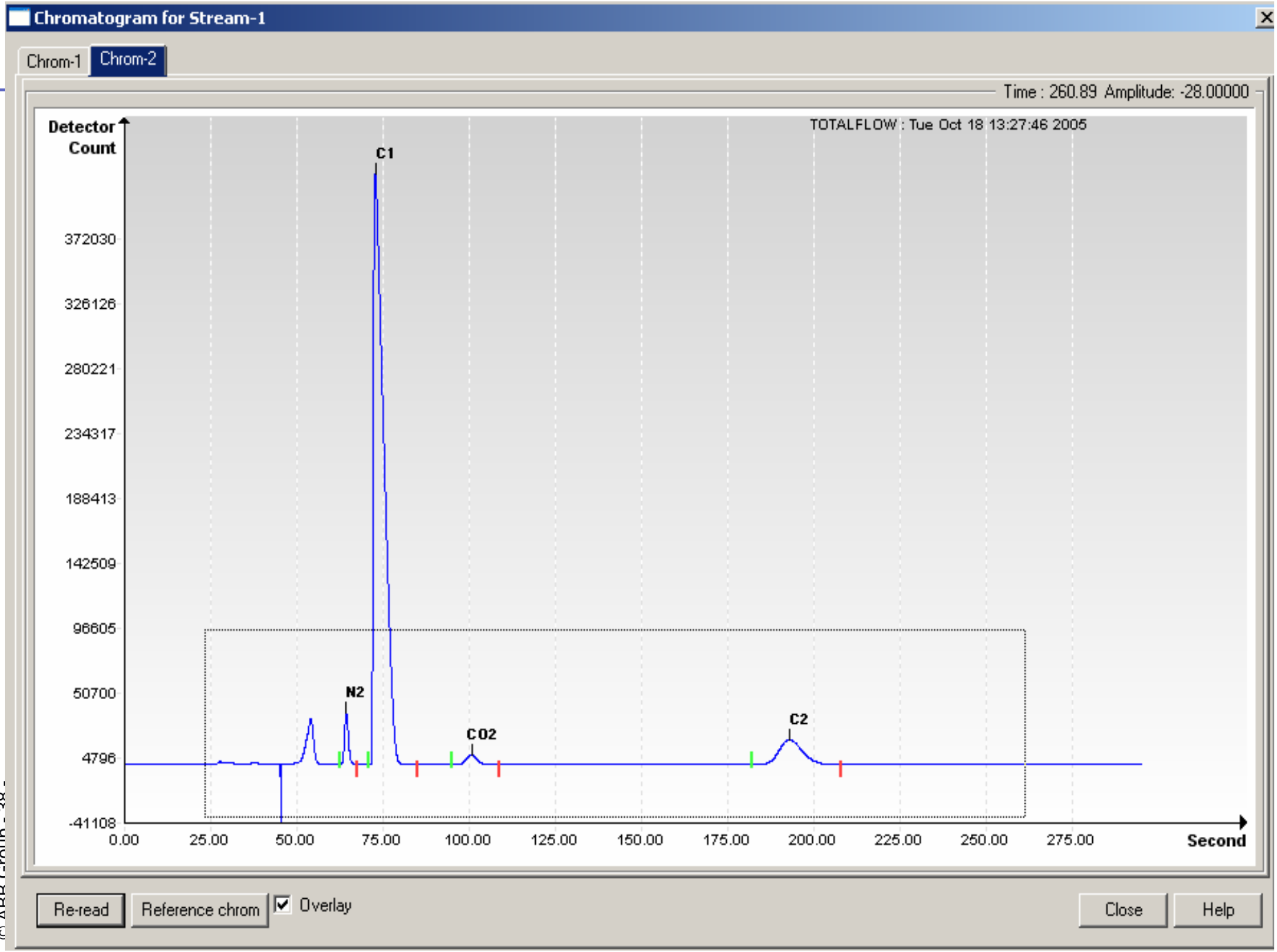
Chromatogram for Stream-1
Chrom-1
Chrom-2
Time : 260.89 Amplitude: -28.00000
TOTALFLOW : Tue Oct 18 13:27:46 2005
Detector Count
372030
326126
280221
234317
188413
142509
96605
50700
4796
-41108
C1
N2
CO2
C2
0.00
25.00
50.00
75.00
100.00
125.00
150.00
175.00
200.00
225.00
250.00
275.00
Second
Re-read
Reference chrom
Overlay
Close
Help

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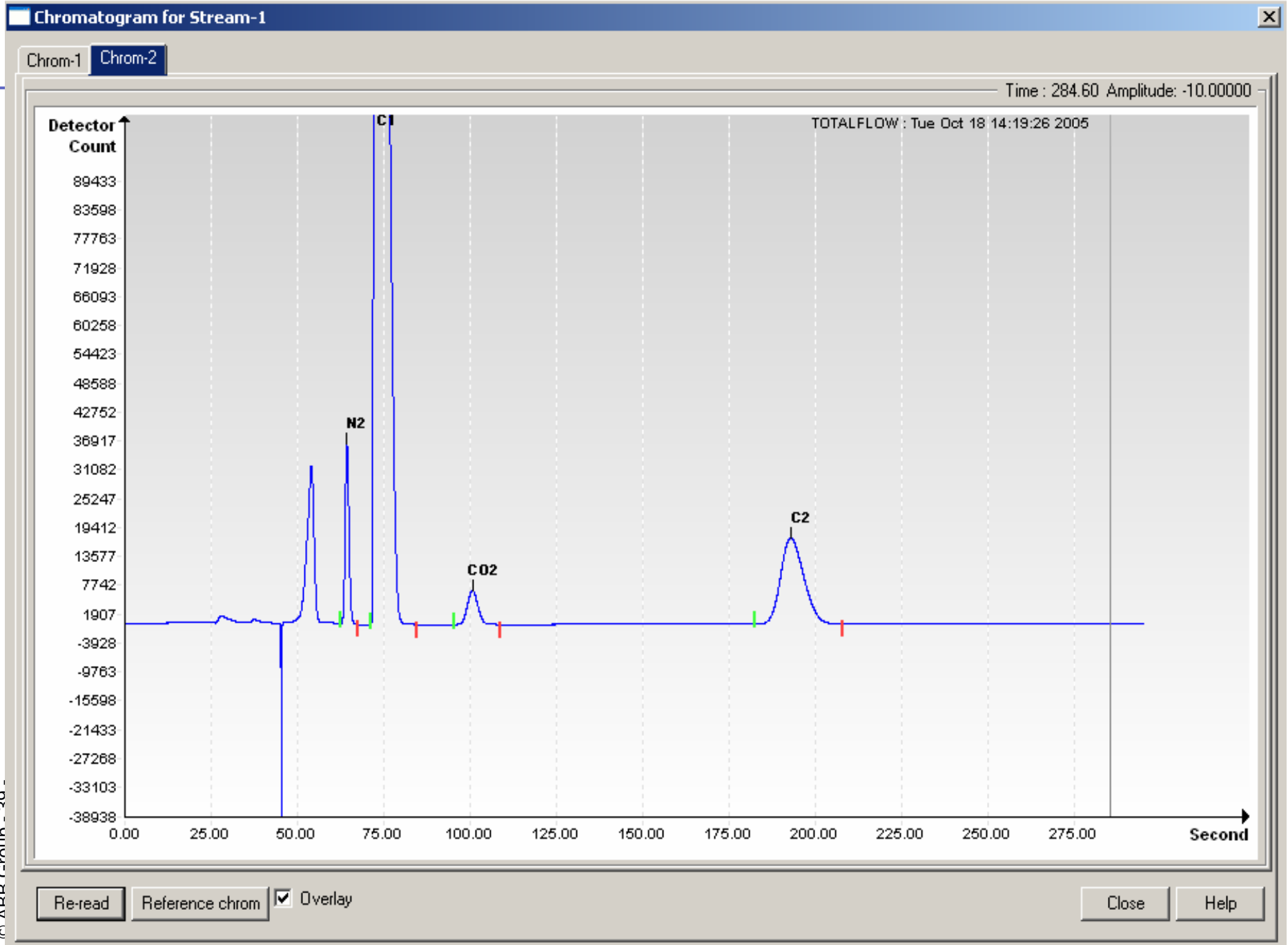
Chromatogram for Stream-1
Chrom-1
Chrom-2
Time : 284.60 Amplitude: -10.00000
TOTALFLOW : Tue Oct 18 14:19:26 2005
Detector Count
89433
83598
77763
71928
66093
60258
54423
48588
42752
36917
31082
25247
19412
13577
7742
1907
-3928
-9763
-15598
-21433
-27268
-33103
-38938
C1
N2
CO2
C2
0.00
25.00
50.00
75.00
100.00
125.00
150.00
175.00
200.00
225.00
250.00
275.00
Second
Re-read
Reference chrom
Overlay
Close
Help

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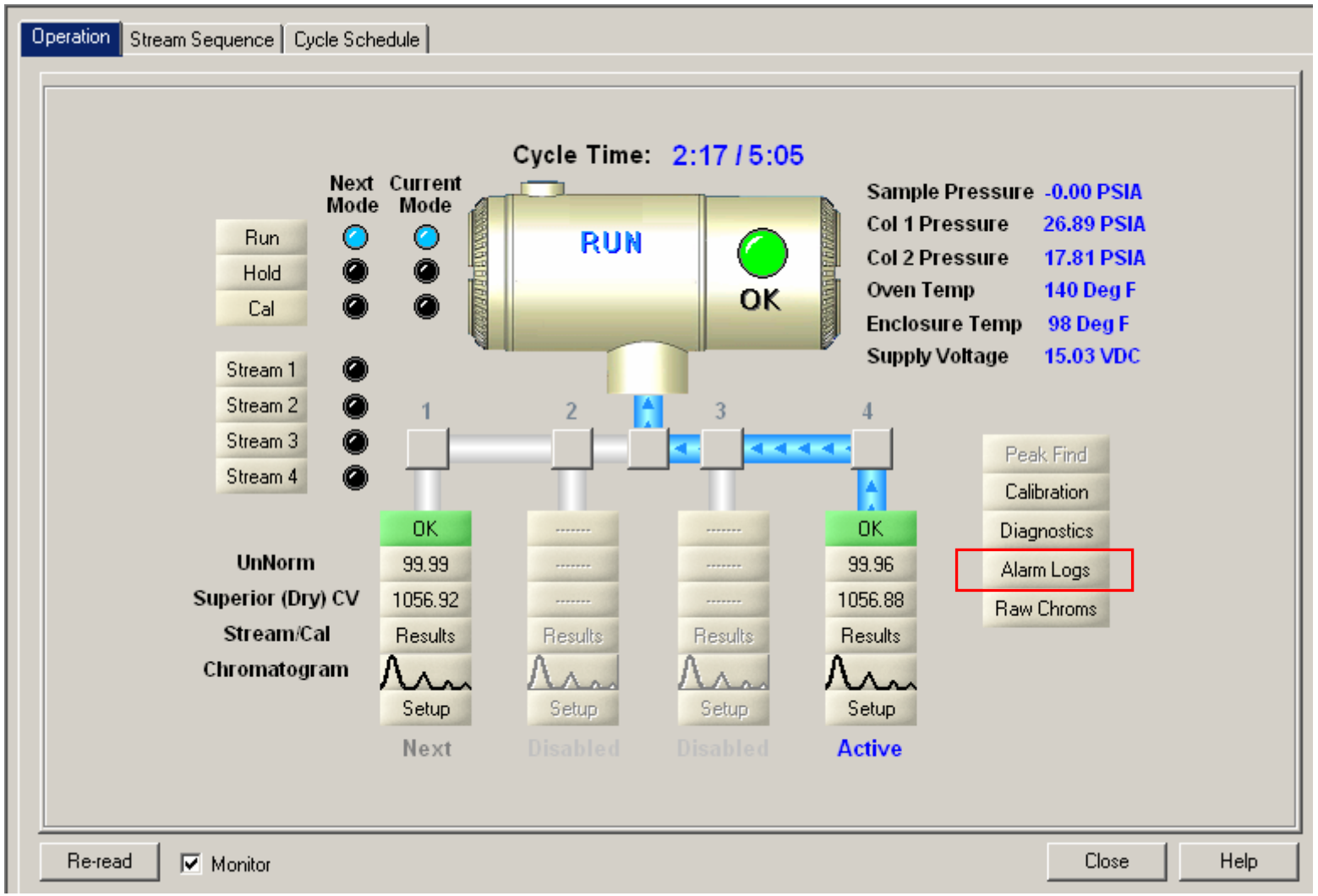
Powerful Graphical User Interface



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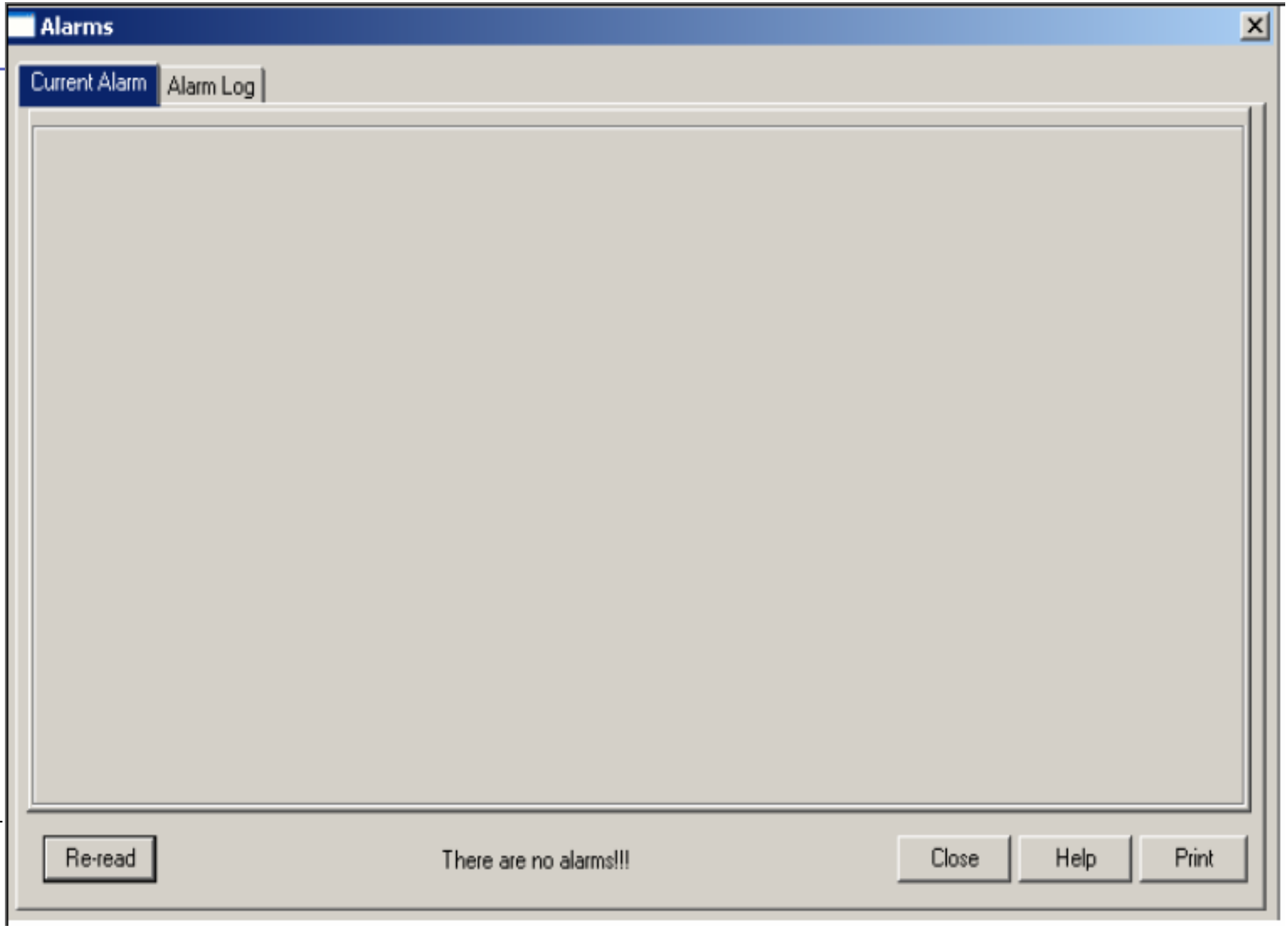
Alarms
Current Alarm
Alarm Log
Re-read
There are no alarms!!!
Close
Help
Print

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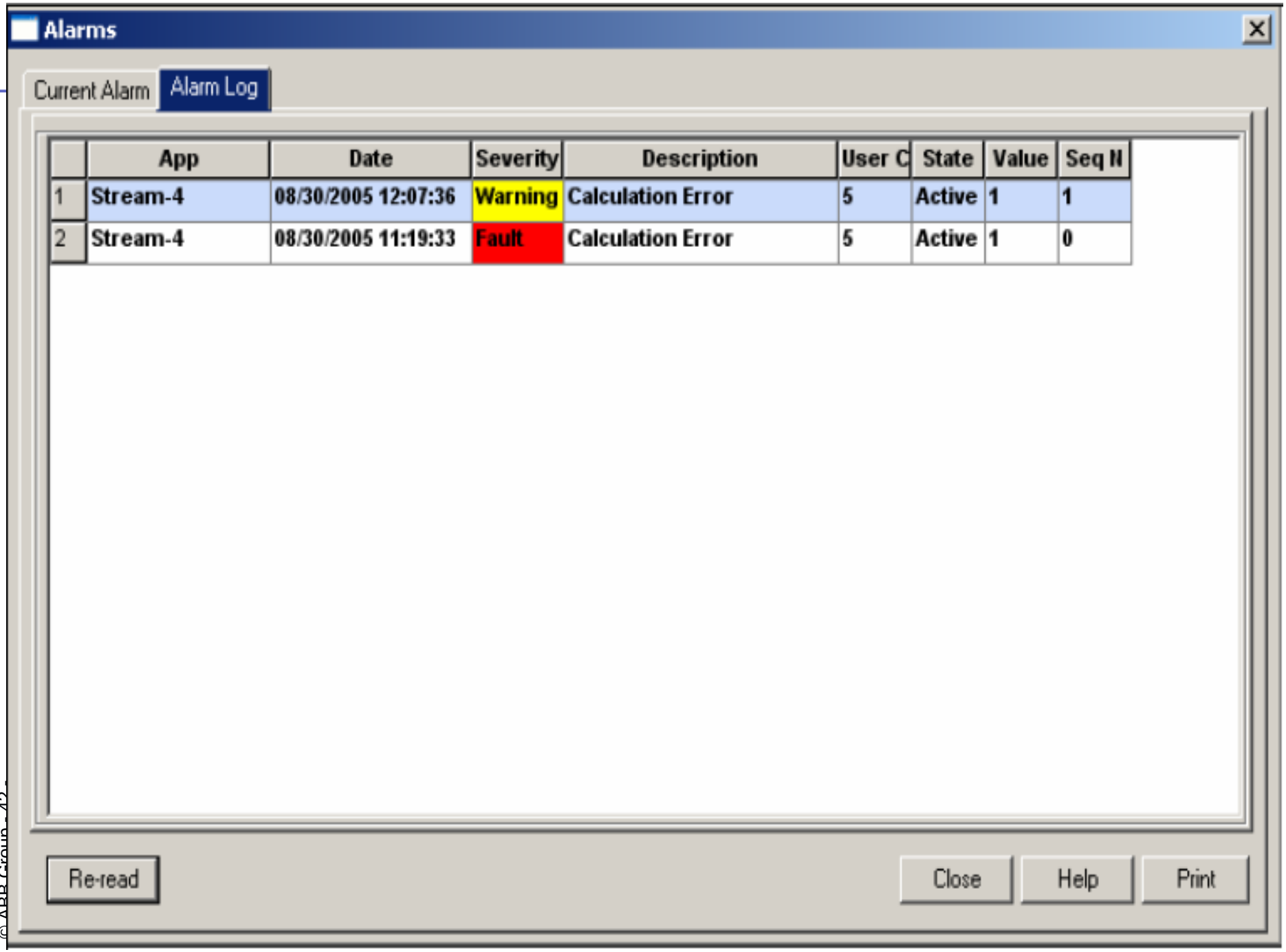
Alarms
Current Alarm
Alarm Log
App
Date
Severity
Description
User C
State
Value
Seq N
1
Stream-4
08/30/2005 12:07:36
Warning
Calculation Error
5
Active
1
1
2
Stream-4
08/30/2005 11:19:33
Fault
Calculation Error
5
Active
1
0
Re-read
Close
Help
Print

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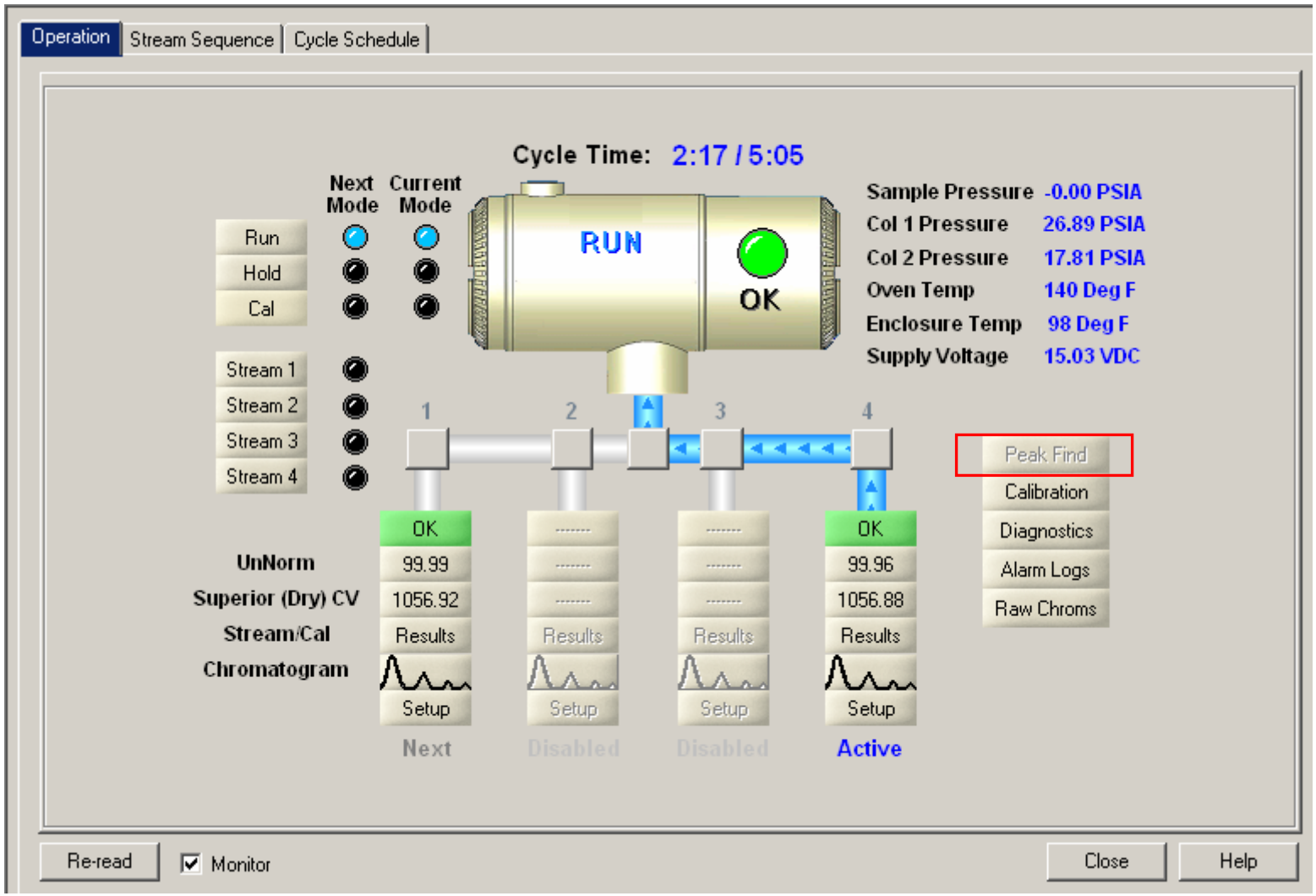
Powerful Graphical User Interface



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Manual Peak Find

Peak Setup

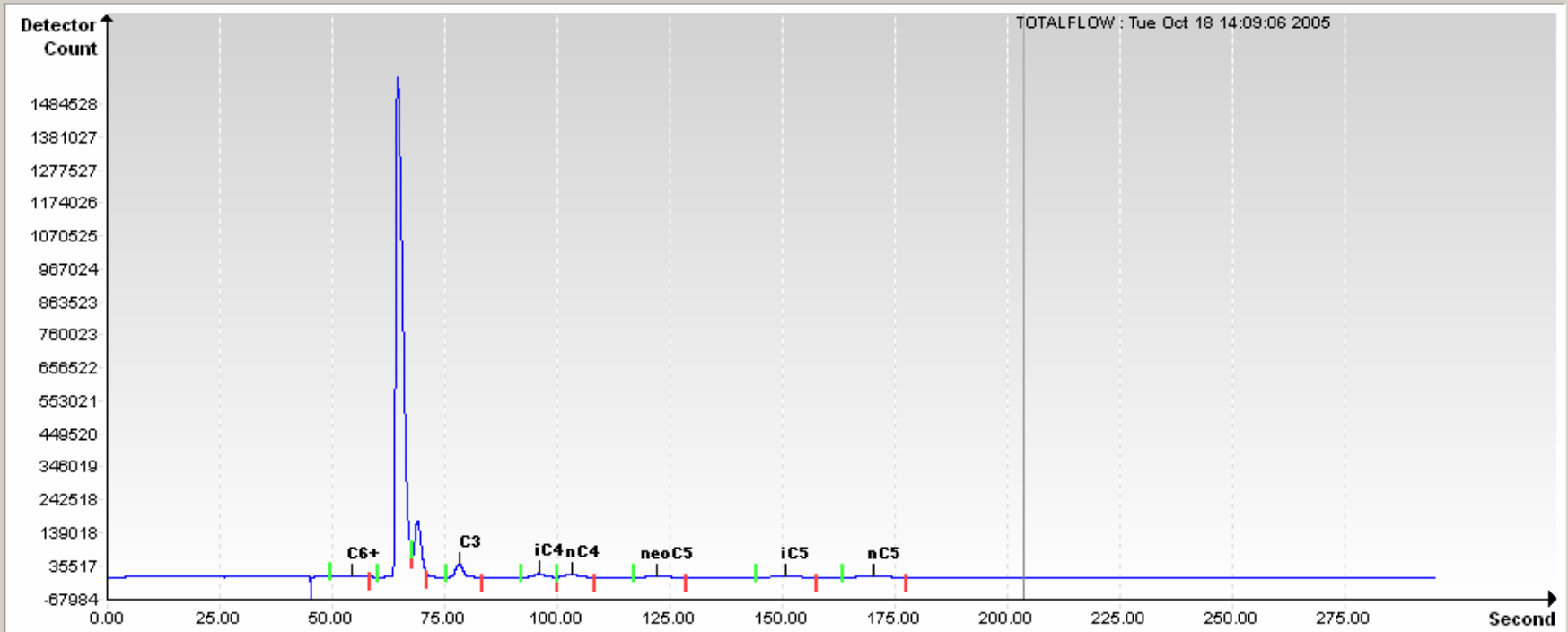
Chrom Processing	Gate On	Gate Off	Slope(Run) Sample Periods	Slope(Rise) Det counts	Min. Peak Area	Front Height Ratio
Yes	48.00	88.00	5	3	3000	0.50
Yes	88.00	220.00	10	3	3000	0.50
No	0.00	0.00	0	0	0	0.00
No	0.00	0.00	0	0	0	0.00

Carrier Pressure 1 Setpoint: 34.5
Carrier Pressure 2 Setpoint: 24
Purge Time: 22
Bleed Time: 4
Forward Flow Duration: 19
Backflush Duration: 250
Cycle Time: 0:00 / 5:11

Send Setup
Re-Read
Run Single Cycle
Close

Chrom-1 Chrom-2

Time : 203.26 Amplitude: -106.00000



Help

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Manual Peak Find

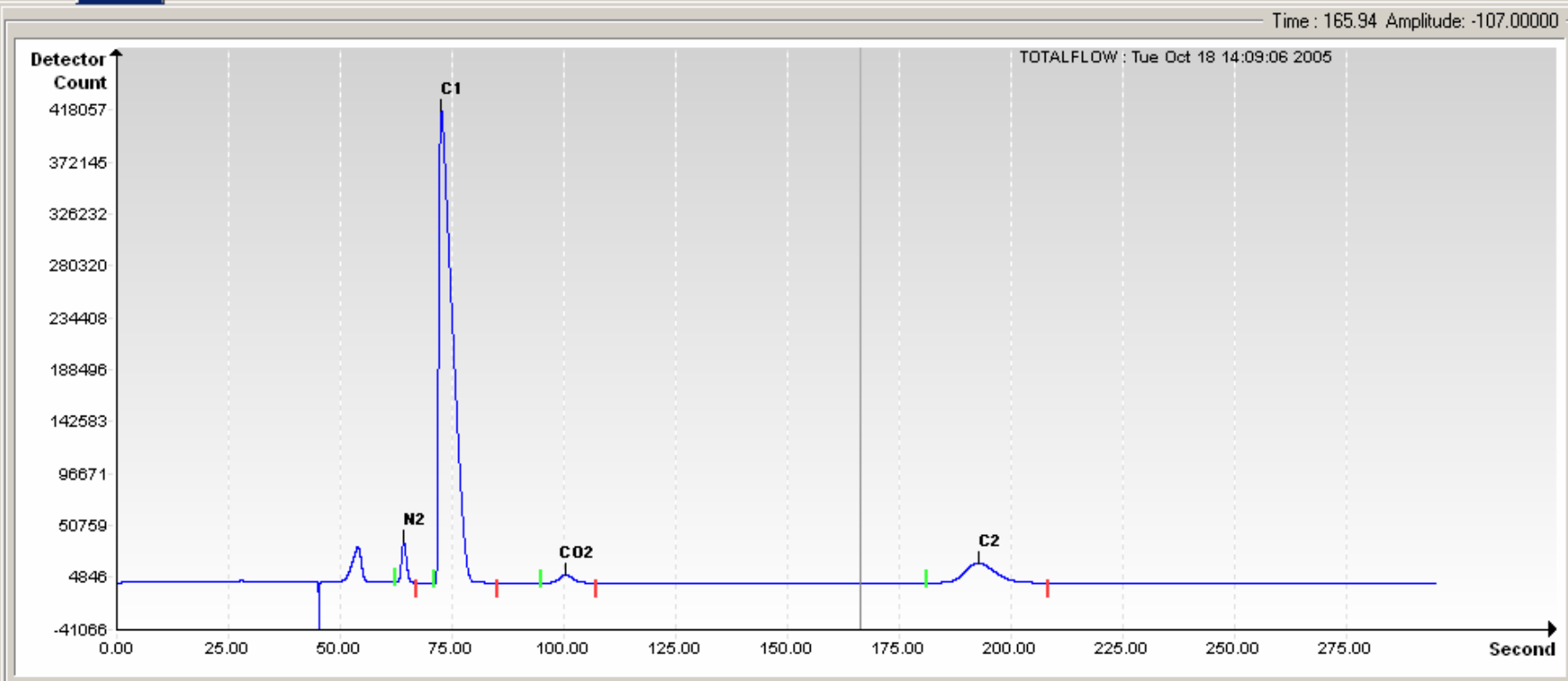
Peak Setup

Chrom Processing	Gate On	Gate Off	Slope(Run) Sample Periods	Slope(Rise) Det counts	Min. Peak Area	Front Height Ratio
Yes	58.00	88.00	5	3	3000	0.50
Yes	88.00	240.00	10	3	10000	0.50
No	0.00	0.00	0	0	0	0.00
No	0.00	0.00	0	0	0	0.00

Carrier Pressure 1 Setpoint: 34.5
Carrier Pressure 2 Setpoint: 24
Purge Time: 22
Bleed Time: 4
Forward Flow Duration: 19
Backflush Duration: 250
Cycle Time: 0:00 / 5:11

Send Setup
Re-Read
Run Single Cycle
Close

Chrom-1 Chrom-2



Help

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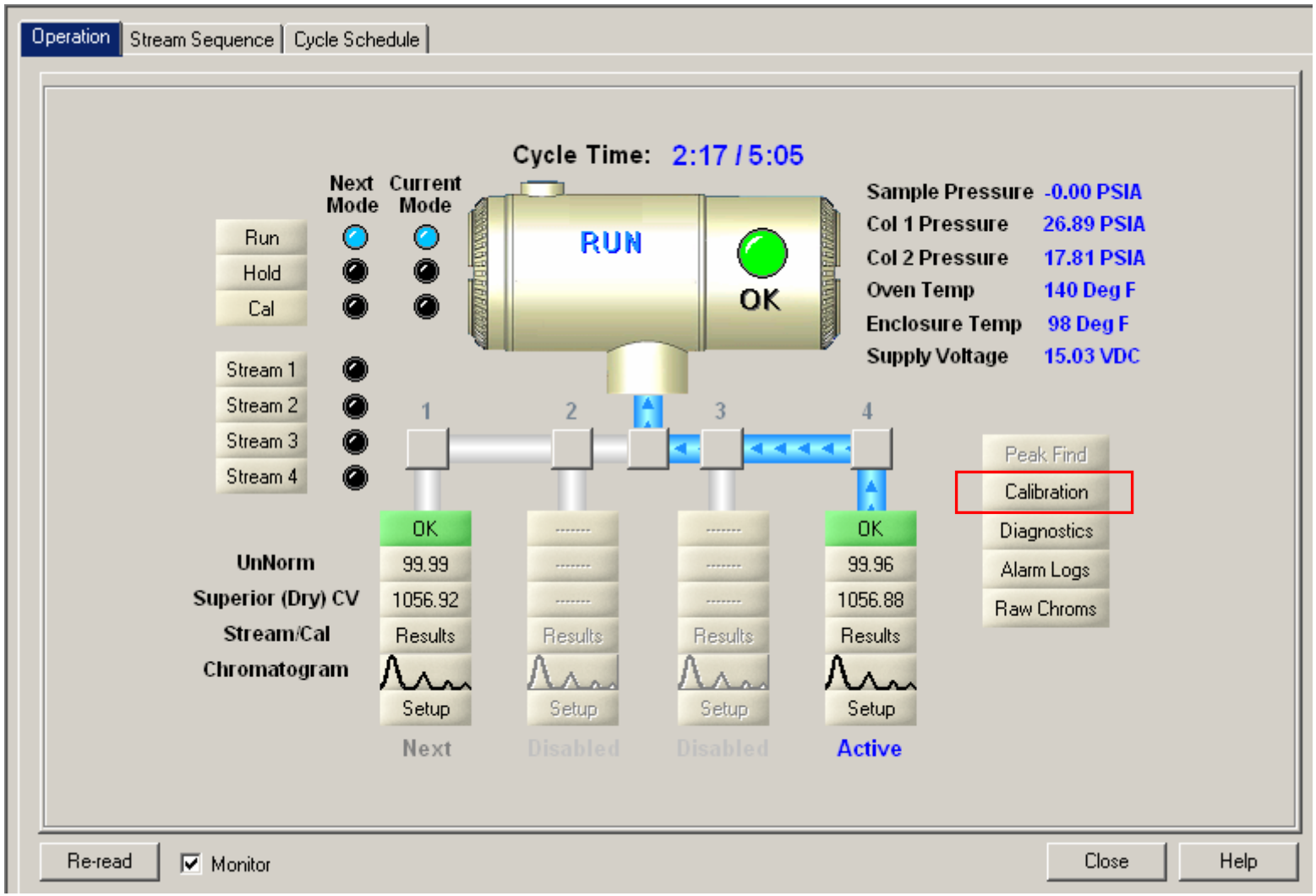
Powerful Graphical User Interface



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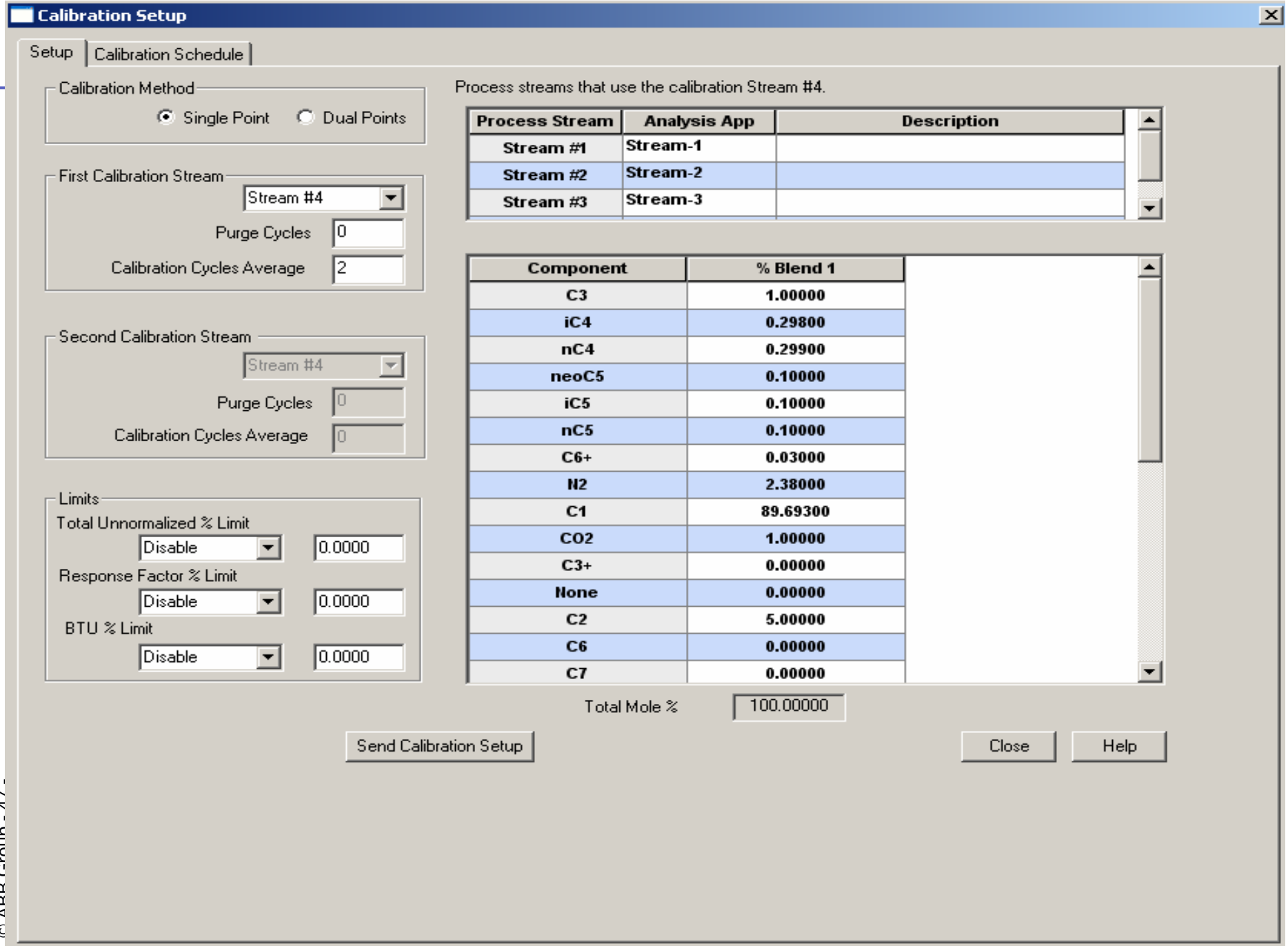
Calibration Setup
Setup
Calibration Schedule
Calibration Method
Single Point
Dual Points
First Calibration Stream
Stream #4
Purge Cycles
0
Calibration Cycles Average
2
Second Calibration Stream
Stream #4
Purge Cycles
0
Calibration Cycles Average
0
Limits
Total Unnormalized % Limit
Disable
0.0000
Response Factor % Limit
Disable
0.0000
BTU % Limit
Disable
0.0000
Process streams that use the calibration Stream #4.
Process Stream
Analysis App
Description
Stream #1
Stream-1
Stream #2
Stream-2
Stream #3
Stream-3
Component
% Blend 1
C3
1.00000
iC4
0.29800
nC4
0.29900
neoC5
0.10000
iC5
0.10000
nC5
0.10000
C6+
0.03000
N2
2.38000
C1
89.69300
CO2
1.00000
C3+
0.00000
None
0.00000
C2
5.00000
C6
0.00000
C7
0.00000
Total Mole %
100.00000
Send Calibration Setup
Close
Help

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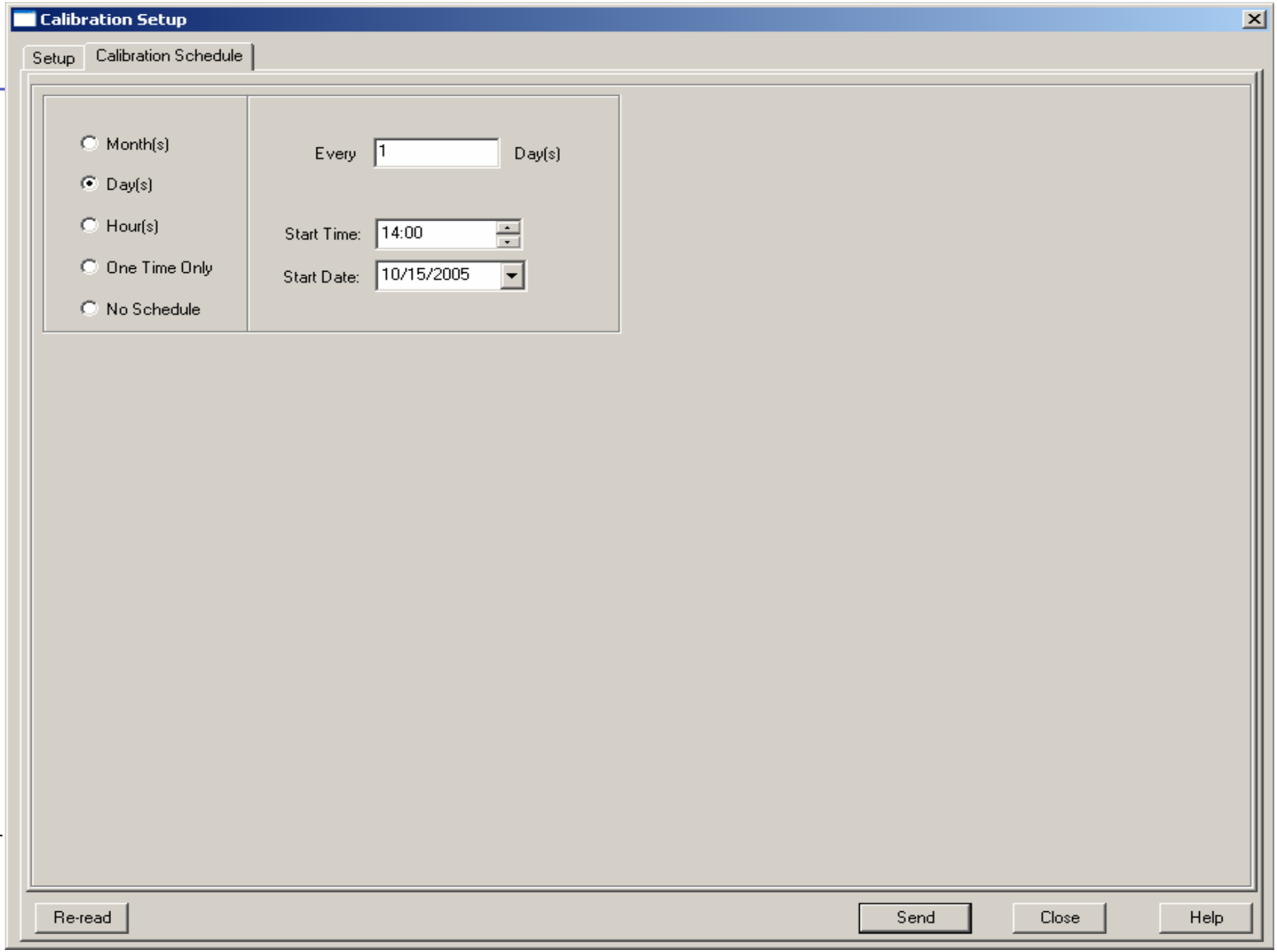
Calibration Setup
Setup
Calibration Schedule
Month(s)
Day(s)
Hour(s)
One Time Only
No Schedule
Every
1
Day(s)
Start Time:
14:00
Start Date:
10/15/2005
Re-read
Send
Close
Help

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Communications

- Two serial ports – both on the terminal board
  - Software selectable, RS 232, RS 422, RS 485
- Host and client USB on terminal board
- USB external via the man-machine interface (MMI connection)
- Ethernet on terminal board
- VistaNET$^{2.0}$ connectivity and compatibility
  - Standard LAN Ethernet protocol connection to the VistaNET$^{2.0}$ Gateway
    - MODBUS RTU output from the VistaNET$^{2.0}$ Gateway to the DCS
    - OPC server availability from the VistaNET$^{2.0}$ Gateway to standard OPC clients

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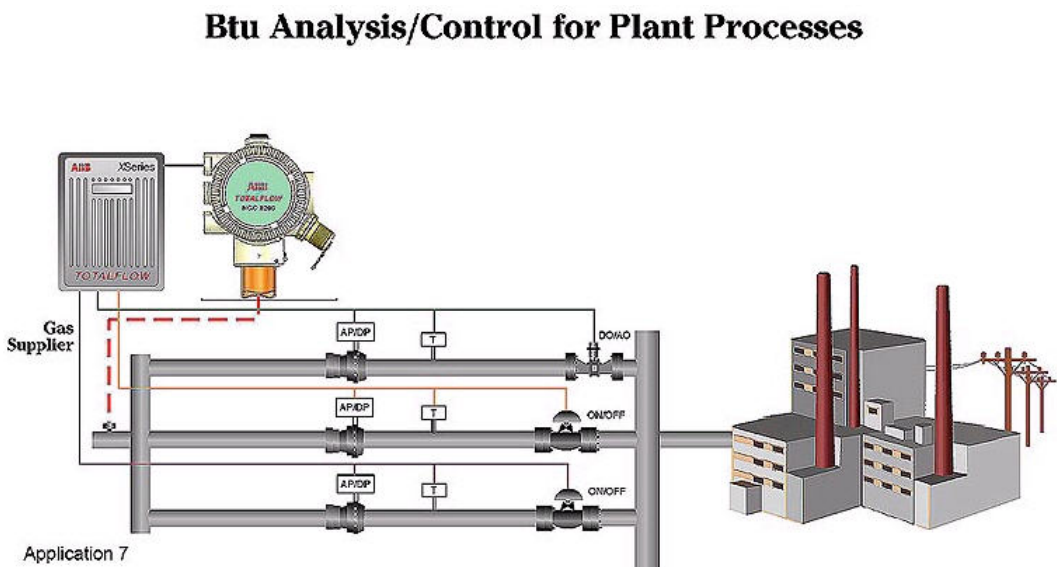
BTU Analysis in the HPI Industry

- HPI natural gas users
  - Any plant that uses a significant volume of natural gas is a potential user of on-line gas analysis
- PGC1000 BTU application
  - Full function GC, N2 to C6+ analysis



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Requirements for a BTU Analysis in the HPI

- Monitor quality of gas from different suppliers
- Provide important measurements for control of plant processes
- Check and verification of the suppliers' data

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Pipeline Quality Natural Gas Definition

- Clean is defined as having no particles larger than 1 micron and no more than 1 milligram of solids per cubic meter of gas
- Dry is defined as no more than 7 psi of water per million cubic feet of gas
- Dry is also defined as having less than 0.1 ppm of liquid at the coldest ambient condition expected at the coldest point in the system
  - The liquid can be water, oil, synthetic lubricant, glycol, condensed sample, or any other non-vapor contaminate
- Stable gas is defined as a vapor containing less than 0.1 ppm of liquid when the vapor is cooled to 10°C below the coldest ambient temperature possible at any point in the system

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PGC1000 Benefits to the HPI

- Move the analysis from the shelter to the plant fuel gas pipeline
  - Remote mounting and analysis (attaches to pipe or meter tube)
- Mount next to probe
  - Reduces the sample transport tubing **saving** money and **reducing** sample condensation during the sampling process
  - Designed to be mounted at the sample point
- Weatherproof enclosure
  - The unit can operate in the weather, under allowable ambient conditions, thereby saving the cost of an analyzer shelter
- Low consumption of utilities
  - He carrier, power, calibration gas
- Optional Solar power
  - 12-volt solar pack with 100 watts of solar panels and 200 AH of battery will start and run this unit

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Innovation

- Transmitter like simplicity and usability
- Miniaturized conventional analytical components
- Superior analytical performance thru state of the art analytical design and signal processing
- High performance applications package using Windows CE and Strong Arm microprocessor technology
- Interactive graphical display

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