IMPROVE Carbon Analysis

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Presented at

the IMPROVE Steering Committee Meeting

Skamania Lodge, Stevenson, WA

October 21, 2010

Objectives

- Report status of IMPROVE carbon analyses
- Enumerate improvements on carbon analyzers

Summary of Carbon Lab Operations

- Maintained 24 hours per day/6-7 days per week operation with 2 full-time and 4 part-time staff
- Recruited Post-Doctoral Fellow Jerome Robles (Chemical Engineer) to perform calibration and maintenance
- Completed IMPROVE backlog (June 2009)
- Analyzed over 23,000 IMPROVE samples (June 2010)

IMPROVE Carbon Analysis following the IMPROVE_A[a] Protocol

(7/09 – 6/10)

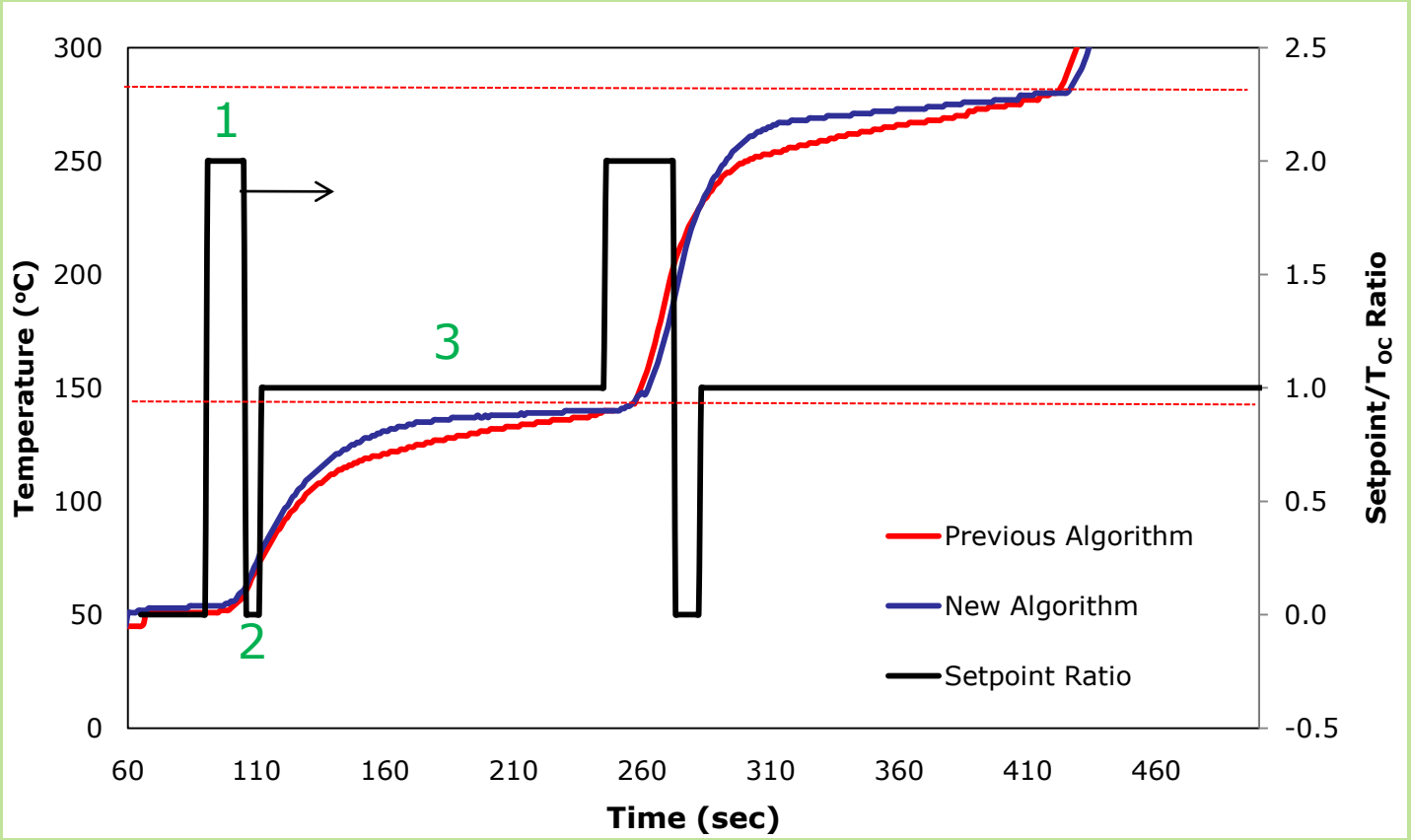
Sampling Period	Samples Received	Analysis Completion Date[b]
7/1/09-12/31/09	11,390	2/21/10
1/1/10-6/30/10	10,880	9/9/10

[a] Chow et al. (2007)

[b] Currently analyzing August and September 2010 samples

Refine Temperature Ramping for OC1 and OC2

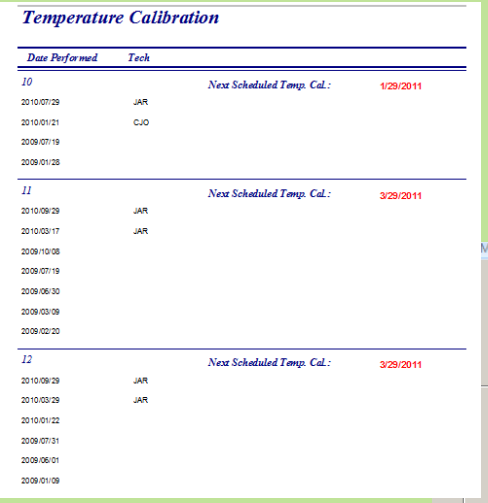
- Create three set points:
  1. Force a 100% controller output (rapid heating)
  2. Turn heater off (stabilization)
  3. Provide fine adjustments



Software Enhancements

- Integrate maintenance database
  - Improved maintenance guide
  - Revised electronic/mechanical trouble shooting guide
- Establish analyzer status program
  - Provides real-time monitoring of instrument operation with direct access to data summary
  - Improved database of maintenance, calibration, and analyses

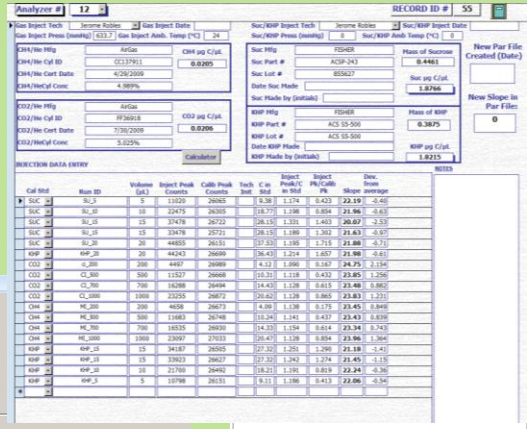
Integrated Maintenance Database



Temperature Calibration

Date Performed	Tech		
10		Next Scheduled Temp. Cal.:	1/29/2011
2010/07/29	JAR		
2010/01/21	CJO		
2009/07/19			
2009/01/28			
11		Next Scheduled Temp. Cal.:	3/29/2011
2010/09/29	JAR		
2010/03/17	JAR		
2009/10/08			
2009/07/19			
2009/06/30			
2009/03/09			
2009/02/20			
12		Next Scheduled Temp. Cal.:	3/29/2011
2010/09/29	JAR		
2010/03/29	JAR		
2010/01/22			
2009/07/31			
2009/06/01			
2009/01/09			

Scheduled Temperature Calibrations



Main

Carbon Analyzer Maintenance

Summarized Entry (old Log Book)

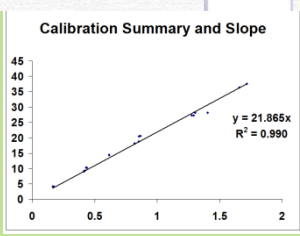
- by Analyzer
- by Problem Type
- by Date
- Add Entry/ Write Summary

Status Logger Maintenance Entry (new Log Book)

- Show Complete Log
- Show Log by Analyzer
- Show Log by Date
- Show Log by Specific Problem

Calibrations/ Maintenance Guide

- View Temperature Calibrations
- Carbon Calibration
- Print Temperature Calib. Checklist
- Maintenance Manual
- Print Troubleshoot Guide
- Punch Calibration Calculator



Carbon Calibration Data Entry and Plot

Analyzer Maintenance Status

Analyzer Number 10

Date	Time	Status	Problem Class	Description	Tech
2/8/2010	9:40 AM	OFFLINE	Other (specify in comment)	Motor whining when He/O2 valve opens. This occurs in the middle of analysis	JAR
2/8/2010	1:37 PM	OFFLINE	Other (specify in comment)	Testing the He/O2 valve. This may have been responsible for the motor whining during the start of the BD1 portion of the run	JAR
2/9/2010	6:47 PM	OFFLINE	analyzer still being used for modifying software failed leak test- needs a new reducing ferrule		sms
2/10/2010	10:08 AM	OFFLINE		Replaced reducing ferrule. Instrument currently used for software testing/modification	JAR
2/10/2010	1:12 PM	OFFLINE		LT and LR drop during He/O 2 portion reappeared	JAR
2/12/2010	8:28 AM	OFFLINE		Performing sucrose test. Problem with unknown LT drop did not surface in multiple blank runs	JAR
2/16/2010	2:00 PM	OFFLINE		Observed a white wire connecting to the left-side circuit board (servo board) affects moto whining at the exact moment when the problem occurs	JAR
2/17/2010	8:08 AM	OFFLINE		Cleaned thermocouple pushrod. Performing blank runs to determine persistent motor grind. Seems to have been eliminated by reattaching wire.	JAR
2/17/2010	8:48 AM	OFFLINE		laser drift observed. replaced LT sedium and testing drift.	JAR
2/17/2010	10:46 AM	OFFLINE		Performing sucrose test	JAR
2/17/2010	11:27 AM	OFFLINE		Passed sucrose test. Performing FRESNO for comparison.	JAR
2/17/2010	1:13 PM	ONLINE		Passed RTI comparison	JAR
3/6/2010	5:14 PM	OFFLINE	Hardware issue	MOTOR GRINDS	APL
3/8/2010	8:24 AM	OFFLINE		Motor grind starts at the BD2 portion. It used to appear in the BD1 portion.	JAR
3/8/2010	10:57 AM	OFFLINE		Loose wire wire again observed that may cause the motor grind. Secured the wiring and performing tests.	JAR
3/8/2010	12:10 PM	ONLINE		Motor grind most likely due to wiring problem. Secured wires and test	JAR

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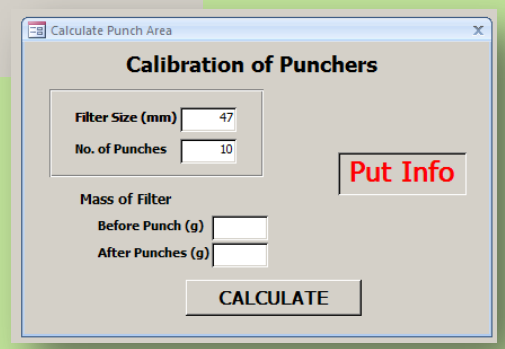
Maintenance History For CA#10



Punch Calibration Calculator

Troubleshooting Guide
(accessible through Maintenance Database)

Troubleshooting Guide

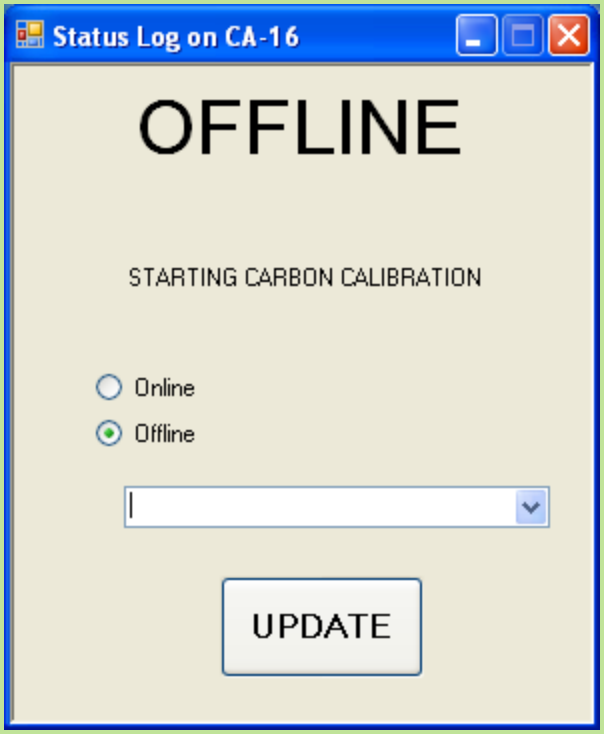
Problem	Possible Cause	Explanation/Solution
Contamination in the EC3 region	Contaminant in the breech and in the "cooler" regions of the pushrod thermocouple	Wipe the entire length of the pushrod with Kimwipes and quartz filter. Bake oven. Perform blank runs until system is contaminant-free. There should be notable decrease in EC3 values for succeeding blank runs; otherwise this is not a contaminant-related issue.
	Electronic noise due to the sample oven temperature controller	This shows up as multiple "noise-like" peaks in the EC3 region. Confirm the temperature controller parameters (PidA, PidB, etc) and make appropriate adjustments.
	Electronic noise/drift due to damage in electrometer or improper grounding	This can show as a drift in the baseline that starts in any temperature region. The drift may also occur at random occasions for unknown reasons. If available, replace the electrometer circuit board and check if the old electrometer is indeed defective. If spare parts are not available, try grounding the electrometer and shield the entire FID assembly.
Low or Sudden Drop in Calibration Peak Area	Insufficient methane injected in the system due to system leaks	Test for system leaks. If detected, fix the leak and perform auto calibration to confirm that calibration peak is restored. The most common source of leak is the orange O-ring in the breech area. Replace this O-ring if signs of damage are observed.
	Fluctuations in gas flow	Check the rotameters. Confirm that the flows are equal to the specified values. Make all the necessary adjustments and confirm results with auto calibration run.
	Misaligned pushrod causing leaks and affects calibration peak area	This problem can sometimes cause leak when the boat is in one position but not in other positions. One of the major reasons for the misalignment is a wobbly breech because the support is not securely fastened. Try tightening the support by rotating until it penetrates more securely into the breech.
	Contamination in the calibration line due to the installation of new methane gas cylinder.	During calibration gas replacement, the calibration gas line may have allowed air into the system. Purge the gas line by connecting a syringe into the methane gas injection port and remove the syringe's plunger to allow faster purging of the calibration gas. Perform autocalibration to test calibration gas response. Check other carbon analyzers since this affects more than one instrument.
	No calibration gas flowing	Make sure that calibration gas is flowing into the system. Check the rotameter to determine if there is enough gas flowing. Sometimes, adjusting the calibration gas rotameter has a very long lag time that, in some cases, operators mistakenly close the valve

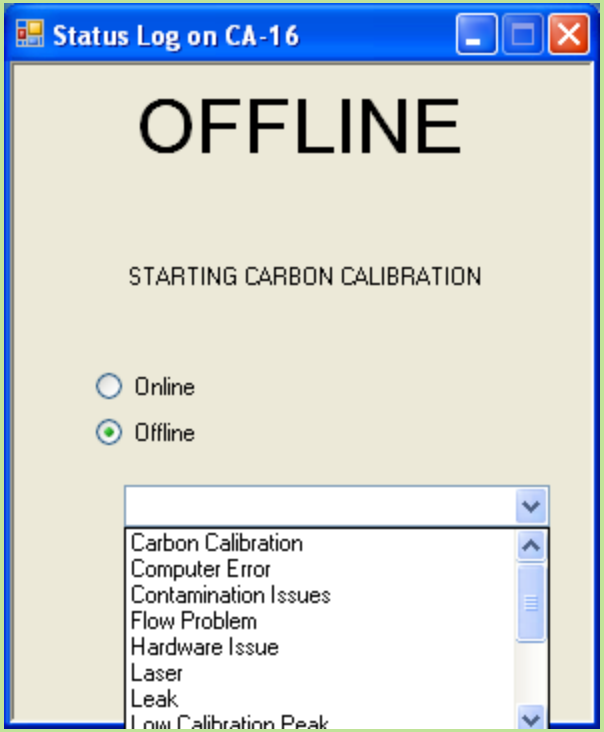
Analyzer Status Programs

- **Status Logger** program allows operator to record abnormal findings and provides analysis updates every two minutes

- **Status Viewer** program stores and provides real-time monitoring on any network PC

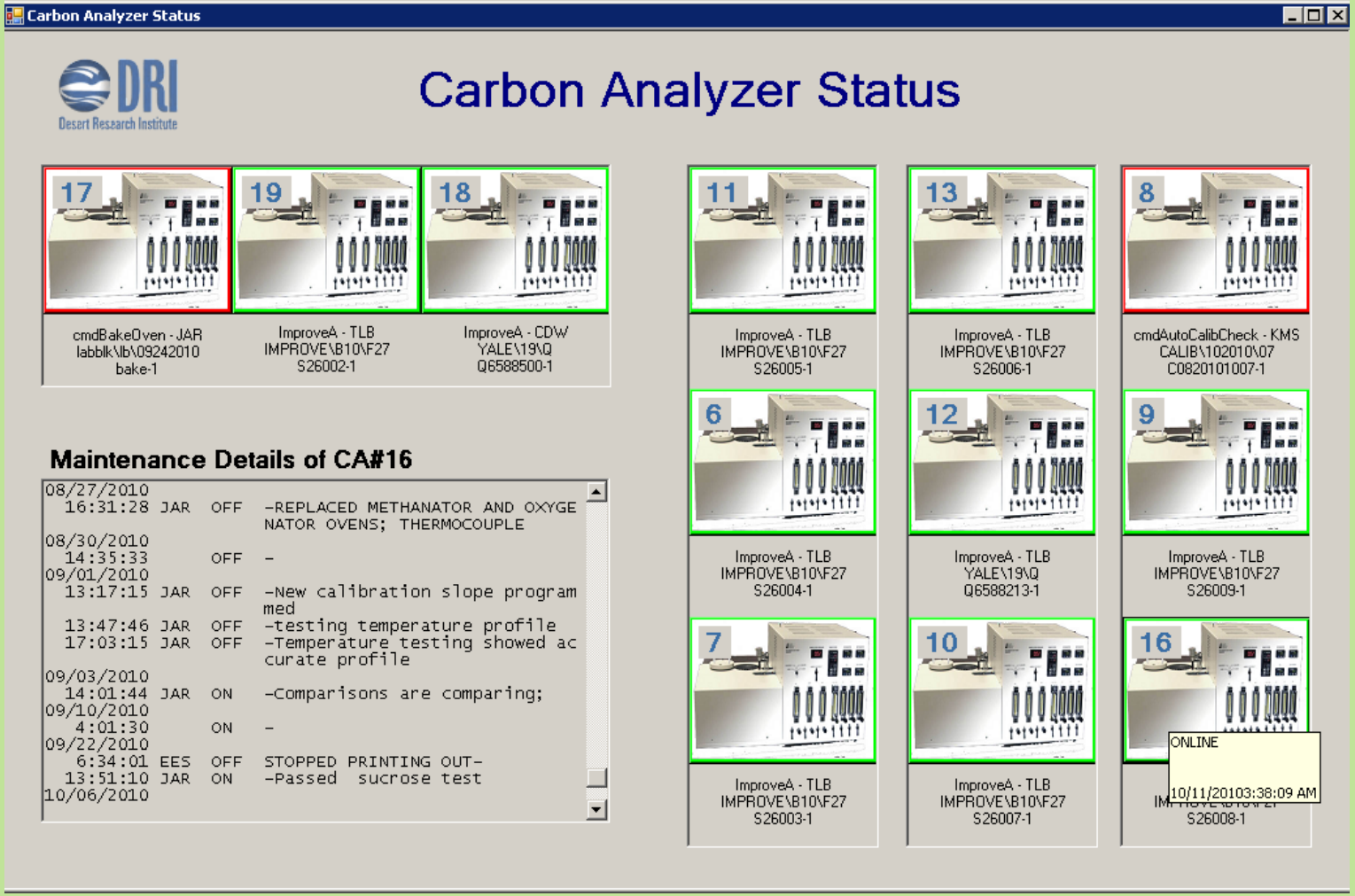
Status Logger Program





- Technician changes status on analyzer computer
- Instrument status is updated to server database every 2 minutes

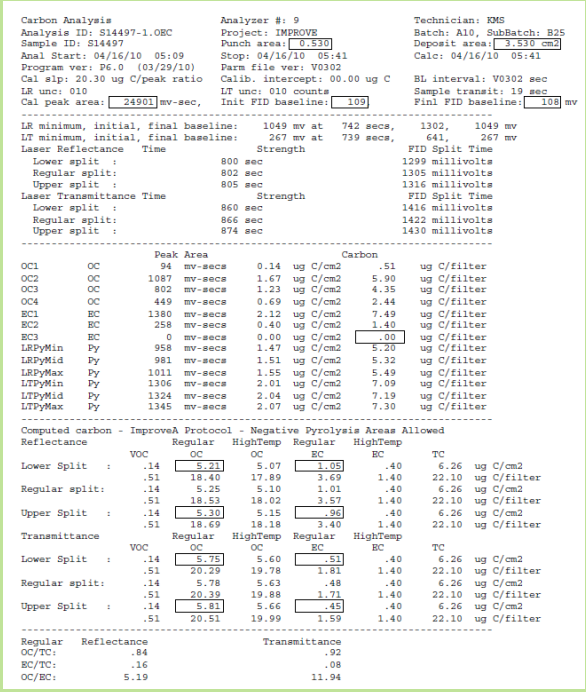
Status Viewer Program



- Hovering mouse over analyzer box gives current status
- Single clicking on the instrument brings up scrollable maintenance history
- Double clicking on any instrument brings up list of PDF thermograms

EAF is Going Green!

- Condensed data summary and thermogram from three pages to one double-sided page.
- Store data files in PDF format for easy retrieval.
- Highlight key fields for enhanced validation.



Carbon Analysis
Analysis ID: S14497-1.OBC
Sample ID: S14497
Anal Start: 04/16/10 05:09
Program ver: P6.0 (03/29/10)
Cal slp: 20.30 ug C/peak ratio
LR unc: 010
Cal peak area: 24901 mv-sec,

Analyzer #: 9
Project: IMPROVE
Punch area: 0.530
Stop: 04/16/10 05:41
Parm file ver: V0302
Calib. intercept: 00.00 ug C
LT unc: 010 counts
Init FID baseline: 109

Technician: KMS
Batch: A10, SubBatch: B25
Deposit area: 3.530 cm2
Calc: 04/16/10 05:41

BL interval: V0302 sec
Sample transit: 19 sec
Finl FID baseline: 108 mv

LR minimum, initial, final baseline: 1049 mv at 742 secs, 1302, 1049 mv
LT minimum, initial, final baseline: 267 mv at 739 secs, 641, 267 mv

Laser Reflectance Time	Strength	FID Split Time
Lower split :	800 sec	1299 millivolts
Regular split:	802 sec	1305 millivolts
Upper split :	805 sec	1316 millivolts

Laser Transmittance Time	Strength	FID Split Time
Lower split :	860 sec	1416 millivolts
Regular split:	866 sec	1422 millivolts
Upper split :	874 sec	1430 millivolts

		Peak Area		Carbon		
OC1	OC	94	mv-secs	0.14 ug C/cm2	.51	ug C/filter
OC2	OC	1087	mv-secs	1.67 ug C/cm2	5.90	ug C/filter
OC3	OC	802	mv-secs	1.23 ug C/cm2	4.35	ug C/filter
OC4	OC	449	mv-secs	0.69 ug C/cm2	2.44	ug C/filter
EC1	EC	1380	mv-secs	2.12 ug C/cm2	7.49	ug C/filter
EC2	EC	258	mv-secs	0.40 ug C/cm2	1.40	ug C/filter
EC3	EC	0	mv-secs	0.00 ug C/cm2	.00	ug C/filter
LRPyMin	Py	958	mv-secs	1.47 ug C/cm2	5.20	ug C/filter
LRPyMid	Py	981	mv-secs	1.51 ug C/cm2	5.32	ug C/filter
LRPyMax	Py	1011	mv-secs	1.55 ug C/cm2	5.49	ug C/filter
LTPyMin	Py	1306	mv-secs	2.01 ug C/cm2	7.09	ug C/filter
LTPyMid	Py	1324	mv-secs	2.04 ug C/cm2	7.19	ug C/filter
LTPyMax	Py	1345	mv-secs	2.07 ug C/cm2	7.30	ug C/filter

Computed carbon - ImproveA Protocol - Negative Pyrolysis Areas Allowed

Reflectance	VOC	Regular OC	HighTemp OC	Regular EC	HighTemp EC	TC	
Lower Split :	.14	5.21	5.07	1.05	.40	6.26	ug C/cm2
	.51	18.40	17.89	3.69	1.40	22.10	ug C/filter
Regular split:	.14	5.25	5.10	1.01	.40	6.26	ug C/cm2
	.51	18.53	18.02	3.57	1.40	22.10	ug C/filter
Upper Split :	.14	5.30	5.15	.96	.40	6.26	ug C/cm2
	.51	18.69	18.18	3.40	1.40	22.10	ug C/filter

Transmittance	VOC	Regular OC	HighTemp OC	Regular EC	HighTemp EC	TC	
Lower Split :	.14	5.75	5.60	.51	.40	6.26	ug C/cm2
	.51	20.29	19.78	1.81	1.40	22.10	ug C/filter
Regular split:	.14	5.78	5.63	.48	.40	6.26	ug C/cm2
	.51	20.39	19.88	1.71	1.40	22.10	ug C/filter
Upper Split :	.14	5.81	5.66	.45	.40	6.26	ug C/cm2
	.51	20.51	19.99	1.59	1.40	22.10	ug C/filter

Regular	Reflectance	Transmittance
OC/TC:	.84	.92
EC/TC:	.16	.08
OC/EC:	5.19	11.94