Update of IMPROVE Carbon Analysis

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Objectives

- Report status of IMPROVE carbon analyses
- **Review internal quality control (QC) checks**
- Discuss operational challenges and improvements

DRI's Environmental Analysis Facility (EAF) continuously operates 10-13 Model 2015 Multiwavelength Carbon Analyzers

(2016-Present, analyzed over ~160,000 samples with ~82,000 for IMPROVE)

EAF Carbon Laboratory (Magee Scientific, Berkeley, CA and Aerosol, d.o.o., Ljubljana, Slovenia)

Carbon Laboratory Operations

(July 2019 - June 2020 samples, n= ~18,000)

- **Received ~1,410 IMPROVE samples per month (varies from ~400 to 3,200 samples per month)**
- Operated ~24 hour/day, 5-6 days/week during December-February; reduced to ~50% capacity during March-May period; currently at ~15-17 hours/day, 4 days/week with one supervisor, one software engineer, and three laboratory technicians
- **Dana Trimble was promoted to Program Manager (Division of Hydrological Sciences), and Vinay Amin has assumed responsibility since October, 2019**

Completed analyses of 2019 samples in March, 2020 and currently analyzing July-August samples

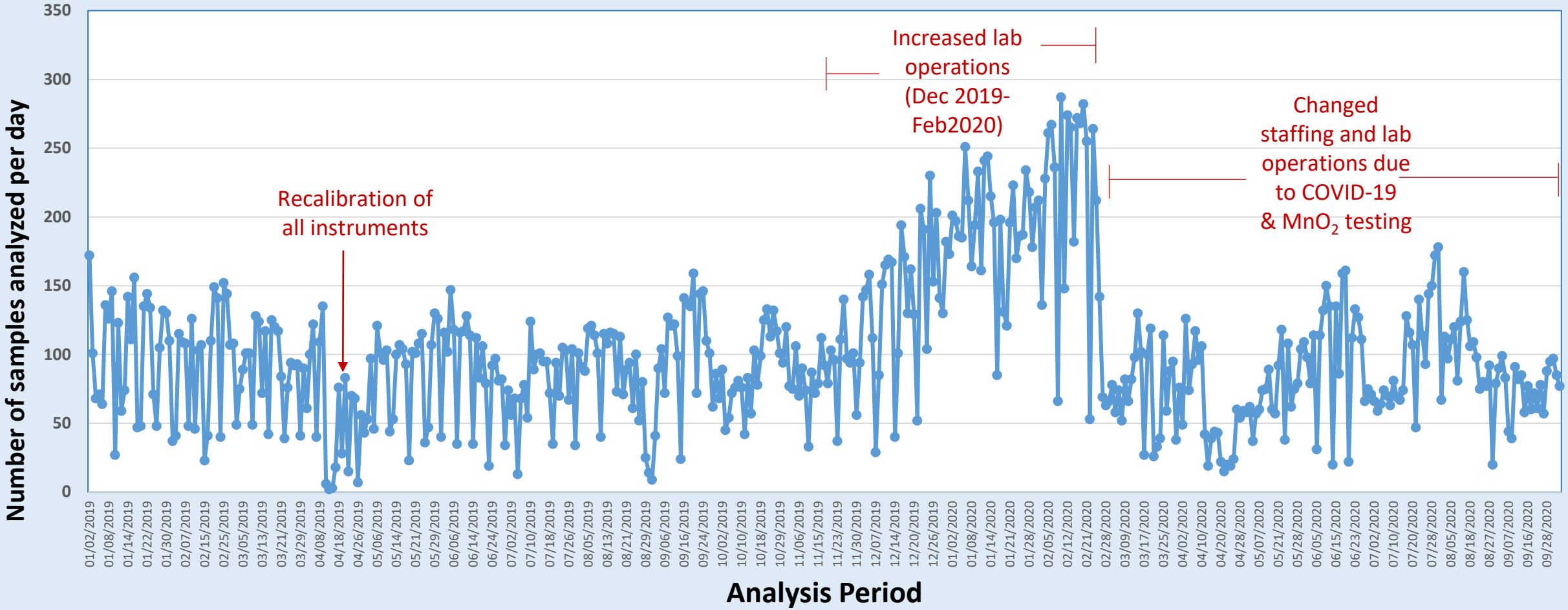
(July 2019 to June 2020 samples)

Sampling Period	Sample Receive Dates	Number of Samples Received	Analysis Completion Date
7/1/19-12/31/19	7/19/19-3/18/20	9,471	March 2020
1/1/20-6/30/20	1/30/20-9/2/20*	9,190*	October 2020

*as of 10/8/20

Carbon throughput averaged ~100 samples per day*

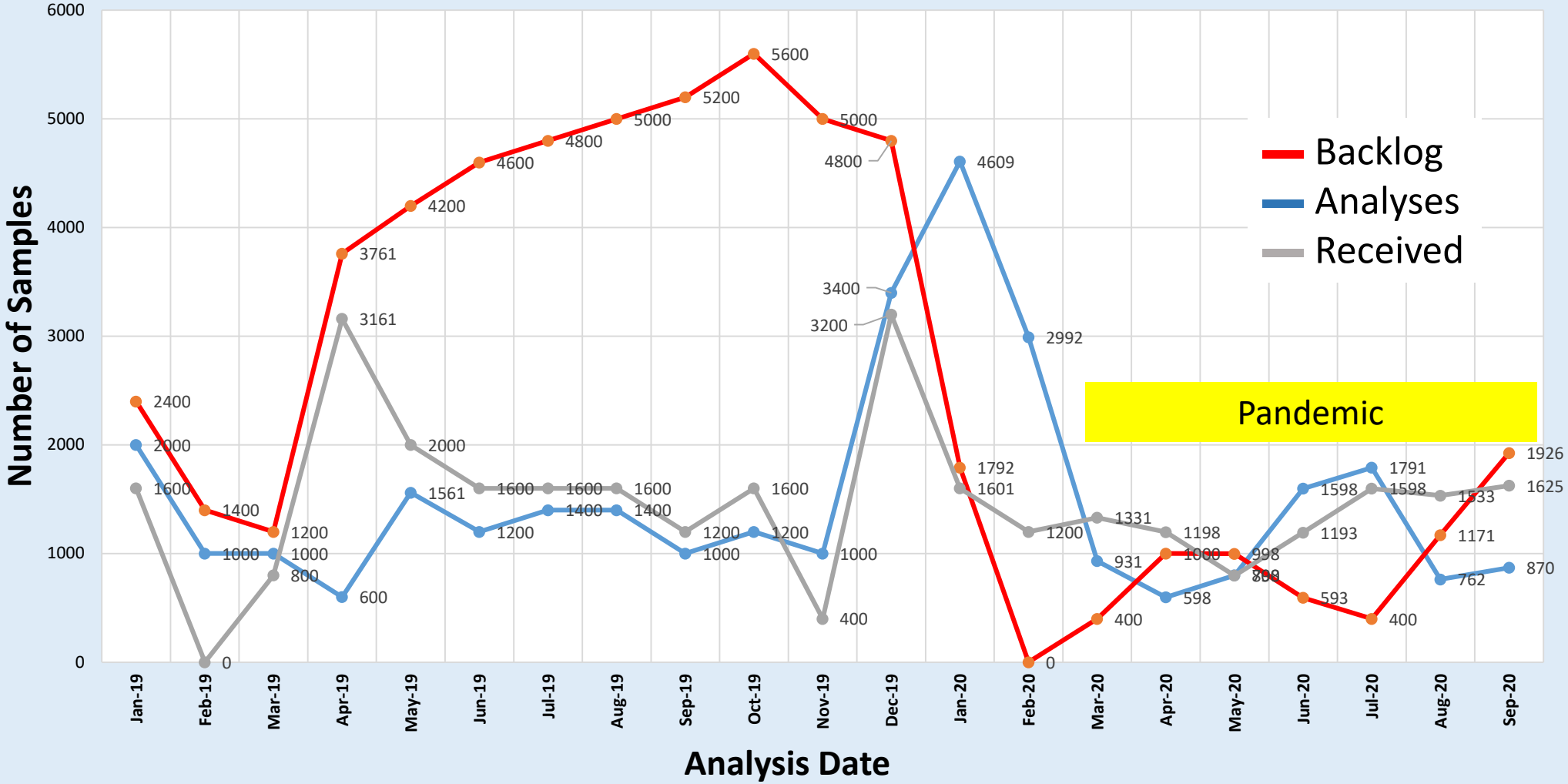
(January 2019 – October 2020)



*Excludes calibration runs and includes other projects

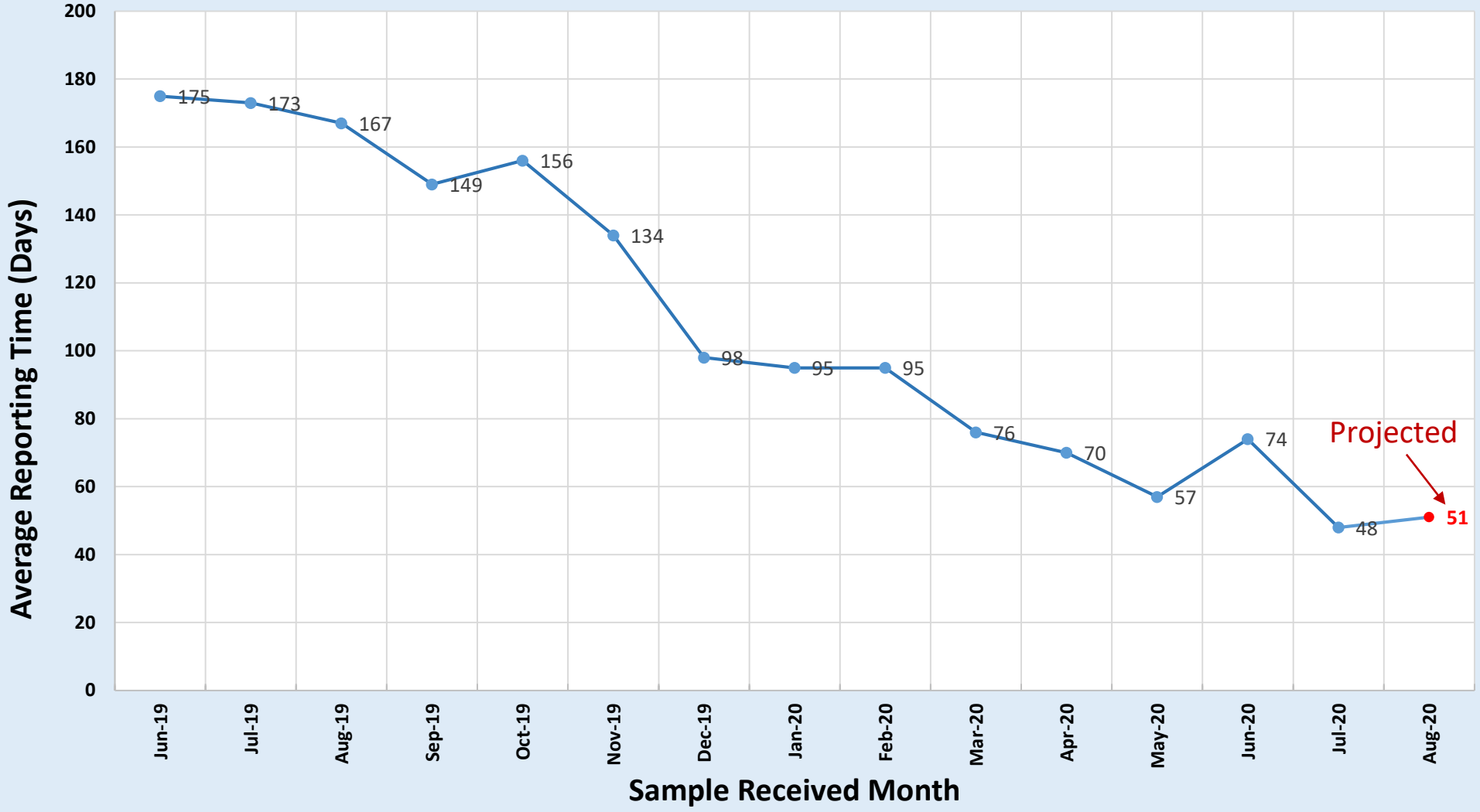
Eliminated carbon backlog since February, 2020 with more fluctuation in recent months

(January, 2019 – September, 2020)



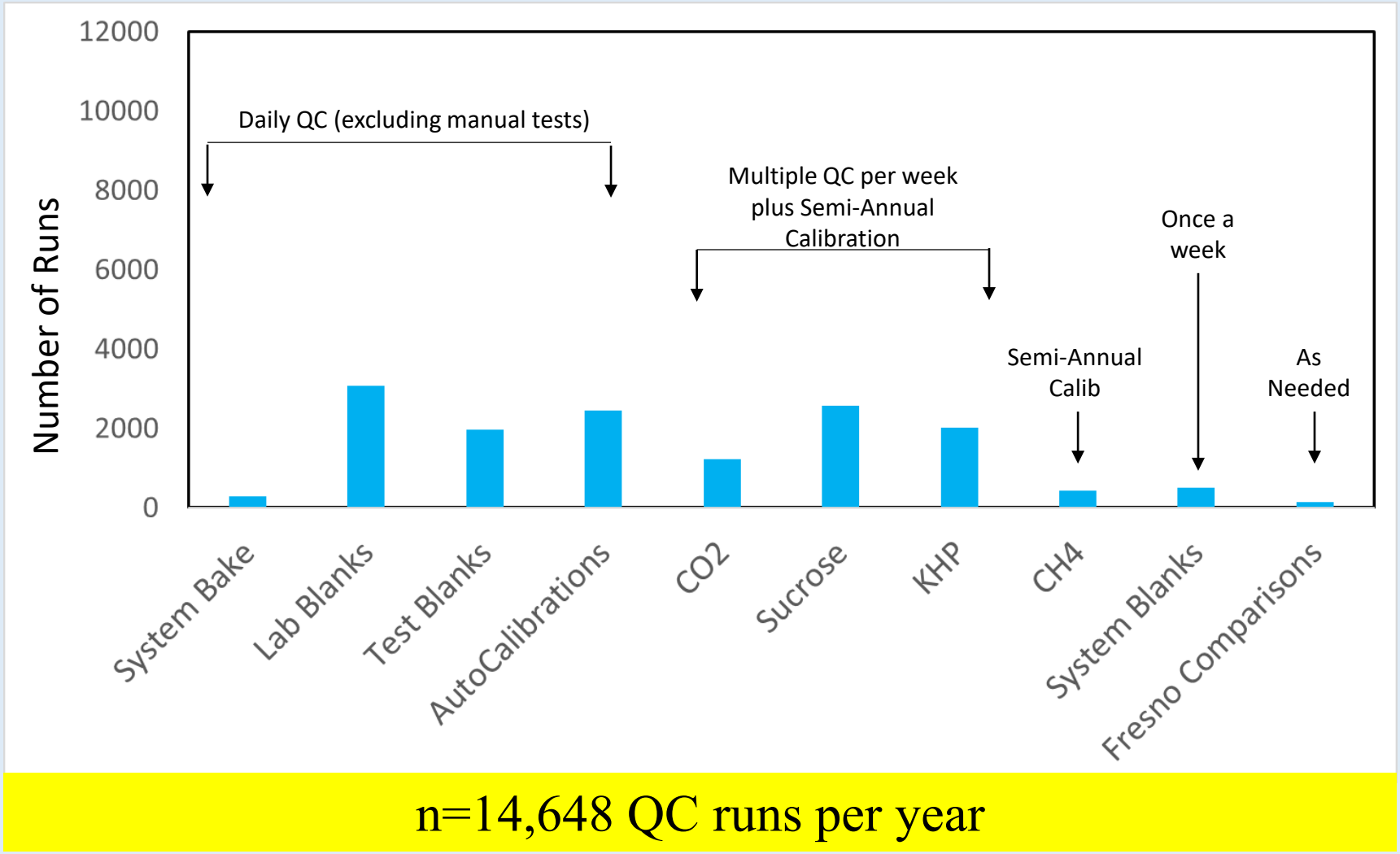
Average reporting time from sample receipt reduced by ~70%

(June, 2019 – August, 2020)



Average 40 runs per day are dedicated to multiple quality control (QC) checks

(October 2019 - September 2020)



n=14,648 QC runs per year

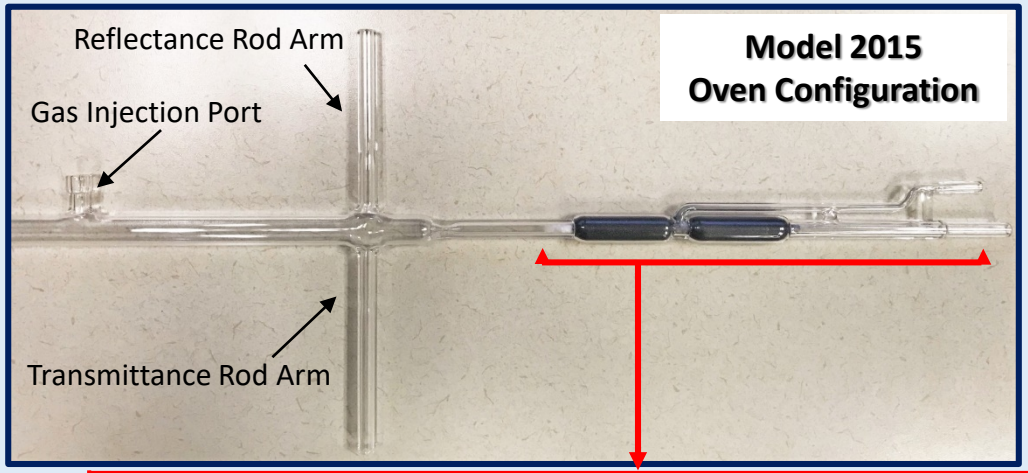
Granulate manganese dioxide (MnO_2) for sample oven is no longer available

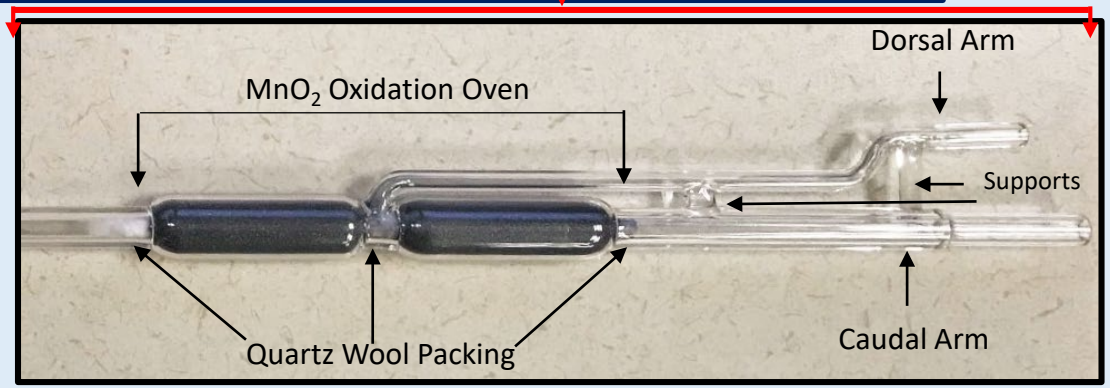
(Sigma Aldrich [the supplier for MnO_2] switched granular crystalline to fine powder MnO_2)

MnO_2

Crystalline form

Fine powder form

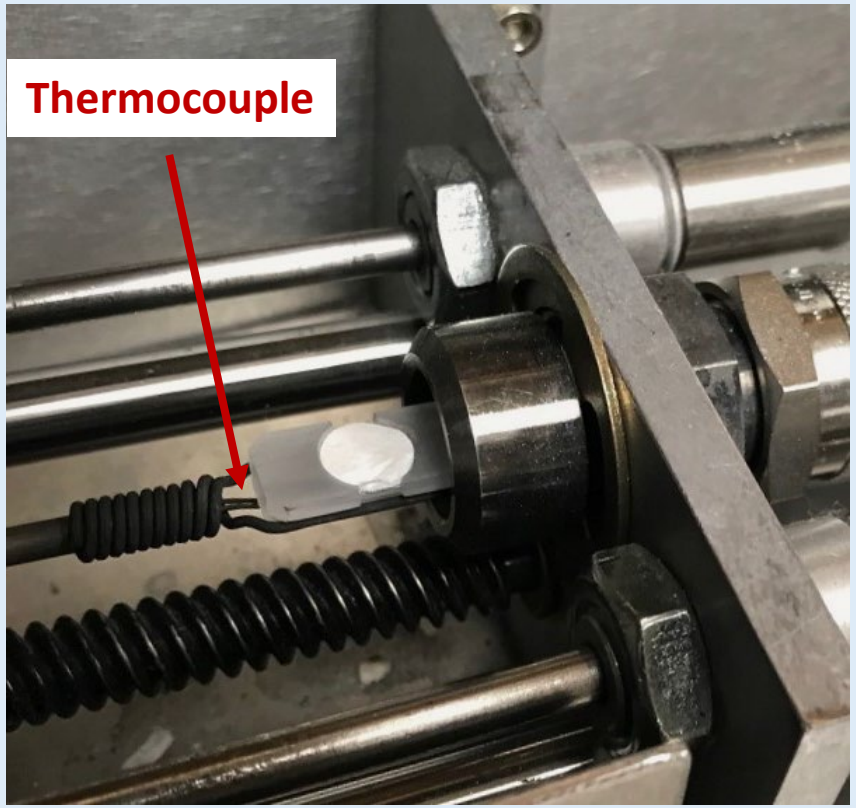




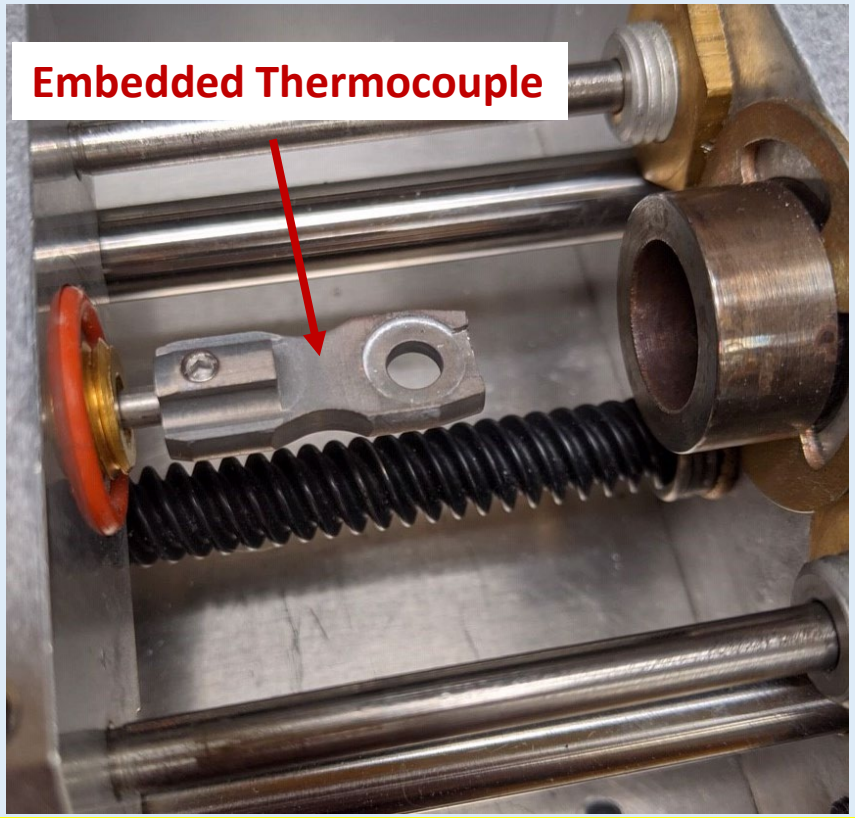
The fine powder MnO_2 restricts gas flow and induces pressure build up (due to agglomeration). Continue searching for new suppliers and testing new packing methods. Have sufficient MnO_2 for now.

Carbon Hardware Improvements

(Replaced the quartz sample boat [with Nickel-Chromium wire holder] with single Kanthal alloy metal boat)



Old, quartz boat

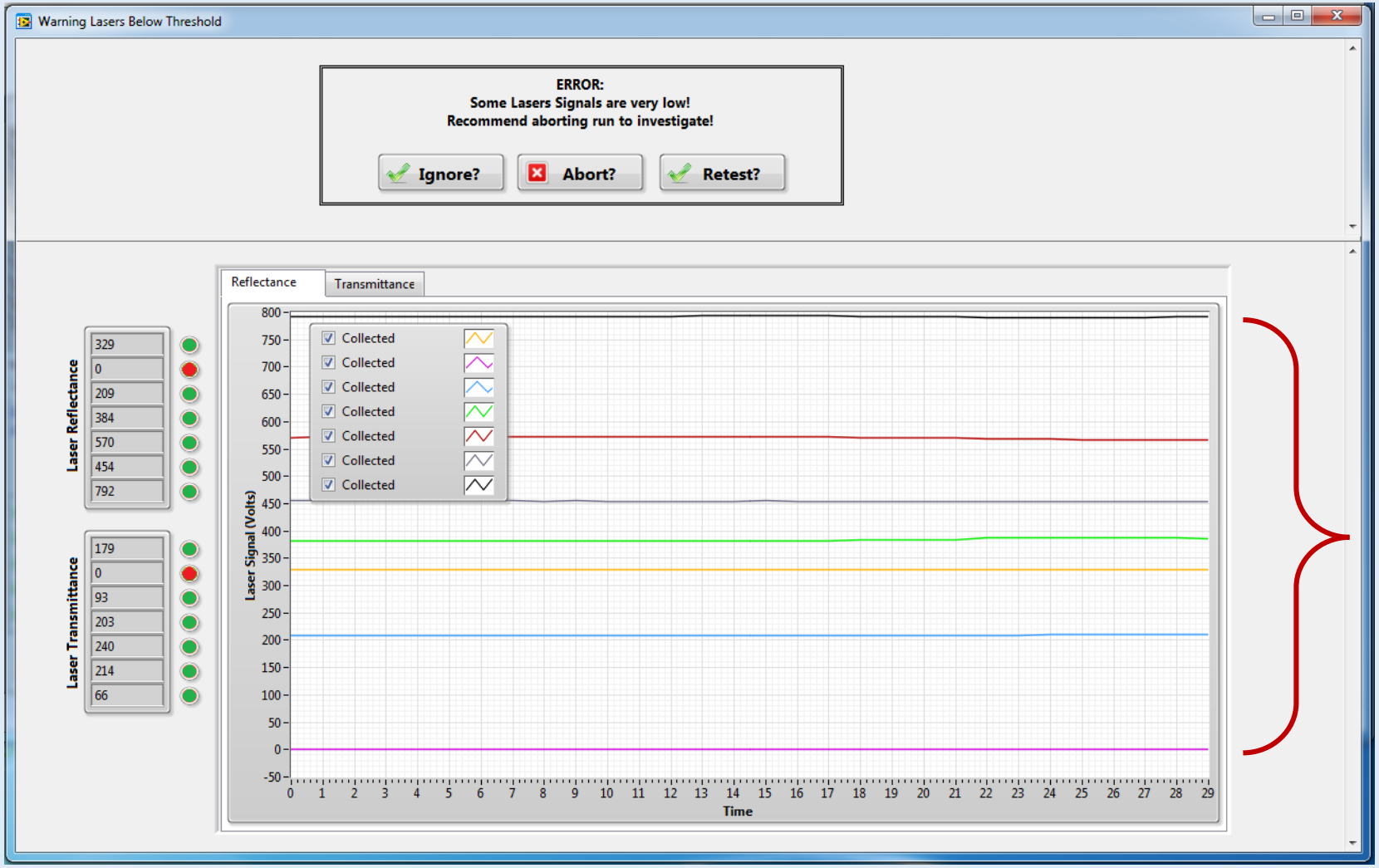


New, Kanthal Alloy boat
(mixture of iron, chromium, and aluminum)

Advantages:

- More stable- screws onto thermocouple
- Easy replacement- remove screw and slide off
- Enclosed thermocouple- minimizes break of "thermocouple tip"
- Longer lifespan- without chipping/distortion

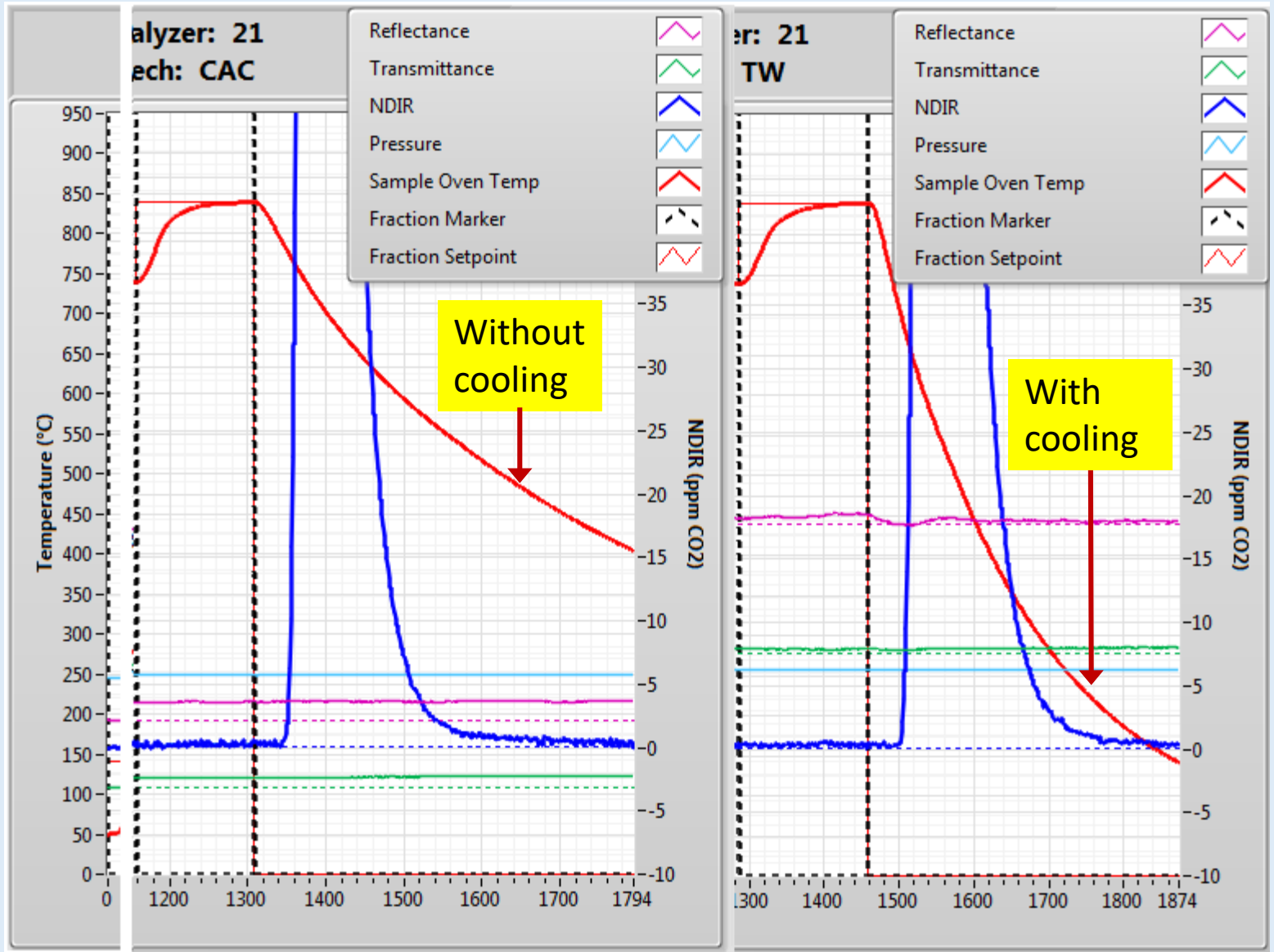
Initiated pre-run laser check to ensure the proper lasers signals



7 laser signals

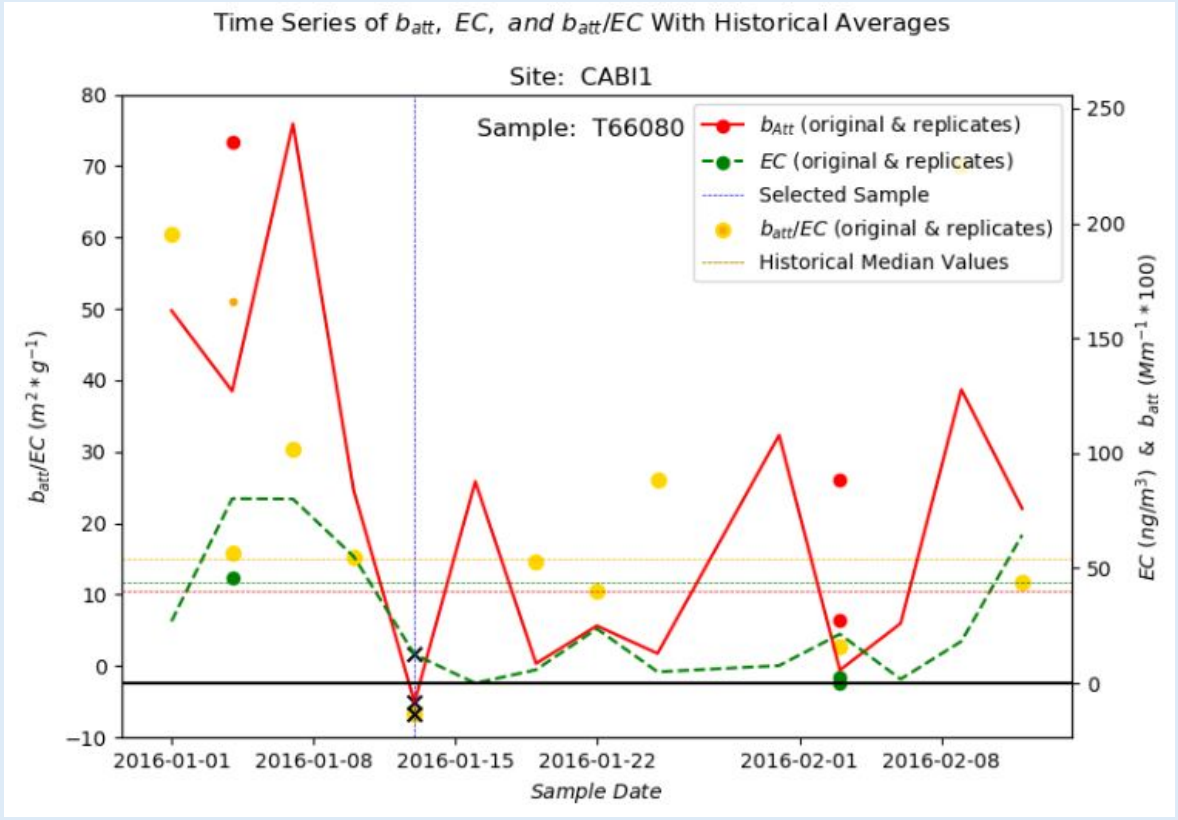
Implemented the “Cal Peak” cooling fan to save ~300 seconds between analysis

(Cools the oven during the final stage of analysis, rather than after analysis)



Established new protocols for data validation

- **Initiated automation to increase accuracy and efficiency**
  - Generate comparisons for replicates, reruns, and collocated samples
  - **Identify extreme values (e.g., high, low, zero, and negative)**
  - Monitor deviations from calibration peaks and send alert of instrument malfunction
  - **Streamline data validation and reporting process**
- **Created visualization tools**
  - Examine relationship between light attenuation and elemental carbon
  - **Evaluate temporal variations (e.g., comparison with historical medians)**



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