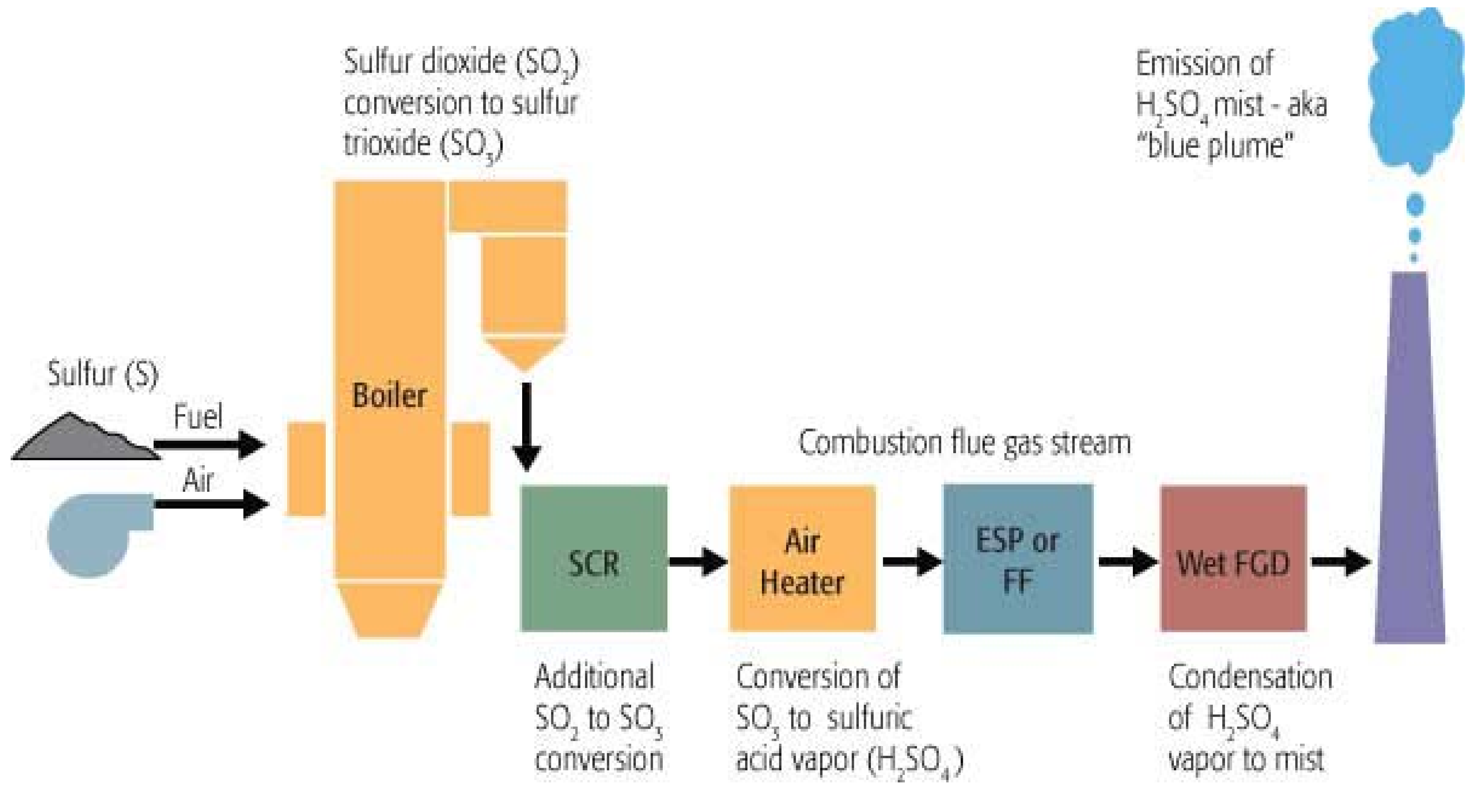
Mid IR Laser Sensor for Continuous SO3 Monitoring to Improve Coal-Fired Power Plant Performance during Flexible Operations

Objective

The primary objective of this project is to produce and demonstrate a continuous SO_3 monitor for coal-fired power plants. The sensor will provide real-time, actionable information to enable control of additive injection and minimize catalyst deactivation leading to cost savings and improved flexible operations capability.



Motivation

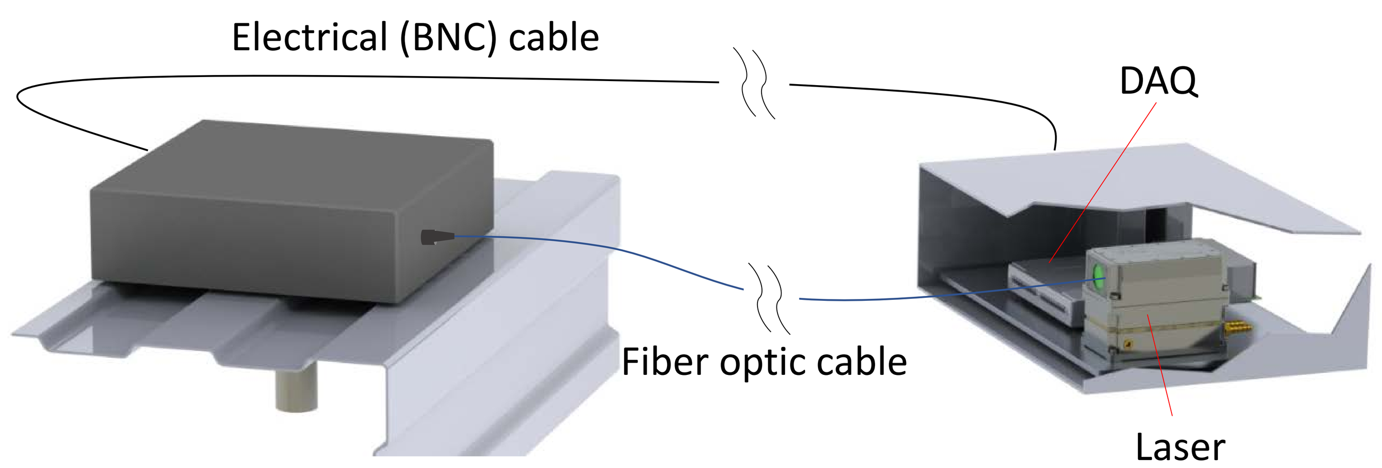
- SO_3 and H_2SO_4 are byproducts of coal combustion and a source of problems at power plants due to high reactivity.
- Higher than desired SO_3 level can result in a visible "blue" plume, which can result in an opacity violation, and can also pose a health hazard
- SO_3 also has deleterious impact on activated carbon that is used for mercury control
- SO_3 can react with the ammonia (injected for NOx control) and form ammonium bisulfate, which can also deactivate the SCR catalyst
- Alkali sorbent into is injected into the flue gas to react with the SO_3 where it is then captured in the particulate collector.
- If SO_3 levels are not known accurately, the amount of alkali injection is typically much more than required (unnecessary cost)
- Current sensor technology is slow, labor-intensive, and/or inaccurate

Need

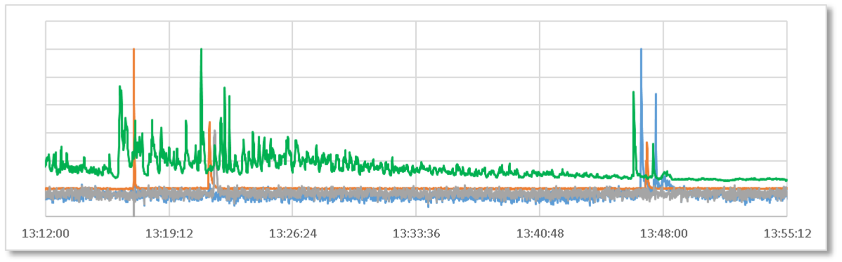
Continuous SO_3 monitor for coal-fired power plants providing real-time, actionable information, which will enable control of additive injection.

Solution

- Mid-Infrared (Mid-IR) tunable laser absorption spectroscopy system
- Close coupled extractive heated gas cell



SO_3:	5.2 ppm
H_2SO_4:	4.3 ppm
SO_2:	1812.6 ppm
H_2O:	5.3 %

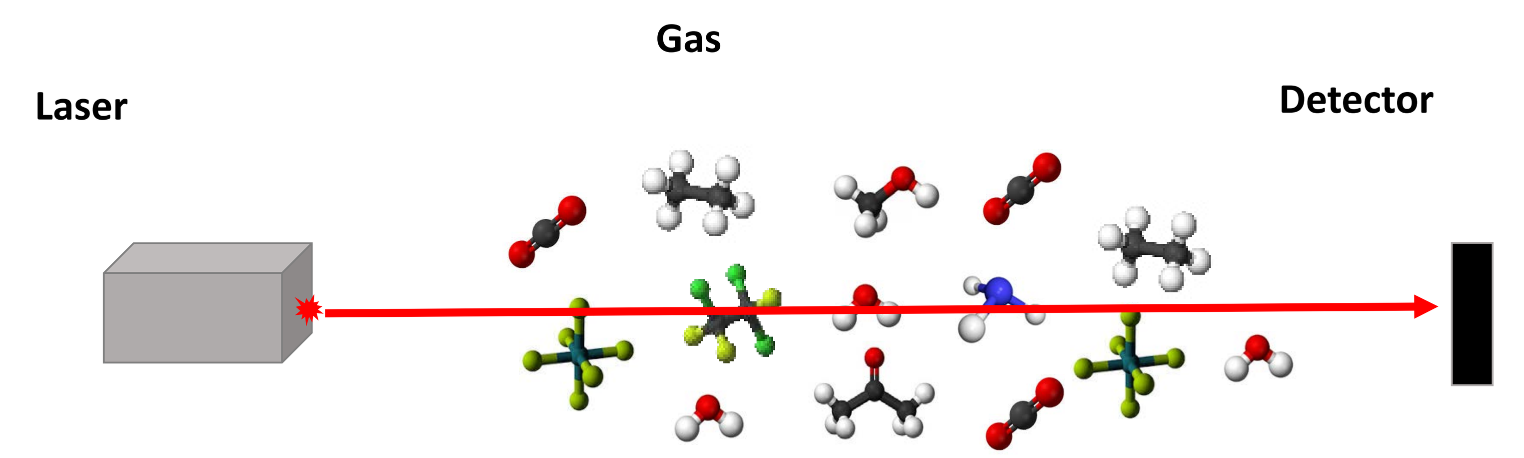


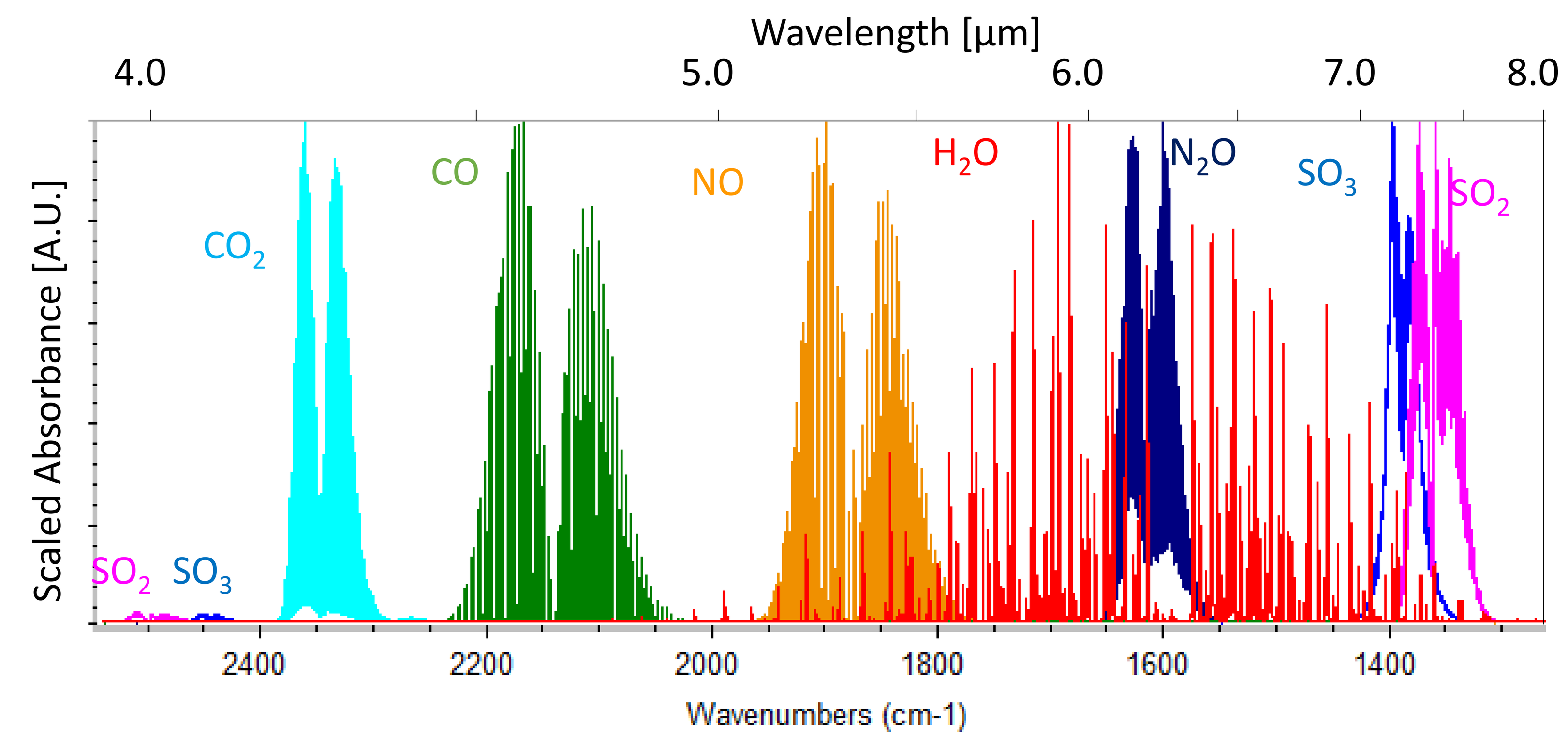
Real-time concentration

Concentration time history

Technology: Laser Absorption Spectroscopy

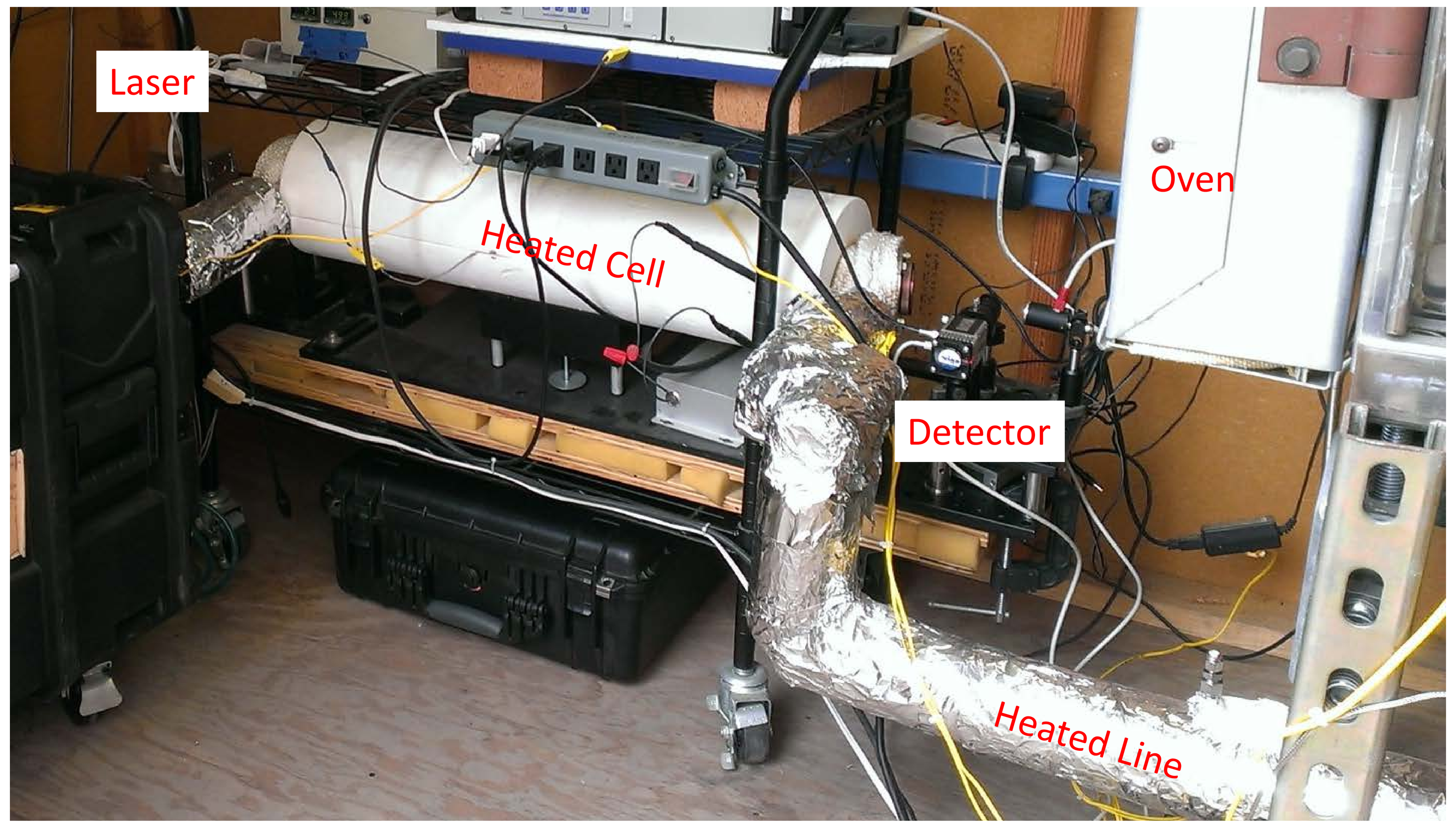
- Different gas species absorb light in different distinct patterns "Molecular Fingerprint"
- The amount of absorption can be used to determine the concentration
- Tunable wavelength lasers can be used in harsh environments with fiber optic delivery





Milestones

- Produce an initial "Alpha Lab" prototype sensor, optimized with relevant testing (TRL5)
- Reconfigure system into an "Alpha Field" prototype and qualify for power plant installation
- Test basic performance of Alpha prototype at a coal-fired power plant (TRL6)
- Produce and optimize a second generation "Beta" prototype and qualify for power plant installation
- Validate Beta prototype performance in an operational setting at a power plant (TRL7).



SO_3 test facility at UC Irvine

Target Sensor Specifications

- Sensitivity: SO_3 and H_2SO_4 concentration detection limits ≤ 1 ppm with 0.5 ppm accuracy
- Update rate: nominal 1 Hz, averaged over 1 min for higher precision and control of alkali injection
- Direct mounting of sample cell to ducting with remote sensor head located at least 10 m from duct
- Simultaneous analysis of SO_2 and H_2O with ability to scale to additional species (e.g., NO, NH_3, CO_2)

Impact

Continuous accurate measurements of SO_3 would allow better control of the alkali injection systems used to mitigate SO_3. In addition, low-load operation would benefit from an online SO_3 measurement, which would allow the region of ABS formation to be more accurately predicted, minimizing catalyst deactivation and improving plant flexible operations capability. An accurate SO_3 measurement would translate directly into better control and an economic savings to the utility.

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