PROJECT facts
U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Carbon Sequestration

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# Low Cost Open-Path Instrument for Monitoring Atmospheric Carbon Dioxide at Sequestration Sites

## CONTACTS

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## Background

Growing concern over the effect on global climate of the buildup of greenhouse gases (GHG), particularly carbon dioxide ($CO_2$), in the atmosphere may lead to the curtailment of $CO_2$ emissions. One potential course of action by industry to reduce GHG emissions is the subsurface disposal of $CO_2$. An important requirement of such disposal is verification that the injected gases remain in place and do not leak to the surface. Perhaps the most direct evidence of a successful sequestration project is the lack of a detectable $CO_2$ concentration above the background level in the air near the ground. Although measurement of $CO_2$ concentration can be performed, it is difficult to accomplish at a reasonable cost over the large area that is typical of large, subsurface gas injection projects. One technically attractive approach is to employ a so-called open-path device that uses a laser to shine a beam – with a wavelength that $CO_2$ absorbs – over many meters. The attenuated beam reflects from a mirror and returns to the instrument for determination of the $CO_2$ concentration. One instrument can sample a large area, if it can reflect from more than one mirror.

Current commercial instruments capable of this cost tens of thousands of dollars. The purpose of this project is to develop an inexpensive (instrument cost of no more than a few hundred dollars) open-path laser instrument to measure $CO_2$ concentration over the range of interest (300–500 ppmv). The low-cost target should be attainable by designing an instrument for this one specific application. In contrast, the expensive commercial units can measure the levels of multiple gases over a wider range of concentrations. The newest technology in the communications industry can be used to build a prototype with inexpensive, off-the-shelf components.

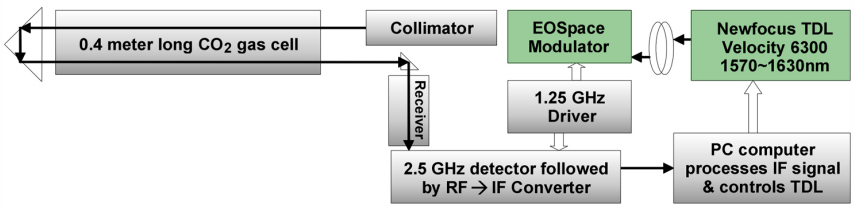


*Figure 1. Schematic for bench top $CO_2$ measurement using FM spectroscopy.*

## PARTNERS

California Institute of Technology

## PERFORMANCE PERIOD

09/30/2004 to 09/30/2008

## COST

**Total Project Value**
$438,286

**DOE/Non-DOE Share**
$350,629 / $87,657

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# Primary Project Goal

The primary goal is to develop and test an inexpensive open-path instrument that will measure and monitor atmospheric $CO_2$ concentrations within a range of 300-500 ppmv.

# Objectives

The objectives of the project are the following:

- To develop a prototype instrument capable of measuring $CO_2$ concentration over a 5-kilometer path length with an update speed of once every several minutes and an accuracy of 98-99%.
- To test the prototype instrument over a short range (e.g., 100 m) and determine its performance range.
- To mount the prototype instrument on a rooftop and determine its performance over a range up to 5 km.
- To field test the monitor in an operating $CO_2$ geological sequestration site.

# Benefits

One approach that is being seriously considered for alleviating the buildup of GHGs in the atmosphere is the capture of $CO_2$ from fossil fuel–fired power plants and sequestering the $CO_2$ in geologic formations. Although this approach appears to be technically feasible, the public will not accept it unless they can be assured that the sequestered $CO_2$ will remain in place and not leak to the surface. A vital part of providing this assurance is the ability to economically measure $CO_2$ concentrations over large areas so that any leaks can be quickly detected and remediation measures taken. The success of this project will go a long way toward providing an instrument to fill this monitoring need.

# Accomplishments

- Specifications and testing protocols have been developed for the $CO_2$ monitor.
- 1% accuracy has been demonstrated in short period tests (~1 hour).
- Unattended system operation and stability over a period of a week has been demonstrated with and without EDFA (laser power amplifier). EDFA amplification can be further increased by a factor of 3-5, therefore, the operating rage of the instrument is estimated to be 2.5 km (5 km round trip).
- The sensitivity of the instrument to $CO_2$ leaks has been demonstrated.