the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Development and Deployment of a Compact Eye-safe Scanning Differential Absorption Lidar (DIAL) for Spatial Mapping of Carbon Dioxide for MVA at Geologic Carbon Sequestration Sites

Description

Through its core research and development program administered by the National Energy Technology Laboratory (NETL), the U.S. Department of Energy (DOE) emphasizes monitoring, verification, and accounting (MVA), as well as computer simulation, of possible carbon dioxide (CO_2) leakage at CO_2 sequestration sites, along with risk assessment of those sites. MVA efforts focus on the development and deployment of technologies that can provide an accurate accounting of stored CO_2, with a high level of confidence that the CO_2 will remain permanently sequestered. Effective application of these MVA technologies will ensure the safety of sequestration projects with respect to both human health and the environment, and provide the basis for establishing carbon credit trading markets for sequestered CO_2. Risk assessment research focuses on identifying and quantifying potential risks to humans and the environment associated with CO_2 sequestration, and helping to ensure that these risks remain low.

This three-year project—performed by Montana State University (MSU)—will develop, test, and deploy a scanning eye-safe diode laser-based Differential Absorption Lidar (DIAL; LIDAR = Laser Induced Differential Absorption Radar). This instrument will perform near-surface mapping of CO_2 number densities for MVA to determine possible CO_2 leakage to the atmosphere at geologic carbon sequestration sites. Development of the CO_2 DIAL will build on MSU's expertise in developing compact, low-power, high-repetition-rate DIAL instruments for atmospheric studies. Horizontal testing of the CO_2 DIAL instrument will be conducted to determine its performance at the Zero Emission Research Technology (ZERT) field site during a controlled release experiment. MSU then will work with the Big Sky Carbon Sequestration Partnership to deploy the CO_2 DIAL at a larger-scale carbon sequestration demonstration project.

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PARTNERS

Big Sky Carbon Sequestration Partnership

COST

Total Project Value
$515,246

DOE/Non-DOE Share
$405,119 / $110,127

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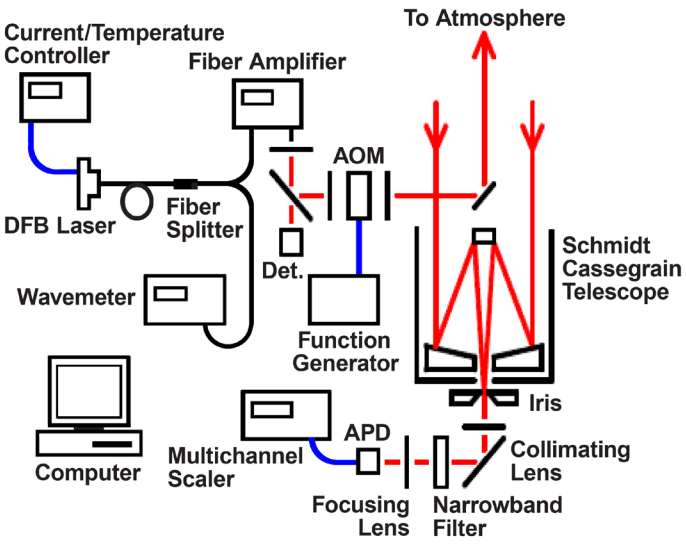
U.S. DEPARTMENT OF ENERGY

Primary Project Goal

The overall project goal is to develop, test, and deploy a scanning, compact, eye-safe diode laser-based DIAL instrument for near-surface mapping of CO_2 number densities. This tool will assist MVA of CO_2 at geologic carbon sequestration sites over large areas for extended periods. Specific project objectives are:

- **Phase 1:** Development and construction of the CO_2 DIAL and operating software.
- **Phase 2:** Horizontal testing of the CO_2 DIAL instrument at the ZERT controlled release facility.
- **Phase 3:** Deployment of the CO_2 DIAL instrument at a field site where CO_2 is being injected into a geologic formation.



Schematic of the DIAL instrument for monitoring CO_2 number densities.

Accomplishments

The project was awarded on September 28, 2009, and anticipated accomplishments relate to the achievement of project objectives. The design of the CO_2 DIAL will be based on modeling the desired performance of the instrument utilizing lidar and DIAL equations associated with existing instruments for measuring atmospheric composition. Construction of the CO_2 DIAL will be based on off-the-shelf telecommunications components. Development of the DIAL instrument and related software will rely on the experience of MSU's Applied Optics and Optical Sensing Research Group in constructing low-power, high-pulse repetition rate, laser diode-based DIAL instruments for atmospheric studies. The second phase of the project will use the existing ZERT controlled-release field facility (located on the MSU campus) to test the DIAL instrument's ability to detect CO_2 at levels needed for successful carbon sequestration site monitoring. An underground release experiment will be performed at the ZERT facility using a CO_2 flow rate that will allow the signal-to-noise and detection limits of the DIAL instrument to be explored. The third phase of the project involves deploying the DIAL instrument at a Big Sky Carbon Sequestration Partnership demonstration site where CO_2 is being injected into a geologic formation to determine its sequestration potential. This phase will test the DIAL instrument's ability to operate in realistic field conditions over large areas.

Benefits

Successful surface monitoring at geologic carbon sequestration sites requires low-cost instrumentation capable of covering large areas for extended periods. The DIAL instrument will be capable of producing range-resolved CO_2 number density maps with the ability to monitor several square kilometers at a resolution on the order of 100 m. Thus, the DIAL instrument provides large area coverage with good spatial resolution. Also, the DIAL instrument can be repeatedly scanned to provide the measurements over extended time intervals. As it will be portable and have minimal power requirements, the DIAL instrument will be easily incorporated into existing and future carbon sequestration efforts. Furthermore, the scanning DIAL will be an eye-safe instrument. The successful completion of this project therefore has the potential to advance the technology development needed for successful geologic carbon sequestration.