Laser Based Absorption Sensors for Trace Gas Monitoring in a Spacecraft Environment

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- Motivation and Background
- Implementation of Diode Laser based Sensors
- Selected Applications of Trace Gas Detection
- Outlook and Summary

Overall Research Aims

- Development of compact fibered diode laser based gas sensors.
- Applications of sensors to trace gas detection relevant to AEMC program goals and requirements.
- Demonstration of implementation of multiple use applications of new laser based gas sensor technologies.

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Wide Range of Gas Sensor Applications

- **Spacecraft and Planetary Surface Monitoring**
  - **Crew Health Maintenance & Life Support**
- Urban and Industrial Emission Measurements
  - Industrial Plants
  - Combustion Sources
  - Automobile and Trucks
- Rural Emission Measurements
  - Agriculture
- Environmental Monitoring
  - Atmospheric Chemistry
  - Volcanic Emissions
- Chemical Analysis and Industrial Process Control
  - Semiconductor Industry
- Medical Applications
- Law Enforcement

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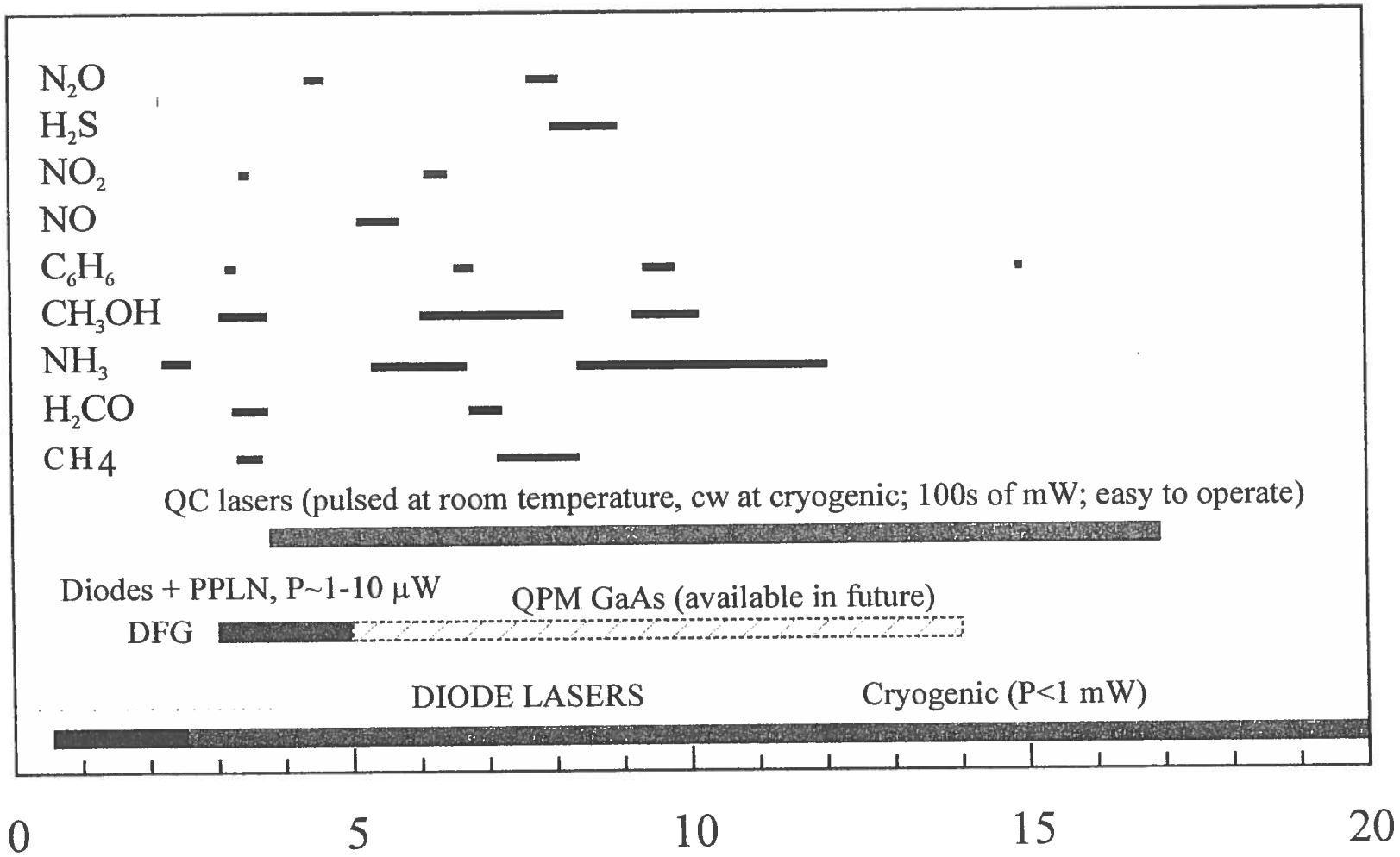
Spectral Coverage by Diode/QC Lasers



Current Research Support

- NASA
- Texas Advanced Technology Program
- EPA
- National Science Foundation
- The Robert Welch Foundation

Current Research Collaborations

- TDA, Inc.Wheat Ridge,CO
- NCAR, NRL, Lucent Technologies
- Rice Environmental Science Department
- Tokai University

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R&D Goals for 1999

- Development of 3 DFG Based Gas Sensor Architectures:
  - Single trace gas target species
  - Multigas species
  - Ultrasensitive trace gas detection.
- H_2CO Concentration Measurements in Trace Contaminant Control System at TDA, Inc.
- H_2CO Detection in Ambient Urban Air
- Trace Gas Detection Using QC-DFB Lasers

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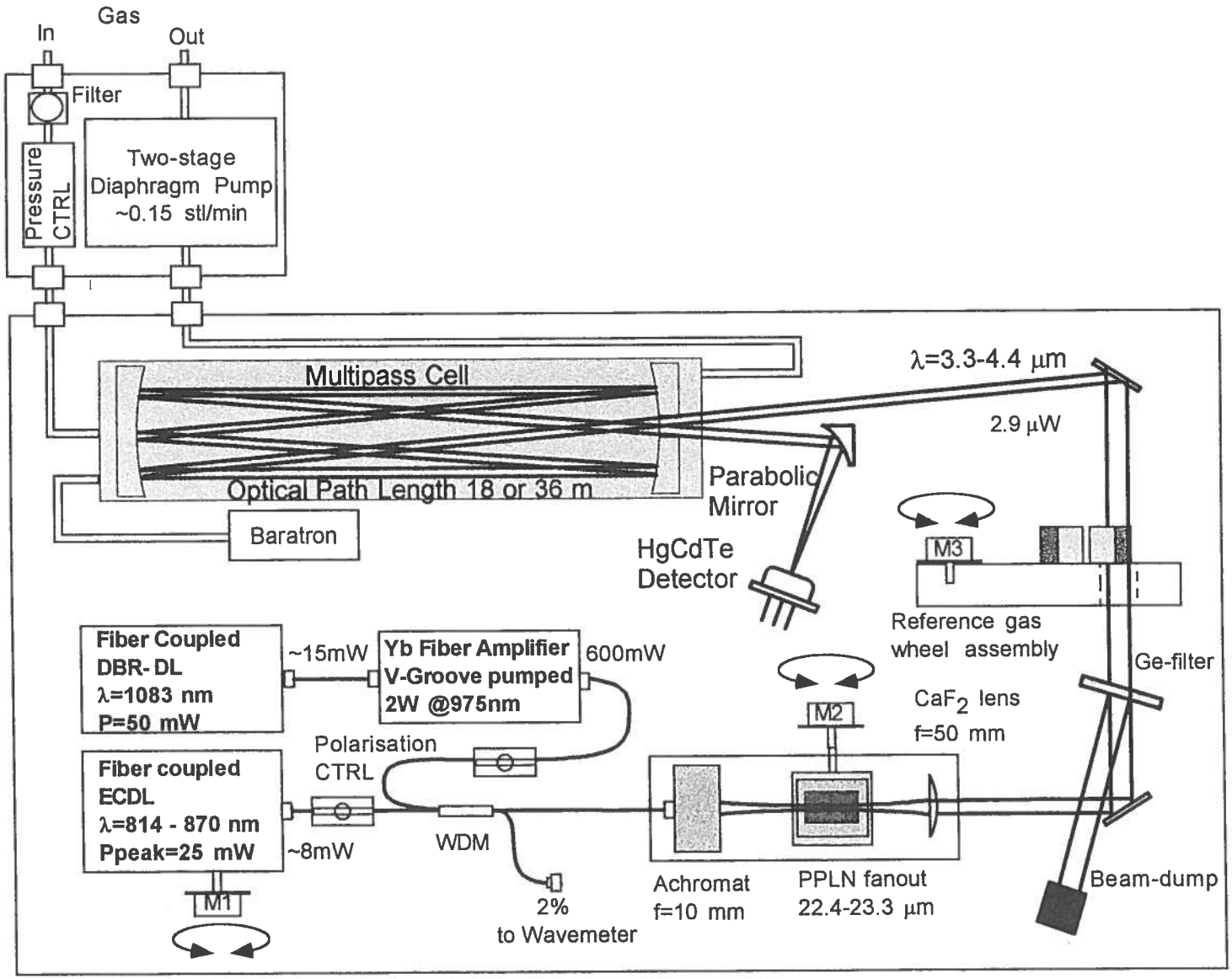
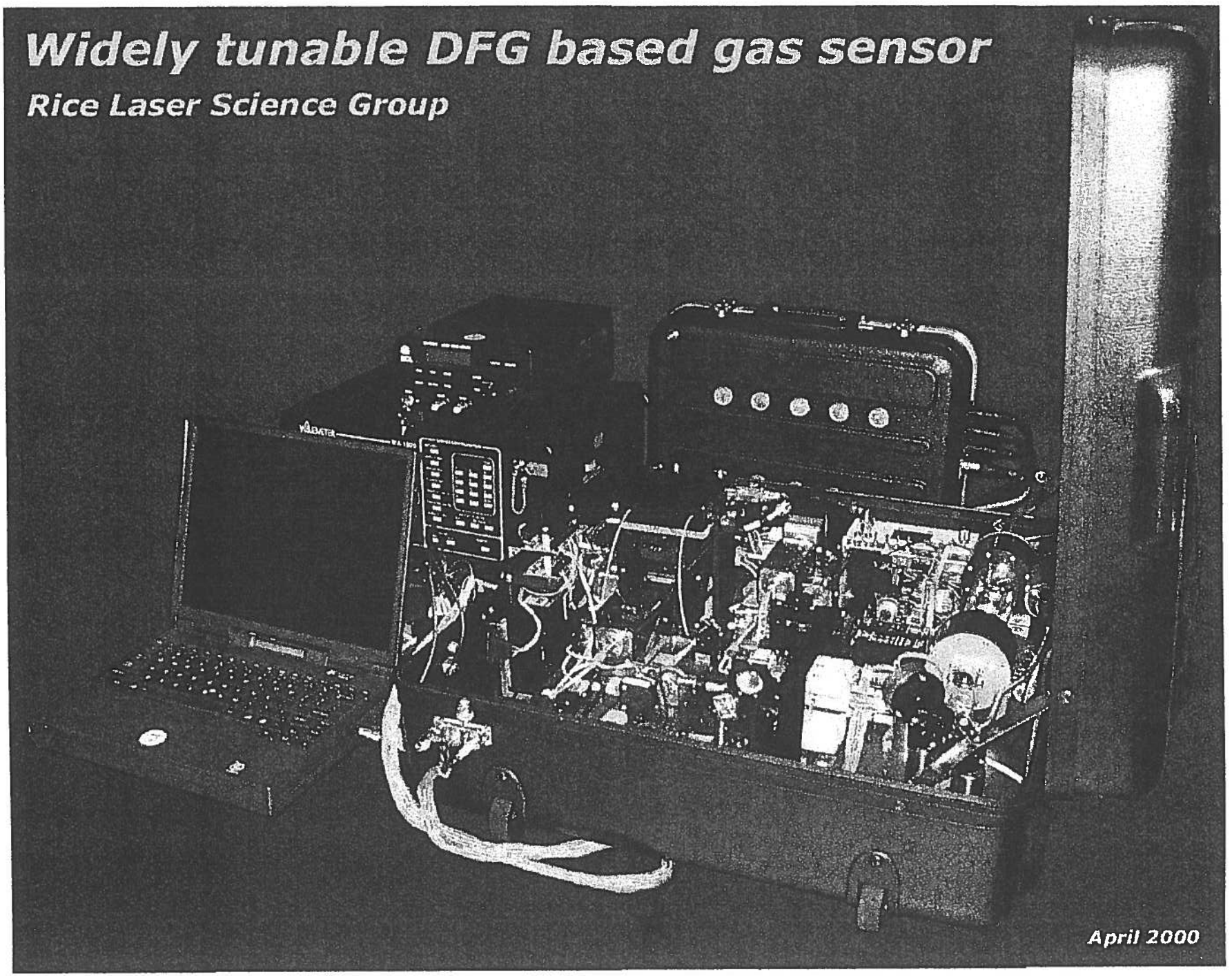
Schematic of DFG multi-component gas sensor



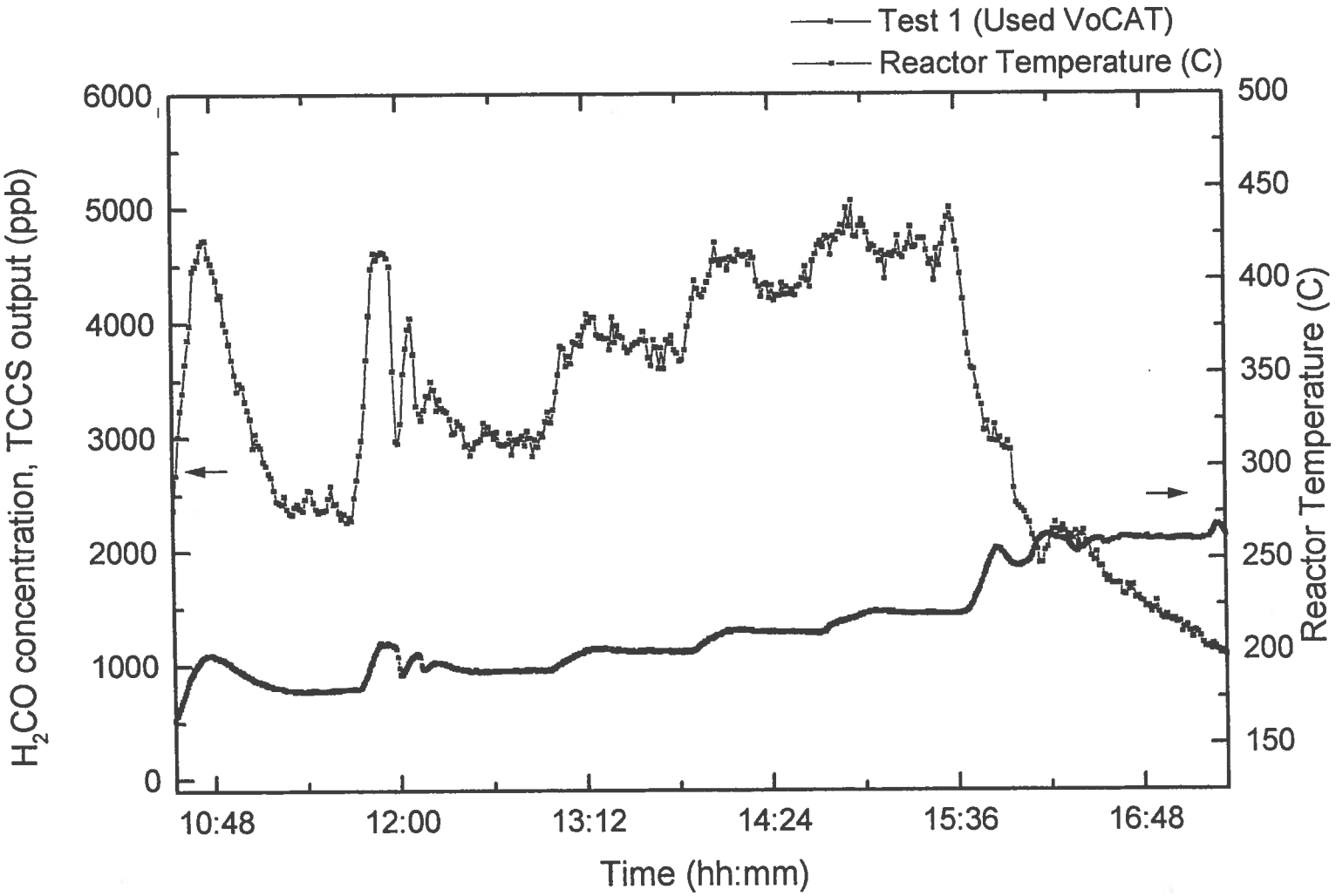
Widely tunable DFG based gas sensor

Rice Laser Science Group

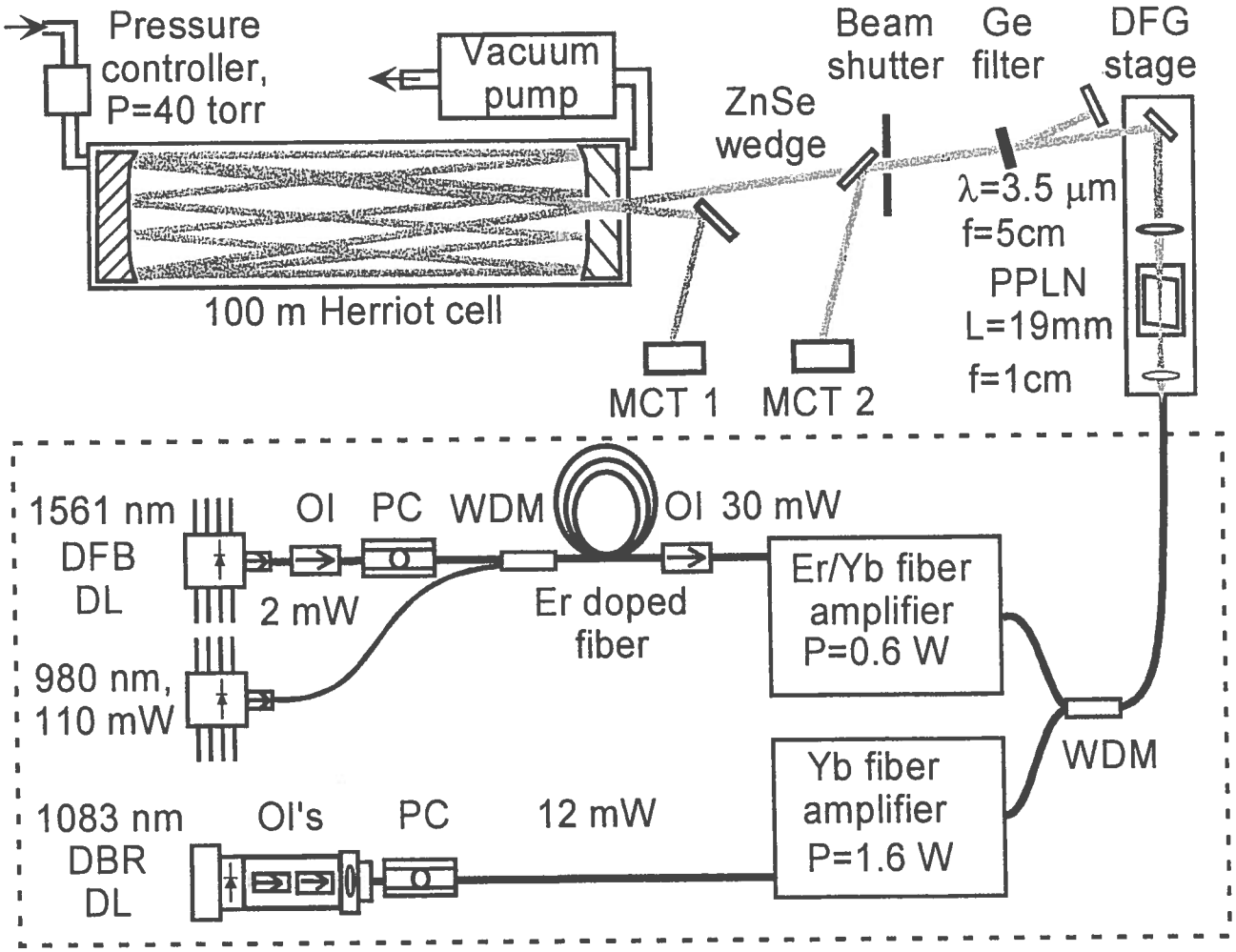


April 2000

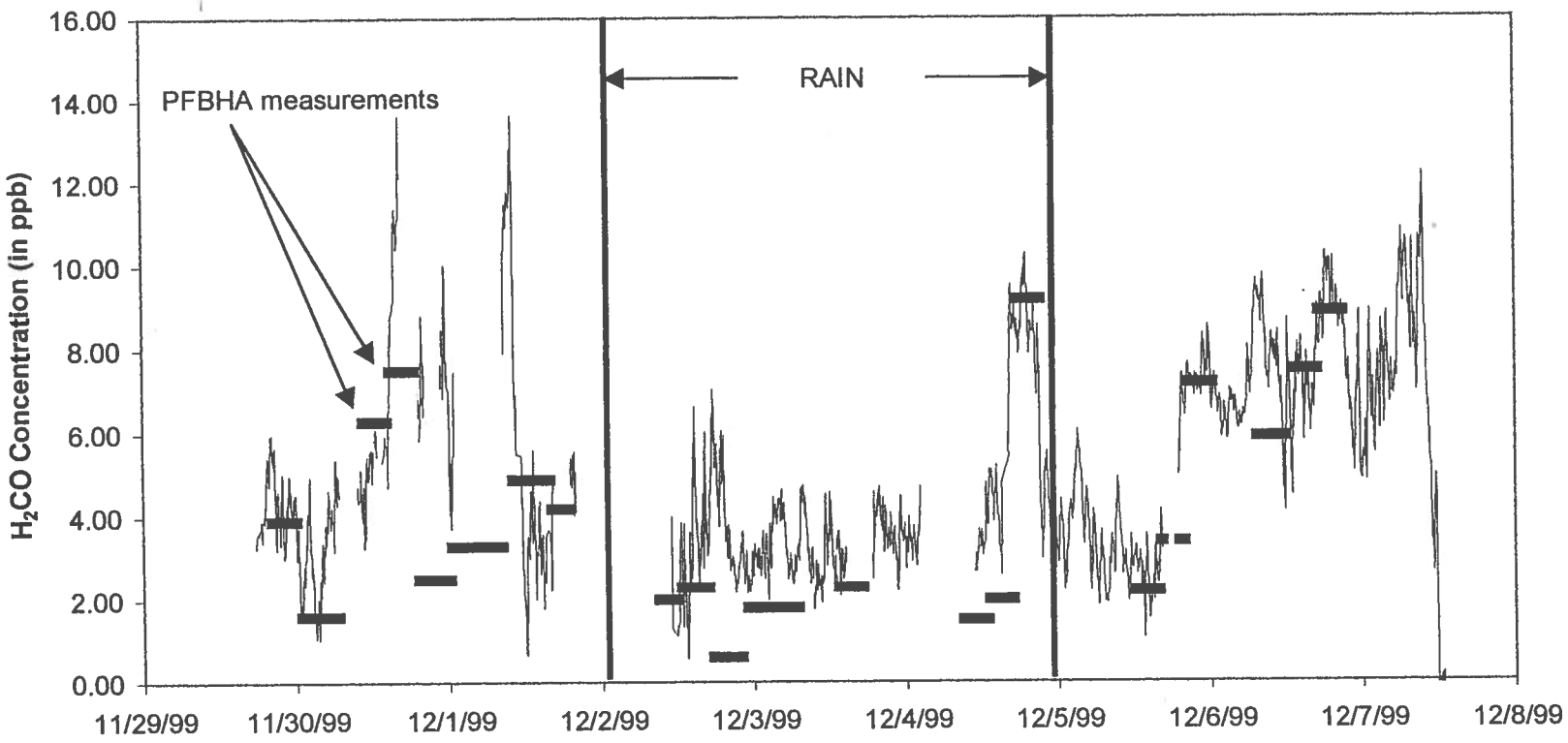
H_2CO Concentration in NASA TCCS System



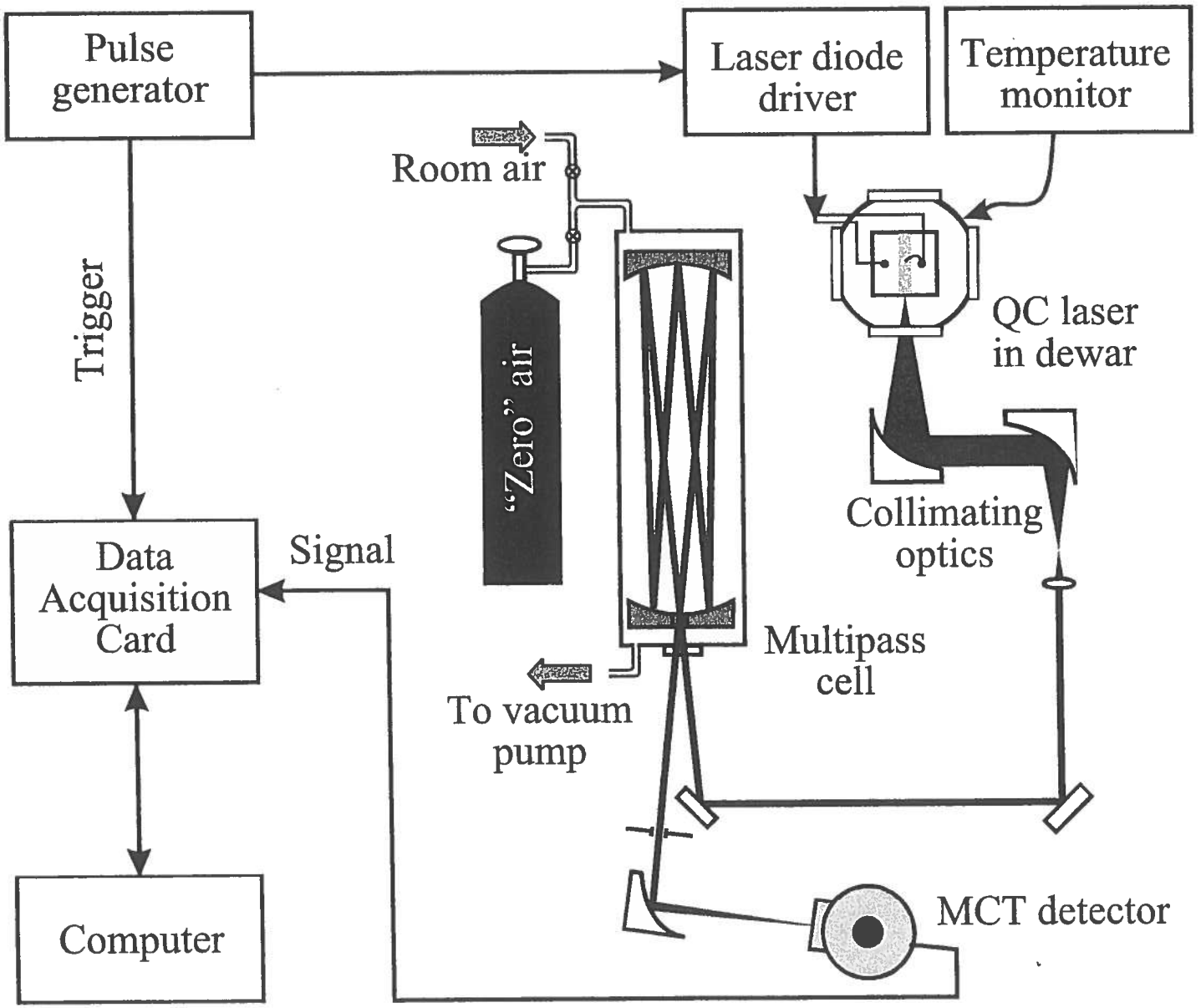
DFG Spectroscopic Source at 3.53 μm



9 Day H_2CO Detection at 3.53 μm in Houston



Trace Gas Detection with a Multipass Cell



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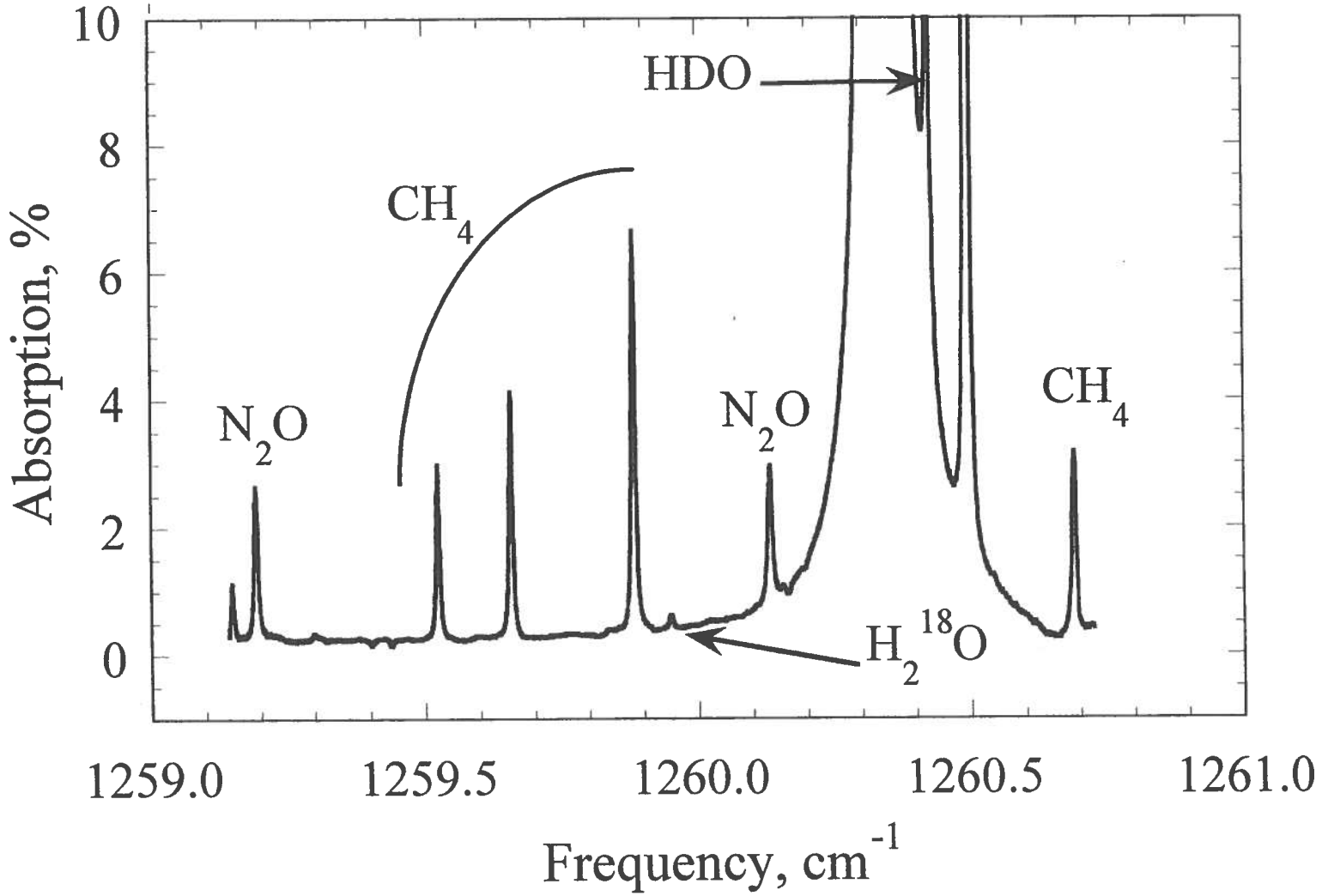
Absorption Spectrum of Room Air



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Problems Encountered

- Mechanical Design Concepts
- Electrical Design Concepts
- Thermal and Power Management
- Delivery Delay of Critical Laser Based Gas Sensor Components
- Commercialization Issues

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Future Work I

Near Term Goals (2000)

- Near-IR laser based NH_3 monitoring of bioreactor system at NASA-JSC
- Evaluation of laser based NH_3 monitoring in silicon wafer processing and combustion environments.
- Advanced prototype development of a DFG based mid-IR gas sensor.
- Development of a compact pulsed QC-DFB laser based gas sensor.
- Formaldehyde field campaign in the Greater Houston area.
- Volcanic gas emissions field campaign at Masaya Volcano, Managua, Nicaragua, conducted jointly with U.K. and NI teams.

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Future Work II

Near Term Goals (2001)

- Further development of compact QC-DFB and other mid-IR diode laser based gas sensors.
- Continuation of NH_3 monitoring application with mid-IR DFG and QC-DFB laser based gas sensors.
- CH_4 and N_2O emission studies of Rice-based agro-ecosystems.
- Airborne H_2CO and CH_4 concentration measurements conducted jointly with NCAR and NOAA.

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