E10

# Long-term unattended TDLS systems operation

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# Abstract

Main gaol of this paper is to demonstrate long-term unattended operation of TDLS system. Other work motivation was related to ecological situation worsening in big cities and industrial estates and global climate change problem. Both cases need continuous monitoring of atmosphere $CO_2$, methane, etc. Humidity measurement is also important for final analysis. Taking into account above mentioned gaols, 4 systems were developed and installed for long-term unattended operation.

First instrument is in operation from September 2005 and measures $CO_2$ concentration in atmosphere between buildings (40 m distance). Second instrument measured $CH_4$ between buildings (100 m distance) starting from July 2006. In November 2006 it was installed in corridor of DLS department. Distance between the instrument and reflector is 35 m. As addition, it simultaneously measures temperature. Finally, in July 2006 instrument was installed to measure water partial pressure.

# Receiving modules

View of receiving modules used in present experiment. Photo was made when modules were installed in corridor of DLS department. During present experiment these modules were installed in rooms (see below).

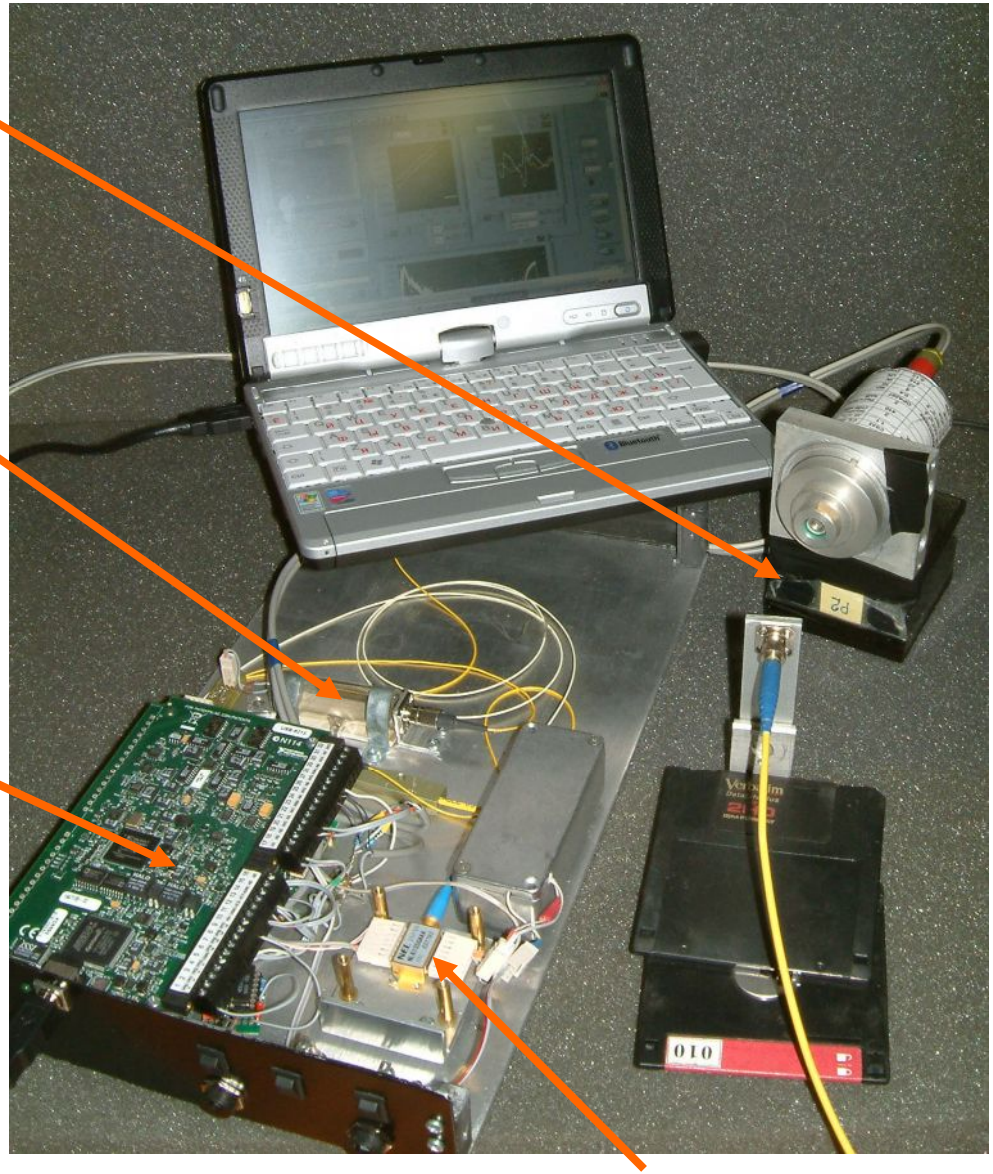
# Electronics


View of multi-channel electronics

1. Display and keyboard
2. NI PXI-1031DC computer station
3. Three laser channels

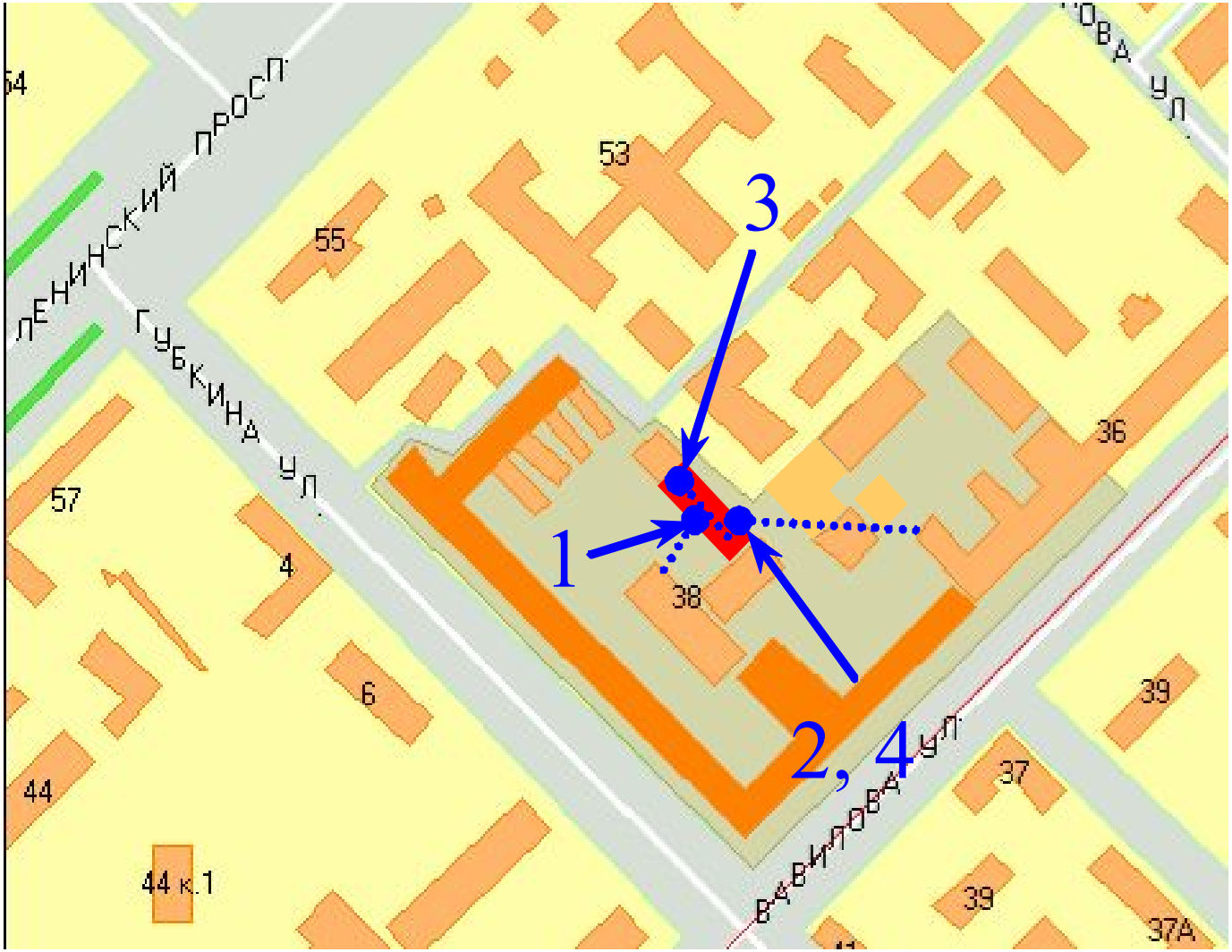
When several molecules concentration was measured simultaneously electronics of trace gas multi-component remote monitoring system (see separate poster) was used.

# Humidity sensor




Water vapor absorption is high enough. So, separate instrument with small optical path was used to measure it. The instrument was installed in one room of DLS department.

# Experiment geography

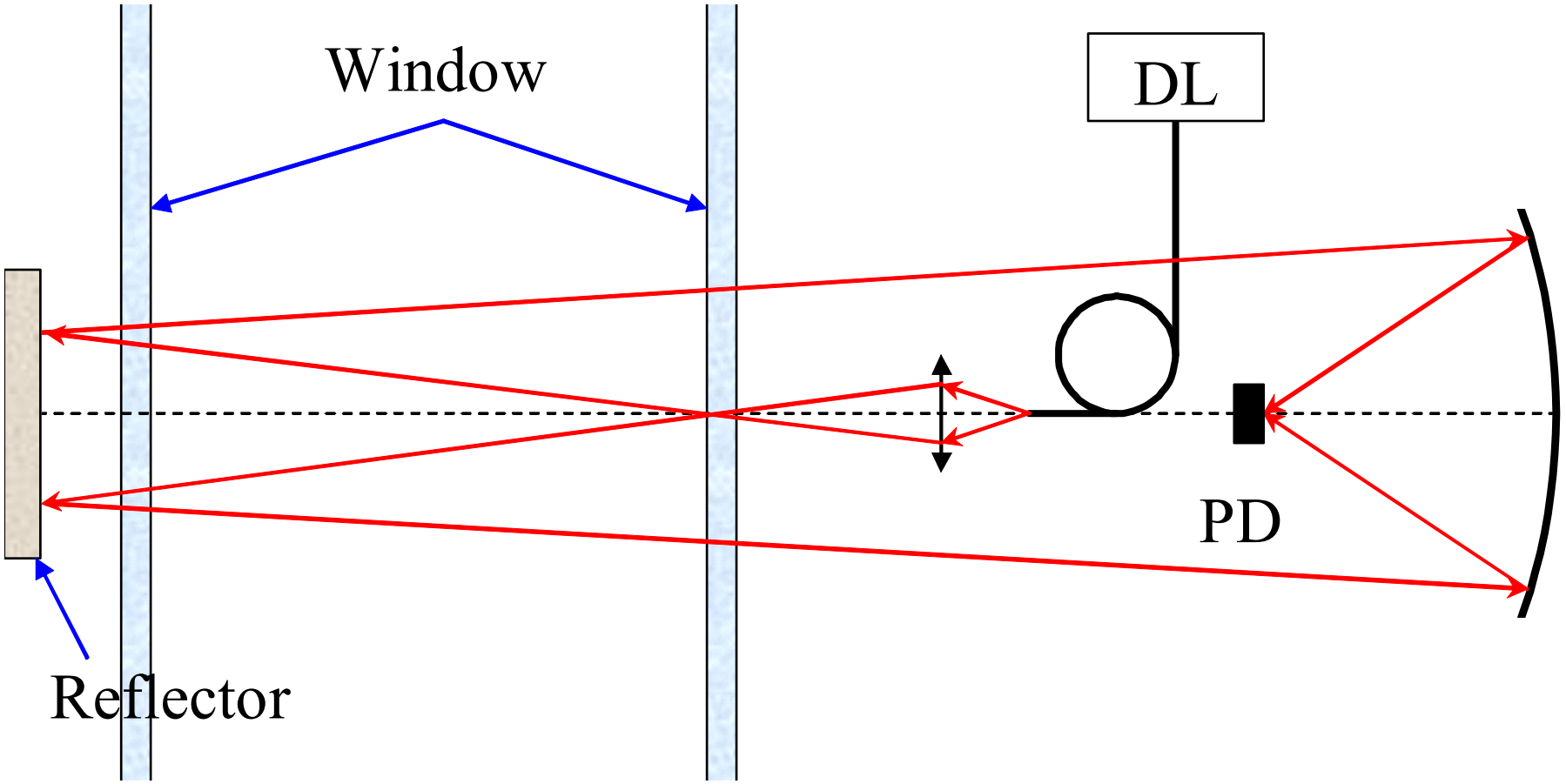



4 instruments were installed in DLS department for long term unattended atmosphere molecules monitoring.

1. $CO_2$ monitor;
2. $CH_4$ monitor;
3. $CH_4$ monitor;
4. $H_2O$ monitor.

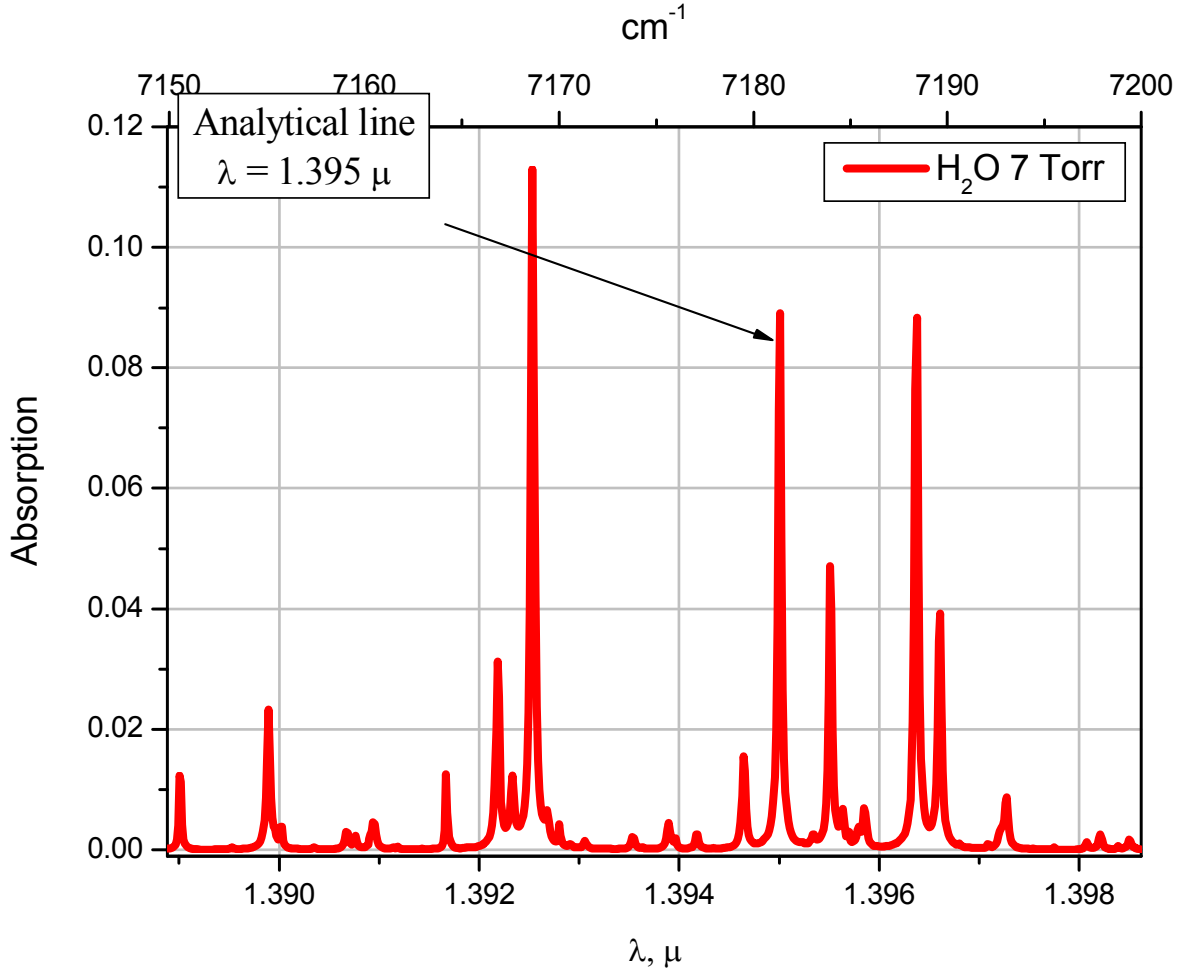
Location of developed instruments in DLS department (solid blue cycles) and optical paths (blue dotted lines) used by these instruments.

# Experiment geometry




For instruments #1, 2, 3 DL radiation was focused on reflector film. Scattered DL light was collected by receiving module optics. For instruments #1 and #2 DL beam passed two window sets (two window glasses in each set) in two different buildings.

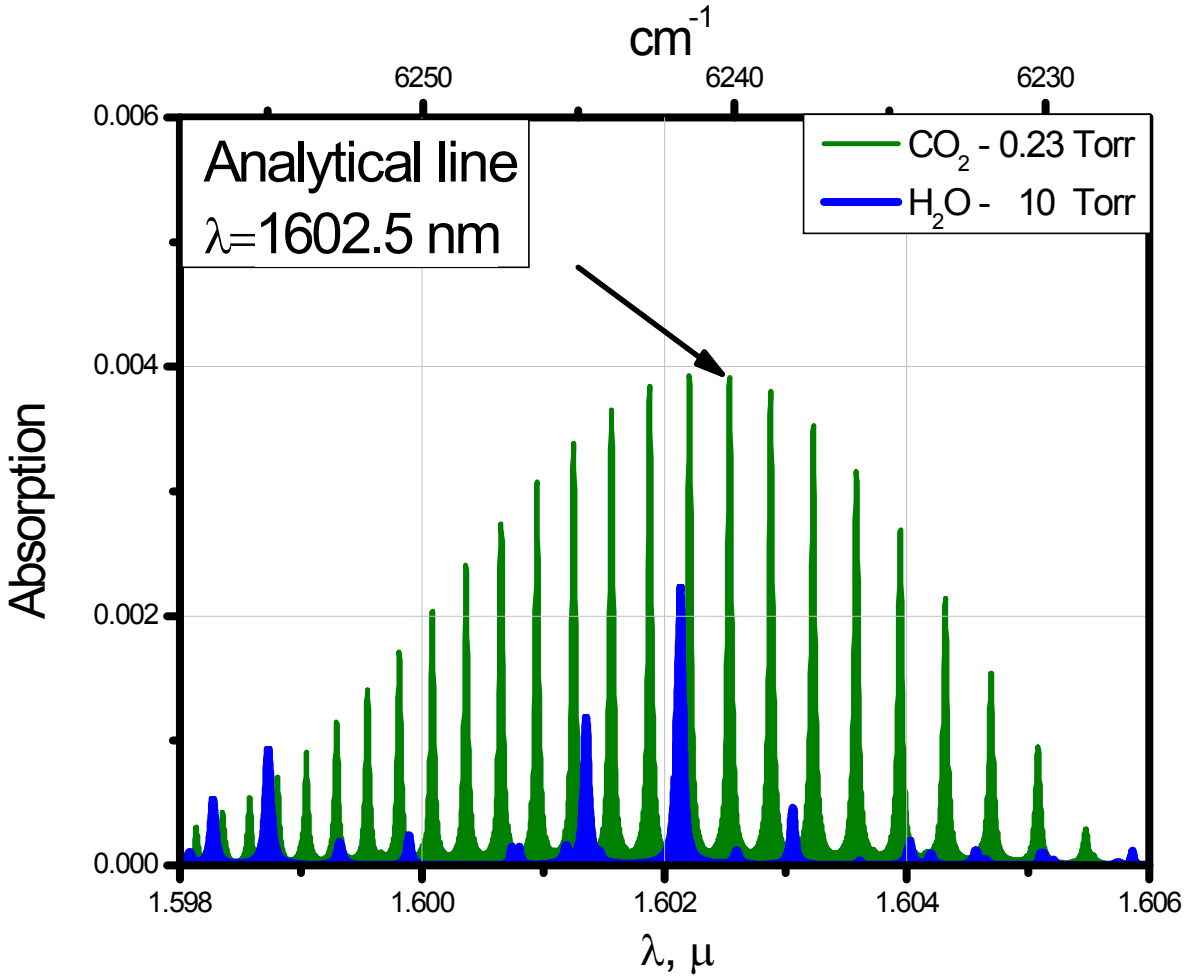
# $H_2O$ detection




Choice of analytical line for $H_2O$ detection.

Instrument #4 was installed in one laboratory room of DLS department and is in operation from July 2006 to measure water vapor partial pressure.

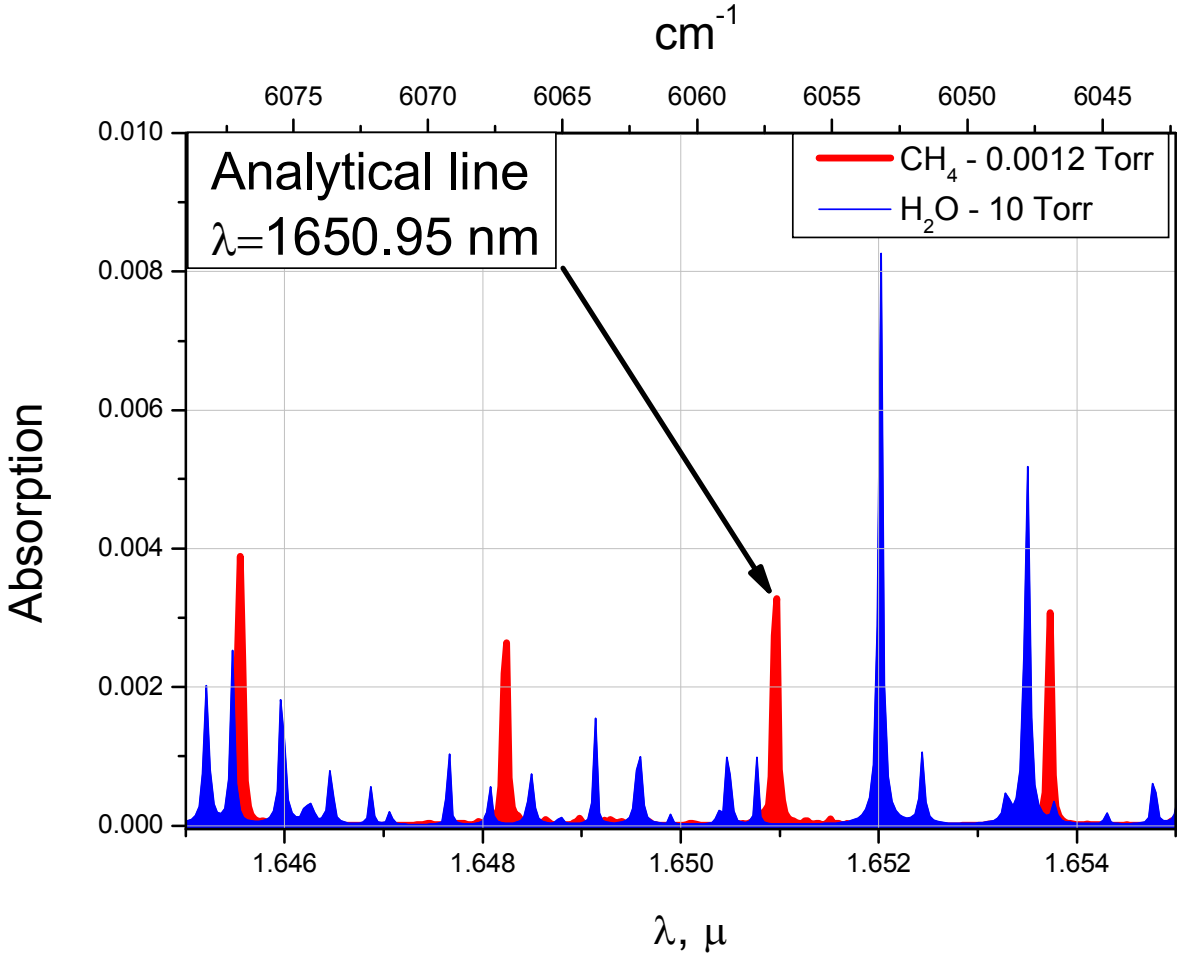
# $CO_2$ detection




Choice of analytical line for $CO_2$ detection taking into account interference with water absorption.

Instrument measuring $CO_2$ (#1, distance between buildings - 40 m) is in operation from September 2005 and measures $CO_2$ concentration in atmosphere between buildings as well as Sun illumination and atmosphere transmission.

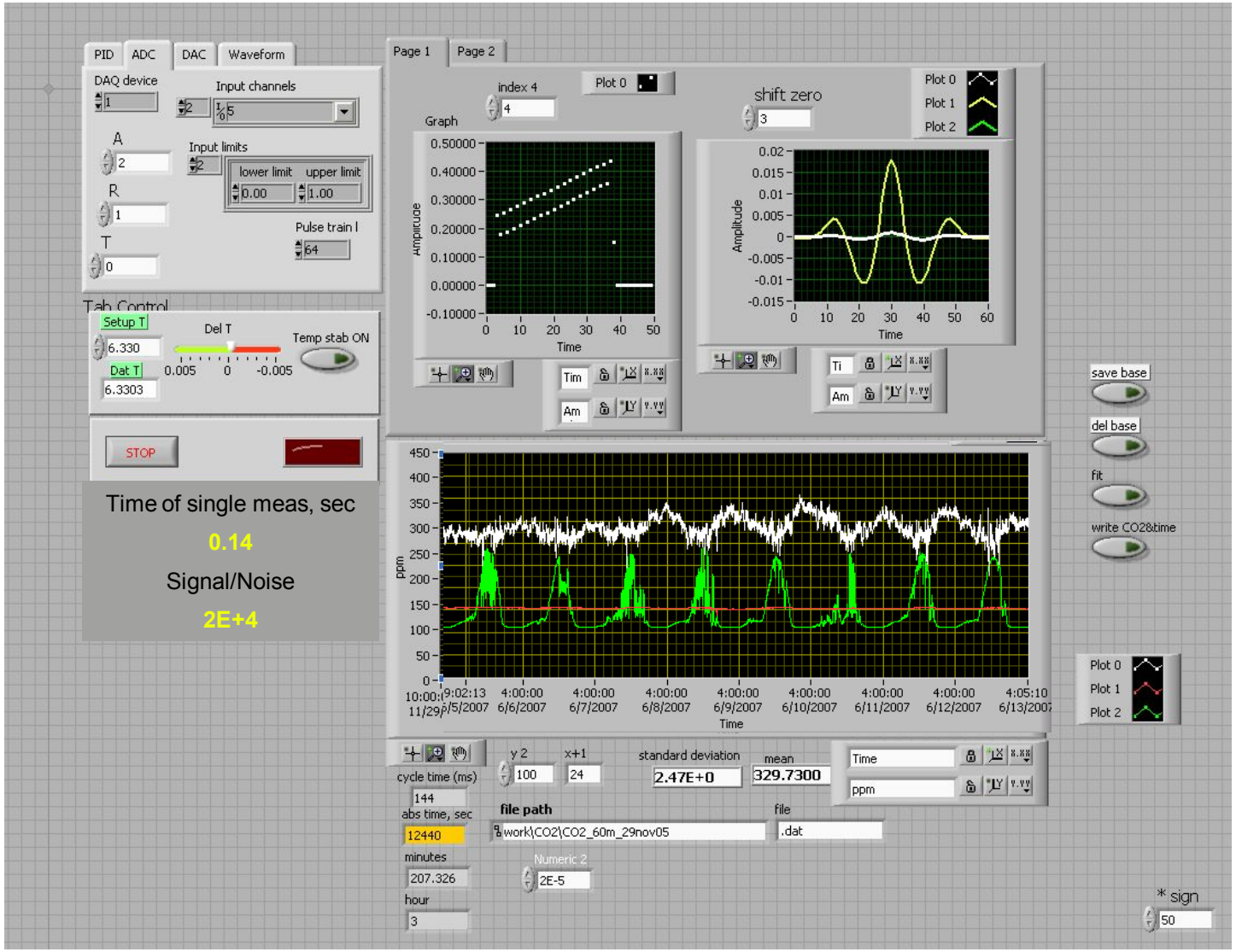
# $CH_4$ detection




Choice of analytical line for $CH_4$ detection taking into account interference with water absorption.

Instrument measuring $CH_4$ (#2, distance between buildings - 100 m; #3 installed in DLS department corridor, distance 35 m) is in operation from July 2006 and measure methane concentration as well as temperature.

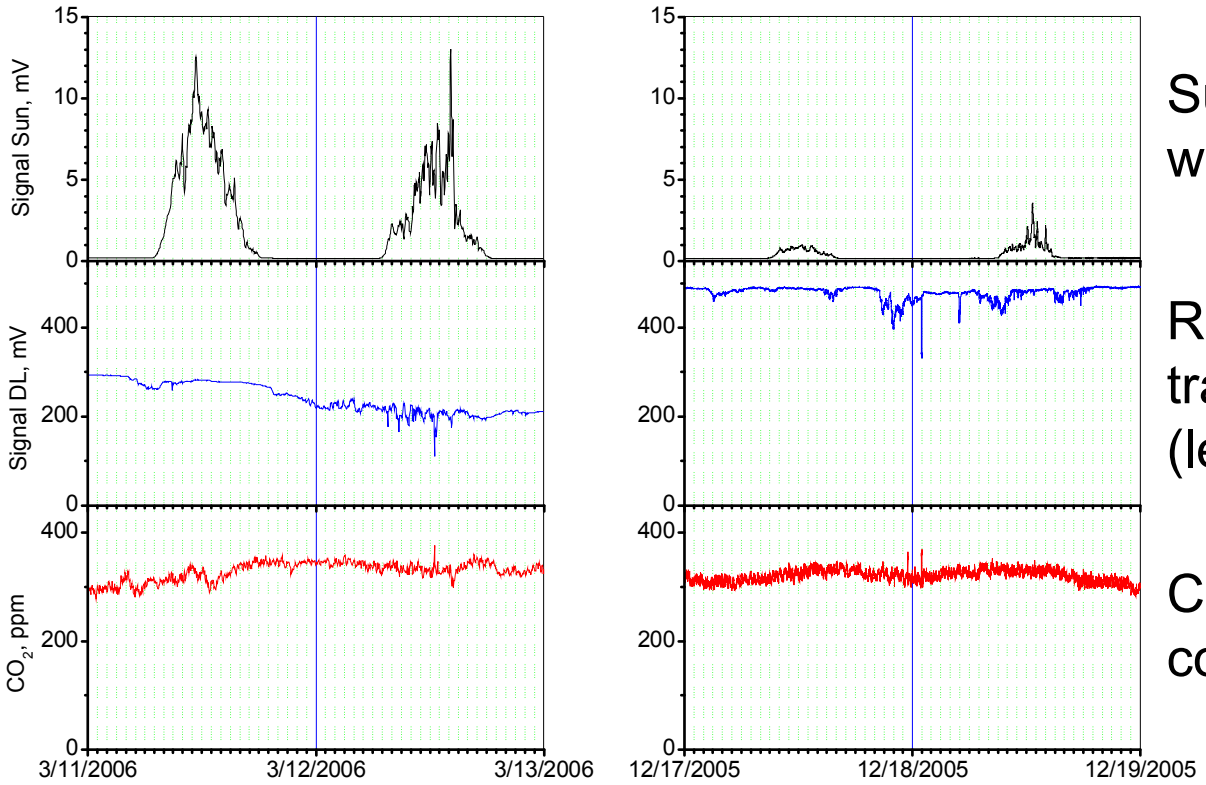
# Program interface




Special software was developed for long-term (years) unattended DL based system operation.

# System operation

Three parameters were recorded: signal due to Sun illumination (black), recorded DL light (blue), and $CO_2$ concentration (red). Graph presents examples of two days monitoring in December (left) and March (right).



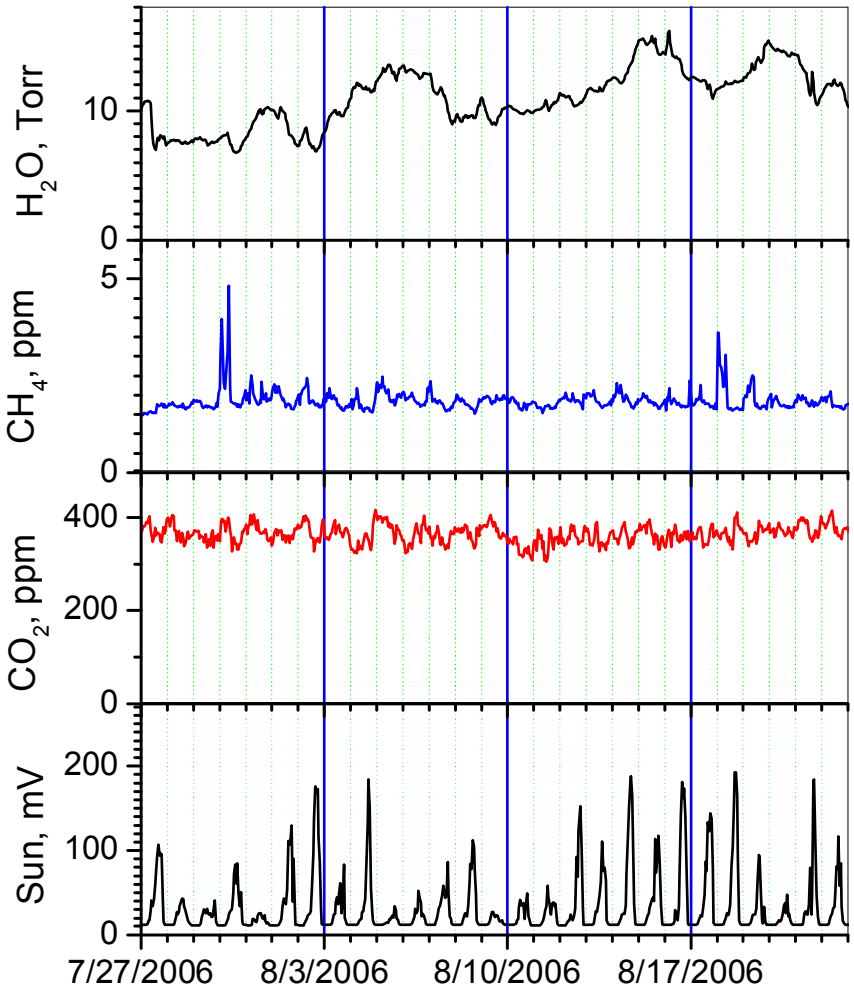

Sun illumination variation in winter and spring.

Reduction of atmosphere transparency due to snow (left) and rain (right)

Concentration measured corresponds $10^{-3}$ absorption

Instrument #1, averaging time - 15 sec.

# $CO_2$, $H_2O$, and $CH_4$ monitoring




Water partial pressure variations, instrument #4.

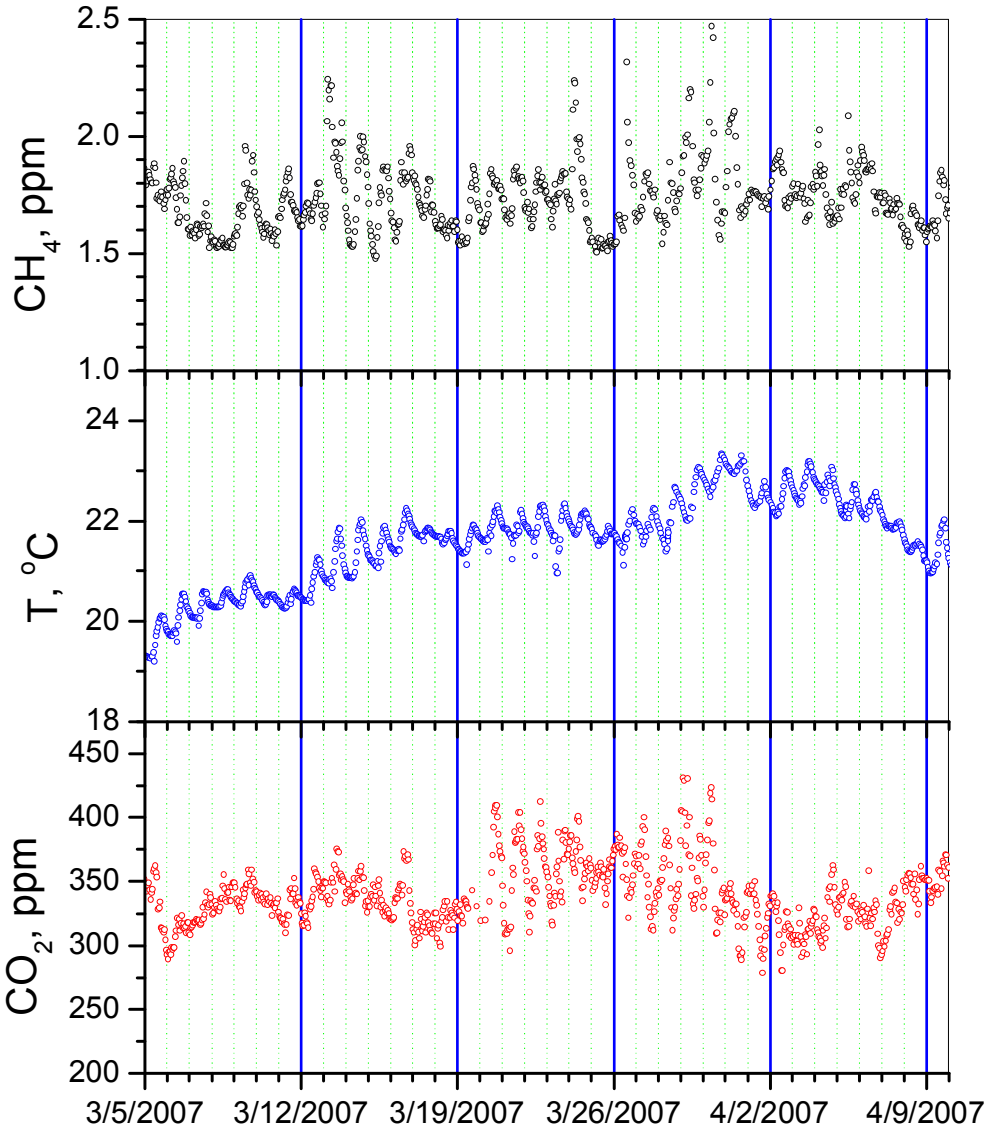
Methane - instrument #2. Two intensive peaks are due to methane plume from power plant (3 km from GPI).

$CO_2$ monitoring – instrument #1.

Sun illumination – instrument #1.

One month simultaneous three molecules concentration monitoring (1 min averaging time).

# Human activity



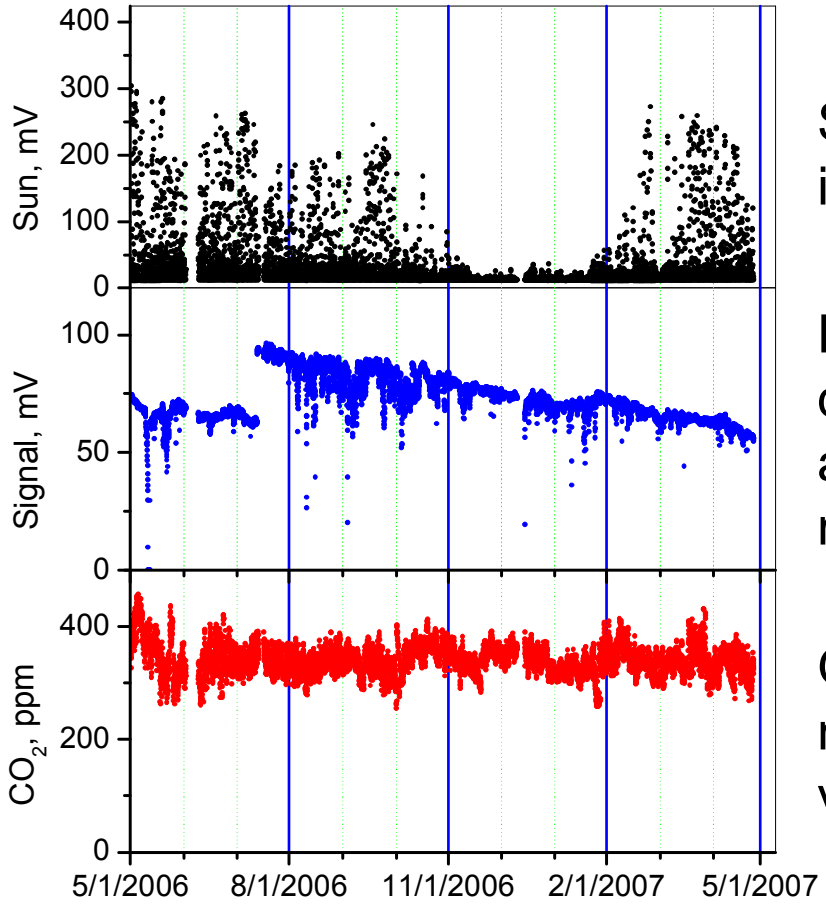

Indoor measurements: methane (black) and temperature (blue) - instrument #3;

Outdoor measurements: $CO_2$ (red) - instrument #1.

Week period of data presented demonstrates influence of human activity on methane and $CO_2$ concentrations.

# Long-term $CO_2$ monitoring

Three parameters were recorded: signal due to Sun illumination (black), recorded DL light (blue), and $CO_2$ concentration (red). Graph presents result of one year monitoring with 1 hour averaging.




Summer – winter variation of Sun illumination intensity can be observed.

Recorded DL signal variation: due to optics dis-alignment and manual alignment as well as transparency change due to snow and rain.

Observed $CO_2$ concentration variations is not noise. It is due to daily concentration variations