



An Integrated Environment For Control and Data Acquisition In Quantum Cascade Laser Experiments



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Introduction

Due to its wavelength tailorability and high power output, Quantum Cascade Lasers (QCLs) have shown tremendous potential in monitoring the concentrations of important environmental trace gases such as ammonia and ozone. One popular technique involves intra-pulse tuning (chirping) the laser wave number across a 2-3 cm^{-1} window with 100-500 ns current pulses. However, this places high demand on data acquisition (DAQ) systems in order to obtain the high resolution spectral information needed for precision experiments. To accurately determine concentrations at the parts per billion (ppb) levels in real time, efficient software for operation of the laser and retrieval of the experimental data is needed.

Methodology

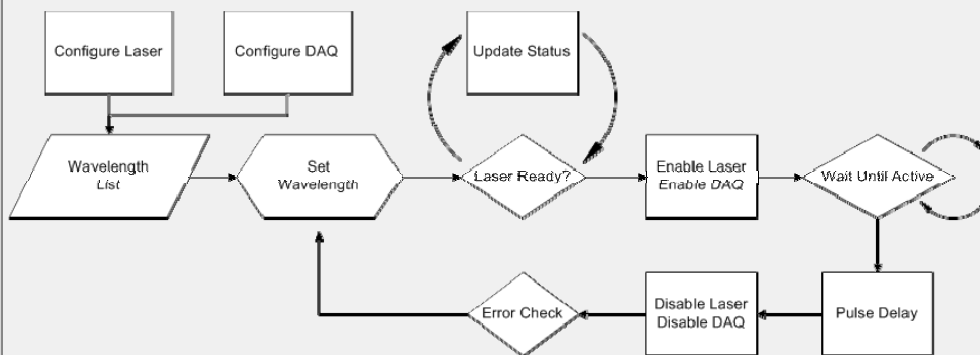
QCL Drivers

- LabVIEW Virtual Instruments (VIs) used for main application and QCL interface
- Modular VI structure for flexibility and interchanging QCL systems
- Built using external cavity QCL system from Daylight Solutions

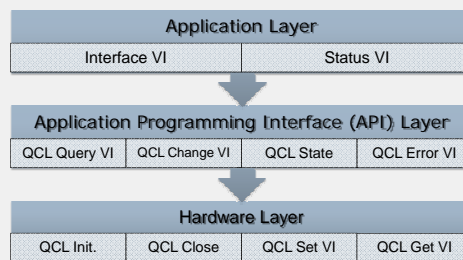
Data Acquisition (DAQ)

- Requires 200 MS/s (0.02 cm^{-1} spectral resolution)
- Trigger-enabled acquisition
- Large buffer to prevent data-loss
- GaGe Compuscope DAQ Card

Laser Operation Flowchart



Virtual Instrument Structure

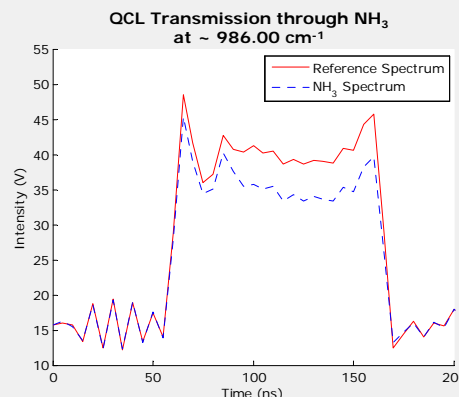
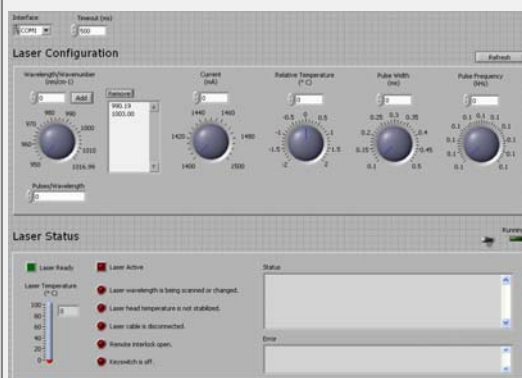


Application Layer: programs and executes laser functions

API Layer: laser commands and queries

Hardware Layer: device input/output

Application Interface & Sample Data



QCL Driver Layers

Hardware Layer

- Provides interface independence
- Uses VISA events for efficient data retrieval

API Layer

QCL-Query / QCL-Change

- Implements version-specific commands via QCL-Set & QCL-Get.
- Controller errors are handled automatically by QCL-Error

QCL-State

- Laser interlocks, wavelength tuning, temperature state, events

QCL-Error

- API-specific error queries for seamless handing

Application Layer

QCL-Interface

- Initializes front panel with values and ranges for current, pulse width, frequency, relative temperature, and wavelength
- Uses *QCL-Status* VI to update temperature and readiness indicators (interlocks and events)
- Provides timed pulses for DAQ device

References

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