

194 (CLEO - Stephen)

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Industrial applications of pulsed quantum cascade laser analyzer for trace-gas monitoring

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<http://www.ece.rice.edu/laser/qci>

- Motivation and Technology Issues
- Specific challenges for QCL based industrial monitoring
- Justification and realization of precise ultrashort wavelength scan
- Data acquisition issues
- Summary and Outlook

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 Aug. 30 - Sept. 3 2004

Wide Range of Gas Sensor Applications

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

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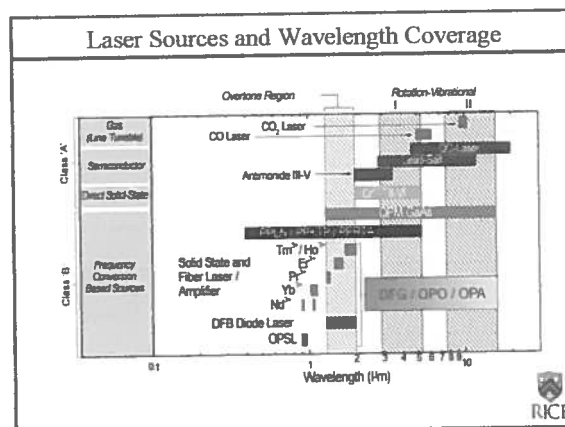
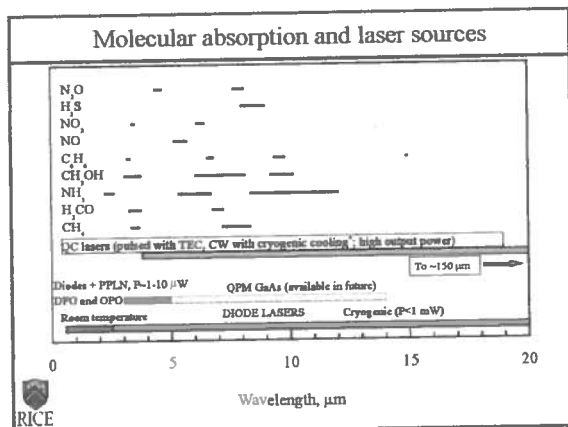
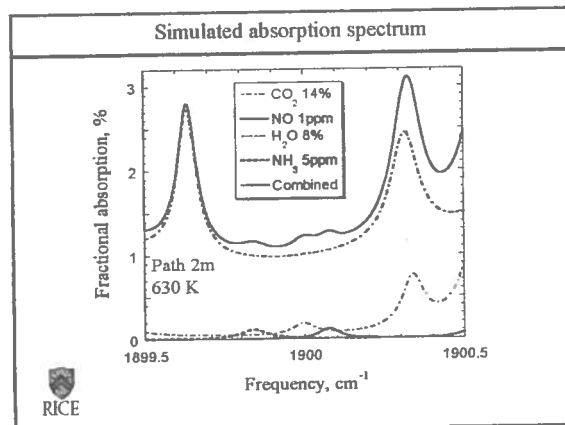
Temperature distribution in industrial exhaust

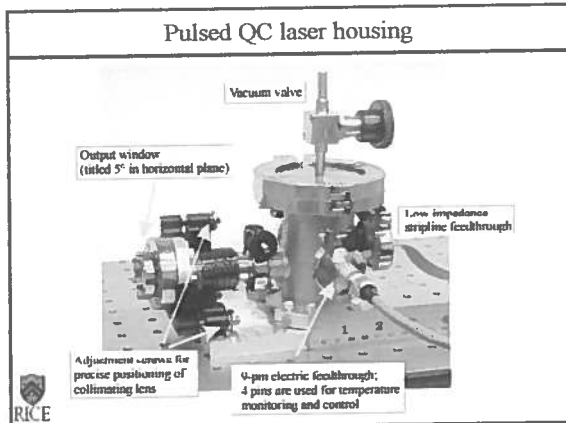
SCR - Selective catalytic reduction, method of removing NOx from combustion gases using a catalyst and ammonia

NO and NH₃ must be monitored at a few ppm level

752°F=400°C

Temperature distribution diagram by courtesy of Trevor Kuntel, Analytical Specialists



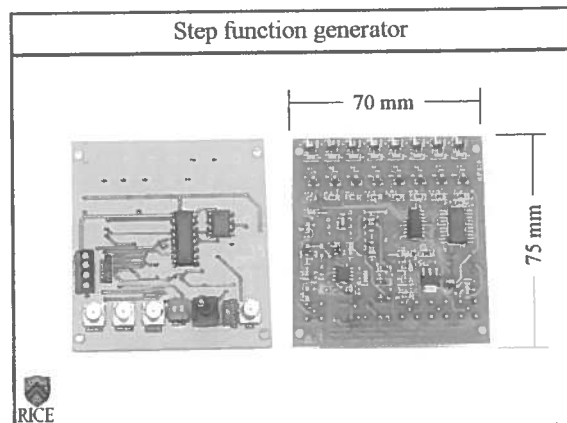
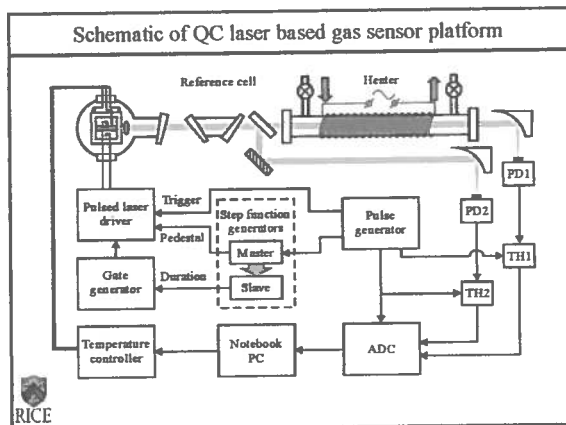
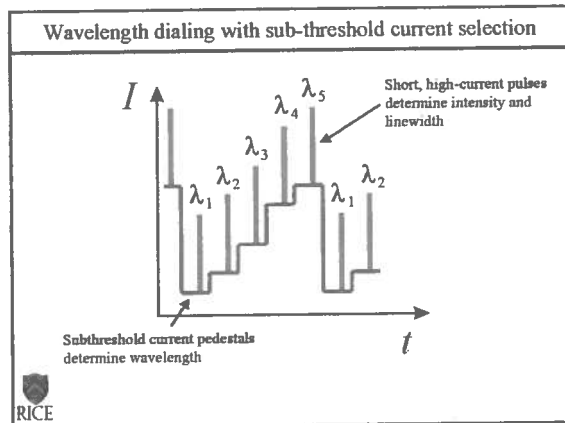
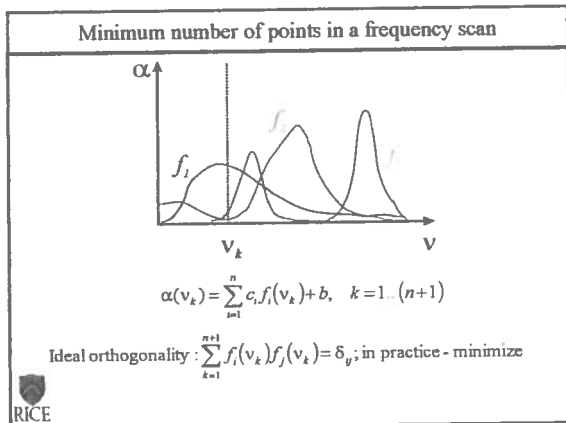


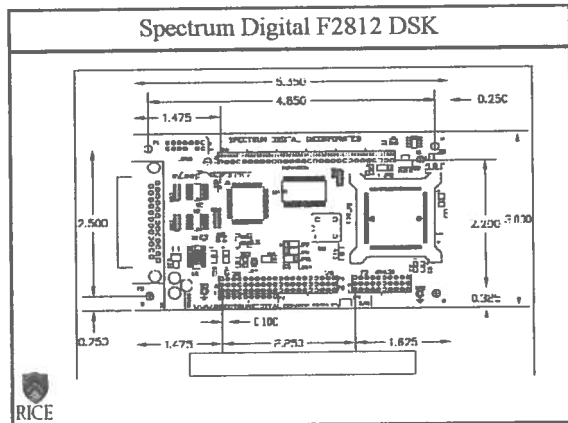
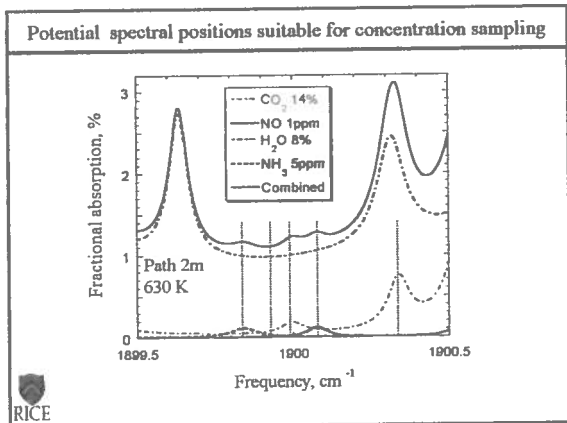
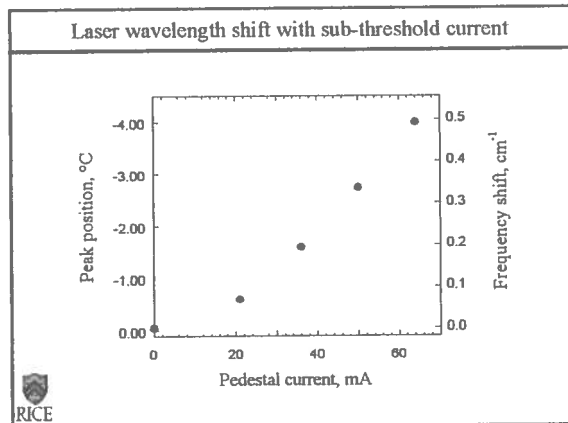
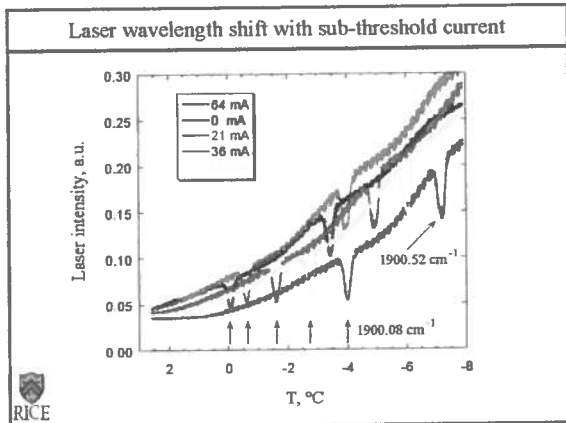
Specific issues for industrial monitoring with a pulsed QCL

- Strong fluctuating nonselective attenuation (~70%) by soot particles and gas flow instabilities
- Unresolved individual absorption lines
- Overlapping absorption spectra of different species
- Pulse-to-pulse laser output fluctuations
- Laser frequency drift

- High-power laser, timed detection and very fast scans to freeze fluctuations (minimum number of points/scan, high repetition rate)
- Pre-acquired spectral envelopes used in data processing
- Integrated data processing to determine concentrations of ALL the components
- Reference channel for normalization
- Reference absorption cell

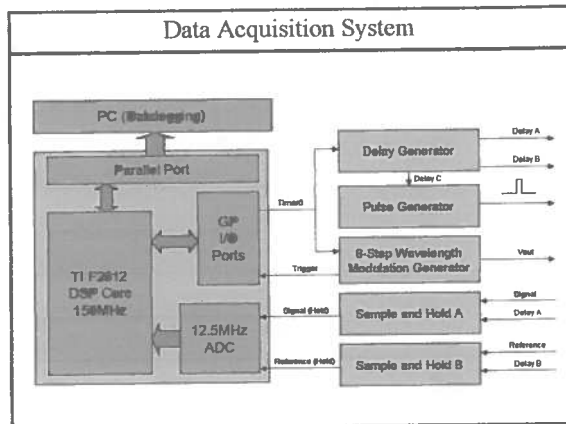
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F2812 Specifications

• Processor Clock Speed	150 MHz
• PC Interface	Parallel Port
• Timers	3 (32-bit)
• Digital Inputs	56
• Flash Memory	512 Kbytes
• RAM	72 Kbytes
• External Memory	Up to 1Mbyte
• ADC	12 bit 16 channel 12.5MHz ADC (2 channel simultaneous sampling)
• Two Serial Communications Interfaces, Standard UART	



Summary and further development

- Specific challenges associated with spectroscopic gas analysis of industrial exhaust gases have been identified and addressed.
- Experimental setup for laboratory evaluation and preliminary calibration of a QC-laser based gas sensor was designed.
- A concept of very fast wavelength scanning using precise wavelength dialing of a pulsed QC-DFB laser was demonstrated.
- A DSP based system for fast data acquisition and autonomous gas sensor control is being developed.

