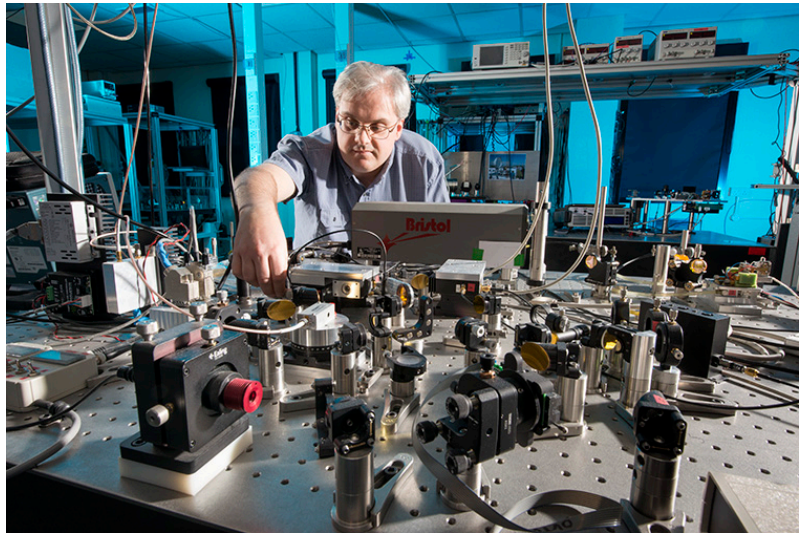
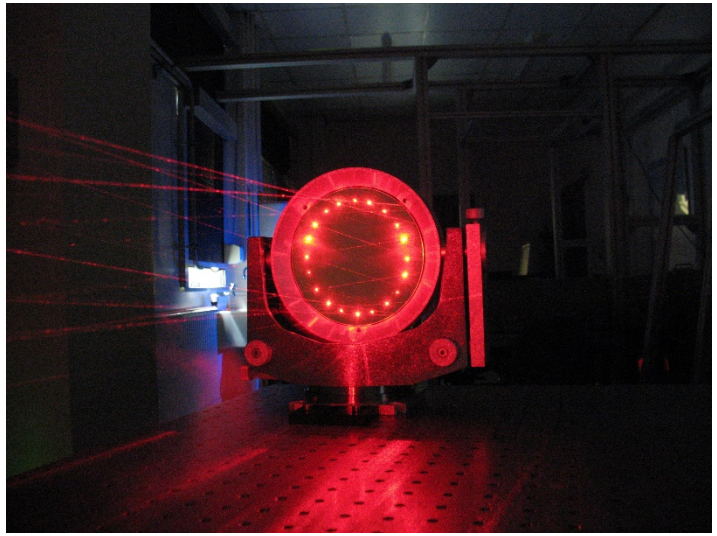
RAL Space
Spectroscopy

STFC Capabilities in Novel High-Specs Sensors

Laser spectroscopy sensors for AQ

Damien Weidmann





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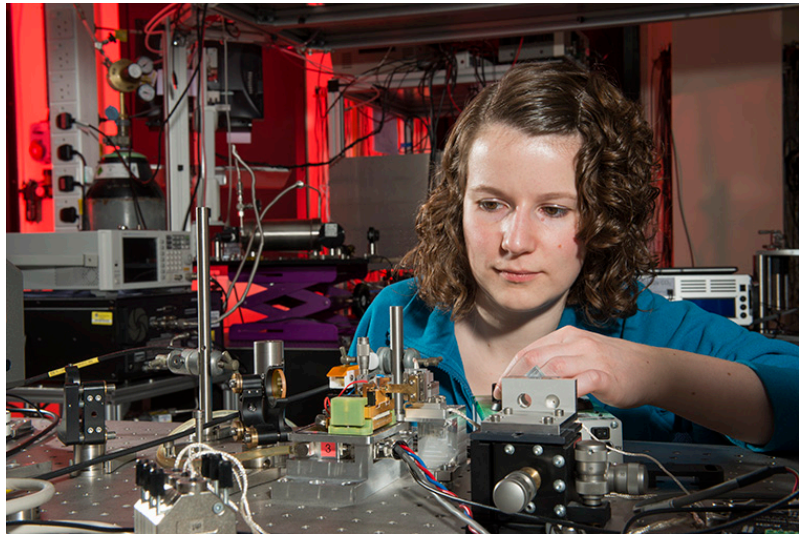
General Presentation

- General activity of Spectroscopy Group
  - Develop analytical sensing technologies
  - Develop analytical sensing instruments (including processors)
  - Develop analytical sensing applications
  - Develop supporting laboratory spectroscopy
- Focus on demanding applications
  - Not low cost but high value for money
- Group of ~10 full time scientists
  - Physical chemistry, Physics, Photonics, Instrumentation, Modelling
  - Leveraging engineering expertise from RAL Space

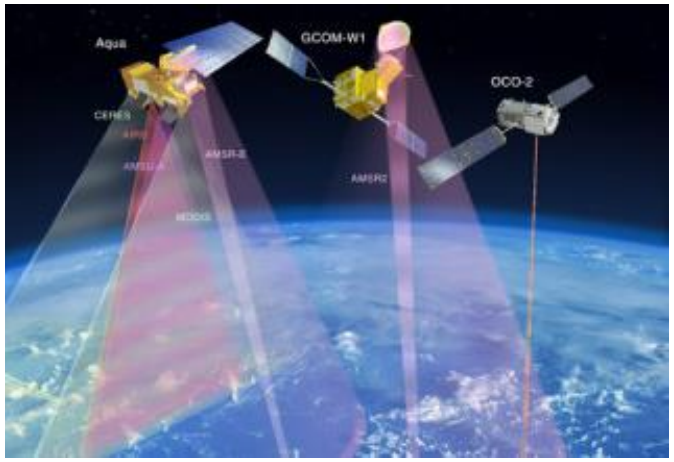
Stating the Problem

- Generic R&D activity
  - Sensitive, accurate, & selective chemical sensing
  - High temporal resolution (real time)
  - Compact, rugged, deployable systems
  - High resolutions – High specifications
  - Non destructive – non contact
- Field of application
  - Atmospheric and space sciences
  - Environment
  - Geochemistry / Earth sciences
  - Security & defence
  - Medical & industrial



Types of Sensing Systems

1.



Remote sensing

Laser heterodyne
Passive
Active

2.

Long open path

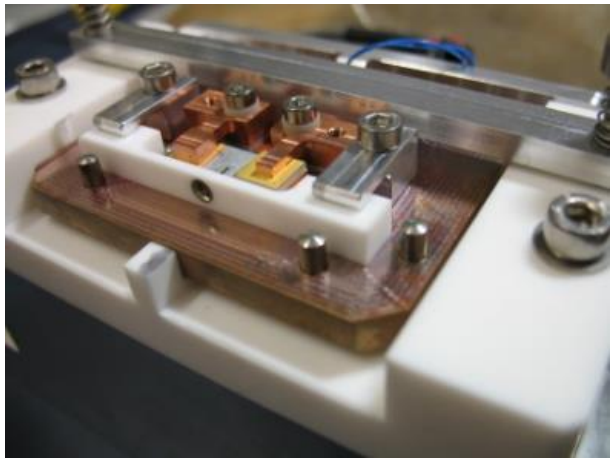
Dispersion sensing
2D mapping

3.

In-situ sensing

Isotopic ratios
Cavity-based
Nonlinear

4.

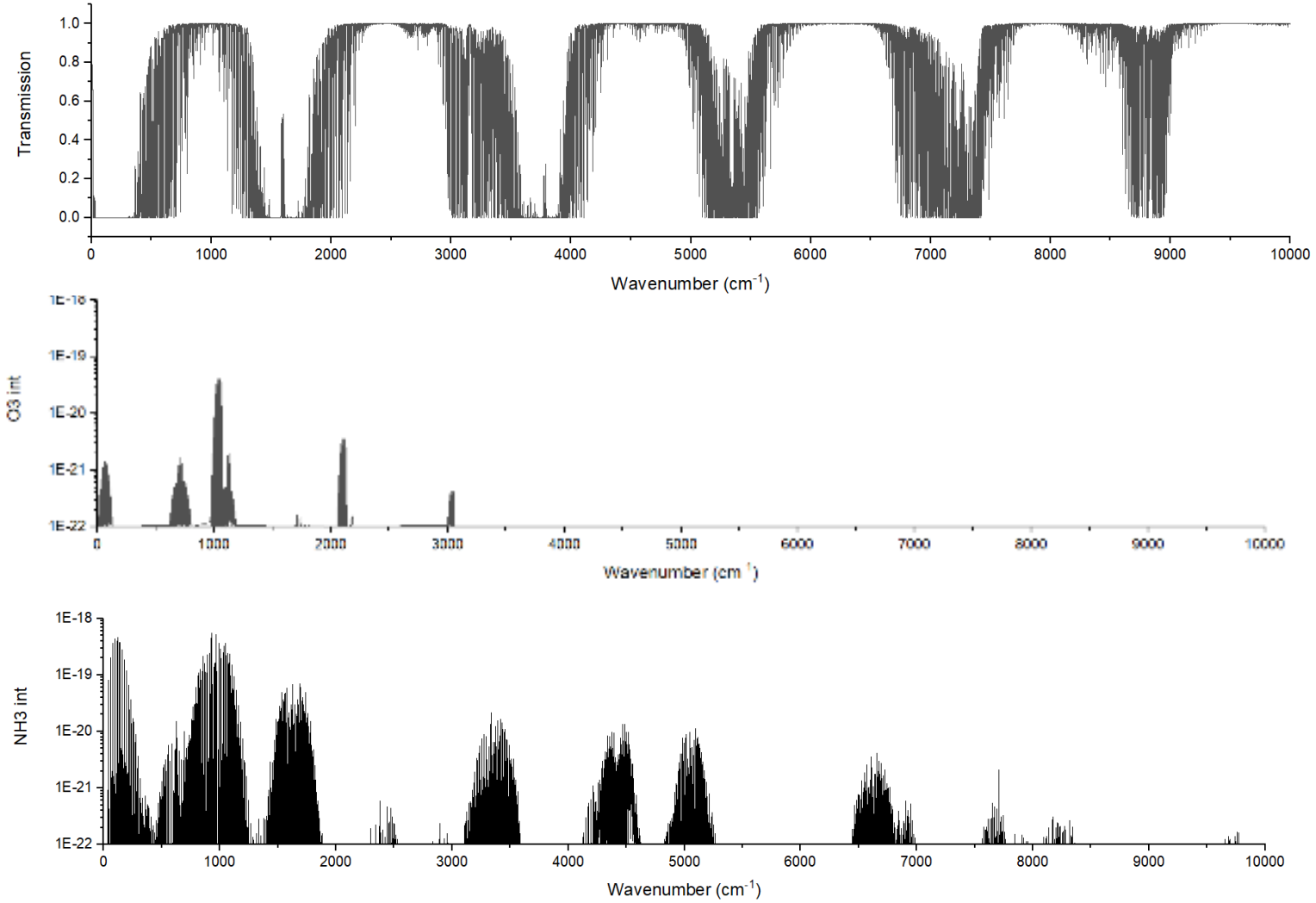


Enabling tech.

Miniaturization
Modelling
Algorithms

Middle Infrared Focus

- Mostly mid IR windows
  - LWIR (8-12 μm)
  - MWIR (3-5 μm)
- Semiconductor lasers
  - QCL
  - ICL
- Molecular fingerprinting
- Thermo-physical info



Miniaturized Point Sensors

RAL Space Spectroscopy

- Molecular gas sensors
  - CO2, CH4, O3, NO, NO2, Isotopes…
  - 0.2% relative precision
  - Few seconds temporal resolution
  - Cost/performance trade-off
- Possible use
  - Fixed networks for AQ and MRV
    - Street furniture
  - Mobile networks for mapping
    - City utility vehicles
  - Autonomous vehicles, UAV, Drones
  - Embarked vehicle emissions
    - Ships, trucks, cars

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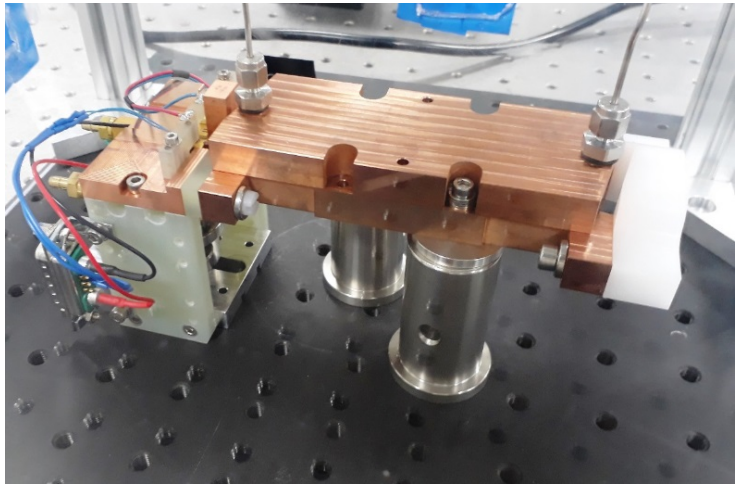

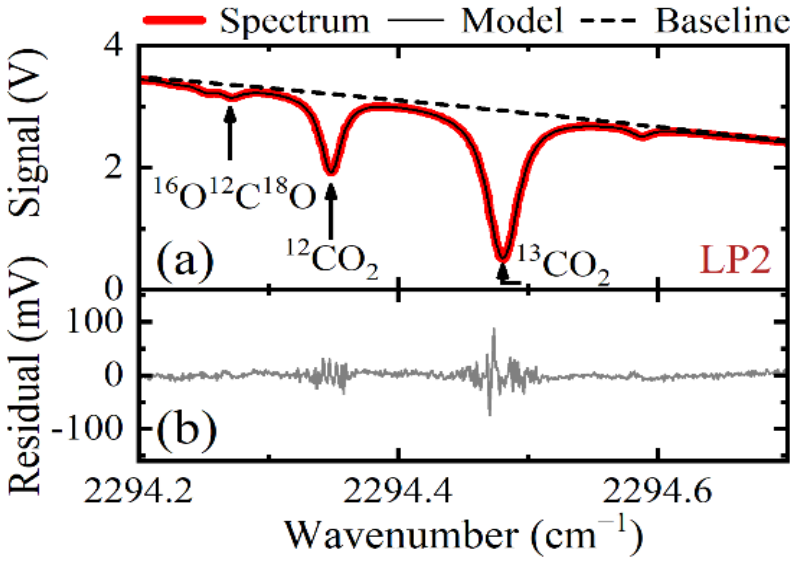

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Wide Area Emission Mapping

- Molecular gas sensors
  - CO_2, CH_4, NH_3, O_3, NO, NO_2, SO_2…
  - Part per billions sensitivity
  - Integrated concentration measurements
  - Eye safe multi-directional sensing
- Dispersion model needed
  - Coupled to meteorological sensors
  - Wide area coverage with one system
- Possible use
  - Large area mapping (MRV)
  - Fence line monitoring
  - Building to building sensing
  - UAV borne lidar mapping

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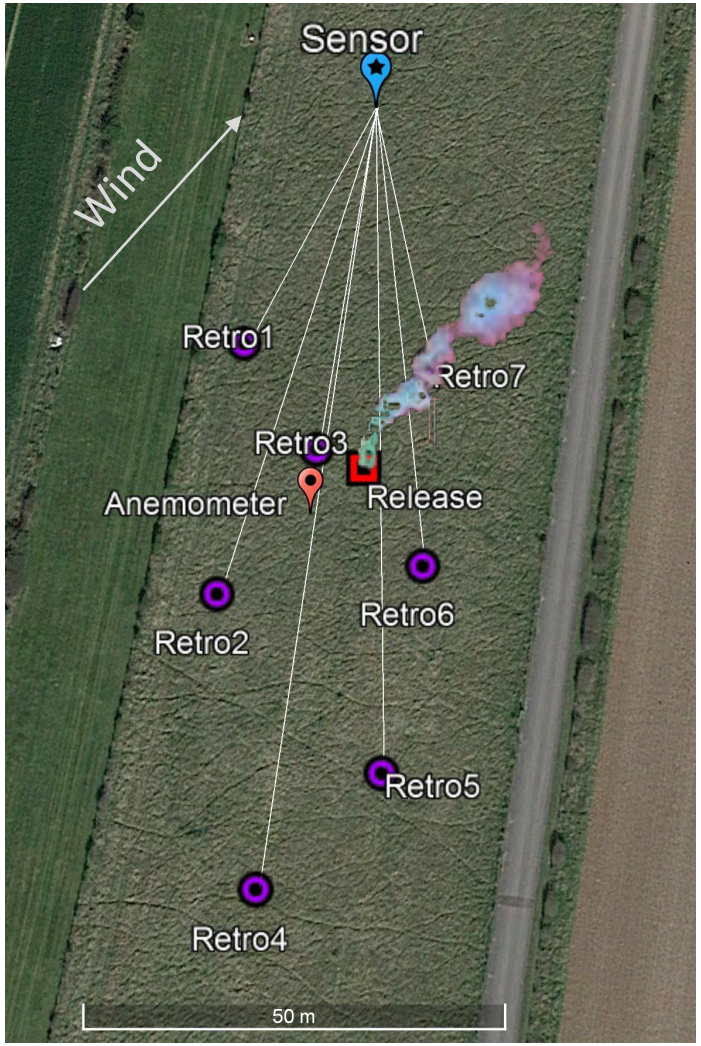

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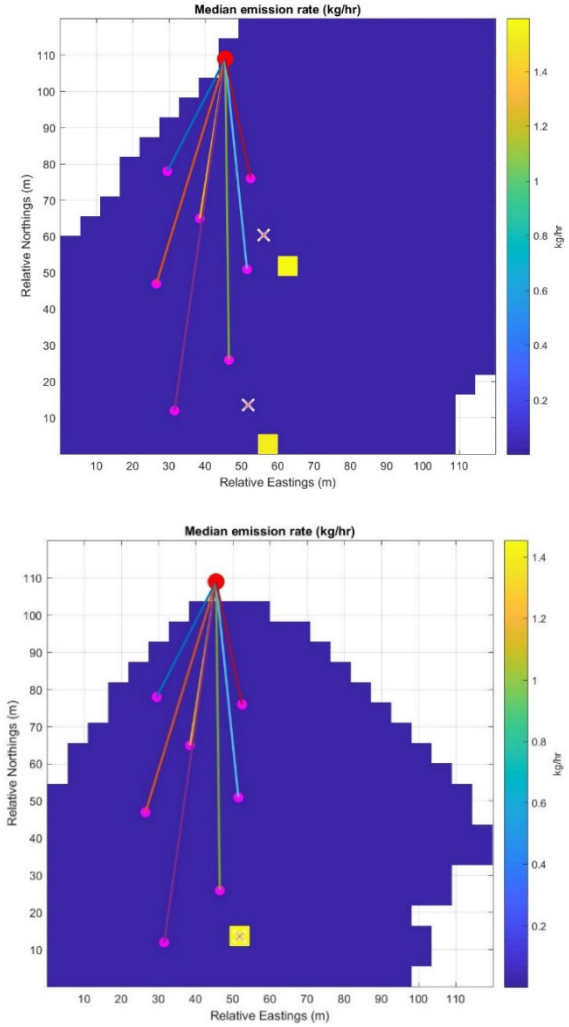

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Miniaturized Remote Sensors

- Molecular gas sensors
  - CO2, CH4, NH3, O3, NO, NO2, SO2…
  - Passive Zenith looking sensors
  - Part per billion sensitivity
  - Minutes temporal resolution
- Possible use
  - Fixed networks for AQ
    - Autonomous sensors network
    - Cal/Val Satellite data
  - Coupling to transport model
    - Fate of pollutant
  - Installation on mobile platforms
    - Convert time into space
  - High altitude platforms over a city

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