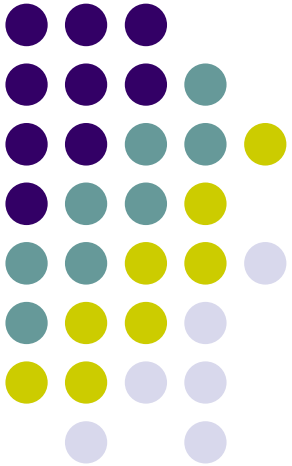
Block Engineering

Quantum Cascade Lasers (QCL)-based Hyperspectral Imaging for Standoff Detection of Explosives



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Advanced Development for Security Applications (ADSA)
Workshop 17: Systems Engineering of Aviation Security Systems

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Introduction

Why Should you Care?

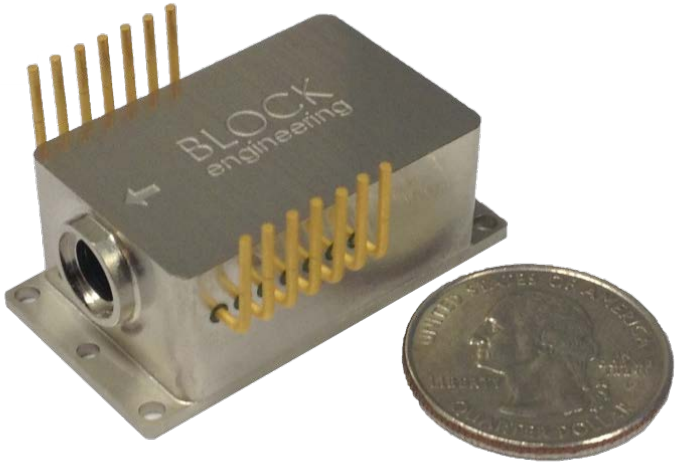
- **Explosives Detection:** Strong need, but also a **significant technical challenge**
- No single technology can provide 100% inspection – need for **Layered Security**
- However, Layered Security causes delays, inconvenient inspections and customer aggravation
- **Standoff Detection** could alleviate many, if not all, of these problems
- However, Standoff Detection has **not yet** lived up to its expectations….

What is our Solution?

- Availability of **powerful, yet eye-safe lasers in the infrared, "chemical fingerprint"** part of the spectrum – Quantum Cascade Lasers (QCLs)
- **Ultra-rapid, laser tuning** across the infrared spectrum
- Highly **sensitive**, **rapid** image acquisition **2D infrared arrays**
- **New**, **sophisticated** data processing and analysis **algorithms**

Block's Standoff Detection technology is being developed under multi-million, government and internal funding

Mini-QCL™ OEM Module



Smallest, External Cavity, Widely-Tunable QCL Module

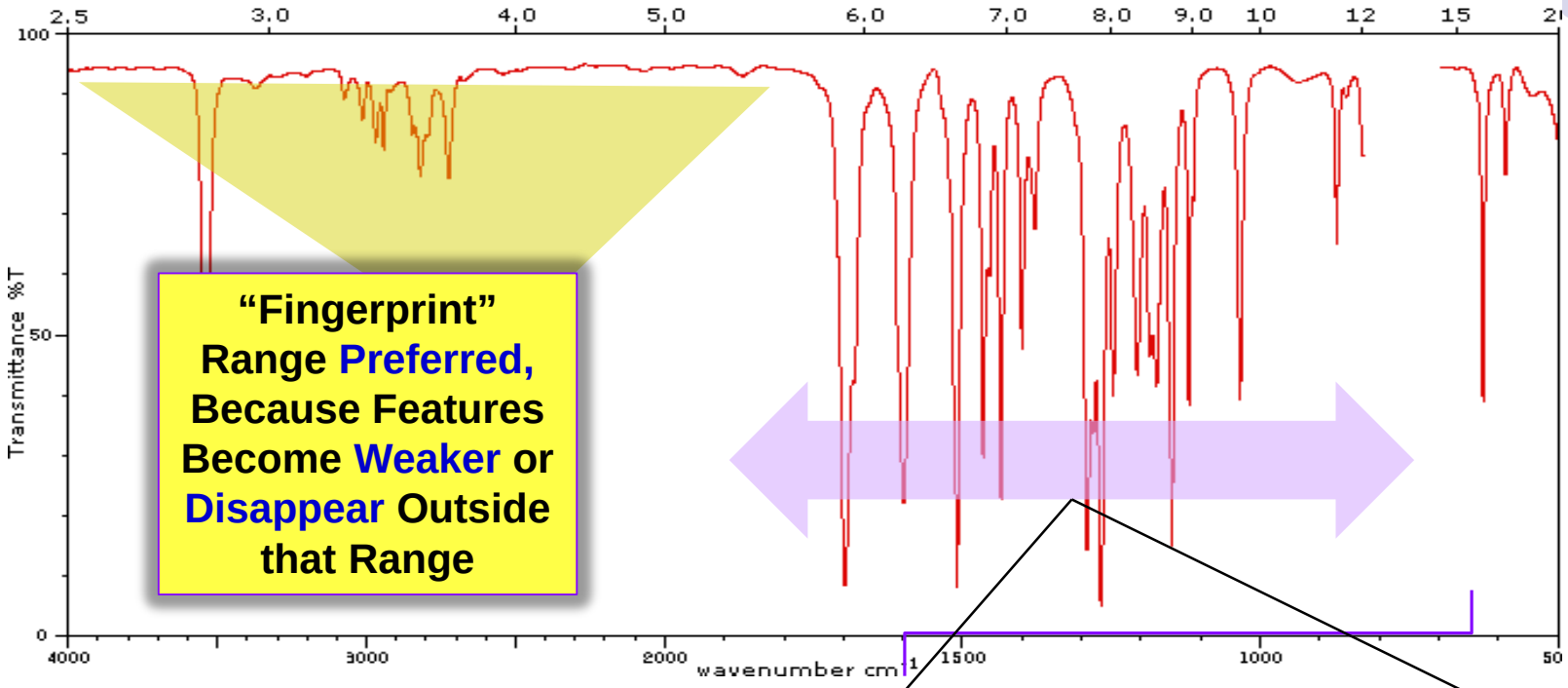
Key Features

- **"Engine" in all Block's QCL products**
- **Ultra-compact, rugged** packaging
- Industry-leading **gap-free** tuning range
  - Each module's tuning range >250 cm^{-1} anywhere in the 5 – 13 µm range
- **Fastest** tuning (sweeps 25 cm^{-1}/msec)
- Excellent **beam pointing stability** (~0.5 mrad)
- Compact and flexible control electronics

Block has been shipping to Customers since October 2013

Mid-Infrared Spectroscopy

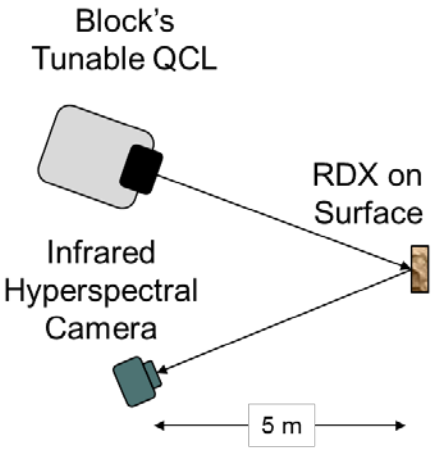
Example of Mid-Infrared Transmission Spectrum

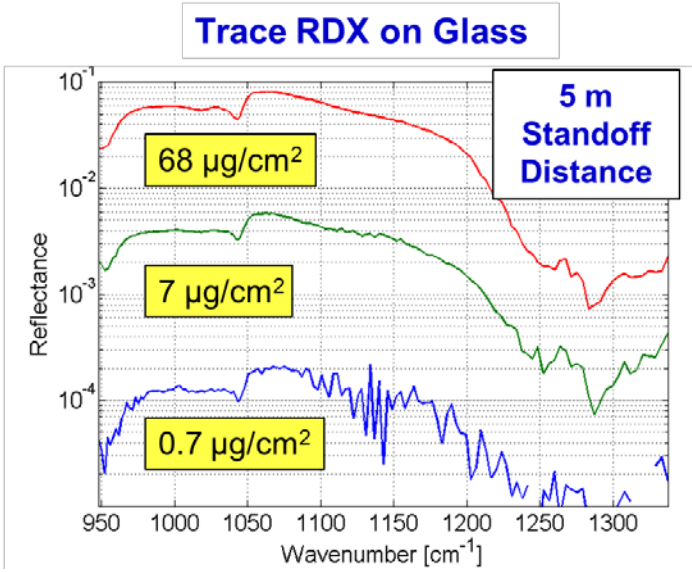


- Block's QCLs cover **5-13µm** – this is called the **"fingerprint zone"**, because most chemicals have unique features there
- Block's QCL spectrometers cover this range **continuously, with no gaps**

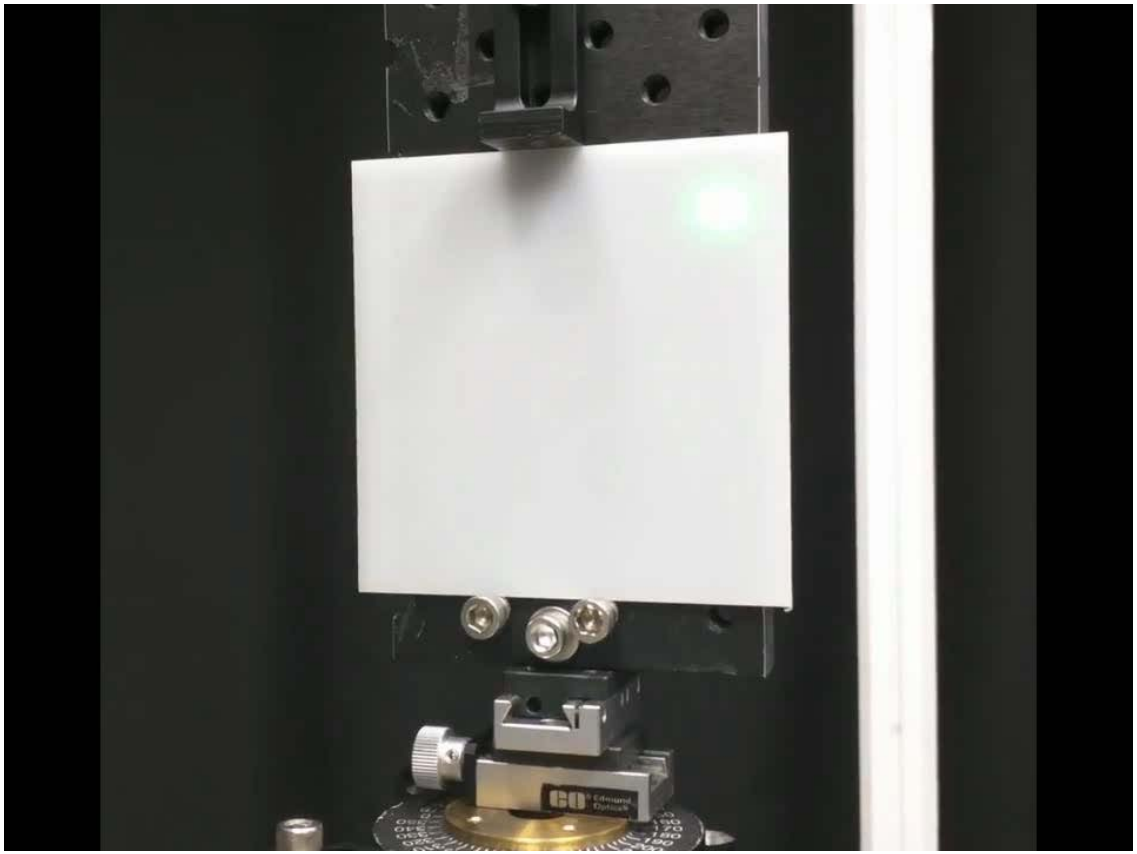
Block's Technology

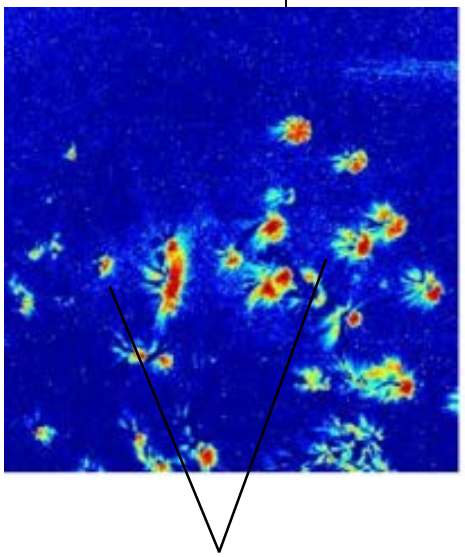
- Technology developed under more than **$35M of government contracts** – most recently a **$9.8M** contract from the Intelligence Advanced Research Projects Activity (**IARPA**) (Block now awarded Phase II, after successful competitive downselection)
- Technology Description: Eye-safe, Quantum Cascade Lasers (**QCLs**) scan in seconds the target from standoff distances (5-50 m) and the reflected light is analyzed using a decades-long, validated technology, called **Mid-Infrared Spectroscopy** – each explosive material has a unique characteristic in the Mid-Infrared spectrum (5-13 microns), so a "fingerprint"-like detection is accomplished by comparing to a built-in library of thousands of materials
- Current technical achievement: **Trace detection in 5 sec at 5 m standoff**
- Projected at the end of the IARPA program: **50 m standoff**





Current Laser Scanning at 5 m Standoff



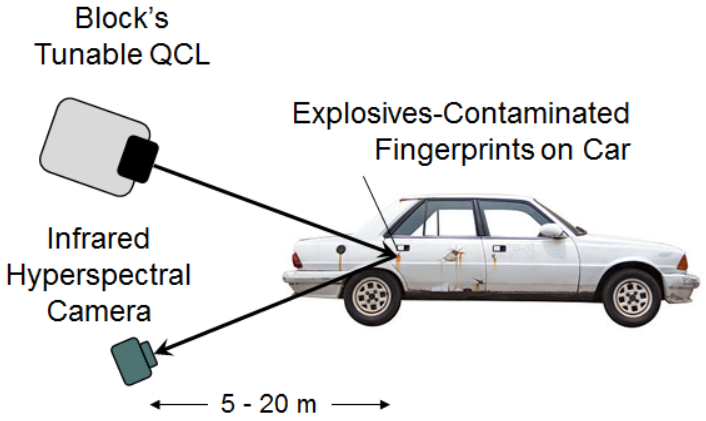


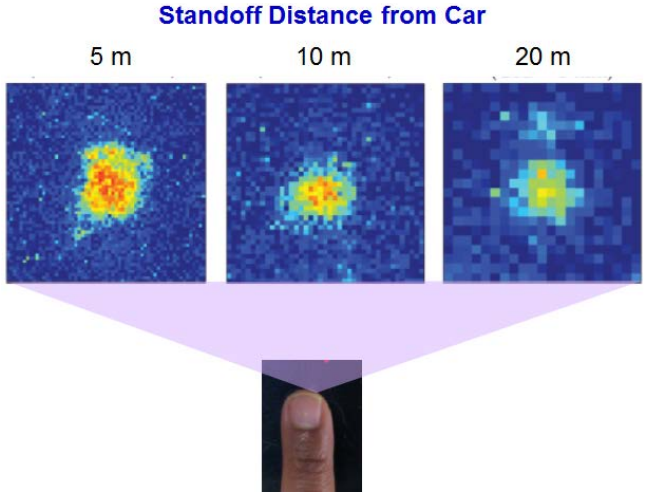
Trace Explosives on Surface

Through IARPA and using a similar setup, Block has just completed Trace Detection tests with excellent results to address a significant, newly presented Terrorism Threat

Demonstrated Performance

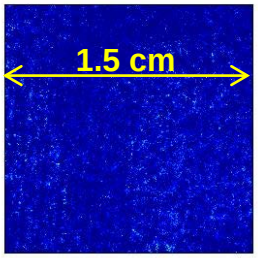
Standoff Detection of Explosives-Contaminated Fingerprints on Cars



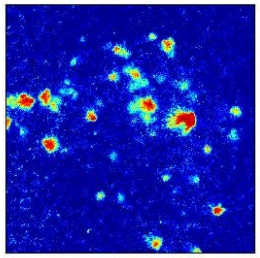


Detection of Potassium Chlorate ($KClO_3$) Particles on Fabric

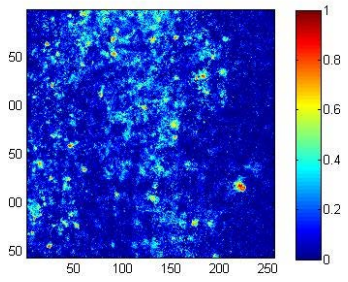
Clean Fabric



Coarse $KClO_3$ Particles



Fine $KClO_3$ Particles

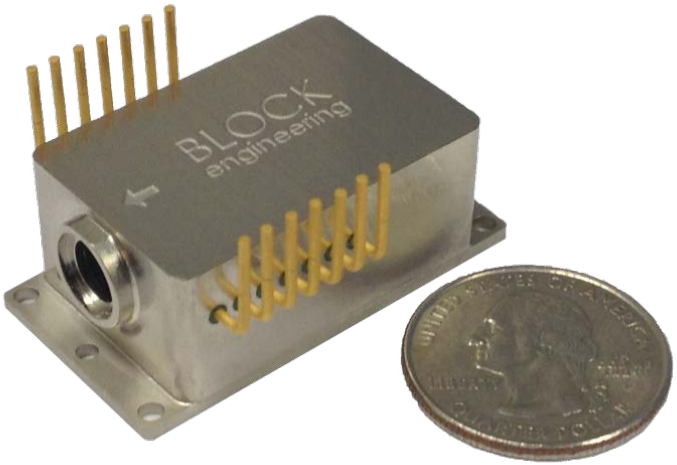


From: Goyal, et al., "Active Infrared Hyperspectral Imaging of Solid Particles on Surfaces", SPIE DSS 2013

Dr. Goyal is currently VP of Technology at Block Engineering

Specific Features

- Standoff Distance: Currently **5 m**, goal is **50 m**
- **Gaseous, liquid, solid** chemical threats can be detected – essentially all chemical threats have spectral features in the "fingerprint region"
- False alarms can happen due to background interferents and clutter – Block is focusing **heavily on algorithms** development
- Tested with **government** supplied and validated samples
- First prototypes can be deployed in **12-18 months**
- Additional topics:
  - Dirty/Contaminated Environments: Block is developing unique algorithms
  - Denial of Service: Need optical access, but covert detection is possible
  - Lack of Material to Sample: Need at least trace amounts on surfaces
  - Operator Compliance: Automated operation, no need for training



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