

# Modulating Retro-reflectors for Free Space Optical Data Transfer Using Multiple Quantum Well Technology

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**Objective:**

To transfer data, optically, between a flyer and a ground station, or large platform, without the need to fly a laser or pointer/tracker.

**Approach:**

Combines an optical retro-reflector and a multiple quantum well (MQW) shutter to modulate a laser beam that is incident on the flyer (Fig. 1).

**Advantages:**

- The MQW modulator is lightweight, compact, and it requires little power (~50 mW per shutter);
- Data rates of 10 Mbps and higher may be supported;
- No pointing and tracking is required on the flyer when payload is configured as an array;
- The communication link is jam resistant and covert;
- Technique provides significant frequency allocation relief over radio frequency carriers.

**Typical applications:**

- UAV to Ground (Fig. 3)  
Surveillance from an unpiloted airborne vehicle
- Air or Space-to-Covert Ground Sensor (Fig. 2)  
Remote interrogation of sensors
- Space to Space (Fig. 4)  
Configuration Management and MicroSat Communications
- Ground-to-Space  
Laser Communication and Surveillance via satellite
- Telecommunications - The Last Mile

**NRL Ground to UAV Demonstration**

- UAV
  - A small (1 meter long) helicopter carries a modulating retro (Figs. 5,6)
  - The UAV is illuminated by an unmodulated laser beam from the ground station.
  - A bit stream is converted to a digital voltage signal which modulates the incoming light beam by switching the quantum well shutter on and off.
  - When the shutter is open the retro-reflector automatically sends the light beam back to the ground station with no need for pointing/tracking (Fig. 6)
- Ground station
  - A motorized gimbal controlled by a tracking camera holds a laser diode, 5 cm diameter telescope and a photodetector
  - The ground station tracks the UAV and illuminates it with the laser.
  - The ground station also receives the retro-reflected signal.

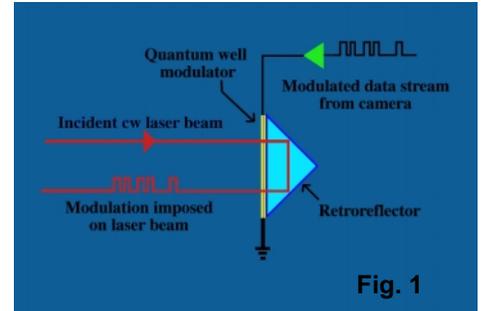


Fig. 1

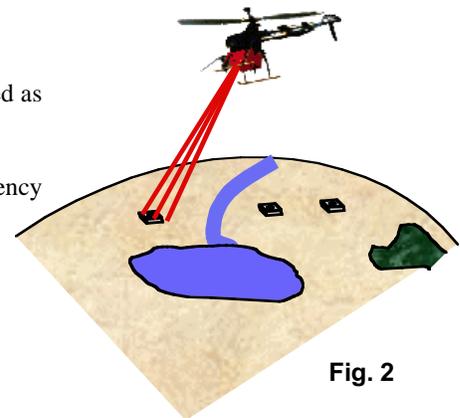


Fig. 2

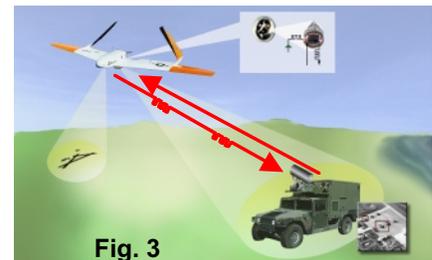


Fig. 3

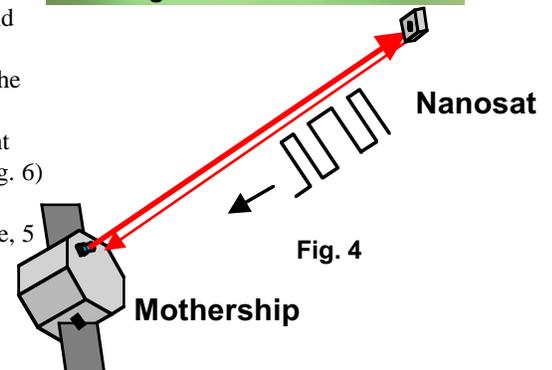


Fig. 4

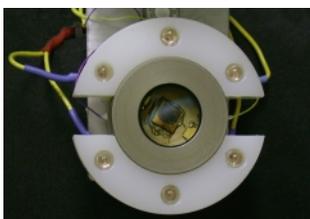


Fig. 5

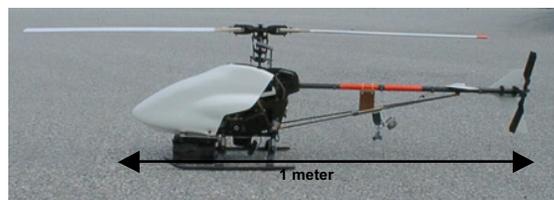


Fig. 6

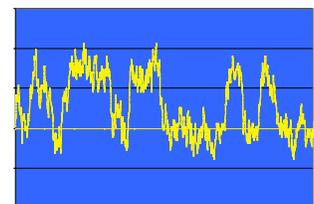


Fig. 7