Micro LADAR and Raman Spectral LADAR for Inspection

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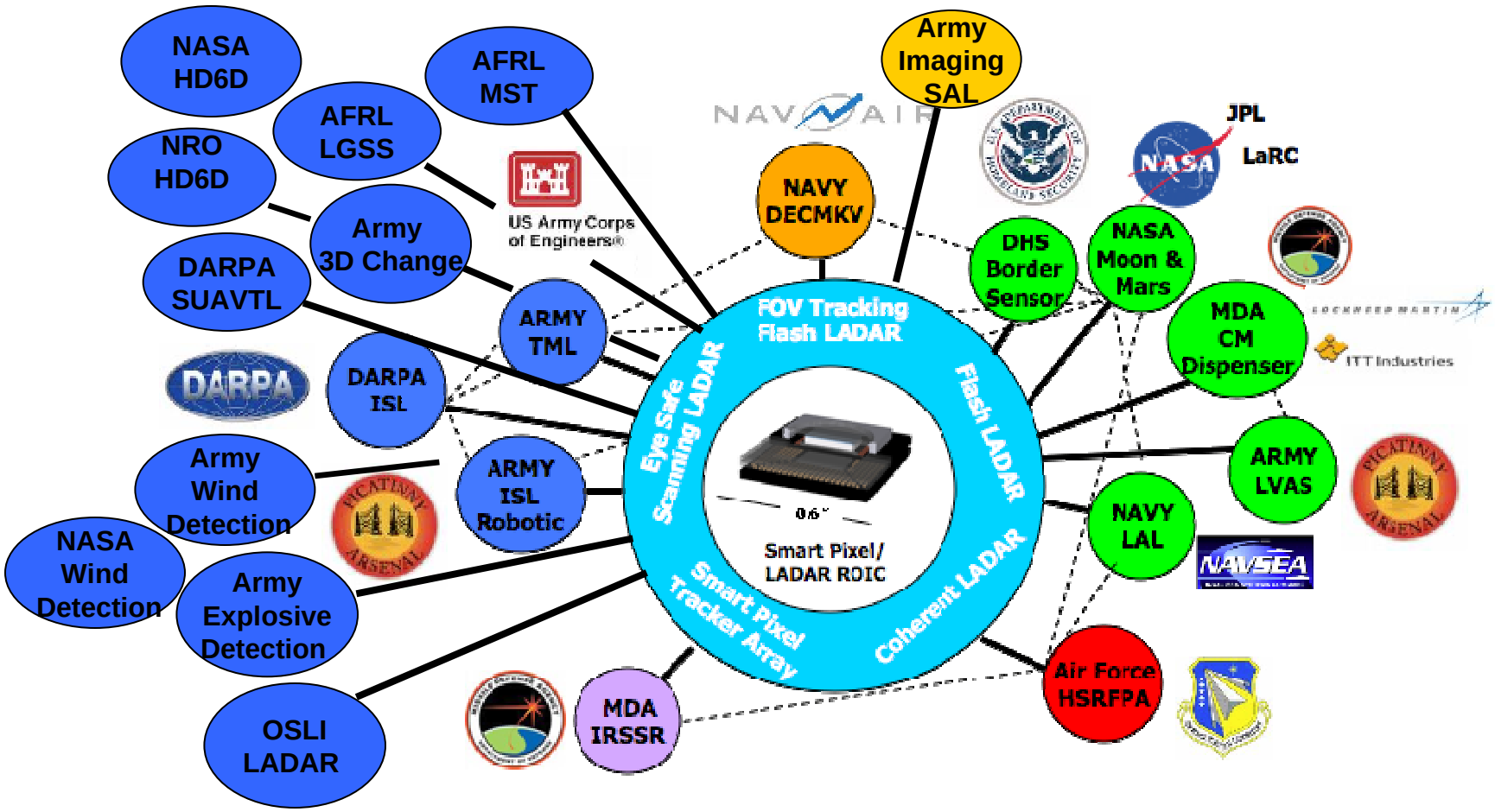
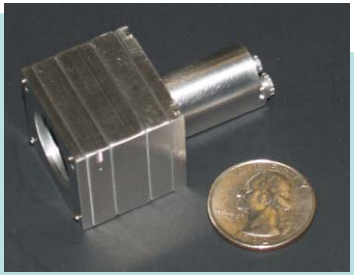
LADAR Family Overview

SPEC's Multi-Dimensional Imaging Programs



Scanner/Telescope Family

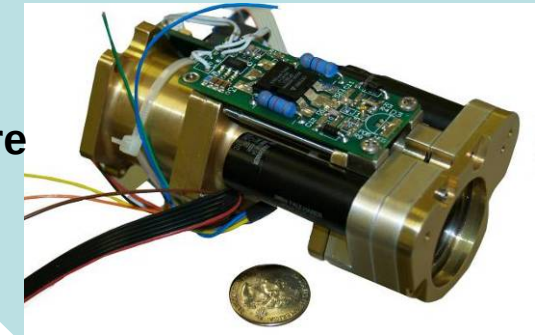
Micro LADAR
10mm aperture



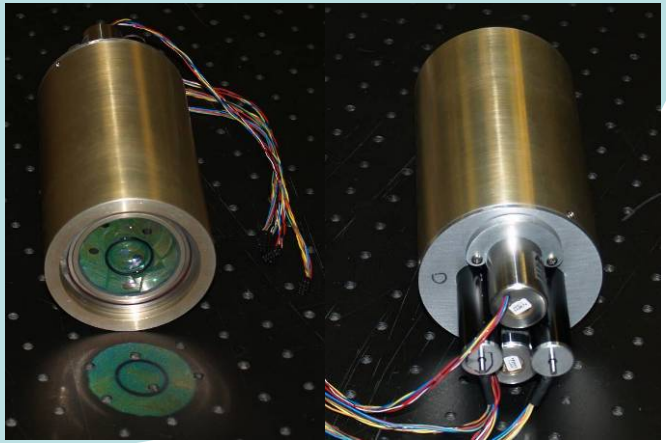
ISL LADAR
18mm aperture

- **Risley Prism Scanners**
- **Cassegrain Receive Telescope**
- **Coaxial Laser Collimator**

Gen I LADAR
25mm aperture

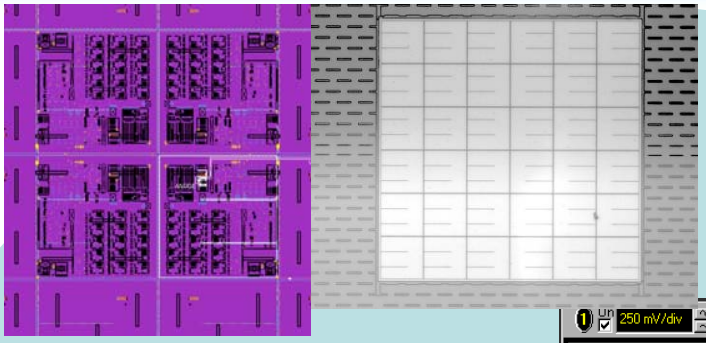


Gen IV LADAR
50mm aperture



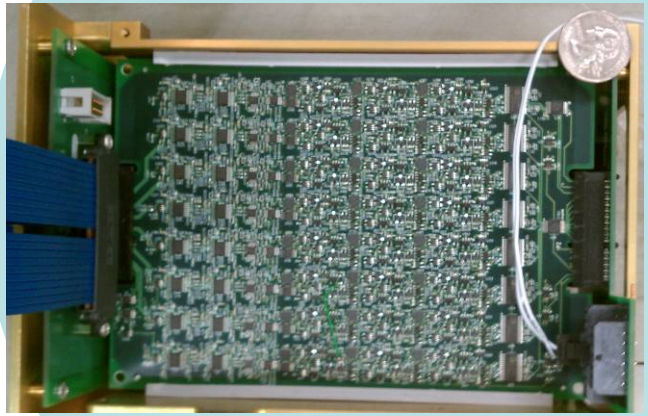
LADAR Receiver Family

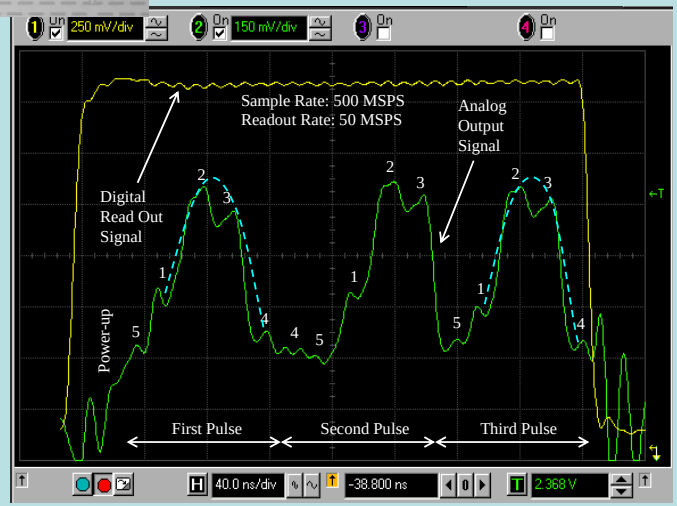
ROIC
NASA
100μx100μ Pixel
15 S&H
800 MSPS
1K Fame/sec



- **Detect First 3 Objects in Range**
- **Capture Waveform**
- **Enhanced Range Accuracy by Deconvolution**

Analog
Gen I
19.35 cm²/channel
9 S&H
55K Frame/sec

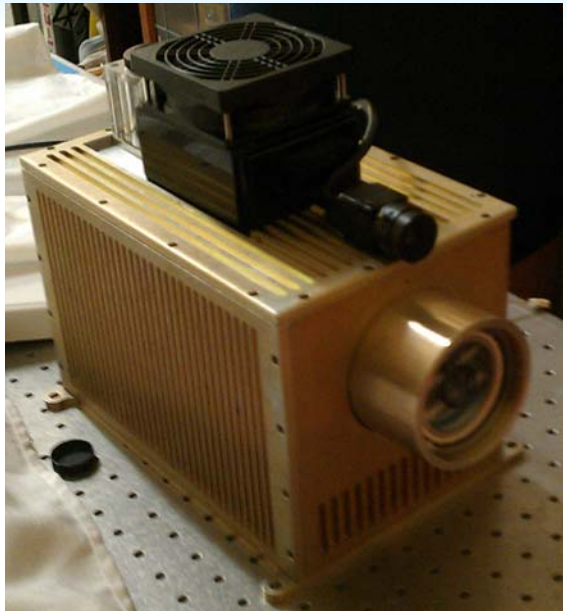




MCML, Pipeline Processing
Gen IV
4.83 cm²/channel
24 S&H
300 MSPS
400K Frame/sec

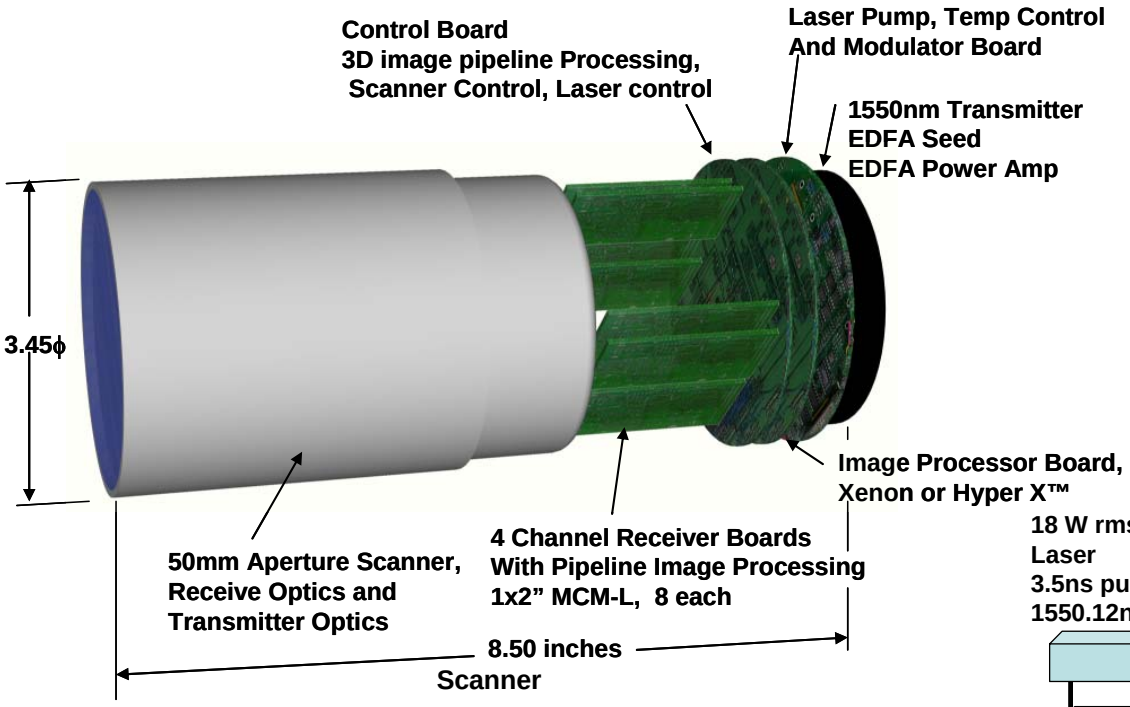
HD6D LADAR Details

HD6D Gen IV LADAR Bench and Aircraft Configuration

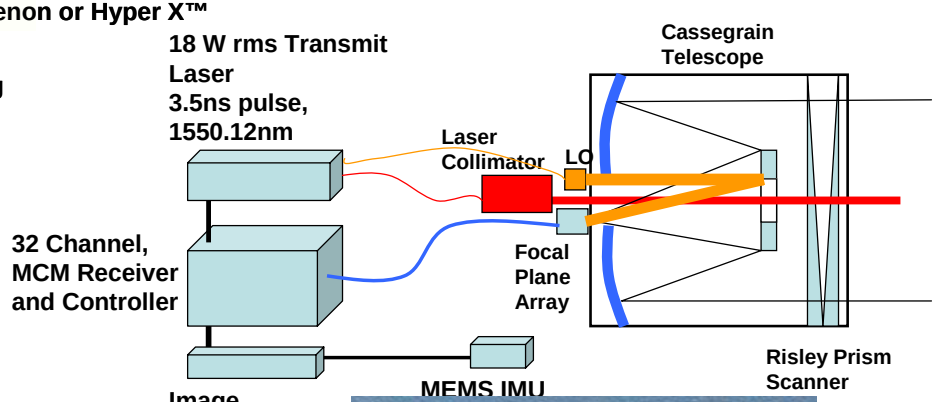


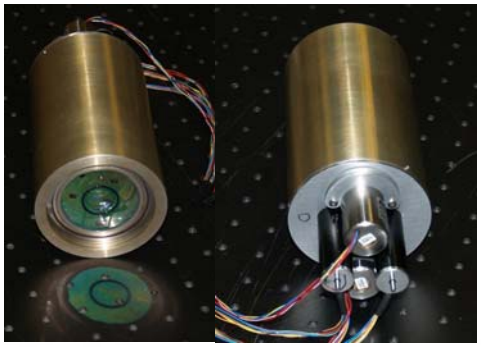
- 12.8M Pixel per second
- 30° FOV
- 0.7mr pixels NRO & OSLI, 0.15mr LGSS
- 3.0 W rms LGSS, 25W rms OSLI
- Final size scanner & receiver boards, output FPGA and processors non miniaturized for ease of software development
- 7.38x7.0x11.0 inches
- Vector Nav Inertial Navigation Included
- Sentech USB3 RGB 5Mpixel camera, bore sighted

Fully Miniaturized Gen IV LADAR (HD6D)



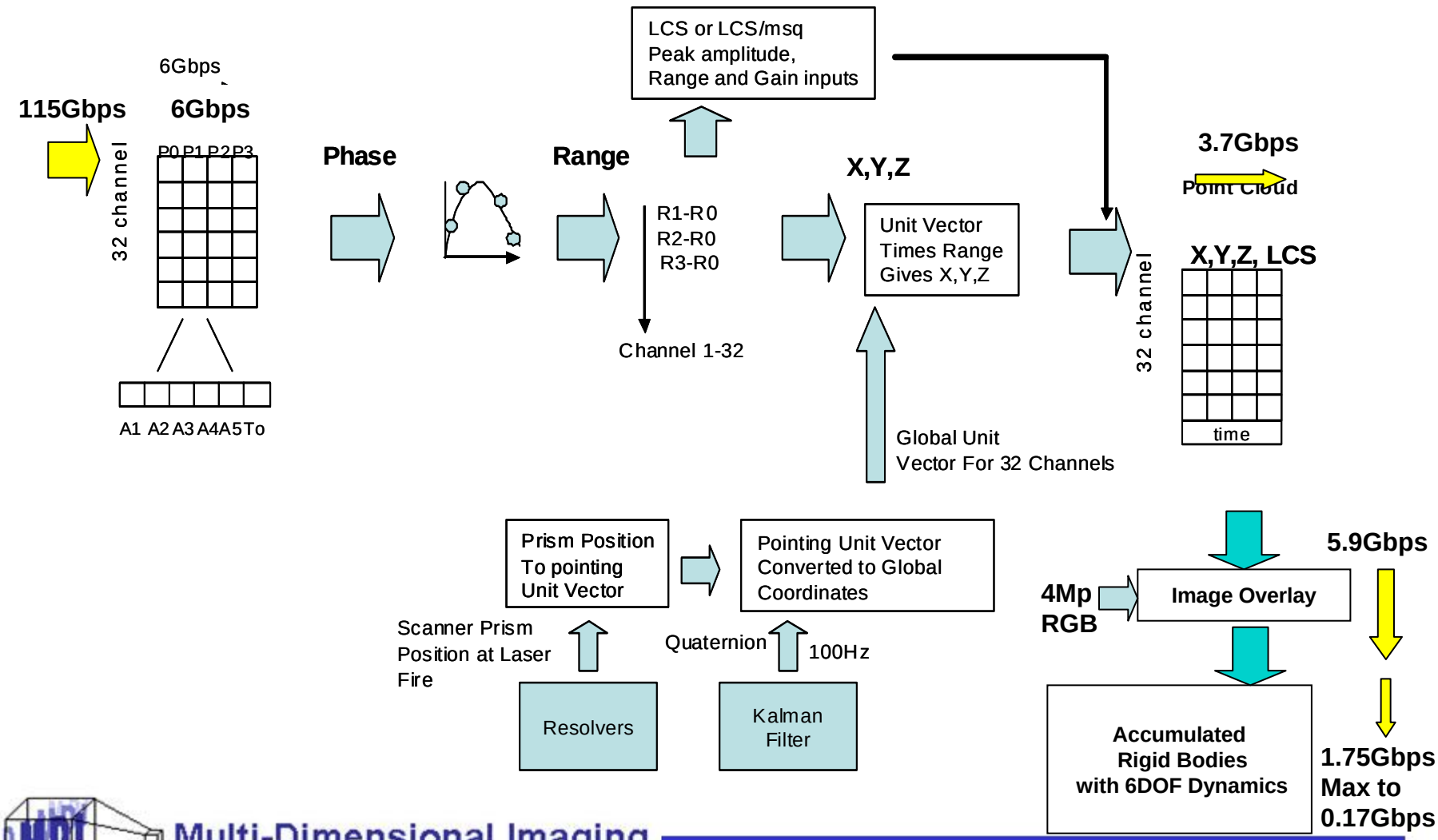
- 12.8M Pixel per second
- First 6 targets in range
- Capture receive waveform
- 3mm range accuracy
- Pixel size 0.7mr to 0.15mr
- Scan FOV 30° to 90°
- Zero net angular momentum
- Range to 30km vacuum, 5km rain
- Pipeline processing receiver





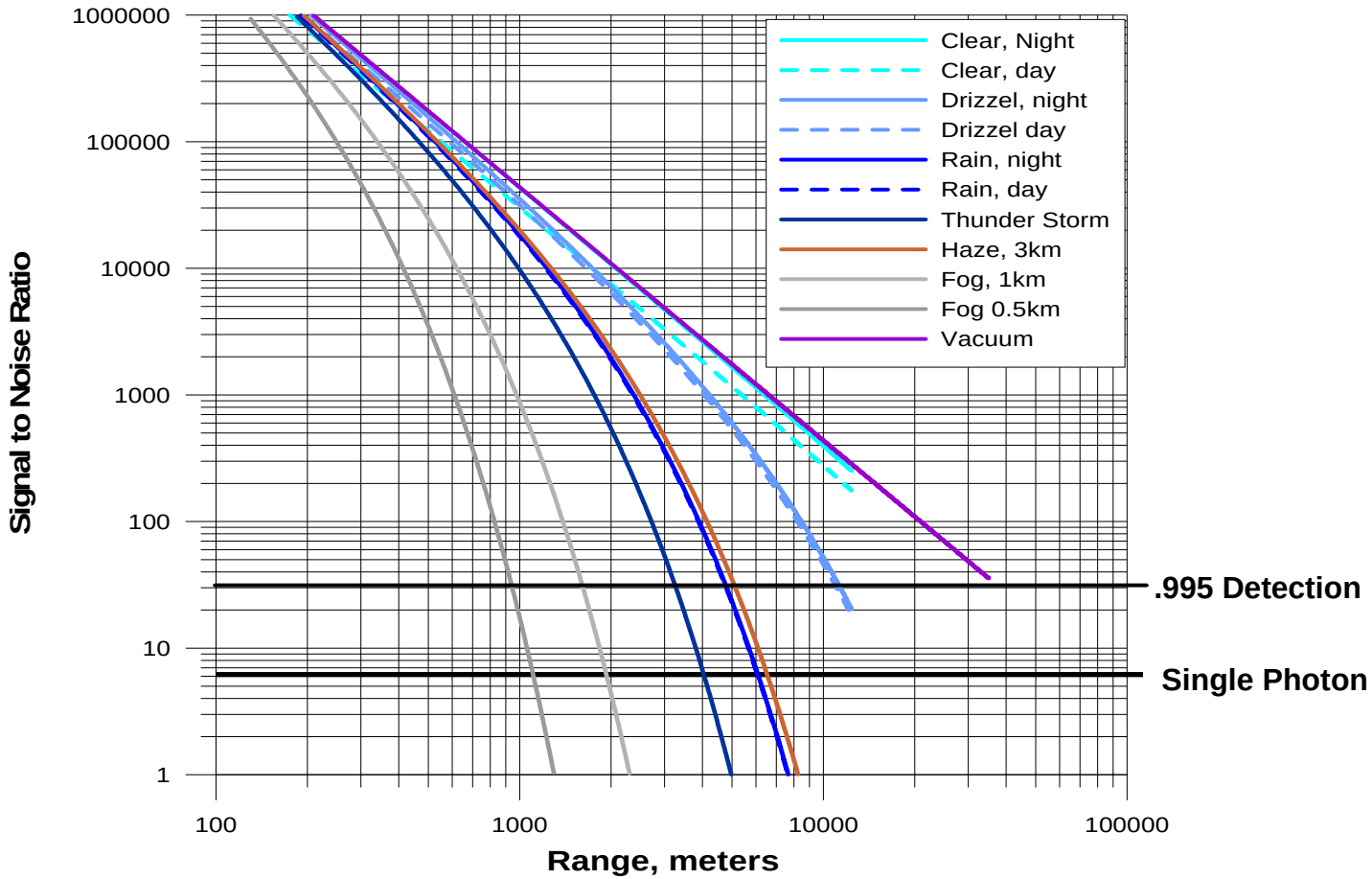
Receiver MCM-L Board

Pipeline Processing Software and Data Flow

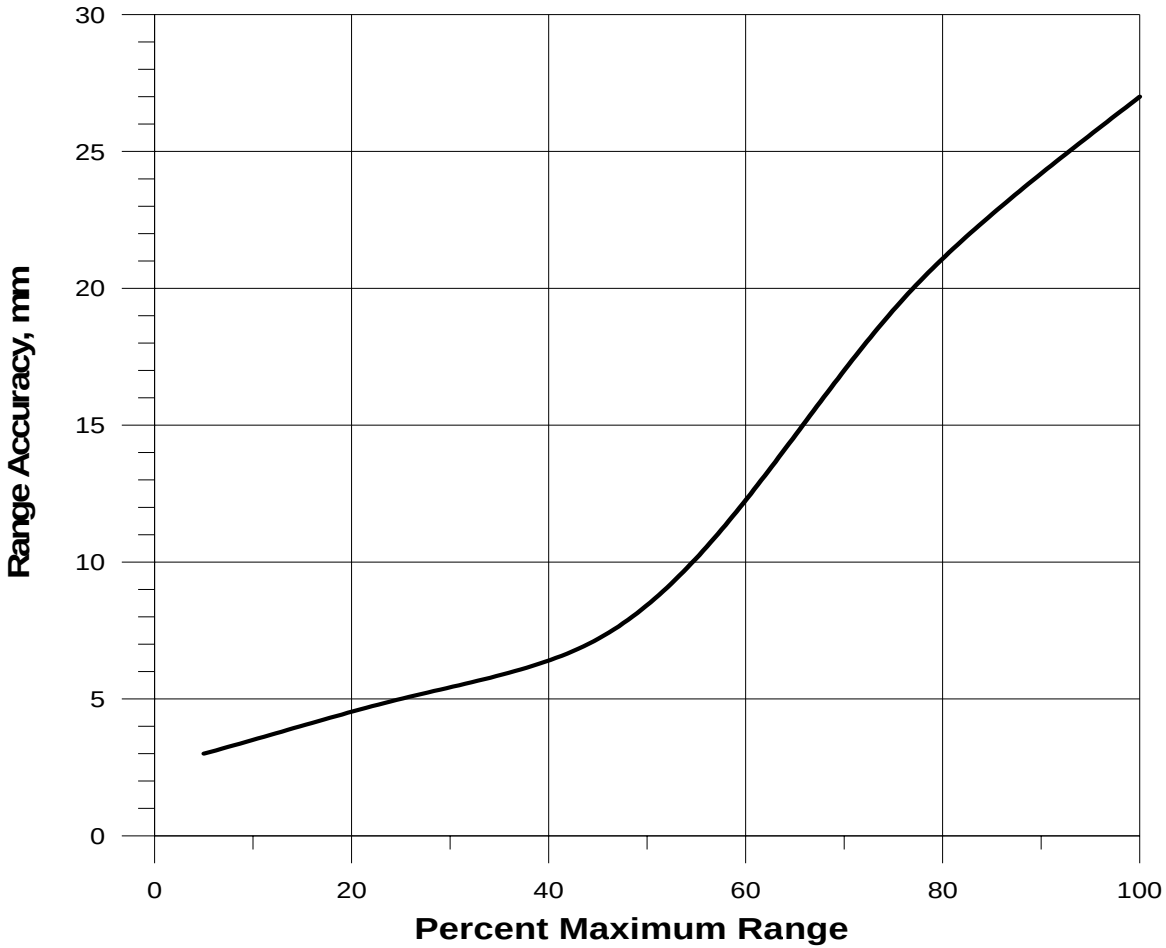


Gen IV LADAR (HD6D) Range

0.1 Reflectivity Target, Perpendicular to line of sight



Range Accuracy vs. Range



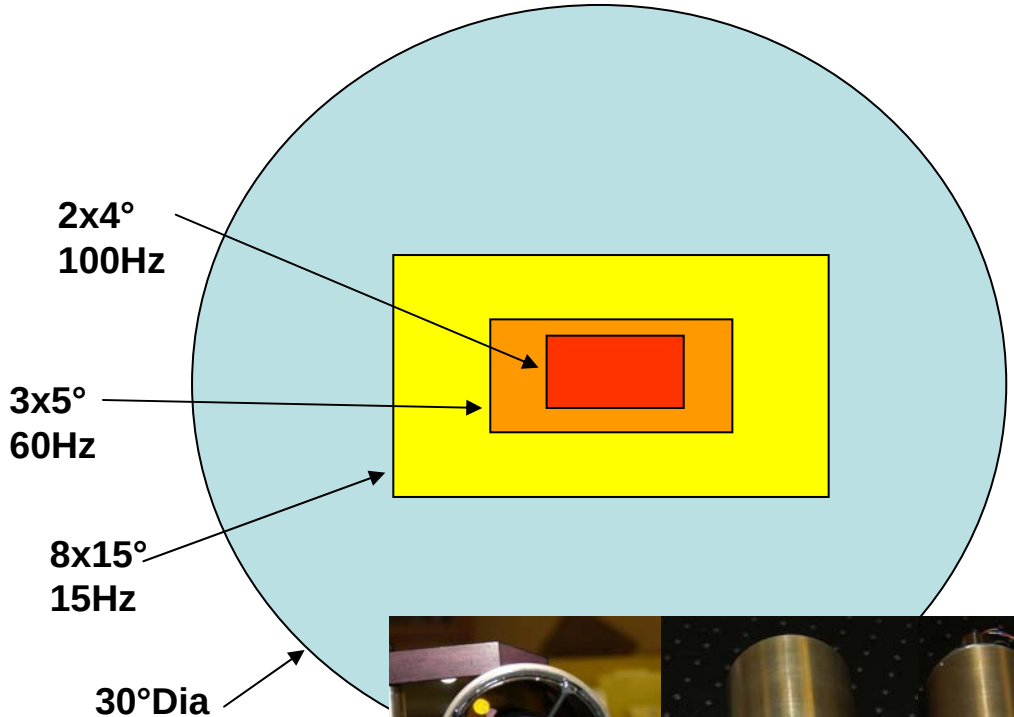
Close Inspection, Complex Waveform Range Accuracy

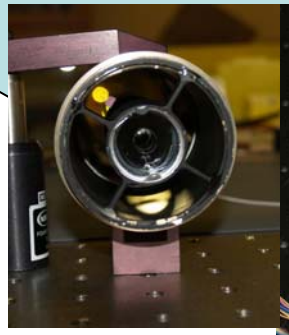
Variable Frequency Modulated Long Pulse Waveform

- **Enables high range accuracy at close ranges (>10 feet)**
- **Accuracies of 15 microns in range demonstrated**
- **Only senses the first object in range**

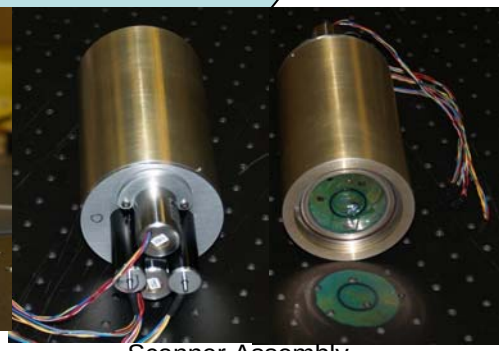
Scanner / Receive Optics Details

Foveal Scan Pattern, 2 Prisms





Internal Cassegrain



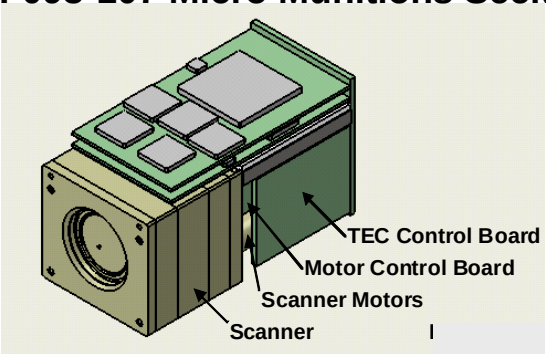
Scanner Assembly

- Flying Frame scan with frame sized optimized for maximum range and pixels per second.
- Foveal Scan allows fast framing center with outside situational awareness
- Foveal Scan is constant velocity counter rotating 2 prism scan tuned to zero net angular momentum
- Isolation rings on prisms gives 54dB isolation transmit to receive, allows sub 1m minimum range.
- Total FOV can be up to 90°+
- Resolvers indicate pointing position to 0.015mr

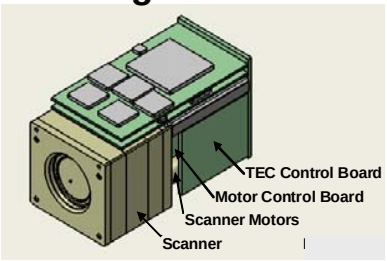
Micro LADAR Details

AF093-107 Micro Seeker Technology Program

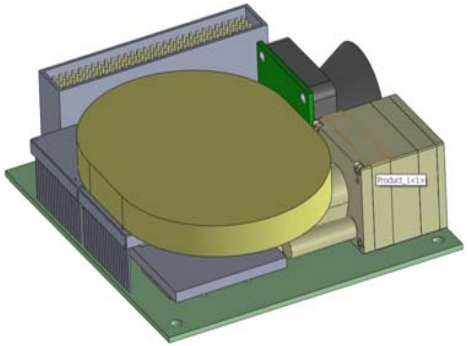
AF093-107 Micro Munitions Seeker, 3 cubic inch



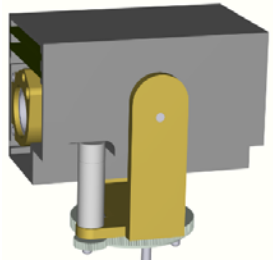
Beyond GPS Navigation



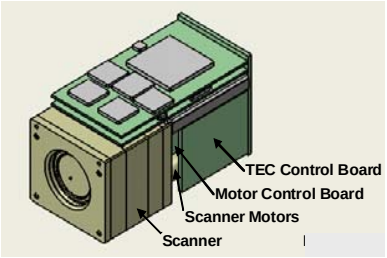
GEO Cube Sat HD3D



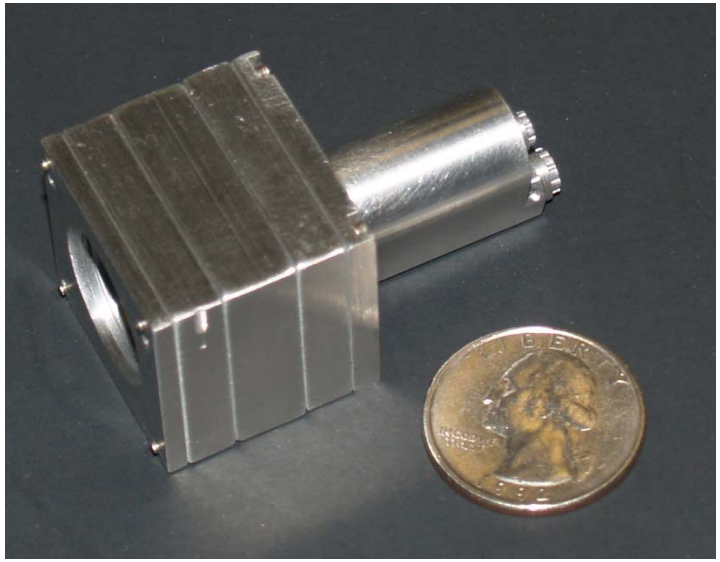
Micro UAV LADAR



1 Shot Counter Sniper Cross Wind Detection



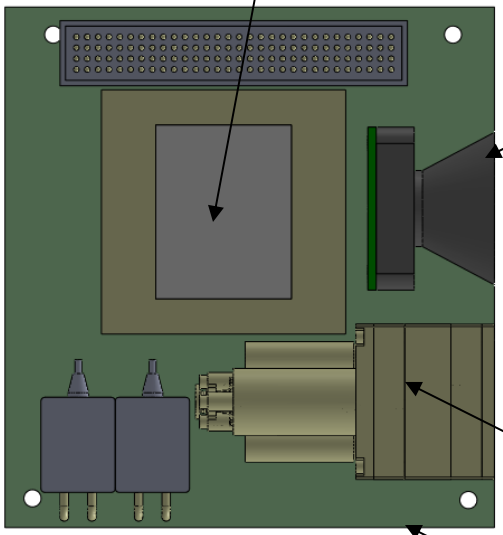
Micro LADAR Hardware

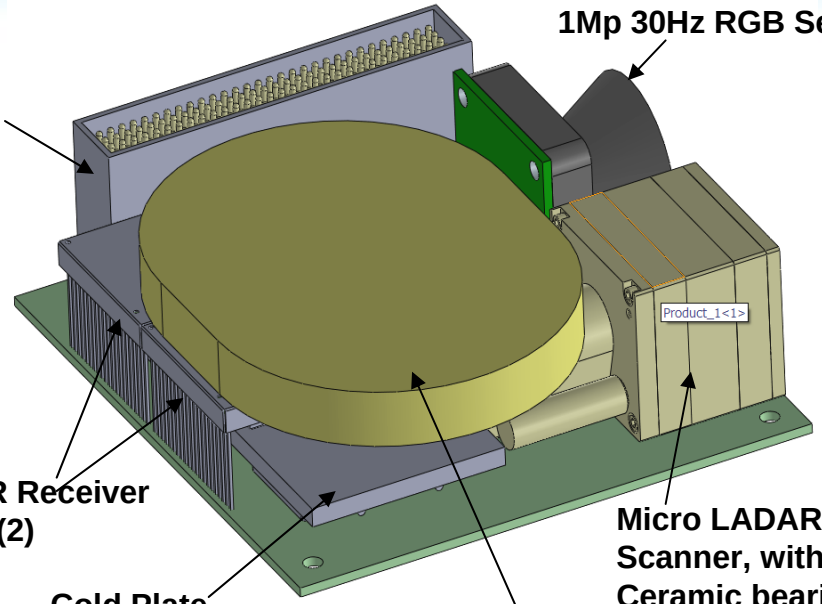


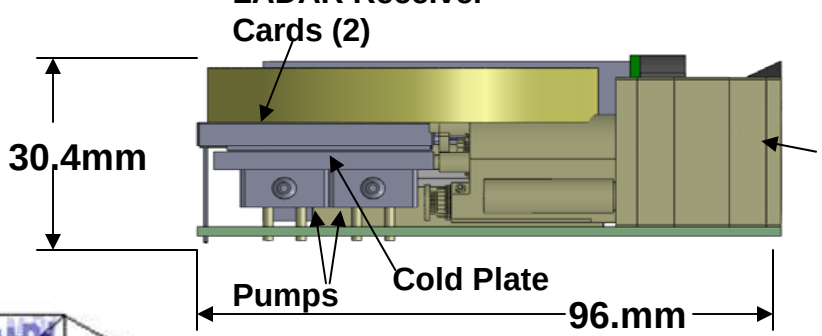
Micro Seeker LADAR Scanner

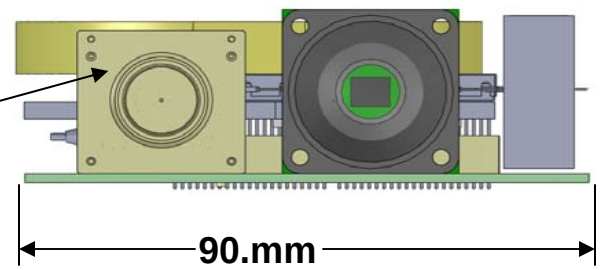
Micro Seeker LADAR 4 Channel Receiver Board

Micro LADAR Adapted for GEO and Cube Sat.

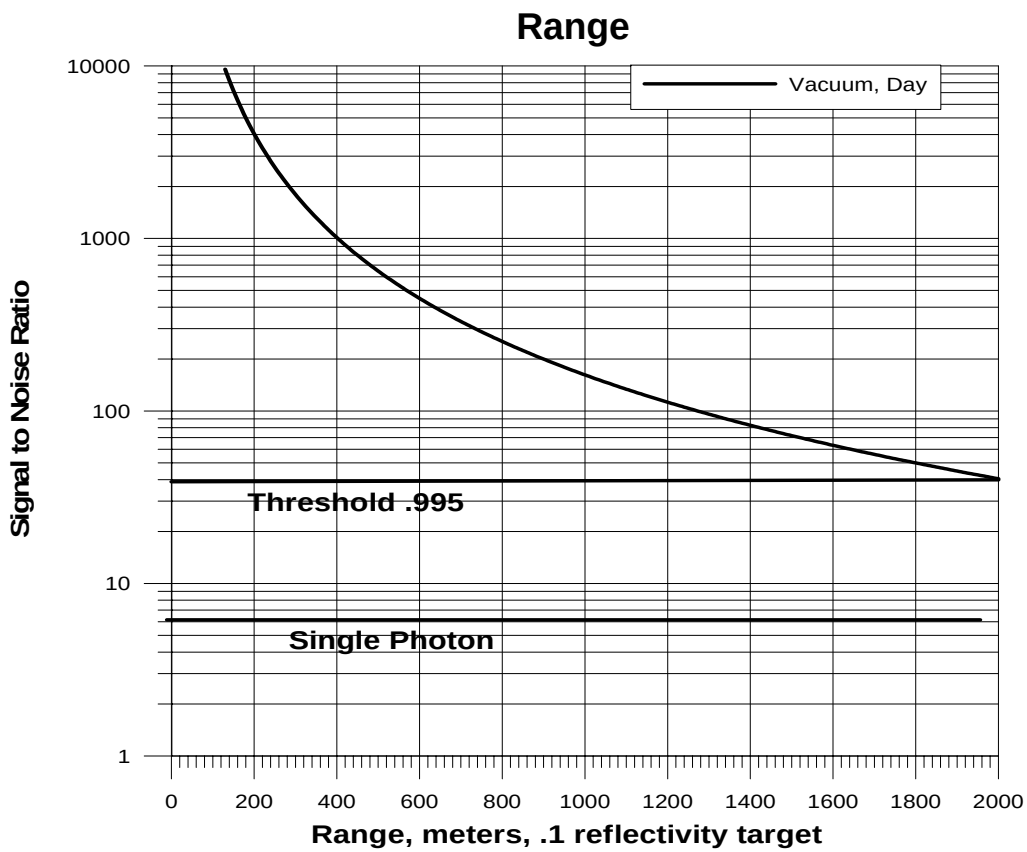




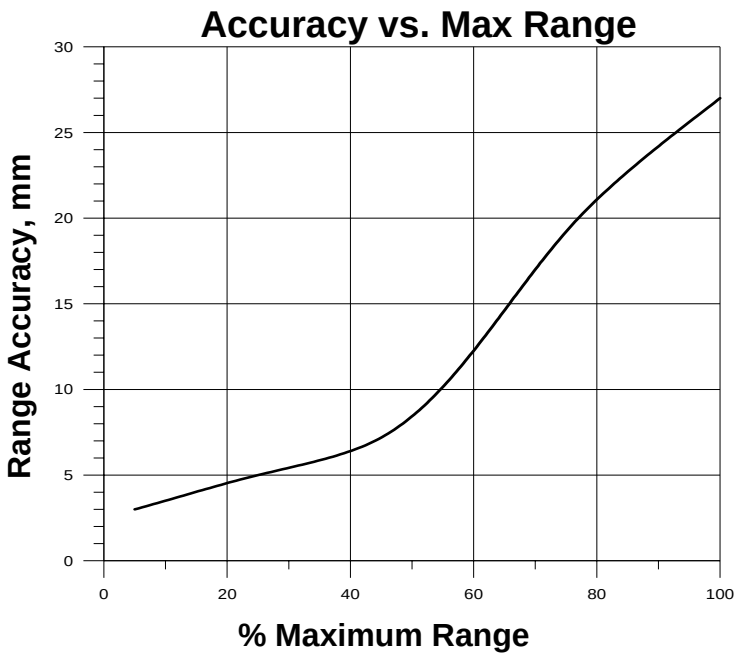




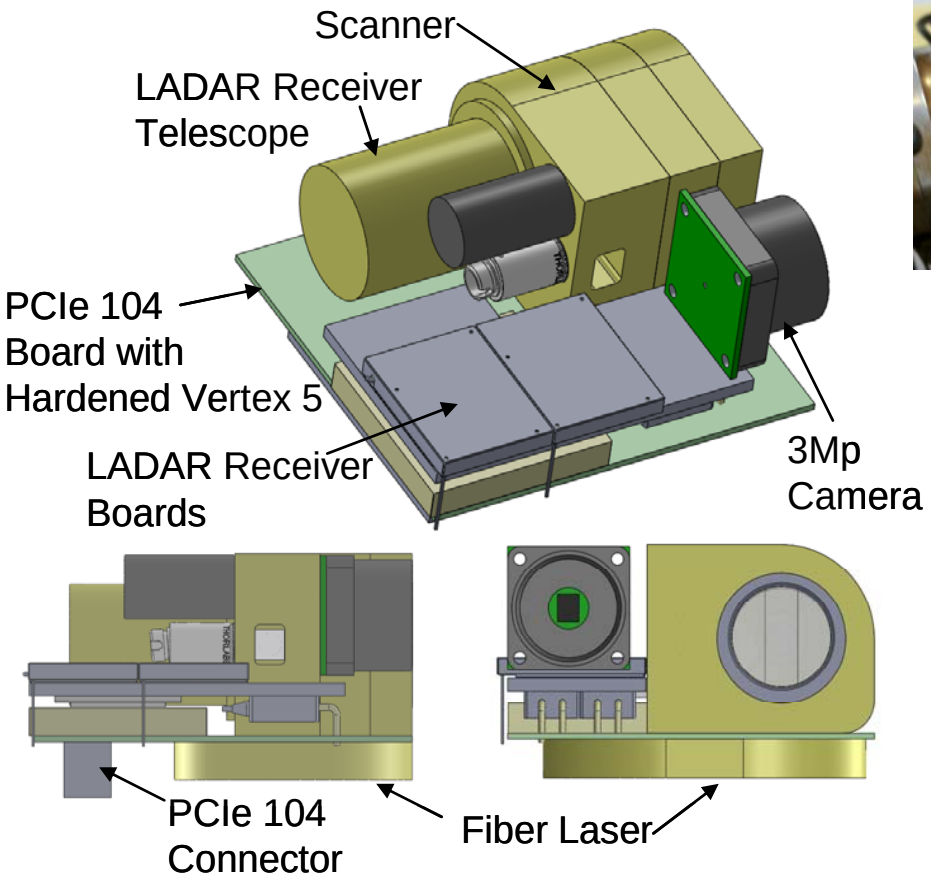
Micro LADAR Range, Fiber Laser 1550nm Pulse SOA/InGaAs APD Sensors

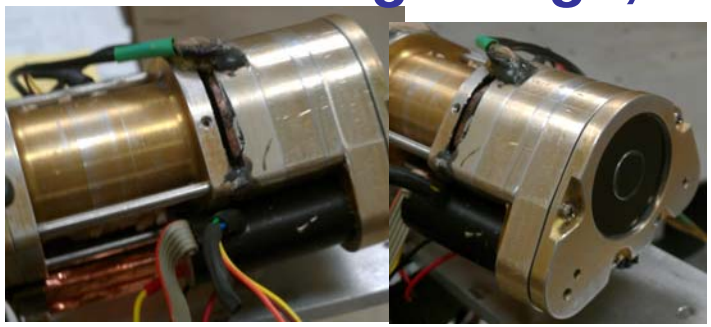


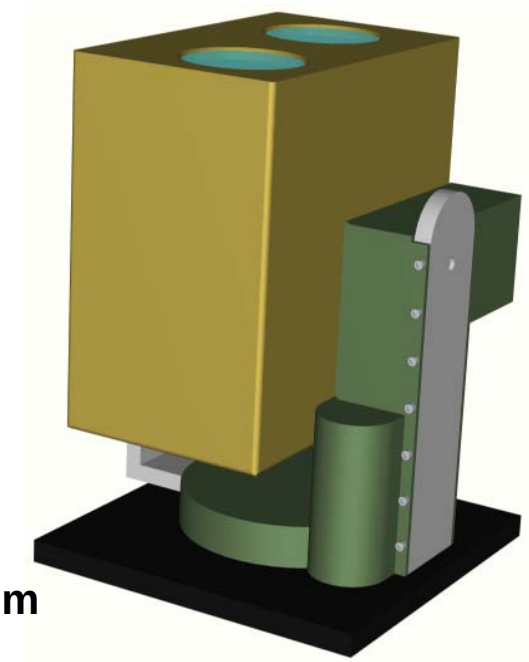
- **1.6M Pixels per second**



Micro LADAR with 25mm scanner
Adapted for GEO and Cube Sat. Long Range, .5U



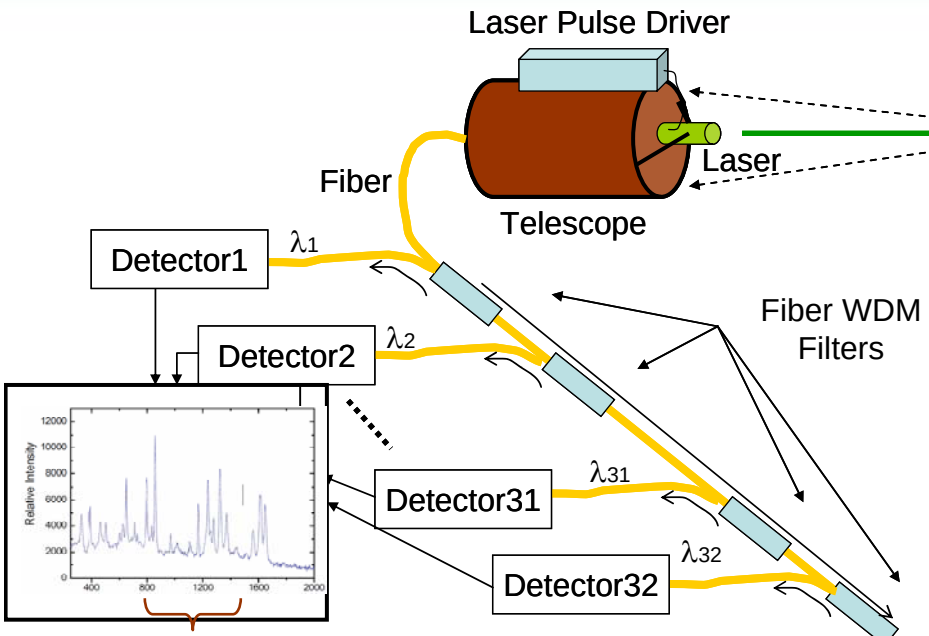




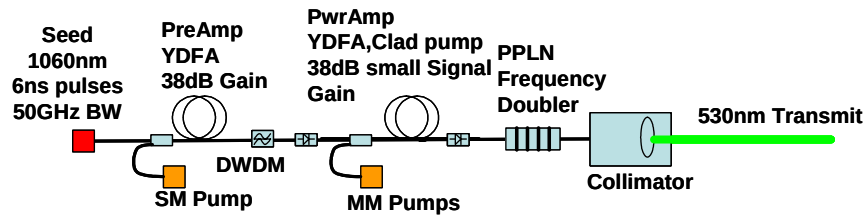
- **5 Km range in Vacuum**
- **3.2 Mpps**

Raman Spectra LADAR Details

Raman Spectra LADAR

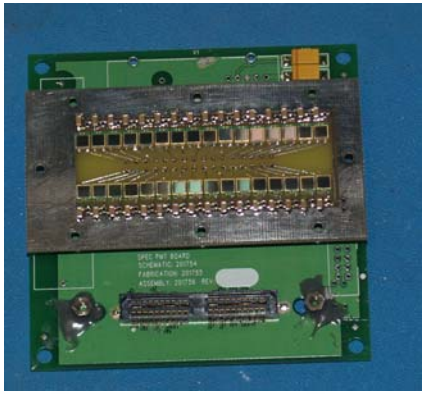


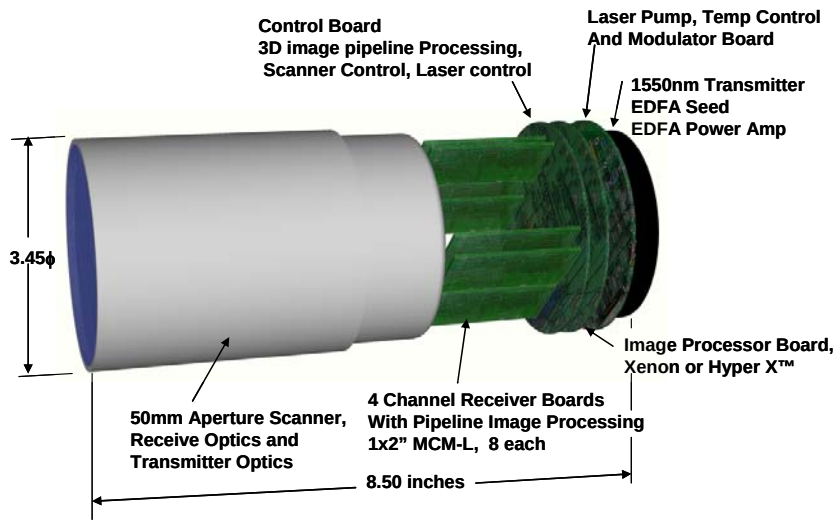
32 Ch Raman LADAR



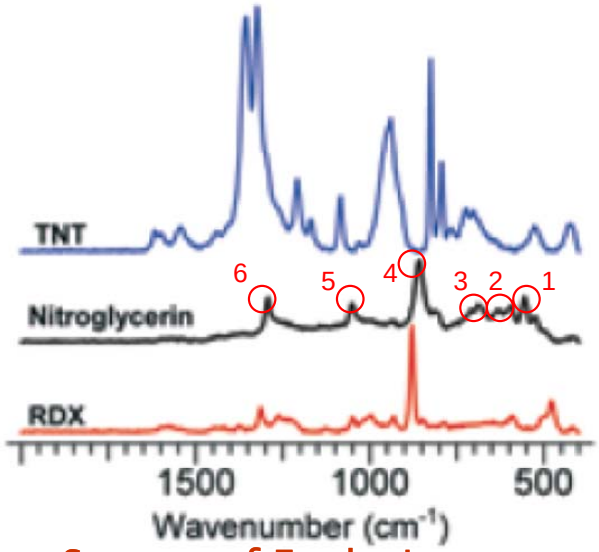
Fiber Laser Transmitter

32 Channel SiPM Sensor Card





Raman Spectra LADAR, Explosive Detection



Spectra of Explosives

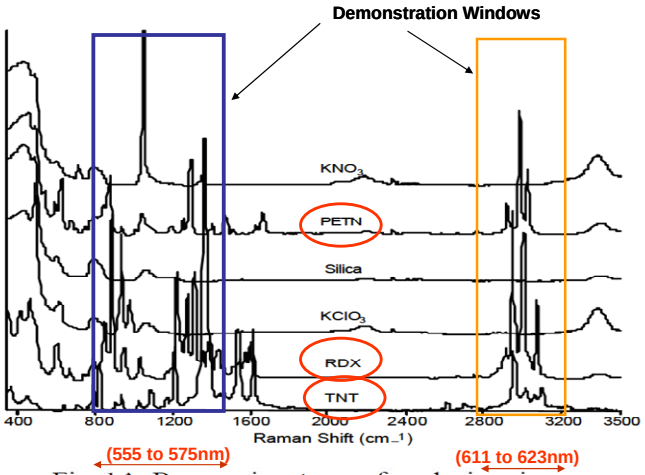
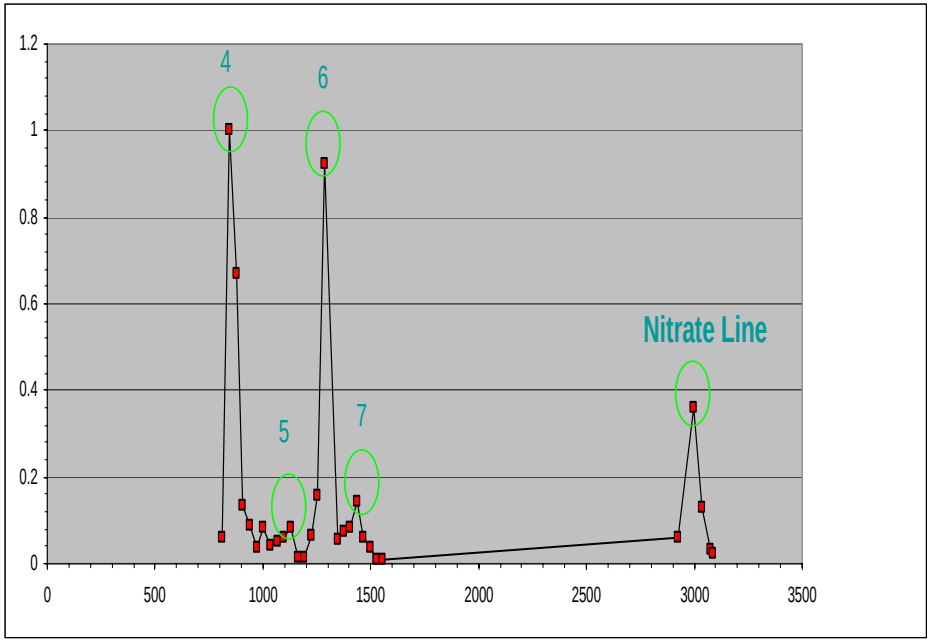
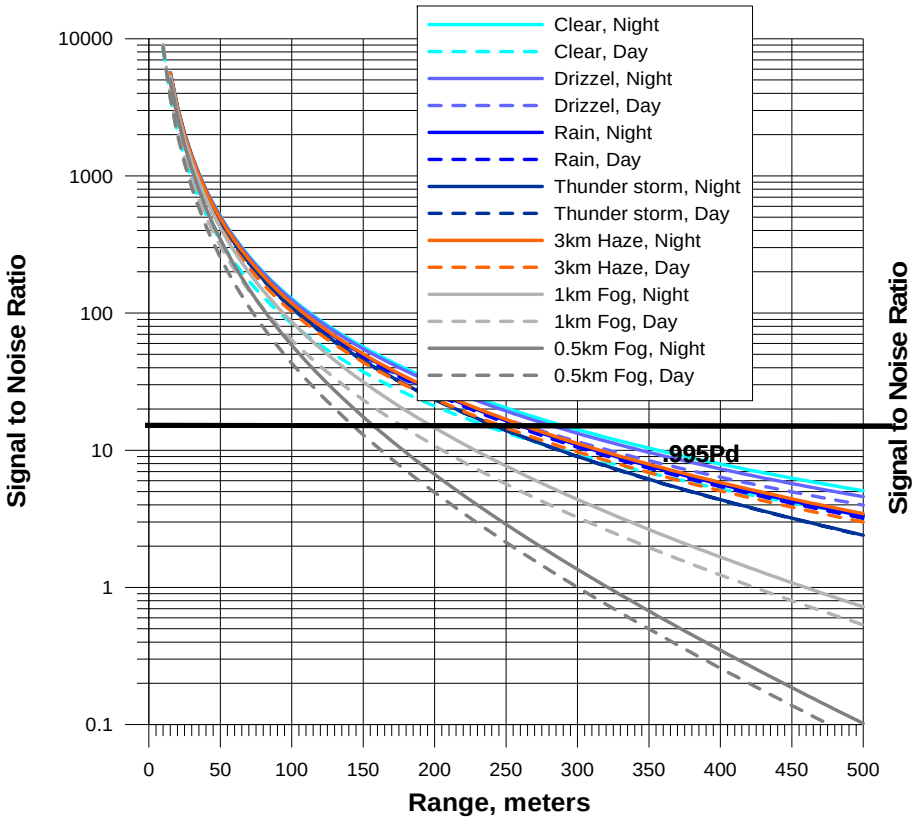


Fig. 1A. Raman signatures of explosives in a silica background (532 nm laser excitation).

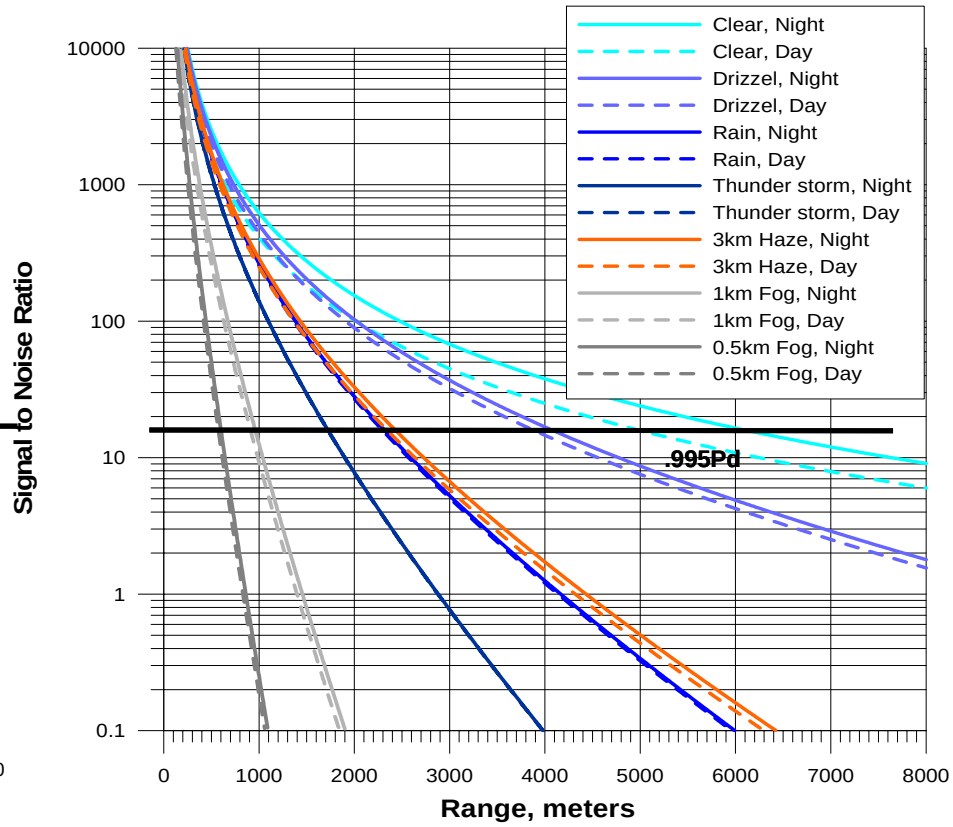


Explosive Detection LADAR Range, 1 molecule layer

Ground Based, Eye-Safe, 17.8 Peak Pwr,



Air Borne, Ground Eye-safe, 8790 Peak Pwr



Raman Spectra LADAR Capabilities

1. Identifies chemical composition of material being looked at an adsorbed gasses on surface

2. Identifies Stokes and AntiStokes giving temperature sensing capability

3. Gives 3D image with 0.7 to 0.14mr cross range pixels, 3mm range accuracy

Resultant Uses:

1. Chemical detection of explosives, propellant, rocks, plants

2. Identification of adsorbed gasses for:
   1. Leak detection
   2. Underground reservoirs
   3. Identification of radioactive boxes (nitrous oxide)

3. Identification of temperature profile, Stokes and Anti-Stokes Ratio

4. Above uses plotted on an accurate 3D profile

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