Photon Counting Airborne Laser Swath Mapping (PC-ALSM)

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Photo Counting Airborne Laser Swath Mapping (PC-ALSM)

Historical Review of LASER Ranging.

Single Photo-electron Lunar Laser Ranging (LLR).

Traditional High Signal-to-Noise Airborne Laser Swath Mapping (ALSM)

Photon Counting Airborne Laser Swath Mapping (PC- ALSM)

Coastal Area Tactical-mapping System (CATS)

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Gordon Gould
Notes: Nov.13, 1957

- Coined the acronym LASER.
- Set out the essential elements of a LASER
- Suggested applications, including range measurements.

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LUNAR LASER Ranging (LURE)

- July 21, 1969, Apollo 11 astronaut Edwin Aldrin place retro-reflector package on lunar surface.
- First LURE observatories used Ruby Lasers, and large aperture (> meter) telescopes.
- Return signals were typically one photo-electron event per several shots.

Lunar Laser Ranging - Continued

- Single photo-electron range measurement uncertainty limited by pulse length (typically 3 to 10 nanoseconds – 1 to 3 meters).

- Uncertainty reduced by combining multiple range measurements into “normal points.”

Second Generation LURE Unit

- NdYAG Laser.
- Flash lamp pumped.
- Sub-nanosecond pulse length.
- Still large, with high energy consumption.

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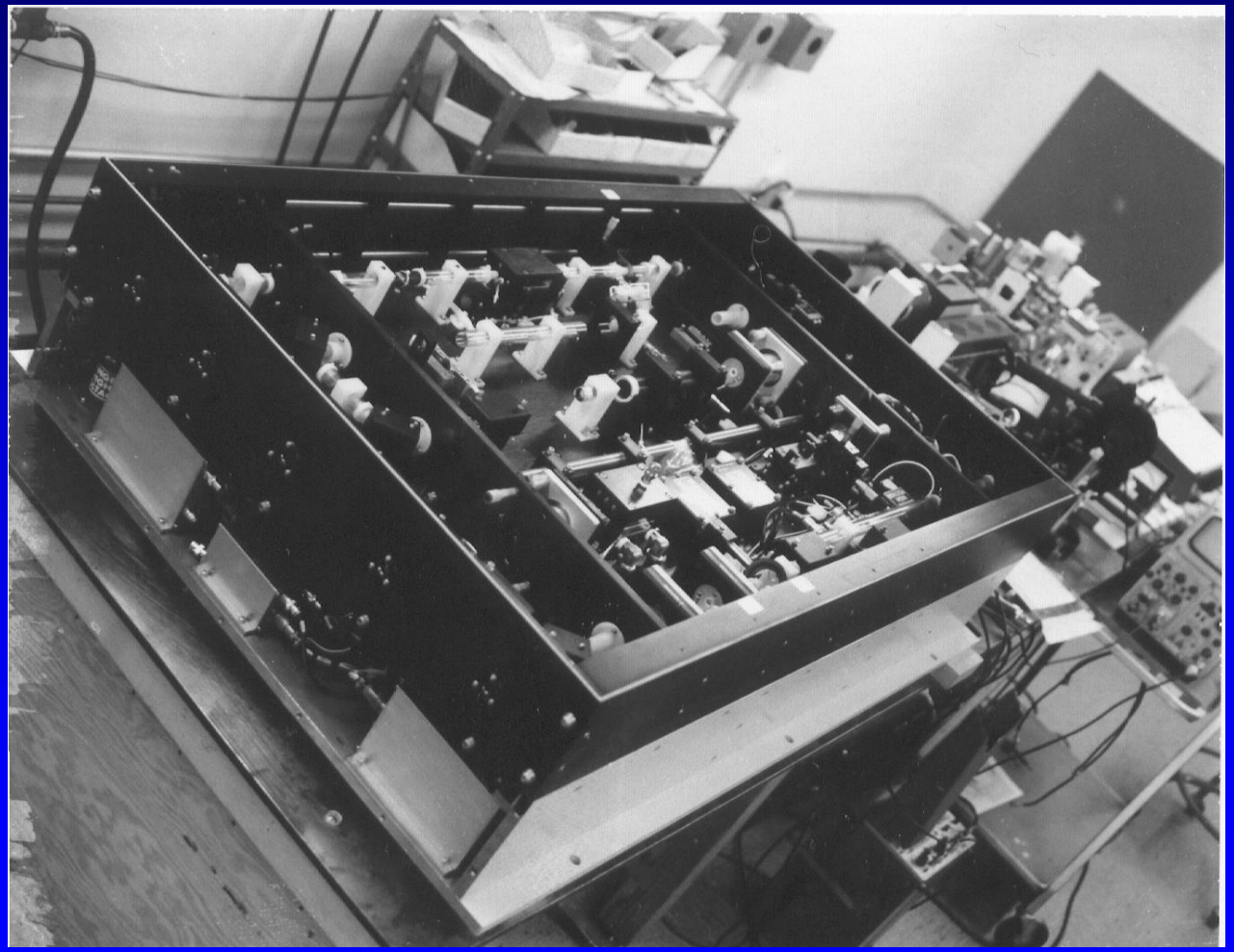
NdYAG Laser at Hawaii Station



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“Traditional” Sensors

- Avalanche photodiode (APD).
- Traditional Photo-multiplier tube (PMT).

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Enabling Technologies for Airborne Laser Swath Mapping (ALSM)

- Diode pumped NdYAG lasers.
- Optical Inertial Measurement Unit (IMU)
- Fast Large Capacity

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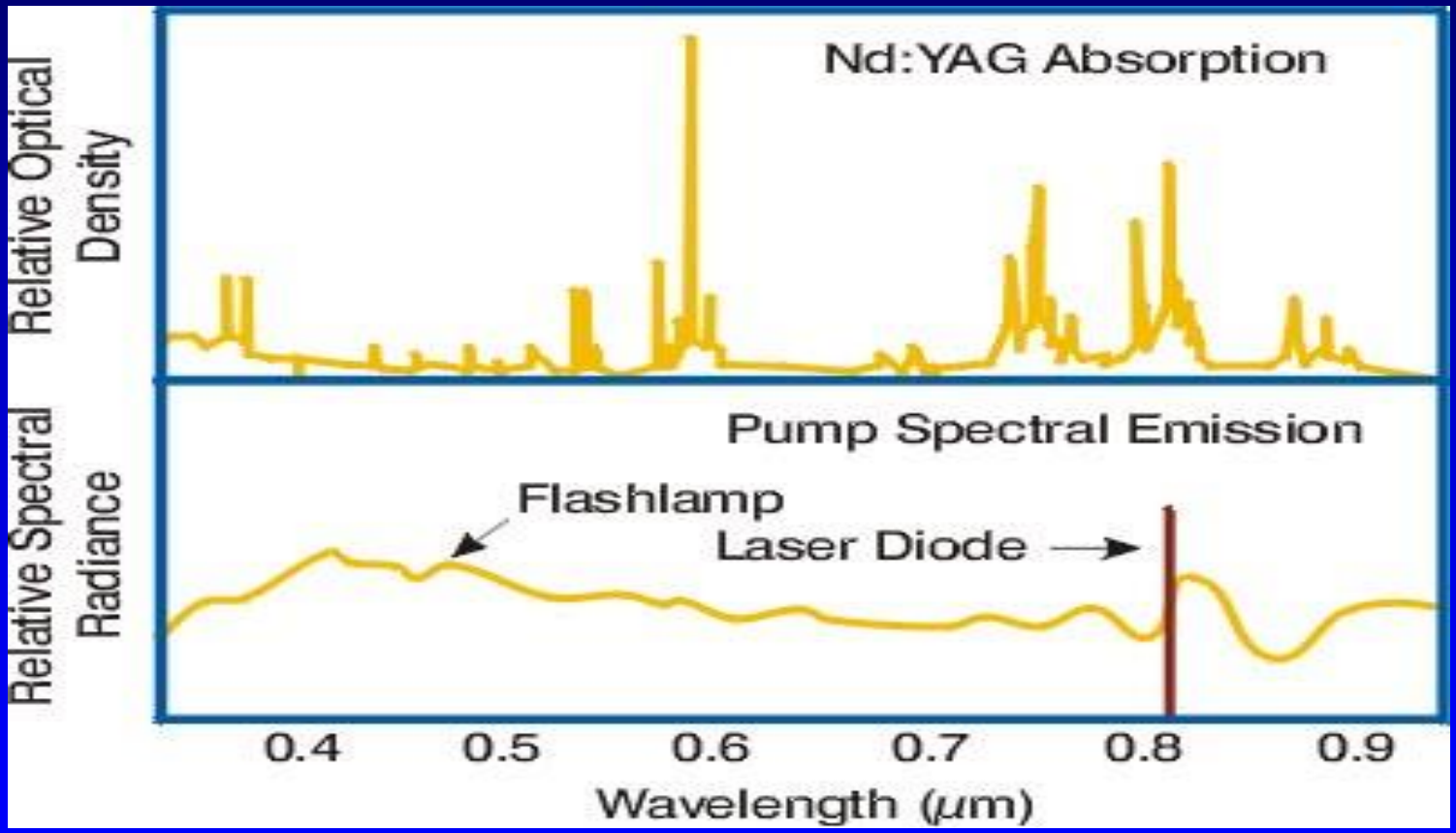
Diode Vs. Flash Lamp Pumping



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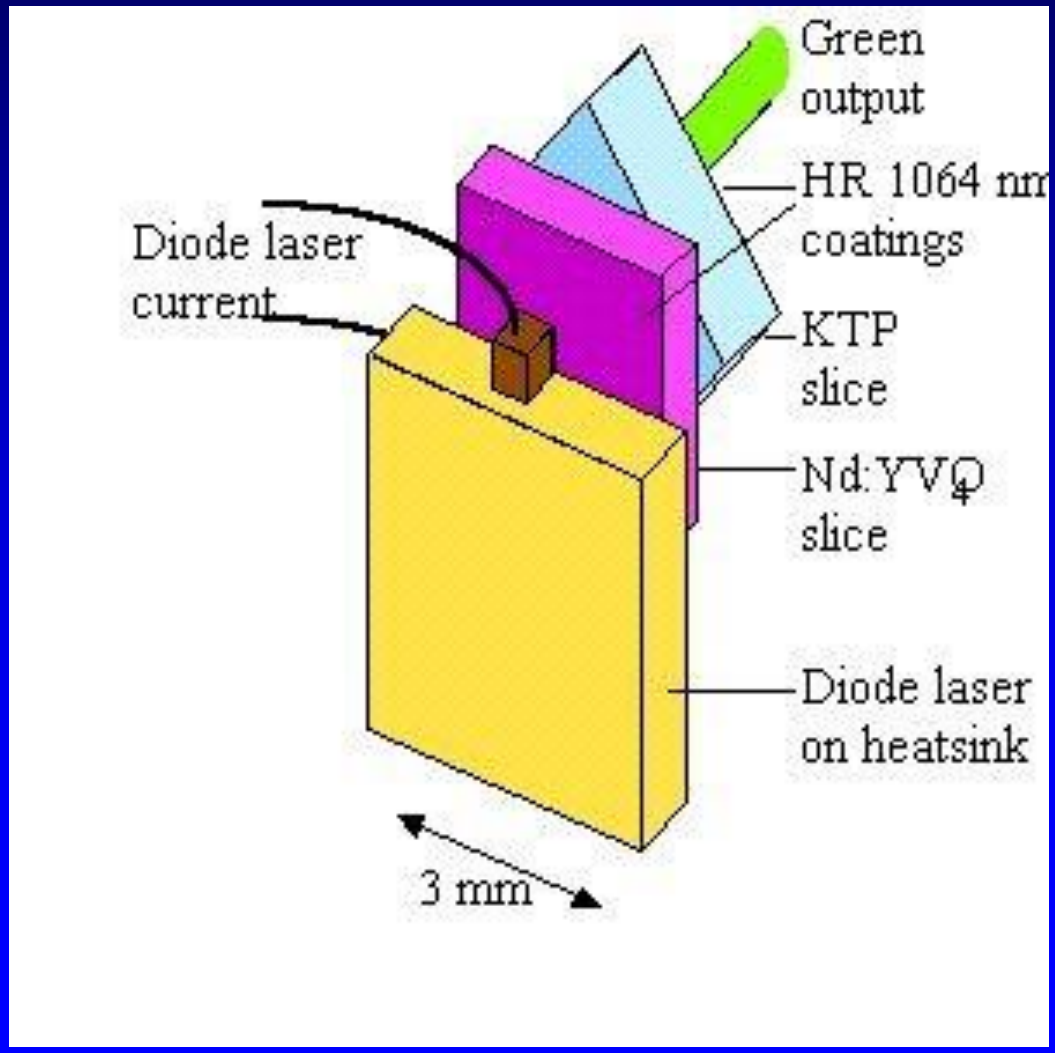
Limitations of Traditional ALSM Units

- Requires millions of shots per second to get contiguous coverage of terrain.
- Obtaining high signal-to-noise requires pulses nominally 10 nanoseconds in length to obtain strong returns.
- Pulse length limits shortest spacing between returns, resulting in 2.5 dimension point cloud.

Enabling Technologies for (PC-ALSM)

- MicroChip lasers.
- Multi-channel photomultiplier tubes.
- Multi-channel Multi-stop event timer.

MicroChip laser structure



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Typical Micro-laser Specifications

Repetition rate:	**5,000 to 10,000 pps**
Pulse length:	**sub-nanosecond FWHM**
Energy per pulse:	**3 to 5 micro joules at 0.532 micrometers wavelength**
Beam divergence:	**1 to 2 milliradians**

MicroChip Laser - CATS

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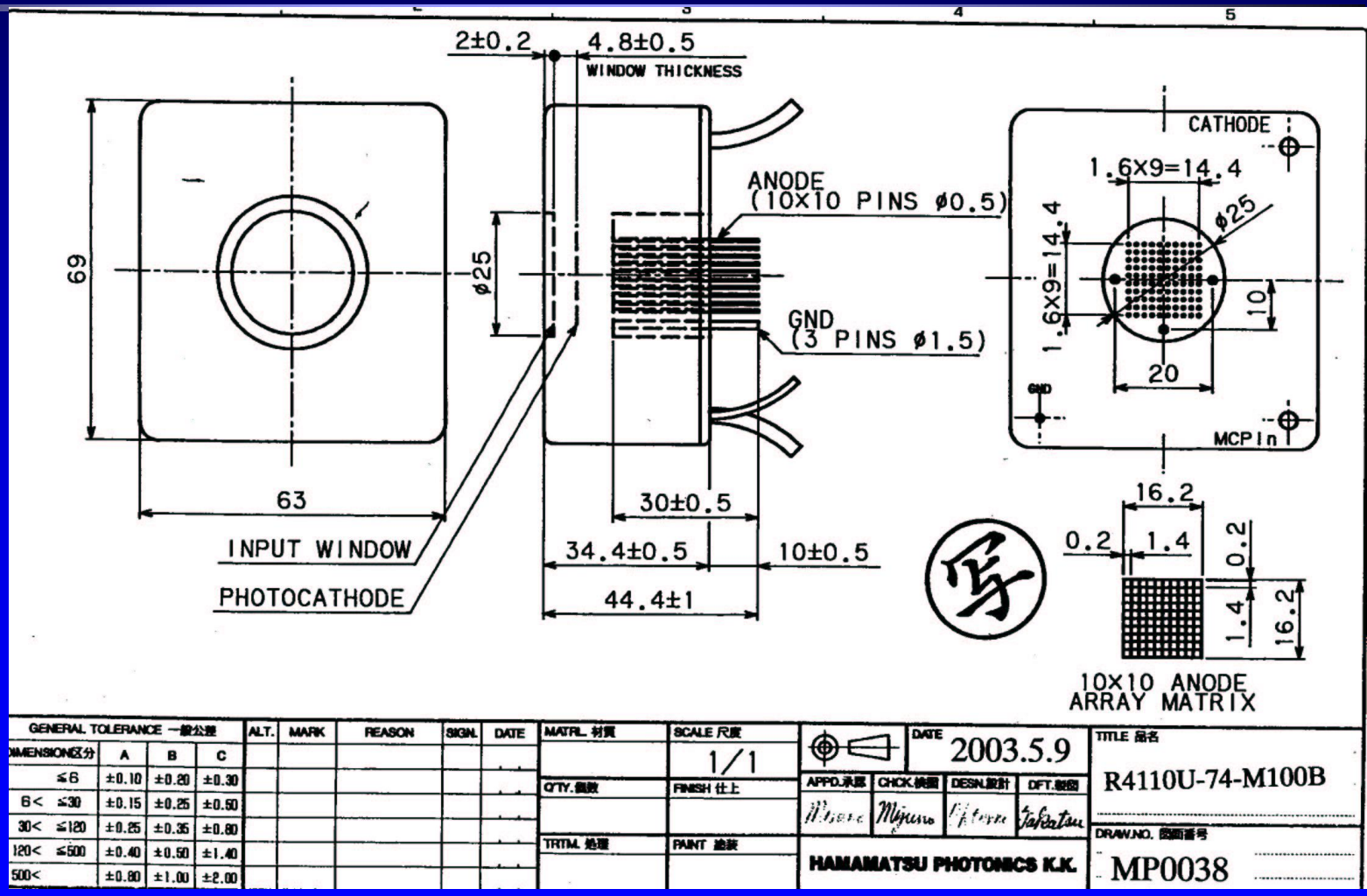
Hamamatsu Microchannel Plate (MCP-PMT



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Micro-channel-plate (MCP)

- Millions of micro glass tubes fused in parallel.
- Each micro tube acts as independent electron multiplier.
- Fast response time (few hundred picoseconds)

Hamamatsu Multianode Metal Package (MC-PMT)

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Multi-channel – multi-event timer

- Modular design with n channels per board.
- Many events per channel.
- Short (less than one nanosecond) dead time

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Multi-channel Photomultiplier Tube (MC-PMT)

- Pixellated photocathode.
- Micro-channel-plate amplification.
- Anode array.

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Coastal Area Tactical-mapping System (CATS) Design Goals

- Detect, identify, and precisely locate mines and obstructions in landing zones (shallow water and beach areas).
- Operate from Unmanned Aerial Vehicle (UAV).
- Cost low enough to be considered “expendable.”

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Coastal Area Tactical-mapping System (CATS)

- Illuminate large enough patches of terrain to get contiguous coverage in single pass.
- Use multi-channel PMT to obtain 30 cm or better horizontal resolution.
- Produce more nearly true 3.0 dimensional point cloud.

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CATS Design Goals (continued)

- Small as possible (30 cm cube x 2?)
- Lightweight as possible (20 Kg?)
- Low power consumption (< 100 Watts?)

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Coastal Area Tactical-mapping System (CATS)

- Operate from 600 to 1000 meter AGL.
- Operate in inclement weather (light fog?)
- Penetrate shallow water (surf zone to 5m?)

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NdYAG Laser

- Infrared (1.064 micrometer)
- Does not penetrate water.
- Frequency Doubling yields Green (0.532 micrometer) light.
- Penetrates water.

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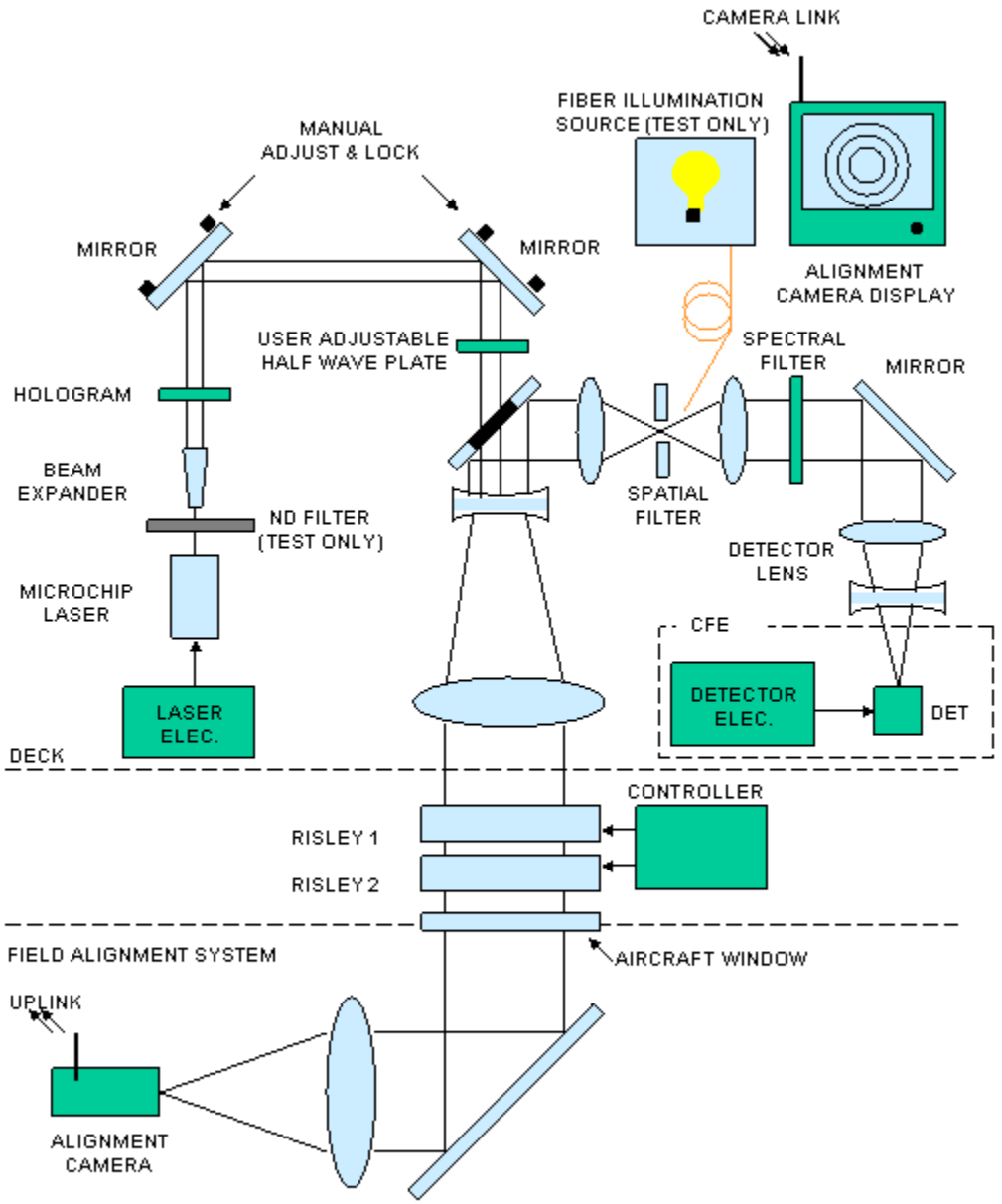
CATS Diagram



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CATS Preliminary Performance Specifications

- 7,000 pps x 96 pix = 672,000 pix/s with just one event per channel.
- 95% probability of at least one return in each channel.
- Horizontal spatial resolution: 20 to 30 cm.
- Range resolution: 7.5 cm.

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Status of CATS in November 2004

- Multi-channel Multi-event Timer under construction at Fibertek Inc.
- Detailed design of Optical-Mechanical Components of Sensor Head in Progress at Sigma Space Inc.
- UF Staff and Graduate Students Developing Data Reduction and Analysis Tools.