1999

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Florida Space Institute

Research Activities at the Florida Space Institute

Ronald L. Phillips, Director
Florida Space Institute
University of Central Florida
US Air Force Cape Canaveral Air Station

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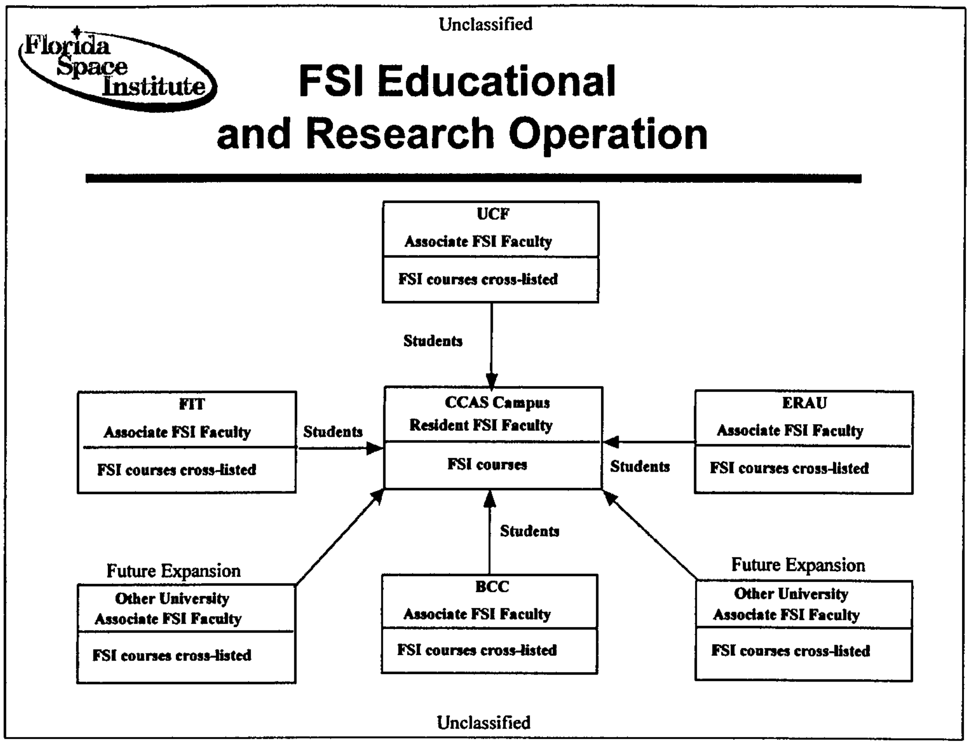
Abstract

The Florida Space Institute is a consortium of Florida community colleges, and public and private universities. The University of Central is the lead university. FSI is funded as a research institute of the State University System. FSI is located at the U.S. Air Force Cape Canaveral Air Station, Florida.

FSI conducts a practiced based educational program in engineering, physics, life sciences. The research program is focused on building payloads that fly into space aboard the Space Shuttle and sounding rockets.



FSI has students and faculty resident at the spaceport facitlies as well as students coming to the spaceport from their respective campuses.

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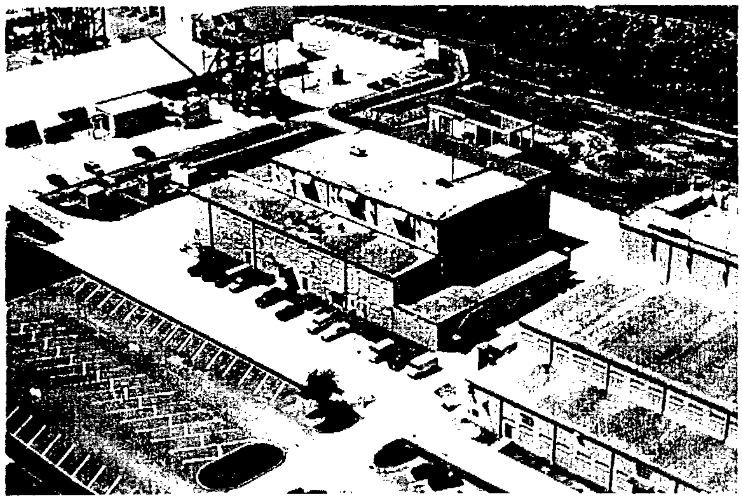
FSI Labs: Building AM



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FSI has offices and laboratories in Building AM within the U.S. Air Force Cape Canaveral Air Station. These facilities are provided to FSI by the Spaceport Florida Authority through an agreement with the U.S. Air Force 45th Space Wing.

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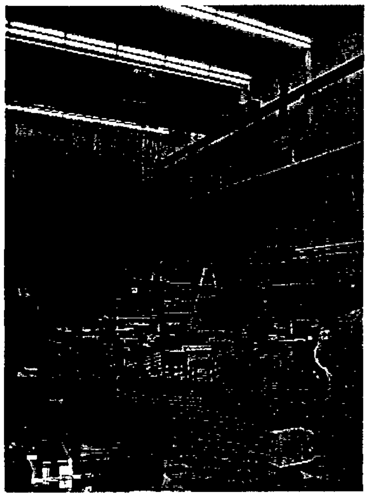
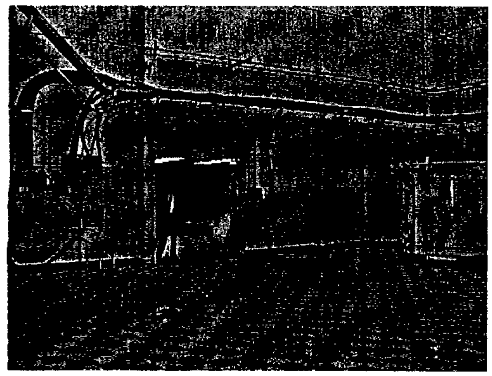
Building AM

High Bay



Small Payload Lab



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FSI has access to Building AM's 8,000 sq. ft. high bay for preparing and processing payloads for Space Shuttle and sounding rockets.

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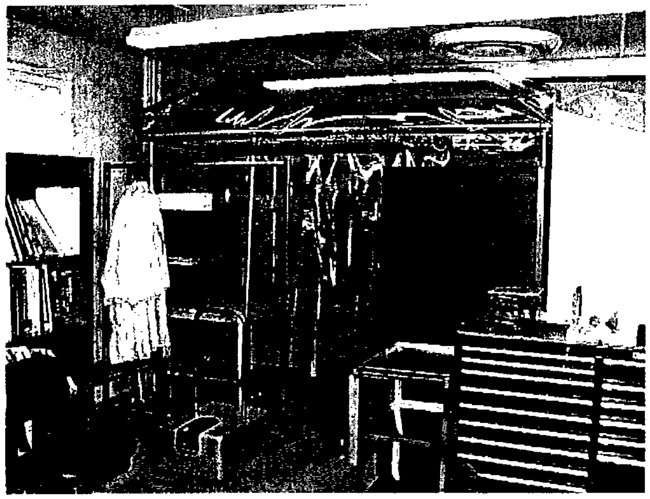
Laboratory Facility

Clean Room



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FSI has built a small satellite and payload laboratory with a cleanroom with a $60,000 grant from the State of Florida's Enterprise Florida, Inc.

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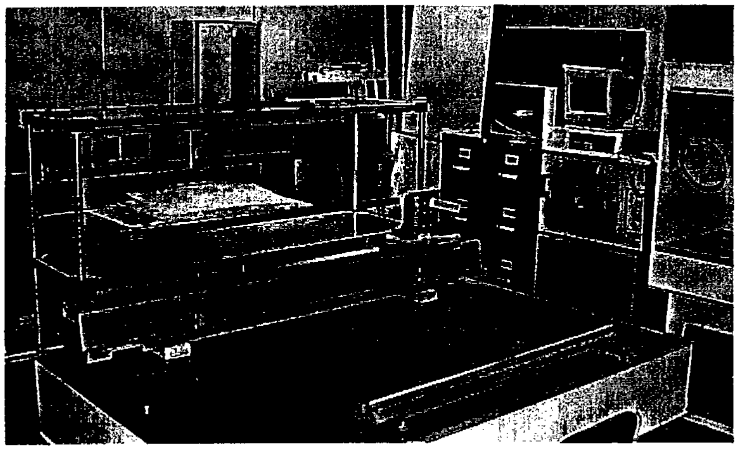
Laboratory Facility

Optics Bench



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Many of the payloads constructed by FSI schools are electro-optic payloads and require optics laboratory equipment.

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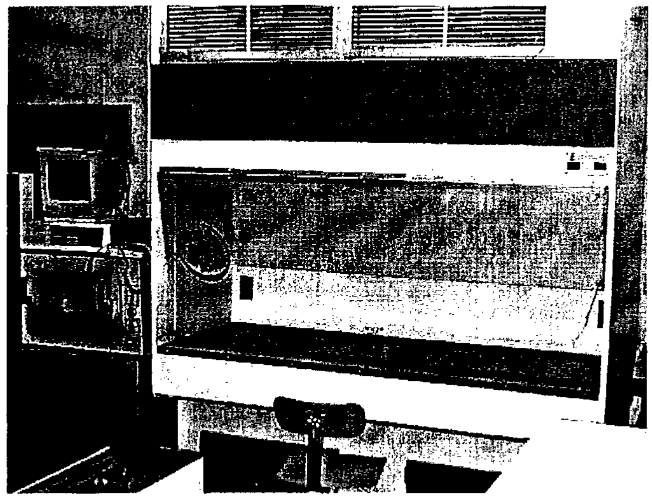
Laboratory Facility

Laminar Flow Clean Bench



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The laboratory also has laminar flow benches for a clean environment assembly.

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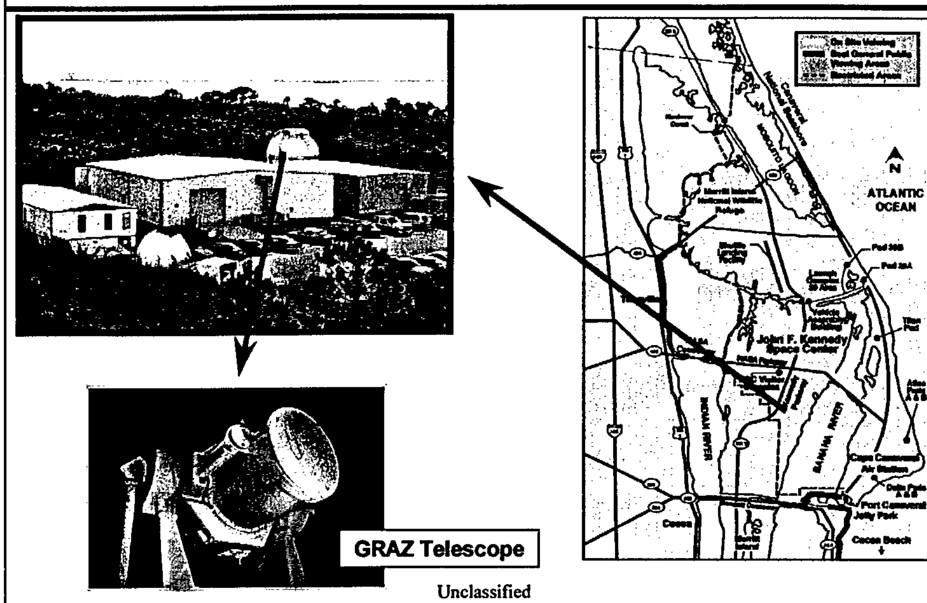
ISTEF Site

(BMDO Innovative Science and Technology Experimentation Facility)



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Many of the experiments conducted by FSI use BMDO's Innovative Science and Technology Experimentation Facility, ISTEF, located on Merritt Island just across the Banana River from Cape Canavera.

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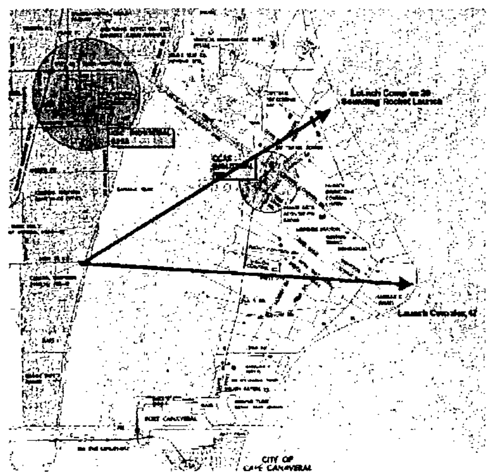
Location of Launch Sites From ISTEF



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From ISTEF two of Spaceport Florida's facilities are accessible. The launch tower at Spaceport Florida's Complex 46 allows for 12.5 Km range from ISTEF on which to perform electro-optical experiments. Spaceport Florida's Complex 20 can viewed from ISTEF for experiments involving the launch of targets.

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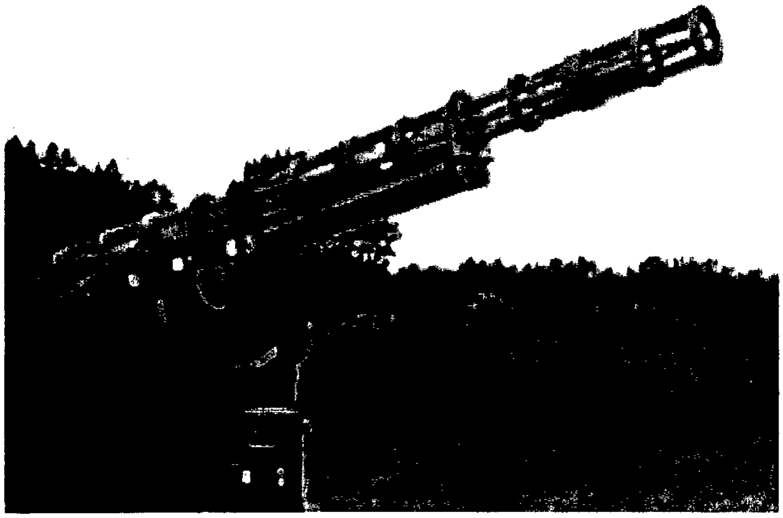
SFA Super-Loki with FSI payload



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Complex 20 is used to launch the Super Loki sounding rocket. It is used to launch 1 Kgm payload experiments. Some of these experiments involve deployable payloads viewed from ISTEF

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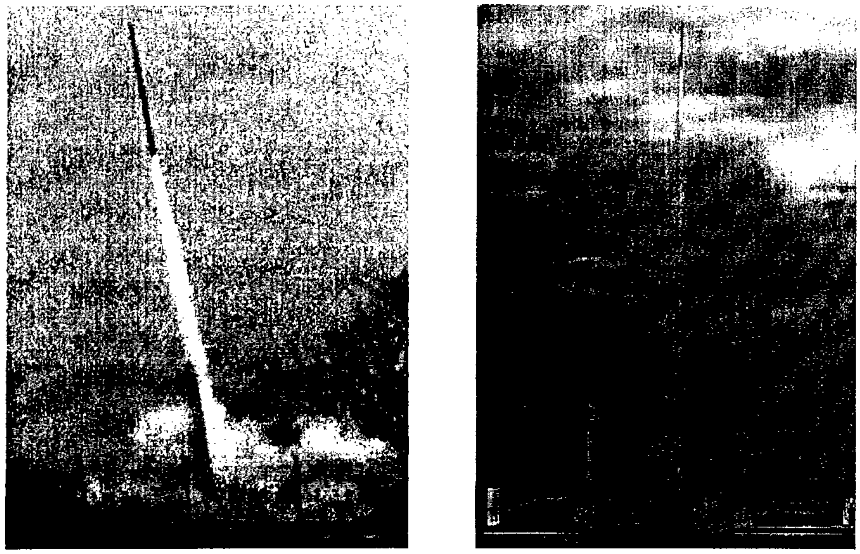
Super-Loki Launch from LC-20



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The Super Loki is launched by Spaceport Florida's personnel. The launch is completely under the control of Spaceport Florida. The SuperLoki vehicle can deploy a payload at an altitude of over 300,000 ft. The payload compartment is 12" in length, with a diameter between 1 3/16" and 2 1/4" depending upon the specific configuration.

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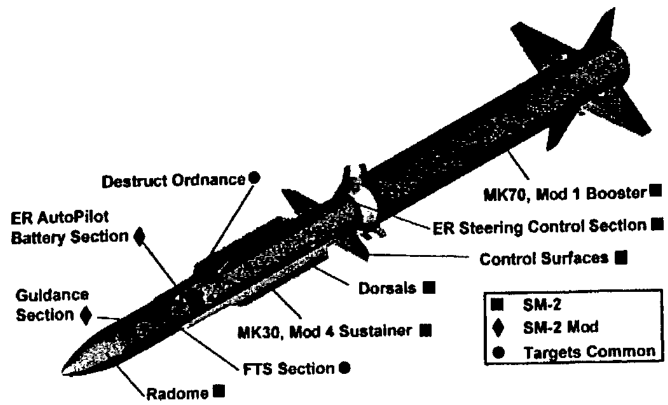
Terrier Orion Sounding Rocket



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The Terrier Orion is a two stage sounding rocket capable of boosting a 300 pound payload to altitudes of 135 miles. The Terrier (MK-70) is an 18 inch diameter, 13-foot long rocket motor that is used as the first-stage booster. The Orian is a 14-inch diameter, 6-foot long rocket that is used as the second stage.

The Spaceport Florida Authority has accepted the transfer of 200 of these vehicles from the U.S. Navy and U.S. Army for suborbital missions from the Cape Canaveral spaceport. The Authority intends to make these vehicles available to the Florida Space Institute and to government agencies interested in flying research projects.

The Terrier/Orion missions will be be conducted from Launch Complex 20, just north of the ISTEF facility, which is now being reactivated by the Spaceport Authority under an agreement with the Air Force 45th Space Wing. The $2.5 million LC-20 conversion includes the installation of a new launch rail for the vehicle.

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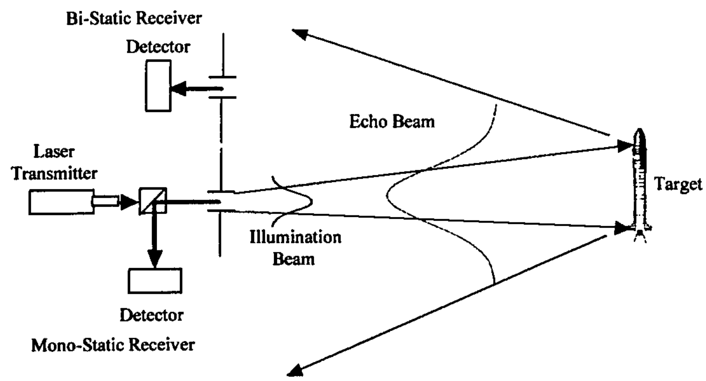
Monostatic and Bistatic Laser Radar



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The echo signal of a laser illumination of a target can be detected from the transmitter aperture, referred to as a mono-static receiver, or detected from a separate receiving aperture referred to as a bi-static receiver. The effects of the atmosphere of the echo wave are very different.

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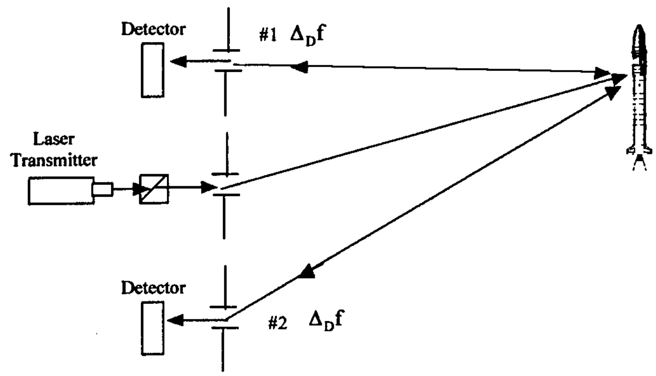
Doppler Shift



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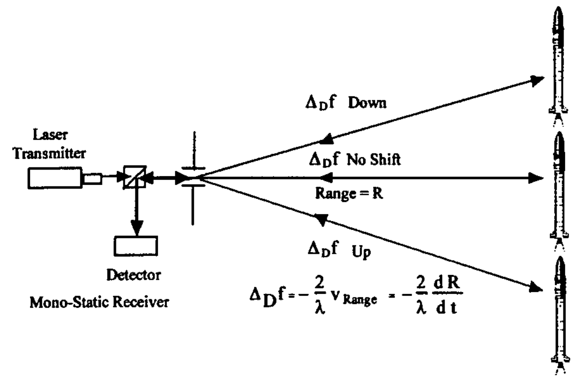
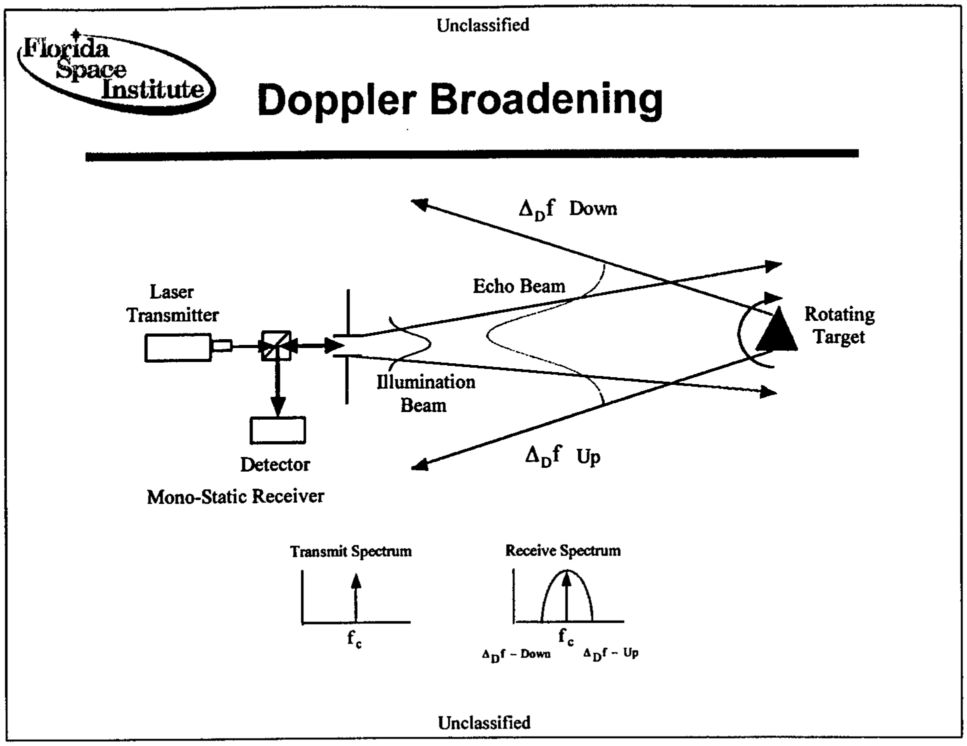
The Doppler frequency shift of the echo wave can be very different between two bi-static receivers in a coherent receiver array. The difference in the Doppler shift can be used to track the target.

Doppler Effects



Doppler shift in the echo wave can be used to infer the vehicle velocity if the range is known.



A rotating target will increase the width of the frequency band of the echo wave. The width depends upon the rotation rate and the range.

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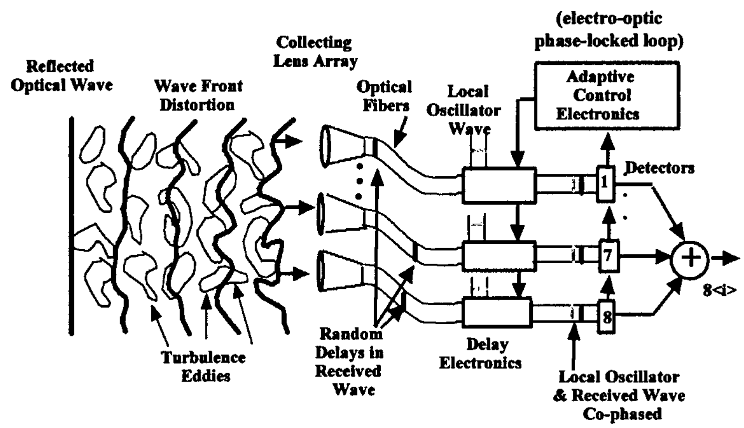
Diagram of a Coherent Array Receiver



A coherent receiver was developed and fabricated to mitigate the effects of echo wave fading due to turbulence and to measure Doppler frequency shift. Experiments were conducted along the ISTEF 1 km range. The array reduced the fading due to turbulence by 5 orders of magnitude.

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Photon Satellite Project

Contractor:
University of Central Florida
Florida Space Institute (FSI)
4000 Central Florida Blvd.
Orlando FL, 32816-0150

Contract No.: N66001-97-C-8644

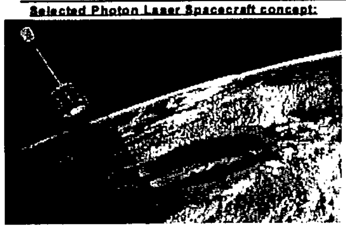
PI: Dr. Ron Phillips (407) 275-8273

COR: Mr. Gregory Adams

Project Summary

PHASE I	(Optional) PHASE II	(Optional) PHASE III	(Optional) PHASE IV
Systems Design	Eng. Design & Initial Assy.	Construction & FAB	Experiment Operations
GFY 97-98 (NCE to 1/00)	GFY 99	GFY 00	GFY 01
460 K$ (Obligated)	3.3 M$	4.8 M$	4.8 M$

Selected Photon Laser Spacecraft concept:



Products:

Validated tractable atmospheric turbulence models

Demonstration of coherent array technique for communications and ladar applications

Largest effective optical target for optical communications, ranging, tracking, geodesy, and lidar research and test

Generic small, low cost and highly reliable satellite bus

Operational ground station supporting wide range of R&D satellites

Trained graduates with relevant experience for DoD, NASA and pricate industry contractors

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Photon Satellite Project Technical and Science Objectives

- Investigate a technique for minimizing constraints imposed by atmospheric turbulence on ground-to-space and space-to-ground laser communication links
- Demonstrate operational ground-to-space and space-to-ground communications using low cost satellite and optical ground station
- Validate new tractable models available to anyone exercising laser propagation through atmosphere
- Develop, design and build a low cost retro-reflector satellite to serve as on-orbit optical relay station capable of assessing performance at the receiver
- Combination satellite based detector and ground measurements combine to separate uplink / downlink propagation effects

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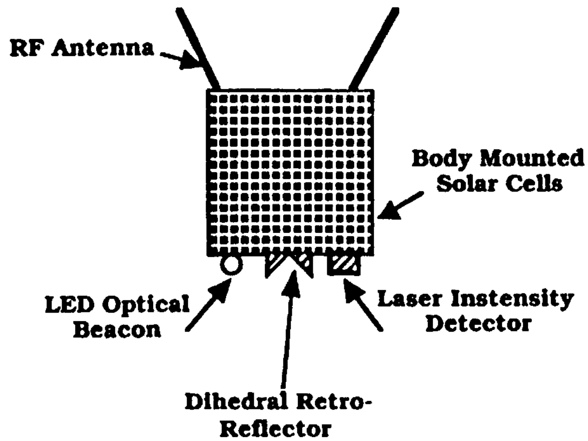
Photon Satellite



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The Photon satellite is a 150 lbs satellite that can be carried aboard the Space Shuttle GAS can container.

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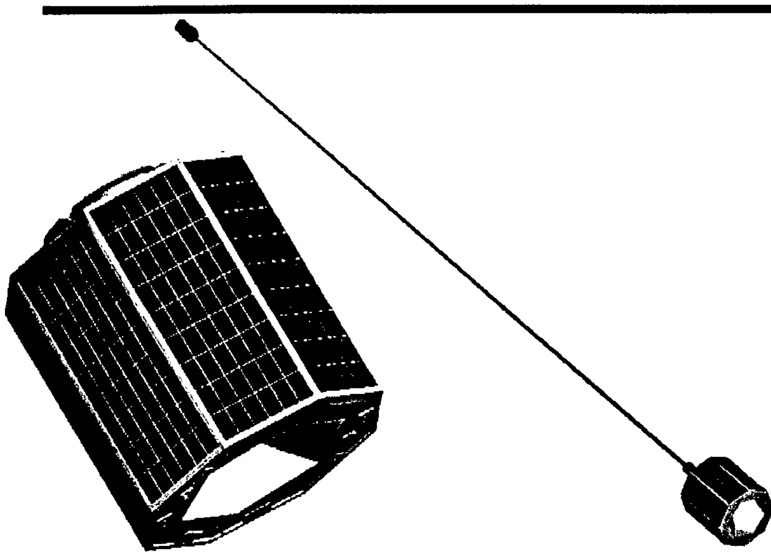
Photon Satellite



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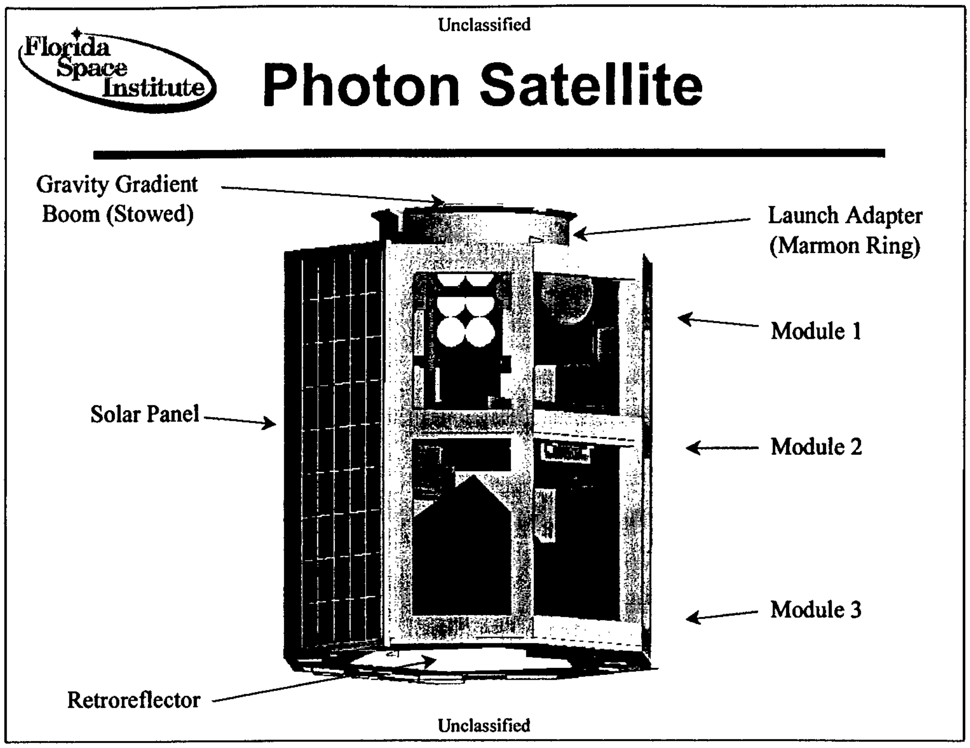
The conceptual design for Photon is shown in this slide, on the left with the gravity gradient boom stowed, on the right with the boom deployed (different scales). The gravity gradient boom, in combination with magnetic damping, provides nadir pointing within ±5°. The retroreflector does not require precision pointing which allows us to use this is a low-cost, low-power, high-reliability approach to attitude control.



The Photon microsatellite design is show in this slide, with three solar panels removed. Module 1 contains the gravity gradient boom and batteries. Module 2 contains the command & data handling system, and Module 3 holds the payload and antennas.

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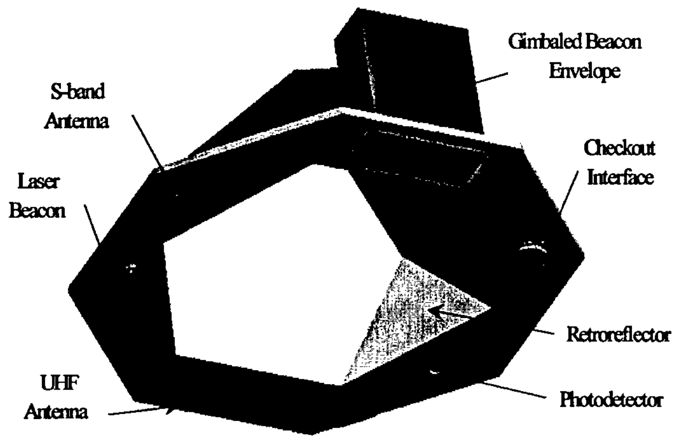
Photon Satellite



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Module 3 is the the payload module, located on the nadir end of the spacecraft. The payload consists of a large diameter (~23 cm) cube-corner retroreflector, two optical beacons, and a photo detector.

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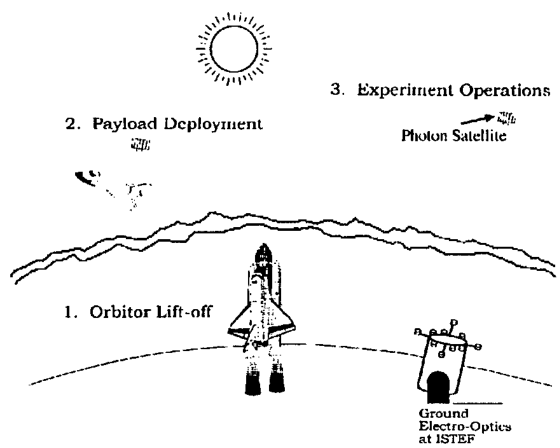
Photon Experiment



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NASA has signed an agreement to carry the satellite into a low earth orbit aboard the Space Shuttle. The satellite will be launched from the Shuttle and controlled from the ground station at the Cape.

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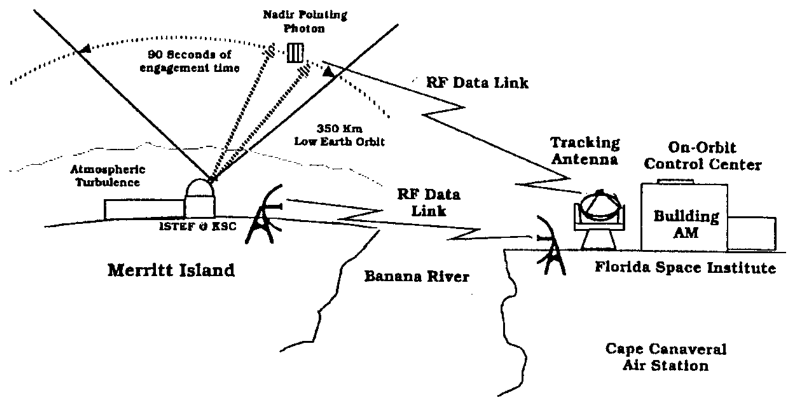
Photon Experiment Scenario



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Laser radar and optical communications experiments are two experiments currently planned to use the Photon target spacecraft. These experiments will be conducted from BMDO's Innovative Science and Technology Experimentation Facility (ISTEF), located at Kennedy Space Center. A traditional RF ground station will be located nearby at Cape Canaveral Air Station, and linked with the ISTEF site by existing communications lines.

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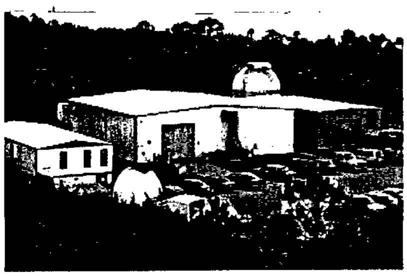
ISTEF Site

(BMDO Innovative Science and Technology Experimentation Facility)



- **ISTEF brings together electro-optics, sensors, and lasers developed for experiments observing launches, etc. at KSC**
- **ISTEF site at sea level with 1 km and 12.5 km ranges**
- **ISTEF operated by Nichols Research**

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The ISTEF site will be the location of the EO ground station and house the laser transmitter and the coherent array receiver.

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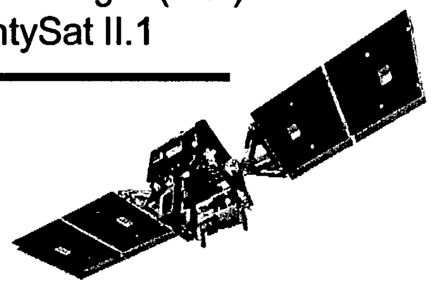
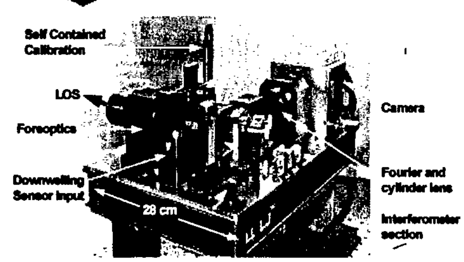
HyperSpectral Imager (HSI) for MightySat II.1

- Sponsor: Air Force Research Laboratory
- Kestrel Corp. prime contractor
  - mechanics
  - electronics
- FSI subcontractor
  - optics
- Imaging spectrometer with 150 spectral bands in 450 - 950 nm range





Sensor shown without protective covers during laboratory characterization

(Airborne precursor instrument shown here)

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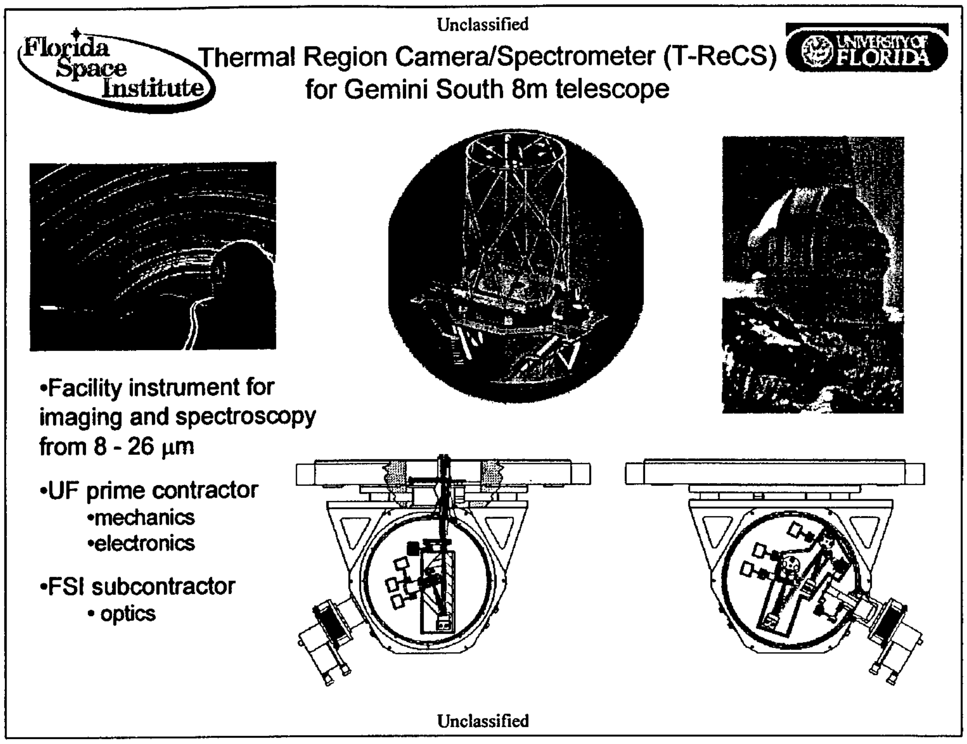
The Florida Space Institute has pioneered in the development of an innovative hyperspectral imaging spectrometer, with high sensitivity and no moving parts.

The HyperSpectral Imager (HSI) is the primary payload on the Air Force Research Laboratory's MightySat II.1 technology demonstration satellite. Kestrel Corporation is the prime contractor for HSI, and the Florida Space Institute is the subcontractor responsible for the optical design.

The upper figure shows the design for MightySat II.1, with the HSI on the nadir face. The lower figure shows the airborne precursor to HIS, the Fourier Transform Visible HyperSpectral Imager (FTVHSI), also optically designed by FSI engineers.

MightySat II.1 is scheduled for launch in 2000, from Vandenburg AFB.



The Thermal Region Camera Spectrometer is a facility instrument for the Gemini South 8 m telescope being constructed at Cerro Pachon, Chile. T-ReCS will provide imagery and spectra in the 8 - 26 µm range.

The University of Florida is the prime contractor for the instrument. FSI is responsible for the optical aspects of the development, as a subcontractor to UF.

The Gemini South 8 m telescope is show in the upper three figures, and the T-ReCS design is show below. The lower left figure shows the upper deck of the instrument, and the lower deck is shown on the right.