APPENDIX B

Engineering Aerial Flight Test Procedure

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Addendum to Task 5 of
Asphalt Surface Aging Prediction System (ASAP)

Prepared in response to:
Broad Agency Announcement Number DTPH56-06-BAA-0002

By

Western Research Institute
&
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1) Introduction

Innova will collect and analyze FTIR data in an aerial flight environment with co-registered true color imagery(Red (650nm), Green (550nm), Blue (450nm)) and up to 5 additional bands of custom imagery within the visible and infrared. This data will be collected coincidentally with the in-flight FTIR device.

4-camera head unit

4-head camera unit with filters integrated into flight-worthy pod

Innova has extensive experience in flight operation services and engineering support for the design and implementation of flight testing airborne remote sensors. We are currently supplying all engineering flight services for John Deere's OptiGro™ sensor that can be viewed at
http://www.deere.com/en_US/newsroom/2006/releases/farmersandranchers/060224_optigro.html

Innova with its technology partner SimWright will utilize its flight operations division to perform the flight testing and validation for RITA in this effort. A formal discussion of all aspects of the flight test is described in the following areas:

- Identify a FBO (Fixed Based Operator) with flight assets
- Identify and assign flight staff and airborne flight assets for test
- Develop engineering flight parameters for FTIR device airborne testing
- Develop engineering design and implementation for FTIR operation and data collection/validation

Mr. Fountain was a flight systems engineer with full responsibility and authority for designing and implementing substantial aircraft modifications and instrumentation suites for the RF-4C fighter (Project "Rough Rider" for National Severe Storm Laboratory), for FB-111 fighter/bomber (Vibrational/Acoustics Testing for Bomb Bay turbulence), and for various fighters that carried AIM-7 and AIM-9 series air-to-air missiles (Project Weapon System Evaluator (WSE)). He also has experience with other aircraft and internal–and external–carriage instrumentation packages. Mr. Fountain was chief project engineer for the GPS Demonstration Pod program, as well as, Flight Mission Director. This experience is directly relevant to and beneficial for the proposed ASAP flight test elements of this project.

2) Establish FBO Affiliation

The FBO will be AMS (http://www.flymilton.com/) that provides the flight assets from Milton, Florida at Peter Prince Airport. In 1990, three 6-unit T-hangars and a four-unit hangar for twin engine aircraft were constructed, together with a full length parallel taxiway on the east side of runway 18-36, and an apron with 21 tiedown spaces. More about Milton flight operations can be found in Appendix A.

Representative aircraft

Milton – Peter Prince Airport

FBO Operation - AMS

3) Identify Flight Staff and Airborne Assets for FTIR Demonstration

a. Identify Trained Pilot Personnel

See Appendix A.

b. Identify Suitable Aircraft

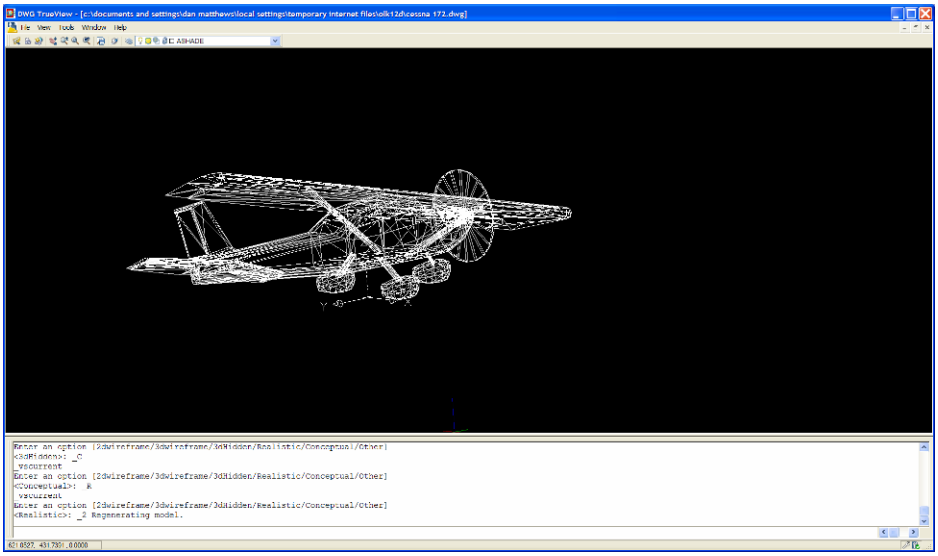
We have identified an appropriate aircraft that has been modified to receive and fly an instrumented device in the interior of the aircraft. Several aircraft have similar modifications to fly camera systems within this class of aircraft. Innova has extensive experience with regard to this type of flight modified aircraft deployment.

One of several Cessna approved aircraft being used currently

c. Prepare Aircraft for Flight Worthiness to Include 337 for Belly Mount

The aircraft selected for this project has been modified with appropriate FAA certifications. The process of approval for flight operation of the FTIR will be performed by Innova. We have previously modified and received approval for this modification in conjunction with the FAA DER (Designated Engineering Representative, **experts concerning FAA certification processes**) and the AMS certified mechanic to ensure all instrumentation and modifications of the aircraft are flight approved and air worthy.

Belly mount access available on asset at Milton Airport

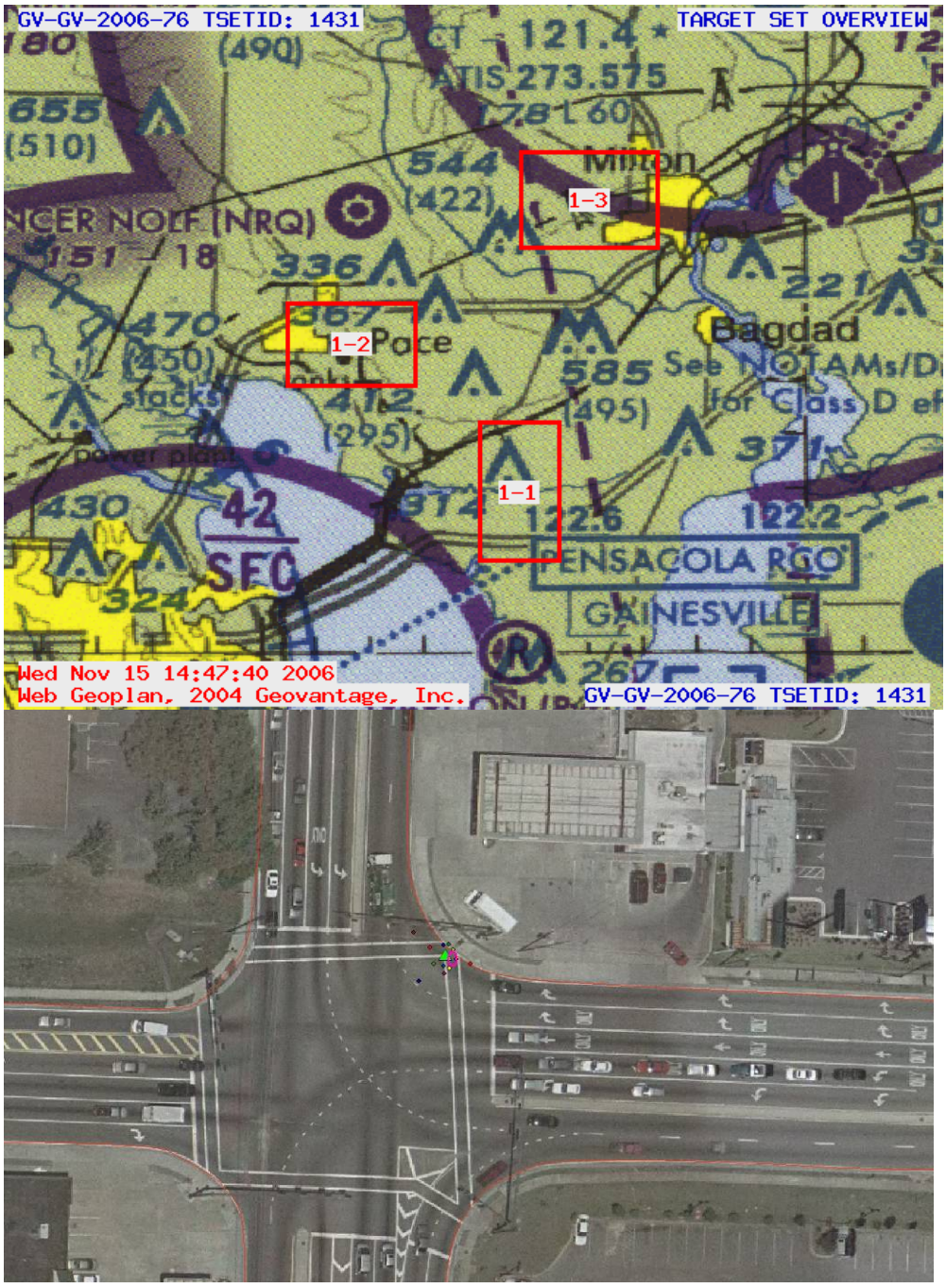


CAD modeling ability to acquire FAA certification for test assets

4) Develop Flight Test

a. Aircraft Mission Flight Planning

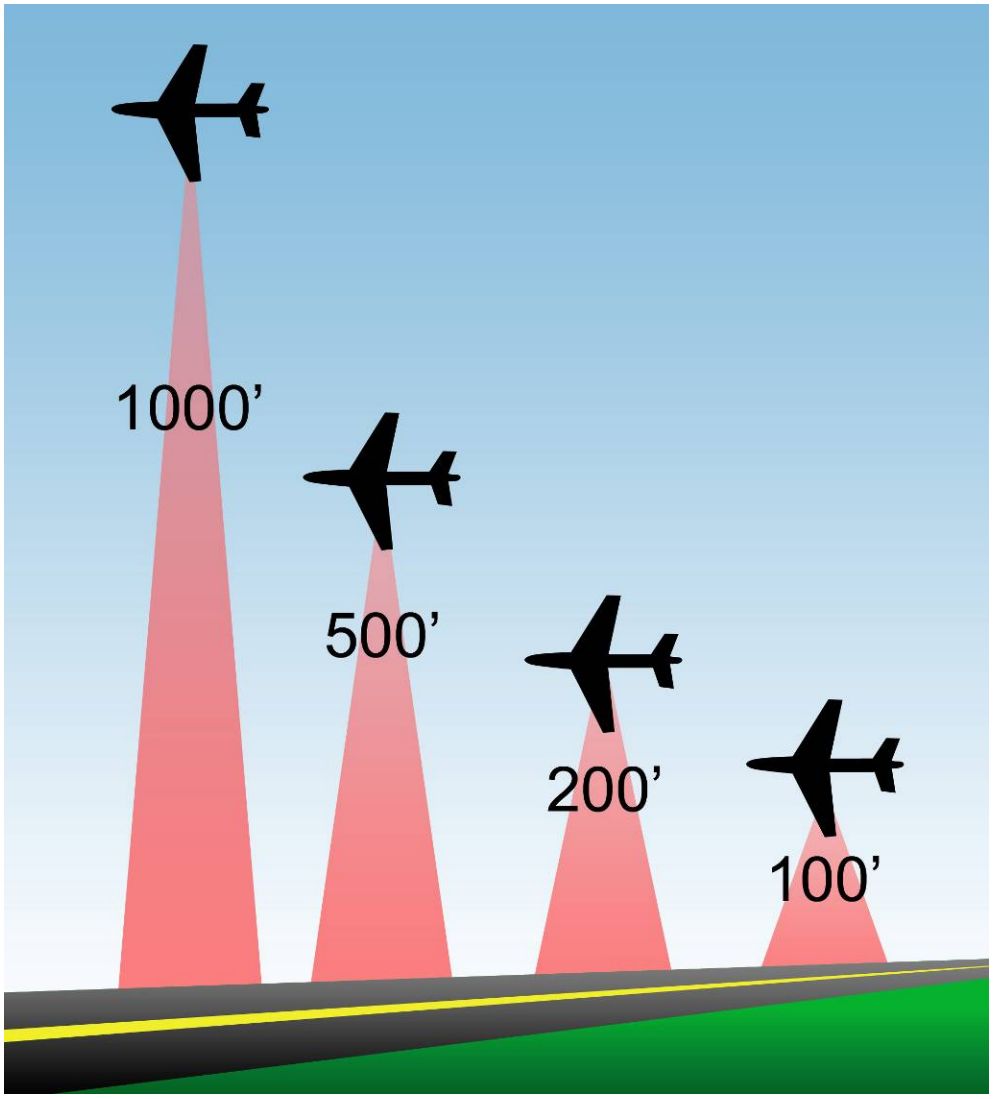
The subsequent graphic depicts the flight planning capability that has been developed for our current customer base. The ability to provide approve flight plans is essential to safe and effective operation of the flight test program. Innova will develop flight plans for the FTIR device. With appropriate consideration of engineering parameters that optimally provide FTIR data for assessment of pavement condition will be developed.



b. Altitude Regimes for FTIR Flight Characterization

Innova will examine flight altitude environments to establish the optimal limits for height above terrain for the pavement FTIR data collection effort. We will use the atmospheric modeling programs of EOASEL and MODTRAN to establish environmental atmospheric effects on the FTIR signal and provide an analysis that predicts theoretical performance expected. Innova has used these respected models in our Department of Defense (DOD) work, previously and we are very knowledgeable on applying them to our

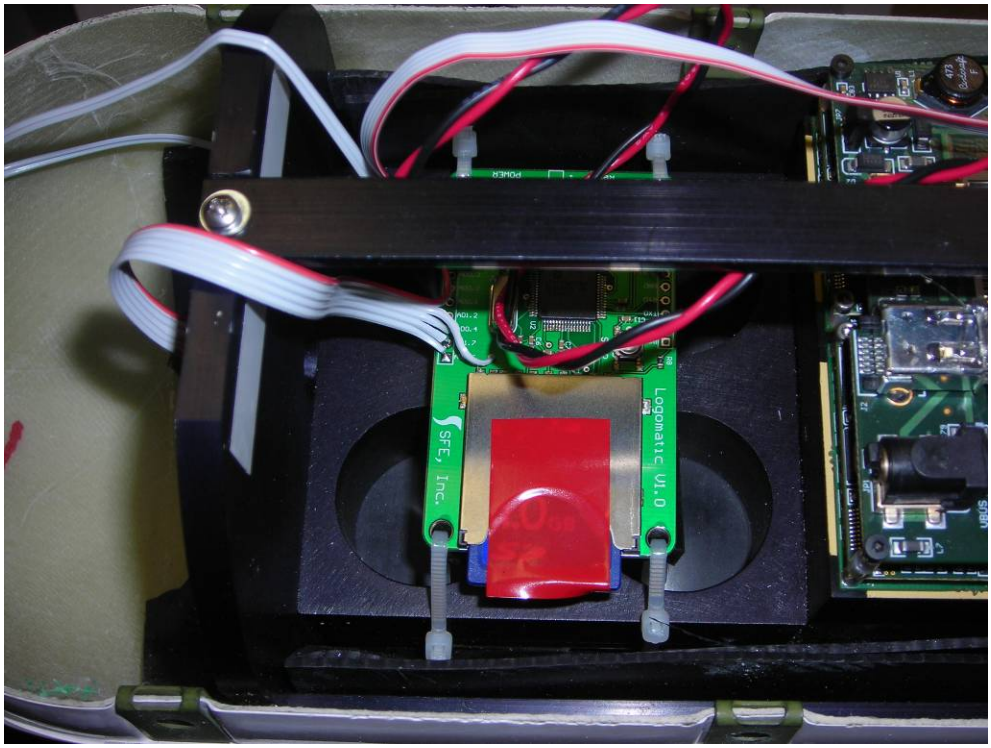
engineering analysis of similar systems. This analysis will better define the flight regimes for testing and determine the amount of atmospheric absorption to be a significant factor in the signal integrity of the FTIR's response.



c. In-Flight System Dynamics Capture (Accelerometers, Temperature and Humidity, GPS)

The flight collection system will be equipped with appropriate instrumentation to collect ancillary information that will be useful for characterizing the environment in which the FTIR device is being tested. Innova has experience in developing geopositioning and environmental sensors that provide valuable data to characterize the vibration and geodetic correlation of the FTIR response data with the pavement being imaged. We will collect accelerometer data to develop vibration characterization profiles to determine effects on the

FTIR. We will also utilize GPS for scoring purposes and develop a Temperature and Humidity collection sensor package for recording the environmental in-cabin and ground returns at the pavement test site.



General purpose data logger designed by Innova to collect in-flight data

d. Georegistration Assessment (GPS pod instrumentation)

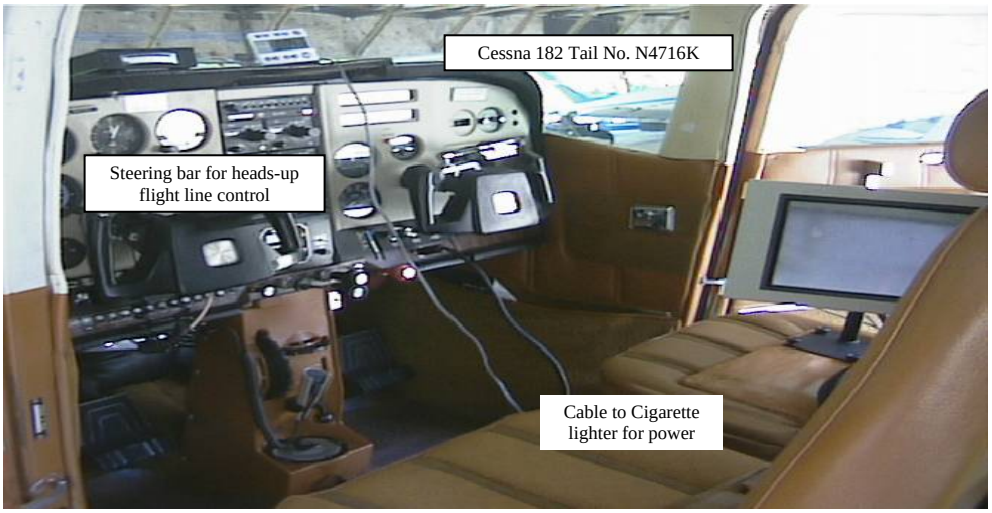
Innova will utilize the current JDAS flight imaging system to co-collect geo-accurate imagery with the FTIR imaging data to demonstrate and document the appropriate pavement asset being imaged with both systems. This provides a unique ability to ensure that the airborne data being collected with the FTIR system can be subsequently examined by field personnel and sampled appropriately for lab investigations.

8-band digital camera system installation on wheel strut

5) Engineering Design for Flight-Ready FTIR Data Collection System

a. Power and Mechanical System Integration Development

Innova will utilize approved FAA engineering procedures to develop a power budget and implementation methodology for the power requirements of the FTIR system with the aircraft. We have previously developed a current operational system with 80 flight-ready camera units for this type of aircraft. Innova will work with FAA certified mechanic staff rated on this Cessna 172 class aircraft to ensure that this FTIR device can be utilized within the Cessna fleet throughout the world.



b. In-flight Data Recording Development

Innova will design the FTIR data recording subsystem to enable it to be used in a flight environment. We have extensive experience in design and development of flight-capable data recording systems from our work with JDAS (John Deere Agricultural Services). We are confident that our experience will provide excellent data recording system capabilities for the FTIR device within a flight environment. We will ensure that the data recording system is vibration isolated and environmentally receptive to the flight environment for these data collection tests/activities.

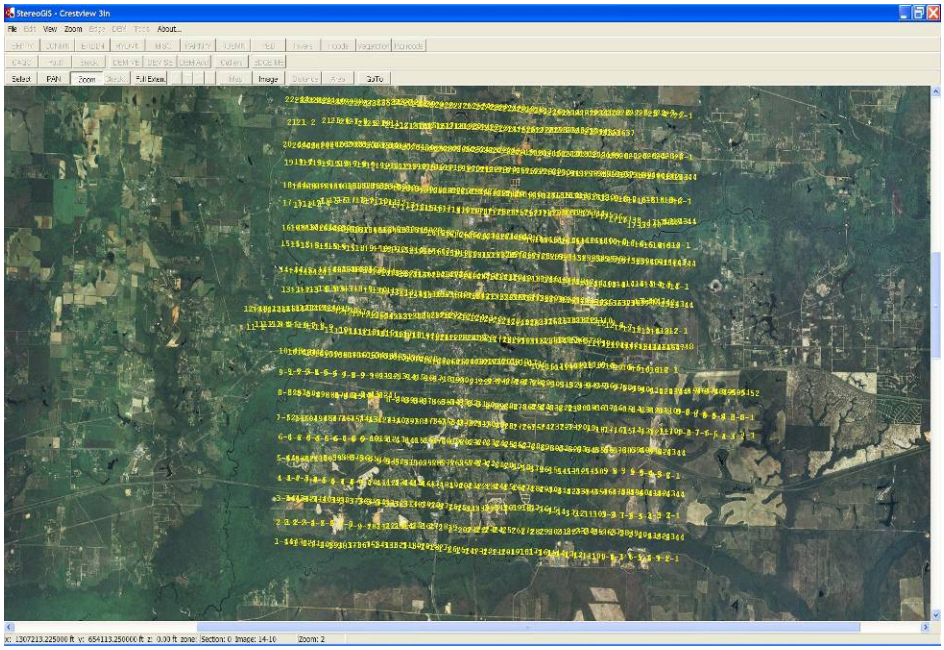
Data recording device integration into aircraft

c. Ground Targeting Design

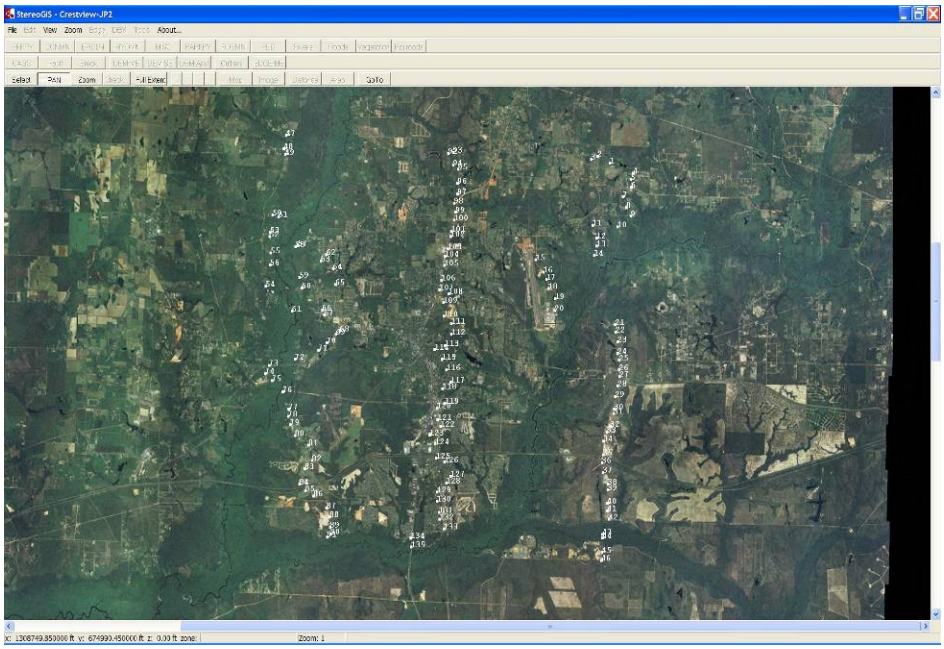
Innova will use its flight test development expertise to establish ground targeting for testing. This targeting will be applied to the FTIR flight data recording development and followed by extensive data collection over selected areas of the Okaloosa County Ground Truth dataset that has been provided as cost-share for this effort. Innova has an existing qualified stereo imagery and ground control database centered on Crestview Florida, including the Bob Sikes Airport, a general aviation airport in Okaloosa County. The imagery covers over 120 sq. miles at 3" resolution. The area has rolling terrain with elevation changes of approximately 150'. It includes predominately urban areas, as well as, mixed agricultural and forested areas.

Using this test database, Innova can update the control information to enable the WRI team to assess current and future accuracy issues related to its sensor suite. SimWright's team of experts in photogrammetry, as well as, sensor accuracy assessment will enable a full end-to-end analysis of the mission effectiveness of the WRI FTIR Carbonyl Detector System.

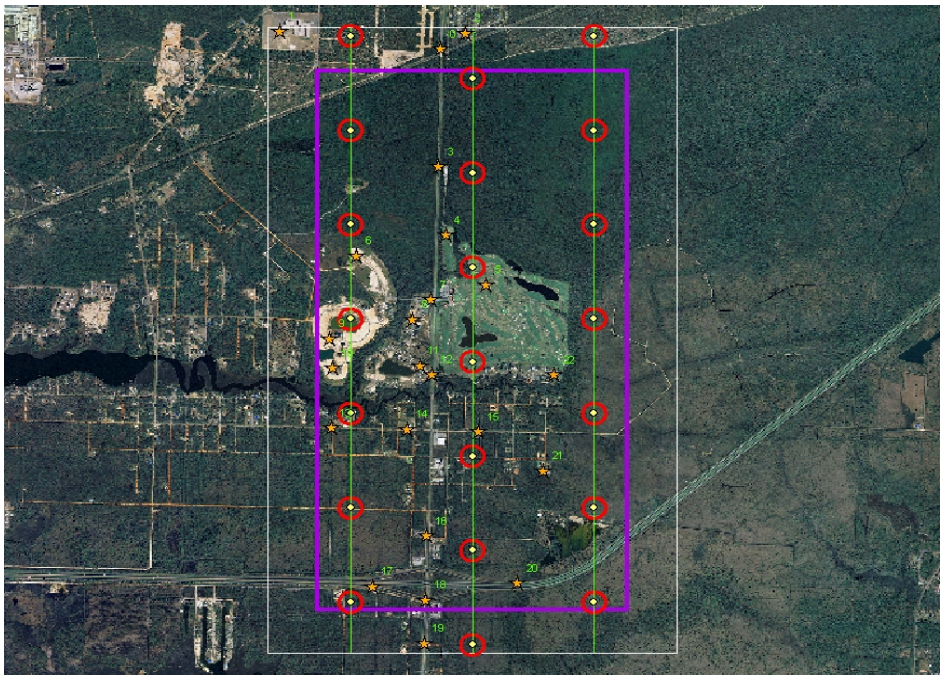
Innova will perform a series of flight tests with the WRI FTIR system within this test area to correlate the FTIR's response with multispectral imagery of pavements within this area. Since, the dataset in existence is multispectral, that is, Red, Green, Blue, and NIR. This will provide aerial registration of the FTIR sensor data combined with the van-mounted measurements on the pavement.



Stereo Imagery Coverage of Crestview test area



Existing Ground Control of Test Area



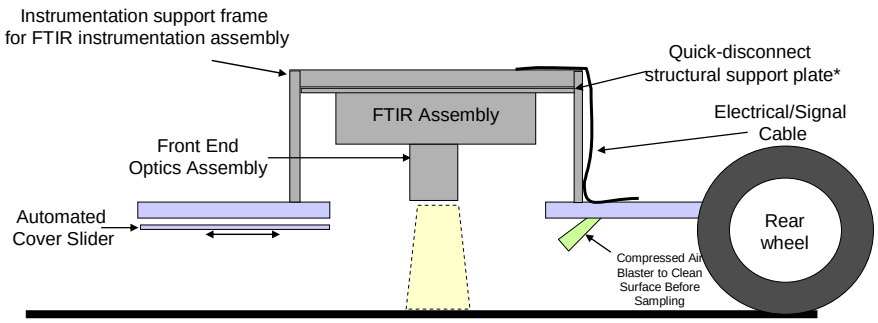
Flight plan targeting for FTIR mission testing

d. Environmental Characterization

The flight environmental considerations are minimal due to the interior mounting of the FTIR in the aircraft. Vibration data will be collected during ground van checkout of the system. Innova has extensive vibration data collected on the Cessna 172 series aircraft and will ensure that the FTIR to aircraft mounting will not be an issue for in-flight testing.

We will provide functional drawings of the mechanical fitment of the FTIR device within the Cessna to include all electrical and optical alignment with the other test assets on the aircraft to ensure co-georegistered image/infrared datasets. The FTIR device will be designed to operate within the flight test environment. Innova has designed the ground vehicle mechanical harness for the FTIR sensor to enable it to be dismounted and mounted with minimal difficulty. This design provides the unit to be mounted in the aircraft with identical operation and mechanical fitment to the van mounted system. In this way, there will be minimal mechanical retrofitting to mount the FTIR in the Cessna belly-mount. This design consideration was utilized when developing the mount in the van.

ASAP System Conceptual Diagram in Van – Notional

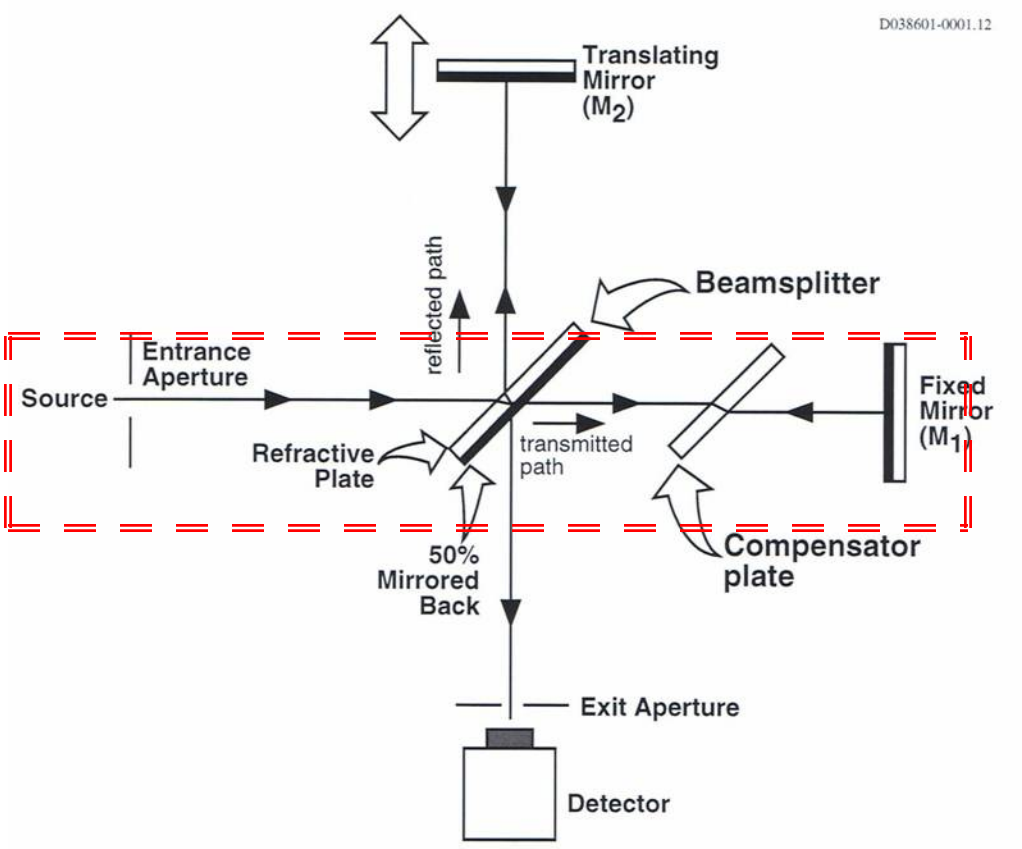


*design will be compatible and certifiable for aircraft testing

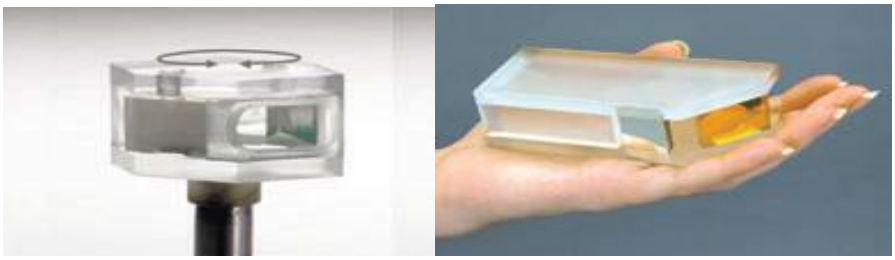
e. Engineering Evaluation of FTIR Airborne Collected Data

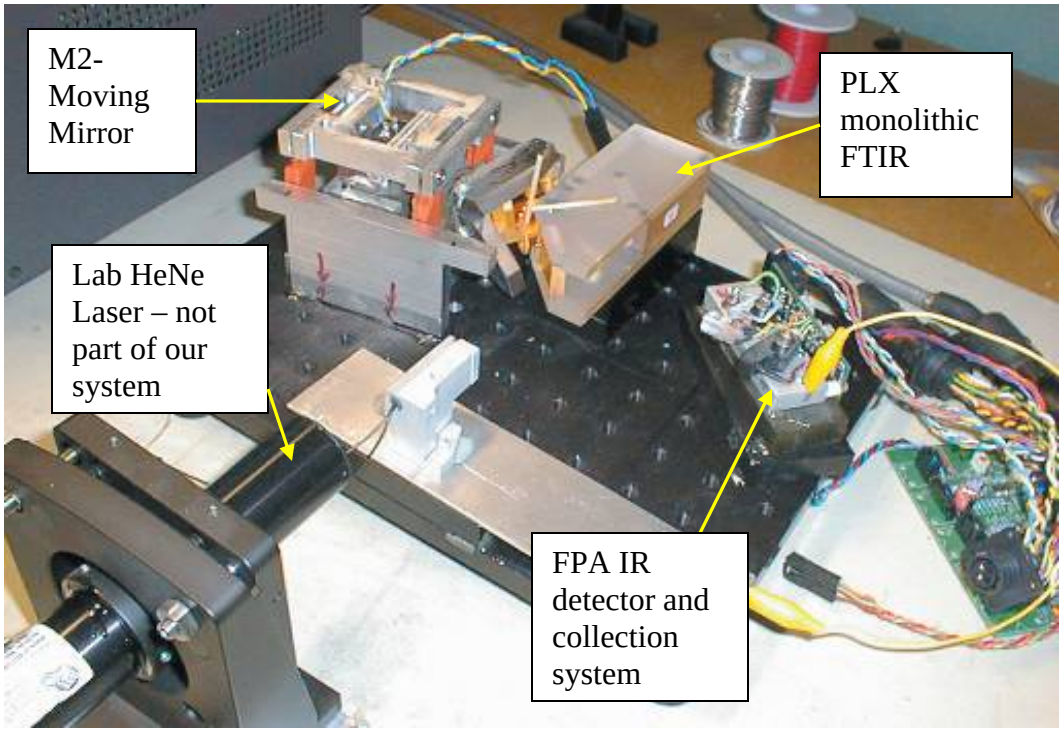
The Monolithic FTIR device is a unique implementation of a standardized Michelson Interferometer taking advantage of material science and state-of-the-art computerized milling and machining. The basic device consists of a handful of monolithic elements that in themselves are low risk elements in the overall design of the ruggedized device.

Innova, in-concert with PLX, will design and construct a field-portable device from the existing breadboard design used to demonstrate the feasibility that these device components function effectively as a traditional FTIR sensor system.



System block diagram of FTIR (PLX FTIR elements in red box)





Breadboard demonstration of monolithic FTIR

The FTIR system will be accessed via the cargo door on the Cessna 172. The system will be mounted in the enclosure developed for van testing and will be instrumented to ensure that it is vibration isolated and electrically powered to ensure proper data collection. The system will be easily accessible such that it can be removed and installed in similar Cessna 172 aircraft at various locations around the country and world. This configuration will enable the camera system and functioning FTIR system to collect coincident data in subsequent airborne testing environments, if desired. The optical platform for the FTIR prototype shown above is 12" X 16".

Cargo door access to FTIR device

Appendix A – Flight Operations

The airport was renamed Peter Prince Airport in 1991. In the 1930's Mr. Prince was a mechanic working in Massachusetts with the Granville Brothers, designers of the GeeBee racing airplane. During WWII he moved to Miami and was in charge of maintaining the fleet of Stearman training planes in that area. He was also engaged in a large banner towing business using Stearmans shortly after the war. He later moved to Foley and began a crop dusting operation, and in 1948 became the FBO at the then Milton-T airport.

In 1993, three additional 6-unit T-hangars were built. During that same year, a new partnership consisting of Mr. Davis Glass and Earl Caudell took over the FBO function.

An above ground fuel storage system containing two 10,000 fuel storage tanks was installed on the west edge of the FBO apron in November 1993.

In 1996, five more 6 unit T-hangars were built, plus a large three unit commercial hangar facility. In addition, a new taxiway was installed from mid-field to the approach end of runway 18 on the west side of the runway.

AMS, Inc. Maintenance Department (http://www.flymilton.com/maint.html) is one of the busiest shops in the local area. Our maintenance staff has kept our flight school fleet of airplanes ready to fly for over ten years. Their dispatch percentage is over 98%, which rivals airline or military maintenance standards. They have operated single and multi-engine Piper and Cessna aircraft since our inception in 1993.

Their capabilities, however, are quite diversified. The maintenance department services aircraft of all makes and models. They have extensive maintenance experience with many aircraft, from the Cessna and Beech to Maule and Navion. They are equipped for major and minor airframe, engine maintenance and repair including modifications and installation of STC's and radial engine maintenance. In addition, AMS maintenance shop is experienced in inspections, including 100-hour, annual, periodic and pre-purchase inspections. Their comprehensive service library includes current manuals and parts catalogs for all the equipment on which we work. We pride ourselves in providing prompt and reasonably priced service, utilizing the latest techniques and equipment.

DAVE RUDOLPH (Chief Flight Instructor)

Dave is retired from the US Air Force and received his instructor rating here at AMS.

PAXTON CORWIN

Paxton received his training at The University of Illinois Institute of Aviation. He has been in the Air National Guard for eleven years and brings a variety of experience to his instructing.

STEVE CRAMER

Steve received his training at The University of Illinois Institute of Aviation and has been flying for over fifteen years.