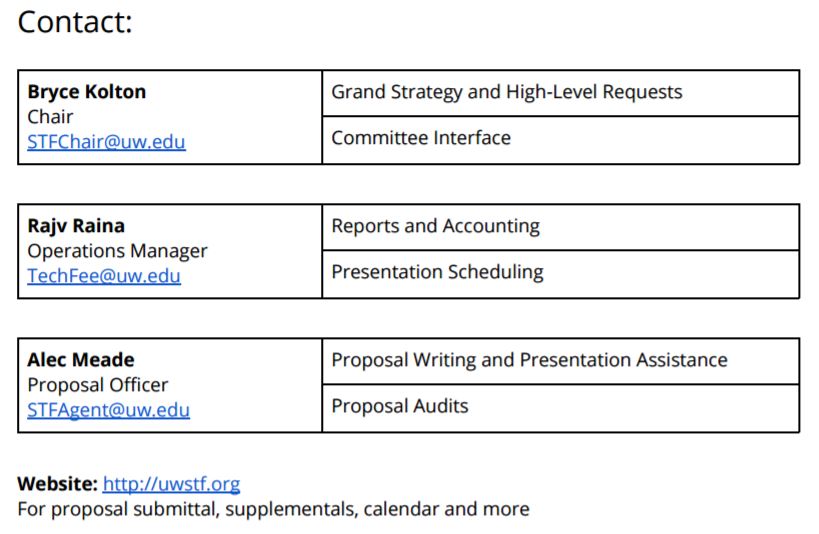
# Notes



<https://uwstf.org/>

**We are Proposal 2017-39: LiDAR Sensor Integration**

<https://uwstf.org/proposals/2017/39>

## Timeline/Deadlines

 15th December 2016: Proposals Begin

 3rd January 2017 @ 5pm HUB303: Proposal Workshops

 3rd January 2017: STF Group Meeting

 6th January 2017 @1pm HUB337: Proposal Workshops

 10th January 2017: STF Group Meeting

 12th January 2017: Hannah, Scott, Connor, Zach to have finish adding everything they would like

 12th January 2017: Move everything from Perforce document to the Online Proposal

 12th January 2017: Address the STP Proposal Officer to look over the proposal

 13th January 2017: Final Draft Completed

 13th January 2017: Submit to Budget Director and Department Chair for Signatures

 20th January 2017: Proposals Submission Deadline

 20th January 2017 @ 330-530pm HUB303: Committee First Winter Meeting

 31st January 2017 @ 230pm GUG212: Mock Presentation

~~ 6~~~~th~~ ~~February 2017 @335pm HUB303: Hearing Proposals / STF Presentation~~

 13th February 2017 @335pm HUB303: Hearing Proposals / STF Presentation

 21st February 2017 @930am AERB139: Meet with Lizzie Palmer (STF Proposal Liaison)

27th February 2017 @ 230-530pm: Committee Votes on Heard Proposals

 Week of March 27th: Funds Awarded

 July 1st: Funds Returned

## To-Do

 Assign primary, budget, dean/department contact.

 Need departmental endorsements, recommend appropriate departmental support

 Need student endorsements, any student who stands to benefit from the project

 Finish filling in the blanks.

 Proof read, make sure everything is grammatically and correct in general.

 Remove Hannah from Student Contact

 Gain signatures from all contacts.

 Submit.

 Prepare for presentation.

 Prepare for meeting with STF proposal liaison.

 Check Results

# Notes from Various People

## 20170105 Beast Author

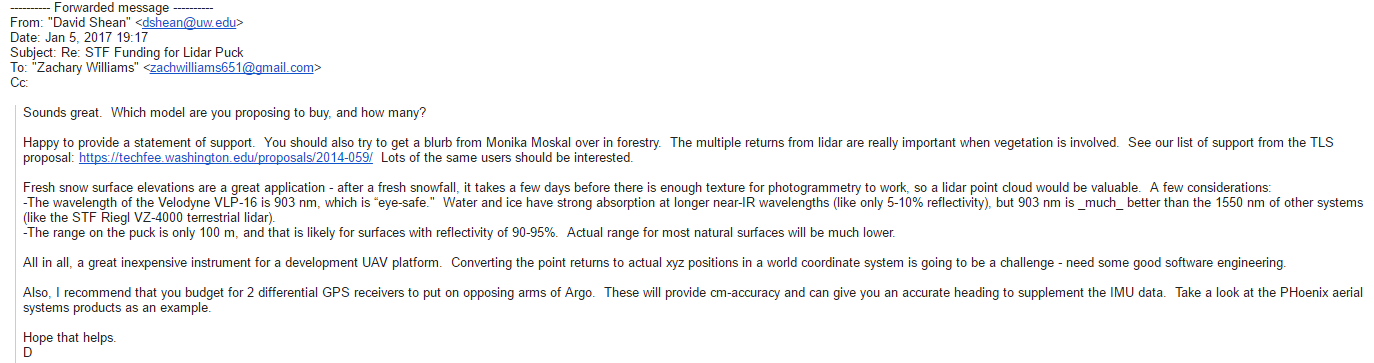
David Shean: [dshean@uw.edu](mailto:dshean@uw.edu)

Beast Proposal #1: [~~https://techfee.washington.edu/proposals/2013-079/~~](https://techfee.washington.edu/proposals/2013-079/)

<https://uwstf.org/proposals/2013/079-1>

Beast Proposal #2: [~~https://techfee.washington.edu/proposals/2014-059/~~](https://techfee.washington.edu/proposals/2014-059/)

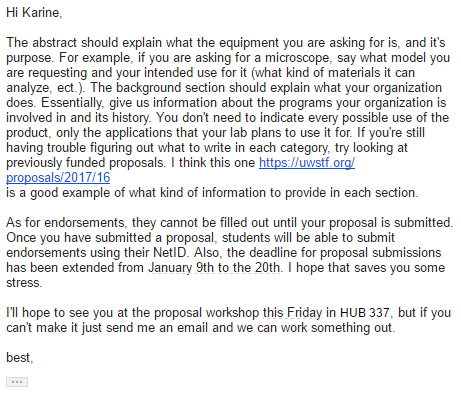
<https://uwstf.org/proposals/2014/059-1>



## 20170104 Tech Fee Proposal Officer: Alec Meade

Alec Meade: [stfagent@uw.edu](mailto:stfagent@uw.edu)

Good Example: <https://uwstf.org/proposals/2017/16>

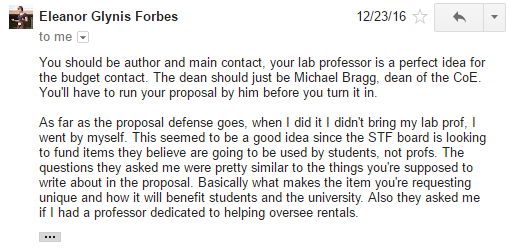


## 20161223 Previous Proposal Author

Eleanor Forbes: [egf6@uw.edu](mailto:egf6@uw.edu)

Proposal: [~~https://techfee.washington.edu/proposals/2015-016/~~](https://techfee.washington.edu/proposals/2015-016/)

<https://uwstf.org/proposals/2015/016-1>



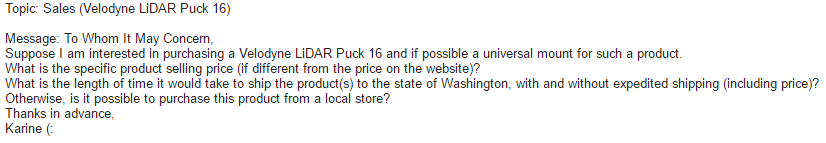
## Velodyne LiDAR, Inc.

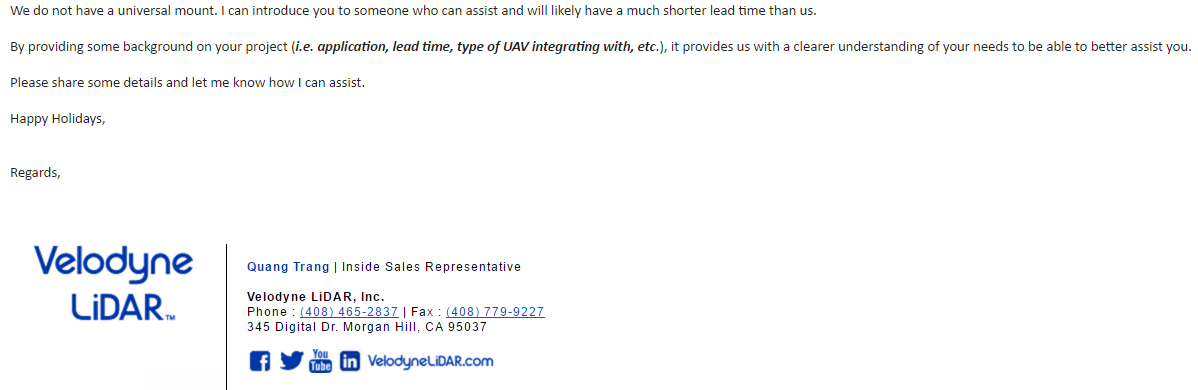
Quang Trang | Inside Sales Representative

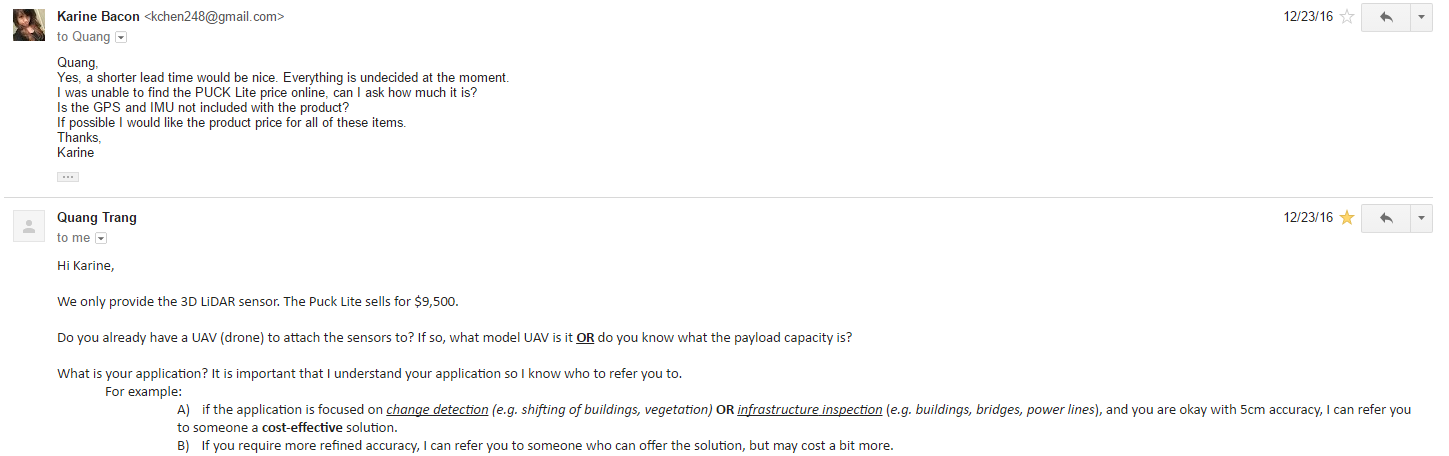
Velodyne LiDAR, Inc.

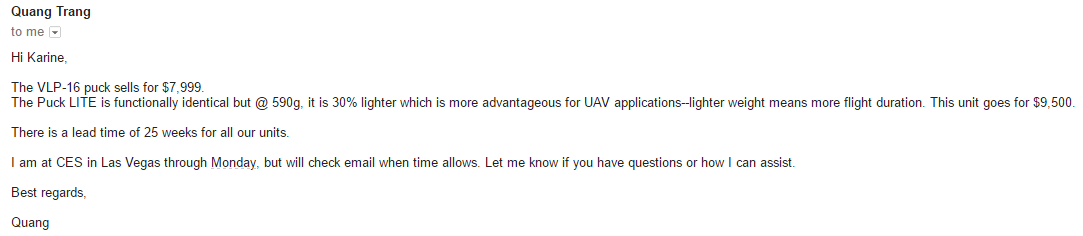
Phone : (408) 465-2837 | Fax : (408) 779-9227

345 Digital Dr. Morgan Hill, CA 95037









## Endorsement: Christopher Lum

To Whom It May Concern,

I am writing to strongly endorse the Student Technology Fund (STF) proposal for purchasing a Light Detection and Ranging (LiDAR) sensor for Unmanned Aerial Systems (UAS) at the University of Washington (UW). As a faculty in the William E. Boeing Department of Aeronautics & Astronautics, I can envision countless applications of this technology to student projects and education at the UW. This system will obtain large data sets of accurate position information. This has applications to mapping, robotics, navigation, forestry, and many others. As such, students in engineering, computer science, agriculture, architecture, earth and space sciences, and many other departments on campus will benefit from its usage. This sensor can be used in classroom demonstrations, educational curriculum, and many other scenarios that directly benefit students. For example, as an instructor, I would use this equipment in “AA101 – Introduction to Air and Space Vehicles” and in “AA448 – Control System Sensors and Actuators”. Many other classes in other departments could integrate this system into their curriculum as well. In addition to student education, many research programs on campus will be able to utilize this technology to benefit their programs. Many PIs on campus have research that requires the ability to obtain data sets similar to those obtained from this equipment. These include laboratories that focus on unmanned aircraft, remote sensing, autonomous cars, and forest management. Finally, STF has previously funded proposals that focused on obtaining unmanned aircraft. The technology in this current proposal would integrate with these systems, thereby acting as an educational force multiplier to the STF inventory of equipment. Please feel free to contact me if you have any questions or concerns, thank you.

Christopher Lum, Ph.D.

Research Assistant Professor

William E. Boeing Department of Aeronautics & Astronautics

University of Washington

# 20170106 STF Funding Workshop Notes

1pm @ HUB 337

Tech Fee Proposal Officer: Alec Meade [stfagent@uw.edu](mailto:stfagent@uw.edu)

## Proposals that STF Does Fund

Projects that directly benefit students.

New and unproven technologies.

## Proposals that STF Does NOT Fund

Specialized Projects (that pertains to only a specific laboratory or research)

Insurance (generally if it’s a monthly fee), but would be possible to request if it is a one time fee.

Long term commitments.

## Proposal Process

Write and submit.

Present to committee.

Await a Decision.

## Changes to STF

Website is changed from [~~https://techfee.washington.edu/~~](https://techfee.washington.edu/) to <https://uwstf.org/>.

Instead of annual model, it is now a quarterly model.

Autumn Deadline changed from ~~January 9~~~~th~~ to January 20th.

## Important Dates

Proposal Deadline: January 20

Funds awarded: week of March 27th

Funds returned: July 1st

## Q & A

**Can we budget some money to pay one of the members to integrate the system and conduct preliminary flight testing of the system to get it operational?**

Most likely not. STF tried it at one point and it didn’t work out so well. The lab could still ask for it, but must have a very straight forward plan, with a specific person to oversee the project, include a timeline, include a back up plan, and can only be applied to students at UW. Try to write the proposal timeline based on if no funding was given to provide salary. If it does get approved, it will require reports in general (quarterly or annual depending on the proposal) to make sure we are on track.

**Reports in general?**

With or without a specific paid person integrating the system, the lab would still need to generate quarterly or annual reports, depending on what we request.

**Multiple options?**

It is possible to submit one proposal that include both the VLP-16 and the VLP-LiTE. The suggest this as an excellent idea because if they decide that we don’t need the VLP-LiTE, the whole proposal isn’t simply rejected.

**Specific difference between abstract and background and benefits to student and university?**

Abstract – who you and what your project is, we are AFSL, we want lidar sensor to attach to existing drone, we want to do that, so we can achieve this.

Background – information about the organization, this is what do, and how long we’ve been around for. (Commotion maker space example) information about equipment

Benefits to Student and University – incorporate it into Research and Scholarship AND Education Experience

**Presentation After the Proposal?**

After the proposal is submitted, the board will email the primary contact a week or two ahead to schedule a presentation date. On the day of the presentation, the lab can bring 1-4 people, usually a total of three people presenting. The primary contact needs to attend, it would be good to bring the professor if he is involved in this proposal, otherwise, bring the ones most directly involved (e.g. ARGO Team and Mapping Team). The presentation will be 10 minutes long, with a recap of the proposal, and 7 minutes of questions. It would be wise to bring in a physical object that pertains to the proposal (e.g. actual UAS to be integrated: ARGO or TEDD or both).

**Requirements for endorsements?**

It would be wise to have student and department endorsements, but it is not required to have any. It may look bad for the proposal if there are no endorsements. For department endorsements, it would be good to have the budget director and department head to each write one as they will be supporting the proposal. For students, it would be good to have those directly involved write an endorsement. Endorsements will be available once the proposal is submitted and will remain available to submit until the end of the quarter, before you present. If at the end of the quarter, there are more endorsements added on, notify the proposal officer, so he can notify the board.

**How does signatures work?**

At the end of the online proposal, a signature is required from the primary author, dean or department head, and the budget director. Once all signatures have been collected, the Submit button will be available to submit the proposal.

**Is there a save button for the online proposal?**

Yes, on every section, there will be a save button at the bottom of the page. Please make sure to click save before you move onto a separate page. Everyone that has given their NetID and are written in the contacts section will have access to the proposal online. Please note that there are only 3 slots for the additional contacts.

Here is the link to sign into the proposal with the NetID you provided: <https://uwstf.org/proposals/myproposals>

Scott, Connor, Zach: if possible, please start researching the mount that you guys would like to use to integrate the LIDAR sensor into the UAS of your preference. The company that sells the sensors does not provide mounts, but if we can find the ones you guys need, we can add it into the items list of the proposal.

# 20161215 Rough Draft

## Introduction

### Contacts

Primary Name Karine Chen

Title Student Research Assistant

Email kchen248@uw.edu

Phone (909)576-8899

Mailbox AERB 139

Budget Name Chris Lum

Title Research Scientist

Email lum@u.washington.edu

Phone (206)409-0204

Mailbox AERB 138

Dean Name

Title

Email

Phone

Mailbox

## Descriptions

### Abstract

This proposal, prepared by students representing several engineering disciplines in the Autonomous Flight Systems Laboratory (AFSL), seeks funding for a Light Detection and Ranging (LiDAR) sensor. When mounted on one of the several UAV platforms utilized in AFSL its several partner labs, the LiDAR sensor will use lasers to create high-resolution, 3D aerial imagery of the terrain, vegetation and animal life.

The VLP-16 LiDAR puck offers a wide range of survey capabilities and will accommodate users of all experience levels. It will provide student researchers with the hardware and software necessary for the aerial data collection essential for cutting edge UAV research and autonomous functions in this rapidly evolving industry. It will also create opportunities to increase research possibilities, education, and collaboration. This type of accessibility to data and technology is crucial for many modern applications and will make the UW more competitive for future research and funding opportunities in the UAV field.

~~This proposal, prepared by students in the Autonomous Flight Systems Laboratory (AFSL), seeks funding for a Light Detection and Ranging (LiDAR) sensor that can be carried on-board a small UAV for. High-accuracy imaging data is essential to the research in the laboratory for its primary use in mapping, surveying, and surveillance applications.~~

~~The VLP-16 offers a wide range of survey capabilities and will accommodate users of all experience levels. This technology will provide researchers in the laboratory the hardware and software necessary for aerial surveys, animal monitoring, and precision agriculture. These data will be essential for cutting edge UAV research and autonomous functions in this rapidly evolving industry. The sensor will allow the UAVs to collect detailed visual data collection and can be used for creating high-accuracy digital elevation models using structure from motion technology. It will also create opportunities to increase research possibilities, education, and collaboration. This type of accessibility to data and technology is crucial for many modern applications and will make the UW more competitive for future research and funding opportunities in the UAS arena.~~

### Category Justification / Funding Category

Machine and Research

The Velodyne LiDAR PUCK 16 can be justified in the category of Machinery and Research as a sophisticated system used for various types of research specific to scientific inquiry, fabrication, and development. It is primarily field survey equipment that will be used by students in the Autonomous Flight Systems Laboratory in different field environments.

### Background

UAV performance and capability are closely linked to aircraft size, and therefore, small, low-cost aircraft will inherently have payload, speed, power and endurance limitations. To date, UAVs have been equipped with small size, lightweight visible-spectrum cameras or, in some cases, near-infrared cameras for conducting air quality measurements. Optical sensors that can be carried on-board a UAV for air pollution monitoring, ranking Light Detecting and Ranging (LIDAR) sensors as the best optical device to be used as a payload for air quality monitoring Larger platforms are costly and require a significant financial investment.

The current technology used in the laboratory presents significant challenges to collecting data. We currently use multiple applications for mapping such as the Canon S100 camera and the MicaSense RedEdge cameraalong with the software Mission Planner and AgiSoft. We conduct flight missions to fly our laboratory unmanned autonomous systems using flight plans preplanned by researchers in the laboratory and collect the data from photos taken from the camera. Current imaging platforms require complicated and unreliable gimbal systems to stabilize the cameras which can result in poor image quality. Integrating LiDAR sensors into current UAVs would minimize errors caused by unstable flight and would provide high quality models. LiDAR sensing is becoming a major method of acquiring high-accuracy geospatial data more economically and safely than traditional in-field methods and evolving as one of the newer and better equipment. This will facilitate more precise and targeted studies of \_\_\_\_, which will strengthen the research of UW students.

Between a camera and LiDAR sensor, cameras measure light reflected from an object into the camera, whereas LiDAR sensors illuminates the objects while avoiding any environmental influences. Camera images are typically in color and display a visual image of the surrounding similar to what the human eye experiences but does not measure distance in three dimensions. It may work in a number of controlled scenarios, but are ultimately unreliable as single data source. They are easily blinded by oncoming light or don’t see anything in twilight or shadows and therefore cannot distinguish important items at a distance, such as traffic signals. Velodyne's LiDAR sensor are independent from such environmental factors as the LiDAR sensor itself illuminates the objects while avoiding obstacles by means of spectral and temporal filtering.

Light Detection and Ranging, or LiDAR for short, is a remote sensing technology where the environment is usually scanned with a pulsed laser beam and the reflection time of the signal from the object back to the detector is measured. The assembly includes a tilting mirror, optical rotary encoder, servo motor, laser source, objects, optical rotary encoder, and a receiver.

How LiDAR works: light pulses are sent out, reflected off objects and received for interpretation

* emission of a laser pulse
* record of the back scattered signal
* distance measurement (time of flight x speed of light)
* retrieving plane position and altitude
* computation of precise echo position

~~Types of LiDAR~~

* ~~Airborne (system installed in either a fixed-wing aircraft or helicopter)~~
* ~~Bathymetric (collect elevation and water depth simultaneously)~~
* ~~terrestrial (collects very dense and highly accurate points)~~
  + ~~mobile (mounted on vehicles, trains, and even boats)~~
  + ~~static (mounted on a tripod mount and is a fully portable, laser-based ranging and imaging system)~~
* ~~topographic (forestry, hydrology, surveying, geomorphology)~~

~~There are different kinds of LiDAR sensors currently available in the market, some of which includes high-functionality, low-functionality, and solid state LiDAR sensors. High-functionality sensors are unique as they use multiple laser beams (patented technology) to measure its environment in 3D very fast and accurate, ideal for quick detection, mapping and localization. Flash LiDAR is a lower functionality alternative technology that requires a much larger and more costly light source to illuminate the whole scene while only a fraction of the light that is reflected into the direction of the sensor is detected by the individual pixels. Solid State approaches are experimental and in the early stages of research. Its future sensors would be only directional and therefore multiple sensors would be needed for a full surround view if this technology ever matures to a commercially useful level.~~

General uses, include, but not limited to:

* Drone Collision Avoidance
* Ground And Above Ground Imagery
* Structural Inspection

General applications, include, but not limited to:

* Agriculture & forestry
* Archaeology and cultural heritage documentation
* Corridor mapping: power line, railway track, and pipeline inspection
* Topography in open-cast mining
* Construction site monitoring
* Building and structural inspections
* Surveying of urban environments
* Resource management
* Collision avoidance
* Shoreline and storm surge modeling
* Hydrodynamic modeling
* Digital Elevation Models

~~General applications, include, but not limited to:~~

**~~DEM (Elevation Value)~~**

* ~~DEM (Digital Elevation Model: Elevation Value): capture surface height in roads, building, bridge and other~~
* ~~Micro-Topography: capture surface elevation value that is hidden by vegetation or forest canopy~~
* ~~Agriculture: create elevation map of the farmland that can be converted to create slope and sunlight exposure area map; create high, medium and low crop production area~~
* ~~Forest Planning and Management: measure vertical structure of forest, canopy bulk density, and canopy base~~
* ~~Forest Fire Management: monitor the possible fire area which is called fuel mapping (fire behavior model)~~
* ~~Precision Forestry: planning and operating the site specific forest area to increase the productivity of wood quality, reduce cost and increase profits, and maintain the environment quality~~
* ~~Tourism and Parks Management: high accurate land surface model helps to find the best area to have playground, trees and walking trail~~
* ~~Environmental Assessment: micro topography data generated is done to protect the plants and environment~~
* ~~Biodiversity for Birds: analyze forest (vertical structure) to see whether it is suitable place for birds, animals and insects.~~
* ~~Flood Model: create high resolution and accurate surface model of the river~~
* ~~Watershed and Stream Delineation: create watershed area and stream line delineation~~
* ~~ELC (Ecological & Land Classification): provide the biological and physical information of the landscape which helps in the sustainable management~~
* ~~River Survey: water information is required to understand depth, flow strength, width of the river and more~~
* ~~Modelling of the Pollution: detect pollutant particles of carbon dioxide, Sulphur dioxide and methane~~
* ~~Mapping: surface model created is used to add graphical value to maps; DEM (from LIDAR) is added underneath of all layers that shows the 3D view of the land which makes easier to plan roads, buildings, bridges and rivers~~
* ~~Management of Coastline: understand the coastline erosion occurrence~~
* ~~Transport Planning: understand width, elevation and length of the existing road~~
* ~~Oil and Gas Exploration: detect molecules content in the atmosphere that has same or bigger wavelength; trace amount of gases above the hydrocarbon region~~
* ~~Mining: measure the ore volume by taking series of photos of ore extraction space~~
* ~~Archeology: detect micro topography that is hidden by vegetation which helps archeologist to understand the surface~~
* ~~Exploring Quarries and Minerals Area: understand human civilization by finding the quarry and minerals site~~
* ~~Viewshed Analysis: uses individual cell to determine that is visible or not from all other remaining cells~~
* ~~Solar Energy Planning: some basic requirements with installation of the Solar panel are identified by the help of the LIDAR data~~
* ~~Right to Light: produce shadow map which shows illumination area during particular time of the day~~
* ~~Glacier Volume Changes: calculate the glacier change over the period~~
* ~~Gaming: capture the surrounding area and this data is feed into the computer and color code is added to it~~
* ~~Accident Scene: capture the accident and crime scene; quickly to record the accident scene on the road that can be used later for the investigation~~
* ~~Architecture: capture the buildings structure to design the house model~~
* ~~Recording of Building: record the inside of the house, interior design, and can be printed on the 3D printer to model it~~
* ~~BIM: planning, organizing and subsequent growth in the energy and utilities industries~~
* ~~Cellular Network Planning: collected surface model can be feed into the GIS system to create the line of sight or view shed map~~
* ~~Vehicle Automation: grab the information on the road and it is passed to computerized system to make a human being like decision~~
* ~~Sewer and Manhole Survey: sensor attached with the robotic machine are sent into the pipe where that is not accessible by human being physical for survey.~~
* ~~Meteorology: uses its wavelength to strike small particles in the cloud to understand it~~
  + ~~Elastic backscatter LiDAR: studies of aerosols and clouds.~~
  + ~~Differential Absorption LiDAR (DIAL): measurements of a gas like ozone, carbon dioxide, or water vapor.~~
  + ~~Raman LiDAR: measuring the concentration of atmospheric gases and quantity of aerosol parameters present.~~
  + ~~Doppler LiDAR: measure wind speed~~
* ~~Geology: finding the fault and measuring the uplift (e.g. Seattle fault in the Washington State)~~
* ~~Astronomy: create the topographic map of the red planet (e.g. the NASA Mars Global Surveyor)~~
* ~~Atmospheric Physics measure the concentration of oxygen, nitrogen, potassium, sodium and other gas particles in the middle and upper atmosphere~~
* ~~Oceanography: calculation of phytoplankton fluorescence and biomass in the ocean surface; measure the depth of the ocean (bathymetry)~~
* ~~Military: creates high resolution map for the military purpose~~
* ~~COPS: LIDAR gun detect the speed of the vehicle and also use it to understand the traffic flow~~
* ~~Forensic: embraced by police department, law enforcement agencies and government crime agencies~~
* ~~Imaging: LID create 3D image of the object that is in distance~~
* ~~Wind Farm: calculate the direction and strength of wind~~
* ~~Dune Monitoring: monitor the dune activities (change in size and shape, vegetation, and rate of change)~~
* ~~Urban Municipality: survey the city~~
* ~~Railway Infrastructure: perform the measurements of the railway track and the topographical and surrounding area of the railway path~~
* ~~Airport Infrastructure: capture features in the airport like runway, terminal building, hangar and other objects~~
* ~~Tunnel Surveying: measure accurate and detailed measurements, used for analysis, assessment and modelling of the tunnel that is for railway track or road~~
* ~~Tsunami Inundation Modeling: help scientist to understand the area that will be covered when Tsunami happens~~
* ~~ISMP (Integrated Storm Water Management Plan): ecosystem-based approach to rain water management; to balance between land use planning, storm water engineering, flood and erosion protection, and environmental protection~~

The VLP-16, as requested falls under the category of high-functionality sensors. Since each laser beam is matched to the numerical aperture of the detector, minimum power consumption is needed, which is especially useful in power conscientious mobile applications like backpack systems and for the use on Unmanned Aerial Vehicles. Also, the lower power lasers allows for precise reflectivity measurement to quickly locate lanes, street signs, etc... Real-time 3D LiDAR sensors are deployed world-wide measuring distances and calibrated reflectivities in mission critical applications.

Companies that uses LiDAR sensors, include, but not limited to:

* SpaceX (Dragon docking with the ISS)
* Google (Self-Driving Cars)
* Tesla (Self-Driving Cars)
* Civil Maps (localization and mapping solutions)
* Green Valley International (aerial and ground data acquisitions)
* Infinite Jib™ Inc. (commercial UAV with mobile mapping)
* LiDAR USA (mobile and aerial LiDAR mapping)
* Phoenix Aerial (revolutionizing geospatial industry)
* YellowScan (surveying and forestry)
* Real Earth, Inc. (3D mapping)
* iLinks Geosolutions LLC (hydrographic and topographic surveying).

Velodyne’s 3D, real-time LiDAR sensors measure distances by measuring the Time of Flight (TOF) that it takes a short laser pulse to travel from the sensor to an object and back, calculating the distance from the known speed of light. Combining multiple laser/detector pairs (up to 64) into one sensor and pulsing each at 20kHz allows for measurements of up to 1.3million data points per second. In addition to each distance measurement, Velodyne’s LiDAR sensors also measure calibrated reflectivities that allow for easy detection of retro-reflectors like street-signs, license-plates and lane-markings.

This real-time 3D lidar has a range of 100 m, low power consumption of (~8 W), light weight (830 g), compact footprint (~Ø103 mm x 72 mm). Its dual return capability makes it ideal not only for autonomous vehicles but also robotics and mobile terrestrial 3D mapping applications. This sensor supports 16 channels, ~300,000 points per second, a 30° vertical field of view, with ± 15° up and down, and a full 360° horizontal field of view by rotating the laser/detector pairs up to 20 times per second. Its protective design does not have visible rotating parts, making it highly resilient in challenging environments while operating over a wide temperature range from -10°C to +60°C.

Different applications require different demands on the data quality, however it is universally accepted that an abundance of data is absolutely necessary for the most reliable object detection. While LiDAR sensors with only one or a few laser channels can give a general indication that an object is in front of the sensor, Velodyne's data rich point clouds allow for the highest level of object recognition in real-time. The real-time aspect is of uttermost importance here as sensors with only one or few laser channels might be able to accumulate data over time, however that is not sufficient in real-world applications for localization and safety-related data for critical real-time safety decisions. LiDAR 3D data is abundant enough to make those lifesaving determinations within the short amount of time available.

Velodyne's wide field of view (up to 360°) allows not only making object recognition decisions for objects directly in front, but also towards objects on the side and rear. LiDAR data can discern a person from streetlight standing on the curb, as well as identify a fast-closing object from the sides or rear. The surround view capability is a major advantage of the sensor in terms of object recognition and safety when compared with mostly directional, limited field of view, limited laser count sensors.

After taking into consideration Seattle weather, Velodyne's LiDAR sensors work well in snow, sleet, and rain. The multiple beam approach of the sensor with laser beams with millions of laser beams at different angles enables to find "holes" in-between the snowflakes to "see" the environment. An inferior LiDAR with only one or a few laser beams would not work as well as one with 16, 32 or 64 laser beams.

Over the past decade, technological advances and increased consumer demand in UAVs have greatly expanded their scientific applications, reduced their price, improved their safety, and made flying them much easier. Right now, civil and industrial UAV applications are proliferating in areas such as science, business, agriculture, and cinematography. Investing in an UAV integration will help ensure that the UW is at the forefront of this technology, generating expertise that will pay research and educational dividends now and in the future. Unmanned Aerial Vehicles (UAVs) equipped with LiDAR sensors can be used to map the terrain they fly over, generating high-accuracy topographic data. The hardware we are requesting will allow researchers to quickly and easily acquire high-accuracy geospatial data.

### Benefits to Students and the University

LiDAR sensors would greatly enhance the ability of \_\_\_\_ researchers at the University of Washington, to learn the \_\_\_\_\_ in various flight missions. A LiDAR sensor would increase the maximum framing capacity and the accuracy of the data collection.

The sensor has direct benefits for student researchers. It will provide graduate and undergraduate students with hands-on experience in both diagnostic implementation and data analysis. Students would have an opportunity to learn about image processing and operations of through mapping, as well as other skills that are applicable in many research and development projects. Interpretation of the data acquired by LiDAR sensor does not require the sophisticated analysis inherent to diagnostics acquired by multiple software.

(Scott insert specifics on how you’d use this sensor, for example, animal peeing and tree watching)

The VLP-16 will be implemented inside a UAV with a mount created by students and data collection will occur during flight operations in various locations with various environments. The sensor will capture images of trees, buildings, plants, cars and various objects.

Applications that could benefit from this resource include, but are not limited to:

* Geology (Engineering and Structural)
* Geomorphology (river migration, hillslope, slackwater Deposits)
* Stratigraphy
* Forestry
* Ecology
* Civil Engineering

Applications that could benefit, but are outside of the study in the lab:

* Paleoclimatology (climate changes)
* Paleotopography (vertical crustal movements)
* Sedimentology (sediments resulting from erosion and weathering)
* Paleoseismology (earthquake monitoring)
* Archaeology (urbanization)
* Architecture (landscape mapping)

Research organizations that could also benefit from this resource include, but are not limited to, (that fish one next to us), \_\_\_\_, and \_\_\_\_. We will also be able to guide the use of this advance technology to the student body who would request to use it. The sensor will also establish the student researchers as having expertise in state-of-the-art technology, adding to the UW’s prestige.

Examples of research programs that would benefit from the use of a LiDAR sensor are Professor \_\_\_\_\_\_ research in \_\_\_\_, Professor \_\_\_\_\_\_ research in \_\_\_\_, Professor \_\_\_\_\_\_ research in \_\_\_\_, and Professor \_\_\_\_\_\_ research in \_\_\_\_. Other researchers at the University of Washington will also have access to unique equipment that would allow for much higher fidelity experiments that would otherwise not be possible.

### Department Endorsements

*The author’s proposal must be approved by a Dean, department chair, or program equivalent (eg. Associate Vice President of Student Life)*

(Insert department endorsements here)

### Installation Timeline

The items described in this proposal will be ordered within one week upon receiving the STF budget award. The items will be shipped by the suppler, Velodyne LiDAR, via FedEx/USPS/UPS and will arrive to the AFSL within 5 business-days. The hardware will then be mounted onto either the DJI S1000 Octocopter or one of the Skywalker 1900s in the laboratory by the Mapping team within one week of arrival.

### Resources Provided by Department

The laboratory has made a long-term commitment to unmanned systems along with possible integrations. Suitable UAVs are already in place within the laboratory, ready to fly. The sensor would be mounted on a DJI S100 octocopter that was previously funded by the Student Tech Fee, substantially expanding the platform’s usefulness. Laboratory researchers have prior experience with fast-framing camera use and data processing. Experience pilots are all licensed and well trained in handling fragile equipment.

Hardwares and Softwares: Mission Planner is installed on all the computers in the laboratory and mission flight center; both Mission Planner and GeoSense are installed on the laboratory’s mission laptops.

These computers and the software will be fully supported and maintained by the Autonomous Flight Systems Laboratory.

The item requested will not be a continuous funding, all repairs and maintenance will be the responsibility of the laboratory.

### Access Restrictions (if any)

Due to the complexity of the \_\_\_\_\_\_\_\_\_\_\_, only available to authorized personnel and individual students who have had proper training and infrastructure to operate the \_\_\_\_\_\_\_\_.

### Student Endorsements

(Insert student endorsements here)

Basic Format:

Introduce yourself, write your endorsement.

Name

Title

## Items

**Group Item Price Quantity Subtotal**

Hardware Velodyne LiDAR’s Puck (VLP-16) $7999 1 $7999

Other Universal Mount $ 1? 2? $

N/A Washington State Sales Tax (9.5%) $ 1 $

Shipping & Handling $ 1 $

**Total Requested $**

**Description**

Velodyne LiDAR’s Puck (VLP-16)

<http://velodynelidar.com/vlp-16.html>

**Justification**

Velodyne's new PUCK™ (VLP-16) sensor is the smallest, newest, and most advanced product in Velodyne's 3D LiDAR product range. Vastly more cost-effective than similarly priced sensors, and developed with mass production in mind, it retains the key features of Velodyne's breakthroughs in LiDAR: Real-time, 360°, 3D distance and calibrated reflectivity measurements.

## Signatures

Main Contact / Author

Budget Contact

Dean Contact

# 20170113 Final Draft

## Introduction (Finished)

Title: LiDAR Sensor Integration

Category: Machinery and Research

Department: Aeronautics & Astronautics

UAC: no

## Persons

### Primary/Student

Name: Karine Chen

Title: Undergraduate Researcher

NetID: kchen248

Phone: (909)576-8899

Mail: AERB 139

### Budget

Name: Christopher Lum

Title: Research Scientist

NetID: lum

Phone: (206)409-0204

Mail: AERB 138

### Dean/Departmental-Head

Name:

Title:

NetID:

Phone:

Mail:

### Additional Contacts

Name: Hannah Rotta

Name: Connor Kafka

Name: Zach Williams

Name: Scott An

## Abstract (Finished)

### Abstract

(Please provide an overview of the proposal – 500 character limit)

This proposal, prepared by students in the AA and EE departments, seeks funding for a Light Detection and Ranging (LiDAR) sensor; specifically between the Velodyne LiDAR PUCKTM LITE or PUCKTM VLP-16. When mounted on one of the UAV platforms utilized in the Autonomous Flight Systems Laboratory (AFSL) and its several partner labs, the LiDAR sensor will use lasers to create high-resolution, 3D aerial imagery of the terrain, vegetation and animal life.

(explain what the equipment you are asking for is, and it's purpose. For example, if you are asking for a microscope, say what model you are requesting and your intended use for it - what kind of materials it can analyze, etc.)

## Description (Finished)

### Background

(Please situate the proposal in the context of past requests and student need)

As the UAV industry rapidly grows, many student groups are dedicated to investigating and developing the technology relevant to unmanned systems. Many of the projects allow students to work closely with industry partners as they research autonomous technology and explore its future uses, leading the way as drone operations continue to increase across the globe. Investigations consist of applying advanced avionics, sensors, and other payloads to various platforms including off-the-shelf fixed wing and multi-rotor unmanned aerial systems as well as customized platforms. Each project is taken from conceptual design through actual flight testing in the field and post flight analysis.

The current technology used by students presents significant challenges to collecting data. Students in the AFSL currently use multiple applications for mapping such as the Canon S100 camera and the MicaSense RedEdge along with the software Mission Planner and AgiSoft. They conduct flight missions to fly laboratory unmanned autonomous systems using flight plans preplanned by researchers in the laboratory and collect the data from photos taken from the camera. Current imaging platforms require complicated and unreliable gimbal systems to stabilize the cameras which can result in poor image quality. Integrating LiDAR sensors into current UAVs would minimize errors caused by unstable flight and would provide high quality models. LiDAR sensing is becoming a widely used method of acquiring high-accuracy geospatial data more economically and safely than traditional in-field methods and evolving as one of the newer and better equipment. Applying a small LiDAR puck to UAV platforms will allow these data to be acquired more quickly and over a wider variety of terrain features and accessibilities than current ground based systems. This will facilitate more precise and targeted studies of the students’ capabilities, which will strengthen the research of UW students.

(explain what your organization does. Essentially, give us information about the programs your organization is involved in and its history)

### Feedback

(How did you hear of the STF proposal process?)

The first source of STF proposals was obtained from conversations between faculty, students, and researchers. Students in the AFSL have previously collaborated with other laboratories in gaining equipment to share, from which we have data from the old STF proposal process that was passed on through email conversations with former proposal authors. The new STF proposal process starting this quarter was found through the STF website and from Facebook events created by the UW Student Technology Fee Committee.

### Estimated Student Use

(How many unique Students will utilize this equipment? – on a quarterly basis)

About 20

### Justification of Estimated Student Usage

(What evidence implies the estimate above is accurate?

Individual student research teams typically consist of 3 to 5 students. This sensor will be used on a weekly to bi-weekly basis for various projects and will often be utilized with software integrations and data collecting during flight test missions. Our researchers and teams often communicate and collaborate with other research laboratories between projects; however, it is reasonable to expect that each group working with the sensor will need to utilize it for more than one flight mission to collect all their data, resulting in a handful of students directly using it off and on in several week increments so that 6 – 10 students will use it per quarter in addition to the students who will indirectly support the testing operations and analysis. ~~Every year, the university is increasing in size and more students show interest in participating in utilizing advance technology.~~

### Research and Scholarship

(What research and scholarship benefits will students receive from interacting with this technology?)

The Velodyne LiDAR PUCK can be justified as a sophisticated system used for various types of research specific to scientific inquiry, fabrication, and development. It is a primarily field survey equipment that will be used by students in the Autonomous Flight Systems Laboratory and partner labs in different field environments.

The sensor has direct benefits for other student researchers and research organizations as well. It will provide graduate and undergraduate students with hands-on experience in both diagnostic implementation and data analysis. Students would have an opportunity to learn about image processing and operations through mapping, as well as other skills that are applicable in many research and development projects. Interpretation of the data acquired by the LiDAR sensor does not require the sophisticated analysis inherent to diagnostics acquired by multiple software, allowing students to focus on a wider variety of applications.

The sensor will also establish the student researchers as having expertise in state-of-the-art technology, adding to the UW’s prestige. Other researchers at the University of Washington will also have access to unique equipment that would allow for much higher fidelity experiments that would otherwise not be possible.

We would like to request labor funds for student researchers to set up the LiDAR sensor for future student use. Undergraduate students who currently receive research funding will be responsible for implementing the new system, giving them the opportunity to take ownership of this equipment’s function from the start and allowing students the chance to investigate and troubleshoot how to best install and use it. This may include, but is not limited to designing and 3D printing a mount, performing necessary hardware and software integration, developing a test/operation procedure and conducting a test of the sensor, to ensure that it can safely and effectively be used in future student projects. This budgets for 20 hours at a rate of $13/hour.

### Education Experience

(How does the project enhance students’ academic experience?

The proposed equipment will provide valuable resources to UW students from multiple academic courses and departments across campus, including, but not limited to:

* Geology (Engineering and Structural)
* Geomorphology (river migration, hillslope, slackwater deposits)
* Stratigraphy (analysis of the order and position of layers of archaeological remains)
* Forestry (planting, managing, and caring for forests)
* Ecology (interactions among organisms and their environment)
* Surveying and Civil Engineering (aerial scanning and terrestrial scanning)
* Paleoclimatology (climate changes)
* Paleotopography (vertical crustal movements)
* Sedimentology (sediments resulting from erosion and weathering)
* Paleoseismology (earthquake monitoring)
* Architecture (landscape mapping)

A parallel objective is to integrate this technology into the flight mechanics and controls courses in the Department of Aeronautics and Astronautics to provide students experience with realistic GNC systems.

### Career Enhancement

(What career enhancing skills will student gain from working with this technology?)

Over the past decade, technological advances and increased consumer demand in UAVs have greatly expanded their scientific applications, reduced their price, improved their safety, and made flying them much easier. Right now, civil and industrial UAV applications are proliferating in areas such as science, business, agriculture, and cinematography. Investing in UAV integration will help ensure that the university is at the forefront of this technology, generating expertise that will pay research and educational dividends now and in the future. Unmanned Aerial Vehicles (UAVs) equipped with LiDAR sensors can be used to map the terrain they fly over, generating high-accuracy topographic data. The hardware we are requesting will allow researchers to quickly and easily acquire high-accuracy geospatial data.

A LiDAR puck offers a wide range of survey capabilities and will accommodate users of all experience levels. It will provide student researchers with the hardware and software necessary for the aerial data collection essential for cutting edge UAV research and autonomous functions in this rapidly evolving industry. It will also create opportunities to increase research possibilities, education, and collaboration. This type of accessibility to data and technology is crucial for many modern applications and will make the UW more competitive for future research and funding opportunities in the UAV field.

Students will also gain knowledge from learning how to use the LiDAR sensor and take this knowledge with them into future companies that demands advance technological knowledge.

Companies that uses LiDAR sensors, include, but are not limited to:

* SpaceX (Dragon docking with the ISS)
* Google (Self-Driving Cars)
* Tesla (Self-Driving Cars)
* Civil Maps (localization and mapping solutions)
* Green Valley International (aerial and ground data acquisitions)
* Infinite Jib™ Inc. (commercial UAV with mobile mapping)
* LiDAR USA (mobile and aerial LiDAR mapping)
* Phoenix Aerial (revolutionizing geospatial industry)
* YellowScan (surveying and forestry)
* Real Earth, Inc. (3D mapping)
* iLinks Geosolutions LLC (hydrographic and topographic surveying).

## Availability (Finished)

### Access Restrictions (if any)

(What restrictions, if any, will be in place to ensure resource safety but allow for broad usage?)

The equipment will mainly be housed in the Autonomous Flight Systems Laboratory (AERB 139). Due to the complexity of the product, it will only be available to authorized personnel and individual students who have had proper training and infrastructure to operate the sensor and UAS. Access will be administered by the experienced researchers, which includes graduate researchers, undergraduate researchers, and faculty/staff (providing continued support as students graduate).

(below are the availability, but if needed, people do come in on weekends and other hours)

### Hours of Availability

(Enter the expected number of hours a day the resource will be available)

8

### Days of Availability

(Enter the expected days the resource will be available with day abbreviations separated by commas, or ‘all days’)

Mon, Tue, Wed, Thu, Fri

### Outreach Strategy

(What is your planned outreach strategy to inform students about this resource and its location?)

Once we finish installing the system, we will inform the students about this resource on the Autonomous Flight Systems Laboratory website at <https://www.aa.washington.edu/research/afsl>. It will also be shared between direct verbal contacts between students and research laboratories, and other methods that STF has found successful.

## Timeline (Finished)

### Proposal Timeline

(When will items be purchased, when will students have access, etc)

The items described in this proposal will be ordered within two weeks upon receiving the STF budget award. The LiDAR sensor will require a twenty-five (25) week lead time and will be shipped by the suppler, Velodyne LiDAR, but we are also looking at requesting the sensor from LiDAR USA (Velodyne’s national company) on a first come first serve basis. Mounts for the sensor are designed on the computer and will be 3D printed in one of the shops containing a 3D printer. Assuming, we gain the product from LiDAR USA instead of Velodyne, all of the equipment should arrive by June and the assigned researchers with trained LiDAR sensor knowledge will begin assembly afterwards. The hardware will be assembled onto the DJI S1000 octocopter or Skywalker 1900 in the laboratory within two weeks of arrival, first to test compatibility and then moving onto software integration. There will also be an additional twenty (20) hours of flight test preparation, execution and post-flight analysis to ensure all systems are operational and documented. Equipment should be available for trained student use once the mounts and software are integrated properly.

One or more funded undergraduate researchers will dedicate the equivalent of 4 hours per day for the first week (five days) to complete the assembly and integration of the sensor.

There is also a set up overview video provided by the company here (<https://www.youtube.com/watch?v=Pa-q5elS_nE&authuser=0>).

### Human Resources

(What human resources will be provided by the college, department, or program to help ensure project success?)

The laboratory has made a long-term commitment to unmanned systems along with endless possible integrations. Supervision of purchases, equipment functional checkout, and integration with existing hardware will be carried out by professional staff and the head of the laboratory. Experienced graduate and undergraduate students will play major roles in this activity. Laboratory researchers have prior experience with fast-framing camera use and data processing. Experienced pilots are all FAA certified and well trained in handling fragile equipment.

### Technology Resources

(What technology resources will be provided by the college, department, or program to help ensure project success?)

Suitable UAVs are already in place within the laboratory, ready to fly. The sensor would first be mounted on a DJI S1000 octocopter that was previously funded by the Student Tech Fee, substantially expanding the platform’s usefulness.

There are currently four computer sets and two Dell precision mobile workstation laptops located within the laboratory. Each computer and laptop has a working installation of Mission Planner and AgiSoft that will be used with the UAS and LiDAR sensor. There is also a computer build with the same fully integrated software that can be found in the Mobile Flight Operations Center.

### Financial Resources

(What financial resources will be provided by the college, department, program, or any other entity that will help ensure project success?)

None outside of the current purchase request are required. External resources required to manage this sensor will be paid by the laboratory. AFSL will be providing financial support of up to one thousand dollars to support the integration and maintenance of this technology (e.g. maintenance, repairs, flight test, etc.).

### Equipment Protection

(Will your department provide protections of any sort for the equipment: warranties, insurance, in-house maintenance, or the department will not be pursuing such a plan)

The computers and the software mentioned in the technology resources will be fully supported and maintained by the Autonomous Flight Systems Laboratory. The items requested will not be a continuous funding; all repairs and maintenance will be the responsibility of the laboratory.

As mentioned in access restrictions, access will be administered by the experienced researchers, who will provide in house maintenance, and to further secure the product. With the one thousand dollars that the AFSL has agreed to fund, the lab can purchase boxes and security products if deemed prudent. Outside of the available hours, the sensor will be stored in a locked office or laboratory.

LIMITED WARRANTY – Fagerman Technologies Inc warrants that the Products will be free from defects in material and workmanship and materially conform to their applicable specifications for a period of one (1) year from the date of shipment by Fagerman Technologies Inc (the “Warranty Period”).

(Will we have specific boxes to store these items? Aside from the box they give us when they ship it to us)

## Items (Finsihed)

Requirements:

Name

Group: (Group by priority of needed funds, or by components - e.g. Software, Hardware)

Quantity: (Number of units desired)

Price: (Cost per unit - exclude dollar sign)

Description: (Describe the item)

Justification: (Justify why you need it)

### VLP-LiTE

Name: Velodyne LiDAR PUCKTM LITE****

Group: Option A

Quantity: 1

Price: 9500

Description: Velodyne LiDAR PUCKTM (LITE)

<http://velodynelidar.com/vlp-16-lite.html>

The Puck LITE is functionally identical to the VLP-16 but at 590g, it is 30% lighter which is more advantageous for UAV applications; lighter weight means more flight duration.

(see Item: Velodyne LiDAR PUCKTM VLP-16 for further details and descriptions on Velodyne LiDAR PUCKTM LITE)

Justification: The DJI S1000 octocopter maintained in the laboratory, has a maximum take-off weight of 11 kilograms. With other payloads attached to the multirotor and also in account for Seattle weather, a lighter payload is advised for the success of each flight mission. Therefore, we propose the Velodyne LiDAR PUCKTM (LITE) well over the Velodyne LiDAR PUCKTM (VLP-16).

### VLP-16

Name: Velodyne LiDAR PUCKTM VLP-16 ****

Group: Option B

Quantity: 1

Price: 7999

Description: Velodyne LiDAR’s Puck (VLP-16)

<http://velodynelidar.com/vlp-16.html>

Velodyne's new PUCK™ (VLP-16) sensor is the smallest, newest, and most advanced product in Velodyne's 3D LiDAR product range. Vastly more cost-effective than similarly priced sensors, and developed with mass production in mind, it retains the key features of Velodyne's breakthroughs in LiDAR: Real-time, 360°, 3D distance and calibrated reflectivity measurements.

Justification: The current technology used by students presents significant challenges to collecting data. Applying a small LiDAR puck to UAV platforms will allow these data to be acquired more quickly and over a wider variety of terrain features and accessibilities than current ground based systems.

After taking into consideration Seattle weather, Velodyne's LiDAR sensors work well in snow, sleet, and rain. The multiple beam approach of the sensor with laser beams with millions of laser beams at different angles enables to find "holes" in-between the snowflakes to "see" the environment. An inferior LiDAR with only one or a few laser beams would not work as well as one with 16, 32 or 64 laser beams.

### ETC

Name: Velodyne Deposit****

Group: A/B

Quantity: 1

Price: 1030

Description: Deposit to reserve a hold on the product and will be refunded once we receive the item. This is due at the time of order and the remainder is due before delivery.

Justification: In order to purchase the product, the company requires a deposit to place a hold on the product, due to the mass amount of requests for production.

Name: Bank/Wire Transfer****

Group: A/B

Quantity: 1

Price: 50

Description: Payment Options

Bank/Wire Transfer + $50 fee

Credit Card +3$ fee

Snail Mail Paper Check

Financing

Justification: In order to purchase the product, full payment is due prior to shipment.

Name: Freight / Shipping Charge****

Group: A/B

Quantity: 1

Price: 80

Description: Freight/Shipping charge for the Velodyne LiDAR’s Puck (VLP-16)

Justification: Identical detailed shipping charges are included in the price quote for the Velodyne LiDAR’s Puck (VLP-16) and Velodyne LiDAR’s Puck (LiTE). As stated in the quote, this is provided purely as an estimate and may subject to change.

Name: WA Sales Tax ****

Group: A/B

Quantity: 1

Price: 902.5

Description: Maximum tax estimates for the product at 9.5%

Justification: This is calculated based on PUCK LiTE ($9500) and will be dependent on the final purchase amount.

### Labor

Name: Undergraduate Wage****

Group: C

Quantity: 60

Price: 13

Description: The wages associated with the time an undergraduate student will spend integrating the sensor into current infrastructure.

Justification: A paid labor implementation will ensure a successful start and faster integration timeline. The lab spends a lot of time at flight mission over the summer and assuming the product arrives before then, we would need to make sure we have a researcher getting the sensor ready for a flight test. This budgets three students for 20 hours at a rate of $13/hour, totaling at 60 hours.

## Signature Page

### Primary Author

### Dean or Department Head

### Budget Director

## Submit

 Submit!

# 20170201 Proposal 2017-39 Questions

**1. Could you elaborate a little more about how this LiDar system would be useful for GNC (which I'm assuming means Guidance, Navigation, and Control)? If it was integrated into the flight mechanics and controls courses, what do you think the proportion of use would be between instructional use and independent research?**

We estimate the majority of usage would be in research and student projects. Maybe 25% of this would be used for class/instructional usage in AA courses. Some departments like CSE might have much higher need and/or use from an educational perspective.

**2. Have you looked into whether this equipment may qualify for tax exempt status?**

Yes, we have looked into the qualifications for the tax exempt status.  We are currently working with that department to file an equipment form for the sensor, but it will take a bit of time to get it fully processed.

**3. For the PUCK itself, is the total cost the amount listed on the PUCK line items plus the amount listed on the deposit line item, so $10,530 for option A and $9,029 for option B?**

It is the PUCK, deposit, shipping, taxes, etc.

Option A total = 11562.5$

Option B total = 10061.5$

Otherwise, yes, JUST the PUCK AND DEPOSIT is what you mentioned.

**4. How would it be determined which graduate and undergraduate students would be allowed to administer access to this equipment?**

We would use a system similar to the system implemented by ESS for their STF equipment. The directors of the laboratory will oversee the equipment and administer access. Students who wish to use the equipment will write a brief proposal and submit it to the lab director. Students that can provide detailed information of their project and elaborate use with a timeline followed by equipment training will be accompanied by researchers trained specifically for this equipment.

**5. Under the timeline, you stated that the sensor would be installed onto either the DJI or Skywalker UAV first. Under technology resources, you stated that it will be mounted onto the Skywalker first. I think it is fine whichever UAV you decide to install mounting on first, but it's just inconsistent in the proposal. If you let me know which one will be first, or if you aren't yet sure, I can edit the proposal to reflect this.**

To elaborate, under timeline, one team is currently working on a mount for the Skywalker and the other team is working on one for the octocopter.  They will work simultaneously to integrate the LiDAR sensor into both UAS, and it will be interchangeable between systems, but mounting onto the DJI octocopter will be the priority (as specified under technology resources).

# 20170206 Presentation Notes

* Since each laser beam is matched to the numerical aperture of the detector, minimum power consumption is needed, which is especially useful in power conscientious mobile applications like backpack systems and for the use on Unmanned Aerial Vehicles.
* Different applications require different demands on the data quality, however it is universally accepted that an abundance of data is absolutely necessary for the most reliable object detection.
* While LiDAR sensors with only one or a few laser channels can give a general indication that an object is in front of the sensor~~,~~ Velodyne's data rich point clouds allow for the highest level of object recognition in real-time. The real-time aspect is of uttermost importance here as sensors with only one or few laser channels might be able to accumulate data over time, however that is not sufficient in real-world applications for localization and safety-related data for critical real-time safety decisions. LiDAR 3D data is abundant enough to make those lifesaving determinations within the short amount of time available.
* Velodyne's wide field of view (up to 360°) allows not only making object recognition decisions for objects directly in front, but also towards objects on the side and rear. LiDAR data can discern a person from streetlight standing on the curb, as well as identify a fast-closing object from the sides or rear. The surround view capability is a major advantage of the sensor in terms of object recognition and safety when compared with mostly directional, limited field of view, limited laser count sensors.
* Outreach - and other methods that STF has found successful
* The equipment will mainly be housed in the Autonomous Flight Systems Laboratory (AERB 139), either that or (AERB 138) in Dr. Lum’s office.
* Need Argo notes on here!!!

20170213 STF Presentation Transcript

* 2017

# 20170221 Meeting with STF Proposal Liaison Notes

My name is Lizzie, and I've been assigned your proposal in STF to act as a liaison for. In order to grasp how the funding will affect your department, I'd love to meet with you to ask some **questions about the proposal** and see the **current equipment you are using** as well as **where the new equipment would be stored**. - Lizzie Palmer | Finance & Budget Director

Questions about proposal:

* With administrative approval, students will be able to check out the equipment along with an AFSL Supervisor to oversee their project.
* Checkout will be documented on version control and will be changed only by authorized users.
* We will be working with the AA department to order the equipment listed in the proposal.
* We will be working with Nancy to file a tax exempt form once the STF committee has finalized their decision between the options.
* We will be working with \_\_\_\_\_ to gain insurance as a prerequisite for the equipment.
* We will be working with the STF committee for anything else that would be needed.

Current equipment we are using:

* MicaSense RedEdge
* Canon S100 (tentative)
* Argo (octocoper) – previous STF funded equipment
* TEDD (skywalker 1900)
* Mission Planner
* MatLab
* Dr. Lum’s MATLAB Analysis Codes

Where new equipment will be stored:

* It will be stored in the locked cabinet behind the desk of the Director of Flight Operations.
* Otherwise, it will be secured in the locked office of the budget director across the laboratory.

Notes:

* Should we “move” some broken aircrafts so our credibility does not drop?
* Do we need to print out check out document from the following page? Our liaison can take the form with her for reference if needed.
* We need printer paper if we are printing the check out document.

(Month) (Year)

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