# National Ecological Observatory Network

# Airborne Observation Platform (AOP)

B. Johnson/NEON AOP, PMCS and Project Teams

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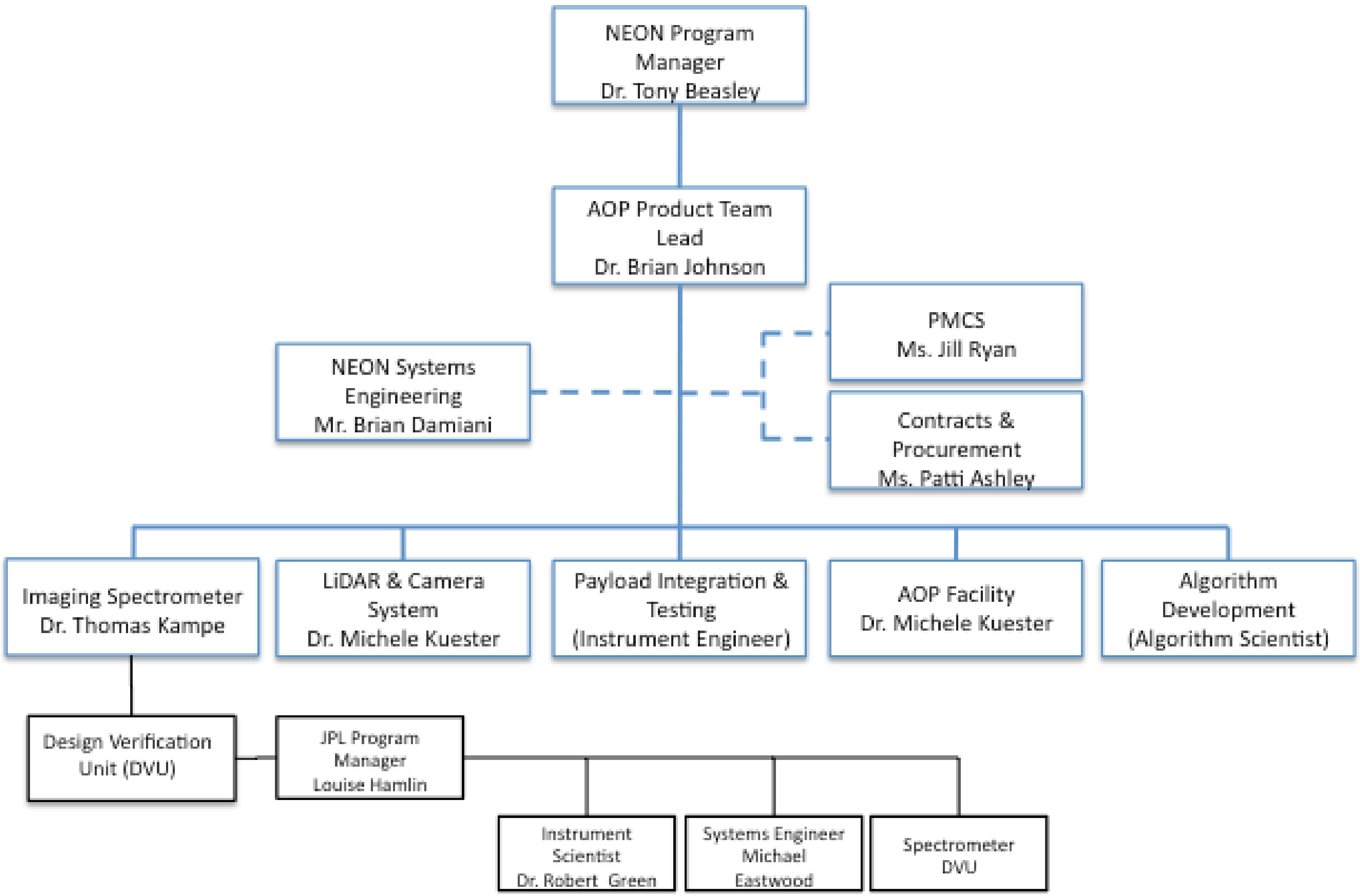
# AOP Core Staff

**Dr. Brian Johnson** is the Product Team Lead responsible for managing the construction, commissioning and operations of the NEON AOP. Dr. Johnson was formerly at Ball Aerospace & Technology Corp. responsible for managing the Earth Science Advanced Systems group, leading the development of instrument concepts and technologies for future NASA Earth Science space missions, and directing airborne sensor development. He earned his B.S. and M.S. in Electrical Engineering at the University of Wisconsin, and his Ph.D. in Atmospheric and Space Sciences at the University of Michigan. Before joining Ball Aerospace, Dr. Johnson was a research scientist in the Atmospheric Chemistry Division at the National Center for Atmospheric Research in Boulder, Colorado. His research interests include development of new sensor technologies, remote sensing techniques and the application of remotely sensed data to atmospheric, climate, land use and ecosystem studies.

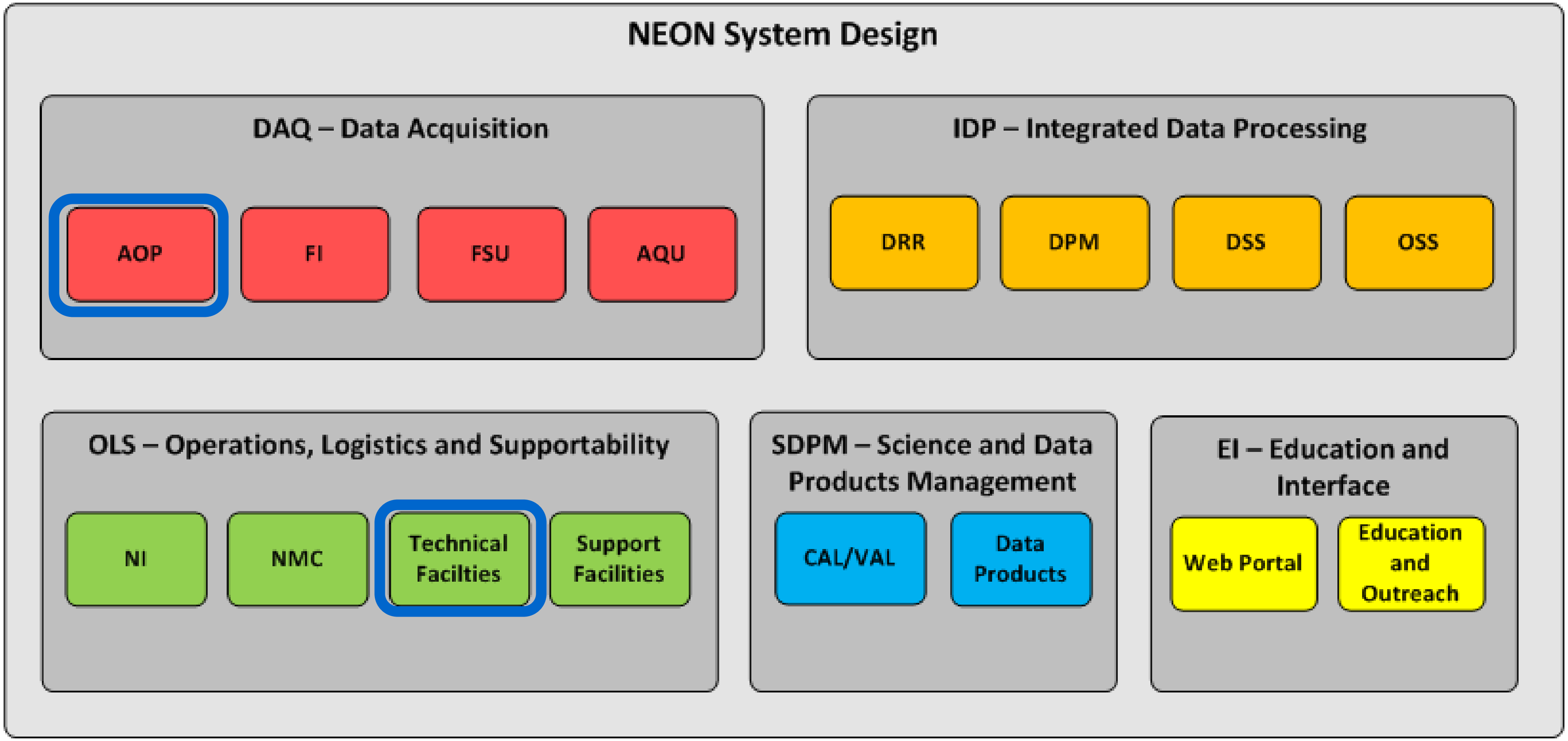
**Dr. Thomas Kampe** is the instrument scientist for the NEON imaging spectrometer and responsible for data algorithm validation. Dr. Kampe has 20+ years of experience in optical instrument design and development. From 1993 to 1996, Dr. Kampe was with Hughes SBRC, where he served as Optics Lead on the MODIS instrument. From 1996 to 2007, he was a Staff Consultant in Electro-Optics with Ball Aerospace & Technologies Corp., working in the Advanced Systems Group. While at Ball, he was PI on several IRADS and the SIRAS-G Instrument Incubator Program, a NASA-funded infrared imaging spectrometer technology development program. On this program, Dr. Kampe had full programmatic and technical responsibility and was instrumental in developing methodologies and apparatus for testing and characterizing imaging spectrometer performance. Dr. Kampe holds a B.S. in Physics from UCLA and M.S. and Ph.D. in atmospheric and oceanic sciences from the University of Colorado-Boulder.

**Dr. Michele Kuester** is the remote sensing scientist for the NEON AOP. Dr. Kuester is responsible for mission operations planning and instrument calibration. She is also the technical lead for the waveform LiDAR and digital camera. Dr. Kuester has 10+ years experience in airborne and field-based earth remote sensing. She came to NEON from Ball Aerospace where she was the lead for the Airborne Sensors Initiative and in charge of their radiometric calibration facilities working on programs such as SBUV, Landsat and OMPS. Prior to Ball, Michele was part of the Remote Sensing Group at the University of Arizona in Tucson, AZ where she was involved in vicarious calibrations of Earth observing instruments such as MODIS, Landsat, and SPOT. Dr. Kuester holds a B.S. in Physics and M.S. in Optical Sciences from the University of Arizona-Tucson and M.S. and Ph.D. in atmospheric and oceanic sciences from the University of Colorado-Boulder.

# AOP Management Structure



# AOP

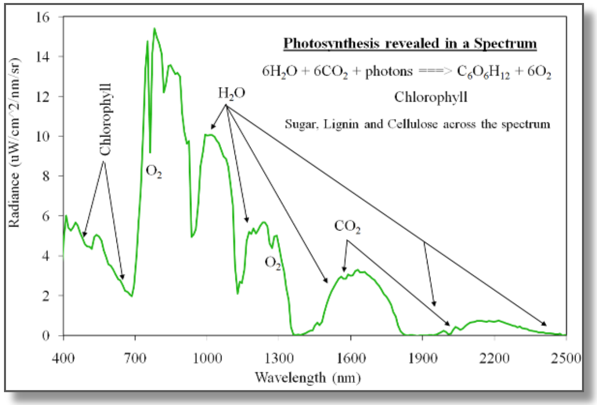

NEON System Design
DAQ – Data Acquisition
AOP
FI
FSU
AQU
IDP – Integrated Data Processing
DRR
DPM
DSS
OSS
OLS – Operations, Logistics and Supportability
NI
NMC
Technical Facilties
Support Facilities
SDPM – Science and Data Products Management
CAL/VAL
Data Products
EI – Education and Interface
Web Portal
Education and Outreach

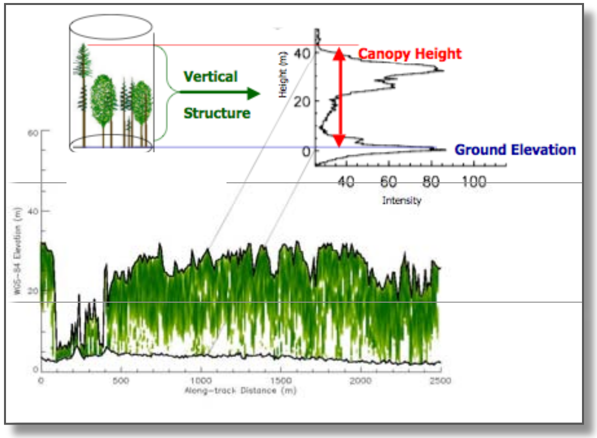
# AOP Science Objectives

- AOP will observe invasive species, land use drivers and ecosystem responses surrounding the NEON Core and Re-locatable sites
  - land cover
  - vegetation structure
  - Invasive plant species
  - biochemical and biophysical properties
  - ecosystem functioning
- Bridge scales from organism and stand scales to the scale of satellite based remote sensing
- Observe unexpected events, targets of opportunity (TOO's)

# Airborne Measurement Approach

- Spectroscopy
  - Vegetation biochemical & biophysical properties
  - Cover type & fraction
- LiDAR altimetry
  - Vegetation Structure
  - Sub-canopy topography
  - biomass
- High resolution imagery
  - Land use & land cover



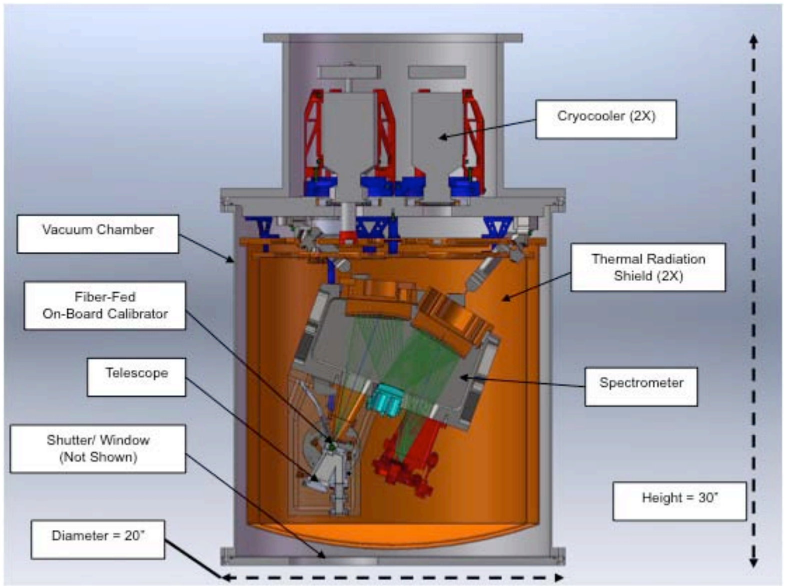




# AOP Baseline Design

- Airborne Instrumentation
  - Optech ATLM Gemini Waveform-LiDAR
  - JPL NEON Imaging spectrometer
  - Applanix 5K x7K DSS 439 airborne digital camera
  - Applanix POS AV 510 GPS/Inertial measurement unit
  - Up-looking Vis/NIR spectrometer (atmos. correction)
- AOP Sensor Technical Facility
  - Optical calibration lab, and sensor maintenance and support facilities
- Flight Operation Approach
  - 3 identical instrument payloads
  - De Havilland DHC-6-300 twin turbo prop (Twin Otter)
  - 2 aircraft for cover NEON sites; third for backup & TOO's
  - Crew: 2 NEON personnel for sensor flight operations

# Payload Instrumentation

*Spectrometer design concept*



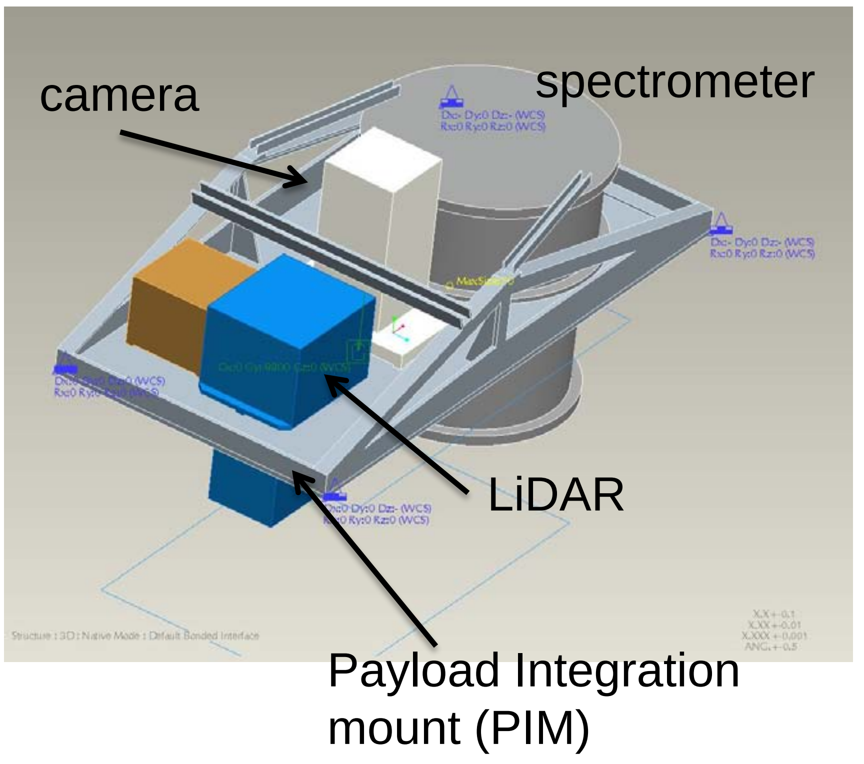

*Optech ALTM Gemini system*

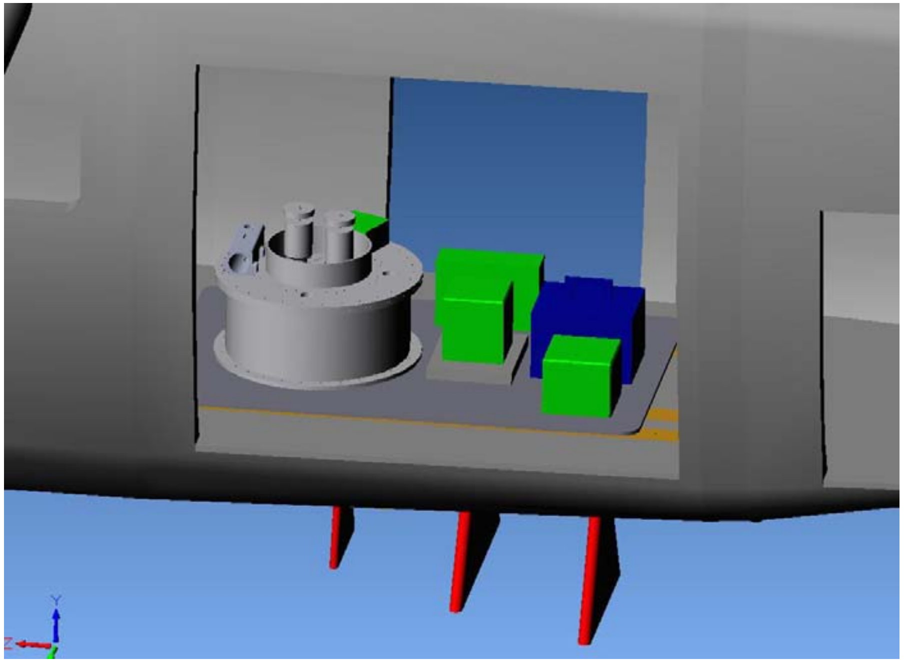


*Applanix digital airborne camera*


*Applanix GPS/IMU*

# Integrated Payload



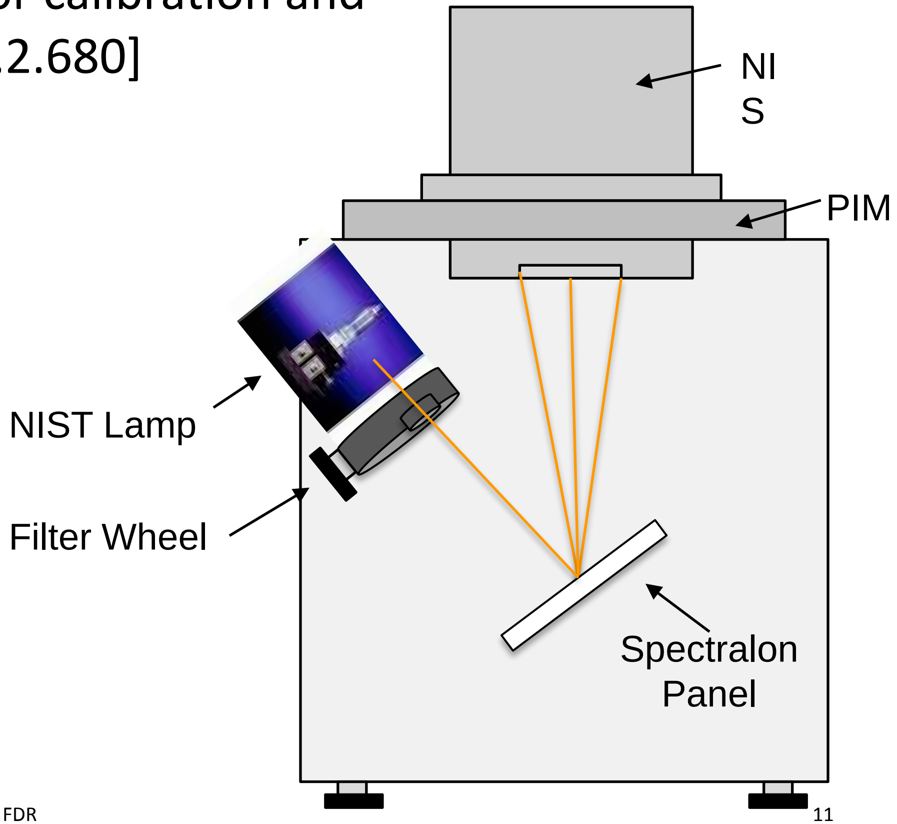



# Sensor Data Products

- Level-0: raw sensor output data
- Level-1: geo-located, calibrated sensor data (1-3 meter res)
  - Sensor spectral radiance: 380 to 2500 nm, 10 nm resolution
  - Surface reflectance: 380 to 2500 nm, 10 nm resolution
  - LiDAR vertical waveform
  - Panchromatic imagery (15 to 30 cm resolution)
- Level-3: mapped 5-meter sensor data
  - Surface reflectance: 380 to 2500 nm, 10 nm resolution
  - “nearest neighbor” LiDAR waveform
  - 5-meter averaged LIDAR waveform
  - 50-cm resolution imagery (zoom to Level-1 resolution)

# AOP Sensor Technical Facility

- System Requirements
  - Provide operations, logistics and support for sensor maintenance and operations [NEON.SYS.2.640]
  - Provide the adequate facilities for calibration and validation of sensors [NEON.SYS.2.680]
- Calibration laboratory
  - NIST traceable sources
  - Special test sets & equipment
- Sensor support facilities
  - repair and maintenance
  - Supporting field equipment
  - storage



# Project Interfaces

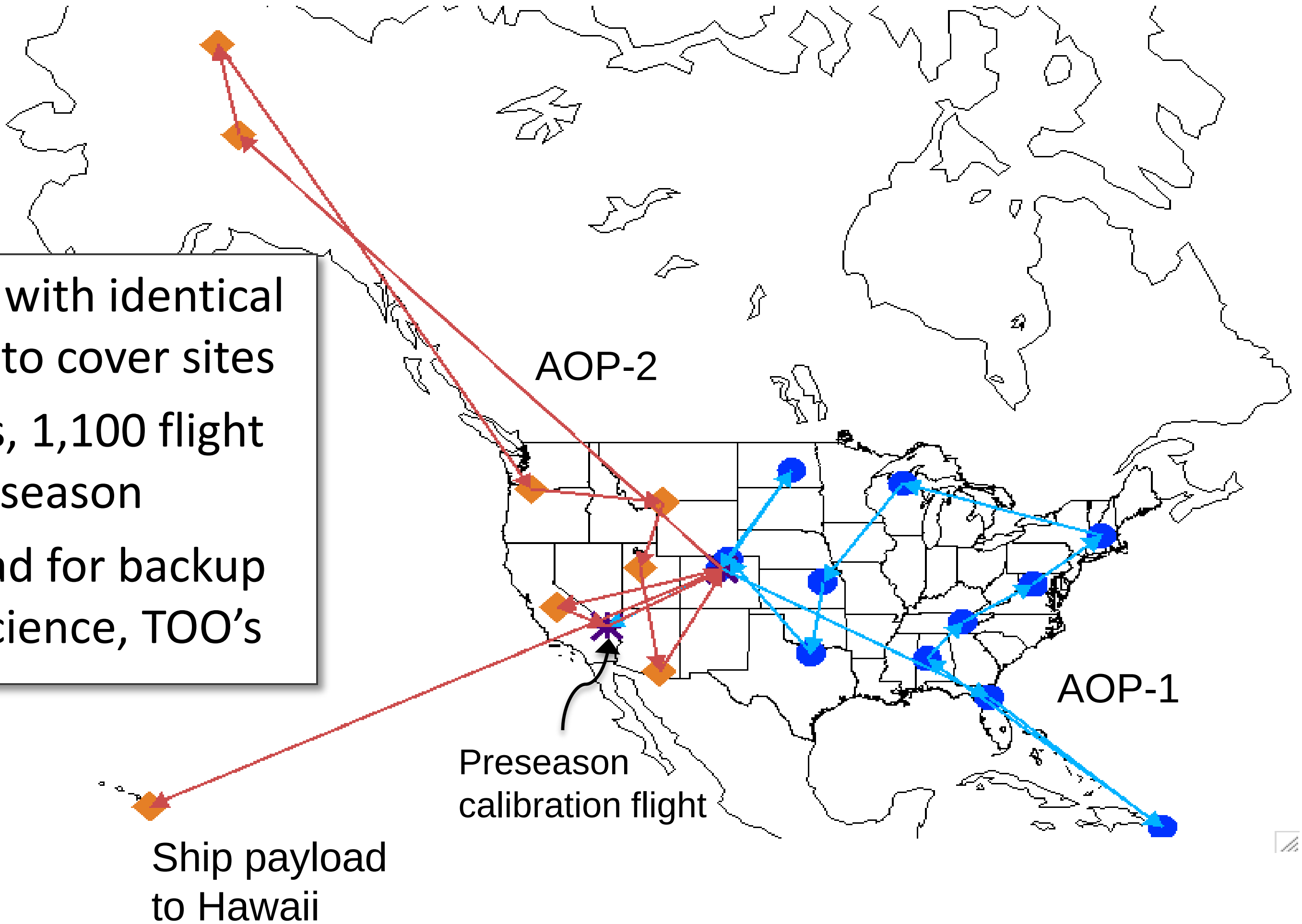
- Facilities and Civil Construction (FCC)
  - FCC responsible for Technical Facility & AOP-specific floor plan
  - AOP responsible for facility requirements, specification, and interior configuration
- Cyber-infrastructure (CI)
  - Computing hardware , operational software implementation of algorithms
- Fundamental Sentinel Unit (FSU)
  - Coordinated field sampling during commissioning
- Fundamental Instrument Unit (FIU)
  - Provide atmospheric measurement data
- Data Products Group
  - Higher level science data products derived from AOP level-1/-3 data

# AOP Operations

- Science Operations
  - Flight operations planning & support
  - Science data analysis, products and QA/QC
  - External science community support
- Flight Operations
  - Aviation safety
  - Aircraft lease contract management
  - Flight logistics, operations & field support
- Instrument Support
  - Instrument calibration
  - Instrument maintenance & repair
  - Aircraft/payload integration

# Example Flight Operations

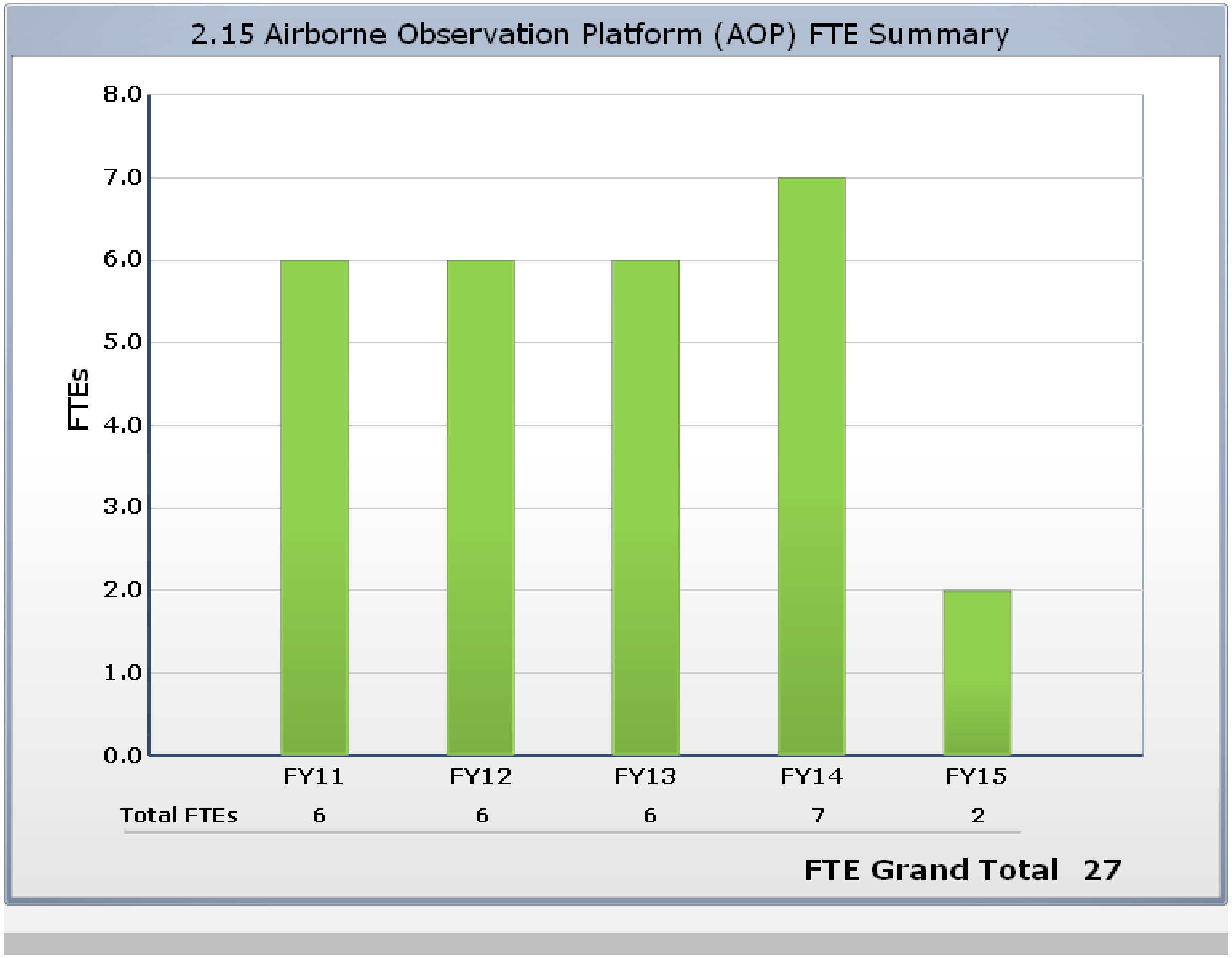
- 2 aircraft with identical payloads to cover sites
- 7-months, 1,100 flight hrs flight season
- 3rd Payload for backup & new science, TOO's



# 2.15 AOP - WBS

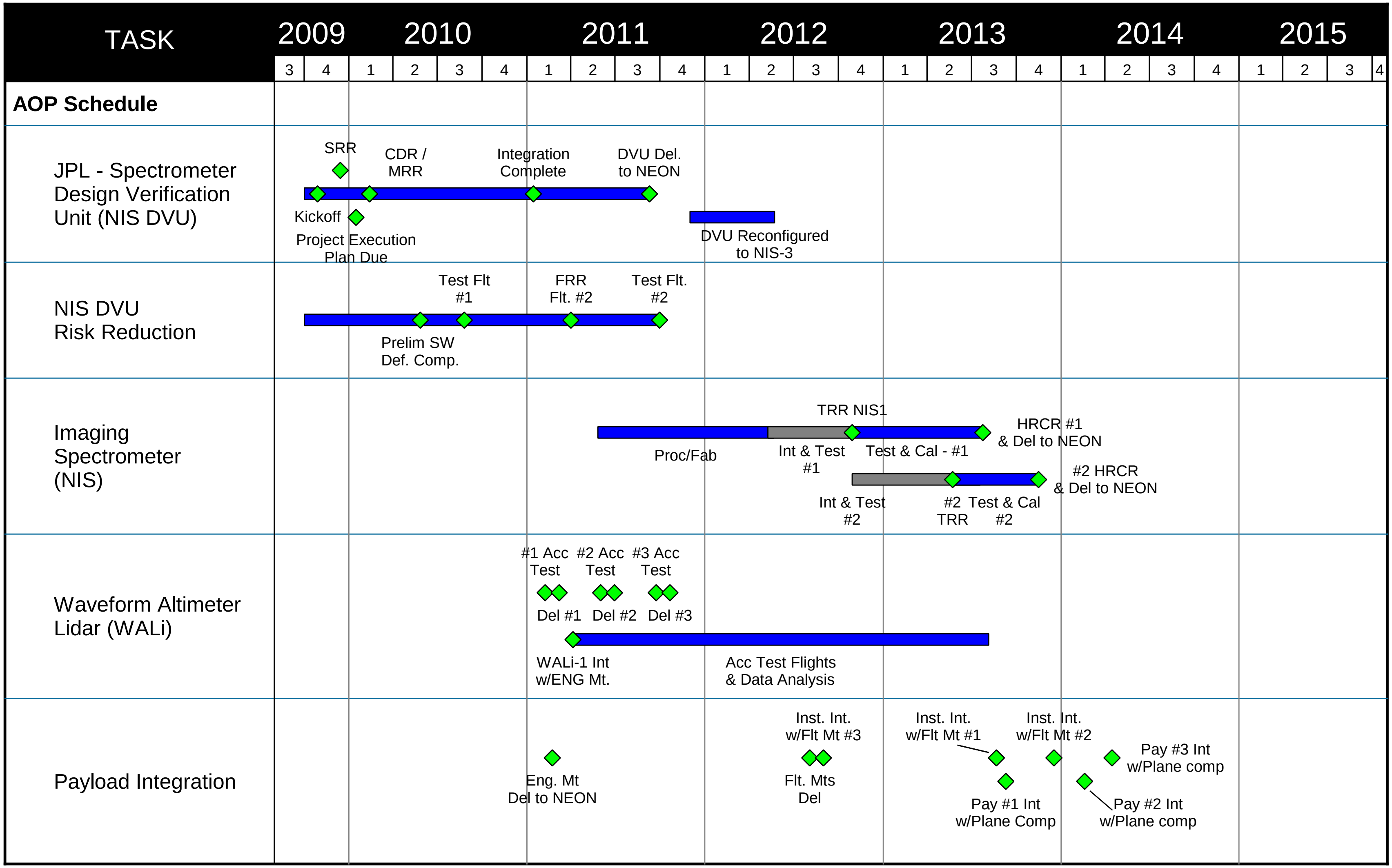
| WBS | Title |
|---|---|
| 2.15 | Airborne Observation Platform (AOP) |
| 2.15.10 | AOP Management |
| 2.15.20 | AOP Commissioning |
| 2.15.20.15 | AOP Sensor Field Commissioning |
| 2.15.20.20 | AOP Calibration Lab Commissioning |
| 2.15.30 | AOP Equipment |
| 2.15.30.10 | AOP Spectrometer |
| 2.15.30.20 | AOP Waveform Lidar |
| 2.15.30.40 | AOP Integrated Payload |
| 2.15.30.50 | AOP Sensor Support Facility |

# 2.15 AOP - FTE Spread by FY



# 2.15 Airborne Observation Platform (AOP)
## Construction Phase Schedule

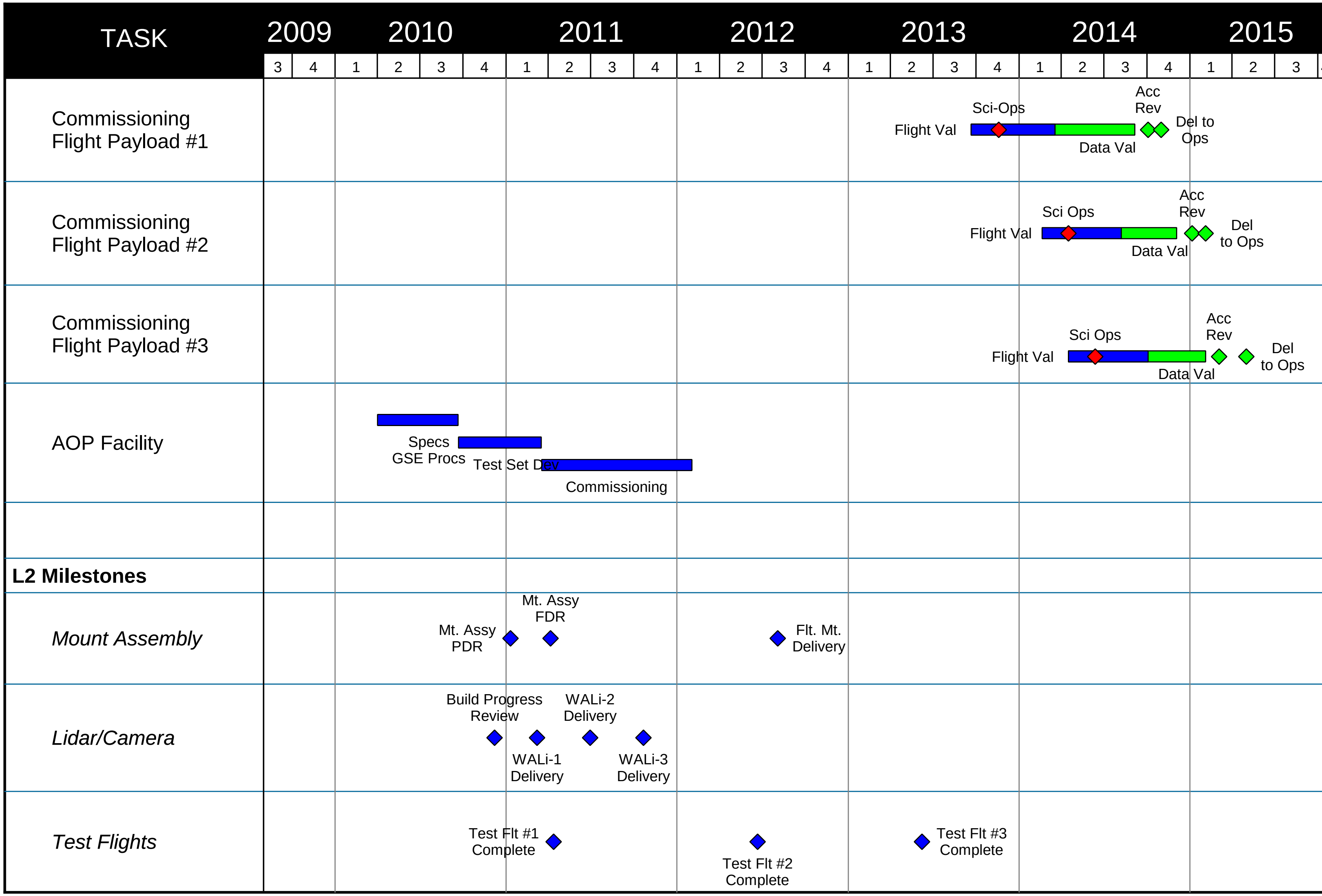
Page 1



# 2.15 Airborne Observation Platform (AOP)

## Construction Phase Schedule





# AOP PT Risk Register

| Risk ID | Risk Title | Description | RRS | Risk Exposure | Occurrence Cost | Program Area | Status |
|---|---|---|---|---|---|---|---|
| 25 | Delayed completion of spectrometer development | A total of 3 NEON imaging spectrometers (NIS) are required to support the NEON Observatory. The NEON imaging spectrometers are being developed at JPL under contract to NEON. The 3.5-year development of the spectrometers defines the critical path for AOP construction. Several factors could delay the delivery or increase cost of the spectrometers resulting in increased AOP construction costs. | 2.5 | High | $ 2,000,000 | AOP | Mitigate |
| 27 | Increasing Aviation Fuel Costs | Historical trends indicate that the cost of aviation fuel fluctuates significantly year-to-year about an average annual increase of 5%. The AOP fuel budget assumes a 5% annual increase in fuel costs but does not anticipate major cost fluctuations which may be as large as a doubling in fuel costs over 2 years. | 2.5 | High | $ 1,000,000 | AOP | Monitor |
| 30 | Payload Failure during Science Operations | 1 or more sensors are inoperable during operations; lengthy repair | 1.5 | Medium | $ 50,000 | AOP | Monitor |
| 32 | | | | | | AOP | Monitor |
| 36 | | | | | | AOP | Mitigate |
| 38 | | functional and performance verification testing. | | | | AOP | Mitigate |
| 31 | Aircraft Mechanical Problem | Mechanical problem, failed routine maintenance check or avionics equipment failure during flight operations. | 1.2 | Medium | $ 50,000 | AOP | Monitor |
| 34 | Lengthy Weather Delays | Flight over a site or entire domain cannot be conducted due to cloudiness, poor horizontal visibility, high winds, rain, or other severe weather; delay beyond baseline reserve | 0.9 | Medium | $ 100,000 | AOP | Monitor |
| 39 | Calibration Laboratory Development Delay | Under-estimated scope in development of calibration lab, and the design, build, and commissioning of calibration test set. | 0.9 | Medium | $ 100,000 | AOP | Mitigate |
| 40 | Payload Integration | Mounting structure, including PIM, for instrument suite does not conform to aircraft interface, including mechanical attachment points, rigidity, or thermal stability. | 0.9 | Medium | $ 50,000 | AOP | Mitigate |

Spectrometer Delays – mitigation via NIS-DVU effort

Fuel costs – prioritize annual surveying

# Progress Since PDR

- Completed the JPL spectrometer risk reduction tasks
- ARRA funds awarded to begin spectrometer DVU development
- Updated risk mitigation plans
- Completed internal preliminary design review of the AOP sensor technical facility
- Established Calibration-Validation working group
- Addressed PDR recommendations
- Presented at and participated in science (ESA, LTER, NASA HyspIRI) and engineering (SPIE) conferences, USGS meeting at NEON HQ

# Work Over Next 12-months

- Spectrometer DVU
- Prototype algorithm development
- Early aircraft flights for operations and algorithm prototyping, and DVU testing
- Early AOP sensor technical facility development
- Prototype PIM design and fabrication
- Internal design reviews for instrumentation
- Refinement of AOP operations plan
- Mature calibration/validation plans and develop procedures

# Summary

- AOP will provide airborne remote sensing data at the local to regional scale bridging scales from organism and stand scale to scale of satellite remote sensing
  - Three identical advanced instrumentation packages: spectrometer, waveform LIDAR and airborne camera
- Final baseline design and project plan are complete; mitigation of spectrometer and algorithm risks has begun
- AOP is ready to proceed to construction

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The National Ecological Observatory Network is a project sponsored by the National Science Foundation and managed under cooperative agreement by NEON Inc.