Status of the TWiLiTE-GH Direct Detection Doppler Lidar

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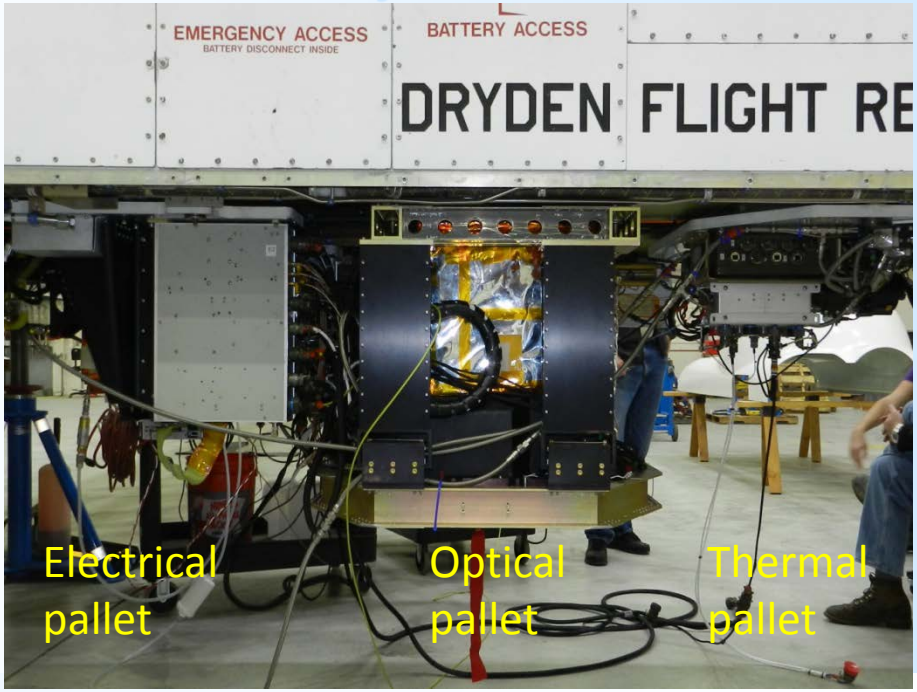
Space Based Lidar Winds Working Group Meeting
May 13, 2014



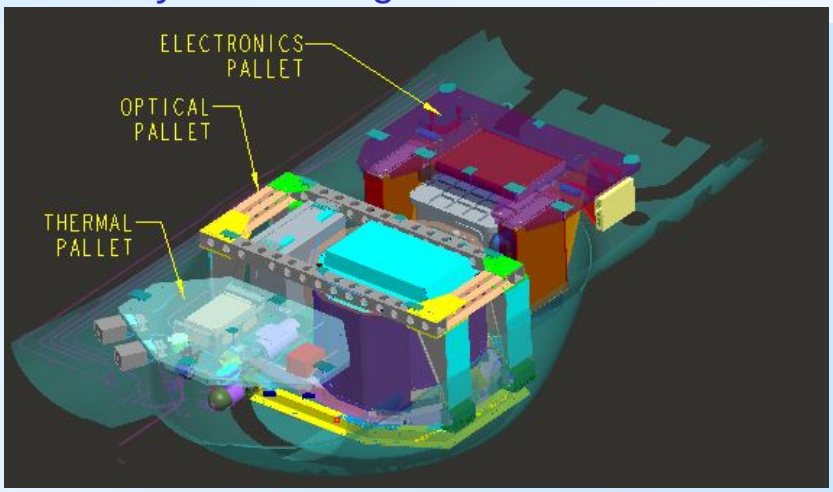
Outline

- TWiLiTE background
- TWiLiTE Data Products
- TWiLiTE Global Hawk integration and test flights - May, 2014

Tropospheric Wind Lidar Technology Experiment – Global Hawk(TWiLiTE-GH)

- TWiLiTE is a compact, rugged direct detection scanning Doppler lidar designed to measure wind profiles in clear air from 20 km to the surface.
- TWiLiTE operates autonomously on NASA research aircraft (ER-2, DC-8, WB-57, Global Hawk).
- Engineering flight tests on the NASA ER-2 in 2009, 2011 and 2012 demonstrated autonomous operation of all major systems.
- TWiLiTE is now configured to fly in Zone 25 of the NASA Global Hawk (AV6)

TWiLiTE system configured for AV6 Zone 25



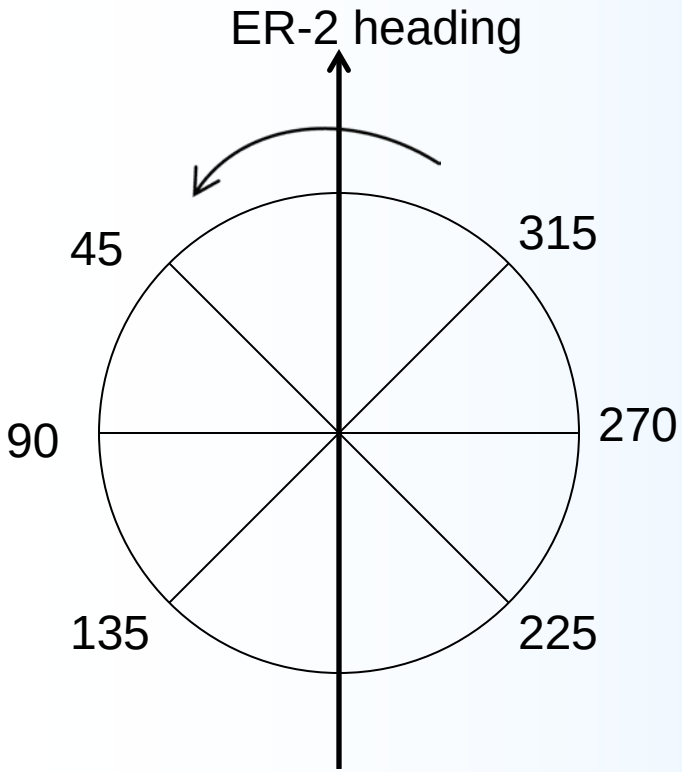
TWiLiTE Instrument Parameters

Wavelength	354.7 nm
Telescope/Scanner Area	0.08 m^2
Laser Linewidth (FWHH)	150 MHz
Laser Energy/Pulse (8 W)	40 mJ @ 200 pps
Etalon FSR	16.65 GHz
Etalon FWHH	2.84 GHz
Edge Channel Separation	6.64 GHz
Locking Channel Separation	4.74 GHz
Interference filter BW (FWHH)	120 pm
PMT Quantum Efficiency	25%

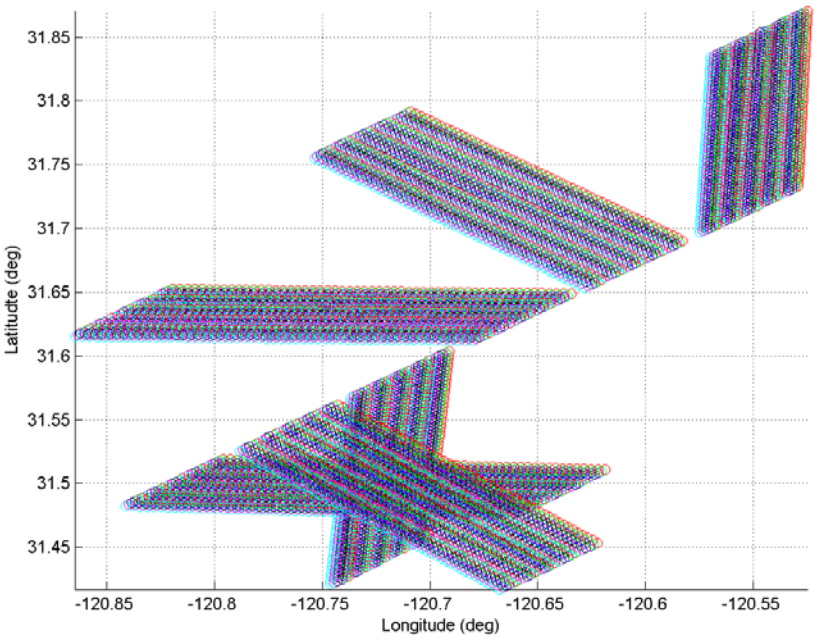
TWiLiTE Performance Summary

Data products	Vertical profiles of u,v wind field from aircraft to surface, clouds permitting
Velocity accuracy (m/s)	< 2.0
Range of regard (km)	0 -18 (ER-2,WB57); 0-12 km (DC-8)
Vertical resolution (km)	0.250 (programmable)
Horizontal integration per LOS (s)	10 s (programmable)
Nadir angle (deg)	45
Scan pattern	8 position conical step-stare (programmable)

Step Stare Azimuth Scanning and Sampling



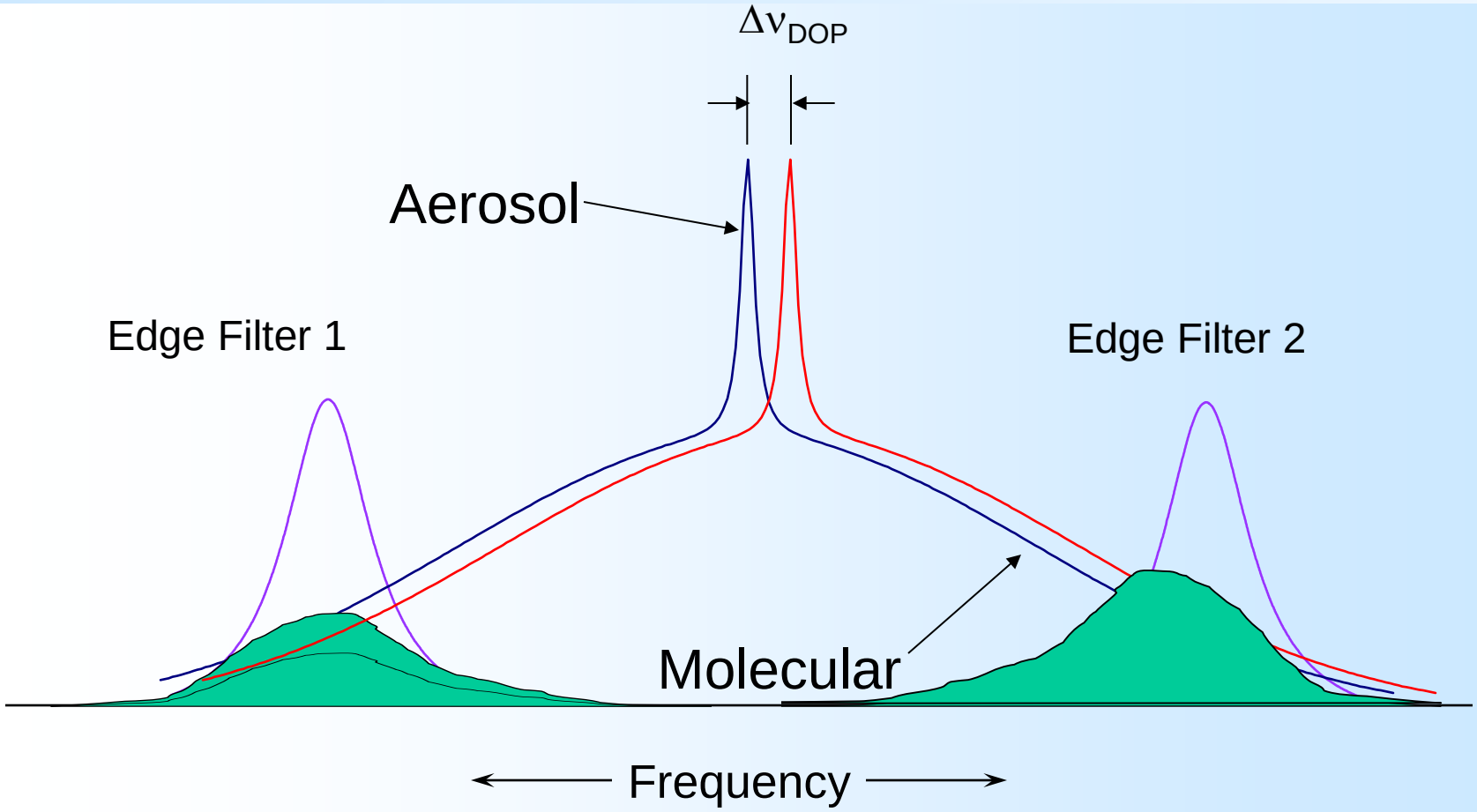
6 direction step stare scanning.
The HOE is rotated CCW to each of the 6 directions. Dwell at each direction is 30 sec. ~3 sec to move and settle



Shot pattern in Earth-relative rotated reference frame. Aircraft ground speed is 206 m/s

Double Edge Measurement Principle

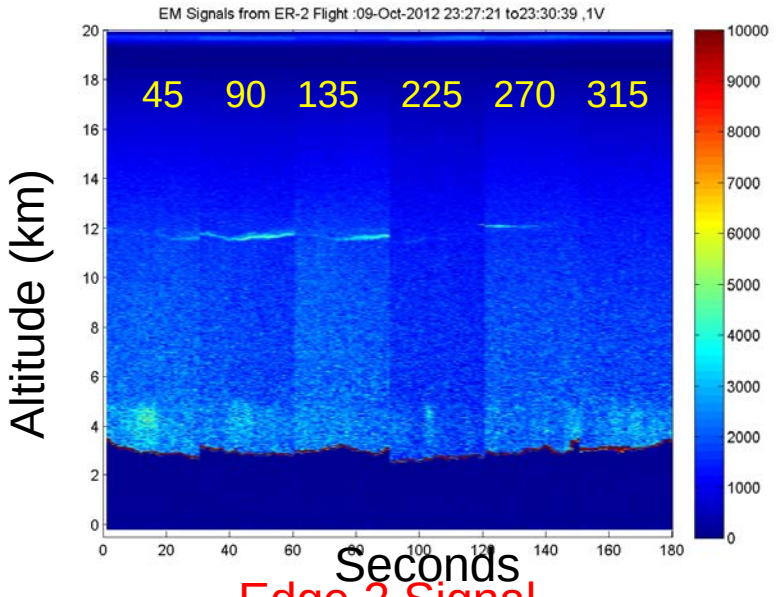
Molecular Channel at 355 nm



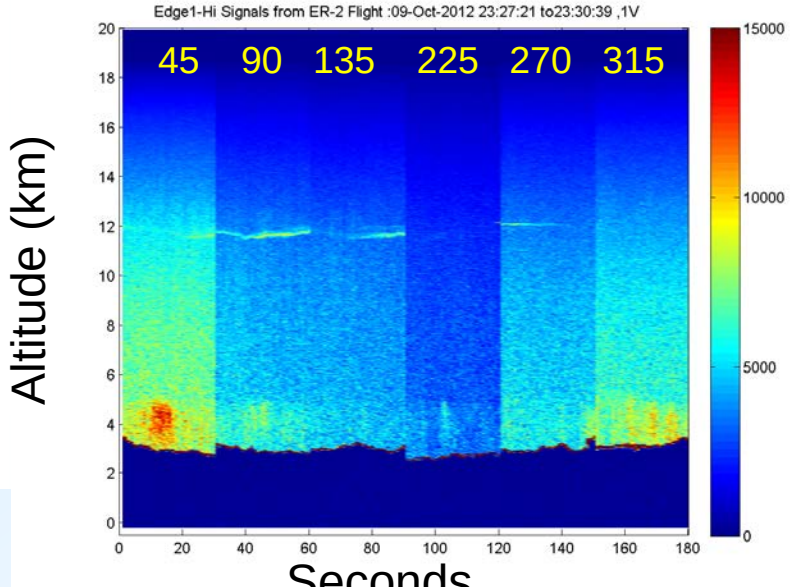
Level 1 TWiLiTE Data Record

- 1 record per scan cycle (6 dir)
- 7 channels of range gated photon counting signals: 6 Edge; 1 EM
- Interpolated to Earth relative, fixed 21 m altitude grid. 1 second sample rate
- Corrected for background, dead time, pitch, roll, drift, heading
- Each data point tagged w/ time, alt, lat, long, azimuth, elevation, airspeed
- Algorithm Development ~95%

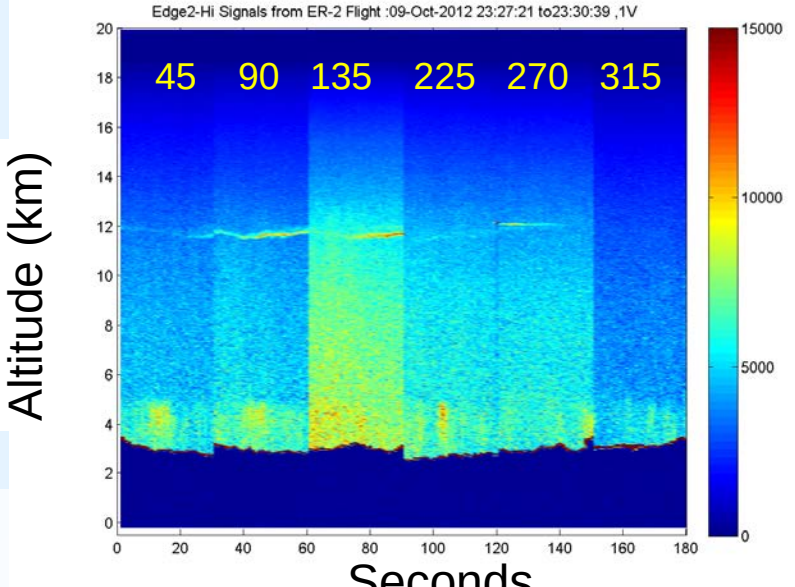
Energy Monitor



Edge 1 Signal



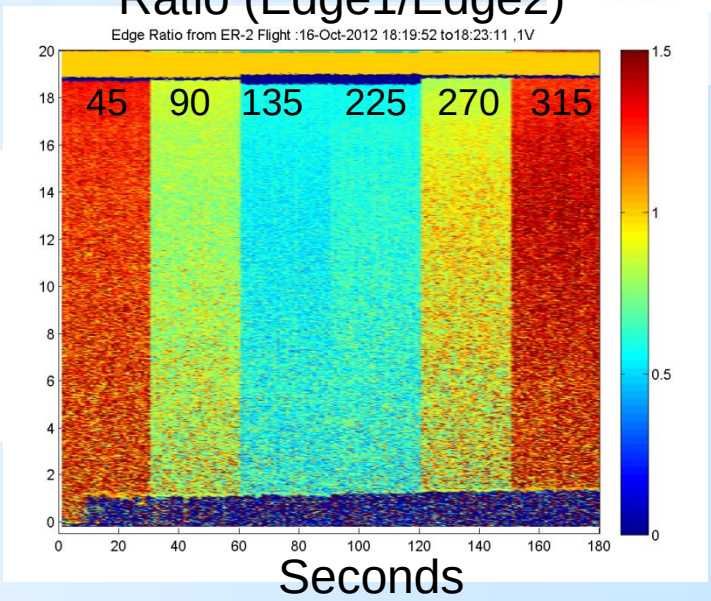
Edge 2 Signal

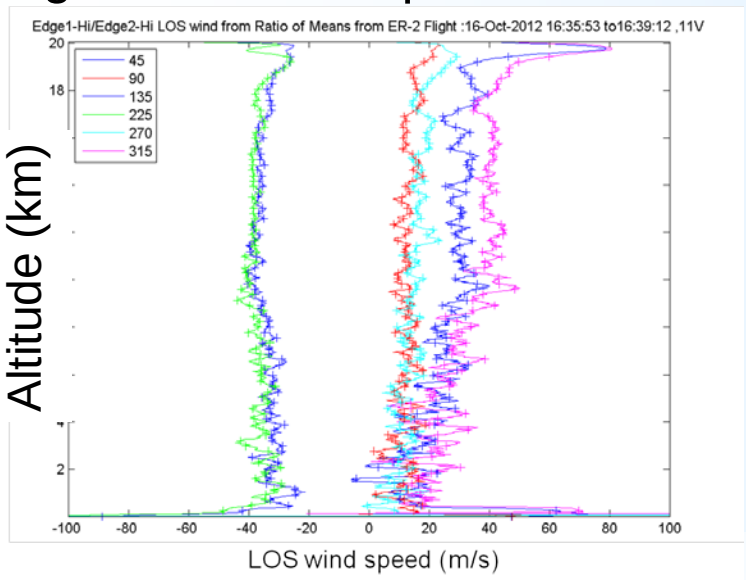


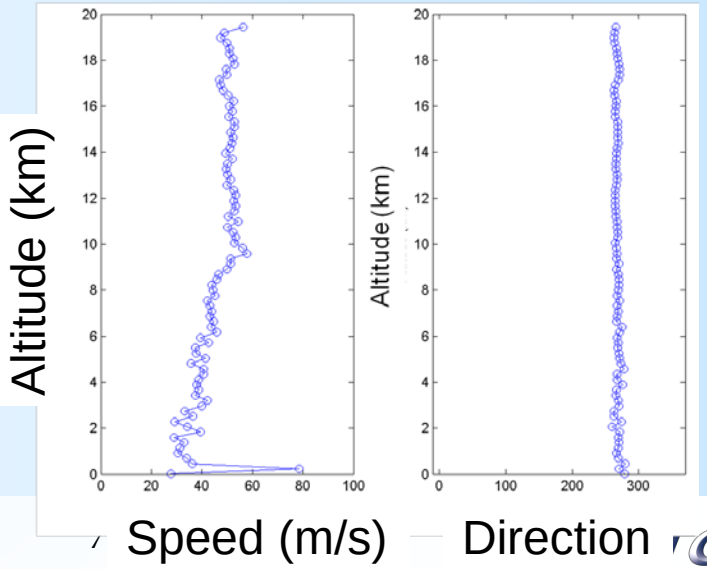
Level 2 Data Products

- LOS wind profiles
  - 252 m vertical resolution
  - 10 to 30 sec along track avg
  - Correct for aircraft Doppler
- Horizontal wind field
  - 252 m vertical resolution
  - 10 to 30 sec along track avg
- Cloud properties (top, thickness …)
- Algorithm Development ~80%

Ratio (Edge1/Edge2)



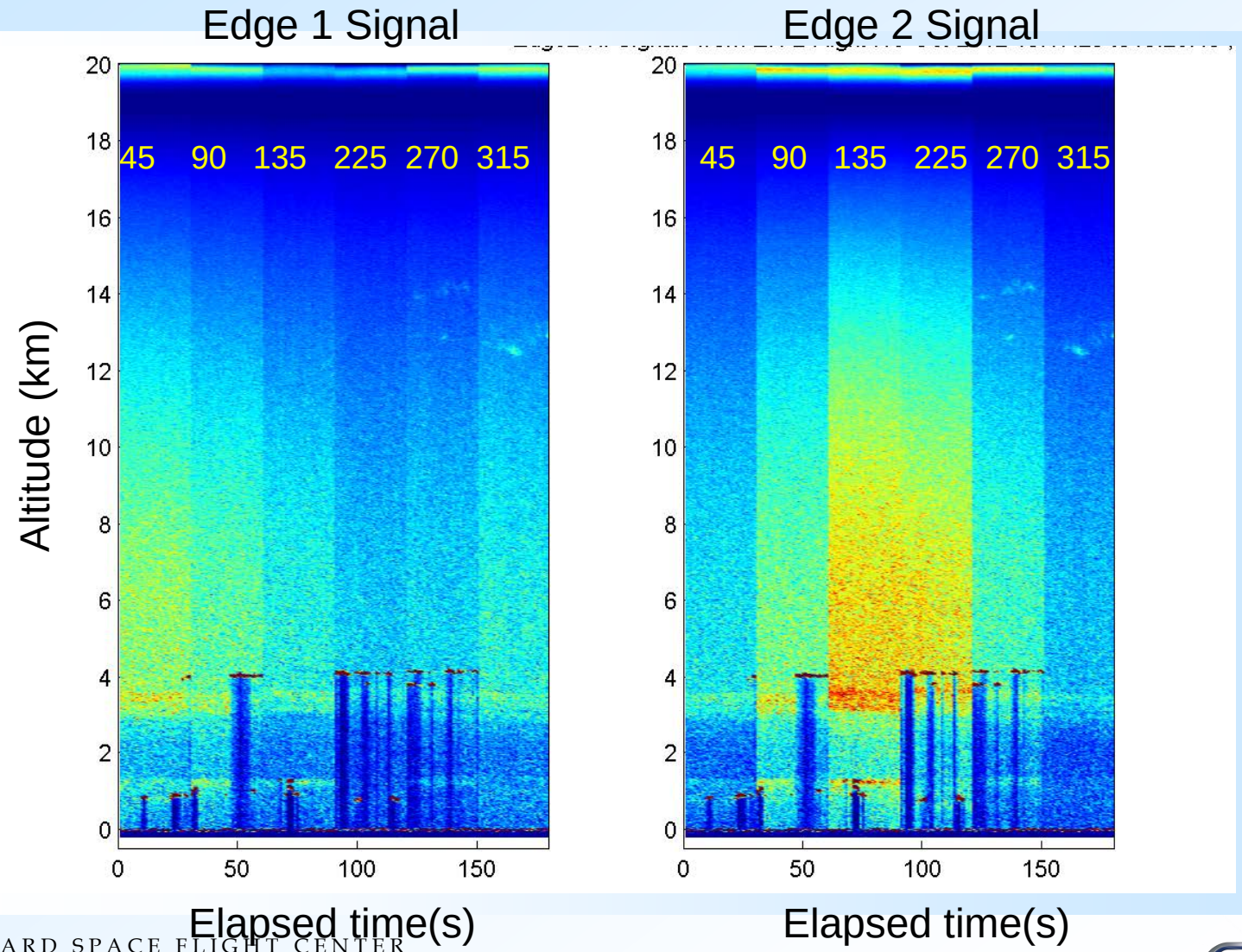




Edge channel, R^2 corrected signal

October 16, 2012 – Cycle 32 of 70

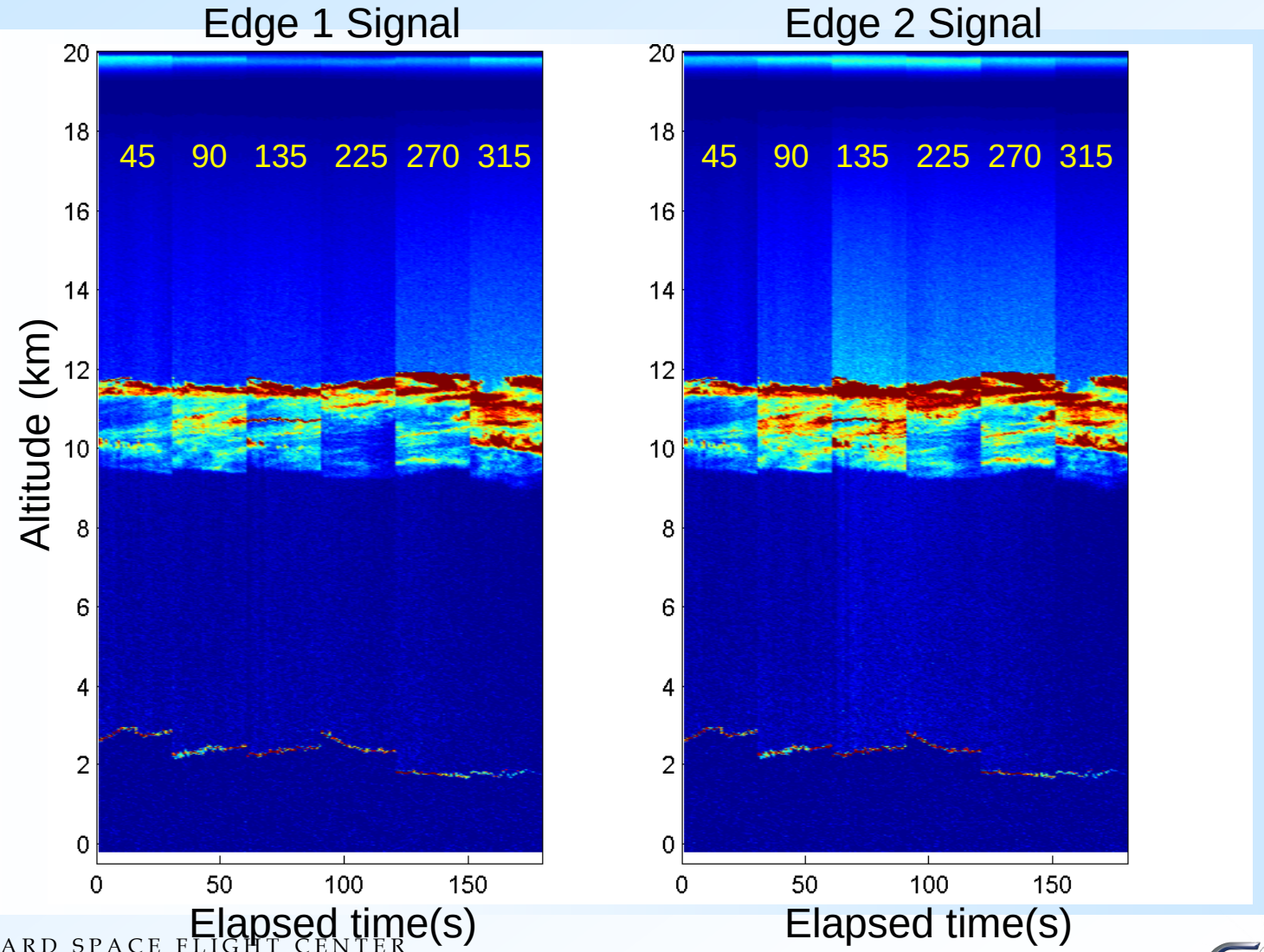
Δt_{avg}=1 seconds, Δz=21 m



Edge channel, R^2 corrected signal

October 16, 2012 – Cycle 1 of 70

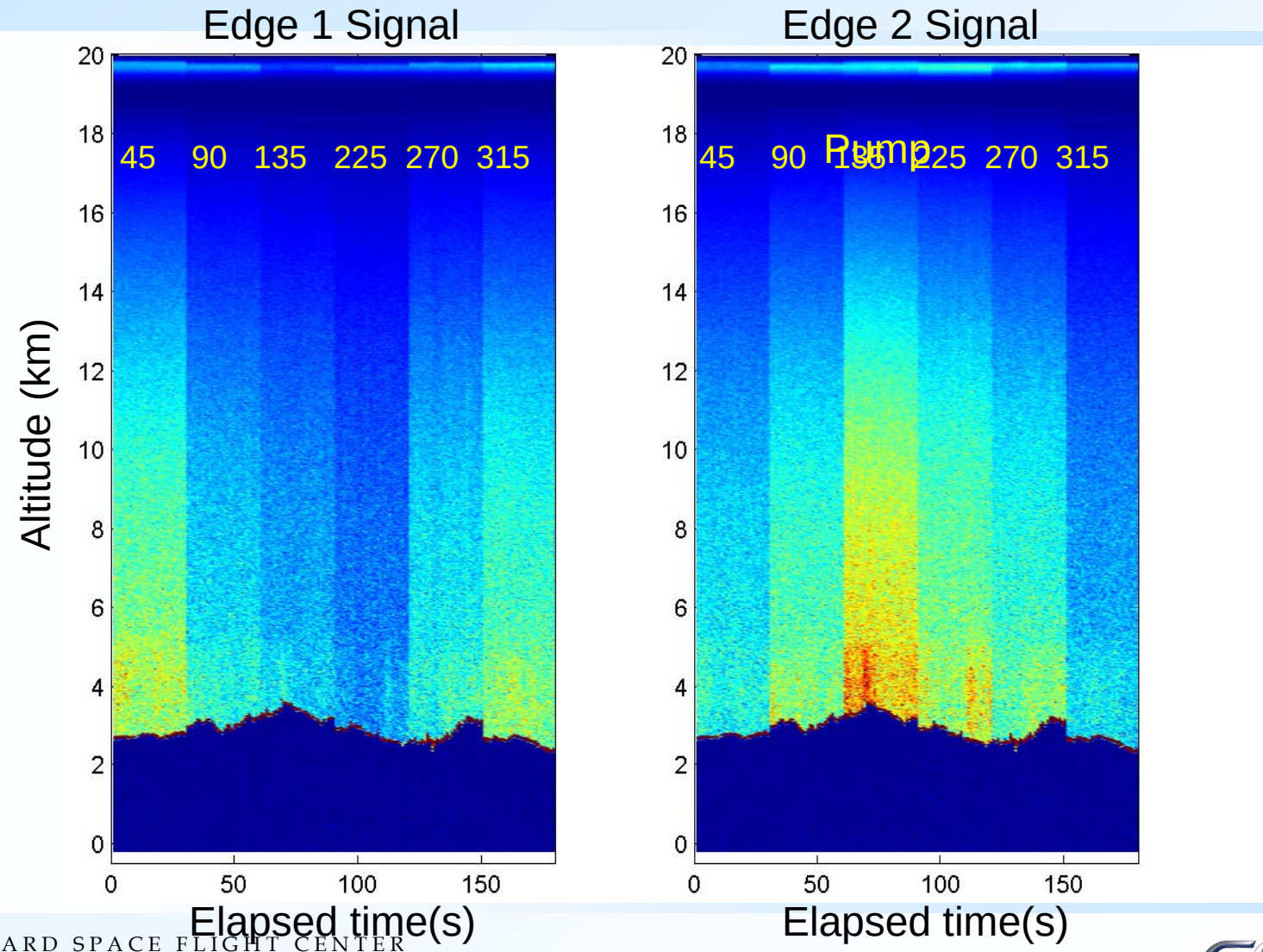
Δt_{avg}=1 seconds, Δz=21 m



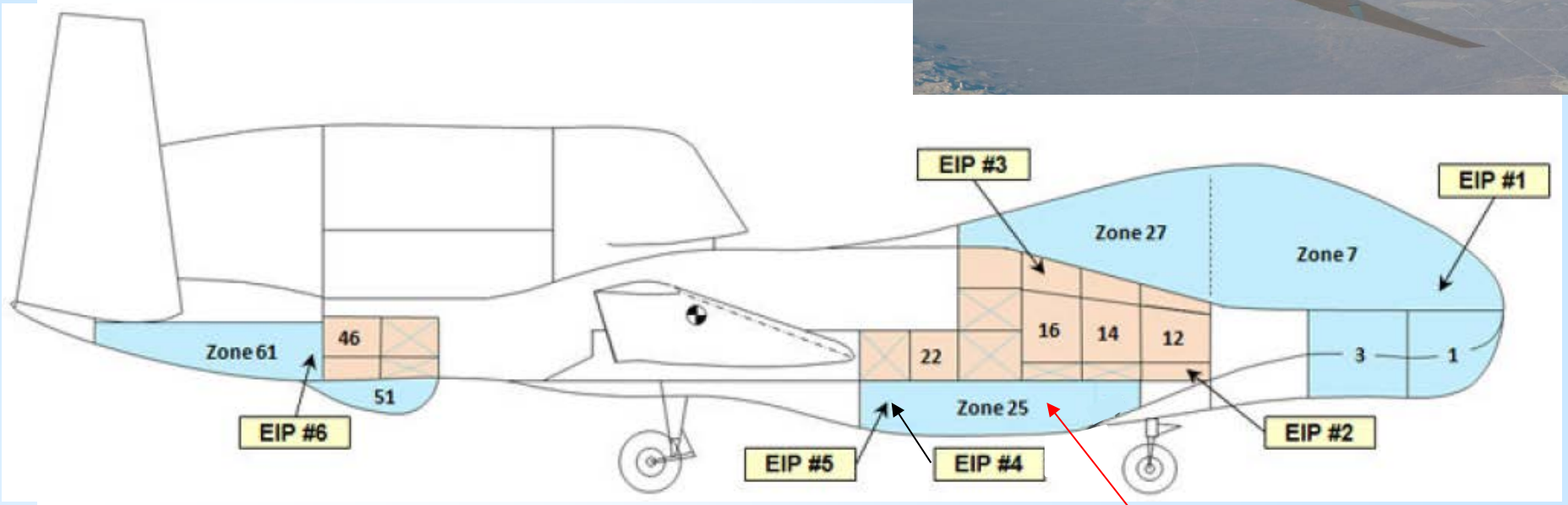
Edge channels, R^2 corrected signal

October 9, 2012 – Cycle 20 of 42

Δt_{avg}=1 seconds, Δz=21 m



TWiLiTE-GH Overview



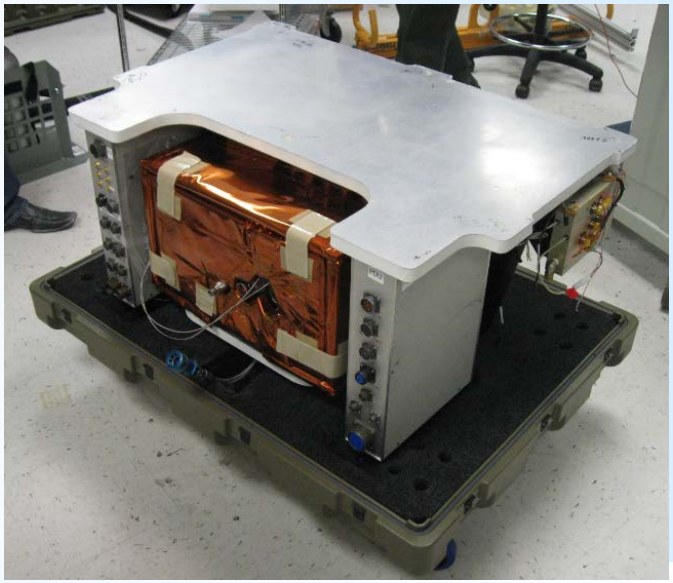
TWiLiTE mounted in zone 25

TWiLiTE Testing on the Global Hawk

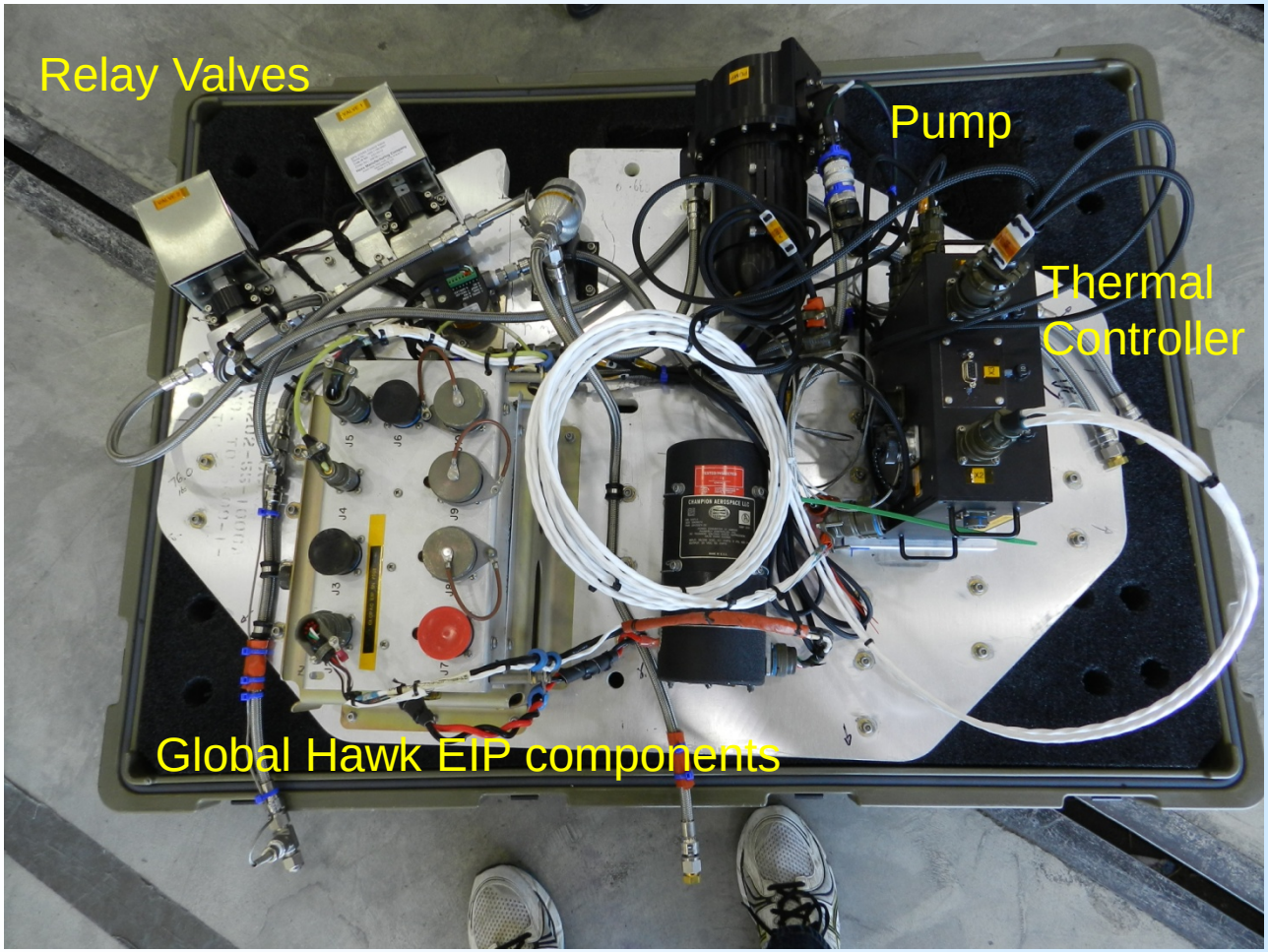
- May 2011- May 2012 - Preparations to fly TWiLiTE on Global Hawk as part of HS3
- June 17-22, 2013 – Initial fit check on Global Hawk. Flights delayed to October, 2013
- September 29-October 20, 2013* – Integration and Flight tests planned. * Government shutdown Oct 1-16 interrupts this schedule. Flights delayed again to spring 2014 after ATTREX Guam deployment.
- April 22- Present – Integration and flight testing including AVAPS dropsondes for validation.
  - TWiLiTE-GH fully integrated on Global Hawk (AV6)
  - All ground tests completed as of May 12, 2014
  - Flights delayed due to aircraft issues and final mechanical certification of TWiLiTE optical pallet structure.

TWiLiTE-GH Optical Pallet

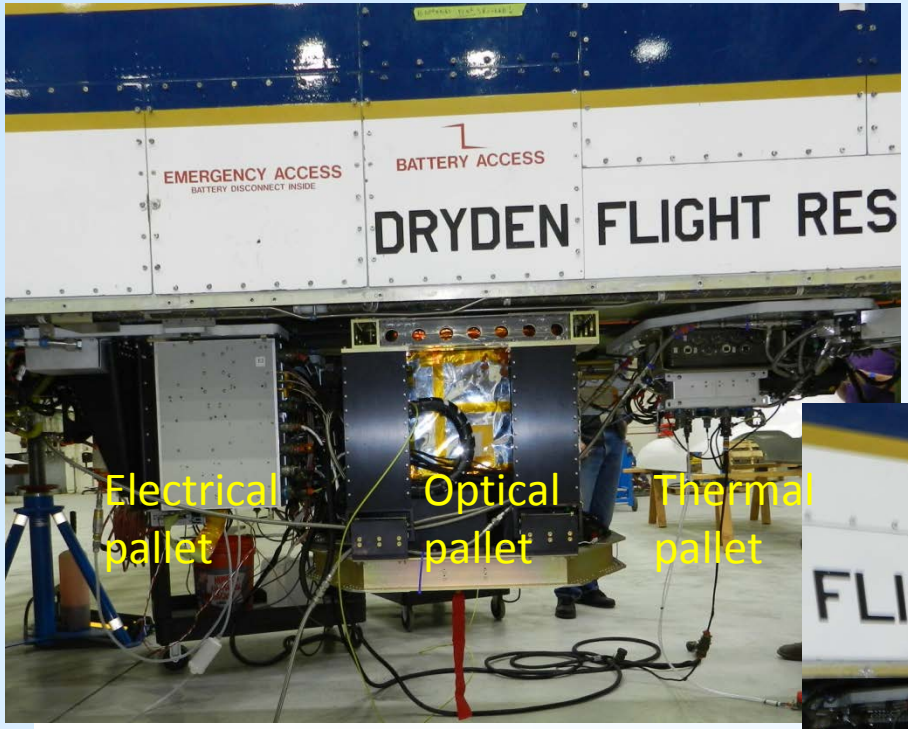
TWiLiTE-GH Doppler Receiver/ Electronics Pallet



TWiLiTE-GH Thermal Pallet + GH EIP components

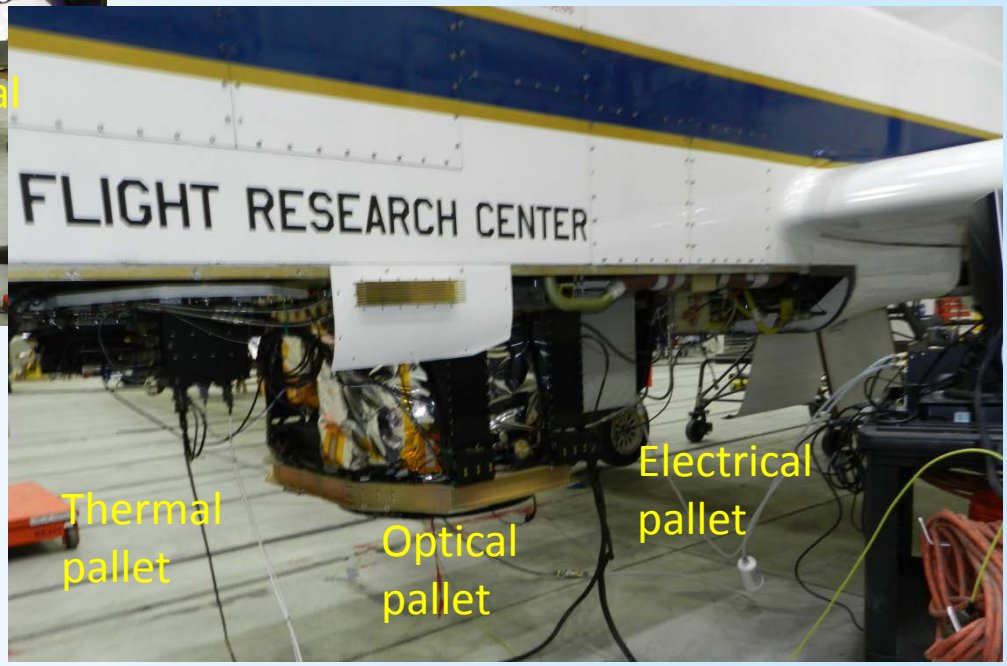


Mechanical Integration
April 24-25, 2014



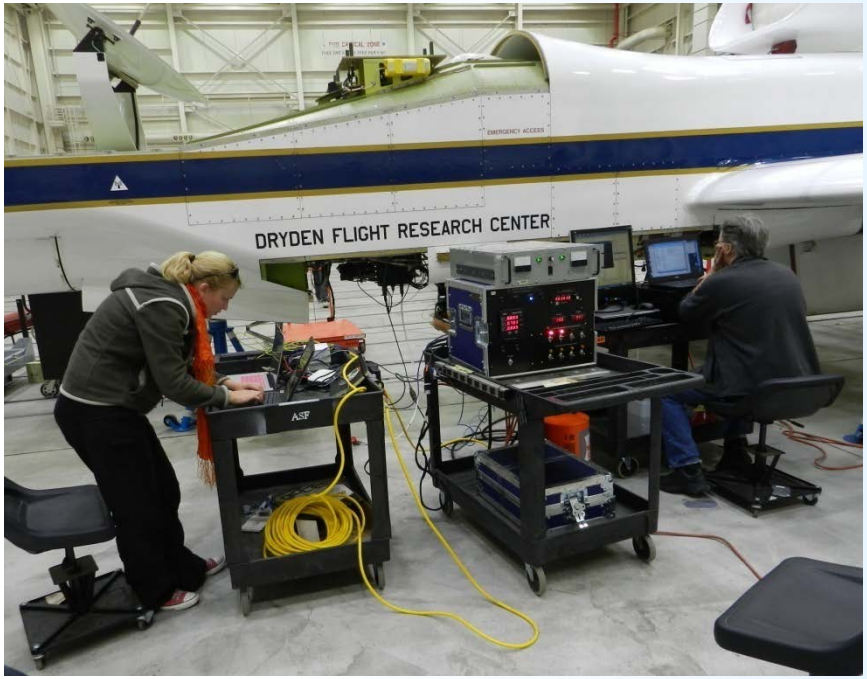
TWiLiTE installed in Zone 25-Starboard

- TWiLiTE fully integrated, cabled and cooling lines plumbed
- EIP cables to aircraft are hooked up to SIL bench for testing



TWiLiTE installed in Zone 25-Port

Electrical Power and Communication testing May 1-3, 2014

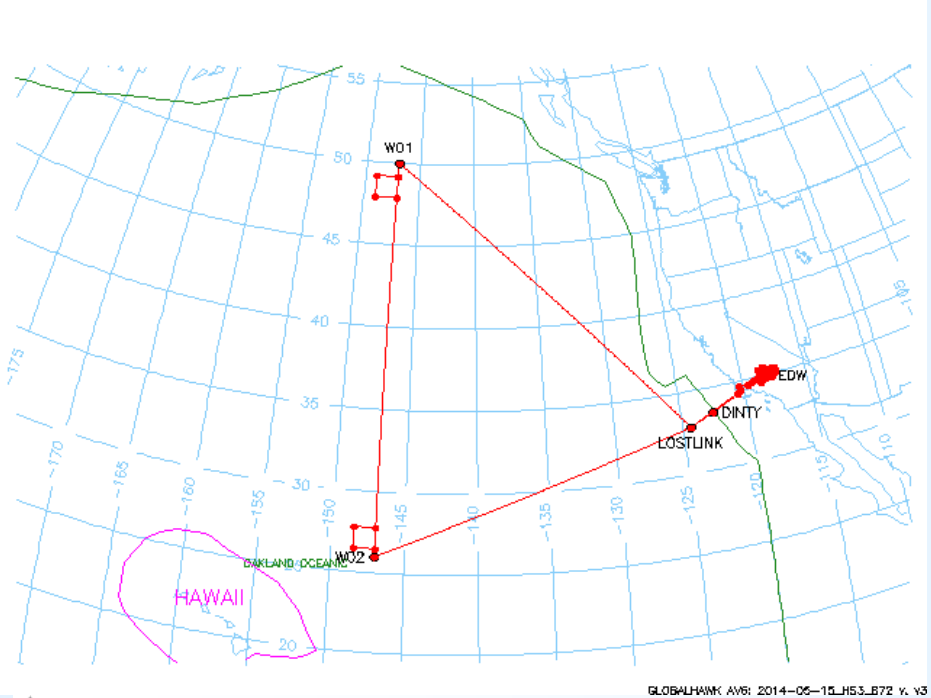


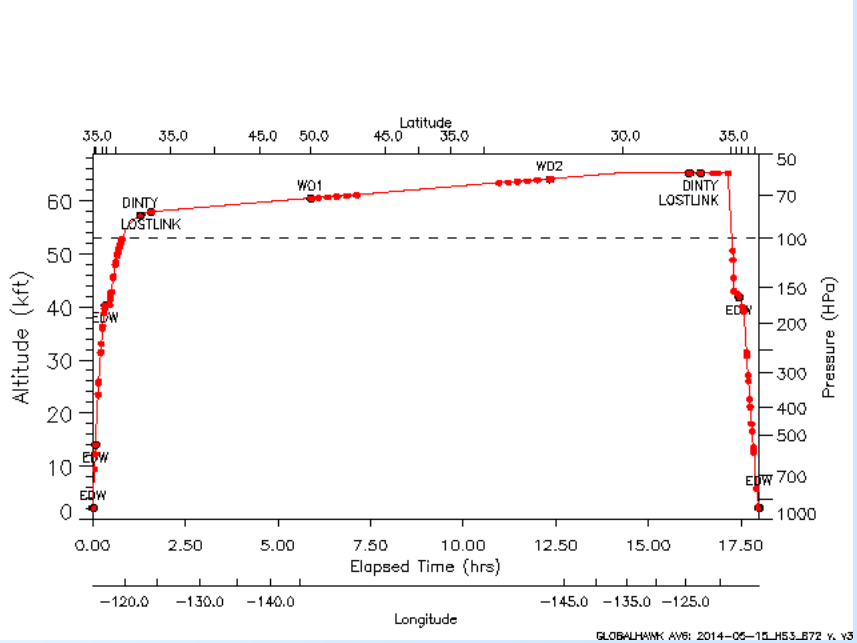
Electrical Power and Instrument control test

Outdoor IT and Communication check

June, 2014 TWiLiTE-GH/ AVAPS Science Flight Plan

- Two flights planned:
  - 6 hour flight on the Edwards Range
  - 18 hour science flight including ~ 20 dropsondes





Summary

- TWiLiTE is a direct detection Dopper lidar designed to measure full tropospheric wind profiles in clear air using the uv laser signal backscattered from air molecules.
- Primary data products are range resolved profiles of radial LOS wind speed.
- Profiles are collected at multiple azimuth angles and can be combined to get u,v winds.
- Secondary products include cloud height and optical properties
- TWiLiTE-GH is now integrated on the Global Hawk in preparation for test flights this month