

Advanced Leak Detection Lidar (ALDL), 5th Quarterly Report

Date of Report: *November 25, 2014*

Contract Number: *DTPH56-13-T-000004*

Prepared for: *DOT, PHMSA*

Project Title: *Advanced Leak Detection Lidar*

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For quarterly period ending: *November 30, 2014*

1.0 Funds and Work Completed During this Quarterly Period

This report covers the fifth 3 month period of the research effort. A summary of the project-to-date cost history, which ties to the Delivery Milestones is provided in **Figure 1**, below. The variance in Q5 is dominated by late delivery of the laser assembly, Milestone D18, Task T4, which is now due 12/14.

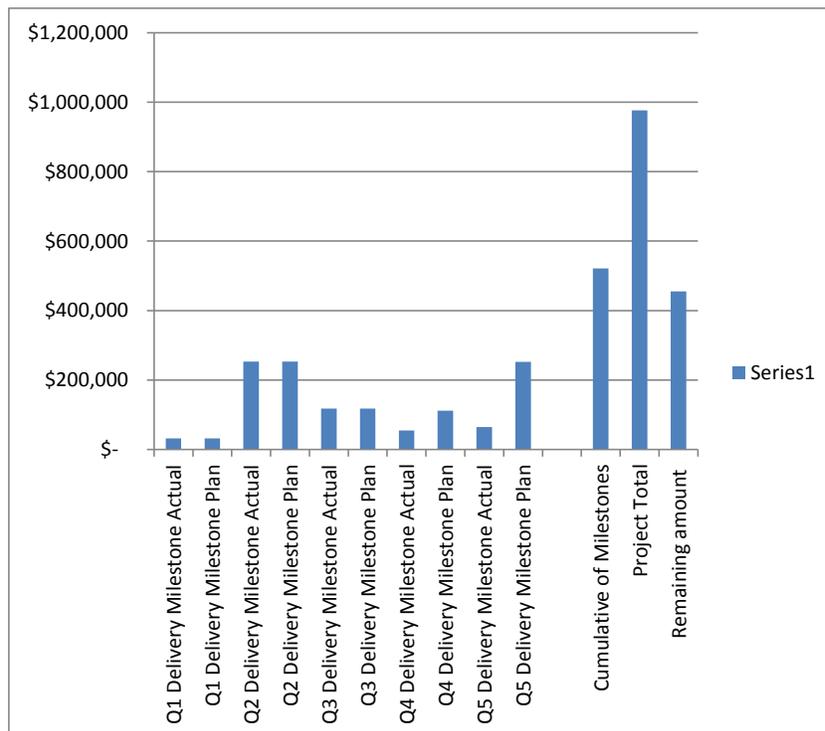


Figure 1, Achievement of payment milestones through the 5th quarter.

2.0 Progress Against 5th Quarter Delivery Milestones

Summary of Progress: The table below summarizes progress against key milestones on ALDL development for Quarters 4 & 5. Some milestones have been accelerated, including: signal processing with software in the loop, fabrication of the optical bench. Other milestones are delayed, including receipt of all procured items for receive and transmit paths and the industry conference presentation and technical paper. The black Xs below indicate the planned completions. Green Xs indicate completions on-time or early and the red Xs indicate re-planned completions.

Milestone Delivery Number & Name	Q4	Q5	Q6	Notes
D14, Validate electrical interfaces	X,X			
D15, Procure receiver and detector components	X		X	Off-axis parabola due for delivery 12/7
D16, Industry conference & paper	X			Not yet re-planned
D18, Procure laser transmitter components		X	X	Laser assembly due for delivery 12/23
D19, Update performance model with as-built characteristics		X,X		
D20, Validate signal processing with software in the loop	X	X,		
D22, Fabricate optical bench & structure		X	X,	

The following paragraphs provide specific information for all milestones completed or missed this quarter.

Delivery Milestone 17. Task T1 Technical Management (Accomplished): Task T1 is an ongoing, level-of effort to organize and manage the project with associated contractual delivery milestones each quarter. Key items for this, the second, quarter have been:

- Monthly and Quarterly Reports prepared and submitted.
- Schedule/technical issues with both the laser subassembly and the receive telescope assembly continue to be monitored and addressed. These issues are described in conjunction with subsequent delivery milestones and have been substantially resolved.
- A Modification Request to add Pointing Controls to the ALDL instrument was finalized and detailed budgeting and task planning accomplished by the Project Manager, Instrument System Engineer and Business Analyst.

Commercialization: Ball Aerospace continues to maintain contacts with several end users in the energy sector and has multiple parties interested in supporting flight testing of instrumentation in 2015. The amount of discretionary funds invested thus far is over 3X the amount promised as resource matching.

Ball Aerospace assisted the University of Colorado (CU) in securing a grant of \$150,000 from the State of Colorado under its Advanced Industries Accelerator Program. This funding will be used to expand flight testing of ALDL and to obtain ground-truth validation of instrument performance.

Delivery Milestone D15. Task T11, Procure Receiver and Detector Components (Not Accomplished) (*Due for completion in December 2014*): As reported last quarter, the receive telescope assembly is still not complete. A single element, the off-axis parabola (OAP), is due for delivery on December 7th, whereupon all the receiver and detector components will have been received.

Delivery Milestone D16. Task T20, Industry Conference Paper and Presentation (Not Accomplished): This milestone was placed on the schedule as a placeholder. We believe that test results from the initial lab demonstration are needed before an abstract and paper for an industry conference should be put forward. We are considering the American Petroleum Institute pipeline industry meeting in April of 2015 as a presentation forum.

Delivery Milestone D18. Task T4, Procure Laser Transmitter Components (Not Accomplished): This milestone was planned for Q5 and is delayed into December. The laser supplier encountered a series of technical issues starting in July (and reported as issues in the various monthly reports). The final residual issue lies in their high-power electronics boards. There are two of these boards. The first drives a large thermo-electric cooler (TEC) that provides bulk cooling for the overall laser assembly. The second provides modulated current to both of the laser modules (i.e. at the “on-line” and “off-line” wavelengths. Both of these boards operate at higher power for ALDL than for prior laser applications by our supplier. It was discovered that the high power components (field-effect transistors, FETS) could not operate in a sustained manner without junctions going over-temperature. The boards have been redesigned and as of Friday, 11/21, the blank PCBs and all components had been received. Board re-build is due for completion by the end of November.

Laser assembly testing is now planned in the 1st 2 weeks of December with delivery by the end of 2015.

Delivery Milestone D19. Task T13, Update Performance with as-built component characteristics (Accomplished): The Instrument Performance Model (IPM) has been continuously updated and maintained throughout the design and fabrication phases of the project. This system engineering analysis tool was used to assess receive telescope options and to confirm the performance of the final off-axis parabola solution. It has been updated with the measured laser line-width and to account for stray light analysis and the addition of the fold mirror between the off-axis parabola and the detector imaging optics. Analytical prediction of chemical sensitivity shows margin against the 50 ppm-m performance target solidified in February of 2015, after the PRCI technical meeting in Atlanta.

Delivery Milestone D20. Task T12, Validate Signal Processing with Software In The Loop (Accomplished In Q4): This task was accomplished early, in Q4, as reported in the Q4 Quarterly Report.

Delivery Milestone D22. Task T14, Fabricate Optical Bench and Other Structural Mounting (Accomplished): This milestone was originally planned for Q6, but has been accomplished early. This has allowed Tasks T15 and T16 to start early. The mechanical integration of the transmit and receive paths has already begun.

3.0 Schedule

The ALDL project remains on schedule. **Figure 2** (next page) presents the project schedule. The plan is shown by the blue bars. Completed tasks are shown in green and tasks that are in-work are shown in yellow. The vertical red line on the schedule shows the current date.

4.0 Payment Milestones

Payment milestones D17, D19 and D22 will be submitted for the fifth Quarter as summarized in Section 2.

Milestones D15 and D16 are delayed (since Q4) and will not be submitted for payment. The delay of these milestones is not expected to affect the overall project plan. Milestone D15 had sufficient schedule slack to the start of the next task (instrument integration) that no substantive impact is expected. Milestone D16 is tied to an industry conference presentation and is not in series with project work flow.

Milestone D18 has also been missed and will not be submitted for payment. As described in Section 2, delivery of the laser assembly is delayed into December of 2015. The planned start date for transmit path integration was February of 2016. So, there is sufficient slack to accommodate the delay in delivery and no impact on the overall project is anticipated.

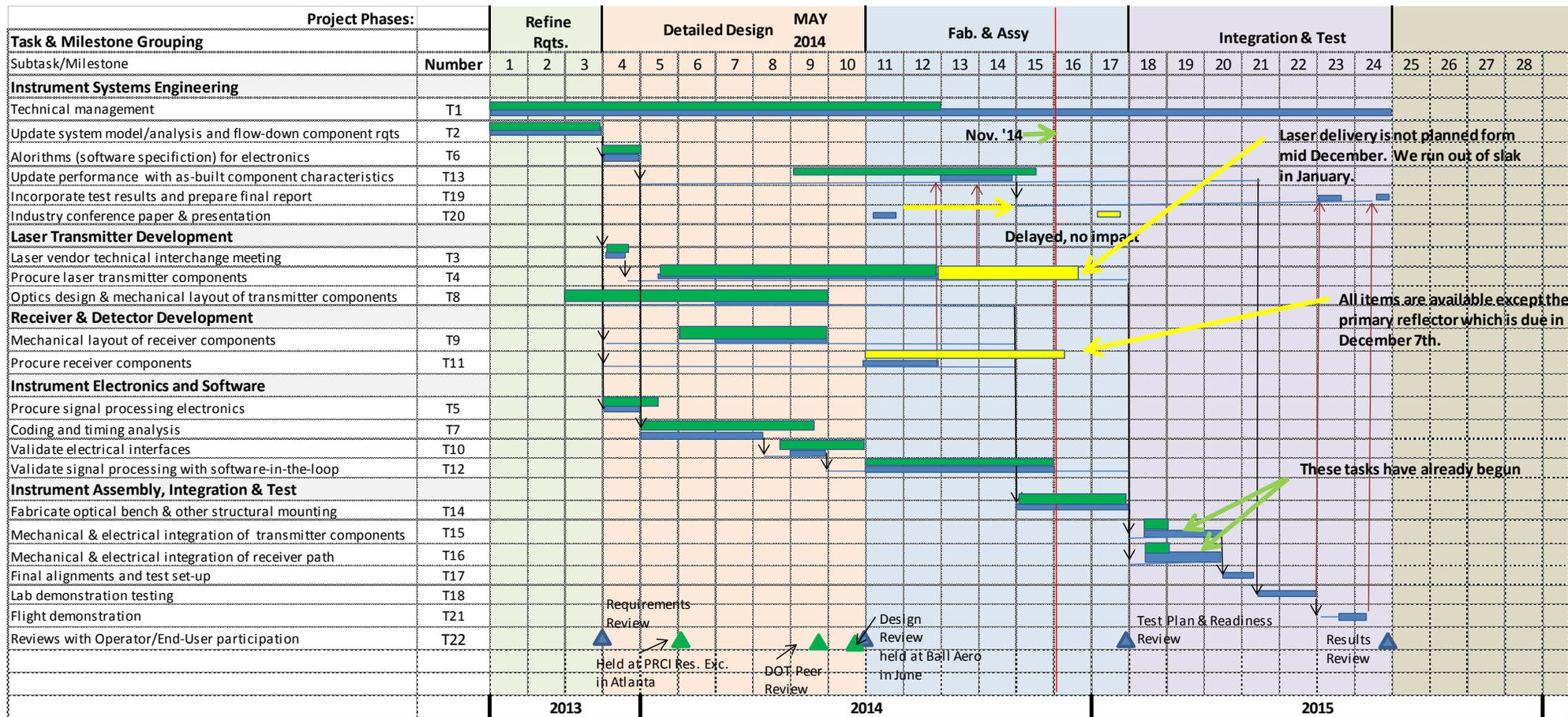


Figure 2, Advanced Leak Detection Lidar (ALDL) schedule progress against plan. Green bars indicate work accomplished and yellow and yellow arrows indicate tasks that are delayed. The vertical red line marks the end of the fifth quarter of the project (i.e. November 30, 2014)

