# Phase I Project Summary

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| **Firm:** | **MetroLaser, Inc.** |
| **Contract Number:** | **NNX11CD66P** |
| **Project Title:** | **Long-Range Nondestructive Testing System** |

### Identification and Significance of Innovation:

The innovation is a versatile laser Doppler vibrometer (LDV) system that can do both modal analysis (MA) and non-destructive inspection (NDI) of arbitrary surfaces from a standoff distance of up to 15 meters. The system would be applied to aircraft structures, and would have the ability to measure composite, metallic, and other types of components. This combined MA and NDI capability would provide the greatest value to NASA while at the same time increase the commercial appeal of the system. For MA, the beam spacing is commensurate with the smallest mode of interest, which can vary substantially depending on the specific target. Current NASA modal tests use accelerometers that are typically spaced by about 1 meter on the aircraft. For NDI, the beam spacing should be less than the smallest flaw of interest, typically on the scale of 1 cm. The final Phase II system will have the flexibility to perform both operations, and will also incorporate long-range operation as well as an eye-safe laser wavelength.

### Technical Objectives and Work Plan:

There were three primary technical objectives of the Phase I effort. First, to demonstrate that LDV technology could be used for both modal analysis and defect detection on aircraft components. Second, to develop a system architecture for a single LDV system capable of performing both of these functions. And third, to develop a conceptual design for an LDV system capable of operation at distances of up to 15 meters with an eye-safe laser wavelength. The Phase I Work Plan included experimental breadboard demonstrations to illustrate both the large area beam spacing required for modal analysis as well as the higher resolution beam spacing for defect detection. In addition, both modal analysis and defect detection were demonstrated on sample test coupons. The Work Plan also included an evaluation of excitation sources as well as design work for the Phase II prototype system.

### Technical Accomplishments:

The Phase I effort successfully achieved all of the specified technical objectives. First, a system architecture was developed that could be converted from a large-scale modal analysis system to a high resolution defect detection system. In Phase I, an existing 15-Beam Multi-Beam LDV was successfully modified to scan in both the x and y directions. The dual-axis scanning capabilities allowed arbitrary resolution in both dimensions. Using the modified LDV, as well as both acoustic and PZT excitation sources, MetroLaser demonstrated both modal analysis and defect detection on representative aircraft components. From these experimental measurements, along with discussions with NASA personnel, a design for a flexible and powerful Phase II instrument was developed. In addition, discussions were held with potential Phase II collaborators, such as ATA Engineering, and potential commercial customers and partners, including The Boeing Company and Quest Integrated. All of these companies have provided Letters of Support for the Phase II effort and possible Phase III collaboration.

**NASA Application(s):**

The proposed system will greatly improve NASA's test capabilities. It will allow long-range modal analysis and defect detection measurements on aircraft components. These tests currently require days of setup. The proposed long-range multi-beam LDV system could greatly reduce the setup time while improving the quality of the data. The proposed system could also be applied to wind tunnel experiments or towards the study of advanced engine designs.

**Non-NASA Commercial Application(s):**

A long-range, multi-beam LDV system for modal analysis and defect detection would be attractive to virtually all commercial and military aircraft companies. In addition, such a system would also find applications in areas such as civil engineering and the automotive industry.

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