



Company Information

Company Name	<i>Lawrence Livermore National Lab</i>	Date Submitted	<i>06/18/21</i>
Project Title	<i>Mobile Metrology Station for GOM Structured Light Scanner (LLL_GOM)</i>	Planned Starting Semester	<i>Fall 2021</i>

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical	5	Electrical	
Computer		Systems	
Other ()			

Company and Project Overview:

For more than 60 years, the Lawrence Livermore National Laboratory (LLNL) has applied science and technology to make the world a safer place. LLNL's defining responsibility is ensuring the safety, security and reliability of the nation's nuclear deterrent. Yet LLNL's mission is broader than stockpile stewardship, as dangers ranging from nuclear proliferation and terrorism to energy shortages and climate change threaten national security and global stability. The Laboratory's science and engineering are being applied to achieve breakthroughs for counterterrorism and nonproliferation, defense and intelligence, energy and environmental security.

LLNL has recently acquired a GOM ATOS 5 structured light scanner and intends to use this system for in-process metrology during machining processes.



The manufacturing facility is located in a single-story building with several rooms separated by double doors and each containing multiple machine tools. The GOM system will be moved manually between rooms to positions close to each machine that contains a workpiece to be scanned. The scan head will likely need to be extended on a boom to get into scanning range over the machine. Once the data is captured, the GOM system can be moved to the next location. We expect to move the system up to 10 times per day, so maneuverability and ease of adjustment are important. The GOM scan head itself is currently mounted onto a 3-wheeled mobile stand provided by GOM, but the supporting hardware (rack-mount electronics box, PC, power supply, monitor, keyboard, mouse) is not attached to any mobile platform. Integration of the supporting hardware into the mobile metrology station and protective wire management need to be taken into consideration. It is challenging to obtain high-quality scans in an active manufacturing environment with the scan head at the end of a cantilever, so stability of the scan head will be a critical requirement of any proposed design.



Project Requirements:

The objective for the project will be to design and manufacture a mobile metrology stand and surrogate measuring head for vibration testing (see item 3) of a GOM structured light scanner.

1. Mobile platform requirements:

- a. Designs may integrate the scanning head and other equipment into one platform or keep the scanning head on a separate structure.
- b. For both one and two-piece designs each individual component should be capable of rolling on casters and then being safely locked in place for use.
- c. For both one and two-piece designs it must be possible for a single operator to easily move each individual component through doors of the labs.
- d. For two-piece designs active management for the cable connecting the scanning head to the computer is required.
- e. The design must incorporate features which make accidental tipping of the stand by a user impossible.
- f. Built-in storage must be provided for: calibration panels, reference documents, datum markers, and a handheld spectrometer.
 - i. Total storage volume required is to be minimized over at least two compartments.
- g. It must be possible to easily and secure all hardware for safe transport. When possible, safely secured should be the default state of any individual piece of hardware.

2. Minimum hardware to be integrated:

- a. GOM ATOS 5 3-D structured light scan head.
 - i. Mounting for scan head that provides, at minimum, safe storage and to be defined, degrees of freedom.
 - ii. The scan head must have a similar range of vertical and horizontal motion as the stock GOM setup.

- b. Instrumented surrogate scan head. This mock-up of the ATOS 5 scan head shall:
 - i. Have the same mounting interface as the true scan head.
 - ii. Have approximately the same mass and center of gravity.
 - iii. Be fitted with low-noise seismic accelerometers.
 - c. Computer and power supply for control of scan head and processing of measurements.
 - i. Operating position of the keyboard, mouse and monitor should be ergonomic.
 - d. Calibrated and traceable temperature sensor and display.
 - e. Other hardware that would increase the functionality of the measurement station may be proposed and possibly integrated.
3. *Qualification requirements: vibration isolation:*
- a. Qualification testing will test how well the scan head is insulated from external vibrations.
 - i. LLNL will provide measurements of typical vibration inputs and the vibration response of the stock GOM setup.
 - ii. Testing shall consist of:
 1. Vibration inputs: simulating the provided typical inputs (approximately is fine).
 2. Expected outputs: showing a reduction in vibration of the scan head compared to the stock configuration in multiple scan head positions and orientations.

Expected Deliverables/Results:

Mobile Metrology Station

- Mobile Stand
- Integrated supplemental instrumentation and associated data acquisition and display systems

Instrumented Surrogate Scanning Head

- DAQ and analysis hardware and software. DAQ hardware not needed if compatible equipment is available at LLNL

Documentation

- Complete design narrative
- Design drawings for all subsystems in Creo or compatible file format
- Bill of materials for all subsystems
- Vibration isolation testing results

Disposition of Deliverables at the End of the Project:

The work product will be displayed at the last Expo then immediately handed over to the supporter unless arrangements are made to deliver at a later date.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

Courses (Strongly Preferred):

- Instrumentation (MEGR 3171)
- Metrology (MEGR 3090) (at least one student)

Courses (Preferred):

- Waves and Optics (MEGR 3235)



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- Advanced CAD/CAM (MEGR 3231)

Other:

- Experience with uncertainty analysis
- Good results in Junior Design
- Interest in metrology
- Strong understanding of machine dynamics and vibrations
- Industry supporter is located in California, so interaction with them will be chiefly through videoconferencing and other on-line tools.