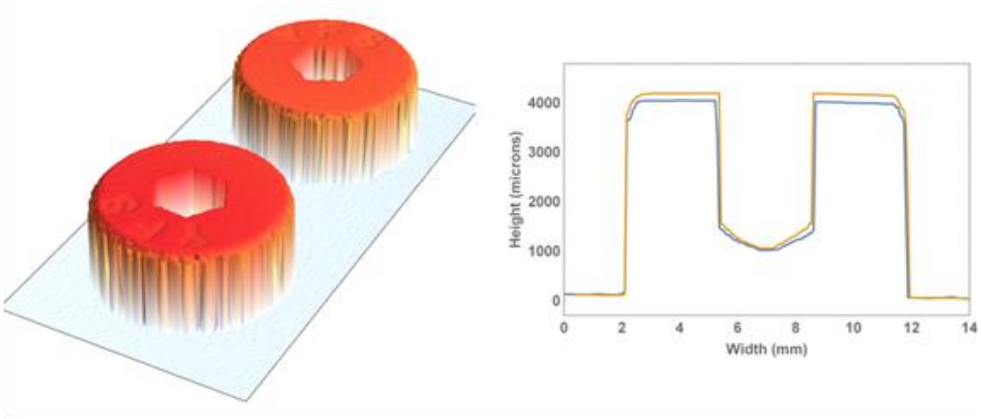
WG6 CoC1 IPNDV Technology Data Sheet

February 19, 2020

CoC Technology Name: Non-Contact Laser Interferometry[1]

Physical Principle/Methodology of Technology:

Non-contact laser interferometry (NCLI) could be used for the verification of container integrity and unique identification activities in support of Chain of Custody. By exploiting intrinsic features of Treaty Accountable Items (TAIs) and/or TAI containers, the instrument can create and verify laser image templates for specific features and interfaces with unique characteristics (e.g., bolt-head wear patterns and interface gapping) to provide unique identification and indication of unauthorized access between inspections. This is applicable particularly because it would afford for unique identification (UID) and integrity verification without the requirement of an applied tag or seal and without making physical contact with the item. The instrument works by illuminating the TAI feature with an eye-safe laser beam and detecting that feature in an interferometric arrangement. The speckle interferograms are recorded as the laser is tuned in frequency and are stored in a hypercube. Fast Fourier Transformation (FFT) of each pixel through the speckle hypercube produces beat frequencies that encode surface heights that are used to create the 3D image. Due to the use of normal incidence illumination, both projections above and holes below the object surface can be imaged in 3D without shadowing. Currently the system is capable of imaging 3D volumes with a lateral extent up to 75 mm with heights up to 7.5 mm with an accuracy of 10 µm.



3D image of bolts (left) and comparison of bolt heights after 60° rotation of the lower bolt (right).

Potential Monitoring Use Cases (pre-dismantlement, dismantlement, post-dismantlement, storage stage):

Storage, pre-dismantlement, and entry into dismantlement.

Physical Description of Technology (e.g., approximate size, weight):

The unit itself is lightweight (<9kg) but due to stability and feature reproducibility requirements it would be mounted on a rotatable fixture or positioning fixture with vibration isolation.

[1] General information on Non-Contact Laser Interrogation is presented with other measurement methods in the IPNVD WG3 CoC7 Technology Data Sheet on Container Integrity Assessment, 2017.)

Time Constraints (e.g., measurement times including distance from object, time to install the equipment):

Measurements can be conducted rapidly for analysis at a later time. Measurement times for full integrity depend upon the size and configuration of the object, but can still be measured in just a few minutes.

Technology Complexity (e.g., hardware, software, and ease of use by personnel):

Existing technology is COTS but the COTS equipment does not have an interpretive software package that is sufficient to interpret measurements for the purpose of verification. Basic Systems Engineering and software has been developed but will need to be optimized for the forms and functions under which the equipment is to perform.

Infrastructure Requirements (e.g., electrical, liquid nitrogen, etc.):

The equipment can be batter operated or plugged into facility power.

Technology Limitations (e.g., operational temperature range, differences in materials):

A battery-supplied unit would be temperature limited. How easily can the system be set to re-align to a reference point for the imaging of surface (or how do you align images from different interrogations over time) requires a fixture with vibration isolation and flexible position design for imaging different surfaces with features at different heights and curvatures.

Information Collected by the Technology (used to help determine if an information barrier is required for use):

3D image of the unique surface feature and interface. Currently the system is capable of imaging 3D volumes with a lateral extent up to 75 mm with heights up to 7.5 mm with an accuracy of 10 µm.

Safety, Security, Deployment Concerns:

The instrument works by illuminating the TAI feature with an eye-safe laser beam and detecting that feature in an interferometric arrangement. Some facilities may have laser concerns that will need to be considered in equipment approval. However, this instrument has passed strict safety approvals for use in previous testbed that used U.S. facility safety requirements.

Technology Development Stage (Technology Readiness Level, TRL):

TRL 4. The technology itself is COTS but there is additional Systems Engineering and software required to prepare it for different types of use cases.

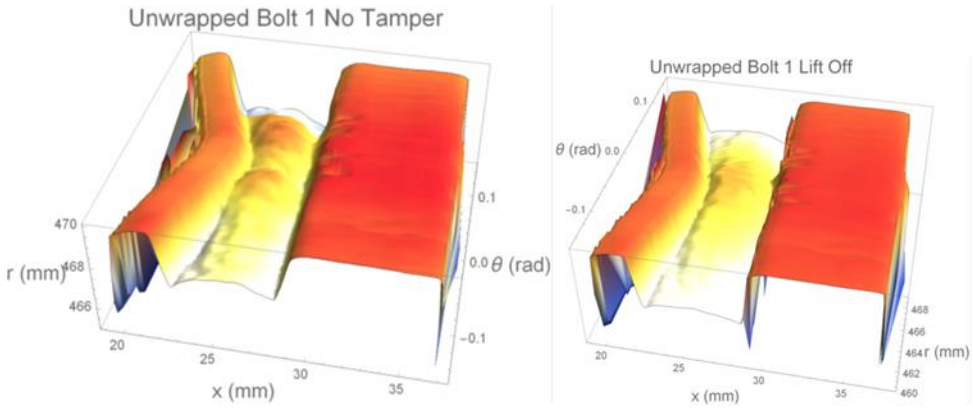
Additional System Functionality (e.g., outside the monitoring use case):

N/A. There are newer versions of similar technologies with incorporated robotic scan arms that would help facilitate the whole item scanning that might be necessary for tamper indication. These technologies may come with greater approval risks due to controls and functionality issues.

Where/How the Technology Is Currently Used (e.g., international safeguards, border protection):

Quality Inspection commercial uses.

Examples of Equipment/References:



Comparison of drum container flange gasket before and after having been opened and reclosed.