

3D Technologies for Nuclear Safeguards Verification

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Objectives

Nuclear safeguards *verification systems based on 3D imaging* for:

- Design Information Verification of nuclear facilities
- Material containers: Identification, authentication and containment
- 3D Surveillance





3D Technologies: laser range scanners

- Single-point range measurement
- Scans 3D space through rotation and deflecting mirror



Phase Shift

- Measures difference in phase of the emitted and received laser signals
- Range < 100m (mm accuracy)</p>

Time of flight

- Measures the time of flight of laser light pulses
- Maximum range between
 350 1Km (cm accuracy)







3D Technologies: laser triangulation (µm accuracy)



Joint Research Centre



3D Laser Verification System (3DLVS)

What:

Design Information Verification (DIV) and change monitoring of nuclear facilities.

How:

- 3D laser range scanners are used to acquire multiple 3D scans with mm accuracy.
- The 3DLVS software processes the data to create an as-built 3D model of the facility.
- The 3D model is used to verify the provided design information (DIV).
- 3D models acquired at different points of time are analyzed to automatically highlight changes that occurred between inspections.



3D Laser Scanner



3DLVS software showing the 3D model of a (non-nuclear) facility.



Change map derived from two 3D model acquired at different points of time. Changes are highlighted in red and green.

Joint Research Centre DIV



Spot the change





Joint Research Centre

DIV



Mobile 3D Laser Scanning

What:

Mobile Laser Scanning Platform (MLSP) which provides change detection while moving. Additionally it allows for **indoor** localization and mapping.





ONKALO DIV/BTC Verification: Mobile Laser Scanning.



How:

- Backpack based real-time 3D scanner (12Hz frame rate) and on-board processing unit.
- Real-time processing software for localisation and change analysis.
- DIV: The system is complementary to existing stop-and-go scanning and significantly improves the efficiency of 3D laser-based DIV.

Identification



Laser surface Mapping for Containment Verification (LMCV)

What:

Identification and integrity verification of dry storage casks (DSC)

How:

- LMCV is a 3D measurement system that creates a unique signature of the DSC weld based on its surface geometry.
- It uses laser-triangulation to measure the weld geometry with 10 µm accuracy.
- The analysis software uniquely identifies the DSC based on the weld signature.
- Scanning hardware and processing software developed at the JRC.



Field trial in Canada

Docking Station

- Wake on LAN
- Remote data transmission to IAEA HQ
- Battery Charger



LMCV: Laser Mapping for Containment Verification (1/4)

Fingerprinting of dry storage casks using unique signature of weld geometry





LMCV: Laser Mapping for Containment Verification (2/4)

Signatures of three different welds







L2IS: Laser Item Identification System

UF6 cylinder identification and authentication based on the "fingerprint" of the cylinder side surface.















Stack Scanner – SPRS, Sellafield

Containment verification for ventilation stacks at SPRS, Sellafield





Research



Ventilation grid with change detection colors



Histogram of distance between reference and verification scans



Laser Surveillance System (LASSY)

What:

Containment Verification and Surveillance System

How:

- Real-time monitoring using low-cost COTS Laser scanners
- Possibility to define geometrical zones which are not supposed to be entered into
- Versatile triggering/alarm to Surveillance camera and/or databases etc.



Sensor

3D Surveillance



3D Laser Surveillance System

- Complimentary to optical surveillance camera
- 'Virtual fencing'
- Robust change detection.







Laser-based NUVER Technologies – Nuclear Fuel Cycle



Research Centre