FUSION FOR ENERGY

TECHNOLOGY OFFER



LiDAR-based detection systems: design, manufacturing & alignment

Through its collaboration with Fusion for Energy (F4E), Bertin Technologies has engineered, manufactured, and qualified a high-precision hybrid AM/FM LiDAR inspection system capable of performing sub-millimetric 3D metrology of plasma-facing components inside vacuum vessels under extreme radiation, magnetic, and thermal conditions.

The technology

Developed specifically for the In-Vessel Viewing System (IVVS) at ITER, this technology performs sub-millimetric 3D imaging and metrology inside the vacuum vessel without requiring a reactor shutdown. The architecture utilizes a hybrid AM/FM LiDAR design that combines amplitude modulation (AM) for wide-field intensity viewing with frequency modulation (FM) ranging to generate 4D point clouds (intensity and 3D spatial coordinates). The compact optomechanical probe (1 m × 115 mm × 125 mm, weighing ~34 kg) delivers a near-spherical scanning field of view of 360° in azimuth and ~155° in elevation. Optical components are integrated under sub-5 µm assembly tolerances, Coordinate Measuring Machines (CMM), and Wavefront Sensors (WFS) within ISO 5 - 8 cleanrooms, utilizing radiation-hard and UHV-compatible materials selected for low neutron activation and long service life.

Advantages and Potential Applications

- Hybrid AM/FM LiDAR design: combines wide-field amplitude modulation viewing with frequency-modulated interferometric ranging to generate 4D datasets with absolute position accuracy < 1 mm over 0.5 - 10 m (standard deviation < 0.1 mm on flat surfaces at distances below 4 m).
- Engineering for extreme environments: proven capability to qualify and operate LiDAR systems under high vacuum (5×10^{-4} Pa), magnetic fields up to 6.5 T, temperatures 0°C - 130°C and radiation doses up to 1.36 MGy, using low-activation materials.
- Reliability: over 2 million guaranteed mechanical scanning cycles.
- Remote electronics: operating with up to 300 m of optical fibers and cabling connecting the probe to a remote diagnostics cubicle, Bertin's technology allows to isolate sensing from control electronics.

This technology is highly transferable to remote inspection in nuclear facilities (tokamaks, hot cells, spent fuel pools), stand-off 3D industrial metrology in inaccessible areas, aerospace inspection, and embedded space sensors.

Collaboration opportunities

Bertin Technologies is open to partnerships, technology transfer and direct supply agreements with organisations requiring LiDAR-based inspection or metrology systems with low human access adapted to their specific environment, providing end-to-end engineering support across all project stages, from initial feasibility studies and optical design through to manufacturing and alignment, system testing, qualification and series delivery.

Fusion for Energy Technology Transfer Programme

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