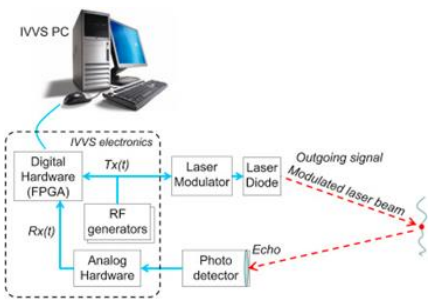
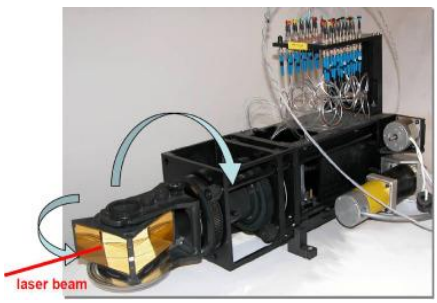
Radiation Resistant 3D Laser Scanner

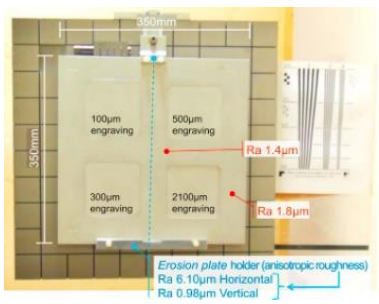
The 3D laser scanner is a system that scans the environment (in a quasi-spherical field of view) obtaining high-definition 3D model of the surrounding environment with a submillimetric resolution. The systems developed in ENEA are designed to withstand radiation, ultra-high vacuum and high magnetic fields and can be used at large distances for object detection with 1 meter accuracy. The development of the 3D laser scanner for Fusion Experimental Machines has led to the creation of many technologies and test that can find potential application across different non-fusion sectors including contactless metrology, inspection and quality control, long-range 3D image reconstruction, nuclear (non-fusion) environment and in obstacle avoidance 3D navigation systems.

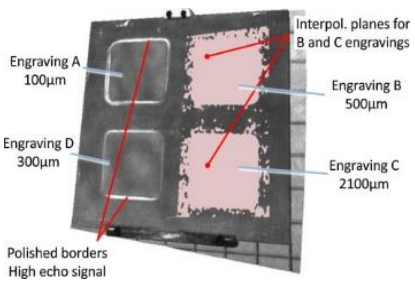
Description of the technology

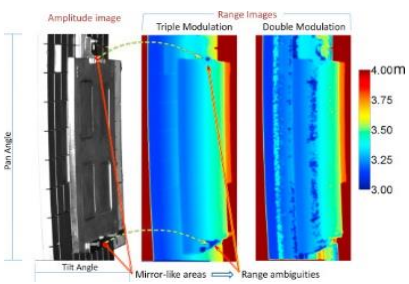
The IVVS 3D laser scanner developed in ENEA is fully ITER radiation compliant (total dose of more than 4 MGy, 14 MeV neutrons, 2.5 kGy/h), ultra-high vacuum resistant (10−9 mbar), temperature resistant (120 °C) and magnetic field resistant (8 Tesla). The 3D model, obtained after the scan, can be used for metrological purposes allowing periodic comparison of geometry. The prototype system was able to perform high resolution images (more than 24 bits in the image amplitude and sub-millimetric spatial resolution in a range of 10 meters) providing for each scanned point the measured backscattered lights and distance.











Short range high resolution (radiation resistent prototipe submillimetrical resolution up to 10 meters)

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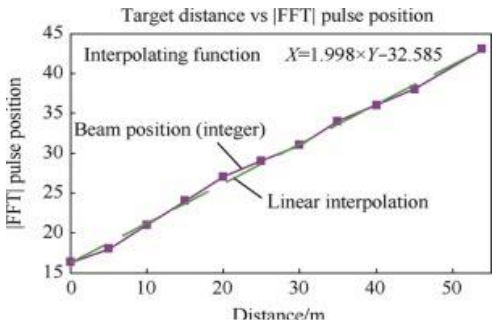
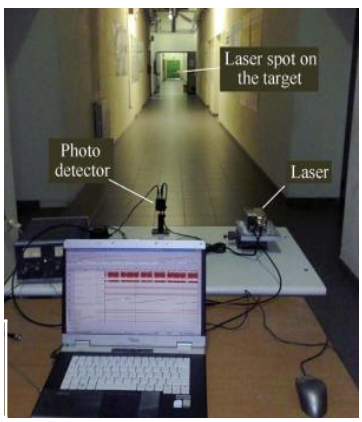
Description of the technology

The developed systems can be used on fusion machines for inspection or metrological purposes. In particular, by means of the high quality of the 3D model it is possible to detect deformation, cracks, erosions or deposits of material on the first wall. An evolution of the distance detection algorithm makes the system compatible with greater distances (up to a few km), with a lower resolution (2 meters), making it suitable for detecting obstacles even in the case of multiple echoes (pollution or fog). With the necessary customizations, the 3D laser scanner can be used for hostile target detection or to avoid obstacles even in avionic or naval applications.



Long Range system test (2 meters resolution up to 55 meters, compatible with multiple echos)



The development of the radiation 3D laser scanner study has provided for the registration of some patents, one of which with extensions in France and Germany. Furthermore, the developed technology contains secret know-how.

The IVVS system has been developed and tested in ENEA laboratories, all components were tested under ITER vacuum vessel constrain (high magnetic field, radiation, high temperature, high vacuum). Following the radiation resistant technology, a Radiation Tolerant 3D Laser Scanner for Structural Inspections in Nuclear Reactor Vessels and Fuel Storage Pools has been developed and tested in a fission reactor in the last years.

Aside the fusion application, the long range system has been tested in laboratory environment with very promising results and features, in a joint project developed in close collaboration with Tor Vergata University (Rome, IT).

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Innovation and advantages of the offer

The developed technology allows obtaining high quality self-illuminated images, avoiding underexposure due to the different distance of the objects. Furthermore, the system is immune from disturbances due to light sources not coming from the system and is difficult to detect.

The obtained resolution is submillimetric for indoor systems (maximum distance range tens of meters single echo) and 2 meters of resolution (outdoor systems few kilometres of range and multiple echoes).

The system is able to operate successfully in demanding environmental conditions, including the presence of radiations and is qualified for underwater operations.

Non-fusion Applications

The technology can be used for contactless metrology, structural inspections and components-integrity check with measurements of cracks and damages in demanding environments, including e.g. nuclear fission applications (nuclear reactor vessels, fuel storage pools, etc.) and underwater applications (e.g robotics, unmanned inspection vehicles, remote handling applications) or, with some modifications, for defence-related applications, including obstacle avoidance navigation systems or for long-range 3D laser scanners.

EUROfusion Heritage

The 3D radiation resistant laser scanner projects started around 1999 with the development of the LIVVS (Laser In Vessel Viewing System developed for, but not at applied to, JET) funded by Euratom. The evolution of this system, funded by EUROFusion, has allowed the development of a radiation resistant prototype for ITER. Studies funded by Fusion For Energy include, materials testing for resistance to radiation, vacuum and magnetic fields; improvements in the optical and electronic system and improvements in image reconstruction.

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