Laserlab-Europe Fighting Cancer

Cancer is a leading cause of death worldwide, accounting for nearly 10 million deaths in 2020 and its burden is rapidly growing mainly as a result of aging, growth of population and socioeconomic developments.

Lasers, photonics and bio-photonics provide an exceptional potential for the fight against cancer, addressing all major challenges identified within the Mission for beating cancer: understanding, diagnosis, treatment and prevention. In particular, laser science contributes to the Mission's aim to improve early detection and to develop drugs and therapies, thereby improving the quality of life of people afflicted with cancer.

Laserlab-Europe, with its consortium of national laser research infrastructures active in the field of laser-based cancer research, offers unique innovation possibilities in the fight against cancer through novel laser-based photonic technologies and devices, revolutionising diagnostic capabilities and treatment efficacy. Our activities range from fundamental research to pre-clinical trial and applied patient studies and encompass a broad spectrum of different instruments, from large scale scientific installation to hand-held medical devices that can be used directly in hospitals and clinics.

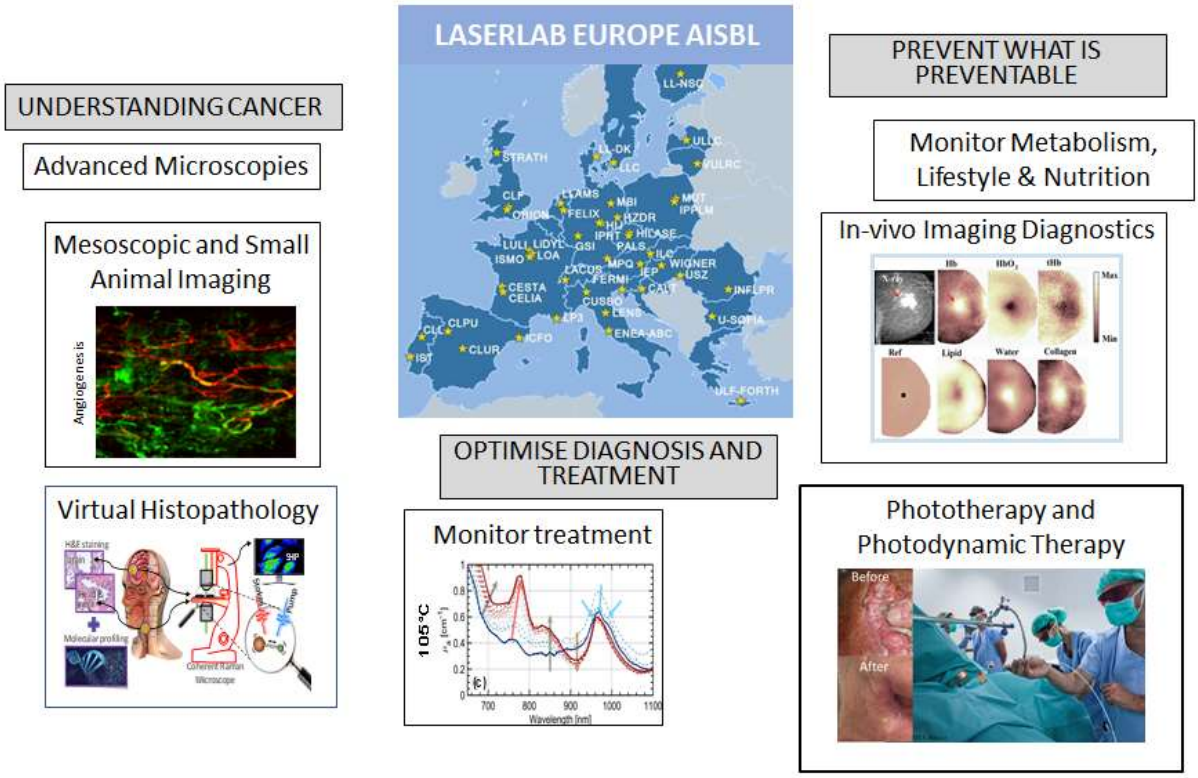

Figure 1 Different Applications of Laserlab Europe AISBL

- Laser-driven methods can help **understanding cancer** with laser-based techniques, leading to a better understanding of healthy versus cancer cells at individual and population level (action 2) and cancer-patient molecular, cell, organ, organismal interaction (action 3). Advanced biological imaging techniques can help to determine the role of genetics in cancer (action 4).

- Advanced real time fluorescence microscopy on customized glass lab-on-chip devices with nanoscale characteristics contribute to the understanding of cancer cell migration and invasiveness.
- Soft X-Ray nanoimaging of adhesion structures and organization of actin cytoskeleton of intact cells for studies of cancer migration and metastasis.

- Non-invasive laser technologies can be effectively used for **prevention, screening and early detection**, applied in situ as well as on biopsy samples. Several diagnostic approaches developed by Laserlab-Europe researchers have been translated into clinical applications.

- Raman spectroscopy coupled with data science could revolutionize cancer diagnosis and research in the next years, providing new and other-wise inaccessible molecular information, and giving a step towards a more rapid, accurate, personalized diagnosis and treatments.
- Non-invasive, high-resolution, highly sensitive, targeted 3D imaging of specific cancer bio-markers, such as multimodal optical spectroscopy of urine for early detection and screening of bladder cancer.
- Novel 3D X-ray imaging modalities in order to generate 3d images of human tissues identified as potentially cancerous. Dose reduction and very fast generation of 3D images.
- non-invasive, and multimodal spectroscopy methods for early detection (early diagnostics) of skin cancer.
- Non-invasive in vivo optical estimate of tissue composition to quantify risk of developing cancer (e.g., breast density) and investigate/assess/monitor the impact of risk factors (e.g., nutrition and lifestyle).

- For **treatment of cancer**, laser-based techniques are tested and applied in clinical settings and can aid the development of personalised medicine. Moreover, understanding and qualification of novel techniques for cancer treatment are enabled and mechanisms of cancer drugs are elucidated.

- In the field of drug-device combination, the combination of innovative drugs with novel technologies, photodynamic therapy combines light (most often, laser light), a dye molecule (named photosensitizer) and oxygen to kill cancer cells, with promising results.
- Non-invasive monitoring of neoadjuvant chemotherapy by means of optical assessment of tissue composition for a personalized therapeutic plan/intervention.

- Finally, laser technology can also have an impact on the improvement of **the quality of life** of cancer patients for long-term tracking of cancer.

- Non-invasive, non-linear optical imaging for longterm tracking of cancer
- Quantitative biomarkers for QoL of cancer patients

Laserlab-Europe represents a unique point of entry for a multitude of research infrastructures across Europe, all with different and complementary technical specifications and areas of expertise, covering all aspects of excellent forefront laser-based science. It provides a bridge between laser experts and biomedical research scientists and clinicians, offering access and expertise in the use of physics-based methods.

Laserlab-Europe network encompasses photonics research and technologies ranging from hard X-rays to THz radiation, with systems ranging from the most potent high-power laser sources that drive secondary sources and particle beams, to small single quantum emitters. The consortium utilizes a wide range of advanced metrology, quantum-limited sensing, and imaging capabilities.

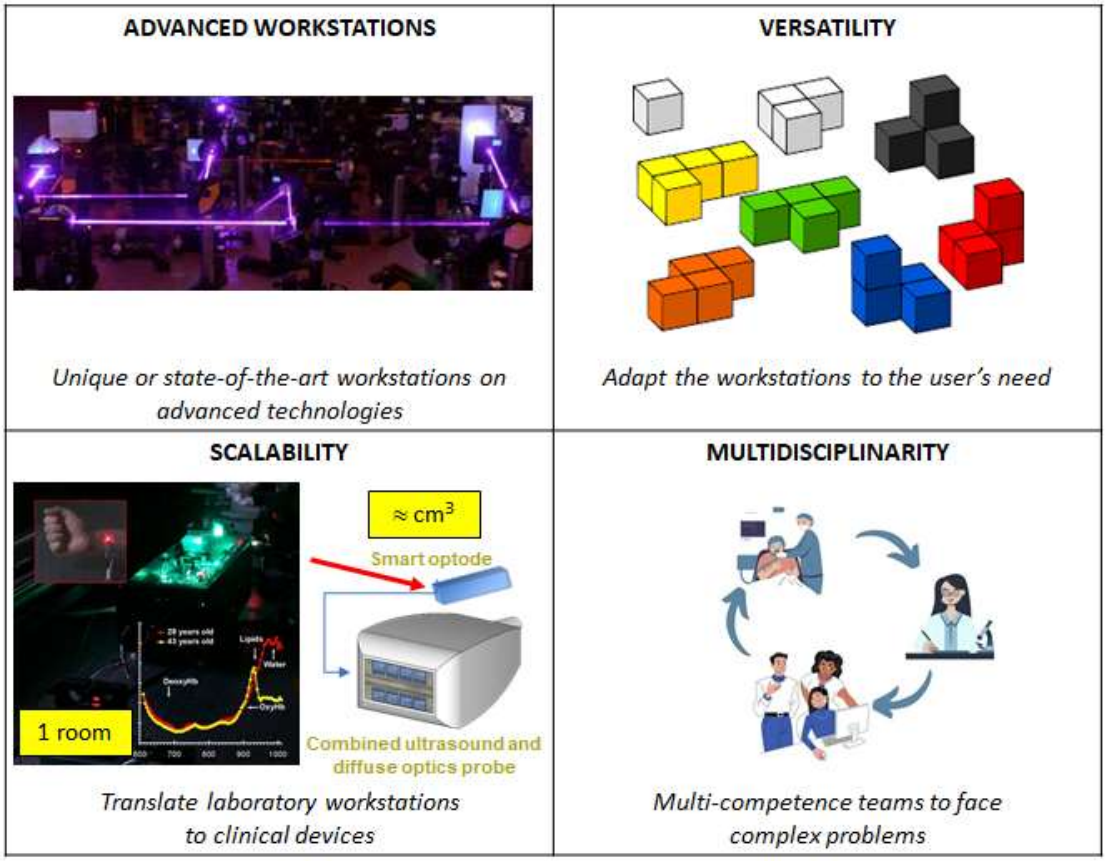

Figure 2 Key features of Laserlab-Europe AISBL support

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