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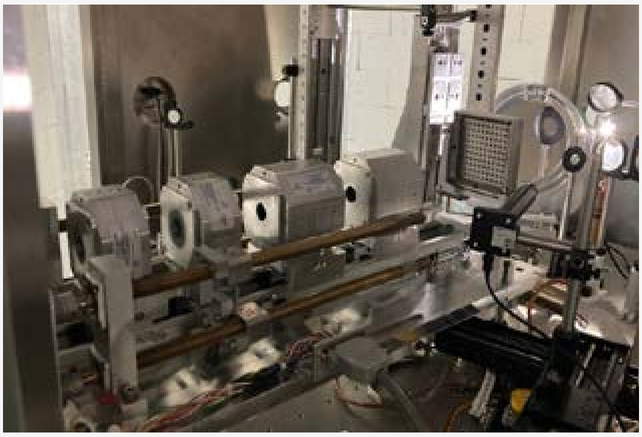

LPA2: PROTONS ACCELERATED WITH LASERS FOR HADRONTHERAPY

A recent result obtained by the LPA2 (Laser Driven Proton Acceleration Applications) experiment could pave the way for the creation of a new generation of more effective and compact medical devices for hadrontherapy that exploit charged particles such as protons to destroy tumour cells. The experiment is funded by the INFN National Scientific Committee dedicated to technological and interdisciplinary research (CSN5), in collaboration with the National Research Council (CNR) National Institute of Optics (INO). Thanks to the use of a laser that can generate very short pulses, the INFN researchers managed to produce, select and transport a beam of protons with optimal intensities, and therefore with optimal energies, for oncological treatments.

The main aim of LPA2 is to form and guide proton beams generated by lasers with enough energy and precision on tumour cells and in less time, thus optimising the efficacy of treatment sessions and their length. The LPA2 project constitutes the first application, in Italy, of a beam of protons produced by laser and guided towards a precise irradiation point.

The experimental run was carried out at the Intense Laser Irradiation Laboratory (ILIL) of the INO, where a laser system able of generating very short, high-power (up to 200 terawatt) pulses has been operating since 2018. The system is funded by the CNR in the context of the development of the European "Extreme Light Infrastructure" (ELI). Using the laser to activate a mechanism called Target Normal Sheath Acceleration (TNSA), it was possible to produce and accelerate a proton beam with intensity that is of interest for future important biomedical applications.

The proton beam transport system, constructed and designed at the INFN Southern National Laboratories (LNS), in collaboration with the INFN Milan division, is the fruit of experience gained in the recent past with four projects funded by the same CSN 5. Together with advanced diagnostic and dosimetry systems, they have, finally, enabled researchers to select and focus a proton beam with energy of 6 MeV and to

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distribute the latter in a single release with a dose of radiation 300,000 times higher than that absorbed during radiography and lasting 10 nanoseconds. This is an experimental measurement that paves the way for the potential use of laser-driven proton beams, including ultra-flash therapy, i.e. where the dosage rate may even exceed nine times the quantity of that conventionally used in clinical practice today. The use of these regimens, which are still wholly unexplored, may constitute a significant advantage in reducing the secondary undesired effects on healthy tissues by increasing the efficacy of the radiotherapy treatment in the same timeframe.

LPA2 is part of one of the strategic research threads of INFN: the transfer of technological solutions to medicine from the area of research into the fundamental constituents of matter, a sector in which the institute holds a long tradition and international supremacy. ■