Ushering in novel radiation therapy systems by zapping bacteria with ultra-short high intensity laser pulses

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Proton beams have found a special use in targeting tumours with high precision. Contrary to conventional radiation therapy, proton therapy minimizes damage to the surrounding tissue by morphing the incident area of the proton beam into the shape of the tumour. Cyclotrons are used for the generation of a proton beam.

However, a cyclotron requires a massive amount of space, in addition to steep operative costs. Researchers from Tata Institute of Fundamental Research (TIFR), Mumbai and TIFR Centre for Interdisciplinary Sciences (TCIS), Hyderabad have come up with an innovative approach to overcome this hurdle. This involves production of a sheath electric field by exciting a layer of bacteria with intense ultrashort laser pulse.

When a high intensity laser beam is incident on a surface, it superheats the substrate releasing electrons. This release of electrons gives rise to an electric field. Dissociation of electrons gives rise to formation of other ions as well. *E.coli* (rod-shaped bacterium) is roughly two microns in length and is composed mostly of water. Therefore, one bacterium imitates a micron sized water capsule which provides a higher surface area of target. Under excitation with a laser beam, protons are accelerated. The energy generated in such a set-up is around 700 keV as compared to 40 keV generated by conventional polished glass surface targets.

It is likely that the surface formed by a layer of bacteria has an increased capability to absorb laser energy as compared to a target of flat glass. Previous observations show that nano-structured surfaces have this ability as well. The free electrons thus generated have a higher energy. This results in the formation of a stronger electric field for the ions to accelerate.

Till date, such high throughput ion acceleration could only be achieved by bulky and expensive cyclotrons. This exclusivity of the ion generator has restricted the spread of proton therapy in hospitals throughout the world. This study provides an important direction to the development of more efficient targets for high throughput ion acceleration.

Reference: Dalui et.al, Scientific Reports (2014), 4: 6002, DOI: 10.1038/srep06002