LhARA; a transformation approach to precision, personalised particle-beam therapy

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Cancer is the second most common cause of death globally. In 2018, 18.1 million new cancer cases were diagnosed, 9.6 million people died of cancer-related disease, and 43.8 million people were living with cancer. Radiotherapy (RT) is used in 50% of cancer patients and is involved in 40% of cancer cures. It is estimated that 26.9 million life-years could be saved in low- and middle-income countries if capacity could be scaled up.

The beam characteristics that can be exploited in proton- and ion-beam therapy (IBT) facilities today are restricted to low dose rates, a small number of temporal schemes, and a small number of spatial distributions. The use of novel beams with strikingly different characteristics has led to exciting evidence of enhanced therapeutic benefit. This evidence, together with developments in our understanding of personalised medicine based on the biology of individual tumours, now provides the impetus for a radical transformation of IBT.

The 'Laser-hybrid Accelerator for Radiobiological Applications', LhARA, is conceived as a novel, uniquely flexible facility dedicated to the study of radiobiology. The technologies that will be demonstrated in LhARA have the potential to allow particle-beam therapy to be delivered in a completely new regime, combining a variety of ion species in a single treatment fraction and exploiting ultra-high dose rates. The laser-hybrid approach will allow the exploration of the vast "terra incognita" of the mechanisms by which the biological response is modulated by the physical characteristics of the beam. We will describe the motivation for LhARA, present the status of its development and summarise the programme upon which the LhARA consortium has embarked to drive a step-change in clinical capability.