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Predicting biological outcome in cancer ion therapy by the BIANCA biophysical model

Hadrontherapy employs heavy charged particles to treat tumours, demanding accurate predictive models to estimate both the beam biological effectiveness on the tumour and the probability of side effects in healthy tissues, making their precise prediction essential for safe and effective treatment planning. To address this, BIANCA, a biophysical Monte Carlo model, is developed by the Computational Radiobiology group to simulate cell survival and chromosome damage (the main cellular effects leading to clinical consequences) following monochromatic irradiation with different ion types across different energies. BIANCA can be coupled with the FLUKA, GEANT4 and PHITS radiation transport codes to model the mixed radiation field generated by beam interactions with the human body and to extract cell survival and chromosome damage parameters. These parameters are then applied to predict tumour cell-killing biological effectiveness and normal-tissue side effect probability in clinically relevant scenarios, with results validated through dedicated statistical analyses and comparisons with data.

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