Contribution ID: **59** Type: **poster**

A comparison study of analytical RBE models.

Tuesday, 25 June 2019 13:30 (1h 30m)

Analytical models of radiobiological response in ion beams are used in studies on improving treatment planning in proton therapy. The best known models are Carabe [1], Wedenberg [2] and McNamara [3]. They relate response of the system (i.e. cell survival) with beam characterication (kinetic energy, linear energy transfer, ion type) and tissue radiosensitivity expressed by parameters of linear quadratic model (alfa, beta). These approaches has been used in studies of variable RBE in proton therapy. Application of these models require time-consuming and complex simulation of particle transport to establish spatial distribution of dose and linear energy transfer (LET).

We propose a simplified approach where particle transport is replaced by two analytical models applicable to pencil-beam dose delivery systems. Spatial dose distribution is calculated using the Bortfeld [4] model and LET distribution according to Wilkens [5] model. Both models assume power-law approximation of energy loss per unit distance are valid for uniform media. The predictions are within 2-3% agreement with particle transport simulations using Monte-Carlo codes.

All models were implemented in open-source program code library called **libamtrack** [6]. The library is written using ANSI C and is freely available on Github service https://github.com/libamtrack. It is designed as a shared library to be used by scientific programmers in their own modelling codes.
To facilitate the use by regular users a web interface was provided, exploiting modern technologies capable of compiling C code directly into JavaScript and WebAssembly languages. This web interface offers calculation of dose, LET and RBE as a function of depth for various media and beam configuration.

Combination of analytical models describing proton beam properties (Bortfeld, Wilkens) with radiobiological response models offers a way for fast model tuning and comparison in uniform media. We believe that the public implementation in the open-source library extended with user-friendly web interface may lead to wider application and futher development of analytical models in proton therapy.

[1] Carabe, Alejandro, et al. “Range uncertainty in proton therapy due to variable biological effectiveness.” Physics in Medicine & Biology 57.5 (2012): 1159.
[2] Wedenberg, Minna, Bengt K. Lind, and Björn Hårdemark. “A model for the relative biological effectiveness of protons: the tissue specific parameter α/β of photons is a predictor for the sensitivity to LET changes.” Acta oncologica 52.3 (2013): 580-588.
[3] McNamara, Aimee L., Jan Schuemann, and Harald Paganetti. “A phenomenological relative biological effectiveness (RBE) model for proton therapy based on all published in vitro cell survival data.” Physics in Medicine & Biology 60.21 (2015): 8399.
[4] Bortfeld, Thomas. “An analytical approximation of the Bragg curve for therapeutic proton beams.” Medical physics 24.12 (1997): 2024-2033.
[5] Wilkens, Jan J., and Uwe Oelfke. “Analytical linear energy transfer calculations for proton therapy.” Medical physics 30.5 (2003): 806-815.
[6] Greilich, Steffen, et al. “Amorphous track models: a numerical comparison study.” Radiation Measurements 45.10 (2010): 1406-1409.

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Session Classification: Poster session