

10. Leszek Grzanka, Kinga Jeleń and Niels Bassler: **Free and extensible software toolbox for research treatment planning in hadrontherapy**

Recent years brought interesting developments in treatment planning with variable effectiveness for proton radiotherapy. Commercial clinical and research treatment planning systems are costly product and hard to adapt to modern data science programming environment. We aim at providing suitable data science toolbox for research in treatment planning, based on TRiP98 program and freely available libraries.

Our research treatment planning system is composed of two projects: core library called pytrip and graphical user interface (GUI) called pytripgui. Both projects are mainly implemented in Python programming language. Core library is capable of handling DICOM and VOXELPLAN dataformats by custom readers based on numpy library. GUI was migrated to PyQt5 framework.

Project management follows best practices in Open-Source programming environments: code is hosted on public infrastructure (github), tasks and issue are being properly traced, code is being formally reviewed before adapting any new changes. Automatic test suite running after any change in the code ensures high code quality.

Optimal plan is being calculated by TRiP98 program which can be run locally or remotely. Several additions not included in TRiP98 are provided by pytrip toolbox, like: empirical models of variable effectiveness in proton therapy, plan quality features calculations, and DICOM dataformat support. GUI supplements TRiP98 by a plotting tool, capable of handling computer tomography scans and relevant quantities like: dose and linear energy transfer.

Pytrip provides a powerful toolbox for research in treatment planning. Usage of python programming language makes it easy to connect with modern data science programming environment (like machine learning models). Graphical user interface aids user in visualization and calculation of treatment plans for research purposes.