TRiP98 (**TR**eatment **P**lann**I**ng for **P**articles)

TRiP98 is the computational kernel for a treatment planning system used clinically for carbon ion radiotherapy at GSI from 1997 to 2008. It served as a prototype for the commercial Syngo PT code from Siemens, and is now being used as a research prototype at various places. One of its main purposes is sophisticated nonlinear dose optimization and dose calculation, taking into account the relevant physical and radiobiological properties of ion radiation. It achieves computational efficiency by using precalculated tables wherever possible, but also has a numerical-analytical (non-MC) transport code to create the necessary base data sets.

The transport model in its first phase uses conventional dE/dx tables, such as provided by the LBL Salamon code, but others could be used as well. The ionization potential has been fine-tuned to reproduce the experimental Bragg peak position, which is the most critical quantity in ion-beam radiotherapy, because it has to be predicted with sub-mm precision. For the nuclear part semi-empirical descriptions like those of Silberberg-Tsao are used, but again the cross sections have to be tuned to agree with representative experimental results. In a second phase, lateral spread of the beam (by nuclear or multiple Coulomb interaction) can be added to create a complete pencil beam description plus a large set of particle energy spectra as a function of depth. In actual treatment planning only these tables are used in order to obtain acceptable planning throughput.

While these codes have not yet been applied to space travel it is easy to imagine how they might be used. Essentially, considering a space craft exposed to GCR as equivalent to being inserted into a computerized tomography device, the dose absorbed by astronauts or their internal organs can be computed efficiently. If RBE or other relevant datasets are used, e.g., late effects rather than clonogenic survival, it should be possible to use TRIP98 components efficiently to generate biological dose distributions relevant for space application.

For more information consult the online writeup <http://bio.gsi.de/DOCS/trip98.html>, or contact the principal author,M.Kraemer@gsi.de.