accuracy derived from the experiment was: DD (5%) – 83.4% and 68% pixels passing, DTA (3mm) – 99.0% and 96,7%, gamma parameter (for DD (3%), DTA (3mm)) – 90% and 75,5% respectively for AAA and PBC algorithms. The comparison between studied parameters DD, DTA and γ for both algorithms implicated AAA as an appropriate approach in radiotherapy treatment planning.

Keywords: Radiotherapy planning algorithms, radiology, medical physics.

References:
[1] – Gagné I M, Zavgorodni S, *Evaluation of the analytical anisotropic algorithm in an extreme water–lung interface phantom using Monte Carlo dose calculations*, Journal Of Applied Clinical Medical Physics, Vol. 7, 2007.
[2] – International Commission on Radiation Units and Measurements (ICRU). *Determination of absorbed dose in a patient irradiated by beams of X or gamma rays in radiotherapy procedures*. ICRU Report 24, Washington (DC): ICRU,1976.
[3] – Van Escha A, Namur E, Tillikainen L, Pyykkonen J, Tenhunen M, Helminen H, Siljamäki S, Alakuijala J, Paiusco M, Iori M, Huyskens D P, *Testing of the analytical anisotropic algorithm for photon dose calculation,* American Association of Physicists in Medicine (AAPM), 2006.

182
Nuclear fragmentation in protontherapy
P. Rebello Teles[1], M. Hussein[2]
[1] Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, Brazil
[2] Instituto de Física, Universidade de São Paulo, São Paulo, Brazil

The effect of nuclear fragmentation in the passage of 180MeV protons through the human body tissue is discussed. Prostate cancer protontherapy with these intermediate-energy protons is discussed in light of model calculation.

Keywords: Nuclear fragmentation, protontherapy, prostate cancer

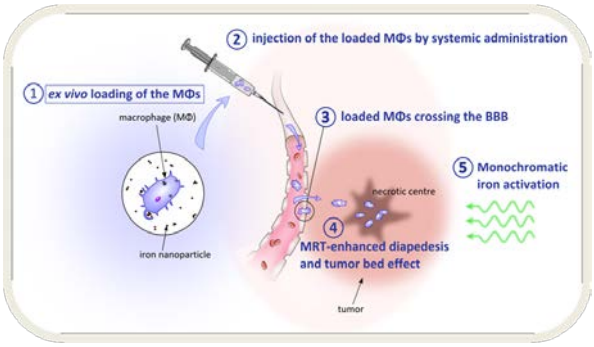
References:
[1] G. Kraft, Tumor therapy with heavy charged particles, Progress in Particle and Nuclear Physics, 2000
[2] A.J. Kreiner and A.A. Burlon, Novel Applications of Particle Accelerators to Radiotherapy, Heavy Ion Physics 16, 243 (2002)
[3] B.V. Carlson, R.C. Mastroleo and M.S. Hussein, Phys. Rev.C46, R3 (1992);
[4]B.V. Carlson, Phys. Rev. C51, 25 (1995)
[5] A.S. Goldhaber, Phys. Lett. B 53, 306 (1974)

183
Internalization of iron nanoparticles by macrophages for the improvement of glioma treatment
S. Reymond[1,2,3,4], P. Gimenez[1,2,3,4,9], R. Serduc[1,3], J. Arnaud[5], J.-P. Kleman[6], V. Djonov[7], W. Graber[7], J.A. Laissue[7], J.-K. Kim[8], S.-J. Seo[8], J.-L. Ravanat[4, 9,10], H. Elleaume[1,2,3,4]
[1] INSERM, U836, Grenoble, France;
[2] Université Joseph Fourier, Grenoble Institut des Neurosciences, UMR-S836, Grenoble, France;
[3] European Synchrotron Radiation Facility, Grenoble, France;
[4] LabEx PRIMES Lyon, France;
[5] CHU Grenoble, France;
[6] IBS Grenoble, France;
[7] University of Berne, Bern, Switzerland;
[8] Catholic University of Daegu, Daegu City, Korea;
[9] INAC/SCIB LAN CEA-Grenoble, France;
[10] Université de Grenoble, France

Rationale: An alternative approach for the improvement of radiotherapy consists in increasing differentially the radiation dose between tumors and healthy tissues using nanoparticles (NPs) that have been beforehand internalized into the tumor. These high-Z NPs can be photo-activated by monochromatic synchrotron X-rays, leading to a local dose enhancement delivered to the neighboring tumor cells[1]. This enhancement is due to secondary and Auger electrons expelled from the NPs by the radiations. In order to carry the NPs into the tumor center, macrophages are currently under study for their phagocytosis and diapedesis abilities[2] (*cf.* Figure adapted from [3] and [4]). In this study we characterized J774A.1 macrophages' internalization kinetics and subcellular distribution of iron NPs and compared them to the internalization abilities of the F98 glioblastoma cell line.
Materials and Methods: Three aspects of internalization were examined: first, the *location of internalized NPs* in J774A.1 macrophages and F98 glioblastoma cells following a 24h incubation with iron NPs (0.3 mg/mL in the cell culture medium) was determined by optical microscopy after cell slicing. Subsequently, the *iron intake* after a 24h incubation with NPs (0.3 mg/mL and 0.06 mg/mL in the cell culture medium) was characterized for the two types of cells using ICP-MS. Finally, the *internalization dynamics* were studied by live phase-contrast microscopy imagining for 11 hours and by absorbance measurements for 24 hours using a plate reader.
Results: F98 tumor cells and J774A.1 macrophages are both able to endocytose NPs: we measured ~61±10 pg of internalized iron per macrophage compared with ~33±5 pg per F98 cell (initial iron concentration: 0.3 mg/mL in culture medium). F98 internalizing NPs for 10 hours showed stress signs during the first minutes after the NPs injection, but behaved like F98 control cells during the rest of the experiment. Finally, we determined that the internalization kinetics for J774A.1 had a typical saturation time of one hour.
Conclusion: Macrophages seem to be promising vectors for NPs, being able to endocytose and retain in their cytoplasm larger quantities of NPs than tumor cells. Our following studies will attempt to shed light on their other potential abilities as "Trojan Horses".

Keywords: radiotherapy; nanoparticles; cell-carriers

References:
[1] F. Taupin *et al.*, Phys Med Biol 60 (2015).
[2] J. Choi *et al.*, Biomaterials 33 (2012).
[3] R. Weissleder *et al.*, Nature Materials 13 (2014).
[4] M.R. Choi *et al.*, Nano Letters 7 (2007).



184
First clinical application of a prompt gamma based *in vivo* proton range verification using a knife-edge slit camera
C. Richter[1-4], G. Pausch[1-3], S. Barczyk[1,2], M. Priegnitz[3], I. Keitz[1], J. Thiele[2], J. Smeets[5], F. Vander Stappen[5], L. Bombelli[6], C. Fiorini[7], L. Hotoiu[5], I. Perali[7], D. Prieels[5], W. Enghardt[1-4], M. Baumann[1-4]
[1] OncoRay – National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany
[2] Department of Radiation Oncology, University Hospital Carl Gustav Carus, Technische Universität Dresden, Dresden, Germany
[3] Helmholtz-Zentrum Dresden – Rossendorf, Dresden, Germany