PhD fellowship on list-mode proton CT reconstruction

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The biomedical imaging lab CREATIS (Lyon) opens a PhD fellowship on proton computed tomography (pCT) reconstruction. The position is funded by the *fondation pour la recherche médicale (FRM)* in the framework of a collaborative project with the nuclear physics lab IPNL. The PhD fellow will be based in the radiotherapy department of the Léon Bérard center which is a hospital focused on cancer care.

Medical and scientific context

Proton therapy is a radiation treatment aiming at improving the ratio between the dose to the target and the dose to healthy tissues [1]. Range uncertainties currently represent the biggest caveat for the exploitation of the full potential of proton therapy [2]. To better predict proton range in tissues and produce more conformal treatment plans, we propose to directly derive the proton range from proton computed tomography (pCT).

The goal of the PhD is to address the issue of poor spatial resolution of pCT. The investigations will be focused on modeling multiple Coulomb scattering and using this model in the reconstruction algorithm to improve existing algorithms that assume homogeneous materials [3, 4].

Objectives and research program

The PhD fellow will first investigate accurate and efficient models of proton multiple Coulomb scattering in heterogenous objects. The resulting model will then be used in the resolution of an inverse problem, possibly coupled with the pCT reconstruction. The developments will be validated on realistic Monte Carlo simulations considering a pCT scanner capable of tracking the position and the residual energy of each individual proton (i.e., list-mode data), and tested on real phantom data (collaboration with Loma Linda and Ludwig Maximillians University). The results will be compared to the current models of the most likely path which assume an homogenous object.

Qualifications

- **Education**: Masters degree in computer sciences, physics or mathematics.
- **Scientific interests**: computer sciences (medical image processing), particle physics, medical physics, mathematics (inverse problems and tomographic reconstruction).
- **Programming skills**: Matlab, Python or C++.
- **Languages**: Command of English required, French optional.
- **Location**: Centre Léon Bérard, Lyon, France.
- **Salary (net)**: 1400 euros/month.
- **Period**: 3 years starting after summer 2017.

Contacts

Send CV, master marks and a brief statement of interest by email to **Simon Rit: simon.rit@creatis.insa-lyon.fr**

References

[1] A.R. Smith. Vision 20/20: proton therapy. *Med Phys*, 36(2):556–568, Feb 2009.

[2] H. Paganetti. Range uncertainties in proton therapy and the role of Monte Carlo simulations. *Phys Med Biol*, 57(11):R99–117, Jun 2012.

[3] R. W. Schulte, S. N. Penfold, J. T. Tafas, and K. E. Schubert. A maximum likelihood proton path formalism for application in proton computed tomography. *Med Phys*, 35(11):4849–4856, Nov 2008.

[4] S. Rit, G. Dedes, N. Freud, D. Sarrut, and J.M. Létang. Filtered backprojection proton CT reconstruction along most likely paths. *Med Phys*, 40(3):031103, 2013.