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Tracking detectors at the LHC rely on hybrid pixel detectors which tag each particle with an extremely high signal to noise ratio and with a time precision of at most 25ns. The same technology has been adapted to numerous other applications by successive Medipix Collaborations. The most recent imaging chip, called Medipix3, permits spectroscopic X-ray imaging at high spatial resolution and relatively high fluxes by using inter-pixel hit-by-hit processing. The Timepix3 chip, on the other hand, takes the opposite approach detecting each hit with a time precision of 1.6ns and sending all data off chip for analysis. Both chips have opened new applications in the medical field: the first for spectroscopic X-ray imaging and CT and the second for beam and dose monitoring during hadron therapy. The presentation will describe the detection technology and focus on some examples of medical applications.

Keywords: Medipix, tracking detectors, CT, hadron therapy

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**Development of a PET Insert for Human Brain Imaging: Detection System**

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In recent years, the combination of techniques such as PET (Positron Emission Tomography) and MRI (Magnetic Resonance Imaging) has shown a great potential to study the processes and progression of diseases (cancer, Alzheimer's) as well as to control and observe novel treatments response.
A brain-size PET detector ring insert for an MRI system is being developed that, if successful, can be inserted into any existing MRI system to enable simultaneous PET and MRI images of the brain to be acquired without mutual interference.
The PET insert consists of detector blocks arranged in a ring of 30 cm diameter. Each detector block is composed of a LYSO array coupled to the Philips Digital Photon Counting. We divided the study of the detection system in three stages. First, we characterized the coupling of the scintillator crystal with the SiPM (Silicon Photomultiplier). Next, we simulated the behaviour or the ring insert using Monte Carlo methods. Finally, we verified the simulation results with the collected data.
As a result of this methodology, we obtained the I-V curves and the energy and time resolution of our system. Results show that the coupling is appropriate and that the sensibility of our system is adequate to move to the next study phase: MRI compatibility.

Keywords: positron emission tomography, PET, PET/MRI, detectors, magnetic resonance imaging

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**A local and global liver function model**

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As the use of SBRT for liver tumors increases and repeated treatments for the same patient become more common, it is increasingly important to predict liver function reserve rather than only likelihood of radiation-induced liver disease after SBRT. This study aimed to develop a local and global function model in the liver based upon regional and organ function measurements to support individualized adaptive RT.
This local and global liver function model was constructed with the assumption of parallel architecture in the liver, so that the global function of the organ was composed of the sum of local function of subunits similar to a previous model [1]. A major advance in this model is the addition of incorporation of functional variability of the liver across the patients as well as the function probability variability over the subunits between 0 and 1, instead of being a binary number of 0 or 1. This model was fitted to 59 datasets of liver regional and global organ function measures from 23 patients obtained prior to, during and 1 month after RT. The local function probability of a subunit was modeled by a previously published sigmoid function related to MRI-derived regional portal venous perfusion values. The global function was fitted to an indocyanine green retention rate at 15 min. Cross-validation was performed by leave-m-out tests. Fitting was also performed separately for the patients with hepatocellular carcinoma (HCC) vs all others due to likely differences in the liver function as well as radiation sensitivity.
The fitted liver function model showed that 1) a portal venous perfusion value of 68.6 ml/(100g·min) yielded a local function probability of 0.5; 2) the local function probability reached 0.9 at a perfusion value of 98 ml/(100g·min); and 3) at an average function probability of 0.03 (corresponding perfusion of 38 ml/(100g·min)) or lower, the subunits did not contribute to the global function. Cross-validations showed that the model parameters were stable. Further, the same amount of portal venous perfusion was translated into less local function probability in patients with HCC than without HCC, reflecting the compromised local liver function by cirrhosis (Fig 1).
The utility of this liver function model was explored, including assessing for individual regional dose response functions that substantially differed from the population average dose response and for dose re-distribution planning by maximizing global liver function by sparing local highly functional regions. This model could be a valuable tool for individualized treatment planning of RT.

Keywords: liver function model, function reserve, individualized RT

References:
[1] Jackson A, Ten Haken RK, Robertson JM, Kessler ML, Kutcher GJ, Lawrence TS. Analysis of clinical complication data for radiation hepatitis using a parallel architecture model. *International journal of radiation oncology, biology, physics* 1995;31:883-891.

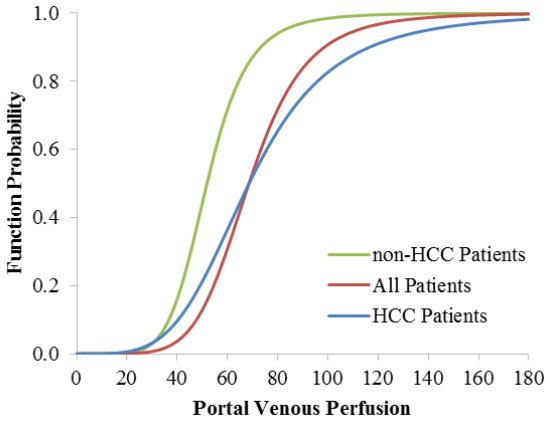


Fig. 1 The local and global liver function models fitted to the data divided based upon the patients who had HCC vs non-HCC tumors. Red curves represent the model fitted to all the data.