Visualization of target inhomogeneities in carbon ion radiotherapy using nuclear fragments

Each channel consists of a 13*13*15 mm³ LYSO crystal glued to a PMT. The PMT signal is sent to an Analog Sampling Module (ASM board). This VME 6U board is based on the DR54 chip technology (Switch Capacitor Array) from the Paul Scherrer Institute and was specially designed for the LAPD chip technology (Switch Capacitor Array) from the Paul Scherrer Institute and was specially designed for the LAPD detector. This board receives up to 24 differential analog input signals, with maximum amplitude of 600 mV, digitized by 12 bits - 33 MHz ADC. The sampling rate varies between 1 and 5 GHz, for a maximum buffer size of 1024 samples. The first part of the talk is devoted to the description of the detector and its electronics. Then, we describe the various trigger strategy, and the on-going upgrade of the VME-based acquisition system to a µTCA-based technology. The selection of the coincident 511 keV γ is also discussed, and the reconstruction using an iterative MLEM algorithm is presented. In the last part of the talk, few results from an experiment with one third of the detector, using proton and carbon ion beams at the Heidelberg Ion-Beam Therapy Center in 2014, are also described, and the Coincidence Resolution Time and energy resolution are given. First reconstruction results, obtained with a phantom filled with a high intensity FDG source at the cancer research center of Clermont-Ferrand in 2015 are also shown.

This detector is now characterized, and will be installed at the Lacassagne hadrontherapy center (Nice, France), on the 65 MeV line (Medicys) in December 2015 first, and on the future 230 MeV line (S2C2 from IBA) in 2016. The capability of this detector and its associated electronics to measure the ballistic of the proton beam in real clinical conditions with a sufficient precision will be evaluated.

Keywords: hadrontherapy, PET, beam ballistic control

References:
[1] https://indico.cern.ch/event/396441/contribution/27

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Figure 4: the LAPD, a PET-like detector dedicated to beam ballistic control in hadrontherapy.
Purpose: To evaluate the significance of fractionated administration of thalidomide combined with γ-ray irradiation in terms of local tumor response and lung metastatic potential, referring to the response of intratumor quiescent (Q) cells.

Materials/methods: B16-BL6 melanoma tumor-bearing C57BL/6 mice were continuously given 5-bromo-2'-deoxyuridine (BrdU) to label all proliferating (P) cells. The tumor-bearing mice then received γ-ray irradiation after thalidomide treatment through a single or 2 consecutive daily intraperitoneal administrations up to a total dose of 400 mg/kg in combination with an acute hypoxia-releasing agent (nicotinamide, 1,000 mg/kg, intraperitoneally administered) or mild temperature hyperthermia (MTH, 40 centigrade for 60 minutes). Immediately after the irradiation, cells from some tumors were isolated and incubated with a cytokinesis blocker. The responses of the Q and total (= P + Q) cell populations were assessed based on the frequency of micronuclei using immunofluorescence staining for BrdU. In other tumor-bearing mice, 17 days after irradiation, microscopic lung metastases were enumerated.

Results: Thalidomide raised the sensitivity of the total cell population more remarkably than Q cells in both single and daily administrations. Daily administration of thalidomide elevated the sensitivity of both the total and Q cell populations, but especially the total cell population, compared with single administration. Daily administration, especially combined with MTH, decreased the number of lung metastases.

Conclusions: Daily fractionated administration of thalidomide in combination with γ-ray irradiation was thought to be more promising than single administration because of its potential to enhance local tumor response and repress lung metastatic potential.

Keywords: Quiescent cell; Lung metastasis; Thalidomide

150 Progress with MRI-linac image-guided radiation dose imaging

P. Metcalfe1, S. Alnaghy1, M. Gargett1, M. Lerch1, M. Patesecca1, A. Rosenfeld1, L. Holloway2, B. Oborn3, G. Linley4

1CMRP, UOW, Australia
2Liverpool and Macarthur Cancer Therapy Centre
3Ingham Institute for Applied Medical Research, Australia
4Ingham Institute for Applied Medical Research, Australia

Purpose: MRI-linacs will enable 4D image-guided radiotherapy and require accurate MR visible and compatible dosimetry systems for verification.

Methods: Motion-tracking utilising a MagicPlate (M512) silicon array dosimeter capable of high resolution dosimetry (Patasecca, 2015) (figure 1a,b) has been modified for purpose of MR imaging during dynamic detector-tracking (i.e. so named ‘MR guided dynamic dosimaging’). The detector was tested for MRI-safety and functionality without irradiation in a 1T fringe field of 3T Siemens Skyra MRI. As solid water cannot be visualized on MRI a tissue-equivalent, gel-water phantom (CIRS® Computerized Imaging Reference Systems Inc. VA, USA), providing signal for detector and fiducial visualisation, was utilised to enable MR imaging (fast spin echo sequence).

Results: MR images of a non-powered detector system demonstrated detector visualization (see figure 1c). Detector movements approximating breathing were also acquired during dynamic MRI acquisition (fast gradient echo), showing that fiducial markers could be visualised when placed on a passive device and tracked. The detector functioned at the 1T bore entry position to simulate the magnetic field of our impending MR linac whilst a water phantom was imaged simultaneously at the mid-bore 3T position, with noise (see figure 1d) seen due to detector RF interference being reduced by aluminium foil shielding of the device and cables (figure 1e).

Conclusions: The current MRI-guided dynamic dosimaging set-up has been demonstrated to be successful in detector visualisation and tracking with a non-powered detector. Noise reduction has been achieved with the detector in operational mode. A MRI-compatible motion platform will be paired with M512. These measurements will be compared to acquisition in MRI-linac magnetic fields on the MRI-linac device being installed at the Ingham Institute in Australia.

Keywords: Health Service Research, Demand Prediction

References: