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Purpose or Objective
Recent developments in heavy ions production increased access to alpha-emitting radioisotopes and opened the door to their use in internal radiotherapy[1]. Targeted alpha therapy is of interest for dedicated applications such as the treatment of disseminated and small brain metastases[2][3], their radiation range in biological matter covering only a few dozens of micrometers. However, when alpha-emitting radionuclides undergo *in vitro* experiments, additional care must be taken compared to beta-emitters because of the higher linear energy transfer values of alpha particles. Indeed, the dose delivered to the cells becomes significantly dependent on the spatial distribution of the radionuclides in the culture medium[4]. Knowledge of this distribution would thus allow dose-effect relationships assessments and make comparisons to other irradiation methods more reliable.

Materials and Methods
We present here an *in vitro* dosimetry system using silicon semiconductor diodes placed below custom-made culture wells, which record energy spectra of the alpha particles passing through the culture medium and cell layer during the irradiation. A detector chamber protecting the electronics was designed to carry out the measurements inside a cell culture incubator. A new spectral deconvolution method was developed to extrapolate the radionuclide spatial distribution from energy spectra acquired during *in vitro* experiments and compute on-line the dose delivered to the cells. Since our custom-made wells are compatible with microscopy imaging, dose-relationship effects can be directly evaluated for all culture wells between actual dosimetry and DNA damage.

Results
Reliability of the spectral analysis methodology has been assessed and demonstrated dose computation errors limited to 3% when applied to simulated 212Pb *in vitro* irradiations. Applications of this methodology carried out in preliminary experiments using the dedicated spectroscopic setup with 212Pb and 223Ra showed that the common homogenous distribution hypothesis is erroneous and could lead to up to 50% dose underestimation. They also revealed that the different radionuclides of complex decay chains present different spatial and temporal distributions, which has further consequences on the dose computation and highlights the necessity of new experimental dosimetry methods.

Conclusion
Dosimetry through α-spectroscopy, when coupled with a new, fast, and flexible deconvolution method, proved to be accurate and reliable for *in vitro* assays. More than feasible, experimental dosimetry appears necessary to improve the reliability of the assessment of new targeted alpha therapy radiopharmaceuticals.

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PD-0898 First dosimetric characterization of an a-Si:H dosimeter on flexible support
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Purpose or Objective
One of the goals of the INFN HASPIDE project (Hydrogenated Amorphous Silicon DEtectors) is to explore the possibility to use a-Si:H detectors to be employed in medical physics application. The choice of this material as sensitive layer is driven by its resistance to radiation damage which allows the sensors to operate in very demanding environments like skin dosimeter and/or FLASH therapy. Furthermore, a sensitive layer very thin and deposited on a thin flexible plastic layer of Polyimmide permits to develop matrix of sensors with a great variety of shapes. First tests on clinical photon beams are reported.

Materials and Methods
Four a-Si:H n-i-p diode structure of 2.5µm thickness are fabricated on Kapton substrate. The upper contact is an ITO/aSi stack while the bottom contact is a stack of Cr/Al/Cr/aSi deposited directly on the kapton substrate. The pad diode area is 2x2 mm2. Samples are mechanically fixed to a kapton pigtail 35cm long via double sided sticky tape. Electrical contacts are made with MG Chemicals 838AR Carbon Conductive Paint and insulated copper wire with 50 µm diameter. 70 µm thick Kapton tape placed over the sample for protection of the electrical contact as well as to create a consistent and reproducible build-up layer for dosimetry.
Tests of the HASPIDE dosimeters were performed by means of an Elekta VERSAHD LINAC, with conventional 6MV photon beams. The dosimeter was placed at the isocenter and sandwiched inside a phantom of water equivalent material at 10cm depth, SSD=90cm. Signal repeatability, linearity with dose and sensitivity was studied for each dosimeter.

Tests were performed with a radiation field of 10 × 10 cm2 and nominal dose rate of 500cGy/min. Linearity with dose was evaluated by fitting the charge signal of each pixel against the dose for a fixed dose-rate, in the dose range 2-1000 cGy. To evaluate the sensitivity, we performed a least-square fit by using the relation Q = αD + ß, with Q the signal in charge and D the dose. The sensitivity was supplied by the angular coefficient α.

Results

Fig.1 shows charge signal against the dose of four Haspide pixels, both data and best fit are shown. The sensitivity of the four pixels is in the range of 140 and 160 fC/cGy with a linearity 0,999 and the signal to noise ratio is about 70.

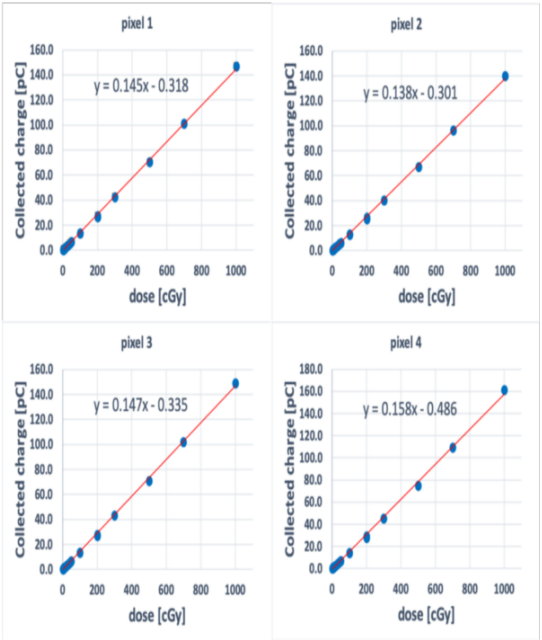

Fig.1 data and best fit for charge signal vs dose for four Haspide pixels

Conclusion

The good performances of the detector and its physical dimensions show that the Haspide device is suitable for application in radiotherapy. Due its small thickness future application in skin dosimeter and flash therapy should be investigated.

PD-0899 Error identification in time-resolved treatment verification with multiple instance learning

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Purpose or Objective

In recent years, artificial intelligence (AI) has been introduced for error detection and identification during radiotherapy treatment dose verification. While dynamic treatments such as IMRT and VMAT have become standard practice, dose verification is still performed in a time-integrated (TI) manner (i.e., summed over a treatment beam). However, it has been shown previously that errors can be hidden by TI verification methods, and that time-resolved (TR) methods are preferable [1]. Yet, the use of TR data, and its associated increase of dataset size and computational needs, poses challenges for interpretation of the data and training of AI models for error identification. The aim of this work was to develop an efficient AI method for identification of realistic simulated errors in TR dose verification data.

Materials and Methods

Clinically realistic ranges of treatment errors (anatomical, positioning and mechanical) were simulated for 46 lung cancer patients (53 treatment plans, 106 VMAT arcs). TR portal dose images were predicted for CT images and treatment plans with and without errors, and compared using (3%, 3 mm) gamma analysis. The complete dataset consisted of 26659 TR gamma maps, with dimensions 128x128x97 pixels (i.e., 97 segments/timepoints of 2D 128x128 images). For efficient AI model training, multiple instance learning (MIL), a technique novel to the radiotherapy field, was employed. The idea behind MIL is that a data sample (in this work a TR gamma map) can be split in patches (in this work in separate segments) that are used separately as input for the AI model, but the model still learns the label (in this work the error type or magnitude) over all patches, i.e. a complete data sample. The MIL model (Figure 1) consisted of (1) a convolutional neural network (CNN) for extracting features from each segment of the TR gamma maps, (2) selection of the most informative segments, (3) a memory cell to retain the temporal information embedded in the data, and (4) an encoder-decoder for performing the final error identification. Two of these models were trained for different purposes: 1) classification of the error type (e.g., tumor regression, patient rotation or MLC systematic error) and 2) classification of the error magnitude (e.g., tumor regression > 50%).