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Hybrid of cloud computing and workstations for radiotherapy planning

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Purpose or Objective: The goal of this work is to develop a hybrid environment composed of treatment planning system(TPS) workstations and a private cloud infrastructure(Radiotherapy Planning Cloud, RTPCloud) for radiotherapy planning in routine job.

Material and Methods: The Eclipse(v11.0) workstations were distributed by Varian Medical Systems. The RTPCloud was based on OpenStack and leveraged the virtual GPU hardware (Nvidia Grid k1) and multi-core CPU server (Dell PowerEdge R910) to act as infrastructure as an service(IAAS) cloud. In the cloud, we created three kinds of virtual machine images: Dev-vmi, Workstation-vmi, DCF-vmi. All of them will be used for creating functional clusters. All of Eclipse modules were transplanted to Workstation-vmi. In addition to what Workstation-vmi has, Dev-vmi has a full script development and run environment. DCF-vmi only has calculation agent components of Eclipse's distributed calculation framework(DCF). All of the functional clusters derived from those images are scalable and their lifecycles are managed by OpenStack REST API. NoMachine is the remote desktop client to access virtual machines in the cloud.

Results: Any NoMachine-enabled computer in the hospital local area network becomes a Eclipse workstation, when an authorized user remotely accesses his virtual workstation. In this manner, we got at least three times as concurrent users as vender's distribution, and overcome office's location constraint. Script development and run cluster gives advanced users an isolated environment for automation of manual job without occupying those rare clinic workstations. The initial outcome is the ContourAutoMargin(CAM), which is developed in AutoHotkey script. It realized an automation of verbose operation of structures for planning. 10 to 20 minutes manual work per patient case will be done by clicking only one button. DCF Agent Cluster derived from DCF-vmi improves the performance of high compute-intensive calculation(e.g. Dose calculation) of planning.

Conclusion: Benefits from cloud computing maximize the utilization ratio of the expensive software features and optimize the radiotherapy planning procedure. The hybrid environment is a very powerful solution with high cost performance, and will boost the radiotherapy planning in clinic and research.

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Practical dosimetry solutions to enhance cell biology studies

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Purpose or Objective: Our current study of the effects of combined therapies on triple negative and HER2 positive breast cancer has motivated an evaluation of the experimental design for the parallel radiation exposure of several cell samples, each representing a different therapeutic combination. To evaluate the synergistic effects between radiotherapy, chemotherapy and nanoparticles, the radiation dose must be accurately known. We focus on radiation beam energies and dose rates typically used in the clinical environment.

Material and Methods: The cells in clonogenic assays are adherent onto the base of the flasks. The dose to the base of six different flask designs from two manufacturers, was measured using GAFCHROMICTM EBT3 film. The flasks were exposed to a 6MV photon beam from a Novalis Tx linear accelerator or to a 50kVp, 150kVp or 280kVP photon beam from a Pantak kilovoltage unit. For the megavoltage beam, the flasks were positioned on virtual water slabs and irradiated from below, with the linac gantry at 180°. For the kilovoltage beam, the flasks were positioned on the face of the cone applicator with the beam directed towards the ceiling. For all exposures, the film was placed immediately beneath the flask. A CT scan was taken of each flask design under the exposure conditions for the MV beam and a plan constructed to calculate the dose to the cell layer using the Varian EclipseTM treatment planning system. The calculated monitor units and dose distribution were compared to the measured values.

Results: For the 6MV photon beam, the dose distributions to the cell layer in the axial and sagittal planes for three flask designs are shown in figure 1. The film measurements were consistent with the planned data. For the kV beams, where the dose distribution is sensitive to scatter conditions, it was found that the calculated dose across all wells and flasks, was inconsistent with measurement. Air channels on the perimeter of the flask, specific to the flask design, need to be filled for reproducible dosimetry. Furthermore, for the 96 well flask, the perimeter wells were found to have a different dose to interior wells.

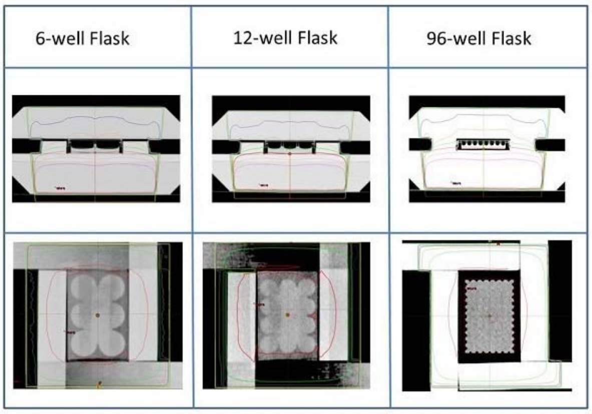

Figure 1: Dose distribution at cell layer shown in the transverse and coronal views

Conclusion: This work indicates that when radiation is used as a therapeutic agent, insufficient attention to dosimetry can substantially compromise cell biology studies leading to false conclusions. For studies of combined therapeutic interventions, we provide practical solutions to the parallel radiation exposure of numerous cell samples, such that additional variables are minimised. Our findings are applicable to any cell study where radiation exposure is involved.

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The Nano-X image-guided adaptive gantry-less linac: imaging and dosimetry under phantom rotation

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Purpose or Objective: Innovative solutions for delivering high-quality, safe, affordable and appropriate treatment are needed to redress a staggering global underutilisation of radiotherapy. Nano-X will be a novel image-guided adaptive radiotherapy machine, quite different to conventional systems. Its key-differentiating feature is a rotating patient couch and a gantry-less linac. We present the first experimental results demonstrating imaging and dosimetric