# Use of Kilo-Voltage Cone Beam Computed Tomography (kV-CBCT) to account for anatomical variations during radiotherapy treatment

## Introduction:

In radiotherapy (RT) CT scans are used primarily to a) outline tumour target(s) and organs at risk (OARs) to ensure the prescribed radiotherapy dose is delivered precisely to the tumour while sparing the OARs b) account for anatomical variations (in-homogeneities) in human body such as lung, tissue etc., during RT dose calculations.

In general, RT clinics including Cork University Hospital (CUH) use conventional kilo Voltage CT (kV CT) for RT dose calculations. In addition, modern Linear Accelerators (LINAC) are fitted with on board imaging systems to facilitate daily verification of patient treatment setup and to ensure the prescribed dose is delivered accurately to the tumour target. In this project, the on board kV-CBCT system built in on the recently commissioned Versa HD™ LINAC at CUH will be used to account for anatomical changes during RT treatment.

Patients undergoing RT may sometime lose weight during their treatment. Weight loss in patient will lead to changes in anatomy of the part of body being treated. These physical changes to patient anatomy will compromise the original RT dose calculations depending on a number of factors. To account for the anatomical change during treatment, the conventional kV CT rescan can be ordered by the treating doctor but this is disruptive to workflow. Alternately, the on board kV-CBCT scans available for patients undergoing RT treatment can be used to re-calculate dose, verified against the original RT dose calculations completed prior to the start of RT treatment and compensated if necessary.

The aim of this project is to commission radiotherapy dose calculations using the on board kV-CBCT as part of routine RT treatment planning (TP) at CUH. This project is similar to last year final year project but this time with kV CT will be used instead of MV CT.

## Materials and method:

Unlike MVCT, soft tissue contrast obtained with kV CT is superior. In addition, radiation dose delivered to patients with kV CT imaging is lower than MVCT imaging. However, kV CT scans can be subjected to metal artefacts due to weak penetrating power of kV X rays compared to MVCT X rays.

In this work, a circular phantom (RMI) with material inserts of varying densities (plugs) ranges from air to Titanium and a rando phantom (Atom) having anatomical details similar to that of a human body would be scanned using conventional kV CT and kV-CBCT. The CT scans then imported in to the Treatment Planning System (TPS) and a calibration curve of CT Hounsfield Units (HU) to Relative Electron Densities (RED) of the different inserts of the phantom(s) will be established. This will then facilitate dose calculations to be performed using kV-CBCT scans and compared against reference dose calculations. To do this, methods outlined in the previous project[1] will be followed. Finally, kV-CBCT scans of real patients undergoing RT treatment can be imported and calculated in the TPS to verify whether there are changes occurred to patient anatomy during RT.

**Steps involved:**

1. Draw out an action plan with time lines.
2. Scan RMI & Atom phantoms using kV CT and kV CBCT.
3. Import both sets in to the TPS.
4. Establish a kV-CBCT HU to RED calibration curve in the TPS (Monaco™).
5. Generate kV CT test plan on a phantom.
6. Generate a kV-CBCT test plan on the same phantom, compare and validate against kV CT calculations(reference).
7. Import and calculate real patient kV-CBCT scans and compare against original kV CT calculations.
8. Draw conclusions from the results and complete the report as required.

**Reference:**


1. Use of Mega Voltage Computed Tomography to Account for Anatomical Variations During Radiotherapy Treatment-FYP, Louise Shanahan, April 2019, UCC, Cork



**Primary Supervisor:** Mr. Ezhilalan Ramalingam
Cork University Hospital
Wilton
Cork
021-4922533/0861794497