# Progress report on a CBCT based 3D image guided workflow in IOeRT

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## Introduction

Linac-based intraoperative radiotherapy (IORT) using electrons (Mobetron, Intraop Medical Ltd) has been integrated with a novel mobile cone-beam CT (CBCT) system (ImagingRing-m, medPhoton) for real-time adaptive dose calculations. This system enables precise irradiation of tumors or tumor beds during cancer surgery, enhancing treatment accuracy. Over the past two years, 120 patients have been treated using this innovative 3D workflow. This presentation shows the follow up of the first technical results of image-guided IORT with CBCT, focusing on the integration of this imaging technology into clinical practice.

## Materials & Methods

Since 2020, 740 breast cancer patients (148 single-shot, 592 boost) and 16 patients with other cancers (GI, GYN, H&N, sarcomas) have undergone IORT treatment. Of these, 123 patients were treated using a 3D workflow. To optimize the process, new interfaces were developed between the imaging system, treatment planning software (Radiance, GMV), linear accelerator control system, and treatment system, alongside improved patient preparation and positioning for imaging.

Non-metallic IORT tubes and a radiolucent mobile patient couch were used to minimize imaging artifacts. However, air artifacts caused by metal components near the calculation zone of the tube affected dose calculations, necessitating corrective measures like HU painting. Additional tissue within the tube also impacted dose accuracy due to the absence of Source-to-Skin distance corrections. A modified phase-space file, based on Monte Carlo simulations, was implemented to enhance dose accuracy and reliability.

Moreover, advanced imaging modalities such as MRI or PET-CT can be integrated for real-time adaptive tube correction. Accurate anatomical references are essential for image fusion, enabling verification of the treatment location.

## Results

After optimizing the 3D treatment workflow and documentation process, the entire IORT procedure can now be completed in under one hour. On average, 12 mm (ranging from 0 to 40 mm) of soft tissue was inside the tube, but 3D calculations based on CBCT allowed for the correction of these inaccuracies. A maximum tissue thicknes within the tube of 40 mm resulted in dose corrections exceeding 10%.

Significant metal artifacts were present in 20% of cases, impacting the depth dose curve (up to 3 mm at D50). By applying HU painting, these errors were reduced, leading to more accurate dose representations.

## Summary

Three-dimensional imaging has revealed previously hidden inaccuracies in dose calculation. Both localization and dosimetric precision can now be corrected, and geometric irregularities accounted for in dose estimations. The introduction of CBCT marks a significant advancement in IORT, offering improved quality and accuracy in dose delivery.

### References


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