Physics Research @ Maastro Clinic

MSc Projects 2018-2019

Lotte Schyns

lotte.schyns@maastro.nl

PhD Student

Maastro Clinic, Maastricht

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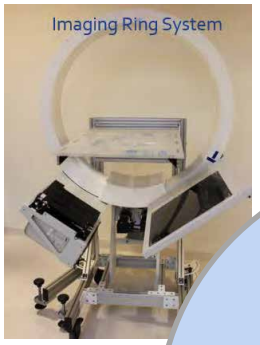
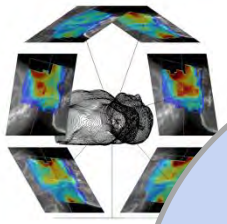
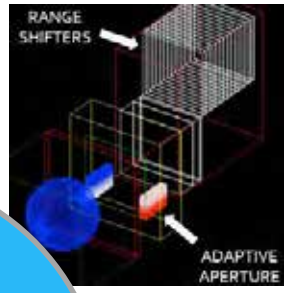
Physics research in radiotherapy







Imaging
-DECT, spectral CT
-autocontouring

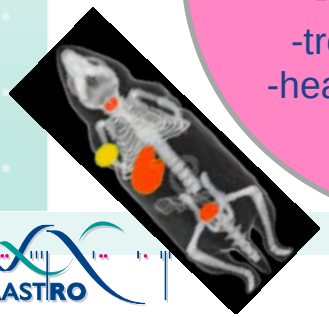
Adaptive Treatment Methods
-Dose Guided RT
-motion management
-deep learning
-decision models

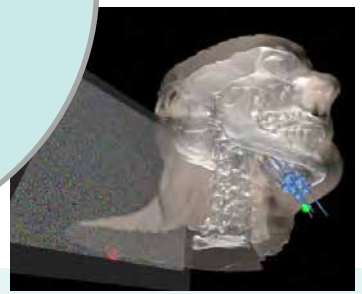
Particle beams
-in silico planning studies
-Monte Carlo modelling
-DECT

TRIALS

Preclinical animal research
-system development
-imaging studies
-treatment planning
-healthy tissue studies

Brachytherapy
-HDR
-heterogeneous treatment planning
-image-guidance
-in-vivo dosimetry
-optimization





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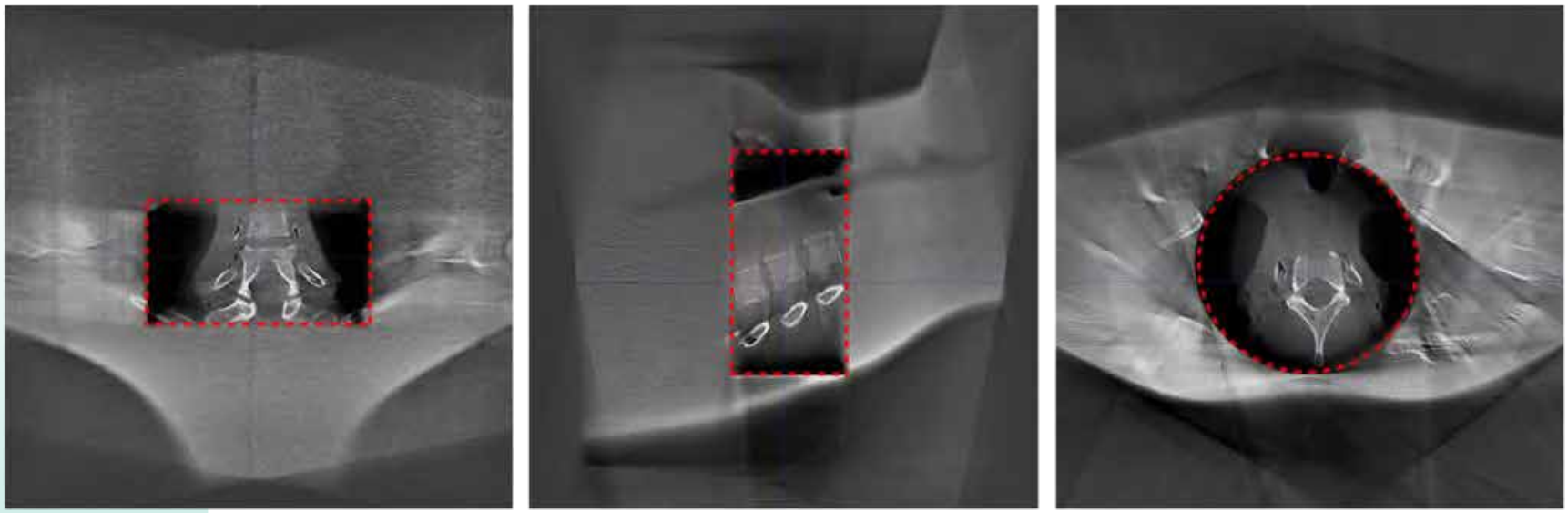
1 medPhoton Imaging Ring



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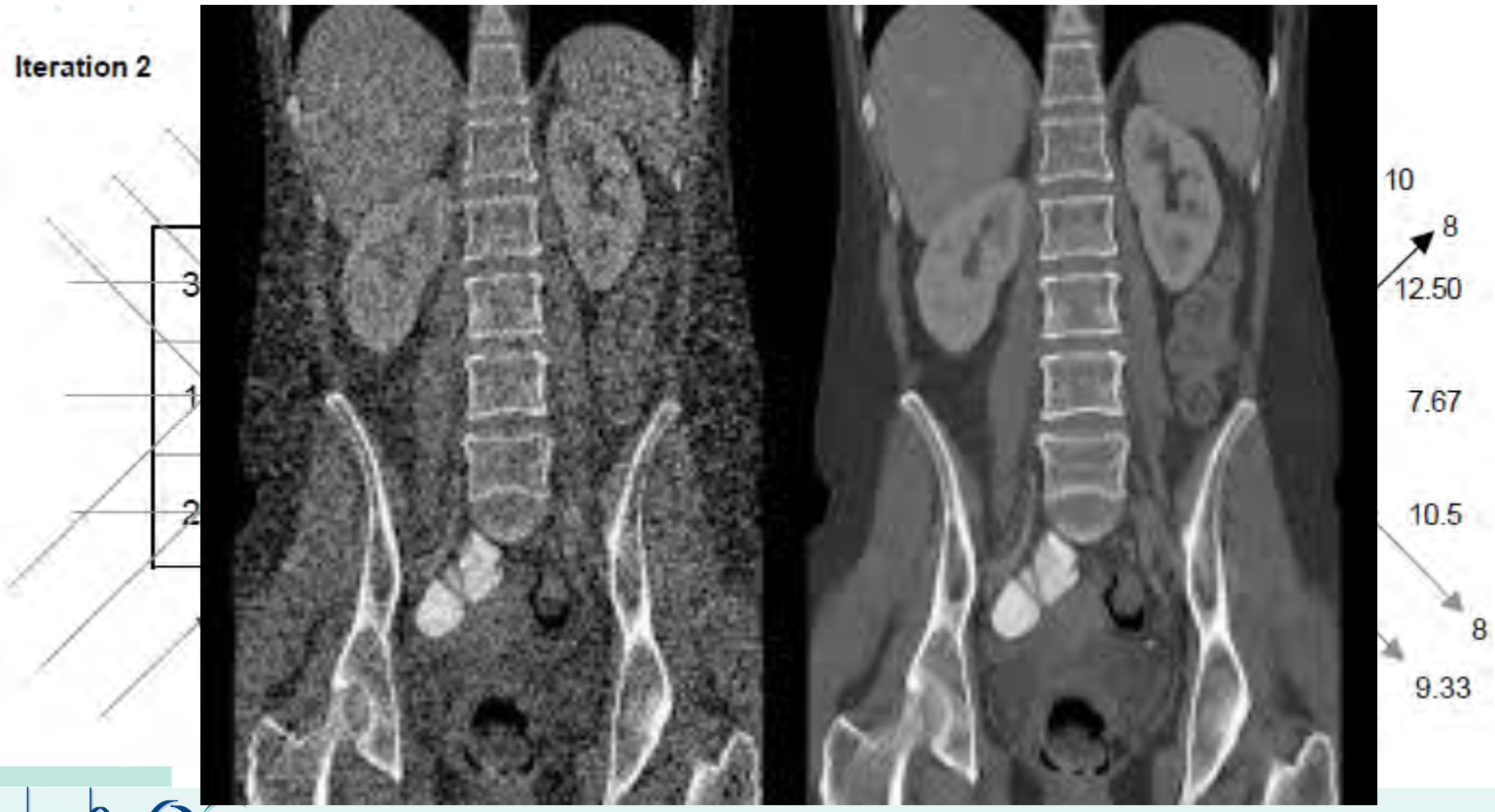
1 medPhoton Imaging Ring

1.1 iterative cone-beam CT image reconstruction



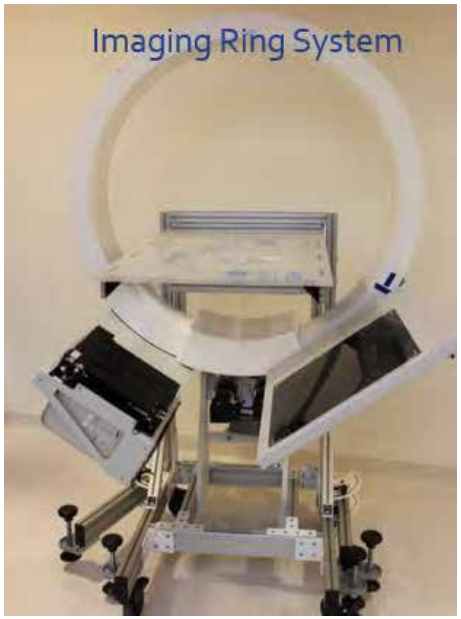
1 Cone Beam CT with medPhoton Imaging Ring

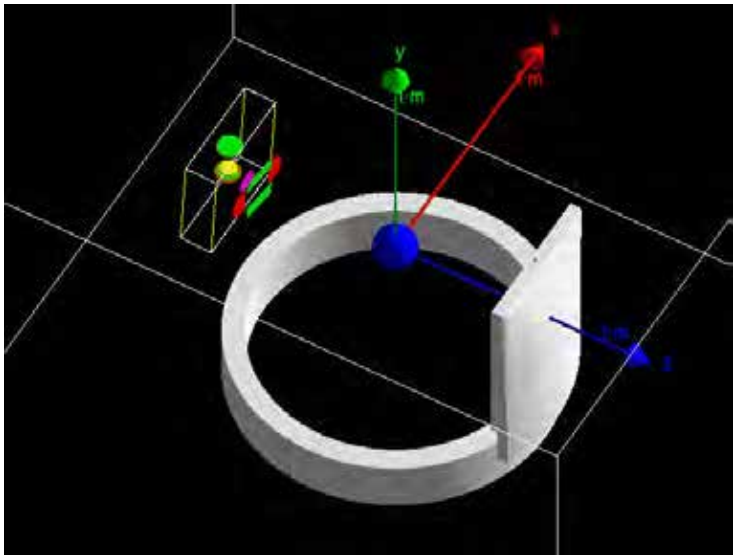
1.2 IRS Photon scatter corrections

-implement various methods

-tests on phantoms

-Monte Carlo simulations





Monte Carlo simulation model for IRS

1 Cone Beam CT with medPhoton Imaging Ring

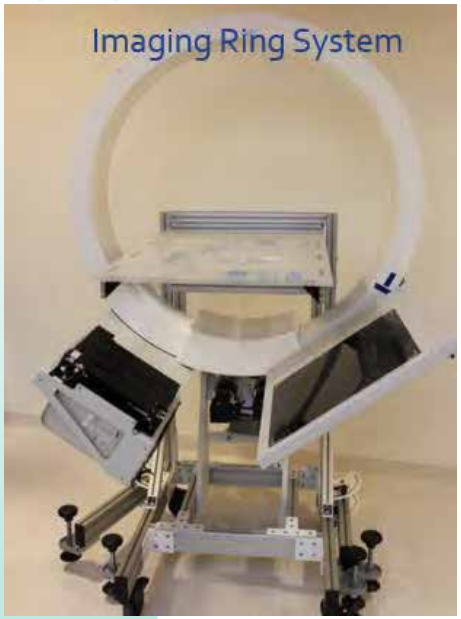
1.3 Dual and multi energy CT

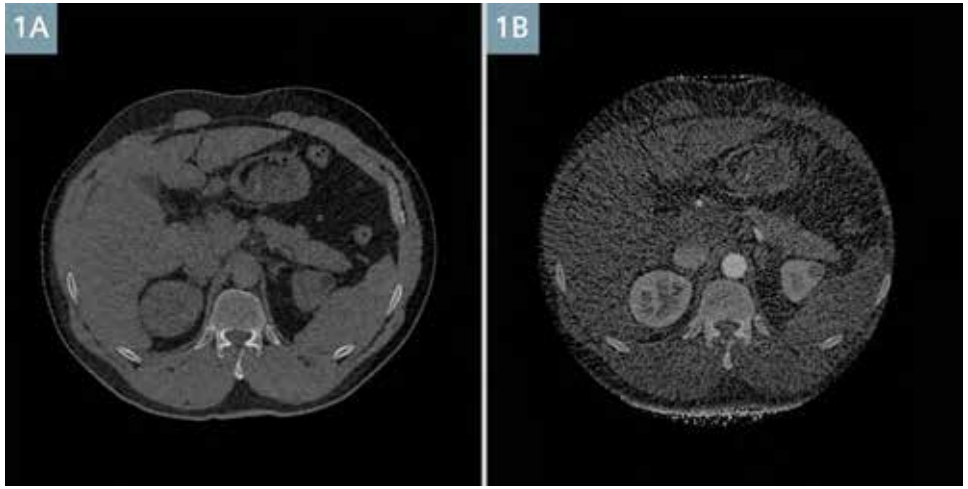
-IRS has rapid kV switching DECT capability

-Assess quality of DECT vs Single Energy CT

-Optimal settings and reconstruction method

-Assess imaging dose

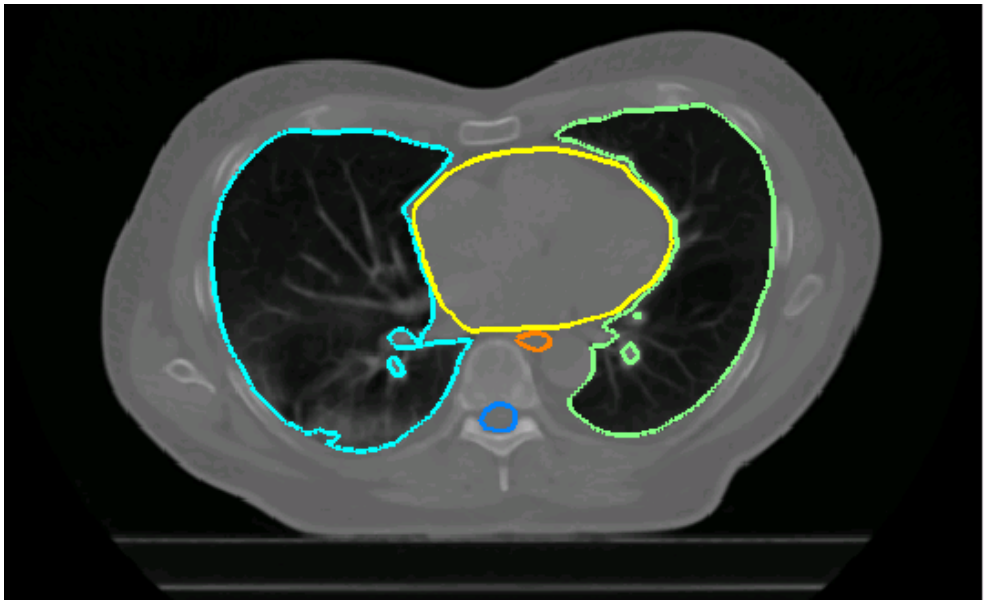




Relative electron density (left) and effective atomic number (right) [Siemens system]

2 Deep learning computer methods

2.1 Automatic segmentation of organs at risk / tumors in CT images
-Study various deep learning methods
-Implement several methods
-Assess correctness of autocontouring on patient CT and CBCT data
-Assess speed of autocontouring on patient CT and CBCT data



Deep learning method for autosegmentation for normal organs and tumors in lung cancer

2 Deep learning computer methods

2.2. Automatic tissue segmentation based on deep learning/machine learning

-Study various deep learning methods

-Implement several methods

-Assess correctness of tissue segmentation on patient CT data

-Assess correctness of dose calculations

-Assess speed of tissue segmentation on patient CT data

2 Deep learning computer methods

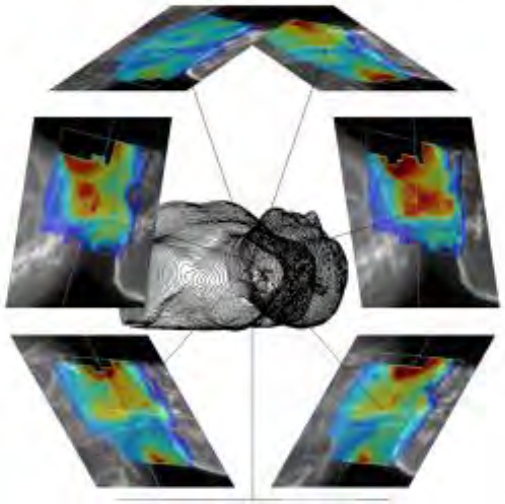
2.3. Automatic detection of anatomical changes in a patient based on ‘electronic portable imaging device’ images

-Use deep learning/machine learning on EPID images for detecting changes in patient anatomy

-Use as trigger for dose recalculations

-Sensitivity of the method

-Uncertainty of the method

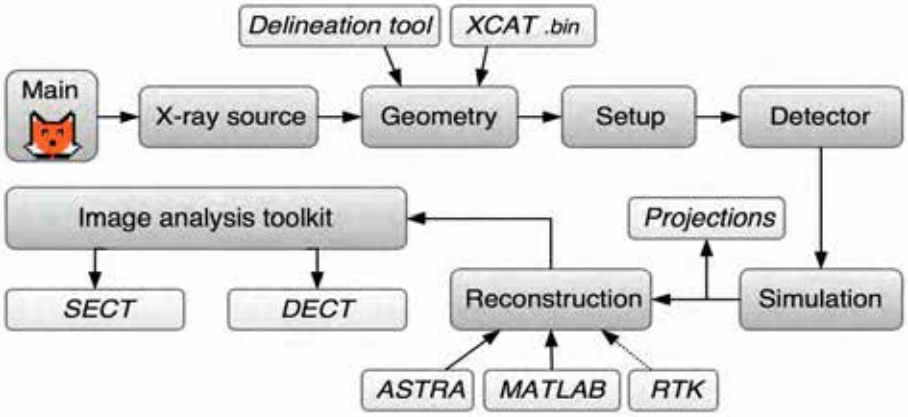


3 CT simulation software VOXSI

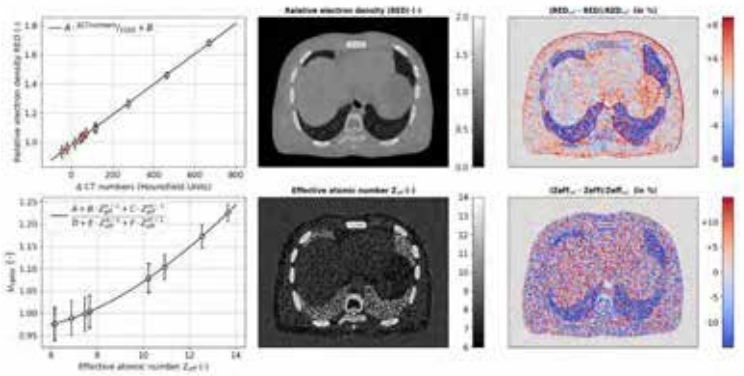
-Extend capabilities of VOXSI towards cone beam CT imaging

-Clinical and preclinical CBCT

-Validate image parameters of CBCT image reconstructions



VOXSI (Voxel Simulator), developed at Maastro



Various images reconstructed with VOXSI

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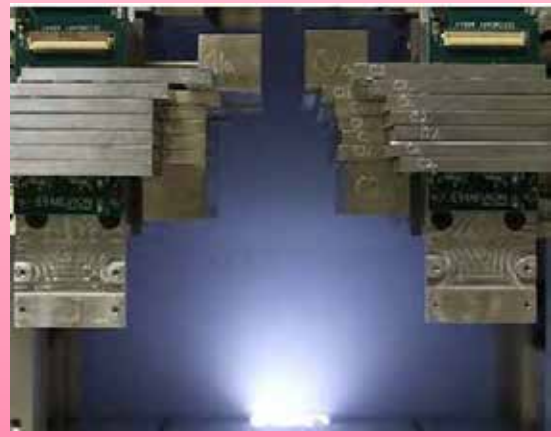
4 Proton beam modelling

4.1 Automation of proton beam shaping device

Zuid-Oost Nederland Protonen Therapie Centrum

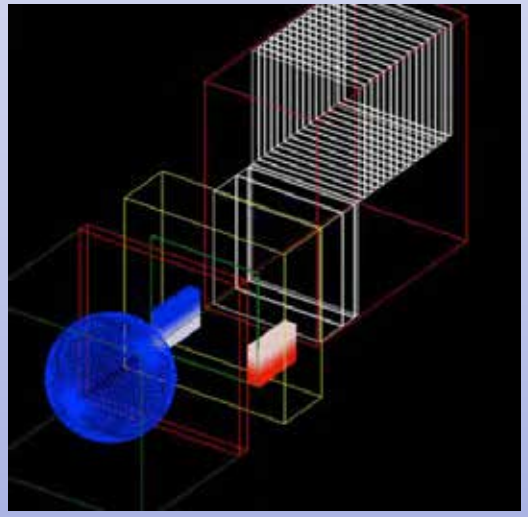
COLLIMATOR AUTOMATION

Developing an algorithm to define collimator leaf positions for Monte Carlo proton dose calculations



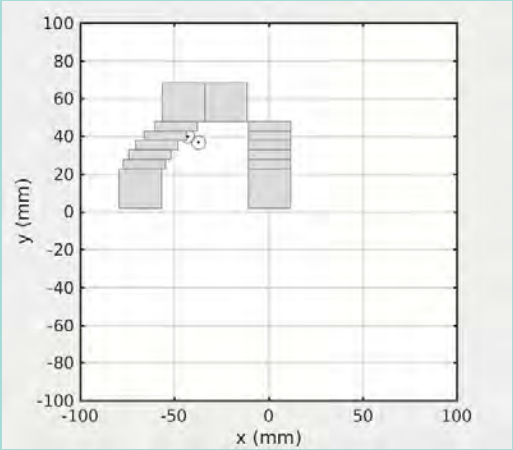
VALIDATION

Performing Monte Carlo proton dose calculations and validate with experimental data



IMPLEMENTATION

Deriving information from clinical proton treatment planning system and including the leaf-collimator algorithm



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5 Dose assessment in radiology

5.1 Camera system for recording patient dose in radiology

-new legislation enforces keeping track of patient dose

-use novel camera system (Kinect gaming computer) to map outline of patient undergoing interventional radiology procedure

-make model of x-ray imaging device

-use patient info to perform dose calculations for skin and organs

Interventional radiology room: what is the radiation dose?

Kinect gaming computer system to acquire patient outline

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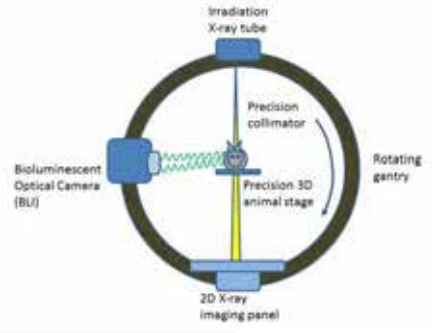
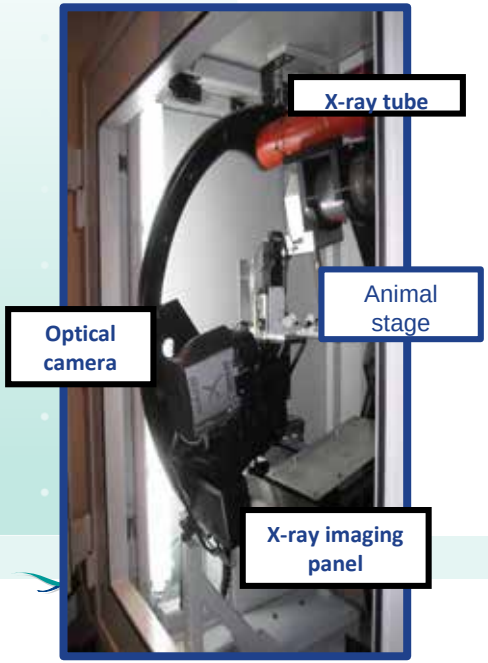
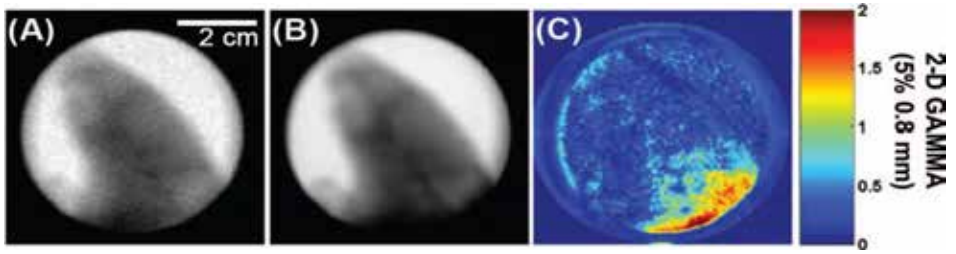
6 Small Animal RadioTherapy (SmART)

1.1. Dose verification using imaging panel







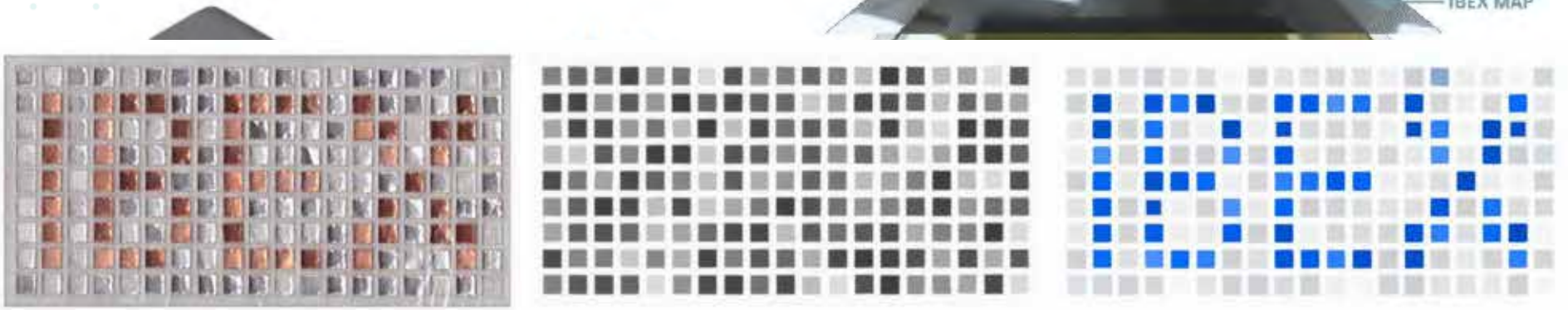
Simulated Measured

Comparison (γ-map)

6 Small Animal RadioTherapy (SmART)

6.2 Distinguishing tissues with novel imaging method

-IBEX imaging panel



6 Small Animal RadioTherapy (SmART)

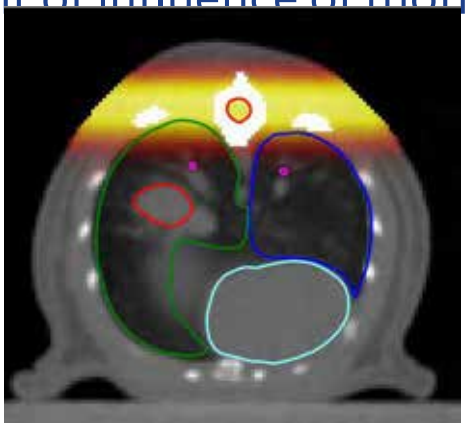
6.3 Dose painting

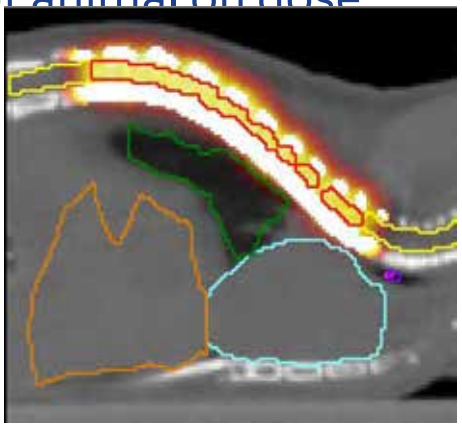
-Developing simultaneous couch and gantry rotation

-Precise dose painting in small targets

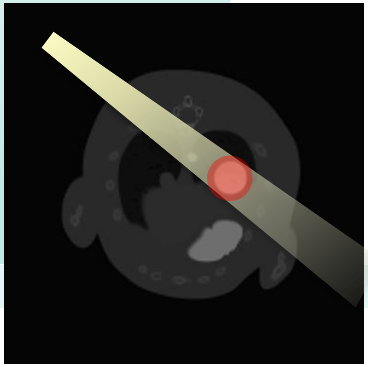
-Implement dose painting technique in SmART-Plan

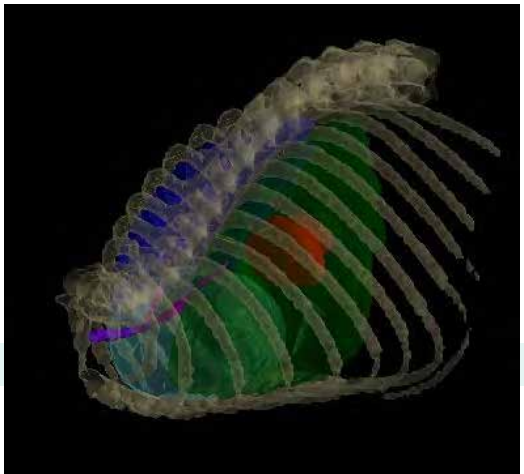
-Assessment of influence of motion of animal on dose





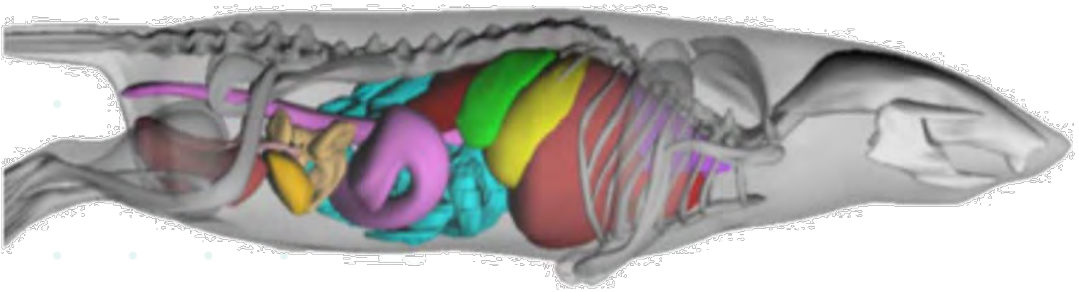
measured with film

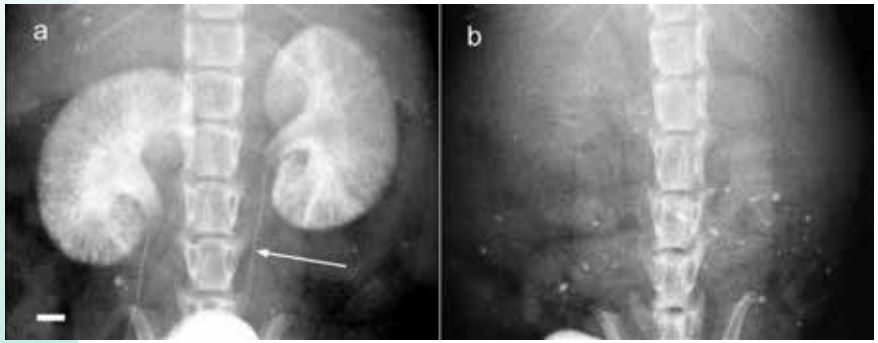


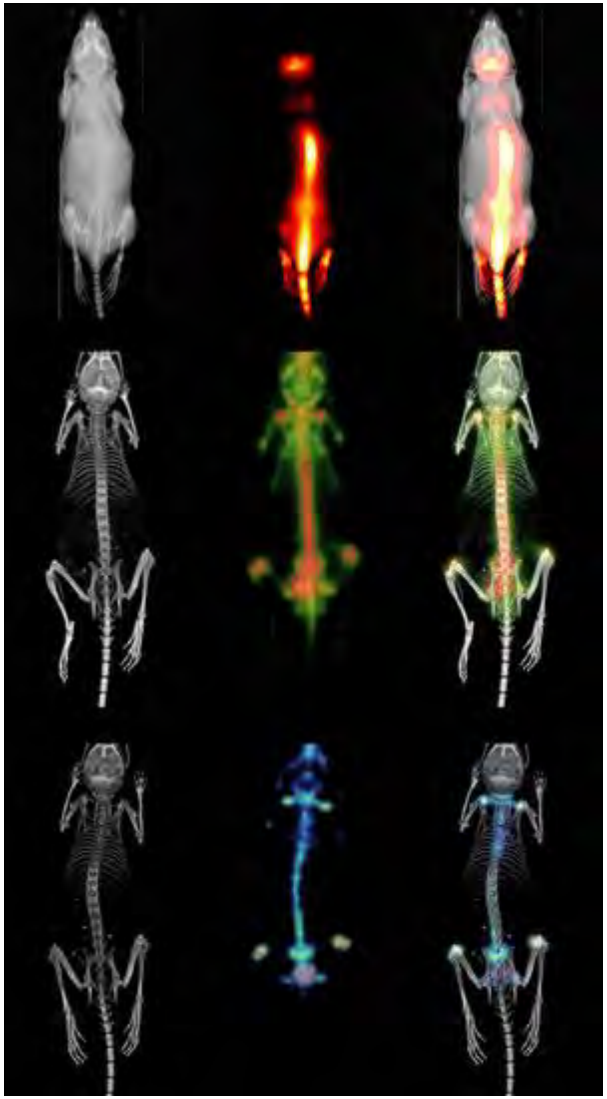


SmART-Plan

6.4 Effect of contrast media on dose calculations







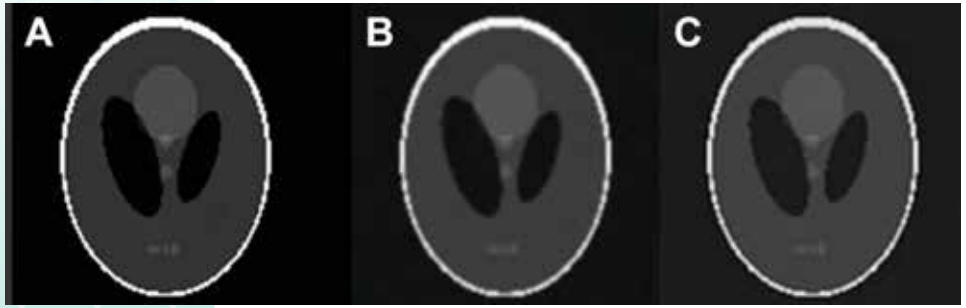
6 Small Animal RadioTherapy (SmART)

6.5 Small animal imaging

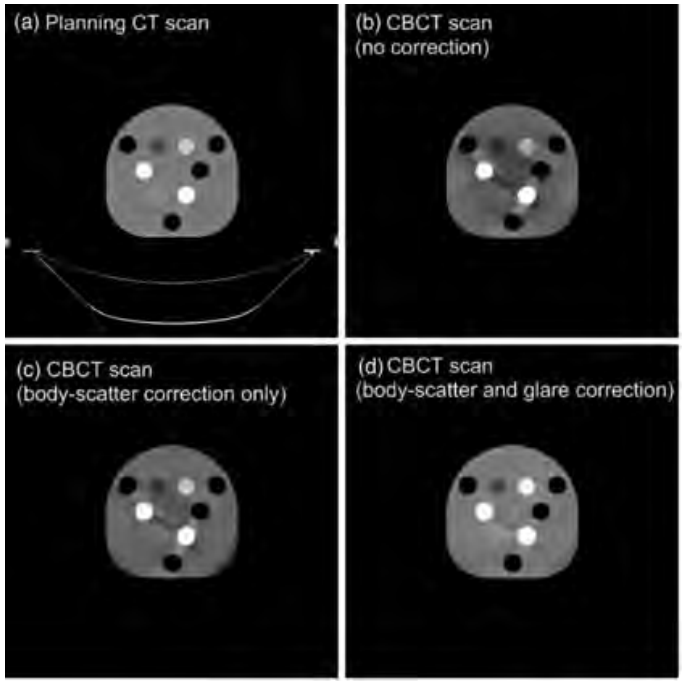
-Implement iterative reconstruction techniques

-Assess magnitude of photon scatter

-Develop corrections for photon scatter



Different image reconstruction methods, in this case for a phantom



CBCT photon scatter correction for human

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