ARDOS
Advanced Radiation Dosimetry System

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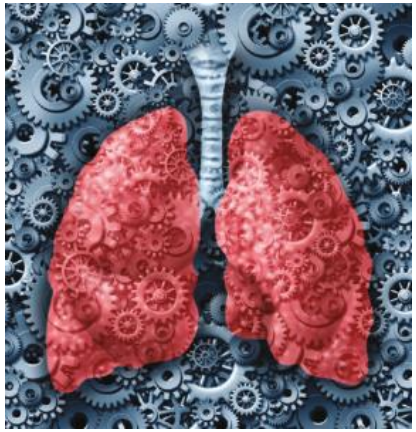
Background

- Respiratory induced intra- and inter-fractional lung tumor motion can cause significant uncertainties in dose delivery of lung cancer radiotherapy

- Motion-management strategies:
  - Beam-gating, breath-hold control
  - Additional margin to Internal Target Volume (ITV)
  - 4D (3D + t) techniques for imaging, treatment planning and dose delivery *

- Necessity to verify such techniques and/or
- Investigate the related dosimetric improvements under conditions as close as possible to the clinical situation



* [*Korremann, 2012; Hugo et al, 2012*]

Respiratory Motion Phantom - ARDOS

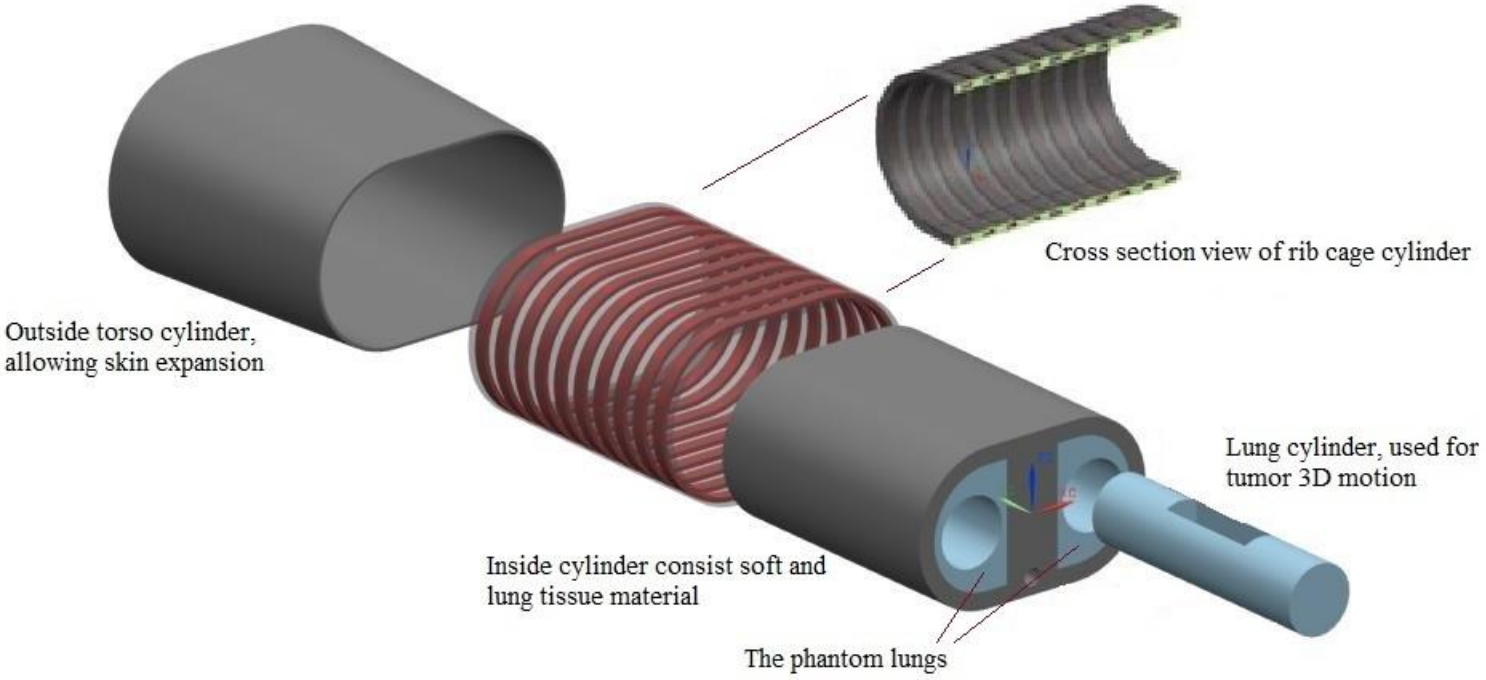
Features (1/2):

1. Represents an average human torso with a movable tumor insert

   Comprises a chest wall, ribs, and lungs

2. Made from tissue-equivalent materials:

   Lung tissue - high density balsa wood (0.3 g/cm3),
   tissue equivalent solid water (1.05 g/cm3), and bone material (1.4 g/cm3)



Respiratory Motion Phantom - ARDOS

Features (2/2):

3. Different types of dosimeters can be used:

   Films, TLDs, pinpoint IC, diamond, diode, alanine

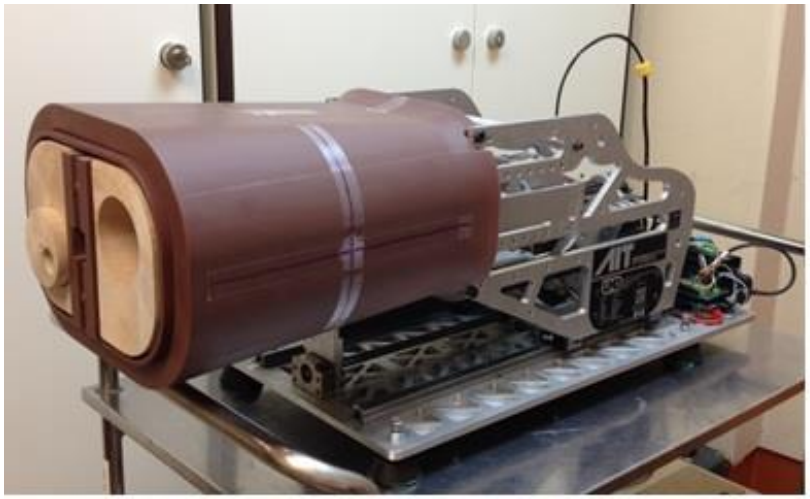
4. 4 programmable independent motions:

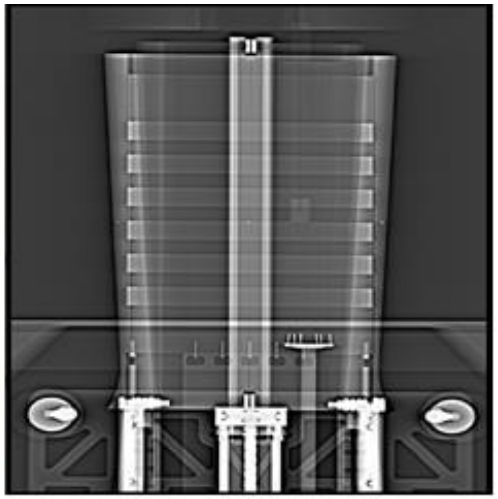
   Tumor insert – up to 360 degrees rotation and 10 cm translation

   Lung expansion – up to 4 cm

   Rib motion – up to 10 cm

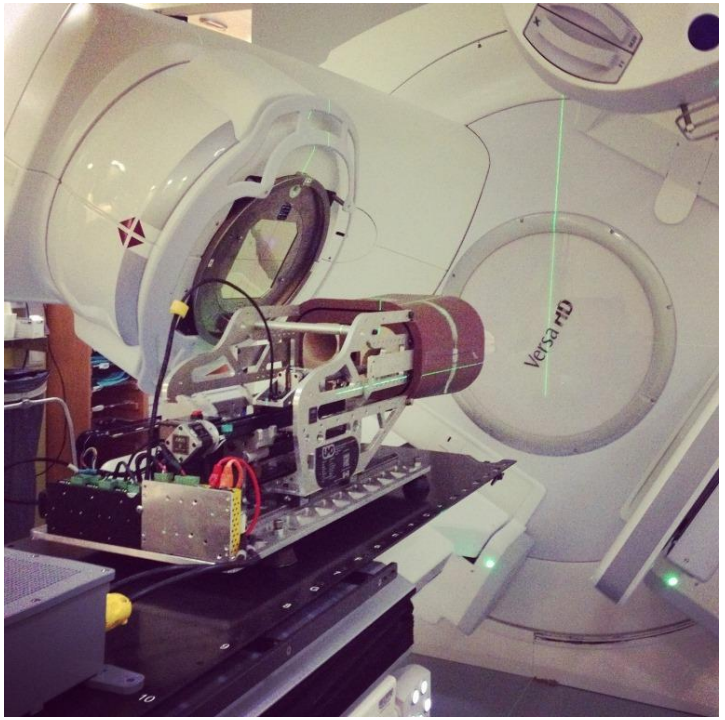
   Declared by the manufacturer accuracy – 0.025 mm





Dosimetric Investigation - Setup

- Based on standard clinical photon beam-based stereotactic protocol
- Dosimetric verification: EBT3, pin-point IC, TLDs
- Implemented motion scenarios:
  - Static
  - Chest wall motion – 7.5 cm amplitude
  - Ribs motion – 1.8 cm amplitude
  - Tumor motion – 1.5 cm amplitude & 90 degrees rotation
  - Combined motion – Chest wall, Ribs & Tumor



Dosimetric Investigation - Preliminary Results

Dose difference depending on the motion of the phantom

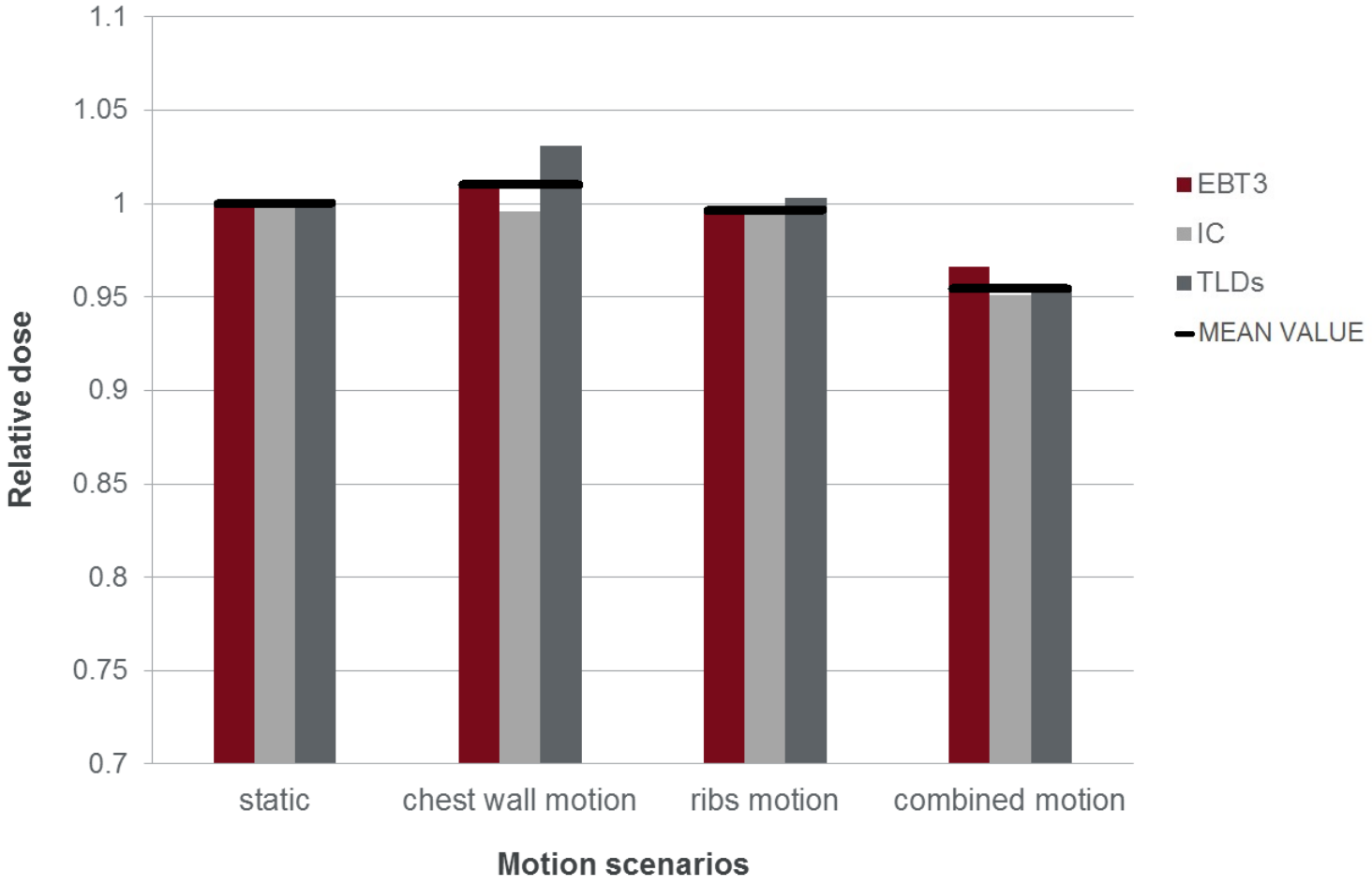


Image Registration Software Verification

Tumor-motion tracking based on 4D-CT data

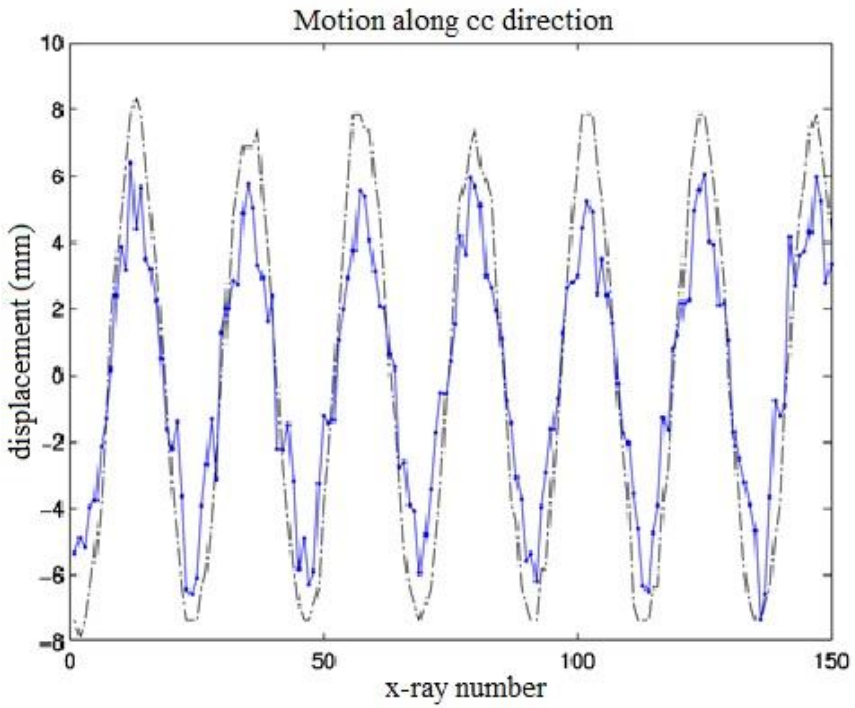
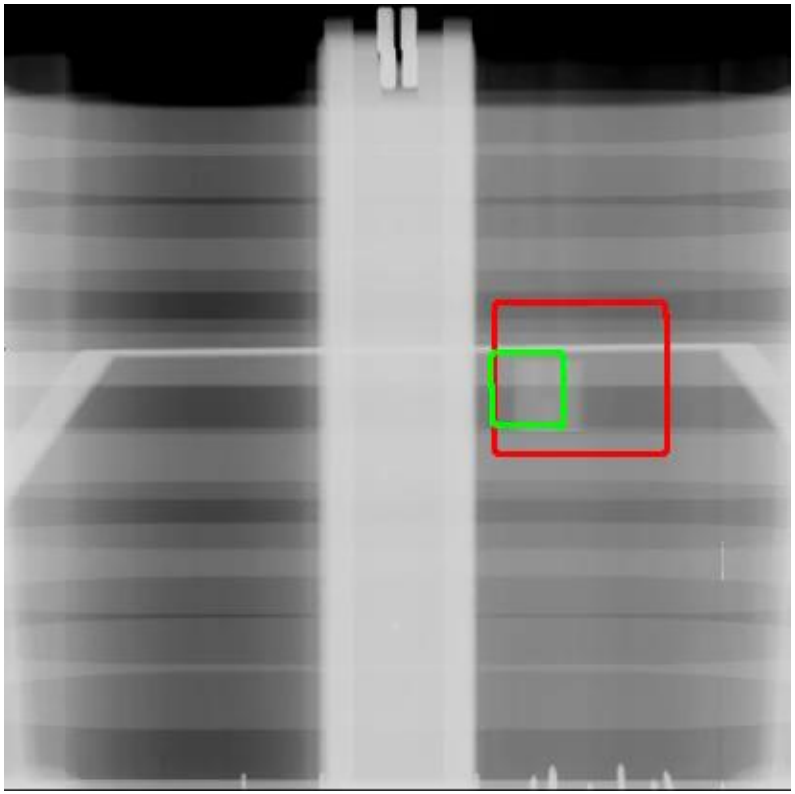


Fig 1 - Extracted tumor motion (blue) in comparison with annotated motion (black)



Next Steps

Short-term

- Continue dosimetric studies with multiple detectors (improve statistics)
- Continue image registration software verification
  - with more challenging tumor inserts and materials
  - using the MV data in combination with kV, and ExacTrac
- Start dosimetric verification of VMAT for lung-cancer
- Start pilot study for 4D PET

Medium-term

- Start research of scanned ion beams
- Develop and implement a QA workflow protocol
- Compare measured data with MC simulation

Thank you for your attention!

Any questions?