AAPM 2016 JUL 31–AUG 4 COMMUNICATING OUR VALUE IMPROVING OUR FUTURE
58TH ANNUAL MEETING & EXHIBITION | WASHINGTON, DC

3D Dosimetry in the Clinic: Motion Interplay Effects in Dynamic Radiotherapy

Sofie Ceberg, PhD Medical Physicist
Skåne University Hospital and Lund University
Lund, Sweden

AAPM 2016 JUL 31–AUG 4 Skåne University Hospital LUND UNIVERSITY

Learning objectives

1: 3D Dosimetry in the Clinic: Background and Motivation

2: 3D Dosimetry in the Clinic: Motion interplay effects in dynamic radiotherapy

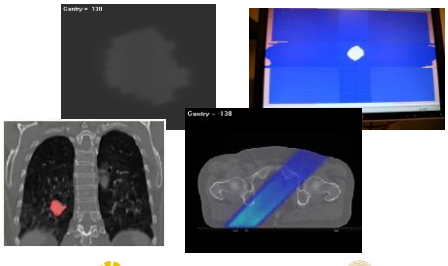
- Observe full dosimetry under dynamic radiotherapy during respiratory motion
- Understand how the measurement of high resolution dose data in an irradiated volume can help understand interplay effects during TomoTherapy or VMAT

3: 3D Dosimetry in the Clinic and Research: Special techniques

4: 3D Dosimetry in end-to-end dosimetry QA

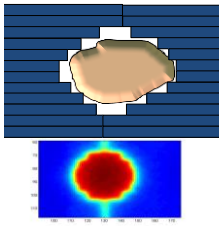
AAPM 2016 JUL 31–AUG 4 Skåne University Hospital LUND UNIVERSITY

What kind of motions?

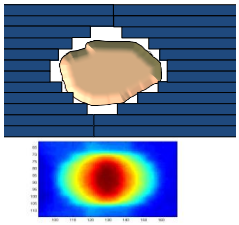


AAPM 2016 JUL 31–AUG 4 Skåne University Hospital LUND UNIVERSITY

If target moves during radiotherapy…



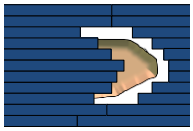
Dose distribution from a static delivery to a stationary target

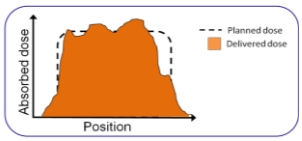


Dose distribution from a static delivery to a moving target

***Ceberg S.**, et al 2008 Verification of dynamic radiotherapy: the potential for 3D dosimetry under respiratory-like motion using polymer gel. PMB, 53 (20). pp. N387-396.*

If both target and MLC move…





Risk of serious under- and over-dosage!

Interplay effects depends on...

Patient specific:

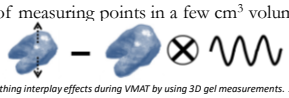
- **Breathing amplitude**
- **Period time**
- **Initial breathing phase**

Machine specific:

- **Dose rate**
- **Plan modulation complexity**
- **Gantry rotation period/pitch/beam width**

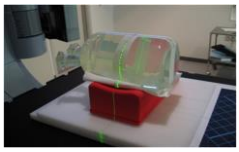
Measure interplay effects (only)

- How much of the target dose reduction is due to breathing interplay effects?
- Need to separate the obvious dose-smearing effect from the total measurement
- It is hard using conventional diod- or ion chamber arrays due to low spatial resolution
- It is possible using 3D gel dosimetry
  - thousands of measuring points in a few cm^3 volume



***Ceberg S.** et al 2013 Evaluation of breathing interplay effects during VMAT by using 3D gel measurements. Journal of Physics: Conference Series*

"Breathing" gel-phantoms



nPAG polymer gel

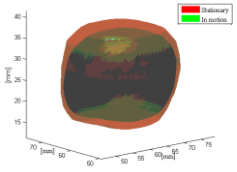
- 89% w/w water
- 5% w/w gelatine
- 3% w/w acrylamide
- 3% w/w bisacrylamide
- 10 mM THP

Read out system

- MRI

Overlay of 3D target isodose surfaces

Lung VMAT measurements

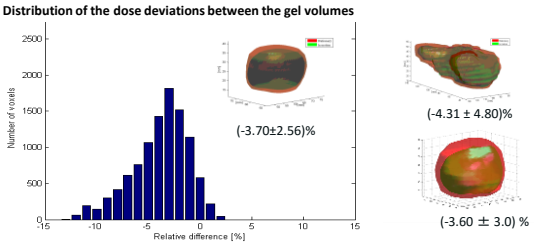


An obvious target dose reduction due to motion

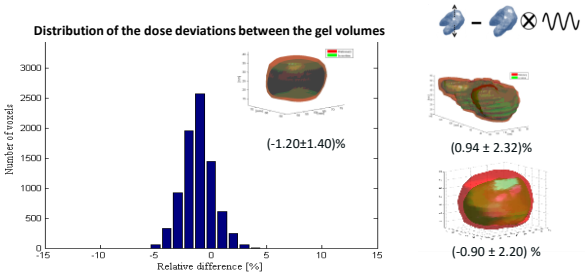
***Ceberg S.** et al 2013 Evaluation of breathing interplay effects during VMAT by using 3D gel measurements. Journal of Physics: Conference Series,*

Total dosimetric effect of the motion

Contains both the dose-smearing and potental interplay effects



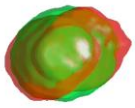
The dosimetric effect of the interplay effects only



In these clinically relevant example

- The total dosimetric effect due to breathing motion and dynamic MLC motion during VMAT and Tomo delivery resulted in an average of about 4% target dose reduction.
- For repeated stationary measurement, i.e. without interplay effects but including all other measurements uncertainties (e.g. set-up), the differences had a narrow distribution with a standard deviation between 0.5-0.9% (1SD).
- Thus, the larger standard deviations of 1.4%-2.3% (1SD) were interpreted as interplay effects.

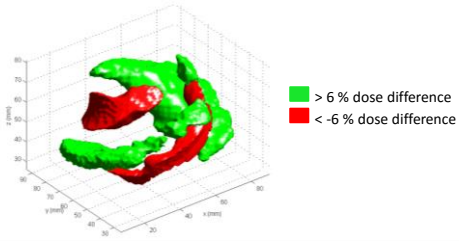
Motion induced thread effect



Experimentally verification of the motion induced thread effect during tomotherapy using 3D gel dosimetry.

Edvardsson A. et al. 2015 Verification of motion induced thread effect during tomotherapy using gel dosimetry Journal of Physics: Conference

Motion induced thread effect



Take home message

To evaluate any potential breathing induced interplay effects during dynamic radiotherapy in your clinic – use a 3D detector system with high resolution that accumulates the absorbed dose

AAPM2016 JUL 31—AUG 4 Skåne University Hospital Lund University