

UMC Utrecht

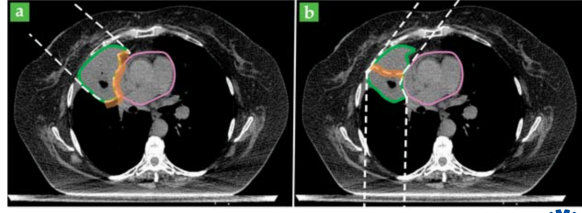
## The promise of the MRI linac: Simultaneous MRI and irradiation

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Disclosure: Receiving research funding from Elekta



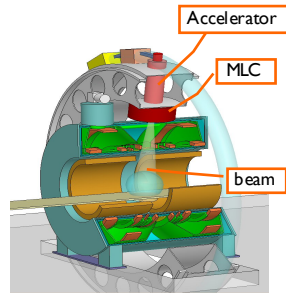

### Limitations of exploiting the Bragg peak: margins and sub-optimal beam angle



From Polfand Parodi, Physics Today 68(2015)




### Concept of MRI accelerator



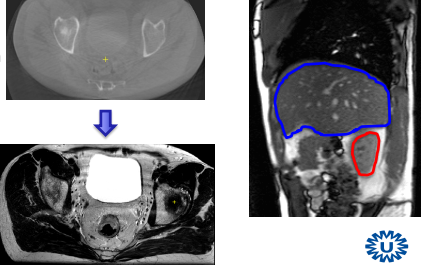

Simultaneous MRI and irradiation

Real-time feed back of soft-tissue anatomy changes for high precision radiotherapy



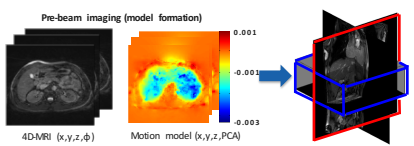
### The goal of MRI guided Radiotherapy: exploit the soft tissue

- On-line imaging
- Soft tissue visualization compared with (cb)CT
- Motion visualization
- Bring (geometrical) certainty to the treatment





### 4D-MRI PCA motion model

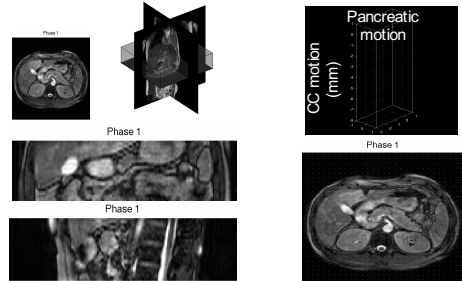
- Acquire **retrospective 4D-MRI** (10 respiratory phases)
- Calculate **motion model** using 4D motion information through Principal Component Analysis (PCA)
- Transform 3D reference volume** based on dynamic **2D images** (acquired during treatment) using the motion model



Stemkens et al 2016 PMB 4D-MRI (x,y,z,φ) Motion model (x,y,z,PCA)




### Example for assessing on-the-fly pancreatic motion: 4D MRI model combined with real-time multislice MRI

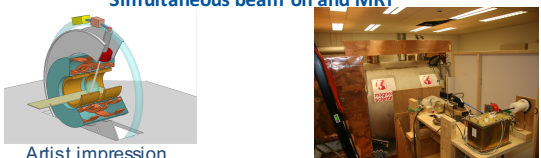


Pancreatic motion

OC-motion (mm)

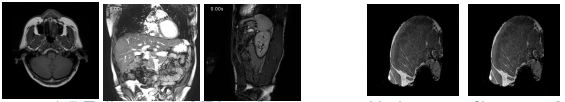


### 1.5 T MRI accelerator: Simultaneous beam on and MRI




Artist impression

First prototype MRI accelerator




1.5 T diagnostic MRI quality

No impact of beam on MRI



### Second prototype MRI linac



Cooling equipment


Power supplies & electronics

MLC & accelerator waveguide

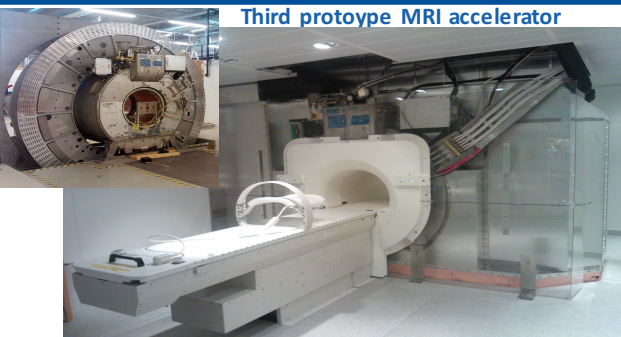


RF waveguides

Slipping




Modulator



### Third prototype MRI accelerator


### Coordinated clinical introduction via the Elekta Atlantic consortium: assessing clinical value of MRigRT

### Active developments MRI guided radiotherapy systems

- Utrecht, The Netherlands
  - 1.5 T MRI, 6 MV linac
  - [www.elekta.com/mr-linac](http://www.elekta.com/mr-linac)
- Edmonton, Canada
  - 0.5 T MRI, 6 MV linac
  - [www.magnetix.com](http://www.magnetix.com)
- Viewray, Cleveland, USA
  - 0.35 T MRI, 3 Co sources
  - Clinical since 2014
  - [www.viewray.com](http://www.viewray.com)
- Australia MR linac project, Sydney
  - 1.0 T MRI, 6 MV linac
  - [www.sydney.edu.au](http://www.sydney.edu.au)

