ESR 6: Dosimetric end-to-end test for high precision lung irradiation using a novel heterogeneous thorax breathing phantom

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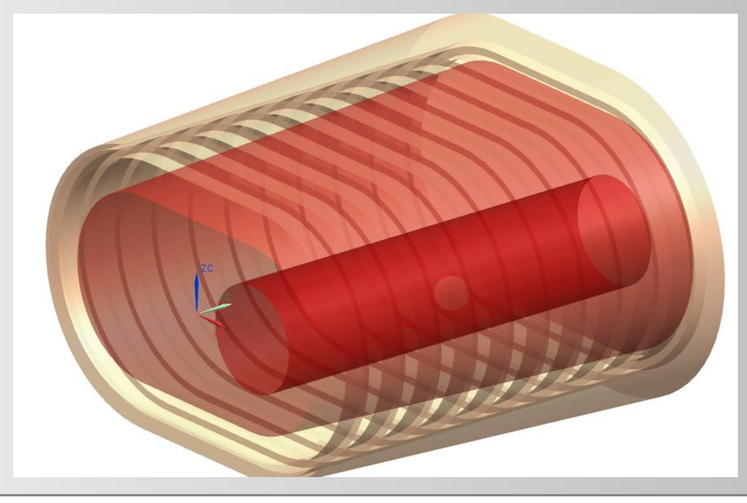
SCIENTIFIC OBJECTIVES

- **Motivation**: The outcome of lung cancer treatment is still suboptimal. The major challenge for high precision radiation therapy of lungs cancer is the movement of the tumor caused by the patient's respiration. Although several technological concepts have been proposed for respiration management, there are not in widespread clinical use. Moreover, their quality assurance is not straightforward since it needs to involve all steps from imaging, treatment planning and beam delivery.
- **Approach**: Design and construction of innovative online quality assurance breathing thorax phantom made of tissue equivalent materials and capabilities to mimic not only the complex tumor motion but also the movement of the rib cage as well as the lung and chest expansion comparable to the human torso.
- **Goal**: Phantom system will enable a complete test of the treatment planning system, starting from a computed tomography (CT) image acquisition, the creation of a corresponding treatment plan with the prescribed dose and finally, the dose delivery by the ion or photon beams.



LABORATORY EQUIPMENT AND SIMULATION TOOLS

Experimental:

- *EBT 3 FILM*
- *Micro Diamond detector (PTW 60019*)

Sensitive volume: 0.004 mm3

- *Silicon detector (PTW 60016)*

Sensitive volume: 0.03 mm3

- *Ion chamber (PTW Semiflex 31010)*

Sensitive volume: 0.125 mm3

- *Medical Linac (Elekta, Varian)*

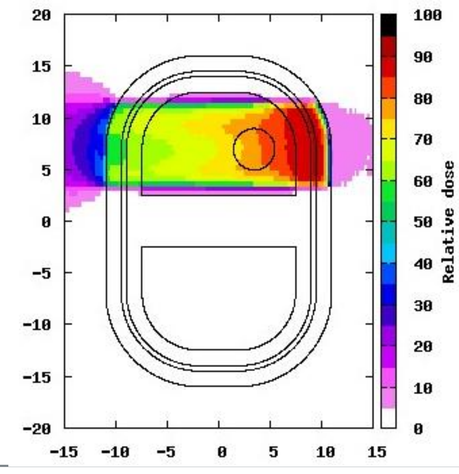
Energies: 6, 9, 12, 15,18 MV/MeV

PTW Micro Diamond
Sensitive area
Radius: 1.1 mm
Thickness: 1 µm

Simulation and Modeling:

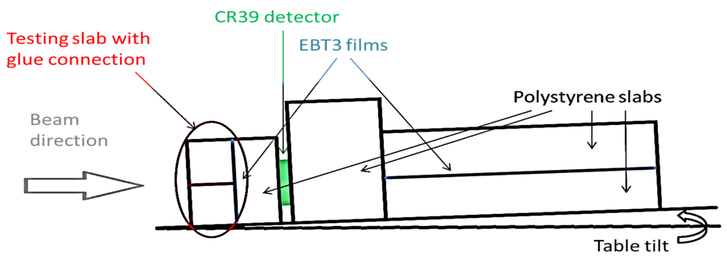
- *FLUKA*
- *AutoCAD (UG NX)*

Engineering design and testing

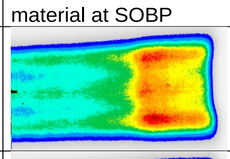
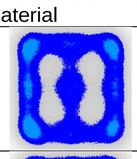
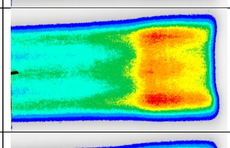
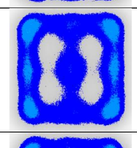
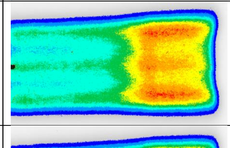
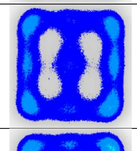
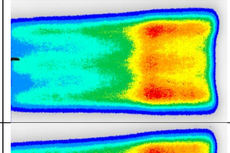
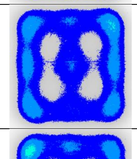
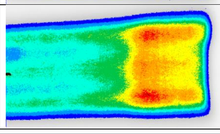
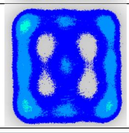


MATERIAL INHOMOGENEITY TEST

Experimental evaluation of different connection materials and techniques for phantom construction by the use of proton beam (169.7 -185.6 MeV) and GAFCHROMIC EBT 3 films



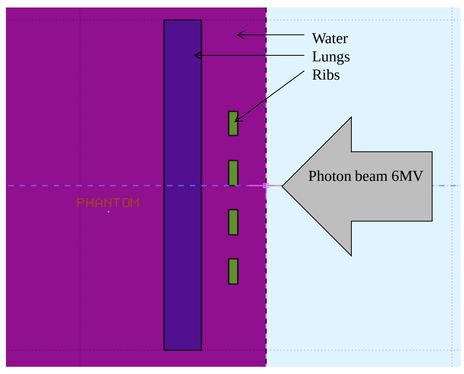
Results:

Test Material	Parallel beam cross section dose distribution after tested material at SOBP	Perpendicular beam cross section dose distribution after tested material
Solid block / No connection material		
Pattex multi-purpose adhesive		
Tesa spray glue (flat cut)		
WELD ON polystyrene glue (flat cut)		
WELD ON polystyrene glue (45 degree Cut)		

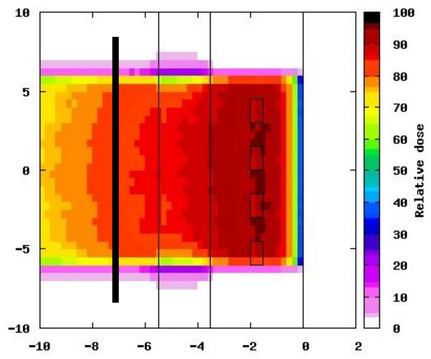
DOSE STUDIES, EXPERIMENTAL AND SIMULATION SETUP

Simulation of simple experimental setup to check the dose response due to anatomical structures

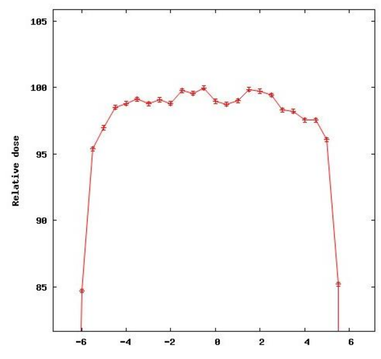
Rib placement in beam direction:



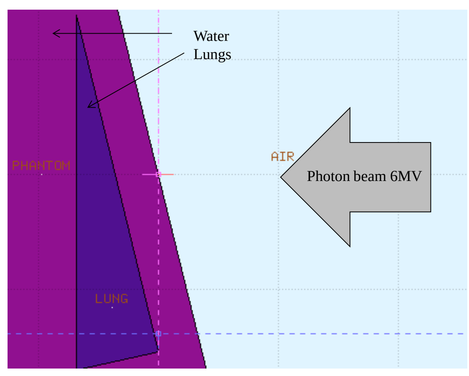
Dose distribution



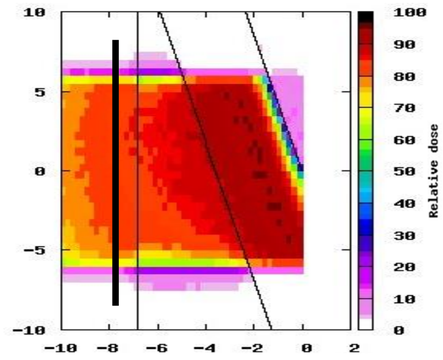
Beam profile



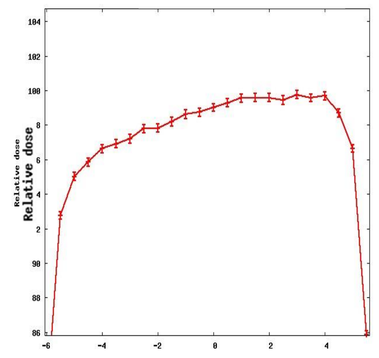
Lung expansion in beam direction:



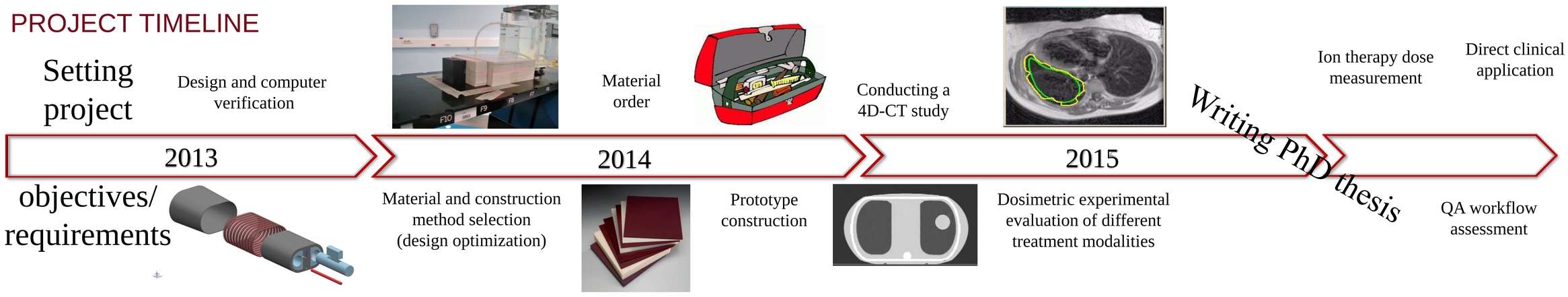
Dose distribution



Beam profile



PROJECT TIMELINE



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