Design and Characterization of a Modular Anthropomorphic Phantom for Total Body Irradiation Verification

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JOINT AAPM | COMP MEETING

Purpose

To upgrade an existing RANDO phantom into a modular platform for reproducible end-to-end dosimetric verification of modern TBI techniques.

Key Findings

- Modular anthropomorphic phantom successfully upgraded
- 83 reproducible integrated OSL detector positions
- Tissue-equivalent inserts reduced dosimetric air-gap effects to <3%
- Excellent measurement reproducibility (<1%)
- Mean absolute deviation: 3.4%
- 72% of measurements agreed within ±5% of TPS
- Enables standardized multicenter dosimetric comparison of modern TBI techniques

Contact

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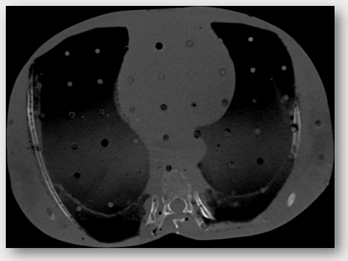
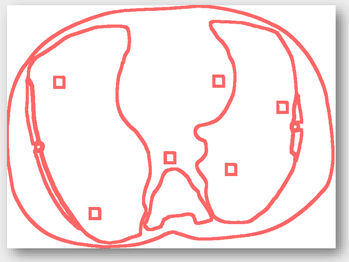
1 Phantom CT

- 3 mm slice thickness
- Axial CT dataset
- RANDO phantom



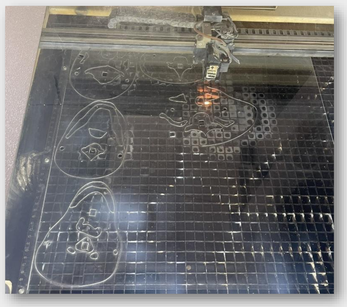
2 Contour Processing

- Inkscape bitmap tracing
- Manual contour refinement
- OSL cavities integrated



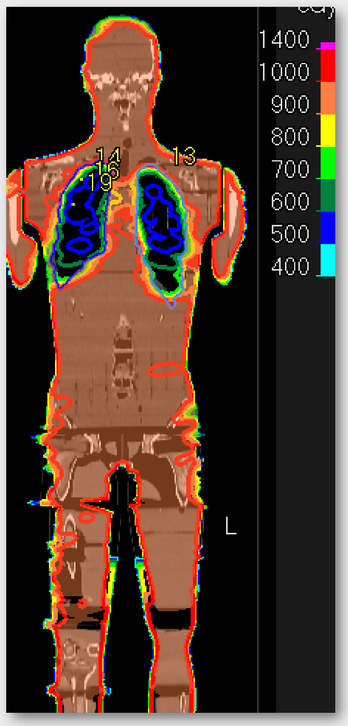
3 Laser Cutting

- 2 mm PMMA plates
- Laser-cut from vector contours
- High positioning accuracy



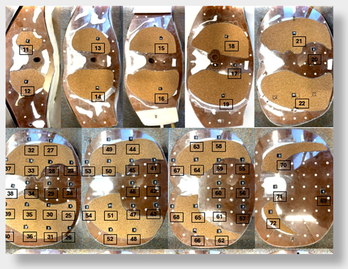
4 Material Selection

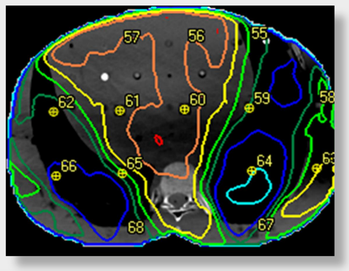
- Bone: Plaster
- Lung: Cork
- Tissue density approximation
- Reduced air-gap effects



5 Phantom Assembly

- 22 interleaved PMMA Plates
- 83 upper-body integrated OSLD Positions
- Modular slice design





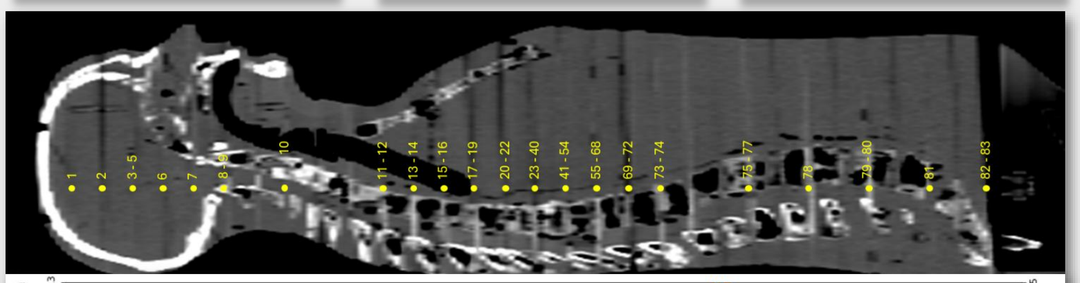
6 E2E Verification

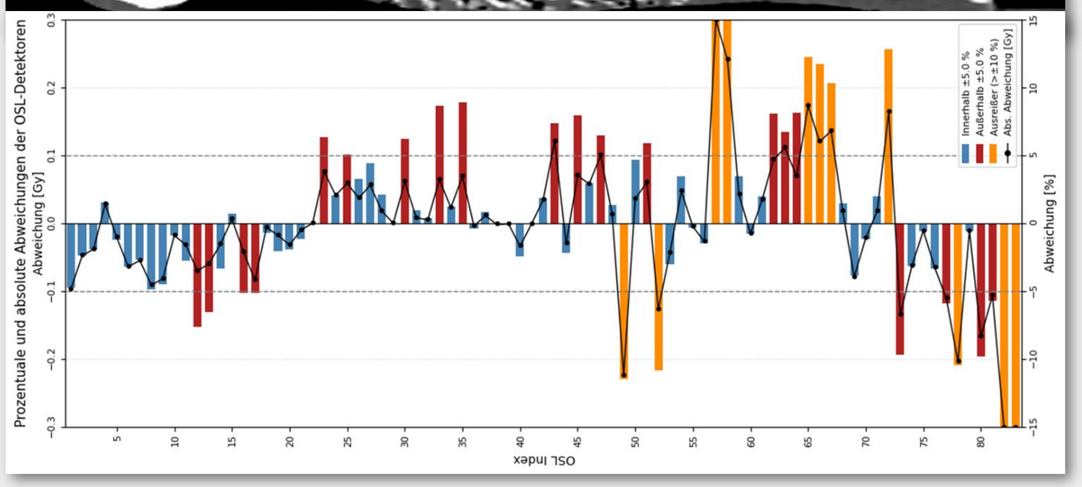
- Clinical treatment workflow
- VMAT TBI Plan
- 6 Isocenters
- 83 upper-body OSLDs measured

3.4 % Mean Absolute Deviation |Δ|

4.3 % Standard Deviation σ

72.2 % Measurements within ±5 % of TPS





Advantages

- Reversible phantom modification
- Low-cost materials
- Reproducible detector positioning
- Suitable for multicenter deployment

Limitations

- Male anatomy only (RANDO)
- Point-dose measurements only
- Small air gap between upper and lower body

Next Steps

- Ionization chamber measurements
- Film dosimetry for 2D
- Gel dosimetry
- Validation with external institutions and different TBI techniques