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Validation of lung Stereotactic Ablative Body Radiotherapy (SABR) treatments with Flattening Filter Free (FFF) beams

I. Floros, A. Bangiri, G. Jolliffe, J. Littler, E. Harron, A. Mckenna, K. Langmack

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Objective

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The objective is to commission and dosimetrically validate MONACO TPS for Lung SABR treatments using FFF beams.

Why Lung SABR treatments need special consideration?

- low density region
- reduction of photon attenuation and enhanced secondary electron range
- Moving target due to breathing

Materials/Methods (1/4)

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Validation Steps

A. Penumbra broadening effect in "Lung" measured with EBT3 gafchromic films

B. Dosimetric verification of 4 clinical cases and 3 fractional regimes using:

Quasar phantom → static point measurements

→ point measurements with breathing trace

Delta 4PT verification system and γ-index analysis

Materials/Methods (2/4)

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EBT3 gafchromic films measurements

Solid water and lung equivalent phantom
6MV FFF photon beam with a Versa HDTM by ELEKTA.

3 depths of 3cm (water), 10cm (lung) and 20cm (water)
3 field sizes : 2x2, 5x5 and 10x10cm2

The setups above were reproduced within Monaco.

Materials/Methods (3/4)

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The profiles were measured from the films and compared to that from the TPS.

Region of interest Field Edge Area FEA: 20-80% of dose maximum.

The FEA was calculated at all depths for both inline/crossline directions and the results were compared.

Materials/Methods (4/4)

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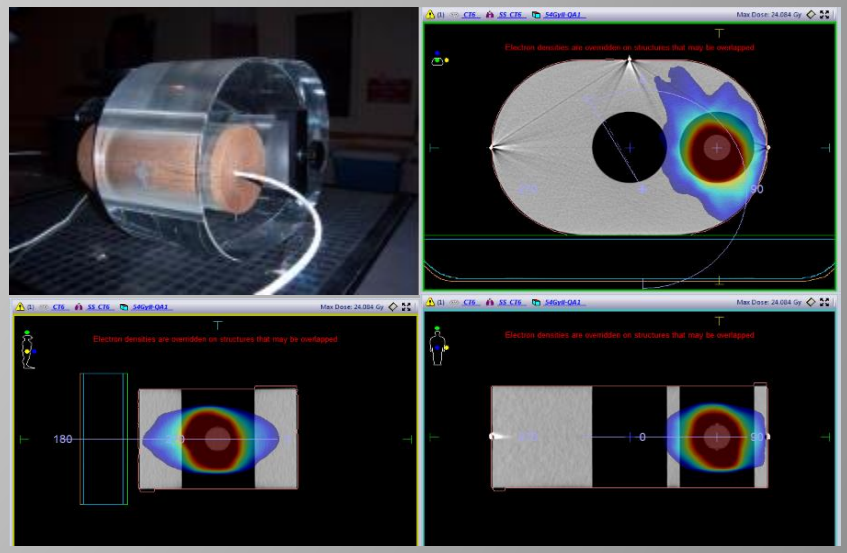
- Quasar Phantom
- Extradin A1SL chamber
- Static and breathing trace measurements



- Delta4PT phantom
- Treatment plans were evaluated with respect to a gamma-index of 3%/3 mm

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Results - EBT3

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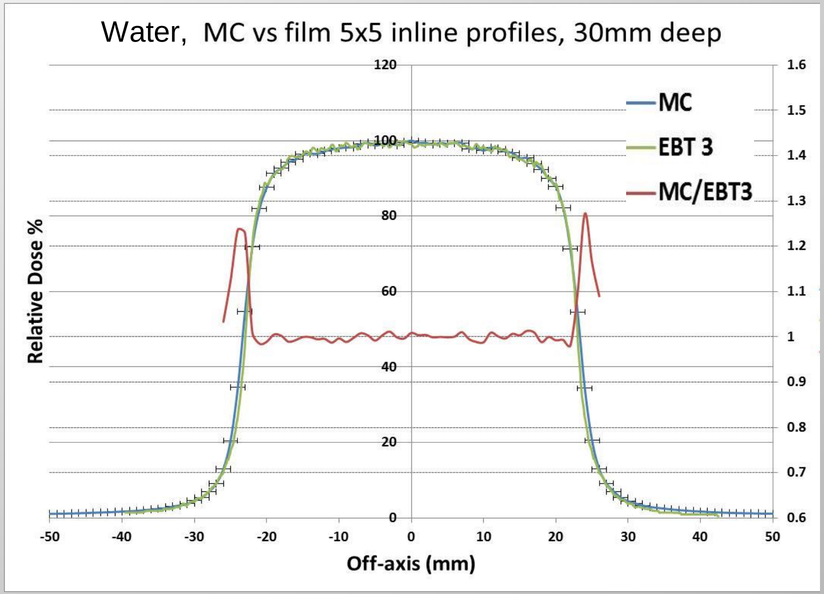
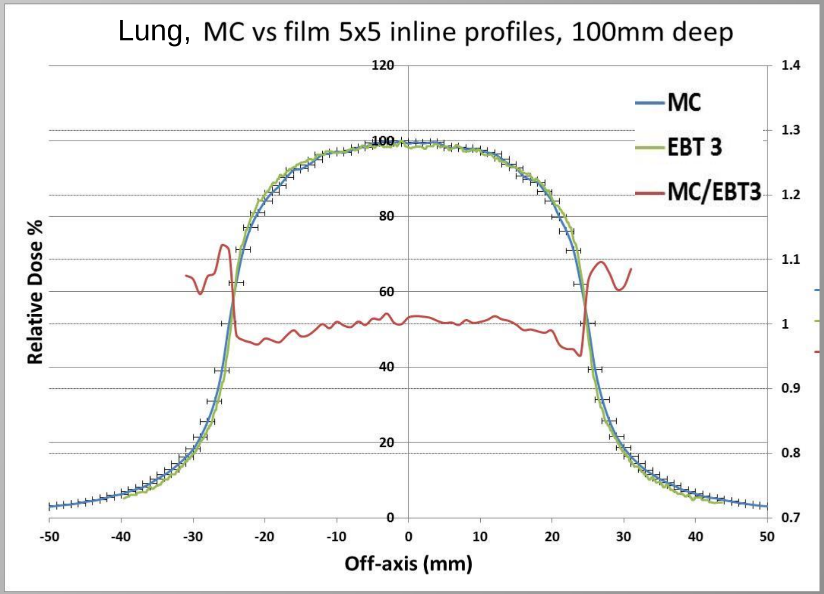
Monaco vs Film dose profiles in water and lung





- [illegible] agree at 2%, 1.5% and 1.0mm for 10x10, 5x5, and $2x2cm^2$ respectively.

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Results - EBT3

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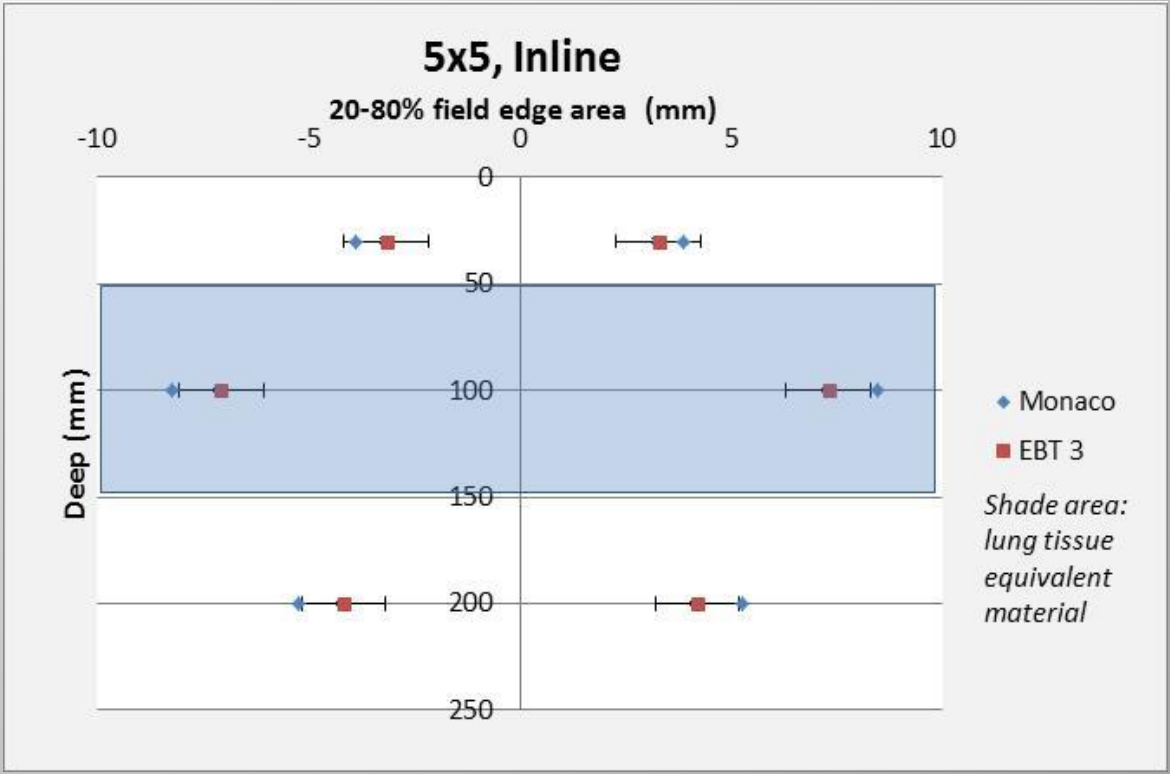

The FEA (mm) calculated with Monaco is overall broader than that measured, with differences being larger in lung.

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Results - Quasar/Delta4

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Clinical case	*Total dose/ num.fractions*	***point measurements***			***point measurements with breathing trace***		***γ-index (%) 3%/3mm (Delta4)***
		Expected dose (Monaco)	*Measured Dose (Gy)*	***% Diff***	Measured Dose (Gy)	**% Diff**	
A	54Gy/3#	23.96	23.506	**-1.9**	23.156	**-3.4**	**100.0**
	55Gy/5#	14.804	14.681	**-1.4**	14.627	**-1.8**	**100.0**
	60Gy/8#	10.69	10.824	**1.1**	10.795	**0.9**	**99.8**
B	54Gy/3#	25.76	26.358	**2.4**	26.105	**1.5**	**99.7**
	55Gy/5#	15.445	15.736	**1.8**	15.710	**1.7**	**100.0**
	60Gy/8#	10.59	10.609	**0.2**	10.436	**-1.4**	**99.0**
C	54Gy/3#	22.976	22.826	**-0.7**	22.715	**-1.1**	**99.8**
	55Gy/5#	14.609	14.546	**-0.4**	14.468	**-1.0**	**99.8**
	60Gy/8#	9.958	9.801	**-1.6**	9.759	**-2.0**	**99.3**
D	54Gy/3#	23.001	22.911	**-0.3**	23.015	**0.1**	**100.0**
	55Gy/5#	14.578	14.516	**-0.7**	14.568	**-0.3**	**100.0**
	60Gy/8#	10.552	10.499	**-0.3**	10.566	**0.3**	**99.8**

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Conclusions

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- The excellent agreement with EBT3 indicates that Monaco satisfactorily predicts profiles in lung.
- The differences observed in FEA could be due to partial volume effect.
- FFF Lung SABR treatments were fully verified and excellent agreement was found with the Quasar and the Delta4 for all clinical plans.