

Dosimetric evaluation of Monte Carlo based treatment planning system in anthropomorphic phantom

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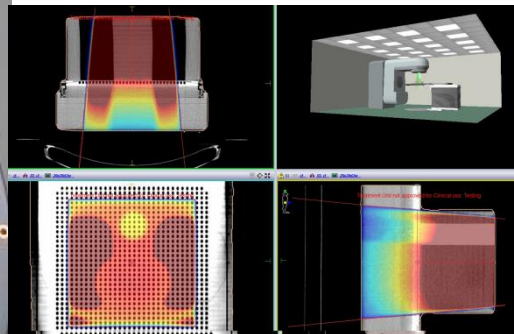
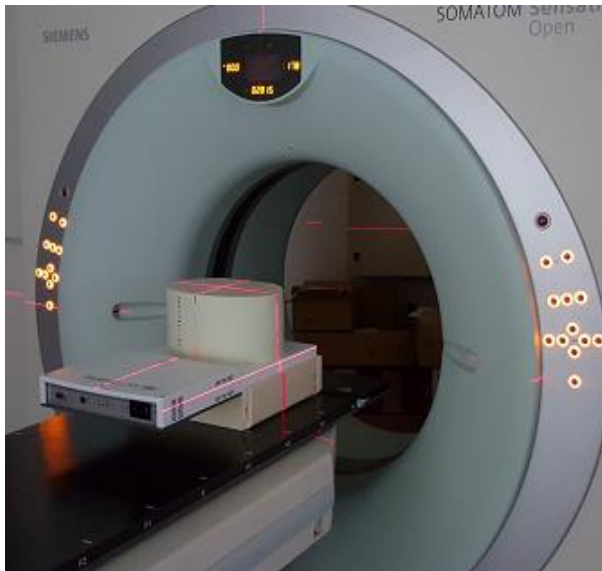
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Introduction & Purpose

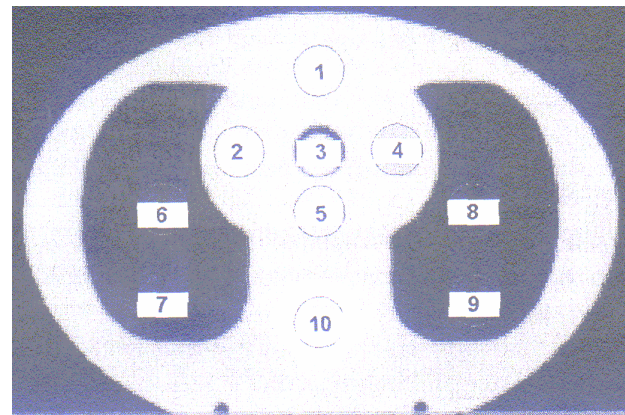
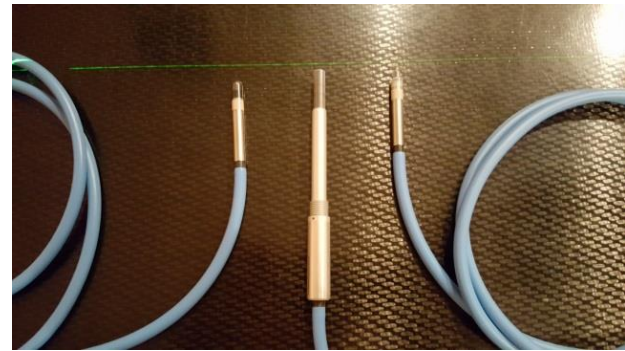
- Extensive dosimetric evaluation and comprehensive verification of calculation algorithms and respective calculation methods (Dose to Water-D2W and Dose to Medium-D2M) built in Elekta Monaco & XiO systems
- Potentials for calculation algorithm verification of 2D methodology developed for the patient specific dosimetry

Materials and methods

- 6MV photon beam of Siemens Oncor Expression with 160 MLC
- Siemens Somatom Sensation Open
- Calculation algorithms: Monte Carlo (MC-D2W&D2M), Colapsed Cone (CC) and Standard Superposition (SS)

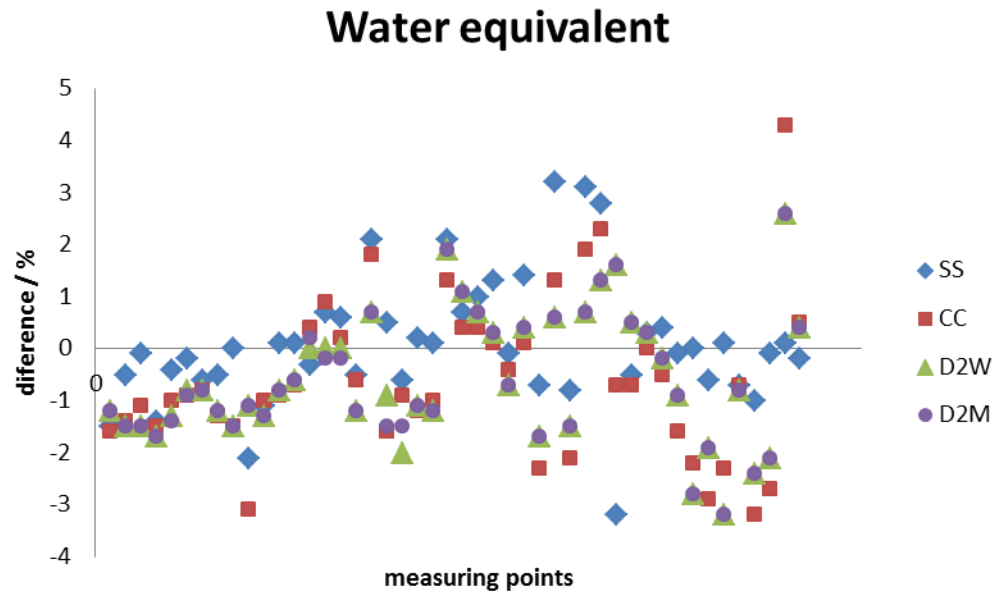


- PTW UNIDOS electrometers
- Farmer type, Semiflex and Pinpoint chambers
- IBA Matrixx detector array (1020 ionization chambers)
- IBA MultiCube and CIRS Thorax phantoms

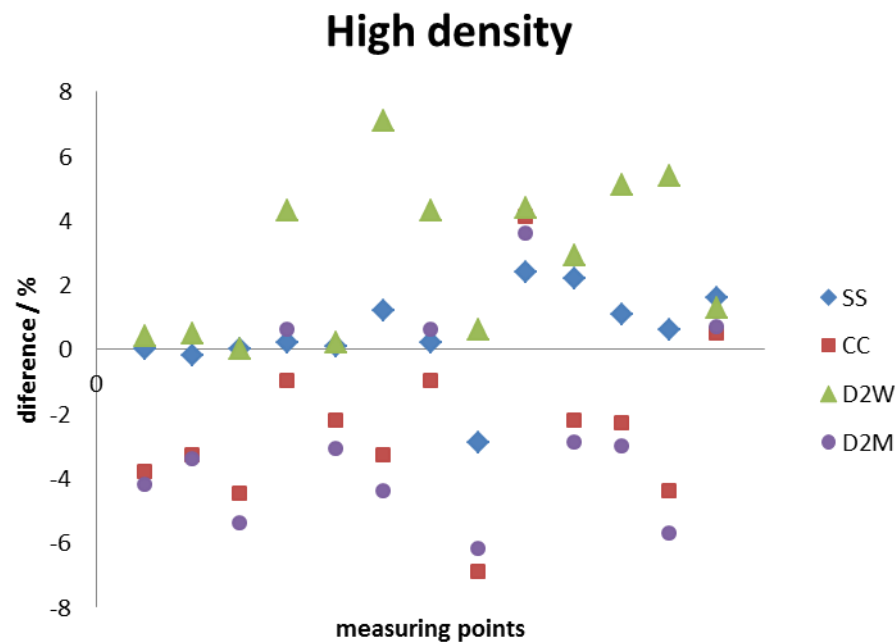
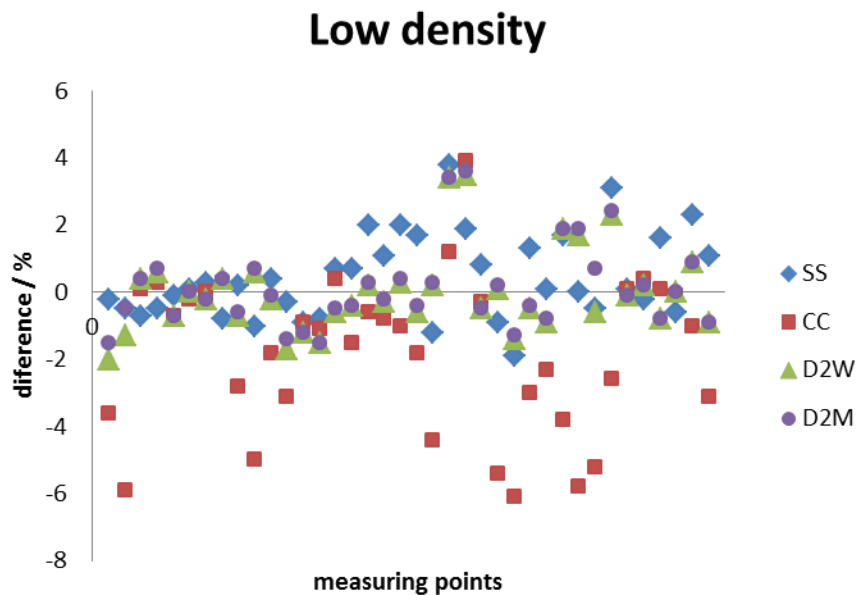


Results: Comparisons in CIRS Thorax phantom

- Calculation and measurements in 10 points (1-5 water equivalent, 6-9 low density, 10 high density)
- Very good agreement in water equivalent part of the phantom

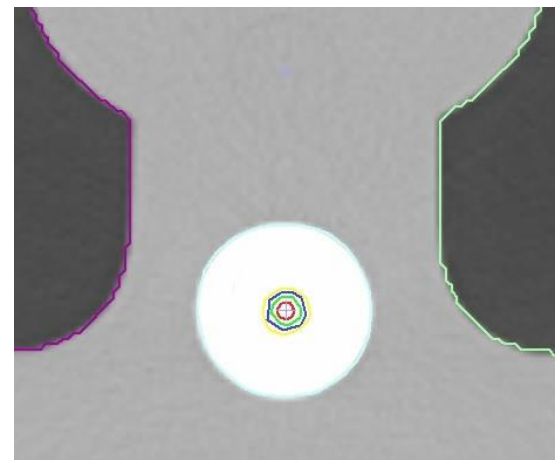
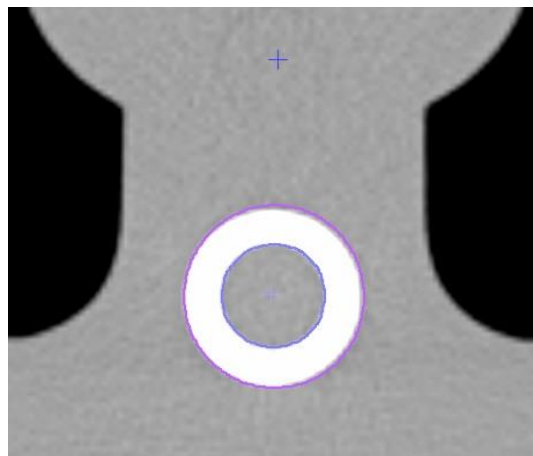
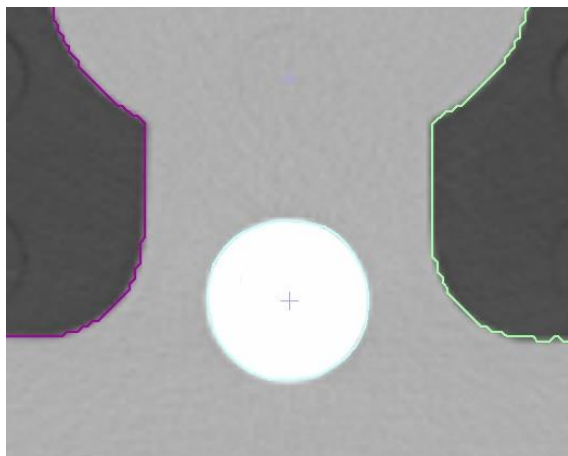


- Dose underestimation with CC algorithm in low density
- Large differences between measured and calculated dose in high density (opposed signs for D2M and D2W)



Additional dose to “bone” analysis

1. “bone” chamber insert inside “bone” calculated and measured
2. “tissue” chamber insert inside “bone” calculated and measured
3. “bone” chamber insert inside “bone” measured, small spheres of varying sizes contoured inside “bone” at chamber position and density forced to water calculated



- For all cases when using “tissue” plug good agreement of measured and D2W and D2M calculated values
- When using spheres with forced density, D2W and D2M converge to measured dose for spheres $V \geq 0.2 \text{ cm}^3$

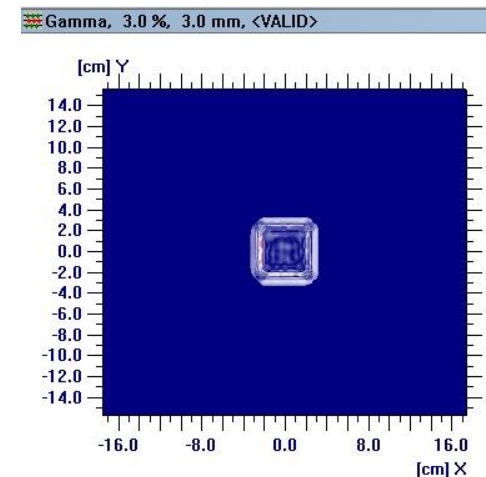
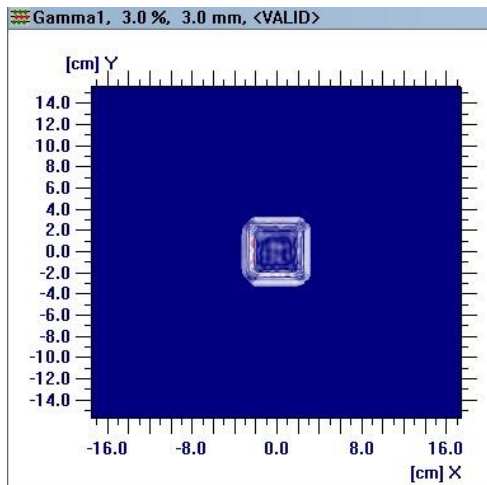
		V/cm ³	DQ/cGy	D _{MCD2W} /cGy	D _{MCD2M} /cGy	$\Delta(D_{MCD2W}/D_Q)/\%$	$\Delta(D_{MCD2M}/D_Q)/\%$
T e s t 1	1.		61,55	64,00	59,10	2,89	-2,89
	2.		62,07	61,90	61,50	-0,20	-0,67
	3.	0,035	61,55	63,20	60,20	1,95	-1,59
	3.	0,141	61,55	62,70	60,80	1,36	-0,88
	3.	0,279	61,55	62,40	61,50	1,00	-0,06
	3.	0,573	61,55	62,20	62,00	0,77	0,53
T e s t 2	1.		84,71	88,90	82,20	5,05	-3,04
	2.		86,15	86,10	85,60	-0,07	-0,67
	3.	0,035	84,71	85,90	81,90	1,44	-3,40
	3.	0,141	84,71	85,40	82,90	0,83	-2,19
	3.	0,279	84,71	85,00	83,94	0,35	-0,90
	3.	0,573	84,71	84,40	84,20	-0,37	-0,62
T e s t 3	1.		109,63	113,80	105,20	5,36	-5,70
	2.		111,47	110,80	110,86	-0,86	-0,91
	3.	0,035	109,63	112,80	107,50	4,08	-2,74
	3.	0,141	109,63	112,00	108,80	3,05	-1,07
	3.	0,279	109,63	111,30	109,80	2,15	0,22
	3.	0,573	109,63	110,26	110,37	0,81	0,95

2D measurements in heterogenous phantom

- CIRS Thorax phantom positioned on top of IBA Matrixx
- Fields of various sizes calculated (D2W and D2M) and measured

5 × 5 cm² field analysis

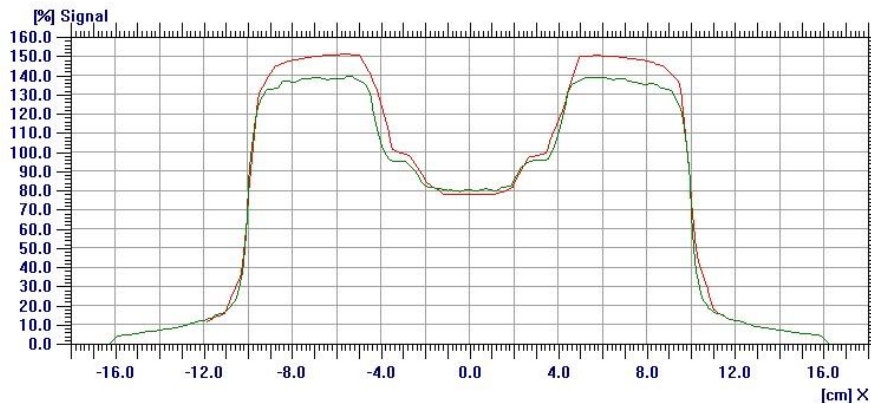
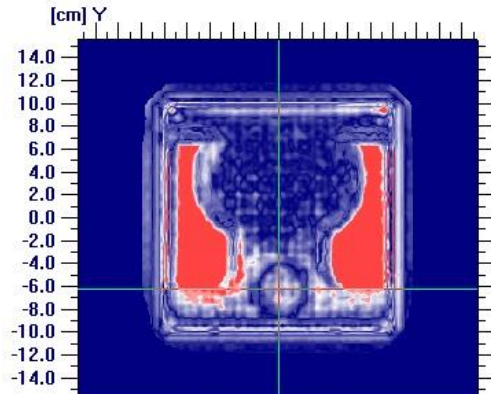
- gamma 3%/3mm only
98.8% pass rate
- difference at CAX = 2.1%
- gamma 3%/3mm only
98.9% pass rate
- difference at CAX = 1.1%



20 × 20 cm² field analysis

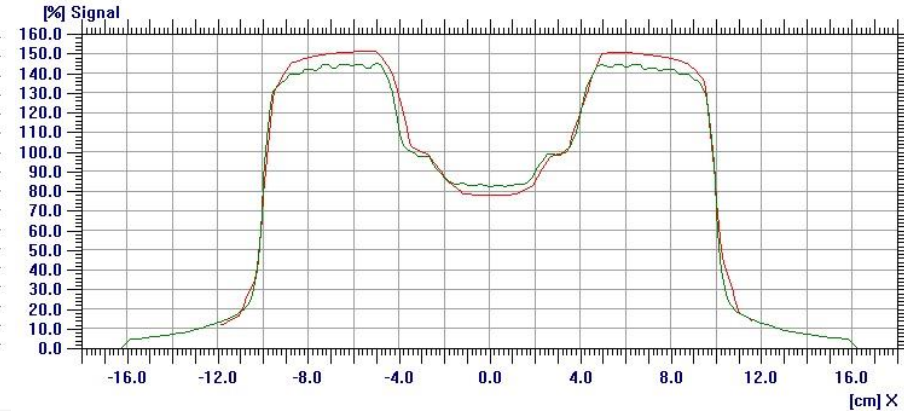
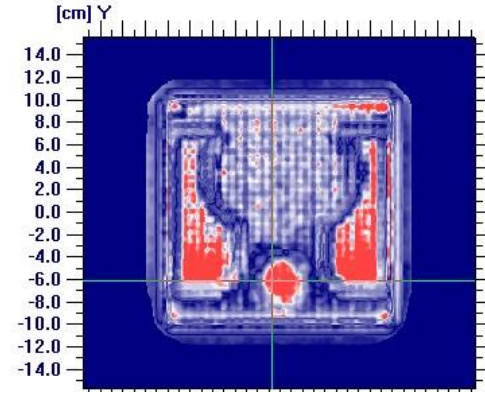
- gamma 3%/3mm only 86.8% pass rate
- difference at CAX = 3.6%

D2W



- gamma 3%/3mm only 88.3% pass rate
- difference at CAX = 1.1%

D2M



Conclusion

- Problems in high density medium imply possible limitations either in calculation algorithms or verification method
- It can be overcome by defining water equivalent spheres inside inhomogeneities
- 2D methodology can be used for verification but problems can arise when inhomogeneous phantoms are used
- Further investigations required