Effect of Alternating Multileaf Collimator Configuration on Collapsed Cone and Monte Carlo 3D Treatment Planning

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Introduction:

An alternating MLC configuration has been historically used in Field-in-Field (FiF) technique for 3D breast treatment utilizing multileaf collimator (MLC) to control dose on the chest wall edge without compromising the dose coverage on the target. This takes advantage of a dose-averaging effect seen by some dose calculation methods

Depending on the dose calculation algorithm, the MLC-defined fields may create a 20% discrepancy[1]. This discrepancy can increase further when the MLCs form into small fields[2]. This study is to compare the effect of alternating MLC leaf configuration on different dose calculation algorithms, specifically collapsed cone (CC) and Monte Carlo (MC).

Methods:

Fields were created in Monaco (Elekta, Version 6.00.01) and delivered dose was calculated using Collapsed Cone and Monte Carlo. These fields were delivered to EBT3 Gafchromic film on a tissue equivalent solid water phantom with 10cm backscatter and 1.5 cm buildup using a SAD technique. The plans were delivered using VersaHD with Agility MLC (Elekta AB, Stockholm, Sweden). The Agility MLC has a leaf width of 5mm at the isocenter. Therefore, the plans were calculated with the following alternating gap and MLC pattern.

- Single leaf separation pattern (5mm)
- Two leaf separation pattern (10mm)

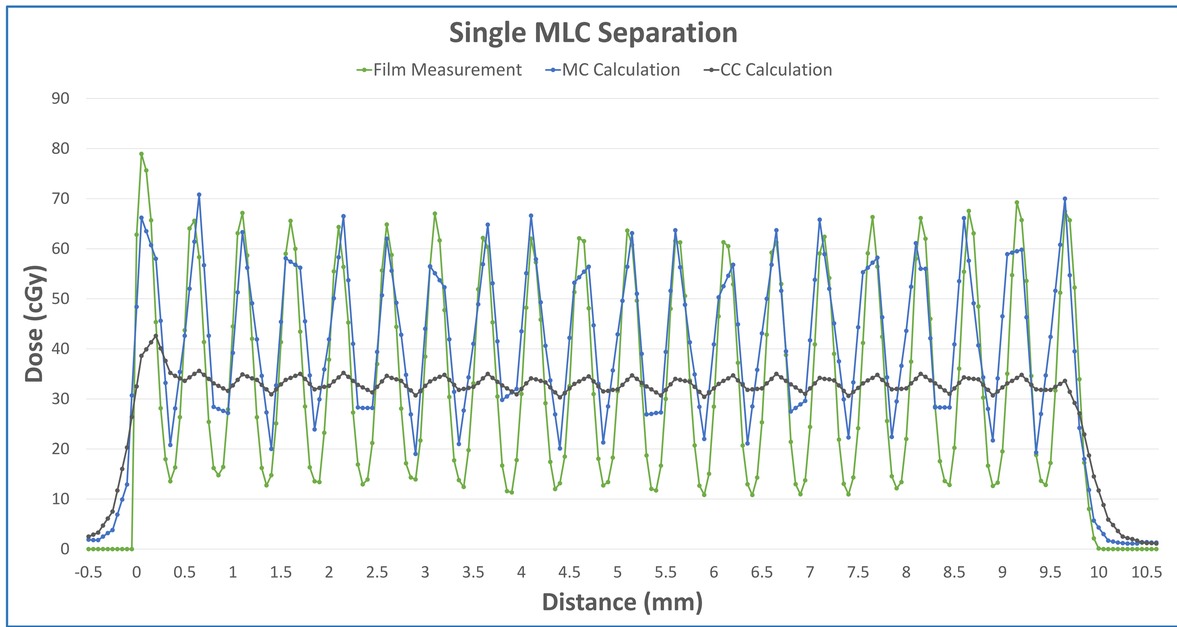
An open field was also delivered to normalize the dose to machine output.

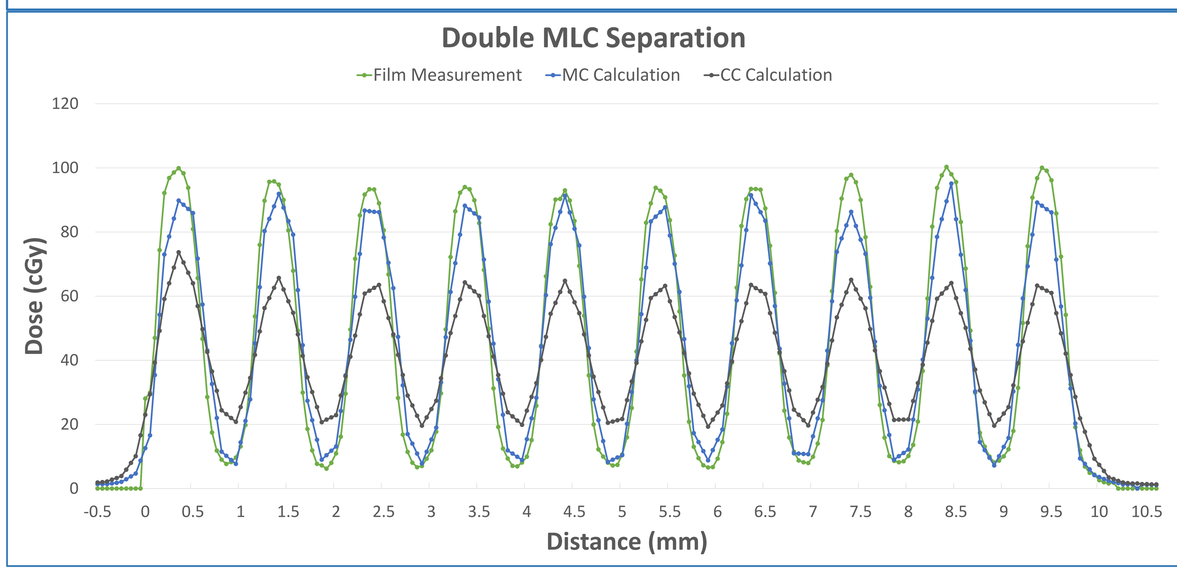
Results were analyzed using filmQA pro™ (Ashland, Version 5.0.6). Field measurements and calculated doses were overlaid in the film processing software. Local maximums and minimums were grouped, and the calculated values were compared to the film measurement.

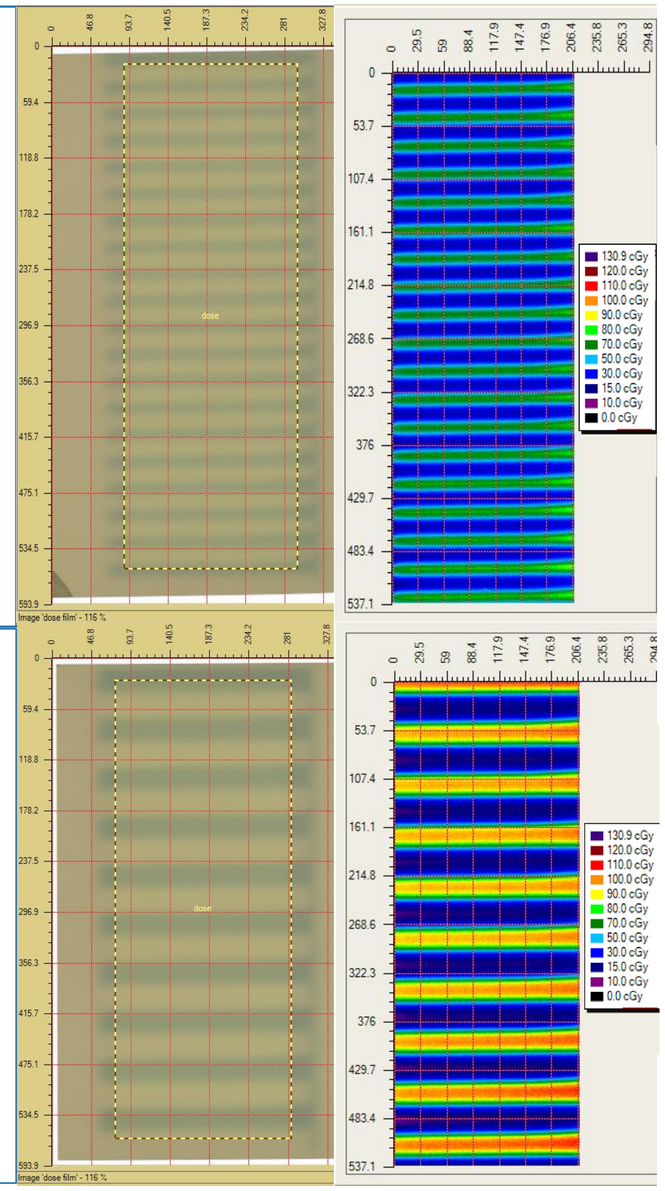
Results:

The average maximum dose measured within the 5mm field gap between MLC leaves showed underestimation of 46.2±2.1% and 3.3±8.0% for CC and MC, respectively. The average maximum dose measured within the 10mm field gap between MLC leaves showed underestimation of 32.6±4.7% and 6.6±3.5% for CC and MC, respectively.

The average minimum dose measured within the 5mm blocked field showed overestimation of 153.7±20.6% and 88.2±34.5% for CC and MC, respectively. The average minimum dose measured within the 10mm blocked field showed overestimation of 179.4±28.2% and 21.8±14.3% for CC and MC, respectively.







References:

1.Kim, Sung Jin, Sung Kyu Kim, and Dong Ho Kim. "Comparison of pencil-beam, collapsed-cone and Monte-Carlo algorithms in radiotherapy treatment planning for 6-MV photons." Journal of the Korean Physical Society 67 (2015): 153-158.

2.Fogliata, Antonella, et al. "Evaluation of the dose calculation accuracy for small fields defined by jaw or MLC for AAA and Acuros XB algorithms." Medical physics 43.10 (2016): 5685-5694.

		Percent Underestimation of Maximum Dose Regions	Percent Overestimation of Minimum Dose Regions
5mm	CC	46.2	153.7
	MC	3.3	88.2
10mm	CC	32.6	179.4
	MC	6.6	21.8

Conclusion:

Overall, both CC and MC have limitations in calculating the alternating MLC leaf configuration accurately. Both CC and MC underestimated the maximum dose within the MLC field gaps and overestimated for blocked sections. However, MC showed stronger agreement with the measured data.

The averaging effect shown by CC does not reflect the measured dose and consequently, MC is recommended for use in the calculation of fields of this shape.