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Physics

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Study on the impact of temporal parameters on dose uniformity In layer-stacking irradiation with carbon-ion beams

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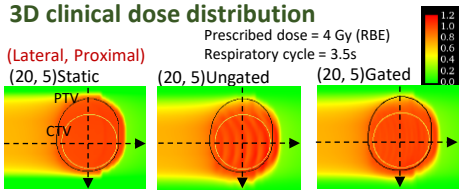
Simulation Result

3D clinical dose distribution



Evaluation metric : Conformity index

$\Delta CI = CI_{Move} - CI_{Static}$ ($CI = (V_{95}-V_{105})/CTV$)

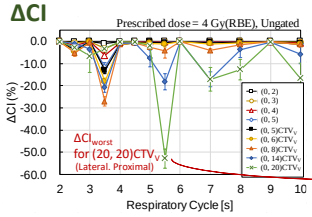
ΔCI_{worst} : The worst ΔCI for respiratory cycles <±5%

→Clinically acceptable

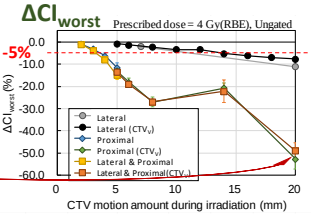
→Accepted maximum motion

= Acceptable motion amount during irradiation

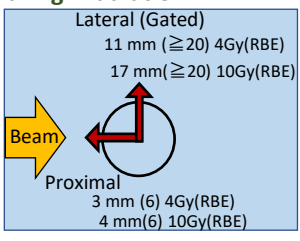
ΔCI



ΔCI_{worst}

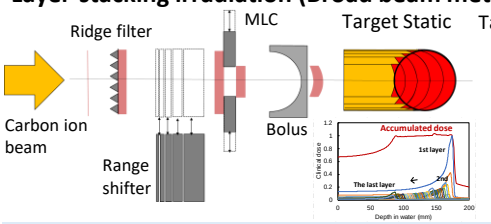


Acceptable motion amount during irradiation



Background / Aim

Layer-stacking irradiation (Broad beam method)



The dose uniformity within the target may be insufficient.

Tajiri S et al., 2017

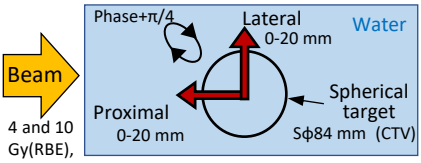
→Not applied in clinical use with non-negligible motion

Aim: To show the motion tolerance from dose uniformity evaluation

Simulation method

This simulation method was validated for reliability through comparisons between measured and simulated physical doses. Hasebe Y et al., 2025

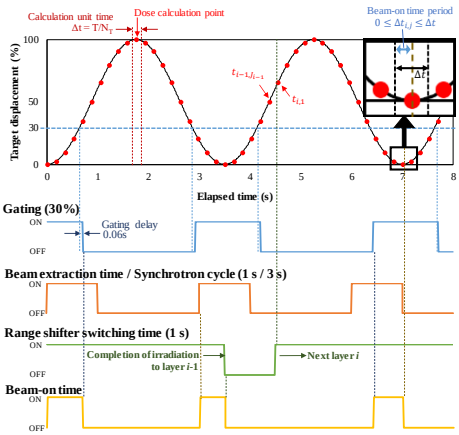
Target setup (Top view)



4 and 10 Gy(RBE), 5Gy(RBE)/min

Respiratory cycle	2-10 s
Respiratory gating	Yes(Lateral30%)/ No

Temporal parameters



3D clinical dose distribution

- 1D PDD→3D expansion
- Using TPS data
- Clinical dose = Physical dose × RBE

(Mixed beam model employed by GHMC)