

**Supplementary Table S1: Abbreviation list:**

CIRT	Carbon-ion therapy
SNSo-CIRT	Sacral nerve sparing optimized carbon-ion therapy
RBE	Relative Biological effectiveness
LEM-I	Local effect model-I
mMKM	Modified microdosimetric kinetic model
MBM	Mixed beam model
LETd	D/ose-averaged linear energy transfer
HD-CTV	High dose clinical target volume
$D_{RBE LEM-I}$ , $D_{RBE mMKM}$	RBE-weighted dose (calculated by LEM-I /mMKM model)
$D_{RBE LEM-I 'x'%}$ or $D_{'x'%}$	RBE weighted dose received by 'x'% target/OAR volume
$D_{'x'cm}$	RBE weighted dose received by 'x' cm length of nerve
$LETd_{'x'%}$	LETd received by 'x'% target/OAR volume
$LETd_{'x'cm}$	LETd received by 'x' cm length of nerve
$D_{RBE-filtered-LETd}$	LETd in volume receiving > $D_{RBE}$ cutoff/threshold