

## Physics Parameters for Carbon Ion Therapy Applications

The use of the GEANT4 materials is highly recommended for Hadrontherapy Applications to obtain correct range values

### 1) EM Physics List

Please use the “Standard Physics List option 3” configuration, summarized in the tables below.

Particle	Process	Model
gamma	PhotoElectric	StandardModel
	Compton	StandardModel
	GammaConversion	StandardModel

Particle	Process	Model	Step Function	Step Limit Type
e-	ElectronIonisation	StandardModel	0.2 0.1 mm	-
	Bremsstrahlung	StandardModel	-	-
	MultipleScattering	Default	-	distanceToBoundary

Particle	Process	Model	Step Function	Step Limit Type
e+	ElectronIonisation	StandardModel	0.2 0.1 mm	-
	Bremsstrahlung	StandardModel	-	-
	PositronAnnihilation	StandardModel	-	-
	MultipleScattering	Default	-	distanceToBoundary

Particle	Process	Model	Step Function
proton	HadronIonisation	Default	0.2 0.05 mm

Particle	Process	Model	Step Function
pi+/pi-	HadronIonisation	Default	0.2 0.05 mm

Particle	Process	Model	Step Function
Ion (GenericIon, alpha, deuteron, triton, He3)	IonIonisation	Default	0.1 0.02 mm

### 2) Hadronic Models

Hadronic process	Particle	Geant4 processes	Geant4 models	Geant4 datasets	Energy range
Elastic scattering	Generic Ion	G4HadronElastic Process	G4LElastic	G4HadronElastic DataSet	-
	All other particles	G4UHadronElastic Process	G4HadronElastic	G4HadronElastic DataSet	-
Inelastic process for protons	Protons	G4ProtonInelastic Process	G4BinaryCascade	G4ProtonInelastic CrossSection	0-20 GeV



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/gate/physics/addProcess PhotoElectric
/gate/physics/processes/PhotoElectric/setModel StandardModel

/gate/physics/addProcess Compton
/gate/physics/processes/Compton/setModel StandardModel

/gate/physics/addProcess GammaConversion
/gate/physics/processes/GammaConversion/setModel StandardModel

/gate/physics/addProcess ElectronIonisation
/gate/physics/processes/ElectronIonisation/setModel StandardModel e-
/gate/physics/processes/ElectronIonisation/setModel StandardModel e+
/gate/physics/processes/ElectronIonisation/setStepFunction e+ 0.2 0.1 mm
/gate/physics/processes/ElectronIonisation/setStepFunction e- 0.2 0.1 mm

/gate/physics/addProcess Bremsstrahlung
/gate/physics/processes/Bremsstrahlung/setModel StandardModel e-
/gate/physics/processes/Bremsstrahlung/setModel StandardModel e+

/gate/physics/addProcess PositronAnnihilation

/gate/physics/addProcess MultipleScattering
/gate/physics/processes/MultipleScattering/setGeometricalStepLimiterType e-
distanceToBoundary
/gate/physics/processes/MultipleScattering/setGeometricalStepLimiterType e+
distanceToBoundary

/gate/physics/addProcess HadronIonisation
/gate/physics/removeProcess HadronIonisation deuteron
/gate/physics/removeProcess HadronIonisation triton
/gate/physics/removeProcess HadronIonisation He3
/gate/physics/removeProcess HadronIonisation alpha
/gate/physics/removeProcess HadronIonisation GenericIon
/gate/physics/processes/HadronIonisation/setStepFunction proton 0.2 0.05 mm
/gate/physics/processes/HadronIonisation/setStepFunction pi+ 0.2 0.05 mm
/gate/physics/processes/HadronIonisation/setStepFunction pi- 0.2 0.05 mm

/gate/physics/addProcess IonIonisation
/gate/physics/processes/IonIonisation/setStepFunction GenericIon 0.1 0.02 mm
/gate/physics/processes/IonIonisation/setStepFunction alpha 0.1 0.02 mm
/gate/physics/processes/IonIonisation/setStepFunction deuteron 0.1 0.02 mm
/gate/physics/processes/IonIonisation/setStepFunction triton 0.1 0.02 mm
/gate/physics/processes/IonIonisation/setStepFunction He3 0.1 0.02 mm

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# Hadronic processes
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/gate/physics/addProcess HadronElastic GenericIon
/gate/physics/processes/HadronElastic/setModel G4LElastic GenericIon

/gate/physics/addProcess UHadronElastic
/gate/physics/processes/UHadronElastic/setModel G4HadronElastic
/gate/physics/processes/UHadronElastic/setDataSet G4HadronElasticDataSet

/gate/physics/addProcess ProtonInelastic
/gate/physics/processes/ProtonInelastic/setModel G4BinaryCascade
/gate/physics/processes/ProtonInelastic/G4BinaryCascade/setEmin 0 MeV
/gate/physics/processes/ProtonInelastic/G4BinaryCascade/setEmax 20 GeV
/gate/physics/processes/ProtonInelastic/setDataSet G4ProtonInelasticCrossSection
proton

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/gate/physics/addProcess IonInelastic
/gate/physics/processes/IonInelastic/setModel G4QMDReaction GenericIon
/gate/physics/processes/IonInelastic/setModel G4QMDReaction alpha
/gate/physics/processes/IonInelastic/setModel G4QMDReaction deuteron
/gate/physics/processes/IonInelastic/setModel G4QMDReaction triton
/gate/physics/processes/IonInelastic/G4QMDReaction/setEmin 0 MeV deuteron
/gate/physics/processes/IonInelastic/G4QMDReaction/setEmax 20 GeV deuteron
/gate/physics/processes/IonInelastic/G4QMDReaction/setEmin 0 MeV alpha
/gate/physics/processes/IonInelastic/G4QMDReaction/setEmax 20 GeV alpha
/gate/physics/processes/IonInelastic/G4QMDReaction/setEmin 0 MeV triton
/gate/physics/processes/IonInelastic/G4QMDReaction/setEmax 20 GeV triton
/gate/physics/processes/IonInelastic/G4QMDReaction/setEmin 0 MeV GenericIon
/gate/physics/processes/IonInelastic/G4QMDReaction/setEmax 20 GeV GenericIon
/gate/physics/processes/IonInelastic/setDataSet G4IonsShenCrossSection GenericIon
/gate/physics/processes/IonInelastic/setDataSet G4IonsShenCrossSection deuteron
/gate/physics/processes/IonInelastic/setDataSet G4IonsShenCrossSection triton
/gate/physics/processes/IonInelastic/setDataSet G4IonsShenCrossSection alpha

/gate/physics/addProcess PionPlusInelastic
/gate/physics/processes/PionPlusInelastic/setModel G4LEPionPlusInelastic

/gate/physics/addProcess PionMinusInelastic
/gate/physics/processes/PionMinusInelastic/setModel G4LEPionMinusInelastic

/gate/physics/addProcess NeutronCapture
/gate/physics/processes/NeutronCapture/setModel G4NeutronHPCapture
/gate/physics/processes/NeutronCapture/G4NeutronHPCapture/setEmin 0 MeV
/gate/physics/processes/NeutronCapture/G4NeutronHPCapture/setEmax 20 MeV
/gate/physics/processes/NeutronCapture/setModel G4LCapture
/gate/physics/processes/NeutronCapture/G4LCapture/setEmin 14 MeV
/gate/physics/processes/NeutronCapture/G4LCapture/setEmax 20 GeV
/gate/physics/processes/NeutronCapture/setDataSet G4NeutronHPCaptureData
/gate/physics/processes/NeutronCapture/setDataSet G4HadronCaptureDataSet

/gate/physics/addProcess Fission
/gate/physics/processes/Fission/setModel G4NeutronHPFission
/gate/physics/processes/Fission/G4NeutronHPFission/setEmin 0 MeV
/gate/physics/processes/Fission/G4NeutronHPFission/setEmax 20 MeV
/gate/physics/processes/Fission/setModel G4LFission
/gate/physics/processes/Fission/G4LFission/setEmin 14 MeV
/gate/physics/processes/Fission/G4LFission/setEmax 20 GeV
/gate/physics/processes/Fission/setDataSet G4NeutronHPFissionData
/gate/physics/processes/Fission/setDataSet G4HadronFissionDataSet

/gate/physics/addProcess NeutronInelastic
/gate/physics/processes/NeutronInelastic/setModel G4NeutronHPInelastic
/gate/physics/processes/NeutronInelastic/G4NeutronHPInelastic/setEmin 0 MeV
/gate/physics/processes/NeutronInelastic/G4NeutronHPInelastic/setEmax 20 MeV
/gate/physics/processes/NeutronInelastic/setDataSet G4NeutronHPInelasticData
neutron
/gate/physics/processes/NeutronInelastic/setModel G4BinaryCascade
/gate/physics/processes/NeutronInelastic/G4BinaryCascade/setEmin 14 MeV
/gate/physics/processes/NeutronInelastic/G4BinaryCascade/setEmax 20 GeV
/gate/physics/processes/NeutronInelastic/setDataSet G4NeutronInelasticCrossSection
neutron

/gate/physics/addProcess Decay
/gate/physics/addProcess RadioactiveDecay

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# Options  

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/gate/physics/setEMin 0.1 keV
/gate/physics/setEMax 10 TeV
/gate/physics/setDEDXbinning 220
/gate/physics/setLambdaBinning 220

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/gate/physics/Gamma/SetCutInRegion world 0 m
/gate/physics/Electron/SetCutInRegion world 12.7 cm
/gate/physics/Positron/SetCutInRegion world 0 cm
/gate/physics/Proton/SetCutInRegion world 0 mm

/gate/physics/Gamma/SetCutInRegion cible 0 cm
/gate/physics/Electron/SetCutInRegion cible 0.114 mm
/gate/physics/Positron/SetCutInRegion cible 0 mm
/gate/physics/Proton/SetCutInRegion cible 0 mm

/gate/physics/SetMinKineticEnergyInRegion world 100 keV
/gate/physics/SetMinKineticEnergyInRegion cible 100 keV
/gate/physics/ActivateSpecialCuts e-
/gate/physics/ActivateSpecialCuts proton
/gate/physics/ActivateSpecialCuts e+
/gate/physics/ActivateSpecialCuts gamma
/gate/physics/ActivateSpecialCuts deuteron
/gate/physics/ActivateSpecialCuts triton
/gate/physics/ActivateSpecialCuts alpha
/gate/physics/ActivateSpecialCuts GenericIon

/gate/physics/displayCuts
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